



Datasheet

WM828CC6

Dual-Band (2.4/5 GHz) Wi-Fi IEEE 802.11 ac/a/b/g/n
Bluetooth v4.2/BLE (Dual-Mode/Smart-Ready)

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Table of Contents

1. General Description	5
1.1 WLAN Client Features	5
1.2 Access Point Features	8
1.3 WiFi Direct / P2P features	11
1.4 Simultaneous AP-STA Operation	11
1.5 Bluetooth Features	11
1.6 Applications	12
2. System Description	13
2.1 Block Diagram	13
2.2 Functional Mode Pin Configuration	13
2.3 Reset Configuration	13
2.4 Pin Diagram	14
2.5 Pin Description	15
2.6 Physical Dimensions and Pad Locations	18
3. Module Characteristics	19
4. Voltage Domains	23
5. WLAN External Host Interface	24
5.1 SDIO Full Speed and High Speed Timing Diagrams	24
5.2 SDIO 3.0 SDR12, SDR25, SDR50 Modes (up to 100 MHz) (1.8 V)	25
5.3 SDIO 3.0 SDR104 Mode (208 MHz) (1.8 V)	26
5.4 DDR50 Mode (50 MHz) (1.8 V)	27
6. WLAN Power-Save Modes	29
6.1 Full Power-Down Mode	29
6.2 IEEE Power Save	29
6.3 Deep Sleep	29
7. Antenna and Clock	30
7.1 Antenna	30
7.2 Clock	30
8. Software	30
9. Reference Schematics	31
10. Manufacturing Notes	33
10.1 Shield Marking	33
10.2 Storage and Baking Instructions	33
10.3 Recommended Reflow Profile	33
10.4 Data Sheet Status	34
11. Ordering Information	35
12. Data Sheet Status	35
13. Certifications	36
14. References	38
14.1 Specifications	38
14.2 Trademarks, Patents and Licenses	38
14.3 Other	38

List of Figures

Figure 1: Block Diagram.....13
 Figure 2:WM828CC6 Module Pin Diagram (TOP View)14
 Figure 3: SDIO FS Timing.....24
 Figure 4: SDIO HS Timing24
 Figure 5: SDIO 3.0 SDR12, SDR25, SDR50 modes (up to 100 MHz) (1.8 V).....25
 Figure 6: SDIO 3.0 SDR104 modes (up to 208 MHz) (1.8 V)26
 Figure 7: SDIO 3.0 Command Timing for DDR50 mode (50 MHz) (1.8 V).....27
 Figure 8: SDIO 3.0 Data Timing for DDR50 mode (50 MHz) (1.8 V)27
 Figure 9: Reference Schematics ¹31
 Figure 10: Reference Schematics32
 Figure 11: Shield Marking (Top View)33
 Figure 12: Recommended Reflow Profile34

List of Table

Table 1: Pin Configuration for Firmware Boot Options13
 Table 2: Pin Description.....18
 Table 3: Module Characteristics22
 Table 4: 3.3V Voltage Domain Signal Limits23
 Table 5: 1.8V Voltage Domain Signal Limits23
 Table 6: SDIO Timing Data25
 Table 7: SDIO Timing Data for SDR12, SDR25, SDR50 modes (up to 100 MHz) (1.8 V).....26
 Table 8: SDIO 3.0 Timing Data for SDR104 mode (208 MHz)26
 Table 9: SDIO 3.0 Timing data for DDR50 mode (50 MHz).....28
 Table 10: Ordering Information for Modules35
 Table 11: Ordering Information for Evaluation Kits35

Revision History:

Revision	Revision Date	Originator	Changes
1.00	12/19/2016	Wi2Wi	Initial version Datasheet
1.03	05/30/2017	Suresh	Only format changes
1.04	10/26/2018	Dhruv	Added regulatory statements
1.05	21-Jan-21	Suresh	Added Sleep clock mandatory section.

1. General Description

The WM828CC6 is a complete wireless subsystem supporting simultaneous or independent operation of 802.11ac/a/b/g/n Wi-Fi and Bluetooth 4.2 (BT)/Bluetooth Low Energy (BLE). This module comes with SDIO 3.0 host interface in a small form factor. WM828CC6 includes a crystal, switch, filter, Diplexer, local OTP memory for calibration data and MAC address storage. It has been fully optimized to yield high throughput and excellent receiver sensitivity. This module supports SDIO host interfaces and available in Extended temperature grades.

1.1 WLAN Client Features

1. 802.11ac – Very High Throughput
 - 5GHz Band Operation
 - 20/40/80 MHz Channel Bandwidth
 - 11ac Data rates – Up to 433 Mbps (MCS0 to MCS9)
 - 256 QAM Modulation – MCS8 and MCS9
 - SU-AMPDU Tx/Rx Support
 - AMSDU-4K Tx/Rx Support
 - Backward Compatibility with non-VHT devices
 - VHT Tx Rate Adaptation

2. 802.11n – High Throughput (Infrastructure Mode)
 - 2.4GHz Band Operation
 - 5GHz Band Operation
 - 20MHz and 40MHz channel Bandwidth
 - Short/Long Guard Interval (400ns/800ns)
 - Green Field Operation
 - 1 Spatial stream (1x1)
 - 11n Data rates – Up to 300 Mbps (MCS0 to MCS15)
 - HT Duplicate mode (MCS32)
 - Tx MCS Rate Adaptation (ABGN)
 - AMPDU Tx and Rx Support
 - AMSDU-4k Tx and Rx Support
 - AMSDU-8k – Only Tx Support
 - Implicit and Explicit Beam forming
 - HT Protection Mechanisms
 - 20/40 MHz Coexistence Support
 - STBC Rx
 - LDPC Parity

3. 802.11a/b/g Features
 - Data Rates (Up to 54 Mbps)
 - Tx Rate Adaptation (ABG)
 - Tx of RTS/CTS based upon RTS Threshold
 - Fragmentation/Defragmentation
 - ERP protection, Slot time, Preamble
 - ERP Protection using mac ctrl command (RTS-CTS/Self-CTS)
4. 802.11d & 802.11h
 - 802.11d – Regulatory Domain/Operating Class/Country Info
 - 802.11h – DFS – Radar Detection and CSA
 - DFS Radar Detection Tests for FCC/FCC1/ETSI/MJJK for W53/W56 channels
5. 802.11e –QoS
 - EDCA[Enhanced Distributed Channel Access] / WMM (Wireless Multi-Media)
 - U-APSD [Unscheduled Automatic Power Save and Delivery]/ WMM-Power save
6. 802.11i - Security
 - Open and Shared Authentication
 - Auto Auth
 - WEP Security (64/128 bit)
 - WPA-PSK, WPA2-PSK Security (TKIP and AES-CCMP Encryption)
 - 802.1x EAP Authentication methods (TLS, TTLS, PEAP, SIM, AKA, AKA-PRIME, FAST, LEAP)
 - Open source WPA Supplicant Support
 - Embedded Supplicant Support
7. 802.11w - Protected Management Frames (PMF)
 - PMF Require and Capable
 - Unicast Management Frames - Encrypt/Decryption -using CCMP
 - Broadcast Management Frames - Encrypt/Decryption - using BIP
 - SA Query Request/Response
 - PMF Support (Open source WPA Supplicant)
 - PMF Support (Embedded Supplicant)
8. Security WAPI
 - WAPI-PSK
 - WAPI-CERT
 - WAPI-PKCS12
9. General Features
 - Auto Deep Sleep

- Host Sleep (hscfg)
- Background Scan
- User Defined Scan (setuserscan)
- Specific scan (scancfg)
- Network Scan (iwlist scan)
- ARP Filter
- Inactivity time out
- Subscriber Event
- Wakeup on Wireless (WoW)
- Auto Response (MEF)
- Auto Tx
- Vendor Specific IE (Custom IE)
- Broadcast/Multicast data Tx/Rx Support
- Antenna Config Command Tests
- Signal Commands Tests (RSSI/SNR)

10. Power Save Modes

- IEEE PS (Infrastructure Mode)
- PPS
- Inactivity Timeout
- Listen Interval

11. Loading Driver - Optional Parameters

- Configuring MAC Address during driver load using init_cfg file
- Loading Driver Using CFG80211 and mlanutl commands
- Loading Driver Using WEXT
- Setting Deep sleep.
- Setting Power save

12. WPS/WSC2.0 Functionality

- PIN Config Method - 8 Digit/4 Digit
- PIN Config Method - Static/Dynamic PIN
- PBC - Virtual Push Button Config Method
- PBC Session Overlap Detection
- STA as Enrollee
- STA as Registrar
- Auto PIN
- Auto PBC
- Configuring ER and Adding an Enrollee (UPnP)
- Standalone ER
- Backward Compatibility with WPS1.0 Devices
- Using mwu_cli app with Embedded Supplicant

- Using mwu_cli app with Opensource WPA Supplicant
- Using wpa_supplicant

13. TDLS

- TDLS Setup(req/res/confirm)
- TDLS Teardown(send/receive)
- TDLS Discovery
- Max. 2 concurrent TDLS links supported

14. 802.11r – FT – Fast BSS Transition

- Active Roaming
- FT over Air
- FT over DS (Distribution System)

15. 802.11u – Hotspot 2.0 R1 / Passpoint Release1

- GAS/ANQP Query
- NAI Home Realm Query
- Operating Class Indication
- EAP SIM and EAP- AKA Methods
- Re-association using Stored/preferred Credentials
- Proxy ARP Service – Discards Gratuitous ARP/ Unsolicited Neighbor Advertisement

1.2 Access Point Features

1. 802.11a/b/g Features

- Data Rates (Up to 54 Mbps)
- Tx Rate Adaptation (ABG)
- Tx of RTS/CTS based upon RTS Threshold
- Fragmentation/Defragmentation
- ERP protection, Slot time, Preamble
- Handling Associated STAs with IEEE PS - PS-Poll and Null Data

2. 802.11d & 802.11h

- 802.11d - Regulatory Domain/Operating Class/Country Info
- 802.11h - DFS - Radar Detection and CSA
- DFS Radar Detection Tests for FCC/FCC1/ETSI/MJJK for W53/W56 channels

3. 802.11e –QoS

- EDCA[Enhanced Distributed Channel Access] / WMM (Wireless Multi-Media)
- U-APSD[Unscheduled Automatic Power save and Delivery]/ WMM-Power save

4. 802.11i – Security
 - Open and Shared Authentication
 - Auto Auth
 - WEP Security (64/128 bit)
 - WPA-PSK, WPA2-PSK Security (TKIP and AES-CCMP Encryption)
 - 802.1x EAP Authentication methods (using Hostapd only)(TLS, TTLS, PEAP, SIM, AKA, AKA-PRIME, FAST, LEAP)
 - Opensource Host based Authenticator Support (Hostapd)
 - Embedded Authenticator Support
 - Group Key Refresh (Rekeying GTK)

5. 802.11w – Protected Management Frames (PMF)
 - PMF Require and Capable
 - Unicast Management Frames - Encrypt/Decryption -using CCMP
 - Broadcast Management Frames - Encrypt/Decryption - using BIP
 - SA Query Request/Response
 - PMF Support (Hostapd)

6. Security WAPI
 - WAPI-PSK
 - WAPI-CERT
 - WAPI-PKCS12

7. 802.11n – High Throughput
 - 2.4GHz Band Operation
 - 5GHz Band Operation
 - 20/40 MHz channel Bandwidth
 - Short/Long Guard Interval (400ns/800ns)
 - Green Field Operation
 - 1 Spatial stream (1x1)
 - 11n Data rates – Up to 300 Mbps (MCS 0 to MCS 15)
 - HT Duplicate mode (MCS32)
 - Tx MCS Rate Adaptation (ABGN)
 - AMPDU Tx and Rx Support
 - AMSDU 4K Tx/Rx Support
 - AMSDU-8k Tx Support
 - HT Protection Mechanisms
 - 20/40 MHz Coexistence Support
 - Beamformee
 - Beamformer - Implicit
 - Beamformer - Explicit
 - SM Power save (MIMO Power save)

- LDPC Parity
8. 802.11ac – Very High Throughput
 - 5GHz Band Operation
 - 20/40/80 MHz channel Bandwidth
 - 11ac Data rates – Up to 433 Mbps (MCS 0 to MCS 9)
 - 256 QAM Modulation - MCS8 and MCS9
 - SU-AMPDU Tx/Rx Support
 - AMSDU - 4K Tx/Rx Support
 - Backward Compatibility with non-VHT devices
 - VHT Tx Rate Adaptation
 9. General Features
 - Auto Deep Sleep
 - Host Sleep (hscfg)
 - Simultaneous client and access point operation (up to 10 clients supported)
 - Automatic Channel Selection (ACS)
 - Hidden SSID (Broadcast SSID Disabled)
 - MAC Address Filter (Allowed/Denied List)
 - Vendor Specific IE (Custom IE)
 - STA Age out Feature for non-PS clients
 - STA Age out Feature for Power save clients
 - Configurable MAX Supported Stations (Up to 8)
 - Configurable Retry Limit
 - Configurable Unicast Data Rate
 - Configurable Broadcast/Multicast Data Rate
 - Broadcast/Multicast data Tx/Rx Support
 - Antenna Config Command Tests
 - MMH Events
 - BSS Privacy Control (Packet forward Control) or AP Isolation
 - Sticky TIM
 10. MH (Mobile hotspot) Power Save Modes
 - Inactivity based Power save
 11. Multi-BSS support
 - MAX MMH BSS = 2
 - MMH power save in MBSS scenario
 - Independent security configurations on different interfaces (All Security Methods)
 12. Loading Driver - Optional Parameters
 - Configuring MAC Address during driver load using init_cfg file

- Loading Driver Using CFG80211 and mlanutl commands
 - Loading Driver Using WEXT
 - Setting DeepSleep
 - Loading MMH configuration using uaputl.conf file
13. WPS/WSC2.0 Functionality
- PIN Config Method - 8 Digit/4 Digit
 - PIN Config Method - Static/Dynamic PIN
 - PBC - Virtual Push Button Config Method
 - AP Setup Locked State - PIN Method
 - PBC Session Overlap Detection
 - MMH as Enrollee
 - MMH as Wireless Registrar
 - MMH as Wired ER (Bridging uap0 and eth interfaces)
 - MMH as Proxy - Configuration by ER and Adding an Enrollee (UPnP)
 - Using mwu_cli app

1.3 WiFi Direct / P2P features

- Autonomous Group Owner (GO) Mode
- P2P Client Mode
- Non P2P Client Association with GO
- P2P client association with WLAN AP
- P2P Client Power save
- P2P Client WMM PS (uAPSD)
- GO WMM PS for associated P2P Clients
- GO IEEE PS for associated P2P Clients
- 8 Client Support

1.4 Simultaneous AP-STA Operation

- Independent security configurations on different interfaces.
- Enhanced Power Save (AP-STA simultaneous power save)

1.5 Bluetooth Features

- BT 4.2
- BT Class 1.5 and Class 2 support
- Automatic Packet Type Selection
- 2.5 scatternet support
- Maximum of seven simultaneous ACL connections
- Maximum of three SCO/eSCO links
- On chip SBC offload for WBS
- ACL (DM1, DH1, DM3, DH3, DM5, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5)
- SCO (HV1, HV3)

- eSCO (EV3, EV4, EV5, 2EV3, 3EV3, 2EV5, 3EV5)
- Deep Sleep
- BT A2DP/PAN traffic distinction
- Wake on BT
- BR/EDR secure connections
- LE 4.2 features – LE secure connection, LE Privacy 1.2
- Time/Spatial Coexistence with Wi-Fi

1.6 Applications

- IoT (Internet of Things)
- M2M (Machine-to-Machine)
- Imaging platforms (printer, digital camera)
- Internet enabled consumer devices
- Wi-Fi enabled security cameras
- Home/mobile audio and video streaming
- Simultaneous multiple Ultra High Definition (UHD) video streaming (DTV, DVD/Blu-ray players)
- Video conferencing, Vo-Fi (Voice over Wi-Fi)
- Hands-free audio (Bluetooth)
- Automotive applications and aftermarket
- Warehousing and logistics handhelds
- Medical imaging and monitoring equipment
- Gaming platforms
- Mobile routers (Mi-Fi) or Mobile hotspot
- Smart homes
- Smart energy
- Wireless control terminals and point-to-point backhaul
- Outdoor content distribution (for indoor use only, when operating in 5GHz U-NII-1 sub-band, 5150-5250 MHz)

2. System Description

WM828CC6 is a complete wireless subsystem with 802.11 ac/a/b/g/n + Bluetooth v4.2 (including BLE) capabilities along with integrated MAC, baseband, RF front-end, PA, crystal, switch, filter and OTP memory for calibration data and MAC address storage. It provides optimized system functions and best-in-class performance, all in a small form factor, 13 x 11 x 1.86 mm.

2.1 Block Diagram

Figure 1 shows a block diagram of WM828CC6 along with the available host interfaces.

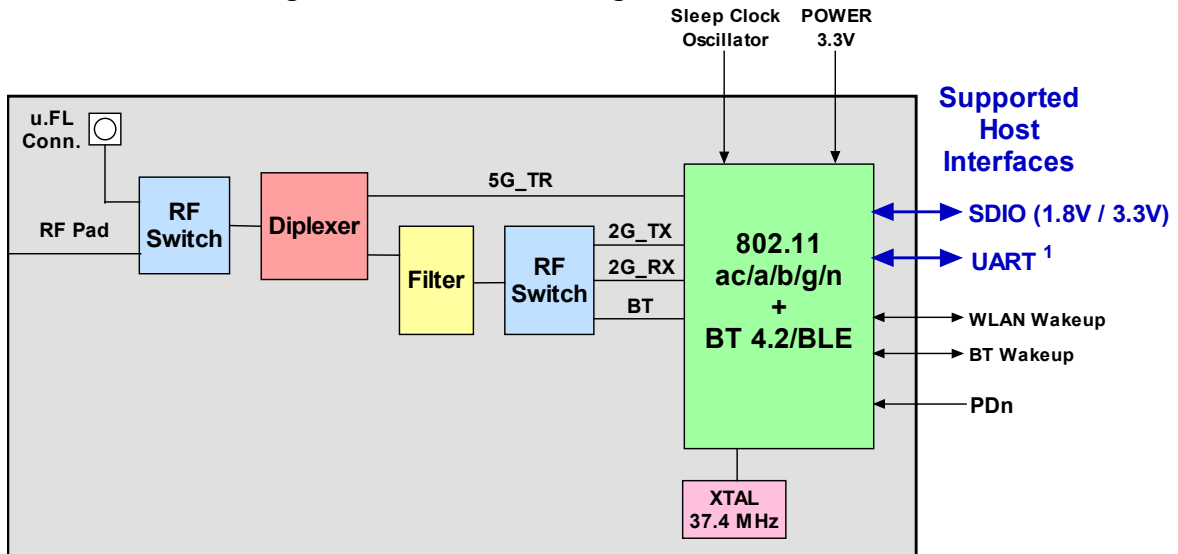


Figure 1: Block Diagram

¹ UART is not supported in the current software release.

2.2 Functional Mode Pin Configuration

GPIO_3/CON[1]	GPIO_2/CON[0]	Wi-Fi	BLUETOOTH/BLE
1	1	SDIO 3.0	SDIO 3.0

Table 1: Pin Configuration for Firmware Boot Options

2.3 Reset Configuration

- External pin assertion (PDn) will generate POR
- Software/Firmware reset

2.4 Pin Diagram

Figure 2 shows the pin assignments for the 58 - pin QFN package module.

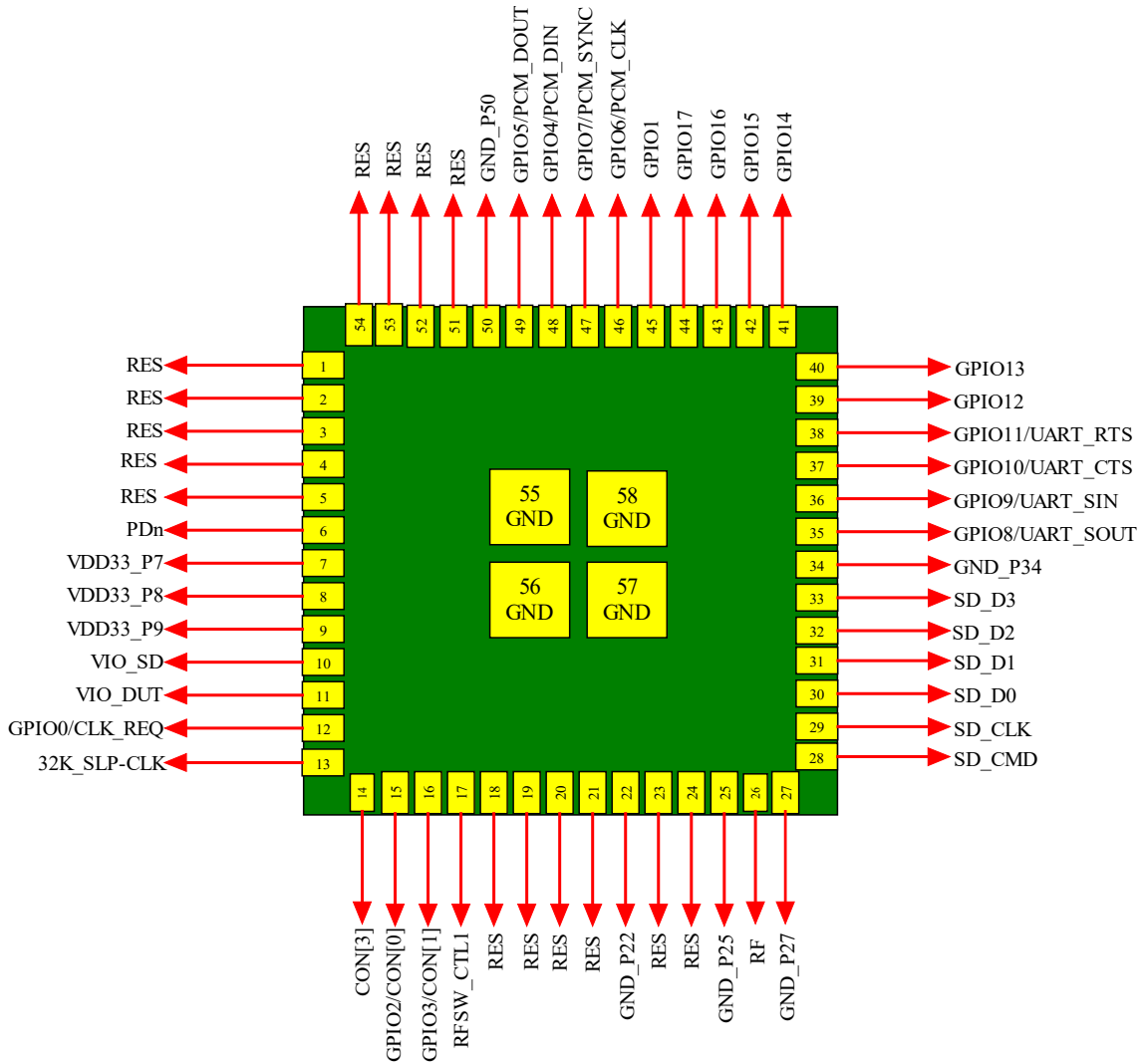


Figure 2:WM828CC6 Module Pin Diagram (TOP View)

- ¹ UART is not supported in the current software release.
- ² PCM is not supported in the current software release.
- ³ GPIO's are not supported in the current software release.

2.5 Pin Description

Table 2 below shows the functional description of each pin in this module.

Pin No.	Pin Name	Supply	Type	Pin Description
Clock and Reset Signals				
6	PDN	VIO_DUT	I	<p>Full Power-Down (Input)(active low)</p> <p>0 = full power-down mode</p> <p>1 = normal mode</p> <p>External host required to drive this pin low for PDN. Internally pulled high to VIO_DUT (51K Ohm)</p>
13	SLP_CLK	1.8V	I	<p>Input for External Sleep Clock (32.768 kHz) to support Wi-Fi/BT low power operation, external sleep clock oscillator should use 1.8V power. Sleep clock is mandatory for low power down modes.</p> <p>By default, Reference clock frequency detection happens by calibration of sleep clock.</p> <p>If this sleep clock is missing, board does not load the firmware.</p> <p>If sleep clock is not required as per customer design, then we need to pull down CON[3] to logic low so that module works on the main crystal by default and skips the reference clock detection.</p>
Reserved Pins				
1	RES	-	-	Wi2Wi Reserved, No Connect on this pin
2	RES	-	-	Wi2Wi Reserved, No Connect on this pin
3	RES	-	-	Wi2Wi Reserved, No Connect on this pin
4	RES	-	-	Wi2Wi Reserved, No Connect on this pin
5	RSE	-	-	Wi2Wi Reserved, No Connect on this pin
23	RES	-	-	Wi2Wi Reserved, No Connect on this pin
24	RES	-	-	Wi2Wi Reserved, No Connect on this pin
51	RES	-	-	Wi2Wi Reserved, No Connect on this pin
52	RES	-	-	Wi2Wi Reserved, No Connect on this pin
53	RES	-	-	Wi2Wi Reserved, No Connect on this pin
54	RES	-	-	Wi2Wi Reserved, No Connect on this pin
Power Management Signals				
7	VDD33_P7	3.3V	Power	Module power supply, 3.3V
8	VDD33_P8	3.3V	Power	Module power supply, 3.3V

9	VDD33_P9	3.3V	Power	Module power supply, 3.3V
10	VIO_SD	1.8V/3.3V	Power	SDIO power supply, 1.8V/3.3V
11	VIO_DUT	1.8V/3.3V	Power	GPIO power supply, 1.8V/3.3V
Reserved Section				
18	RES	-	-	Wi2Wi Reserved, No Connect on this pin
19	RES	-	-	Wi2Wi Reserved, No Connect on this pin
20	RES	-	-	Wi2Wi Reserved, No Connect on this pin
21	RES	-	-	Wi2Wi Reserved, No Connect on this pin
RF Pad				

26	RF	3.3V	I/O	RF Pin for Tx/Rx of Wi-Fi/BT signal; internally powered by 3.3V
SDIO Interface Signals				
28	SD_CMD	VIO_SD	I/O	SDIO 4-bit Mode: Command line
				SDIO 1-bit Mode: Command line
29	SD_CLK	VIO_SD	I	SDIO 4-bit Mode: Clock input
				SDIO 1-bit Mode: Clock input
30	SD_D0	VIO_SD	I/O	SDIO 4-bit Mode: Data line Bit[0]
				SDIO 1-bit Mode: Data line
31	SD_D1	VIO_SD	I/O	SDIO 4-bit Mode: Data line Bit[1]
				SDIO 1-bit Mode: Interrupt
32	SD_D2	VIO_SD	I/O	SDIO 4-bit Mode: Data line Bit[2] or Read wait (optional)
				SDIO 1-bit Mode: Read wait (optional)
33	SD_D3	VIO_SD	I/O	SDIO 4-bit Mode: Data line Bit[3]
				SDIO 1-bit Mode: Not used
GPIO PINS				
12	GPIO0 ³	VIO_DUT	I/O	Wi2Wi Reserved, No Connect on this pin
14	CON[3]	Res	Res	Default: Internally pull high. Leave open if not used. PULL LOW externally to avoid sleep clock source and boot from internal reference clock.
15	GPIO2/CON[1]	VIO_DUT	I	CON[0]: During Boot this pin is INPUT with weak pull up, Firmware boot configuration – see Table 1
			O	After boot up GPIO2 is configured as WLAN_LED: Wi-Fi activity LED
16	GPIO3/CON[1]/PCM_MCLK ²	VIO_DUT	I	CON[1]: During Boot this pin is INPUT with weak pull up, Firmware boot configuration – see Table 1

			O	After boot up GPIO3 is configured as BT_LED: Bluetooth activity LED
			I/O	PCM_MCLK ² : PCM Clock Signal (optional): Optional clock used for some codecs, derived from PCM_CLK; Output if PCM master, Input if PCM slave
17	RFSW_CTL1	VIO_DUT	I	External Pull up required for RF PAD (Pin # 26), Open for default MHF4 on module
35	GPIO8 ³ /UART_SOUT ¹	VIO_DUT	I/O	GPIO Mode: GPIO8
			O	UART Mode ¹ : Serial data output to modem, data set or peripheral device
36	GPIO9 ³ /UART_SIN ¹	VIO_DUT	I/O	GPIO Mode: GPIO9
			I	UART Mode ¹ : Serial data input from modem, data set or peripheral device
37	GPIO10 ³ /UART_CTS ¹	VIO_DUT	I/O	GPIO Mode: GPIO10
			I	UART Mode ¹ : Clear To Send, input from modem, data set or peripheral device (active low)
38	GPIO11 ³ /UART_RTS ¹	VIO_DUT	I/O	GPIO Mode: GPIO11
			O	UART Mode ¹ : Request To Send, output to modem, data set or peripheral device (active low)
39	GPIO12 ³ /UART_DSR ¹	VIO_DUT	I	Data set Ready ¹ , Input for module(Active Low)
40	GPIO13	VIO_DUT	O	BT_WKUP_HOST: Module Bluetooth to Host Wakeup.
41	GPIO14	VIO_DUT	I	HOST_WKUP_WLAN : Host to Module WLAN Wakeup
42	GPIO15	VIO_DUT	I	HOST_WKUP_BT: Host to Module Bluetooth Wakeup
43	GPIO16 ³	Res	Res	Wi2Wi Reserved, No Connect on this pin
44	GPIO17 ³	Res	Res	Wi2Wi Reserved, No Connect on this pin
45	GPIO1	VIO_DUT	O	WLAN_WKUP_HOST : Module WLAN to Host Wakeup
46	GPIO6 ³ /PCM_CLK ²	VIO_DUT	I/O	PCM_CLK ² : PCM Clock Signal: Output if PCM master, Input if PCM slave
47	GPIO7 ³ /PCM_CLK ²	VIO_DUT	I/O	PCM_SYNC ² : PCM Sync Pulse Signal: Output if PCM master, Input if PCM slave
48	GPIO4 ³ /PCM_DIN ²	VIO_DUT	I	PCM_DIN ² : PCM Data Input
49	GPIO5 ³ /PCM_DOUT ²	VIO_DUT	O	PCM_DOUT ² : PCM Data Output

Ground Pins				
22	GND_P22	GND	Ground	Ground Pin
25	GND_P25	GND	Ground	Ground Pin
27	GND_P27	GND	Ground	Ground Pin
34	GND_P34	GND	Ground	Ground Pin
50	GND_P50	GND	Ground	Ground Pin
55	EPAD_P55	GND	Ground	Exposed Ground Pad
56	EPAD_P56	GND	Ground	Exposed Ground Pad
57	EPAD_P57	GND	Ground	Exposed Ground Pad
58	EPAD_P58	GND	Ground	Exposed Ground Pad

Table 2: Pin Description

¹ UART is not supported in the current software release.

² PCM is not supported in the current software release.

³ GPIO functionality is not supported in the current software release.

2.6 Physical Dimensions and Pad Locations

- Module Physical Size: 13 x 11 x 1.86 mm (including shield)
- Solder Pad Size: 0.4 x 0.4 mm
- Pad to Pad Space: 0.350 mm
- Pad Pitch: 0.750 mm
- Last Pad to Module Edge: 0.3 mm
- Pad Finish: ENIG (Electro-less Nickel Immersion Gold)
- Pads: [(four sides (13 + 14 + 13 + 14) + 4 Ground Pads in the middle)]

Note: For Hardware Application notes, module dimensions and symbol library files please contact Wi2Wi sales or send an email to sales@wi2wi.com

3. Module Characteristics

Table 3 below indicates the electrical data and RF characteristics of the WM828CC6 module.

Parameter	Condition	MIN	TYP	MAX	UNITS
Absolute Maximum Ratings					
Storage Temperature		-40		+85	°C
VDD33	Module Power Supply		3.3	4.0	V
VIO_DUT	GPIO Power Supply		1.8	2.2	V
			3.3	4.0	V
VIO_SD	SDIO Power Supply		1.8	2.2	V
			3.3	4.0	V
Recommended Operating Conditions					
Operating Temperature		-30	25	+85	°C
VDD33	Module Power Supply	3.0	3.3	3.6	V
VIO_DUT	GPIO Power Supply	1.6	1.8	2.0	V
		3.0	3.3	3.6	V
VIO_SD	SDIO Power Supply	1.6	1.8	2.0	V
		3.0	3.3	3.6	V
Wi-Fi Power Consumption, 5 GHz, TX/RX, with BT in Deep Sleep mode					
Initialization Current			-		mA
Transmit Mode	12dBm, @54Mbps		280		mA
	8dBm, @54Mbps		196		mA
	12dBm, HT20 @MCS7		282		mA
	10dBm, HT20 @MCS7		270		mA
	11dBm, VHT80 @MCS7		360		mA
	11dBm, VHT20 @MCS8		266		mA
	10dBm, VHT40 @MCS8		265		mA
	8dBm, VHT80 @MCS8		356		mA
	10dBm, VHT40 @MCS9		263		mA
	8dBm, VHT80 @MCS9		350		mA
Receive Mode	@54Mbps		67		mA
	HT20 @MCS7		78		mA

	HT40 @MCS7		89		mA
	VHT80 @MCS7		112		mA
	VHT20 @MCS8		81		mA
	VHT40 @MCS8		105		mA
	VHT80 @MCS8		114		mA
	VHT40 @MCS9		104		mA
	VHT80 @MCS9		121		mA
Wi-Fi Power Consumption, 2.4 GHz, TX/RX, with BT in Deep Sleep mode					
Initialization Current			-		mA
Transmit Mode	18dBm, @11Mbps		290		mA
	10dBm, @11Mbps		184		mA
	15dBm, @54Mbps		258		mA
	15dBm, HT20 @MCS7		260		mA
Receive Mode	Idle		50		mA
	@11 Mbps		50		mA
	@54 Mbps		54		mA
	11n, HT20 @MCS7		66		mA
Module Power Consumption in Deep Sleep Mode, with Wi-Fi DTIM (1,3,5)					
Wi-Fi + BT Deep sleep ⁴			146		uA
Wi-Fi DTIM 1 and BT Deep Sleep			1.14		mA
Wi-Fi DTIM 3 and BT Deep Sleep			470		uA
Wi-Fi DTIM 5 and BT Deep Sleep			340		uA
Bluetooth Power Consumption, TX @ 0dBm with Wi-Fi					
Power Down ⁴			36		uA
Chip Deep sleep ⁴			146		uA
BT idle (Sleep Mode)			4.23		mA
SCO HV3 Peak TX			18.75		mA
SCO HV3 Peak RX			16.50		mA
HV3 SCO mode ACL sniff 0x800			7.57		mA
eSCO link, Master (2-EV3), ACL sniff 0x800			6.57		mA
eSCO link, Master (EV3), ACL sniff 0x800			7.69		mA
ACL (data pump) DH1			11.59		mA
ACL (data pump) DH3			14.59		mA
ACL (data pump) DH5			16.39		mA
ACL Link, master sniff mode, interval=1.28s (800)			186		uA
ACL Link, master sniff mode,			278		uA

interval=500ms (320)				
SCO HV3 Average TX @ 4 dBm (external antenna)			7.83	mA
SCO HV3 Average RX @ 4 dBm (external antenna)			22.00	mA
Interlaced scan (= P&I scan)			372	uA
Page & Inquiry scan			372	uA
Page Scan			257	uA
Inquiry Scan			257	uA
LE Advertise @ 1.28s interval			149	uA
LE Link (interval=400=1.28s)			154	uA
LE Link (interval=320=1.00s)			155	uA
LE Scan (interval=800=1.28s)			231	uA
LE Scan (interval=640=1.00s)			262	uA
Bluetooth System Specifications				
Parameter		Value		
Frequency		2.400 GHz – 2.4835 GHz		
Channels		79		
BT Modes		BT, BLE		
Tx Power		Class 2, Class 1, BT-BDR: 10 dBm ± 2 dB, BT-EDR: 4.4 dBm ± 2 dBm, BLE: 7.1 dBm ± 2 dBm		
Rx Sensitivity		-85 dBm		
Modulation		1 Mbps: GFSK (BR)		
		2 Mbps: $\pi/4$ -DQPSK (EDR)		
		3 Mbps: 8-DQPSK (EDR)		
Wi-Fi IEEE 802.11 System Specifications				
Parameter	Protocol	Value		
Frequency	IEEE 802.11 b/g/n	2.400 – 2.500 GHz		
	IEEE 802.11 a/n/ac	5.180 – 5.240 GHz and 5.745 – 5.825 GHz		
Supported Rates	IEEE 802.11b	1, 2, 5.5, 11 Mbps		
	IEEE 802.11g	6, 9, 12, 18, 24, 36, 48, 54 Mbps		
	IEEE 802.11a	6, 9, 12, 18, 24, 36, 48, 54 Mbps		
	IEEE 802.11n	MCS0 – MCS7 (150 Mbps)		
	IEEE 802.11ac	MCS0 – MCS9 (433 Mbps)		
Modulation	IEEE 802.11b	DSSS and CCK		
	IEEE 802.11g	OFDM		
	IEEE 802.11a	OFDM		
	IEEE 802.11n	OFDM		
	IEEE 802.11ac	OFDM		
Supported Bandwidth	IEEE 802.11b	20MHz		
	IEEE 802.11g	20MHz		
	IEEE 802.11a	20MHz		
	IEEE 802.11n	20MHz, 40MHz		

	IEEE 802.11ac	20MHz, 40MHz, 80MHz		
Max Transmit Power	IEEE 802.11b	18 dBm ± 2 dBm		
	IEEE 802.11g	15 dBm ± 2 dBm		
	IEEE 802.11a	15 dBm ± 2dBm		
	IEEE 802.11n	15 dBm ± 2dBm		
	IEEE 802.11ac	15 dBm ± 2dBm		
			Signal Strength	Data Rate
2.4GHz Receive Sensitivity	IEEE 802.11b	-98 dBm ± 1 dBm	1Mbps	20MHz
		-89 dBm ± 1 dBm	11Mbps	20MHz
	IEEE 802.11g	-91 dBm ± 1 dBm	6Mbps	20MHz
		-74 dBm ± 1 dBm	54Mbps	20MHz
	IEEE 802.11n	-91 dBm ± 1 dBm	MCS0	20MHz
		-73 dBm ± 1 dBm	MCS7	20MHz
		-89 dBm ± 1 dBm	MCS0	40MHz
	5GHz Receive Sensitivity	IEEE 802.11a	-91 dBm ± 1 dBm	6Mbps
-74 dBm ± 1 dBm			54Mbps	20MHz
IEEE 802.11n		-90 dBm ± 1 dBm	MCS0	20MHz
		-72 dBm ± 1 dBm	MCS7	20MHz
		-88 dBm ± 1 dBm	MCS0	40MHz
IEEE 802.11ac		-85 dBm ± 1 dBm	MCS0	80MHz

Table 3: Module Characteristics

Notes:

- 1) VIO_SD, VIO_DUT, XTAL power rail are excluded from measurement for Power Down and Deep Sleep modes
- 2) On 2.4GHz band, only Channels 1-11 are supported in United States and Canada as per regulatory requirements from FCC and IC/ISED, while Channels 1-13 are all supported in Europe as per regulatory requirements from CE/ETSI/RED

4. Voltage Domains

Voltage domains and limits of all the signal pins are listed in Table 4 and Table 5.

	Min	Typical	Max	Units
Vih	2	-	3.6	V
Vil	-0.3	-	1	V
Vihys	300	-	-	mV
Voh	2.3	-	-	V
Vol	-	-	0.4	V

Table 4: 3.3V Voltage Domain Signal Limits

	Min	Typical	Max	Units
Vih	1.2	-	2.1	V
Vil	-0.3	-	0.6	V
Vihys	250	-	-	mV
Voh	1.22	-	-	V
Voj	-	-	0.4	V

Table 5: 1.8V Voltage Domain Signal Limits

5. WLAN External Host Interface

For connection to a host processor, WM828CC6 supports the SDIO 3.0 SDR104 with 1 bit and 4 bit transfers.

5.1 SDIO Full Speed and High Speed Timing Diagrams

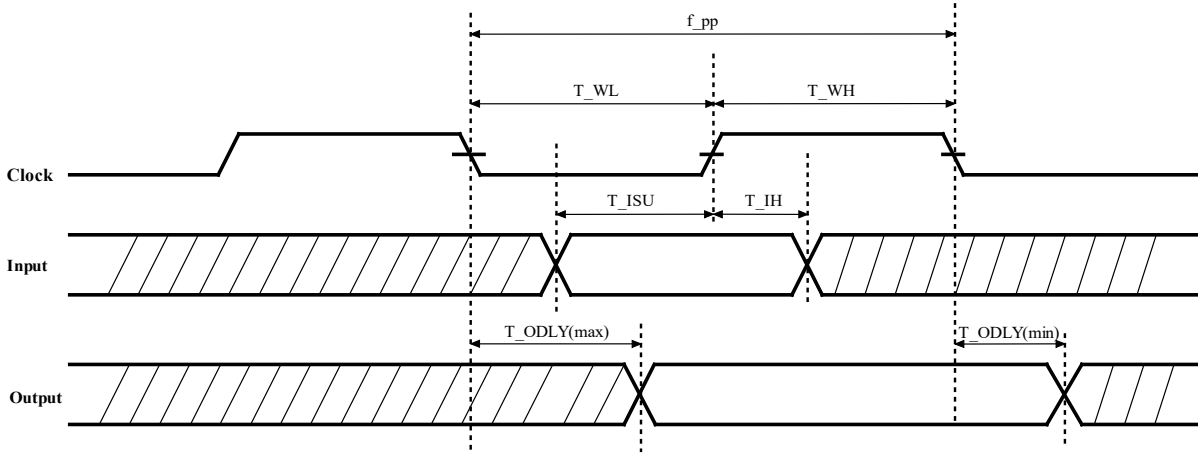


Figure 3: SDIO FS Timing

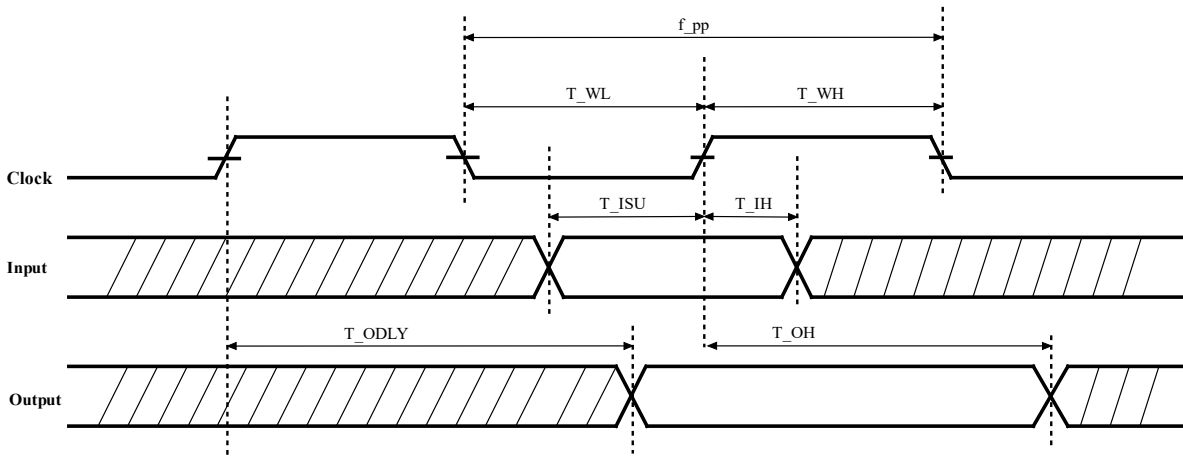


Figure 4: SDIO HS Timing

Note: The SDIO-SPI CS Signal timing is identical to all other SDIO inputs

Symbol	Parameter	Condition	Min	Typical	Max	Units
f _{pp}	Clock Frequency	Normal	0	--	25	MHz
		High speed	0	--	50	MHz
T _{WL}	Clock Low Time	Normal	10	--	--	ns
		High speed	7	--	--	ns
T _{WH}	Clock High Time	Normal	10	--	--	ns
		High speed	7	--	--	ns
T _{ISU}	Input Setup Time	Normal	5	--	--	ns
		High speed	6	--	--	
T _{IH}	Input Hold Time	Normal	5	--	--	ns
		High speed	2	--	--	
T _{ODLY} (max)	Max Output Delay Time	Normal			14	ns
T _{ODLY} (min)	Min Output Delay Time	Normal			0	ns
T _{ODLY}	Output Delay Time	Normal		--	14	ns
T _{OH}	Output Hold Time	High Speed	2.5	--	--	ns

Table 6: SDIO Timing Data

Note: Over full range of values specified in the Recommended Operating Conditions unless otherwise specified

5.2 SDIO 3.0 SDR12, SDR25, SDR50 Modes (up to 100 MHz) (1.8 V)

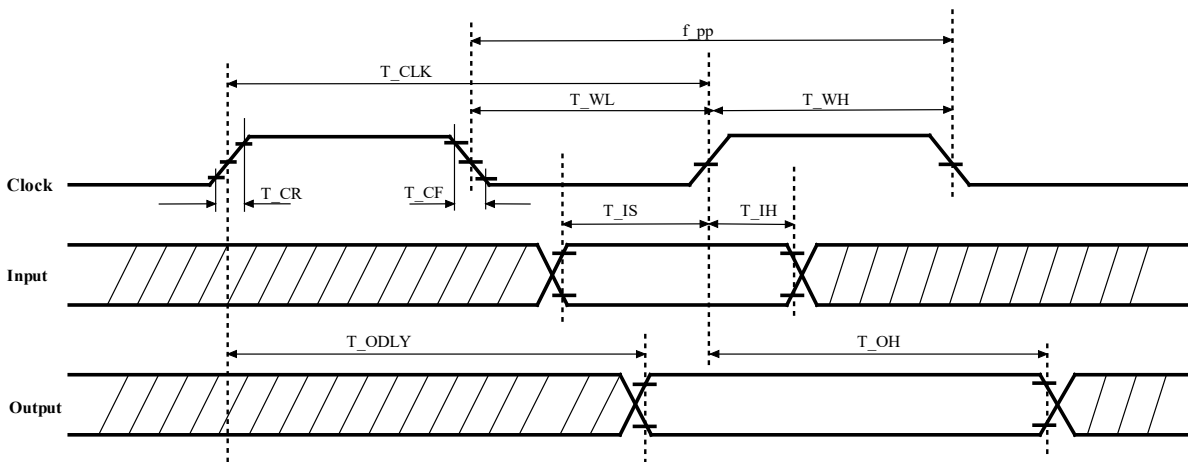


Figure 5: SDIO 3.0 SDR12, SDR25, SDR50 modes (up to 100 MHz) (1.8 V)

Symbol	Parameter	Condition	Min	Typical	Max	Units
--------	-----------	-----------	-----	---------	-----	-------

f _{pp}	Clock Frequency	SDR12/25/50	25	--	100	MHz
T _{IS}	Input Setup Time	SDR12/25/50	3	--	--	ns
T _{IH}	Input Hold Time	SDR12/25/50	0.8	--	--	ns
T _{CLK}	Clock Time	SDR12/25/50	10	--	40	ns
T _{CR} , T _{CF}	Rise Time, Fall Time	SDR12/25/50		--	0.2x T _{CLK}	ns
T _{ODLY}	Output Delay Time	SDR12/25/50			7.5	ns
T _{OH}	Output Hold Time	SDR12/25/50	1.5	--	--	ns

Table 7: SDIO Timing Data for SDR12, SDR25, SDR50 modes (up to 100 MHz) (1.8 V)

5.3 SDIO 3.0 SDR104 Mode (208 MHz) (1.8 V)

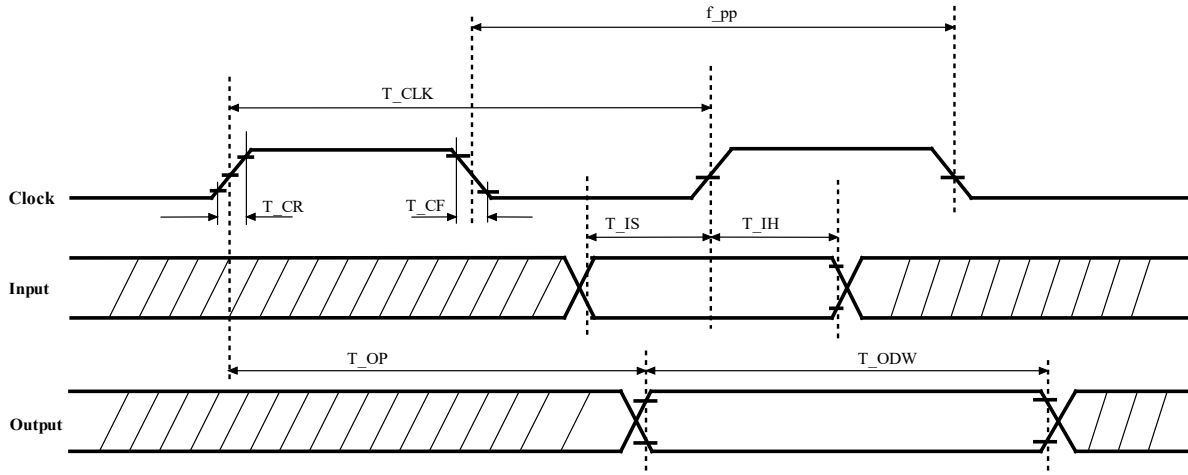


Figure 6: SDIO 3.0 SDR104 modes (up to 208 MHz) (1.8 V)

Symbol	Parameter	Condition	Min	Typical	Max	Units
f _{pp}	Clock Frequency	SDR104	0	--	208	MHz
T _{IS}	Input Setup Time	SDR104	1.4	--	--	ns
T _{IH}	Input Hold Time	SDR104	0.8	--	--	ns
T _{CLK}	Clock Time	SDR104	4.8	--	40	ns
T _{CR} , T _{CF}	Rise Time, Fall Time	SDR104		--	0.2x T _{CLK}	ns
T _{OP}	Output Phase	SDR104	0		10	ns
T _{ODW}	Output Timing over Variable Data Window	SDR104	2.88	--	--	ns

Table 8: SDIO 3.0 Timing Data for SDR104 mode (208 MHz)

5.4 DDR50 Mode (50 MHz) (1.8 V)

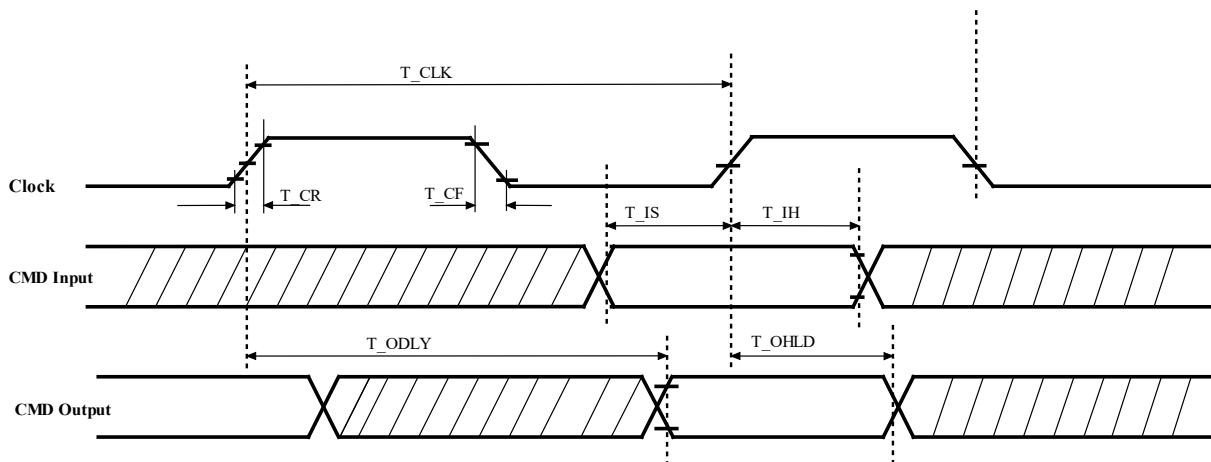


Figure 7: SDIO 3.0 Command Timing for DDR50 mode (50 MHz) (1.8 V)

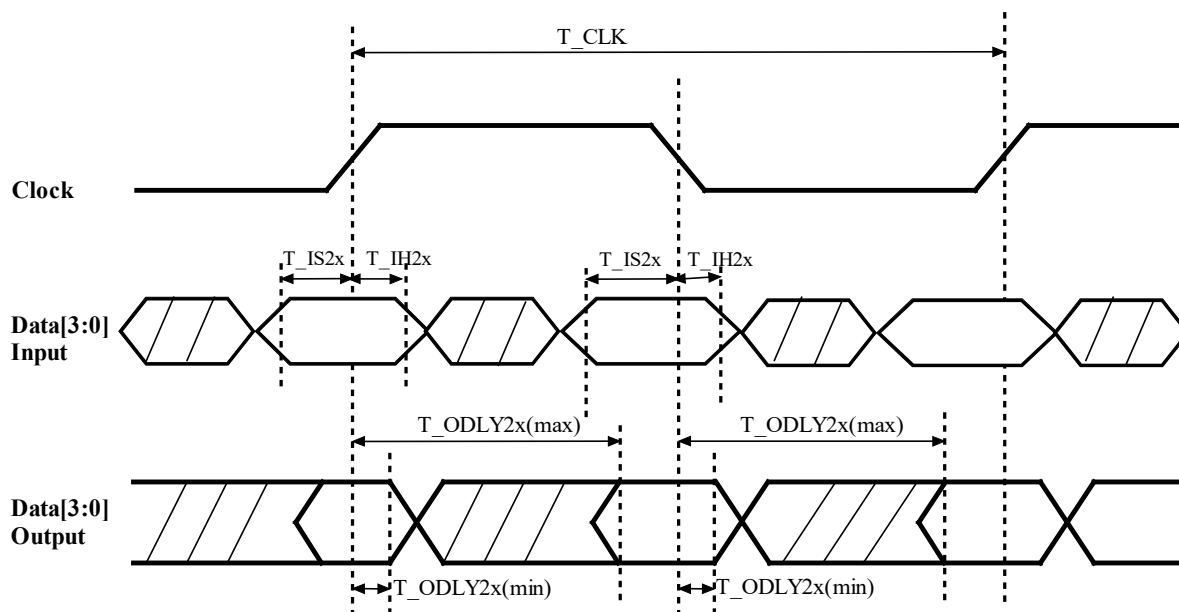


Figure 8: SDIO 3.0 Data Timing for DDR50 mode (50 MHz) (1.8 V)

Symbol	Parameter	Condition	Min	Typical	Max	Units
T_{CLK}	Clock time 50 MHz (max) between rising edges	DDR50	20	--	--	ns
T_{CR}, T_{CF}	Rise Time, Fall Time	DDR50		--	0.2x T_{CLK}	ns
Clock Duty	Output Phase	DDR50	45		55	ns
CMD Input (referenced to clock rising edge)						
T_{IS}	Input setup time	DDR50	6			ns
T_{IH}	Input hold time	DDR50	0.8			ns
CMD Output (referenced to clock rising edge)						
T_{ODLY}	Output delay time during data transfer mode	DDR50			13.7	ns
T_{OH}	Output Hold Time	DDR50	1.5			ns
DAT[3:0] Input (referenced to clock rising and falling edges)						
T_{IS2X}	Input setup time	DDR50	3			ns
T_{IH2X}	Input hold time	DDR50	0.8			ns
DAT[3:0] Output (referenced to clock rising and falling edges)						
$T_{ODLY2x(max)}$	Output delay time during data transfer mode	DDR50			7.0	ns
T_{OH2x}	Output hold time	DDR50	1.5			ns

Table 9: SDIO 3.0 Timing data for DDR50 mode (50 MHz)

6. WLAN Power-Save Modes

Three types of power save modes can be used by the WM828CC6. They are Full Power-Down mode, IEEE Power Save mode, and Deep Sleep mode. The key difference between the three modes is the current consumption, and the time it takes to the transition from the power save mode to normal Wi-Fi operation.

6.1 Full Power-Down Mode

In this mode all internal clocks are shutdown, register and memory states are not maintained. Upon exiting power down mode, a reset is automatically performed and a firmware re-download is required to re-enter any of the other modes.

6.2 IEEE Power Save

This mode puts sections of the Wi-Fi into “sleep with periodic wake” mode. This mode is entered when the appropriate command is sent by the host processor to the Wi-Fi.

The device automatically wakes up to receive beacons periodically, and if there is no traffic indicated for the device, it will go back to sleep. Power consumption is dependent on the DTIM value of the AP it is connected to.

When DTIM=1, the device wakes up every 100ms to receive and acknowledge the beacon from AP to maintain association.

6.3 Deep Sleep

This mode puts the complete Wi-Fi section into deep sleep mode, which is the same as the IEEE mode above except there are no periodic wake-ups to receive beacons. Thus it offers lower power consumption than IEEE mode.

This mode is entered when the host processor sends the appropriate command. In deep sleep mode, the device is not listening for packets or beacons from the AP, so it cannot maintain an association with it.

When the host processor sends a command to take the device out of deep sleep mode, the device will have to re-associate with the AP.

This is a low-power used in the sleeps state of many power save modes. It is a low-power state where the external reference clock and many blocks in the chip are switched off. Only a slow sleep clock is used to maintain register and memory states. Wake-up does not require a firmware re-download.

7. Antenna and Clock

7.1 Antenna

WM828CC6 module has an MHF4 IPEX connector for antenna.

The antenna RF PAD on WM828CC6 module has 50 Ohm impedance trace.

7.2 Clock

WM828CC6 module has an internal 37.4 MHz crystal to serve clock requirements.

In order to enable sleep clock functionality in power save modes, an external sleep clock oscillator (32.768 KHz) should be connected to the WM828CC6 module.

If sleep clock is not required as per customer design, then we need to pull down CON[3] to logic low so that module works on the main crystal by default and skips the reference clock detection.

8. Software

End-user drivers needed for full operation of the WM828CC6 module are available from Wi2Wi. This driver is specific to the operating system, processor and host bus, and cannot be used for any other processors, operating systems or host buses. Since the operating system and platform matrix is quite large, it is not possible to have all the combinations available off the shelf. Please contact your sales representative for cost and availability. Wi2Wi can also provide custom driver development services based on customers' requirements at an added cost.

Wi2Wi provides Linux device drivers, once you sign the License Agreement (EULA) with Wi2Wi. Driver release package includes the following:

- Linux Kernel drivers for Wi-Fi, Bluetooth/BLE
- Firmware image which will be loaded to module during initialization
- User Guide
- Manufacturing and Configuration Software

9. Reference Schematics

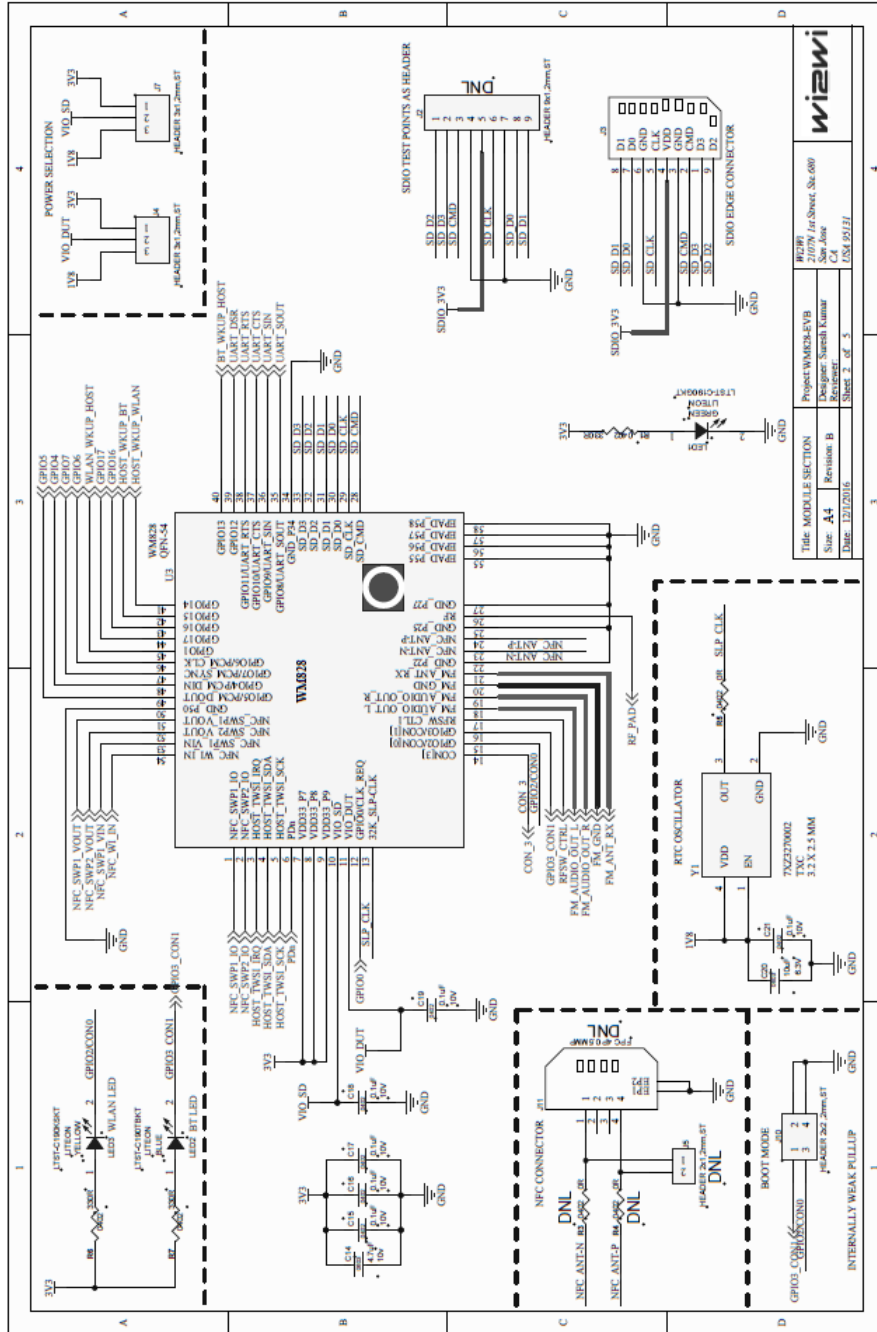


Figure 9: Reference Schematics ¹

¹ UART is not supported in the current software release.

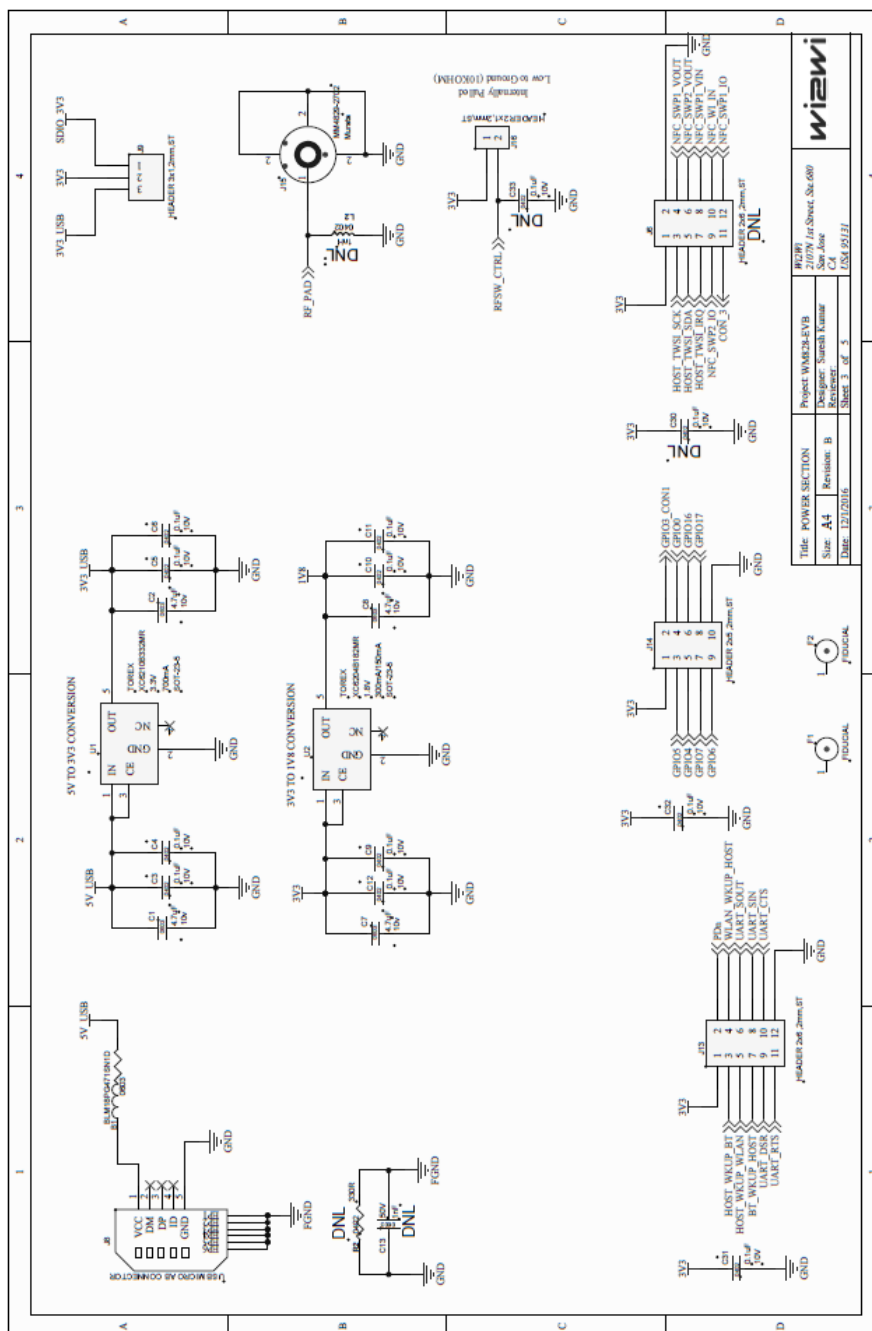


Figure 10: Reference Schematics

10. Manufacturing Notes

10.1 Shield Marking

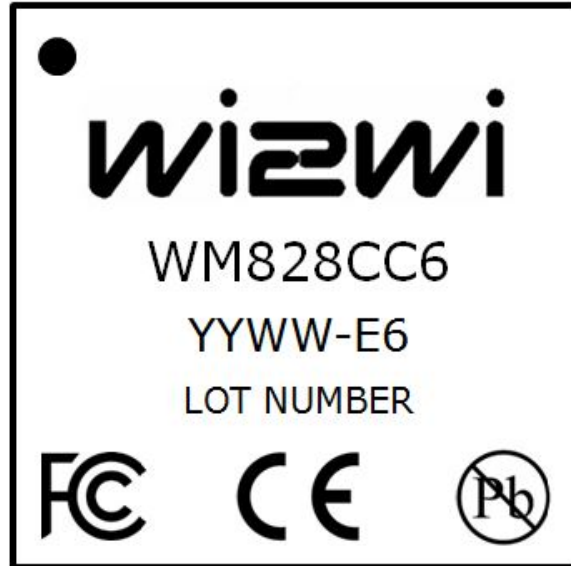


Figure 11: Shield Marking (Top View)

- YY indicates Year
- WW indicates Work Week
- E indicates Industrial operating temperature range (-30°C to +85°C)
- 6 indicates RF Pad + MHF4 IPEX Connector

10.2 Storage and Baking Instructions

WM828CC6 is an MSL3 qualified package.

- After opening the bag, the parts should be stored as per J-STD-033 standard, and mounted within 168 hours of factory conditions ($\leq 30^{\circ}\text{C}$, 60% RH)
- If the parts have been exposed in transit, they need to be baked at 125°C for 16 hours

10.3 Recommended Reflow Profile

Assembly Guidelines:

1. Follow solder paste manufacturers recommended profile
 - a. All RoHS solder pastes contain the same basic chemistry; however, each manufacturer may have a recommended reflow profile that performs best for their product
2. The profile illustrated below is for reference only

- a. **There is no one profile that fits all scenarios**
- 3. Profiles must be dialed in to the specific assembly type
- 4. ENIG finishes are more susceptible to voids and air entrapment
 - a. Selecting a RoHS solder paste that is “ENIG” compatible is recommended

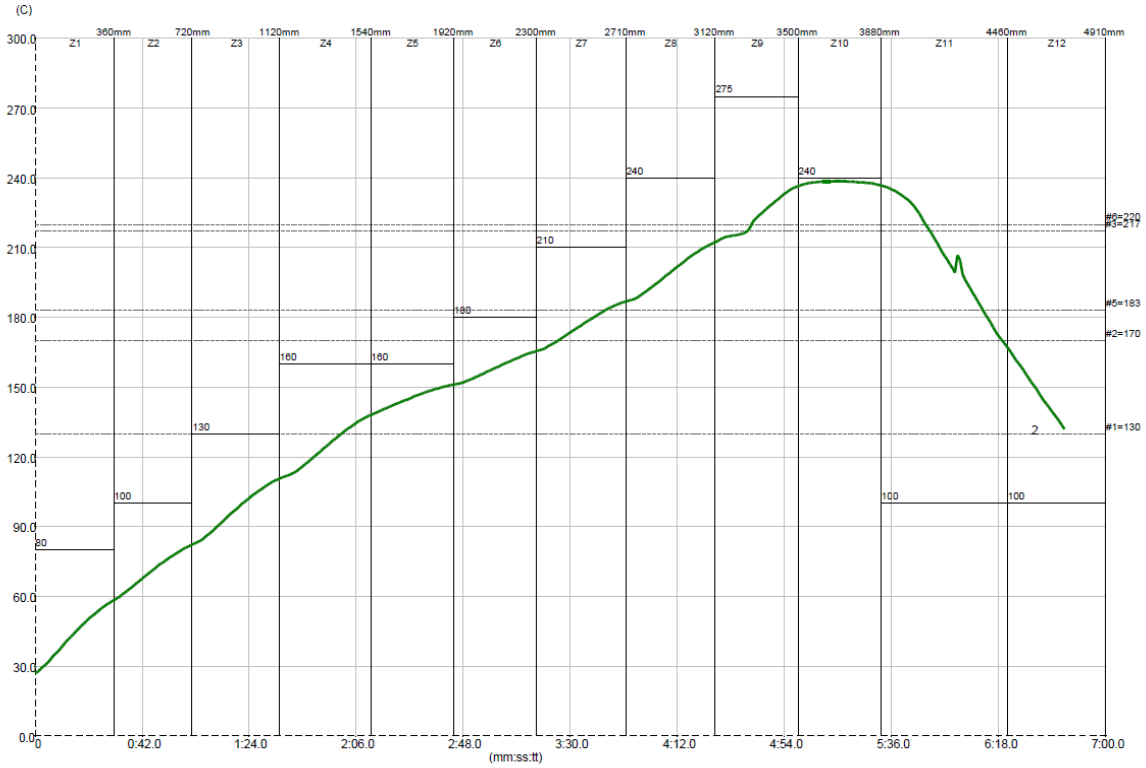


Figure 12: Recommended Reflow Profile

10.4 Data Sheet Status

Wi2Wi, Inc. reserves the right to change the specification without prior notice in order to improve the design and supply the best possible product. Updated information, firmware and release notes will be made available on www.wi2wi.com. Please check with Wi2Wi Inc. for the most recent data before initiating or completing a design.

11. Ordering Information

Part Order Number	Features	Operating Temperature	Packaging
WM828CC6-E6QT	802.11ac/a/b/g/n + BT 4.2/BLE	Extended: -30°C to +85°C	Tray
WM828CC6-E6QR	802.11ac/a/b/g/n + BT 4.2/BLE	Extended: -30°C to +85°C	Tape & Reel

Table 10: Ordering Information for Modules

Part Order Number	Features	Contents of the Evaluation Kit	Packaging
WM828CC6-EVK6	802.11ac/a/b/g/n + BT 4.2/BLE	WM828CC6 Evaluation Board, Dual-Band Rubber-Duck Antenna, u.FL Cable	Box
WM828CC6-DVK6	802.11ac/a/b/g/n + BT 4.2/BLE	WM828CC6 Evaluation Board, iMX6 Processor Board, Dual- Band Rubber-Duck Antenna, u.FL Cable	Box

Table 11: Ordering Information for Evaluation Kits

12. Data Sheet Status

Wi2Wi, Inc. reserves the right to change the specification without prior notice in order to improve the design and supply the best possible product. Updated information, firmware and release notes will be made available on www.wi2wi.com. Please check with Wi2Wi Inc. for the most recent data before initiating or completing a design.

13. Certifications

WM828CC6 module complies with the following standards:

FCC:	15C
IC/ISED:	RSS-247
CE/ETSI:	EN 300 328 V2.1.1, EN 301 489-1 V2.2.0, EN 301 489-17 V3.2.0, EN 62311, EN 300 893 V2.1.1, EN 300 440 V2.1.1, EN 60950-1:2016+A2:2013

FCC Statement:

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.

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.

The FCC requires the user to be notified that any changes or modifications made to this device that are not expressly approved by Wi2Wi may void the user's authority to operate the equipment.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must be at least 20 cm from the user and must not be co-located or operating in conjunction with any other antenna or transmitter.

IC/ISED Statement:

English:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions:

1. This device may not cause harmful interference;

2. This device must accept any interference received, including interference that may cause undesired operation of the device.

Français:

Cet appareil est conforme à Industrie Canada une licence standard RSS exonérés (s). Son fonctionnement est soumis aux deux conditions suivantes:

- 1. Cet appareil ne doit pas provoquer d'interférences;
- 2. Cet appareil doit accepter toute interférence reçue, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil.

IC/ISED Radiation Exposure Statement:

English:

This equipment complies with the IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 cm between the radiator and your body.


Français:

Cet équipement est conforme aux limites d'exposition au rayonnement IC RSS-102 définies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec une distance minimale de 20 cm entre le radiateur et votre corps.

CE/ETSI/RED Statement:

This equipment may be subject to: any restrictions on putting into service, or any requirements for authorization of use; that may exist under RED (Radio Equipment Directive) regulations in the following EU member states:

Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Denmark (DK), Germany (DE), Estonia (EE), Ireland (IE), Greece (EL), Spain (ES), France (FR), Croatia (HR), Italy (IT), Cyprus (CY), Latvia (LV), Lithuania (LT), Luxembourg (LU), Hungary (HU), Malta (MT), Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovakia (SK), Finland (FI), Sweden (SE) and United Kingdom (UK)

	BE	BG	CZ	DK	DE	EE	IE
	EL	ES	FR	HR	IT	CY	LV
	LT	LU	HU	MT	NL	AT	PL
	PT	RO	SI	SK	FI	SE	UK

Integrator Guidance:

- All certifications apply to the tested antenna(s) only. Customers using any other antenna via the MHF4 IPEX RF connector or via the RF Pad must get their antenna certified.
- Only the antenna(s) described in the filings under this FCC ID or equivalent antenna(s) with equal or lesser gain may be used with this transmitter. Any new antenna type, or higher gain antenna would require a Class II permissive change.

- If the operation of the equipment is for portable use (within 20 cm of user), or where co-location configuration use is required; the end product, including the transmitter will require re-evaluation in accordance to the FCC rules.

Labeling:

The final end product must be labeled in a visible area with the following text:

“Contains FCC ID: U9RWM828CC6, IC: 7089A-WM828CC6”, where:

- “U9RWM828CC6” is the approved FCC ID of this module
- “7089A-WM828CC6” is the approved IC ID of this module

The grantee's FCC/IC ID can be used only when all FCC/IC compliance requirements are met.

14. References

14.1 Specifications

IEEE 802.11 ac/a/b/g/n Wireless LAN Specification

Bluetooth 4.2/BLE (Low Energy)

SDIO, SDIO HS, 1-bit, 4-bit Specifications

14.2 Trademarks, Patents and Licenses

Trademarks: Wi-Fi, Bluetooth.

14.3 Other

WM828CC6-EVK6: Evaluation Board

WM828CC6-DVK6: Development Kit