Re-imagining Cellular IoT Solutions

Cavli C42GM
CAT M1/NB1/NB2 Module
Integrated eSIM
Hardware Manual
External Release Version 1.9

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VERSION HISTORY

Version	Description	Date
1.0	Initial	17-09-2021
1.1	1. Updated functional block diagram 2. Audio interface changed to PCM 3. Updated the corrected GNSS Active Antenna reference circuit 4. Updated the corrected USB connection design diagram 5. In 3.3.1,updated values of components 6. Replaced VBAT power supply diagram with new design	25-10-2021
1.2	1. Updated tape and reel information 2. Changed quantity per reel	10-01-2022
1.3	1. Bluetooth feature removed 2. Updated SPQ to 500 pcs/reel	13-01-2022
1.4	1. Ordering Information Updated	11-07-2022
1.5	Status and Netlight reference circuits updated	15-12-2022
1.6	GNSS Performance parameters updated	15-02-2023
1.7	Updated LTE bandlist	21-02-2023
1.8	Updated temperature values and Band Frequency Information	10-03-2023
1.9	Net_Status Pin description updated	24-04-2023

1 Introduction

This document is the Hardware Manual of Cavli Wireless solution product C42GM Smart Module, which describes the hardware composition and functional features of the module, the definition and usage of the application interface, and 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.

1.1 Module characteristics

Table 1 Characteristic Table

Characteristic	Description
Physical properties	26.5mm*22.5mm*2.3mm
Application processor	Cortex R4, Max clock frequency above 1.5 Ghz Cache: 4 to 64 kB
Working voltage	3.1-4.2 V, Typical voltage: 3.6 V
Power saving	PSM mode power < 5μA Dormant mode current < 1mA
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 & I2Cinterface ✓ Power interface ✓ Network status indication interface GPIO interface ✓ ADC ✓ CAN ✓ GPIO ✓ SPI ✓ SigFox ✓ SDIO

Operating frequency band	LTE Bands: B1/B2/B3/B4/B5/B6/B8/B9/B10/B12/B13/B14/ B15/B16/B17/B18/B19/B20/B24/B25/B26/B27/B28/B65/B66/B68/B71/B90/B105
Data service	✓ LTE CAT M1: 588Kbps (DL), 1119Kbps (UL) ✓ LTE CAT NB2: 127Kbps (DL), 158.5Kbps (UL) ✓ LTE CAT NB1: 20 Kbps (DL), 60 Kbps (UL)
Satellite positioning	*GPS/GLONASS/BeiDou/Galileo/QZSS/SBAS*
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 –30°C to +85°C
AT command	Supports standard AT Command (3GPP TS 27.007.27.005)

NOTE

- The C42GM 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 suggested 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 C42GM module may not meet the 3GPP standards.

1.2 Variant information

Table 2 Variant Information

C42GM	Variant			
Features	C42GM-S	C42GM-SH	C42GM-HG	C42GM-HGAI
LTE-M	✓	✓	✓	✓
NB-IoT	✓	✓	✓	✓
SigFox	✗	✓	✓	✓
GNSS	✗	✗	✓	✓
CAN-FD	✗	✗	✗	✓
OpenSDK	Optional	Optional	Optional	Optional
Internal SIM	Optional	Optional	Optional	Optional

2 Module overview

2.1 Module introduction

C42GM module is an LTE M1/NB1/NB2 based wireless communication module for the Internet of things. It is a highly integrated System-in-a-Chip (SoC) designed to support LTE CAT-M1 (eMTC) and CAT-NB1/NB2 (NB-IoT). It includes RAM memory and integrates low power and high-performance Cortex-R4 processor and radio transceivers as well as an impressive array of peripherals for connectivity. It supports concurrent operation of LTE, and SigFox. It is encapsulated for LGA with 102 pins, and the structure size of the module is 26.5mm*22.5mm*2.3mm.

C42GM Integrated multi constellation GNSS receiver supports *GPS/GLONASS/BeiDou/Galileo/QZSS/SBAS* positioning system. C42GM 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, C42GM can deliver ultra-low power consumption and smaller form factor design and fit into the Internets of things applications.

The C42GM 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 function

C42GM 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

C42GM module function block diagram is as follows:

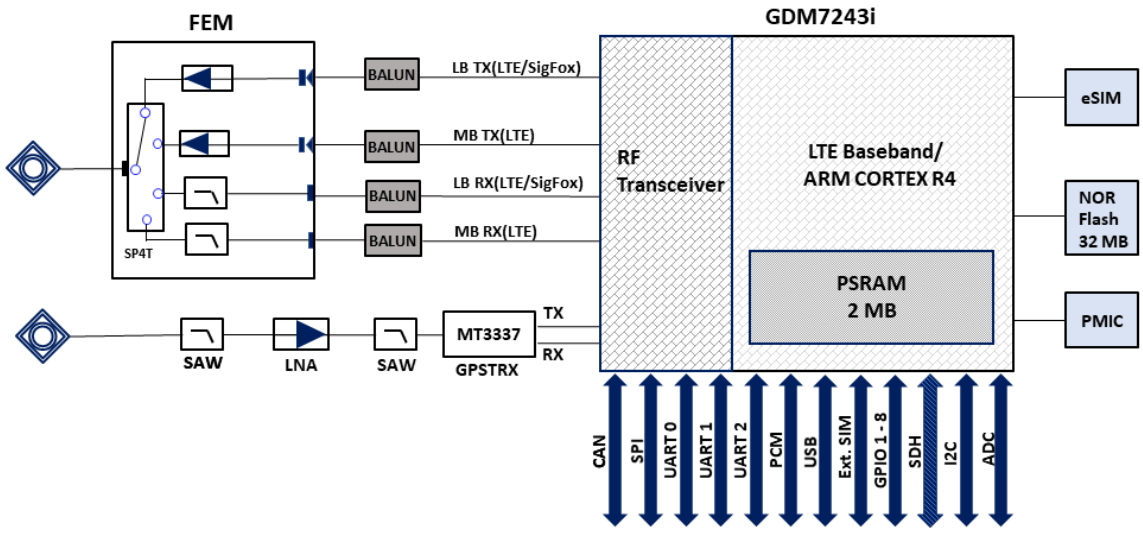


Figure 1 Functional block diagram of the C42GM module

2.3 Device development kit

In order to assist customers, develop their applications with ease, we provide a Device Development Kit (DDK) with RS232, USB and UART ports, Audio and stereo jacks and other peripherals to test and control the modules. For more details refer ***C Series DDK User Manual***

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
- CAN
- SigFox
- SPI

3.2 Module interface

3.2.1 C42GM Pin layout

C42GM pins are assigned as follows：

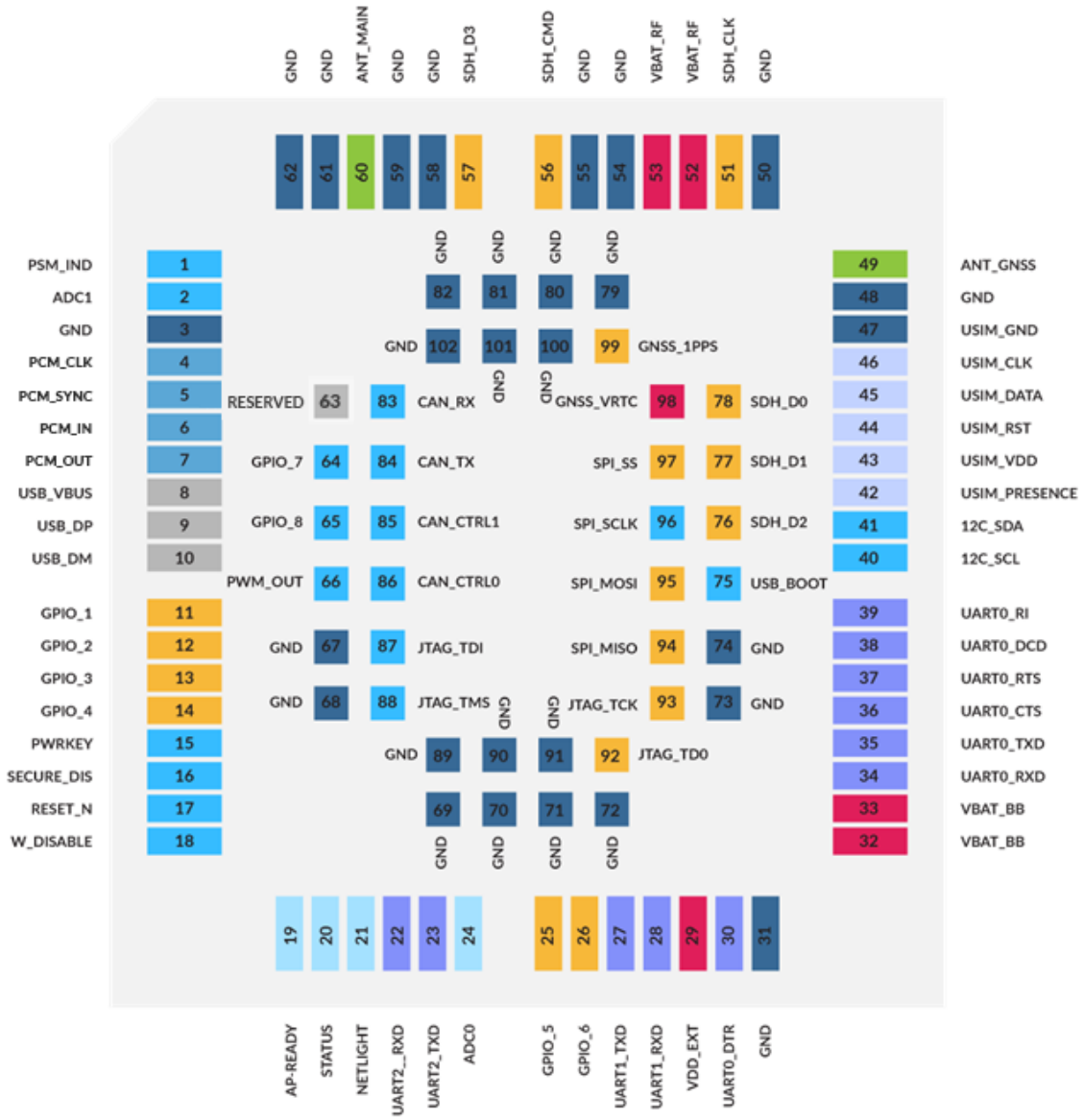


Figure 2 C42GM module interface definition

NOTE

- All RESERVED and unused pins are left unconnected

3.2.2 C42GM Pin interface

The C42GM module has the LCC interface. The module interface definition is shown in the following table

Table 3 Pin Assignment

Pin no.	Pin name	C42GM-S	C42GM-SH	C42GM-HG	C42GM-HGAI
1	PSM_IND	✓	✓	✓	✓
2	ADC1	✓	✓	✓	✓
3	GND	✓	✓	✓	✓
4	PCM_CLK	✓	✓	✓	✓
5	PCM_SYNC	✓	✓	✓	✓
6	PCM_IN	✓	✓	✓	✓
7	PCM_OUT	✓	✓	✓	✓
8	USB_VBUS	✓	✓	✓	✓
9	USB_DP	✓	✓	✓	✓
10	USB_DM	✓	✓	✓	✓
11	GPIO_1	✓	✓	✓	✓
12	GPIO_2	✓	✓	✓	✓
13	GPIO_3	✓	✓	✓	✓
14	GPIO_4	✓	✓	✓	✓
15	PWRKEY	✓	✓	✓	✓
16	SECURE_DIS	✓	✓	✓	✓
17	RESET_N	✓	✓	✓	✓
18	W_DISABLE	✓	✓	✓	✓
19	AP_READY	✓	✓	✓	✓
20	STATUS	✓	✓	✓	✓
21	NETLIGHT	✓	✓	✓	✓
22	UART2_RXD	✓	✓	✓	✓
23	UART2_TXD	✓	✓	✓	✓

Pin no.	Pin name	C42GM-S	C42GM-SH	C42GM-HG	C42GM-HGAI
24	ADC0	✓	✓	✓	✓
25	GPIO_5	✓	✓	✓	✓
26	GPIO_6	✓	✓	✓	✓
27	UART1_TXD	✓	✓	✓	✓
28	UART1_RXD	✓	✓	✓	✓
29	VDD_EXT	✓	✓	✓	✓
30	UART0_DTR	✓	✓	✓	✓
31	GND	✓	✓	✓	✓
32	VBAT_BB	✓	✓	✓	✓
33	VBAT_BB	✓	✓	✓	✓
34	UART0_RXD	✓	✓	✓	✓
35	UART0_TXD	✓	✓	✓	✓
36	UART0_CTS	✓	✓	✓	✓
37	UART0_RTS	✓	✓	✓	✓
38	UART0_DCD	✓	✓	✓	✓
39	UART0_RI	✓	✓	✓	✓
40	I2C_SCL	✓	✓	✓	✓
41	I2C_SDA	✓	✓	✓	✓
42	USIM_PRESENCE	✓	✓	✓	✓
43	USIM_VDD	✓	✓	✓	✓
44	USIM_RST	✓	✓	✓	✓
45	USIM_DATA	✓	✓	✓	✓
46	USIM_CLK	✓	✓	✓	✓
47	USIM_GND	✓	✓	✓	✓
48	GND	✓	✓	✓	✓
49	ANT_GNSS	R	R	✓	✓
50	GND	✓	✓	✓	✓
51	SDH_CLK	✓	✓	✓	✓
52	VBAT_RF	✓	✓	✓	✓

Pin no.	Pin name	C42GM-S	C42GM-SH	C42GM-HG	C42GM-HGAI
53	VBAT_RF	✓	✓	✓	✓
54	GND	✓	✓	✓	✓
55	GND	✓	✓	✓	✓
56	SDH_CMD	✓	✓	✓	✓
57	SDH_D3	✓	✓	✓	✓
58	GND	✓	✓	✓	✓
59	GND	✓	✓	✓	✓
60	ANT_MAIN	✓	✓	✓	✓
61	GND	✓	✓	✓	✓
62	GND	✓	✓	✓	✓
63	RESERVED	R	R	R	R
64	GPIO_7	✓	✓	✓	✓
65	GPIO_8	✓	✓	✓	✓
66	PWM_OUT	✓	✓	✓	✓
67	GND	✓	✓	✓	✓
68	GND	✓	✓	✓	✓
69	GND	✓	✓	✓	✓
70	GND	✓	✓	✓	✓
71	GND	✓	✓	✓	✓
72	GND	✓	✓	✓	✓
73	GND	✓	✓	✓	✓
74	GND	✓	✓	✓	✓
75	USB_BOOT	R	R	R	R
76	SDH_D2	✓	✓	✓	✓
77	SDH_D1	✓	✓	✓	✓
78	SDH_D0	✓	✓	✓	✓
79	GND	✓	✓	✓	✓
80	GND	✓	✓	✓	✓

Pin no.	Pin name	C42GM-S	C42GM-SH	C42GM-HG	C42GM-HGAI
81	GND	✓	✓	✓	✓
82	GND	✓	✓	✓	✓
83	CAN_RX	✗	✗	✗	✓
84	CAN_TX	✗	✗	✗	✓
85	CAN_CTRL1	✗	✗	✗	✓
86	CAN_CTRL0	✗	✗	✗	✓
87	JTAG_TDI	R	R	R	R
88	JTAG_TMS	R	R	R	R
89	GND	✓	✓	✓	✓
90	GND	✓	✓	✓	✓
91	GND	✓	✓	✓	✓
92	JTAG_TD0	R	R	R	R
93	JTAG_TCK	R	R	R	R
94	SPI_MISO	✓	✓	✓	✓
95	SPI_MOSI	✓	✓	✓	✓
96	SPI_SCLK	✓	✓	✓	✓
97	SPI_SS	✓	✓	✓	✓
98	GNSS_VRTC	✗	✗	✓	✓
99	GNSS_1PPS	✗	✗	✓	✓
100	GND	✓	✓	✓	✓
101	GND	✓	✓	✓	✓
102	GND	✓	✓	✓	✓

✓ FUNCTION ACTIVE

✗ FUNCTION INACTIVE

R RESERVED

Table 4 I/O Parameter Definition

Type	Description
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

3.3 Power interface

The C42GM 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

Table 5 Power Pin Definition

Pin no.	Name	I/O	Description	Min	Typical	Max
32,33	VBAT_BB	PI	Baseband power supply	3.1V	3.6V	4.2V
52,53	VBAT_RF	PI	Radio frequency power supply	3.1V	3.6V	4.2V

29	VDD_EXT	PO	Output power supply		1.8V/50mA	
3,31,48,50,54,55,58,59,61,62,67-74,79-82,89-91,100-102	GND		Ground		0	

3.3.1 Input power supply design

The C42GM 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 3.1V - 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.

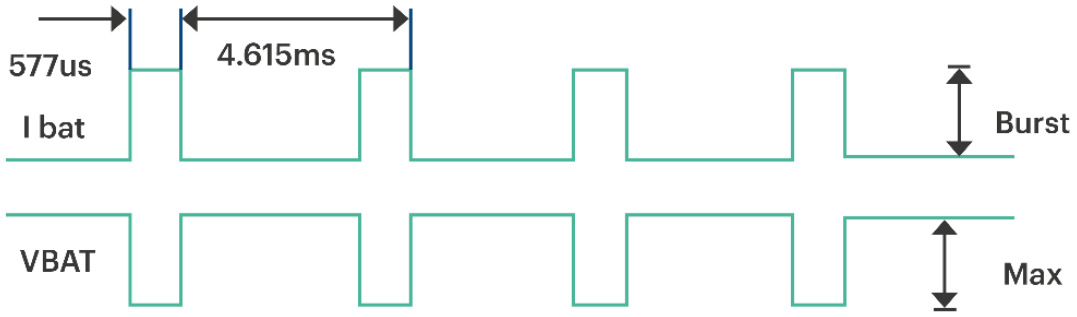


Figure 3 Burst current supply voltage drop for GSM TDMA network

In order to ensure that the power supply is sufficient,

- ✓ A 220μF/6.3V tantalum capacitors can be connected in close proximity to the power input, and
- ✓ Then a 10pF, 33pF, 0.1μF, 22μF ceramic capacitor can be added to improve the performance and stability of the system.

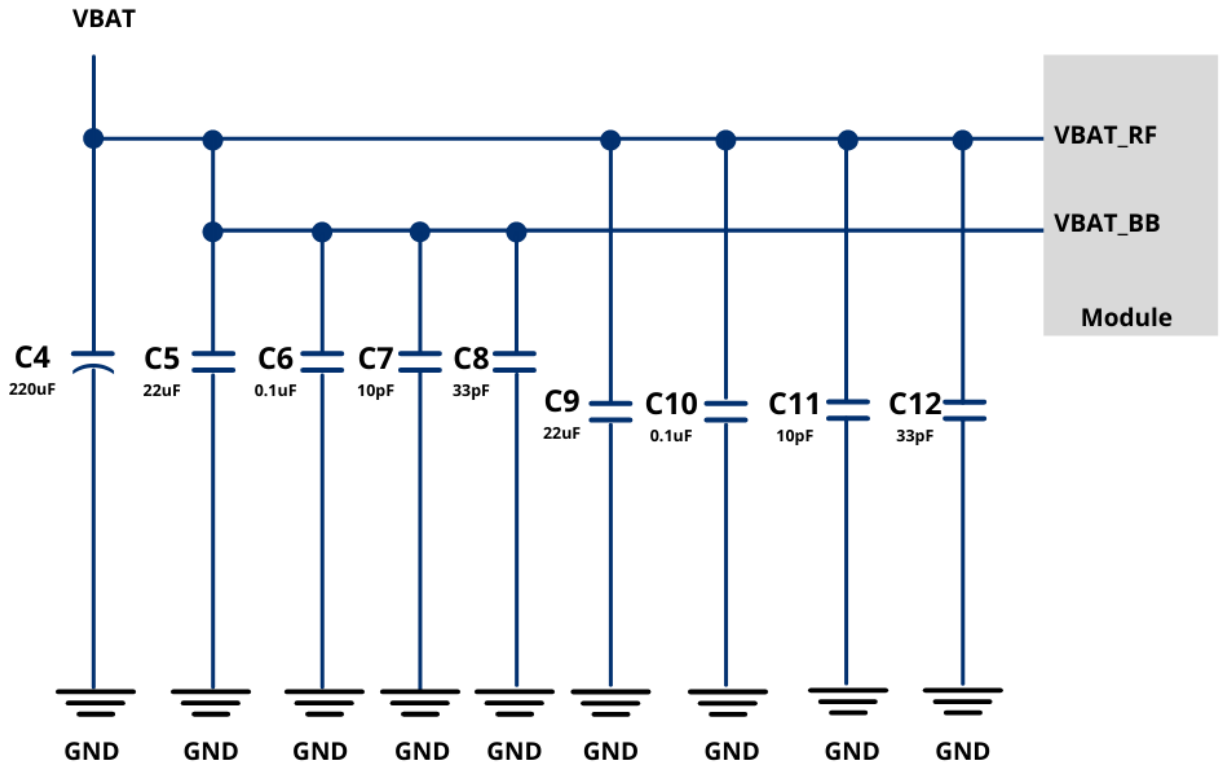


Figure 4 VBAT power supply

3.3.2 Power reference circuit

The actual design of the power circuit can use a switching DC power supply or a linear LDO power supply to design the VBAT power supply, and then the PMOS transistor is used to control the power supply input so that the power supply can be completely cut off. Both design circuits need to supply enough current.

For better understanding, refer the circuits given below. The users can choose one of the following circuits or design one on their own.

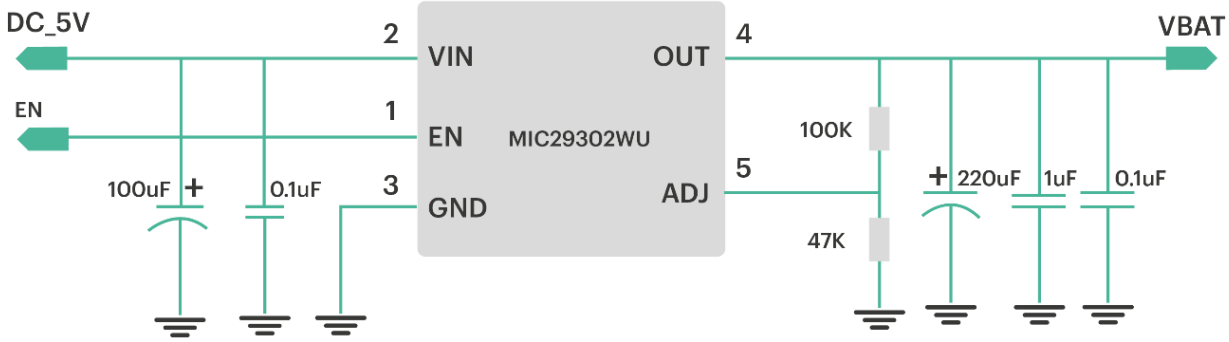


Figure 5 LDO linear power reference circuit

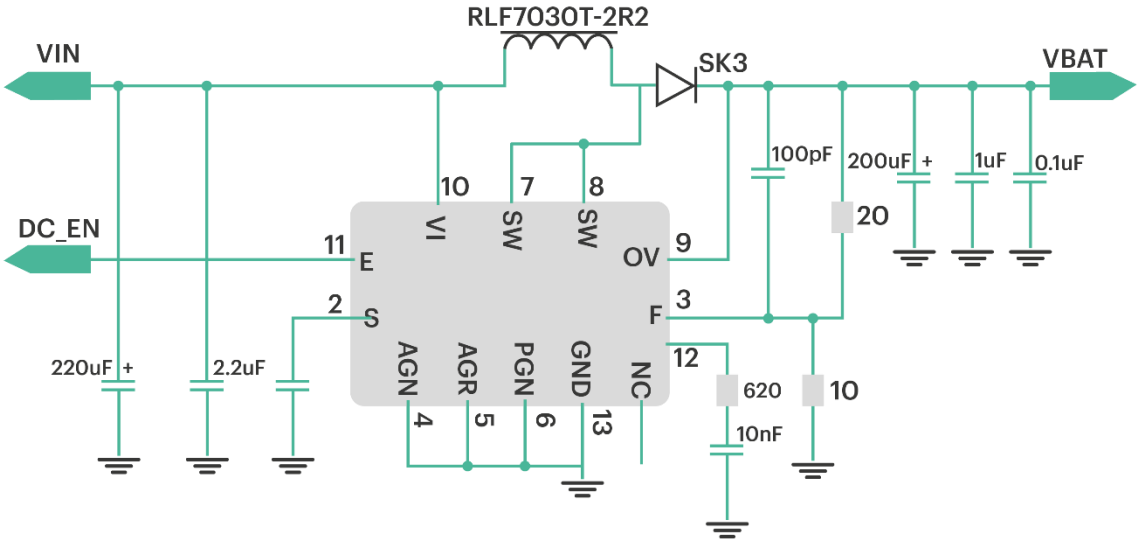


Figure 6 DC switching power supply reference circuit

S

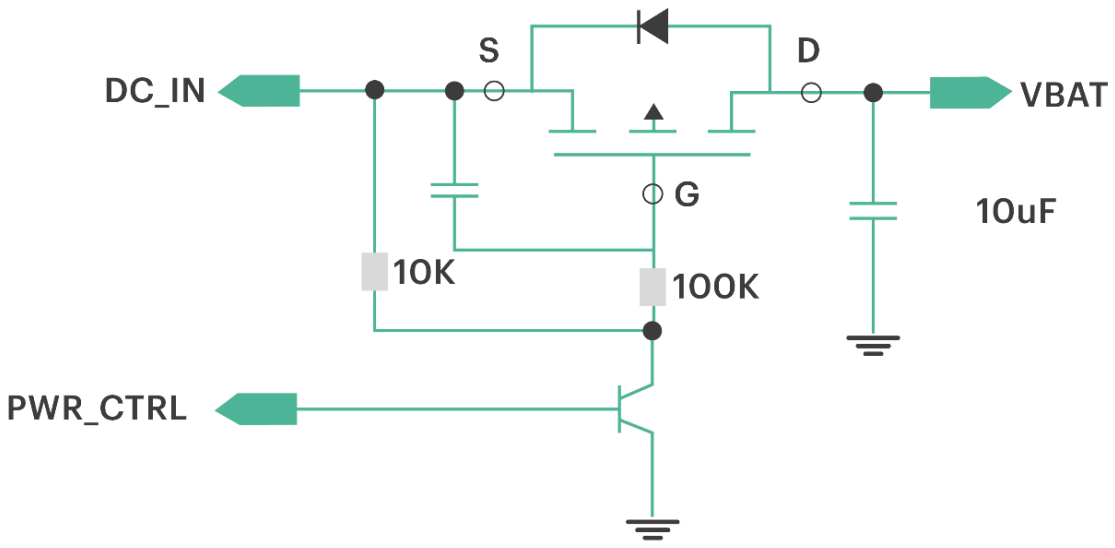


Figure 7 PMOS tube control power switch reference circuit

NOTE

- In order to prevent the module from being damaged by surge and overvoltage, a 5.1V/500mW Zener diode is suggested to be connected in parallel at the VBAT pin of the module.
- It is suggested that 3 ceramic capacitors (33pF, 10pF, 100nF) be added to the VBAT line and placed near the VBAT pin.

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 6 Switch Pin Definition

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

It is recommended to use the open-collector drive circuit to control the PWRKEY. After the STATUS pin shows a high voltage level, PWRKEY pin can be released. A simple reference circuit is given below:

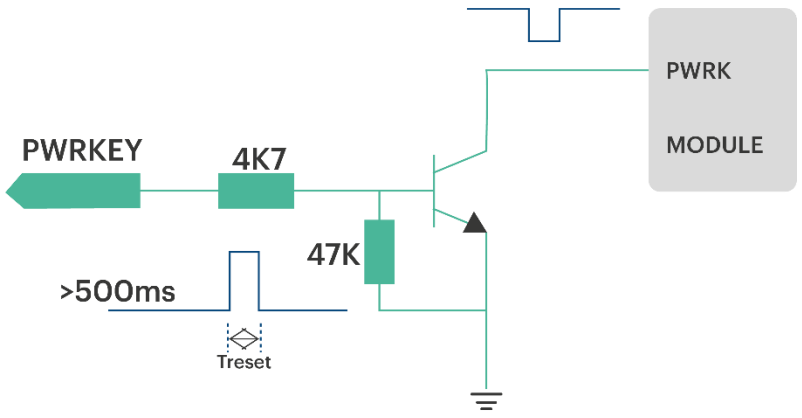


Figure 8 Power-on reference circuit

The PWRKEY can also be controlled with a button directly. In that case button accessories should be kept with a TVS tube for ESD protection. Reference circuit for the same is given below:

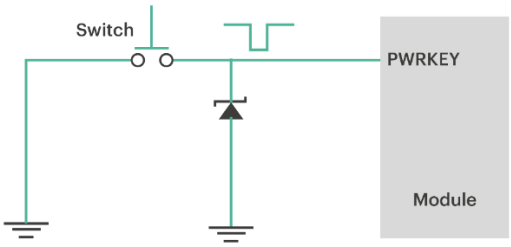


Figure 9 Reference circuit for Button control

NOTE

- Before pulling down the PWRKEY pin the user must ensure a stable VBAT supply.

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 7 Reset Foot Definition

Pin no.	Signal name	I/O	High value	Description
17	RESET_N	DI	1.8V	Module reset control foot, low efficiency

The refence circuit for RESET operation is as follows:

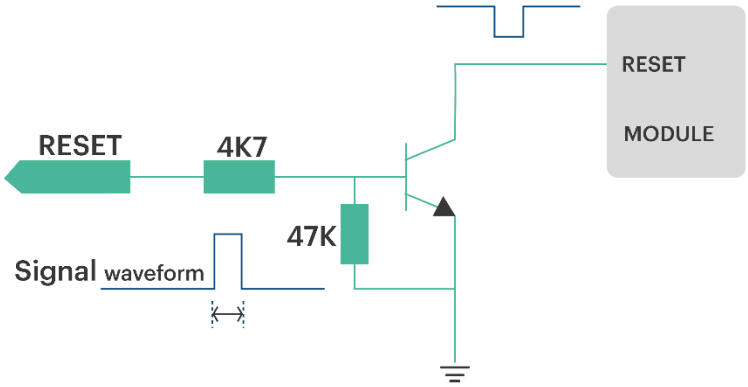


Figure 10 Reset reference circuit

Table 8 Reset Pin Parameters

Symbol	Description	Min	Typical	Max	Unit
T-Reset	Low level pulse width	100		600	ms
VIH	RESET input high level voltage	1.3	1.8	2.1	V
VIL	RESET input low level voltage	-0.3	0	0.5	V

C42GM module can be reset with the AT Command AT+CFUN=1,1 for full functionality reset. Detailed instructions can be viewed in the C42GM AT instruction set manual.

3.5 USB interface

The USB interface supports the following features:

- ✓ Software debugging, download/upgrade
- ✓ Data transmission
- ✓ AT Command
- ✓ GNSS NMEA output, etc.
- ✓ Slave device mode; does not support charging mode

Table 9 Interface Pin Definition

Pin no.	Signal name	I/O	Description
8	USB_VBUS	PI	USB insertion detection, high level effective
9	USB_DP	IO	USB differential signal +
10	USB_DM	IO	USB differential signal -

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

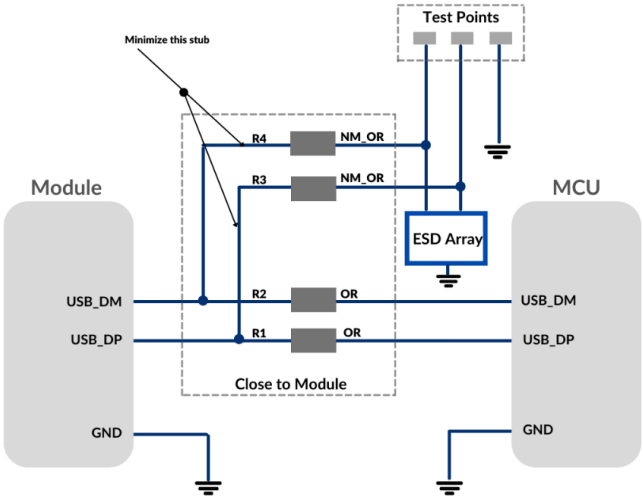


Figure 11 USB connection design circuit diagram

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)
- The USB interface bus supply voltage is provided internally by the module and does not need to be externally supplied.

3.6 UART interface

C42GM module provides a full function serial port and two UART (2 lines) ports. The UART interface is defined as follows:

Table 10 UART Serial Port Signal Definition

Pin no.	Name	I/O	Description
39	UART0_RI	DOH	Ringing indication
38	UART0_DCD	DOH	Output carrier detection
36	UART0_CTS	DO	UART clear to send
37	UART0_RTS	DI	UART request to send
30	UART0_DTR	DI	Data terminal preparation
35	UART0_TXD	DO	Data transmission
34	UART0_RXD	DI	Data reception

3.6.1 UART serial ports

The serial level is 1.8V. The module's serial port baud rate can be set to 4800 to 921600bps baud rate, the default is 115200bps.

The UART0 serial port can realize

- ✓ AT interactive instructions,
- ✓ Print program log information
- ✓ Interact with peripheral data.

When users want to use the full-featured serial port, they can refer to the following connection methods

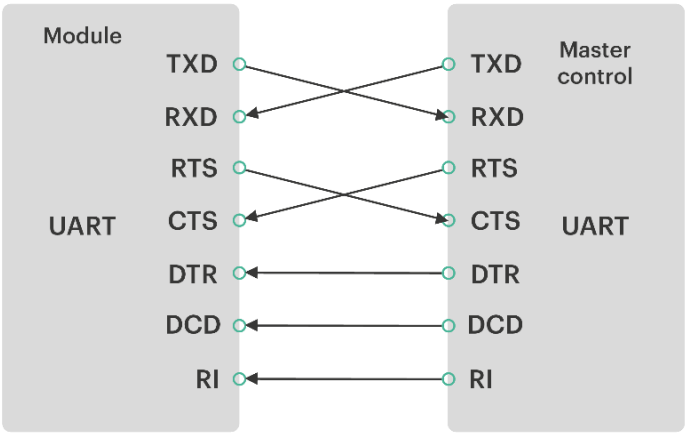


Figure 12 Full-featured serial port design

If you need to use a 2-wire serial port, you can refer to the following serial port design:

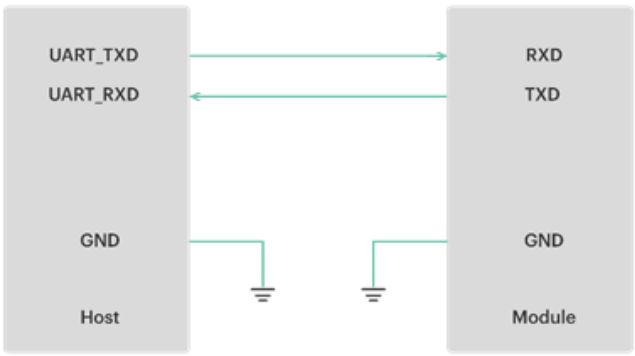


Figure 13 UART serial port design

- ✓ The serial port of the module is TTL 1.8V level.
- ✓ If the serial port needs to be connected to the MCU of 3.3V level, it is necessary to add a level conversion chip externally to achieve level matching.
- ✓ Use an external 1.8V power source for VCCA.

For the chip connection method, refer to the following circuit:

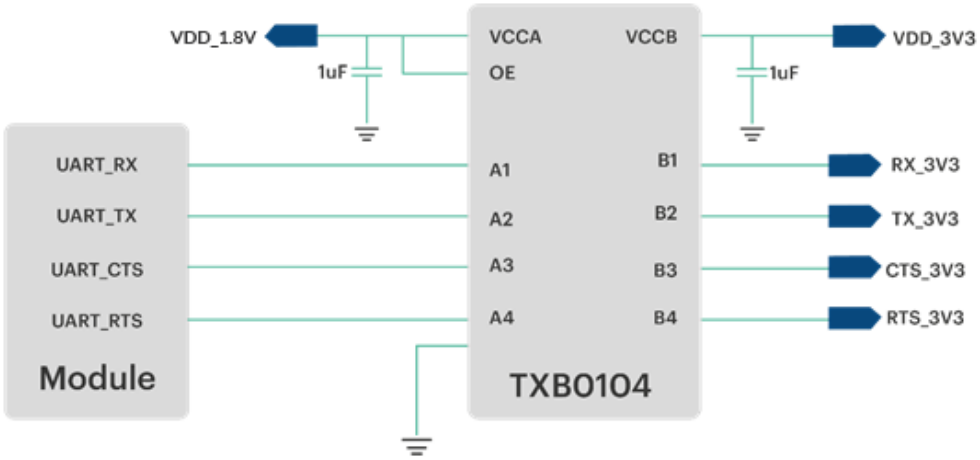


Figure 14 Level conversion chip circuit

3.6.2 Debug serial port

The debug serial port supports 115200bps baud rate. It is used for Linux control and log printing. It can reserve test points for module debugging.

Do not leave it floating.

Table 11 Debug Serial Port Pin Definition

Pin no.	Signal name	I/O	Description
27	UART1_TXD	DO	Data transmission
28	UART1_RXD	DI	Data reception
23	UART2_TXD	DO	Data transmission
22	UART2_RXD	DI	Data Reception

3.6.3 RI and DTR interface

The C42GM module supports the serial sleep wake-up function.

RI:

The RI pin can be used as an interrupt to wake up the host.

Table 12 RI State Definition

State	Response
Idle	RI keeps in low level
SMS/Voice Call	RI outputs 500 ms rectangular pulse (high level for 250ms, low level for 250ms)

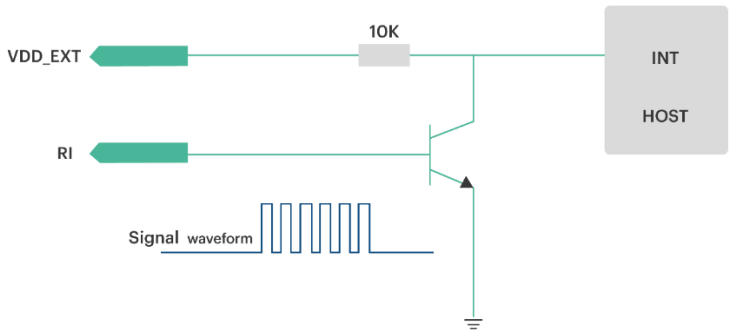


Figure 15 RI pin signal waveform

DTR:

The DTR pin can be used as the sleep wake-up pin of the C42GM module. When the module enters sleep, the DTR pin can be pulled low to wake up the module.

1. Pull the DTR pin high first
2. Send AT+DISABLEUSB=1, AT+CSCLK=1, after the module enters sleep
3. Low DTR pin wake-up module

3.7 USIM interface

The C42GM module provides a USIM card interface compatible with the ISO 7816-3 standard. The USIM card power supply is provided by the module's internal power manager and supports 1.8V/3.0V

Table 13 SIM Card Signal Definition

Pin no.	Signal name	I/O	Description
42	USIM_PRESENCE	I	SIM detect
43	USIM_VDD	PO	USIM card power supply
45	USIM_DATA	IO	USIM card data
46	USIM_CLK	DO	USIM card clock
44	USIM_RST	DO	USIM card reset

3.7.1 USIM card reference circuit

The C42GM 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:

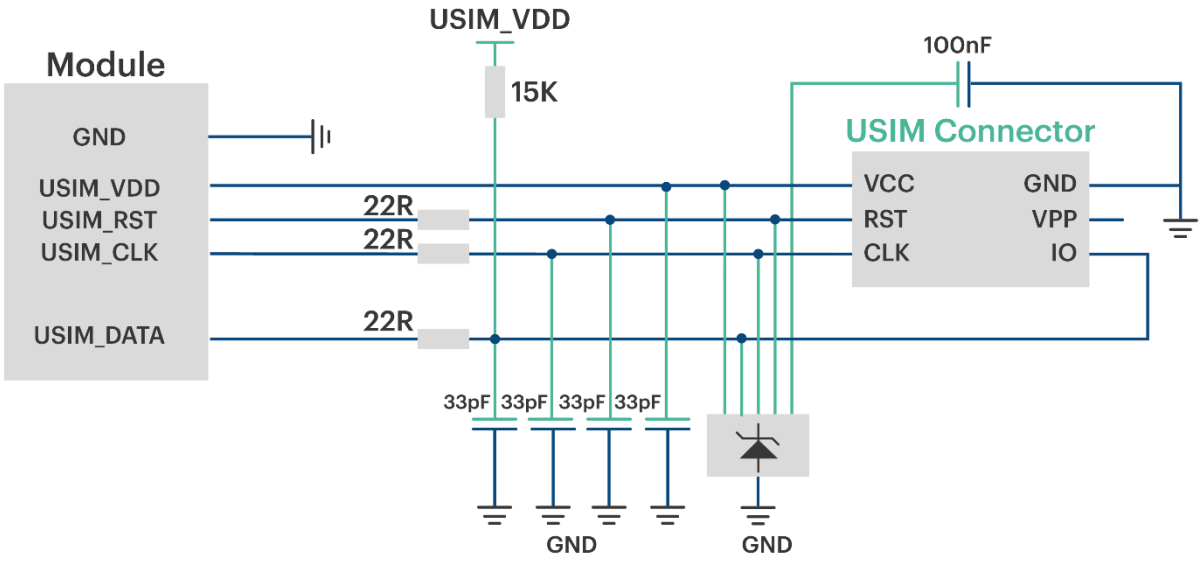


Figure 16 USIM design circuit diagram

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 C42GM module contains eight general control signals. The interface is defined as follows:

Table 14 General GPIO Pin Definitions

Pin no.	Signal name	I/O	Description
11	GPIO_1	IO	General input / output port
12	GPIO_2	IO	General input / output port
13	GPIO_3	IO	General input / output port
14	GPIO_4	IO	General input / output port
25	GPIO_5	IO	General input / output port
26	GPIO_6	IO	General input / output port
64	GPIO_7	IO	General input / output port
65	GPIO_8	IO	General input / output port

3.9 Indication interface

The C42GM module provides an open-drain GPIO signal to indicate the status of the RF communication.

3.9.1 Network status

C42GM 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 15 Network Indicator Pin Definition

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

Table 16 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:

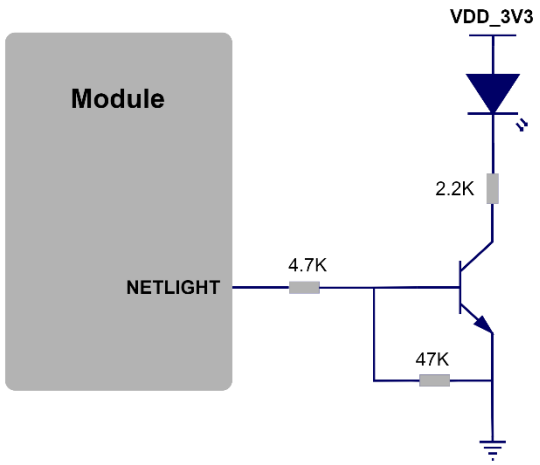


Figure 17 Net light circuit diagram

W_DISABLE# is airplane mode. When the module enters flight mode, the RF function do not work and all AT commands related to RF functions will be inaccessible. This mode can be set by

- ✓ Hardware: By pulling W_DISABLE# high.
- ✓ Software: AT+CFUN=4

AP_READY is used to allow the Application Processor to tell the module when it is ready to receive signals. It does not involve the sleep state of the module.

Table 17 Network Indicator Pin Definition 2

Pin no.	Signal name	I/O	Description
19	AP-READY	_	RESERVED
18	W-DISABLE	I	FLIGHT MODE

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.

3.9.2 Module status indication

- ✓ The C42GM module provides a pin as a working status indicator for the module.
- ✓ This pin can be used to connect to a GPIO or LED with pull-up.
- ✓ It is used to indicate the power-on status of the module.
- ✓ The drive current should be less than 0.8mA.
- ✓ The STATUS pin will output a low level and the rest will be in a high impedance state.

Table 18 Module Status Indicator Pin Definition

Pin no.	Signal name	I/O	Description	Remarks
20	STATUS	DO	Module power on status indication	External pull-up

The following figure shows the STATUS reference circuit design:

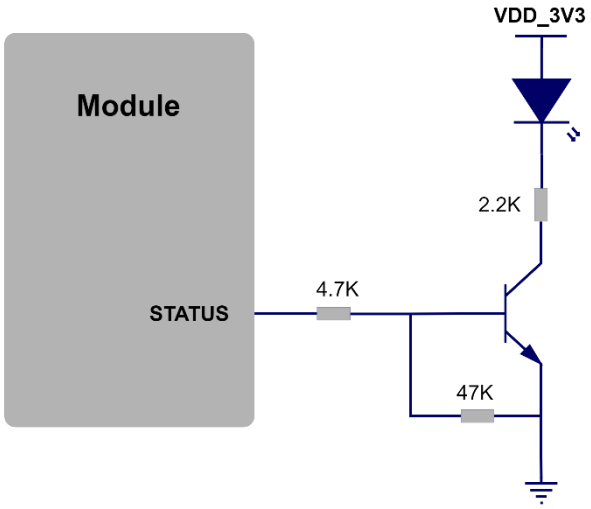


Figure 18 STATUS Pin Reference Circuit

3.10 PCM and I2C interface

- ✓ C42GM one Pulse Code Modulation (PCM) and one I2C interface.
- ✓ The module provides PCM interface pins for external codec PCM decoder chip.
- ✓ The module provides a set of hardware bidirectional serial buses with an I2C interface
- ✓ It has 1.8V level, a 5.0 protocol interface, and a clock rate of 400 KHz.

Table 19 PCM Pin Definition

Pin no.	Signal name	I/O	Description
6	PCM_IN	DI	PCM data input
7	PCM_OUT	DO	PCM data output
5	PCM_SYNC	DI	PCM Frame sync clock pulse
4	PCM_CLK	DI	PCM bit clock pulse
40	I2C_SCL	DO	I2C bus clock output
41	I2C_SDA		

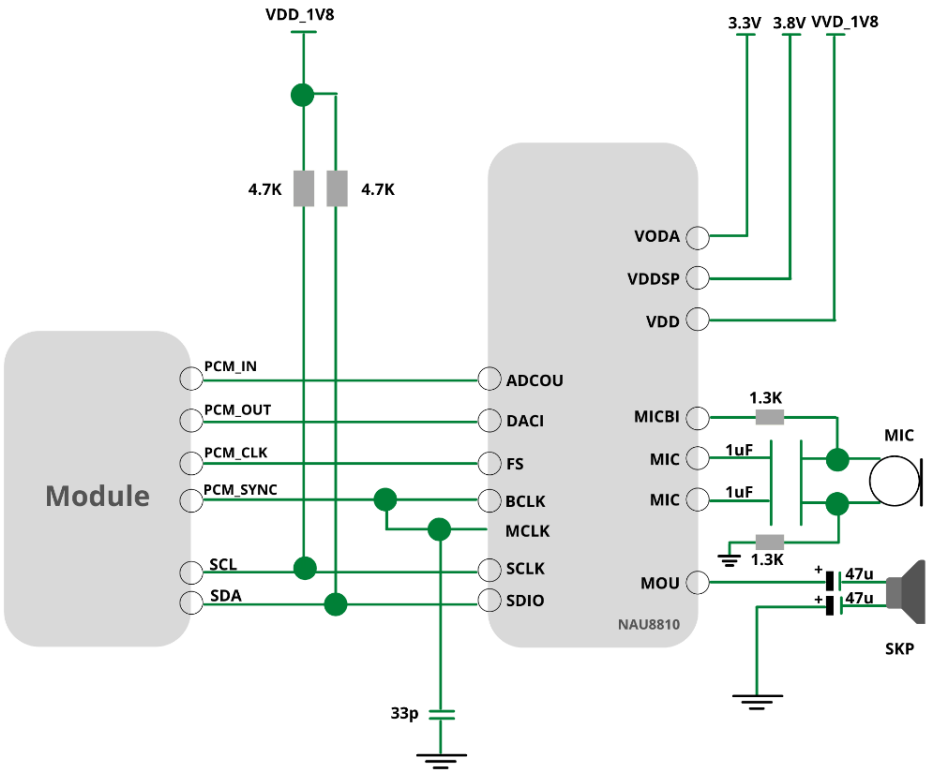


Figure 19 PCM to analog voice map

The I2C reference circuit is connected as follows:

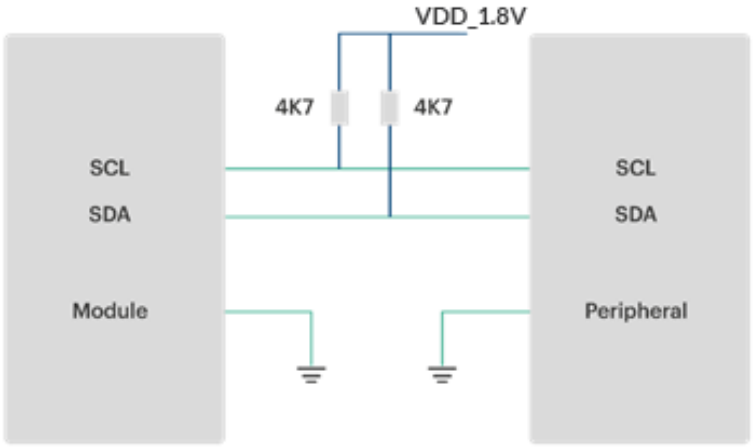


Figure 20 I2C interface reference circuit diagram

3.11 ADC interface

The C42GM 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

Pin no.	Signal name	IO	Description
2	ADC1		Analog to digital converter interface 1
24	ADC0		Analog to digital converter interface 0

Table 20 ADC Pin Definitions

3.12 CAN interface

Controller Area Network is an electronic communication bus which defines how communication happens, how wiring is configured and how messages are constructed, among other things. Collectively, this system is referred to as a CAN bus. It is a broadcast type of bus, all nodes can "hear" all transmissions. There is no way to send a message to just a specific node; all nodes will invariably pick up all traffic. The CAN hardware, however, provides local filtering so that each node may react only on the interesting messages.

- ✓ The module offers latest 5.0 protocol CAN bus
- ✓ It is primarily used in automotive applications
- ✓ It is certified for applications within 80 degrees Celsius
- ✓ The CAN comes with preset API commands, which enables the user to design applications according to his needs along with Cavli's Hubble platform

The following table describes CAN interface:

Table 21 CAN Pin definition

Pin no.	Signal name	I/O	Description
83	CAN_RX	IO	CAN Receiver
84	CAN_TX	IO	CAN Transmitter
85	CAN_CTRL1	IO	CAN Control pin 1
86	CAN_CTRL0	IO	CAN Control pin 2

The following circuit shows a reference diagram for CAN interface:

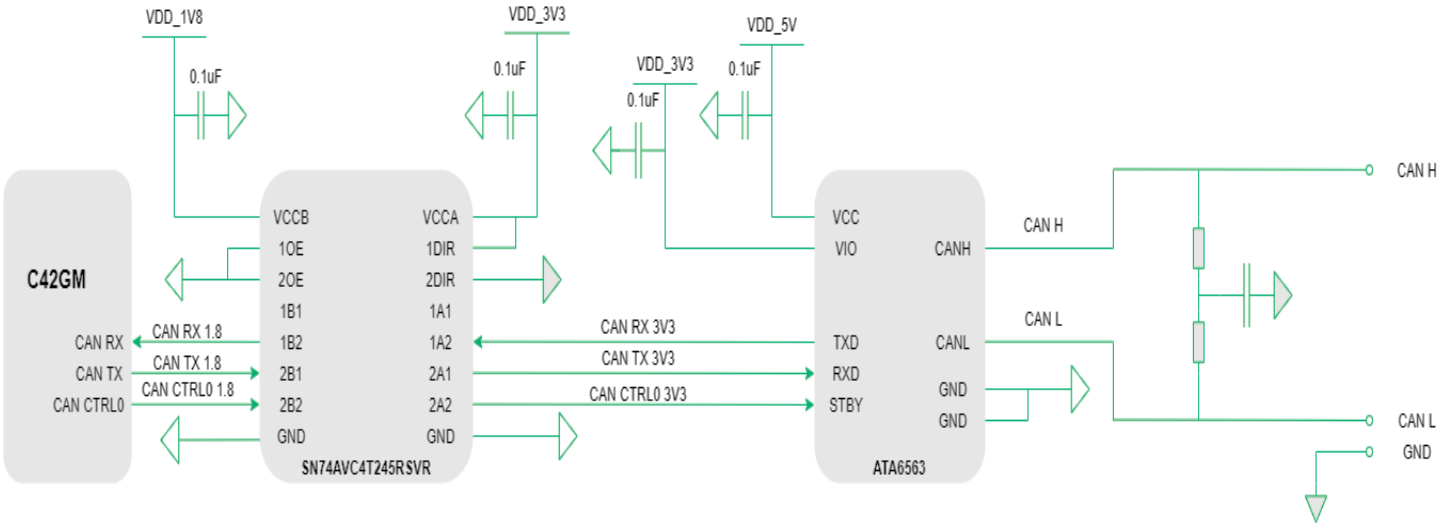


Figure 21 CAN reference circuit diagram

3.13 SPI interface

Table 22 SPI Interface Pin Definition

Pin no.	Signal name	I/O	Description
97	SPI_SS	DO	Slave select
96	SPI_SCLK	DO	Clock
95	SPI_MOSI	DI	Master output slave input
94	SPI_MISO	DI	Master input slave output

3.14 Sigfox interface

- ✓ Sigfox Network has a star topology: each of the access stations communicates with the Sigfox Cloud via a point-to-point link.
- ✓ It is implemented between the connected devices and the network.
- ✓ AT command is used to switch between Sigfox and LTE CAT M1 or NB.

Table 23 SigFox Antenna Pin Definition

Pin no.	Signal name	I/O	Description	Remarks
60	ANT_MAIN	IO	Main set antenna interface for LTE/ SigFox	50Ω characteristic impedance

3.15 SDIO interface

Table 24 SDIO Pin Definition

Pin no.	Signal name	I/O	Description
78	SDH_D0	IO	SD card SDIO bus DATA0
77	SDH_D1	IO	SD card SDIO bus DATA1
76	SDH_D2	IO	SD card SDIO bus DATA2
57	SDH_D3	IO	SD card SDIO bus DATA3
56	SDH_CMD	IO	SD card SDIO bus command
51	SDH_CLK	IO	SD card SDIO bus clock

3.16 PWM_OUT

C42GM provides one Pulse width modulation signal output. The user can program the signal frequency using the SDK.

Table 25 PWM_out Pin Definition

Pin no.	Signal name	I/O	Description
66	PWM_OUT	O	Pulse Width Modulation signal

3.17 GPS

C42GM provides Global Positioning System (GPS) whose pin description is given below.

Table 26 GPS Pin Definition

Pin no.	Signal name	I/O	Description
98	GNSS_VRTC	PI	Backup voltage for GNSS
99	GNSS_1PPS	O	One pulse per second

4 Antenna interface

4.1 Chapter overview

The C42GM 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 C42GM module provides two antenna interfaces,

Main Antenna Interface:

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

GNSS Antenna Interface:

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

Table 27 Antenna Interface Pin Definition

Pin no.	Signal name	I/O	Description	Remarks
60	ANT_MAIN	IO	Main set antenna interface for LTE / SigFox	50Ω characteristic impedance
49	ANT_GNSS	AI	GNSS antenna interface	50Ω characteristic 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:

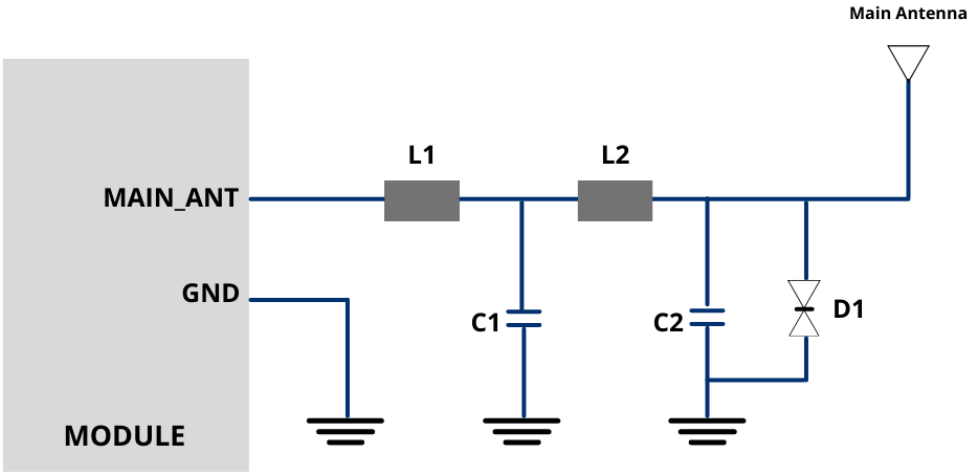


Figure 22 Main antenna circuit diagram

The main antenna requirements are tabulated below:

Table 28 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

B6 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B8 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B9 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B10 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
B15 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B16 FDD	<2.5:1	〉-4dbi	〉40%	19	<-94
B17 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
B24 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
B27 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B28 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B65 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B66 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93

B68 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93
B71 FDD	<2.5:1	〉-4dbi	〉40%	19	<-93

4.2.2 GNSS interface

To use GNSS, you need to open the GPS with AT command AT+CGPS=1 (for details, please refer to C42GM 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 antenna

The recommended circuit is as follows:

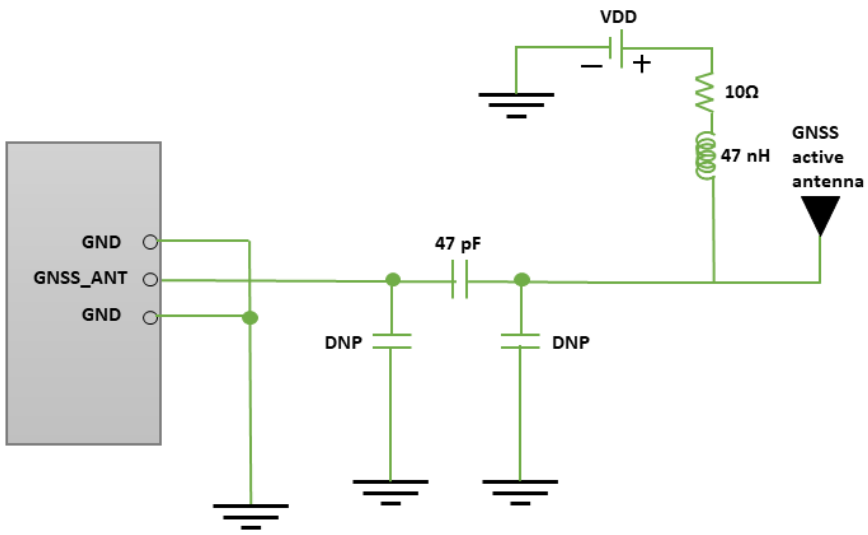


Figure 23 GNSS active antenna reference circuit

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 29 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 GNSS reception performance

Table 30 GNSS Performance parameters

Features	Description
Receiving Bands	✓ GPS L1/ Galileo E1 C/A: 1575.42 Mhz ✓ GLONASS L1 C/A: 1602.5625 MHz ✓ BD2 B1 C/A: 1561.098 MHz ✓ SBAS: WAAS, EGNOS, MSAS, GAGAN
Horizontal Positioning Accuracy:	< 2.0 m CEP50
Vertical Positioning accuracy	< 3.0 m CEP50
Velocity Accuracy:	Without Aid: < 0.01 m/s
TTFF@-130dBm	✓ Cold Start < 28s ✓ Hot Start ≤ 1s

	✓ Reacquisition ≤ 1 s
Sensitivity:	✓ Cold Start: -147 dBm ✓ Tracking: -160 dBm ✓ Hot Start: -155 dBm ✓ Reacquisition: -158 dBm

4.4 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:

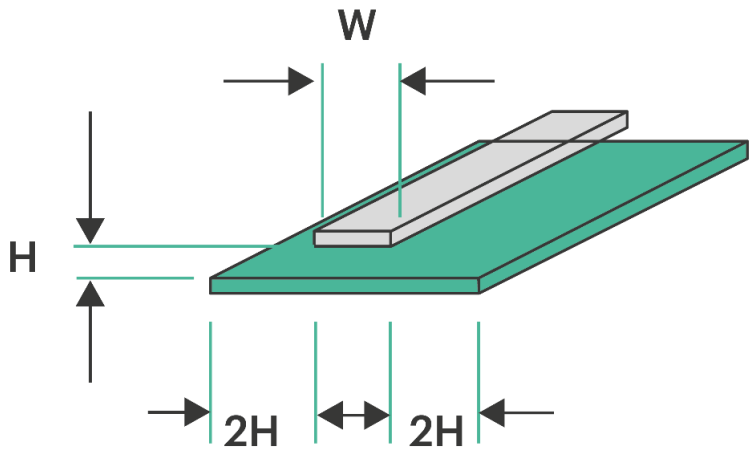


Figure 24 The complete structure of the two-layer PCB microstrip line

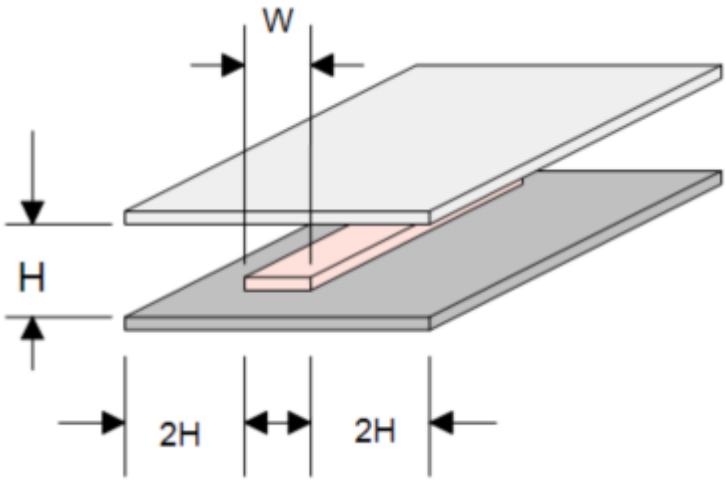


Figure 25 The complete structure of the multilayer PCB strip line

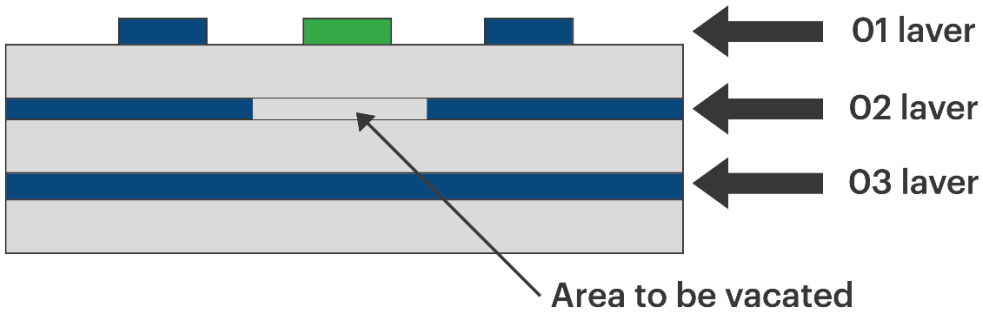


Figure 26 Reference ground is the third layer PCB coplanar transmission line structure

4.5 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.

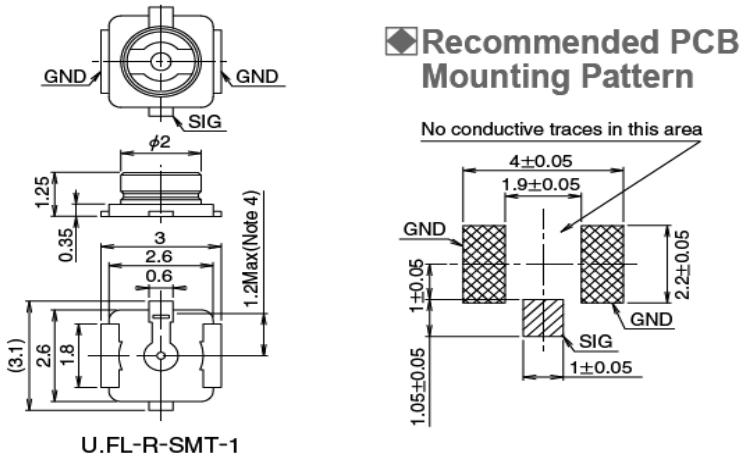


Figure 27 RF connector size chart

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

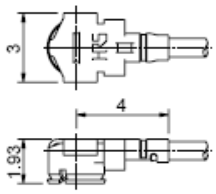
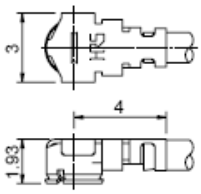
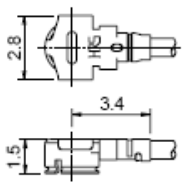
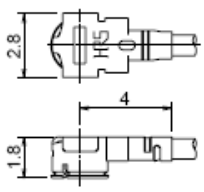
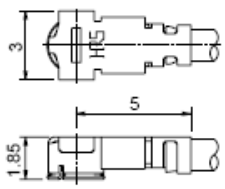
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 28 Antenna connector matching plug diagram

Table 31 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

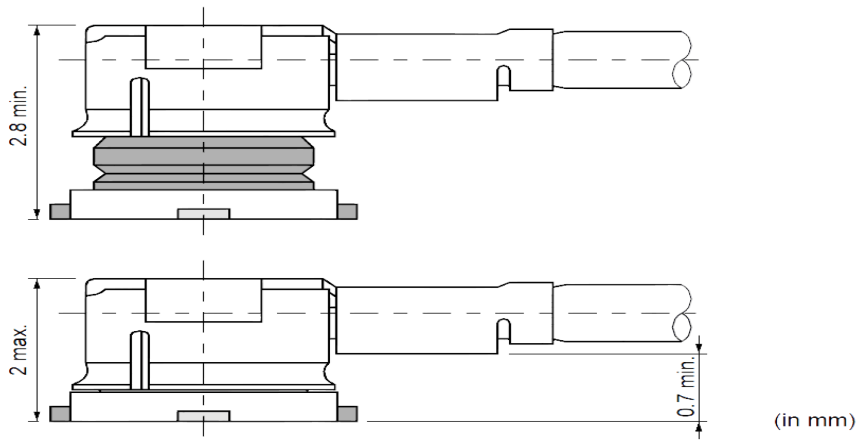


Figure 29 Matching coaxial RF line size

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

4.6 Working Frequency

Table 32 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 B6	830 MHz – 840 MHz	875 MHz- 885 MHz	FDD
LTE B8	880 MHz–915 MHz	925 MHz–960 MHz	FDD
LTE B9	1749.9 MHz - 1784.9 MHz	1844.9 MHz - 1879.9 MHz	FDD
LTE B10	1710 MHz - 1770 MHz	2110 MHz - 2170 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 B15	1900 MHz - 1920 MHz	2600 MHz - 2620 MHz	FDD
LTE B16	2010 MHz - 2025 MHz	2585 MHz - 2600 MHz	FDD
LTE B17	704 MHz - 716 MHz	734 MHz - 746 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 B24	1625.5 MHz - 1660.5 MHz	1525 MHz - 1559 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 B27	807 MHz - 824 MHz	852 MHz - 869 MHz	FDD
LTE B28	703 MHz– 748 MHz	758 MHz– 803 MHz	FDD
LTE B65	1920 MHz - 2010 MHz	2110 MHz - 2200 MHz	FDD
LTE B66	1710 MHz– 1780 MHz	2110 MHz– 2200 MHz	FDD
LTE B68	698 MHz - 728 MHz	753 MHz - 783 MHz	FDD
LTE B71	663 MHz – 698 MHz	617 MHz – 652 MHz	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 33 C42GM Module Working Storage Temperature

Parameter	Minimum value	Maximum value
Normal operating temperature	-30°C	85°C

5.3 Module IO level

The C42GM module IO levels are as follows:

Table 34 Electrical Characteristics of C42GM 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 C42GM module input power requirements are as follows:

Table 35 C42GM 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 36 UART Serial Power Definition

Name	Parameter	Voltage Level (V)		
		Min	Typical	Max
UART0_RI	VOH	1.35	1.8	2
	VOL	0		0.45
UART0_DCD	VOH	1.35	1.8	2
	VOL	0		0.45
UART0_CTS	VOH	1.35	1.8	2
	VOL	0		0.45
UART0_RTS	VIH	1.2	1.8	2
	VIL	-0.3		0.6
UART0_DTR	VIH	1.2	1.8	2
	VIL	-0.3		0.6
UART0_TXD	VOH	1.35	1.8	2
	VOL	0		0.45
UART0_RXD	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

5.5.2 USIM

Table 37 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:3.0V /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:3.0V /1.8V
	VOL	0	0	0.45	
USIM_RST	VOH	VDD-0.45		3.05	USIM_VDD:3.0V /1.8V
	VOL	0	0	0.45	

5.5.3 ADC

Table 38 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 and I2C

Table 39 PCM 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

Table 40 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 41 Power Consumption of C42GM Module

Mode	Type	Current consumption		
		Avg	Max	Unit
Power Saving mode			3.9	uA
Sleep State Idle state	@LTE CAT M1 DRX=1.28s @ Paging = 24ms	1.65	106	mA
	@LTE CAT NB1 DRX=1.28s @ Paging = 24ms	1.56	80	mA
	@ LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 20.48 s, DRX = 2.56 s	0.85	117	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 20.48 s, DRX = 2.56 s	0.81	85	mA
LTE Cat M1 data transfer (GNSS OFF)	Band 1 @ 22.37 dBm	186	412	mA
	Band 2 @ 21.96 dBm	187	402	mA
	Band 3 @ 22.11 dBm	187	403	mA
	Band 4 @ 21.96 dBm	182	387	mA
	Band 5 @ 20.48 dBm	192	422	mA
	Band 8 @ 22.30 dBm	190	413	mA
	Band 12 @ 22.41 dBm	185	412	mA
	Band 13 @ 20.82 dBm	199	450	mA
	Band 18 @ 20.33dBm	193	434	mA
	Band 19 @ 20.44dBm	191	430	mA
	Band 20 @ 22.37 dBm	192	429	mA
	Band 25 @ 22.57 dBm	186	416	mA

	Band 26 @ TBD	TBD	TBD	mA
	Band 28A @ 23.52 dBm	188	431	mA
	Band 28A @ 23.52 dBm	190	425	mA
	Band 66 @ 22.13 dBm	181	382	mA
LTE CAT NB1	Band 1 @ 22.10 dBm	149	373	mA
	Band 2 @ 21.40 dBm	151	384	mA
	Band 3 @ 21.07 dBm	144	360	mA
	Band 4 @ 20.72 dBm	145	365	mA
	Band 5 @ 20.49 dBm	165	423	mA
	Band 8 @ 23.76 dBm	155	399	mA
	Band 12 @ 21.30 dBm	150	385	mA
	Band 13 @ 20.54 dBm	172	442	mA
	Band 18 @ 21.32 dBm	165	427	mA
	Band 19 @ 20.98 dBm	164	431	mA
	Band 20 @ 21.55 dBm	165	423	mA
	Band 25 @ 21.42 dBm	153	389	mA
	Band 26 @ TBD	TBD	TBD	mA
	Band 28 @ 21.45 dBm	158	410	mA
	Band 65 @ 22.99 dBm	147	376	mA
	Band 66 @ 20.55 dBm	147	376	mA
	Band 71 @ 22.02 dBm	147	376	mA
	Band 85 @ 21.68 dBm	147	376	mA
GNSS(Searching) AT+CFUN=0	Cold start @ Instrument		71	mA
	Cold start @ Real network with half sky, Active Antenna		71	mA
GNSS(Tracking)	Instrument Environment @ DPO off		56	mA
	Instrument Environment @ DPO on		21	mA

AT+CFUN=0	Half Sky @ Real network, Active Antenna, DPO off		56	mA

5.7 Electrostatic property

There is no overvoltage protection inside the C42GM 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 42 C42GM 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 43 C42GM 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 to the horizontal marble platform Working mode: no packaging, no Power on, do not boot	IEC60068-2-32	Visual inspection: to be tested Function check: to be tested 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 30 Module Structural design

6.3 C42GM module mechanical size

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

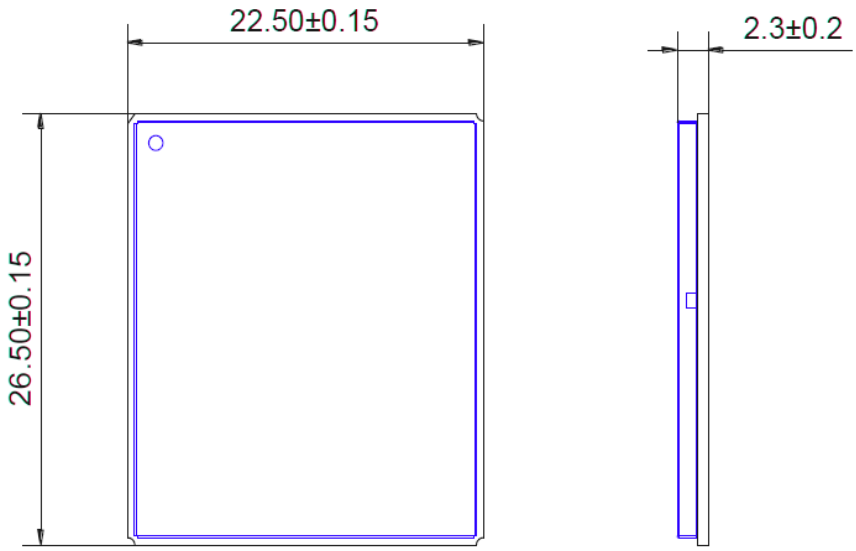


Figure 31 Front view and side view of the module (unit: mm)

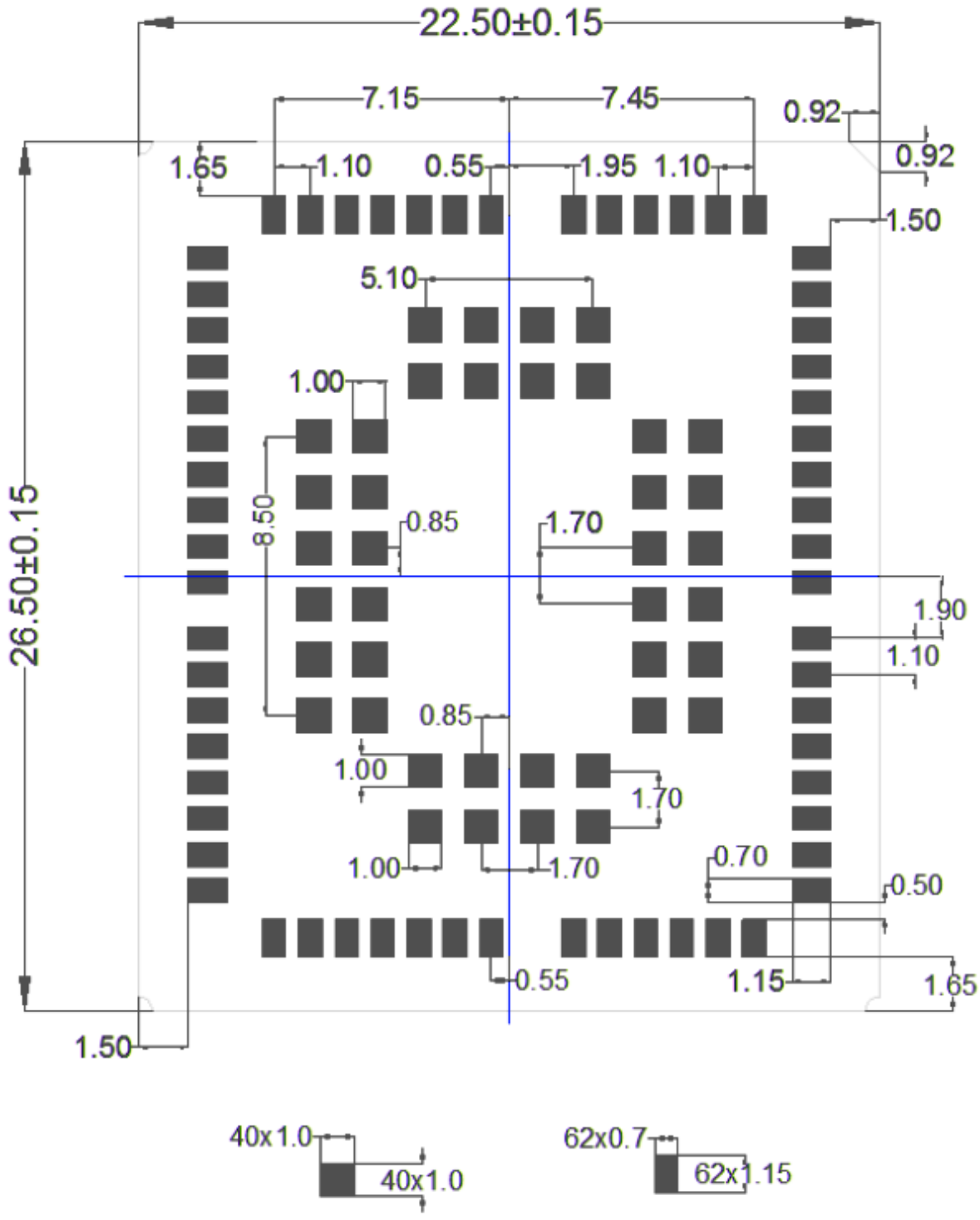


Figure 32 Bottom view of the module (unit: mm)

Module recommended footprint:

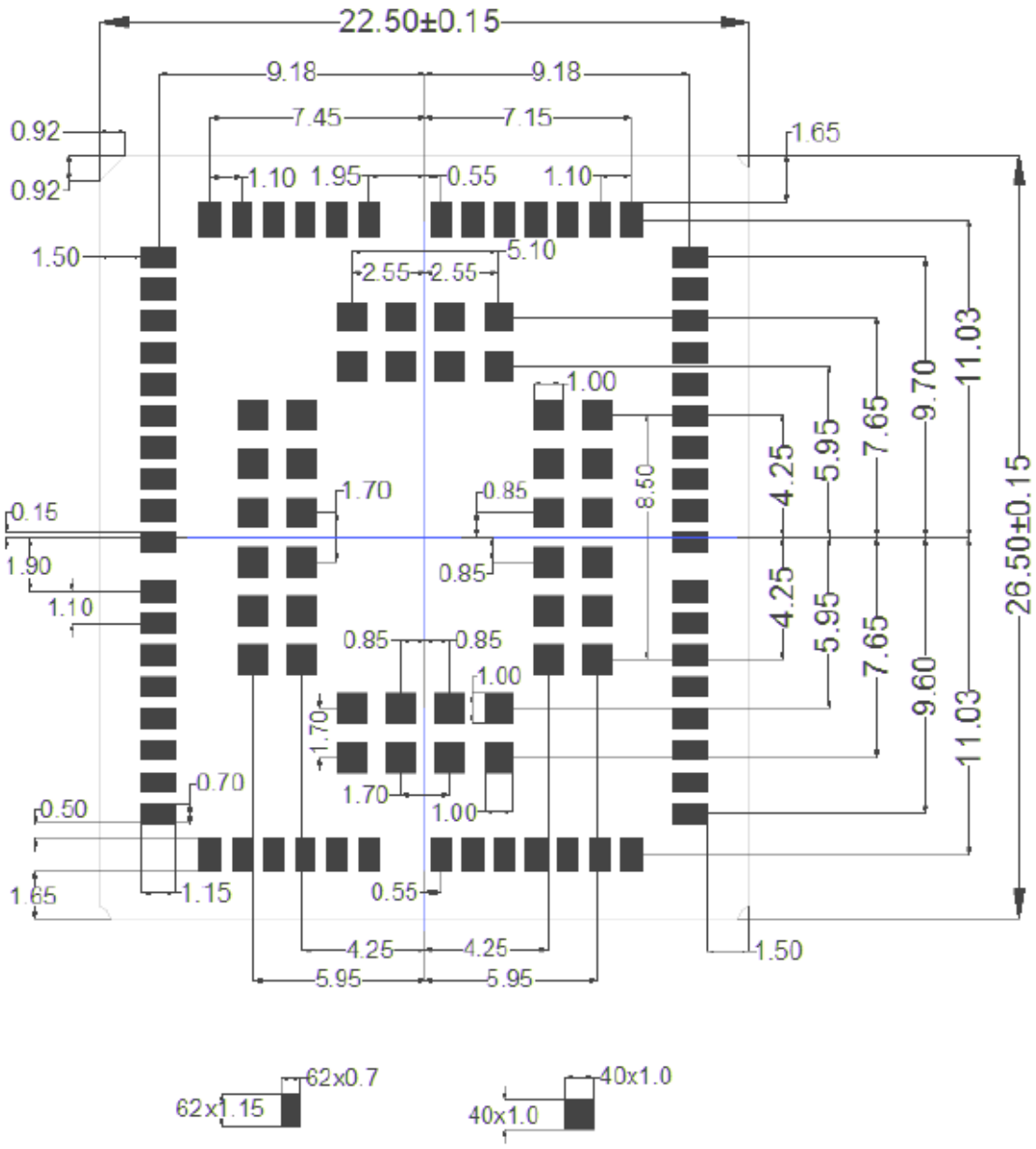


Figure 33 Recommended Footprint (Top View) (unit: mm)

7 Ordering information

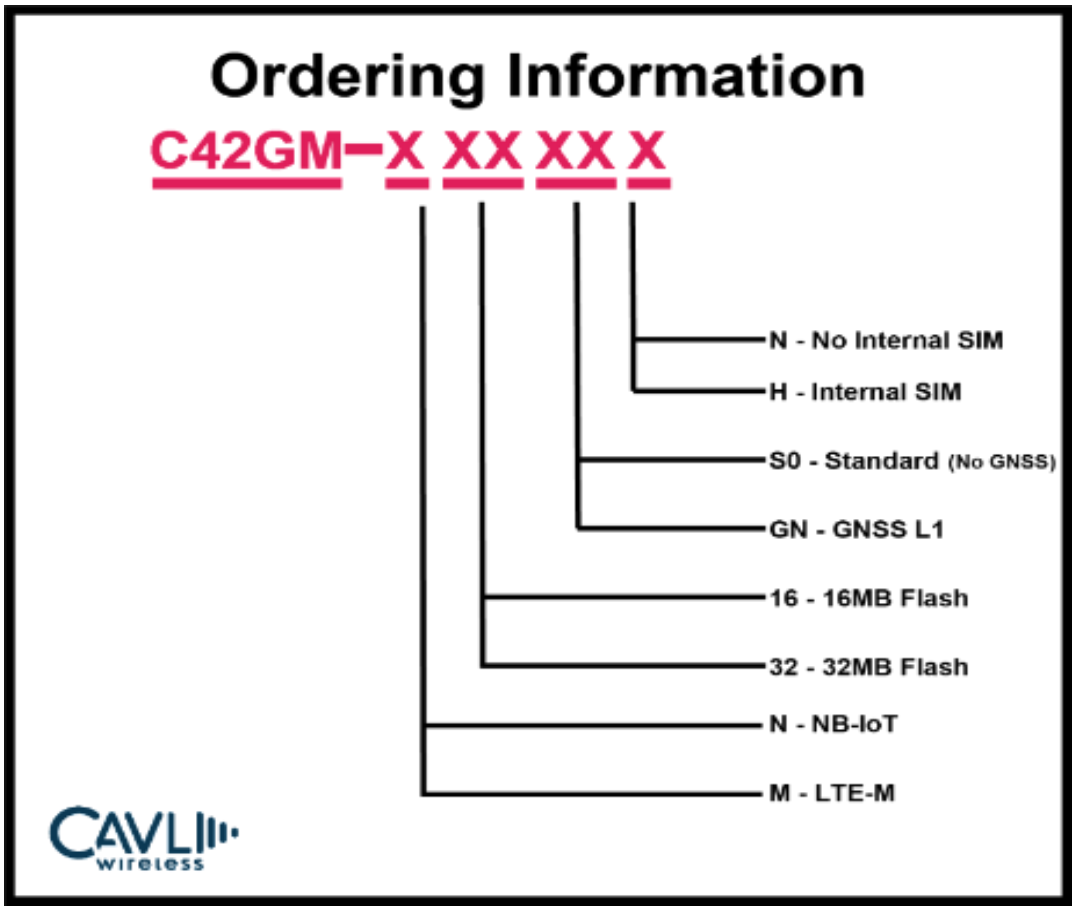


Figure 34 Ordering Information

Table 44 Ordering Information

Part Number	Package Type	Tape width	Tolerance	SPQ
C42GM-M16S0N	Tape & Reel	44mm	0.2 mm	500
C42GM-M16S0H	Tape & Reel	44mm	0.2 mm	500
C42GM-M16GNN	Tape & Reel	44mm	0.2 mm	500
C42GM-M16GNH	Tape & Reel	44mm	0.2 mm	500

C42GM-M32S0N	Tape & Reel	44mm	0.2 mm	500
C42GM-M32S0H	Tape & Reel	44mm	0.2 mm	500
C42GM-M32GNN	Tape & Reel	44mm	0.2 mm	500
C42GM-M32GNH	Tape & Reel	44mm	0.2 mm	500
C42GM-N16S0N	Tape & Reel	44mm	0.2 mm	500
C42GM-N16S0H	Tape & Reel	44mm	0.2 mm	500
C42GM-N16GNN	Tape & Reel	44mm	0.2 mm	500
C42GM-N16GNH	Tape & Reel	44mm	0.2 mm	500
C42GM-N32S0N	Tape & Reel	44mm	0.2 mm	500
C42GM-N32S0H	Tape & Reel	44mm	0.2 mm	500
C42GM-N32GNN	Tape & Reel	44mm	0.2 mm	500
C42GM-N32GNH	Tape & Reel	44mm	0.2 mm	500

8 Packaging and production

8.1 Chapter overview

- Module packaging and storage
- Production welding

8.2 Module packaging and storage

The C42GM module is packaged in a tape reel with 500 pcs per reel, shipped as a tape reel sealed bag.

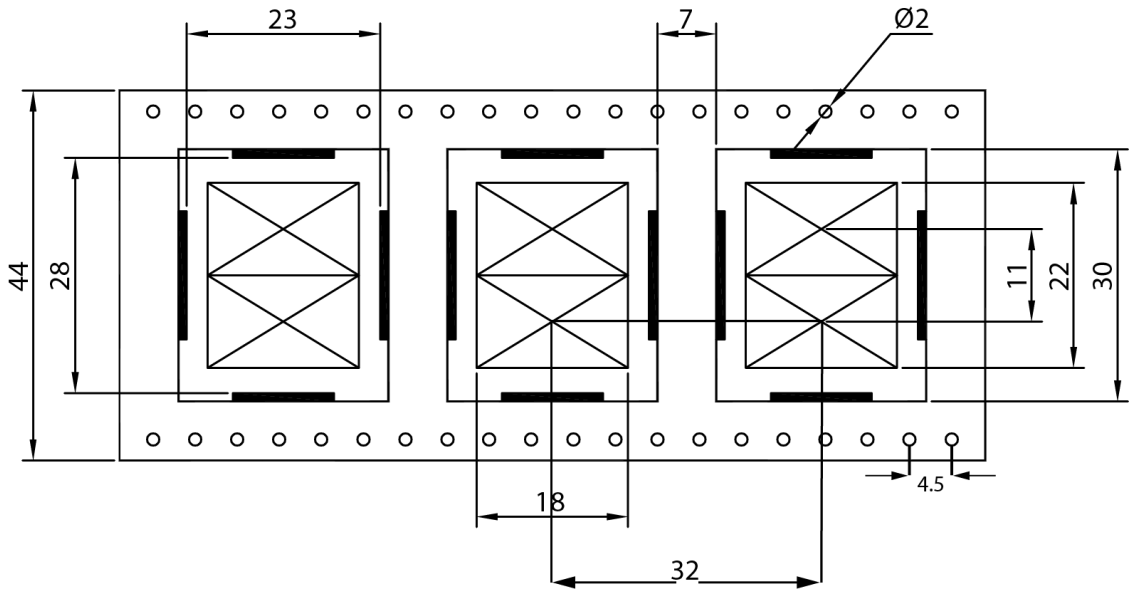


Figure 35 C42GM Tape Measurements (in mm)

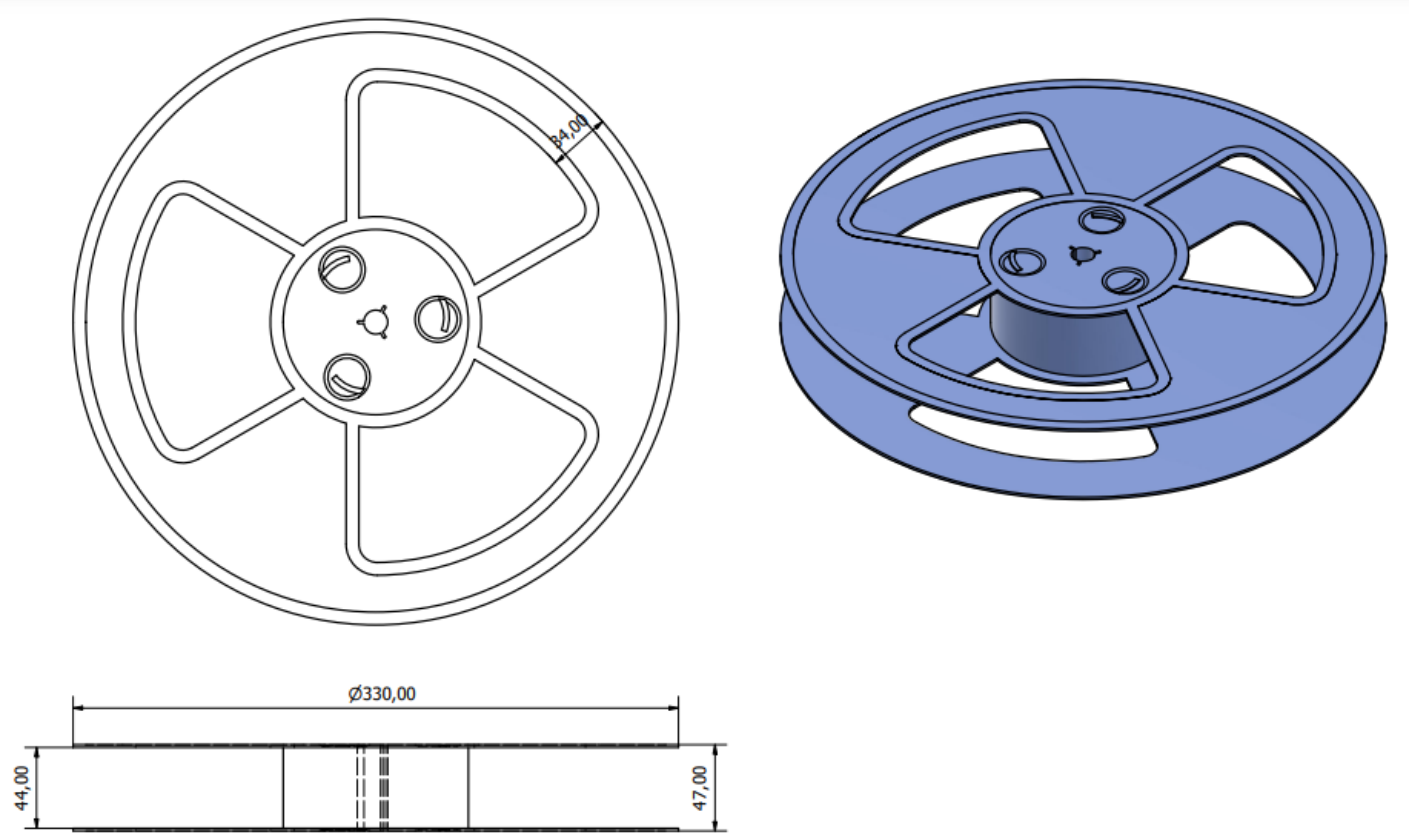


Figure 36 Reel Dimensions of C42GM (in mm)

The storage of the C42GM 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).

8.3 Production welding

The C42GM 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 C42GMmodule 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:

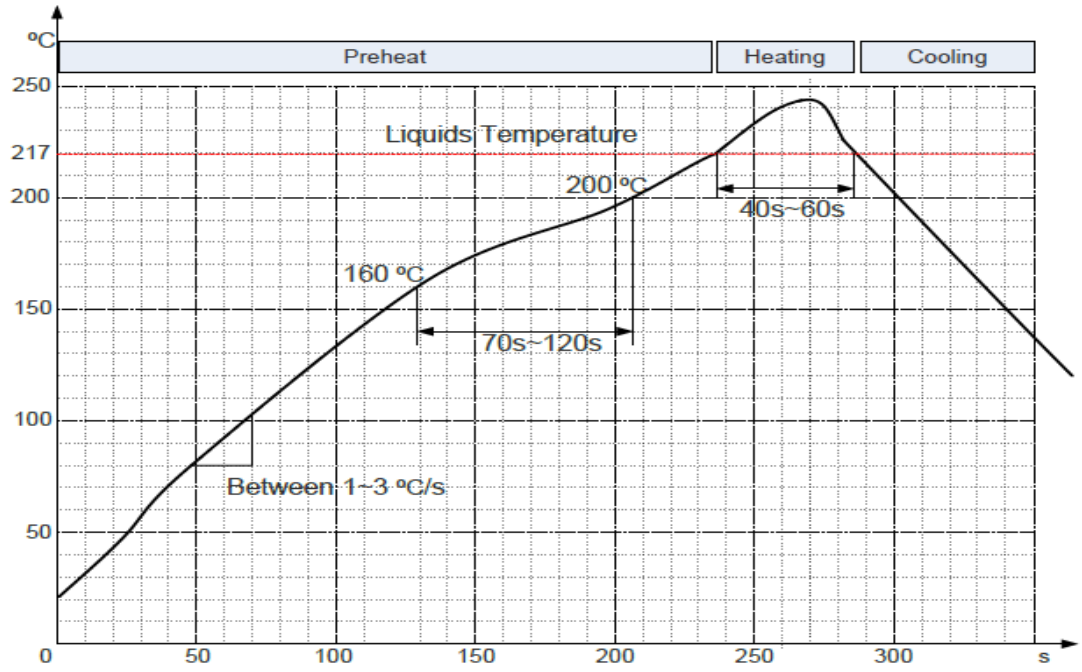


Figure 37 Reflow soldering temperature graph.

Table 45 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	

9 Appendix

9.1 Chapter overview

- Abbreviations
- Safety and precautions

9.2 Abbreviations

Table 46 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

9.3 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.

10. CE EU Conformity Statement

HEREBY, CAVLI INC DECLARES THAT THE EQUIPMENT TYPE LTE MODEM, MODEL C42GM IS IN COMPLIANCE WITH DIRECTIVE 2014/53/EU.

MANUFACTURER ADDRESS: 99 SOUTH ALMADEN BLVD., SUITE 600, SAN JOSE, CA 95113 UNITED STATES.

THE FULL TEXT OF THE EU DECLARATION OF CONFORMITY IS AVAILABLE AT THE FOLLOWING INTERNET ADDRESS: https://www.cavliwireless.com

11. FCC and ISED Statement

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device. And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source based timeaveraging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3. A label with the following statements must be attached to the host end product: This device contains FCC ID: 2BB64C42GM
4. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed 2dBi.
5. This module must not transmit simultaneously with any other antenna or transmitter.
6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines. For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093.

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products. The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: 2BB64C42GM" or "Contains FCC ID: 2BB64C42GM" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device. The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

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

Manual Information To the End User

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

ISED Statement

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device."The transmitter module may not be co-located with any other transmitter orantenna. or "Le présentappareil est conforme aux CNR d' Industrie Canada applicables aux appareils radio exempts de licence.L'exploitation est autorisée aux deux conditions suivantes :

1) l'appareil ne doit pas produire de brouillage; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

Déclaration sur l'exposition aux rayonnements RF

L'autre utilisépour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

The host product shall be properly labeled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must

be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word “Contain” or similar wording expressing the same meaning, as follows: “Contains IC:31113-C42GM” or “where: 31113-C42GM is the module’s certification number”.

Le produit hôte doit être correctement étiquetép our identifier les modules dans le produit hôte. L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, préc édéd u mot «Contient»o u d'un libellés emblable exprimant la même signification, comme suit:

"Contient IC:31113-C42GM” ou "où: 31113-C42GM est le numéro de certification du module".