

Prüfbericht-Nr.: Test Report No.:	JP232NN1 001	Auftrags-Nr.: Order No.:	150277637, 150277641	Seite 1 von 65 Page 1 of 65
Kunden-Referenz-Nr.: Client Reference No.:	N/A	Auftragsdatum: Order Date:	2023-04-27	
Auftraggeber: Client:	HOUWA SYSTEM DESIGN K.K. 3-22-14 Higashi, Shibuya-ku, Tokyo, 150-0011 JAPAN			
Prüfgegenstand: Test Item:	BLE Module			
Bezeichnung / Typ-Nr.: Identification / Type No.:	BLEAD-MOD33QDNA (Model A), BLEAD-MOD33QDA (Model B)	Serien-Nr.: Serial No.:	NA00000001 (Model A), A500000001 (Model B)	
Auftrags-Inhalt: Order Content:	Radio Testing			
Prüfgrundlage: Test Specification:	FCC 47 CFR Part 15, Subpart C, Section 15.247 ANSI C63.10-2013 KDB Publication No. 558074 D01: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247			
Wareneingangsdatum: Date of Receipt:	2023-09-08			
Prüfmuster-Nr.: Test Sample No.:	A003565791			
Prüfzeitraum: Testing Period:	2023-09-08 - 2023-09-25			
Ort der Prüfung: Place of Testing:	Yokohama EMC Laboratory			
Prüflaboratorium: Testing Laboratory:	TÜV Rheinland Japan Ltd.			
Prüfergebnis*: Test Result*:	Pass			
Überprüft von: Reviewed by:		Genehmigt von: Authorized by:		
Datum: 2023-10-18 Date:	_____ Daisuke Watanuki	Datum: 2023-10-18 Date:	_____ Pin Zhang	
Stellung / Position:	Inspector	Stellung / Position:	Reviewer	
Sonstiges / Other:	BLEAD-MOD33QDNA (Model A), BLEAD-MOD33QDA (Model B) are identical except antennas. BLEAD-MOD33QDNA has UFL antenna connector for an external antenna. BLEAD-MOD33QDA has an integrated antenna which is not detachable. These 2 models are subject to certification application under one common FCC ID. Model A is subject to full assessment according to Part 15.247 while Model B is subject to radiated spurious test only.			
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the Test Item at Delivery:	Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>			
* Legende: P(ass) = entspricht o.g. Prüfgrundlage(n) * Legend: P(ass) = passed a.m. test specification(s)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n) F(ail) = failed a.m. test specification(s)	N/A = nicht anwendbar N/A = not applicable	N/T = nicht getestet N/T = not tested	
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i>				

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REVISIONS

Report No.	Issue date	Changes / Remarks
JP232NN1 001	2023-10-18	Original document

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1. General Remarks

1.1 Test Specifications

Table 1: Test Summary

Test	Specifications	Result
Radio: FCC 47 CFR Part 15, Subpart C, Section 15.247 ANSI C63.10-2013		
Maximum Peak Output Power	FCC 15.247(b)(3)	Pass
6dB Bandwidth	FCC 15.215(c), 15.247(a)(2)	Pass
99% Bandwidth	For reference	Performed
Conducted Spurious Emissions	FCC 15.247(d)	Pass
Peak Power Spectral Density	FCC 15.247(e)	Pass
Radiated Spurious Emissions of Transmitter	FCC 15.247(d)	Pass
Conducted Emission on AC Power Ports	FCC 15.207	Pass

1.2 Test Report Purpose

The purpose of this test report is to show compliance of the EUT (Equipment Under Test) with the requirements of the FCC rules listed in section 1.1 for original grant application.

1.3 Complementary Materials

There is no attachment to this test report.

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2. Test Sites

2.1 Test Facilities

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The test facility is recognized by the Federal Communications Commission (FCC) as Accredited Testing Laboratory under designation number JP0017.

The test facility is accredited by VLAC (member of ILAC) under number VLAC-017 according to ISO/IEC 17025:2017.

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2.2 List of Test and Measurement Instruments

Table 2: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
For Power Port and Telecommunication Port Conducted Emission (CE)							
Conducted Emission Measurement Software	Toyo Corporation	EP9/CE	Ver. 4.2.010	RF-0810	N/A	N/A	N/A
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2023-03-17	2024-03-17
LISN	Rohde & Schwarz	ENV216	100276	RF-0016	1 year	2023-05-16	2024-05-16
LISN	Rohde & Schwarz	ENV216	101958	RF-0708	1 year	2023-05-16	2024-05-16
For Radiated Emission (RE)							
Radiated Emission Measurement Software (below 30MHz)	Toyo Corporation	EP5/ME	Ver. 5.2.10	RF-0172	N/A	N/A	N/A
Radiated Emission Measurement Software (above 30MHz)	Toyo Corporation	EP7/RE	VER. 8.0.90	RF-0026	N/A	N/A	N/A
EMI Receiver	Rohde & Schwarz	ESU 8	100025	RF-0020	1 year	2023-03-17	2024-03-17
EMI Receiver	Rohde & Schwarz	ESW 26	101316	RF-0812	1 year	2023-05-26	2024-05-26
RF Selector (10m Chamber)	Toyo Corporation	NS4900	0703-182	RF-0029	N/A	N/A	N/A
Loop Antenna with Amplifier, 9kHz-30MHz	Rohde & Schwarz	HFH2-Z2	100139	RF-0048	1 year	2023-05-26	2024-05-26
Trilog Antenna No. 2, 30-1000MHz	Schwarzbeck	VULB 9168	9168-475	RF-0462	1 year	2023-05-30	2024-05-30
5dB Attenuator	Pasternack	PE7047-5	-	RF-0731	1 year	2023-05-29	2024-05-29
Low Noise Preamplifier, 9kHz-1GHz	TSJ	MLA-10K01-B01-35	1370750	RF-0253	1 year	2022-12-21	2023-12-21
Low Pass Filter, DC-1GHz	R&K	LP1000CH 3	12104001	RF-0515	1 year	2022-12-22	2023-12-22
Horn Antenna, 1-8GHz	Schwarzbeck	BBHA9120 D	9120D-2280	RF-0845	1 year	2023-03-18	2024-03-18
Microwave Preamplifier, 1-8GHz	Toyo Corporation	TPA0108-40	0634	RF-0052	1 year	2022-12-21	2023-12-21
Band Reject Filter, 1-8GHz	Nitsuki	NF-49BT	027	RF-0131	1 year	2022-12-21	2023-12-21
Horn Antenna with Preamplifier, 6-18GHz (RX)	Toyo Corporation	HAP06-18W	B1510452 210-123	RF-1095	N/A	N/A	N/A
High Pass Filter, 8-18GHz	Micro-Tronics	HPM50107	G089	RF-1094	1 year	2022-11-24	2023-11-24

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Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
Horn Antenna with Preamplifier, 18-26.5GHz (RX)	Toyo Corporation	HAP18-26W	B2010482 210-125	RF-1096	1 year	2022-11-24	2023-11-24
Constant Voltage Constant Frequency Stabilizers and Power Accessories							
CVCF (Shielded Room)	NF Corporation	ES2000S	9075612	RF-0210	1 year	2023-03-24	2024-03-24
CVCF Booster (Shielded Room)	NF Corporation	ES2000B	9074403	RF-0211	1 year	2023-03-24	2024-03-24
CVCF (10m Chamber)	NF Corporation	ES2000U	9067307	RF-0212	1 year	2023-03-24	2024-03-24
CVCF Booster (10m Chamber)	NF Corporation	ES2000B	9074408	RF-0213	1 year	2023-03-24	2024-03-24
DC Power Supply (*)	Kikusui	PWR800L	NA003235	PV-0039	N/A	N/A	N/A
True RMS Multimeter	Fluke	87V	97680445	RF-0281	1 year	2022-12-08	2023-12-08
For Antenna Port Conducted Emission							
EMI Receiver	Rohde & Schwarz	ESU 40	100029	RF-0021	1 year	2023-09-11	2024-09-11
EMI Receiver	Rohde & Schwarz	ESW 26	101316	RF-0812	1 year	2023-05-26	2024-05-26
DC Power Supply (*)	Agilent	E3646A	MY503500 07	RF-0412	N/A	N/A	N/A
True RMS Multimeter	Fluke	87V	97680445	RF-0281	1 year	2022-12-08	2023-12-08

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025 has been confirmed before testing.

(*) This equipment is calibrated or validated before testing by using calibrated equipment.

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2.3 Measurement Uncertainty

Table 3: Emission Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	20Hz - 40GHz	±1.5dB
Radiated Emission	9kHz - 30MHz	±4.8dB
	30MHz - 1GHz	±6.0dB
	> 1GHz	±5.2dB
AC Power Line Conducted Emission	150k – 30MHz	±3.3dB

Note:

The measurement instrumentation uncertainty (MIU) was determined according to CISPR 16-4-2 and ETSI TR 100-028. All MIU values mentioned in the above table are smaller than the uncertainty budgets specified by CISPR 16-4-2 and ETSI TR 100-028, therefore compliance for all emission measurements is deemed to occur if no measured disturbance level exceeds the disturbance limit.

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3. General Product Information

3.1 Product Function and Intended Use

The **EUT** (Equipment Under Test) is a Bluetooth Low Energy module for multi host devices.

3.2 Ratings and System Details

Radio standard:	Bluetooth 5.1
Frequency range:	2402 – 2480MHz
Antenna gain:	2.24dBi (Model A), 0.79dBi (Model B)
Antenna type:	Mono-pole (Model A), Pattern Antenna (Model B)
Antenna mounting type:	External (Model A), Internal (Model B)
Modulation type:	GFSK
Signal spreading:	None
Transmit speed:	1 Mbps, 2 Mbps
Number of channels:	40
Channel spacing:	2MHz
Rated temperature:	0 to 75°C
Rated voltage:	1.7 ~ 3.6VDC, 3VDC for normal
Rated input Current:	Not specified
Protection class:	III
Test voltage:	DC 3V

3.3 Noise Generating and Noise Suppressing Parts

The highest frequency generated or used by the EUT is 2480MHz as maximum fundamental frequency of incorporated Bluetooth SoC.

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3.4 Submitted Documents and Information

Following information provided in this test report has been submitted by the client:

- client name and address;
- EUT identification, ratings, system details, and description of product function and intended use;
- information related to noise generating and noise suppressing parts (if any).

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4. Test Setup and Operation Modes

4.1 Test Methodology

The test methodology used is based on the requirements of 47 CFR Part 15, Sections 15.31, 15.33, 15.35, 15.205, 15.207, 15.209, 15.247.

The test methods, which have been used, are based on ANSI C63.10.

For details, see under each test item.

4.2 Operation Modes

Testing was performed at the lowest operating frequency (2402MHz), at the operating frequency in the middle of the specified frequency band (2440MHz) and at the highest operating frequency (2480MHz).

The basic operation modes used for testing are:

- A. EUT transmits a modulated signal at lowest channel (2402MHz)
- B. EUT transmits a modulated signal at middle channel (2440MHz)
- C. EUT transmits a modulated signal at middle channel (2480MHz)

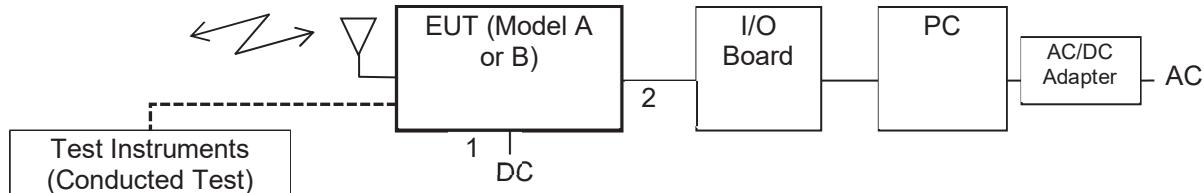
Configurations:

- 1M. 1Mbps (1M PHY)
- 2M. 2Mbps (2M PHY)

4.3 Physical Configuration for Testing

The test system was configured in a typical fashion (as a customer would normally use it).

The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.10.

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Page 13 of 65**Figure 1: Block Diagram**

Note: The antenna is attached only when radiated test is performed. It is removed and test instruments are connected to its antenna port instead when conducted test is performed.

Table 4: Interfaces present on the EUT

No.	Interface(s):	Max. Cable Length, Shielding	Cable Classification
1.	DC Input	0.2m, Un-shielded	DC Power Line
2.	Control Cable	0.2m, Un-shielded	Signal Line

Note:

For more details, refer to section: Photographs of the Test Set-Up.

4.4 Test Software

The EUT was provided by the manufacturer with suitable software to allow operation in all the required modes.

Software used for testing: Tera Term version 4.106 (SVN#9298) by Tera Term Project

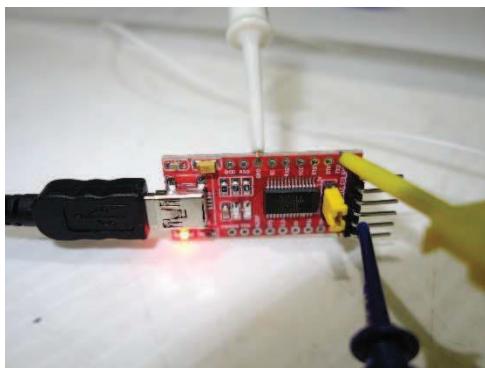
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4.5 Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

1. Product: I/O Board
Manufacturer: N/A
Model: N/A

Photograph 1: I/O Board



2. Product: PC
Manufacturer: FFF Smart Life Connected Corporation
Model: FFF-PCM2B
Rated Voltage: 12V
Input Current: 2.0A
Serial Number: M222120335
3. Product: AC/DC Adapter
Manufacturer: FFF Smart Life Connected Corporation
Model: JZ8024
Rated Voltage: 100-240V
Input Current: 0.7A
Frequency: 50/60Hz
Serial Number: 120200D

4.6 Countermeasures to achieve Compliance

No additional measures were employed to achieve compliance.

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5. Test Results RADIO

5.1 Technical Requirements

5.1.1 Supply Voltage Requirements

RESULT: PASS

Requirements:

FCC 15.31(e)

For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

Verdict:

The EUT has an internal voltage regulator to supply the RF circuit. Hence it complies with the supply voltage requirements.

5.1.2 Antenna Requirements

RESULT: PASS

Requirements:

FCC 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.

Verdict:

The EUTs have mono-pole antenna (Model A) with a unique connector and on-board pattern antenna (Model B) which are not easily accessible for modification. Hence it complies with the antenna requirements.

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5.1.3 Restricted Bands of Operation

RESULT:**PASS**

Requirements:

FCC 15.205

Only spurious emissions are permitted in any of the restricted frequency bands, unless otherwise specified.

Verdict:

The EUT operation frequency range is 2400-2483.5MHz. Therefore only spurious emissions may be found in the restricted bands of operation and the EUT complies with the restricted frequency band requirement.

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5.2 Conducted Measurements at Antenna Port

5.2.1 Maximum Peak Output Power

RESULT:**PASS**

Date of testing: 2023-09-25

Ambient temperature: 25°C

Relative humidity: 74%

Atmospheric pressure: 1009hPa

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A

Requirements:

FCC 15.247(b)(3)

For systems using digital modulation in the 2400-2483.5MHz band, the maximum peak output power is 1W (30dBm).

If transmitting antennas of directional gain greater than 6dBi are used, the conducted output power from the intentional radiator shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi.

Test procedure:

KDB Publication No. 558074 D01.

The maximum peak output power was measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth and the video bandwidth were set to 3MHz and 10MHz.

The readings of the measurements take into account the loss generated by all the involved cables.

The measurement was performed at all the available data rates (1M and 2Mbps) in order to identify the one producing the highest output power.

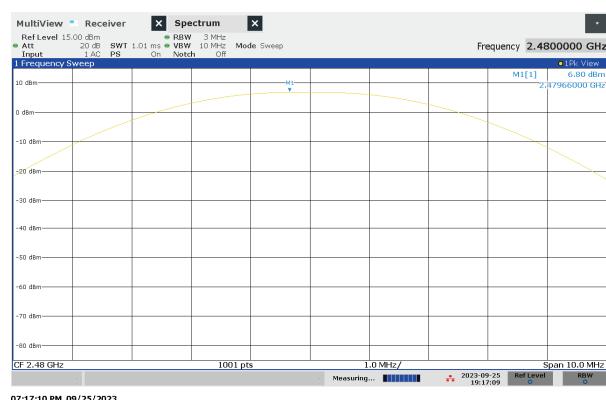
Prüfbericht-Nr.:
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Page 18 of 65**Table 5: Maximum Peak Output Power, 1Mbps**

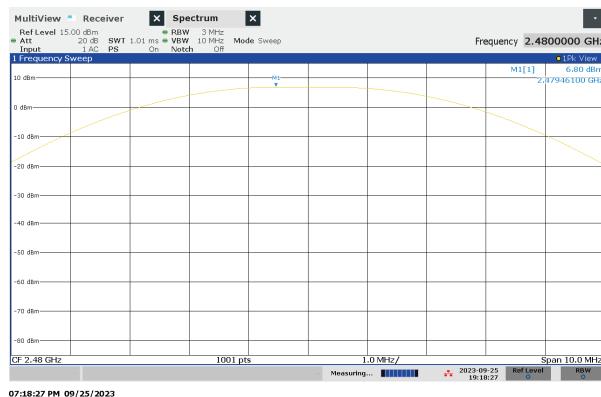
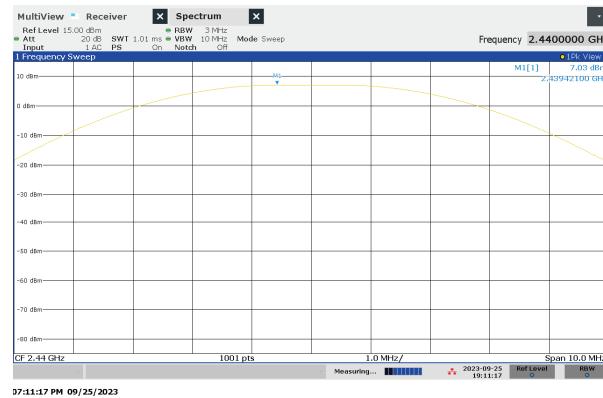
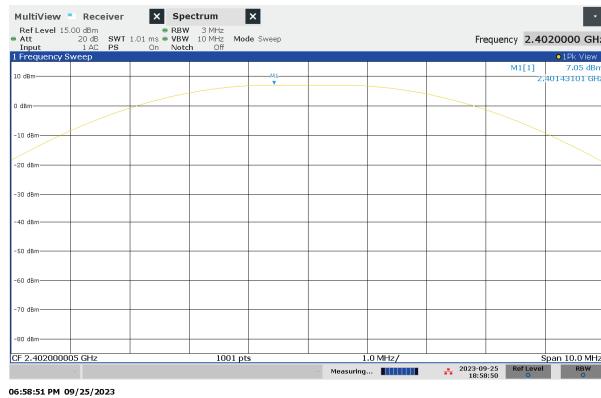
Freq. [MHz]	Peak Output Power [dBm]	Limit [dBm]	Margin [dB]
2402	7.35	30	22.65
2440	7.33	30	22.67
2480	7.11	30	22.89

Table 6: Maximum Peak Output Power, 2Mbps

Freq. [MHz]	Peak Output Power [dBm]	Limit [dBm]	Margin [dB]
2402	7.36	30	22.64
2440	7.34	30	22.66
2480	7.11	30	22.89

Note: These measured values in the tables above were corrected with extra RF cable loss 0.31dB.

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Page 21 of 65**5.2.2 6dB Bandwidth****RESULT:****PASS**

Date of testing: 2023-09-14, 2023-09-15

Ambient temperature: 25, 24°C

Relative humidity: 73, 74%

Atmospheric pressure: 1006, 1009hPa

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A

Requirements:

FCC 15.215(c) and 15.247(a)(2)

For systems using digital modulation in the 2400-2483.5MHz band, the 6dB bandwidth shall be at least 500kHz.

Test procedure:

KDB Publication No. 558074 D01.

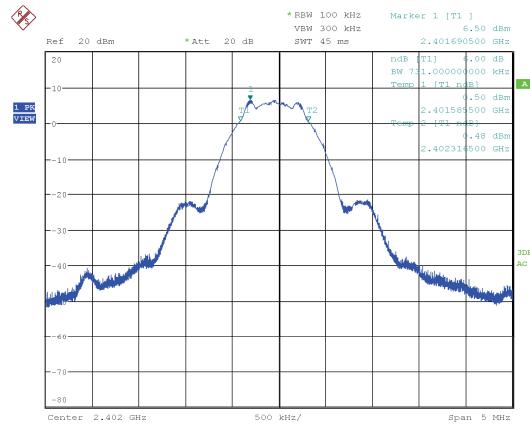
The 6dB bandwidth was measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. Markers placed at the lowest and highest intersections of the trace with a 6dBc line were used to calculate the emission bandwidth.

Table 7: 6dB Bandwidth, 1Mbps

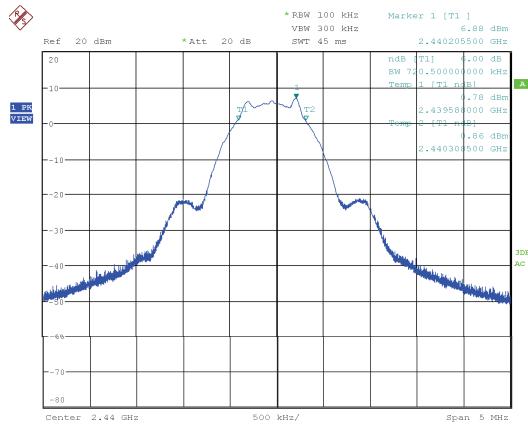
Operating Frequency [MHz]	6dB Bandwidth [MHz]	Limit [MHz]
2402	0.73	0.5
2440	0.72	0.5
2480	0.70	0.5

Table 8: 6dB Bandwidth, 2Mbps

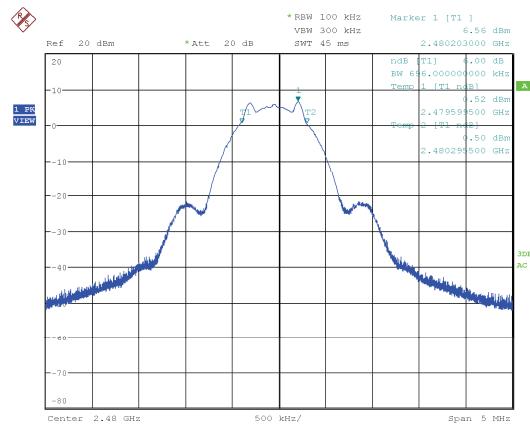
Operating Frequency [MHz]	6dB Bandwidth [MHz]	Limit [MHz]
2402	1.20	0.5
2440	1.22	0.5
2480	1.24	0.5

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Page 22 of 65**Figure 4: 6dB Bandwidth, Mode A ~ C, 1Mbps**

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Date: 16.SEP.2023 14:17:21



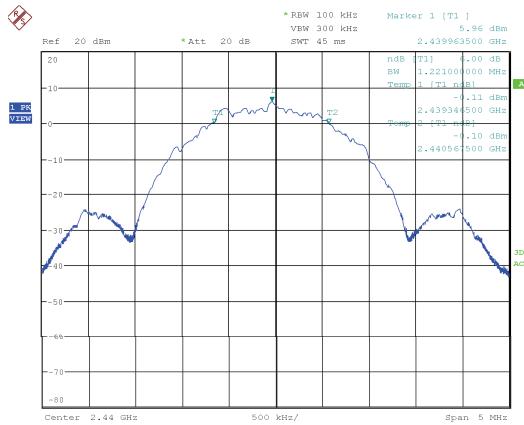
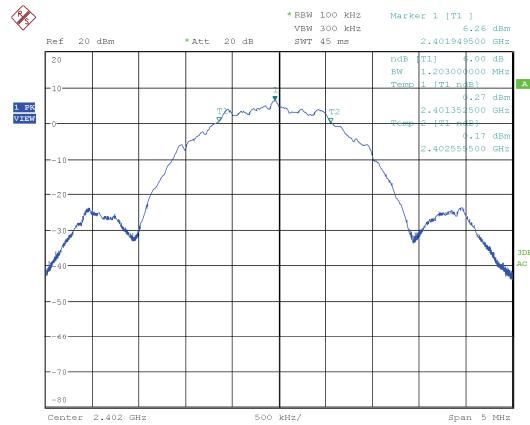
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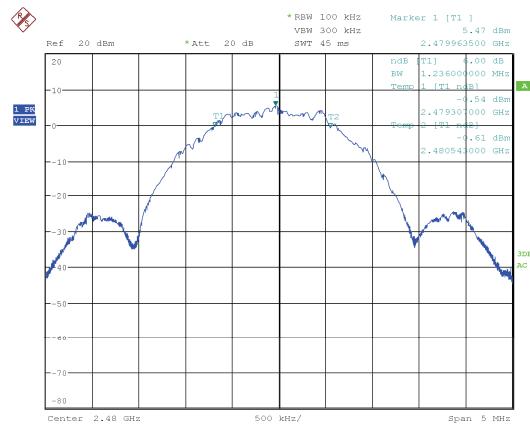
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Figure 5: 6dB Bandwidth, Mode A ~ C, 2Mbps



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Date: 16.SEP.2023 14:33:23



Date: 16.SEP.2023 14:27:01

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5.2.3 99% Bandwidth

RESULT:**PERFORMED**

Date of testing: 2023-09-14, 2023-09-15

Ambient temperature: 25, 24°C

Relative humidity: 73, 74%

Atmospheric pressure: 1006, 1009hPa

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A

Test procedure:

ANSI C63.10 §6.9.3

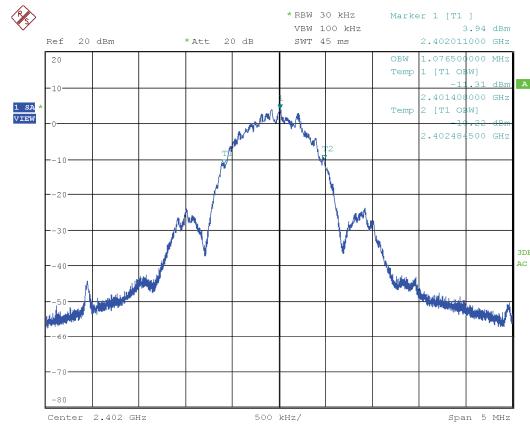
The 99% bandwidth was measured at the antenna port with a spectrum analyzer using a peak detector. The value of the emission bandwidth was obtained by using the OBW function of the analyzer with a 99% coverage setting.

Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 25 von 65
Page 25 of 65**Table 9: 99% Bandwidth and Edge Frequencies, 1Mbps**

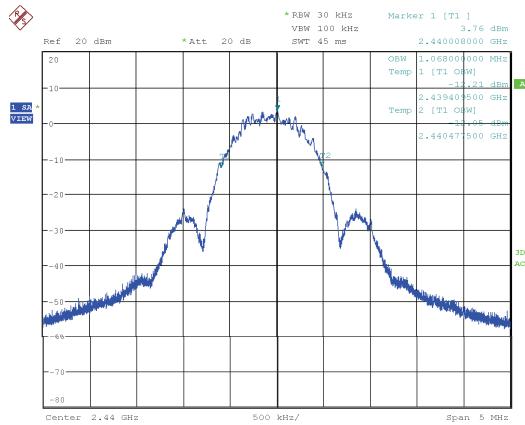
Operating Frequency [MHz]	99% Bandwidth [MHz]	Edge Frequency [MHz]	Limit [MHz]	Margin [MHz]
2402	1.08	2401.4	2400	1.4
2440	1.07	---	---	---
2480	1.06	2480.5	2483.5	3.0

Table 10: 99% Bandwidth and Edge Frequencies, 2Mbps

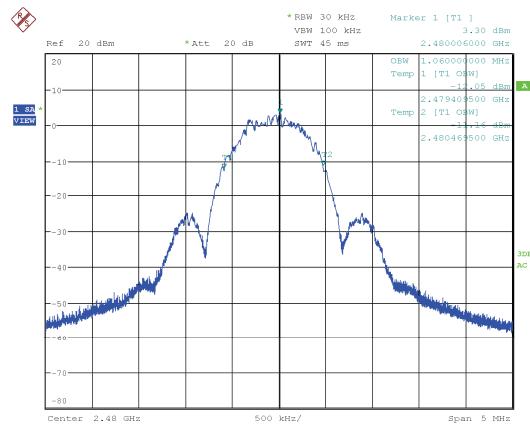
Operating Frequency [MHz]	99% Bandwidth [MHz]	Edge Frequency [MHz]	Limit [MHz]	Margin [MHz]
2402	2.09	2400.9	2400	0.9
2440	2.11	---	---	---
2480	2.10	2481.0	2483.5	2.5

Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 26 von 65
Page 26 of 65**Figure 6: 99% Bandwidth, Mode A ~ C, 1Mbps**

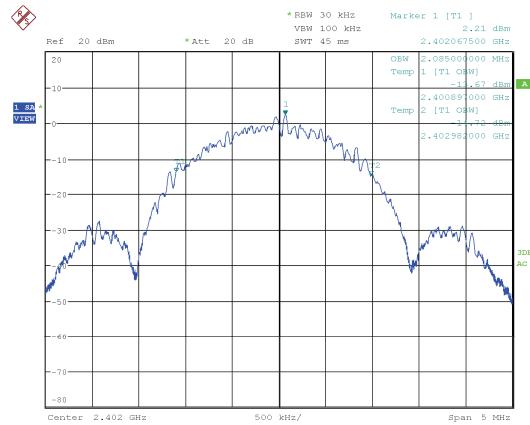
Date: 16.SEP.2023 15:12:09



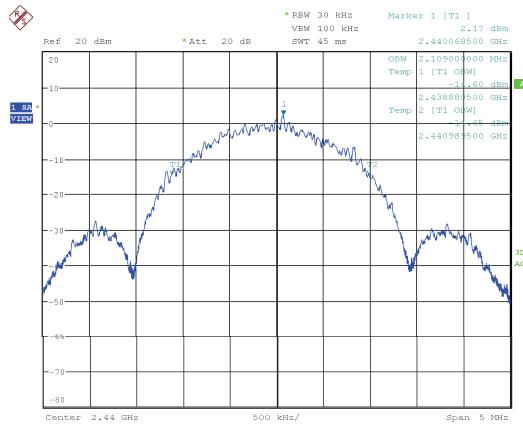
Date: 16.SEP.2023 15:09:04



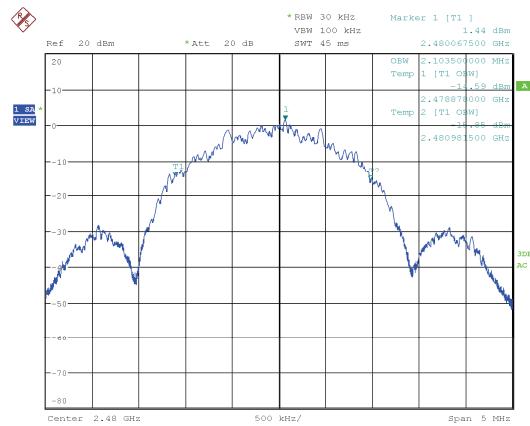
Date: 16.SEP.2023 15:06:17

Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 27 von 65
Page 27 of 65**Figure 7: 99% Bandwidth, Mode A ~ C, 2Mbps**

Date: 16.SEP.2023 14:54:19



Date: 16.SEP.2023 14:58:57



Date: 16.SEP.2023 15:02:56

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5.2.4 Conducted Spurious Emissions

RESULT:**PASS**

Date of testing: 2023-09-14, 2023-09-15

Ambient temperature: 25, 24°C

Relative humidity: 73, 74%

Atmospheric pressure: 1006, 1009hPa

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A

Requirements:

FCC 15.247(d)

In any 100kHz bandwidth outside the frequency band in which the intentional radiator is operating, the RF power shall be at least 20dB below that of the maximum in-band 100kHz emission.

Test procedure:

ANSI C63.10 §7.8.8.

The conducted spurious emissions were measured at the antenna port with a spectrum analyzer using a peak detector. The resolution bandwidth was set to 100kHz and the video bandwidth to 300kHz. Measurements were performed from 30MHz to 25GHz (10th harmonics).

The readings of the measurements take into account the loss generated by all the involved cables.

Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 29 von 65
Page 29 of 65**Table 11: Conducted Spurious Emissions, 30MHz – 25GHz, -20dB Limit to Peak Power, 1Mbps**

Operating Frequency [MHz]	Fundamental Level [dBm]	Spurious Limit [dBm]	Measured Frequency [MHz]	Measured Level [dBm]	Margin [dB]
2402	4.87	-15.13	2273.55	-47.37	26.37
2440	5.44	-14.56	2296.03	-45.18	30.62
2480	5.75	-14.25	2606.90	-43.92	29.67

Table 12: Conducted Spurious Emissions, 30MHz – 25GHz, -20dB Limit to Peak Power, 2Mbps

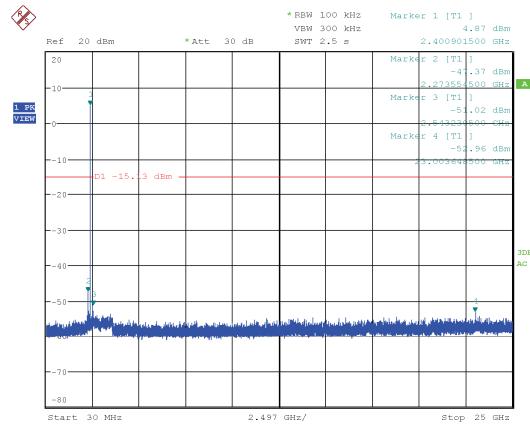
Operating Frequency [MHz]	Fundamental Level [dBm]	Spurious Limit [dBm]	Measured Frequency [MHz]	Measured Level [dBm]	Margin [dB]
2402	4.16	-15.84	2529.50	-45.20	29.36
2440	5.43	-14.54	2566.95	-44.48	29.94
2480	4.38	-15.62	2608.15	-43.31	27.69

Table 13: Conducted Spurious Emissions, Band Edge, -20dB Limit to Peak Power, 1Mbps

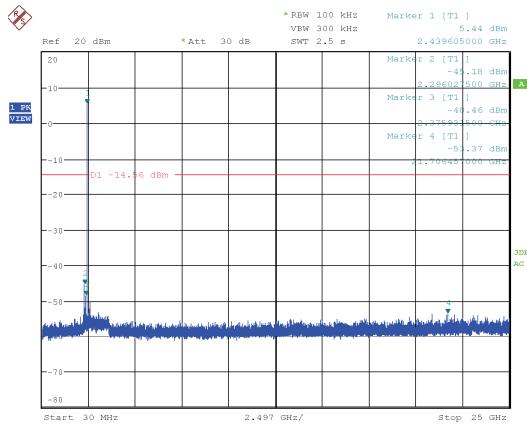
Operating Frequency [MHz]	Fundamental Level [dBm]	Spurious Limit [dBm]	Measured Frequency [MHz]	Measured Level [dBm]	Margin [dB]
2402	6.95	-13.05	2400.00	-42.16	29.11
2480	6.12	-13.88	2483.50	-54.87	40.99

Table 14: Conducted Spurious Emissions, Band Edge, -20dB Limit to Peak Power, 2Mbps

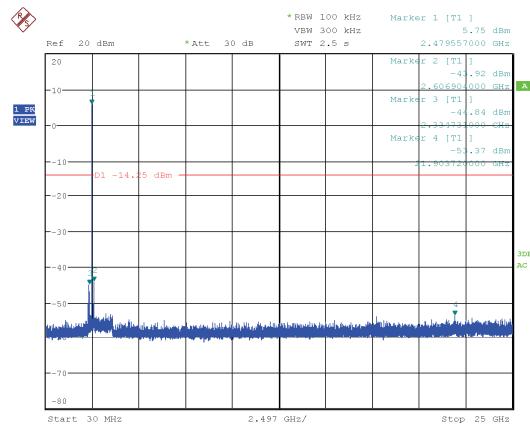
Operating Frequency [MHz]	Fundamental Level [dBm]	Spurious Limit [dBm]	Measured Frequency [MHz]	Measured Level [dBm]	Margin [dB]
2402	5.73	-14.27	2400.00	-25.10	10.83
2480	6.07	-13.93	2484.70	-53.67	39.74

Prüfbericht-Nr.:
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Page 30 of 65**Figure 8: Conducted Spurious Emissions, 30MHz – 25GHz, Mode A ~ C, 1Mbps**

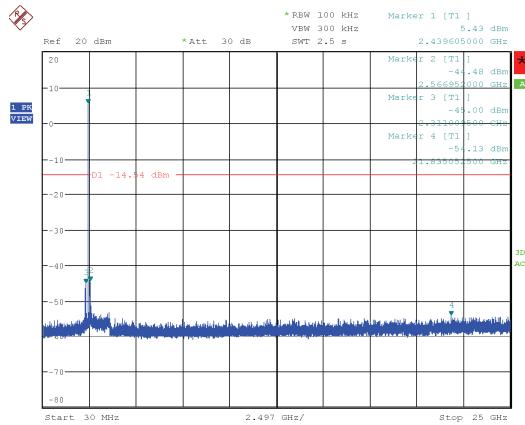
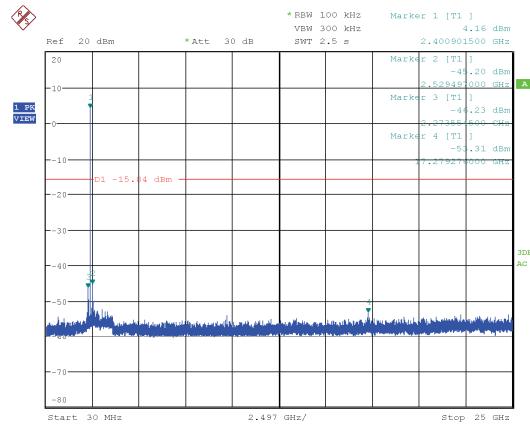
Date: 16.SEP.2023 11:42:32



Date: 16.SEP.2023 11:44:53

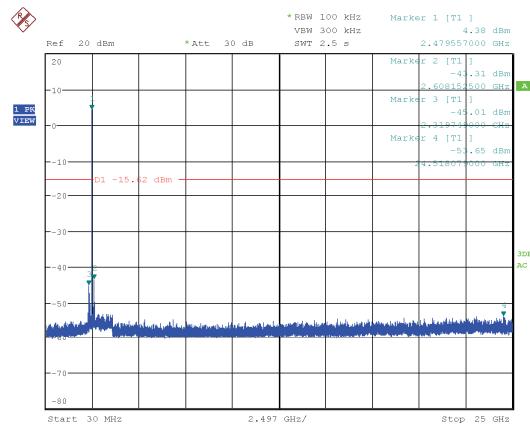


Date: 16.SEP.2023 11:47:25

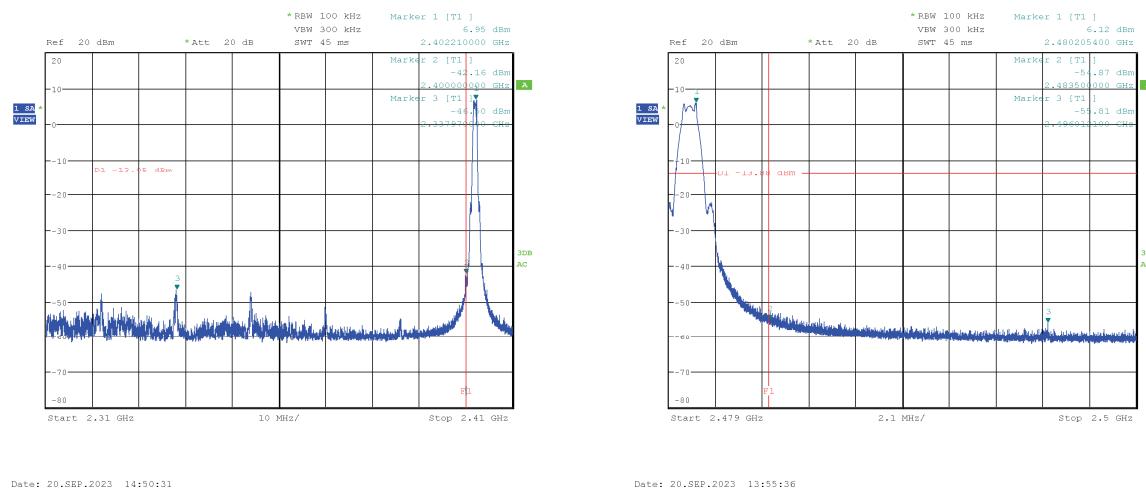
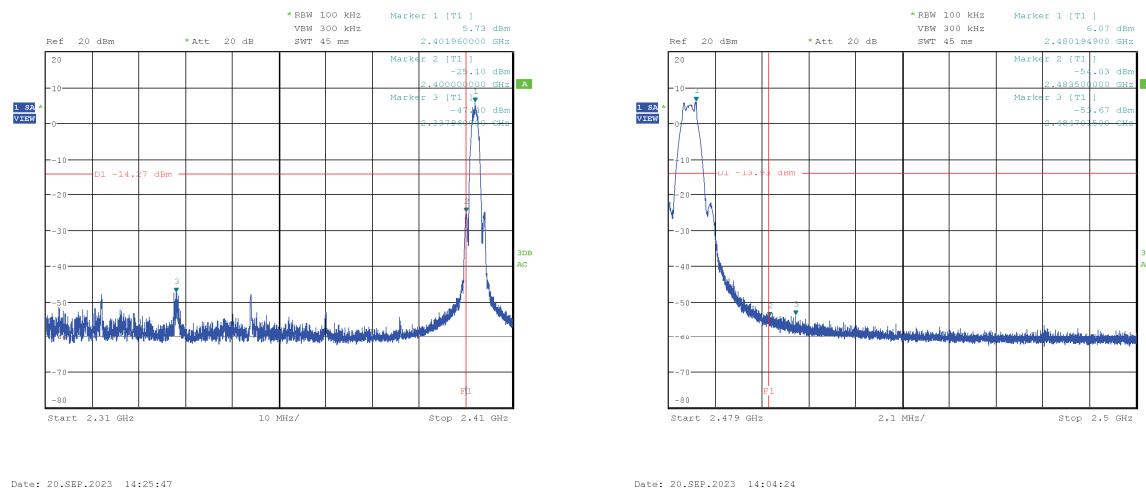
Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 31 von 65
Page 31 of 65**Figure 9: Conducted Spurious Emissions, 30MHz – 25GHz, Mode A ~ C, 2Mbps**

Date: 16.SEP.2023 11:35:23

Date: 16.SEP.2023 11:32:15



Date: 16.SEP.2023 11:38:57

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Page 32 of 65**Figure 10: Conducted Emissions at Band Edge, Spectral Diagram, Modes A (2402MHz) and C (2480MHz), 1Mbps****Figure 11: Conducted Emissions at Band Edge, Spectral Diagram, Modes A (2402MHz) and C (2480MHz), 2Mbps**

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5.2.5 Peak Power Spectral Density

RESULT:**PASS**

Date of testing: 2023-09-14, 2023-09-15

Ambient temperature: 25, 24°C

Relative humidity: 73, 74%

Atmospheric pressure: 1006, 1009hPa

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A

Requirements:

FCC 15.247€

For digitally modulated systems, the power spectral density (PSD) conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

Test procedure:

KDB Publication No. 558074 D01.

The peak power spectral density was measured at the antenna port with a spectrum analyzer using a peak detector with a resolution bandwidth of 3kHz and a video bandwidth of 10kHz.

The readings of the measurements take into account the loss generated by all the involved cables.

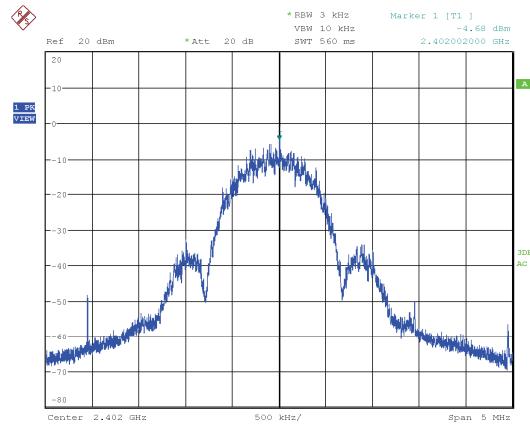
Prüfbericht-Nr.:
Test Report No.:**JP232NN1 001**Seite 34 von 65
Page 34 of 65**Table 15: Peak Power Spectral Density**

Operating Frequency [MHz]	Max PSD Frequency [MHz]	Max PSD [dBm]	Limit [dBm]	Margin [dB]
2402	2402.00	-4.37	8.0	12.37
2440	2439.85	-4.91	8.0	12.91
2480	2480.00	-5.41	8.0	13.41

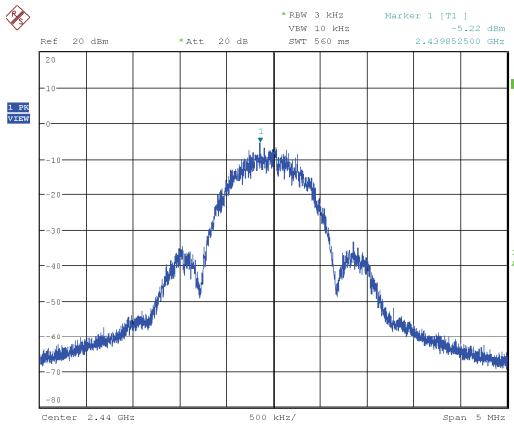
Table 16: Peak Power Spectral Density

Operating Frequency [MHz]	Max PSD Frequency [MHz]	Max PSD [dBm]	Limit [dBm]	Margin [dB]
2402	2402.13	-7.55	8.0	15.55
2440	2439.86	-7.75	8.0	15.75
2480	2480.00	-9.13	8.0	17.13

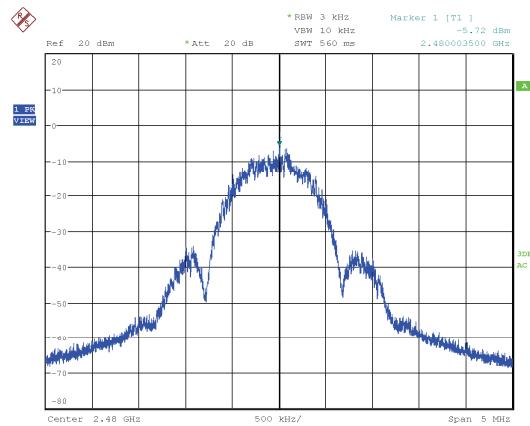
Note: These measured values in the tables above were corrected with extra RF cable loss 0.31dB.

Prüfbericht-Nr.:
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Page 35 of 65**Figure 12: Power Spectral Density, Mode A ~ C, 1Mbps**

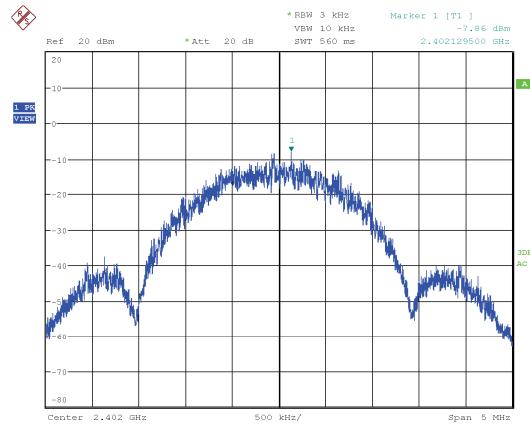
Date: 16.SEP.2023 16:18:55



Date: 16.SEP.2023 16:20:58

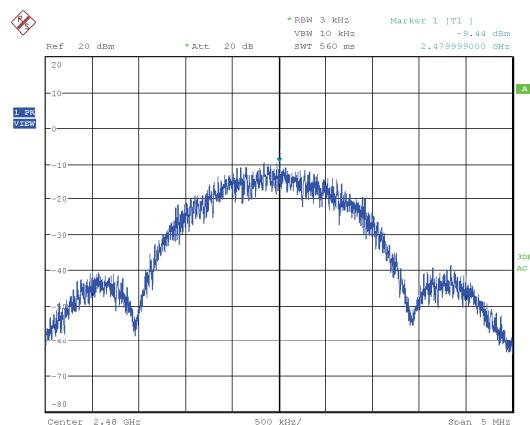


Date: 16.SEP.2023 16:25:20

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Page 36 of 65**Figure 13: Power Spectral Density, Mode A ~ C, 2Mbps**

Date: 16.SEP.2023 16:16:30

Date: 16.SEP.2023 16:13:42



Date: 16.SEP.2023 16:10:39

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5.3 Radiated Measurements

5.3.1 Radiated Spurious Emissions of Transmitter

RESULT:
PASS

Date of testing: 2023-09-08, 2023-09-11, 2023-09-12
2023-09-13

Ambient temperature: 26, 26, 23, 24°C

Relative humidity: 43, 56, 54, 57%

Atmospheric pressure: 1004, 1008, 1009, 1010hPa

Frequency range: 9kHz - 25GHz

Measurement distance: 3m

Kind of test site: Semi Anechoic Chamber

Operation Modes: A ~ C

Configurations: 1M, 2M

Tested Models: Model A and B

Requirements:

FCC 15.205, FCC 15.209, FCC 15.247(d).

Radiated emissions which fall in the restricted bands, as defined in FCC 15.205(a), must comply with the radiated emission limits specified in FCC 15.209(a).

Radiated emissions which fall outside the operation frequency band and outside restricted bands shall either meet the limit specified in FCC 15.209(a) or be attenuated at least 20dB below the power level in the 100kHz bandwidth within the band that contains the highest level of the desired power (the less severe limit applies).

Test procedure:

The EUT was placed on a nonconductive turntable. The table height was 0.8m for measurements below 1GHz and 1.5m for measurements above 1GHz. Before final measurements of radiated emissions were performed, the EUT was scanned to determine its emission spectrum profile. The physical arrangement of the test system, the associated cabling were varied in order to ensure that maximum emission amplitudes were attained.

The spectrum was examined from 9kHz to the 10th harmonic of the highest fundamental transmitter frequency (25GHz). Final radiated emission measurements were made at 3m distance.

At each frequency where a spurious emission was found, the EUT was rotated 360° in order to determine the emission's maximum level. For frequencies above 30MHz, the antenna was raised and lowered from 1 to 4m and measurements were taken using both horizontal and vertical antenna polarizations.

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For emissions between 30MHz and 1GHz, measurements were performed with a test receiver operating in the CISPR quasi-peak detection mode with a 20dB Bandwidth set to 120kHz. For emissions above 1GHz, measurements were performed with a spectrum analyzer using Peak and Average detector.

Absorbers have been placed on the floor between the EUT and the measuring antenna for testing above 1GHz.

The highest emission amplitudes relative to the appropriate limit were recorded in this report. Emissions other than those mentioned are small or not detectable.

Pre-check was performed to determine the worst orientation of the EUT from X, Y and Z axis in each test case and the final measurements were performed with the worst orientations.

For emissions below 1GHz, final measurements were performed with the worst case which was determined by pre-check.

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Page 39 of 65**Table 17: [Model A] Radiated Emissions, Quasi Peak Data, 9kHz - 30MHz, Mode B (2440MHz), 1Mbps, X axis**

Freq. [MHz]	Reading QP [dB μ V]	Factor [dB(1/m)]	Level QP [dB μ V/m]	Limit [dB μ V/m]	Margin QP [dB]	Angle [°]
1.434	6.1	19.3	25.4	64.5	39.1	184

Table 18: [Model A] Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 2Mbps, X axis

Freq. [MHz]	Antenna Orientation	Reading QP [dB μ V]	Factor [dB(1/m)]	Level QP [dB μ V/m]	Limit [dB μ V/m]	Margin QP [dB]	Height [cm]	Angle [°]
47.671	V	53.9	-20.7	33.2	40.0	6.8	100	339
59.590	V	51.2	-21.3	29.9	40.0	10.1	104	1
62.566	V	55.3	-21.6	33.7	40.0	6.3	104	88
65.549	V	54.9	-21.9	33.0	40.0	7.0	100	10
68.524	V	54.9	-22.3	32.6	40.0	7.4	100	37
71.504	H	49.2	-22.9	26.3	40.0	13.7	294	148
71.507	V	61.4	-22.9	38.5	40.0	(*) 1.5	100	133
100.001	H	51.9	-25.1	26.8	43.5	16.7	216	15
172.807	V	47.7	-21.3	26.4	43.5	17.1	100	175
387.324	V	47.9	-16.9	31.0	46.0	15.0	100	176

Note:

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

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Page 40 of 65**Table 19: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 1Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4803.825	H/X	56.3	-7.2	49.1	74	24.9	100	209
4803.867	H/X	56.6	-7.2	49.4	74	24.6	113	199
4803.867	V/X	58.0	-7.2	50.8	74	23.2	139	37
7205.601	H/X	54.6	-0.1	54.5	74	19.5	197	304
7206.201	V/X	55.1	-0.1	55.0	74	19.0	183	40
7206.210	V/X	55.7	-0.1	55.6	74	18.4	197	33
9608.621	V/Z	52.6	-8.3	44.3	74	29.7	165	302
19197.49	V/Y	56.5	-11.0	45.5	74	28.5	115	270

Table 20: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4803.825	H/X	44.0	-7.2	36.8	54	17.2	100	209
4803.867	H/X	44.6	-7.2	37.4	54	16.6	113	199
4803.867	V/X	48.6	-7.2	41.4	54	12.6	139	37
7205.601	H/X	40.4	-0.1	40.3	54	13.7	197	304
7206.201	V/X	42.3	-0.1	42.2	54	11.8	183	40
7206.210	V/X	42.1	-0.1	42.0	54	12.0	197	33
9608.621	V/Z	38.2	-8.3	29.9	54	24.1	165	302
19197.49	V/Y	41.5	-11.0	30.5	54	23.5	115	270

Table 21: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4879.801	H/X	55.6	-6.9	48.7	74	25.3	100	239
4920.547	H/X	55.3	-6.7	48.5	74	25.5	179	137
4879.853	V/X	56.5	-6.9	49.6	74	24.4	130	324
7295.944	V/X	54.4	0.3	54.7	74	19.3	193	98
7320.311	V/X	54.5	0.2	54.7	74	19.3	175	49
7296.105	H/X	54.8	0.3	55.1	74	18.9	152	205
12200.88	H/Z	51.5	-5.5	46.0	74	28.0	195	45
19462.59	H/Y	56.8	-10.7	46.1	74	27.9	159	283

Prüfbericht-Nr.:
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Page 41 of 65**Table 22: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 1Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4879.801	H/X	43.5	-6.9	36.6	54	17.4	100	239
4920.547	H/X	41.6	-6.7	34.9	54	19.1	179	137
4879.853	V/X	45.7	-6.9	38.8	54	15.2	130	324
7295.944	V/X	40.2	0.3	40.5	54	13.5	193	98
7320.311	V/X	41.6	0.2	41.8	54	12.2	175	49
7296.105	H/X	40.2	0.3	40.5	54	13.5	152	205
12200.88	H/Z	38.1	-5.5	32.6	54	21.4	195	45
19462.59	H/Y	41.7	-10.7	31.0	54	23.0	159	283

Table 23: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4959.860	H/X	56.2	-6.5	49.7	74	24.3	197	43
4959.889	H/X	56.6	-6.5	50.0	74	24.0	109	203
4959.834	V/X	57.1	-6.5	50.6	74	23.4	104	48
7439.399	V/X	55.4	-0.3	55.1	74	18.9	130	31
7439.325	V/X	54.9	-0.3	54.6	74	19.4	100	184
7439.268	H/X	54.7	-0.3	54.4	74	19.6	100	112
12401.02	V/Z	51.8	-7.2	44.6	74	29.4	195	169
19847.09	H/Y	56.0	-10.3	45.7	74	28.3	129	185

Table 24: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4959.860	H/X	44.8	-6.5	38.3	54	15.7	197	43
4959.889	H/X	43.8	-6.5	37.3	54	16.7	109	203
4959.834	V/X	45.9	-6.5	39.4	54	14.6	104	48
7439.399	V/X	42.2	-0.3	41.9	54	12.1	130	31
7439.325	V/X	41.4	-0.3	41.1	54	12.9	100	184
7439.268	H/X	41.5	-0.3	41.2	54	12.8	100	112
12401.02	V/Z	37.1	-7.2	29.9	54	24.1	195	169
19847.09	H/Y	41.3	-10.3	31.0	54	23.0	129	185

Prüfbericht-Nr.:
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Page 42 of 65**Table 25: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 2Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4804.091	H/X	57.0	-7.2	49.8	74	24.2	197	18
4803.648	V/X	57.7	-7.2	50.5	74	23.5	130	17
7204.655	V/X	55.7	-0.1	55.6	74	18.4	152	43
7204.683	H/X	54.7	-0.1	54.6	74	19.4	157	283
7930.300	H/X	54.9	0.8	55.7	74	18.3	104	81
8005.679	V/Z	56.2	0.0	56.2	74	17.8	122	10
12012.02	H/Z	50.2	-5.2	45.0	74	29.0	155	246
19247.70	V/Y	56.1	-10.9	45.2	74	28.8	146	153

Table 26: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4804.091	H/X	44.7	-7.2	37.5	54	16.5	197	18
4803.648	V/X	45.6	-7.2	38.4	54	15.6	130	17
7204.655	V/X	41.4	-0.1	41.3	54	12.7	152	43
7204.683	H/X	40.6	-0.1	40.5	54	13.5	157	283
7930.300	H/X	40.9	0.8	41.7	54	12.3	104	81
8005.679	V/Z	42.1	0.0	42.1	54	11.9	122	10
12012.02	H/Z	36.1	-5.2	30.9	54	23.1	155	246
19247.70	V/Y	41.5	-10.9	30.6	54	23.4	146	153

Table 27: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4879.489	H/X	56.9	-6.9	50.0	74	24.0	171	16
4879.369	H/X	56.6	-6.9	49.6	74	24.4	113	123
4879.378	V/X	57.5	-6.9	50.5	74	23.5	183	57
7318.611	H/X	55.7	0.3	56.0	74	18.0	121	31
7204.573	V/X	56.0	-0.1	55.9	74	18.1	135	290
7203.521	V/X	54.3	-0.1	54.2	74	19.8	168	157
12201.99	H/Z	50.6	-5.5	45.1	74	28.9	107	147
19510.83	H/Y	55.4	-10.6	44.8	74	29.2	142	141

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Page 43 of 65**Table 28: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 2Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4879.489	H/X	44.4	-6.9	37.5	54	16.5	171	16
4879.369	H/X	43.5	-6.9	36.6	54	17.4	113	123
4879.378	V/X	44.8	-6.9	37.9	54	16.1	183	57
7318.611	H/X	42.9	0.3	43.2	54	10.8	121	31
7204.573	V/X	40.4	-0.1	40.3	54	13.7	135	290
7203.521	V/X	40.4	-0.1	40.3	54	13.7	168	157
12201.99	H/Z	35.9	-5.5	30.4	54	23.6	107	147
19510.83	H/Y	41.2	-10.6	30.6	54	23.4	142	141

Table 29: [Model A] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4960.440	V/X	57.7	-6.5	51.2	74	22.8	164	339
4960.563	H/X	57.7	-6.5	51.2	74	22.8	139	166
7441.116	H/X	54.9	-0.3	54.6	74	19.4	185	173
7441.009	H/X	54.7	-0.3	54.4	74	19.6	164	171
7204.091	V/X	54.6	-0.1	54.5	74	19.5	169	320
7199.600	H/X	54.4	-0.1	54.1	74	19.9	143	68
12402.04	V/Z	51.1	-7.2	43.9	74	30.1	183	342
19903.35	H/Y	55.7	-10.2	45.5	74	28.5	100	307

Table 30: [Model A] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4960.440	V/X	44.6	-6.5	38.1	54	15.9	164	339
4960.563	H/X	44.3	-6.5	37.8	54	16.2	139	166
7441.116	H/X	41.8	-0.3	41.5	54	12.5	185	173
7441.009	H/X	42.4	-0.3	42.1	54	11.9	164	171
7204.091	V/X	40.4	-0.1	40.3	54	13.7	169	320
7199.600	H/X	40.3	-0.1	40.2	54	13.8	143	68
12402.04	V/Z	36.8	-7.2	29.6	54	24.4	183	342
19903.35	H/Y	40.6	-10.2	30.4	54	23.6	100	307

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Page 44 of 65**Table 31: [Model A] Band Edge, Modes A (2402MHz) and C (2480MHz), -20dB Limit to Peak Power, 1Mbps, X axis**

Operating Frequency [MHz]	Fundamental Level [dBm]	Band Edge Limit [dBm]	Band Edge Frequency [MHz]	Band Edge Level [dBm]	Margin [dB]
2402	-5.3	-25.3	2400.0	-56.8	31.6
2480	-2.5	-22.5	2483.5	-57.9	35.4

Table 32: [Model A] Band Edge, Modes A (2402MHz) and C (2480MHz), Restricted Band, 1Mbps, X axis

Operating Frequency [MHz]	Band Edge Frequency [MHz]	Average Limit [dBuV/m]	Peak Limit [dBuV/m]	Average Level [dBuV/m]	Peak Level [dBuV/m]	Average Margin [dB]	Peak Margin [dB]
2402	2390.0	54	74	46.2	56.7	7.8	17.3
2480	2483.5	54	74	47.3	58.5	6.7	15.5

Table 33: [Model A] Band Edge, Modes A (2402MHz) and C (2480MHz), -20dB Limit to Peak Power, 2Mbps, X axis

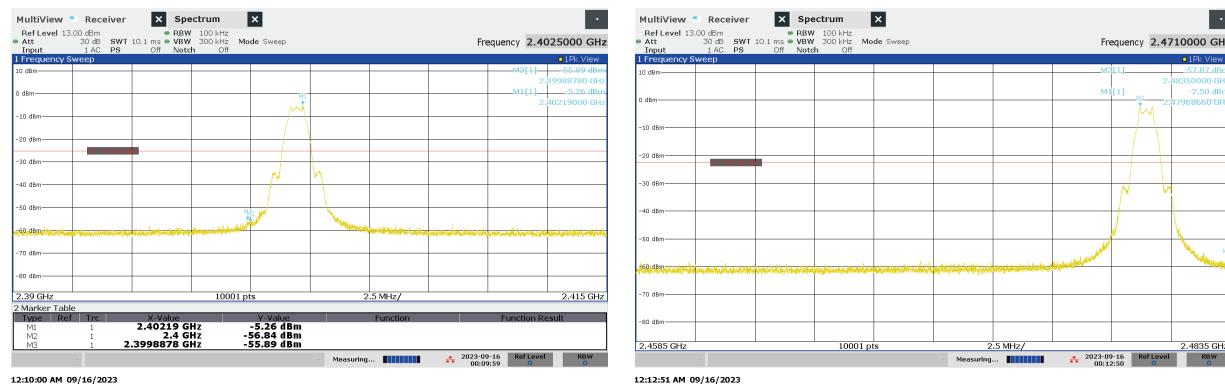
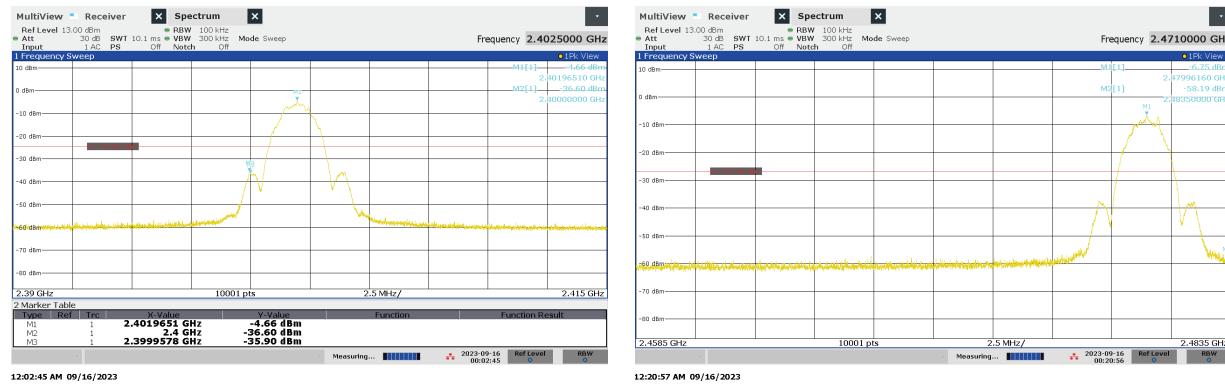
Operating Frequency [MHz]	Fundamental Level [dBm]	Band Edge Limit [dBm]	Band Edge Frequency [MHz]	Band Edge Level [dBm]	Margin [dB]
2402	-4.7	-24.7	2400.0	-36.6	11.9
2480	-6.8	-26.8	2483.5	-58.2	31.4

Table 34: [Model A] Band Edge, Modes A (2402MHz) and C (2480MHz), Restricted Band, 2Mbps, X axis

Operating Frequency [MHz]	Band Edge Frequency [MHz]	Average Limit [dBuV/m]	Peak Limit [dBuV/m]	Average Level [dBuV/m]	Peak Level [dBuV/m]	Average Margin [dB]	Peak Margin [dB]
2402	2390.0	54	74	46.1	56.6	7.9	17.4
2480	2483.5	54	74	50.8	60.5	(*) 3.2	13.5

Notes:

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

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Page 45 of 65**Figure 14: Radiated Emissions at Band Edge, Spectral Diagram, Modes A (2402MHz) and C (2480MHz), 1Mbps****Figure 15: Radiated Emissions at Band Edge, Spectral Diagram, Modes A (2402MHz) and C (2480MHz), 2Mbps**

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Page 46 of 65**Table 35: [Model B] Radiated Emissions, Quasi Peak Data, 9kHz - 30MHz, Mode B (2440MHz), 2Mbps, Z axis**

Freq. [MHz]	Reading QP [dB μ V]	Factor [dB(1/m)]	Level QP [dB μ V/m]	Limit [dB μ V/m]	Margin QP [dB]	Angle [°]
1.612	5.8	19.3	25.1	63.4	38.3	206

Table 36: [Model B] Radiated Emissions, Quasi Peak Data, 30MHz - 1GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 1Mbps, X axis

Freq. [MHz]	Antenna Orientation	Reading QP [dB μ V]	Factor [dB(1/m)]	Level QP [dB μ V/m]	Limit [dB μ V/m]	Margin QP [dB]	Height [cm]	Angle [°]
47.671	V	52.7	-20.7	32.0	40	8.0	100	356
62.568	V	52.4	-21.6	30.8	40	9.2	100	74
65.547	V	52.5	-21.9	30.6	40	9.4	100	6
65.553	H	39.2	-21.9	17.3	40	22.7	100	162
68.528	V	52.5	-22.3	30.2	40	9.8	100	30
71.506	H	45.6	-22.9	22.7	40	17.3	100	143
71.506	V	59.0	-22.9	36.1	40	(*) 3.9	100	162
74.487	V	56.3	-23.6	32.7	40	7.3	100	62

Note:

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

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Page 47 of 65**Table 37: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 1Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4803.849	V/Z	56.0	-7.2	48.8	74	25.2	198	113
4803.853	H/Z	57.7	-7.2	50.5	74	23.5	113	335
7205.335	H/Z	55.6	-0.1	55.5	74	18.5	183	356
7205.800	V/Z	56.9	-0.1	56.8	74	17.2	195	26
7311.176	V/Z	55.2	0.3	55.5	74	18.5	197	11
7867.684	H/Z	53.3	0.6	54.0	74	20.0	186	123
14410.55	V/Z	51.5	-6.8	44.7	74	29.3	184	112
19258.78	H/Z	56.7	-10.9	45.8	74	28.2	120	316

Table 38: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4803.849	V/Z	46.2	-7.2	39.0	54	15.0	198	113
4803.853	H/Z	50.3	-7.2	43.1	54	10.9	113	335
7205.335	H/Z	43.1	-0.1	43.0	54	11.0	183	356
7205.800	V/Z	45.6	-0.1	45.5	54	8.5	195	26
7311.176	V/Z	40.4	0.3	40.7	54	13.3	197	11
7867.684	H/Z	39.1	0.6	39.7	54	14.3	186	123
14410.55	V/Z	36.7	-6.8	29.9	54	24.1	184	112
19258.78	H/Z	41.8	-10.9	30.9	54	23.1	120	316

Table 39: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4859.970	H/Z	55.1	-7.0	48.0	74	26.0	197	130
4860.370	V/Z	55.0	-7.0	48.0	74	26.0	135	114
6679.990	V/Z	55.4	-1.9	53.6	74	20.4	198	242
7311.120	H/Z	55.4	0.3	55.7	74	18.3	118	227
7311.306	H/Z	54.7	0.3	54.9	74	19.1	164	250
7311.979	V/Z	54.7	0.3	55.0	74	19.0	196	201
14641.32	V/Z	50.9	-6.2	44.7	74	29.3	181	359
19514.07	H/Z	56.7	-10.6	46.1	74	27.9	109	137

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Page 48 of 65**Table 40: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 1Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4859.970	H/Z	40.7	-7.0	33.7	54	20.3	197	130
4860.370	V/Z	40.7	-7.0	33.7	54	20.3	135	114
6679.990	V/Z	41.3	-1.9	39.4	54	14.6	198	242
7311.120	H/Z	40.5	0.3	40.8	54	13.2	118	227
7311.306	H/Z	40.5	0.3	40.8	54	13.2	164	250
7311.979	V/Z	40.6	0.3	40.9	54	13.1	196	201
14641.32	V/Z	36.6	-6.2	30.4	54	23.6	181	359
19514.07	H/Z	41.8	-10.6	31.2	54	22.8	109	137

Table 41: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4959.874	H/Z	56.7	-6.5	50.2	74	23.8	113	158
4959.859	V/Z	56.6	-6.5	50.1	74	23.9	179	133
7205.908	V/Z	54.5	-0.1	54.5	74	19.5	179	16
7311.920	H/Z	54.4	0.3	54.7	74	19.3	113	76
7440.089	H/Z	55.9	-0.3	55.6	74	18.4	100	340
7440.247	V/Z	55.5	-0.3	55.2	74	18.8	179	27
12397.37	H/Z	52.0	-7.2	44.8	74	29.2	122	265
19790.80	H/Z	55.6	-10.3	45.3	74	28.7	149	303

Table 42: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 1Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4959.874	H/Z	45.8	-6.5	39.3	54	14.7	113	158
4959.859	V/Z	46.6	-6.5	40.1	54	13.9	179	133
7205.908	V/Z	40.4	-0.1	40.3	54	13.7	179	16
7311.920	H/Z	40.3	0.3	40.6	54	13.4	113	76
7440.089	H/Z	43.8	-0.3	43.5	54	10.5	100	340
7440.247	V/Z	42.8	-0.3	42.5	54	11.5	179	27
12397.37	H/Z	37.1	-7.2	29.9	54	24.1	122	265
19790.80	H/Z	40.8	-10.3	30.5	54	23.5	149	303

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Page 49 of 65**Table 43: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 2Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4803.975	H/Z	58.0	-7.2	50.8	74	23.2	121	326
4804.396	V/Z	55.3	-7.2	48.1	74	25.9	200	131
7204.575	H/Z	55.0	-0.1	54.9	74	19.1	157	70
7206.939	V/Z	54.6	-0.1	54.5	74	19.5	100	273
7206.994	V/Z	56.8	-0.1	56.7	74	17.3	194	28
7309.758	H/Z	55.1	0.3	55.4	74	18.6	157	123
12012.03	V/Z	50.5	-5.2	45.3	74	28.7	107	64
19471.13	H/Z	56.0	-10.7	45.3	74	28.7	180	305

Table 44: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode A (2402MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4803.975	H/Z	47.5	-7.2	40.3	54	13.7	121	326
4804.396	V/Z	41.8	-7.2	34.6	54	19.4	200	131
7204.575	H/Z	40.5	-0.1	40.4	54	13.6	157	70
7206.939	V/Z	40.8	-0.1	40.7	54	13.3	100	273
7206.994	V/Z	44.8	-0.1	44.7	54	9.3	194	28
7309.758	H/Z	40.4	0.3	40.7	54	13.3	157	123
12012.03	V/Z	36.0	-5.2	30.8	54	23.2	107	64
19471.13	H/Z	41.4	-10.7	30.7	54	23.3	180	305

Table 45: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4880.180	V/Z	57.0	-6.9	50.1	74	23.9	171	116
4880.294	H/Z	56.4	-6.9	49.5	74	24.5	100	323
7321.015	H/Z	56.7	0.2	57.0	74	17.0	100	341
7321.013	V/Z	56.9	0.2	57.1	74	16.9	171	147
6864.826	H/Z	55.9	-1.4	54.5	74	19.5	164	152
6850.046	V/Z	55.2	-1.4	53.8	74	20.2	135	321
12206.64	V/Z	51.1	-5.5	45.6	74	28.4	183	298
19471.13	H/Z	56.0	-10.7	45.3	74	28.7	180	305

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Page 50 of 65**Table 46: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode B (2440MHz), 2Mbps**

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4880.180	V/Z	45.5	-6.9	38.6	54	15.4	171	116
4880.294	H/Z	44.5	-6.9	37.6	54	16.4	100	323
7321.015	H/Z	43.7	0.2	43.9	54	10.1	100	341
7321.013	V/Z	44.0	0.2	44.2	54	9.8	171	147
6864.826	H/Z	41.0	-1.4	39.6	54	14.4	164	152
6850.046	V/Z	40.9	-1.4	39.5	54	14.5	135	321
12206.64	V/Z	36.2	-5.5	30.7	54	23.3	183	298
19471.13	H/Z	41.4	-10.7	30.7	54	23.3	180	305

Table 47: [Model B] Radiated Emissions, Peak Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading PK [dB μ V]	Factor [dB(1/m)]	Level PK [dB μ V/m]	Limit [dB μ V/m]	Margin PK [dB]	Height [cm]	Angle [°]
4959.337	H/Z	57.4	-6.5	50.9	74	23.1	100	348
4959.635	V/Z	60.2	-6.5	53.7	74	20.3	179	28
7124.210	H/Z	54.0	-0.6	53.3	74	20.7	179	281
7295.611	V/Z	54.9	0.3	55.2	74	18.8	168	16
7438.616	H/Z	56.3	-0.3	56.0	74	18.0	104	294
7438.540	V/Z	55.0	-0.3	54.7	74	19.3	130	181
12401.54	V/Z	51.7	-7.2	44.5	74	29.5	192	151
19902.28	H/Z	55.4	-10.2	45.2	74	28.8	194	261

Table 48: [Model B] Radiated Emissions, Average Data, 1 - 25GHz, Horizontal and Vertical Antenna Orientations, Mode C (2480MHz), 2Mbps

Freq. [MHz]	ANT/EUT Orientation	Reading AV [dB μ V]	Factor [dB(1/m)]	Level AV [dB μ V/m]	Limit [dB μ V/m]	Margin AV [dB]	Height [cm]	Angle [°]
4959.337	H/Z	45.3	-6.5	38.8	54	15.2	100	348
4959.635	V/Z	49.8	-6.5	43.3	54	10.7	179	28
7124.210	H/Z	40.0	-0.6	39.4	54	14.6	179	281
7295.611	V/Z	40.2	0.3	40.5	54	13.5	168	16
7438.616	H/Z	44.7	-0.3	44.4	54	9.6	104	294
7438.540	V/Z	41.2	-0.3	40.9	54	13.1	130	181
12401.54	V/Z	37.1	-7.2	29.9	54	24.1	192	151
19902.28	H/Z	40.9	-10.2	30.7	54	23.3	194	261

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Operating Frequency [MHz]	Fundamental Level [dBm]	Band Edge Limit [dBm]	Band Edge Frequency [MHz]	Band Edge Level [dBm]	Margin [dB]
2402	-7.0	-27.0	2400.0	-57.2	30.2
2480	-3.3	-23.3	2483.5	-59.9	36.5

Table 50: [Model B] Band Edge, Modes A (2402MHz) and C (2480MHz), Restricted Band, 1Mbps, X axis

Operating Frequency [MHz]	Band Edge Frequency [MHz]	Average Limit [dBuV/m]	Peak Limit [dBuV/m]	Average Level [dBuV/m]	Peak Level [dBuV/m]	Average Margin [dB]	Peak Margin [dB]
2402	2390.0	54	74	46.2	56.9	7.8	17.1
2480	2483.5	54	74	46.8	57.3	7.2	16.7

Table 51: [Model B] Band Edge, Modes A (2402MHz) and C (2480MHz), -20dB Limit to Peak Power, 2Mbps, X axis

Operating Frequency [MHz]	Fundamental Level [dBm]	Band Edge Limit [dBm]	Band Edge Frequency [MHz]	Band Edge Level [dBm]	Margin [dB]
2402	-7.4	-27.4	2400.0	-38.0	10.5
2480	-7.2	-27.2	2483.5	-58.5	31.3

Table 52: [Model B] Band Edge, Modes A (2402MHz) and C (2480MHz), Restricted Band, 2Mbps, X axis

Operating Frequency [MHz]	Band Edge Frequency [MHz]	Average Limit [dBuV/m]	Peak Limit [dBuV/m]	Average Level [dBuV/m]	Peak Level [dBuV/m]	Average Margin [dB]	Peak Margin [dB]
2402	2390.0	54	74	46.2	56.9	7.8	17.1
2480	2483.5	54	74	48.5	60.0	5.5	14.0

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5.4 AC Power Line Conducted Measurements

5.4.1 AC Power Line Conducted Emission of Transmitter

RESULT:**PASS**

Date of testing: 2023-09-13

Ambient temperature: 24°C

Relative humidity: 67%

Atmospheric pressure: 1005hPa

Frequency range: 0.15 - 30MHz

Kind of test site: Shielded Room

Operation Modes: B

Configurations: 1M, 2M

Tested Models: Model A

Requirements:

FCC 15.207

The AC power line conducted emission on any frequency within the band 150kHz to 30MHz shall not exceed the limits specified in FCC 15.207.

Test procedure:

ANSI C63.10 §6.2

The EUT was placed on a wooden table raised 80cm above the reference ground plane. A vertical conducting plane of the screened room was located 40cm to the rear of the EUT. The AC adapter of the EUT was connected to a Line Impedance Stabilization Network (LISN).

The physical arrangement of the test system and associated cabling was varied to determine the effect on the EUT's emissions in amplitude and frequency in order to ensure that maximum emission amplitudes were attained.

The measurements were performed with a test receiver operating in the CISPR quasi-peak and average detection modes. The receiver's 6dB bandwidth was set to 9kHz.

Disturbances other than those mentioned are small or not detectable.

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0.15 - 30MHz, Phase N (N) and L1 (L), Mode B (2440MHz), 1Mbps**

Freq. [MHz]	Phase	Reading QP [dB μ V]	Reading AV [dB μ V]	Factor [dB]	Level QP [dB μ V]	Level AV [dB μ V]	Limit QP [dB μ V]	Limit AV [dB μ V]	Margin QP [dB]	Margin AV [dB]
0.254	N	29.8	24.1	9.8	39.6	33.9	61.6	51.6	22.0	17.7
0.254	L1	30.9	24.7	9.8	40.7	34.5	61.6	51.6	20.9	17.1
0.483	L1	19.8	19.5	9.8	29.6	29.3	56.3	46.3	26.7	17.0
0.484	N	23.7	23.6	9.8	33.5	33.4	56.3	46.3	22.8	12.9
0.564	N	21.7	21.4	9.8	31.5	31.2	56.0	46.0	24.5	14.8
0.886	N	23.6	20.5	9.7	33.3	30.2	56.0	46.0	22.7	15.8
1.253	L1	20.4	20.2	9.8	30.2	30.0	56.0	46.0	25.8	16.0
2.506	L1	21.8	20.3	9.8	31.6	30.1	56.0	46.0	24.4	15.9
4.385	N	23.2	22.1	9.9	33.1	32.0	56.0	46.0	22.9	14.0
11.746	N	36.4	33.9	10.1	46.5	44.0	60.0	50.0	13.5	6.0
12.217	L1	36.9	35.9	10.1	47.0	46.0	60.0	50.0	13.0	4.0
12.843	L1	37.0	35.8	10.1	47.1	45.9	60.0	50.0	12.9	4.1
13.156	L1	37.2	36.0	10.1	47.3	46.1	60.0	50.0	12.7	3.9
13.783	L1	37.0	36.1	10.1	47.1	46.2	60.0	50.0	12.9	3.8
13.783	L1	37.0	36.1	10.1	47.1	46.2	60.0	50.0	12.9	3.8
14.096	N	38.0	37.5	10.1	48.1	47.6	60.0	50.0	11.9	(*) 2.4
14.409	N	38.4	37.4	10.1	48.5	47.5	60.0	50.0	11.5	(*) 2.5
14.409	N	38.4	37.4	10.1	48.5	47.5	60.0	50.0	11.5	(*) 2.5
15.035	N	37.4	36.3	10.1	47.5	46.4	60.0	50.0	12.5	3.6
23.839	N	31.0	25.3	10.3	41.3	35.6	60.0	50.0	18.7	14.4
28.561	N	36.8	29.5	10.4	47.2	39.9	60.0	50.0	12.8	10.1
28.600	L1	35.9	28.2	10.3	46.2	38.5	60.0	50.0	13.8	11.5
0.254	N	29.8	24.1	9.8	39.6	33.9	61.6	51.6	22.0	17.7
0.254	L1	30.9	24.7	9.8	40.7	34.5	61.6	51.6	20.9	17.1
0.483	L1	19.8	19.5	9.8	29.6	29.3	56.3	46.3	26.7	17.0
0.484	N	23.7	23.6	9.8	33.5	33.4	56.3	46.3	22.8	12.9

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

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Page 55 of 65**Table 54: AC Power Line Conducted Emission, Quasi Peak and Average Data,
0.15 - 30MHz, Phase N (N) and L1 (L), Mode B (2440MHz), 2Mbps**

Freq. [MHz]	Phase	Reading QP [dB μ V]	Reading AV [dB μ V]	Factor [dB]	Level QP [dB μ V]	Level AV [dB μ V]	Limit QP [dB μ V]	Limit AV [dB μ V]	Margin QP [dB]	Margin AV [dB]
0.254	N	29.9	24.3	9.8	39.7	34.1	61.6	51.6	21.9	17.5
0.254	L1	30.9	24.6	9.8	40.7	34.4	61.6	51.6	20.9	17.2
0.254	L1	31.0	24.8	9.8	40.8	34.6	61.6	51.6	20.8	17.0
0.483	L1	19.7	19.3	9.8	29.5	29.1	56.3	46.3	26.8	17.2
0.484	N	23.7	23.6	9.8	33.5	33.4	56.3	46.3	22.8	12.9
0.564	N	21.8	21.5	9.8	31.6	31.3	56.0	46.0	24.4	14.7
0.806	N	23.1	22.9	9.7	32.8	32.6	56.0	46.0	23.2	13.4
2.193	L1	21.2	19.9	9.8	31.0	29.7	56.0	46.0	25.0	16.3
2.506	L1	21.6	20.2	9.8	31.4	30.0	56.0	46.0	24.6	16.0
11.590	L1	35.5	33.9	10.1	45.6	44.0	60.0	50.0	14.4	6.0
12.843	L1	36.8	35.7	10.1	46.9	45.8	60.0	50.0	13.1	4.2
13.156	N	37.1	36.0	10.1	47.2	46.1	60.0	50.0	12.8	3.9
13.470	L1	36.7	36.1	10.1	46.8	46.2	60.0	50.0	13.2	3.8
13.783	N	38.1	37.3	10.1	48.2	47.4	60.0	50.0	11.8	(*) 2.6
13.783	N	38.1	37.4	10.1	48.2	47.5	60.0	50.0	11.8	(*) 2.5
13.783	L1	37.0	36.1	10.1	47.1	46.2	60.0	50.0	12.9	3.8
14.096	N	38.0	37.5	10.1	48.1	47.6	60.0	50.0	11.9	(*) 2.4
14.409	N	38.4	37.4	10.1	48.5	47.5	60.0	50.0	11.5	(*) 2.5
15.036	L1	36.1	34.4	10.1	46.2	44.5	60.0	50.0	13.8	5.5
15.036	N	37.6	36.4	10.1	47.7	46.5	60.0	50.0	12.3	3.5
17.385	L1	34.2	33.2	10.2	44.4	43.4	60.0	50.0	15.6	6.6
20.480	L1	33.0	28.6	10.2	43.2	38.8	60.0	50.0	16.8	11.2
23.854	L1	30.1	24.4	10.2	40.3	34.6	60.0	50.0	19.7	15.4
26.641	N	34.5	28.0	10.3	44.8	38.3	60.0	50.0	15.2	11.7
28.480	L1	36.2	29.7	10.3	46.5	40.0	60.0	50.0	13.5	10.0
28.520	N	37.0	30.2	10.4	47.4	40.6	60.0	50.0	12.6	9.4

Note: Level QP = Reading QP + Factor, Level AV = Reading AV + Factor

(*) The measured result is below the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to determine compliance at a level of confidence of 95%. However, the measured result indicates a high probability that the tested product complies with the specification limit.

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