

EG91-Quecopen

Hardware Design

LTE Module Series

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About the Document

History

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Contents

About the Document	2
Contents	3
Table Index	5
Figure Index	7
1 Introduction	9
1.1. Safety Information.....	10
2 Product Concept	11
2.1. General Description	11
2.2. Key Features	12
2.3. Functional Diagram	15
2.4. Evaluation Board	16
3 Application Interfaces	17
3.1. General Description	17
3.2. Pin Assignment.....	18
3.3. Pin Description.....	19
3.4. Operating Modes	27
3.5. Power Saving.....	27
3.5.1. Sleep Mode	27
3.5.1.1. USB Application with USB Remote Wakeup Function	28
3.5.1.2. USB Application with USB Suspend/Resume and RI Function	28
3.5.1.3. USB Application without USB Suspend Function.....	29
3.5.2. Airplane Mode	30
3.6. Power Supply.....	30
3.6.1. Power Supply Pins	30
3.6.2. Decrease Voltage Drop.....	31
3.6.3. Reference Design for Power Supply.....	32
3.6.4. Monitor the Power Supply.....	33
3.7. Power-on/off Scenarios	33
3.7.1. Turn on Module Using the PWRKEY	33
3.7.2. Turn off Module	35
3.7.2.1. Turn off Module Using the PWRKEY Pin.....	35
3.7.2.2. Turn off Module Using Related Software Command or API	35
3.7.3. Reset the Module	36
3.8. (U)SIM Interfaces.....	37
3.9. USB Interface	40
3.10. UART Interfaces	42
3.11. PCM and I2C Interfaces	45
3.12. SPI Interface	48
3.13. ADC Interface	49
3.14. GPIOs	49

3.15.	Network Status Indication.....	51
3.16.	STATUS.....	52
3.17.	Behaviors of RI	53
3.18.	USB_BOOT Interface	53
4	GNSS Receiver	55
4.1.	General Description	55
4.2.	GNSS Performance	55
4.3.	Layout Guidelines	56
5	Antenna Interfaces.....	57
5.1.	Main/Rx-diversity Antenna Interfaces.....	57
5.1.1.	Pin Definition	57
5.1.2.	Operating Frequency	57
5.1.3.	Reference Design of RF Antenna Interface	58
5.1.4.	Reference Design of RF Layout.....	59
5.2.	GNSS Antenna Interface	61
5.3.	Antenna Installation	62
5.3.1.	Antenna Requirement	62
5.3.2.	Recommended RF Connector for Antenna Installation	63
6	Electrical, Reliability and Radio Characteristics	65
6.1.	Absolute Maximum Ratings.....	65
6.2.	Power Supply Ratings	65
6.3.	Operation and Storage Temperatures	66
6.4.	Current Consumption	67
6.5.	RF Output Power	70
6.6.	RF Receiving Sensitivity.....	71
6.7.	Electrostatic Discharge.....	72
6.8.	Thermal Consideration	72
7	Mechanical Dimensions	75
7.1.	Mechanical Dimensions of the Module.....	75
7.2.	Recommended Footprint	77
7.3.	Design Effect Drawings of the Module	78
8	Storage, Manufacturing and Packaging	79
8.1.	Storage	79
8.2.	Manufacturing and Soldering	80
8.3.	Packaging	81
9	Appendix A References.....	83
10	Appendix B GPRS Coding Schemes	87
11	Appendix C GPRS Multi-slot Classes.....	88
12	Appendix D EDGE Modulation and Coding Schemes	90

Table Index

TABLE 1: FREQUENCY BANDS OF EG91-QUECOPEN MODULE	12
TABLE 2: KEY FEATURES OF EG91-QUECOPEN MODULE	12
TABLE 3: IO PARAMETERS DEFINITION	19
TABLE 4: PIN DESCRIPTION	20
TABLE 5: MULTIPLEXING PIN FUNCTIONS OF EG91-QUECOPEN	26
TABLE 6: PULL-UP/PULL-DOWN RESISTANCE OF GPIOs	27
TABLE 7: OVERVIEW OF OPERATING MODES	27
TABLE 8: PIN DEFINITION OF VBAT AND GND	30
TABLE 9: PIN DEFINITION OF PWRKEY	33
TABLE 10: PIN DEFINITION OF RESET_N	36
TABLE 11: PIN DEFINITION OF (U)SIM INTERFACES	38
TABLE 12: PIN DEFINITION OF USB INTERFACE	40
TABLE 13: PIN DEFINITION OF MAIN UART INTERFACE	42
TABLE 14: PIN DEFINITION OF DEBUG UART INTERFACE	43
TABLE 15: PIN DEFINITION OF APPLICATION UART INTERFACE (MULTIPLEXED WITH SPI)	43
TABLE 16: LOGIC LEVELS OF DIGITAL I/O	43
TABLE 17: PIN DEFINITION OF PCM AND I2C INTERFACES	47
TABLE 18: PIN DEFINITION OF SPI INTERFACE	48
TABLE 19: PIN DEFINITION OF ADC INTERFACE	49
TABLE 20: CHARACTERISTIC OF THE ADC	49
TABLE 21: GPIO FUNCTION OF EG91-QUECOPEN PINS	50
TABLE 22: LOGIC LEVELS OF DIGITAL I/O	50
TABLE 23: PIN DEFINITION OF NETWORK STATUS INDICATOR	51
TABLE 24: WORKING STATE OF NETWORK STATUS INDICATOR	51
TABLE 25: PIN DEFINITION OF STATUS	52
TABLE 26: DEFAULT BEHAVIORS OF RI	53
TABLE 27: PIN DEFINITION OF USB_BOOT INTERFACE	53
TABLE 28: GNSS PERFORMANCE	55
TABLE 29: PIN DEFINITION OF RF ANTENNA	57
TABLE 30: MODULE OPERATING FREQUENCIES	57
TABLE 31: PIN DEFINITION OF GNSS ANTENNA INTERFACE	61
TABLE 32: GNSS FREQUENCY	61
TABLE 33: ANTENNA REQUIREMENTS	62
TABLE 34: ABSOLUTE MAXIMUM RATINGS	65
TABLE 35: POWER SUPPLY RATINGS	65
TABLE 36: OPERATION AND STORAGE TEMPERATURES	66
TABLE 37: EG91-E-QUECOPEN CURRENT CONSUMPTION	67
TABLE 38: EG91-NA-QUECOPEN CURRENT CONSUMPTION	69
TABLE 39: GNSS CURRENT CONSUMPTION OF EG91-NA-QUECOPEN	70
TABLE 40: RF OUTPUT POWER	70
TABLE 41: EG91-E-QUECOPEN CONDUCTED RF RECEIVING SENSITIVITY	71
TABLE 42: EG91-NA-QUECOPEN CONDUCTED RF RECEIVING SENSITIVITY	71

TABLE 43: ELECTROSTATIC DISCHARGE CHARACTERISTICS	72
TABLE 44: RECOMMENDED THERMAL PROFILE PARAMETERS	80
TABLE 45: RELATED DOCUMENTS	83
TABLE 46: TERMS AND ABBREVIATIONS	83
TABLE 47: DESCRIPTION OF DIFFERENT CODING SCHEMES	87
TABLE 48: GPRS MULTI-SLOT CLASSES	88
TABLE 49: EDGE MODULATION AND CODING SCHEMES.....	90

Figure Index

FIGURE 1: FUNCTIONAL DIAGRAM	15
FIGURE 2: PIN ASSIGNMENT (TOP VIEW).....	18
FIGURE 3: SLEEP MODE APPLICATION WITH USB REMOTE WAKEUP	28
FIGURE 4: SLEEP MODE APPLICATION WITH RI	29
FIGURE 5: SLEEP MODE APPLICATION WITHOUT SUSPEND FUNCTION	29
FIGURE 6: POWER SUPPLY LIMITS DURING BURST TRANSMISSION	31
FIGURE 7: STAR STRUCTURE OF THE POWER SUPPLY	32
FIGURE 8: REFERENCE CIRCUIT OF POWER SUPPLY	32
FIGURE 9: TURN ON THE MODULE USING DRIVING CIRCUIT	33
FIGURE 10: TURN ON THE MODULE USING BUTTON	34
FIGURE 11: POWER-ON SCENARIO	34
FIGURE 12: POWER-OFF SCENARIO	35
FIGURE 13: REFERENCE CIRCUIT OF RESET_N BY USING DRIVING CIRCUIT	36
FIGURE 14: REFERENCE CIRCUIT OF RESET_N BY USING BUTTON	37
FIGURE 15: RESET SCENARIO	37
FIGURE 16: REFERENCE CIRCUIT OF (U)SIM INTERFACE WITH AN 8-PIN (U)SIM CARD CONNECTOR	39
FIGURE 17: REFERENCE CIRCUIT OF (U)SIM INTERFACE WITH A 6-PIN (U)SIM CARD CONNECTOR	39
FIGURE 18: REFERENCE CIRCUIT OF USB INTERFACE	41
FIGURE 19: REFERENCE CIRCUIT WITH TRANSLATOR CHIP	44
FIGURE 20: REFERENCE CIRCUIT WITH TRANSISTOR CIRCUIT	45
FIGURE 21: PRIMARY MODE TIMING	46
FIGURE 22: AUXILIARY MODE TIMING	46
FIGURE 23: REFERENCE CIRCUIT OF PCM APPLICATION WITH AUDIO CODEC	47
FIGURE 24: REFERENCE CIRCUIT OF SPI INTERFACE WITH PERIPHERALS	48
FIGURE 25: REFERENCE CIRCUIT OF NETWORK STATUS INDICATOR	52
FIGURE 26: REFERENCE CIRCUIT OF STATUS	52
FIGURE 27: REFERENCE CIRCUIT OF USB_BOOT INTERFACE	54
FIGURE 28: TIMING SEQUENCE FOR ENTERING INTO EMERGENCY DOWNLOAD MODE.....	54
FIGURE 29: REFERENCE CIRCUIT OF RF ANTENNA INTERFACE	58
FIGURE 30: MICROSTRIP LINE DESIGN ON A 2-LAYER PCB.....	59
FIGURE 31: COPLANAR WAVEGUIDE DESIGN ON A 2-LAYER PCB	59
FIGURE 32: COPLANAR WAVEGUIDE DESIGN ON A 4-LAYER PCB (LAYER 3 AS REFERENCE GROUND)	60
FIGURE 33: COPLANAR WAVEGUIDE DESIGN ON A 4-LAYER PCB (LAYER 4 AS REFERENCE GROUND)	60
FIGURE 34: REFERENCE CIRCUIT OF GNSS ANTENNA.....	61
FIGURE 35: DIMENSIONS OF THE U.FL-R-SMT CONNECTOR (UNIT: MM).....	63
FIGURE 36: MECHANICALS OF U.FL-LP CONNECTORS	63
FIGURE 37: SPACE FACTOR OF MATED CONNECTOR (UNIT: MM)	64
FIGURE 38: REFERENCED HEATSINK DESIGN (HEATSINK AT THE TOP OF THE MODULE)	73

FIGURE 39: REFERENCED HEATSINK DESIGN (HEATSINK AT THE BACKSIDE OF CUSTOMERS' PCB)	74
FIGURE 40: MODULE TOP AND SIDE DIMENSIONS	75
FIGURE 41: MODULE BOTTOM DIMENSIONS (TOP VIEW)	76
FIGURE 42: RECOMMENDED FOOTPRINT (TOP VIEW)	77
FIGURE 43: TOP VIEW OF THE MODULE	78
FIGURE 44: BOTTOM VIEW OF THE MODULE	78
FIGURE 45: REFLOW SOLDERING THERMAL PROFILE	80
FIGURE 46: TAPE DIMENSIONS	81
FIGURE 47: REEL DIMENSIONS	82
FIGURE 48: TAPE AND REEL DIRECTIONS	82

1 Introduction

This document defines the EG91-Quecopen module and describes its air interface and hardware interface which are connected with customers' applications.

This document can help customers quickly understand module interface specifications, electrical and mechanical details, as well as other related information of EG91-Quecopen module. Associated with application note and user guide, customers can use EG91-Quecopen module to design and set up mobile applications easily.

1.1. 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 EG91-Quecopen module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for customers' failure to comply with these precautions.



Full attention must be given 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 the device offers an Airplane Mode, then it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the 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 signals and cellular network cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. 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.



The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.



In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

2 Product Concept

2.1. General Description

Quecopen[®] is an application solution where the module acts as a main processor. With the development of communication technology and the ever-changing market demands, more and more customers have realized the advantages of Quecopen[®] solution. Especially, its advantage in reducing the product cost is greatly valued by customers. With Quecopen[®] solution, development flow for wireless application and hardware design will be simplified. Main features of Quecopen[®] solution are listed below:

- Simplifies the development of embedded applications, and shortens product development cycle
- Simplifies circuit design, and reduces product cost
- Decreases the size of terminal products
- Reduces power consumption
- Supports remote upgrade of firmware wirelessly
- Improves products' cost-performance ratio, and enhances products' competitiveness

EG91-Quecopen module is a baseband processor platform based on ARM Cortex A7 kernel. The maximum dominant frequency is up to 1.2GHz. Customers can use EG91-Quecopen module as the basis for development of Quecopen[®] applications.

EG91-Quecopen module is an embedded 4G wireless communication module with receive diversity. It supports LTE-FDD/WCDMA/GSM wireless communication, and provides data connectivity on LTE-FDD, DC-HSDPA, HSPA+, HSDPA, HSUPA, WCDMA, EDGE and GPRS networks. It can also provide voice functionality ¹⁾ to meet customers' specific application demands.

With a compact profile of 29.0mm × 25.0mm × 2.3mm, EG91-Quecopen can meet almost all requirements for M2M applications such as automotive, smart metering, tracking system, security, router, wireless POS, mobile computing device, PDA phone, tablet PC, etc.

EG91-Quecopen is an SMD type module which can be embedded into applications through its 106 LGA pads.

EG91-Quecopen is integrated with internet service protocols like TCP, UDP and PPP. Extended AT commands have been developed for customers to use these internet service protocols easily.

The following table shows the frequency bands of EG91-Quecopen module.

Table 1: Frequency Bands of EG91-Quecopen Module

Module	LTE Bands (with Rx-diversity)	WCDMA (with Rx-diversity)	GSM	GNSS ²⁾
EG91-E	FDD: B1/B3/B7/B8/B20/B28A	B1/B8	900/1800MHz	Not supported
EG91-NA	FDD: B2/B4/B5/B12/B13	B2/B4/B5	Not supported	GPS, GLONASS, BeiDou/Compass, Galileo, QZSS

NOTES

- ¹⁾ EG91-Quecopen contains **Telematics** version and **Data-only** version. **Telematics** version supports voice and data functions, while **Data-only** version only supports data function.
- ²⁾ GNSS function is optional.

2.2. Key Features

The following table describes the detailed features of EG91-Quecopen module.

Table 2: Key Features of EG91-Quecopen Module

Feature	Details
Power Supply	Supply voltage: 3.3V~4.3V Typical supply voltage: 3.8V
Transmitting Power	Class 4 (33dBm±2dB) for EGSM900 Class 1 (30dBm±2dB) for DCS1800 Class E2 (27dBm±3dB) for EGSM900 8-PSK Class E2 (26dBm±3dB) for DCS1800 8-PSK Class 3 (24dBm+1/-3dB) for WCDMA bands Class 3 (23dBm±2dB) for LTE-FDD bands
LTE Features	Support up to non-CA Cat 1 FDD Support 1.4MHz~20MHz RF bandwidth Support MIMO in DL direction LTE-FDD: Max 10Mbps (DL), Max 5Mbps (UL)
UMTS Features	Support 3GPP R8 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA Support QPSK, 16-QAM and 64-QAM modulation DC-HSDPA: Max 42Mbps (DL) HSUPA: Max 5.76Mbps (UL) WCDMA: Max 384Kbps (DL), Max 384Kbps (UL)

GSM Features	<p>R99: CSD: 9.6kbps</p> <p>GPRS: Support GPRS multi-slot class 33 (33 by default) Coding scheme: CS-1, CS-2, CS-3 and CS-4 Max 107Kbps (DL), Max 85.6Kbps (UL)</p> <p>EDGE: Support EDGE multi-slot class 33 (33 by default) Support GMSK and 8-PSK for different MCS (Modulation and Coding Scheme) Downlink coding schemes: CS 1-4 and MCS 1-9 Uplink coding schemes: CS 1-4 and MCS 1-9 Max 296Kbps (DL), Max 236.8Kbps (UL)</p>
Internet Protocol Features	<p>Support TCP/UDP/PPP/FTP/HTTP/NTP/PING/QMI/NITZ/CMUX*/HTTPS*/SMTP*/MMS*/FTPS*/SMTPS*/SSL*/FILE* protocols</p> <p>Support PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) protocols which are usually used for PPP connections</p>
SMS	<p>Text and PDU modes</p> <p>Point-to-point MO and MT</p> <p>SMS cell broadcast</p> <p>SMS storage: ME by default</p>
(U)SIM Interfaces	Support 1.8V and 3.0V (U)SIM cards
GPIO Interfaces	Support 12 GPIOs that can be used for input and output, and 1 PMU GPIO that can only be used for output
Audio Features	<p>Support one digital audio interface: PCM interface</p> <p>GSM: HR/FR/EFR/AMR/AMR-WB</p> <p>WCDMA: AMR/AMR-WB</p> <p>LTE: AMR/AMR-WB</p> <p>Support echo cancellation and noise suppression</p>
PCM Interface	<p>Used for audio function with external codec</p> <p>Support 16-bit linear data format</p> <p>Support long frame synchronization and short frame synchronization</p> <p>Support master and slave modes, but must be the master in long frame synchronization</p>
USB Interface	<p>Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480Mbps</p> <p>Used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging, firmware upgrade and voice over USB*</p> <p>Support USB serial drivers for: Windows 7/8/8.1/10, Windows CE 5.0/6.0/7.0*, Linux 2.6/3.x/4.1~4.14, Android 4.x/5.x/6.x/7.x/8.x, etc.</p>

UART Interface	<p>Main UART: Used for AT command communication only Baud rates reach up to 3000000bps, 115200bps by default Support RTS and CTS hardware flow control</p> <p>Debug UART: Used for Linux console and log output 115200bps baud rate</p> <p>Application UART: Multiplexed with pin 26~28 of SPI interface Used for communication and data transmission with peripherals Baud rates reach up to 3000000bps, 115200bps by default</p>
Rx-diversity	Support LTE/WCDMA Rx-diversity
GNSS Features	Gen8C Lite of Qualcomm Protocol: NMEA 0183
AT Commands	Compliant with 3GPP TS 27.007, 27.005 and Quectel enhanced AT commands
Network Indication	NETLIGHT pin for network activity status indication
Antenna Interfaces	Including main antenna interface (ANT_MAIN), Rx-diversity antenna (ANT_DIV) interface and GNSS antenna interface (ANT_GNSS) ¹⁾
Physical Characteristics	Size: (29.0±0.15)mm × (25.0±0.15)mm × (2.3±0.2)mm Package: LGA Weight: approx. 3.8g
Temperature Range	Operation temperature range: -35°C ~ +75°C ²⁾ Extended temperature range: -40°C ~ +85°C ³⁾ Storage temperature range: -40°C ~ +90°C
Firmware Upgrade	USB interface or DFOTA*
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

- ¹⁾ GNSS antenna interface is only supported on EG91-NA-Quecopen.
- ²⁾ Within operating temperature range, the module is 3GPP compliant.
- ³⁾ Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operation temperature levels, the module will meet 3GPP specifications again.
- * means under development.

2.3. Functional Diagram

The following figure shows a block diagram of EG91-Quecopen and illustrates the major functional parts.

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

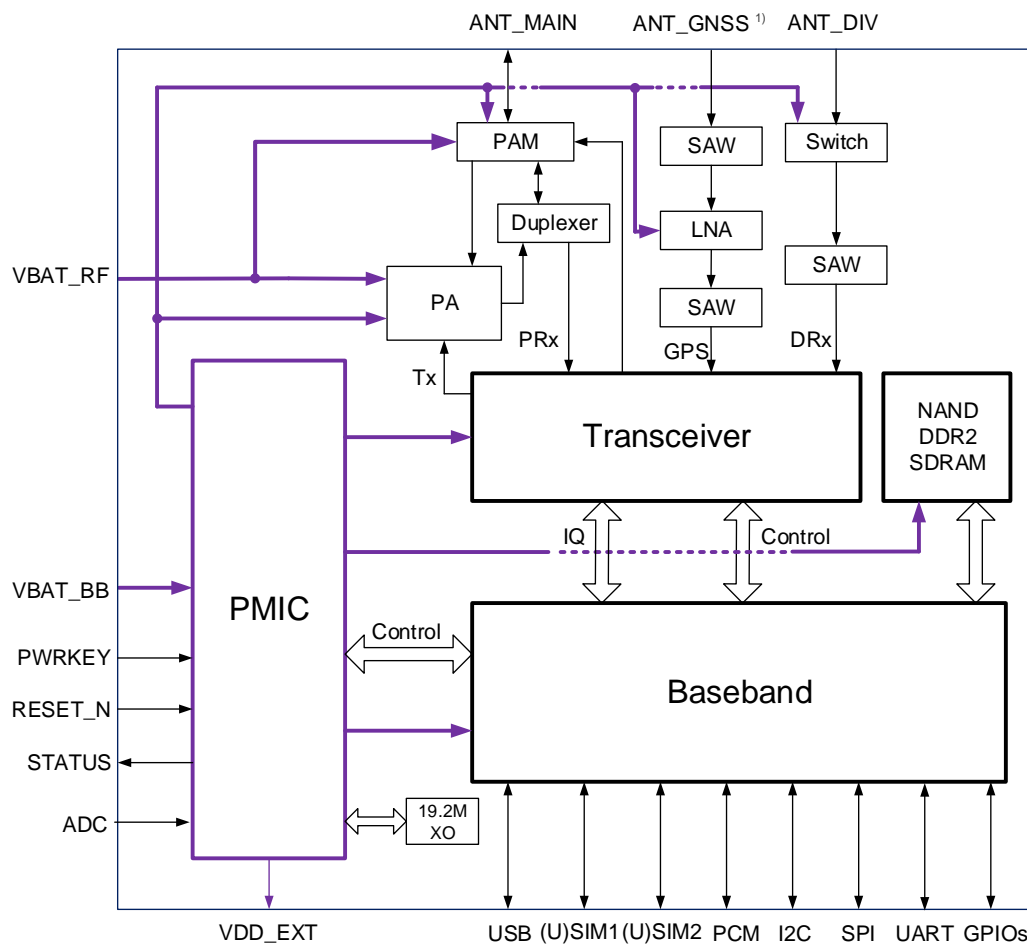


Figure 1: Functional Diagram

NOTE

¹⁾ GNSS antenna interface is only supported on EG91-NA-Quecopen.

2.4. Evaluation Board

Quectel provides a complete set of evaluation tools to facilitate the use and testing of EG91-Quecopen module. The evaluation tool kit includes the evaluation board (EVB), USB data cable, earphone, antenna and other peripherals.

3 Application Interfaces

3.1. General Description

EG91-Quecopen is equipped with 62-pin 1.1mm pitch SMT pads plus 44-pin ground/reserved pads that can be connected to customers' cellular application platforms. Sub-interfaces included in these pads are described in detail in the following chapters:

- Power supply
- (U)SIM interfaces
- USB interface
- UART interfaces
- PCM and I2C interfaces
- SPI interface
- ADC interface
- GPIO interfaces
- Status indication
- USB_BOOT interface

3.2. Pin Assignment

The following figure shows the pin assignment of EG91-Quecopen module.

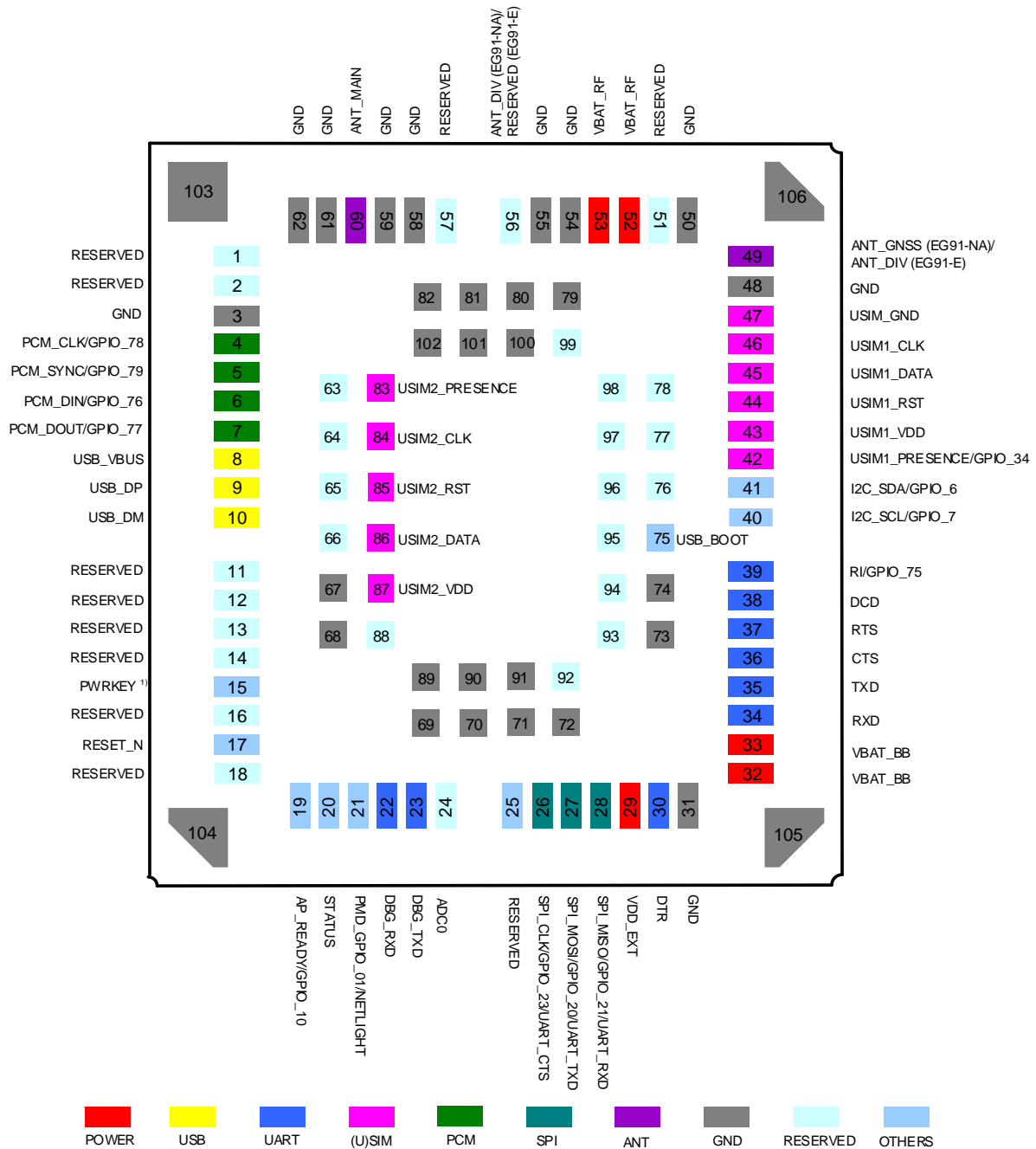


Figure 2: Pin Assignment (Top View)

NOTES

1. ¹⁾ PWRKEY output voltage is 0.8V because of the diode drop in the Qualcomm chipset.
2. Keep all RESERVED pins and unused pins unconnected.
3. GND pads should be connected to ground in the design.
4. Definition of pin 49 and 56 are different between EG91-E-Quecopen and EG91-NA-Quecopen.

3.3. Pin Description

The following tables show pin definition, multiplexing function and GPIO pull-up/down resistance of EG91-Quecopen.

Table 3: IO Parameters Definition

Type	Description
AI	Analog input
AO	Analog output
B	Bidirectional digital with CMOS input
BH	High-voltage tolerant bidirectional digital with CMOS input
DI	Digital input
DO	Digital output
H	High level
IO	Bidirectional
L	Low level
OD	Open drain
PD	Pull down
PI	Power input
PO	Power output
PU	Pull up

Table 4: Pin Description

Power Supply					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
VBAT_BB	32, 33	PI	Power supply for module's baseband part	V _{max} =4.3V V _{min} =3.3V V _{norm} =3.8V	It must be able to provide sufficient current up to 0.8A.
VBAT_RF	52, 53	PI	Power supply for module's RF part	V _{max} =4.3V V _{min} =3.3V V _{norm} =3.8V	It must be able to provide sufficient current up to 1.8A in a burst transmission.
VDD_EXT	29	PO	Provide 1.8V for external circuit	V _{norm} =1.8V I _o max=50mA	Power supply for external GPIO's pull up circuits. If unused, keep it open.
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67~74, 79~82, 89~91, 100~106		Ground		
Turn on/off					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY	15	DI	Turn on/off the module	V _{IH} max=2.1V V _{IH} min=1.3V V _{IL} max=0.5V	The output voltage is 0.8V because of the diode drop in the Qualcomm chipset.
RESET_N	17	DI	Reset signal of the module	V _{IH} max=2.1V V _{IH} min=1.3V V _{IL} max=0.5V	Pull-up to 1.8V internally. Active low. If unused, keep it open.
Status Indication					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
STATUS	20	DO	Indicate the module's operating status	V _{OH} min=1.35V V _{OL} max=0.45V	1.8V power domain. If unused, keep this pin open.

NETLIGHT	21	DO	Indicate the module's network activity status	$V_{OHmin}=1.35V$ $V_{OLmax}=0.45V$	1.8V power domain. If unused, keep it open.
USB Interface					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_VBUS	8	PI	USB connection detection	$V_{max}=5.25V$ $V_{min}=3.0V$ $V_{norm}=5.0V$	Typical: 5.0V If unused, keep it open.
USB_DP	9	IO	USB differential data bus (+)	Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω.
USB_DM	10	IO	USB differential data bus (-)	Compliant with USB 2.0 standard specification.	Require differential impedance of 90Ω.
(U)SIM Interfaces					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USIM_GND	47		Specified ground for (U)SIM card		Connect to ground of (U)SIM card connector.
USIM1_VDD	43	PO	Power supply for (U)SIM card	For 1.8V (U)SIM: $V_{max}=1.9V$ $V_{min}=1.7V$	Either 1.8V or 3.0V is supported by the module automatically.
USIM2_VDD	87			For 3.0V (U)SIM: $V_{max}=3.05V$ $V_{min}=2.7V$ $I_{Omax}=50mA$	
USIM1_DATA	45	IO	Data signal of (U)SIM card	For 1.8V (U)SIM: $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	
USIM2_DATA	86			For 3.0V (U)SIM: $V_{ILmax}=1.0V$ $V_{IHmin}=1.95V$ $V_{OLmax}=0.45V$ $V_{OHmin}=2.55V$	

USIM1_CLK	46	DO	Clock signal of (U)SIM card	For 1.8V (U)SIM: $V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
USIM2_CLK	84			For 3.0V (U)SIM: $V_{OLmax}=0.45V$ $V_{OHmin}=2.55V$	
USIM1_RST	44	DO	Reset signal of (U)SIM card	For 1.8V (U)SIM: $V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	
USIM2_RST	85			For 3.0V (U)SIM: $V_{OLmax}=0.45V$ $V_{OHmin}=2.55V$	
USIM1_PRESENCE	42	DI	(U)SIM card insertion detection	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$	1.8V power domain. If unused, keep it open.
USIM2_PRESENCE	83			$V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	

Main UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RI	39	DO	Ring indicator	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
DCD	38	DO	Data carrier detection	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
CTS	36	DO	Clear to send	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
RTS	37	DI	Request to send	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep it open.
DTR	30	DI	Data terminal ready. Sleep mode control.	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. Pull-up by default. Low level wakes up the module. If unused, keep it open.
TXD	35	DO	Transmit data	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.

open.

RXD	34	DI	Receive data	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep it open.
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Debug UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
DBG_TXD	23	DO	Transmit data	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
DBG_RXD	22	DI	Receive data	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep it open.

PCM Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PCM_DIN	6	DI	PCM data input	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep it open.
PCM_DOUT	7	DO	PCM data output	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
PCM_SYNC	5	IO	PCM data frame synchronization signal	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. In master mode, it is an output signal. In slave mode, it is an input signal. If unused, keep it open.
PCM_CLK	4	IO	PCM clock	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$ $V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. In master mode, it is an output signal. In slave mode, it is an input signal. If unused, keep it open.

I2C Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
I2C_SCL	40	OD	I2C serial clock. Used for external codec.		An external pull-up resistor is required. 1.8V only. If unused, keep it open.
I2C_SDA	41	OD	I2C serial data. Used for external codec.		An external pull-up resistor is required. 1.8V only. If unused, keep it open.

SPI Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
SPI_CLK	26	DO	Clock signal of SPI interface	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
SPI_MOSI	27	DO	Master output slave input of SPI interface	$V_{OLmax}=0.45V$ $V_{OHmin}=1.35V$	1.8V power domain. If unused, keep it open.
SPI_MISO	28	DI	Master input slave output of SPI interface	$V_{ILmin}=-0.3V$ $V_{ILmax}=0.6V$ $V_{IHmin}=1.2V$ $V_{IHmax}=2.0V$	1.8V power domain. If unused, keep it open.

ADC Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ADC0	24	AI	General purpose analog to digital converter	Voltage range: 0.3V to VBAT_BB	If unused, keep it open.

RF Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ANT_GNSS	49 (EG91-NA-Quecopen)	AI	GNSS antenna pad		50Ω impedance. If unused, keep it open. The pin is defined as ANT_DIV on EG91-E-Quecopen.

ANT_DIV	49 (EG91-E-Quecopen)	AI	Receive diversity antenna pad	50Ω impedance. If unused, keep it open.
	56 (EG91-NA-Quecopen)	AI	Receive diversity antenna pad	50Ω impedance. If unused, keep it open. The pin is reserved on EG91-E-Quecopen.
ANT_MAIN	60	IO	Main antenna pad	50Ω impedance

Other Pins

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
AP_READY	19	DI	Application processor sleep state detection	V _{IL} min=-0.3V V _{IL} max=0.6V V _{IH} min=1.2V V _{IH} max=2.0V	1.8V power domain. If unused, keep it open.
USB_BOOT	75	DI	Force the module to enter into emergency download mode	V _{IL} min=-0.3V V _{IL} max=0.6V V _{IH} min=1.2V V _{IH} max=2.0V	1.8V power domain. It is recommended to reserve the test points.

RESERVED Pins

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RESERVED	1, 2, 11~14, 16, 18, 25, 51, 57, 63~66, 76~78, 88, 92~99		Reserved		Keep these pins unconnected.

NOTE

Keep all RESERVED pins and unused pins unconnected.

For EG91-Quecopen module, some pins have multi-function that can be used as GPIO or UART besides its' default function. The following table shows the alternate functions of these multiplexing pins.

Table 5: Multiplexing Pin Functions of EG91-Quecopen

Pin Name	Pin No.	Model 1 (Default)	Model 2	Model 3	Reset ¹⁾	Interrupt ²⁾	Comment
PCM_CLK	4	PCM_CLK	GPIO_78	--	B-PD,L	NO	BOOT_CONFIG_8
PCM_SYNC	5	PCM_SYNC	GPIO_79	--	B-PD,L	YES	BOOT_CONFIG_7
PCM_DIN	6	PCM_DIN	GPIO_76	--	B-PD,L	YES	
PCM_DOUT	7	PCM_DOUT	GPIO_77	--	B-PD,L	NO	
AP_READY	19	AP_READY	GPIO_10	--	B-PD,L	NO	
STATUS	20	STATUS	--	--	B-PD,L	NO	
NETLIGHT	21	NETLIGHT	PMU_GPIO_01	--	B-PD,L	NO	
SPI_CLK	26	SPI_CLK	GPIO_23	UART_CTS_BLSP6	B-PU,H	NO	BOOT_CONFIG_4
SPI_MOSI	27	SPI_MOSI	GPIO_20	UART_TXD_BLSP6	B-PD,L	YES	
SPI_MISO	28	SPI_MISO	GPIO_21	UART_RXD_BLSP6	B-PD,L	YES	
RI	39	RI	GPIO_75	--	B-PD,L	YES	
I2C_SCL	40	I2C_SCL	GPIO_7	--	B-PD,L	NO	
I2C_SDA	41	I2C_SDA	GPIO_6	--	B-PD,L	NO	
USIM1_PRESENCE	42	USIM1_PRESENCE	GPIO_34	--	B-PD,L	YES	

NOTES

1. The pin function in Model 2 and Model 3 takes effect only after software configuration.
2. ¹⁾ Please refer to **Table 3** for more details about the symbol description.
3. ²⁾ YES means this pin can be used as a normal interrupt source or sleep wakeup interrupt source.
4. PMU_GPIO_XX means the GPIO is on PMU of Qualcomm chipset.
5. GPIO_XX means the GPIO is on Qualcomm baseband chipset.
6. All BOOT_CONFIG pins are prohibited to be pulled up to high level, even if pulled up to VDD_EXT before startup.

Table 6: Pull-up/Pull-down Resistance of GPIOs

Symbol	Description	Pin No.	Min	Typ	Max	Unit
R _P	Pull-up&Pull-down resistance	4~7, 19, 13, 26~28, 40~42	55	100	390	kohm

3.4. Operating Modes

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

Table 7: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module has registered on network, and it is ready to send and receive data.
	Talk/Data	Network connection is ongoing. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	AT+CFUN command can set the module to a minimum functionality mode without removing the power supply. In this case, both RF function and (U)SIM card will be invalid.	
Airplane Mode	AT+CFUN command can set the module enter into airplane mode. In this case, RF function will be invalid.	
Sleep Mode	In this mode, the current consumption of the module will be reduced to the minimal level. During this mode, the module can still receive paging message, SMS, voice call and TCP/UDP data from the network normally.	
Power Down Mode	In this mode, the power management unit shuts down the power supply. Software is not active. The serial interface is not accessible. Operating voltage (connected to VBAT_RF and VBAT_BB) remains applied.	

3.5. Power Saving

3.5.1. Sleep Mode

EG91-Quecopen is able to reduce its current consumption to a minimum value during the sleep mode. The following sub-chapters describe the power saving procedures of EG91-Quecopen module.

3.5.1.1. USB Application with USB Remote Wakeup Function

If the host supports USB suspend/resume and remote wakeup functions, the following three preconditions must be met to let the module enter into sleep mode.

- Enable the sleep mode by the sleep and wakeup relevant APIs.
- Ensure the level of pins that configured as wakeup interrupt in **Table 5** are under none-wakeup status.
- The host's USB bus, which is connected with the module's USB interface, enters into suspend state.

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

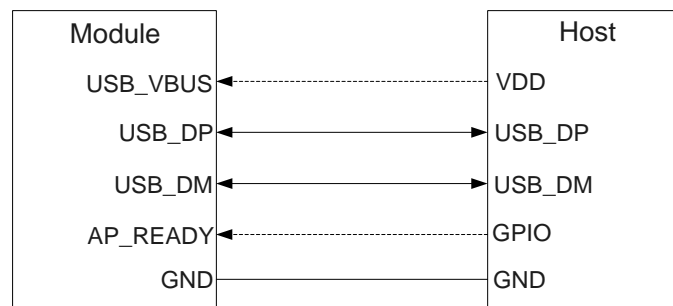


Figure 3: Sleep Mode Application with USB Remote Wakeup

- Sending data to EG91-Quecopen through USB will wake up the module.
- When EG91-Quecopen has a URC to report, the module will send remote wakeup signals via USB bus so as to wake up the host.

3.5.1.2. USB Application with USB Suspend/Resume and RI Function

If the host supports USB suspend/resume, but does not support remote wakeup function, the RI signal is needed to wake up the host.

There are three preconditions to let the module enter into the sleep mode.

- Enable the sleep mode by the sleep and wakeup relevant APIs.
- Ensure the level of pins that configured as wakeup interrupt in **Table 5** are under none-wakeup status.
- The host's USB bus, which is connected with the module's USB interface, enters into suspended state.

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

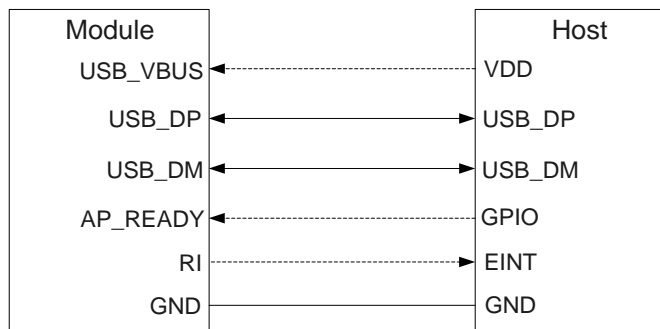


Figure 4: Sleep Mode Application with RI

- Sending data to EG91-Quecopen through USB will wake up the module.
- When EG91-Quecopen has a URC to report, RI signal will wake up the host.

3.5.1.3. USB Application without USB Suspend Function

If the host does not support USB suspend function, USB_VBUS should be disconnected with an external control circuit to let the module enter into sleep mode.

- Enable the sleep mode by the sleep and wakeup relevant APIs.
- Ensure the level of pins that configured as wakeup interrupt in **Table 5** are under none-wakeup status.
- Disconnect USB_VBUS.

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

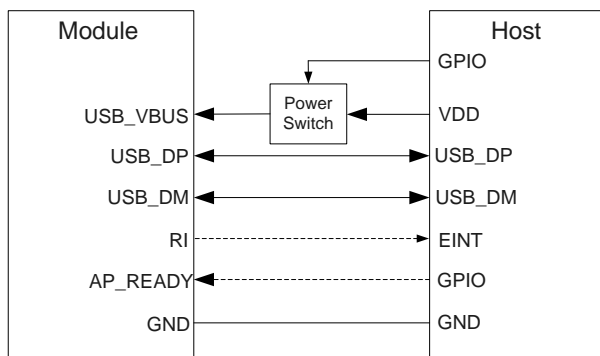


Figure 5: Sleep Mode Application without Suspend Function

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

NOTE

Please pay attention to the level match shown in dotted line between the module and the host. Please refer to **document [1]** for more details about EG91-Quecopen power management application.

3.5.2. Airplane Mode

When the module enters into airplane mode, the RF function does not work, and all AT commands correlative with RF function will be inaccessible. This mode can be set via the following ways.

AT+CFUN command provides the choice of the functionality level through setting **<fun>** into 0, 1 or 4.

- **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.

NOTES

The execution of **AT+CFUN** command will not affect GNSS function.

3.6. Power Supply

3.6.1. Power Supply Pins

EG91-Quecopen provides four VBAT pins dedicated to connect with an external power supply. There are two separate voltage domains for VBAT.

- Two VBAT_RF pins for module's RF part.
- Two VBAT_BB pins for module's baseband part.

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

Table 8: Pin Definition of VBAT and GND

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_RF	52, 53	Power supply for module's RF part.	3.3	3.8	4.3	V
VBAT_BB	32, 33	Power supply for module's baseband part.	3.3	3.8	4.3	V

	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67~74, 79~82, 89~91, 100~106	Ground	-	0	-	V
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3.6.2. Decrease Voltage Drop

The power supply range of the module is from 3.3V to 4.3V. Please make sure that the input voltage will never drop below 3.3V. The following figure shows the voltage drop during burst transmission in 2G network. The voltage drop will be less in 3G and 4G networks.

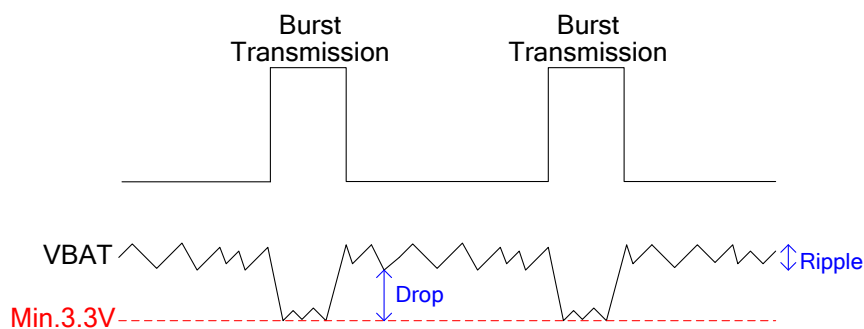


Figure 6: Power Supply Limits during Burst Transmission

To decrease voltage drop, a bypass capacitor of about 100μF with low ESR (ESR=0.7Ω) should be used, and a multi-layer ceramic chip (MLCC) capacitor array should also be reserved due to its ultra-low ESR. It is recommended to use three ceramic capacitors (100nF, 33pF, 10pF) for composing the MLCC array, and place these capacitors close to VBAT_BB/VBAT_RF pins. The main power supply from an external application has to be a single voltage source and can be expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 1mm, and the width of VBAT_RF trace should be no less than 2mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, in order to avoid the damage caused by electric surge and ESD, it is suggested that a TVS diode with low reverse stand-off voltage V_{RWM} , low clamping voltage V_C and high reverse peak pulse current I_{PP} should be used. The following figure shows the star structure of the power supply.

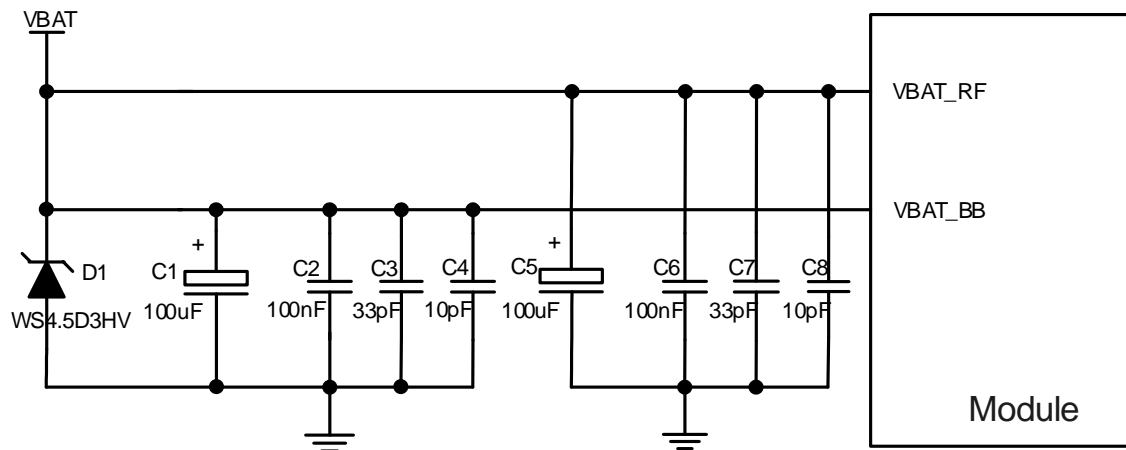


Figure 7: Star Structure of the Power Supply

3.6.3. Reference Design for Power Supply

Power design for the module is very important, as the performance of the module largely depends on the power source. The power supply should be able to provide sufficient current up to 2A at least. If the voltage drop between the input and output is not too high, it is suggested that an LDO should be used 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 +5V input power source. The typical output of the power supply is about 3.8V and the maximum load current is 3A.

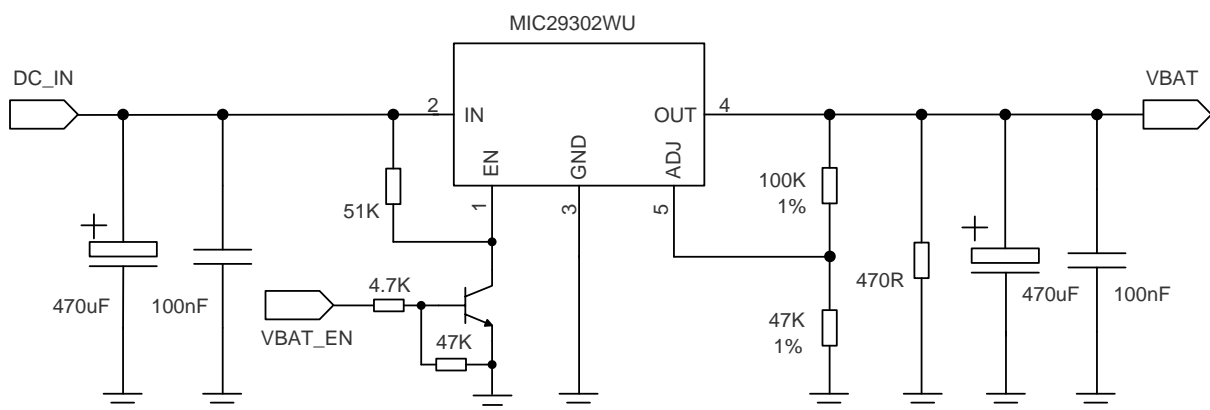


Figure 8: Reference Circuit of Power Supply

3.6.4. Monitor the Power Supply

Related software command or API can be used to monitor the VBAT_BB voltage value.

3.7. Power-on/off Scenarios

3.7.1. Turn on Module Using the PWRKEY

The following table shows the pin definition of PWRKEY.

Table 9: Pin Definition of PWRKEY

Pin Name	Pin No.	Description	DC Characteristics	Comment
PWRKEY	15	Turn on/off the module	$V_{IHmax}=2.1V$ $V_{IHmin}=1.3V$ $V_{ILmax}=0.5V$	The output voltage is 0.8V because of the diode drop in the Qualcomm chipset.

When EG91-Quecopen is in power down mode, it can be turned on to normal mode by driving the PWRKEY pin to a low level for at least 500ms. It is recommended to use an open drain/collector driver to control the PWRKEY. After STATUS pin outputs a high level, PWRKEY pin can be released. A simple reference circuit is illustrated in the following figure.

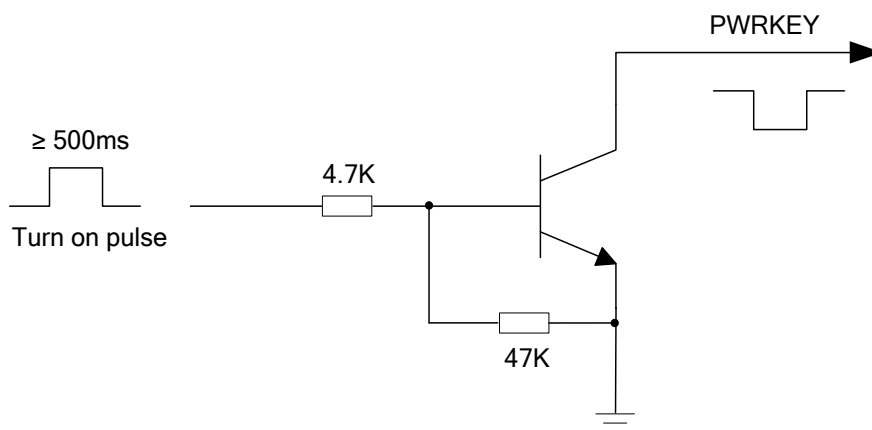


Figure 9: Turn on the Module Using Driving Circuit

Another way to control the PWRKEY is using a button directly. When pressing the key, 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.

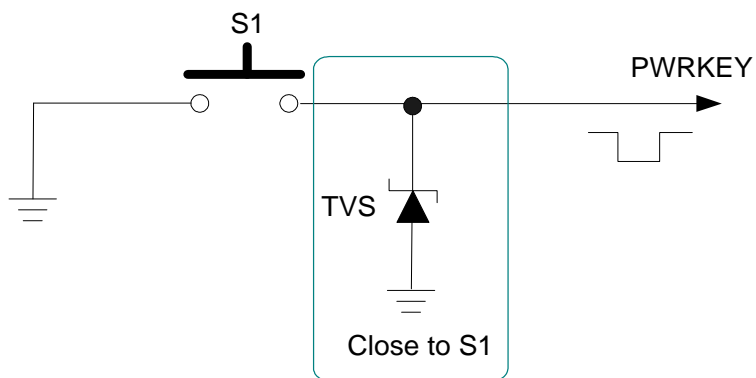


Figure 10: Turn on the Module Using Button

The power-on scenario is illustrated in the following figure.

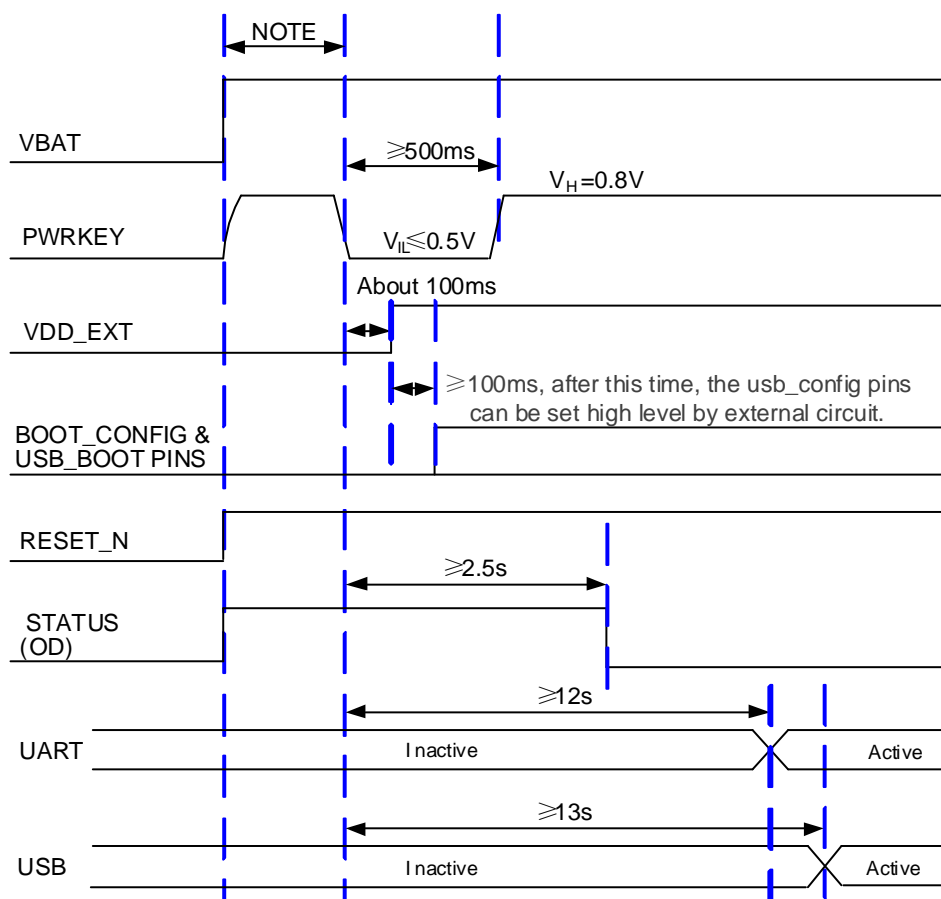


Figure 11: Power-on Scenario

NOTE

1. Please make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is no less than 30ms.
2. PWRKEY can be pulled down directly to GND with a recommended 10K resistor if module needs to be powered on automatically and shutdown is not needed.

3.7.2. Turn off Module

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

- Normal power-off procedure: Turn off the module using the PWRKEY pin.
- Normal power-off procedure: Turn off the module using related software command or API.

3.7.2.1. Turn off Module Using the PWRKEY Pin

Driving the PWRKEY pin to a low level voltage for at least 650ms, the module will execute power-off procedure after the PWRKEY is released. The power-off scenario is illustrated in the following figure.

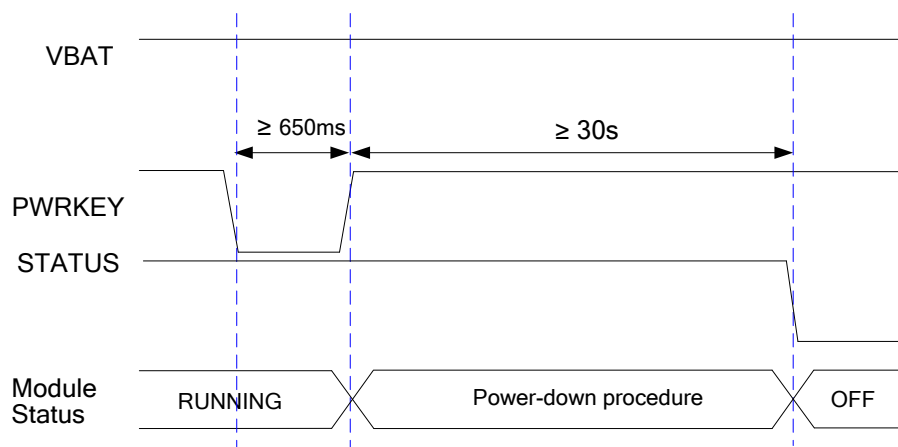


Figure 12: Power-off Scenario

3.7.2.2. Turn off Module Using Related Software Command or API

It is also a safe way to use software command or API interface to turn off the module, which is similar to turning off the module via PWRKEY pin.

NOTES

1. In order to avoid damaging internal flash, please do not switch off the power supply when the module works normally. Only after the module is shut down by PWRKEY or related software command, the power supply can be cut off.
2. When turning off module with related software command or API, please keep PWRKEY at high level after the execution of power-off command. Otherwise the module will be turned on again after successful turn-off.

3.7.3. Reset the Module

The RESET_N pin can be used to reset the module. The module can be reset by driving RESET_N to a low level voltage for 150ms~460ms.

Table 10: Pin Definition of RESET_N

Pin Name	Pin No.	Description	DC Characteristics	Comment
RESET_N	17	Reset the module	$V_{IHmax}=2.1V$ $V_{IHmin}=1.3V$ $V_{ILmax}=0.5V$	

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

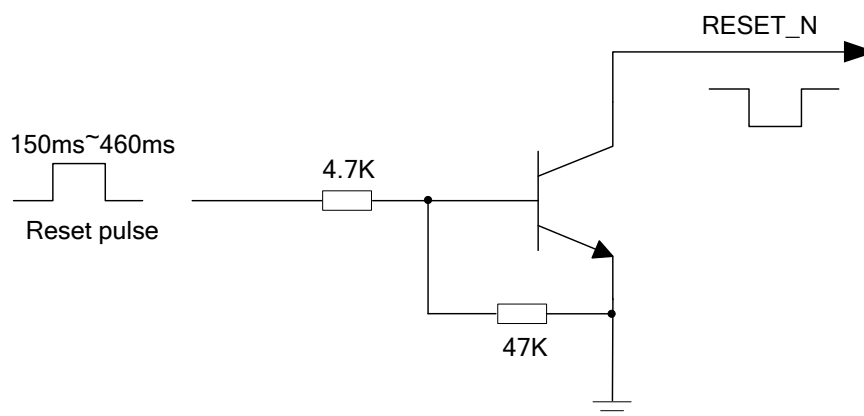


Figure 13: Reference Circuit of RESET_N by Using Driving Circuit

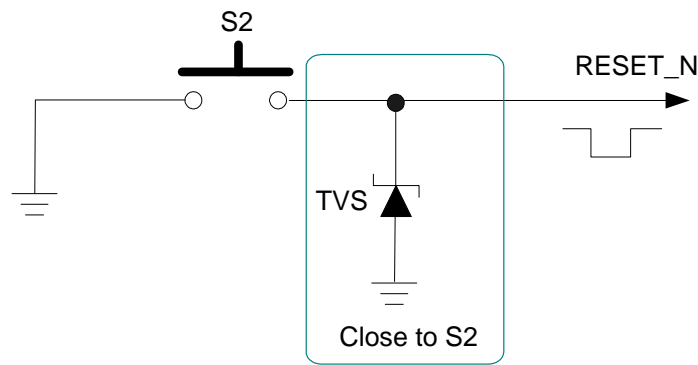


Figure 14: Reference Circuit of RESET_N by Using Button

The reset scenario is illustrated in the following figure.

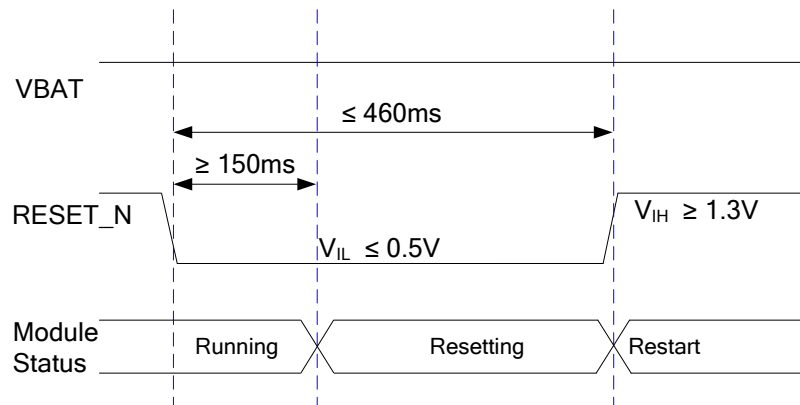


Figure 15: Reset Scenario

NOTES

1. Use RESET_N only when turning off the module by software shut down command and PWRKEY pin failed.
2. Ensure that there is no large capacitance on PWRKEY and RESET_N pins.

3.8. (U)SIM Interfaces

EG91-Quecopen provides two (U)SIM interfaces, and only one (U)SIM card can work at a time. The (U)SIM1 and (U)SIM2 cards can be switched by related software command or API.

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

Table 11: Pin Definition of (U)SIM Interfaces

Pin Name	Pin No.	I/O	Description	Comment
USIM1_VDD	43	PO	Power supply for (U)SIM1 card	Either 1.8V or 3.0V is supported by the module automatically.
USIM1_DATA	45	IO	Data signal of (U)SIM1 card	
USIM1_CLK	46	DO	Clock signal of (U)SIM1 card	
USIM1_RST	44	DO	Reset signal of (U)SIM1 card	
USIM1_PRESENCE	42	DI	(U)SIM1 card insertion detection	
USIM_GND	47		Specified ground for (U)SIM card	
USIM2_VDD	87	PO	Power supply for (U)SIM2 card	Either 1.8V or 3.0V is supported by the module automatically.
USIM2_DATA	86	IO	Data signal of (U)SIM2 card	
USIM2_CLK	84	DO	Clock signal of (U)SIM2 card	
USIM2_RST	85	DO	Reset signal of (U)SIM2 card	
USIM2_PRESENCE	83	DI	(U)SIM2 card insertion detection	

EG91-Quecopen supports (U)SIM card hot-plug via USIM_PRESENCE (USIM1_PRESENCE/USIM2_PRESENCE) pin. The function supports low level and high level detection, and is disabled by default. Please refer to **document [2]** about **AT+QSIMDET** command for details.

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

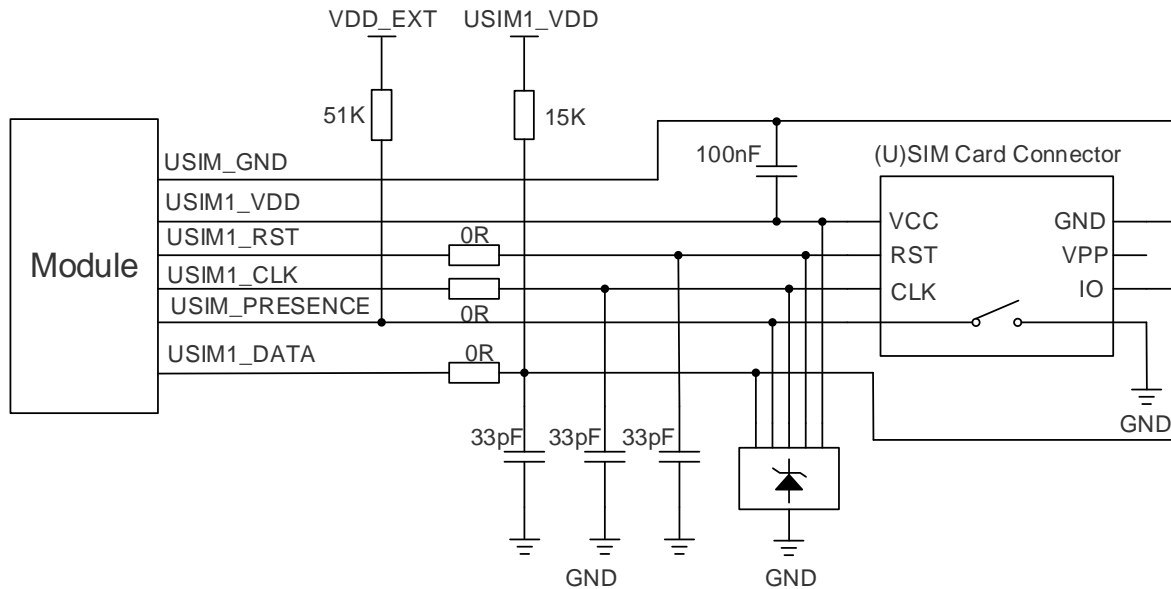


Figure 16: Reference Circuit of (U)SIM Interface with an 8-Pin (U)SIM Card Connector

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

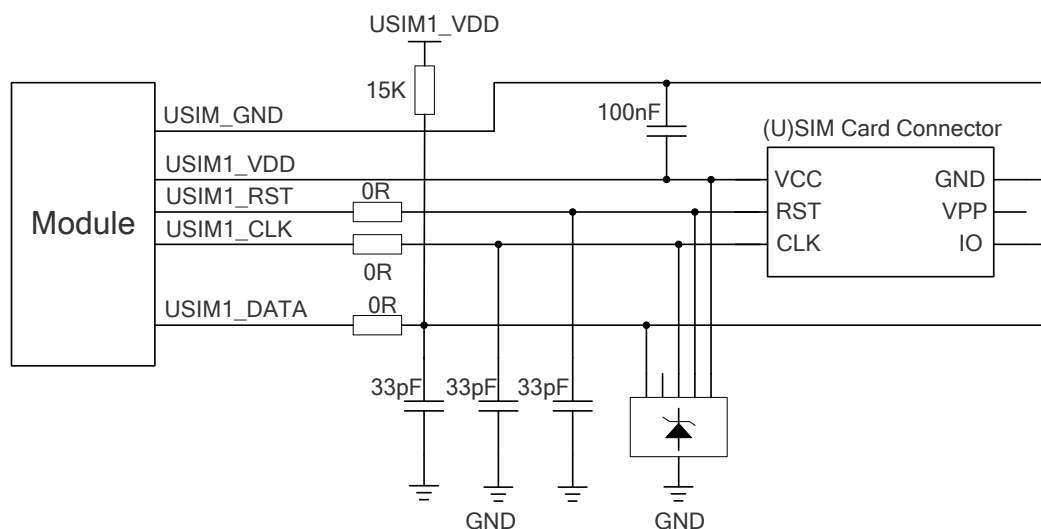


Figure 17: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

In order to enhance the reliability and availability of the (U)SIM card in customers' applications, please follow the criteria below in the (U)SIM circuit design:

- Keep placement of (U)SIM card connector to the module as close as possible. Keep the trace length as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.

- Assure the ground trace between the module and the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5mm to maintain the same electric potential. Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1uF, and place it as close to (U)SIM card connector as possible. If the ground is complete on customers' PCB, USIM_GND can be connected to PCB ground directly.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- In order to offer good ESD protection, it is recommended to add a TVS diode array whose parasitic capacitance should not be more than 15pF. The 0Ω resistors should be added in series between the module and the (U)SIM card to facilitate debugging. The 33pF 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 pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

3.9. USB Interface

EG91-Quecopen contains one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports high-speed (480Mbps) and full-speed (12Mbps) modes. The USB interface is used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging, firmware upgrade and voice over USB*. The following table shows the pin definition of USB interface.

Table 12: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DP	9	IO	USB differential data bus (+)	Require differential impedance of 90Ω.
USB_DM	10	IO	USB differential data bus (-)	Require differential impedance of 90Ω.
USB_VBUS	8	PI	USB connection detection	Typical: 5.0V
GND	3		Ground	

For more details about USB 2.0 specifications, please visit <http://www.usb.org/home>.

The USB interface is recommended to be reserved for firmware upgrade in customers' design. The following figure shows a reference circuit of USB interface.

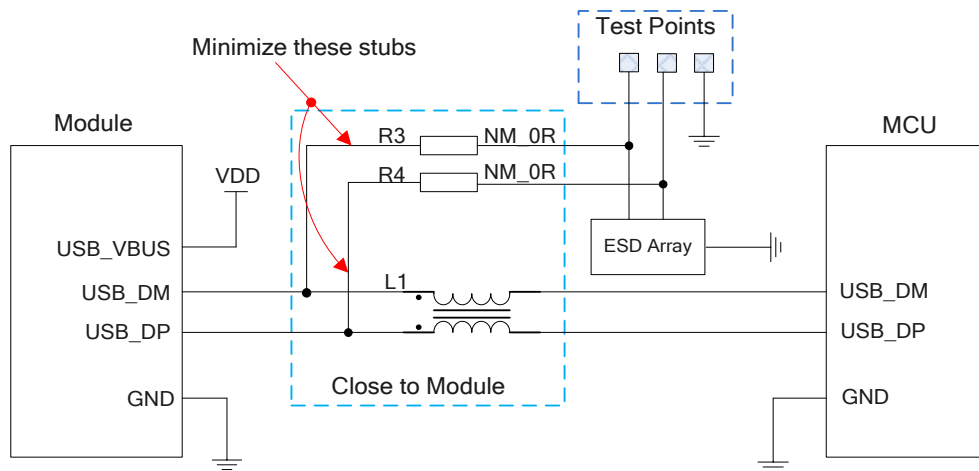


Figure 18: Reference Circuit of USB Interface

A common mode choke L1 is recommended to be added in series between the module and customer's MCU in order to suppress EMI spurious transmission. Meanwhile, the 0Ω resistors (R3 and R4) should be added in series between the module and the test points so as to facilitate debugging, and the resistors are not mounted by default. In order to ensure the integrity of USB data line signal, L1/R3/R4 components must be placed close to the module, and also these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

The following principles should be complied with when design the USB interface, so as to meet USB 2.0 specification.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90Ω.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. It is important to route the USB differential traces in inner-layer with ground shielding on not only upper and lower layers but also right and left sides.
- Pay attention to the influence of junction capacitance of ESD protection components on USB data lines. Typically, the capacitance value should be less than 2pF.
- Keep the ESD protection components to the USB connector as close as possible.

NOTES

1. EG91-Quecopen module can only be used as a slave device.
2. “*” means under development.

3.10. UART Interfaces

EG91-Quecopen provides three UART interfaces: main UART interface, debug UART interface and application UART which is multiplexed with pin 26~28 of SPI interface.

The application UART means this UART interface can be controlled by customers' application software and is used for communication and data transmission with peripherals such as MCU.

The following shows their features.

- The main UART interface supports 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps and 3000000bps baud rates, and the default is 115200bps. It supports RTS and CTS hardware flow control, and it is used for AT command communication only.
- The debug UART interface supports 115200bps baud rate. It is used for Linux console and log output.
- The application UART which multiplexed with SPI interface supports 9600bps, 19200bps, 38400bps, 57600bps, 115200bps, 230400bps, 460800bps, 921600bps and 3000000bps baud rates, and the default is 115200bps. The interface can be used for communication and data transmission with peripherals.

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

Table 13: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
RI	39	DO	Ring indicator	
DCD	38	DO	Data carrier detection	
CTS	36	DO	Clear to send	
RTS	37	DI	Request to send	1.8V power domain
DTR	30	DI	Sleep mode control	
TXD	35	DO	Transmit data	
RXD	34	DI	Receive data	

Table 14: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	23	DO	Transmit data	1.8V power domain
DBG_RXD	22	DI	Receive data	1.8V power domain

Table 15: Pin Definition of Application UART Interface (Multiplexed with SPI)

Pin Name	Pin No.	I/O	Description		
			Function 1 (Default)	Function 2	Function 3
SPI_CLK	26	DO	SPI_CLK_BLSP6	GPIO_23	UART_CTS_BLSP6
SPI_MOSI	27	DO	SPI_MOSI_BLSP6	GPIO_20	UART_TXD_BLSP6
SPI_MISO	28	DI	SPI_MISO_BLSP6	GPIO_21	UART_RXD_BLSP6

NOTE

SPI is a three-wire interface, so the application UART that multiplexing with SPI is also a three-wire interface.

The logic levels are described in the following table.

Table 16: Logic Levels of Digital I/O

Parameter	Min.	Max.	Unit
V _{IL}	-0.3	0.6	V
V _{IH}	1.2	2.0	V
V _{OL}	0	0.45	V
V _{OH}	1.35	1.8	V

The module provides 1.8V UART interfaces. A level translator should be used if customers' application is equipped with a 3.3V UART interface. A level translator TXS0108EPWR provided by *Texas Instruments* is recommended. The following figure shows a reference design.

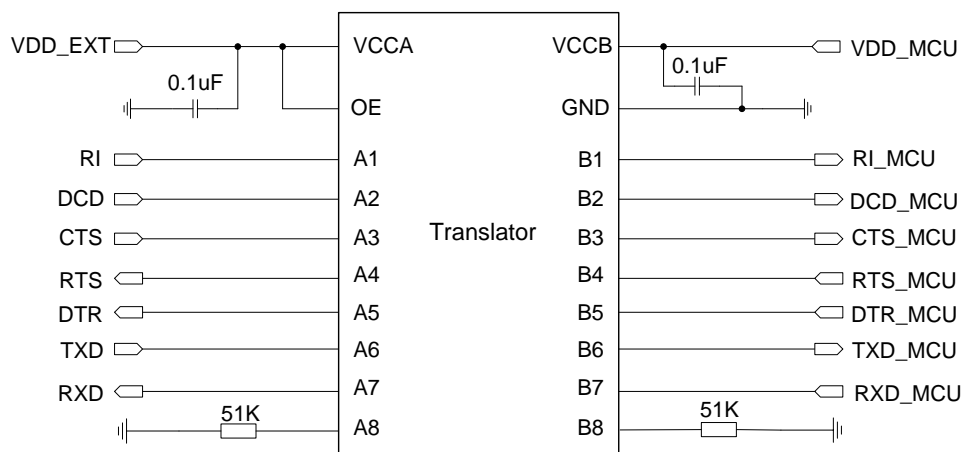


Figure 19: Reference Circuit with Translator Chip

Please visit <http://www.ti.com> for more information.

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

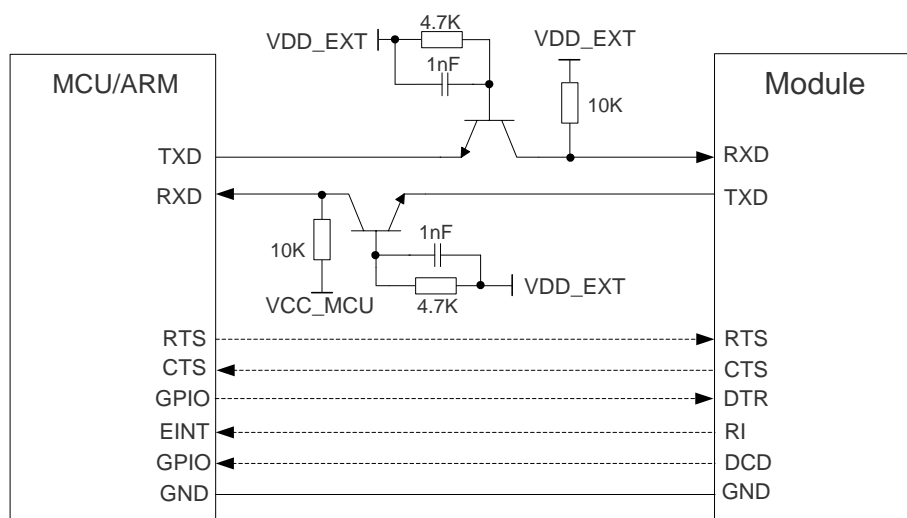


Figure 20: Reference Circuit with Transistor Circuit

NOTE

Transistor circuit solution is not suitable for applications with high baud rates exceeding 460Kbps.

3.11. PCM and I2C Interfaces

EG91-Quecopen provides one Pulse Code Modulation (PCM) digital interface for audio design, which supports the following modes and one I2C interface:

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

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 256KHz, 512KHz, 1024KHz or 2048KHz PCM_CLK at 8KHz PCM_SYNC, and also supports 4096KHz PCM_CLK at 16KHz PCM_SYNC.

In auxiliary mode, the data is also 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 256KHz, 512KHz, 1024KHz or 2048KHz PCM_CLK and an 8KHz, 50% duty cycle PCM_SYNC.

EG91-Quecopen supports 16-bit linear data format. The following figures show the primary mode's timing relationship with 8KHz PCM_SYNC and 2048KHz PCM_CLK, as well as the auxiliary mode's timing relationship with 8KHz PCM_SYNC and 256KHz PCM_CLK.

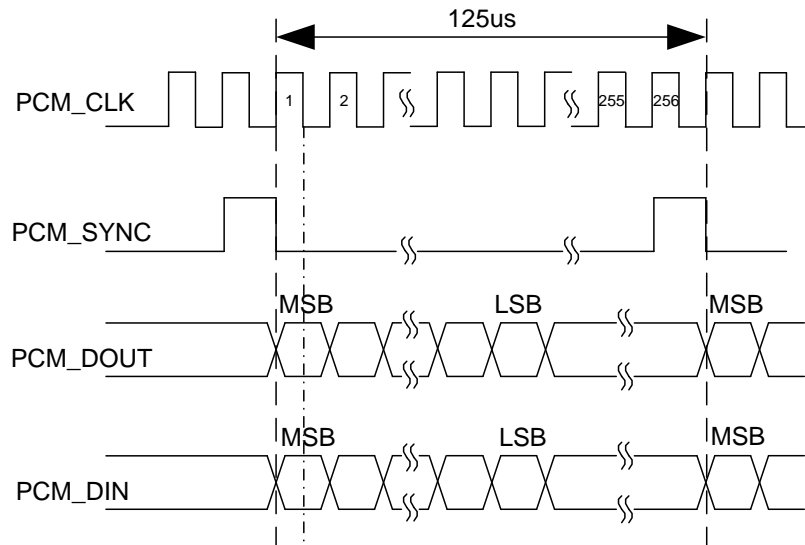


Figure 21: Primary Mode Timing

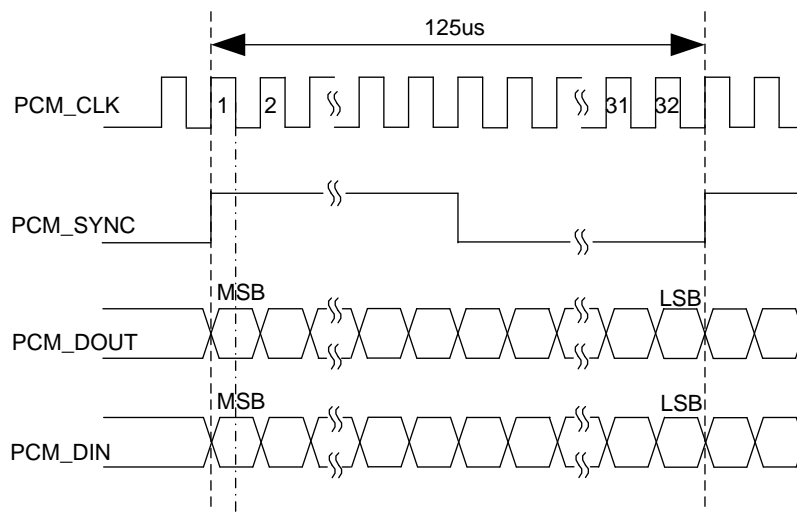


Figure 22: Auxiliary Mode Timing

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

Table 17: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_DIN	6	DI	PCM data input	1.8V power domain
PCM_DOUT	7	DO	PCM data output	1.8V power domain
PCM_SYNC	5	IO	PCM data frame synchronization signal	1.8V power domain
PCM_CLK	4	IO	PCM data bit clock	1.8V power domain
I2C_SCL	40	OD	I2C serial clock	Require an external pull-up to 1.8V
I2C_SDA	41	OD	I2C serial data	Require an external pull-up to 1.8V

Clock and mode can be configured by related software command or API, and the default configuration is master mode using short frame synchronization format with 2048KHz PCM_CLK and 8KHz PCM_SYNC.

The following figure shows a reference design of PCM interface with external codec IC.

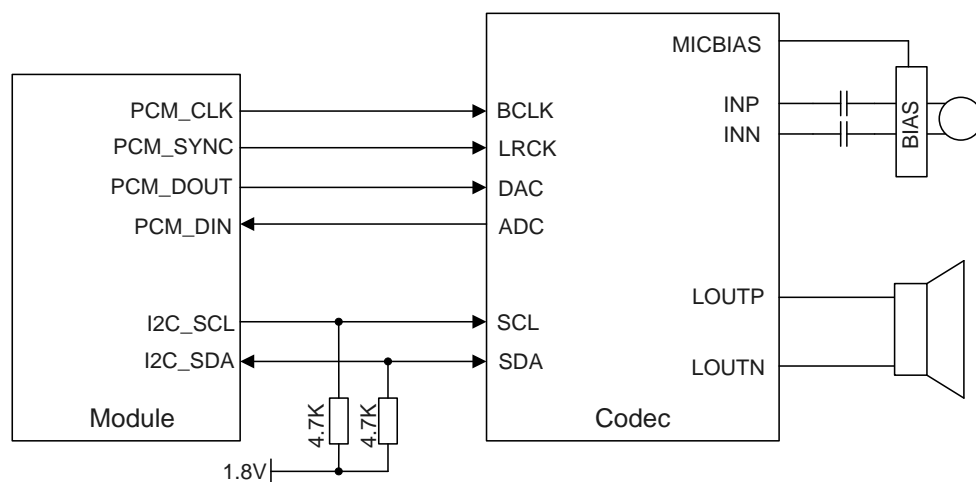


Figure 23: Reference Circuit of PCM Application with Audio Codec

NOTES

1. It is recommended to reserve an RC ($R=22\Omega$, $C=22pF$) circuit on the PCM lines, especially for PCM_CLK.
2. EG91-Quecopen works as a master device pertaining to I2C interface.

3.12. SPI Interface

SPI interface of EG91-Quecopen acts as the master only. It provides a duplex, synchronous and serial communication link with the peripheral devices. It is dedicated to one-to-one connection, without chip select signal. Its operation voltage is 1.8V with clock rates up to 50MHz.

The following table shows the pin definition of SPI interface.

Table 18: Pin Definition of SPI Interface

Pin Name	Pin No.	I/O	Description	Comment
SPI_CLK	26	DO	Clock signal of SPI interface	1.8V power domain If unused, keep it open.
SPI_MOSI	27	DO	Master output slave input of SPI interface	1.8V power domain
SPI_MISO	28	DI	Master input slave output of SPI interface	1.8V power domain

The following figure shows a reference design of SPI interface with peripherals.

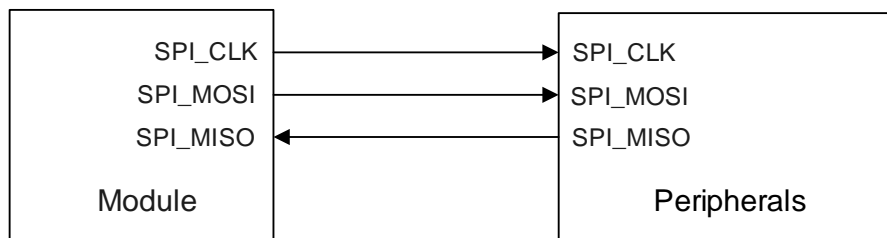


Figure 24: Reference Circuit of SPI Interface with Peripherals

NOTE

The module provides 1.8V SPI interface. A level translator should be used between the module and the host if customer's application is equipped with a 3.3V processor or device interface.

3.13. ADC Interface

The module provides one analog-to-digital converter (ADC) interface. Related software command or API can be used to read the voltage value on ADC0 pin.

In order to improve the accuracy of ADC, the trace of ADC should be surrounded by ground.

Table 19: Pin Definition of ADC Interface

Pin Name	Pin No.	Description
ADC0	24	General purpose analog to digital converter

The following table describes the characteristic of the ADC function.

Table 20: Characteristic of the ADC

Parameter	Min.	Typ.	Max.	Unit
ADC0 Voltage Range	0.3		VBAT_BB	V
ADC1 Voltage Range	0.3		VBAT_BB	V
ADC Resolution		15		bits

NOTES

1. It is prohibited to supply any voltage to ADC pins when VBAT is removed.
2. It is recommended to use resistor divider circuit for ADC application.

3.14. GPIO Interfaces

EG91-Quecopen provides up to 13 multi-function pins that can be configured as GPIOs when the default function is not used. The following table shows the alternate GPIO function of EG91-Quecopen pins.

Table 21: GPIO Function of EG91-Quecopen Pins

Pin Name	Pin No.	Default Function	GPIO Function	Comment
PCM_CLK	4	PCM_CLK	GPIO_78	BOOT_CONFIG_8
PCM_SYNC	5	PCM_SYNC	GPIO_79	BOOT_CONFIG_7
PCM_DIN	6	PCM_DIN	GPIO_76	
PCM_DOUT	7	PCM_DOUT	GPIO_77	
AP_READY	19	AP_READY	GPIO_10	
NETLIGHT	21	NETLIGHT	PMD_GPIO_01	
SPI_CLK	26	SPI_CLK	GPIO_23	BOOT_CONFIG_4
SPI_MOSI	27	SPI_MOSI	GPIO_20	
SPI_MISO	28	SPI_MISO	GPIO_21	
RI	39	RI	GPIO_75	
I2C_SCL	40	I2C_SCL	GPIO_07	
I2C_SDA	41	I2C_SDA	GPIO_06	
USIM1_PRESENCE	42	USIM1_PRESENCE	GPIO_34	

NOTES

1. The voltage domain of this pin is 1.8V, and attention should be paid to logic level when connecting to peripherals.
2. All BOOT_CONFIG and FORCE_USB_BOOT pins are prohibited to be pulled up to high level, even pulled up to VDD_EXT before startup.

The logic levels are described in the following table.

Table 22: Logic Levels of Digital I/O

Parameter	Min.	Max.	Unit
V _{IL}	-0.3	0.6	V
V _{IH}	1.2	2.0	V

V_{OL}	0	0.45	V
V_{OH}	1.35	1.8	V

3.15. Network Status Indication

The module provides one network indication pin: NETLIGHT. The pin is used to drive a network status indication LED.

The following tables describe the pin definition and logic level changes of NETLIGHT in different network status.

Table 23: Pin Definition of Network Status Indicator

Pin Name	Pin No.	I/O	Description	Comment
NETLIGHT	21	DO	Indicate the module's network activity status	1.8V power domain

Table 24: Working State of Network Status Indicator

Pin Name	Logic Level Changes	Network Status
NETLIGHT	Flicker slowly (200ms High/1800ms Low)	Network searching
	Flicker slowly (1800ms High/200ms Low)	Idle
	Flicker quickly (125ms High/125ms Low)	Data transfer is ongoing
	Always High	Voice calling

A reference circuit is shown in the following figure.

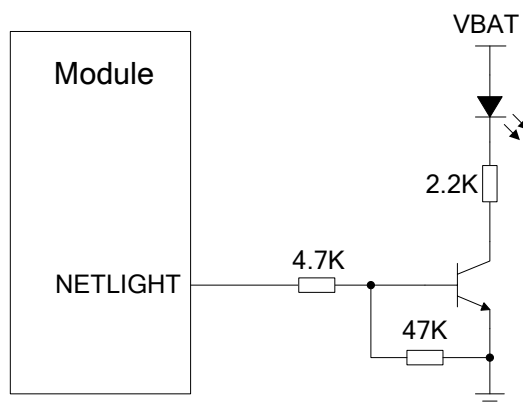


Figure 25: Reference Circuit of Network Status Indicator

3.16. STATUS

The STATUS pin is set as the module's operation status indicator. It will output high level when the module is powered on. The following table describes the pin definition of STATUS.

Table 25: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	20	DO	Indicate the module's operating status	1.8V power domain

A reference circuit is shown as below.

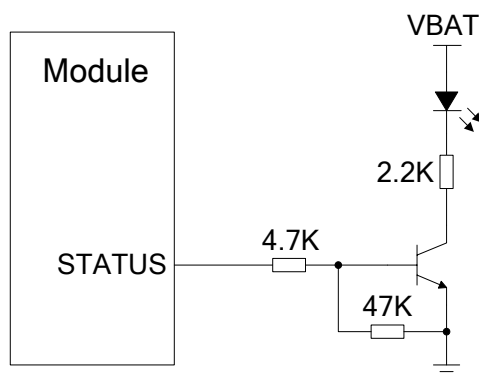


Figure 26: Reference Circuit of STATUS

3.17. Behaviors of RI

Related software command or API can be used to configure RI behavior. The default RI behaviors can be changed by related software command. Please refer to **document [2]** for details.

No matter on which port URC is presented, URC will trigger the behavior of RI pin.

NOTE

URC can be outputted from UART port, USB AT port and USB modem port through configuration via related software command or API. The default port is USB AT port.

The default behaviors of the RI are shown as below.

Table 26: Default Behaviors of RI

State	Response
Idle	RI keeps at high level
URC	RI outputs 120ms low pulse when a new URC returns

3.18. USB_BOOT Interface

EG91-Quecopen provides a USB_BOOT pin. Customers can pull up USB_BOOT to VDD_EXT before powering on the module, thus the module will enter into emergency download mode when powered on. In this mode, the module supports firmware upgrade over USB interface.

Table 27: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	75	DI	Force the module to enter into emergency download mode	1.8V power domain. It is recommended to reserve the test points.

The following figures show a reference circuit of USB_BOOT interface and timing sequence of entering into emergency download mode.

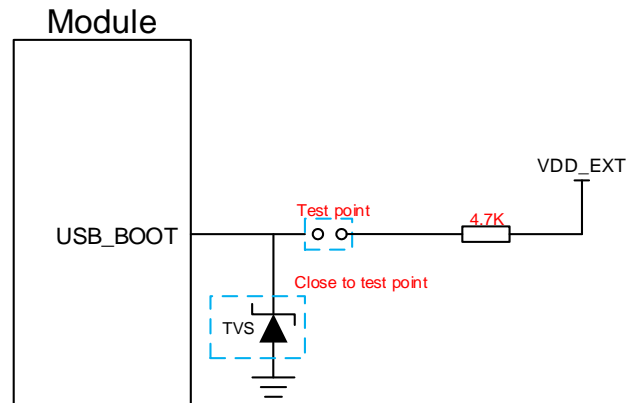


Figure 27: Reference Circuit of USB_BOOT Interface

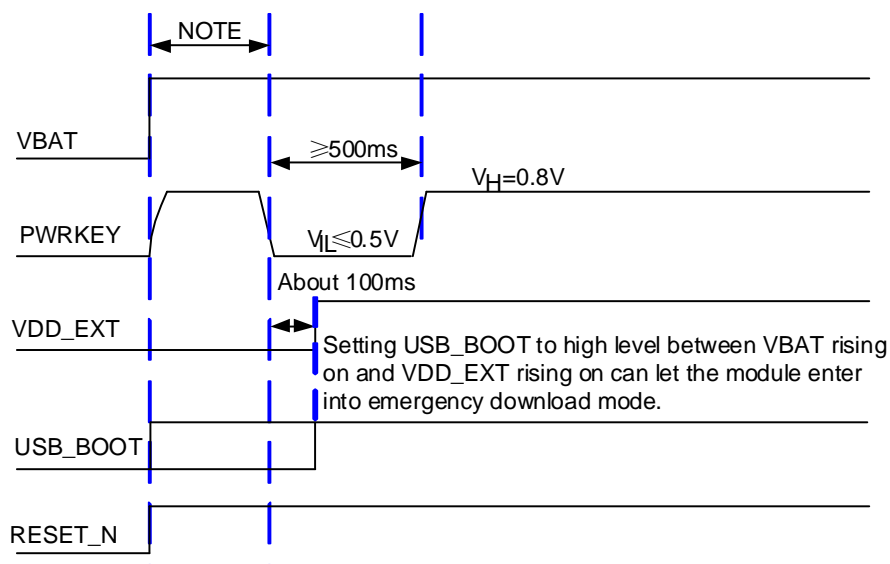


Figure 28: Timing Sequence for Entering into Emergency Download Mode

NOTES

1. Please make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is no less than 30ms.
2. When using MCU to control module to enter into the emergency download mode, follow the above timing sequence. It is not recommended to pull up USB_BOOT to 1.8V before powering up the VBAT. Short the test points as shown in **Figure 27** can manually force the module to enter into download mode.

4 GNSS Receiver

4.1. General Description

EG91-Quecopen includes a fully integrated global navigation satellite system solution that supports Gen8C-Lite of Qualcomm (GPS, GLONASS, BeiDou, Galileo and QZSS).

EG91-Quecopen supports standard NMEA-0183 protocol, and outputs NMEA sentences at 1Hz data update rate via USB interface by default.

By default, EG91-Quecopen GNSS engine is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, please refer to **document [3]**.

4.2. GNSS Performance

The following table shows GNSS performance of EG91-Quecopen.

Table 28: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF (GNSS)	Cold start @open sky	Autonomous	34.6	s
		XTRA enabled	11.57	s
	Warm start @open sky	Autonomous	26.09	s
		XTRA enabled	3.7	s

	Hot start @open sky	Autonomous	1.8	s
		XTRA enabled	3.4	s
Accuracy (GNSS)	CEP-50	Autonomous @open sky	<2.5	m

NOTES

1. Tracking sensitivity: the lowest GNSS signal value at the antenna port on which the module can keep on positioning for 3 minutes.
2. Reacquisition sensitivity: the lowest GNSS signal value at the antenna port on which the module can fix position again within 3 minutes after loss of lock.
3. Cold start sensitivity: the lowest GNSS signal value at the antenna port on which the module fixes position within 3 minutes after executing cold start command.

4.3. Layout Guidelines

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

- Maximize the distance among GNSS antenna, main antenna and Rx-diversity antenna.
- Digital circuits such as (U)SIM card, USB interface, camera module and display connector 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.
- Keep the characteristic impedance for ANT_GNSS trace as 50Ω.

Please refer to **Chapter 5** for GNSS antenna reference design and antenna installation information.

5 Antenna Interfaces

EG91-Quecopen antenna interfaces include a main antenna interface, an Rx-diversity antenna interface which is used to resist the fall of signals caused by high speed movement and multipath effect, and a GNSS antenna interface which is only supported on EG91-NA-Quecopen. The impedance of the antenna port is 50Ω.

5.1. Main/Rx-diversity Antenna Interfaces

5.1.1. Pin Definition

The pin definition of main antenna and Rx-diversity antenna interfaces is shown below.

Table 29: Pin Definition of RF Antenna

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	60	IO	Main antenna pad	50Ω impedance
ANT_DIV (EG91-E-Quecopen)	49	AI	Receive diversity antenna pad	50Ω impedance
ANT_DIV (EG91-NA-Quecopen)	56	AI	Receive diversity antenna pad	50Ω impedance

5.1.2. Operating Frequency

Table 30: Module 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 B2	1850~1910	1930~1990	MHz

WCDMA B4	1710~1755	2110~2155	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
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 B12	699~716	729~746	MHz
LTE FDD B13	777~787	746~756	MHz
LTE-FDD B20	832~862	791~821	MHz
LTE-FDD B28A	703~733	758~788	MHz

5.1.3. Reference Design of RF Antenna Interface

A reference design of ANT_MAIN and ANT_DIV antenna pads is shown as below. A π -type matching circuit should be reserved for better RF performance. The capacitors are not mounted by default.

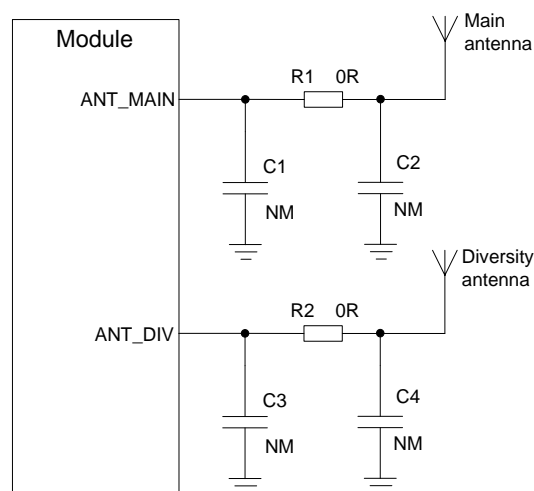


Figure 29: Reference Circuit of RF Antenna Interface

NOTES

1. Keep a proper distance between the main antenna and the Rx-diversity antenna to improve the receiving sensitivity.
2. ANT_DIV function is enabled by default.
3. Place the π -type matching components (R1/C1/C2, R2/C3/C4) as close to the antenna as possible.

5.1.4. Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled as 50Ω . 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 space between the RF trace and the ground (S). Microstrip and coplanar waveguide are typically used in RF layout to control characteristic impedance. The following figures are reference designs of microstrip or coplanar waveguide with different PCB structures.

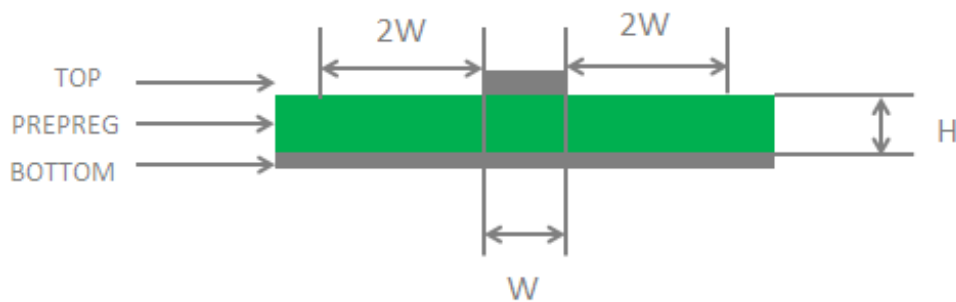


Figure 30: Microstrip Line Design on a 2-layer PCB

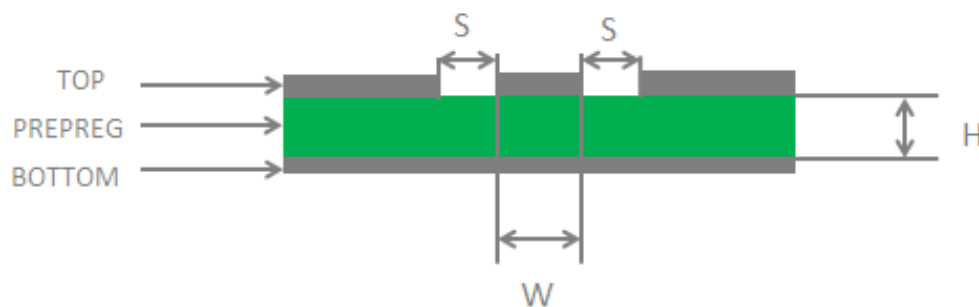


Figure 31: Coplanar Waveguide Design on a 2-layer PCB

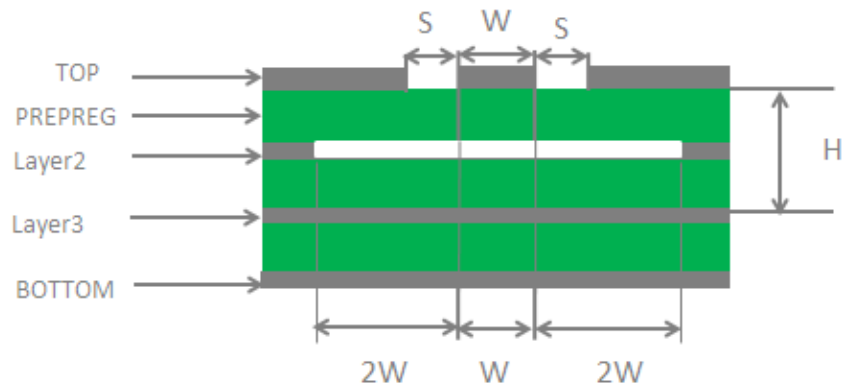


Figure 32: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

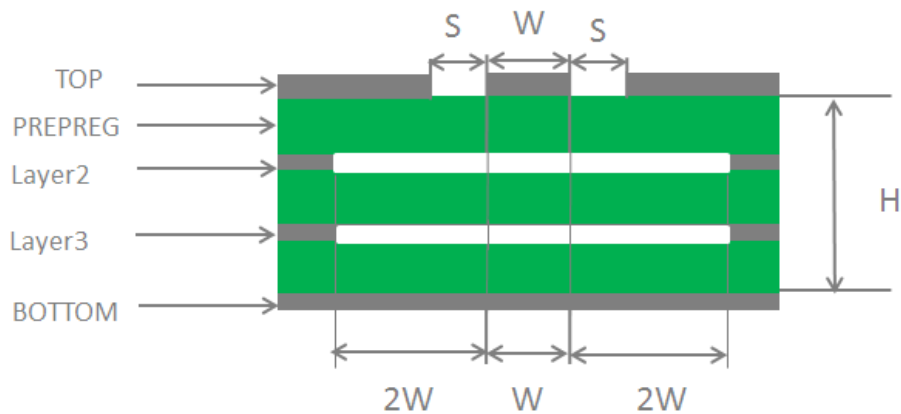


Figure 33: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use an impedance simulation tool to control the characteristic impedance of RF traces as 50Ω.
- 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.
- There should be clearance area 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 no less than two times the width of RF signal traces ($2 \times W$).

For more details about RF layout, please refer to **document [5]**.

5.2. GNSS Antenna Interface

The GNSS antenna interface is only supported on EG91-NA-Quecopen. The following tables show pin definition and frequency specification of GNSS antenna interface.

Table 31: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS (EG91-NA-Quecopen)	49	AI	GNSS antenna	50Ω impedance

Table 32: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42±1.023	MHz
Galileo	1575.42±2.046	MHz
GLONASS	1597.5~1605.8	MHz
BeiDou	1561.098±2.046	MHz
QZSS	1575.42	MHz

A reference design of GNSS antenna is shown as below.

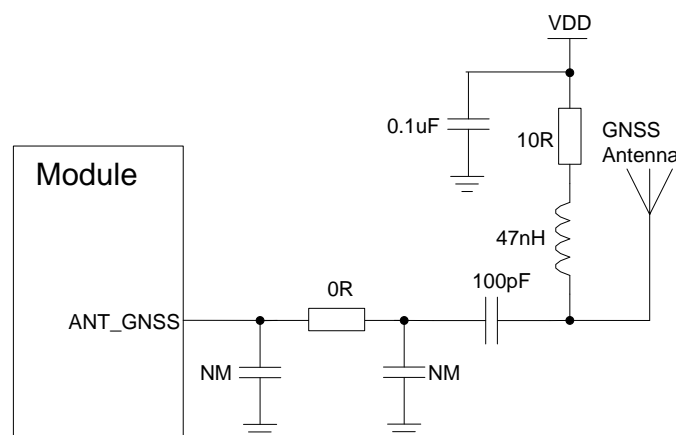


Figure 34:Reference Circuit of GNSS Antenna

NOTES

1. An external LDO can be selected to supply power according to the active antenna requirement.
2. If the module is designed with a passive antenna, then the VDD circuit is not needed.

5.3. Antenna Installation

5.3.1. Antenna Requirement

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

Table 33: Antenna Requirements

Type	Requirements
GNSS ¹⁾	Frequency range: 1559MHz~1609MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0dBi Active antenna noise figure: < 1.5dB Active antenna gain: > 0dBi Active antenna embedded LNA gain: < 17dB
GSM/WCDMA/LTE	VSWR: ≤ 2 Efficiency : > 30% Max Input Power: 50 W Input Impedance: 50Ω Cable insertion loss: < 1dB (EGSM900, WCDMA B5/B8, LTE B5/B8/B12/B13/B20/B28A) Cable Insertion Loss: < 1.5dB (DCS1800, WCDMA B1/B2/B4, LTE B1/B2/B3/B4) Cable insertion loss: < 2dB (LTE B7)

NOTE

- ¹⁾ It is recommended to use a passive GNSS antenna when LTE B13 or B14 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.

5.3.2. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use U.FL-R-SMT connector provided by HIROSE.

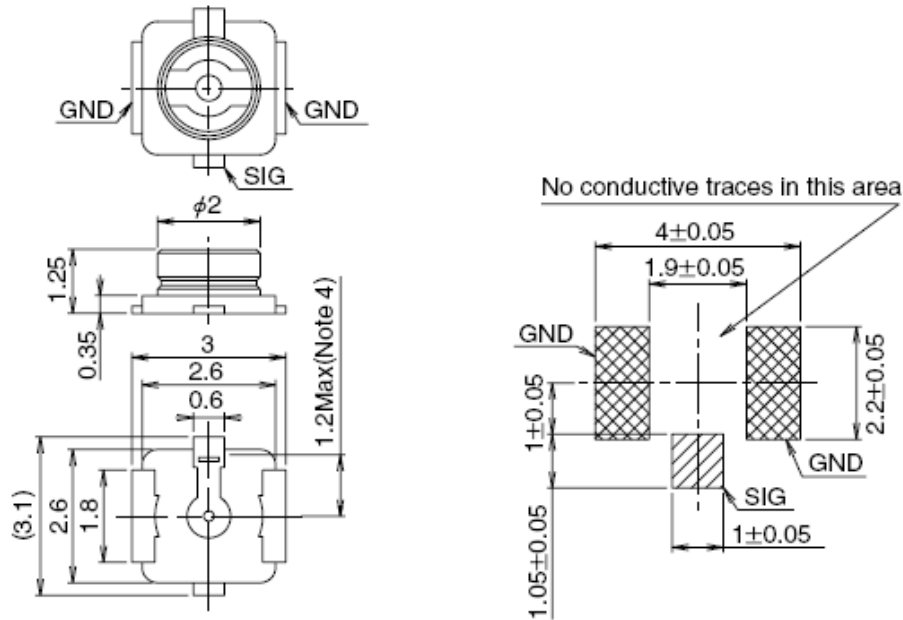


Figure 35: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 36: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

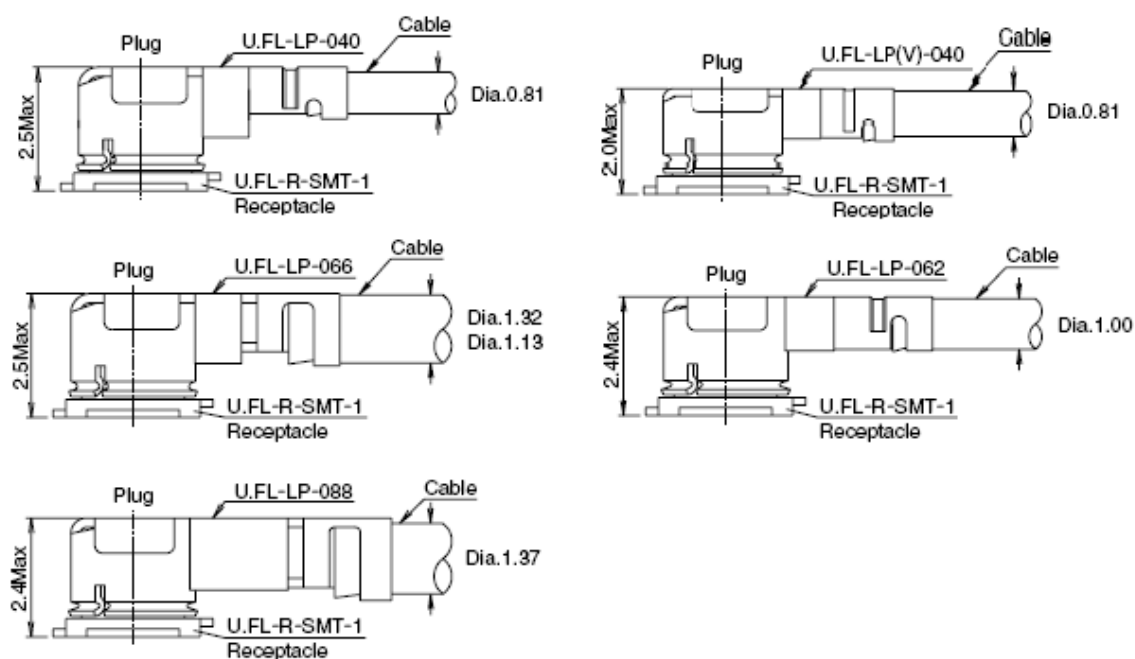


Figure 37: Space Factor of Mated Connector (Unit: mm)

For more details, please visit <http://www.hirose.com>.

6 Electrical, Reliability and Radio 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 34: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.3	4.7	V
USB_VBUS	-0.3	5.5	V
Peak Current of VBAT_BB	0	0.8	A
Peak Current of VBAT_RF	0	1.8	A
Voltage at Digital Pins	-0.3	2.3	V

6.2. Power Supply Ratings

Table 35: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB and VBAT_RF	The actual input voltages must stay between the minimum and maximum values.	3.3	3.8	4.3	V

	Voltage drop during burst transmission	Maximum power control level on EGSM900		400	mV
I _{VBAT}	Peak supply current (during transmission slot)	Maximum power control level on EGSM900	1.8	2.0	A
USB_VBUS	USB connection detection		3.0	5.0	5.25 V

6.3. Operation and Storage Temperatures

The operation and storage temperatures are listed in the following table.

Table 36: Operation and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operation Temperature Range ¹⁾	-35	+25	+75	°C
Extended Temperature Range ²⁾	-40		+85	°C
Storage Temperature Range	-40		+90	°C

NOTES

- ¹⁾ Within operation temperature range, the module is 3GPP compliant.
- ²⁾ Within extended temperature range, the module remains the ability to establish and maintain a voice, SMS, data transmission, emergency call, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operation temperature levels, the module will meet 3GPP specifications again.

6.4. Current Consumption

The values of current consumption are shown below.

Table 37: EG91-E-Quecopen Current Consumption

Parameter	Description	Conditions	Typ.	Unit
I _{VBAT}	OFF state	Power down	13	uA
	Sleep state	AT+CFUN=0 (USB disconnected)	1.1	mA
		GSM DRX=2 (USB disconnected)	2.0	mA
		GSM DRX=5 (USB suspended)	1.9	mA
		GSM DRX=9 (USB disconnected)	1.3	mA
		WCDMA PF=64 (USB disconnected)	1.7	mA
		WCDMA PF=64 (USB suspended)	2.1	mA
		WCDMA PF=512 (USB disconnected)	1.1	mA
		LTE-FDD PF=64 (USB disconnected)	2.1	mA
		LTE-FDD PF=64 (USB suspended)	2.6	mA
		LTE-FDD PF=256 (USB disconnected)	1.4	mA
	Idle state	GSM DRX=5 (USB disconnected)	19.0	mA
		GSM DRX=5 (USB connected)	29.0	mA
		WCDMA PF=64 (USB disconnected)	19.0	mA
		WCDMA PF=64 (USB connected)	29.0	mA
		LTE-FDD PF=64 (USB disconnected)	19.0	mA
		LTE-FDD PF=64 (USB connected)	29.0	mA
	GPRS data transfer	EGSM900 4DL/1UL @32.67dBm	260	mA
		EGSM900 3DL/2UL @32.59dBm	463	mA
		EGSM900 2DL/3UL @30.74dBm	552	mA

	EGSM900 1DL/4UL @29.26dBm	619	mA
	DCS1800 4DL/1UL @29.2dBm	165	mA
	DCS1800 3DL/2UL @29.13dBm	267	mA
	DCS1800 2DL/3UL @29.01dBm	406	mA
	DCS1800 1DL/4UL @28.86dBm	467	mA
EDGE data transfer	EGSM900 4DL/1UL PCL=8 @27.1dBm	163	mA
	EGSM900 3DL/2UL PCL=8 @27.16dBm	274	mA
	EGSM900 2DL/3UL PCL=8 @26.91dBm	383	mA
	EGSM900 1DL/4UL PCL=8 @26.12dBm	463	mA
	DCS1800 4DL/1UL PCL=2 @25.54dBm	136	mA
	DCS1800 3DL/2UL PCL=2 @25.68dBm	220	mA
	DCS1800 2DL/3UL PCL=2 @25.61dBm	306	mA
	DCS1800 1DL/4UL PCL=2 @25.41dBm	396	mA
WCDMA data transfer	WCDMA B1 HSDPA CH10700 @22.29dBm	507	mA
	WCDMA B1 HSUPA CH10700 @21.79dBm	516	mA
	WCDMA B8 HSDPA CH3012 @22.47dBm	489	mA
	WCDMA B8 HSUPA CH3012 @21.98dBm	482	mA
LTE data transfer	LTE-FDD B1 CH18300 @22.98dBm	685	mA
	LTE-FDD B3 CH19575 @23.23dBm	698	mA
	LTE-FDD B7 CH21100 @23.46dBm	723	mA
	LTE-FDD B8 CH21625 @23.35dBm	655	mA
	LTE-FDD B20 CH24300 @23.41dBm	723	mA
	LTE-FDD B28A CH27360 @23.16dBm	660	mA
GSM voice call	EGSM900 PCL=5 @32.5dBm	258	mA
	DCS1800 PCL=0 @29.23dBm	159	mA

WCDMA voice call	WCDMA B1 CH10700 @23.06dBm	555	mA
	WCDMA B8 CH3012 @23.45dBm	535	mA

Table 38: EG91-NA-Quecopen Current Consumption

Parameter	Description	Conditions	Typ.	Unit
I _{BAT}	OFF state	Power down	13	uA
	Sleep state	AT+CFUN=0 (USB disconnected)	1.0	mA
		WCDMA PF=64 (USB disconnected)	2.2	mA
		WCDMA PF=64 (USB suspended)	2.5	mA
		WCDMA PF=512 (USB disconnected)	1.4	mA
		LTE-FDD PF=64 (USB disconnected)	2.6	mA
		LTE-FDD PF=64 (USB suspended)	2.9	mA
		LTE-FDD PF=256 (USB disconnected)	1.7	mA
		WCDMA PF=64 (USB disconnected)	14.0	mA
		WCDMA PF=64 (USB connected)	26.0	mA
		LTE-FDD PF=64 (USB disconnected)	15.0	mA
		LTE-FDD PF=64 (USB connected)	26.0	mA
	WCDMA data transfer	WCDMA B2 HSDPA CH9938 @22.45 dBm	569	mA
		WCDMA B2 HSUPA CH9938 @21.73 dBm	559	mA
		WCDMA B4 HSDPA CH1537 @23.05 dBm	572	mA
		WCDMA B4 HSUPA CH1537 @22.86 dBm	586	mA
		WCDMA B5 HSDPA CH4407 @23 dBm	518	mA
		WCDMA B5 HSUPA CH4407 @ 22.88 dBm	514	mA
	LTE data transfer	LTE-FDD B2 CH1100 @23.29 dBm	705	mA
		LTE-FDD B4 CH2175 @23.19 dBm	693	mA

		LTE-FDD B5 CH2525 @23.39 dBm	601	mA
		LTE-FDD B12 CH5060 @23.16 dBm	650	mA
		LTE-FDD B13 CH5230 @23.36 dBm	602	mA
	WCDMA voice call	WCDMA B2 CH9938 @23.34 dBm	627	mA
		WCDMA B4 CH1537 @23.47 dBm	591	mA
		WCDMA B5 CH4357 @ 23.37 dBm	536	mA

Table 39: GNSS Current Consumption of EG91-NA-Quecopen

Parameter	Description	Conditions	Typ.	Unit
I _V BAT (GNSS)	Searching (AT+CFUN=0)	Cold start @Passive Antenna	53	mA
		Hot Start @Passive Antenna	50	mA
		Lost state @Passive Antenna	53	mA
	Tracking (AT+CFUN=0)	Open Sky @Passive Antenna	32	mA

6.5. RF Output Power

The following table shows the RF output power of EG91-Quecopen module.

Table 40: RF Output Power

Frequency	Max.	Min.
EGSM900	33dBm±2dB	5dBm±5dB
DCS1800	30dBm±2dB	0dBm±5dB
EGSM900 (8-PSK)	27dBm±3dB	5dBm±5dB
DCS1800 (8-PSK)	26dBm±3dB	0dBm±5dB
WCDMA B1/B2/B4/B5/B8	24dBm+1/-3dB	<-49dBm

LTE-FDD B1/B2/B3/B4/B5/B7/ B8/B12/B13/B20/B28A	23dBm±2dB	<-39dBm
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NOTE

In GPRS 4 slots TX mode, the maximum output power is reduced by 3.0dB. The design conforms to the GSM specification as described in **Chapter 13.16** of 3GPP TS 51.010-1.

6.6. RF Receiving Sensitivity

The following tables show the conducted RF receiving sensitivity of EG91-Quecopen module.

Table 41: EG91-E-Quecopen Conducted RF Receiving Sensitivity

Frequency	Primary	Diversity	SIMO	3GPP
EGSM900	-108.6dBm	NA	NA	-102dBm
DCS1800	-109.4 dBm	NA	NA	-102dbm
WCDMA B1	-109.5dBm	-110dBm	-112.5dBm	-106.7dBm
WCDMA B8	-109.5dBm	-110dBm	-112.5dBm	-103.7dBm
LTE-FDD B1 (10M)	-97.5dBm	-98.3dBm	-101.4dBm	-96.3dBm
LTE-FDD B3 (10M)	-98.3dBm	-98.5dBm	-101.5dBm	-93.3dBm
LTE-FDD B7 (10M)	-96.3dBm	-98.4dBm	-101.3dBm	-94.3dBm
LTE-FDD B8 (10M)	-97.1dBm	-99.1dBm	-101.2dBm	-93.3dBm
LTE-FDD B20 (10M)	-97dBm	-99dBm	-101.3dBm	-93.3dBm
LTE-FDD B28A (10M)	-98.3dBm	-99dBm	-101.4dBm	-94.8dBm

Table 42: EG91-NA-Quecopen Conducted RF Receiving Sensitivity

Frequency	Primary	Diversity	SIMO	3GPP
WCDMA B2	-110dBm	-111dBm	-112.5dBm	-104.7dBm

WCDMA B4	-110dBm	-111dBm	-112.5dBm	-106.7dBm
WCDMA B5	-111dBm	-111.5dBm	-113dBm	-104.7dBm
LTE-FDD B2 (10M)	-98dBm	-99dBm	-102.2dBm	-94.3dBm
LTE-FDD B4 (10M)	-97.8dBm	-99.5dBm	-102.2dBm	-96.3dBm
LTE-FDD B5 (10M)	-99.6dBm	-100.3dBm	-103dBm	-94.3dBm
LTE-FDD B12 (10M)	-99.5dBm	-100dBm	-102.5dBm	-93.3dBm
LTE-FDD B13 (10M)	-99.2dBm	-100dBm	-102.5dBm	-93.3dBm

6.7. Electrostatic Discharge

The module is not protected against electrostatic discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

The following table shows the module's electrostatic discharge characteristics.

Table 43: Electrostatic Discharge Characteristics

Tested Points	Contact Discharge	Air Discharge	Unit
VBAT, GND	±5	±10	KV
All Antenna Interfaces	±4	±8	KV
Other Interfaces	±0.5	±1	KV

6.8. Thermal Consideration

In order to achieve better performance of the module, it is recommended to comply with the following principles for thermal consideration:

- On customers' PCB design, please keep placement of the module away from heating sources, especially high power components such as ARM processor, audio power amplifier, power supply, etc.

- Do not place components on the opposite side of the PCB area where the module is mounted, in order to facilitate adding of heatsink when necessary.
- Do not apply solder mask on the opposite side of the PCB area where the module is mounted, so as to ensure better heat dissipation performance.
- The reference ground of the area where the module is mounted should be complete, and add ground vias as many as possible for better heat dissipation.
- Make sure the ground pads of the module and PCB are fully connected.
- According to customers' application demands, the heatsink can be mounted on the top of the module, or the opposite side of the PCB area where the module is mounted, or both of them.
- The heatsink should be designed with as many fins as possible to increase heat dissipation area. Meanwhile, a thermal pad with high thermal conductivity should be used between the heatsink and module/PCB.

The following shows two kinds of heatsink designs for reference and customers can choose one or both of them according to their application structure.

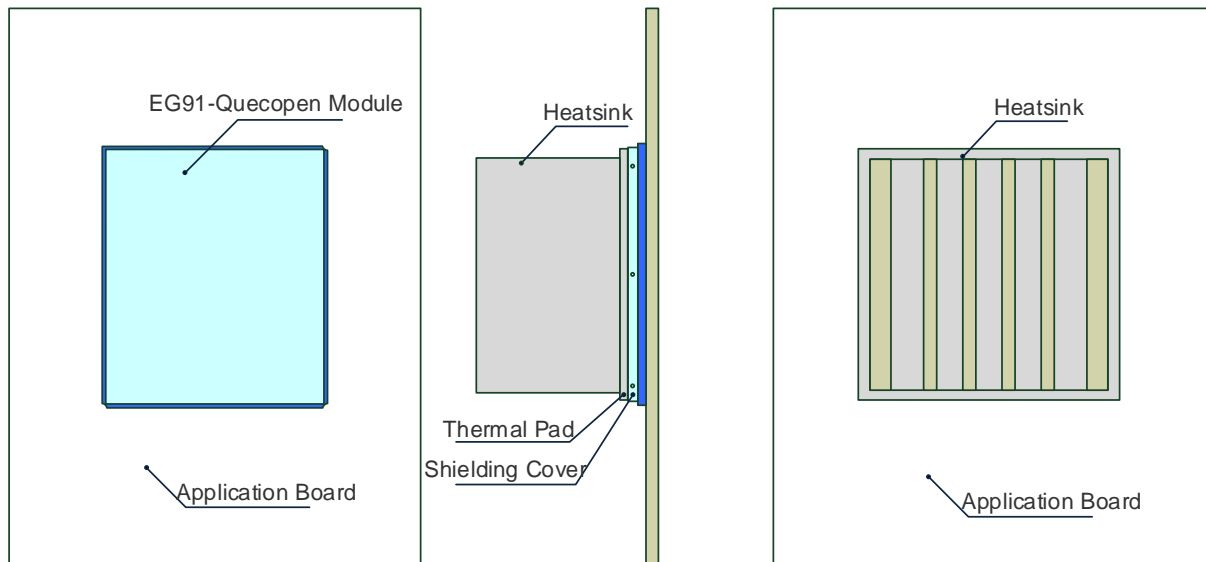


Figure 38: Referenced Heatsink Design (Heatsink at the Top of the Module)

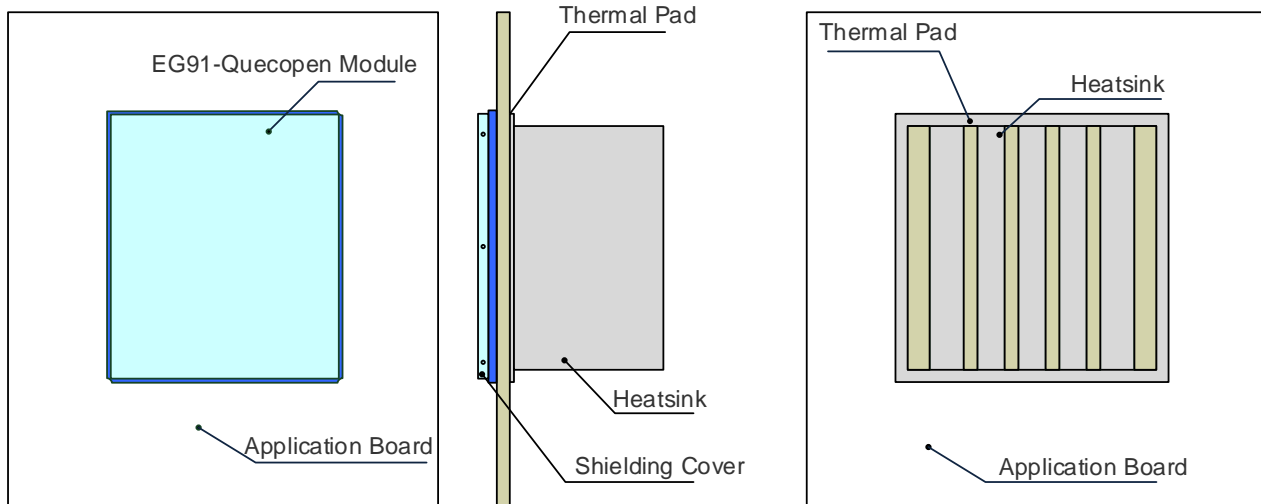


Figure 39: Referenced Heatsink Design (Heatsink at the Backside of Customers' PCB)

NOTES

1. The module offers the best performance when the internal BB chip stays below 105°C. When the maximum temperature of the BB chip reaches or exceeds 105°C, the module works normal but provides reduced performance (such as RF output power, data rate, etc.). When the maximum BB chip temperature reaches or exceeds 115°C, the module will disconnect from the network, and it will recover to network connected state after the maximum temperature falls below 115°C. Therefore, the thermal design should be maximally optimized to make sure the maximum BB chip temperature always maintains below 105°C. Customers can execute related software command or API to get the maximum BB chip temperature from the returned value.
2. For more detailed guidelines on thermal design, please refer to **document [6]**.

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in mm. The tolerances for dimensions without tolerance values are $\pm 0.05\text{mm}$.

7.1. Mechanical Dimensions of the Module

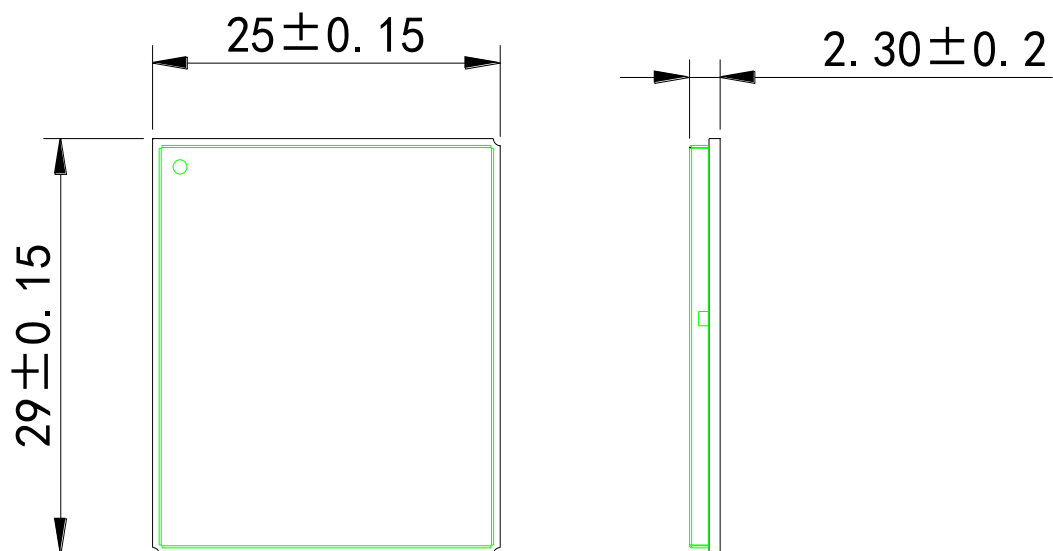


Figure 40: Module Top and Side Dimensions

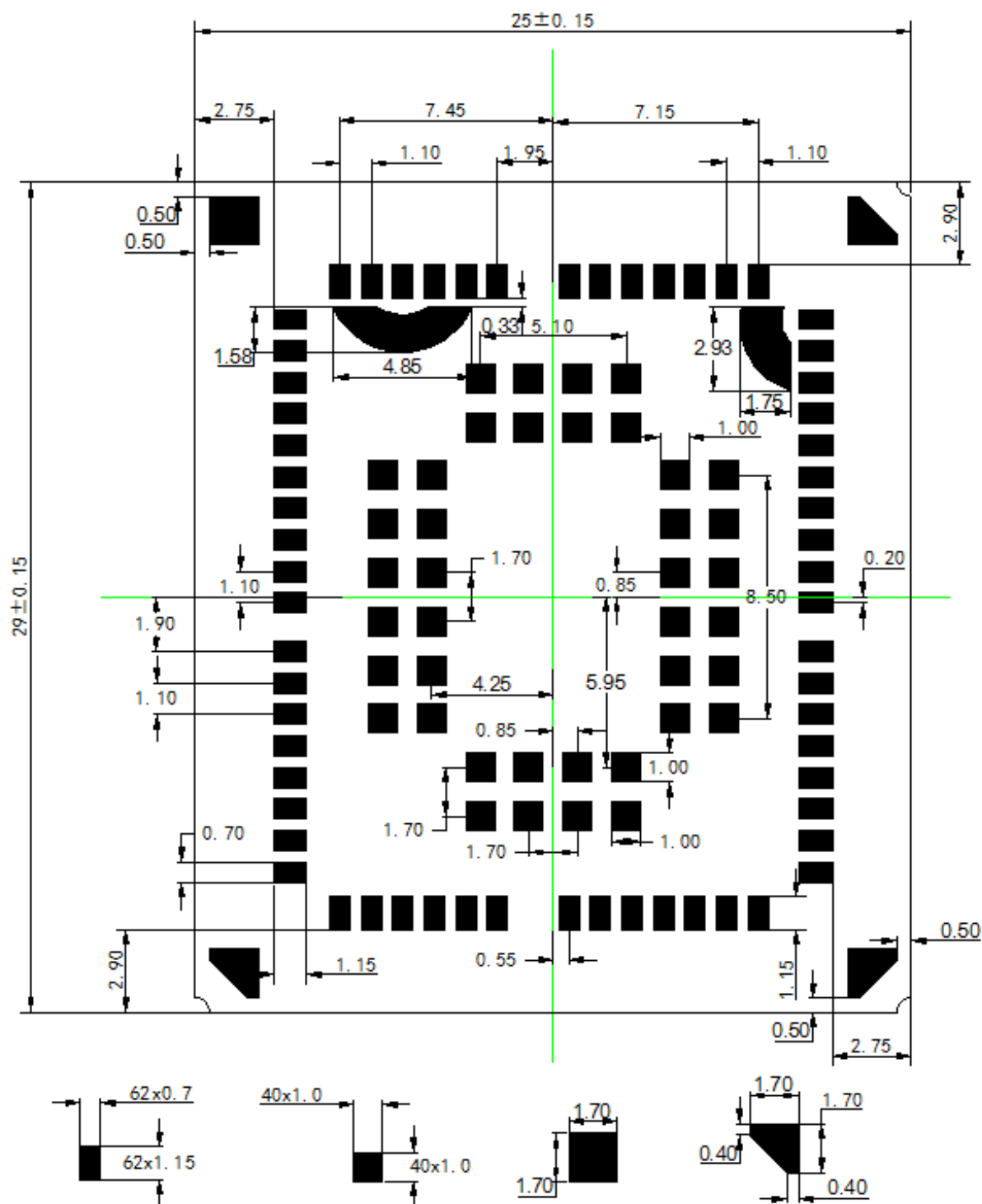


Figure 41: Module Bottom Dimensions (Top View)

7.2. Recommended Footprint

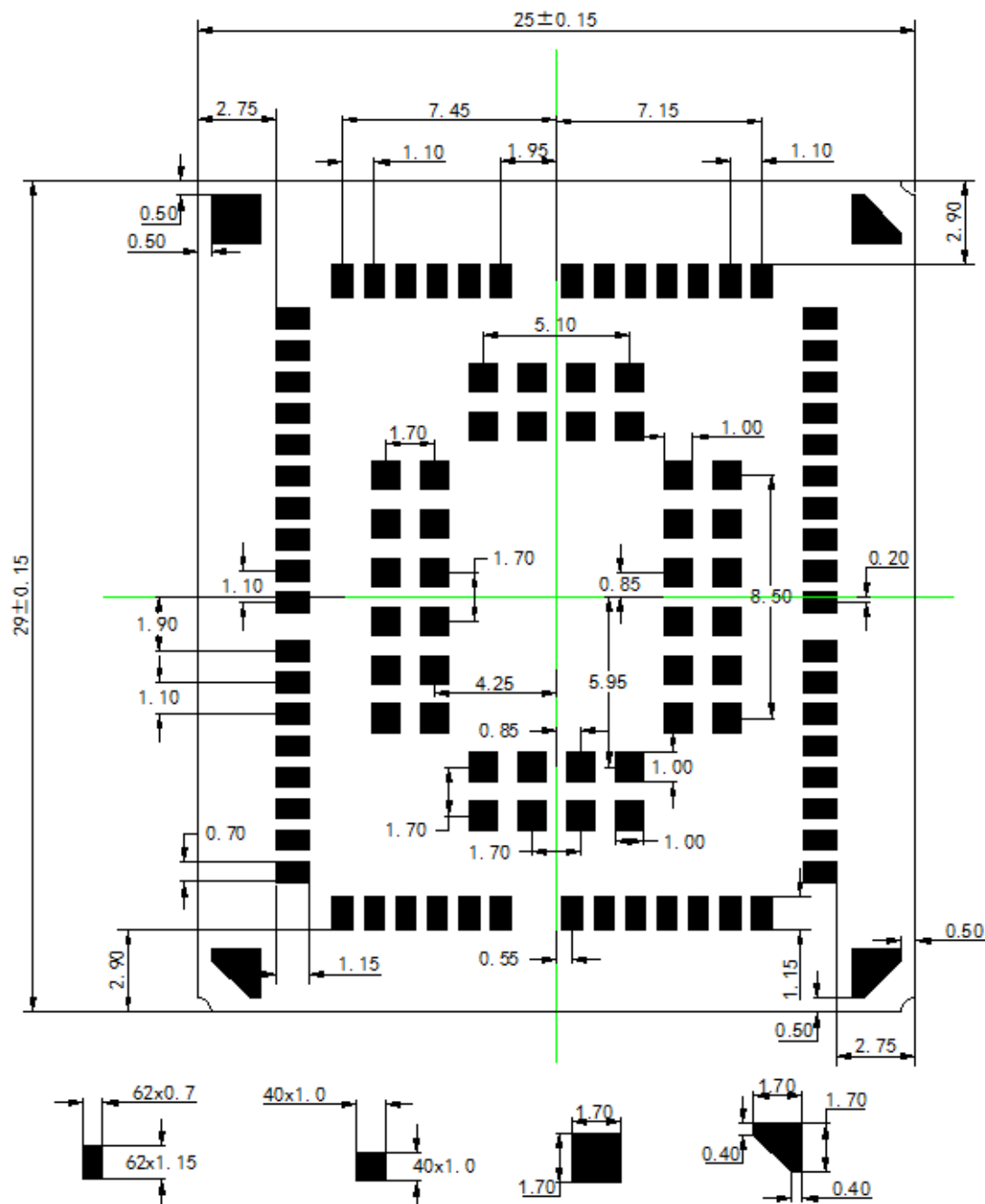


Figure 42: Recommended Footprint (Top View)

NOTE

For easy maintenance of the module, please keep about 3mm between the module and other components in the host PCB.

7.3. Design Effect Drawings of the Module



Figure 43: Top View of the Module

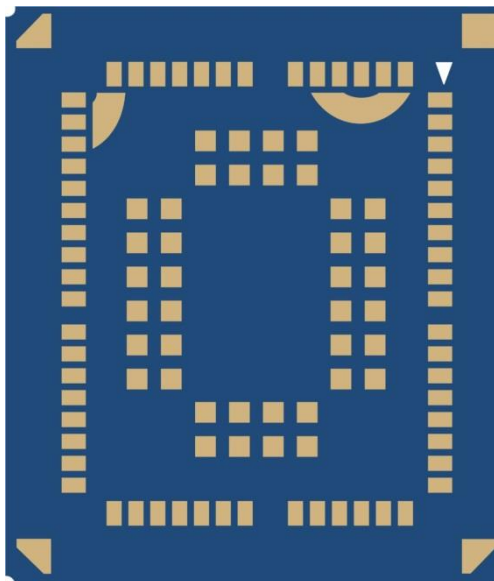


Figure 44: Bottom View of the Module

NOTE

These are design effect drawings of EG91-Quecopen module. For more accurate pictures, please refer to the module that you get from Quectel.

8 Storage, Manufacturing and Packaging

8.1. Storage

EG91-Quecopen is stored in a vacuum-sealed bag. It is rated at MSL 3, and its storage restrictions are listed below.

1. Shelf life in vacuum-sealed bag: 12 months at <40°C/90%RH.
2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high temperature processes must be:
 - Mounted within 168 hours at the factory environment of $\leq 30^{\circ}\text{C}/60\%\text{RH}$.
 - Stored at <10% RH.
3. Devices require bake before mounting, if any circumstances below occurs:
 - When the ambient temperature is $23^{\circ}\text{C}\pm 5^{\circ}\text{C}$ and the humidity indicator card shows the humidity is >10% before opening the vacuum-sealed bag.
 - Device mounting cannot be finished within 168 hours at factory conditions of $\leq 30^{\circ}\text{C}/60\%\text{RH}$.

If baking is required, devices may be baked for 8 hours at $120^{\circ}\text{C}\pm 5^{\circ}\text{C}$.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (120°C) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

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. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.15mm~0.18mm. For more details, please refer to **document [4]**.

It is suggested that the peak reflow temperature is 240°C~245°C, and the absolute maximum reflow temperature is 245°C. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted 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.

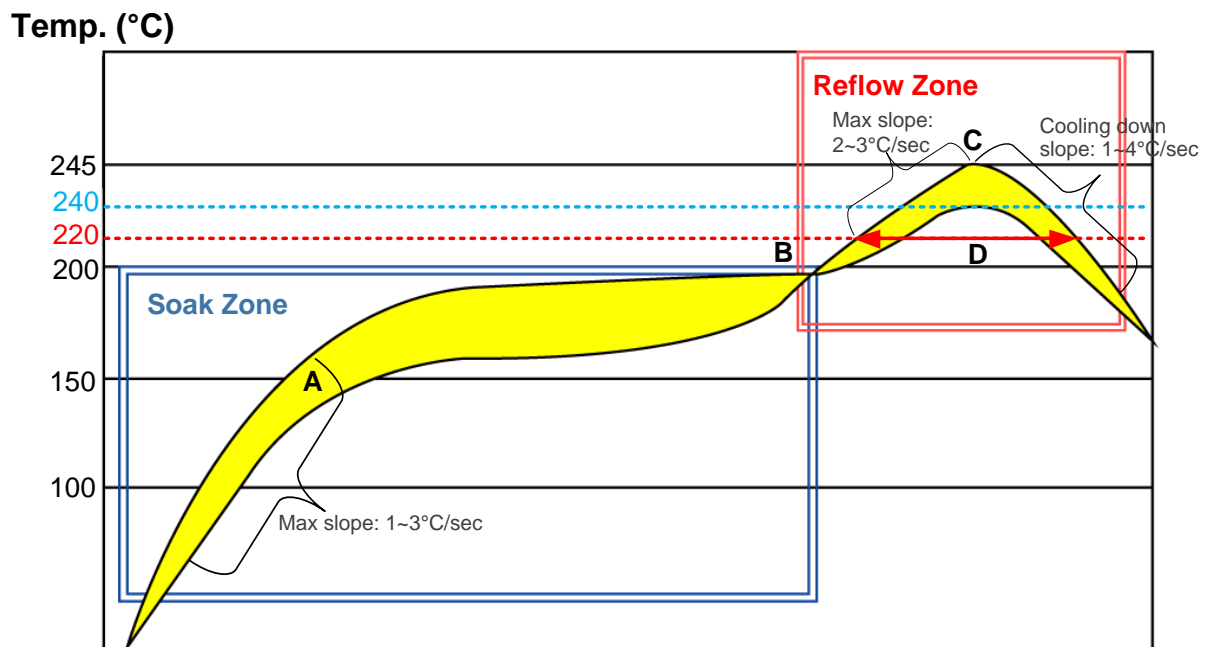


Figure 45: Reflow Soldering Thermal Profile

Table 44: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec

Reflow Zone

Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	240°C ~ 245°C
Cooling down slope	1 to 4°C/sec

Reflow Cycle

Max reflow cycle	1
------------------	---

8.3. Packaging

EG91-Quecopen is packaged in a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application.

The reel is 330mm in diameter and each reel contains 250pcs modules. The following figures show the packaging details, measured in mm.

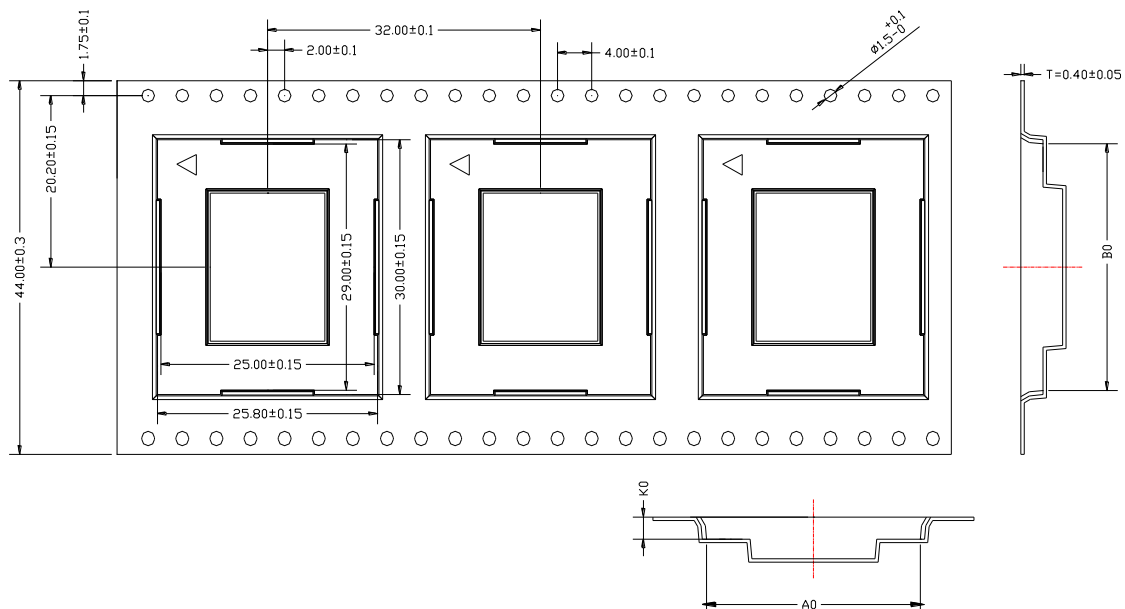


Figure 46: Tape Dimensions

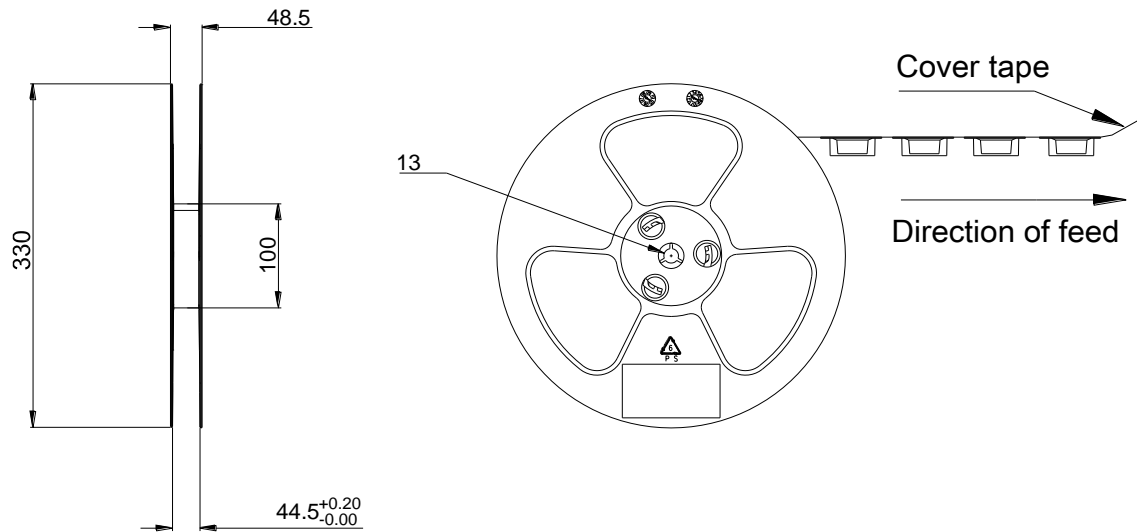


Figure 47: Reel Dimensions

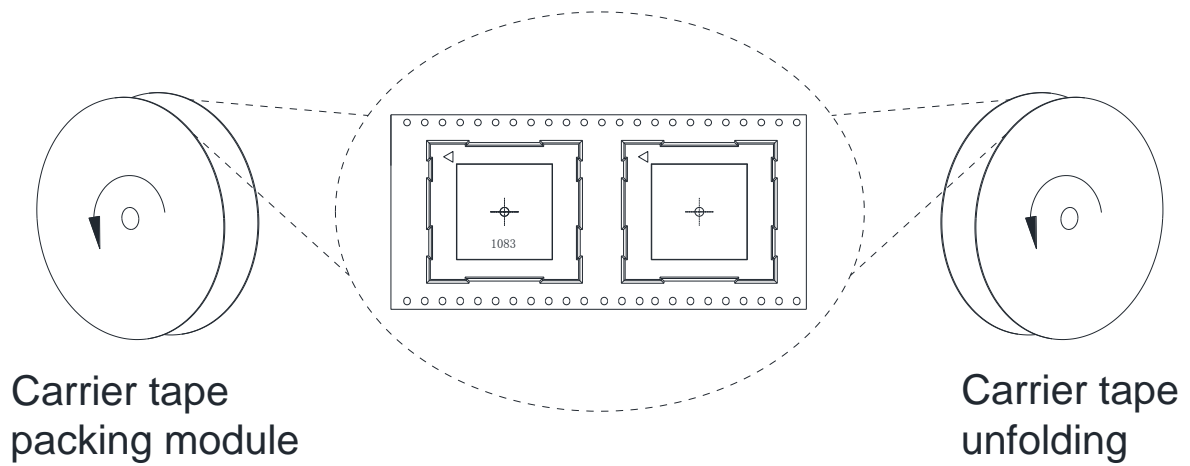


Figure 48: Tape and Reel Directions

9 Appendix A References

Table 45: Related Documents

SN	Document Name	Remark
[1]	Quectel_EC2x&EG9x&EM05_Power_Management_Application_Note	Power Management Application Note for EC25, EC21, EC20 R2.0, EC20 R2.1, EG95, EG91 and EM05
[2]	Quectel_EG9x_AT_Commands_Manual	AT Commands Manual for EG95 and EG91
[3]	Quectel_EC25&EC21_GNSS_AT_Commands_Manual	GNSS AT Commands Manual for EC25 and EC21 modules
[4]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[5]	Quectel_RF_Layout_Application_Note	RF Layout Application Note
[6]	Quectel_LTE_Module_Thermal_Design_Guide	Thermal design guide for LTE modules including EC25, EC21, EC20 R2.0, EC20 R2.1, EG91, EG95, EG25-G, EP06, EG06, EM06 and AG35.

Table 46: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
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
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
I/O	Input/Output
Inorm	Normal Current
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
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
PPP	Point-to-Point Protocol
PMD	Power Management Device
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
Rx	Receive
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
V _{max}	Maximum Voltage Value
V _{norm}	Normal Voltage Value
V _{min}	Minimum Voltage Value
V _{IHmax}	Maximum Input High Level Voltage Value
V _{IHmin}	Minimum Input High Level Voltage Value
V _{ILmax}	Maximum Input Low Level Voltage Value
V _{ILmin}	Minimum Input Low Level Voltage Value
V _{imax}	Absolute Maximum Input Voltage Value
V _{imin}	Absolute Minimum Input Voltage Value
V _{Oax}	Maximum Output High Level Voltage Value

V _{OHmin}	Minimum Output High Level Voltage Value
V _{OLmax}	Maximum Output Low Level Voltage Value
V _{OLmin}	Minimum Output Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access

10 Appendix B GPRS Coding Schemes

Table 47: Description of Different Coding Schemes

Scheme	CS-1	CS-2	CS-3	CS-4
Code Rate	1/2	2/3	3/4	1
USF	3	3	3	3
Pre-coded USF	3	6	6	12
Radio Block excl.USF and BCS	181	268	312	428
BCS	40	16	16	16
Tail	4	4	4	-
Coded Bits	456	588	676	456
Punctured Bits	0	132	220	-
Data Rate Kb/s	9.05	13.4	15.6	21.4

11 Appendix C GPRS Multi-slot Classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependent, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3+1 or 2+2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications.

The description of different multi-slot classes is shown in the following table.

Table 48: GPRS Multi-slot Classes

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
13	3	3	NA
14	4	4	NA

15	5	5	NA
16	6	6	NA
17	7	7	NA
18	8	8	NA
19	6	2	NA
20	6	3	NA
21	6	4	NA
22	6	4	NA
23	6	6	NA
24	8	2	NA
25	8	3	NA
26	8	4	NA
27	8	4	NA
28	8	6	NA
29	8	8	NA
30	5	1	6
31	5	2	6
32	5	3	6
33	5	4	6

12 Appendix D EDGE Modulation and Coding Schemes

Table 49: EDGE Modulation and Coding Schemes

Coding Scheme	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	GMSK	/	9.05kbps	18.1kbps	36.2kbps
CS-2:	GMSK	/	13.4kbps	26.8kbps	53.6kbps
CS-3:	GMSK	/	15.6kbps	31.2kbps	62.4kbps
CS-4:	GMSK	/	21.4kbps	42.8kbps	85.6kbps
MCS-1	GMSK	C	8.80kbps	17.60kbps	35.20kbps
MCS-2	GMSK	B	11.2kbps	22.4kbps	44.8kbps
MCS-3	GMSK	A	14.8kbps	29.6kbps	59.2kbps
MCS-4	GMSK	C	17.6kbps	35.2kbps	70.4kbps
MCS-5	8-PSK	B	22.4kbps	44.8kbps	89.6kbps
MCS-6	8-PSK	A	29.6kbps	59.2kbps	118.4kbps
MCS-7	8-PSK	B	44.8kbps	89.6kbps	179.2kbps
MCS-8	8-PSK	A	54.4kbps	108.8kbps	217.6kbps
MCS-9	8-PSK	A	59.2kbps	118.4kbps	236.8kbps