Re-imagining Cellular IoT Solutions

Cavli C42QM LTE CAT M1/NB2 and EGPRS Module

Hardware Manual

Pre-release Version 1.4

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Version History

Version	Description	Release Date
1.0	• Initial Version	28/06/2023
1.1	• Updated entire document as per the new updated design.	23/08/2023
1.2	• Updated the Pin Interface as per the new design. • Updated Voltage definition tables	20/11/2023
1.3	• Updated the Pin layout into Top view • Updated the USB Interface Circuit Diagram • Updated the USIM Interface Circuit Diagram • Updated the GNSS Antenna reference Circuit	01/12/2023
1.4	• Updted Pin Interface as per the new design	25/07/2024

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1 Introduction

This document is the **Hardware Manual** of Cavli Wireless solution product C42QM Smart Module, which describes:

- ✓ The hardware composition and functional features of the module
- ✓ The definition and usage of the application interface
- ✓ The electrical performance and mechanical properties of the module

This document and the other application documents combined will enable users to develop end devices with Cavli Modules.

2 Module overview

2.1 Introduction

C42QM module is an LTE M1/NB1/NB2/EGPRS based wireless communication module for the Internet of things. It is a highly integrated System-in-a-Chip (SoC) Module designed to support LTE CAT-M1 (eMTC) and CAT-NB1/NB2 (NB-IoT) and EGPRS. It includes RAM memory and integrates Customized single core application processor Arm Cortex-A7 CPU and radio transceivers as well as an impressive array of peripherals for connectivity. It supports concurrent operation of LTE. It is encapsulated for LGA with 102 pins, and the structure size of the module is 26.5mm*22.5mm*2.3mm.

C42QM has an Integrated multi constellation GNSS receiver supports *GPS/GLONASS/BeiDou and Galileo*. C42QM is capable of simultaneous multiband/multi-mode wireless connection with on-chip RF transceiver, which results in seamless broadband. Due to the complete RF/BB integrated architecture and power optimized dedicated micro controller for sensor hub, C42QM can deliver ultra-low power consumption and smaller form factor design and fit into the Internets of things applications.

The C42QM module can be used in the following applications:

- ✓ Vehicle equipment
- ✓ Smart city (intelligent parking, water / gas meter, streetlamp, smoke alarm, garbage bin, etc.)
- ✓ Intelligent medical treatment
- ✓ Industrial and agricultural intelligent monitoring (machine alarm, gas detection, irrigation, soil pH value, etc.)
- ✓ Smart home

2.2 Module characteristics

Table 1 Characteristic Table

Characteristic	Description
Physical properties	26.5mm*22.5mm*2.3mm
Application processor	Arm Cortex-A7 up to 800 MHz with 256 KB L2 cache
Working voltage	3.4V – 4.2V Typical Voltage 3.7 V
Application interface	✓ Standard SIM interface, support 3.0V/1.8V, support hot-swapping function ✓ USB2.0 (High-Speed) Hardware reset interface UART serial interface PCM & I2S interface ✓ Power interface ✓ Network status indication interface GPIO interface ✓ ADC ✓ GPIO ✓ SPI
Operating frequency band	LTE CAT-M1, NB1 and NB2 Bands: LB: B5, B8, B12, B13, B14, B18, B19, B26, B20, B28, B72, B73 and B85 MB: B1, B2/B25, B3 and B4/B66 GSM: Quad band
Data service	✓ LTE CAT M1: 588Kbps (DL), 1119Kbps (UL) ✓ LTE CAT NB2: 127Kbps (DL), 158.5Kbps (UL) ✓ LTE CAT NB1: 34/19.7 Kbps (DL/single-tone UL), 34/66.6 Kbps (DL/multi-tone UL)
Satellite positioning	*GPS/GLONASS/BeiDou/Galileo*
GNSS Interface	GNSS Antenna interface
SMS	✓ Support Text and PDU patterns ✓ Support point - to - point MO and MT SMS storage: USIM card /ME (default)
Operating temperature	Normal working temperature –35°C to +75°C
AT command	Supports standard AT Command (3GPP TS 27.007.27.005)

NOTE

- The C42QM module recommends working at - 35°C to +75°C environment. It is suggested that the application terminal adopt temperature control measures under harsh conditions. At the same time, some RF indexes may exceed the limit. At the same time, it is suggest11111ed to be stored under a certain temperature
- When the temperature is in the range of −40°C to −30°C or +75°C to +85°C, some RF specifications of the C42QM module may not meet the 3GPP standards.

2.3 Module function

C42QM module contains the following circuit elements:

- ✓ Baseband processing unit
- ✓ Power management unit
- ✓ Memory unit
- ✓ RF transceiver unit
- ✓ RF front-end unit
- ✓ GPS RF receiving unit

C42QM module functional block diagram is as follows,

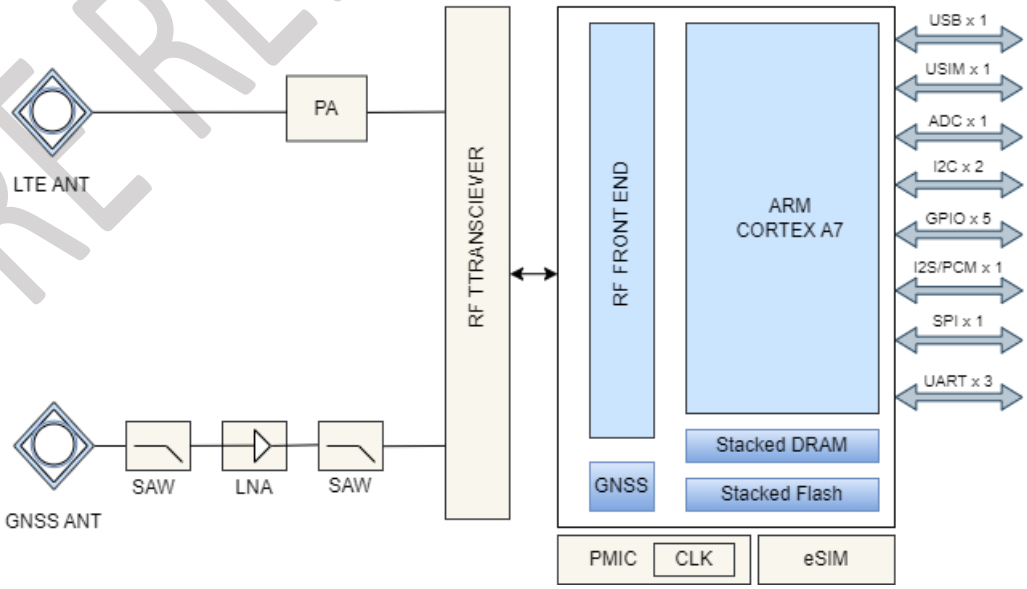


Figure 1 Functional block diagram of the C42QM module

2.4 Module Working Mode

Table 2 Module working Mode

Working mode	Description
Turn off the machine	In the case of shutdown, the module is fully powered off.
Flight Mode	The module closes the module RF circuit, unable to interact with the network.
Dormancy	The module closes most functions, and it will synchronize with the network.
Ideal state	Turn on the machine and register the network successfully, in the idle state
Data transmission	The module is in working state and has data interaction with the network.

3 Interface application description

3.1 Chapter Overview

This chapter mainly describes the interface definition and application of this module. It contains the following sections:

- Module interface
- Power interface
- Switching machine reset mode
- USB interface
- UART interface
- USIM interface
- General purpose GPIO interface
- Network status indication interface
- Module status indication
- PCM interface
- I2C bus
- ADC interface
- SPI

3.2 Module interface

3.2.1 C42QM Pin layout

C42QM pins are assigned as follows：

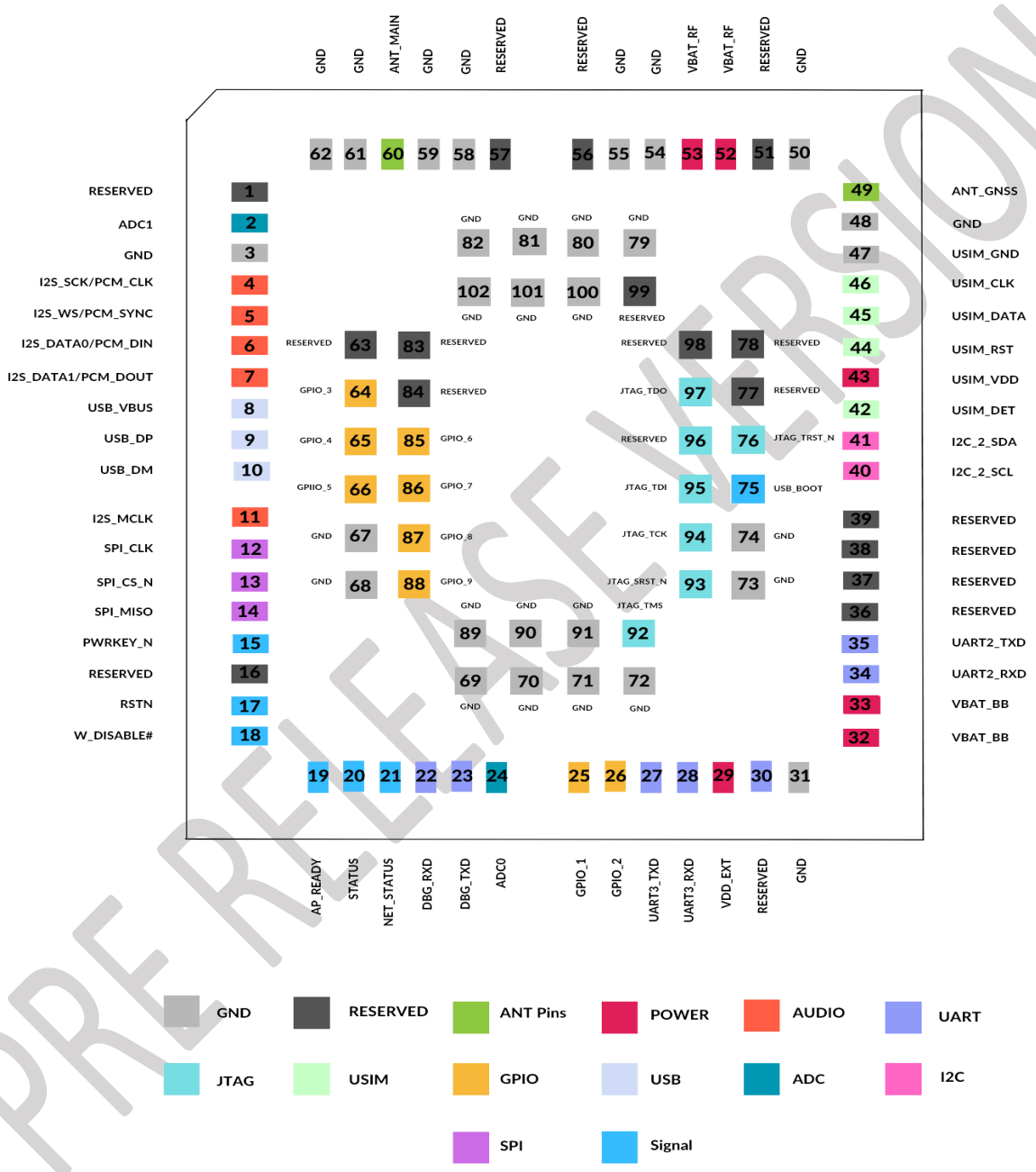


Figure 2 C42QM module Interface definition (Top view)

NOTE

- All RESERVED and unused pins are to be left floating.

3.2.2 C42QM Pin interface

The C42QM module has the LGA interface. The module interface definition is shown in the following table

Table 3 I/O Parameter Definition

Type	Description
PAD ATTRIBUTE	
IO	Two-way input and output
PI	Power input
PO	Power Output
AI	Analog input
AO	Analog output
DI	Digital input
DO	Digital output
OD	Leaky open circuit
RF_I	Radio Frequency Input
RF_IO	Bidirectional Radio Frequency Input/Output

3.2.3 Absolute maximum Ratings

The absolute maximum ratings table reflects the stress levels that, if exceeded, may cause permanent damage to the device. No functionality is guaranteed outside the operating specifications. Functionality and reliability are only guaranteed within the operating conditions described in Operating conditions.

Table 4 Absolute Maximum ratings

Pin Type	V_min	V_max
P3	-0.3V	2.09V
VB	3.4V	4.2V

3.2.4 Operating Conditions

The operating voltages are listed below.

Table 5 Operating Conditions

Pin Type	V_min (if applicable)	V_typical	V max (if applicable)
P3	1.65V	1.8V	1.95V
P5	-	1.8V	-
VB	3.4V	3.7V	4.2V

Table 6 Pin Assignment

Pin No.	Pin Name	IO Type	Voltage Definition	Pin Description	Comments
1	RESERVED	-	-	Do not connect	-
2	ADC1	AI	P3	Analog to digital Converter	-
3	GND	GND	-	Ground Pin	-
4	I2S_SCK/PCM_CLK	DO	P3	PCM clock	-
5	I2S_WS/PCM_SYNC	DO	P3	PCM data frame synchronization signal	-
6	I2S_DATA0/PCM_DIN	DI	P3	PCM data input	-
7	I2S_DATA1/PCM_DOUT	DO	P3	PCM data output	-
8	USB_VBUS	PI	-	USB connection detection	-
9	USB_DP	AIO	-	Differential Data bus (+)	-

10	USB_DM	AIO	-	Differential Data bus (-)	-
11	I2S_MCLK	DIO	P3	I2S Master clock	-
12	SPI_CLK	DO	P3	SPI Clock	-
13	SPI_CS_N	DO	P3	Slave select	-
14	SPI_MISO	DI	P3	Master input slave output	-
15	PWRKEY_N	DI	P3	Powe ON trigger	-
16	SPI_MOSI	DO	-	Master output slave input	-
17	RSTN	DI	P3	Reset the module	-
18	W_DISABLE#	DI	P3	Flight mode control	-
19	AP_READY	DI	P3	Wake up Interrupt	-
20	STATUS	DO	P3	Module power on status indication	-
21	NET_STATUS	DO	P3	Network status indication	-
22	DBG_RXD	DI	-	Debug UART reception	-
23	DBG_TXD	DO	-	Debug UART transmission	-
24	ADC0	AI	P3	Generic ADC	-
25	GPIO1	DIO	P3	Configurable I/O Pin	-
26	GPIO2	DIO	P3	Configurable I/O Pin	-
27	UART3_TXD	DO	P3	UART3 transmission	-
28	UART3_RXD	DI	P3	UART3 reception	-
29	VDD_EXT	DO	P3	Reference Voltage	-
30	RESERVED	-	-	Do not connect	-
31	GND	GND	-	Ground Pin	-
32	VBAT_BB	PI	VB	Input power	-
33	VBAT_BB	PI	VB	Input power	-

34	UART2_RXD	DI	P3	UART2 reception	-
35	UART2_TXD	DO	P3	UART2 transmission	-
36	RESERVED	-	-	Do not connect	-
37	RESERVED	-	-	Do not connect	-
38	RESERVED	-	-	Do not connect	-
39	RESERVED	-	-	Do not connect	-
40	I2C2_SCL	DO	P3	I2C2 clock signal	-
41	I2C2_SDA	DIO	P3	I2C3 data signal	-
42	USIM_DET	DI	P5	USIM detection	-
43	USIM_VDD	PO	P5	USIM power supply	-
44	USIM_RST	DIO	P5	USIM reset	-
45	USIM_DATA	DIO	P5	USIM Data	-
46	USIM_CLK	DIO	P5	USIM clock	-
47	USIM_GND	GND	-	Ground Pin	-
48	GND	GND	-	Ground Pin	-
49	ANT_GNSS	RF_I	-	GNSS Antenna	50Ω impedance
50	GND	GND	-	Ground Pin	-
51	RESERVED	-	-	Do not connect	-
52	VBAT_RF	PI	VB	Power supply for module's RF part	-
53	VBAT_RF	PI	VB	Power supply for module's RF part	-
54	GND	GND	-	Ground Pin	-
55	GND	GND	-	Ground Pin	-
56	RESERVED	-	-	Do not connect	-

57	RESERVED	-	-	Do not connect	-
58	GND	GND	-	Ground Pin	-
59	GND	GND	-	Ground Pin	-
60	ANT_MAIN	RF_IO	-	Main Antenna	50Ω impedance
61	GND	GND	-	Ground Pin	-
62	GND	GND	-	Ground Pin	-
63	RESERVED	-	-	Do not connect	
64	GPIO3	DIO	P3	Configurable I/O Pin	-
65	GPIO4	DIO	P3	Configurable I/O Pin	-
66	GPIO5	DIO	P3	Configurable I/O Pin	-
67	GND	GND	-	Ground Pin	-
68	GND	GND	-	Ground Pin	-
69	GND	GND	-	Ground Pin	-
70	GND	GND	-	Ground Pin	-
71	GND	GND	-	Ground Pin	-
72	GND	GND	-	Ground Pin	-
73	GND	GND	-	Ground Pin	-
74	GND	GND	-	Ground Pin	-
75	USB_BOOT	DO	P3	Indicate the module's network activity status	-
76	JTAG_TRST_N	DI	P3	JTAG Test Reset	-
77	RESERVED	-	-	Do not connect	-
78	RESERVED	-	-	Do not connect	-
79	GND	GND	-	Ground Pin	-

80	GND	GND	-	Ground Pin	-
81	GND	GND	-	Ground Pin	-
82	GND	GND	-	Ground Pin	-
83	RESERVED	-	-	Do not connect	-
84	RESERVED	-	-	Do not connect	-
85	GPIO6	DIO	P3	Configurable I/O Pin	-
86	GPIO7	DIO	P3	Configurable I/O Pin	-
87	GPIO8	DIO	P3	Configurable I/O Pin	-
88	GPIO9	DIO	P3	Configurable I/O Pin	-
89	GND	GND	-	Ground Pin	-
90	GND	GND	-	Ground Pin	-
91	GND	GND	-	Ground Pin	-
92	JTAG_TMS	DIO	P3	JTAG Module select input	-
93	JTAG_SRST_N	DI	P3	JTAG Reset for debug	-
94	JTAG_TCK	DI	P3	JTAG Clock input	-
95	JTAG_TDI	DI	P3	JTAG data input	-
96	RESERVED	-	-	-	-
97	JTAG_TDO	DO	P3	JTAG Data output	-
98	RESERVED	-	-	Do not connect	-
99	RESERVED	-	-	-	-
100	GND	GND	-	Ground Pin	-
101	GND	GND	-	Ground Pin	-
102	GND	GND	-	Ground Pin	-

3.3 Power Interface

The C42QM module power interface consists of three parts:

- ✓ **VBAT_BB** is the module working power supply
- ✓ **VBAT_RF** is the module RF power supply
- ✓ **VDD_EXT** is 1.8V output power

3.3.1 Power Supply Design

Table 7 Power Pin Definition

Power supply							
Pin no.	Definition	IO	Description	Remarks	Min	Typical	Max
32,33	VBAT_BB	PI	Baseband power supply		3.4V	3.7V	4.2V
52,53	VBAT_RF	PI	Radio frequency power supply		3.4V	3.7V	4.2V
43	USIM_VDD	PO	SIM card power supply		-	1.8V	-
29	VDD_EXT	PO	Output power supply	Output Voltage 1.8	-	1.8V	-
3,31,48,50,54,55,58,59, 61,62,67,68,69,70,71,72 ,73,74,79,80,81,82,89,9 0,91,100,101,102	GND		Ground		-	-	-

The C42QM module can be powered by a single power supply mode.

- ✓ The module has 4 channels of power supply, two VBAT_BB and two VBAT_RF pins.
- ✓ The module power supply range is between 3.4V - 4.2V
- ✓ Power supply current should be more than 1A.
- ✓ The external power supply is connected to the module from a single voltage source and can be expanded to two sub paths with star structure.
- ✓ The VBAT_BB line width should be within 1mm, and the VBAT_RF line width should not be less than 2mm.

3.4 Switching machine reset mode

3.4.1 Boot

The module can be turned on by pressing PWRKEY for at least 500ms. The user can check the same by querying the high and low levels of the VDD_EXT pin.

Table 8 Switch Pin Definition

Pin no.	Signal name	I/O	High value	Description
15	PWRKEY	DI	VBAT	Internal pull down to GND. Active high pin.

3.4.2 Turn Off

The module can be turned off by driving the PWRKEY low for at least 650 ms, the module will power off after the release of the PWRKEY.

3.4.3 Reset control

When the application end needs to reset the module, the RESET_N pin can be lowered for 100ms to 600ms. The external resistance of the pin is 10K. RESET_N pin is sensitive to interference and needs to stay away from the RF interference signal.

Table 9 Reset Foot Definition

Pin no.	Signal name	I/O	High value	Description
17	RSTN	DO	1.8V	Module reset control

3.5 USB interface

Table 10 Interface Pin Definition

Pin no.	Signal name	I/O	Description
9	USB_DP	AIO	USB differential signal +
10	USB_DM	AIO	USB differential signal -

Module as USB slave device, supporting USB dormancy and wakeup mechanism. The USB interface application reference circuit is as follows:

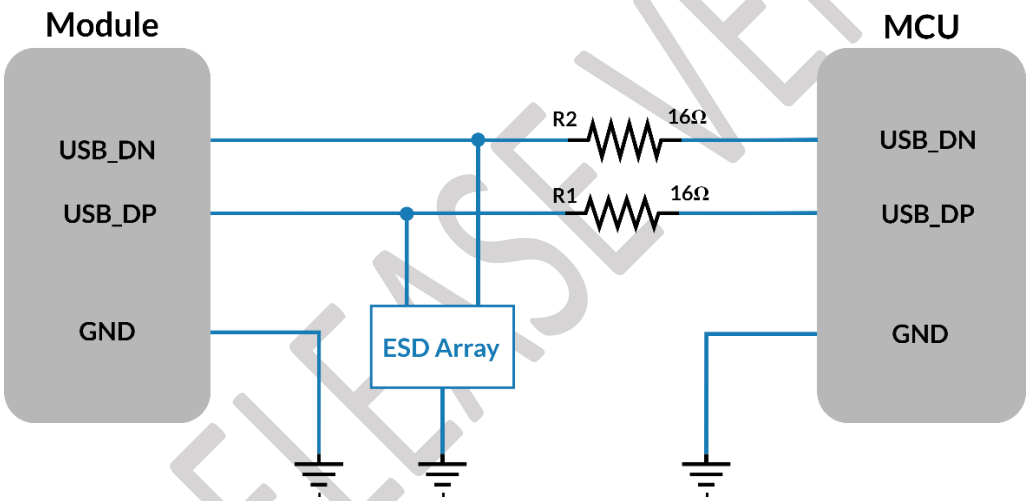


Figure 3 USB connection design circuit diagram

NOTE

- The trace design needs to strictly follow the USB2.0 protocol requirements, pay attention to the protection of the data line, differential trace, control impedance is 90Ω.
- In order to improve the antistatic performance of the USB interface, it is recommended to add an ESD protection device on the data line. The equivalent capacitance of the protection device is less than 2pF (Refer section 5.6)

3.6 UART interface

3.6.1 UART1 Serial Port (Debug UART)

Pin 22 and pin 23 of the module are UART1 serial port pins. UART1 serial ports can be used for debugging purposes. The pins are defined as follows:

Table 11 Debug Serial Port Pin Definition

Pin no.	Signal name	I/O	Description
22	DBG_RXD	DI	Data transmission
23	DBG_TXD	DO	Data Reception

3.6.1 UART2 Serial Port (AT UART)

The pins 35 and 34 of the module are UART2 serial port pins. UART2 serial interface is configured as the AT port. User can use this UART port for communication using AT commands.

Table 12 Debug Serial Port Pin Definition

Pin no.	Signal name	I/O	Description
35	UART2_TXD	DO	Data transmission
34	UART2_RXD	DI	Data Reception

3.6.1 UART3 Serial Port (GNSS UART)

The pins 27 and 28 of the module are UART2 serial port pins.This UART is used for obtaining GNSS NMEA data.

Table 13 GNSS Port Pin Definition

Pin no.	Signal name	I/O	Description
27	UART3_TXD	DO	Data transmission
28	UART3_RXD	DI	Data Reception

3.7 USIM interface

The C42QM module provides a USIM card interface. The USIM card power supply is provided by the module's internal power manager and supports 1.8V/3.0V

Table 12 SIM Card Signal Definition

Pin no.	Signal name	I/O	Description
42	USIM_DET	DIO	USIM detection
43	USIM_VDD	PO	USIM card power supply
45	USIM_DATA	DIO	USIM card data
46	USIM_CLK	DIO	USIM card clock
44	USIM_RST	DIO	USIM card reset

3.7.1 USIM card reference circuit

The C42QM module does not come with a USIM card slot. Users need to design a USIM card slot on their own interface board.

The USIM card interface reference circuit is as follows:

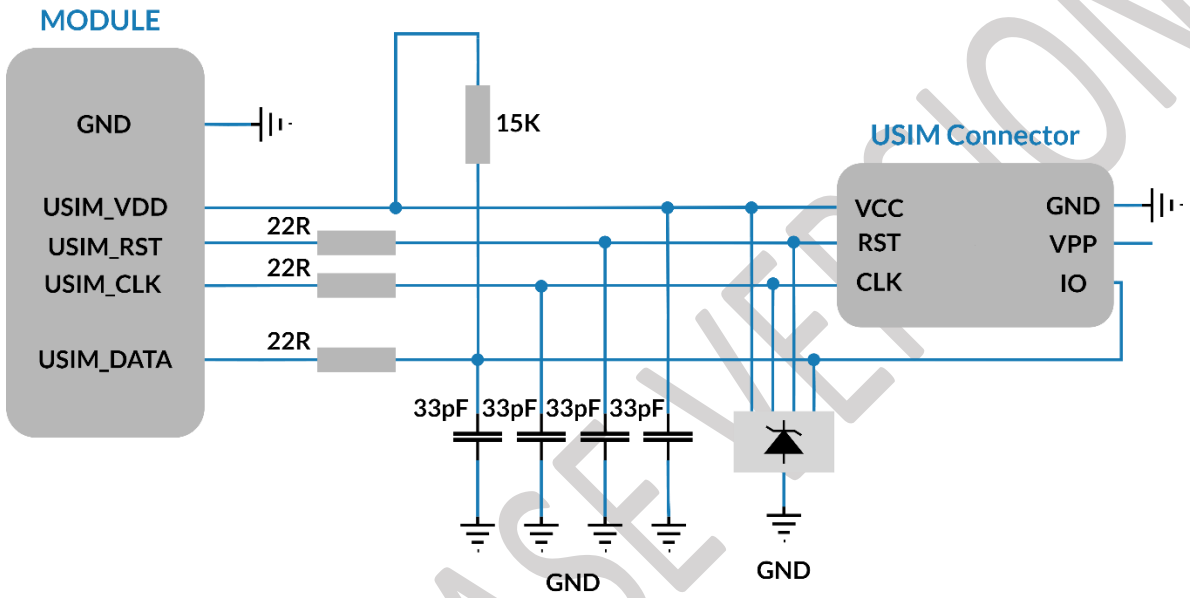


Figure 4 USIM design circuit diagram

NOTE

- The recommended USIM interface cable is ONSEMI's SMF15C device for ESD protection. The peripheral circuit components should be placed close to the card holder, and the SIM card holder is close to the module layout. (For details refer section *5.6*)
- The card slot and trace should be placed away from the RF, power supply and high-speed signal lines.
- The USIM_DATA has been internally pulled up to 1.8V (only resistor, use an external power source) through a 47K resistor, and no external pull-up is required.
- USIM_PRESENCE is high by default. The SIM card status can be detected by this PIN during hot plug application.
- To avoid transient voltage overload, the USIM interface requires a 22R resistor in series with each

other on the signal line path

- The ground of the USIM deck and the ground of the module should maintain good connectivity.

3.8 General purpose GPIO interface

The C42QM module contains five general control signals. The interface is defined as follows:

Table 13 General GPIO Pin Definition

Pin no.	Signal name	I/O	Description
25	GPIO1	DIO	General input / output port
26	GPIO2	DIO	General input / output port
64	GPIO3	DIO	General input / output port
65	GPIO4	DIO	General input / output port
66	GPIO5	DIO	General input / output port
85	GPIO6	DIO	General input / output port
86	GPIO7	DIO	General input / output port
87	GPIO8	DIO	General input / output port
88	GPIO9	DIO	General input / output port

3.9 Indication interface

The C42QM module provides an open-drain GPIO signal to indicate the status of the RF communication.

3.9.1 Network status

C42QM provides one network status 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 activity status.

Table 14 Network Indicator Pin Definition

Pin no.	Signal name	I/O	Description
21	NET_STATUS	DO	Network status indication

Table 15 Network Indication Status

Status	LED display status
No service	OFF
Module Searching for Network	Flashing
The module registers 4G network or module to registers non-4G network for voice SMS and other services (Latched on to Network)	Constantly bright

The LED network indicator reference design is as follows:

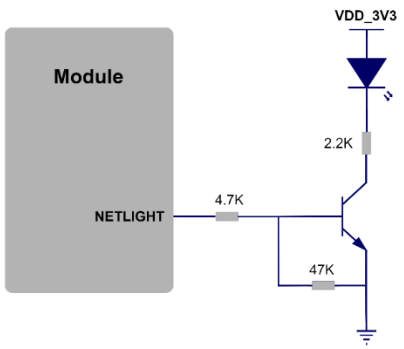


Figure 5 Net light circuit diagram

NOTE

- The brightness of the network indicator can be adjusted by adjusting the current limiting resistor, which can be adjusted to a maximum of 40 mA.

3.10 Control Interface

Table 16 Network Indication Status

Pin no.	Signal name	I/O	Description
19	AP-READY	DI	Sleep Interrupt control
18	W-DISABLE#	DI	Flight mode control

3.11 PCM/I2S interface

- ✓ C42QM provides one Pulse Code Modulation (PCM) / I2S interface.
- ✓ C42QM have common I2S and PCM interfaces, it can be used either as I2S or PCM.
- ✓ The module provides a set of hardware bidirectional serial buses with an I2S interface

Table 17 PCM/I2S Interface

Pin no.	Signal name	I/O	Description
7	I2S_DATA1/PCM_DOUT	DO	I2S/PCM data output
6	I2S_DATA0/PCM_DIN	DI	I2S/PCM data input
5	I2S_WS/PCM_SYNC	DO	I2S/PCM Frame sync clock pulse
4	I2S_SCK/PCM_CLK	DO	I2S/PCM bit clock pulse
11	I2S_MCLK	DIO	I2S bus clock output

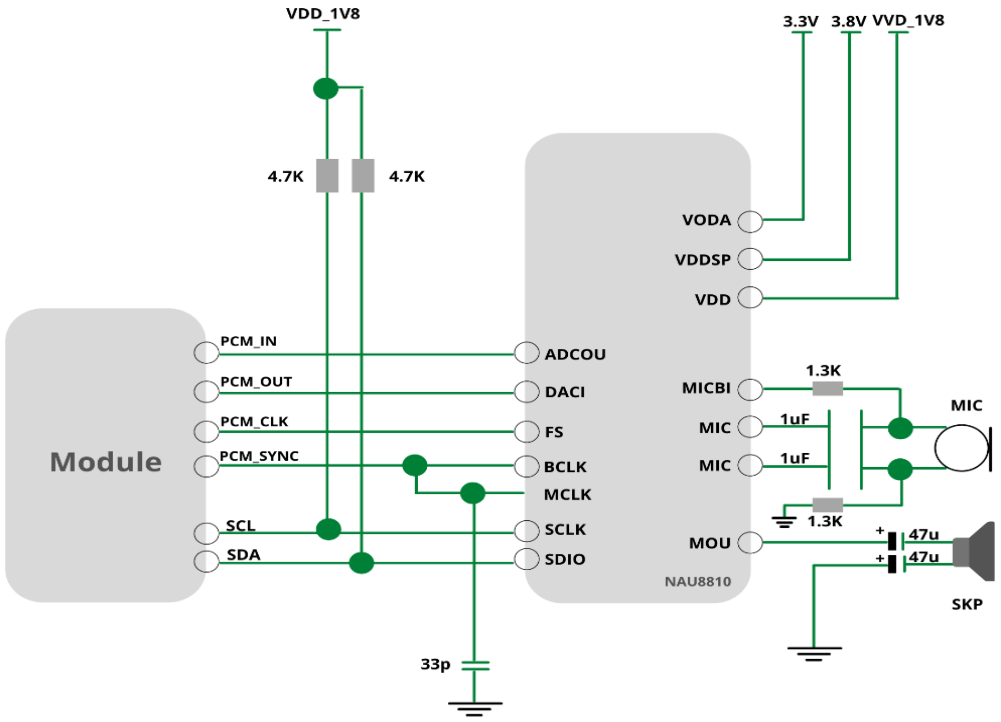


Figure 6 PCM to analog voice map

3.12 ADC interface

The C42QM provides two analog-to-digital converter interfaces to read the voltage value.

- ✓ The ADC interface input voltage cannot exceed VBAT
- ✓ It is recommended that the ADC pin be input with a voltage divider circuit

Table 18 ADC Pin Definitions

Pin no.	Signal name	IO	Description
24	ADC0	AI	Analog to digital converter interface 1
2	ADC1	AI	Analog to digital converter interface 2

3.13 SPI interface

Table 19 SPI Interface Pin Definition

Pin no.	Signal name	I/O	Description
13	SPI_CS_N	DO	Slave select
12	SPI_CLK	DO	Clock
16	SPI_MOSI	DO	Master output slave input
14	SPI_MISO	DI	Master input slave output

3.14 GNSS Interface

C42QM provides Global navigation satellite system (GNSS) whose pin description is given below.

Table 20 GNSS Pin Definition

Pin no.	Signal name	I/O	Description
49	ANT_GNSS	RF_I	GNSS antenna interface (50Ω impedance)

3.15 I2C BUS

The C42QM module provides a set of hardware bidirectional serial buses with an I2C interface of 1.8V level.

Table 19 I2C bus Definition

Pin no.	Signal name	I/O	Description
40	I2C_SCL	DO	I2C bus data clock output
41	I2C_SDA	DIO	I2C bus data output

3.15 JTAG Interface

Table 19 JTAG Interface Definition

Pin no.	Signal name	I/O	Description
76	JTAG_TRST_N	DI	JTAG Reset
93	JTAG_SRST_N	DI	JTAG Reset for debug
95	JTAG_TDI	DI	JTAG Data input
92	JTAG_TMS	DIO	JTAG Mode select input
97	JTAG_TDO	DO	JTAG Data output
94	JTAG_TCK	DI	JTAG Clock Input

Timing diagram for JTAG Interface as follows.

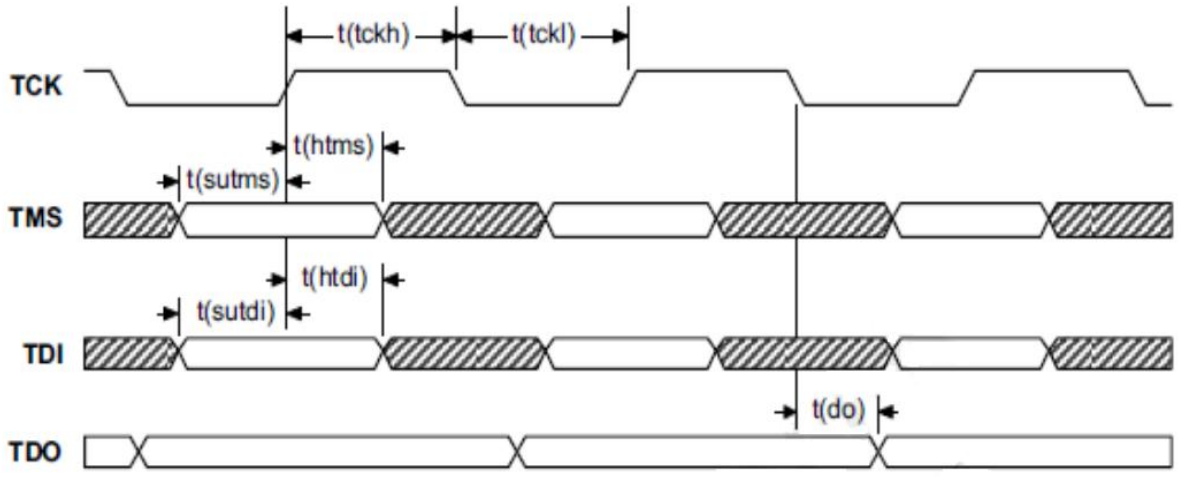


Figure 7 Timing diagram for JTAG interface

4 Antenna interface

4.1 Chapter overview

The C42QM module RF General Specifications contain the following sections:

- RF Interface
- GNSS reception performance
- Working frequency
- RF trace reference
- RF connector size

4.2 RF interface

The C42QM module provides two antenna interfaces,

Main Antenna Interface:

✓ Responsible for CAT M1/NB1/NB2/EGPRS signals of the transceiver module.

GNSS Antenna Interface:

✓ For GPS, GLONASS, Galileo, BeiDou, signal reception which can provide positioning solutions for users.

Table 21 Antenna Interface Pin Definition

Pin no.	Signal name	I/O	Description	Remarks
60	ANT_MAIN	RF_IO	Main antenna interface	50Ω wave impedance
49	ANT_GNSS	RF_I	GNSS antenna interface	50Ω wave impedance

4.2.1 Main antenna interface

In order to facilitate the antenna debugging, one need to add π-type matching circuit on the motherboard and take 50-ohm impedance line. The π-type matching components should be placed as close to the antenna as possible. Recommended circuit is as follows:

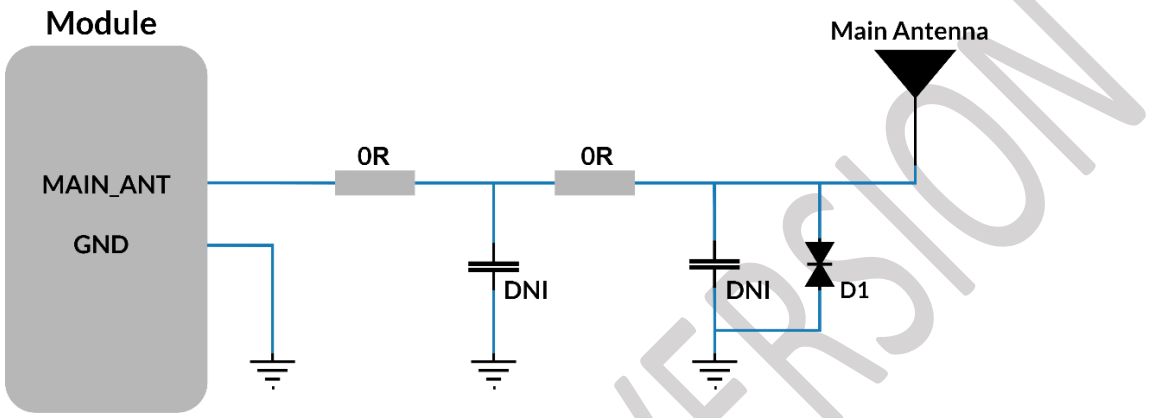


Figure 8 Main antenna circuit diagram

The main antenna requirements are tabulated below:

Table 22 Main Set Antenna Indicator Requirements

Frequency band	Standing wave ratio	Antenna gain	Effectiveness	TRP (in dBm)	TIS (in dBm)
B1 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B2 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B3 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B4 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B5 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B8 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94

B12 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B13 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B14 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B18 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B19 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B20 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B25 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B26 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B28 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B66 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B72 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B73 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B85 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93

4.2.2 GNSS Antenna interface

To use GNSS, you need to open the GPS with AT command AT+CGPS=1 (for details, please refer to C42QM AT command set manual)

- ✓ In order to facilitate the debugging of the antenna, it is necessary to add a π-type matching circuit to the main board, and to take a 50-ohm impedance line.
- ✓ The GNSS antenna needs to maintain a certain distance from the main antenna.
- ✓ The GNSS antenna has two antenna connection modes - Passive antenna mode and Active antenna mode.
- ✓ External power needs to be provided since the module itself cannot supply power to GNSS active ant

The recommended circuit is as follows:

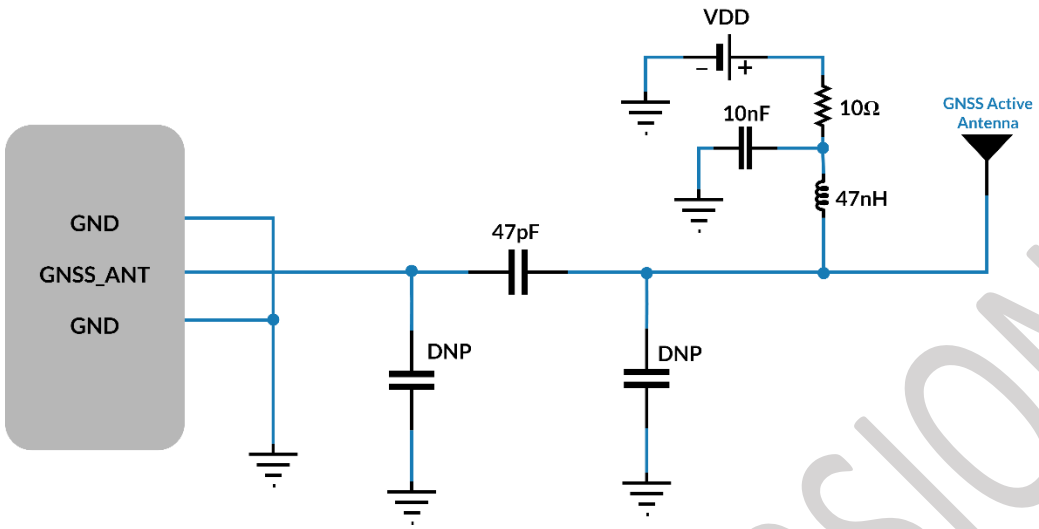


Figure 9 GNSS active antenna reference circuit

NOTE

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

The following table gives GNSS antenna requirements:

Table 23 GNSS Antenna Indicator Requirements

Frequency band	Standing wave ratio	Active antenna noise figure	Active antenna gain	Active antenna embedded LNA gain
GPS L1 1575.41+/1.023MHZ	<2:1	<1.5DB	>-2DBi	20DB
GLONASS 1597.5-1605.8MHZ	<2:1	<1.5DB	>-2DBi	20DB
BeiDou 1559.05-1563.14MHZ	<2:1	<1.5DB	>-2DBi	20DB
Galileo E1 1573.4-1577.5MHZ	<2:1	<1.5DB	>-2DBi	20DB

4.3 RF trace reference

- ✓ The impedance of the RF signal line is determined by
- ✓ The dielectric constant of the material
- ✓ The trace width (W)
- ✓ The ground clearance (S), and
- ✓ The height (H) of the reference ground plane.
- ✓ Use the impedance simulation tool to calculate the impedance of the RF trace.
- ✓ The control of the PCB's characteristic impedance is usually done in microstrip and coplanar waveguides.

The following are the reference designs of microstrip or coplanar waveguides:

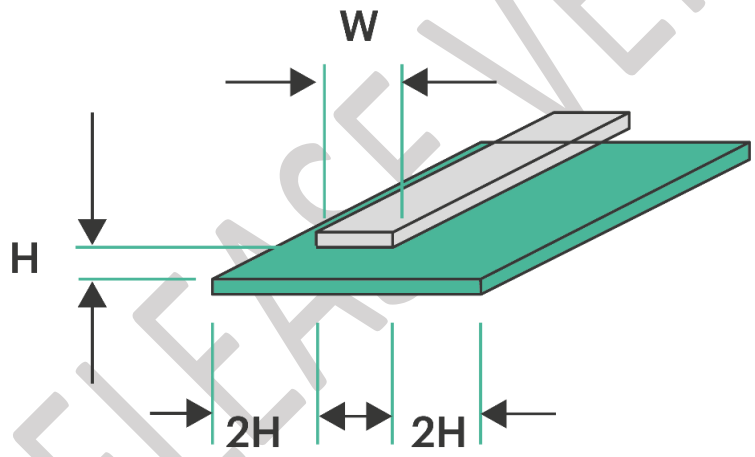


Figure 10 The complete structure of the two-layer PCB microstrip line

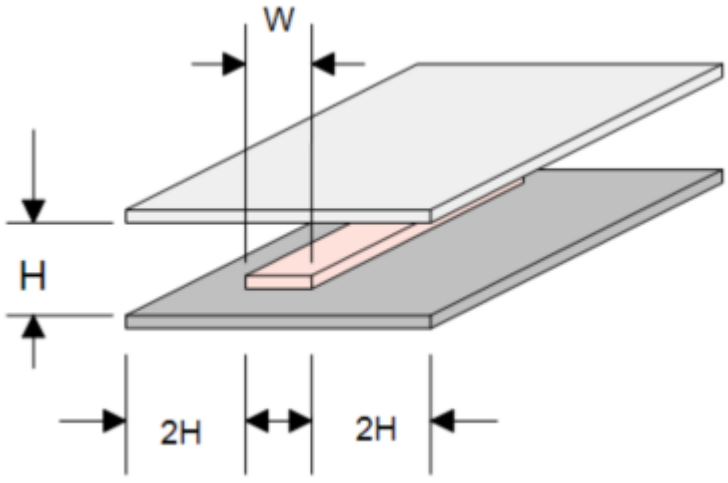


Figure 11 The complete structure of the multilayer PCB strip line

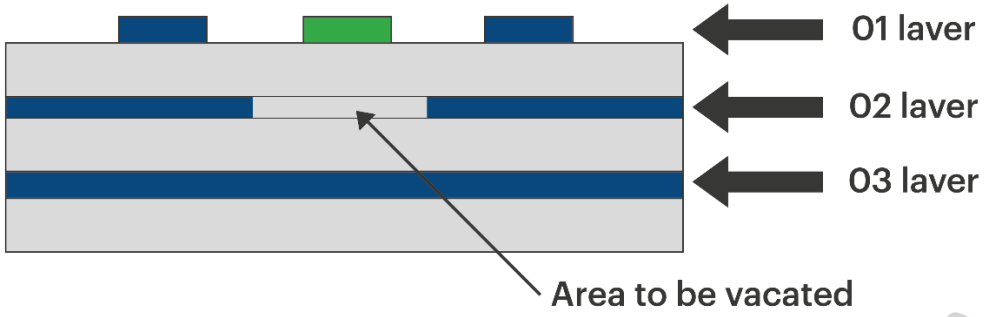


Figure 12 Reference ground is the third layer PCB coplanar transmission line structure

4.4 RF connector size

- ✓ If the RF connector is used, the antenna connector must use a coaxial connector with a 50ohm characteristic impedance.
- ✓ Hirose's U.FL-R-SMT connector is recommended.

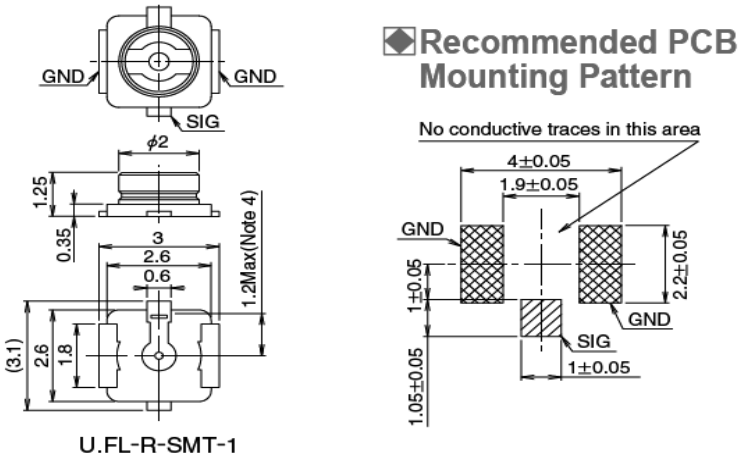


Figure 13 RF connector size chart

The RF connector plug for this connector is the U.FL-LP series from HRS.

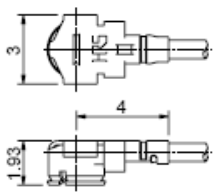
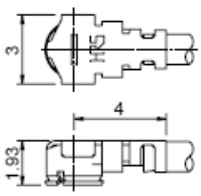
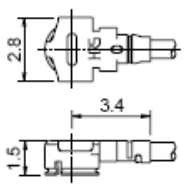
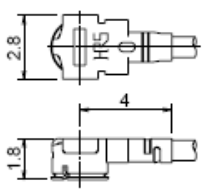
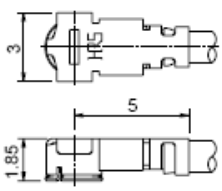
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 14 Antenna connector matching plug diagram

Table 24 Main Parameters of the RF Connector

Rated conditions		Environmental conditions
Frequency Range	DC to 6 GHZ	–40°C to +85°C
Characteristic impedance	50 Ω	–40°C to +85°C

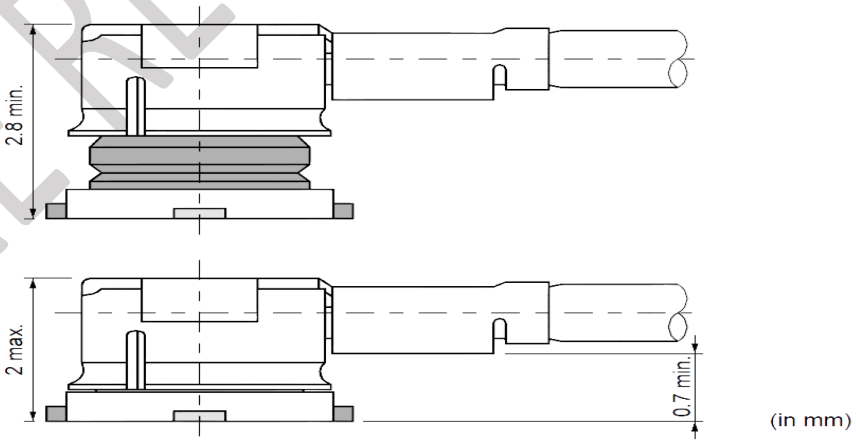


Figure 15 Matching coaxial RF line size

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

4.5 Working Frequency

Table 25 RF Frequency Table

Frequency band	Uplink frequency	Downstream frequency	Mode
LTE B1	1920 MHz–1980 MHz	2110 MHz–2170 MHz	FDD
LTE B2	1850 MHz–1910 MHz	1930 MHz–1990 MHz	FDD
LTE B3	1710 MHz–1785 MHz	1805 MHz–1880MHz	FDD
LTE B4	1710 MHz–1755 MHz	2110 MHz–2155 MHz	FDD
LTE B5	824 MHz–849 MHz	869 MHz–894 MHz	FDD
LTE B8	880 MHz–915 MHz	925 MHz–960 MHz	FDD
LTE B12	698 MHz–716 MHz	728 MHz–746 MHz	FDD
LTE B13	777 MHz–787 MHz	746 MHz–756 MHz	FDD
LTE B14	788 MHz - 798 MHz	788 MHz - 798 MHz	FDD
LTE B18	815 MHz–830 MHz	860 MHz–875 MHz	FDD
LTE B19	830 MHz–845 MHz	875 MHz–890 MHz	FDD
LTE B20	832 MHz– 862 MHz	791 MHz– 821 MHz	FDD
LTE B25	1850 MHz– 1915 MHz	1930 MHz– 1995 MHz	FDD
LTE B26	814 MHz– 849 MHz	859 MHz– 894 MHz	FDD
LTE B28	703 MHz– 748 MHz	758 MHz– 803 MHz	FDD
LTE B66	1710 MHz– 1780 MHz	2110 MHz– 2200 MHz	FDD
LTE B72	451MHz-456MHz	461MHz-466MHz	FDD

LTE B73	450MHz-455MHz	460MHz-465MHz	FDD
LTE B85	698MHz-716MHz	728MHz-746MHz	FDD

5 Interface electrical characteristics

5.1 Chapter overview

- Working storage temperature
- Module IO level
- Power supply
- Power consumption characteristics
- Electrostatic property
- Reliability index

5.2 Working storage temperature

Table 26 C42QM Module Working Storage Temperature

Parameter	Minimum value	Maximum value
Normal operating temperature	-30°C	75°C
	-40°C	85°C
Storage temperature	-55°C	150°C

5.3 Module IO level

The C42QM module IO levels are as follows:

Table 27 Electrical Characteristics of C42QM Module

Parameter	Description	Minimum value	Maximum value
VIH	High level input voltage	0.65* VDD_EXT	VDD_EXT+0.3V
VIL	Low level input voltage	-	0.35*VDD_EXT
VOH	High level output voltage	VDD_EXT-0.45V	VDD_EXT
VOL	Low level output voltage	0	0.45V

5.4 Power supply

The C42QM module input power requirements are as follows:

Table 28 C42QM Module Operating Voltage

Parameter	Minimum value	Typical value	Maximum value
Input voltage	3.1V	3.6V	4.2V

NOTE

- The power-on time of any interface of the module must not be earlier than the boot time of the module, otherwise the module may be abnormal or damaged.

5.5 Interface power requirements

5.5.1 UART

Table 29 UART Serial Power Definition

Name	Parameter	Voltage Level (V)		
		Min	Typical	Max
UART1_CTS	VOH	1.35	1.8	2
	VOL	0		0.45
UART1_RTS	VIH	1.2	1.8	2
	VIL	-0.3		0.6
UART1_TXD	VOH	1.35	1.8	2
	VOL	0		0.45
UART1_RXD	VIH	1.2	1.8	2
	VIL	-0.3		0.6
UART2_TXD	VOH	1.35	1.8	2
	VOL	0		0.45
UART2_RXD	VIH	1.2	1.8	2
	VIL	-0.3		0.6
UART3_TXD	VOH	1.35	1.8	2
	VOL	0		0.45
UART3_RXD	VIH	1.2	1.8	2
	VIL	-0.3		0.6

5.5.2 USIM

Table 30 SIM Card Power Definition

Signal name	Parameter	Level value (V)			Remarks
		Min	Typical	Max	
USIM_VDD	V3.0	2.75	3.0	3.05	USIM_VDD=3.0V
	V1.8	1.75	1.8	1.95	USIM_VDD=1.8V

USIM_DATA	VIH	0.65*VDD		3.05	USIM_VDD:3.0 V /1.8V
	VIL	-0.3	0	0.25*VDD	
	VOH	VDD-0.45		3.05	
	VOL	0	0	0.45	
USIM_CLK	VOH	VDD-0.45		3.05	USIM_VDD:3.0 V /1.8V
	VOL	0	0	0.45	
USIM_RST	VOH	VDD-0.45		3.05	USIM_VDD:3.0 V /1.8V
	VOL	0	0	0.45	

5.5.3 ADC

Table 31 ADC Power Definitions

Signal name	Parameter	Level value (V)			Remarks
		Min	Typical	Max	
ADC1	VIN	0.3		VBAT	ADC resolution 12Bits
ADC0	VIN	0.3		VBAT	ADC resolution 12Bits

5.5.4 PCM/I2S

Table 32 PCM/I2S Power Definition

Signal name	Parameter	Level value (V)		
		Min	Typical	Max
PCM_IN	VIH	1.2	1.8	2
	VIL	-0.3		0.6
PCM_OUT	VOH	1.35	1.8	2

	VOL	0		0.45
PCM_SYNC	VIH	1.2	1.8	2
	VIL	-0.3		0.6
PCM_CLK	VIH	1.2	1.8	2
	VIL	-0.3		0.6

5.5.5 I2C

Table 33 I2C Power Definition

Signal name	I/O	Parameter	Level value (V)		
			Min	Typical	Max
I2C_SCL	DO	VOH	1.35	1.8	2
		VOL	0		0.45
I2C_SDA		VOH	1.35	1.8	2
		VOL	0		0.45
		VIH	1.2	1.8	2
		VIL	-0.3		0.6

5.6 Power consumption characteristics

Table 34 Power Consumption of C42QM Module

Mode	Type	Current consumption		
		Avg	Max	Unit
Power Saving mode		TBD	TBD	uA

Sleep State **Idle state**	@LTE CAT M1 DRX=1.28s @ Paging = 24ms	TBD	TBD	mA
	@LTE CAT NB2 DRX=1.28s @ Paging = 24ms	TBD	TBD	mA
	@ LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 20.48 s, DRX = 2.56 s	TBD	TBD	mA
	LTE Cat NB2 e-I-DRX = 81.92 s @ PTW = 20.48 s, DRX = 2.56 s	TBD	TBD	mA
LTE Cat M1 data transfer (GNSS OFF)	Band 1 @ 21.03 dBm	TBD	TBD	mA
	Band 2 @ 21.03 dBm	TBD	TBD	mA
	Band 3 @ 21.42 dBm	TBD	TBD	mA
	Band 4 @ 21.27 dBm	TBD	TBD	mA
	Band 5 @ 21.22 dBm	TBD	TBD	mA
	Band 8 @ 21.11 dBm	TBD	TBD	mA
	Band 12 @ 20.98 dBm	TBD	TBD	mA
	Band 13 @ 21.05 dBm	TBD	TBD	mA
	Band 18 @ 21.05 dBm	TBD	TBD	mA
	Band 19 @ 20.9 dBm	TBD	TBD	mA
	Band 20 @ 20.94 dBm	TBD	TBD	mA
	Band 25 @ 20.09 dBm	TBD	TBD	mA
	Band 26 @ TBD	TBD	TBD	mA
	Band 28A @ 20.99 dBm	TBD	TBD	mA
	Band 28A @ 20.99 dBm	TBD	TBD	mA
	Band 66 @ 20.95 dBm	TBD	TBD	mA
	Band 1 @ 21.19 dBm	TBD	TBD	mA
	Band 2 @ 21.43 dBm	TBD	TBD	mA

LTE CAT NB2	Band 3 @ 21.4 dBm	TBD	TBD	mA
	Band 4 @ 21.48 dBm	TBD	TBD	mA
	Band 5 @ 21.54 dBm	TBD	TBD	mA
	Band 8 @ 21.13 dBm	TBD	TBD	mA
	Band 12 @ 21.43 dBm	TBD	TBD	mA
	Band 13 @ 21.62 dBm	TBD	TBD	mA
	Band 18 @ 21.5 dBm	TBD	TBD	mA
	Band 19 @ 21.48 dBm	TBD	TBD	mA
	Band 20 @ 21.55 dBm	TBD	TBD	mA
	Band 25 @ 21.61 dBm	TBD	TBD	mA
	Band 26 @ TBD	TBD	TBD	mA
	Band 28 @ 21.45 dBm	TBD	TBD	mA
	Band 66 @ 21.5 dBm	TBD	TBD	mA
	Band 71 @ 21.5 dBm	TBD	TBD	mA
	Band 85 @ 21.5 dBm	TBD	TBD	mA
GNSS(Searching) AT+CFUN=0	Cold start @ Instrument	TBD	TBD	mA
	Cold start @ Real network with half sky, Active Antenna	TBD	TBD	mA
GNSS(Tracking) AT+CFUN=0	Instrument Environment @ DPO off	TBD	TBD	mA
	Instrument Environment @ DPO on	TBD	TBD	mA
	Half Sky @ Real network, Active Antenna, DPO off	TBD	TBD	mA

5.7 Electrostatic property

There is no overvoltage protection inside the C42QM module. When the module is used, the ESD needs to be protected to ensure product quality.

EMC design recommendations:

- ✓ The USB port needs to add TVS on VDD, D+, D- for protection, and the TVS parasitic

capacitance on D+/D- is < 2 pF;

- ✓ The module's USIM card external pin needs to be TVS protected for parasitic capacitance requirements < 10 pF
- ✓ At the module input power supply, increase the TVS. It is recommended that the clamp voltage VCL (Clamping Voltage) is less than 12 V and the peak power PPP (Peak Pulse Power) is not less than 100 W.
- ✓ The protective device PCB layout should be as close as possible to the "V" shaped line to avoid the "T" shaped line.
- ✓ The ground plane around the module guarantees integrity and should not be split.
- ✓ ESD control of the surrounding environment and operators needs to be taken into account during module production, assembly and laboratory testing

Table 35 C42QM ESD Features

Test port	Contact discharge	Air discharge	Unit
USB interface	±4	±8	KV
USIM interface	±4	±8	KV
Analog voice interface	±4	±8	KV
VBAT power supply	±4	±8	KV

5.8 Reliability index

Table 36 C42QM Reliability Test

Test items	Test Conditions	Guideline	Test Results
Low temperature work	Temperature: -40°C Working mode: normal work Test duration: 24 h	IEC60068-2-1	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested

High temperature work	Temperature: 85°C Working mode: normal work Test duration: 24 h	JESD22-A108-C	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested
Temperature cycle	High temperature: 85°C Low temperature: –40°C Working mode: normal work Test duration: 30 Cycles;1 h+1h /cycle	JESD22-A105-B	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested
Alternating hot and humid	High temperature: 55°C Low temperature: 25°C Humidity: 95% ± 3% Working mode: normal work Test duration: 6 Cycles;12 h+12 h/cycle	JESD22-A101-B	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested
Temperature shock	High temperature: 85°C Low temperature: –40°C Temperature change time: < 30s Working mode: no packaging, no Power on, do not boot Test duration: 100 Cycles;15 min+15 Min/cycle	JESD22-A106-B	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested
Drop test	Height 0.8 m, 6 sides each time, dropped	IEC60068-2-32	Visual inspection: to be tested Function check: to be tested

	to the horizontal marble platform Working mode: no packaging, no Power on, do not boot		RF indicator check: to be tested
Low temperature storage	Temperature: −40°C Working mode: no packaging, no power, no boot Test duration: 24 h	JESD22-A119-C	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested
High temperature storage	Temperature: 85oC Working mode: no packaging, no power, no boot Test duration: 24 h	JESD22-A103-C	Visual inspection: to be tested Function check: to be tested RF indicator check: to be tested

6 Structural and mechanical properties

6.1 Chapter overview

- Module structural image
- Module mechanical size

6.2 Module structural image

Figure 16 Module Structural design

6.3 C42QM module mechanical size

The figure below shows the bottom view size of the module:

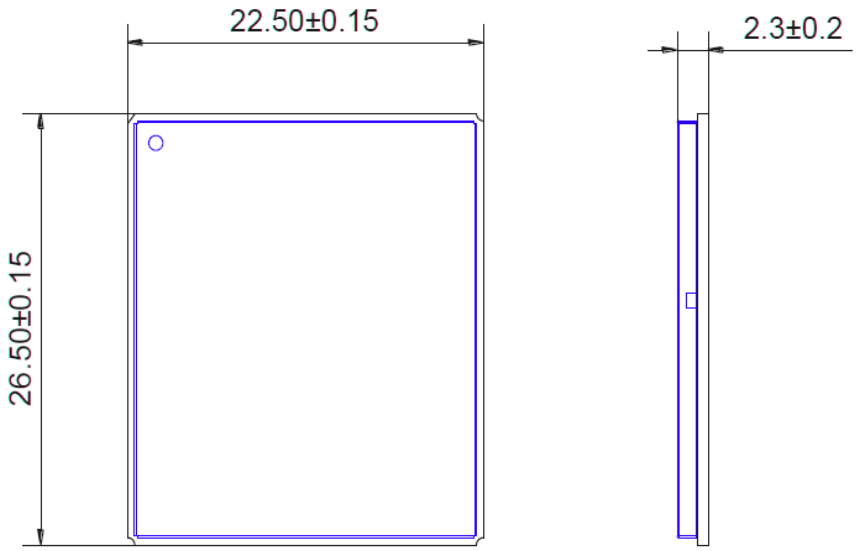


Figure 17 Front view and side view of the module (unit: mm)

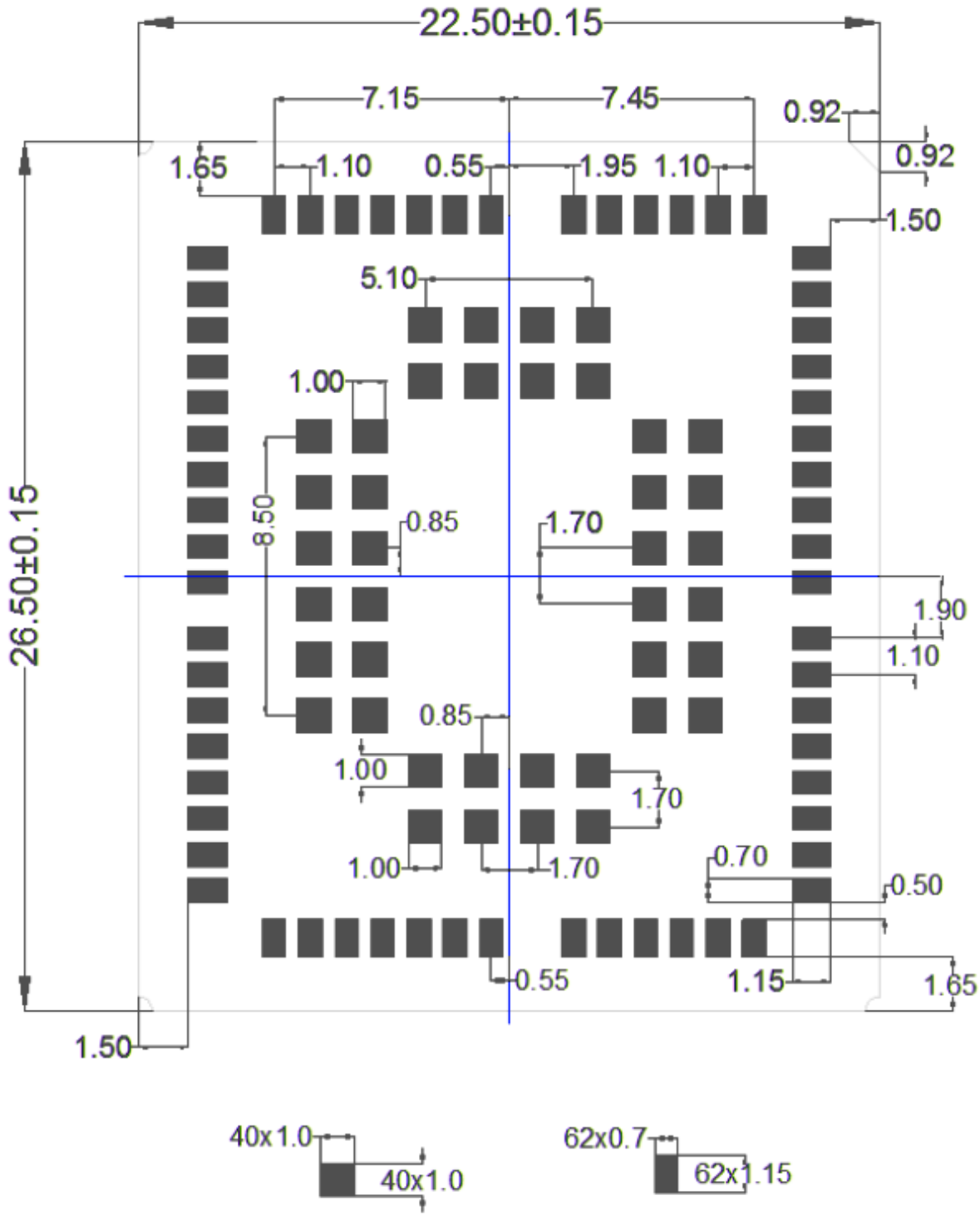


Figure 18 Bottom view of the module (unit: mm)

Module recommended footprint:

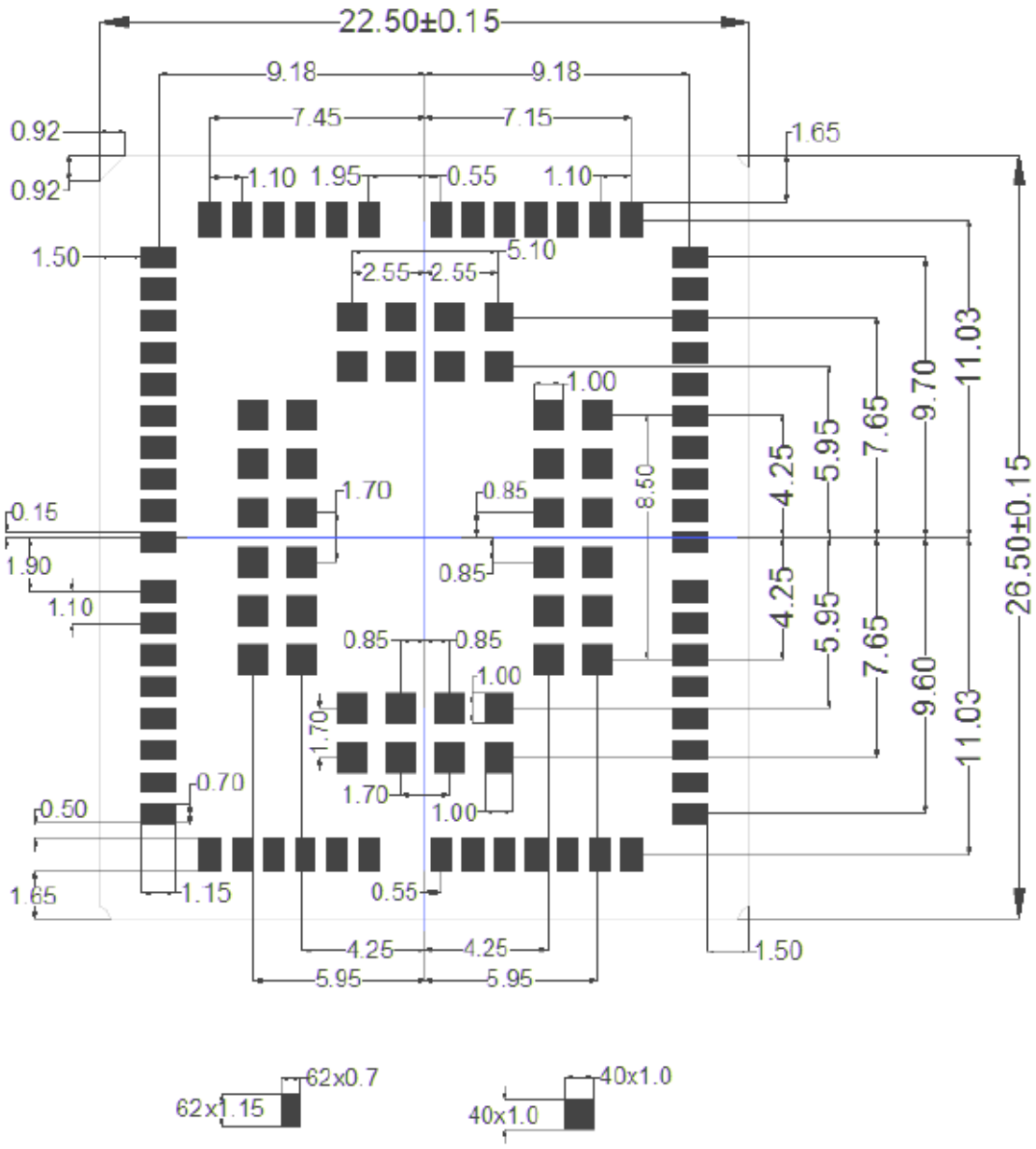


Figure 19 Recommended Footprint (Top View) (unit: mm)

7 Packaging and production

7.1 Chapter overview

- Module packaging and storage
- Production welding

7.2 Module packaging and storage

The C42QM module is packaged in a tape reel with 500 pcs per reel, shipped as a tape reel sealed bag.

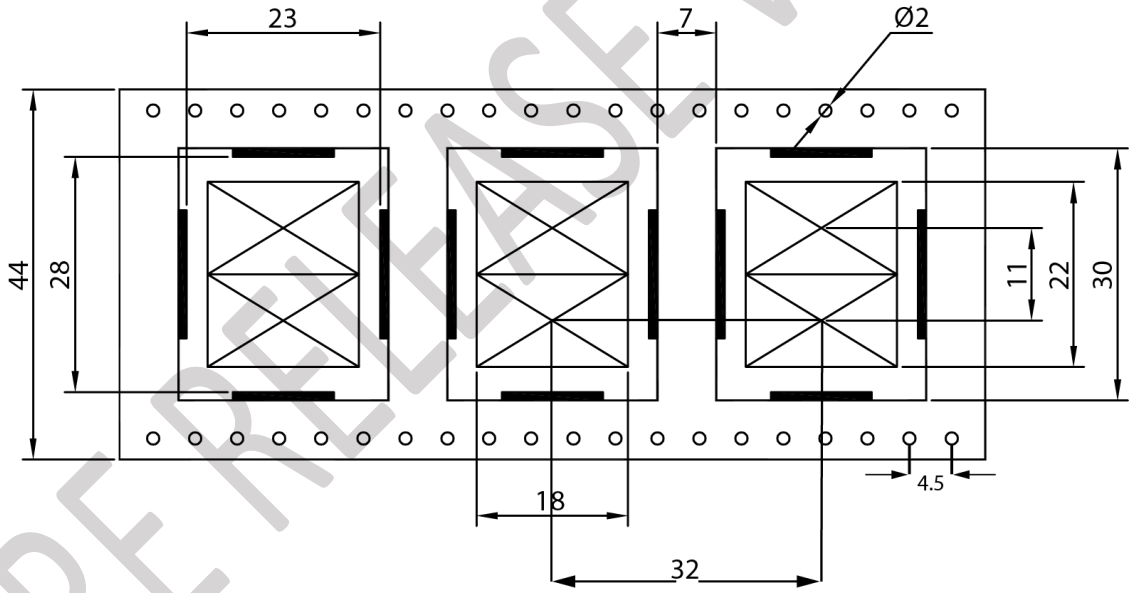


Figure 20 C42QM Tape Measurements (in mm)

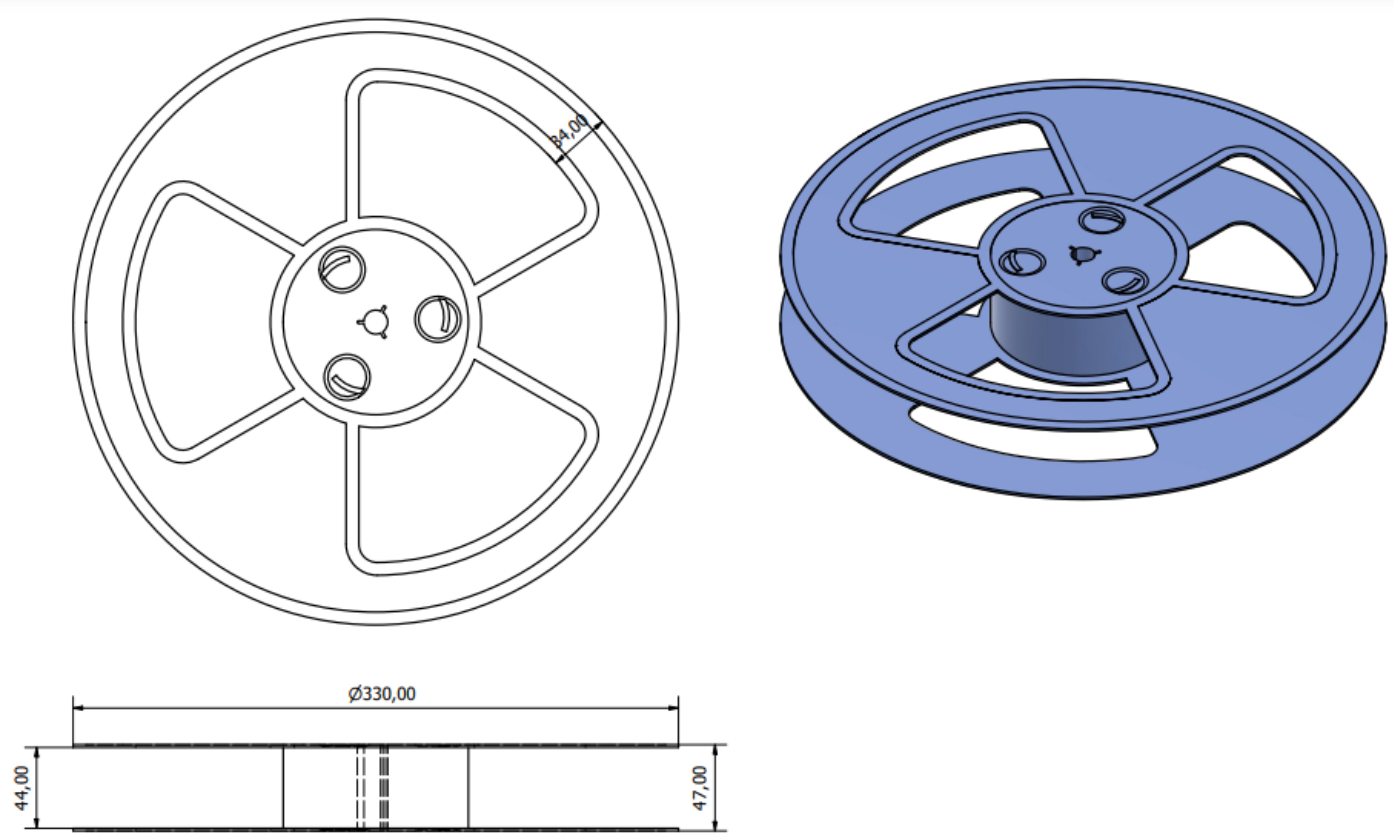


Figure 21 Reel Dimensions of C42QM (in mm)

The storage of the C42QM module is subject to the following conditions:

- ✓ The module has a moisture sensitivity rating of 3.
- ✓ When the ambient temperature is greater than 40 degrees Celsius and the air humidity is less than 90%, the module can be stored in a vacuum sealed bag for 12 months.
- ✓ When the vacuum sealed bag is opened, if the ambient temperature of the module is lower than 30 degrees Celsius and the air humidity is less than 60%, the factory can complete the patch within 72 hours, and the module can directly perform reflow soldering or other high temperature process.
- ✓ If the module is in other conditions, it needs to be baked before the patch.
- ✓ If the module needs to be baked, remove the module and bake for 48 hours at 125 degrees Celsius (allowing fluctuations of up to 5 degrees Celsius).

7.3 Production welding

The C42QM module is packaged in an anti-static tray. The SMT wire body needs to be equipped with a Tray module. It is recommended to use a reflow oven above 7 temperature zones.

- ✓ To ensure the quality of the module paste, the thickness of the stencil corresponding to the pad portion of the C42QMmodule is recommended to be 0.18 mm.
- ✓ The recommended reflow temperature is 235~245oC, which cannot exceed 260oC.
- ✓ When the PCB is laid out on both sides, the LGA module layout must be machined on the 2nd side. Avoid module falling parts, welding and welding, and poor internal welding of the module caused by the gravity of the module.

The recommended furnace temperature curve is shown below:

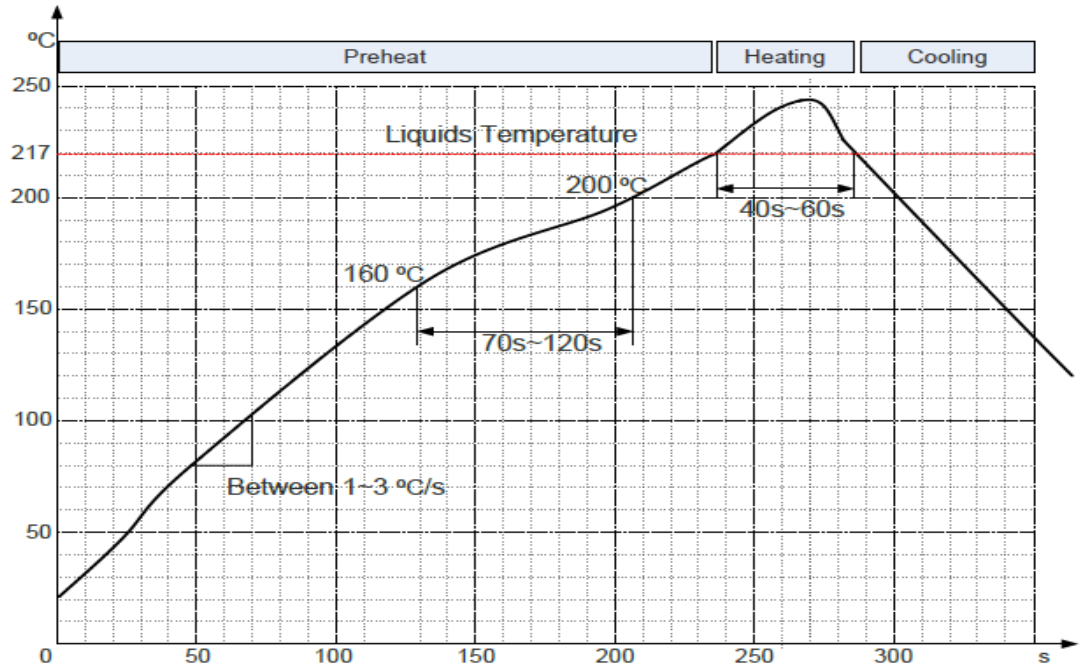


Figure 22 Reflow soldering temperature graph.

Table 37 Reflow Process Parameter Table

Warm zone	Time	Key parameter
Preheating zone (4℃~ 165℃)		Heating rate: 1℃/ s ~ 3℃ / s
Temperature zone (160℃～210℃)	（t1～t2）：70s～120s	
Recirculation zone (> 217 ℃)	（t3～t4）：40s～60s	Peak temperature: 235℃~ 245 ℃
Cooling zone	Cooling rate: 2℃/s ≤ Slope ≤ 5℃/s	

8 Appendix

8.1 Chapter overview

- Abbreviations
- Safety and precautions

8.2 Abbreviations

Table 38 Abbreviations

Abbreviations	Full name
3GPP	Third Generation Partnership Project
AP	Access Point
AMR	Adaptive Multi-rate
BER	Bit Error Rate
CCC	China Compulsory Certification
CDMA	Code Division Multiple Access
CE	European Conformity
CSD	Circuit Switched Data
CTS	Clear to Send
DC	Direct Current
DTR	Data Terminal Ready
DL	Down Link
DTE	Data Terminal Equipment
DRX	Discontinuous Reception
EDGE	Enhanced Data Rate for GSM Evolution
EU	European Union
EMC	Electromagnetic Compatibility

ESD	Electrostatic Discharge
FCC	Federal Communications Commission
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSDPA	High-Speed Downlink Packet Access
HSPA	Enhanced High Speed Packet Access
HSUPA	High Speed Up-link Packet Access
IMEI	International Mobile Equipment Identity
LED	Light-Emitting Diode
LTE	Long Term Evolution
NC	Not Connected
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PMU	Power Management Unit
PPP	Point-to-point protocol
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of the Use of Certain Hazardous Substances
SMS	Short Message Service
TIS	Total Isotropic Sensitivity
TVS	Transient Voltage Suppressor
TX	Transmitting Direction
UART	Universal Asynchronous Receiver-Transmitter
UMTS	Universal Mobile Telecommunications System
USIM	Universal Subscriber Identity Module
USSD	Unstructured Supplementary Service Data
VSWR	Voltage Standing Wave Ratio
WCDMA	Wideband Code Division Multiple Access
WWAN	Wireless Wide Area Network

8.3 Safety and precautions

To use the wireless device safely, the terminal device informs the user of the relevant safety information:

- ✓ **Interference:** When the use of wireless devices is prohibited or the use of the device may cause interference and security of the electronic device, turn off the wireless device. Because the terminal will send and receive RF signals when it is powered on. It can interfere with TV, radio, computer or other electrical equipment.
- ✓ **Medical equipment:** In medical and health care facilities where the use of wireless devices is prohibited in the express text, please follow the regulations of the site and turn off the device. Some wireless devices may interfere with the medical device, causing the medical device to malfunction or cause errors. If interference occurs, turn off the wireless device and consult a physician.
- ✓ **Flammable and explosive areas:** In flammable and explosive areas, please turn off your wireless device and follow the relevant label instructions to avoid an explosion or fire. For example; gas stations, fuel zones, chemical products areas, chemical transportation and storage facilities, areas with explosion hazard signs, areas with "turn off radio equipment" signs, etc.
- ✓ **Traffic Safety:** Please comply with local laws or regulations in your country or region regarding the use of wireless devices when driving a vehicle.
- ✓ **Aviation Safety:** When flying, please follow the airline's regulations and regulations regarding the use of wireless devices. Before taking off, turn off the wireless device to prevent wireless signals from interfering with aircraft control signals.
- ✓ **Environmental Protection:** Please comply with local laws regarding the handling of equipment packaging materials, equipment or accessories, and support recycling operations.
- ✓ **Emergency call:** This device uses wireless signals for propagation. Therefore, there is no guarantee that the network can be connected in all situations, so in an emergency this wireless device cannot be used as the only contact method.