GOC-RN440

Bluetooth+WIFI6 Module Hardware Specification

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NOTE:

1. Unpacking exceeds 72h, vacuum packaging exceeds half a year and has not been used. Baking at 60 ℃ for 12h is required.

Release Record

Version Number	Release Date	Comments
V1.0	2022/05/30	Initial draft
V1.1	2023/05/16	Update current and Weight

Contents

1. Introduction

GOC-RN440 is a highly integrated single-chip that support 2-stream 802.11ax solutions with Multi-user MIMO (Multiple-Input, Multiple-Output) with Wireless LAN (WLAN) PCIExpress network interface controller and HS-UART mixed interface . It combines a WLAN MAC, a 2T2R capable WLAN baseband, and RF in a single chip. The GOC-RN440 provides a complete solution for a high-performance integrated wireless and Bluetooth device.

GOC-RN440 baseband implements Multi-user Multiple Input, Multiple Output (MU-MIMO) Orthogonal Frequency Division Multiplexing (OFDM) with two transmit and two receive paths (2T2R). Features include two spatial stream transmissions, short Guard Interval (GI) , spatial spreading, and support for variant channel bandwidth. Moreover, GOC-RN440 provides one spatial stream space-time block code (STBC), Transmit Beamforming (TxBF) and Low Density Parity Check (LDPC) to extend the range of transmission. At the receiver, extended range and good minimum sensitivity is achieved by having receiver diversity up to 2 antennas. As the recipient, the GOC-RN440 also supports explicit sounding packet feedback that helps senders with beamforming capability.

For legacy compatibility, Direct Sequence Spread Spectrum (DSSS), Complementary Code Keying (CCK) and OFDM baseband processing are included to support all IEEE 802.11b, 802.11g and 802.11a data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability are available, and CCK provides support for legacy data rates, with long or short preamble.The CCK processor can perform dual-receiver by providing diversity gain to extend range and improve the reception.The high speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, 64QAM, 256QAM, and up to 1024QAM modulation of the individual subcarriers, and rate compatible coding rate of 1/2, 2/3, 3/4,and 5/6, provide up to 1201Mbps for IEEE 802.11ax MIMO OFDM.

For advanced 11ax spec, GOC-RN440 can receive with OFDMA (OFDM Access) technology. The RU size can be supported form small unit, e.g., RU26, and RU52, 106, 242, 484, and finally up to RU996. The high-order modulation scheme, such as 1024-QAM, can also be handled very well. Meanwhile, diff number of total subcarrier in the HE-LTF, such as 1x, 2x and 4x is considered. More networking efficiency can be achieved by 1x, and better channel estimation performance provided by 4x.

GOC-RN440 builds in an enhanced signal detector, an adaptive frequency domain equalizer,and a soft-decision Viterbi decoder to alleviate severe multi-path effects and mutual interference in the reception of multiple streams. For better detection quality, receive diversity with Maximal-Ratio-Combine (MRC) applying up to two receive paths, and Maximum-Likelihood Detection (MLD) are implemented.Robust interference detection and suppression are provided to protect against Bluetooth, cordless phone,and microwave oven interference.

Receive vector diversity for multi-stream application is implemented for efficient utilization of the MIMO channel. Efficient IQ-imbalance, DC offset, phase noise, frequency offset, and timing offset compensations are provided for the radio frequency front-end.

The GOC-RN440 supports fast receiver Automatic Gain Control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control functions to obtain better performance in the analog portions of the transceiver.

The GOC-RN440 MAC supports 802.11e for multimedia applications, 802.11i and WAPI(Wireless Authentication Privacy Infrastructure) for security, and 802.11n/802.11ac/802.11ax for enhanced MAC protocol efficiency. Using packet aggregation techniques such as A-MPDU with BA and A-MSDU,protocol efficiency is significantly improved. Power saving mechanisms such as Legacy Power Save, UAPSD, and MIMO power saving reduce the power wasted during idle time, and compensate for the extra power required to transmit MIMO OFDM. The GOC-RN440 provides simple legacy, 20MHz/40MHz/80MHz co-existence mechanisms to ensure backward and network compatibility.

2. Block Diagram

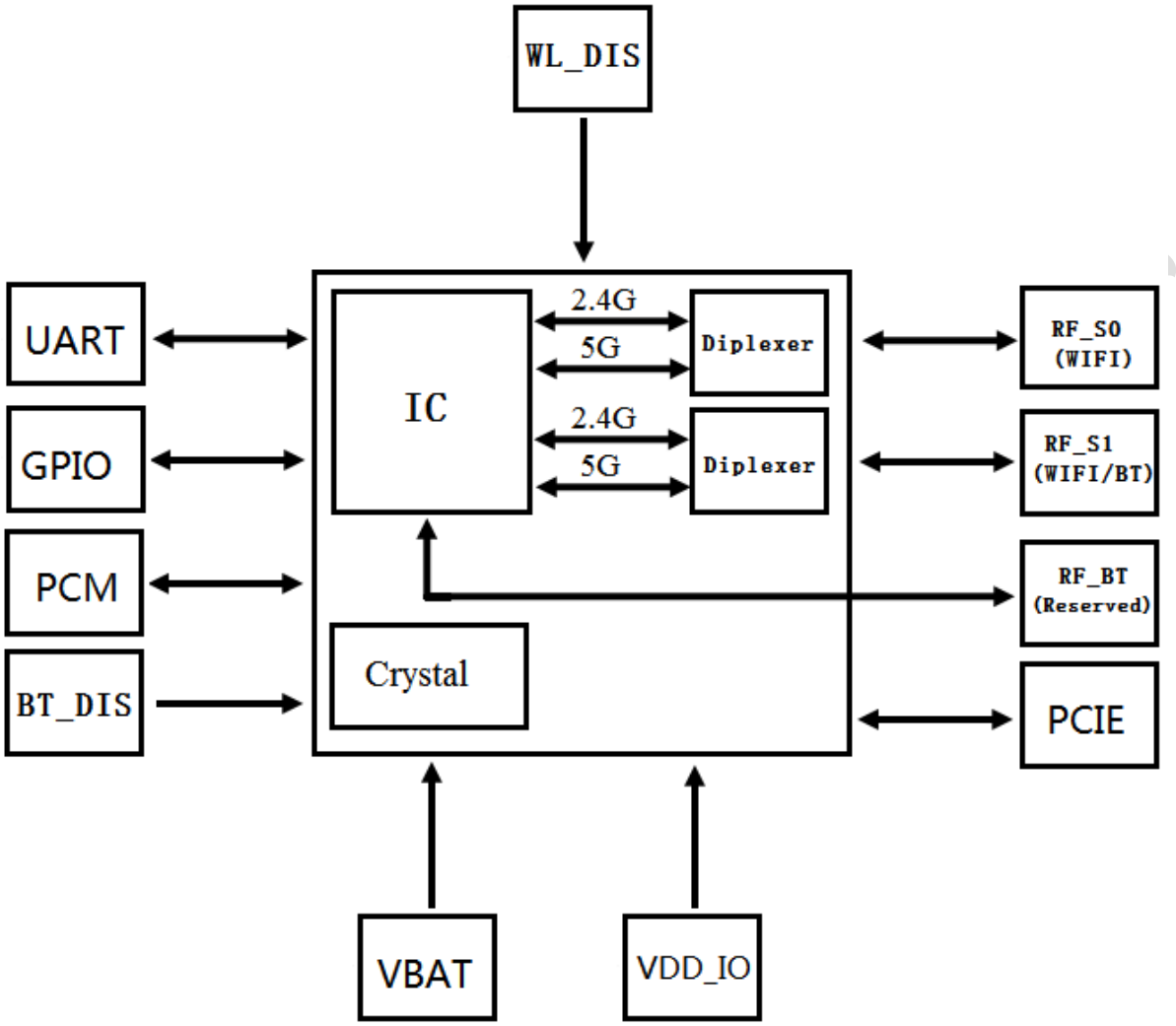


Figure 1: GOC-RN440 system Block Diagram

3. Features

3.1 General

- CMOS MAC, Baseband PHY and RF in a single chip for IEEE 802.11a/b/g/n/ac/ax compatible WLAN
- Support 802.11ac 2x2,Wave-2 compliant with RX MU-MIMO
- Support 802.11ax 2x2, with OFDMA and MU-MIMO, by 4 types PPDU format, such as HE-SU-PPDU, HE-ER-SU-PPDU, HEMU-PPDU, and HE-TB-PPDU
- Maximum PHY data rate up to 286.8 Mbps using 20MHz bandwidth, 573.5Mbps using 40MHz bandwidth, and 1201Mbps using 80MHz bandwidth
- Backward compatible with 802.11a/b/g devices while operating at 802.11n data rates
- Backward compatible with 802.11a/n/ac devices while operating at 802.11ax data rates

3.2 Host Interface

- Complies with PCI Express Base Specification Revision 1.1

- PCIe LTR/L1.Off state supported
- Complies with HS-UART with configurable baud rate for Bluetooth

3.3 Standards Supported

- IEEE 802.11a/b/g/n/ac/ax compatible WLAN
- IEEE 802.11e QoS Enhancement (WMM)
- IEEE 802.11i (WPA, WPA2, WPA3). Open,shared key, and pair-wise key authentication services
- IEEE 802.11h DFS, TPC, Spectrum Measurement
- IEEE 802.11k Radio Resource Measurement
- WAPI (Wireless Authentication Privacy Infrastructure) certified

3.4 MAC Features

- Frame aggregation for increased MAC efficiency (A-MSDU, A-MPDU)
- Low latency immediate Block Acknowledgement (BA)
- PHY-level spoofing to enhance legacy compatibility
- MIMO power saving mechanism
- Support TWT function for power saving.
- Channel management and co-existence
- Multiple BSSID feature allows the GOC-RN440 to assume multiple
- MAC identities when used as a wireless bridge
- Transmit Opportunity (TXOP) Short InterFrame Space (SIFS) bursting for higher multimedia bandwidth
- WiFi Direct supports wireless peer to peer applications.Support BSR and queue size of Qos.
- Support MU EDCA feature.
- Support DFS, Channelinfo, PPDU state by Rx path

3.5 Other Features

- Supports Wake-On-WLAN via Magic Packet and Wake-up frame
- Transmit Beamforming
- Support S3/S4 AES/TKIP group key update
- FTM support distance measurement
- Support Network List Offload
- CCA on secondary through RTS/CTS handshake
- Support TCP/UDP/IP checksum offload

3.6 PHY Features

- IEEE 802.11ax MIMO OFDM/OFDMA
- IEEE 802.11ac MIMO OFDM
- IEEE 802.11n MIMO OFDM
- Two Transmit and Two Receive paths
- 20MHz / 40MHz / 80MHz bandwidth transmission
- Support 2.4Ghz and 5Ghz band channels
- Short Guard Interval (400ns)
- Sounding packet
- DSSS with DBPSK and DQPSK, CCK modulation with long and short preamble
- OFDM with BPSK, QPSK, 16QAM,64QAM, 256QAM and 1024QAM modulation. Convolutional Coding Rate:1/2, 2/3, 3/4, and 5/6
- Maximum data rate 54Mbps in 802.11g,300Mbps in 802.11n and 866.7Mbps in 802.11ac, 1201Mbps in 802.11ax.
- OFDM/DSSS receive diversity with MRC using up to 2 receive paths. Switch diversity used for CCK

- Support STBC
- Support LDPC
- Hardware antenna diversity
- Maximum-Likelihood Detection (MLD)
- Fast receiver Automatic Gain Control (AGC)
- On-chip ADC and DAC
- Build-in both 2.4GHz and 5GHz PA
- Build-in both 2.4GHz and 5GHz LNA

3.7 Bluetooth Controller

- Support Bluetooth 5 system (BT 5.2 Logo Compliant)
- Compatible with Bluetooth v2.1+EDR
- Supports all packet types in basic rate and enhanced data rate
- Dual Mode support: Simultaneous LE and BR/EDR
- Supports multiple Low Energy states
- Supports Bluetooth Low Energy

3.8 Bluetooth Transceiver

- Fast AGC control to improve receiving dynamic range
- Integrated internal Class 1, Class 2, and Class 3 PA
- Supports Enhanced Power Control
- Supports Bluetooth Low Energy
- Integrated 32K oscillator for power management

4. Specification

Feature	Description
Model Name	GOC-RN440
Bluetooth	
Bluetooth Standard	Bluetooth V5.2
Frequency Band	2402MHz~2480MHz
Interface	UART/PCM
WIFI	
Frequency Band	2.4GHz/5GHz
Interface	PCIe
Size	17mm*17mm*2.4mm
Operating Temperature	-40℃~+85℃
Storage Temperature	-55℃~+125℃
VBAT	3.3V
VDD_IO	1.8V or 3.3V
Working Current	150~350mA
Peak Current	2A
Humidity	Operating Humidity 60% to 85% Non-Condensing

Table 1: Specifications

5. Pin Diagram And Description

5.1 Pin Diagram

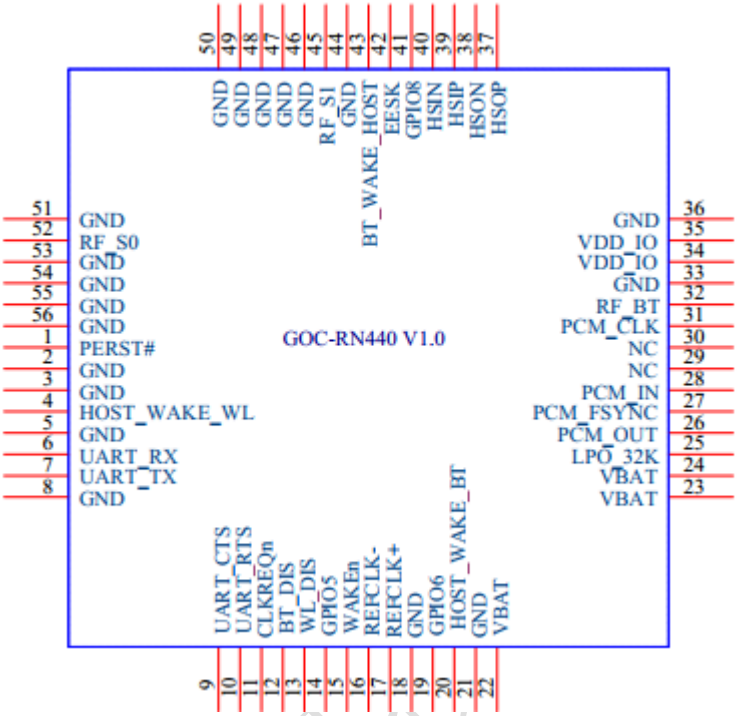


Figure 2: GOC-RN440 Pin

5.2 Pin Description

Pin	Pin Name	**Type**	Description
1	PERST#	Input	PCI Express Reset Signal: active low
2	GND	Ground	Ground
3	GND	Ground	Ground
4	HOST_WAKE_WL	Input	The Host wakes up the WLAN controller in Remote Wakeup Mode
5	GND	Ground	Ground
6	UART_RX	Input	High-Speed UART Data In
7	UART_TX	Output	High-Speed UART Data Out
8	GND	Ground	Ground
9	UART_CTS	Input	High-Speed UART CTS
10	UART_RTS	Output	High-Speed UART RTS
11	CLKREQn	Input/Open Drain	Reference Clock Request Signal
12	BT_DIS	Input	Bluetooth enable
13	WL_DIS	Input	WIFI enable
14	GPIO5	Input/Output	General Purpose Input/ Output Pin
15	WAKEn	Output	Power Management Event: Open drain, active low. Used to reactivate the PCI Express slot's main power rails and reference clocks. This WAKE# can be shared with BT wake up host
16	REFCLK-	Input	PCI Express Differential Reference Clock Source:

			100MHz ±300ppm
17	REFCLK+	Input	PCI Express Differential Reference Clock Source: 100MHz ±300ppm
18	GND	Ground	Ground
19	GPIO6	Input/Output	General Purpose Input/ Output Pin
20	HOST_WAKE_BT	Input	HOST to wake-up Bluetooth device
21	GND	Ground	Ground
22	VBAT	POWER	3.3V Supply Voltage
23	VBAT	POWER	3.3V Supply Voltage
24	VBAT	POWER	3.3V Supply Voltage
25	LPO_32K	Input	External sleep clock input (32.768 kHz)(Reserved)
26	PCM_OUT	Output	PCM data Output
27	PCM_SYNC	Input/Output	PCM Synchronization control
28	PCM_IN	Input	PCM data Input
29	NC	NC	NC
30	NC	NC	NC
31	PCM_CLK	Input/Output	PCM clock
32	RF_BT	RF	Bluetooth antenna (Reserved)
33	GND	Ground	Ground
34	VDD_IO	POWER	1.8V~3.3V Supply Voltage
35	VDD_IO	POWER	1.8V~3.3V Supply Voltage
36	GND	Ground	Ground
37	HSOP	Output	PCI Express Transmit Differential Pair
38	HSON	Output	PCI Express Transmit Differential Pair
39	HSIP	Input	PCI Express Receive Differential Pair
40	HSIN	Input	PCI Express Receive Differential Pair
41	GPIO8	Input/Output	General Purpose Input/ Output Pin
42	EESK	Input	WLAN eFuse autoload
43	BT _WAKE_HOST	Output	Bluetooth device to wake-up HOST
44	GND	Ground	Ground
45	RF_S1	RF	WIFI/BT antenna
46	GND	Ground	Ground
47	GND	Ground	Ground
48	GND	Ground	Ground
49	GND	Ground	Ground
50	GND	Ground	Ground
51	GND	Ground	Ground
52	RF_S0	RF	WIFI antenna
53	GND	Ground	Ground
54	GND	Ground	Ground
55	GND	Ground	Ground
56	GND	Ground	Ground

Table 2: Pin Description

5.3 PCB Layout Footprint

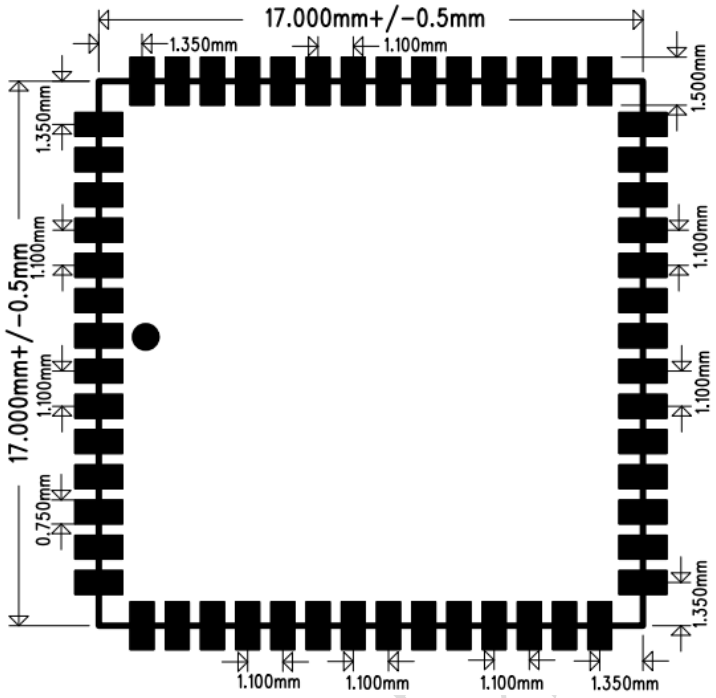


Figure 3: PCB Layout Footprint

5.4 Module Package

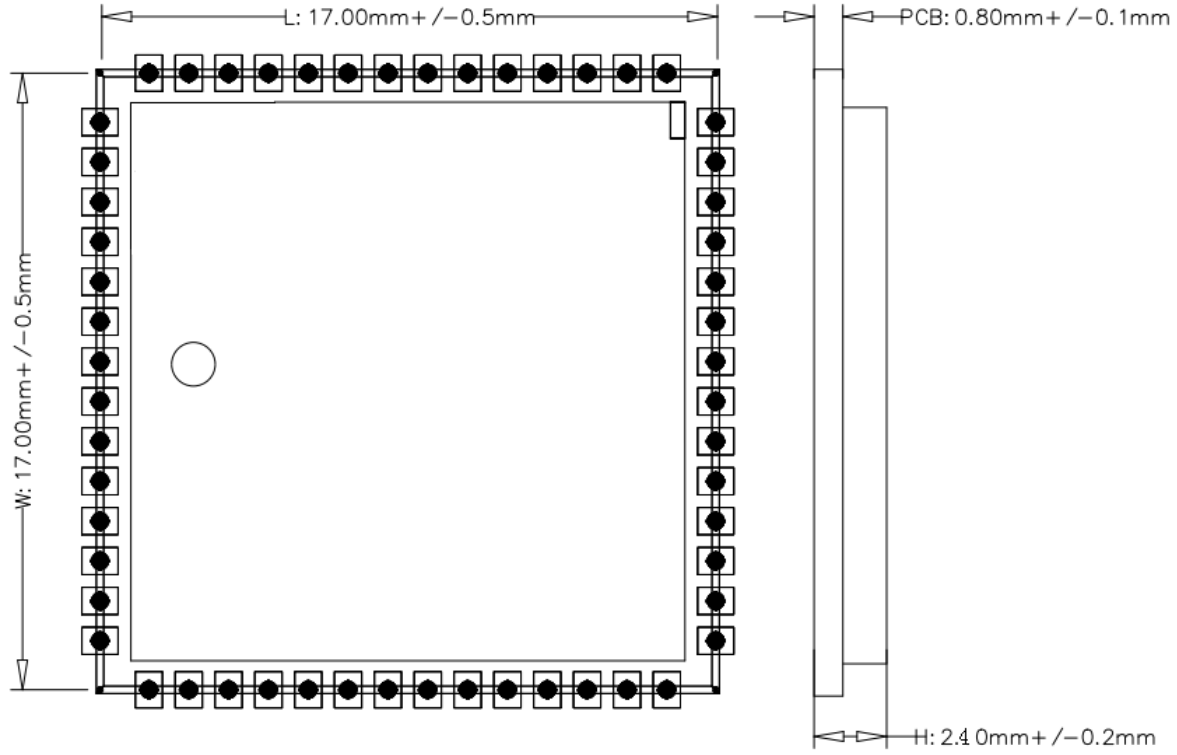


Figure 4: Module Package

6. Interface Timing Specification

6.1 PCIe Bus during Power On Sequence

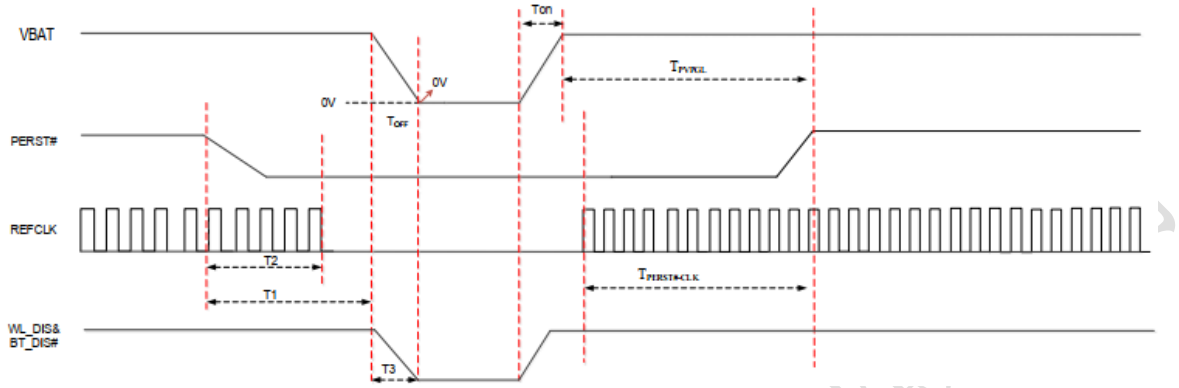


Figure 5: When WLAN is power off

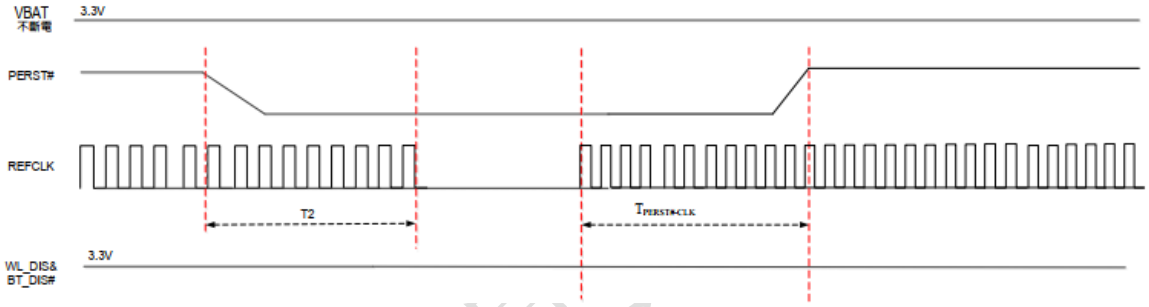


Figure 6: When WLAN is NOT power off

T_{on}: The main power ramp up duration

T_{off}: The main power off duration

T_{PVPGL}: Power valid to PERST# input inactive

$T_{PERST\#-CLK}$: Reference clock stable before PERST# inactive

T1: PERST# goes active before the power on the connector is removed.

T2: Clock to inactive after PERST# goes active.

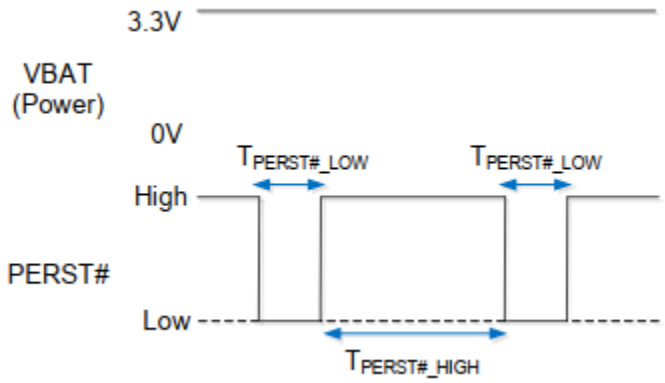
T3: WL_DIS# and BT_DIS# goes asserted when the power on the connector is removed.

T1/T2/T3 timing value should large than 0.

Symbol	Unit	Min	Typical	Max
T_{on}	ms	0.5	1.5	5
T_{off}	ms	1.5		
T_{PVPGL}	ms	Implementation specific;recommended 50ms	--	--
$T_{PERST\#-CLK}$	us	100	--	--

Table 3: The typical timing range

6.2 PCIe PERST# Timing Sequence (if need at least twice)



	Min	Typical	Max	Unit	Description
$T_{PERST\#\_LOW}$	6	10	X	ms	PERST# low duration
$T_{PERST\#\_HIGH}$	400	500	X	ms	PERST# hig

Table 4: Timing Parameters

6.3 Power Off Sequence

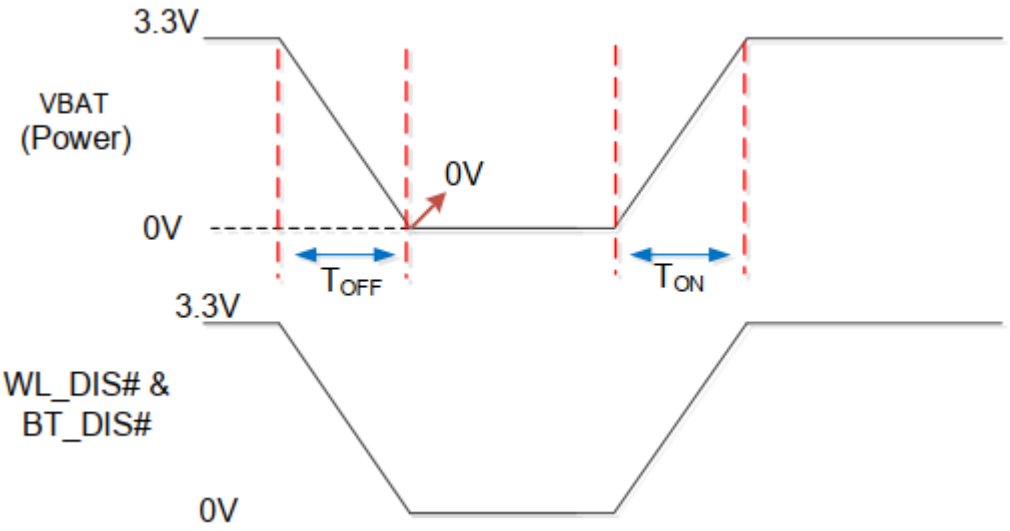


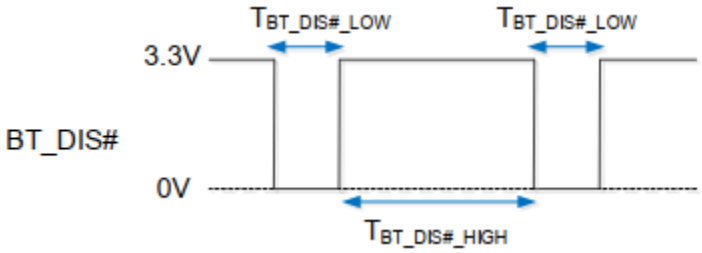
Figure 7: Power Off Sequence of 3.3V platform

Symbol	Min.	Typical	Max.	Unit	Description
T_{OFF}	1.5	--	--	ms	Measure point start on 100% Measure point end on 0% (must be 0V)
T_{ON}	0.5	1.5	5	ms	Measure point start on 0% (must be 0V) Measure point end on 100%

Note: If BT_DIS# can't connect to the same power source with 3.3V, it need to be de-asserted before PERST# with 100ms in power on sequence.

Table 5: Power Off Timing Parameters

6.4 BT_DIS Timing Sequence



	Min.	Typical	Max.	Unit	Description
BT_DIS#_LOW	200	--	--	ms	BT_DIS# low duration
BT_DIS#_HIGH	500	--	--	ms	BT_DIS# high duration

Table 6: BT_DIS Timing Parameters

7. UART

The GOC-RN440 UART interface is a 3-wire interface with RX, TX, CTS. The interface supports the Bluetooth 2.0 UART HCI H4 and H5 specifications. The default baud rate is 115.2 k baud. In order to support high and low speed baud rate, the GOC-RN440 provides multiple UART clocks.

7.1 UART Interface Signal Levels

The UART signal level ranges from 1.8V or 3.3V. The host provides the power source with the targeted power level to the GOC-RN440 UART interface via the VDD_IO pin (Pin 34/35).

7.2 UART Interface Timing

The interface includes four signals, TXD/RXD/CTS. Flow control between the host and the device is bytewise by hardware.When the UART_CTS signal is set high, the device stops transmitting on the interface. If HCI_CTS is set high in the middle of transmitting a byte, the device finishes transmitting the byte and stops the transmission.

7.3 UART Interface Power-On Sequence

The UART interface power-on sequence differs depending on whether or not host flow control is supported.

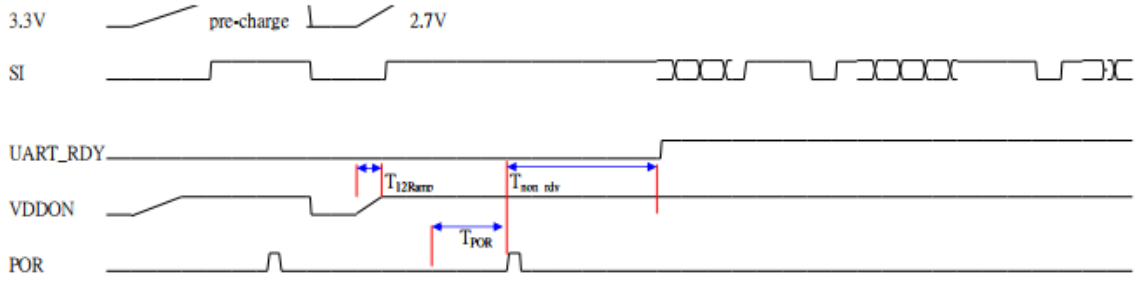


Figure 8: UART Power-On Sequence Without Hardware Flow Control

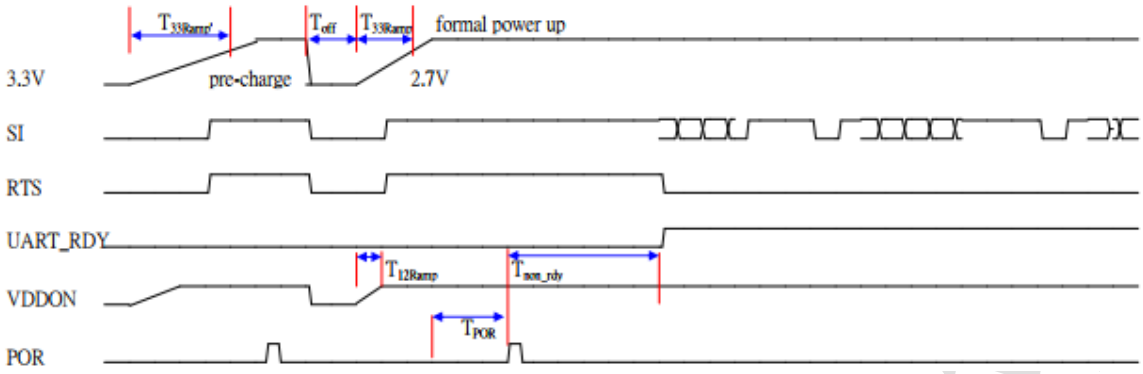


Figure 9: UART Power On Sequence With Hardware Flow Control

Symbol	Description
T_{33ramp}	3.3V Power Pre-Charge Ramp Up Duration Before Formal Power Up.We recommend that a 3.3V power-on and then power-off sequence is executed by the host controller before the formal power on sequence. This procedure can eliminate host card detection issues when power ramp up duration is too long, or when a system warm reboot fails.
T_{off}	The duration 3.3V is cut off before formal power up.
T_{33ramp}	The 3.3V main power ramp up duration.
T_{12ramp}	The internal 1.2V ramp up duration.
T_{POR}	The duration from when the power-on reset releases and the power management unit executes power on tasks. A power on reset will detect both 3.3V and 1.2V power ramp up after a predetermined duration.
T_{non_rdy}	UART Not Ready Duration. In this state, the GOC-RN440 will not respond to any commands.

We recommend that the card detection procedures are divided into two phases: A 3.3V power pre-charge phase and a formal power-up phase.During the 3.3V power pre-charge phase, the power ramp up duration is not limited. The 3.3V power is cut off and is turned on after the T_{off} period. The ramp up time is specified in the T_{33ramp} duration. After main 3.3V ramp up and 1.2V ramp up, the power management unit is enabled by the power ready detection circuit. The power management unit enables the Bluetooth block. The Bluetooth firmware then initializes all circuits included the UART.

Table 7: UART Interface Power-On Sequence

	Min.	Typical	Max.	Unit
T_{33ramp}	-	-	No Limit	ms
T_{off}	250	500	1000	ms
T_{33ramp}	0.1	0.5	2.5	ms
T_{12ramp}	0.1	0.5	1.5	ms
T_{por}	2	2	8	ms
$T_{non-rdy}$	1	2	10	ms

Table 8: UART Interface Power On Timing Parameters

8. Electrical Characteristic

8.1 Absolute Maximum Ratings

Maximum Ratings	Min	Typical	Max
VBAT	3.0V	3.3V	3.6V
VDD_IO	1.71V	1.8V	1.89V
	3.16V	3.3V	3.46V

Table 9: Absolute Maximum Ratings

8.2 Recommended Operating Conditions

Operating Conditions	Min	Typical	Max
Operating Temperature	-40 ℃	/	+85 ℃
Storage Temperature	-55 ℃	/	+125 ℃
VBAT	3.16V	3.3V	3.46V
VDD_IO	1.71V	1.8V	1.89V
	3.16V	3.3V	3.46V

Table 10: Recommended Operating Conditions

9. Recommended Reflow Profile

Referred to IPC/JEDEC standard.
Peak package body temperature :<260 ℃.
Time of peak temperature for Pb-free assembly : 5~10sec.

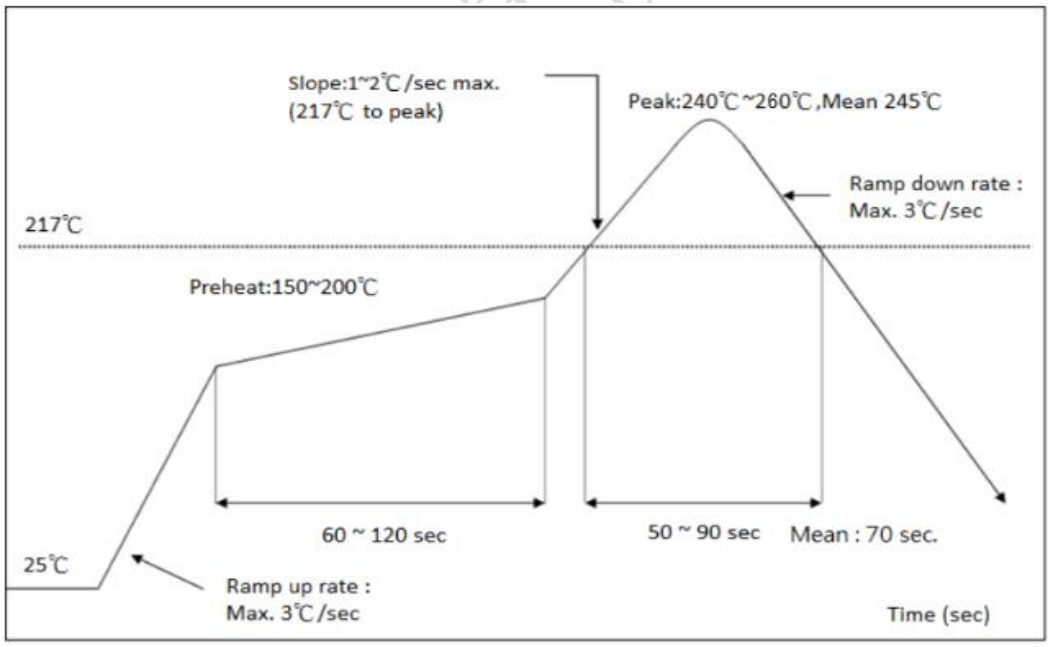


Figure 10 : Recommended Reflow Profile

10. PCB Layout Recommendation

10.1 Antenna

Antenna trace impedance should be adjusted to 50ohm.The area above (or under) the RF antenna trace should be free from other traces.

10.2 HCI UART Lines Layout Guideline

The following HCI line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 4 ~ 8mA.

UART_RX UART_TX UART_CTS UART_RTS

10.3 PCM Lines Layout Guideline

The following HCI line routing must obey the following rule to prevent overshoot/undershoot, as these lines drive 4 mA.

PCM_SYNC PCM_CLK PCM_OUT PCM_IN

10.4 Power Trace Lines Layout Guideline

VBAT Trace Width: 50mil
VDD_IO Trace Width: 25mil

10.5 Ground Lines Layout Guideline

A Complete Ground in Ground Layer.
Add Ground Through Holes to GOC-RN440 Module Ground Pads.
Decoupling Capacitors close to GOC-RN440 Module Power and Ground Pads.

11. Module Part Number Description

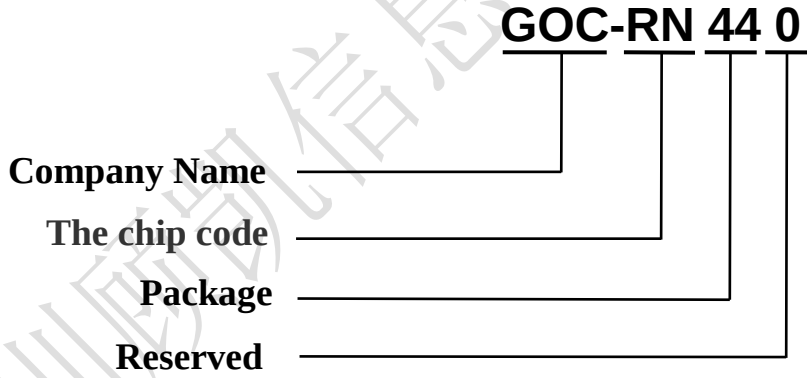


Figure 11: Module Part Number Description

For a list of available options (e.g. package, packing) and orderable part numbers or for further information on any aspect of this device, please go to *www.goodocom.com* or contact the GOODOCOM Sales Office nearest to you.

12. Ordering Information

Part Number	Description	Remark
GOC-RN440 V1.0	2.4 GHz and 5 GHz WLAN+ BT 5.2 module	

Table 11: Ordering Information

13. Packaging Information

13.1 Net Weight

The module net weight: 1.2g±0.2g

13.2 Package

72pcs module in one tray 2000pcs modules into one pack 4000pcs Modules One Box
Carton size:270mm*275mm*220mm
Tray size:225mm*205mm*7mm

13.3 Storage Requirements

1）Temperature: 22~28℃;
2 ）Humidity: <70%（ RH）;
Vacuum packed and sealed in good condition to ensure 12 months of welding.

13.4 Humidity Sensitive Characteristic

1） MSL: 3 level
2） Once opened, SMT within 168 hours in the condition of temperature: 22~28℃ and humidity<60%(RH).
3） Handling, storage, and processing should follow IPC/JEDECJ-STD-033