

AW-CU345

IEEE 802.11 b/g/n + Bluetooth 5.0 LE

WLAN/BT Microcontroller Module

Datasheet

Rev. 0.9

(For Standard)

Revision History

Revision	Date	Description	Initials	Approved
Version0.1	2017/09/29	Initial	Alex Yu	Daniel Lee
Version0.2	2017/10/22	Update: Delete 2.2.1 Power pin VPP_BT_6V8	Alex Yu	Daniel Lee
Version0.3	2017/12/15	Update: Pin Definition	Alex Yu	Daniel Lee
Version0.4	2017/12/19	Update: PCB Footprint	Alex Yu	Daniel Lee
Version0.5	2018/03/14	Update: Coexistence use cases	Alex Yu	Daniel Lee
Version0.6	2018/03/26	Update: Specifications Table	Alex Yu	Daniel Lee
Version0.7	2018/05/28	Update: Antenna change to Metal Antenna Mechanical Information	Alex Yu	N.C. Chen
Version0.8	2018/09/12	Update: IC Information	Alex Yu	N.C. Chen
Version0.9	2018/11/29	Update: Mechanical Drawing Operating Conditions Power Consumption Certifications FCC/ETSI Bluetooth 2.4GHz Power Table Packaging Information	Alex Yu	N.C. Chen

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1. Introduction

1.1 Product Overview

AzureWave presents **AW-CU345** Wi-Fi/BT Microcontroller Smart Energy Platform Solution provides a highly cost-effective, flexible and easy to-use hardware/software platform to build a new generation of connected, smart devices. These smart-connected devices enable device to deliver a broad-range of services to consumers including energy-management, demand-response, home automation and remote access. This allows a user to manage comfort and convenience, also run diagnostics and receive alerts and notifications, in addition to managing and controlling the device. Developers can leverage the rich connectivity features of these new smart devices to create a new generation of innovative new applications and services.

The platform builds upon the success of Marvell's first-generation Wi-Fi/BT microcontroller platforms using the Marvell/Dialog 88MW320/DA14585 Wi-Fi/BT System-on-Chip (SoC), a 4MByte QSPI flash memory and Marvell Easy Connect software.

1.2 Features

1.2.1 WLAN

MCUs of AW-CU345

- 88MW320 (Marvell 88MW320 is a WLAN IEEE 802.11 b/g/n standalone SoC)
 - Processor
 - ARM Cortex-M4F, 32bit
 - 200MHz main bus clock
 - Memory
 - 128KB ROM
 - 512KB RAM
 - Flash Controller
 - 32KB SRAM cache to support XIP
 - Memory-mapped access to QSPI Flash devices
 - Wireless
 - IEEE 802.11 b/g/n HT20
 - Low-power with deep sleep and standby modes
 - Fully supports clients (stations) implementing IEEE Power Save mode
 - Wi-Fi direct connectivity

1.2.2 ooth

- DA14585 (Dialog DA14585 is a Bluetooth Low Energy 5.0 SoC)
 - Processor
 - ARM Cortex-M0, 32bit, 16MHz
 - Dedicated Link Layer Processor
 - AES-128 bit encryption Processor
 - Memory
 - 64 KB OTP Memory
 - 128 KB ROM
 - 96 KB Retention SRAM
 - Wireless
 - Bluetooth V5.0

Memory of AW-CU345

- 4M Byte QSPI flash

IO Interfaces

- UART
- SWD(JTAG)
- SSP(SPI)
- GPT(PWM)
- I2C
- ADC
- GPIO

Package

- LGA Module – 36 mm x 18 mm x 2.5 mm 111 pin

Antenna

- Internal Antenna for WLAN/BT
- External U.FL connector for WLAN/BT

Certifications

- TBD

1.3 Block Diagram

1.4 Specifications Table

1.4.1 neral

Features	Description
Product Description	AW-CU345 Wireless Smart Energy module
Major Chipset	Marvell 88MW320 + Dialog DA14585 + 4MB flash
Host Interface	UART/JTAG/SSP/I2C/ADC
Dimension	36 mm x 18 mm x 2.5 mm
Package	111-pin LGA
Antenna	Function1: Internal Antenna for WLAN/BT Function2: U.FL(external antenna) for WLAN/BT
Weight	3g

1.4.2 WLAN

Features	Description
WLAN Standard	IEEE 802.11b/g/n, Wi-Fi compliant
Frequency Range	2.4 GHz ISM radio band
Modulation	DSSS, OFDM, DBPSK, DQPSK, CCK, 16-QAM, 64-QAM for WLAN
Number of Channels	802.11b: USA, Canada and Taiwan – 11 Most European Countries – 13 Japan – 13 802.11g: USA, Canada and Taiwan – 11 Most European Countries – 13 Japan – 13 802.11n(HT20): Channel 1~13(2412~2472)
Output Power (Board Level Limit)*	WLAN: Module for IEEE 802.11b/g/n spec: 802.11b 17dBm(+2dBm) for IEEE 802.11b spec 802.11g 14dBm(+2dBm) for IEEE 802.11g spec 802.11n 13dBm(+2dBm) for IEEE 802.11n HT20 spec * FCC/CE output power limit spec: - Refer to the 3.7 CERTIFICATIONS
Receiver Sensitivity	WLAN: -84dBm for 11M IEEE 802.11b -69dBm for 54M IEEE 802.11g -66dBm for MCS7 IEEE 802.11n HT20
Data Rate	WLAN: 802.11b: 1, 2, 5.5, 11Mbps 802.11g: 6, 9, 12, 18, 24, 36, 48, 54Mbps 802.11n: MCS0-7, up to 72.2Mbps(20MHz channel)
Security	1.802.11i and 802.11w security standard. 2.WEP 64 and 128 bit encryption with hardware TKIP. 3.WLAN Authentication and privacy infrastructure.

1.4.3 Bluetooth

Features	Description
Bluetooth Standard	Bluetooth V5.0 complaint
Frequency Range	2402~2480MHz
Modulation	GFSK (1Mbps) for Bluetooth
Output Power	0~-4dBm
Receiver Sensitivity	-84dBm
Data Rates	Bluetooth Low Energy Only

1.4.4 Operating Conditions

Features	Description
Operating Conditions	
Voltage	3.3V +/- 9%
Operating Temperature	Operating: -30 ~ 85°C
Operating Humidity	<85%
Storage Temperature	-40 ~ 85°C
Storage Humidity	< 60 %
ESD Protection	
Human Body Model	2KV per JEDEC EID/JESD22-A114
Changed Device Model	250V per JEDEC EIA/JESD22-C101

2. Pin Definition

2.1 Pin Map(Top View)

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
	GND	GND	GPIO_1_2_BT	SWDIO_BT	XTAL3Kp	XTAL32Km	GPIO_1_1_BT	RESETN_BT	GPIO_2	GPIO_3	GPIO_49	GPIO_46	GPIO_48	GPIO_47	GND	K
	GND		GPIO_1_3_BT	SWCLK_BT	GPIO_0_0_BT	GPIO_0_1_BT	GPIO_25	Don't connect debug GPIO_39		Don't connect debug GPIO_1	Don't connect debug DPDT	Don't connect debug GPIO_0	Don't connect debug GPIO_22	GND	Floating	J
			GND					GND					GND	Floating	Don't connect debug GPIO_40	H
	GND	GPIO_6	GND	GND			GND	GND	GND		GND	GND	GND	Floating	Don't connect debug GPIO_41	G
	GND	GPIO_9						GND	GND	GND	GND		Don't connect debug Rx	Floating	GPIO_27	F
	GND	GND	GND		GND			GND	GND	GND			Don't connect debug Tx	Floating	GPIO_16	E
	GND	GND	GND	GND	GND				GND				GND	Floating	GPIO_26	D
	GND	GND	GND	GND	GND		GND	GND			GND			Floating	GPIO_25	C
	GND	GND	GPIO_2_5_BT	GND	VBAT_BT_3V3	VBAT_VL_3V3	GPIO_2_6_BT	GPIO_2_8_BT	GPIO_4		GPIO_7	Floating		GND	GPIO_24	B
	GND	GND	Don't connect	GND	VBAT_BT_3V3	VBAT_VL_3V3	GND	GPIO_2_7_BT	GPIO_2_9_BT	GPIO_10	GPIO_8	GPIO_5	GPIO_23	RESETN_VL	GND	A

2.2 Pin Table

2.2.1 Power pin

Pin No	Definition	Basic Description	Type	Level
A10	VBAT_WL_3V3	88MW320/FLASH power supply. (Pin A10 with Pin B10 configuration)	A, I	3.3V
B10	VBAT_WL_3V3	88MW320/FLASH power supply. (Pin A10 with Pin B10 configuration)	A, I	3.3V
A11	VBAT_BT_3V3 ^(a)	DA14585 power supply. (Pin A11 with B11 configuration)	A, I	3.3V
B11	VBAT_BT_3V3 ^(a)	DA14585 power supply. (Pin A11 with B11 configuration)	A, I	3.3V

(a) The BT has to keep power supply for the module RF switch.

2.2.2 GPIO[88MW320] pin

Pin No	Definition	Function 0	Function 1	Function 2	Function 3	Function 4	Function 5	Type	Level
G14	GPIO_6	JTAG TDO	GPIO_6	I2C1_SDA				I/O	3.3V
F14	GPIO_9	JTAG TDI	GPIO_9	UART2_TXD	SSP2_TXD	I2C1_SDA		I/O	3.3V
K7	GPIO_2 ⁽⁴⁾	GPIO_2	GPT0_CH2	UART0_TXD	SSP0_TXD			I/O	3.3V
K6	GPIO_3 ⁽⁴⁾	GPIO_3	GPT0_CH3	UART0_RXD	SSP0_RXD			I/O	3.3V
B7	GPIO_4	GPIO_4	GPT0_CH4	I2C0_SDA	AUDIO_CLK			I/O	3.3V
A4	GPIO_5	GPIO_5	GPT0_CH5	I2C0_SCL				I/O	3.3V
B5	GPIO_7 ⁽²⁾	JTAG TCK	GPIO_7	UART2_CTS	SSP2_CLK	I2C0_SDA		I/O	3.3V
A5	GPIO_8 ⁽²⁾	JTAG TMS	GPIO_8	UART2_RTS	SSP2_FRM	I2C0_SDL		I/O	3.3V
A6	GPIO_10	JTAG TRST	GPIO_10	UART2_RXD	SSP2_RXD	I2C1_SDL		I/O	3.3V
E1	GPIO_16 ⁽¹⁾	GPIO_16	CON[5]		AUDIO_CLK			I/O	3.3V
A3	GPIO_23	WAKE_UP_1	GPIO_23	UART0_CTS			COMP_IN_P	I/O	3.3V
B1	GPIO_24 ⁽³⁾	OCS32K	GPIO_24	UART0_RXD	GPT1_CH5		COMP_IN_N	I/O	3.3V
C1/J9	GPIO_25 ⁽³⁾	XTAL32K_IN	GPIO_25	I2C1_SDA				I/O	3.3V
D1	GPIO_26 ⁽³⁾	XTAL32K_OUT	GPIO_26	I2C1_SCL				I/O	3.3V
F1	GPIO_27 ⁽¹⁾	GPIO_27	CON[4]	UART0_TXD				I/O	3.3V
K4	GPIO_46	GPIO_46	ADC_4/ ACOMP4	UART2_CTS	SSP2_CLK			I/O	3.3V
K2	GPIO_47	GPIO_47	ADC_5/ ACOMP5	UART2_RTS	SSP2_FRM			I/O	3.3V
K3	GPIO_48	GPIO_48	ADC_6/ ACOMP6	UART2_TXD	SSP2_TXD			I/O	3.3V
K5	GPIO_49	GPIO_49	ADC_7/ ACOMP7	UART2_RXD	SSP2_RXD			I/O	3.3V
A2	RESETN_WL	RESETn	Host reset					I	3.3V(internal pull high 51k ohm)

***(1) Configuration Pins Table:**

	Pin No	Definition	Function 1 Description (Configuration Bits)
AW-CU345	F1	GPIO_27	88MW320 Boot Options with CON[4], CON[5] 00 = boot from UART 11 = boot from internal QSPI Flash (default)
	E1	GPIO_16	

***(2) 32k clock reference (sleep clock)**

- External crystal-oscillator driving 32.768 KHz clock to GPIO_25
- External crystal connected to GPIO_25 & GPIO_26 at 32.768 KHz
- Connect GPIO_24 to GPIO_25 for calibration reference to RC32K

***(3) SWD support on GPIO_7 (SWDCLK) and GPIO_8 (SWDIO)**

***(4) Console UART0 on GPIO_2 (TXD) and GPIO_3 (RXD)**

2.2.3 GPIO [DA14585] pin

Pin No	Definition	Function	Type	Level
J11	GPIO_0_0_BT	Support ADC[0]. Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	AIO	3.3V
J10	GPIO_0_1_BT	Support ADC[1]. Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	AIO	3.3V
K9	GPIO_1_1_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
K13	GPIO_1_2_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
J13	GPIO_1_3_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
B13	GPIO_2_5_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
B9	GPIO_2_6_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
A8	GPIO_2_7_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
B8	GPIO_2_8_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
A7	GPIO_2_9_BT	Pull-down enabled during and after reset. General purpose I/O port bit or alternate function nodes.	I/O	3.3V
K8	RESET_BT	Reset signal (active high). Must be connected to GND if not used.	I	3.3V(internal pull low 2.2k ohm)
J12	SWCLK_BT	JTAG Data input/output. Bidirectional data and control communication. Can also be used as a GPIO.	I/O	3.3V
K12	SWDIO_BT	INPUT JTAG clock signal. Can also be used as a GPIO.	I/O	3.3V
K10	XTAL32Km	OUTPUT. Crystal input for the 32.768kHz XTAL.	I	3.3V
K11	XTAL32Kp	INPUT. Crystal output for the 32.768kHz XTAL.	O	3.3V

2.2.4 Ground pin

AW-CU345 Pin No				Basic Description
A1	C13	E13	G12	GND(CONFIGURATION PINS)
A9	C14	E14	G13	
A12	C15	E15	G15	
A14	D3	F5	H3	
A15	D7	F6	H8	
B2	D11	F7	H13	
B12	D12	F8	J2	
B14	D13	F15	J15	
B15	D14	G3	K1	
C5	D15	G4	K14	
C8	E6	G5	K15	
C9	E7	G7		
C11	E8	G8		
C12	E11	G9		

2.2.5 FLOATING pin

AW-CU345 Pin No				Basic Description
B4	G2	H2		FLOATING PIN (FLOATING)
C2	F2	J1		
D2				
E2				

2.2.6 DEBUG pin

AW-CU345 Pin No	Basic Description
H1	DNS(Don't connect)
F3	
J5	
E3	
G1	
A13	
J3	

J4	
J6	
J8	

2.3 Configuration Pins

2.3.1 Power pin

AW-CU345 Pin No		Basic Description
A10	B10	VBAT_WL_3V3(CONFIGURATION PINS)
A11		
B11		
		VBAT_BT_3V3(CONFIGURATION PINS)

2.3.2 CLOCK [88MW320] pin

AW-CU345Pin No		Basic Description
C1		XTAL32K_IN (CONFIGURATION PINS)
J9		

2.3.3 GROUND pin

AW-CU345 Pin No				Basic Description
A1	C13	E13	G12	GND(CONFIGURATION PINS)
A9	C14	E14	G13	
A12	C15	E15	G15	
A14	D3	F5	H3	
A15	D7	F6	H8	
B2	D11	F7	H13	
B12	D12	F8	J2	
B14	D13	F15	J15	
B15	D14	G3	K1	
C5	D15	G4	K14	
C8	E6	G5	K15	
C9	E7	G7		
C11	E8	G8		
C12	E11	G9		

3. Electrical Characteristics

3.1 Absolute Maximum Ratings

Symbol	Parameter	Minimum	Typical	Maximum	Unit
VBAT_WL_3V3	Power supply (input)	--	3.3	3.6	V
VBAT_BT_3V3	Power supply (input)	--	3.3	3.6	V

3.2 Recommended Operating Conditions

Symbol	Parameter	Minimum	Typical	Maximum	Unit
VBAT_WL_3V3	3.3V power supply for 88MW320/flash	3.0	3.3	3.6	V
VBAT_BT_3V3	3.3V power supply for DA14585	3.0	3.3	3.6	V

3.3 Digital IO Pin DC Characteristics

WLAN:

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V _{IH}	Input high voltage	3.3 *70%		3.3 +0.4	V
V _{IL}	Input low voltage	-0.4		3.3 *30%	V

BT:

Symbol	Parameter	Minimum	Typical	Maximum	Unit
V _{IH}	Input high voltage	0.84			V
V _{IL}	Input low voltage			0.36	V

3.4 Internal Memory

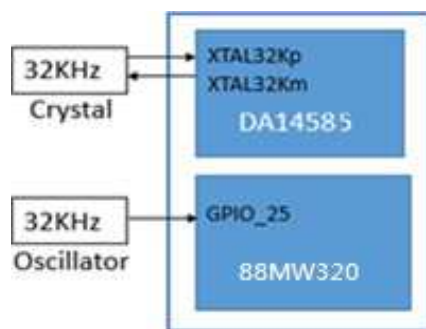
A QSPI Flash is used in AW-CU345. The size of the internal QSPI Flash is 32Mbit (4MByte).

Manufacturer	Manufacturer's part number
GigaDevice	GD25LQ32 series
WinBond	W25Q32 series

3.4.1 EXTERNAL 32KHZ CRYSTAL REQUIREMENTS

Two external 32.768kHz crystal and oscillator can be used for low-power consumption for BT and WLAN.

(a) Application:



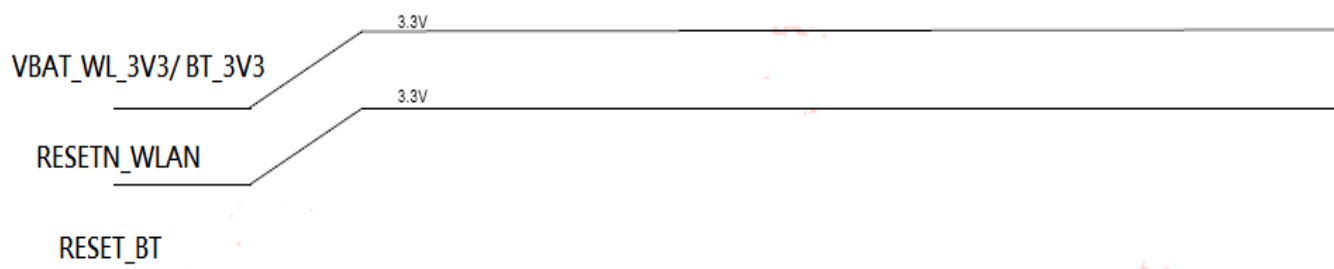
Please refer to the Page11 Configuration Pins Table for more details.

(b) Below are the specifications for this crystal.

Parameter	Description	Conditions	Min	Typ	Max	Unit
$V_{CLK(EXT)}(32K)$	external clock voltage	peak-peak voltage of external clock at XTAL32Kp, pin XTAL32Km floating. note: XTAL32Kp is internally AC coupled	0.1	0.2	1.5	V
$f_{XTAL}(32k)$	crystal oscillator frequency	frequency range for an external clock (for a crystal, use either 32.000 kHz or 32.768 kHz)	10	32.768	100	kHz
ESR(32k)	equivalent series resistance				100	k Ω
$C_L(32k)$	load capacitance	no external capacitors are required for a 6 pF or 7 pF crystal	6	7	9	pF
$C_0(32k)$	shunt capacitance			1	2	pF
$\Delta f_{XTAL}(32k)$	crystal frequency tolerance (including aging)	Timing accuracy is dominated by crystal accuracy. A much smaller value is preferred	-250		250	ppm
$P_{DRV(MAX)}(32k)$	maximum drive power	(Note)	0.1			μW

Note : Select a crystal that can handle a drive-level of at least this specification.

3.5 Power up Timing Sequence



3.6 Power Consumption

3.6.1 WLAN

MFG Continuous Tx Mode

No.	Item			Voltage=3.3V				
Band (GHz)	Mode	BW (MHz)	RF Power (dBm)	Transmit			Receive	
				Max.	Avg.	Duty. (%)	Max.	Avg.
2.4 (4)(5)	11b@1Mbps	20	17	352mA	305mA	99%	88.3mA	82.8mA
	11b@11Mbps	20	17	348mA	292mA	93%	90.9mA	83.2mA
	11g@54Mbps	20	14	332mA	234mA	76%	93.9mA	85.2mA
	11n@MCS7	20	13	320mA	224mA	75%	93.8mA	85.0mA

*Current Unit: mA

3.6.2 Bluetooth

Tx/Rx Test Results

No.	Mode	Packet Type	RF Power (dBm)	Voltage=3.3V	
				Max.	Avg.
1.	TX	LE	-2.19dBm	3.43mA	3.42mA
2.	RX	LE	n/a	4.95mA	4.94mA

Current Unit: mA

The power consumption is based on Azurewave test environment, these data for reference only.

3.7 Certifications FCC/ETSI WIFI Bluetooth 2.4GHz Power Table

FCC WIFI 2.4GHz power table:

Embedded Antenna(2.81dBi)

Composite Antenna Gain Type		Antenna Gain (dBi)			Chain0	
No		2400 ~ 2483.5 MHz:			2.81	
Mode	Data Rate	Channel	Frequency (MHz)	Power Setting	Chain0	
					Avg (dBm)	Peak (dBm)
11b	1Mbps	1	2412	25	20.33	22.61
		6	2437	25	20.39	22.67
		11	2462	23	20.03	22.35
11g	6Mbps	1	2412	17	16.24	23.35
		6	2437	29	21.95	25.46
		11	2462	16	15.76	23.21
11n20 2.4G	MCS0 6.5Mbps	1	2412	16	15.36	22.97
		6	2437	27	20.16	25.26
		11	2462	15	14.86	22.84

FCC Bluetooth 2.4GHz Power Table:

Embedded Antenna(2.81dBi)

Composite Antenna Gain Type		Antenna Gain (dBi)			Chain0	
No		2400 ~ 2483.5 MHz:			2.81	
Mode	Data Rate	Channel	Frequency (MHz)	Power Setting	Chain0	
					Avg (dBm)	Peak (dBm)
BT 5.0	1Mbps	0	2402	Default	-1.36	-1.32
		19	2440	Default	-1.51	-1.47
		39	2480	Default	-1.56	-1.51

ETSI WIFI 2.4GHz Power Table:

Embedded Antenna(2.81dBi)

Mode:			11b				Data Rate:		1Mbps			Gain(dBi) :		2.81
Channel	Freq. (MHz)	Power Setting	Conducted AVG Power (dBm)					EIRP						
			Chain0				Total	Tnorm	Tmin		Tmax		Limit (dBm)	
1	2412	15	15.83				15.83	18.64	19.58		17.72		20.00	
7	2442	14	15.47				15.47	18.28	19.20		17.40		20.00	
13	2472	14	15.36				15.36	18.17	19.03		17.21		20.00	

Mode:			11g				Data Rate:		6Mbps			Gain(dBi) :		2.81
1	2412	15	15.53				15.53	18.34	19.24		17.18		20.00	
7	2442	16	15.74				15.74	18.55	19.36		17.48		20.00	
13	2472	15	15.85				15.85	18.66	19.78		17.58		20.00	

Mode:			11n20 2.4G				Data Rate:		MCS0 6.5Mbps			Gain(dBi) :		2.81
1	2412	15	15.47				15.47	18.28	19.35		17.28		20.00	
7	2442	14	15.33				15.33	18.14	19.15		17.13		20.00	
13	2472	15	15.84				15.84	18.65	19.59		17.61		20.00	

ETSI Bluetooth 2.4GHz Power Table:

Embedded Antenna(2.81dBi)

Mode:		BT LE-GFSK_5					Data Rate:		1Mbps		Gain(dBi) :		2.81	
Channel	Freq. (MHz)	Power Setting	Conducted AVG Power (dBm)					EIRP						
			Chain0				Total	Tnorm	Tmin		Tmax		Limit (dBm)	
0	2402	Default	-0.52				-0.52	2.29	3.24		1.29		20.00	
19	2440	Default	-0.66				-0.66	2.15	3.01		1.14		20.00	
39	2480	Default	-0.80				-0.80	2.01	2.91		1.06		20.00	

3.8 Coexistence use cases

1. BLE only case

- If WLAN MCU is in sleep or powered down mode, then WLAN_EIP is LOW so BLE firmware would configure antenna controller to give desired antenna to BLE.

2. WLAN only case

- In this case there is no BLE Tx/Rx scheduled so BLE_EIP is LOW.
- From WLAN MCU WLAN_EIP is always HIGH because WLAN is doing Tx/Rx.
- On WLAN_EIP rising edge, BLE firmware will configure antenna controller and gives desired antenna to WLAN.

3. BLE + WLAN case

- During BLE activity BLE_EIP will be HIGH.
- If BLE priority is HIGH then,
 - a. WLAN firmware will block WLAN Tx and pull WLAN_EIP to LOW.
 - b. On WLAN_EIP falling edge, BLE firmware will configure antenna controller to give desired antenna to BLE.
- If BLE priority is LOW then,
 - a. WLAN_EIP was already HIGH, BLE firmware had already given desired antenna to WLAN, so WLAN will retain the antenna.

FEDERAL COMMUNICATIONS COMMISSION INTERFERENCE 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.

CAUTION:

Any changes or modifications not expressly approved by the grantee of this device could void the user's authority to operate the equipment.

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

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20cm 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: TLZ-CU345 "

Information for the OEMs and Integrators

The following statement must be included with all versions of this document supplied to an OEM or integrator, but should not be distributed to the end user.

- 1) This device is intended for OEM integrators only.
- 2) Please see the full Grant of Equipment document for other restrictions.

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.
