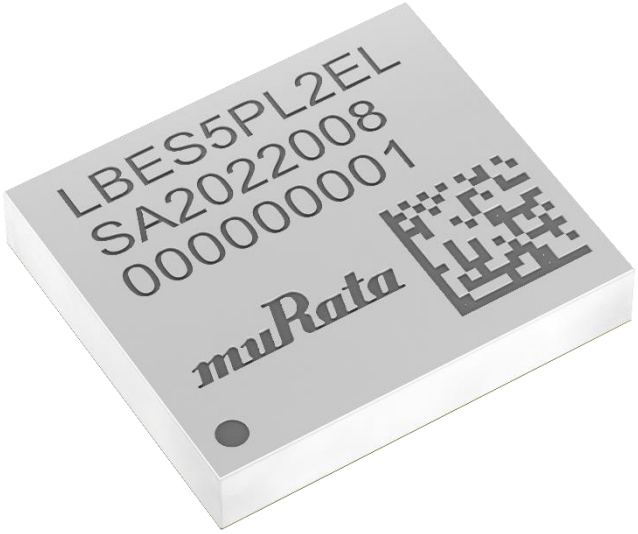
Hardware Application Note

Type 2EL/2DL

Wi-Fi™ + Bluetooth® + 802.15.4 Module (2EL Only)

NXP IW612/IW611 Chipset for
802.11a/b/g/n/ac/ax + Bluetooth 5.4 + IEEE802.15.4 (IW612 only)
Hardware Application Note - Rev. 9.0

- NXP Chipset: IW612 / IW611
- Design Name: Type 2EL / Type 2DL
- P/N: LBES5PL2EL-923 / LBEE5PL2DL-921



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About This Document

Murata's Type 2EL is a small and high-performance module based on NXP's IW612 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.4 BR/EDR/LE + 802.15.4.
Murata's Type 2DL is a small and high-performance module based on NXP's IW611 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.4 BR/EDR/LE.
This application note provides RF and hardware design guidance. Refer to Type 2EL Datasheet and Type 2DL 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 2EL Datasheet and Type 2DL Datasheet for module specification.

2 Module Introduction

Type 2EL/2DL is a small and high-performance module based on NXP IW612/IW611 combo chipset which supports Wi-Fi 802.11a/b/g/n/ac/ax + Bluetooth 5.4 BR/EDR/LE + 802.15.4 (2EL only) up to 600 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 and PCM for audio data. The 802.15.4 section supports SPI interface.

The IW612/IW611 implements sophisticated enhanced collaborative coexistence hardware mechanisms and algorithms, which ensure that WLAN and Bluetooth and 802.15.4 (IW612 only) collaboration is optimized for maximum performance.

In IEEE 802.11ax mode, the WLAN operation supports rates of MCS0 – MCS11 in 20 MHz and 40 MHz and 80 MHz channels for data rate up to 600 Mbps.

2.1 Features

- WLAN 802.11a/b/g/n/ac/ax 1x1 SISO + Bluetooth Classic and Low Energy (Version 5.4) + 802.15.4 combo SMD module with NXP IW612.
- Small size LGA package with resin molding and metal shielding.
- Host interfaces: SDIO 3.0 for WLAN; HCI UART, PCM, and I2S for Bluetooth; SPI for 802.15.4.
- WLAN MAC address and BD address and 802.15.4 MAC address are stored in OTP

802.15.4 only for 2EL/IW612

2.2 Hardware Block Diagrams

This section shows the difference between the single shared WLAN/Bluetooth/802.15.4 antenna configuration and the dedicated Bluetooth antenna configuration for Type 2EL / 2DL modules. The key difference is shown in **Figure 2** and **Figure 4**: the dual-antenna configuration has a dedicated Bluetooth antenna “ANT1”. WLAN has its dedicated antenna “ANT0”. By comparison, the single-antenna configuration has a single shared WLAN-Bluetooth antenna.

Figure 1: Block Diagram - Type 2EL for Shared WLAN/Bluetooth/802.15.4 Antenna

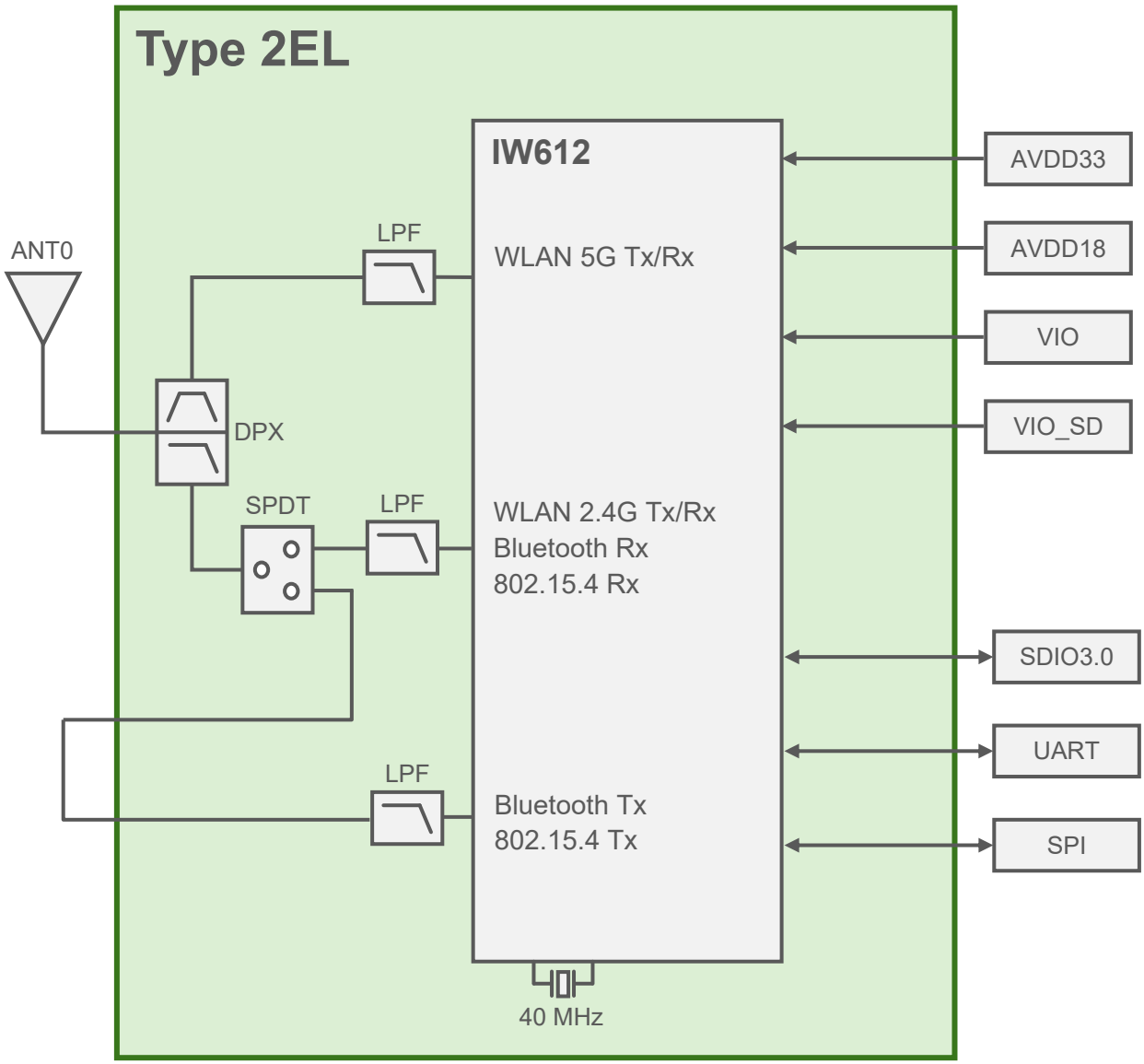


Figure 2: Block Diagram - Type 2EL for Dedicated Bluetooth/802.15.4 Antenna

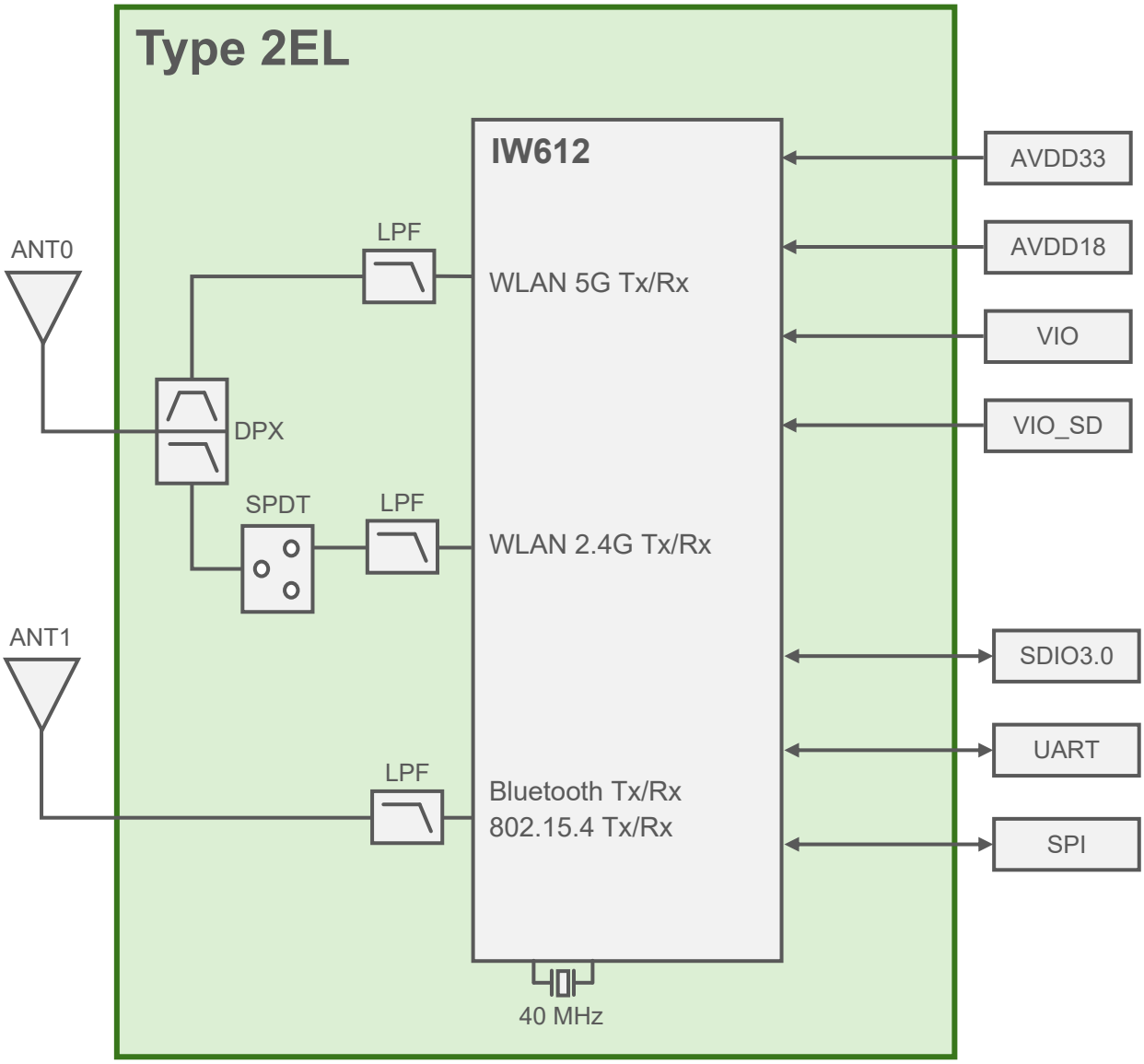


Figure 3: Block Diagram - Type 2DL for Shared WLAN/Bluetooth Antenna

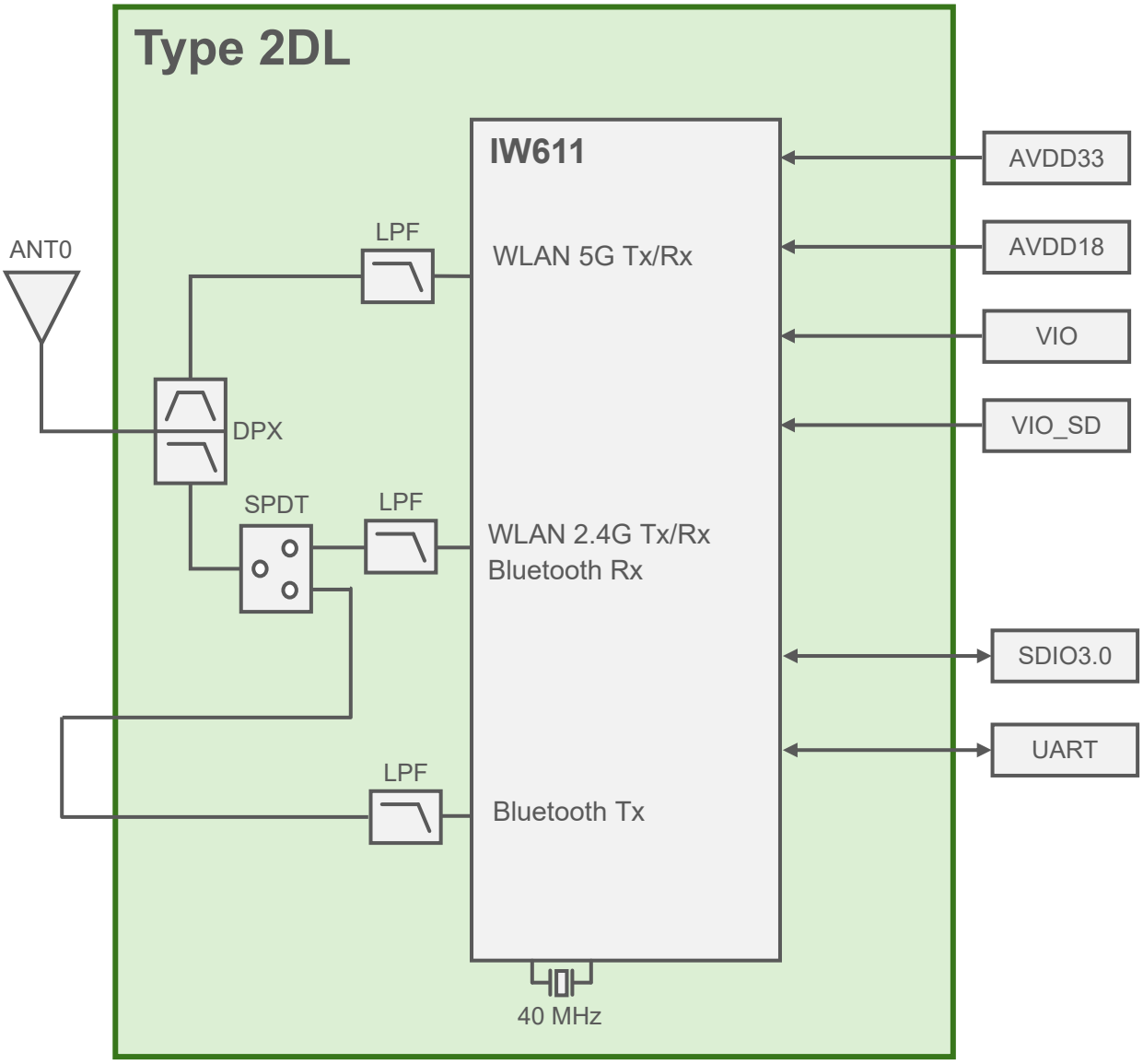
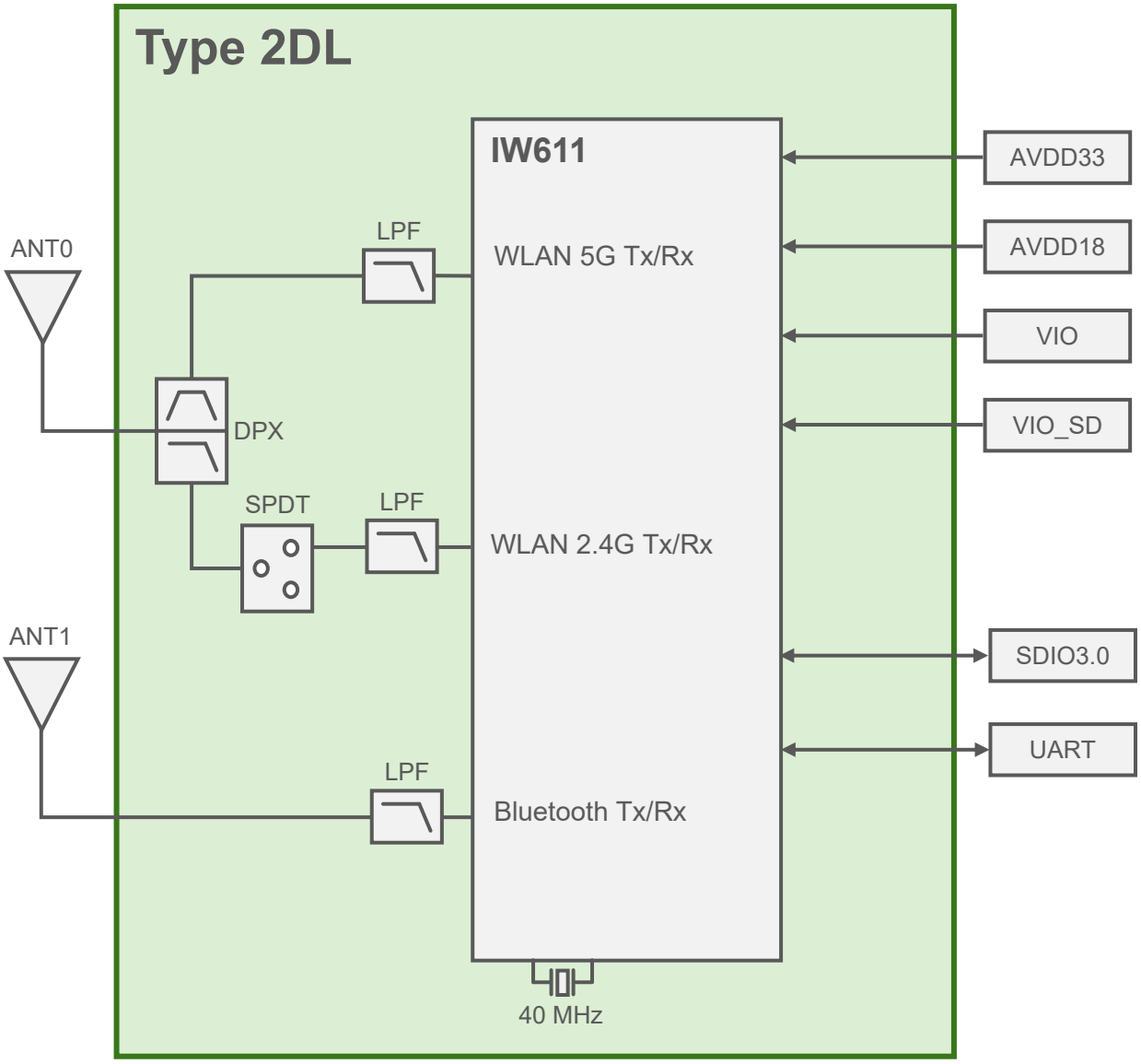


Figure 4: Block Diagram - Type 2DL for Dedicated Bluetooth Antenna



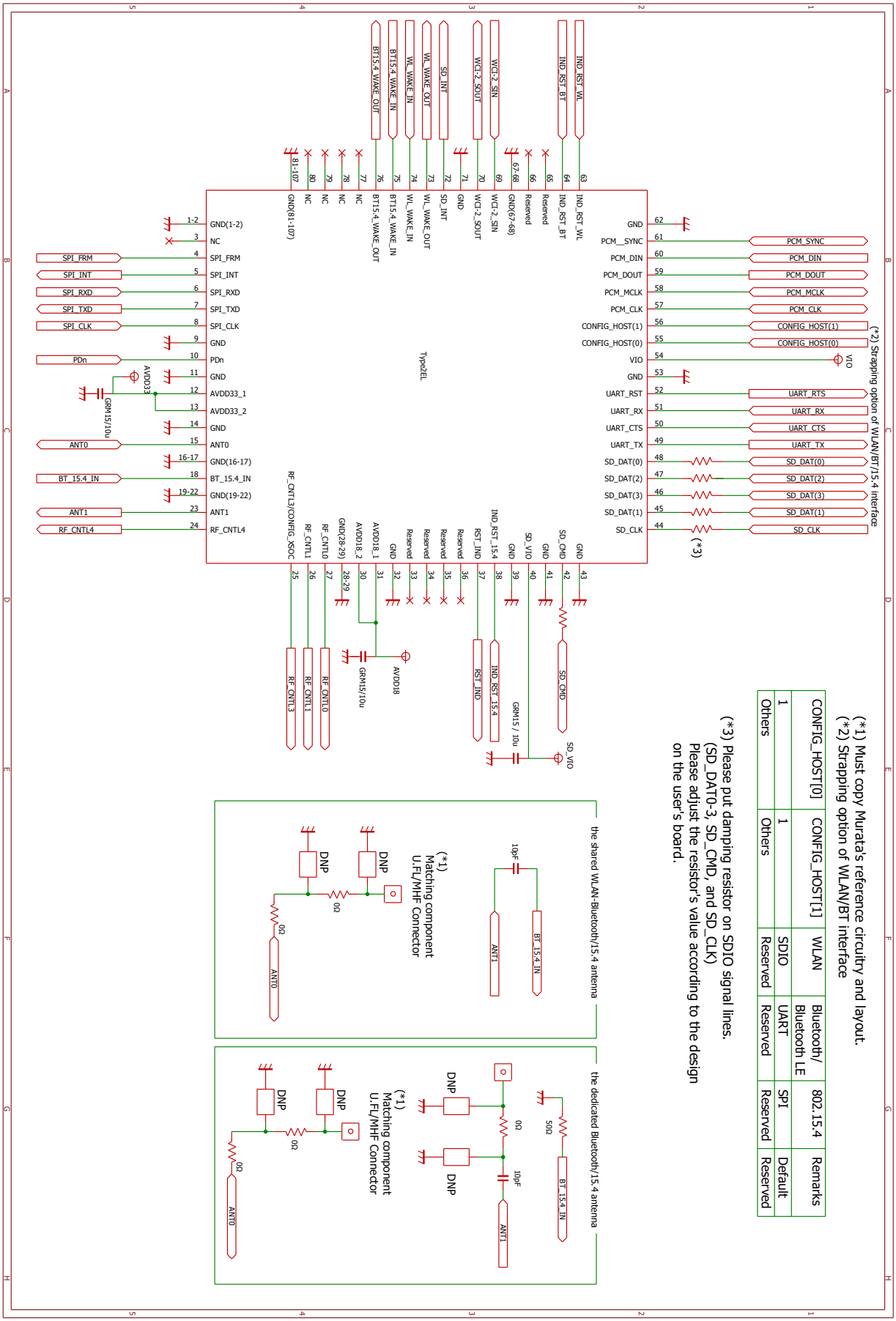
3 Reference Design

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 2EL/2DL for the dedicated Bluetooth/802.15.4 antenna configuration uses u.FL or MHF connector for independent Bluetooth/802.15.4.

3.1 Reference Circuit

Figure 5 and **Figure 6** show the u.FL/MHF connector and the trace antenna for Type 2EL module.
Figure 7 and **Figure 8** show the u.FL/MHF connector and the trace antenna for Type 2DL module.

Figure 5: u.FL/MHF Connector - Type 2EL



CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth/ Bluetooth LE	802.15.4	Remarks
1	1	SDIO	UART	SPI	Default
Others	Others	Reserved	Reserved	Reserved	Reserved

Figure 6: Trace Antenna - Type 2EL

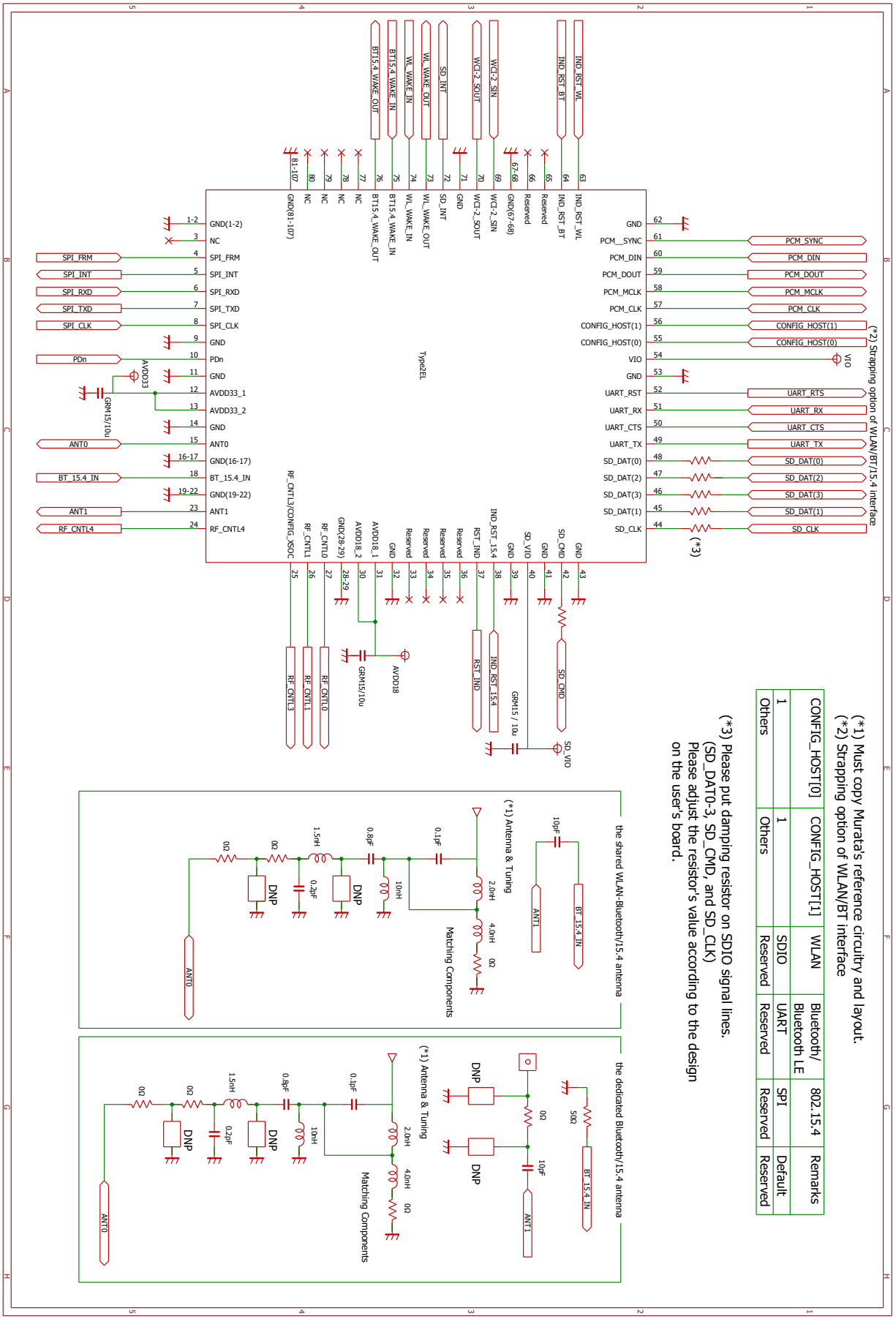


Figure 7: u.FL/MHF Connector - Type 2DL

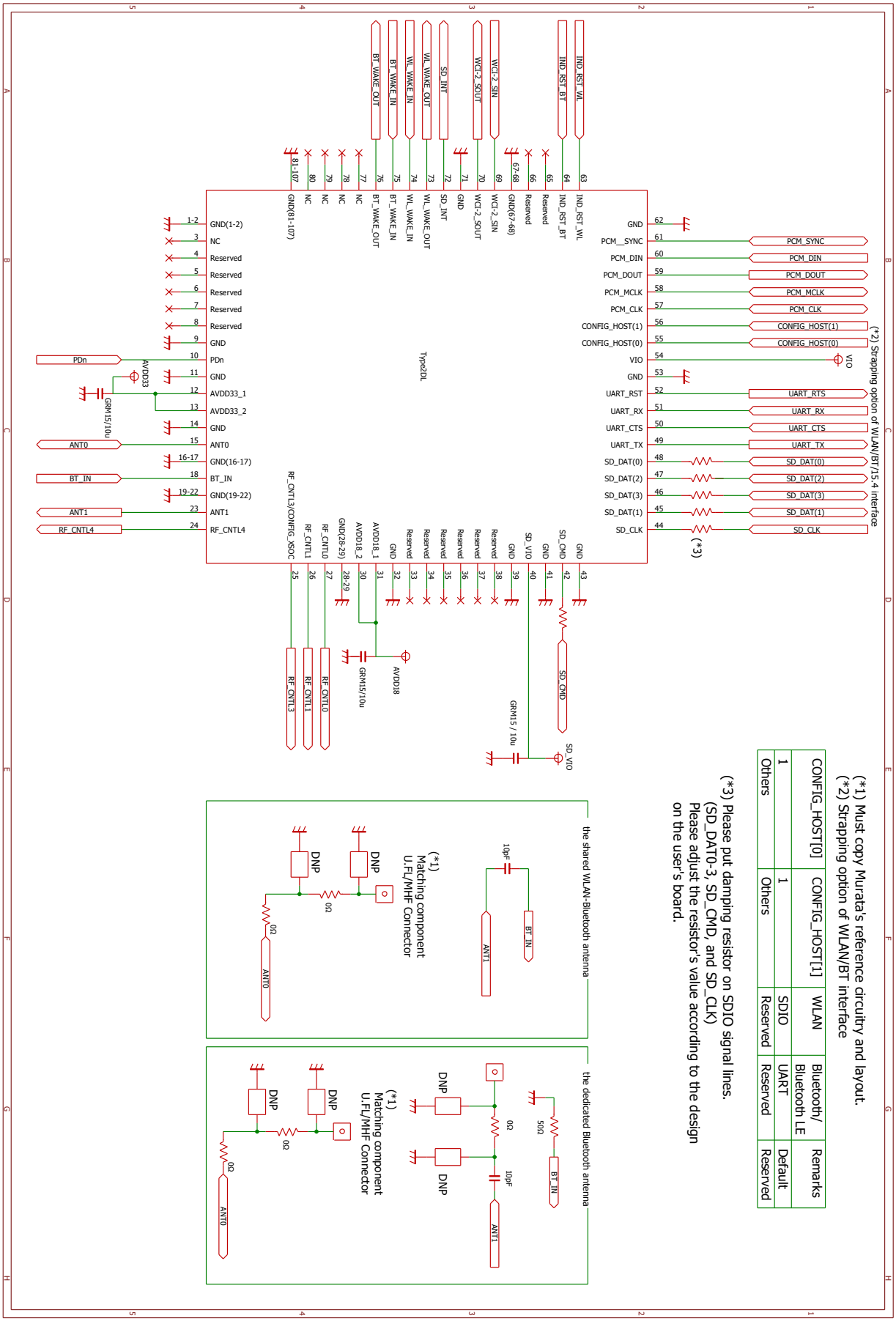
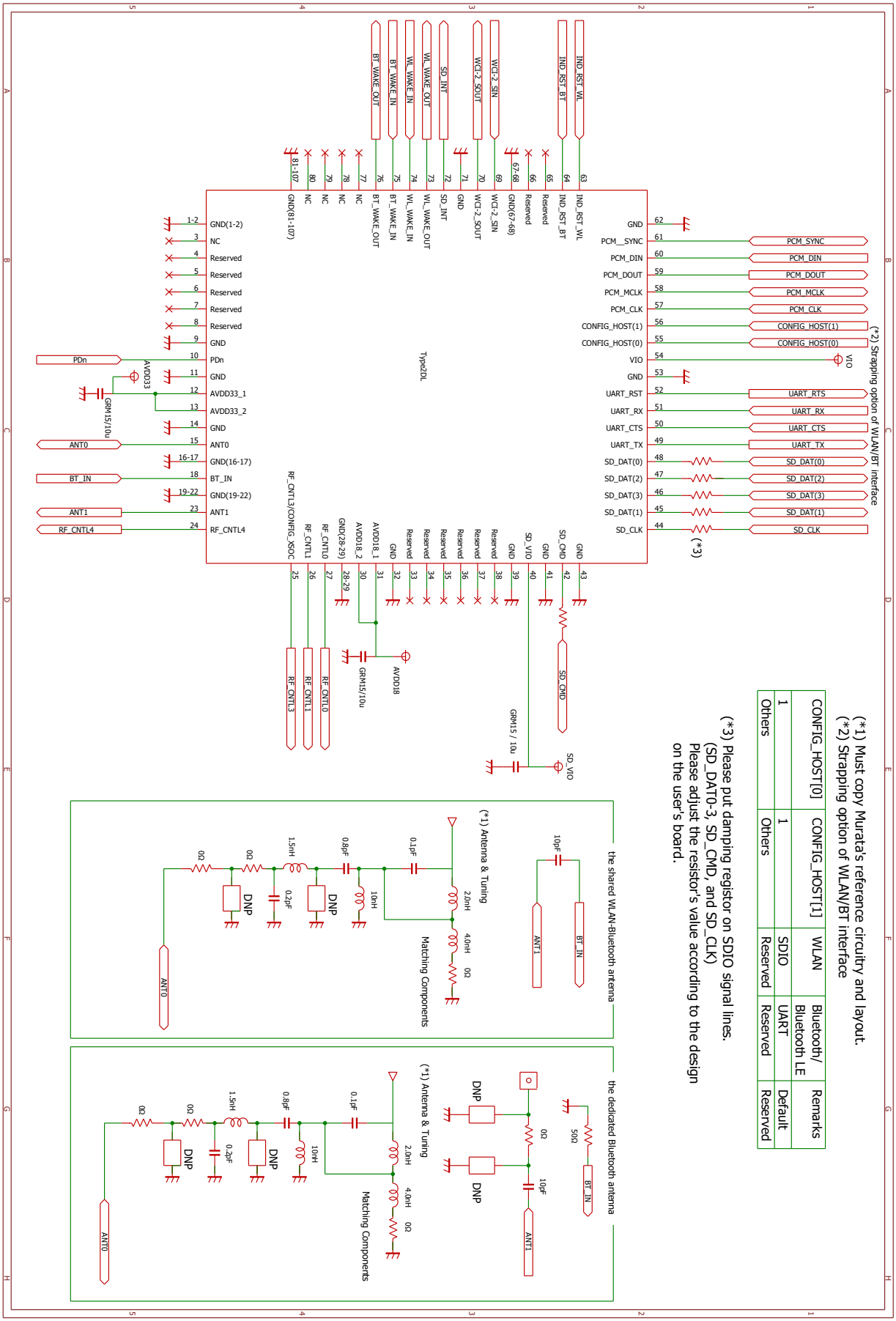


Figure 8: Trace Antenna - Type 2DL



CONFIG_HOST[0]	CONFIG_HOST[1]	WLAN	Bluetooth/ Bluetooth LE	Remarks
1	1	SDIO	UART	Default
Others	Others	Reserved	Reserved	Reserved

(*1) Must copy Murata's reference circuitry and layout.
(*2) Strapping option of WLAN/BT interface

(*3) Please put damping registor on SDIO signal lines.
(SD_DAT0-3, SD_CMD, and SD_CLK)
Please adjust the resistor's value according to the design on the user's board.

3.2 Requirement for SDIO Signals

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

Table 2: SDIO Internal Pull-Up/Pull-Down Specifications

Parameter	Minimum	Typical	Maximum	Unit
Internal nominal pull-up/pull-down resistance	70	100	140	kΩ

3.3 Requirements for Unused Signals

If these signals are not used, no pull-up/down is necessary (floating) for:

- GPIO [0…31]
- RF_CNTL0,1,3,4

3.4 Module Footprint Design

Refer to dimensions in the Type 2EL Datasheet / Type 2DL 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 are shown in **Table 3**. However, user can use any equivalent type of antenna with less antenna gain than antenna gain of recommended antennas for US/CA and EU under approval of Class I Permissive Change by Murata.

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 3** and **Table 4**.

Table 3: 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	Dipole	3.2 dBi	4.25 dBi	50 mm or more
219611	Molex	u.FL/PCB	Dipole	2.67 dBi	3.67 dBi	40 mm or more
WT32D1-KX	Unictron	MHF I/PCB	Dipole	3.0 dBi	4.0 dBi	119 mm or more
W24P-U	Inventek	u.FL/PCB	Dipole	3.2 dBi	N/A	90 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.

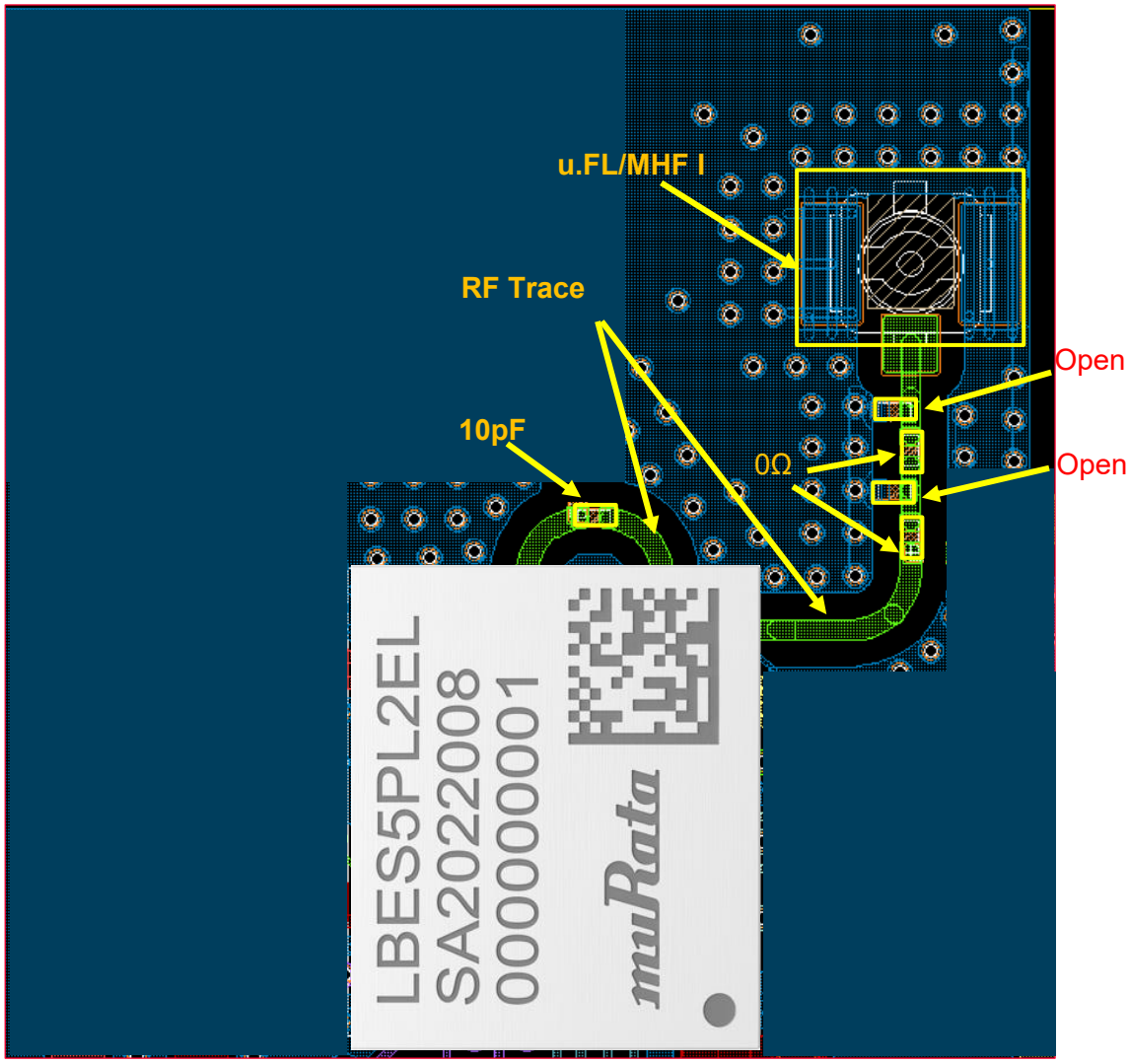
Table 4: Additional Registered Antennas in Japan Radio Law certification

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
146187	Molex	u.FL/PCB	Dipole	3.2	4.25	50 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
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

- 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 connector.

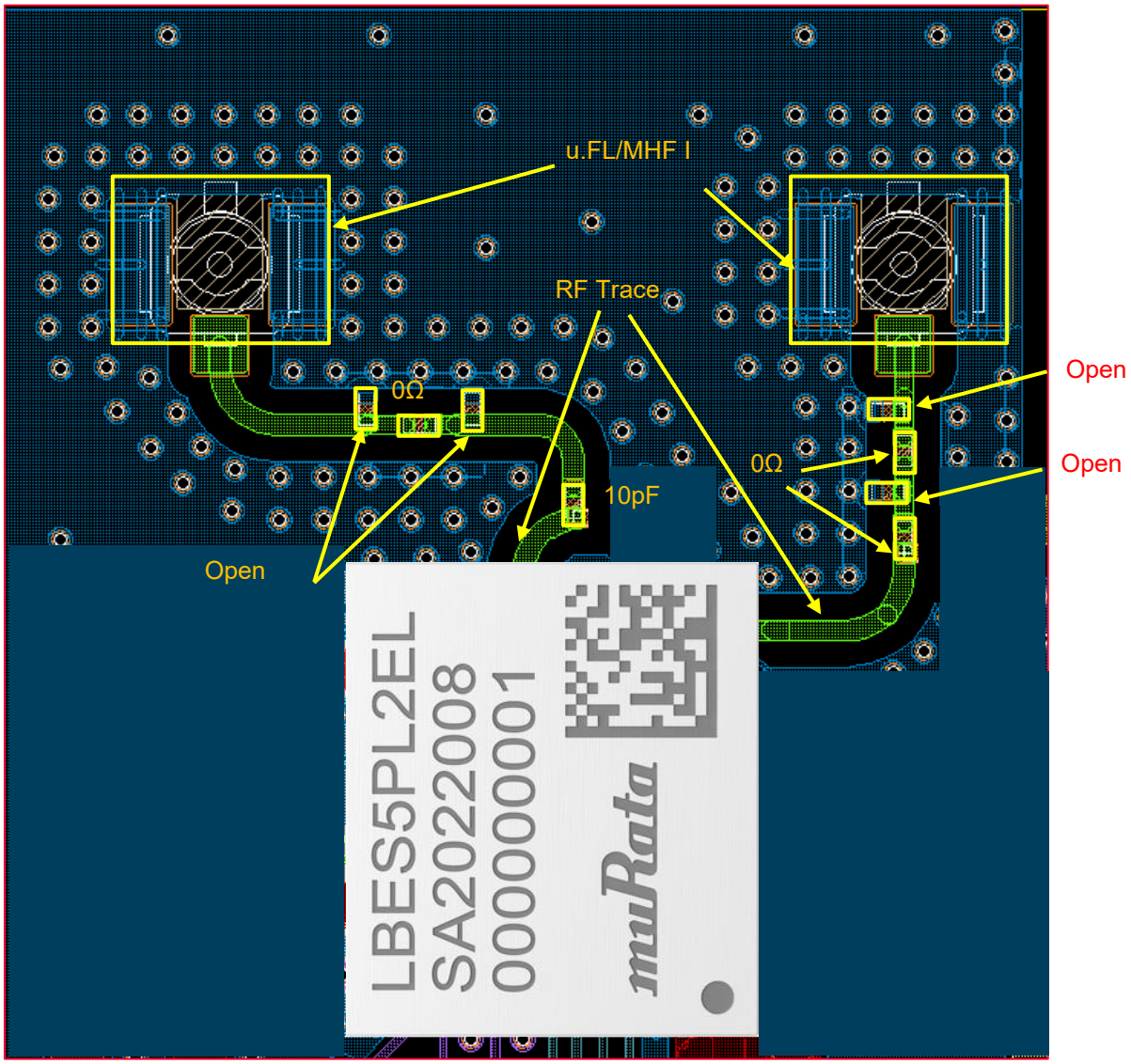
Figure 9 and **Figure 10** show the PCB Type di-pole antenna for Type 2EL/2DL module.

Figure 9: PCB Type Di-pole Antenna - Type 2EL/2DL for Shared Antenna



Size: 0603 LQP03 / GRM03 / Resistor.

Figure 10: PCB Type Di-pole Antenna - Type 2EL/2DL for Dedicated Antenna



Size: 0603 LQP03 / GRM03 / Resistor.

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 (0.8 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 gain of Type 2EL module.

Table 5: Trace Antenna Gain

Part Number	Vendor	Peak Gain [dBi]		Type	Connector
		2.4GHz	5GHz		
Type2EL_Antenna	Murata	3.6	4.6	Monopole	Trace

Size: 0603 LQP03 / GRM03 / Resistor

Figure 11 and **Figure 12** show the trace antenna guidelines for Type 2EL/2DL module.

Figure 11: Trace Antenna Guidelines - Type 2EL/2DL for Shared Antenna

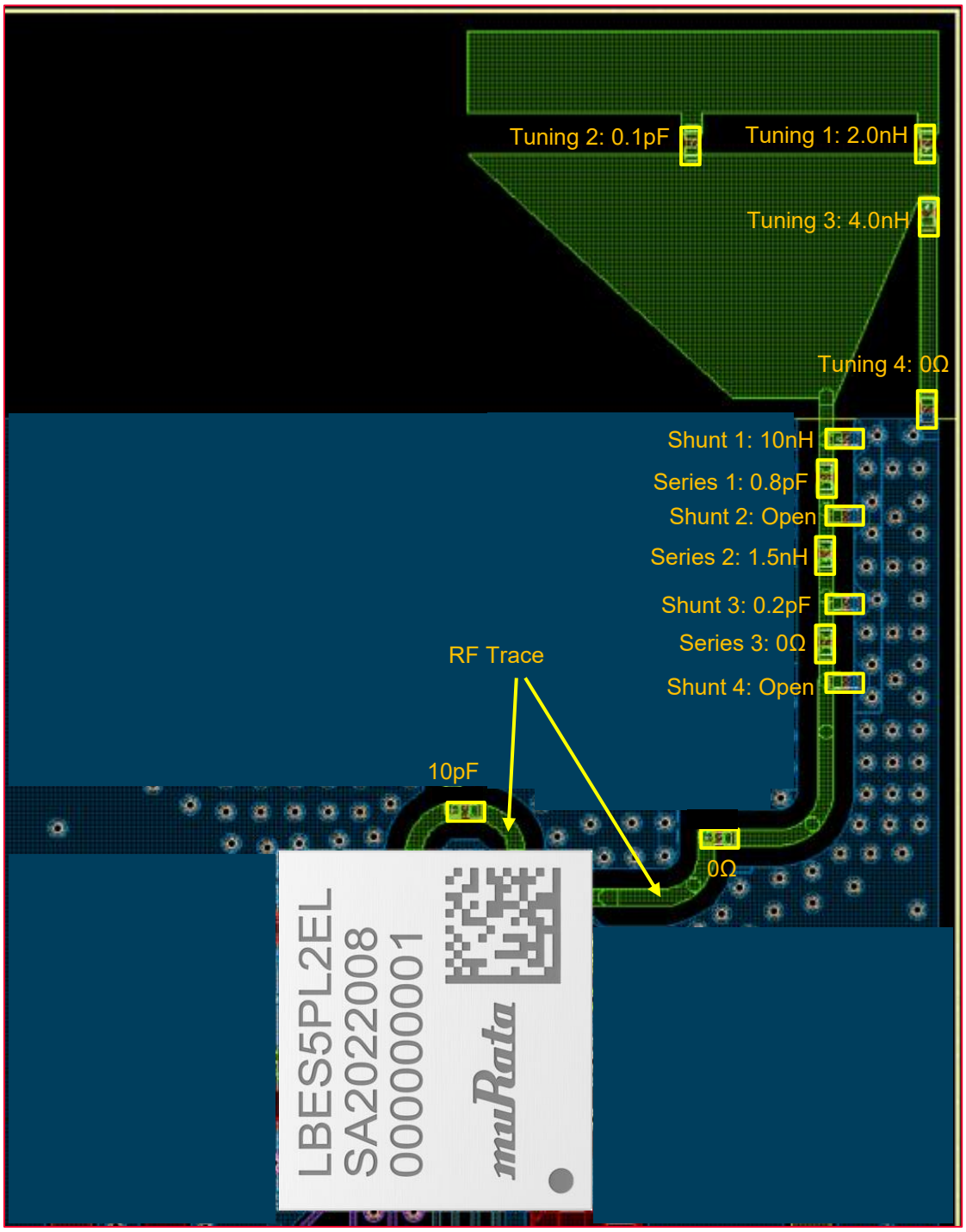


Figure 12: Trace Antenna Guidelines - Type 2EL/2DL for Dedicated Antenna

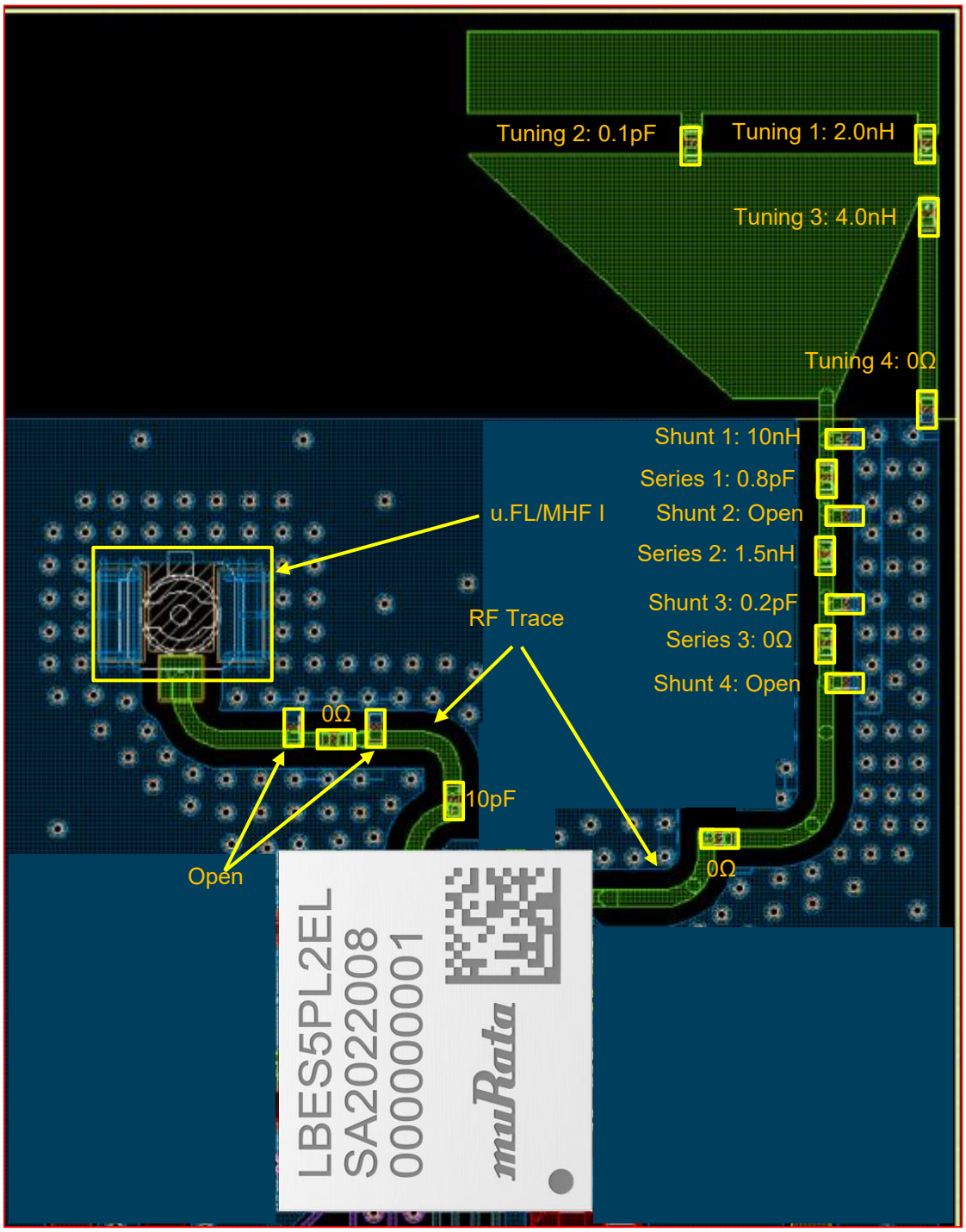


Table 6 shows reference SRF (Self-Resonant Frequency) values used during murata internal evaluations. Since each matching components is utilized for tuning within the specified frequency band, please select SRF values that are higher than the tuning band frequency.

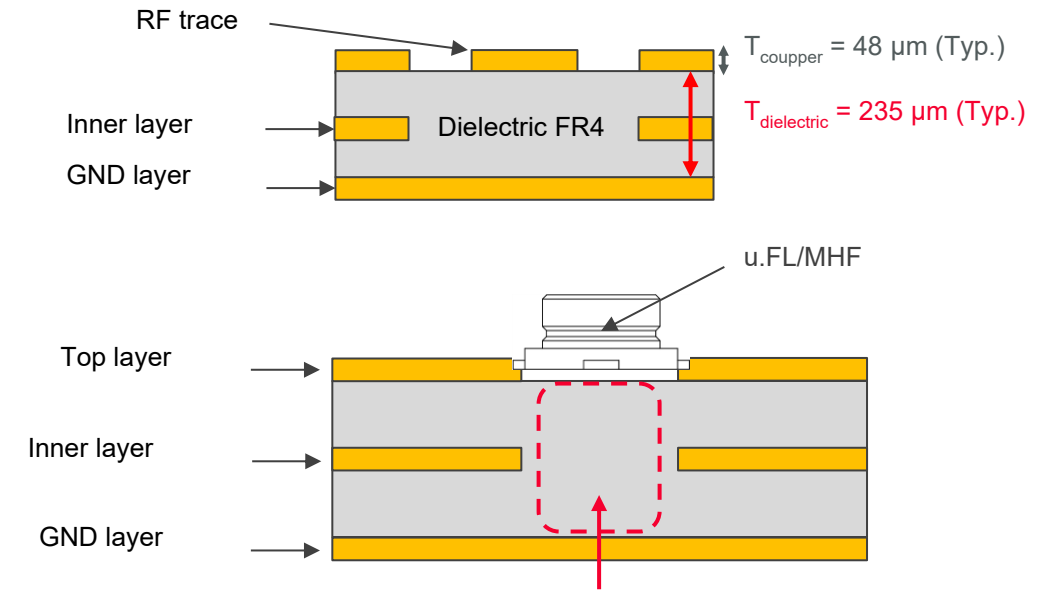
Table 6: Reference parameters of Trace Antenna tuning components

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 13 shows the PCB stack-up layers.

Figure 13: PCB Stack-Up Layers



3.5.4 Trace Antenna Performance

This section illustrates the trace antenna performance results as shown in **Figure 14**.

Figure 14: Trace Antenna Performance

Gain and Efficiency

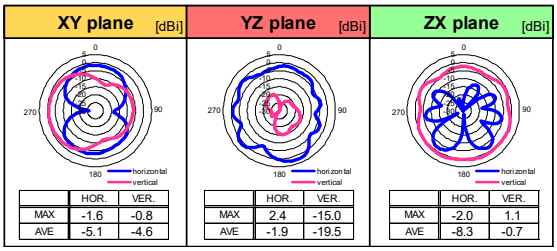
[dBi] [dB]

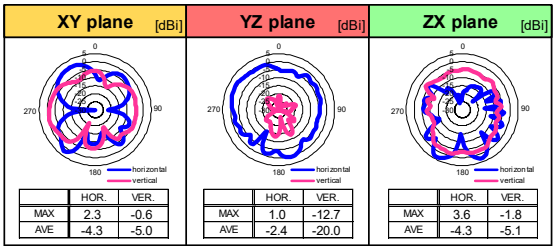
LINEAR POLARIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
2400 MHz	MAX.	-1.6	-0.9	2.6	-16.3	-2.2	1.0	
	AVE.	-4.9	-4.6	-2.0	-20.4	-8.3	-0.9	-1.0
2442 MHz	**MAX.**	**-1.6**	**-0.8**	**2.4**	**-15.0**	**-2.0**	**1.1**	
	AVE.	**-5.1**	**-4.6**	**-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]

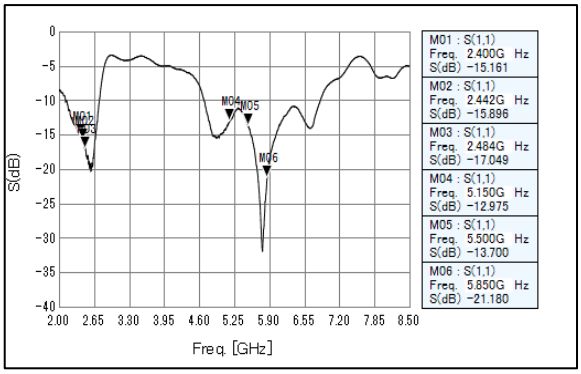
LINEAR POLARIZATION		XY-plane hor.	XY-plane ver.	YZ-plane hor.	YZ-plane ver.	ZX-plane hor.	ZX-plane ver.	Total Efficiency
5150 MHz	MAX.	2.3	0.1	2.2	-11.4	3.5	-0.2	
	AVE.	-4.1	-4.5	-2.0	-19.2	-3.9	-3.9	-1.3
5500 MHz	**MAX.**	**2.3**	**-0.6**	**1.0**	**-12.7**	**3.6**	**-1.8**	
	AVE.	**-4.3**	**-5.0**	**-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

Directivity





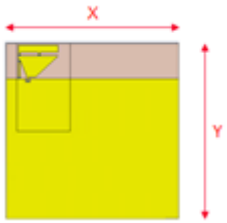
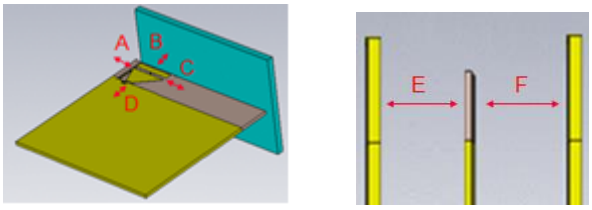
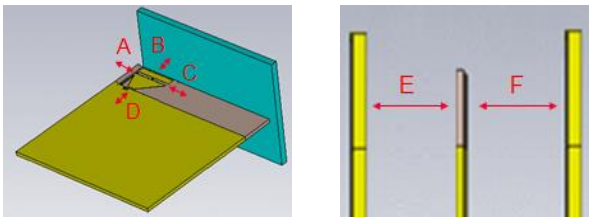
Return Loss



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, the configuration file below 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 **Table 8** shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification. For more regulatory information, refer to 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 OFDMA RU Tx power configuration files	USA	US	rutxpower_US.bin
	Canada	CA	rutxpower_CA.bin
	Europe	DE	rutxpower_EU.bin
	Japan	JP	rutxpower_JP.bin

Names	Country	Country Code	Configuration Files
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 files shall be loaded after Bluetooth device initialization.

The files listed in **Table 9** shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification.

Table 9: Bluetooth Configuration Files - Linux

Names	Country	Country Code	Script Files
Bluetooth Tx power configuration script files	USA	US	bt_power_config_US_CA.sh
	Canada	CA	bt_power_config_US_CA.sh
	Europe	DE	bt_power_config_EU.sh
	Japan	JP	bt_power_config_JP.sh

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

```
# sh bt_power_config_US_CA.sh
```

    - Content of shell script file “bt_power_config_US_CA.sh”

```
hcitool -i hci0 cmd 0x3f 0x00ee 0x01 0x0D
hcitool -i hci0 cmd 0x03 0x003
```

  - bt_power_config_EU.sh
    - Command examples are as below:

```
# sh bt_power_config_EU.sh
```

    - Content of shell script file “bt_power_config_EU.sh”

```
hcitool -i hci0 cmd 0x3f 0x61 0x00 0x00 0x01 0x1C 0x37 0x43 0x1C 0x00
0x1C 0x00 0x00 0x00 0x01 0x7F 0x03 0x07 0x08 0x00 0x00 0x00 0xC0 0xC6
0x2D 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
hcitool -i hci0 cmd 0x03 0x003
hcitool -i hci0 cmd 0x3f 0xff 0x64 0x87 0x10 0x00 0xFF 0xFF 0xFF 0xFF
0x01 0x00 0x04 0x00 0x01 0x00 0x04 0x00
hcitool -i hci0 cmd 0x03 0x003
hcitool -i hci0 cmd 0x3f 0x00ee 0x01 0x03
hcitool -i hci0 cmd 0x03 0x003
```

- bt_power_config_JP.sh
  - Command examples are as below:

```
# sh bt_power_config_JP.sh
```

  - Content of shell script file “bt_power_config_JP.sh”

```
hcitool -i hci0 cmd 0x3f 0x61 0x00 0x00 0x01 0x1C 0x37 0x43 0x1C 0x00
0x1C 0x00 0x00 0x00 0x01 0x7F 0x05 0x07 0x08 0x00 0x00 0x00 0xC0 0xC6
0x2D 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00
hcitool -i hci0 cmd 0x03 0x003
hcitool -i hci0 cmd 0x3f 0xff 0x64 0x87 0x10 0x00 0xFF 0xFF 0xFF 0xFF
0x01 0x00 0x04 0x00 0x01 0x00 0x04 0x00
hcitool -i hci0 cmd 0x03 0x003
hcitool -i hci0 cmd 0x3f 0x00ee 0x01 0x05
hcitool -i hci0 cmd 0x03 0x003
```

- Option for Japan
  In case of only BR/EDR/Not use BLE, you can set BR = 12dBm, EDR = 5dBm

```
hcitool -i hci0 cmd 0x03 0x003
hcitool -i hci0 cmd 0x3f 0x00ee 0x01 0x0C
hcitool -i hci0 cmd 0x03 0x003
```

This script is based on baud rate 3000000.
Please be sure to run bt_power_config_EU.sh / bt_power_config_JP.sh script after the baud rate set as 3000000.

Bluetooth Tx power is configured by using hcitool.

4.3 802.15.4 Power Setting Command for Linux (2EL only)

802.15.4 Tx power setting command shall be implemented after 802.15.4 device initialization.

Tx power setting command shall be used to satisfy regulatory requirements if user wants to use Murata regulatory certification.

- US/CA/JP
  - Command examples are as below:

```
Ot-ctl txpower 15
```

- EU
  - Command examples are as below:

```
Ot-ctl txpower 3
```

4.4 Dedicated Antenna Configuration Files for Linux

The dedicated Bluetooth / 802.15.4 antenna configuration file shall be loaded at device initialization.

The file listed in **Table 10** shall be used to set the dedicated antenna configuration.

For more information about loading configuration file, refer to Linux User Guide.

Table 10: Dedicated Bluetooth / 802.15.4 Antenna Configuration File – Linux

Names	Configuration Files
Type 2EL: Dedicated Bluetooth / 802.15.4 antenna configuration file Type 2DL: Dedicated Bluetooth antenna configuration file	WlanCalData_ext_dANT.conf

4.5 Configuration Files for FreeRTOS

Please ask Murata at Murata Community Forum.

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:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Table 11, Table 12, Table 13, Table 14, and **Table 15** describe the typical Rx minimum sensitivity level at module antenna ports for WLAN at 2.4 GHz and 5 GHz.

Table 11: Rx Minimum Sensitivity Level - WLAN at 2.4 GHz (20 MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]									
	11b		11g		11n (HT 20)		11ac (VHT 20)		11ax (HE 20)	
	1 Mbps	11 Mbps	6 Mbps	54 Mbps	MCS0	MCS7	MCS0	MCS8	MCS0	MCS11
2412	-98	-88	-92	-75	-91	-72	-91	-69	-92	-63
2442	-97	-89	-92	-75	-91	-72	-91	-69	-92	-63
2472	-97	-88	-92	-75	-91	-72	-91	-69	-92	-62

Table 12: Rx Minimum Sensitivity Level - WLAN at 2.4 GHz (40MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]					
	11n (HT 40)		11ac (VHT 40)		11ax (HE 40)	
	MCS0	MCS7	MCS0	MCS9	MCS0	MCS11
2412	-88	-70	-88	-65	-88	-60
2442	-88	-70	-88	-65	-88	-60
2472	-88	-69	-88	-64	-88	-60

Table 13: 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 (HE 20)	
	6 Mbps	54 Mbps	MCS0	MCS7	MCS0	MCS8	MCS0	MCS11
5180	-91	-74	-91	-71	-91	-69	-91	-62
5500	-92	-75	-91	-71	-91	-69	-91	-61
5825	-92	-74	-90	-71	-90	-68	-90	-61

Table 14: Rx Minimum Sensitivity Level - WLAN at 5 GHz (40 MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]					
	11n (HT 40)		11ac (VHT 40)		11ax (HE 40)	
	MCS0	MCS7	MCS0	MCS9	MCS0	MCS11
5190	-88	-69	-88	-65	-89	-59
5510	-88	-69	-88	-65	-89	-59
5795	-87	-69	-87	-64	-88	-59

Table 15: Rx Minimum Sensitivity Level - WLAN at 5 GHz (80 MHz)

Frequency in MHz	Rx Minimum Sensitivity Level [dBm]			
	11ac (VHT 80)		11ax (HE 80)	
	MCS0	MCS9	MCS0	MCS11
5210	-84	-61	-85	-57
5530	-84	-61	-85	-57
5775	-83	-60	-84	-57

5.1.2 Bluetooth

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Table 16 describes the typical Rx minimum sensitivity level for Bluetooth.

Table 16: Rx Minimum Sensitivity Level - Bluetooth

Frequency in MHz	Rx Minimum Sensitivity level[dBm]						
	DH5	2DH5	3DH5	LE 1M	LE 2M	125K	500K
2412	-94	-94	-89	-102	-100	-107	-106
2442	-95	-95	-89	-101	-99	-106	-105
2472	-95	-95	-89	-102	-100	-107	-106

5.1.3 802.15.4

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Table 17 describes the typical Rx minimum sensitivity level for 802.15.4.

Table 17: Rx Minimum Sensitivity Level - 802.15.4

Frequency in MHz	Rx Minimum Sensitivity level[dBm]
	802.15.4
2412	-101
2442	-100
2472	-100

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:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Figure 15 shows a typical graph of Tx/Rx current consumption for Wi-Fi.

Figure 15: Typical Tx/Rx Current Consumption - Wi-Fi

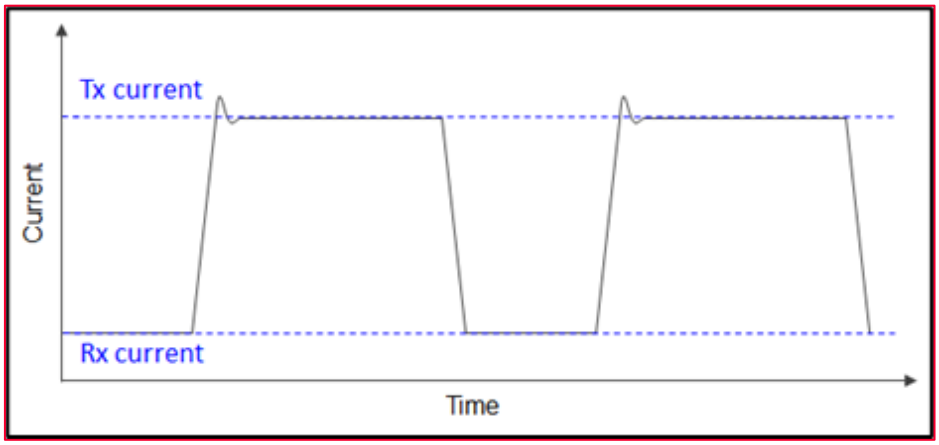


Table 18 describes the typical Tx/Rx current consumption for WLAN at 2.4 GHz.

Table 18: Typical Tx/Rx Current Consumption - WLAN at 2.4 GHz

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]			
			Tx		Rx	
			AVDD18	AVDD33	AVDD18	AVDD33
11b	1 Mbps	18	150	235	100	0.2
11g	6 Mbps	16	165	200	100	0.2
11n (HT20)	MCS0	15	165	190	100	0.2
11ac (VHT20)	MCS0	15	165	190	100	0.2
11ax (HE20)	MCS0	15	165	190	100	0.2
11n (HT40)	MCS0	15	170	190	110	0.2
11ac (VHT40)	MCS0	15	170	190	110	0.2

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]			
			Tx		Rx	
			AVDD18	AVDD33	AVDD18	AVDD33
11ax (HE40)	MCS0	15	170	190	110	0.2

Table 19 describes the typical Tx/Rx current consumption for WLAN at 5 GHz.

Table 19: Typical Tx/Rx Current Consumption - WLAN at 5 GHz

Mode	Data Rate	Setting Tx Power [dBm]	Current [mA]			
			Tx		Rx	
			AVDD18	AVDD33	AVDD18	AVDD33
11a	6 Mbps	16	250	240	120	0.2
11n (HT20)	MCS0	14	220	210	120	0.2
11ac (VHT20)	MCS0	14	220	210	120	0.2
11ax (HE20)	MCS0	14	220	215	120	0.2
11n (HT40)	MCS0	14	230	205	140	0.2
11ac (VHT40)	MCS0	14	230	205	140	0.2
11ax (HE40)	MCS0	14	235	210	140	0.2
11ac (VHT80)	MCS0	14	250	210	170	0.2
11ax (HE80)	MCS0	14	255	210	170	0.2

5.2.2 Bluetooth

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

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Figure 16 shows the typical graph of Tx/Rx current consumption for Bluetooth.

Figure 16: Typical Tx/Rx Current Consumption - Bluetooth

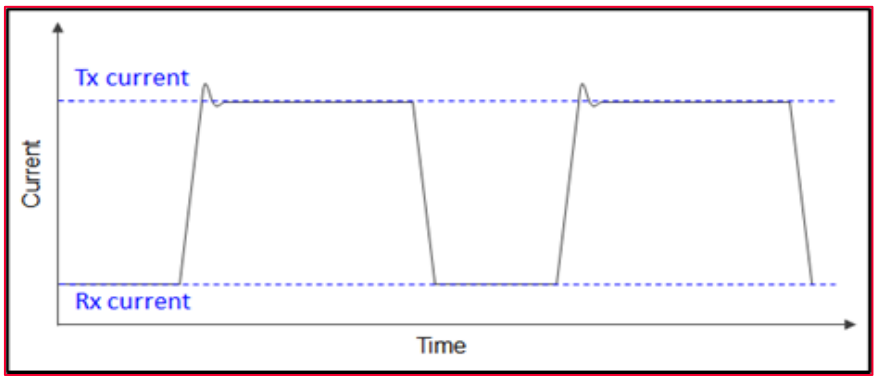


Table 20 describes the typical Tx/Rx current consumption for Bluetooth.

Table 20: Typical Tx/Rx Current Consumption - Bluetooth

Mode	Setting Tx Power [dBm]	Current [mA]			
		Tx		Rx	
		AVDD18	AVDD33	AVDD18	AVDD33
BR (1DH5)	13	323	0.2	125	0.2
EDR (3DH5)	5	190	0.2	125	0.2
LE 1M	13	325	0.2	125	0.2
LE 2M	13	345	0.2	125	0.2

5.2.3 802.15.4 (2EL only)

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

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Combo FW: 18.80.1.p154.38

Figure 17 shows the typical Tx/Rx current consumption for 802.15.4.

Figure 17: Typical Tx/Rx Current Consumption - 802.15.4

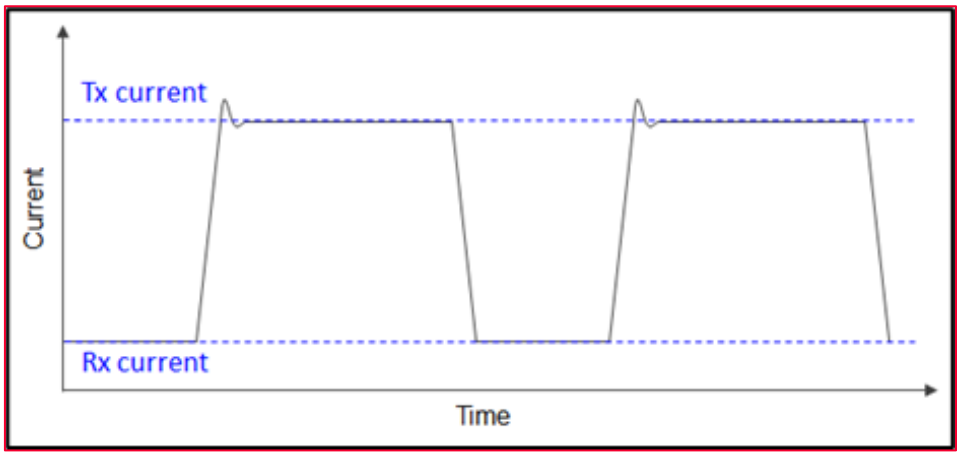


Table 21 describes the typical Tx/Rx current consumption for 802.15.4.

Table 21: Typical Tx/Rx Current Consumption - 802.15.4

Mode	Setting Tx Power [dBm]	Current [mA]			
		Tx		Rx	
		AVDD18	AVDD33	AVDD18	AVDD33
802.15.4	13	390	0.2	125	0.2

5.3 Typical Sleep Current Consumption

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

5.3.1 WLAN

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Target: NXP 8MMINILPD4-EVKB
  - WLAN FW: 18.99.1.p154.72
  - Beacon Interval = 100 ms
  - SDIO Signal Level = 1.8V
    SD Clock off/on (# mlanutl mlan0 sdioclock 0, #mlanutl mlan0 sdioclock 1)

Table 22 describes the typical sleep current consumption for WLAN.

Table 22: Typical Sleep Current Consumption - WLAN

Current Consumption AVDD18 (1.8V) in mA						Current Consumption
Band	SD clock speed	25 MHz		200 MHz		AVDD33 (3.3V) in mA
	Clock enablement	Disable	Enable	Disable	Enable	
	Chip deep sleep	0.6	0.7	1.1	1.6	0.05
2.4 GHz	IEEE Power Save: DTIM1	3.2	3.3	3.6	4.1	0.05
	IEEE Power Save: DTIM3	1.5	1.6	1.9	2.5	0.05
	IEEE Power Save: DTIM5	1.2	1.2	1.6	2.1	0.05
5 GHz	IEEE Power Save: DTIM1	2.0	2.0	2.4	2.9	0.05
	IEEE Power Save: DTIM3	1.1	1.1	1.5	2.0	0.05
	IEEE Power Save: DTIM5	0.9	0.9	1.4	1.9	0.05

5.3.2 Bluetooth

- **Conditions:**
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Target: NXP 8MMINILPD4-EVKB
  - Bluetooth/15.4 FW: 18.99.1.p154.72

Table 23 describes the typical sleep current consumption for Bluetooth.

Table 23: Typical Sleep Current Consumption - Bluetooth

Current Consumption AVDD (1.8V) in mA	
Bluetooth and 802.15.4 only in deep sleep mode	0.25

5.4 Typical Bluetooth Current Consumption

This section describes the typical Bluetooth current consumption.

- **Conditions**:
  - AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
  - Target: NXP 8MMINILPD4-EVKB
  - Bluetooth/15.4 FW: 18.99.1.p154.72

Table 24 describes the typical Bluetooth advertise current consumption.

Table 24: Typical Bluetooth Current Consumption

Current Consumption AVDD18 (1.8V) in mA	
Bluetooth page scan	0.58
Bluetooth page and inquiry scan	0.80
Bluetooth ACL / Sniff mode interval = 1.28sec	0.35
Bluetooth LE advertise / Interval = 1.28sec	0.32
Bluetooth LE scan / interval = 1.28sec	0.46

5.5 Typical Throughput

The typical throughput test configurations are:

- AVDD18 = 1.8V, AVDD33 = 3.3V, SD_VIO/VIO = 1.8V
- Target: NXP 8MMINILPD4-EVKB
- Combo FW: 18.99.1.p154.72
- 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 25 describes the typical throughput data for the modules.

Table 25: WLAN Typical Throughput Data

Mode	TCP Throughput in Mbps		UDP Throughput in Mbps	
	Tx	Rx	Tx	Rx
2.4 GHz 11ax HE20	119	116	125	122
5 GHz 11ax HE80	419	384	465	503

6 References

Table 26 reviews all the key reference documents that the user may like to refer to.

Table 26: Reference Table

Support Site	Notes
Murata Type 2EL Module Datasheet	Murata Type 2EL module datasheet (TYPE2EL.pdf)
Murata Type 2DL Module Datasheet	Murata Type 2DL module datasheet (TYPE2DL.pdf)
Murata Type 2EL 2DL Module Footprint	Murata Type 2EL / 2DL module footprint (type2el-2dl-module-footprint-topview.dxf)
Murata Type 2EL 2DL PCB Type Di-pole and Trace Antenna	Murata Type 2EL / 2DL module trace antenna (type2el-2dl-u-fl.dxf)
Linux	Murata GitHub link for Linux transmit power files for 2EL /2DL
FreeRTOS	TBD
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 27 lists all the support resources available for the Murata Wi-Fi/BT solution.

Table 27: 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	Jun 12, 2023	First Issue	
2.0	Jul 04, 2023	Added 2DL	Revision 1.0 only 2EL. Added 2DL in Revision 2.0.
3.0	Oct 10, 2023	3.1 Reference Circuit 5.1 Typical Rx Minimum Sensitivity Level at Module Antenna port	Format change / corrected a pin name (Pin79) Added
4.0	Apr 19, 2024	2.2 Hardware Block Diagram 3.1 Reference Circuit 3.5 Recommended Antenna 4.4 Dedicated Antenna Configuration File for Linux	Added Dedicated Antenna Block Diagrams. Added Dedicated Antenna reference schematics. Added Dedicated Antenna design. Added
5.0	Sep 20, 2024	3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector 5.3.1 WLAN	Added an additional registered antennas in Japan Radio Law certification. Added Current consumption AVDD33
6.0	Dec 17, 2024	4.2 Bluetooth Configuration Files for Linux	Corrected JP Bluetooth Power setting
7.0	Mar 05, 2025	3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector 3.5.3 PCB Stack-Up 4.5 Configuration Files for FreeRTOS	Added Info Note Modify the wording: Underneath u.FL/MHF connector. Removed configuration files.
7.1	May 08, 2025	3.5.1 PCB Type Di-pole Antenna with the Co-axial Connector	Correct a typographical error
8.0	Aug 05, 2025	3.5.2 Trace Antenna	Added reference SRF value
9.0	May 21, 2026	4.2 Bluetooth Configuration Files for Linux	Updated Script for EU and JP. New script supports 3M baud rate

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