

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-22N-RWD-055

Reception No. : 2209002852

Applicant : LG Electronics USA

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Manufacturer : LG Electronics Inc.

Address : 222 LG-ro, Jinwi-Myeon, Pyeongtaek -Si, Gyeonggi-Do, 451-713, Korea

Type of Equipment : Car Navigation

FCC ID. : BEJ-MIB3OI01

Model Name : MIB3 OI

Multiple Model Name : N/A

Serial number : N/A

Total page of Report : 37 pages (including this page)

Date of Incoming : October 13, 2022

Date of issue : November 21, 2022

SUMMARY

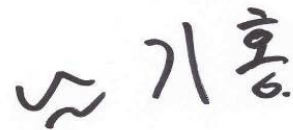
The equipment complies with the regulation; *FCC PART 15 SUBPART C Section 15.247*

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

This report is not correlated with the "KS Q ISO/IEC 17025 and KOLAS accreditation" of Korean Laboratory Accreditation Scheme.





Tested by
Ju-Yun, Park / Manager
ONETECH Corp.

Reviewed by
Tae-Ho, Kim / General Manager
ONETECH Corp.

Approved by
Ki-Hong, Nam / General Manager
ONETECH Corp.

CONTENTS

	Page
1. VERIFICATION OF COMPLIANCE	6
2. TEST SUMMARY.....	7
2.1 Test items and results	7
2.2 Additions, deviations, exclusions from standards	7
2.3 Related Submittal(s) / Grant(s).....	7
2.4 Purpose of the test.....	7
2.5 Test Methodology	7
2.6 Test Facility	7
3. GENERAL INFORMATION.....	8
3.1 Product Description.....	8
3.2 Alternative type(s)/model(s); also covered by this test report.....	10
4. EUT MODIFICATIONS.....	10
5. SYSTEM TEST CONFIGURATION	11
5.1 Justification	11
5.2 Peripheral equipment	11
5.3 Mode of operation during the test.....	12
5.4 Configuration of Test System	15
5.5 Antenna Requirement	15
6. PRELIMINARY TEST	15
6.1 AC Power line Conducted Emissions Tests	15
6.2 General Radiated Emissions Tests	15
7. MINIMUM 20 dB BANDWIDTH.....	16
7.1 Operating environment	16
7.2 Test set-up	16
7.3 Test Date.....	16
7.4 Test data for 1 Mbps	16
7.5 Test data for 2 Mbps	16
7.6 Test data for 3 Mbps	16
8. HOPPING FREQUENCY SEPARATION.....	17
8.1 Operating environment	17
8.2 Test set-up	17
8.3 Test Date.....	17

8.4 Test data for 1 Mbps	17
8.5 Test data for 2 Mbps	17
8.6 Test data for 3 Mbps	17
9. NUMBER OF HOPPING CHANNELS	18
9.1 Operating environment	18
9.2 Test set-up	18
9.3 Test Date.....	18
9.4 Test data for 1 Mbps	18
9.5 Test data for 2 Mbps	18
9.6 Test data for 3 Mbps	18
10. TIME OF OCCUPANCY	19
10.1 Operating environment	19
10.2 Test set-up	19
10.3 Test Date.....	19
10.4 Test data for 1 Mbps	20
10.5 Test data for 2 Mbps	20
10.6 Test data for 3 Mbps	21
11. MAXIMUM PEAK OUTPUT POWER	22
11.1 Operating environment	22
11.2 Test set-up	22
11.3 Test Date.....	22
11.4 Test data for 1 Mbps	23
11.5 Test data for 2 Mbps	23
11.6 Test data for 3 Mbps	23
12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND	24
12.1 Operating environment	24
12.2 Test set-up for conducted measurement	24
12.3 Test set-up for radiated measurement	24
12.4 Test Date.....	24
12.5 Test data for conducted emission	24
12.6 Test data for Transmitting mode radiated emission	25
12.6.1 Radiated Emission which fall in the Restricted Band.....	25
12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz.....	28
13. RADIATED EMISSION TEST	31
13.1 Operating environment	31
13.2 Test set-up	31

13.3 Test Date32

13.4 Test data for 30 MHz ~ 1 000 MHz33

13.4.1 Test data for Bluetooth33

13.4.2 Test data for Intermodulation Mode(Bluetooth + WLAN 2.4 GHz)34

13.4.3 Test data for Intermodulation Mode(Bluetooth + WLAN 5 GHz)35

13.5 Test data for Below 30 MHz36

13.6 Test data for above 1 GHz36

14. LIST OF TEST EQUIPMENT37

※ Please refer to the Annex section for All test plots

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-22N-RWD-055	November 21, 2022	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Electronics USA
 Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States
 Contact Person : Sung Soo, Kim / Director, Regulatory and Environmental Affairs
 Telephone No. : +201-266-2215
 FCC ID : BEJ-MIB3OI01
 Model Name : MIB3 OI
 Brand Name : Volkswagen, Seat
 Serial Number : N/A
 Date : November 21, 2022

EQUIPMENT CLASS	DSS – PART 15 SPREAD SPECTRUM TRANSMITTER
E.U.T. DESCRIPTION	Car Navigation
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (1)	Carrier Frequency Separation	Met the Limit / PASS
15.247 (a) (1) (iii)	Minimum Number of Hopping Channels	Met the Limit / PASS
15.247 (a) (1) (iii)	Average Time of Occupancy	Met the Limit / PASS
15.247 (b) (1)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.209	Radiated Emission Limits, General Requirement	Met the Limit / PASS
15.207	Conducted Limits	N/A (See Note)
15.203	Antenna Requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by only using DC Power.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The LG Electronics USA, Model MIB3 OI (referred to as the EUT in this report) is a Car Navigation. The product specification described herein was obtained from product data sheet or user’s manual.

DEVICE TYPE	Car Navigation	
OPERATING FREQUENCY	Bluetooth	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))
	WLAN 5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20))
		5 190 MHz ~ 5 230 MHz (802.11n(HT40))
		5 210 MHz (802.11ac(VHT80))
	WLAN 5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20))
		5 755 MHz ~ 5 795 MHz (802.11n(HT40))
		5 775 MHz (802.11ac(VHT80))
MODULATION TYPE	Bluetooth	GFSK for 1Mbps, $\pi/4$ -DQPSK for 2Mbps, 8-DPSK for 3Mbps
	WLAN 2.4 GHz	802.11b: DSSS Modulation (DBPSK/DQPSK/CCK)
		802.11g/n(HT20): OFDM Modulation (BPSK/QPSK/16QAM/64QAM)
WLAN 5 GHz	802.11a/n(HT20)/n(HT40)/ac(VHT80): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	

RF OUTPUT POWER	Bluetooth	1 Mbps	2.16 dBm	
		2 Mbps	0.93 dBm	
		3 Mbps	1.07 dBm	
	WLAN 2.4 GHz	10.49 dBm(802.11b) 10.88 dBm(802.11g) 11.11 dBm(802.11n_HT20)		
	WLAN 5 150 MHz ~ 5 250 MHz Band	Antenna 0	9.39 dBm(802.11a) 8.37 dBm(802.11n_HT20) 8.24 dBm(802.11n_HT40) 8.21 dBm(802.11ac_VHT80)	
		Antenna 1	8.46 dBm(802.11a) 8.45 dBm(802.11n_HT20) 8.29 dBm(802.11n_HT40) 8.24 dBm(802.11ac_VHT80)	
		Multiple Antenna	11.96 dBm(802.11a) 11.42 dBm(802.11n_HT20) 11.28 dBm(802.11n_HT40) 11.24 dBm(802.11ac_VHT80)	
	WLAN 5 725 MHz ~ 5 850 MHz Band	Antenna 0	13.70 dBm(802.11a) 13.72 dBm(802.11n_HT20) 13.86 dBm(802.11n_HT40) 13.98 dBm(802.11ac_VHT80)	
		Antenna 1	12.68 dBm(802.11a) 12.71 dBm(802.11n_HT20) 12.62 dBm(802.11n_HT40) 12.67 dBm(802.11ac_VHT80)	
		Multiple Antenna	16.22 dBm(802.11a) 16.25 dBm(802.11n_HT20) 16.29 dBm(802.11n_HT40) 16.38 dBm(802.11ac_VHT80)	

ANTENNA TYPE	Bluetooth	PCB Antenna		
	WLAN 2.4 GHz	Chip Antenna		
	WLAN 5 GHz	Antenna 0	Chip Antenna	
Antenna 1		PCB Antenna		
ANTENNA GAIN	Bluetooth	1.39 dBi		
	WLAN 2.4 GHz	4.64 dBi		
	5 150 MHz ~ 5 250 MHz Band	Antenna 0	3.19 dBi	
		Antenna 1	4.62 dBi	
		Multiple Antenna	6.97 dBi	
	5 725 MHz ~ 5 850 MHz Band	Antenna 0	2.29 dBi	
		Antenna 1	7.30 dBi	
		Multiple Antenna	8.49 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		55.466 67 MHz, 40 MHz, 32 MHz, 28.63636 MHz, 25 MHz, 26 MHz, 20 MHz. 19.2 MHz		
RATED SUPPLY VOLTAGE		DC 12.0 V		

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
MIB3 OI	LG Electronics Inc.	Car Navigation (EUT)	-
GP-4303D	LG Precision Co.,Ltd	DC Power Supply	EUT
TC-3000C	TESCOM	BLUETOOTH TESTER	EUT

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 402 MHz, 2 441 MHz, and 2 480 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

-. Channel List (Bluetooth)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
0	2 402.00	27	2 429.00	54	2 456.00
1	2 403.00	28	2 430.00	55	2 457.00
2	2 404.00	29	2 431.00	56	2 458.00
3	2 405.00	30	2 432.00	57	2 459.00
4	2 406.00	31	2 433.00	58	2 460.00
5	2 407.00	32	2 434.00	59	2 461.00
6	2 408.00	33	2 435.00	60	2 462.00
7	2 409.00	34	2 436.00	61	2 463.00
8	2 410.00	35	2 437.00	62	2 464.00
9	2 411.00	36	2 438.00	63	2 465.00
10	2 412.00	37	2 439.00	64	2 466.00
11	2 413.00	38	2 440.00	65	2 467.00
12	2 414.00	39	2 441.00	66	2 468.00
13	2 415.00	40	2 442.00	67	2 469.00
14	2 416.00	41	2 443.00	68	2 470.00
15	2 417.00	42	2 444.00	69	2 471.00
16	2 418.00	43	2 445.00	70	2 472.00
17	2 419.00	44	2 446.00	71	2 473.00
18	2 420.00	45	2 447.00	72	2 474.00
19	2 421.00	46	2 448.00	73	2 475.00
20	2 422.00	47	2 449.00	74	2 476.00
21	2 423.00	48	2 450.00	75	2 477.00
22	2 424.00	49	2 451.00	76	2 478.00
23	2 425.00	50	2 452.00	77	2 479.00
24	2 426.00	51	2 453.00	78	2 480.00
25	2 427.00	52	2 454.00		
26	2 428.00	53	2 455.00		

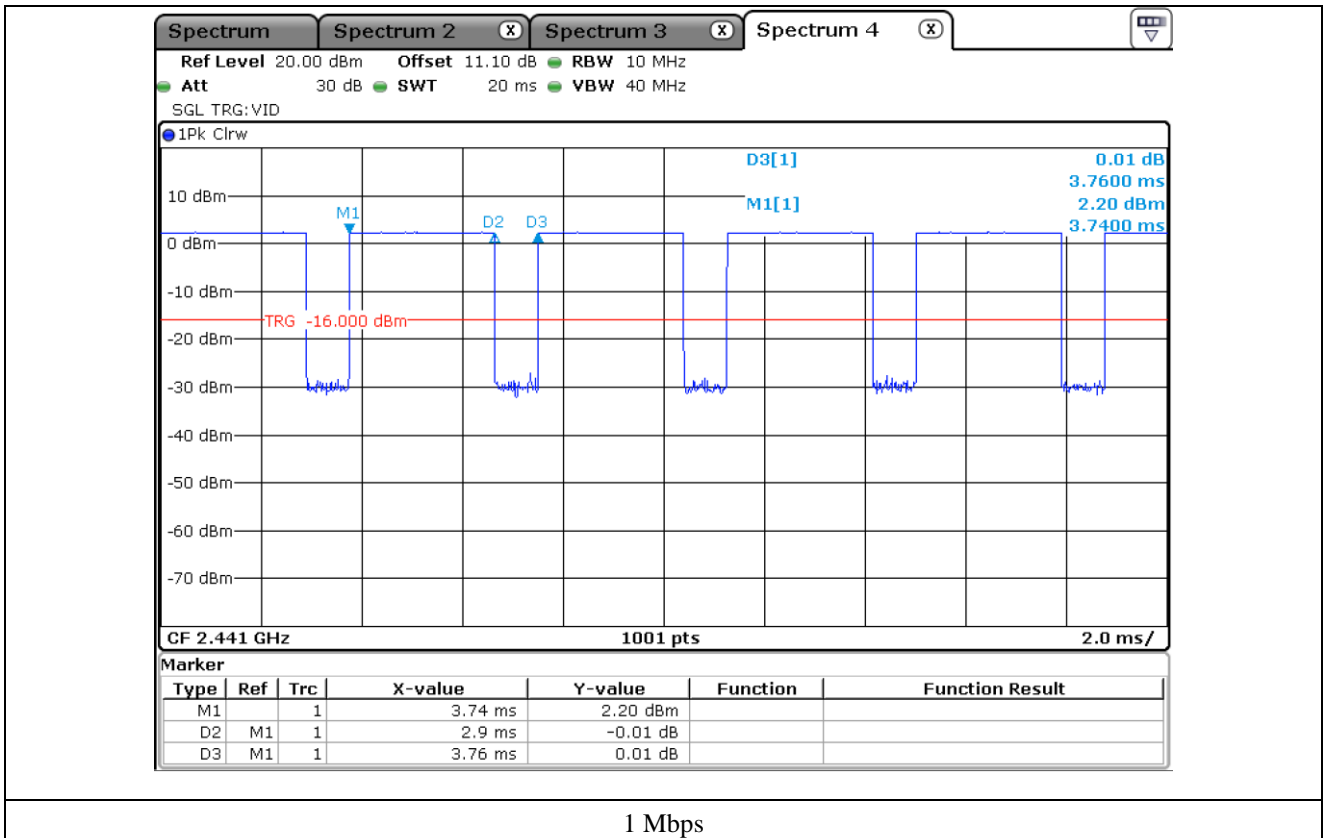
- Duty Cycle

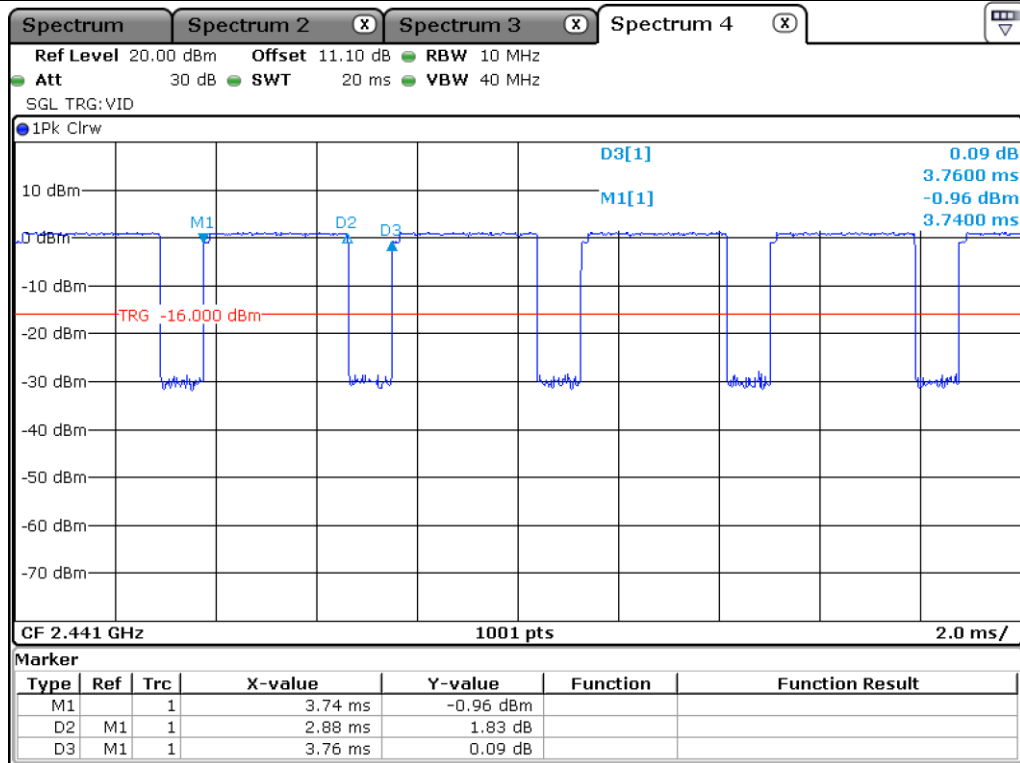
Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth [1 Mbps]	2.90	0.860	77.13	1.13
Bluetooth [2 Mbps]	2.88	0.880	76.60	1.16
Bluetooth [3 Mbps]	2.88	0.880	76.60	1.16

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

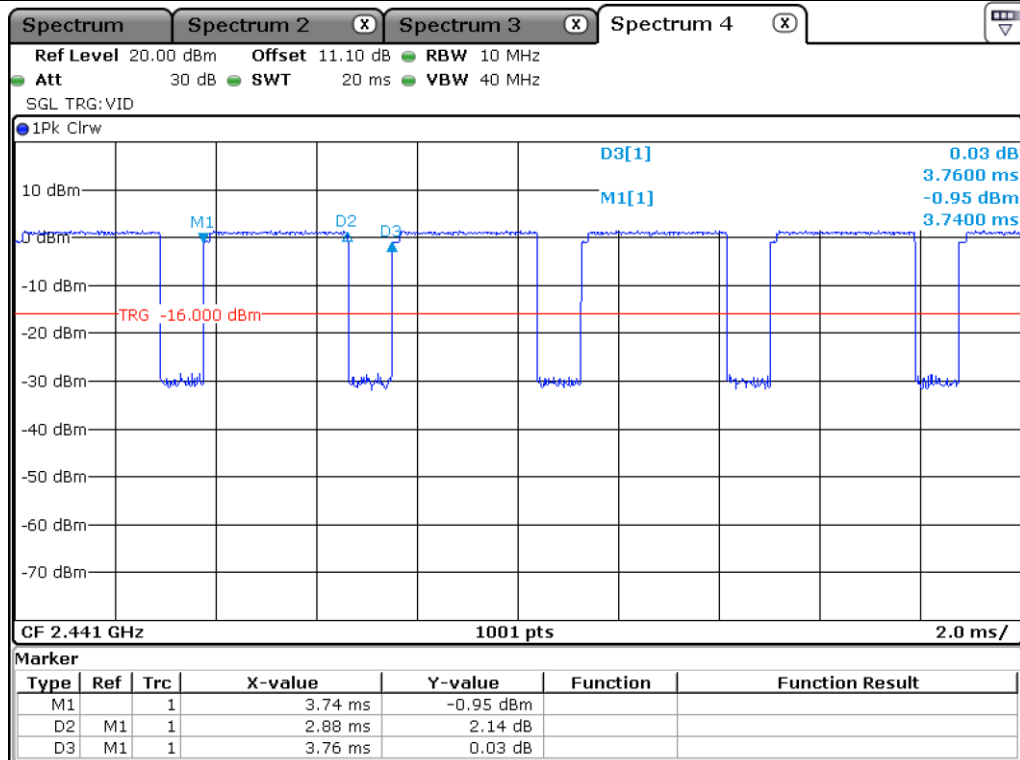
Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

- Test Plot





2 Mbps



3 Mbps

5.4 Configuration of Test System

Line Conducted Test: It is not need to test this requirement, because the EUT shall be operated by only using DC Power.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Antenna and Chip Antenna on the main board in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
It is not need to test this requirement, because the power of the EUT is supplied by DC Power.	

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

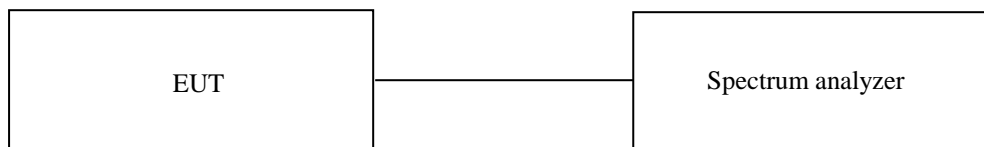
7. MINIMUM 20 dB BANDWIDTH

7.1 Operating environment

Temperature : 23 °C
 Relative humidity : 48 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 1 % to 5 % of the OBW, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.



7.3 Test Date

October 17, 2022 ~ October 31, 2022

7.4 Test data for 1 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	809.20
Middle	2 441.00	819.20
High	2 480.00	849.20

7.5 Test data for 2 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 263.70
Middle	2 441.00	1 323.70
High	2 480.00	1 323.70

7.6 Test data for 3 Mbps

CHANNEL	FREQUENCY (MHz)	20 dB Bandwidth (kHz)
Low	2 402.00	1 288.70
Middle	2 441.00	1 288.70
High	2 480.00	1 273.70

8. HOPPING FREQUENCY SEPARATION

8.1 Operating environment

Temperature : 23 °C
 Relative humidity : 48 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 10 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.



8.3 Test Date

October 17, 2022 ~ October 31, 2022

8.4 Test data for 1 Mbps

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1009.00	546.13	Separated by a minimum of 546.13 kHz

8.5 Test data for 2 Mbps

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 004.00	882.47	Separated by a minimum of 882.47 kHz

8.6 Test data for 3 Mbps

-. Test Result : Pass

MEASURED VALUE (kHz)	Two-third of 20 dB Bandwidth (kHz)	LIMIT
1 004.00	859.13	Separated by a minimum of 859.13 kHz

9. NUMBER OF HOPPING CHANNELS

9.1 Operating environment

Temperature : 23 °C
 Relative humidity : 48 % R.H.

9.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 100 kHz and the resolution bandwidth is set to 300 kHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured.



9.3 Test Date

October 17, 2022 ~ October 31, 2022

9.4 Test data for 1 Mbps

-. Test Result : Pass

Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
1 Mbps	79	Minimum of 15	64

9.5 Test data for 2 Mbps

-. Test Result : Pass

Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
2 Mbps	79	Minimum of 15	64

9.6 Test data for 3 Mbps

-. Test Result : Pass

Data Transfer Rate	Measured value (Number)	Limit (Number)	Margin (Number)
3 Mbps	79	Minimum of 15	64

10. TIME OF OCCUPANCY

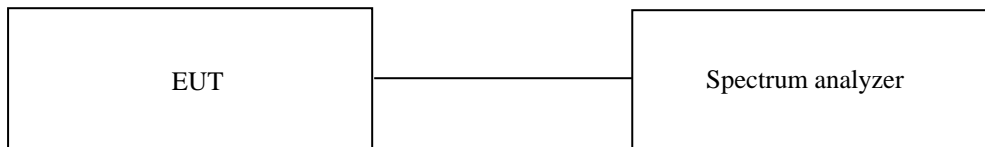
10.1 Operating environment

Temperature : 23 °C

Relative humidity : 48 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.



10.3 Test Date

October 17, 2022 ~ October 31, 2022

10.4 Test data for 1 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.90	3.38	31.60	309.74	400.00	

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

10.5 Test data for 2 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

10.6 Test data for 3 Mbps

The system makes worst case 1 600 hops per second or 1 time slot has a length of 625 μs with 79 channels.

For DH1 packet type, the EUT needs 1 time slot for transmitting and 1 time slot for receiving and for DH3 packet type, the EUT needs 3 times slots for transmitting and 1 time slot for receiving, and DH5 packet needs 5 times slots for transmitting and 1 time slot for receiving. So The EUT has each channel for 10.13 times per second (= 1 600/2/79) for DH1, and 5.06 times (= 1 600/4/79) for DH3, and 3.38 times (= 1 600/6/79) for DH5.

Packet Type	Pulse Time (ms)	Hops per second with channels	Period Time (ms)	Total Dwell Time (ms)	Limit (ms)	Test Result
DH1	0.38	10.13	31.60	121.64	400.00	PASS
DH3	1.64	5.06	31.60	262.23	400.00	
DH5	2.88	3.38	31.60	307.61	400.00	

Total dwell time is calculated as following.

Total Dwell Time = Pulse time * Hops per second with channels * period time

Remark: See next page for an overview sweep performed with peak detector.

11. MAXIMUM PEAK OUTPUT POWER

11.1 Operating environment

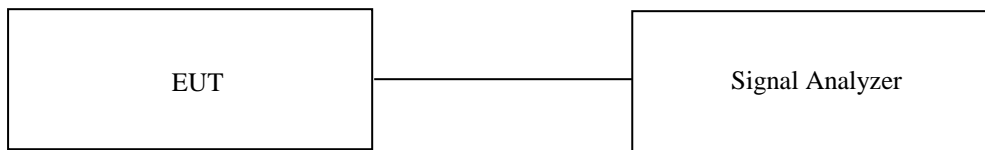
Temperature : 23 °C

Relative humidity : 48 % R.H.

11.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to \geq DTS Bandwidth, the video bandwidth is set to 3 times the resolution bandwidth.



11.3 Test Date

October 17, 2022 ~ October 31, 2022

11.4 Test data for 1 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	2.16	21.00	18.84
MIDDLE	2 441.00	2.16	21.00	18.84
HIGH	2 480.00	1.97	21.00	19.03

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

11.5 Test data for 2 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	0.93	21.00	20.07
MIDDLE	2 441.00	0.90	21.00	20.10
HIGH	2 480.00	0.91	21.00	20.09

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

11.6 Test data for 3 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	1.07	21.00	19.93
MIDDLE	2 441.00	1.02	21.00	19.98
HIGH	2 480.00	1.05	21.00	19.95

Remark. Margin = Limit – Measured Value (=Receiver Reading + Cable Loss)

12. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

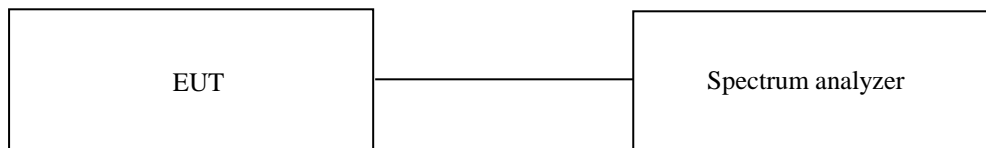
12.1 Operating environment

Temperature : 23 °C

Relative humidity : 48 % R.H.

12.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz and video bandwidth is set to 300 kHz, and peak detection was used.



12.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

12.4 Test Date

October 17, 2022 ~ October 31, 2022

12.5 Test data for conducted emission

Please refer to the Annex

12.6 Test data for Transmitting mode radiated emission

12.6.1 Radiated Emission which fall in the Restricted Band

12.6.1.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 77.13 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 333.11	54.63	Peak	H	28.00	7.39	44.97	5.77	-	50.82	74.00	23.18
2 384.68	41.32	Average	H	28.35	7.60	44.95	5.77	1.13	39.22	54.00	14.78
2 335.32	53.32	Peak	V	28.00	7.39	44.97	5.77	-	49.51	74.00	24.49
2 317.31	40.96	Average	V	28.00	7.39	44.97	5.77	1.13	38.28	54.00	15.72
Test Data for High Channel											
2 489.92	53.56	Peak	H	28.82	7.65	44.90	5.77	-	50.90	74.00	23.10
2 487.80	41.64	Average	H	28.82	7.65	44.90	5.77	1.13	40.11	54.00	13.89
2 494.30	53.45	Peak	V	28.81	7.65	44.90	5.77	-	50.78	74.00	23.22
2 487.40	41.62	Average	V	28.83	7.65	44.91	5.77	1.13	40.09	54.00	13.91

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{ATT} + \text{Duty Factor} - \text{Amp Factor}$$

12.6.1.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 365.01	53.83	Peak	H	28.15	7.60	44.95	5.77	-	50.40	74.00	23.60
2 387.98	41.39	Average	H	28.38	7.60	44.94	5.77	1.16	39.36	54.00	14.64
2 332.93	56.13	Peak	V	28.00	7.39	44.97	5.77	-	52.32	74.00	21.68
2 321.26	41.43	Average	V	28.00	7.39	44.97	5.77	1.16	38.78	54.00	15.22
Test Data for High Channel											
2 483.55	55.21	Peak	H	28.83	7.65	44.91	5.77	-	52.55	74.00	21.45
2 483.91	41.82	Average	H	28.83	7.65	44.91	5.77	1.16	40.32	54.00	13.68
2 486.00	53.42	Peak	V	28.83	7.65	44.91	5.77	-	50.76	74.00	23.24
2 496.03	41.58	Average	V	28.81	7.65	44.90	5.77	1.16	40.07	54.00	13.93

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{ATT} + \text{Duty Factor} - \text{Amp Factor}$$

12.6.1.3 Test data for 3 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 389.46	53.97	Peak	H	28.39	7.60	44.94	5.77	-	50.79	74.00	23.21
2 315.56	41.87	Average	H	28.00	7.39	44.97	5.77	1.16	39.22	54.00	14.78
2 332.66	54.26	Peak	V	28.00	7.39	44.97	5.77	-	50.45	74.00	23.55
2 380.91	41.41	Average	V	28.31	7.60	44.95	5.77	1.16	39.30	54.00	14.70
Test Data for High Channel											
2 483.59	55.28	Peak	H	28.83	7.65	44.91	5.77	-	52.62	74.00	21.38
2 484.21	42.31	Average	H	28.83	7.65	44.91	5.77	1.16	40.81	54.00	13.19
2 483.51	54.45	Peak	V	28.83	7.65	44.91	5.77	-	51.79	74.00	22.21
2 483.53	41.94	Average	V	28.83	7.65	44.91	5.77	1.16	40.44	54.00	13.56

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{ATT} + \text{Duty Factor} - \text{Amp Factor}$$

12.6.2 Spurious & Harmonic Radiated Emission above 1 GHz

12.6.2.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 77.13 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	50.34	Peak	H	33.50	11.81	44.66	-	50.99	74.00	23.01
4 804.000	37.97	Average	H	33.50	11.81	44.66	1.13	39.75	54.00	14.25
4 804.000	50.05	Peak	V	33.50	11.81	44.66	-	50.70	74.00	23.30
4 804.000	37.84	Average	V	33.50	11.81	44.66	1.13	39.62	54.00	14.38
Test Data for Middle Channel										
4 882.000	49.59	Peak	H	33.47	11.93	44.68	-	50.31	74.00	23.69
4 882.000	37.95	Average	H	33.47	11.93	44.68	1.13	39.80	54.00	14.20
4 882.000	49.88	Peak	V	33.47	11.93	44.68	-	50.60	74.00	23.40
4 882.000	37.81	Average	V	33.47	11.93	44.68	1.13	39.66	54.00	14.34
Test Data for High Channel										
4 960.000	49.91	Peak	H	33.62	11.96	44.69	-	50.80	74.00	23.20
4 960.000	37.90	Average	H	33.62	11.96	44.69	1.13	39.92	54.00	14.08
4 960.000	49.64	Peak	V	33.62	11.96	44.69	-	50.53	74.00	23.47
4 960.000	37.84	Average	V	33.62	11.96	44.69	1.13	39.86	54.00	14.14

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Duty Factor} - \text{Amp Factor}$$

12.6.2.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	50.30	Peak	H	33.50	11.81	44.66	-	50.95	74.00	23.05
4 804.000	38.16	Average	H	33.50	11.81	44.66	1.16	39.97	54.00	14.03
4 804.000	50.06	Peak	V	33.50	11.81	44.66	-	50.71	74.00	23.29
4 804.000	37.97	Average	V	33.50	11.81	44.66	1.16	39.78	54.00	14.22
Test Data for Middle Channel										
4 882.000	50.20	Peak	H	33.47	11.93	44.68	-	50.92	74.00	23.08
4 882.000	38.20	Average	H	33.47	11.93	44.68	1.16	40.08	54.00	13.92
4 882.000	50.24	Peak	V	33.47	11.93	44.68	-	50.96	74.00	23.04
4 882.000	38.18	Average	V	33.47	11.93	44.68	1.16	40.06	54.00	13.94
Test Data for High Channel										
4 960.000	50.62	Peak	H	33.62	11.96	44.69	-	51.51	74.00	22.49
4 960.000	38.32	Average	H	33.62	11.96	44.69	1.16	40.37	54.00	13.63
4 960.000	50.63	Peak	V	33.62	11.96	44.69	-	51.52	74.00	22.48
4 960.000	38.30	Average	V	33.62	11.96	44.69	1.16	40.35	54.00	13.65

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Duty Factor} - \text{Amp Factor}$$

12.6.2.3 Test data for 3 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 76.60 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Factor	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	51.17	Peak	H	33.50	11.81	44.66	-	51.82	74.00	22.18
4 804.000	38.95	Average	H	33.50	11.81	44.66	1.16	40.76	54.00	13.24
4 804.000	50.62	Peak	V	33.50	11.81	44.66	-	51.27	74.00	22.73
4 804.000	38.33	Average	V	33.50	11.81	44.66	1.16	40.14	54.00	13.86
Test Data for Middle Channel										
4 882.000	50.89	Peak	H	33.47	11.93	44.68	-	51.61	74.00	22.39
4 882.000	38.68	Average	H	33.47	11.93	44.68	1.16	40.56	54.00	13.44
4 882.000	50.27	Peak	V	33.47	11.93	44.68	-	50.99	74.00	23.01
4 882.000	38.34	Average	V	33.47	11.93	44.68	1.16	40.22	54.00	13.78
Test Data for High Channel										
4 960.000	50.68	Peak	H	33.62	11.96	44.69	-	51.57	74.00	22.43
4 960.000	38.72	Average	H	33.62	11.96	44.69	1.16	40.77	54.00	13.23
4 960.000	50.64	Peak	V	33.62	11.96	44.69	-	51.53	74.00	22.47
4 960.000	38.57	Average	V	33.62	11.96	44.69	1.16	40.62	54.00	13.38

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Duty Factor} - \text{Amp Factor}$$

13. RADIATED EMISSION TEST

13.1 Operating environment

Temperature : 22 °C

Relative humidity : 48 % R.H.

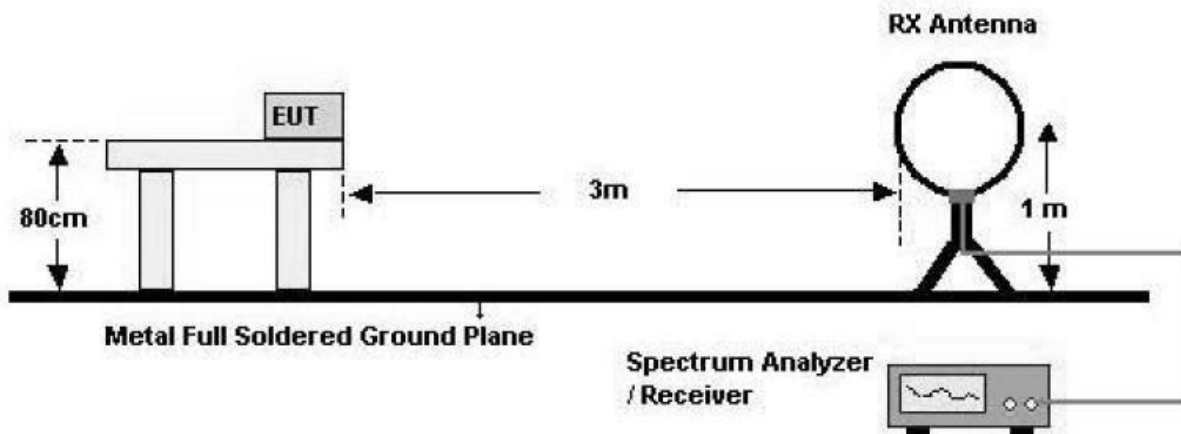
13.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

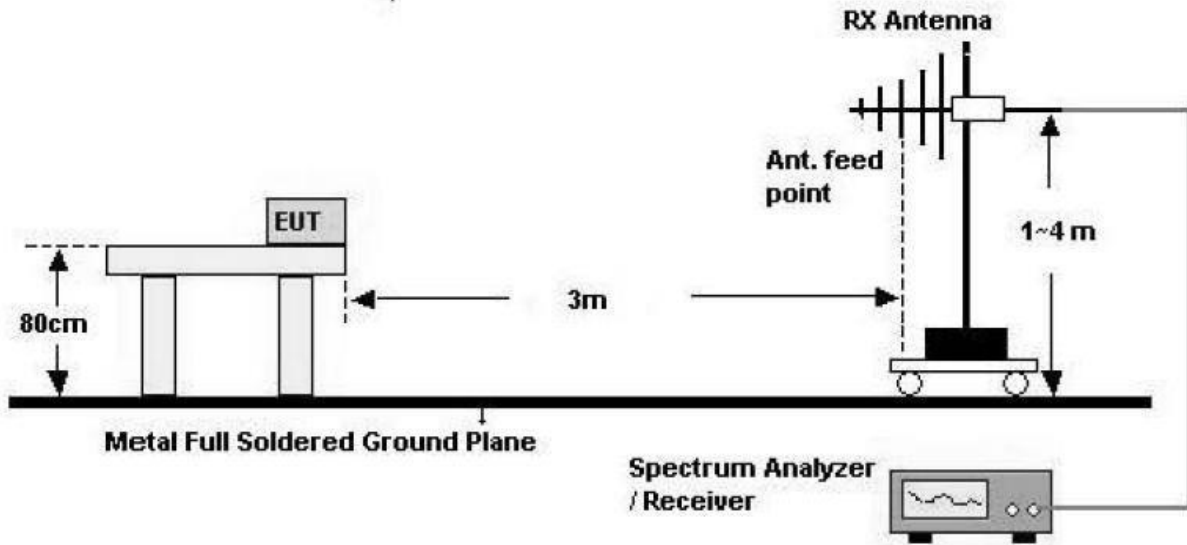
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

- Test Configuration

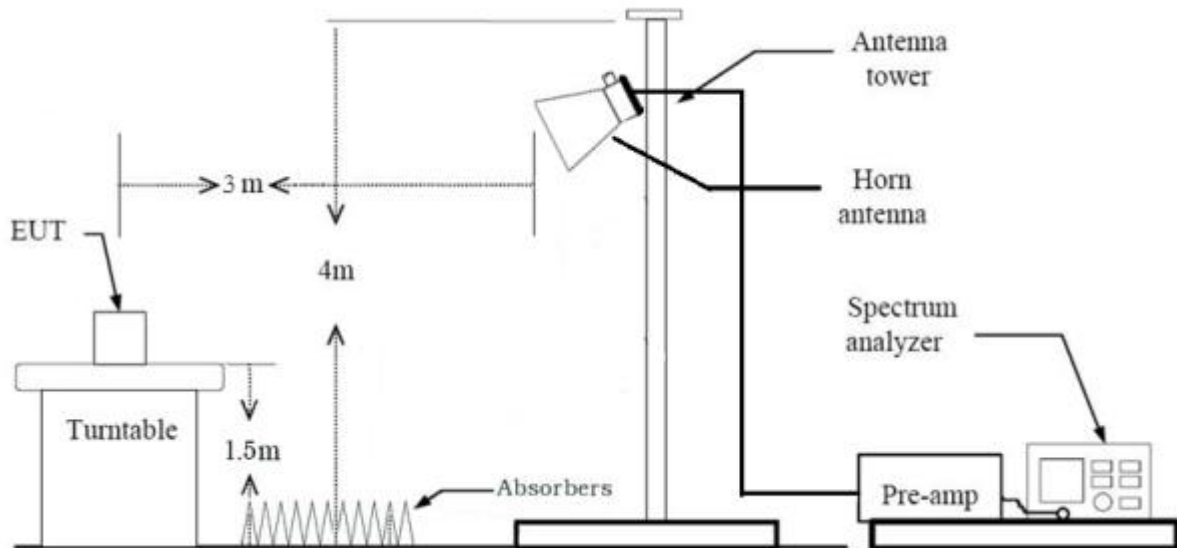
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



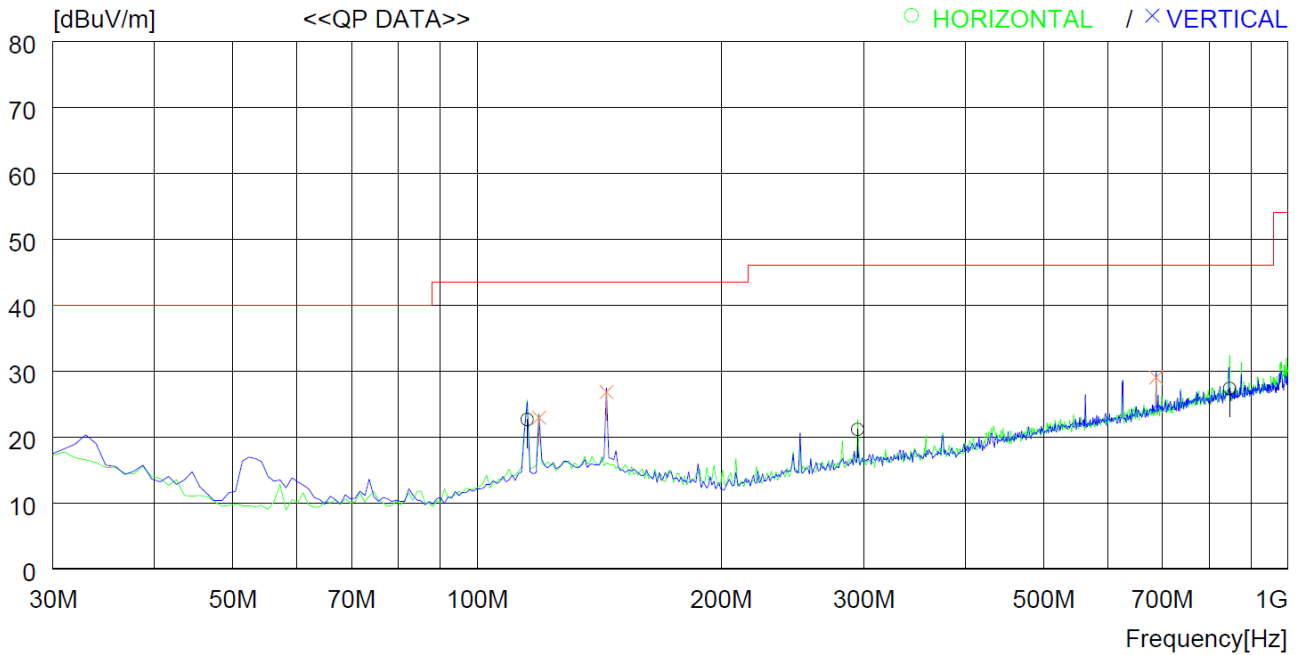
13.3 Test Date

October 17, 2022 ~ October 31, 2022

13.4 Test data for 30 MHz ~ 1 000 MHz

13.4.1 Test data for Bluetooth

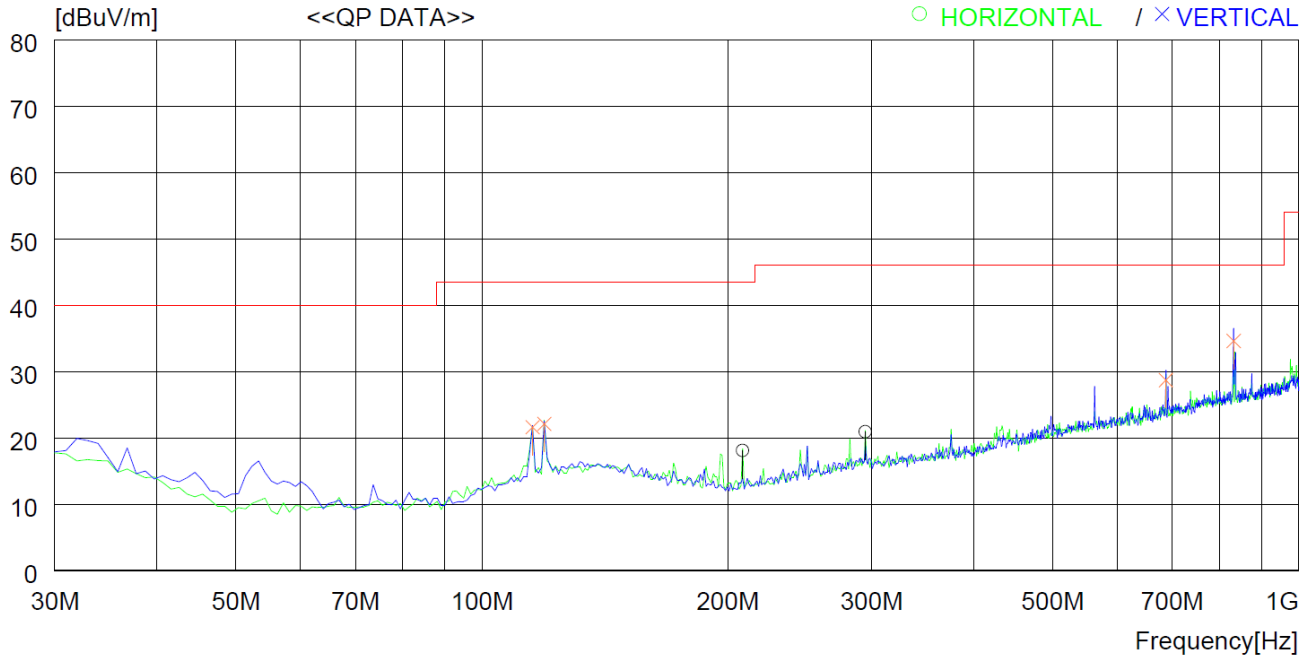
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	115.360	35.5	17.8	1.4	32.1	22.6	43.5	20.9	300	137
2	294.810	32.1	19.0	2.2	32.2	21.1	46.0	24.9	100	101
3	847.700	28.5	27.2	3.8	32.2	27.3	46.0	18.7	400	359
----- Vertical -----										
4	119.240	35.1	18.5	1.4	32.1	22.9	43.5	20.6	300	359
5	144.460	38.5	18.9	1.5	32.1	26.8	43.5	16.7	100	359
6	687.655	32.8	25.2	3.4	32.4	29.0	46.0	17.0	100	359

13.4.2 Test data for Intermodulation Mode(Bluetooth + WLAN 2.4 GHz)

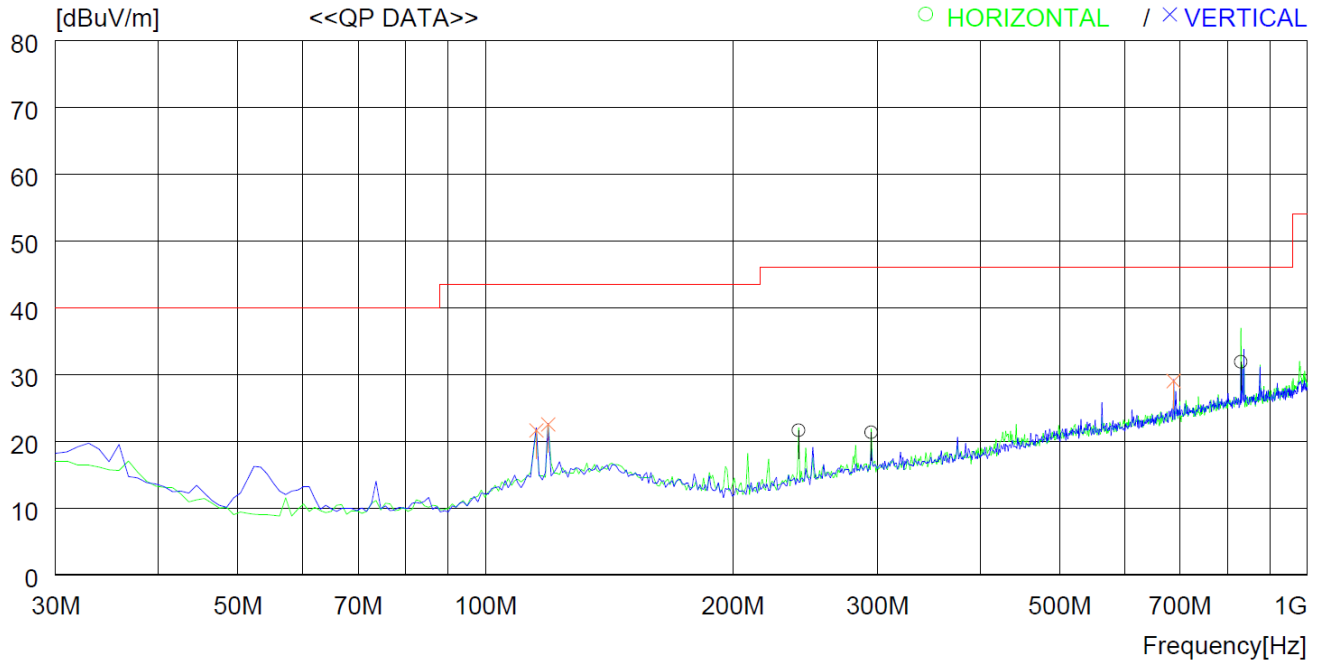
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	208.480	32.6	15.8	1.8	32.1	18.1	43.5	25.4	200	359
2	294.810	31.9	19.0	2.2	32.2	20.9	46.0	25.1	100	112
----- Vertical -----										
3	115.360	34.5	17.8	1.4	32.1	21.6	43.5	21.9	400	0
4	119.240	34.3	18.5	1.4	32.1	22.1	43.5	21.4	100	359
5	687.655	32.5	25.2	3.4	32.4	28.7	46.0	17.3	100	359
6	832.181	35.8	27.2	3.8	32.2	34.6	46.0	11.4	200	0

13.4.3 Test data for Intermodulation Mode(Bluetooth + WLAN 5 GHz)

- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	240.490	34.5	17.2	2.0	32.1	21.6	46.0	24.4	100	0
2	294.810	32.3	19.0	2.2	32.2	21.3	46.0	24.7	100	0
3	830.241	33.1	27.2	3.8	32.2	31.9	46.0	14.1	200	203
----- Vertical -----										
4	115.360	34.5	17.8	1.4	32.1	21.6	43.5	21.9	200	70
5	119.240	34.7	18.5	1.4	32.1	22.5	43.5	21.0	400	276
6	687.655	32.8	25.2	3.4	32.4	29.0	46.0	17.0	100	359

13.5 Test data for Below 30 MHz

- Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- Frequency range : 9 kHz ~ 30 MHz
- Measurement distance : 3 m

Frequency (MHz)	Reading (dB μ V)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

13.6 Test data for above 1 GHz

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m

Frequency (MHz)	Reading (dB μ V)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.								

14. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSVA40	Rohde & Schwarz	Signal Analyzer	101586	Apr. 21, 2022 (1Y)
ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 07, 2022 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 13, 2022 (1Y)
SCU18	Rohde & Schwarz	Signal Conditioning unit	102266	Jul. 12, 2022 (1Y)
SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Jan. 18, 2022 (1Y)
GP-4303D	LG Precision Co.,Ltd	DC POWER SUPPLY	5071069	Jan. 03, 2022 (1Y)
WT-A3882-R10	Microwave	Cavity Band Rejection Filter	WT22040502-1	Jun. 21, 2022 (1Y)
DT2000-2t	Innco System	Turn Table	N/A	N/A
MA-4640-XPET	Innco System	Antenna Master	MA4640/652/43100318/P	N/A
CO3000	Innco System	Controller	1026/40960617/P	N/A
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2022 (2Y)
HLP-2008	TDK	Hybrid Antenna	131316	Mar. 07, 2022 (2Y)
BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1349	Jul. 08, 2022 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 21, 2022 (1Y)
TC-3000C	TESCOM	BLUETOOTH TESTER	3000C000634	Jan. 17, 2022 (1Y)