Application Note

Type 2LL Wi-Fi™ + Bluetooth® + 802.15.4 Tri-Radio Module

NXP IW610G Chipset for 802.11a/b/g/n/ac/ax + Bluetooth(LE) + IEEE 802.15.4 Radio Law Certification Application Note - Rev. 1.0

- Design Name: Type 2LL
- P/N: LBES0ZZ2LL

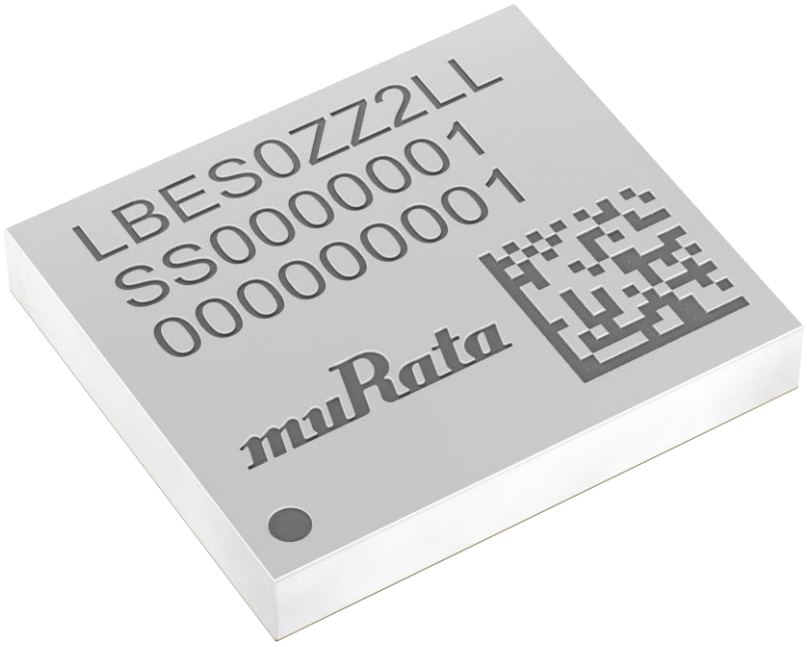


Table of Contents

1 General Information for Radio Regulatory Certification 5
1.1 Application Model Part Number 5
1.2 Label 5
1.3 Pin Layout 6
1.4 Operating Conditions 7
1.5 Package Label 8
1.6 Country of Origin 9
2 Radio Regulatory Certification Information by Country 9
2.1 FCC 9
2.1.1 Setting RF Power 10
2.1.2 Theory of Operation 14
2.1.3 Integration Instructions 14
2.1.4 About Power Supply (Limited Condition) 18
2.1.5 Trace Antenna and Feed Line 18
2.1.6 Layout Guidance for Microstrip Design and External Antenna 20
2.2 ISED 24
2.2.1 Antenna List 25
2.2.2 Setting RF Power 26
2.2.3 Theory of Operation 30
2.2.4 Integration Instructions 30
2.2.5 Antenna 33
2.2.6 Layout Guidance for Microstrip Design and External Antenna 35
2.2.7 About Power Supply (Limited Condition) 38
2.3 EU 39
2.3.1 Setting RF Power 40
2.3.2 Theory of Operation 42
2.4 Japan 42
2.4.1 Product Outline 43
2.4.2 Feature 43
2.4.3 Setting RF Power 43
2.4.4 Types of Radio Emissions 45
2.4.5 Theory of Operation 45
2.4.6 Antenna 45
2.4.7 Notification 49
2.5 NCC 50

2.5.1 Product Outline....51
2.5.2 Feature....51
2.5.3 Setting RF Power....51
2.5.4 Theory of Operation....52
2.5.5 Antenna....52
Revision History....54

Figures

Figure 1: Labels....5
Figure 2: Pin Layout....6
Figure 3: Package (Humidity-proof packaging)....8
Figure 4: Package Label Display Example....8
Figure 5: EVB Design Used for Testing (FCC)....19
Figure 6: Trace Antenna and Feed Line of The Jig (FCC)....19
Figure 7: 50 Ω microstrip line and Type2LL_Antenna (FCC)....20
Figure 8: Trace antenna (Type2LL_Antenna) Layout Guide (FCC)....20
Figure 9: Antenna with u.FL Connector Layout Guide (FCC)....21
Figure 10: Microstrip RF Trace Structure (FCC)....22
Figure 11: EVB Design Used for Testing (ISED)....34
Figure 12: Trace Antenna and Feed Line of The Jig (ISED)....35
Figure 13: 50 Ω Microstrip Line and Type2LL_Antenna (ISED)....36
Figure 14: Trace Antenna (Type2LL_Antenna) Layout Guide (ISED)....36
Figure 15: Antenna with u.FL Connector Layout Guide (ISED)....37
Figure 16: Microstrip RF Trace Structure (ISED)....37
Figure 17: Type2LL_Antenna Drawing (Japan)....47
Figure 18: Type2LL Antenna Appearance (Japan)....47
Figure 19: Antenna Measurement Directions (Japan)....48
Figure 20: Antenna Measurement Result (Japan)....48

Tables

Table 1: Document Conventions....4
Table 2: Marking Labels....5
Table 3: Dimension Labels....6
Table 4: Terminal Configurations....7
Table 5: Operating Conditions....7
Table 6: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (FCC)....10
Table 7: WLAN RF Power Setting - 2.4 GHz 802.11ax (FCC)....11

Table 8: WLAN RF Power Setting - 2.4 GHz 802.11ax OFDMA (FCC) 11
Table 9: BLE / IEEE 802.15.4 RF Power Setting (FCC) 11
Table 10: WLAN RF Power Setting - 5 GHz 802.11a (FCC) 12
Table 11: WLAN RF Power Setting - 5 GHz 802.11n (FCC) 12
Table 12: WLAN RF Power Setting - 5 GHz 802.11ac (FCC) 12
Table 13: WLAN RF Power Setting - 5 GHz 802.11ax (FCC) 13
Table 14: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (FCC) 13
Table 15: Theory of Operation (FCC) 14
Table 16: Antennas (FCC) 15
Table 17: Power Supply Voltages (FCC) 18
Table 18: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (ISED) 26
Table 19: WLAN RF Power Setting - 2.4 GHz 802.11ax (ISED) 26
Table 20: WLAN RF Power Setting - 2.4 GHz 802.11ax OFDMA (ISED) 27
Table 21: BLE / IEEE 802.15.4 RF Power Setting (ISED) 27
Table 22: WLAN RF Power Setting - 5 GHz 802.11a (ISED) 27
Table 23: WLAN RF Power Setting - 5 GHz 802.11n (ISED) 28
Table 24: WLAN RF Power Setting - 5 GHz 802.11ac (ISED) 28
Table 25: WLAN RF Power Setting - 5 GHz 802.11ax (ISED) 28
Table 26: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (ISED) 29
Table 27: Theory of Operation (ISED) 30
Table 28: Antennas (ISED) 33
Table 29: Power Supply Voltages (ISED) 38
Table 30: WLAN RF Power Setting - 2.4 GHz (EU) 40
Table 31: WLAN RF Power Setting - 2.4 GHz 802.11ax(HE20) OFDMA (EU) 40
Table 32: BLE / IEEE 802.15.4 RF Power Setting (EU) 40
Table 33: WLAN RF Power Setting - 5 GHz 802.11a/n/ac/ax for Channels 36 ~ 140 (EU) 41
Table 34: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA for Channels 36 ~ 140 (EU) 41
Table 35: WLAN RF Power Setting - 5 GHz 802.11 a/n/ac/ax for Channels 149 ~ 169 (EU) 41
Table 36: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA for Channels 149 ~ 169 (EU) 41
Table 37: Theory of Operation (EU) 42
Table 38: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (Japan) 43
Table 39: WLAN RF Power Setting - 2.4 GHz 802.11ax(HE20) OFDMA (Japan) 44
Table 40: BLE / IEEE 802.15.4 RF Power Setting (Japan) 44
Table 41: WLAN RF Power Setting - 5 GHz 802.11a/n/ac/ax (Japan) 44
Table 42: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (Japan) 44
Table 43: Types of Radio Emissions 45
Table 44: Theory of Operation (Japan) 45
Table 45: Antenna (Japan) 45
Table 46: Theory of Operation (NCC) 52
Table 47: Antenna (NCC) 52

About This Document

Murata's Type 2LL is a small and very high-performance module based on NXP IW610G combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth LE + 802.15.4. This application note provides Radio Law Certification user manual. It is designed to ensure that module manufacturers correctly communicate the necessary information to host manufacturers that incorporate their modules. Refer to Type 2LL Datasheet for module specification.

Audience & Purpose

The Intended audience of this document are the manufacturers and host manufacture that will integrate this module to their modules.

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**: Operating Conditions 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 General Information for Radio Regulatory Certification

This section contains the following topics:

- Application model part number
- Markings/Dimensions
- Pin Layout
- Operating Conditions
- Package Label
- Country of Origin

1.1 Application Model Part Number

Application model part number: LBES0ZZ2LL

1.2 Label

Figure 1 shows the module labels. **Table 2** and **Table 3** describes the labels.

Figure 1: Labels

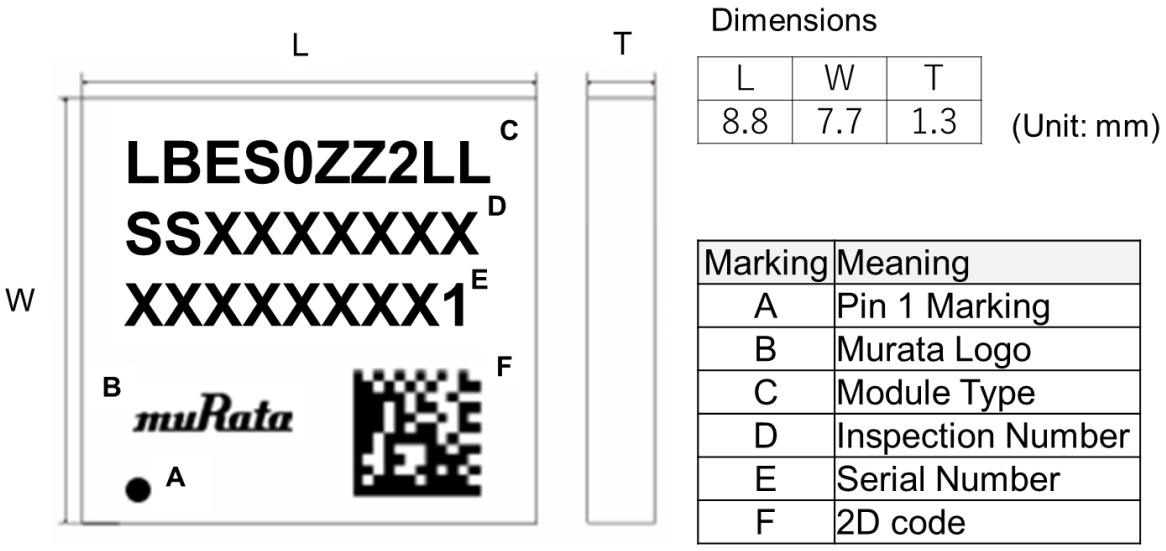


Table 2: Marking Labels

Marking Label	Meaning
A	Pin 1 Marking
B	Murata logo
C	Module Type
D	Inspection Number
E	Serial Numbler

Marking Label	Meaning
F	2D code

Table 3: Dimension Labels

L	W	T
8.8 mm	7.7 mm	1.3 mm

Since there is no space to describe the notational requirements of each country, we are applying for the notational requirements to be posted in the manual or package.

1.3 Pin Layout

Figure 2 shows the pin layout.

Figure 2: Pin Layout

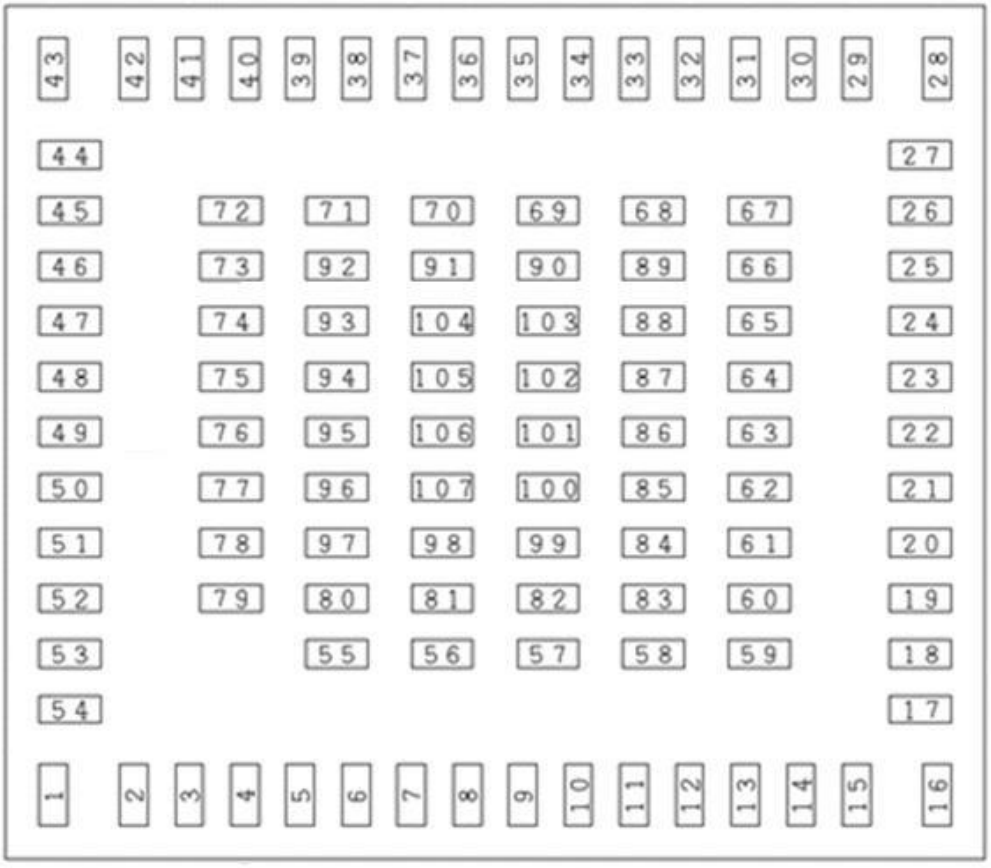


Table 4 describes the pins.

Table 4: Terminal Configurations

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	29	GND	57	NC	85	GND
2	GND	30	NC	58	Reserved	86	GND
3	AVDD33_USB	31	NC	59	Reserved	87	GND
4	SPI_FRMn	32	GND	60	CONFIG_HOST_BOOT[2]/ SD_VOLTAGE_SEL	88	GND
5	SPI_INT	33	NC	61	NC	89	GND
6	SPI_RXD/PCM_SYNC	34	AVDD18_USB_OUT	62	GND	90	GND
7	SPI_TXD	35	NC	63	IND_RST_WL	91	GND
8	SPI_CLK	36	AVDD18_USB_IN	64	IND_RST_BT	92	GND
9	GND	37	NC	65	EXT_GNT	93	GND
10	PDn	38	IND_RST_NB	66	EXT_REQ	94	GND
11	GND	39	GND	67	GND	95	GND
12	AVDD33	40	SD_VIO	68	GND	96	GND
13	AVDD33	41	GND	69	WCI-2_SIN/ EXT_STATE	97	GND
14	GND	42	SD_CMD	70	WCI-2_SOUT/EXT_FREQ	98	GND
15	ANT0	43	GND	71	GND	99	GND
16	GND	44	SD_CLK	72	SD_INT/USB_VB US_ON	100	GND
17	GND	45	SD_DAT[1]	73	WL_WAKE_OUT	101	GND
18	NC	46	SD_DAT[3]	74	WL_WAKE_IN	102	GND
19	GND	47	SD_DAT[2]	75	NB_WAKE_IN	103	GND
20	GND	48	SD_DAT[0]	76	NB_WAKE_OUT	104	GND
21	GND	49	UART_SOUT	77	USB_DP	105	GND
22	GND	50	UART_CTSn	78	USB_DM	106	GND
23	Reserved	51	UART_SIN	79	XOSC_EN	107	GND
24	NC	52	UART_RTSn	80	EXT_PRI		
25	RF_CNTL3	53	GND	81	GND		
26	RF_CNTL2	54	VIO	82	GND		
27	RF_CNTL0	55	CONFIG_HOST[0]	83	GND		
28	GND	56	CONFIG_HOST[1]	84	GND		

1.4 Operating Conditions

Table 5 describes the operating conditions.

Table 5: Operating Conditions

Parameter		Minimum	Typical	Maximum	Unit
Operating Temperature		-40	25	85	°C
Supply Voltage	VDD33	3.14	3.3	3.46	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	VIO_SD	1.71 3.14	1.8 3.3	1.89 3.46	V

VIO, VIO_SD have two systems, 1.8V system and 3.3V system. However, these do not affect the RF characteristics.

1.5 Package Label

Figure 3 shows the package and **Figure 4** shows an example of the package label.

Figure 3: Package (Humidity-proof packaging)

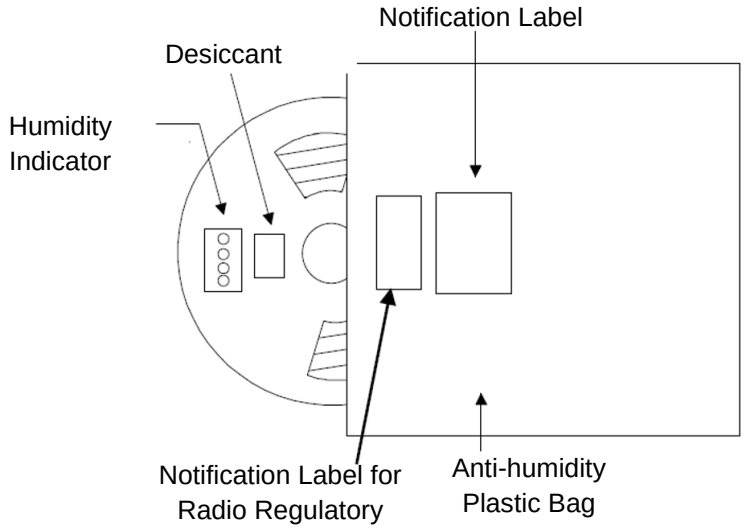
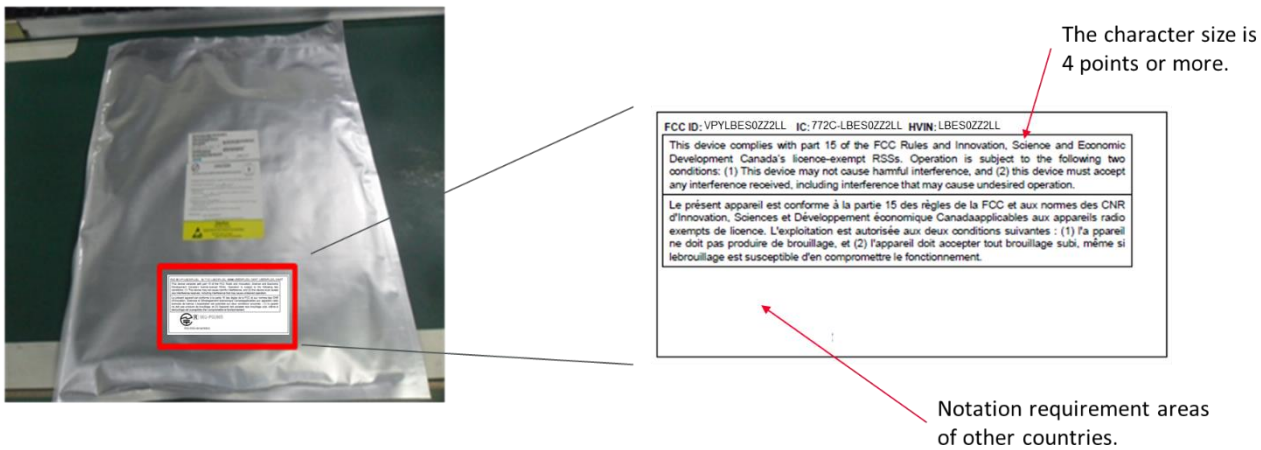


Figure 4: Package Label Display Example



The package label may be attached on one side only.

1.6 Country of Origin

China

SHENZHEN MURATA TECHNOLOGY CO., LTD.

Some countries have applied for certification in two countries, China and Japan, in preparation for future factory changes, but the production site in the delivery specifications is the above-mentioned factory in China.

2 Radio Regulatory Certification Information by Country

This section contains the following country/region specific information:

- FCC (USA)
- ISED (Canada)
- EU
- Japan
- NCC (Taiwan)

2.1 FCC

Model Name: LBES0ZZ2LL

FCC ID: VPYLBES0ZZ2LL

For the details about this module, please refer to the specification sheet of module. This module should be installed in the host device according to the interface specification (installation procedure)

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the end user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as shown in User manual.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

This device complies with below part 15 of the FCC Rules.

- Part 15 Subpart C
- Part 15 Subpart E

Since there is no space which indicates FCC ID on this module, FCC ID is indicated in a manual. If the module is installed inside another device, then the device must also display a label referring to the enclosed module.

For example : [Contains FCC ID : VPYLBES0ZZ2LL] or [Contains Transmitter Module FCC ID : VPYLBES0ZZ2LL]

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

This module is designed for mounting inside of the end product by us professionally. Therefore, it complies with the antenna and transmission system requirements of §15.203.

2.1.1 Setting RF Power

This section describes the RF power settings.

2.1.1.1 RF Power Setting for 2.4 GHz WLAN

RF Power Settings for 2.4 GHz WLAN are described in the following tables.

Table 6: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (FCC)

Mode	Channel	Rate / MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11b	1, 2	All Rate	16.0 ± 2.0
	3~9	All Rate	17.0 ± 2.0
	10, 11	All Rate	15.0 ± 2.0
IEEE 802.11g	1,11	All Rate	11.0 ± 2.0
	2	All Rate	14.0 ± 2.0
	3~10	6Mbps~36Mbps	16.0 ± 2.0
		48Mbps, 54Mbps	15.0 ± 2.0
IEEE 802.11n (HT20) IEEE 802.11ac (VHT20)	1	MCS0 ~ MCS7 MCS8(11ac)	8.0 ± 2.0
	2	MCS0 ~ MCS7 MCS8(11ac)	13.0 ± 2.0
	3,9,10	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8(11ac)	13.0 ± 2.0
	4~8	MCS0~MCS4	15.0 ± 2.0
		MCS5~MCS7	14.0 ± 2.0
		MCS8(11ac)	13.0 ± 2.0
	11	MCS0 ~ MCS7 MCS8(11ac)	10.0 ± 2.0

Table 7: WLAN RF Power Setting - 2.4 GHz 802.11ax (FCC)

Mode	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	1	All MCS index	8.0 ± 2.0
	2	All MCS index	13.0 ± 2.0
	3, 9, 10	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8, MCS9	13.0 ± 2.0
	4~8	MCS0 ~ 4	15.0 ± 2.0
		MCS5 ~ MCS7	14.0 ± 2.0
		MCS8, MCS9	13.0 ± 2.0
	11	All MCS index	10.0 ± 2.0

Table 8: WLAN RF Power Setting - 2.4 GHz 802.11ax OFDMA (FCC)

Mode	Channel	MCS index	RU	MAXIMUM TUNE UPTOLERANCE [dBm]
IEEE 802.11ax (HE20)	1	All MCS index	26, 52, 106, 242 tone	8.0 ± 2.0
	2	All MCS index	26, 52, 106, 242 tone	13.0 ± 2.0
	3, 9, 10	MCS0 ~ MCS7	26, 52, 106, 242 tone	14.0 ± 2.0
		MCS8, MCS9	26, 52, 106, 242 tone	13.0 ± 2.0
	4~8	MCS0~4	26, 52, 106, 242 tone	15.0 ± 2.0
		MCS5~MCS7	26, 52, 106, 242 tone	14.0 ± 2.0
		MCS8, MCS9	26, 52, 106, 242 tone	13.0 ± 2.0
	11	All MCS index	26, 52, 106, 242 tone	10.0 ± 2.0

2.1.1.2 RF Power Setting for BLE / IEEE 802.15.4

RF power settings for BLE and IEEE 802.15.4 are described in the following tables.

Table 9: BLE / IEEE 802.15.4 RF Power Setting (FCC)

Mode	Channel	MAXIMUM TUNE UP TOLERANCE [dBm]
LE 1Mbps	NA	10.0 ± 3.0
LE 2Mbps	NA	10.0 ± 3.0
LE 125kbps	NA	10.0 ± 3.0
LE 500kbps	NA	10.0 ± 3.0
IEEE802.15.4	11~25	10.0 ± 3.0
	26	0.0 ± 3.0

2.1.1.3 RF Power Setting for 5 GHz WLAN

RF power settings for 5 GHz WLAN are described in the following tables.

Table 10: WLAN RF Power Setting - 5 GHz 802.11a (FCC)

Mode	Band	Channel	Rate	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11a	W52/W53	36~64	6Mbps~36Mbps	16.0 ± 2.0
			48Mbps, 54Mbps	15.0 ± 2.0
	W56	100~144	6Mbps~36Mbps	16.0 ± 2.0
			48Mbps, 54Mbps	15.0 ± 2.0
	W58	149~165	6Mbps~36Mbps	16.0 ± 2.0
			48Mbps, 54Mbps	15.0 ± 2.0

Table 11: WLAN RF Power Setting - 5 GHz 802.11n (FCC)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11n (HT20)	W52/W53	36, 64	All MCS index	14.0 ± 2.0
		40~60	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
	W56	100~136, 144	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0

Table 12: WLAN RF Power Setting - 5 GHz 802.11ac (FCC)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ac (VHT20)	W52/W53	36, 64	MCS0~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
		40~60	MCS0 ~ MCS4	15.0 ± 2.0
			MCS5 ~ MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
	W56	100~136, 144	MCS0 ~ MCS4	15.0 ± 2.0
			MCS5 ~ MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0

Table 13: WLAN RF Power Setting - 5 GHz 802.11ax (FCC)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	W52/W53	36, 64	MCS0 ~ MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0
		40~60	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
	W56	100~136, 144	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0

Table 14: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (FCC)

Mode	Band	Channel	RU	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	W52/W53	36, 64	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0 ~ MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
		40~60	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0 ~ MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
	W56	100~136, 144	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0~MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
		140	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	12.0 ± 2.0
			106, 242 tone	All MCS index	13.0 ± 2.0
	W58	149~165	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0~MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0

2.1.2 Theory of Operation

Table 15 describes the theory of operation.

Table 15: Theory of Operation (FCC)

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n/ac/ax (BW20)	2412-2462 MHz	Active	Yes
	BLE	2402-2480 MHz	N/A	N/A
	IEEE 802.15.4	2405-2480 MHz	N/A	N/A
W52	11a/n/ac/ax (BW20)	5180-5240 MHz	Active	Yes
W53[1] [2]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
W56[1] [2]	11a/n/ac/ax (BW20)	5500-5720 MHz	Passive	No
W58	11a/n/ac/ax (BW20)	5745-5825 MHz	Active	Yes

2.1.3 Integration Instructions

This manual is based on KDB 996369. It is designed to ensure that module manufacturers correctly communicate the necessary information to host manufacturers that incorporate their modules.

1. General: Applicable

Sections 2 through 10 describe the items that must be provided in the integration instructions for host product manufacturers (e.g., OEM instruction manual) to use when integrating a module in a host product. This Modular transmitter applicant (muRata) should include information in their instructions for all these items indicating clearly when they are not applicable.

2. List of Applicable FCC Rules: Applicable

This device complies with below part 15 of FCC Rules.

- Part 15 Subpart C
- Part 15 Subpart E

3. Summarize the specific operational use conditions: Applicable

This module designed for mounting inside of the end product by OEM.

Antenna, antenna cable and antenna connectors of this module should be installed inside the end product so end users Cannot change these setting.

Other than supported frequencies of the attached antenna should be controlled not to be transmitted by the host software.

This module is a dedicated module for OEM customers and must not be sold to the general public.

Therefore, it complies with the antenna and transmission system requirements of § 15.203.

4. Limited Module Procedures: Applicable

This module needs to supply a regulated voltage from host device.

Since there is no space which indicates FCC ID on this module, FCC ID is indicated in a manual. If the module is installed inside another device, then the device must also display a label referring to the enclosed module.

For example : [Contains FCC ID : VPYLBES0ZZ2LL] or [Contains Transmitter Module FCC ID : VPYLBES0ZZ2LL]

[1] DFS MASTER function not available. DFS client function available.
[2] There is a TPC function.

5. Trace Antenna Designs: Applicable

Please perform the Trace antenna design that followed the specifications of the antenna.
The concrete contents of a check are the following three points.

1. It is the same type as the antenna type of antenna specifications.
   Confirm the same size as the Gerber file.
2. An antenna gain is lower than a gain given in antenna specifications.
   Measure the gain, and confirm the peak gain is less than the application value.
3. The emission level is not getting worse.
   Measure the spurious and confirm degradation of less than 3dB than spurious value of worst of report used for the application. However it is spurious defined below.

Please send those reports to Murata. And please refer to the Antenna in Section 2.1.6.7.

6. RF Exposure Considerations: Applicable

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment should be installed and operated keeping the radiator at least 20 cm or more away from person's body.

When installing it in a portable equipment, it is necessary to take a SAR test with your set mounting this module. Class II permissive change application is necessary using the SAR report. Please contact Murata. And an application for a Class II permissive change from a Mobile equipment to a Portable equipment is also required.

1. **Portable equipment:** Equipment for which the spaces between human body and antenna are used within 20 cm.
2. **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20 cm.

7. Antennas: Applicable

Table 16: Antennas (FCC)

Part number	Vendor	Type	Peak Gain [dBi]		Connector
			2.4 GHz	5 GHz	
146187	Molex	Dipole	3.2	4.25	u.FL
146153	Molex	Dipole	3.2	4.25	u.FL
219611	Molex	Dipole	2.67	3.67	u.FL
WT32D1-KX	Unictron	Dipole	3.0	4.0	u.FL
AA258	Unictron	Dipole	0.9	3.8	u.FL
FXP830.07.0100C	Taoglas	Dipole	2.5	4.7	MHF1
SRF2W012	Antenova	Dipole	3.0	4.0	u.FL
STDANTEMD-013	Sansei	Dipole	1.9	2.8	u.FL
EMF2471A3S	Laird	Dipole	2.2	4.4	MHF1
1001932FT	KAVX	Dipole	2.5	4.4	MHF1
1001932PT	KAVX	Dipole	2.03	4.45	MHF1

Part number	Vendor	Type	Peak Gain [dBi]		Connector
			2.4 GHz	5 GHz	
W3P35x8W04	KAVX	Dipole	2.3	5.0	MHF1
W2.4-5P-U	Inventek	Dipole	3.73	5.18	u.FL
Type2LL_Antenna	Murata	Monopole	3.6	4.6	Trace

8. Label and Compliance Information: Applicable

The following statements must be described on the user manual of the host device of this module:

Contains Transmitter Module FCC ID: VPYLBES0ZZ2LL	OR	Contains FCC ID: VPYLBES0ZZ2LL

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

If it is difficult to describe this statement on the host product due to the size, please describe in the User's manual.

FCC CAUTION

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Compliance with FCC requirement 15.407(c)

Data transmission is always initiated by software, which is passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted. In other words, this device automatically discontinue transmission in case of either absence of information to transmit or operational failure.

Frequency Tolerance: ±20 ppm

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

When installing it in mobile equipment, please describe the following warning to the manual.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines. This equipment should be installed and operated keeping the radiator at least 20cm or more away from person's body.

This module is only approved as mobile equipment. Therefore, do not install it on portable equipment.

If you wish to use it as a portable equipment, please contact Murata in advance as Class II application accompanied by SAR testing using the final product are required.

3. **Portable equipment:** Equipment for which the spaces between human body and antenna are used within 20 cm.
4. **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20 cm.

9. Information On Test Modes and Additional Testing Requirements: Applicable

Please check the installation manual first. Please contact Murata if you have any questions when conducting the RF certification test on the host. We (Murata) are ready to present the control manual and others for the RF certification test.

10. Additional Testing, Part 15 Subpart B Disclaimer: Applicable

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

If the final product with this module is FCC Class A digital device, include the following in the manual of the final product.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

If the final product with this module is FCC Class B digital device, include the following in the manual of the final product.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

11. Note on EMI Considerations: Applicable

A host manufacture is recommended to use KDB 996369 D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

For standalone mode, reference the guidance in D04 Module Integration Guide and for simultaneous mode7; see D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.

12. How to Make Changes: Applicable

When changing from the conditions of approval, please present technical documentation that it is equivalent to a Class I change. For example, when adding or changing an antenna, the following technical documents are required.

1. The document indicating the same type as the original antenna.
2. Technical document showing that the gain is the same or lower than the gain at the time of the original approval.
3. Technical document showing that the spurious is no more than 3 dB worse than when it was originally certified.

2.1.4 About Power Supply (Limited Condition)

This Module (LBES0ZZ2LL) has been approved as Limited Modular Approval. These modules do not have a voltage stabilizing circuit in the power path to the internal RF circuitry. Therefore, the Limited Condition must provide a stable power supply for the supply voltage to the module. Please supply a stable power supply so that the voltage shown in **Table 17** is applied.

Table 17: Power Supply Voltages (FCC)

Parameter		Minimum	Typical	Maximum	Unit
Supply Voltage	VDD33	3.14	3.3	3.46	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	VIO_SD	1.71 3.14	1.8 3.3	1.89 3.46	V

2.1.5 Trace Antenna and Feed Line

2.1.5.1 Signal Line Between an Antenna and a Module

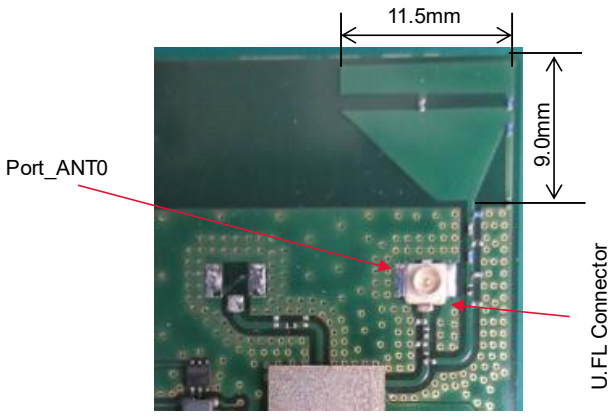
It is a 50 Ω line design. Fine tuning of return loss etc. can be performed using a matching network. However, it is required to check "Class1 change" and "Class2 change" which the authorities define then.

The concrete contents of a check are the following three points.

1. It is the same type as the antenna type of antenna specifications.
2. An antenna gain is lower than a gain given in antenna specifications.
3. The emission level is not getting worse.

50 Ω line (microstrip line length) and Trace Antenna (Type2LL_Antenna) are used as the design of the EVB used for the test. **Figure 5** shows the pattern used in the certification test.

Figure 5: EVB Design Used for Testing (FCC)



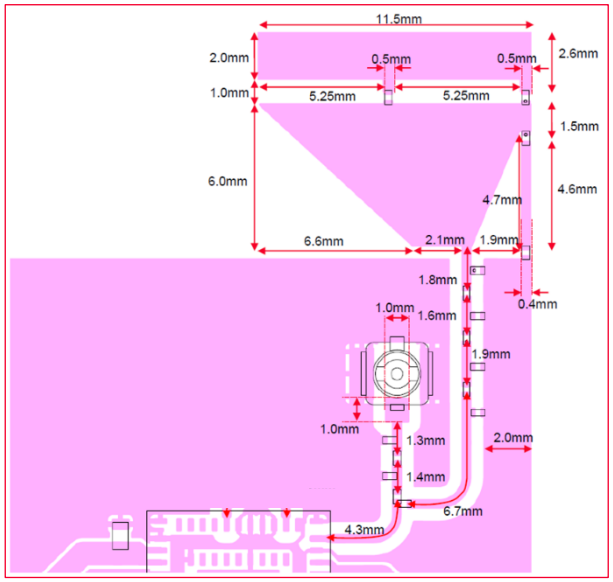
The 50 Ω microstrip line and Type2LL_Antenna needs to be copied when module is installed in the End product.

Murata provides set makers with Gerber data or something similar.

2.1.5.2 Trace Antenna and Feed Line of The Jig Where the Certification Test is Conducted

- Substrate type name of certification test jig: **P2ML11761**
- Feed line width: **0.4 mm**
- Substrate thin: **0.8 ± 0.1 mm**
- Substrate material: **FR-4**
- Substrate thickness between GND layer and surface layer: **0.235 mm**

Figure 6: Trace Antenna and Feed Line of The Jig (FCC)



2.1.6 Layout Guidance for Microstrip Design and External Antenna

2.1.6.1 Trace Antenna (Type2LL_Antenna)

The LBES0ZZ2LL module is certified with a PCB antenna (Type2LL_Antenna).

The following precautions should be taken when using this PCB antenna (Type2LL_Antenna)

- When the module is installed in the final product, the 50 Ω microstrip line and Type2LL_Antenna, outlined in right red in **Figure 7**, must be copied to the state shown in **Figure 8** where it was certified.
- Port_ANT1 can use the following four antennas when it is in Dedicated Usage.
  - 146153, 219611, WT32D1-KX, W24P-U

Murata provides set makers with Gerber data or something similar.

Figure 7: 50 Ω microstrip line and Type2LL_Antenna (FCC)

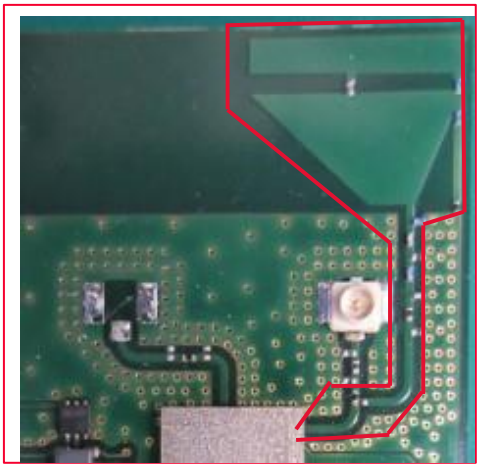
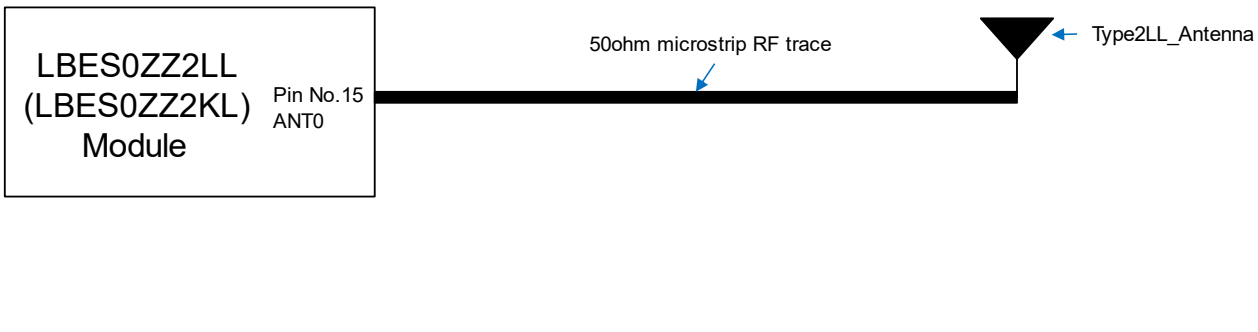


Figure 8: Trace antenna (Type2LL_Antenna) Layout Guide (FCC)



2.1.6.2 Antenna With u.FL Connector and Cables and Feed Lines

- The LBES0ZZ2LL module is certified with four external antennas.

The external antenna should be connected to the LBES0ZZ2LL module using 50 Ω microstrip RF trace and a u.FL RF connector as described below.

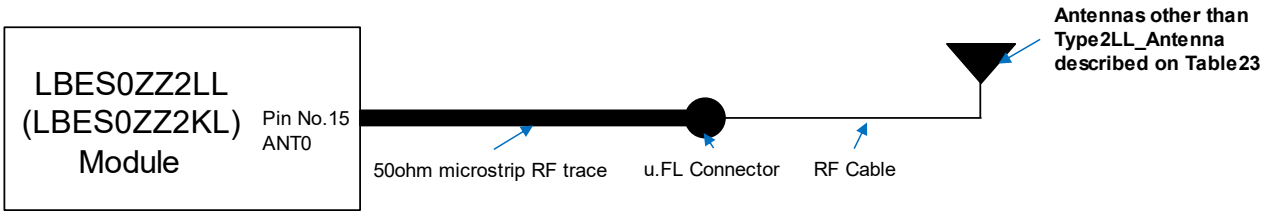
- The microstrip RF trace and u.FL connector are placed on the customer‘s PCB and are external to the LBES0ZZ2LL module.
- The antenna is then connected to this u.FL Connector via a 50 Ω RF adapter cable.
- The design of the 50 Ω microstrip RF trace on the customer’s PCB is crucially important.

Compliant operation of the LBES0ZZ2LL module is dependent on proper construction of this 50 Ω line and the following guidelines must be followed to ensure legal operation of the product.

Figure 9 shows the required microstrip structure to be routed between module pin 15 and the u.FL connector.

The top PCB trace carries the RF energy from module to u.FL connector.

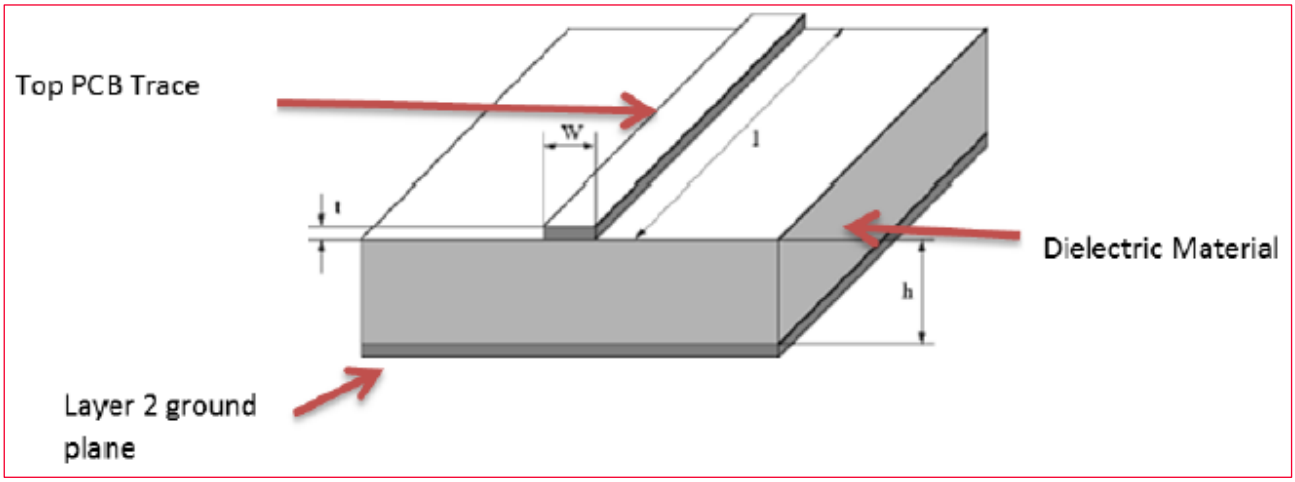
Figure 9: Antenna with u.FL Connector Layout Guide (FCC)



50 Ω microstrip RF trace: Murata provides set makers with Gerber data or something similar.

As shown in **Figure 10**, the Layer2 ground plane provides a return path for the circuit. The Dielectric material (along with the dimensions of the microstrip structures) determines the characteristic impedance of the microstrip transmission line.

Figure 10: Microstrip RF Trace Structure (FCC)



Note the representative dimensions shown in the drawing above. It is imperative that the module customer (the integrator) use the exact dimensions we recommend ensuring a 50 Ω impedance for this transmission line.

The following dimensions and/or ratios should be used to set the microstrip impedance to 50 Ω:

- Dielectric (PCB) Material: We recommend standard FR4 PCB material. Other dielectrics will work but will require recalculation of microstrip dimensions.

  The following guidance is predicated on the use of FR4 Dielectric:

  - If FR4 is not used for PCB material, please contact Murata to determine new dimensions for microstrip structure.

- **h** (Dielectric Height) - this is the thickness of dielectric between the trace layer (layer 1) and the ground plane on layer 2.

  Note that layer 2 must be electrical ground. We recommend a dielectric thickness of 8-15 mils. This range provides the customer with some flexibility in board construction.

- **t** (**trace thickness**): Microstrip impedance is not severely affected by the thickness dimension. Standard 102 or 202 copper deposition is recommended. Equivalent thickness is 1-2 mils.

- **W** (**trace width**): this is the crucial dimension. This width must be set correctly to obtain the desired 50 Ω impedance.

  When using FR-4 dielectric, the width (W) of the microstrip trace should be set to: W = H* 1.8, where W is microstrip trace width and H is Dielectric height. Note that both values must be measured in identical units (mils or mm).

  Example:

  H = 12 mils, W =12 * 1.8 = 21.6 mils

  H = 0.4 mm, W = 0.4*1.8 = 0.72 mm

A reliable 50-ohm transmission line will be produced if the above guidance is closely followed.

Any deviations from the guidance above may cause the module to operate in noncompliant manner.

Any implementation questions or concerns should be directed to Murata module technical support.

2.2 ISED

PMN: LBES0ZZ2LL	**HVIN:** LBES0ZZ2LL	**IC:** 722C- LBES0ZZ2LL

This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

English Version
For indoor use only (5150-5250 MHz band and channel 52, 54, 58).
French Version
Pour usage intérieur seulement (5150-5250 MHz band and channel 52, 54, 58)

English Version
Data transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted. In other words, this device automatically discontinue transmission in case of either absence of information to transmit or operational failure.
French Version
La transmission des données est toujours initiée par le logiciel, puis les données sont transmises par l'intermédiaire du MAC, par la bande de base numérique et analogique et, enfin, à la puce RF. Plusieurs paquets spéciaux sont initiés par le MAC. Ce sont les seuls moyens pour qu'une partie de la bande de base numérique active l'émetteur RF, puis désactive celui-ci à la fin du paquet. En conséquence, l'émetteur reste uniquement activé lors de la transmission d'un des paquets susmentionnés. En d'autres termes, ce dispositif interrompt automatiquement toute transmission en cas d'absence d'information à transmettre ou de défaillance.

English Version
This radio transmitter (IC: 772C-LBES0ZZ2LL) has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.
French Version
Le présent émetteur radio (IC: 772C-LBES0ZZ2LL) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour

English Version
When installing it in mobile equipment: This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment should be installed and operated by keeping the radiator at least 20 cm or more away from person's body.
French Version
Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'IC. Cet équipement doit être installé et utilisé en gardant une distance de 20 cm ou plus entre le radiateur et le corps humain.

When installing it in a portable equipment:

It is necessary to take a SAR test with your set mounting this module.

Class 4 permissive change application is necessary using the SAR report.

Please contact Murata.

- **Portable equipment:** Equipment for which the spaces between human body and antenna are used within 20 cm.
- **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20 cm.

2.2.1 Antenna List

English Version

This radio transmitter (772C-LBES0ZZ2LL) has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated.

Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

: Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	2.67 dBi@2.4GHz / 3.67 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	0.9 dBi@2.4GHz / 3.8 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.7 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	1.9 dBi@2.4GHz / 2.8 dBi@5GHz
Dipole Antenna	Gain:	2.2 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.03 dBi@2.4GHz / 4.45 dBi@5GHz
Dipole Antenna	Gain:	2.3 dBi@2.4GHz / 5.0 dBi@5GHz
Dipole Antenna	Gain:	3.73 dBi@2.4GHz / 5.18 dBi@5GHz
Monopole Antenna	Gain:	3.6 dBi@2.4GHz / 4.6 dBi@5GHz

French Version

Le présent émetteur radio (772C-LBES0ZZ2LL) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal.

Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

: Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	2.67 dBi@2.4GHz / 3.67 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	0.9 dBi@2.4GHz / 3.8 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.7 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	1.9 dBi@2.4GHz / 2.8 dBi@5GHz
Dipole Antenna	Gain:	2.2 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.03 dBi@2.4GHz / 4.45 dBi@5GHz
Dipole Antenna	Gain:	2.3 dBi@2.4GHz / 5.0 dBi@5GHz
Dipole Antenna	Gain:	3.73 dBi@2.4GHz / 5.18 dBi@5GHz
Monopole Antenna	Gain:	3.6 dBi@2.4GHz / 4.6 dBi@5GHz

2.2.2 Setting RF Power

This section describes the RF power settings.

2.2.2.1 RF Power Setting for 2.4 GHz WLAN

RF Power Settings for 2.4 GHz WLAN are described in the following tables.

Table 18: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (ISED)

Mode	Channel	Rate / MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11b	1, 2	All Rate	16.0 ± 2.0
	3~9	All Rate	17.0 ± 2.0
	10, 11	All Rate	15.0 ± 2.0
IEEE 802.11g	1,11	All Rate	11.0 ± 2.0
	2	All Rate	14.0 ± 2.0
	3~10	6Mbps~36Mbps	16.0 ± 2.0
		48Mbps, 54Mbps	15.0 ± 2.0
IEEE 802.11n (HT20) IEEE 802.11ac (VHT20)	1	MCS0 ~ MCS7 MCS8(11ac)	8.0 ± 2.0
	2	MCS0 ~ MCS7 MCS8(11ac)	13.0 ± 2.0
	3,9,10	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8(11ac)	13.0 ± 2.0
	4~8	MCS0~MCS4	15.0 ± 2.0
		MCS5~MCS7	14.0 ± 2.0
		MCS8(11ac)	13.0 ± 2.0
	11	MCS0 ~ MCS7 MCS8(11ac)	10.0 ± 2.0

Table 19: WLAN RF Power Setting - 2.4 GHz 802.11ax (ISED)

Mode	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	1	All MCS index	8.0 ± 2.0
	2	All MCS index	13.0 ± 2.0
	3, 9, 10	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8, MCS9	13.0 ± 2.0
	4~8	MCS0 ~ 4	15.0 ± 2.0
		MCS5 ~ MCS7	14.0 ± 2.0
		MCS8, MCS9	13.0 ± 2.0
	11	All MCS index	10.0 ± 2.0

Table 20: WLAN RF Power Setting - 2.4 GHz 802.11ax OFDMA (ISED)

Mode	Channel	MCS index	RU	MAXIMUM TUNE UPTOLERANCE [dBm]
IEEE 802.11ax (HE20)	1	All MCS index	26, 52, 106, 242 tone	8.0 ± 2.0
	2	All MCS index	26, 52, 106, 242 tone	13.0 ± 2.0
	3, 9, 10	MCS0 ~ MCS7	26, 52, 106, 242 tone	14.0 ± 2.0
		MCS8, MCS9	26, 52, 106, 242 tone	13.0 ± 2.0
	4~8	MCS0~4	26, 52, 106, 242 tone	15.0 ± 2.0
		MCS5~MCS7	26, 52, 106, 242 tone	14.0 ± 2.0
		MCS8, MCS9	26, 52, 106, 242 tone	13.0 ± 2.0
	11	All MCS index	26, 52, 106, 242 tone	10.0 ± 2.0

2.2.2.2 RF Power Setting for BLE / IEEE 802.15.4

RF power settings for BLE and IEEE 802.15.4 are described in the following tables.

Table 21: BLE / IEEE 802.15.4 RF Power Setting (ISED)

Mode	Channel	MAXIMUM TUNE UP TOLERANCE [dBm]
LE 1Mbps	NA	10.0 ± 3.0
LE 2Mbps	NA	10.0 ± 3.0
LE 125kbps	NA	10.0 ± 3.0
LE 500kbps	NA	10.0 ± 3.0
IEEE802.15.4	11~25	10.0 ± 3.0
	26	0.0 ± 3.0

2.2.2.3 RF Power Setting for 5 GHz WLAN

RF power settings for 5 GHz WLAN are described in the following tables.

Table 22: WLAN RF Power Setting - 5 GHz 802.11a (ISED)

Mode	Band	Channel	Rate	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11a	W52	36~48	All Rate	13.0 ± 2.0
	W53	52~64	6Mbps~36Mbps	16.0 ± 2.0
		52~64	48Mbps, 54Mbps	15.0 ± 2.0
	W56	100~116, 132~144	6Mbps~36Mbps	16.0 ± 2.0
		100~116, 132~144	48Mbps, 54Mbps	15.0 ± 2.0
	W58	149~165	6Mbps~36Mbps	16.0 ± 2.0
		149~165	48Mbps, 54Mbps	15.0 ± 2.0

Table 23: WLAN RF Power Setting - 5 GHz 802.11n (ISED)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11n (HT20)	W52	36~48	All MCS index	13.0 ± 2.0
	W53	52~60	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
		64	All MCS index	14.0 ± 2.0
	W56	100~116, 132, 136, 144	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
		149~165	MCS5~MCS7	14.0 ± 2.0

Table 24: WLAN RF Power Setting - 5 GHz 802.11ac (ISED)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ac (VHT20)	W52	36~48	All MCS index	13.0 ± 2.0
	W53	52~60	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
		64	MCS0~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
	W56	100~116, 132, 136, 144	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0
		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8	13.0 ± 2.0

Table 25: WLAN RF Power Setting - 5 GHz 802.11ax (ISED)

Mode	Band	Channel	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	W52	36~48	All MCS index	13.0 ± 2.0
	W53	52~60	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0
		64	MCS0~MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0
	W56	100~116, 132, 136, 144	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0

		140	All MCS index	13.0 ± 2.0
	W58	149~165	MCS0~MCS4	15.0 ± 2.0
			MCS5~MCS7	14.0 ± 2.0
			MCS8, MCS9	13.0 ± 2.0

Table 26: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (ISED)

Mode	Band	Channel	RU	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	W52	36~48	26 tone	All MCS index	4.0 ± 2.0
			52 tone	All MCS index	6.0 ± 2.0
			106 tone	All MCS index	9.0 ± 2.0
			242 tone	All MCS index	13.0 ± 2.0
	W53	52~60	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0~MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
		64	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
	W56	100~116, 132,136,144	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	13.0 ± 2.0
			106, 242 tone	MCS0~MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0
		140	26 tone	All MCS index	10.0 ± 2.0
			52 tone	All MCS index	12.0 ± 2.0
			106, 242 tone	All MCS index	13.0 ± 2.0
	W58	149~165	26 tone	MCS0~MCS4	10.0 ± 2.0
			52 tone	MCS0~MCS4	13.0 ± 2.0
			106, 242 tone	MCS0~MCS4	15.0 ± 2.0
				MCS5~MCS7	14.0 ± 2.0
				MCS8, MCS9	13.0 ± 2.0

2.2.3 Theory of Operation

Table 27 describes the theory of operation.

Table 27: Theory of Operation (ISED)

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n/ac/ax(BW20)	2412-2462MHz	Active	Yes
	BLE	2402-2480MHz	N/A	N/A
	IEEE802.15.4	2405-2480MHz	N/A	N/A
W52	11a/n/ac/ax(BW20)	5180-5240MHz	Active	Yes
W53[3] [4]	11a/n/ac/ax(BW20)	5260-5320MHz	Passive	No
W56[3] [4] [5]	11a/n/ac/ax(BW20)	5500-5720MHz*	Passive	No
W58	11a/n/ac/ax(BW20)	5745-5825MHz	Active	Yes

2.2.4 Integration Instructions

Since this module is not sold to general end users directly, there is no user manual of module. For the details about this module, please refer to the specification sheet of module.

This module should be installed in the host device according to the interface specification (installation procedure).

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the end user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as shown in User manual.

- The following information must be indicated on the host device of this module.

  Contains IC: 772C-LBES0ZZ2LL

- In the case of the final product which can be carried around to outdoors. The following indication is necessary for the final product.
  - When the STA function is used in channel 52, 54, or 58.
    At the time of the channel 52, 54 or 58 setting, please indicate "for indoor use only channel". During connecting, please show the channel number which connects. And please indicate that the end user may find out "for indoor use only channel".
- If the final product uses the following frequency, please note that there is a limit.

English Version For indoor use only (5150-5250 MHz band and channel 52, 54, 58).
French Version Pour usage intérieur seulement (5150-5250 MHz band and channel 52, 54, 58)

[3] DFS MASTER function not available. DFS client function available.
[4] There is a TPC function.
[5] The frequency band 5600MHz-5640MHz (11a/n 20M band), 5590MHz-5630MHz (11n/ac/ax 40M band) and 5610MHz(11ac/ax 80M band) is restricted in ISED.

English Version Data transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be on only while one of the aforementioned packets is being transmitted. In other words, this device automatically discontinues transmission in case of either absence of information to transmit or operational failure.
French Version La transmission des données est toujours initiée par le logiciel, puis les données sont transmises par l'intermédiaire du MAC, par la bande de base numérique et analogique et, enfin, à la puce RF. Plusieurs paquets spéciaux sont initiés par le MAC. Ce sont les seuls moyens pour qu'une partie de la bande de base numérique active l'émetteur RF, puis désactive celui-ci à la fin du paquet. En conséquence, l'émetteur reste uniquement activé lors de la transmission d'un des paquets susmentionnés. En d'autres termes, ce dispositif interrompt automatiquement toute transmission en cas d'absence d'information à transmettre ou de défaillance.

English Version This radio transmitter (IC: 772C-LBES0ZZ2LL) has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.
French Version Le présent émetteur radio (IC: 772C-LBES0ZZ2LL) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour

- The following statements must be described on the user manual of the host device of this module:

English Version This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions: 1. This device may not cause interference. 2. This device must accept any interference, including interference that may cause undesired operation of the device.
French Version L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : 1. L'appareil ne doit pas produire de brouillage. 2. L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

- When installing it in a mobile equipment:

English Version This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment and meets RSS-102 of the IC radio frequency (RF) Exposure rules. This equipment should be installed and operated by keeping the radiator at least 20cm or more away from a person's body.
French Version Cet équipement est conforme aux limites d'exposition aux rayonnements énoncées pour un environnement non contrôlé et respecte les règles d'exposition aux fréquences radioélectriques (RF) CNR-102 de l'ISED. Cet équipement doit être installé et utilisé en gardant une distance de 20 cm ou plus entre le radiateur et le corps humain.

- When installing it in a portable equipment:
  It is necessary to take a SAR test with your set mounting this module.
  Class 4 permissive change application is necessary using the SAR report.
  Please contact Murata.

- **Portable equipment:** Equipment for which the spaces between human body and antenna are used within 20cm.
- **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20cm.

- If the antenna of the end product is removed, please describe the following warning on the manual of the end product which contains this module.

English Version

This radio transmitter (772C-LBES0ZZ2LL) has been approved by Innovation, the Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated.

Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

: Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	2.67 dBi@2.4GHz / 3.67 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	0.9 dBi@2.4GHz / 3.8 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.7 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	1.9 dBi@2.4GHz / 2.8 dBi@5GHz
Dipole Antenna	Gain:	2.2 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.03 dBi@2.4GHz / 4.45 dBi@5GHz
Dipole Antenna	Gain:	2.3 dBi@2.4GHz / 5.0 dBi@5GHz
Dipole Antenna	Gain:	3.73 dBi@2.4GHz / 5.18 dBi@5GHz
Monopole Antenna	Gain:	3.6 dBi@2.4GHz / 4.6 dBi@5GHz

French Version

Le présent émetteur radio (772C-LBES0ZZ2LL) a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal.

Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué pour tout type figurant sur la liste, sont strictement interdits pour l'exploitation de l'émetteur.

: Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	3.2 dBi@2.4GHz / 4.25 dBi@5GHz
Dipole Antenna	Gain:	2.67 dBi@2.4GHz / 3.67 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	0.9 dBi@2.4GHz / 3.8 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.7 dBi@5GHz
Dipole Antenna	Gain:	3.0 dBi@2.4GHz / 4.0 dBi@5GHz
Dipole Antenna	Gain:	1.9 dBi@2.4GHz / 2.8 dBi@5GHz
Dipole Antenna	Gain:	2.2 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.5 dBi@2.4GHz / 4.4 dBi@5GHz
Dipole Antenna	Gain:	2.03 dBi@2.4GHz / 4.45 dBi@5GHz
Dipole Antenna	Gain:	2.3 dBi@2.4GHz / 5.0 dBi@5GHz
Dipole Antenna	Gain:	3.73 dBi@2.4GHz / 5.18 dBi@5GHz
Monopole Antenna	Gain:	3.6 dBi@2.4GHz / 4.6 dBi@5GHz

2.2.5 Antenna

The antenna models for ISED are described in **Table 28**.

Table 28: Antennas (ISED)

Antenna P/N	Maker	Type	Peak Gain [dBi]		Connector / form
			2.4GHz	5GHz	
146187	Molex	Dipole	3.2	4.25	u.FL
146153	Molex	Dipole	3.2	4.25	u.FL
219611	Molex	Dipole	2.67	3.67	u.FL
WT32D1-KX	Unictron	Dipole	3.0	4.0	u.FL
AA258	Unictron	Dipole	0.9	3.8	u.FL
FXP830.07.0100C	Taoglas	Dipole	2.5	4.7	MHF1
SRF2W012	Antenova	Dipole	3.0	4.0	u.FL
STDANTEMD-013	Sansei	Dipole	1.9	2.8	u.FL
EMF2471A3S	Laird	Dipole	2.2	4.4	MHF1
1001932FT	KAVX	Dipole	2.5	4.4	MHF1
1001932PT	KAVX	Dipole	2.03	4.45	MHF1
W3P35x8W04	KAVX	Dipole	2.3	5.0	MHF1
W2.4-5P-U	Inventek	Dipole	3.73	5.18	u.FL
Type2LL_Antenna	Murata	Monopole	3.6	4.6	Trace

2.2.5.1 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.

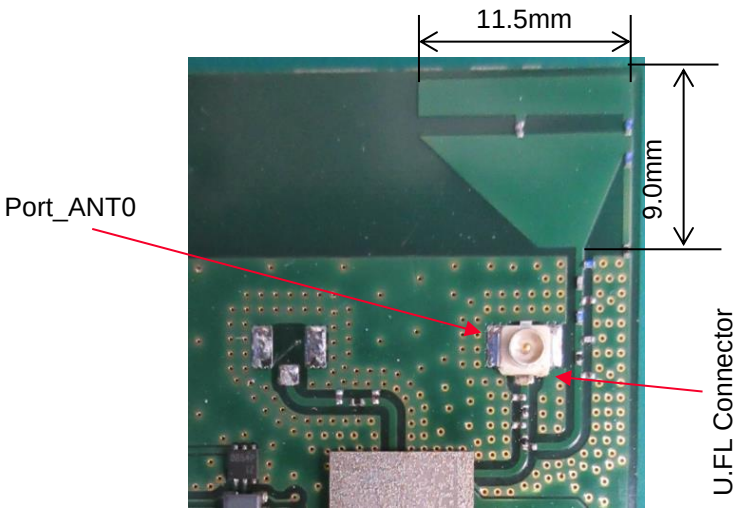
The concrete contents of a check are the following three points:

1. It is the same type as the antenna type of antenna specifications.
2. An antenna gain is lower than a gain given in antenna specifications.
3. The emission level is not getting worse.

The following is the design of the EVB used for the test.

50 Ω line (microstrip line length) and Trace Antenna (Type2LL_Antenna) are used as the design of the EVB used for the test. **Figure 11** shows the pattern used in the certification test.

Figure 11: EVB Design Used for Testing (ISED)



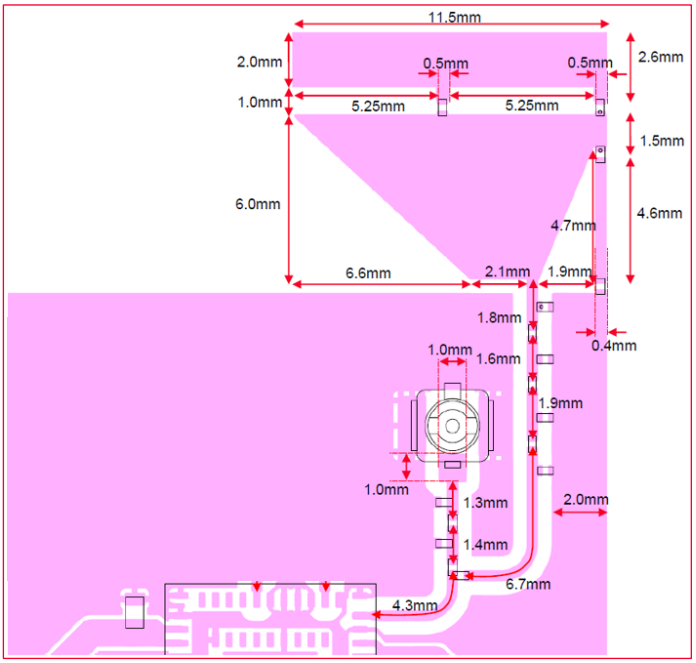
The 50 Ω microstrip line and Type2LL_Antenna needs to be copied when module is installed in the End product.

Murata provides set makers with Gerber data or something similar.

2.2.5.2 Trace Antenna and Feed Line of The Jig Where the Certification Test is Conducted

- Substrate type name of certification test jig: **P2ML11761**
- Feed line width: **0.4 mm**
- Substrate thin: **0.8 ± 0.1 mm**
- Substrate material: **FR-4**
- Substrate thickness between GND layer and surface layer: **0.235 mm**

Figure 12: Trace Antenna and Feed Line of The Jig (ISED)



2.2.6 Layout Guidance for Microstrip Design and External Antenna

2.2.6.1 Trace Antenna (Type2LL_Antenna)

The LBES0ZZ2LL module is certified with a PCB antenna(Type2LL_Antenna).

The following precautions should be taken when using this PCB antenna (Type2LL_Antenna):

- When the module is installed in the final product, the 50 Ω microstrip line and Type2LL_Antenna, outlined in right red in **Figure 13**, must be copied to the state shown in **Figure 14** where it was certified.

Murata provides set makers with Gerber data or something similar.

Figure 13: 50 Ω Microstrip Line and Type2LL_Antenna (ISED)

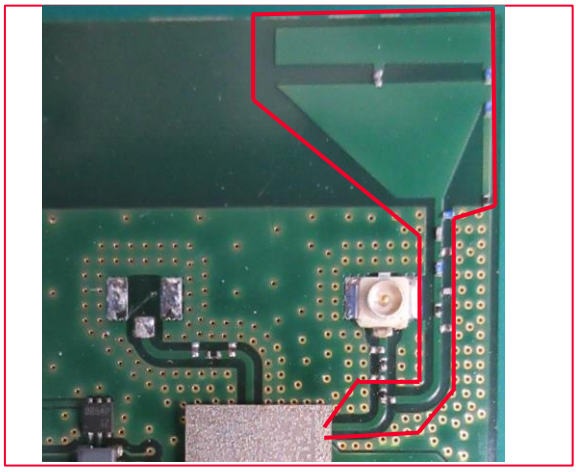
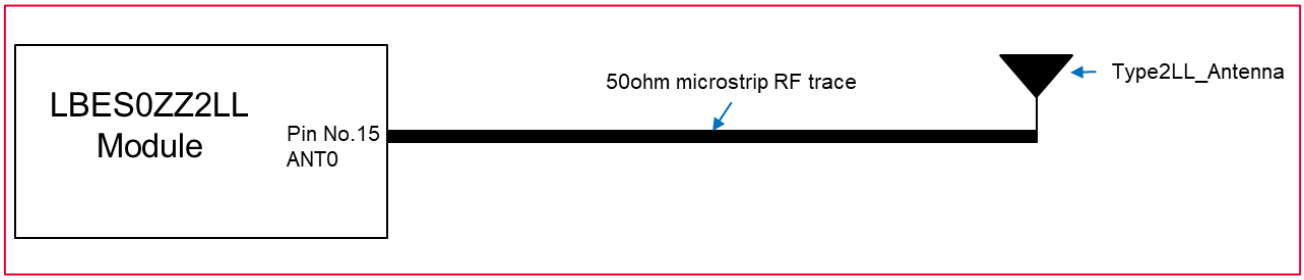


Figure 14: Trace Antenna (Type2LL_Antenna) Layout Guide (ISED)



2.2.6.2 Antenna with uFL connector and cables and feed lines

- The LBES0ZZ2LL module is certified with a PCB antenna and four external antenna.

The external antenna should be connected to the LBES0ZZ2LL module using 50 Ω microstrip RF trace and a u.FL RF connector as described below.

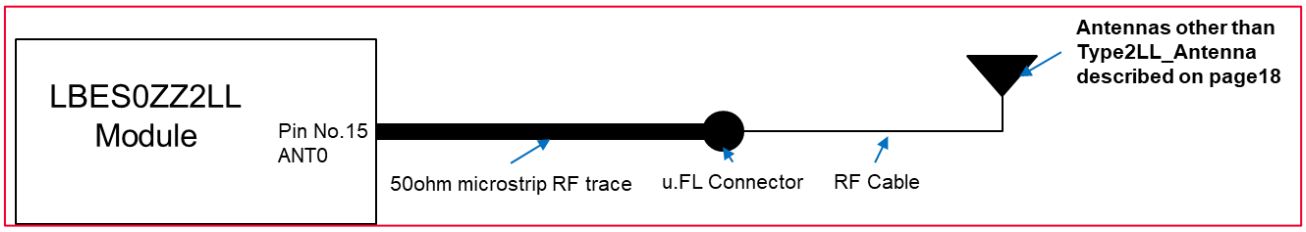
- The microstrip RF trace and u.FL connector are placed on the customer‘s PCB and are external to the LBES0ZZ2LL module.
- The antenna is then connected to this u.FL Connector via a 50 Ω RF adapter cable.
- The design of the 50 Ω microstrip RF trace on the customer’s PCB is crucially important.

Compliant operation of the LBES0ZZ2LL module is dependent on proper construction of this 50 Ω line and the following guidelines must be followed to ensure legal operation of the product.

Figure 15 shows the required microstrip structure to be routed between module pin 15 and the u.FL connector.

The top PCB trace carries the RF energy from module to u.FL connector.

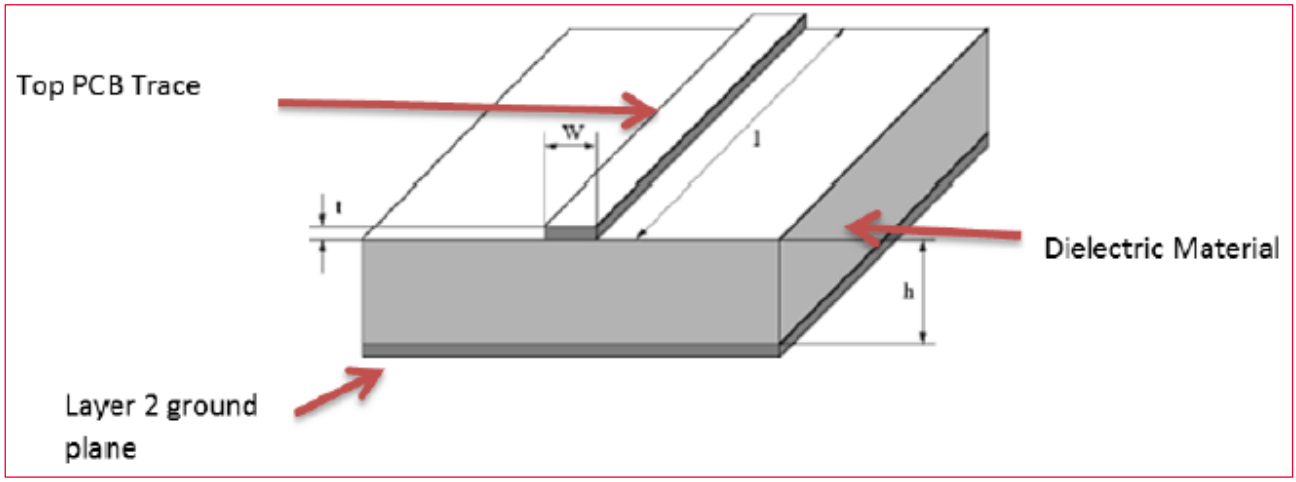
Figure 15: Antenna with u.FL Connector Layout Guide (ISED)



50 Ω microstrip RF trace: Murata provides set makers with Gerber data or something similar.

As shown in **Figure 16**, The Layer2 ground plane provides a return path for the circuit. The Dielectric material (along with the dimensions of the microstrip structures) determines the characteristic impedance of the microstrip transmission line.

Figure 16: Microstrip RF Trace Structure (ISED)



Note the representative dimensions shown in the drawing above. It is imperative that the module customer (the integrator) use the exact dimensions we recommend ensuring a 50 Ω impedance for this transmission line.

The following dimensions and/or ratios should be used to set the microstrip impedance to 50 Ω:

- Dielectric (PCB) Material: We recommend standard FR4 PCB material. Other dielectrics will work but will require recalculation of microstrip dimensions.

  The following guidance is predicated on the use of FR4 Dielectric:

  - If FR4 is not used for PCB material, please contact Murata to determine new dimensions for microstrip structure.

- **h** (Dielectric Height) - this is the thickness of dielectric between the trace layer (layer 1) and the ground plane on layer 2.

Note that layer 2 must be electrical ground. We recommend a dielectric thickness of 8-15 mils. This range provides the customer with some flexibility in board construction.

- **t** (**trace thickness**): Microstrip impedance is not severely affected by the thickness dimension. Standard 102 or 202 copper deposition is recommended. Equivalent thickness is 1-2 mils.
- **W** (**trace width**): this is the crucial dimension. This width must be set correctly to obtain the desired 50 Ω impedance.

  When using FR-4 dielectric, the width (W) of the microstrip trace should be set to: W = H* 1.8, where W is microstrip trace width and H is Dielectric height. Note that both values must be measured in identical units (mils or mm).

  Example:

  H = 12 mils, W =12 * 1.8 = 21.6 mils

  H = 0.4 mm, W = 0.4*1.8 = 0.72 mm

A reliable 50 Ω transmission line will be produced if the above guidance is closely followed.

Any deviations from the guidance above may cause the module to operate in noncompliant manner.

Any implementation questions or concerns should be directed to Murata module technical support.

2.2.7 About Power Supply (Limited Condition)

This Module (LBES0ZZ2LL) has been approved as Limited Modular Approval.
These modules do not have a voltage stabilizing circuit in the power path to the internal RF circuitry. Therefore, the Limited Condition must provide a stable power supply for the supply voltage to the module.
Please supply a stable power supply so that the voltage shown in the table below is applied.

Table 29: Power Supply Voltages (ISED)

Parameter		Minimum	Typical	Maximum	Unit
Supply Voltage	AVDD33	3.14	3.3	3.46	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	VIO_SD	1.71 3.14	1.8 3.3	1.89 3.46	V

2.3 EU

The following report is issued:

Only the Antenna Terminated Conducted test section of each report is available for TCF of the final product.

The radiation characteristic data should be acquired by you in the final product.

Radio Equipment Directive (RED) 2014/53/EU Article 3.2

Conforms to: EN 300 328 v2.2.2:2019

Report No.: TERF2410002908E2

Report No.: TERF2410002910E2

EN 301 893 v2.1.1:2017

Report No.: TERF2410002911E2

Report No.: TERF2410002913E2

EN 300 440 v2.1.1:2017

Report No.: TERF2410002912E2

Report No.: TERF2410002909E2

Radio Equipment Directive (RED) 2014/53/EU Article 3.1a

Conforms to: EN 62311:2020

Report No.: TESA2410000624ES

Product name: Communication Module

Model: LBES0ZZ2LL

Manufacture: Murata manufacturing Co., Ltd.

When shipping final products with this module to Europe, make a self-declaration that the product complies with European regulations and apply the CE mark.

2.3.1 Setting RF Power

This section describes the RF power settings.

2.3.1.1 RF Power Setting for 2.4 GHz WLAN

RF Power Settings for 2.4 GHz WLAN are described in the following tables.

Table 30: WLAN RF Power Setting - 2.4 GHz (EU)

Mode	Channel	Rate/MCS index	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	1~13	All Rate	12.0 ± 2.0
IEEE 802.11g	1~13	All Rate	11.0 ± 2.0
IEEE 802.11n (HT20)	1~13	All MCS index	11.0 ± 2.0
IEEE 802.11ac (VHT20)	1~13	All MCS index	11.0 ± 2.0
IEEE 802.11ax (HE20)	1~13	All MCS index	11.0 ± 2.0

Table 31: WLAN RF Power Setting - 2.4 GHz 802.11ax(HE20) OFDMA (EU)

Mode	Channel	RU	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	1~13	26 tone	All MCS index	6.0 ± 2.0
		52 tone	All MCS index	9.0 ± 2.0
		106, 242 tone	All MCS index	11.0 ± 2.0

2.3.1.2 RF Power Setting for BLE / IEEE 802.15.4

RF power settings for BLE and IEEE 802.15.4 are described in the following tables.

Table 32: BLE / IEEE 802.15.4 RF Power Setting (EU)

Mode	Channel	Maximum Tune Up Tolerance (dBm)
LE 1Mbps	NA	3.0 ± 3.0
LE 2Mbps	NA	3.0 ± 3.0
LE 125kbps	NA	3.0 ± 3.0
LE 500kbps	NA	3.0 ± 3.0
IEEE802.15.4	11~25	3.0 ± 3.0
	26	0.0 ± 3.0

2.3.1.3 RF Power Setting for 5 GHz WLAN (W52/W53/W56)

RF power settings for 5 GHz WLAN (W52/W53/W56) are described in the following tables.

Table 33: WLAN RF Power Setting - 5 GHz 802.11a/n/ac/ax for Channels 36 ~ 140 (EU)

Mode	Channel	Rate/MCS Index	Maximum Tune Up Tolerance [dBm]
IEEE 802.11a	36 ~ 140	All Rate	14.0 ± 2.0
IEEE 802.11n (HT20)	36 ~ 140	All MCS index	14.0 ± 2.0
IEEE 802.11ac (VHT20)	36 ~ 140	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8	13.0 ± 2.0
IEEE 802.11ax (HE20)	36 ~ 140	MCS0 ~ MCS7	14.0 ± 2.0
		MCS8 ~ MCS9	13.0 ± 2.0

Table 34: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA for Channels 36 ~ 140 (EU)

Mode	Channel	RU	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	36 ~ 140	26 tone	All MCS index	5.0 ± 2.0
		52 tone	All MCS index	8.0 ± 2.0
		106 tone	All MCS index	11.0 ± 2.0
		242 tone	MCS0 ~ MCS7	14.0 ± 2.0
			MCS8 ~ MCS9	13.0 ± 2.0

2.3.1.4 RF Power Setting for 5 GHz WLAN (W58)

RF power settings for 5 GHz WLAN (W58) are described in the following tables.

Table 35: WLAN RF Power Setting - 5 GHz 802.11 a/n/ac/ax for Channels 149 ~ 169 (EU)

Mode	Channel	Rate/MCS Index	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	149 ~ 169	All Rate	6.0 ± 2.0
IEEE 802.11n (HT20)	149 ~ 169	All MCS index	6.0 ± 2.0
IEEE 802.11ac (VHT20)	149 ~ 169	All MCS index	6.0 ± 2.0
IEEE 802.11ax (HE20)	149 ~ 169	All MCS index	6.0 ± 2.0

Table 36: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA for Channels 149 ~ 169 (EU)

Mode	Channel	RU	MCS index	MAXIMUM TUNE UP TOLERANCE [dBm]
IEEE 802.11ax (HE20)	149 ~ 169	26, 52, 106, 204 tone	All MCS index	6.0 ± 2.0

2.3.2 Theory of Operation

Table 37 describes the theory of operation.

Table 37: Theory of Operation (EU)

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n/ac/ax (BW20)	2412-2472 MHz	Active	Yes
	BLE	2402-2480 MHz	N/A	N/A
	IEEE 802.15.4	2405-2480 MHz	N/A	N/A
W52	11a/n/ac/ax (BW20)	5180-5240 MHz	Active	Yes
W53[6] [7]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
W56[6] [7]	11a/n/ac/ax (BW20)	5500-5700 MHz	Passive	No
W58	11a/n/ac/ax (BW20)	5745-5845 MHz	Active	Yes

2.4 Japan

- **Manufacturer Name:** Murata Manufacturing Co., Ltd.
- **Model or Product Name:** LBES0ZZ2LL

This module has received “CERTIFICATION for TYPE CERTIFICATION" under the Japanese Radio Act.

電波法の要求に基づく警告

（警告）5 GHz の周波数帯においては、5.2 GHz/5.3GHz/5.6GHz 帯 (W52/W53/W56)の 3 種類の帯域を使用することができます。5.2 GHz/5.3 GHz 帯無線 LAN (W52/W53)の屋外使用は 5.2GHz 帯高出力データ通信システムの基地局又は陸上移動中継局と通信する場合を除き電波法で禁止されています

English Translation
Warning based on the requirements of Japanese Radio Act.
(Warning) In the 5GHz frequency band, you can use 3 bands: 5.2GHz/5.3GHz/5.6GHz(W52/W53/W56).
Outdoor use of 5.2 GHz/5.3 GHz band wireless LANs(W52/W53) is prohibited by the Radio Act except when communicating with 5.2 GHz band high-power data communication system base stations or land mobile relay stations.

2.4GHz と 5GHz(W52,W53,W56)で使用するモジュールです。
W53/W56 は子局としてのみ動作させてください。

English Translation
This is a module for use at 2.4 GHz and 5 GHz (W52, W53, W56).
Operate the W53/W56 only as a client mode.

[6] DFS MASTER function not available. DFS client function available.
[7] There is a TPC function.

2.4.1 Product Outline

This specification characterizes the IEEE 802.11 a/b/g/n/ac/ax + Bluetooth LE + 802.15.4 tri-radio solution combo module.

- **Product Size:** 8.8 x 7.7 mm (Typical), H = 1.3 mm (Maximum)
- **Wireless-IC:** NXP IW610G inside
- **Reference Clock**: 40 MHz X′tal
- **Weight:** 0.223 g

2.4.2 Feature

- **Product Name:** Communication Module
- **Model Name:** LBES0ZZ2LL
- **Purpose of the equipment:** Telecommunication
- **Equipment Type:** Transceiver
- **Frequency band:** 2412-2472 MHz/ 2402-2480 MHz/ 2405-2480 MHz/ 5180-5320 MHz/ 5500-5720 MHz
- **Channel:** (WLAN)1 ~ 13 ch/ 36 ~ 64 ch/ 100 ~ 144 ch
  (BLE) 1 ~ 40 ch (IEEE 802.15.4)11 ~ 26 ch
- **Bandwidth:** (WLAN) 2.4 GHz 11b(20MHz)/11g(20MHz)/11n(20MHz)/ 11ac(20MHz)/11ax(20MHz)
  5 GHz 11a (20MHz)/11n (20MHz)/11ac(20MHz)/11ax(20MHz)
  (BLE) 1 MHz / 2 MHz
  (IEEE 802.15.4) 1 MHz
- **Input Voltage to RF parts:** VDD33 Typical 3.3V / VIO Typical 1.8V or 3.3V / VIO_SD Typical 1.8V or 3.3V

2.4.3 Setting RF Power

2.4.3.1 RF Power Setting for 2.4 GHz WLAN

RF Power Settings for 2.4 GHz WLAN are described in the following tables.

Table 38: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n/ac (Japan)

Mode	Channel	Rate/MCS index	Output Power in dBm (typical) [dBm]
IEEE 802.11b	1 ~ 13	All Rate	14.0
IEEE 802.11g	1 ~ 13	6 Mbps ~ 36 Mbps	16.0
		48 Mbps, 54 Mbps	15.0
IEEE 802.11n (HT20)	1 ~ 13	MCS0 ~ MCS4	15.0
		MCS5 ~ MCS7	14.0
IEEE 802.11ac (VHT20)	1 ~ 13	MCS0 ~ MCS4	15.0
		MCS5 ~ MCS7	14.0
		MCS8	13.0
IEEE 802.11ax (HE20)	1 ~ 13	MCS0 ~ MCS4	15.0
		MCS5 ~ MCS7	14.0

Mode	Channel	Rate/MCS index	Output Power in dBm (typical) [dBm]
		MCS8, MCS9	13.0

Table 39: WLAN RF Power Setting - 2.4 GHz 802.11ax(HE20) OFDMA (Japan)

Mode	Channel	RU	MCS index	Output Power in dBm (typical) [dBm]
IEEE 802.11ax (HE20)	1~13	26 tone	All MCS index	9.0
		52 tone	All MCS index	10.0
		106 tone	All MCS index	13.0
		242 tone	MCS0 ~ MCS4	15.0
			MCS5 ~ MCS7	14.0
			MCS8, MCS9	13.0

2.4.3.2 RF Power Setting BLE / IEEE 802.15.4

RF power settings for BLE and IEEE 802.15.4 are described in the following tables.

Table 40: BLE / IEEE 802.15.4 RF Power Setting (Japan)

Mode	Channel	Setting Power [dBm]
LE 1Mbps	NA	5.0
LE 2Mbps	NA	5.0
LE 125kbps	NA	5.0
LE 500kbps	NA	5.0
IEEE802.15.4	11~25	8.0
	26	0.0

2.4.3.3 RF Power Setting for 5 GHz WLAN

Table 41 and **Table 42** describes the RF power settings for 5 GHz WLAN.

Table 41: WLAN RF Power Setting - 5 GHz 802.11a/n/ac/ax (Japan)

Mode	Channel	Rate/MCS Index	Output Power in dBm (typical) [dBm]
IEEE 802.11a	36 ~ 64	All Rate	13.0
	100 ~ 144	All Rate	14.0
IEEE 802.11n (HT20)	36 ~ 144	All MCS index	13.0
IEEE 802.11ac (VHT20)	36 ~ 144	All MCS index	13.0
IEEE 802.11ax (HE20)	36 ~ 144	All MCS index	13.0

Table 42: WLAN RF Power Setting - 5 GHz 802.11ax OFDMA (Japan)

Mode	Channel	RU	MCS index	Output Power in dBm (typical) [dBm]
IEEE 802.11ax (HE20)	36 ~ 144	26 tone	All MCS index	4.0
		52 tone	All MCS index	7.0
		106 tone	All MCS index	10.0
		242 tone	All MCS index	13.0

2.4.4 Types of Radio Emissions

Table 43 describes the types of radio emissions.

Table 43: Types of Radio Emissions

Mode	Rate/MCS Index	Modulation System	Types of Radio Emissions
Bluetooth	LE 1 Mbps, LE 2 Mbps	GFSK	F1D
IEEE 802.15.4	-	O-QPSK	G1D
IEEE 802.11b	1 Mbps	DBPSK	G1D
	2 Mbps	DQPSK	G1D
	5.5 Mbps, 11 Mbps	CCK	G1D
IEEE 802.11g IEEE 802.11a	6Mbps, 9 Mbps	BPSK	G1D
	12Mbps, 18 Mbps	QPSK	G1D
	24Mbps, 36 Mbps	16 QAM	D1D
	48Mbps, 54 Mbps	64 QAM	D1D
IEEE 802.11n IEEE 802.11ac IEEE 802.11ax	MCS0	BPSK	G1D
	MCS1, MCS2	QPSK	G1D
	MCS3, MCS4	16 QAM	D1D
	MCS5, MCS6, MCS7	64 QAM	D1D
IEEE 802.11ac IEEE 802.11ax	MCS8, MCS9	256 QAM	D1D

2.4.5 Theory of Operation

Table 44 describes the theory of operation.

Table 44: Theory of Operation (Japan)

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n/ac/ax (BW20)	2412-2472 MHz	Active	Yes
	BLE	2402-2480 MHz	N/A	N/A
	IEEE 802.15.4	2405-2480 MHz	N/A	N/A
W52	11a/n/ac/ax (BW20)	5180-5240 MHz	Active	Yes
W53[8] [9]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
W56[8] [9]	11a/n/ac/ax (BW20)	5500-5720 MHz	Passive	No

2.4.6 Antenna

The antenna registered under the Radio Act Certification of Japan are described in **Table 45**.

Table 45: Antenna (Japan)

Antenna P/N	Maker	Type	Peak Gain [dBi]		Connector / form
			2400-2500 MHz	5150-5850 MHz	
146187	Molex	Dipole	3.2	4.25	u.FL
146153	Molex	Dipole	3.2	4.25	u.FL

[8] DFS MASTER function not available. DFS client function available.

[9] There is a TPC function.

Antenna P/N	Maker	Type	Peak Gain [dBi]		Connector / form
			2400-2500 MHz	5150-5850 MHz	
219611	Molex	Dipole	2.67	3.67	u.FL
WT32D1-KX	Unictron	Dipole	3.0	4.0	u.FL
AA258	Unictron	Dipole	0.9	3.8	u.FL
TA-38B-A-W01	Unictron	Dipole	2.61	3.07	RSMA
TA-68-A-WE01	Unictron	Dipole	2.23	4.59	RSMA
FXP830.07.0100C	Taoglas	Dipole	2.5	4.7	MHF1
GW.48.A151	Taogras	Dipole	1.82	3.28	RSMA
GW.40.2153	Taoglas	Dipole	3.15	4.39	RSMA
GW.52.A153	Taogras	Dipole	2.93	4.53	RSMA
SRF2W012	Antenova	Dipole	3.0	4.0	u.FL
STDANTEMD-013	Sansei	Dipole	1.9	2.8	u.FL
EMF2471A3S	Laird	Dipole	2.2	4.4	MHF1
1001932FT	KAVX	Dipole	2.5	4.4	MHF1
1001932PT	KAVX	Dipole	2.03	4.45	MHF1
W3P35x8W04	KAVX	Dipole	2.3	5.0	MHF1
W24-U	Inventek	Dipole	3.58	NA	u.FL
W2.4-5P-U	Inventek	Dipole	3.73	5.18	u.FL
Type2LL_Antenna	Murata	Monopole	3.6	4.6	Trace

No. 4 W24P-U can only be used at 2.4 GHz band.

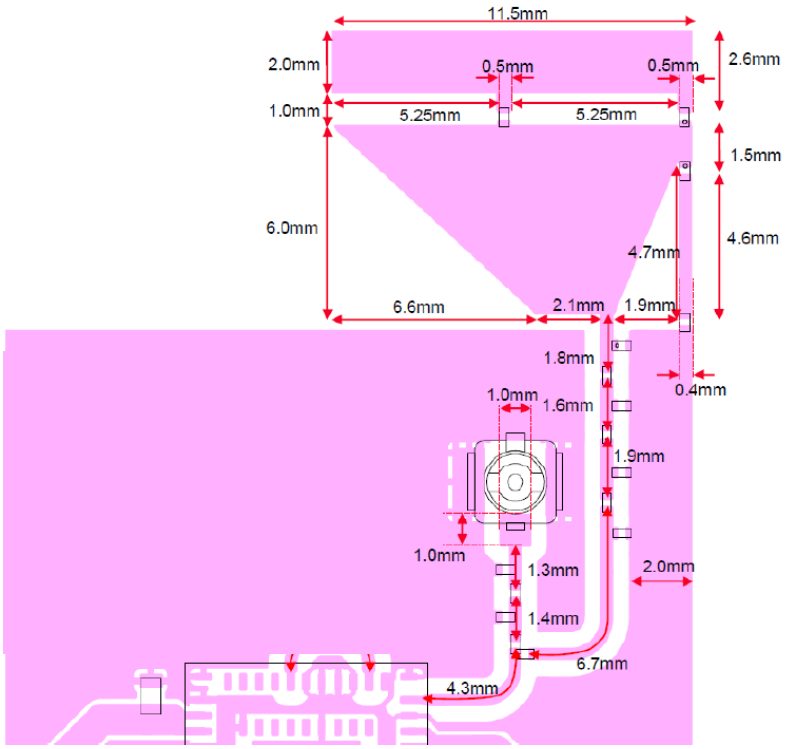
For Each antenna, obtain a data sheet from the antenna manufacturer's website, as given below. Refer to Section 2.4.5.1 for details of the Type2LL_Antenna from Murata.

- Molex Electronic Solutions
- Unictron Technologies Corp.
- Taoglas Group Holdings Limited
- Antenova Ltd.
- Inventek Systems, LLC.
- TE Connectivity Laird
- KYOCERA AVX Components Corporation

2.4.6.1 Type2LL_Antenna

When using Type2LL_Antenna, make sure to match the drawings shown in **Figure 17** below.

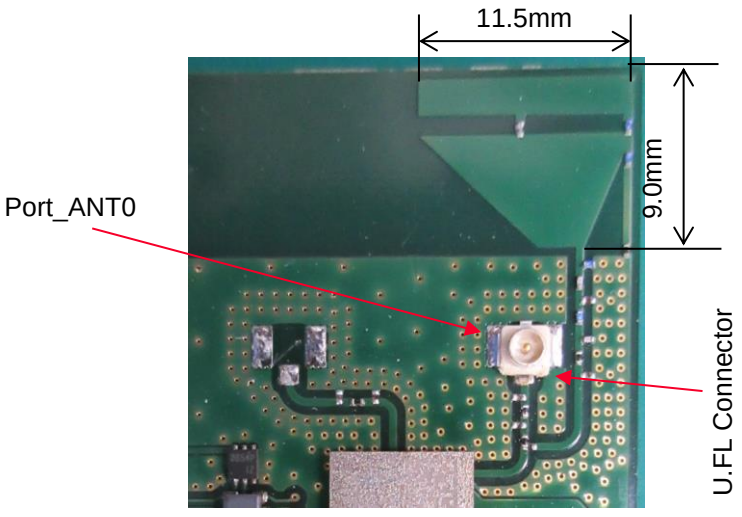
Figure 17: Type2LL_Antenna Drawing (Japan)



2.4.6.2 Appearance

Figure 18 shows the antenna appearance.

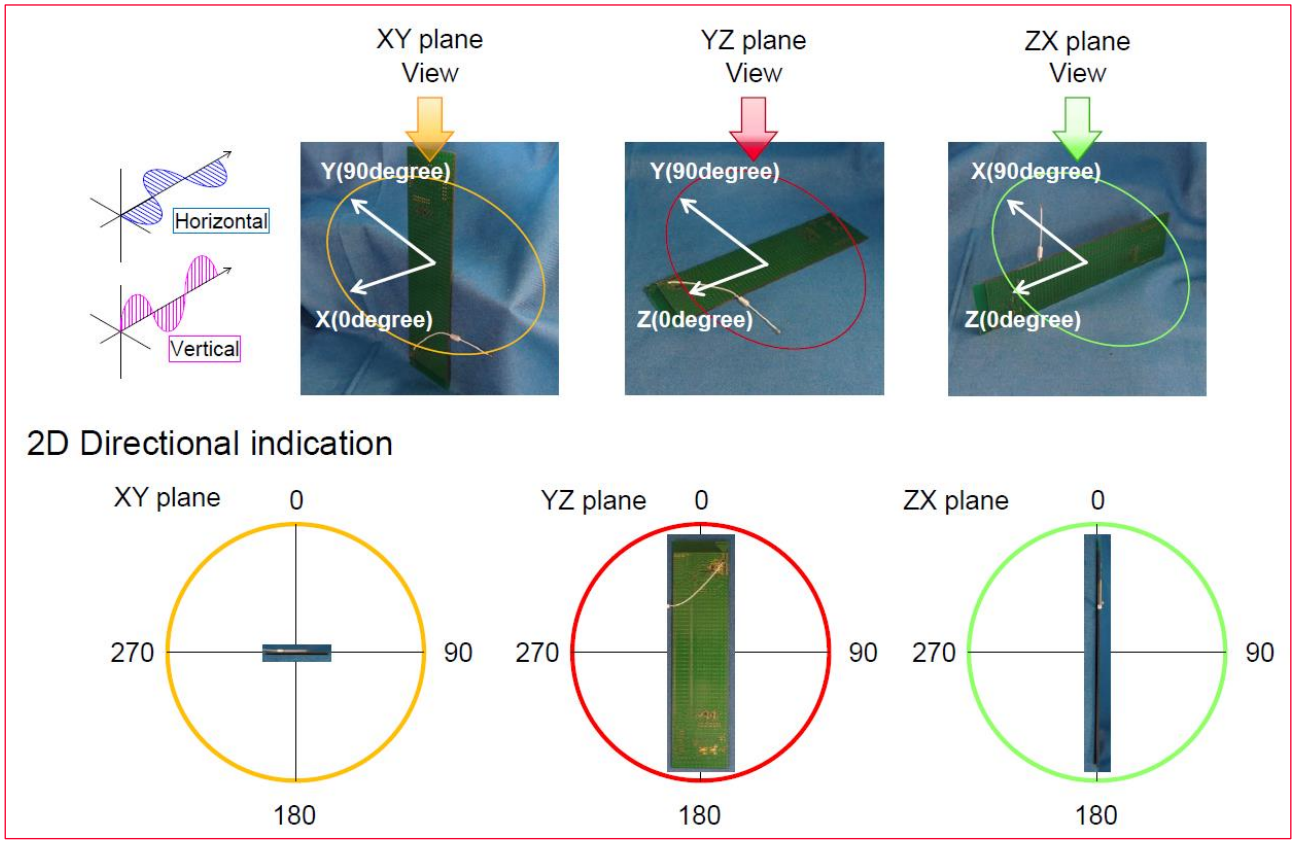
Figure 18: Type2LL Antenna Appearance (Japan)



2.4.6.3 Measurement Directions

Figure 19 shows the measurement directions.

Figure 19: Antenna Measurement Directions (Japan)



2.4.6.4 Measurement Result

The measurement results are shown in **Figure 20**.

Figure 20: Antenna Measurement Result (Japan)

<Efficiency>

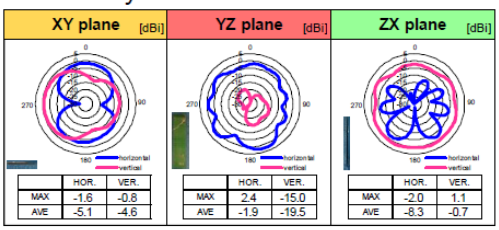
[dBi] [dB]

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

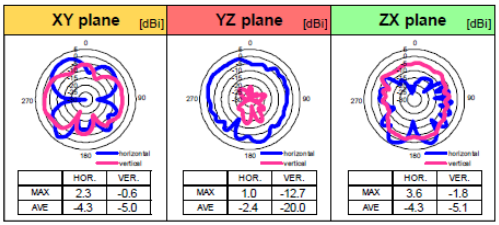
[dBi] [dB]

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>



@2442MHz



@5500MHz

2.4.7 Notification

It is recommended that the indication of (1) or (2) below is described on the product incorporating this module in Japanese. If there is any problem with the indication of (1) or (2) on the product, we recommend indicating (1) or (2) in the user manual or on the package of the product incorporating this module, or electronic display on the product. In the case of the electronic display, it is necessary to describe "using the electronic display" + "how to reach to below indication" in the user manual of the product.

(1)

本製品は、電波法に基づく工事設計認証(認証番号:003-250020)を受けた特定無線設備を内蔵しています。

(2)

003-250020 5.2GHz/5.3GHz 帯無線 LAN(W52/W53)の屋外使用は 5.2GHz 帯高出力データ通信システムの基地局又は陸上移動中継局と通信する場合を除き電波法で禁止されています。

(English Translation)
(1)

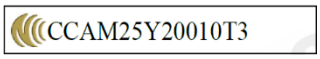
This product incorporates specified radio equipment that has received CERTIFICATION for TYPE CERTIFICATION (certification number: 001-P02018) based on the Japan Radio Act.

(2)

003-250020 Outdoor use of 5.2GHz/5.3GHz band wireless LANs (W52/W53) is prohibited by the Radio Act except when communicating with 5.2GHz band high-power data communication system base stations or land mobile relay stations.

2.5 NCC

This certification does not apply to products with wireless LAN capabilities only (Ex: Dongle devices and adapter products).

NCC ID： 

NCC warning statement

根據 NCC LP0002 低功率射頻器材技術規範_章節 3.8.2：

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻器材之使用不得影響飛航安全及干擾合法通信；經發現有干擾現象時，應立即停用，並改善至無干擾時方得繼續使用。

前述合法通信，指依電信管理法規定作業之無線電通信。

低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾

此模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求平台廠商於平台上標示

『內含發射器模組：

』

或相似含意的標示

1. 應避免影響附近雷達系統之操作。

2. 高增益指向性天線只得應用於固定式點對點系統。

(English Translation)

Without permission granted by the NCC, any company, enterprise, or user is not Allowed to change frequency, enhance transmitting power or alter original characteristic as well as performance to a approved low power radio-frequency devices. The low power radio-frequency devices shall not influence aircraft security and interfere legal communications; If found, the user shall cease operating immediately until no interference is achieved. The said legal communications means radio communications is operated in compliance with the Telecommunications Management Act. The low power radio-frequency devices must be susceptible with the interference from legal communications or ISM radio wave radiated devices.

1.Please operate in a way that does not affect nearby radar systems.

2.High-gain directional antennas can only be used in fixed point-to-point systems.

2.5.1 Product Outline

This specification characterizes the IEEE 802.11 a/b/g/n/ac/ax + Bluetooth LE + 802.15.4 tri-radio solution combo module.

- **Product Size:** 8.8 x 7.7 mm (Typical), H = 1.3 mm (Maximum)
- **Wireless-IC:** NXP IW610G inside
- **Reference Clock**: 40 MHz X′tal
- **Weight:** 0.223 g

2.5.2 Feature

- **Product Name:** Communication Module
- **Model Name:** LBES0ZZ2LL
- **Purpose of the equipment:** Telecommunication
- **Equipment Type:** Transceiver
- **Frequency band:** BLE 2402~2480MHz
  WLAN 2.4GHz 2412~2462MHz
  WLAN 5GHz 5180~5240MHz/5260~5320MHz/5500~5720MHz/5745~5825MHz
  IEEE802.15.4 2405~2480MHz
- **Type of Modulation:** BLE GFSK
  WLAN DBPSK/DQPSK/CCK/BPSK/QPSK/16QAM/64QAM/256QAM
  IEEE802.15.4 O-QPSK
- **Bandwidth:** BLE : 2MHz
  WLAN 2.4GHz 11b/g/n/ax : 20MHz
  WLAN 5GHz 11a/n/ac/ax : 20MHz
  IEEE802.15.4 : 1MHz
- **Input Voltage to RF parts:** VDD33 Typical 3.3V / VIO Typical 1.8V or 3.3V / VIO_SD Typical 1.8V or 3.3V

2.5.3 Setting RF Power

The RF power setting for the NCC follows the FCC setting.

2.5.4 Theory of Operation

Table 46 describes the theory of operation.

Table 46: Theory of Operation (NCC)

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n(BW20)	2412-2462MHz	Active	Yes
	BLE	2402-2480MHz	N/A	N/A
	IEEE802.15.4	2405-2480MHz	N/A	N/A
W52	11a/n/ac/ax(BW20)	5180-5240MHz	Active	Yes
W53	11a/n/ac/ax(BW20)	5260-5320MHz	Passive	No
W56	11a/n/ac/ax(BW20)	5500-5720MHz	Passive	No
W58	11a/n/ac/ax(BW20)	5745-5825MHz	Active	Yes

*DFS MASTER function not available.

*DFS client function available.

*There is a TPC function.

2.5.5 Antenna

The antenna registered under the Radio Act Certification of Japan are described in .

Table 47: Antenna (NCC)

Antenna P/N	Maker	Type	Peak Gain [dBi]		Connector / form
			2400-2500 MHz	5150-5850 MHz	
146187	Molex	Dipole	3.2	4.25	u.FL
146153	Molex	Dipole	3.2	4.25	u.FL
219611	Molex	Dipole	2.5	3.4	u.FL
WT32D1-KX	Unictron	Dipole	3.0	4.0	u.FL
AA258	Unictron	Dipole	0.9	3.8	u.FL
FXP830.07.0100C	Taoglas	Dipole	2.5	4.7	MHF1
SRF2W012	Antenova	Dipole	3.0	4.0	u.FL
EMF2471A3S	Laird	Dipole	2.2	4.4	MHF1
1001932FT	KAVX	Dipole	2.5	4.4	MHF1
1001932PT	KAVX	Dipole	2.03	4.45	MHF1
W3P35x8W04	KAVX	Dipole	2.3	5.0	MHF1
W2.4-5P-U	Inventek	Dipole	3.73	5.18	u.FL
Type2LL_Antenna	Murata	Monopole	3.6	4.6	Trace

219611 can only be used with cable length 100mm or more.
W24P-U can only be used at 2.4 GHz band.

For Each antenna, obtain a data sheet from the antenna manufacturer's website, as given below. Refer to Section 2.4.5.1 for details of the Type2LL_Antenna from Murata.

- Molex Electronic Solutions
- Unictron Technologies Corp.
- Taoglas Group Holdings Limited
- Antenova Ltd.
- Inventek Systems, LLC.
- TE Connectivity Laird
- KYOCERA AVX Components Corporation
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Revision History

Revision	Date	Changed Item	Comment
1.0	April 28, 2025	Issued as Application Note.	Initial Release

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