

Wi-Fi® + Bluetooth® Combo Module

Infineon CYW54590 Chipset for 802.11a/b/g/n/ac 2x2 MIMO
+ Bluetooth 5.2

Hardware Application Note - Rev. 2.0

- Design Name: Type 2BZ
- Module P/N: LBEE5XV2BZ-883



Table of Contents

1 Scope	4
2 Module Introduction	4
2.1 Features.....	4
2.2 Hardware Block Diagram	5
3 Reference Design	6
3.1 Reference Circuitry	6
3.2 Requirement for SDIO Signals	7
3.3 Requirements for Unused Signals.....	7
3.4 Module Footprint Design	7
3.5 Recommended Antenna.....	7
3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector	7
3.5.2 Antenna Design and Configuration	8
3.5.3 PCB Stack-up.....	10
4 Setup Configuration Files.....	11
4.1 WLAN Configuration Files	11
4.2 Bluetooth Configuration Files	11
5 Reference Performance Data	12
5.1 Typical Rx Minimum Sensitivity Level (at Module Antenna Port)	12
5.1.1 WLAN.....	12
5.1.2 Bluetooth	13
5.2 Typical Tx/Rx Current Consumption.....	13
5.2.1 Typical WLAN Current Consumption	13
5.2.2 Bluetooth	15
5.3 IEEE Power Save Current Consumption	16
5.3.1 WLAN.....	16
5.3.2 BT Sleep Mode Current Consumption	16
5.4 Typical Throughput	17
6 References	17
7 Technical Support Contacts	18
Revision History.....	19

Figures

Figure 1: Hardware Block Diagram	5
Figure 2: Reference Design	6

Figure 3: Module Antenna.....	7
Figure 4: Antenna Test EVB - Overall Design	8
Figure 5: ANT0 Antenna Design	9
Figure 6: ANT1 Antenna Design	9
Figure 7: ANT2 Antenna Design	10
Figure 8: PCB Stack-up	10
Figure 9: WLAN Test Current Configurations.....	13
Figure 10: Bluetooth Test Current Configuration	15

Tables

Table 1: Document Conventions.....	3
Table 2: Certified Antenna List.....	8
Table 3: An example of Class I Permissive Change Capable Antenna	8
Table 4: WLAN Configuration Files – Linux.....	11
Table 5: Bluetooth Configuration Files - Linux.....	11
Table 6: Rx Minimum Sensitivity Level - 2.4 MHz	12
Table 7: Rx Minimum Sensitivity Level in dBm - 5 MHz	12
Table 8: Bluetooth Sensitivity Level Parameters	13
Table 9: Typical WLAN Current Consumption Test Parameters at 2.4 GHz - SISO	14
Table 10: Typical WLAN Current Consumption Test Parameters at 5 GHz - SISO	14
Table 11: Typical WLAN Current Consumption Test Parameters at 2.4 GHz - MIMO	14
Table 12: Typical WLAN Current Consumption Test Parameters at 5 GHz - MIMO	14
Table 13: Typical Bluetooth Current Test Configuration Parameters.....	15
Table 14: IEEE Power Save Current Consumption Test Parameters	16
Table 15: Bluetooth Sleep Mode Current Consumption Test Parameters	16
Table 16: Typical Throughput Test Parameters	17
Table 17: Reference Table	17
Table 18: List of Support Resources	18

About This Document

Murata's Type 2BZ is a small and very high-performance module based on Infineon CYW54590 combo chipset which supports Wi-Fi 802.11a/b/g/n/ac 2×2 MIMO + Bluetooth 5.2 BR/EDR/LE. This application note provides RF and hardware design guidance.

Audience & Purpose

This document is targeted towards system integrators for Wi-Fi/Bluetooth solutions using Murata Type 2BZ (LBEE5XV2BZ) module, based on chipset.

Document Conventions

Table 1 describes the document conventions.

Table 1: Document Conventions

Conventions	Description
	Warning Note Indicates very important note. Users are strongly recommended to review.
	Info Note Intended for informational purposes. Users should review.
	Menu Reference Indicates menu navigation instructions. Example: Insert → Tables → Quick Tables → Save Selection to Gallery 
	External Hyperlink This symbol indicates a hyperlink to an external document or website. Example: Murata  Click on the text to open the external link.
	Internal Hyperlink This symbol indicates a hyperlink within the document. Example: Scope  Click on the text to open the link.
<code>Console input/output or code snippet</code>	Console I/O or Code Snippet This text Style denotes console input/output or a code snippet.
<code># Console I/O comment // Code snippet comment</code>	Console I/O or Code Snippet Comment This text Style denotes a console input/output or code snippet comment. • Console I/O comment (preceded by "#") is for informational purposes only and does not denote actual console input/output. • Code Snippet comment (preceded by "//") may exist in the original code.

1 Scope

This application note covers HW development and provides how to design the schematic and layout, and reference RF performance. Refer to [Type 2BZ Datasheet](#)  for detailed module specification.

2 Module Introduction

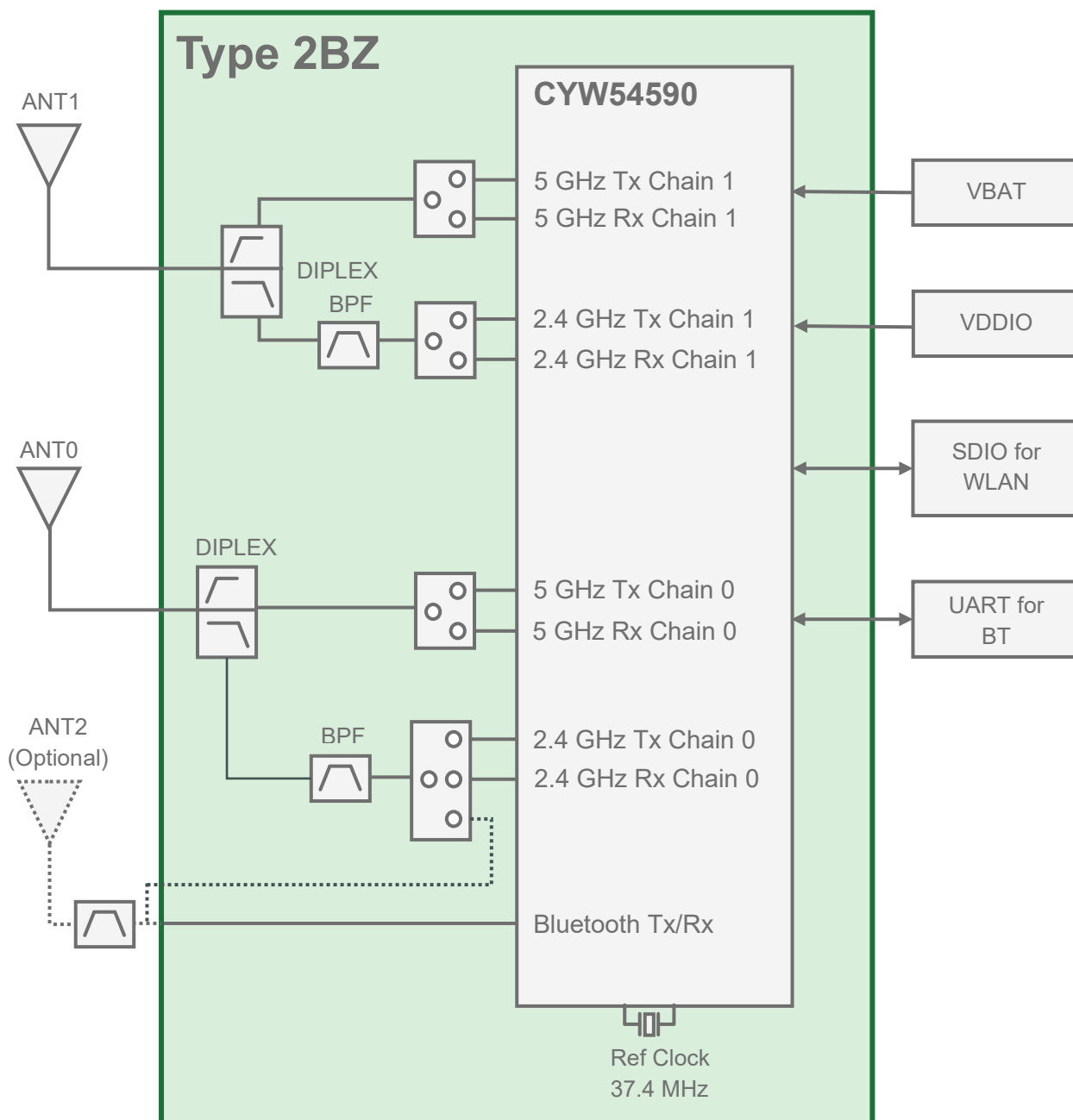
2.1 Features

- IEEE802.11a/b/g/n/ac W-LAN 2x2 MIMO + Bluetooth 5.2 combo module with Infineon CYW54590
- Supports Bluetooth specification version 5.2
- 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

Figure 1 shows the type 2BZ module block diagram.

Figure 1: Hardware Block Diagram



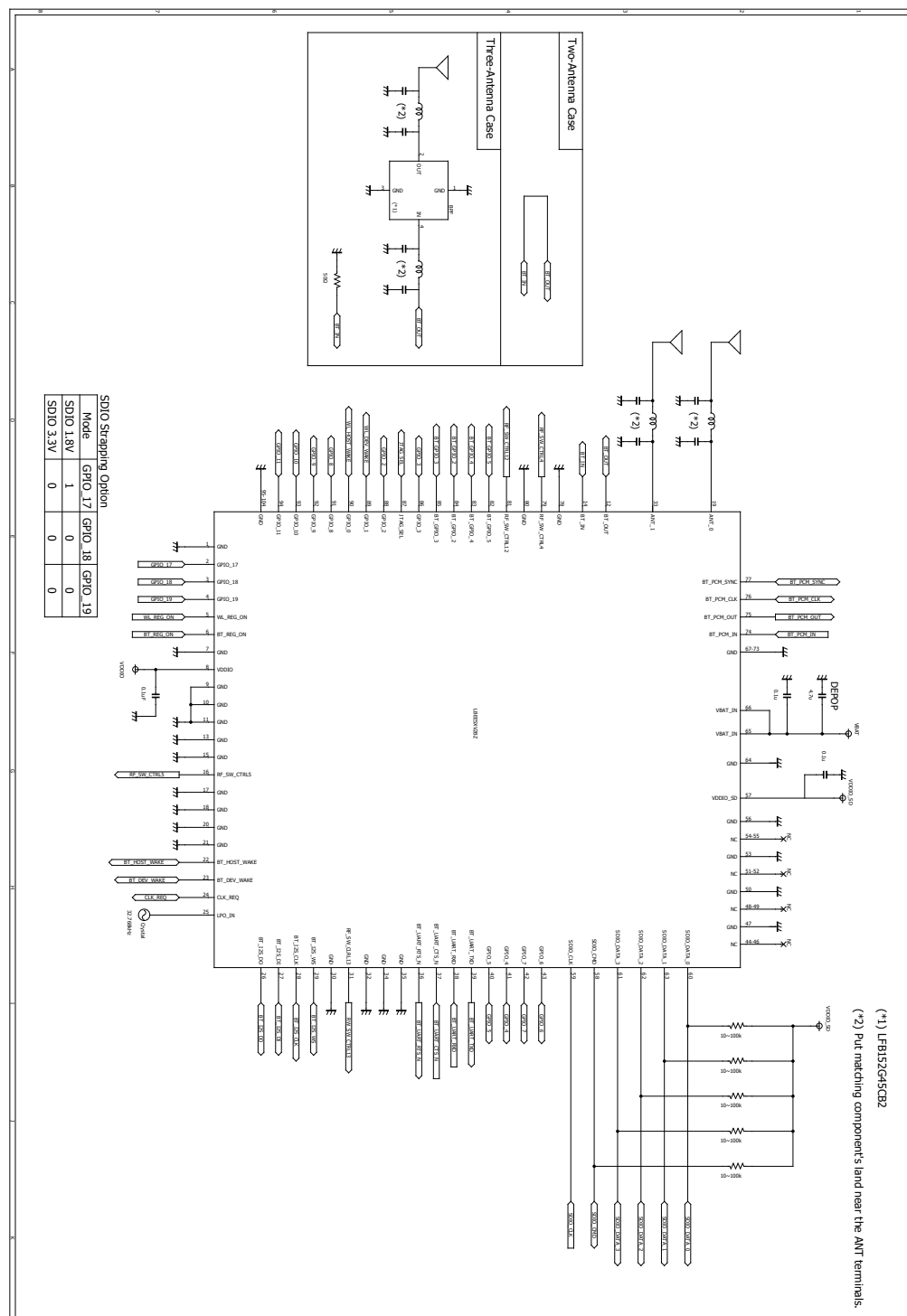
3 Reference Design

This section describes the circuit design and antenna information.

3.1 Reference Circuitry

Figure 2 shows the reference design.

Figure 2: Reference Design



3.2 Requirement for SDIO Signals

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

3.3 Requirements for Unused Signals

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

3.4 Module Footprint Design

Refer to dimensions in the [Type 2BZ Datasheet](#) [☞](#). The [DXF File](#) [☞](#) of module footprint is provided via website.

3.5 Recommended Antenna

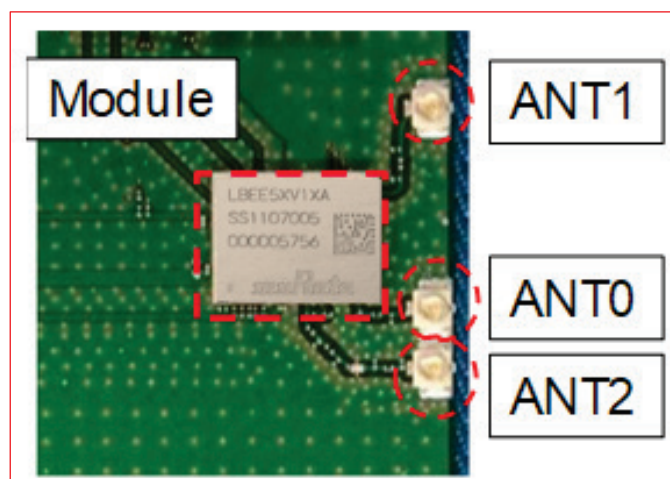
This module is certified with an antenna solution by regulatory certification body. To use Murata's regulatory certification, any user must follow below instructions.

3.5.1 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.
- 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 μ m (Exclude inaccuracy of PCB).
 - Passive component location matching Murata design.
 - Necessary "Keep out" area around U.FL/MHF connector.

Figure 3 shows the module antenna.

Figure 3: Module Antenna



3.5.2 Antenna Design and Configuration

Table 2 shows the list of certified antenna.

Table 2: Certified Antenna List

No.	Type	P/N	Form Factor	Type	Cable Options	Gain (dBi)	
						2.4 GHz	5GHz
1	Molex	146153	U.FL/PCB	dipole	050, 100, 150, 200, 250, and 300	3.2	4.25
2	Molex	146187	U.FL/PCB	dipole	050, 100, 150, 200, 250, and 300	3.4	4.75

Table 3 shows an example of class I permissive change capable antenna.

Table 3: An example of Class I Permissive Change Capable Antenna

P/N	Vendor	Form factor	Type	2.4 GHz Gain	5 GHz Gain	Cable options
WT32D1-KX	Unictron	U.FL/PCB	Di-pole	3.0 dBi	4.0 dBi	119 mm (H2B1WD1A3B0200)

- Please perform the antenna design that followed the specifications of the antenna.
- About the signal line between an antenna and a module
 - It is a 50 Ω line design.
 - Fine tuning of return loss etc. can be performed using a matching network.
 - It is required to check "Class1 change" and "Class2 change" which the authorities define then.
- The concrete contents of a check are the following three points:
 - It is the same type as the antenna type of antenna specifications.
 - An antenna gain is lower than a gain given in antenna specifications.
 - The emission level is not getting worse.

Figure 4, Figure 5, Figure 6, and Figure 7 and shows the overall design of the EVB used for the test and the antennas.

Figure 4: Antenna Test EVB - Overall Design

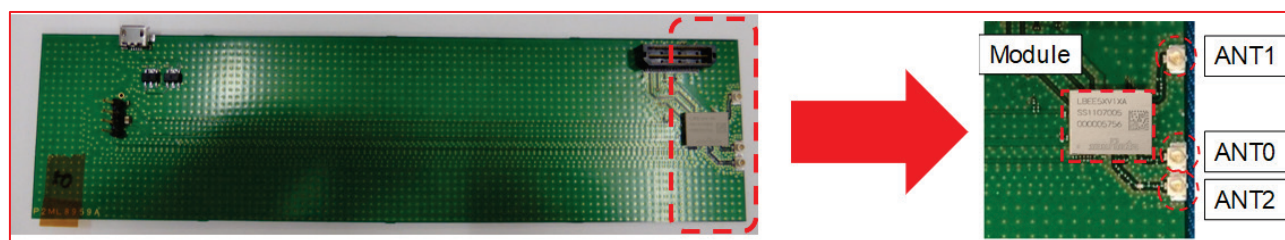


Figure 5: ANT0 Antenna Design

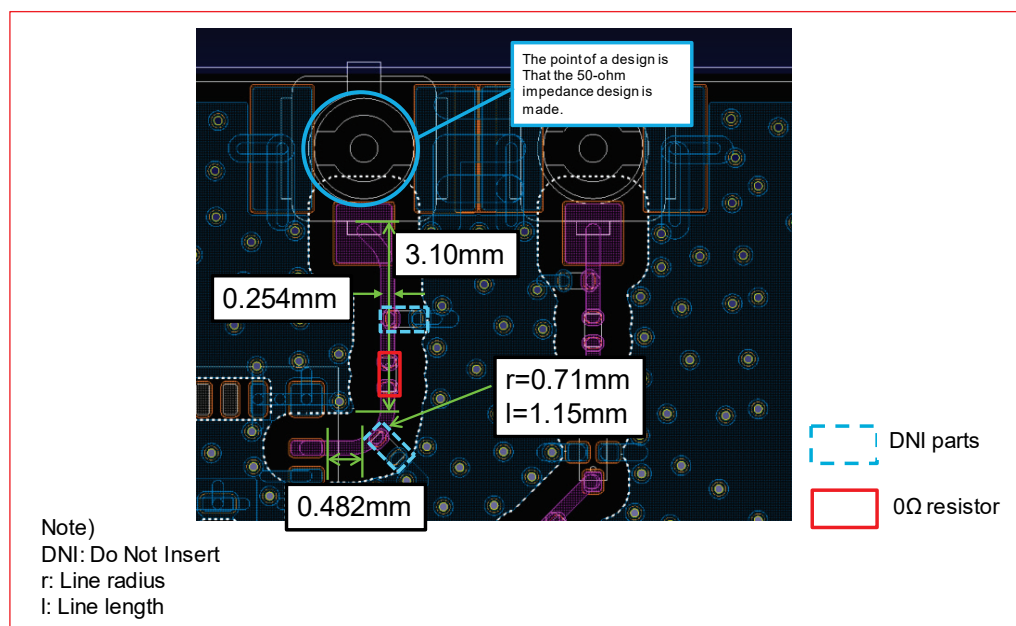


Figure 6: ANT1 Antenna Design

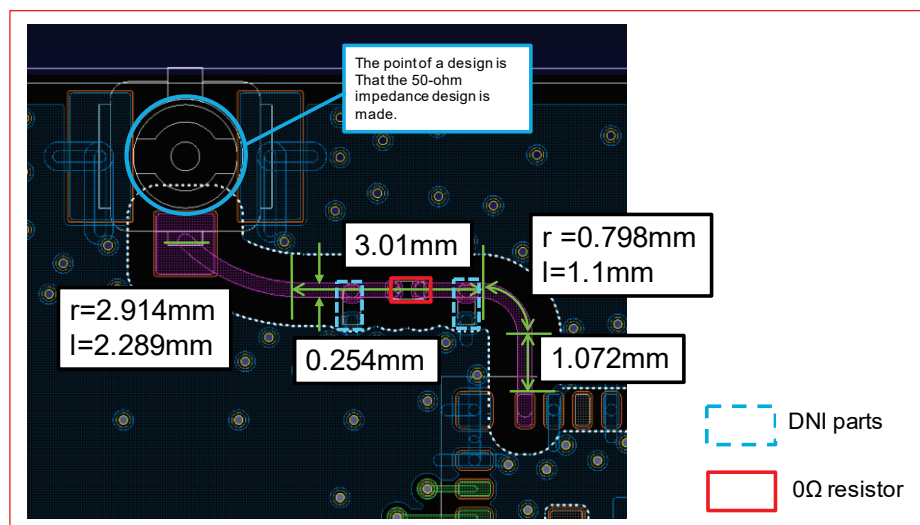
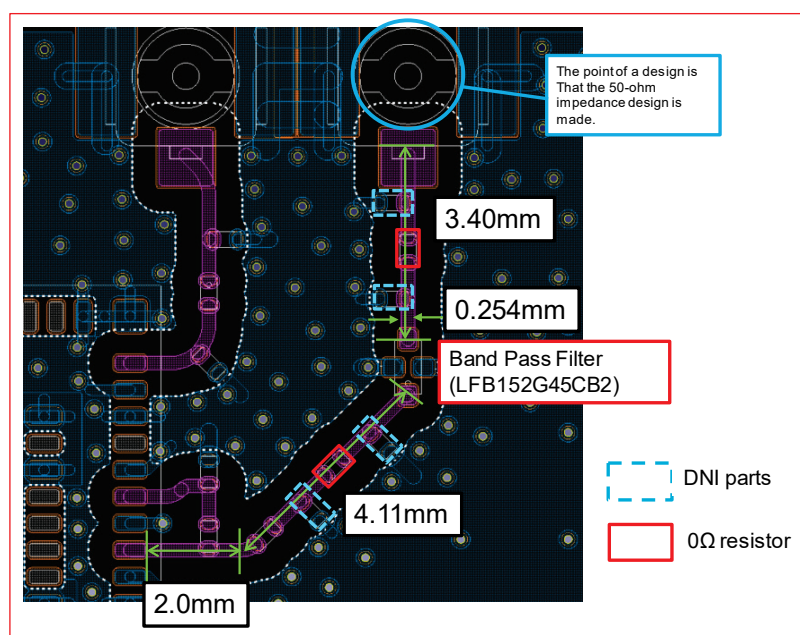


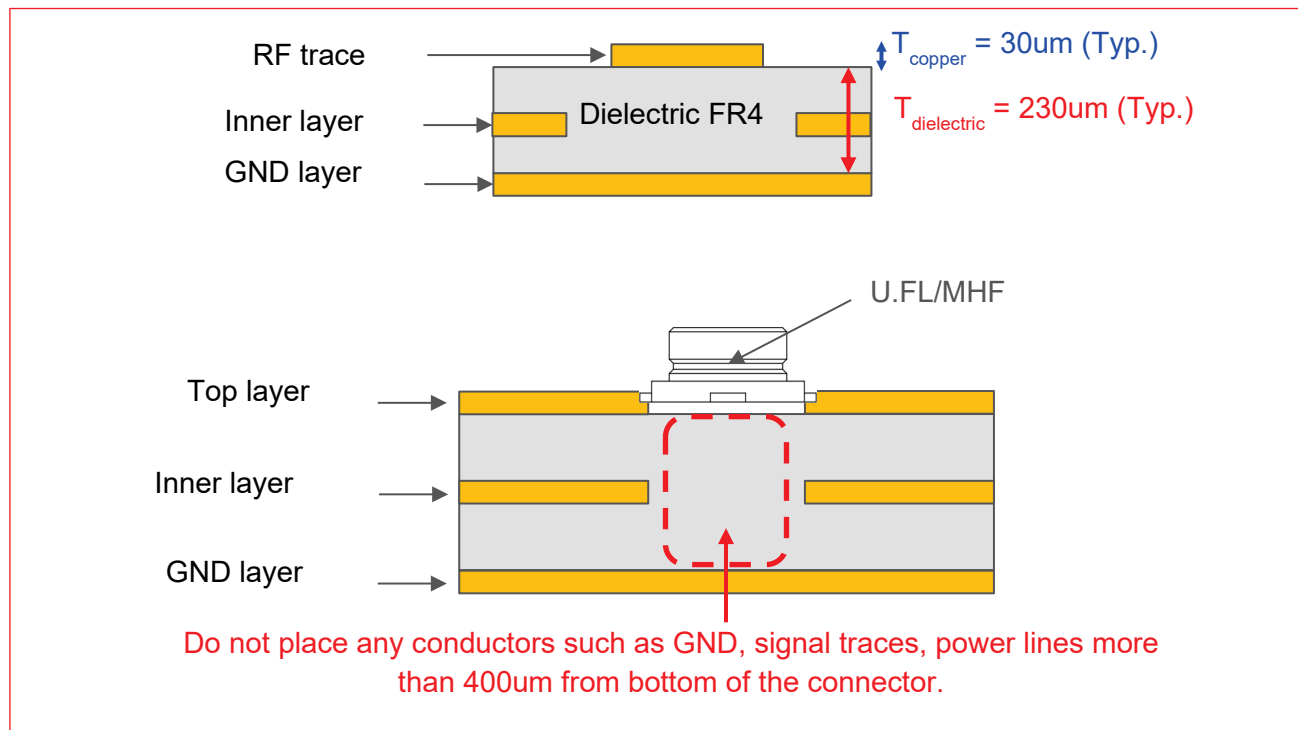
Figure 7: ANT2 Antenna Design



3.5.3 PCB Stack-up

Figure 8 shows the PCB stack-up design.

Figure 8: 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 for both Wi-Fi and Bluetooth via [Murata GitHub](#) . For more regulatory information, refer to section 11 of [Linux User Guide](#) .

4.1 WLAN Configuration Files

The files listed in **Table 4** shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification.

Table 4: WLAN Configuration Files – Linux

Names	Configuration Files
WLAN configuration files 	cyfmac54591-sdio.2ant.2BZ.txt cyfmac54591-sdio.3ant.2BZ.txt
WLAN regulatory configuration 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

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. **Table 5** lists the Bluetooth configuration files.

Table 5: Bluetooth Configuration Files - Linux

Names	Antenna Configuration	Configuration Files
Bluetooth configuration files 	Shared Antenna	BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
	Dedicated Antenna	BCM4359D0_004.001.016.0241.0274.2BZ.dAnt.hcd

5 Reference Performance Data

This section describes the typical Rx minimum sensitivity level for WLAN at 2.4 GHz and 5 GHz and Bluetooth and typical Tx/Rx current consumption at various power levels.

5.1 Typical Rx Minimum Sensitivity Level (at Module Antenna Port)

This section describes the typical Rx minimum sensitivity level at module antenna port for WLAN and Bluetooth.

5.1.1 WLAN

This section describes the WLAN power levels at 2.4 GHz and 5 GHz.

Test Configuration:

- Power supply: VBAT = 3.3V, VDDIO = 1.8V
- Host IF: SDIO
- Nvram file: [cyfmac54591-sdio.2ant.2BZ.txt](#) 

Table 6 shows minimum sensitivity level at 2.4 MHz.

Table 6: Rx Minimum Sensitivity Level - 2.4 MHz

Frequency in MHz	Rx Minimum Sensitivity Level in dBm		
	11b	11g	11n
	11 Mbps	54 Mbps	MCS7
2412	-89	-76	-74
2442	-89	-76	-74
2472	-89	-76	-74

Table 7 shows the minimum sensitivity level at 5 MHz for various WLAN standards.

Table 7: Rx Minimum Sensitivity Level in dBm - 5 MHz

Frequency in MHz	Rx Minimum Sensitivity Level in dBm		
	11a	11n (HT20)	11ac (VHT20)
	54 Mbps	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	

5.1.2 Bluetooth

This section describes the Bluetooth power levels.

Test Configurations:

- Power supply: VBAT = 3.3V, VDDIO = 1.8V
- Host IF: UART
- HCD file: [BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd](#) 

Table 8 shows minimum sensitivity level parameters for Bluetooth.

Table 8: Bluetooth Sensitivity Level Parameters

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

5.2 Typical Tx/Rx Current Consumption

This section describes the typical Tx/Rx current consumption for WLAN and Bluetooth at different power levels.

5.2.1 Typical WLAN Current Consumption

Test Configurations:

- Power supply: VBAT = 3.3V, VDDIO = 1.8V
- Host IF: SDIO
- Nvram file: cyfmac54591-sdio.2ant.2BZ.txt
- Current definition: Shown in **Figure 9**.

Figure 9: WLAN Test Current Configurations

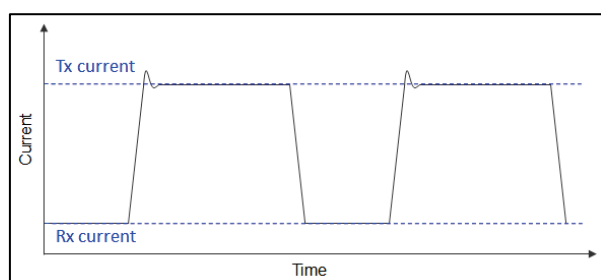


Table 9 describes the typical WLAN current consumption test parameters at 2.4 MHz (SISO).

Table 9: Typical WLAN Current Consumption Test Parameters at 2.4 GHz - SISO

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

Table 10 describes the typical WLAN current consumption test parameters at 5 GHz (SISO).

Table 10: Typical WLAN Current Consumption Test Parameters at 5 GHz - 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

Table 11 describes the typical WLAN current consumption test parameters at 2.4 GHz (MIMO).

Table 11: Typical WLAN Current Consumption Test Parameters at 2.4 GHz - MIMO

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

Table 12 describes the typical WLAN current consumption test parameters at 5 GHz (MIMO).

Table 12: Typical WLAN Current Consumption Test Parameters at 5 GHz - MIMO

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

5.2.2 Bluetooth

Test Configurations:

- Power supply: VBAT = 3.3V, VDDIO = 1.8V
- Host IF: UART
- HCD file: BCM4359D0_004.001.016.0241.0275.2BZ.sAnt.hcd
- Current Definition: The current Bluetooth definition is shown in **Figure 10**.

Figure 10: Bluetooth Test Current Configuration

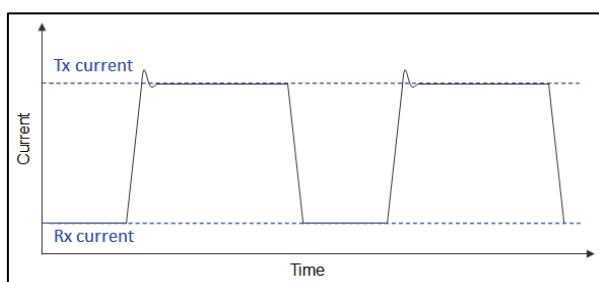


Table 13 describes the parameters for typical Bluetooth current test configuration at 2.4 GHz.

Table 13: Typical Bluetooth Current Test Configuration Parameters

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

5.3 IEEE Power Save Current Consumption

This section describes the IEEE power save current consumption for WLAN and Bluetooth test configurations and parameters.

5.3.1 WLAN

Test Configurations:

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

Table 14 describes the test parameters for IEEE power save current consumption.

Table 14: IEEE Power Save Current Consumption Test Parameters

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

5.3.2 BT Sleep Mode Current Consumption

Test Configurations:

- 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

Table 15 describes the BT sleep mode current consumption test parameters.

Table 15: Bluetooth Sleep Mode Current Consumption Test Parameters

Mode	Current Consumption (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

5.4 Typical Throughput

This section describes the throughput conditions and parameters.

Test Configurations:

- 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

Table 16 describes the test parameters for typical throughput.

Table 16: Typical Throughput Test Parameters

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

6 References

Table 17 reviews all the key reference documents that the user may like to refer to.

Table 17: Reference Table

Support Site	Notes
Murata Type 2BZ Module Datasheet 	Murata Type 2BZ module datasheet (TYPE2BZ.pdf)
Murata Type 2BZ Module Footprint 	Murata Type 2BZ module footprint (type2bz-module-footprint-topview.dxf)
Murata GitHub 	Murata GitHub link
Linux WLAN Configuration Files 	Murata GitHub link for Linux NVRAM file for 2BZ
Linux WLAN Regulatory Configuration Files 	Murata GitHub link for Linux CLM_BLOB file for 2BZ
Linux Bluetooth Configuration Files 	Murata GitHub link for Linux HCD file for 2BZ
Linux User Guide 	Murata Linux User Guide for Infineon modules (Murata Wi-Fi & BT (IFX) Solution for i.MX Linux User Guide.pdf).



In case Murata website does not have the updated document, please refer to the [Connectivity Module](#)  page on the Murata Community Forum. This contains a pinned post with all the updated documents.

7 Technical Support Contacts

Table 18 lists all the support resources available for the Murata Wi-Fi/BT solution.

Table 18: List of Support Resources

Support Site	Notes
Murata Community Forum 	Primary support point for technical queries. This is an open forum for all customers. Registration is required.
Murata i.MX Landing Page 	No login credentials required. Murata documentation covering hardware, software, testing, etc. is provided here.
Murata uSD-M.2 Adapter Landing Page 	Landing page for uSD-M.2 Adapter. In conjunction with Murata i.MX Landing Page, this should provide the user with comprehensive getting started documentation.
Murata Module Landing Page 	No login credentials required. Murata documentation covering all Infineon-based Wi-Fi/BT modules is provided here.

Revision History

Revision	Date	Section	Change Description
1	July 3, 2022		First issue
2	Oct 6, 2023	Converted to new template 3.5.2 Antenna Design and Configuration	Converted to new template Added an example of C1PC antenna list



Copyright © Murata Manufacturing Co., Ltd. All rights reserved. The information and content in this document are provided “as-is” with no warranties of any kind and are for informational purpose only. Data and information have been carefully checked and are believed to be accurate; however, no liability or responsibility for any errors, omissions, or inaccuracies is assumed.

Wi-Fi® is a registered trademark of Wi-Fi Alliance. The Bluetooth® word mark and logos are registered trademarks owned by Bluetooth SIG, Inc. Other brand and product names are trademarks or registered trademarks of their respective owners.

Specifications are subject to change without notice.