
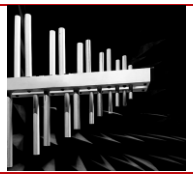
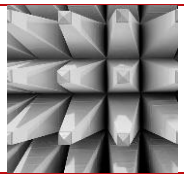

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consulting - testing - certification

TEST REPORT

Test report no.: 1-1078/15-02-02-B

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

Testing laboratory

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

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

Applicant

ATMEL Automotive GmbH
Theresienstrasse 2
74072 Heilbronn / GERMANY
Phone: +49 (0) 7131 67-0
Fax: +49 71 31 67 27 77
Contact: Jürgen Strohal
e-mail: juergen.strohal@atmel.com
Phone: +49 71 31 67 29 48

Manufacturer

ATMEL Automotive GmbH
Theresienstrasse 2
74072 Heilbronn / GERMANY

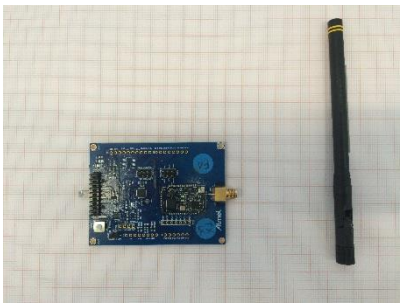
Test standard/s

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

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

Test Item

Kind of test item:	**RF Transceiver Evaluation kit**
Model name:	**ATA8520-EK1-F**
FCC ID:	**2AHW9-ATA8520EB1F**
IC:	**7352A-ATA8520EB1F**
Frequency:	902.0-928.0 MHz
Technology tested:	FHSS
Antenna:	External antenna
Power supply:	2.9 V to 3.1 V DC by battery (or external power supply)
Temperature range:	-20°C to +55°C



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

Test report authorized:

cn=Joerg Warken, o=CETECOM ICT Services GmbH, ou=WAK-150225, email=Joerg.Warken@cetecom.com, c=DE
2016.06.03 13:11:28 +02'00'

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Radio Communications & EMC

Test performed:

David Lang
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2016.06.03 08:11:07 +02'00'

David Lang
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. CETECOM ICT Services GmbH does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item.
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This test report 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 the test report with the number 1-1078/15-02-02-A and dated 2016-05-25

2.2 Application details

Date of receipt of order:	2016-01-13
Date of receipt of test item:	2016-04-04
Start of test:	2016-04-04
End of test:	2016-04-16
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	01.05.2015	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence - Exempt Local Area Network (LE-LAN) Devices

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

4 Test environment

Temperature	:	T_{nom} T_{max} T_{min}	+22 °C during room temperature tests +55 °C during high temperature tests -20 °C during low temperature tests
Relative humidity content	:		55 %
Barometric pressure	:		not relevant for this kind of testing
Power supply	:	V_{nom} V_{max} V_{min}	3.0 V DC by battery (or external power supply) 3.1 V 2.9 V

5 Test item

5.1 General description

Kind of test item	:	RF Transceiver Evaluation kit
Type identification	:	ATA8520-EK1-F
HMN	:	-/-
PMN	:	ATA8520-EK1-F
HVIN	:	ATA8520-EB1-F
FVIN	:	V2.3
S/N serial number	:	Not available!
HW hardware status	:	ATAB8520E_FCC_V1.0
Firmware status	:	V2.3
Frequency band	:	902.0-928.0 MHz Frequencies tested: lowest channel: 902.2 MHz middle channel: 903.4 MHz highest channel: 904.6 MHz
Type of radio transmission Use of frequency spectrum	: :	FHSS
Type of modulation	:	DBPSK
Number of channels	:	54 (9 Macro channels x 6 Micro channels)
Antenna	:	External antenna
Power supply	:	2.9 V to 3.1 V DC by battery (or external power supply)
Temperature range	:	-20°C to +55°C

5.2 Additional information

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

Test setup- and EUT-photos are included in test report: 1-1078/15-02-01_AnnexA
1-1078/15-02-01_AnnexB
1-1078/15-02-01_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).

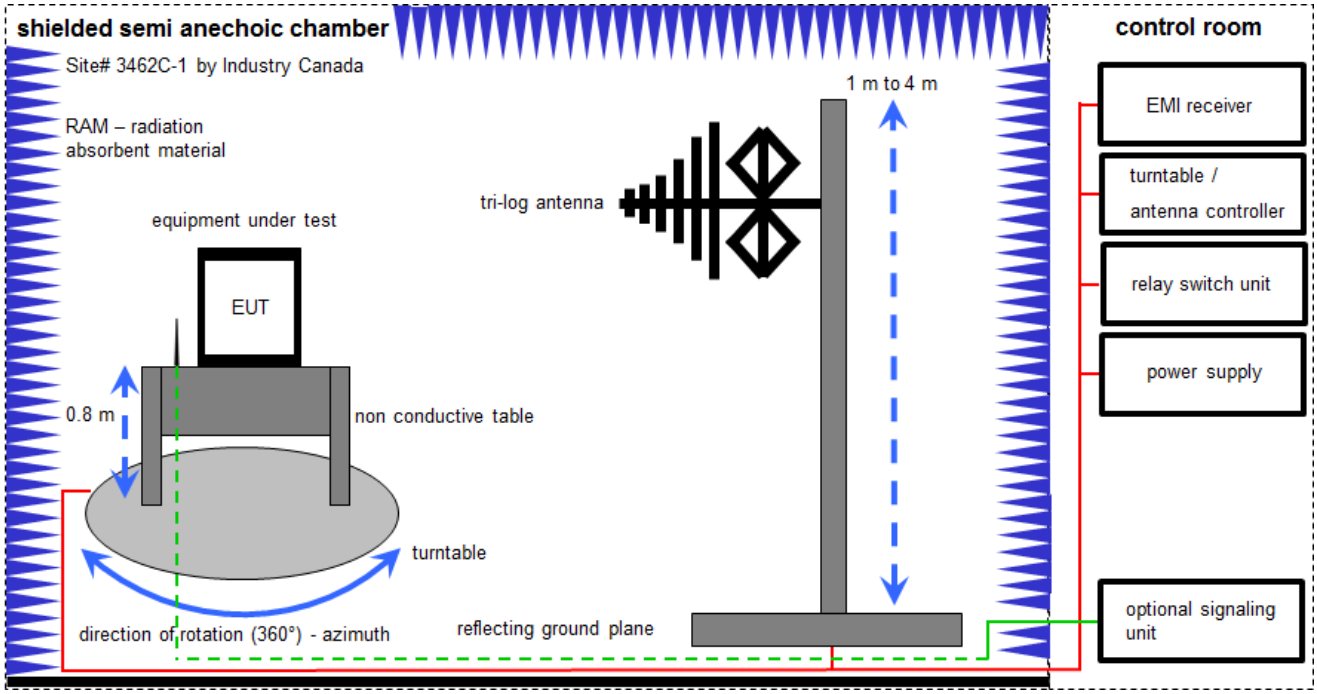
In order to simplify the identification of the equipment used at some special tests, some items of test equipment and ancillaries can be provided with an identifier or number in the equipment list below (Lab/Item).

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

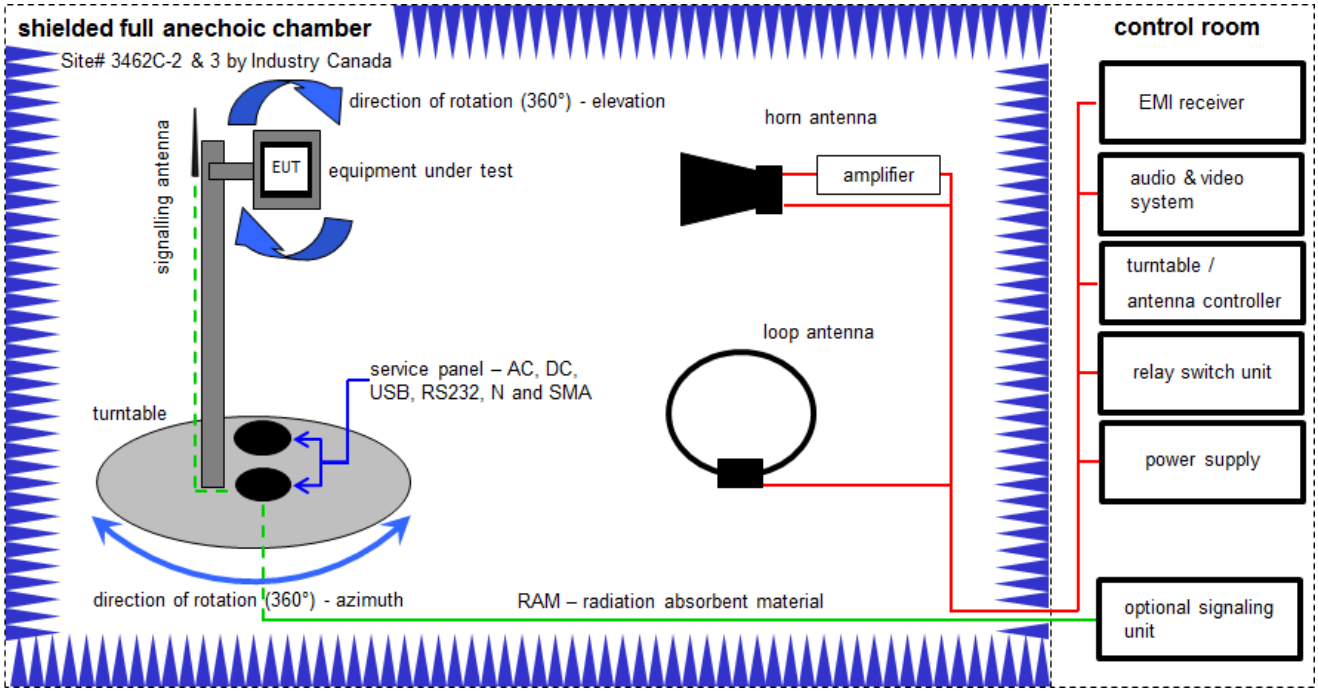
FS = UR + CL + AF
(FS-field strength; UR-voltage at the receiver; CL-loss of the cable; AF-antenna factor)

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	A	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	08.03.2016	08.03.2017
2	A	Antenna Tower	Model 2175	ETS-Lindgren	64762	300003745	izw	-/-	-/-
3	A	Positioning Controller	Model 2090	ETS-Lindgren	64672	300003746	izw	-/-	-/-
4	A	Turntable Interface-Box	Model 105637	ETS-Lindgren	44583	300003747	izw	-/-	-/-
5	A	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	22.04.2014	22.04.2017
6	A	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP	2818A03450	300001040	Ve	20.01.2015	20.01.2018

7.2 Shielded fully anechoic chamber



Measurement distance: horn antenna 3 meter; loop antenna 3 meter / 1 meter

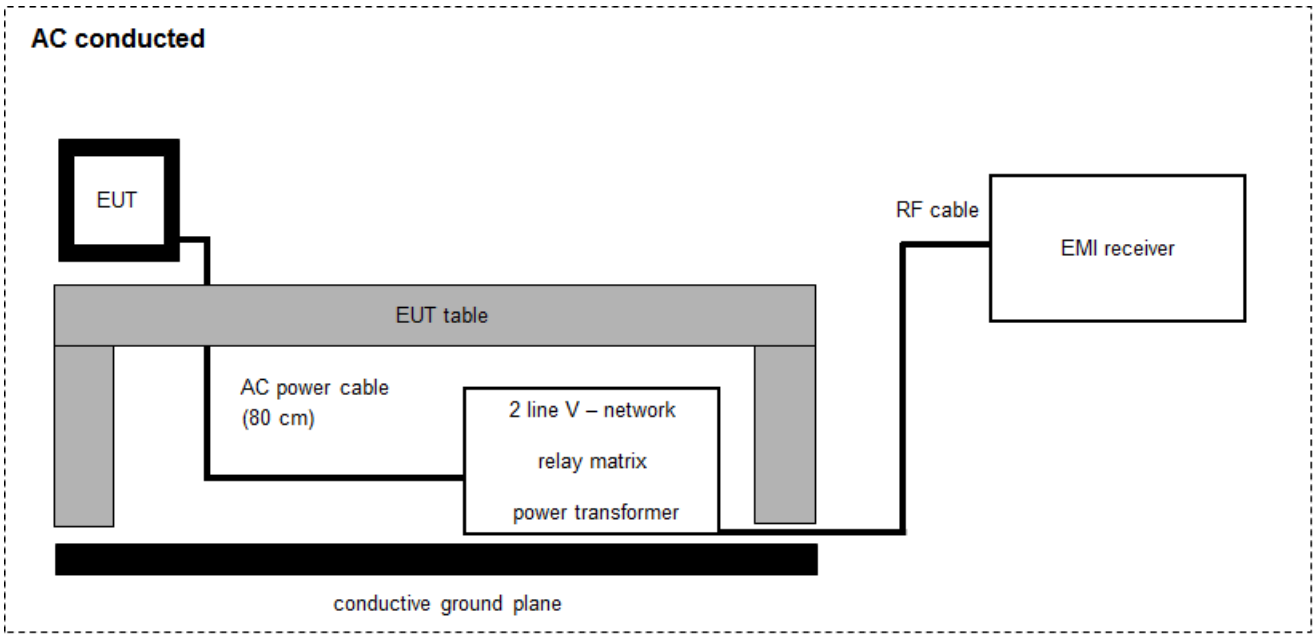
FS = UR + CA + AF
(FS-field strength; UR-voltage at the receiver; CA-loss of the signal path; AF-antenna factor)

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

Equipment table:

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

7.3 AC conducted



FS = UR + CF + VC
(FS-field strength; UR-voltage at the receiver; CR-loss of the cable and filter; VC-correction factor of the ISN)

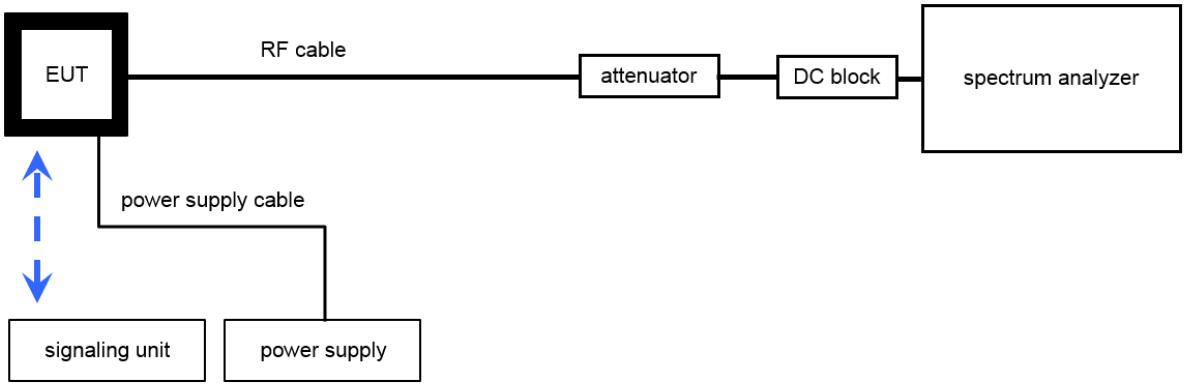
Example calculation:
FS [dBµV/m] = 37.62 [dBµV/m] + 9.90 [dB] + 0.23 [dB] = 47.75 [dBµV/m] (244.06 µV/m)

Equipment table:

No.	Lab / Item	Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	A	Two-line V-Network (LISN) 9 kHz to 30 MHz	ESH3-Z5	R&S	892475/017	300002209	k	17.06.2014	17.06.2016
2	A	MXE EMI Receiver 20 Hz to 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	06.03.2016	06.03.2017
3	A	software	SPS_PHE 1.4f	Spitzenberger & Spiess	B5981; 5D1081;B5979	300000210	ne	-/-	-/-
4	A	Analyzer-Reference-System (Harmonics and Flicker)	ARS 16/1	SPS	A3509 07/0 0205	300003314	Ve	02.02.2016	02.02.2018

7.4 Conducted measurements

Conducted measurements normal 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	A	DC Power Supply, 60V, 10A	6038A	HP	2752A04866	300001161	Ve	21.01.2015	21.01.2018
2	A	Signal- and Spectrum Analyzer	FSW26	R&S	101455	300004528	k	14.03.2016	14.03.2017
3	A	RF-Cable WLAN-Tester Port 1	ST18/SMAm/SMAm/36	Huber & Suhner	Batch no. 601494	400001216	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 Measurement uncertainty

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

10 Summary of measurement results

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

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS - 247, Issue 1	See table!	2016-06-02	-/-

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

Note:

C	Compliant
NC	Not compliant
NA	Not applicable
NP	Not performed
*1	Not performed since separation between band edge of the used band (902-926 MHz) and lower/upper restricted band is greater than 2x channel bandwidth of the lowest/highest used channel. Next lower restricted band starts at 614 MHz. Next upper restricted band starts at 960 MHz.
*2	Test performed with a lab power supply by R&S (NGSM 32/10 / SN: 1757)

11 Measurement results

11.1 Antenna gain

Measurement:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 7.2 A (radiated) See sub clause 7.4 A (conducted)
Measurement uncertainty	See sub clause 9

Limits:

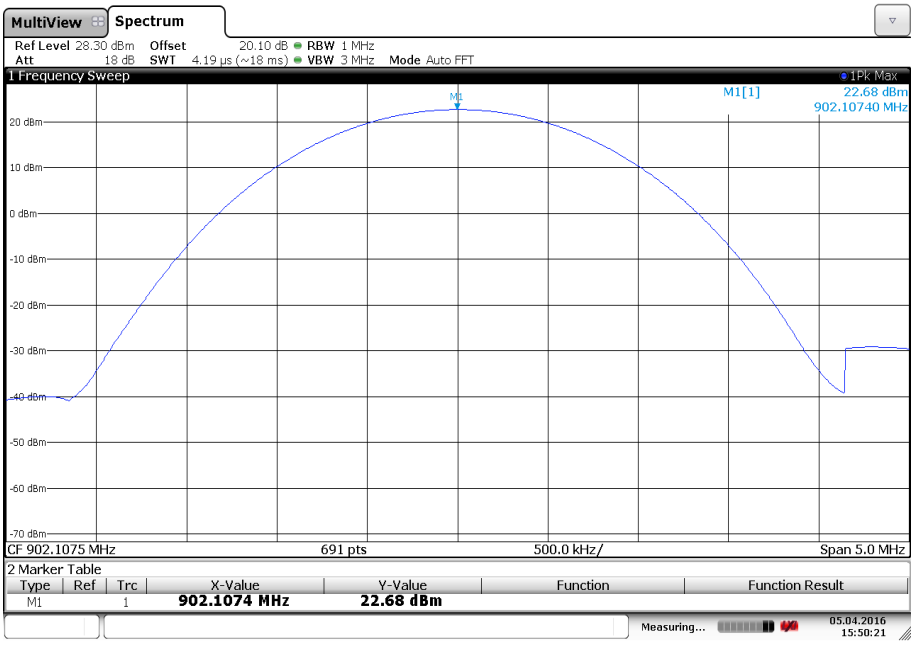
FCC	IC
Antenna gain	
6 dBi	

Results:

T_{nom}	V_{nom}	lowest channel	middle channel	highest channel
Conducted power [dBm] Measured with DBPSK modulation		22.7	22.7	22.7
Radiated power [dBm] Measured with DBPSK modulation		24.7	24.6	24.1
Gain [dBi] Calculated		2.0	1.9	1.4

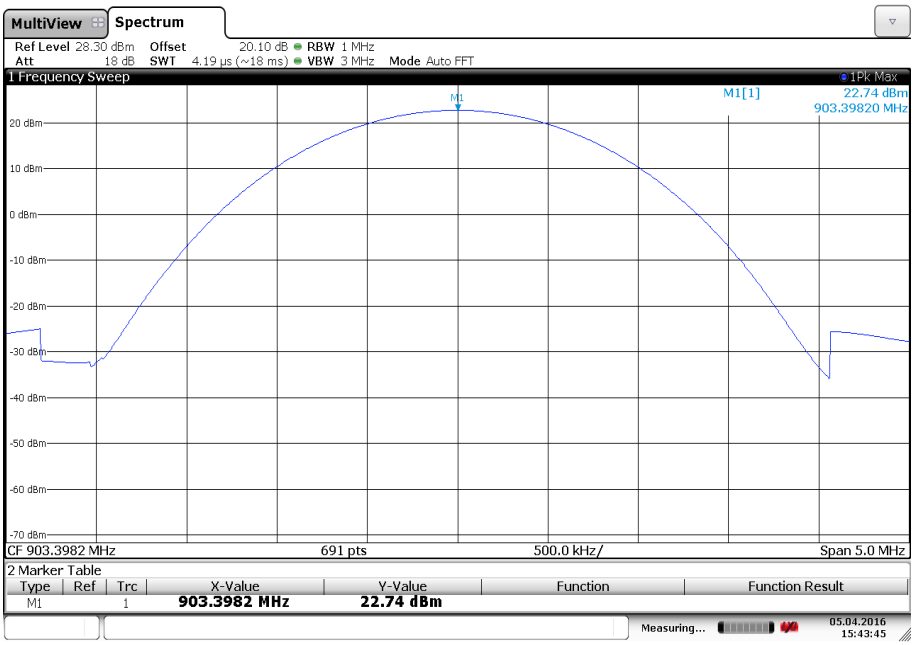
Plots:

Plot 1: Conducted output power – lowest channel



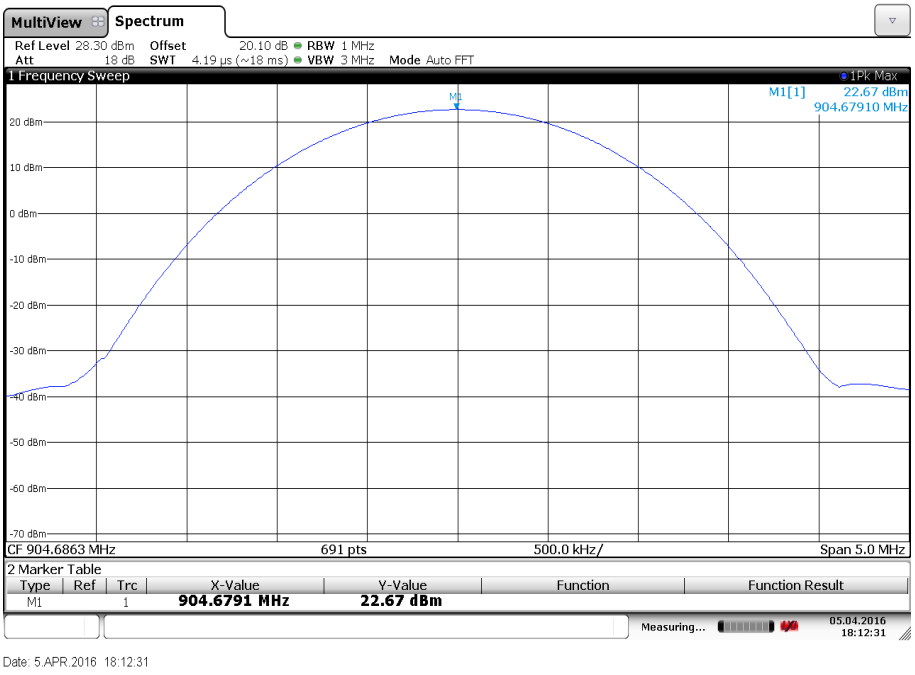
Date: 5.APR.2016 15:50:22

Plot 2: Conducted output power – middle channel



Date: 5.APR.2016 15:43:44

Plot 3: Conducted output power – highest channel



11.2 Carrier frequency separation

Description:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	300 Hz
Video bandwidth	1 kHz
Span	4 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

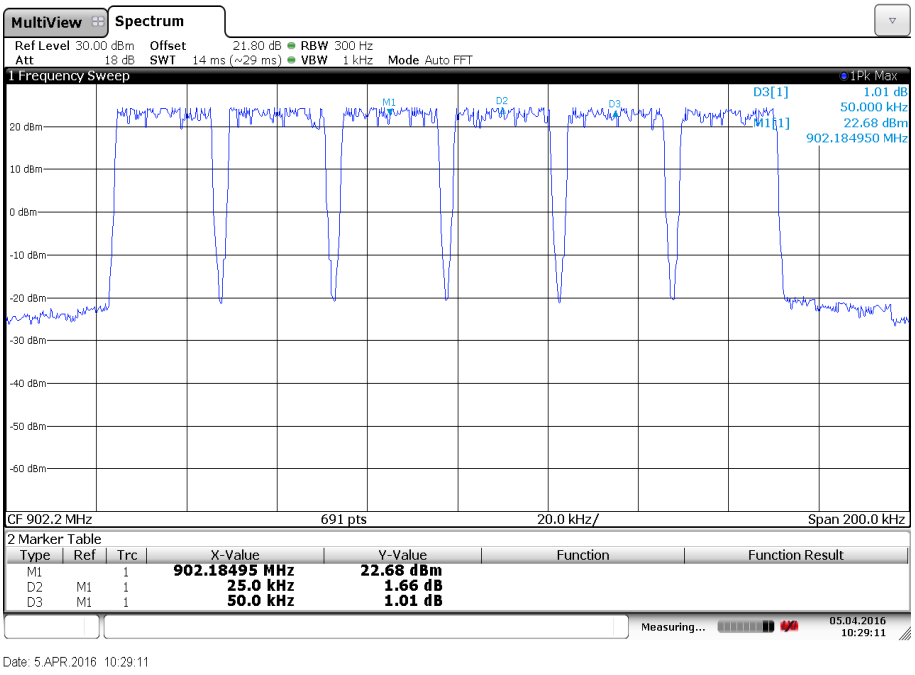
FCC	IC
Carrier frequency separation	
Minimum 25 kHz or two-thirds of the 20 dB bandwidth of the hopping system whichever is greater.	

Result:

Carrier frequency separation	25 kHz

Plot:

Plot 1: Carrier frequency separation (DBPSK modulation)



11.3 Number of hopping channels

Description:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	500 kHz
Video bandwidth	500 kHz
Span	Plot 1: 200 kHz Plot 2: 4 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

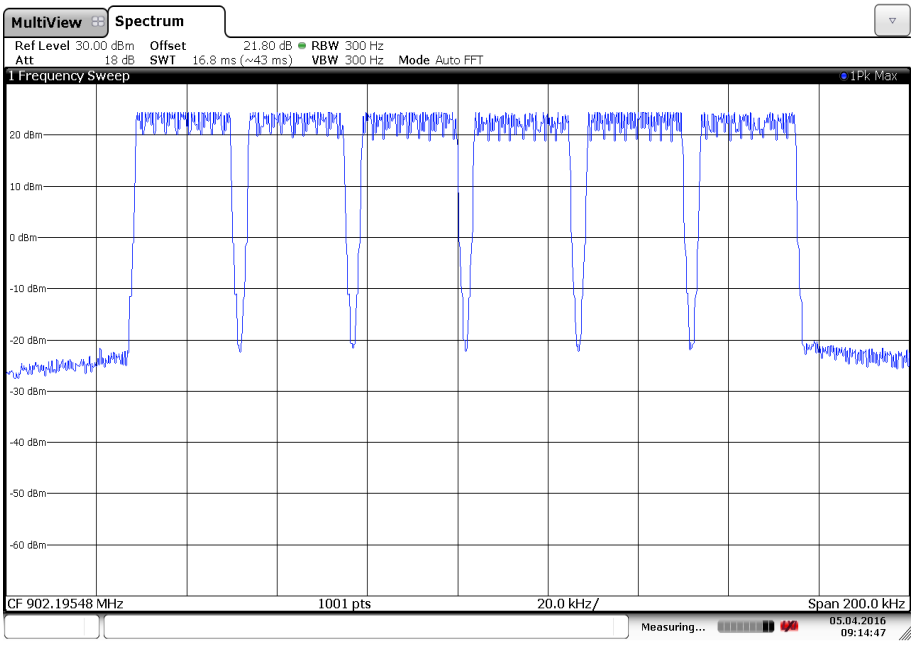
FCC	IC
Number of hopping channels	
At least 15 non overlapping hopping channels	

Result:

Number of hopping channels	54

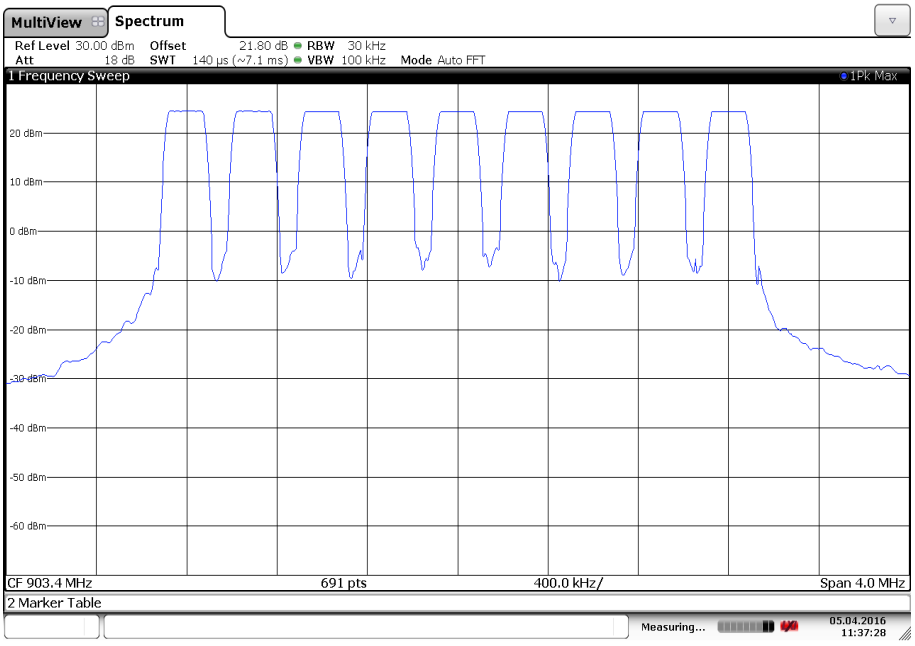
Plots:

Plot 1: Number of hopping channels – six micro channels within one macro channel (DBPSK modulation)



Date: 5.APR.2016 09:14:48

Plot 2: Number of hopping channels – nine macro channels (DBPSK modulation)



Date: 5.APR.2016 11:37:28

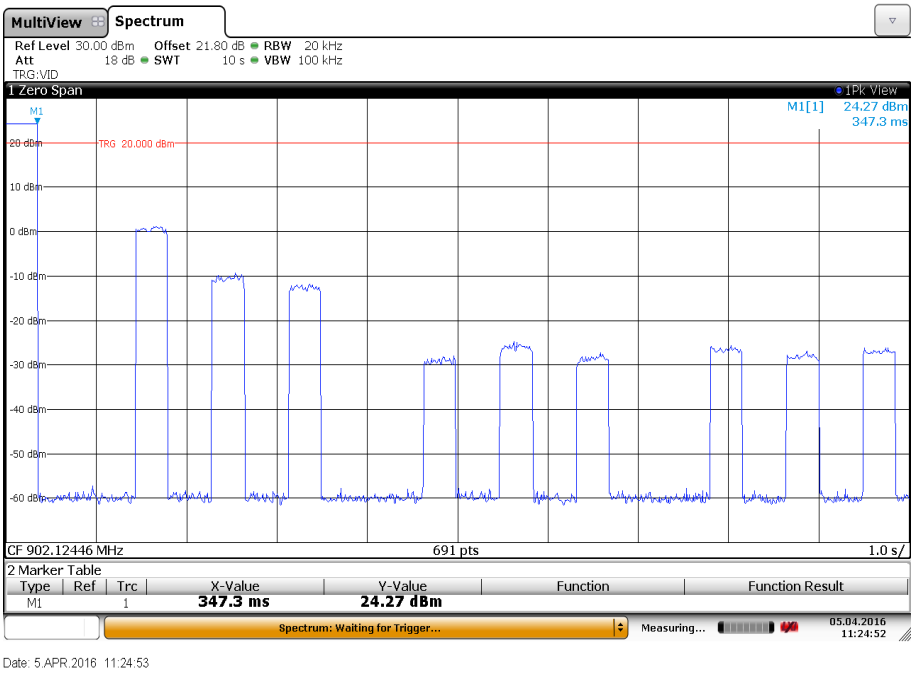
11.4 Time of occupancy (dwell time)

Measurement:

The measurement is performed in zero span mode to show that none of the 54 used channels is allocated more than 0.4 seconds within a 21.6 seconds interval (54 channels times 0.4s).

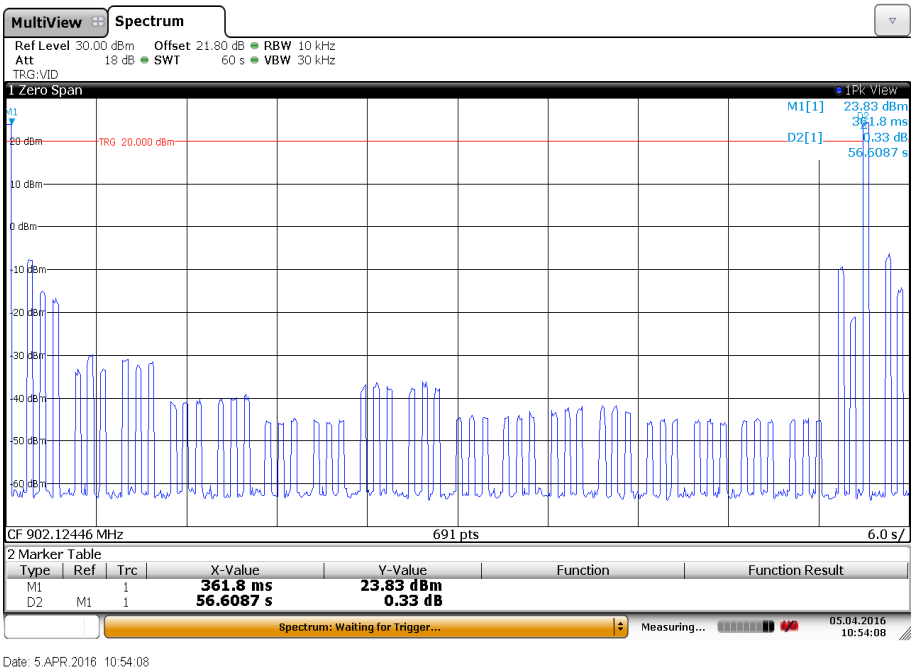
Plots:

Plot 1: Burst length (time at one hopping channel) – DBPSK modulation



The maximum burst length per SigFox protocol is 380 ms. The maximum burst length measured is 347.3 ms.

Plot 2: Channel allocation – DBPSK modulation



Each channel is allocated every 56.6 seconds. Hence the dwell time is less than 400 ms.

11.5 Spectrum bandwidth of a FHSS system

Description:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	300 Hz
Video bandwidth	1 kHz
Span	25 kHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

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

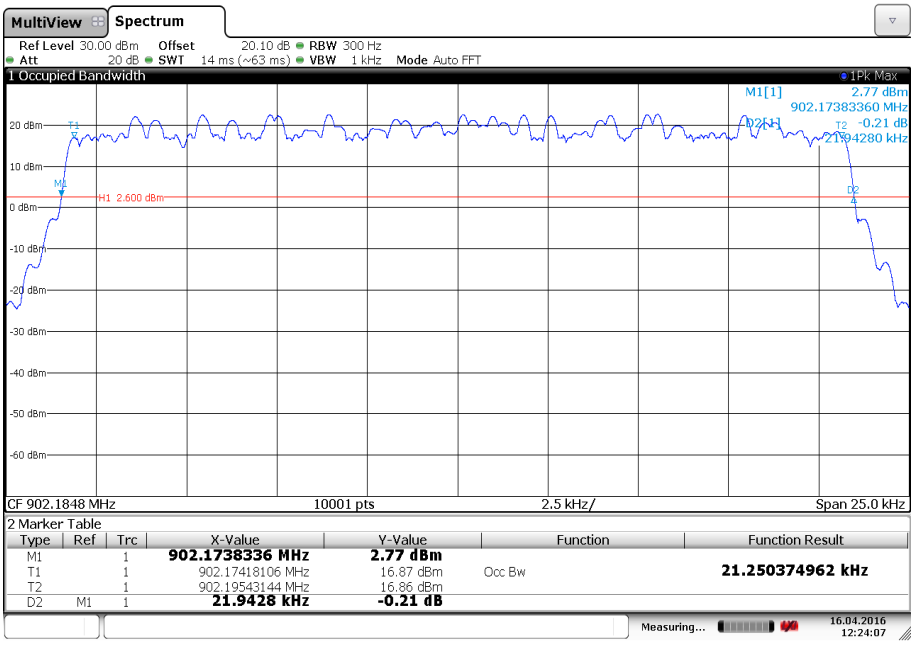
Results:

Modulation	20 dB bandwidth [kHz]		
Frequency	lowest channel	middle channel	highest channel
DBPSK	21.9	21.7	22.0

Modulation	99 % bandwidth [kHz]		
Frequency	lowest channel	middle channel	highest channel
DBPSK	21.3	21.0	21.3

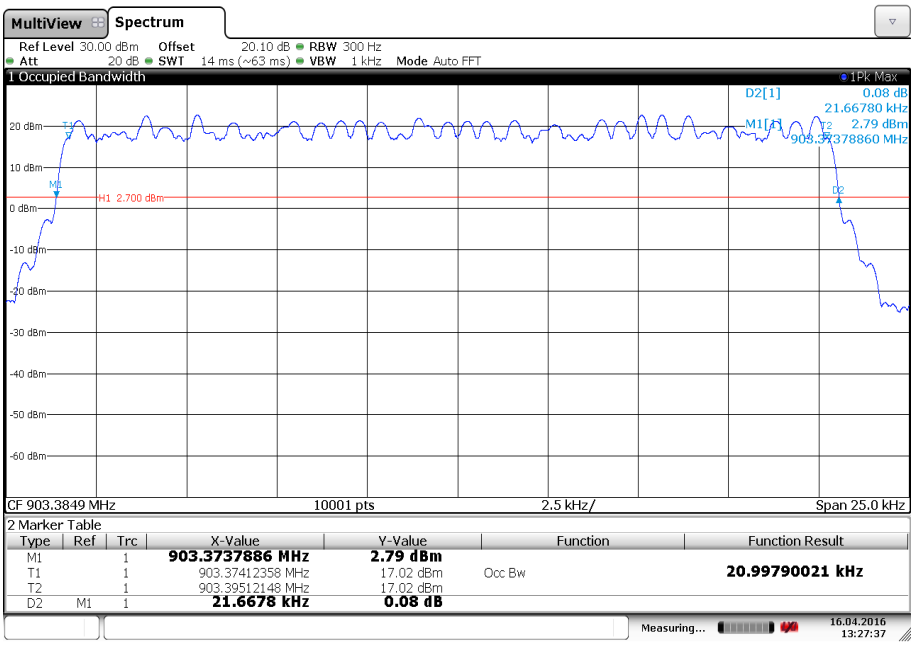
Plots:

Plot 1: 20 db/ 99% BW - lowest channel – DBPSK modulation



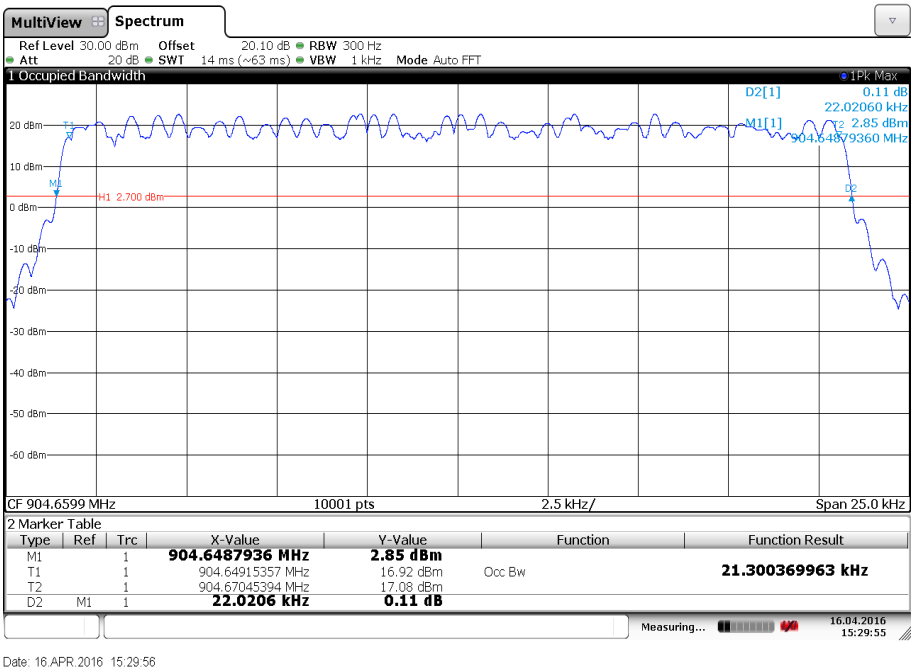
Date: 16.APR.2016 12:24:07

Plot 2: 20 db/ 99% BW - middle channel – DBPSK modulation



Date: 16.APR.2016 13:27:37

Plot 3: 20 db/ 99% BW - highest channel – DBPSK modulation



11.6 Maximum output power

Description:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Span	5 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

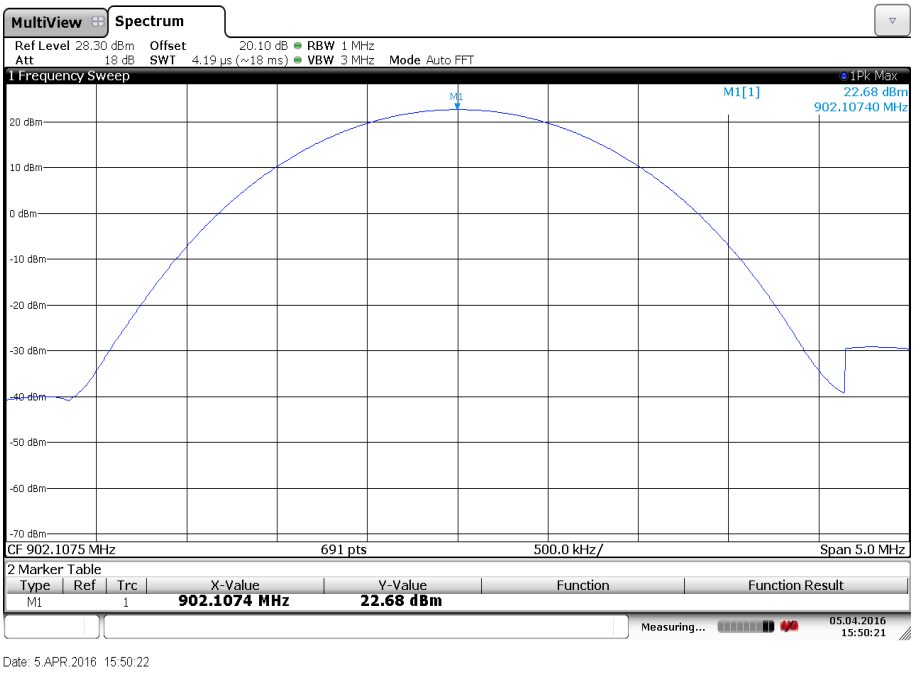
FCC	IC
Maximum output power	
For frequency hopping systems operating in the 902–928 MHz band: 1 watt (30 dBm) for systems employing at least 50 hopping channels; and, 0.25 watts (24 dBm) for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph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

Results:

Modulation	Maximum output power conducted [dBm]		
Frequency	lowest channel	middle channel	highest channel
DBPSK	22.7	22.7	22.7

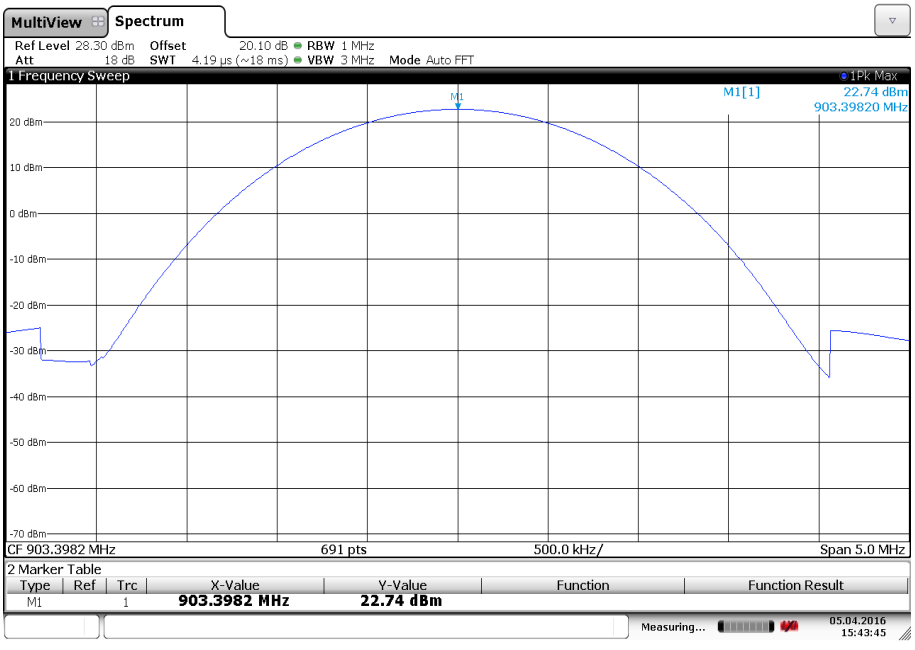
Plots:

Plot 1: Conducted output power – lowest channel



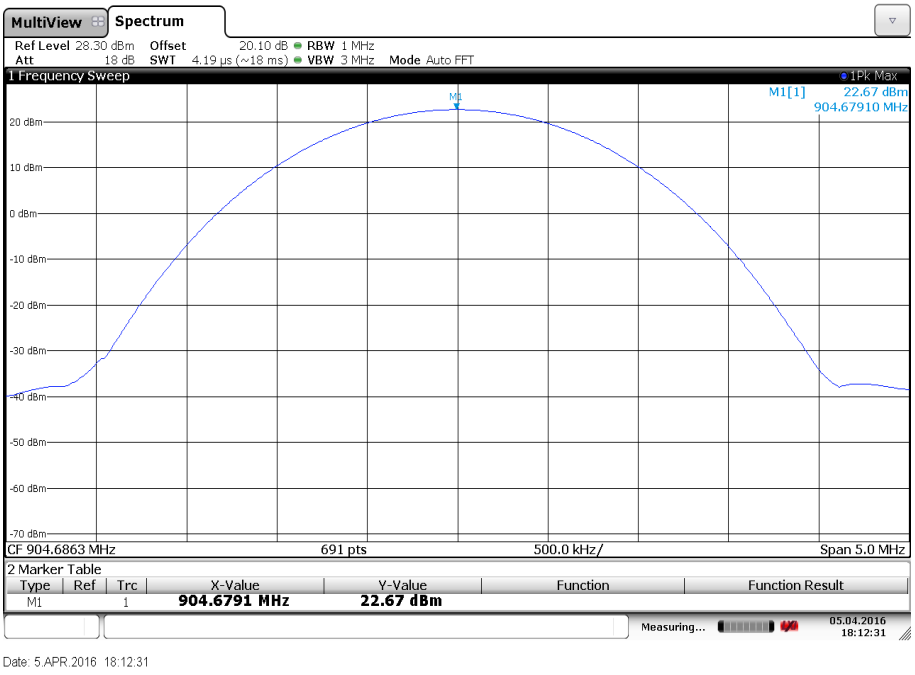
Date: 5.APR.2016 15:50:22

Plot 2: Conducted output power – middle channel



Date: 5.APR.2016 15:43:44

Plot 3: Conducted output power – highest channel



11.7 Detailed spurious emissions @ the band edge - conducted

Description:

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

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz
Video bandwidth	300 kHz / 500 kHz
Span	Lower Band Edge: 902 MHz Upper Band Edge: 928 MHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

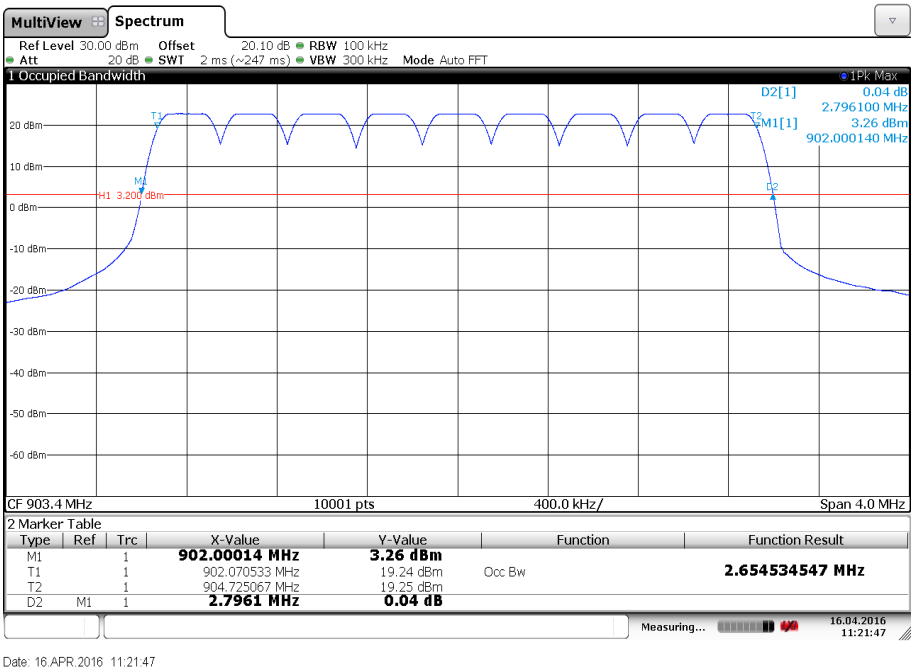
FCC	IC
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains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

Results:

Scenario	Spurious band edge conducted [dB]		
Modulation	lowest channel	middle channel	highest channel
Lower band edge – hopping on	> 20 dB	> 20 dB	> 20 dB
Upper band edge – hopping on	> 20 dB	> 20 dB	> 20 dB

Plots:

Plot 1: 20 dB/ 99% BW – hopping on



11.8 Spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The EUT is set to single channel mode. The measurement is repeated for low, mid and high channel.

Measurement parameters	
Detector	Peak
Sweep time	Auto
Resolution bandwidth	100 kHz < 1 GHz 1000 MHz > 1 GHz
Video bandwidth	300 kHz < 1 GHz 3000 MHz > 1 GHz
Span	9 kHz to 25 GHz
Trace mode	Max hold
Test setup	See sub clause 7.4 A
Measurement uncertainty	See sub clause 9

Limits:

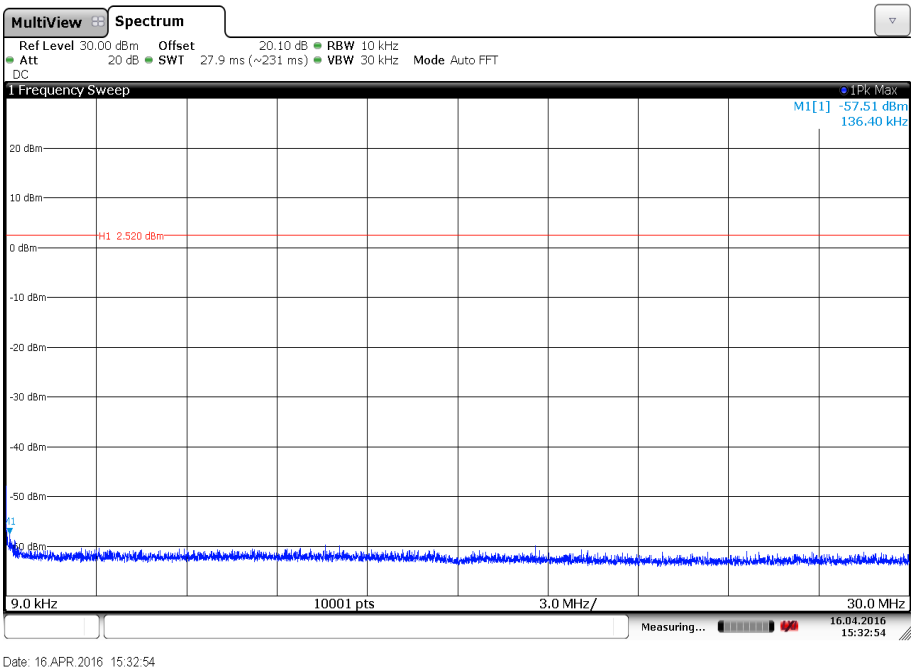
FCC	IC
TX spurious emissions conducted	
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth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

Results:

TX spurious emissions conducted					
DBPSK - mode					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
902.1375		22.5	30 dBm	>20	Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc		compliant
903.3875		22.5	30 dBm		Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc	>20	compliant
904.6625		22.6	30 dBm		Operating frequency
All detected emissions are below the -20 dBc criteria. Please take a look at the plot!			-20 dBc	>20	compliant

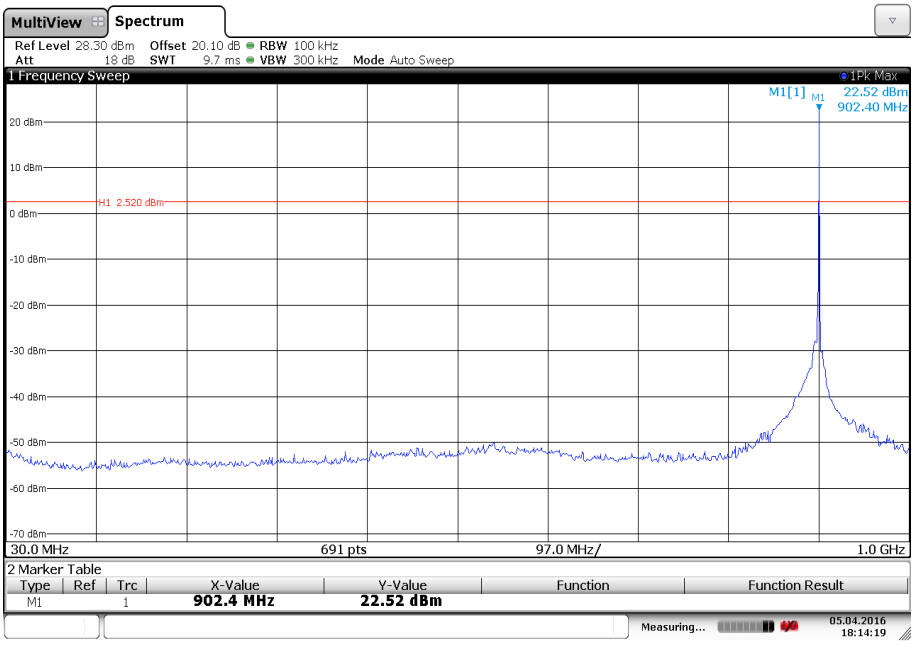
Plots:

Plot 1: 9kHz – 30MHz - lowest channel – DBPSK modulation



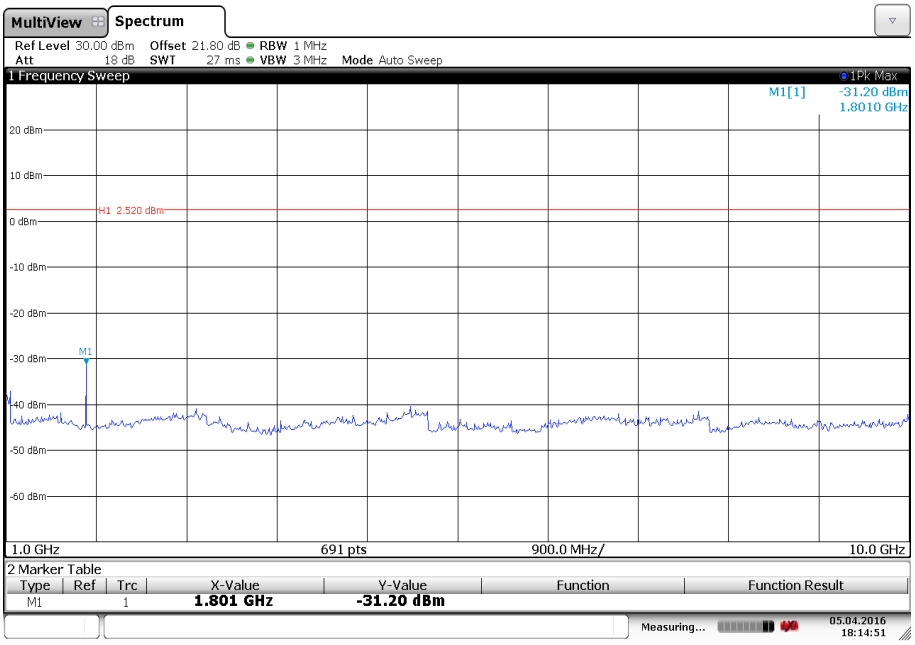
Date: 16.APR.2016 15:32:54

Plot 2: 30MHz – 1GHz - lowest channel – DBPSK modulation



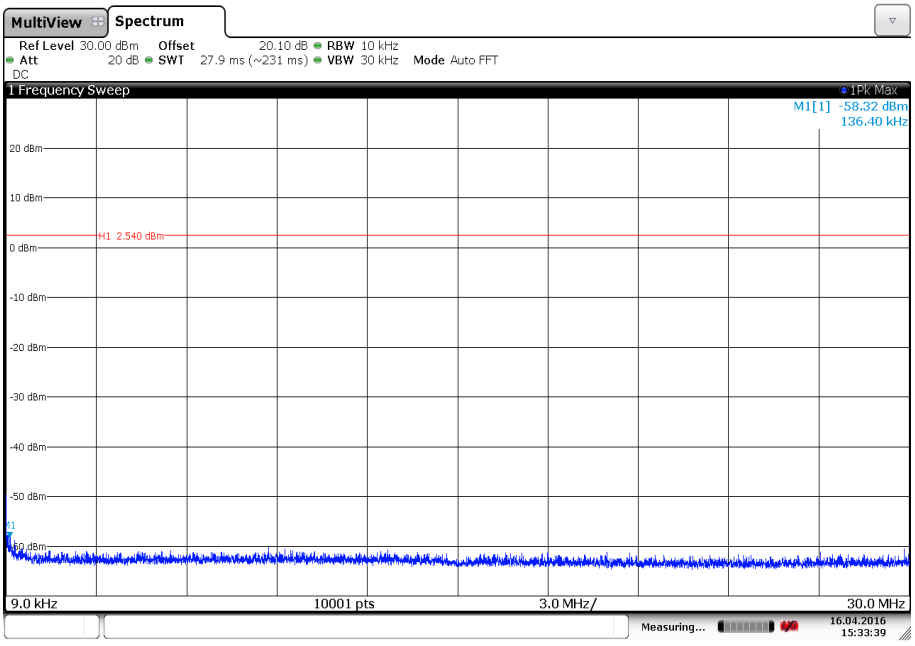
Date: 5.APR.2016 18:14:18

Plot 3: 1GHz – 10GHz - lowest channel – DBPSK modulation



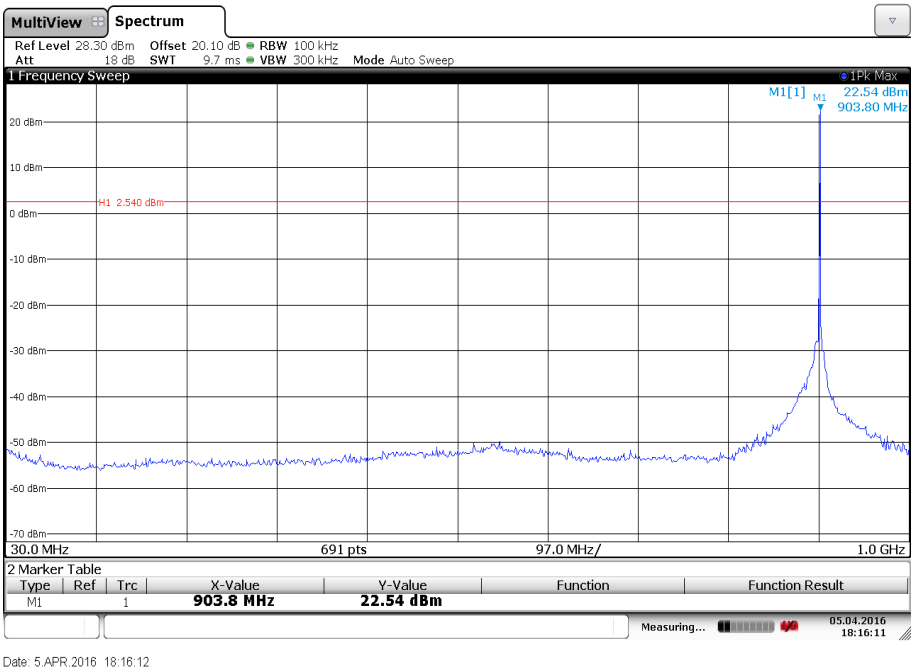
Date: 5.APR.2016 18:14:51

Plot 4: 9kHz – 30MHz - middle channel – DBPSK modulation



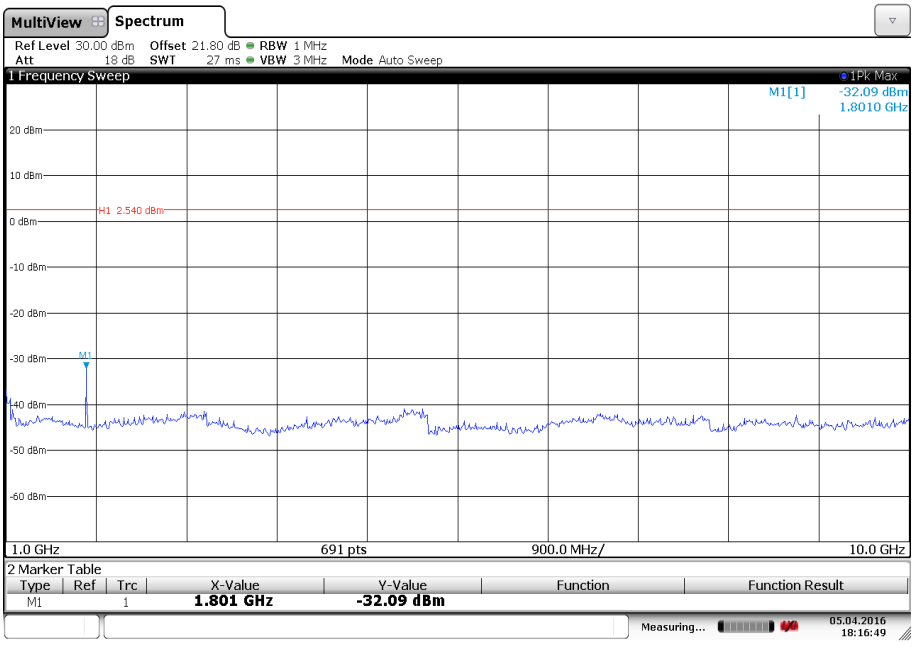
Date: 16.APR.2016 15:33:40

Plot 5: 30MHz – 1GHz - middle channel – DBPSK modulation



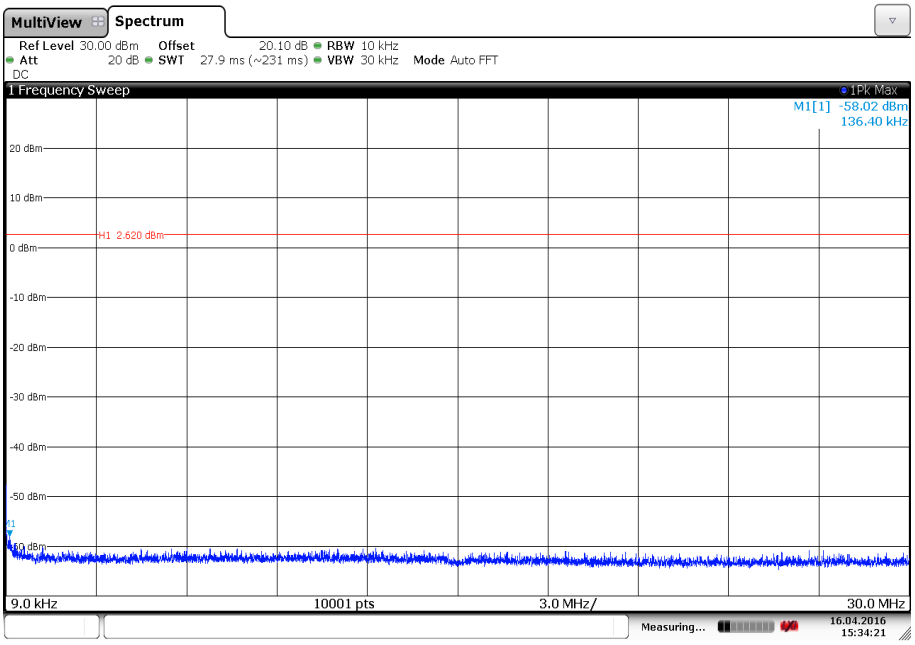
Date: 5.APR.2016 18:16:12

Plot 6: 1GHz – 10GHz - middle channel – DBPSK modulation



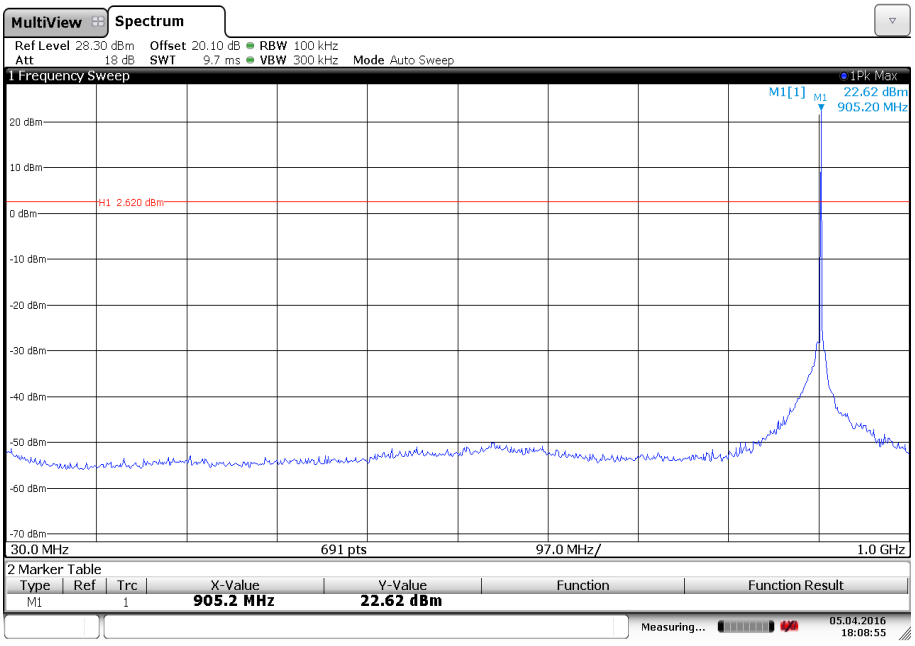
Date: 5.APR.2016 18:16:49

Plot 7: 9kHz – 30MHz - highest channel – DBPSK modulation



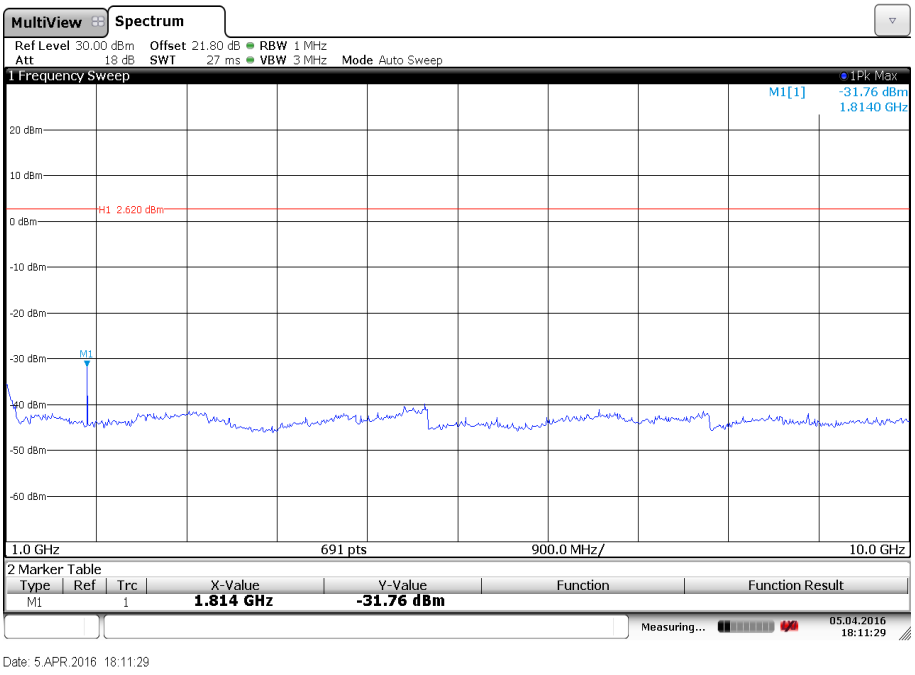
Date: 16.APR.2016 15:34:20

Plot 8: 30MHz – 1GHz - highest channel – DBPSK modulation



Date: 5.APR.2016 18:08:56

Plot 9: 1GHz – 10GHz - highest channel – DBPSK modulation



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 channels are 00; 39 and 78. The measurement is performed in the mode with the highest output power. The limits are recalculated to a measurement distance of 3 m according the ANSI C63.10.

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

Limits:

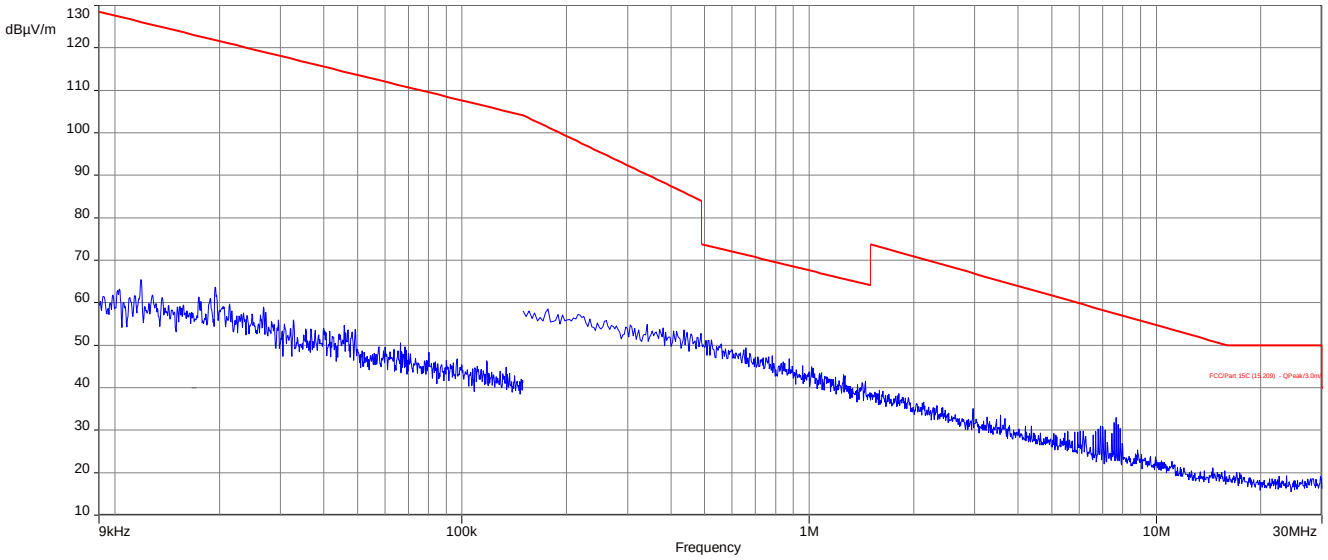
FCC		IC
TX spurious emissions radiated below 30 MHz		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30.0	30	30

Results:

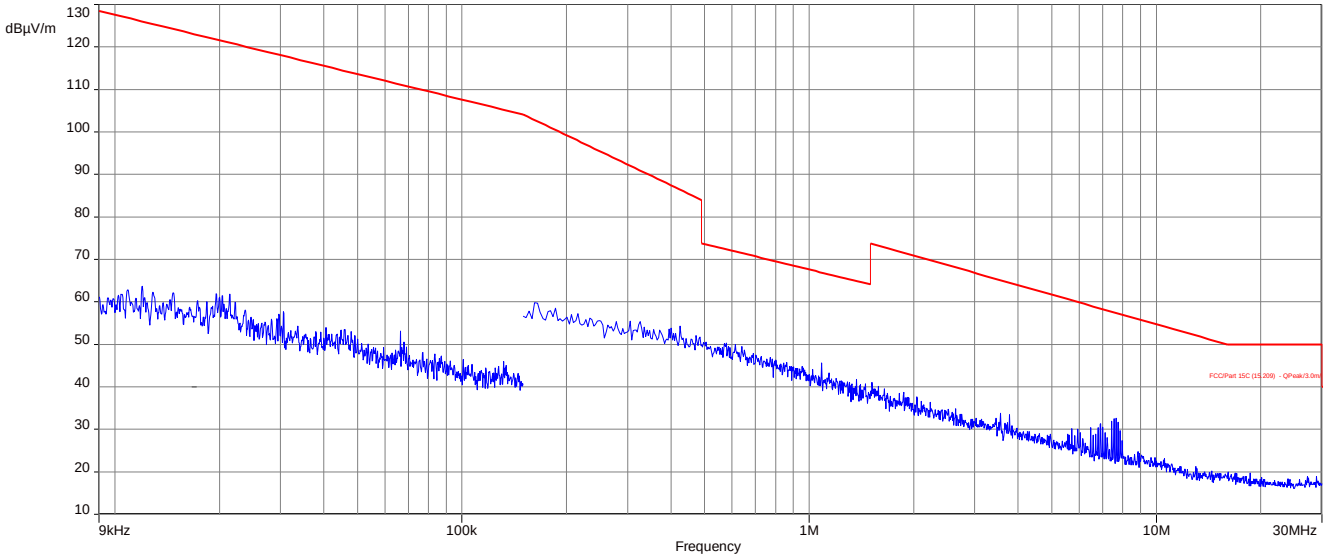
TX spurious emissions radiated below 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
All detected emissions are more than 20 dB below the limit.		
Measurement uncertainty	± 3 dB	

Plots:

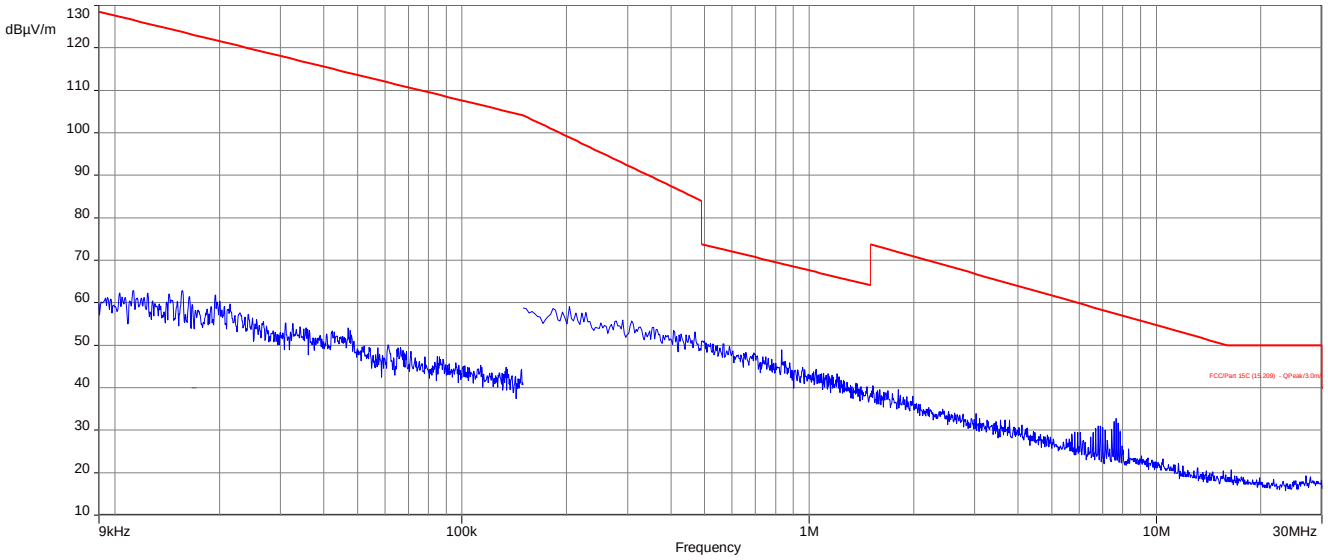
Plot 1: 9 kHz to 30 MHz, - lowest channel – DBPSK modulation



Plot 2: 9 kHz to 30 MHz, - middle channel – DBPSK modulation



Plot 3: 9 kHz to 30 MHz, - highest channel – DBPSK modulation



11.10 Spurious emissions radiated 30 MHz to 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed in the mode with the highest output power.

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

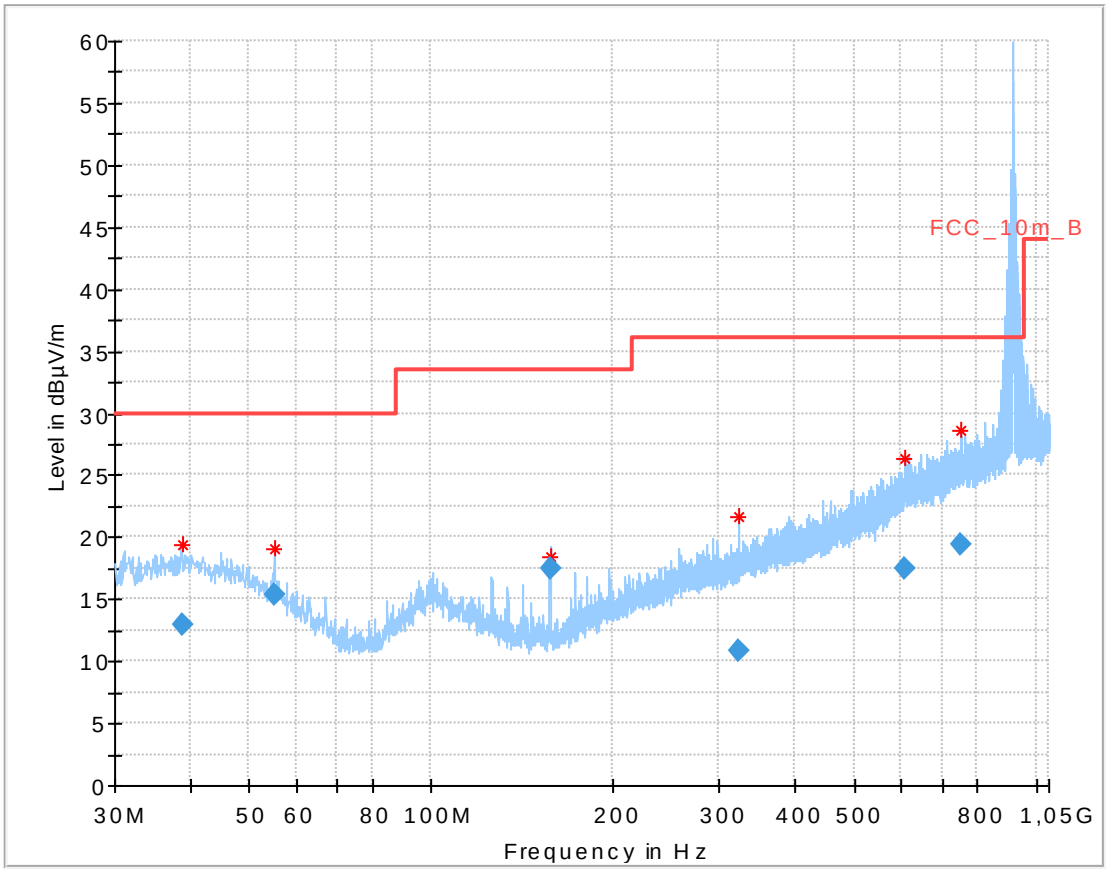
The modulation with the highest output power was used to perform the transmitter spurious emissions. If spurious were detected a re-measurement was performed on the detected frequency with each modulation.

Limits:

FCC		IC
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
30 - 88	30.0	10
88 – 216	33.5	10
216 – 960	36.0	10
Above 960	54.0	3

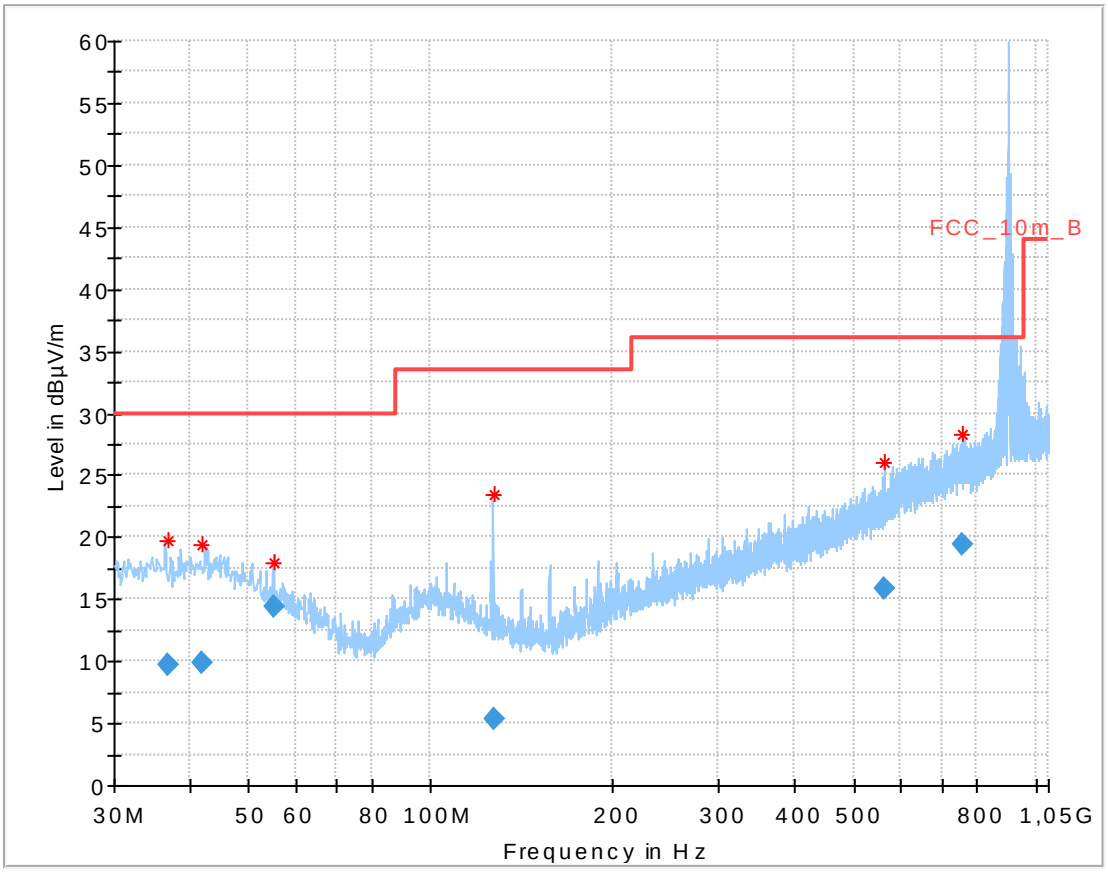
Plots: Transmit mode

Plot 1: 30 MHz to 1 GHz, - lowest channel – DBPSK modulation



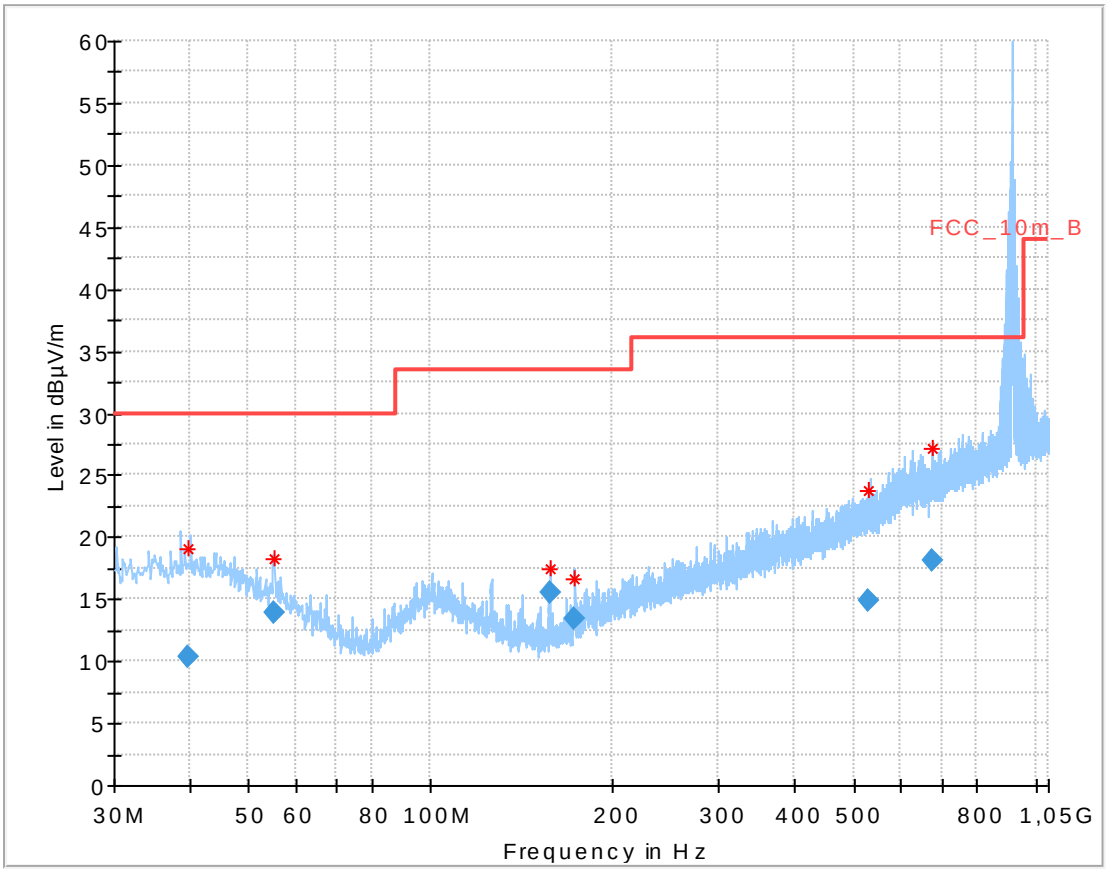
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.735700	13.00	30.00	17.00	1000.0	120.000	200.0	V	40.0	14.0
55.120500	15.36	30.00	14.64	1000.0	120.000	276.0	V	50.0	11.8
157.343550	17.41	33.50	16.09	1000.0	120.000	100.0	V	163.0	9.0
323.319750	10.80	36.00	25.20	1000.0	120.000	275.0	V	95.0	15.2
606.962550	17.54	36.00	18.46	1000.0	120.000	100.0	H	277.0	20.8
753.596850	19.37	36.00	16.63	1000.0	120.000	400.0	H	185.0	22.7

Plot 2: 30 MHz to 1 GHz, - middle channel – DBPSK modulation



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.867000	9.68	30.00	20.32	1000.0	120.000	274.0	H	27.0	13.9
41.821950	9.79	30.00	20.21	1000.0	120.000	172.0	V	52.0	14.0
55.176450	14.32	30.00	15.68	1000.0	120.000	272.0	V	32.0	11.8
127.032450	5.28	33.50	28.22	1000.0	120.000	355.0	V	230.0	9.6
560.920200	15.77	36.00	20.23	1000.0	120.000	174.0	V	77.0	19.6
757.911000	19.45	36.00	16.55	1000.0	120.000	400.0	V	220.0	22.7

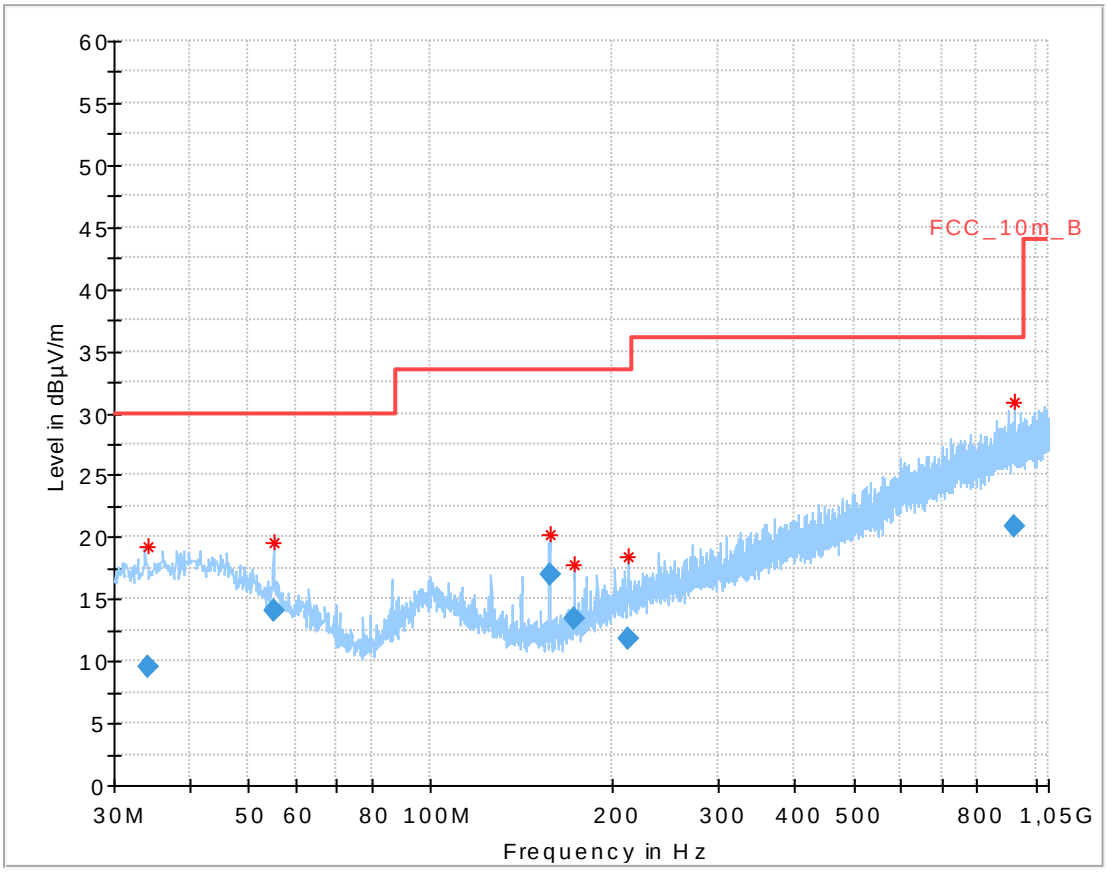
Plot 3: 30 MHz to 1 GHz, - highest channel – DBPSK modulation



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
39.907200	10.34	30.00	19.66	1000.0	120.000	274.0	H	5.0	14.0
55.061250	13.98	30.00	16.02	1000.0	120.000	277.0	V	320.0	11.8
157.370700	15.45	33.50	18.05	1000.0	120.000	100.0	V	277.0	9.0
173.133000	13.43	33.50	20.07	1000.0	120.000	274.0	V	130.0	9.9
530.890050	14.82	36.00	21.18	1000.0	120.000	200.0	V	52.0	19.1
675.357300	18.08	36.00	17.92	1000.0	120.000	400.0	V	265.0	21.3

Plots: Receiver mode

Plot 1: 30 MHz to 1 GHz, RX / idle – mode



Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
34.271700	9.56	30.00	20.44	1000.0	120.000	274.0	H	162.0	13.7
54.975600	14.14	30.00	15.86	1000.0	120.000	351.0	V	188.0	11.9
157.275300	16.97	33.50	16.53	1000.0	120.000	174.0	V	185.0	9.0
172.917900	13.47	33.50	20.03	1000.0	120.000	273.0	V	167.0	9.9
212.398200	11.88	33.50	21.62	1000.0	120.000	103.0	V	211.0	12.1
925.478700	20.80	36.00	15.20	1000.0	120.000	200.0	H	28.0	24.2

11.11 Spurious emissions radiated above 1 GHz

Description:

Measurement of the radiated spurious emissions in transmit mode. 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	DBPSK
Test setup	See sub clause 7.2 A (1 GHz - 10 GHz)
Measurement uncertainty	See sub clause 9

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

Limits:

FCC		IC
TX spurious emissions radiated		
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).		
§15.209		
Frequency (MHz)	Field strength (dBµV/m)	Measurement distance
Above 960	54.0	3

Results: Transmitter mode

TX spurious emissions radiated [dBµV/m]								
902.1375 MHz			903.3875 MHz			904.6625 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
2710.2	Peak	55.4	2706.3	Peak	55.2	2714.1	Peak	55.5
	AVG	53.4		AVG	53.1		AVG	53.7
3613.6	Peak	53.1	5412.7	Peak	51.1	-/-	Peak	-/-
	AVG	48.1		AVG	47.9		AVG	-/-
5420.4	Peak	50.6	-/-	Peak	-/-	-/-	Peak	-/-
	AVG	47.4		AVG	-/-		AVG	-/-

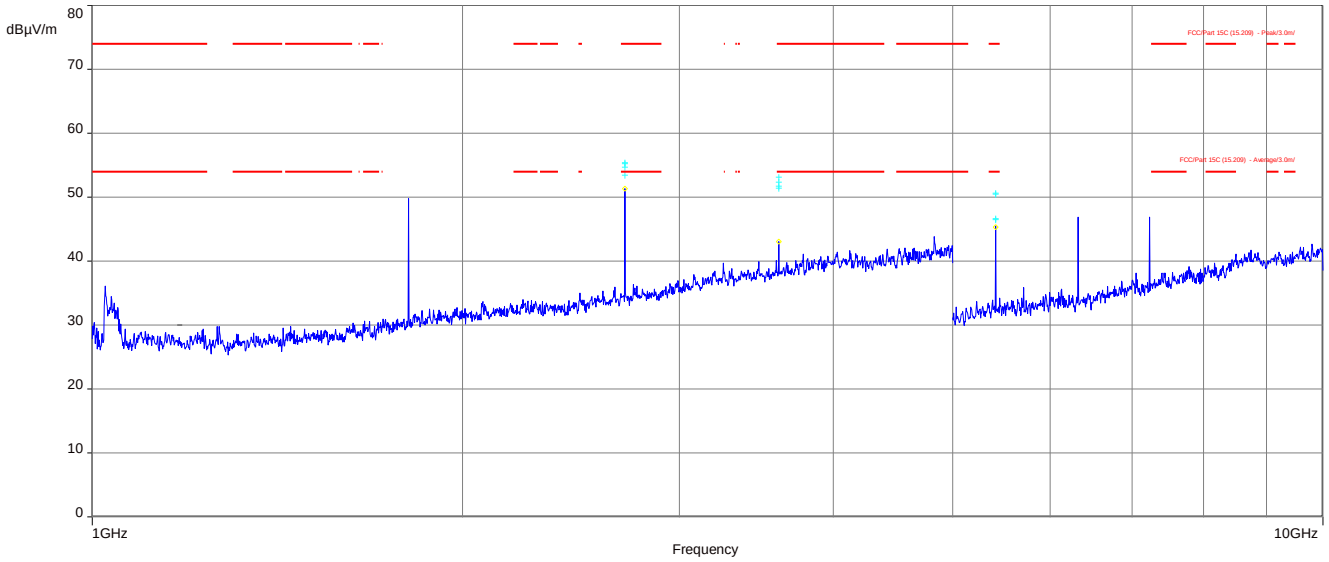
Results: Receiver mode

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	-/-

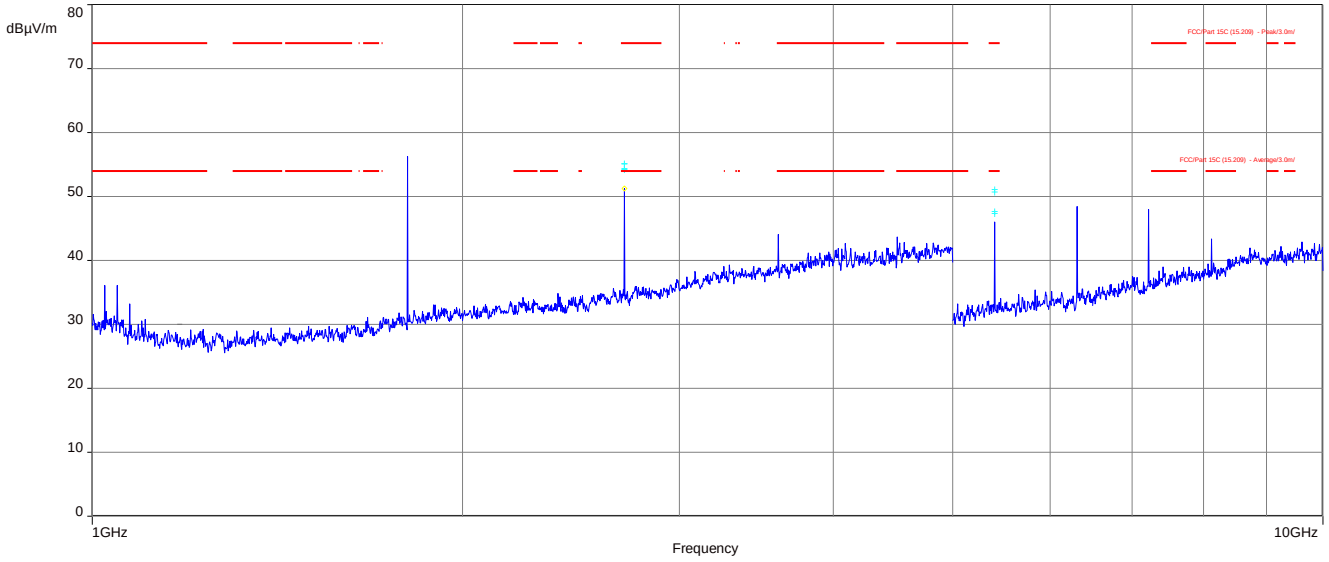
Note: The limit was recalculated with 20 dB / decade (Part 15.31) for all radiated spurious emissions 30 MHz to 1 GHz from 3 meter limit to a 10 meter distance. (40dB/decade for emissions < 30MHz)

Plots: Transmitter mode

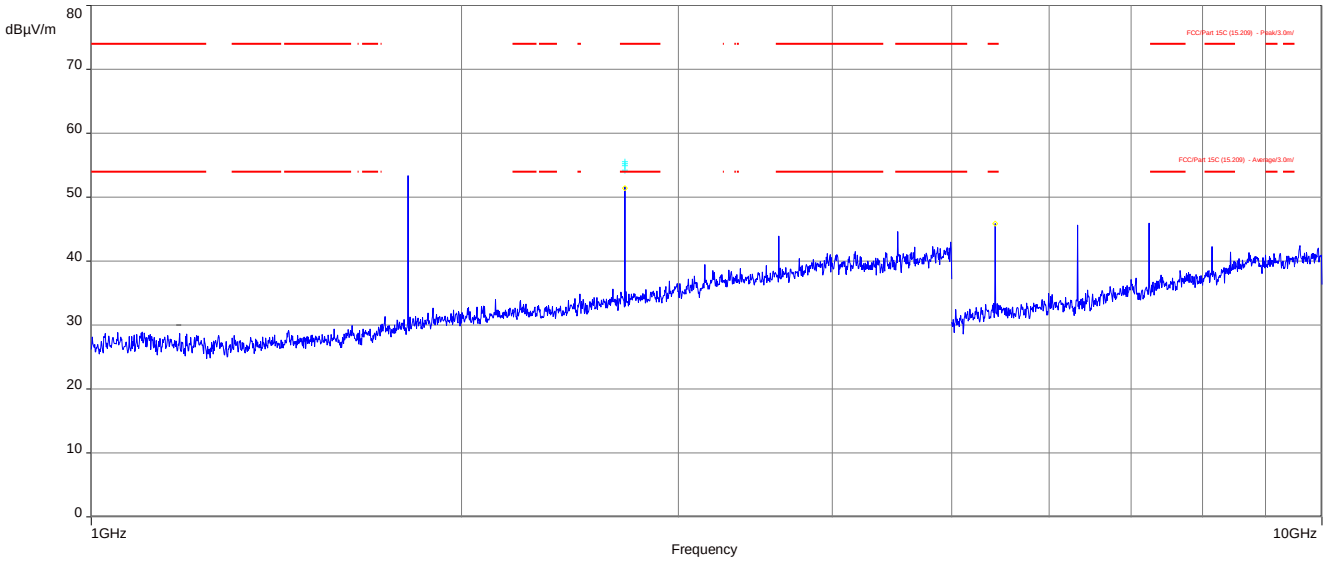
Plot 1: 1 GHz to 10 GHz, - lowest channel – DBPSK modulation



Plot 2: 1 GHz to 10 GHz, - middle channel – DBPSK modulation

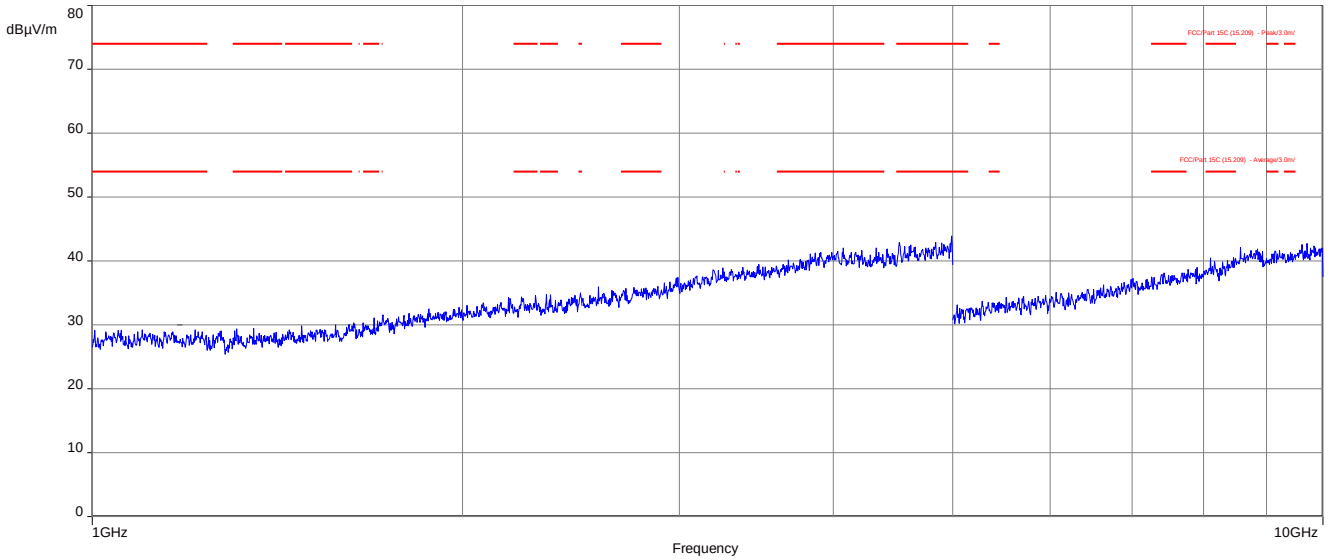


Plot 3: 1 GHz to 10 GHz, - highest channel – DBPSK modulation



Plots: Receiver mode

Plot 1: 1 GHz to 10 GHz, RX / idle-mode



11.12 Spurious emissions conducted below 30 MHz (AC conducted)

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The measurement is performed in the mode with the highest output power. Both power lines, phase and neutral line, are measured. Found peaks are remeasured with average and quasi peak detection to show compliance to the limits.

Measurement parameters	
Detector	Peak - Quasi peak / average
Sweep time	Auto
Resolution bandwidth	F < 150 kHz: 200 Hz F > 150 kHz: 9 kHz
Video bandwidth	F < 150 kHz: 1 kHz F > 150 kHz: 100 kHz
Span	9 kHz to 30 MHz
Trace mode	Max hold
Test setup	See sub clause 7.5. A
Measurement uncertainty	See sub clause 9

Limits:

FCC		IC
TX spurious emissions conducted < 30 MHz		
Frequency (MHz)	Quasi-peak (dBµV/m)	Average (dBµV/m)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30.0	60	50

*Decreases with the logarithm of the frequency

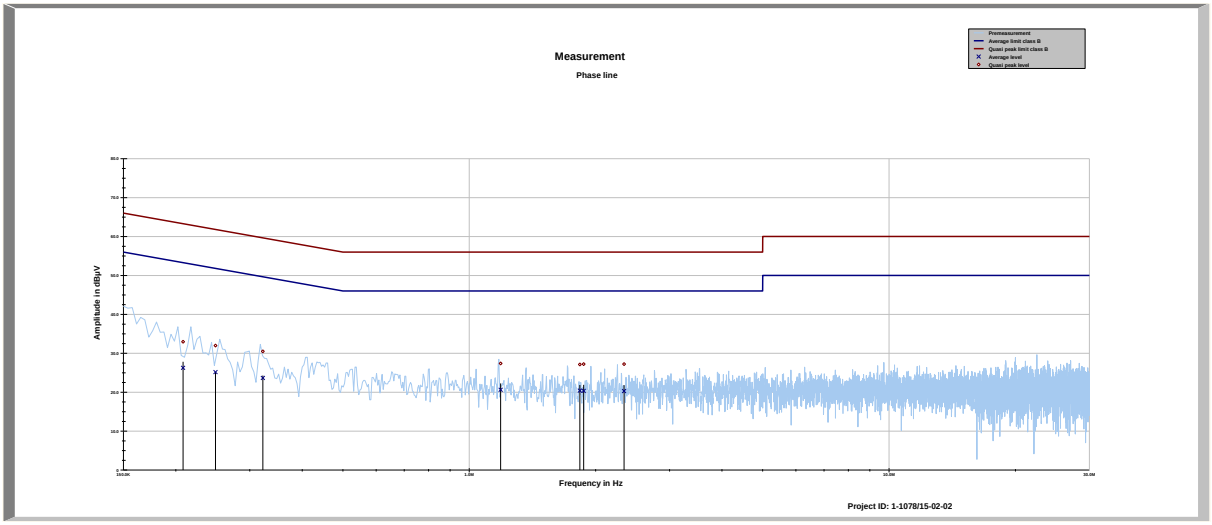
Results:

Spurious emissions conducted < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
See table below plots!		
Measurement uncertainty	± 3 dB	

Note: Test performed with a lab power supply.

Plots:

Plot 1: 150 kHz to 30 MHz, phase line – middle channel

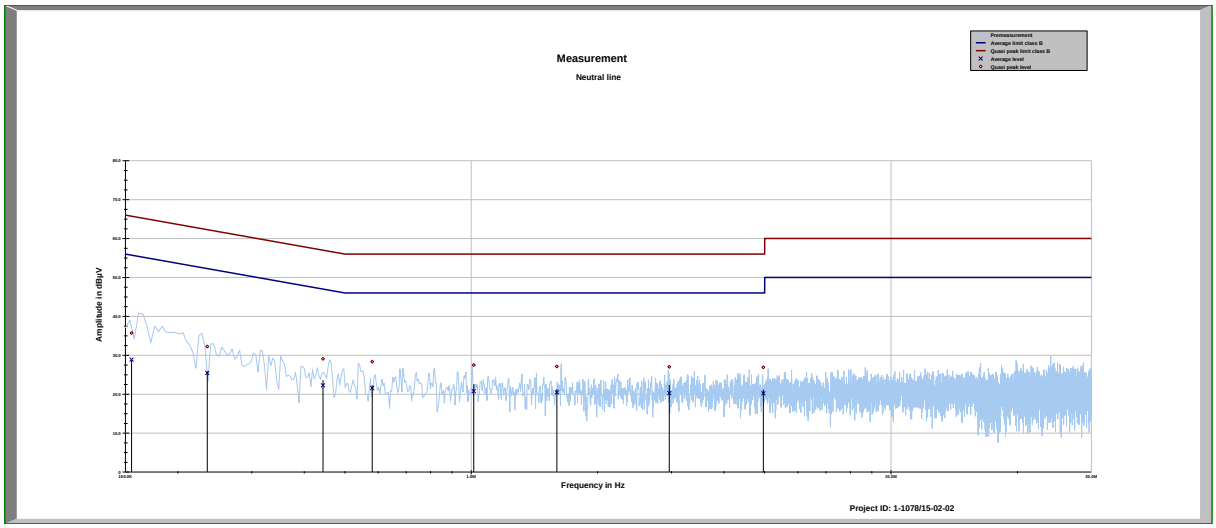


Phase line tbl

Project ID: 1-1078/15-02-02

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.147364	17.26			14.18		
0.208090	32.96	30.33	63.281	26.26	28.08	54.340
0.248524	31.97	29.83	61.806	25.16	28.02	53.185
0.322392	30.49	29.16	59.645	23.65	27.42	51.075
1.187919	27.38	28.62	56.000	20.61	25.39	46.000
1.834577	27.12	28.88	56.000	20.41	25.59	46.000
1.872854	27.21	28.79	56.000	20.33	25.67	46.000
2.337193	27.21	28.79	56.000	20.27	25.73	46.000

Plot 2: 150 kHz to 30 MHz, neutral line – middle channel



Neutral line tbl
Project ID: 1-1078/15-02-02

Frequency	Quasi peak level	Margin quasi peak	Limit QP	Average level	Margin average	Limit AV
MHz	dBµV	dB	dBµV	dBµV	dB	dBµV
0.155142	35.71	30.01	65.720	28.89	26.96	55.853
0.235064	32.23	30.04	62.269	25.43	28.14	53.570
0.443369	29.08	27.92	56.998	22.26	25.36	47.618
0.580814	28.35	27.65	56.000	21.58	24.42	46.000
1.013445	27.49	28.51	56.000	20.79	25.21	46.000
1.599213	27.11	28.89	56.000	20.46	25.54	46.000
2.961683	27.02	28.98	56.000	20.26	25.74	46.000
4.963812	26.90	29.10	56.000	20.20	25.80	46.000

12 Observations

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

Annex A Document history

Version	Applied changes	Date of release
	Initial release	2016-04-27
-A	Editorial changes, Model name, PMN, HVIN, IC ID and FCC ID changed	2016-05-25
-B	Section 5.1: test frequency information added	2016-06-02

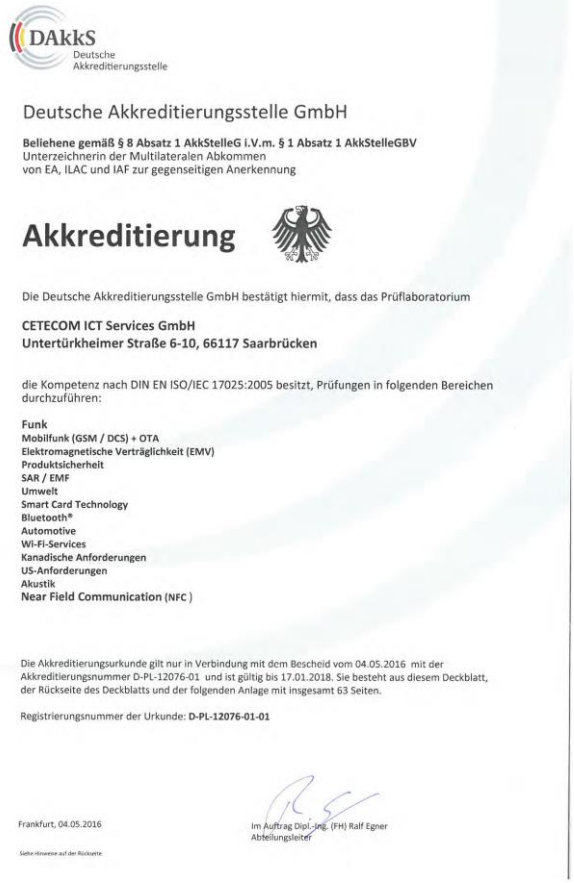
Annex B Further information

Glossary

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

Annex C Accreditation Certificate

Front side of certificate



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