

# RF Exposure Evaluation Report

**FCC 47 CFR § 2.1091**

for

**Communication module**

**Model Name.: LBEE6XX1UR**

Prepared for:

**Murata Manufacturing Co., Ltd.**

**10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555 Japan**

Prepared by

**Compliance Certification Services Inc.**

**Wugu Laboratory**

**No.11, Wugong 6th Rd., Wugu Dist.,**

**New Taipei City, Taiwan.**

**Issue Date: May 28, 2024**

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### Revision History

Rev.	Issue Date	Revisions	Effect Page	Revised By
00	May 16, 2024	Initial Issue	ALL	Allison Chen
01	May 28, 2024	See the following Note Rev.(01)	P.1, 4	Allison Chen

Note:


Rev.(01)

1. Modify applicant's name and address.

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## 1 Attestation of Test Results

Applicant Name	Murata Manufacturing Co., Ltd.
Model Name	Communication module
Applicable Standards	FCC 47 CFR § 2.1091 FCC 47 CFR § 1.1307 FCC 47 CFR § 1.1310 Published RF exposure KDB procedures
Receive EUT Date:	March 12, 2024
<p>Compliance Certification Services Inc. , tested the above equipment in accordance with the requirements set forth in the above standards. Determination of compliance is based on the results of the compliance measurement,not taking into account measurement instrumentation uncertainty.All indications of Pass/Fail in this report are opinions expressed by Compliance Certification Services Inc, based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.</p>	
<p>Approved &amp; Released By:</p> 	
<p>Sky Zhou Asst. Supervisor Compliance Certification Services Inc.</p>	

## 2 Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1091, the following FCC Published RF exposure [KDB](#) procedures:

- 447498 D04 Interim General RF Exposure Guidance v01
- 865664 D02 RF Exposure Reporting v01r02

### 3 Device Under Test (DUT) Information

#### 3.1 DUT Description

Product	Communication module
Trade Name	muRata
Model No.	LBEE6XX1UR
Model Discrepancy	N/A
Hardware Version	1.0
Software Version	1.1.1.2
Sample Stage	Identical prototype

### 3.2 Wireless Technologies

<b>Frequency bands</b>	<input checked="" type="checkbox"/> Bluetooth: 2402 MHz~2480 MHz <input checked="" type="checkbox"/> 802.11b/g/n HT20: 2412 MHz~2462 MHz <input type="checkbox"/> 802.11n HT40: 2422 MHz~2452 MHz <input checked="" type="checkbox"/> 802.11a/n HT20: 5180MHz ~ 5240MHz / 5260MHz ~ 5320MHz / 5500MHz ~ 5720MHz / 5745MHz ~ 5825MHz <input checked="" type="checkbox"/> 802.11ac VHT20: 5180MHz ~ 5240MHz / 5260MHz ~ 5320MHz / 5500MHz ~ 5720MHz / 5745MHz ~ 5825MHz <input checked="" type="checkbox"/> 802.11n HT40: 5190MHz ~ 5230MHz / 5270MHz ~ 5310MHz / 5510MHz ~ 5710MHz / 5755MHz ~ 5795MHz <input checked="" type="checkbox"/> 802.11ac VHT 40: 5190MHz ~ 5230MHz / 5270MHz ~ 5310MHz / 5510MHz ~ 5710MHz / 5755MHz ~ 5795MHz <input checked="" type="checkbox"/> 802.11ac VHT80: 5210MHz / 5290MHz / 5530MHz ~ 5690MHz / 5775MHz <input type="checkbox"/> 802.11ac VHT160/ax HE160: 5250 MHz / 5570 MHz <input type="checkbox"/> Others																								
<b>Exposure classification</b>	<input type="checkbox"/> Occupational/Controlled exposure <input checked="" type="checkbox"/> General Population/Uncontrolled exposure																								
<b>Antenna Specification</b>	<p>1. WIFI 2.4GHz &amp; 5GHz            Type: Chip Antenna            Brand / Model: INPAQ TECHNOLOGY / VGAP-CLB-AS-A1</p> <p style="text-align: center;">Antenna Gain:</p> <table border="0"> <tr> <td>WIFI 2.4GHz</td> <td>-0.60 dBi</td> <td>(Numeric gain: 0.87)</td> <td>Worst</td> </tr> <tr> <td>WIFI 5.2GHz (U-NII 1)</td> <td>1.70 dBi</td> <td>(Numeric gain: 1.48)</td> <td>Worst</td> </tr> <tr> <td>WIFI 5.3GHz (U-NII 2a)</td> <td>1.70 dBi</td> <td>(Numeric gain: 1.48)</td> <td>Worst</td> </tr> <tr> <td>WIFI 5.5GHz (U-NII 2c)</td> <td>1.70 dBi</td> <td>(Numeric gain: 1.48)</td> <td>Worst</td> </tr> <tr> <td>WIFI 5.8GHz (U-NII 3)</td> <td>1.70 dBi</td> <td>(Numeric gain: 1.48)</td> <td>Worst</td> </tr> </table> <p>2. BT            Type: PCB Antenna            Brand / Model: Forvia / BT_IFA</p> <p style="text-align: center;">Antenna Gain:</p> <table border="0"> <tr> <td>Bluetooth</td> <td>1.00 dBi</td> <td>(Numeric gain: 1.26)</td> <td>Worst</td> </tr> </table>	WIFI 2.4GHz	-0.60 dBi	(Numeric gain: 0.87)	Worst	WIFI 5.2GHz (U-NII 1)	1.70 dBi	(Numeric gain: 1.48)	Worst	WIFI 5.3GHz (U-NII 2a)	1.70 dBi	(Numeric gain: 1.48)	Worst	WIFI 5.5GHz (U-NII 2c)	1.70 dBi	(Numeric gain: 1.48)	Worst	WIFI 5.8GHz (U-NII 3)	1.70 dBi	(Numeric gain: 1.48)	Worst	Bluetooth	1.00 dBi	(Numeric gain: 1.26)	Worst
WIFI 2.4GHz	-0.60 dBi	(Numeric gain: 0.87)	Worst																						
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WIFI 5.8GHz (U-NII 3)	1.70 dBi	(Numeric gain: 1.48)	Worst																						
Bluetooth	1.00 dBi	(Numeric gain: 1.26)	Worst																						

<b>Maximum tune up power</b>	<b>2.4GHz</b>		
	IEEE 802.11b	17.00 dBm	(50.12 mW)
	IEEE 802.11g	13.00 dBm	(19.95 mW)
	IEEE 802.11n HT20	13.00 dBm	(19.95 mW)
	<b>Bluetooth</b>		
	BT	3.50 dBm	(2.239 mW)
	<b>WIFI 5.2GHz (U-NII 1)</b>		
	IEEE 802.11a	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 20	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 40	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 20	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 40	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 80	13.00 dBm	(19.953 mW)
	<b>WIFI 5.3GHz (U-NII 2A)</b>		
	IEEE 802.11a	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 20	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 40	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 20	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 40	13.00 dBm	(19.953 mW)
	IEEE 802.11ac VHT 80	13.00 dBm	(19.953 mW)
	<b>WIFI 5.5GHz (U-NII 2C)</b>		
	IEEE 802.11a	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 20	13.00 dBm	(19.953 mW)
	IEEE 802.11n HT 40	13.00 dBm	(19.953 mW)
IEEE 802.11ac VHT 20	13.00 dBm	(19.953 mW)	
IEEE 802.11ac VHT 40	13.00 dBm	(19.953 mW)	
IEEE 802.11ac VHT 80	13.00 dBm	(19.953 mW)	
<b>WIFI 5.8GHz (U-NII 3)</b>			
IEEE 802.11a	13.00 dBm	(19.953 mW)	
IEEE 802.11n HT 20	13.00 dBm	(19.953 mW)	
IEEE 802.11n HT 40	13.00 dBm	(19.953 mW)	
IEEE 802.11ac VHT 20	13.00 dBm	(19.953 mW)	
IEEE 802.11ac VHT 40	13.00 dBm	(19.953 mW)	
IEEE 802.11ac VHT 80	13.00 dBm	(19.953 mW)	

**Notes:**

1. For more details, please refer to the User's manual of the EUT.
2. Disclaimer: Antenna information is provided by the applicant, test results of this report are applicable to the sample EUT received.
3. The tune up power referred the AVG power of the test report TMWK2308002691KR, TMWK2308002692KR, TMWK2308002698KR and TMWK2403000682KR for RF Exposure assessment purpose.
4. Other test data is referenced from cross authorization(s) measurement results in the original test report (TMWK2308002693KS) under issue date (September 22, 2023) are fully leveraged in this test report.



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## 4 Maximum Permissible Exposure

### 4.1 Limits for Maximum Permissible Exposure (MPE)

**Table 1 - Limits for Maximum Permissible Exposure (MPE)**

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm <sup>2</sup> )	Averaging time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	* 100	6
3.0-30	1842/f	4.89/f	* 900/f <sup>2</sup>	6
30-300	61.4	0.163	1.0	6
300-1,500			f/300	6
1,500-100,000			5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	* 100	30
1.34-30	824/f	2.19/f	* 180/f <sup>2</sup>	30
30-300	27.5	0.073	0.2	30
300-1,500			f/1500	30
<b>1,500-100,000</b>			1.0	30

## 4.2 MPE Calculation Method

### Calculation

Given  $E = \frac{\sqrt{30 \times P \times G}}{d}$  &  $S = \frac{E^2}{377}$

Where E = Field strength in Volts / meter

P = Power in Watts

G = Numeric antenna gain

d = Distance in meters

S = Power density in milliwatts / square centimeter

Combining equations and re-arranging the terms to express the distance as a function of the remaining variables yields:

$$S = \frac{30 \times P \times G}{377 d^2}$$

Changing to units of mW and cm, using:

$$P \text{ (mW)} = P \text{ (W)} / 1000 \text{ and}$$

$$d \text{ (cm)} = d \text{ (m)} / 100$$

Yields

$$S = \frac{30 \times (P/1000) \times G}{377 \times (d/100)^2} = 0.0796 \times \frac{P \times G}{d^2} \text{ Equation 1}$$

Where d = Distance in cm

P = Power in mW

G = Numeric antenna gain

S = Power density in mW / cm<sup>2</sup>

If, Substituting the MPE safe distance using d = 20 cm into Equation 1:

$$S = 0.000199 \times P \times G$$

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### 4.3 MPE EXEMPTION

- (A) The available maximum time-averaged power is no more than 1 mW
- (B) The available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold  $P_{th}$  (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive).  $P_{th}$  is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left( \frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

$d$  = the separation distance (cm);

- (C) Using Table 1 and the minimum separation distance ( $R$  in meters) from the body of a nearby person for the frequency ( $f$  in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply,  $R$  must be at least  $\lambda/2\pi$ , where  $\lambda$  is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of  $\lambda/4$  or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

Single RF Sources Subject to Routine Environmental Evaluation	
RF Source frequency (MHz)	Threshold ERP (watts)
0.3-1.34	1,920 $R^2$ .
1.34-30	3,450 $R^2/f^2$ .
30-300	3.83 $R^2$ .
300-1,500	0.0128 $R^2f$ .
1,500-100,000	19.2 $R^2$ .

Note:  $R$  is in meters,  $f$  is in MHz.

#### 4.4 Multiple RF sources

In the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation),

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

## 5 MPE Exemption Option B

### WIFI 2.4GHz

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11b	2462.00	0.2	17.0	-0.60	16.40	14.25	26.607	3060	Complies
IEEE 802.11g	2462.00	0.2	13.0	-0.60	12.40	10.25	10.593	3060	Complies
IEEE 802.11n HT 20	2462.00	0.2	13.0	-0.60	12.40	10.25	10.593	3060	Complies

### Bluetooth

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
BT	2480.00	0.2	3.5	1.00	4.50	2.35	1.718	3060	Complies

### WIFI 5.2GHz (U-NII 1)

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11a	5240.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 20	5240.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 40	5230.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 20	5240.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 40	5230.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 80	5210.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies

### WIFI 5.3GHz (U-NII 2A)

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11a	5320.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 20	5320.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 40	5310.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 20	5320.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 40	5310.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 80	5290.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies

### WIFI 5.5GHz (U-NII 2C)

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11a	5720.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 20	5720.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT 40	5710.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 20	5720.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 40	5710.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT 80	5690.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies

### WIFI 5.8GHz (U-NII 3)

Mode	Frequency (MHz)	R(m)	Max Tune-up power (dBm)	G(dBi)	Max Tune-up EIRP (dBm)	Max Tune-up ERP (dBm)	Max Tune-up ERP (mW)	ERP Threshold (mW)	MPE Exemption
IEEE 802.11a	5825.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT20	5825.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11n HT40	5795.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT20	5825.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT40	5795.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies
IEEE 802.11ac VHT80	5775.00	0.2	13.0	1.70	14.70	12.55	17.989	3060	Complies

## 6 Simultaneous Transmission Analysis

In the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation),

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{j=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure Limit_k} \leq 1$$

### Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations	
	1	WiFi 5GHz	+
2	WiFi 2.4GHz	+	Bluetooth

#### 6.1 Sum of the WIFI 5GHz & Bluetooth

##### WIFI 5GHz + Bluetooth

Mode	Frequency (MHz)	Max Tune-up ERP(mW)	ERP Threshold(mW)	simultaneous Transmission	simultaneous Transmission Limit
WiFi 5GHz	5825.00	17.989	3060	0.006	≤1
Bluetooth	2480.00	1.718	3060		

#### 6.2 Sum of the WIFI 2.4GHz & Bluetooth

##### WIFI 2.4GHz + Bluetooth

Mode	Frequency (MHz)	Max Tune-up ERP(mW)	ERP Threshold(mW)	simultaneous Transmission	simultaneous Transmission Limit
WiFi 2.4GHz	2462.00	26.607	3060	0.009	≤1
Bluetooth	2480.00	1.718	3060		



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## 7 Facilities

All measurement facilities used to collect the measurement data are located at

No.11, Wugong 6th Rd., Wugu Dist., New Taipei City, Taiwan.

**--End of Test Report--**