

Test Report No.:	DE21CTNK 001	Order No.:	7974615	Page 1 of 102
Order date:	01-03-2021			
Client:	ABAX AS – Hammergata 20, 3264 Larvik, Norway			
Test item:	BLE tracker			
Identification / Type No.:	MINI2			
FCC ID:	2A2EO-MINI2			
Trademark:	ABAX			
Order content:	Full tests according to the following standard:			
Test specification:	FCC Cfr 47 part 15 – Subpart C - §15.247			
Date of receipt:	22-04-2021			
Test sample No.:	Storage no.: A003039511-001 to 003			
Testing period:	08-06-2021 ÷ 17-06-2021			
Place of testing:	TÜV Rheinland Italia S.r.l. Via E. Mattei, 3 20005 Pogliano Milanese (MI) - IT			
Testing laboratory:	TÜV Rheinland Italia S.r.l. Via E. Mattei,3 20005 Pogliano Milanese (MI) - IT			
Test result:	Pass			
Tested by:	Roberto Radice 	Authorized by:	Giovanni Molteni 	
Date:	30-06-2021	Date:	30-06-2021	
Position	(Laboratory technician) Expert	Position	(Laboratory manager) Expert	
Other:	---			
Condition of the test item at delivery:	Test item complete and undamaged			
This test report only 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.				

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1	The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.
2	As contractually agreed, this document has been signed digitally only. TÜV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TÜV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged.
3	Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report. Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.
4	The measurement uncertainty of the measurement procedures listed in this test report does not include the compliance of the respective limit values / operating conditions. For emission tests the requirements, CISPR 16-4-2 / EN55016-4-2 (chapter 4.2) apply in their current form.
5	Unless otherwise agreed with the customer, a conformity assessment is always carried out based on the applied standards. At the customer's request, the statement on the conformity of the product tested in this test report is carried out according to the criteria/requirements of the applied standards. Evaluation conditions deviating from these are documented separately in the respective chapters.

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6	Description	BLE tracker
7	Model name	MINI2
8	Serial number	Not present
9	Manufacturer	Norautron - Nedre vei 8, 3183 Horten, Norway
10	Trademark	ABAX
11	Power supply	Coin Cell Battery 3V 220mAH
12	Rated voltage	3V
13	Rated frequency	D.C.
14	Rated current	220mAH
15	Maximum power consumption	----
16	Modulation type	☐ Frequency hopping (FHSS) equipment ☒ Wideband data transmission (non-FHSS equipment) ☐ Direct Sequence Spread Spectrum (DSSS equipment) ☐ Others:
17	Hardware version	Mini 2 rev. 2
18	Software version	1.0.0
19	Dimensions	19x43x6.5 mm
20	Weight	25g
21	Test sample obtaining	☐ Sampling by customer ☒ Sampling by TÜV Rheinland Group ☐ others:

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Applied basic standards

Reference document

Title 47 Part 15 Subpart C	Radio Frequency Device – Intentional Radiators
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Title 47 Part 15 Subpart C § 15.203	Radio frequency devices – Intentional Radiators Antenna requirement
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Title 47 Part 15 Subpart C § 15.205	Radio frequency devices – Intentional Radiators Restricted bands of operation
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Title 47 Part 15 Subpart C § 15.207	Radio frequency devices – Intentional Radiators Conducted Limits
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Title 47 Part 15 Subpart C § 15.209	Radio frequency devices – Intentional Radiators Radiated Emissions Limits
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Title 47 Part 15 Subpart C § 15.247	Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
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558074 D01 DTS Meas Guidance v05r02 - April 02,2019	Guidance for performing compliance measurements on digital transmission systems (DTS) operating under §15.247
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ANSI C63.4	2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
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ANSI C63.10	2020	American National Standard for Testing Unlicensed Wireless Devices
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23 *Equipment used during test*
Equipment under test

No.	Product type	Manufacturer	Model	Comments
1	BLE Tracker	ABAX	MINI2	None

Auxiliary Equipment / Peripherals

No.	Product type	Manufacturer	Model	Comments
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24 *Input/Output ports*

No.	Name	Type	Cable length	Cable shielded	Comments
1	Enclosure	Non-conductive surface	—	—	IP67 enclosure
2	AC power port	Port not present			
3	DC power port	Coin Cell Battery 3V 220mAH	N.A. Internal battery	---	---
4	I/O port	Port not present			
5	Telecommunication port	Port not present			

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25 *Used radio technologies and frequencies*

Radio Type	☒ Transceiver ☐ Receiver only
Radio technology	☐ Short – Range Device ☐ WiFi ☒ Bluetooth Low Energy ☐ GPS / GNSS ☐ GSM/ GPRS (2G) ☐ UTRA (UMTS, 3G) ☐ E-UTRA (LTE, 4G) ☐ Other: ZigBee
Equipment type	☒ Without audio speech (data only) ☐ With audio speech
Antenna type	☐ External (dedicated antenna) ☒ Intergrated antenna
Short –Range Band / Frequency	---
WiFi Channel / Frequency	---
Bluetooth Channel / Frequency	2400 – 2483.5MHz Frequency Band 2402 – 2480 MHz Frequency Range
GPS / GNSS Band / Frequency	---
GSM Bands / Frequency	---
Utra Bands / Frequency	---
E-Utra Bands / Frequency	---
Other Bands / Frequency	---

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26	<i>Radio module identification (technical data of the Bluetooth low energy)</i>	
	Module manufacturer	Nordic Semiconductor
	Module type	System-on-Chip (SoC) model nRF52820
	Frequency Band	2402 – 2480MHz
	Number of channel	40
	Channel bandwidth	1MHz
	Channel Separation	2MHz
	Modulation	GFSK
	Antenna	PCB antenna/Integrated Antenna
	Antenna Gain	Values provided by applicant: • 2402 MHz: 5.35 dBi • 2430 MHz: 5.83 dBi • 2460 MHz: 5.74 dBi • 2480 MHz: 5.92 dBi

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27 Operating modes

No. Description

- | | |
|----------|--|
| 1 | Continuous BLE Modulation RF Transmission (duty cycle >98%), at Low channel (frequency: 2402MHz) at 1Mb/s |
| 2 | Continuous BLE Modulation RF Transmission (duty cycle >98%), at Middle channel (frequency: 2440MHz) at 1Mb/s |
| 3 | Continuous BLE Modulation RF Transmission (duty cycle >98%), at High channel (frequency: 2480MHz) at 1Mb/s |

For details see the corresponding protocol

28 Channel list Bluetooth Low Energy

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

For details see the corresponding protocol

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29 Summary of tests result

Port	Test	Operating condition	Result
Enclosure	Radiated emission (9KHz – 25GHz)	1, 2, 3	PASS
AC mains power port	Conducted emission	/	Test not applicable – Battery supplied
Antenna connector	Antenna requirement	1, 2, 3	PASS
	RF power output (conducted) for systems using digitally modulation	1, 2, 3	PASS
	6 dB minimum Bandwidth	1, 2, 3	PASS
	Out-of-band emissions	1, 2, 3	PASS
	100 kHz Bandwidth of Frequency Band Edges	1, 2, 3	PASS
	Power Spectral Density	1, 2, 3	PASS
	Additional provisions to the general radiated emission limitations	1, 2, 3	PASS

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu\text{V/m} = 10^{\frac{\text{dB}\mu\text{V/m} - 20}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

$$25 \text{ dBuV/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dBuV/m}$$

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30	<i>EUT configuration</i>										
	<i>The test setup was made in accordance with mentioned standards.</i> <i>Measurements and tests were executed under "worst case" conditions. Typical EUT arrangements or operating modes were chosen or assumed which let suspect maximum emission or susceptibility (a so called "unfavourable configuration").</i> <i>Details of test setup or adjustments are (particularly) shown inside the photo documentation.</i> <i>As far as not mentioned otherwise these statements are valid for all following tests.</i>										
31	<i>Climatic conditions</i>										
	<table> <tr> <td><i>Ambient Temperature</i></td><td>15 - 35 °C</td><td>22°</td></tr> <tr> <td><i>Relative Humidity</i></td><td>30 - 60 %</td><td>45%</td></tr> <tr> <td><i>Air pressure</i></td><td>860 - 1060 mbar</td><td>1012</td></tr> </table>		<i>Ambient Temperature</i>	15 - 35 °C	22°	<i>Relative Humidity</i>	30 - 60 %	45%	<i>Air pressure</i>	860 - 1060 mbar	1012
<i>Ambient Temperature</i>	15 - 35 °C	22°									
<i>Relative Humidity</i>	30 - 60 %	45%									
<i>Air pressure</i>	860 - 1060 mbar	1012									

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32 Statement of the measurement uncertainty

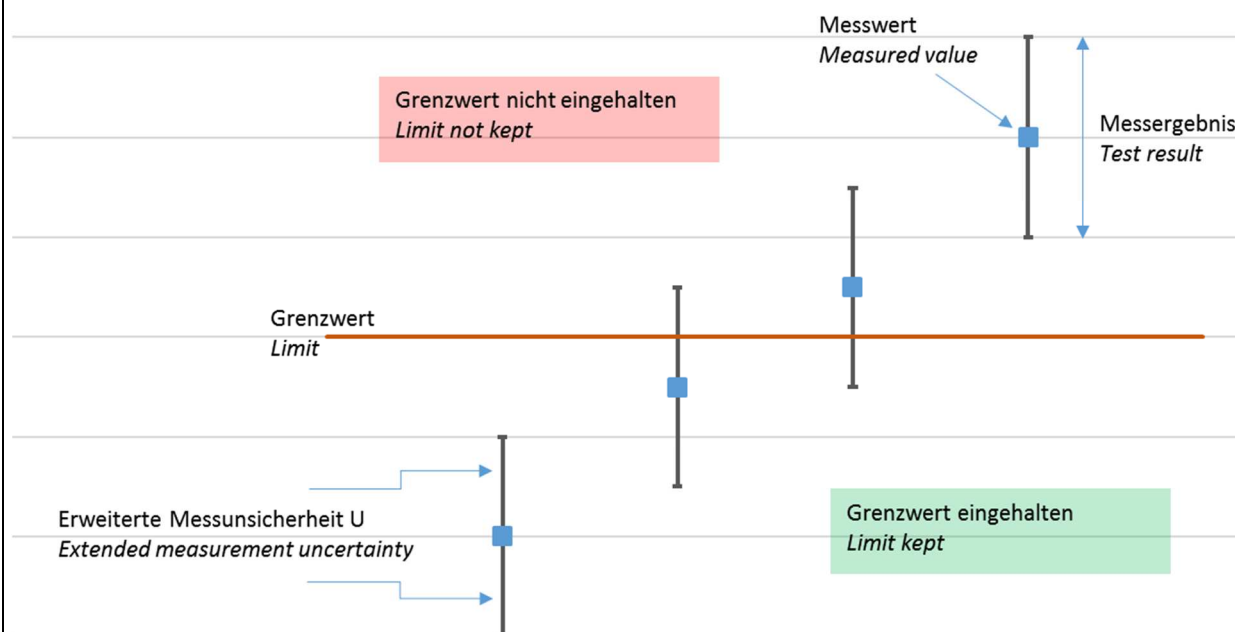
The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the quality system acc. to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation.

The manufacturer has the sole responsibility of continued compliance of the device.

Test Method	Uncertainty (95%)	Coverage factor k
RF Conducted discontinuous emissions - range (150 kHz - 30MHz)	3,3 dB	2,0
RF Radiated emissions – range (30 – 1000) MHz	4,9 dB	2,0
RF Radiated emissions – range (1 – 8) GHz	5,1 dB	2,0
RF Radiated emissions – range (8 – 40) GHz	5,4 dB	2,0
Carrier Power (conducted) (1 – 8) GHz	1,5 dB	2,0
Occupied Bandwidth (OBW) (conducted)	514.4 x 1.00 ⁻⁹	2,0
Power Spectral Density (PSD) (conducted)	1,5 dB	2,0
Transmitter unwanted emissions (conducted) range (0 – 1) GHz	0.92 dB	2,0
Transmitter unwanted emissions (conducted) range (1 – 8) GHz	1,5 dB	2,0
Transmitter unwanted emissions (conducted) range (8 – 40) GHz	2,4 dB	2,0

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33 Example for interpretation of measuring results


Measured value	Limit	Extended measurement uncertainty (k=2)	Test result
48.9 dB μ V @ 16.5 MHz	50 dB μ V	2.2 dB	46.7 dB μ V – 51.1 dB μ V

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REVISION HISTORY

34	Change history		
	Test report number	List of revisions	Date
	DE21CTNK 001	First edition	30-06-2021

ADDITIONAL DOCUMENTATION
EMISSION TEST
Radiated emission test (9KHz – 25GHz)

Test date	08-06-2021 ÷ 09-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.205; §15.209; §15.247
Test method	Par. 8.6 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 11.12.1 Radiated emission measurements of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.	N°3 Sample tested (1 for each frequency)
Operating mode	1, 2, 3
Tested terminals	Enclosure
Result	PASS

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

Remark: In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is:

Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(300m/3m) (Below 30MHz)

Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(30m/3m) (Below 30MHz)

ADDITIONAL DOCUMENTATION
Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
Semi-anechoic Chamber	ETS Lindgren	FACT3	2782378	05/2020	05/2022
Active Loop Antenna	Rohde&Schwarz	HFH2-Z2E	9015215	05/2020	05/2023
BiConiLog Antenna	ETS Lindgren	3142-E	2782348	08/2020	08/2023
Antenna Horn with external Preamplifier	ETS Lindgren	3117-PA	2782349	08/2020	08/2023
Antenna Horn with external Preamplifier	ETS Lindgren	3160-09	2782350	09/2020	09/2023
Highpass Filter	Wainwright Instr.	WHKX10-2520-2800-180	2782704	12/2019	12/2021
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021
EMI Receiver	Rohde&Schwarz	ESR3	2782768	01/2021	01/2022
Software EMC32	Rohde&Schwarz	10.60.15	---	---	---

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

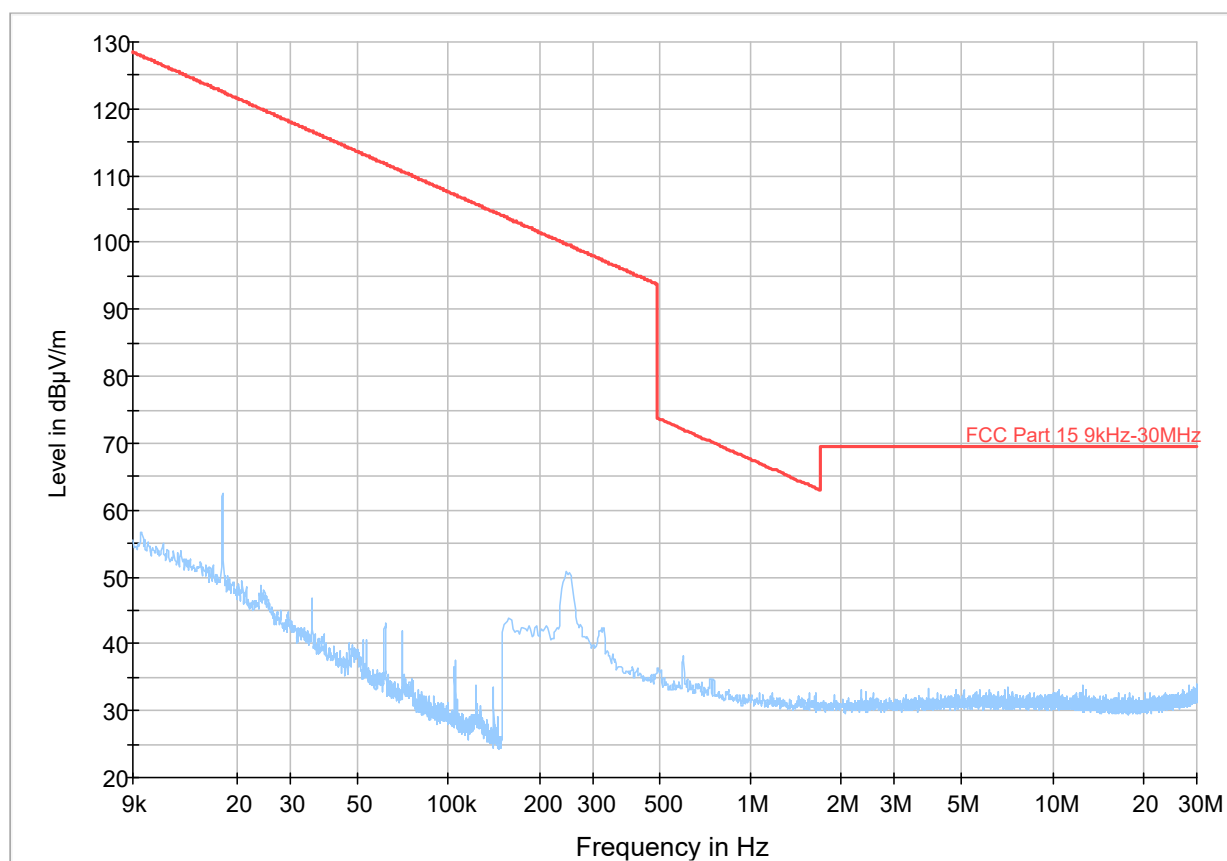
Frequency: 9KHz-30MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: X

Full Spectrum



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

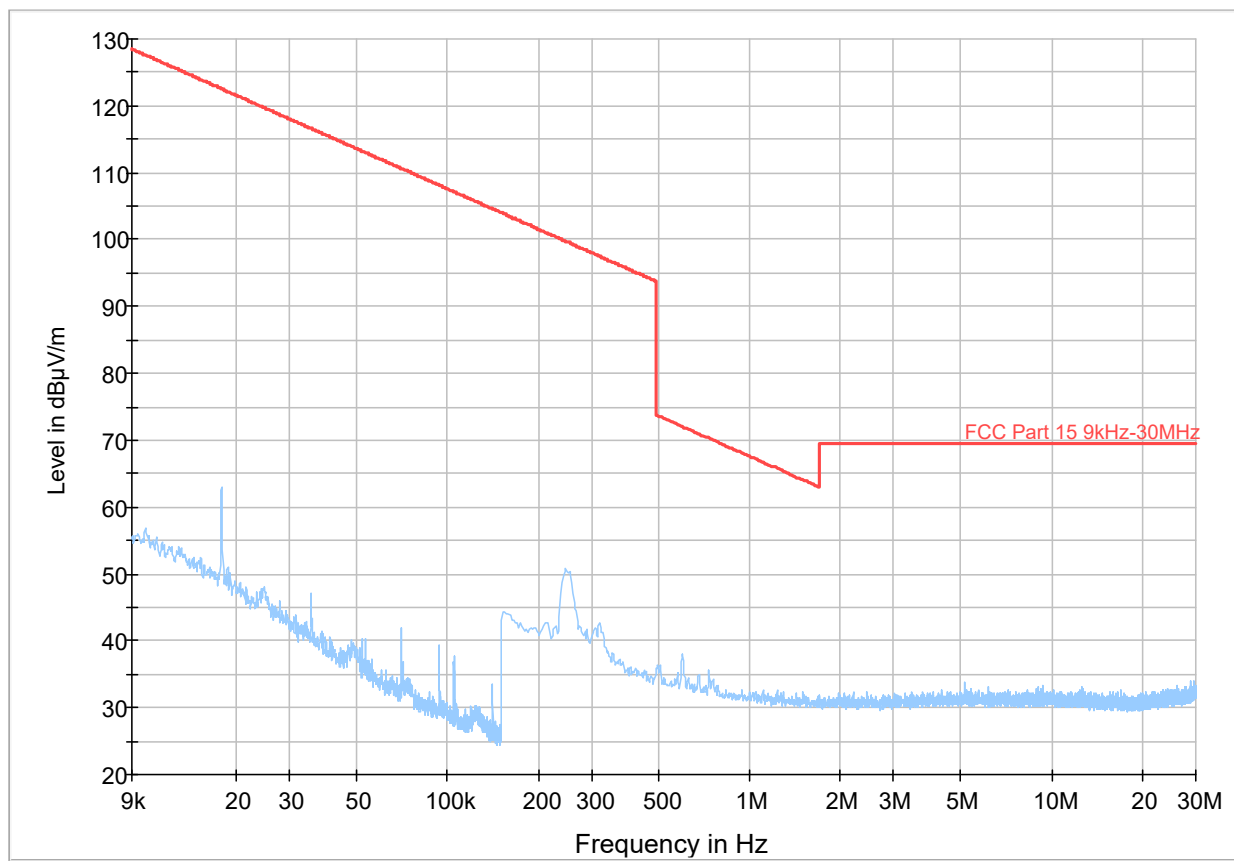
Frequency: 9KHz-30MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: Y

Full Spectrum





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

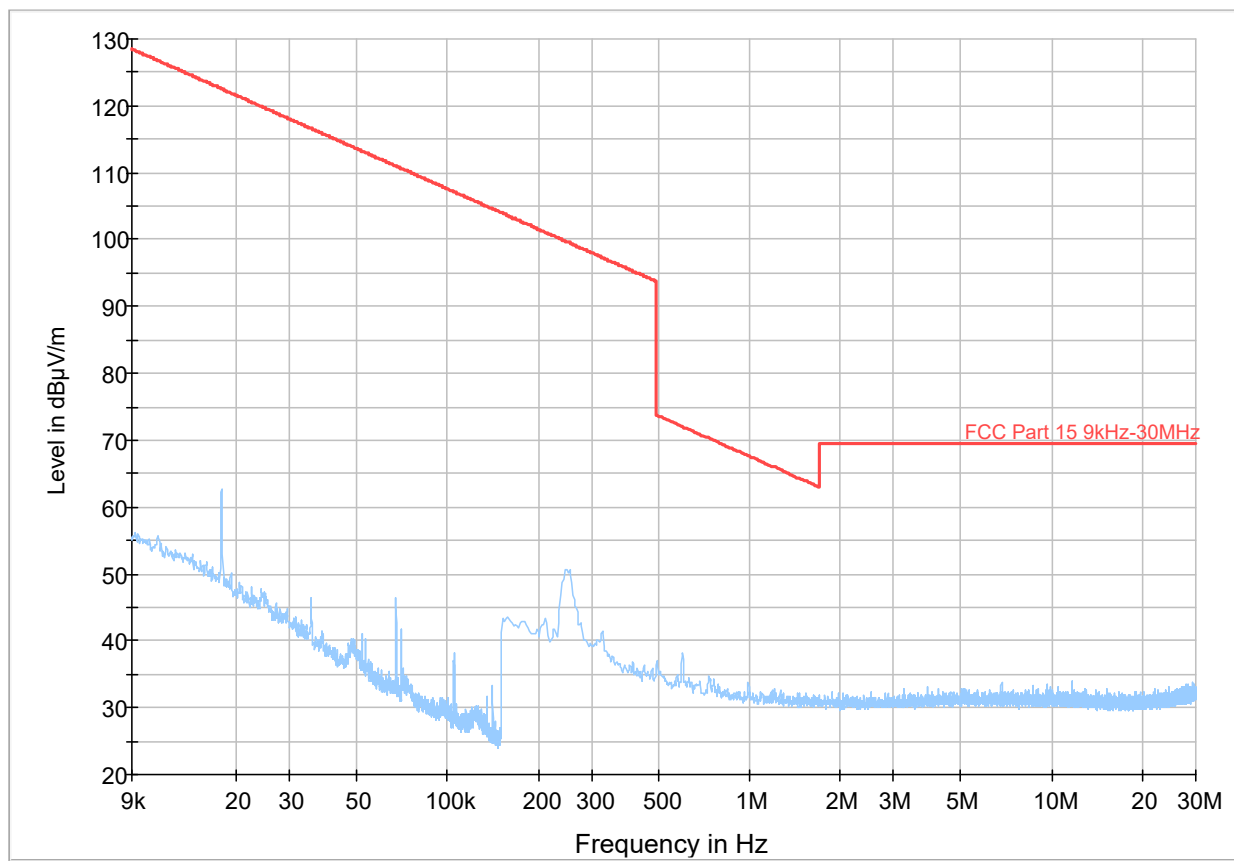
Frequency: 9KHz-30MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: Z

Full Spectrum



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (worst case)

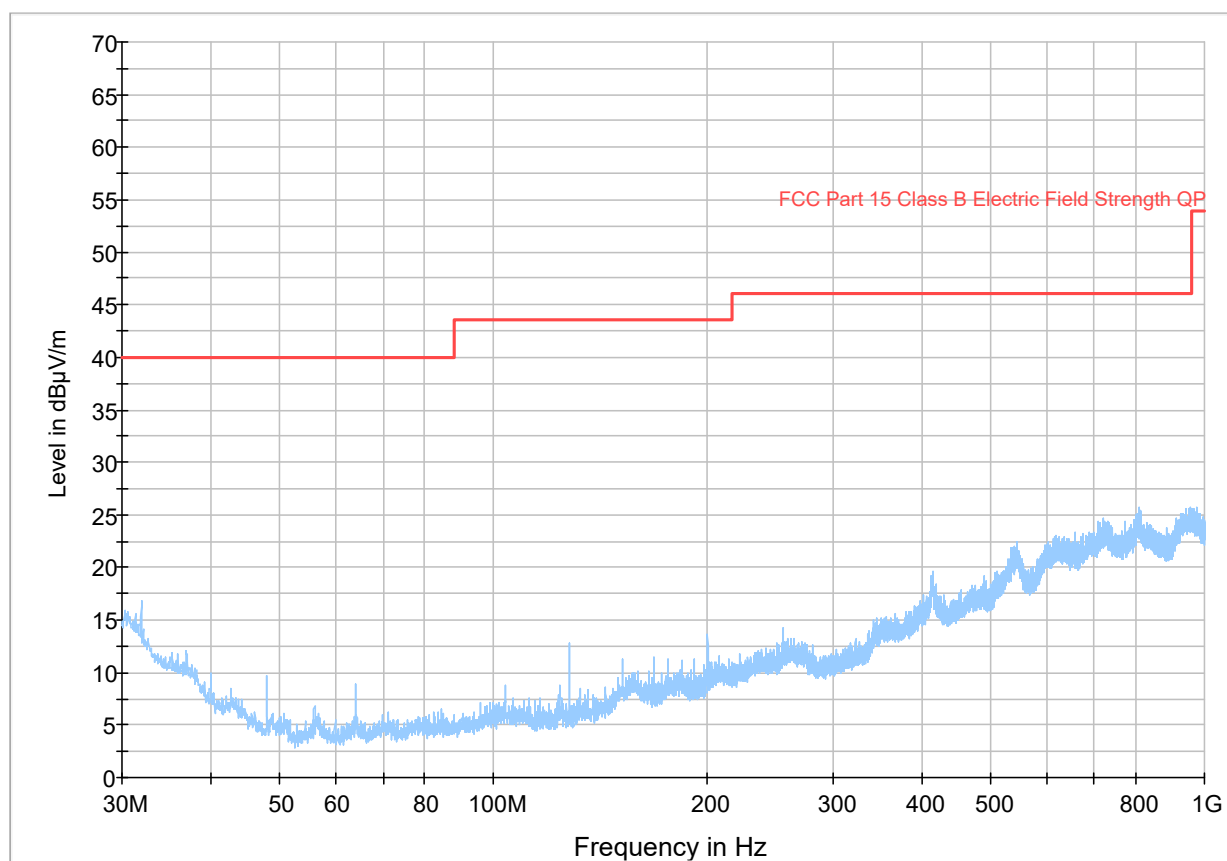
Frequency: 30-1000MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: X

Full Spectrum



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (worst case)

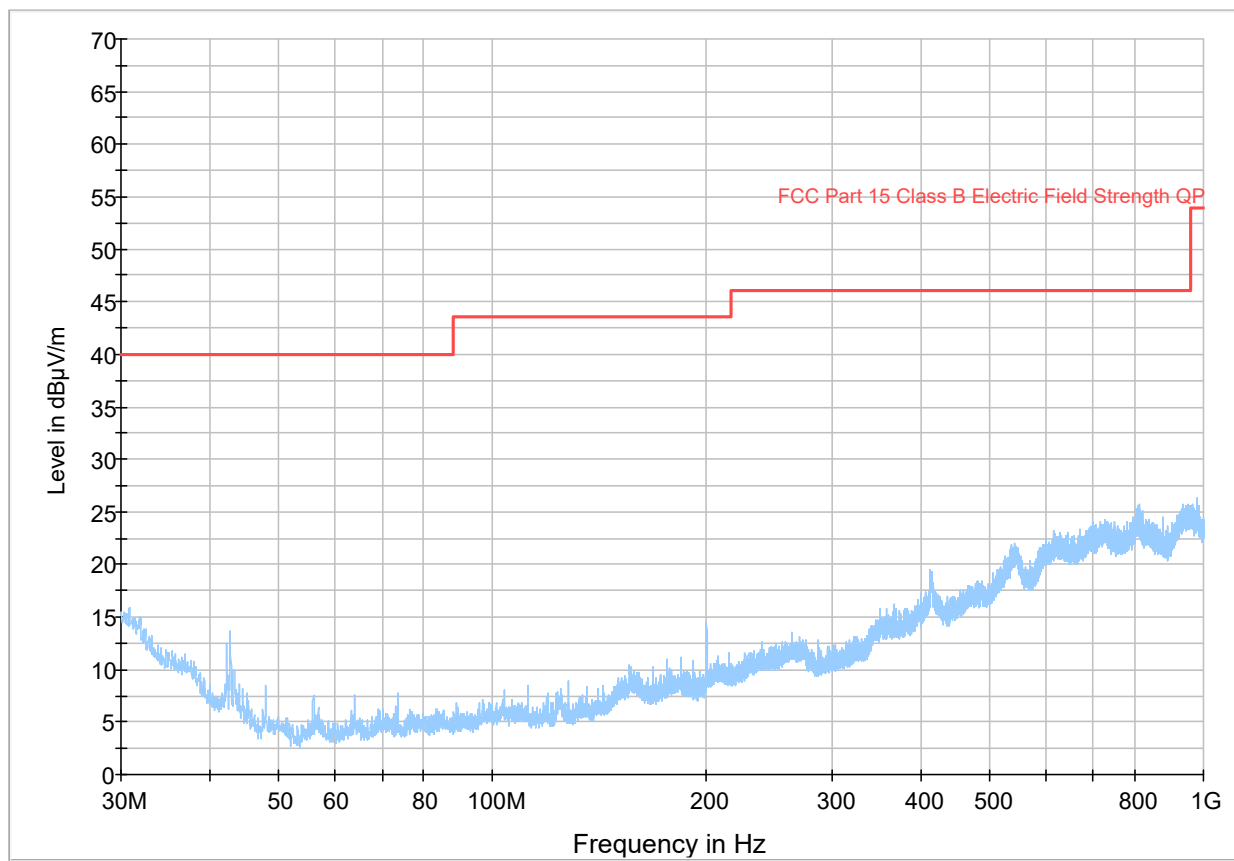
Frequency: 30-1000MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: Y

Full Spectrum



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (worst case)

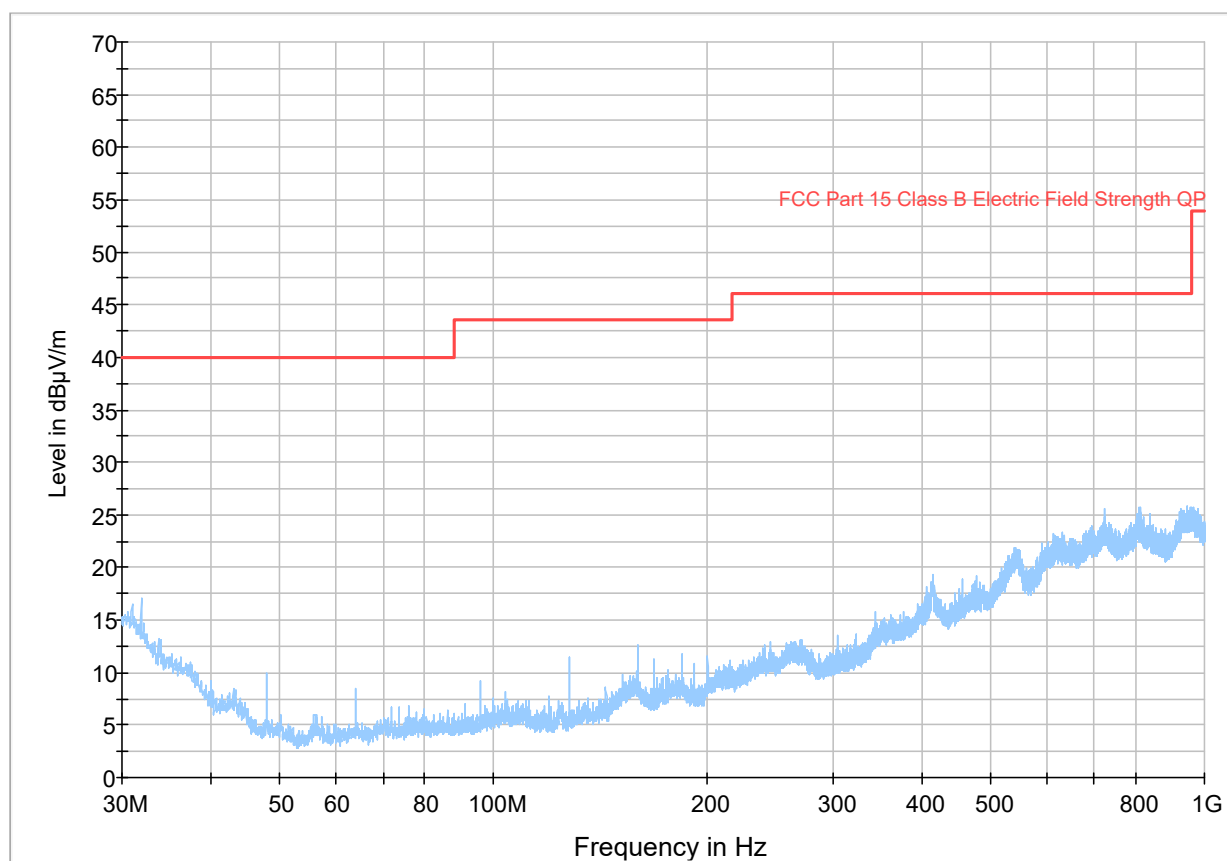
Frequency: 30-1000MHz

Trace: Peak (blue trace)

Measurement distance: 3m.

Axis: Z

Full Spectrum





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

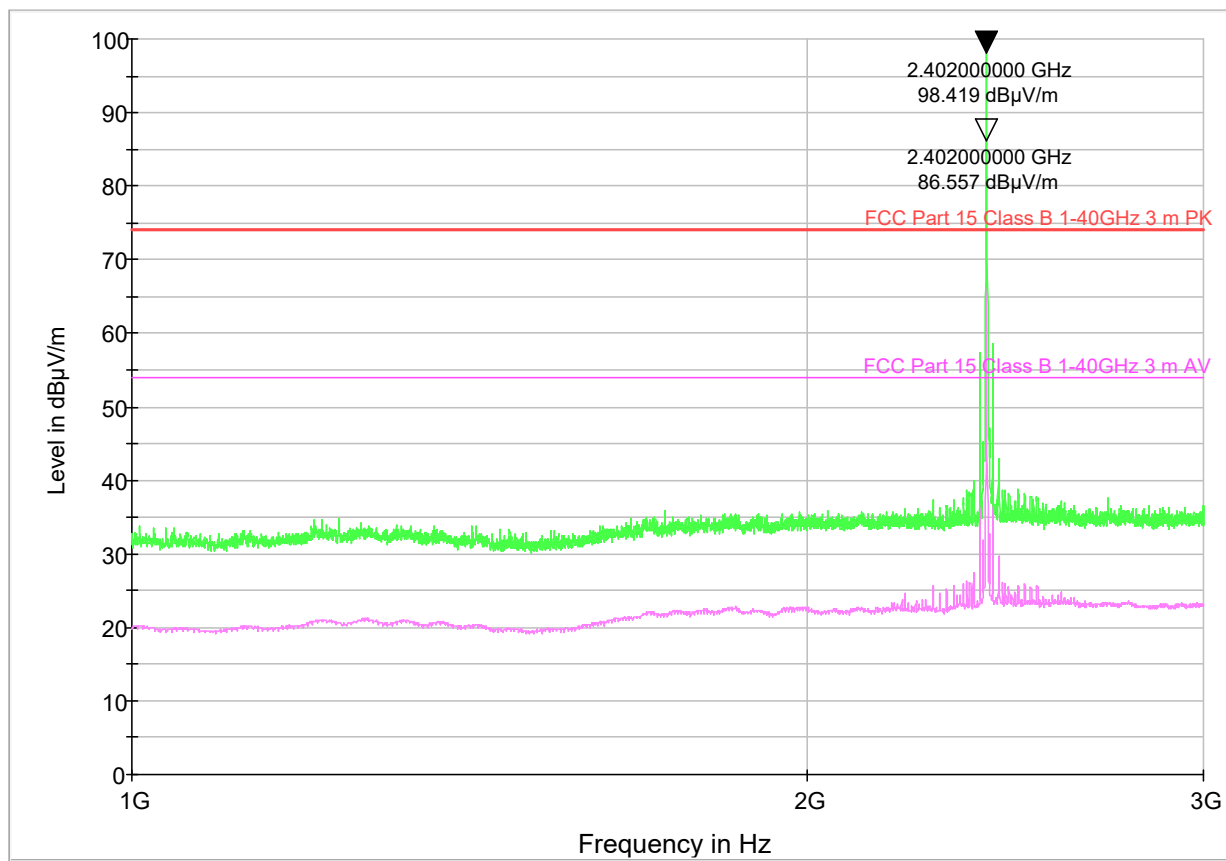
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2402	108.359	-13.23	3.29	98.419

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2402	96.479	-13.23	3.29	86.557

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

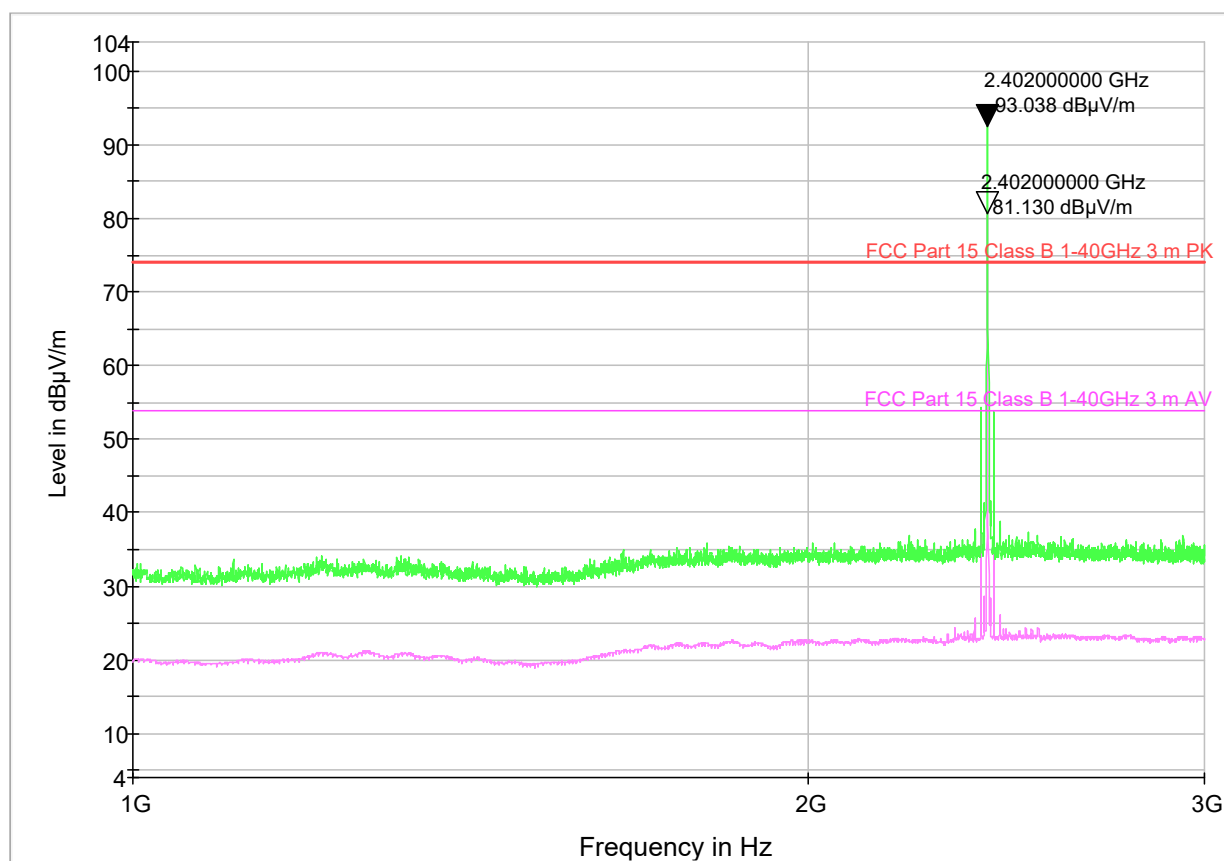
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2402	102.978	-13.23	3.29	93.038

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2402	91.070	-13.23	3.29	81.130



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

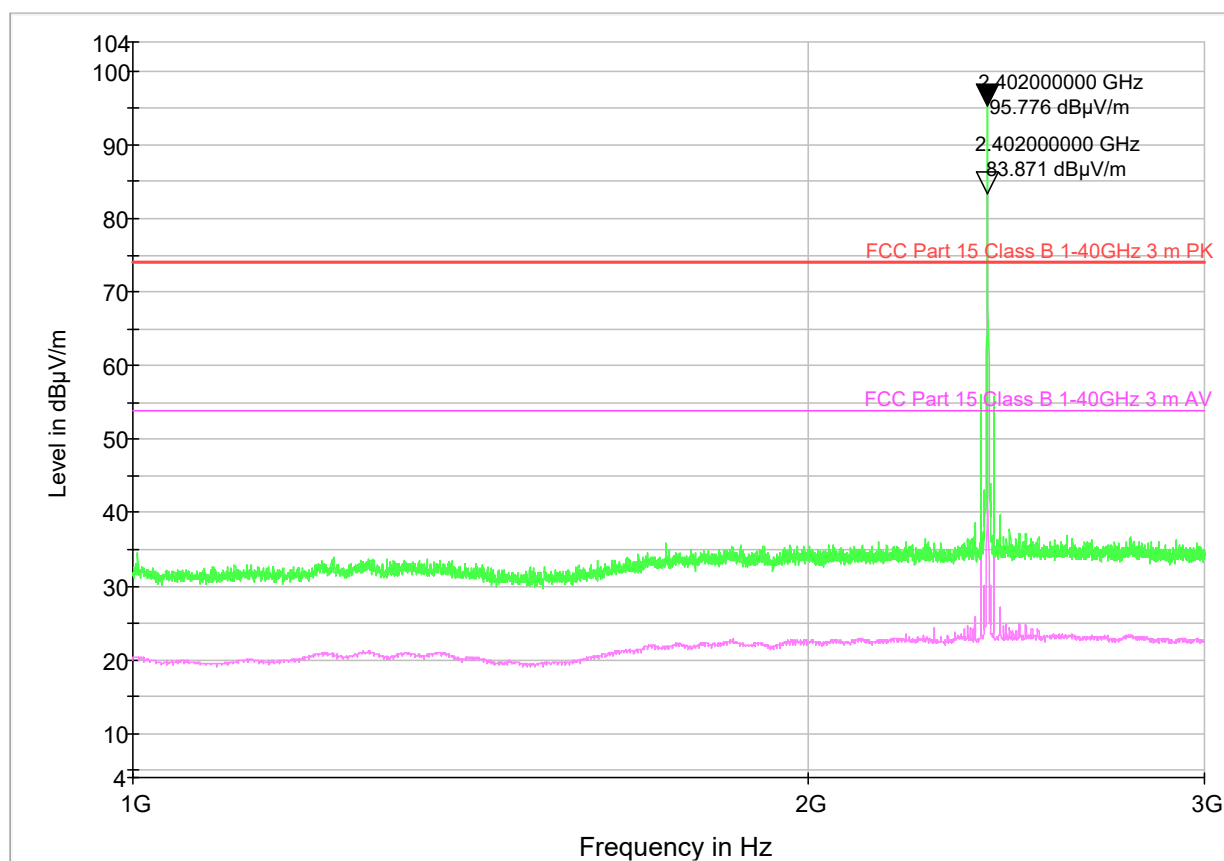
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2402	105.716	-13.23	3.29	95.776

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2402	93.811	-13.23	3.29	83.871

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

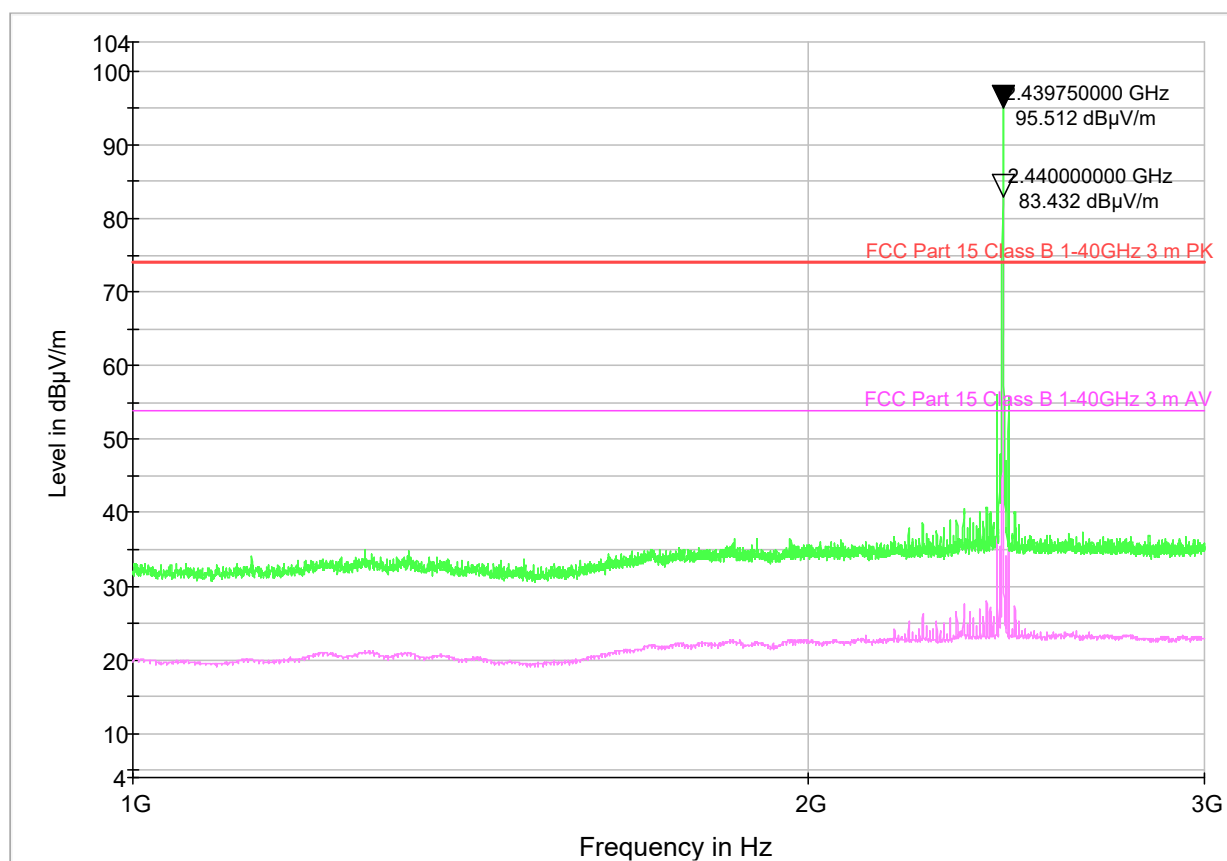
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2440	105.452	-13.26	3.32	95.512

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2440	93.372	-13.26	3.32	83.432



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

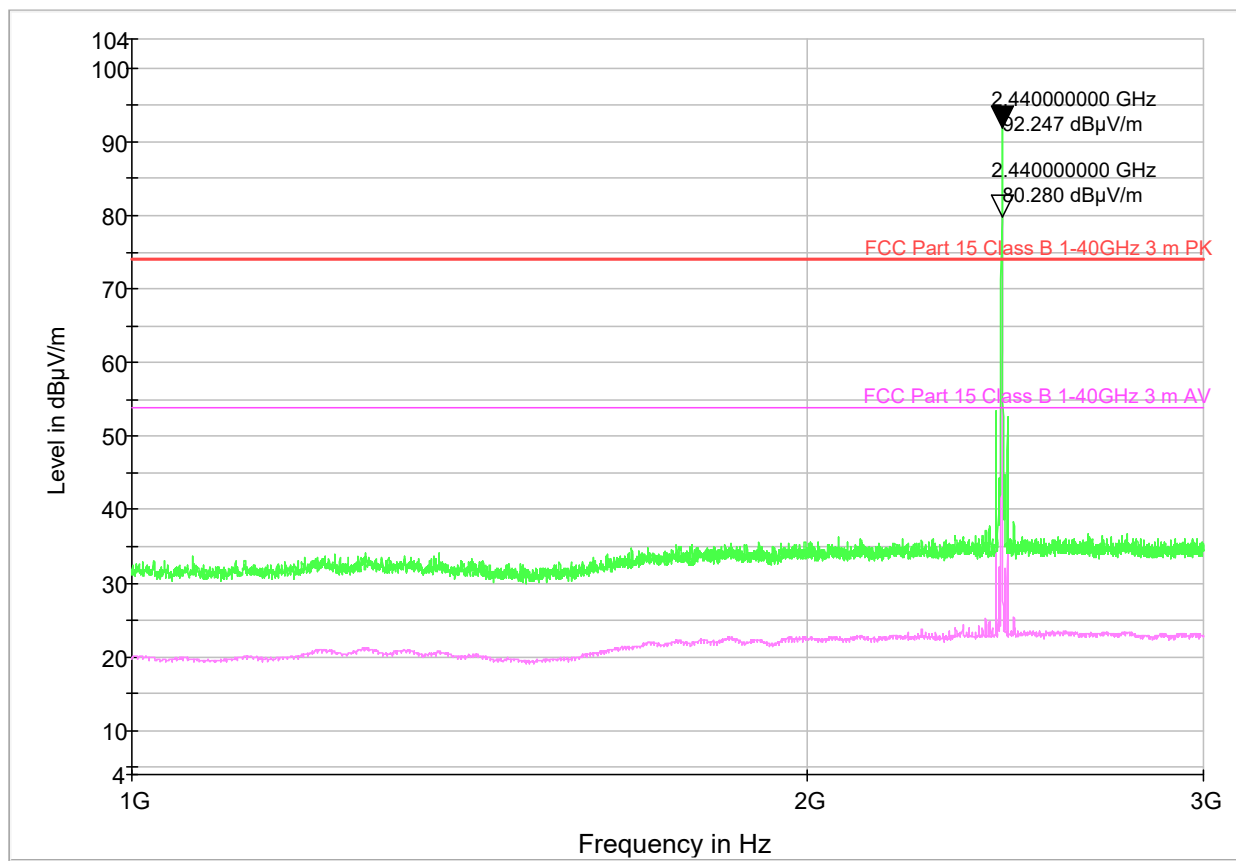
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2440	102.187	-13.26	3.32	92.247

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2440	90.220	-13.26	3.32	80.280



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

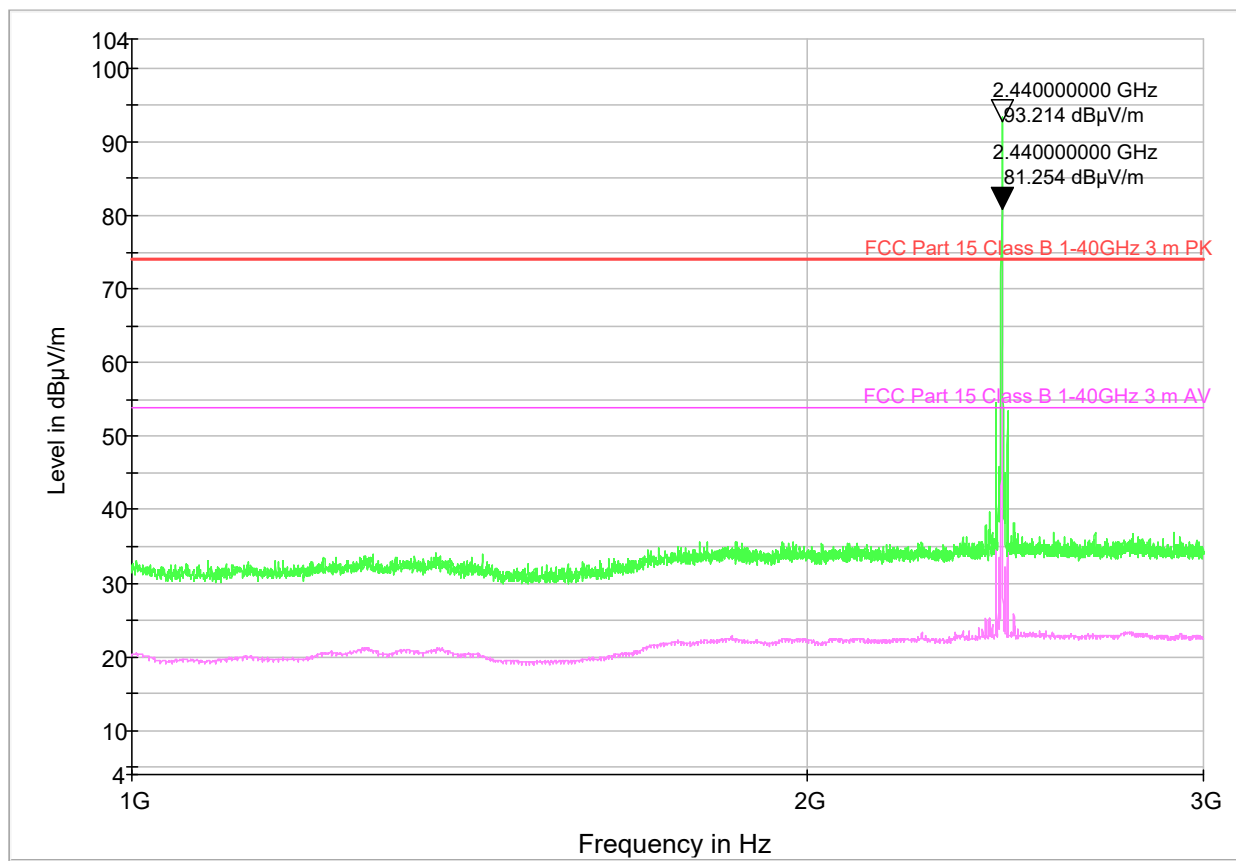
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2440	103.154	-13.26	3.32	93.214

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2440	91.194	-13.26	3.32	81.254



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

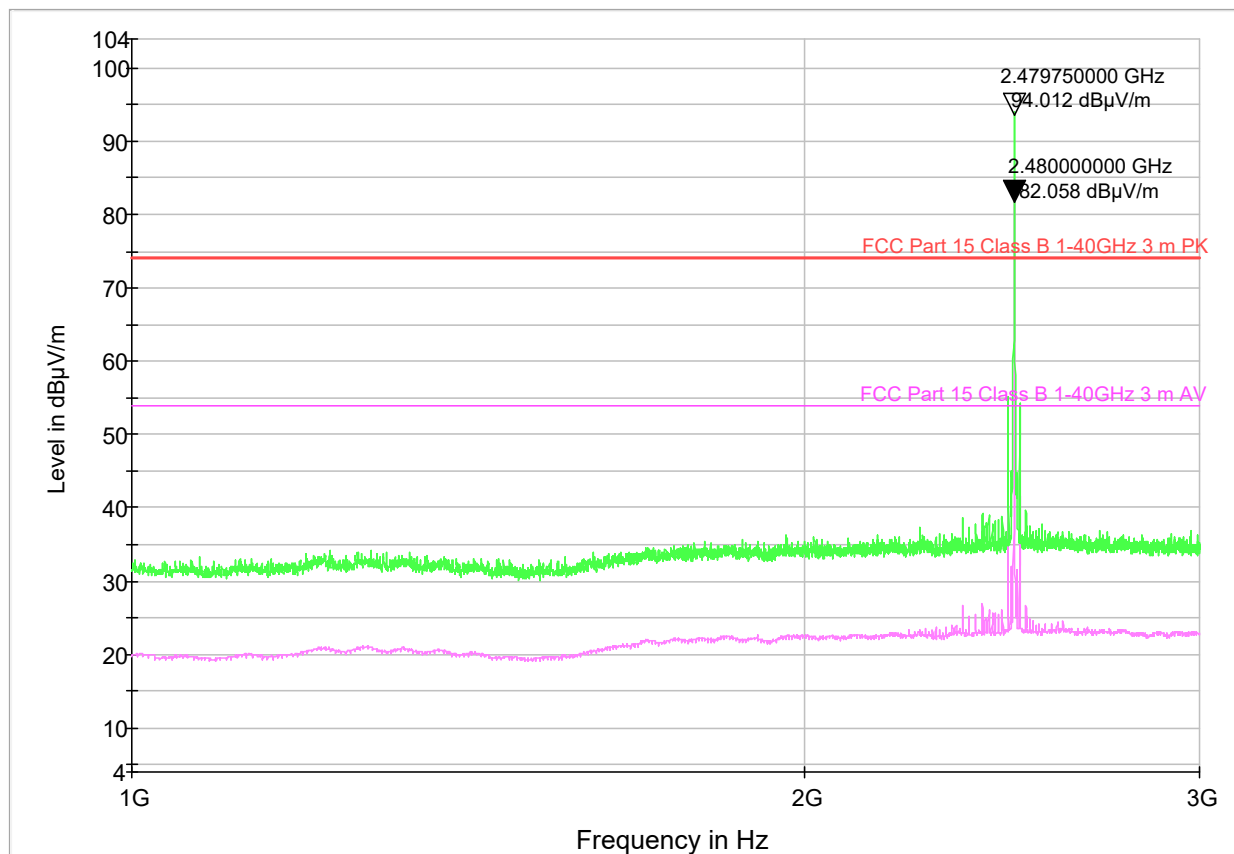
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2480	103.682	-13.02	3.35	94.012

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2480	91.728	-13.02	3.35	82.058



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

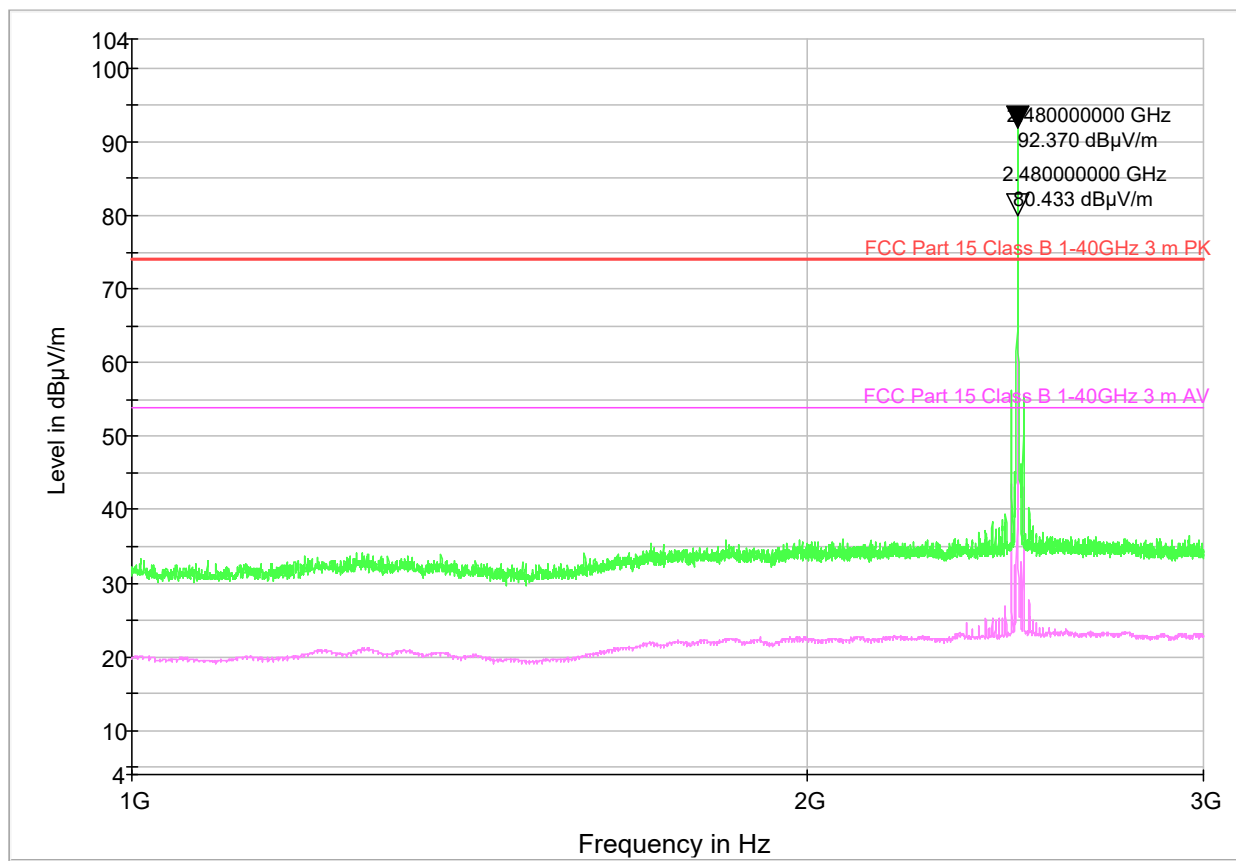
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2480	102.040	-13.02	3.35	92.370

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2480	90.103	-13.02	3.35	80.433



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

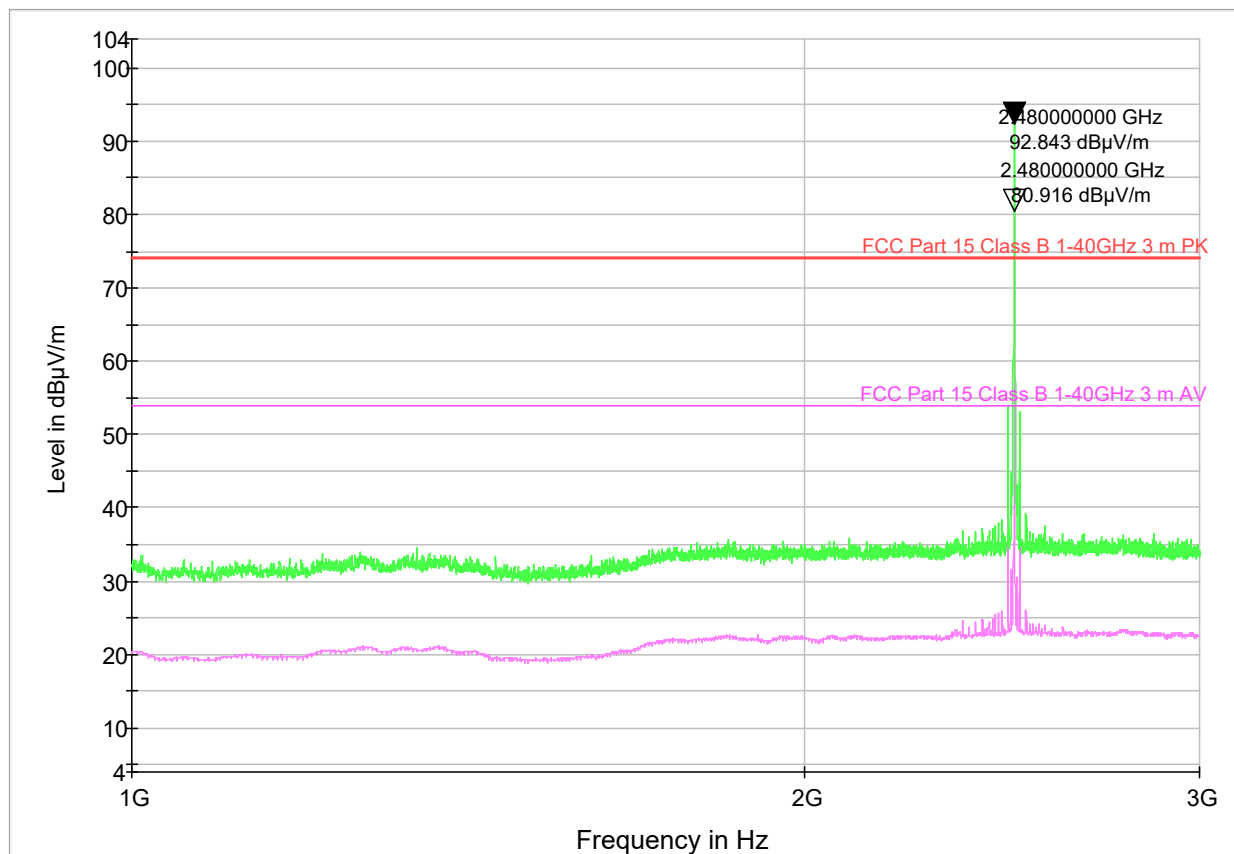
Frequency: 1000-3000MHz

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC



NOTE: Peak out of limits is Bluetooth fundamental frequency, this peak fall into the Exclusion Band and is not evaluated in this test.

ADDITIONAL DOCUMENTATION
FUNDAMENTAL LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2480	102.513	-13.02	3.35	92.843

FUNDAMENTAL LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2480	90.586	-13.02	3.35	80.916



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

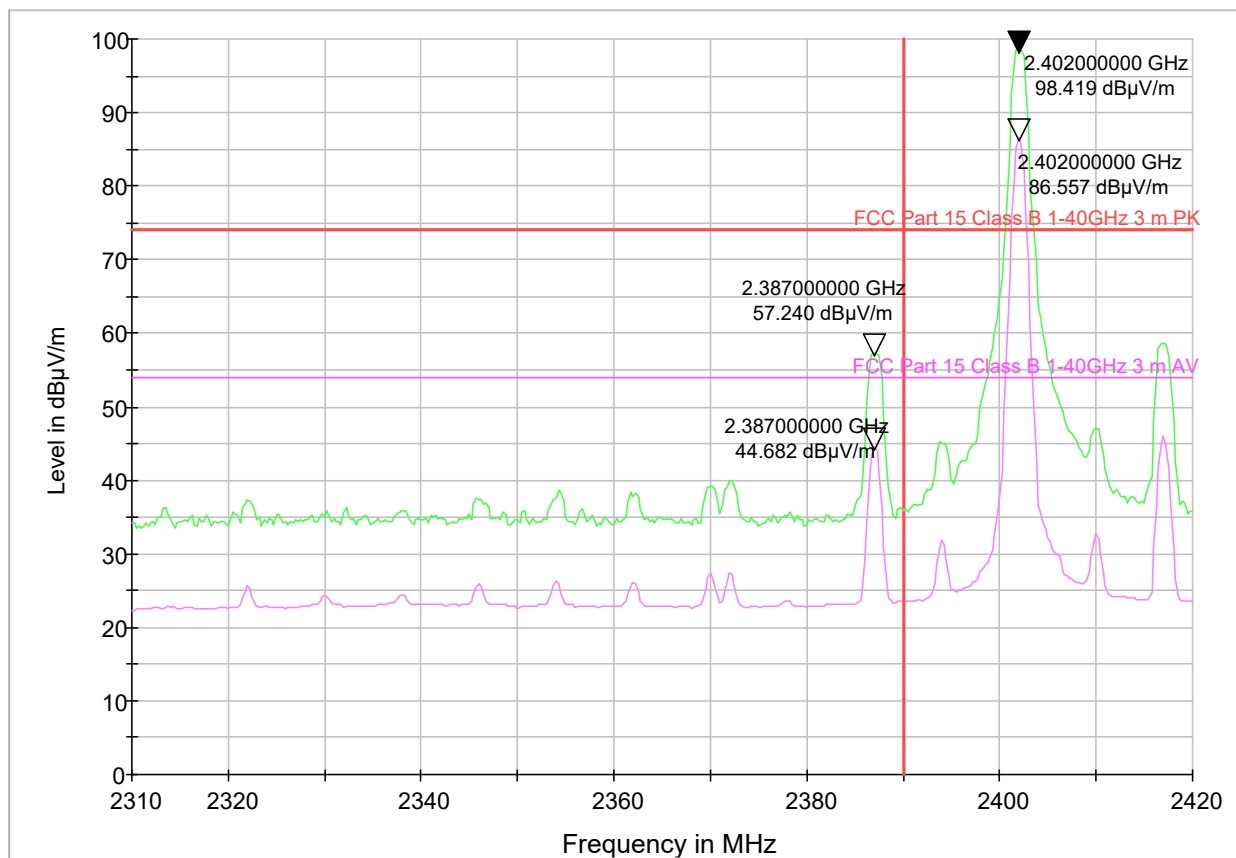
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2387	67.190	-13.23	3.28	57.240

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2387	54.632	-13.23	3.28	44.682



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

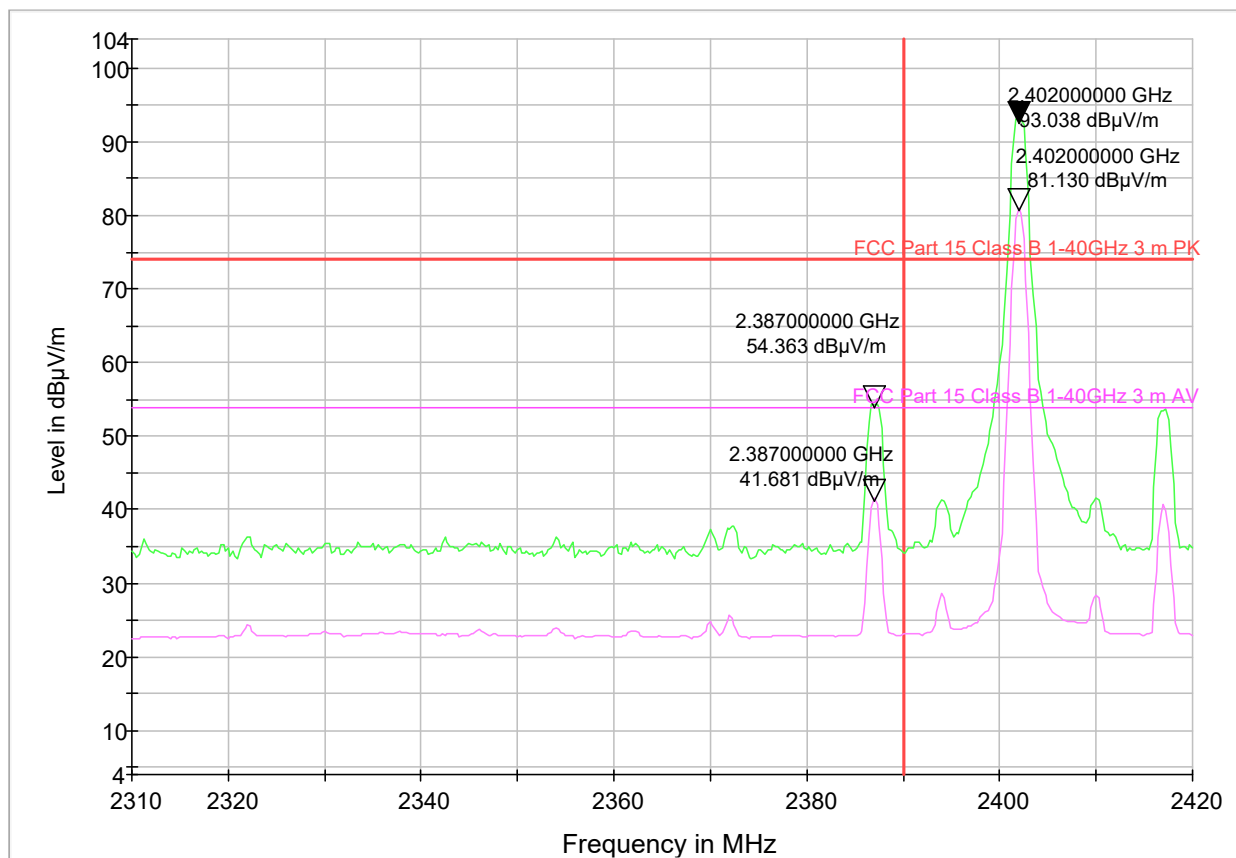
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2387	67.313	-13.23	3.28	57.363

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)
2387	51.631	-13.23	3.28	41.681



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

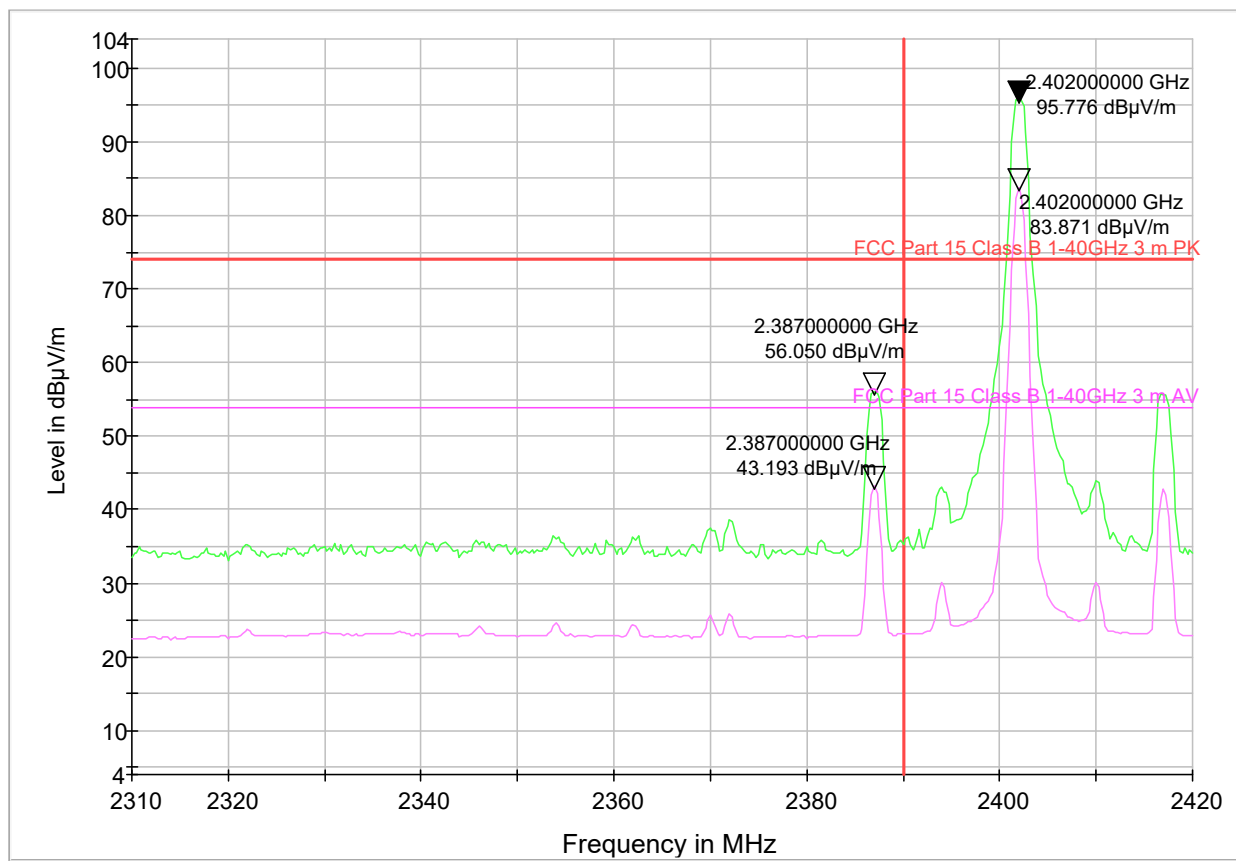
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2387	66.000	-13.23	3.28	56.050

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2387	53.143	-13.23	3.28	43.193



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

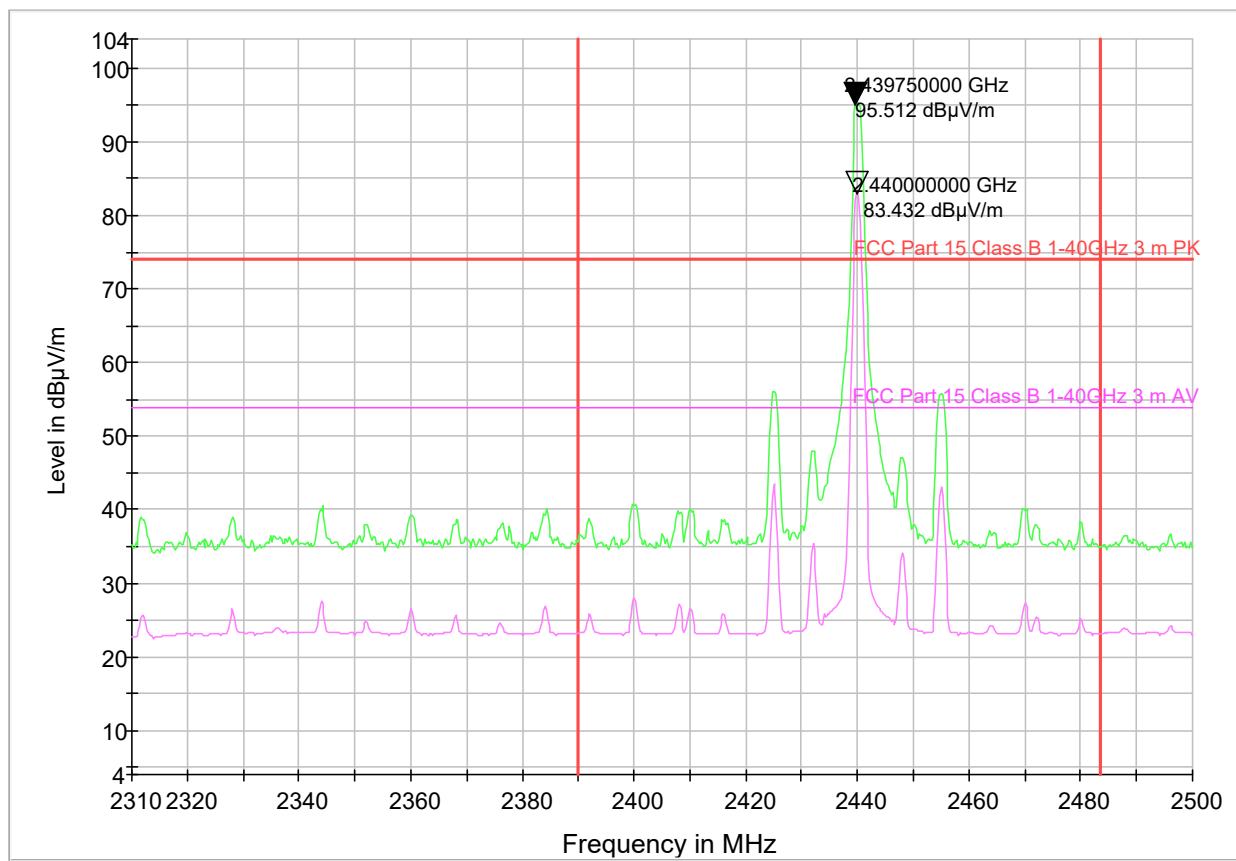
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

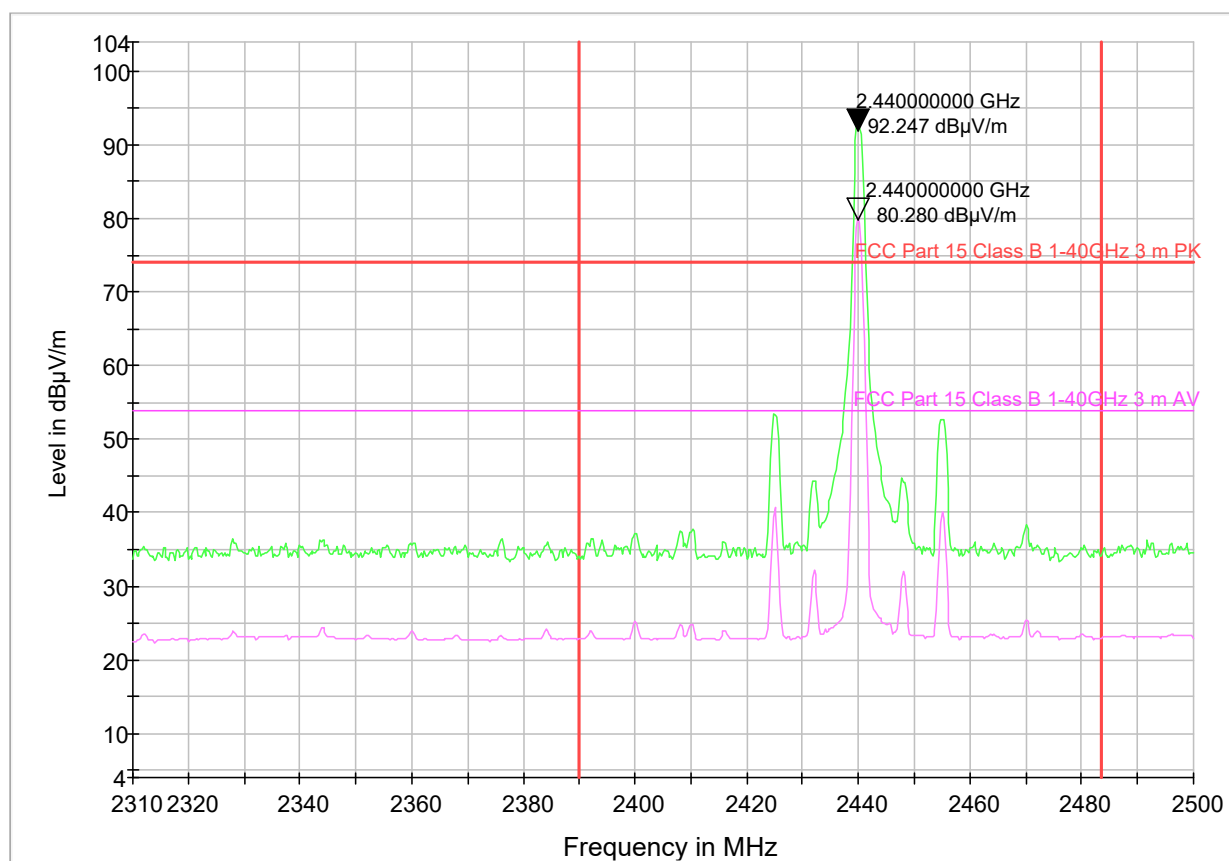
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

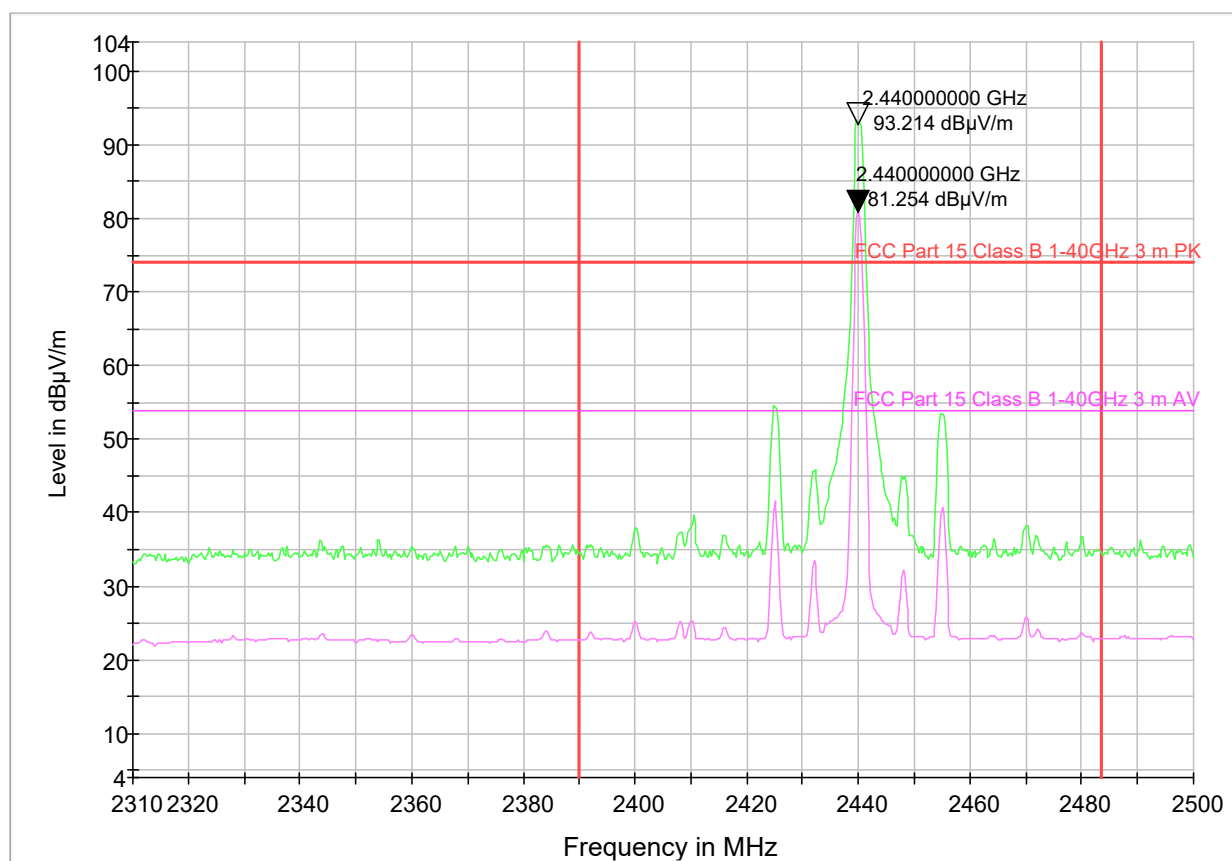
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

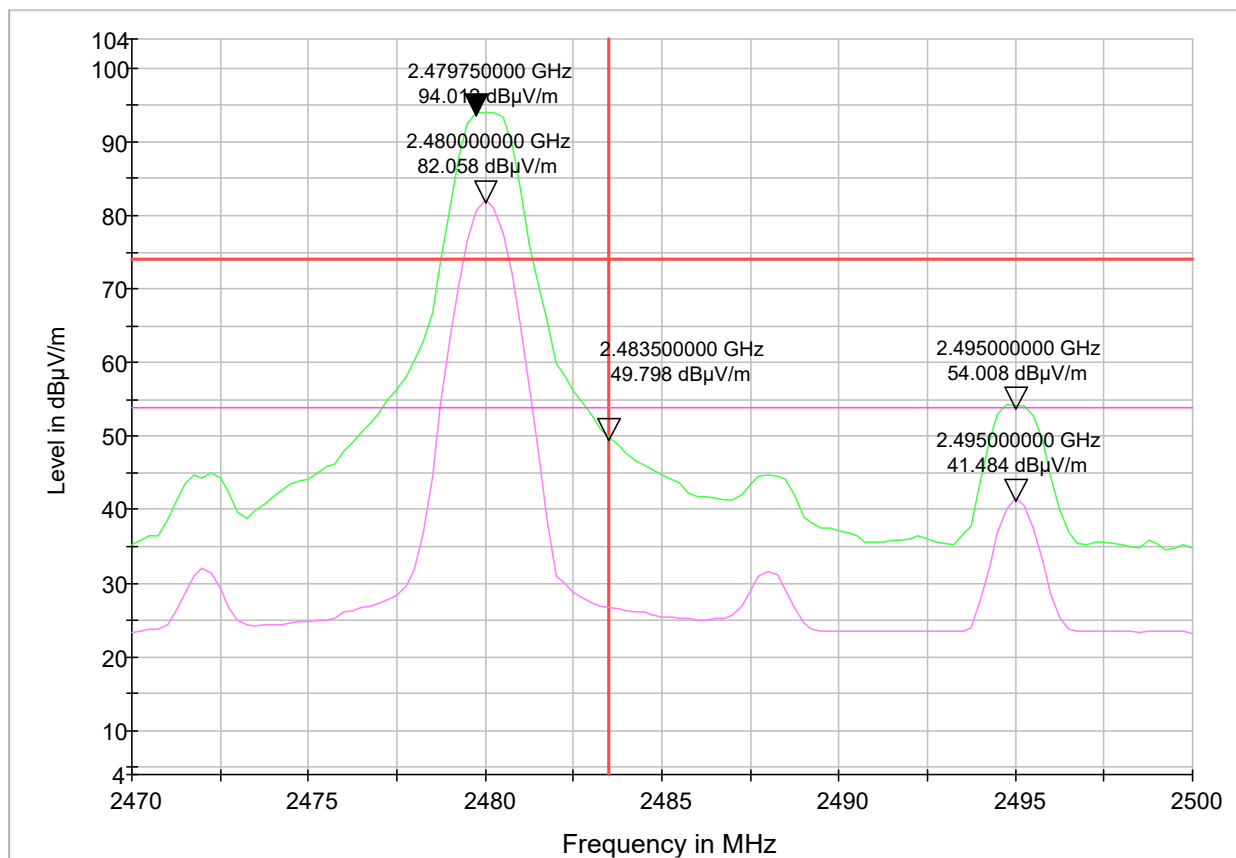
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: X

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2483.5	59.468	-13.02	3.35	49.798
2495.0	63.658	-13.02	3.37	54.008

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
2495.0	51.134	-13.02	3.37	41.484



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

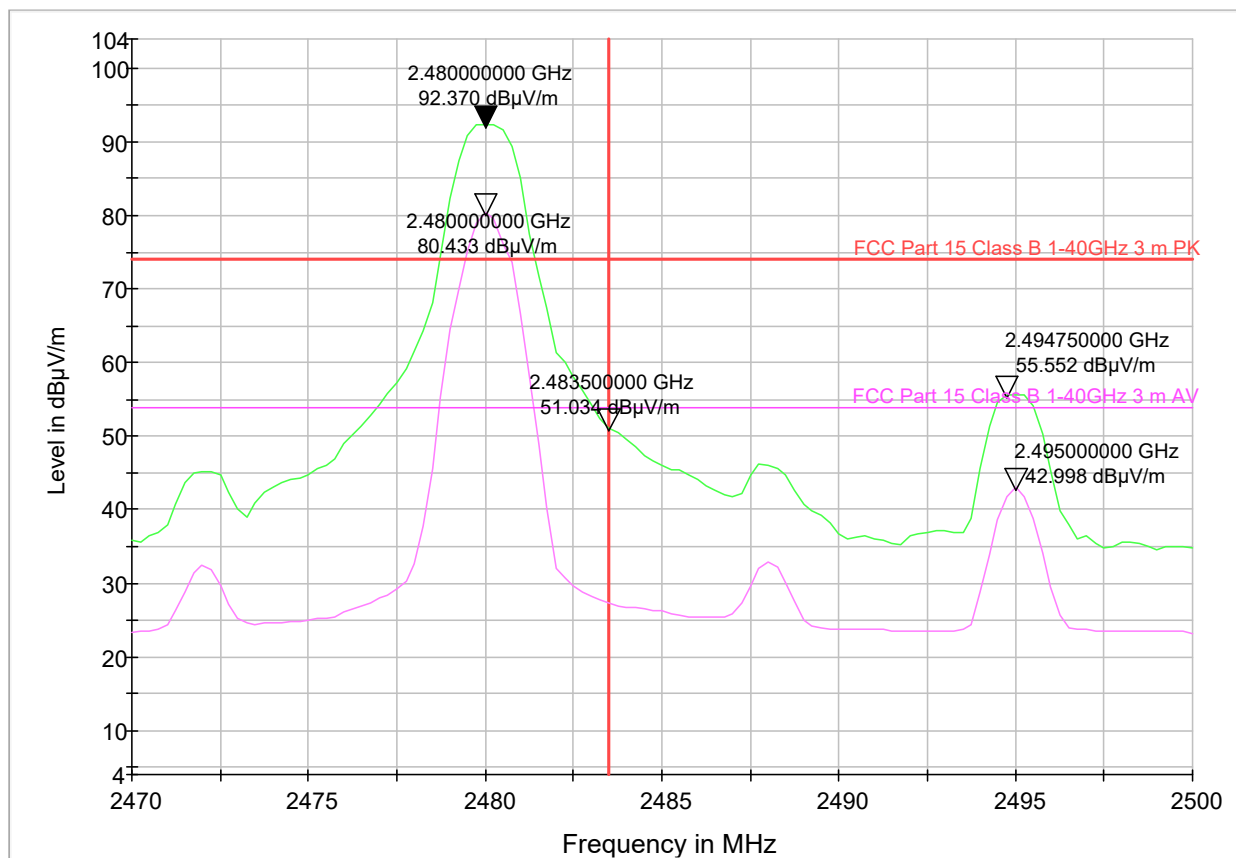
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Y

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2483.5	60.704	-13.02	3.35	51.034
2494.7	65.202	-13.02	3.37	55.552

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2495.0	52.648	-13.02	3.37	42.998



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

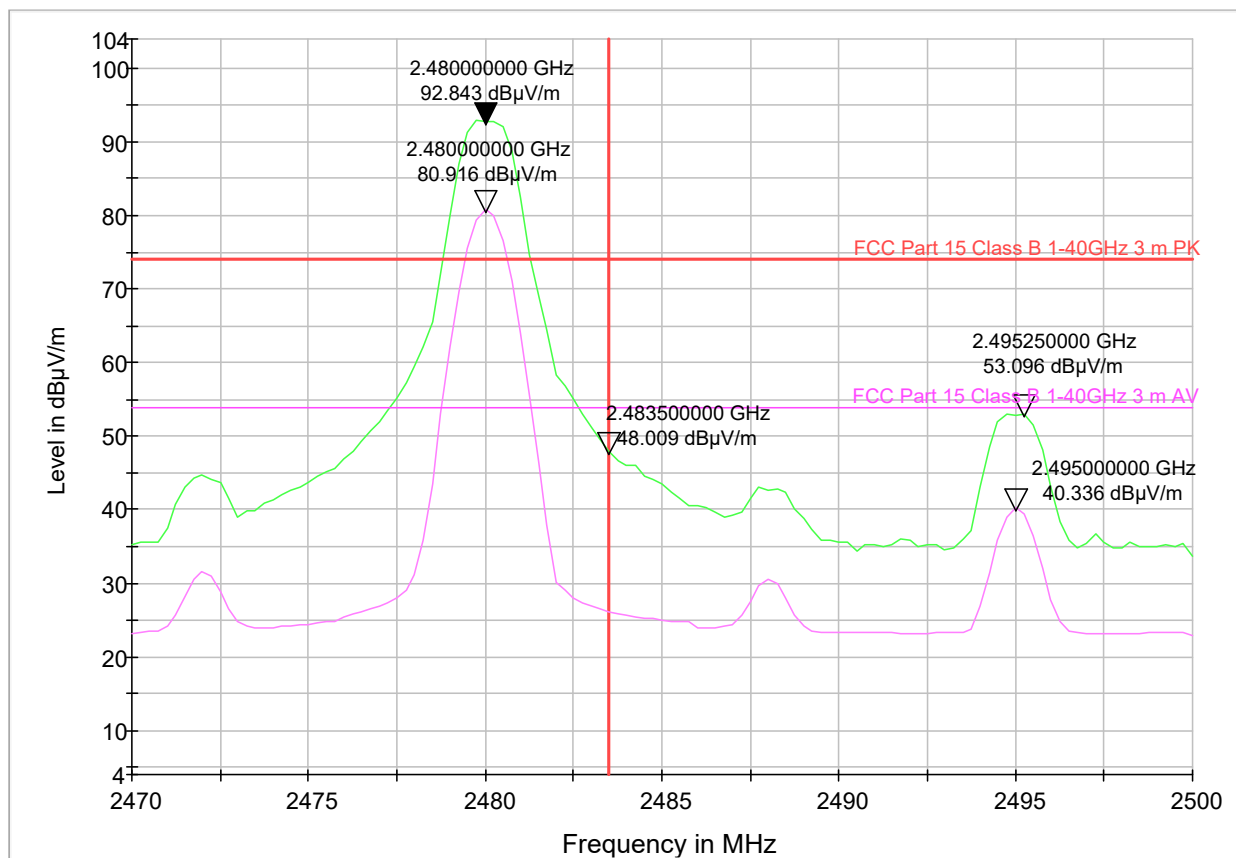
Frequency: Restricted band of operations near fundamental

Trace: Peak (green trace); Average (violet)

Measurement distance: 3m.

Axis: Z

Electric Field Strength 1-18GHz FCC



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2483.5	57.679	-13.02	3.35	48.009
2495.2	62.746	-13.02	3.37	53.096

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
2495.0	49.986	-13.02	3.37	40.336



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

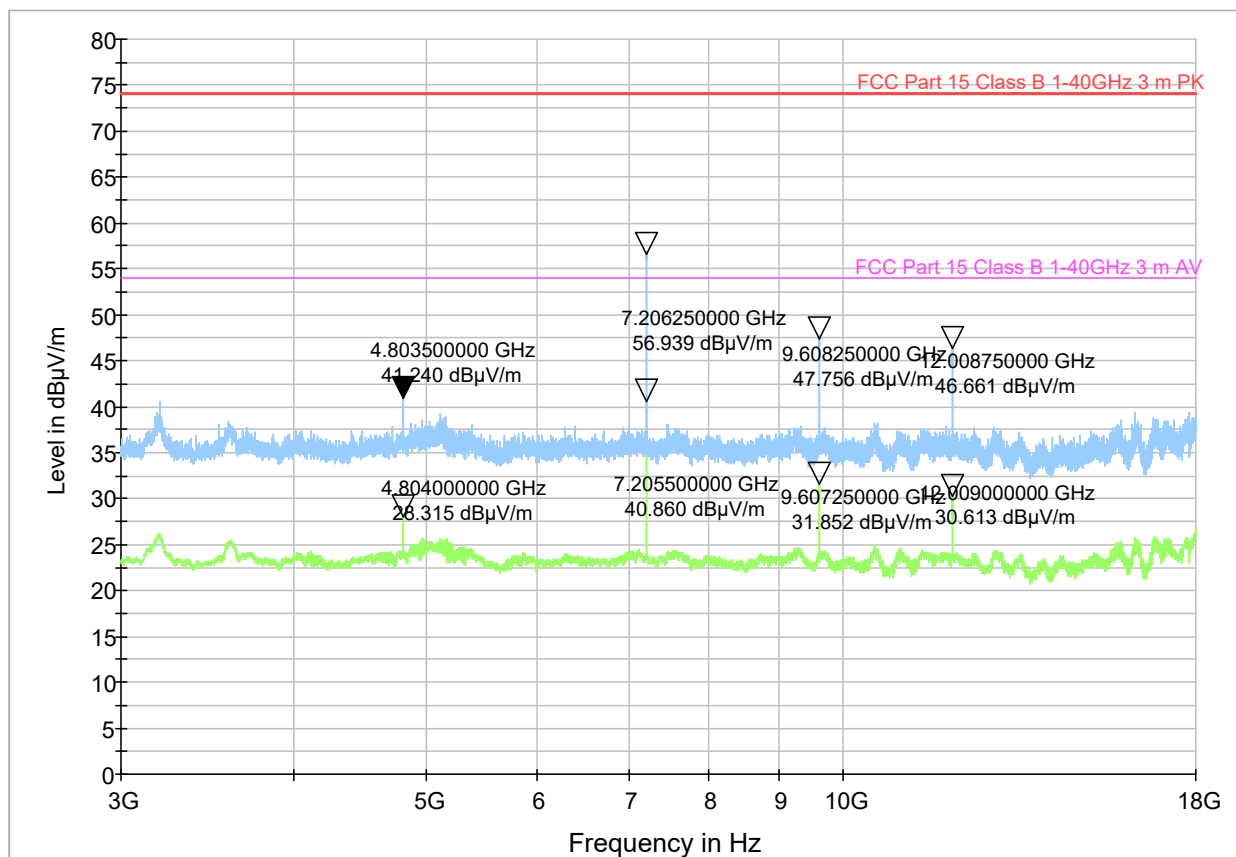
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: X

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4803.5*	46.750	-10.45	4.94	41.240
7206.2	59.879	-9.38	6.44	56.939
9608.2	46.956	-7.15	7.95	47.756
12008.7*	44.741	-6.60	8.52	46.661

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4804.0*	33.825	-10.45	4.94	28.315
7205.5	43.800	-9.38	6.44	40.860
9607.2	31.052	-7.15	7.95	31.852
12009.0*	28.693	-6.60	8.52	30.613

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

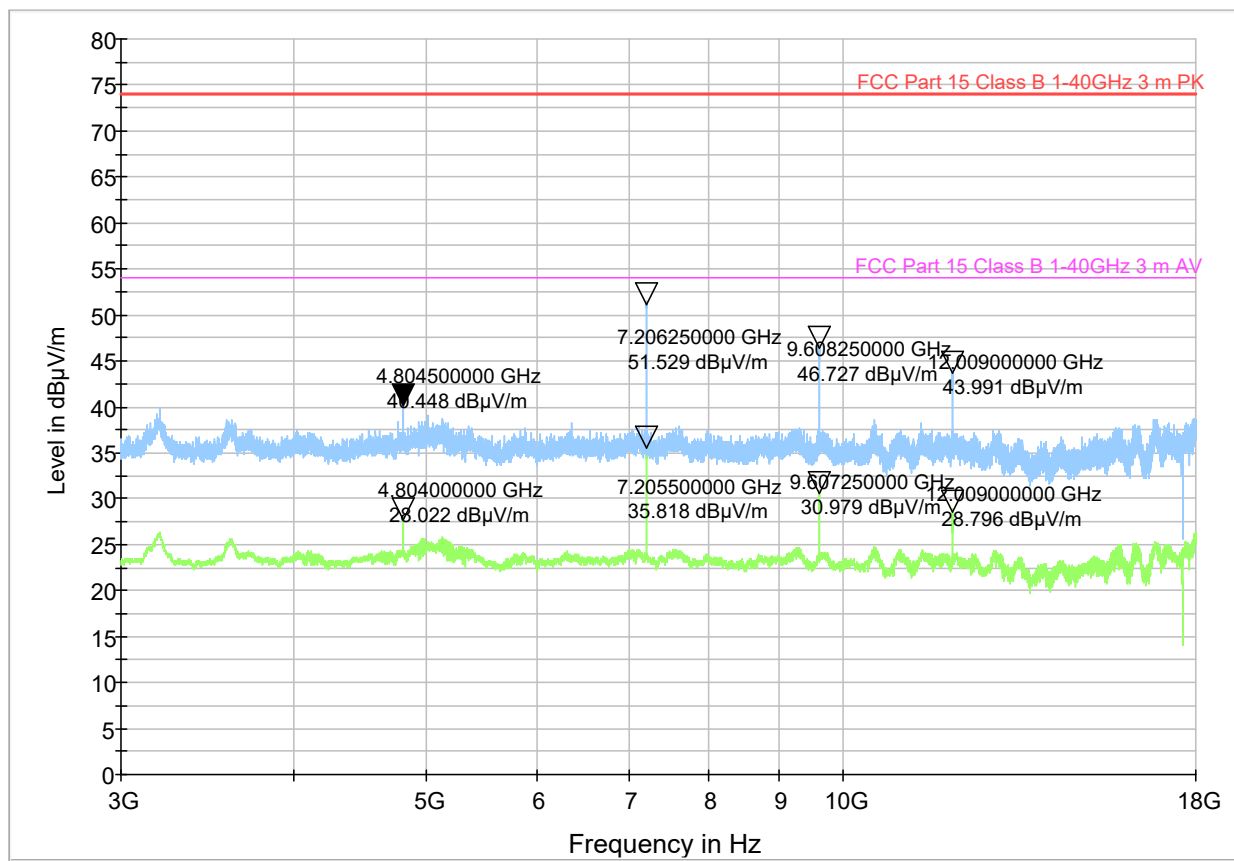
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Y

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4804.5*	45.958	-10.45	4.94	40.448
7206.2	54.469	-9.38	6.44	51.529
9608.2	50.729	-7.15	7.95	46.727
12009.0*	42.071	-6.60	8.52	43.991

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4804.0*	33.532	-10.45	4.94	28.022
7205.5	38.758	-9.38	6.44	35.818
9607.2	30.179	-7.15	7.95	30.979
12009.0*	26.876	-6.60	8.52	28.796

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1

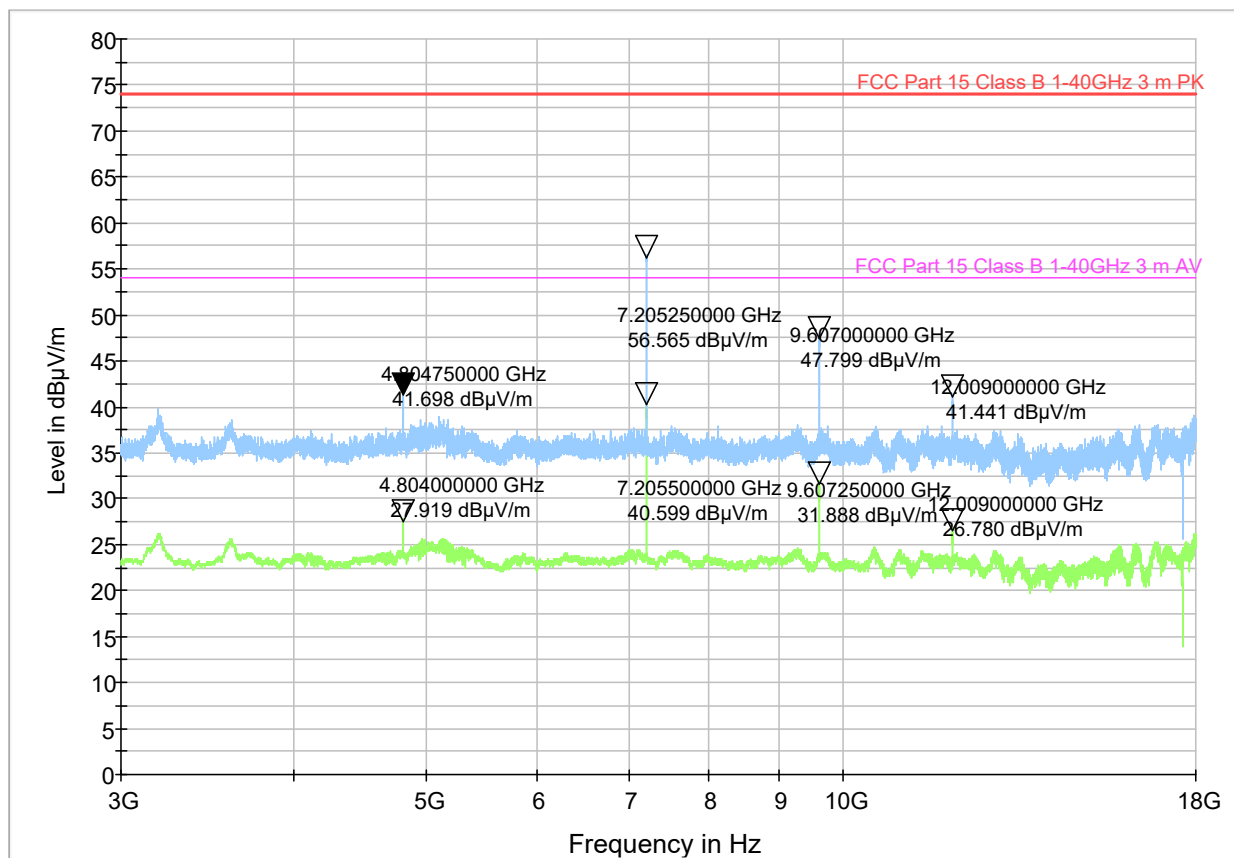
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Z

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4804.7*	47.208	-10.45	4.94	41.698
7205.2	59.505	-9.38	6.44	56.565
9607.0	46.999	-7.15	7.95	47.799
12009.0*	39.521	-6.60	8.52	41.441

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4804.0*	33.429	-10.45	4.94	27.919
7205.5	43.539	-9.38	6.44	40.599
9607.2	31.088	-7.15	7.95	31.888
12009.0*	24.860	-6.60	8.52	26.780

Note*: Restricted band



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

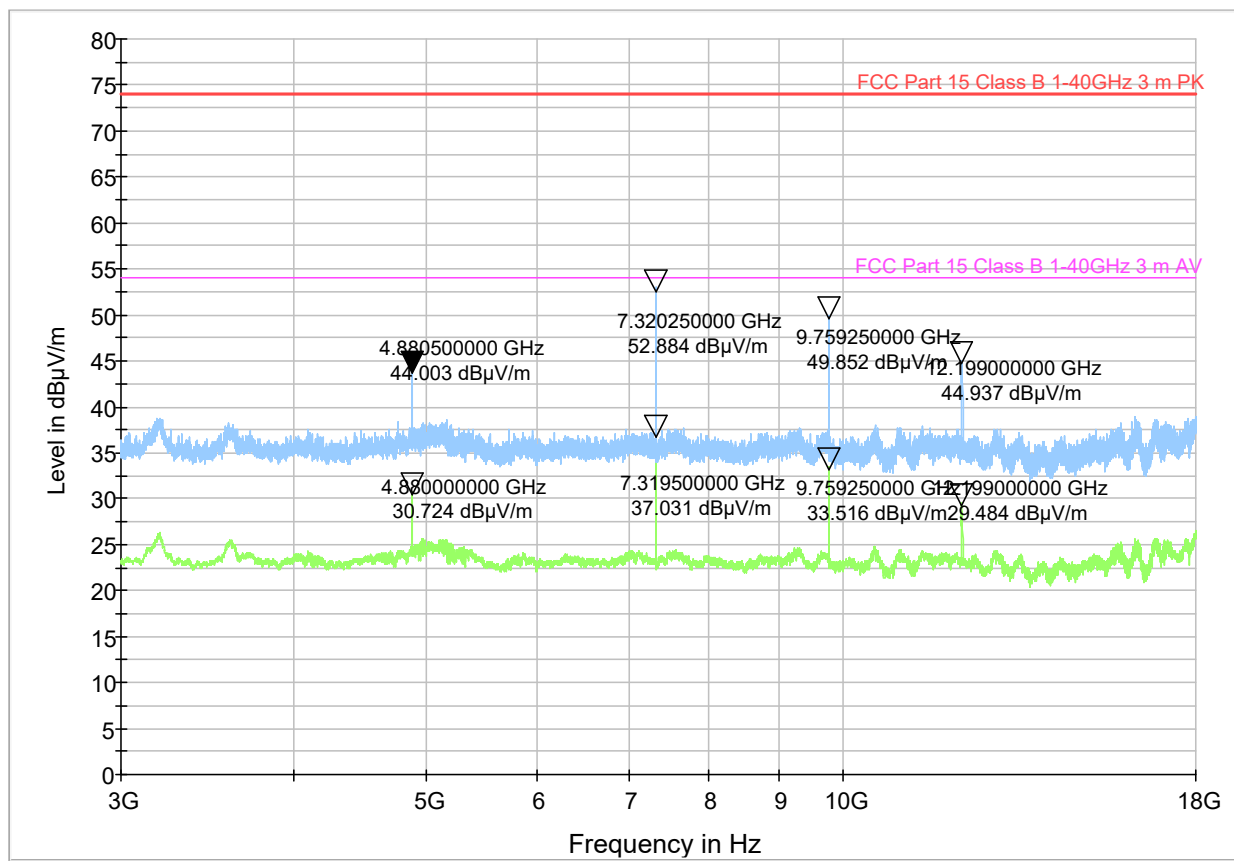
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: X

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4880.5*	49.093	-10.08	4.99	44.003
7320.2*	56.004	-9.58	6.46	52.884
9759.2	48.752	-6.99	8.09	49.852
12199.0*	43.127	-6.72	8.53	44.937

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4880.0*	35.814	-10.08	4.99	30.724
7319.5*	40.151	-9.58	6.46	37.031
9759.2	32.416	-6.99	8.09	33.516
12199.0*	27.674	-6.72	8.53	29.484

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

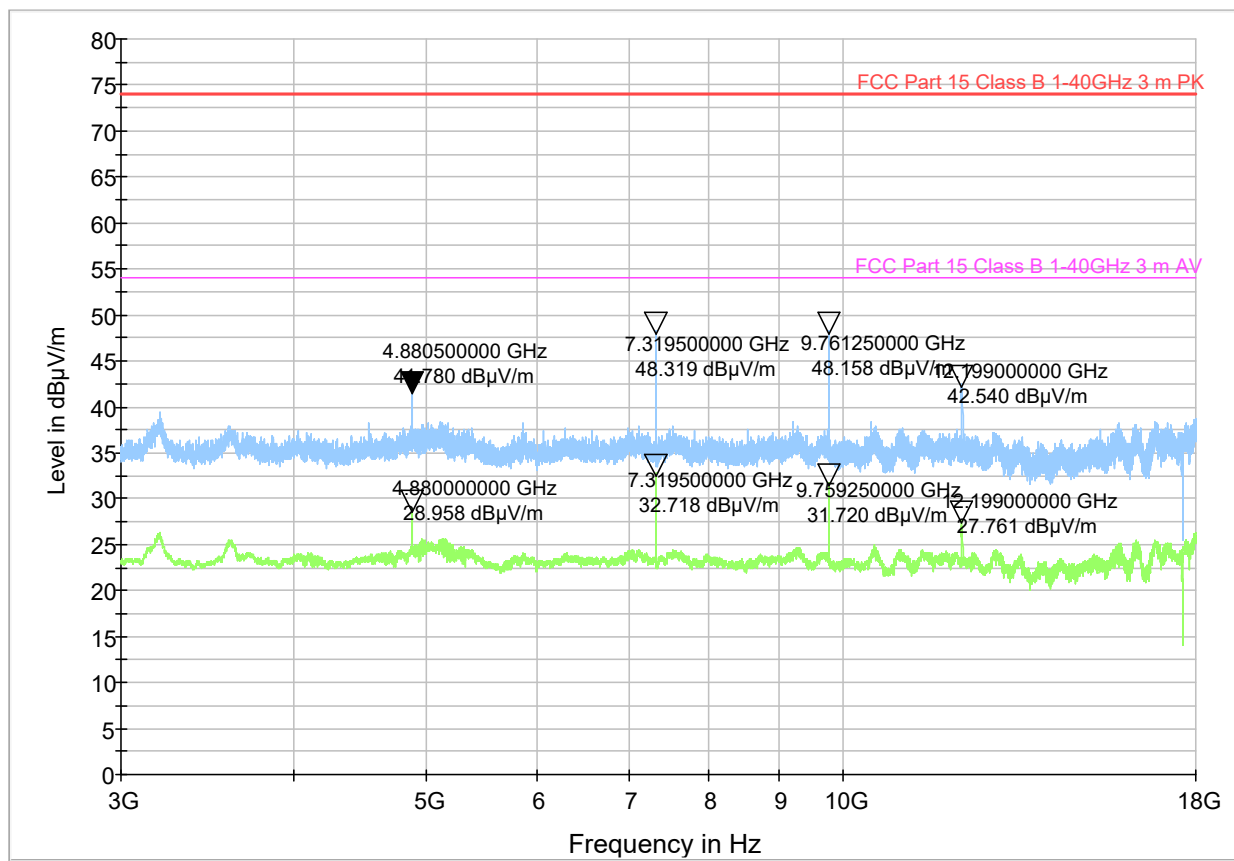
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Y

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4880.5*	46.870	-10.08	4.99	41.780
7319.5*	51.439	-9.58	6.46	48.319
9761.2	47.058	-6.99	8.09	48.158
12199.0*	40.730	-6.72	8.53	42.540

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4880.0*	34.048	-10.08	4.99	28.958
7319.5*	35.838	-9.58	6.46	32.718
9759.2	30.620	-6.99	8.09	31.720
12199.0*	25.951	-6.72	8.53	27.761

Note*: Restricted band



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 2

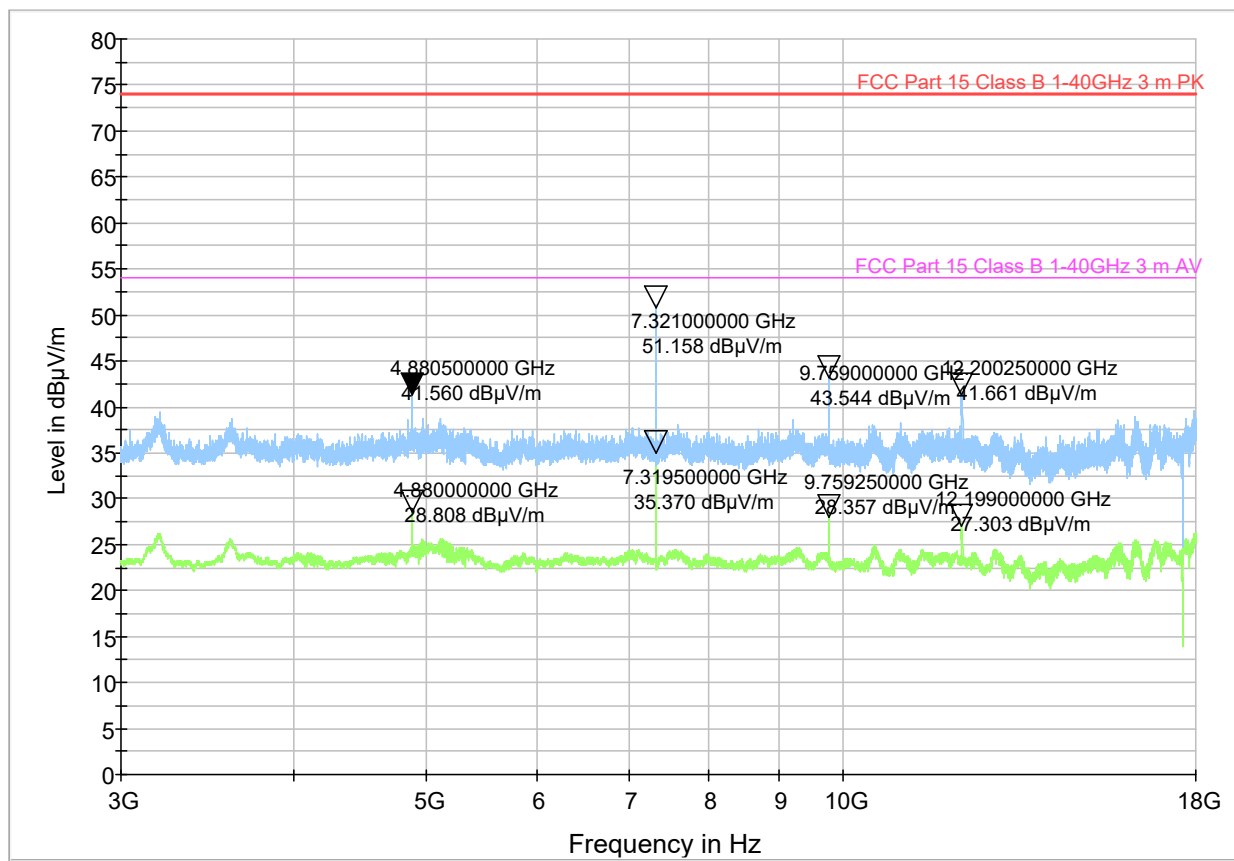
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Z

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4880.5*	46.650	-10.08	4.99	41.560
7321.0*	54.278	-9.58	6.46	51.158
9759.0	42.444	-6.99	8.09	43.544
12200.2*	39.851	-6.72	8.53	41.661

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4880.0*	33.898	-10.08	4.99	28.808
7319.5*	38.490	-9.58	6.46	35.370
9759.2	27.257	-6.99	8.09	28.357
12199.0*	25.493	-6.72	8.53	27.303

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

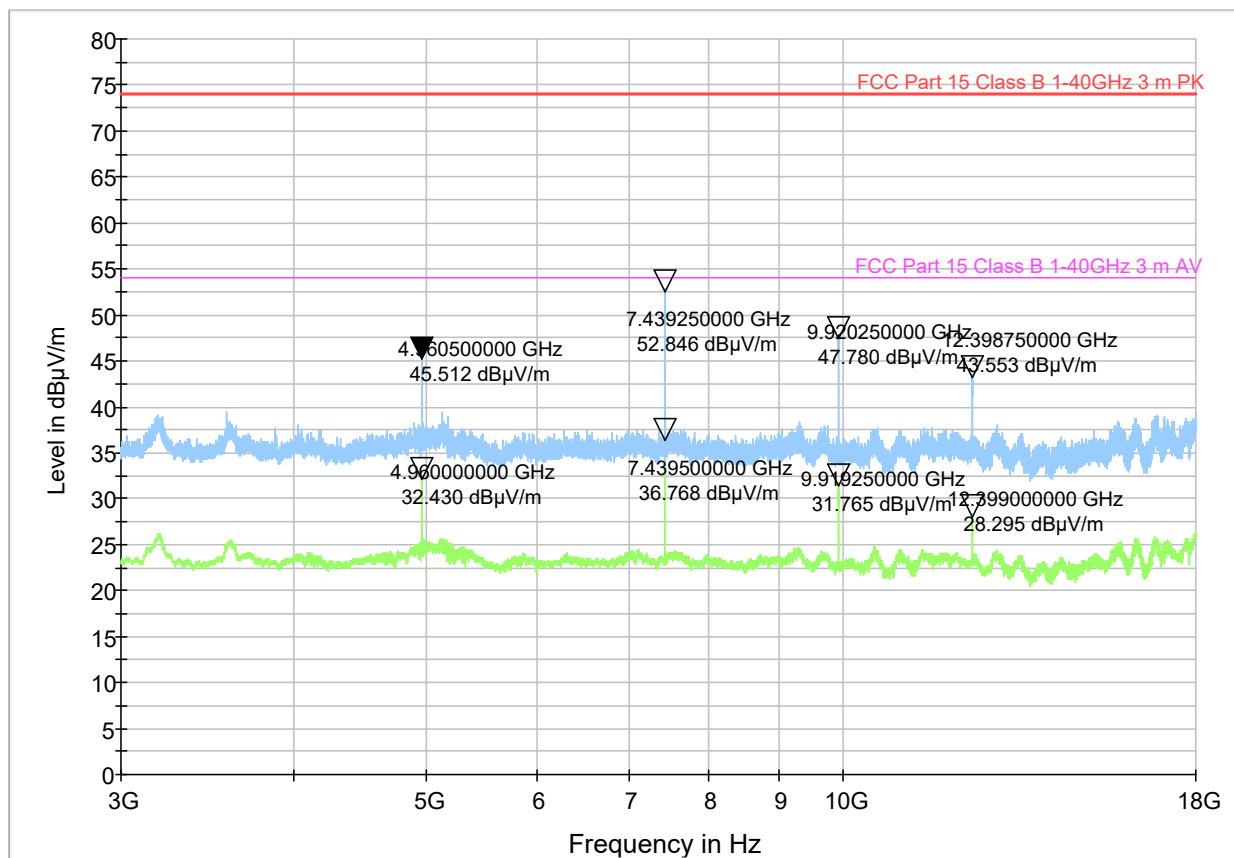
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: X

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4960.5*	50.552	-10.08	5.04	45.512
7439.2*	55.536	-9.17	6.48	52.846
9920.2	46.490	-7.12	8.41	47.780
12398.7*	41.613	-6.60	8.54	43.553

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4960.0*	37.470	-10.08	5.04	32.430
7439.5*	39.458	-9.17	6.48	36.768
9919.2	30.475	-7.12	8.41	31.765
12399.0*	26.355	-6.60	8.54	28.295

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

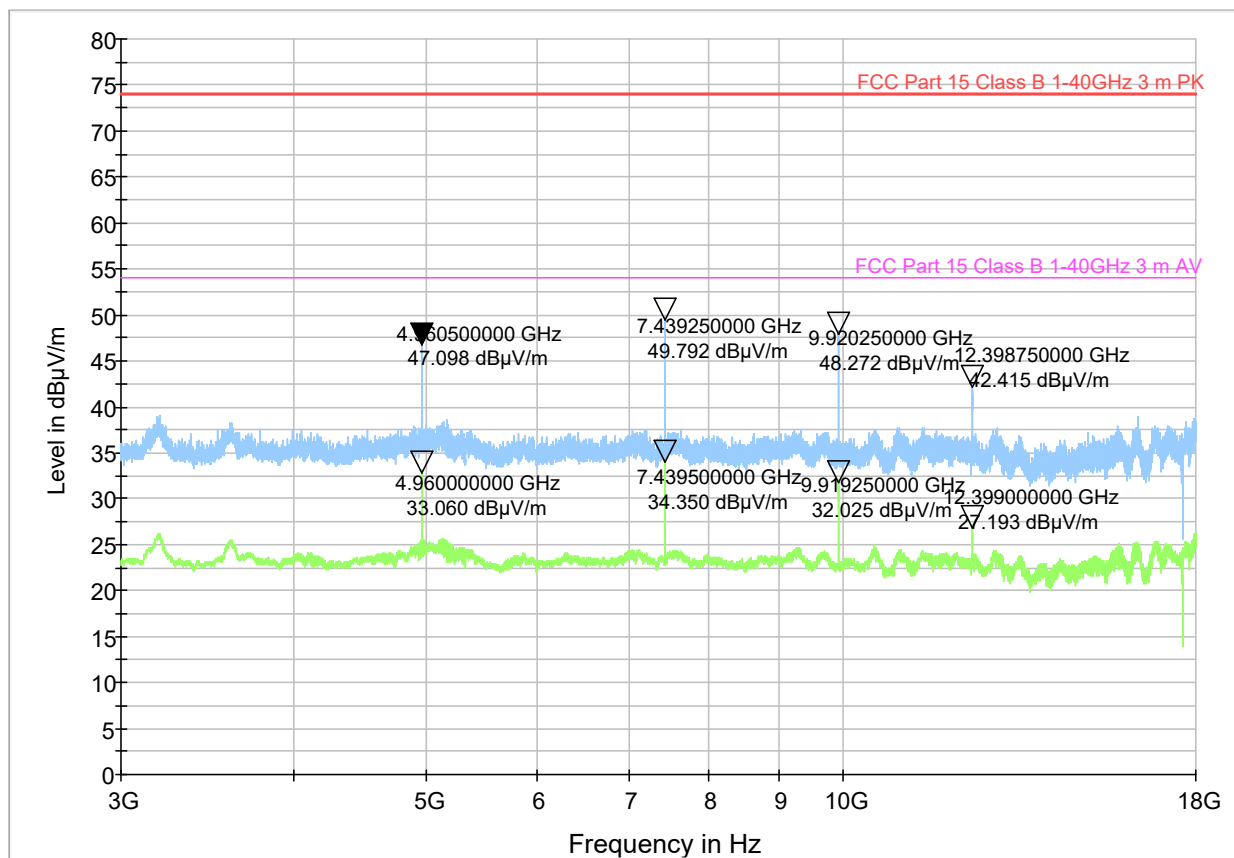
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Y

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4960.5*	52.138	-10.08	5.04	47.098
7439.2*	52.482	-9.17	6.48	49.792
9920.2	46.982	-7.12	8.41	48.272
12398.7*	40.475	-6.60	8.54	42.415

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dB μ V)	(dB3/m)	(dB)	(dB μ V/m)
4960.0*	38.100	-10.08	5.04	33.060
7439.5*	37.040	-9.17	6.48	34.350
9919.2	30.735	-7.12	8.41	32.025
12399.0*	25.253	-6.60	8.54	27.193

Note*: Restricted band

ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 3

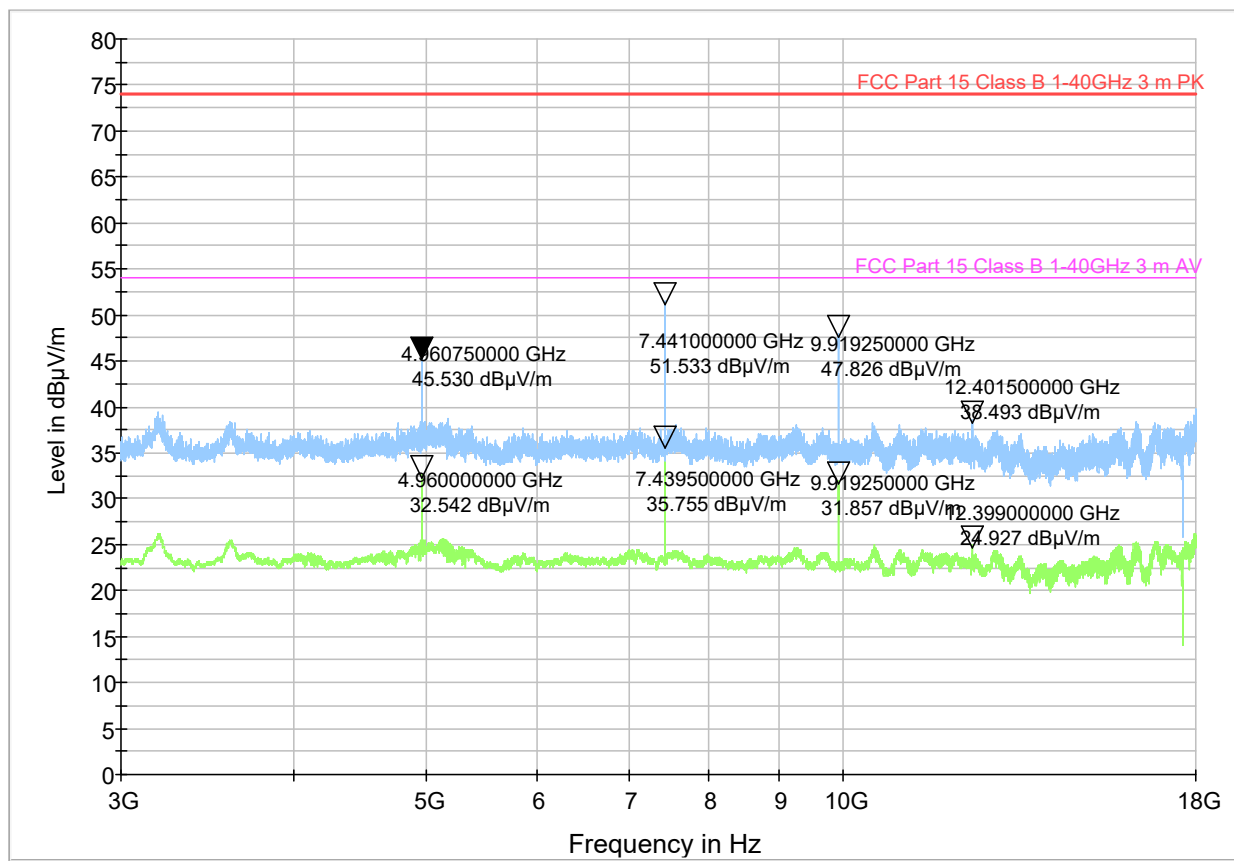
Frequency: 3000-18000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Z

Full Spectrum



ADDITIONAL DOCUMENTATION
HARMONIC LEVEL (PK)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4960.7*	50.570	-10.08	5.04	45.530
7441.0*	54.223	-9.17	6.48	51.533
9919.2	46.536	-7.12	8.41	47.826
12401.5*	36.553	-6.60	8.54	38.493

Note*: Restricted band

HARMONIC LEVEL (AV)

Frequency	Reading value	Antenna Factor with pre-Amplifier	Cable Loss	Correcting reading
(MHz)	(dBμV)	(dB3/m)	(dB)	(dBμV/m)
4960.0*	37.582	-10.08	5.04	32.542
7439.5*	38.445	-9.17	6.48	35.755
9919.2	30.567	-7.12	8.41	31.857
12399.0*	22.987	-6.60	8.54	24.927

Note*: Restricted band



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (Worst case)

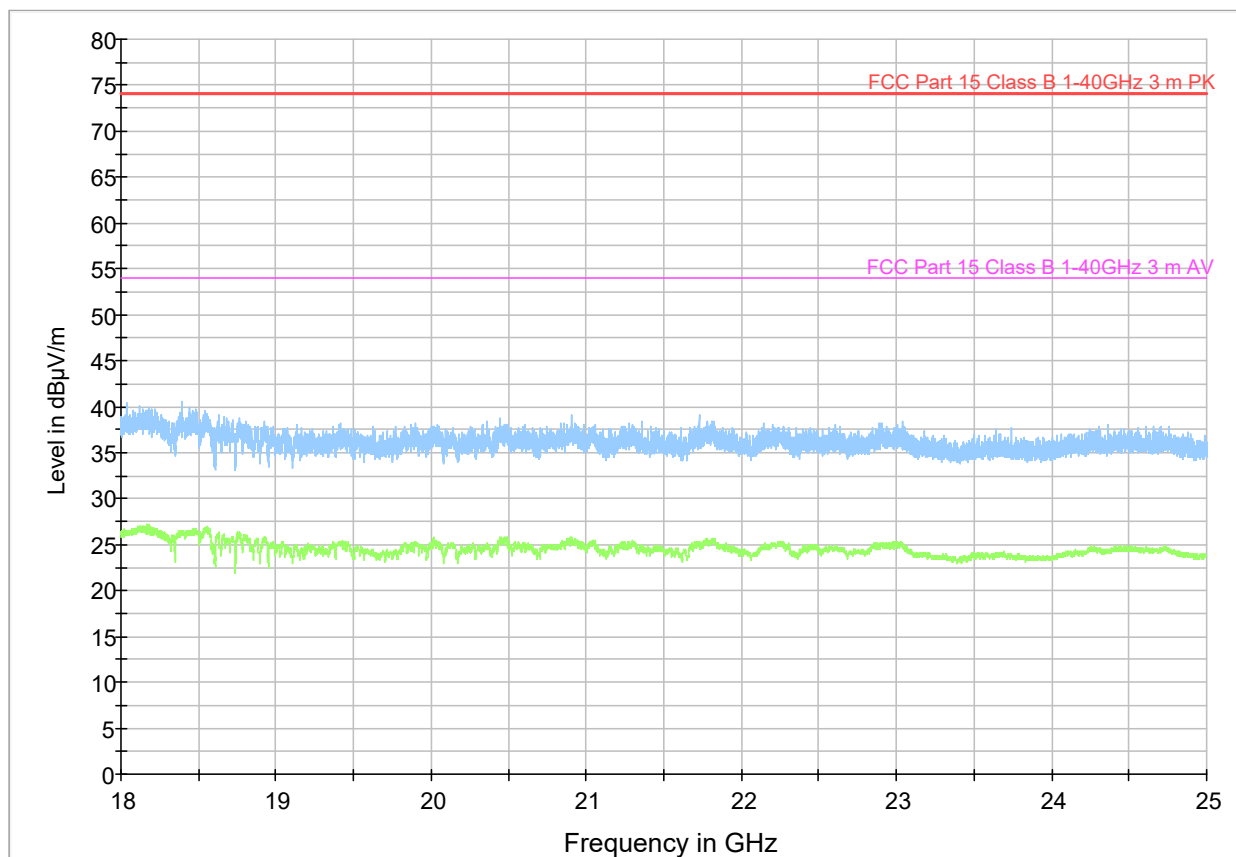
Frequency: 18000-25000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: X

Full Spectrum





ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (Worst case)

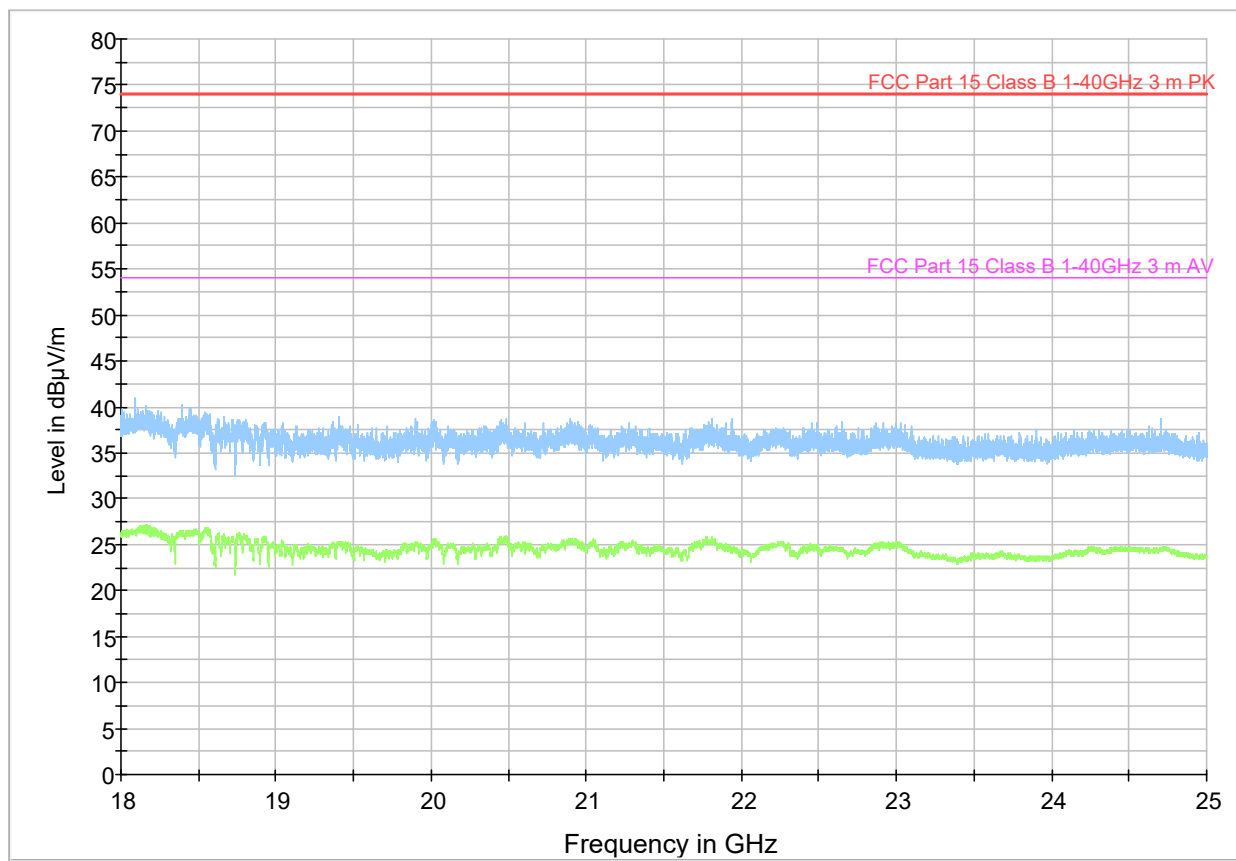
Frequency: 18000-25000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Y

Full Spectrum



ADDITIONAL DOCUMENTATION

Graphical presentation of radiated emission measurement

Operation mode: 1 (Worst case)

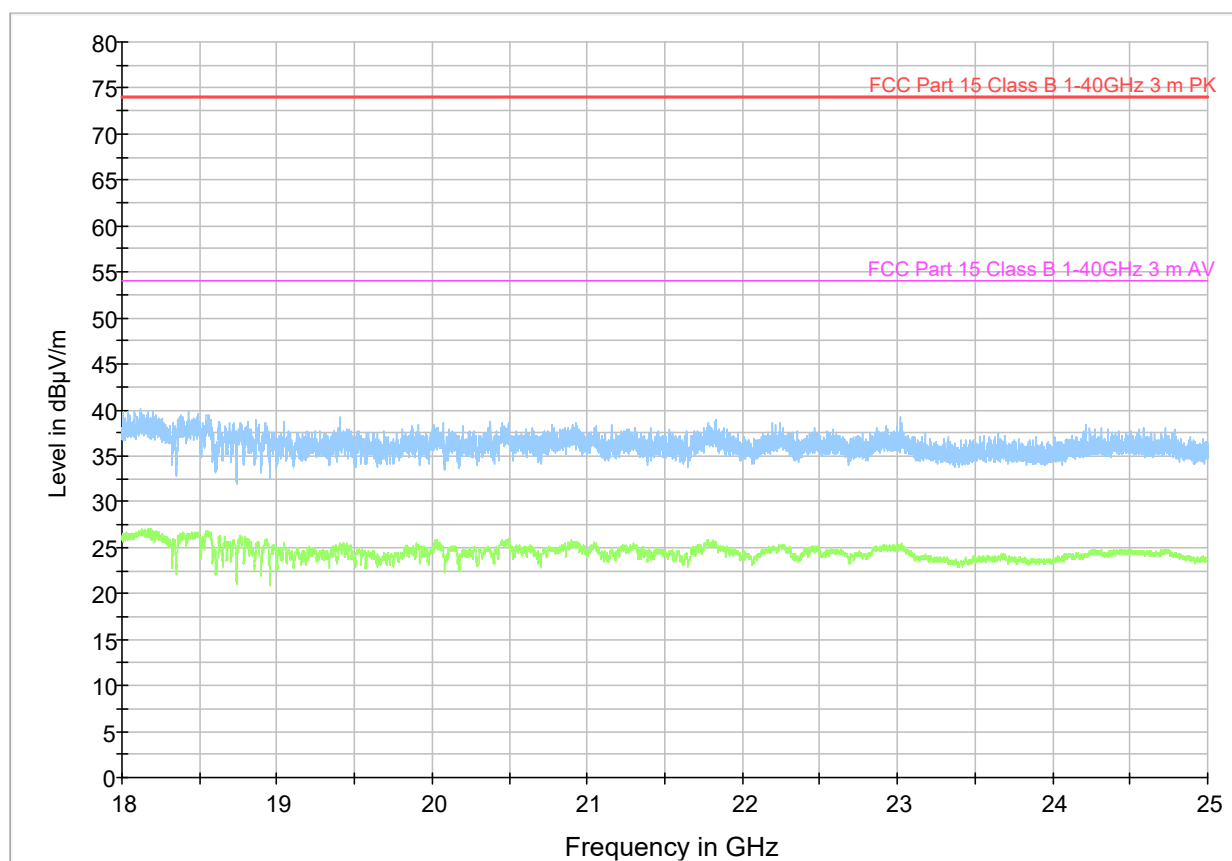
Frequency: 18000-25000MHz

Trace: Peak (blue trace); Average (green)

Measurement distance: 3m.

Axis: Z

Full Spectrum



ADDITIONAL DOCUMENTATION
Antenna requirements

Test date	08-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.203
Test method	§ 5.8 of ANSI C63.10
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.:	N°3 Sample tested (1 for each frequency)
Operating mode	1, 2, 3
Tested terminals	Antenna
Result	PASS

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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Antenna specifications

N° of authorized antenna types	1
Antenna type	PCB antenna/Integrated Antenna
Maximum total gain	5.92 dBi (at 2480MHz)
External power amplifiers	Not present

ADDITIONAL DOCUMENTATION

RF power output, radiated (EIRP)	
<i>Test date</i>	17-06-2021
<i>Applied Standard</i>	Title 47 Part 15 Subpart C §15.247
<i>Test method</i>	According to Par. 8.3.2.2 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.9.1.1 of ANSI C63.10)
<i>Temperature</i>	22° C
<i>Humidity</i>	42%
<i>Air pressure</i>	1027 mbar
<i>Tested by</i>	Roberto Radice
<i>Model</i>	MINI2
<i>Test sample No.:</i>	N°3 Sample tested (1 for each frequency)
<i>Operating mode</i>	1, 2, 3
<i>Tested terminals</i>	Antenna connector
<i>Result</i>	PASS

ADDITIONAL DOCUMENTATION

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Note: since it was not possible to put in an antenna connector, test was carried out in a radiated manner According to Par. 2.3 of KDB 412172 D01 Determining ERP and EIRP v01r01

ADDITIONAL DOCUMENTATION
Used test equipment

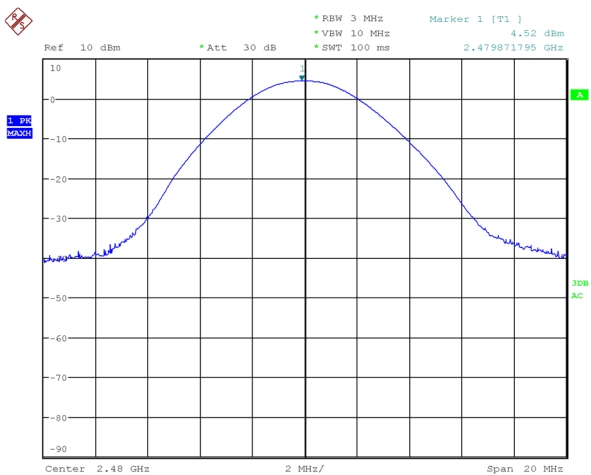
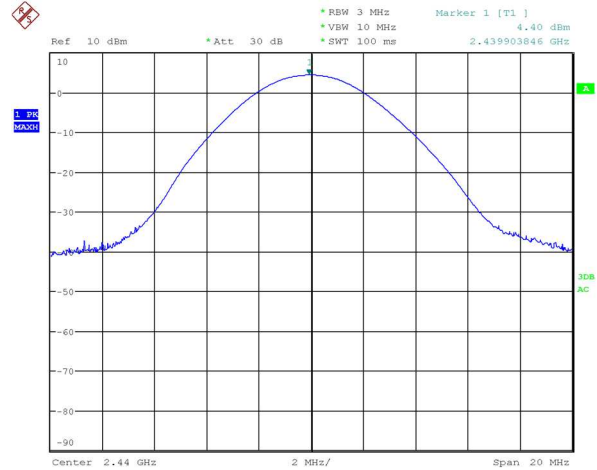
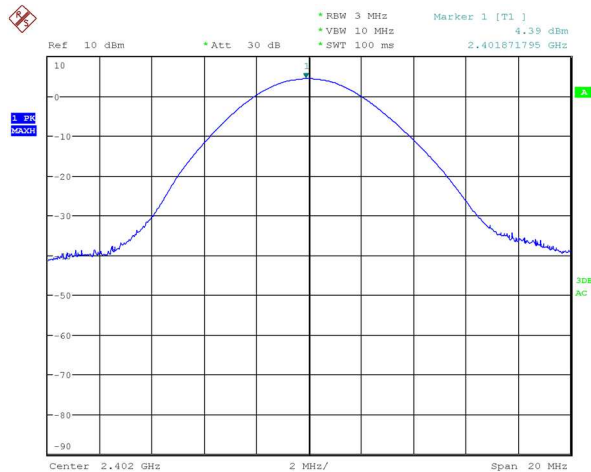
Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

Measurement data of RF power output, conducted measurement

Test conditions			Frequency (MHz)	Ch.	Conducted Output Power		Antenna Gain	Limits (W)		Result
Temperature	Voltage	Modulation			dBm	mW		Conducted	Radiated	
Tnom +22°C	3 V dc	GFSK	2402	0	4.39	2.74	5.35	1	4	PASS
Tnom +22°C	3 V dc	GFSK	2440	20	4.40	2.75	5.83	1	4	PASS
Tnom +22°C	3 V dc	GFSK	2480	39	4.52	2.83	5.92	1	4	PASS

ADDITIONAL DOCUMENTATION

Graphical Results of RF power output, conducted measurement



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ADDITIONAL DOCUMENTATION
6 dB minimum Bandwidth

Test date	17-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.2 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.8.1 Option 1 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.:	N°3 Sample tested (1 for each frequency)
Operating mode	1, 2, 3
Tested terminals	Antenna connector
Result	PASS

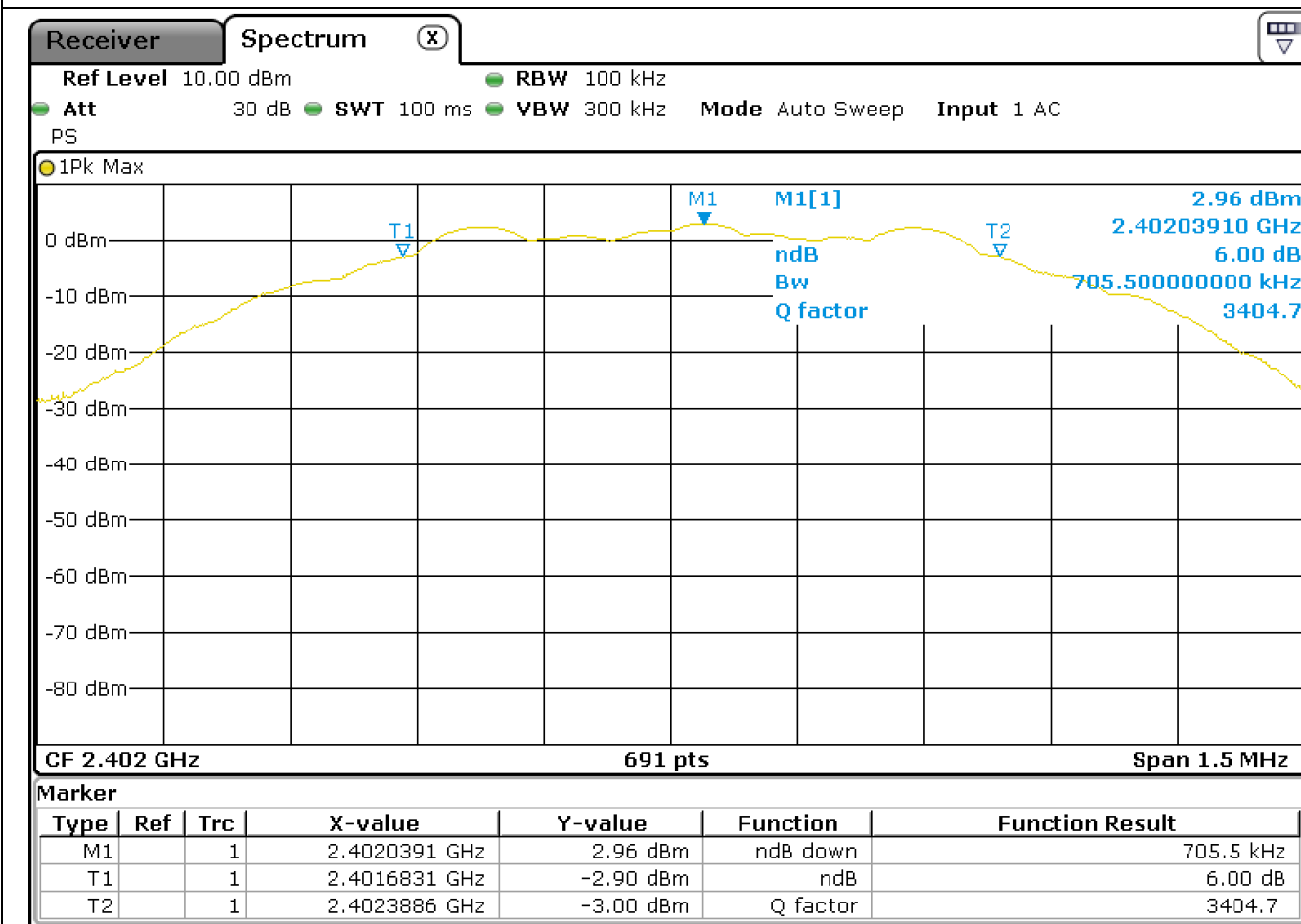
Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESR3	2782768	01/2021	01/2022

ADDITIONAL DOCUMENTATION
Graphical presentation of 6dB Bandwidth measurement

Operation mode: 1

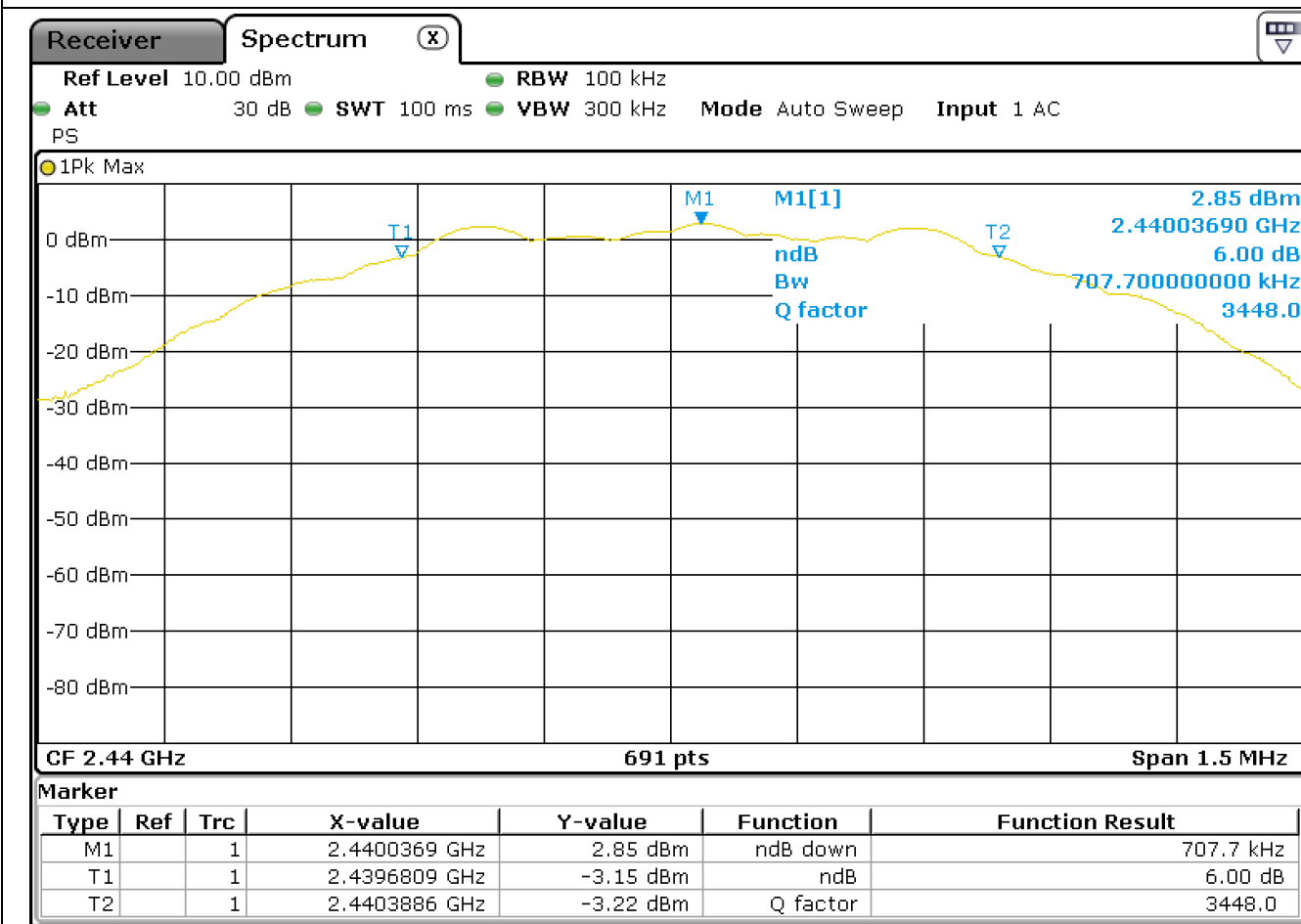


Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -6dB (kHz)
Low	2402	1Mbit/s	705.50

Bandwidth at -6dB (Fmin and Fmax)				
1Mbit/s	Fmin	2401.683 MHz	Fmax	2402.388 MHz

ADDITIONAL DOCUMENTATION
Graphical presentation of 6dB Bandwidth measurement

Operation mode: 2



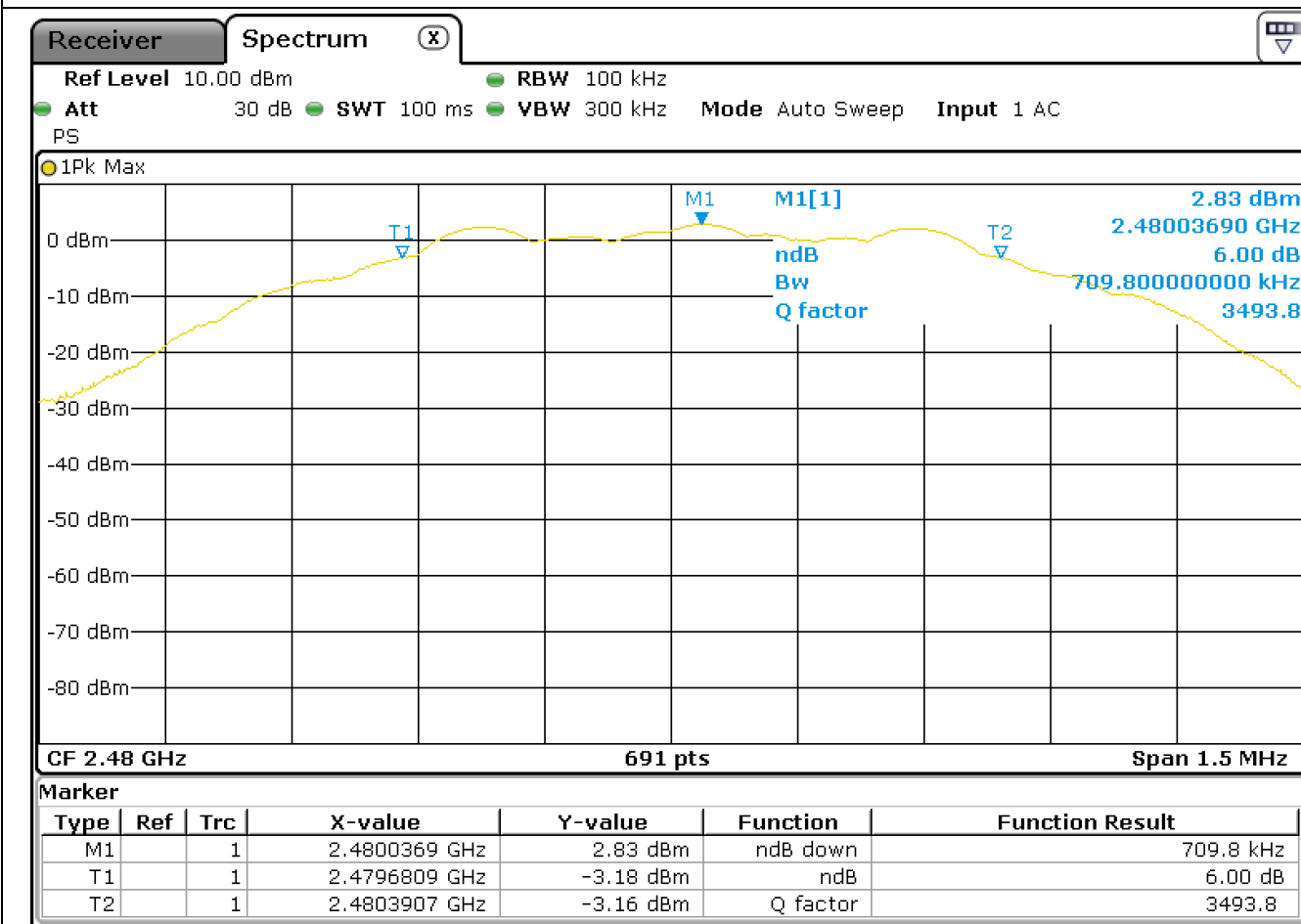
Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -6dB (kHz)
Middle	2440	1Mbit/s	707.70

Bandwidth at -6dB (Fmin and Fmax)				
1Mbit/s	Fmin	2439.681 MHz	Fmax	2440.388 MHz

ADDITIONAL DOCUMENTATION

Graphical presentation of 6dB Bandwidth measurement

Operation mode: 3



Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -6dB (kHz)
High	2480	1Mbit/s	709.80

Bandwidth at -6dB (Fmin and Fmax)				
1Mbit/s	Fmin	2479.681 MHz	Fmax	2480.390 MHz

ADDITIONAL DOCUMENTATION
Out-of-band emissions

Test date	17-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.5 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.11 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.:	N°3 Sample tested (1 for each frequency)
Operating mode	1, 2, 3
Tested terminals	Antenna connector
Result	PASS

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

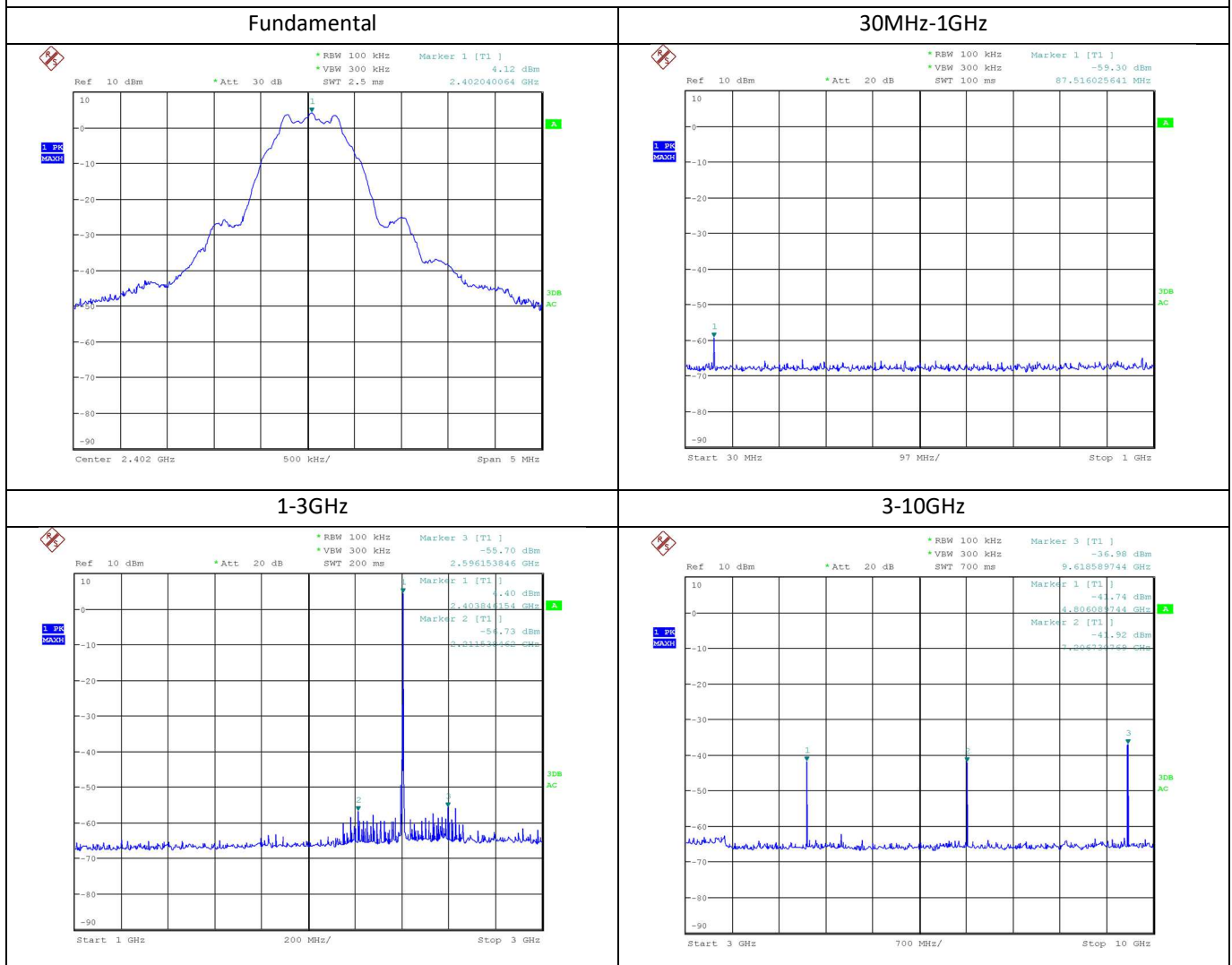
Used test equipment

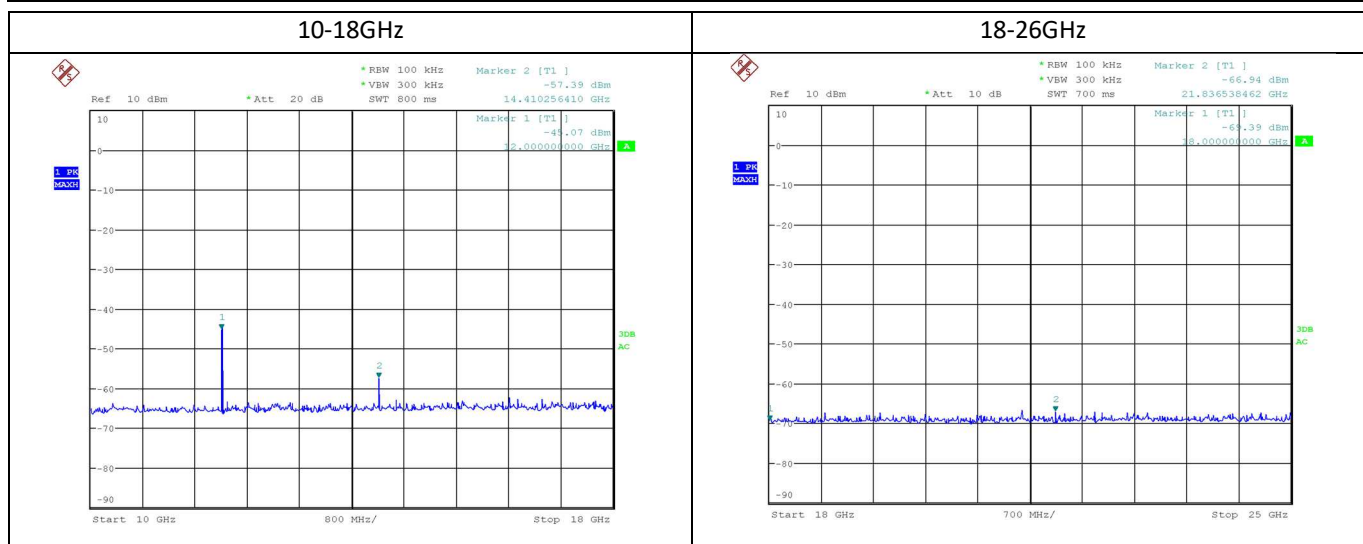
Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

ADDITIONAL DOCUMENTATION

Graphical presentation of spurious emission

Operation mode: 1



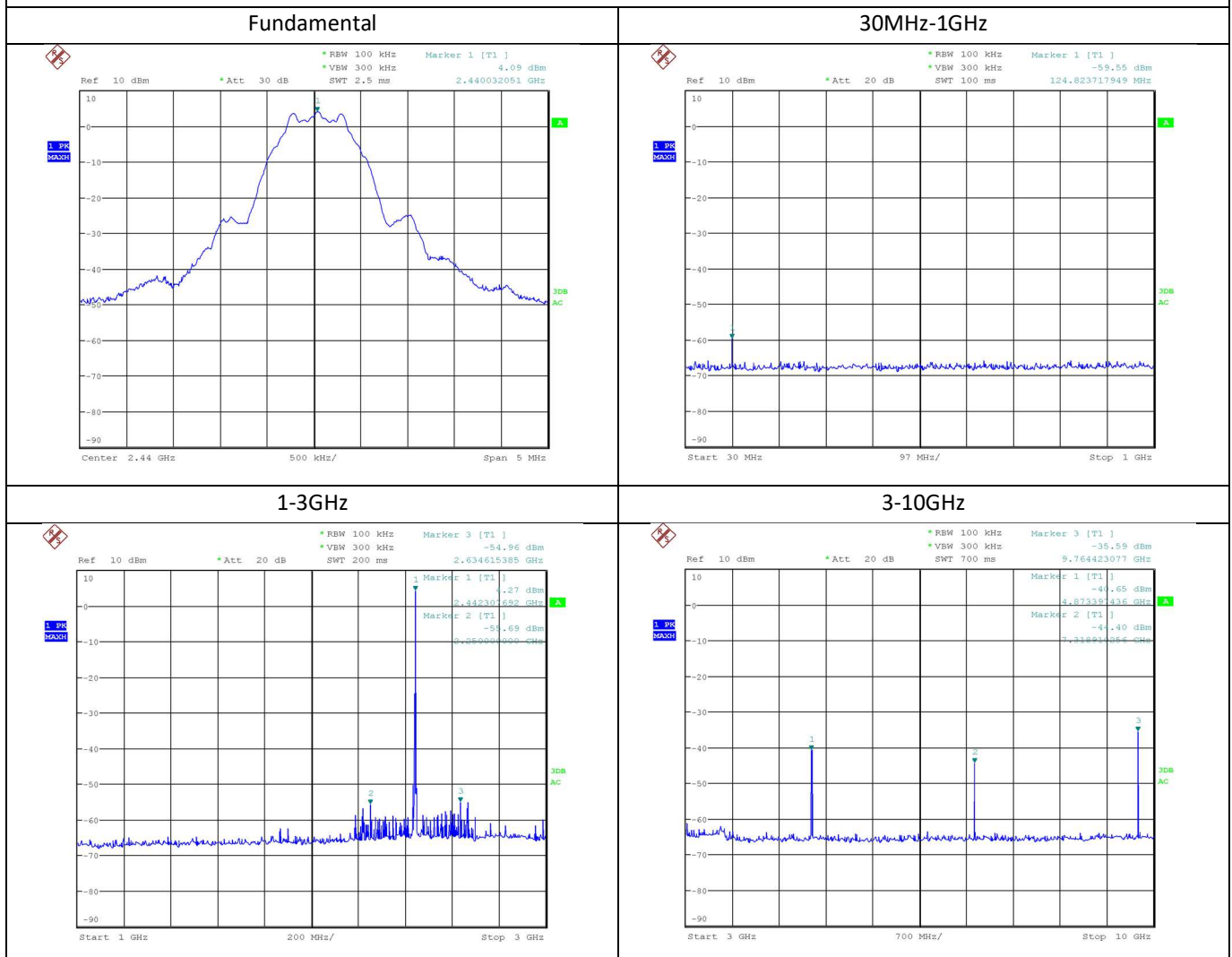
ADDITIONAL DOCUMENTATION


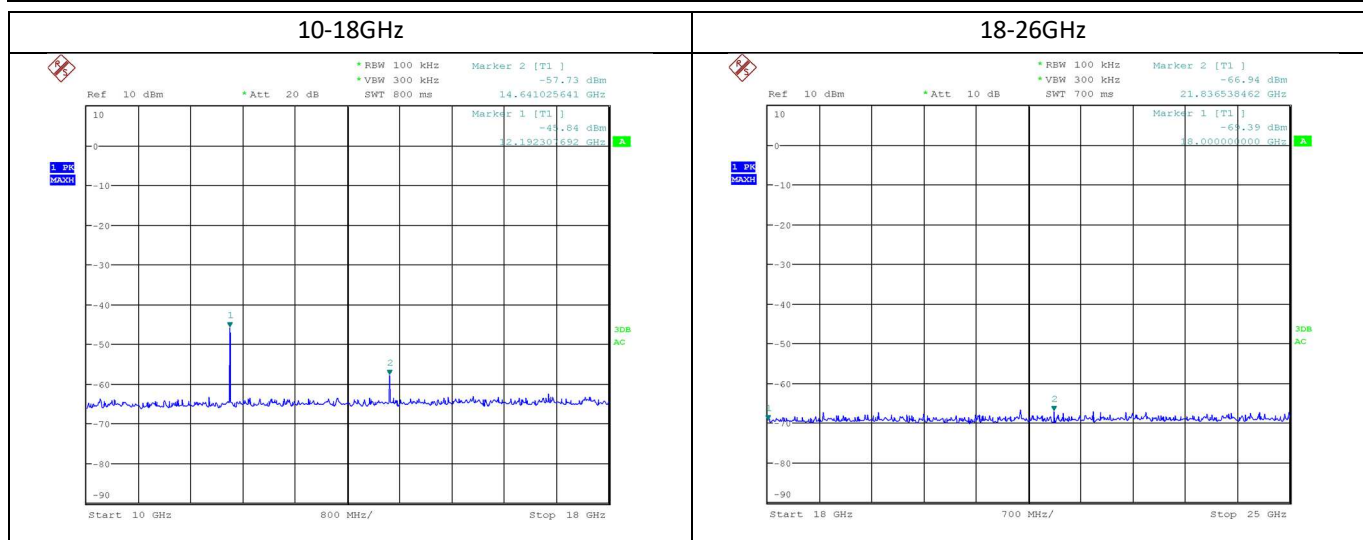
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
87.516	-59.30	4.12	63.42	-15.88	43.42
2211.53	-56.73		60.85		40.85
2596.15	-55.70		59.82		39.82
4806.09	-41.74		45.86		25.86
7206.73	-41.92		46.04		26.04
9618.59	-36.98		41.10		21.10
12000.0	-45.07		49.19		29.19
14410.2	-57.39		61.51		41.51
21836.5	-66.94		71.06		51.06

ADDITIONAL DOCUMENTATION

Graphical presentation of spurious emission

Operation mode: 2



ADDITIONAL DOCUMENTATION


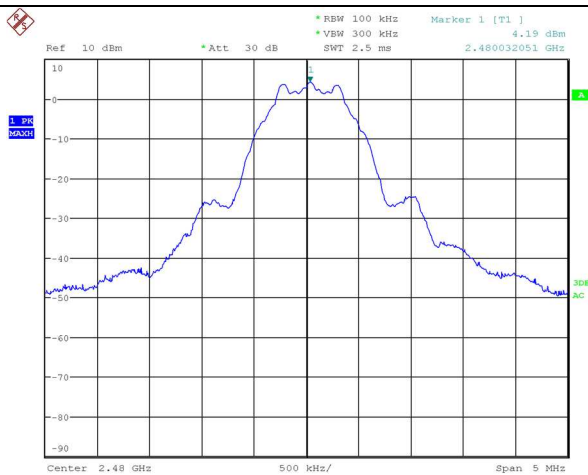
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
124.82	-59.55	4.09	63.64	-15.91	43.64
2250.00	-55.69		59.78		39.78
2634.61	-54.96		59.05		39.05
4873.39	-40.65		44.74		24.74
7318.91	-44.40		48.49		28.49
9764.42	-35.59		39.68		59.68
12192.3	-45.84		49.93		29.93
14641.0	-57.73		61.82		41.82
21836.5	-66.94		71.03		51.03

ADDITIONAL DOCUMENTATION

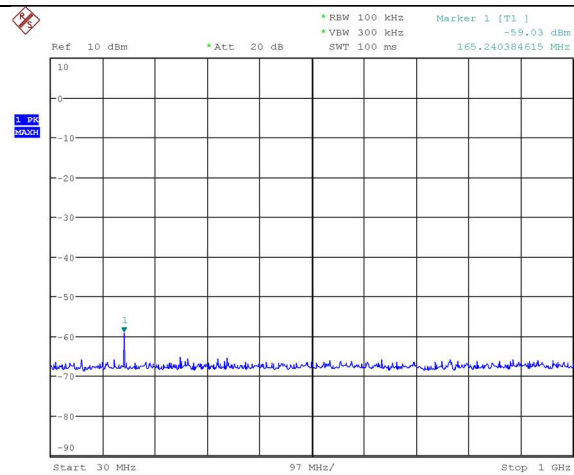
Graphical presentation of spurious emission

Operation mode: 3

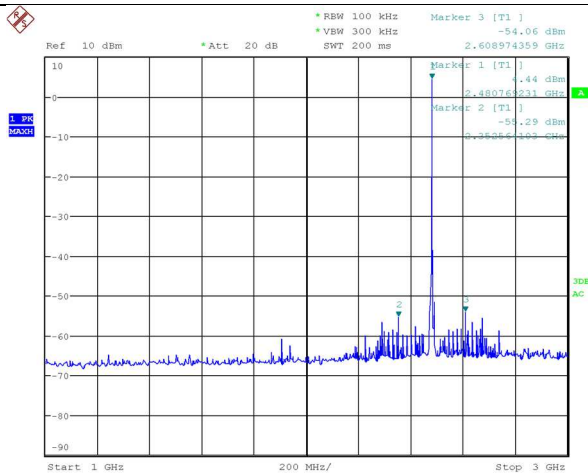
Fundamental



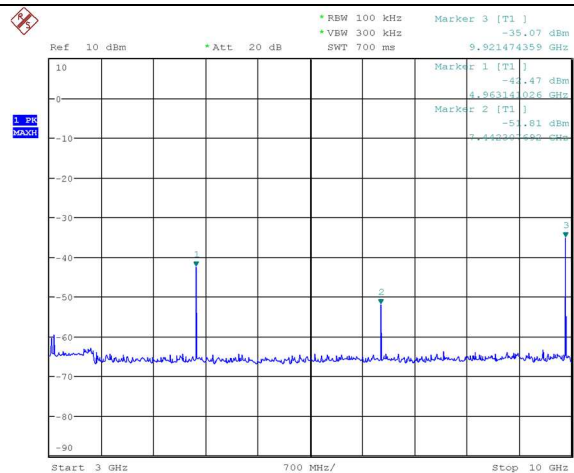
30MHz-1GHz

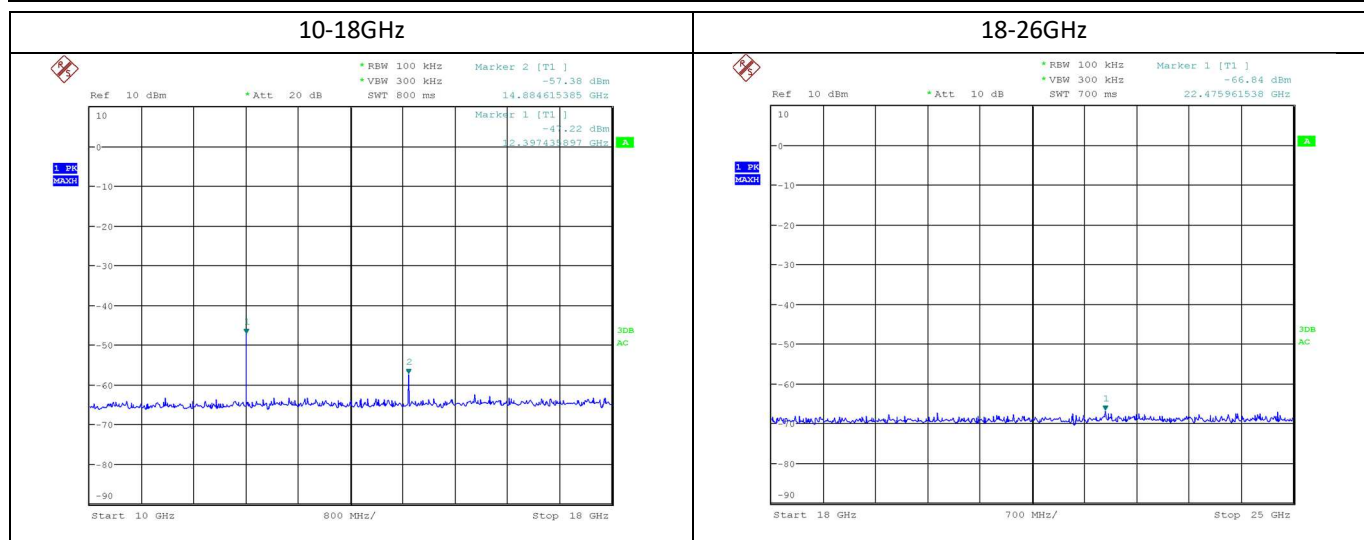


1-3GHz



3-10GHz



ADDITIONAL DOCUMENTATION


Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power -20dB (dBm)	Margin (dB)
165.24	-59.03	4.19	63.22	-15.81	43.22
2352.56	-55.29		59.48		39.48
2608.97	-54.06		58.25		38.25
4963.14	-42.47		46.66		26.66
7442.30	-51.81		56.00		36.00
9921.47	-35.07		39.26		19.26
12397.4	-47.22		51.41		31.41
14884.6	-57.38		61.57		41.57
22475.9	-66.84		71.03		51.03

ADDITIONAL DOCUMENTATION
100kHz Bandwidth of Frequency Band Edges

Test date	17-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.7.2 (Marker-Delta method) of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 6.10.4 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.:	N°2 Sample tested (1 for each frequency low and high)
Operating mode	1, 3
Tested terminals	Antenna connector
Result	Within the limit

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

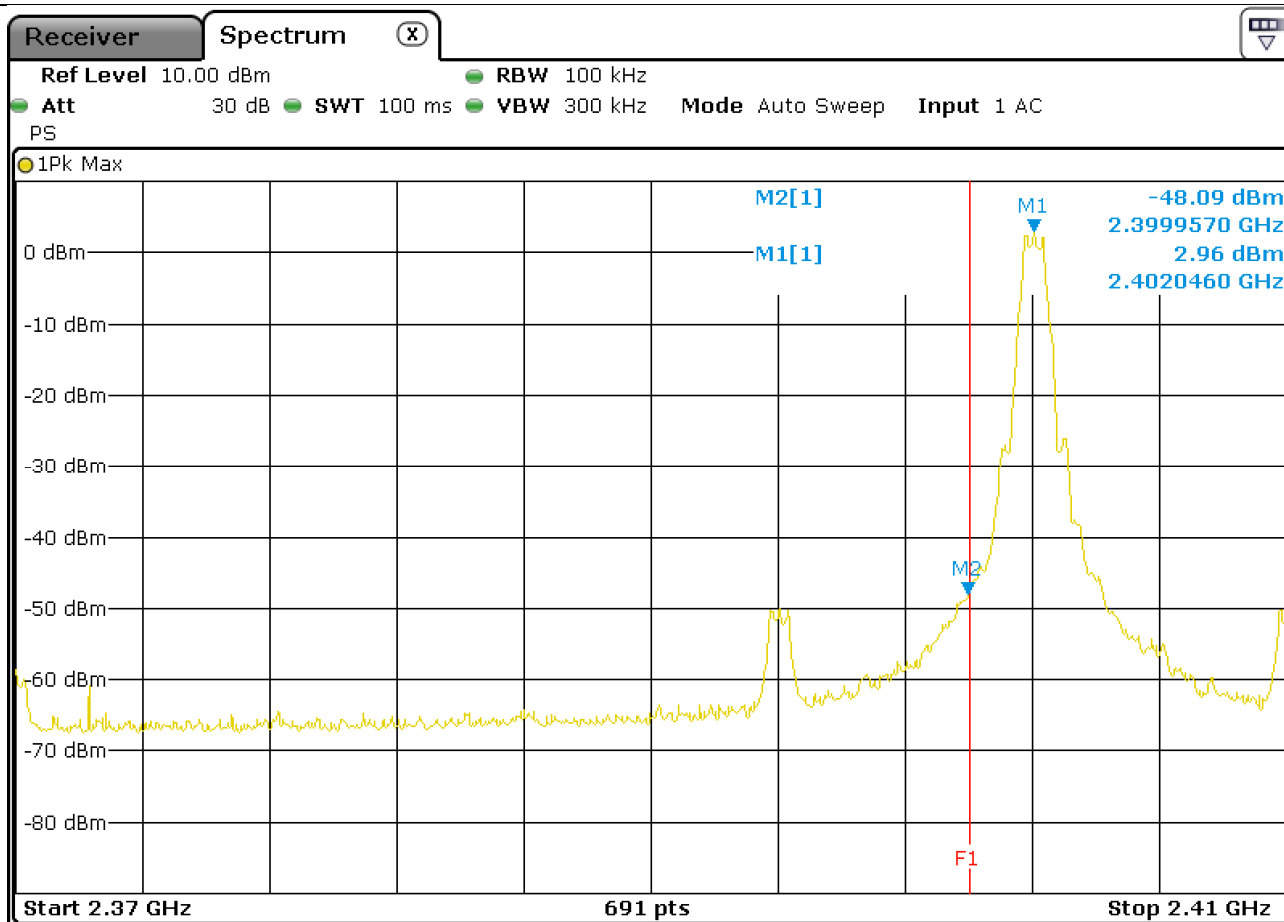
Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESR3	2782768	01/2021	01/2022

ADDITIONAL DOCUMENTATION

Graphical presentation of Band-Edge measurement

Operation mode: 1

**LOWER BAND-EDGE
CH 0**

Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

PEAK					
Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBm)	Margin (dB)
2399.95	-48.09	2.96	51.05	-17.04	31.05

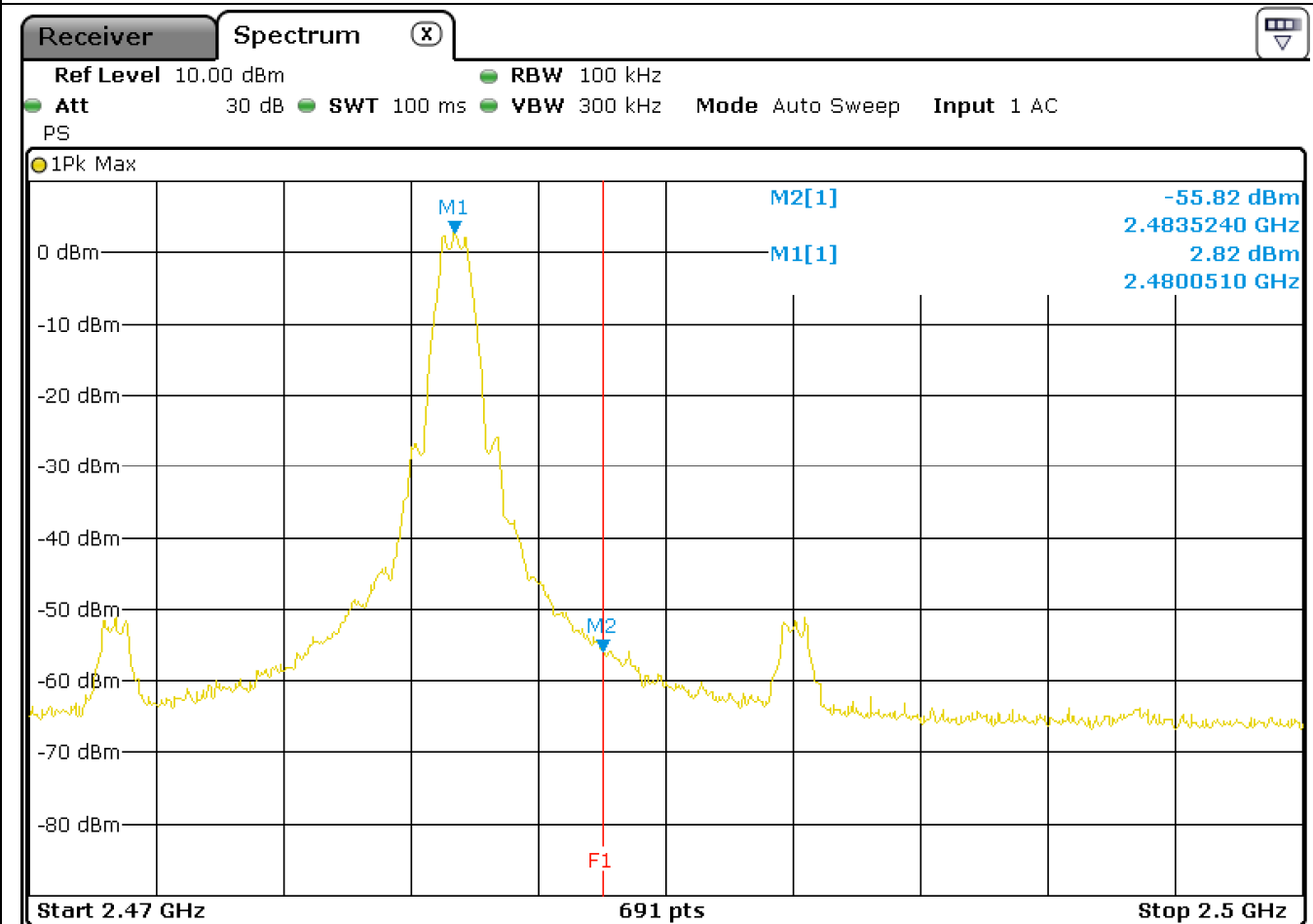


ADDITIONAL DOCUMENTATION

Graphical presentation of Band-Edge measurement

Operation mode: 3

UPPER BAND-EDGE
CH 39



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

PEAK					
Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dBm)	Margin (dB)
2483.52	-55.82	2.82	58.64	-17.17	38.65

ADDITIONAL DOCUMENTATION
Power Spectral Density

Test date	17-06-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.4 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 11.10.2 Method PK PSD of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	MINI2
Test sample No.:	N°3 Sample tested (1 for each frequency)
Operating mode	1, 2, 3
Tested terminals	Antenna connector
Result	PASS

(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

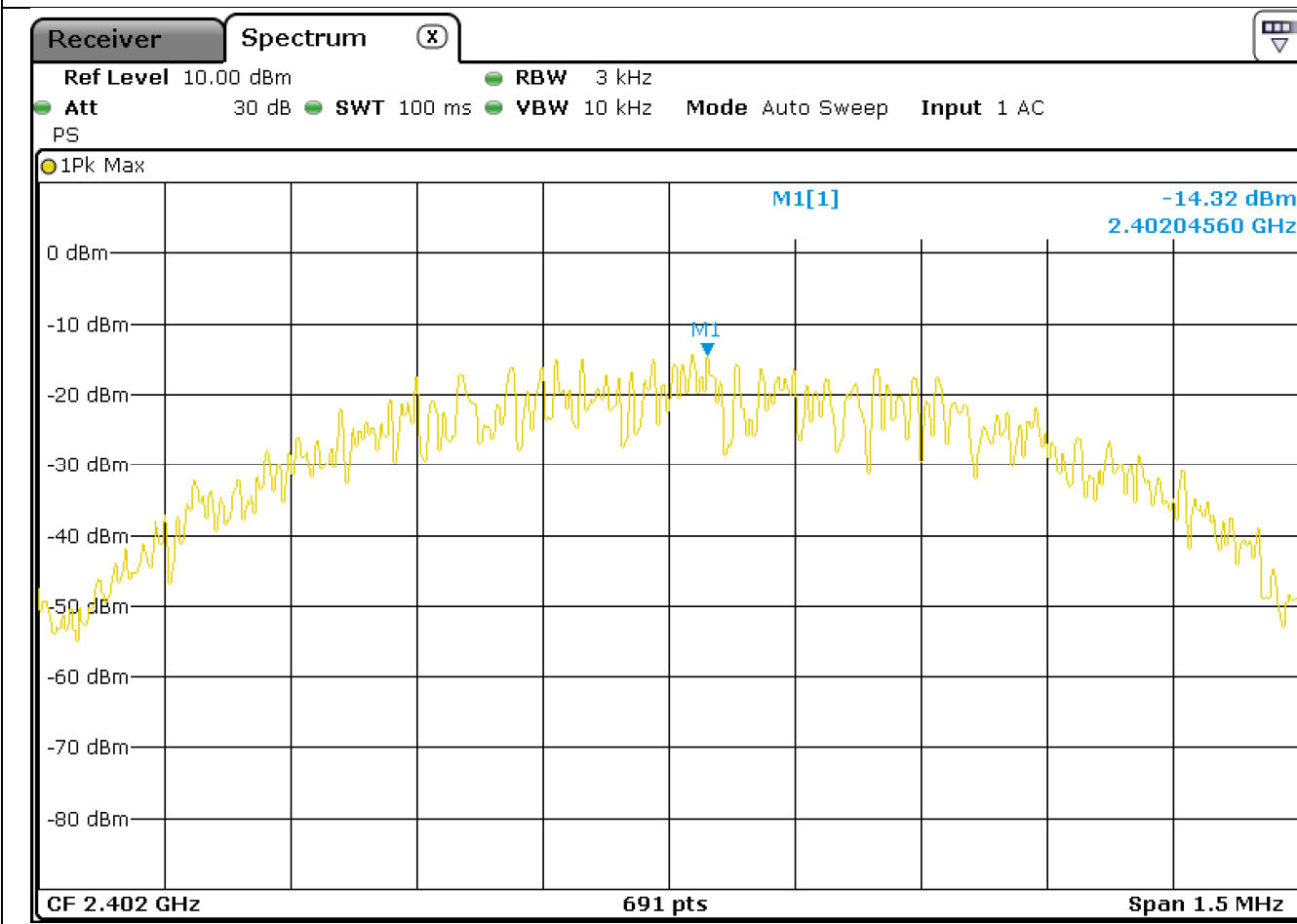
Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESR3	2782768	01/2021	01/2022

ADDITIONAL DOCUMENTATION

Graphical presentation of spectral density measurement

Operation mode: 1

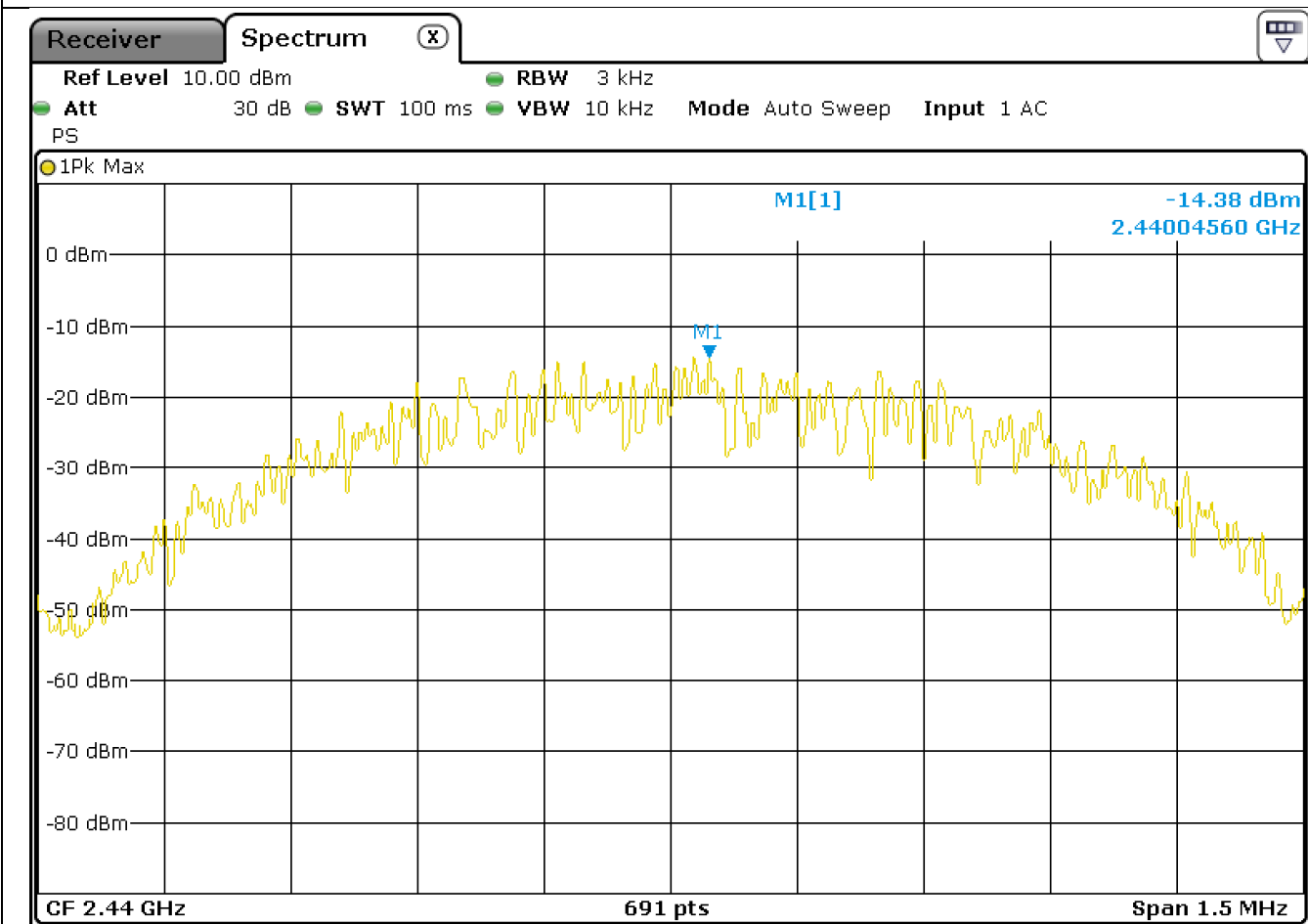


Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density	Limit (dBm)
		Measured (dBm)	
Low	2402	-14.32	8

ADDITIONAL DOCUMENTATION

Graphical presentation of spectral density measurement

Operation mode: 2

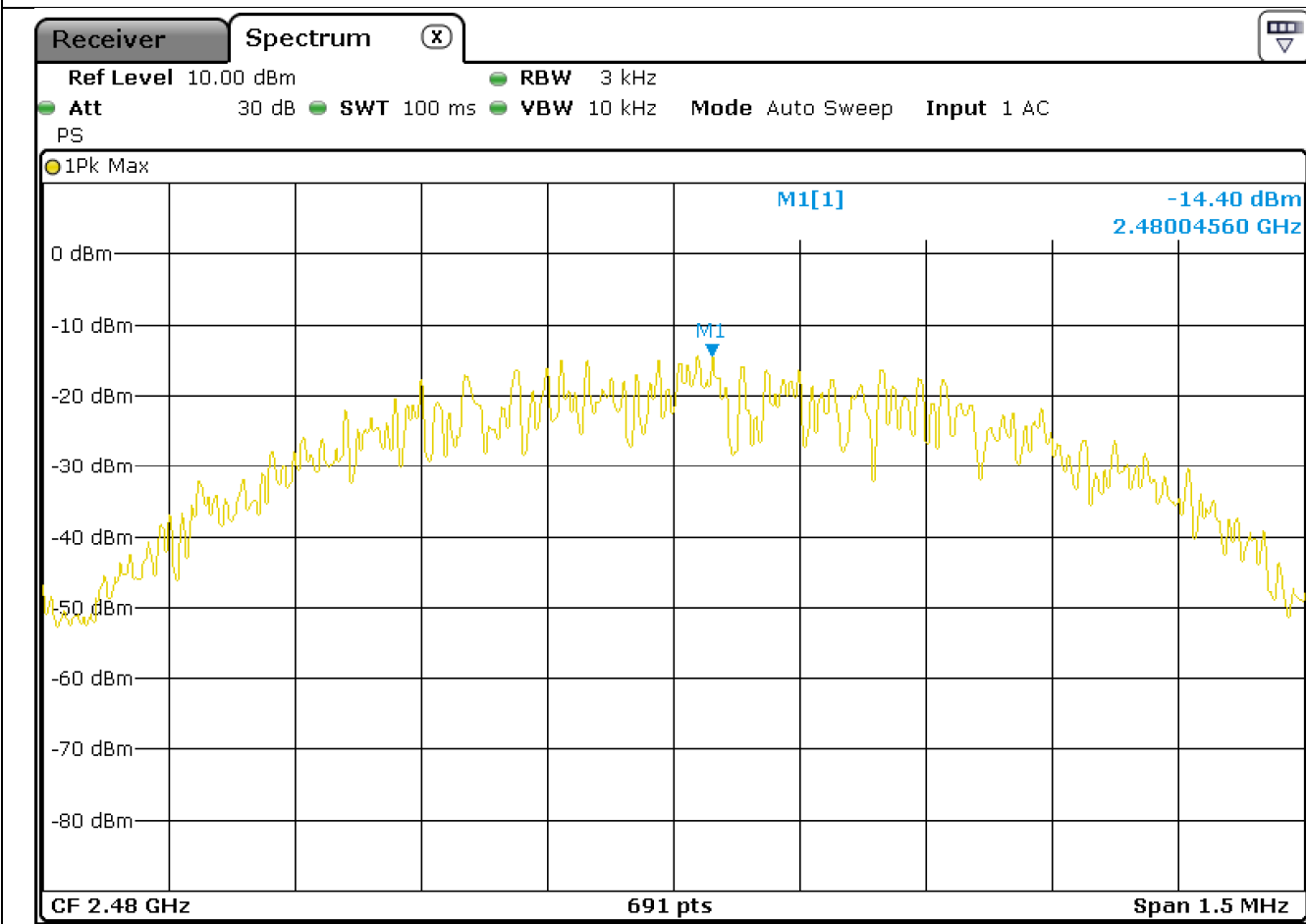


Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density	Limit (dBm)
		Measured (dBm)	
Middle	2440	-14.38	8

ADDITIONAL DOCUMENTATION

Graphical presentation of spectral density measurement

Operation mode: 3



Channel (No.)	Frequency (MHz)	Conducted Power Spectral Density	Limit (dBm)
		Measured (dBm)	
High	2480	-14.40	8

ADDITIONAL DOCUMENTATION
Additional provisions to the general radiated emission limitations.

<i>Test date</i>	17-06-2021
<i>Applied Standard</i>	Title 47 Part 15 Subpart C §15.215
<i>Test method</i>	---
<i>Temperature</i>	22° C
<i>Humidity</i>	42%
<i>Air pressure</i>	1027 mbar
<i>Tested by</i>	Roberto Radice
<i>Model</i>	MINI2
<i>Test sample No.:</i>	N°3 Sample tested (1 for each frequency)
<i>Operating mode</i>	1, 2, 3
<i>Tested terminals</i>	Antenna connector
<i>Result</i>	Within the limit

ADDITIONAL DOCUMENTATION

(A) The regulations in §§ 15.217-15.257 provide alternatives to the general radiated emission limits for intentional radiators operating in specified frequency bands. Unless otherwise stated, there are no restrictions as to the types of operation permitted under these sections.	
(B) In most cases, unwanted emissions outside of the frequency bands shown in these alternative provisions must be attenuated to the emission limits shown in Section 15.209. In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.	VERDICT
	PASS
(C) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least	VERDICT
	PASS

ADDITIONAL DOCUMENTATION**PHOTOGRAPHIC DOCUMENTATION**

See the Annex below:

DE21CTNK 001 Annex 1

Test Set-up photos

SAR EVALUATION

See the Annex below:

DE21CTNK 001 Annex 2

SAR Evaluation

---END OF TEST REPORT---