Hardware Application Note

Type 2FY Wi-Fi® + Bluetooth® Module

Infineon CYW55513 Chipset for 802.11a/b/g/n/ac/ax + Bluetooth 5.4
Hardware Application Note - Rev. 1.1

- Design Name: 2FY
- P/N: LBEE5HY2FY

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About This Document

Murata's Type 2FY is a small and high-performance module based on IFX's CYW55513 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.4. This application note provides RF and hardware design guidance. For detailed module specification, refer to Type 2FY Datasheet.

Audience & Purpose

Intended audience includes any customer looking to integrate this module into their product. In particular RF, hardware, systems, and software engineers.

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**: Embedded Artists AB 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.
`Console input/output or code snippet`	**Console I/O or Code Snippet** This text ***Style*** denotes console input/output or a code snippet.
`# Console I/O comment` `// Code snippet comment`	**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 2FY Datasheet for detailed Module specification.

2 Module Introduction

This section describes module features.

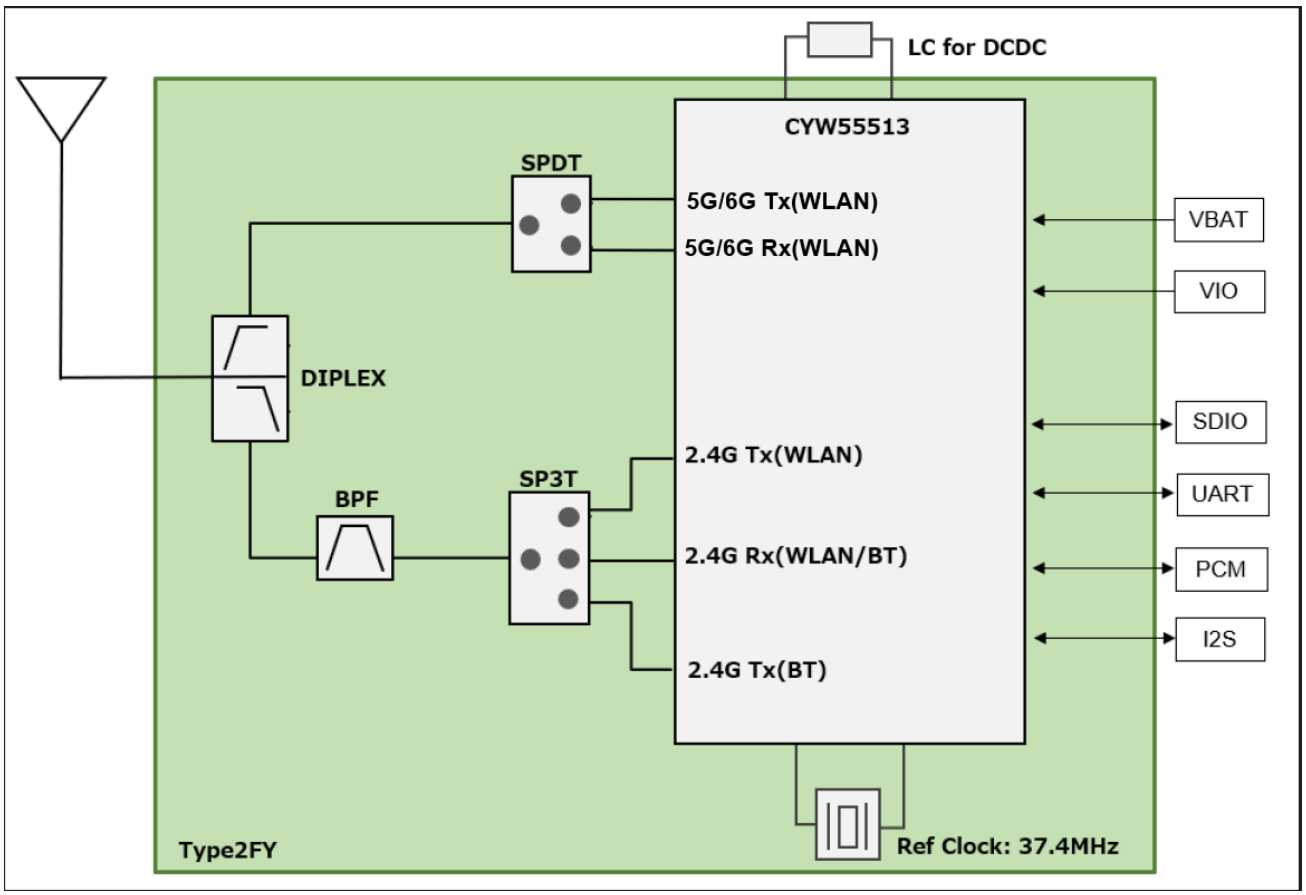
2.1 Features

- Compliant with IEEE802.11a/b/g/n/ac/ax: Tri band 2.4 GHz, 5 GHz and 6 GHz
- Compliant with Bluetooth specification v5.4
- SDIO interface for W-LAN
- Interface support for Bluetooth is Host Controller Interface (HCI)
- Surface mount type 7.9 x 7.3 mm (Typical), H = 1.1 mm (Max)
- Weight: 0.17g
- MSL: 3
- RoHS compliant

2.2 Hardware Block Diagram

The Type 2FY block diagram is shown in **Figure 1**.

Figure 1: Block Diagram of Type 2FY



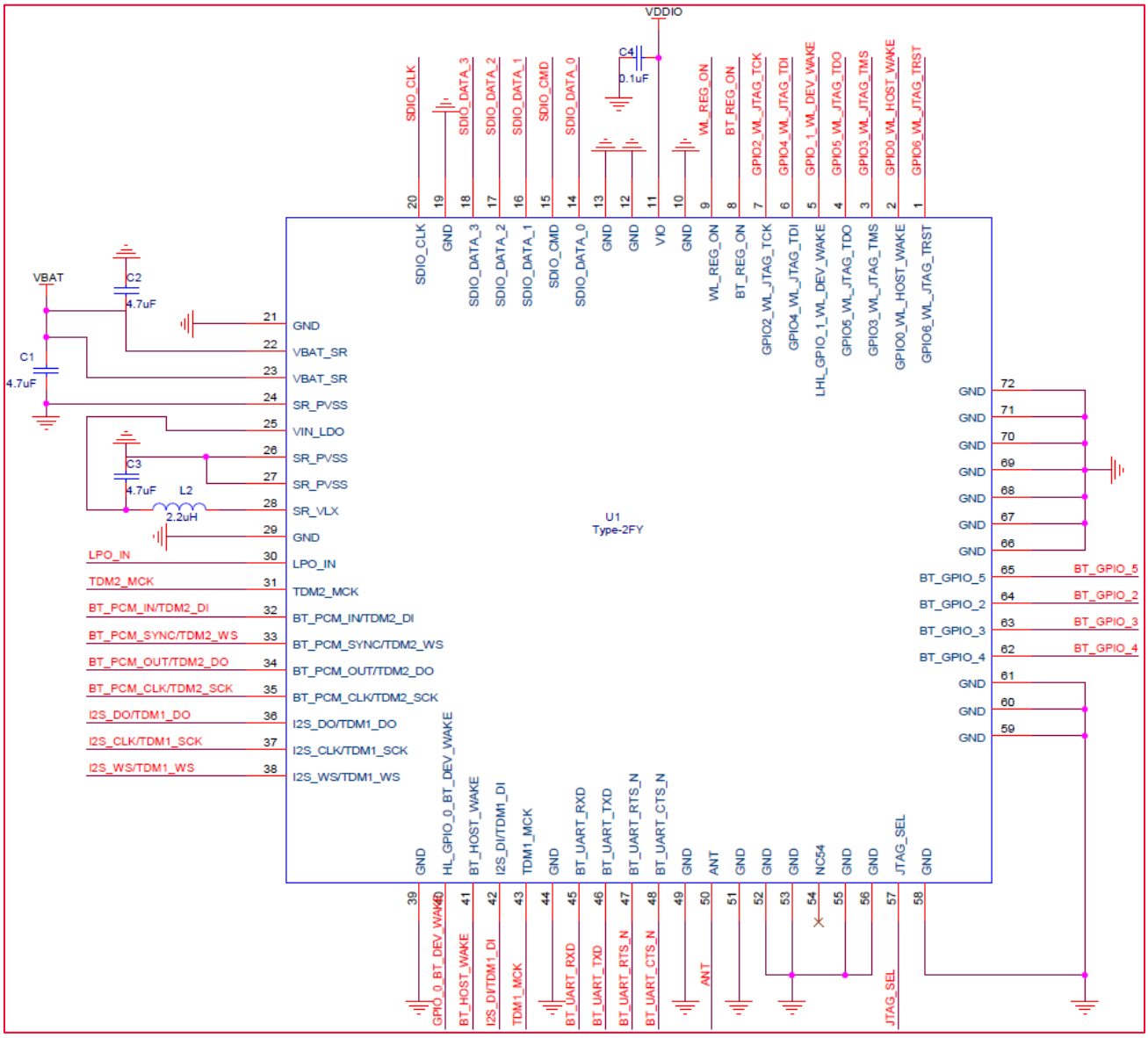
3 Reference Circuitry Design

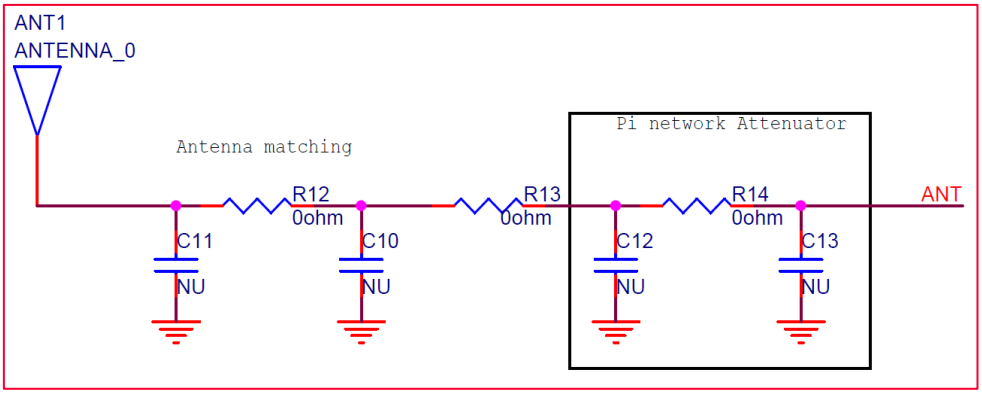
This section describes reference circuit design for Type 2FY module.

3.1 Reference Circuit

The reference circuits of the module are shown in **Figure 2**.

Figure 2: Module Reference Circuit

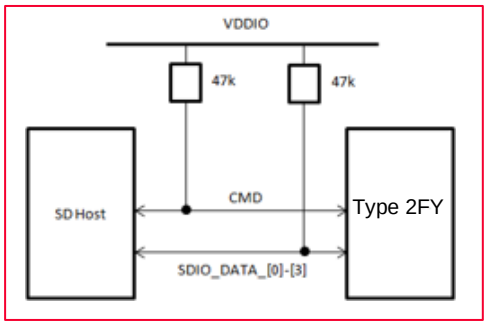




1. 2.2uH Inductor recommended P/N is LQM18PN2R2M
2. VBAT typical value is 3.3V
3. VDDIO typical value is 1.8V
4. LPO_IN must be provided
5. Please arrange SDIO lines with 50ohm and put series-R, shunt-C parts to reject the noise if needed. 10k~100k ohm pull-ups are required on the four DATA lines and the COMD line. This requirement must be met during all operating states by using external pull-ups. This module does not have internal pull-ups on these lines.

10 to 100k ohm pull-ups are required on the four DATA lines and the CMD line. This requirement must be met during all operating states by using external pull-up resisters or properly programming internal SDIO Host pull-ups. The CYW55513 module (LBEE5HY2FY) does not have internal pull-ups on these lines.

Figure 3: SDIO Pullup Requirements



3.2 Requirement for SDIO Signals

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

3.3 Requirements for Unused signals

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

3.4 Module Footprint Design

Refer to dimensions in the Type 2FY Datasheet. The DXF File of module footprint is provided via website.

3.5 Recommended Antenna

This module is certified with two types of antenna solution by the regulatory certification body. To use Murata's regulatory certification, any user must follow the instructions below. The DXF File of the trace antenna is provided via website.

3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector

PCB Type Di-pole Antenna with the Co-axial Connector guidelines are as below:

- Users must use recommended antennas. The approved vendor and its parameters for Di-pole antenna is shown in **Table 2**. However, an antenna of equivalent type that has less antenna gain than antenna gain of recommended antennas for US and EU can be used. However, it must be as per Class I Permissive Change approved by Murata. An example of a Class I Permissive Change capable antenna is shown in **Table 3**.

Table 2: Approved Vendor and its Parameters for Di-Pole Antenna

P/N	Vendor	Form factor	Type	2.4 GHz Gain	5 GHz Gain	6 GHz Gain	Cable options
N/A	Murata	PCB	RF Trace	2.8 dBi	3.4 dBi	2.1 dBi	050,100,150,200,250 and 300

Table 3: An example of Class I Permissive Change capable antenna

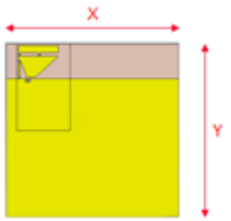
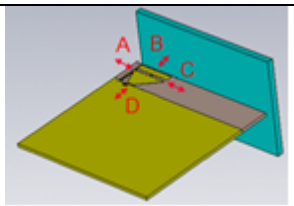
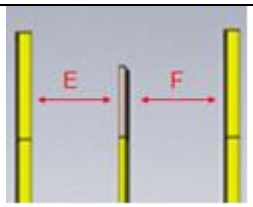
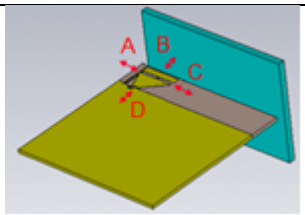
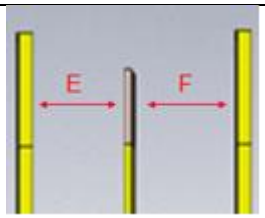
P/N	Vendor	Form factor	Type	2.4 GHz Gain	5 GHz Gain	Cable options
WT32D1-KX	Unictron	U.FL	Di-pole	3.0 dBi	4.0 dBi	119 mm (H2B1WD1A3B0200)

- 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 +/- 0.025 mm.
  - Stack height between GND layer and RF trace of 210 ~ 260 um (include inaccuracy of PCB).
  - Passive component location matching Murata design.
  - Necessary "Keep out" area around u.FL/MHF connector.

3.5.2 Trace Antenna Installation

Keep board size and clearance to Metal/GND and Dielectric around the trace antenna for good antenna performance. The specifications are presented in **Table 4**.

Table 4: Trace Antenna Installing Specification

Board Size			X ≥ 40 mm Y ≥ 40 mm
Clearance to Metal/GND			A ≥ 20 mm B ≥ 20 mm C ≥ 20 mm D ≥ 20 mm E/F ≥ 20 mm
Clearance to Dielectric			A ≥ 4 mm B ≥ 4 mm C ≥ 4 mm D ≥ 4 mm E/F ≥ 4 mm

3.6 Antenna

Please perform the antenna design that followed the specifications of the antenna.

The following provide information 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. However, 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.

Table 5: 50 Ω Line (Microstrip Line Length)

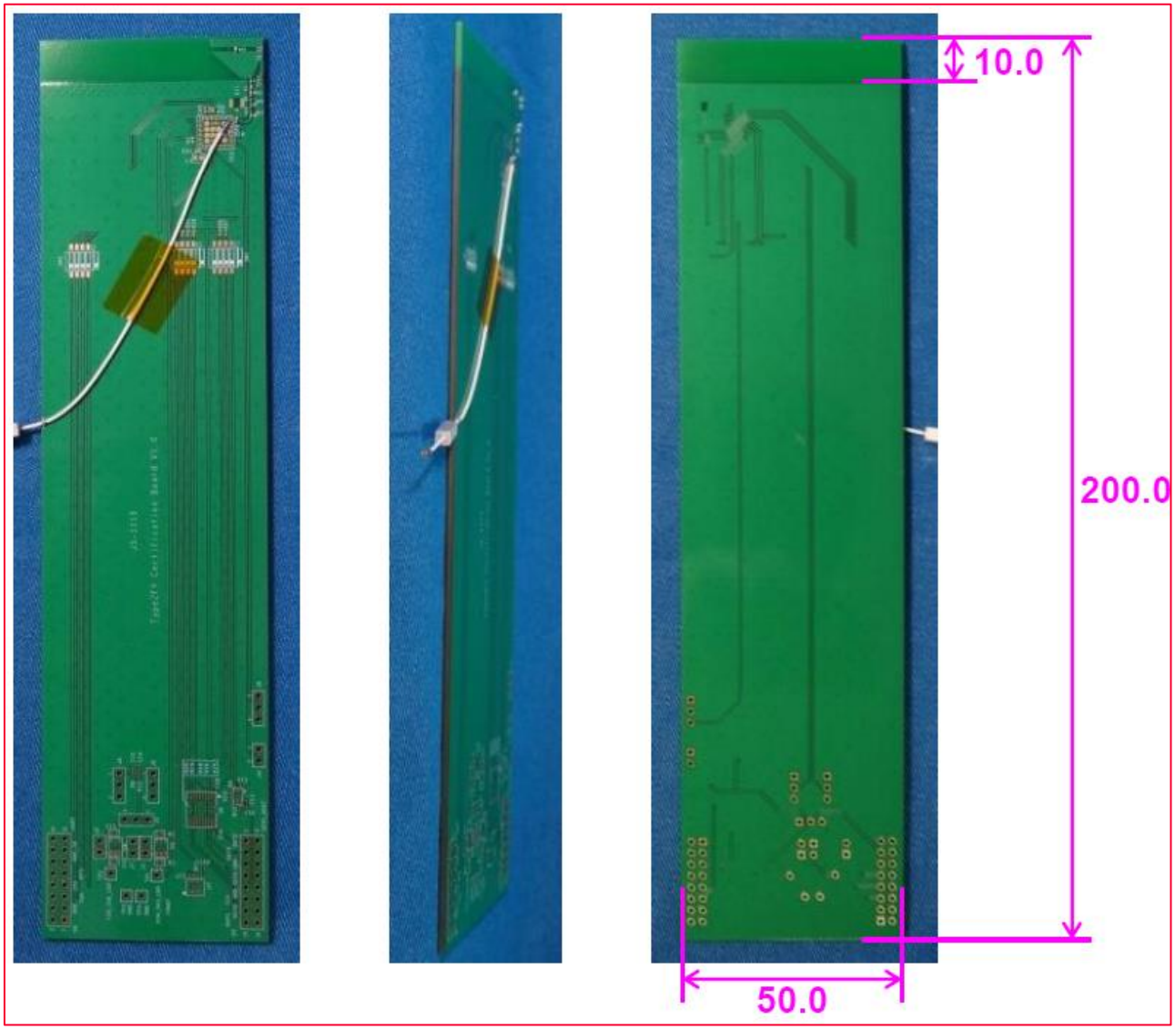
	Antenna
Antenna Type	Monopole PCB antenna/dipole antenna
50 Ω Feed Line Length	Tested at 0 mm as a representative

3.7 Recommended RF Test

3.7.1 RF Test DUT Appearance

Figure 4 shows the Murata reference RF DUT appearance.

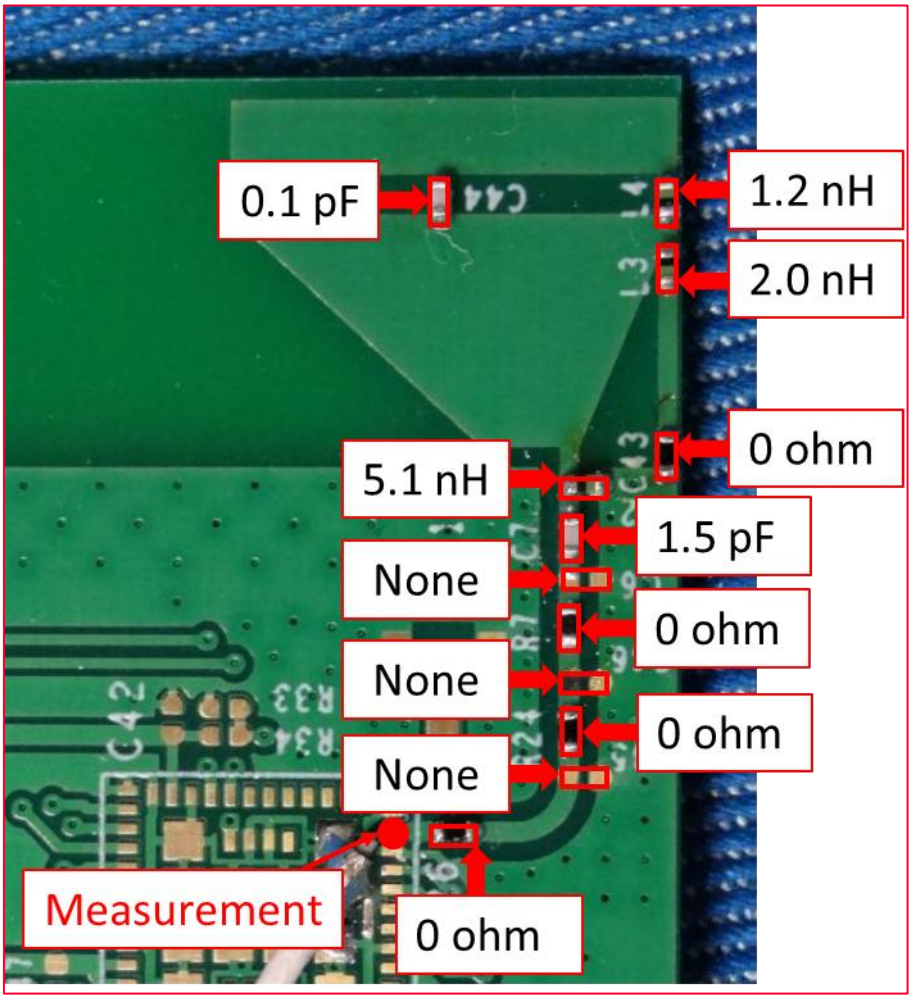
Figure 4: Murata Reference RF DUT Appearance



3.7.2 Measurement Condition

Figure 5 shows the locations of Murata reference passive components.

Figure 5: Measurement Condition and Reference Passive Component Locations



3.7.3 Direction Definition

Figure 6 shows the 3D plane view for the DUT.

Figure 6: 3D Plane View of the DUT

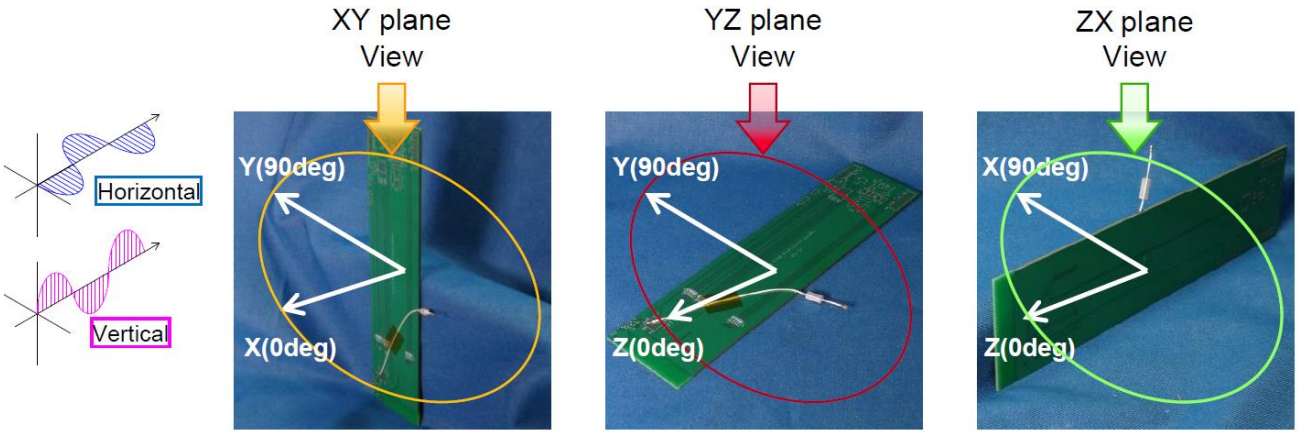
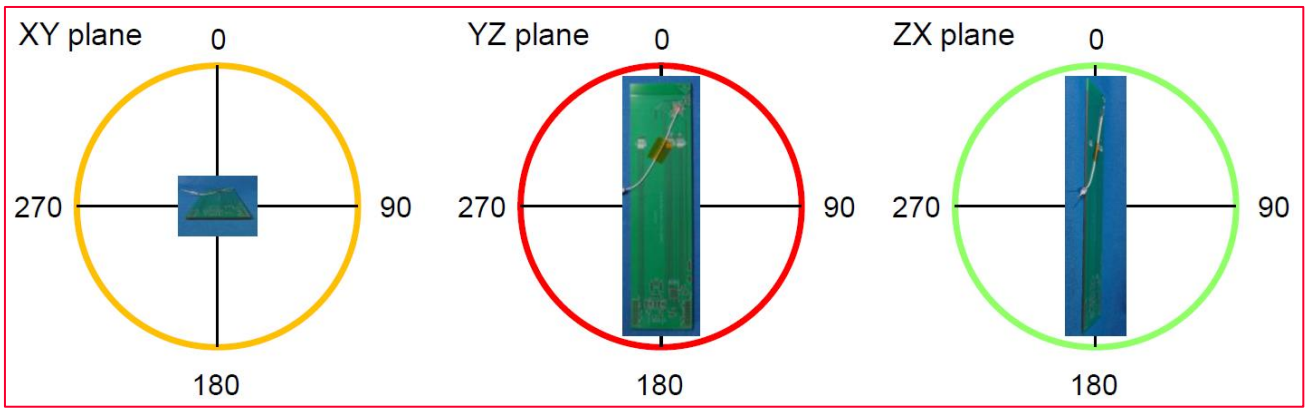


Figure 7 shows the 2D plane view for the DUT.

Figure 7: 2D Plan View of the DUT



3.7.4 RF Performance

Figure 8, **Figure 9**,

Figure 10 and **Figure 11** shows the RF performance for Type 2FY module.

Figure 8: Return Loss

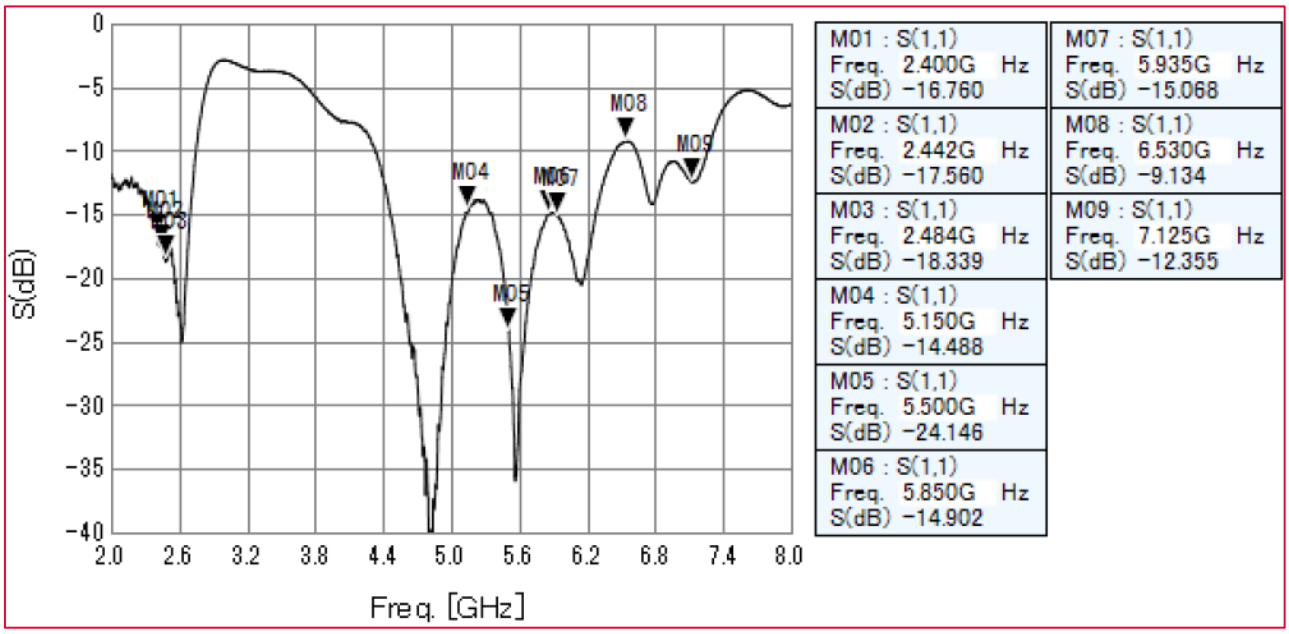


Figure 9: V.S.W.R

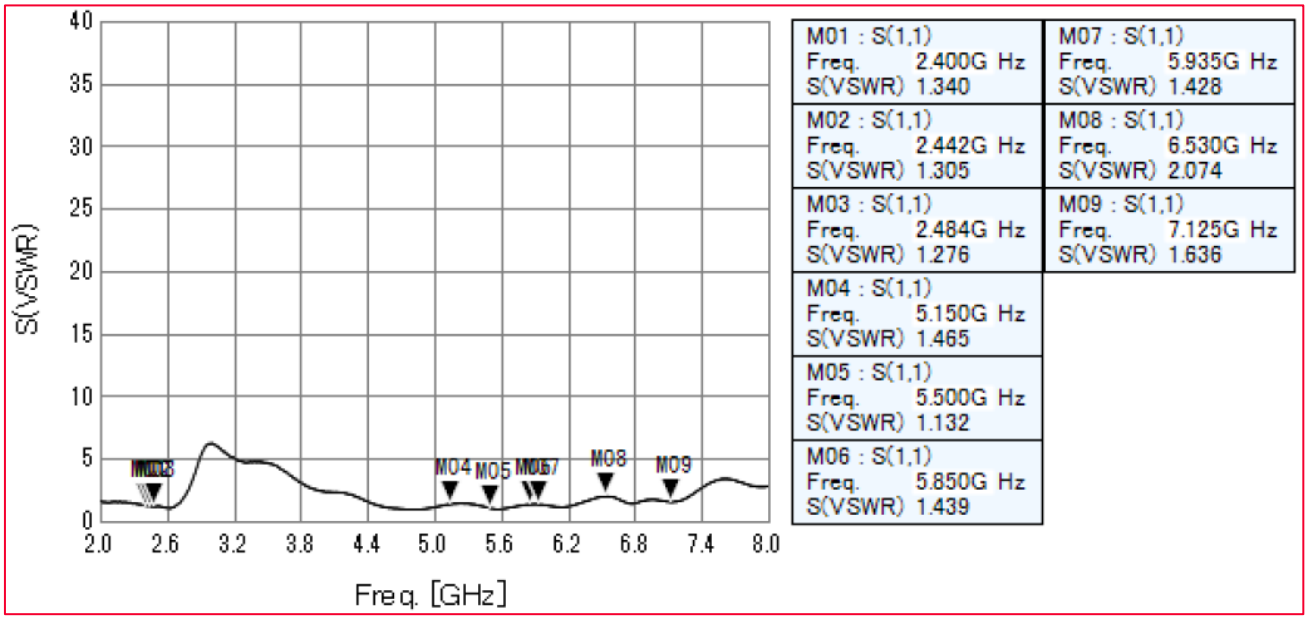
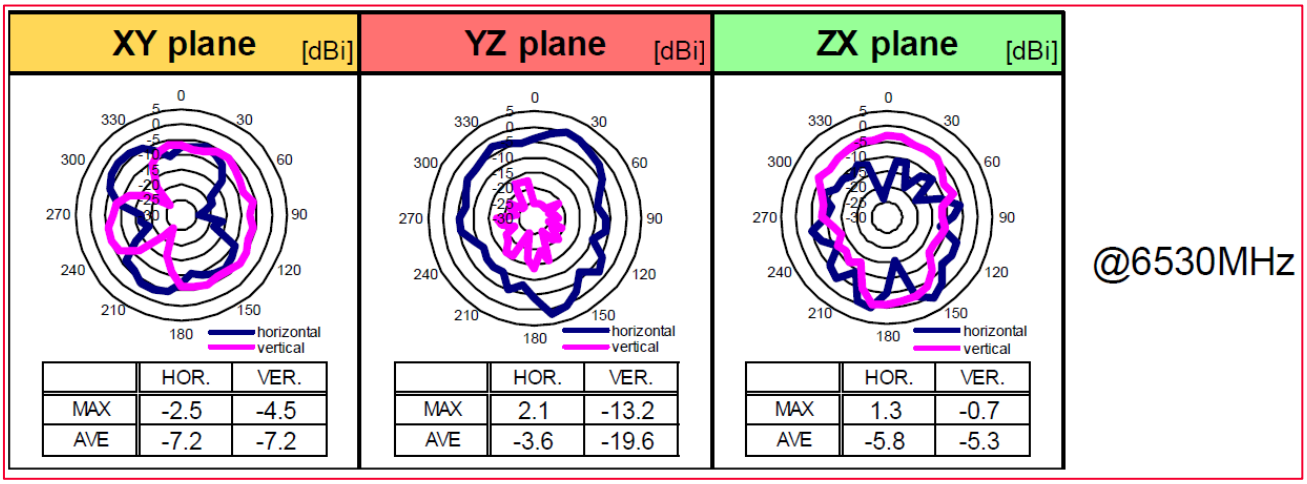


Figure 10: Efficiency

[dBi] [dB]

LINEAR POLARIZATION		XY-plane		YZ-plane		ZX-plane		Total Efficiency
		hor.	ver.	hor.	ver.	hor.	ver.	
5935 MHz	MAX.	0.8	-0.4	0.5	-11.0	1.9	-3.9	
	AVE.	-4.2	-5.1	-2.5	-18.2	-5.0	-6.1	-1.7
6530 MHz	**MAX.**	**-2.5**	**-4.5**	**2.1**	**-13.2**	**1.3**	**-0.7**	
	AVE.	**-7.2**	**-7.2**	**-3.6**	**-19.6**	**-5.8**	**-5.3**	**-1.5**
7125 MHz	MAX.	-2.4	0.7	1.3	-12.1	-2.4	-7.1	
	AVE.	-7.4	-5.6	-4.4	-19.0	-8.8	-12.0	-4.3

Figure 11: Directivity



4 Setup Configuration Files

To enable Murata's regulatory certification, the configuration file shall be loaded initially. The transmit power files are hosted at Murata GitHub for Linux.

4.1 WLAN configuration files for Linux

The files listed in Error! Reference source not found. shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification. For more regulatory information, refer to Section 11 of Linux User Guide.

Table 6: WLAN Configuration Files – Linux

Names	Configuration Files
WLAN configuration file	cyfmac55500-sdio.txt
WLAN regulatory configuration file	cyfmac55500-sdio.clm_blob

4.2 Bluetooth configuration files for Linux

Bluetooth Tx power configuration script file will be loaded after Bluetooth device initialization.

The files listed in **Table 7** shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification.

Table 7: Bluetooth Configuration Script Files – Linux

Names	Country	Configuration Files
Bluetooth configuration files	USA	CYW55500A1_001.002.032.0040.0033_FCC.hcd
	Canada	CYW55500A1_001.002.032.0040.0033_FCC.hcd
	Europe	CYW55500A1_001.002.032.0040.0032_CE.hcd
	Japan	CYW55500A1_001.002.032.0040.0033_FCC.hcd

5 Reference Performance Data

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

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - FW: 28.10.215

Table *8*, Table *9*Error! Reference source not found., Error! Reference source not found.,describes the typical Rx minimum sensitivity level at module antenna port for WLAN at 2.4 GHz, 5 GHz and 6 GHz.

Table 8: Rx Minimum Sensitivity Level - WLAN at 2.4 GHz

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]							
	11b		11g		11n (HT 20)		11ax	
	1 Mbps	11 Mbps	6 Mbps	54 Mbps	MCS0	MCS7	MCS0	MCS11
2412	-98	-89	-93	-76	-93	-76	-93	-63
2442	-98	-89	-93	-76	-93	-76	-93	-63
2472	-98	-89	-93	-76	-93	-76	-93	-63

Table 9: Rx Minimum Sensitivity Level - WLAN at 5 GHz (20 MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]							
	11a		11n (HT 20)		11ac (VHT 20)		11ax (HE20)	
	6 Mbps	54 Mbps	MCS0	MCS7	MCS0	MCS8	MCS0	MCS11
5180	-91	-74	-91	-74	-91	-70	-90	-59
5500	-91	-74	-91	-74	-91	-70	-90	-59
5825	-91	-74	-91	-74	-91	-70	-90	-59

Table 10: Rx Minimum Sensitivity Level - WLAN at 6 GHz (20 MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]			
	11a		11ax (HE20)	
	6 Mbps	24 Mbps	MCS0	MCS11
5955	-91	-83	-90	-59
6475	-91	-83	-90	-59
6695	-91	-83	-90	-59
7115	-90	-82	-89	-58

5.1.2 Bluetooth

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - hcd file: CYW55500A1_001.002.032.0040.MR275026_Generic_UART_37_4MHz_wlbga_iPA_sLNA_ANT0_0715_EDR.hcd

Table describes the typical Rx minimum sensitivity level for Bluetooth.

Table 10: Rx Minimum Sensitivity Level – Bluetooth

Frequency in MHz	Rx Minimum Sensitivity level[dBm]						
	DH5	2DH5	3DH5	LE 1M	LE 2M	LE 500K	LE 125K
2402	-92	-94	-88	-96	-93	-102	-108
2442	-92	-94	-88	-96	-93	-102	-108
2480	-92	-94	-88	-96	-93	-102	-108

5.2 Typical Tx/Rx Current Consumption

This section describes the typical Tx/Rx current consumption for WLAN and Bluetooth.

5.2.1 WLAN

Typical Tx/Rx current consumption for Wi-Fi has certain conditions as described below.

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - FW: 28.10.215
  - Current definition: 1024byte, 20usec interval

Table describes the typical Tx/Rx current consumption for WLAN at 2.4 GHz.

Table 11: Typical Tx/Rx Current Consumption - WLAN at 2.4 GHz

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]	
			Tx	Rx
			VBAT	VBAT
11b	1 Mbps	19	290	40
11g	6 Mbps	17	260	40
11n (HT20)	MCS0	17	260	40
11ax	MCS0	17	260	40

Table describes the typical Tx/Rx current consumption for WLAN at 5 GHz.

Table 12: Typical Tx/Rx Current Consumption - WLAN at 5 GHz

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]	
			Tx	Rx
			VBAT	VBAT
11a	6 Mbps	16	360	50
11n (HT20)	MCS0	16	360	50
11ac (VHT20)	MCS0	16	360	50
11ax (HE20)	MCS0	16	360	50

Table describes the typical Tx/Rx current consumption for WLAN at 6 GHz.

Table 13: Typical Tx/Rx Current Consumption - WLAN at 6 GHz

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]	
			Tx	Rx
			VBAT	VBAT
11a	6 Mbps	16	380	50
11ax (HE20)	MCS0	16	380	50

5.2.2 Bluetooth

Typical Tx/Rx current consumption for Bluetooth has certain conditions as described below.

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - hcd file: CYW55500A1_001.002.032.0040.MR275026_Generic_UART_37_4MHz_wlbga_iPA_sLNA_ANT0_0715_EDR.hcd
  - Current definition: Tx/Rx fully occupied

Table describes the typical Tx/Rx current consumption for Bluetooth.

Table 14 : Typical Tx/Rx Current Consumption - Bluetooth

Mode	Setting Tx Power [dBm]	Current [mA]
		VBAT
BR (1DH5)	9	45
EDR (3DH5)	4	40
LE 1M	9	45

5.3 Typical Sleep Current Consumption

This section describes the typical sleep current consumption for Wi-Fi and Bluetooth.

5.3.1 WLAN

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - WL_REG_ON: ON, BT_REG_ON: OFF
  - Platform: Raspberry PI CM4
  - FW: 28.10.215
  - WLAN I/F: SDIO
  - Beacon Interval = 100 ms

Table 6 describes the typical sleep current consumption for WLAN.

Table 15: Typical Sleep Current Consumption - WLAN

Band	Mode	Current consumption VBAT [uA]
-	Chip deep sleep	TBD
2.4 GHz	IEEE Power Save: DTIM1	1318
	IEEE Power Save: DTIM3	415
	IEEE Power Save: DTIM10	181
5 GHz	IEEE Power Save: DTIM1	597
	IEEE Power Save: DTIM3	281
	IEEE Power Save: DTIM10	155
6GHz	IEEE Power Save: DTIM1	590
	IEEE Power Save: DTIM3	229
	IEEE Power Save: DTIM10	163

5.3.2 Bluetooth

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - WL_REG_ON: OFF, BT_REG_ON: ON
  - Platform: Windows PC/CyBluetool

    Hcd file:
    CYW55500A1_001.002.032.0040.MR275026_Generic_UART_37_4MHz_wlbga_iPA_sLNA_ANT0_0715_EDR.hcd
  - Bluetooth I/F: UART

Table 7 describes the typical sleep current consumption for Bluetooth.

Table 16: Typical Sleep Current Consumption - Bluetooth

Mode	Current consumption VBAT [uA]
Deep Sleep (BT Only)	40
BT Page Scan 1.28 s	198

BT Page & Inquiry Scan 1.28 s	TBD
BT Master Sniff mode 500 ms	TBD
Advertise 1.28 s	91
BLE Scan 1.28 s	TBD
LE Link Master 1 s	99

5.4 Typical Throughput

The typical throughput test configurations are:

- VBAT = 3.3V, VDDIO = 1.8V
- Target: NXP 8MMINILPD4-EVKB
- FW: 28.10.177(2G/5G)/28.10.215(6G)
- Access Point: RT-AX88U (ASUS)
- Distance between Access Point and the Target is around 3 ft.
- 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 18 shows the typical throughput data for the modules.

Table 18: WLAN Typical Throughput Data

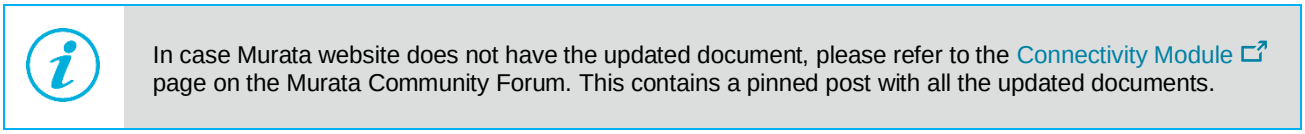
Mode	TCP Throughput in Mbps		UDP Throughput in Mbps	
	Tx	Rx	Tx	Rx
2.4 GHz 11ax HE20	75	98	74	93
5 GHz 11ax HE20	76	103	84	99
6 GHz 11ax HE20	97	106	103	TBD

6 References

Table 19 reviews all the key reference documents that the user may like to refer to.

Table 19: Reference Table

Support Site	Notes
Linux WLAN Configuration	Murata GitHub link for Linux NVRAM file for 2FY
Linux WLAN Regulatory Configuration	Murata GitHub link for Linux CLM_BLOB file for 2FY
Linux Bluetooth Configuration	Murata GitHub link for Linux HCD files for 2FY
Linux User Guide	Murata Linux User Guide for Infineon modules (Murata Wi-Fi & BT (IFX) Solution for i.MX Linux User Guide.pdf).



7 Technical Support Contacts

Table 2020 lists all the support resources available for the Murata Wi-Fi/BT solution.

Table 20: 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	Change	Change Description
1.0	May 15, 2024		First Issue
1.1	November 25, 2024		Performance update and necessary information