
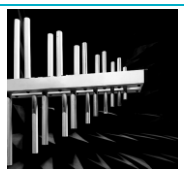
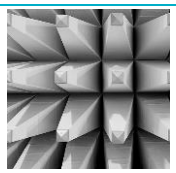

CTC advanced
member of RWTÜV group

Bundesnetzagentur

BNetzA-CAB-02/21-102

TEST REPORT

Test report no.: 1-5687/17-01-07

DAkkS Deutsche Akkreditierungsstelle D-PL-12076-01-03

Testing laboratory

CTC advanced GmbH
Untertuerkheimer Strasse 6 – 10
66117 Saarbruecken / Germany
Phone: + 49 681 5 98 – 0
Fax: + 49 681 5 98 – 9075
Internet: http://www.ctcadvanced.com
e-mail: mail@ctcadvanced.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-12076-01-03

Applicant

Telit Wireless Solutions GmbH
Friesenweg 4, Haus 14
22763 Hamburg / GERMANY
Phone: +49 40 89088-0
Fax: +49 40 89088-444
Contact: Jens Jensen
e-mail: jens.jensen@telit.com
Phone: +49 40 89088-498

Manufacturer

Telit Wireless Solutions GmbH
Friesenweg 4, Haus 14
22763 Hamburg / 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 2	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 4	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus

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

Test Item

Kind of test item:	**Bluetooth LE BT 5 Module**
Model name:	**BlueMod+S50/AI BE890D3-SI** **BlueMod+S50/AP BE890D3-SP**
FCC ID:	**RFR-S50**
IC:	**4957A-S50**
Frequency:	DTS band 2.4 GHz
Technology tested:	Bluetooth® LE
Antenna:	On-board multilayer chip antenna or external antenna (Antenova Titanis B4844-R)
Power supply:	1.7 V to 3.6 V DC by external power source
Temperature range:	-40°C to +85°C

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

Test report authorized:

cn=Joerg Warken, o=CTC advanced GmbH, ou=WAK-281116, email=joerg.warken@ctcadvanced.com, c=DE
2018.02.20 10:56:45 +01'00'

Joerg Warken
Lab Manager
Radio Communications & EMC

Test performed:

cn=Andreas Luckenbill, o=CTC advanced GmbH, ou=LUC-180217, email=andreas.luckenbill@ctcadvanced.com, c=DE
2018.02.20 10:31:16 +01'00'

Andreas Luckenbill
Lab 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. CTC advanced 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 is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

2.2 Application details

Date of receipt of order:	2018-01-11
Date of receipt of test item:	2018-02-12
Start of test:	2018-02-12
End of test:	2018-02-16
Person(s) present during the test:	Jens Jensen

2.3 Test laboratories sub-contracted

None

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 2	February 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices
RSS - Gen Issue 4	November 2014	Spectrum Management and Telecommunications Radio Standards Specifications - General Requirements and Information for the Certification of Radio Apparatus

Guidance	Version	Description
DTS: KDB 558074 D01	v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
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}	+20 °C during room temperature tests No tests under extreme temperature conditions required No tests under extreme temperature conditions required
Relative humidity content	:		42 %
Barometric pressure	:		1021 hpa
Power supply	:	V_{nom} V_{max} V_{min}	3.0 V DC by external power source No tests under extreme voltage conditions required No tests under extreme voltage conditions required

5 Test item

5.1 General description

Kind of test item	:	Bluetooth LE BT 5 Module
Type identification	:	BlueMod+S50/AI BE890D3-SI BlueMod+S50/AP BE890D3-SP
HMN	:	N/A
PMN	:	BlueMod+S50/AI BlueMod+S50/AP
HVIN	:	BE890D3-SI BE890D3-SP
FVIN	:	SD 1.32 V5.1.0
S/N serial number	:	Rad. Rad3 (internal antenna), Cond2 (external antenna) Cond. Cond1
HW hardware status	:	BlueMod+S50/AI BE890D3-SI BlueMod+S50/AP BE890D3-SP
SW software status	:	SD 1.32 V5.1.0
Frequency band	:	DTS band 2.4 GHz lowest channel: 2402 MHz; highest channel: 2480 MHz
Type of radio transmission Use of frequency spectrum	: :	DSSS
Type of modulation	:	GFSK
Number of channels	:	40
Antenna	:	On-board multilayer chip antenna or external antenna (Antenova Titanis B4844-R)
Power supply	:	1.7 V to 3.6 V DC by external power source
Temperature range	:	-40°C to +85°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: 1-5687/17-01-01_AnnexA
1-5687/17-01-01_AnnexB
1-5687/17-01-01_AnnexD

6 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).

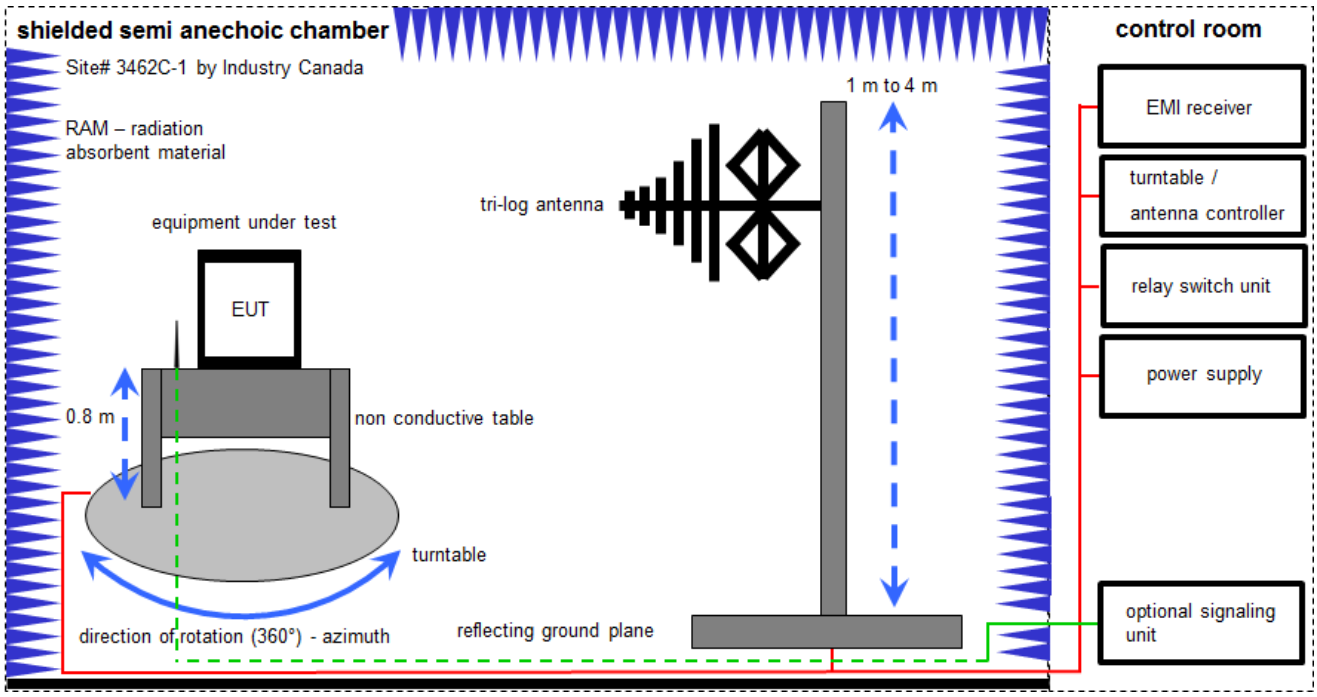
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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
vlkI!	Attention: extended calibration interval		
NK!	Attention: not calibrated	*)	next calibration ordered / currently in progress

6.1 Shielded semi anechoic chamber

The radiated measurements are performed in vertical and horizontal plane in the frequency range from 30 MHz 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 conform to 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

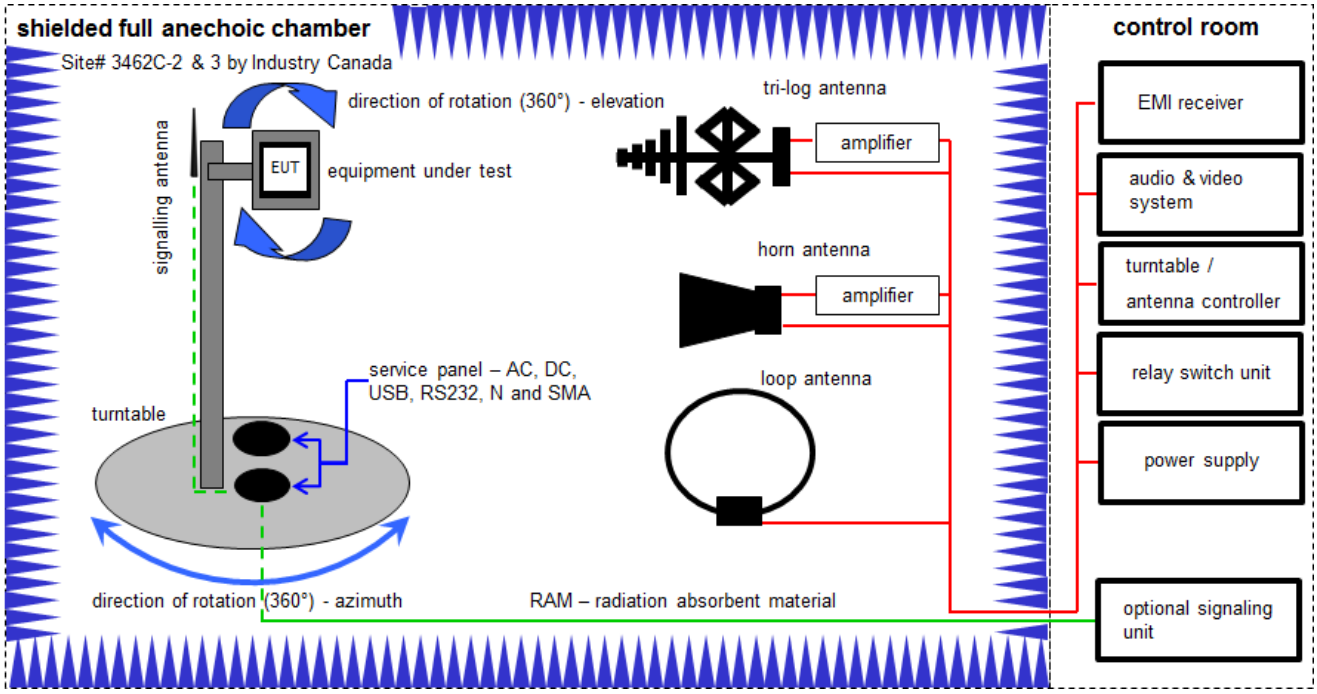
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	A	Meßkabine 1	HF-Absorberhalle	MWB AG 300023		300000551	ne	-/-	-/-
3	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	15.12.2017	14.12.2018
4	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
5	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
6	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
7	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018

6.2 Shielded fully anechoic chamber



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

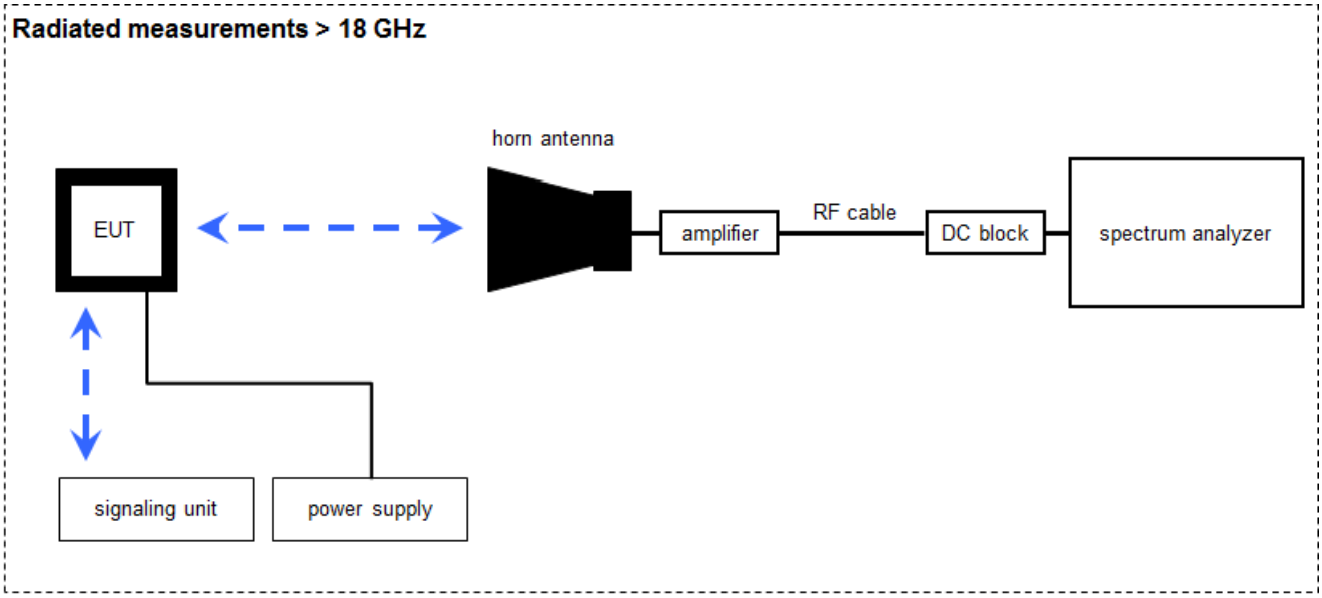
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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.	Kind of Calibration	Last Calibration	Next Calibration
1	A, B	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032	vlKI!	07.07.2017	06.07.2019
2	C	Active Loop Antenna 9 kHz to 30 MHz	6502	EMCO	2210	300001015	k	07.07.2017	06.07.2019
3	A	Band Reject Filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	26	300003792	ne	-/-	-/-
4	A, B	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	318	300003696	k	23.05.2017	22.05.2020
5	A, B, C	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
6	A, B, C	Computer	Intel Core i3 3220/3,3 GHz, Prozessor		2V2403033A5421	300004591	ne	-/-	-/-
7	A	Highpass Filter	WHKX2.6/18G-10SS	Wainwright	12	300004651	ne	-/-	-/-
8	A, B, C	NEXIO EMV-Software	BAT EMC V3.16.0.49	EMCO		300004682	ne	-/-	-/-
9	A, B, C	Anechoic chamber		TDK		300003726	ne	-/-	-/-
10	A, B, C	EMI Test Receiver 9kHz-26,5GHz	ESR26	R&S	101376	300005063	k	14.12.2017	13.12.2018
11	A, B	RF-Amplifier	AMF-6F06001800-30-10P-R	NARDA-MITEQ Inc	2011571	300005240	ev	-/-	-/-

6.3 Radiated measurements > 18 GHz



Measurement distance: horn antenna 50 cm

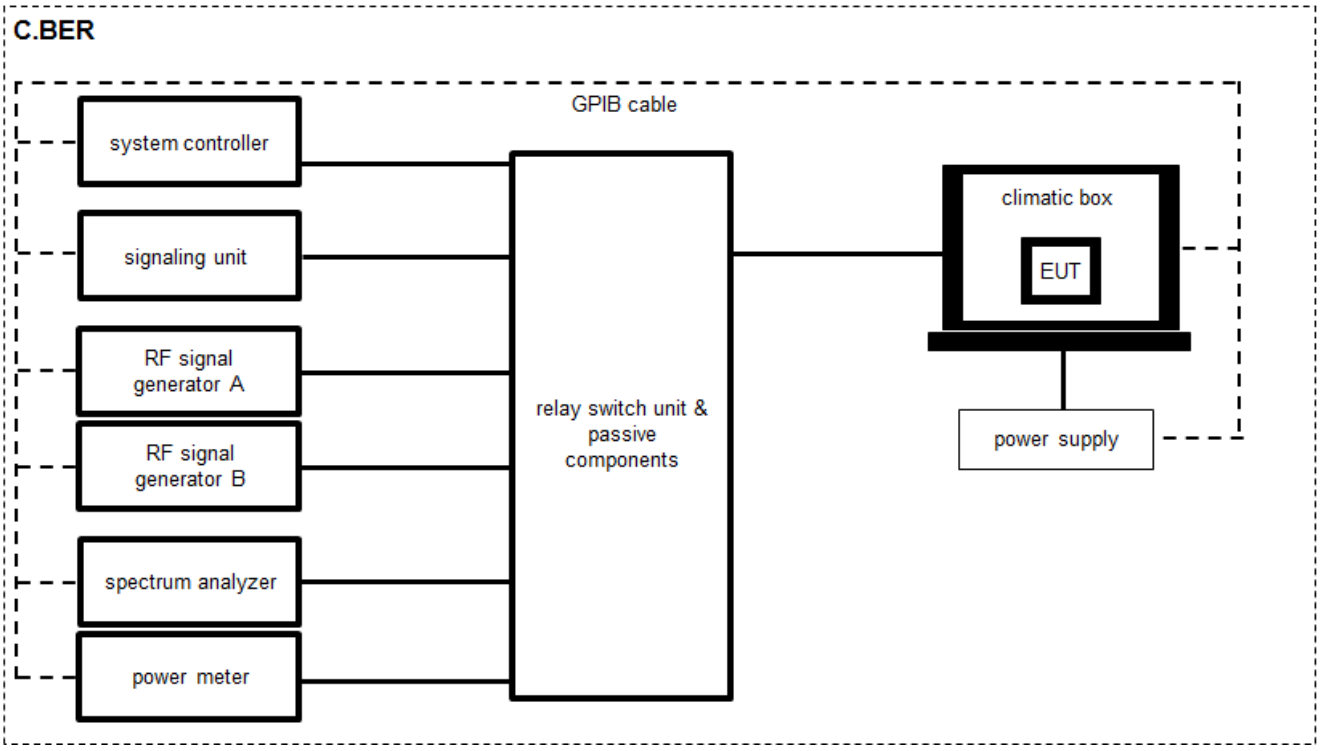
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss signal path & distance correction; AF-antenna factor)

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.	Kind of Calibration	Last Calibration	Next Calibration
1	A	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP	00419	300002268	ev	-/-	-/-
2	A	Horn Antenna 18,0-40,0 GHz	LHAF180	Microw.Devel	39180-103-022	300001748	k	22.05.2015	22.05.2018
3	A	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	16.01.2018	15.01.2019

6.4 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.	Kind of Calibration	Last Calibration	Next Calibration
1	A	USB/GPIB interface	82357B	Agilent Technologies	MY52103346	300004390	ne	-/-	-/-
2	A	PC	Exone	F+W		300004179	ne	-/-	-/-
3	A	Wireless Connectivity Tester	CMW270	Rohde & Schwarz	100683	300005133	k	03.01.2018	02.01.2020
4	A	Spectrum Analyzer	FSV30	Rohde & Schwarz	103809	300005359	k	04.04.2017	03.04.2019
5	A	Relay Switch Matrix	RSM-1	CTC	1	400001355	ev	07.02.2018	06.02.2019

7 Sequence of testing

7.1 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, it is placed on a table with 0.8 m height.
- 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 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 pre-measurement are maximized by the software by rotating the turntable from 0° to 360°.
- Loop antenna is rotated about its vertical axis for maximum response at each azimuth about the EUT. (For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT)
- 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.

*)Note: The sequence will be repeated three times with different EUT orientations.

7.2 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.

7.3 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.

7.4 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.

8 Measurement uncertainty

Measurement uncertainty	
Test case	**Uncertainty**
Antenna gain	± 3 dB
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

9 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 2	See table!	2018-02-20	-/-

Test specification clause	Test case	Guideline	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Remark
§15.247(b)(4) RSS - 247 / 5.4 (4)	System gain	-/-	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.247(e) RSS - 247 / 5.2 (b)	Power spectral density	KDB 558074 DTS clause: 10.6	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.247(a)(2) RSS - 247 / 5.2 (a)	DTS bandwidth – 6 dB bandwidth	KDB 558074 DTS clause: 8.1	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.247(b)(3) RSS - 247 / 5.4 (4)	Maximum output power	KDB 558074 DTS clause: 9.1.1	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	Detailed spurious emissions @ the band edge - conducted	-/-	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.205 RSS - 247 / 5.5 RSS - Gen	Band edge compliance radiated	KDB 558074 DTS clause: 13.3.2	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5	TX spurious emissions conducted	KDB 558074 DTS clause: 11.1 & 11.2 11.3	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.209(a) RSS - Gen	Spurious emissions radiated below 30 MHz	-/-	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated 30 MHz to 1 GHz	-/-	Nominal	Nominal	-/-	☒	☐	☐	☐	-/-
§15.247(d) RSS - 247 / 5.5 §15.109 RSS - Gen	Spurious emissions radiated above 1 GHz	-/-	Nominal	Nominal	1 Msps 2 Msps	☒	☐	☐	☐	-/-
§15.107(a) §15.207	Conducted emissions below 30 MHz (AC conducted)	-/-	Nominal	Nominal	1 Msps 2 Msps	☐	☐	☒	☐	-/-

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

10 Additional comments

The Bluetooth® word mark and logos are owned by the Bluetooth SIG Inc. and any use of such marks by CTC advanced GmbH is under license.

Reference documents: None

Special test descriptions: None

Configuration descriptions: TX tests: were performed with LE packets (255 byte payload) and static PRBS pattern.
RX/Standby tests: BT enabled, TX Idle
Tested frequencies: lowest: 2402 MHz
middle: 2440 MHz
- highest: 2480 MHz

Test mode:

☒ Bluetooth LE Test mode enabled for conducted measurements (EUT is controlled over CBT)

☒ Special software is used for radiated measurements
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)*

☐ Operating mode 2 (multiple antennas, no beamforming)
- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously but without beamforming.*

☐ Operating mode 3 (multiple antennas, with beamforming)
- *Equipment operating in this mode contains a smart antenna system using two or more transmit/receive chains simultaneously with beamforming.*
In addition to the antenna assembly gain (G), the beamforming gain (Y) may have to be taken into account when performing the measurements.

11 Measurement results

11.1 System gain

Limits:

FCC	IC
6 dBi / > 6 dBi output power and power density reduction required	

Results: for the on-board antenna

T_{nom}	V_{nom}	lowest channel	middle channel	highest channel
Customer Declared Peak Antenna Gain [dBi]		3 dBi		

Results: for the external antenna

T_{nom}	V_{nom}	lowest channel	middle channel	highest channel
Data Sheet Peak Gain [dBi]		2.2 dBi		

11.2 Power spectral density

Description:

Measurement of the power spectral density of a digital modulated system.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 kHz
Video bandwidth	10 kHz
Span	≥ EBW
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

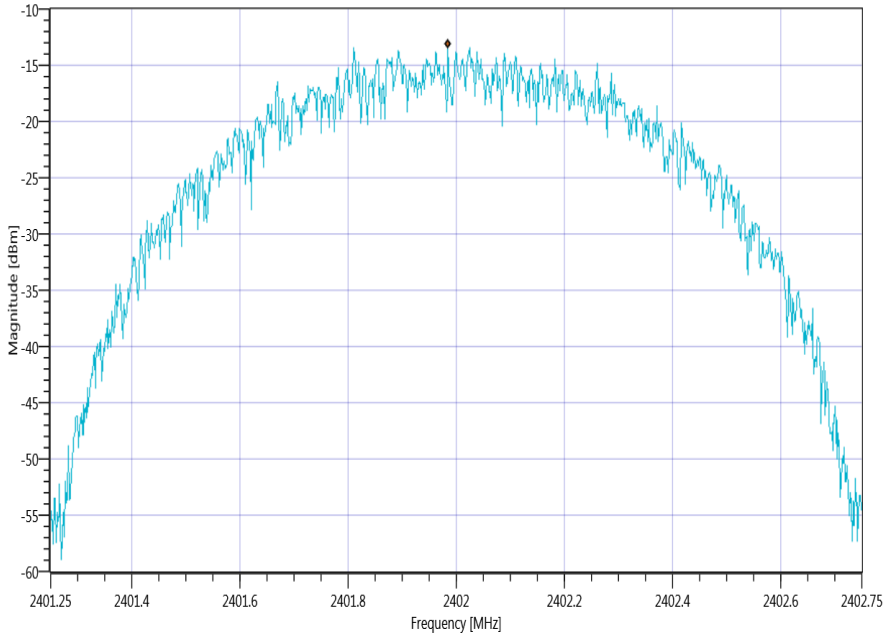
FCC	IC
Power spectral density	
For digitally modulated systems the transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission or over 1.0 second if the transmission exceeds 1.0-second duration.	

Results:

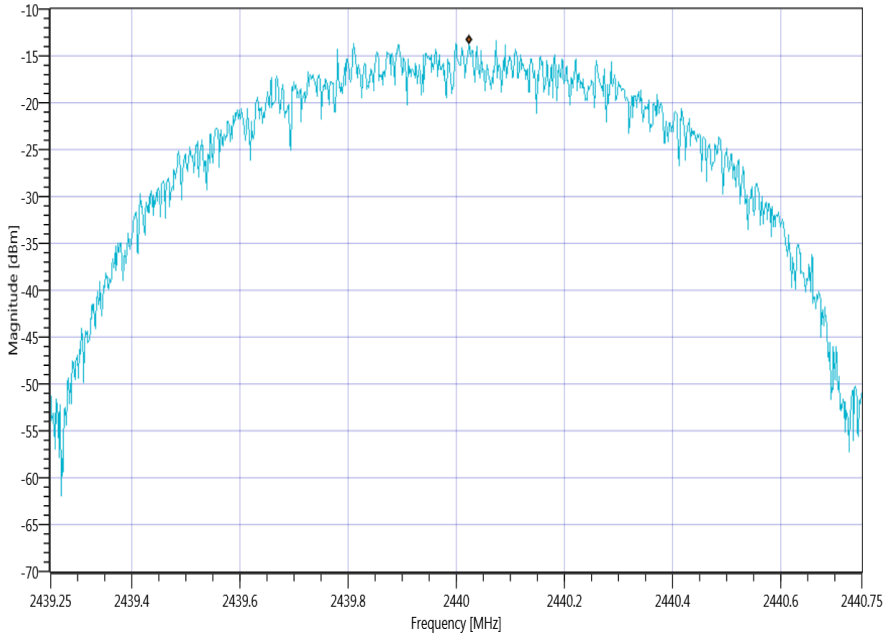
	Frequency		
	2402 MHz	2440 MHz	2480 MHz
Power spectral density [dBm / 3kHz] 1 Msps	-13.19	-13.31	-13.38
Power spectral density [dBm / 3kHz] 2 Msps	-14.89	-15.14	-14.85

Plots:

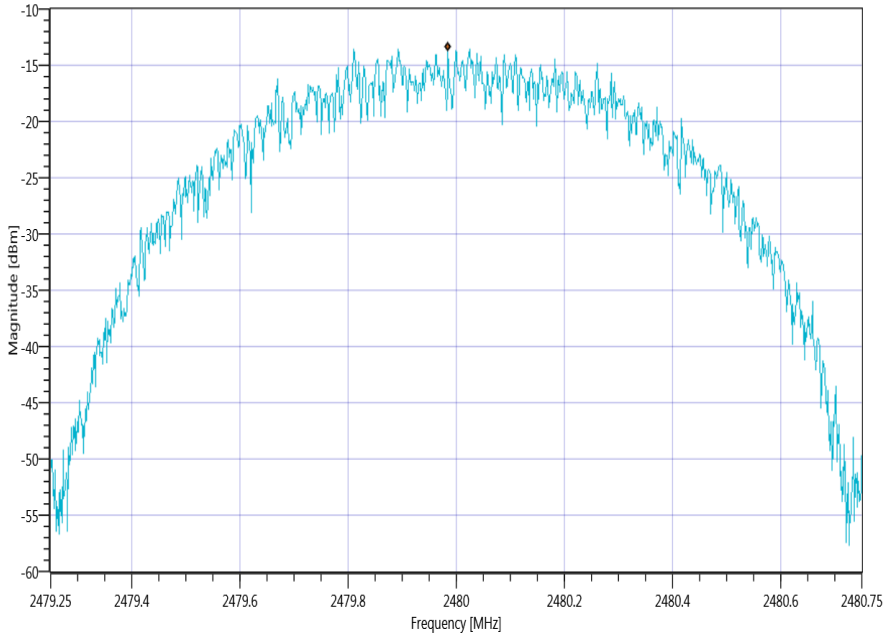
Plot 1: lowest channel, 1 Msps



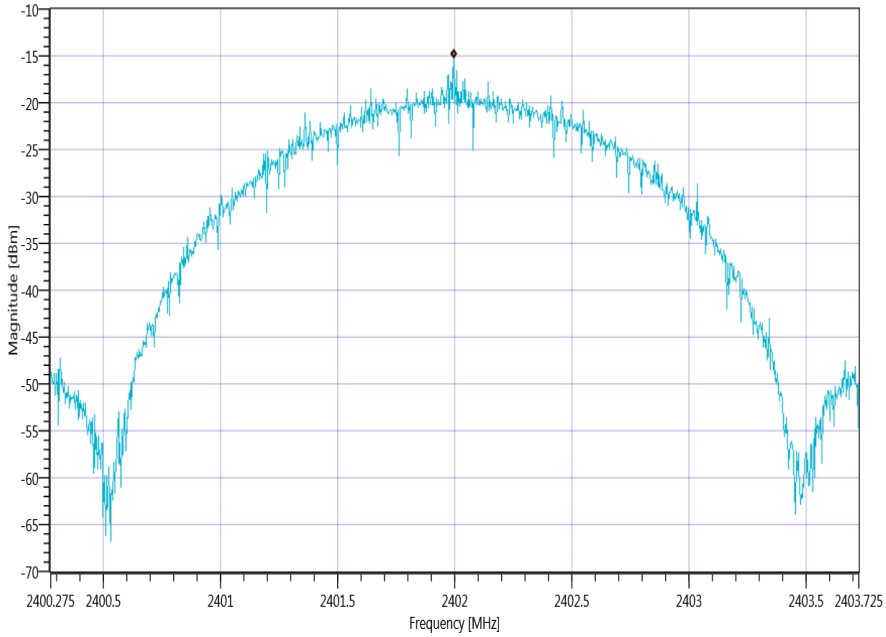
Plot 2: mid channel, 1 Msps



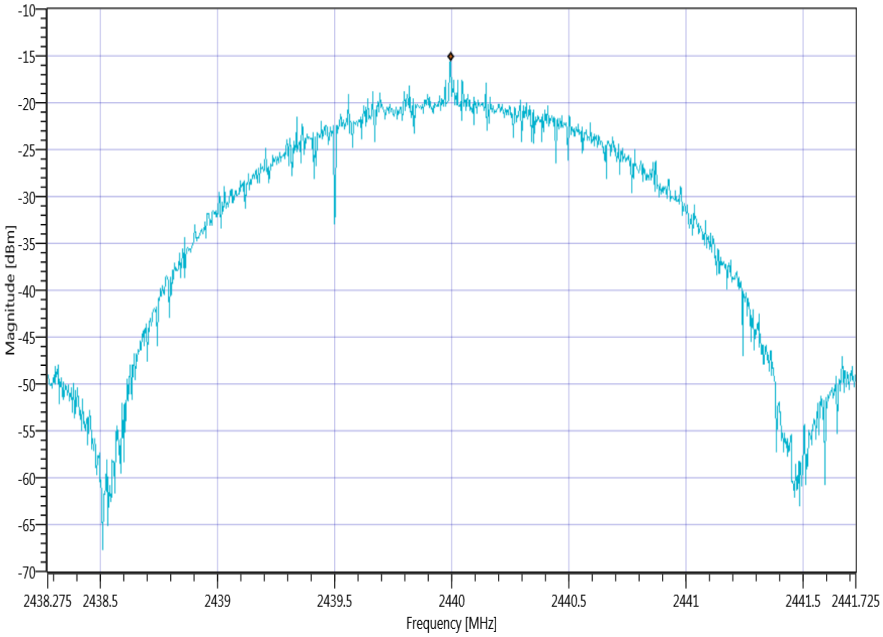
Plot 3: highest channel, 1 Msps



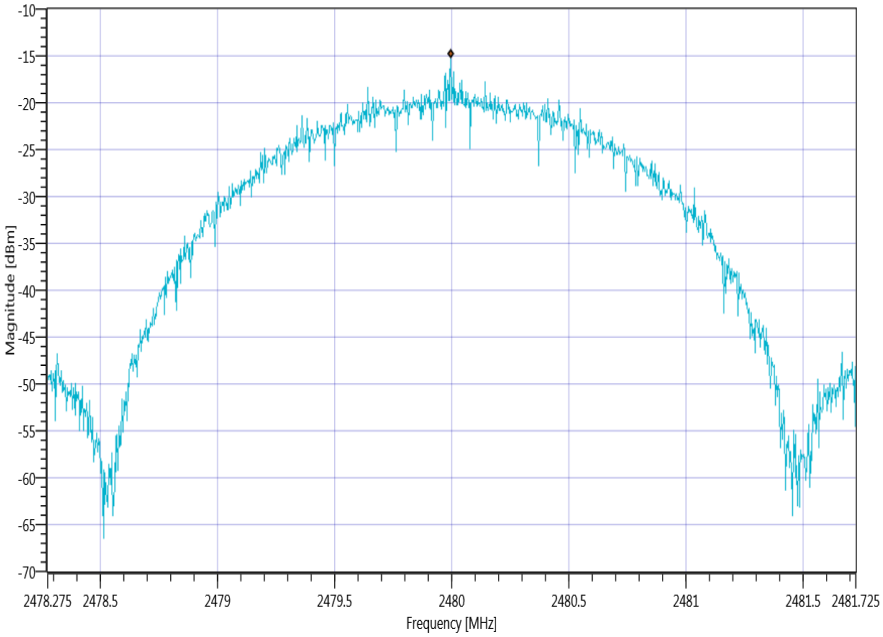
Plot 4: lowest channel, 2 Msps



Plot 5: mid channel, 2 Msps



Plot 6: highest channel, 2 Msps



11.3 DTS bandwidth – 6 dB bandwidth

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement parameters	
According to DTS clause: 8.1	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz
Span	5 MHz
Measurement procedure	Using 3 marker (max + 2x-6dB)
Trace mode	Max hold (allow trace to stabilize)
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

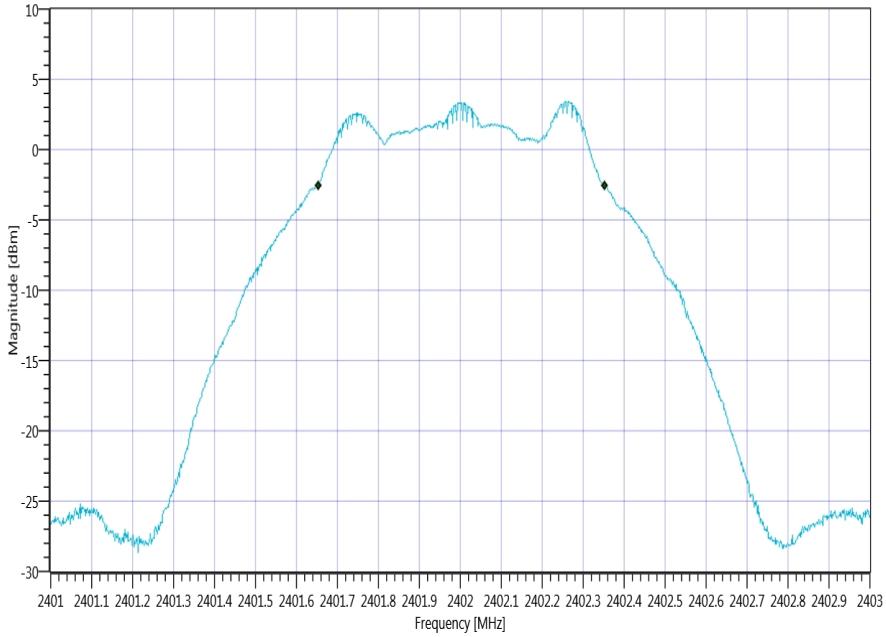
FCC	IC
DTS bandwidth – 6 dB bandwidth	
Systems using digital modulation techniques may operate in the 2400–2483.5 MHz band. The minimum 6 dB bandwidth shall be at least 500 kHz.	

Results:

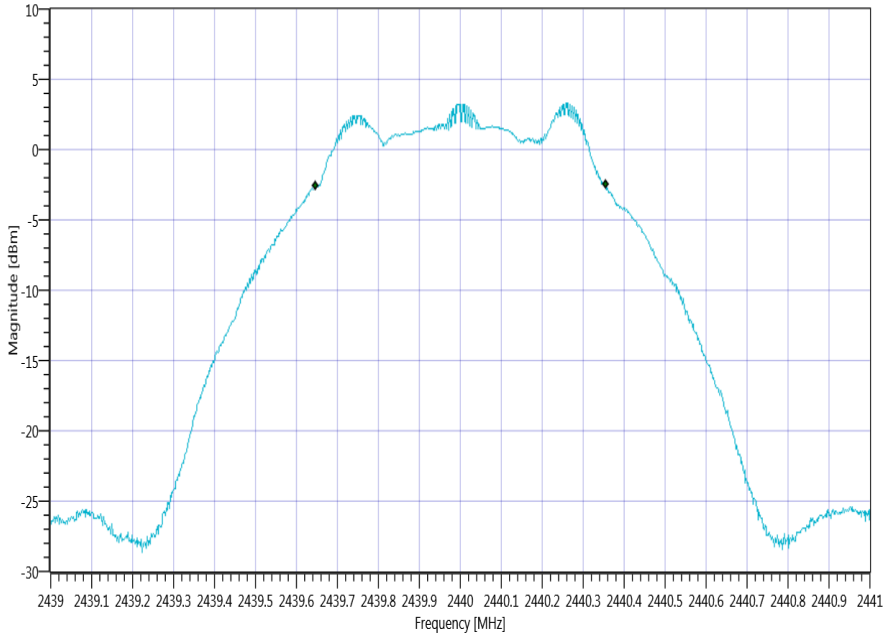
	Frequency		
	2402 MHz	2440 MHz	2480 MHz
6 dB bandwidth 1 Msps [kHz]	698	710	716
6 dB bandwidth 2 Msps [kHz]	1155	1145	1145

Plots:

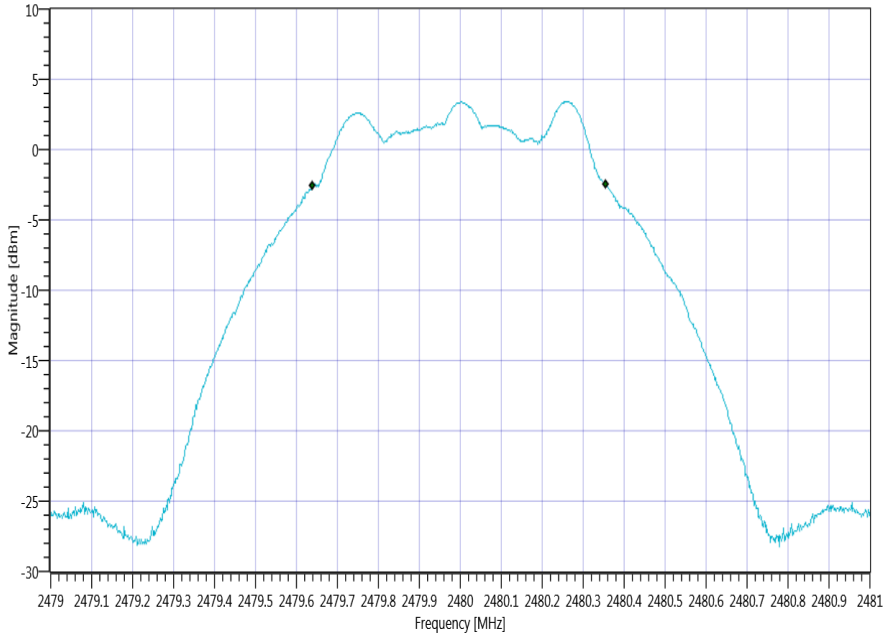
Plot 1: lowest channel, 1 Msps



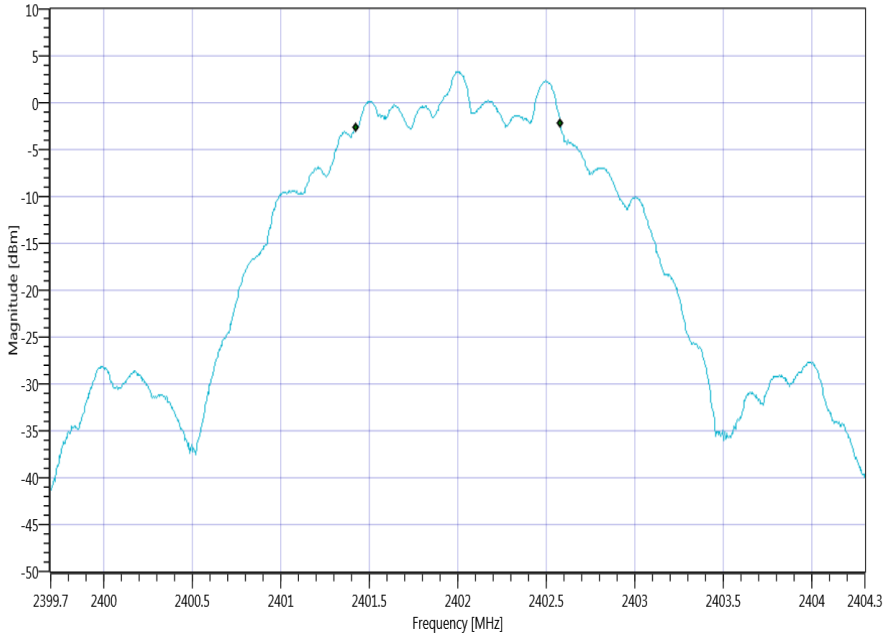
Plot 2: mid channel, 1 Msps



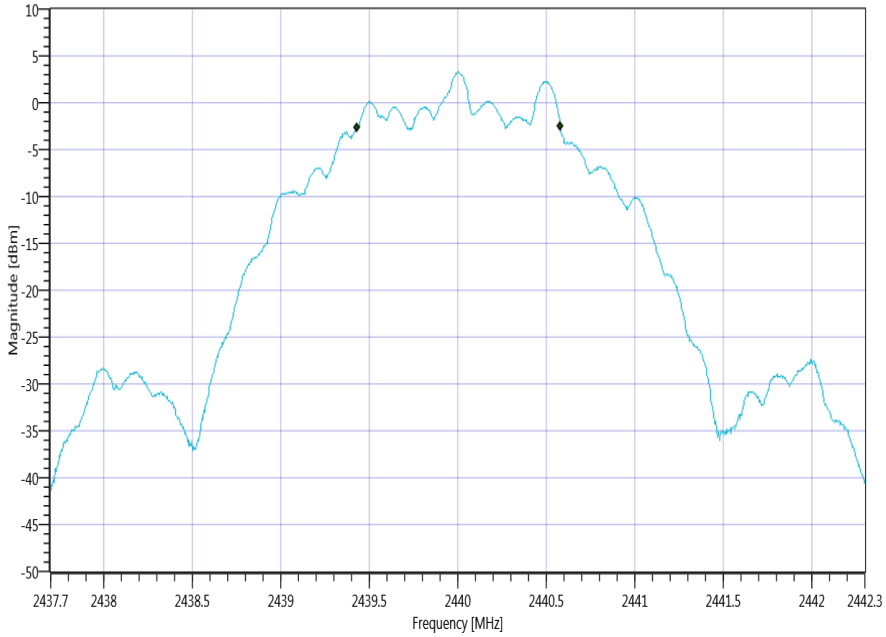
Plot 3: highest channel, 1 Msps



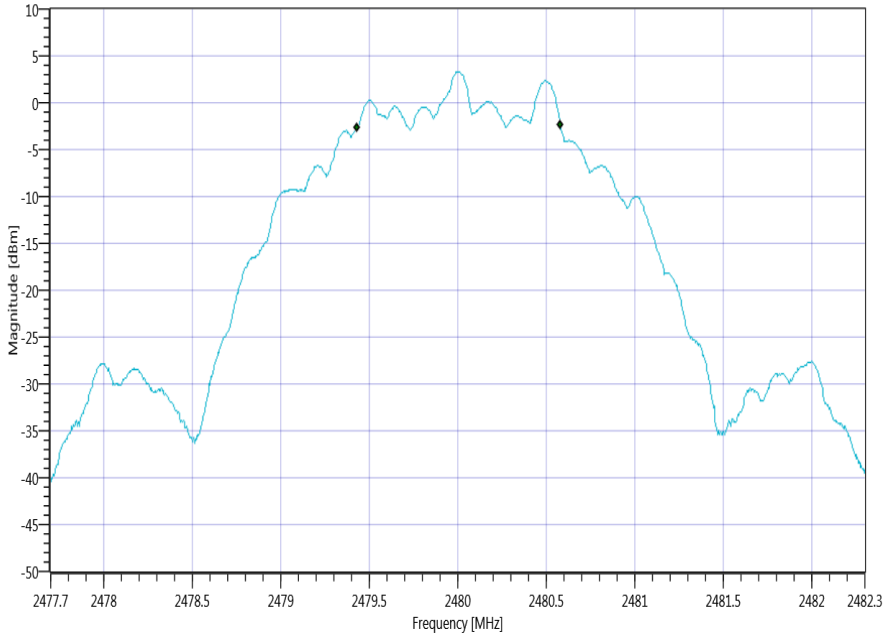
Plot 4: lowest channel, 2 Msps



Plot 5: mid channel, 2 Msps



Plot 6: highest channel, 2 Msps



11.4 Occupied bandwidth – 99% emission bandwidth

Description:

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	30 kHz
Video bandwidth	100 kHz
Span	5 MHz
Measurement procedure	Measurement of the 99% bandwidth using the integration function of the analyzer
Trace mode	Max hold (allow trace to stabilize)
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Usage:

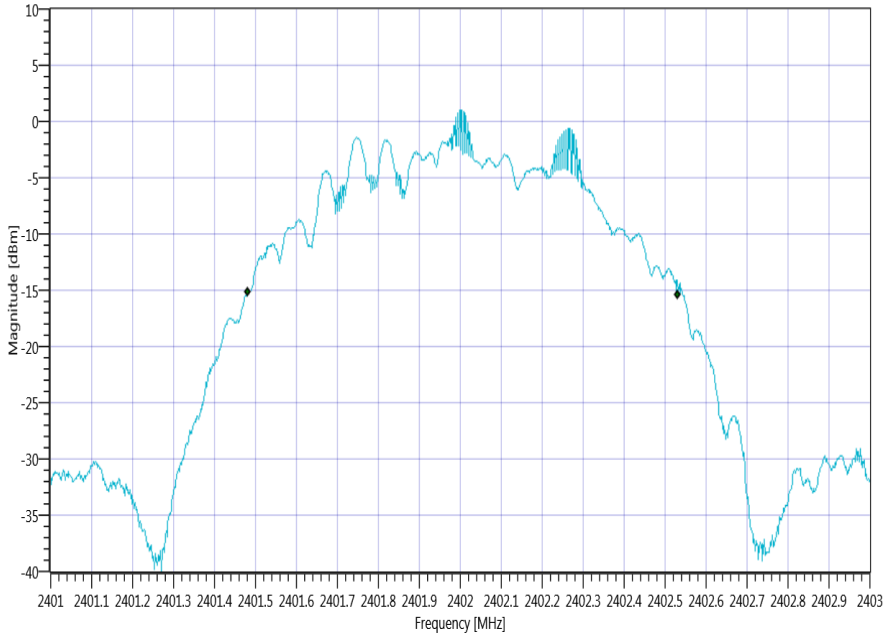
-/-	IC
Occupied bandwidth – 99% emission bandwidth	
OBW is necessary for emission designator	

Results:

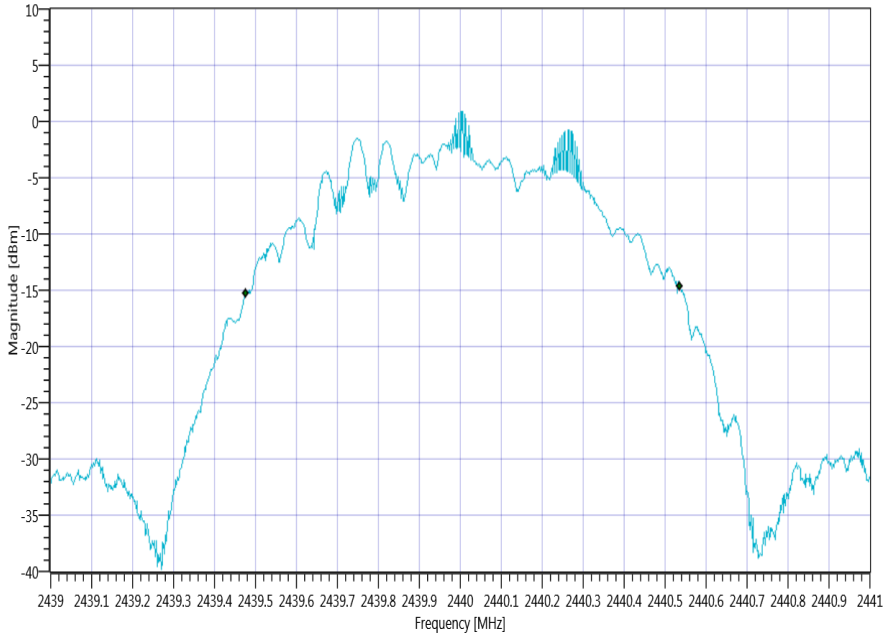
	Frequency		
	2402 MHz	2440 MHz	2480 MHz
99% bandwidth 1 Msps [kHz]	1051	1059	1053
99% bandwidth 2 Msps [kHz]	2063	2068	2073

Plots:

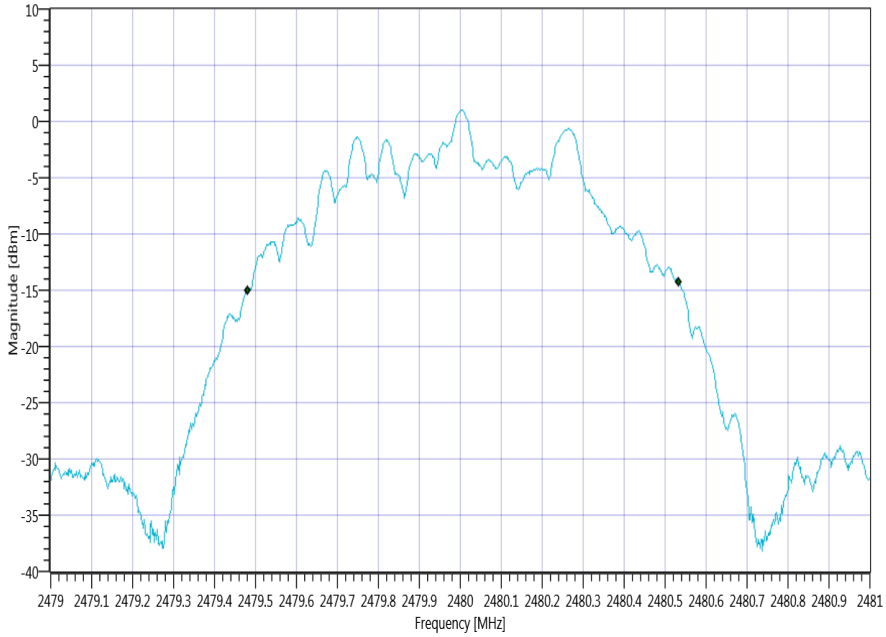
Plot 1: lowest channel, 1 Msps



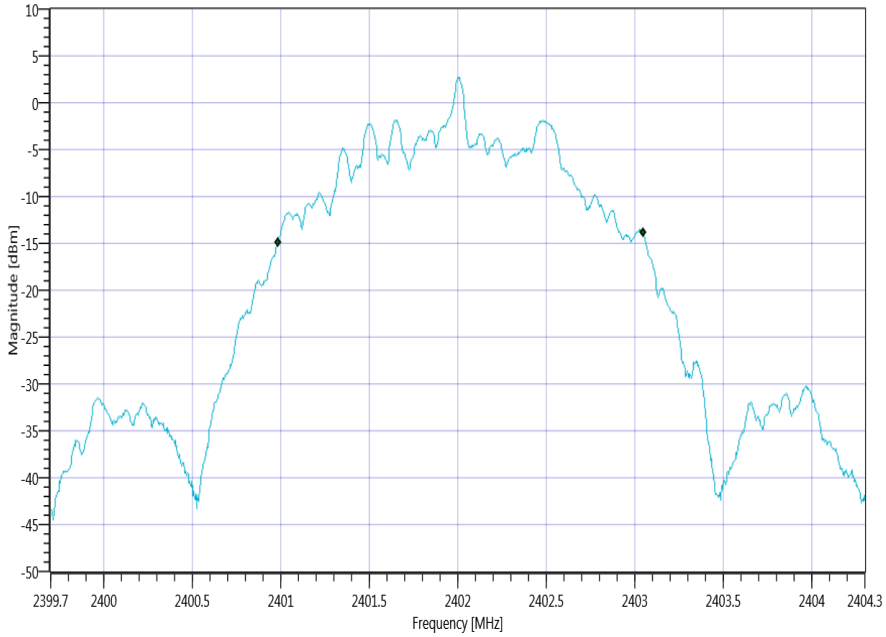
Plot 2: mid channel, 1 Msps



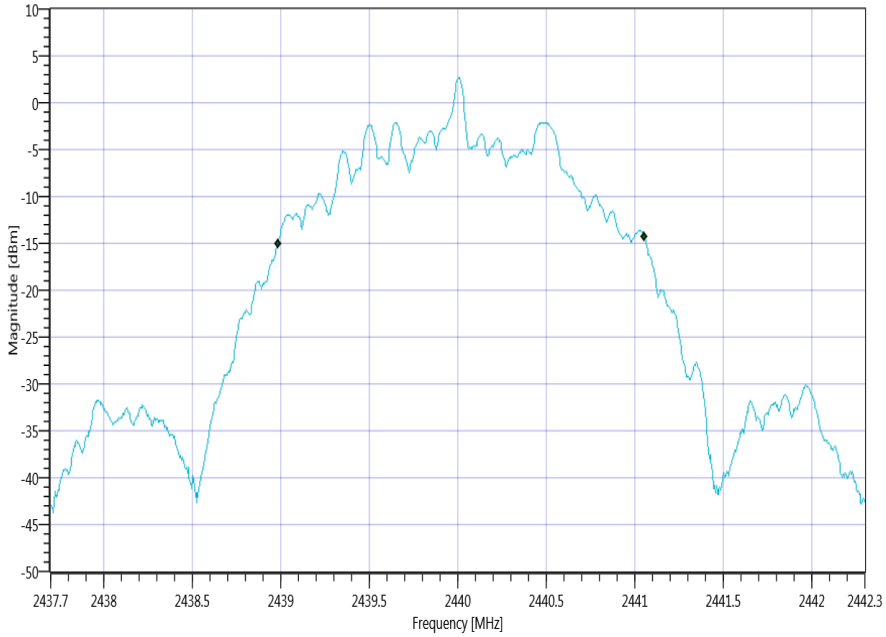
Plot 3: highest channel, 1 Msps



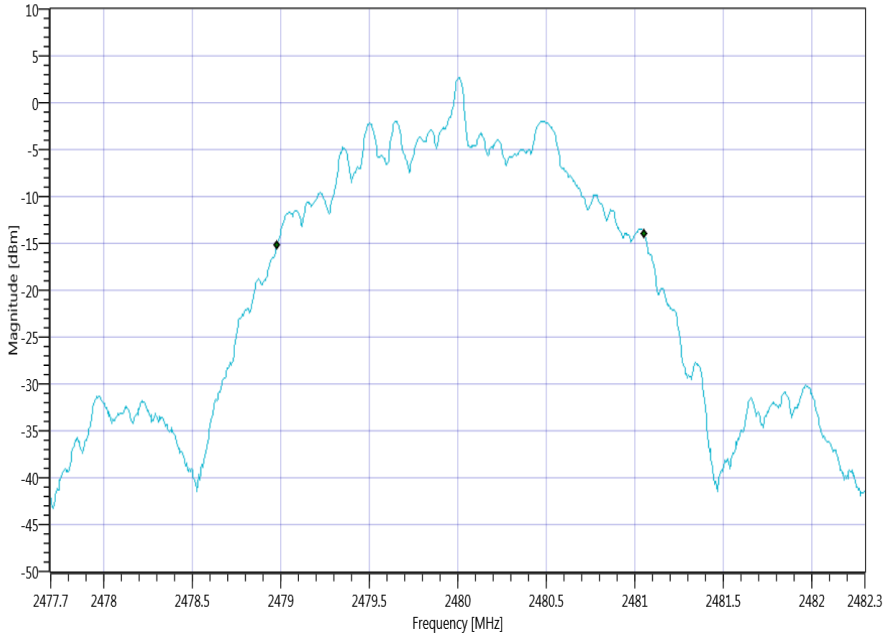
Plot 4: lowest channel, 2 Msps



Plot 5: mid channel, 2 Msps



Plot 6: highest channel, 2 Msps



11.5 Maximum output power

Description:

Measurement of the maximum output power conducted and radiated. EUT in single channel mode.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	3 MHz
Video bandwidth	10 MHz
Span	10 MHz
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

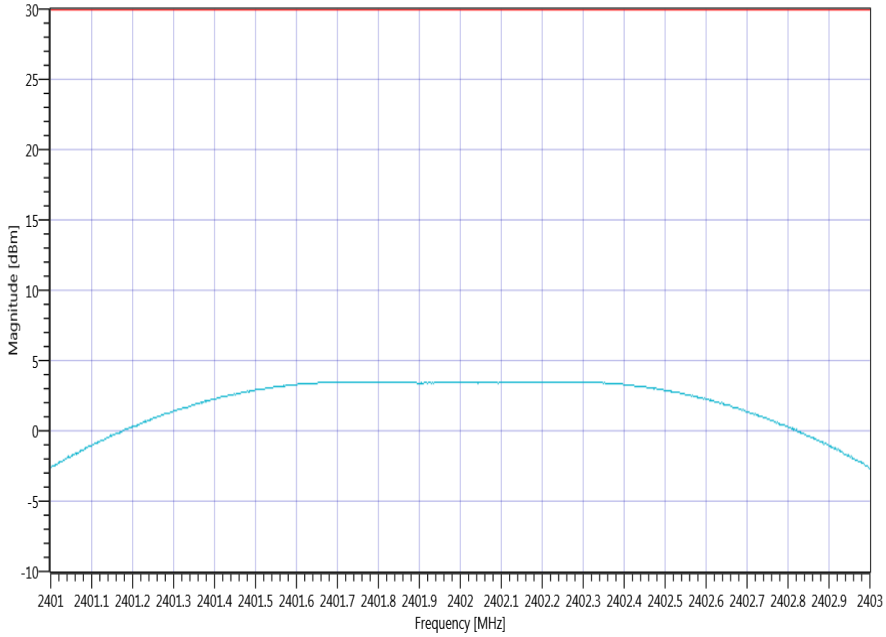
FCC	IC
Maximum output power	
Conducted: 1.0 W – antenna gain max. 6 dBi	

Results:

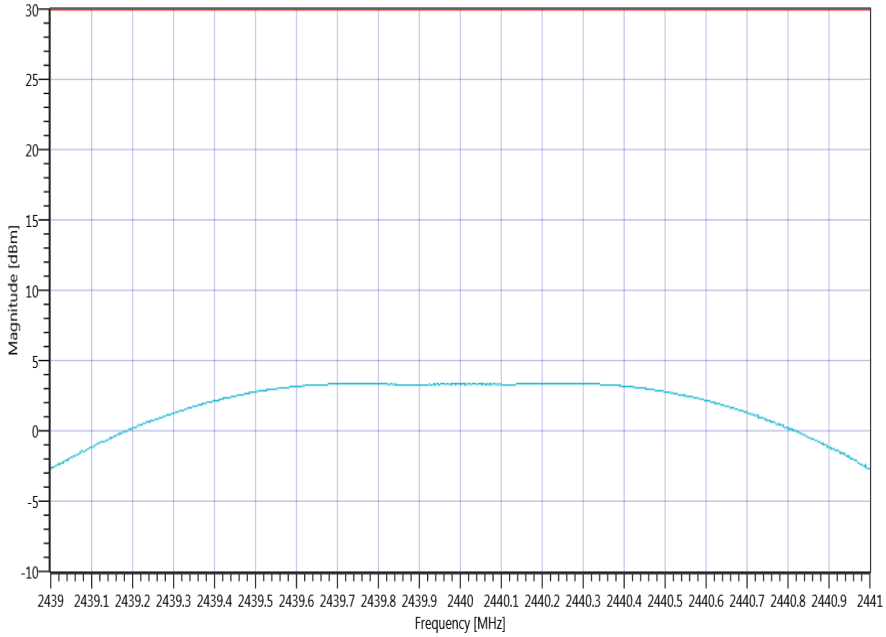
	Frequency		
	2402 MHz	2440 MHz	2480 MHz
Maximum output power conducted 1 Msps [dBm]	3.5	3.4	3.4
Maximum output power conducted 2 Msps [dBm]	3.5	3.4	3.5

Plots:

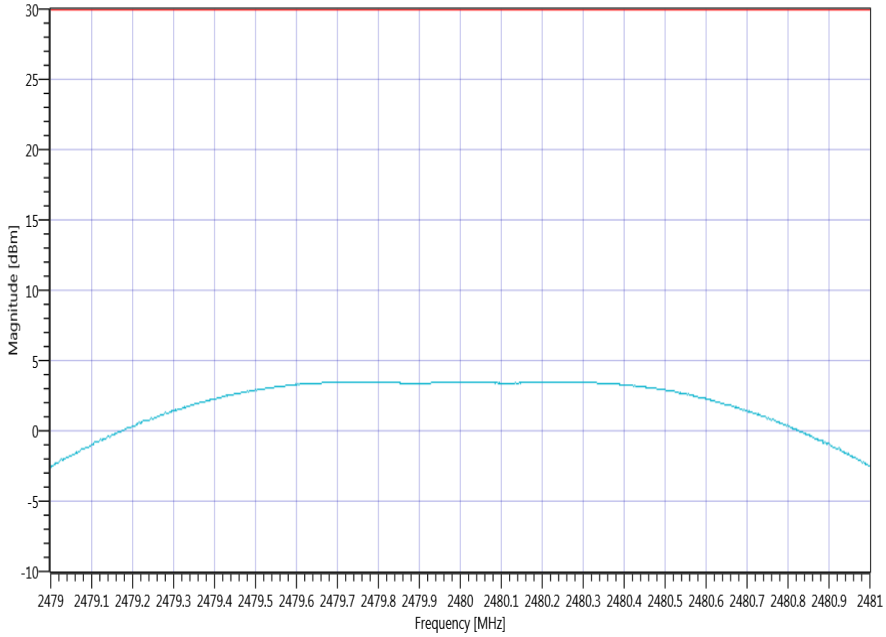
Plot 1: lowest channel, 1 Msps



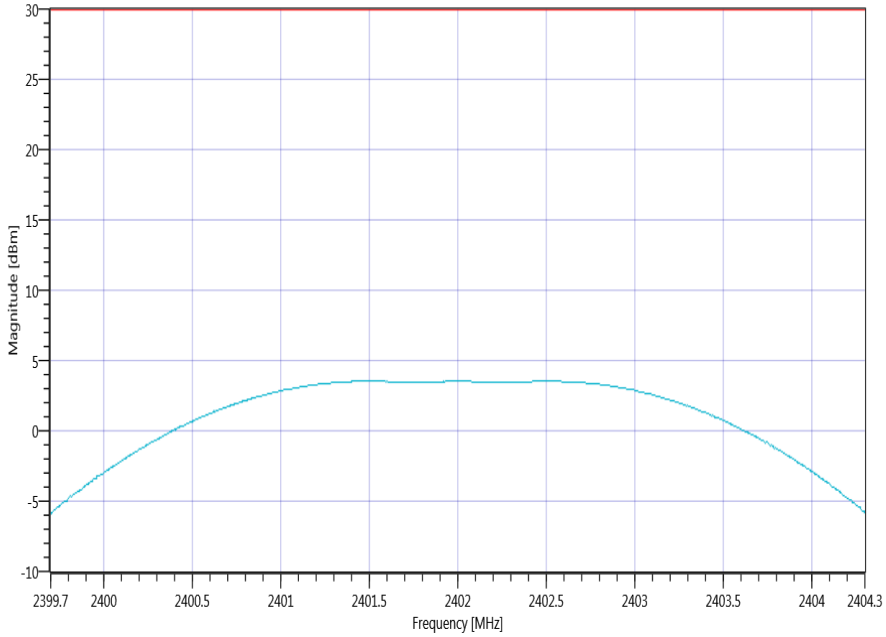
Plot 2: mid channel, 1 Msps



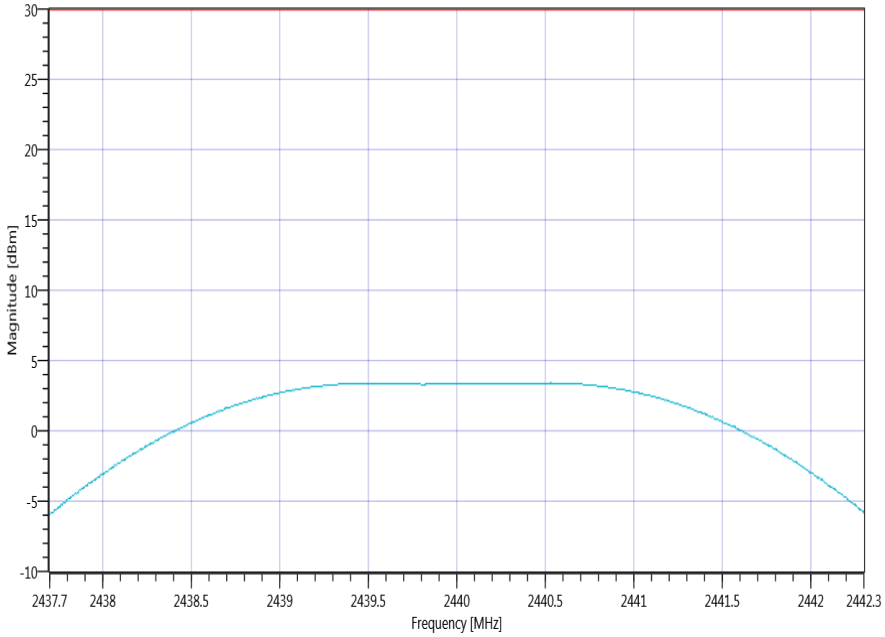
Plot 3: highest channel, 1 Msps



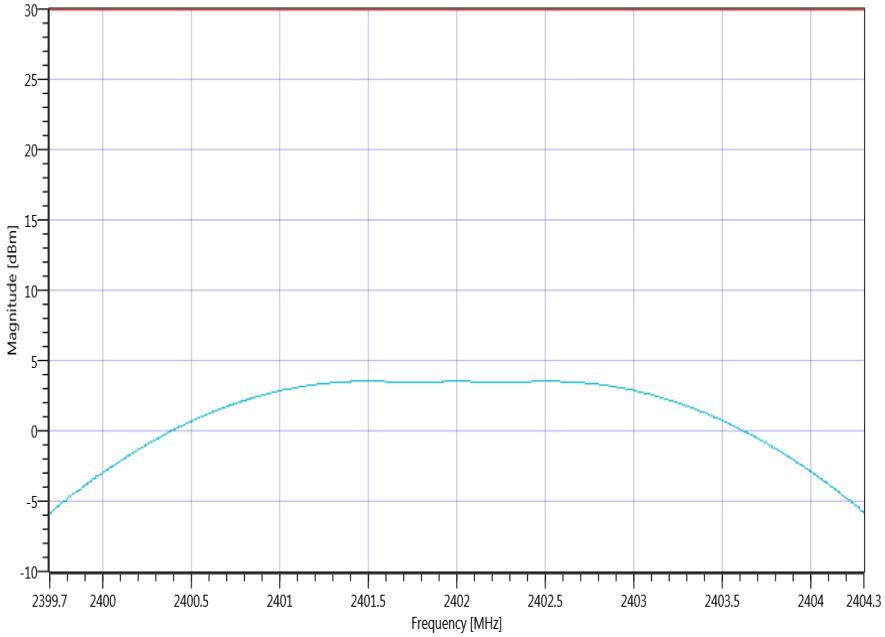
Plot 4: lowest channel, 2 Msps



Plot 5: mid channel, 2 Msps



Plot 6: highest channel, 2 Msps



11.6 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.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz / 500 kHz
Span	Lower Band Edge: 2395 – 2405 MHz higher Band Edge: 2478 – 2489 MHz
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

Limits:

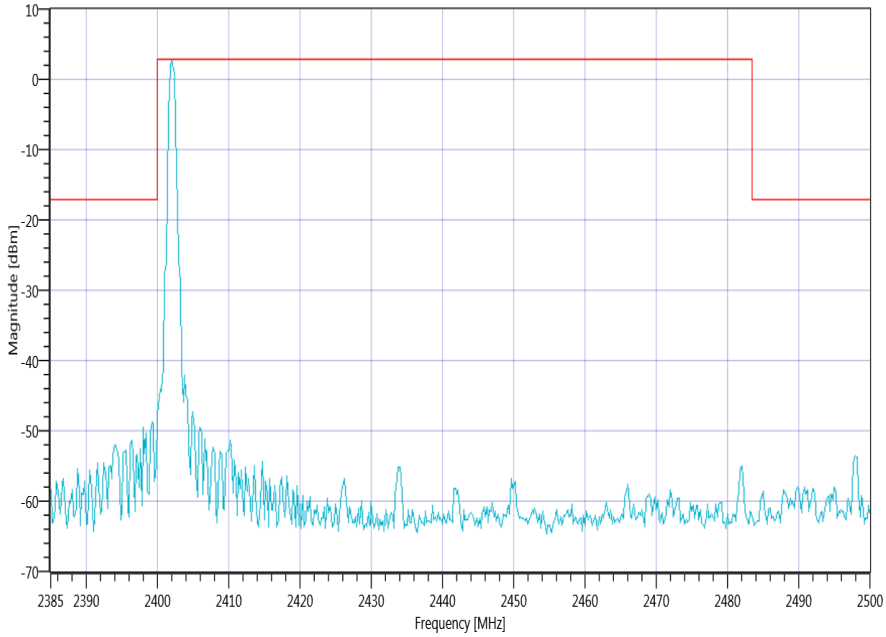
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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.	

Result:

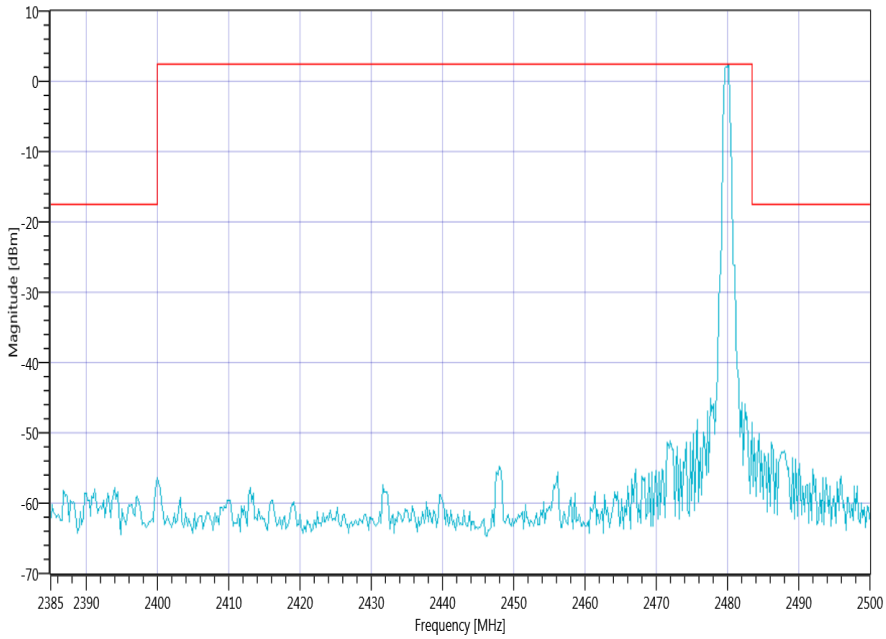
Scenario	Spurious band edge conducted [dB]
Modulation	GFSK
Lower band edge – hopping off	> 20 dB
Upper band edge – hopping off	> 20 dB

Plots:

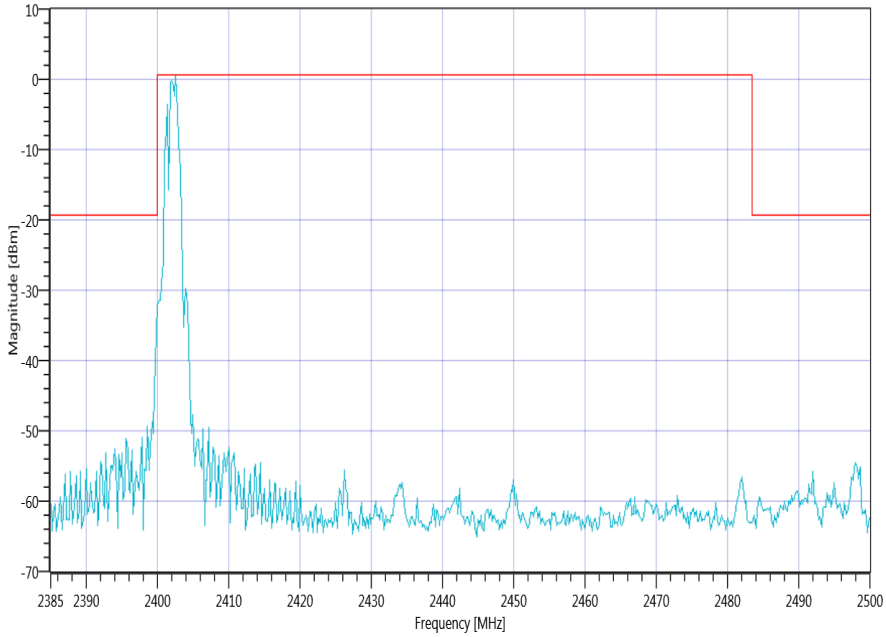
Plot 1: Lower band edge, 1 Msps



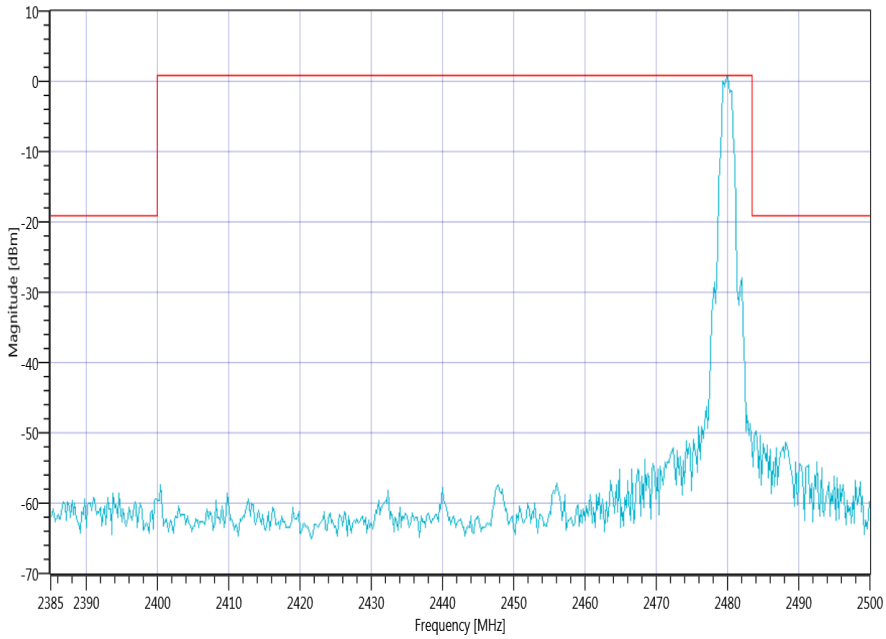
Plot 2: Upper band edge, 1 Msps



Plot 3: Lower band edge, 2 Msps



Plot 4: Upper band edge, 2 Msps



11.7 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 frequency 2402 MHz for the lower restricted band and 2480 MHz for the upper restricted band. Measurement distance is 3m.

Measurement parameters	
Detector	Peak / RMS
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	Lower Band: 2300 – 2400 MHz higher Band: 2480 – 2500 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 B
Measurement uncertainty	See sub clause 8

Limits:

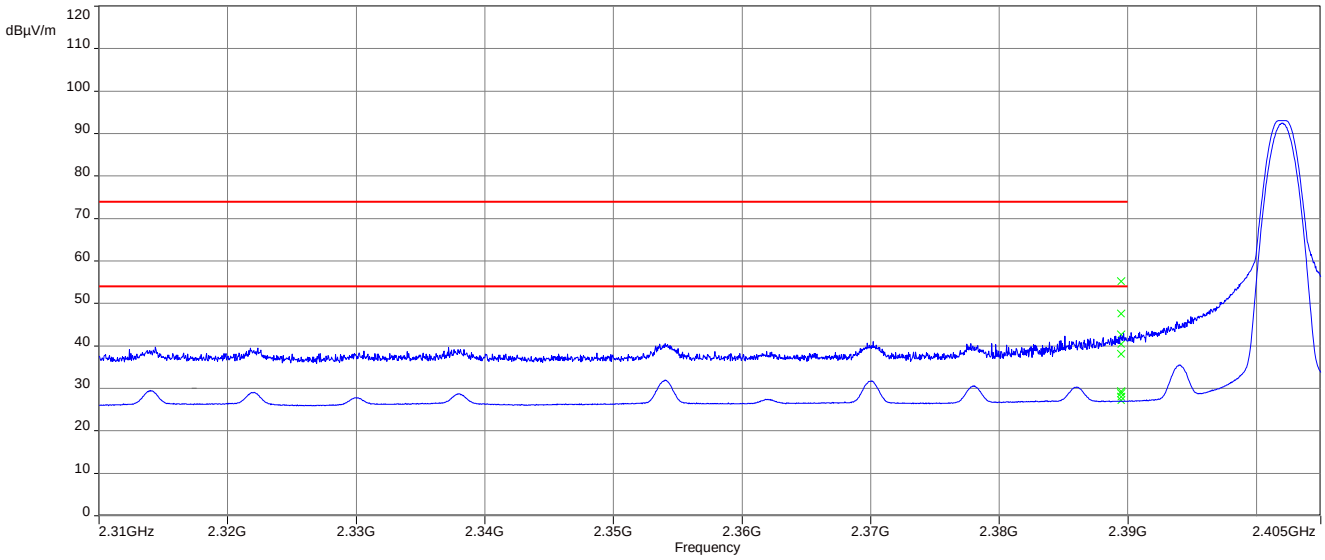
FCC	IC
Band edge compliance radiated	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth 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	

Result:

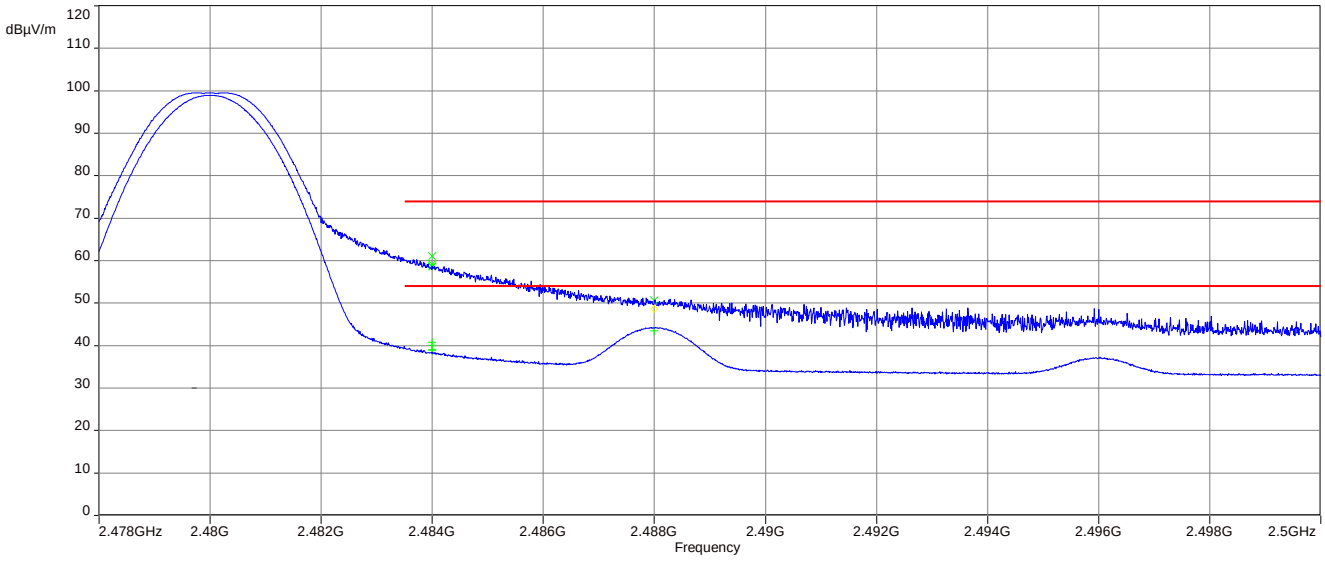
Scenario	Band edge compliance radiated [dBµV/m]
Modulation	GFSK
Lower restricted band	< 54 AVG / < 74 PP
Upper restricted band	< 54 AVG / < 74 PP

Plots:

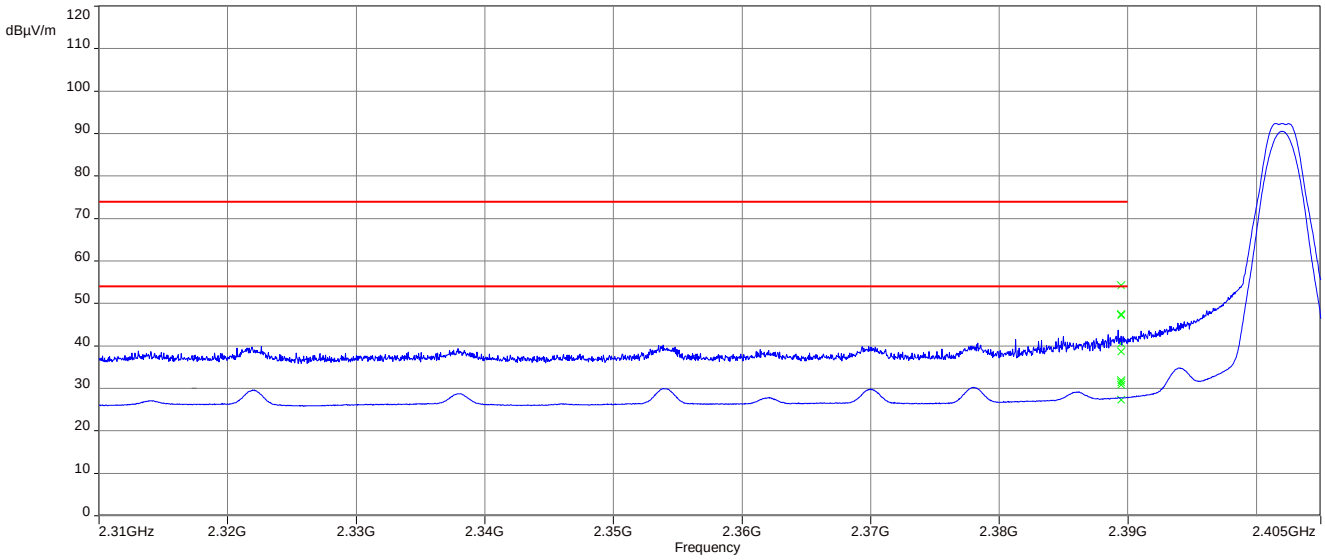
Plot 1: Lower restricted band, 1 Msps, on-board antenna



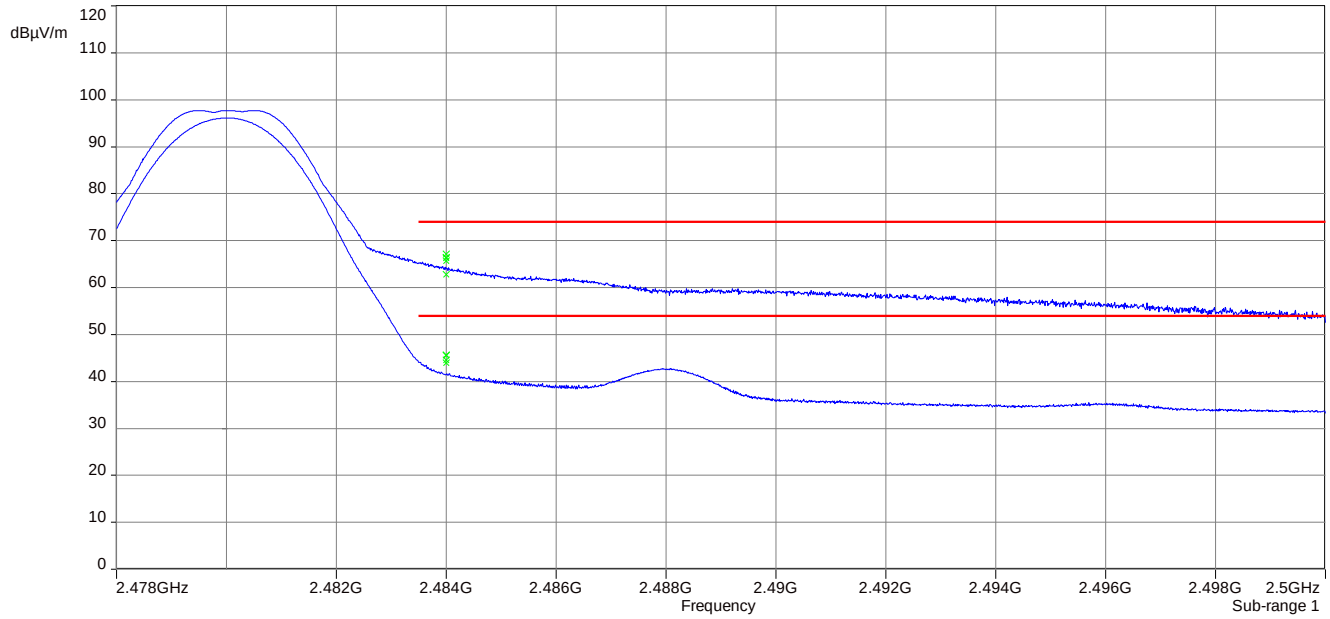
Plot 2: Upper restricted band, 1 Msps, on-board antenna



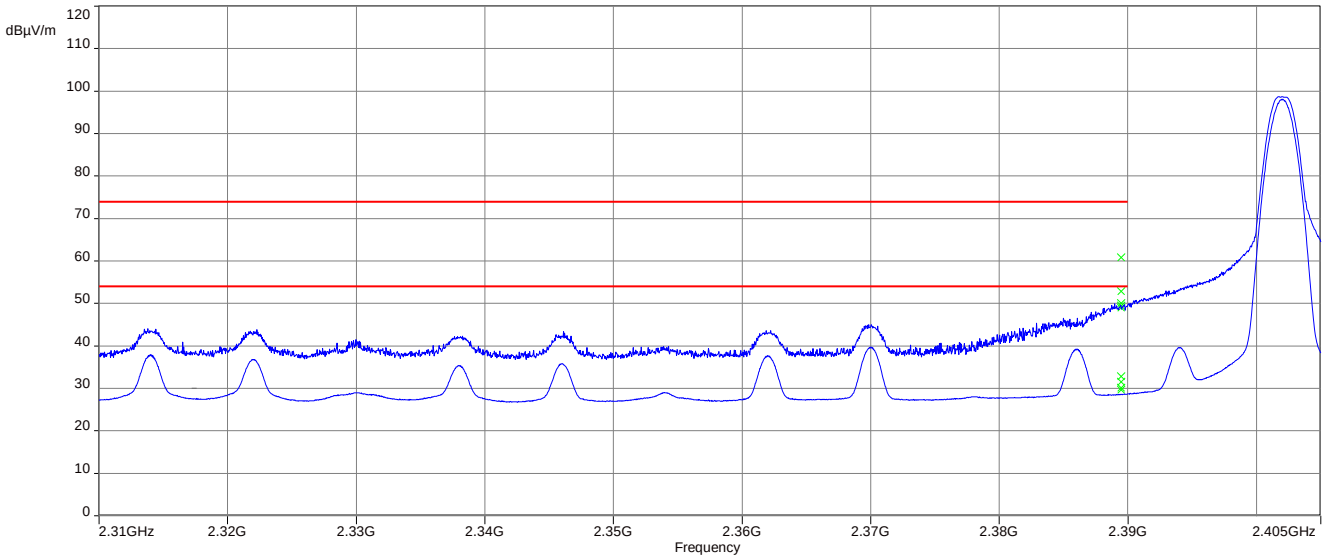
Plot 3: Lower restricted band, 2 Msps, on-board antenna



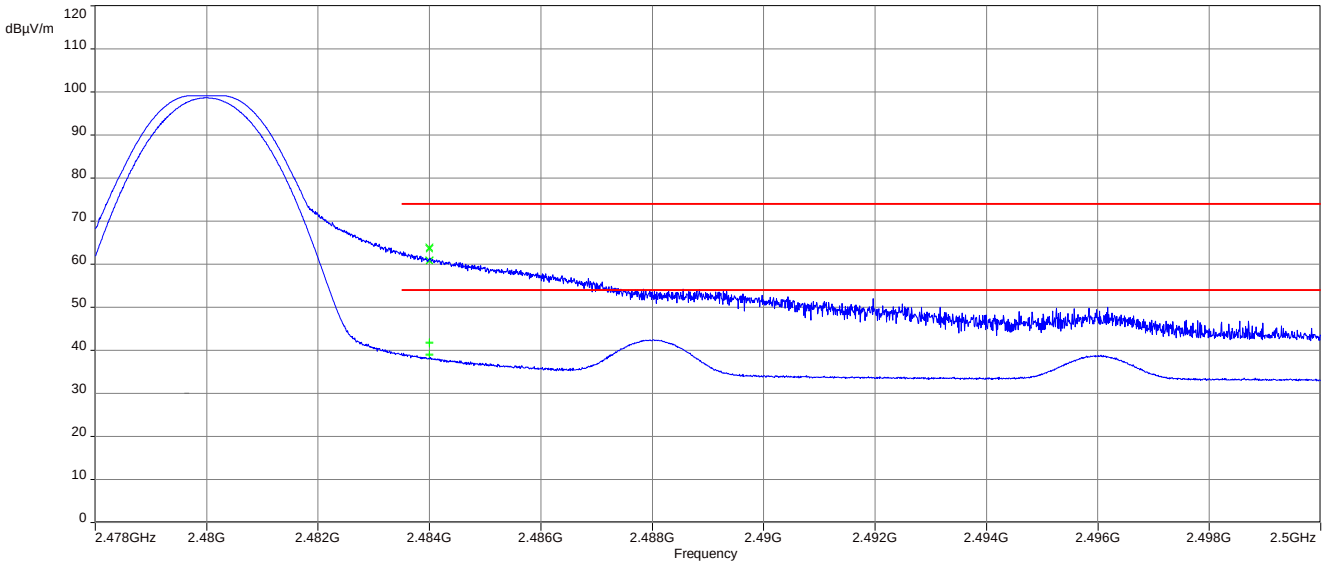
Plot 4: Upper restricted band, 2 Msps, on-board antenna



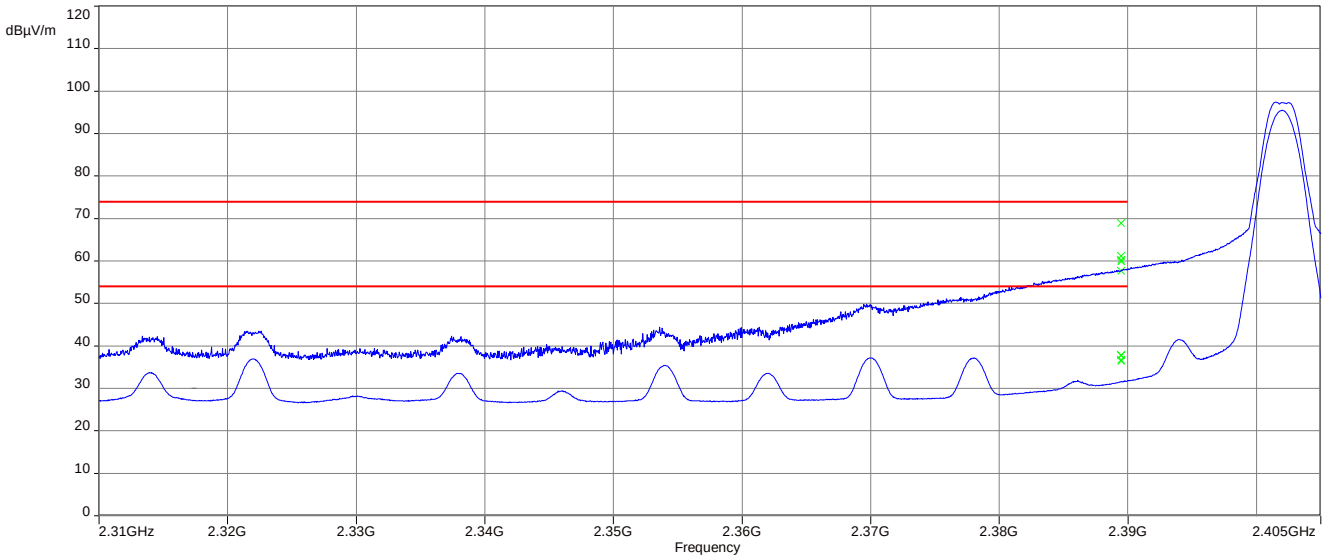
Plot 5: Lower restricted band, 1 Msps, external antenna



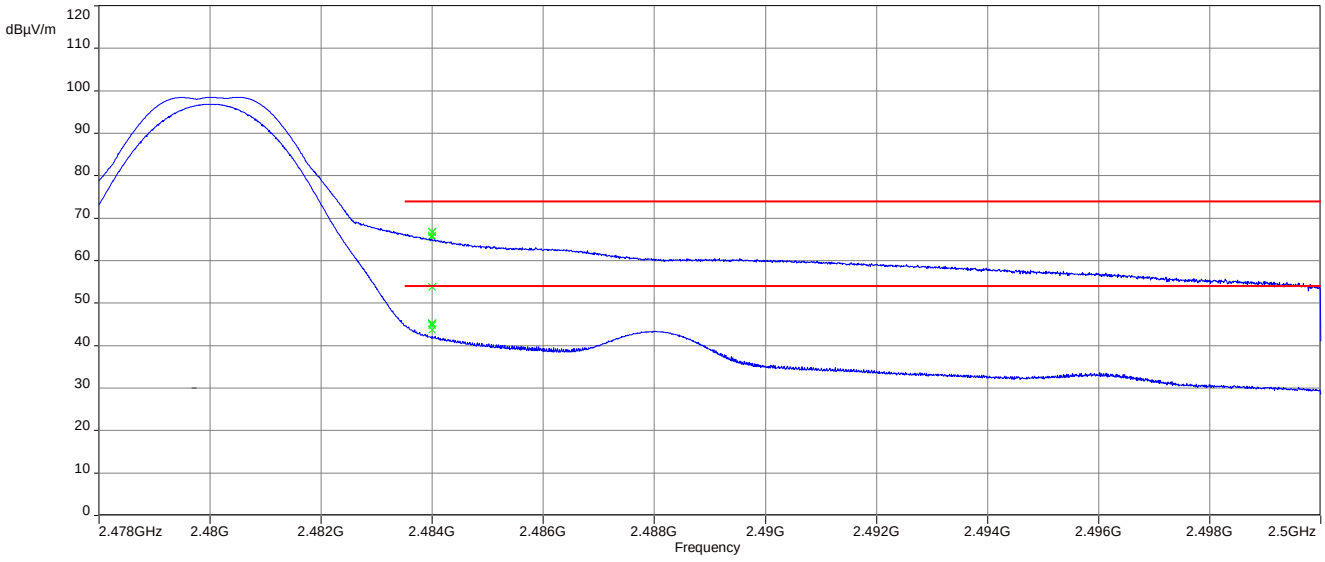
Plot 6: Upper restricted band, 1 Msps, external antenna



Plot 7: Lower restricted band, 2 Msps, external antenna



Plot 8: Upper restricted band, 2 Msps, external antenna



11.8 TX spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz or 500 kHz
Span	9 kHz to 25 GHz
Trace mode	Max hold
Test setup	See sub clause 6.4 A
Measurement uncertainty	See sub clause 8

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: 1 Msps

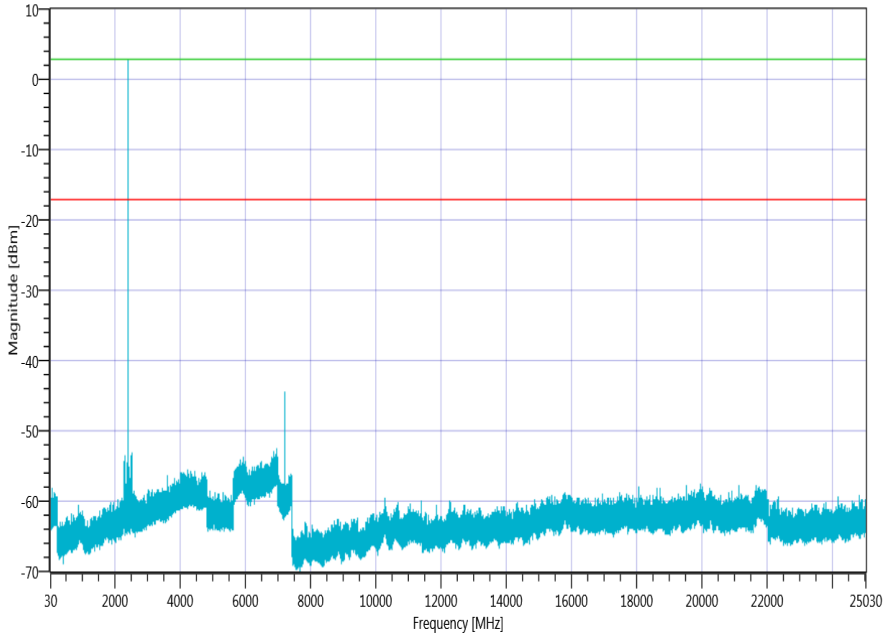
TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2402		2.9	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant
2440		3.1	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant
2480		2.5	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant

Results: 2 Msps

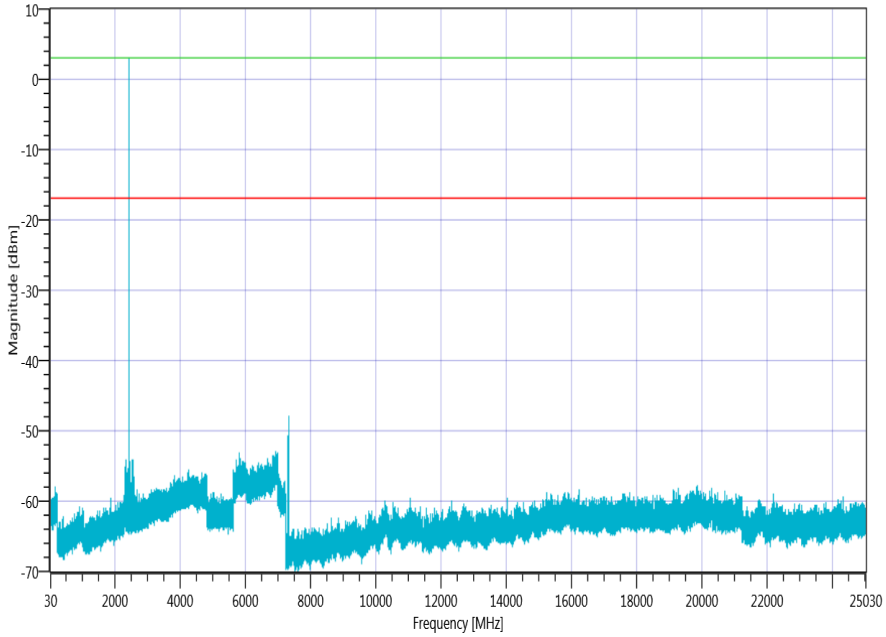
TX spurious emissions conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
2402		0.7	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant
2440		0.0	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant
2480		0.9	30 dBm		Operating frequency
All detected emissions are compliant with the -20 dBc limit!			-20 dBc		compliant

Plots:

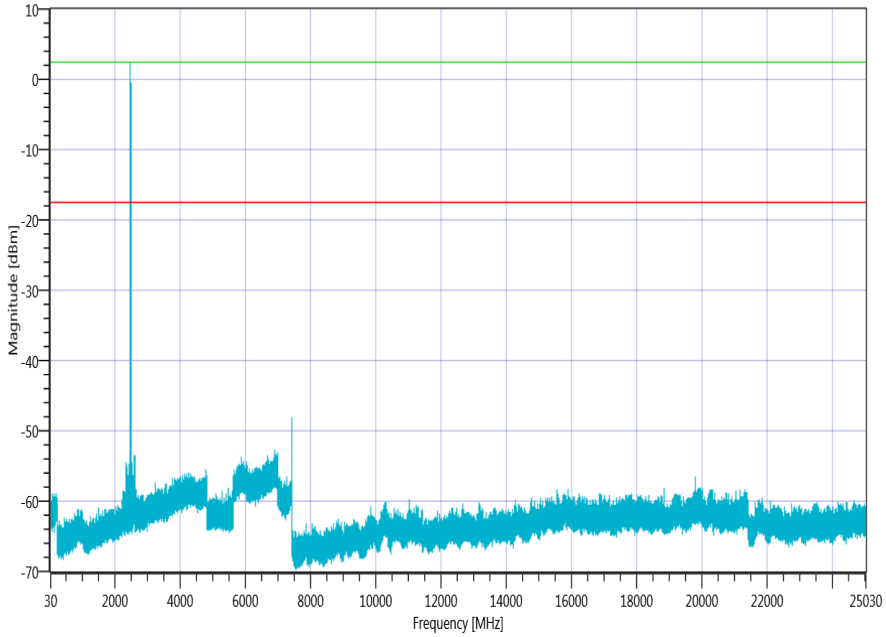
Plot 1: lowest channel, 1 Msps



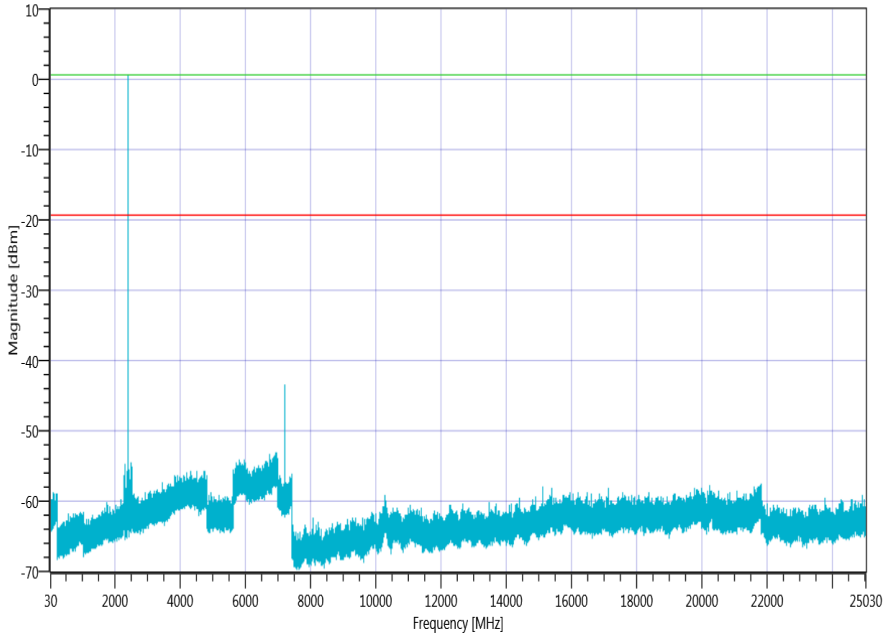
Plot 2: mid channel, 1 Msps



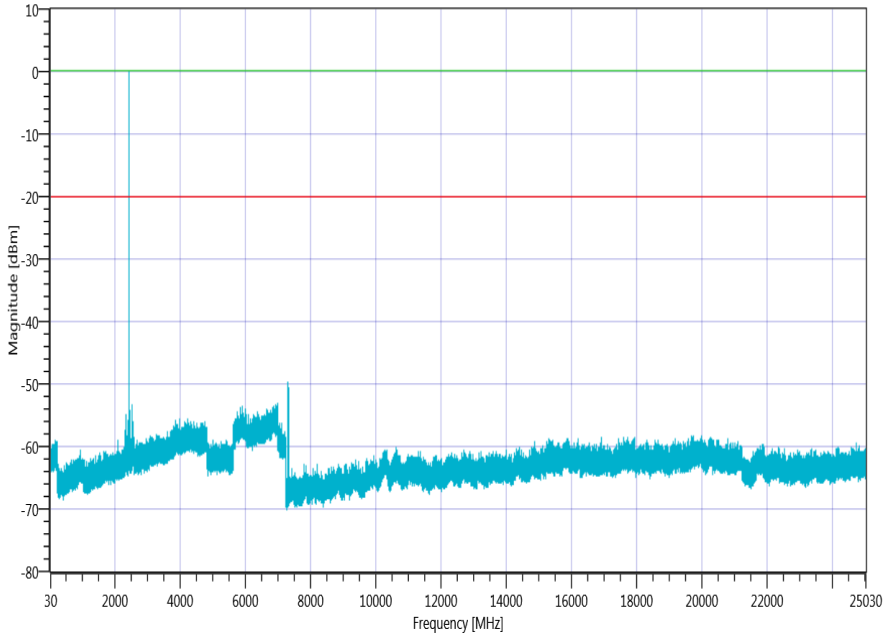
Plot 3: highest channel, 1 Msps



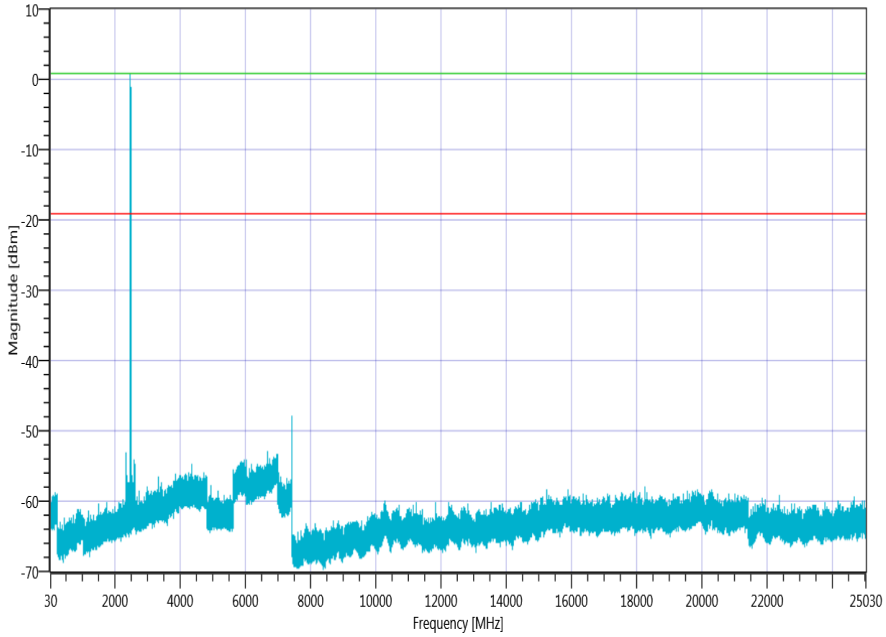
Plot 4: lowest channel, 2 Msps



Plot 5: mid channel, 2 Msps



Plot 6: highest channel, 2 Msps



11.9 Spurious emissions radiated below 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 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: 30 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Test setup	See sub clause 6.2 C
Measurement uncertainty	See sub clause 8

Limits:

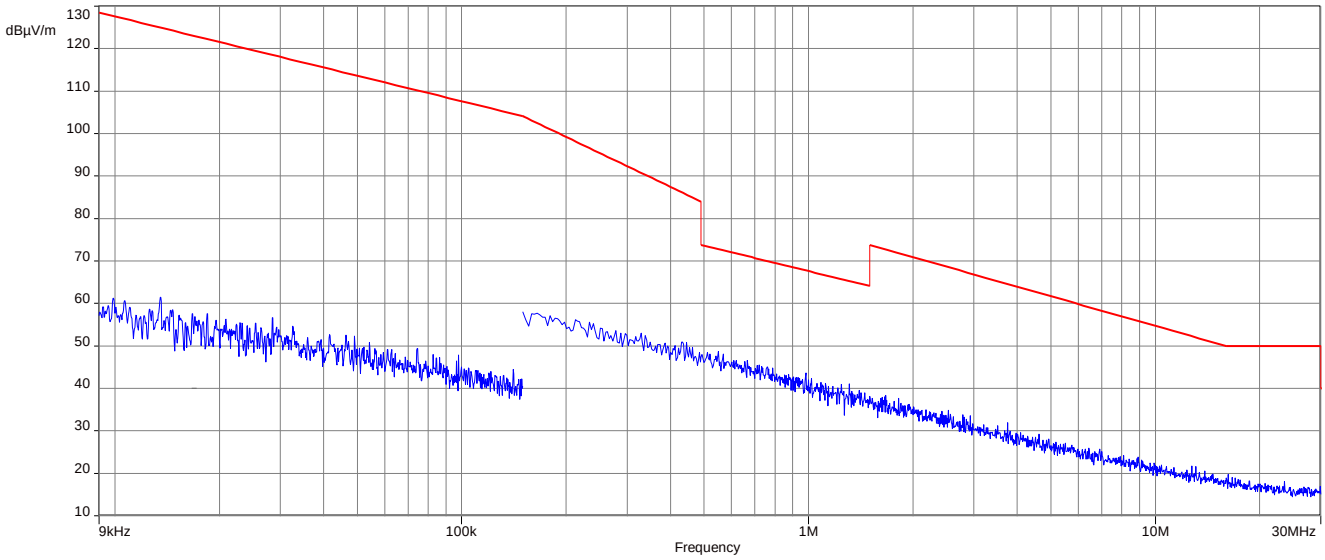
FCC		IC
TX spurious emissions radiated below 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

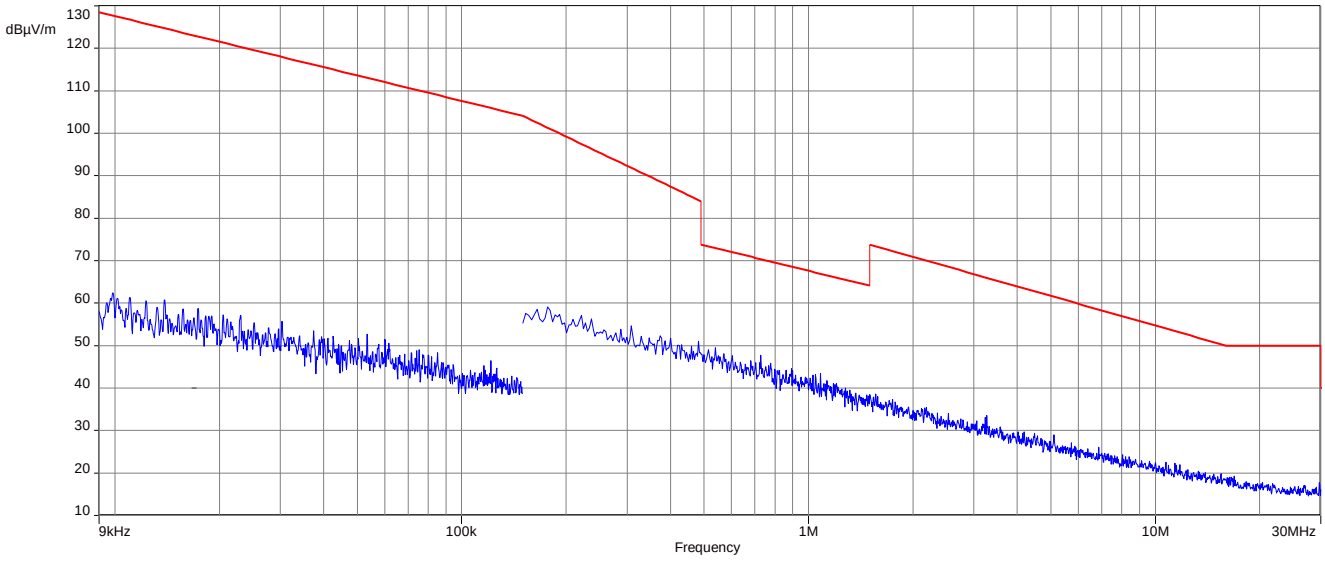
TX spurious emissions radiated below 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		

Plots:

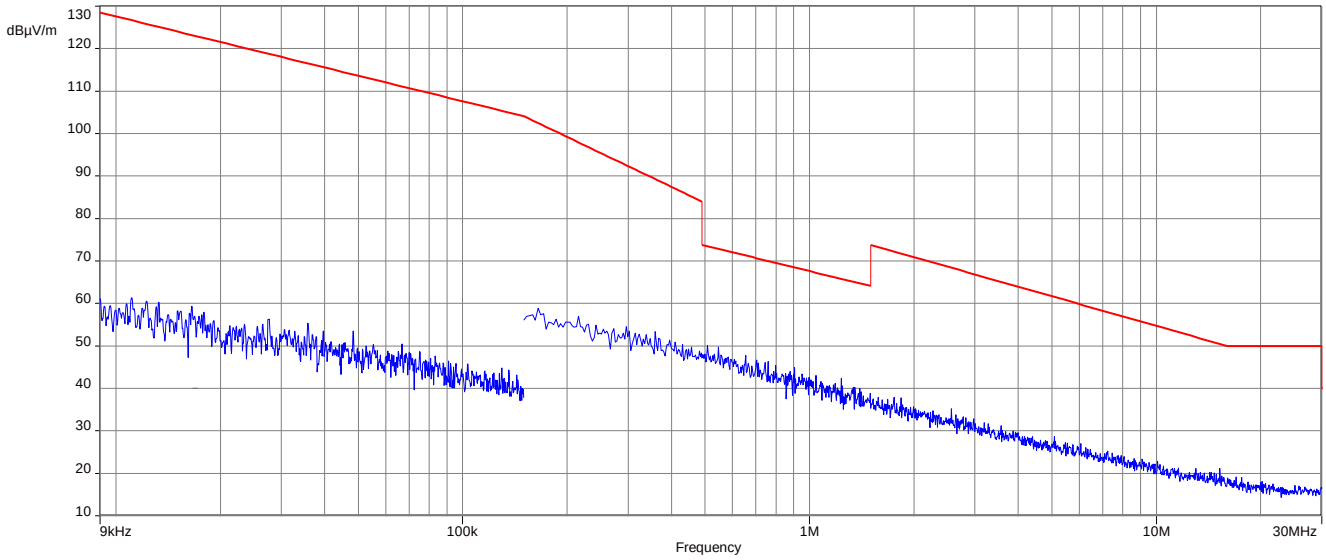
Plot 1: 9 kHz to 30 MHz, 2402 MHz, transmit mode, 1 Msps, on-board antenna



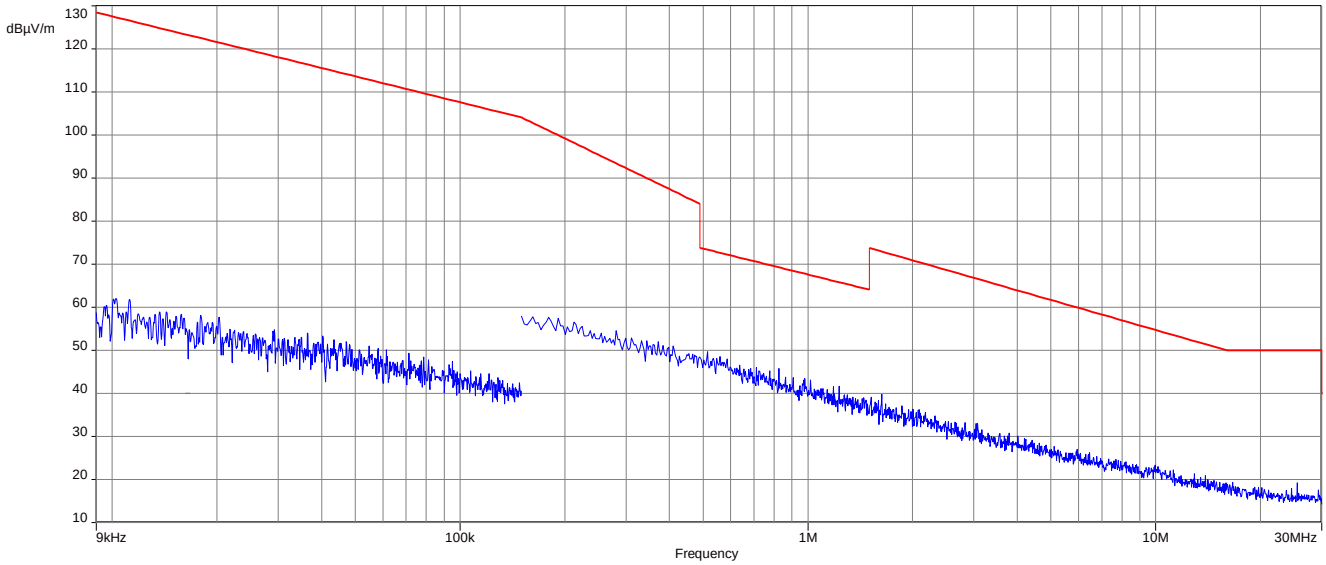
Plot 2: 9 kHz to 30 MHz, 2440 MHz, transmit mode, 1 Msps, on-board antenna



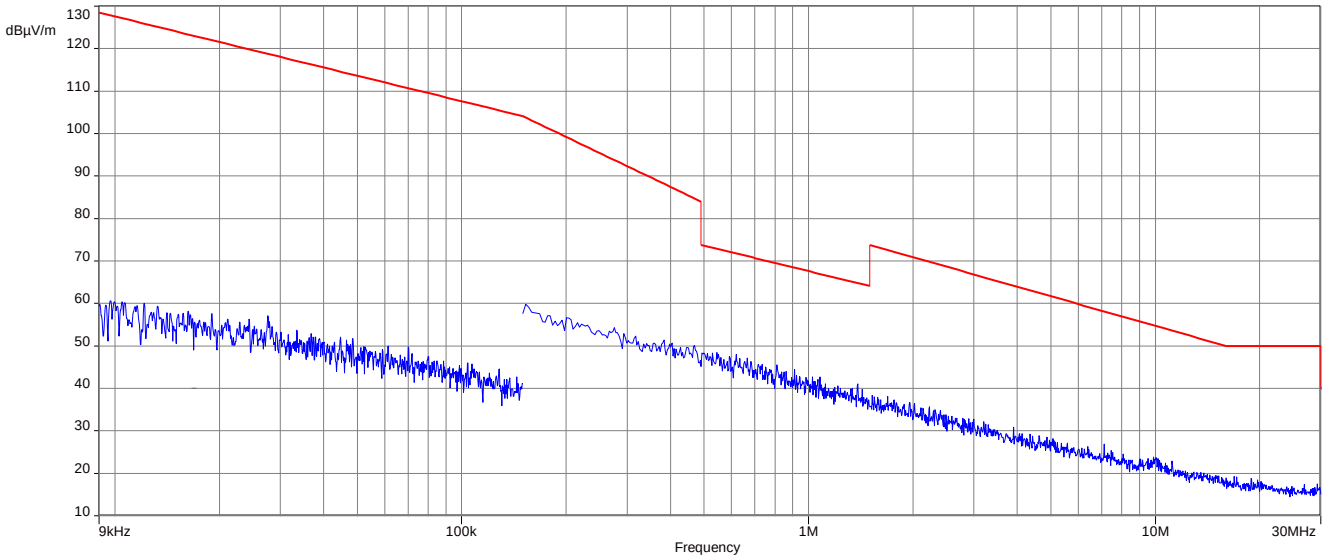
Plot 3: 9 kHz to 30 MHz, 2480 MHz, transmit mode, 1 Msps, on-board antenna



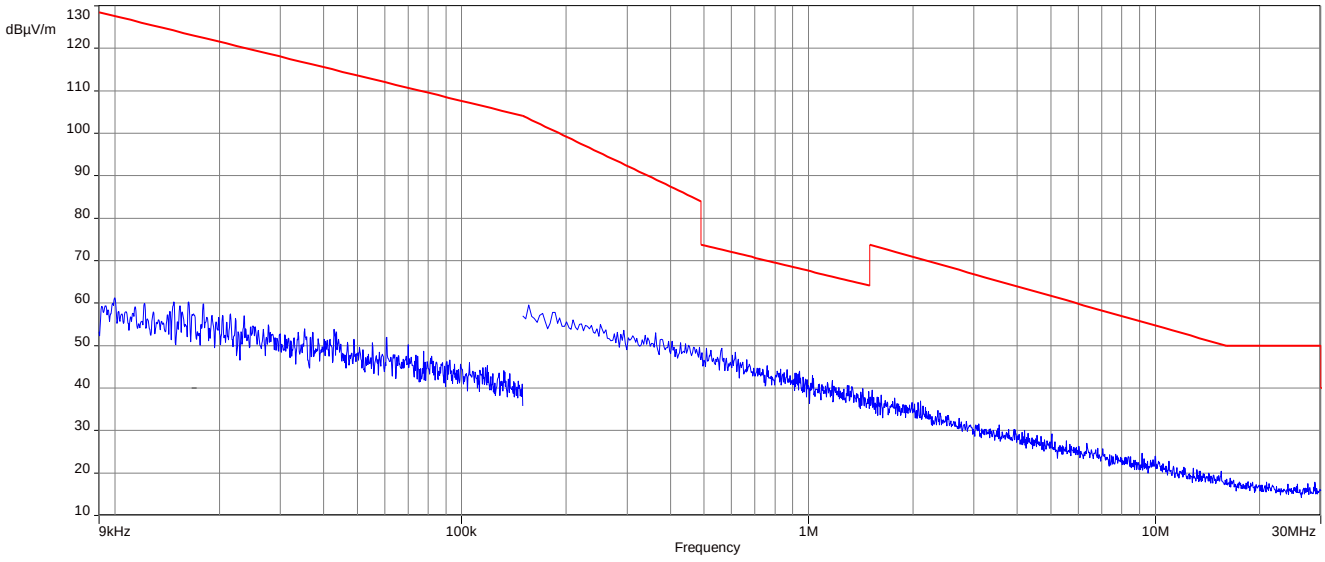
Plot 4: 9 kHz to 30 MHz, 2402 MHz, transmit mode, 2 Msps, on-board antenna



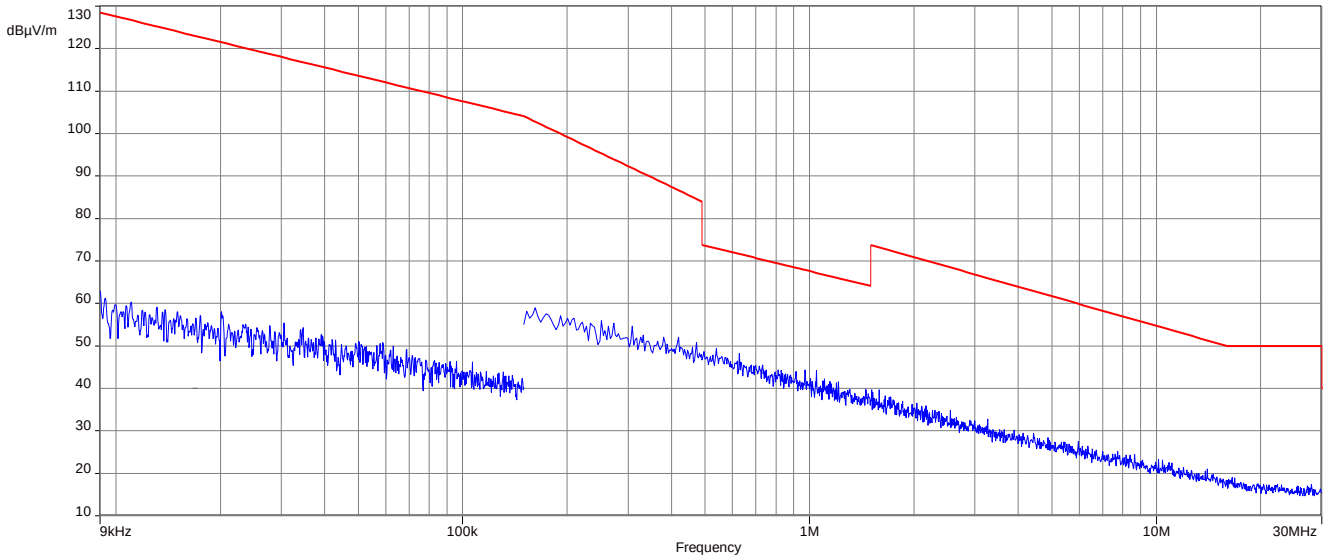
Plot 5: 9 kHz to 30 MHz, 2440 MHz, transmit mode, 2 Msps, on-board antenna



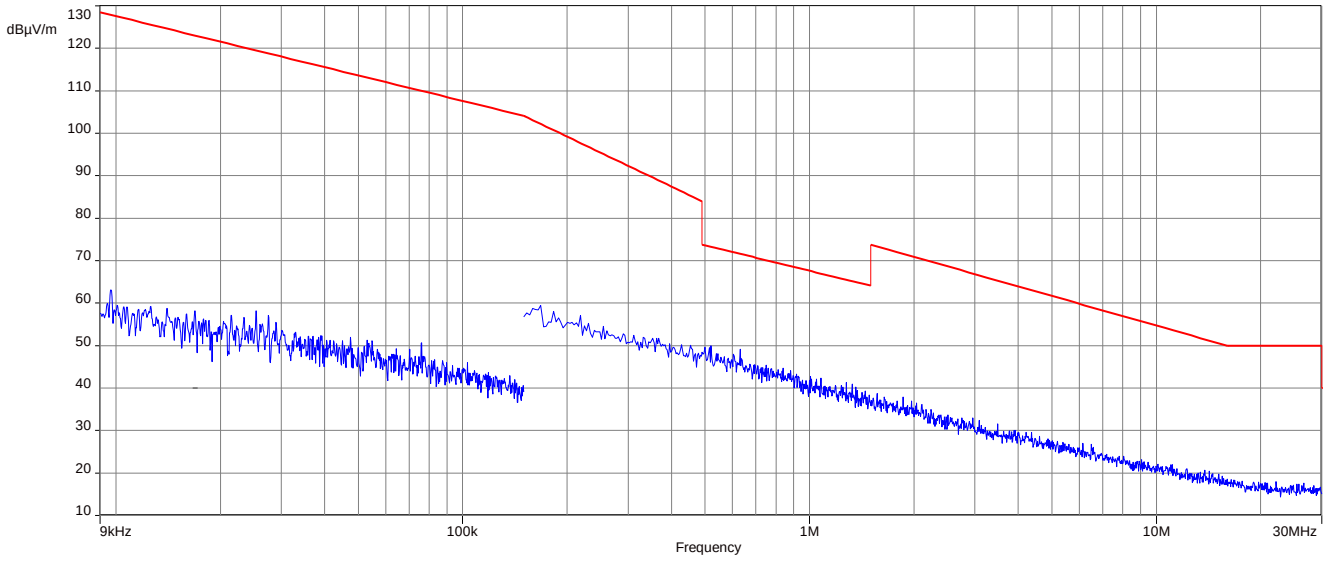
Plot 6: 9 kHz to 30 MHz, 2480 MHz, transmit mode, 2 Msps, on-board antenna



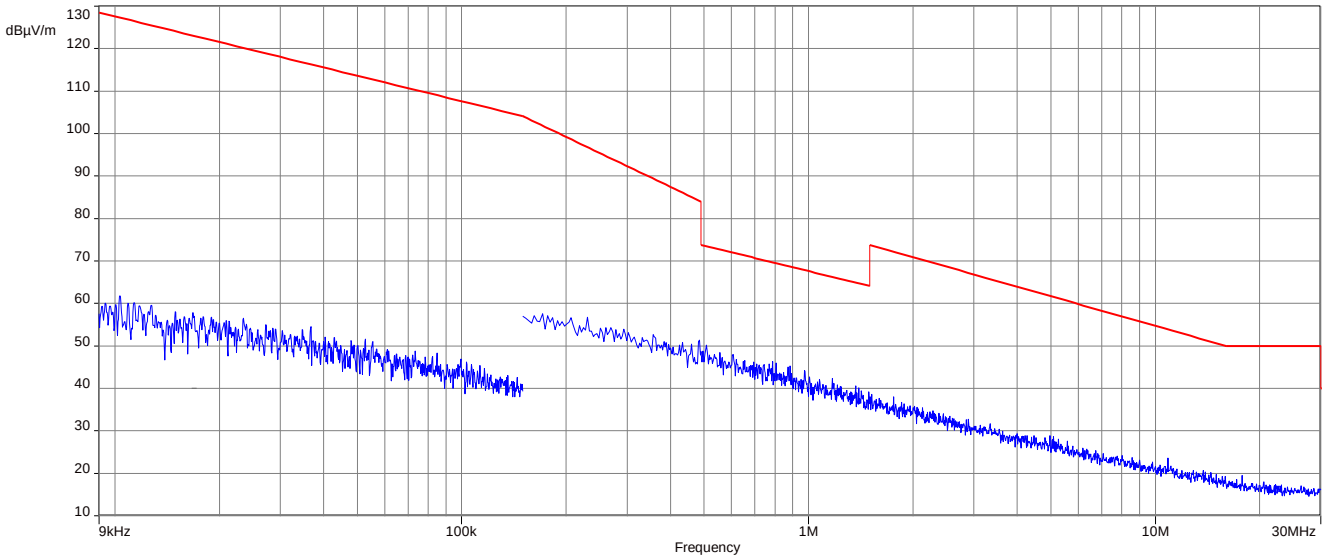
Plot 7: 9 kHz to 30 MHz, 2402 MHz, transmit mode, 1 Msps, external antenna



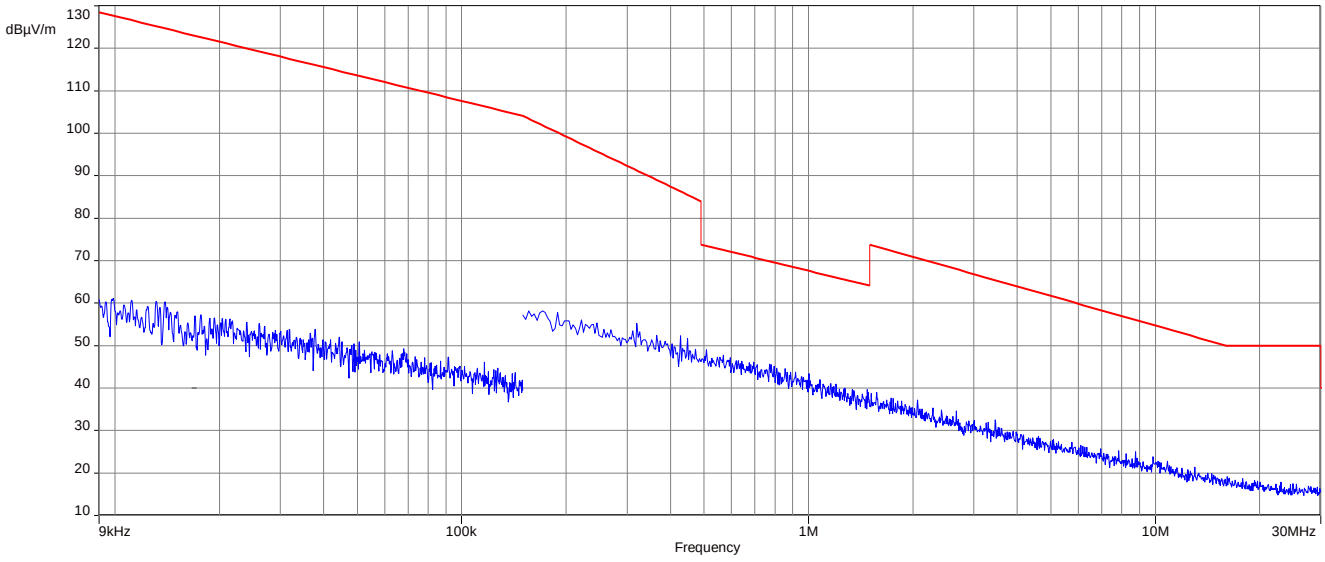
Plot 8: 9 kHz to 30 MHz, 2440 MHz, transmit mode, 1 Msps, external antenna



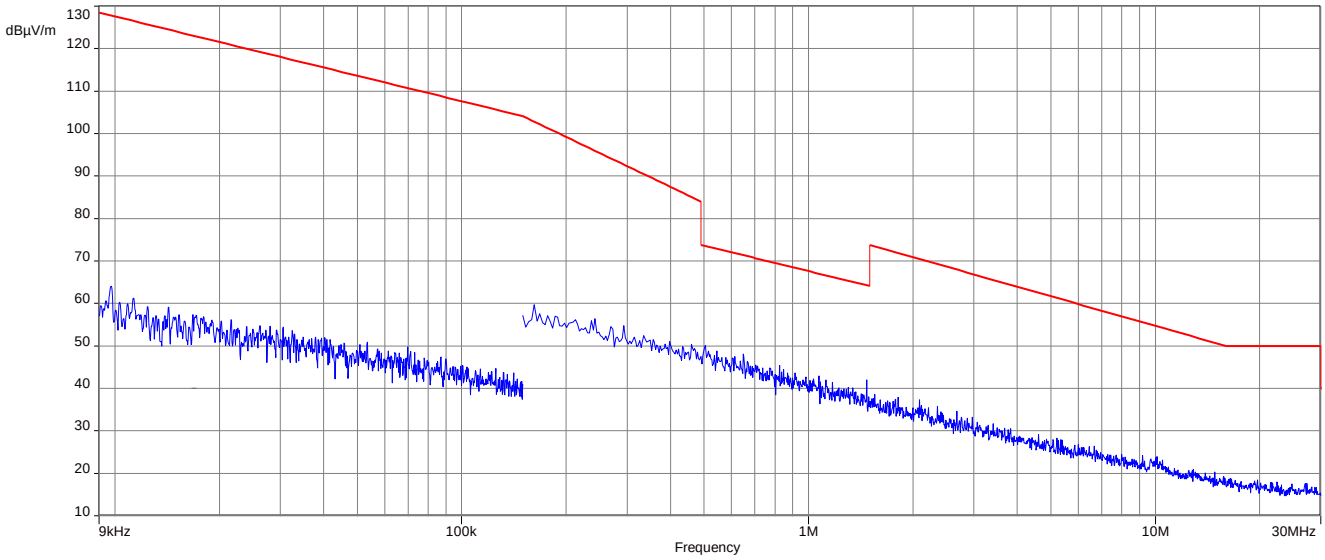
Plot 9: 9 kHz to 30 MHz, 2480 MHz, transmit mode, 1 Msps, external antenna



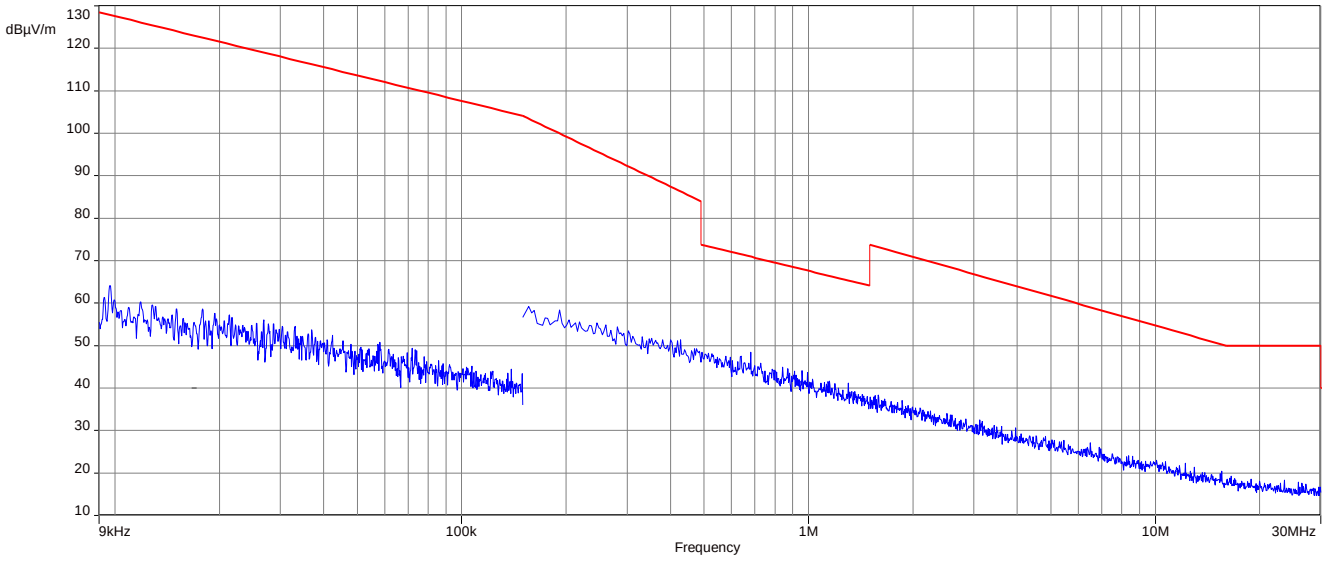
Plot 10: 9 kHz to 30 MHz, 2402 MHz, transmit mode, 2 Msps, external antenna



Plot 11: 9 kHz to 30 MHz, 2440 MHz, transmit mode, 2 Msps, external antenna



Plot 12: 9 kHz to 30 MHz, 2480 MHz, transmit mode, 2 Msps, external antenna



11.10 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 and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The measurement is performed in the mode with the highest output power.

Measurement parameters	
Detector	Peak / Quasi Peak
Sweep time	Auto
Resolution bandwidth	120 kHz
Video bandwidth	3 x RBW
Span	30 MHz to 1 GHz
Trace mode	Max hold
Measured modulation	GFSK
Test setup	See sub clause 6.1 A
Measurement uncertainty	See sub clause 8

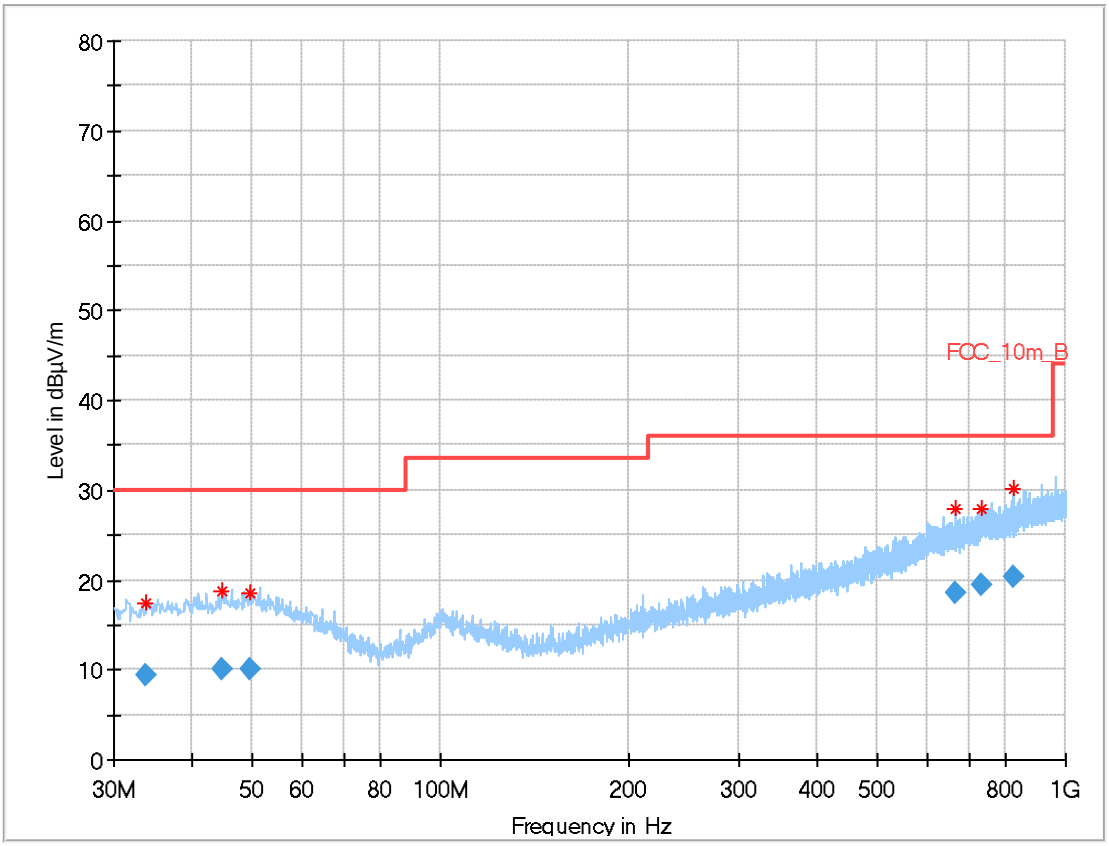
The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

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

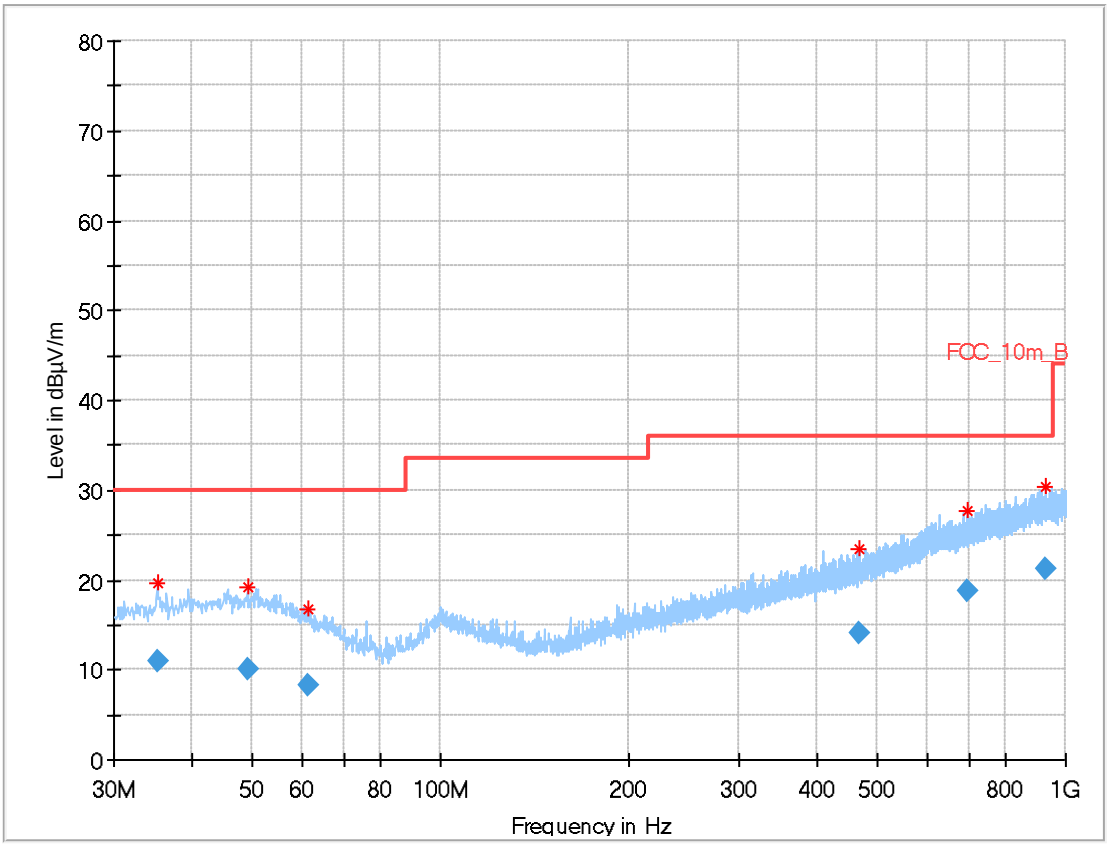
Plot 1: 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.832	9.33	30.0	20.67	1000	120	170.0	H	94.0	12.5
44.713	10.14	30.0	19.86	1000	120	101.0	H	240.0	13.6
49.450	10.03	30.0	19.97	1000	120	170.0	H	274.0	13.7
665.857	18.59	36.0	17.41	1000	120	170.0	H	-10.0	21.3
733.200	19.51	36.0	16.49	1000	120	100.0	V	99.0	22.3
825.045	20.32	36.0	15.68	1000	120	170.0	V	303.0	23.1

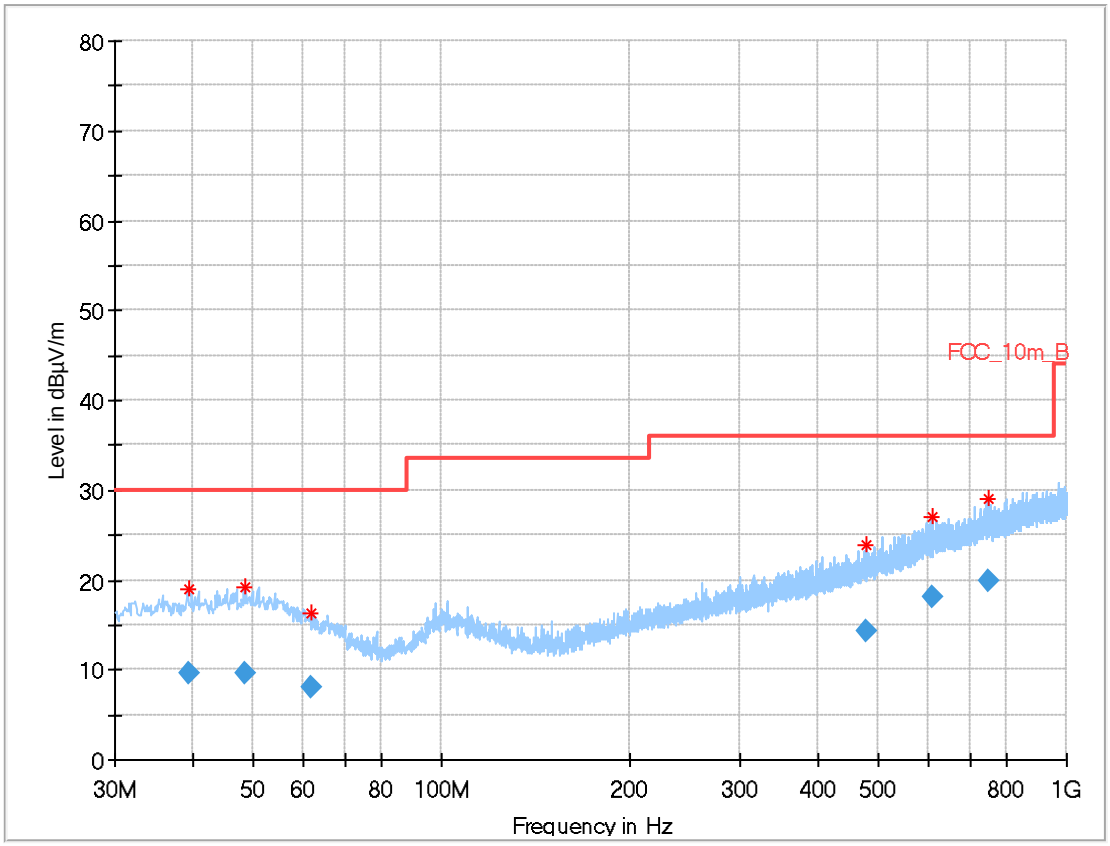
Plot 2: 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.281	10.97	30.0	19.03	1000	120	100.0	V	111.0	12.7
49.353	10.06	30.0	19.94	1000	120	170.0	V	296.0	13.7
61.242	8.35	30.0	21.65	1000	120	170.0	V	0.0	11.6
468.717	14.04	36.0	21.96	1000	120	170.0	H	209.0	18.1
696.646	18.79	36.0	17.21	1000	120	170.0	H	265.0	21.5
930.252	21.26	36.0	14.74	1000	120	170.0	H	235.0	24.3

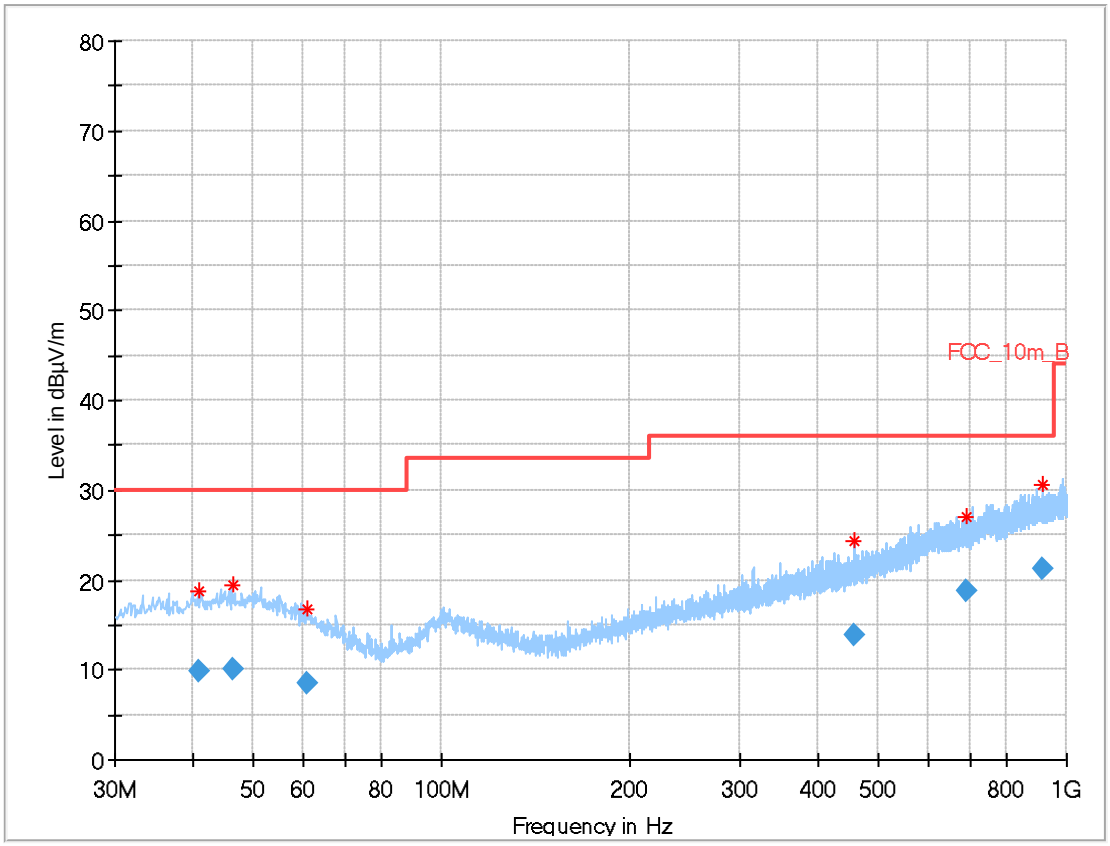
Plot 3: 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.548	9.63	30.0	20.37	1000	120	101.0	H	13.0	13.2
48.307	9.53	30.0	20.47	1000	120	98.0	V	147.0	13.7
61.925	8.05	30.0	21.95	1000	120	101.0	H	180.0	11.4
479.005	14.33	36.0	21.67	1000	120	170.0	V	-10.0	18.3
607.947	18.10	36.0	17.90	1000	120	101.0	V	178.0	20.8
748.785	19.80	36.0	16.20	1000	120	170.0	V	45.0	22.7

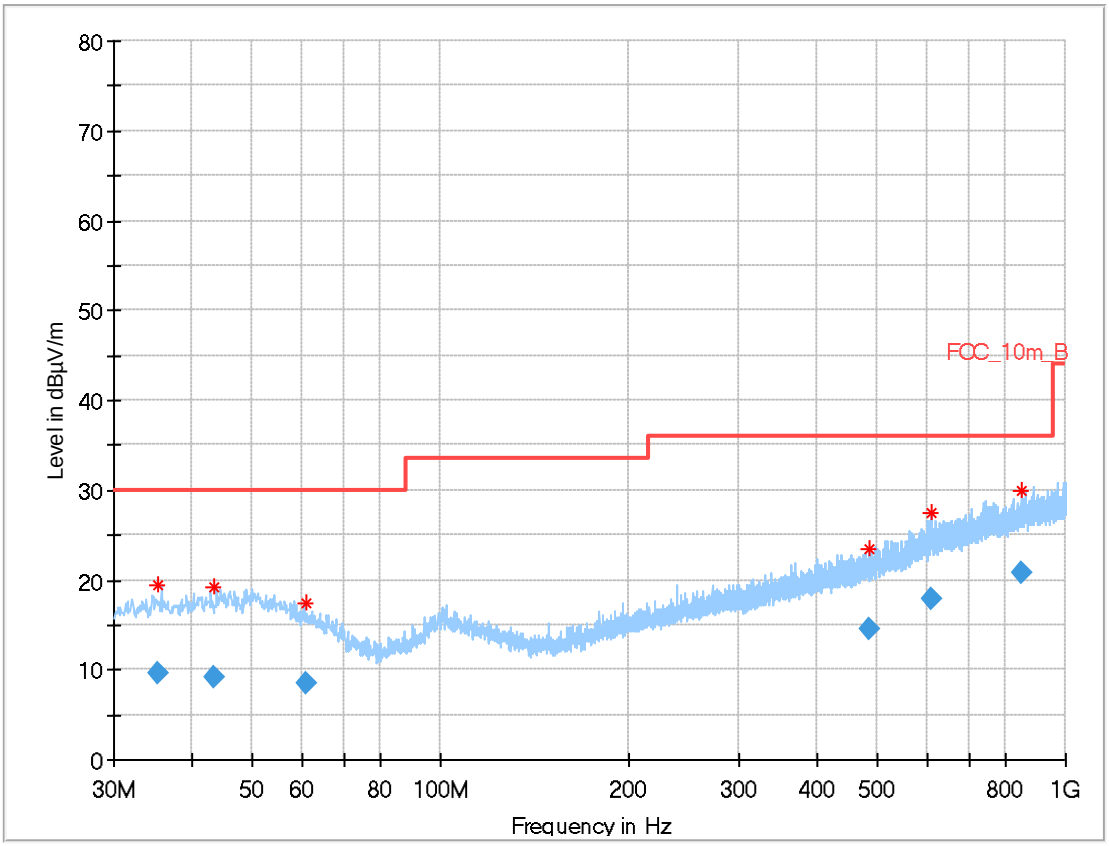
Plot 4: 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.811	9.92	30.0	20.08	1000	120	101.0	H	336.0	13.3
46.391	10.07	30.0	19.93	1000	120	101.0	V	183.0	13.7
60.968	8.38	30.0	21.62	1000	120	170.0	H	162.0	11.6
457.861	13.91	36.0	22.09	1000	120	170.0	V	340.0	17.8
690.529	18.76	36.0	17.24	1000	120	170.0	H	289.0	21.5
914.734	21.29	36.0	14.71	1000	120	170.0	V	124.0	24.2

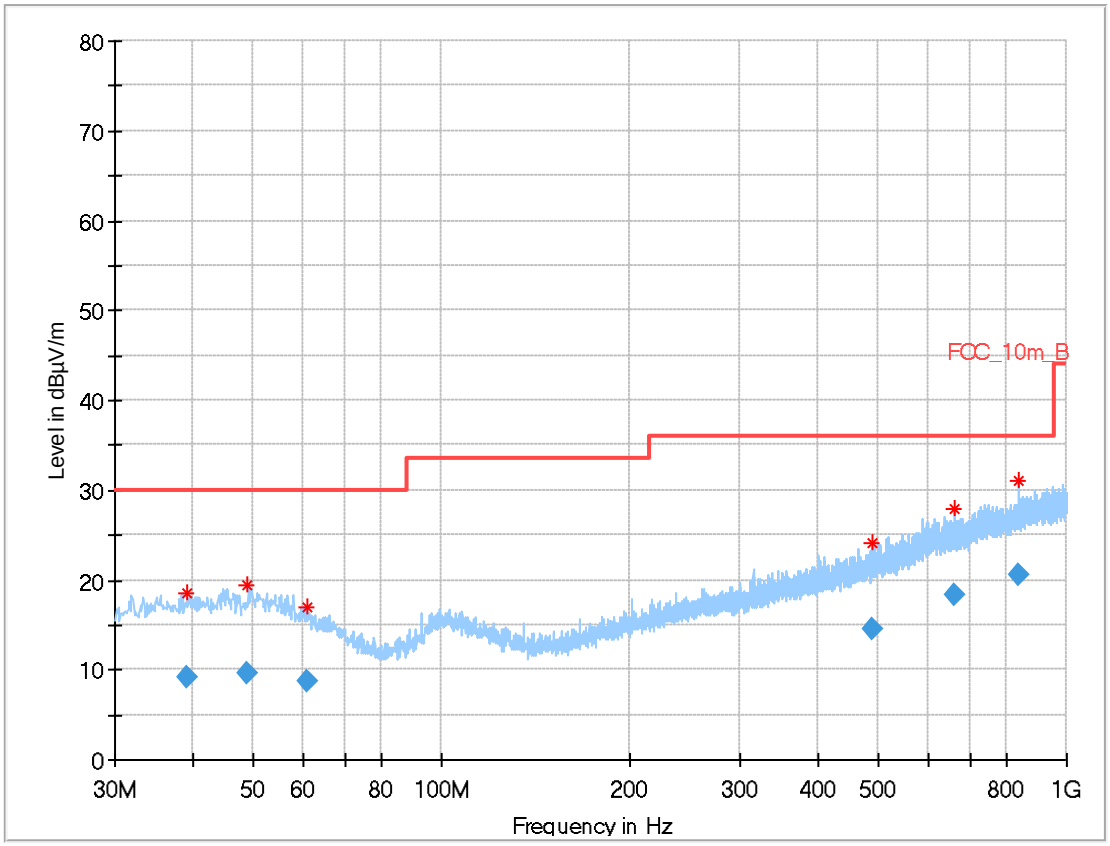
Plot 5: 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.372	9.69	30.0	20.31	1000	120	101.0	H	332.0	12.7
43.315	9.24	30.0	20.76	1000	120	101.0	H	105.0	13.5
61.020	8.57	30.0	21.43	1000	120	101.0	V	222.0	11.6
484.797	14.43	36.0	21.57	1000	120	170.0	H	333.0	18.4
611.444	17.97	36.0	18.03	1000	120	170.0	H	-3.0	20.8
849.746	20.71	36.0	15.29	1000	120	170.0	H	357.0	23.5

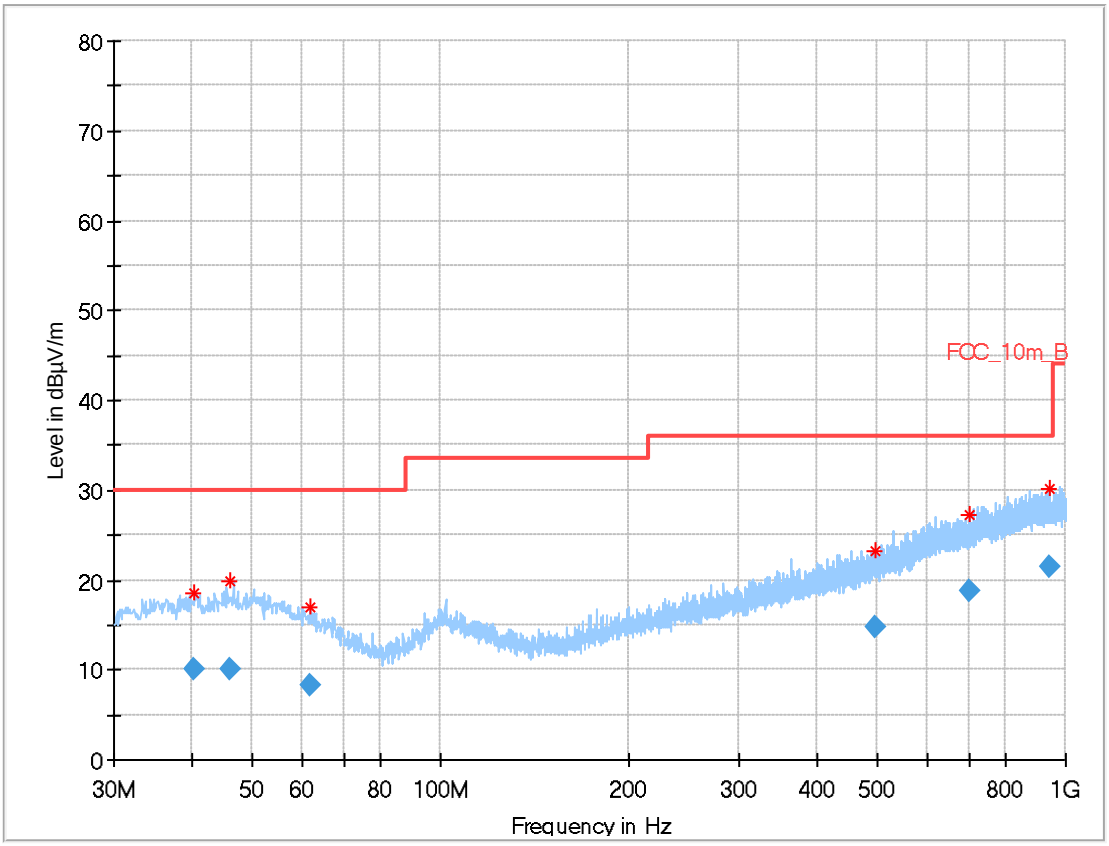
Plot 6: 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.072	9.24	30.0	20.76	1000	120	100.0	H	165.0	13.1
48.697	9.64	30.0	20.36	1000	120	170.0	H	229.0	13.7
60.976	8.62	30.0	21.38	1000	120	101.0	V	149.0	11.6
488.100	14.47	36.0	21.53	1000	120	98.0	H	75.0	18.5
661.106	18.36	36.0	17.64	1000	120	170.0	H	0.0	21.2
838.633	20.54	36.0	15.46	1000	120	170.0	H	12.0	23.4

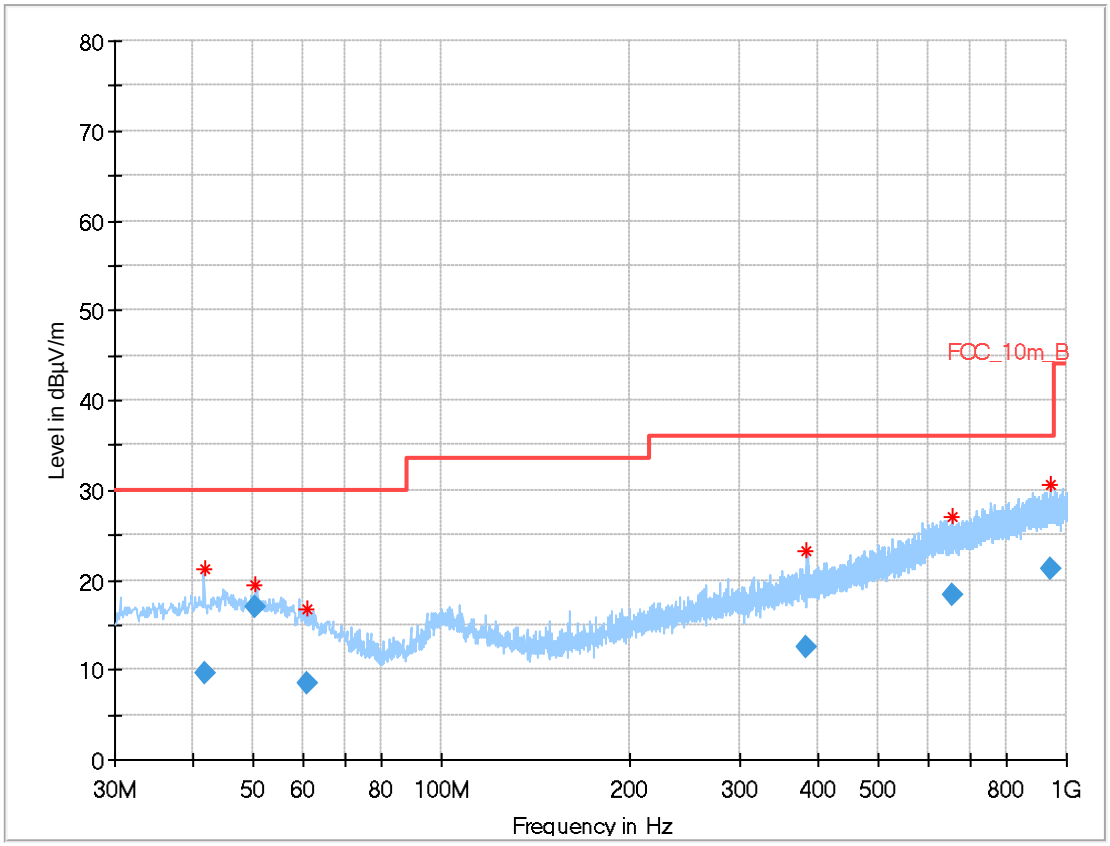
Plot 7: 30 MHz to 1 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, external antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.223	10.10	30.0	19.90	1000	120	101.0	V	200.0	13.2
46.153	10.13	30.0	19.87	1000	120	101.0	V	357.0	13.7
61.911	8.26	30.0	21.74	1000	120	170.0	V	115.0	11.4
495.182	14.78	36.0	21.22	1000	120	101.0	H	237.0	18.6
700.072	18.83	36.0	17.17	1000	120	170.0	V	306.0	21.6
944.450	21.37	36.0	14.63	1000	120	170.0	V	-10.0	24.3

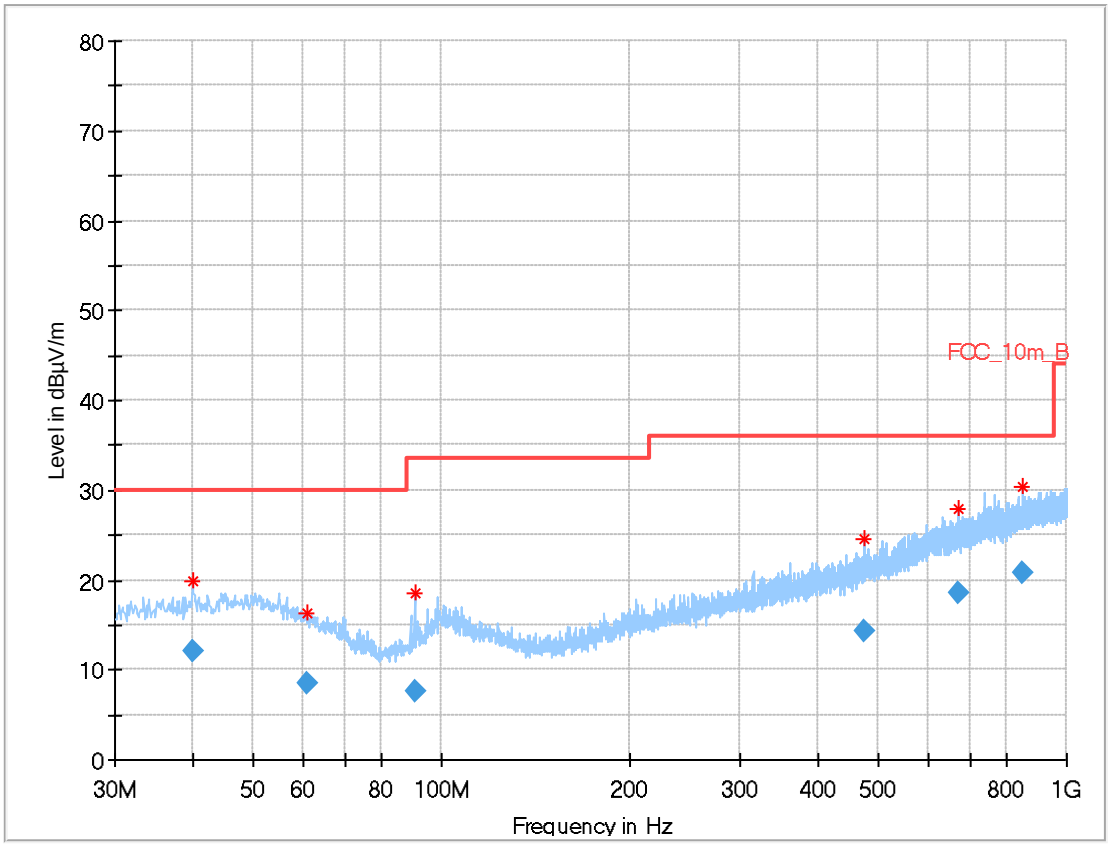
Plot 8: 30 MHz to 1 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
41.942	9.62	30.0	20.38	1000	120	101.0	V	284.0	13.4
50.141	16.89	30.0	13.11	1000	120	101.0	V	303.0	13.7
61.044	8.39	30.0	21.61	1000	120	170.0	H	101.0	11.6
384.209	12.44	36.0	23.56	1000	120	170.0	H	304.0	16.6
657.641	18.31	36.0	17.69	1000	120	170.0	V	282.0	21.2
942.000	21.33	36.0	14.67	1000	120	170.0	H	157.0	24.3

Plot 9: 30 MHz to 1 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, external antenna

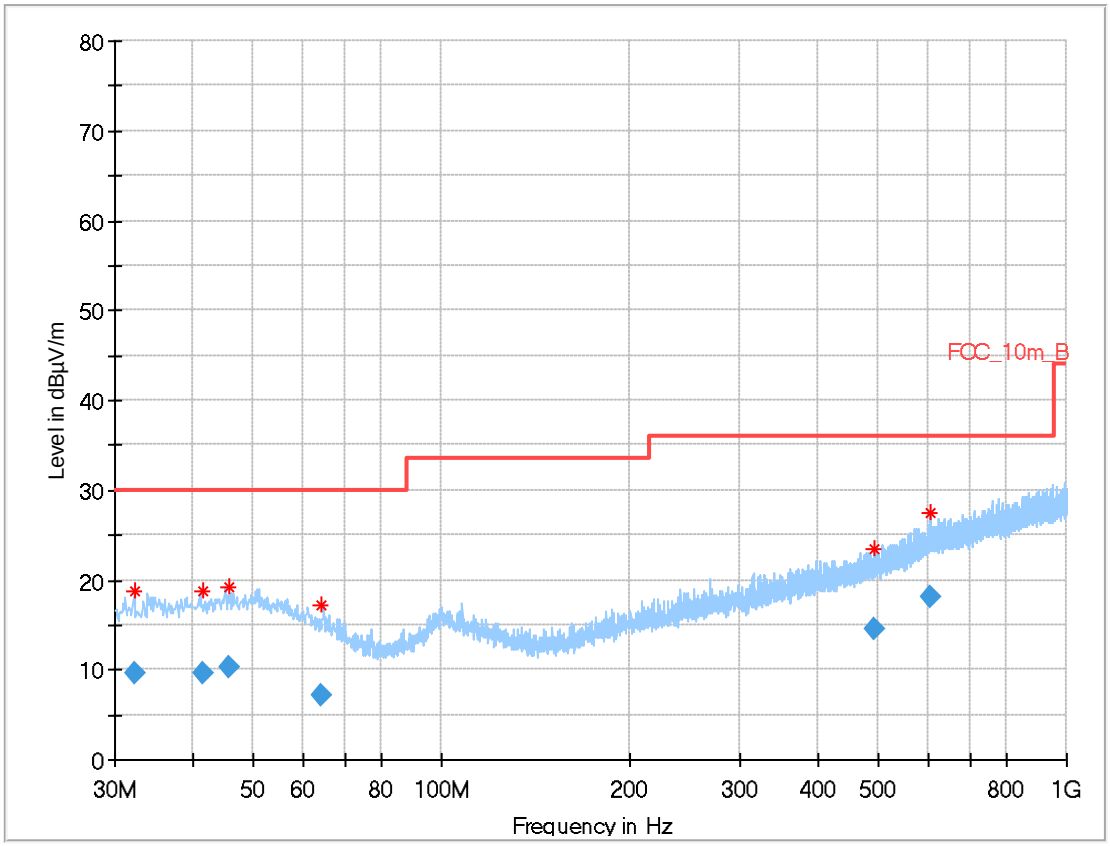


Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.940	12.13	30.0	17.87	1000	120	170.0	V	32.0	13.2
61.016	8.44	30.0	21.56	1000	120	170.0	H	347.0	11.6
90.979	7.49	33.5	26.01	1000	120	101.0	V	347.0	9.6
474.818	14.24	36.0	21.76	1000	120	170.0	H	147.0	18.2
670.630	18.61	36.0	17.39	1000	120	98.0	H	267.0	21.3
848.220	20.73	36.0	15.27	1000	120	170.0	H	198.0	23.5

Plots: Receiver mode

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



Final results:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
32.277	9.62	30.0	20.38	1000	120	101.0	V	201.0	12.2
41.486	9.70	30.0	20.30	1000	120	101.0	V	353.0	13.3
45.580	10.35	30.0	19.65	1000	120	101.0	V	103.0	13.6
64.408	7.19	30.0	22.81	1000	120	101.0	V	67.0	10.9
493.557	14.63	36.0	21.37	1000	120	98.0	H	247.0	18.6
606.875	18.01	36.0	17.99	1000	120	170.0	V	0.0	20.8

11.11 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The EUT is set to single channel mode and the transmit frequencies are 2402 MHz, 2440 MHz and 2480 MHz. The measurement is performed in the mode with the highest output power.

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	GFSK
Test setup	See sub clause 6.2 A (TX - 1 GHz - 18 GHz) See sub clause 6.2 B (RX - 1 GHz – 18GHz) See sub clause 6.3 A (18 GHz - 26 GHz)
Measurement uncertainty	See sub clause 8

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 (Average)	3
Above 960	74.0 (Peak)	3

Results: Transmitter mode

TX spurious emissions radiated [dBµV/m]								
2402 MHz			2440 MHz			2480 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.								
	Peak			Peak			Peak	
	AVG			AVG			AVG	
	Peak			Peak			Peak	
	AVG			AVG			AVG	
	Peak			Peak			Peak	
	AVG			AVG			AVG	

*) Average emission adjusting factor:

F = 20 * log (dwell time* / 100 ms)
*with TXon time as dwell time!

Bluetooth LE connected mode: Duty Cycle correction Scenarios

TX payload bytes	TX dwell time [ms]	TXon time [ms]	RX dwell time min [ms]	No of TX within 100 ms 100ms/(TxDwell +RxDwell)	min no of hopping channels (AFH)	max TX time [ms]/channel within 100ms	DC correction F [dB]	Scenario
37	0.625	0.376	0.625	80.0	2	15	-16.46	TX Packet. Rx =ACK
224	1.875	1.875	0.625	40.0	2	38	-8.52	TX Packet. Rx =ACK (worst case)
255	2.500	2.120	0.625	32.0	2	34	-9.39	TX Packet. Rx =ACK
37	0.625	0.376	0.625	80.0	2	15	-16.46	TX Packet = RX Packet
255	2.500	2.120	2.500	20.0	2	21	-13.47	TX Packet = RX Packet

Note: For BT LE the dwell time is a multiple of 0.625ms

Bluetooth LE Advertising mode:

Advertising is always in none Hopping mode.

A Bluetooth LE packet in advertising mode consists of:
Preamble (1 Byte)
Access Address (4 Bytes):always: 0x8E89BED6
PDU Header (2 Bytes)
PDU MAC address (6 Bytes)
PDU Data (0-31 Bytes) (connected undirected advertising (ADV_IND)
CRC (3 Bytes)

The maximum size of a complete advertising packet is 47 Bytes (376us)
Minimum possible advertising interval (per advertising channel): 20 ms
Duty cycle within 100ms: 5*0.376ms /100ms = 0.0188 =1.88%
Correction factor for average calculation:

F = 20 *log (0.0188) = -34.51dB

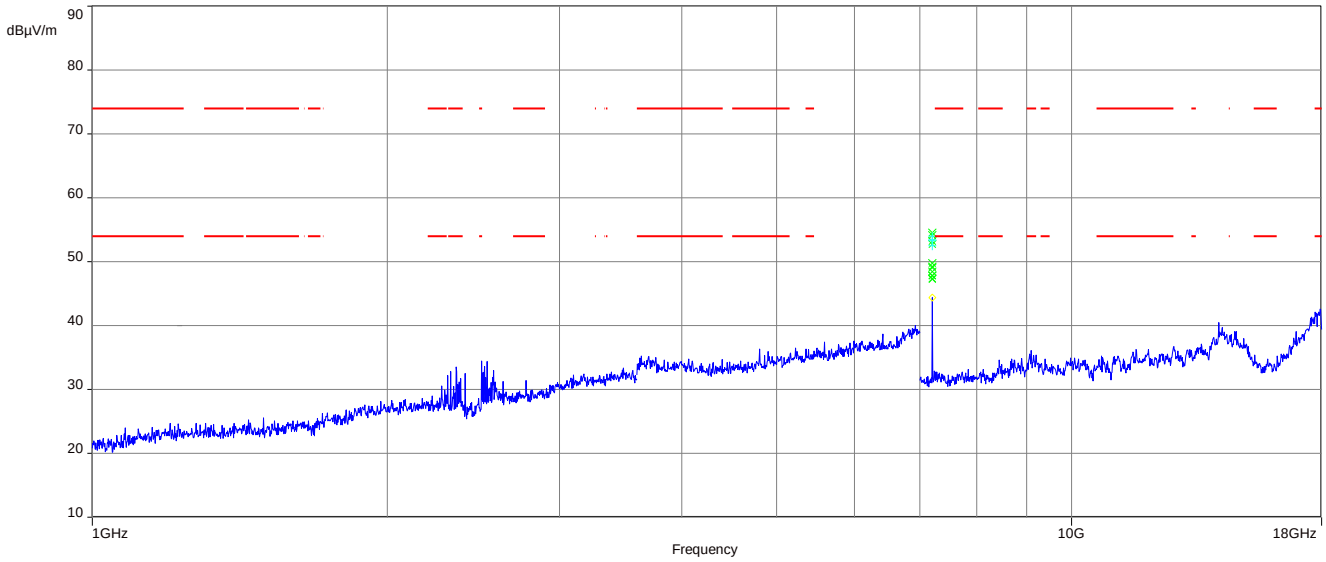
Results: Receiver mode

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	

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)

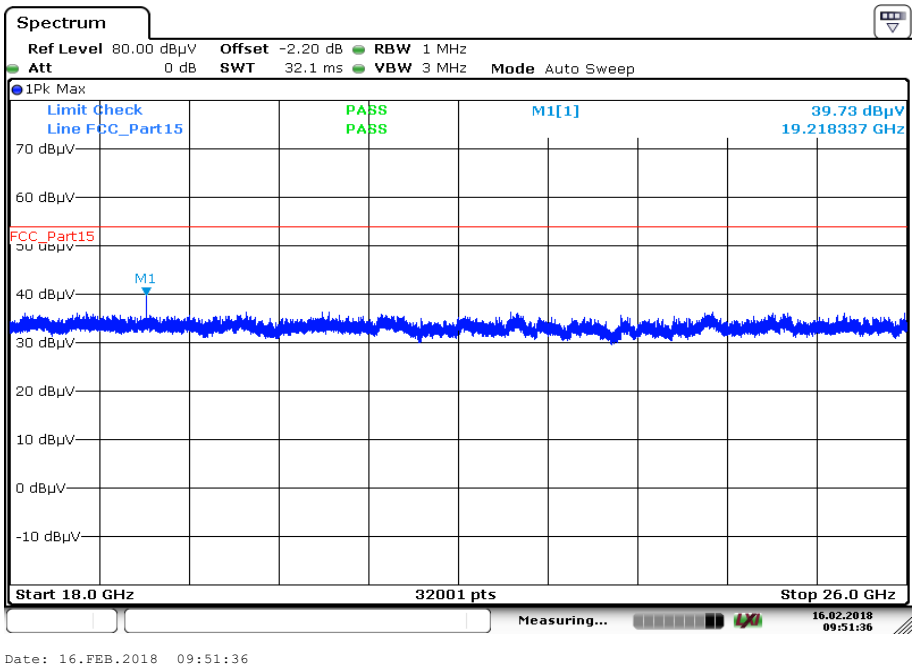
Plots: Transmitter mode

Plot 1: 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

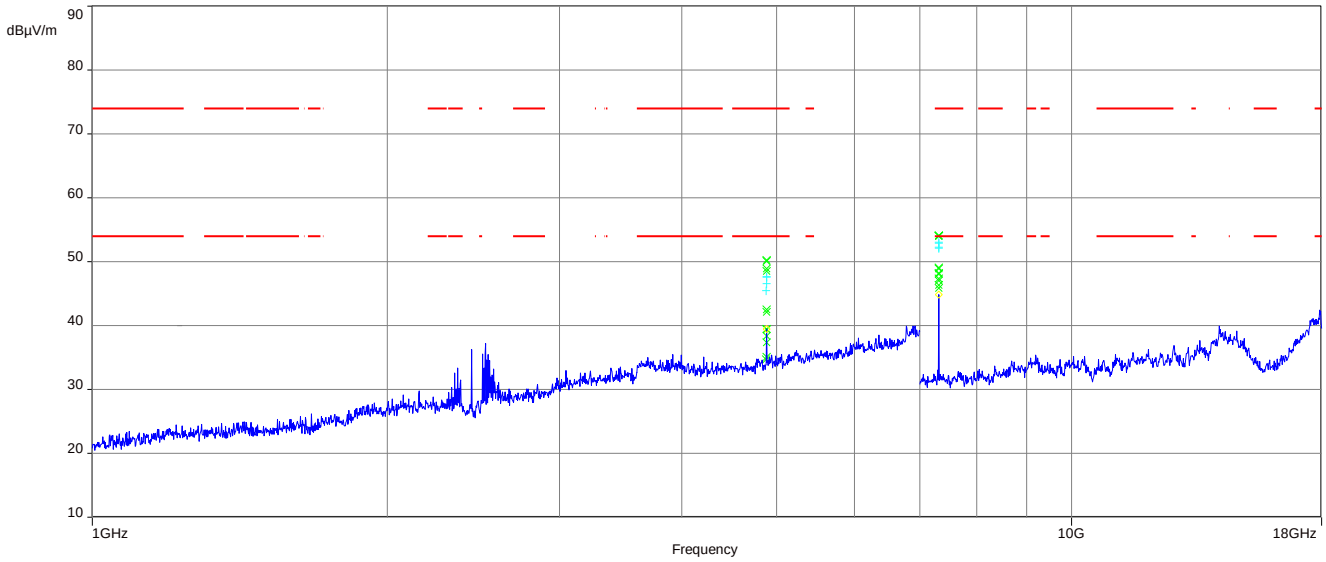


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 2: 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

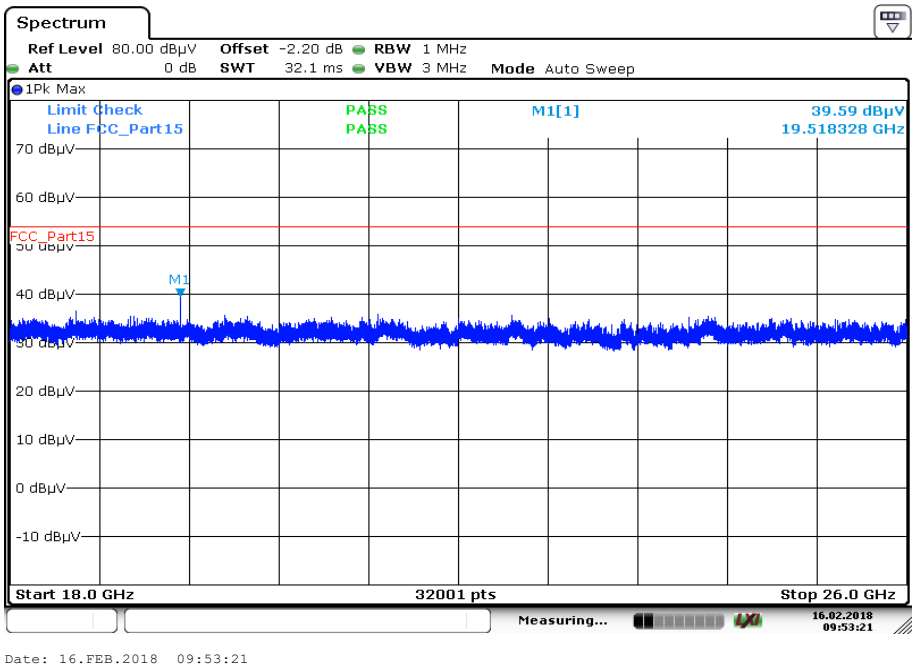


Plot 3: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

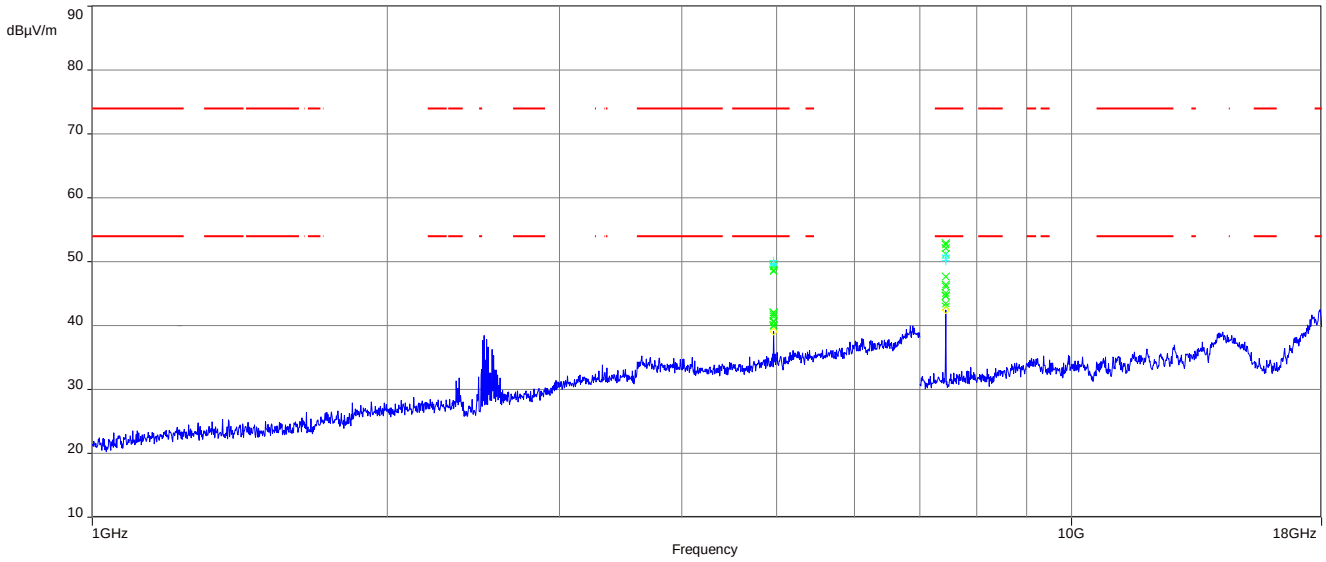


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 4: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

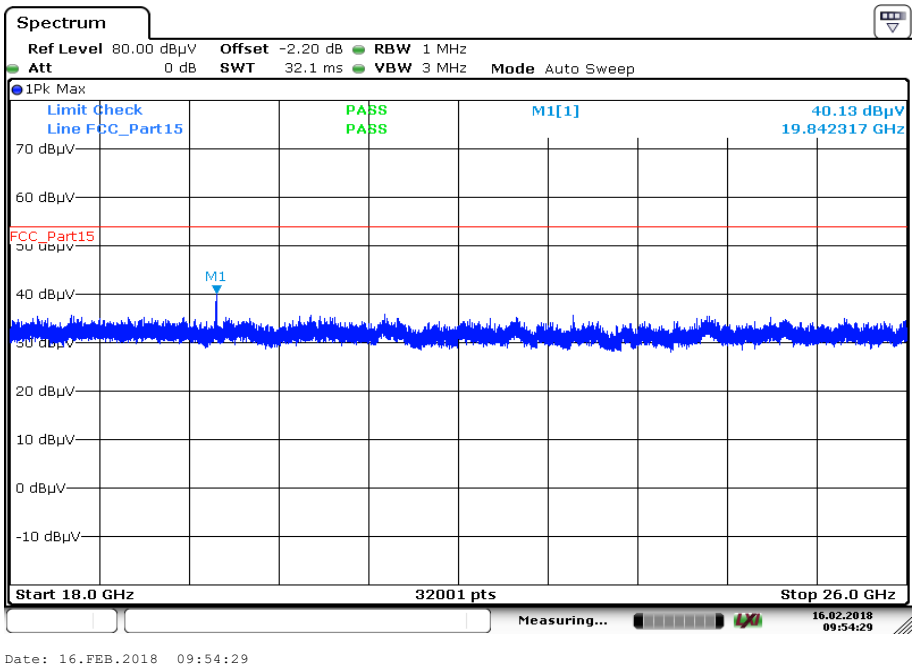


Plot 5: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

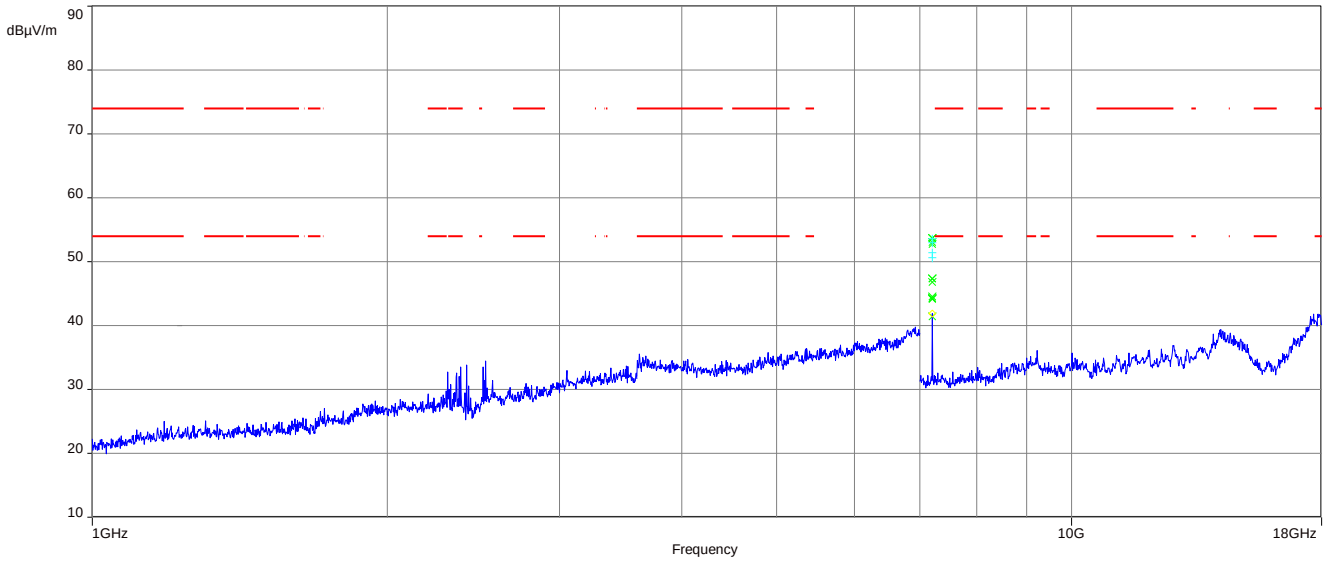


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 6: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps, on-board antenna

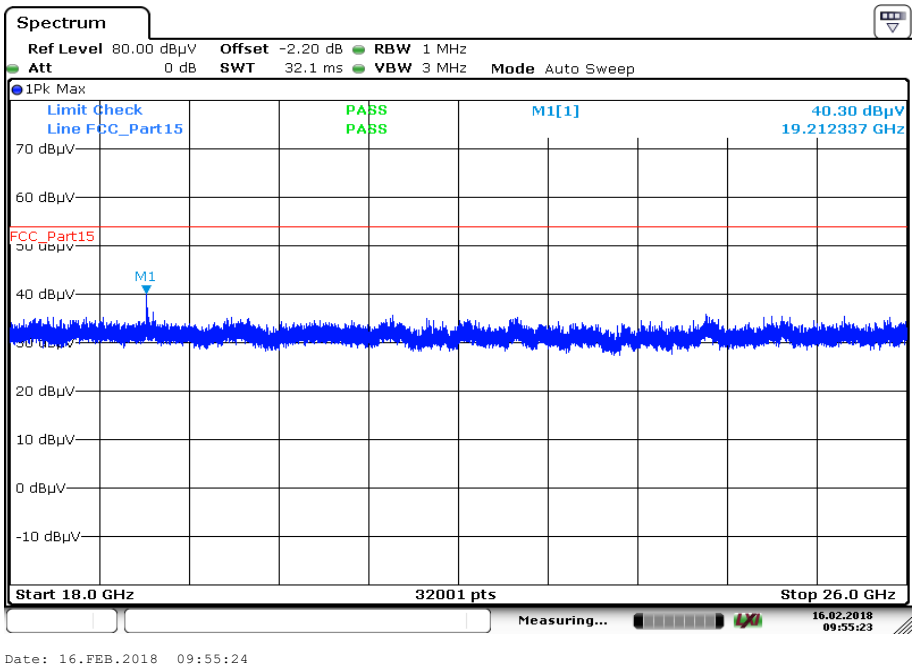


Plot 7: 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

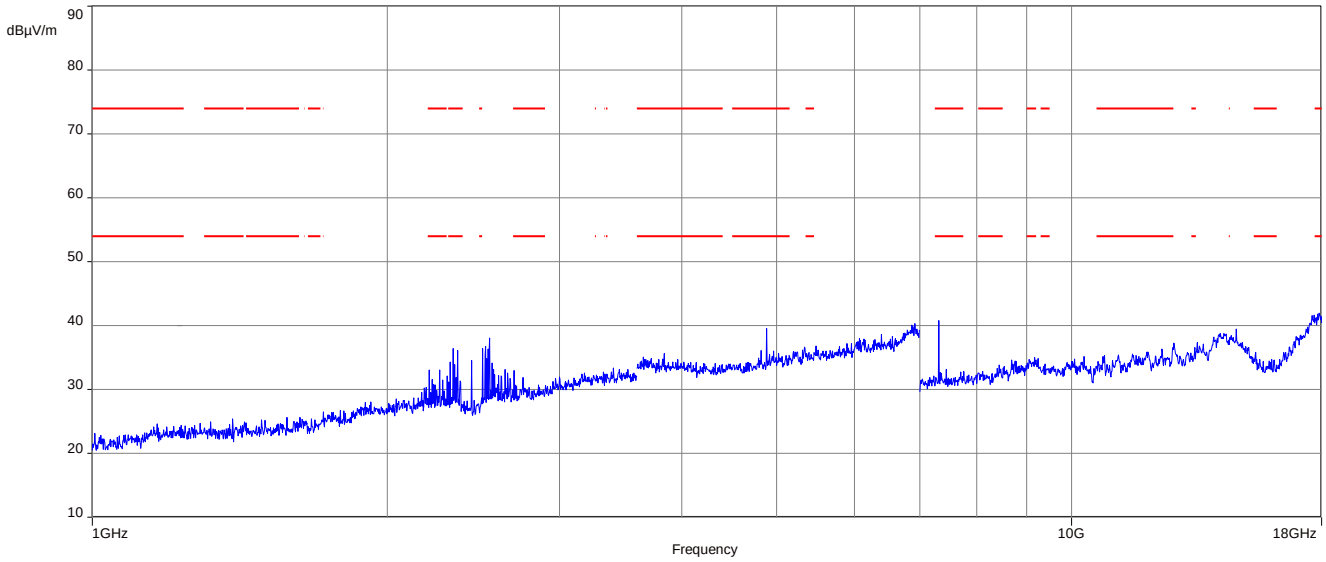


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 8: 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

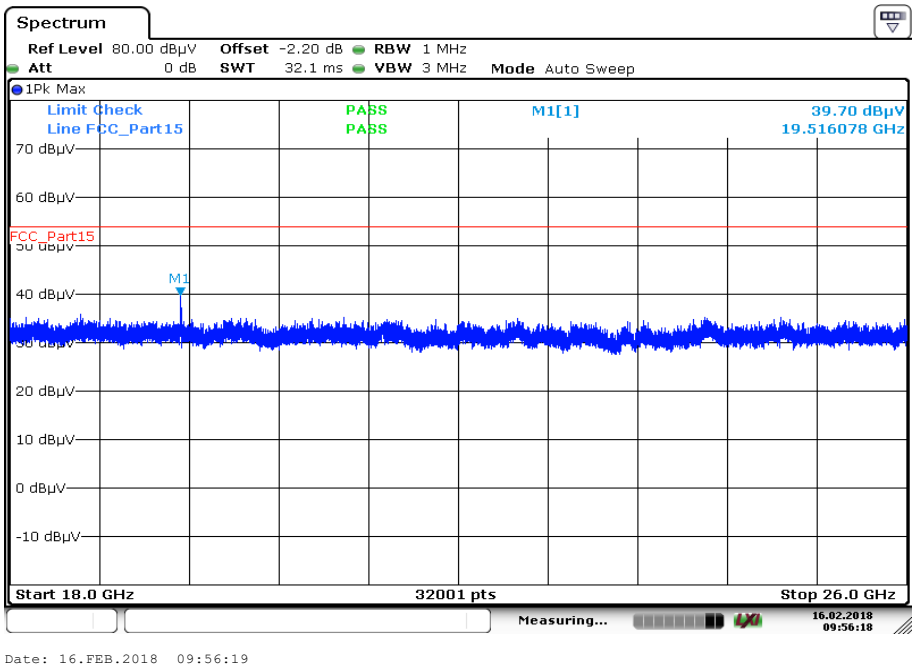


Plot 9: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

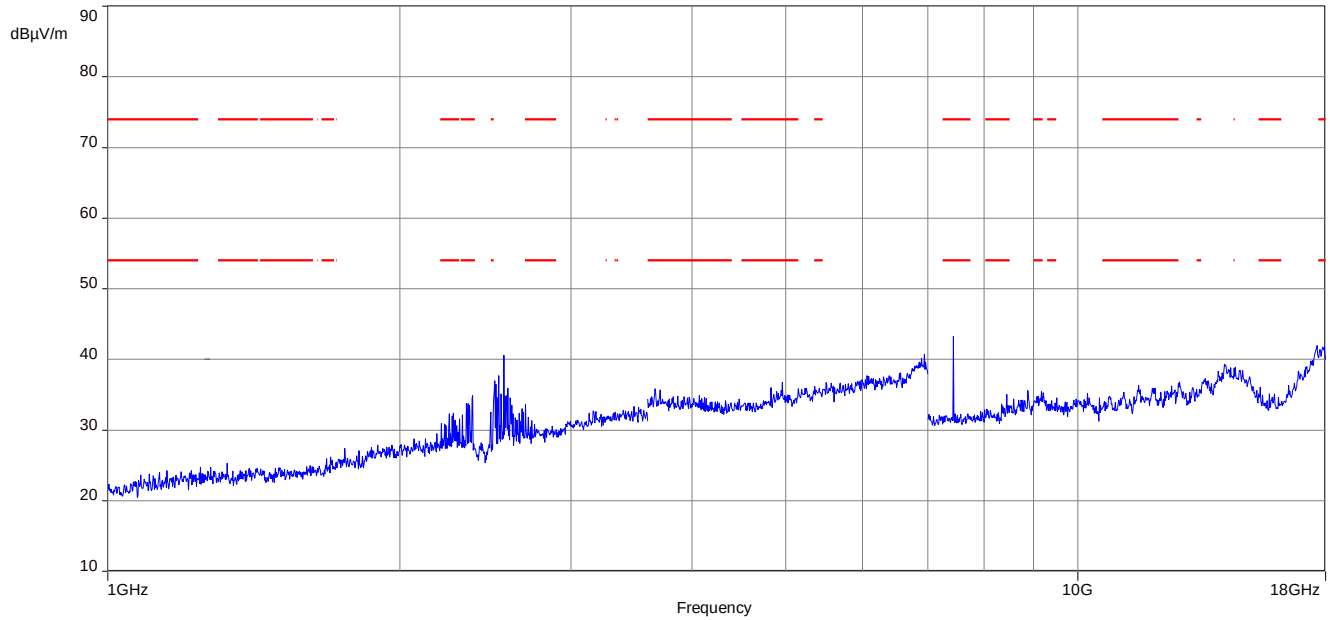


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 10: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

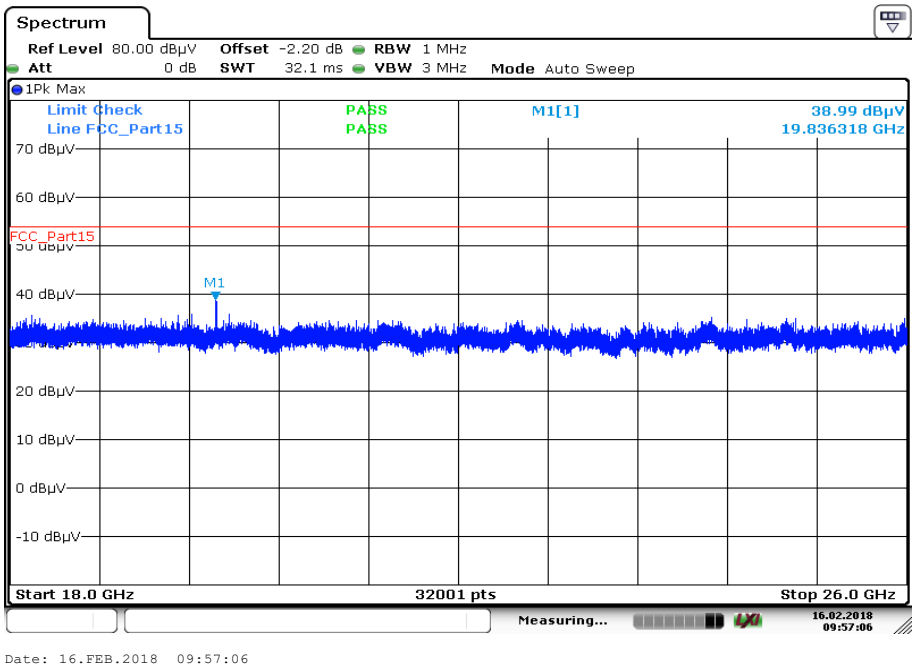


Plot 11: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

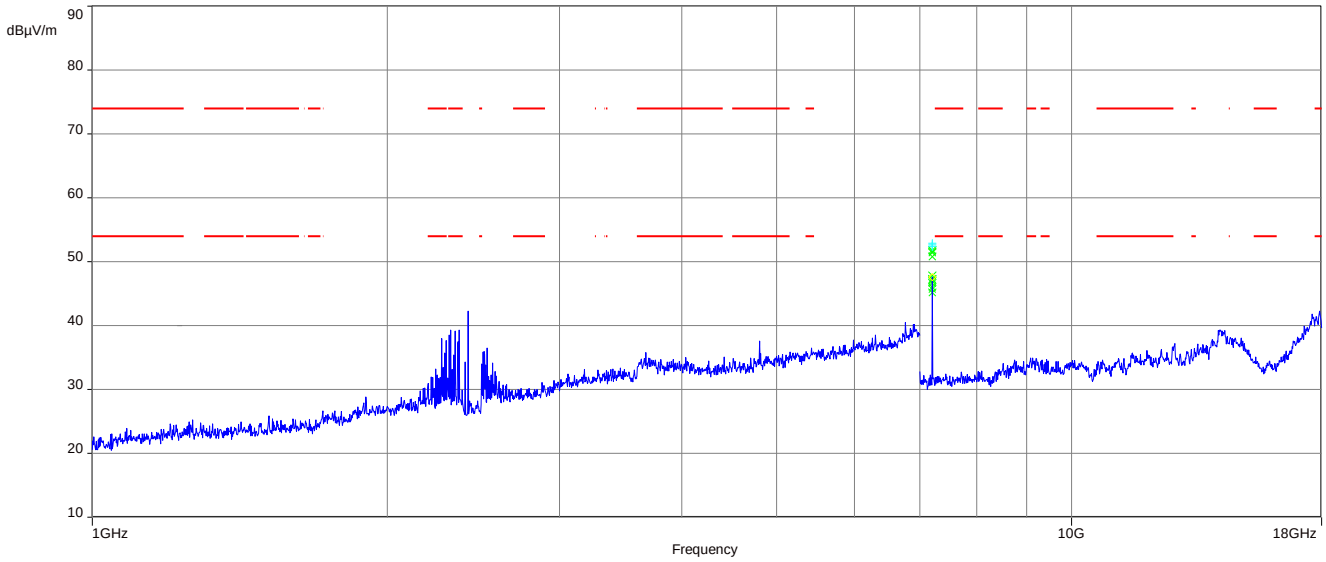


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 12: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 2 Msps, on-board antenna

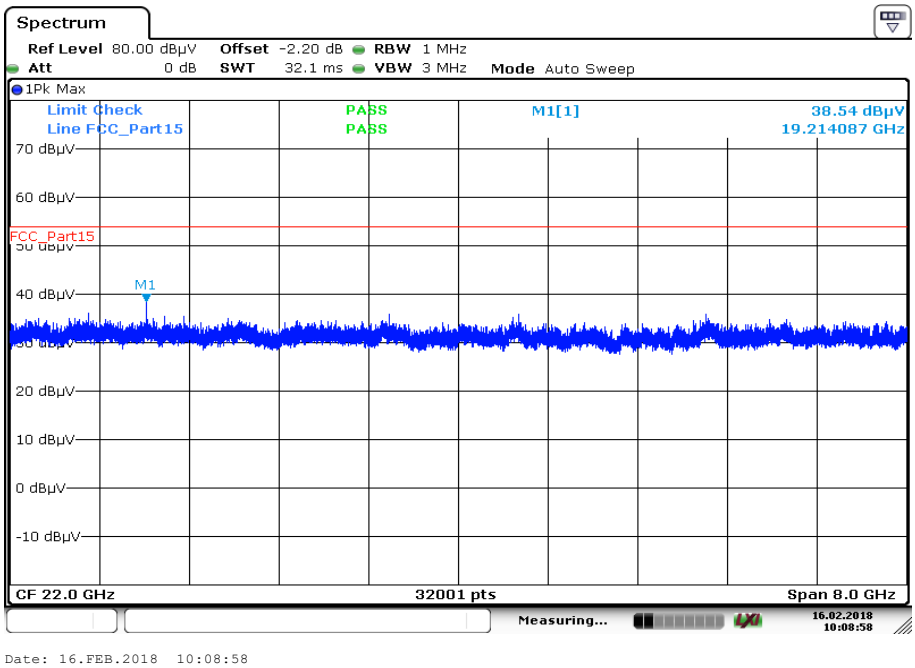


Plot 13: 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, external antenna

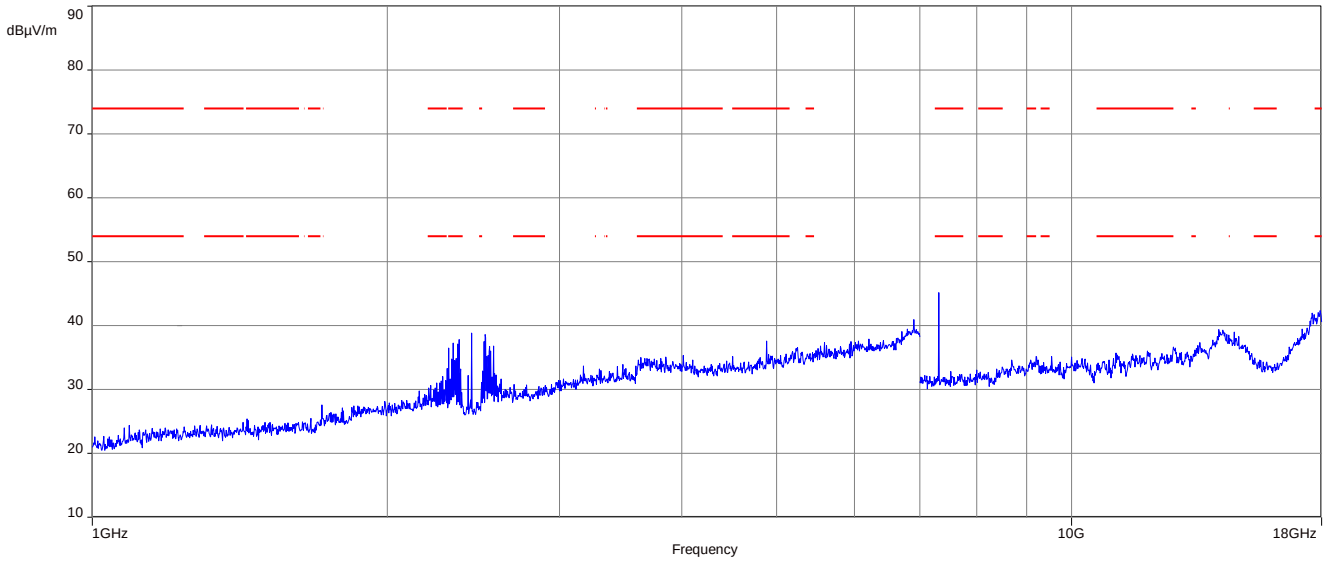


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 14: 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 1 Msps, external antenna

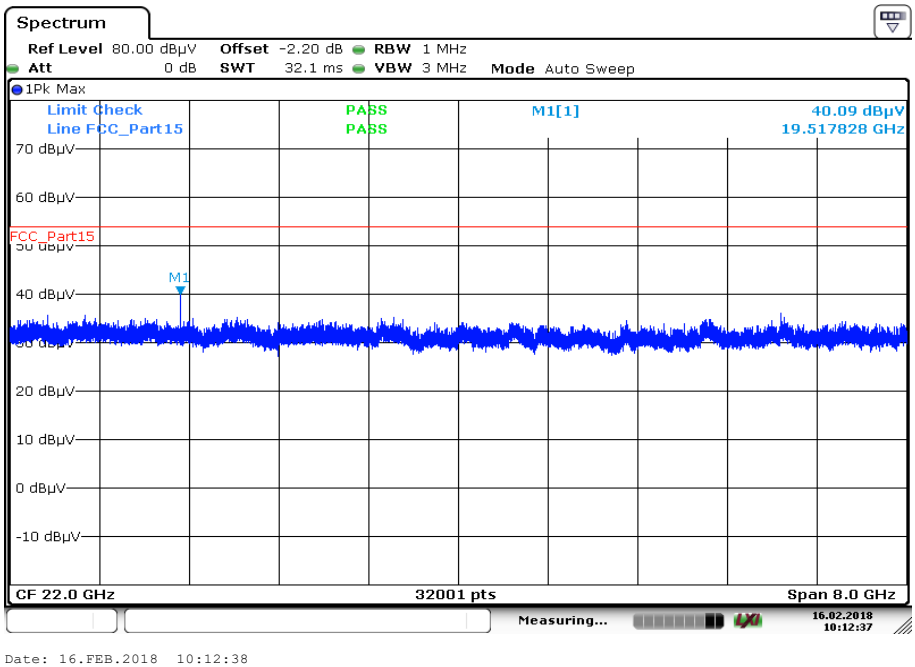


Plot 15: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, external antenna

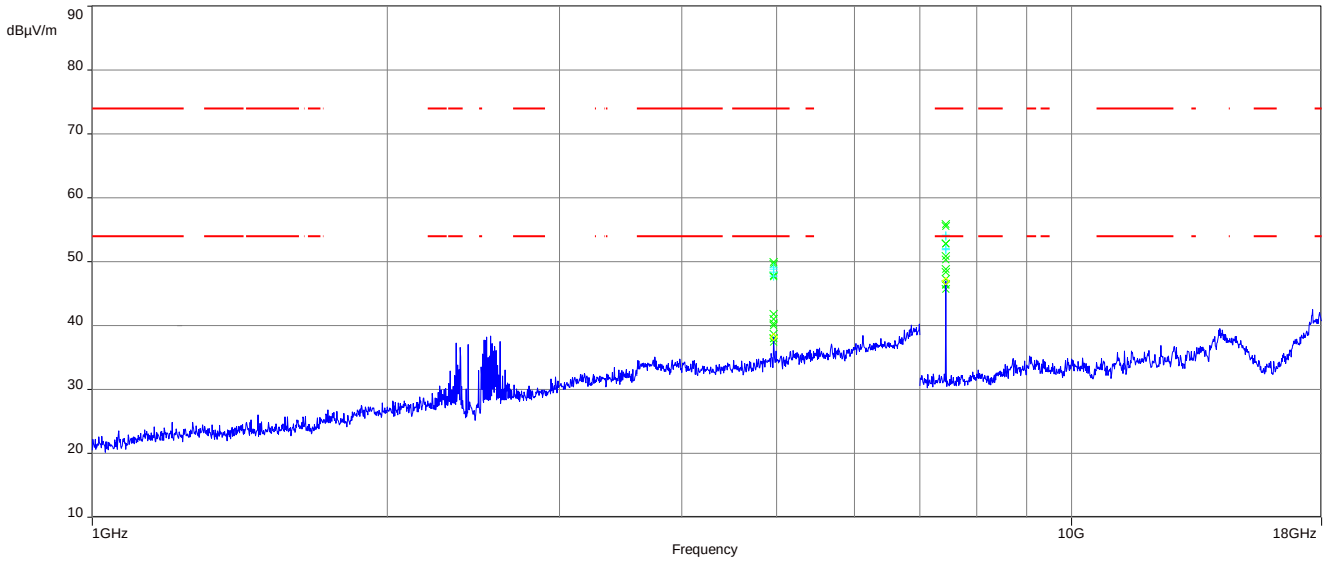


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 16: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 1 Msps, external antenna

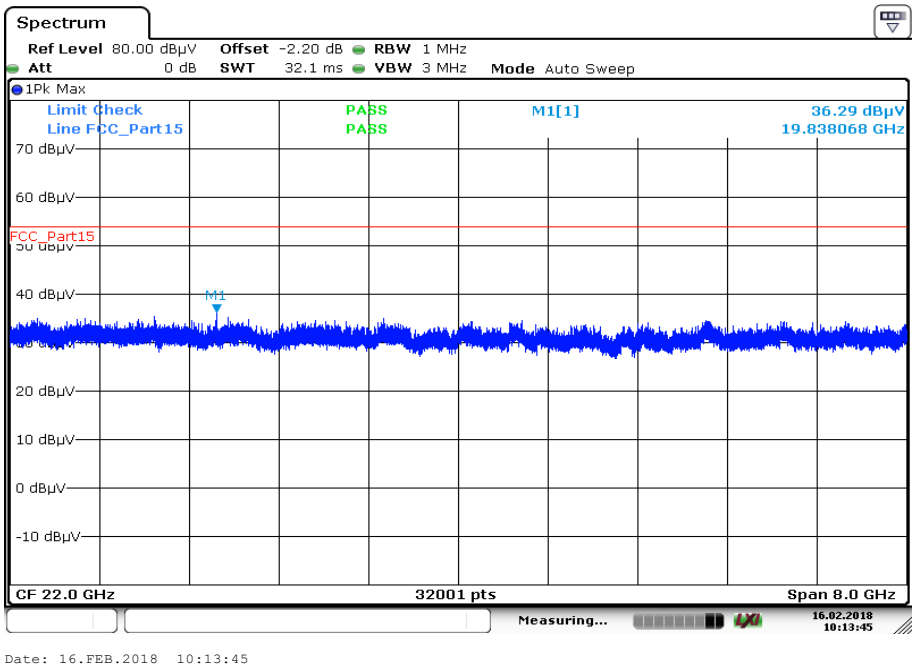


Plot 17: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps, external antenna

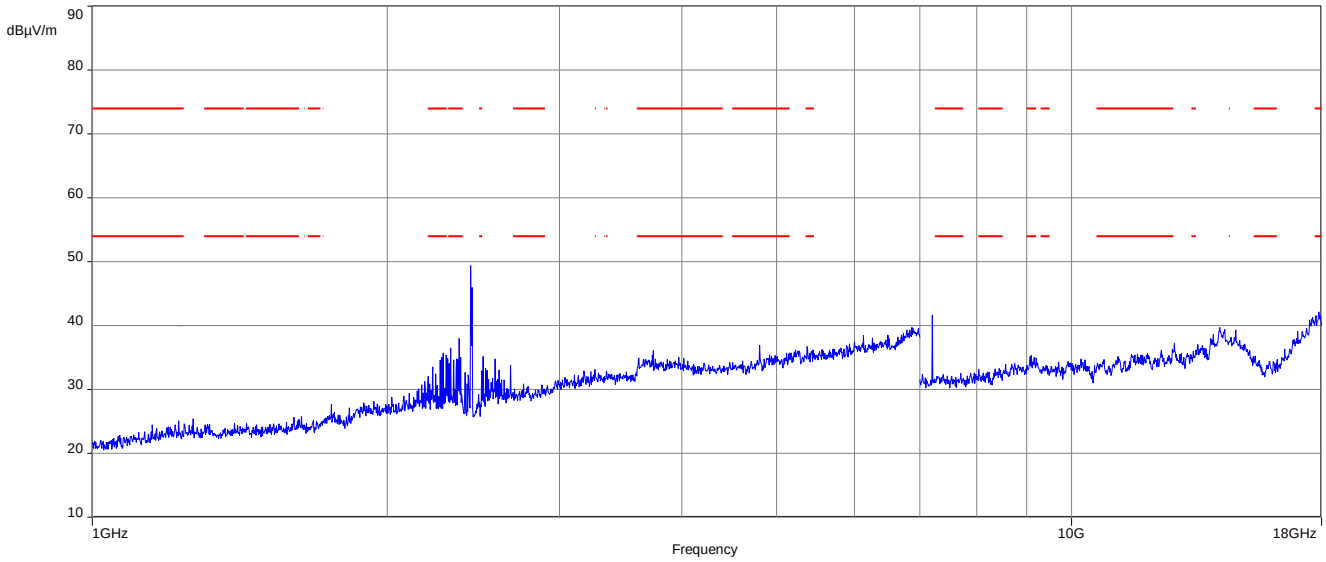


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 18: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 1 Msps, external antenna

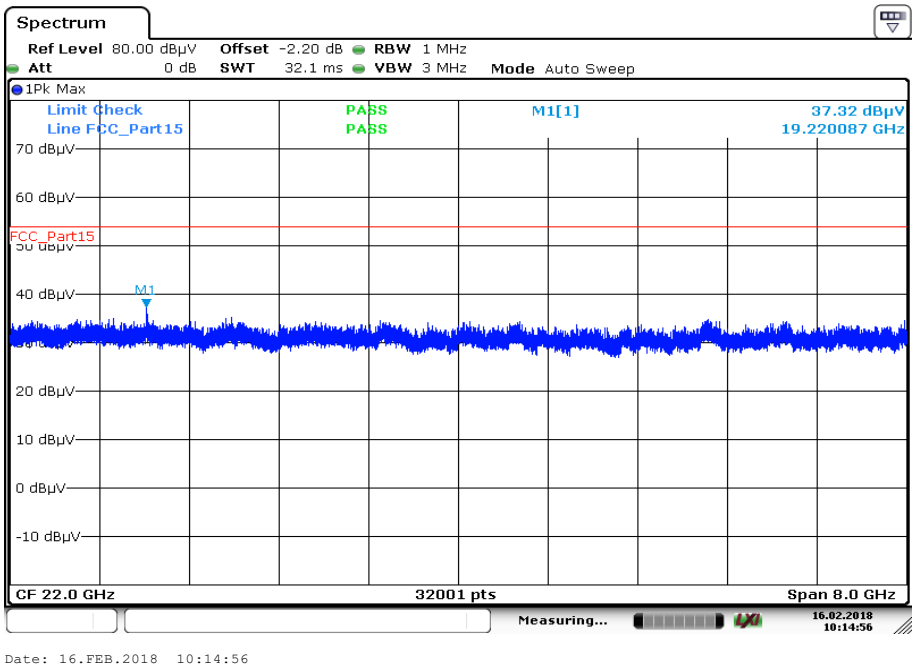


Plot 19: 1 GHz to 18 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 2 Msps, external antenna

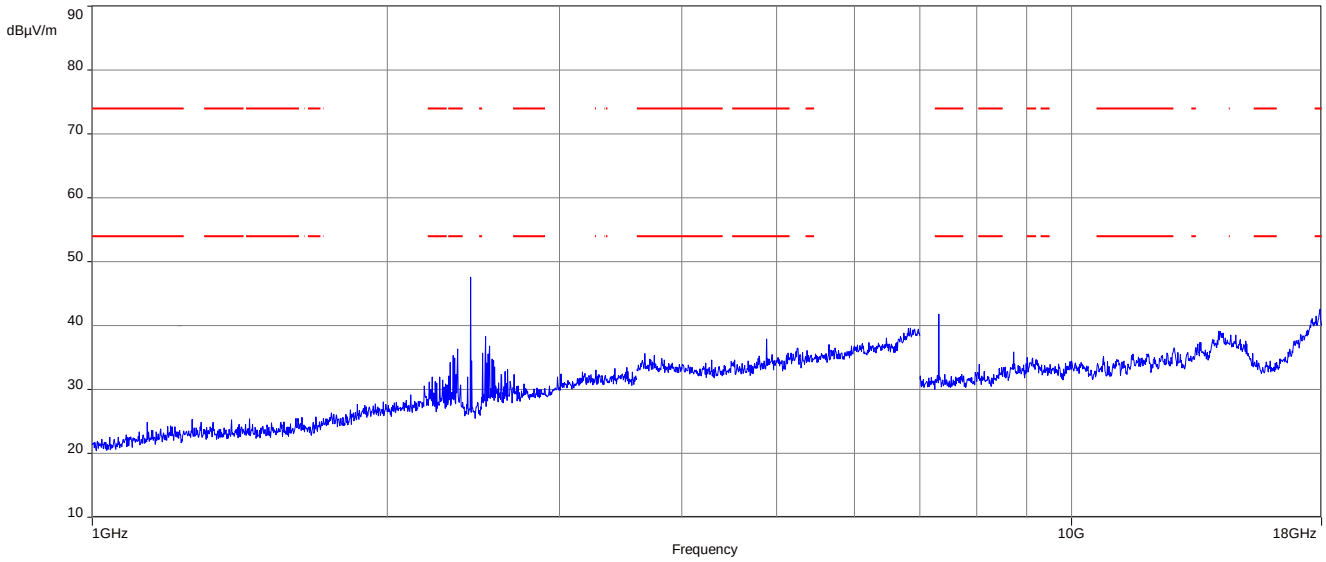


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 20: 18 GHz to 26 GHz, TX mode, 2402 MHz, vertical & horizontal polarization, 2 Msps, external antenna

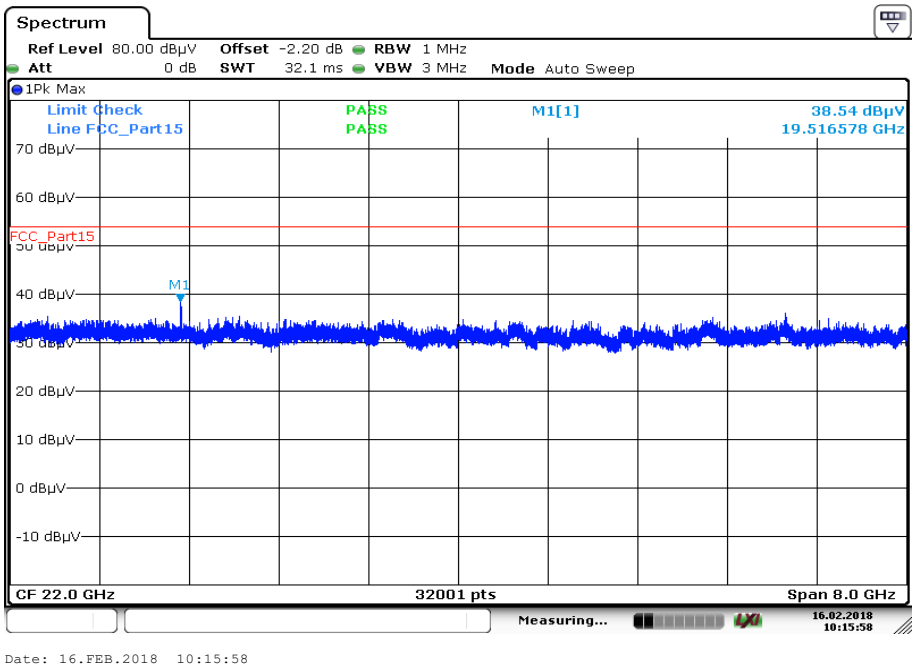


Plot 21: 1 GHz to 18 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 2 Msps, external antenna

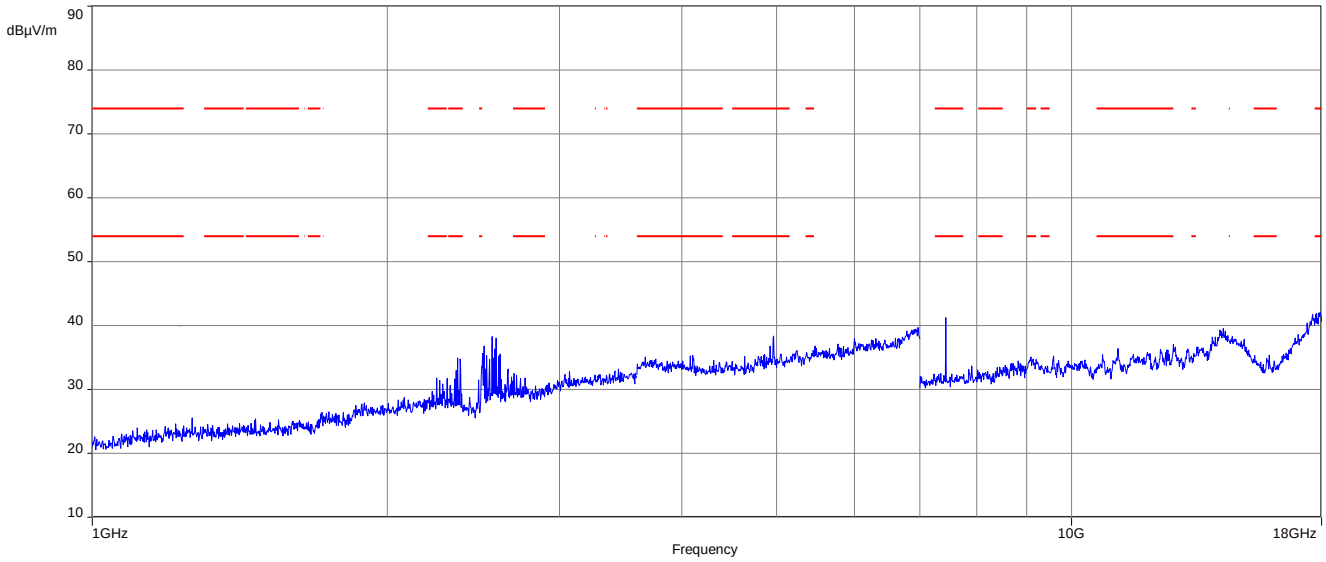


The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 22: 18 GHz to 26 GHz, TX mode, 2440 MHz, vertical & horizontal polarization, 2 Msps, external antenna

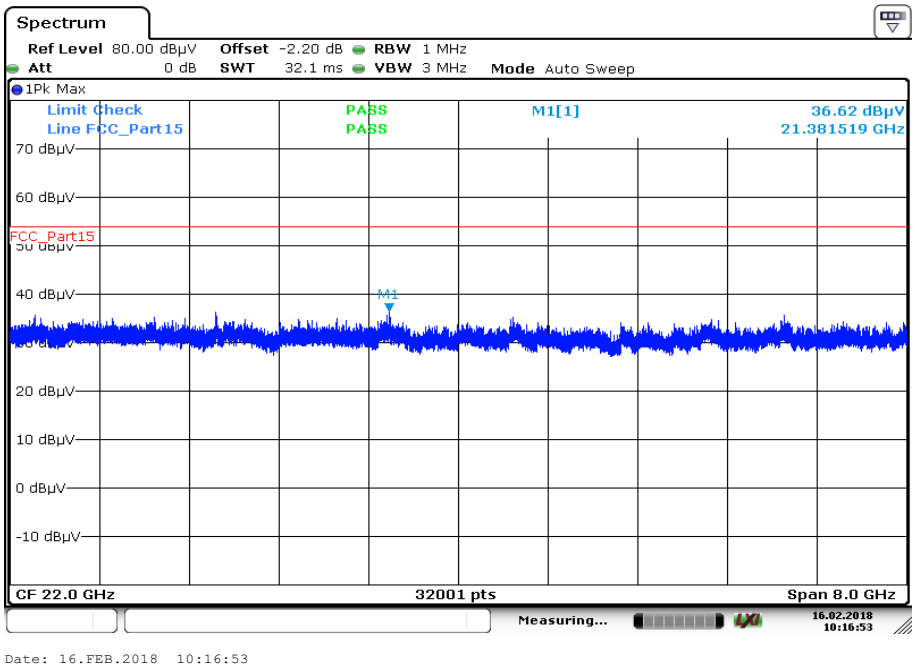


Plot 23: 1 GHz to 18 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 2 Msps, external antenna



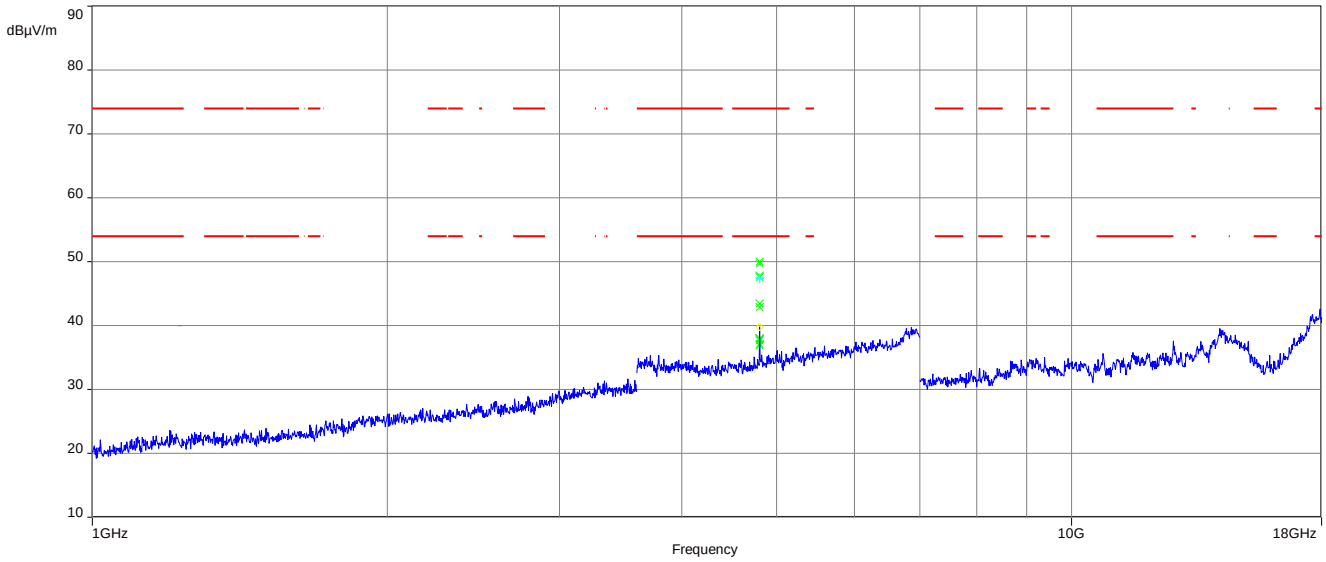
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 24: 18 GHz to 26 GHz, TX mode, 2480 MHz, vertical & horizontal polarization, 2 Msps, external antenna

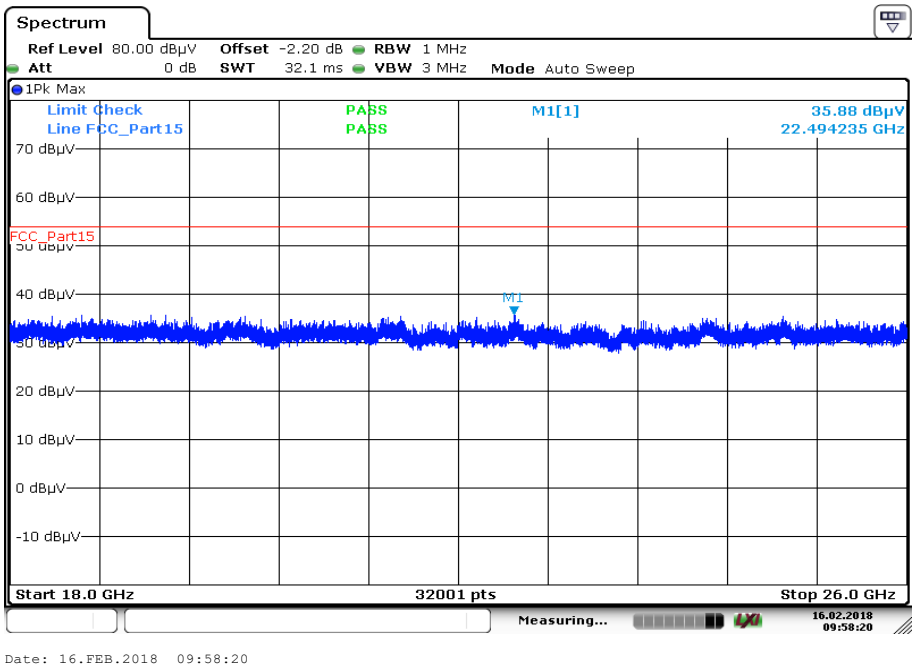


Plots: Receiver mode

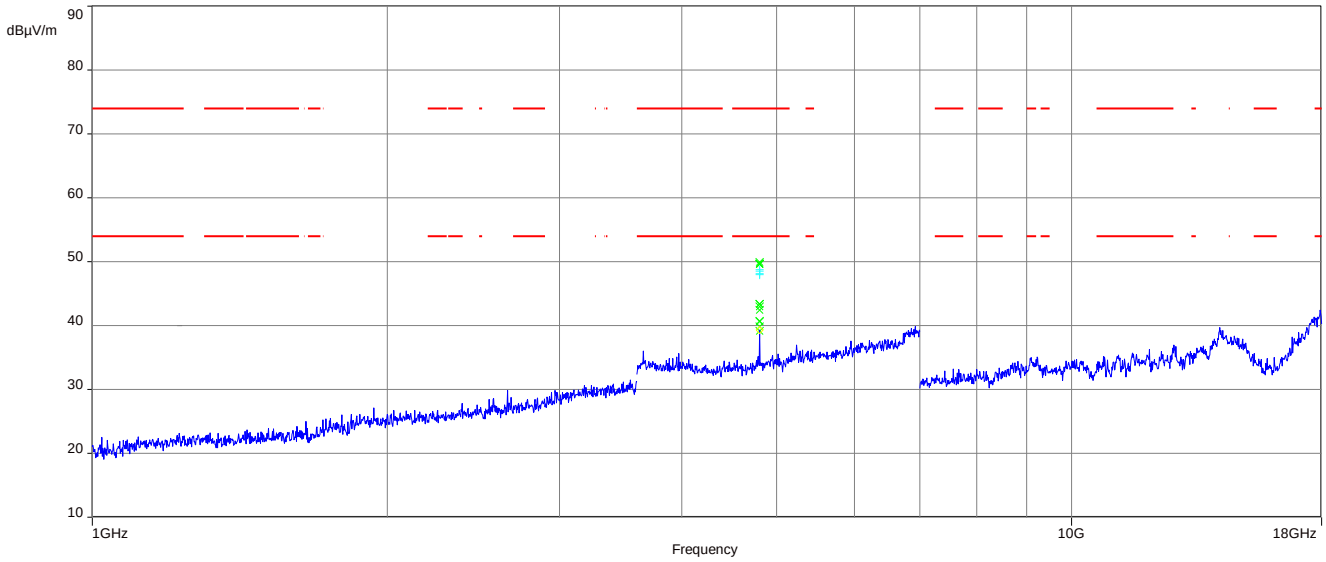
Plot 1: 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization, on-board antenna



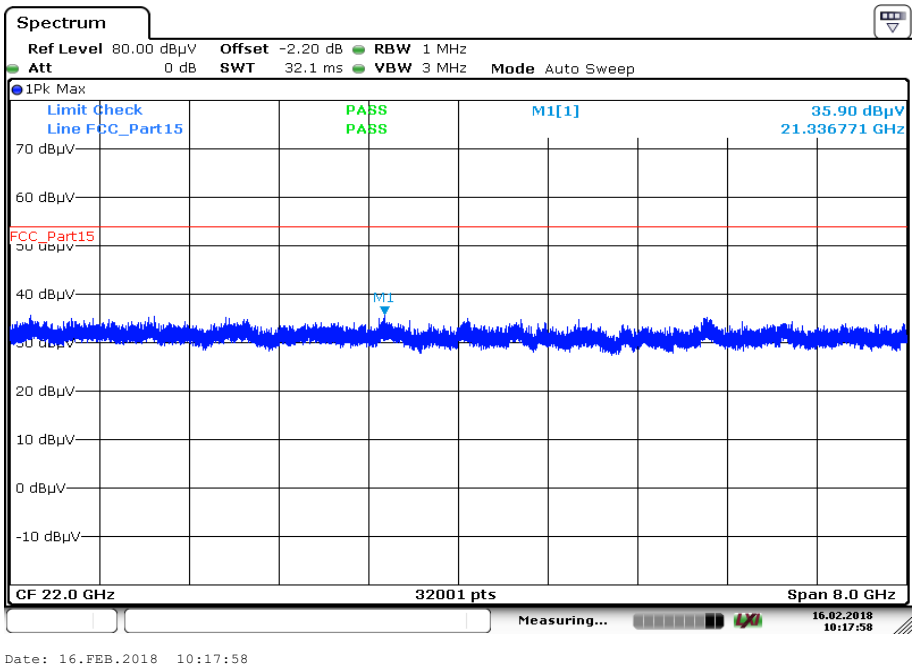
Plot 2: 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization, on-board antenna



Plot 3: 1 GHz to 18 GHz, RX / idle – mode, vertical & horizontal polarization, external antenna



Plot 4: 18 GHz to 26 GHz, RX / idle – mode, vertical & horizontal polarization, external antenna



Annex A Glossary

EUT	Equipment under test
DUT	Device under test
UUT	Unit under test
GUE	GNSS User Equipment
ETSI	European Telecommunications Standards Institute
EN	European Standard
FCC	Federal Communications Commission
FCC ID	Company Identifier at FCC
IC	Industry Canada
PMN	Product marketing name
HMN	Host marketing name
HVIN	Hardware version identification number
FVIN	Firmware version identification number
EMC	Electromagnetic Compatibility
HW	Hardware
SW	Software
Inv. No.	Inventory number
S/N or SN	Serial number
C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
PP	Positive peak
QP	Quasi peak
AVG	Average
OC	Operating channel
OCW	Operating channel bandwidth
OBW	Occupied bandwidth
OOB	Out of band
DFS	Dynamic frequency selection
CAC	Channel availability check
OP	Occupancy period
NOP	Non occupancy period
DC	Duty cycle
PER	Packet error rate
CW	Clean wave
MC	Modulated carrier
WLAN	Wireless local area network
RLAN	Radio local area network
DSSS	Dynamic sequence spread spectrum
OFDM	Orthogonal frequency division multiplexing
FHSS	Frequency hopping spread spectrum
GNSS	Global Navigation Satellite System
C/N_0	Carrier to noise-density ratio, expressed in dB-Hz

Annex B Document history

Version	Applied changes	Date of release
-/-	Initial release	2018-02-20

Annex C Accreditation Certificate

first page	last page
	

Note: The current certificate annex is published on the website (link see below) of the Accreditation Body DAkkS or may be received by CTC advanced GmbH on request

http://www.dakks.de/as/ast/d/D-PL-12076-01-03.pdf