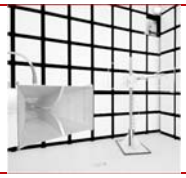
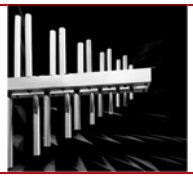
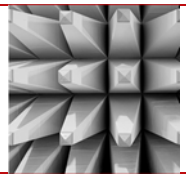

CETECOM™

CETECOM ICT Services
consulting - testing - certification

TEST REPORT

Test report no.: 1-1062/15-01-02-B

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-00

Testing laboratory

CETECOM ICT Services GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 - 0
Fax: + 49 681 5 98 - 9075
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e-mail: ict@cetecom.com

Accredited Testing Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2005) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12076-01-00

Applicant

Steute Schaltgeräte GmbH & Co. KG
Brückenstraße 91
32584 Löhne / GERMANY
Phone: +49 (0) 5731 745 - 249
Fax: -/-
Contact: Nils Fischer
e-mail: n.fischer@steute.de
Phone: +49 573 174-5203

Manufacturer

Steute Schaltgeräte GmbH & Co. KG
Brückenstraße 91
32584 Löhne / GERMANY

Test standard/s

47 CFR Part 15	Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 1	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	**Foot panel GR212, foot panel OPMI, Receiver 12**
Model name:	**E-4448-E / E-4448-I / SW100 Wireless Modul**
FCC ID:	**XK5-SW100AMBINT**
IC:	**5158A-SW100AMBINT**
Frequency:	DTS band 2400 MHz to 2483.5 MHz
Technology tested:	Proprietary
Antenna:	2 external antennas and 1 internal antenna
Power supply:	3 V DC by battery pack
Temperature range:	-20°C to +55°C

This test report is electronically signed and valid without handwriting signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test report authorized:

cn=Stefan Boes, o=CETECOM ICT Services GmbH, ou=BOE-111011, email=Stefan.Boes@cetecom.com, c=DE
2016.05.04 13:32:54 +02'00'

Stefan Bös
Lab Manager
Radio Communications & EMC

Test performed:

cn=Mihail Dorongovskij, o=CETECOM ICT Services GmbH, ou=DOG-151008, email=Michael.Dorongovski@cetecom.com, c=DE
2016.05.04 08:54:33 +02'00'

Mihail Dorongovskij
Testing Manager
Radio Communications & EMC

1 Table of contents

2 General information

2.1 Notes and disclaimer

The test results of this test report relate exclusively to the test item specified in this test report. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report replaces the test report with the number 1-1062/15-01-02-A and dated 2016-05-03.

2.2 Application details

Date of receipt of order:	2016-01-25
Date of receipt of test item:	2016-01-29
Start of test:	2016-02-08
End of test:	2016-03-11
Person(s) present during the test:	-/-

3 Test standard/s and references

Test standard	Date	Description
47 CFR Part 15		Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 247 Issue 1	May 2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

Guidance	Version	Description
ANSI C63.4-2014	-/-	American national standard for methods of measurement of radio-noise emissions from low-voltage electrical and electronic equipment in the range of 9 kHz to 40 GHz
ANSI C63.10-2013	-/-	American national standard of procedures for compliance testing of unlicensed wireless devices

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom}	3.0 V DC by battery pack

5 Test item

5.1 General description

Kind of test item	:	Foot panel GR212, foot panel OPMI, Receiver 12
Type identification	:	E-4448-E / E-4448-I / SW100 Wireless Modul
HMN	:	-/-
PMN	:	SW100AMB
HVIN	:	SW100AMBINT SW100AMBEXT
FVIN	:	-/-
S/N serial number	:	Rad. 1185111 (ceramic chip antenna) and 1185555 (external antennas) Cond. 1185555
HW hardware status	:	1.0
SW software status	:	2.6.0
Frequency band	:	DTS band 2400 MHz to 2483.5 MHz
Type of radio transmission Use of frequency spectrum	: :	FHSS
Type of modulation	:	MSK
Number of channels	:	32
Antenna	:	2 external antennas and 1 internal antenna
Power supply	:	3.0 V DC by battery pack
Temperature range	:	-20°C to +55 °C

5.2 Additional information

The content of the following annexes is defined in the QA. It may be that not all of the listed annexes are necessary for this report, thus some values in between may be missing.

Test setup- and EUT-photos are included in test report: 1-1062/15-01-02_AnnexA
1-1062/15-01-02_AnnexB
1-1062/15-01-02_AnnexD

6 Test laboratories sub-contracted

None

7 Description of the test setup

Typically, the calibrations of the test apparatus are commissioned to and performed by an accredited calibration laboratory. The calibration intervals are determined in accordance with the DIN EN ISO/IEC 17025. In addition to the external calibrations, the laboratory executes comparison measurements with other calibrated test systems or effective verifications. Weekly chamber inspections and range calibrations are performed. Where possible, RF generating and signaling equipment as well as measuring receivers and analyzers are connected to an external high-precision 10 MHz reference (GPS-based or rubidium frequency standard).

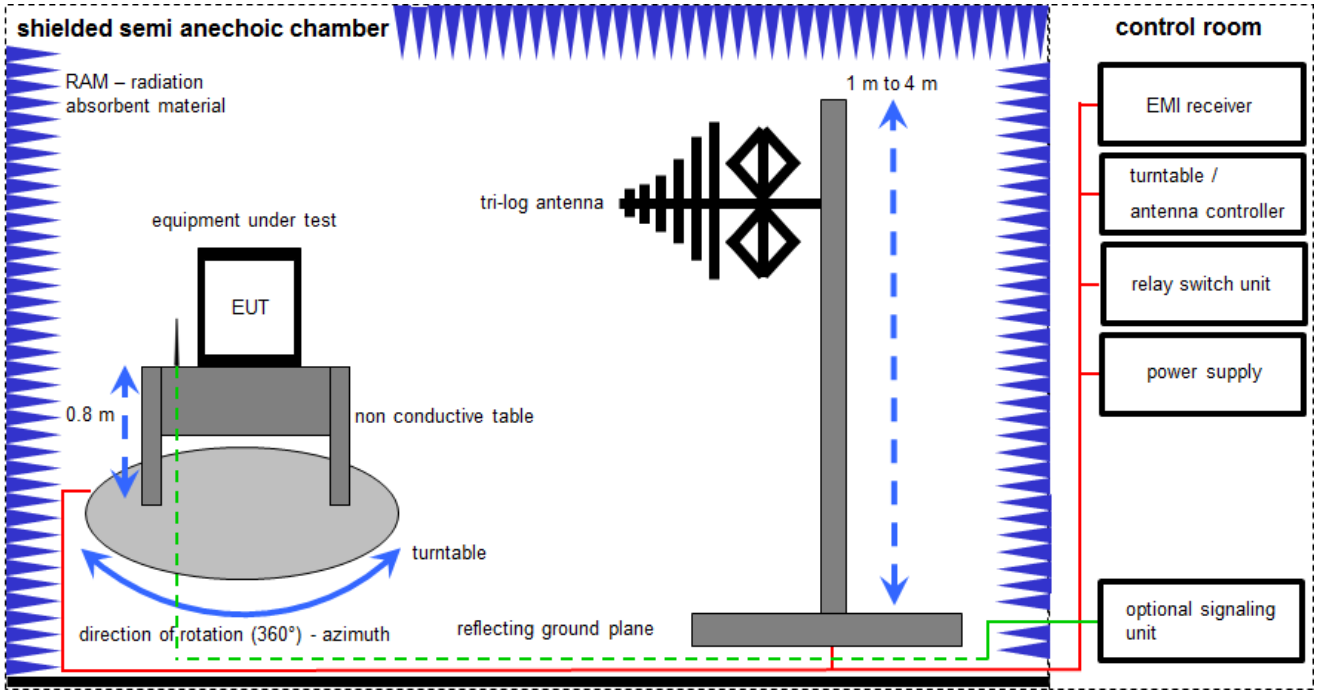
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

Agenda: Kind of Calibration

k	calibration / calibrated	EK	limited calibration
ne	not required (k, ev, izw, zw not required)	zw	cyclical maintenance (external cyclical maintenance)
ev	periodic self verification	izw	internal cyclical maintenance
Ve	long-term stability recognized	g	blocked for accredited testing
vlkl!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

7.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas are confirmed with specifications ANSI C63. These antennas can be moved over the height range between 1.0 m and 4.0 m in order to search for maximum field strength emitted from EUT. The measurement distances between EUT and receiving antennas are indicated in the test setups for the various frequency ranges. For each measurement, the EUT is rotated in all three axes until the maximum field strength is received. The wanted and unwanted emissions are received by spectrum analyzers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Measurement distance: tri-log antenna 10 meter

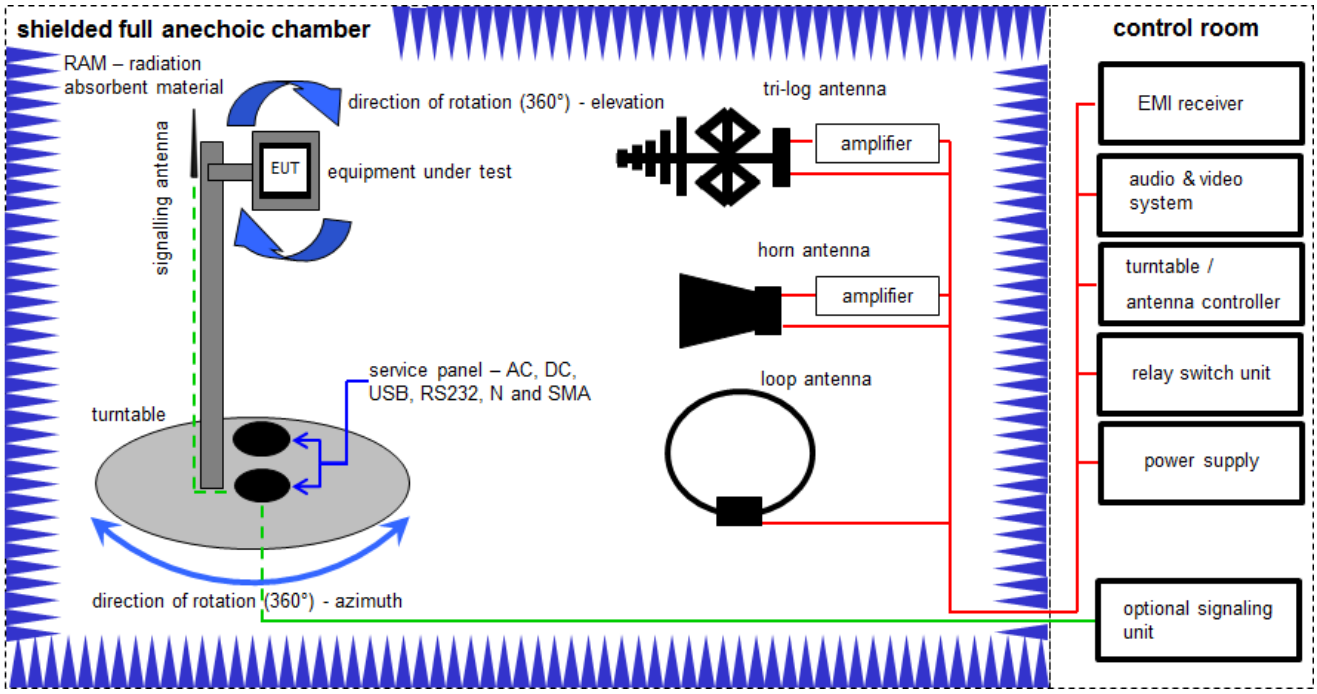
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 12.35 [dBµV/m] + 1.90 [dB] + 16.80 [dB/m] = 31.05 [dBµV/m] (35.69 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	28.01.2016	27.01.2017
3	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
4	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
5	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
6	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	22.04.2014	22.04.2016

7.2 Shielded fully anechoic chamber



Measurement distance: tri-log antenna and horn antenna 3 meter; loop antenna 3 meter / 1 meter

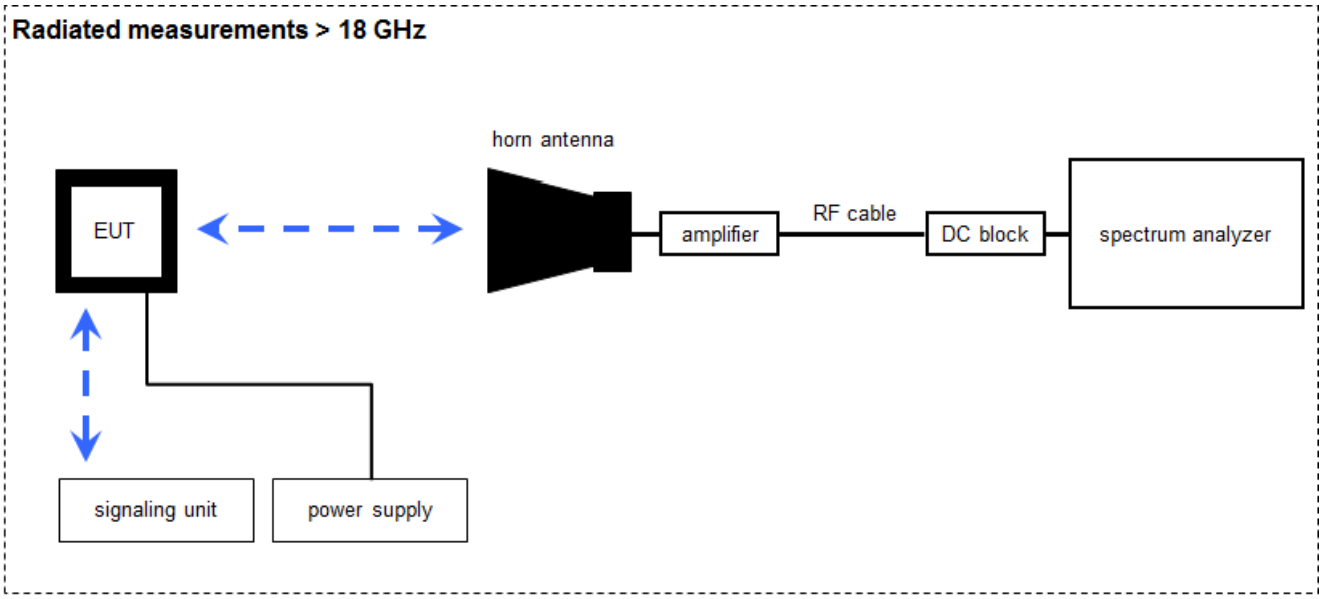
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vIKI!	20.05.2015	20.05.2017
2	A, B, C	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev	-/-	-/-
3	A, B, C	Switch / Control Unit	3488A	HP	*	300000199	ne	-/-	-/-
4	C	Active Loop Antenna 10 kHz to 30 MHz	6502	EMCO/2	8905-2342	300000256	k	24.06.2015	24.06.2017
5	A	Amplifier	js42-00502650-28-5a	Parzich GMBH	928979	300003143	ne	-/-	-/-
6	A	Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev	-/-	-/-
7	A	Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789	ne	-/-	-/-
8	A, B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vIKI!	29.10.2014	29.10.2017
9	A, B, C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000037	300004509	ne	-/-	-/-
10	A, B, C	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	04.09.2015	04.09.2016

7.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

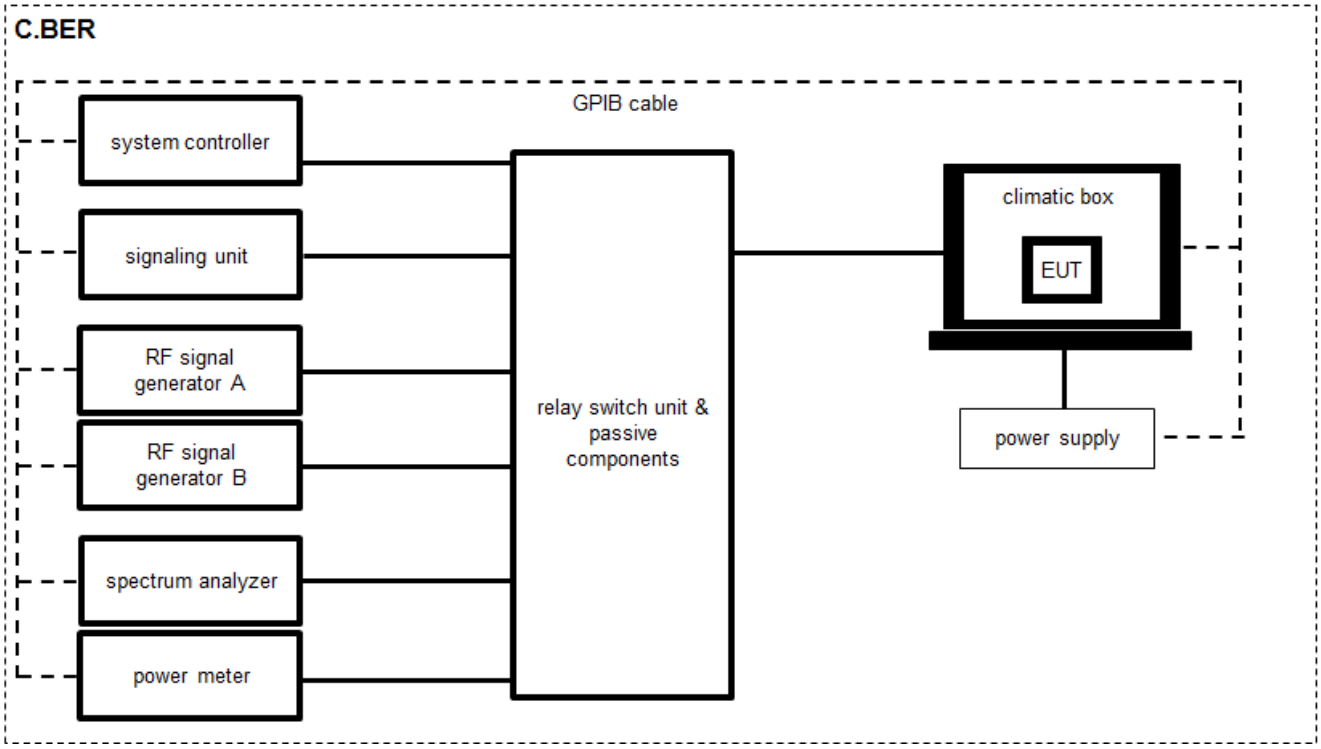
$FS = U_R + CA + AF$
(FS-field strength; U_R-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-60.1) [dB] + 36.74 [dB/m] = 16.64 [dBµV/m] (6.79 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda		300000486	k	10.09.2015	10.09.2017
2	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	21.01.2016	21.01.2017
3	A	Amplifier 2-40 GHz	JS32-02004000-57-5P	MITEQ	1777200	300004541	ev	-/-	-/-
4	A	RF-Cable	ST18/SMAm/SMAm/60	Huber & Suhner	Batch no. 606844	400001181	ev	-/-	-/-
5	A	RF-Cable	ST18/SMAm/SMAm/48	Huber & Suhner	Batch no. 600918	400001182	ev	-/-	-/-
6	A	DC-Blocker 0.1-40 GHz	8141A	Inmet	Batch no. 600918	400001185	ev	-/-	-/-

7.4 Conducted measurements C.BER system



OP = AV + CA
(OP-output power; AV-analyzer value; CA-loss signal path)

Example calculation:
OP [dBm] = 6.0 [dBm] + 11.7 [dB] = 17.7 [dBm] (58.88 mW)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch / Control Unit	3488A	HP		300000929	ne	-/-	-/-
2	A	Signal Analyzer 30GHz	FSV30	R&S	103170	300004855	k	25.01.2016	25.01.2017
3	A	Directional Coupler	101020010	Krytar	70215	300002840	ev	-/-	-/-
4	A	DC-Blocker	8143	Inmet Corp.	none	300002842	ne	-/-	-/-
5	A	Powersplitter	6005-3	Inmet Corp.	none	300002841	ev	-/-	-/-
6	A	RF-Cable	ST18/SMAm/SMAm/ 72	Huber & Suhner	Batch no. 605505	400001187	ev	-/-	-/-
7	A	RF-Cable	Sucoflex 104	Huber & Suhner	147636/4	400001188	ev	-/-	-/-

8 Sequence of testing

8.1 Sequence of testing radiated spurious 9 kHz to 30 MHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna height is 1.5 m.
- At each turntable position the analyzer sweeps with positive-peak detector to find the maximum of all emissions.

Final measurement

- Identified emissions during the premeasurement are maximized by the software by rotating the turntable from 0° to 360°. In case of the 2-axis positioner is used the elevation axis is also rotated from 0° to 360°.
- The final measurement is done in the position (turntable and elevation) causing the highest emissions with quasi-peak (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, correction factor, margin to the limit and limit will be recorded. A plot with the graph of the premeasurement and the limit is stored.

8.2 Sequence of testing radiated spurious 30 MHz to 1 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a table with 0.8 m height is used, which is placed on the ground plane.
- If the EUT is a floor standing device, it is placed on the ground plane with insulation between both.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 10 m or 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height changes from 1 m to 3 m.
- At each turntable position, antenna polarization and height the analyzer sweeps three times in peak to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximize the peaks by changing turntable position ± 45° and antenna height between 1 and 4 m.
- The final measurement is done with quasi-peak detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, antenna height, antenna polarization, turntable angle, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.3 Sequence of testing radiated spurious 1 GHz to 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- If the EUT is a tabletop system, a 2-axis positioner with 1.5 m height is used.
- If the EUT is a floor standing device, it is placed directly on the turn table.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet below the turntable.
- Measurement distance is 3 m (see ANSI C 63.4) – see test details.
- EUT is set into operation.

Premeasurement

- The turntable rotates from 0° to 315° using 45° steps.
- The antenna is polarized vertical and horizontal.
- The antenna height is 1.5 m.
- At each turntable position and antenna polarization the analyzer sweeps with positive peak detector to find the maximum of all emissions.

Final measurement

- The final measurement is performed for at least six highest peaks according to the requirements of the ANSI C63.4.
- Based on antenna and turntable positions at which the peak values are measured the software maximizes the peaks by rotating the turntable from 0° to 360°. This measurement is repeated for different EUT-table positions (0° to 150° in 30°-steps) and for both antenna polarizations.
- The final measurement is done in the position (turntable, EUT-table and antenna polarization) causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, turntable position, EUT-table position, antenna polarization, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement with marked maximum final results and the limit is stored.

8.4 Sequence of testing radiated spurious above 18 GHz

Setup

- The equipment is set up to simulate normal operation mode as described in the user manual or defined by the manufacturer.
- Auxiliary equipment and cables are positioned to simulate normal operation conditions as described in ANSI C 63.4.
- The AC power port of the EUT (if available) is connected to a power outlet.
- The measurement distance is as appropriate (e.g. 0.5 m).
- The EUT is set into operation.

Premeasurement

- The test antenna is handheld and moved carefully over the EUT to cover the EUT's whole sphere and different polarizations of the antenna.

Final measurement

- The final measurement is performed at the position and antenna orientation causing the highest emissions with Peak and RMS detector (as described in ANSI C 63.4).
- Final levels, frequency, measuring time, bandwidth, correction factor, margin to the limit and limit are recorded. A plot with the graph of the premeasurement and the limit is stored.

9 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
Carrier frequency separation	± 21.5 kHz
Number of hopping channels	-/-
Spectrum bandwidth	± 21.5 kHz absolute; ± 15.0 kHz relative
Maximum output power	± 1 dB
Detailed conducted spurious emissions @ the band edge	± 1 dB
Band edge compliance radiated	± 3 dB
Spurious emissions conducted	± 3 dB
Spurious emissions radiated below 30 MHz	± 3 dB
Spurious emissions radiated 30 MHz to 1 GHz	± 3 dB
Spurious emissions radiated 1 GHz to 12.75 GHz	± 3.7 dB
Spurious emissions radiated above 12.75 GHz	± 4.5 dB
Spurious emissions conducted below 30 MHz (AC conducted)	± 2.6 dB

10 Summary of measurement results

☐	No deviations from the technical specifications were ascertained
☐	There were deviations from the technical specifications ascertained
☒	This test report is only a partial test report. The content and verdict of the performed test cases are listed below.

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 1	See table!	2016-05-04	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (2)	Antenna gain	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (2)	Carrier frequency separation	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.247(a)(1) RSS - 247 / 5.1 (4)	Number of hopping channels	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.247(a)(1) (iii) RSS - 247 / 5.1 (4)	Time of occupancy (dwell time)	Nominal	Nominal	MSK	☐	☐	☐	☒	See 1-1225-01-02/09
§15.247(a)(1) RSS - 247 / 5.1 (1)	Spectrum bandwidth of a FHSS system bandwidth	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.247(b)(1) RSS - 247 / 5.4 (2)	Maximum output power	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	Nominal	Nominal	MSK	☒	☐	☐	☐	Measured with 3 different antennas
§15.247(d) RSS - 247 / 5.5	Spurious emissions conducted	Nominal	Nominal	MSK	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	Nominal	Nominal	MSK	☒	☐	☐	☐	Measured with 3 different antennas
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	Nominal	Nominal	MSK RX mode	☒	☐	☐	☐	Measured with 3 different antennas
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	Nominal	Nominal	MSK RX mode	☒	☐	☐	☐	Measured with 3 different antennas
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	Nominal	Nominal	MSK RX mode	☐	☐	☒	☐	Only battery powered.

Note: C = Compliant; NC = Not compliant; NA = Not applicable; NP = Not performed

11 Additional comments

Reference documents:	Test report: 1-1225-01-02/09
Special test descriptions:	Cetecom Inbetriebnahme Funkmodul
Configuration descriptions:	None
Test mode:	☒ Special software is used. EUT is transmitting pseudo random data by itself
Antennas and transmit operating modes:	☒ Operating mode 1 (single antenna) - Equipment with 1 antenna, - Equipment with 2 diversity antennas operating in switched diversity mode by which at any moment in time only 1 antenna is used, - Smart antenna system with 2 or more transmit/receive chains, but operating in a mode where only 1 transmit/receive chain is used)

12 Measurement results

12.1 Antenna gain

Measurement:

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module. For normal Bluetooth® devices, the MSK modulation is used.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B (radiated) See sub clause 7.4 A (conducted)
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Antenna gain	
6 dBi	

Results:

T_{nom}	V_{nom}	lowest channel 2403.5 MHz	middle channel 2449.5 MHz	highest channel 2478.5 MHz
Conducted power [dBm] Measured with MSK modulation		-0.9	-1.2	-1.2
Radiated power [dBm] Measured with MSK modulation Ceramic chip antenna		-2.1	0.1	1.0
Radiated power [dBm] Measured with MSK modulation External rubber antenna		3.0	3.6	3.8
Radiated power [dBm] Measured with MSK modulation External PCB antenna		4.2	4.3	2.6
Gain [dBi] Calculated Ceramic chip antenna		-1.2	1.3	2.2
Gain [dBi] Calculated External rubber antenna		3.9	4.8	5.0
Gain [dBi] Calculated External PCB antenna		5.1	5.5	3.8

12.2 Carrier frequency separation

Description:

Measurement of the carrier frequency separation of a hopping system. The carrier frequency separation is constant for all modulation-modes. We use MSK-modulation to show compliance. EUT in hopping mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	4 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

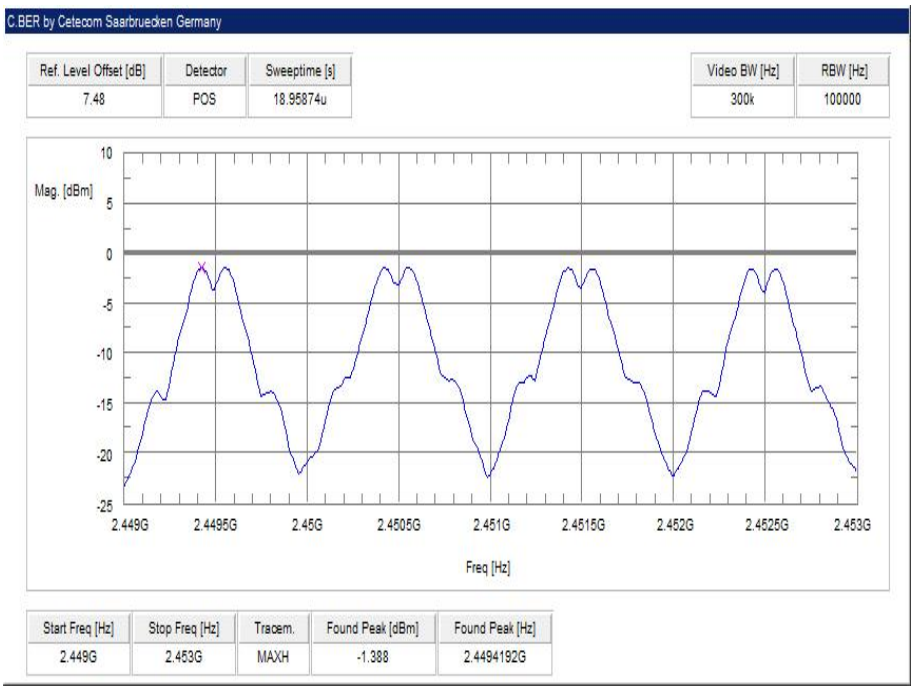
FCC	IC
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater.	

Result:

Carrier frequency separation	~ 1 MHz

Plot:

Plot 1: Carrier frequency separation (MSK modulation)



12.3 Number of hopping channels

Description:

Measurement of the total number of used hopping channels. The number of hopping channels is constant for all modulation-modes. We use MSK-modulation to show compliance. EUT in hopping mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	500 kHz
Video bandwidth	500 kHz
Span	Plot 1: 2400 – 2445 MHz Plot 2: 2445 – 2485 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

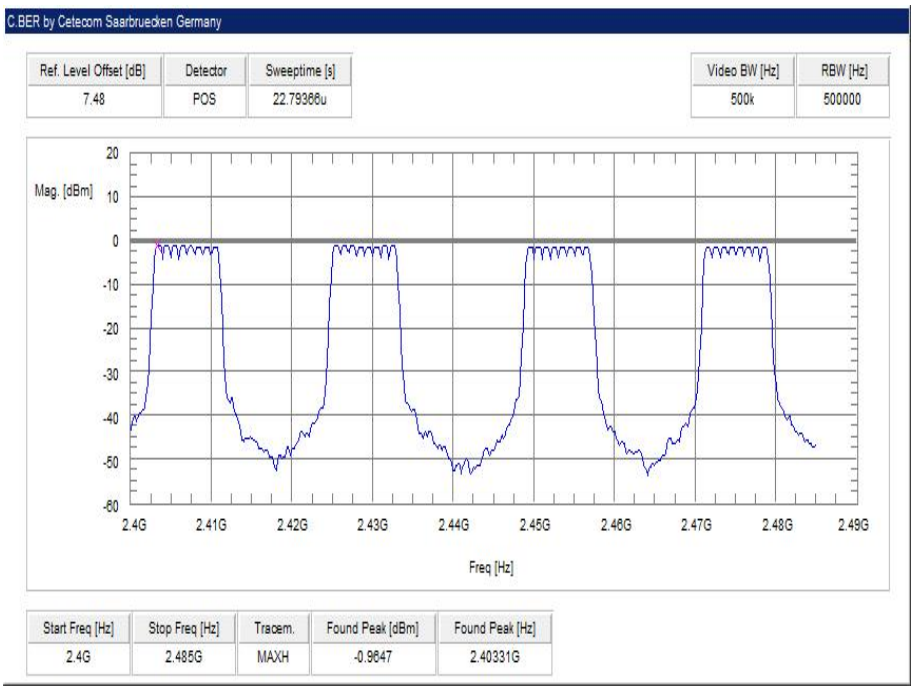
FCC	IC
Number of hopping channels	
At least 15 non overlapping hopping channels	

Result:

Number of hopping channels	32

Plots:

Plot 1: Number of hopping channels (MSK modulation)



12.4 Spectrum bandwidth of a FHSS system

Description:

Measurement of the 20dB bandwidth and 99% bandwidth of the modulated signal. The measurement is performed according to the “Measurement Guidelines” (DA 00-705, March 30, 2000). EUT in single channel mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Span	3 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Spectrum bandwidth of a FHSS system	
MSK < 1500 kHz	

Results:

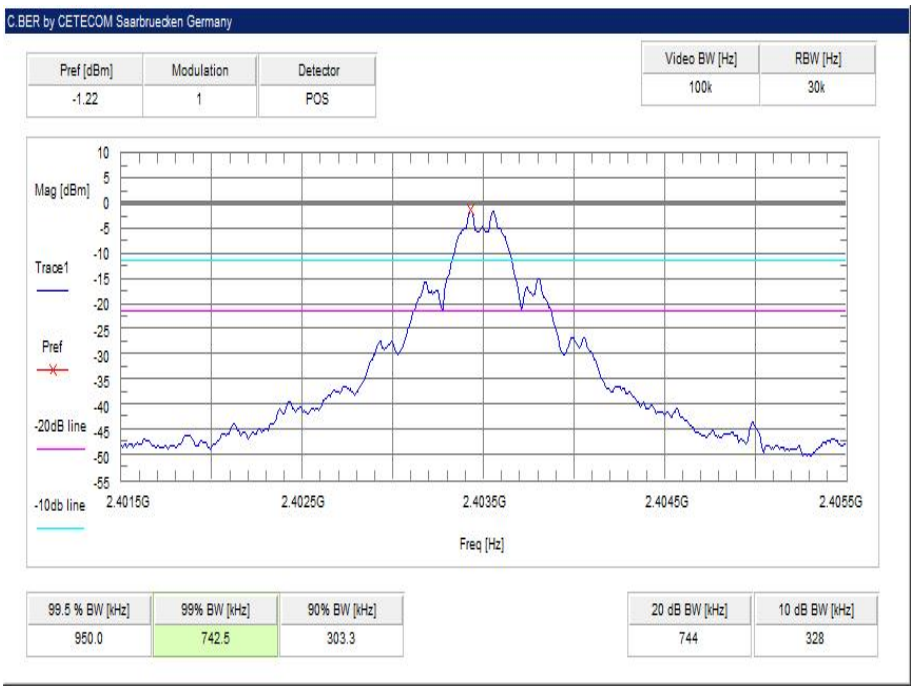
Modulation	20 dB bandwidth [kHz]		
Frequency	2403.5 MHz	2449.5 MHz	2478.5 MHz
MSK	744	752	752

Results:

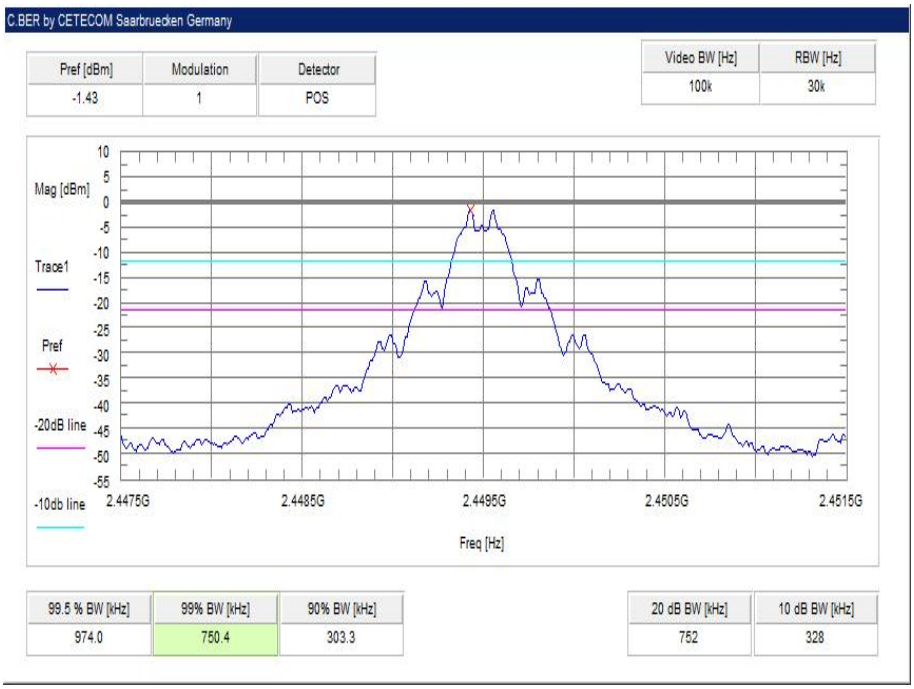
Modulation	99 % bandwidth [kHz]		
Frequency	2403.5 MHz	2449.5 MHz	2478.5 MHz
MSK	743	750	750

Plots:

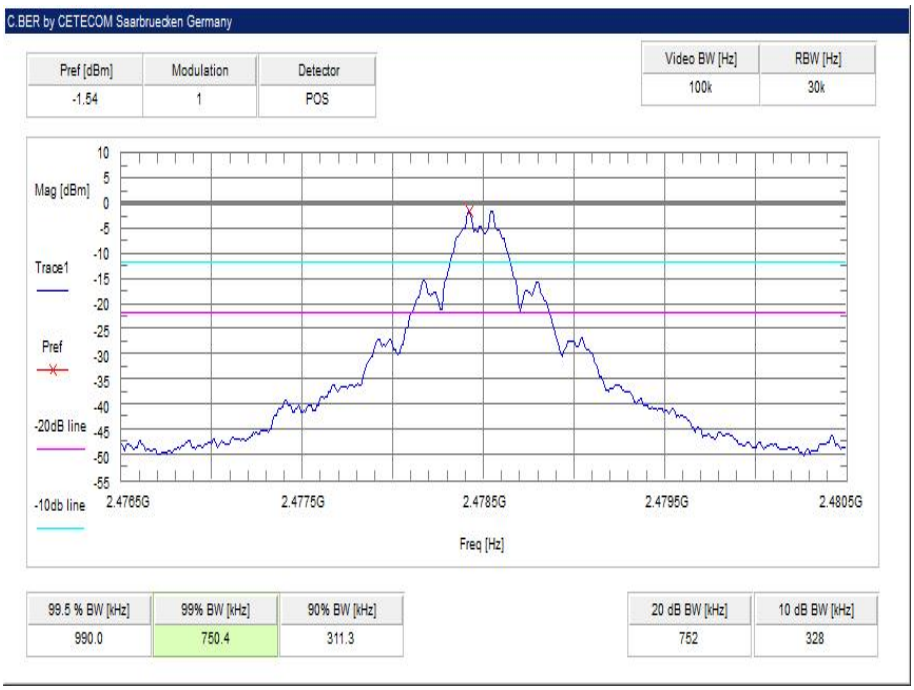
Plot 1: lowest channel – 2403.5 MHz, MSK modulation



Plot 2: middle channel – 2449.5 MHz, MSK modulation



Plot 3: highest channel – 2478.5 MHz, MSK modulation



12.5 Maximum output power

Description:

Measurement of the maximum output power conducted and radiated. EUT in single channel mode. The measurement is performed according to the ANSI C63.10.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	10 MHz
Span	6 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

FCC	IC
Maximum output power	
[Conducted: 0.125 W – antenna gain max. 6 dBi] Systems using more than 75 hopping channels: Conducted: 1.0 W – antenna gain max. 6 dBi	

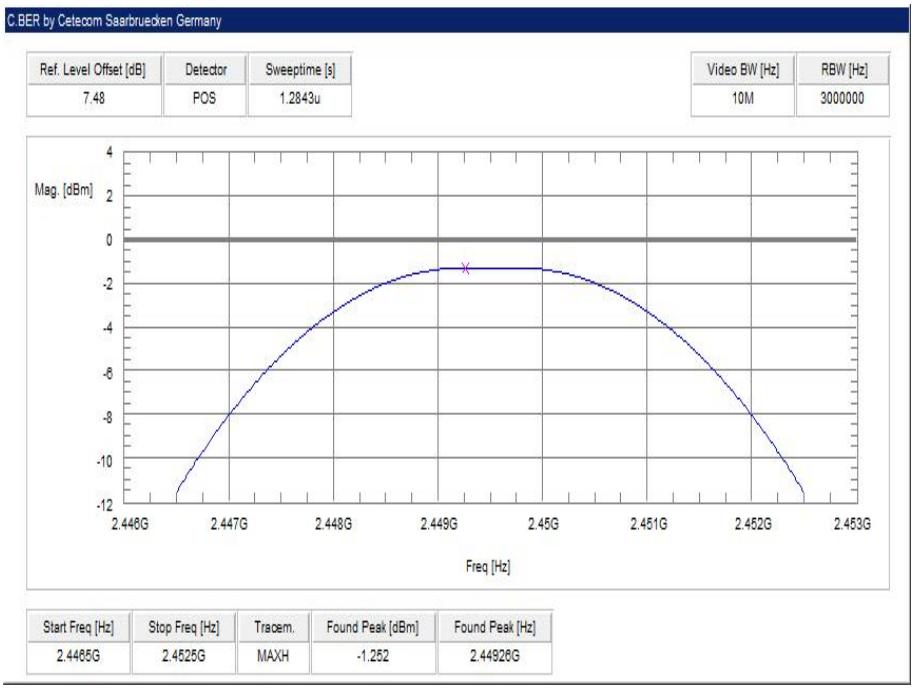
Results:

Modulation	Maximum output power conducted [dBm]		
Frequency	2403.5 MHz	2449.5 MHz	2478.5 MHz
MSK	-1.0	-1.3	-1.2

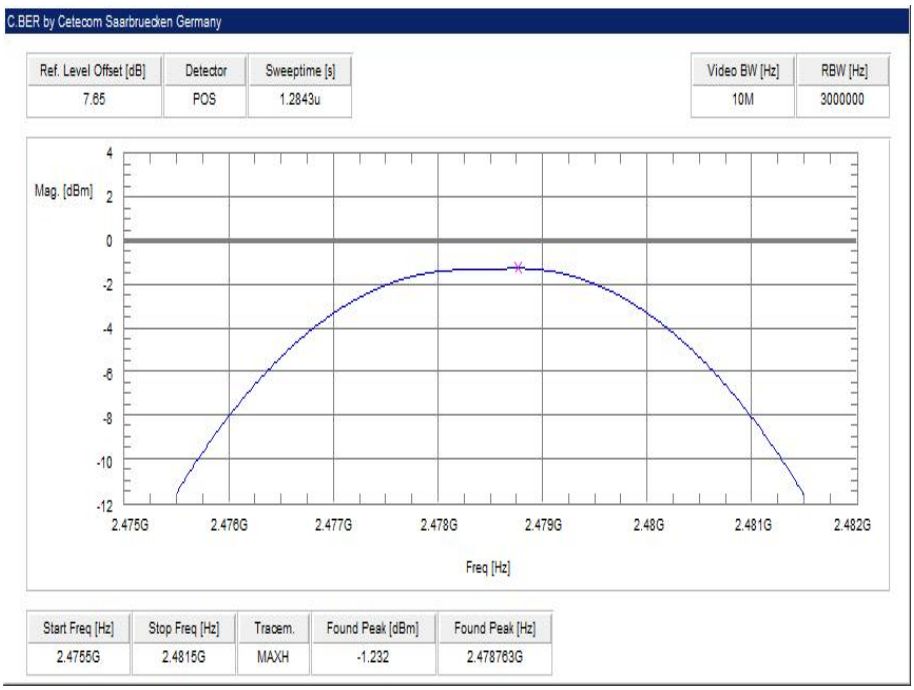
Plots:

Plot 1: lowest channel – 2403.5 MHz, MSK modulation

Plot 2: middle channel – 2449.5 MHz, MSK modulation



Plot 3: highest channel – 2478.5 MHz, MSK modulation



12.6 Detailed spurious emissions @ the band edge - conducted

Description:

Measurement of the conducted band edge compliance. EUT is measured at the lower and upper band edge in single channel and hopping mode. The measurement is repeated for all modulations.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz / 500 kHz
Span	Lower Band Edge: 2395 – 2405 MHz Upper Band Edge: 2478 – 2489 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

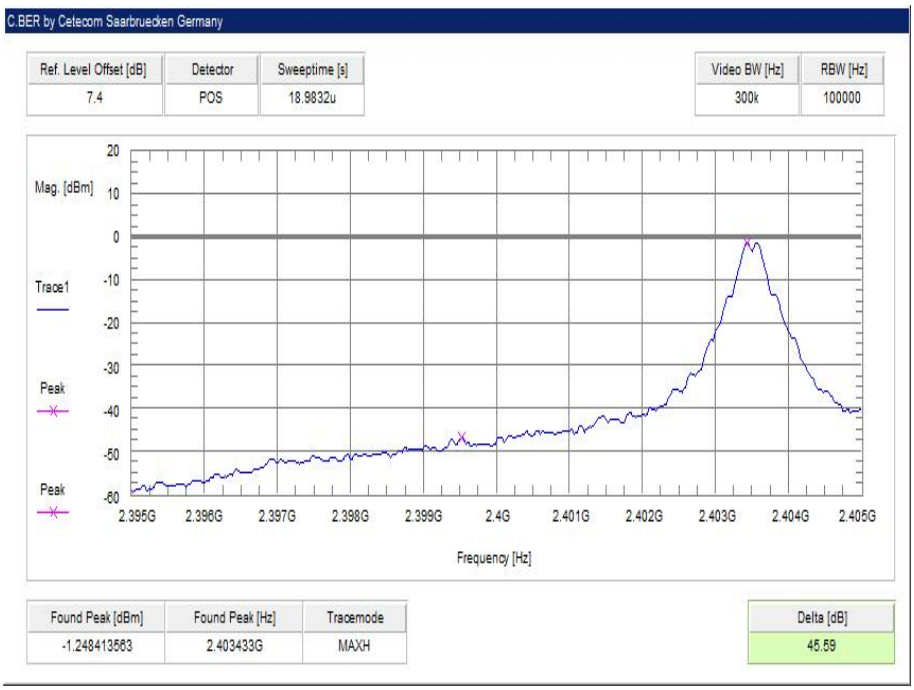
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required.	

Results:

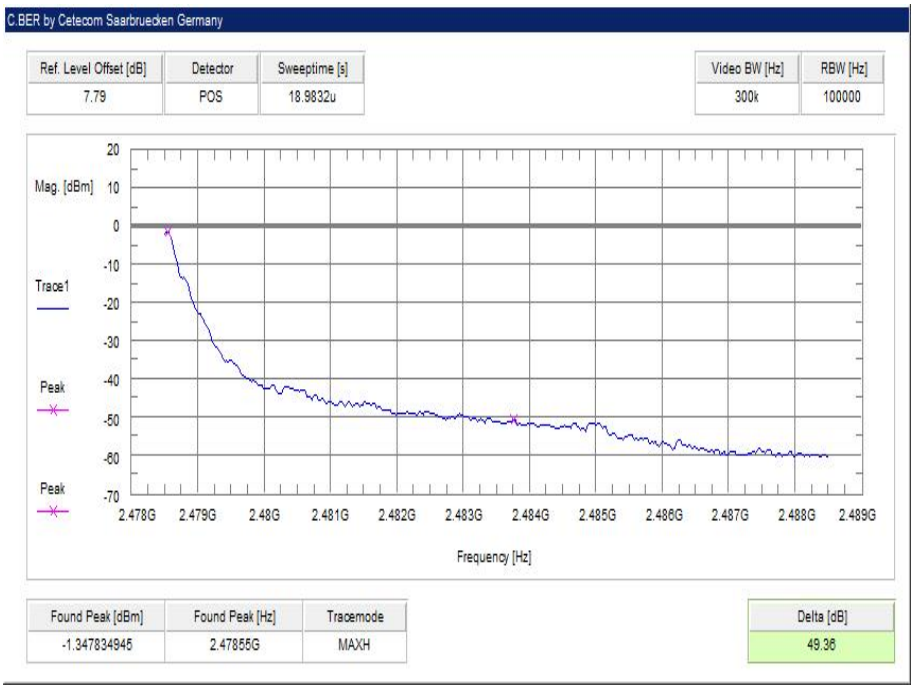
Scenario	Spurious band edge conducted [dB]
Modulation	MSK
Lower band edge – hopping off	> 20 dB
Upper band edge – hopping off	> 20 dB

Plots:

Plot 1: Lower band edge – hopping off, MSK modulation



Plot 2: Upper band edge – hopping off, MSK modulation



12.7 Band edge compliance radiated

Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to single channel mode and the transmit channel is channel 00 for the lower restricted band and channel 78 for the upper restricted band. The measurement is repeated for all modulations. Measurement distance is 3m.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	Lower Band: 2370 – 2400 MHz Upper Band: 2478.5 – 2500 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B
Measurement uncertainty	See sub clause 9

Limits:

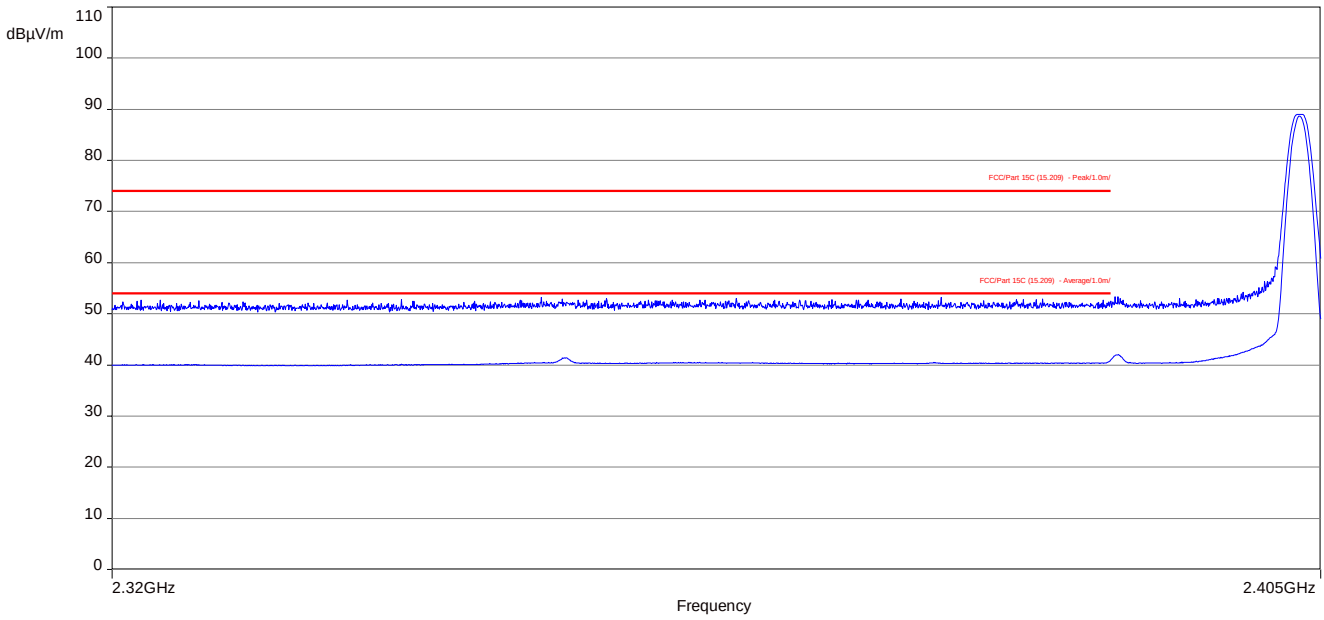
FCC	IC
Band edge compliance radiated	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. 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 5.205(c)).	
54 dBµV/m AVG 74 dBµV/m Peak	

Results:

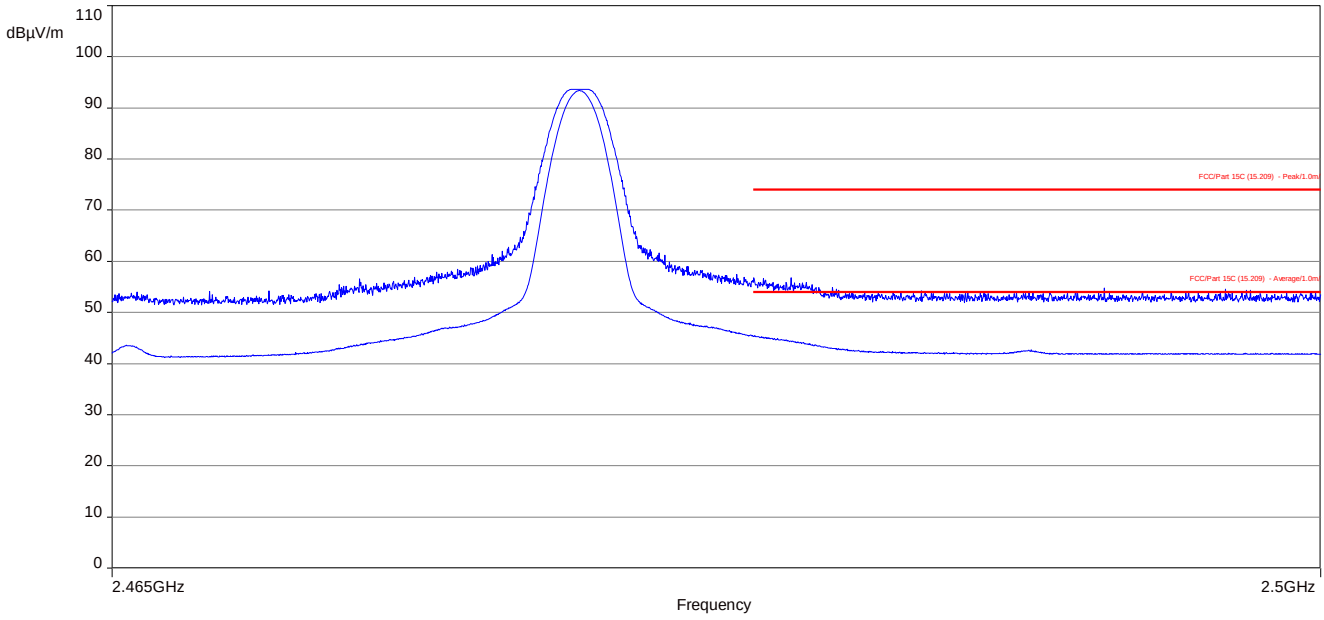
Scenario	Band edge compliance radiated [dBµV/m]
Modulation	MSK
Lower restricted band, ceramic chip antenna	< 54 AVG / < 74 PP
Upper restricted band, ceramic chip antenna	< 54 AVG / < 74 PP
Lower restricted band, external rubber antenna	< 54 AVG / < 74 PP
Upper restricted band, external rubber antenna	< 54 AVG / < 74 PP
Lower restricted band, external PCB antenna	< 54 AVG / < 74 PP
Upper restricted band, external PCB antenna	< 54 AVG / < 74 PP

Plots:

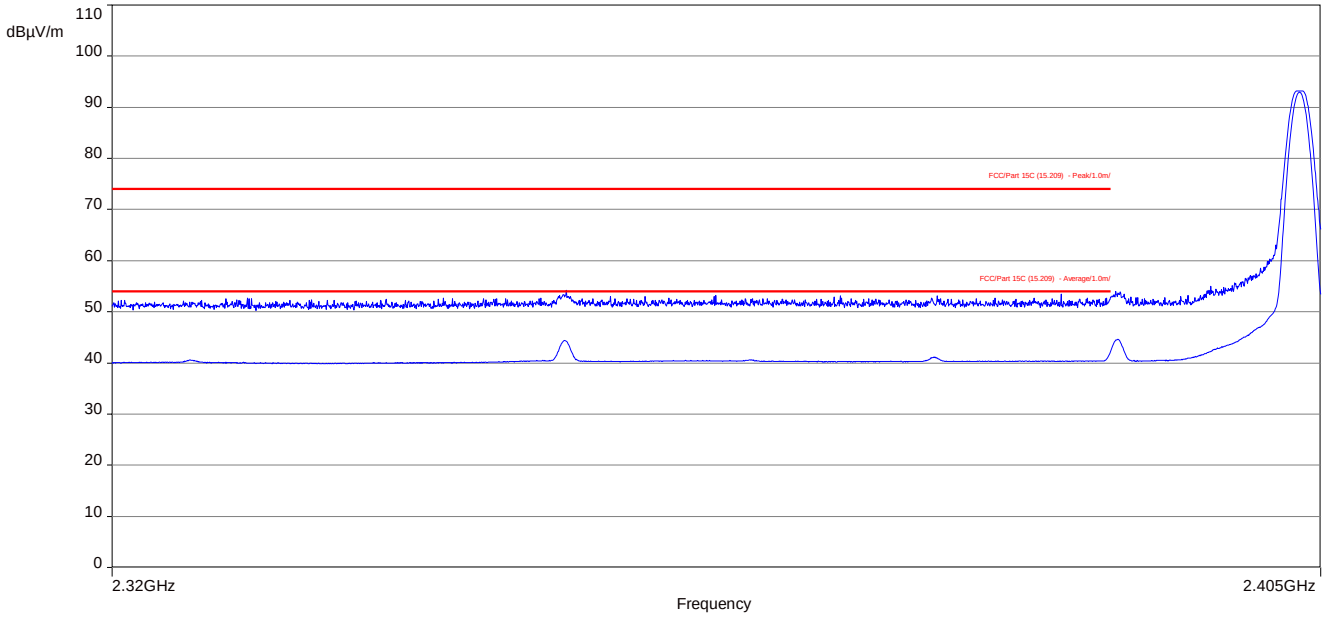
Plot 1: Lower band edge, MSK modulation, vertical & horizontal polarization, ceramic chip antenna



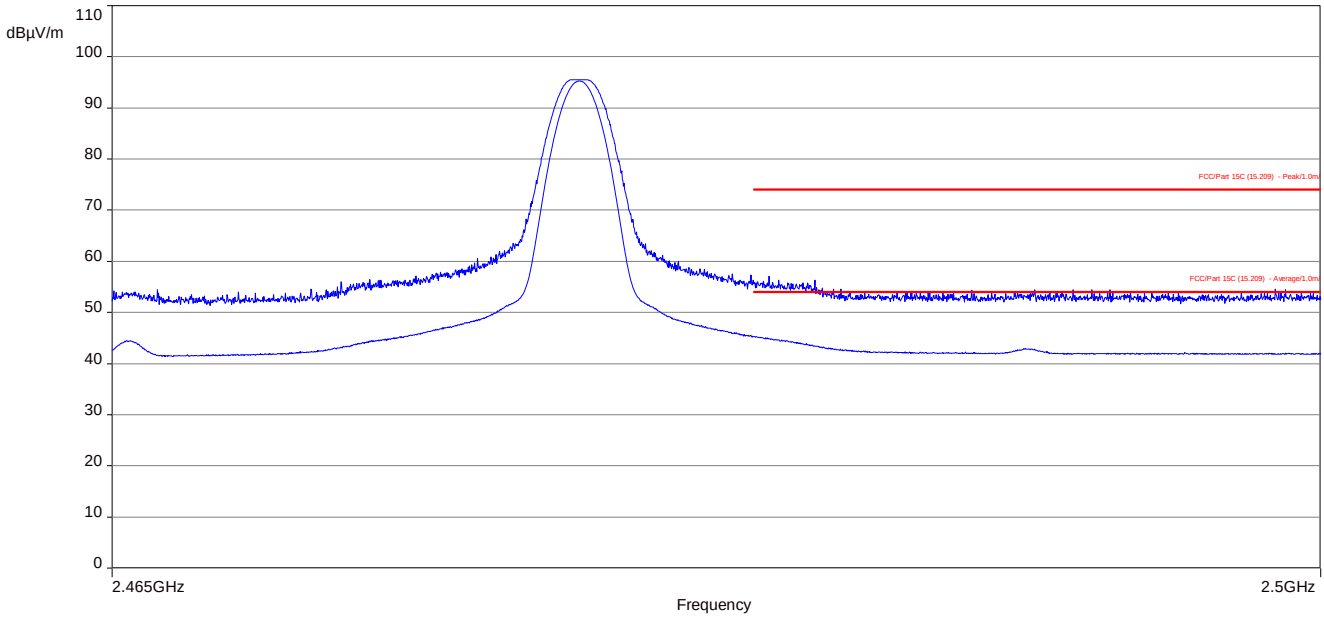
Plot 2: Upper band edge, MSK modulation, vertical & horizontal polarization, ceramic chip antenna



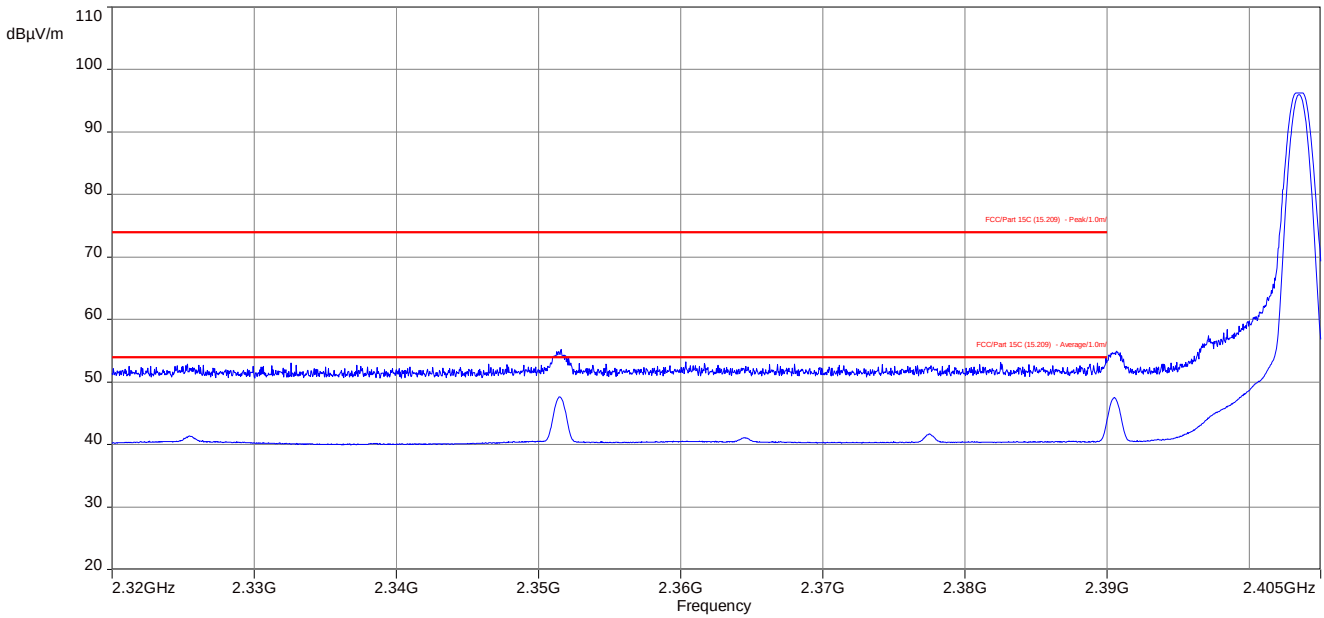
Plot 3: Lower band edge, MSK modulation, vertical & horizontal polarization, external rubber antenna



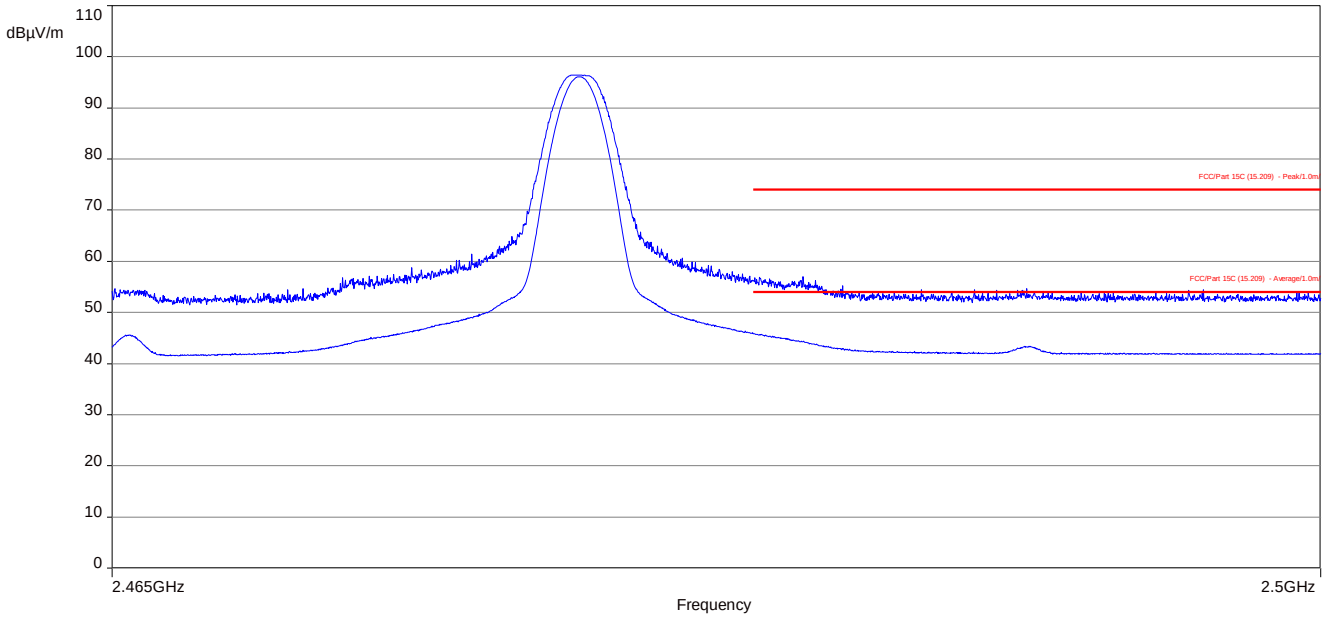
Plot 4: Upper band edge, MSK modulation, vertical & horizontal polarization, external rubber antenna



Plot 5: Lower band edge, MSK modulation, vertical & horizontal polarization, external PCB antenna



Plot 6: Upper band edge, MSK modulation, vertical & horizontal polarization, external PCB antenna



12.8 Spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	9 kHz to 25 GHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

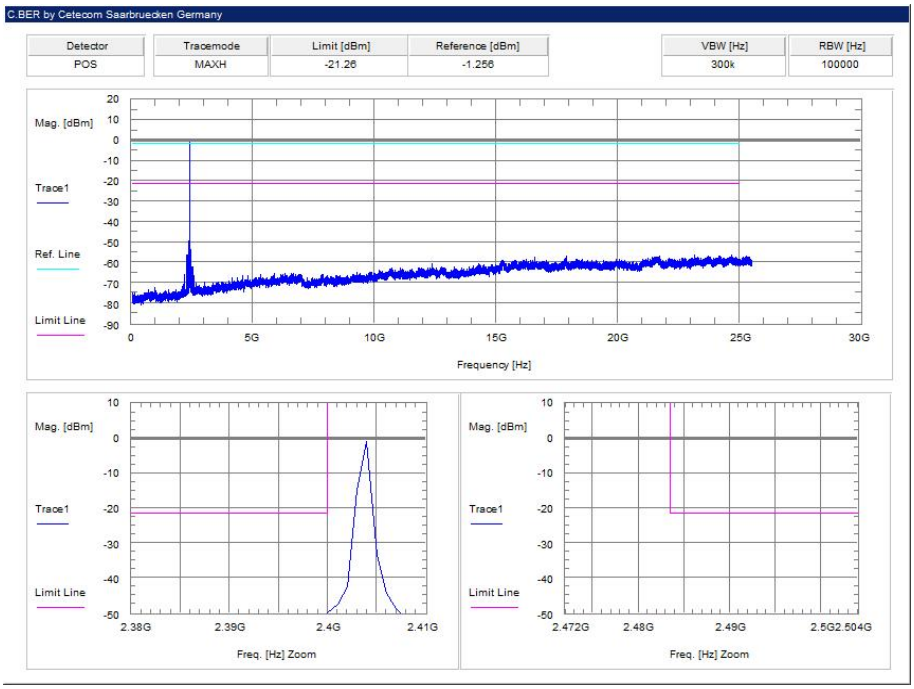
FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required	

Results:

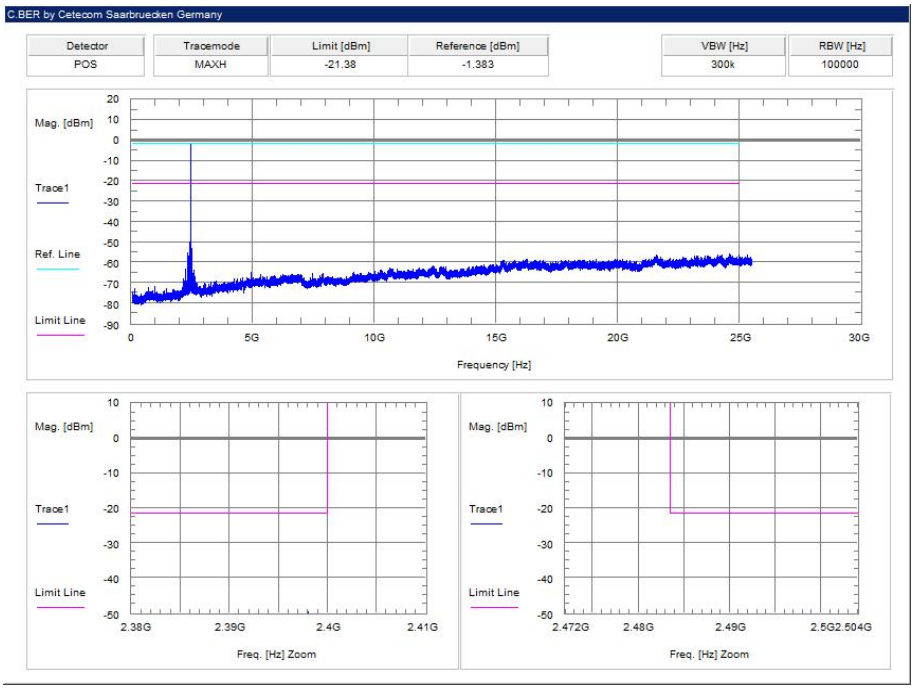
TX spurious emissions conducted					
MSK - mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2403.5		-1.3	30 dBm		Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc		compliant
2449.5		-1.4	30 dBm		Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc		compliant
2478.5		-1.4	30 dBm		Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc		compliant

Plots:

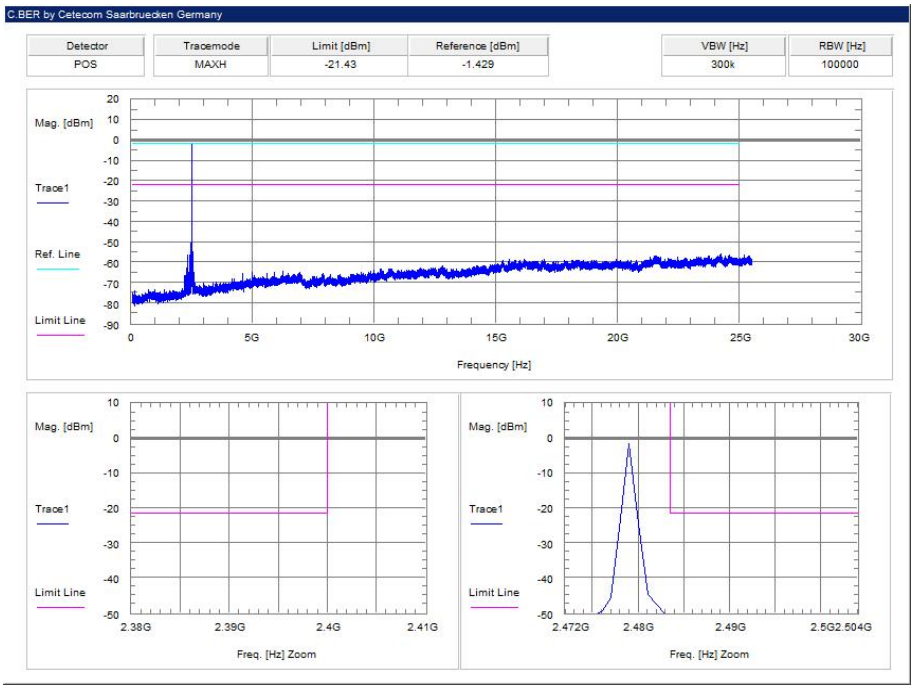
Plot 1: lowest channel – 2403.5 MHz, MSK modulation



Plot 2: middle channel – 2449.5 MHz, MSK modulation



Plot 3: highest channel – 2478.5 MHz, MSK modulation



12.9 Spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

Measurement parameters	
Detector	Peak / Quasi peak
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 C
Measurement uncertainty	See sub clause 9

Limits:

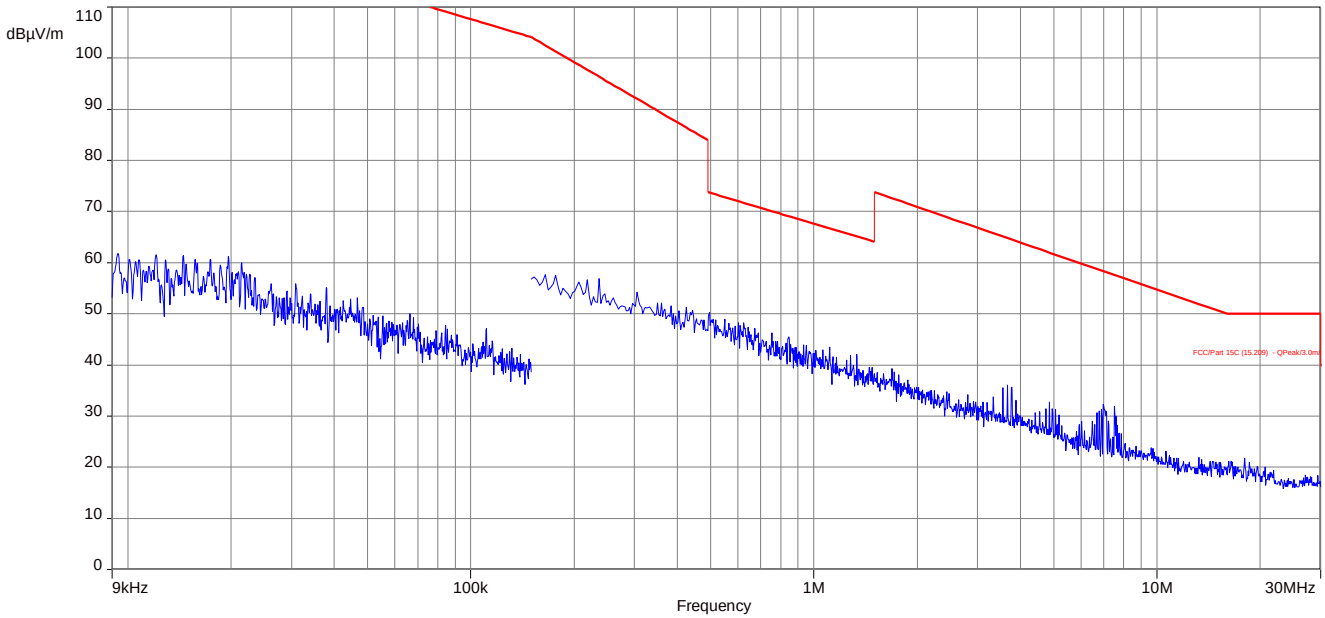
FCC		IC
TX spurious emissions radiated below 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

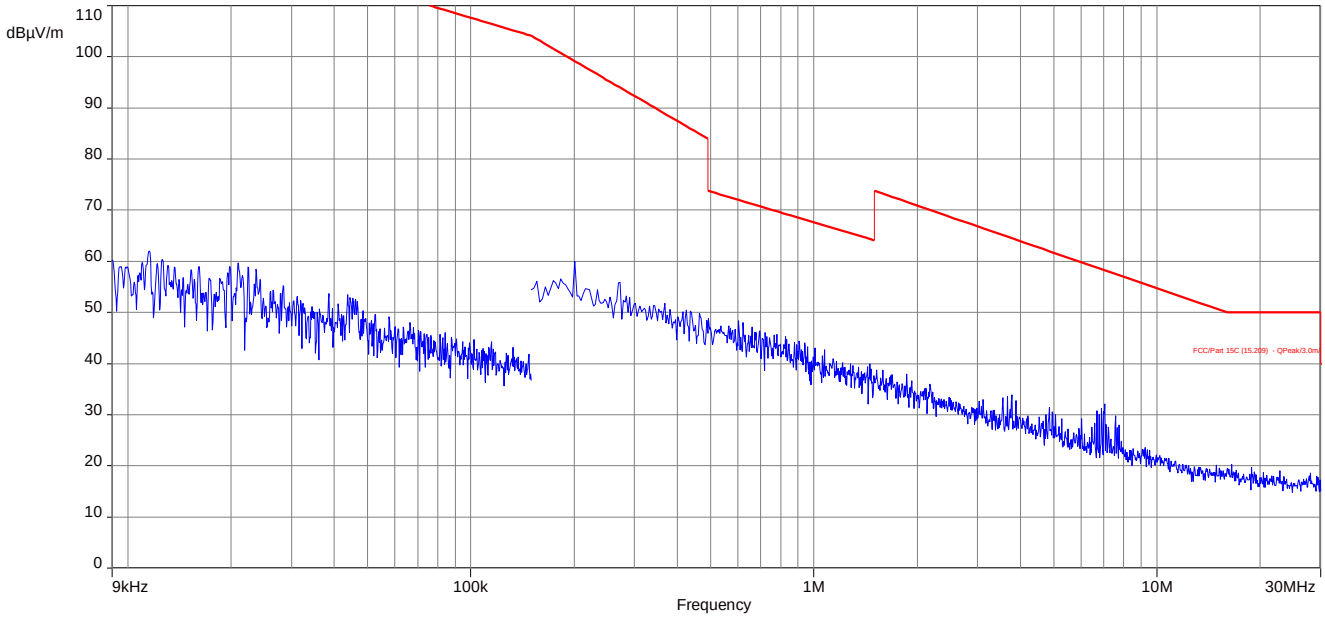
TX spurious emissions radiated below 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		

Plots: ceramic chip antenna

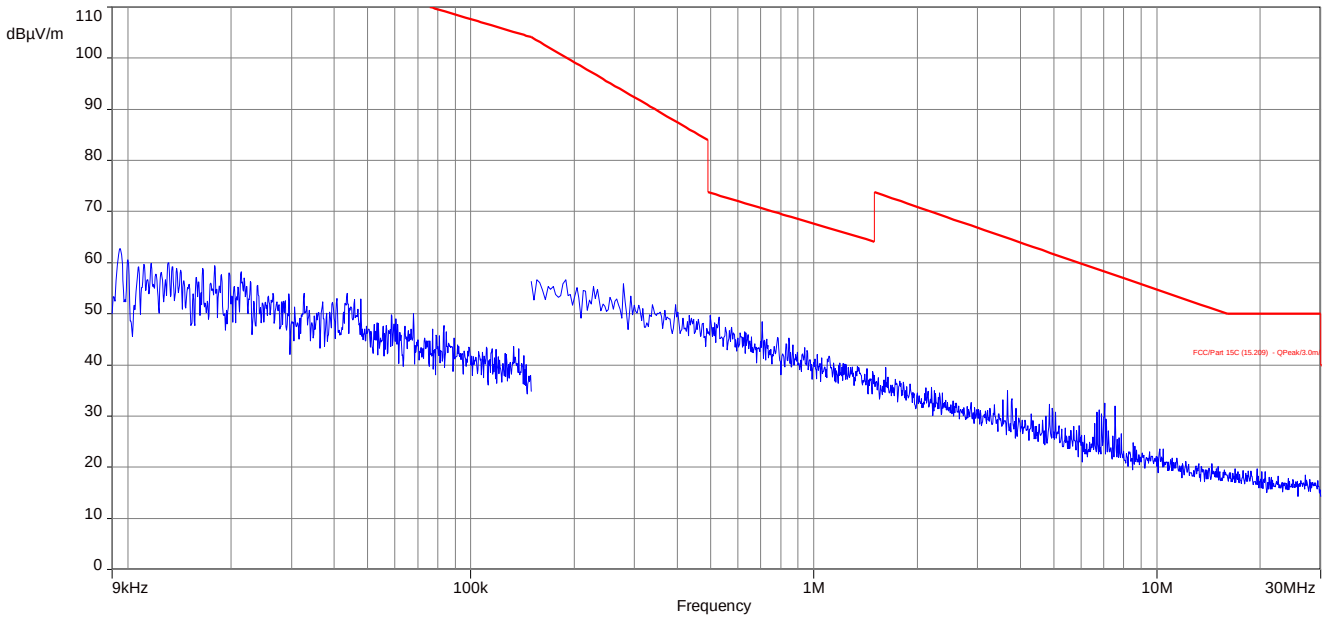
Plot 1: 9 kHz to 30 MHz, 2403.5 MHz, transmit mode



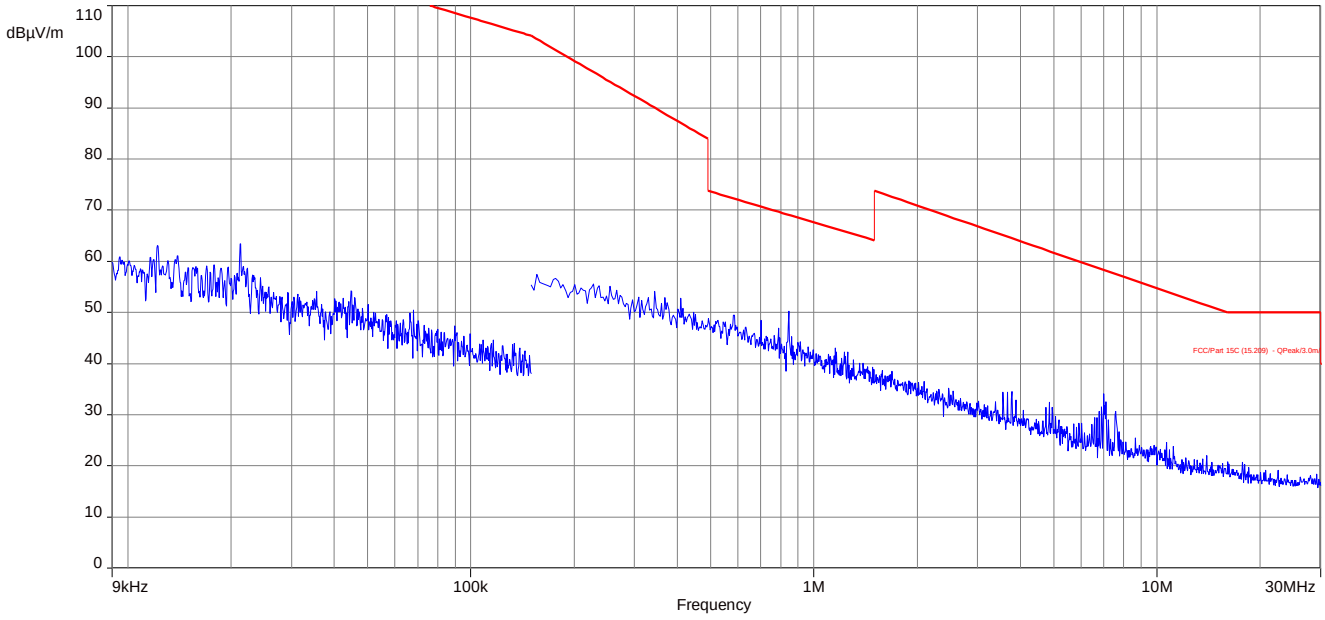
Plot 2: 9 kHz to 30 MHz, 2449.5 MHz, transmit mode



Plot 3: 9 kHz to 30 MHz, 2478.5 MHz, transmit mode

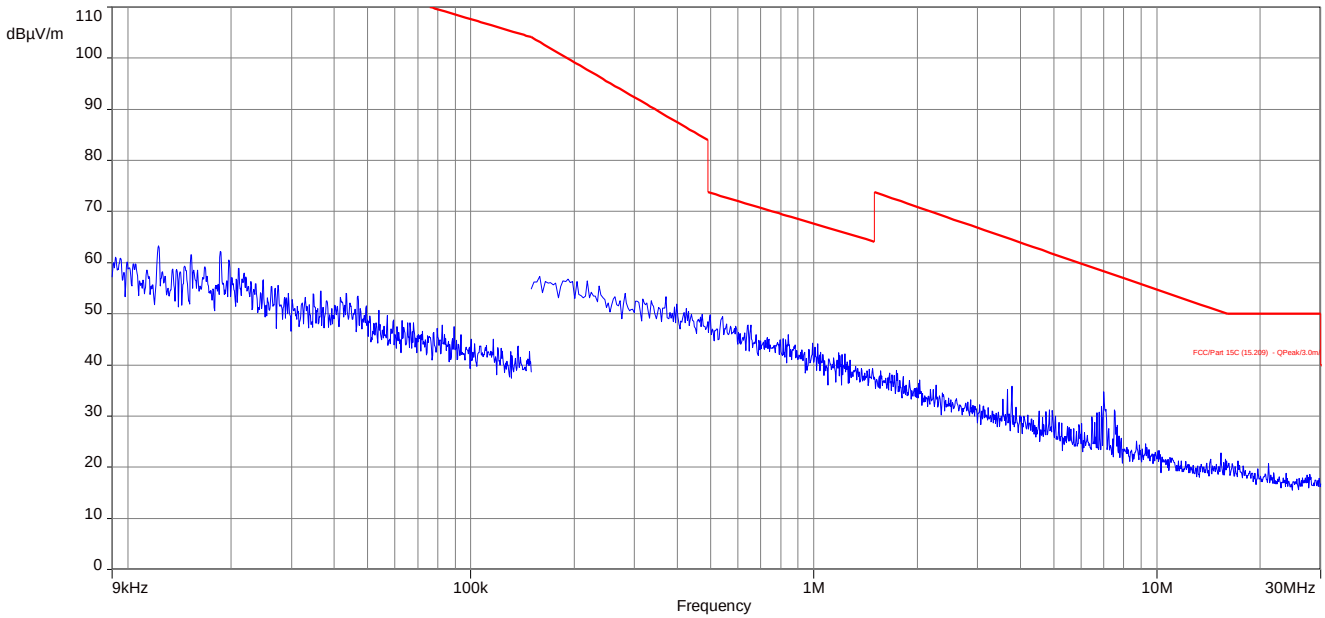


Plot 4: 9 kHz to 30 MHz, idle mode

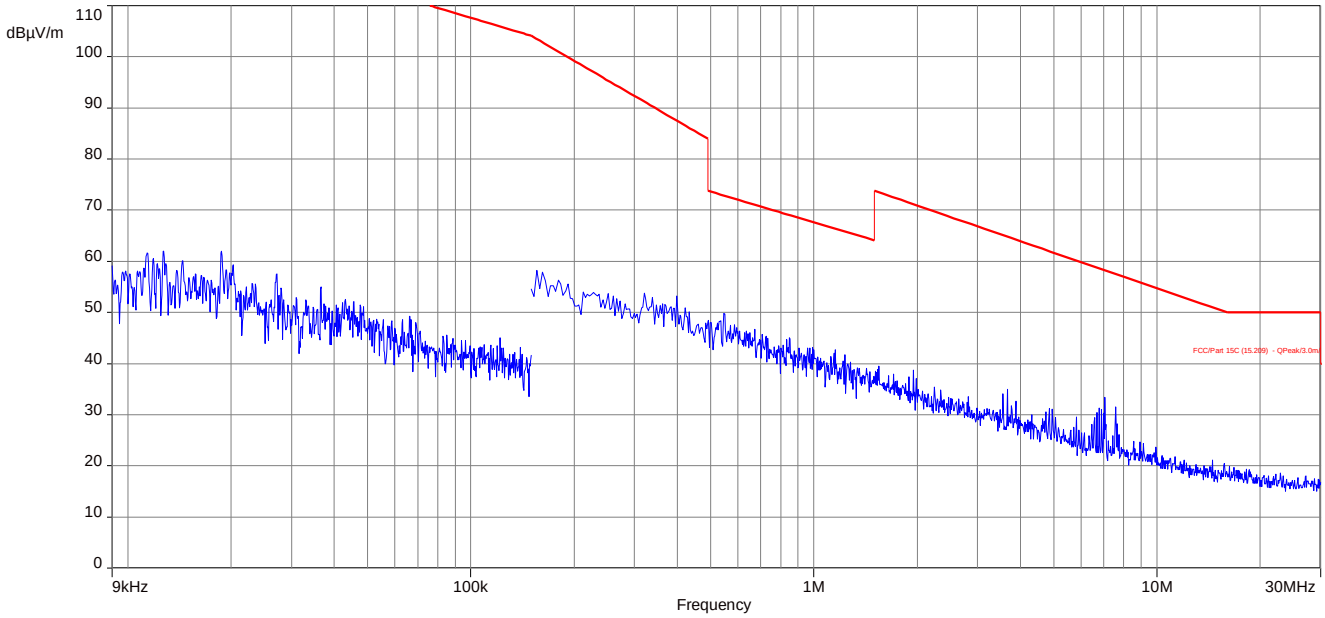


Plots: external rubber antenna

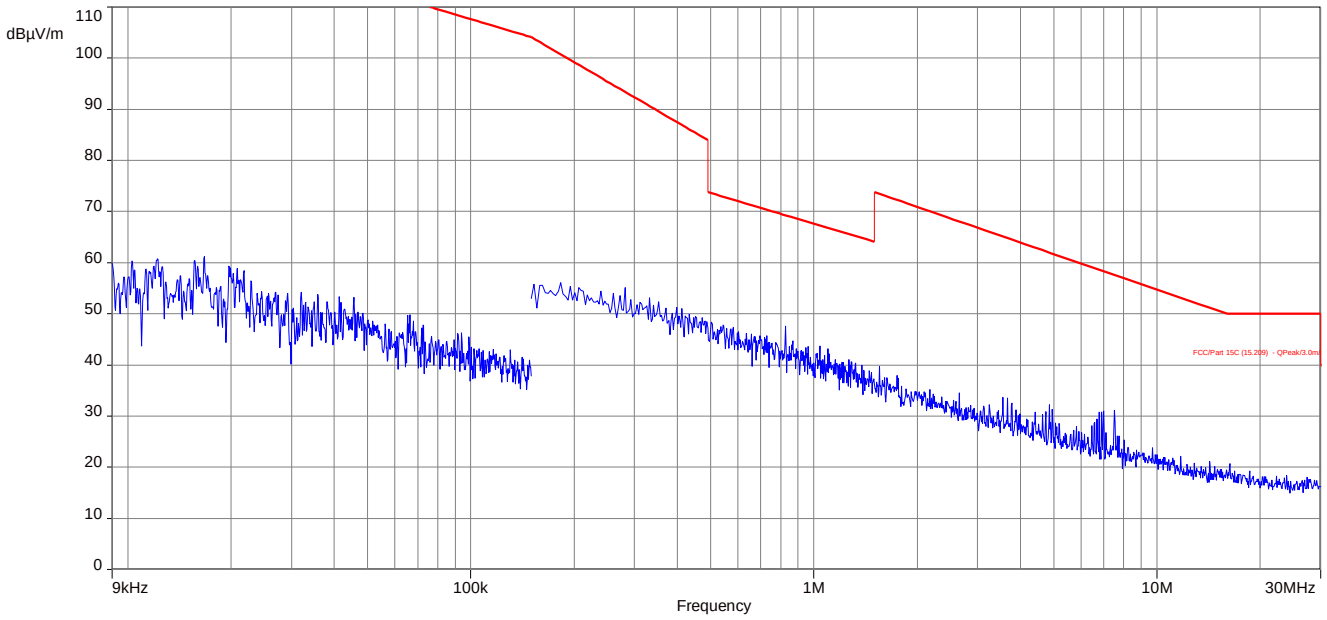
Plot 1: 9 kHz to 30 MHz, 2403.5 MHz, transmit mode



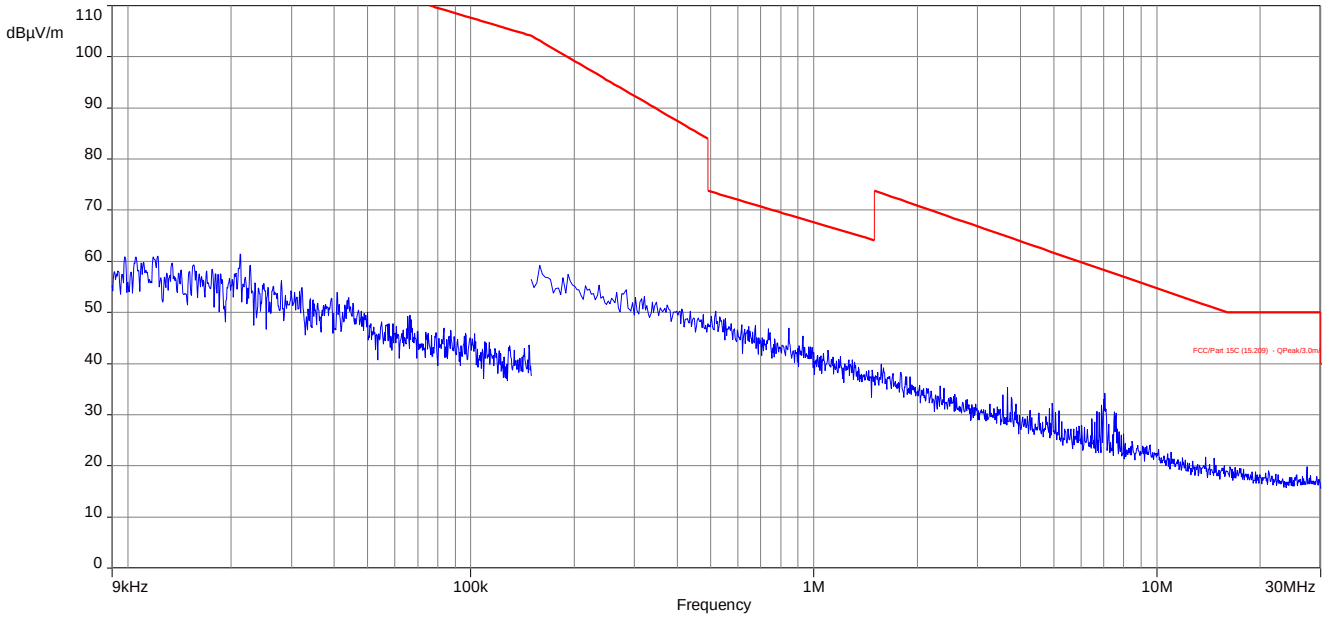
Plot 2: 9 kHz to 30 MHz, 2449.5 MHz, transmit mode



Plot 3: 9 kHz to 30 MHz, 2478.5 MHz, transmit mode

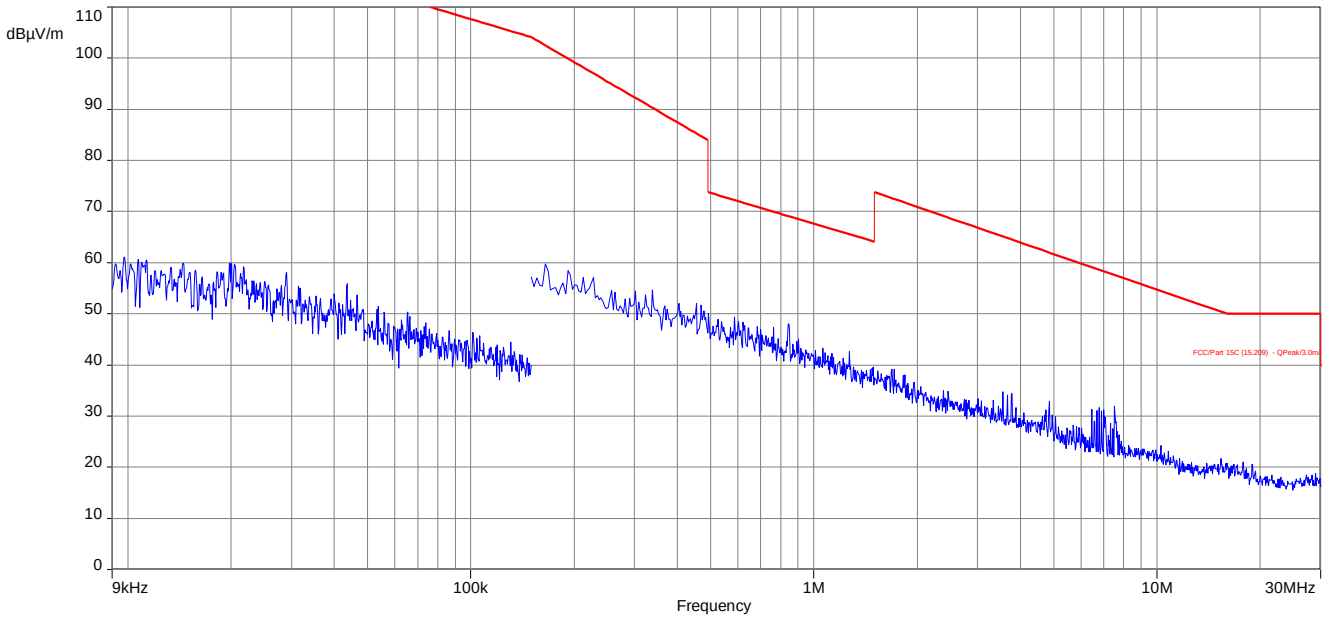


Plot 4: 9 kHz to 30 MHz, idle mode

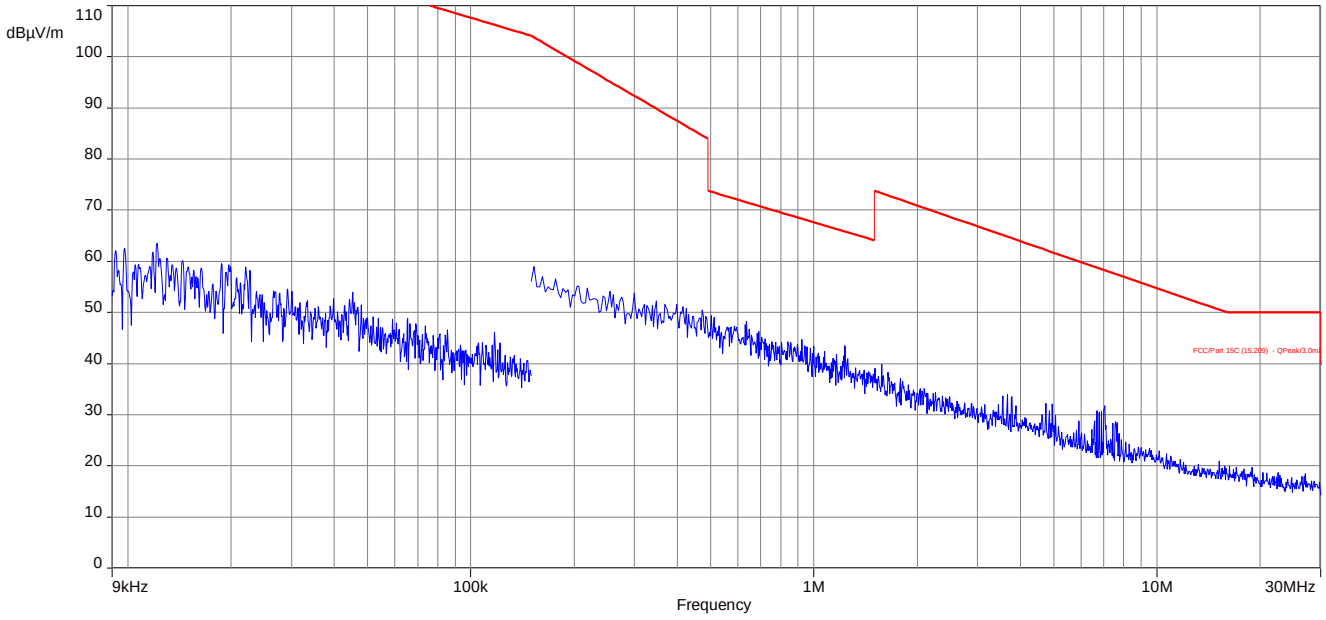


Plots: external PCB antenna

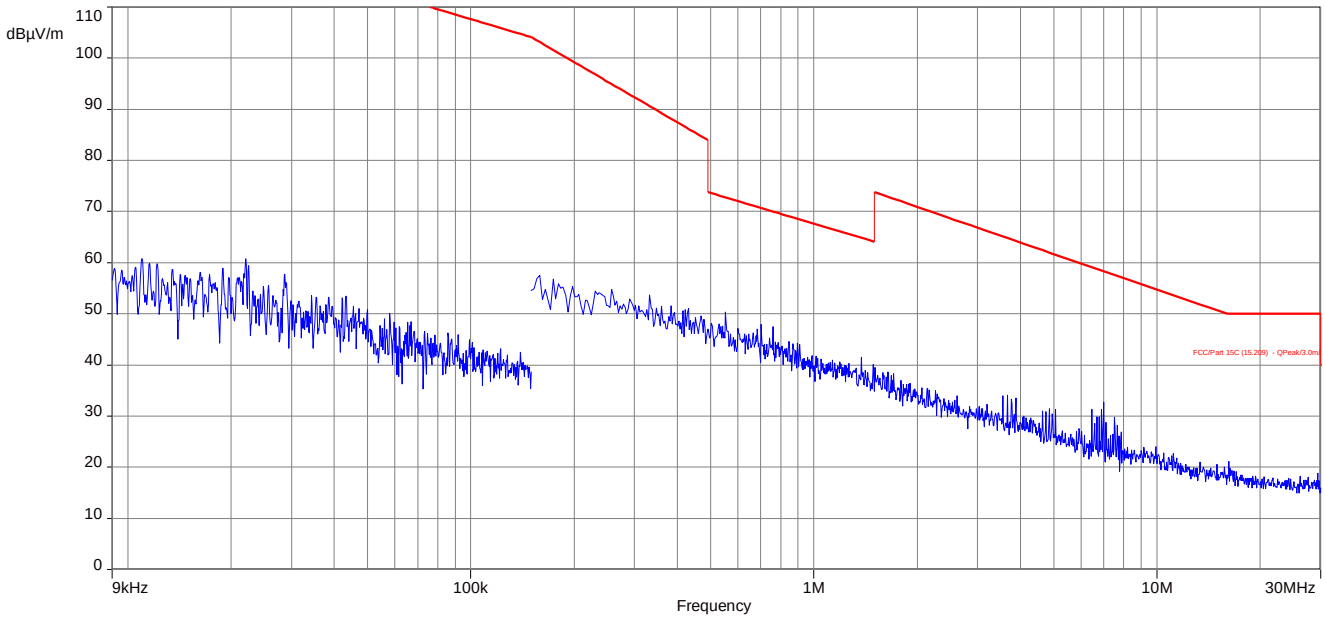
Plot 1: 9 kHz to 30 MHz, 2403.5 MHz, transmit mode



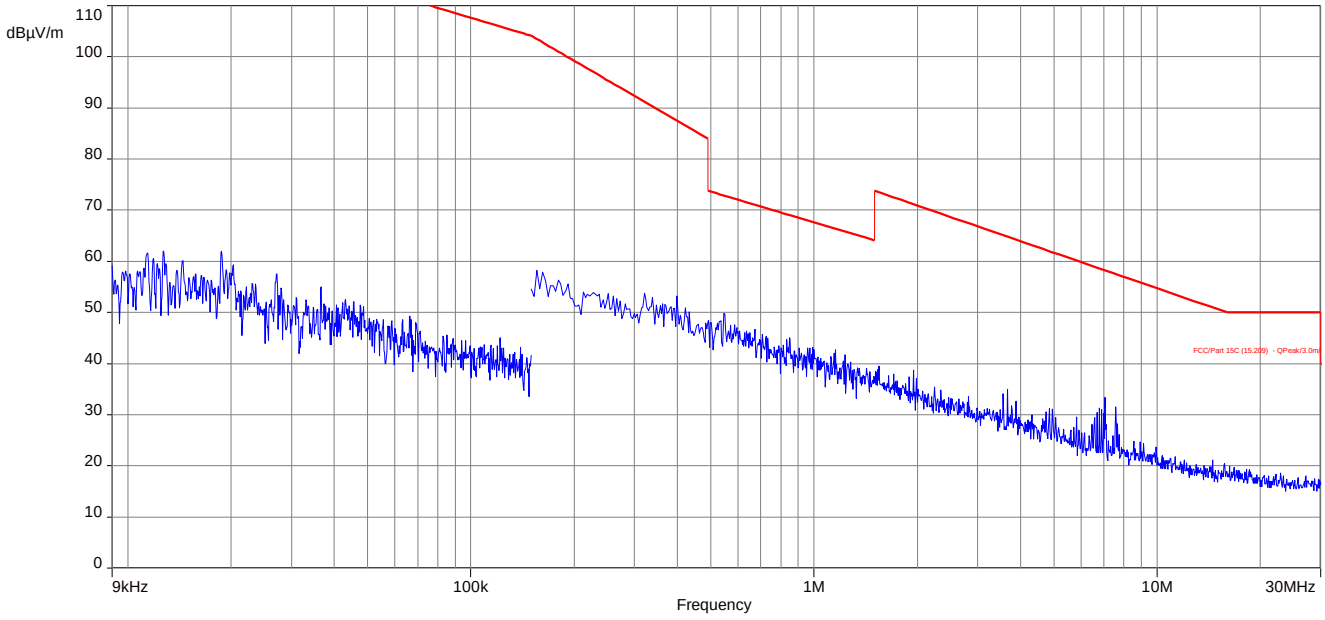
Plot 2: 9 kHz to 30 MHz, 2449.5 MHz, transmit mode



Plot 3: 9 kHz to 30 MHz, 2478.5 MHz, transmit mode



Plot 4: 9 kHz to 30 MHz, idle mode



12.10 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode.

Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	3 x VBW
Video bandwidth	120 kHz
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	MSK
Test setup	See sub clause 7.1 A
Measurement uncertainty	See sub clause 9

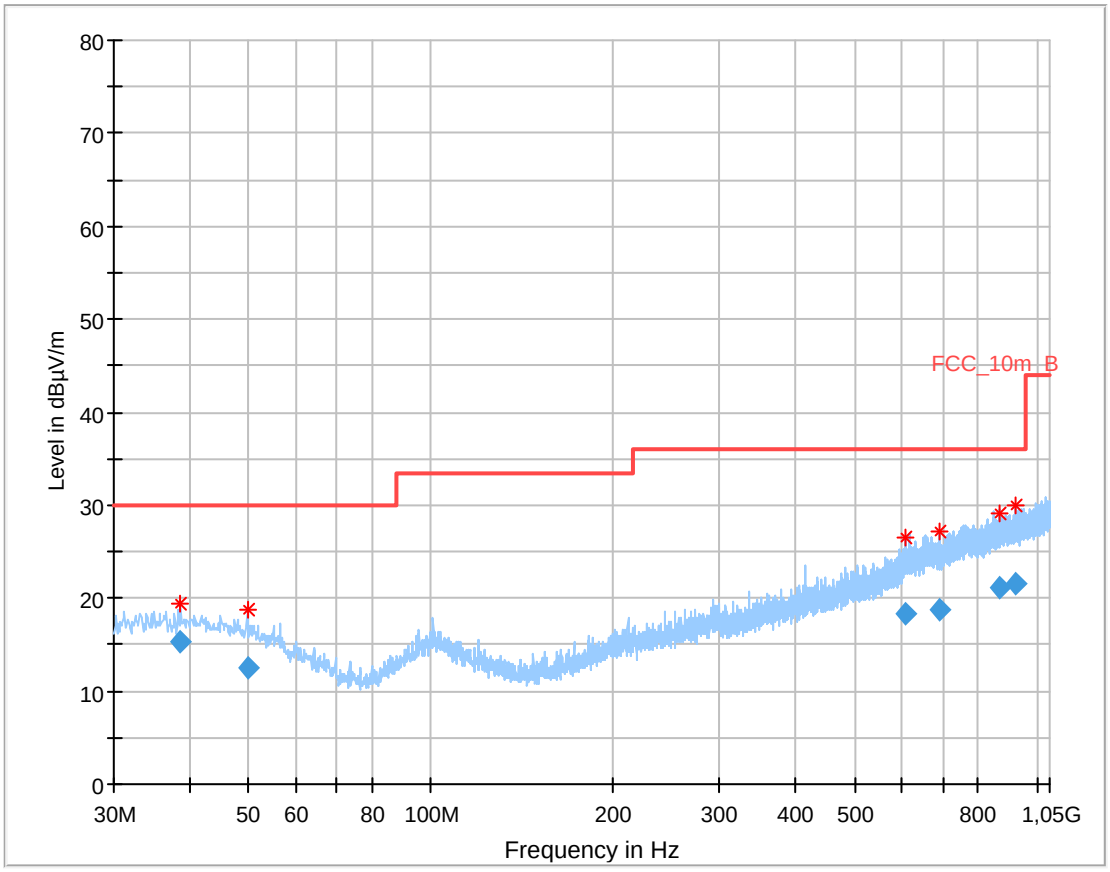
The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

FCC		IC
TX spurious emissions radiated		
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. Attenuation below the general limits specified in Section 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)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

Plots: Transmit mode, ceramic chip antenna

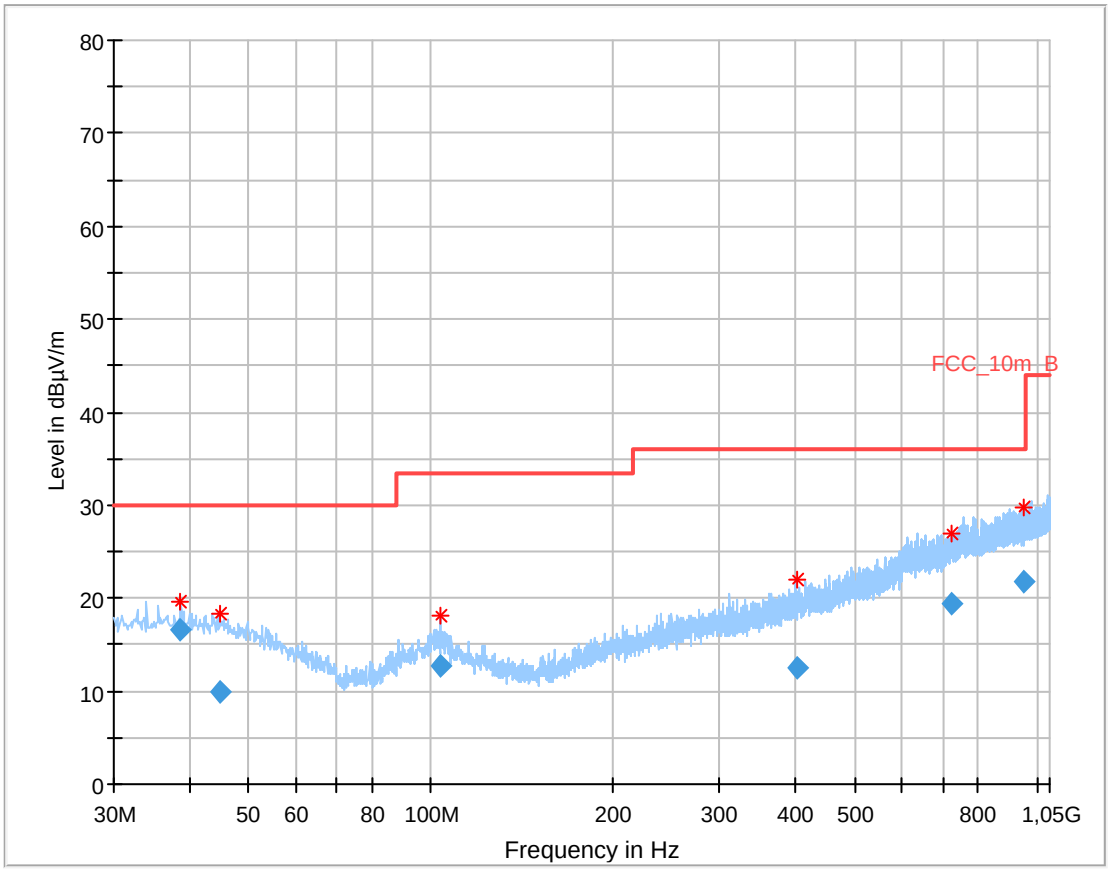
Plot 1: 30 MHz to 1 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.677050	15.41	30.00	14.59	1000.0	120.000	98.0	V	248.0	14.0
50.019000	12.52	30.00	17.48	1000.0	120.000	170.0	V	282.0	12.6
607.213500	18.37	36.00	17.63	1000.0	120.000	98.0	V	153.0	20.8
688.552350	18.81	36.00	17.19	1000.0	120.000	98.0	V	227.0	21.4
867.190350	21.05	36.00	14.95	1000.0	120.000	170.0	V	168.0	23.7
920.015850	21.50	36.00	14.50	1000.0	120.000	98.0	H	144.0	24.2

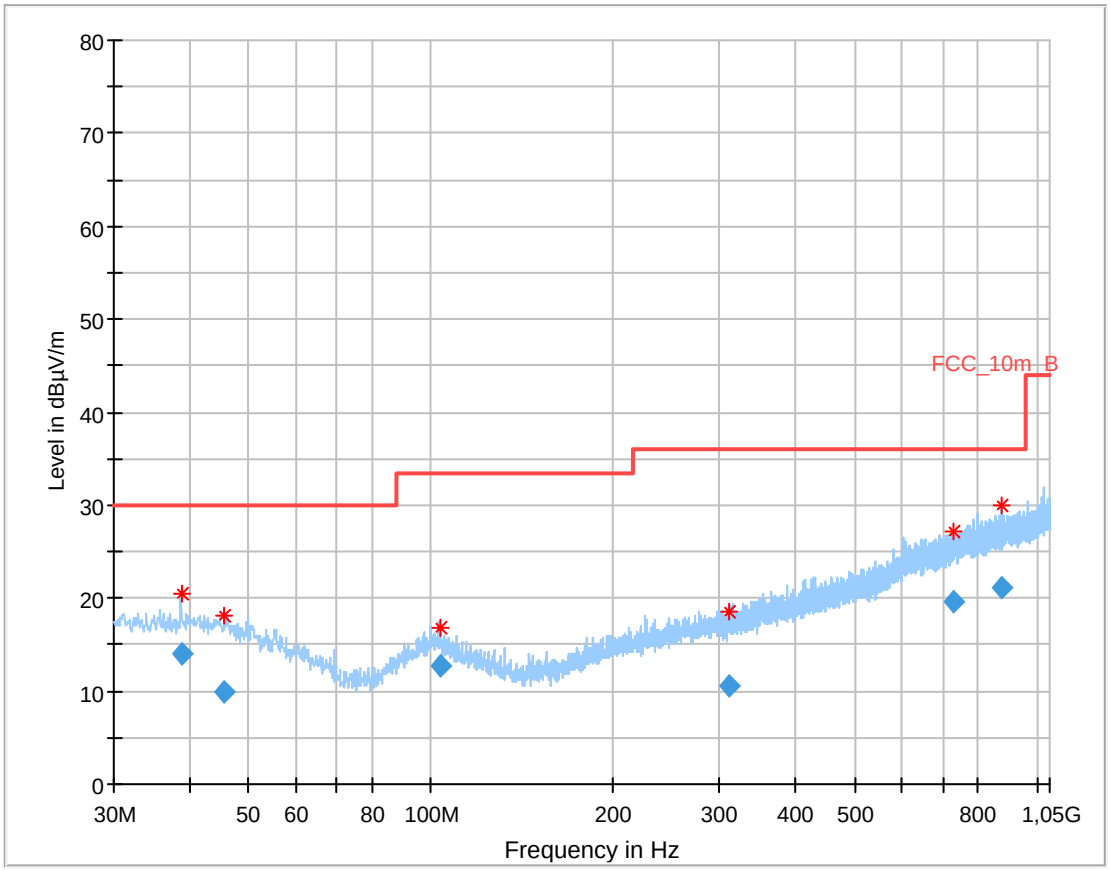
Plot 2: 30 MHz to 1 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.705250	16.53	30.00	13.47	1000.0	120.000	101.0	V	51.0	14.0
44.757750	9.83	30.00	20.17	1000.0	120.000	101.0	H	270.0	13.9
104.000400	12.71	33.50	20.79	1000.0	120.000	101.0	V	219.0	11.7
400.999200	12.42	36.00	23.58	1000.0	120.000	170.0	V	312.0	16.9
724.881900	19.43	36.00	16.57	1000.0	120.000	101.0	H	0.0	22.1
953.266800	21.74	36.00	14.26	1000.0	120.000	101.0	V	0.0	24.3

Plot 3: 30 MHz to 1 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

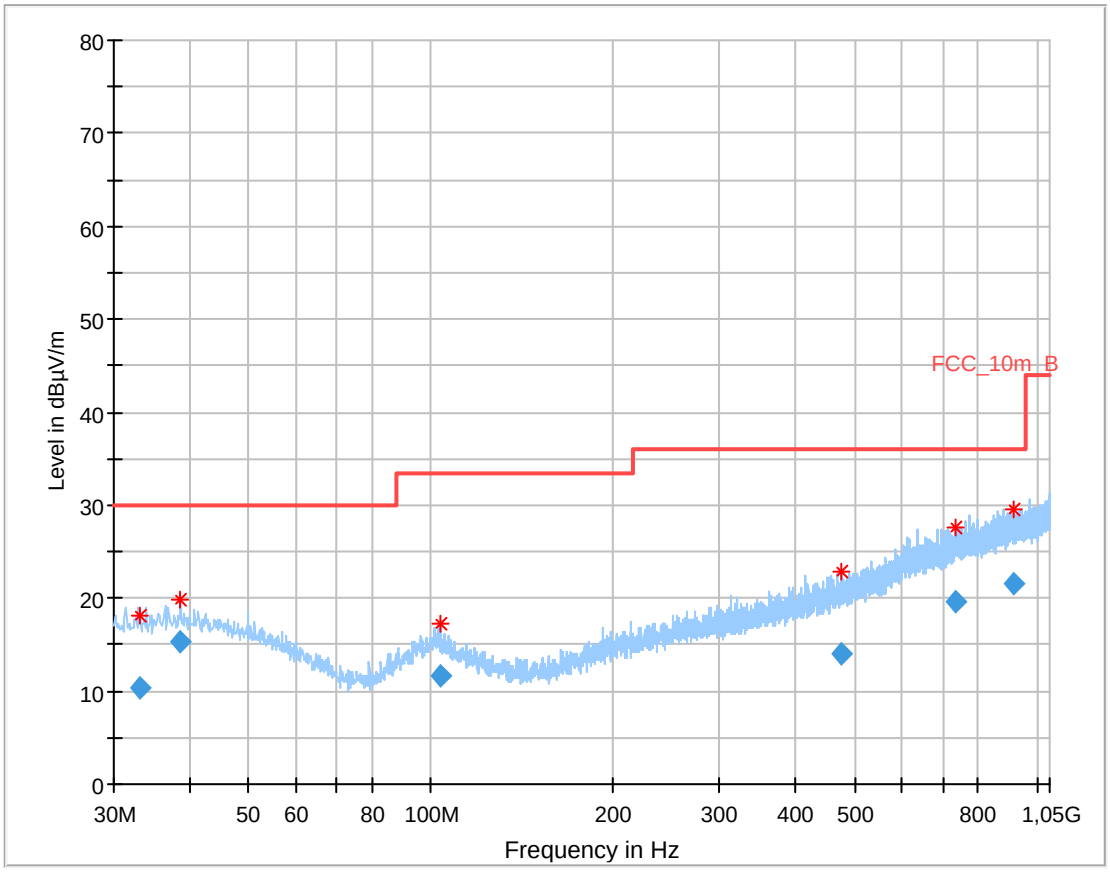


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.742300	13.92	30.00	16.08	1000.0	120.000	170.0	V	232.0	14.0
45.764700	9.86	30.00	20.14	1000.0	120.000	170.0	H	278.0	13.7
103.980150	12.72	33.50	20.78	1000.0	120.000	170.0	V	178.0	11.7
310.234200	10.52	36.00	25.48	1000.0	120.000	101.0	V	353.0	14.8
727.099650	19.55	36.00	16.45	1000.0	120.000	98.0	V	232.0	22.2
872.304600	21.16	36.00	14.84	1000.0	120.000	98.0	V	39.0	23.7

Plots: Transmit mode, external rubber antenna

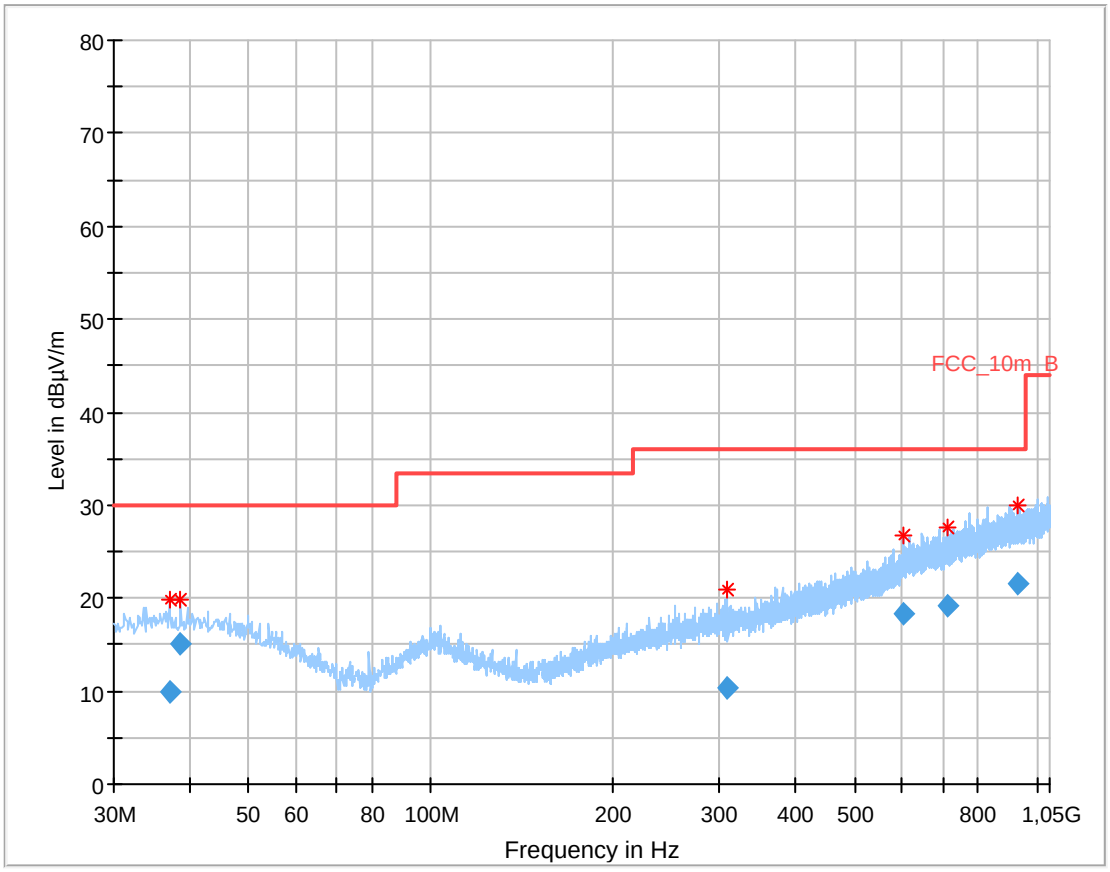
Plot 1: 30 MHz to 1 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.139200	10.25	30.00	19.75	1000.0	120.000	98.0	V	32.0	13.6
38.705550	15.28	30.00	14.72	1000.0	120.000	170.0	V	195.0	14.0
103.958850	11.67	33.50	21.83	1000.0	120.000	98.0	V	232.0	11.7
475.484100	13.94	36.00	22.06	1000.0	120.000	170.0	H	147.0	18.2
733.207950	19.72	36.00	16.28	1000.0	120.000	170.0	H	271.0	22.3
913.080750	21.50	36.00	14.50	1000.0	120.000	170.0	V	6.0	24.2

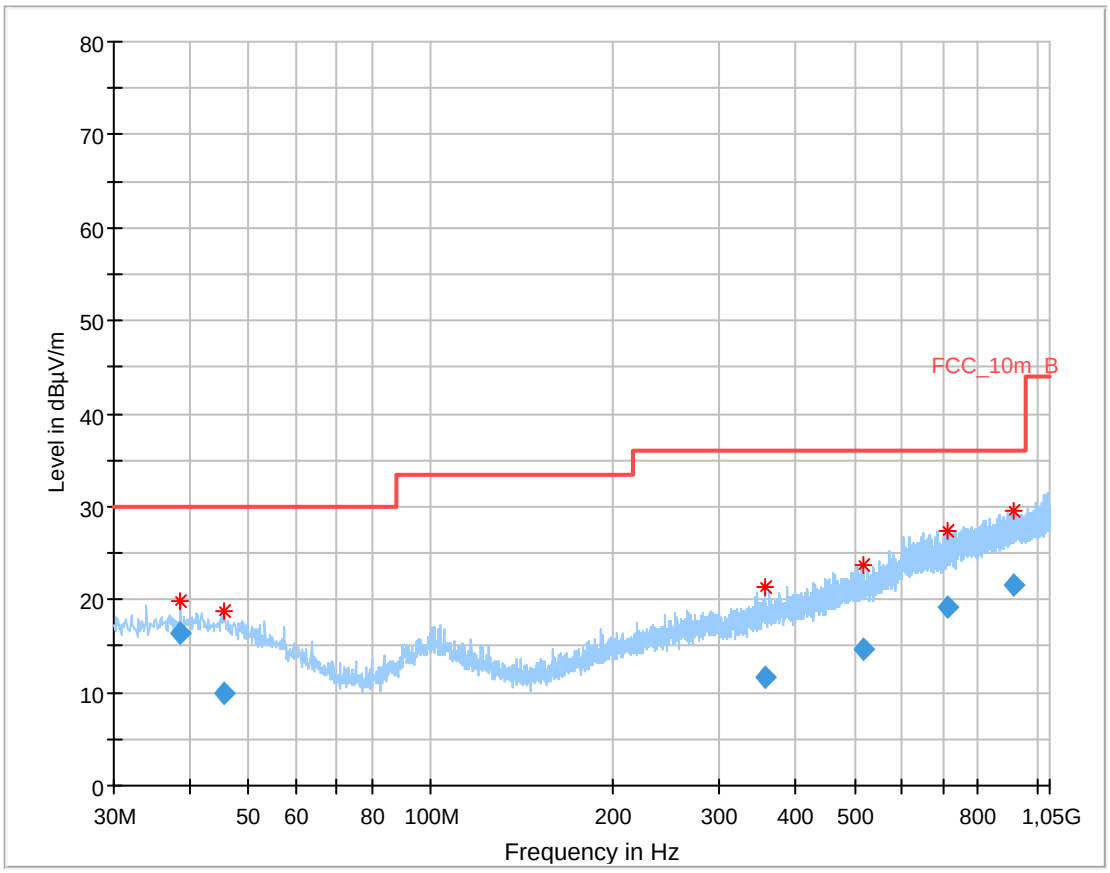
Plot 2: 30 MHz to 1 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
37.115550	9.91	30.00	20.09	1000.0	120.000	101.0	H	91.0	13.9
38.695950	15.16	30.00	14.84	1000.0	120.000	170.0	V	181.0	14.0
308.183550	10.36	36.00	25.64	1000.0	120.000	170.0	H	280.0	14.7
604.004400	18.30	36.00	17.70	1000.0	120.000	170.0	H	60.0	20.7
711.801450	19.22	36.00	16.78	1000.0	120.000	170.0	H	268.0	21.8
929.057550	21.58	36.00	14.42	1000.0	120.000	98.0	V	303.0	24.2

Plot 3: 30 MHz to 1 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

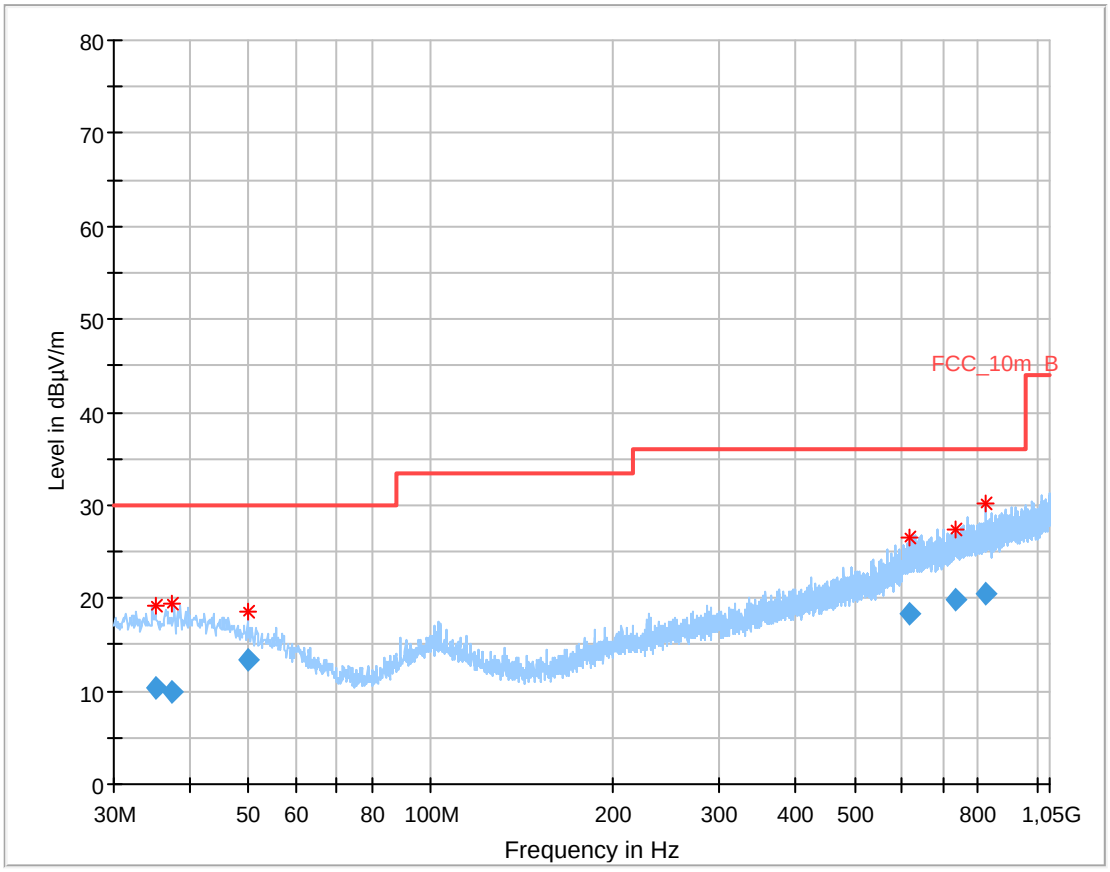


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.707500	16.47	30.00	13.53	1000.0	120.000	101.0	V	60.0	14.0
45.734400	9.86	30.00	20.14	1000.0	120.000	170.0	V	122.0	13.7
356.102100	11.68	36.00	24.32	1000.0	120.000	98.0	H	227.0	16.1
515.321550	14.70	36.00	21.30	1000.0	120.000	170.0	V	351.0	18.9
711.244050	19.16	36.00	16.84	1000.0	120.000	170.0	H	182.0	21.8
914.900700	21.54	36.00	14.46	1000.0	120.000	170.0	V	227.0	24.2

Plots: Transmit mode, external PCB antenna

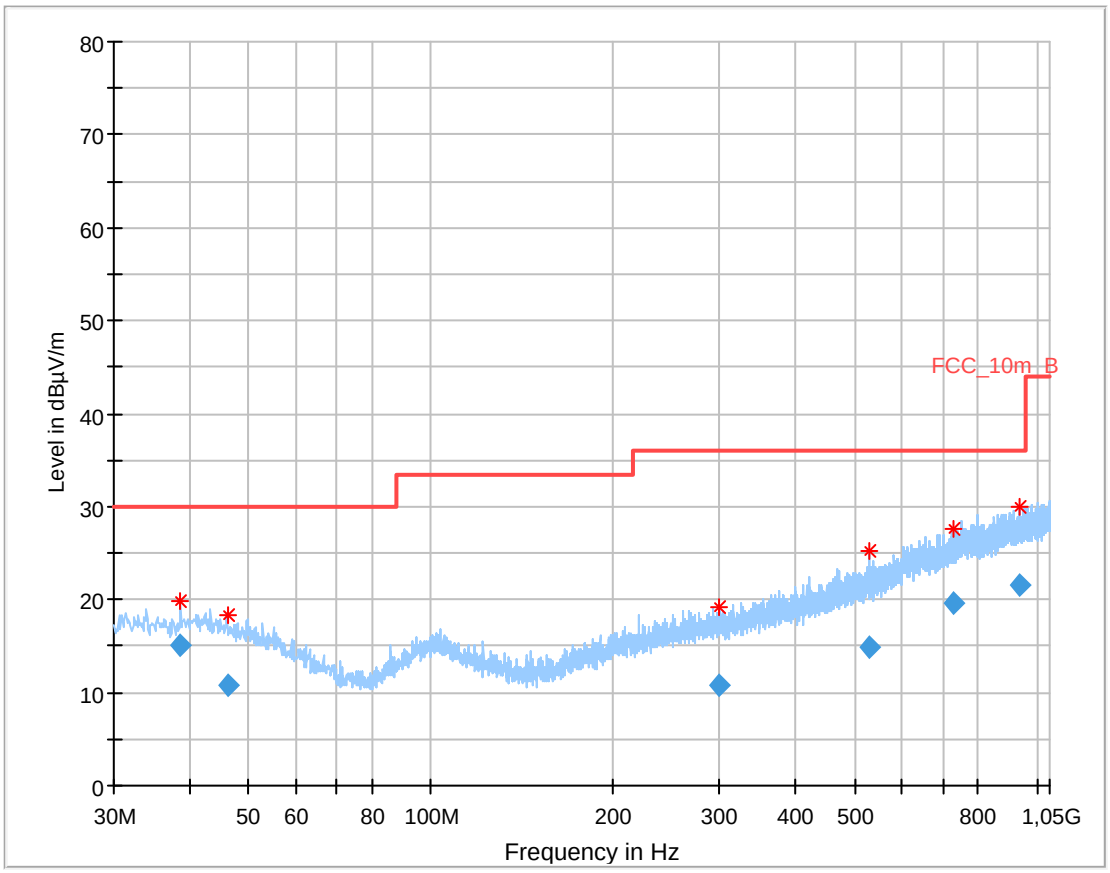
Plot 1: 30 MHz to 1 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.273100	10.29	30.00	19.71	1000.0	120.000	170.0	V	276.0	13.8
37.516200	10.01	30.00	19.99	1000.0	120.000	98.0	V	276.0	13.9
49.964250	13.32	30.00	16.68	1000.0	120.000	98.0	V	241.0	12.7
615.329850	18.35	36.00	17.65	1000.0	120.000	98.0	H	35.0	20.8
734.105250	19.77	36.00	16.23	1000.0	120.000	101.0	V	353.0	22.3
821.405550	20.52	36.00	15.48	1000.0	120.000	98.0	H	241.0	23.0

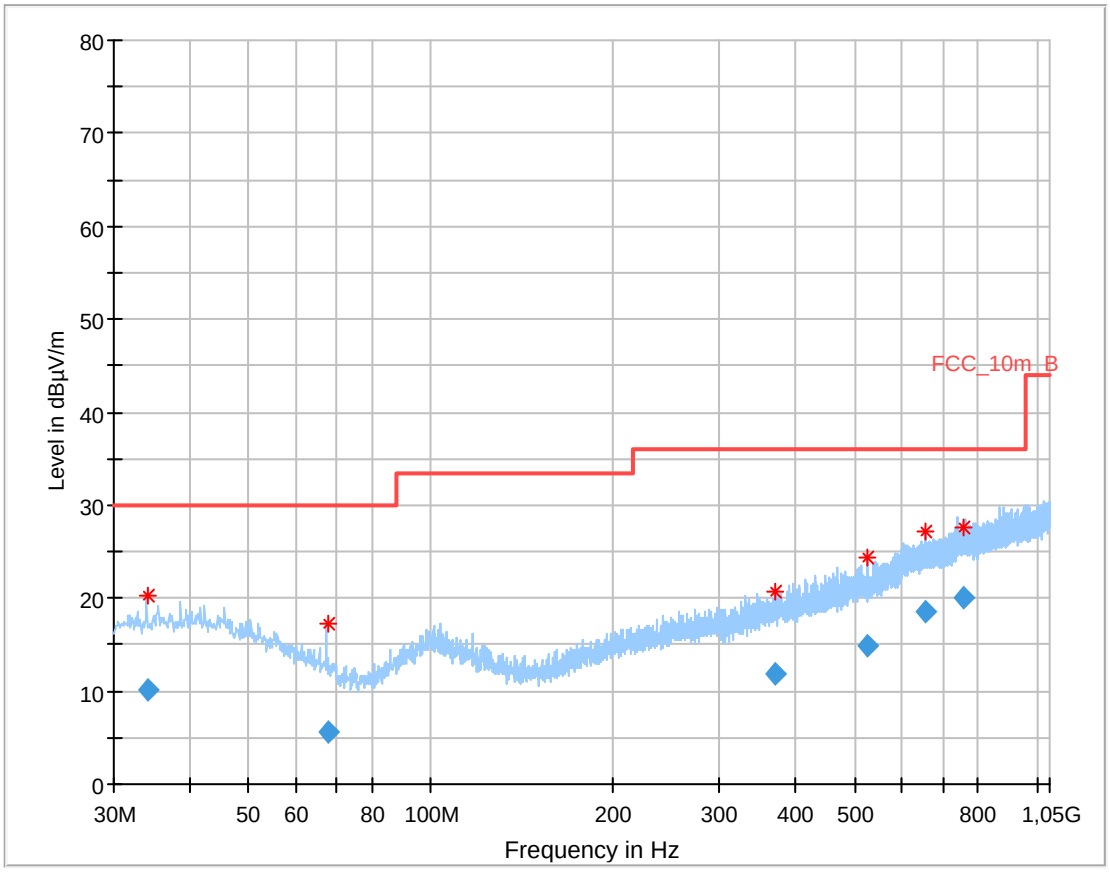
Plot 2: 30 MHz to 1 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.692350	15.07	30.00	14.93	1000.0	120.000	170.0	V	200.0	14.0
46.229700	10.75	30.00	19.25	1000.0	120.000	170.0	V	58.0	13.5
299.387550	10.68	36.00	25.32	1000.0	120.000	170.0	H	144.0	14.4
530.591250	14.89	36.00	21.11	1000.0	120.000	170.0	H	200.0	19.1
730.579500	19.60	36.00	16.40	1000.0	120.000	101.0	H	156.0	22.2
934.738650	21.63	36.00	14.37	1000.0	120.000	170.0	V	299.0	24.2

Plot 3: 30 MHz to 1 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

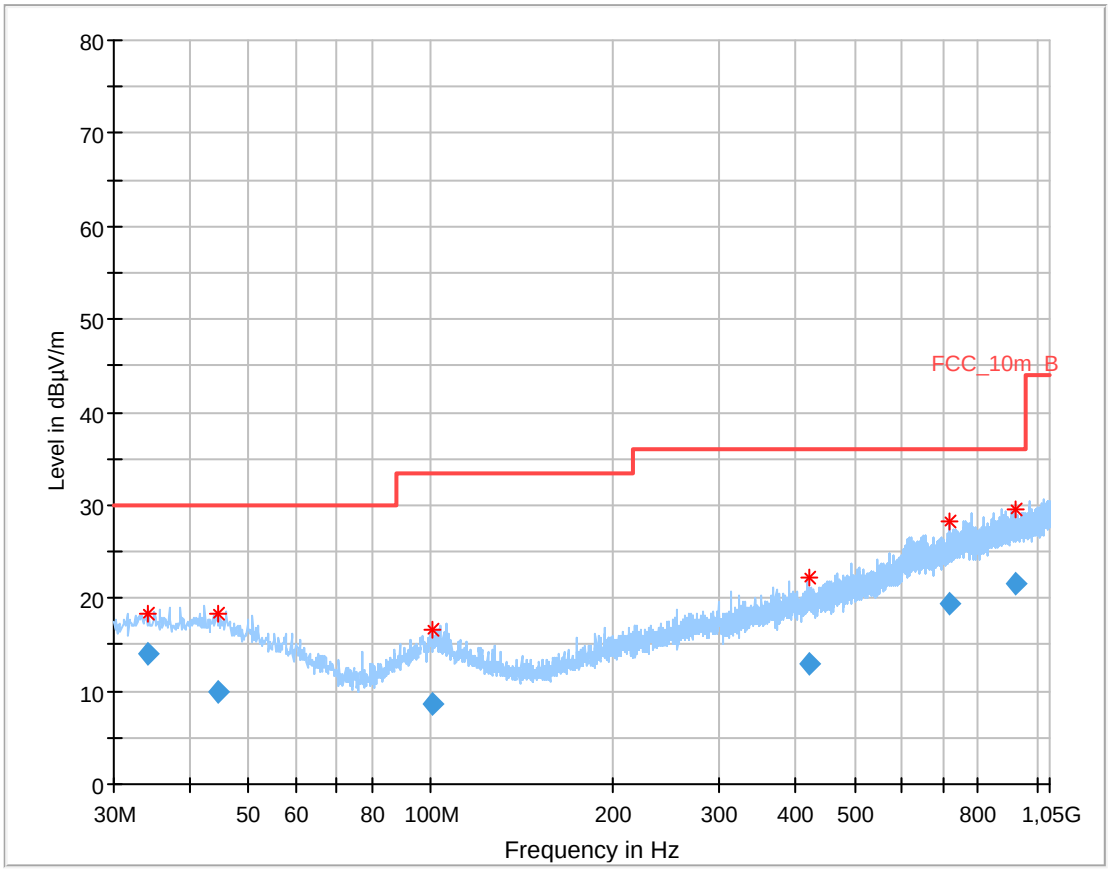


Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.218900	10.07	30.00	19.93	1000.0	120.000	170.0	V	65.0	13.7
67.745400	5.60	30.00	24.40	1000.0	120.000	101.0	V	10.0	8.9
370.622400	11.77	36.00	24.23	1000.0	120.000	101.0	H	116.0	16.4
524.113800	14.78	36.00	21.22	1000.0	120.000	98.0	H	208.0	19.0
653.911500	18.58	36.00	17.42	1000.0	120.000	170.0	V	42.0	21.1
757.278750	20.10	36.00	15.90	1000.0	120.000	101.0	V	76.0	22.7

Plots: Receiver mode

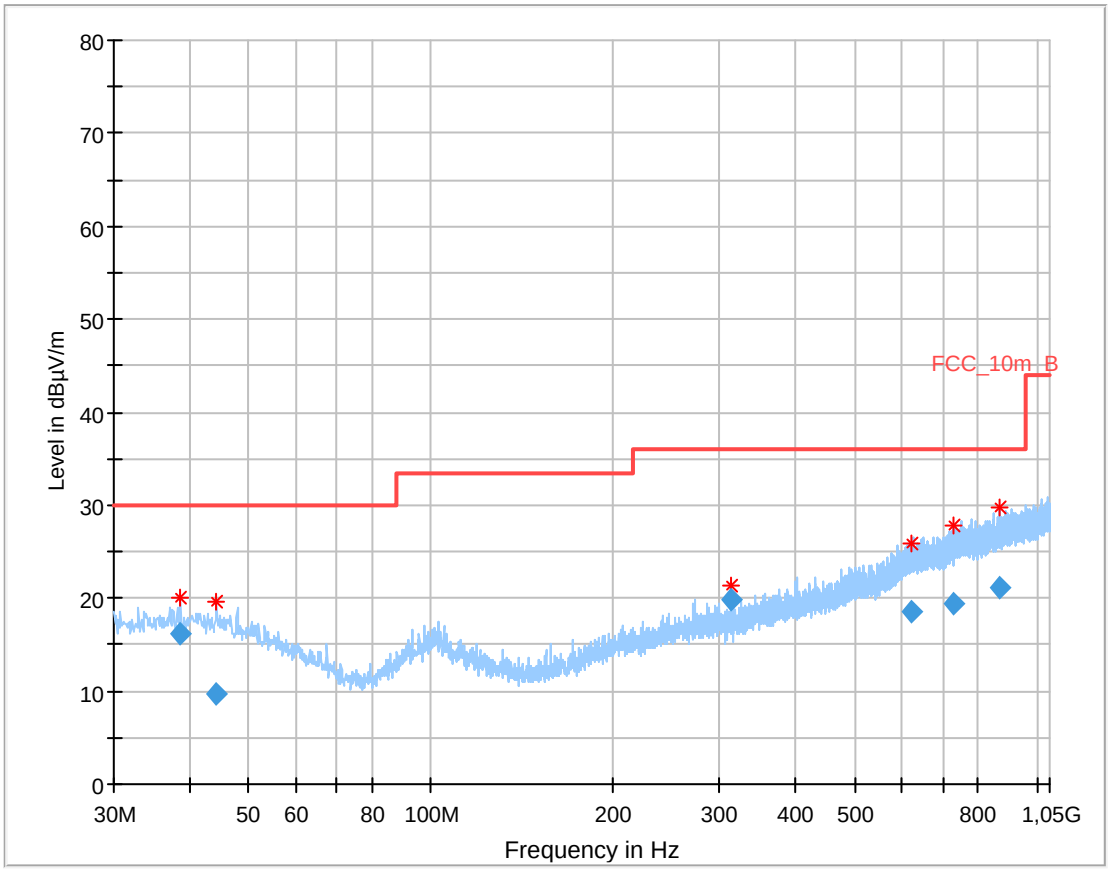
Plot 1: 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization, external PCB antenna



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.027950	13.95	30.00	16.05	1000.0	120.000	101.0	V	247.0	13.7
44.664000	9.84	30.00	20.16	1000.0	120.000	101.0	V	236.0	13.9
100.927950	8.63	33.50	24.87	1000.0	120.000	98.0	V	161.0	12.1
419.748900	12.92	36.00	23.08	1000.0	120.000	103.0	V	99.0	17.2
719.665200	19.41	36.00	16.59	1000.0	120.000	101.0	H	284.0	22.0
919.370550	21.55	36.00	14.45	1000.0	120.000	170.0	V	247.0	24.2

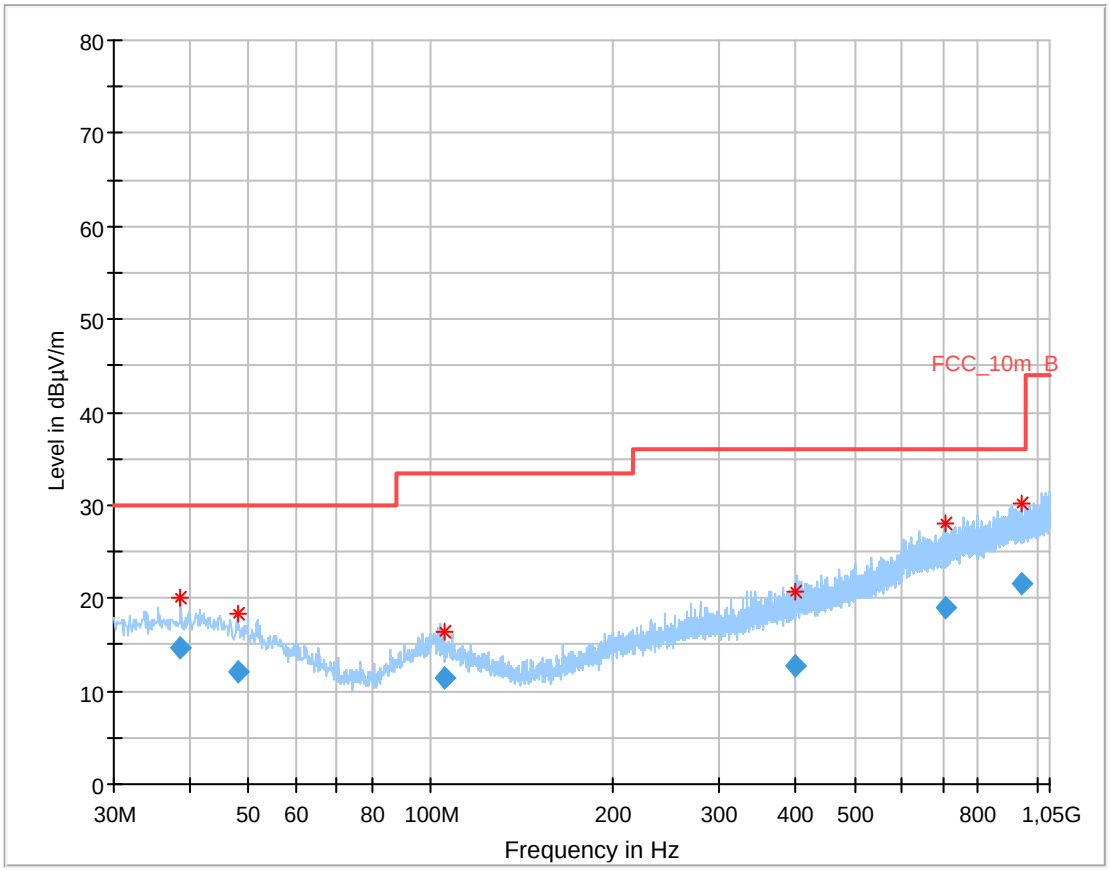
Plot 2: 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization, external rubber antenna



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.693400	16.20	30.00	13.80	1000.0	120.000	101.0	V	350.0	14.0
44.119050	9.73	30.00	20.27	1000.0	120.000	170.0	V	20.0	13.9
312.013050	19.88	36.00	16.12	1000.0	120.000	170.0	H	14.0	14.8
621.369900	18.46	36.00	17.54	1000.0	120.000	170.0	H	168.0	20.9
729.073950	19.51	36.00	16.49	1000.0	120.000	170.0	V	135.0	22.2
866.110200	21.04	36.00	14.96	1000.0	120.000	98.0	H	203.0	23.7

Plot 3: 30 MHz to 1 GHz, RX / idle – mode, vertical & horizontal polarization, ceramic chip antenna



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.685150	14.76	30.00	15.24	1000.0	120.000	170.0	V	2.0	14.0
48.005100	12.02	30.00	17.98	1000.0	120.000	100.0	V	314.0	13.1
104.995800	11.50	33.50	22.00	1000.0	120.000	170.0	V	98.0	11.6
398.937300	12.64	36.00	23.36	1000.0	120.000	170.0	H	166.0	16.9
707.681400	19.05	36.00	16.95	1000.0	120.000	170.0	V	353.0	21.7
944.797650	21.66	36.00	14.34	1000.0	120.000	170.0	V	118.0	24.2

12.11 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 x RBW
Span	1 GHz to 26 GHz
Trace mode	Max hold
Measured modulation	MSK
Test setup	See sub clause 7.2 A (1 GHz - 12.75 GHz) See sub clause 7.3 A (12.75 GHz - 26 GHz)
Measurement uncertainty	See sub clause 9

The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

FCC		IC
TX spurious emissions radiated		
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. Attenuation below the general limits specified in Section 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)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
Above 960	54.0	3

Results: Transmitter mode, ceramic chip antenna

TX spurious emissions radiated [dBµV/m]								
2403.5 MHz			2449.5 MHz			2478.5 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
2807	Peak	58.5	2501	Peak	51.4	4957	Peak	59.5
	AVG	53.9		AVG	-/-		AVG	53.6
-/-	Peak	-/-	4899	Peak	59.0	-/-	Peak	-/-
	AVG	-/-		AVG	53.7		AVG	-/-
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Results: Transmitter mode, external rubber antenna

TX spurious emissions radiated [dBµV/m]								
2403.5 MHz			2449.5 MHz			2478.5 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.								
2351	Peak	51.8	2898	Peak	57.8	2530	Peak	51.2
	AVG	47.4		AVG	52.4		AVG	-/-
4807	Peak	58.9	-/-	Peak	-/-	4957	Peak	59.4
	AVG	53.4		AVG	-/-		AVG	53.9
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Results: Transmitter mode, external PCB antenna

TX spurious emissions radiated [dBµV/m]								
2403.5 MHz			2449.5 MHz			2478.5 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
2351	Peak	53.6	2293	Peak	51.3	4957	Peak	58.8
	AVG	49.8		AVG	46.6		AVG	53.5
4806	Peak	58.4	4899	Peak	58.6	-/-	Peak	-/-
	AVG	53.6		AVG	53.7		AVG	-/-
-/-	Peak	-/-	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	-/-		AVG	-/-		AVG	-/-

Results: Idle/Receiver mode, ceramic chip antenna

Idle/RX spurious emissions radiated [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		
-/-	Peak	-/-
	AVG	-/-

Results: Idle/Receiver mode, external rubber antenna

Idle/RX spurious emissions radiated [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		
-/-	Peak	-/-
	AVG	-/-

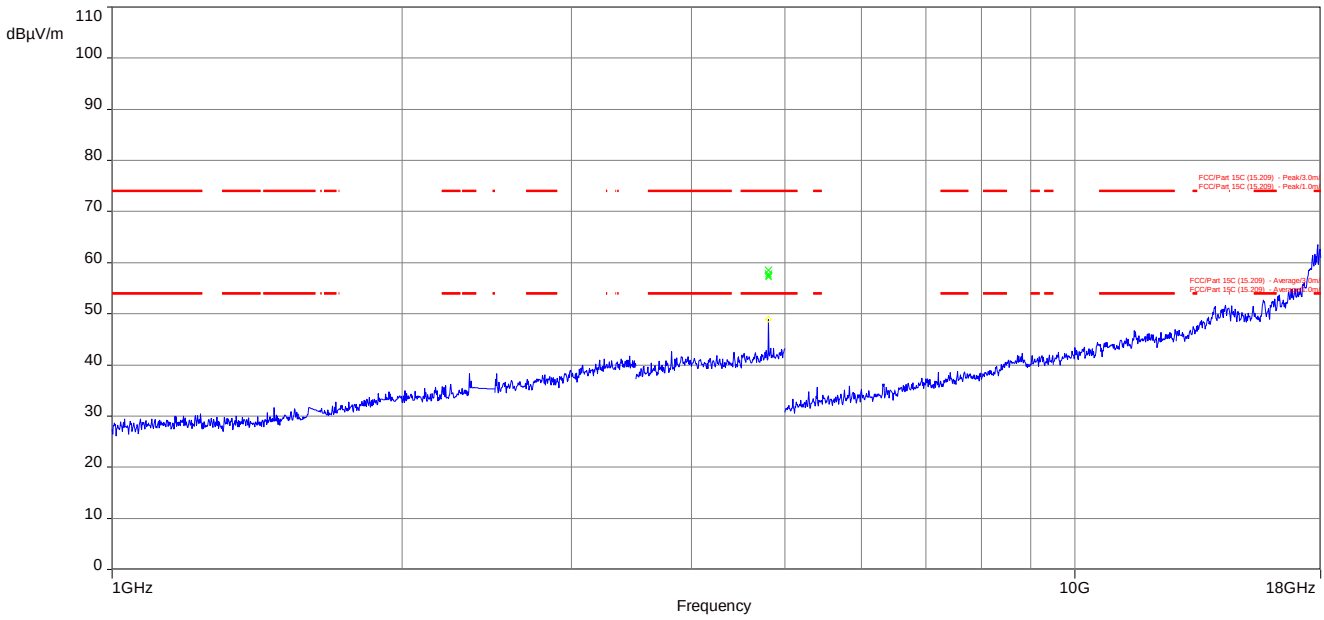
Results: Idle/Receiver mode, external PCB antenna

Idle/RX spurious emissions radiated [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
4960	Peak	56.8
	AVG	52.3

Note: The limit was recalculated with 20 dB / decade (Part 15.31) for all radiated spurious emissions 30 MHz to 1 GHz from 3 meter limit to a 10 meter distance. (40dB/decade for emissions < 30MHz)

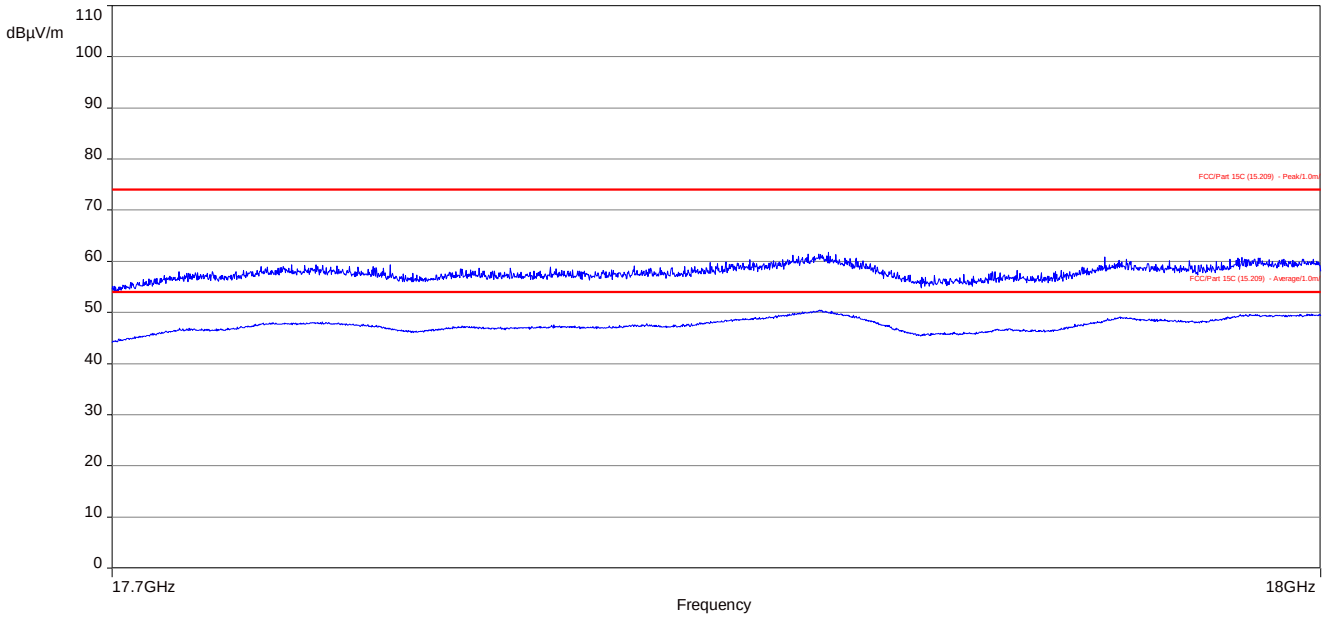
Plots: Transmitter mode, ceramic chip antenna

Plot 1: 1 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

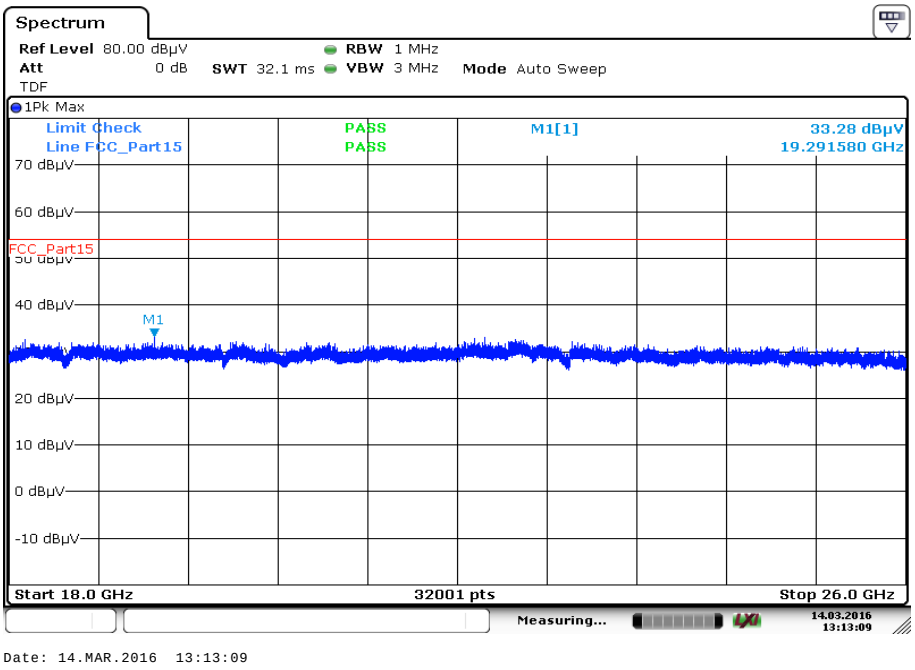


The carrier signal is notched with a 2.4 GHz band rejection filter.

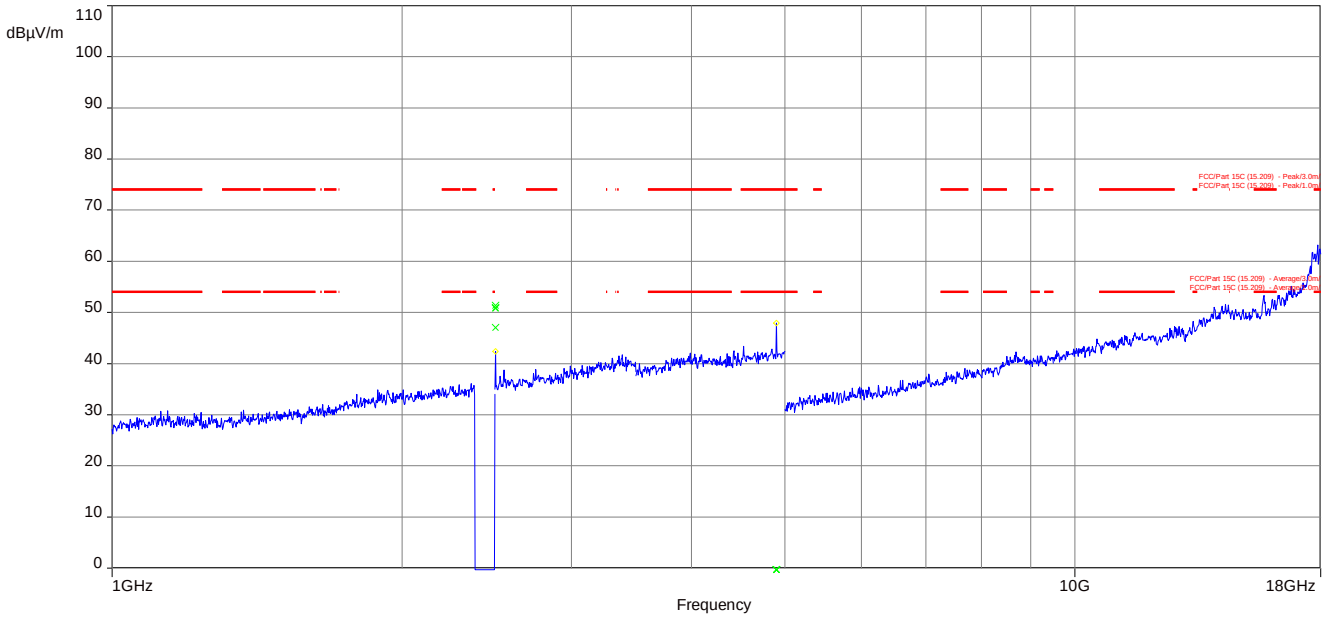
Plot 2: 17.7 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Plot 3: 18 GHz to 26 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

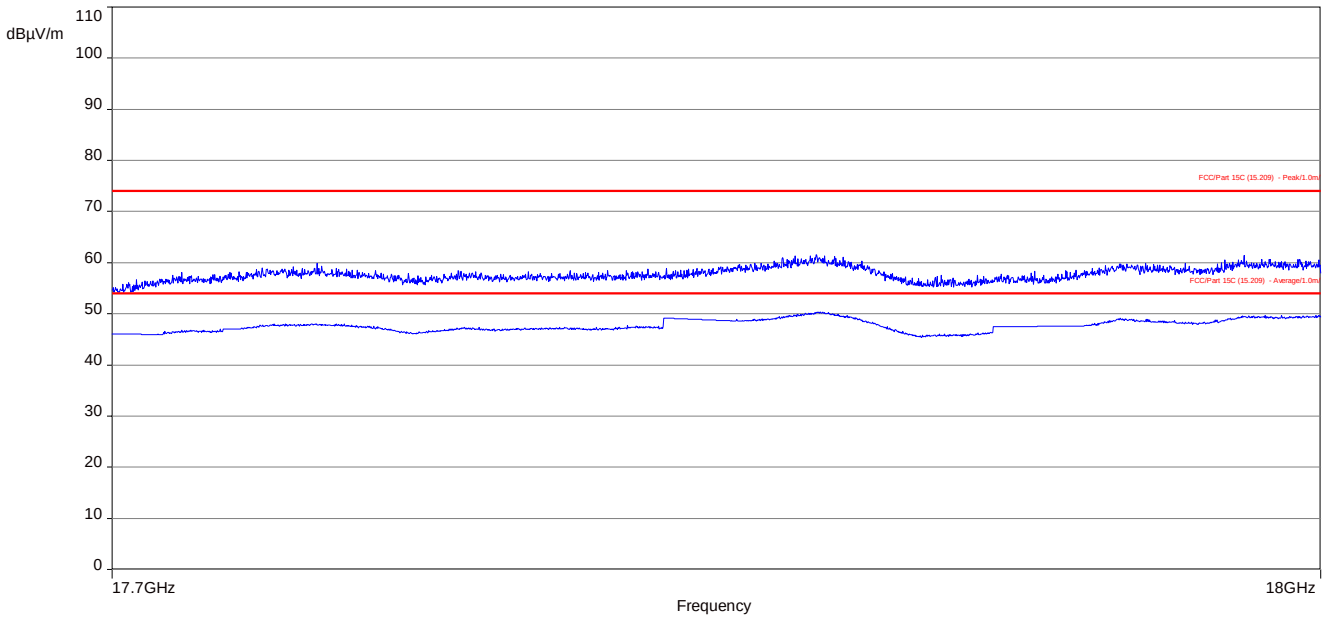


Plot 4: 1 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization

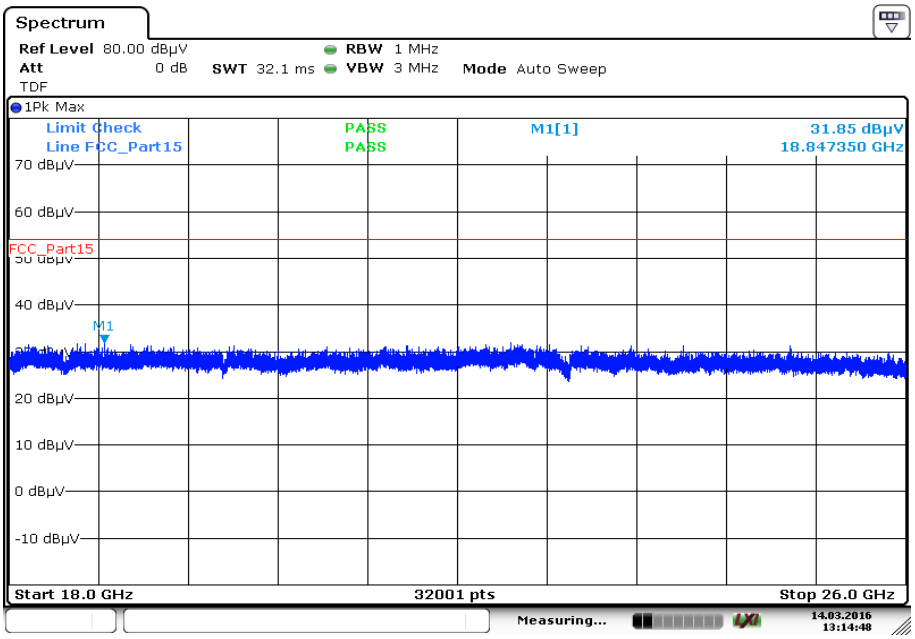


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 5: 17.7 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Plot 6: 18 GHz to 26 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



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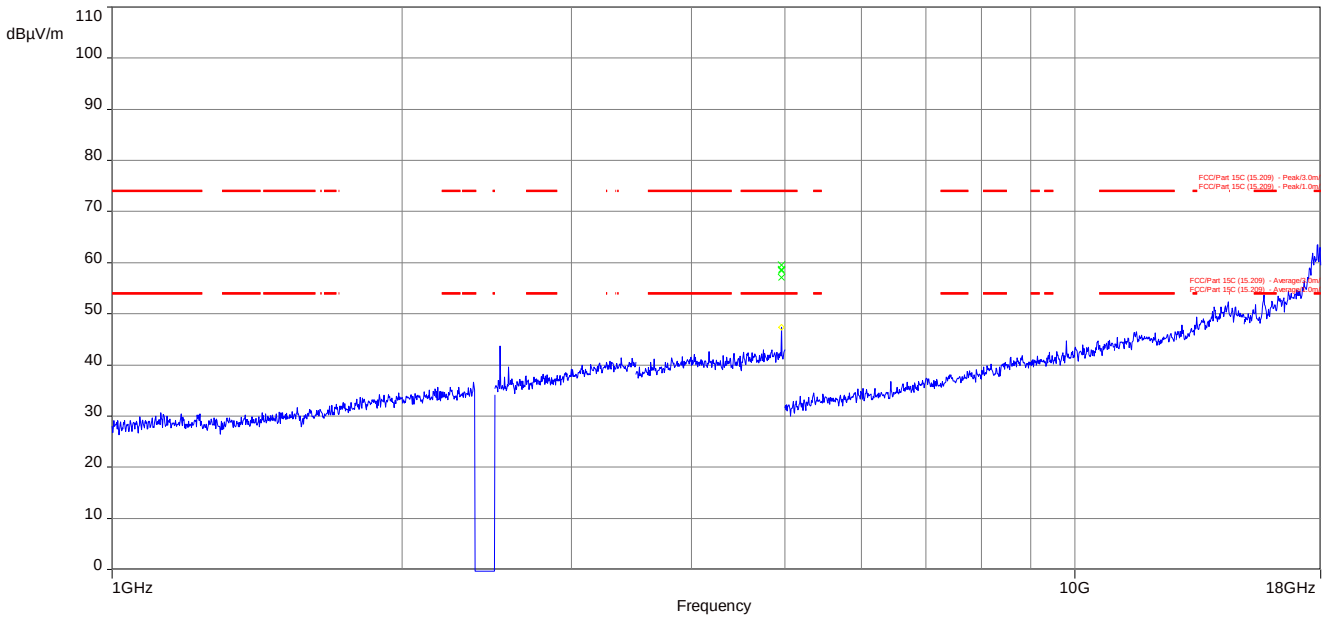
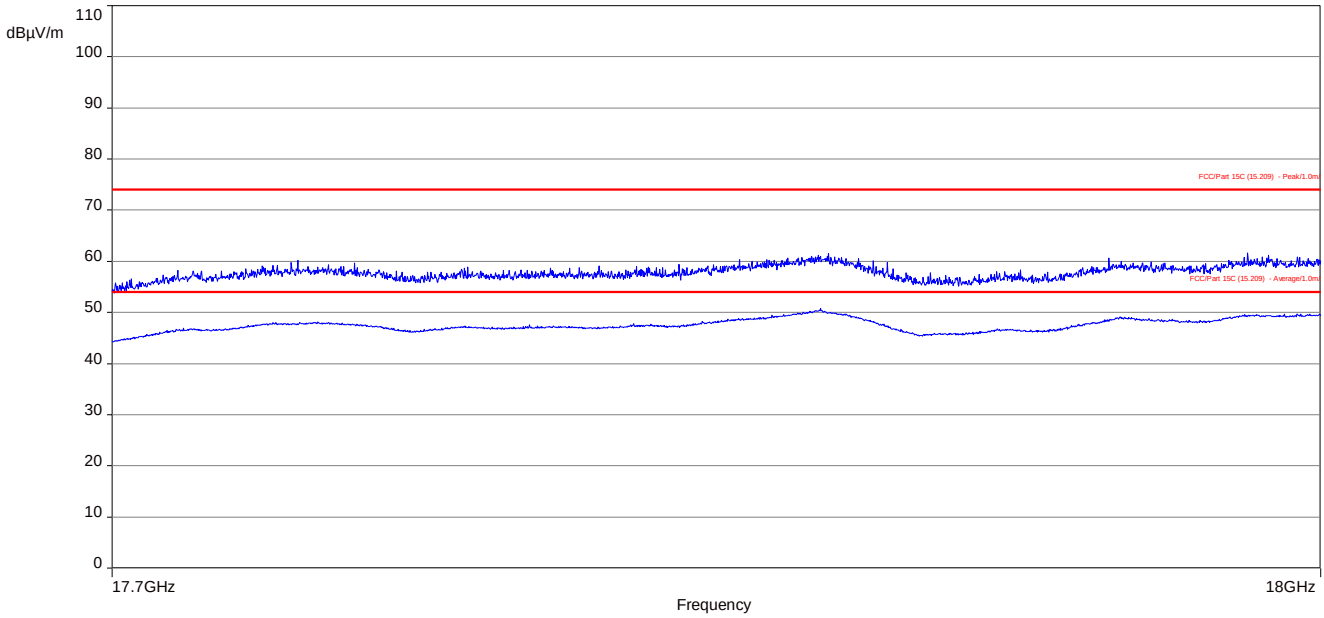
Plot 7: 1 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

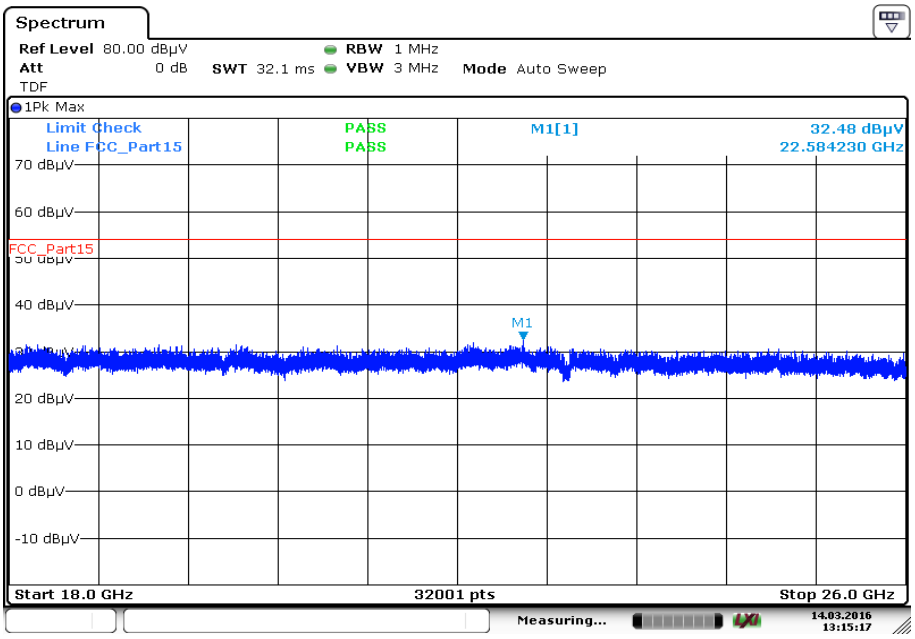


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 8: 17.7 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

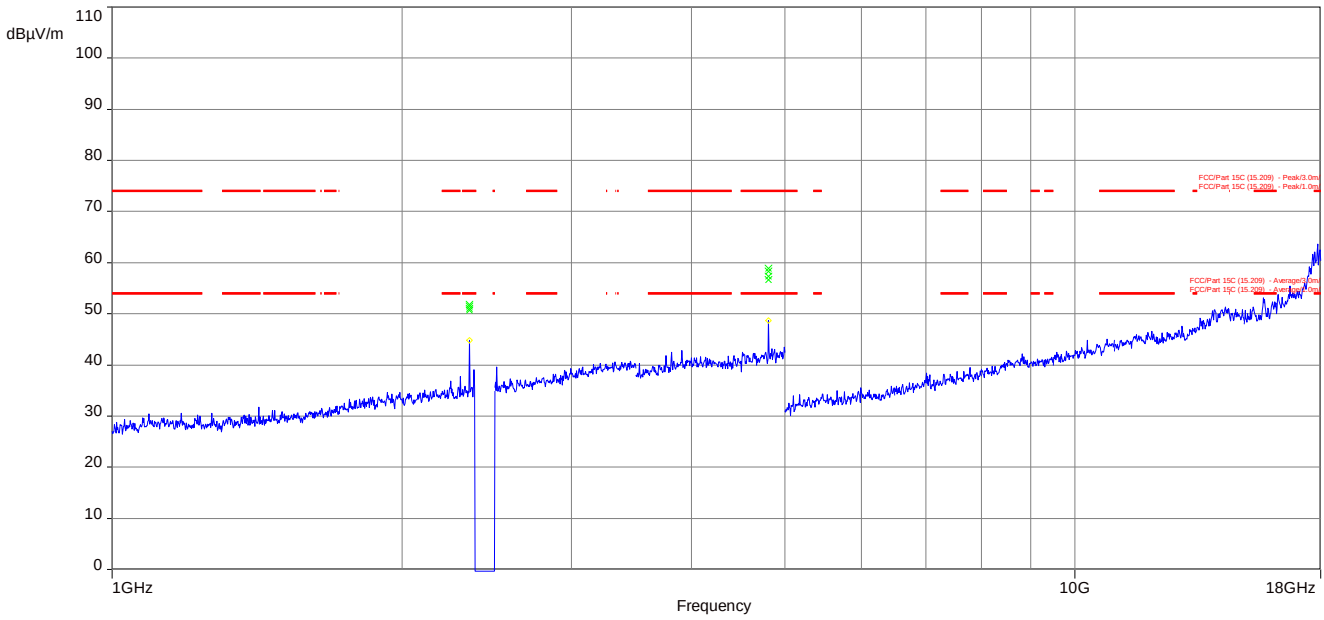


Plot 9: 18 GHz to 26 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization



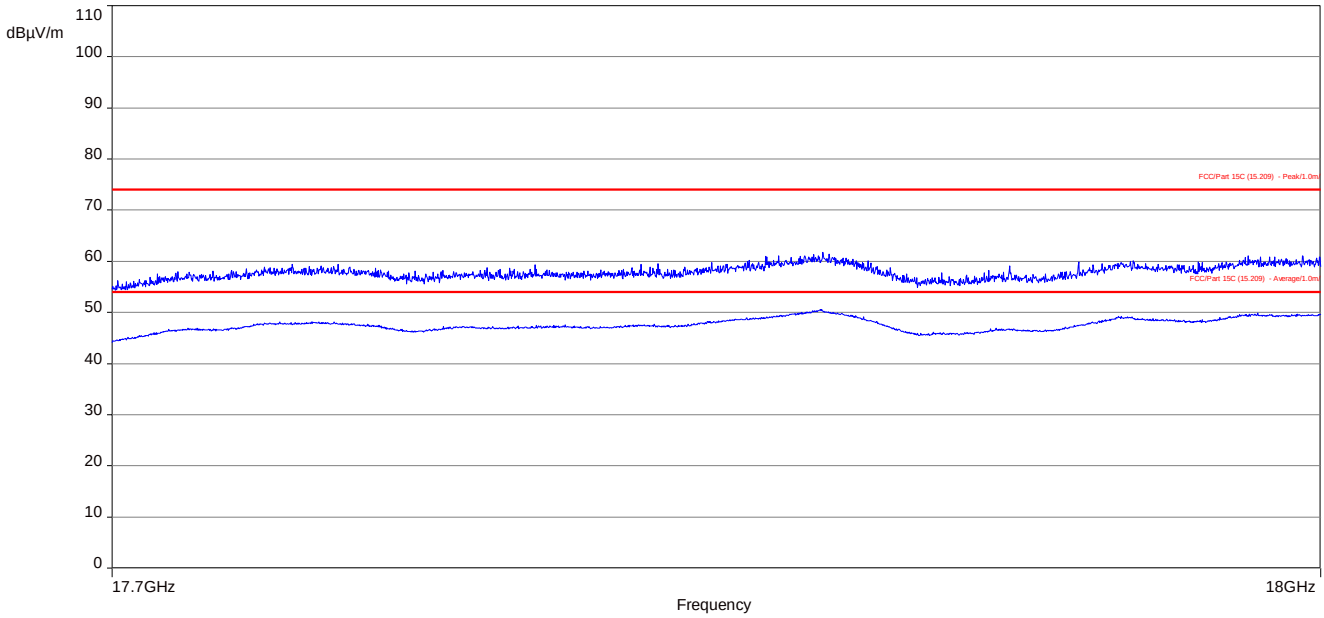
Plots: Transmitter mode, external rubber antenna

Plot 1: 1 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

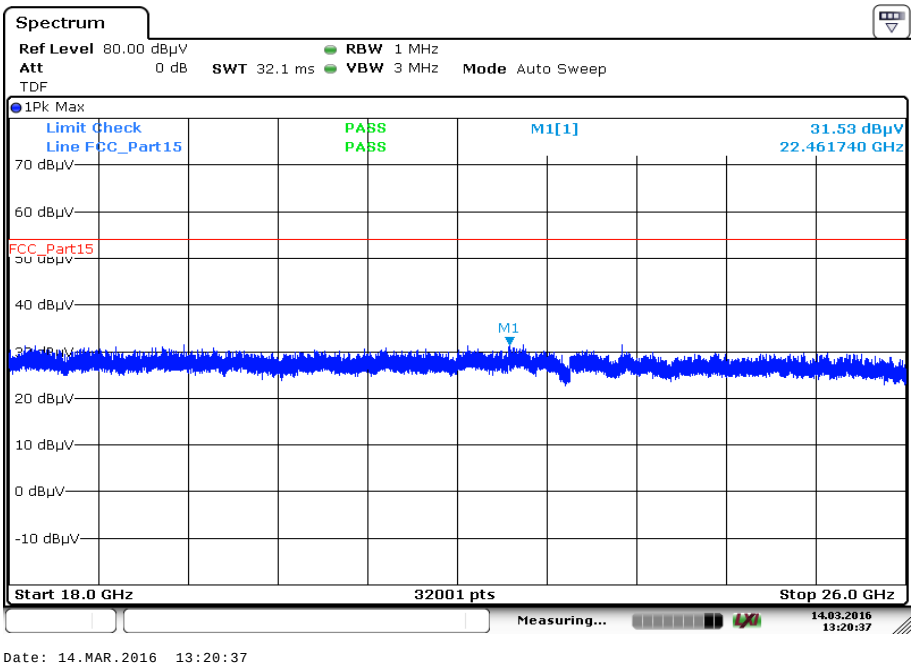


The carrier signal is notched with a 2.4 GHz band rejection filter.

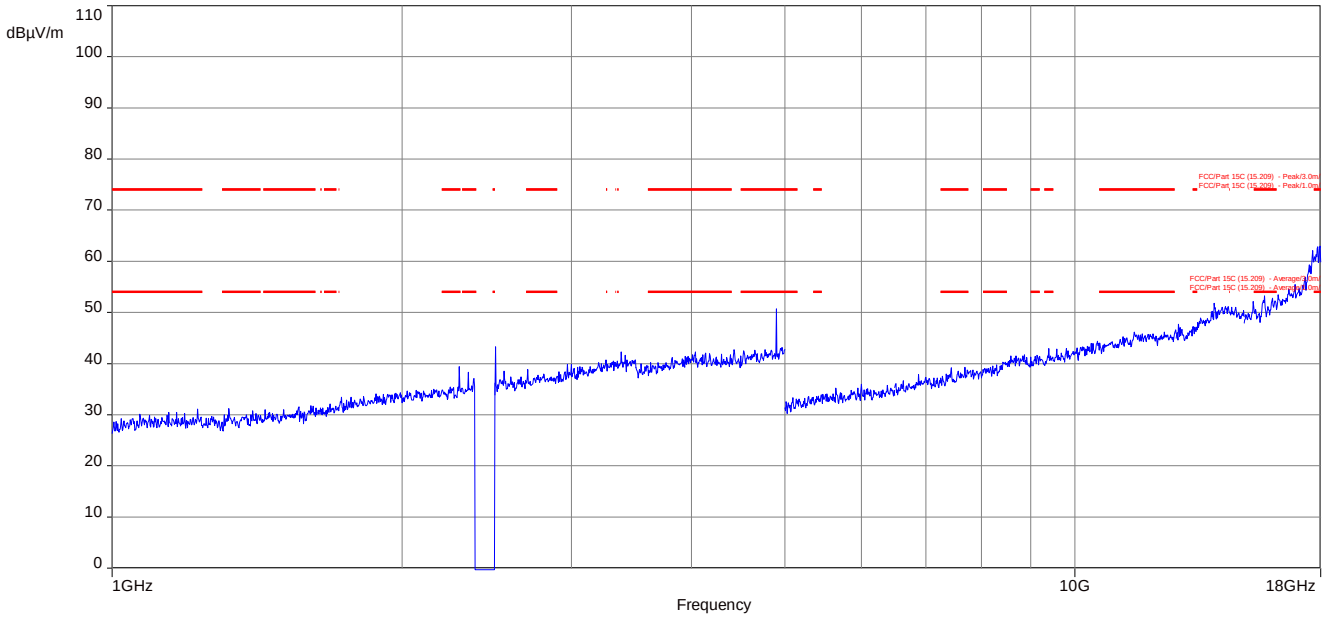
Plot 2: 17.7 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Plot 3: 18 GHz to 26 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

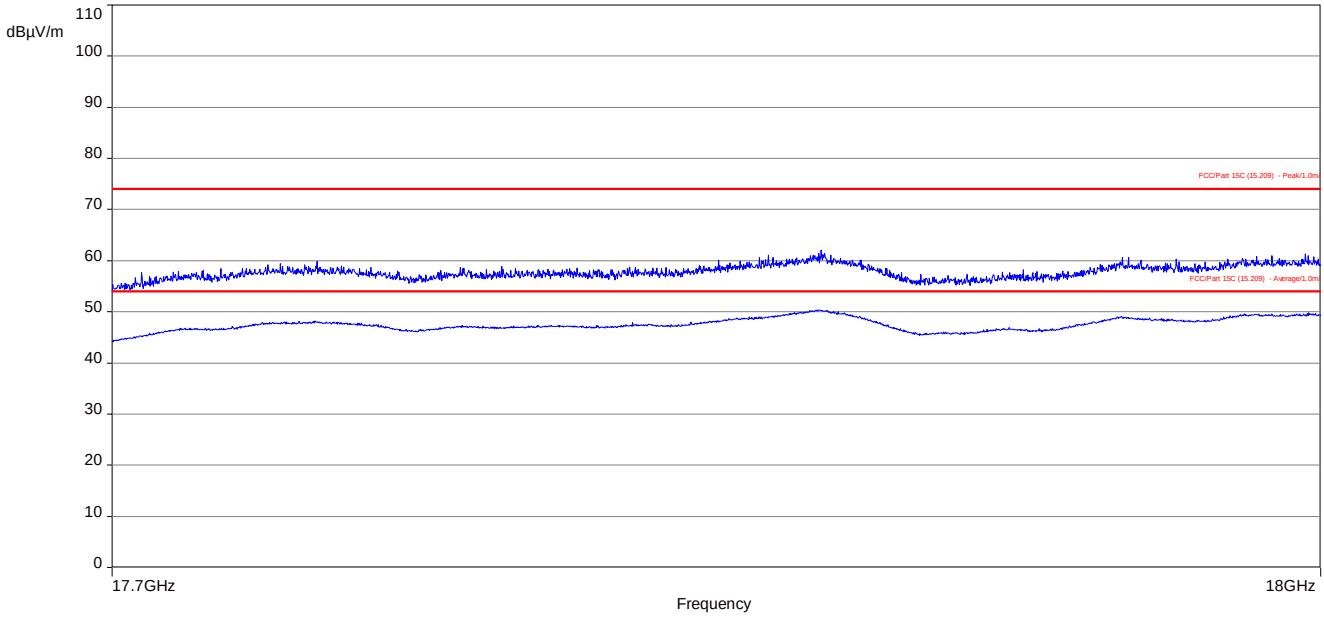


Plot 4: 1 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization

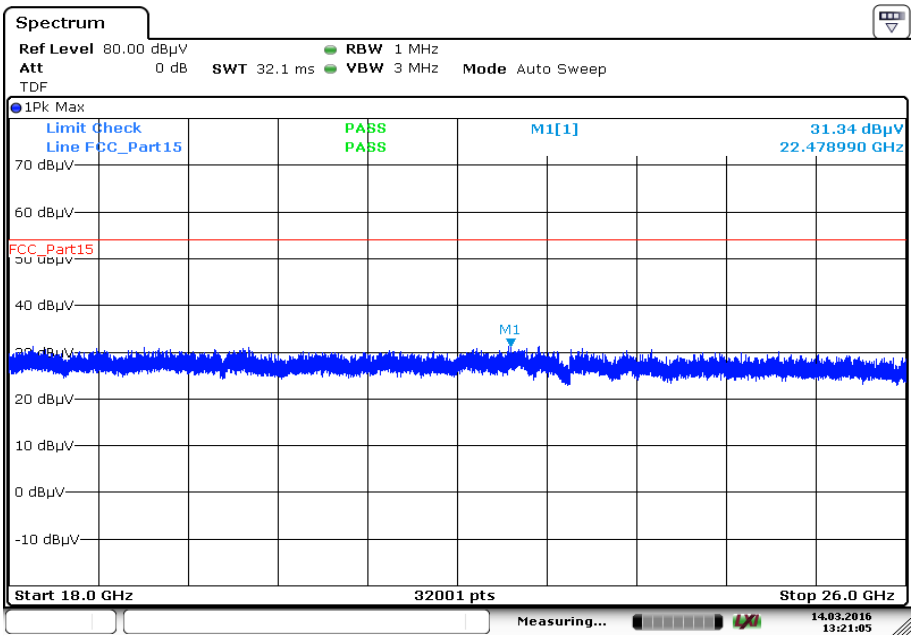


The carrier signal is notched with a 2.4 GHz band rejection filter.

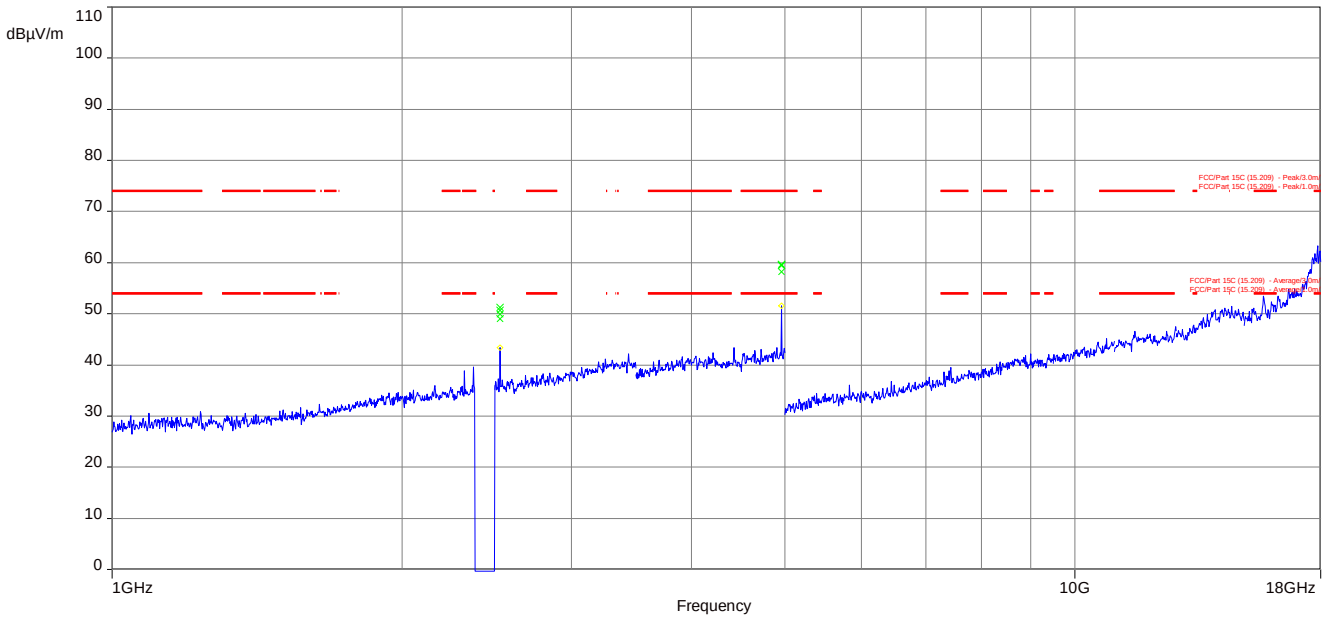
Plot 5: 17.7 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Plot 6: 18 GHz to 26 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization

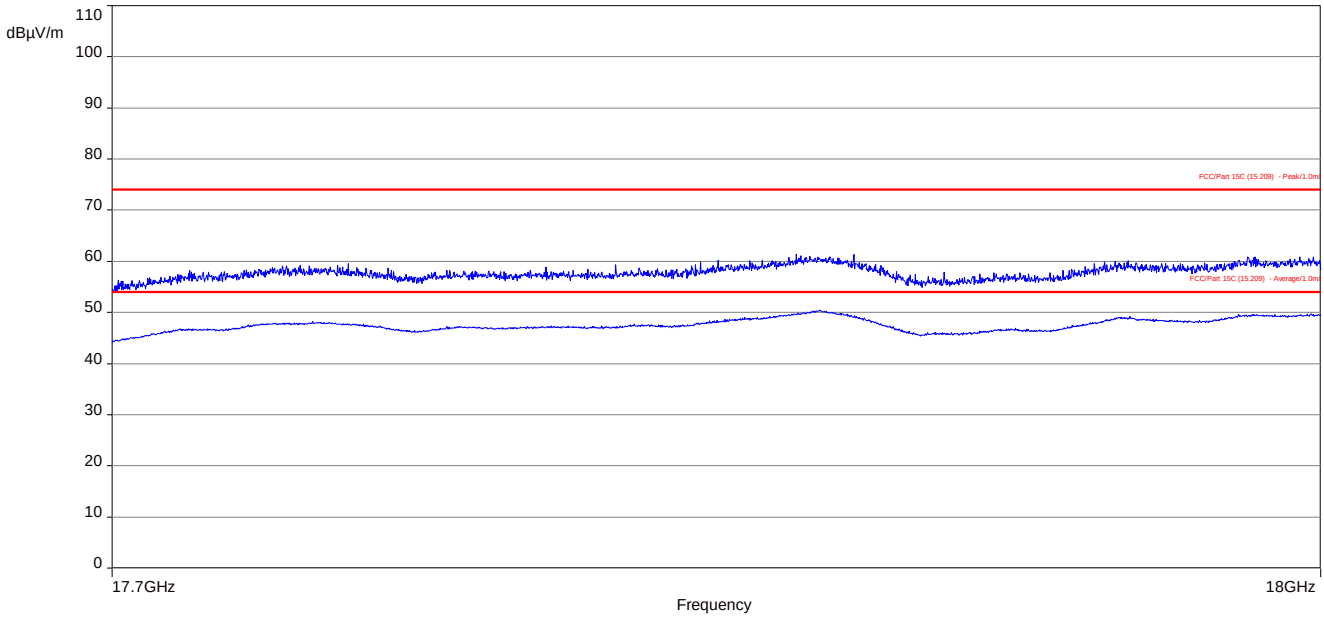


Plot 7: 1 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

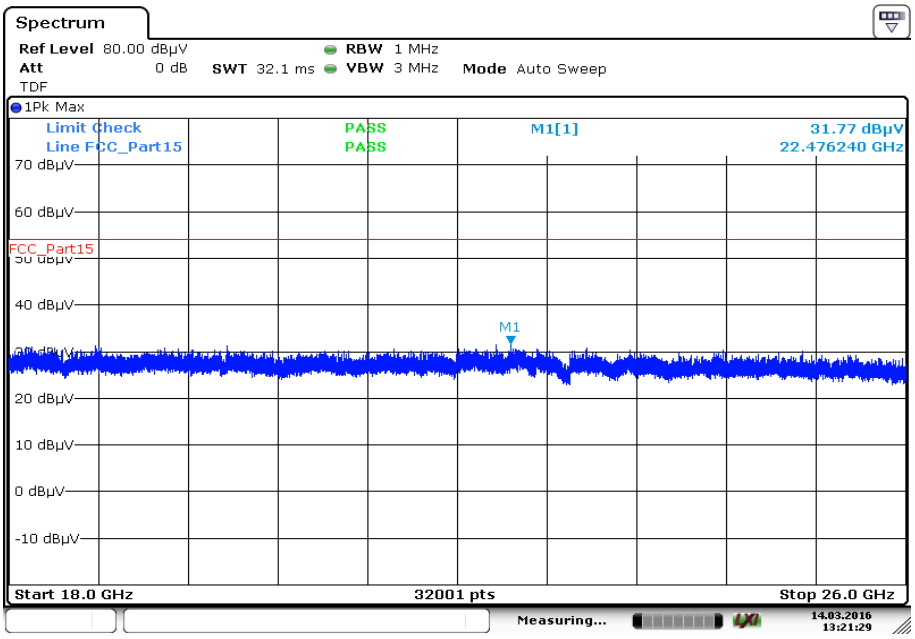


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 8: 17.7 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization



Plot 9: 18 GHz to 26 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization



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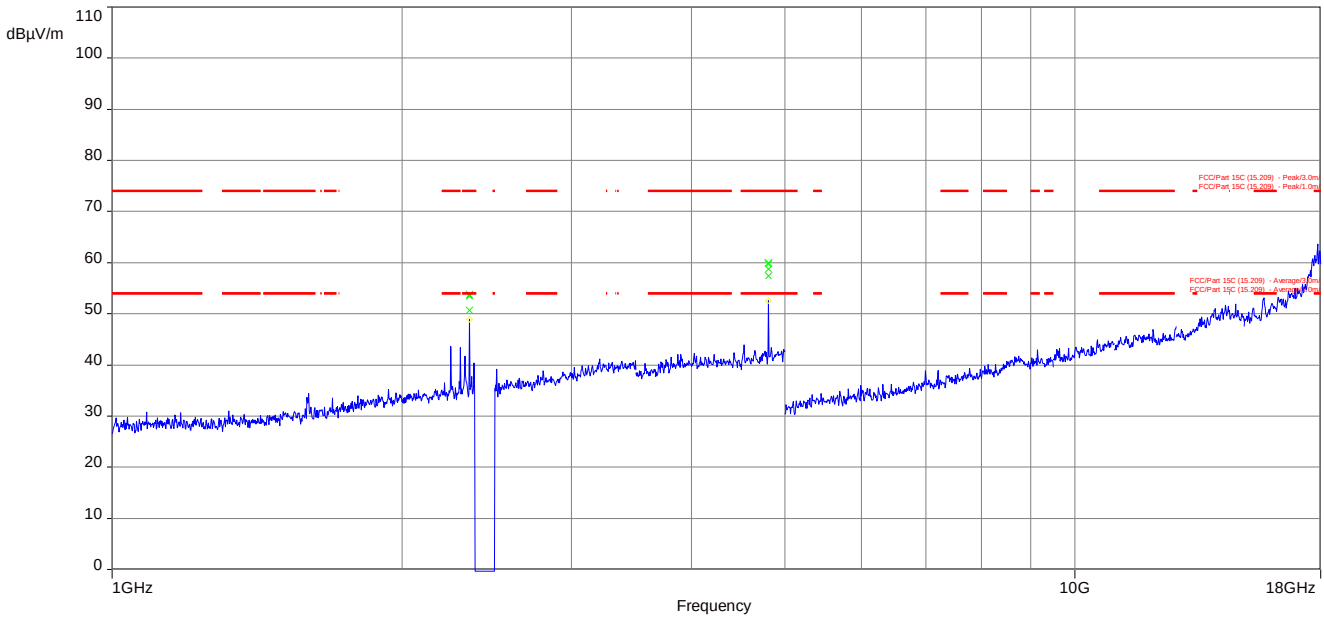
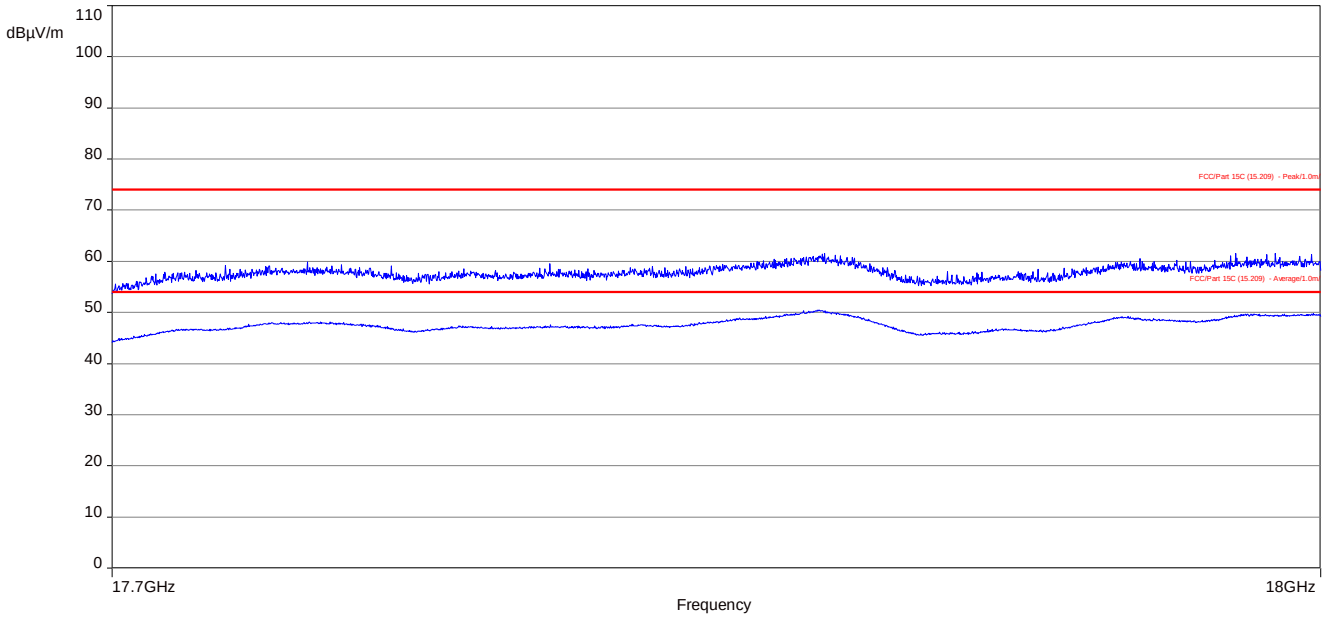
Plots: Transmitter mode, external PCB antenna

Plot 1: 1 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

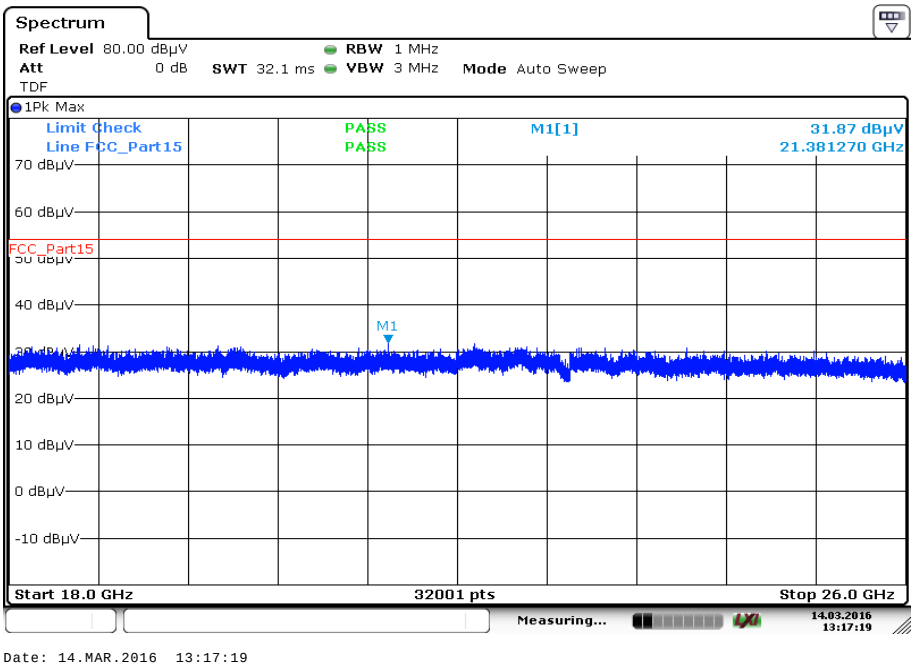


The carrier signal is notched with a 2.4 GHz band rejection filter.

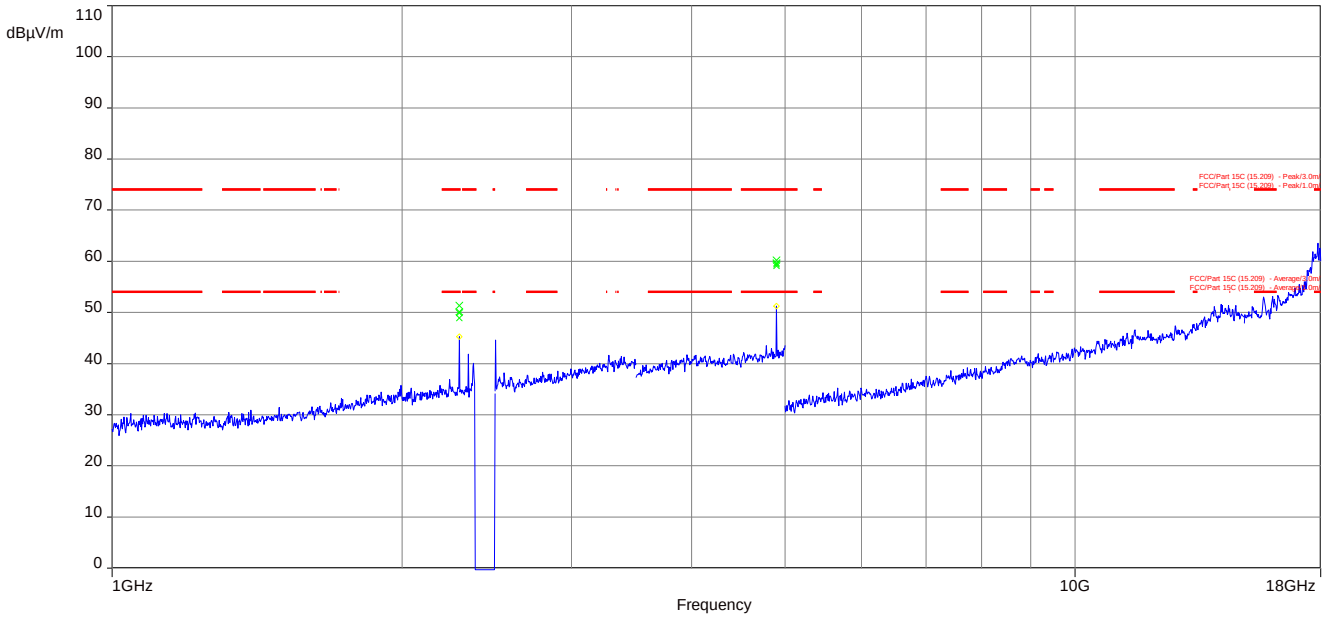
Plot 2: 17.7 GHz to 18 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization



Plot 3: 18 GHz to 26 GHz, TX mode, 2403.5 MHz, vertical & horizontal polarization

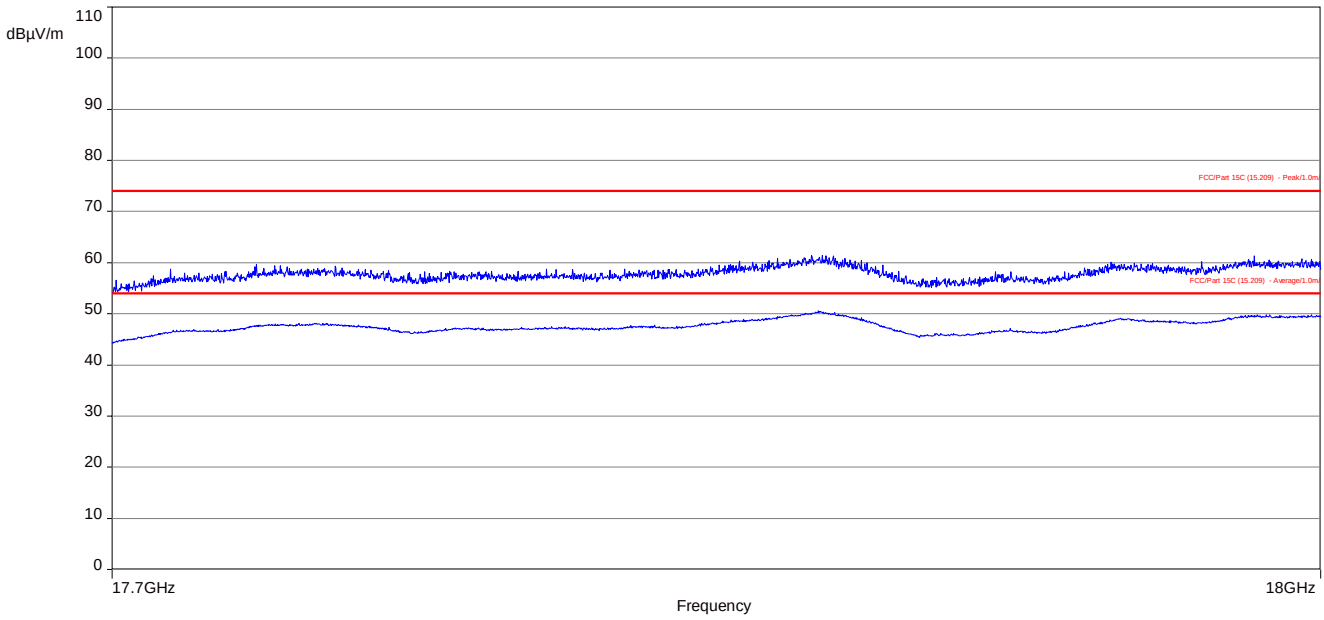


Plot 4: 1 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization

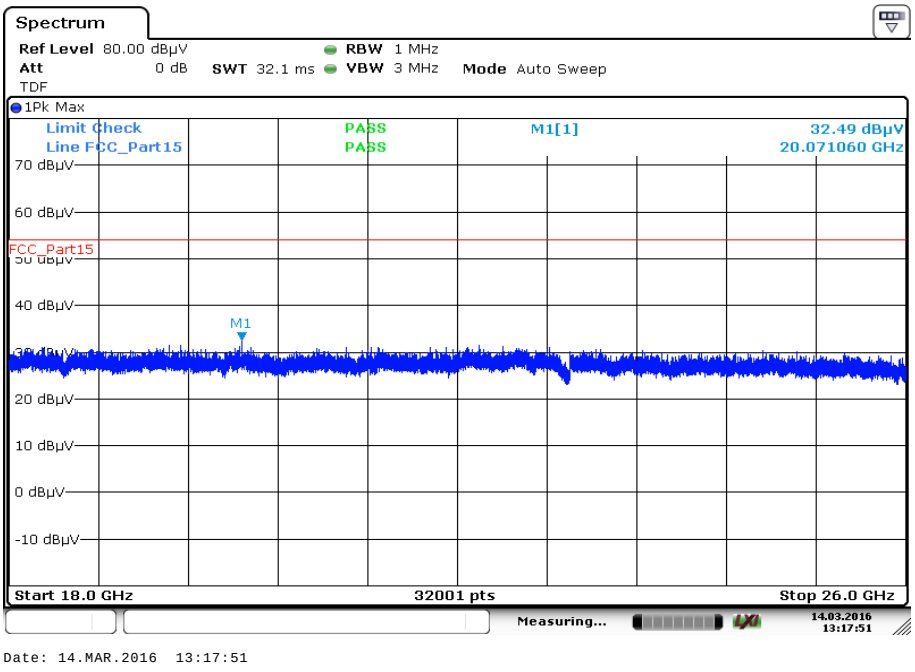


The carrier signal is notched with a 2.4 GHz band rejection filter.

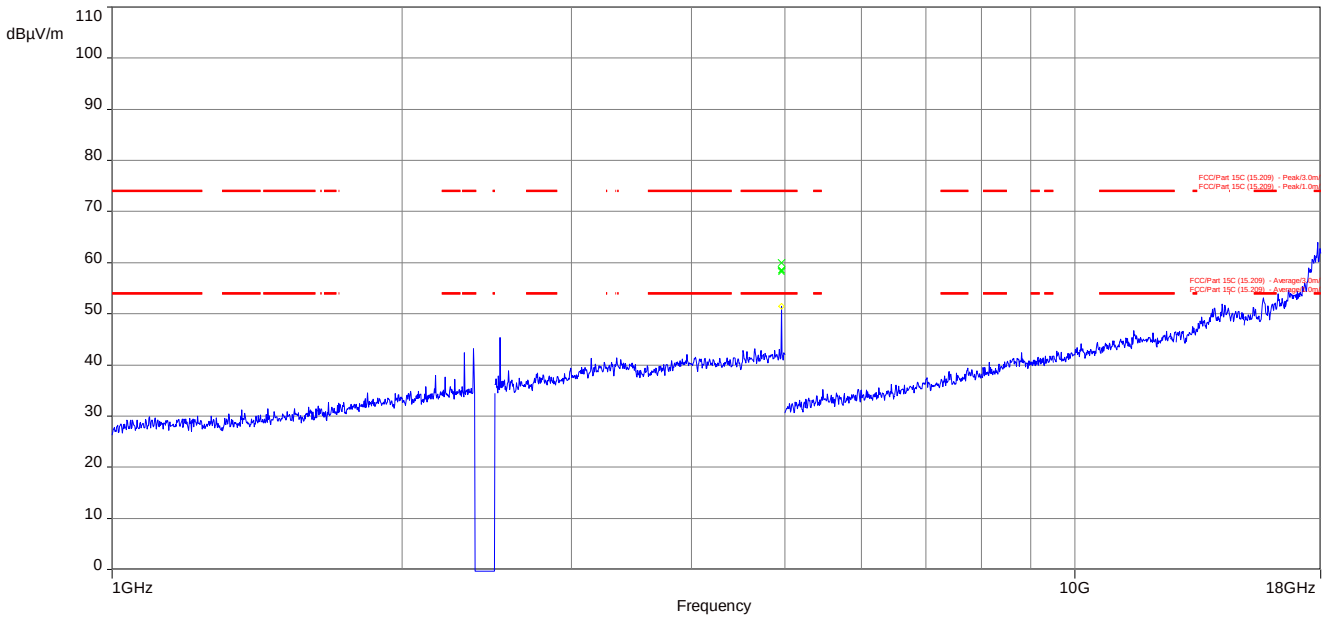
Plot 5: 17.7 GHz to 18 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization



Plot 6: 18 GHz to 26 GHz, TX mode, 2449.5 MHz, vertical & horizontal polarization

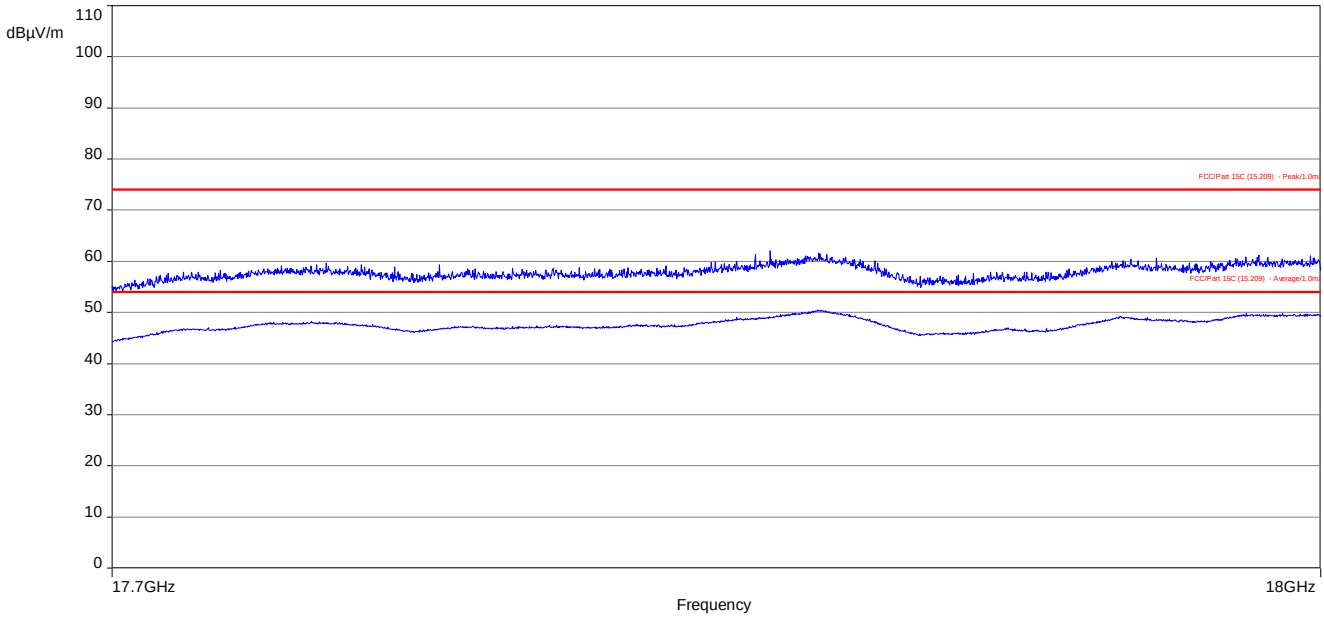


Plot 7: 1 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

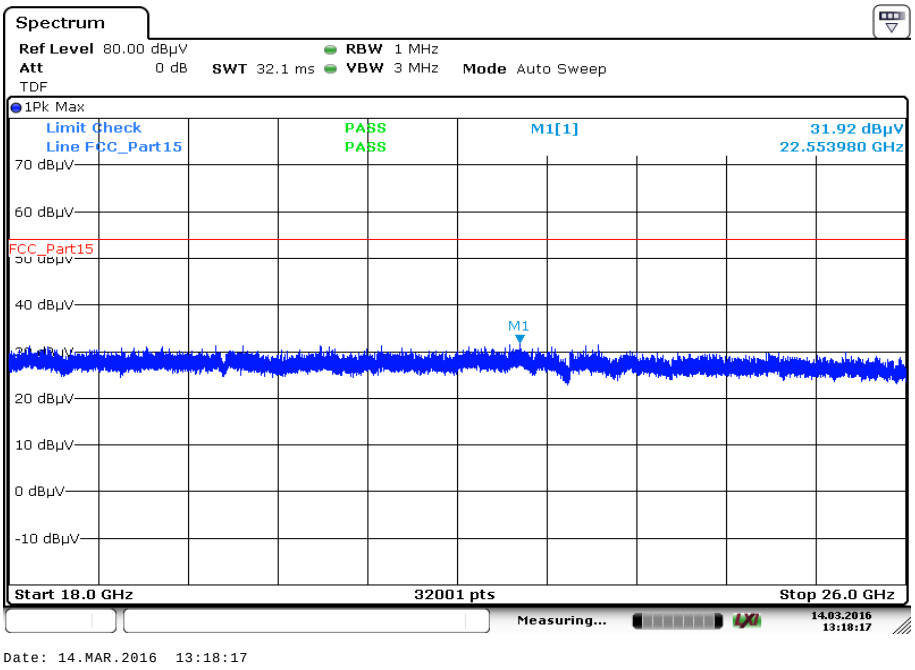


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 8: 17.7 GHz to 18 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

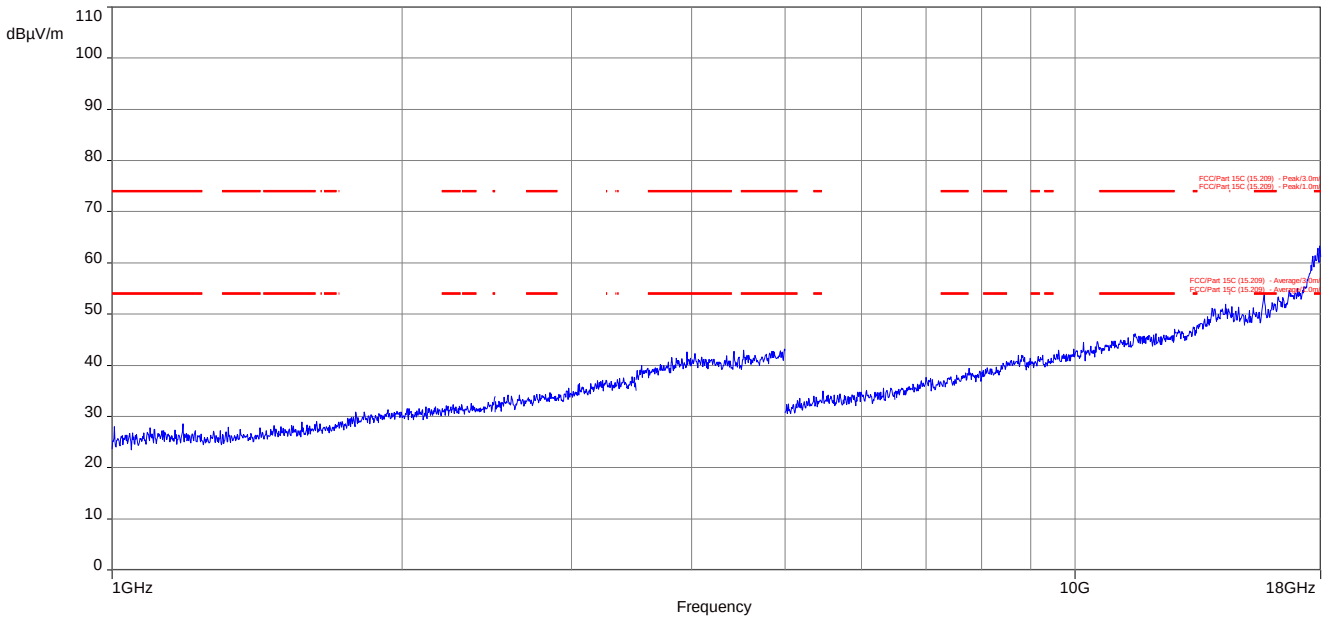


Plot 9: 18 GHz to 26 GHz, TX mode, 2478.5 MHz, vertical & horizontal polarization

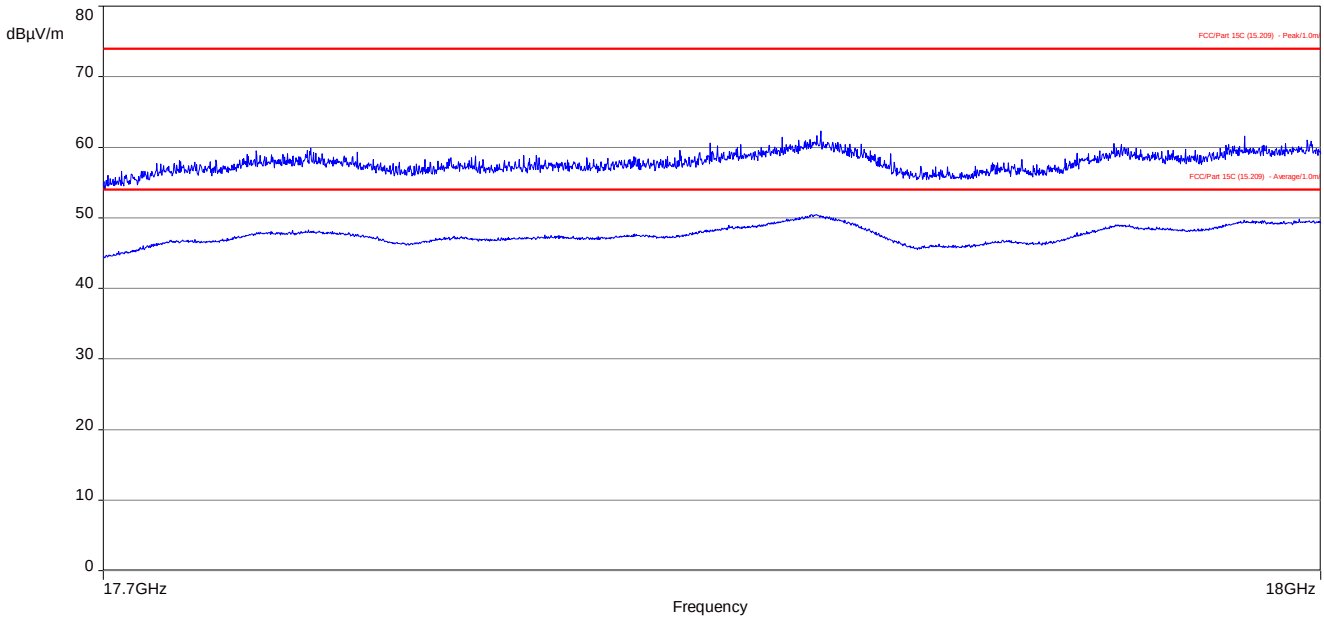


Plots: Idle/receiver mode, ceramic chip antenna

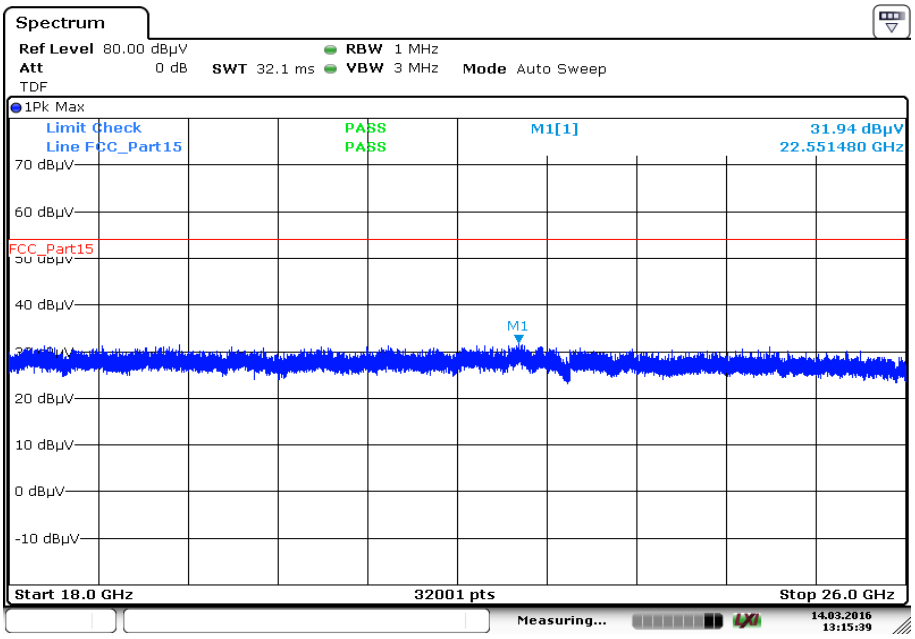
Plot 1: 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



Plot 2: 17.7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization

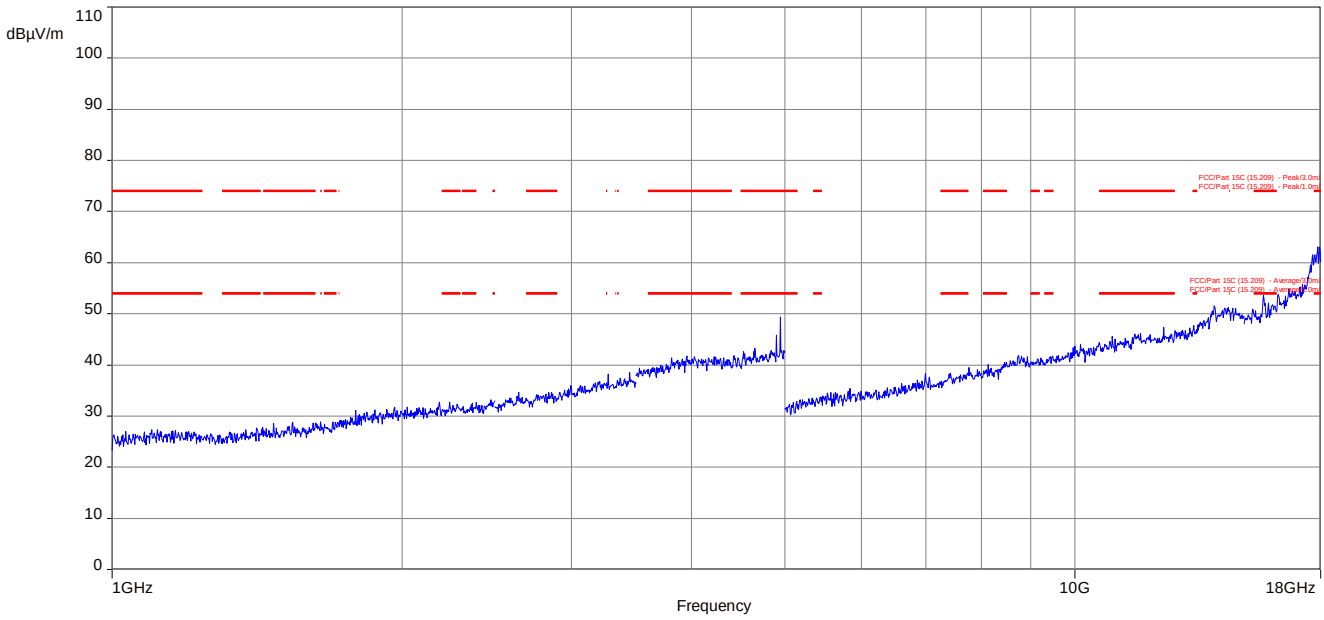


Plot 3: 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization

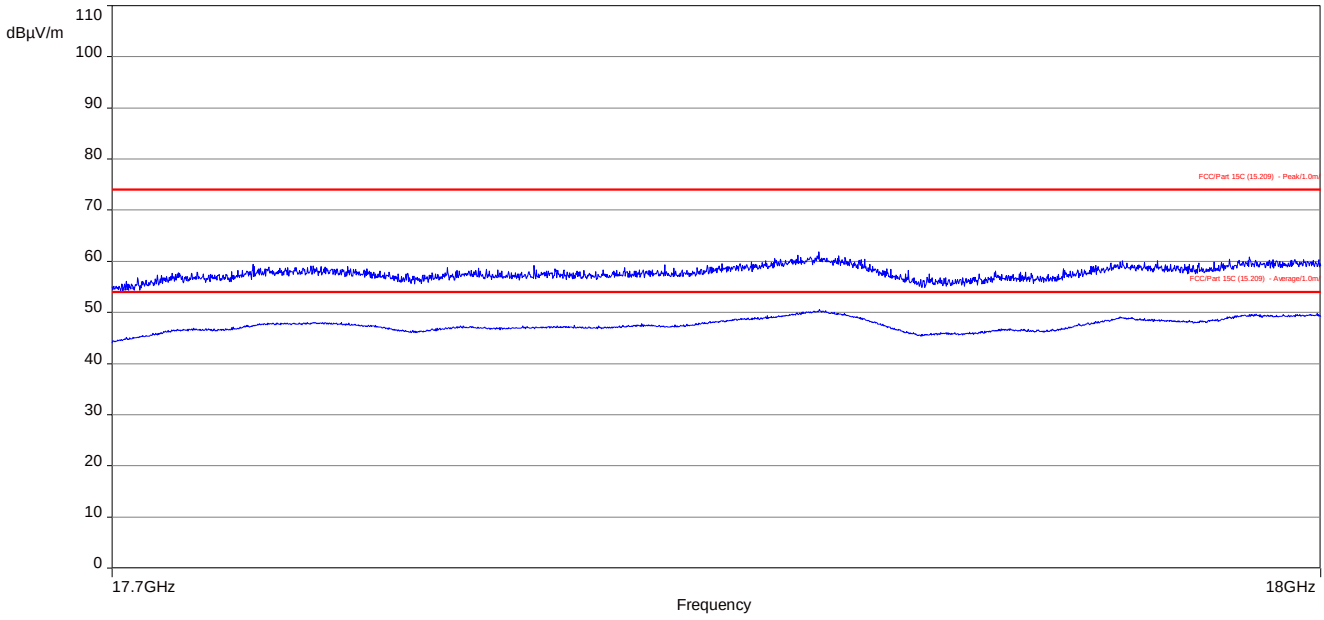


Plots: Idle/receiver mode, external rubber antenna

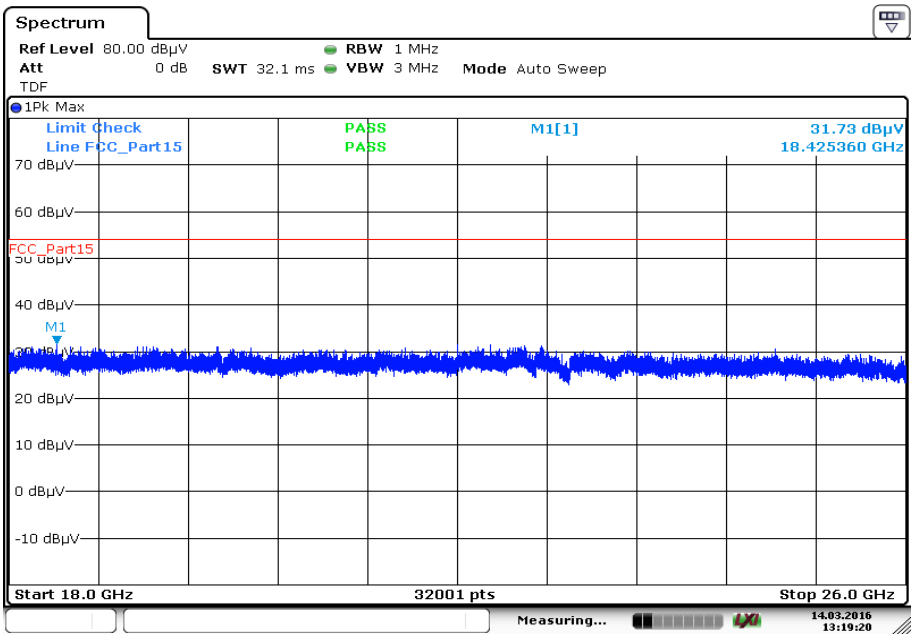
Plot 1: 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



Plot 2: 17.7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization

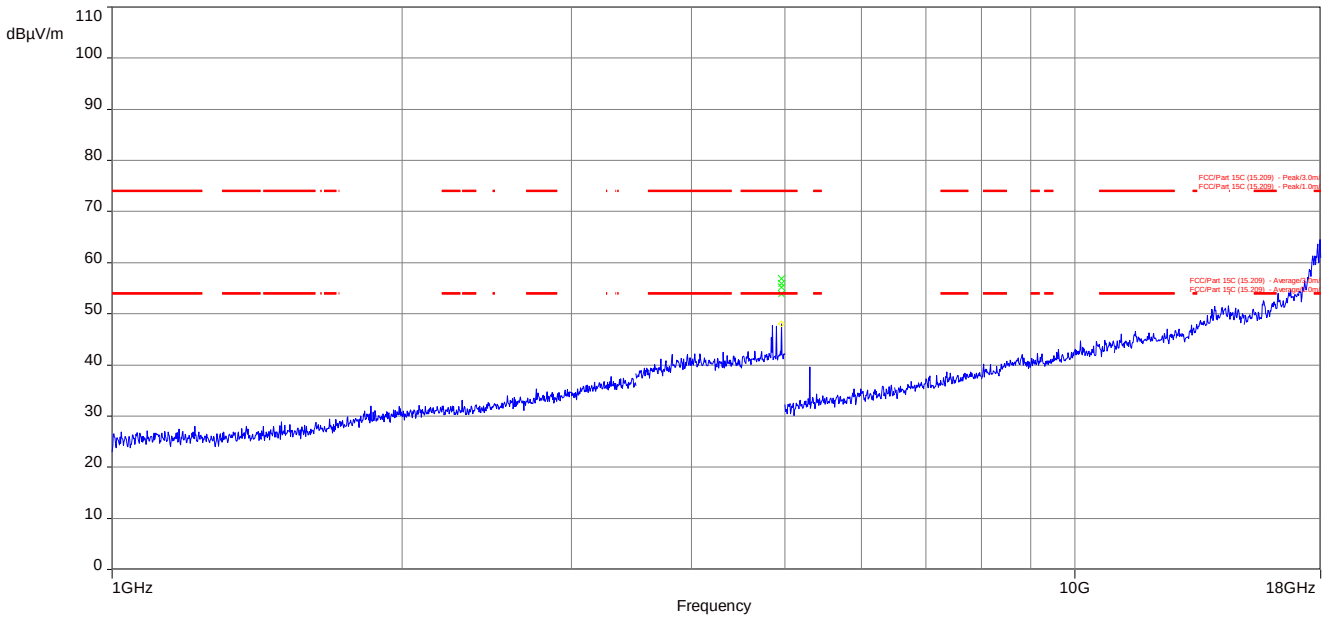


Plot 3: 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization

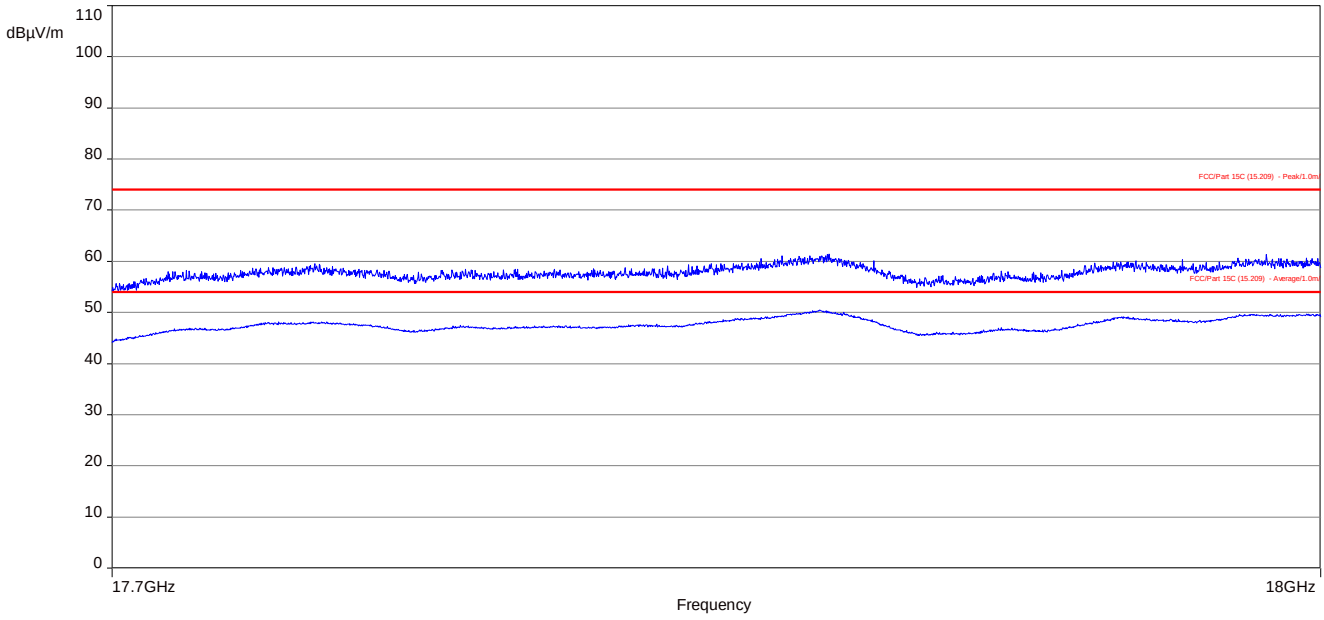


Plots: Idle/receiver mode, external PCB antenna

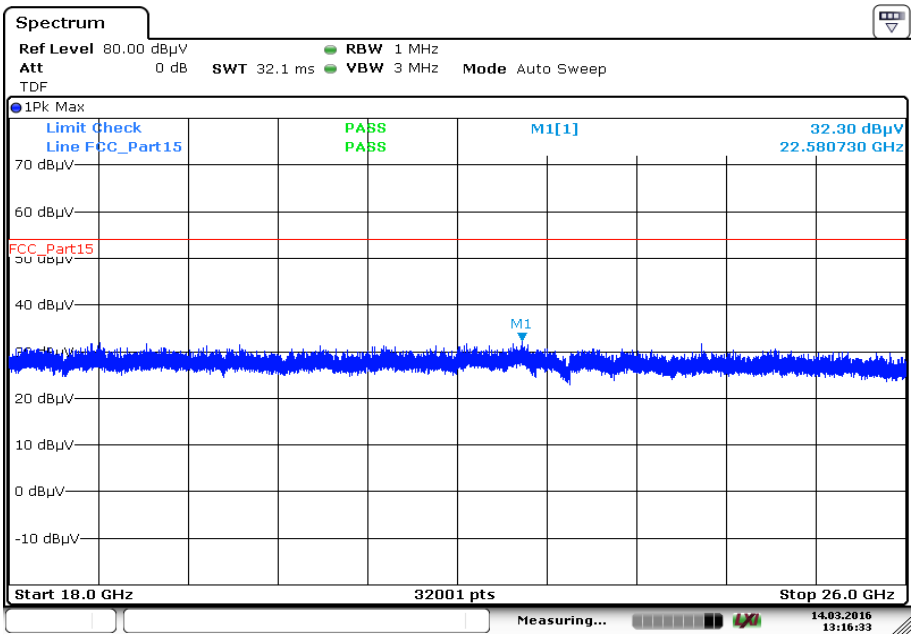
Plot 1: 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



Plot 2: 17.7 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization



Plot 3: 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization



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13 Observations

No observations except those reported with the single test cases have been made.

Annex A Document history

Version	Applied changes	Date of release
	Initial release	2016-04-06
A	Type identification changed	2016-05-03
B	Type identification changed	2016-05-04

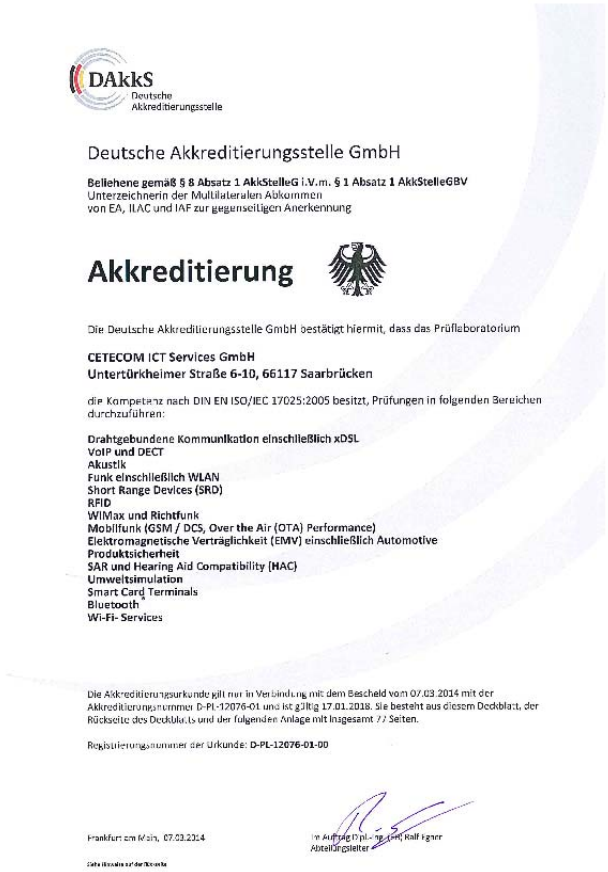
Annex B Further information

Glossary

AVG - Average
DUT - Device under test
EMC - Electromagnetic Compatibility
EN - European Standard
EUT - Equipment under test
ETSI - European Telecommunications Standard Institute
FCC - Federal Communication Commission
FCC ID - Company Identifier at FCC
HW - Hardware
IC - Industry Canada
Inv. No. - Inventory number
N/A - Not applicable
PP - Positive peak
QP - Quasi peak
S/N - Serial number
SW - Software
PMN - Product marketing name
HMN - Host marketing name
HVIN - Hardware version identification number
FVIN - Firmware version identification number

Annex C Accreditation Certificate

Front side of certificate



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Mobilfunk (GSM / DCS, Over the Air (OTA) Performance)
Elektromagnetische Verträglichkeit (EMV) einschließlich Automotive
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SAR und Hearing Aid Compatibility (HAC)
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Smart Card Terminals
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Frankfurt am Main, 07.03.2014

Im Auftrag Dipl.-Ing. (FH) Ralf Egner
Abteilungsleiter

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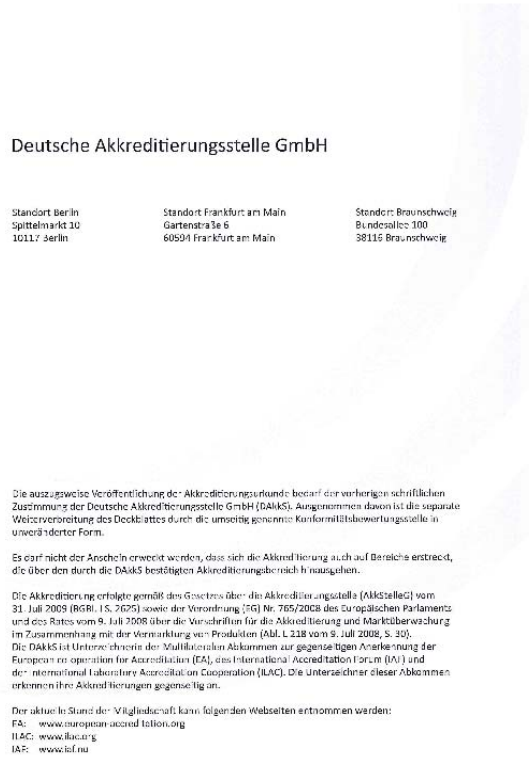

Deutsche Akkreditierungsstelle GmbH

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Gartenstraße 6
60594 Frankfurt am Main

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