

Approval Sheet

Project Name	IEEE802.11 ac/n/a/b/g Bluetooth 4.0 NGFF1216-S3 Card
Approval Sheet Rev.	0.2
FOXCONN Part No.	T77H526
Module Rev.	015
Customer Part No.	TBD

Prepared by	Reviewed by	Approved by
Wei.Liao		

COMPANY CONFIDENTIAL

Revision History

Revision	Date	Originator	Comment
0.1	2013/11/26	Wei.Liao	Initial
0.2	2014/03/03	Wei.Liao	1> Add BAW Filter design as option 2> Add RF performance specification 3> Add package type

T77H526.01 is made in China,
Manufactured by HongFuJin Precision Industry Co., LTD
Manufacture Site: ShenZhen, Chongqing, Nanning
<http://www.foxconn.com>

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1. Introduction

The T77H526.01 NGFF1216-S3 Card is based on Marvell 88W8897-B0-CBK2-T solution with WLAN/Bluetooth functions and provides DSSS and OFDM baseband modulation, MAC, CPU, OTP (one time programmable) memory, host interfaces, power management unit (PMU) and direct conversion WLAN RF radio.

1.1 Scope

IEEE 802.11 Standards

- 802.11 data rates of 1 and 2 Mbps
- 802.11b data rates of 5.5 and 11 Mbps
- 802.11a/g data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mbps
- 802.11n HT20 with 800ns GI data rates of 6.5, 13, 19.5, 26, 39, 52, 58.5 and 65Mbps
- 802.11n HT20 with 400ns GI data rates of 7.2, 14.4, 21.7, 28.9, 43.3, 57.8, 65 and 72.2Mbps
- 802.11n HT40 with 800ns GI data rates of 13.5, 27, 40.5, 54, 81, 108, 121.5 and 135Mbps
- 802.11n HT40 with 400ns GI data rates of 15, 30, 45, 60, 90, 120, 135 and 150Mbps
- 802.11ac VHT80 with 800ns GI data rates of 29.3, 58.5, 87.8, 117, 175.5, 234, 263.3, 292.5, 351 and 390Mbps
- 802.11ac VHT80 with 400ns GI data rates of 32.5, 65, 97.5, 130, 195, 260, 292.5, 325, 390 and 433.3Mbps
- 802.11n up to 144.4Mbps (20 MHz), 300Mbps (40 MHz) for 2X2 MIMO.
- 802.11ac up to 173.3Mbps (20 MHz), 400Mbps (40 MHz), 866.7Mbps (80 MHz) for 2X2 MIMO.

Bluetooth

- Bluetooth 4.0 + HS
- Bluetooth Class 2
- Bluetooth Class 1
- Baseband and radio BDR and EDR packet types—1 Mbps (GFSK), 2 Mbps ($\pi/4$ -DQPSK), and 3 Mbps (8DPSK)
- Supports Low Energy (LE)

2. Module Hardware Overview

Chipset	Marvell 88W8897_CSP
RF Diplexer	Two 2.4/5GHz WLAN diplexer
RF Switch	One SPDT
XTAL	40MHz crystal on board
WLAN connector	2pcs RF coaxial connector
Memory	OTP without EEPROM IC
PCB design	6-layers,Tg170,HDI,Gold Plating

Features

- IEEE802.11a/b/g/n /ac (2X2 MIMO) + BT4.0 Module
- 2.4GHz + 5GHz bands RF interface.
- Host interface for WLAN, Bluetooth Configure from platform.
- PCIE M.2 Type 1216-S3 card with 76 pins Soldered down solution Module.
- +3.3V +/- 5% supply power from host platform for VBAT.
- +1.8V +/- 5% supply power from host platform for digital IO SDIO.
- Two RF micro-coaxial connectors (2.0mmx2.0mm), One for Wi-Fi1 antenna port,
Another antenna port shared by Wi-Fi2 and BT
- Uses MRVL 88W8897 integrated OTP memory instead of external EEPROM.
- Provide coexistence interface for connecting to an external LTE (Long Term Evolution) device.
- RoHS and Green Compliant.

3. Electrical Characteristics

3.1 DC Characteristics (recommended operating rating)

Parameter		Minimum	Typical	Maximum	Units
+3.3V (Analog power supply)		2.97	3.3	3.63	V
+3.3V_USB (USB power supply)		2.97	3.3	3.63	V
+VIO (Digital I/O power supply)		2.97	3.3	3.63	V
		1.62	1.8	1.98	V
VIO_SD (Digital I/O SDIO power supply)		1.62	1.8	1.98	V
Storage Temperature		-30	~	+85	°C
Storage Humidity		0	~	90	%
Operation Temperature		0	~	60	°C
ESD Level	HBM	-	1.0K	-	V
	MM	-	200	-	V

3.3 Host interface

Configure table

Configuration	WLAN	BT	BTAMPS
CONFIG_HOST [3:0] = b1111	PCIE	UART	N/A
CONFIG_HOST [3:0] = b1110	PCIE	USB	USB
CONFIG_HOST [3:0] = b1101	SDIO	UART	SDIO
CONFIG_HOST [3:0] = b0111	SDIO	SDIO	SDIO
CONFIG_HOST [3:0] = b0110	USB	USB	USB
CONFIG_HOST [3:0] = b0010	USB	UART	USB

PCIe Interface

The 88W8897 PCI Express Interface Unit (PCIe) functions as a PCI Express endpoint device that conforms to the following standards:

- PCI Express Base Specification, Revision 3.0
- PCI Express Card Electromechanical Specification, Revision 1.1
- PCI Express Bus Power Management Interface Specification, Revision 1.2
- PCI Express Mini Card Electromechanical Specification, Revision 1.2
- Express Card Standard, Revision 1.1
- Latency Tolerance Reporting (LTR) Capability
- L1 Substates ECR Capability

USB 2.0 Device Interface

The USB device interface is compliant with the Universal Serial Bus Specification, Revision 2.0, April 27, 2000. A USB host uses the USB cable bus and the USB 2.0 device Interface to communicate with the chip.

The main features of the USB device interface include:

- High/full speed operation (480/12 Mbps)
- Suspend/host resume/device resume (remote wake-up)
- Built-in DMA engine that reduces interrupt loads on the embedded processor and reduces the system bus bandwidth requirement for serving the USB device operation
- Supports Link Power Management (LPM), corresponding host resume or device resume (remote wakeup) to exit from L1 sleep state

The USB 2.0 device interface is designed with 3.3V signal level pads.

SDIO Device Interface

The 88W8897 supports a SDIO device interface that conforms to the industry standard SDIO full-speed card specification and allows a host controller using the SDIO bus protocol to access the wireless SoC device.

The SDIO device interface main features include:

- Supports SDIO 3.0 standard
- On chip memory used for CIS
- Supports SPI, 1-bit SDIO, and 4-bit SDIO transfer modes at the full clock range of 0 to 208MHz
- Special interrupt register for information exchange
- Allows card to interrupt host

High-Speed UART Interface

The 88W8897 supports a high-speed Universal asynchronous receiver/transmitter interface, compliant to the industry standard 16650 specification.

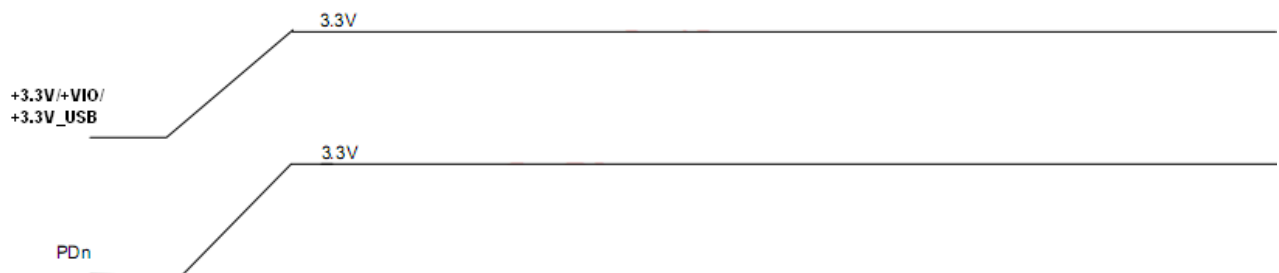
The UART interface features include:

- FIFO mode permanently selected for transmit and receive operations
- 2 pins for transmit and receive operations
- 2 flow control pins
- Interrupt triggers for low power, high throughput operation

3.4 Power up sequence

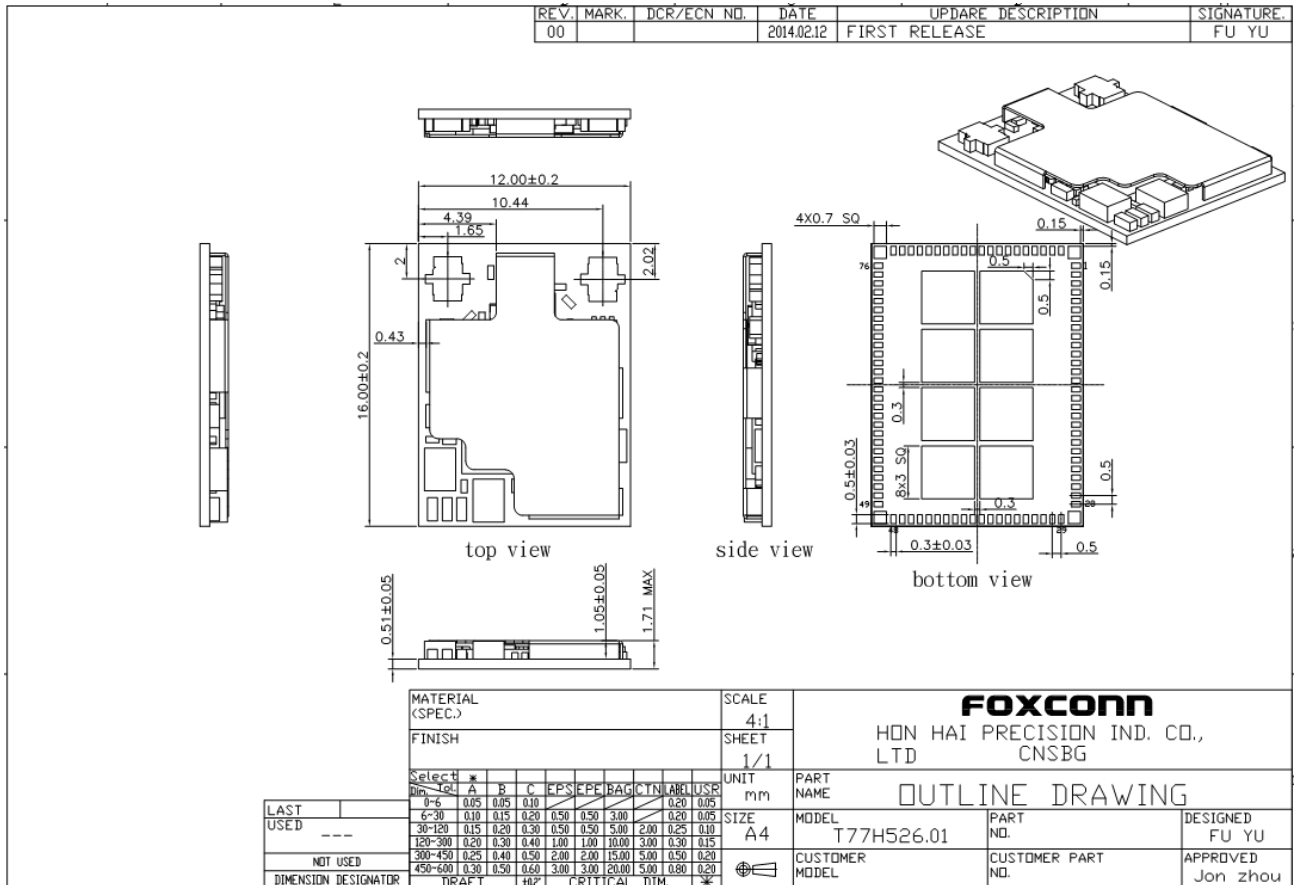
The following requirements must be met for correct power up:

- Ramp-up time of +3.3V should be < 5ms.
- PDn is tied to +3.3V directly.
- External +3.3V/+VIO/+3.3V_USB from host
- VIO_SD is provided by host if SDIO interface is used.
- GPIO_3 need tied to +VIO by host if SDIO interface is used.



4. Mechanical Drawing

4.1 Module dimension



4.2 Antenna of Connector location

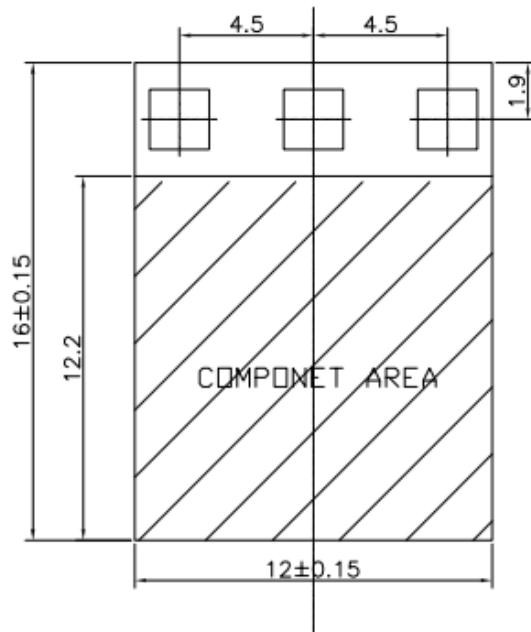


ANTENNA PLACEMENT

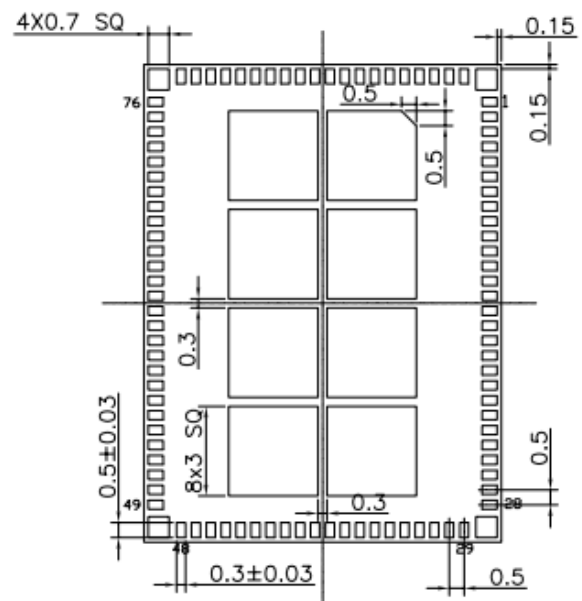
Antenna	Interface
1	Wi-Fi Main
2	N/A
3	Wi-Fi/Bluetooth

4.3 Card Pin-mapping

Top view



Bottom view



PIN map 1216																							
1	TMS																						
2	TCCK																						
3	TDI																						
4	3.3VRF																						
5	3.3VBAT																						
6	GND																						
7	TDO																						
8	CONFIG_HOST[0]																						
9	CONFIG_HOST[1]																						
10	CONFIG_HOST[2]																						
11	GPIO[1] LTE_SOUT (O)																						
12	GPIO[2] LTE_SIN (I)																						
13	CONFIG_HOST[3]																						
14	GPIO[10] NFC_NOT_ALLOW																						
15	NFC_WL_IN																						
16	NFC_SWAP1_VDDIN																						
17	GND																						
18	NFC_SWAP2_IO																						
19	NFC_SWAP1_IO																						
20	GND																						
21	NFC_SWAP1_Vout																						
22	NFC_SWAP2_Vout																						
23	GND																						
24	NFC_ANTN																						
25	NFC_ANTP																						
26	GND																						
27	SLPCLK																						
28	GPIO[13] / NFC/BT_IRQ (O)																						
29	PCIE_WAKEn																						
30	PCIE_CLKREQn																						
31	GPIO[12] PCIE_PERSn																						
32	GND																						
33	PCIE_RCLK_N																						
34	PCIE_RCLK_P																						
35	GND																						
36	PCIE_TX_N																						
37	PCIE_TX_P																						
38	GND																						
39	PCIE_RX_N																						
40	PCIE_RX_P																						
41	GND																						
42	GPIO[0] CLK_REQ																						
43	GPIO[1] / NFC_ACTIVE (O)																						
44	VIO_SD																						
45	P0n																						
46	GPIO[3] WLAN_IRQ (O)																						
47	SD_DAT[3]																						
48	SD_DAT[2]																						
49	SD_DAT[1]																						
50	SD_DAT[0]																						
51	SD_CMD																						
52	SD_CLK																						
53	NC																						
54	GPIO[6] AIART_CTSh																						
55	GPIO[4] AIART_SOUT																						
56	GPIO[5] AIART_SIN																						
57	GPIO[7] UART_RTSh																						
58	GPIO[22] / PCM_SYNC																						
59	GPIO[19] / PCM_IN																						
60	GPIO[20] / PCM_OUT																						
61	GPIO[21] / PCM_CLK																						
62	GND																						
63	GPIO[14] USE_CASE TBD																						
64	GPIO[8] LED_WLAN (O)																						
65	GPIO[9] LED_BT (O)																						
66	NFC_SDA																						
67	NFC_CLK																						
68	GND																						
69	USB_D-																						
70	USB_D+																						
71	GND																						
72	3.3V_USB																						
73	VIO																						
74	GND																						
75	GND																						
76	GND																						

5. WLAN RF Specification

This specification is based on additional references listed below for each RF chain.

- *IEEE Std. 802.11ac*
- *IEEE Std. 802.11a*
- *IEEE Std. 802.11b*
- *IEEE Std. 802.11g*
- *IEEE Std. 802.11n*

IEEE802.11b

Items	Contents			
Standard	IEEE802.11b			
Modulation	DBPSK/DQPSK/CCK			
Channel	CH1 to CH13, CH14			
Data rate	1, 2, 5.5, 11Mbps			
TX Characteristics	Min.	Typ	Max.	Unit
1. Power Levels (Calibrated)				
1) 1Mbps	+14.5	+16	+17.5	dBm
2) 2Mbps	+14.5	+16	+17.5	dBm
3) 5.5Mbps	+14.5	+16	+17.5	dBm
4) 11Mbps	+14.5	+16	+17.5	dBm
2. Spectrum Mask				
1) $f_c \pm 11\text{MHz}$ to $\pm 22\text{MHz}$	-	-	-30	dBr
2) $f_c > \pm 22\text{MHz}$	-	-	-50	dBr
3. Modulation Accuracy (EVM)				
1) 1Mbps	-	-27	-9.10	dB
2) 2Mbps	-	-27	-9.10	dB
3) 5.5Mbps	-	-27	-9.10	dB
4) 11Mbps	-	-27	-9.10	dB
4. Frequency Error	-25	-	+25	ppm
RX Characteristics	Min.	Typ	Max.	Unit
5. Minimum Input Level Sensitivity				
1) 1Mbps ($\text{FER} \leq 8\%$)	-	-95	-76	dBm
2) 2Mbps ($\text{FER} \leq 8\%$)	-	-94	-76	dBm
3) 5.5Mbps ($\text{FER} \leq 8\%$)	-	-91	-76	dBm
4) 11Mbps ($\text{FER} \leq 8\%$)	-	-88	-76	dBm
6. Maximum Input Level ($\text{FER} \leq 8\%$)	-10	-	-	dBm

IEEE802.11g

Items	Contents			
Standard	IEEE802.11g			
Modulation	OFDM			
Channel	CH1 to CH13			
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) 6Mbps	13.5	15	16.5	dBm
2) 9Mbps	13.5	15	16.5	dBm
3) 12Mbps	13.5	15	16.5	dBm
4) 18Mbps	13.5	15	16.5	dBm
5) 24Mbps	13.5	15	16.5	dBm
6) 36Mbps	13.5	15	16.5	dBm
7) 48Mbps	13.5	15	16.5	dBm
8) 54Mbps	13.5	15	16.5	dBm
2. Spectrum Mask				
1) fc +/- 11MHz	-	-	-20	dBr
2) fc +/- 20MHz	-	-	-28	dBr
3) fc > +/-30MHz	-	-	-40	dBr
3. Modulation Accuracy (EVM)				
1) 6Mbps	-	-32	-5	dB
2) 9Mbps	-	-32	-8	dB
3) 12Mbps	-	-32	-10	dB
4) 18Mbps	-	-32	-13	dB
5) 24Mbps	-	-32	-16	dB
6) 36Mbps	-	-32	-19	dB
7) 48Mbps	-	-32	-22	dB
8) 54Mbps	-	-32	-25	dB
4. Frequency Error	-25	-	+25	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) 6Mbps (PER <10%)		-89	-82	dBm
2) 9Mbps (PER < 10%)		-88	-81	dBm
3) 12Mbps (PER < 10%)		-87	-79	dBm
4) 18Mbps (PER < 10%)		-86	-77	dBm
5) 24Mbps (PER < 10%)		-82	-74	dBm
6) 36Mbps (PER < 10%)		-80	-70	dBm
7) 48Mbps (PER < 10%)		-75	-66	dBm
8) 54Mbps (PER < 10%)		-74	-65	dBm
6. Maximum Input Level (PER < 10%)	-20	-	-	dBm

IEEE802.11n HT20-2.4G

Items	Contents			
Standard	IEEE802.11n HT20			
Modulation	OFDM			
Channel	CH1 to CH13			
Data rate (MCS index)	MCS0~7			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	12.5	14	15.5	dBm
2) MCS1	12.5	14	15.5	dBm
3) MCS2	12.5	14	15.5	dBm
4) MCS3	12.5	14	15.5	dBm
5) MCS4	12.5	14	15.5	dBm
6) MCS5	12.5	14	15.5	dBm
7) MCS6	12.5	14	15.5	dBm
8) MCS7	12.5	14	15.5	dBm
2. Spectrum Mask				
1) $f_c \pm 11\text{MHz}$	-	-	-20	dBr
2) $f_c \pm 20\text{MHz}$	-	-	-28	dBr
3) $f_c > \pm 30\text{MHz}$	-	-	-45	dBr
3. Modulation Accuracy (EVM)				
1) MCS0	-	-32	-5	dB
2) MCS1	-	-32	-10	dB
3) MCS2	-	-32	-13	dB
4) MCS3	-	-32	-16	dB
5) MCS4	-	-32	-19	dB
6) MCS5	-	-32	-22	dB
7) MCS6	-	-32	-25	dB
8) MCS7	-	-32	-27	dB
4. Frequency Error	-25	-	+25	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-89	-82	dBm
2) MCS1 (PER < 10%)	-	-87	-79	dBm
3) MCS2 (PER < 10%)	-	-85	-77	dBm
4) MCS3 (PER < 10%)	-	-80	-74	dBm
5) MCS4 (PER < 10%)	-	-78	-70	dBm
6) MCS5 (PER < 10%)	-	-75	-66	dBm
7) MCS6 (PER < 10%)	-	-72	-65	dBm
8) MCS7 (PER < 10%)	-	-71	-64	dBm
6. Maximum Input Level (PER < 10%)	-20	-	-	dBm

IEEE802.11n HT40-2.4G

Items	Contents			
Standard	IEEE802.11n HT40			
Modulation	OFDM			
Channel	CH3~CH9			
Data rate (MCS index)	MCS0~MCS7			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	11.5	13	14.5	dBm
2) MCS1	11.5	13	14.5	dBm
3) MCS2	11.5	13	14.5	dBm
4) MCS3	11.5	13	14.5	dBm
5) MCS4	11.5	13	14.5	dBm
6) MCS5	11.5	13	14.5	dBm
7) MCS6	11.5	13	14.5	dBm
8) MCS7	11.5	13	14.5	dBm
2. Spectrum Mask				
1) fc +/- 21MHz	-	-	-20	dBr
2) fc +/- 40MHz	-	-	-28	dBr
3) fc > +/-60MHz	-	-	-45	dBr
3. Modulation Accuracy (EVM)				
1) MCS0	-	-30	-5	dB
2) MCS1	-	-30	-10	dB
3) MCS2	-	-30	-13	dB
4) MCS3	-	-30	-16	dB
5) MCS4	-	-30	-19	dB
6) MCS5	-	-30	-22	dB
7) MCS6	-	-30	-25	dB
8) MCS7	-	-30	-27	dB
4. Frequency Error	-25	-	+25	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-86	-79	dBm
2) MCS1 (PER < 10%)	-	-84	-76	dBm
3) MCS2 (PER < 10%)	-	-81	-74	dBm
4) MCS3 (PER < 10%)	-	-18	-71	dBm
5) MCS4 (PER < 10%)	-	-75	-67	dBm
6) MCS5 (PER < 10%)	-	-72	-63	dBm
7) MCS6 (PER < 10%)	-	-70	-62	dBm
8) MCS7 (PER < 10%)	-	-69	-61	dBm
6. Maximum Input Level (PER < 10%)	-20	-	-	dBm

IEEE802.11a

Items	Contents			
Standard	IEEE802.11a			
Modulation	OFDM			
Channel	CH36~CH48, CH52~CH64, CH100~CH165			
Data rate	6, 9, 12, 18, 24, 36, 48, 54Mbps			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) 6Mbps	13.5	15	16.5	dBm
2) 9Mbps	13.5	15	16.5	dBm
3) 12Mbps	13.5	15	16.5	dBm
4) 18Mbps	13.5	15	16.5	dBm
5) 24Mbps	13.5	15	16.5	dBm
6) 36Mbps	13.5	15	16.5	dBm
7) 48Mbps	13.5	15	16.5	dBm
8) 54Mbps	13.5	15	16.5	dBm
2. Spectrum Mask				
1) fc +/- 11MHz	-	-	-20	dBr
2) fc +/- 20MHz	-	-	-28	dBr
3) fc > +/-30MHz	-	-	-40	dBr
3. Modulation Accuracy (EVM)				
1) 6Mbps	-	-24	-5	dB
2) 9Mbps	-	-25	-8	dB
3) 12Mbps	-	-25	-10	dB
4) 18Mbps	-	-25	-13	dB
5) 24Mbps	-	-25	-16	dB
6) 36Mbps	-	-25	-19	dB
7) 48Mbps	-	-27	-22	dB
8) 54Mbps	-	-30	-25	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) 6Mbps (PER <10%)	-	-87	-82	dBm
2) 9Mbps (PER < 10%)	-	-86	-81	dBm
3) 12Mbps (PER < 10%)	-	-84	-79	dBm
4) 18Mbps (PER < 10%)	-	-82	-77	dBm
5) 24Mbps (PER < 10%)	-	-79	-74	dBm
6) 36Mbps (PER < 10%)	-	-74	-70	dBm
7) 48Mbps (PER < 10%)	-	-72	-66	dBm
8) 54Mbps (PER < 10%)	-	-71	-65	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

IEEE802.11n HT20-5G

Items	Contents			
Standard	IEEE802.11n HT20			
Modulation	OFDM			
Channel	CH36~CH48, CH52~CH64, CH100~CH165			
Data rate (MCS index)	MCS0~7			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	12.5	14	15.5	dBm
2) MCS1	12.5	14	15.5	dBm
3) MCS2	12.5	14	15.5	dBm
4) MCS3	12.5	14	15.5	dBm
5) MCS4	12.5	14	15.5	dBm
6) MCS5	12.5	14	15.5	dBm
7) MCS6	12.5	14	15.5	dBm
8) MCS7	12.5	14	15.5	dBm
3. Spectrum Mask				
1) $f_c \pm 11\text{MHz}$	-	-	-20	dB
2) $f_c \pm 20\text{MHz}$	-	-	-28	dB
3) $f_c > \pm 30\text{MHz}$	-	-	-40	dB
3. Modulation Accuracy (EVM)				
1) MCS0	-	-30	-5	dB
2) MCS1	-	-30	-10	dB
3) MCS2	-	-30	-13	dB
4) MCS3	-	-30	-16	dB
5) MCS4	-	-30	-19	dB
6) MCS5	-	-30	-22	dB
7) MCS6	-	-30	-25	dB
8) MCS7	-	-30	-27	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-86	-82	dBm
2) MCS1 (PER < 10%)	-	-84	-79	dBm
3) MCS2 (PER < 10%)	-	-81	-77	dBm
4) MCS3 (PER < 10%)	-	-78	-74	dBm
5) MCS4 (PER < 10%)	-	-74	-70	dBm
6) MCS5 (PER < 10%)	-	-70	-66	dBm
7) MCS6 (PER < 10%)	-	-69	-65	dBm
8) MCS7 (PER < 10%)	-	-68	-64	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

IEEE802.11n HT40-5G

Items	Contents			
Standard	IEEE802.11n HT40			
Modulation	OFDM			
Channel	CH38~CH62, CH102~CH159			
Data rate (MCS index)	MCS0~MCS7			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	11.5	13	14.5	dBm
2) MCS1	11.5	13	14.5	dBm
3) MCS2	11.5	13	14.5	dBm
4) MCS3	11.5	13	14.5	dBm
5) MCS4	11.5	13	14.5	dBm
6) MCS5	11.5	13	14.5	dBm
7) MCS6	11.5	13	14.5	dBm
8) MCS7	11.5	13	14.5	dBm
2. Spectrum Mask				
1) +/- 21MHz	-	-	-20	dBr
2) +/- 40MHz	-	-	-28	dBr
3) > +/-60MHz	-	-	-40	dBr
3. Modulation Accuracy (EVM)				
1) MCS0	-	-30	-5	dB
2) MCS1	-	-30	-10	dB
3) MCS2	-	-30	-13	dB
4) MCS3	-	-30	-16	dB
5) MCS4	-	-30	-19	dB
6) MCS5	-	-30	-22	dB
7) MCS6	-	-30	-25	dB
8) MCS7	-	-30	-27	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-84	-79	dBm
2) MCS1 (PER < 10%)	-	-81	-76	dBm
3) MCS2 (PER < 10%)	-	-79	-74	dBm
4) MCS3 (PER < 10%)	-	-76	-71	dBm
5) MCS4 (PER < 10%)	-	-72	-67	dBm
6) MCS5 (PER < 10%)	-	-67	-63	dBm
7) MCS6 (PER < 10%)	-	-66	-62	dBm
8) MCS7 (PER < 10%)	-	-65	-61	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

Items	Contents			
Standard	IEEE802.11ac VHT20			
Modulation	OFDM			
Channel	CH36~CH48, CH52~CH64, CH100~CH165			
Data rate (MCS index)	MCS0~MCS8			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	6.5	8	9.5	dBm
2) MCS1	6.5	8	9.5	dBm
3) MCS2	6.5	8	9.5	dBm
4) MCS3	6.5	8	9.5	dBm
5) MCS4	6.5	8	9.5	dBm
6) MCS5	6.5	8	9.5	dBm
7) MCS6	6.5	8	9.5	dBm
8) MCS7	6.5	8	9.5	dBm
9) MCS8	6.5	8	9.5	dBm
2. Spectrum Mask				
1) $f_c \pm 11\text{MHz}$	-	-	-20	dBm
2) $f_c \pm 20\text{MHz}$	-	-	-28	dBm
3) $f_c > \pm 30\text{MHz}$	-	-	-40	dBm
3. Modulation Accuracy (EVM)				
1) MCS0	-	-33	-5	dB
2) MCS1	-	-33	-10	dB
3) MCS2	-	-33	-13	dB
4) MCS3	-	-33	-16	dB
5) MCS4	-	-33	-19	dB
6) MCS5	-	-33	-22	dB
7) MCS6	-	-33	-25	dB
8) MCS7	-	-33	-27	dB
9) MCS8	-	-33	-30	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-89	-82	dBm
2) MCS1 (PER < 10%)	-	-85	-79	dBm
3) MCS2 (PER < 10%)	-	-83	-77	dBm
4) MCS3 (PER < 10%)	-	-80	-74	dBm
5) MCS4 (PER < 10%)	-	-75	-70	dBm
6) MCS5 (PER < 10%)	-	-72	-66	dBm
7) MCS6 (PER < 10%)	-	-71	-65	dBm
8) MCS7 (PER < 10%)	-	-70	-64	dBm
9) MCS8 (PER < 10%)	-	-66	-59	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

Items	Contents			
Standard	IEEE802.11ac VHT40			
Modulation	OFDM			
Channel	CH38~CH62, CH102~CH159			
Data rate (MCS index)	MCS0~MCS9			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	6.5	8	9.5	dBm
2) MCS1	6.5	8	9.5	dBm
3) MCS2	6.5	8	9.5	dBm
4) MCS3	6.5	8	9.5	dBm
5) MCS4	6.5	8	9.5	dBm
6) MCS5	6.5	8	9.5	dBm
7) MCS6	6.5	8	9.5	dBm
8) MCS7	6.5	8	9.5	dBm
9) MCS8	6.5	8	9.5	dBm
10) MCS9	6.5	8	9.5	dBm
2. Spectrum Mask				
1) $f_c \pm 21\text{MHz}$	-	-30	-20	dBr
2) $f_c \pm 40\text{MHz}$	-	-37	-28	dBr
3) $f_c > \pm 60\text{MHz}$	-	-50	-40	dBr
3. Modulation Accuracy (EVM)				
1) MCS0	-	-33	-5	dB
2) MCS1	-	-33	-10	dB
3) MCS2	-	-33	-13	dB
4) MCS3	-	-33	-16	dB
5) MCS4	-	-33	-19	dB
6) MCS5	-	-33	-22	dB
7) MCS6	-	-33	-25	dB
8) MCS7	-	-33	-27	dB
9) MCS8	-	-33	-30	dB
10) MCS9	-	-33	-32	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-86	-79	dBm
2) MCS1 (PER < 10%)	-	-83	-76	dBm
3) MCS2 (PER < 10%)	-	-81	-74	dBm
4) MCS3 (PER < 10%)	-	-77	-71	dBm
5) MCS4 (PER < 10%)	-	-73	-67	dBm
6) MCS5 (PER < 10%)	-	-70	-63	dBm
7) MCS6 (PER < 10%)	-	-69	-62	dBm
8) MCS7 (PER < 10%)	-	-66	-61	dBm
9) MCS8 (PER < 10%)	-	-64	-56	dBm
10) MCS9 (PER < 10%)	-	-62	-54	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

Items	Contents			
Standard	IEEE802.11ac VHT80			
Modulation	OFDM			
Channel	CH42,CH58,CH106,CH122,CH138,CH155			
Data rate (MCS index)	MCS0~MCS9			
TX Characteristics	Min.	Typ.	Max.	Unit
1. Power Levels (Calibrated)				
1) MCS0	6.5	8	9.5	dBm
2) MCS1	6.5	8	9.5	dBm
3) MCS2	6.5	8	9.5	dBm
4) MCS3	6.5	8	9.5	dBm
5) MCS4	6.5	8	9.5	dBm
6) MCS5	6.5	8	9.5	dBm
7) MCS6	6.5	8	9.5	dBm
8) MCS7	6.5	8	9.5	dBm
9) MCS8	6.5	8	9.5	dBm
10) MCS9	6.5	8	9.5	dBm
2. Spectrum Mask				
1) +/-41MHz	-	-25	-20	dBr
2) +/-80MHz	-	-33	-28	dBr
3) +/-120MHz	-	-45	-40	dBr
3. Modulation Accuracy (EVM)				
1) MCS0	-	-33	-5	dB
2) MCS1	-	-33	-10	dB
3) MCS2	-	-33	-13	dB
4) MCS3	-	-33	-16	dB
5) MCS4	-	-33	-19	dB
6) MCS5	-	-33	-22	dB
7) MCS6	-	-33	-25	dB
8) MCS7	-	-33	-27	dB
9) MCS8	-	-33	-30	dB
10) MCS9	-	-33	-32	dB
4. Frequency Error	-20	-	+20	ppm
RX Characteristics	Min.	Typ.	Max.	Unit
5. Minimum Input Level Sensitivity				
1) MCS0 (PER < 10%)	-	-82	-76	dBm
2) MCS1 (PER < 10%)	-	-79	-73	dBm
3) MCS2 (PER < 10%)	-	-77	-71	dBm
4) MCS3 (PER < 10%)	-	-74	-68	dBm
5) MCS4 (PER < 10%)	-	-70	-64	dBm
6) MCS5 (PER < 10%)	-	-66	-60	dBm
7) MCS6 (PER < 10%)	-	-65	-59	dBm
8) MCS7 (PER < 10%)	-	-64	-58	dBm
9) MCS8 (PER < 10%)	-	-59	-53	dBm
10) MCS9 (PER < 10%)	-	-57	-51	dBm
6. Maximum Input Level (PER < 10%)	-30	-	-	dBm

Bluetooth 4.0

Items	Contents			
Standard	Bluetooth 4.0 Basic rate (BR), Enhanced data rate (EDR). Bluetooth low energy (BLE).			
Modulation	1Mbps(GFSK), 2Mbps($\pi/4$ -DQPSK), 3Mbps(8-DPSK)			
Channel	2.402GHz ~ 2.480GHz (CH0~CH78)			
Channel spacing	1 MHz for BR,EDR, 2MHz for LE			
Duplex transmission	Time-Division Duplex (TDD) scheme			
TX Characteristics - BR	Min.	Typ.	Max.	Unit
1. Power Levels				
1Mbps (GFSK)	5	7	9	dBm
2. Frequency Tolerance				
Initial center frequency	-75	3.2	75	kHz
3. Carrier Frequency Drift				
Maximum drift rate within 50us	-20	-4.5	20	kHz/50us
DH1 (Maximum length 1-slot packet)	-25	-3	25	kHz
DH3 (Maximum length 3-slot packet)	-40	0	40	kHz
DH5 (Maximum length 5-slot packet)	-40	0	40	kHz
4. Modulation Characteristic (Frequency deviations)				
Δf_{1avg}	140	164	175	kHz
Δf_{2max}	115	140	-	kHz
$\Delta f_{2avg}/\Delta f_{1avg}$ Ratio	0.80	0.89	-	
TX Characteristics - EDR	Min.	Typ.	Max.	Unit
1. Power Levels				
2Mbps($\pi/4$ -DQPSK)	5	7	9	dBm
3Mbps(8-DPSK)	5	7	9	dBm
2.Carrier Frequency Stability and Modulation Accuracy				
2Mbps: $\pi/4$ -DQPSK				
Packet Initial Frequency Error: ω_i	-75	1.1	75	kHz
Block Frequency Error: ω_0	-10	2.9	10	kHz
Total Frequency Error: $\omega_i + \omega_0$	-75	4	75	kHz
RMS DEVM	-	0.05	0.2	
Peak DEVM	-	0.15	0.35	
99% DEVM (% Symbols ≤ 0.3)	99%	100%	-	
3Mbps: 8-DPSK				
Initial Frequency Error: ω_i	-75	1.4	75	kHz
Frequency Error: ω_0	-10	2.8	10	kHz
Block Frequency Error: $\omega_i + \omega_0$	-75	4.2	75	kHz
RMS DEVM	-	0.05	0.13	
Peak DEVM	-	1.15	0.25	
99% DEVM (% Symbols ≤ 0.13)	99%	100%	-	
3. Differential Phase Encoding				
2Mbps($\pi/4$ -DQPSK)	99%	100%	-	
3Mbps(8-DPSK)	99%	100%	-	
TX Characteristics - BLE	Min.	Typ.	Max.	Unit
1. Power Levels				
1Mbps(GFSK)	-2	0	+2	dBm
2. Modulation Characteristic (Frequency deviations)				
Δf_{1avg}	225	253	275	kHz
Δf_{2max}	185	227	-	kHz
$\Delta f_{2avg}/\Delta f_{1avg}$ Ratio	0.8	0.92	-	
3. Carrier frequency offset and drift				
$f_n - f_{TX}$, $n = 0, 1, 2, 3...k$	-150	2.57	+150	kHz
$ f_0 - f_n $, $n = 2, 3, 4...k$	-	1.41	50	kHz

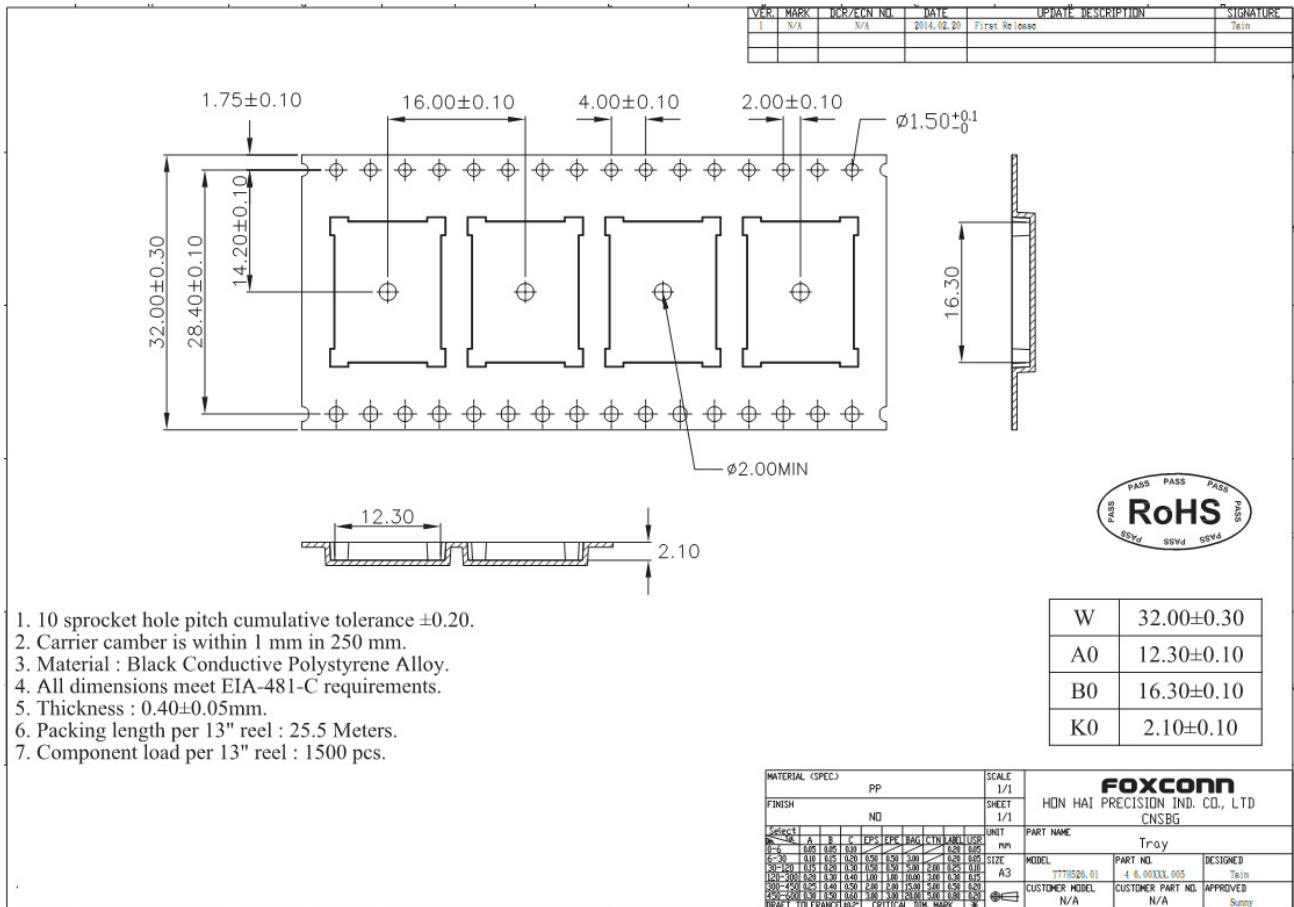
$ f_1 - f_0 $	-	0.98	20	kHz
$ f_n - f_{n-5} , n = 6, 7, 8 \dots k$	-	0.49	20	kHz

RX Characteristics	Min.	Typ.	Max.	Unit
1. Minimum Input Level Sensitivity				
GFSK (1Mbps) (BER $\leq 0.1\%$)	-	-88	-70	dBm
$\pi/4$ DQPSK (2Mbps) (BER $\leq 0.1\%$)	-	-88	-70	dBm
8DPSK (3Mbps) (BER $\leq 0.1\%$)	-	-84	-70	dBm
GFSK (1Mbps) – BLE (BER < 30.8%)	-	-80	-70	dBm
2. Maximum Input Level				
GFSK (1Mbps) (BER $\leq 0.1\%$)	-20	-	-	dBm
$\pi/4$ DQPSK (2Mbps) (BER $\leq 0.1\%$)	-20	-	-	dBm
8DPSK (3Mbps) (BER $\leq 0.1\%$)	-20	-	-	dBm
GFSK (1Mbps) – BLE (BER < 30.8%)	-20	-	-	dBm

7. Software Requirement

Marvell is the owner for driver and Firmware release.

8. Packing Specification



9. Environmental Requirements

1> Operating Temperature Conditions

The product shall be capable of continuous reliable operation when operating in ambient temperature of 0 °C to 60 °C.

2> Non-Operating Temperature Conditions

Neither subassemblies shall be damaged nor shall the operational performance be degraded when restored to the operating temperature when exposed to storage temperature in the range of -20 °C to +85 °C.

3> Operating Humidity Conditions

The product shall be capable of continuous reliable operation when subjected to relative humidity in the range of 0% and 90% non-condensing.

4> Non-Operating Humidity conditions

The product shall not be damaged nor shall the performance be degraded after exposure to relative humidity.

5> Terminals

The product is mounted with motherboard through Land Grid Array. In order to prevent poor soldering, Please do not touch LGA portion by hand.

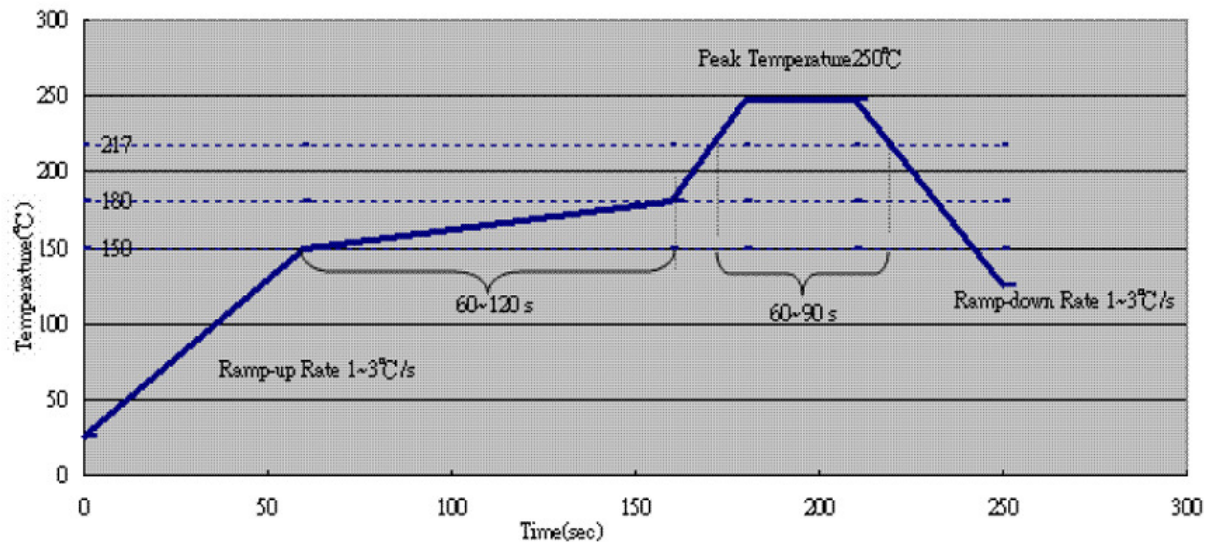
6> Falling

It will cause damage on the mounted components when the product is falling or receiving drop shock. It may cause the product mal-function.

10. Soldering and reflow condition

Reflow soldering shall be done according to the below temperature profile.

B) Foxconn Recommend Profile





COMPANY CONFIDENTIAL

Federal Communication Commission Interference Statement

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.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains FCC ID: MCLT77H526". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

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.



Industry Canada statement:

This device complies with RSS-210 of the Industry Canada 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.

Ce dispositif est conforme à la norme CNR-210 d'Industrie Canada applicable aux appareils radio exempts de licence. Son fonctionnement est sujet aux deux conditions suivantes: (1) le dispositif ne doit pas produire de brouillage préjudiciable, et (2) ce dispositif doit accepter tout brouillage reçu, y compris un brouillage susceptible de provoquer un fonctionnement indésirable.

Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment.

This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

This device is intended only for OEM integrators under the following conditions: (For module device use)

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

- 1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
- 2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC: 2878D-T77H526".

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 2878D-T77H526".

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.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.

Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

Caution :

- (i) the device for operation in the band 5150-5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
- (ii) the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall comply with the e.i.r.p. limit; and
- (iii) the maximum antenna gain permitted for devices in the band 5725-5825 MHz shall comply with the e.i.r.p. limits specified for point-to-point and non point-to-point operation as appropriate.
- (iv) Users should also be advised that high-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.

Avertissement:

Le guide d'utilisation des dispositifs pour réseaux locaux doit inclure des instructions précises sur les restrictions susmentionnées, notamment :

- (i) les dispositifs fonctionnant dans la bande 5 150-5 250 MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux;
- (ii) le gain maximal d'antenne permis pour les dispositifs utilisant les bandes 5 250-5 350 MHz et 5 470-5 725 MHz doit se conformer à la limite de p.i.r.e.;
- (iii) le gain maximal d'antenne permis (pour les dispositifs utilisant la bande 5 725-5 825 MHz) doit se conformer à la limite de p.i.r.e. spécifiée pour l'exploitation point à point et non point à point, selon le cas.
- (iv) De plus, les utilisateurs devraient aussi être avisés que les utilisateurs de radars de haute puissance sont désignés utilisateurs principaux (c.-à-d., qu'ils ont la priorité) pour les bandes 5 250-5 350 MHz et 5 650-5 850 MHz et que ces radars pourraient causer du brouillage et/ou des dommages aux dispositifs LAN-EL.

DETACHABLE ANTENNA USAGE

This device has been designed to operate with an antenna having a maximum gain of 1.84dBi.

Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

This radio transmitter (IC: 2878D-T77H526 / Model: T77H526) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Ce dispositif a été conçu pour fonctionner avec une antenne ayant un gain maximal de dB 1.84. Une antenne à gain plus élevé est strictement interdite par les règlements d'Industrie Canada. L'impédance d'antenne requise est de 50 ohms.



Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (IC: 2878D-T77H526 / Modèle: T77H526) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

For Taiwan: 低功率電波輻射性電機管理辦法

第十二條 經型式認證合格之低功率射頻電機，非經許可，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

第十四條 低功率射頻電機之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前項合法通信，指依電信法規定作業之無線電通信。

低功率射頻電機須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

在5.25-5.35 兆赫頻帶內操作之無線資訊傳輸設備，限於室內使用。

1. 本模組於取得認證後將依規定於模組本體標示審驗合格標籤。
2. 系統廠商應於平台上標示「本產品內含射頻模組：XXXyyyLPDzzzz-x」字樣。