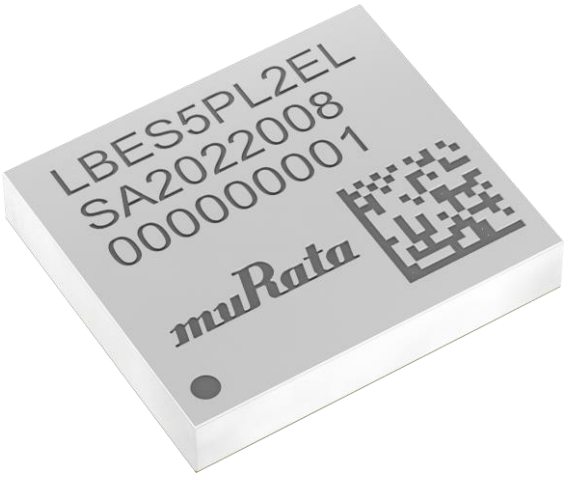
Application Note

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

NXP IW612 Chipset for 802.11a/b/g/n/ac/ax + Bluetooth 5.3 + IEEE 802.15.4

Radio Law Certification Application Note - Rev. 6.0

- Design Name: Type 2EL
- P/N: LBES5PL2EL



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About This Document

Murata's Type 2EL is a small and very high-performance module based on NXP IW612 combo chipset, supporting IEEE 802.11a/b/g/n/ac/ax + Bluetooth 5.3 BR/EDR/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 2EL 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: **LBES5PL2EL**

1.2 Labels

Figure 1 shows the module labels. **Table 2** and **Table 3** describe the marking and dimension labels.

Figure 1: Labels

Table 2: Marking Labels

Marking Label	Meaning
A	Module type
B	Inspection number
C	Serial number
D	Murata logo
E	Pin 1 marking
F	2D code

Table 3: Dimension Labels

L	W	T
8.8 millimeter	7.7 millimeter	1.3 millimeter

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

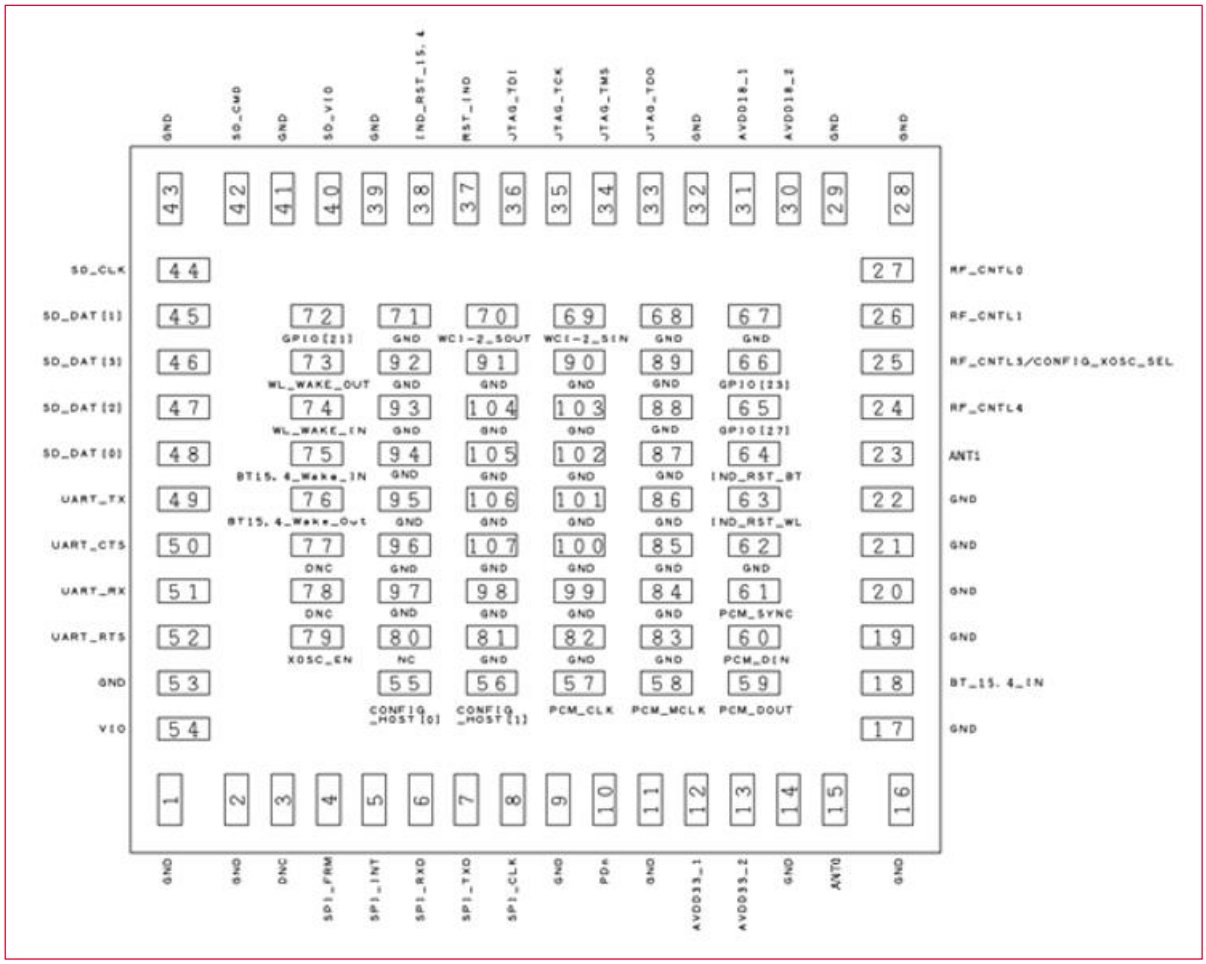


Table 4 describes the pins.

Table 4: Terminal Configurations

No.	Terminal Name	No.	Terminal Name	No.	Terminal Name	No.	Terminal Name
1	GND	29	GND	57	PCM_CLK	85	GND
2	GND	30	AVDD18_2	58	PCM_MCLK	86	GND
3	NC	31	AVDD18_1	59	PCM_DOUT	87	GND
4	SPI_FRM	32	GND	60	PCM_DIN	88	GND
5	SPI_INT	33	Reserved	61	PCM_SYNC	89	GND
6	SPI_RXD	34	Reserved	62	GND	90	GND
7	SPI_TXD	35	Reserved	63	IND_RST_WL	91	GND
8	SPI_CLK	36	Reserved	64	IND_RST_BT	92	GND
9	GND	37	RST_IND	65	Reserved	93	GND
10	PDn	38	IND_RST_15.4	66	Reserved	94	GND
11	GND	39	GND	67	GND	95	GND
12	AVDD33_1	40	SD_VIO	68	GND	96	GND
13	AVDD33_2	41	GND	69	WCI-2_SIN	97	GND
14	GND	42	SD_CMD	70	WCI-2_SOUT	98	GND
15	ANT0	43	GND	71	GND	99	GND
16	GND	44	SD_CLK	72	SD_INT	100	GND
17	GND	45	SD_DAT[1]	73	WL_WAKE_OUT	101	GND
18	BT_15.4_IN	46	SD_DAT[3]	74	WL_WAKE_IN	102	GND
19	GND	47	SD_DAT[2]	75	BT15.4_WAKE_IN	103	GND
20	GND	48	SD_DAT[0]	76	BT15.4_WAKE_OUT	104	GND
21	GND	49	UART_TX	77	NC	105	GND
22	GND	50	UART_CTS	78	NC	106	GND
23	ANT1	51	UART_RX	79	XOSC_EN	107	GND
24	RF_CNTL4	52	UART_RTS	80	NC		
25	RF_CNTL3/ CONFIG_XOSC_SEL	53	GND	81	GND		
26	RF_CNTL1	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	AVDD33	3.14	3.3	3.46	V
	AVDD18	1.71	1.8	1.89	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	SD_VIO	1.71 3.14	1.8 3.3	1.89 3.46	V

VIO, SD_VIO 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)

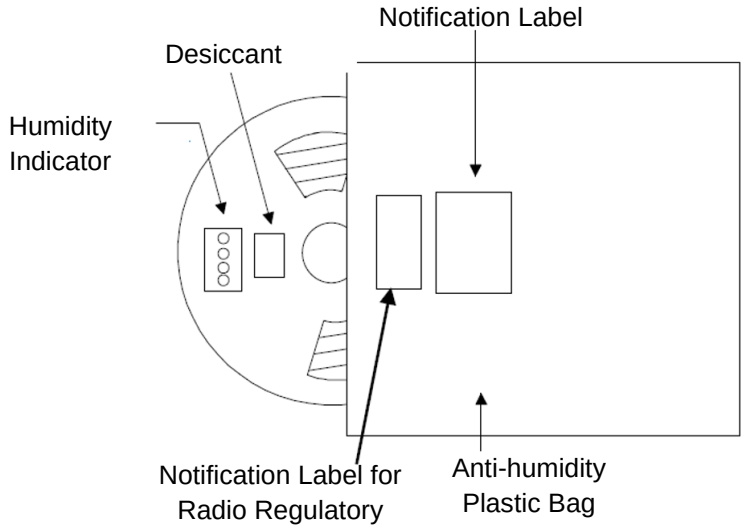


Figure 4: Package Label Display Example

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

2.1 FCC

Model Name: LBES5PL2EL

FCC ID: VPYLBES5PL2EL

This module is not sold to general end users directly. Therefore, 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.

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 FCC ID is not visible when the module is installed inside another device, then the module is installed must also display a label referring to the enclosed module.

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.

Since there is no space which indicates FCC ID on this module, FCC ID is indicated in a manual. If the FCC ID is not visible when the module is installed inside another device, then the module is installed must also display a label referring to the enclosed module.

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

Table 6, **Table 7**, and **Table 8** describes the RF power settings for 2.4 GHz WLAN.

Table 6: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n (HT20/40)/ac (VHT20/40) (FCC)

Mode	Rate/MCS index	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	All Rate	1	16.0 ± 2.0
		2, 10, 11	17.0 ± 2.0
		3, 4, 5, 6, 7, 8, 9	18.0 ± 2.0
IEEE 802.11g	All rate	1, 11	12.0 ± 2.0
		2	13.0 ± 2.0
		3, 9, 10	14.0 ± 2.0
		4, 5	15.0 ± 2.0
		6, 7, 8	16.0 ± 2.0
IEEE 802.11n (HT20)	All MCS index	1, 11	11.0 ± 2.0
		2	12.0 ± 2.0
		3, 9	14.0 ± 2.0
		4, 5, 6, 7, 8	15.0 ± 2.0
		10	13.0 ± 2.0
IEEE 802.11n (HT40)	All MCS index	3, 8, 9	10.0 ± 2.0
		4, 5, 6, 7	11.0 ± 2.0
IEEE 802.11ac (VHT20)	All MCS index	1, 11	11.0 ± 2.0
		2	12.0 ± 2.0
		3, 9	14.0 ± 2.0
		4, 5, 6, 7, 8	15.0 ± 2.0
		10	13.0 ± 2.0
IEEE 802.11ac (VHT40)	All MCS index	3, 8, 9	10.0 ± 2.0
		4, 5, 6, 7	11.0 ± 2.0

Table 7: WLAN RF Power Setting - 2.4 GHz 802.11ax (HE20) (FCC)

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	1	MCS0 ~ MCS7	SU	11.0 ±2.0		
					242 tone (Full tone)	10.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
		MCS8 ~ MCS11	SU	11.0 ±2.0		
					242 tone (Full tone)	10.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
	2	MCS0 ~ MCS11	SU	12.0 ±2.0		
					242 tone (Full tone)	12.0 ±2.0
					26 tone	12.0 ±2.0
					52 tone	12.0 ±2.0
					106 tone	12.0 ±2.0
	3	MCS0 ~ MCS7	SU	14.0 ±2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	4	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	5, 6	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	15.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	7, 8	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	9	MCS0 ~ MCS7	SU	14.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	10	MCS0 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	12.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	11	MCS0 ~ MCS11	SU	11.0 ± 2.0		
					242 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0

Table 8: WLAN RF Power Setting - 2.4 GHz 802.11ax (HE40) (FCC)

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE40)	3	MCS0 ~ MCS11	SU	10.0 ±2.0		
					484 tone (Full tone)	6.0 ±2.0
					26 tone	9.0 ±2.0
					52 tone	10.0 ±2.0
					106 tone	10.0 ±2.0
					242 tone	10.0 ±2.0
	4	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	8.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
					242 tone	11.0 ±2.0
	5	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	10.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
					242 tone	11.0 ±2.0
	6	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0
					242 tone	11.0 ± 2.0
	7	MCS0 ~ MCS11	SU	11.0 ± 2.0		
					484 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0
					242 tone	11.0 ± 2.0
	8	MCS0 ~ MCS11	SU	10.0 ± 2.0		
					484 tone (Full tone)	8.0 ± 2.0
					26 tone	10.0 ± 2.0
					52 tone	10.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0
	9	MCS0 ~ MCS7	SU	10.0 ± 2.0		
					484 tone (Full tone)	7.0 ± 2.0
					26 tone	10.0 ± 2.0
					52 tone	10.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0

2.1.1.2 RF Power Setting for BT (BR/EDR) / BLE / IEEE 802.15.4

Table 9 describes the RF power settings for BT (BR/EDR), BLE, and IEEE 802.15.4.

Table 9: BT / BLE / IEEE 802.15.4 RF Power Setting - FCC

Mode	Channel	Maximum Tune Up Tolerance (dBm)
BR	NA	13.0 ± 3.0
EDR	NA	5.0 ± 3.0
LE	NA	13.0 ± 3.0
LE 2 Mbps	NA	13.0 ± 3.0
IEEE 802.15.4	11 ~ 25	15.0 ± 3.0
	26	0.0 ± 3.0

2.1.1.3 RF Power Setting for 5 GHz WLAN

Table 10 describes the RF power settings for 5 GHz 802.11a WLAN.

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

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	All Rate	W52/W53	36, 40, 60, 64	14.0 ± 2.0
	All Rate	W52/W53	44, 48, 52, 56	16.0 ± 2.0
	All Rate	W56	100, 104	14.0 ± 2.0
	All Rate	W56	108 ~ 136, 144	16.0 ± 2.0
	All Rate	W56	140	13.0 ± 2.0
	All Rate	W58	161, 165	14.0 ± 2.0
	All Rate	W58	149 ~ 157	16.0 ± 2.0

Table 11 and **Table 12** describe the RF power settings for 5 GHz 802.11n WLAN.

Table 11: WLAN RF Power Setting - 5 GHz 802.11n (HT20) (FCC)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11n (HT20)	All MCS Index	W52/W53	36, 40, 60, 64	11.0 ± 2.0
	All MCS Index	W52/W53	44 ~ 56	14.0 ± 2.0
	All MCS Index	W56	100, 104	11.0 ± 2.0
	All MCS Index	W56	108 ~ 136, 144	14.0 ± 2.0
	All MCS Index	W56	140	10.0 ± 2.0
	All MCS Index	W58	161, 165	11.0 ± 2.0
	All MCS Index	W58	149 ~ 157	14.0 ± 2.0

Table 12: WLAN RF Power Setting - 5 GHz 802.11n (HT40) (FCC)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11n (HT40)	All MCS index	W52/W53	38	10.0 ± 2.0
	All MCS Index	W52/W53	62	11.0 ± 2.0
	All MCS Index	W52/W53	46, 54	14.0 ± 2.0
	All MCS Index	W56	102	10.0 ± 2.0
	All MCS Index	W56	110 ~ 126, 142	14.0 ± 2.0
	All MCS Index	W56	134	13.0 ± 2.0
	All MCS Index	W58	151	14.0 ± 2.0
	All MCS index	W58	159	11.0 ± 2.0

Table 13, **Table 14**, and **Table 15** describe the RF power settings for 5 GHz 802.11ac WLAN.

Table 13: WLAN RF Power Setting - 5 GHz 802.11ac (VHT20) (FCC)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT20)	All MCS index	W52/W53	36, 40, 60, 64	11.0 ± 2.0
	All MCS index	W52/W53	44 ~ 56	14.0 ± 2.0
	All MCS index	W56	100, 104	11.0 ± 2.0
	All MCS index	W56	108 ~ 136, 144	14.0 ± 2.0
	All MCS index	W56	140	10.0 ± 2.0
	All MCS index	W58	149 ~ 157	14.0 ± 2.0
	All MCS index	W58	161, 165	11.0 ± 2.0

Table 14: WLAN RF Power Setting - 5 GHz 802.11ac (VHT40) (FCC)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	W52/W53	38	10.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	38	10.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	62	11.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	62	11.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	46, 54	14.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	46, 54	12.0 ± 2.0
	MCS0 ~ MCS7	W56	102	10.0 ± 2.0
	MCS8 ~ MCS9	W56	102	10.0 ± 2.0
	MCS0 ~ MCS7	W56	110 ~ 126, 142	14.0 ± 2.0
	MCS8 ~ MCS9	W56	110 ~ 126, 142	12.0 ± 2.0
	MCS0 ~ MCS7	W56	134	13.0 ± 2.0
	MCS8 ~ MCS9	W56	134	12.0 ± 2.0
	MCS0 ~ MCS7	W58	159	11.0 ± 2.0
	MCS8 ~ MCS9	W58	159	11.0 ± 2.0
	MCS0 ~ MCS7	W58	151	14.0 ± 2.0
	MCS8 ~ MCS9	W58	151	12.0 ± 2.0

Table 15: WLAN RF Power Setting - 5 GHz 802.11ac (VHT80) (FCC)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT80)	MCS0 ~ MCS7	W52/W53	42	10.0 ± 2.0
	MCS8 ~ MCS9	W52/W3	42	10.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	58	11.0 ± 2.0
	MCS8 ~ MCS9	W52/W3	58	11.0 ± 2.0
	MCS0 ~ MCS7	W56	106	7.0 ± 2.0
	MCS8 ~ MCS9	W6	106	7.0 ± 2.0
	MCS0 ~ MCS7	W56	122, 138	14.0 ± 2.0
	MCS8 ~ MCS9	W56	122, 138	12.0 ± 2.0
	MCS0 ~ MCS7	W58	155	9.0 ± 2.0
	MCS8 ~ MCS9	W58	155	9.0 ± 2.0

Table 16, **Table 17**, and **Table 18** describe the RF power settings for 5 GHz 802.11ax WLAN.

Table 16: WLAN RF Power Setting - 5 GHz 802.11ax (HE20) (FCC)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	36, 40, 60, 64	MCS0 ~ MCS7	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	44 ~ 56	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	100, 104	MCS0 ~ MCS9	W56	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	108 ~ 136	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	140	MCS0 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	7.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	144	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	161, 165	MCS0 ~ MCS9	W58	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	149 ~ 157	MCS0 ~ MCS7	W58	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W58	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0

Table 17: WLAN RF Power Setting - 5 GHz 802.11ax (HE40) (FCC)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11 ax (HE40)	38	MCS0 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	7.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	46, 54	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	62	MCS0 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	102	MCS0 ~ MCS7	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	3.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						106 tone	10.0 ± 2.0
						242 tone	8.0 ± 2.0
		MCS8 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	3.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	8.0 ± 2.0
	110 ~ 126	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	134	MCS0 ~ MCS7	W56	SU	13.0 ± 2.0		
						484 tone (Full tone)	13.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	13.0 ± 2.0
						106 tone	13.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						242 tone	10.0 ± 2.0
	142	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	151	MCS0 ~ MCS7	W58	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W58	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	159	MCS0 ~ MCS7	W58	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
		MCS8 ~ MCS9	W58	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0

Table 18: WLAN RF Power Setting - 5 GHz 802.11ax (HE80) (FCC)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE80)	42	MCS0 ~ MCS7	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	7.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
		MCS8 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	7.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
	58	MCS0 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						996 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
						484 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
	106	MCS0 ~ MCS11	W56	SU	7.0 ± 2.0		
						996 tone (Full tone)	5.0 ± 2.0
						26 tone	7.0 ± 2.0
						52 tone	7.0 ± 2.0
						106 tone	7.0 ± 2.0
						242 tone	7.0 ± 2.0
						484 tone	7.0 ± 2.0
	122, 138	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						996 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
						484 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						996 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
						484 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						996 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
	155	MCS0 ~ MCS11	W58	SU	9.0 ± 2.0		
						996 tone (Full tone)	9.0 ± 2.0
						26 tone	9.0 ± 2.0
						52 tone	9.0 ± 2.0
						106 tone	9.0 ± 2.0
						242 tone	9.0 ± 2.0
						484 tone	9.0 ± 2.0

2.1.2 Theory of Operation

Table 19 describes the theory of operation for FCC.

Table 19: 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
	11n/ac/ax (BW40)	2422-2452 MHz	Active	Yes
	BT	2402-2480 MHz	N/A	N/A
	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
	11n/ac/ax (BW40)	5190-5230 MHz	Active	Yes
	11ac/ax (BW80)	5210 MHz	Active	Yes
W53[1]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
	11n/ac/ax (BW40)	5270-5310 MHz	Passive	No
	11ac/ax (BW80)	5290 MHz	Passive	No
W56[1]	11a/n/ac/ax (BW20)	5500-5720 MHz	Passive	No
	11n/ac/ax (BW40)	5510-5710 MHz	Passive	No
	11ac/ax (BW80)	5530-5690 MHz	Passive	No
W58	11a/n/ac/ax (BW20)	5745-5825 MHz	Active	Yes
	11n/ac/ax (BW40)	5755-5795 MHz	Active	Yes
	11ac/ax (BW80)	5775 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.

2.1.3.1 General: Applicable

Section 2.1.3.2 through Section 2.1.3.10 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.

2.1.3.2 List of Applicable FCC Rules: Applicable

This device complies with below part 15 of FCC Rules.
- Part 15 Subpart C
- Part 15 Subpart E

2.1.3.3 Summarize the specific operational use conditions: Applicable

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.

2.1.3.4 Limited Module Procedures: Applicable

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

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

Since there is no space which indicates FCC ID on this module, FCC ID is indicated in a manual. If the FCC ID is not visible when the module is installed inside another device, then the module is installed must also display a label referring to the enclosed module.

2.1.3.5 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.

- It is the same type as the antenna type of antenna specifications.
  Confirm the same size as the Gerber file.
- 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.
- 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 2.1.3.7.

2.1.3.6 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 centimeters or more away from person's body.

It is necessary to take a SAR test with your set mounting this module (except to use only Bluetooth). 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.

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

2.1.3.7 Antennas: Applicable

Table 20 lists the antenna for FCC.

Table 20: Antenna - FCC

No.	Part number	Vendor	Peak Gain [dBi]		Type	Connector
			2.4 GHz	5 GHz		
1	146153	Molex	3.2	4.25	Dipole	u.FL
2	219611	Molex	2.67	3.67	Dipole	u.FL
3	WT32D1-KX	Unictron	3.0	4.0	Dipole	MHF I
4	W24P-U	Inventek	3.2	N/A	Dipole	u.FL
5	Type2EL_Antenna	Murata	3.6	4.6	Monopole	Trace

- No. 4 W24P-U can only be used at 2.4 GHz.
- No. 5 Type2EL_Antenna can only be used for ANT0 (Antenna port0).

2.1.3.8 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: VPYLBES5PL2EL	OR	Contains FCC ID: VPYLBES5PL2EL

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

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.

2.1.3.9 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.

2.1.3.10 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.

2.1.3.11 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.

2.1.3.12 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 (LBES5PL2EL and LBEE5PL2DL) 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 21** is applied.

Table 21: Power Supply Voltages - FCC

Parameter		Minimum	Typical	Maximum	Unit
Supply Voltage	AVDD33	3.14	3.3	3.46	V
	AVDD18	1.71	1.8	1.89	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	SD_VIO	1.71 3.14	1.8 3.3	1.89 3.46	V

2.1.5 Trace Antenna and Feed Line

This section describes the trace antenna and feed line.

2.1.5.1 Signal Line Between an Antenna and a Module

It is a 50Ω 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.

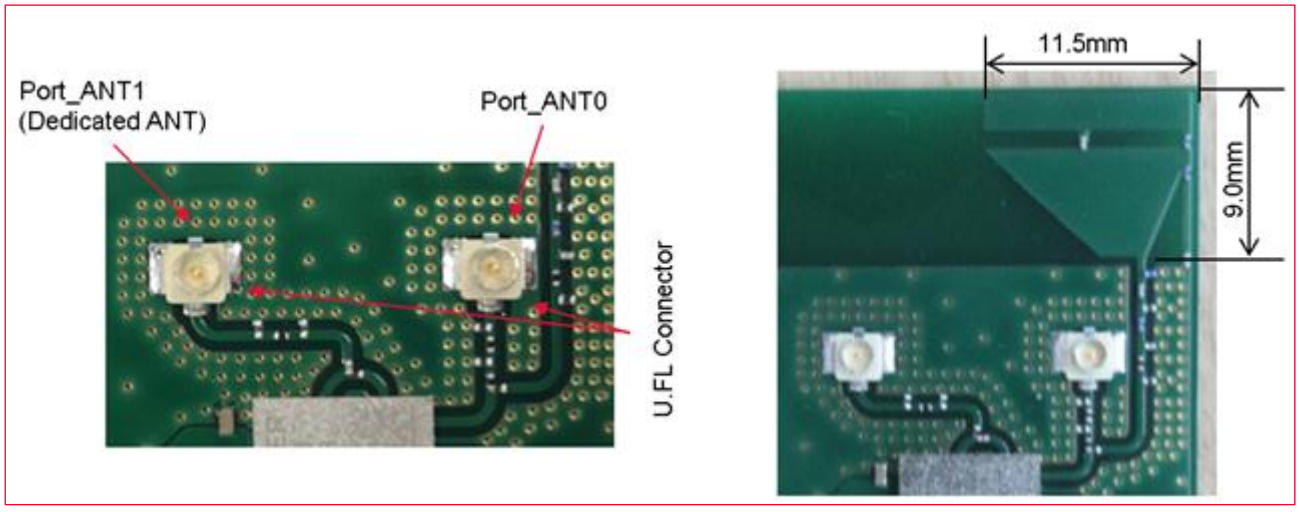
The concrete contents of a check are the following three points.

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.

50Ω line (microstrip line length) and Trace Antenna (Type2EL_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 50Ω microstrip line and Type2EL_Antenna needs to be copied when module is installed in the End product.

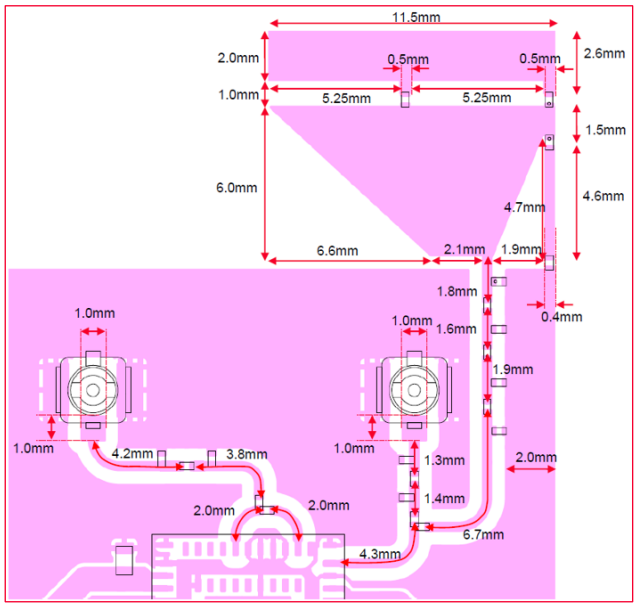
Murata provides set makers (type2el-2dl-module-footprint-topview.dxf) with Gerber data or something similar.

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: **P2ML10229**
- Feed line width: **0.4 millimeter**
- Substrate thin: **0.8 ± 0.1 millimeter**
- Substrate material: **FR-4**
- Substrate thickness between GND layer and surface layer: **0.235 millimeter**

Figure 6 shows the trace antenna and feed line for FCC.

Figure 6: Trace Antenna and Feed Line of Jig - FCC



2.1.6 Layout Guidance for Microstrip Design and External Antenna

This section describes about the layout guidance and external antenna.

2.1.6.1 Trace Antenna (Type2EL_Antenna)

The LBES5PL2EL (LBEE5PL2DL) module is certified with a PCB antenna (Type2EL_Antenna).

The following precautions should be taken when using this PCB antenna (Type2EL_Antenna).

- Type2EL_Antenna can only be used for port_ANT0 side.
- When the module is installed in the final product, the 50Ω microstrip line and Type2EL_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 (type2el-2dl-u-fl.dxf) with Gerber data or something similar.

Figure 7: 50Ω Microstrip Line and Type2EL_Antenna - FCC

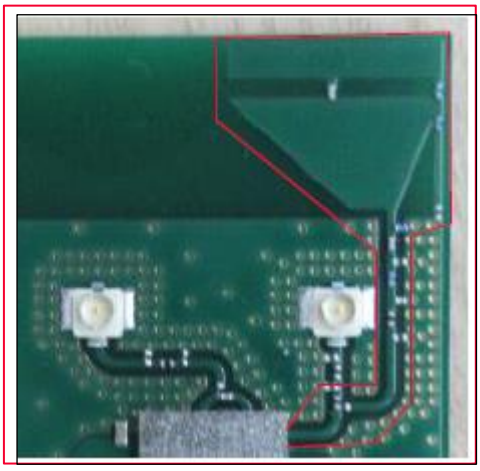
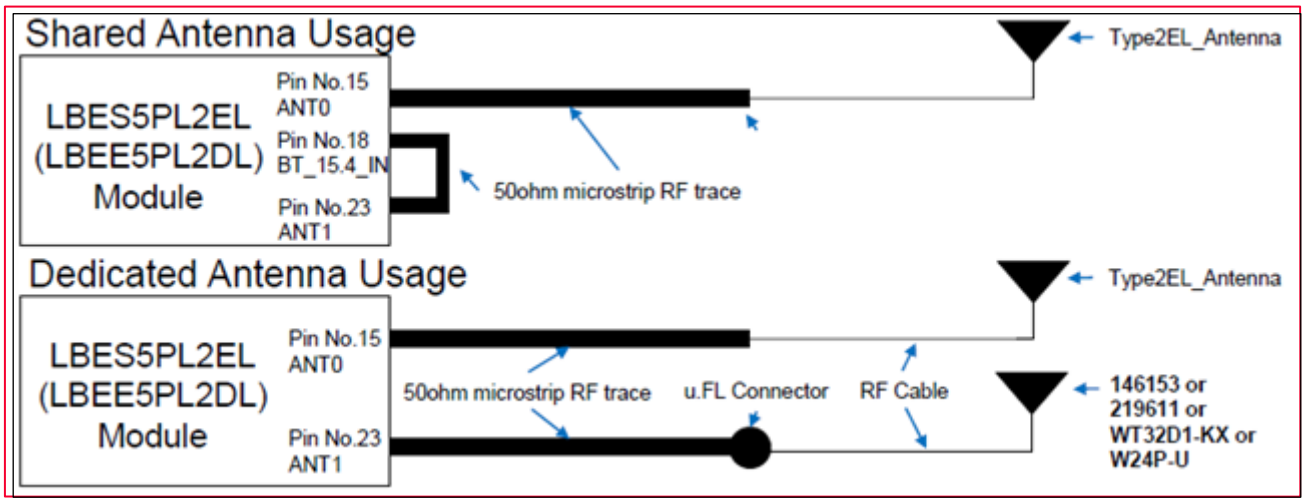


Figure 8: Trace antenna (Type2EL_Antenna) Layout Guide - FCC



2.1.6.2 Antenna With u.FL Connector and Cables and Feed Lines (146153, 219611, WT32D1-KX, W24P-U)

- The LBES5PL2EL (LBEE5PL2DL) module is certified with four external antennas.

The external antenna should be connected to the LBES5PL2EL (LBEE5PL2DL) module using 50Ω microstrip RF trace and a u.FL RF connector as described below.

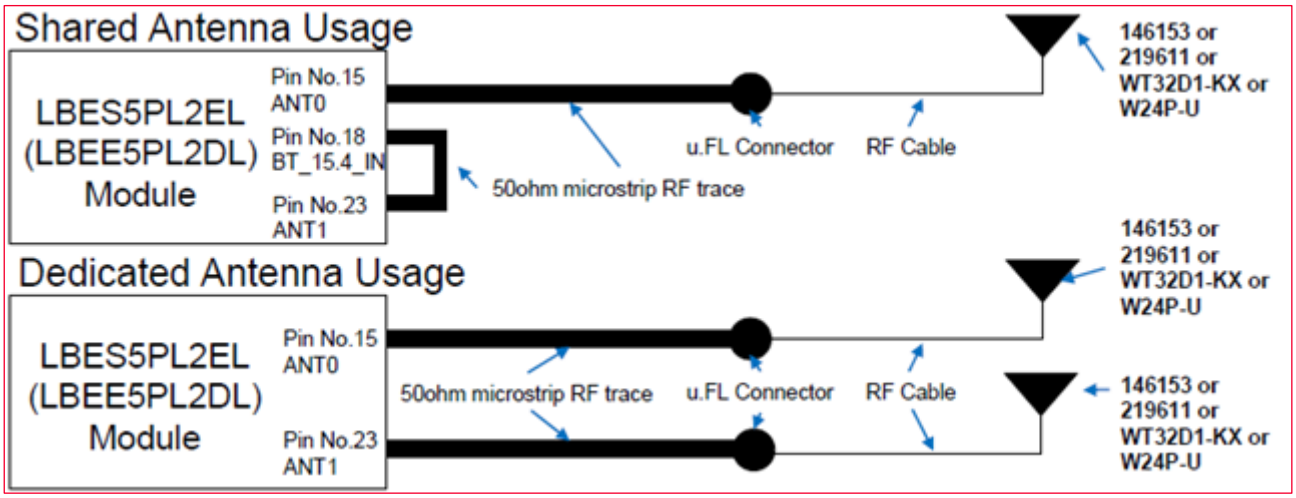
- The microstrip RF trace and u.FL connector are placed on the customer‘s PCB and are external to the LBES5PL2EL(LBEE5PL2DL) module.
- The antenna is then connected to this u.FL Connector via a 50Ω RF adapter cable.
- The design of the 50Ω microstrip RF trace on the customer’s PCB is crucially important.

Compliant operation of the LBES5PL2EL (LBEE5PL2DL) module is dependent on proper construction of this 50Ω 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, 23 and the u.FL connector.

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

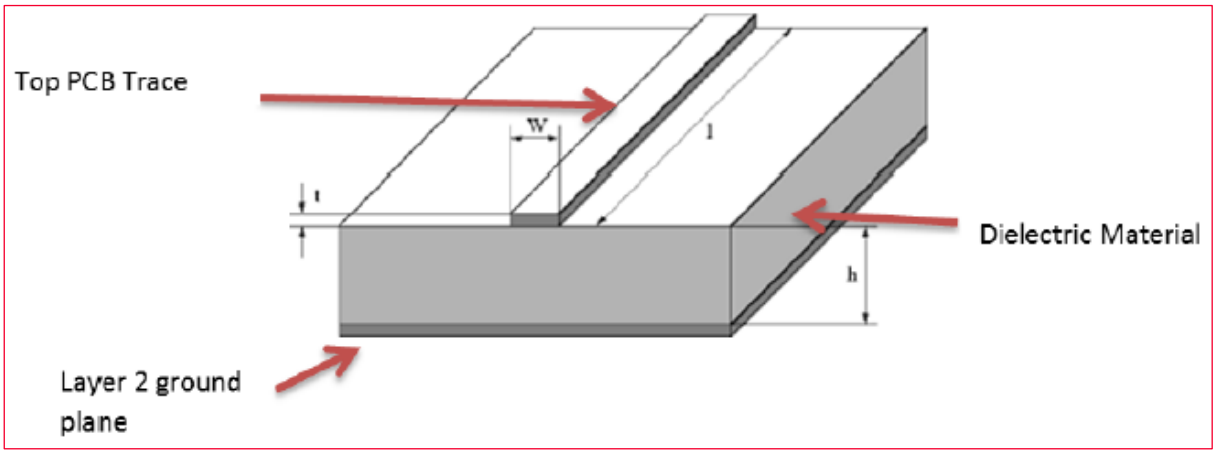
Figure 9: Antenna with u.FL Connector Layout Guide - FCC



50Ω 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 50Ω impedance for this transmission line.

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

- 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 50Ω 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 millimeter).

  Example:

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

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

- **l (trace length):** the impedance of the microstrip line is not dependent on its length. However, regulatory and performance limitations practically determine the actual length to be used by the customer (integrator).

  The length of this microstrip line must be longer than 7 millimeter to mimic the length used during FCC/ISED certification of the LBES5PL2EL (LBEE5PL2DL) module.
  Lengths longer than 7 millimeter are acceptable although additional signal loss will occur as a result.

  Given these restrictions, Murata recommends microstrip trace lengths between 7 millimeters and 25 millimeters.

  In any event, the microstrip line must operate over the same Dielectric-Ground Plane configuration shown above to act as a 50Ω transmission line.

  Do not run the microstrip trace through sections of PCB that do not have the Dielectric-Ground plane configuration shown above.

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: LBES5PL2EL	**HVIN:** LBES5PL2EL-SANT LBES5PL2EL-DANT	**IC:** 772C-LBES5PL2EL

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-LBES5PL2EL) 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-LBES5PL2EL) 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 centimeter 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 centimeter.
- **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20 centimeter.

English Version This radio transmitter (772C-LBES5PL2EL) 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 @ 2.4 GHz/4.25 dBi @ 5 GHz Dipole Antenna Gain: 2.67 dBi @ 2.4 GHz/3.67 dBi @ 5 GHz Dipole Antenna Gain: 3.0 dBi @2.4 GHz/4.0 dBi @ 5 GHz Dipole Antenna Gain: 3.2 dBi@ 2.4 GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/4.6 dBi @ 5GHz
French Version Le présent émetteur radio (772C-LBES5PL2EL) 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 @ 2.4 GHz/4.25 dBi @ 5 GHz Dipole Antenna Gain: 2.67 dBi @ 2.4 GHz/3.67 dBi @ 5 GHz Dipole Antenna Gain: 3.0 dBi @ 2.4 GHz/4.0 dBi @ 5 GHz Dipole Antenna Gain: 3.2 dBi @ 2.4 GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/4.6 dBi @ 5 GHz

2.2.1 Setting RF Power

This section describes the RF power settings.

2.2.1.1 RF Power Setting for 2.4 GHz WLAN

Table 22, **Table 23**, and **Table 24** describes the RF Power Settings for 2.4 GHz WLAN.

Table 22: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n (HT20/40)/ac (VHT20/40) (ISED)

Mode	Rate/MCS index	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	All Rate	1	16.0 ± 2.0
		2, 10, 11	17.0 ± 2.0
		3, 4, 5, 6, 7, 8, 9	18.0 ± 2.0
IEEE 802.11g	All rate	1, 11	12.0 ± 2.0

Mode	Rate/MCS index	Channel	Maximum Tune Up Tolerance (dBm)
		2	13.0 ± 2.0
		3, 9, 10	14.0 ± 2.0
		4, 5	15.0 ± 2.0
		6, 7, 8	16.0 ± 2.0
IEEE 802.11n (HT20)	All MCS index	1, 11	11.0 ± 2.0
		2	12.0 ± 2.0
		3, 9	14.0 ± 2.0
		4, 5, 6, 7, 8	15.0 ± 2.0
		10	13.0 ± 2.0
IEEE 802.11n (HT40)	All MCS index	3, 8, 9	10.0 ± 2.0
		4, 5, 6, 7	11.0 ± 2.0
IEEE 802.11ac (VHT20)	All MCS index	1, 11	11.0 ± 2.0
		2	12.0 ± 2.0
		3, 9,	14.0 ± 2.0
		4, 5, 6, 7, 8	15.0 ± 2.0
		10	13.0 ± 2.0
IEEE 802.11ac (VHT40)	All MCS index	3, 8, 9	10.0 ± 2.0
		4, 5, 6, 7	11.0 ± 2.0

Table 23: WLAN RF Power Setting - 2.4 GHz 802.11ax (HE20) (ISED)

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	1	MCS0 ~ MCS7	SU	11.0 ± 2.0		
					242 tone (Full tone)	10.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0
		MCS8 ~ MCS11	SU	11.0 ± 2.0		
					242 tone (Full tone)	10.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0
	2	MCS0 ~ MCS11	SU	12.0 ± 2.0		
					242 tone (Full tone)	12.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	3	MCS0 ~ MCS7	SU	14.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	4	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	5, 6	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	15.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ 11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	7, 8	MCS0 ~ MCS7	SU	15.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ 11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	9	MCS0 ~ MCS7	SU	14.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
		MCS8 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
	10	MCS0 ~ MCS11	SU	13.0 ± 2.0		
					242 tone (Full tone)	12.0 ± 2.0
					26 tone	12.0 ± 2.0
					52 tone	12.0 ± 2.0
					106 tone	12.0 ± 2.0
	11	MCS0 ~ MCS11	SU	11.0 ± 2.0		
					242 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0

Table 24: WLAN RF Power Setting - 2.4 GHz 802.11ax (HE40) (ISED)

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE40)	3	MCS0 ~ MCS11	SU	10.0 ±2.0		
					484 tone (Full tone)	6.0 ±2.0
					26 tone	9.0 ±2.0
					52 tone	10.0 ±2.0
					106 tone	10.0 ±2.0
					242 tone	10.0 ±2.0
	4	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	8.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
					242 tone	11.0 ±2.0
	5	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	10.0 ±2.0
					26 tone	11.0 ±2.0
					52 tone	11.0 ±2.0
					106 tone	11.0 ±2.0
					242 tone	11.0 ±2.0
	6	MCS0 ~ MCS11	SU	11.0 ±2.0		
					484 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0
					242 tone	11.0 ± 2.0
	7	MCS0 ~ MCS11	SU	11.0 ± 2.0		
					484 tone (Full tone)	11.0 ± 2.0
					26 tone	11.0 ± 2.0
					52 tone	11.0 ± 2.0
					106 tone	11.0 ± 2.0

Mode	Channel	Rate / MCS index	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					242 tone	11.0 ± 2.0
	8	MCS0 ~ MCS11	SU	10.0 ± 2.0		
					484 tone (Full tone)	8.0 ± 2.0
					26 tone	10.0 ± 2.0
					52 tone	10.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0
	9	MCS0 ~ MCS7	SU	10.0 ± 2.0		
					484 tone (Full tone)	7.0 ± 2.0
					26 tone	10.0 ± 2.0
					52 tone	10.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0

2.2.1.2 RF Power Setting for BT (BR/EDR) / BLE / IEEE 802.15.4

Table 25 describes the RF power settings for BT (BR/EDR), BLE, and IEEE 802.15.4.

Table 25: BT / BLE / IEEE 802.15.4 RF Power Setting - ISED

Mode	Channel	Maximum Tune Up Tolerance (dBm)
BR	NA	13.0 ± 3.0
EDR	NA	5.0 ± 3.0
LE	NA	13.0 ± 3.0
LE 2 Mbps	NA	13.0 ± 3.0
IEEE 802.15.4	11 ~ 25	15.0 ± 3.0
	26	0.0 ± 3.0

2.2.1.3 RF Power Setting for 5 GHz WLAN

Table 26 describes the RF power settings for 5 GHz 802.11a WLAN.

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

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	All Rate	W52/W53	36, 40, 44, 48 60, 64	14.0 ± 2.0
	All Rate	W52/W53	52, 56	16.0 ± 2.0
	All Rate	W56	100, 104	14.0 ± 2.0
	All Rate	W56	108 ~ 138, 144 (w/o 120, 124, 128)	16.0 ± 2.0
	All Rate	W56	140	13.0 ± 2.0
	All Rate	W58	161, 165	14.0 ± 2.0
	All Rate	W58	149 ~ 157	16.0 ± 2.0

Table 27 and **Table 28** describe the RF power settings for 5 GHz 802.11n WLAN.

Table 27: WLAN RF Power Setting - 5 GHz 802.11n (HT20) (ISED)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11n (HT20)	All MCS Index	W52/W53	36, 40, 60, 64	11.0 ± 2.0
	All MCS Index	W52/W53	44 ~ 56	14.0 ± 2.0
	All MCS Index	W56	100, 104	11.0 ± 2.0
	All MCS Index	W56	108 ~ 136, 144 (w/o 120, 124, 128)	14.0 ± 2.0
	All MCS Index	W56	140	10.0 ± 2.0
	All MCS Index	W58	161, 165	11.0 ± 2.0
	All MCS Index	W58	149 ~ 157	14.0 ± 2.0

Table 28: WLAN RF Power Setting - 5 GHz 802 11n (HT40) (ISED)

Mode	Rate	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802 11n (HT40)	All MCS index	W52/W53	38	10.0 ± 2.0
	All MCS index	W52/W53	62	11.0 ± 2.0
	All MCS index	W52/W53	46, 54	14.0 ± 2.0
	All MCS Index	W56	102	10.0 ± 2.0
	All MCS Index	W56	110 ~ 126, 142 (w/o 118, 126)	14.0 ± 2.0
	All MCS Index	W56	134	13.0 ± 2.0
	All MCS Index	W58	159	11.0 ± 2.0
	All MCS Index	W58	151	14.0 ± 2.0

Table 29, **Table 30**, and **Table 31** describe the RF power settings for 5 GHz 802.11ac WLAN.

Table 29: WLAN RF Power Setting - 5 GHz 802.11ac (VHT20) (ISED)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT20)	All MCS index	W52/W53	36, 40, 60, 64	11.0 ± 2.0
	All MCS index	W52/W53	44 ~ 56	14.0 ± 2.0
	All MCS index	W56	100, 104	11.0 ± 2.0
	All MCS index	W56	108 ~ 136, 144 (w/o 120,124,128)	14.0 ± 2.0
	All MCS index	W56	140	10.0 ± 2.0
	All MCS index	W58	161 ~ 165	11.0 ± 2.0
	All MCS index	W58	149 ~ 157	14.0 ± 2.0

Table 30: WLAN RF Power Setting - 5 GHz 802.11ac (VHT40) (ISED)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	W52/W53	38	10.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	38	10.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	62	11.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	62	11.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	46, 54	14.0 ± 2.0
	MCS8 ~ MCS9	W52/W53	46, 54	12.0 ± 2.0
	MCS0 ~ MCS7	W56	102	10.0 ± 2.0
	MCS8 ~ MCS9	W56	102	10.0 ± 2.0

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
	MCS0 ~ MCS7	W56	110 ~ 126, 142 (w/o 1 18, 126)	14.0 ± 2.0
	MCS8 ~ MCS9	W56	110 ~ 126, 142 (w/o 1 18, 126)	12.0 ± 2.0
	MCS0 ~ MCS7	W56	134	13.0 ± 2.0
	MCS8 ~ MCS9	W56	134	12.0 ± 2.0
	MCS0 ~ MCS7	W58	159	11.0 ± 2.0
	MCS8 ~ MCS9	W58	159	11.0 ± 2.0
	MCS0 ~ MCS7	W58	151	14.0 ± 2.0
	MCS8 ~ MCS9	W58	151	12.0 ± 2.0

Table 31: WLAN RF Power Setting - 5 GHz 802.11ac (VHT80) (ISED)

Mode	MCS Index	Band	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ac (VHT80)	MCS0 ~ MCS7	W52/W53	42	10.0 ± 2.0
	MCS8 ~ MCS9	W52/W3	42	10.0 ± 2.0
	MCS0 ~ MCS7	W52/W53	58	11.0 ± 2.0
	MCS8 ~ MCS9	W52/W3	58	11.0 ± 2.0
	MCS0 ~ MCS7	W56	106	7.0 ± 2.0
	MCS8 ~ MCS9	W6	106	7.0 ± 2.0
	MCS0 ~ MCS7	W56	138	14.0 ± 2.0
	MCS8 ~ MCS9	W56	138	12.0 ± 2.0
	MCS0 ~ MCS7	W58	155	9.0 ± 2.0
	MCS8 ~ MCS9	W58	155	9.0 ± 2.0

Table 32, **Table 33** and **Table 34** describe the RF power settings for 5 GHz 802.11ax WLAN.

Table 32: WLAN RF Power Setting - 5 GHz 802.11ax (HE20) (ISED)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	36, 40	MCS0 ~ MCS7	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
	44	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	48	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	52, 56	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	60, 64	MCS0 ~ MCS7	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	100, 104	MCS0 ~ MCS9	W56	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	108 ~ 136 (w/o 120,124,128)	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						106 tone	10.0 ± 2.0
	140	MCS0 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	7.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	144	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	161, 165	MCS0 ~ MCS9	W58	SU	11.0 ± 2.0		
						242 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
	149 ~ 157	MCS0 ~ MCS7	W58	SU	14.0 ± 2.0		
						242 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W58	SU	12.0 ± 2.0		
						242 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						242 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0

Table 33: WLAN RF Power Setting - 5 GHz 802.11ax (HE40) (ISED)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE40)	38	MCS0 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	7.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	46	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	54	MCS0 ~ MCS7	W52/W53	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W52/W53	SU	12.0 ± 2.0		

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	62	MCS0 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
	102	MCS0 ~ MCS7	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	3.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	8.0 ± 2.0
		MCS8 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	3.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	8.0 ± 2.0
	110 ~ 126 (w/o 118, 126)	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
	134	MCS0 ~ MCS7	W56	SU	13.0 ± 2.0		
						484 tone (Full tone)	13.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	13.0 ± 2.0
						106 tone	13.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	142	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	151	MCS0 ~ MCS7	W58	SU	14.0 ± 2.0		
						484 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W58	SU	12.0 ± 2.0		
						484 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
	159	MCS0 ~ MCS7	W58	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
		MCS8 ~ MCS9	W58	SU	11.0 ± 2.0		
						484 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W58	SU	10.0 ± 2.0		
						484 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0

Table 34: WLAN RF Power Setting - 5 GHz 802.11ax (HE80) (ISED)

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE80)	42	MCS0 ~ MCS7	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	7.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
		MCS8 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	7.0 ± 2.0
						26 tone	8.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone (Full tone)	10.0 ± 2.0
	58	MCS0 ~ MCS9	W52/W53	SU	11.0 ± 2.0		
						996 tone (Full tone)	11.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	11.0 ± 2.0
						106 tone	11.0 ± 2.0
						242 tone	11.0 ± 2.0
						484 tone	11.0 ± 2.0
		MCS10 ~ MCS11	W52/W53	SU	10.0 ± 2.0		
						996 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
	106	MCS0 ~ MCS11	W56	SU	7.0 ± 2.0		
						996 tone (Full tone)	5.0 ± 2.0
						26 tone	7.0 ± 2.0
						52 tone	7.0 ± 2.0
						106 tone	7.0 ± 2.0
						242 tone	7.0 ± 2.0
						484 tone	7.0 ± 2.0
	138	MCS0 ~ MCS7	W56	SU	14.0 ± 2.0		
						996 tone (Full tone)	14.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	14.0 ± 2.0

Mode	Channel	MCS Index	Band	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
						106 tone	14.0 ± 2.0
						242 tone	14.0 ± 2.0
						484 tone	14.0 ± 2.0
		MCS8 ~ MCS9	W56	SU	12.0 ± 2.0		
						996 tone (Full tone)	12.0 ± 2.0
						26 tone	11.0 ± 2.0
						52 tone	12.0 ± 2.0
						106 tone	12.0 ± 2.0
						242 tone	12.0 ± 2.0
						484 tone	12.0 ± 2.0
		MCS10 ~ MCS11	W56	SU	10.0 ± 2.0		
						996 tone (Full tone)	10.0 ± 2.0
						26 tone	10.0 ± 2.0
						52 tone	10.0 ± 2.0
						106 tone	10.0 ± 2.0
						242 tone	10.0 ± 2.0
						484 tone	10.0 ± 2.0
	155	MCS0 ~ MCS11	W58	SU	9.0 ± 2.0		
						996 tone (Full tone)	9.0 ± 2.0
						26 tone	9.0 ± 2.0
						52 tone	9.0 ± 2.0
						106 tone	9.0 ± 2.0
						242 tone	9.0 ± 2.0
						484 tone	9.0 ± 2.0

2.2.2 Theory of Operation

Table 35 describes the theory of operation for ISED.

Table 35: Theory of Operation - ISED

Frequency of Operation			Scan	Ad hoc Mode
2.4 GHz	11b/g/n/ac/ax (BW20)	2412-2462 MHz	Active	Yes
	11n/ac/ax (BW40)	2422-2452 MHz	Active	Yes
	BT	2402-2480 MHz	N/A	N/A
	BLE	2402-2480 MHz	N/A	N/A
	IEEE802.15.4	2405-2480 MHz	N/A	N/A
W52	11a/n/ac/ax (BW20)	5180-5240 MHz	Active	Yes
	11n/ac/ax (BW40)	5190-5230 MHz	Active	Yes
	11ac/ax (BW80)	5210 MHz	Active	Yes
W53[2]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
	11n/ac/ax (BW40)	5270-5310 MHz	Passive	No
	11ac/ax (BW80)	5290 MHz	Passive	No
W56[3]	11a/n/ac/ax (BW20)	5500-5720 MHz	Passive	No
	11n/ac/ax (BW40)	5510-5710 MHz	Passive	No
	11ac/ax (BW80)	5530-5690 MHz	Passive	No
W58	11a/n/ac/ax (BW20)	5745-5825 MHz	Active	Yes
	11n/ac/ax (BW40)	5755-5795 MHz	Active	Yes
	11ac/ax (BW80)	5775 MHz	Active	Yes

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-LBES5PL2EL

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.

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

[3] 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 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 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-LBES5PL2EL) 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-LBES5PL2EL) 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 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.
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 20 centimeter.
- **Mobile equipment:** Equipment used at position in which the spaces between human body and antenna exceeded 20 centimeter.

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-LBES5PL2EL) 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 @ 2.4 GHz/4.25 dBi @ 5 GHz Dipole Antenna Gain: 2.67 dBi @ 2.4 GHz/3.67 dBi @ 5 GHz Dipole Antenna Gain: 3.0 dBi @ 2.4 GHz/4.0 dBi @ 5 GHz Dipole Antenna Gain: 3.2 dBi @ 2.4 GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/4.6 dBi @ 5 GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/3.6 dBi @ 5 GHz
French Version Le présent émetteur radio (772C-LBES5PL2EL) 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 @2.4 GHz/4.25 dBi @ 5 GHz Dipole Antenna Gain: 2.67 dBi @ 2.4 GHz/3.67 dBi @ 5 GHz Dipole Antenna Gain: 3.0 dBi @ 2.4 GHz/4.0 dBi @ 5 GHz Dipole Antenna Gain: 3.2 dBi @ 2.4GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/4.6 dBi @ 5 GHz Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/3.6 dBi @ 5 GHz

2.2.3 Antenna

The antenna models for ISED are described in **Table 36**.

Table 36: Antenna - ISED

No.	Antenna P/N	Maker	Type	Peak Gain [dBi]		Connector / form
				2400-2500 MHz	5150-5850 MHz	
1	146153 (50 mm cable)	Molex	Dipole	3.2 dBi	4.25 dBi	u.FL
2	219611 (50 millimeter cable)	Molex	Dipole	2.67 dBi	3.67 dBi	u.FL
3	WT32D1-KX	Unitron	Dipole	3.0 dBi	4.0 dBi	MHF I
4	W24P-U	Inventek	Dipole	3.2 dBi	N/A	u.FL
5	Type2EL_Antenna	Murata	Monopole	3.6 dBi	4.6 dBi	Trace (pattern)

No. 4 W24P-U can only be used at 2.4 GHz band.
No. 5 Type2EL_Antenna can only be used for ANT0 (Antenna Port 0)

2.2.3.1 Signal Line Between an Antenna and a Module

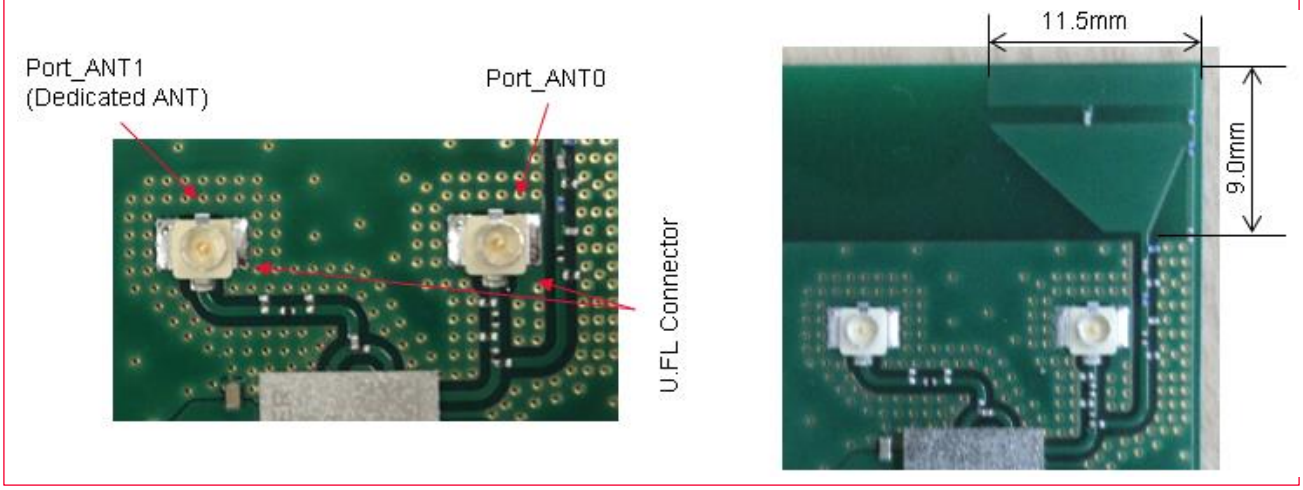
It is a 50Ω line design. Fine tuning of return loss etc. can be performed using a matching network. However, it is required to check "Class1 change" and "Class2 change" which the authorities define then.

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.

50Ω line (micfrostrip line length) and Trace Antenna (Type2EL_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 50Ω microstrip line and Type2EL_Antenna needs to be copied when module is installed in the end product.

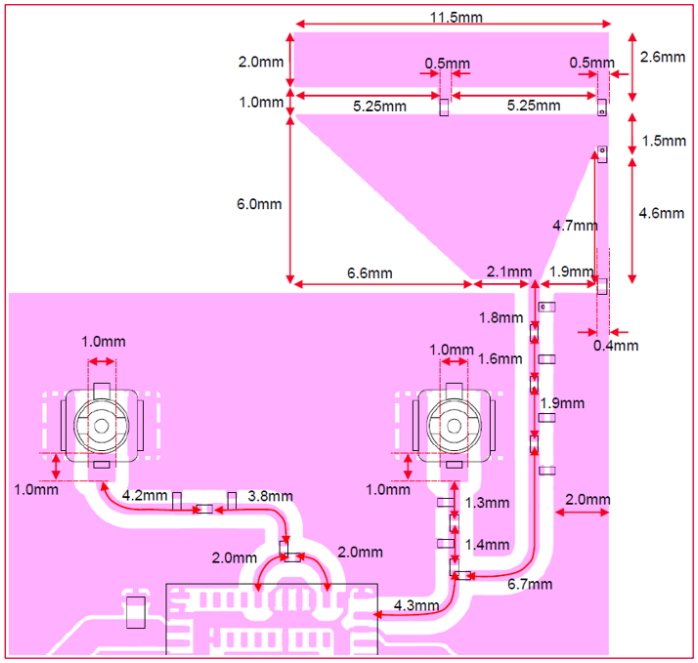
Murata provides set makers (type2el-2dl-module-footprint-topview.dxf) with Gerber data or something similar.

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

- Substrate type name of certification test jig: **P2ML10229-S** and **P2ML10229-D**
- Feed line width: **0.4 mm**
- Substrate thin: **0.8 ± 0.1 millimeter**
- Substrate material: **FR-4**
- Substrate thickness between GND layer and surface layer: **0.235 millimeter**

Figure 12 shows the trace antenna and feed line for ISED.

Figure 12: Trace Antenna and Feed Line of Jig - ISED



2.2.4 Layout Guidance for Microstrip Design and External Antenna

This section describes the layout guidance and external antenna.

2.2.4.1 Trace Antenna (Type2EL_Antenna)

The LBES5PL2EL module is certified with a PCB antenna (Type2EL_Antenna).

The following precautions should be taken when using this PCB antenna (Type2EL_Antenna):

- Type2EL_Antenna can only be used for port_ANT0 side.
- When the module is installed in the final product, the 50Ω microstrip line and Type2EL_Antenna, outlined in right red in **Figure 13**, must be copied to the state shown in **Figure 14** 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 (type2el-2dl-u-fl.dxf) with Gerber data or something similar.

Figure 13: 50Ω Microstrip Line and Type2EL_Antenna - ISED

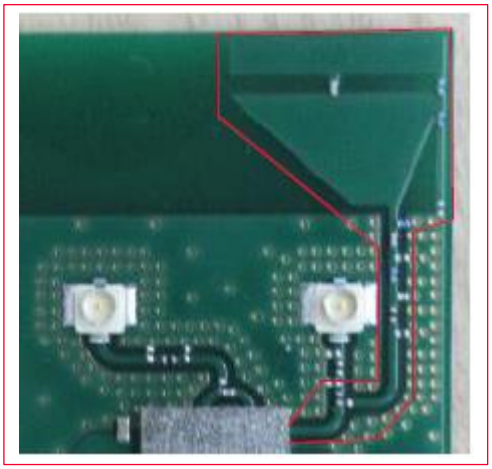
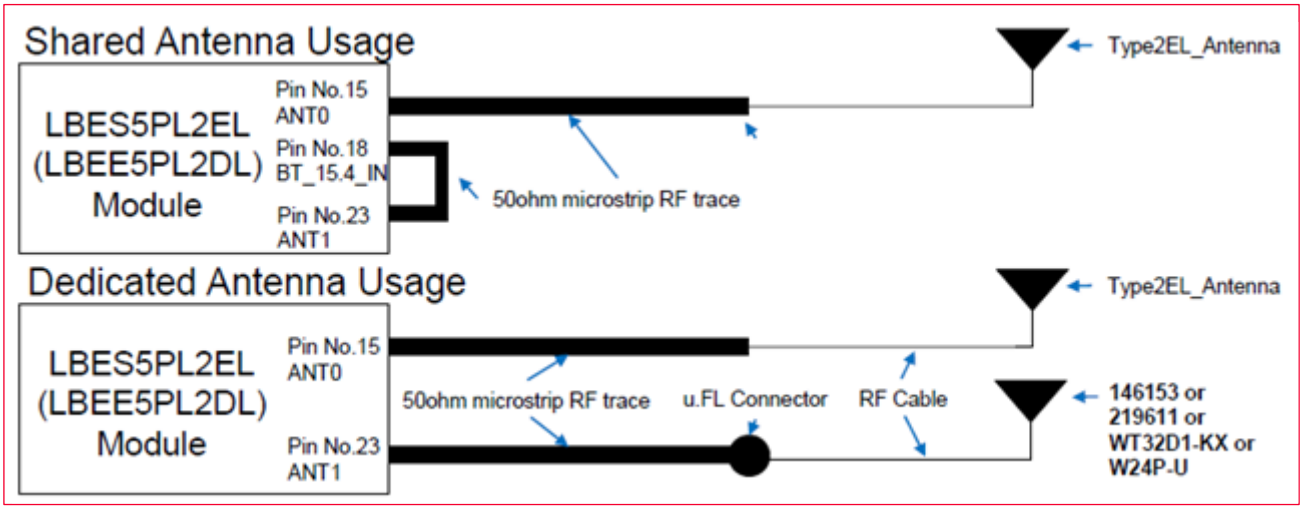


Figure 14: Trace Antenna (Type2EL_Antenna) Layout Guide - ISED



2.2.4.2 Antenna with u.FL Connector and Cables and Feed Lines (146153, 219611, WT32D1-KX, W24P-U)

- The LBES5PL2EL module is certified with a PCB antenna and four external antenna.

The external antenna should be connected to the LBES5PL2EL module using 50Ω microstrip RF trace and a u.FL RF connector as described below.

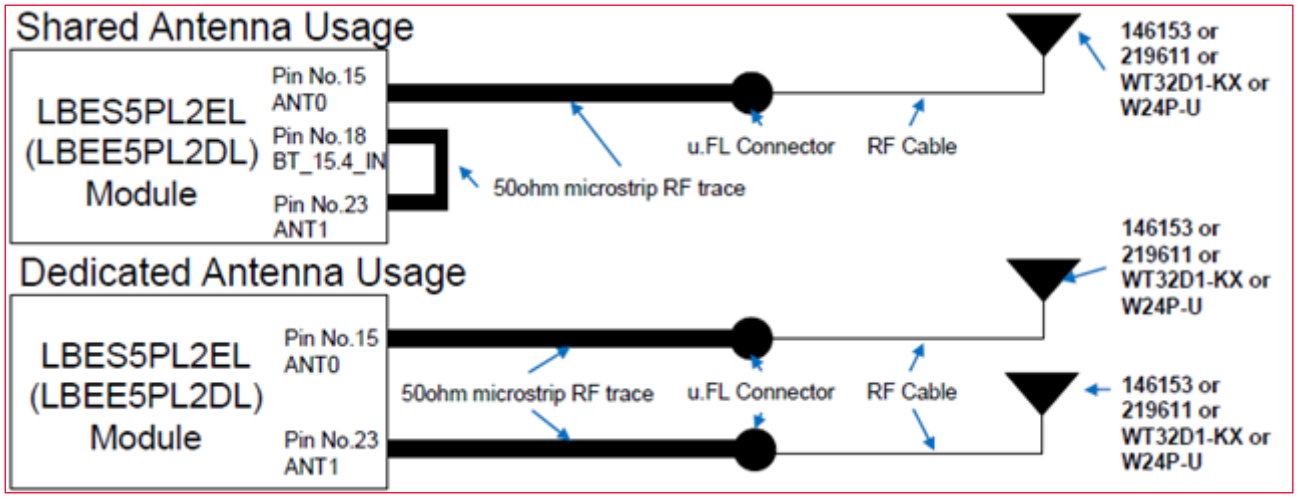
- The microstrip RF trace and u.FL connector are placed on the customer‘s PCB and are external to the LBES5PL2EL module.
- The antenna is then connected to this u.FL Connector via a 50Ω RF adapter cable.
- The design of the 50Ω microstrip RF trace on the customer’s PCB is crucially important.

Compliant operation of the LBES5PL2EL module is dependent on proper construction of this 50Ω 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, 23 and the u.FL connector.

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

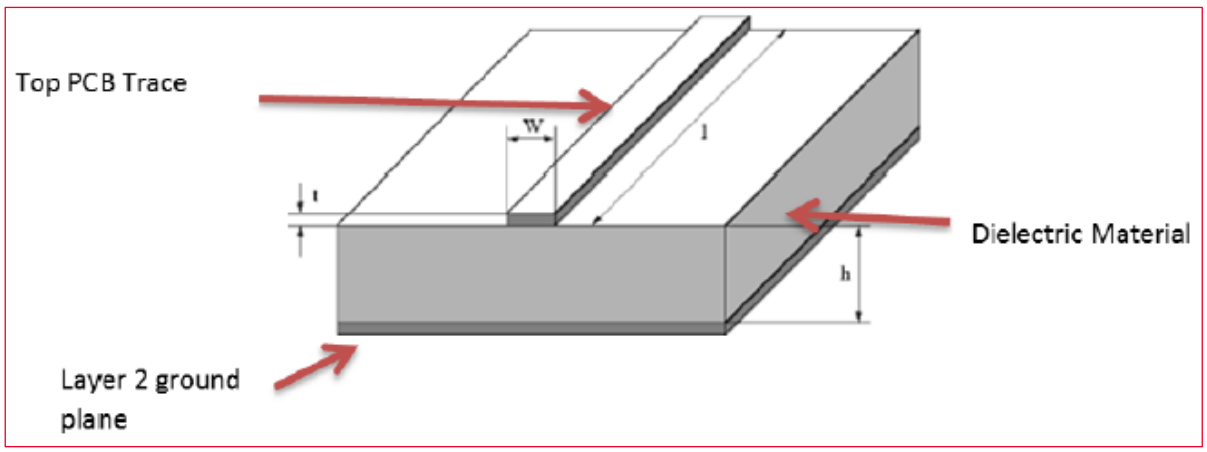
Figure 15: Antenna with u.FL Connector Layout Guide - ISED



50Ω 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 50Ω impedance for this transmission line.

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

- 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 50Ω 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 millimeter).

  Example:

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

  H = 0.4 millimeter, W = 0.4*1.8 = 0.72 millimeter
- **l (trace length):** the impedance of the microstrip line is not dependent on its length. However, regulatory and performance limitations practically determine the actual length to be used by the customer (integrator).

> The length of this microstrip line must be longer than 7 millimeter to mimic the length used during FCC/ISED certification of the LBES5PL2EL (LBEE5PL2DL) module.
> Lengths longer than 7 millimeter are acceptable although additional signal loss will occur as a result.

Given these restrictions, Murata recommends microstrip trace lengths between 7 millimeter and 25 millimeter.

In any event, the microstrip line must operate over the same Dielectric-Ground Plane configuration shown above to act as a 50Ω transmission line.

> Do not run the microstrip trace through sections of PCB that do not have the Dielectric-Ground plane configuration shown above.

A reliable 50Ω 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.

2.2.5 About Power Supply (Limited Condition)

This module (LBES5PL2EL) 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 37 shows the power supply voltage for ISED.

Table 37: Power Supply Voltage - ISED

Parameter		Minimum	Typical	Maximum	Unit
Supply Voltage	AVDD33	3.14	3.3	3.46	V
	AVDD18	1.71	1.8	1.89	V
	VIO	1.71 3.14	1.8 3.3	1.89 3.46	V
	SD_VIO	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.: TERF2211002503E2

Report No.: TERF2211002504E2

Report No.: TERF2211002505E2

EN 301 893 v2.1.1:2017

Report No.: TERF2211002506E2

Report No.: TERF2211002507E2

EN 300 440 v2.1.1:2017

Report No.: TERF2211002508E2

Report No.: TERF2211002509E2

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

Conforms to: EN 62311:2020

Report No.: TESA2304000207ES

Product name: Communication Module

Model: LBES5PL2EL

Manufacturer: 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

Table 38, **Table 39**, and **Table 40** describe the RF Power Settings for 2.4 GHz WLAN.

Table 38: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n (HT20/40)/ac (VHT20/40) (EU)

Mode	Rate/MCS index	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11b	All Rate	1 ~ 13	13.0 ± 2.0
IEEE 802.11g	All Rate	1 ~ 13	14.0 ± 2.0
IEEE 802.11n (HT20)	All MCS index	1 ~ 13	14.0 ± 2.0
IEEE 802.11n (HT40)	All MCS index	3 ~ 11	14.0 ± 2.0
IEEE 802.11ac (VHT20)	All MCS index	1 ~ 13	14.0 ± 2.0
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	3 ~ 11	14.0 ± 2.0
	MCS8 ~ MCS9	3 ~ 11	13.0 ± 2.0

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

Mode	Rate / MCS index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	MCS0 ~ MCS7	1 ~ 13	SU	14.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
	MCS8 ~ MCS11	1 ~ 13	SU	13.0 ±2.0		
					242 tone (Full tone)	13.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0

Table 40: WLAN RF Power Setting - 2.4 GHz 802.11ax (HE40) (EU)

Mode	Rate / MCS index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE40)	MCS0 ~ MCS7	3 ~ 11	SU	14.0 ± 2.0		
					484 tone (Full tone)	14.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
					242 tone	14.0 ± 2.0
	MCS8 ~ MCS11	3 ~ 11	SU	13.0 ±2.0		

Mode	Rate / MCS index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					484 tone (Full tone)	13.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
					242 tone	13.0 ± 2.0

2.3.1.2 RF Power Setting for BT (BR/EDR) / BLE / IEEE 802.15.4

Table 41 describes the RF power settings for BT (BR/EDR), BLE and IEEE 802.15.4.

Table 41: BT / BLE / IEEE 802.15.4 RF Power Setting - EU

Mode	Channel	Maximum Tune Up Tolerance (dBm)
BR	NA	3.0 ± 3.0
EDR	NA	0.0 ± 3.0
LE	NA	3.0 ± 3.0
LE 2 Mbps	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)

Table 42, **Table 43**, **Table 44**, and **Table 45** describe the RF power settings for 5 GHz WLAN (W52/W53/W56).

Table 42: WLAN RF Power Setting - 5 GHz 802.11a/n/ac for Channels 36 ~ 140 (EU)

Mode	Rate/MCS Index	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	All Rate	36 ~ 140	15.0 ± 2.0
IEEE 802.11n (HT20)	All MCS index	36 ~ 140	14.0 ± 2.0
IEEE 802.11n (HT40)	All MCS index	38 ~ 134	14.0 ± 2.0
IEEE 802.11ac (VHT20)	All MCS index	36 ~ 140	14.0 ± 2.0
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	38 ~ 134	14.0 ± 2.0
	MCS8 ~ MCS9	38 ~ 134	12.0± 2.0
IEEE 802.11ac (VHT80)	MCS0 ~ MCS7	42 ~ 122	14.0± 2.0
	MCS8 ~ MCS9	42 ~ 122	12.0± 2.0

Table 43: WLAN RF Power Setting - 5 GHz 802.11ax (HE20) for Channels 36 ~ 140 (EU)

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	MCS0 ~ MCS7	36 ~ 140	SU	14.0 ± 2.0		
					242 tone (Full tone)	14.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
	MCS8 ~ MCS9	36 ~ 140	SU	12.0 ± 2.0		
					242 tone (Full tone)	12.0 ± 2.0
					26 tone	7.0 ± 2.0

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
	MCS10 ~ MCS11	36 ~ 140	SU	10.0 ± 2.0		
					242 tone (Full tone)	10.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	10.0 ± 2.0

Table 44: WLAN RF Power Setting - 5 GHz 802.11ax (HE40) for Channels 38 ~ 134 (EU)

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE40)	MCS0 ~ MCS7	38 ~ 134	SU	14.0 ± 2.0		
					484 tone (Full tone)	14.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
					242 tone	14.0 ± 2.0
	MCS8 ~ MCS9	38 ~ 134	SU	12.0 ± 2.0		
					484 tone (Full tone)	12.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
					242 tone	12.0 ± 2.0
	MCS10 ~ MCS11	38 ~ 134	SU	10.0 ± 2.0		
					484 tone (Full tone)	10.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0

Table 45: WLAN RF Power Setting - 5 GHz 802.11ax (HE80) for Channels 42 ~ 122 (EU)

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE80)	MCS0 ~ MCS7	42~122	SU	14.0 ± 2.0		
					996 tone (Full tone)	14.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	12.0 ± 2.0
					242 tone	14.0 ± 2.0
					484 tone	14.0 ± 2.0
	MCS8 ~ MCS9	42 ~ 122	SU	12.0 ± 2.0		
					996 tone (Full tone)	12.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
					106 tone	12.0 ± 2.0
					242 tone	12.0 ± 2.0
					484 tone	12.0 ± 2.0
	MCS10 ~ MCS11	42 ~ 122	SU	10.0 ± 2.0		
					996 tone (Full tone)	10.0 ± 2.0
					26 tone	7.0 ± 2.0
					52 tone	9.0 ± 2.0
					106 tone	10.0 ± 2.0
					242 tone	10.0 ± 2.0
					484 tone	10.0 ± 2.0

2.3.1.4 RF Power Setting for 5 GHz WLAN (W58)

Table 46 and **Table 47** describe the RF power settings for 5 GHz WLAN (W58).

Table 46: WLAN RF Power Setting - 5 GHz 802.11 a/n/ac for Channels 149 ~ 169 (EU)

Mode	Rate/MCS Index	Channel	Maximum Tune Up Tolerance (dBm)
IEEE 802.11a	All Rate	149 ~ 169	4.0 ± 2.0
IEEE 802.11n (HT20)	All MCS index	149 ~ 169	4.0 ± 2.0
IEEE 802.11n (HT40)	All MCS index	149 ~ 169	4.0 ± 2.0
IEEE 802.11ac (VHT20)	All MCS index	149 ~ 169	4.0 ± 2.0
IEEE 802.11ac (VHT40)	All MCS index	151 ~ 167	4.0 ± 2.0
IEEE 802.11ac (VHT80)	All MCS index	155	4.0 ± 2.0

Table 47: WLAN RF Power Setting - 5 GHz 802.11ax for Channels 149 ~ 169 (EU)

Mode	MCS Index	Channel	SU	Maximum Tune Up Tolerance (dBm)	RU	Maximum Tune Up Tolerance (dBm)
IEEE 802.11ax (HE20)	All MCS index	149 ~ 169	SU	4.0 ± 2.0		
					242 tone (Full tone)	4.0 ± 2.0
					26 tone	4.0 ± 2.0
					52 tone	4.0 ± 2.0
					106 tone	4.0 ± 2.0
IEEE 802.11ax (HE40)	All MCS index	151 ~ 159	SU	4.0 ± 2.0		
					484 tone (Full tone)	4.0 ± 2.0
					26 tone	4.0 ± 2.0
					52 tone	4.0 ± 2.0
					106 tone	4.0 ± 2.0
					242 tone	4.0 ± 2.0
IEEE 802.11ax (HE80)	All MCS index	155	SU	4.0 ± 2.0		
					996 tone (Full tone)	4.0 ± 2.0
					26 tone	4.0 ± 2.0
					52 tone	4.0 ± 2.0
					106 tone	4.0 ± 2.0
					242 tone	4.0 ± 2.0
					484 tone	4.0 ± 2.0

2.3.2 Theory of Operation

Table 48 describes the theory of operation for EU.

Table 48: 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
	11n/ac/ax (BW40)	2422-2462 MHz	Active	Yes
	BT	2402-2480 MHz	N/A	N/A
	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
	11n/ac/ax (BW40)	5190-5230 MHz	Active	Yes
	11ac/ax (BW80)	5210 MHz	Active	Yes
W53[4]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
	11n/ac/ax (BW40)	5270-5310 MHz	Passive	No
	11ac/ax (BW80)	5290 MHz	Passive	No
W56[4]	11a/n/ac/ax (BW20)	5500-5700 MHz	Passive	No
	11n/ac/ax (BW40)	5510-5670 MHz	Passive	No
	11ac/ax (BW80)	5530-5610 MHz	Passive	No
W58	11a/n/ac/ax (BW20)	5745-5845 MHz	Active	Yes
	11n/ac/ax (BW40)	5755-5835 MHz	Active	Yes
	11ac/ax (BW80)	5775 MHz	Active	Yes

2.4 Japan

- **Manufacturer Name:** Murata Manufacturing Co., Ltd.
- **Model or Product Name:** LBES5PL2EL

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 5.2 GHz 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: 5.2 GHz/5.3 GHz/5.6 GHz(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.

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

2.4 GHz と 5 GHz (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.

2.4.1 Product Outline

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

- **Product Size:** 8.8 x 7.7 millimeter (Typical), H = 1.3 millimeter (Maximum)
- **Wireless-IC:** NXP IW612 inside
- **Reference Clock**: 40 MHz X′tal
- **Weight:** 0.22 g

2.4.2 Feature

- **Product Name:** Communication Module
- **Model Name:** LBES5PL2EL
- **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
  (BT)1 ~ 79 ch (BLE) 1 ~ 40 ch (IEEE 802.15.4)11 ~ 26 ch
- **Bandwidth:** (WLAN) 2.4 GHz 11b (20 MHz)/11g (20 MHz)/11n (20/40 MHz)/
  11ac(20/40MHz)/11ax(20/40MHz)
  5 GHz 11a (20 MHz)/11n (20/40 MHz)/11ac (20/40/80 MHz)/11ax (20/40/80 MHz)
  (BT) Hopping off 1 MHz / Hopping on 79 MHz
  (BLE) 1 MHz / 2 MHz
  IEEE 802.15.4 1 MHz
- **Input Voltage to RF parts:** AVDD33 Typical 3.3V
  AVDD18 Typical 1.8V

2.4.3 Setting RF Power

This section describes the RF power settings.

2.4.3.1 RF Power Setting for 2.4 GHz WLAN

Table 49 describes the RF power settings for 2.4 GHz WLAN.

Table 49: WLAN RF Power Setting - 2.4 GHz 802.11 b/g/n (HT20/40)/ac (VHT20/40) (Japan)

Mode	Rate/MCS index	Channel	Output Power in dBm (typical)
IEEE 802.11b	All Rate	1 ~ 13	15.0
IEEE 802.11g	All Rate	1 ~ 13	16.0

Mode	Rate/MCS index	Channel	Output Power in dBm (typical)
IEEE 802.11n (HT20)	All MCS index	1 ~ 13	15.0
IEEE 802.11n (HT20)	All MCS index	3 ~ 11	15.0
IEEE 802.11ac (VHT20)	All MCS index	1 ~ 13	15.0
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	3 ~ 11	15.0
	MCS8 ~ MCS9	3 ~ 11	13.0
IEEE 802.11ax (HE20)	MCS0 ~ MCS7	1 ~ 13	15.0
	MCS8 ~ MCS11	1 ~ 13	13.0
IEEE 802.11ax (HE40)	MCS0 ~ MCS7	3 ~ 11	15.0
	MCS8 ~ MCS11	3 ~ 11	13.0

2.4.3.2 RF Power Setting BT (BR/EDR) / BLE / IEEE 802.15.4

RF power settings for BT (BR/EDR), BLE and IEEE 802.15.4 are described in the following tables.

Table 50 shows BT (BR/EDR) and BLE power setting. In case of only BT (BR/EDR), you can select a high-power setting as shown in **Table 51**. **Table 52** shows the 802.15.4 RF power setting.

Table 50: BT / BLE RF Power Setting - Japan

Mode	Output Power in dBm (typical)
BR	5.0
EDR	2.0
LE	5.0
LE 2 Mbps	5.0

Table 51: BT RF Power Setting - Japan

Mode	Output Power in dBm (typical)
BR	12.0
EDR	5.0

Table 52: IEEE 802.15.4 RF Power Setting - Japan

Mode	Channel	Output Power in dBm (typical)
IEEE802.15.4	11 ~ 25	3.0
	26	0.0

2.4.3.3 RF Power Setting for 5 GHz WLAN

Table 53 describes the RF power settings for 5 GHz WLAN.

Table 53: WLAN RF Power Setting - 5 GHz 802.11a/n/ac/ax (Japan)

Mode	Rate/MCS Index	Channel	Output Power in dBm (typical)
IEEE 802.11a	All Rate	36 ~ 144	14.0
IEEE 802.11n (HT20)	All MCS index	36 ~ 144	13.0
IEEE 802.11n (HT40)	All MCS index	38 ~ 142	13.0
IEEE 802.11ac (VHT20)	All MCS index	36 ~ 144	13.0
IEEE 802.11ac (VHT40)	MCS0 ~ MCS7	38 ~ 142	13.0
	MCS8 ~ MCS9	38 ~ 142	12.0
IEEE 802.11ac (VHT80)	MCS0 ~ MCS7	42 ~ 138	13.0
	MCS8 ~ MCS9	42 ~ 138	12.0

Mode	Rate/MCS Index	Channel	Output Power in dBm (typical)
IEEE 802.11ax (HE20)	MCS0 ~ MCS7	36 ~ 144	13.0
	MCS8 ~ MCS9	36 ~ 144	12.0
	MCS10 ~ MCS11	36 ~ 144	10.0
IEEE 802.11ax (HE40)	MCS0 ~ MCS7	38 ~ 142	13.0
	MCS8 ~ MCS9	38 ~ 142	12.0
	MCS10 ~ MCS11	38 ~ 142	10.0
IEEE 802.11ax (HE80)	MCS0 ~ MCS7	42 ~ 138	13.0
	MCS8, MCS9	42 ~ 138	12.0
	MCS10 ~ MCS11	42 ~ 138	10.0

2.4.4 Types of Radio Emissions

Table 54 describes the types of radio emissions.

Table 54: Types of Radio Emissions

Mode	Rate/MCS Index	Modulation System	Types of Radio Emissions
Bluetooth	BR	GFSK	F1D
	EDR 2Mbps	π/4DQPSK	G1D
	EDR 3Mbps	8DPSK	G1D
	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
IEEE 802.11ax	MCS10, MCS11	1024QAM	D1D

2.4.5 Theory of Operation

Table 55 describes the theory of operation for Japan.

Table 55: 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
	11n/ac/ax(BW40)	2422-2462 MHz	Active	Yes
	BT	2402-2480 MHz	N/A	N/A
	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
	11n/ac/ax (BW40)	5190-5230 MHz	Active	Yes
	11ac/ax (BW80)	5210 MHz	Active	Yes

Frequency of Operation			Scan	Ad hoc Mode
W53[5]	11a/n/ac/ax (BW20)	5260-5320 MHz	Passive	No
	11n/ac/ax (BW40)	5270-5310 MHz	Passive	No
	11ac/ax (BW80)	5290 MHz	Passive	No
W56[5]	11a/n/ac/ax (BW20)	5500-5720 MHz	Passive	No
	11n/ac/ax (BW40)	5510-5710 MHz	Passive	No
	11ac/ax (BW80)	5530-5690 MHz	Passive	No

2.4.6 Antenna

The antenna registered under the Radio Act Certification of Japan are described in **Table 56**.

Table 56: Antenna - Japan

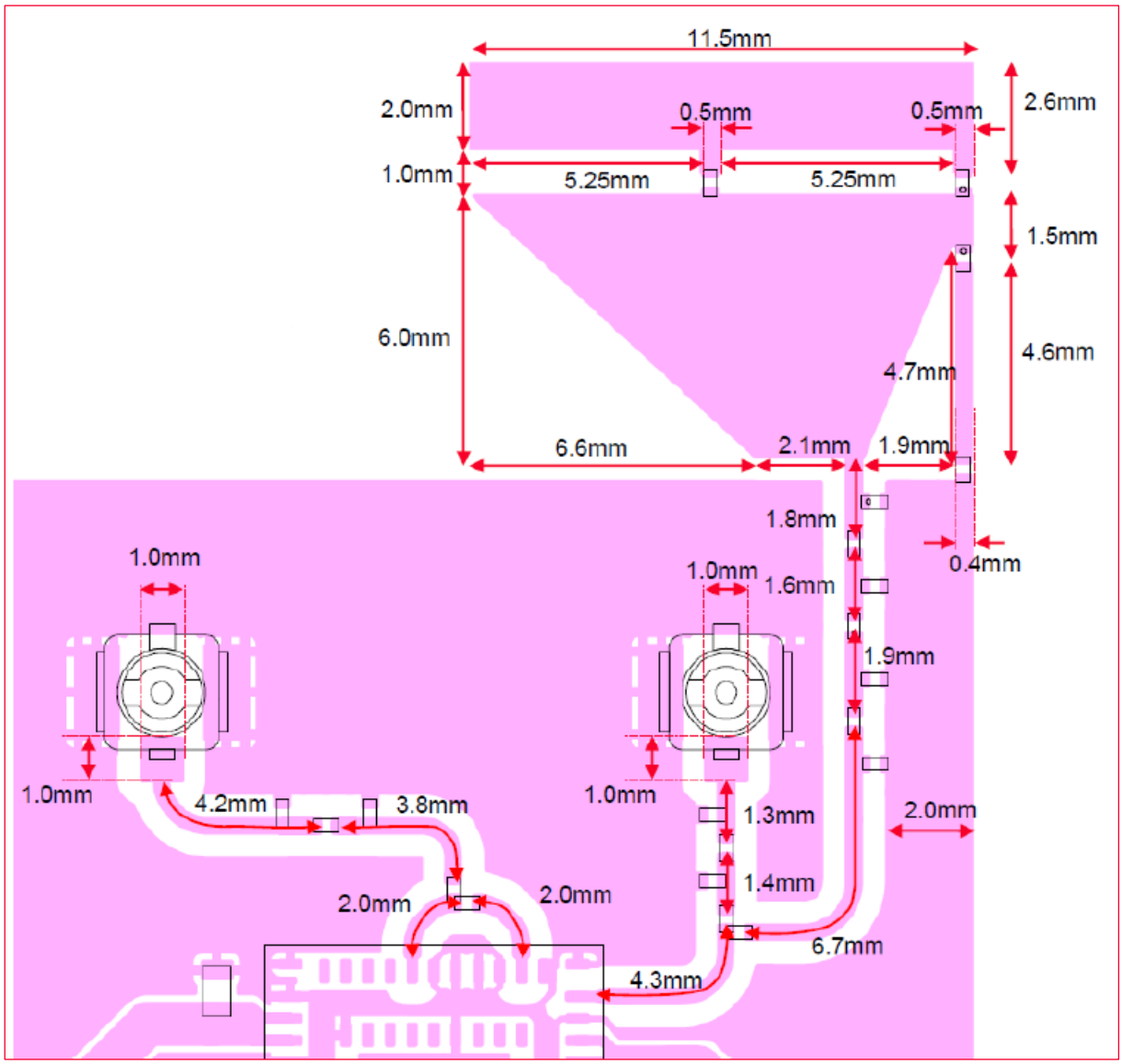
No.	Part number	Vendor	Peak Gain [dBi]		Type	Connector
			2.4 GHz	5 GHz		
1	146153	Molex	3.2	4.25	Dipole	u.FL
2	219611	Molex	2.67	3.67	Dipole	u.FL
3	WT32D1-KX	Unictron	3.0	4.0	Dipole	MHF I
4	W24P-U	Invetek	3.2	N/A	Dipole	u.FL
5	Type2EL_Antenna	Murata	3.6	4.6	Monopole	Trace
6	206994	Molex	3.6	3.6	Monopole	u.FL
7	146187	Molex	3.2	4.25	Dipole	u.FL
8	AA258	Unictron	0.9	3.8	Dipole	MHF I
9	TA-38B-A-W01	Unictron	2.61	3.07	Dipole	RSMA
10	TA-6B-A-WE01	Unictron	2.23	4.59	Dipole	RSMA
11	GW.48.A151	Taoglas	1.82	3.28	Dipole	RSMA
12	GW.40.2153	Taoglas	3.15	4.39	Dipole	RSMA
13	GW.52.A153	Taoglas	2.93	4.53	Dipole	RSMA
14	SRF2W012	Antenova	3.0	4.0	Dipole	MHF I
15	EMF2471A3S	Laird	2.4	4.4	Dipole	MHF I
16	1001932FT	KAVX	2.5	4.4	Dipole	MHF I
17	1001932PT	KAVX	2.03	4.45	Dipole	MHF I

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

2.4.6.1 Type2EL_Antenna

When using Type2EL_Antenna, make sure to match the drawings shown in **Figure 17** below.

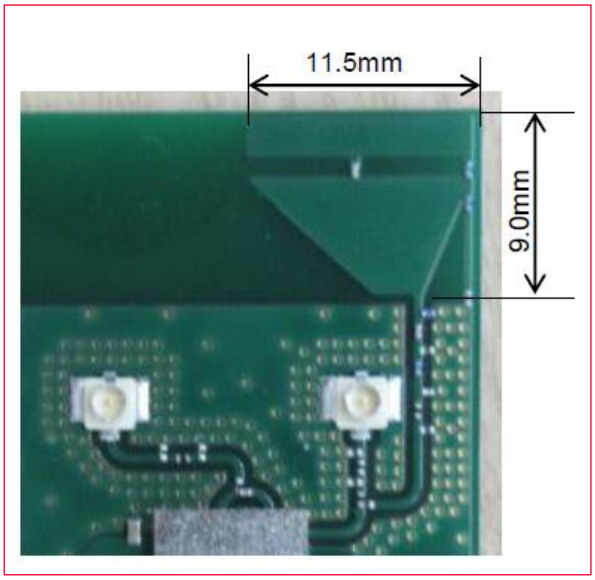
Figure 17: Type2EL_Antenna Drawing - Japan



2.4.6.2 Appearance

Figure 18 shows the antenna appearance.

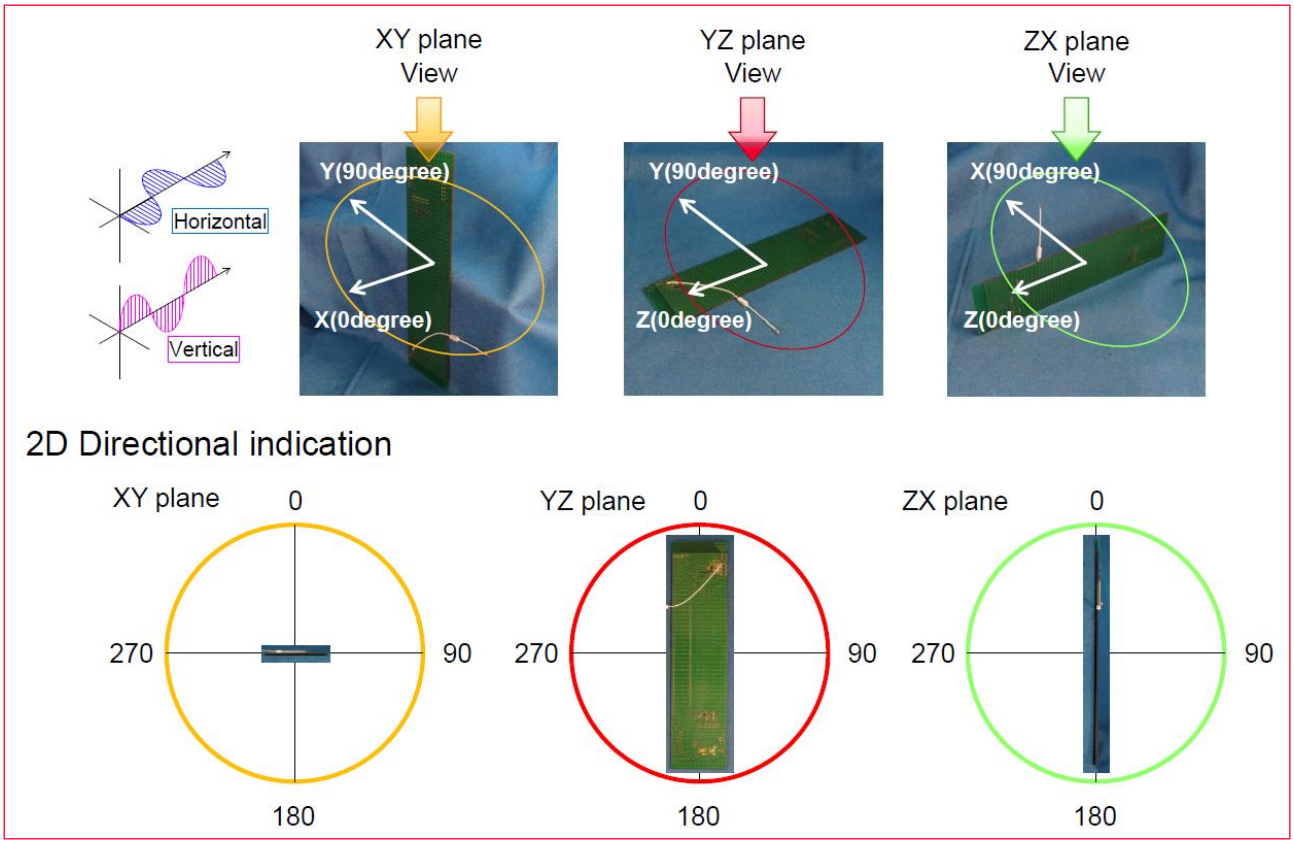
Figure 18: Type2EL Antenna Appearance - Japan



2.4.6.3 Measurement Directions

Figure 19 shows the antenna 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>

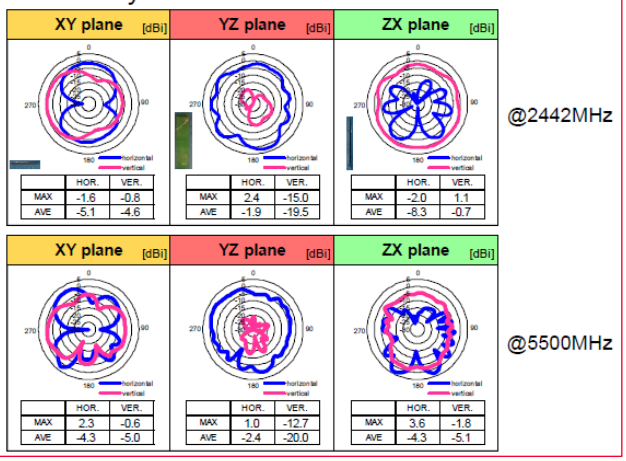
[dBi] [dB]

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>



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.

Japan Version

(1)

本製品は、電波法に基づく工事設計認証(認証番号:001-P02018)を受けた特定無線設備を内蔵しています。

(2)

R 001-P02018 5.2 GHz/5.3 GHz 帯無線 LAN(W52/W53)の屋外使用は 5.2 GHz 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 Version

(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)

R 001-P02018

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.

Revision History

Revision	Date	Changed Item	Comment
1.0	Apr.18, 2023	Issued as Application Note.	Initial Release
2.0	Apr 27, 2023	Page 11 and 43, Pin Layout	Correction of errors
3.0	May 12, 2023	Page 40, Removed “Monopole Antenna Gain: 3.6 dBi @ 2.4 GHz/3.6 dBi @ 5 GHz”	Erasure of errors
4.0	Sep 15, 2023	2.4 GHz Power table	Added 40 MHz band power table
5.0	Jun 27, 2024	2.2 ISED	Corrected ISED ID
6.0	Mar 04, 2025	1.3 Pin Layout 1.4 Operating Conditions 2.4.3 Setting RF Power 2.4.6 Antenna 2.4.7 Notification (Japan)	Merged information from FCC and ISED Changed format of power table Added No7~17 Antenna Corrected Certification Number

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