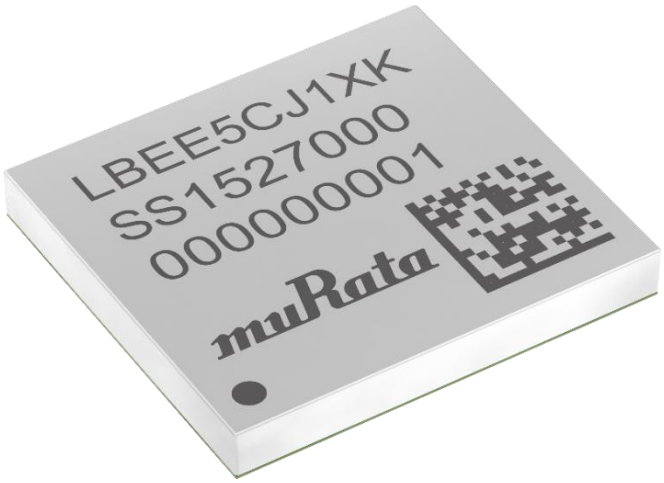
Hardware Application Note

Type 1XK/2XK Wi-Fi™ + Bluetooth® Module

NXP IW416 Chipset for 802.11a/b/g/n + Bluetooth 5.2
Hardware Application Note - Rev. 7.0

- Design Name: Type 1XK / Type 2XK
- P/N: LBEE5CJ1XK-687 / LBEE5CJ2XK-845



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About This Document

Murata's Type 1XK/2XK is a small and high-performance module based on NXP's IW416 combo chipset, supporting IEEE 802.11a/b/g/n + Bluetooth 5.2 BR/EDR/LE. This application note provides RF and hardware design guidance. Refer to Type 1XK/2XK Datasheet for module specification.

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**: 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.
`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 provides detailed information on schematic/layout design, and references RF performance benchmarks. Refer to Type 1XK/2XK Datasheet for module specification.

2 Module Introduction

Type 1XK/2XK is a small and high-performance module based on NXP IW416 combo chipset which supports Wi-Fi 802.11a/b/g/n + Bluetooth 5.2 BR/EDR/LE up to 150 Mbps PHY data rate on Wi-Fi and 3 Mbps PHY data rate on Bluetooth.

The WLAN section supports SDIO 3.0 interface. The Bluetooth section supports high-speed 4-wire UART interface (optional support for SDIO) and PCM for audio data.

The IW416 implements sophisticated enhanced collaborative coexistence hardware mechanisms and algorithms, which ensure that WLAN and Bluetooth collaboration is optimized for maximum performance.

In IEEE 802.11n mode, the WLAN operation supports rates of MCS0 - MCS7 in 20 MHz and 40 MHz channels for data rate up to 150 Mbps.

2.1 Features

- WLAN 802.11a/b/g/n 1x1 SISO + Bluetooth Classic and Low Energy (Version 5.2) combo SMD module with NXP IW416
- Small size LGA package with resin molding and metal shielding.
- Host interfaces: SDIO 3.0 for WLAN; HCI UART, PCM, and I2S for Bluetooth.
- MAC address and BD address are stored in OTP

2.2 Hardware Block Diagrams

This section shows the difference between the Type 1XK and Type 2XK modules. **Figure 1** shows the Type 1XK block diagram. The key difference is shown in **Figure 2**. Type 2XK has a dedicated Bluetooth antenna “ANT_BT”. Type 2XK WLAN has its dedicated antenna “ANT_A”. By comparison, Type 1XK has a single shared WLAN-Bluetooth antenna.

Figure 1: Block Diagram - Type 1XK

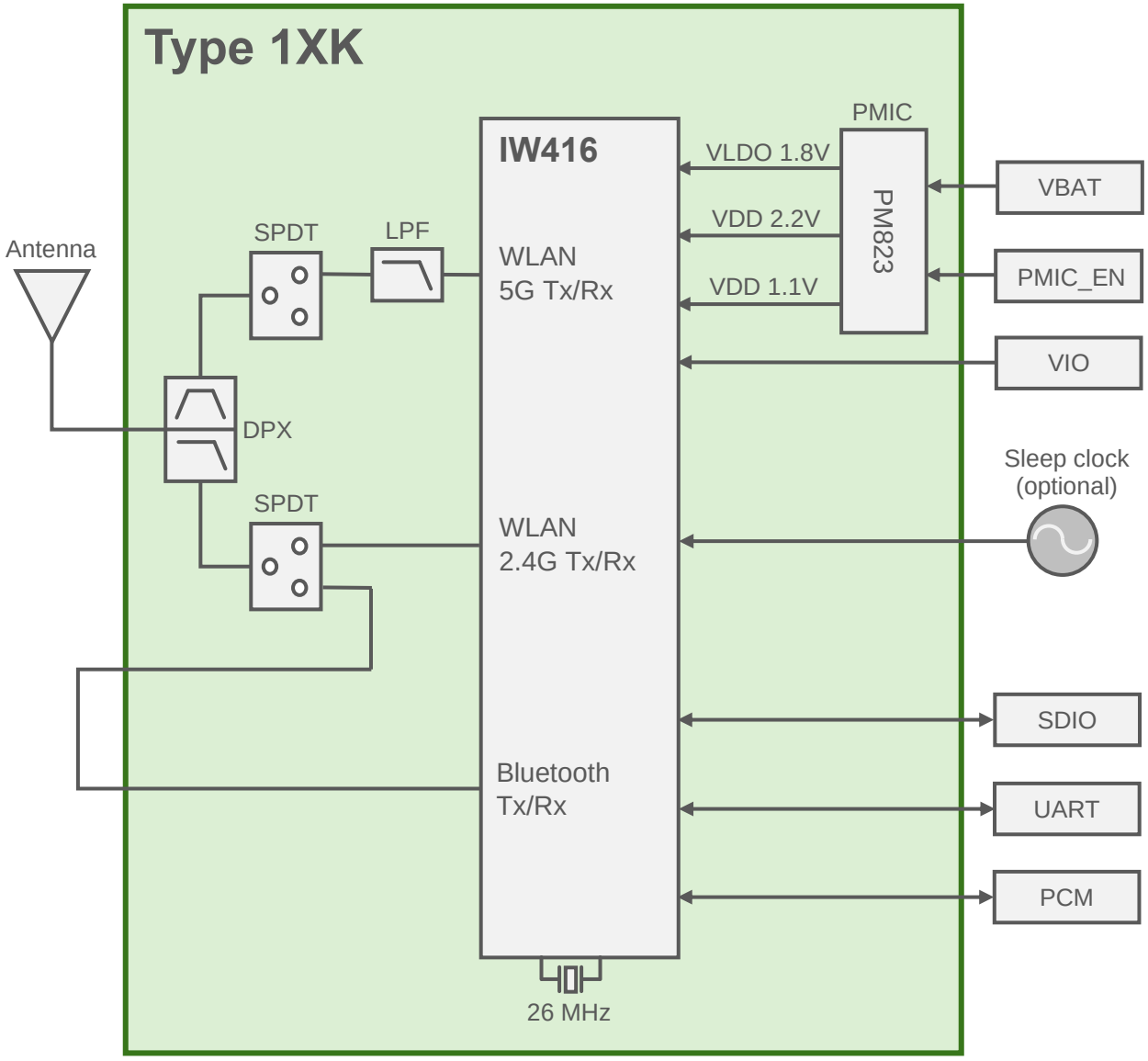
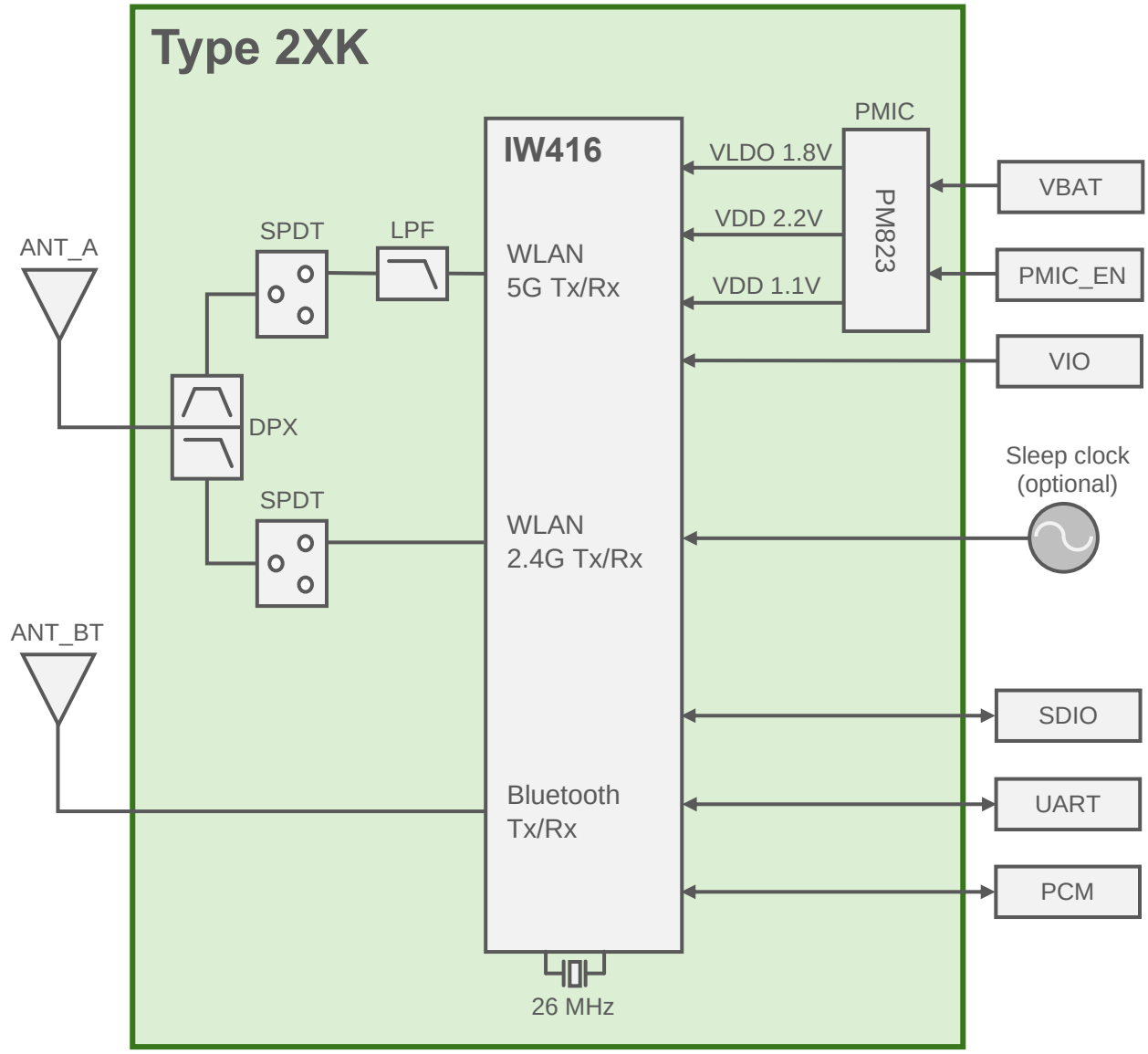


Figure 2: Block Diagram - Type 2XK



3 Reference Design

This section details reference schematics which the end user can leverage for designing their own hardware. Two implementations are shown: one using the PCB trace antenna; the other using u.FL or MHF connectors. Note that in both instances, Type 2XK uses u.FL or MHF connector for independent Bluetooth.

3.1 Reference Circuit

Figure 3 and **Figure 4** show the u.FL/MHF connector for Type 1XK and Type 2XK modules.
Figure 5 and **Figure 6** show the trace antenna for Type 1XK and Type 2XK modules.

Figure 3: u.FL/MHF Connector - Type 1XK

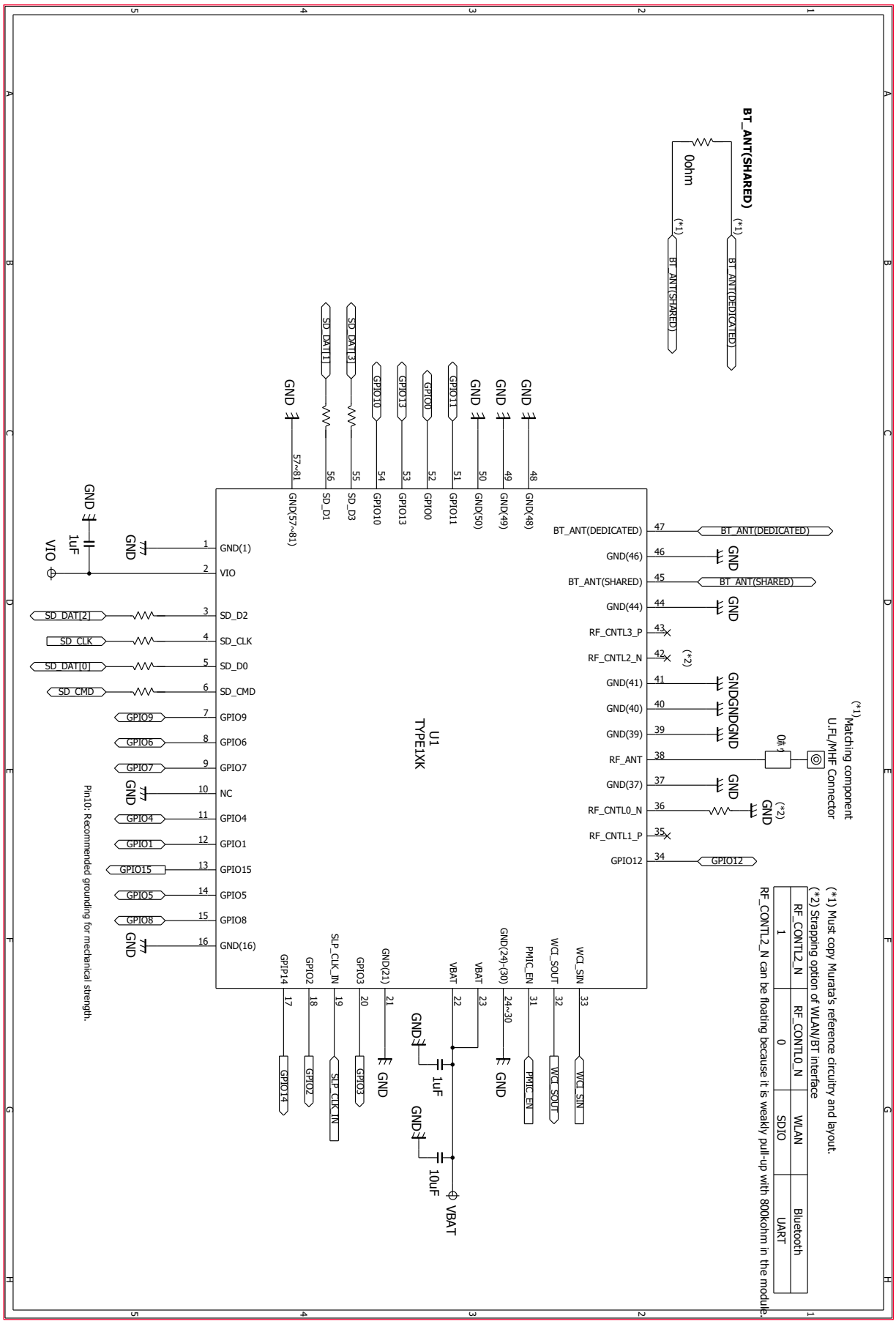


Figure 4: u.FL/MHF Connector - Type 2XK

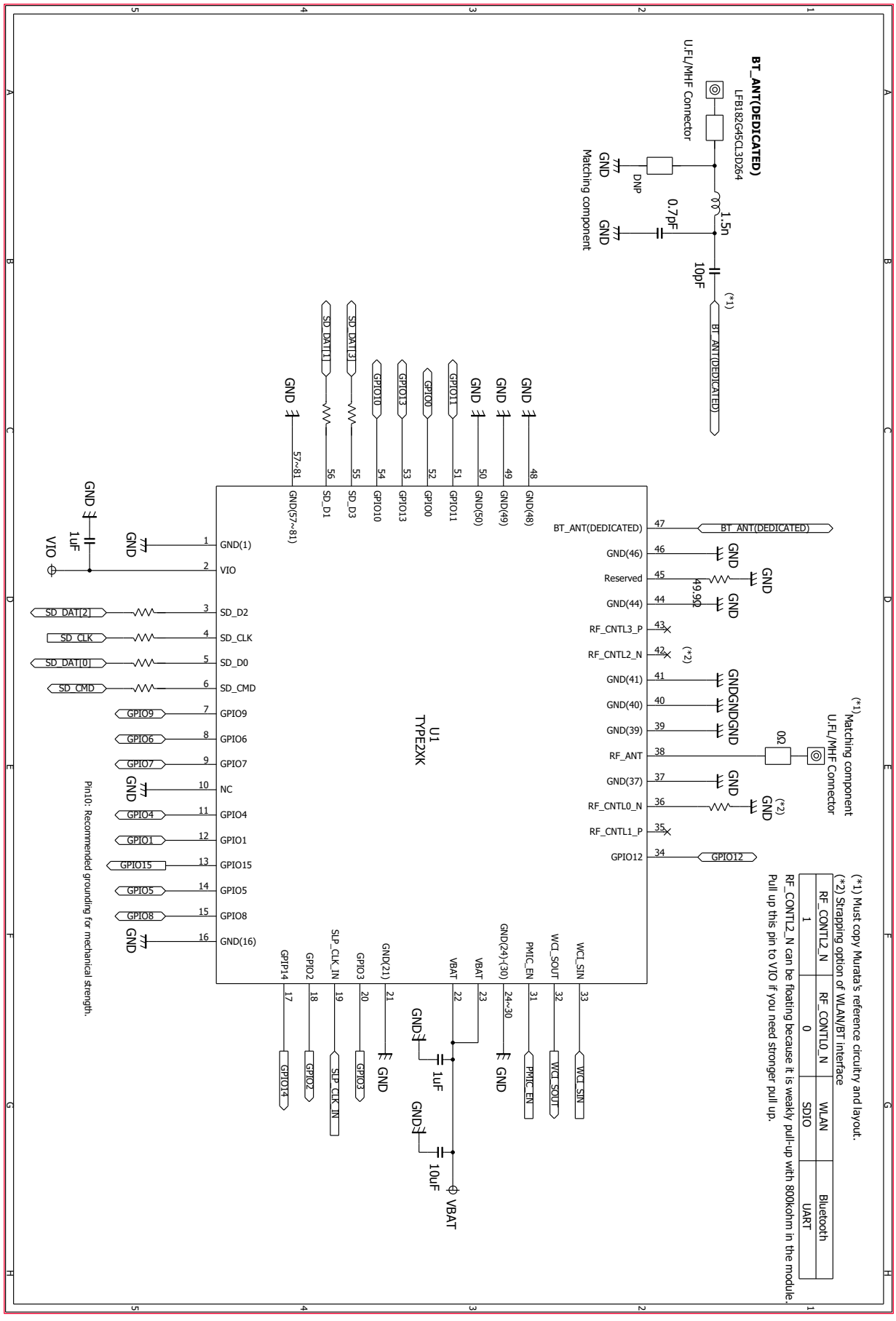


Figure 5: Trace Antenna - Type 1XK

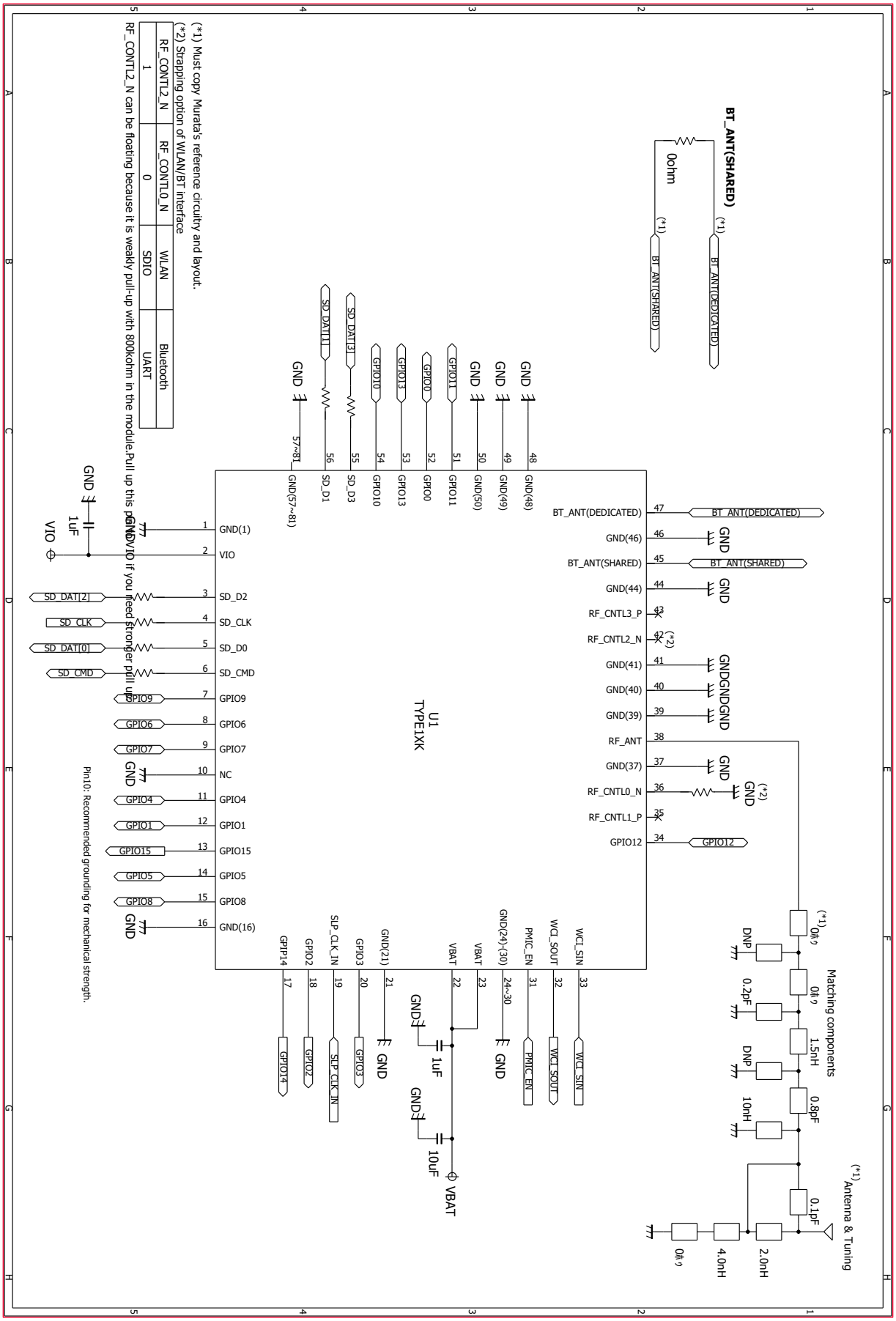
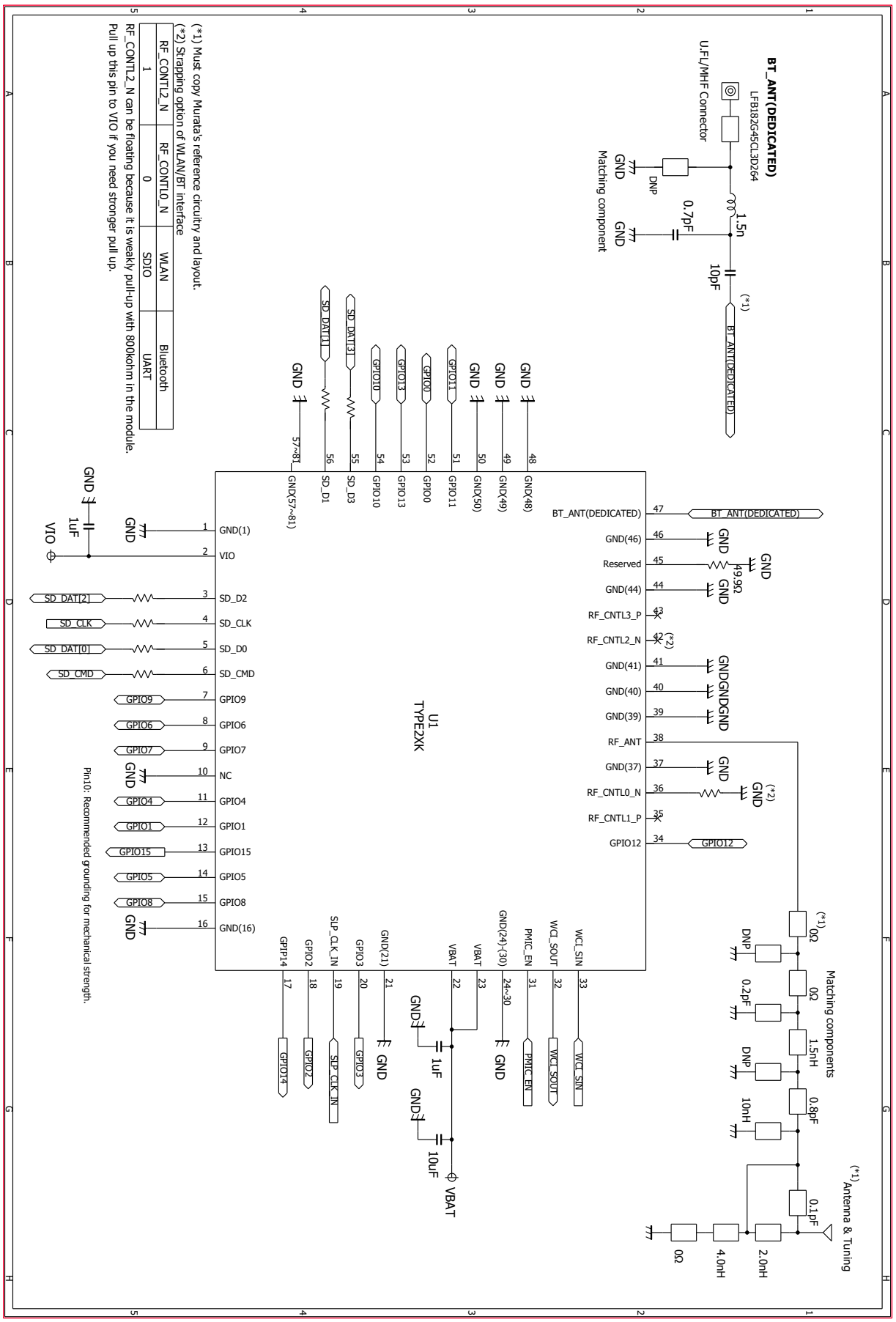


Figure 6: Trace Antenna - Type 2XK



3.2 Requirement for SDIO Signals

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

3.3 Requirements for Unused Signals

If these signals are not used, no pull-up/down is necessary (floating) for GPIO [0...15]

3.4 Module Footprint Design

Refer to dimensions in the Type 1XK 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 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

- 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/CA 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**.
- JP is required to add an antenna in the Certified antenna list if user use an antenna that is not in the certified antenna list in **Table 2** and **Table 4**.

Table 2: Cable Options for Antenna Gains

P/N	Vendor	Form factor	Type	2.4 GHz Gain	5 GHz Gain	Cable Options
146153	Molex	u.FL/PCB	Di-pole	3.2 dBi	4.25 dBi	50 mm or more
146187	Molex	u.FL/PCB	Di-pole	3.0 dBi	4.25 dBi	50 mm or more

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 or more

If using an antenna vendor that is not listed (Antenova, Pulse, Taoglas, TE, etc.) with the Class I Permissive Change, please evaluate the antenna complies with the technical rules of the FCC KDB 178919 Permissive Change Policy.

Table 4: Additional Registered Antennas in Japan Radio Law certification

P/N	Vendor	Form factor	Type	2.4 GHz Gain	5 GHz Gain	Cable Options
206994	Molex	u.FL/PCB	Monopole	3.6	3.6	100 mm or more
219611	Molex	u.FL/PCB	Dipole	2.67	3.67	40 mm or more
WT32D1-KX	Unictron	MHF I/PCB	Dipole	3.0	4.0	119 mm or more
AA258	Unictron	MHF I/PCB	Dipole	0.9	3.8	100 mm or more
TA-38B-A-W01	Unictron	RSMA	Dipole	2.61	3.07	
TA-6B-A-WE01	Unictron	RSMA	Dipole	2.23	4.59	
GW.48.A151	Taoglas	RSMA	Dipole	1.82	3.28	
GW.40.2153	Taoglas	RSMA	Dipole	3.15	4.39	
GW.52.A153	Taoglas	RSMA	Dipole	2.93	4.53	
SRF2W012	Antenova	MHF I/PCB	Dipole	3.0	4.0	100 mm or more
STDANTEMD-013	Sansei	MHF I/PCB	Dipole	1.9	2.8	120 mm
EMF2471A3S	Laird	MHF I/PCB	Dipole	2.4	4.4	100 mm
1001932FT	KAVX	MHF I/PCB	Dipole	2.5	4.4	100 mm or more
1001932PT	KAVX	MHF I/PCB	Dipole	2.03	4.45	100 mm or more
W24P-U	Inventek	u.FL/PCB	Dipole	3.2	-	90 mm

- Users must copy RF trace to u.FL/MHF I connector from the trace layout file provided by Murata in adherence to the guidelines on:
  - Trace width accuracy within +/- 0.25 mm.
  - Stack height between GND layer and RF trace of 230 ~ 240 µm (Exclude inaccuracy of PCB).
  - Passive component location matching Murata design.
  - Necessary “Keep out” area around u.FL/MHF I connector.

Figure 7 and **Figure 8** shows the PCB Type di-pole antenna for Type 1XK and Type 2XK modules.

Figure 7: PCB Type Di-pole Antenna - Type 1XK

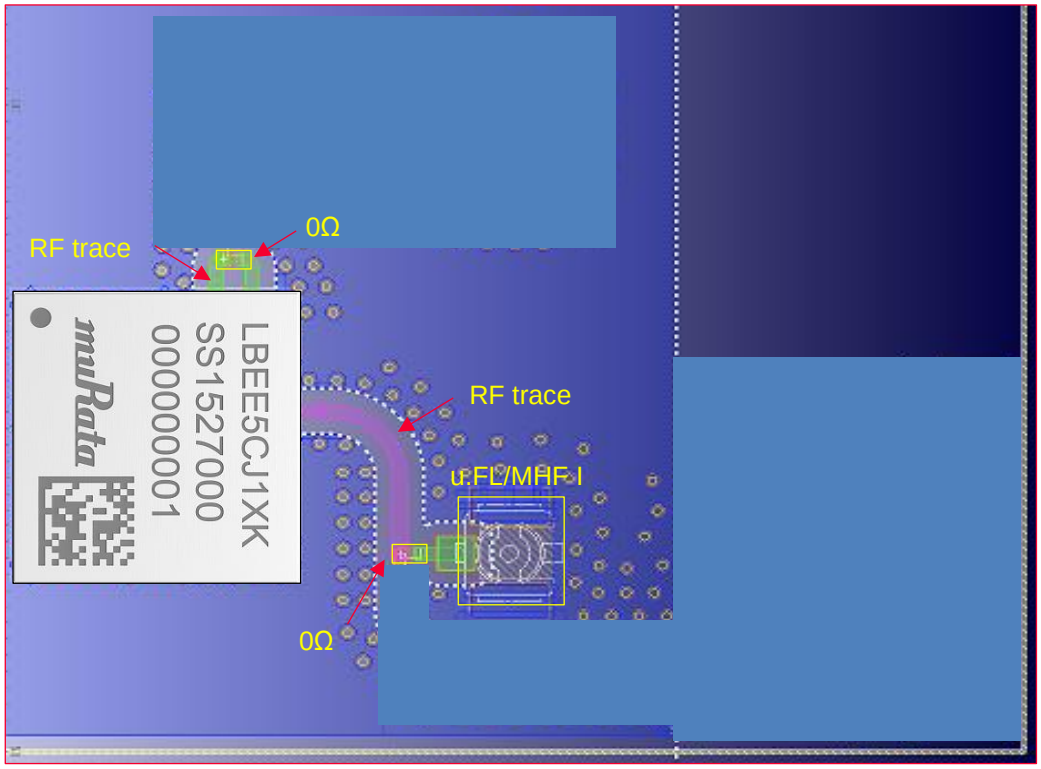
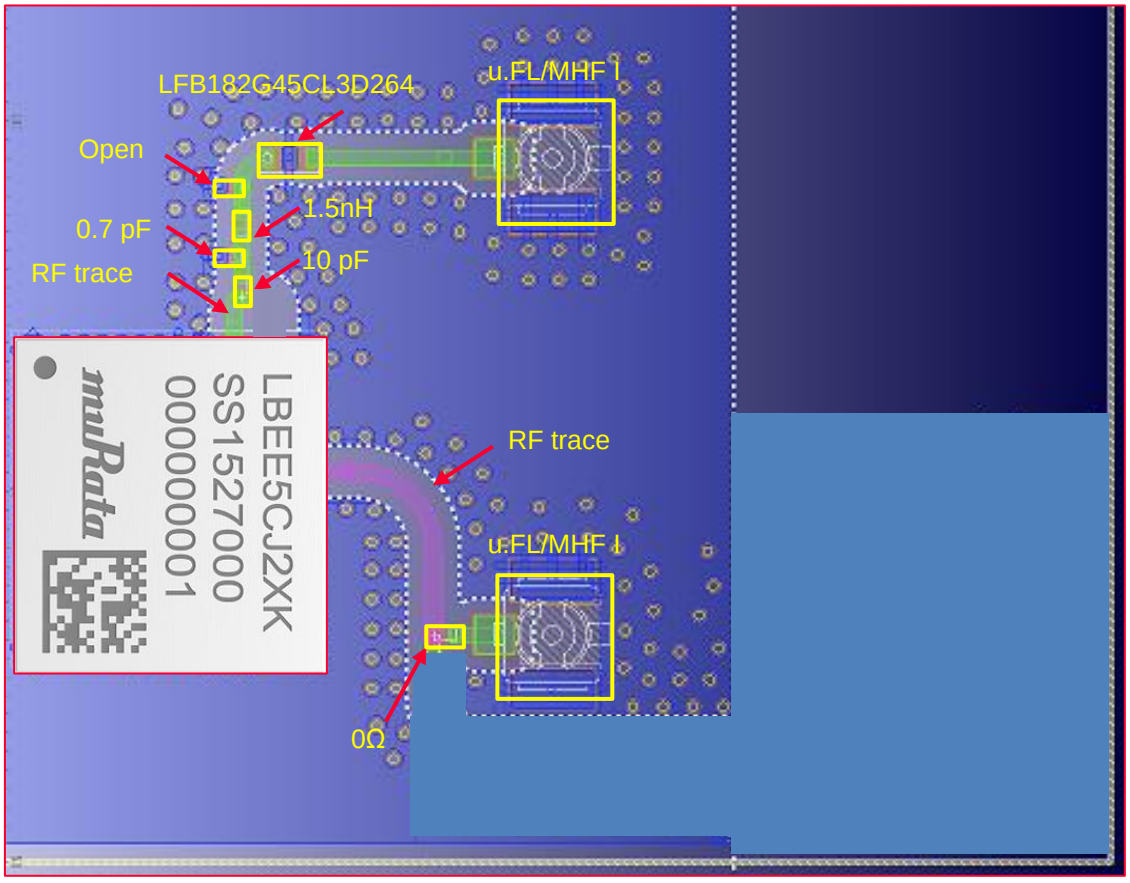


Figure 8: PCB Type Di-pole Antenna - Type 2XK



3.5.2 Trace Antenna

- Users must follow the antenna guidelines listed below:
  - Copy antenna design from the antenna layout file provided by Murata.
  - Copy RF trace to PCB trace antenna from the trace layout file provided by Murata adhering to the guidelines listed below:
    - Trace width accuracy within +/- 0.25 mm.
    - PCB thickness within 0.6 ~ 1.6 mm range (1.0 mm typ.).
    - Stack height between GND layer and RF trace of 235 µm; keeping inaccuracy within +/-0.5 µm.
    - Passive component location matching Murata design.

Table 5 shows the trace antenna gains for Type 1XK and 2XK modules.

Table 5: Trace Antenna Gain

Part number	Vendor	Peak Gain [dBi]		Type	Connector
		2.4GHz	5GHz		
LBEE5CJ1XK-Antenna	Murata	3.6	4.6	Monopole	Trace

Figure 9 and **Figure 10** shows the trace antenna for Type 1XK and Type 2XK modules.

Figure 9: Trace Antenna Guidelines - Type 1XK

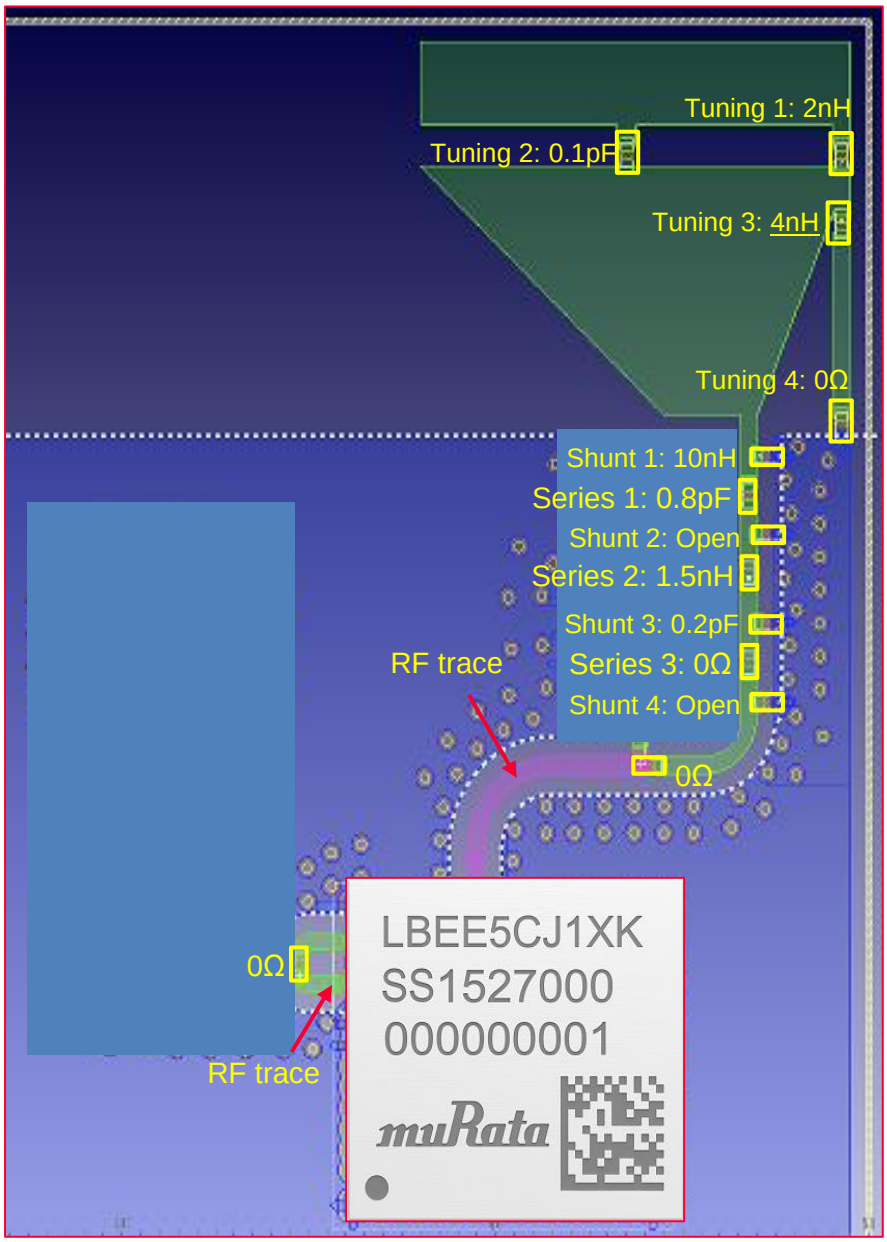


Figure 10: Trace Antenna Guideline - Type 2XK

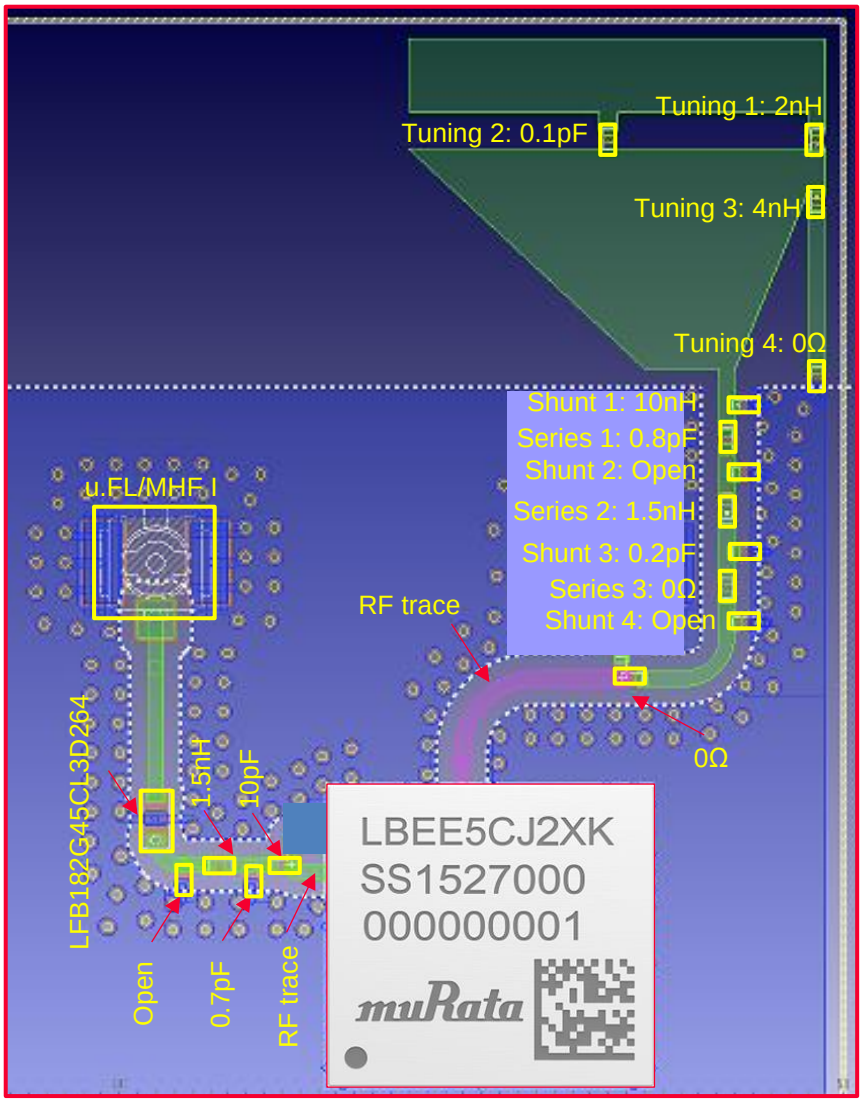


Table 6 shows reference SRF (Self-Resonant Frequency) values used during murata internal evaluations. Since each matching components is utilized for tuning within the specified frequency band, please select SRF values that are higher than the tuning band frequency.

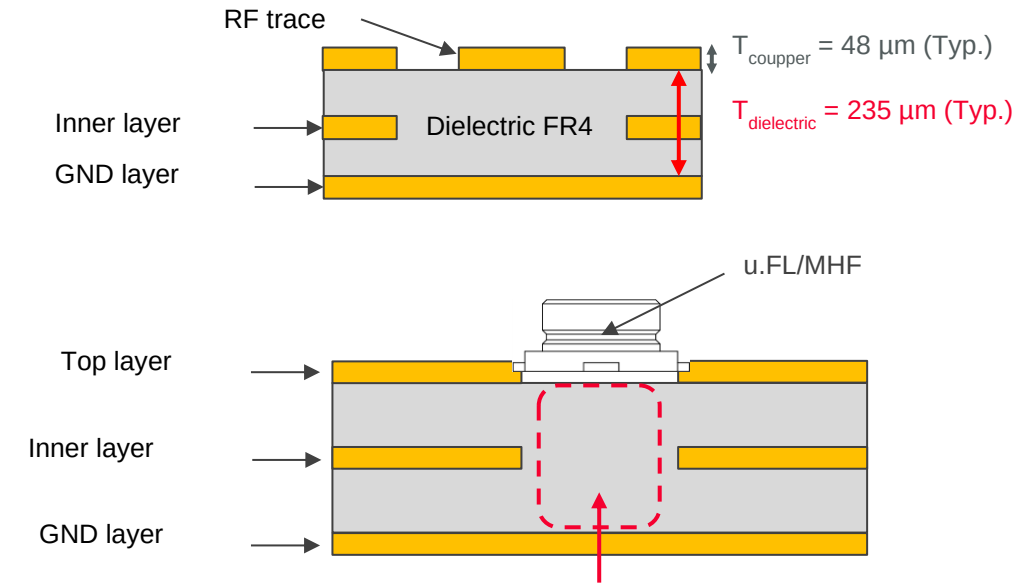
Table 6: Reference parameters of Trace Antenna tuning components

Reference No.	Tuning Band	Component Value	SRF
Tuning 1	2.4 GHz	2.0nH	12500MHz
Tuning 2	5 GHz	0.1pF	–
Tuning 3	2.4 GHz	4.0nH	5300MHz
Tuning 4	2.4 GHz	0ohm	–
Shunt 1	2.4 GHz	10nH	3200MHz
Series 1	2.4 GHz	0.8pF	–
Shunt 2	-	None	–
Series 2	5 GHz	1.5nH	15000MHz
Shunt 3	5 GHz	0.2pF	–
Series 3	2.4 G/5 GHz	0ohm	–
Shunt 4	-	None	–

3.5.3 PCB Stack-Up

Figure 11 shows the PCB stack-up layers.

Figure 11: PCB Stack-Up Layers



3.5.4 Trace Antenna Performance

This section illustrates the trace antenna performance results as shown in **Figure 12**.

Figure 12: Trace Antenna Performance

Gain and Efficiency

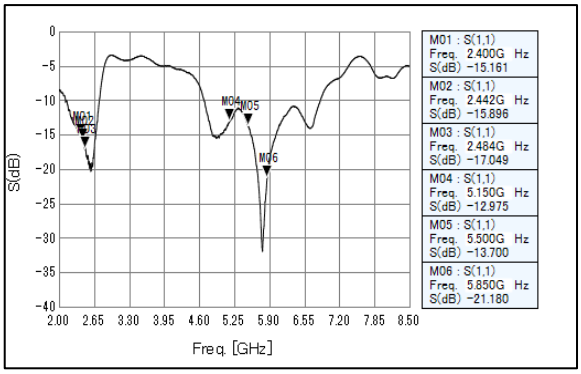
[dBi] [dB]

LINEAR POLARIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
2400 MHz	MAX.	-1.6	-0.9	2.6	-16.3	-2.2	1.0	
	AVE.	-4.9	-4.6	-2.0	-20.4	-8.3	-0.9	-1.0
2442 MHz	**MAX.**	**-1.6**	**-0.8**	**2.4**	**-15.0**	**-2.0**	**1.1**	
	AVE.	**-5.1**	**-4.6**	**-1.9**	**-19.5**	**-8.3**	**-0.7**	**-1.0**
2484 MHz	MAX.	-1.7	-0.7	2.5	-13.6	-1.7	1.6	
	AVE.	-5.2	-4.5	-1.6	-18.7	-8.2	-0.5	-0.9

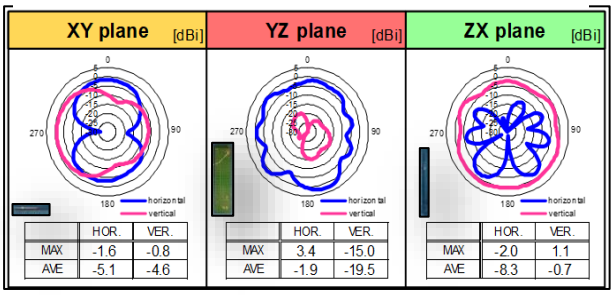
[dBi] [dB]

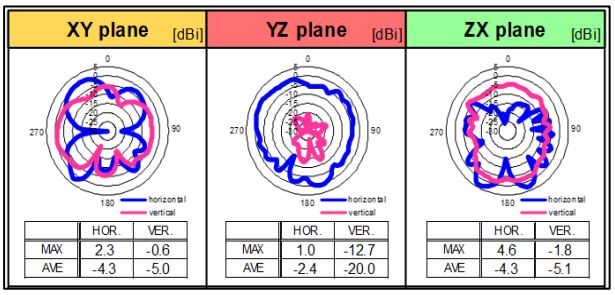
LINEAR POLARIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
5150 MHz	MAX.	2.3	0.1	2.2	-11.4	3.5	-0.2	
	AVE.	-4.1	-4.5	-2.0	-19.2	-3.9	-3.9	-1.3
5500 MHz	**MAX.**	**2.3**	**-0.6**	**1.0**	**-12.7**	**3.6**	**-1.8**	
	AVE.	**-4.3**	**-5.0**	**-2.4**	**-20.0**	**-4.3**	**-5.1**	**-1.6**
5850 MHz	MAX.	2.3	-0.7	1.0	-12.9	3.5	-1.6	
	AVE.	-4.1	-5.4	-2.4	-19.8	-4.2	-5.5	-1.5

Return Loss



Directivity

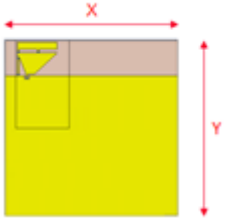


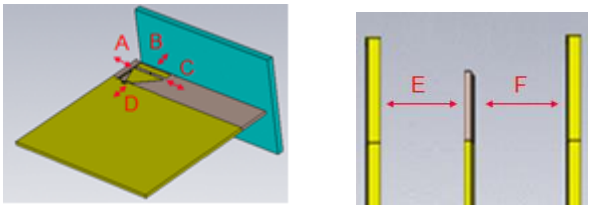
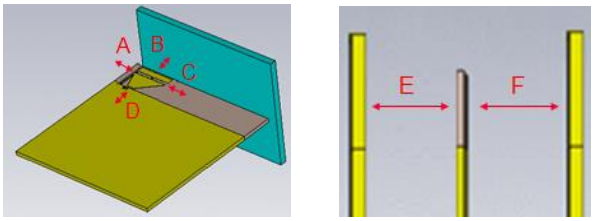


3.5.5 Trace Antenna Installation

Keep board size and clearance to Metal/GND and dielectric around the trace antenna for good antenna performance. **Table 7** lists the antenna installation details.

Table 7: Trace Antenna Installation

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

4 Setup Configuration Files

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

4.1 WLAN Configuration Files for Linux

The files listed in **Table 8** 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 8: WLAN Configuration Files - Linux

Names	Country	Country Code	Configuration Files
WLAN Tx power configuration files	USA	US	txpower_US.bin
	Canada	CA	txpower_CA.bin
	Europe	DE	txpower_EU.bin
	Japan	JP	txpower_JP.bin
WLAN Carrier Sense / Adaptivity threshold configuration file			ed_mac.bin
WLAN regulatory limitation configuration file			db.txt

NXP IC based module shall use CRDA mechanism which is provided by Linux-wireless. Compile the new regulatory.bin file from "db.txt" which is provided by Murata as explained in wireless-regdb.

4.2 Bluetooth Configuration files for Linux

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

- Bluetooth Tx power configuration files
  - bt_power_config_1.sh
    - Command examples are as below:

```
# sh bt_power_config_1.sh
```

    - Content of shell script file “bt_power_config_1.sh”

```
hcitool -i hci0 cmd 0x3f 0x00ee 0x01
```

Bluetooth Tx power is configured by using hcitool.

4.3 Configuration Files for FreeRTOS

Please ask Murata at Murata Community Forum.

5 Reference Performance Data

This section describes the 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, VIO = 1.8V
  - Combo FW: 16.80.210.p231

Table 9 and **Table 10** describe the typical Rx minimum sensitivity level at module antenna port for WLAN at 2.4 GHz and 5 GHz.

Table 9: Rx Minimum Sensitivity Level - WLAN at 2.4 GHz

Frequency in MHz	Rx Minimum Sensitivity level[dBm]					
	11b		11g		11n	
	1 Mbps	11 Mbps	6 Mbps	54 Mbps	MCS0	MCS7
2412	-98	-89	-90	-75	-90	-72
2442	-98	-89	-90	-75	-90	-72
2472	-98	-89	-90	-75	-90	-72

Table 10: Rx Minimum Sensitivity Level - WLAN at 5 GHz

Frequency in MHz	Rx Minimum Sensitivity level[dBm]			
	11a		11n (HT20)	
	6 Mbps	54 Mbps	MCS0	MCS7
5180	-88	-73	-87	-70
5500	-88	-73	-87	-70
5825	-87	-72	-86	-70
Frequency in MHz	**Rx Minimum Sensitivity level[dBm]**			
	11n (VHT40)			
	MCS0		**MCS7**	
5190	-84		-70	
5510	-84		-70	
5795	-83		-69	

5.1.2 Bluetooth

- Conditions
  - VBAT = 3.3V, VDDIO = 1.8V
  - Combo FW: 16.80.210.p231

Table 11 describes the typical Rx minimum sensitivity level for Bluetooth.

Table 11: Rx Minimum Sensitivity Level - Bluetooth

Frequency in MHz	Rx Minimum Sensitivity level[dBm]						
	DH5	2DH5	3DH5	LE 1M	LE 2M	125K	500K
2412	**-93**	**-93**	**-87**	**-101**	**-99**	**-106**	**-104**
2442	-94	-94	-77	-101	-99	-106	-104
2472	-93	-92	-87	-101	-98	-106	-104

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, VIO = 1.8V
  - Combo FW: 16.80.210.p231
  - Current definition

Figure 13: Typical Tx/Rx Current Consumption - Wi-Fi

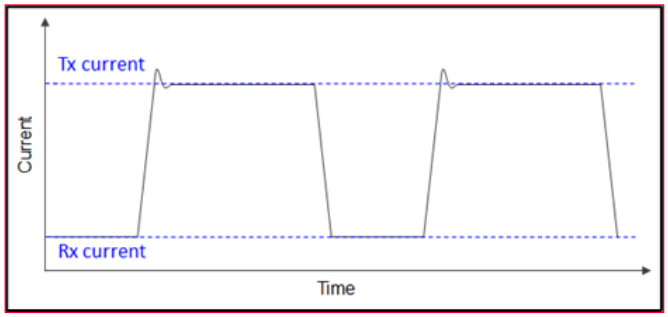


Table 12 describes the typical Tx/Rx current consumption for WLAN at 2.4 GHz.

Table 12: Typical Tx/Rx Current Consumption - WLAN at 2.4 GHz

Mode	Rate	Setting Power in dBm	Current in mA	
			Tx	Rx
11b	1 Mbps	17.0	370	64
11g	6 Mbps	17.0	366	64
11n	MCS0	16.0	342	64

Table 13 describes the typical Tx/Rx current consumption for WLAN at 5 GHz.

Table 13: Typical Tx/Rx Current Consumption - WLAN at 5 GHz

Mode	Rate	Setting Power in dBm	Current in mA	
			Tx	Rx
11a	6 Mbps	15.0	408	79
11n-20	MCS0	14.0	386	79
11n-40	MCS0	14.0	388	91

5.2.2 Bluetooth

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

- Conditions
  - VBAT = 3.3V, VIO = 1.8V
  - Combo FW: 16.80.210.p231

Figure 14: Typical Tx/Rx Current Consumption - Bluetooth

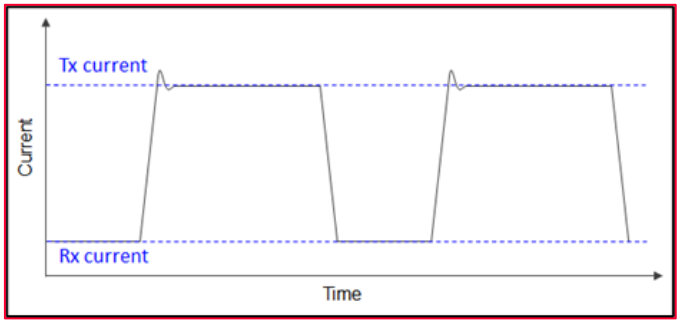


Table 14 describes the typical Tx/Rx current consumption for Bluetooth.

Table 14: Typical Tx/Rx Current Consumption - Bluetooth

Mode	Rate	Setting Power in dBm	Current in mA	
			Tx	Rx
BR	DH5	3.0	91	61
EDR	3DH5	0	87	61
LE	LE	3.0	90	60

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, VIO = 1.8V
  - Target: NXP iMX6SoloX-SABRE (MCIMX6SX-SDB)
  - WLAN FW: 16.91.10.p105
  - Beacon Interval = 100 ms
  - SDIO Signal Level = 1.8V
    SD Clock off/on (# mlanutl mlan0 sdioclock0, #mlanutl mlan0 sdioclock1)

Table 15 describes the typical sleep current consumption for WLAN.

Table 15: Typical Sleep Current Consumption – WLAN

Current Consumption VBAT (3.3V) in mA			
Band	SD clock speed	50 MHz	
	Clock enablement	Disable	Enable
	Chip deep sleep	0.169	0.224
2.4 GHz	IEEE Power Save: DTIM1	1.42	1.48
	IEEE Power Save: DTIM3	0.58	0.64
	IEEE Power Save: DTIM5	0.42	0.47
5 GHz	IEEE Power Save: DTIM1	1.00	1.05
	IEEE Power Save: DTIM3	0.44	0.5
	IEEE Power Save: DTIM5	0.33	0.39

5.3.2 Bluetooth

- Conditions
  - VBAT = 3.3V, VIO = 1.8V
  - Target: NXP iMX6SoloX-SABRE (MCIMX6SX-SDB)
  - WLAN FW: 16.91.10.p105
  - SDIO Level = 1.8V
    SD Clock off

Table 16 describes the typical sleep current consumption for Bluetooth.

Table 16: Typical Sleep Current Consumption - Bluetooth

Current Consumption VBAT (3.3V) in mA	
Deep Sleep	0.17

5.4 Typical Bluetooth Current Consumption

This section describes the typical Bluetooth advertise current consumption for Bluetooth.

- Conditions
  - VBAT = 3.3V, VIO =1.8V
  - Target: NXP iMX6SoloX-SABRE (MCIMX6SX-SDB)
  - FW: 16.91.10.p105
  - SDIO Signal = 1.8V
    SD Clock off

Table 17 describes the typical Bluetooth advertise current consumption.

Table 17: Typical Bluetooth Advertise Current Consumption

Current Consumption VBAT (3.3V) in mA	
Bluetooth page scan	0.53
Bluetooth page and inquiry scan	0.72
Bluetooth ACL / Sniff mode interval = 1.28sec	0.31
Bluetooth LE advertise / Interval = 1.28sec	0.34
Bluetooth LE scan / interval = 1.28sec	0.27

5.5 Typical Throughput

The typical throughput test configurations are:

- VBAT = 3.3V, VIO = 1.8V
- Target: i.MX6 SoloX-SABRE (MCIMX6SX-SDB)
- 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 11n HT20	53.6	55.4	60.9	56.6
5 GHz 11n HT40	92	113	113	135

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
Murata Type 1XK Module Datasheet	Murata Type 1XK module datasheet (type1xk.pdf)
Murata Type 2XK Module Datasheet	Murata Type 2XK module datasheet (TYPE2XK.pdf)
Murata Type 1XK/2XK Module Footprint	Murata Type 1XK/2XK module footprint (type1xk-2xk_module_footprint_topview.dxf)
Murata Type 1XK/2XK Trace Antenna	Murata Type 1XK/2XK module trace antenna (type1xk-2xk-Trace-u-FL.dxf)
Linux	Murata GitHub link for Linux transmit power files for 1XK
FreeRTOS	Murata GitHub link for FreeRTOS transmit power files for 1XK
wireless-regdb	Regulatory database used by Linux
Linux User Guide	Murata Linux User Guide for NXP modules (Murata Wi-Fi & BT (NXP) Solution for i.MX Linux User Guide.pdf). Murata website to be updated soon.

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 20 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	Changed Item	Comment
1.0	Oct 14, 2021		First Issue
2.0	Jul 01, 2022	3.1 Reference Circuit	Shared Antenna • Corrected Pin 22 Dedicated Antenna • Corrected Pin 22, Pin 45
3.0	Oct 03, 2022	Updated to new format	• Moved transmit power table to 1XK and 2XK Datasheets. • Added the antenna section. • Removed the external sleep clock requirement section.
4.0	Jan 26, 2023	Changed to follow new datasheet & HW App note content	• Moved transmit power table to 1XK and 2XK Datasheet. • Added the antenna section 3.5.6. • Removed the external sleep clock requirement section. It is present in datasheet.
5.0	Sep 12, 2023	3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector	• Added an example of C1PC antenna list
6.0	Mar 03, 2025	2.2 Hardware Block Diagrams 3.5 Recommended Antenna 3.5.3 PCB Stack-Up Antenna Design and Configuration 4.3 Configuration Files for FreeRTOS 5.4 Typical Bluetooth Current Consumption	• Minor update • Added Info Note • Added an additional registered antennas in Japan Radio Law certification (Table 4). • Modify the wording: Underneath of u.FL/MHF connector. • Removed. Merged to Radio Law Approval application note. • Removed Configuration files. • Added the current consumption data
7.0	Aug 22, 2025	3.5.2 Trace Antenna	• Added reference SRF value