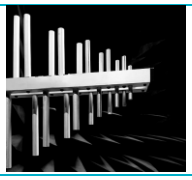
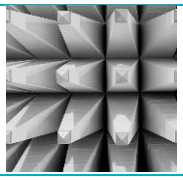




CETECOM ICT Services is now

CTC advanced
member of RWTÜV group

TEST REPORT

Test report no.: 1-1204/16-01-06-C

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

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-12076-01-01

Applicant

SAFEmine (part of Hexagon Mining)
Lindenstr. 4
6340 Baar / SWITZERLAND
Phone: +41417608567
Fax: +41417608565
Contact: André Reichmuth
e-mail: andre.reichmuth@hexagonmining.com
Phone: +41417298766

Manufacturer

Placetec AG
Industriestrasse 17
4410 Liestal / SWITZERLAND

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:	**Collision Avoidance Main Unit**
Model name:	**QC250**
FCC ID:	**ZKSQC250B**
IC:	**9849A-QC250B**
Frequency:	902 MHz - 928 MHz Lowest channel 902.4 MHz – highest channel 922.0 MHz
Technology tested:	Proprietary hopping system
Antenna:	External antenna
Power supply:	10.8 V to 13.2 V DC by car battery
Temperature range:	-40°C to +60°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=CTC advanced GmbH, ou=BOE-161129, email=Stefan.Boes@ctcadvanced.com, c=DE
2017.02.16 14:27:00 +01'00'

Stefan Bös
Lab Manager
Radio Communications & EMC

Test performed:

cn=Rene Oelmann, o=CTC Advanced GmbH, ou=OEL-161129, email=rene.oelmann@ctcadvanced.com, c=DE
2017.02.16 10:10:08 +01'00'

René Oelmann
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.
The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CTC advanced GmbH.
The testing service provided by CTC advanced GmbH has been rendered under the current "General Terms and Conditions for CTC advanced GmbH".
CTC advanced GmbH will not be liable for any loss or damage resulting from false, inaccurate, inappropriate or incomplete product information provided by the customer.
Under no circumstances does the CTC advanced GmbH test report include any endorsement or warranty regarding the functionality, quality or performance of any other product or service provided.
Under no circumstances does the CTC advanced GmbH test report include or imply any product or service warranties from CTC advanced GmbH, including, without limitation, any implied warranties of merchantability, fitness for purpose, or non-infringement, all of which are expressly disclaimed by CTC advanced GmbH.
All rights and remedies regarding vendor's products and services for which CTC advanced GmbH has prepared this test report shall be provided by the party offering such products or services and not by CTC advanced GmbH.
In no case this test report can be considered as a Letter of Approval.

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.

This test report replaces test report 1-1204/16-01-06-B dated from 2017-01-04.

2.2 Application details

Date of receipt of order:	2016-03-03
Date of receipt of test item:	2016-03-21
Start of test:	2016-03-21
End of test:	2016-05-04
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
DTS: KDB 558074 D01	v03r05	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}	+23 °C during room temperature tests +60 °C during high temperature tests -40 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	12.0 V DC by car battery 13.2 V 10.8 V

5 Test item

5.1 General description

Kind of test item	:	Collision Avoidance Main Unit
Type identification	:	QC250
HMN	:	-/-
PMN	:	QC250
HVIN	:	QC250 Rev. B
FVIN	:	-/-
S/N serial number	:	70040114431
HW hardware status	:	Rev. B
SW software status	:	3.10_4509
Frequency band	:	902 MHz - 928 MHz Lowest channel 902.4 MHz – highest channel 922.0 MHz
Type of radio transmission Use of frequency spectrum	: :	Proprietary hopping system
Number of channels	:	50
Antenna	:	External antenna
Power supply	:	10.8 V to 13.2 V DC by car battery
Temperature range	:	-40°C to +60°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: 1-1204/06-01-01_AnnexA
1-1204/06-01-01_AnnexB
1-1204/06-01-01_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).

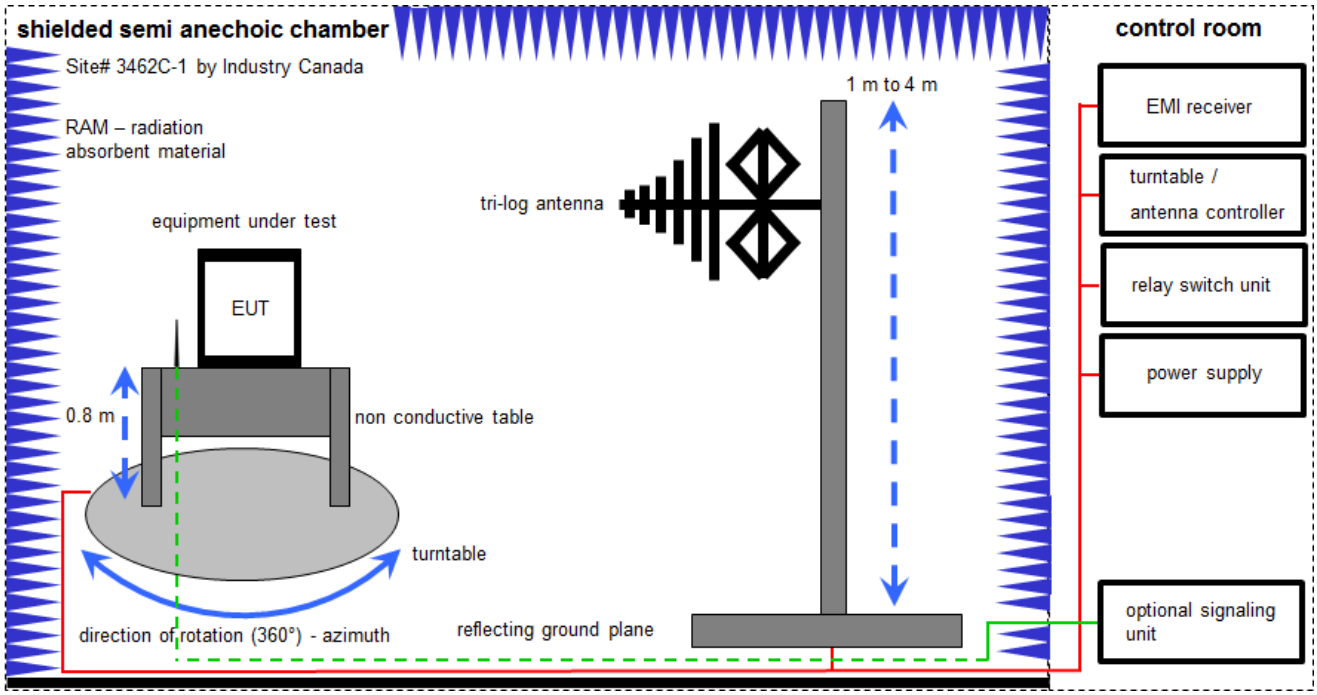
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

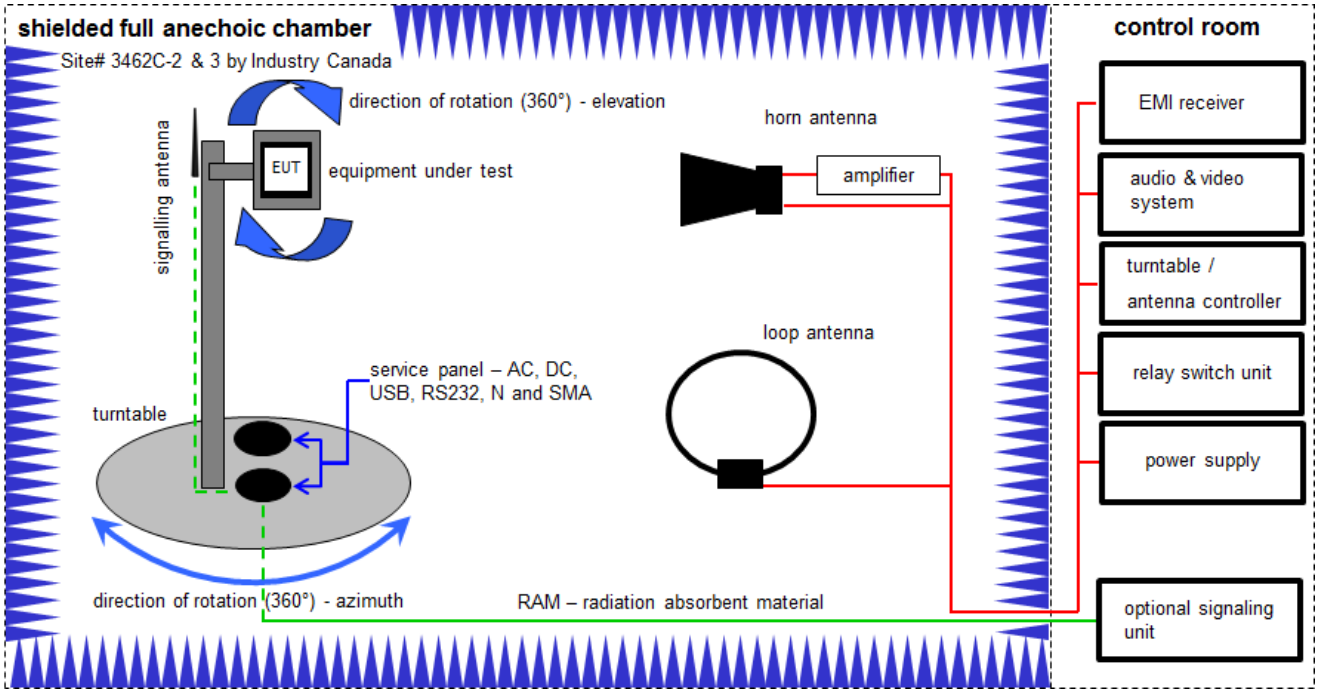
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	45	Switch-Unit	3488A	HP	2719A14505	300000368	ev	-/-	-/-
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2920A04466	300000580	ne	-/-	-/-
3	67	RF-Filter-section	85420E	HP	3427A00162	300002214	k	27.11.2006	-/-
4	67	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	08.03.2016	08.03.2017
5	67	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
6	67	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
7	67	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
8	67	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	25.04.2016	25.04.2018
9	67	Spectrum-Analyzer	FSU26	R&S	200809	300003874	k	29.01.2016	29.01.2017

7.2 Shielded fully anechoic chamber



Measurement distance: 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)

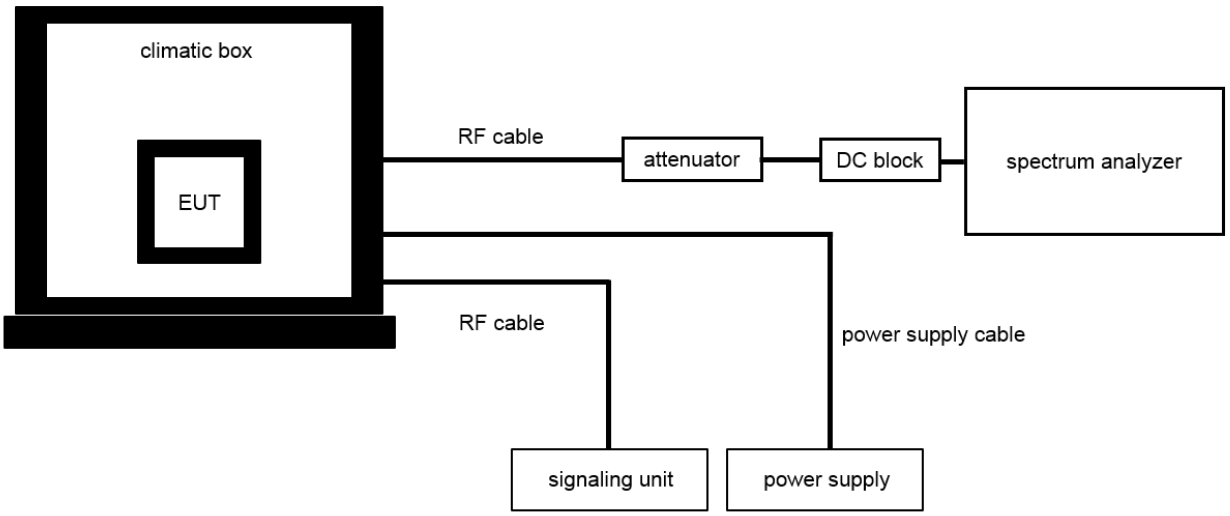
Example calculation:
FS [dBµV/m] = 40.0 [dBµV/m] + (-35.8) [dB] + 32.9 [dB/m] = 37.1 [dBµV/m] (71.61 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	n. a.	Power Supply 0-20V	6632A	HP	2851A01814	300000924	ne	09.11.2005	-/-
2	n. a.	Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	9709-5290	300000212	k	13.08.2015	13.08.2017
3	n. a.	Universal Communication Tester	CMU200	R&S	106826	300003346	k	10.02.2016	10.02.2017
4	n. a.	Software Option für CMU 200	CMU-Kxx	R&S	106826	300003345	ne	-/-	-/-
5	n. a.	EMI Test Receiver 20Hz- 26,5GHz	ESU26	R&S	100037	300003555	k	02.02.2016	02.02.2017
6	n. a.	Highpass Filter	WHK1.1/15G-10SS	Wainwright	37	400000148	ne	-/-	-/-
7	n. a.	4U RF Switch Platform	L4491A	Agilent Technologies	MY50000032	300004510	ne	-/-	-/-
8	n. a.	Messrechner und Monitor	Intel Core i3 3220/3,3 GHz, Prozessor	Agilent Technologies	2V2403033A5421	300004591	ne	-/-	-/-
9	n. a.	Highpass Filter	WHKX2.6/18G-10SS	Wainwright	12	300004651	ne	-/-	-/-
10	n. a.	NEXIO EMV-Software	BAT EMC	EMCO	1	300004682	ne	-/-	-/-

7.3 Conducted measurements normal and extreme conditions

Conducted measurements normal & extreme conditions



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	n. a.	Isolating Transformer	RT5A	Grundig	8041	300001626	g	-/-	-/-
2	8	DC Power Supply, 60V, 10A	6038A	HP	3122A11097	300001204	Ve	21.01.2015	21.01.2018
3	8	Vektor Signal Generator	SMU200A	R&S	101633	300003496	k	07.04.2014	07.04.2017
4	8	Signalgenerator 1-20 GHz	SMR20	R&S	101697/020	300003593	k	27.01.2016	27.01.2018
5	8	Power Supply 0-20V; 0-5A	6632B	HP	US37478366	400000117	vIKI!	20.01.2015	20.01.2017
6	8	Temperature Test Chamber	VT 4002	Heraeus Voetsch	521/84193	300003889	ev	03.09.2015	03.09.2017
7	8	Vektorsignalgenerator	SMBV100A	R&S	257994	300004516	Ve	25.01.2016	25.01.2019
8	8	Signal Analyzer 40 GHz	FSV40	R&S	101353	300004819	k	24.08.2015	24.08.2016
9	8	Open Switch and Control Unit and Power Sensors	OSP120 incl. B157	R&S	101274, 100877	300004825	k	05.08.2014	05.08.2016
10	8	Rechner für Schalt- und Steuerplattform OSP	exone Variety	R&S	060931P1302P00109	300004869	ne	-/-	-/-
11	8	Power Supply + 2nd Power Supply	LA 2x75/2 GF	zentro-elektrik	900003	300001008	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.

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 1	See table	2017-02-16	-/-

Test specification clause	Test case	Temperature conditions	Power source voltages	Mode	C	NC	NA	NP	Results (max.)
§15.247(b)(4)	**Antenna Gain**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(a)(1) (i) RSS-247 5.1(2)	**Carrier Frequency Separation**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(a)(1)(i) RSS-247 5.1(3)	**Number of Hopping channels**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(a)(1)(i) RSS-247 5.1(3)	**Average Time of Occupancy (Dwell Time)**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(a)(1)(i) RSS-247 5.1(3)	**20dB Bandwidth**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(b)(2) RSS-247 5.4(1)	**Maximum Output Power Radiated**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(b)(4) RSS-247 5.4(1)	**Maximum Output Power Conducted**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(d) §15.205(a)	**Band-edge Compliance**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(d) RSS-247 5.5	**TX Spurious Emission Conducted**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.209(a)	**TX Spurious Emission Radiated < 30 MHz**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.247(d) §15.209	**TX Spurious Emission Radiated > 30 MHz**	Nominal	Nominal	TX	☒	☐	☐	☐	
§15.109 §15.207	**RX Spurious Emissions Radiated**	Nominal	Nominal	Idle	☒	☐	☐	☐	

Note: C = Compliant; NC = Not compliant; NA = Not Applicable; NP = Not Performed

10 RF measurements

10.1 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

Test mode: ☒ Special software is used.
EUT is transmitting pseudo random data by itself

11 Measurement results

11.1 Antenna gain

The antenna gain of the complete system is calculated by the difference of radiated power in EIRP and the conducted power of the module.

	Low channel 902.4 MHz	Middle channel 912.0 MHz	High channel 922.0 MHz
Conducted power [dBm]	15.91	17.42	16.89
Radiated power [dBm]	19.56	19.35	18.91
Gain [dBi] Calculated	3.65	1.93	2.02

Limits:

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

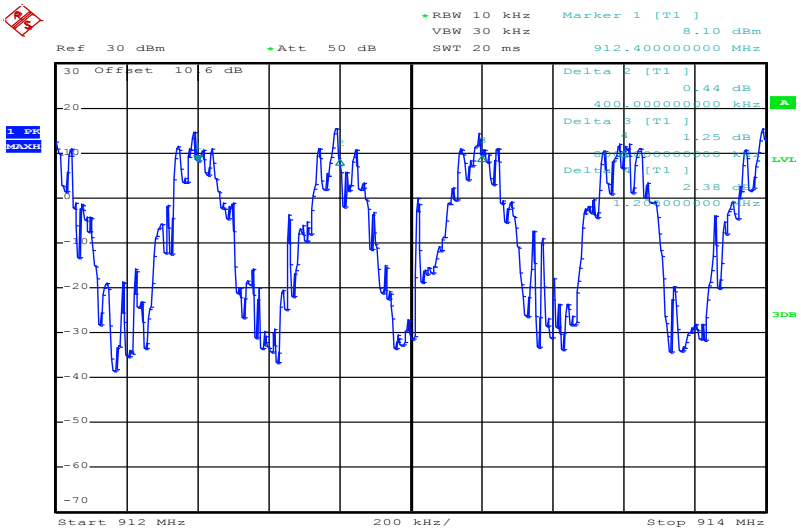
11.2 Carrier Frequency Separation

Result: The channel separation is: 400 kHz

Limits:

FCC	IC
Carrier Frequency Separation	
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.	

Plot 1:



NOP
Date: 29.APR.2016 11:06:06

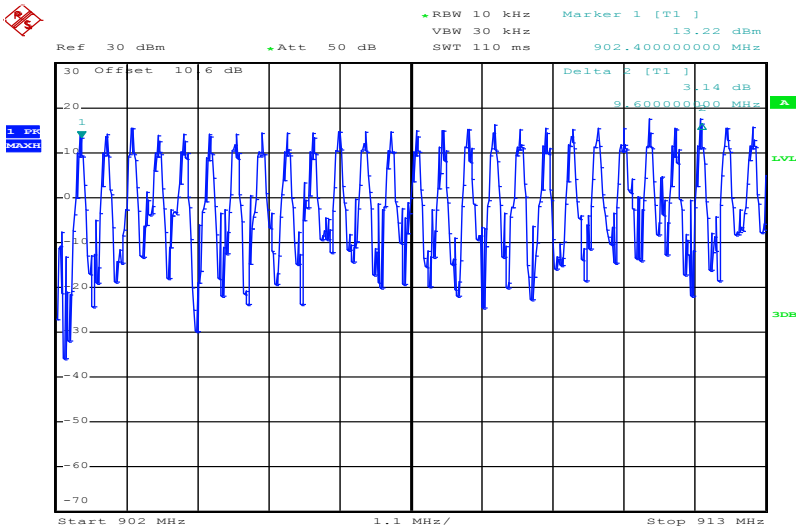
11.3 Number of Hopping Channels

Result: The number of hopping channels is: 50

Limits:

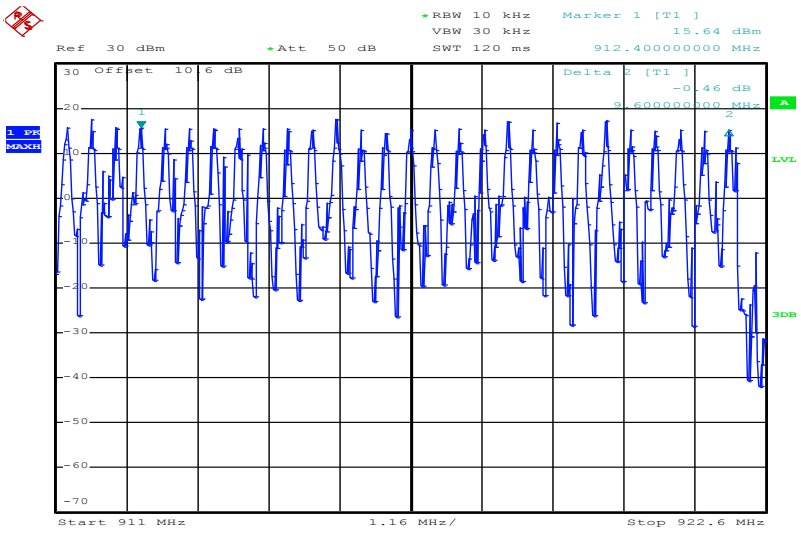
FCC	IC
Number of Hopping Channels	
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.	

Plot 1:



NOP
Date: 29.APR.2016 09:58:44

Plot 2:

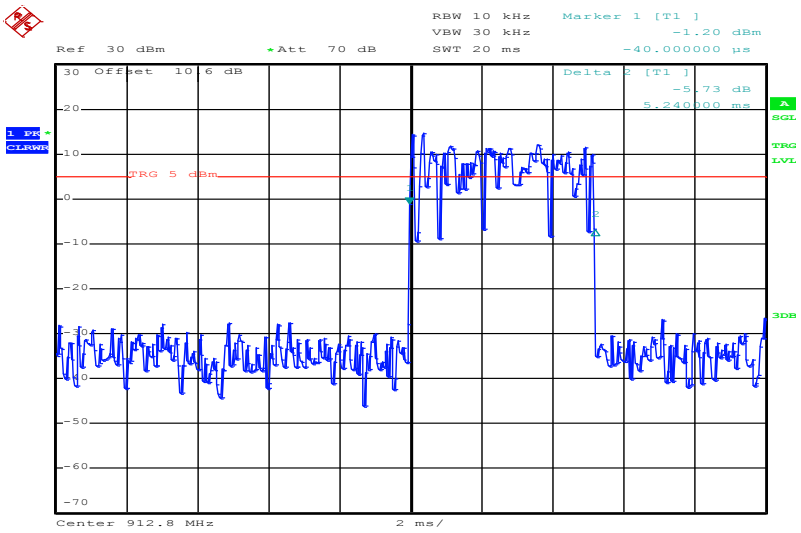


NOP
Date: 29.APR.2016 10:59:30

11.4 Average Time of Occupancy

Plots:

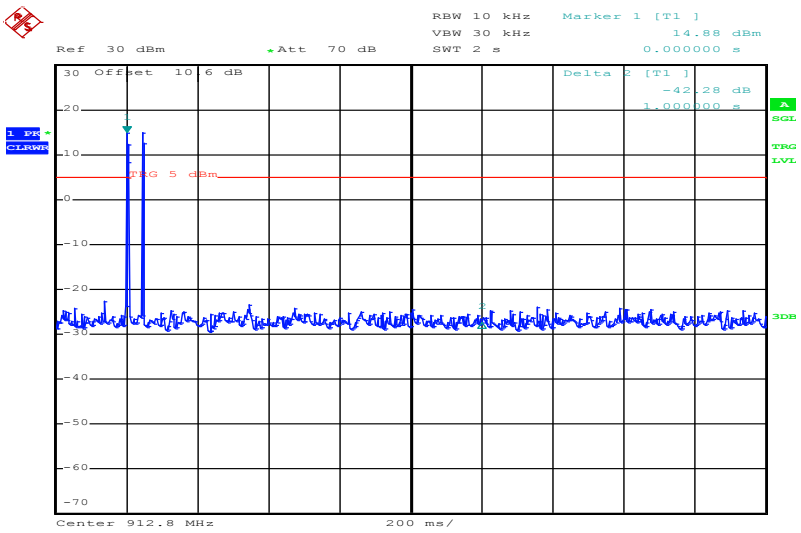
Plot 1: Time slot length = 5.24 ms



NOP

Date: 29.APR.2016 11:21:33

Plot 2: hops / channel @ 1s = 2



NOP

Date: 29.APR.2016 11:24:32

Result: The time slot length is = 5.24 ms
Number of hops / channel @ 1s = 2

Within 10 s period, the average time of occupancy = 10 s * 2 * 5.24 ms

→ The average time of occupancy = 104.8 ms

Limits:

FCC	IC
Average time of occupancy	
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within 10 second period.	

11.5 20 dB Bandwidth

Description:

Measurement of the 20 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	10 kHz
Resolution bandwidth:	30 kHz
Span:	See plots
Trace-Mode:	Max Hold

Result:

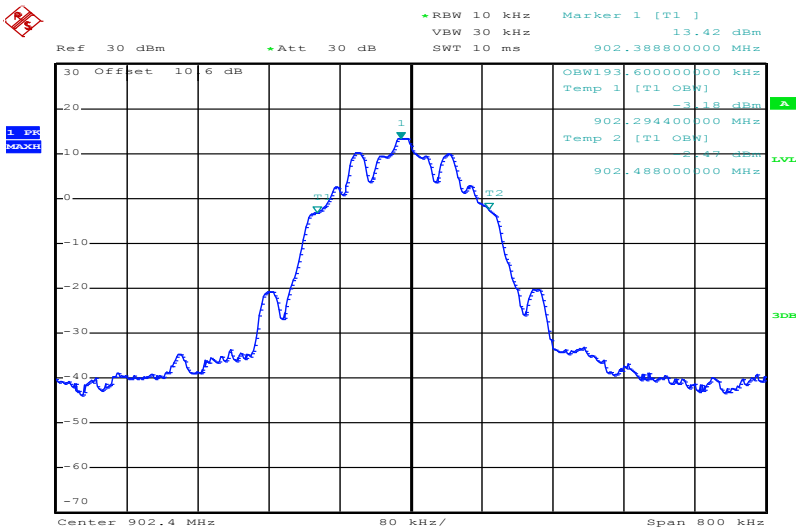
Test Conditions		20dB BANDWIDTH [kHz]		
		Low channel 902.4 MHz	Middle channel 912.0 MHz	High channel 922.0 MHz
T_{nom}	V_{nom}	193.6	193.6	190.4
Measurement uncertainty		± 30 kHz		

Limits:

FCC	IC
20dB Bandwidth	
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	

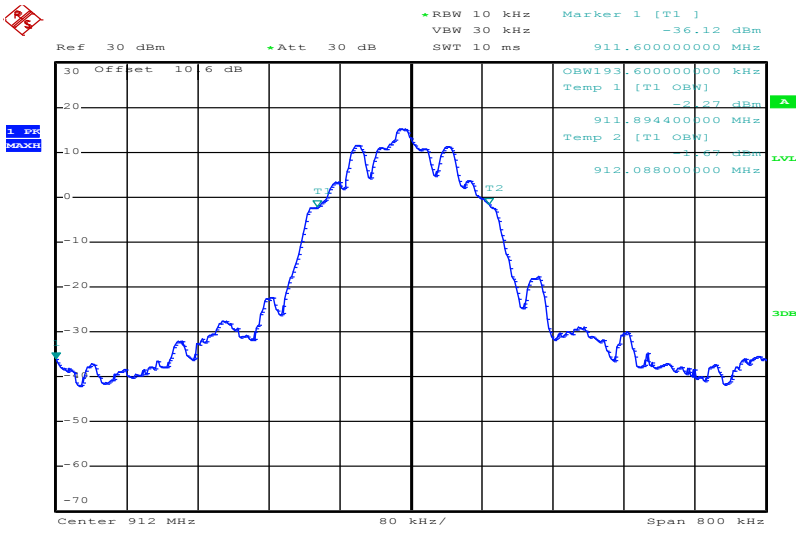
Plots:

Plot 1: Low Channel



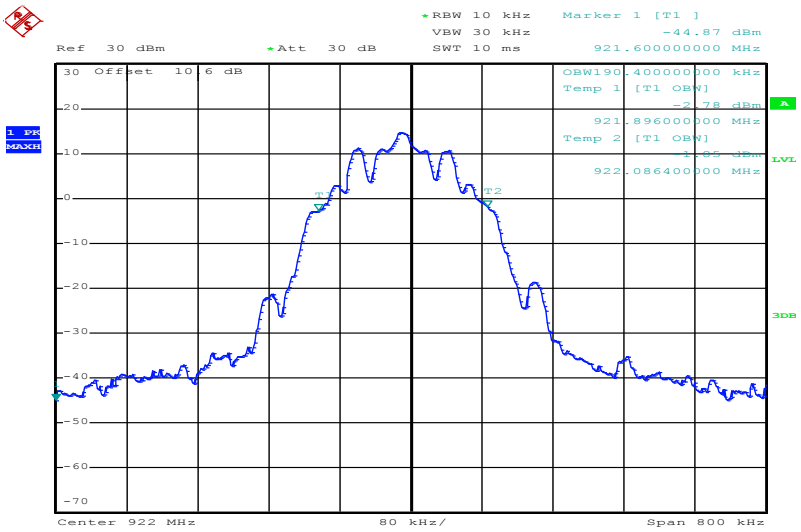
NOP
Date: 29.APR.2016 14:07:00

Plot 2: Middle Channel



NOP
Date: 29.APR.2016 14:13:22

Plot 3: High Channel



NOP
Date: 29.APR.2016 14:14:26

11.6 Maximum Output Power Radiated

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	1 MHz
Span:	5 MHz
Trace-Mode:	Max Hold

Result:

Test Conditions		EIRP [dBm]		
		Low channel 902.4 MHz	Middle channel 912.0 MHz	High channel 922.0 MHz
T_{nom}	V_{nom}	19.56	19.35	18.91
Measurement uncertainty		± 3dB		

Limits:

FCC	IC
EIRP	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	

11.7 Maximum Output Power Conducted

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	1 MHz
Video bandwidth:	1 MHz
Span:	5 MHz
Trace-Mode:	Max Hold

Result:

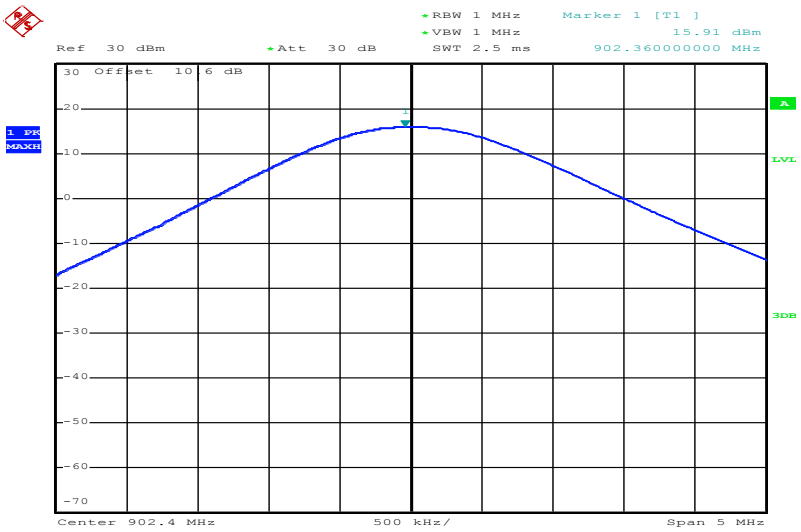
Test Conditions		Maximum Output Power Conducted [dBm]		
		Low channel 902.4 MHz	Middle channel 912.0 MHz	High channel 922.0 MHz
T_{nom}	V_{nom}	15.91	17.42	16.89
Measurement uncertainty		± 3 dB		

Limits:

FCC	IC
Maximum Output Power Conducted	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.	

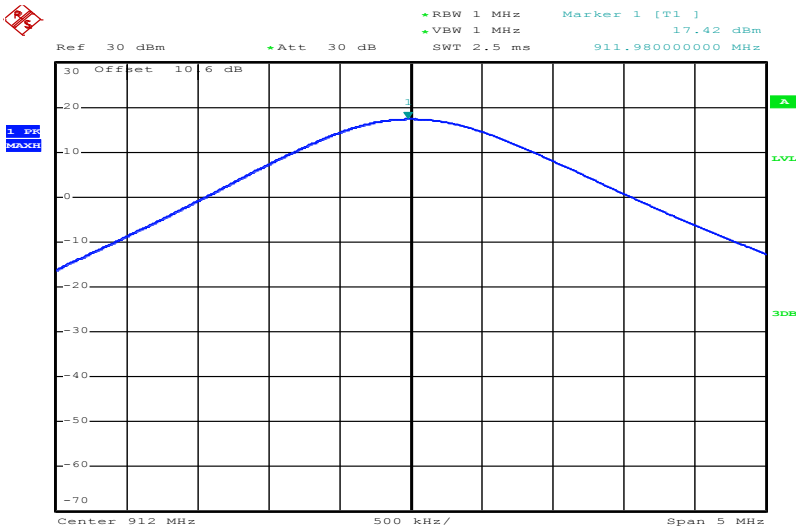
Plots:

Plot 1: Low Channel



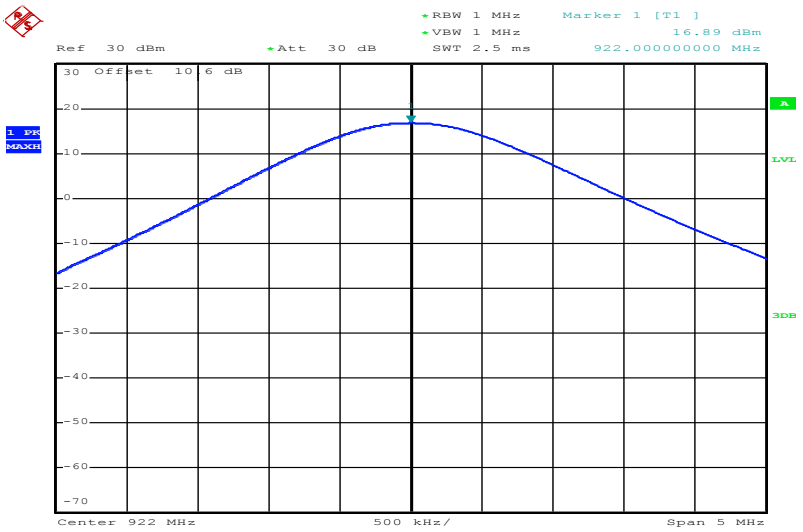
NOP
Date: 2.MAY.2016 08:09:32

Plot 2: Middle Channel



NOP
Date: 2.MAY.2016 08:11:25

Plot 3: High Channel



NOP
Date: 2.MAY.2016 08:14:16

11.8 Band-edge Compliance of conducted and radiated emissions

No restricted band in the range ± 2 channel bandwidths of the Band-edges of the specified emission band! (608 MHz – 614 MHz and 960 MHz – 1240 MHz).

Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

Limits:

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

Result: See Results of spurious emissions conducted and radiated.

11.9 Spurious Emissions Conducted (Transmitter)

Description:

Measurement of the conducted spurious emissions in transmit mode. The measurement is performed at channel 00, 12 and 24.

Measurement:

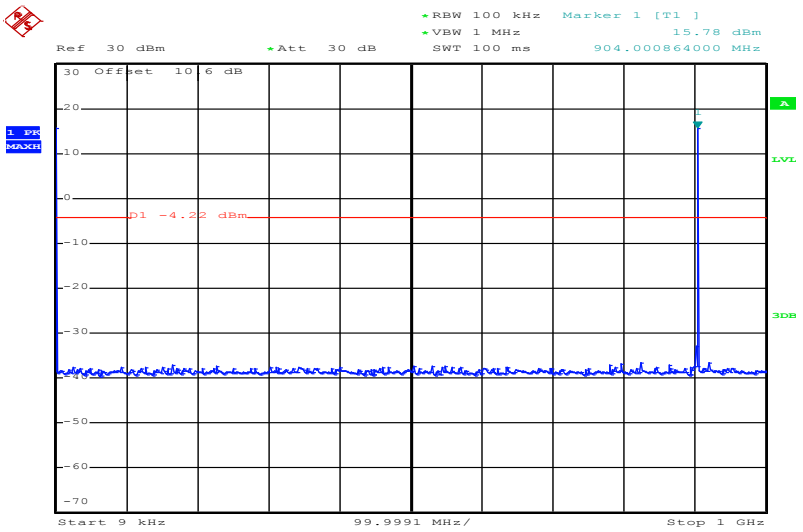
Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Video bandwidth:	F < 1 GHz: 1 MHz F > 1 GHz: 1 MHz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 100 kHz
Span:	9 kHz to 12.75 GHz
Trace-Mode:	Max Hold

Limits:

FCC	IC
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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).	

Plots:

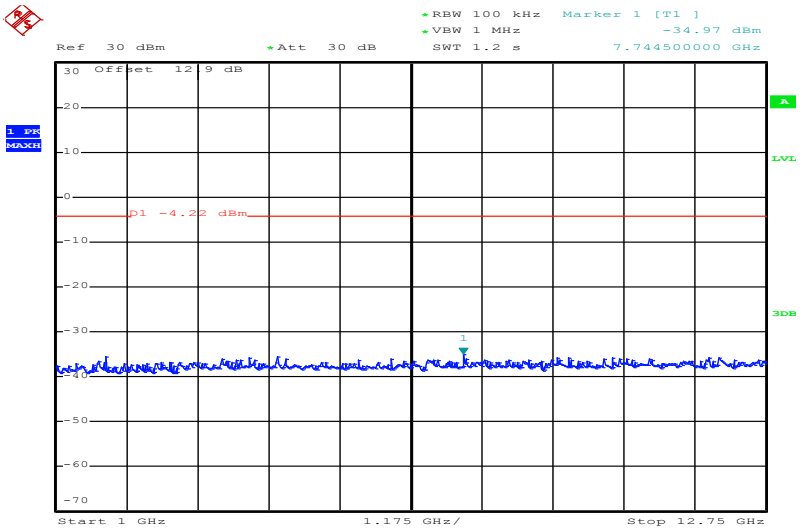
Plot 1: Low channel



NOP

Date: 2.MAY.2016 08:31:45

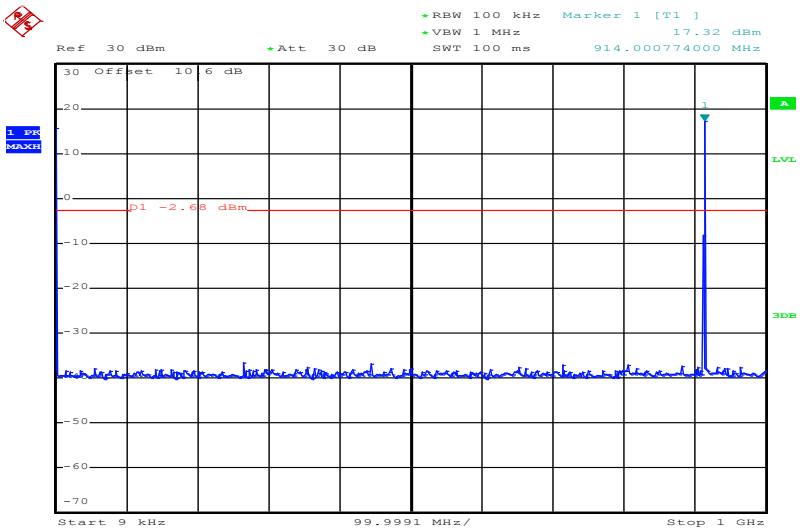
Plot 2: Low channel



NOP

Date: 2.MAY.2016 08:48:41

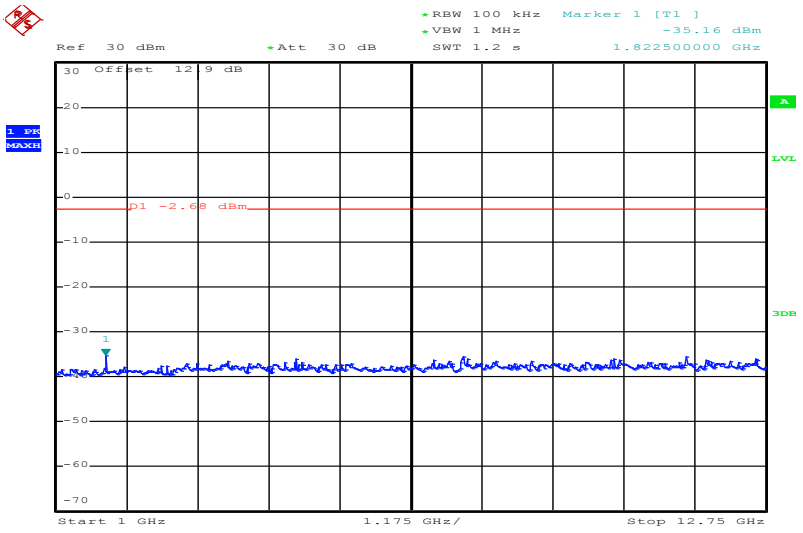
Plot 3: Middle channel



NOP

Date: 2.MAY.2016 08:33:40

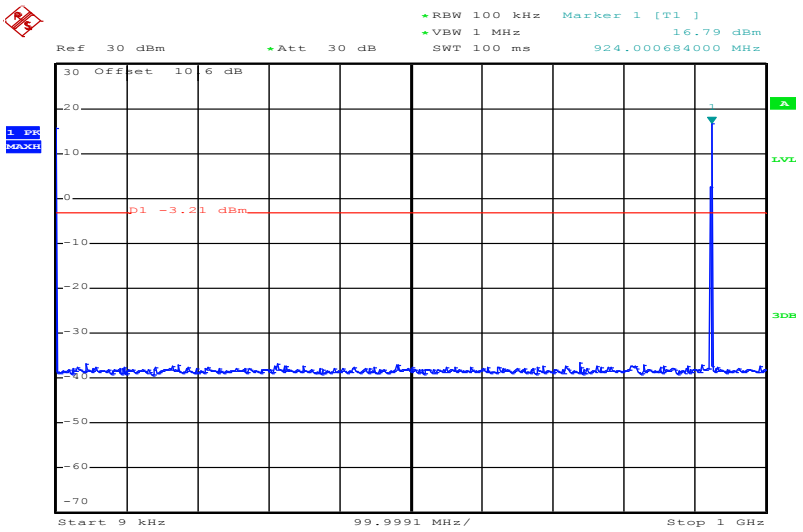
Plot 4: Middle channel



NOP

Date: 2.MAY.2016 08:50:02

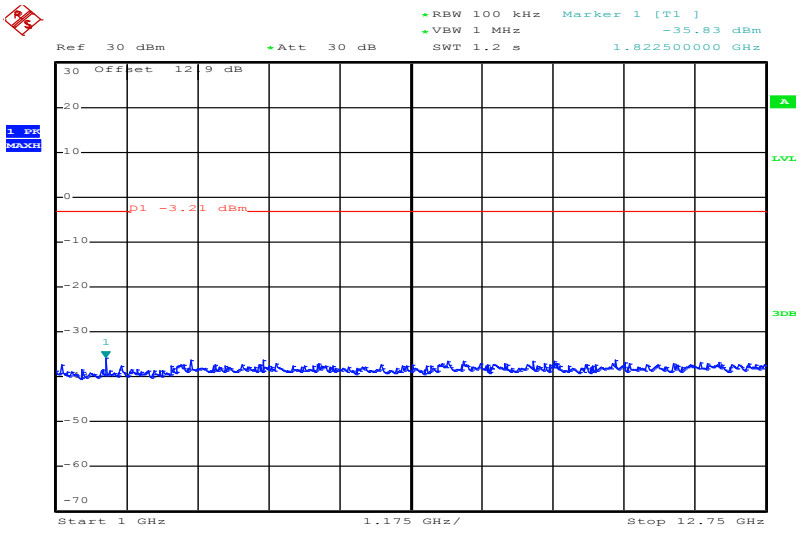
Plot 5: High channel



NOP

Date: 2.MAY.2016 08:45:51

Plot 6: High channel



NOP

Date: 2.MAY.2016 08:51:58

Result:

Emission Limitation					
Frequency [MHz]		Amplitude of emission [dBm]	Limit max. allowed emission power	actual attenuation below frequency of operation [dB]	Results
902.4		15.78	24 dBm		Operating frequency
No critical peaks detected! All detected emissions are more than 20 dB below the limit!			-20 dBc		
912.0		17.32	24 dBm		Operating frequency
No critical peaks detected! All detected emissions are more than 20 dB below the limit!			-20 dBc		
922.0		16.79	24 dBm		Operating frequency
No critical peaks detected! All detected emissions are more than 20 dB below the limit!			-20 dBc		
Measurement uncertainty		± 3dB			

Limits:

FCC	IC
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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).	

11.10 Spurious Emissions Radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to channel 12. This measurement is representative for all channels and modes. If any peaks are found channel 00 and channel 24 will be measured too. The limits are recalculated to a measurement distance of 3 m with 40 dB/decade according CFR Part 2.

Measurement:

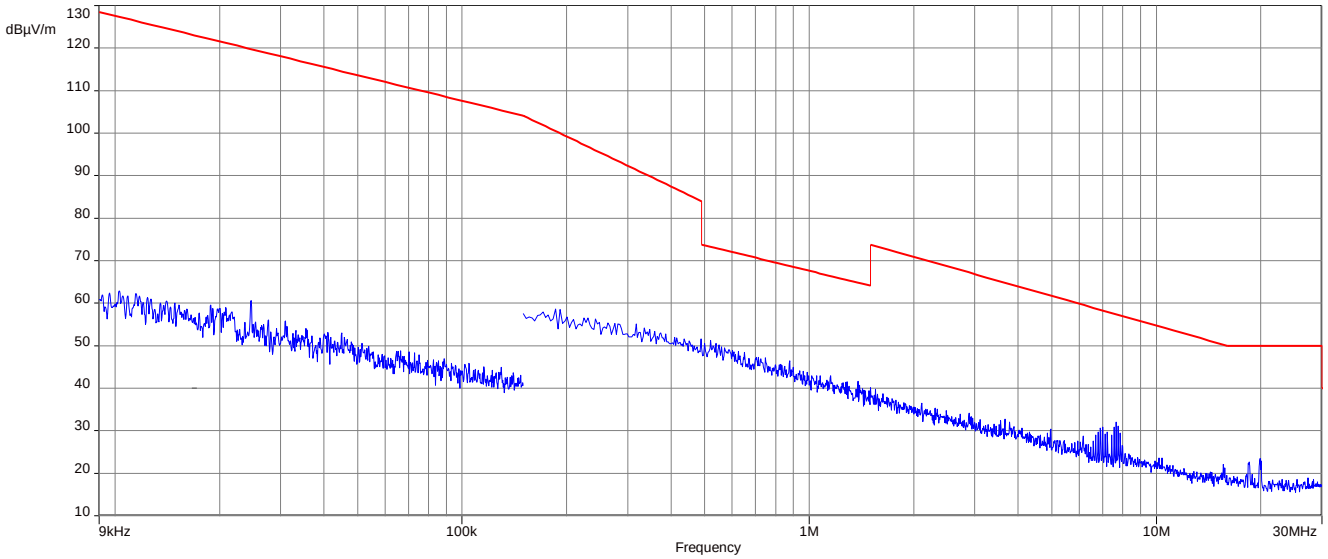
Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Resolution bandwidth:	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span:	9 kHz to 30 MHz
Trace-Mode:	Max Hold

Limits:

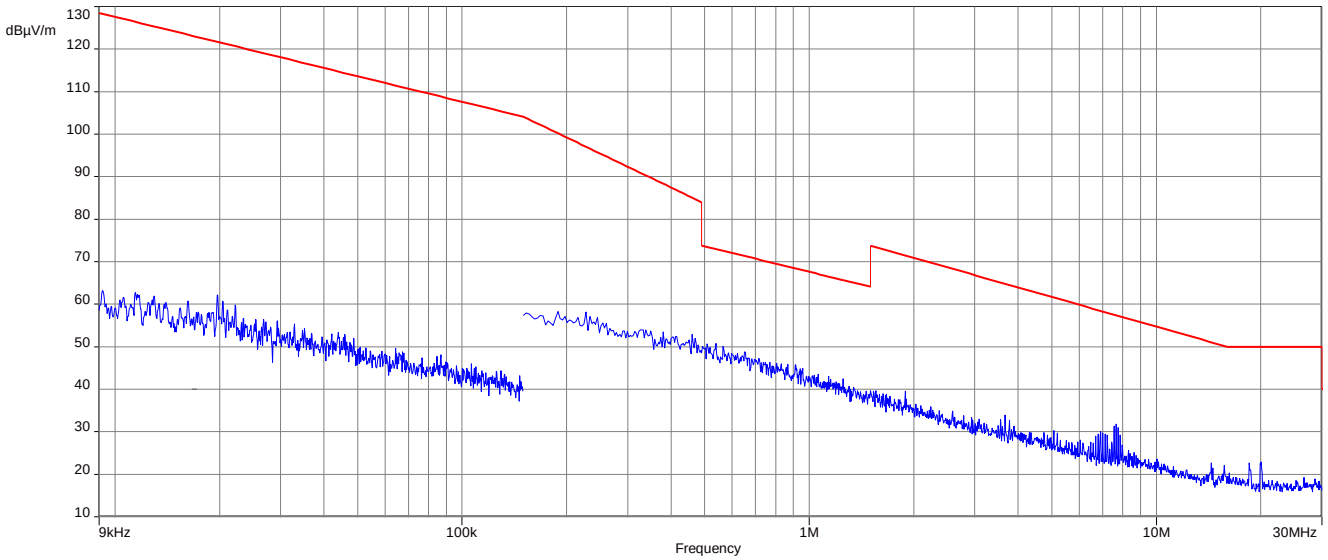
FCC		IC
TX spurious emissions radiated < 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Plots:

Plot 1: TX-Mode



Plot 2: RX-Mode



11.11 Spurious Emissions Radiated (Transmitter) > 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	3 x RBW Remeasurement: 10 Hz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Span:	30 MHz to 25 GHz
Trace-Mode:	Max Hold
Measured Modulation	FSK

Limits:

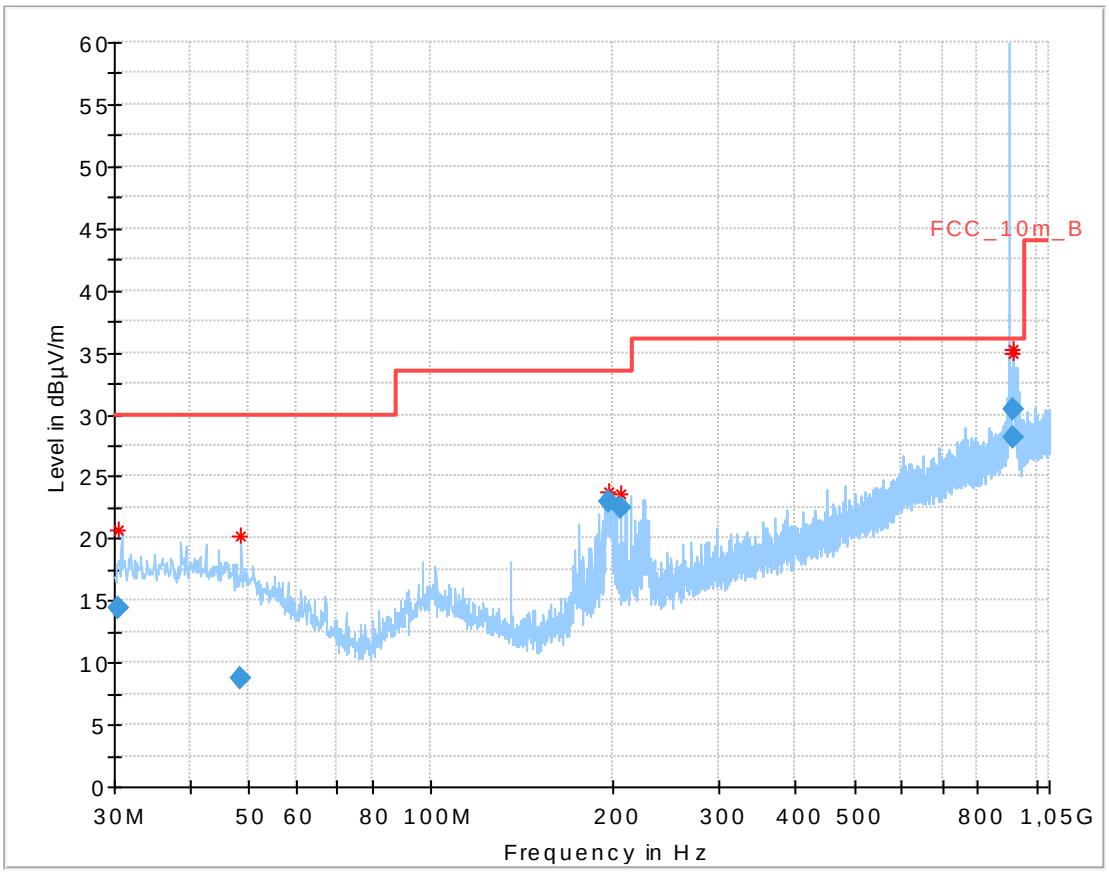
ANSI C63.10 – FCC Public Notice DA 00-705
The average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor: F = 20log (dwell time/100 ms)

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

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:

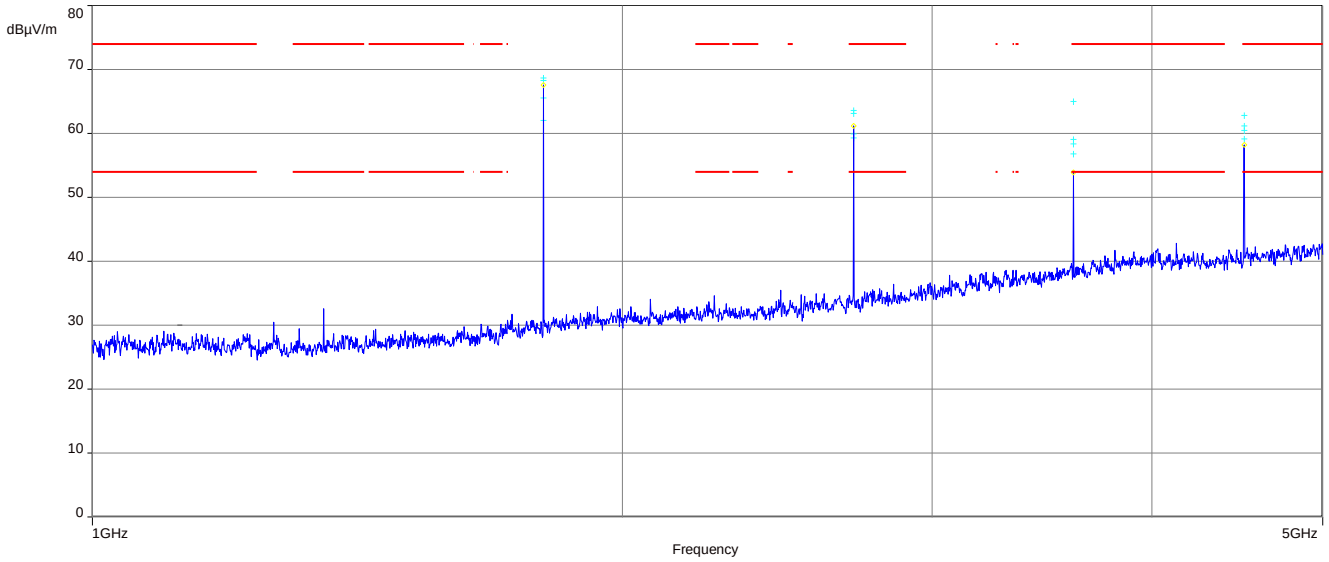
Plot 1: 30 MHz – 1 GHz, horizontal & vertical polarisation (lowest channel)



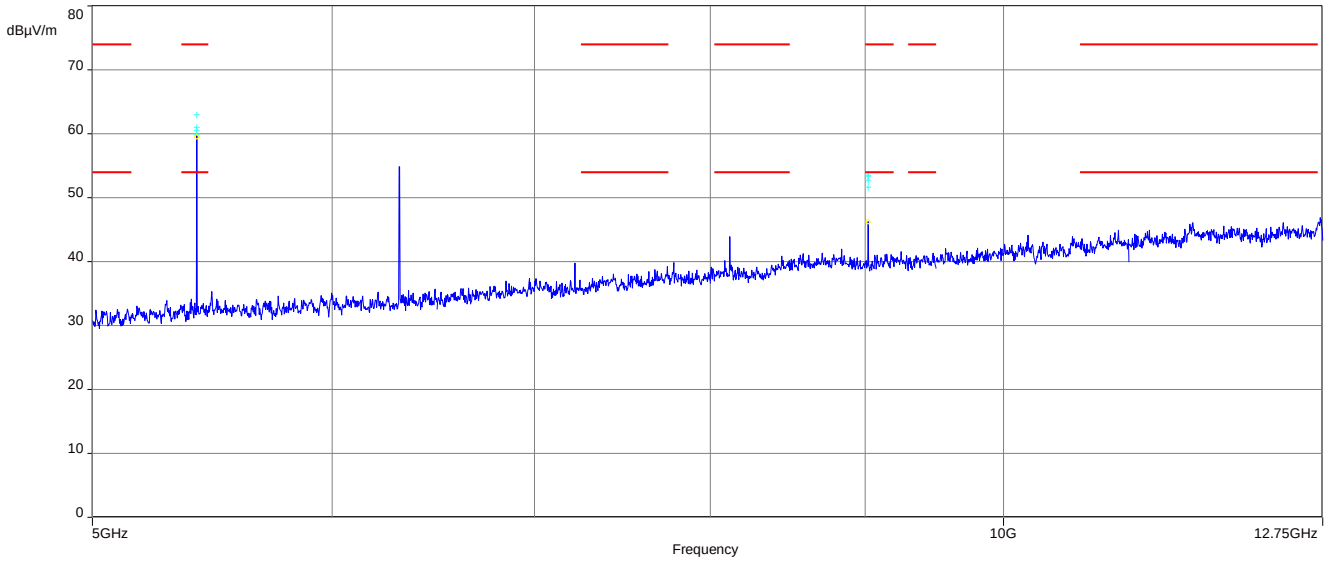
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
30.419100	14.32	30.00	15.68	1000.0	120.000	175.0	V	254.0	13.4
48.432150	8.73	30.00	21.27	1000.0	120.000	274.0	V	320.0	13.0
196.006050	23.03	33.50	10.47	1000.0	120.000	352.0	H	299.0	11.4
206.110350	22.56	33.50	10.94	1000.0	120.000	103.0	V	54.0	11.9
914.408100	28.13	36.00	7.87	1000.0	120.000	273.0	H	73.0	24.2
918.579600	30.42	36.00	5.58	1000.0	120.000	274.0	H	54.0	24.2

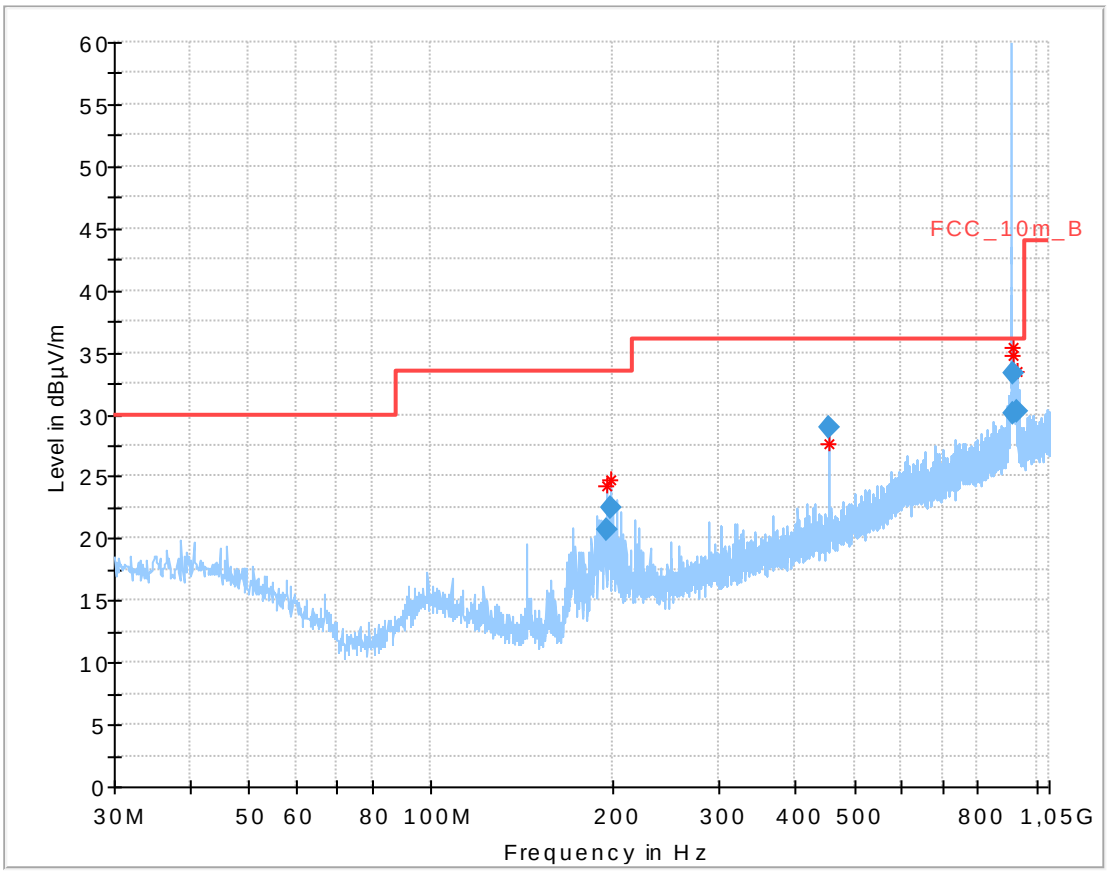
Plot 2: 1 GHz – 5 GHz, horizontal & vertical polarisation (lowest channel)



Plot 3: 5 GHz – 12.75 GHz, horizontal & vertical polarisation (lowest channel)



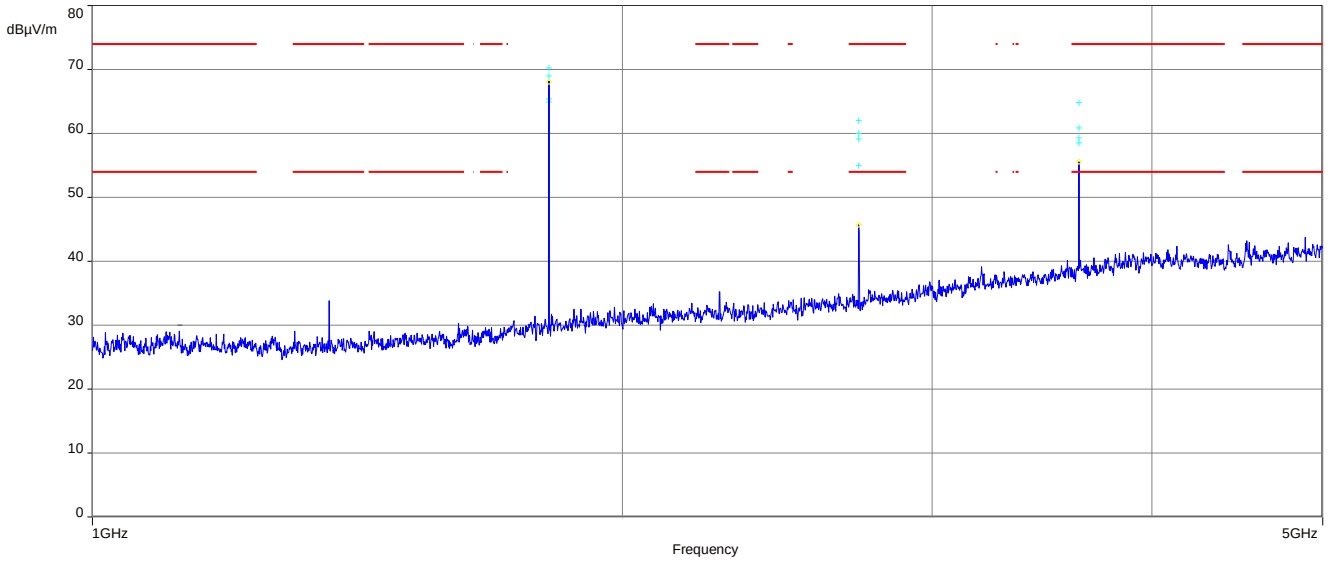
Plot 4: 30 MHz – 1 GHz, horizontal & vertical polarisation (middle channel)



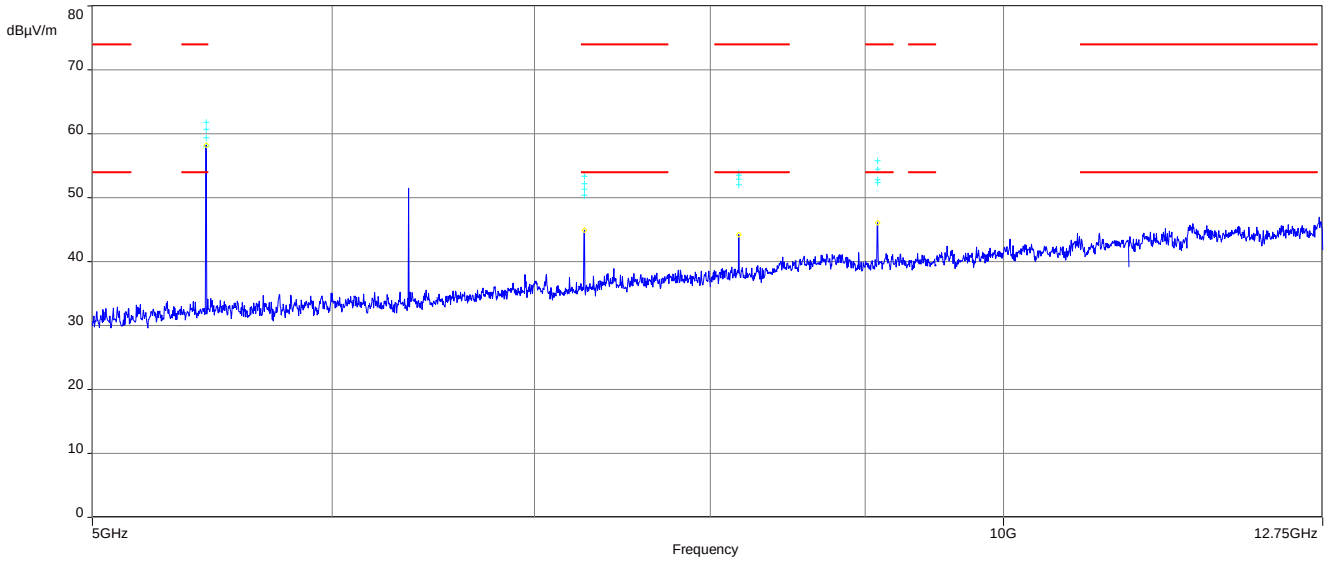
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
195.098550	20.72	33.50	12.78	1000.0	120.000	100.0	V	9.0	11.4
198.820650	22.55	33.50	10.95	1000.0	120.000	100.0	V	2.0	11.6
454.295250	28.98	36.00	7.02	1000.0	120.000	100.0	V	53.0	17.7
912.508950	33.26	36.00	2.74	1000.0	120.000	100.0	H	127.0	24.1
918.605250	30.01	36.00	5.99	1000.0	120.000	100.0	H	142.0	24.2
926.206050	30.20	36.00	5.80	1000.0	120.000	100.0	H	142.0	24.2

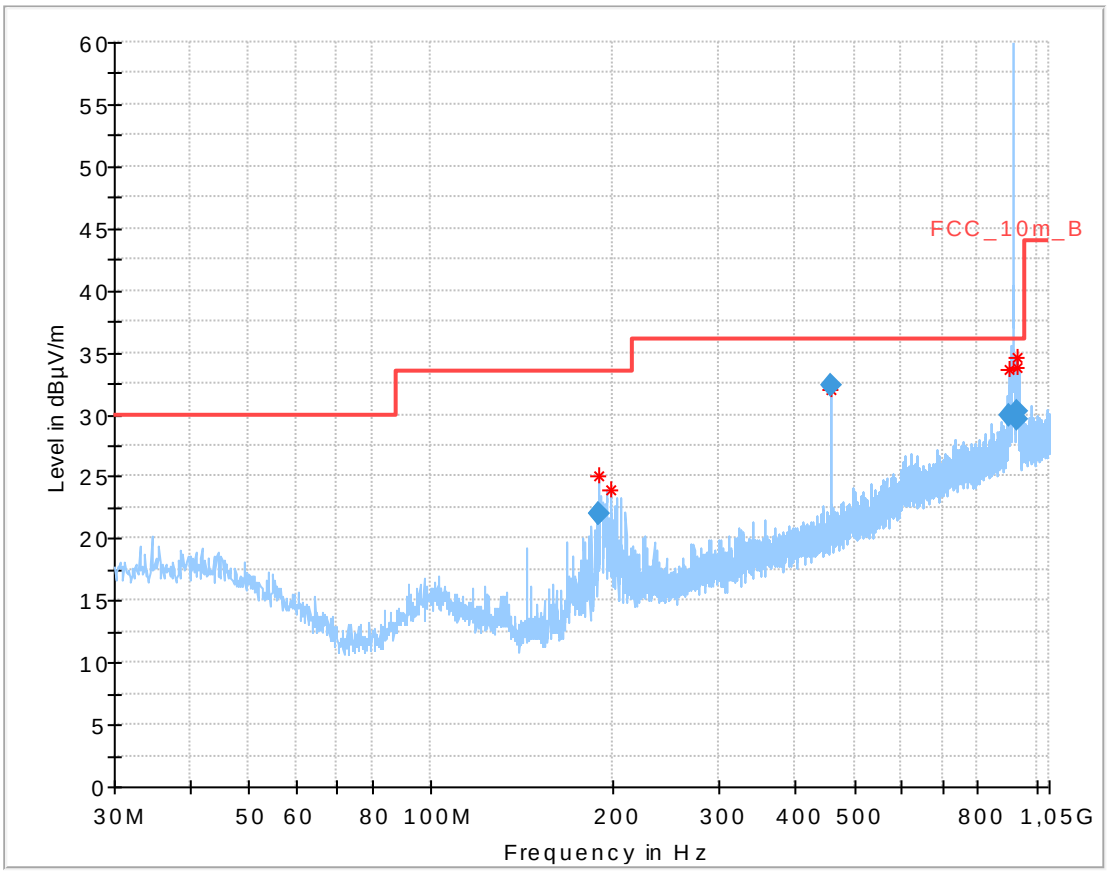
Plot 5: 1 GHz – 5 GHz, horizontal & vertical polarisation (middle channel)



Plot 6: 5 GHz – 12.75 GHz, horizontal & vertical polarisation (middle channel)



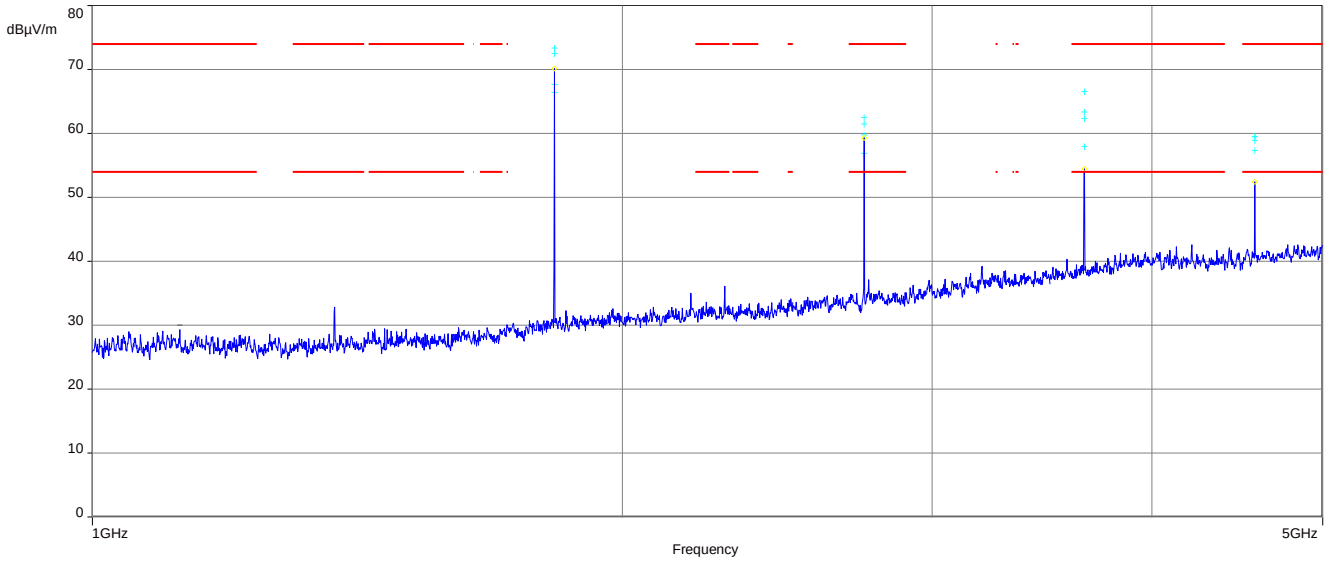
Plot 7: 30 MHz – 1 GHz, horizontal & vertical polarisation (highest channel)



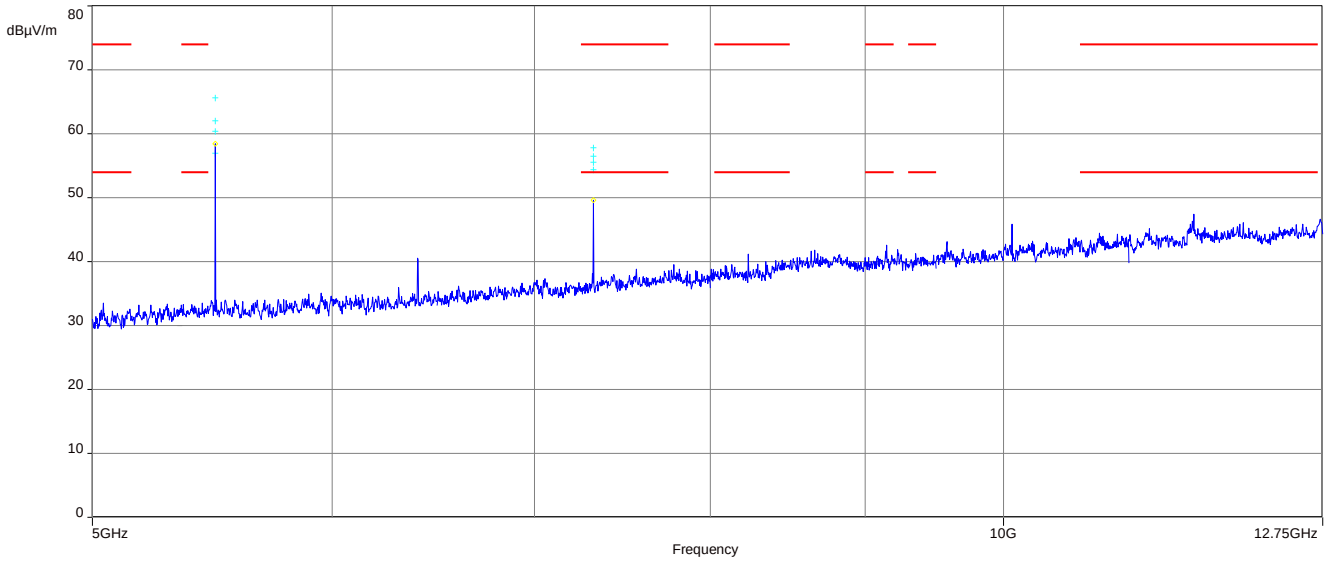
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
189.792750	22.03	33.50	11.47	1000.0	120.000	101.0	V	53.0	11.0
189.792750	21.95	33.50	11.55	1000.0	120.000	101.0	V	53.0	11.0
457.520550	32.30	36.00	3.70	1000.0	120.000	101.0	V	52.0	17.8
901.002000	29.96	36.00	6.04	1000.0	120.000	103.0	H	142.0	24.1
929.824950	30.17	36.00	5.83	1000.0	120.000	98.0	H	144.0	24.2
932.579400	29.59	36.00	6.41	1000.0	120.000	98.0	H	143.0	24.2

Plot 8: 1 GHz – 5 GHz, horizontal & vertical polarisation (highest channel)



Plot 9: 5 GHz – 12.75 GHz, horizontal & vertical polarisation (highest channel)



Result:

For radiated spurious emission the limits of 15.209 applies for all frequencies mentioned in 15.205. According to FCC Public Notice DA 00-705 (ANSI C63.10) the average emission shall be determined by using Video averaging (VBW = 10 Hz). If the dwell time of the hopping signal is less than 100 ms (per channel), the VBW=10 Hz reading may be adjusted by a factor:

F = 20*log (dwell time/100 ms)

In a period of 100 ms, we have a maximum of 2 transmissions and that gives the correction factor for spurious measurement. (See plots in chapter 11.4)

F = 20*log (2 * 5.24 ms/100 ms) = -19.59 dB

SPURIOUS EMISSIONS LEVEL [dBµV/m]								
902.4 MHz			912.0 MHz			922.0 MHz		
Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]
2707.2	Pk	63.59	2736.0	Pk	62.07	2766.0	Pk	62.53
2707.2	Avg	44.00	2736.0	Avg	42.48	2766.0	Avg	42.94
3609.6	Pk	64.98	3648.0	Pk	64.85	3688.0	Pk	66.53
3609.6	Avg	45.39	3648.0	Avg	45.26	3688.0	Avg	46.94
4512.0	Pk	62.82	5472.0	Pk	61.76	4610.0	Pk	59.56
4512.0	Avg	43.23	5472.0	Avg	42.17	4610.0	Avg	39.97
5414.4	Pk	62.99	7296.0	Pk	53.37	7376.0	Pk	57.83
5414.4	Avg	43.40	7296.0	Avg	33.78	7376.0	Avg	38.24
9024.0	Pk	53.48	8208.0	Pk	53.91			
9024.0	Avg	33.89	8208.0	Avg	34.32			
			9120.0	Pk	55.80			
			9120.0	Avg	36.21			
Measurement uncertainty			±3 dB					

***AVG:** Detector Average corrected with the correction factor F = -19.59 dB

11.12 RX spurious emissions radiated

Description:

Measurement of the radiated spurious emissions in idle/receive mode.

Measurement:

Measurement parameter	
Detector:	Peak / Quasi Peak
Sweep time:	Auto
Video bandwidth:	3 x RBW Remeasurement: 10 Hz
Resolution bandwidth:	F < 1 GHz: 100 kHz F > 1 GHz: 1 MHz
Span:	30 MHz to 26 GHz
Trace-Mode:	Max Hold

Limits:

FCC		IC
Frequency (MHz)	Field Strength (dBµV/m)	Measurement distance
30 - 88	40	3
88 – 216	43.5	3
216 – 960	46.0	3
Above 960	54.0	3

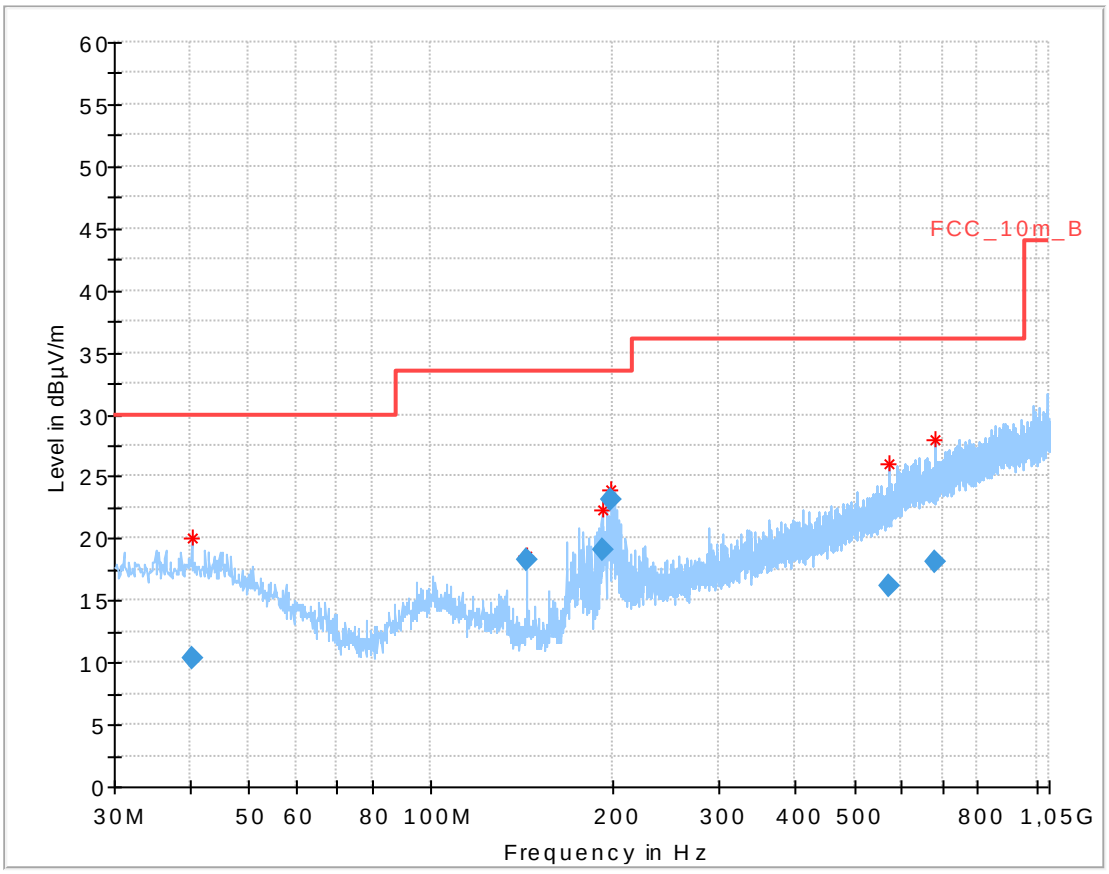
Result:

SPURIOUS EMISSIONS LEVEL [dBµV/m]								
RX			-/-			-/-		
Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]	Frequency [MHz]	Detector	Level [dBµV/m]
See table below plot 1								
Measurement uncertainty			±3 dB					

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:

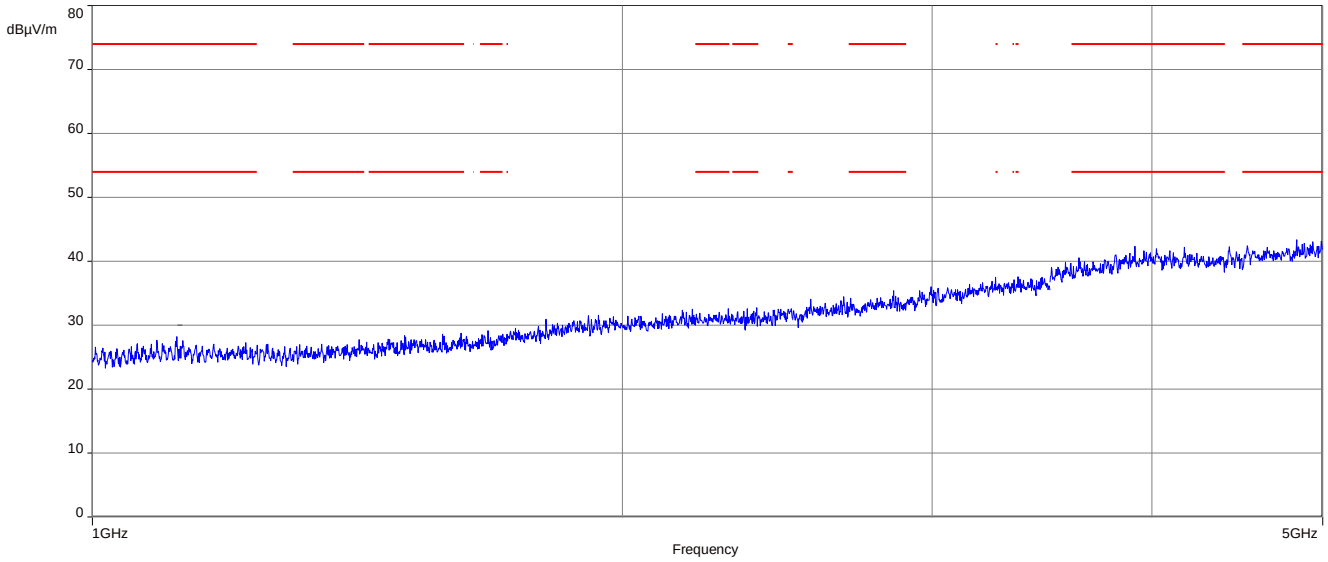
Plot 1: 30 MHz – 1 GHz, RX-Mode, horizontal & vertical polarisation



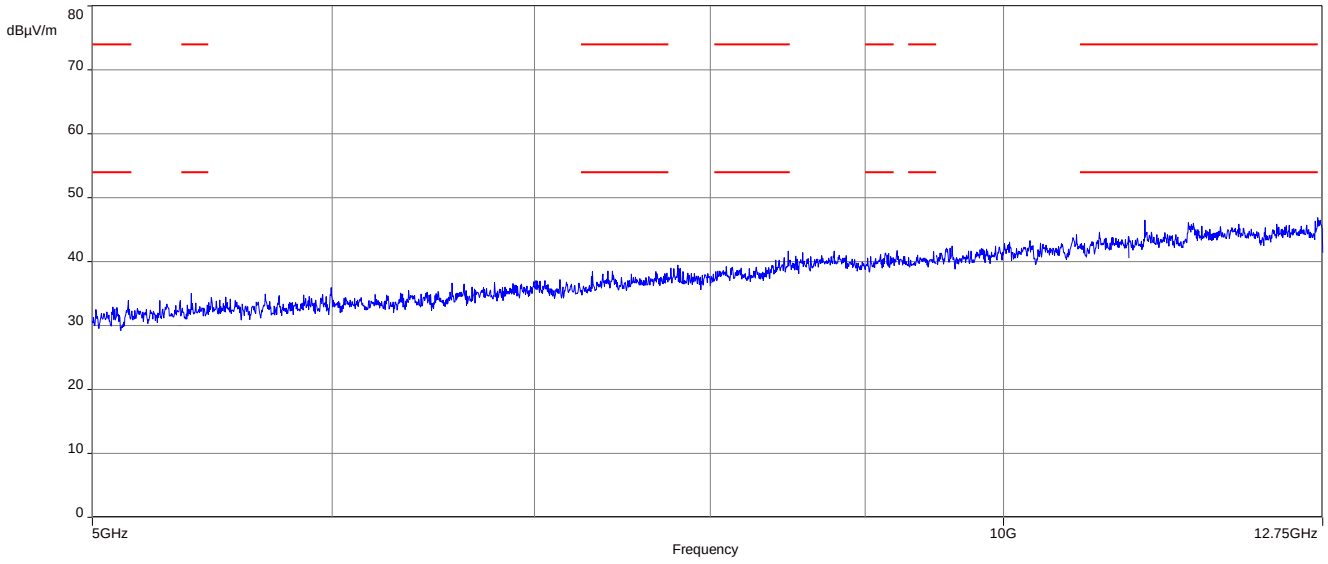
Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
40.238550	10.43	30.00	19.57	1000.0	120.000	103.0	V	230.0	14.0
143.992500	18.32	33.50	15.18	1000.0	120.000	100.0	V	209.0	8.8
191.553300	19.09	33.50	14.41	1000.0	120.000	98.0	V	188.0	11.2
198.863250	23.06	33.50	10.44	1000.0	120.000	98.0	V	53.0	11.6
571.059150	16.14	36.00	19.86	1000.0	120.000	100.0	V	5.0	19.9
679.217250	18.19	36.00	17.81	1000.0	120.000	273.0	V	232.0	21.4

Plot 2: 1GHz – 5 GHz, RX-Mode, horizontal & vertical polarisation



Plot 3: 5GHz – 12.75 GHz, RX-Mode, horizontal & vertical polarisation



Annex A Document history

Version	Applied changes	Date of release
	Initial release	2016-05-31
-A	HVIN changed	2016-10-26
-B	HVIN and model name changed	2017-01-04
-C	ISED reference changed to RSS-247 Issue 1	2017-02-16

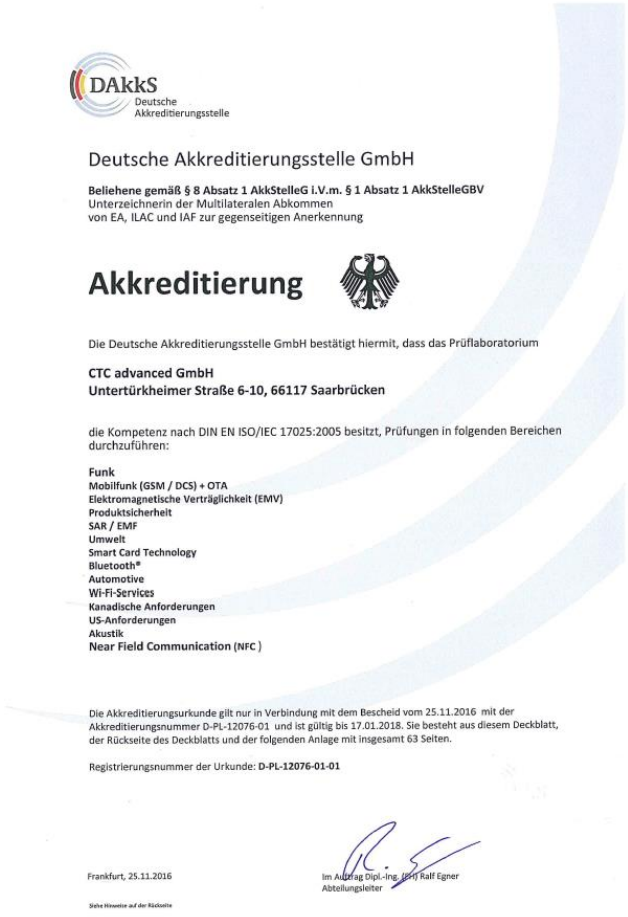
Annex B Further information

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

first page



DAkkS Deutsche Akkreditierungsstelle

Deutsche Akkreditierungsstelle GmbH

Beliehene gemäß § 8 Absatz 1 AkkStelleG i.V.m. § 1 Absatz 1 AkkStelleGBV
Unterzeichnerin der Multilateralen Abkommen
von EA, ILAC und IAF zur gegenseitigen Anerkennung

Akkreditierung

Die Deutsche Akkreditierungsstelle GmbH bestätigt hiermit, dass das Prüflaboratorium

CTC advanced GmbH
Untertürkheimer Straße 6-10, 66117 Saarbrücken

die Kompetenz nach DIN EN ISO/IEC 17025:2005 besitzt, Prüfungen in folgenden Bereichen durchzuführen:

Funk
Mobilfunk (GSM / DCS) + OTA
Elektromagnetische Verträglichkeit (EMV)
Produktsicherheit
SAR / EMF
Umwelt
Smart Card Technology
Bluetooth®
Automotive
Wi-Fi-Services
Kanadische Anforderungen
US-Anforderungen
Akustik
Near Field Communication (NFC)

Die Akkreditierungsurkunde gilt nur in Verbindung mit dem Bescheid vom 25.11.2016 mit der Akkreditierungsnummer D-PL-12076-01 und ist gültig bis 17.01.2018. Sie besteht aus diesem Deckblatt, der Rückseite des Deckblatts und der folgenden Anlage mit insgesamt 63 Seiten.

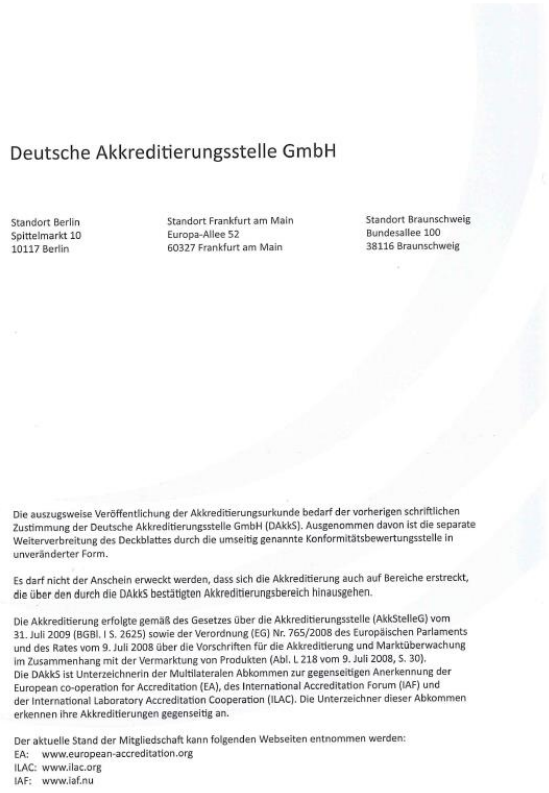
Registrierungsnummer der Urkunde: **D-PL-12076-01-01**

Frankfurt, 25.11.2016

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

Siehe Hinweise auf der Rückseite

last page



Deutsche Akkreditierungsstelle GmbH

Standort Berlin
Spittelmarkt 10
10117 Berlin

Standort Frankfurt am Main
Europa-Allee 52
60327 Frankfurt am Main

Standort Braunschweig
Bundesallee 100
38116 Braunschweig

Die auszugsweise Veröffentlichung der Akkreditierungsurkunde bedarf der vorherigen schriftlichen Zustimmung der Deutsche Akkreditierungsstelle GmbH (DAkkS). Ausgenommen davon ist die separate Weiterverbreitung des Deckblattes durch die umseitig genannte Konformitätsbewertungsstelle in unveränderter Form.

Es darf nicht der Anschein erweckt werden, dass sich die Akkreditierung auch auf Bereiche erstreckt, die über den durch die DAkkS bestätigten Akkreditierungsbereich hinausgehen.

Die Akkreditierung erfolgte gemäß des Gesetzes über die Akkreditierungsstelle (AkkStelleG) vom 31. Juli 2009 (BGBl. I S. 2625) sowie der Verordnung (EG) Nr. 765/2008 des Europäischen Parlaments und des Rates vom 9. Juli 2008 über die Vorschriften für die Akkreditierung und Marktüberwachung im Zusammenhang mit der Vermarktung von Produkten (Abl. L 218 vom 9. Juli 2008, S. 30).
Die DAkkS ist Unterzeichnerin der Multilateralen Abkommen zur gegenseitigen Anerkennung der European co-operation for Accreditation (EA), des International Accreditation Forum (IAF) und der International Laboratory Accreditation Cooperation (ILAC). Die Unterzeichner dieser Abkommen erkennen ihre Akkreditierungen gegenseitig an.

Der aktuelle Stand der Mitgliedschaft kann folgenden Webseiten entnommen werden:
EA: www.european-accreditation.org
ILAC: www.ilac.org
IAF: www.iaf.nu

Note:
The current certificate including annex can be received on request.