

**Murata Type 2BZ
(LBEE5XV2BZ)**

Application Note



Revision History

Revision	Date	Section	Change Description
1	July 3, 2022		First issue

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1 Scope

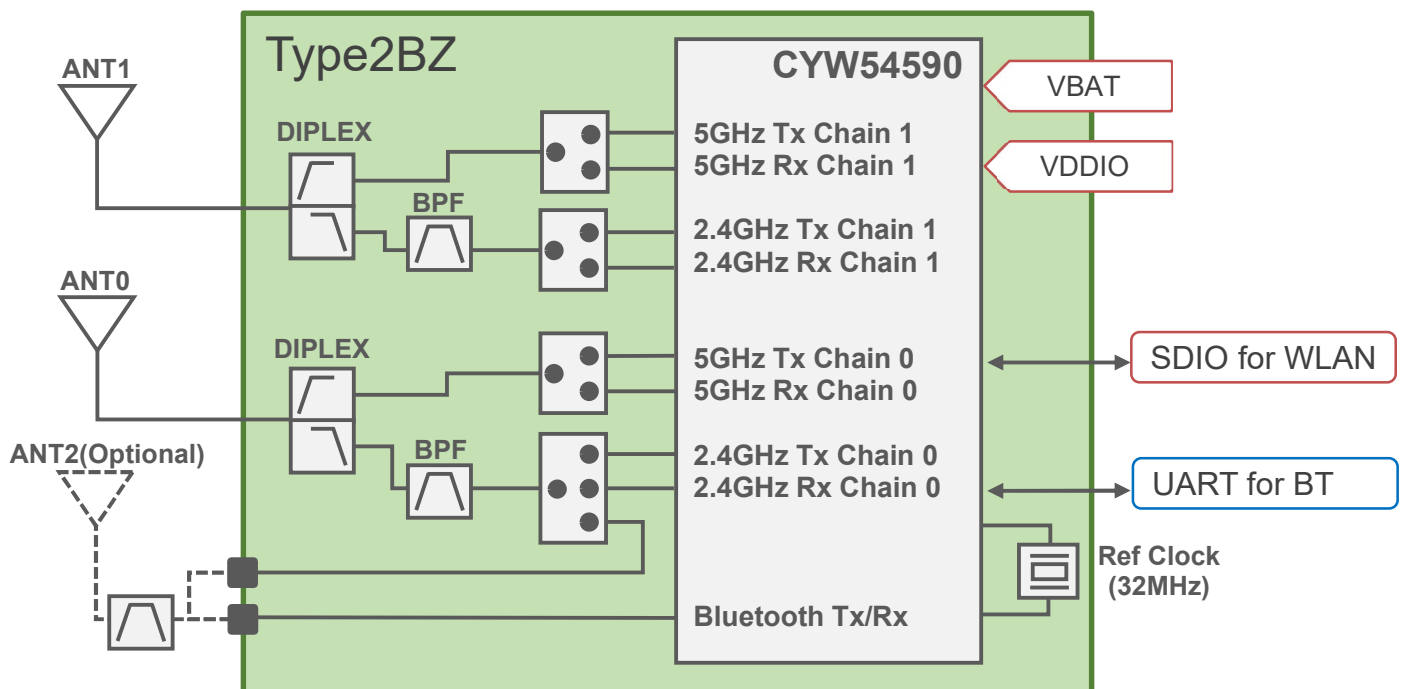
This Application Note covers HW development and provides how to design the Schematic and Layout, and reference RF performance. Refer to “type2bz_datasheet” for Module specification.

2 Module Introduction

2.1 Features

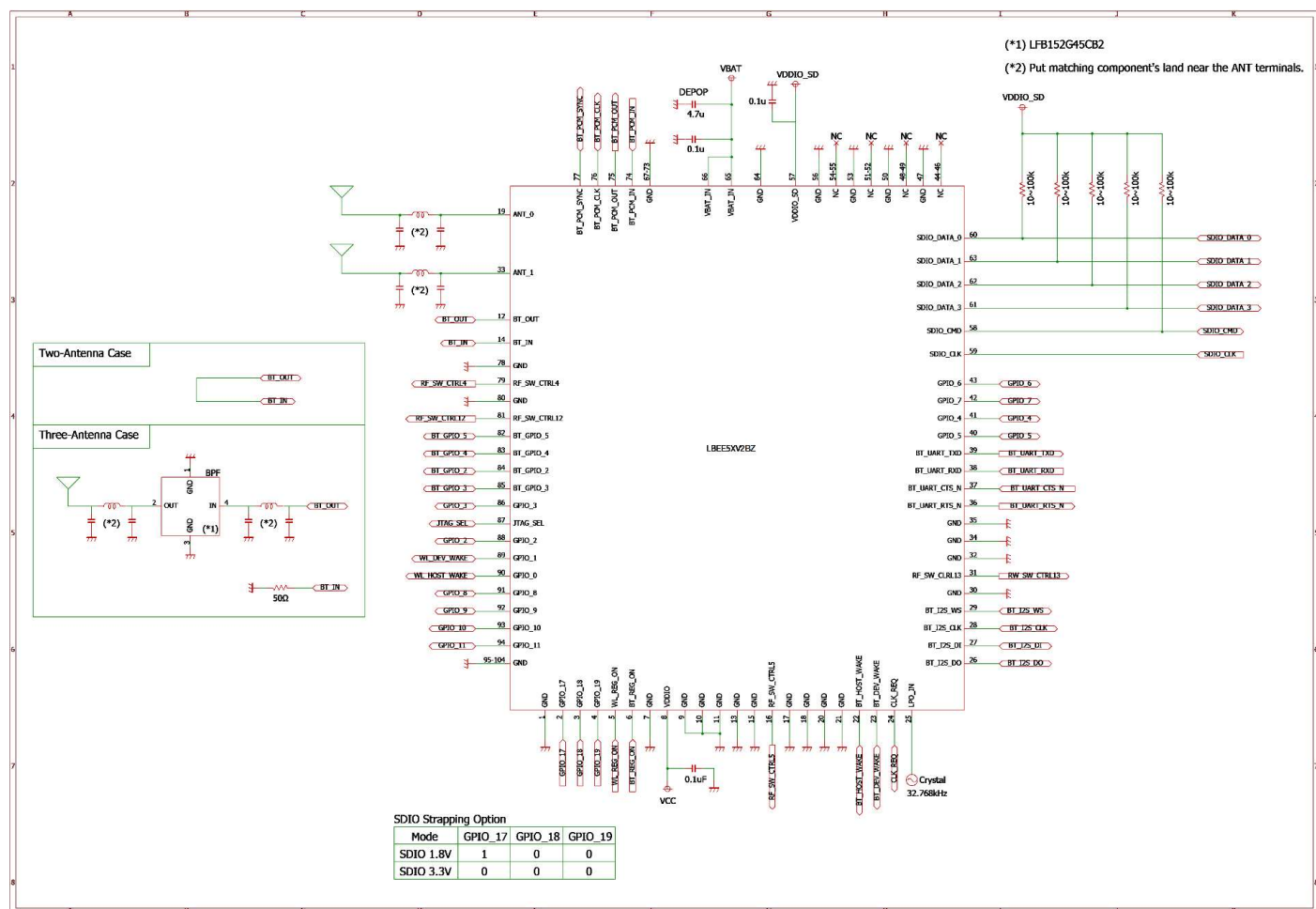
- IEEE802.11a/b/g/n/ac W-LAN 2x2 MIMO + Bluetooth 5.2 combo module with Infineon CYW54590
- Small size LGA package with resin molding and metal shielding.
- SDIO Interface for WLAN
- Interface support for Bluetooth is Host Controller Interface (HCI)
- MAC address and BD address are stored in OTP

2.2 Hardware block diagram



3 Reference design

3.1 Reference circuitry



3.2 Requirements for SDIO signals

- SDIO traces should be isometric zero delay routing with 50-ohm impedance.

3.3 External sleep clock requirements

External sleep clock (LPO) is necessary if internal sleep clock is not used. The following table shows requirements for external sleep clock.

Parameter	External LPO_IN Clock	Unit
Nominal input frequency	32.768	kHz
Frequency accuracy	+/-250	ppm
Duty cycle	30-70	%
Input signal amplitude	200 - 3300	mV, p-p
Signal type	Square-wave or sine-wave	-
Input impedance ¹	> 100k	ohm
	< 5	pF
Clock jitter (during initial start-up)	<10,000	ppm

¹ When power is applied or switch off.

3.4 Requirements for unused signals

Any pull-up/down is not necessary (floating) for GPIO [0..19] if these signals are not used.

3.5 Module footprint design

Refer to dimensions in the datasheet "type2bz.pdf". The DXF file of module footprint "type2bz_footprint_topview.dxf" is provided via website.

3.6 Recommended antenna

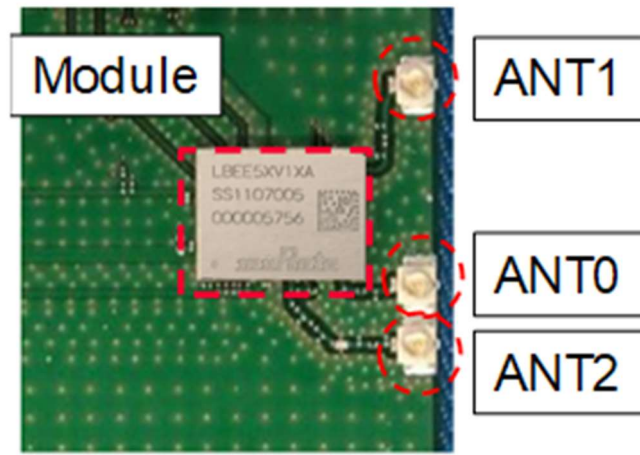
This module is certified with an antenna solution by regulatory certification body. To use Murata's regulatory certification, any user must follow below instructions.

3.6.1 PCB Type Di-pole Antenna with the co-axial connector

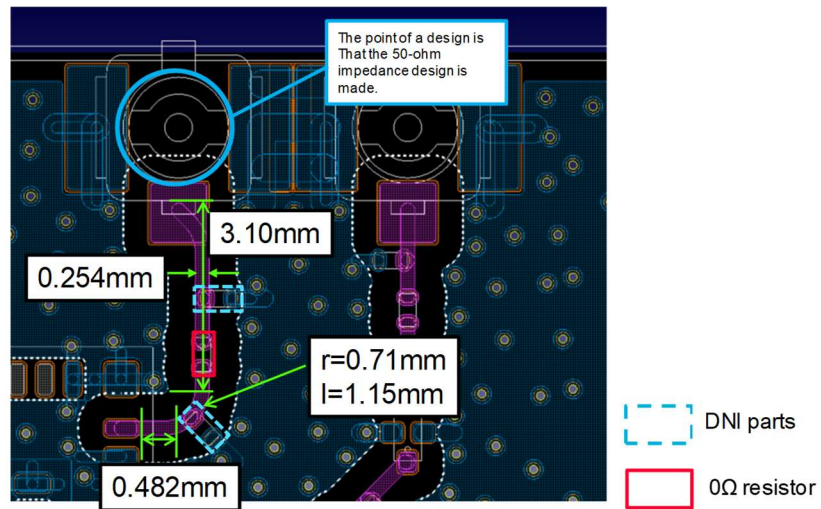
- Any users must use recommended antennas. However, user can use any equivalent type antenna with less antenna gain than antenna gain of recommended antennas for US and EU under approval of Class I Permissive Change by Murata.

P/N	Vendor	Form factor	Type	2.4GHz Gain	5GHz Gain	Cable options
146153	Molex	U.FL/PCB	Di-pole	3.2dBi	4.25dBi	050,100,150,200,250 and 300
146187	Molex	U.FL/PCB	Di-pole	3.4dBi	4.75dBi	050,100,150,200,250 and 300

- Any users must copy RF trace to U.FL/MHF connector from the trace layout file provided by Murata; adhering to below guidelines on:
 - Trace width accuracy within +/- 0.25 mm.
 - Stack height between GND layer and RF trace of 230 ~ 240 um (Exclude inaccuracy of PCB).
 - Passive component location matching Murata design.
 - Necessary "Keep out" area around U.FL/MHF connector.

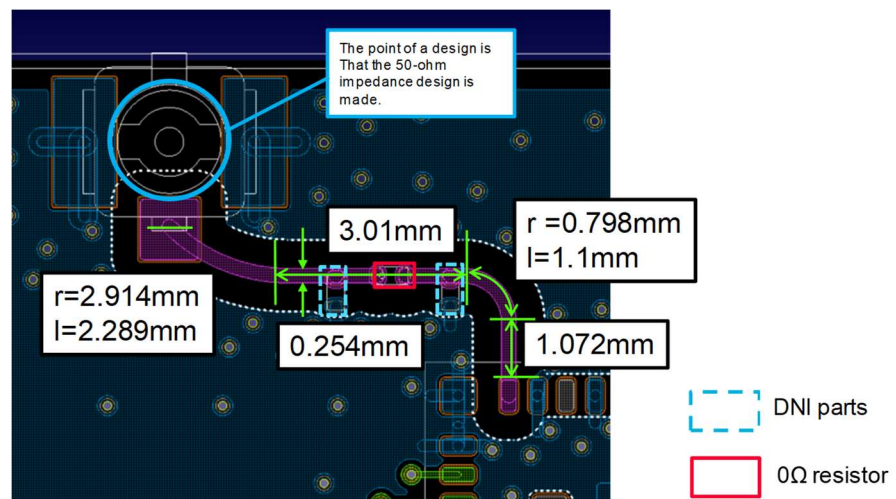


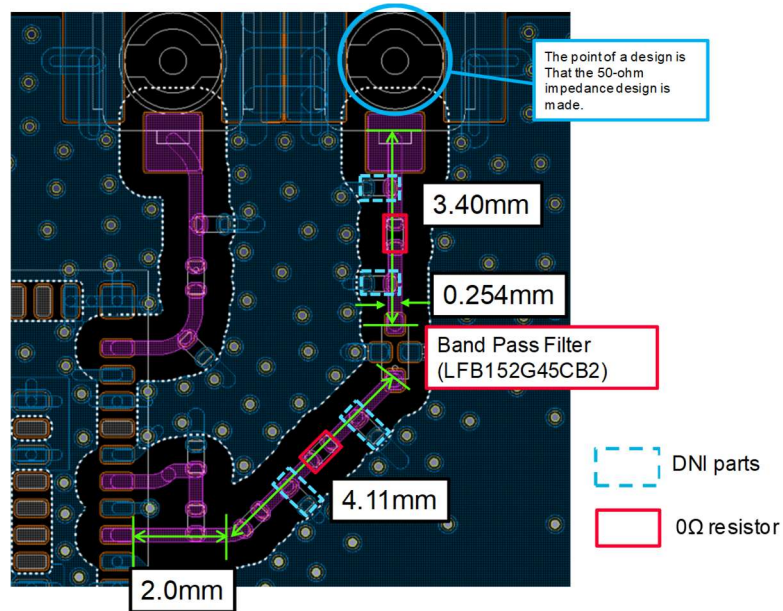
ANT0



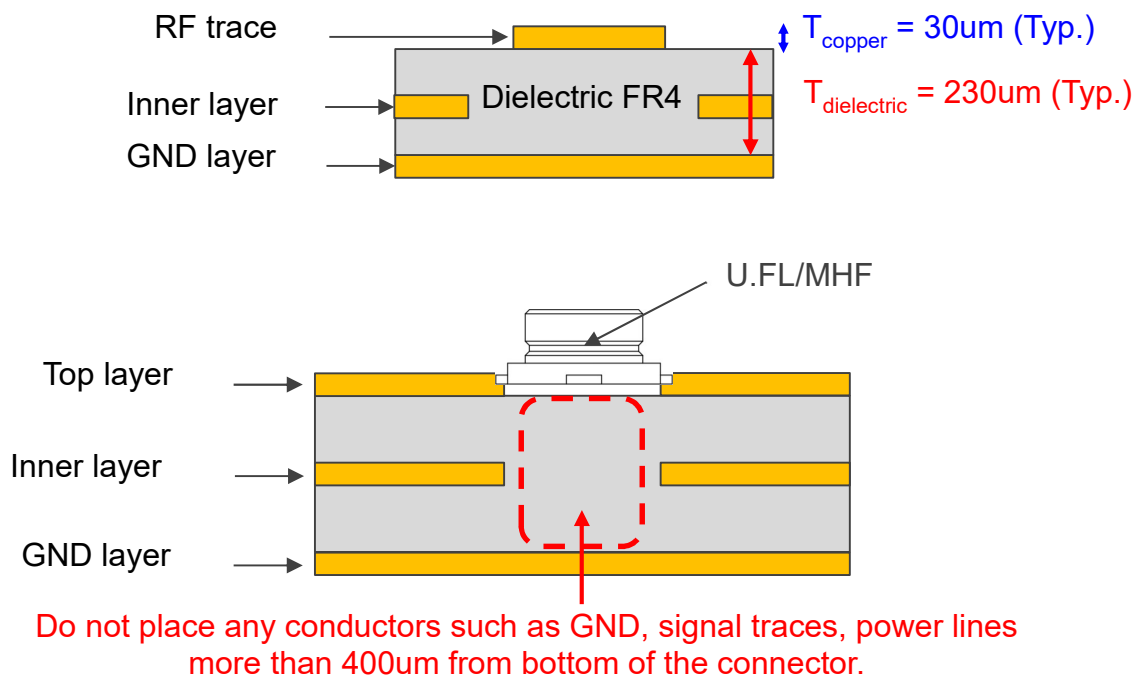
Note)
DNI: Do Not Insert
r: Line radius
l: Line length

ANT1





3.6.2 PCB Stack-up



4 Setup configuration files

To enable Murata's regulatory certification, below configuration file shall be loaded initially. Murata will provide configuration files via Murata's GitHub. (<https://github.com/murata-wireless/cyw-fmac-nvram> & <https://github.com/murata-wireless/cyw-fmac-fw>)

4.1 WLAN configuration files

Regulatory power configuration file

CLM blob file : cyfmac54591-sdio.2BZ.clm_blob

The following country codes are defined in "cyfmac54591-sdio.2BZ.clm_blob".

- US : United States of America
- CA : Canada
- DE : Europe
- JP : Japan

WLAN regulatory limitation configuration file

Nvram file : cyfmac54591-sdio.2ant.2BZ.txt
cyfmac54591-sdio.3ant.2BZ.txt

4.2 Bluetooth configuration files

Bluetooth Tx power configuration is included in HCD file which is firmware of Infineon's chipset. Please use the appropriate hcd file from the following according to your antenna configuration.

- Shared Bluetooth antenna : BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
- Dedicated Bluetooth antenna : BCM4359D0_004.001.016.0241.0274.2BZ.dAnt.hcd

5 Reference performance data

5.1 Typical Tx output power level (at module antenna port)

5.1.1 WLAN

<Condition>

- Tx output power setting is defined by [cyfmac54591-sdio.2BZ.clm_blob](#)
- Tx Power per antenna chain
- Indoor STA mode (For other configuration, please contact Murata sales)

United States of America (Country code = US)

2.4GHz

- SISO/1SS

Mode	Data Rate	Output Power in dBm (typ.)										
		Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	7ch	8ch	9ch	10ch	11ch
11b	1,2,5.5,11M	14.5	15.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	15.0	15.5
11g	6,9,12,18,24,36,48,54M	12.5	14.0	14.0	14.5	14.5	15.5	16.5	15.5	15.0	14.0	12.5
11n(HT20)	MCS0,1,2,3,4,5,6,7	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
Equivalent to 11ac(VHT20)	MCS0,1,2,3,4,5,6,7	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS8	11.0	13.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	12.5	11.5

- MIMO/2SS

Mode	Data Rate	Output Power in dBm (typ.)										
		Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	7ch	8ch	9ch	10ch	11ch
11n(HT20)	MCS8,9,10,11,12,13,14,15	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0
Equivalent to 11ac(VHT20)	MCS0,1,2,3,4,5,6,7,8	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0

5GHz

- SISO/1SS

(W52-53)

Mode		Output Power in dBm (typ.)					
	Data Rate	Ch.36	Ch.40	Ch.44-48	Ch.52-56	Ch.60	Ch.64
11a	6,9,12,18,24M	10.0	13.5	13.5	15.0	15.0	10.5
	36,48,54M	10.0	13.5	13.5	14.0	14.0	10.5
11n-20	MCS0,1,2,3	9.0	13.5	13.5	15.0	15.0	10.0
	MCS4,5,6	9.0	13.5	13.5	14.0	14.0	10.0
	MCS7	9.0	13.5	13.0	13.0	13.0	10.0
11ac-20	MCS0,1,2,3	9.0	13.5	13.5	15.0	15.0	10.0
	MCS4,5,6	9.0	13.5	13.5	14.0	14.0	10.0
	MCS7	9.0	13.0	13.0	13.0	13.0	10.0
	MCS8	9.0	12.0	12.0	12.0	12.0	10.0
Mode	Data Rate	Ch.38		Ch.46	Ch.54	Ch.62	
11n/ac-40	MCS0,1,2,3,4,5	10.5		13.0	14.0	9.5	
	MCS6	10.5		13.0	13.0	9.5	
	MCS7	10.5		12.0	12.0	9.5	
11ac-40	MCS8	10.5		11.0	11.0	9.5	
	MCS9	10.5		10.0	10.0	9.5	
Mode	Data Rate	Ch.42			Ch.58		
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	8.0			5.5		

(W56)

Mode	Data Rate	Output Power in dBm (typ.)						
		Ch.100	Ch.104	Ch.108-112	Ch.116-128	Ch.132-136	Ch.140	Ch.144
11a	6,9,12,18,24M	10.0	15.0	15.0	15.0	15.0	10.0	15.0
	36,48,54M	10.0	14.0	14.0	14.0	14.0	10.0	14.0
11n/ac-20	MCS0,1,2,3	9.0	15.0	15.0	15.0	15.0	9.0	15.0
	MCS4,5,6	9.0	14.0	14.0	14.0	14.0	9.0	14.0
	MCS7	9.0	13.0	13.0	13.0	13.0	9.0	13.0
11ac-20	MCS8	9.0	12.0	12.0	12.0	12.0	9.0	12.0
Mode	Data Rate	Ch.102		Ch.110	Ch.118-126	Ch.134	Ch.142	
11n/ac-40	MCS0,1,2,3,4,5	8.5		14.0	14.0	12.0	14.0	
	MCS6	8.5		13.0	13.0	12.0	13.0	
	MCS7	8.5		12.0	12.0	12.0	12.0	
11ac-40	MCS8	8.5		11.0	11.0	11.0	11.0	
	MCS9	8.5		10.0	10.0	10.0	10.0	
Mode	Data Rate	Ch.106			Ch.122	Ch.138		
11ac-80	MCS0,1,2,3,4,5	7.5			14.0	14.0		
	MCS6	7.5			13.0	13.0		
	MCS7	7.5			12.0	12.0		
	MCS8	7.5			11.0	11.0		
	MCS9	7.5			10.0	10.0		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11a	6,9,12,18,24M	15.0	15.0
	36,48,54M	14.0	14.0
11n/ac-20	MCS0,1,2,3	15.0	15.0
	MCS4,5,6	14.0	14.0
	MCS7	13.0	13.0
11ac-20	MCS8	12.0	12.0
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS0,1,2,3,4,5	14.0	-
	MCS6	13.0	-
	MCS7	12.0	-
11ac-40	MCS8	11.0	-
	MCS9	10.0	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6	13.0	-
	MCS7	12.0	-
	MCS8	11.0	-
	MCS9	10.0	-

- MIMO/2SS

(W52-53)

		Output Power in dBm (typ.)					
Mode	Data Rate	Ch.36	Ch.40	Ch.44-48	Ch.52-56	Ch.60	Ch.64
11n-20	MCS8,9,10,11,12,13,14	7.5	10.5	10.5	14.0	14.0	7.0
	MCS15	7.5	10.5	10.5	13.0	13.0	7.0
11ac-20	MCS0,1,2,3,4,5,6	7.5	10.5	10.5	14.0	14.0	7.0
	MCS7	7.5	10.5	10.5	13.0	13.0	7.0
	MCS8	7.5	10.5	10.5	12.0	12.0	7.0
Mode	Data Rate	Ch.38		Ch.46	Ch.54	Ch.62	
11n/ac-40	MCS8,9,10,11,12,13	7.5		10.0	14.0	7.0	
	MCS14	7.5		10.0	13.0	7.0	
	MCS15	7.5		10.0	12.0	7.0	
11ac-40	MCS0,1,2,3,4,5	7.5		10.0	14.0	7.0	
	MCS6	7.5		10.0	13.0	7.0	
	MCS7	7.5		10.0	12.0	7.0	
	MCS8	7.5		10.0	11.0	7.0	
	MCS9	7.5		10.0	10.0	7.0	
Mode	Data Rate	Ch.42			Ch.58		
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	6.0			4.0		

(W56)

Mode		Output Power in dBm (typ.)						
	Data Rate	Ch.100	Ch.104	Ch.108-112	Ch.116-128	Ch.132-136	Ch.140	Ch.144
11n-20	MCS8,9,10,11	7.0	14.5	14.5	14.5	14.5	6.0	14.5
	MCS12,13,14	7.0	14.0	14.0	14.0	14.0	6.0	14.0
	MCS15	7.0	13.0	13.0	13.0	13.0	6.0	13.0
11ac-20	MCS0,1,2,3	7.0	14.5	14.5	14.5	14.5	6.0	14.5
	MCS4,5,6	7.0	14.0	14.0	14.0	14.0	6.0	14.0
	MCS7	7.0	13.0	13.0	13.0	13.0	6.0	13.0
	MCS8	7.0	12.0	12.0	12.0	12.0	6.0	12.0
Mode	Data Rate	Ch.102		Ch.110	Ch.118-126	Ch.134	Ch.142	
11n/ac-40	MCS8,9,10,11,12,13	8.0		14.0	14.0	9.0	14.0	
	MCS14	8.0		13.0	13.0	9.0	13.0	
	MCS15	8.0		12.0	12.0	9.0	12.0	
11ac-40	MCS0,1,2,3,4,5	8.0		14.0	14.0	9.0	14.0	
	MCS6	8.0		13.0	13.0	9.0	13.0	
	MCS7	8.0		12.0	12.0	9.0	12.0	
	MCS8	8.0		11.0	11.0	9.0	11.0	
	MCS9	8.0		10.0	10.0	9.0	10.0	
Mode	Data Rate	Ch.106			Ch.122	Ch.138		
11ac-80	MCS0,1,2,3,4,5	5.5			14.0	14.0		
	MCS6	5.5			13.0	13.0		
	MCS7	5.5			12.0	12.0		
	MCS8	5.5			11.0	11.0		
	MCS9	5.5			10.0	10.0		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11n-20	MCS8,9,10,11	15.0	15.0
	MCS12,13,14	14.0	14.0
	MCS15	13.0	13.0
11ac-20	MCS0,1,2,3	15.0	15.0
	MCS4,5,6	14.0	14.0
	MCS7	13.0	13.0
	MCS8	12.0	12.0
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS8,9,10,11,12,13	14.0	-
	MCS14	13.0	-
	MCS15	12.0	-
11ac-40	MCS0,1,2,3,4,5	14.0	-
	MCS6	13.0	-
	MCS7	12.0	-
	MCS8,9,10,11,12,13	14.0	-
	MCS14	13.0	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	10.5	-

Canada (Country code = CA)

2.4GHz (1SS/2SS)

- SISO/1SS

Mode	Data Rate	Output Power in dBm (typ.)										
		Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	7ch	8ch	9ch	10ch	11ch
11b	1,2,5.5,11M	14.5	15.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	15.0	15.5
11g	6,9,12,18,24,36,48,54M	12.5	14.0	14.0	14.5	14.5	15.5	16.5	15.5	15.0	14.0	12.5
11n(HT20)	MCS0,1,2,3	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS4,5,6,7	11.0	13.0	14.0	14.0	14.5	15.0	15.0	15.0	14.5	12.5	11.5
Equivalent to 11ac(VHT20)	MCS0,1,2,3	11.0	13.0	14.0	14.0	14.5	15.5	15.5	15.0	14.5	12.5	11.5
	MCS4,5,6,7	11.0	13.0	14.0	14.0	14.5	15.0	15.0	15.0	14.5	12.5	11.5
	MCS8	11.0	13.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	12.5	11.5

- MIMO/2SS

Mode	Data Rate	Output Power in dBm (typ.)										
		Ch.1	Ch.2	Ch.3	Ch.4	Ch.5	Ch.6	7ch	8ch	9ch	10ch	11ch
11n(HT20)	MCS8,9,10,11,12,13,14,15	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0
Equivalent to 11ac(VHT20)	MCS0,1,2,3,4,5,6,7,8	8.0	11.0	11.5	13.0	13.0	14.0	14.0	13.0	12.0	10.5	10.0

5GHz

- SISO/1SS

(W52-53)

		Output Power in dBm (typ.)					
Mode	Data Rate	Ch.36	Ch.40	Ch.44-48	Ch.52-56	Ch.60	Ch.64
11a	6,9,12,18,24M	10.0	13.5	13.5	15.0	15.0	10.5
	36,48,54M	10.0	13.5	13.5	14.0	14.0	10.5
11n-20	MCS0,1,2,3	9.0	13.5	13.5	15.0	15.0	10.0
	MCS4,5,6	9.0	13.5	13.5	14.0	14.0	10.0
	MCS7	9.0	13.5	13.0	13.0	13.0	10.0
11ac-20	MCS0,1,2,3	9.0	13.5	13.5	15.0	15.0	10.0
	MCS4,5,6	9.0	13.5	13.5	14.0	14.0	10.0
	MCS7	9.0	13.0	13.0	13.0	13.0	10.0
	MCS8	9.0	12.0	12.0	12.0	12.0	10.0
Mode	Data Rate	Ch.38		Ch.46	Ch.54	Ch.62	
11n/ac-40	MCS0,1,2,3,4,5	10.5		13.0	14.0	9.5	
	MCS6	10.5		13.0	13.0	9.5	
	MCS7	10.5		12.0	12.0	9.5	
11ac-40	MCS8	10.5		11.0	11.0	9.5	
	MCS9	10.5		10.0	10.0	9.5	
Mode	Data Rate	Ch.42			Ch.58		
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	8.0			5.5		

(W56)

Mode		Output Power in dBm (typ.)							
	Data Rate	Ch.100	Ch.104	Ch.108-112	Ch.116	Ch.120-128	Ch.132-136	Ch.140	Ch.144
11a	6,9,12,18,24M	10.0	15.0	15.0	15.0	-	15.0	10.0	15.0
	36,48,54M	10.0	14.0	14.0	14.0	-	14.0	10.0	14.0
11n/ac-20	MCS0,1,2,3	9.0	15.0	15.0	15.0	-	15.0	9.0	15.0
	MCS4,5,6	9.0	14.0	14.0	14.0	-	14.0	9.0	14.0
	MCS7	9.0	13.0	13.0	13.0	-	13.0	9.0	13.0
11ac-20	MCS8	9.0	12.0	12	12.0	-	12.0	9.0	12.0
Mode	Data Rate	Ch.102		Ch.110	Ch.118-126		Ch.134	Ch.142	
11n/ac-40	MCS0,1,2,3,4,5	8.5		14.0	-		12.0	14.0	
	MCS6	8.5		13.0	-		12.0	13.0	
	MCS7	8.5		12.0	-		12.0	12.0	
11ac-40	MCS8	8.5		11.0	-		11.0	11.0	
	MCS9	8.5		10.0	-		10.0	10.0	
Mode	Data Rate	Ch.106			Ch.122		Ch.138		
11ac-80	MCS0,1,2,3,4,5	7.5			-		14.0		
	MCS6	7.5			-		13.0		
	MCS7	7.5			-		12.0		
	MCS8	7.5			-		11.0		
	MCS9	7.5			-		10.0		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11a	6,9,12,18,24M	15.0	15.0
	36,48,54M	14.0	14.0
11n/ac-20	MCS0,1,2,3	15.0	15.0
	MCS4,5,6	14.0	14.0
	MCS7	13.0	13.0
11ac-20	MCS8	12.0	12.0
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS0,1,2,3,4,5	14.0	-
	MCS6	13.0	-
	MCS7	12.0	-
11ac-40	MCS8	11.0	-
	MCS9	10.0	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6	13.0	-
	MCS7	12.0	-
	MCS8	11.0	-
	MCS9	10.0	-

- MIMO/2SS

(W52-53)

		Output Power in dBm (typ.)						
Mode	Data Rate	Ch.36	Ch.40	Ch.44	Ch.48	Ch.52-56	Ch.60	Ch.64
11n-20	MCS8,9,10,11,12,13,14	7.5	6.0	10.5	5.5	14.0	14.0	7.0
	MCS15	7.5	6.0	10.5	5.5	13.0	13.0	7.0
11ac-20	MCS0,1,2,3,4,5,6	7.5	6.0	10.5	5.5	14.0	14.0	7.0
	MCS7	7.5	6.0	10.5	5.5	13.0	13.0	7.0
	MCS8	7.5	6.0	10.5	5.5	12.0	12.0	7.0
Mode	Data Rate	Ch.38		Ch.46		Ch.54	Ch.62	
11n/ac-40	MCS8,9,10,11,12,13	7.5		10.0		14.0	7.0	
	MCS14	7.5		10.0		13.0	7.0	
	MCS15	7.5		10.0		12.0	7.0	
11ac-40	MCS0,1,2,3,4,5	7.5		10.0		14.0	7.0	
	MCS6	7.5		10.0		13.0	7.0	
	MCS7	7.5		10.0		12.0	7.0	
	MCS8	7.5		10.0		11.0	7.0	
	MCS9	7.5		10.0		10.0	7.0	
Mode	Data Rate	Ch.42				Ch.58		
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	6.0				4.0		

(W56)

Output Power in dBm (typ.)									
Mode	Data Rate	Ch.100	Ch.104	Ch.108-112	Ch.116	Ch.120-128	Ch.132-136	Ch.140	Ch.144
11n-20	MCS8,9,10,11	7.0	14.5	14.5	14.5	-	14.5	6.0	14.5
	MCS12,13,14	7.0	14.0	14.0	14.0	-	14.0	6.0	14.0
	MCS15	7.0	13.0	13.0	13.0	-	13.0	6.0	13.0
11ac-20	MCS0,1,2,3	7.0	14.5	14.5	14.5	-	14.5	6.0	14.5
	MCS4,5,6	7.0	14.0	14.0	14.0	-	14.0	6.0	14.0
	MCS7	7.0	13.0	13.0	13.0	-	13.0	6.0	13.0
	MCS8	7.0	12.0	12.0	12.0	-	12.0	6.0	12.0
Mode	Data Rate	Ch.102		Ch.110	Ch.118-126		Ch.134	Ch.142	
11n/ac-40	MCS8,9,10,11,12,13	8.0		14.0	-		9.0	14.0	
	MCS14	8.0		13.0	-		9.0	13.0	
	MCS15	8.0		12.0	-		9.0	12.0	
11ac-40	MCS0,1,2,3,4,5	8.0		14.0	-		9.0	14.0	
	MCS6	8.0		13.0	-		9.0	13.0	
	MCS7	8.0		12.0	-		9.0	12.0	
	MCS8	8.0		11.0	-		9.0	11.0	
	MCS9	8.0		10.0	-		9.0	10.0	
Mode	Data Rate	Ch.106			Ch.122		Ch.138		
11ac-80	MCS0,1,2,3,4,5	5.5			-		14.0		
	MCS6	5.5			-		13.0		
	MCS7	5.5			-		12.0		
	MCS8	5.5			-		11.0		
	MCS9	5.5			-		10.0		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11n-20	MCS8,9,10,11	15.0	15.0
	MCS12,13,14	14.0	14.0
	MCS15	13.0	13.0
11ac-20	MCS0,1,2,3	15.0	15.0
	MCS4,5,6	14.0	14.0
	MCS7	13.0	13.0
	MCS8	12.0	12.0
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS8,9,10,11,12,13	14.0	-
	MCS14	13.0	-
	MCS15	12.0	-
11ac-40	MCS0,1,2,3,4,5	14.0	-
	MCS6	13.0	-
	MCS7	12.0	-
	MCS8	11.0	-
	MCS9	10.0	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	10.5	-

EU (Country code = DE)

2.4GHz

- SISO/1SS

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.1-12	Ch.13
11b	1,2,5.5,11M	11.50	11.5
11g	6,9,12,18,24,36,48,54M	13.50	13.0
11n-20	MCS0,1,2,3,4,5,6,7	14.00	13.25
Equivalent to 11ac-20	MCS0,1,2,3,4,5,6,7,8	14.00	13.25

- MIMO/2SS

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.1-12	Ch.13
11n-20	MCS8,9,10,11,12,13,14,15	11.00	10.25
Equivalent to 11ac-20	MCS0,1,2,3,4,5,6,7,8	11.00	10.25

5GHz

- SISO/1SS

(W52-53)

Mode	Data Rate	Output Power in dBm (typ.)
		Ch.36-64
11a	6,9,12,18,24,36,48,54M	13.0
11n/ac-20	MCS0,1,2,3,4,5,6,7	13.0
11ac-20	MCS8	12.0
Mode	Data Rate	Ch.38-62
11n/ac-40	MCS0,1,2,3,4,5	14.0
	MCS6	13.0
	MCS7	12.0
11ac-40	MCS8	11.0
	MCS9	10.0
Mode	Data Rate	Ch.42-58
11ac-80	MCS0,1,2,3,4,5	14.0
	MCS6	13.0
	MCS7	12.0
	MCS8	11.0
	MCS9	10.0

(W56)

		Output Power in dBm (typ.)			
Mode	Data Rate	Ch.100-128	Ch.132-136	Ch.140	Ch.144
11a	6,9,12,18,24,36,48,54M	13.0	13.0	13.0	13.0
11n/ac-20	MCS0,1,2,3,4,5,6,7	13.0	13.0	13.0	13.0
11ac-20	MCS8	12.0	12.0	12.0	12.0
Mode	Data Rate	Ch.102-126	Ch.134	Ch.142	
11n/ac-40	MCS0,1,2,3,4,5	14.0	14.0	-	
	MCS6	13.0	13.0	-	
	MCS7	12.0	12.0	-	
11ac-40	MCS8	11.0	11.0	-	
	MCS9	10.0	10.0	-	
Mode	Data Rate	Ch.106-122	Ch.138		
11ac-80	MCS0,1,2,3,4,5	14.0	-		
	MCS6	13.0	-		
	MCS7	12.0	-		
	MCS8	11.0	-		
	MCS9	10.0	-		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11a	6,9,12,18,24,36,48,54M	6.5	6.5
11n/ac-20	MCS0,1,2,3,4,5,6,7	6.5	6.5
11ac-20	MCS8	6.5	6.5
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS0,1,2,3,4,5,6,7	6.5	-
11ac-40	MCS8	6.5	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	6.5	-

- MIMO/2SS

(W52-53)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.36-64	
11n-20	MCS0,1,2,3,4,5,6,7	13.0	
11ac-20	MCS8	12.0	
Mode	Data Rate	Ch.38-62	
11n-40	MCS8,9,10,11,12,13,14	12.5	
	MCS15	12.0	
11ac-40	MCS0,1,2,3,4,5,6	12.5	
	MCS7	12.0	
	MCS8	11.0	
	MCS9	10.0	
Mode	Data Rate	Ch.42-58	
11ac-80	MCS0,1,2,3,4,5,6,7	12.0	
	MCS8	11.0	
	MCS9	10.0	

(W56)

		Output Power in dBm (typ.)			
Mode	Data Rate	Ch.100-128	Ch.132-136	Ch.140	Ch.144
11n/ac-20	MCS8,9,10,11,12,13,14,15	10.0	10.0	10.0	10.0
11ac-20	MCS0,1,2,3,4,5,6,7,8	10.0	10.0	10.0	10.0
Mode	Data Rate	Ch.102-126	Ch.134	Ch.142	
11n/ac-40	MCS8,9,10,11,12,13,14	12.5	12.5	-	
	MCS15	12.0	12.0	-	
11ac-40	MCS0,1,2,3,4,5,6	12.5	12.5	-	
	MCS7	12.0	12.0	-	
	MCS8	11.0	11.0	-	
	MCS9	10.0	10.0	-	
Mode	Data Rate	Ch.106-122	Ch.138		
11ac-80	MCS0,1,2,3,4,5,6,7	12.0	-		
	MCS8	11.0	-		
	MCS9	10.0	-		

(W58)

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.149-161	165ch
11n/ac-20	MCS8,9,10,11,12,13,14,15	3.5	3.5
11ac-20	MCS0,1,2,3,4,5,6,7,8	3.5	3.5
Mode	Data Rate	Ch.151-159	-
11n/ac-40	MCS8,9,10,11,12,13,14,15	3.5	-
11ac-40	MCS0,1,2,3,4,5,6,7,8	3.5	-
Mode	Data Rate	Ch.155	-
11ac-80	MCS0,1,2,3,4,5,6,7,8,9	2.5	-

Japan (Country code = JP)

2.4GHz (1SS/2SS)

- SISO

Mode	Data Rate	Output Power in dBm (typ.)
		Ch.1-13
11b	1,2,5.5,11M	13.5
11g	6,9,12,18M	15.5
	24,36,48,54M	15.0
11n-20	MCS0,1,2,3	15.5
	MCS4,5,6,7	15.0
Equivalent to 11ac-20	MCS0,1,2,3	15.5
	MCS4,5,6,7	15.0
	MCS8	14.0

- MIMO/2SS

Mode	Data Rate	Output Power in dBm (typ.)
		Ch.1-13
11n-20	MCS8,9,10,11,12,13,14,15	12.5
Equivalent to 11ac-20	MCS0,1,2,3,4,5,6,7,8	12.5

5GHz

- SISO/1SS

Mode	Data Rate	Output Power in dBm (typ.)		
		Ch.36-48	Ch.52-64	Ch.100-144
11a	6,9,12,18,24M	12.50	12.50	15.00
	36,48,54M	12.50	12.50	14.00
11n/ac-20	MCS0,1,2,3	12.50	12.75	15.00
	MCS4,5,6	12.50	12.75	14.00
	MCS7	12.50	12.75	13.00
11ac-20	MCS8	12.00	12.00	12.00
Mode	Data Rate	Ch.38-46	Ch.54-62	Ch.102-142
11n/ac-40	MCS0,1,2,3,4,5	13.25	13.50	14.00
	MCS6	13.00	13.00	13.00
	MCS7	12.00	12.00	12.00
11ac-40	MCS8	11.00	11.00	11.00
	MCS9	10.00	10.00	10.00
Mode	Data Rate	Ch.42	Ch.58	Ch.106-138
11ac-80	MCS0,1,2,3,4,5	13.00	13.00	14.00
	MCS6	13.00	13.00	13.00
	MCS7	12.00	12.00	12.00
	MCS8	11.00	11.00	11.00
	MCS9	10.00	10.00	10.00

- MIMO/2SS

Mode	Data Rate	Output Power in dBm (typ.)	
		Ch.36-48	
11n-20	MCS8,9,10,11,12,13,14,15	11.0	
11ac-20	MCS0,1,2,3,4,5,6,7,8	11.0	
Mode	Data Rate	Ch.38-46	
11n/ac-40	MCS8,9,10,11,12,13,14,15	11.0	
11ac-40	MCS0,1,2,3,4,5,6,7,8	11.0	
	MCS9	10.0	
Mode	Data Rate	Ch.42	
11ac-80	MCS0,1,2,3,4,5,6,7,8	11.0	
	MCS9	10.0	

5.1.2 Bluetooth

<Condition>

- HCD file = BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
(<https://github.com/murata-wireless/cyw-bt-patch>)

Frequency in MHz	Output Power in dBm		
	DH5	3DH5	BLE
2402	11	7	3
2440	11	7	3
2480	11	7	3

5.2 Typical Rx minimum sensitivity level (at module antenna port)

5.2.1 WLAN

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : SDIO
- Nvram file : cyfmac54591-sdio.2ant.2BZ.txt
(<https://github.com/murata-wireless/cyw-fmac-nvram>)

2.4GHz

Frequency in MHz	Rx minimum sensitivity level in dBm		
	11b	11g	11n
	11Mbps	54Mbps	MCS7
2412	-89	-76	-74
2442	-89	-76	-74
2472	-89	-76	-74

5GHz

Frequency in MHz	Rx minimum sensitivity level in dBm		
	11a	11n (HT20)	11ac (VHT20)
	54Mbps	MCS7	MCS8
5180	-76	-74	-69
5500	-76	-74	-70
5825	-75	-73	-69

Frequency in MHz	Rx minimum sensitivity level in dBm	
	11n (HT40)	11ac (VHT40)
	MCS7	MCS9
5190	-71	-65
5510	-71	-65
5795	-70	-64

Frequency in MHz	Rx minimum sensitivity level in dBm	
	11ac (VHT80)	
	MCS9	
5210	-62	
5530	-62	
5775	-61	

5.2.2 Bluetooth

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : UART
- HCD file : BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
(<https://github.com/murata-wireless/cyw-bt-patch>)

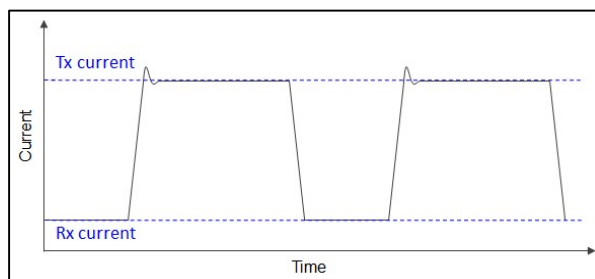
Frequency in MHz	Rx minimum sensitivity level in dBm				
	DH5	2DH5	3DH5	LE 1M	LE 2M
2402	-91	-92	-87	-99	-96
2441	-91	-93	-88	-99	-96
2480	-91	-91	-88	-99	-96

5.3 Typical Tx/Rx current consumption

5.3.1 WLAN

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : SDIO
- Nvram file : cyfmac54591-sdio.2ant.2BZ.txt
- Current definition :



2.4GHz (SISO)

Mode	Data Rate	Setting Tx Power (dBm)	Current (mA)			
			Ant0		Ant1	
			Tx	Rx	Tx	Rx
11b	1Mbps	17	340	75	370	85
11g	6Mbps	17	340	75	365	85
11n	MCS0	17	340	75	365	85

5GHz (SISO)

Mode	Data Rate	Setting Tx Power (dBm)	Current (mA)			
			Ant0		Ant1	
			Tx	Rx	Tx	Rx
11a	1Mbps	15	370	80	420	110
11n	MCS0	15	370	80	420	110
11ac	MCS0	15	370	80	420	110

2.4GHz (MIMO)

Mode	Data Rate	Setting Tx Power (dBm)	Current (mA)	
			Tx	Rx
11n	MCS8	17	635	110

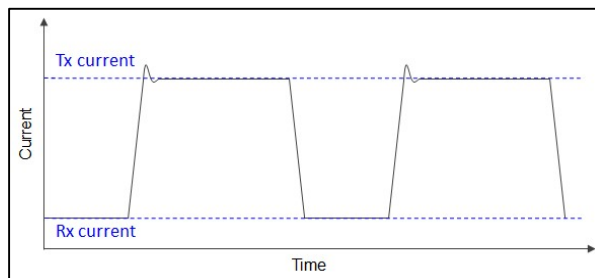
5GHz (MIMO)

Mode	Data Rate	Setting Tx Power (dBm)	Current (mA)	
			Tx	Rx
11n	MCS8	15	710	135
11ac	MCS0	15	710	135

5.3.2 Bluetooth

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : UART
- HCD file : BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
- Current definition :



2.4GHz

Mode	Setting Tx Power (dBm)	Current in mA	
		Tx	Rx
BR(1DH5)	11	51	16
EDR(3DH5)	7	40	16
1LE	3	32	16
2LE	3	32	17

5.4 IEEE power save current consumption

5.4.1 WLAN

Test Configuration:

- Power Supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : SDIO
- BT_REG_ON : OFF
- Driver ver. : FMAC(Zigra)
- FW ver : 13.35.173
- Platform : BRIX
- Access Point : ASUS RT-AX6000

Band	Mode	Current in mA
2.4GHz	IEEE Power Save:DTIM1	3.61
	IEEE Power Save:DTIM3	1.20
	IEEE Power Save:DTIM5	0.72
5GHz	IEEE Power Save:DTIM1	2.53
	IEEE Power Save:DTIM3	0.84
	IEEE Power Save:DTIM5	0.50

5.4.2 BT Sleep mode current consumption

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : UART
- HCD file : BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
- WL_REG_ON : OFF

Mode	Current Consumption in uA
Deep Sleep(BT Only)	3
Advertise 1s	160
BLE Scan 1.28s	173
BT Page Scan 1.28s	151
BT Page & Inquiry Scan 1.28s	43
LE Link Master 1s	21

5.5 Typical Throughput

Test Configuration:

- Power supply : VBAT=3.3V, VDDIO=1.8V
- Host IF : SDIO
- DUT : Murata Type2BZ M.2 EVB (LBEE5XV2BZ-EVB)
 - WLAN Driver : FMAC(Baragon)
 - FW version : 13.35.225 (r728326 CY)
- Platform : MCIMX8MQuad-EVK
 - Linux Kernel version : 4.14.78
- Access Point : ASUS RT-AX6000
- UDP commands : Bit rate was set at more than 20% of observed corresponding TCP throughput.
Sample UDP command: *iperf3 <server-ip-addr> -u -b <20%-of-TCP>M -P1 -t 60*

Mode	TCP Throughput in Mbps		UDP Throughput in Mbps	
	Tx	Rx	Tx	Rx
2.4GHz 11n HT20 MIMO	113	111	123	113
5GHz 11ac VHT80 MIMO	337	337	406	310