AG52xR Series QuecOpen Hardware Design

Automotive Module Series

Version: 1.2.0

Date: 2023-03-13

Status: Preliminary

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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

Or our local offices. For more information, please visit:
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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2021-05-10	Charlie BAO/ Alex ZHANG/ Larry ZHANG	Creation of the document
1.0	2021-06-11	Charlie BAO/ Alex ZHANG/ Larry ZHANG	First official release
1.1	2022-07-06	Charlie BAO/ Alex ZHANG/ Evan SHEN	1. Added the information of AG525R-GL, AG529R-CN and AG529R-EU. 2. The pin functions are changed as follows: – Updated the pin 57 from LDO_2P7 to RESERVED. – Updated pins 256–260 from RESERVED to USIM2_VDD, USIM2_DATA, USIM2_DET, USIM2_CLK, USIM2_RST respectively. – Updated pins 103, 105, 106, 108 from RESERVED to SPI2_CLK, SPI2_CS, SPI2_MISO, SPI2_MOSI. – Updated pins 1–6, 266, 268–270 from RESERVED to MIC1_N, MIC1_P, MICBIAS, MIC2_N, MIC2_P, AGND, SPK1_N, SPK1_P, SPK2_P, SPK2_N. 3. Updated the default configuration of TDD max. downlink rate from 410 Mbps to 447 Mbps on AG520R-EU/-JP, and AG521R-EU (Chapter 2.2). 4. Updated the information of USB serial drivers (Chapter 2.2). 5. Added the information of turning off the module with API interface (Chapters 3.7.3 & 3.9). 6. Deleted the description of (U)SIM card hot-plug function (Chapter 3.11).

			7. Updated GNSS frequency (Table 46). 8. Deleted GNSS power consumption information (Chapter 6.4). 9. Updated the SIMO data of Rx sensitivity and deleted the information of primary and diversity (Chapter 6.6). 10. Updated the description of thermal dissipation (Chapter 6.8). 11. Updated the max. slope of manufacturing and soldering; added the note of ultrasonic soldering (Chapter 8.2).
1.2.0	2023-03-13	Zoe GAO/ Lucas LI/ Evan SHEN	Preliminary: 1. Added the applicable module AG529R-LA. 2. Updated VBAT_RF minimum input voltage (Table 3, Table 6, Chapter 3.7.2 & Table 50). 3. Updated pin 113 from RESERVED to ADC3 and added the related note information (Chapter 3.3, Chapter 3.20 & Table 49). 4. Updated power up timing (Figure 10). 5. Updated power down timing (Figure 12). 6. Deleted the table of analog audio characteristic parameters (Chapter 3.24) 7. Updated GNSS performance data and note information (Chapter 4.2). 8. Updated the power current data of AG529R-EU (Table 61). 9. Updated the information of receive sensitivity (Chapter 6.6). 10. Updated the ramp-up slope and cool-down in manufacturing and soldering (Figure 44 & Table 83). 11. Added the module mounting direction information in packaging specification (Chapter 8.3).

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1 Introduction

QuecOpen® is a solution where the module acts as the main processor. Constant transition and evolution of both the communication technology and the market highlight its merits. It can help you to:

- Realize embedded applications' quick development and shorten product R&D cycle
- Simplify circuit and hardware structure design to reduce engineering costs
- Miniaturize products
- Reduce product power consumption
- Apply OTA technology
- Enhance product competitiveness and price-performance ratio

The document defines AG52xR family in QuecOpen® solution and describes its air interface and hardware interfaces which are connected with your applications.

This document helps you quickly understand the interface specifications, electrical and mechanical details, as well as other related information of the module. To facilitate application designs, it also includes some reference designs for your reference. The document, coupled with application notes and user guides, makes it easy to design and set up automotive mobile applications with the module.

Table 1: Applicable Module

Module Family	Module Series	Module Model
AG52xR	AG520R	AG520R-CN/-EU/-NA/-JP
	AG521R	AG521R-CN/-EU/-NA
	AG525R	AG525R-GL
	AG529R	AG529R-CN/-EU/-LA

1.1. Special Marks

Table 2: Special Marks

Mark	Definition
*	Unless otherwise specified, when an asterisk (*) is used after a function, feature, interface, pin name, AT command, or argument, it indicates that the function, feature, interface, pin, AT command, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, RGMII_RX_[0:3] refers to all four RGMII_RX pins: RGMII_RX_0, RGMII_RX_1, RGMII_RX_2 and RGMII_RX_3.

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that the radio equipment type [AG529R-LA] is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address: http://www.quectel.com/support/technical.htm

The device could be used with a separation distance of 20cm to the human body.

2 Product Overview

2.1. Frequency Bands and Functions

AG52xR family is a series of automotive-grade C-V2X [1] /LTE/WCDMA/GSM wireless communication modules with diversity reception, and provides data connectivity on C-V2X [1] TDD, LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, EDGE and GPRS networks. It also provides single-frequency/dual-frequency GNSS and voice functionalities to meet specific application demands.

Engineered to meet the demanding requirements in automotive applications and other harsh operating conditions, the module offers a premium solution for high performance automotive and intelligent transportation system (ITS) applications, such as fleet management, onboard vehicle telematics, in-car entertainment systems, emergency calling, and roadside assistance.

With a compact profile of 38.0 mm × 42.0 mm × 2.65 mm, the module can be embedded into applications through the 400 LGA pins.

[1] C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

The frequency bands, supported category and GNSS function of the module are shown as below:

Table 3: Frequency Bands, Supported Category and GNSS Function of the Module

Network Type/ Feature	AG520R Series				AG521R Series			AG525R-GL	AG529R Series		
	AG520R-CN	AG520R-EU	AG520R-NA	AG520R-JP	AG521R-CN	AG521R-EU	AG521R-NA		AG529R-CN	AG529R-EU [2]	AG529R-LA
LTE-FDD (with Rx-diversity)	**2 × 2 MIMO:** B1/B3/B5/B7/ B8	**2 × 2 MIMO:** B1/B3/B5/B7/B8/ B20/B28/B32 [3] **4 × 4 MIMO [4]:** B1/B3/B7/B32 [3]	**2 × 2 MIMO:** B2/B4/B5/B7/B12/ B13/B14/B25/B26/ B29 [3]/B30 [3]/B66/ B71 **4 × 4 MIMO [4]:** B2/B4/B7/B25/B66	**2 × 2 MIMO:** B1/B3/B5/B8/B9/ B11/B18/B19/B21/ B28 **4 × 4 MIMO [4]:** B1/B3/B9/B11/ B21	**2 × 2 MIMO:** B1/B3/B5/B7/ B8	**2 × 2 MIMO:** B1/B3/B5/B7/ B8/B20/B28/ B32 [3]	**2 × 2 MIMO:** B2/B4/B5/B7/B12/ B13/B14/B25/B26/ B29 [3]/B30 [3]/B66/ B71	**2 × 2 MIMO:** B1/B2/B3/B4/B5/B7/ B8/B9/B11/B12/B13 /B18/B19/B20/B21 /B25/B26/B28/B29 [3] /B30 [3]/B32 [3]/B66/ B71	**2 × 2 MIMO:** B1/B3/B5/ B7 [5]/B8	**2 × 2 MIMO:** B1/B3/B7/B8/ B20/B28A	**2 × 2 MIMO:** B1/B2/B3/B4/ B5/B7/B8/ B28A/B28B
LTE-TDD (with Rx-diversity)	**2 × 2 MIMO:** B34/B38/B39/ B40/B41	**2 × 2 MIMO:** B38/B40/B41 **4 × 4 MIMO [4]:** B38/B40/B41	-	**2 × 2 MIMO:** B41 **4 × 4 MIMO [4]:** B41	**2 × 2 MIMO:** B34/B38/B39/ B40/B41	**2 × 2 MIMO:** B38/B40/B41	-	**2 × 2 MIMO:** B34/B38/B39/B40/ B41	**2 × 2 MIMO:** B34/B38/ B39/B40/ B41	**2 × 2 MIMO:** B38/B40/B41	-
WCDMA (with Rx-diversity)	B1/B8	B1/B3/B5/B8	-	B1/B3/B5/B8/B9/ B19	B1/B8	B1/B3/B5/B8	-	B1/B2/B3/B4/B5/B6/ B8/B19	B1/B8	B1/B8	B1/B2/B5/B8
GSM	EGSM900/ DCS1800	EGSM900/ DCS1800	-	-	EGSM900/ DCS1800	EGSM900/ DCS1800	-	GSM850/EGSM900/ DCS1800/PCS1900	EGSM900/ DCS1800	EGSM900/ DCS1800	--
C-V2X [1] (with TRX0 and TRX1)	B47	B47	B47	B47	-	-	-	-	-	-	-
Default Category	Cat 6	Cat 12	Cat 12	Cat 12	Cat 6	Cat 12	Cat 12	Cat 12	Cat 6	Cat 6	Cat 4
Max. Category	Cat 6	Cat 16 (Optional)	Cat 16 (Optional)	Cat 16 (Optional)	Cat 6	Cat 16 (Optional)	Cat 16 (Optional)	Cat 16 (Optional)	Cat 6	Cat 6	Cat 4
GNSS (Optional)	Single-frequency GNSS: L1 (GPS, GLONASS, BDS, Galileo, QZSS)										
	Dual-frequency GNSS [6]: L1 + L5 (GPS, GLONASS, BDS, Galileo, QZSS)										

NOTE

In all CA band combinations, B30 only supports 2 × 2 MIMO.

[2] LTE-TDD B38/B40/B41 is optional on AG529R-EU.
[3] LTE-FDD B29, B30 and B32 support Rx only, and B30 is subject to carrier's deployment.
[4] 4 × 4 MIMO is only supported when Cat 16 is supported.
[5] LTE-FDD B7 is optional on AG529R-CN.
[6] AG529R-CN only supports single-frequency GNSS L1 by default, but the module is designed to be compatible with dual-frequency GNSS.

2.2. Key Features

The following table describes detailed features of the modules.

Table 4: Key Features

Feature	Details
Power Supply	**VBAT_BB:** ● Supply voltage: 3.3–4.3 V ● Typical supply voltage: 3.8 V **VBAT_RF:** **AG520R Series/AG521R Series/AG525R-GL/AG529R-CN:** ● Supply voltage: 3.3–4.3 V ● Typical supply voltage: 3.8 V **AG529R-EU/AG529R-LA:** ● Supply voltage: 3.7–4.3 V ● Typical supply voltage: 3.8 V **VBAT_CV2X:** ● Supply voltage: 4.75–5.25 V ● Typical supply voltage: 5.0 V
Transmitting Power	● LTE-FDD bands: Class 3 (23 dBm ±2 dB) ● LTE-TDD and C-V2X TDD bands: Class 3 (23 dBm ±2 dB) ● WCDMA bands: Class 3 (23 dBm ±2 dB) ● GSM850: Class 4 (33 dBm ±2 dB) ● EGSM900: Class 4 (33 dBm ±2 dB) ● DCS1800: Class 1 (30 dBm ±2 dB) ● PCS1900: Class 1 (30 dBm ±2 dB) ● GSM850 8-PSK: Class E2 (27 dBm ±3 dB) ● EGSM900 8-PSK: Class E2 (27 dBm ±3 dB) ● DCS1800 8-PSK: Class E2 (26 dBm ±3 dB) ● PCS1900 8-PSK: Class E2 (26 dBm ±3 dB)
LTE Features	**AG520R-CN:** – Supports up to 2CA Cat 6 LTE FDD and TDD – Supports 1.4/3/5/10/15/20 MHz RF bandwidth – Supports multi-user 2 × 2 MIMO in DL direction – FDD: Max. 300 Mbps (DL)/50 Mbps (UL) – TDD: Max. 226 Mbps (DL)/28 Mbps (UL)

AG520R-EU:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/75 Mbps (UL)
  - TDD: Max. 447 Mbps (DL)/45 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 4 × 4 MIMO in DL direction
  - FDD: Max. 1.0 Gbps (DL)/75 Mbps (UL)
  - TDD: Max. 716 Mbps (DL)/45 Mbps (UL)

AG520R-NA:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/75 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 4 × 4 MIMO in DL direction
  - FDD: Max. 1.0 Gbps (DL)/75 Mbps (UL)

AG520R-JP:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/75 Mbps (UL)
  - TDD: Max. 447 Mbps (DL)/45 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 4 × 4 MIMO in DL direction
  - FDD: Max. 1.0 Gbps (DL)/75 Mbps (UL)
  - TDD: Max. 716 Mbps (DL)/45 Mbps (UL)

AG521R-CN:

- Supports up to 2CA Cat 6 LTE FDD and TDD
- Supports 1.4/3/5/10/15/20 MHz RF bandwidth
- Supports multi-user 2 × 2 MIMO in DL direction
- FDD: Max. 300 Mbps (DL)/50 Mbps (UL)
- TDD: Max. 226 Mbps (DL)/28 Mbps (UL)

AG521R-EU:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/150 Mbps (UL)
  - TDD: Max. 447 Mbps (DL)/90 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 4 × 4 MIMO in DL direction
  - FDD: Max. 1.0 Gbps (DL)/150 Mbps (UL)
  - TDD: Max. 716 Mbps (DL)/90 Mbps (UL)

AG521R-NA:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/150 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD optionally
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 4 × 4 MIMO in DL direction
  - FDD: Max. 1.0 Gbps (DL)/150 Mbps (UL)

AG525R-GL:

- Default configuration:
  - Up to 3CA Cat 12 LTE FDD and TDD
  - 1.4/3/5/10/15/20 MHz RF bandwidth
  - Multi-user 2 × 2 MIMO in DL direction
  - FDD: Max. 600 Mbps (DL)/150 Mbps (UL)
  - TDD: Max. 447 Mbps (DL)/90 Mbps (UL)

- Optional configuration:
  - Up to 4CA Cat 16 LTE FDD

	– 1.4/3/5/10/15/20 MHz RF bandwidth – Multi-user 4 × 4 MIMO in DL direction – FDD: Max. 1.0 Gbps (DL)/150 Mbps (UL) – TDD: Max. 716 Mbps (DL)/90 Mbps (UL) **AG529R-CN:** – Supports up to 2CA Cat 6 LTE FDD and TDD – Supports 1.4/3/5/10/15/20 MHz RF bandwidth – Supports multi-user 2 × 2 MIMO in DL direction – FDD: Max. 300 Mbps (DL)/50 Mbps (UL) – TDD: Max. 226 Mbps (DL)/28 Mbps (UL) **AG529R-EU:** – Default configuration: – Up to 2CA Cat 6 LTE FDD – 1.4/3/5/10/15/20 MHz RF bandwidth – Multi-user 2 × 2 MIMO in DL direction – FDD: Max. 300 Mbps (DL)/50 Mbps (UL) – Optional configuration: – TDD: 5/10/15/20 MHz RF bandwidth – TDD: Max. 226 Mbps (DL)/28 Mbps (UL) **AG529R-LA:** – Up to Cat 4 LTE FDD – 1.4/3/5/10/15/20 MHz RF bandwidth – Multi-user 2 × 2 MIMO in DL direction – FDD: Max. 150 Mbps (DL)/50 Mbps (UL)
C-V2X Features [7]	● Supports C-V2X TDD up to 30 Mbps (UL)/30 Mbps (DL) ● Supports ITS @ 5.9 GHz
UMTS Features	● Supports 3GPP Rel-8 DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA ● Supports QPSK, 16QAM and 64QAM modulation ● DC-HSDPA: Max. 42 Mbps (DL) ● HSUPA: Max. 5.76 Mbps (UL) ● WCDMA: Max. 384 kbps (DL)/384 kbps (UL)
GSM Features	**GPRS:** ● Supports GPRS multi-slot class 33 (33 by default) ● Coding scheme: CS 1–4 ● Max. 107 kbps (DL)/85.6 kbps (UL) **EDGE:** ● Supports EDGE multi-slot class 33 (33 by default)

[7] C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

	● Supports GMSK and 8-PSK for different MCS (Modulation and Coding Scheme) ● Downlink coding schemes: MCS 1–9 ● Uplink coding schemes: MCS 1–9 ● Max. 296 kbps (DL)/236.8 kbps (UL)
Internet Protocol Features	Supports TCP/UDP/PPP/FTP/HTTP/NTP/PING/QMI/HTTPS/MMS/ FTPS/SSL/SMTP/TLS protocols
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interfaces	Support USIM/SIM card: 1.8/3.0 V
Audio Features	● One digital audio interface: I2S interface ● GSM: HR/FR/EFR/AMR/AMR-WB ● WCDMA: AMR/AMR-WB ● LTE: AMR/AMR-WB ● Supports echo cancellation and noise suppression
I2S Interface	● Used for codec configuration by default ● Supports master and slave modes
I2C Interface	● Compliant with *I2C Specification Version 3.0* ● Multi-master is not supported ● Used for codec configuration by default
PCM Interface	● Used for Bluetooth audio transmission by default ● Supports 16-bit linear data format ● Supports long frame and short frame synchronization ● Supports master and slave modes, but must be the master in long frame synchronization
USB Interface	● Compliant with USB 3.0 and 2.0 specifications (slave mode by default; supports USB host mode), with maximum transmission rates up to 5 Gbps on USB 3.0 and 480 Mbps on USB 2.0 ● Both USB 3.0 and USB 2.0 can be used for AT command communication, data transmission, software debugging, GNSS NMEA sentence output, and voice over USB*. ● USB 3.0 is used for data communication with AP by default. ● Only USB 2.0 can be used for firmware upgrading. ● When USB 3.0 and USB 2.0 are connected to the same host, USB 3.0 takes effect by default. ● Supports USB serial drivers for: Windows 7/8/8.1/10/11; Linux 2.6–5.18
UART Interfaces	**UART1:** ● Supports baud rate up to 921600 bps, 115200 bps by default ● Supports RTS and CTS hardware flow control

	Bluetooth UART: ● Supports baud rate up to 921600 bps, 115200 bps by default ● Supports RTS and CTS hardware flow control **Debug UART:** ● Used for Linux console and log output ● Supports 115200 bps baud rate
SDIO Interface	Supports eMMC 4.5.1
SPI Interfaces	● 2 SPI interfaces, and SPI2 is optional ● Support master mode only ● Support max. clock frequency rate up to 50 MHz
RGMII Interface	Supports 10/100/1000 Mbps
WLAN and Bluetooth Application Interfaces	● Supports a PCIe Gen 2 interface for WLAN function ● Supports UART and PCM interfaces for Bluetooth function
Rx-diversity	Supports LTE/WCDMA Rx-diversity
GNSS Features (Optional)	● Supports single-frequency (L1) ● Supports dual-frequency (L1 + L5) GNSS [8] ● Protocol: NMEA 0183
Antenna Interfaces	● Main antenna interface (ANT_MAIN) ● Rx-diversity antenna interface (ANT_DIV) ● MIMO3 antenna interface (ANT_MIMO3) [9] ● MIMO4 antenna interface (ANT_MIMO4) [9] ● C-V2X TRX0 antenna interface (ANT_CV2X_TRX0) [7] ● C-V2X TRX1 antenna interface (ANT_CV2X_TRX1) [7] ● GNSS antenna interface (ANT_GNSS)
Physical Characteristics	● Size: (38.0 ±0.2) mm × (42.0 ±0.2) mm × (2.65 ±0.2) mm ● Weight: approx. 9.23 g
Temperature Range	● Operating temperature range [10]: -35 °C to + 75 °C ● Extended temperature range [11]: -40 °C to + 85 °C ● eCall temperature range [12]: -40 °C to + 95 °C ● Storage temperature range: -40 °C to + 95 °C

[8] AG529R-CN supports single-frequency GNSS L1 by default, but the module is designed to be compatible with dual-frequency GNSS.
[9] ANT_MIMO3 and ANT_MIMO4 are not supported by AG520R-CN, AG521R-CN, AG529R-CN and AG529R-EU, and optional for other module models.
[10] Within the operating temperature range, the module meets 3GPP specifications, and emergency call (Only AG52xR-EU and AG525R-GL support emergency call function) can be dialed out with a maximum power and data rate.
[11] Within the extended temperature range, the module remains fully functional and the ability to establish and maintain functions such as voice, SMS, data transmission and emergency call, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.
[12] Within eCall temperature range, the emergency call function must be functional until the module is broken. When the ambient temperature is between 75 °C and 95 °C and the module temperature has reached the threshold value, the module will trigger protective measures (such as reduce power, decrease throughput, and unregister the device) to ensure the full function of emergency call.

Firmware Upgrade	● USB 2.0 interface ● DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows a block diagram of the module and illustrates the major functional parts.

- Power management
- Baseband
- LPDDR4X + NAND flash
- Radio frequency
- Peripheral interfaces

NOTE

1. C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.
2. GPIO9, GPIO10, GPIO11 are only supported by AG525R-GL, and reserved for other module models.
3. ADC2 is only supported by AG525R-GL, and reserved for other module models.
4. GNSS is optional.

2.4. EVB Kit

To help you develop applications conveniently with the module, Quectel supplies the evaluation board (V2X&5G EVB), a USB data cable, a pair of earphones, antennas and other peripherals to control or test the module. For more details, see ***document [1]***.

3 Application Interfaces

3.1. General Description

AG52xR series is equipped with 400 LGA pins that can be connected to cellular application platforms. The subsequent chapters will provide detailed descriptions of the following interfaces:

- Power supply
- (U)SIM interfaces
- USB interface
- UART interfaces
- I2S and I2C interfaces
- PCM interface
- SDIO interface
- SPI interfaces
- RGMII interface
- WLAN and Bluetooth application interfaces
- ADC interfaces
- USB_BOOT interface
- RTC
- GPIO interfaces
- Audio interface (optional)

3.2. Pin Assignment

The following figure shows the pin assignment of the module.

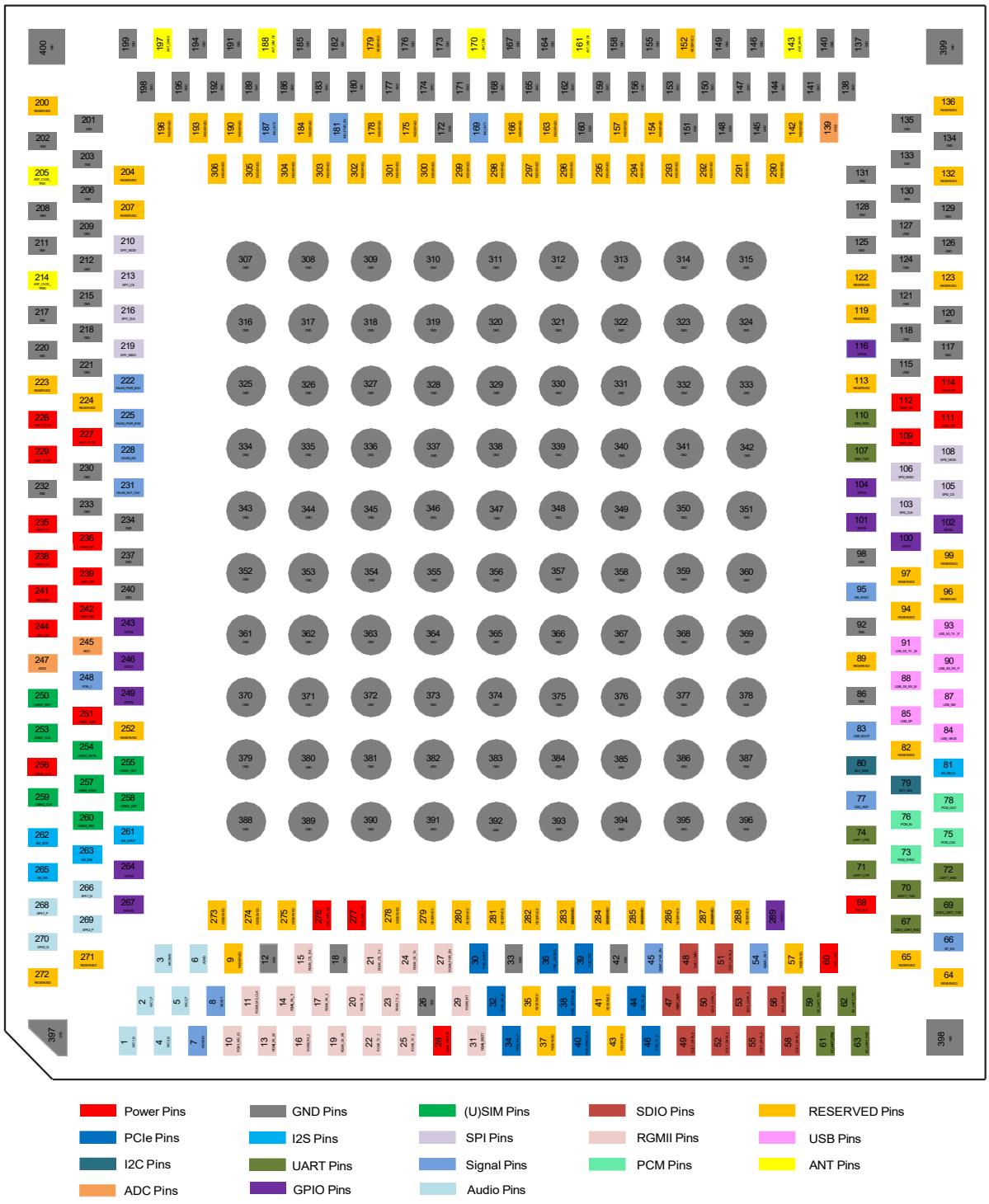


Figure 2: Pin Assignment (Top View)

NOTE

1. Keep all RESERVED pins and unused pins unconnected.
2. GND pins should be connected to ground in the design.
3. GPIO9, GPIO10, GPIO11 are only supported by AG525R-GL, and reserved for other module models.
4. ADC2 is only supported by AG525R-GL, and reserved for other module models.
5. ANT_MIMO3 and ANT_MIMO4 are not supported by AG520R-CN, AG521R-CN, AG529R-CN and AG529R-EU, and optional for other module models.
6. GNSS is optional for AG52xR series. But AG529R-CN only supports single-frequency GNSS L1 by default, but the module is designed to be compatible with dual-frequency GNSS.
7. C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

3.3. Pin Description

The following tables show the pin definition of the module.

Table 5: I/O Parameters Definition

Symbol	Description
AI	Analog Input
AO	Analog Output
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
OD	Open Drain
PI	Power Input
PO	Power Output

Table 6: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	241, 242, 244	PI	Power supply for the module's BB part	Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V	It must be provided with sufficient current up to 0.8 A.
VBAT_RF [13]	109, 111, 112, 114 235, 236 238, 239	PI	Power supply for the module's RF part	Vmax = 4.3 V Vmin = 3.3/3.7 V Vnom = 3.8 V	It must be provided with sufficient current up to 2.0 A in a burst transmission.
VBAT_CV2X [14]	226, 227, 229	PI	Power supply for the module's C-V2X part	Vmax = 5.25 V Vmin = 4.75 V Vnom = 5.0 V	It must be provided with sufficient current up to 1.5 A.
VDD_EXT	68	PO	Provide 1.8 V for external circuits	Vnom = 1.8 V $I_O$max = 50 mA	Power supply for external GPIO's pull up circuits.
VDD_WIFI_VM	276	PO	Medium-voltage power supply for Wi-Fi	Vnom = 1.35 V $I_O$max = 400 mA	If unused, keep it open.
VDD_WIFI_VH	277	PO	High-voltage power supply for Wi-Fi	Vnom = 1.95 V $I_O$max = 400 mA	If unused, keep it open.
GND	12, 18, 26, 33, 42, 86, 92, 98, 115, 117, 118, 120, 121, 124–131, 133–135, 137, 138, 140, 141, 144–151, 153, 155, 156, 158, 159, 160, 162, 164, 165, 167, 168, 171–174, 176, 177, 180, 182, 183, 185, 186, 189, 191, 192, 194, 195, 198, 199, 201, 202, 203, 206, 208, 209, 211, 212, 215, 217, 218, 220, 221, 230, 232, 233, 234, 237, 240, 307–400				
Turn On/Off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	7	DI	Turn on/off the module	V_{IH}max = 1.89 V V_{IH}min = 1.17 V V_{IL}max = 0.63 V	Internally pulled up to 1.8 V. Active low.

[13] The minimum input voltage of AG520R series/AG521R series/AG525R-GL/AG529R-CN is 3.3 V; but the minimum input voltage of AG529R-EU/AG529R-LA is 3.7 V.
[14] C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

PON_1	248	DI	Power on the module upon rising edge		Valid voltage range: 0.78–1.89 V.
RESET	8	DI	Reset the module	V_{IH}max = 1.89 V V_{IH}min = 1.17 V V_{IL}max = 0.63 V	Internally pulled up to 1.8 V. Active low.
(U)SIM Interfaces [15]					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM1_VDD	251	PO	(U)SIM1 card power supply	**For 1.8 V (U)SIM:** Vmax = 1.9 V Vmin = 1.7 V **For 3.0 V (U)SIM:** Vmax = 3.05 V Vmin = 2.7 V $I_O$max = 50 mA	Either 1.8 V or 3.0 V is supported by the module automatically. If unused, keep it open.
USIM1_DATA	254	DIO	(U)SIM1 card data	**For 1.8 V (U)SIM:** V_{IL}max = 0.36 V V_{IH}min = 1.26 V V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{IL}max = 0.57 V V_{IH}min = 2.0 V V_{OL}max = 0.4 V V_{OH}min = 2.28 V	If unused, keep it open.
USIM1_CLK	253	DO	(U)SIM1 card clock	**For 1.8 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 2.28 V	If unused, keep it open.
USIM1_RST	250	DO	(U)SIM1 card reset	**For 1.8 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{OL}max = 0.4 V	If unused, keep it open.

[15] (U)SIM2 interface is optional.

				V_{OH}min = 2.28 V	
USIM1_DET	255	DI	(U)SIM1 card hot-plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. If unused, keep it open.
USIM2_VDD	256	PO	(U)SIM2 card power supply	**For 1.8 V (U)SIM:** Vmax = 1.9 V Vmin = 1.7 V **For 3.0 V (U)SIM:** Vmax = 3.05 V Vmin = 2.7 V $I_O$max = 50 mA	Either 1.8 V or 3.0 V is supported by the module automatically. If unused, keep it open.
USIM2_DATA	257	DIO	(U)SIM2 card data	**For 1.8 V (U)SIM:** V_{IL}max = 0.36 V V_{IH}min = 1.26 V V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{IL}max = 0.57 V V_{IH}min = 2.0 V V_{OL}max = 0.4 V V_{OH}min = 2.28 V	If unused, keep it open.
USIM2_CLK	259	DO	(U)SIM2 card clock	**For 1.8 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 2.28 V	If unused, keep it open.
USIM2_RST	260	DO	(U)SIM2 card reset	**For 1.8 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 1.44 V **For 3.0 V (U)SIM:** V_{OL}max = 0.4 V V_{OH}min = 2.28 V	If unused, keep it open.
USIM2_DET	258	DI	(U)SIM2 card hot-plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. If unused, keep it open.

USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	84	DI	USB connection detect	Vmax = 5.25 V Vmin = 3.0 V Vnom = 5.0 V	
USB_DP	85	AIO	USB 2.0 differential data (+)		Compliant with USB 2.0 standard specification. Require differential impedance of 90 Ω.
USB_DM	87	AIO	USB 2.0 differential data (-)		
USB_SS_TX_P	93	AO	USB 3.0 SuperSpeed transmit (+)		Compliant with USB 3.0 standard specification. Require differential impedance of 90 Ω.
USB_SS_TX_M	91	AO	USB 3.0 SuperSpeed transmit (-)		
USB_SS_RX_P	90	AI	USB 3.0 SuperSpeed receive (+)		
USB_SS_RX_M	88	AI	USB 3.0 SuperSpeed receive (-)		

GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO1	100	DIO	General-purpose input/output	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep them open.
GPIO2	101	DIO	General-purpose input/output		
GPIO3	102	DIO	General-purpose input/output		
GPIO4	104	DIO	General-purpose input/output		
GPIO5	116	DIO	General-purpose input/output		
GPIO6	243	DIO	General-purpose input/output		
GPIO7	246	DIO	General-purpose input/output		

GPIO8	249	DO	General-purpose output	V_{OL}max = 0.36 V V_{OH}min = 1.44 V	
GPIO9 [16]	264	DIO	General-purpose input/output	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
GPIO10 [16]	267	DIO	General-purpose input/output		
GPIO11 [16]	289	DIO	General-purpose input/output		
UART1 Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
UART1_CTS	71	DO	DTE clear to send signal from DCE	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep these pins open.
UART1_RTS	74	DI	DTE request to send signal to DCE	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
UART1_TXD	70	DO	UART1 transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
UART1_RXD	72	DI	UART1 receive	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
Bluetooth UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
BT_UART_TXD	59	DO	Bluetooth UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep these pins open.
BT_UART_RXD	63	DI	Bluetooth UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
BT_UART_RTS	61	DI	DTE request to send signal to DCE	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
BT_UART_CTS	62	DO	DTE clear to send signal from DCE	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	

[16] GPIO9, GPIO10, GPIO11 are only supported by AG525R-GL, and reserved for other module models.

Debug UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_RXD	110	DI	Debug UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain.
DBG_TXD	107	DO	Debug UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
I2C Interface (for Codec Configuration by Default)					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C1_SCL	79	OD	I2C serial clock		External pull-up resistor is required. 1.8 V only. Can be configured to GPIOs. If unused, keep them open.
I2C1_SDA	80	OD	I2C serial data		
I2S Interface (for Codec Configuration by Default)					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
CDC_RST	77	DO	External codec reset	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep them open.
I2S_MCLK	81	DO	Clock output for codec	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
I2S_WS	265	DIO	I2S word select	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
I2S_SCK	262	DIO	I2S clock		
I2S_DIN	263	DI	I2S data in	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
I2S_DOUT	261	DO	I2S data out	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
PCM Interface					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PCM_SYNC	73	DIO	PCM data frame sync	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep them open.
PCM_CLK	75	DIO	PCM clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
PCM_IN	76	DI	PCM data input	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
PCM_OUT	78	DO	PCM data output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
PCIe Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCIE_REFCLK_P	40	AIO	PCIe reference clock (+)		Require differential impedance of 95 Ω. 1.8 V power domain. If unused, keep them open.
PCIE_REFCLK_M	38	AIO	PCIe reference clock (-)		
PCIE_TX_M	44	AO	PCIe transmit (-)		
PCIE_TX_P	46	AO	PCIe transmit (+)		
PCIE_RX_M	32	AI	PCIe receive (-)		
PCIE_RX_P	34	AI	PCIe receive (+)		
PCIE_CLKREQ	36	DIO	PCIe clock request	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain If unused, keep them open.
PCIE_RST	39	DIO	PCIe reset		
PCIE_WAKE	30	DIO	PCIe wake up		
RGMII Interface					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RGMII_MD_IO	10	DIO	RGMII management data		
RGMII_MD_CLK	11	DO	RGMII management data clock		
RGMII_RX_0	13	DI	RGMII receive data bit 0		
RGMII_RX_1	14	DI	RGMII receive data bit 1		
RGMII_CTL_RX	15	DI	RGMII receive control		
RGMII_RX_2	16	DI	RGMII receive data bit 2		If unused, keep them open. Power domain is determined by RGMII_PWR_IN.
RGMII_RX_3	17	DI	RGMII receive data bit 3		
RGMII_CK_RX	19	DI	RGMII receive clock		
RGMII_TX_0	20	DO	RGMII transmit data bit 0		
RGMII_CTL_TX	21	DO	RGMII transmit control		
RGMII_TX_1	22	DO	RGMII transmit data bit 1		
RGMII_TX_2	23	DO	RGMII transmit data bit 2		
RGMII_CK_TX	24	DO	RGMII transmit clock		
RGMII_TX_3	25	DO	RGMII transmit data bit 3		
RGMII_PWR_EN	27	DO	Enable an external power supply to power RGMII_ PWR_IN	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep it open.
RGMII_PWR_IN	28	PI	RGMII interface power supply input		1.8/2.5 V power supply input. If RGMII is not used, connect it to VDD_EXT.

RGMII_INT	29	DI	RGMII interrupt input	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. If unused, keep them open.
RGMII_RST	31	DO	Reset output for RGMII PHY	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
SDIO Interface (for eMMC by Default)					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SDIO_VDD	60	PI	SDIO power supply		Connect it to VDD_EXT.
SDC1_DATA_0	49	DIO	SDIO data bit 0	**For 1.8 V signal:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V V_{IL}min = -0.3 V V_{IL}max = 0.58 V V_{IH}min = 1.27 V V_{IH}max = 2.0 V **For 3.0 V signal:** V_{OL}max = 0.37 V V_{OH}min = 2.21 V V_{IL}min = -0.3 V V_{IL}max = 0.74 V V_{IH}min = 1.84 V V_{IH}max = 3.25 V	If unused, keep them open.
SDC1_DATA_1	50	DIO	SDIO data bit 1		
SDC1_DATA_2	51	DIO	SDIO data bit 2		
SDC1_DATA_3	52	DIO	SDIO data bit 3		
SDC1_CMD	48	DIO	SDIO command		
SDC1_DATA_4	53	DIO	SDIO data bit 4	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. For eMMC configuration by default. Can be configured to GPIOs. If unused, keep them open.
SDC1_DATA_5	55	DIO	SDIO data bit 5		
SDC1_DATA_6	56	DIO	SDIO data bit 6		
SDC1_DATA_7	58	DIO	SDIO data bit 7		
SDC1_CLK	47	DIO	SDIO clock	**For 1.8 V signal:** V_{OL}max = 0.45 V V_{OH}min = 1.4 V **For 3.0 V signal:** V_{OL}max = 0.37 V V_{OH}min = 2.21 V	If unused, keep it open.
EMMC_RST*	54	DO	eMMC reset	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep

EMMC_PWR_EN	45	DO	eMMC power supply enable control	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	them open.
SPI Interfaces [17]					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SPI1_CLK	216	DO	SPI1 clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep them open.
SPI1_CS	213	DO	SPI1 chip select	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
SPI1_MISO	219	DI	SPI1 master-in slave-out	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
SPI1_MOSI	210	DO	SPI1 master-out slave-in	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
SPI2_CLK	103	DO	SPI2 clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
SPI2_CS	105	DO	SPI2 chip select	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
SPI2_MISO	106	DI	SPI2 master-in slave-out	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
SPI2_MOSI	108	DO	SPI2 master-out slave-in	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
ADC Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0	247	AI	General-purpose ADC interface	Voltage range: 0–1.875 V	If unused, keep them open.
ADC1	245	AI	General-purpose ADC interface		
ADC2 [18]	139	AI	General-purpose ADC interface		
ADC3 [19]	113	AI	General-purpose ADC interface		
Other Interface Pins					

[17] SPI2 interface is optional.
[18] ADC2 is only supported by AG525R-GL, and reserved for other module models.
[19] ADC3 is only supported by AG529R-LA, and reserved for other module models.

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_BOOT	83	DI	Force the module into emergency download mode		1.8 V power domain. If unused, keep them open.
BT_EN	66	DO	Bluetooth enable control	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
DR_SYNC	95	DO	Dead reckoning sync	V_{OL}max = 0.45 V V_{OH}min =1.35 V	
IMU_INT1	169	DI	IMU interrupt 1	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	1.8 V power domain. Can be configured to GPIOs. If unused, keep them open.
IMU_INT2	187	DI	IMU interrupt 2	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
IMU_PWR_EN	181	DO	IMU power enable control	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
WLAN and Bluetooth Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_PWR_EN1	222	DO	WLAN power supply enable control 1	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep them open.
WLAN_PWR_EN2	225	DO	WLAN power supply enable control 2	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
WLAN_EN	228	DO	WLAN function enable control	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
COEX_UART_RXD	67	DI	LTE & WLAN/Bluetooth coexistence receive	V_{IL}min = -0.3 V V_{IL}max = 0.63 V V_{IH}min = 1.17 V V_{IH}max = 2.1 V	
COEX_UART_TXD	69	DO	LTE & WLAN/Bluetooth coexistence transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
WLAN_SLP_CLK	231	DO	WLAN sleep clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	

RF Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	143	AIO	Main antenna interface		50 Ω impedance.
ANT_DIV	170	AI	Diversity antenna interface		
ANT_MIMO3 [20]	188	AI	4 × 4 MIMO antenna interface		
ANT_MIMO4 [20]	161	AI	4 × 4 MIMO antenna interface		
ANT_GNSS [21]	197	AI	GNSS antenna interface		
ANT_CV2X_TRX1 [22]	205	AIO	C-V2X TRX1 antenna interface		
ANT_CV2X_TRX0 [22]	214	AIO	C-V2X TRX0 antenna interface		
Analog Audio Interface (Optional)					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MIC1_P	2	AI	Microphone input channel 1 (+)		Analog audio interface is optional, and is not supported by default. SPK signals are used for headset application. If unused, keep these pins open.
MIC1_N	1	AI	Microphone input channel 1 (-)		
MIC2_P	5	AI	Microphone input channel 2 (+)		
MIC2_N	4	AI	Microphone input channel 2 (-)		
MICBIAS	3	PO	Bias voltage output for microphone	Vmax = 1.55 V Vmin = 1.5 V Vnom = 1.525 V	

[20] ANT_MIMO3 and ANT_MIMO4 are not supported by AG520R-CN, AG521R-CN, AG529R-CN and AG529R-EU, and optional for other module models.
[21] GNSS is optional.
[22] C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

SPK1_P	268	AO	Analog audio differential output 1 (+)	
SPK1_N	266	AO	Analog audio differential output 1 (-)	
SPK2_P	269	AO	Analog audio differential output 2 (+)	
SPK2_N	270	AO	Analog audio differential output 2 (-)	
AGND	6	-	Analog ground	Connect it to GND or keep it open if unused.
RESERVED Pins				
Pin Name	**Pin No.**			**Comment**
RESERVED	9, 35, 37, 41, 43, 57, 64, 65, 82, 89, 94, 96, 97, 99, 119, 122, 123, 132, 136, 142, 152, 154, 157, 163, 166, 175, 178, 179, 184, 190, 193, 196, 200, 204, 207, 223, 224, 252, 271–275, 278–288, 290–306			Keep these pins open.

NOTE

1. Keep all RESERVED pins and unused pins unconnected.
2. GND pins should be connected to ground in the design.

3.4. Pin Multiplexing and BLSP Assignment

See ***document [2]*** for details about the pin multiplexing and BLSP assignment of the module.

3.5. Operating Modes

The table below briefly summarizes the various operating modes of the module referred in the following chapters.

Table 7: Overview of Operating Modes

Mode	Details	
Full functionality mode	Idle	The module remains registered on the network, and is ready to send and receive data. In this mode, the software is active.
	Voice/Data	The module is connected to network. Its power consumption varies with the network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0** or device management related API function can set the module into a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.	
Airplane Mode	**AT+CFUN=4** or device management related API function can set the module into airplane mode where the RF function is invalid.	
Sleep Mode	The module retains the ability to receive paging message, SMS, voice call and TCP/UDP data from the network normally. In this mode, the power consumption is reduced to a very low level.	
Power OFF Mode	The module's power supply is cut off by its power management unit. In this mode, the software is inactive, the serial interfaces are inaccessible, while the operating voltage (connected to VBAT_RF, VBAT_BB and VBAT_CV2X) remains applied.	

NOTE

See ***document [3]*** for details of device management API functions, and ***document [4]*** for details of **AT+CFUN**.

3.6. Power Saving

3.6.1. Sleep Mode

The module is able to reduce its power consumption to a minimum value during the sleep mode. This chapter mainly introduces the way to make the module enter or exit from sleep mode. The diagram below illustrates the power consumption of the module during sleep mode. See ***document [5]*** for more details about low power mode of the module.

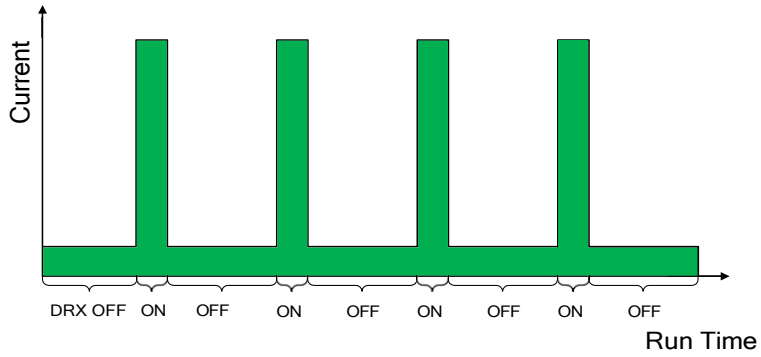


Figure 3: Sleep Mode Current Consumption Diagram

NOTE

The DRX cycle values are broadcasted by the wireless network.

3.6.1.1. USB Application Without USB Suspend Function

If the host does not support USB suspend function, USB_VBUS should be connected with an external control circuit to set the module to sleep mode.

- Use LPM related API functions to enable the sleep mode.
- Ensure that all pins configured to interrupt the wake-up function are in the non-wakeup state.
- Disconnect USB_VBUS.

The following figure shows the connection between the module and the host.

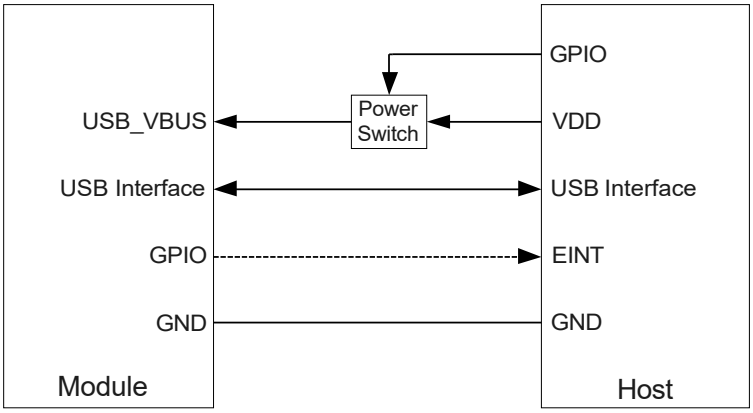


Figure 4: Sleep Mode Application without Suspend Function

Switching on the power switch to supply power to USB_VBUS will wake up the module.

NOTE

Pay attention to the level match of the circuit in dotted line when the host interface is not 1.8 V power domain.

3.6.2. Airplane Mode

When the module enters airplane mode, the RF function does not work, and all AT commands and API functions correlative with RF function will be inaccessible.

AT command:

The mode can be set via **AT+CFUN=<fun>**. The parameter **<fun>** indicates the module's functionality levels, as shown below.

- **AT+CFUN=0:** Minimum functionality mode. Both (U)SIM and RF functions are disabled.
- **AT+CFUN=1:** Full functionality mode (by default).
- **AT+CFUN=4:** Airplane mode. RF function is disabled.

API functions:

The mode can be set via device management related API functions. See ***document [3]*** for more details about device management API functions.

NOTE

The execution of **AT+CFUN** or related API functions will not affect GNSS function.

3.7. Power Supply

3.7.1. Power Supply Pins

The module provides 14 VBAT pins for connection with an external power supply.

- Three VBAT_BB pins for module's baseband part.
- Eight VBAT_RF pins for module's RF part.
- Three VBAT_CV2X pins for module's C-V2X part.

The following table shows the details of VBAT pins and ground pins.

Table 8: VBAT and GND Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT_BB	241, 242, 244	PI	Power supply for the module's baseband part	3.3	3.8	4.3	V
VBAT_RF	109, 111, 112, 114 235, 236, 238, 239	PI	Power supply for the module's RF part	3.3/3.7 [23]	3.8	4.3	V
VBAT_CV2X	226, 227, 229	PI	Power supply for the module's C-V2X part	4.75	5.0	5.25	V
GND	12, 18, 26, 33, 42, 86, 92, 98, 115, 117, 118, 120, 121, 124–131,133–135, 137, 138, 140, 141, 144–151,153, 155, 156, 158, 159, 160, 162, 164, 165, 167, 168, 171–174, 176, 177, 180, 182, 183, 185, 186, 189, 191, 192, 194, 195, 198, 199, 201, 202, 203, 206, 208, 209, 211, 212, 215, 217, 218, 220, 221, 230, 232, 233, 234, 237, 240, 307–400						

3.7.2. Voltage Stability Requirements

The power supply range of VBAT_BB is 3.3–4.3 V, VBAT_RF is 3.3/3.7–4.3 V [23] and that of VBAT_CV2X is 4.75–5.25 V. Ensure that the input voltage of VBAT_BB will never drop below 3.3 V, VBAT_RF will never drop its minimum input voltage, and the input voltage of VBAT_CV2X will never drop below 4.75 V. The following figure shows the voltage drop during burst transmission in 2G network. The voltage drop will be less in 3G and 4G networks.

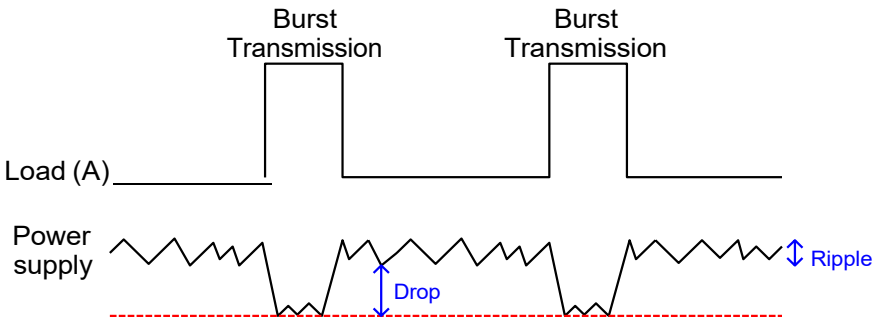


Figure 5: Power Supply Limits During Burst Transmission

To decrease voltage drop, the bypass capacitors of about 100 μF with low ESR should be used, and a multi-layer ceramic chip capacitor (MLCC) array should also be reserved for VBAT_BB, VBAT_RF and VBAT_CV2X respectively, due to its low ESR. It is recommended to use three ceramic capacitors (100 nF, 33 pF, 10 pF) for composing the MLCC array, and place these capacitors close to VBAT pins. The external 3.8 V main power supply connected to VBAT_BB and VBAT_RF has to be a single voltage source and can

[23] The minimum input voltage of AG520R series/AG521R series/AG525R-GL/AG529R-CN is 3.3 V; but the minimum input voltage of AG529R-EU/AG529R-LA is 3.7 V.

be expanded to two sub paths with star structure. The width of VBAT_BB trace should be not less than 1 mm. The width of VBAT_RF trace should be not less than 2 mm. The width of VBAT_CV2X trace should be not less than 1.5 mm. In principle, the longer the VBAT trace is, the wider it should be.

In addition, to get a stable power source, it is suggested to use TVS components to prevent static electricity, and place them as close to the VBAT pins as possible. The following figure shows a reference design of VBAT power supply pins.

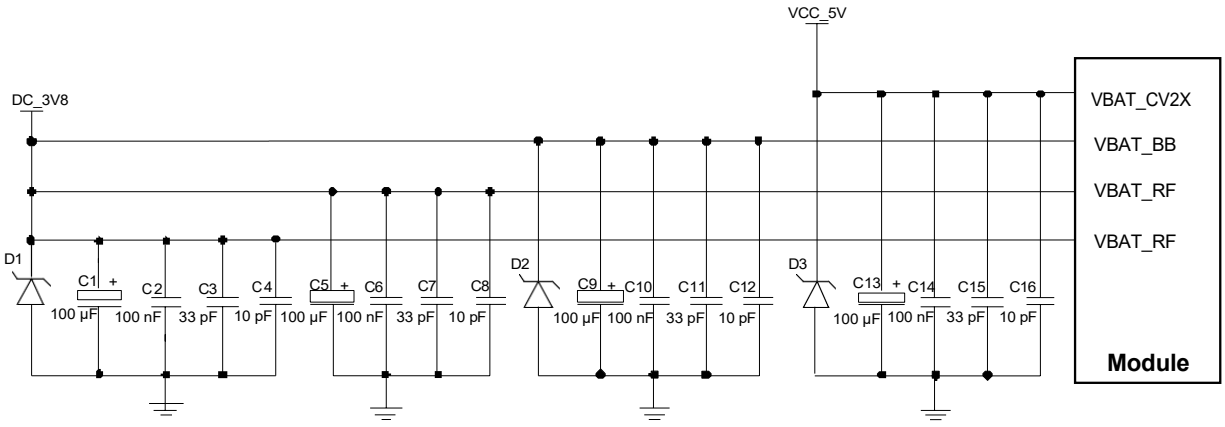


Figure 6: VBAT Reference Design

NOTE

An external control circuit can be added to switch off the VBAT_CV2X power supply automatically when the module enters sleep mode, thus further reducing power consumption.

3.7.3. Reference Design for Power Supply

The performance of the module largely depends on the power source. If the voltage drop between the input and output is not too high, it is recommended to use an LDO to supply power for the module. If there is a big voltage difference between the input source and the desired output (VBAT), a buck converter is preferred to be used as the power supply.

The following figure shows a reference design for +12/+24 V input power source. The designed output for the power supply is about 5.0 V and the maximum rated current is 5.0 A.

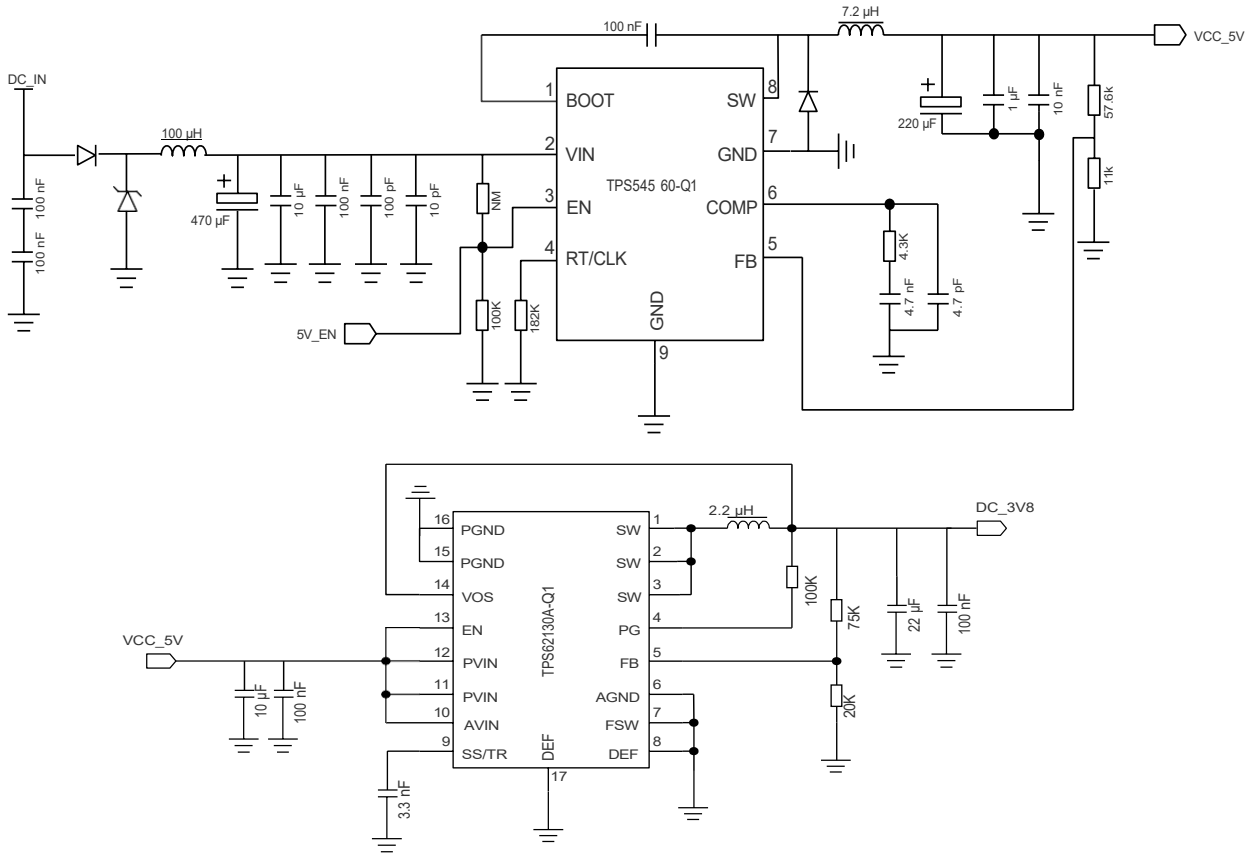


Figure 7: 12/24 V Power Supply System Reference Design

NOTE

To avoid damaging the data of internal flash, do not switch off the power supply when the module works normally. Only after the module is shut down by PWRKEY or API interface or Linux commands, the power supply can be cut off.

3.7.4. Power Supply Monitoring

API can be used to monitor the VBAT_BB voltage value. For more details of the command, see ***document [6]***.

3.8. Turn On

3.8.1. Turn On with PWRKEY

The following table shows the pin definition of PWRKEY.

Table 9: PWRKEY Pin Description

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	7	DI	Turn on/off the module	1.8 V power domain. Pulled-up internally. Active low.

When the module is turned off, it can be turned on by driving PWRKEY low for at least 500 ms. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

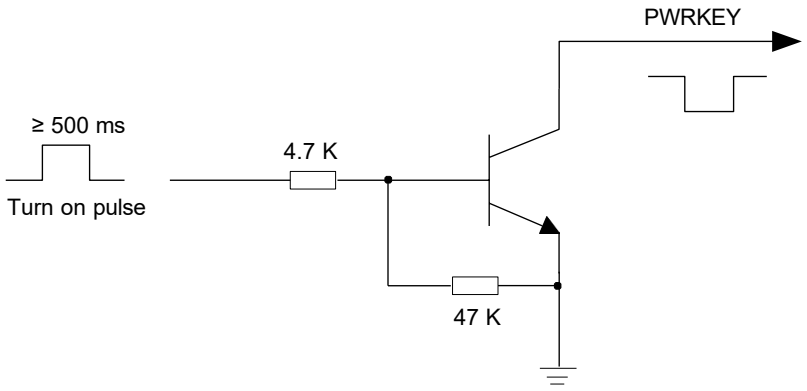


Figure 8: Turn On the Module Using Driving Circuit

Another way to control the PWRKEY is using a button directly. When pressing the button, electrostatic strike may generate from the finger. Therefore, a TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure.

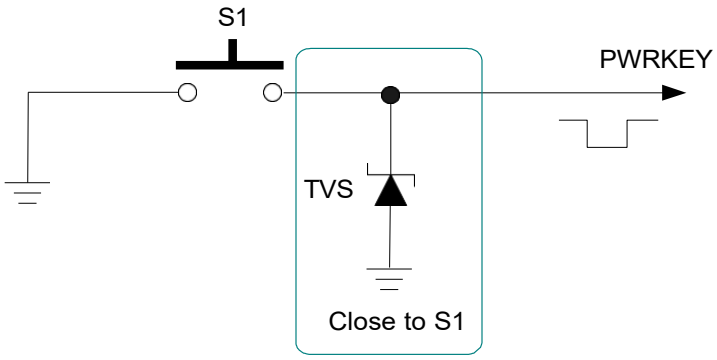


Figure 9: Turn On the Module Using a Button

The power-up timing is illustrated in the following figure.

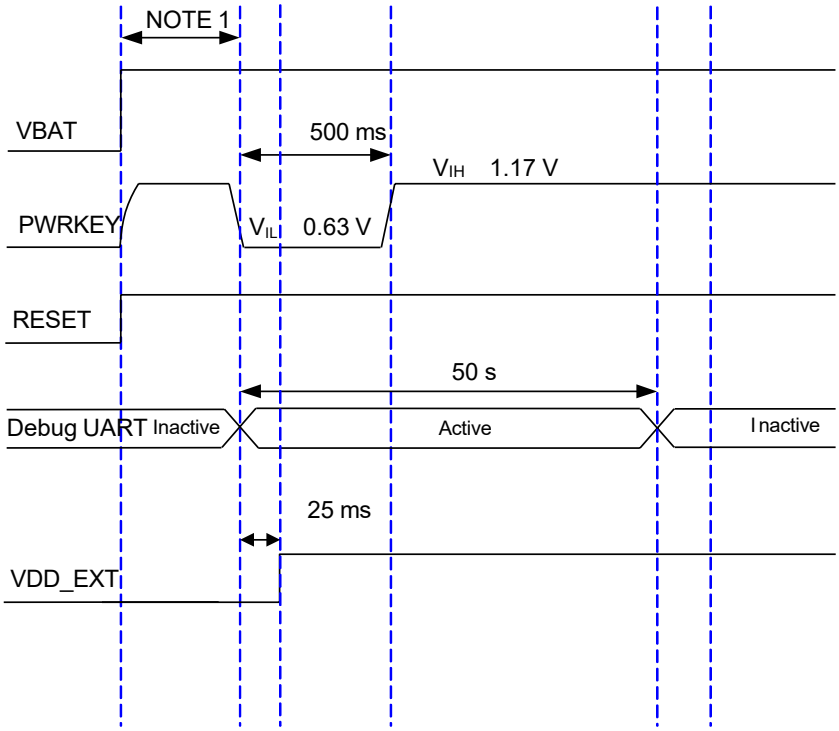


Figure 10: Power-up Timing

NOTE

3.8.2. Turn On with PON_1

The following table shows the pin definition of PON_1.

Table 10: PON_1 Pin Description

Pin Name	Pin No.	I/O	Description	Comment
PON_1	248	DI	Power on the module upon rising edge	Valid voltage range: 0.78–1.89 V.

When the module is powered off, driving PON_1 high (rising edge) will make the module turn on automatically. A simple reference circuit is illustrated in the following figure.

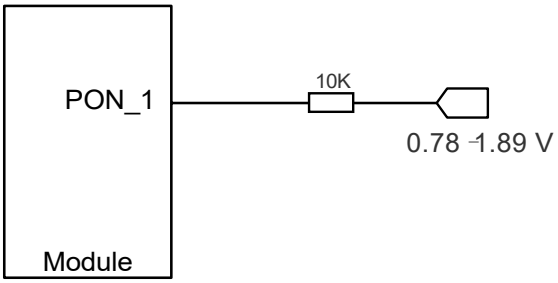


Figure 11: Turn On the Module Using PON_1

NOTE

If PON_1 is not used, it is recommended to connect it to the ground.

3.9. Turn Off

Either of the following methods can be used to turn off the module normally:

- Turn off the module using the PWRKEY pin.
- Turn off the module using API interface.
- Turn off the module using Linux commands.

3.9.1. Turn Off with PWRKEY

Driving PWRKEY low for at least 2 s, the module will execute power-down procedure after PWRKEY is released. The power-down timing is illustrated in the following figure.

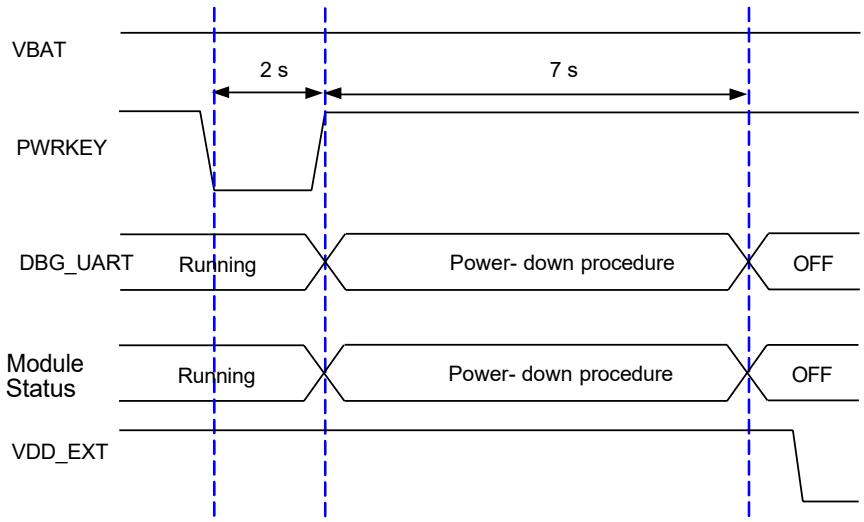


Figure 12: Power-down Timing

3.9.2. Turn Off with API Interface

It is a safe way to use API interface to turn off the module, which is similar to turning off the module via PWRKEY Pin. See ***document [3]*** for details about API function.

3.9.3. Turn Off with Linux Commands

It is also a safe way to use Linux commands, such as **shutdown** and **poweroff**, to turn off the module, which is similar to turning off the module via PWRKEY pin.

NOTE

1. To avoid damaging the data of internal flash, do not switch off the power supply when the module works normally. Only after the module is shut down by PWRKEY or API interface or Linux commands, the power supply can be cut off.
2. When you turn off module with API interface or Linux commands, keep PWRKEY at high level after the execution of power-off command. Otherwise, the module will be turned on again after successful turn-off.

3.10. Reset

The module can be reset by driving RESET low for 250–550 ms. As the RESET pin is sensitive to interference, the routing trace is recommended to be as short as possible and totally ground surrounded.

Table 11: RESET Pin Description

Pin Name	Pin No.	I/O	Description	Comment
RESET	8	DI	Reset the module	Internally pulled up to 1.8 V. Active low.

The recommended circuit is similar to the PWRKEY control circuit. An open drain/collector driver or button can be used to control the RESET.

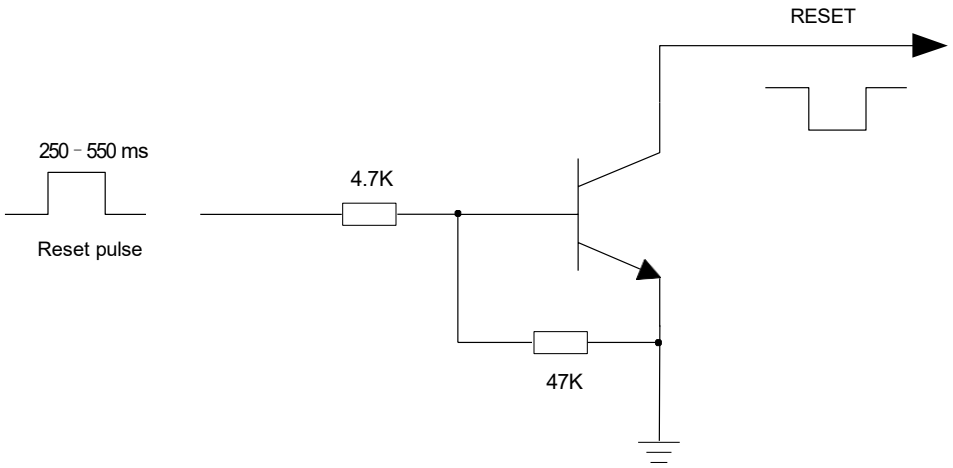


Figure 13: Reference Circuit of RESET by Using Driving Circuit

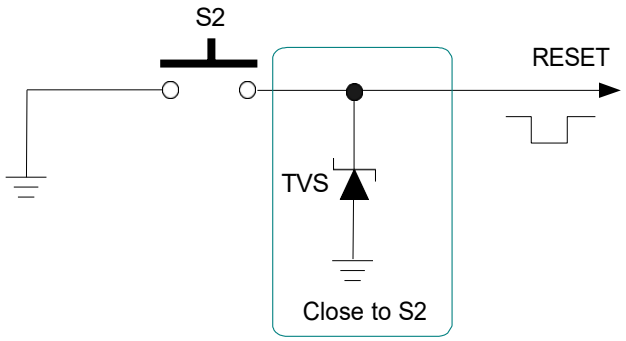


Figure 14: Reference Circuit of RESET by Using a Button

The reset scenario is illustrated in the following figure.

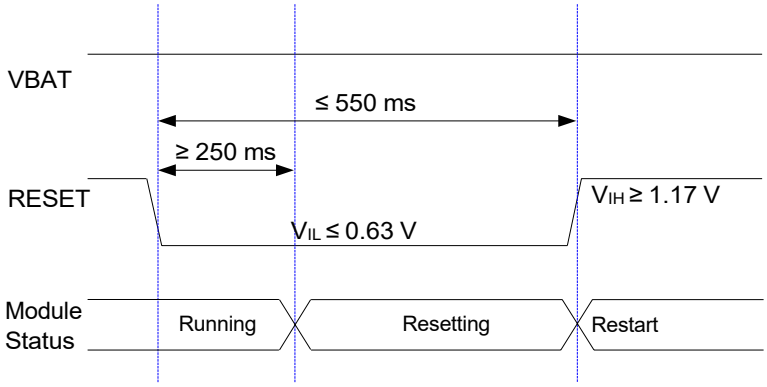


Figure 15: Reset Timing

NOTE

1. Ensure that there is no large capacitance load on RESET pin.
2. RESET should only be used when turning off the module by API interface, Linux commands and PWRKEY pin all failed.

3.11. (U)SIM Interfaces

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both 1.8 V and 3.0 V (U)SIM cards are supported.

Table 12: Pin Definition of (U)SIM Interfaces

Pin Name	Pin No.	I/O	Description	Comment
USIM1_VDD	251	PO	(U)SIM1 card power supply	Either 1.8 V or 3.0 V is supported by the module automatically.
USIM1_DATA	254	DIO	(U)SIM1 card data	
USIM1_CLK	253	DO	(U)SIM1 card clock	
USIM1_RST	250	DO	(U)SIM1 card reset	
USIM2_VDD	256	PO	(U)SIM2 card power supply	
USIM2_DATA	257	DIO	(U)SIM2 card data	
USIM2_CLK	259	DO	(U)SIM2 card clock	

USIM2_RST	260	DO	(U)SIM2 card reset	
USIM1_DET	255	DI	(U)SIM1 card hot-plug detect	1.8 V power domain. If unused, keep them open.
USIM2_DET	258	DI	(U)SIM2 card hot-plug detect	

The following figure shows a reference design for (U)SIM interface with an 8-pin (U)SIM card connector.

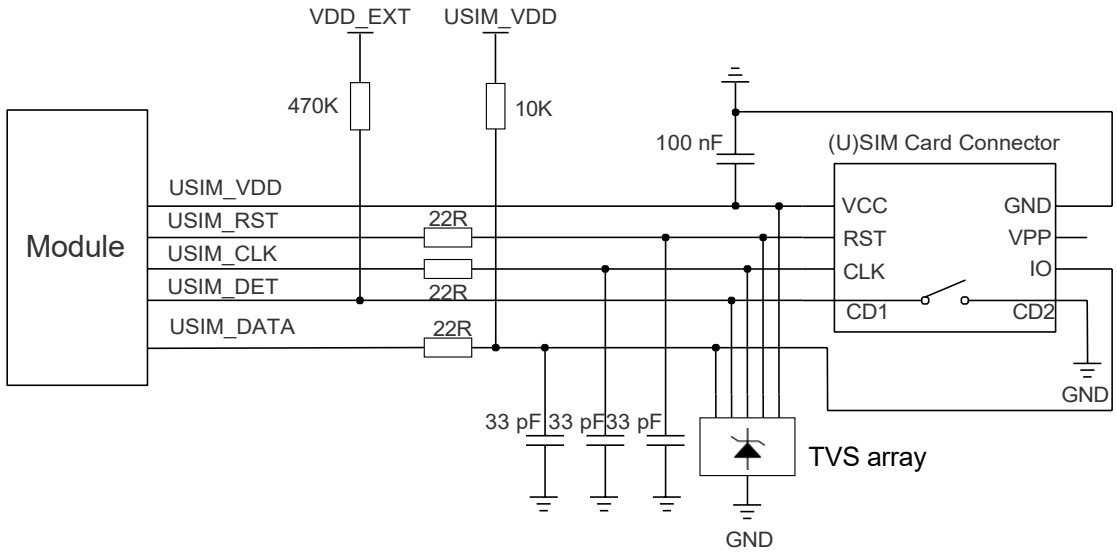


Figure 16: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

If (U)SIM card detection function is not needed, keep USIM_DET unconnected. A reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector is illustrated in the following figure.

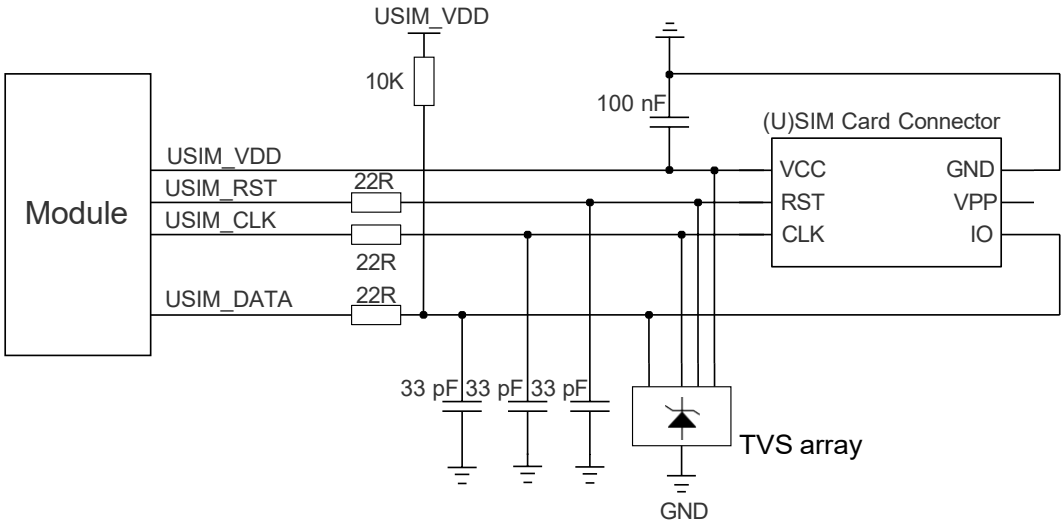


Figure 17: Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

To enhance the reliability and availability of the (U)SIM card in your applications, follow the criteria below in the (U)SIM circuit design:

- Keep the placement of (U)SIM card connector as close to the module as possible. Keep the trace length as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- Assure the trace between the ground of the module and that of the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD not less than 0.5 mm to maintain the same electric potential.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- To offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 10 pF. The 22 Ω resistors should be added in series between the module and the (U)SIM card connector to suppress EMI spurious transmission and enhance ESD protection. The 33 pF capacitors are used for filtering interference of EGSM900. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The 10 kΩ pull-up resistor on USIM_DATA trace can improve anti-jamming capability when long layout trace and sensitive occasions are applied, and should be placed close to the (U)SIM card connector.

NOTE

1. The load capacitance of (U)SIM interface will affect the rising and falling time of the data exchange.
2. (U)SIM2 interface is optional.

3.12. USB Interface

The module provides one integrated USB interface which complies with the USB 3.0/2.0 specifications, and supports SuperSpeed (5 Gbps on USB 3.0) and high-speed (480 Mbps on USB 2.0) modes.

Both USB 2.0 and USB 3.0 support AT command communication, data transmission, GNSS NMEA sentence output, software debugging and voice over USB*.

USB 3.0 is used for data communication with AP by default. Only USB 2.0 can be used for firmware upgrading. When USB 2.0 and USB 3.0 are connected to the same host, USB 3.0 takes effect by default.

Table 13: Pin Description of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	84	DI	USB connection detect	Maximum current: 0.1 mA. Typical 5.0 V

USB_DP	85	AIO	USB 2.0 differential data (+)	Compliant with USB 2.0 standard specification. Require differential impedance of 90 Ω.
USB_DM	87	AIO	USB 2.0 differential data (-)	
USB_SS_TX_P	93	AO	USB 3.0 SuperSpeed transmit (+)	Compliant with USB 3.0 standard specification. Require differential impedance of 90 Ω.
USB_SS_TX_M	91	AO	USB 3.0 SuperSpeed transmit (-)	
USB_SS_RX_P	90	AI	USB 3.0 SuperSpeed receive (+)	
USB_SS_RX_M	88	AI	USB 3.0 SuperSpeed receive (-)	

For more details about the USB 3.0 and 2.0 specifications, visit http://www.usb.org/home.

It is recommended to reserve USB 2.0 for firmware upgrade in application designs, and reserve test points for debugging purpose. The following figure is the reference circuits of USB 2.0 interface.

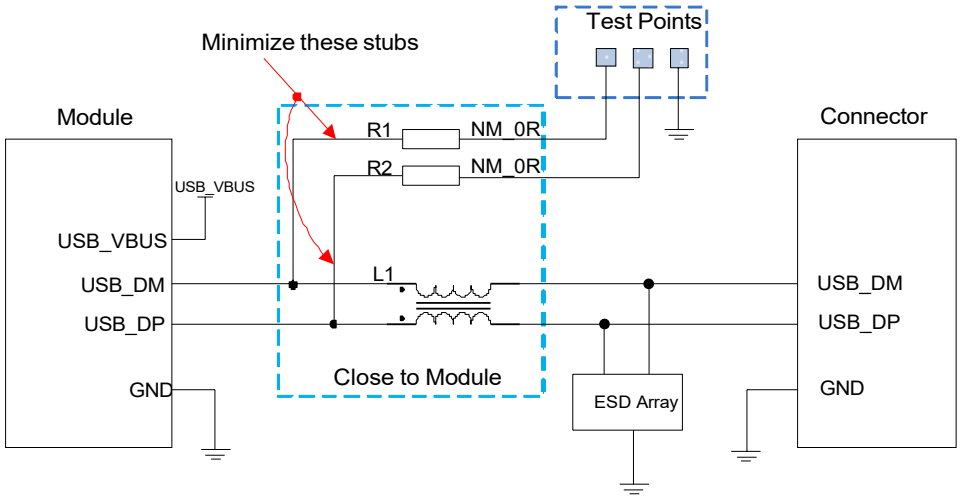


Figure 18: Reference Circuit of USB 2.0 Application

In USB 2.0 applications, a common mode choke L1 is recommended to be added in series between the module and MCU to suppress EMI spurious transmission. Meanwhile, the 0 Ω resistors (R1 and R2) should be added in series between the module and the test points to facilitate debugging, and the resistors are not mounted by default. To ensure signal integrity of USB data traces, place R1, R2 and L1 close to the module, and also place these resistors close to each other. The extra stubs of trace must be as short as possible.

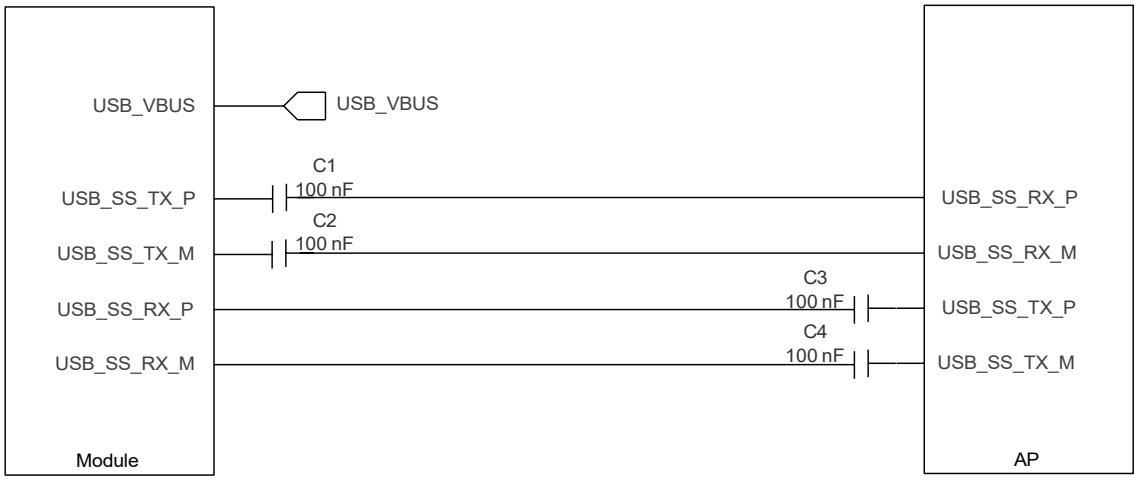


Figure 19: Reference Circuit of USB 3.0 Application

In USB 3.0 application, place C1 and C2 near the module, and place C3 and C4 near the AP. The extra stubs of trace must be as short as possible.

To meet USB 2.0 and USB 3.0 specifications, the following principles of USB interface should be complied with.

- It is important to route the USB 2.0 and 3.0 signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90 Ω.
- The length of each trace in USB 2.0 differential pair should be less than 120 mm, and the length matching of the differential pair should be less than 0.7 mm (5 ps).
- The length of each trace in USB 3.0 differential pairs should be less than 100 mm, and the length matching of each differential pair should be less than 0.7 mm (5 ps).
- Do not route signal traces under crystals, oscillators, magnetic devices, PCIe and RF signal traces. It is important to route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. Route the RF signals operating at 2.4 GHz frequency with the highest isolation possible from USB_SS_TX/RX traces.
- Keep the ESD protection components as close to the USB connector as possible.
- Junction capacitance of the ESD protection component might cause influences on USB data traces, so you should pay attention to the selection of the device. Typically, the capacitance value should be less than 2.0 pF for USB 2.0, and less than 0.4 pF for USB 3.0.
- USB_SS_TX AC coupling capacitors can be anywhere along the line, but better to be placed close to the source or the ESD/connector side to keep good signal integrity of main route on PCB.

NOTE

1. The module supports USB host mode, but works in slave mode by default.
2. The high-speed PHY and SuperSpeed PHY share the same controller inside baseband chipset, so USB 2.0 and USB 3.0 cannot be used simultaneously.

3.13. UART Interfaces

The module provides three UART interfaces: UART1, Bluetooth UART and debug UART. The following are the features of these UART interfaces.

- UART1 and Bluetooth UART interfaces support RTS and CTS hardware flow control, and are used for data transmission with peripherals. They support 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800 and 921600 bps baud rates, and the default is 115200 bps.
- Debug UART interface supports 115200 bps baud rate, and is used for Linux console and log output.

The following tables show the pin definition of the UART interfaces.

Table 14: Pin Definition of UART1 Interface

Pin Name	Pin No.	I/O	Description	Comment
UART1_CTS	71	DO	DTE clear to send signal from DCE (Connects to DTE's CTS)	1.8 V power domain. Can be configured to GPIOs.
UART1_RTS	74	DI	DTE request to send signal to DCE (Connects to DTE's RTS)	
UART1_TXD	70	DO	UART1 transmit	
UART1_RXD	72	DI	UART1 receive	

Table 15: Pin Definition of Bluetooth UART Interface

Pin Name	Pin No.	I/O	Description	Comment
BT_UART_TXD	59	DO	Bluetooth UART transmit	1.8 V power domain. Can be configured to GPIOs.
BT_UART_RXD	63	DI	Bluetooth UART receive	
BT_UART_RTS	61	DI	DTE request to send signal to DCE (Connects to DTE's RTS)	
BT_UART_CTS	62	DO	DTE clear to send signal from DCE (Connects to DTE's CTS)	

Table 16: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	107	DO	Debug UART transmit	1.8 V power domain
DBG_RXD	110	DI	Debug UART receive	1.8 V power domain

The module provides 1.8 V UART interfaces. A voltage-level translator should be used if your application is equipped with a 3.3 V UART interface. The following figure shows a reference design.

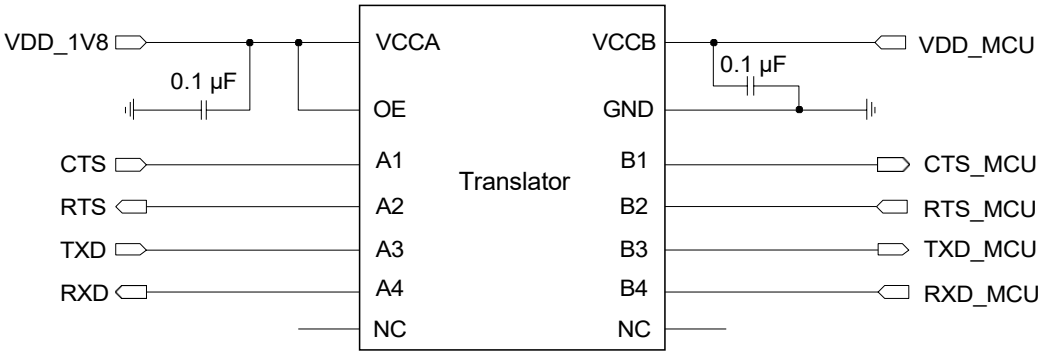


Figure 20: Reference Circuit with Translator Chip

Another example with transistor translation circuit is shown as below. The circuit design of dotted line section can refer to the design of solid line section, in terms of both module input and output circuit designs, but pay attention to the direction of connection.

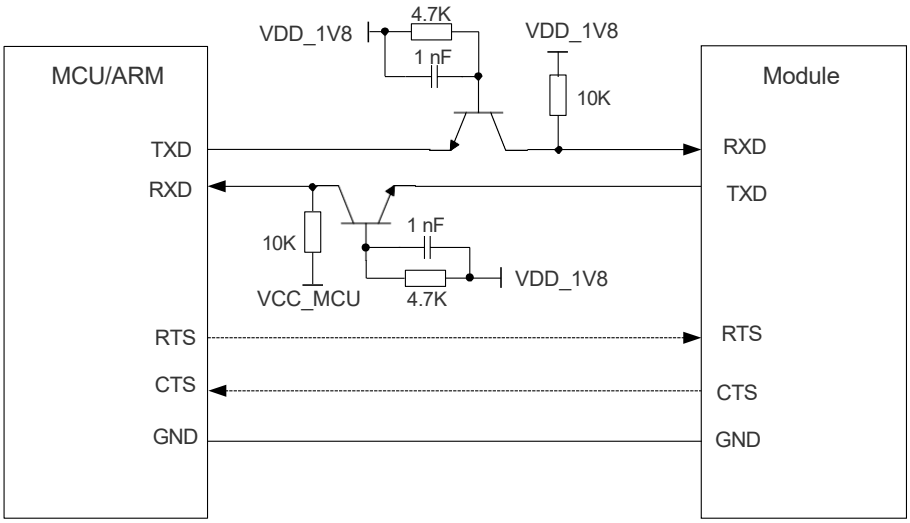


Figure 21: Reference Circuit with Transistor Circuit

NOTE

1. Transistor circuit solution is not suitable for applications with high baud rates exceeding 460 kbps.
2. For the purpose of reducing power consumption, it is recommended to switch off the power supply for VDD_1V8 in sleep mode.
3. If hardware flow control is intended to be used, then CTS and RTS should also be designed with the level-shifting circuit.
4. Please note that the module's CTS is connected to the host's CTS, and the module's RTS is connected to the host's RTS.

3.14. I2S and I2C Interfaces

The module provides I2S and I2C interfaces for audio design. The following table shows the pin definition of I2S and I2C interfaces which can be applied on audio codec design.

Table 17: Pin Definition of I2S Interface

Pin Name	Pin No.	I/O	Description	Comment
CDC_RST	77	DO	External codec reset	1.8 V power domain. Can be configured to GPIOs.
I2S_MCLK	81	DO	Clock output for codec	
I2S_WS	265	DIO	I2S word select	
I2S_SCK	262	DIO	I2S clock	
I2S_DIN	263	DI	I2S data in	
I2S_DOUT	261	DO	I2S data out	

Table 18: Pin Definition of I2C Interface

Pin Name	Pin No.	I/O	Description	Comment
I2C1_SCL	79	OD	I2C serial clock	Require external pull-up to 1.8 V. Can be configured to GPIOs.
I2C1_SDA	80	OD	I2C serial data	

The following figure shows a reference design of I2S and I2C interfaces with an external codec IC.

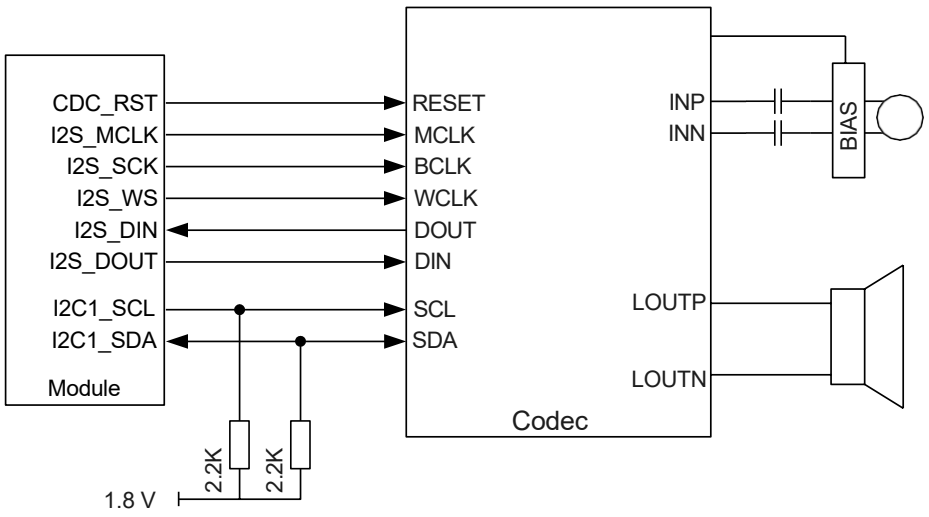


Figure 22: Reference Circuit of I2S and I2C Application with Audio Codec

NOTE

The module works as a master device in applications pertaining to I2C interface.

3.15. PCM Interface

The module provides one PCM interface for Bluetooth audio transmission function by default. See ***Chapter 3.19*** for more details.

The PCM interface supports the following modes:

- Primary mode (short frame synchronization, works as both master and slave)
- Auxiliary mode (long frame synchronization, works as master only)

Table 19: Pin Definition of PCM Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_SYNC	73	DIO	PCM data frame sync	In master mode, it is an output signal. In slave mode, it is an input signal. 1.8 V power domain. Can be configured to GPIO.
PCM_CLK	75	DIO	PCM clock	
PCM_IN	76	DI	PCM data input	1.8 V power domain.

PCM_OUT	78	DO	PCM data output	Can be configured to GPIO.

In primary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC falling edge represents the MSB. In this mode, the PCM interface supports 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM_CLK at 8 kHz PCM_SYNC, and also supports 4096 kHz PCM_CLK at 16 kHz PCM_SYNC.

In auxiliary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC rising edge represents the MSB. In this mode, the PCM interface operates with a 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM_CLK and an 8 kHz, 50% duty cycle PCM_SYNC only.

The module supports 16-bit linear data format. The following figures show the primary mode's timing relationship with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK, as well as the auxiliary mode's timing relationship with 8 kHz PCM_SYNC and 256 kHz PCM_CLK.

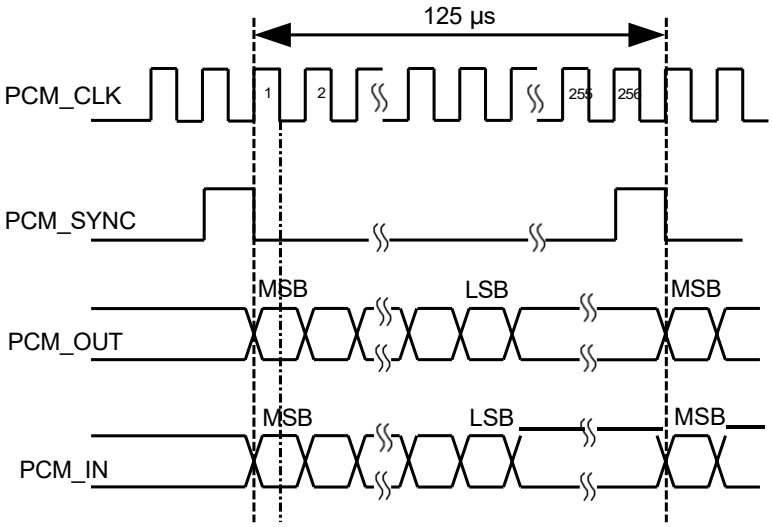


Figure 23: Primary Mode Timing

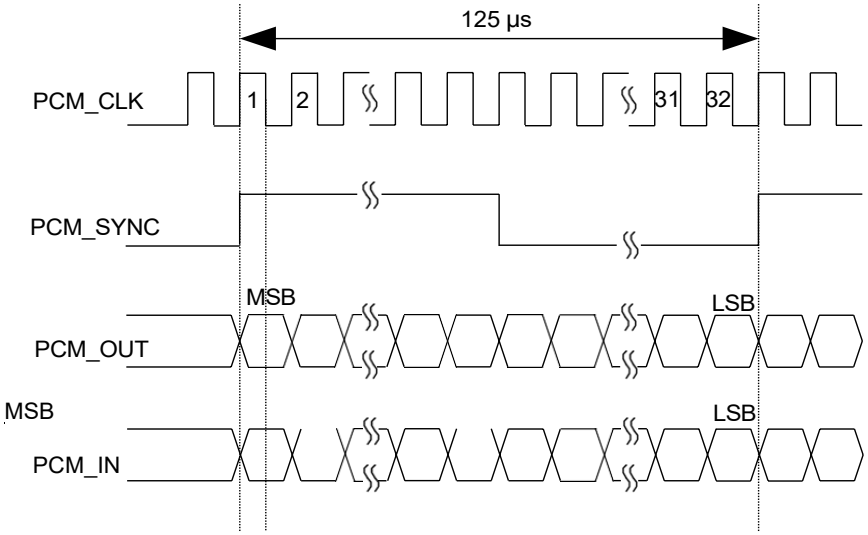


Figure 24: Auxiliary Mode Timing

Clock and mode can be configured, and the default configuration is master mode using short frame sync format with 2048 kHz PCM_CLK and 8 kHz PCM_SYNC.

NOTE

3.16. SDIO Interface

The module provides an SDIO interface. It is recommended to use the interface for eMMC application.

The following tables show the pin definition of SDIO interface.

Table 20: Pin Definition of SDIO Interface

Pin Name	Pin No.	I/O	Description	Comment
SDIO_VDD	60	PI	SDIO power supply	Connect it to VDD_EXT.
SDC1_DATA_0	49	DIO	SDIO data bit 0	1.8 V power domain.
SDC1_DATA_1	50	DIO	SDIO data bit 1	

SDC1_DATA_2	51	DIO	SDIO data bit 2	
SDC1_DATA_3	52	DIO	SDIO data bit 3	
SDC1_CMD	48	DIO	SDIO command	
SDC1_DATA_4	53	DIO	SDIO data bit 4	1.8 V power domain. For eMMC configuration by default. Can be configured to GPIOs. If unused, keep them open.
SDC1_DATA_5	55	DIO	SDIO data bit 5	
SDC1_DATA_6	56	DIO	SDIO data bit 6	
SDC1_DATA_7	58	DIO	SDIO data bit 7	
SDC1_CLK	47	DIO	SDIO clock	1.8 V power domain.
EMMC_RST*	54	DO	eMMC reset	1.8 V power domain.
EMMC_PWR_EN	45	DO	eMMC power supply enable control	

3.16.1. Reference Design for eMMC Application

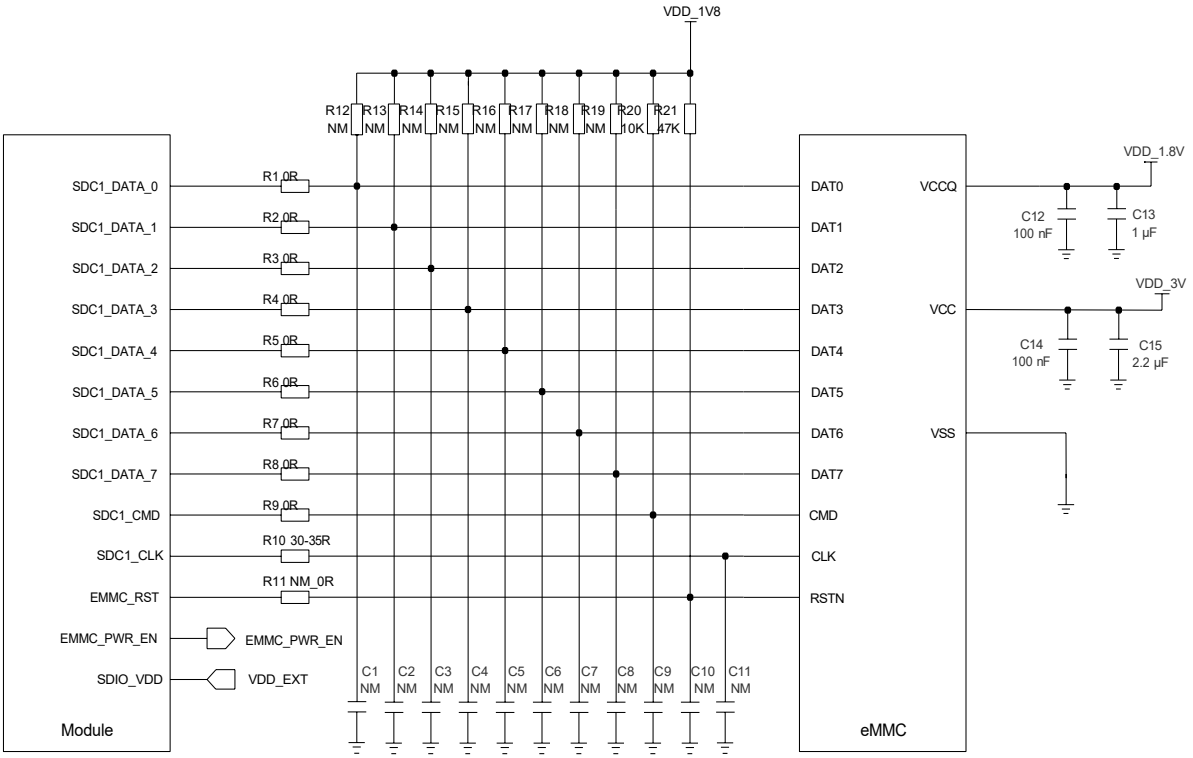


Figure 25: Reference Design for eMMC Application

Follow the principles below in eMMC circuit design:

- To avoid jitter of bus, it is recommended to reserve resistors R12–R19 (10–100 kΩ) to pull up SDIOs to VDD_1V8. Resistors R12–R19 are not mounted by default.
- To improve signal quality, it is recommended to add 0 Ω resistors R1–R9 and R11 in series between the module and eMMC. Resistor R10 should be 30–35 Ω. The bypass capacitors C1–C11 are reserved and not mounted by default. All resistors and bypass capacitors should be placed close to the module.
- SDIO signal traces should comply with the following principles:
  1) It is important to route the SDIO signal traces with ground surrounded. The impedance of SDIO data trace is 50 Ω ±10 %.
  2) Keep the spacing between adjacent SDC1_DATA traces and that between SDC1_DATA and SDC1_CLK traces at least twice the trace width.
  3) Keep SDIO signals far away from other sensitive circuits/signals such as RF circuits and analog signals, as well as noisy signals such as clock signals and DC-DC signals.
  4) It is recommended to keep the trace length difference between SDC1_CLK and SDC1_DATA[0:7]/SDC1_CMD less than 1 mm and the total routing length less than 50 mm. The total trace length inside the module is 17 mm, so the exterior total trace length should be less than 33 mm.
  5) Keep the spacing between SDIO and other signal traces at least twice the trace width and the load capacitance of SDIO bus less than 40 pF.

3.17. SPI Interfaces

The module provides two SPI interfaces supporting only master mode. The maximum clock frequency of SPI is up to 50 MHz.

The following tables show the pin definition of SPI interfaces.

Table 21: Pin Definition of SPI Interfaces

Pin Name	Pin No.	I/O	Description	Comment
SPI1_CLK	216	DO	SPI1 clock	1.8 V power domain. Can be configured to GPIOs.
SPI1_CS	213	DO	SPI1 chip select	
SPI1_MISO	219	DI	SPI1 master-in slave-out	
SPI1_MOSI	210	DO	SPI1 master-out slave-in	

SPI2_CLK [24]	103	DO	SPI2 clock
SPI2_CS [24]	105	DO	SPI2 chip select
SPI2_MISO [24]	106	DI	SPI2 master-in slave-out
SPI2_MOSI [24]	108	DO	SPI2 master-out slave-in

The following figure shows the timing relationship of SPI interfaces. The related parameters of SPI timing are shown in the table below.

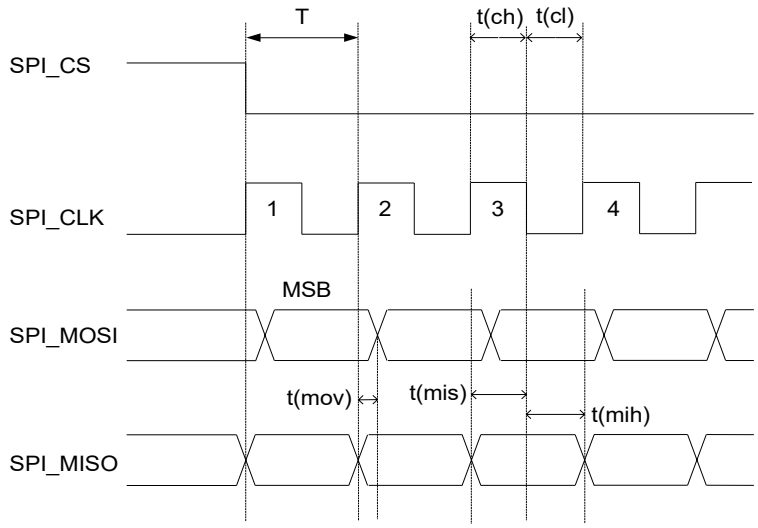


Figure 26: SPI Timing

Table 22: Parameters of SPI Interfaces Timing

Parameter	Description	Min.	Typ.	Max.	Unit
T	SPI clock period	20.0	-	-	ns
t(ch)	SPI clock high-level time	9.0	-	-	ns
t(cl)	SPI clock low-level time	9.0	-	-	ns
t(mov)	SPI master data output valid time	-5.0	-	5.0	ns
t(mis)	SPI master data input setup time	5.0	-	-	ns
t(mih)	SPI master data input hold time	1.0	-	-	ns

[24] SPI2 interface is optional.

NOTE

The module provides two 1.8 V SPI interfaces. A voltage-level translator should be used between the module and the host if your application is equipped with a 3.3 V processor or device interface.

3.18. RGMII Interface

The module includes an integrated Ethernet MAC with a RGMII interface. Key features of the RGMII interface are shown below:

- Supports IEEE 1588-2008, IEEE 802.1AS-2011 and IEEE 802.1Qav-2009
- Supports half/full duplex for 10/100/1000 Mbps
- Supports VLAN tagging
- Supports connection to an external Ethernet PHY such as Marvell 88Q2112, or an external switch

The following table shows the pin definition of RGMII interface.

Table 23: Pin Definition of RGMII Interface

Pin Name	Pin No.	I/O	Description	Comment
RGMII_MD_IO	10	DIO	RGMII management data	Power domain determined by RGMII_PWR_IN.
RGMII_MD_CLK	11	DO	RGMII management data clock	
RGMII_RX_0	13	DI	RGMII receive data bit 0	
RGMII_RX_1	14	DI	RGMII receive data bit 1	
RGMII_CTL_RX	15	DI	RGMII receive control	
RGMII_RX_2	16	DI	RGMII receive data bit 2	
RGMII_RX_3	17	DI	RGMII receive data bit 3	
RGMII_CK_RX	19	DI	RGMII receive clock	
RGMII_TX_0	20	DO	RGMII transmit data bit 0	
RGMII_CTL_TX	21	DO	RGMII transmit control	
RGMII_TX_1	22	DO	RGMII transmit data bit 1	
RGMII_TX_2	23	DO	RGMII transmit data bit 2	

RGMII_CK_TX	24	DO	RGMII transmit clock	
RGMII_TX_3	25	DO	RGMII transmit data bit 3	
RGMII_PWR_EN	27	DO	Enable external power supply to power RGMII_PWR_IN	1.8 V power domain. If unused, keep it open.
RGMII_PWR_IN	28	PI	RGMII interface power supply input	Typical voltage: 1.8/2.5 V. If RGMII interface is not used, connect this pin to VDD_EXT.
RGMII_INT	29	DI	RGMII interrupt output	1.8 V power domain.
RGMII_RST	31	DO	Reset output for RGMII PHY	

The following figure shows the simplified block diagram for Ethernet application.

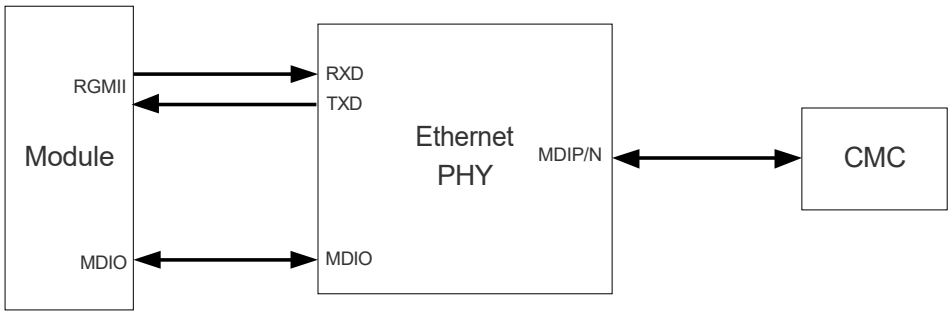


Figure 27: Simplified Block Diagram for Ethernet Application

The following figure shows a reference design of RGMII interface with PHY application. For more details, see ***document [7]***.

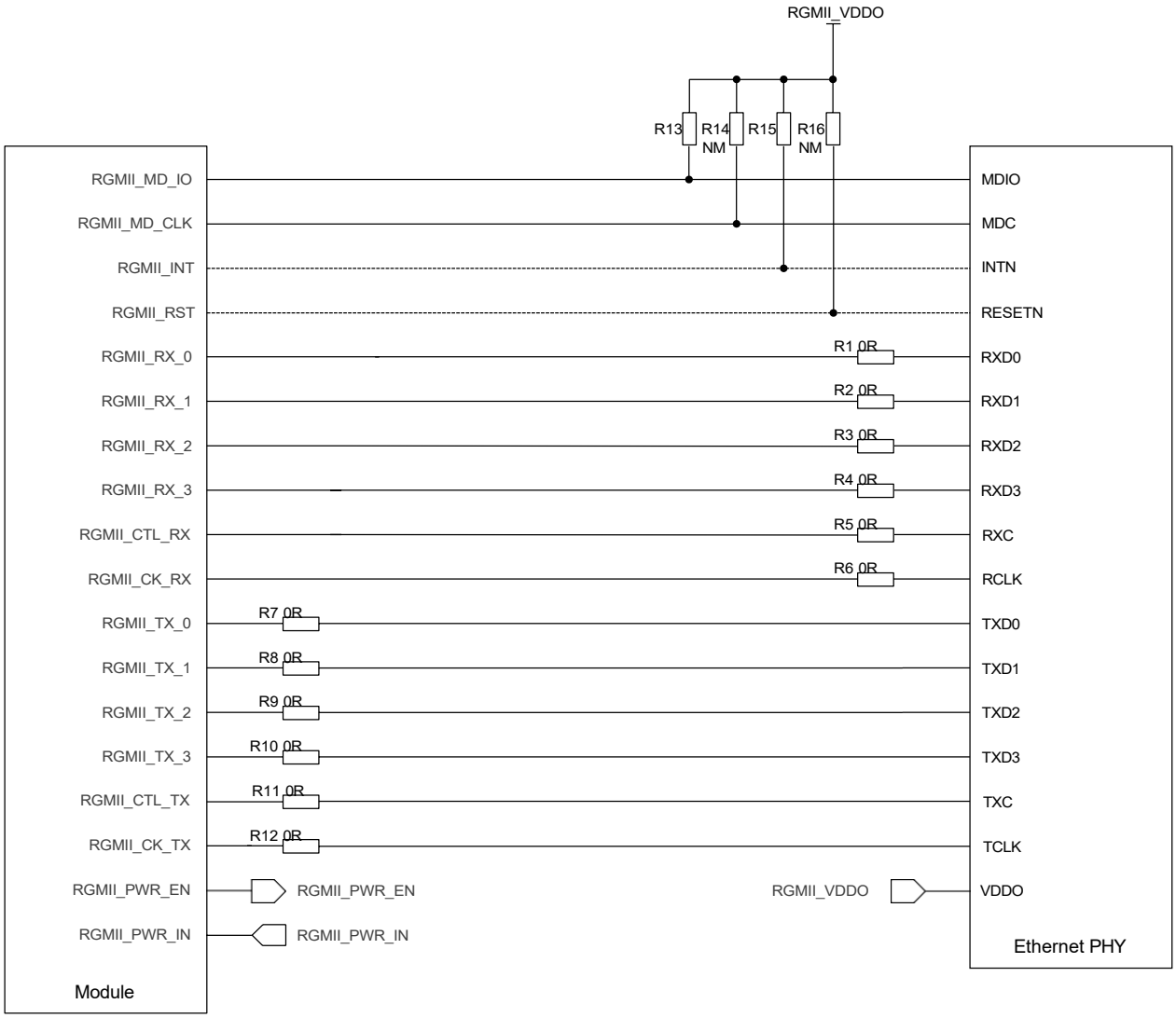


Figure 28: Reference Circuit of RGMII Interface with PHY Application

To enhance the reliability and availability of your application, follow the criteria below in the Ethernet PHY circuit design:

- The I/O voltage of RGMII matches with that of PHY.
- The typical power consumption of RGMII_PWR_IN is 150 mA @ 1.8 V.
- Keep RGMII data and control signals away from sensitive signals, such as RF, clock, VBAT and analog signals.
- Ensure the impedance of RGMII signals trace is 50 Ω ±20 %.
- The length matching between Tx signals (RGMII_CK_TX, RGMII_CTL_TX and RGMII_TX_[0:3]) or Rx signals (RGMII_CK_RX, RGMII_CTL_RX and RGMII_RX_[0:3]) is less than 2 mm.
- Keep the spacing between Tx bus traces (RGMII_CK_TX, RGMII_CTL_TX, RGMII_TX_[0:3]) or that between Rx bus traces (RGMII_CK_RX, RGMII_CTL_RX, RGMII_RX_[0:3]) at least twice the trace width.
- Keep the spacing between Tx bus and Rx bus traces at least 2.5 times trace width.

- Keep the spacing between of RGMII and other signal traces at least 3 times trace width.
- Resistors R7–R12 should be placed near the module. Resistors R1–R6 should be placed near the Ethernet PHY. The value of R1–R16 varies with the selection of PHY.

3.19. WLAN and Bluetooth Application Interfaces

The module provides a PCIe interface for WLAN function, and UART and PCM interfaces for Bluetooth function. If Bluetooth function is needed, the module should be connected with WLAN & Bluetooth module.

The following table shows the pin definition of wireless connectivity interfaces.

Table 24: Pin Definition of WLAN and Bluetooth Application Interfaces

PCIe Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
PCIE_REFCLK_P	40	AIO	PCIe reference clock (+)	Require differential impedance of 95 Ω.
PCIE_REFCLK_M	38	AIO	PCIe reference clock (-)	Serves as an output signal in RC mode. Serves as an input signal in EP mode.
PCIE_TX_M	44	AO	PCIe transmit (-)	Require differential impedance of 95 Ω.
PCIE_TX_P	46	AO	PCIe transmit (+)	
PCIE_RX_M	32	AI	PCIe receive (-)	
PCIE_RX_P	34	AI	PCIe receive (+)	
PCIE_CLKREQ	36	DIO	PCIe clock request	1.8 V power domain. Serves as an input signal in RC mode. Serves as an output signal in EP mode.
PCIE_WAKE	30	DIO	PCIe wakeup	
PCIE_RST	39	DIO	PCIe reset	1.8 V power domain. Serves as an output signal in RC mode. Serves as an input signal in EP mode.

Coexistence Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
COEX_UART_RXD	67	DI	LTE & WLAN/Bluetooth coexistence receive	1.8 V power domain.
COEX_UART_TXD	69	DO	LTE & WLAN/Bluetooth coexistence transmit	
Bluetooth Application Interfaces				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
BT_UART_TXD	59	DO	Bluetooth UART transmit	1.8 V power domain. Can be configured to GPIOs.
BT_UART_RXD	63	DI	Bluetooth UART receive	
BT_UART_RTS	61	DI	Bluetooth UART request to send	
BT_UART_CTS	62	DO	Bluetooth UART clear to send	
PCM_SYNC	73	DIO	PCM data frame sync	
PCM_CLK	75	DIO	PCM data bit clock	
PCM_IN	76	DI	PCM data input	
PCM_OUT	78	DO	PCM data output	
Other Interfaces				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
WLAN_PWR_EN1	222	DO	WLAN power supply enable control 1	1.8 V power domain.
WLAN_PWR_EN2	225	DO	WLAN power supply enable control 2	
WLAN_EN	228	DO	WLAN function enable control	
BT_EN	66	DO	Bluetooth enable control	
WLAN_SLP_CLK	231	DO	WLAN sleep clock	
VDD_WIFI_VM	276	PO	Medium-voltage power supply for Wi-Fi	Vnom = 1.35 V
VDD_WIFI_VH	277	PO	High-voltage power supply for Wi-Fi	Vnom = 1.95 V

NOTE

1. When WLAN or Bluetooth function is used, the coexistence interface must be used simultaneously. And the coexistence interface cannot be used as a general UART interface.
2. When Bluetooth function is enabled on the module, PCM_SYNC and PCM_CLK serve as output signals only.
3. It is recommended to pull up PCIE_CLKREQ and PCIE_WAKE to VDD_EXT.

The following figure shows a reference design for WLAN and Bluetooth interface application. For more details, see ***document [7]***.

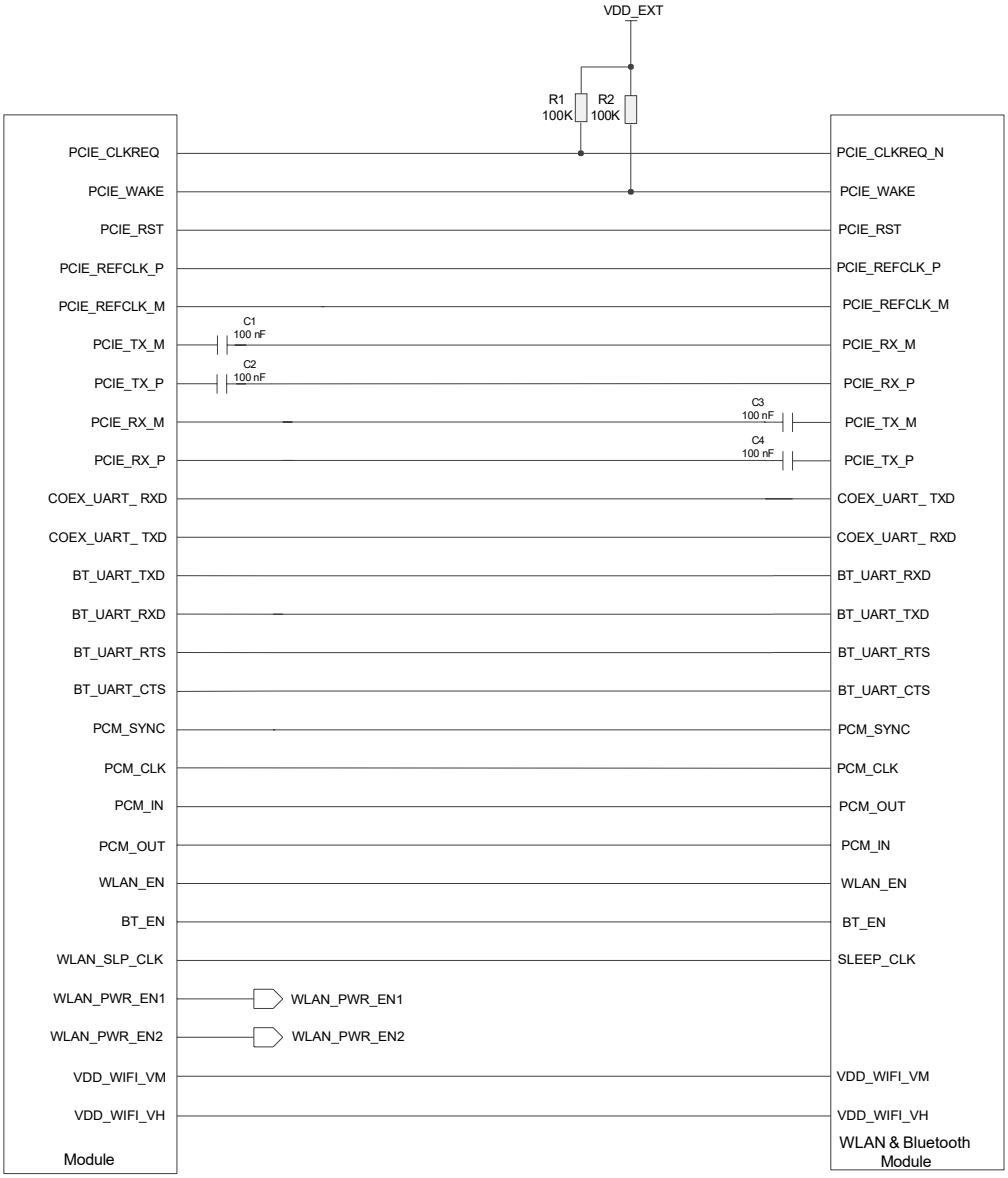


Figure 29: Reference Circuit for Connection with WLAN & Bluetooth Module

To ensure the signal integrity of PCIe interface, C1 and C2 should be placed close to the module, and C3 and C4 should be placed close to the WLAN & Bluetooth module. The extra stubs of trace must be as short as possible.

To meet PCIe Gen 2 specifications, the following principles of PCIe interface design should be complied with.

- It is important to route the PCIe signal traces as differential pairs with ground surrounded. And the differential impedance is 95 Ω ±10 %.
- The length of each trace in PCIE_TX, PCIE_RX and PCIE_REFCLK differential pairs should be less than 270 mm, and the length matching of each differential pair should be less than 0.7 mm (5 ps).
- Keep the spacing between Tx and Rx pairs at least 3 times trace width, and the spacing between Tx/Rx pairs and other signal traces at least 4 times trace width.
- Do not route PCIe signal traces under crystals, oscillators, magnetic devices or RF signal traces. It is important to route the PCIe differential traces in inner-layer with ground planes above and below.

3.20. ADC Interfaces

The module provides three analog-to-digital converter (ADC) interfaces. The voltage value on ADC pins can be read via **AT+QADC=<port>**, through setting **<port>** into 0, 1 or 2. For more details about the AT command, see ***document [4]***.

- **AT+QADC=0**: read the voltage value on ADC0
- **AT+QADC=1**: read the voltage value on ADC1
- **AT+QADC=2**: read the voltage value on ADC2 [25]
- **AT+QADC=3**: read the voltage value on ADC3 [26]

ADC related API can also read the voltage value of ADC. For more details, see ***document [6]***.

To improve the accuracy of ADC, the traces of ADC interfaces should be surrounded by ground.

Table 25: Pin Definition of ADC Interfaces

Pin Name	Pin No.	Description
ADC0	247	General purpose ADC interface
ADC1	245	General purpose ADC interface

[25] ADC2 is only supported by AG525R-GL, and reserved for other module models.
[26] ADC3 is only supported by AG529R-LA, and reserved for other module models.

ADC2 [25]	139	General purpose ADC interface
ADC3 [26]	113	General purpose ADC interface

The following table describes the characteristic of ADC interfaces.

Table 26: Characteristic of ADC Interfaces

Parameter	Min.	Typ.	Max.	Unit
ADC0 Voltage Range	0	-	1.875	V
ADC1 Voltage Range	0	-	1.875	V
ADC2 [25] Voltage Range	0	-	1.875	V
ADC3 [26] Voltage Range	0	-	1.875	V
ADC Resolution	-	14	-	bits
ADC Sample Rate	-	4.8	-	MHz

NOTE

1. The input voltage for each ADC interface must not exceed its corresponding voltage range.
2. It is prohibited to supply any voltage to ADC pins when VBAT is removed.
3. It is recommended to use resistor divider circuit for ADC application.

3.21. USB_BOOT Interface

The module provides a USB_BOOT pin. Developers can pull up the USB_BOOT to VDD_EXT before powering on the module, thus the module will enter emergency download mode when powered on. In this mode, the module supports firmware upgrade over USB 2.0 interface.

Table 27: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	83	DI	Force the module into emergency download mode	1.8 V power domain. Active high. If unused, keep it open.

The following figure shows a reference circuit of USB_BOOT interface.

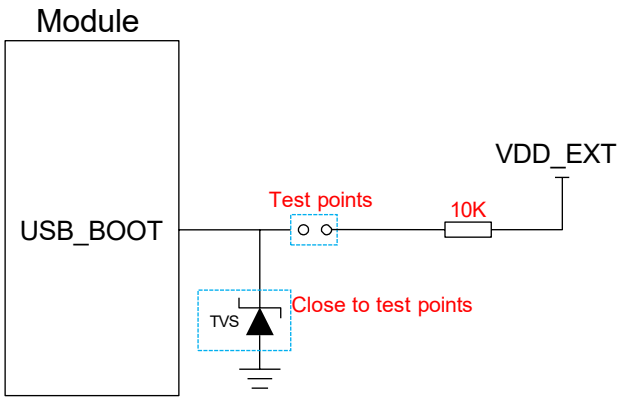


Figure 30: Reference Circuit of USB_BOOT Interface

3.22. RTC

The module has a real time clock within the PMIC, but has no dedicated RTC power supply pin. The RTC is powered by VBAT_BB. If VBAT_BB is removed, the RTC will not be maintained.

Table 28: RTC Performance Specification

Parameter	Test Condition	Max.	Unit
Accuracy	Power on	24	ppm
	Power down, but with power supply connected	200	ppm

3.23. GPIO Interfaces

AG520R series, AG521R series and AG529R series module provides 8 GPIOs and AG525R-GL provides 11 GPIOs for your designs.

Table 29: Pin Definition of GPIOs

Pin Name	Pin No.	I/O	Description	Comment
GPIO1	100	DIO	General-purpose input/output	1.8 V power domain. If unused, keep them open.
GPIO2	101	DIO		
GPIO3	102	DIO		
GPIO4	104	DIO		
GPIO5	116	DIO		
GPIO6	243	DIO		
GPIO7	246	DIO		
GPIO8	249	DO	General-purpose output	
GPIO9 [27]	264	DIO	General-purpose input/output	
GPIO10 [27]	267	DIO		
GPIO11 [27]	289	DIO		

3.24. Audio Interface (Optional)

The module is designed with an optional built-in audio codec to enable analog audio function. The following table shows the pin definition of analog audio interface.

Table 30: Pin Definition of Audio Interface

Pin Name	Pin No.	I/O	Description	Comment
MIC1_P	2	AI	Microphone input channel 1 (+)	If unused, keep these pins open.
MIC1_N	1	AI	Microphone input channel 1 (-)	
MIC2_P	5	AI	Microphone input channel 2 (+)	
MIC2_N	4	AI	Microphone input channel 2 (-)	

[27] GPIO9, GPIO10, GPIO11 are only supported by AG525R-GL, and reserved for other module models.

MICBIAS	3	PO	Bias voltage output for microphone	
SPK1_P	268	AO	Earphone analog output 1 (-)	
SPK1_N	266	AO	Earphone analog output 1 (-)	
SPK2_P	269	AO	Earphone analog output 2 (+)	
SPK2_N	270	AO	Earphone analog output 2 (-)	
AGND	6	-	Analog ground	Connect it to GND or keep it open if unused.

NOTE

1. The built-in codec uses the same signals as the module's I2C interface (pins 79, 80) and I2S interface (pins 261, 262, 263, 265) for external digital audio design. Therefore, when the built-in codec is utilized, the module's I2S interface cannot be used for other purposes (that is, keep pins 261, 262, 263 and 265 unconnected).
2. Connect AGND of the analog audio interface to the main ground through a 0 Ω resistor.
3. The built-in audio codec (analog audio function) is optional.

4 GNSS Receiver (Optional)

4.1. General Description

The module includes a fully integrated dual-band, multi-constellation GNSS solution that supports GPS, GLONASS, BDS, Galileo and QZSS.

The module supports standard NMEA 0183 protocol, and outputs NMEA sentences at 1–10 Hz (1 Hz by default) data update rate via USB interface.

By default, GNSS engine of the module is switched off. It has to be switched on via API. For more details about GNSS engine technology and configurations, see ***document [8]***.

4.2. GNSS Performance

The following table shows GNSS performance of the module.

Table 31: AG52xR Series GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition	Autonomous	-142	dBm
	Reacquisition	Autonomous	-152	dBm
	Tracking	Autonomous	-154	dBm
TTFF	Cold start @ open sky	Autonomous	34.99	s
		XTRA enabled	9.36	s
	Warm start @ open sky	Autonomous	33.6	s
		XTRA enabled	2.96	s

	Hot start @ open sky	Autonomous	2.87	s
		XTRA enabled	2.29	s
Accuracy	CEP-50	Autonomous @ open sky	1.5	m

NOTE

1. Tracking sensitivity: the minimum GNSS signal power at which the module can maintain lock (the module lost lock 3 times in 5 minutes for 10 seconds each time).
2. Reacquisition sensitivity: the minimum GNSS signal power required for the module to maintain lock within 5 minutes after loss of lock.
3. Acquisition sensitivity: the minimum GNSS signal power at which the module can fix position successfully within 3 minutes after executing cold start command.

4.3. Layout Guidelines

The following layout guidelines should be taken into account in application design.

- Maximize the distance among GNSS antenna, main antenna, Rx-diversity antenna, C-V2X TRX0 antenna and C-V2X TRX1 antenna.
- Digital circuits such as (U)SIM card, USB interface, camera module, display connector and eMMC should be kept away from the antennas.
- Use ground vias around the GNSS trace and sensitive analog signal traces to provide coplanar isolation and protection.
- Control the characteristic impedance for ANT_GNSS trace as 50 Ω.

See ***Chapter 5*** for GNSS antenna reference design and antenna installation information.

5 Antenna Interfaces

The antenna interfaces of the module are shown as follows, and the impedance of antenna ports is 50 Ω.

Table 32: Antenna Interfaces of the Modules

Interface Type	Number of Interface	Comment
Main antenna interface	1	ANT_MAIN
Rx-diversity antenna interface [28]	1	ANT_DIV
C-V2X antenna interfaces [29]	2	ANT_CV2X_TRX0, ANT_CV2X_TRX1
MIMO antenna interfaces [30]	2	ANT_MIMO3, ANT_MIMO4
GNSS antenna interface [31]	1	ANT_GNSS

5.1. Cellular and C-V2X Antenna Interfaces

5.1.1. Pin Definition

The pin definition of main, Rx-diversity, MIMO and C-V2X antenna interfaces are shown below.

Table 33: Pin Definition of Main/Rx-diversity/C-V2X Antenna Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	143	AIO	Main antenna interface	50 Ω impedance
ANT_DIV	170	AI	Diversity antenna interface	

[28] The Rx-diversity antenna is used to resist the fall of signals caused by high-speed movement and multipath effect.
[29] C-V2X is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.
[30] ANT_MIMO3 and ANT_MIMO4 are not supported by AG520R-CN, AG521R-CN AG529R-CN and AG529R-EU, and optional for other module models.
[31] AG529R-CN supports single-frequency GNSS L1 by default, but the module is designed to be compatible with dual-frequency GNSS.

ANT_MIMO3	188	AI	4 × 4 MIMO antenna interface
ANT_MIMO4	161	AI	4 × 4 MIMO antenna interface
ANT_CV2X_TRX0	214	AIO	C-V2X TRX0 antenna interface
ANT_CV2X_TRX1	205	AIO	C-V2X TRX1 antenna interface

5.1.2. Operating Frequency

Table 34: AG520R-CN Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-TDD B34	2010–2025	2010–2025	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz
C-V2X TDD B47 [32]	5855–5925	5855–5925	MHz

[32] C-V2X TDD B47 is supported by AG520R-CN/-EU/-NA/-JP. AG525R-GL does not support C-V2X. AG521R series and AG529R series do not support C-V2X by default.

Table 35: AG520R-EU Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B32 [33]	-	1452–1496	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz
C-V2X TDD B47 [32]	5855–5925	5855–5925	MHz

Table 36: AG520R-NA Operating Frequencies

3GPP Band	Transmit	Receive	Unit
LTE-FDD B2	1850–1910	1930–1990	MHz

[33] LTE-FDD B29, B30 and B32 support Rx only, and B30 is subject to carrier's deployment.

LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B12	699–716	729–746	MHz
LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B14	788–798	758–768	MHz
LTE-FDD B25	1850–1915	1930–1995	MHz
LTE-FDD B26	814–849	859–894	MHz
LTE-FDD B29 [33]	-	717–728	MHz
LTE-FDD B30 [33]	-	2350–2360	MHz
LTE-FDD B66	1710–1780	2110–2200	MHz
LTE-FDD B71	663–698	617–652	MHz
C-V2X TDD B47 [32]	5855–5925	5855–5925	MHz

Table 37: AG520R-JP Operating Frequencies

3GPP Band	Transmit	Receive	Unit
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B5	826–847	871–892	MHz
WCDMA B8	880–915	925–960	MHz
WCDMA B9	1752–1782	1847–1877	MHz
WCDMA B19	830–845	875–890	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz

LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B9	1750–1785	1845–1880	MHz
LTE-FDD B11	1428–1448	1476–1496	MHz
LTE-FDD B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B21	1448–1463	1496–1511	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz
C-V2X TDD B47 [32]	5855~5925	5855~5925	MHz

Table 38: AG521R-CN Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-TDD B34	2010–2025	2010–2025	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz

LTE-TDD B41	2496–2690	2496–2690	MHz

Table 39: AG521R-EU Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B32 [33]	-	1452–1496	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz

Table 40: AG521R-NA Operating Frequencies

3GPP Band	Transmit	Receive	Unit
LTE-FDD B2	1850–1910	1930–1990	MHz

LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B12	699–716	729–746	MHz
LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B14	788–798	758–768	MHz
LTE-FDD B25	1850–1915	1930–1995	MHz
LTE-FDD B26	814–849	859–894	MHz
LTE-FDD B29 [33]	-	717–728	MHz
LTE-FDD B30 [33]	-	2350–2360	MHz
LTE-FDD B66	1710–1780	2110–2200	MHz
LTE-FDD B71	663–698	617–652	MHz

Table 41: AG525R-GL Operating Frequencies

3GPP Band	Transmit	Receive	Unit
GSM850	824–850	869–894	MHz
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
PCS1900	1850–1910	1930–1990	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B2	1850–1910	1930–1990	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B4	1710–1755	2110–2155	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B6	830–840	875–885	MHz

WCDMA B8	880–915	925–960	MHz
WCDMA B19	830–845	875–890	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B2	1850–1910	1930–1990	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B9	1749.9–1784.9	1844.9–1879.9	MHz
LTE-FDD B11	1427.9–1447.9	1475.9–1495.9	MHz
LTE-FDD B12	698–716	728–746	MHz
LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B21	1447.9–1462.9	1495.9–1510.9	MHz
LTE-FDD B25	1850–1915	1930–1995	MHz
LTE-FDD B26	814–849	859–894	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B29 [33]	-	717–728	MHz
LTE-FDD B30 [33]	-	2350–2360	MHz
LTE-FDD B32 [33]	-	1452–1496	MHz
LTE-FDD B66	1710–1780	2110–2200	MHz
LTE-FDD B71	663–698	617–652	MHz

LTE-TDD B34	2010–2025	2010–2025	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz

Table 42: AG529R-CN Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7 [34]	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-TDD B34	2010–2025	2010–2025	MHz
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2555–2655	2555–2655	MHz

[34] LTE-FDD B7 is optional on AG529R-CN.

Table 43: AG529R-EU Operating Frequencies

3GPP Band	Transmit	Receive	Unit
EGSM900	880–915	925–960	MHz
DCS1800	1710–1785	1805–1880	MHz
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B28A	703–733	758–788	MHz
LTE-TDD B38 [35]	2570–2620	2570–2620	MHz
LTE-TDD B40 [35]	2300–2400	2300–2400	MHz
LTE-TDD B41 [35]	2496–2690	2496–2690	MHz

Table 44：AG529R-LA Operating Frequencies

3GPP Band	Transmit	Receive	Unit
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B2	1850–1910	1930–1990	MHz
WCDMA B5	824–849	869–894	MHz
WCDMA B8	880–915	925–960	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B2	1850–1910	1930–1990	MHz

[35] LTE-TDD B38, B40 and B41 are optional on AG529R-EU.

LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B28A	703–733	758–788	MHz
LTE-FDD B28B	718–748	773–803	MHz

5.1.3. Reference Design

A reference design of main and Rx-diversity antenna interfaces is shown as below. It is recommended to reserve a π-type matching circuit for better RF performance, and the π-type matching components (R1/C1/C2 and R2/C3/C4) should be placed as close to the antennas as possible. The capacitors are not mounted by default.

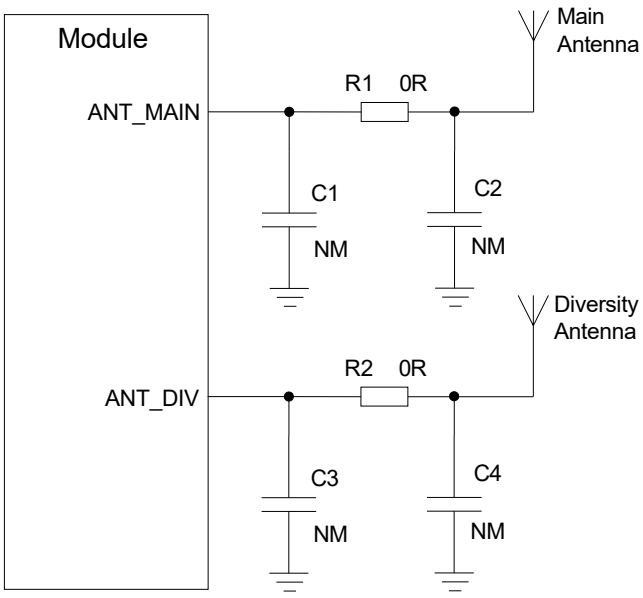


Figure 31: Reference Circuit of RF Antenna Interfaces

NOTE

1. C-V2X TRX antennas share the same reference design and design requirements with the main and Rx-diversity antennas. If C-V2X function is not used, keep C-V2X antenna interface pins (ANT_CV2X_TRX0, ANT_CV2X_TRX1) unconnected.

2. Keep a proper distance between the main antenna, Rx-diversity antenna, C-V2X TRX antennas to improve receiving sensitivity.

5.2. GNSS Antenna Interface

The following tables show the pin definition and frequency specification of GNSS antenna interface.

Table 45: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	197	AI	GNSS antenna interface	50 Ω impedance

Table 46: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42 ±1.023 (L1) 1176.45 ±10.23 (L5)	MHz
GLONASS	1597.5–1605.8	MHz
Galileo	1575.42 ±2.046 (E1) 1176.45 ±10.23 (E5a)	MHz
BDS	1561.098 ±2.046	MHz
QZSS	1575.42 (L1) 1176.45 (L5)	MHz

A reference design of GNSS antenna is shown as below.

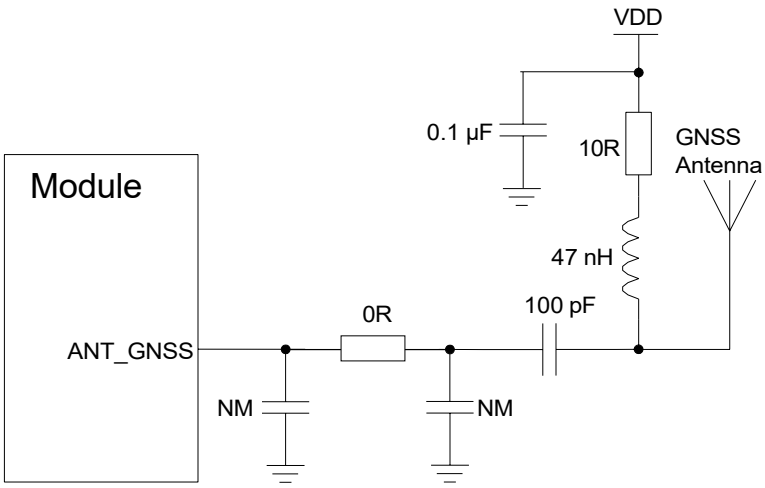


Figure 32: Reference Design of GNSS Antenna

NOTE

1. GNSS is an optional function. If GNSS function is not used, keep ANT_GNSS unconnected.
2. An external LDO can be selected to supply power according to the active antenna requirement.
3. If the module is designed with a passive antenna, then the VDD circuit is not needed.

5.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

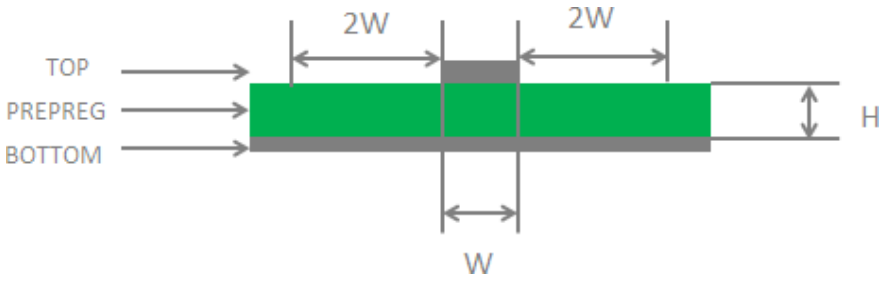


Figure 33: Microstrip Design on a 2-layer PCB

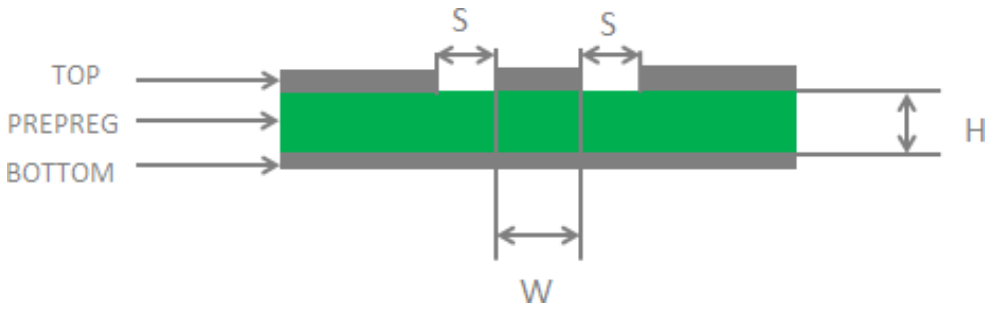


Figure 34: Coplanar Waveguide Design on a 2-layer PCB

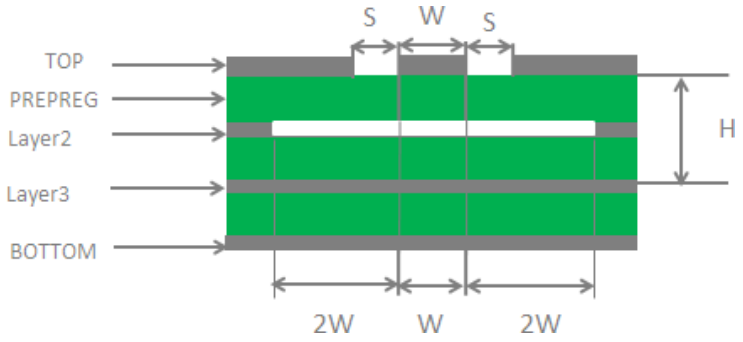


Figure 35: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

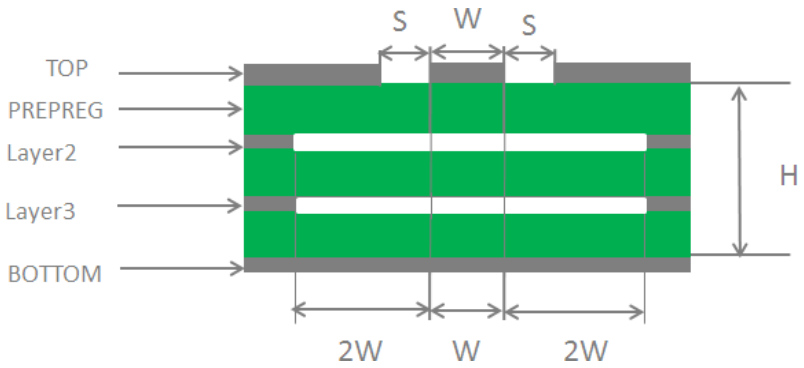


Figure 36: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, the following principles should be complied with in RF layout design:

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to 50 Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible, and all the right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be not less than twice as wide as RF signal traces (2 × W).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see ***document [9]***.

5.4. Antenna Design Requirements

The following table shows the requirements on main antenna, Rx-diversity antenna, C-V2X TRX antenna, MIMO antenna and GNSS antenna.

Table 47: Antenna Design Requirements

Type	Requirements
GNSS [36]	Frequency range: 1166–1187 MHz, 1559–1609 MHz Polarization: RHCP or linear VSWR: ≤ 2 (Typ.) Passive antenna gain: > 0 dBi Active antenna noise figure: < 1.5 dB Active antenna gain: > 0 dBi Active antenna embedded LNA gain: < 17 dB
GSM/UMTS/LTE	VSWR: ≤ 2 Efficiency: > 30 % Max input power: 50 W Input impedance: 50 Ω Cable insertion loss: **< 1 dB:** LB (< 1 GHz) **< 1.5 dB:** MB (1–2.3 GHz) **< 2 dB:** HB (> 2.3 GHz)
C-V2X	Frequency range: 5770–5925 MHz

[36] It is recommended to add a 25 dB notch filter at the LNA input end of the active antenna when LTE B13 or B14 is supported.

	Gain：Min.4 dBi VSWR: ≤ 2 Efficiency: > 30 % Max input power: 10 W Recommend antenna pattern: ±10 to 15° Input impedance: 50 Ω Cable insertion loss: **< 2 dB:** C-V2X TDD B47

5.5. RF Connector Recommendation

If RF connector is used for antenna connection, it is recommended to use the HFM connector provided by Rosenberger.

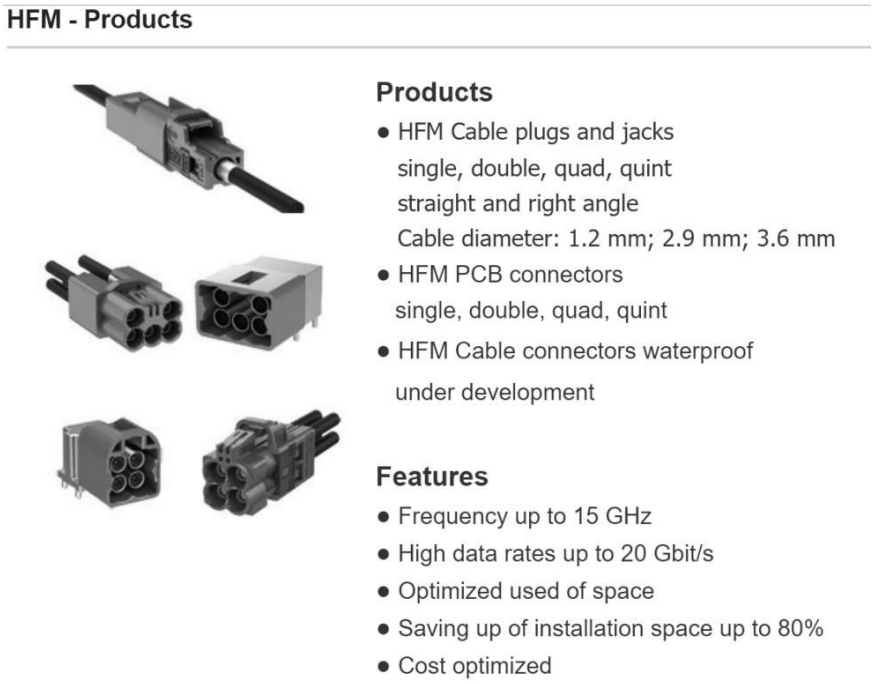


Figure 37: Description of the HFM Connector

For more details, visit https://www.rosenbergerap.com.

6 Reliability, Radio and Electrical Characteristics

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital and analog pins of the module are listed in the following table.

Table 48: **Absolute Maximum Ratings**

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.3	6.0	V
VBAT_CV2X	-0.5	5.5	V
USB_VBUS	-0.3	5.5	V
Peak Current of VBAT_BB	-	0.8	A
Peak Current of VBAT_RF	-	2.0	A
Peak Current of VBAT_CV2X	-	1.5	A
Voltage at Digital Pins	-0.3	2.04	V
Voltage at ADC0	0	1.91	V
Voltage at ADC1	0	1.91	V
Voltage at ADC2	0	1.91	V
Voltage at ADC3	0	1.91	V

6.2. Power Supply Ratings

Table 49: **Power Supply Ratings**

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB	The actual input voltages must stay between the minimum and maximum values.	3.3	3.8	4.3	V
	VBAT_RF		3.3/3.7 [37]	3.8	4.3	V
VBAT_CV2X	Power supply for the module's C-V2X part	The actual input voltages must stay between the minimum and maximum values.	4.75	5.0	5.25	V
USB_VBUS	USB connection detection	-	3.0	5.0	5.25	V

6.3. Operating and Storage Temperatures

Table 50: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [38]	-35	+25	+75	ºC
Extended Temperature Range [39]	-40	-	+85	ºC
eCall Temperature Range [40]	-40	-	+95	ºC
Storage Temperature Range	-40	-	+95	ºC

[37] The minimum input voltage of AG520R series/AG521R series/AG525R-GL/AG529R-CN is 3.3 V; but the minimum input voltage of AG529R-EU/AG529R-LA is 3.7 V.
[38] Within the operating temperature range, the module meets 3GPP specifications, and emergency call (Only AG52xR-EU and AG525R-GL support emergency call function) can be dialed out with a maximum power and data rate.
[39] Within the extended temperature range, the module remains fully functional and the ability to establish and maintain functions such as voice, SMS, data transmission and emergency call, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.
[40] Within eCall temperature range, the emergency call function must be functional until the module is broken. When the ambient temperature is between 75 °C and 95 °C and the module temperature has reached the threshold value, the module will trigger protective measures (such as reduce power, decrease throughput, and unregister the device) to ensure the full function of emergency call.

6.4. Power Consumption

6.4.1. AG520R-CN Power Consumption

Table 51: AG520R-CN Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	EGSM900 DRX = 2 (USB disconnected)	3.322	mA
	EGSM900 DRX = 5 (USB disconnected)	2.151	mA
	EGSM900 DRX = 5 (USB suspend)	2.56	mA
	EGSM900 DRX = 9 (USB disconnected)	1.816	mA
	DCS1800 DRX = 2 (USB disconnected)	3.115	mA
	DCS1800 DRX = 5 (USB disconnected)	2.119	mA
	DCS1800 DRX = 5 (USB suspend)	2.89	mA
	DCS1800 DRX = 9 (USB disconnected)	1.79	mA
	WCDMA PF = 64 (USB disconnected)	2.46	mA
	WCDMA PF = 64 (USB suspend)	3.02	mA
	WCDMA PF = 128 (USB disconnected)	1.892	mA
	WCDMA PF = 256 (USB disconnected)	1.621	mA
	WCDMA PF = 512 (USB disconnected)	1.502	mA
	LTE-FDD PF = 32 (USB disconnected)	4.969	mA
	LTE-FDD PF = 64 (USB disconnected)	2.814	mA
	LTE-FDD PF = 64 (USB suspend)	6.76	mA
	LTE-FDD PF = 128 (USB disconnected)	2.355	mA
	LTE-FDD PF = 256 (USB disconnected)	2.14	mA

	LTE-TDD PF = 32 (USB disconnected)	5.466	mA
	LTE-TDD PF = 64 (USB disconnected)	4.037	mA
	LTE-TDD PF = 64 (USB suspend)	4.74	mA
	LTE-TDD PF = 128 (USB disconnected)	3.122	mA
	LTE-TDD PF = 256 (USB disconnected)	2.245	mA
Idle state	EGSM900 DRX = 5 (USB connected)	54	mA
	EGSM900 DRX = 5 (USB disconnected)	11.94	mA
	WCDMA PF = 64 (USB connected)	54.37	mA
	WCDMA PF = 64 (USB disconnected)	15.49	mA
	LTE-FDD PF = 64 (USB connected)	53.913	mA
	LTE-FDD PF = 64 (USB disconnected)	15.82	mA
	LTE-TDD PF = 64 (USB connected)	57.44	mA
	LTE-TDD PF = 64 (USB disconnected)	16.82	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	322	mA
	EGSM900 3DL/2UL @ 32 dBm	531	mA
	EGSM900 2DL/3UL @ 30 dBm	621.1	mA
	EGSM900 1DL/4UL @ 29 dBm	714.7	mA
	DCS1800 4DL/1UL @ 29.5 dBm	258	mA
	DCS1800 3DL/2UL @ 29.0 dBm	412.7	mA
	DCS1800 2DL/3UL @ 26.5 dBm	530.7	mA
	DCS1800 1DL/4UL @ 25.5 dBm	662.8	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	213.4	mA
	EGSM900 3DL/2UL @ 26.0 dBm	336.7	mA
	EGSM900 2DL/3UL @ 24.0 dBm	424.9	mA
	EGSM900 1DL/4UL @ 23.0 dBm	523.8	mA

	DCS1800 4DL/1UL @ 26.0 dBm	219.3	mA
	DCS1800 3DL/2UL @ 25.0 dBm	353.6	mA
	DCS1800 2DL/3UL @ 23.0 dBm	472.8	mA
	DCS1800 1DL/4UL @ 22.0 dBm	593.3	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	480	mA
	WCDMA B8 HSDPA @ 22.5 dBm	536	mA
	WCDMA B1 HSUPA @ 22.5 dBm	499	mA
	WCDMA B8 HSUPA @ 22.5 dBm	556	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	521.62	mA
	LTE-FDD B3 @ 23.0 dBm	547.94	mA
	LTE-FDD B5 @ 23.0 dBm	595.74	mA
	LTE-FDD B7 @ 23.0 dBm	614.5	mA
	LTE-FDD B8 @ 23.0 dBm	610.56	mA
	LTE-TDD B34 @ 23.0 dBm	301.38	mA
	LTE-TDD B38 @ 23.0 dBm	385.57	mA
	LTE-TDD B39 @ 23.0 dBm	291.54	mA
	LTE-TDD B40 @ 23.0 dBm	343.66	mA
	LTE-TDD B41 @ 23.0 dBm	383.88	mA
	LTE-TDD B47 @ 21.5 dBm (3.8 V BB)	230	mA
	LTE-TDD B47 @ 21.5 dBm (5 V PA)	4.5	mA
GSM voice call	EGSM900, PCL = 5 @ 33 dBm	338.4	mA
	EGSM900, PCL = 12 @ 19.0 dBm	200.4	mA
	EGSM900, PCL = 19 @ 5.0 dBm	195.2	mA
	DCS1800, PCL = 0 @ 29.5 dBm	268.4	mA
	DCS1800, PCL = 7 @ 16.0 dBm	238.8	mA

	DCS1800, PCL = 15 @ 0 dBm	241.2	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	520	mA
	WCDMA B8 @ 23 dBm	583	mA

6.4.2. AG520R-EU Power Consumption

Table 52: AG520R-EU Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	EGSM900 DRX = 2 (USB disconnected)	3.05	mA
	EGSM900 DRX = 5 (USB disconnected)	1.96	mA
	EGSM900 DRX = 5 (USB suspend)	3.38	mA
	EGSM900 DRX = 9 (USB disconnected)	1.64	mA
	DCS1800 DRX = 2 (USB disconnected)	3.07	mA
	DCS1800 DRX = 5 (USB disconnected)	1.98	mA
	DCS1800 DRX = 5 (USB suspend)	3.35	mA
	DCS1800 DRX = 9 (USB disconnected)	1.64	mA
	WCDMA PF = 64 (USB disconnected)	2.31	mA
	WCDMA PF = 64 (USB suspend)	3.40	mA
	WCDMA PF = 128 (USB disconnected)	1.8	mA
	WCDMA PF = 256 (USB disconnected)	1.52	mA
	WCDMA PF = 512 (USB disconnected)	1.39	mA
	LTE-FDD PF = 32 (USB disconnected)	4.05	mA
	LTE-FDD PF = 64 (USB disconnected)	2.66	mA
	LTE-FDD PF = 64 (USB suspend)	3.95	mA

	LTE-FDD PF = 128 (USB disconnected)	1.96	mA
	LTE-FDD PF = 256 (USB disconnected)	1.8	mA
	LTE-TDD PF = 32 (USB disconnected)	4.36	mA
	LTE-TDD PF = 64 (USB disconnected)	2.81	mA
	LTE-TDD PF = 64 (USB suspend)	4.16	mA
	LTE-TDD PF = 128 (USB disconnected)	2.03	mA
	LTE-TDD PF = 256 (USB disconnected)	1.61	mA
Idle state	EGSM900 DRX = 5 (USB connected)	26.27	mA
	EGSM900 DRX = 5 (USB disconnected)	17.37	mA
	WCDMA PF = 64 (USB connected)	26.74	mA
	WCDMA PF = 64 (USB disconnected)	17.78	mA
	LTE-FDD PF = 64 (USB connected)	27.02	mA
	LTE-FDD PF = 64 (USB disconnected)	17.65	mA
	LTE-TDD PF = 64 (USB connected)	27.27	mA
	LTE-TDD PF = 64 (USB disconnected)	18.2	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	303.9	mA
	EGSM900 3DL/2UL @ 32 dBm	464.9	mA
	EGSM900 2DL/3UL @ 30 dBm	576.8	mA
	EGSM900 1DL/4UL @ 29 dBm	642.8	mA
	DCS1800 4DL/1UL @ 29.5 dBm	240.7	mA
	DCS1800 3DL/2UL @ 29.0 dBm	366.1	mA
	DCS1800 2DL/3UL @ 26.5 dBm	423.2	mA
	DCS1800 1DL/4UL @ 25.5 dBm	494.7	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	187.4	mA
	EGSM900 3DL/2UL @ 26.0 dBm	292.8	mA

	EGSM900 2DL/3UL @ 24.0 dBm	342	mA
	EGSM900 1DL/4UL @ 23.0 dBm	395.1	mA
	DCS1800 4DL/1UL @ 26.0 dBm	194.6	mA
	DCS1800 3DL/2UL @ 25.0 dBm	281.8	mA
	DCS1800 2DL/3UL @ 23.0 dBm	337.1	mA
	DCS1800 1DL/4UL @22.0 dBm	394.1	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	546.3	mA
	WCDMA B3 HSDPA @ 22.5 dBm	602.38	mA
	WCDMA B5 HSDPA @ 22.0 dBm	525.11	mA
	WCDMA B8 HSDPA @ 22.0 dBm	566.56	mA
	WCDMA B1 HSUPA @ 22.0 dBm	554.77	mA
	WCDMA B3 HSUPA @ 22.5 dBm	610.17	mA
	WCDMA B5 HSUPA @ 21.5 dBm	525.26	Ma
	WCDMA B8 HSUPA @ 21.5 dBm	575.88	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	661.02	mA
	LTE-FDD B3 @ 23.0 dBm	666.58	mA
	LTE-FDD B5 @ 23.0 dBm	540.58	mA
	LTE-FDD B7 @ 23.0 dBm	703.11	mA
	LTE-FDD B8 @ 23.0 dBm	565	mA
	LTE-FDD B20 @ 23.0 dBm	540.29	mA
	LTE-FDD B28 @ 23.0 dBm	573.25	mA
	LTE-TDD B38 @ 23.0 dBm	449.52	mA
	LTE-TDD B40 @ 23.0 dBm	406.21	mA
	LTE-TDD B41 @ 23.0 dBm	447.86	mA
	LTE-TDD B47 @ 23 dBm (3.8 V BB)	230	mA

	LTE-TDD B47 @ 23 dBm (5 V PA)	5.4	mA
	EGSM900, PCL = 5 @ 32.0 dBm	330.2	mA
	EGSM900, PCL = 12 @ 19.0 dBm	150.6	mA
GSM voice call	EGSM900, PCL = 19 @ 5.0 dBm	130.4	mA
	DCS1800, PCL = 0 @ 29.5 dBm	254.9	mA
	DCS1800, PCL = 7 @ 16.0 dBm	144.5	mA
	DCS1800, PCL = 15 @ 0 dBm	136.9	mA
	WCDMA B1 @ 22.5 dBm	567.66	mA
WCDMA voice call	WCDMA B3 @ 22.5 dBm	604.82	mA
	WCDMA B5 @ 23.0 dBm	532.44	mA
	WCDMA B8 @ 23.0 dBm	591.36	mA

6.4.3. AG520R-NA Power Consumption

Table 53: AG520R-NA Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	LTE-FDD PF = 32 (USB disconnected)	4.15	mA
	LTE-FDD PF = 64 (USB disconnected)	2.77	mA
	LTE-FDD PF = 64 (USB suspend)	4.12	mA
	LTE-FDD PF = 128 (USB disconnected)	1.98	mA
	LTE-FDD PF = 256 (USB disconnected)	1.63	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 23.0 dBm	569.18	mA
	LTE-FDD B4 @ 23.0 dBm	563.03	mA
	LTE-FDD B5 @ 23.0 dBm	491.24	mA

	LTE-FDD B7 @ 23.0 dBm	645.35	mA
	LTE-FDD B12 @ 23.0 dBm	483.64	mA
	LTE-FDD B13 @ 23.0 dBm	482.77	mA
	LTE-FDD B14 @ 23.0 dBm	496.16	mA
	LTE-FDD B25 @ 23.0 dBm	582.69	mA
	LTE-FDD B26 @ 23.0 dBm	513.48	mA
	LTE-TDD B47 @ 22 dBm (3.8 V BB)	225	mA
	LTE-TDD B47 @ 22 dBm (5 V PA)	4.4	mA
	LTE-FDD B66 @ 23.0 dBm	577.45	mA
	LTE-FDD B71 @ 23.0 dBm	494.47	mA

6.4.4. AG520R-JP Power Consumption

Table 54: AG520R-JP Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	WCDMA PF = 64 (USB disconnected)	2.47	mA
	WCDMA PF = 64 (USB suspend)	3.61	mA
	WCDMA PF = 128 (USB disconnected)	1.95	mA
	WCDMA PF = 256 (USB disconnected)	1.7	mA
	WCDMA PF = 512 (USB disconnected)	1.53	mA
	LTE-FDD PF = 32 (USB disconnected)	4.64	mA
	LTE-FDD PF = 64 (USB disconnected)	3.05	mA
	LTE-FDD PF = 64 (USB suspend)	5.29	mA
	LTE-FDD PF = 128 (USB disconnected)	2.23	mA

	LTE-FDD PF = 256 (USB disconnected)	1.85	mA
	LTE-TDD PF = 32 (USB disconnected)	5.14	mA
	LTE-TDD PF = 64 (USB disconnected)	3.33	mA
	LTE-TDD PF = 64 (USB suspend)	5.38	mA
	LTE-TDD PF = 128 (USB disconnected)	2.46	mA
	LTE-TDD PF = 256 (USB disconnected)	2.09	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	594.31	mA
	WCDMA B3 HSDPA @ 22.5 dBm	570.78	mA
	WCDMA B5 HSDPA @ 22.5 dBm	593.64	mA
	WCDMA B8 HSDPA @ 22.5 dBm	572.66	mA
	WCDMA B9 HSDPA @ 22.5 dBm	595.41	mA
	WCDMA B19 HSDPA @ 22.5 dBm	590.65	mA
	WCDMA B1 HSUPA @ 22 dBm	598.36	mA
	WCDMA B3 HSUPA @ 22.5 dBm	571.97	mA
	WCDMA B5 HSUPA @ 22 dBm	601.59	mA
	WCDMA B8 HSUPA @ 22.5 dBm	589.06	mA
	WCDMA B9 HSUPA @ 22 dBm	597.12	mA
	WCDMA B19 HSUPA @ 23 dBm	601.88	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 22.5 dBm	648.02	mA
	LTE-FDD B3 @ 22.5 dBm	662.11	mA
	LTE-FDD B5 @ 23.0 dBm	583.2	mA
	LTE-FDD B8 @ 23.0 dBm	558.08	mA
	LTE-FDD B9 @ 22.5 dBm	660.04	mA
	LTE-FDD B11 @ 22.5 dBm	638.48	mA
	LTE-FDD B18 @ 23.0 dBm	591.64	mA

	LTE-FDD B19 @ 23.0 dBm	597.48	mA
	LTE-FDD B21 @ 22.5 dBm	671.77	mA
	LTE-FDD B28 @ 23.0 dBm	594.84	mA
	LTE-TDD B41 @ 22.5 dBm	420.54	mA
	WCDMA B1 @ 23 dBm	597.3	mA
	WCDMA B3 @ 23 dBm	598.36	mA
WCDMA voice call	WCDMA B5 @ 23 dBm	580.9	mA
	WCDMA B8 @ 23 dBm	566.23	mA
	WCDMA B9 @ 23 dBm	596.66	mA
	WCDMA B19 @ 23 dBm	595.75	mA

6.4.5. AG521R-CN Power Consumption

Table 55: AG521R-CN Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.55	mA
	EGSM900 DRX = 2 (USB disconnected)	2.83	mA
	EGSM900 DRX = 5 (USB disconnected)	1.79	mA
	EGSM900 DRX = 5 (USB suspend)	2.91	mA
	EGSM900 DRX = 9 (USB disconnected)	1.51	mA
	DCS1800 DRX = 2 (USB disconnected)	2.86	mA
	DCS1800 DRX = 5 (USB disconnected)	1.76	mA
	DCS1800 DRX = 5 (USB suspend)	2.87	mA
	DCS1800 DRX = 9 (USB disconnected)	1.39	mA
	WCDMA PF = 64 (USB disconnected)	2.13	mA

	WCDMA PF = 64 (USB suspend)	3.38	mA
	WCDMA PF = 128 (USB disconnected)	1.51	mA
	WCDMA PF = 256 (USB disconnected)	1.34	mA
	WCDMA PF = 512 (USB disconnected)	1.17	mA
	LTE-FDD PF = 32 (USB disconnected)	3.73	mA
	LTE-FDD PF = 64 (USB disconnected)	2.31	mA
	LTE-FDD PF = 64 (USB suspend)	3.62	mA
	LTE-FDD PF = 128 (USB disconnected)	1.71	mA
	LTE-FDD PF = 256 (USB disconnected)	1.55	mA
	LTE-TDD PF = 32 (USB disconnected)	3.85	mA
	LTE-TDD PF = 64 (USB disconnected)	2.42	mA
	LTE-TDD PF = 64 (USB suspend)	3.89	mA
	LTE-TDD PF = 128 (USB disconnected)	1.79	mA
	LTE-TDD PF = 256 (USB disconnected)	1.57	mA
Idle state	EGSM900 DRX = 5 (USB connected)	26.59	mA
	EGSM900 DRX = 5 (USB disconnected)	11.65	mA
	WCDMA PF = 64 (USB connected)	26.59	mA
	WCDMA PF = 64 (USB disconnected)	12.02	mA
	LTE-FDD PF = 64 (USB connected)	26.92	mA
	LTE-FDD PF = 64 (USB disconnected)	12.24	mA
	LTE-TDD PF = 64 (USB connected)	26.75	mA
	LTE-TDD PF = 64 (USB disconnected)	12.18	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	341.41	mA
	EGSM900 3DL/2UL @ 32 dBm	470.83	mA
	EGSM900 2DL/3UL @ 30 dBm	610.71	mA

	EGSM900 1DL/4UL @ 29 dBm	680	mA
	DCS1800 4DL/1UL @ 29.5 dBm	269.91	mA
	DCS1800 3DL/2UL @ 29.0 dBm	419.01	mA
	DCS1800 2DL/3UL @ 26.5 dBm	541.72	mA
	DCS1800 1DL/4UL @ 25.5 dBm	671.45	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	218.58	mA
	EGSM900 3DL/2UL @ 26.0 dBm	345.78	mA
	EGSM900 2DL/3UL @ 24.0 dBm	447.81	mA
	EGSM900 1DL/4UL @ 23.0 dBm	550.73	mA
	DCS1800 4DL/1UL @ 26.0 dBm	206.36	mA
	DCS1800 3DL/2UL @ 25.0 dBm	341.02	mA
	DCS1800 2DL/3UL @ 23.0 dBm	460.45	mA
	DCS1800 1DL/4UL @ 22.0 dBm	577.58	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	521.63	mA
	WCDMA B8 HSDPA @ 22.5 dBm	589.86	mA
	WCDMA B1 HSUPA @ 22.5 dBm	535.91	mA
	WCDMA B8 HSUPA @ 22.5 dBm	597.83	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	543.62	mA
	LTE-FDD B3 @ 23.0 dBm	586.69	mA
	LTE-FDD B5 @ 23.0 dBm	569.79	mA
	LTE-FDD B7 @ 23.0 dBm	701.88	mA
	LTE-FDD B8 @ 23.0 dBm	564.16	mA
	LTE-TDD B34 @ 23.0 dBm	336.38	mA
	LTE-TDD B38 @ 23.0 dBm	458.73	mA
	LTE-TDD B39 @ 23.0 dBm	336.88	mA

	LTE-TDD B40 @ 23.0 dBm	425.48	mA
	LTE-TDD B41 @ 23.0 dBm	455.08	mA
	EGSM900, PCL = 5 @ 33 dBm	337.26	mA
	EGSM900, PCL = 12 @ 19.0 dBm	161	mA
GSM voice call	EGSM900, PCL = 19 @ 5.0 dBm	128	mA
	DCS1800, PCL = 0 @ 29.5 dBm	265.87	mA
	DCS1800, PCL = 7 @ 16.0 dBm	149.1	mA
	DCS1800, PCL = 15 @ 0 dBm	143.21	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	516.34	mA
	WCDMA B8 @ 23 dBm	577.87	mA

6.4.6. AG521R-EU Power Consumption

Table 56: AG521R-EU Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	EGSM900 DRX = 2 (USB disconnected)	2.77	mA
	EGSM900 DRX = 5 (USB disconnected)	1.88	mA
	EGSM900 DRX = 5 (USB suspend)	2.88	mA
	EGSM900 DRX = 9 (USB disconnected)	1.51	mA
	DCS1800 DRX = 2 (USB disconnected)	2.88	mA
	DCS1800 DRX = 5 (USB disconnected)	1.87	mA
	DCS1800 DRX = 5 (USB suspend)	2.92	mA
	DCS1800 DRX = 9 (USB disconnected)	1.54	mA
	WCDMA PF = 64 (USB disconnected)	2.22	mA

	WCDMA PF = 64 (USB suspend)	4.06	mA
	WCDMA PF = 128 (USB disconnected)	1.69	mA
	WCDMA PF = 256 (USB disconnected)	1.43	mA
	WCDMA PF = 512 (USB disconnected)	1.32	mA
	LTE-FDD PF = 32 (USB disconnected)	3.79	mA
	LTE-FDD PF = 64 (USB disconnected)	2.48	mA
	LTE-FDD PF = 64 (USB suspend)	3.69	mA
	LTE-FDD PF = 128 (USB disconnected)	1.81	mA
	LTE-FDD PF = 256 (USB disconnected)	1.46	mA
	LTE-TDD PF = 32 (USB disconnected)	4.11	mA
	LTE-TDD PF = 64 (USB disconnected)	2.59	mA
	LTE-TDD PF = 64 (USB suspend)	3.89	mA
	LTE-TDD PF = 128 (USB disconnected)	1.9	mA
	LTE-TDD PF = 256 (USB disconnected)	1.72	mA
Idle state	EGSM900 DRX = 5 (USB connected)	25.41	mA
	EGSM900 DRX = 5 (USB disconnected)	14.16	mA
	WCDMA PF = 64 (USB connected)	29.32	mA
	WCDMA PF = 64 (USB disconnected)	15.74	mA
	LTE-FDD PF = 64 (USB connected)	29.15	mA
	LTE-FDD PF = 64 (USB disconnected)	14.48	mA
	LTE-TDD PF = 64 (USB connected)	29.61	mA
	LTE-TDD PF = 64 (USB disconnected)	14.84	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	309.87	mA
	EGSM900 3DL/2UL @ 32 dBm	476.91	mA
	EGSM900 2DL/3UL @ 30 dBm	570.09	mA

	EGSM900 1DL/4UL @ 29 dBm	653.47	mA
	DCS1800 4DL/1UL @ 29.5 dBm	243.69	mA
	DCS1800 3DL/2UL @ 29.0 dBm	357.75	mA
	DCS1800 2DL/3UL @ 26.5 dBm	417.87	mA
	DCS1800 1DL/4UL @ 25.5 dBm	490.29	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	191.06	mA
	EGSM900 3DL/2UL @ 26.0 dBm	293.24	mA
	EGSM900 2DL/3UL @ 24.0 dBm	335.62	mA
	EGSM900 1DL/4UL @ 23.0 dBm	389.66	mA
	DCS1800 4DL/1UL @ 26.0 dBm	186.69	mA
	DCS1800 3DL/2UL @ 25.0 dBm	260.62	mA
	DCS1800 2DL/3UL @ 23.0 dBm	310.08	mA
	DCS1800 1DL/4UL @ 22.0 dBm	362.34	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.5 dBm	512.84	mA
	WCDMA B3 HSDPA @ 22.5 dBm	586.04	mA
	WCDMA B5 HSDPA @ 22.5 dBm	530.06	mA
	WCDMA B8 HSDPA @ 22.5 dBm	552.42	mA
	WCDMA B1 HSUPA @ 22.5 dBm	523.88	mA
	WCDMA B3 HSUPA @ 22.5 dBm	598.01	mA
	WCDMA B5 HSUPA @ 22.5 dBm	538.45	mA
	WCDMA B8 HSUPA @ 22.5 dBm	564.55	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	587.23	mA
	LTE-FDD B3 @ 23.0 dBm	584.53	mA
	LTE-FDD B5 @ 23.0 dBm	549.59	mA
	LTE-FDD B7 @ 23.0 dBm	639.76	mA

	LTE-FDD B8 @ 23.0 dBm	561.8	mA
	LTE-FDD B20 @ 23.0 dBm	450.35	mA
	LTE-FDD B28 @ 23.0 dBm	457	mA
	LTE-TDD B38 @ 23.0 dBm	430.04	mA
	LTE-TDD B40 @ 23.0 dBm	407.61	mA
	LTE-TDD B41 @ 23.0 dBm	439.48	mA
GSM voice call	EGSM900, PCL = 5 @ 33 dBm	355.1	mA
	EGSM900, PCL = 12 @ 19.0 dBm	185.4	mA
	EGSM900, PCL = 19 @ 5.0 dBm	119.21	mA
	DCS1800, PCL = 0 @ 29.5 dBm	282.9	mA
	DCS1800, PCL = 7 @ 16.0 dBm	137.61	mA
	DCS1800, PCL = 15 @ 0 dBm	130.08	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	530.06	mA
	WCDMA B3 @ 23 dBm	585.26	mA
	WCDMA B5 @ 23 dBm	549.97	mA
	WCDMA B8 @ 23 dBm	577.2	mA

6.4.7. AG521R-NA Power Consumption

Table 57: AG521R-NA Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	LTE-FDD PF = 32 (USB disconnected)	4.15	mA
	LTE-FDD PF = 64 (USB disconnected)	2.77	mA
	LTE-FDD PF = 64 (USB suspend)	4.12	mA

	LTE-FDD PF = 128 (USB disconnected)	1.98	mA
	LTE-FDD PF = 256 (USB disconnected)	1.63	mA
LTE data transfer (GNSS OFF)	LTE-FDD B2 @ 23.0 dBm	569.18	mA
	LTE-FDD B4 @ 23.0 dBm	563.03	mA
	LTE-FDD B5 @ 23.0 dBm	491.24	mA
	LTE-FDD B7 @ 23.0 dBm	645.35	mA
	LTE-FDD B12 @ 23.0 dBm	483.64	mA
	LTE-FDD B13 @ 23.0 dBm	482.77	mA
	LTE-FDD B14 @ 23.0 dBm	496.16	mA
	LTE-FDD B25 @ 23.0 dBm	582.69	mA
	LTE-FDD B26 @ 23.0 dBm	513.48	mA
	LTE-FDD B66 @ 23.0 dBm	577.45	mA
	LTE-FDD B71 @ 23.0 dBm	494.47	mA

6.4.8. AG525R-GL Power Consumption

Table 58: AG525R-GL Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	GSM850 DRX = 2 (USB disconnected)	3.183	mA
	GSM850 DRX = 5 (USB disconnected)	2.128	mA
	GSM850 DRX = 5 (USB suspend)	3.020	mA
	GSM850 DRX = 9 (USB disconnected)	1.760	mA
	EGSM900 DRX = 2 (USB disconnected)	3.360	mA
	EGSM900 DRX = 5 (USB disconnected)	2.451	mA

EGSM900 DRX = 5 (USB suspend)	3.140	mA
EGSM900 DRX = 9 (USB disconnected)	2.168	mA
DCS1800 DRX = 2 (USB disconnected)	3.281	mA
DCS1800 DRX = 5 (USB disconnected)	2.547	mA
DCS1800 DRX = 5 (USB suspend)	3.140	mA
DCS1800 DRX = 9 (USB disconnected)	2.281	mA
PCS1900 DRX = 2 (USB disconnected)	3.156	mA
PCS1900 DRX = 5 (USB disconnected)	2.154	mA
PCS1900 DRX = 5 (USB suspend)	3.120	mA
PCS1900 DRX = 9 (USB disconnected)	1.886	mA
WCDMA PF = 64 (USB disconnected)	3.295	mA
WCDMA PF = 64 (USB suspend)	3.230	mA
WCDMA PF = 128 (USB disconnected)	2.458	mA
WCDMA PF = 256 (USB disconnected)	2.019	mA
WCDMA PF = 512 (USB disconnected)	1.925	mA
LTE-FDD PF = 32 (USB disconnected)	4.623	mA
LTE-FDD PF = 64 (USB disconnected)	3.096	mA
LTE-FDD PF = 64 (USB suspend)	3.620	mA
LTE-FDD PF = 128 (USB disconnected)	2.381	mA
LTE-FDD PF = 256 (USB disconnected)	2.177	mA
LTE-TDD PF = 32 (USB disconnected)	4.922	mA
LTE-TDD PF = 64 (USB disconnected)	3.349	mA
LTE-TDD PF = 64 (USB suspend)	3.540	mA
LTE-TDD PF = 128 (USB disconnected)	2.422	mA
LTE-TDD PF = 256 (USB disconnected)	2.002	mA

Idle state	GSM850 DRX = 5 (USB connected)	29.93	mA
	GSM850 DRX = 5 (USB disconnected)	11.99	mA
	WCDMA PF = 64 (USB connected)	30.93	mA
	WCDMA PF = 64 (USB disconnected)	15.59	mA
	LTE-FDD PF = 64 (USB connected)	42.91	mA
	LTE-FDD PF = 64 (USB disconnected)	14.813	mA
	LTE-TDD PF = 64 (USB connected)	30.243	mA
	LTE-TDD PF = 64 (USB disconnected)	15.017	mA
GPRS data transfer (GNSS OFF)	GSM850 4DL/1UL @ 33 dBm	312.63	mA
	GSM850 3DL/2UL @ 32 dBm	479.63	mA
	GSM850 2DL/3UL @ 30 dBm	576.35	mA
	GSM850 1DL/4UL @ 29 dBm	664.84	mA
	EGSM900 4DL/1UL @ 33 dBm	320.54	mA
	EGSM900 3DL/2UL @ 32 dBm	505.12	mA
	EGSM900 2DL/3UL @ 30 dBm	579.53	mA
	EGSM900 1DL/4UL @ 29 dBm	657.95	mA
	DCS1800 4DL/1UL @ 29.5 dBm	226.14	mA
	DCS1800 3DL/2UL @ 29.0 dBm	349.83	mA
	DCS1800 2DL/3UL @ 26.5 dBm	408.21	mA
	DCS1800 1DL/4UL @ 25.5 dBm	474.23	mA
	PCS1900 4DL/1UL @ 29.5 dBm	234.12	mA
	PCS1900 3DL/2UL @ 29.0 dBm	350.85	mA
	PCS1900 2DL/3UL @ 26.5 dBm	415.95	mA
	PCS1900 1DL/4UL @ 25.5 dBm	469.37	mA
EDGE data transfer	GSM850 4DL/1UL @ 27.0 dBm	189.46	mA

(GNSS OFF)	GSM850 3DL/2UL @ 26.0 dBm	298.57	mA
	GSM850 2DL/3UL @ 24.0 dBm	348.54	mA
	GSM850 1DL/4UL @ 23.0 dBm	405.33	mA
	EGSM900 4DL/1UL @ 27.0 dBm	187.32	mA
	EGSM900 3DL/2UL @ 26.0 dBm	293.34	mA
	EGSM900 2DL/3UL @ 24.0 dBm	343.53	mA
	EGSM900 1DL/4UL @ 23.0 dBm	395.45	mA
	DCS1800 4DL/1UL @ 26.0 dBm	173.94	mA
	DCS1800 3DL/2UL @ 25.0 dBm	265.73	mA
	DCS1800 2DL/3UL @ 23.0 dBm	325.33	mA
	DCS1800 1DL/4UL @ 22.0 dBm	372.54	mA
	PCS1900 4DL/1UL @ 26.0 dBm	181.25	mA
	PCS1900 3DL/2UL @ 25.0 dBm	267.94	mA
	PCS1900 2DL/3UL @ 23.0 dBm	311.14	mA
	PCS1900 1DL/4UL @ 22.0 dBm	359.12	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 23.0 dBm	606.95	mA
	WCDMA B2 HSDPA @ 23.0 dBm	685.23	mA
	WCDMA B3 HSDPA @ 23.0 dBm	616.42	mA
	WCDMA B4 HSDPA @ 23.0 dBm	670.12	mA
	WCDMA B5 HSDPA @ 23.0 dBm	608.32	mA
	WCDMA B6 HSDPA @ 23.0 dBm	607.15	mA
	WCDMA B8 HSDPA @ 23.0 dBm	621.63	mA
	WCDMA B19 HSDPA @ 23.0 dBm	605.41	mA
	WCDMA B1 HSUPA @ 23.0 dBm	595.71	mA
	WCDMA B2 HSUPA @ 23.0 dBm	689.3	mA

	WCDMA B3 HSUPA @ 23.0 dBm	602.99	mA
	WCDMA B4 HSUPA @ 23.0 dBm	614.63	mA
	WCDMA B5 HSUPA @ 23.0 dBm	549.26	mA
	WCDMA B6 HSUPA @ 23.0 dBm	547.24	mA
	WCDMA B8 HSUPA @ 23.0 dBm	575.01	mA
	WCDMA B19 HSUPA @ 23.0 dBm	584.83	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	606.86	mA
	LTE-FDD B2 @ 23.0 dBm	686.61	mA
	LTE-FDD B3 @ 23.0 dBm	615.63	mA
	LTE-FDD B4 @ 23.0 dBm	704.68	mA
	LTE-FDD B5 @ 23.0 dBm	585.82	mA
	LTE-FDD B7 @ 23.0 dBm	735.87	mA
	LTE-FDD B8 @ 23.0 dBm	607.38	mA
	LTE-FDD B9 @ 23.0 dBm	613.53	mA
	LTE-FDD B11 @ 23.0 dBm	674.67	mA
	LTE-FDD B12 @ 23.0 dBm	595.34	mA
	LTE-FDD B13 @ 23.0 dBm	661.65	mA
	LTE-FDD B18 @ 23.0 dBm	636.57	mA
	LTE-FDD B19 @ 23.0 dBm	627.77	mA
	LTE-FDD B20 @ 23.0 dBm	617.46	mA
	LTE-FDD B21 @ 23.0 dBm	665.74	mA
	LTE-FDD B25 @ 23.0 dBm	622.94	mA
	LTE-FDD B26 @ 23.0 dBm	623.07	mA
	LTE-FDD B28 @ 23.0 dBm	577.96	mA
	LTE-TDD B34 @ 23.0 dBm	289.23	mA

	LTE-TDD B38 @ 23.0 dBm	437.17	mA
	LTE-TDD B39 @ 23.0 dBm	266.25	mA
	LTE-TDD B40 @ 23.0 dBm	477.97	mA
	LTE-TDD B41 @ 23.0 dBm	436.46	mA
	LTE-FDD B66 @ 23.0 dBm	617.93	mA
	LTE-FDD B71 @ 23.0 dBm	590.43	mA
GSM voice call	GSM850, PCL = 5 @ 32 dBm	340.32	mA
	GSM850, PCL = 12 @ 19.0 dBm	155.64	mA
	GSM850, PCL = 19 @ 5.0 dBm	127.55	mA
	EGSM900, PCL = 5 @ 32 dBm	327.34	mA
	EGSM900, PCL = 12 @ 19.0 dBm	154.83	mA
	EGSM900, PCL = 19 @ 5.0 dBm	125.1	mA
	DCS1800, PCL = 0 @ 30 dBm	248.9	mA
	DCS1800, PCL = 7 @ 16.0 dBm	139.2	mA
	DCS1800, PCL = 15 @ 0 dBm	132.3.	mA
	PCS1900, PCL = 0 @ 30 dBm	255.6	mA
	PCS1900, PCL = 7 @ 16.0 dBm	138.8	mA
	PCS1900, PCL = 15 @ 0 dBm	129.8	mA
WCDMA voice call	WCDMA B1 @ 22.5 dBm	579.63	mA
	WCDMA B2 @ 22.5 dBm	652.99	mA
	WCDMA B3 @ 22.5 dBm	599.32	mA
	WCDMA B4 @ 22.5 dBm	659.48	mA
	WCDMA B5 @ 22.5 dBm	576.24	mA
	WCDMA B6 @ 22.5 dBm	575.66	mA
	WCDMA B8 @ 23.0 dBm	615.13	mA

	WCDMA B19 @ 23.0 dBm	598.64	mA

6.4.9. AG529R-CN Power Consumption

Table 59: AG529R-CN Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.021	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.4	mA
	EGSM900 @ DRX = 2 (USB disconnected)	3.17	mA
	EGSM900 @ DRX = 5 (USB disconnected)	2.11	mA
	EGSM900 @ DRX = 5 (USB suspend)	3.35	mA
	EGSM900 @ DRX = 9 (USB disconnected)	1.76	mA
	DCS1800 @ DRX = 2 (USB disconnected)	3.09	mA
	DCS1800 @ DRX = 5 (USB disconnected)	2.09	mA
	DCS1800 @ DRX = 5 (USB suspend)	3.34	mA
	DCS1800 @ DRX = 9 (USB disconnected)	1.78	mA
	WCDMA @ PF = 64 (USB disconnected)	2.44	mA
	WCDMA @ PF = 64 (USB suspend)	3.72	mA
	WCDMA @ PF = 128 (USB disconnected)	1.92	mA
	WCDMA @ PF = 256 (USB disconnected)	1.68	mA
	WCDMA @ PF = 512 (USB disconnected)	1.57	mA
	LTE-FDD @ PF = 32 (USB disconnected)	4.56	mA
	LTE-FDD @ PF = 64 (USB disconnected)	3.07	mA
	LTE-FDD @ PF = 64 (USB suspend)	4.07	mA
	LTE-FDD @ PF = 128 (USB disconnected)	2.36	mA
	LTE-FDD @ PF = 256 (USB disconnected)	1.95	mA

	LTE-TDD @ PF = 32 (USB disconnected)	4.88	mA
	LTE-TDD @ PF = 64 (USB disconnected)	3.21	mA
	LTE-TDD @ PF = 64 (USB suspend)	5.47	mA
	LTE-TDD @ PF = 128 (USB disconnected)	2.34	mA
	LTE-TDD @ PF = 256 (USB disconnected)	1.94	mA
Idle state	EGSM900 @ DRX = 5 (USB connected)	29.33	mA
	EGSM900 @ DRX = 5 (USB disconnected)	15.04	mA
	WCDMA @ PF = 64 (USB connected)	24.25	mA
	WCDMA @ PF = 64 (USB disconnected)	14.67	mA
	LTE-FDD @ PF = 64 (USB connected)	30.61	mA
	LTE-FDD @ PF = 64 (USB disconnected)	16.03	mA
	LTE-TDD @ PF = 64 (USB connected)	26.11	mA
	LTE-TDD @ PF = 64 (USB disconnected)	15.76	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	283.6	mA
	EGSM900 3DL/2UL @ 32 dBm	438.8	mA
	EGSM900 2DL/3UL @ 30 dBm	495.5	mA
	EGSM900 1DL/4UL @ 29 dBm	595.8	mA
	DCS1800 4DL/1UL @ 29.5 dBm	204.8	mA
	DCS1800 3DL/2UL @ 29.0 dBm	293.5	mA
	DCS1800 2DL/3UL @ 26.5 dBm	357.3	mA
	DCS1800 1DL/4UL @ 25.5 dBm	425.2	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	182.3	mA
	EGSM900 3DL/2UL @ 26.0 dBm	274.1	mA
	EGSM900 2DL/3UL @ 24.0 dBm	317.4	mA
	EGSM900 1DL/4UL @ 23.0 dBm	378.3	mA

	DCS1800 4DL/1UL @ 26.0 dBm	166.6	mA
	DCS1800 3DL/2UL @ 25.0 dBm	245.1	mA
	DCS1800 2DL/3UL @ 23.0 dBm	311.3	mA
	DCS1800 1DL/4UL @ 22.0 dBm	376.9	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.0 dBm	564.93	mA
	WCDMA B8 HSDPA @ 22.5 dBm	520.51	mA
	WCDMA B1 HSUPA @ 22.5 dBm	582.33	mA
	WCDMA B8 HSUPA @ 22.5 dBm	536.54	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	637.27	mA
	LTE-FDD B3 @ 23.0 dBm	610.82	mA
	LTE-FDD B5 @ 23.0 dBm	587.18	mA
	LTE-FDD B8 @ 23.0 dBm	598.06	mA
	LTE-TDD B34 @ 23.0 dBm	318.32	mA
	LTE-TDD B38 @ 23.0 dBm	465.24	mA
	LTE-TDD B39 @ 23.0 dBm	305.92	mA
	LTE-TDD B40 @ 23.0 dBm	445.12	mA
	LTE-TDD B41 @ 23.0 dBm	427.62	mA
GSM voice call	EGSM900, PCL = 5 @ 33 dBm	304.4	mA
	EGSM900, PCL = 12 @ 19.0 dBm	147.2	mA
	EGSM900, PCL = 19 @ 5.0 dBm	130.8	mA
	DCS1800, PCL = 0 @ 29.5 dBm	211.3	mA
	DCS1800, PCL = 7 @ 16.0 dBm	161.2	mA
	DCS1800, PCL = 15 @ 0 dBm	158.3	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	595.2	mA
	WCDMA B8 @ 23 dBm	568.39	mA

6.4.10. AG529R-EU Power Consumption

Table 60: AG529R-EU Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	0.035	mA
Sleep state	**AT+CFUN=0** (USB disconnected)	1.180	mA
	EGSM900 @ DRX = 2 (USB disconnected)	3.189	mA
	EGSM900 @ DRX = 5 (USB disconnected)	2.237	mA
	EGSM900 @ DRX = 5 (USB suspend)	3,757	mA
	EGSM900 @ DRX = 9 (USB disconnected)	2.689	mA
	DCS1800 @ DRX = 2 (USB disconnected)	3.191	mA
	DCS1800 @ DRX = 5 (USB disconnected)	2.288	mA
	DCS1800 @ DRX = 5 (USB suspend)	3.750	mA
	DCS1800 @ DRX = 9 (USB disconnected)	3.377	mA
	WCDMA @ PF = 64 (USB disconnected)	2.713	mA
	WCDMA @ PF = 64 (USB suspend)	4.085	mA
	WCDMA @ PF = 128 (USB disconnected)	2.228	mA
	WCDMA @ PF = 256 (USB disconnected)	2.050	mA
	WCDMA @ PF = 512 (USB disconnected)	1.398	mA
	LTE-FDD @ PF = 32 (USB disconnected)	4.248	mA
	LTE-FDD @ PF = 64 (USB disconnected)	2.848	mA
	LTE-FDD @ PF = 64 (USB suspend)	4.273	mA
	LTE-FDD @ PF = 128 (USB disconnected)	2.276	mA
	LTE-FDD @ PF = 256 (USB disconnected)	2.183	mA
	LTE-TDD @ PF = 32（USB disconnected）	4.293	mA
	LTE-TDD @ PF = 64（USB disconnected）	2.908	mA

	LTE-TDD @ PF = 64（USB suspend）	4.390	mA
	LTE-TDD @ PF = 128（USB disconnected）	2.783	mA
	LTE-TDD @ PF = 256（USB disconnected）	2.635	mA
Idle state	EGSM900 @ DRX = 5 (USB connected)	15.91	mA
	EGSM900 @ DRX = 5 (USB disconnected)	33.12	mA
	WCDMA @ PF = 64 (USB connected)	15.97	mA
	WCDMA @ PF = 64 (USB disconnected)	42.96	mA
	LTE-FDD @ PF = 64 (USB connected)	16.29	mA
	LTE-FDD @ PF = 64 (USB disconnected)	43.90	mA
GPRS data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 33 dBm	338.90	mA
	EGSM900 3DL/2UL @ 32 dBm	562.80	mA
	EGSM900 2DL/3UL @ 30 dBm	689.70	mA
	EGSM900 1DL/4UL @ 29 dBm	761.20	mA
	DCS1800 4DL/1UL @ 29.5 dBm	216.30	mA
	DCS1800 3DL/2UL @ 29.0 dBm	321.60	mA
	DCS1800 2DL/3UL @ 26.5 dBm	370.90	mA
	DCS1800 1DL/4UL @ 25.5 dBm	537.90	mA
EDGE data transfer (GNSS OFF)	EGSM900 4DL/1UL @ 27.0 dBm	233.30	mA
	EGSM900 3DL/2UL @ 26.0 dBm	365.20	mA
	EGSM900 2DL/3UL @ 24.0 dBm	422.20	mA
	EGSM900 1DL/4UL @ 23.0 dBm	493.70	mA
	DCS1800 4DL/1UL @ 26.0 dBm	163.70	mA
	DCS1800 3DL/2UL @ 25.0 dBm	225.90	mA
	DCS1800 2DL/3UL @ 23.0 dBm	265.90	mA
	DCS1800 1DL/4UL @ 22.0 dBm	368.80	mA

WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.0 dBm	642.00	mA
	WCDMA B8 HSDPA @ 22.5 dBm	628.00	mA
	WCDMA B1 HSUPA @ 22.5 dBm	651.00	mA
	WCDMA B8 HSUPA @ 22.5 dBm	637.00	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	658.00	mA
	LTE-FDD B3 @ 23.0 dBm	593.00	mA
	LTE-FDD B7 @ 23.0 dBm	670.00	mA
	LTE-FDD B8 @ 23.0 dBm	636.00	mA
	LTE-FDD B20 @ 23.0 dBm	648.00	mA
	LTE-FDD B28A @ 23.0 dBm	636.00	mA
	LTE-TDD B38 @ 23.0 dBm	356.00	mA
	LTE-TDD B40 @ 23.0 dBm	324.00	mA
	LTE-TDD B341 @ 23.0 dBm	400.00	mA
GSM voice call	EGSM900, PCL = 5 @ 33 dBm	368.00	mA
	EGSM900, PCL = 12 @ 19.0 dBm	154.90	mA
	EGSM900, PCL = 19 @ 5.0 dBm	110.80	mA
	DCS1800, PCL = 0 @ 29.5 dBm	227.20	mA
	DCS1800, PCL = 7 @ 16.0 dBm	128.70	mA
	DCS1800, PCL = 15 @ 0 dBm	126.00	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	676.00	mA
	WCDMA B8 @ 23 dBm	654.00	mA

6.4.11. AG529R-LA Power Consumption

Table 61: AG529R-LA Power Consumption (25 °C, 3.8 V Power Supply)

Description	Conditions	Typ.	Unit
OFF state	Power down	TBD	mA
Sleep state	WCDMA @ PF = 64 (USB disconnected)	TBD	mA
	WCDMA @ PF = 64 (USB suspend)	TBD	mA
	WCDMA @ PF = 128 (USB disconnected)	TBD	mA
	WCDMA @ PF = 256 (USB disconnected)	TBD	mA
	WCDMA @ PF = 512 (USB disconnected)	TBD	mA
	LTE-FDD @ PF = 32 (USB disconnected)	TBD	mA
	LTE-FDD @ PF = 64 (USB disconnected)	TBD	mA
	LTE-FDD @ PF = 64 (USB suspend)	TBD	mA
	LTE-FDD @ PF = 128 (USB disconnected)	TBD	mA
	LTE-FDD @ PF = 256 (USB disconnected)	TBD	mA
	WCDMA @ PF = 64 (USB connected)	TBD	mA
	WCDMA @ PF = 64 (USB disconnected)	TBD	mA
	LTE-FDD @ PF = 64 (USB connected)	TBD	mA
	LTE-FDD @ PF = 64 (USB disconnected)	TBD	mA
WCDMA data transfer (GNSS OFF)	WCDMA B1 HSDPA @ 22.0 dBm	TBD	mA
	WCDMA B2 HSDPA @ 22.0 dBm	TBD	mA
	WCDMA B5 HSDPA @ 22.0 dBm	TBD	mA
	WCDMA B8 HSDPA @ 22.5 dBm	TBD	mA
	WCDMA B1 HSUPA @ 22.5 dBm	TBD	mA
	WCDMA B2 HSUPA @ 22.5 dBm	TBD	mA
	WCDMA B5 HSUPA @ 22.5 dBm	TBD	mA

	WCDMA B8 HSUPA @ 22.5 dBm	TBD	mA
LTE data transfer (GNSS OFF)	LTE-FDD B1 @ 23.0 dBm	TBD	mA
	LTE-FDD B2 @ 23.0 dBm	TBD	mA
	LTE-FDD B3 @ 23.0 dBm	TBD	mA
	LTE-FDD B4 @ 23.0 dBm	TBD	mA
	LTE-FDD B5 @ 23.0 dBm	TBD	mA
	LTE-FDD B7 @ 23.0 dBm	TBD	mA
	LTE-FDD B8 @ 23.0 dBm	TBD	mA
	LTE-FDD B28A @ 23.0 dBm	TBD	mA
	LTE-FDD B28B @ 23.0 dBm	TBD	mA
WCDMA voice call	WCDMA B1 @ 23 dBm	TBD	mA
	WCDMA B2 @ 23 dBm	TBD	mA
	WCDMA B5 @ 23 dBm	TBD	mA
	WCDMA B8 @ 23 dBm	TBD	mA

6.5. Tx Power

The following table shows the RF output power of AG52xR series module.

6.5.1. AG520R-CN Tx Power

Table 62: AG520R-CN Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	< -49 dBm

WCDMA B8	23 dBm ±2 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B7	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B39	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm
C-V2X TDD B47	23 dBm ±2 dB	<- 39 dBm

6.5.2. AG520R-EU Tx Power

Table 63: AG520R-EU Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	<- 49 dBm
WCDMA B3	23 dBm ±2 dB	<- 49 dBm
WCDMA B5	23 dBm ±2 dB	<- 49 dBm
WCDMA B8	23 dBm ±2 dB	<- 49 dBm
LTE-FDD B1	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B3	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B5	23 dBm ±2 dB	<- 39 dBm

LTE-FDD B7	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B8	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B20	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B28	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B32 [41]	-	-
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm
C-V2X TDD B47	23 dBm ±2 dB	<- 39 dBm

6.5.3. AG520R-NA Tx Power

Table 64: AG520R-NA Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
LTE-FDD B2	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B4	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B5	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B7	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B12	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B13	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B14	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B25	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B26	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B29 [41]	-	-
LTE-FDD B30 [41]	-	-

[41] LTE-FDD B29, B30 and B32 support Rx only, and B30 is subject to carrier's deployment.

LTE-FDD B66	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B71	23 dBm ±2 dB	<- 39 dBm
C-V2X TDD B47	23 dBm ±2 dB	<- 39 dBm

6.5.4. AG520R-JP Tx Power

Table 65: AG520R-JP Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
WCDMA B1	23 dBm ±2 dB	<- 49 dBm
WCDMA B3	23 dBm ±2 dB	<- 49 dBm
WCDMA B5	23 dBm ±2 dB	<- 49 dBm
WCDMA B8	23 dBm ±2 dB	<- 49 dBm
WCDMA B9	23 dBm ±2 dB	<- 49 dBm
WCDMA B19	23 dBm ±2 dB	<- 49 dBm
LTE-FDD B1	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B3	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B5	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B8	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B9	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B11	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B18	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B19	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B21	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B28	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm
C-V2X TDD B47	TBD	TBD

6.5.5. AG521R-CN Tx Power

Table 66: AG521R-CN Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	< -49 dBm
WCDMA B8	23 dBm ±2 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B7	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B39	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm

6.5.6. AG521R-EU Tx Power

Table 67: AG521R-EU Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	<- 49 dBm

WCDMA B3	23 dBm ±2 dB	<- 49 dBm
WCDMA B5	23 dBm ±2 dB	<- 49 dBm
WCDMA B8	23 dBm ±2 dB	<- 49 dBm
LTE-FDD B1	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B3	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B5	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B7	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B8	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B20	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B28	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B32 [41]	-	-
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm

6.5.7. AG521R-NA Tx Power

Table 68: AG521R-NA Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
LTE-FDD B2	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B4	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B5	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B7	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B12	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B13	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B14	23 dBm ±2 dB	<- 39 dBm

LTE-FDD B25	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B26	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B29 [41]	-	-
LTE-FDD B30 [41]	-	-
LTE-FDD B66	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B71	23 dBm ±2 dB	<- 39 dBm

6.5.8. AG525R-GL Tx Power

Table 69: AG525R-GL Tx Power (25 °C, 3.8 V Power Supply)

Frequency	Max. Tx Power	Min. Tx Power
GSM850	33 dBm ±2 dB	5 dBm ±5 dB
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
PCS1900	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	< -49 dBm
WCDMA B2	23 dBm ±2 dB	< -49 dBm
WCDMA B3	23 dBm ±2 dB	< -49 dBm
WCDMA B4	23 dBm ±2 dB	< -49 dBm
WCDMA B5	23 dBm ±2 dB	< -49 dBm
WCDMA B6	23 dBm ±2 dB	< -49 dBm
WCDMA B8	23 dBm ±2 dB	< -49 dBm
WCDMA B19	23 dBm ±2 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B2	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm

LTE-FDD B4	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B7	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-FDD B9	23 dBm ±2 dB	< -39 dBm
LTE-FDD B11	23 dBm ±2 dB	< -39 dBm
LTE-FDD B12	23 dBm ±2 dB	< -39 dBm
LTE-FDD B13	23 dBm ±2 dB	< -39 dBm
LTE-FDD B18	23 dBm ±2 dB	< -39 dBm
LTE-FDD B19	23 dBm ±2 dB	< -39 dBm
LTE-FDD B20	23 dBm ±2 dB	< -39 dBm
LTE-FDD B21	23 dBm ±2 dB	< -39 dBm
LTE-FDD B25	23 dBm ±2 dB	< -39 dBm
LTE-FDD B26	23 dBm ±2 dB	< -39 dBm
LTE-FDD B28	23 dBm ±2 dB	< -39 dBm
LTE-FDD B66	23 dBm ±2 dB	< -39 dBm
LTE-FDD B71	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34	23 dBm ±2 dB	< -39 dBm
LTE-TDD B38	23 dBm ±2 dB	< -39 dBm
LTE-TDD B39	23 dBm ±2 dB	< -39 dBm
LTE-TDD B40	23 dBm ±2 dB	< -39 dBm
LTE-TDD B41	23 dBm ±2 dB	< -39 dBm

6.5.9. AG529R-CN Tx Power

Table 70: AG529R-CN Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	< -49 dBm
WCDMA B8	23 dBm ±2 dB	< -49 dBm
LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B5	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-TDD B34	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B39	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm

6.5.10. AG529R-EU Tx Power

Table 71: AG529R-EU Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
WCDMA B1	23 dBm ±2 dB	< -49 dBm
WCDMA B8	23 dBm ±2 dB	< -49 dBm

LTE-FDD B1	23 dBm ±2 dB	< -39 dBm
LTE-FDD B3	23 dBm ±2 dB	< -39 dBm
LTE-FDD B7	23 dBm ±2 dB	< -39 dBm
LTE-FDD B8	23 dBm ±2 dB	< -39 dBm
LTE-FDD B20	23 dBm ±2 dB	<- 39 dBm
LTE-FDD B28A	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B38	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B40	23 dBm ±2 dB	<- 39 dBm
LTE-TDD B41	23 dBm ±2 dB	<- 39 dBm

6.5.11. AG529R-LA Tx Power

Table 72: AG529R-LA Tx Power (25 °C, 3.8 V Power Supply)

Frequency Bands	Max. Tx Power	Min. Tx Power
WCDMA B1	TBD	TBD
WCDMA B2	TBD	TBD
WCDMA B5	TBD	TBD
WCDMA B8	TBD	TBD
LTE-FDD B1	TBD	TBD
LTE-FDD B2	TBD	TBD
LTE-FDD B3	TBD	TBD
LTE-FDD B4	TBD	TBD
LTE-FDD B5	TBD	TBD
LTE-FDD B7	TBD	TBD
LTE-FDD B8	TBD	TBD
LTE-FDD B28A	TBD	TBD

LTE-FDD B28B	TBD	TBD

NOTE

1. For GPRS transmission on 4 uplink timeslots, the maximum output power reduction is 4.0 dB. The design conforms to *3GPP TS 51.010-1* subclause 13.16.
2. WCDMA specified power tolerance conforms to *3GPP TS 34.121-1* requirements.
3. LTE specified typical power tolerance conforms to *3GPP TS 36.521-1* requirements and the module is tested @ BW = 10 MHz, 1RB.

6.6. Rx Sensitivity

6.6.1. AG520R-CN Rx Sensitivity

Table 73: AG520R-CN RF Receiving Sensitivity(dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-109.4	-102
DCS1800 (1RX)	-104	-107	-108.6	-102
WCDMA B1 (1RX)	-108.9	-109	-109.0	-106.7
WCDMA B8 (1RX)	-105.7	-109	-111.0	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.7	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-101.7	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.2	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-101.2	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-103.2	-93.3
LTE-TDD B34 (10 MHz)	-98.3	-99.3	-101.7	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-100.2	-96.3
LTE-TDD B39 (10 MHz)	-98.3	-99.3	-101.7	-96.3

LTE-TDD B40 (10 MHz)	-98.3	-99.3	-101.2	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-99.7	-94.3
C-V2X TDD B47 (PRX)	-92.4	-95	-96.1	-90.4
C-V2X TDD B47 (DRX)	-92.4	-95	-98.4	-90.4

6.6.2. AG520R-EU Rx Sensitivity

Table 74: AG520R-EU RF Receiving Sensitivity(dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-109	-102
DCS1800 (1RX)	-104	-107	-108.5	-102
WCDMA B1 (1RX)	-108.7	-109	-110.5	-106.7
WCDMA B3 (1RX)	-105.7	-109	-110.5	-103.7
WCDMA B5 (1RX)	-106.7	-109	-110.0	-104.7
WCDMA B8 (1RX)	-105.7	-109	-109.5	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.8	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-101.8	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.9	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-101.4	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-102.9	-93.3
LTE-FDD B20 (10 MHz)	-95.3	-97.3	-99.2	-93.3
LTE-FDD B28 (10 MHz)	-96.8	-98.8	-103.2	-94.8
LTE-FDD B32 (10 MHz)	-98.3	-98.9	-98.9	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-100.9	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-100.4	-96.3

LTE-TDD B41 (10 MHz)	-96.3	-97.3	-100.1	-94.3
C-V2X TDD B47 (PRX)	-92.4	-95	-98.2	-90.4
C-V2X TDD B47 (DRX)	-92.4	-95	-98.4	-90.4

6.6.3. AG520R-NA Rx Sensitivity

Table 75: AG520R-NA RF Receiving Sensitivity(dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
LTE-FDD B2 (10 MHz)	-96.3	-98.3	-101.4	-94.3
LTE-FDD B4 (10 MHz)	-98.3	-100.3	-101.2	-96.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.0	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-98.4	-94.3
LTE-FDD B12 (10 MHz)	-95.3	-97.3	-102.8	-93.3
LTE-FDD B13 (10 MHz)	-95.3	-97.3	-102.6	-93.3
LTE-FDD B14 (10 MHz)	-95.3	-97.3	-101.0	-93.3
LTE-FDD B25 (10 MHz)	-94.8	-96.8	-101.3	-92.8
LTE-FDD B26 (10 MHz)	-95.8	-97.8	-102.0	-93.8
LTE-FDD B29 (10 MHz)	-95.3	-97.3	-102.0	-93.3
LTE-FDD B30 (10 MHz)	TBD	TBD	TBD	-95.3
LTE-FDD B66 (10 MHz)	-97.8	-99.8	-101.1	-95.8
LTE-FDD B71 (10 MHz)	-95.5	-97.5	-102.6	-93.5
C-V2X TDD B47 (PRX)	-92.4	-94.3	-94.3	-90.4
C-V2X TDD B47 (DRX)	-92.4	-95	-98.2	-90.4

6.6.4. AG520R-JP Rx Sensitivity

Table 76: AG520R-JP RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
WCDMA B1 (1RX)	-108.7	-109	-110.5	-106.7
WCDMA B3 (1RX)	-108.7	-109	-111.0	-106.7
WCDMA B5 (1RX)	-106.7	-109	-110.0	-103.7
WCDMA B8 (1RX)	-106.7	-109	-110.5	-103.7
WCDMA B9 (1RX)	-108.7	-109	-111.5	-106.7
WCDMA B19 (1RX)	-105.7	-109	-111.0	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.4	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-101.8	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.4	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-102.8	-93.3
LTE-FDD B9 (10 MHz)	-97.3	-99.3	-102.5	-95.3
LTE-FDD B11 (10 MHz)	-98.3	-100.3	-102.7	-96.3
LTE-FDD B18 (10 MHz)	-98.3	-100.3	-102.7	-96.3
LTE-FDD B19 (10 MHz)	-98.3	-100.3	-102.4	-96.3
LTE-FDD B21 (10 MHz)	-98.3	-100.3	-102.4	-96.3
LTE-FDD B28 (10 MHz)	-96.8	-98.8	-103.2	-94.8
LTE-TDD B41 (10 MHz)	-95.3	-97.3	-99.3	-94.3
C-V2X TDD B47 (PRX)	TBD	TBD	TBD	-90.4
C-V2X TDD B47 (DRX)	TBD	TBD	TBD	-90.4

6.6.5. AG521R-CN Rx Sensitivity

Table 77: AG521R-CN RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-109	-102
DCS1800 (1RX)	-104	-107	-109	-102
WCDMA B1 (1RX)	-108.7	-109	-112.0	-106.7
WCDMA B8 (1RX)	-105.7	-109	-113.5	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.6	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-101.7	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-103.5	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-101.3	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-103.5	-93.3
LTE-TDD B34 (10 MHz)	-98.3	-99.3	-101.8	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-100.7	-96.3
LTE-TDD B39 (10 MHz)	-98.3	-99.3	-101.9	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-101.7	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-99.9	-94.3

6.6.6. AG521R-EU Rx Sensitivity

Table 78: AG521R-EU RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-109	-102
DCS1800 (1RX)	-104	-107	-109	-102

WCDMA B1 (1RX)	-108.7	-109	-110.8	-106.7
WCDMA B3 (1RX)	-105.7	-109	-111.4	-103.7
WCDMA B5 (1RX)	-106.7	-109	-111.5	-104.7
WCDMA B8 (1RX)	-105.7	-109	-111.4	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-102.1	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-102.2	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.7	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-101.1	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-102.5	-93.3
LTE-FDD B20 (10 MHz)	-95.3	-97.3	-102.8	-93.3
LTE-FDD B28 (10 MHz)	-96.8	-98.8	-103.0	-94.8
LTE-FDD B32 (10 MHz)	-98.3	-100.3	-100.9	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-100.9	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-100.5	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-100.6	-94.3

6.6.7. AG521R-NA Rx Sensitivity

Table 79: AG521R-NA RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
LTE-FDD B2 (10 MHz)	-96.3	-98.3	-102.1	-94.3
LTE-FDD B4 (10 MHz)	-98.3	-100.3	-102.0	-96.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-102.5	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-100.1	-94.3
LTE-FDD B12 (10 MHz)	-95.3	-97.3	-103.2	-93.3

LTE-FDD B13 (10 MHz)	-95.3	-97.3	-103.1	-93.3
LTE-FDD B14 (10 MHz)	-95.3	-97.3	-102.6	-93.3
LTE-FDD B25 (10 MHz)	-94.8	-96.8	-102.1	-92.8
LTE-FDD B26 (10 MHz)	-95.8	-97.8	-102.6	-93.8
LTE-FDD B29 (10 MHz)	-95.3	-97.8	-103.4	-93.3
LTE-FDD B30 (10 MHz)	TBD	TBD	TBD	-95.3
LTE-FDD B66 (10 MHz)	-97.8	-99.8	-102.0	-95.8
LTE-FDD B71 (10 MHz)	-95.5	-97.5	-103.1	-93.5

6.6.8. AG525R-GL Rx Sensitivity

Table 80: AG525R-GL RF Receiving Sensitivity(dBm) (25 °C, 3.8 V Power Supply)

Frequency	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
GSM850 (1RX)	-104	-107	-109.3	-102
EGSM900 (1RX)	-104	-107	-108.8	-102
DCS1800 (1RX)	-104	-107	-108.3	-102
PCS1900 (1RX)	-104.0	-107	-107.5	-102
WCDMA B1 (1RX)	-108.7	-109	-113.6	-106.7
WCDMA B2 (1RX)	-106.7	-109	-113.5	-104.7
WCDMA B3 (1RX)	-105.7	-109	-114.0	-103.7
WCDMA B4 (1RX)	-108.7	-109	-113.4	-106.7
WCDMA B5 (1RX)	-106.7	-109	-114.8	-104.7
WCDMA B6 (1RX)	-106.7	-109	-114.7	-104.7
WCDMA B8 (1RX)	-105.7	-109	-111.9	-103.7
WCDMA B19 (1RX)	-105.7	-109	-114.7	-103.7

LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.3	-96.3
LTE-FDD B2 (10 MHz)	-96.3	-98.3	-101.4	-94.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-101.6	-93.3
LTE-FDD B4 (10 MHz)	-98.3	-100.3	-101.1	-96.3
LTE-FDD B5 (10 MHz)	-96.3	-97.3	-102.1	-94.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-99.6	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-101.6	-93.3
LTE-FDD B9 (10 MHz)	-97.3	-99.3	-101.6	-95.3
LTE-FDD B11 (10 MHz)	-98.3	-100.3	-101.8	-96.3
LTE-FDD B12 (10 MHz)	-95.3	-97.3	-101.9	-93.3
LTE-FDD B13 (10 MHz)	-95.3	-97.3	-102.7	-93.3
LTE-FDD B18 (10 MHz)	-98.3	-100.3	-102.5	-96.3
LTE-FDD B19 (10 MHz)	-98.3	-100.3	-102.0	-96.3
LTE-FDD B20 (10 MHz)	-95.3	-97.3	-102.3	-93.3
LTE-FDD B21 (10 MHz)	-98.3	-100.3	-102.0	-96.3
LTE-FDD B25 (10 MHz)	-94.8	-96.8	-101.4	-92.8
LTE-FDD B26 (10 MHz)	-96.3	-98.3	-102.0	-94.3
LTE-FDD B28 (10 MHz)	-96.8	-98.8	-102.8	-94.8
LTE-FDD B29 (10 MHz)	-95.3	-97.3	-102.2	-93.3
LTE-FDD B30 (10 MHz)	TBD	TBD	TBD	-95.3
LTE-FDD B32 (10 MHz)	-98.3	-100.3	-100.5	-95.3
LTE-FDD B66 (10 MHz)	-97.8	-99.8	-101.0	-95.8
LTE-FDD B71 (10 MHz)	-95.5	-97.5	-99.5	-93.5
LTE-TDD B34 (10 MHz)	-98.3	-99.3	-101.1	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-100.7	-96.3

LTE-TDD B39 (10 MHz)	-98.3	-99.3	-99.9	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-101.2	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-101.9	-94.3

6.6.9. AG529R-CN Rx Sensitivity

Table 81: AG529R-CN RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-110	-102
DCS1800 (1RX)	-104	-107	-109	-102
WCDMA B1 (1RX)	-108.7	-109	-114.0	-106.7
WCDMA B8 (1RX)	-105.7	-109	-114.5	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-102.9	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-102.6	-93.3
LTE-FDD B5 (10 MHz)	-96.3	-98.3	-103.8	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-104.0	-93.3
LTE-TDD B34 (10 MHz)	-98.3	-99.3	-101.9	-96.3
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-102.0	-96.3
LTE-TDD B39 (10 MHz)	-98.3	-99.3	-101.8	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-101.7	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-101.4	-94.3

6.6.10. AG529R-EU Rx Sensitivity

Table 82: AG529R-EU RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
EGSM900 (1RX)	-104	-107	-108.5	-102
DCS1800 (1RX)	-104	-107	-108.5	-102
WCDMA B1 (1RX)	-108.7	-111	-111.3	-106.7
WCDMA B8 (1RX)	-105.7	-111	-114.9	-103.7
LTE-FDD B1 (10 MHz)	-98.3	-100.3	-101.1	-96.3
LTE-FDD B3 (10 MHz)	-95.3	-97.3	-97.8	-93.3
LTE-FDD B7 (10 MHz)	-96.3	-98.3	-100.2	-94.3
LTE-FDD B8 (10 MHz)	-95.3	-97.3	-102.4	-93.3
LTE-FDD B20 (10 MHz)	-95.3	-96.3	-102.5	-93.3
LTE-FDD B28A (10 MHz)	-96.8	--97.8	-103.1	-94.8
LTE-TDD B38 (10 MHz)	-98.3	-99.3	-99.7	-96.3
LTE-TDD B40 (10 MHz)	-98.3	-99.3	-99.7	-96.3
LTE-TDD B41 (10 MHz)	-96.3	-97.3	-99.4	-94.3

6.6.11. AG529R-LA Rx Sensitivity

Table 83: AG529R-LA RF Receiving Sensitivity (dBm) (25 °C, 3.8 V Power Supply)

Frequency Bands	SIMO			3GPP (SIMO)
	Max. (Worst Case)	Typ.	Min. (Best Case)	
WCDMA B1 (1RX)	TBD	TBD	TBD	-102
WCDMA B2 (1RX)	TBD	TBD	TBD	-102
WCDMA B5 (1RX)	TBD	TBD	TBD	-106.7

WCDMA B8 (1RX)	TBD	TBD	TBD	-103.7
LTE-FDD B1 (10 MHz)	TBD	TBD	TBD	-96.3
LTE-FDD B2 (10 MHz)	TBD	TBD	TBD	-96.3
LTE-FDD B3 (10 MHz)	TBD	TBD	TBD	-93.3
LTE-FDD B4 (10 MHz)	TBD	TBD	TBD	-96.3
LTE-FDD B5 (10 MHz)	TBD	TBD	TBD	-96.3
LTE-FDD B7 (10 MHz)	TBD	TBD	TBD	-94.3
LTE-FDD B8 (10 MHz)	TBD	TBD	TBD	-93.3
LTE-TDD B28A (10 MHz)	TBD	TBD	TBD	-93.3
LTE-TDD B28B (10 MHz)	TBD	TBD	TBD	-94.8

NOTE

1. GSM sensitivity values meet *3GPP TS 51.010-1* requirements.
2. WCDMA sensitivity values meet *3GPP TS 34.121-1* requirements.
3. LTE sensitivity values meet *3GPP TS 36.521-1* requirements and it is tested under BW = 10 MHz according to 3GPP 1 RB configuration.

6.7. ESD Protection

Static electricity occurs naturally and it may damage the module. Therefore, applying proper ESD countermeasures and handling methods is imperative. For example, wear anti-static gloves during the development, production, assembly and testing of the module; add ESD protection components to the ESD sensitive interfaces and points in the product design.

The following table shows the module electrostatic discharge characteristics.

Table 84: Electrostatic Discharge Characteristics (Temperature: 25–30 ºC, Humidity: 40 ±5 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	±6	±10	kV

Antenna Interfaces	±5	±10	kV
Other Interfaces	±0.5	±1	kV

6.8. Thermal Dissipation

The module offers the best performance when all internal IC chips are working within their operating temperatures. When the IC chip reaches or exceeds the maximum junction temperature, the module may still work but the performance and function (such as RF output power and data rate) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips always work within the recommended operating temperature range.

The following principles for thermal consideration are provided for reference:

- Keep the module away from heat sources on your PCB, especially high-power components such as processor, power amplifier, and power supply.
- Maintain the integrity of the PCB copper layer and drill as many thermal vias as possible.
- Follow the principles below when the heatsink is necessary:
  - Do not place large size components in the area where the module is mounted on your PCB to reserve enough place for heatsink installation.
  - Attach the heatsink to the shielding cover of the module; In general, the base plate area of the heatsink should be larger than the module area to cover the module completely;
  - Choose the heatsink with adequate fins to dissipate heat;
  - Choose a TIM (Thermal Interface Material) with high thermal conductivity, good softness and good wettability and place it between the heatsink and the module;
  - Fasten the heatsink with four screws to ensure that it is in close contact with the module to prevent the heatsink from falling off during the drop, vibration test, or transportation.

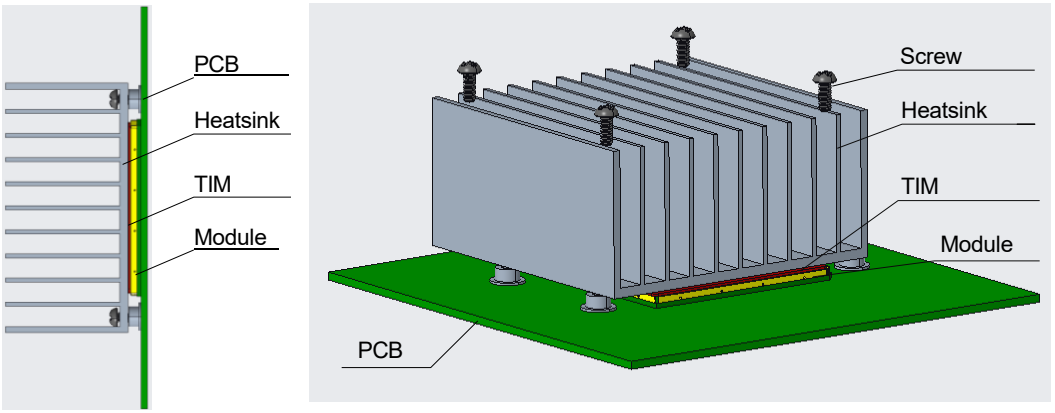


Figure 38: Placement and Fixing of the Heatsink

NOTE

1. The module works normal when the internal BB chip is below 105 °C. When the maximum temperature of the BB chip reaches or exceeds 105 °C, the module detaches from the network and enters Limited Service State in which only eCall is available, and it will recover to network connected state after the maximum temperature falls below 90 °C. Therefore, the thermal design should be maximally optimized to make sure the maximum BB chip temperature always maintains below 105 °C. Specified commands can be used to query the current temperature. See ***document [10]*** for details about the command and the detailed information on software thermal management.
2. For more detailed introduction on thermal design, see ***document [11]***.

7 Mechanical Information

This chapter describes the mechanical dimensions of the module. All dimensions are measured in mm, and the dimensional tolerances are ±0.2 mm unless otherwise specified.

7.1. Mechanical Dimensions

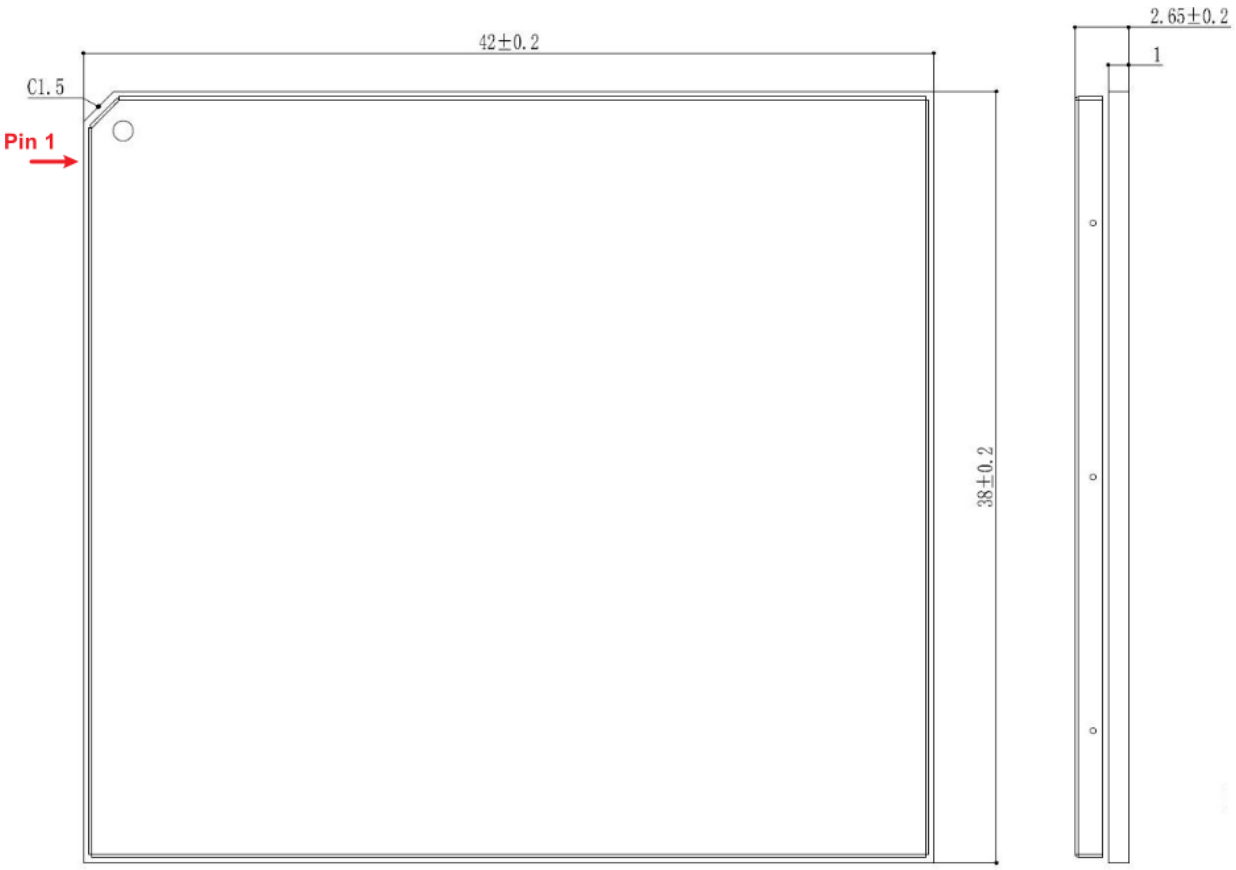


Figure 39: Module Top and Side Dimensions (Unit: mm)

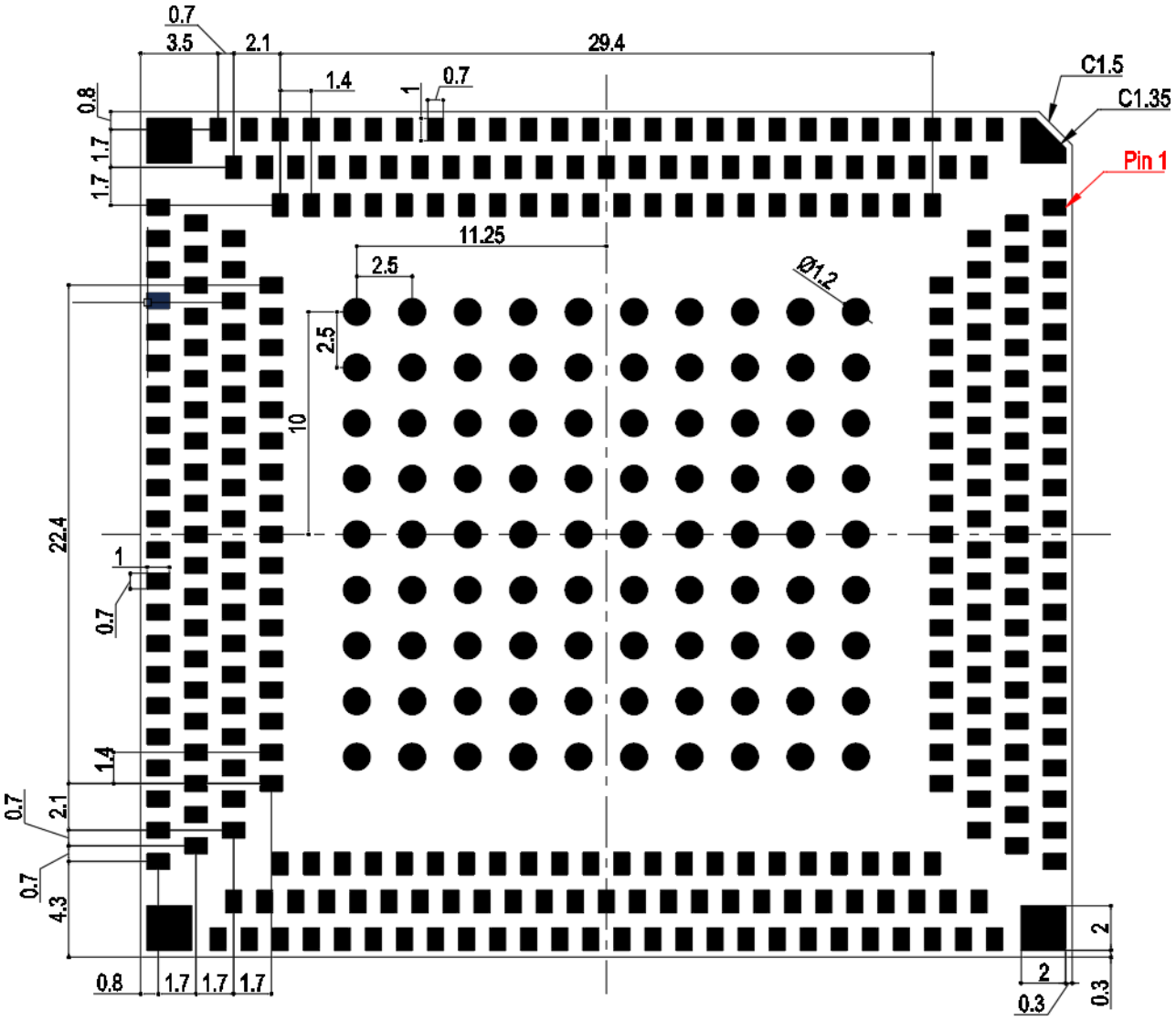


Figure 40: Module Bottom Dimensions (Bottom View) (Unit: mm)

NOTE

The package warpage level of the module conforms to *JEITA ED-7306 standard*.

7.2. Recommended Footprint

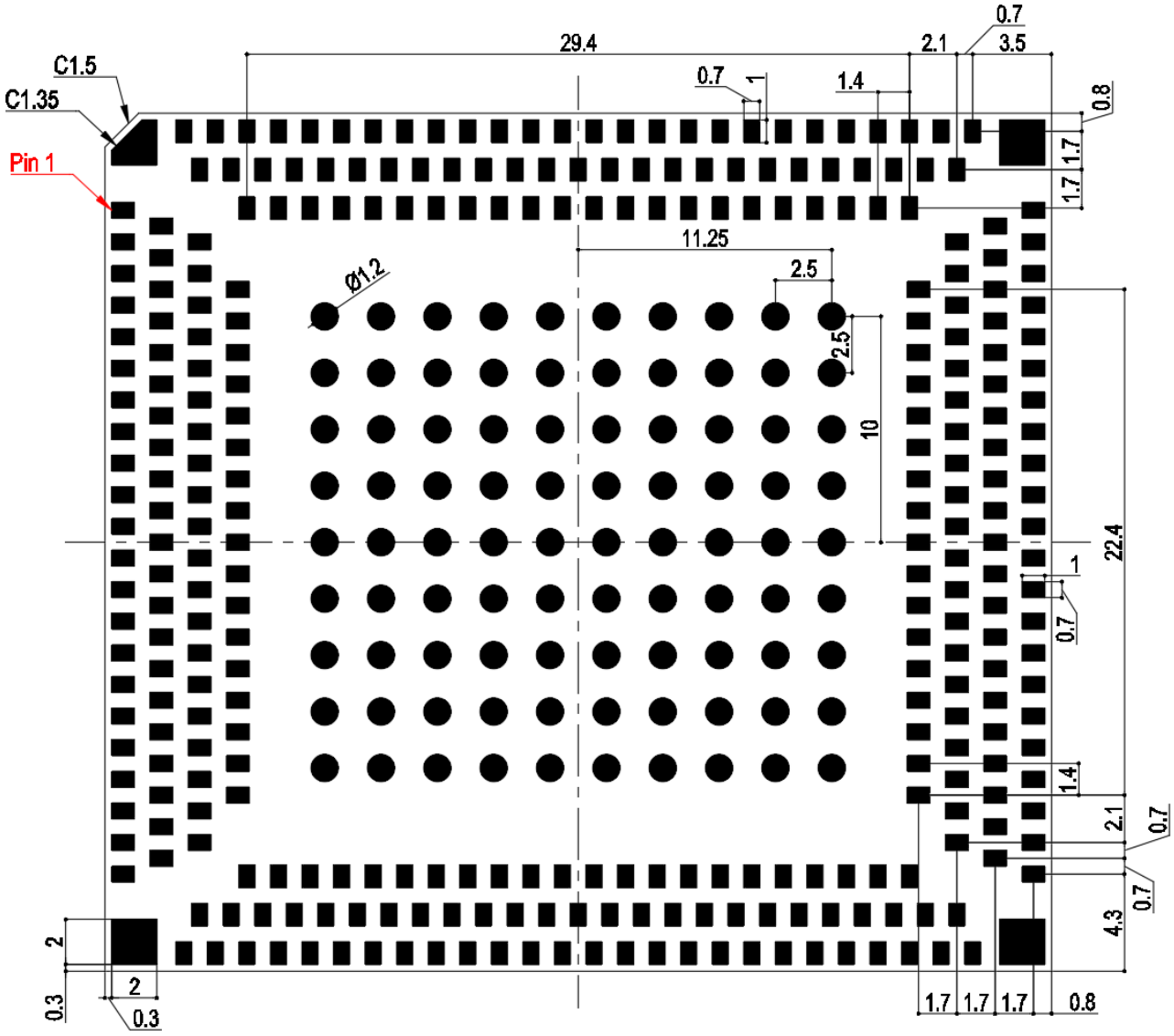


Figure 41: Recommended Footprint (Perspective View)

NOTE

Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.

7.3. Top and Bottom Views

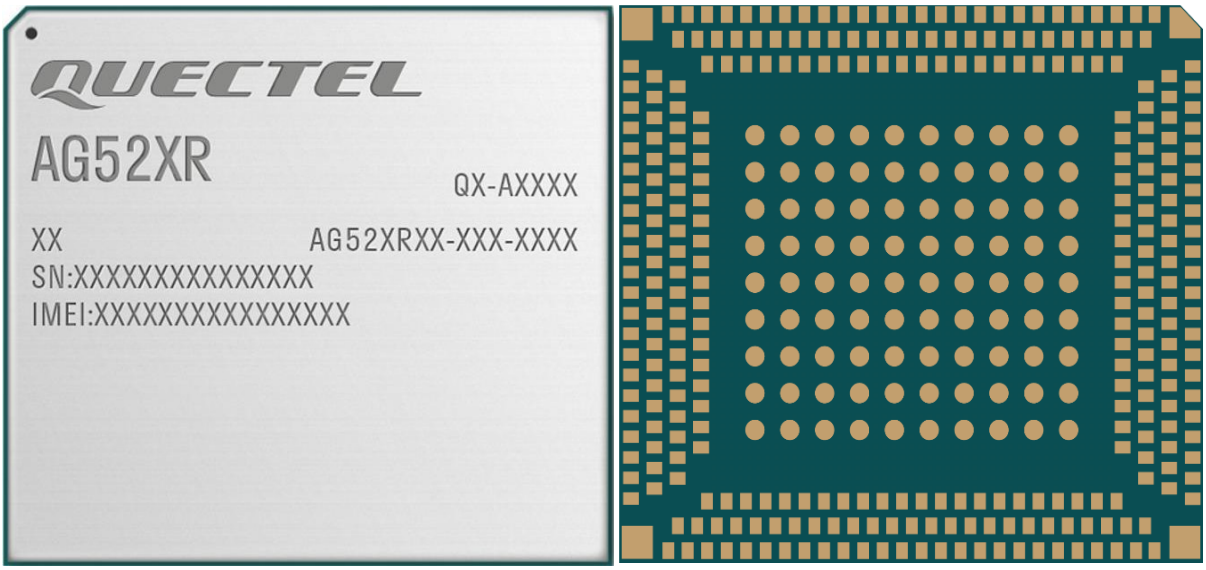


Figure 42: Top and Bottom Views of the Module

NOTE

Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.

8 Storage, Manufacturing and Packaging

8.1. Storage Conditions

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: the temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [42] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement mentioned above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

[42] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. Do not unpack the modules in large quantities until they are ready for soldering.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

8.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see ***document [12]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

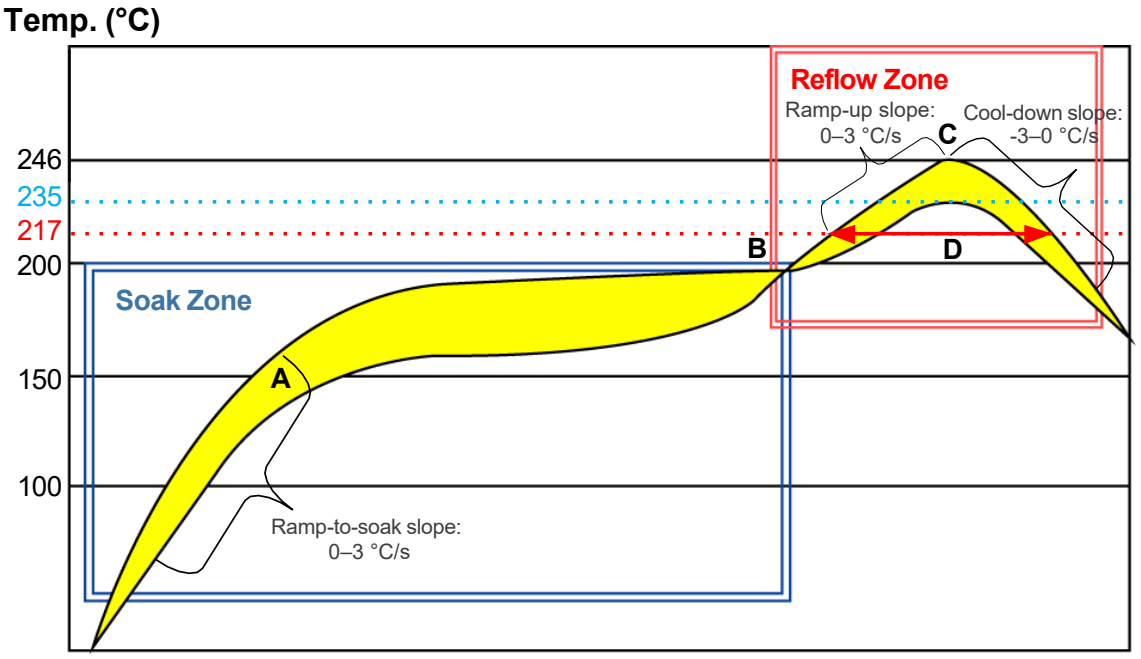


Figure 43: Recommended Reflow Soldering Thermal Profile

Table 85: Recommended Thermal Profile Parameters

Factor	Recommended Value
Soak Zone	
Ramp-to-soak slope	0–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Ramp-up slope	0–3 °C/s
Reflow time (D: over 217°C)	40–70 s
Max temperature	235–246 °C
Cool-down slope	-3–0 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
3. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
4. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [12]***.

8.3. Packaging Specifications

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of the packaging materials are subject to the actual delivery.

The module adopts carrier tape packaging and details are as follow:

8.3.1. Carrier Tape

Dimension details are as follow:

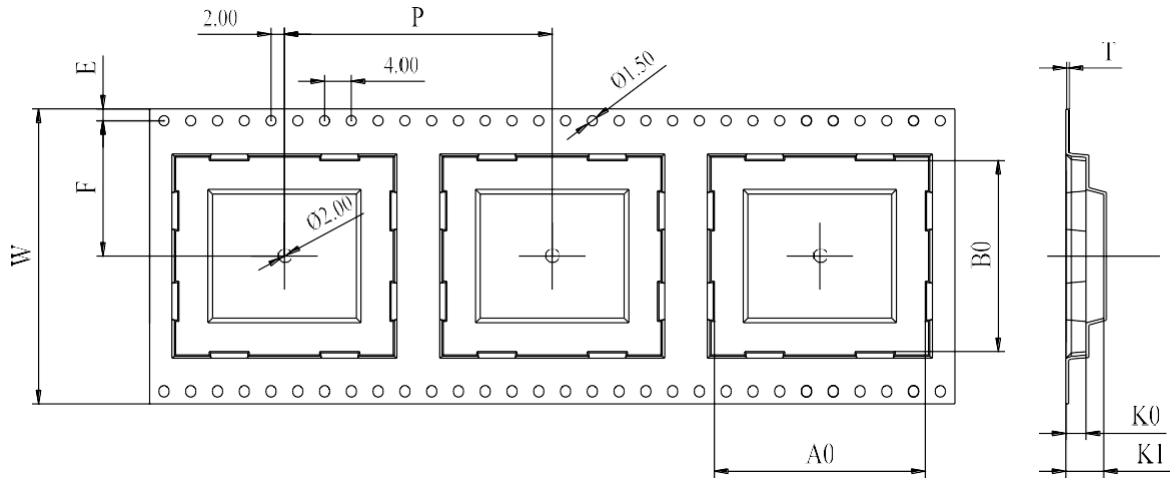


Figure 44: Carrier Tape Dimension Drawing

Table 86: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
72	56	0.5	42.5	38.5	4.05	4.65	34.2	1.75

8.3.2. Plastic Reel

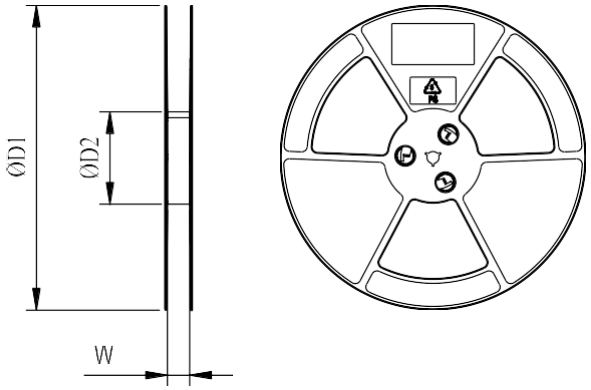


Figure 45: Plastic Reel Dimension Drawing

Table 87: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
380	180	72.5

8.3.3. Mounting Direction

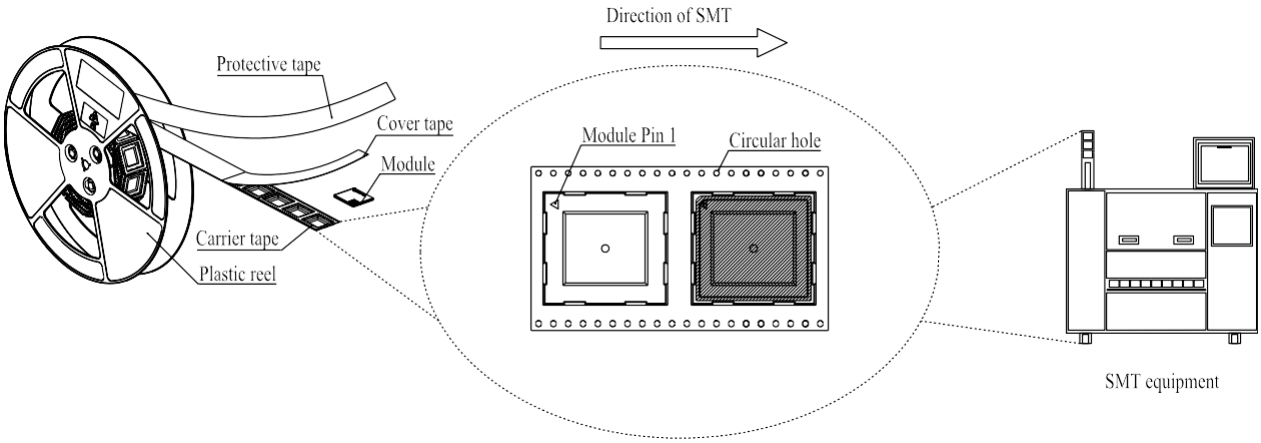
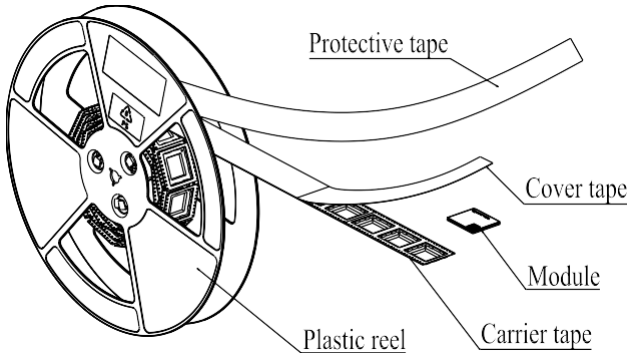


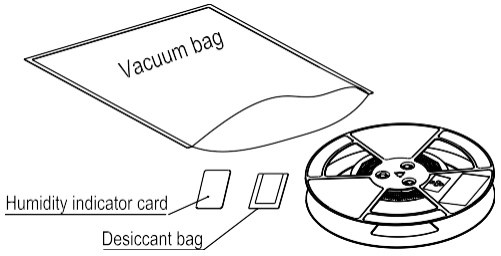
Figure 46: Mounting Direction

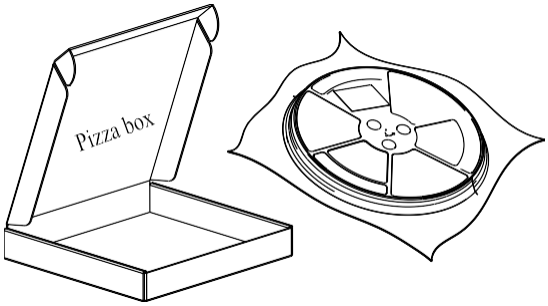
8.3.4. Packaging Process



Place the module into the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. 1 plastic reel can load 200 modules.

Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag into a vacuum bag, vacuumize it.





Place the vacuum-packed plastic reel into the pizza box.

Put 4 packaged pizza boxes into 1 carton box and seal it. 1 carton box can pack 800 modules.

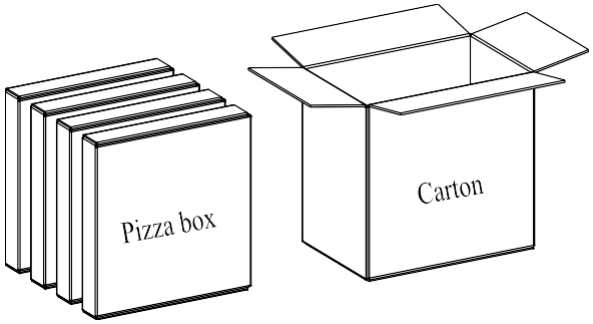


Figure 47: Packaging Process

9 Appendix References

Table 88: Related Documents

Document Name
[1] Quectel_V2X&5G_EVB_User_Guide
[2] Quectel_AG520R&AG521R_Series_QuecOpen_GPIO_Configuration
[3] Quectel_AG52xR_Series_QuecOpen_Device_Management_API_Reference_Manual
[4] Quectel_AG52xR_Series_QuecOpen_AT_Commands_Manual
[5] Quectel_AG52xR_Series_QuecOpen_Low_Power_Mode_Application_Note
[6] Quectel_AG52xR_Series_QuecOpen_ADC_Development_Guide
[7] Quectel_AG52xR_Series_QuecOpen_Reference_Design
[8] Quectel_AG52xR_Series_QuecOpen_GNSS_API_Reference_Manual
[9] Quectel_RF_Layout_Application_Note
[10] Quectel_AG52xR_Series_QuecOpen_Thermal_Mitigation_Application_Note
[11] Quectel_Module_Thermal_Design_Guide
[12] Quectel_Module_SMT_Application_Note

Table 89: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
API	Application Program Interface
bps	Bits Per Second

BW	Bandwidth
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CTS	Clear to Send
DC-HSPA+	Dual-carrier High Speed Packet Access
DFOTA	Delta Firmware Upgrade Over the Air
DL	Downlink
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
FR	Full Rate
GLONASS	Global Navigation Satellite System (Russia)
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HB	High-Band
HR	Half Rate
HSPA	High Speed Packet Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
I/O	Input/Output
LB	Low-Band

LED	Light Emitting Diode
LNA	Low Noise Amplifier
LPM	Low Power Mode
LTE	Long Term Evolution
MB	Mid-Band
MDIO	Management Data Input/Output
MIMO	Multiple Input Multiple Output
MO	Mobile Originated
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PMIC	Power Management IC
PPP	Point-to-Point Protocol
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RB	Resource Block
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
Rx	Receive
SIMO	Single Input Multiple Output
SMS	Short Message Service
TDD	Time Division Duplexing
TX	Transmitting Direction

UL	Uplink
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
Vmax	Maximum Voltage
Vnom	Nominal Voltage
Vmin	Minimum Voltage
V_{IH}max	Maximum High-level Input Voltage
V_{IH}min	Minimum High-level Input Voltage
V_{IL}max	Maximum Low-level Input Voltage
V_{IL}min	Minimum Low-level Input Voltage
$V_I$max	Absolute Maximum Input Voltage
$V_I$min	Absolute Minimum Input Voltage
V_{OH}max	Maximum High-level Output Voltage
V_{OH}min	Minimum High-level Output Voltage
V_{OL}max	Maximum Low-level Output Voltage
V_{OL}min	Minimum Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
WLAN	Wireless Local Area Network

Product Marketing Name:Quectel AG529R-LA
FCC Certification Requirements.
According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.
And the following conditions must be met:
1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3. A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR202308AG529RLA
4. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

radiation, maximum antenna gain (including cable loss) must not exceed: Operating Band	FCC Max Antenna Gain（dBi）
WCDMA B2	8.00
WCDMA B5	9.42
LTE Band 2	8.00
LTE Band 4	5.00
LTE Band 5	9.41
LTE Band 7	8.00

5.This module must not transmit simultaneously with any other antenna or transmitter
6.The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.
For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093
If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
For this device, OEM integrators must be provided with labeling instructions of finished products.
Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:
A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).
For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: XMR202308AG529RLA" or "Contains FCC ID: XMR202308AG529RLA" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.
The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be

expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.