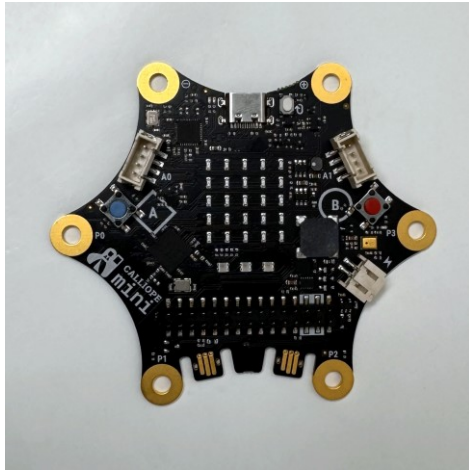


Prüfbericht-Nr.: Test report no.:	DE23OWMA 003	Auftrags-Nr.: Order no.:	1145625 50	Seite 1 von 67 Page 1 of 67
Kunden-Referenz-Nr.: Client reference no.:	-	Auftragsdatum: Order date:	2023-07-24	
Auftraggeber: Client:	Calliope gGmbH, Raumerstr. 11, 10437 Berlin, +49 (0)30 4849 2030			
Prüfgegenstand: Test item:	Calliope mini			
Bezeichnung / Typ-Nr.: Identification / Type no.:	Calliope mini V3			
Auftrags-Inhalt: Order content:	Prüfung der Funkparameter nach FCC & ISED Test of radio parameters acc. to FCC & ISED			
Prüfgrundlage: Test specification:	Vollprüfung / Complete test FCC CFR 47 Part 15 Subpart C- §15.247 ISED RSS-247:2017			
Wareneingangsdatum: Date of sample receipt:	2023-09-11			
Prüfmuster-Nr.: Test sample no.:	A003559646-002 to 003			
Prüfzeitraum: Testing period:	2023-10-04 - 2023-10-17			
Ort der Prüfung: Place of testing:	Nürnberg Nuremberg			
Prüflaboratorium: Testing laboratory:	Wireless Labor Wireless Test Lab			
Prüfergebnis*: Test result*:	Pass			
geprüft von: tested by:	 X _____ Signed by: Shriniwas Naikar		genehmigt von: authorized by:	 X _____ Signiert von: Matthias Kraeutlein
Datum: Date:	2024-01-18		Ausstellungsdatum: Issue date:	2024-01-18
Stellung / Position:	Sachverständige(r)/Expert		Stellung / Position:	Sachverständige(r)/Expert
Sonstiges / Other:	FCC ID: 2AQMD-CALLIOPE-V30 IC ID: 24686-CALLIOPEV30 Dieser Prüfbericht DE23OWMA-002 ersetzt den Prüfbericht DE23OWMA-001 und 002 (siehe Änderungsverzeichnis) / The test report DE23OWMA-003 replaces the test report DE23OWMA-001 and 002 (see change history).			
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:	Prüfmuster vollständig und unbeschädigt Test item complete and undamaged			
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet * Legend: P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable 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. This test report only relates to the above mentioned 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.				

V05

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 2 von 67
Page 2 of 67

Anmerkungen Remarks

1	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. <i>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.</i>
2	Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben. <i>As contractually agreed, this document has been signed digitally only. TUV 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, TUV 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.</i>
3	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. <i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i> <i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i>
4	Die Entscheidungsregel für Konformitätserklärungen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. <i>The decision rule for statements of conformity in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report.</i>

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 3 von 67
Page 3 of 67

Produktbeschreibung
Product description

1	Test item	Calliope mini
2	Typ-No.	Calliope mini V3
3	Test sample obtaining	☒ Sending by customer ☐ Sampling by TÜV Rheinland Group ☐ others:
4	Supported radio technologies	BLE 5.1
5	Description of EUT	The Calliope mini has been designed to be a micro controller board for the use by children aged 8-16 in schools. It is an open development system.
6	Max RF output power (declared)	0 dBm
7	Operating Frequency (declared)	2402MHz – 2480MHz
8	Channel Bandwidth (declared)	1MHz
9	Number of Channels	40
10	Modulation	GFSK
11	Rated Voltage / Frequency	2-5V DC (Battery Operated)
12	Radio Module / Antenna Type	☒ Radio module with antenna on module PCB ☐ Radio module with dedicated antenna ☐ Radio module with user accessible antenna connector
13	Antenna Name	PCB Antenna
14	Antenna Type	☒ Integral antenna ☐ Dedicated antenna ☐ Permanent antenna connector
15	Antenna number of chains	1
16	Antenna Gain (declared)	3.14 dBi
17	Software	6.0.27
18	Hardware	REV14
19	Used Samples	A003559646-002 to 003
20	Accessory Devices	A003562613-001 (Battery holder)
21	I/O Ports	Refer to the product specification (Section 6, 7 and 8)
22	Temperature Range	-10° to 50°C
23	Environment	Indoor and Outdoor

Prüfbericht-Nr.: DE23OWMA 003

Seite 4 von 67

Test report no.:

Page 4 of 67

Absatz Clause	Anforderungen – Prüfungen / Requirements - Tests	Bemerkungen / Remarks	Ergebnis Result
FCC 15.247 (a)(1) RSS-247 sec. 5.1	20 dB Bandwidth	Does not apply for DTS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Number of Hopping Frequencies	Does not apply for DTS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Time of Occupancy	Does not apply for DTS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (a)(1) RSS-247 sec. 5.1	Carrier Frequency Separation	Does not apply for DTS equipment	P ☐ F ☐ N/A ☒ N/T ☐
FCC 15.247 (b) RSS-247 sec. 5.4	Maximum Output Power	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (e) RSS-247 sec. 5.2 (b)	Power Spectral Density	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (a)(2) RSS-247 sec. 5.2 (a)	6dB Bandwidth	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (d) RSS-247 sec. 5.5	Band Edge Measurement	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.247 (d) RSS-247 sec. 5.5	Conducted Spurious Emission	-	P ☒ F ☐ N/A ☐ N/T ☐
FCC 15.205, 15.209 RSS-Gen sec. 8.9, 8.10	Restricted Bands of Operation and Radiated Spurious Emission	Tested on the worst-case modulation and channel per frequency range as shown in original filing.	P ☒ F ☐ N/A ☐ N/T ☐

Prüfbericht-Nr.: DE23OWMA 003

Seite 5 von 67

Test report no.:

Page 5 of 67

Absatz Clause	Anforderungen – Prüfungen / Requirements - Tests	Bemerkungen / Remarks	Ergebnis Result
FCC 15.207 RSS-Gen sec. 8.8	AC Power Conducted Emissions	-	P ☒ F ☐ N/A ☐ N/T ☐

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 6 von 67
Page 6 of 67

Prüfdokumentation
Test documentation

Contents

1	EUT Classification	7
1.1	Wireless technologies and frequencies supported by the EUT	7
1.2	Standard specific classification of the EUT	7
2	General	8
2.1	Registration	8
2.2	Equipment modifications	8
2.3	Test modes	8
2.4	Worst case Test Modes	9
3	Test conditions	10
3.1	General	10
3.2	Normal test conditions	10
3.3	Antenna assemblies	10
3.4	Measurement Uncertainty	11
4	Test results in detail	12
4.1	Maximum Output Power	12
4.2	Power Spectral Density	18
4.3	6 dB Bandwidth (DTS bandwidth) and 99% Bandwidth	23
4.4	Conducted Spurious Emissions	28
4.5	Band Edge Measurement	35
4.6	Radiated Spurious Emissions& Restricted Bands of Operation	40
4.7	AC Power Conducted Emission	58
5	Photo documentation	64
6	Equipment List	65
6.1	Hardware	65
6.2	Software	66
7	Change History	67

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 7 von 67
Page 7 of 67

Prüfdokumentation
Test documentation

1 EUT Classification

1.1 Wireless technologies and frequencies supported by the EUT

The named technologies are only those falling in the specification of the applied standard.

Technology	Frequency Range (TX)	TX Function	Supported by the EUT	Evaluated in this report
802.11b	2400 – 2483.5 MHz	SISO	☐	☐
802.11g	2400 – 2483.5 MHz	SISO	☐	☐
802.11n (20MHz)	2400 – 2483.5 MHz	SISO	☐	☐
802.11n (40MHz)	2400 – 2483.5 MHz	SISO	☐	☐
BLE 5.1	2402 – 2480 MHz	SISO	☒	☒

1.2 Standard specific classification of the EUT

1.2.1 Applied standards

FCC CFR 47 Part 15 Subpart C - §15.247

ISED RSS-247:2017

1.2.2 Test Methods and Guidance Documents

ANSI C63.10:2013

KDB 558074 D01 DTS Measurement Guidance v05

1.2.3 System Type

☒	DTS (Digital Transmission System)
☐	FHSS (Frequency Hopping Spread Spectrum)

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 8 von 67
Page 8 of 67

Prüfdokumentation
Test documentation

2 General

2.1 Registration

The measurement facilities for conducted and radiated disturbance measurements of the TÜV Rheinland LGA Products have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules. Measurement data will be accepted in conjunction with applications for Certification under Parts 15 and 18 of the Commission's Rules.

FCC Registration Number: 939976

Bundesnetzagentur Registration Number: BNetzA-CAB-17/21-16

The measurement facilities are also recognized by Innovation, Science and Economic Development (ISED) Canada to test to Canadian radio equipment requirements.

Company Number: 11235A

CAB Identifier: DE0018

2.2 Equipment modifications

No modifications were found to be necessary in order to perform the tests or to achieve compliance.

2.3 Test modes

Mode	Description	Mode configuration
All Modes 1		☒ The auxiliary equipment (laptop) was connected to the EUT during the tests to keep the configured settings active. The laptop was placed outside of the FAC. The connection was realized by a shielded feedthrough. ☐ The auxiliary equipment (Laptop) was only connected to the EUT before the tests for the mode configuration. During the test the auxiliary equipment was disconnected from the EUT.
1	Continuous transmit Mode	Tx modulated with continuous transmission on low, mid, and high channels Frequencies: 2402 MHz, 2440 MHz, 2480 MHz. bandwidth: 1 MHz. Datarates: 1Mbps and 2Mbps. NRF Direct Test Mode tool was used for channel and data rate configuration.

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 9 von 67
Page 9 of 67

Prüfdokumentation
Test documentation

2.4 Worst case Test Modes

Following configurations were used for the test cases:

Test case	Worst case Configuration
Maximum Output Power	Freq: 2402MHz, 2440MHz, 2480MHz. BW:1 MHz. Data rate:1Mbps and 2Mbps.
Radiated Spurious Emissions < 30 MHz	Freq: 2402MHz, 2440MHz, 2480MHz. BW:1 MHz. Data rate:1Mbps
Radiated Spurious Emissions 30 MHz – 1 GHz	Freq: 2402MHz, 2440MHz, 2480MHz. BW:1 MHz. Data rate:1Mbps
Radiated Spurious Emissions > 1 GHz	Freq: 2402MHz, 2440MHz, 2480MHz. BW:1 MHz. Data rate:1Mbps

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 10 von 67
Page 10 of 67

Prüfdokumentation
Test documentation

3 Test conditions

3.1 General

The DUT was tested standalone on the transmit test mode in normal test conditions.

3.2 Normal test conditions

Environmental condition	Parameter	Range
Temperature	°C	21-24
Relative humidity	%	20-60
Supply voltage	Volts DC	2 to 5

3.3 Antenna assemblies

Antenna connector is prepared so tests were done in conducted and radiated mode.

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 11 von 67
Page 11 of 67

Prüfdokumentation
Test documentation

3.4 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	Value	Unit	Range
Frequency Error	2,7 *10 ⁻⁸	Hz	-
Frequency Stability under low voltage conditions			
Time	1,1*10 ⁻⁹	s	-
Conducted Carrier Power	1.0	dB	9k-1GHz
Conducted Spurious Emissions (RX/TX)	1.7	dB	1GHz-6GHz
	2.8	dB	6GHz-40GHz
Occupied Bandwidth (OBW)	0.1	%	-
TX Power Spectral Density	4.2	mW	9kHz - 6GHz
	1.6	dB	9kHz - 6GHz
Dwell Time	4,6 *10 ⁻⁷	Hz	-
Frequency Separation			-
Measurement of conducted emissions at the power supply connection to LISN	2.3	dB	9kHz – 150kHz
	2.2	dB	150kHz – 30MHz
Measurement of the field strength at distance 3m	1.6	dB	9k-150kHz
	4.5	dB	30-1000MHz
	5	dB	1-6GHz
	5.3	dB	6-40GHz
Temperature	0.8	K	-
Humidity	4	%	-
Voltage (AC/DC)	1.0	%	-

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 12 von 67
Page 12 of 67

Prüfdokumentation
Test documentation

4 Test results in detail

4.1 Maximum Output Power

4.1.1 Requirements / Limits

The maximum output power limit is expressed in terms of either maximum peak conducted output power or maximum conducted output power.

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the full signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

	Condition		Limit
☒	Systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands		<i>FCC Part 15, Subpart C, §15.247 (b) (3)</i> 1 watt = 30dBm. Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).
☐	Frequency hopping systems operating 2400-2483.5 MHz band.	Employing less than 75 non-overlapping hopping channels	<i>FCC Part 15, Subpart C, §15.247 (b) (1)</i> 0.125 watt = 21dBm.
☐		Employing at least 75 non-overlapping hopping channels	<i>FCC Part 15, Subpart C, §15.247 (b) (1)</i> 1 watt = 30dBm.
☐	Frequency hopping systems operating 5725-5850 MHz band.		<i>FCC Part 15, Subpart C, §15.247 (b) (1)</i> 1 watt = 30dBm.
☐	Frequency hopping systems operating 902-928 MHz band.	Employing less than 50 but at least 25 hopping channels	<i>FCC Part 15, Subpart C, §15.247 (b) (2)</i> 0.25 watt = 24dBm.
☐		Employing at least 50 hopping channels	<i>FCC Part 15, Subpart C, §15.247 (b) (2)</i> 1 watt = 30dBm
☐	Antenna gain greater than 6dBi		<i>FCC Part 15, Subpart C, §15.247 (b) (4)</i> The conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3), as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi

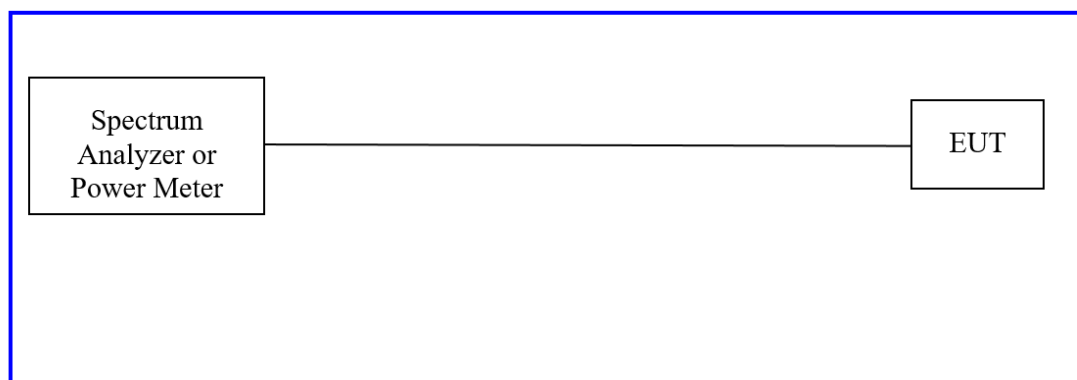
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 13 von 67
Page 13 of 67

Prüfdokumentation Test documentation

4.1.2 Test Method

Conducted method was used to measure the maximum output power according to ANSI C63.10:2013 clause 11.9.1.1 peak power (RBW > DTS bandwidth). The EUT was connected to the spectrum analyzer via a coax cable with a known loss.



4.1.3 Test setup

EUT		A003559646-002 to 003
Test Condition		Normal conditions
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan ☒ N/A
Operation mode		Mode1: TX Modulated 1 Mbps with continuous transmission. TX Modulated 2 Mbps with continuous transmission
Spectrum Analyzer	Frequency	2402MHz. 2440MHz and 2480MHz
	Resolution Bandwidth	1 MHz (1Mbps) 2MHz (2Mbps)
	Video Bandwidth	3 MHz (1Mbps) 10MHz (2Mbps)
	Detector	Max Peak
Further parameters		-
Test engineer		Shrinivas Naikar

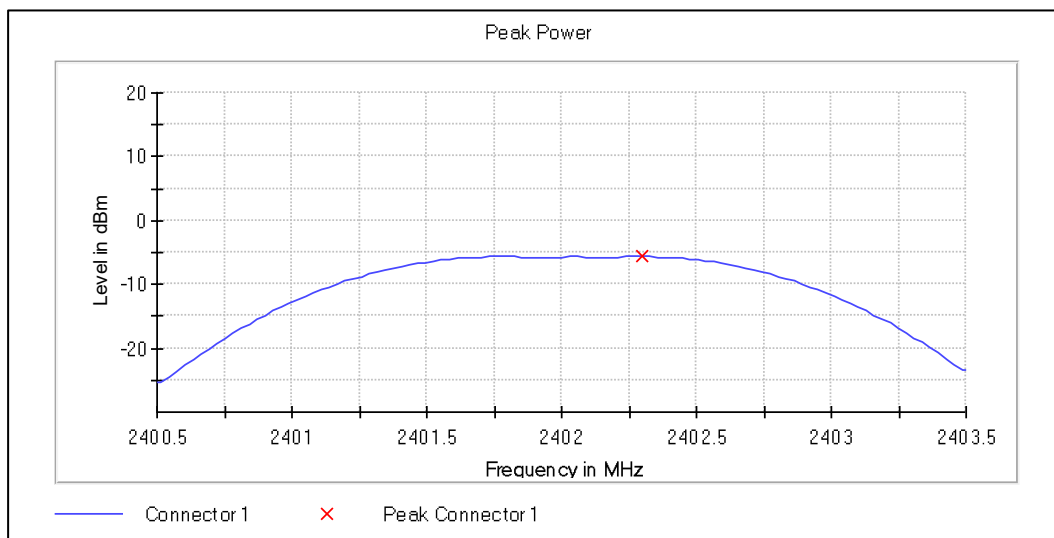
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 14 von 67
Page 14 of 67

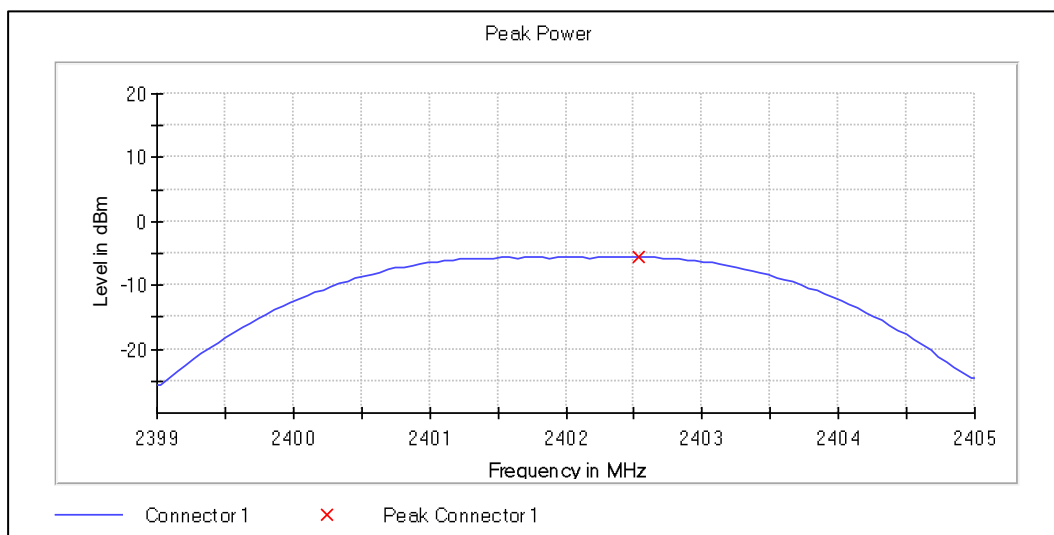
Prüfdokumentation Test documentation

4.1.4 Test results

- - Lowest Channel 1Mbps -



- - Lowest Channel 2Mbps -

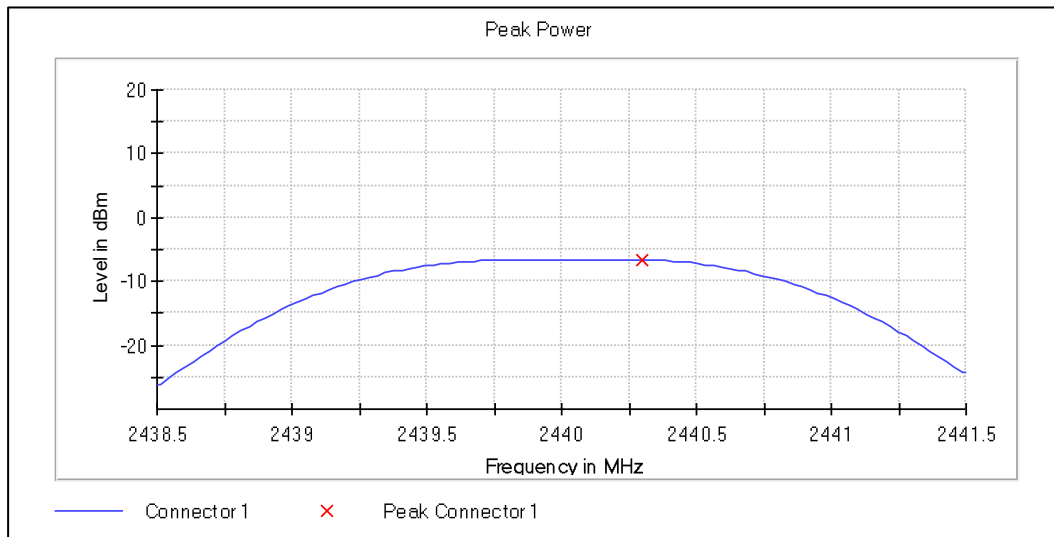


Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

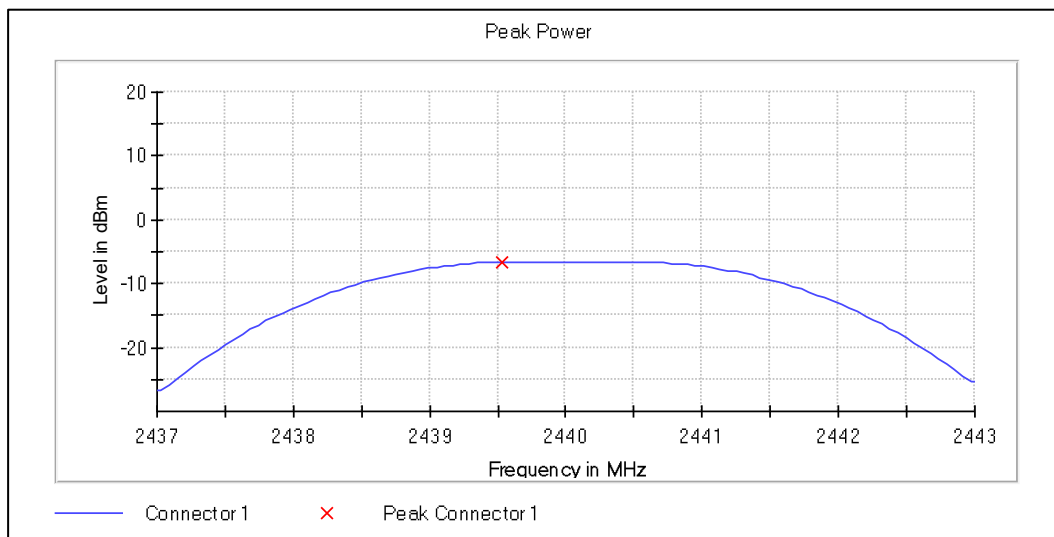
Seite 15 von 67
Page 15 of 67

Prüfdokumentation
Test documentation

- **Middle Channel 1Mbps**



- **Middle Channel 2Mbps**

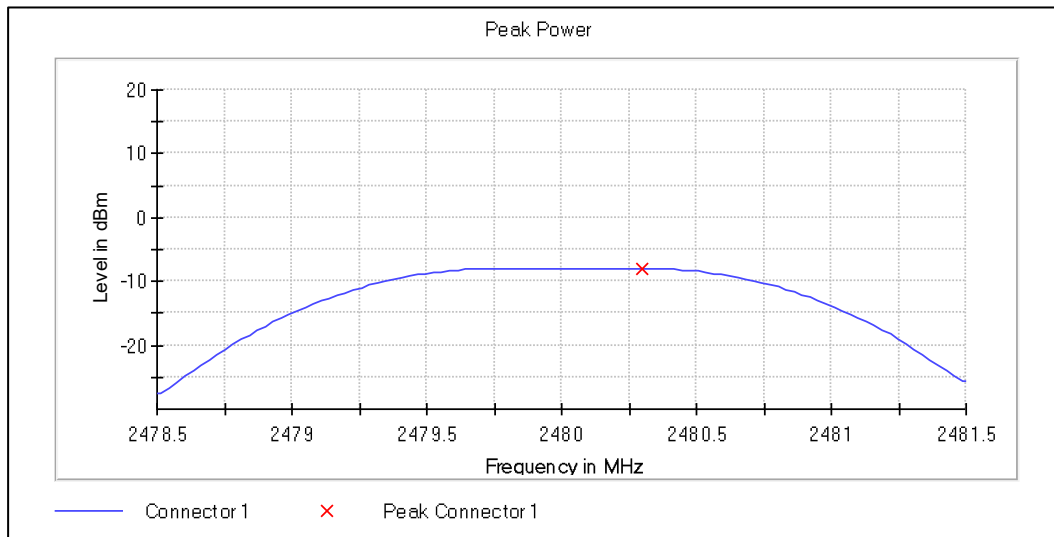


Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

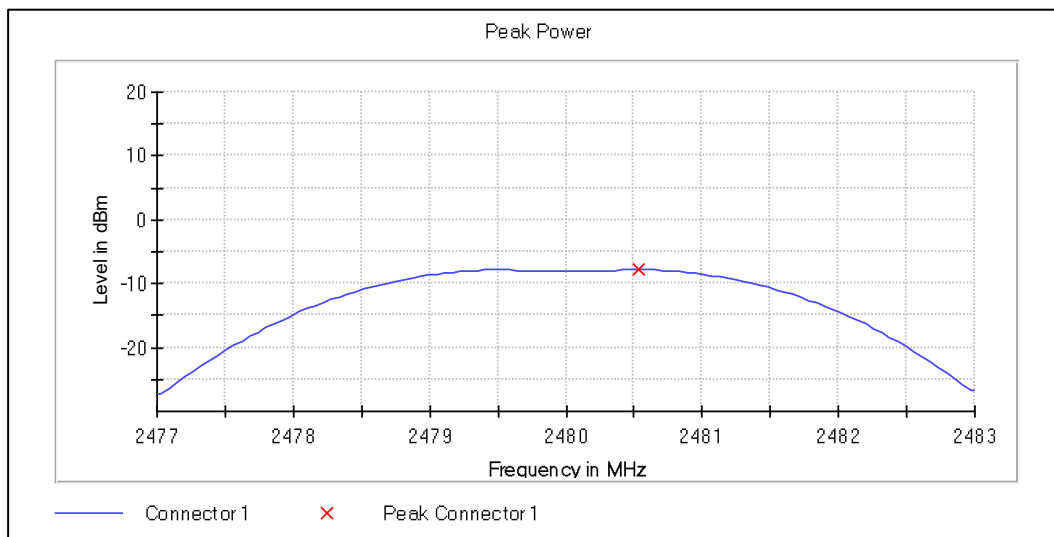
Seite 16 von 67
Page 16 of 67

Prüfdokumentation
Test documentation

- **Highest Channel 1Mbps**



- **Highest Channel 2Mbps**



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 17 von 67
Page 17 of 67

Prüfdokumentation
Test documentation

Data Rates [Mbps]	Frequency [MHz]	Peak conducted output power (dBm)	Limit (dBm)	Margin (dB)	Test Result
1	2402	-5.6	30	35.6	Pass
	2440	-6.7		36.7	Pass
	2480	-7.9		37.9	Pass
2	2402	-5.6	30	35.6	Pass
	2440	-6.7		36.7	Pass
	2480	-7.8		37.8	Pass

Final test result	Pass
--------------------------	------

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 18 von 67
Page 18 of 67

Prüfdokumentation Test documentation

4.2 Power Spectral Density

4.2.1 Requirements / Limits

FCC Part 15, Subpart C, §15.247 (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.

4.2.2 Test Method

The same method of determining the conducted output power shall be used to determine the power spectral density according to ANSI C63.10:2013 clause 11.10.2 peak PSD.

4.2.3 Test setup

EUT		A003559646-002 to 003
Test Condition		Normal conditions
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan
		☒ N/A
Operation mode		Mode1: TX Modulated 1 Mbps with continuous transmission. TX Modulated 2 Mbps with continuous transmission
Spectrum Analyzer	Centre Frequency	2402MHz, 2440MHz and 2480MHz
	Resolution Bandwidth	10KHz
	Video Bandwidth	30KHz
	Span	1.5 MHz
	Detector	Max Peak
Further parameters		-
Test engineer		Shrinivas Naikar

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

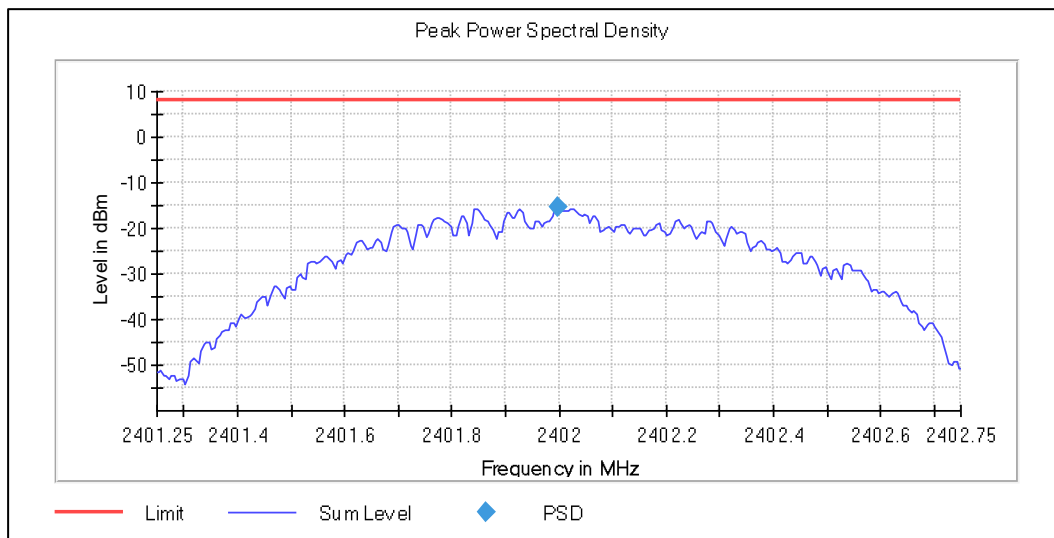
Seite 19 von 67
Page 19 of 67

Prüfdokumentation
Test documentation

4.2.4 Test results

- Lowest Channel 1Mbps

-



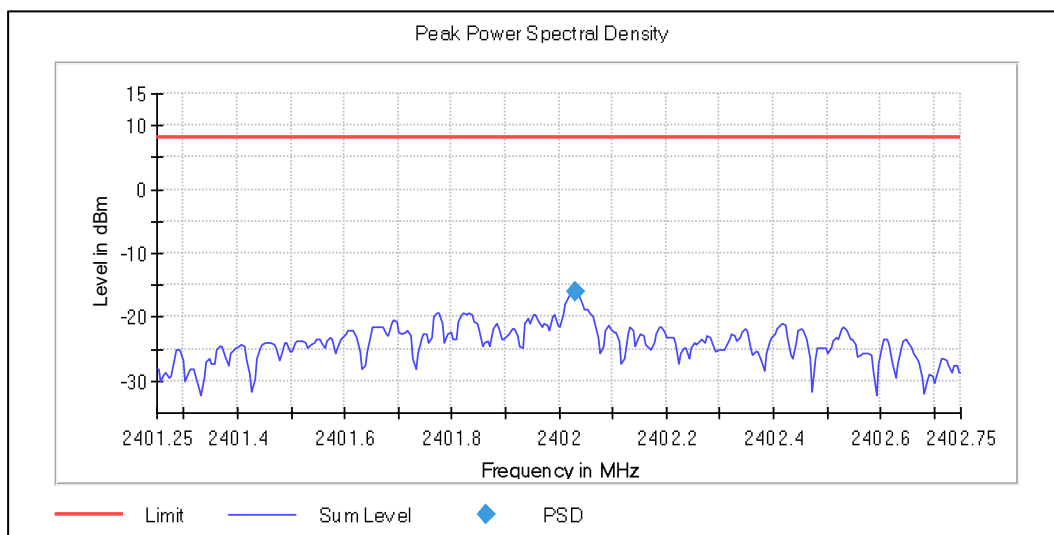
-

-

-

- Lowest Channel 2Mbps

-



-

-

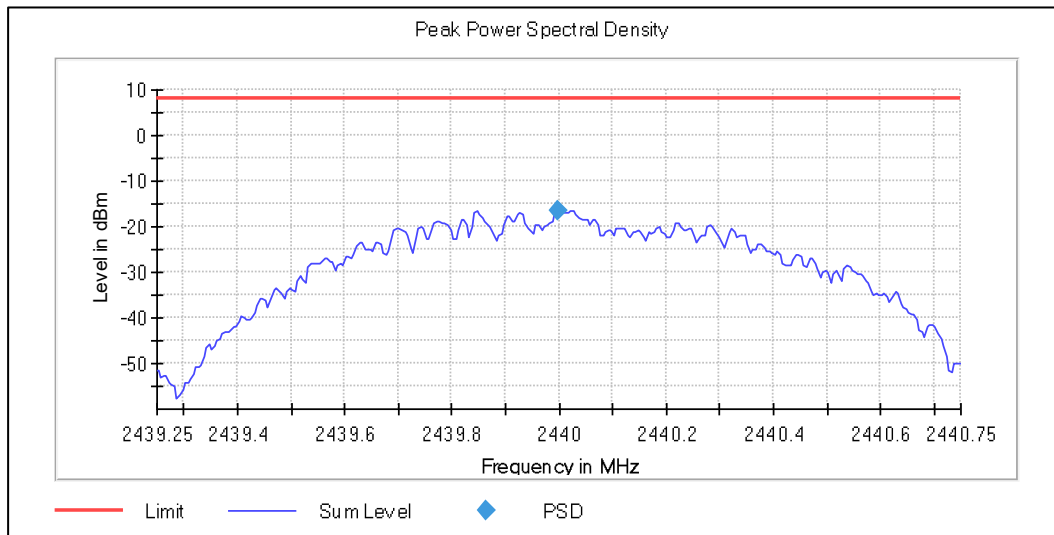
-

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

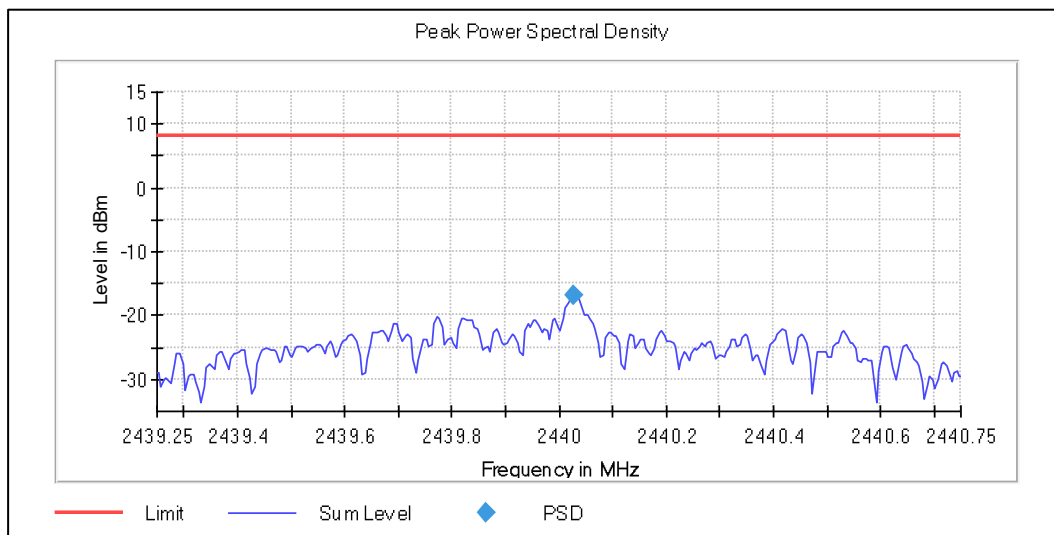
Seite 20 von 67
Page 20 of 67

Prüfdokumentation
Test documentation

- **Middle Channel 1Mbps**



- **Middle Channel 2Mbps**

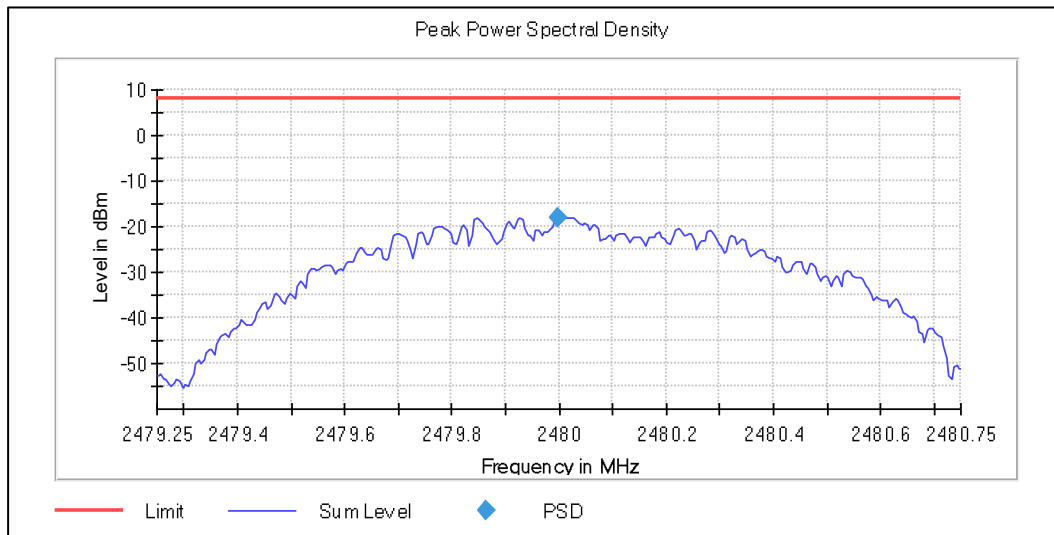


Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

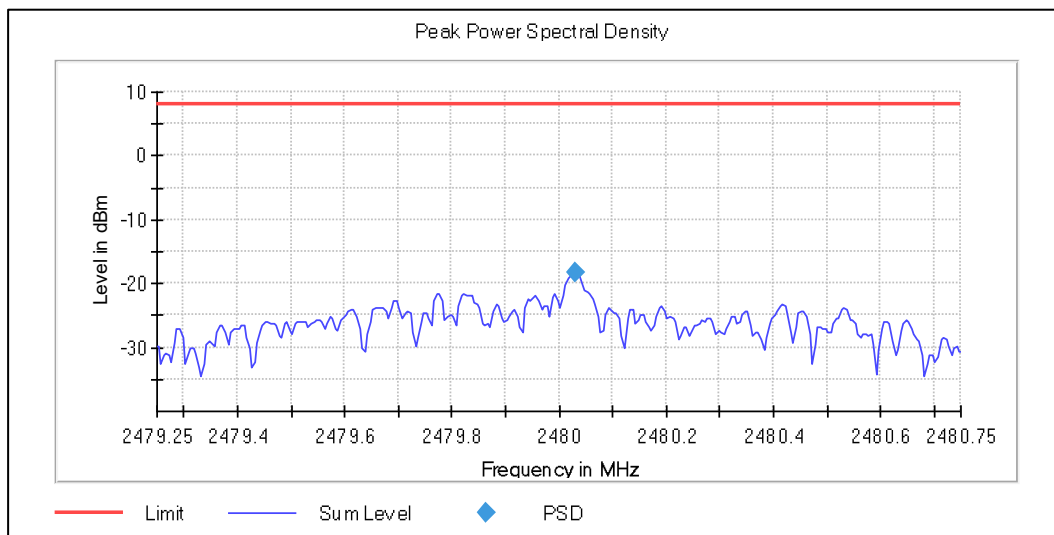
Seite 21 von 67
Page 21 of 67

Prüfdokumentation
Test documentation

- **Highest Channel 1Mbps**



- **Highest Channel 2Mbps**



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 22 von 67
Page 22 of 67

Prüfdokumentation
Test documentation

Data Rates (Mbps)	Frequency (MHz)	Peak conducted power spectral density (dBm/MHz)	Limit (dBm)	Margin (dB)	Test Result
1	2402	-15.49	8	23.49	Pass
	2440	-16.64		24.64	Pass
	2480	-17.89		25.89	Pass
2	2402	-16.03	8	24.03	Pass
	2440	-16.97		24.97	Pass
	2480	-18.26		26.26	Pass

Final test result	Pass
--------------------------	------

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 23 von 67
Page 23 of 67

Prüfdokumentation
Test documentation

4.3 6 dB Bandwidth (DTS bandwidth) and 99% Bandwidth

4.3.1 Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (2)

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.

4.3.2 Test Method

Conducted method was used to measure the 6 dB bandwidth according to ANSI C63.10:2013 clause 6.9.2. The EUT was connected to the spectrum analyzer via a coax cable with a known loss

4.3.3 Test setup

EUT		A003559646-002 to 003
Test Condition		Normal conditions
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan
		☒ N/A
Operation mode		Mode1: TX Modulated 1 Mbps with continuous transmission. TX Modulated 2 Mbps with continuous transmission
Spectrum Analyzer	Centre Frequency	2402MHz, 2440MHz and 2480MHz
	Resolution Bandwidth	100 kHz for 6 dB bandwidth 1 to 5% of OCB for 99% bandwidth (BW:1MHz so RBW is 10 KHz)
	Video Bandwidth	300 kHz for 6 dB bandwidth 30 KHz for 99% bandwidth
	Span	2MHz
	Detector	Max Peak
Further parameters		-
Test engineer		Shrinivas Naikar

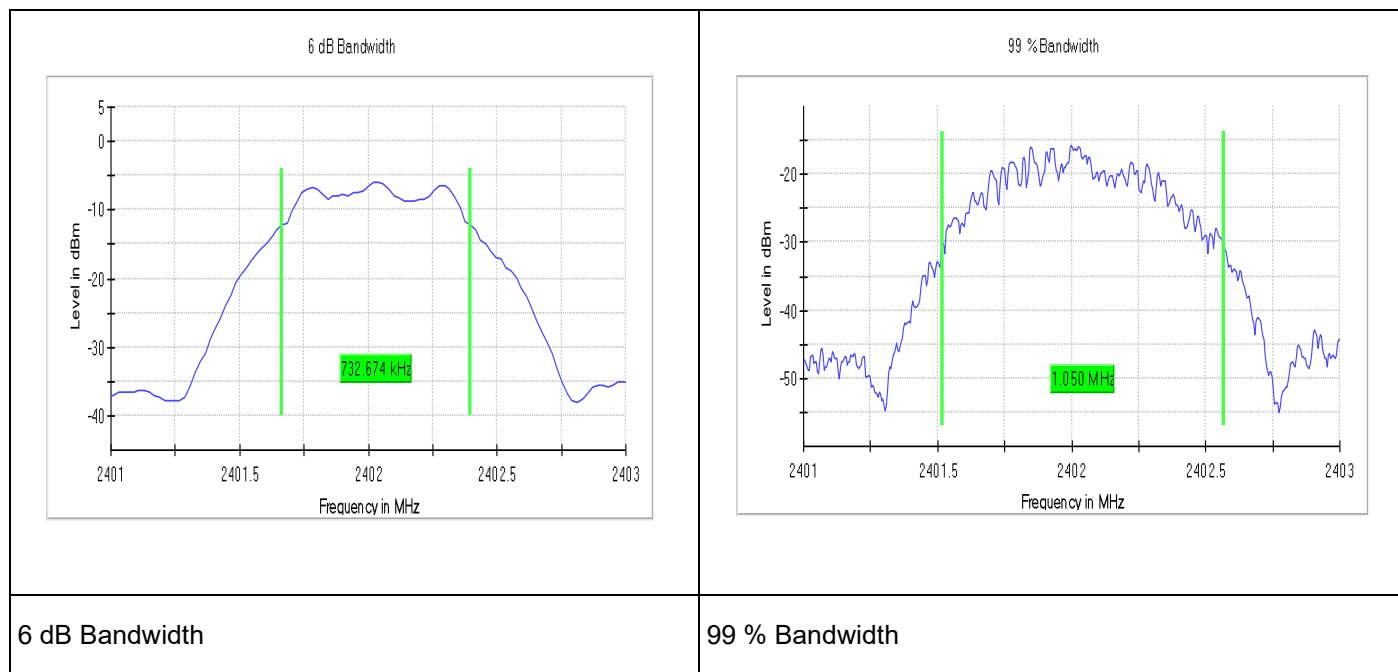
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 24 von 67
Page 24 of 67

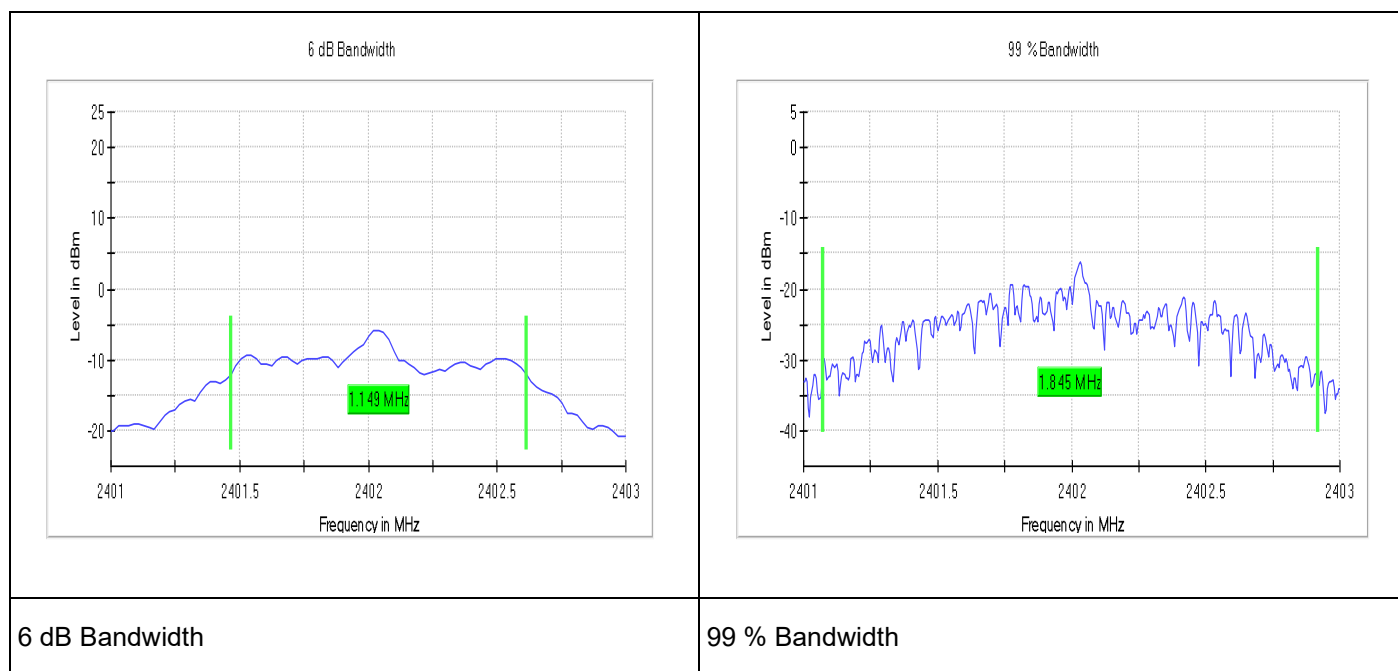
Prüfdokumentation Test documentation

4.3.4 Test Results

- Lowest Channel 1Mbps



- Lowest Channel 2Mbps

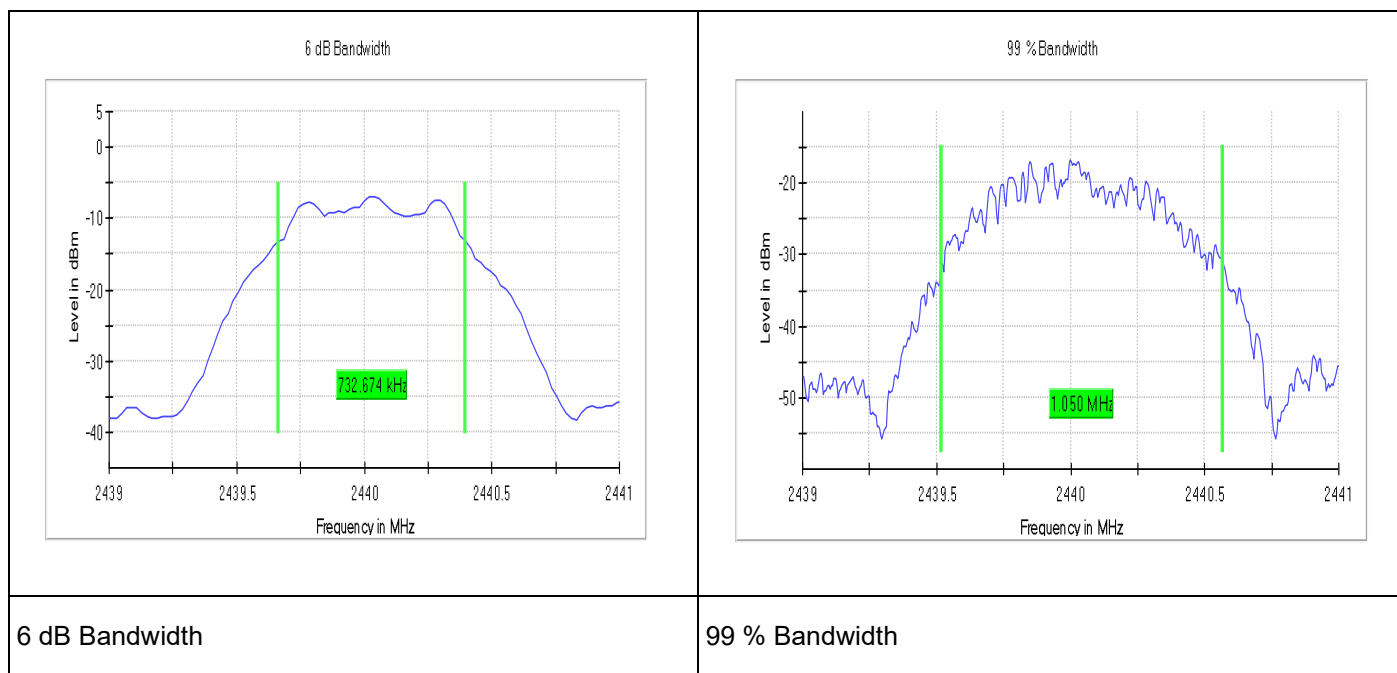


Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

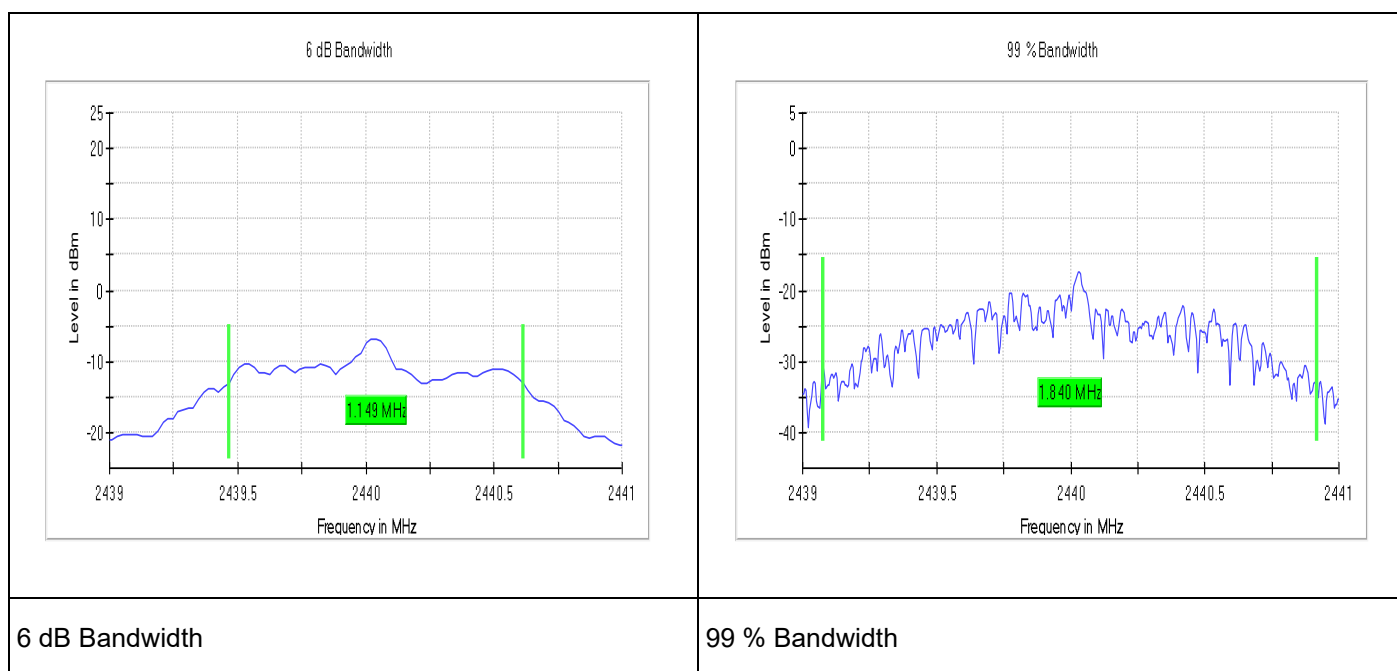
Seite 25 von 67
Page 25 of 67

Prüfdokumentation Test documentation

- Middle Channel 1Mbps



- Middle Channel 2Mbps

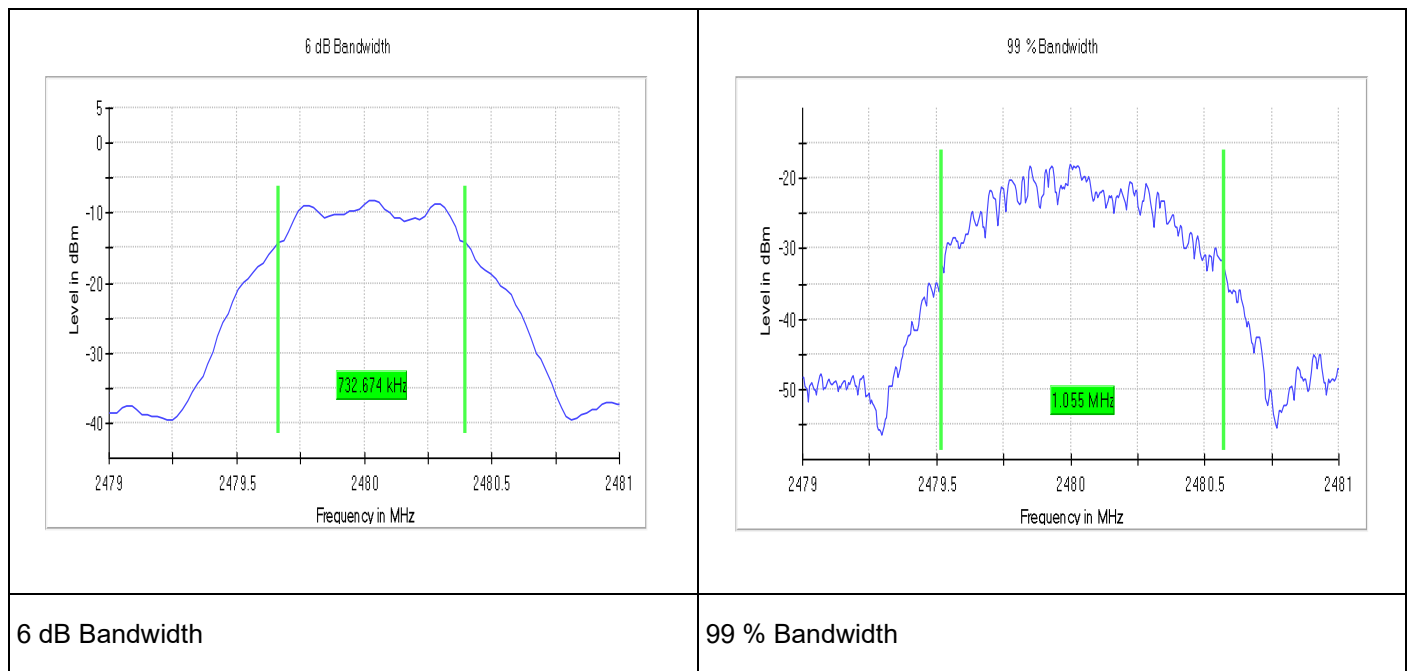


Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

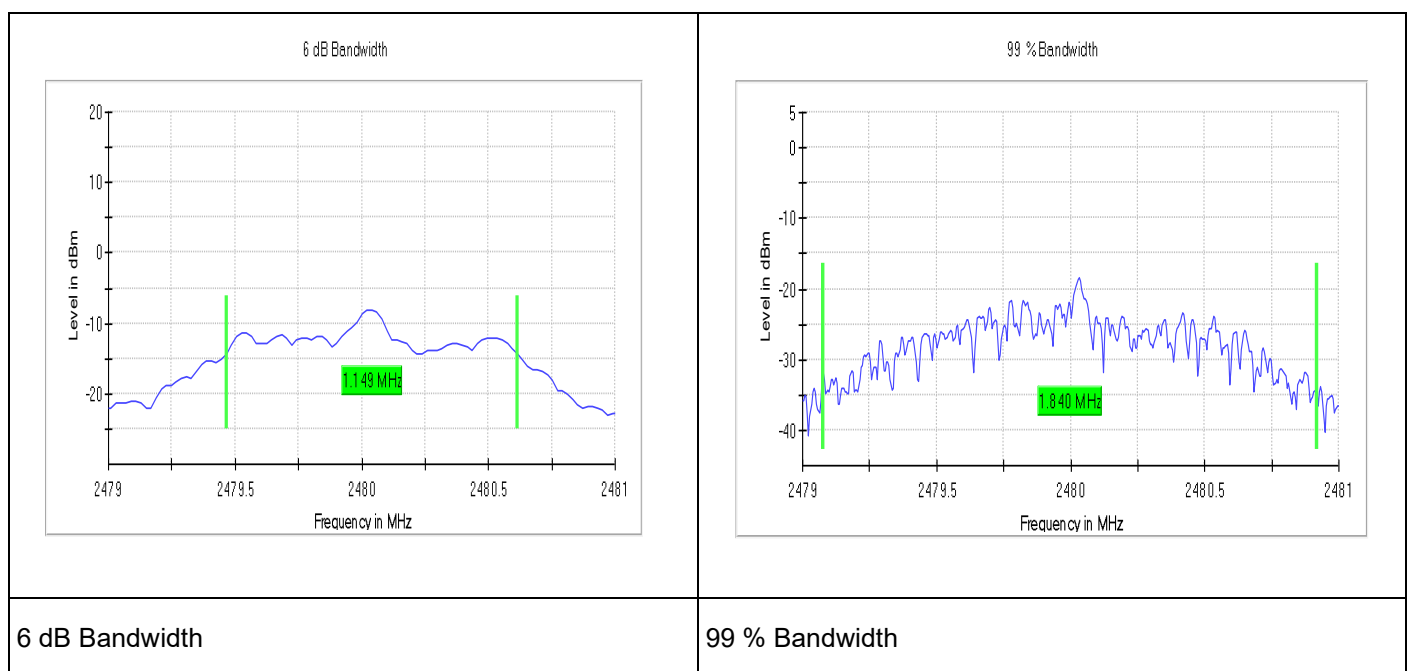
Seite 26 von 67
Page 26 of 67

Prüfdokumentation Test documentation

- Highest Channel 1Mbps



- Highest Channel 2Mbps



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 27 von 67
Page 27 of 67

Prüfdokumentation
Test documentation

Data Rate (Mbps)	Frequency (MHz)	99% Bandwidth (MHz)	6 dB Bandwidth (kHz)	Minimum DTS bandwidth (kHz)	Test Result
1	2402	1.05	732.67	500	Pass
	2440	1.05	732.67		Pass
	2480	1.05	732.67		Pass
2	2402	1.84	1149	500	Pass
	2440	1.84	1149		Pass
	2480	1.84	1149		Pass

Final test result

Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 28 von 67
Page 28 of 67

Prüfdokumentation
Test documentation

4.4 Conducted Spurious Emissions

4.4.1 Requirements / Limits

☒	<i>FCC Part 15, Subpart C, §15.247 (d)</i> 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, provide the transmitter demonstrates compliance with the peak conducted power limits.
☐	<i>FCC Part 15, Subpart C, §15.247 (d)</i> If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this test shall be 30 dB instead of 20 dB.

4.4.2 Test Method

Conducted method was used to measure the conducted spurious emissions in frequency range (30 MHz to 26 GHz) according to ANSI C63.10:2013 11.11.3 The EUT was connected to the spectrum analyzer via a coax cable with a known loss.

4.4.3 Test Setup

EUT		A003559646-002 to 003
Test Condition		Normal conditions
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan ☒ N/A
Operation mode		Mode1: TX Modulated 1 Mbps with continuous transmission. TX Modulated 2 Mbps with continuous transmission
Spectrum Analyzer	Centre Frequency	2402MHz, 2440MHz and 2480MHz
	Resolution Bandwidth	100KHz
	Video Bandwidth	300KHz
	Span	2.37GHz, 83.5MHz, 23.516GHz
	Detector	Max Peak
Further parameters		-
Test engineer		Shrinivas Naikar

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

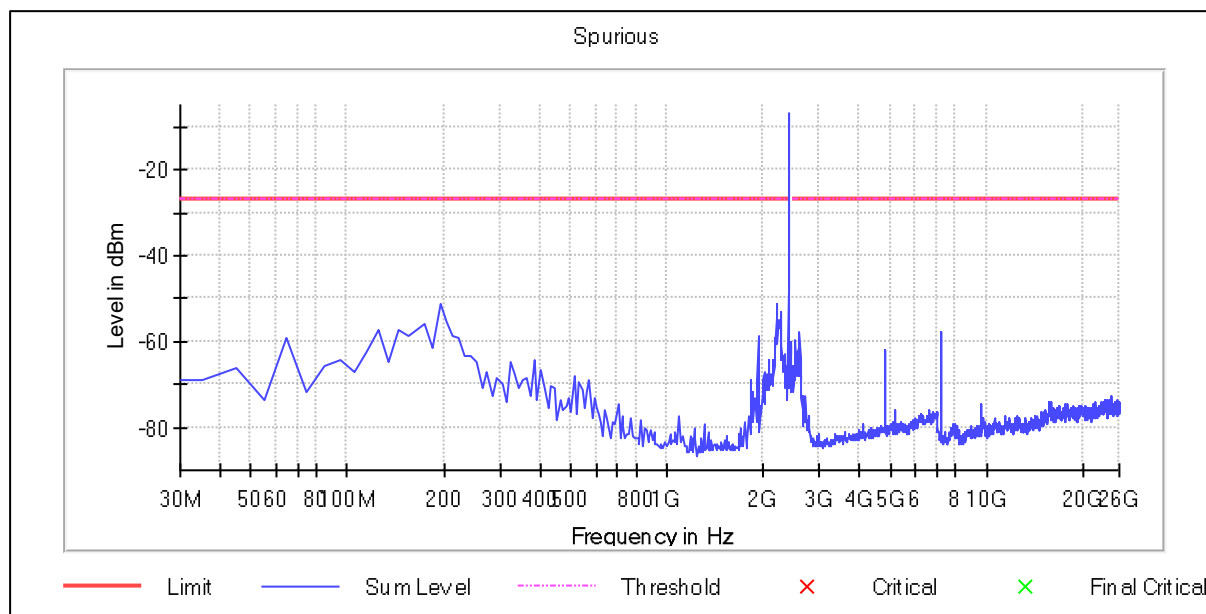
Seite 29 von 67
Page 29 of 67

Prüfdokumentation Test documentation

4.4.4 Test results

- Lowest Channel 1Mbps

-



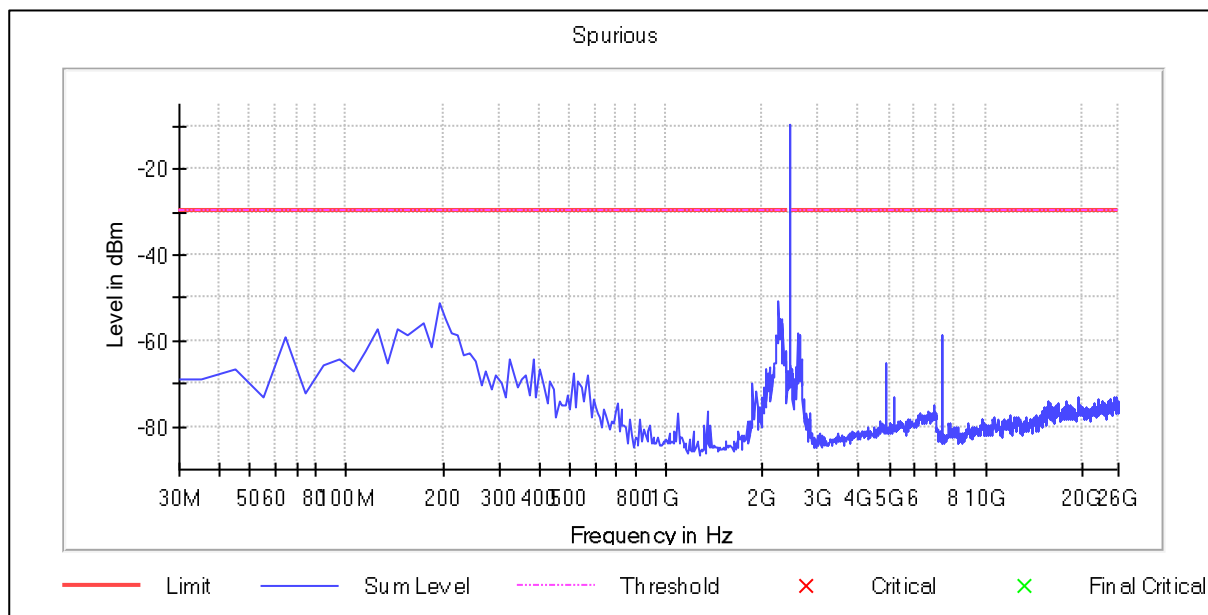
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2395.021008	-47.7	20.7	-27.0	Pass
194.306723	-51.2	24.1	-27.0	Pass
2205.819328	-51.3	24.3	-27.0	Pass
2275.525210	-52.9	25.8	-27.0	Pass
2195.861345	-54.4	27.3	-27.0	Pass
2225.735294	-54.8	27.8	-27.0	Pass
2235.693277	-55.0	27.9	-27.0	Pass
204.264706	-55.6	28.5	-27.0	Pass
2255.609244	-55.6	28.6	-27.0	Pass
174.390756	-55.8	28.8	-27.0	Pass
2245.651261	-56.8	29.7	-27.0	Pass
144.516807	-57.1	30.1	-27.0	Pass
164.432773	-57.3	30.3	-27.0	Pass
124.600840	-57.3	30.3	-27.0	Pass
2598.434020	-57.8	30.7	-27.0	Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 30 von 67
Page 30 of 67

Prüfdokumentation Test documentation

- Lowest Channel 2Mbps



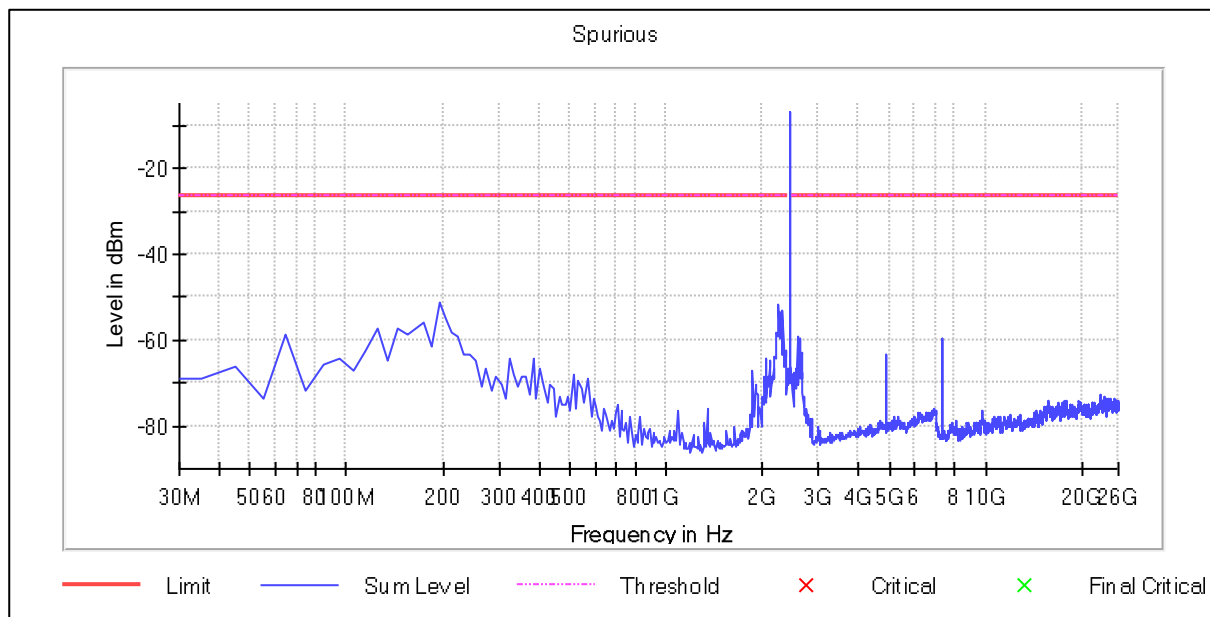
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2245.651261	-50.6	20.9	-29.7	Pass
194.306723	-51.1	21.4	-29.7	Pass
2295.441176	-54.7	25.0	-29.7	Pass
204.264706	-55.0	25.3	-29.7	Pass
2265.567227	-55.0	25.3	-29.7	Pass
2235.693277	-55.2	25.5	-29.7	Pass
2315.357143	-55.7	26.0	-29.7	Pass
174.390756	-55.8	26.1	-29.7	Pass
2285.483193	-55.9	26.2	-29.7	Pass
2275.525210	-56.9	27.2	-29.7	Pass
164.432773	-57.3	27.5	-29.7	Pass
144.516807	-57.3	27.6	-29.7	Pass
124.600840	-57.5	27.7	-29.7	Pass
214.222689	-58.1	28.4	-29.7	Pass
2568.451232	-58.4	28.6	-29.7	Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 31 von 67
Page 31 of 67

Prüfdokumentation Test documentation

- Middle Channel 1Mbps



Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
194.306723	-51.2	24.5	-26.7	Pass
2245.651261	-51.5	24.8	-26.7	Pass
2315.357143	-53.3	26.6	-26.7	Pass
2265.567227	-53.7	27.0	-26.7	Pass
2235.693277	-54.3	27.6	-26.7	Pass
204.264706	-55.1	28.4	-26.7	Pass
2295.441176	-55.6	28.9	-26.7	Pass
2275.525210	-55.8	29.1	-26.7	Pass
174.390756	-55.8	29.1	-26.7	Pass
2285.483193	-57.0	30.3	-26.7	Pass
144.516807	-57.3	30.6	-26.7	Pass
124.600840	-57.4	30.7	-26.7	Pass
164.432773	-57.4	30.7	-26.7	Pass
2215.777311	-58.1	31.4	-26.7	Pass
214.222689	-58.3	31.6	-26.7	Pass

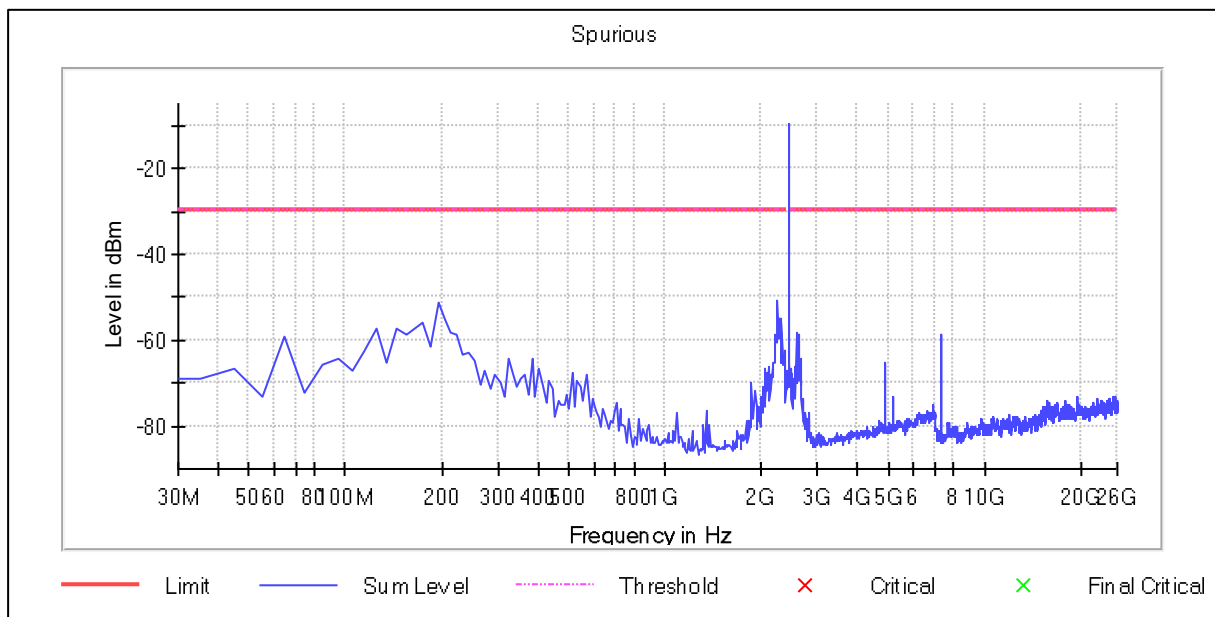
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 32 von 67
Page 32 of 67

Prüfdokumentation
Test documentation

- **Middle Channel 2Mbps**

-



Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2245.651261	-50.6	20.9	-29.7	Pass
194.306723	-51.1	21.4	-29.7	Pass
2295.441176	-54.7	25.0	-29.7	Pass
204.264706	-55.0	25.3	-29.7	Pass
2265.567227	-55.0	25.3	-29.7	Pass
2235.693277	-55.2	25.5	-29.7	Pass
2315.357143	-55.7	26.0	-29.7	Pass
174.390756	-55.8	26.1	-29.7	Pass
2285.483193	-55.9	26.2	-29.7	Pass
2275.525210	-56.9	27.2	-29.7	Pass
164.432773	-57.3	27.5	-29.7	Pass
144.516807	-57.3	27.6	-29.7	Pass
124.600840	-57.5	27.7	-29.7	Pass
214.222689	-58.1	28.4	-29.7	Pass
2568.451232	-58.4	28.6	-29.7	Pass

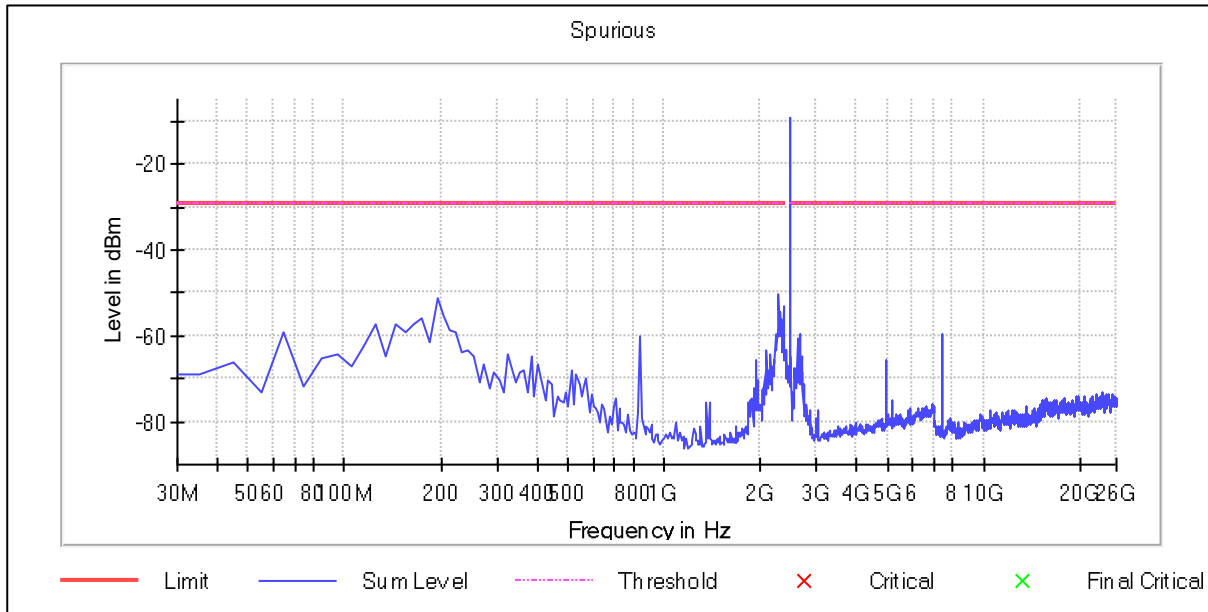
-

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 33 von 67
Page 33 of 67

Prüfdokumentation Test documentation

- Highest Channel 1Mbps



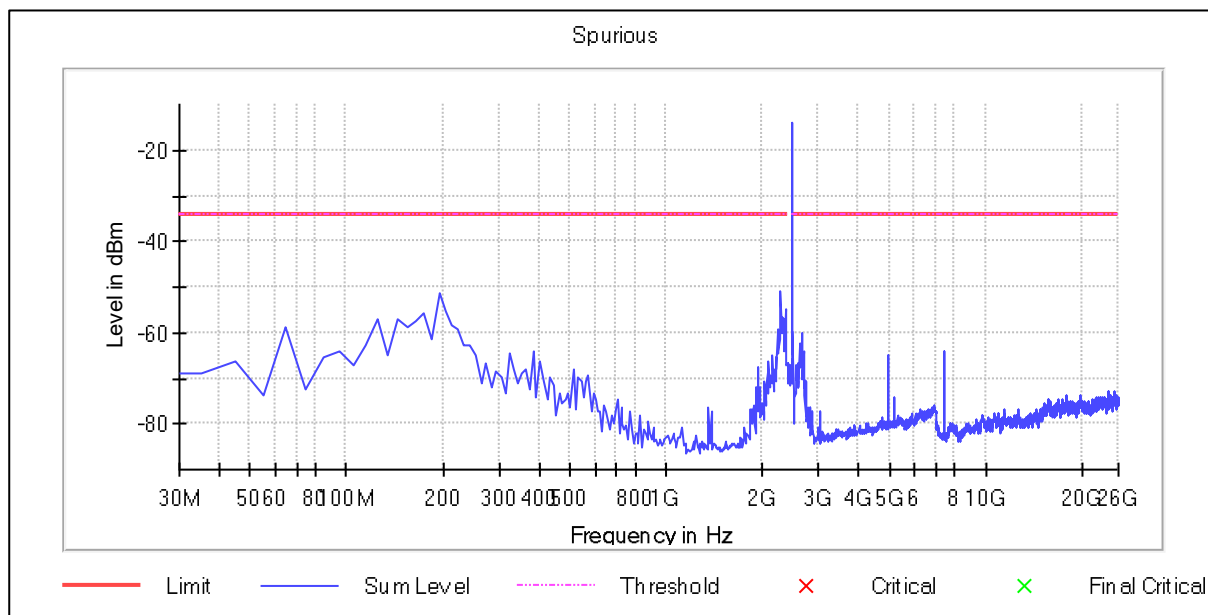
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2285.483193	-50.3	21.0	-29.2	Pass
194.306723	-51.3	22.0	-29.2	Pass
2355.189076	-53.3	24.1	-29.2	Pass
2275.525210	-54.1	24.8	-29.2	Pass
2305.399160	-54.3	25.1	-29.2	Pass
204.264706	-55.4	26.1	-29.2	Pass
174.390756	-55.8	26.5	-29.2	Pass
2315.357143	-56.1	26.8	-29.2	Pass
2335.273109	-56.4	27.2	-29.2	Pass
2325.315126	-56.4	27.2	-29.2	Pass
124.600840	-57.2	27.9	-29.2	Pass
144.516807	-57.2	28.0	-29.2	Pass
164.432773	-57.4	28.1	-29.2	Pass
2255.609244	-58.8	29.5	-29.2	Pass
214.222689	-58.8	29.6	-29.2	Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 34 von 67
Page 34 of 67

Prüfdokumentation Test documentation

- Highest Channel 2Mbps



Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2285.483193	-50.8	16.8	-34.0	Pass
194.306723	-51.1	17.2	-34.0	Pass
2355.189076	-54.8	20.8	-34.0	Pass
204.264706	-55.1	21.1	-34.0	Pass
174.390756	-55.8	21.8	-34.0	Pass
2305.399160	-56.6	22.6	-34.0	Pass
2315.357143	-56.6	22.6	-34.0	Pass
144.516807	-57.0	23.1	-34.0	Pass
124.600840	-57.1	23.1	-34.0	Pass
2325.315126	-57.2	23.2	-34.0	Pass
164.432773	-57.4	23.4	-34.0	Pass
2275.525210	-57.8	23.8	-34.0	Pass

Final test result

Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 35 von 67
Page 35 of 67

Prüfdokumentation
Test documentation

4.5 Band Edge Measurement

4.5.1 Requirements / Limits

☒	<i>FCC Part 15, Subpart C, §15.247 (d)</i> 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, provide the transmitter demonstrates compliance with the peak conducted power limits.
☐	<i>FCC Part 15, Subpart C, §15.247 (d)</i> If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this test shall be 30 dB instead of 20 dB.

4.5.2 Test Method

Conducted method was used to perform the band edge measurements according to ANSI C63.10:2013 clause 11.13.3.2 Peak detection. The EUT was connected to the spectrum analyzer via a coax cable with a known loss. The measurements are done when DUT is configured to the lowest and highest channels, and in

4.5.3 Test Setup

EUT		A003559646-002 to 003
Test Condition		Normal conditions
Chamber details		☐ 3m Fully Anechoic Chamber (FAC) ☐ 10m Semi Anechoic Chamber (SAC) ☒ Shielded room
Measurement positioning		Distance: EUT height: Antenna height: ☐ 3m ☐ 1.5m ☐ 1.5m ☐ 10m ☐ 0.8m ☐ 1m to 4m – height scan
		☒ N/A
Operation mode		Mode1: TX Modulated 1 Mbps with continuous transmission. TX Modulated 2 Mbps with continuous transmission
Spectrum Analyzer	Centre Frequency	2.355GHz; 2.44175GHz; 2.49175GHz
	Resolution Bandwidth	100KHz
	Video Bandwidth	300KHz
	Span	90MHz; 83.5MHz;16.5MHz
	Detector	Max Peak
Further parameters		-
Test engineer		Shrinivas Naikar

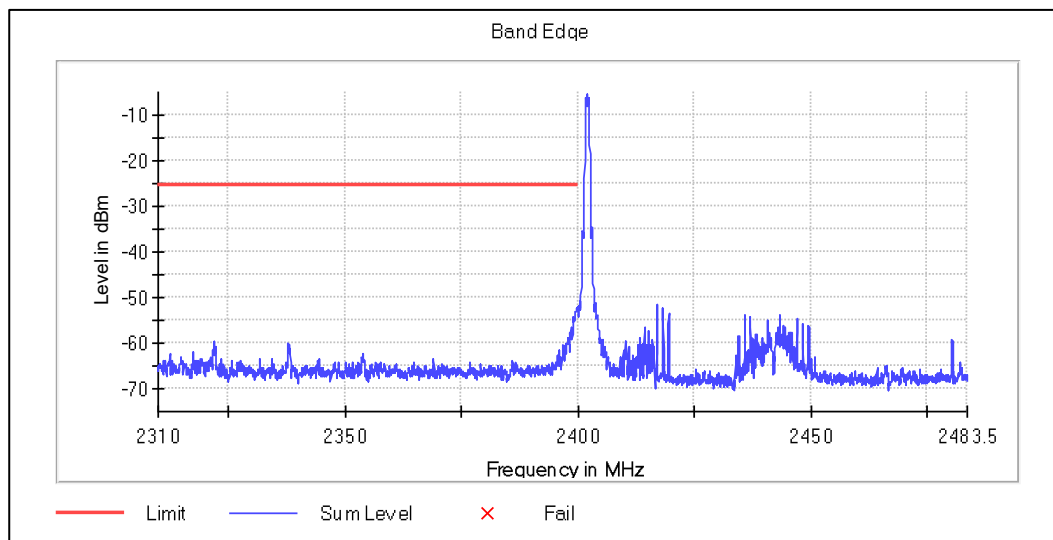
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 36 von 67
Page 36 of 67

Prüfdokumentation Test documentation

4.5.4 Test results

- Lowest Channel 1Mbps



Inband Peak

Frequency [MHz]	Level [dBm]
2402.025000	-5.4

Measurements

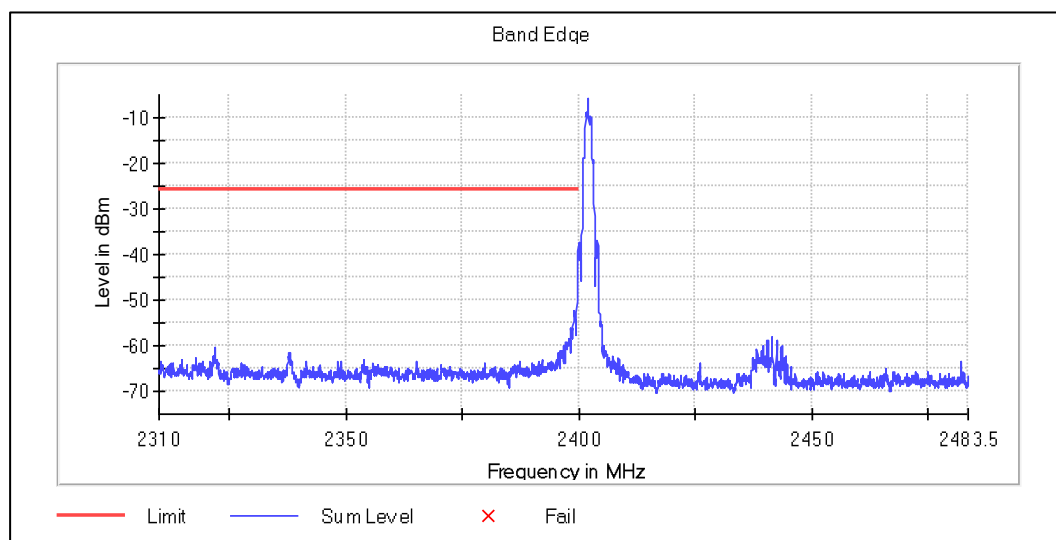
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2399.975000	-51.9	26.5	-25.4	Pass
2399.875000	-52.2	26.8	-25.4	Pass
2399.925000	-52.3	26.9	-25.4	Pass
2399.675000	-52.3	26.9	-25.4	Pass
2399.725000	-52.3	26.9	-25.4	Pass
2399.625000	-52.5	27.2	-25.4	Pass
2399.775000	-52.7	27.4	-25.4	Pass
2399.825000	-52.8	27.4	-25.4	Pass
2399.575000	-52.9	27.6	-25.4	Pass
2399.525000	-53.1	27.7	-25.4	Pass
2399.475000	-53.2	27.8	-25.4	Pass
2399.425000	-53.8	28.5	-25.4	Pass
2399.025000	-54.1	28.7	-25.4	Pass
2399.075000	-54.1	28.8	-25.4	Pass
2399.375000	-54.2	28.8	-25.4	Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 37 von 67
Page 37 of 67

Prüfdokumentation Test documentation

Lowest Channel 2Mbps



Inband Peak

Frequency [MHz]	Level [dBm]
2402.025000	-5.7

Measurements

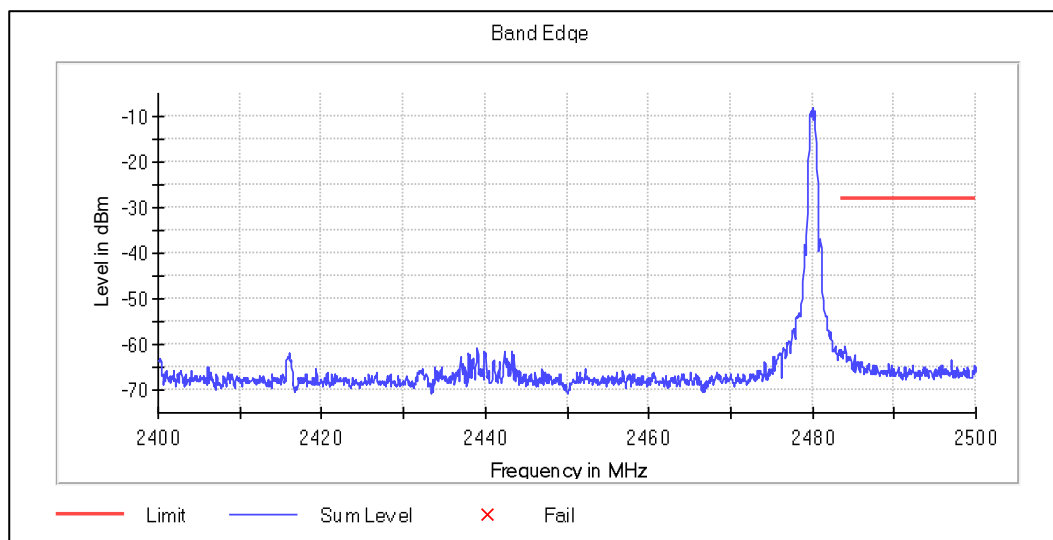
Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2399.975000	-37.3	11.6	-25.7	Pass
2399.925000	-39.1	13.5	-25.7	Pass
2399.875000	-42.4	16.7	-25.7	Pass
2399.825000	-43.3	17.7	-25.7	Pass
2399.775000	-44.7	19.0	-25.7	Pass
2399.725000	-46.7	21.0	-25.7	Pass
2399.675000	-49.0	23.3	-25.7	Pass
2399.625000	-49.4	23.7	-25.7	Pass
2399.575000	-50.4	24.8	-25.7	Pass
2399.075000	-52.3	26.6	-25.7	Pass
2399.125000	-52.5	26.8	-25.7	Pass
2399.025000	-52.6	26.9	-25.7	Pass
2399.525000	-52.6	27.0	-25.7	Pass
2399.175000	-53.2	27.5	-25.7	Pass
2398.975000	-53.2	27.6	-25.7	Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 38 von 67
Page 38 of 67

Prüfdokumentation Test documentation

- Highest Channel 1Mbps



Inband Peak

Frequency [MHz]	Level [dBm]
2480.025000	-8.1

Measurements

Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2483.975000	-60.5	32.4	-28.1	Pass
2484.025000	-60.6	32.5	-28.1	Pass
2483.925000	-61.1	33.0	-28.1	Pass
2483.525000	-61.3	33.3	-28.1	Pass
2483.825000	-61.7	33.7	-28.1	Pass
2483.775000	-61.8	33.7	-28.1	Pass
2484.075000	-61.8	33.7	-28.1	Pass
2483.875000	-61.8	33.8	-28.1	Pass
2483.575000	-62.1	34.0	-28.1	Pass
2485.125000	-62.4	34.3	-28.1	Pass
2485.175000	-62.4	34.3	-28.1	Pass
2484.425000	-62.6	34.5	-28.1	Pass
2483.625000	-62.7	34.6	-28.1	Pass
2484.675000	-62.7	34.7	-28.1	Pass
2484.625000	-62.7	34.7	-28.1	Pass

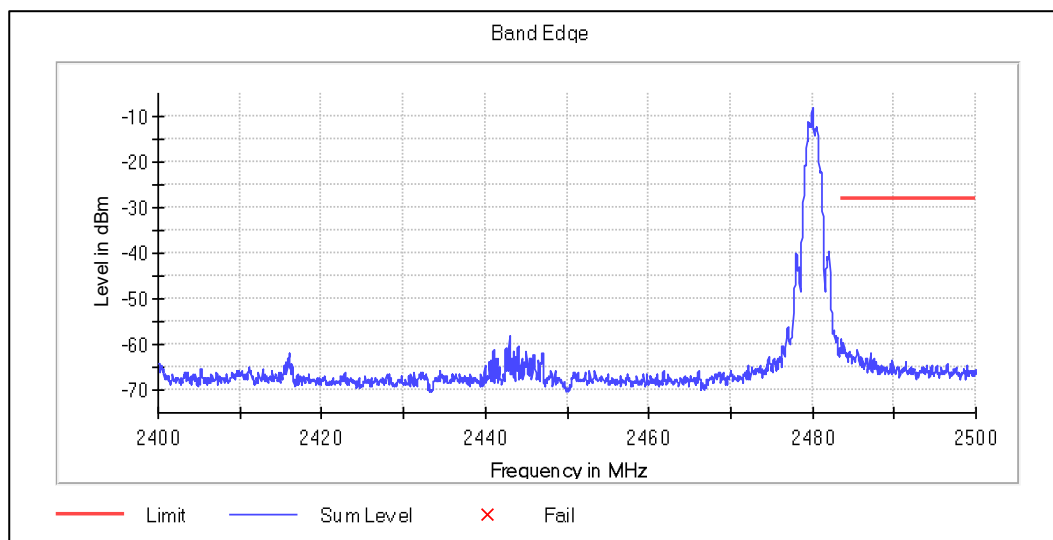
-
-
-

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 39 von 67
Page 39 of 67

Prüfdokumentation Test documentation

- Highest Channel 2Mbps



Inband Peak

Frequency [MHz]	Level [dBm]
2480.025000	-8.1

Measurements

Frequency [MHz]	Level [dBm]	Margin [dB]	Limit [dBm]	Result
2483.525000	-58.8	30.7	-28.1	Pass
2483.825000	-59.5	31.5	-28.1	Pass
2483.575000	-59.6	31.5	-28.1	Pass
2483.775000	-59.9	31.9	-28.1	Pass
2483.875000	-60.6	32.5	-28.1	Pass
2485.525000	-61.0	32.9	-28.1	Pass
2483.975000	-61.0	33.0	-28.1	Pass
2485.475000	-61.1	33.0	-28.1	Pass
2483.625000	-61.2	33.1	-28.1	Pass
2484.025000	-61.2	33.1	-28.1	Pass
2484.525000	-61.5	33.4	-28.1	Pass
2484.175000	-61.8	33.7	-28.1	Pass
2483.925000	-61.8	33.8	-28.1	Pass
2484.125000	-61.8	33.8	-28.1	Pass
2484.475000	-61.9	33.8	-28.1	Pass

Final test result

Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 40 von 67
Page 40 of 67

Prüfdokumentation
Test documentation

4.6 Radiated Spurious Emissions & Restricted Bands of Operation

4.6.1 Requirements / Limits

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode. The emissions shall not exceed the values in FCC Part 15, Subpart C §15.205, §15.209, §15.247(d).

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency [MHz]	Limit [$\mu\text{V/m}$]	Measurement distance [m]	Limits [dB $\mu\text{V/m}$]
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (f)(2).

Frequency [MHz]	Limit [$\mu\text{V/m}$]	Measurement distance [m]	Limits [dB $\mu\text{V/m}$]
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 40000	500@3m	3	54.0@3m

§15.35(b) ..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor:

$$\text{Limit [dB}\mu\text{V/m]} = 20 \log (\text{Limit } [\mu\text{V/m}] / 1\mu\text{V/m})$$

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 41 von 67
Page 41 of 67

Prüfdokumentation Test documentation

4.6.2 Test Method

4.6.2.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. Preliminary emission profile testing was performed inside the anechoic chamber. The receiving antenna was placed at a distance of 3m for all measurements. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT. The different measurement setup for each frequency range are shown below.

9 kHz - 30 MHz

Following Measurement Setup is used:

Test Site	Semi-anechoic chamber
Receiving Antenna	Loop antenna (HFH 2)
Receiving Antenna Height	1 m
Receiving Antenna Polarization	Parallel – Perpendicular
EUT Table	1.0m x 1.5m non-conductive table 80cm above the floor
EUT Turn Table Step Size	22.5°
Receiver Configurations	Average and peak detectors
	RBW: 200Hz (9 - 150 kHz) and 9 kHz (150 kHz – 30 MHz)
	Step Size: 50Hz (9-150kHz) and 2.25kHz (150k-30MHz)
	Sweep Time: 100ms (FFT)

30 MHz - 1 GHz

Following Measurement Setup is used:

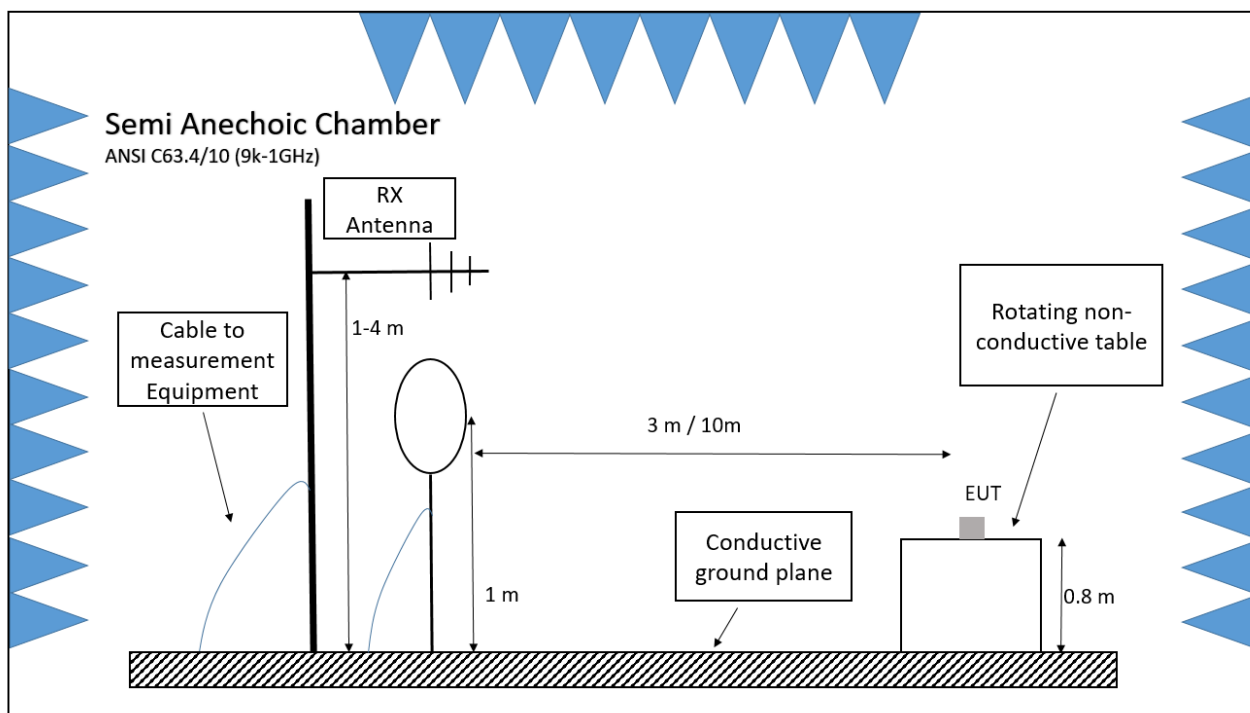
Test Site	Semi-anechoic chamber
Receiving Antenna	Hybrid Antenna VULB 9168
Receiving Antenna height	Varied (1m to 4 m, step size 1m)
Receiving Antenna Polarization	Horizontal– Vertical
EUT Table	1.0m x 1.5m non-conductive table 80cm above the floor
EUT Turn Table Step Size	45°
Receiver Configurations	Peak detector
	RBW :120 kHz
	Step Size: 30kHz (30-1000MHz)
	Sweep Time : 100 ms (FFT)

For Measurements below 1 GHz, the EUT was positioned as shown in the setup photograph:

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 42 von 67
Page 42 of 67

Prüfdokumentation Test documentation



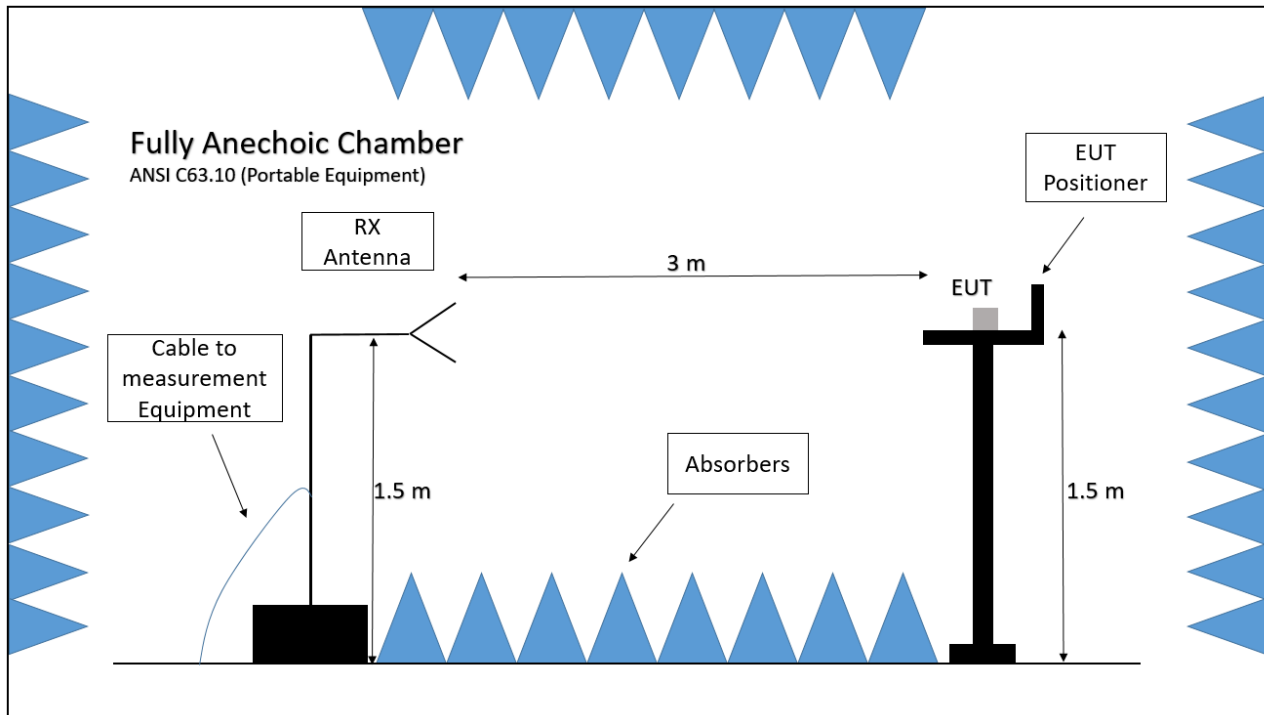
1 GHz - 26 GHz

Following Measurement Setup is used:

Test Site	Fully-anechoic chamber
Receiving Antenna	Horn Antenna HF907 (1-18 GHz), 3116C-PA (18-26GHz)
Receiving Antenna Height	1.5 m
Receiving Antenna Polarization	Horizontal– Vertical
EUT Positioner	40 cm x 60 cm non-conductive positioner 1.5 m above the floor / Step size,elevation angle 45°
EUT Turn Table Step Size	45°
Spectrum Analyzer	Average and peak detectors
	RBW: 1 MHz
	Sweep Time : 100 ms

For Measurements over 1 GHz, the EUT was positioned as shown in the setup photograph:

Prüfdokumentation
Test documentation



4.6.2.2 Final Test

The placement of EUT and cables were the same as for preliminary testing. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, then the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked. For the measurements in the frequency range 30 MHz to 1 GHz for each measured frequency the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. For measurement above 1 GHz the turntable and positioner step sizes were set to a range of 22° and the antenna height is fixed.

For the measurements in the frequency ranges (90-110kHz, 490 kHz-1 GHz) quasi-peak detector is used, while average and peak detectors are used in other ranges.

Final testing was performed on an SVSWR compliant test site.

The final average electric field value (E_{final}) is calculated in the final measurement table using the following equation:

$$E_{final} = \text{RawRec} + \text{Corr.}$$

While

$$\text{Corr.} = \text{Trd. Corr.} + \text{Sig Path} + \text{Preamp}$$

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 44 von 67
Page 44 of 67

Prüfdokumentation
Test documentation

4.6.3 Test Setup

EUT	A003559646-002 to 0032
Test Condition	Normal conditions
Operation mode	Mode1: TX Modulated 1 Mbps (Worst Case) with continuous transmission.
Further parameters	-
Test engineer	Shrinivas Naikar

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

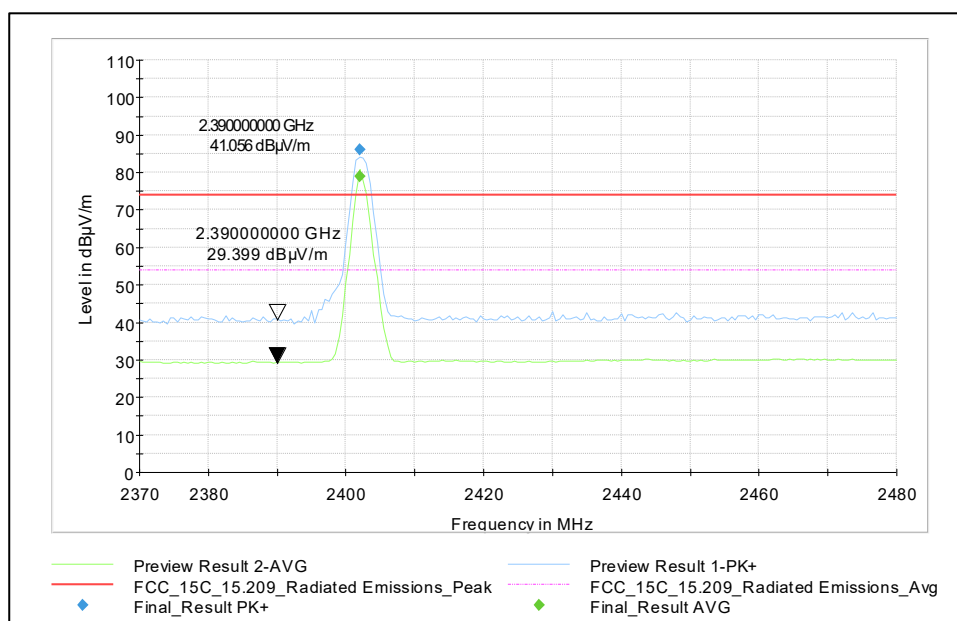
Seite 45 von 67
Page 45 of 67

Prüfdokumentation Test documentation

4.6.4 Test results

4.6.4.1 Fundamental Field strength and restricted bands of operation Lowest Channel

Data rate: 1Mbps



Frequency Type	Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)
Fundamental	2402.0592	85.98	---
	2402.0210	---	78.88
Restricted Band	2390.00	41.05	---
	2390.00	---	29.39

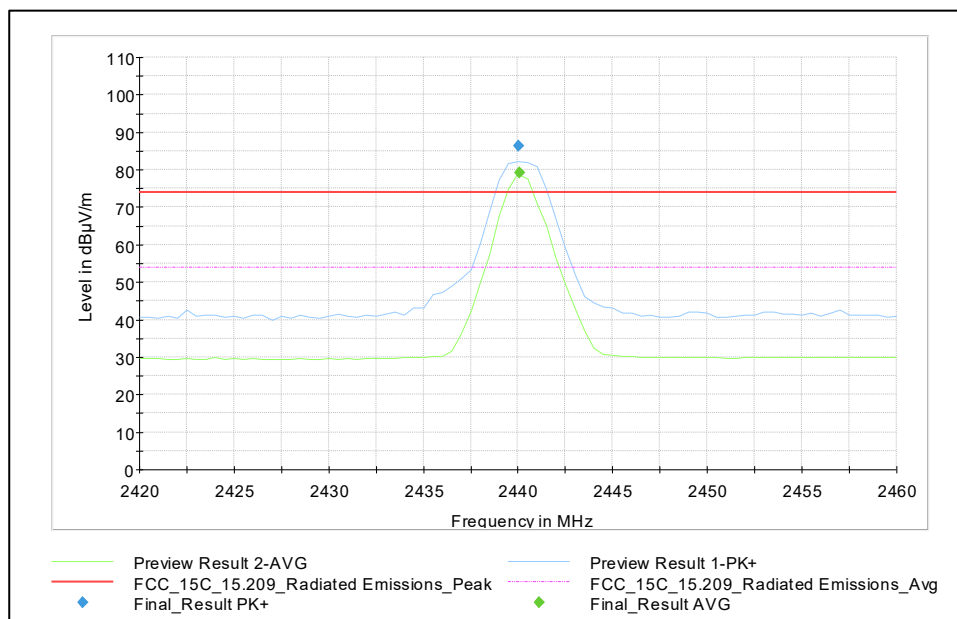
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 46 von 67
Page 46 of 67

Prüfdokumentation
Test documentation

4.6.4.2 Fundamental Field strength Middle Channel

Data rate: 1Mbps



Frequency Type	Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)
Fundamental	2440.051316	86.23	---
	2440.071053	---	79.12

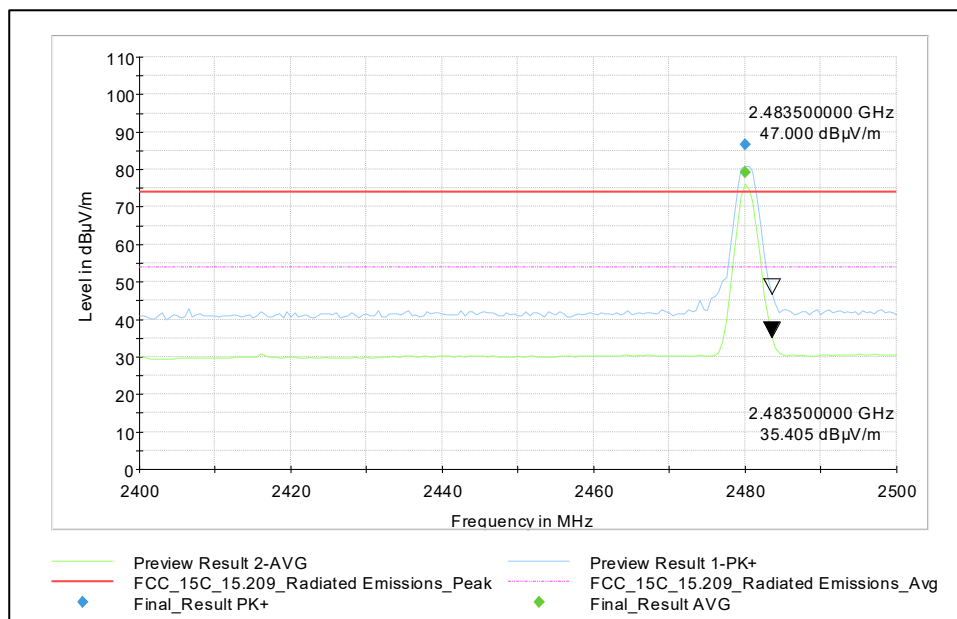
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 47 von 67
Page 47 of 67

Prüfdokumentation Test documentation

4.6.4.3 Fundamental Field strength and restricted bands of operation Highest Channel

Data rate: 1Mbps



Frequency Type	Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)
Fundamental	2479.9960	86.54	---
	2480.0644	---	79.08
Restricted Band	2483.500	47.00	---
	2483.500	---	35.40

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

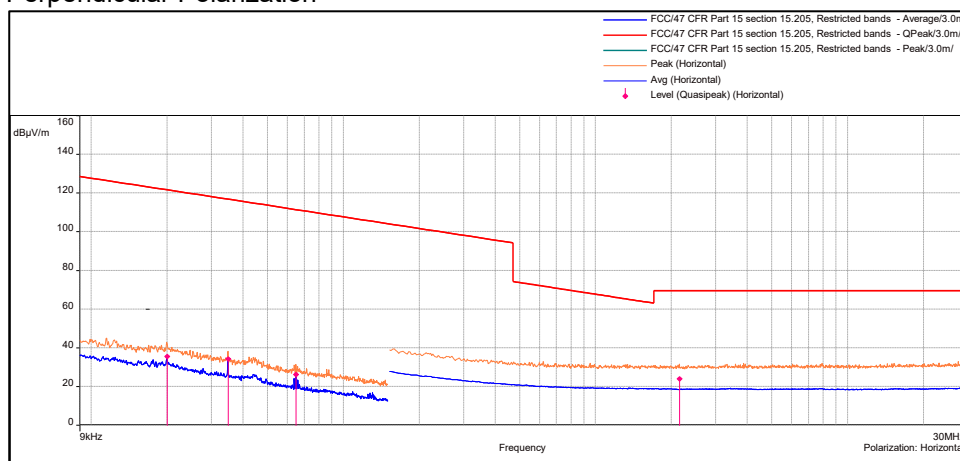
Seite 48 von 67
Page 48 of 67

Prüfdokumentation Test documentation

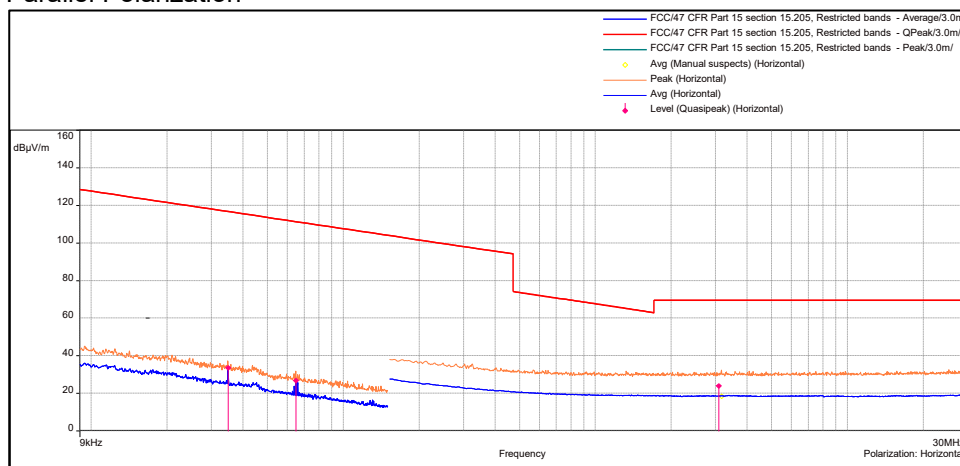
4.6.4.4 9 kHz to 30 MHz, Lowest Channel

Data rate: 1Mbps

Perpendicular Polarization



Parallel Polarization



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

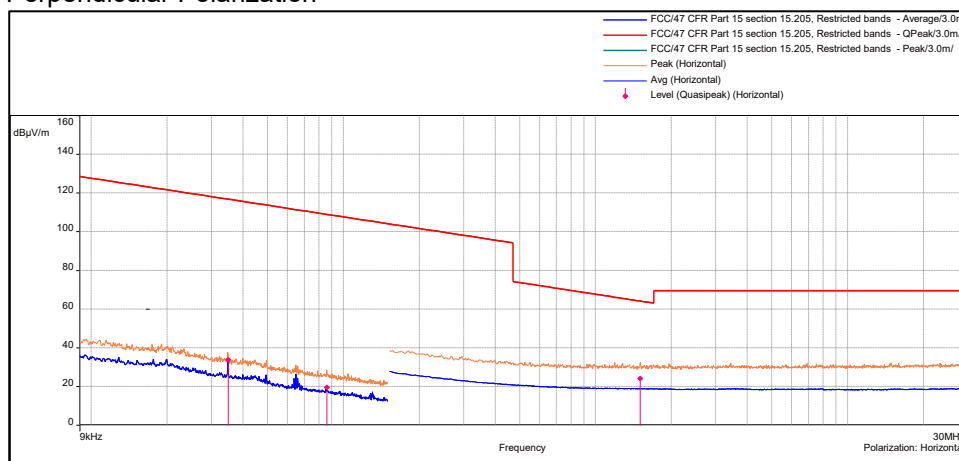
Seite 49 von 67
Page 49 of 67

Prüfdokumentation Test documentation

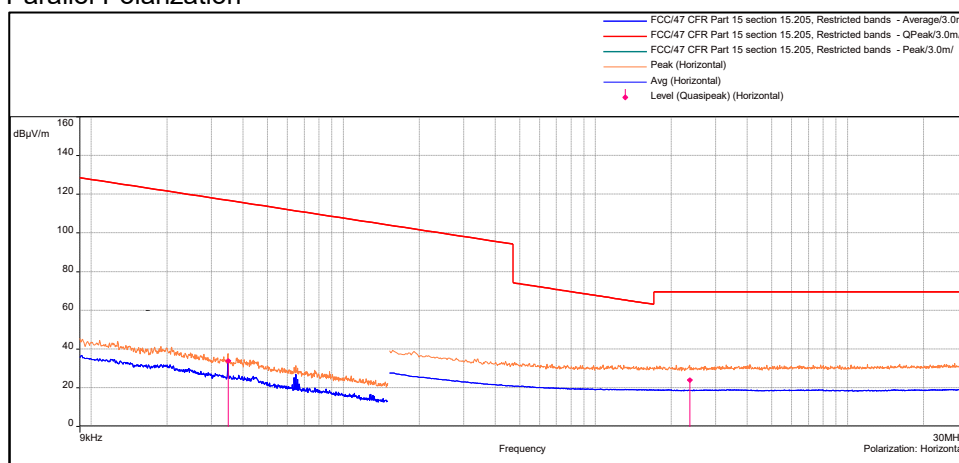
4.6.4.5 9 kHz to 30 MHz, Highest Channel

Data rate: 1Mbps

Perpendicular Polarization



Parallel Polarization



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

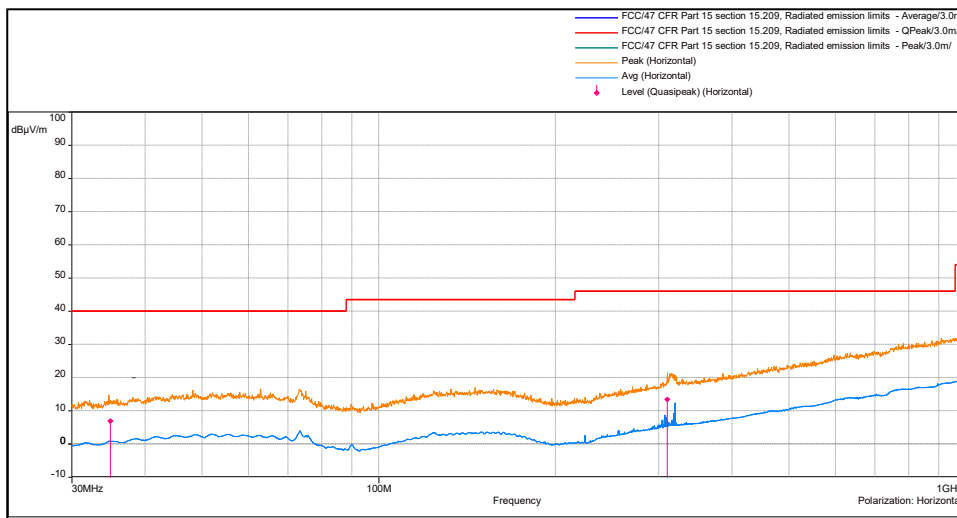
Seite 50 von 67
Page 50 of 67

Prüfdokumentation Test documentation

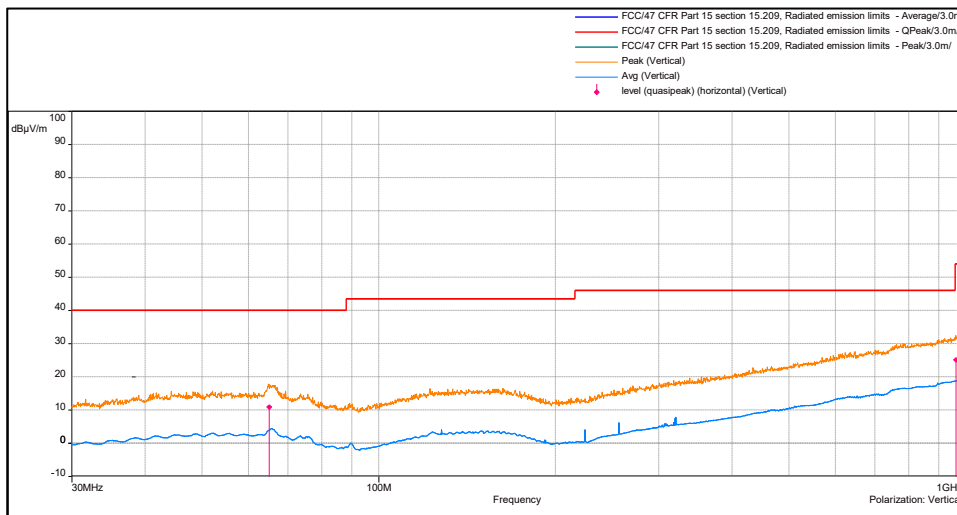
4.6.4.6 30 MHz to 1 GHz, Lowest Channel.

Data rate: 1Mbps

Horizontal Polarization



Vertical Polarization



Frequency (MHz)	SR	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Height (m)	Azimuth (deg)	Meas. Time (s)	Corr. (dB)
34.899358	1	6.95	40.00	-33.05	Horizontal	2.07	150.20	5.00	13.35
310.22589	1	13.53	46.00	-32.47	Horizontal	1.02	287.40	5.00	16.10
65.010192	2	10.92	40.00	-29.08	Vertical	1.42	182.20	5.00	13.55
962.73211	2	25.14	53.98	-28.84	Vertical	1.02	107.60	5.00	28.81

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

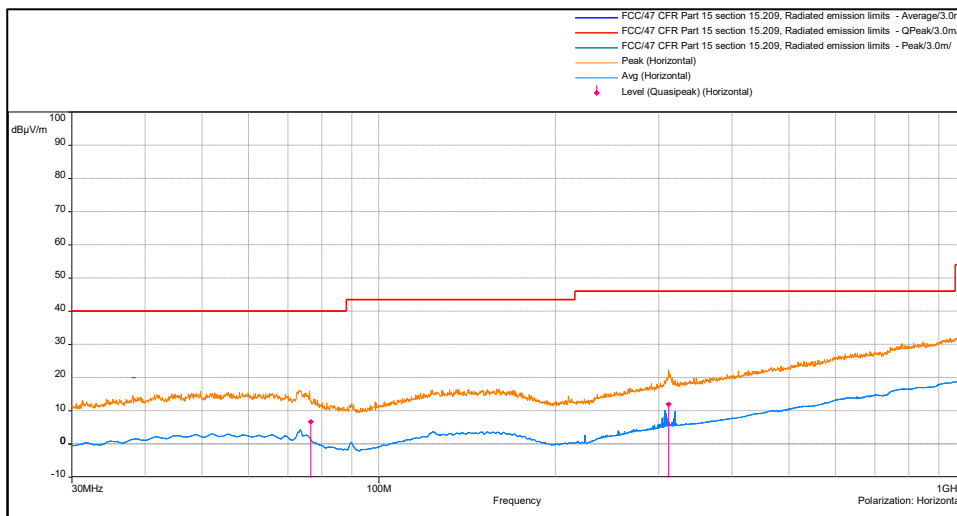
Seite 51 von 67
Page 51 of 67

Prüfdokumentation Test documentation

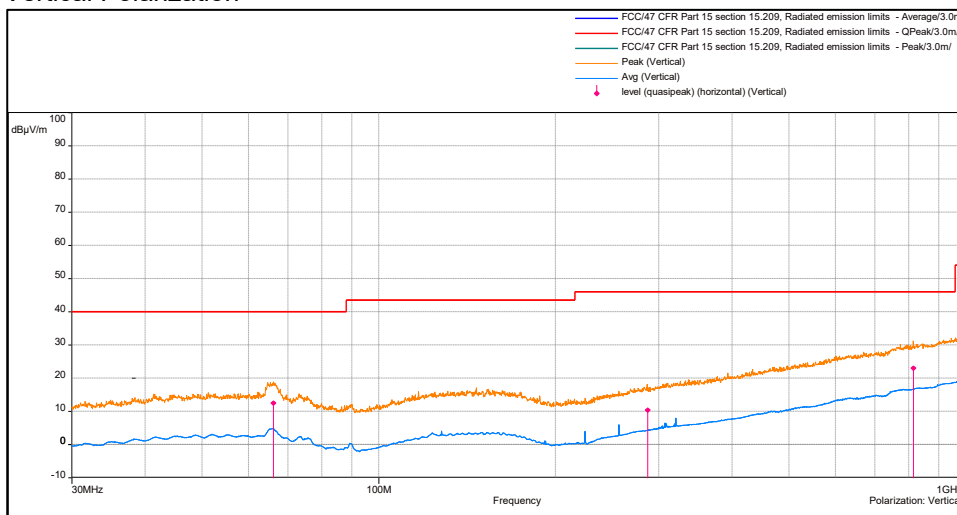
4.6.4.7 30 MHz to 1 GHz, Highest Channel

Data rate: 1Mbps

Horizontal Polarization



Vertical Polarization



Frequency (MHz)	SR	Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Pol	Height (m)	Azimuth (deg)	Meas. Time (s)	Corr. (dB)
76.53769274	1	6.75	40.00	-33.25	Horizontal	4.00	108.20	5.00	11.60
311.7792315	1	12.01	46.00	-33.99	Horizontal	1.58	287.80	5.00	16.14
66.14474408	2	12.53	40.00	-27.47	Vertical	1.00	63.10	5.00	13.42
287.0209654	2	10.43	46.00	-35.57	Vertical	4.00	141.90	5.00	15.38
814.4674392	2	23.05	46.00	-22.95	Vertical	4.00	20.60	5.00	26.91

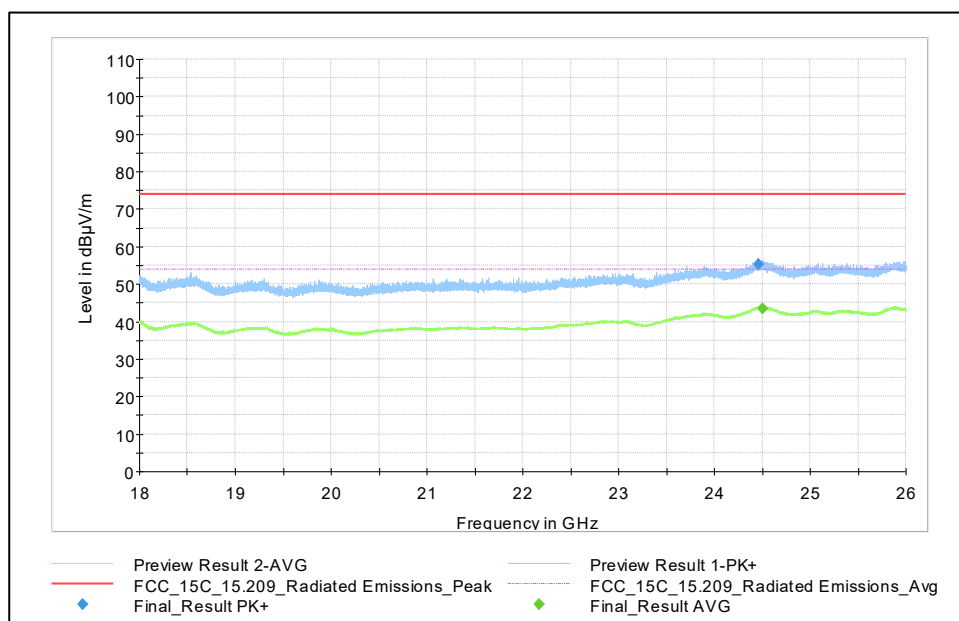
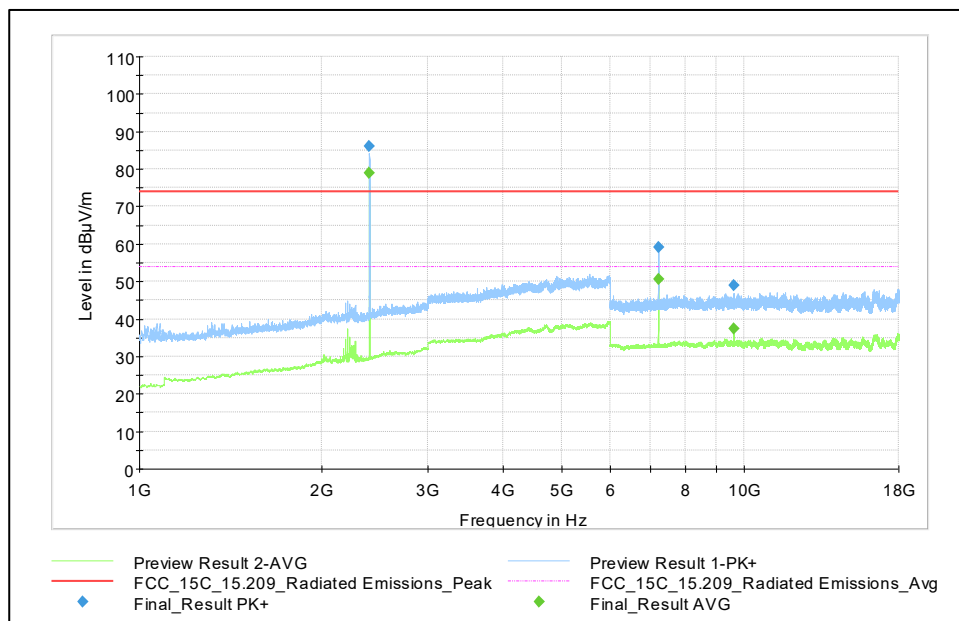
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 52 von 67
Page 52 of 67

Prüfdokumentation Test documentation

4.6.4.8 1 to 26 GHz, Lowest Channel.

Data rate: 1Mbps



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 53 von 67
Page 53 of 67

Prüfdokumentation
Test documentation

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
2402.0210	---	78.88	Fundamental Emission								
2402.0592	85.98	---									
7205.5156	59.20	---	74.00	14.80	100.0	1000.000	150.0	V	355.0	349.0	-2.9
7205.7908	---	50.64	54.00	3.36	100.0	1000.000	150.0	V	142.0	92.0	-2.9
9607.4339	---	37.41	54.00	16.59	100.0	1000.000	150.0	V	110.0	91.0	-0.2
9608.9995	48.90	---	74.00	25.10	100.0	1000.000	150.0	V	91.0	93.0	-0.2
24462.8965	55.36	---	74.00	18.64	100.0	1000.000	150.0	H	94.0	109.0	23.0
24501.9406	---	43.58	54.00	10.42	100.0	1000.000	150.0	H	299.0	9.0	23.0

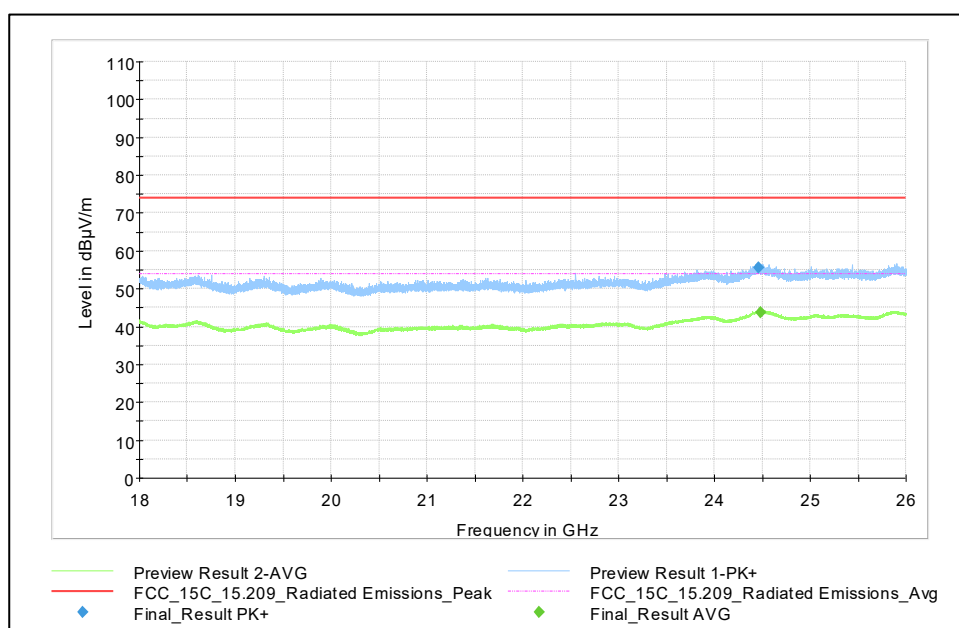
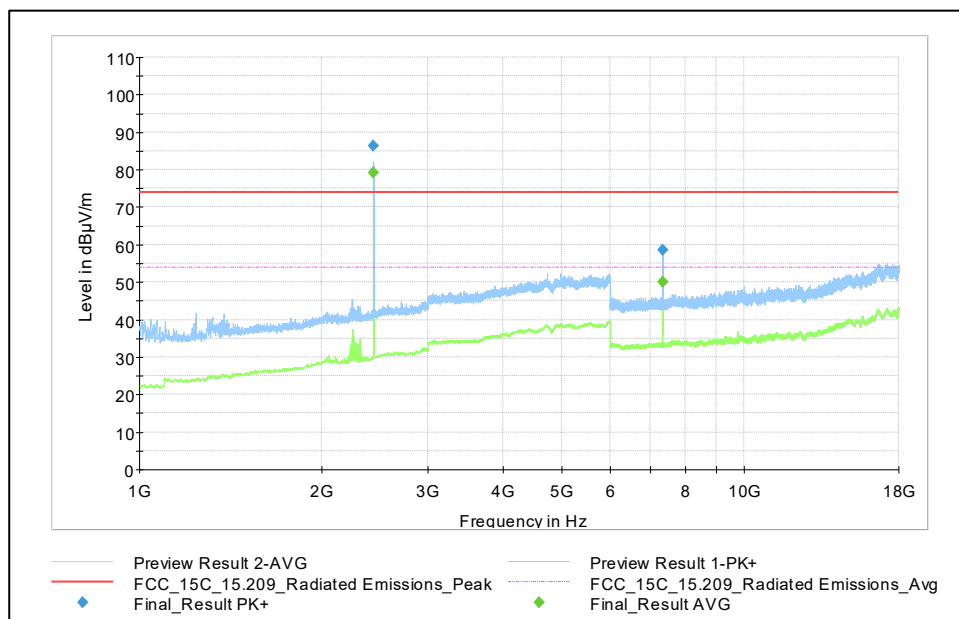
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 54 von 67
Page 54 of 67

Prüfdokumentation Test documentation

4.6.4.9 1 to 26 GHz, Middle Channel

Data rate: 1Mbps



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 55 von 67
Page 55 of 67

Prüfdokumentation
Test documentation

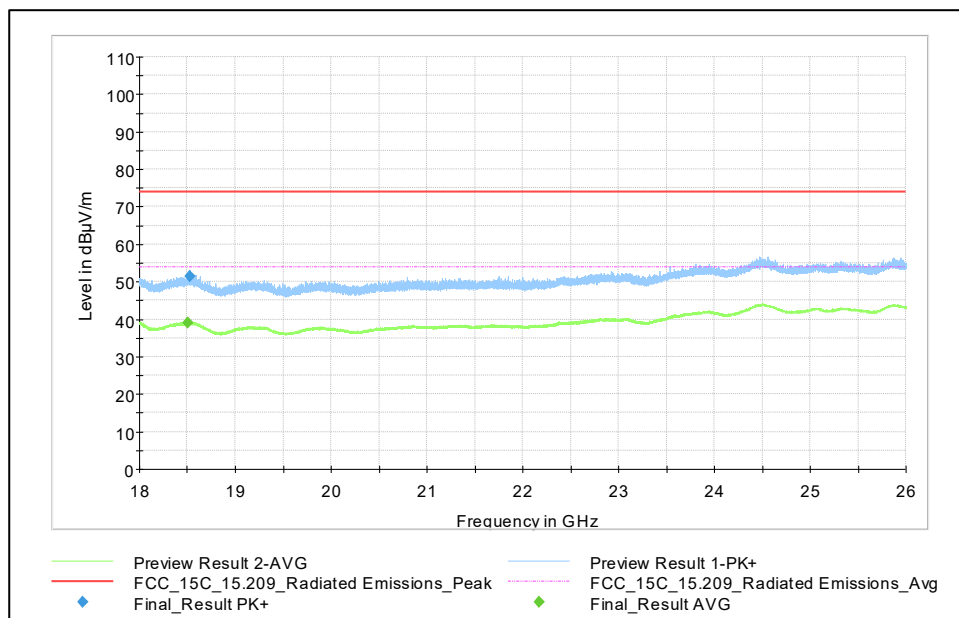
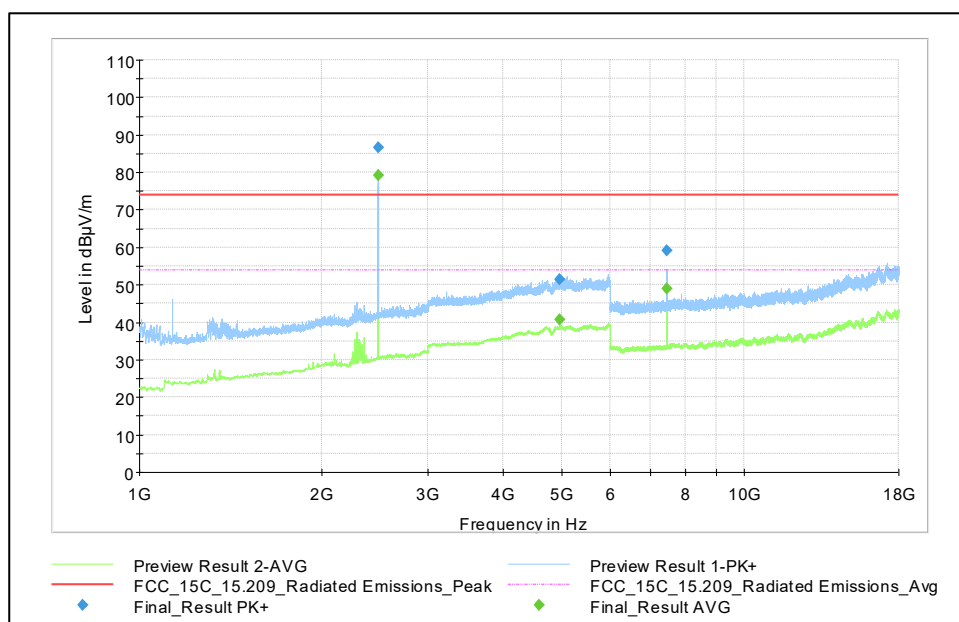
Frequency (MHz)	MaxPeak (dBμV/m)	Average (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
2440.051	86.23	---	Fundamental Emission								
2440.071	---	79.12									
7319.410	58.64	---	74.00	15.36	100.0	1000.000	150.0	V	124.0	85.0	-3.1
7319.738	---	50.18	54.00	3.82	100.0	1000.000	150.0	V	353.0	344.0	-3.1
24464.65	55.63	---	74.00	18.37	100.0	1000.000	150.0	V	5.0	3.0	23.0
24486.90	---	43.69	54.00	10.31	100.0	1000.000	150.0	V	76.0	-18.0	23.0

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 56 von 67
Page 56 of 67

Prüfdokumentation
Test documentation

4.6.4.10 1 to 26 GHz, Highest Channel



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 57 von 67
Page 57 of 67

Prüfdokumentation
Test documentation

Frequency (MHz)	MaxPeak (dBµV/m)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Elevation (deg)	Corr. (dB)
2479.9960	86.54		74.00	-12.54	100.0	1000.000	150.0	V	104.0	159.0	-0.5
2480.0644	---	79.08	54.00	-25.08	100.0	1000.000	150.0	V	293.0	335.0	-0.5
4960.2633	---	40.6	54.00	13.40	100.0	1000.000	150.0	H	148.0	105.0	10.0
4960.3100	51.49		74.00	22.51	100.0	1000.000	150.0	V	0.0	233.0	10.0
7439.7335	---	48.82	54.00	5.18	100.0	1000.000	150.0	V	126.0	84.0	-3.2
7440.9170	59.06		74.00	14.94	100.0	1000.000	150.0	V	143.0	82.0	-3.2
18500.5531	---	39.19	54.00	14.81	100.0	1000.000	150.0	H	135.0	9.0	20.4
18526.6809	51.39		74.00	22.61	100.0	1000.000	150.0	V	107.0	65.0	20.4

Final test result

Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 58 von 67
Page 58 of 67

Prüfdokumentation
Test documentation

4.7 AC Power Conducted Emission

4.7.1 Requirements / Limits

AC power-line conducted emission measurements shall be made, unless otherwise specified, over the frequency range from 150 kHz to 30 MHz, to determine the line-to-ground radio-noise voltage that is conducted from all of the EUT current-carrying power input terminals that are directly (or indirectly via separate transformers or power supplies) connected to a public power network.

FCC Part 15, Subpart C, §15.207 (a)

... for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN).

FCC Part 15, Subpart C, §15.207, Conducted Emission Limits

Frequency [MHz]	Conducted Limit [dB μ V]	
	Quasi-peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

*Decreases with logarithm of the frequency

FCC Part 15, Subpart C, §15.207 (c)

... Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

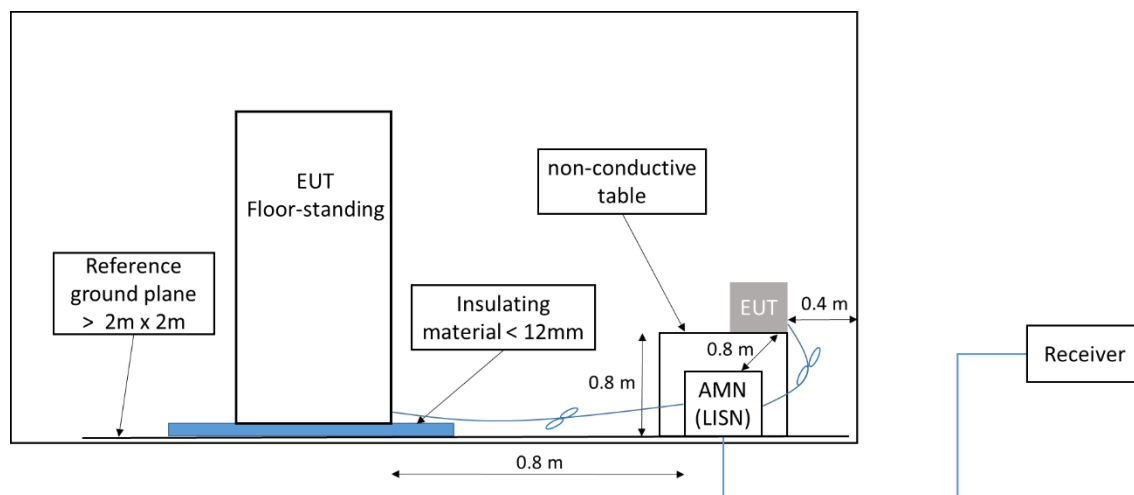
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 59 von 67
Page 59 of 67

Prüfdokumentation Test documentation

4.7.2 Test Method

The test setup was made according to ANSI C63.10:2013 clauses 6.2.2 & 6.2.3 as shown in the photograph



The EUT was configured to transmit on the lowest channel since it has the highest output power.

4.7.3 Test Setup

EUT	A003559646-002 to 0032
Test Condition	Normal conditions
Operation mode	Mode1: TX Modulated 1 Mbps (Worst Case) with continuous transmission.
Further parameters	The USB cable was connected to the Wireless Lab Laptop to power on the EUT
Test engineer	Shrinivas Naikar

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

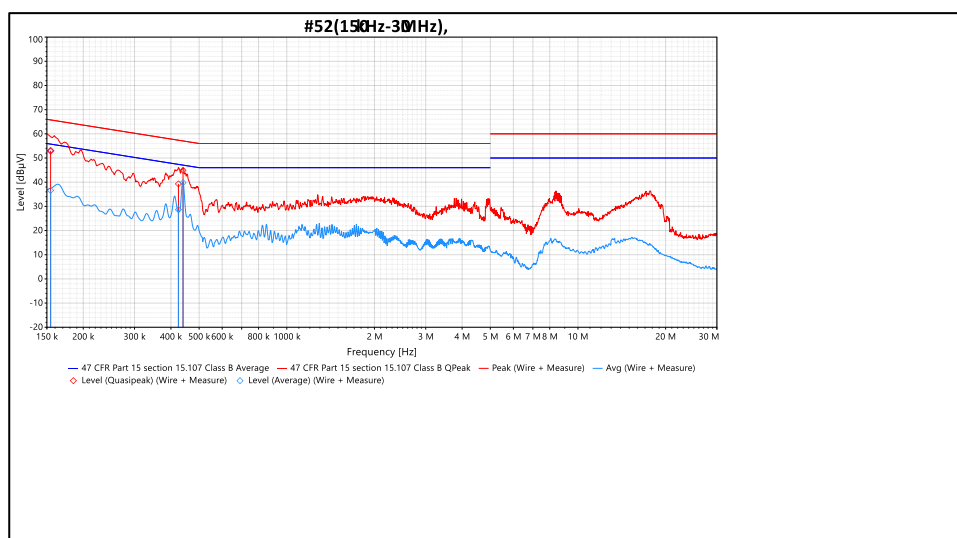
Seite 60 von 67
Page 60 of 67

Prüfdokumentation Test documentation

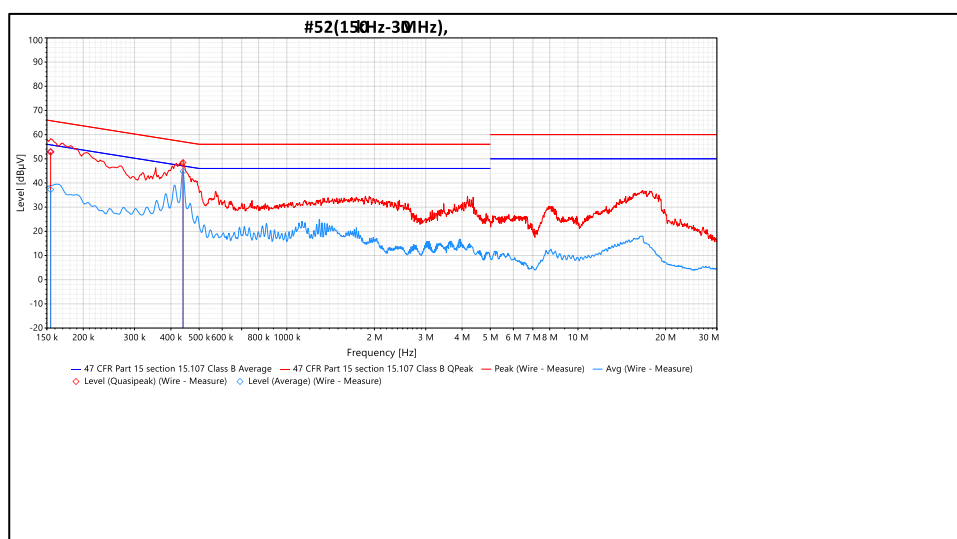
4.7.4 Test results

- Frequency: 2402MHz
- DataRate: 1Mbps

Line: Phase 1



Line: Neutral



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 61 von 67
Page 61 of 67

Prüfdokumentation
Test documentation

QuasiPeak:

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Pos	Correction (dB)	RBW (Hz)	M. time (s)	M. time (s)
424.5 k	39.3	57.4	-18.1	Phase	10.0	9 k	1.0	0.1
154.5 k	52.9	65.8	-12.9	Neutral	10.0	9 k	1.0	0.1
154.5 k	53.0	65.8	-12.8	Phase	10.0	9 k	1.0	0.1
440.25 k	44.9	57.1	-12.1	Phase	10.0	9 k	1.0	0.1
440.25 k	48.5	57.1	-8.6	Neutral	10.0	9 k	1.0	0.1

Average:

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Pos	Correction (dB)	RBW (Hz)	M. time (s)	M. time (s)
154.5 k	36.6	55.8	-19.1	Phase	10.0	9 k	1.0	0.1
424.5 k	28.7	47.4	-18.7	Phase	10.0	9 k	1.0	0.1
154.5 k	37.3	55.8	-18.5	Neutral	10.0	9 k	1.0	0.1
440.25 k	39.8	47.1	-7.2	Phase	10.0	9 k	1.0	0.1
440.25 k	44.8	47.1	-2.3	Neutral	10.0	9 k	1.0	0.1

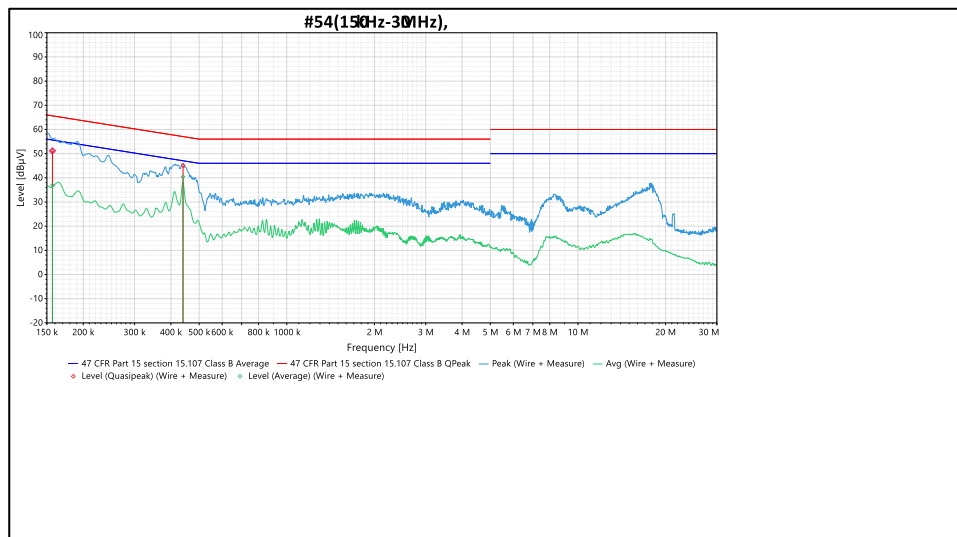
Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 62 von 67
Page 62 of 67

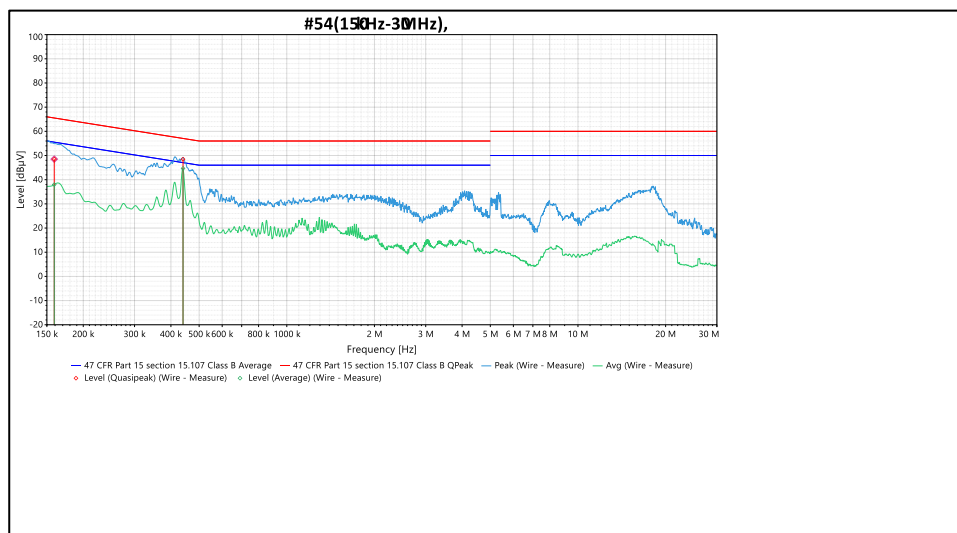
Prüfdokumentation Test documentation

- Frequency: 2480MHz
- DataRate: 1Mbps

Line: Phase 1



Line: Neutral



Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 63 von 67
Page 63 of 67

Prüfdokumentation
Test documentation

QuasiPeak:

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Pos	Correction (dB)	RBW (Hz)	M. time (s)	M. time (s)
159 k	48.5	65.5	-17.0	Phase	10.0	9 k	1.0	0.1
156.75 k	51.1	65.6	-14.5	Neutral	10.0	9 k	1.0	0.1
440.25 k	45.1	57.1	-12.0	Phase	10.0	9 k	1.0	0.1
440.25 k	48.5	57.1	-8.6	Phase	10.0	9 k	1.0	0.1

Average:

Frequency (MHz)	Level (dBμV)	Limit (dBμV)	Margin (dB)	Pos	Correction (dB)	RBW (Hz)	M. time (s)	M. time (s)
156.75 k	37.0	55.6	-18.7	Phase	10.0	9 k	1.0	0.1
159 k	38.0	55.5	-17.5	Phase	10.0	9 k	1.0	0.1
440.25 k	40.5	47.1	-6.6	Neutral	10.0	9 k	1.0	0.1
440.25 k	44.7	47.1	-2.4	Phase	10.0	9 k	1.0	0.1

Final test result

Pass

Prüfbericht-Nr.: DE23OWMA 003
Test report no.:

Seite 64 von 67
Page 64 of 67

Fotodokumentation
Photo documentation

5 Photo documentation

Refer to EUT Test Setup Photos_DE23OWMA 001

Refer to EUT Internal Photos_DE23OWMA 001

Refer to EUT External Photos_DE23OWMA 001

Prüfbericht-Nr.: DE23OWMA 003
Test report No.:

Seite 65 von 67
Page 65 of 67

Liste der verwendeten Prüfmittel
List of used test equipment

6 Equipment List

6.1 Hardware

Prüfmittel Test equipment			Prüfmittel-Nr. / ID-Nr. Equipment No. / ID-No.	Nächste Kalibrierung Next calibration
TS8997 (2728871)	OSP-B157 WX. (with integrated power meter)	Rohde & Schwarz	9000266	08.09.2024
	OSP-B157W8	Rohde & Schwarz	9000267	07.09.2024
	Spectrum Analyzer: FSV- 30	Rohde & Schwarz	9000268	10.08.2025
Fully Anechoic Room		Albatross Projects GmbH	2959749	08.10.2024
Signal Analyzer FSU 26		Rohde & Schwarz	2844118	04.08.2025
Signal Analyzer UXA N9041B		Keysight	2971644	06.04.2024
RSE-Filtersystem		Rohde & Schwarz	9002802	20.01.2024
Antenna CBL 6111D 25MHz-1GHz		CHASE	2815644	06.09.2024
Antenna HF907 1-18GHz		Rohde & Schwarz	2856263	01.09.2024
Horn Antenna 3116C-PA 18-40GHz		ETS LINDGREN	2900393	19.12.2025
Semi-Anechoic Chamber 30-1000 MHz		Siemens	2729645	15.06.2025
Receiver ESU 8		Rohde & Schwarz	2728844	26.01.2024
Antenna HFH 2 (Loop) 9kHz-30MHz		Rohde & Schwarz	2728893	09.07.2024
Antenna VULB 9168 30MHz – 1GHz		Schwarzbeck	2728136	05.10.2026
LISN ESH2-Z5		Rohde & Schwarz	2728096	27.01.2026
Receiver ESU 26		Rohde & Schwarz	2723865	04.10.2024
Shielded room		TDK	SR 2	—

Prüfbericht-Nr.: DE23OWMA 003
Test report No.:

Seite 66 von 67
Page 66 of 67

Liste der verwendeten Prüfmittel
List of used test equipment

6.2 Software

Test Software	Developer	Version
EMC32	Rohde & Schwarz	10.60.20
WMS32	Rohde & Schwarz	10.60.10
BAT-EMC	NEXIO	2022.0.8.0

Prüfbericht-Nr.: DE23OWMA 003
Test report No.:

Seite 67 von 67
Page 67 of 67

Änderungsverzeichnis
Change history

7 Change History

Revision Number	List of revisions	Date of issue
DE23OWMA 001	Initial Release	2023-11-09
DE23OWMA 002	99% Bandwidth value corrected for High channel 1 Mbps	2023-12-19
DE23OWMA 003	Antenna Gain and software version updated as per Reviewer Comment.	2024-01-18
Note: Latest revision report will replace all previous reports.		

Ende des Prüfberichts

End of Test Report