

MA188 Hardware Design Manual

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1 Functional description

1.1 Overview

MA188 is an automotive grade wireless multifunction module based on the Qualcomm QCA6688. It is a integrated Wi-Fi and Bluetooth combo module that supports 2X2+2X2 configuration. It is intended for in-car infotainment and connectivity systems. It incorporates Wi-Fi 6 .

The MA188 can be operated in the following modes:

- Dual band Wifi 2.4G and 5GHz, 802.11a/b/g/n/ac/ax
- Concurrent dual band 2.4GHz and 5GHz
- Support 1X1 2G + 2X2 5G mode, dual MAC

Table 1 shows the functional blocks of MA188.

Table 1: Module Functional Blocks

Product Name	WLAN 2.4GHz	WLAN 5GHz	WLAN 2.4G MIMO	WLAN 5G MIMO	BT, BLE	WLAN 2.4G _0/BT Shared Antenna
MA188	√	√	√	√		√

1.2 Applications

The MA188 can be applied to automotive electronics, RSU and other wireless terminal devices.

1.3 Block Diagram

Figure 1 shows the block diagram of MA188, which include the major components and interfaces.

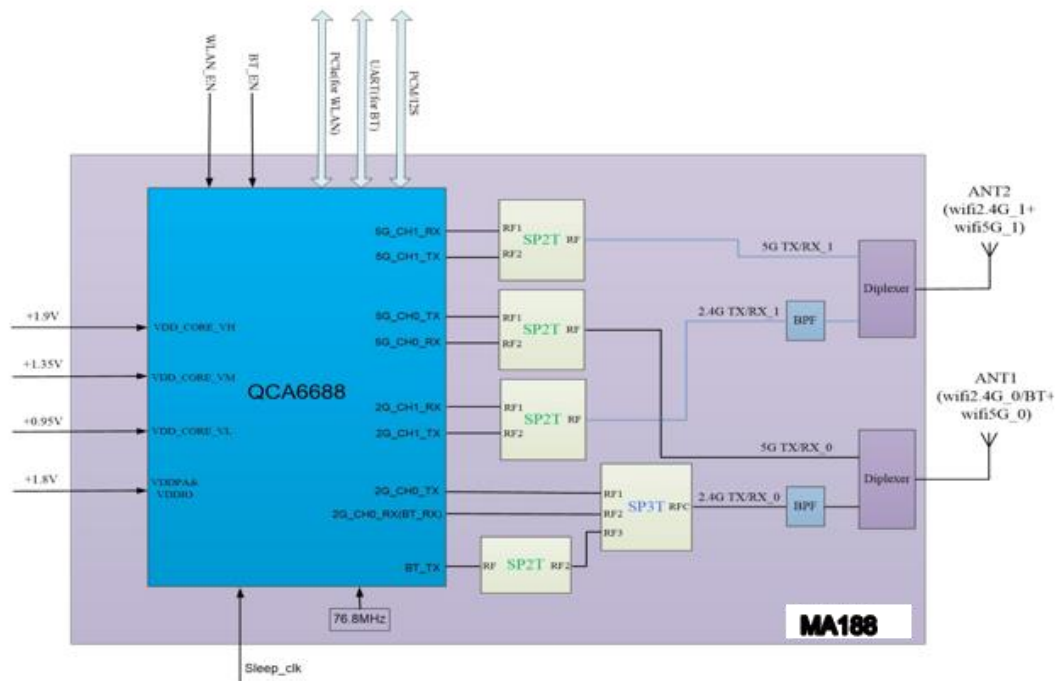


Figure 1: MA188 Block Diagram

1.4 Features

1.4.1 Wlan Key Features

- Wifi standards: IEEE 802.11a/b/g/n/ac/ax
- Supports wifi5G 2X2 Multi-User Multiple-Input Multiple-Output (MU-MIMO)
- 20MHz/40MHz channel bandwidth for 2.4GHz and 20MHz/40MHz/80MHz channel bandwidth for 5GHz
- Dual Band Simultaneous (DBS) with dual MAC
- Offloading traffic for minimal host utilization at 11ac/ax speeds
- Low power PCIe (with L1 substate) interface

- Integrated close-loop power detector

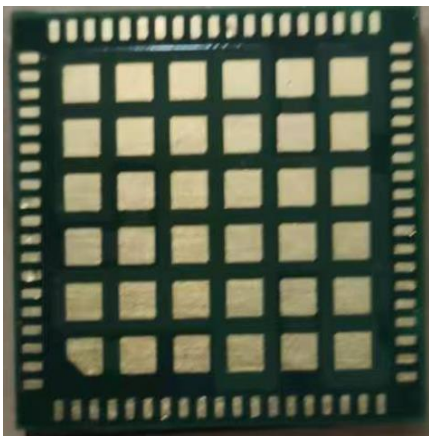
1.4.2 General Features

- Dimensions: 23mm X 23mm X 3.2mm
- AEC-Q100 support
- Host Interface
Wlan: PCIe Gen3
- Antenna of MA188:
Ant1: wifi2.4G_0 coexistence+wifi5G_0 Ant2:
wifi2.4G_1+wifi5G_1

1.4.3 Module Top View



1.4.4 Module Bottom View



2 General Specification

Table 2 shows the General Specification of MA188.

Table 2: General Specification

WLAN	
Frequency Band	2.4/5.0 GHz
RF Input Impedance	50 Ohms
Interfaces	PCIe
Power	
VDDPA	+1.8V DC(typical)
VDD_VL	+0.95V DC(typical)
VDD_VM	+1.35V DC(typical)
VDD_VH	+1.9V DC(typical)
VDDIO	+1.8V DC(typical)
Operating Environment	
Temperature	-40°C to +85°C
Relative Humidity	Less than 85%
Dimension and Weight	
Dimension	23mm (L)*23mm(W)*3.2mm(H)
Weight	TBD

3 Pin Definition

3.1 Pin Assignments

Figure 2 shows the pin assignments of MA188(top view).



Figure 2: MA188 Pin Assignments(top view)

3.2 Pin Definition

Table 3: MA188 Pin Definition

Pin	Pin Name	I/O Type	Description
1	LTE_COEX_RXD	I	QCOM Platform: LTE_COEX_RXD 3rd Party Platform: Host_wakeup_BT Debug Function: BT_DBG_UART_RXD(option)
2	PCM_IN/I2S_SD_IN	I	PCM mode: PCM input signal I2S mode: BT I2S data in
3	PCM_OUT/I2S_SD_OUT	O	PCM mode: PCM output signal I2S mode: BT I2S data out
4	PCM_CLK/I2S_SCK	I/O	PCM mode: PCM clock signal I2S mode: BT I2S clock in
5	PCM_SYNC/I2S_WS	O	PCM mode: PCM synchronnization signal I2S mode: BT I2S word select
6	GND	GND	Ground
7	PCIE_RST_L	I	PCIe reset
8	PCIE_WAKE_L	O	PCIe wake up signal. It is an open-drain signal that requires an external 10 K Ω pull-up resistor.
9	PCIE_CLKREQ_L	O	PCIe clock reques signal. It is an open-drain signal that requires an external 10 K Ω pull-up resistor.
10	WL_SW_CTRL	O	Switch request tp external PMU between active and sleep mode.
11	GND	GND	Ground
12	PCIE_RX_P	I	Differential Receive
13	PCIE_RX_N	I	Differential Receive
14	GND	GND	Ground
15	PCIE_TX_P	O	Differential Transmit (A 0.22uF series capacitor has been already exist inside module)
16	PCIE_TX_N	O	Differential Transmit (A 0.22uF series capacitor has been already exist inside module)
17	GND	GND	Ground
18	PCIE_CLK_N	I	PCIe clock differential signal
19	PCIE_CLK_P	I	PCIe clock differential signal
20	WL_DB_UART_RXD	I	WLAN Debug Signal(Reserved Point)
21	WL_DB_UART_TXD	O	WLAN Debug Signal(Reserved Point)
22	SLEEP_CLK	I	External 32.768KHz sleep clock input. A pull-down resistor is required if SLEEP_CLK is not used.
23	GND	GND	Ground

24	NC	NC	No connection
25	NC	NC	No connection
26	GND	GND	Ground
27	NC	NC	No connection
28	NC	NC	No connection
29	GND	GND	Ground
30	NC	NC	No connection
31	NC	NC	No connection
32	NC	NC	No connection
33	NC	NC	No connection
34	NC	NC	No connection
35	NC	NC	No connection
36	GND	GND	Ground
37	NC	NC	No connection
38	GND	GND	Ground
39	NC	NC	No connection
40	NC	NC	No connection
41	NC	NC	No connection
42	NC	NC	No connection
43	GND	GND	Ground
44	GND	GND	Ground
45	WL_RF0	RF	Wifi5G_0 、 Wifi2.4G_0 and Bluetooth coexistence RF in/out port
46	GND	GND	Ground
47	GND	GND	Ground
48	NC	NC	No connection
49	NC	NC	No connection
50	NC	NC	No connection
51	NC	NC	No connection
52	GND	GND	Ground
53	GND	GND	Ground
54	WL_RF1	RF	WIFI 2.4G_1 and wifi_5G_1 RF in/out port
55	GND	GND	Ground
56	GND	GND	Ground
57	NC	NC	No connection
58	/	/	/

59	I2C_CLK_GPIO	-	I ² C master mode interface. Bluetooth GPIO pins.
60	I2C_DATA_GPIO	-	The clock rate is up to 400 KHz.
61	BT_SENS_UART_RXD	I	Bluetooth two-wire UART interfaces connect to the sensor block in the host.
62	NC	NC	No connection
63	NC	NC	No connection
64	NC	NC	No connection
65	NC	NC	No connection
66	NC	NC	No connection
67	GND	GND	Ground
68	WL_EN	I	Wifi Function Enable, active high
69	/	/	/
70	GND	GND	Ground
71	VDDIO	PI	Module Main Power Input (1.8V)
72	/	/	/
73	/	/	/
74	/	/	/
75	/	/	/
76	LTE_COEX_TXD	O	QCOM Platform: LTE_COEX_TXD 3rd Party Platform: BT_WAKEUP_HOST Debug Function: BT_DBG_UART_TXD(option)
77	VDD_CORE_VH_1	PI	Module Main Power Input (1.9V)
78	GND	GND	Ground
79	VDD_CORE_VL_1	PI	Module Main Power Input (0.95V)
80	GND	GND	Ground
81	GND	GND	Ground
82	GND	GND	Ground
83	VDD_CORE_VH_2	PI	Module Main Power Input (1.9V)
84	GND	GND	Ground
85	VDD_CORE_VL_2	PI	Module Main Power Input (0.95V)
86	VDD_CORE_VL_3	PI	Module Main Power Input (0.95V)
87	GND	GND	Ground
88	GND	GND	Ground
89	VDD_CORE_VM	PI	Module Main Power Input (1.35V)
90	GND	GND	Ground

91	GND	GND	Ground
92	GND	GND	Ground
93	GND	GND	Ground
94	GND	GND	Ground
95	GND	GND	Ground
96	GND	GND	Ground
97	GND	GND	Ground
98	GND	GND	Ground
99	GND	GND	Ground
100	GND	GND	Ground
101	VDD_PA_1	PI	Module PA Power Input (1.8V)
102	VDD_PA_2	PI	Module PA Power Input (1.8V)
103	GND	GND	Ground
104	GND	GND	Ground
105	VDD_PA_3	PI	Module PA Power Input (1.8V)
106	VDD_PA_4	PI	Module PA Power Input (1.8V)
107-112	GND	GND	Ground

4 Power Up/Down Sequence

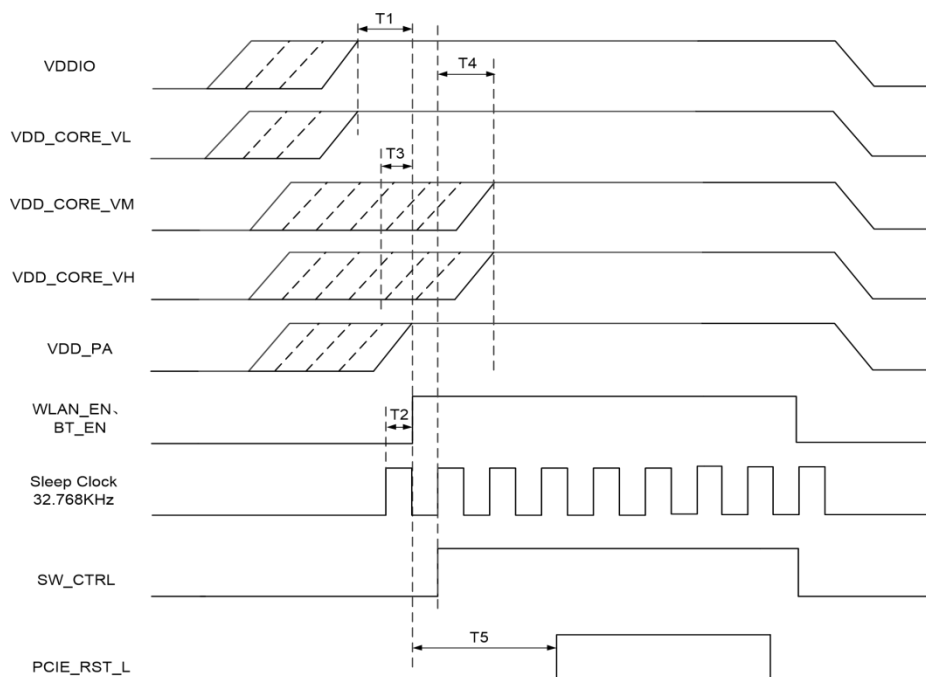


Figure 3: Power Up/Down Sequence

Table 4: Power up/down timing parameters

Symbol	Description	Min	Max	Units
t1	VDDIO/VDD_CORE_VL ^a valid to WLAN_EN is asserted	4	--	ms
t2	Sleep clock(32.768KHz) valid to WLAN_EN is asserted	0	--	us
t3	VDD_CORE_VM /VDD_CORE_VH ^b valid to WLAN_EN asserted without SW_CTRL usage	0	--	us
t4	SW_CTRL ^c is asserted to VDD_CORE_VM /VDD_CORE_VH ^d	--	1	ms
t5	WLAN_EN valid to PCIE_RST_L de-assert	15	--	ms

a Can be in any order.

b Can be in any order.

c It is about 700us SW_CTRL becomes asserted after WL_EN valid.

d Can be in any order.

5 DC Characteristics

5.1 Absolute Maximum Ratings

Table 5: Absolute Maximum Rating

Parameter	Min	Max	Unit
VDD_PA	-0.5	2.2	V
VDDIO	-0.3	2.0	V
VDD_CORE_VL	-0.3	2.1	V

VDD_CORE_VM	-0.3	1.55	V
VDD_CORE_VH	-0.3	2.1	V

5.2 Environmental Ratings

Table 6: Environmental Ratings

Characteristic	Value	Units	Conditions/Comments
Ambient Temperature (TA)	−40 to +85	°C	Functional operation
Relative Humidity	Less than 60	%	Storage
	Less than 85	%	Operation

5.3 Electrostatic Discharge Specifications

Table 7: ESD Specifications

Symbol	Condition	Minimum ESD Rating	Unit
ESD_HAND_HBM ^a	Human body model	TBD	V
ESD_HAND_CDM ^b	Charged device model	TBD	V

a.AEC-Q100-002

b.AEC-Q100-011

5.4 Recommended Operating Conditions and DC Characteristics

Table 8: Recommended Operating Conditions

Symbol	Value			Unit
	Min	Typ	Max	
VDD_PA	1.71	1.8	2.1	V
VDDIO	1.71	1.8	1.89	V
VDD_CORE_VL	0.9	0.95	1.2	V
VDD_CORE_VM	1.28	1.35	1.45	V
VDD_CORE_VH	1.85	1.9	2.1	V

5.5 Power consumption

Table 9: Maximum power consumption

Power supply	Value	Unit
VDD_PA	1200	mA
VDDIO	50	mA
VDD_CORE_VL	1700	mA
VDD_CORE_VM	435	mA
VDD_CORE_VH	415	mA

When designing the power supply, it is recommended to reserve another 50% current

margin.

6 Bluetooth RF Specifications

Table10: Bluetooth Performance of MA188

Parameter		Min	Typ	Max	Unit	Accuracy
RF frequency range		2402		2480	MHz	-
Output Power	Class1 BR	-	TBD	-	dBm	
	Class1 EDR	-	TBD	-		
	LE	-	TBD	-		
Receiver sensitivity	BR(DH5)	-	TBD	-		
	EDR	-	TBD	-		
	LE 1 Mbits/s	-	TBD	-		
	LE 2 Mbits/s	-	TBD	-		
	LE S=2	-	TBD	-		
	LE S=8	-	TBD	-		

7 WLAN RF Specifications

7.1 WLAN Receiver Performance

Table 11: WLAN 2.4GHz Receiver Performance of MA188

Modulation	Data rate	Min	Typ	Max	Unit
802.11b CCK	1Mbps	-	TBD	-	dBm
	11Mbps	-	TBD	-	dBm
802.11g OFDM	6Mbps	-	TBD	-	dBm
	54Mbps	-	TBD	-	dBm
802.11n HT20	MCS0	-	TBD	-	dBm
	MCS7	-	TBD	-	dBm
802.11n HT40	MCS0	-	TBD	-	dBm
	MCS7	-	TBD	-	dBm
802.11ac VHT20	MCS0	-	TBD	-	dBm
	MCS8	-	TBD	-	dBm
802.11ac VHT40	MCS0	-	TBD	-	dBm
	MCS9	-	TBD	-	dBm
802.11ax HE20	MCS0	-	TBD	-	dBm
	MCS11	-	TBD	-	dBm
802.11ax HE40	MCS0	-	TBD	-	dBm
	MCS11	-	TBD	-	dBm
Receive accuracy		-		-	dB

Table 12: WLAN 5GHz Receiver Performance of MA188

Modulation	Data rate	Min	Typ	Max	Unit
802.11g OFDM	6Mbps	-	TBD	-	dBm
	54Mbps	-	TBD	-	dBm
802.11n HT20	MCS0	-	TBD	-	dBm
	MCS7	-	TBD	-	dBm
802.11n HT40	MCS0	-	TBD	-	dBm
	MCS7	-	TBD	-	dBm
802.11ac VHT20	MCS0	-	TBD	-	dBm
	MCS8	-	TBD	-	dBm
802.11ac VHT40	MCS0	-	TBD	-	dBm
	MCS9	-	TBD	-	dBm
802.11ac VHT80	MCS0	-	TBD	-	dBm
	MCS9	-	TBD	-	dBm
802.11ax HE20	MCS0	-	TBD	-	dBm
	MCS11	-	TBD	-	dBm
802.11ax HE40	MCS0	-	TBD	-	dBm
	MCS11	-	TBD	-	dBm

802.11ax HE80	MCS0	-	TBD	-	dBm
	MCS11	-	TBD	-	dBm

7.2 WLAN Transmitter Performance

Table 13: WLAN 2.4GHz Transmitter Performance of MA188

Modulation	Data rate	Conditions	Min	Typ	Max	Unit
802.11b CCK	1Mbps	Mask compliant	-	TBD	-	dBm
	11Mbps	Mask compliant	-	TBD	-	dBm
802.11g OFDM	6Mbps	Mask compliant	-	TBD	-	dBm
	54Mbps	Mask compliant	-	TBD	-	dBm
802.11n HT20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS7	EVM limited(-27dB)	-	TBD	-	dBm
802.11n HT40	MCS0	Mask compliant	-	TBD	-	dBm
	MCS7	EVM limited(-27dB)	-	TBD	-	dBm
802.11ac VHT20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS8	EVM limited(-30dB)	-	TBD	-	dBm
802.11ac VHT40	MCS0	Mask compliant	-	TBD	-	dBm
	MCS9	EVM limited(-32dB)	-	TBD	-	dBm
802.11ax HE20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS11	EVM limited(-35dB)	-	TBD	-	dBm
802.11ax HE40	MCS0	Mask compliant	-	TBD	-	dBm
	MCS11	EVM limited(-35dB)	-	TBD	-	dBm
Transmit output power accuracy			-		-	dB

Table 14: WLAN 5GHz Transmitter Performance of MA188

Modulation	Data rate	Conditions	Min	Typ	Max	Unit
802.11g OFDM	6Mbps	Mask compliant	-	TBD	-	dBm
	54Mbps	Mask compliant	-	TBD	-	dBm
802.11n HT20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS7	EVM limited(-27dB)	-	TBD	-	dBm
802.11n HT40	MCS0	Mask compliant	-	TBD	-	dBm
	MCS7	EVM limited(-27dB)	-	TBD	-	dBm
802.11ac VHT20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS8	EVM limited(-30dB)	-	TBD	-	dBm
802.11ac VHT40	MCS0	Mask compliant	-	TBD	-	dBm
	MCS9	EVM limited(-32dB)	-	TBD	-	dBm
802.11ac VHT80	MCS0	Mask compliant	-	TBD	-	dBm
	MCS9	EVM limited(-32dB)	-	TBD	-	dBm
802.11ax HE20	MCS0	Mask compliant	-	TBD	-	dBm
	MCS11	EVM limited(-35dB)	-	TBD	-	dBm
802.11ax HE40	MCS0	Mask compliant	-	TBD	-	dBm

	MCS11	EVM limited(-35dB)	-	TBD	-	dBm
802.11ax HE80	MCS0	Mask compliant	-	TBD	-	dBm
	MCS11	EVM limited(-35dB)	-	TBD	-	dBm
Transmit output power accuracy			-		-	dB

Table 15: Maximum input level sensitivity of MA188

Standard	Band	Data rate	Typ	Unit
802.11b	2.4 GHz	CCK	TBD	dBm
802.11g	2.4GHz	DSSS-OFDM	TBD	dBm
802.11a	5GHz	OFDM	TBD	dBm
802.11n	2.4GHz	OFDM	TBD	dBm
	5GHz	OFDM	TBD	dBm
802.11ac	2.4GHz	OFDM	TBD	dBm
	5GHz	OFDM	TBD	dBm
802.11ax	2.4GHz	OFDM	TBD	dBm
	5GHz	OFDM	TBD	dBm

7.3 WLAN Throughput Performance

Table 16: Throughput Performance of CBM232AL2A

Standard	TCP		UDP	
	Tx	Rx	Tx	Rx
2.4G 802.11b	6	5.03	6	7
2.4G 802.11g	29	34	34.7	35.5
2.4G 802.11n	147	222	199	242
2.4G 802.11ax	279	449	313	481
5G 802.11a	30.3	35.4	36	36.7
5G 802.11n	230	250	257	258
5G 802.11ac	708	734	764	775
5G 802.11ax	807	878	805	945

Note: Because Qualcomm has a Automotive Active Thermal Mitigation, throughput data will decrease as the ambient temperature increases.

8 Clock requirement

Sleep clock is a digital signal input. Figure 4 and Table 16 show the sleep clock timing requirements.

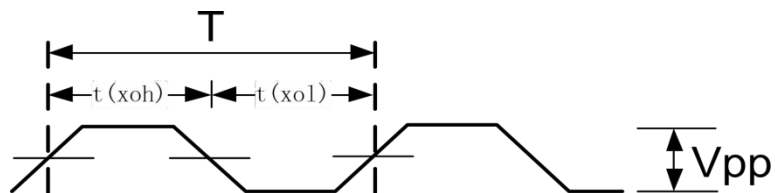


Figure 4: External 32.768KHz sleep clock timing

Table 16: External sleep clock timing

Parameter		Comments	Min	Typ	Max	Units
t(xoh)	Sleep-clock logic high	-	4.58	-	25.94	us
t(xol)	Sleep-clock logic low	-	4.58	-	25.94	us
T	Sleep-clock period	-	-	30.5208	-	us
F	Sleep-clock frequency	$F=1/T$	-	32.768	-	kHz
Vpp	Peak-to-peak voltage	-	-	1.8	-	V

9 Interface Timing

9.1 PCIe Interface

The module supports PCIe Gen 3 interface for WLAN.

The recommended impedance is 90 ohms $\pm 10\%$.

9.2 HCI UART interface

MA188 supports the HCI UART transport layer as defined in the *Bluetooth Core Specification, Version 4.0, Volume4, Part A*. In addition to communication with the host, the HCI UART interface also supports Bluetooth software (in-band) sleep control. The HCI UART interface circuits use digital I/O pins that receive power from the VDDIO supply.

The HCI UART transport layer uses the following settings for MA188.

Table 17: UART parameters

UART parameter	Value
Number of data bits	Eight
Parity bit	No parity
Stop bit	One stop bit
Flow control	RTS/CTS (hardware)
Flow off response	Two bytes maximum
Supported transport bit rates (bps) ^[1]	9.6 K, 19.2 K, 38.4 K, 57.6 K, 115.2 K, 125 K, 230.4 K, 250 K, 460.8 K, 500 K, 720 K, 921.6 K, 1 M, 1.6 M, 2 M, 3 M, 3.2 M, with an accuracy of +1.5/-2.5%

[1] UART maximum baud rate is 3.2 Mbps.

Figure 5 and Table 18 show the HCI UART transmit timing.

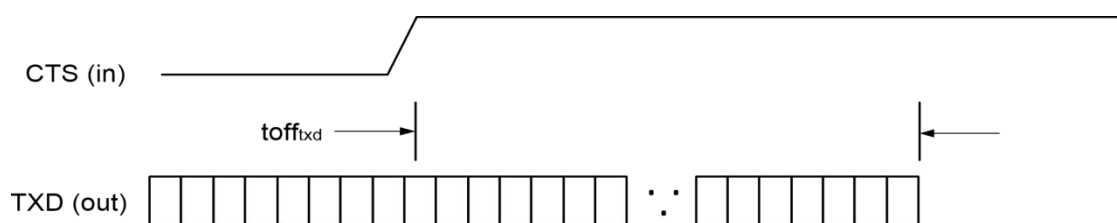


Figure 5: HCI UART transmit flow control timing

Table 18: HCI UART transmit flow control timing

Parameter	Description	Min	Typ	Max	Unit
$toff_{txd}$	Delay from CTS to TXD stop	--	--	1	byte

Figure 6 and Table 19 show the HCI UART receive timing.

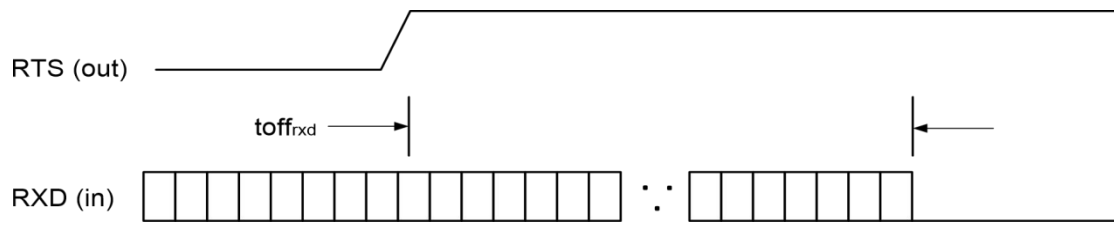


Figure 6: HCI UART receive flow control timing

Table 19: HCI UART receive flow control timing

Parameter	Description	Min	Typ	Max	Unit
Toff _{rx}	Delay from RTS to RXD stop	16	--	--	byte

13 Recommended Reflow Profile

The soldering profile depends on various parameters necessitating a set up for each application. The data here is given only for guidance on solder reflow.

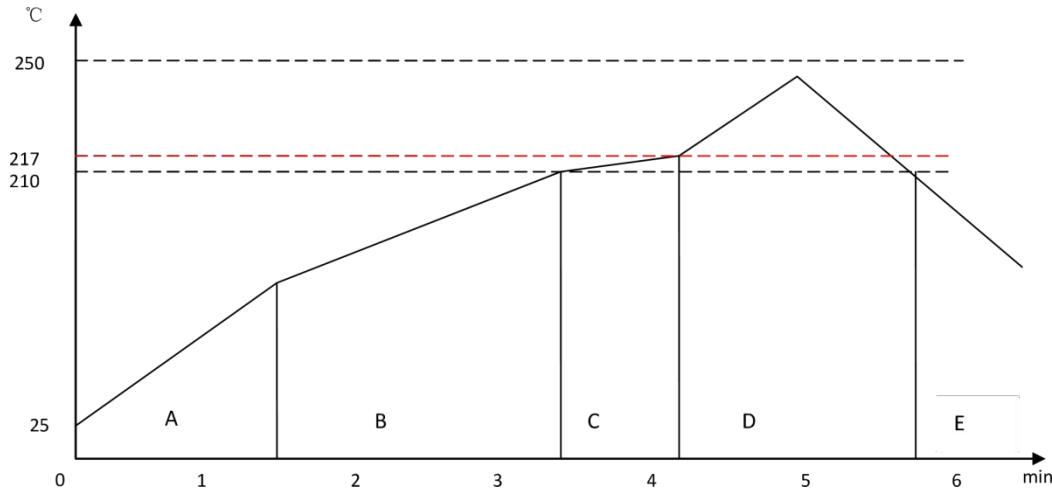


Figure 11: Recommended Reflow Profile

Please use the reflow within 1 times.

- Pre-heat zone (A) — This zone raises the temperature at a controlled rate, typically 0.5 – 2 °C/s. The purpose of this zone is to preheat the PCB board and components to 120 ~ 150 °C. This stage is required to distribute the heat uniformly to the PCB board and completely remove solvent to reduce the heat shock to components.
- Equilibrium Zone 1 (B) — In this stage the flux becomes soft and uniformly encapsulates solder particles and spread over PCB board, preventing them from being re-oxidized. Also with elevation of temperature and liquefaction of flux, each activator and rosin get activated and start eliminating oxide film formed on the surface of each solder particle and PCB board. The temperature is recommended to be 150° to 210° for 60 to 120 second for this zone.
- Equilibrium Zone 2 (c) (optional) — In order to resolve the upright component issue, it is recommended to keep the temperature in 210 – 217 ° for about 20 to 30 second.
- Reflow Zone (D) — The profile in the figure is designed for Sn/Ag3.0/Cu0.5. It can be a reference for other lead-free solder. The peak temperature should be high enough to achieve good wetting but not so high as to cause component discoloration or damage. Excessive soldering time can lead to intermetallic growth which can result in a brittle joint. The recommended peak temperature (Tp) is 230 ~ 250 °C. The soldering time should be 30 to 90 second when the temperature is above 217 °C.
- Cooling Zone (E) — The cooling ate should be fast, to keep the solder grains small which will give a longer lasting joint. Typical cooling rate should be 4 °C.

14 Ordering Information

14.1 Module Coding

Table 24: Ordering Information

Package		Order Number
LGA	Tape and reel	MA188

14.1.1 Product Revision

Table 25: Product Revision

Product Revision	Description	Availability
A	Dual Antenna	Yes

14.1.2 Shipping Package

Table 26: Shipping Package

Shipping Package	Description	Quantity	Availability
0	Foam Tray	—	No
1	Plastic Tray	—	No
2	Reel	600	Yes

14.1.3 Product Package

Table 27: Product Package

Product Package	Description	Availability
Q	QFN	No
L	LGA	Yes
B	BGA	No
C	Connector	No

14.1.4 Product Grade

Table 28: Product Grade

Product Grade	Description	Availability
C	Consumer	No
I	Industrial	No
V	Automobile After-Market	No
A	Automobile Before-Market	Yes

14.2 Product Label Information

TBD

14.3 Storage and Baking conditions

1)MS-LEVEL		3	
※When not compliant with JEDEC, write JEDEC MSL conversion values.			
2)Baking conditions			
①Baking conditions of tray packaging parts		125 °C	9 hours
Number of bakings	NA times	Cumulative	96 hours
②Baking conditions in the reel state	45 °C	192 hours	5 %
Number of bakings.	NA times	Cumulative	NA hours
③Storage period (Anti-humidity packaging state)	12 months	(Storage conditions)	<40 °C 90 %
④Storage period(Open state)	7days	(Storage conditions)	30 °C 60 %
⑤With or without indicator label	☐	Not exist	☒ exist
⑥MS label description on the surface of anti-humidity packaging	☐	Not exist	☒ exist
⑦Other conditions			
※For ⑤ indicator label, when using silica gel whose color changes with humidity, please check "Exist".			
Aside from MS-LEVEL, when there is restriction on expiry date, storage conditions, etc., due to the reasons such as oxidized pin, please write below. Also, when expiry date exists, the start date (manufactured date, delivery date, etc.)			
3)Expiry date(Anti-humidity packaging state)		12 months	
Baking conditions	Bake in accordance with the above (2), and then vacuum again to save		
storage conditions	<40 °C	90 %	Other
4)Expiry date(open state)		7 days	
Baking conditions	Bake in accordance with the above (2), and then vacuum again to save		
storage conditions	<40 °C	90 %	Other

14.4 Warning

EU Conformity Statement



Hereby, [MeiG Smart Technology Co., Ltd] declares that the radio equipment type [MA188] is in compliance with Directive 2014/53/EU.

RF Exposure Information This device has been tested and meets applicable limits for Radio Frequency (RF) exposure.

This radio equipment operates with the following frequency bands and maximum radio-frequency power:

WIFI 2.4G(2400-2483.5MHz):17.91dBm

WIFI 5G Band1(5150-5250MHz): 15.49dBm

WIFI 5G Band3(5470-5725MHz) :19.59dBm

WIFI 5G Band4(5725-5850MHz) :12.97dBm

The device could be used with minimum distance of 20cm to the human body.

FCC Statement:

Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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 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.

(1) Operational use conditions

Module has professional users use condition limitations, Host product manufacturer please ensure giving such warning like "Product is limited to professional users use" in your product's instruction.

(2) Antenna used

Antenna Type: External Antenna

Max Gain: 3.95 dBi

(3) Labelling Instruction for Host Product Integrator

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. For FCC, this exterior label should follow “Contains FCC ID: 2APJ4-MA188”. In accordance with FCC KDB guidance 784748 Labeling Guidelines.

§15.19 and RSS-Gen Labelling requirements shall be complied on end user device. Labelling rules for special device, please refer to §2.925, § 15.19 (a)(5) and relevant KDB publications. For E-label, please refer to §2.935.

(4) Installation Notice to Host Product Manufacturer

The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile application, a separate approval is required for all other operating configurations, including portable configurations with respect to §2.1093 and difference antenna configurations.

(5) Antenna Change Notice to Host manufacturer

If you desire to increase antenna gain and either change antenna type or use same antenna type certified, a Class II permissive change application is required to be filed by us, or you (host manufacturer) can take responsibility through the change in FCC ID and IC ID (new application) procedure followed by a Class II permissive change application.

(6) FCC other Parts, Part 15B Compliance Requirements for Host product manufacturer

This modular transmitter is only FCC authorized for the specific rule parts listed on our grant, host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

Host manufacturer in any case shall ensure host product which is installed and operating with the module is in compliant with Part 15B requirements.

Please note that For a Class B or Class A digital device or peripheral, the instructions furnished the user manual of the end-user product shall include statement set out in §15.105 Information to the user or such similar statement and place it in a prominent location in the text of host product manual. Original texts as following:

For Class B

Note: 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 or more 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.

For Class A

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Japan MIC label ID:



D240057020

020-240232

15 Qualification Certification Information

TBD