

TEST REPORT

Test report no.: 1-5753/12-01-15-A



Deutsche
 Akkreditierungsstelle
 D-PL-12076-01-00

Testing laboratory

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Accredited Testing Laboratory:

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

Applicant

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 Phone: +49 5130 600-0
 Fax: +49 5130 600-574
 Contact: Marco Happ
 e-mail: marco.happ@sennheiser.com
 Phone: +49 5130 600-2621

Manufacturer

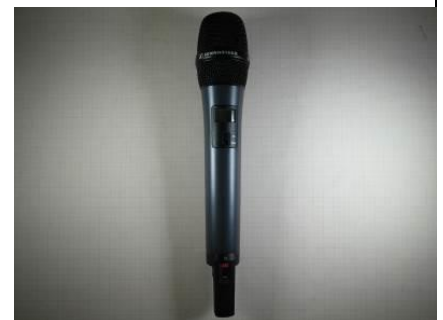
Sennheiser electronic GmbH & Co. KG
 Am Labor 1
 30900 Wedemark / GERMANY

Test standard/s

47 CFR Part 15 Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
 RSS - 210 Issue 8 Spectrum Management and Telecommunications Radio Standards Specification - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
 For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item: Wireless Microphone Handheld
Model name: SKM D1, SKM-S D1
FCC ID: DMOSK2G4WE
IC: 2099A-SKM2G4WE
Frequency: DTS band 2400 MHz to 2483.5 MHz
Technology tested: Proprietary digital audio transmission
Antenna: Integrated PCB / chip antennas
Power supply: 3.0 V DC by Li - Ion or 2x AA batteries
Temperature range: -10°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 authorised:

Stefan Bös
 Radio Communications & EMC

Test performed:

Andreas Luckenbill
 Radio Communications & EMC

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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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2.2 Application details

Date of receipt of order:	2013-01-14
Date of receipt of test item:	2014-06-23
Start of test:	2014-06-23
End of test:	2014-12-13
Person(s) present during the test:	-/-

3 Test standard/s

Test standard	Date	Test standard description
47 CFR Part 15	-/-	Title 47 of the Code of Federal Regulations; Chapter I; Part 15 - Radio frequency devices
RSS - 210 Issue 8	01.12.2010	Spectrum Management and Telecommunications Radio Standards Specification - Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment

3.1 Measurement guidance

DTS : KDB 558074	2014-06	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247
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4 Test environment

Temperature:	T_{nom}	+22 °C during room temperature tests
	T_{max}	+55 °C during high temperature tests
	T_{min}	-10 °C during low temperature tests
Relative humidity content:		56 %
Barometric pressure:		not relevant for this kind of testing
Power supply:	V_{nom}	3.0 V DC by Li - Ion or 2x AA batteries
	V_{max}	4.7 V
	V_{min}	1.8 V

5 Test item

Kind of test item	:	Wireless Microphone Handheld
Type identification	:	SKM D1, SKM-S D1
S/N serial number	:	Radiated units:
		Conducted unit:
		ANT 1: 1234100128, 1474100462 ANT 2: 1234100079, 1474100462 1474100454
HW hardware status	:	556660-11
SW software status	:	0.4.7
		Power setting: 6F 50 00 68 03 A0
Frequency band [MHz]	:	DTS band 2400 MHz to 2483.5 MHz (lowest channel 2403 MHz, highest channel 2481 MHz)
Type of radio transmission	:	DTS
Use of frequency spectrum	:	
Type of modulation	:	GFSK
Number of channels	:	40
Antenna	:	Integrated PCB / chip antennas
Power supply	:	3.0 V DC by Li - Ion or 2x AA batteries
Temperature range	:	-10°C to +55°C

5.1 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: 1-5753/12-01-02_AnnexA
1-5753/12-01-02_AnnexB
1-5753/12-01-02_AnnexD

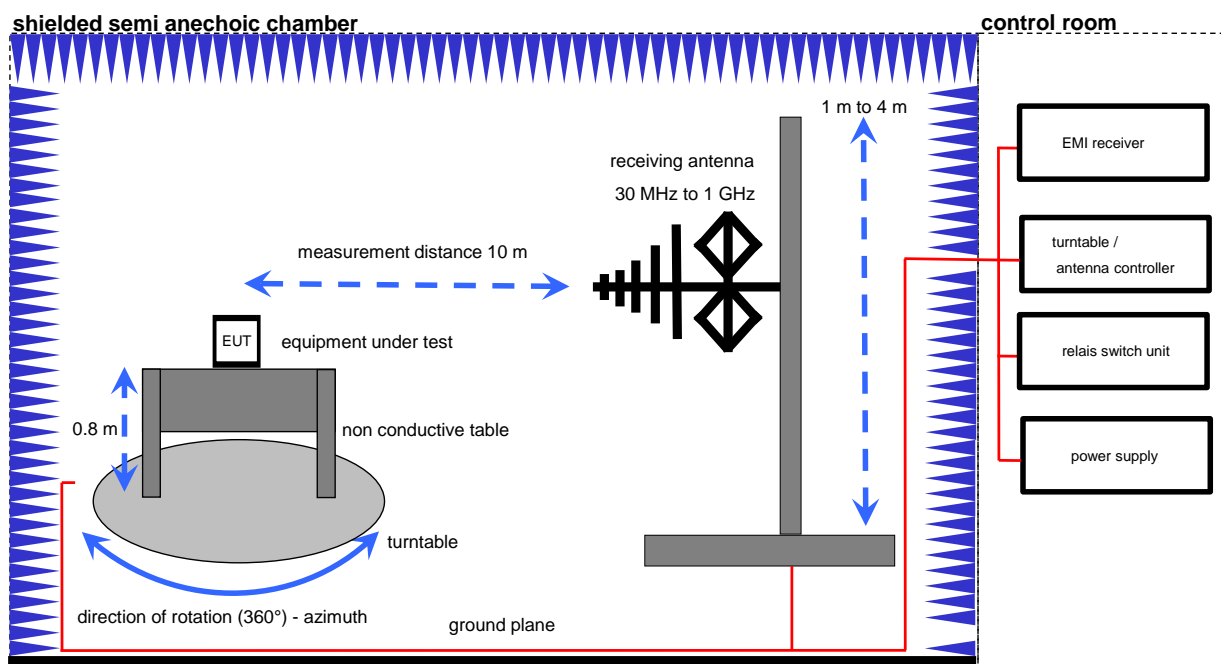
6 Test laboratories sub-contracted

None

7 Description of the test setup

7.1 Radiated measurements chamber F

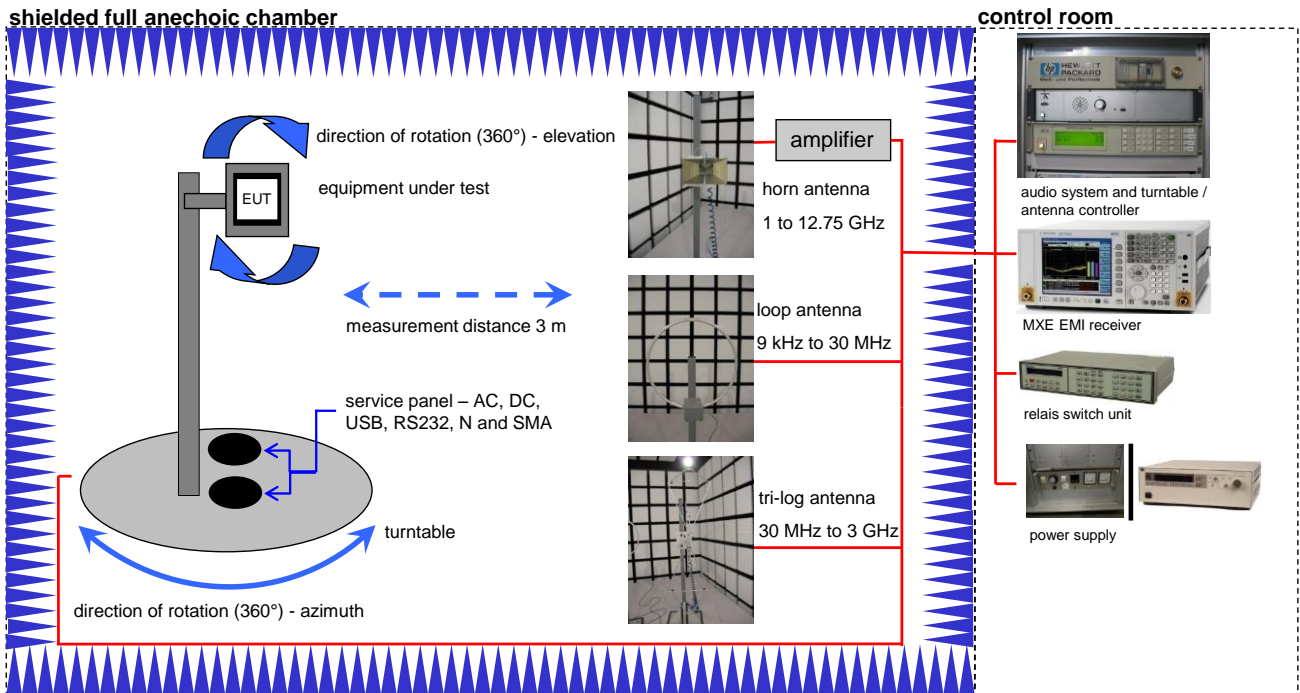
The radiated measurements are performed in vertical and horizontal plane in the frequency range from 9 kHz to 1 GHz in semi-anechoic chambers. The EUT is positioned on a non-conductive support with a height of 0.80 m above a conductive ground plane that covers the whole chamber. The receiving antennas 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 analysers where the detector modes and resolution bandwidths over various frequency ranges are set according to requirement ANSI C63.



Equipment table:

Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom
Software	EMC32 V. 9.12.05	R&S	-/-	-/-
Switch-Unit	3488A	HP Meßtechnik	2719A14505	30000368
DC power supply, 60Vdc, 50A, 1200 W	6032A	HP Meßtechnik	2920A04466	30000580
EMI Test Receiver	ESCI 3	R&S	100083	300003312
Amplifier	JS42-00502650-28-5A	MITEQ	1084532	300003379
Antenna Tower	Model 2175	ETS-LINDGREN	64762	300003745
Positioning Controller	Model 2090	ETS-LINDGREN	64672	300003746
Turntable Interface-Box	Model 105637	ETS-LINDGREN	44583	300003747
TRILOG Broadband Test- Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787

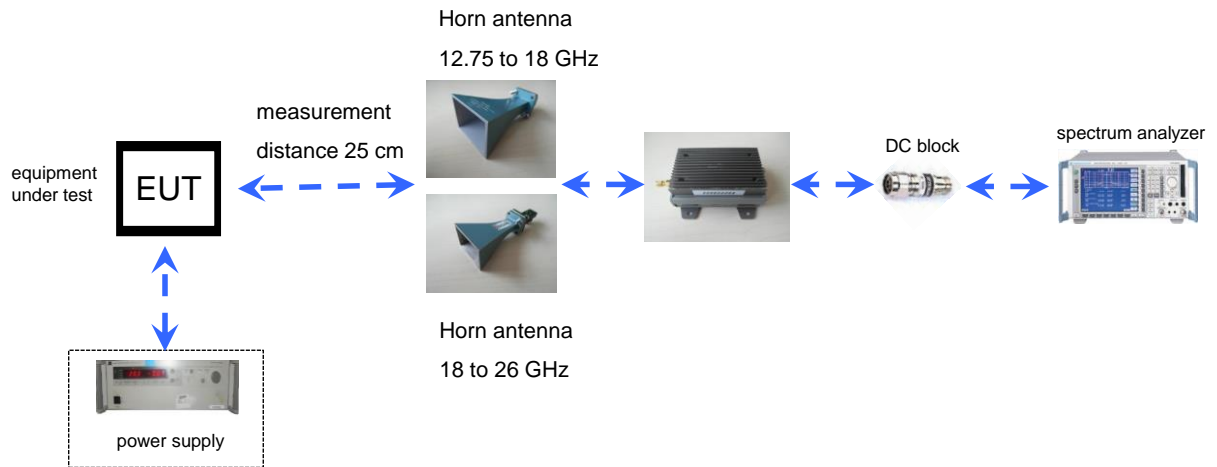
7.2 Radiated measurements chamber C



Equipment table:

Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom
MXE EMI Receiver 20 Hz bis 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405
TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854
Band Reject filter	WRCG2400/2483-2375/2505-50/10SS	Wainwright	11	300003351
Highpass Filter	WHKX7.0/18G-8SS	Wainwright	18	300003789
Double-Ridged Waveguide Horn Antenna 1-18.0GHz	3115	EMCO	8812-3088	300001032
Active Loop Antenna	6502	EMCO	8905-2342	300000256
Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996
Switch / Control Unit	3488A	HP Meßtechnik	*	300000199
Switch / Control Unit	3488A	HP Meßtechnik	2719A15013	300001156
Isolating Transformer	MPL IEC625 Bus Regeltrenntravo	Erfi	91350	300001155
Three-Way Power Splitter, 50 Ohm	11850C	HP Meßtechnik		300000997
Amplifier	js42-00502650-28-5a	Parzich GMBH	928979	300003143

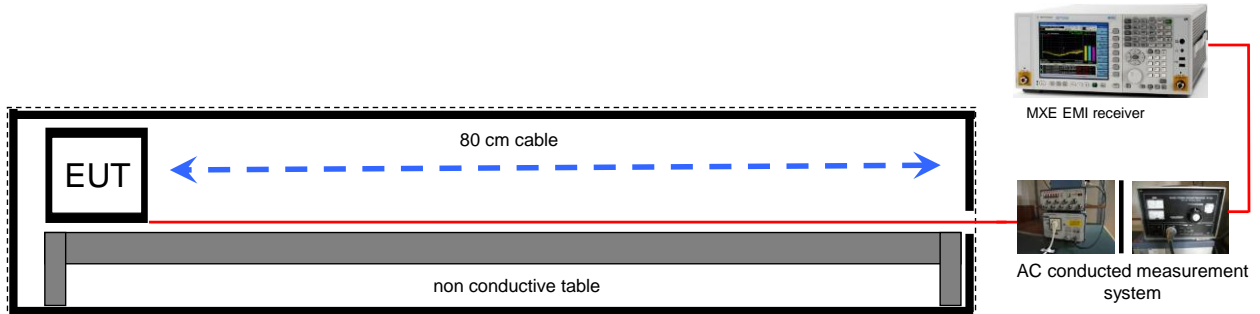
7.3 Radiated measurements 12.75 GHz to 26 GHz



Equipment table:

Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom
Std. Gain Horn Antenna 12.4 to 18.0 GHz	639	Narda	8402	300000787
Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda	8205	300002442
Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP Meßtechnik	00419	300002268
Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517

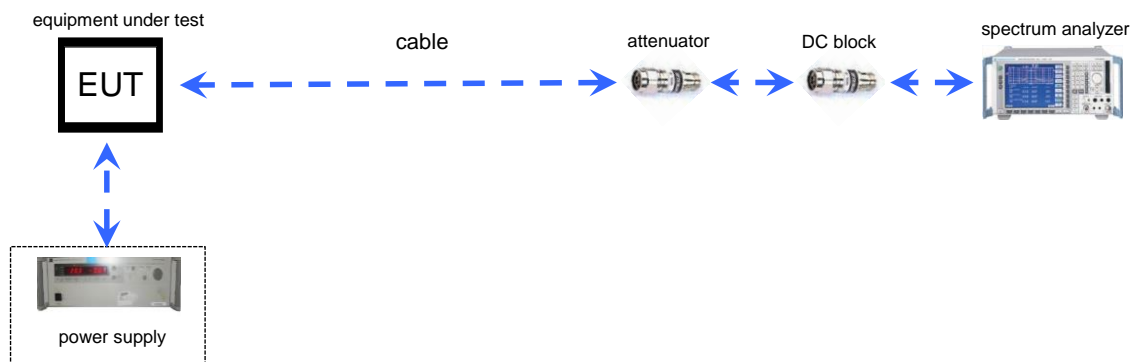
7.4 AC conducted



Equipment table:

Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom
MXE EMI Receiver 20 Hz bis 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405
Isolating Transformer	MPL IEC625 Bus Regeltrenntravo	Erfi	91350	300001155
Switch / Control Unit	3488A	HP Meßtechnik	*	300000199
Switch / Control Unit	3488A	HP Meßtechnik	2719A15013	300001168
Artificial Mains 9 kHz to 30 MHz	ESH3-Z5	R&S	828576/020	300001210

7.5 Conducted measurements



Equipment table:

Equipment	Type	Manufacturer	Serial No.	INV. No Cetecom
Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517

8 Summary of measurement results

- No deviations from the technical specifications were ascertained
- There were deviations from the technical specifications ascertained

TC Identifier	Description	Verdict	Date	Remark
RF-Testing	CFR Part 15 RSS 210, Issue 8	Passed	2015-01-23	-/-

Test specification clause	Test case	Guideline	Temperature conditions	Power source voltages	Mode	Pass	Fail	NA	NP	Remark
§15.247(b)(4) RSS 210 / A8.4(2)	Antenna gain	-/-	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(e) RSS 210 / A8.2(b)	Power spectral density	KDB 558074 DTS clause: 10.6	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(a)(2) RSS 210 / A8.2(a)	Spectrum bandwidth – 6 dB bandwidth	KDB 558074 DTS clause: 8.2	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
RSS Gen clause 4.6.1	Occupied bandwidth	-/-	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(b)(3) RSS-210 / A8.4(4)	Maximum output power	KDB 558074 DTS clause: 9.2.2.5	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d) RSS-210 / A8.5	Spurious emissions near the band edges	KDB 558074 DTS clause: 11.1 (b)	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.205 RSS-210 / A8.5	Band edge compliance radiated	KDB 558074 DTS clause: 13.2	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d) RSS-210 / A8.5	TX spurious emissions conducted	KDB 558074 DTS clause: 11.1 (b)	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.247(d) RSS-210 / A8.5	TX spurious emissions radiated	-/-	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.109 RSS-Gen	RX spurious emissions radiated	-/-	Nominal	Nominal	RX mode	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.209(a) RSS-Gen	TX spurious emissions radiated < 30 MHz	-/-	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies
§15.107(a) §15.207	Conducted emissions < 30 MHz	-/-	Nominal	Nominal	GFSK	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	complies

Note: NA = Not Applicable; NP = Not Performed

9 Additional comments

Reference documents: None

Special test descriptions: None

Configuration descriptions: None

Test mode: No test mode available.
Iperf was used to ping another device with the largest support packet size

Special software is used.
EUT is transmitting pseudo random data by itself

10 Measurement results

10.1 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:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	3 MHz
Video bandwidth:	3 MHz
Trace-Mode:	Max hold

Limits:

FCC	IC
Antenna Gain	
6 dBi	

Results: ANT 1 (PCB Antenna)

T _{nom}	V _{nom}	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
Gain [dBi]		-1.47	-0.55	1.33
Measurement uncertainty		± 1.5 dB (cond.) / ± 3 dB (rad.)		

Results: ANT 2 (Ceramic Antenna)

T _{nom}	V _{nom}	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
Gain [dBi]		-3.08	-2.73	-3.65
Measurement uncertainty		± 1.5 dB (cond.) / ± 3 dB (rad.)		

Verdict: **Passed**

10.2 Maximum output power

Description:

Measurement of the maximum output power conducted and radiated.

Measurement:

Measurement parameter	
According to DTS clause: 9.2.2.5	
Detector:	Peak
Sweep time:	930 ms
Resolution bandwidth:	30 kHz
Video bandwidth:	100 kHz
Span:	2.75 MHz
Integration bandwidth:	99% power - bandwidth (OBW)
Trace-Mode:	Single Sweep
Measurement function:	Channel power over OBW

Limits:

FCC	IC
Maximum Output Power	
Conducted: 1.0 W – Antenna Gain max. 6 dBi	

Results:

GFSK / ANT 1 & ANT 2 Frequency	Maximum Output Power [dBm]		
	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
Peak output power conducted	15.85	16.71	16.96
Measurement uncertainty	± 1.5 dB (cond.)		

Verdict: Passed

10.3 Power spectral density

Description:

Measurement of the power spectral density of a digital modulated system. The measurement is repeated at the lowest, middle and highest channel.

Measurement:

Measurement parameter	
According to DTS clause: 10.6	
Detector:	RMS
Sweep time:	15.2
Resolution bandwidth:	3 kHz
Video bandwidth:	10 kHz
Span:	3 MHz

Limits:

FCC	IC
Power Spectral Density	
8 dBm (conducted)	

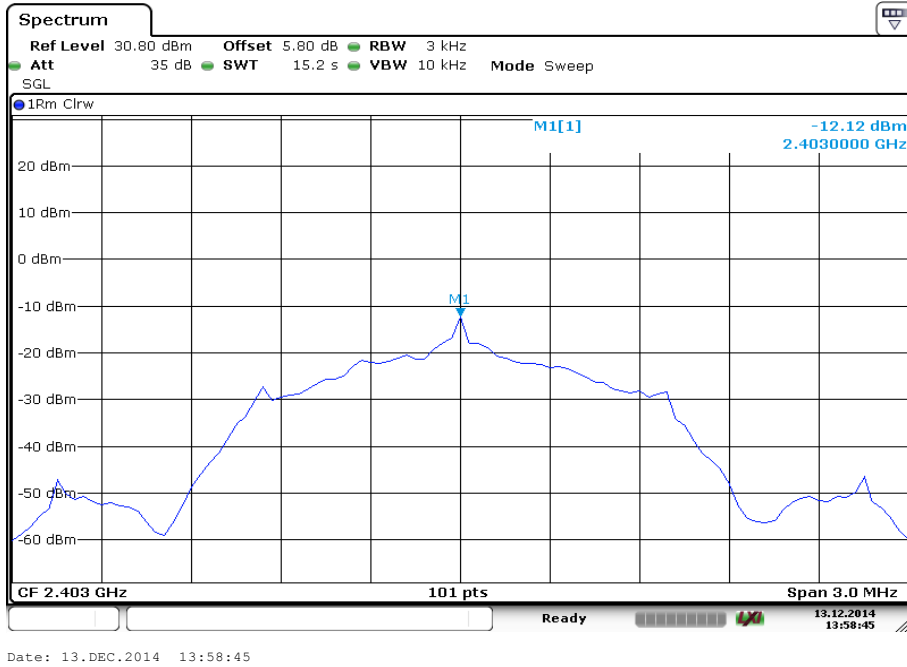
Results:

Modulation	Power Spectral density [dBm]		
	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
Frequency			
GFSK / ANT 1 & ANT 2	-12.1	-11.5	-11.3
Measurement uncertainty	± 1.5 dB (cond.)		

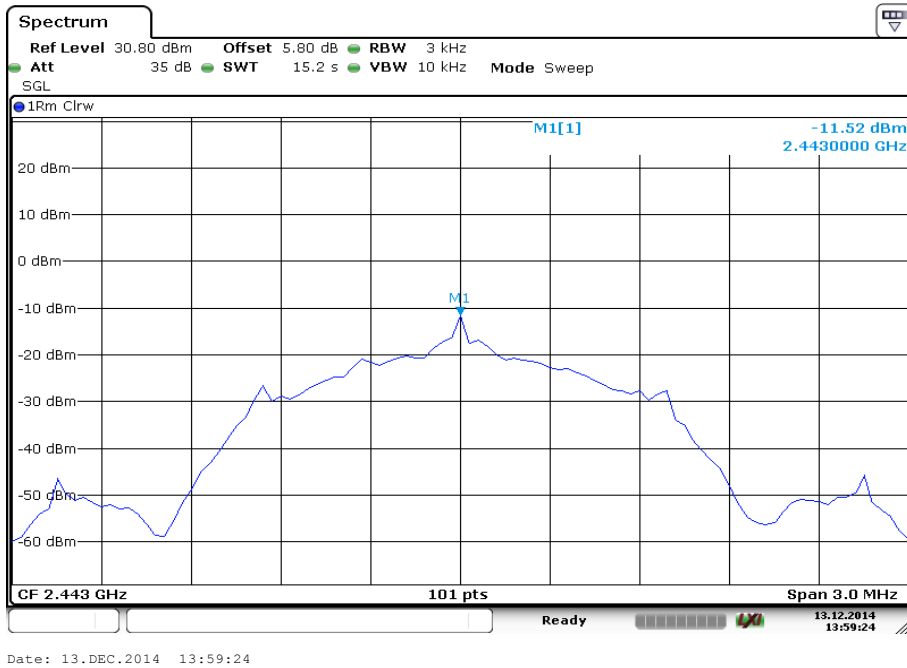
Verdict: Passed

Plots: ANT 1 and ANT 2

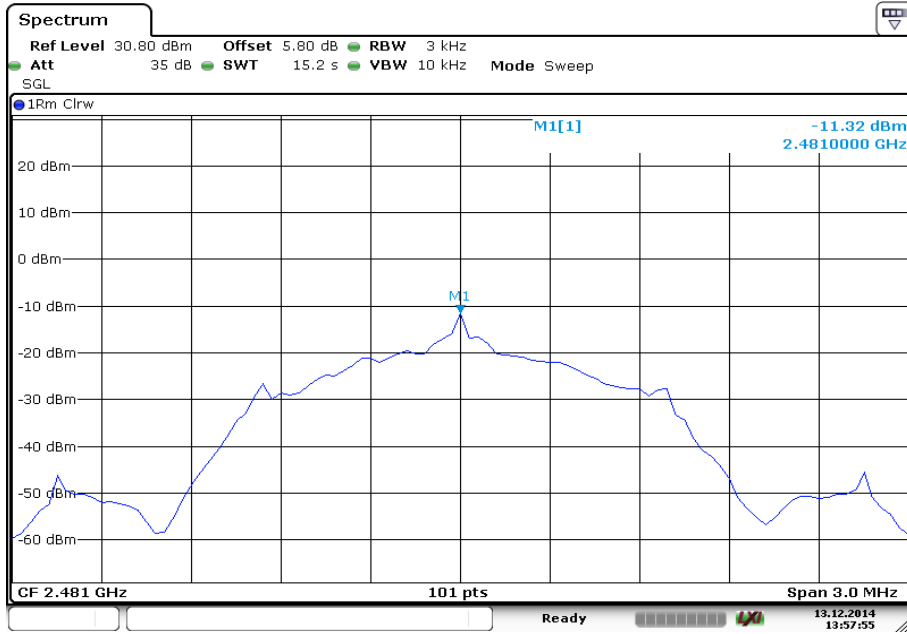
Plot 1: TX mode, lowest channel



Plot 2: TX mode, middle channel



Plot 3: TX mode, highest channel



Date: 13.DEC.2014 13:57:55

10.4 Spectrum bandwidth – 6 dB

Description:

Measurement of the 6 dB bandwidth of the modulated signal.

Measurement:

Measurement parameter	
According to DTS clause: 8.2	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Span:	3 MHz
Measurement procedure:	Using marker function 6 dB down.
Trace-Mode:	Max hold (allow trace to stabilize)

Limits:

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

Results:

Frequency	6 dB bandwidth [kHz]		
	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
GFSK / ANT 1 & ANT 2	856	854	850
Measurement uncertainty	± RBW		

Verdict: Passed

10.5 Occupied bandwidth – 99% emission bandwidth

Description:

Measurement of the 99% bandwidth of the modulated signal acc. RSS-GEN or ANSI C63.10.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	30 kHz
Video bandwidth:	100 kHz
Span:	3 MHz
Measurement procedure:	Measurement of the 99% bandwidth using the integration function of the analyzer
Trace-Mode:	Max hold (allow trace to stabilize)

Usage:

-/-	IC
Occupied Bandwidth – 99% emission bandwidth	
OBW is necessary for Emission Designator	

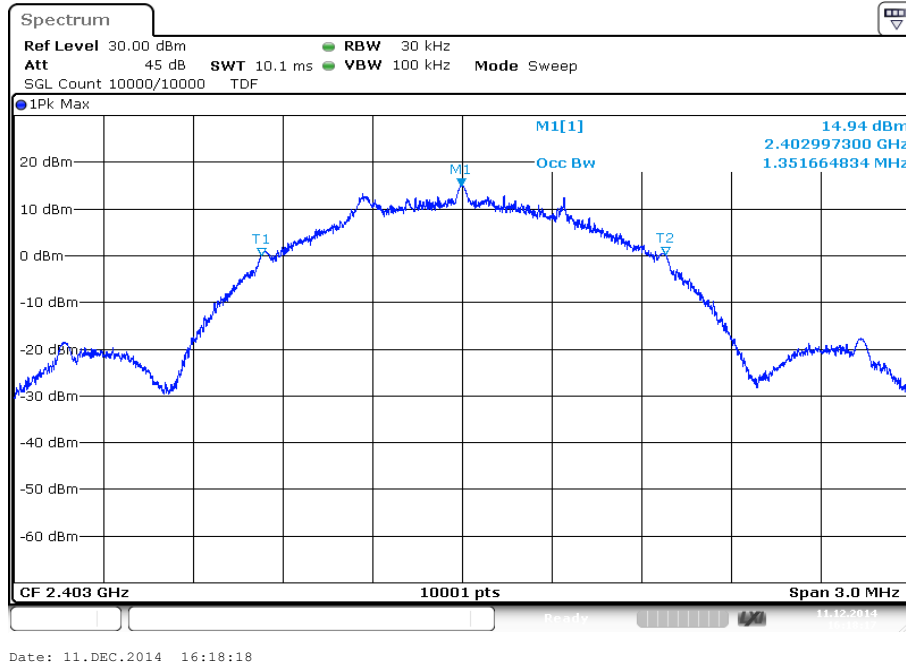
Results:

Modulation Frequency	99 % bandwidth [kHz]		
	Lowest channel 2403 MHz	Middle channel 2443 MHz	Highest channel 2481 MHz
GFSK / ANT 1 & ANT 2	1352	1346	1346
Measurement uncertainty	± RBW		

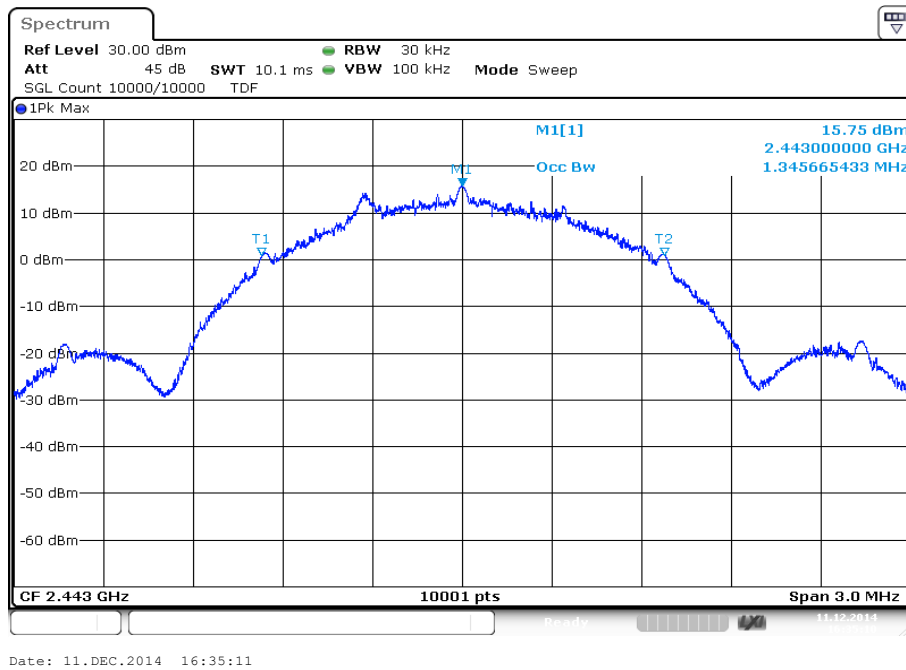
Verdict: Passed

Plots: ANT 1 + ANT 2

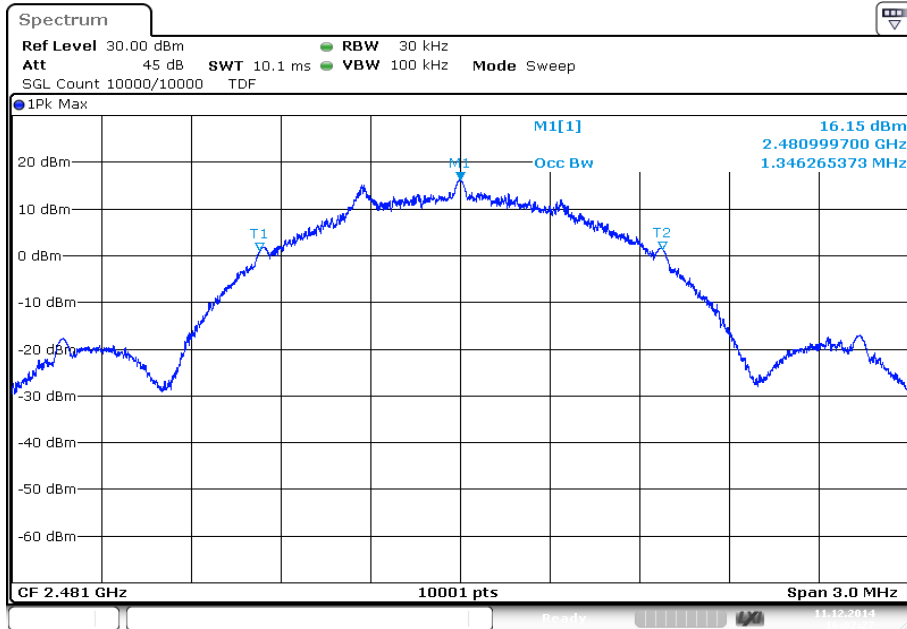
Plot 1: TX mode, lowest channel



Plot 2: TX mode, middle channel



Plot 3: TX mode, highest channel



Date: 11.DEC.2014 16:02:28

10.6 Spurious emissions near the band edges

Description:

EUT is measured at the lower and upper band edge of the frequency band.

Measurement:

Measurement parameter	
According to DTS clause: 11.1 (b)	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	500 kHz
Span:	2380 MHz – 2500 MHz
Trace-Mode:	Max hold

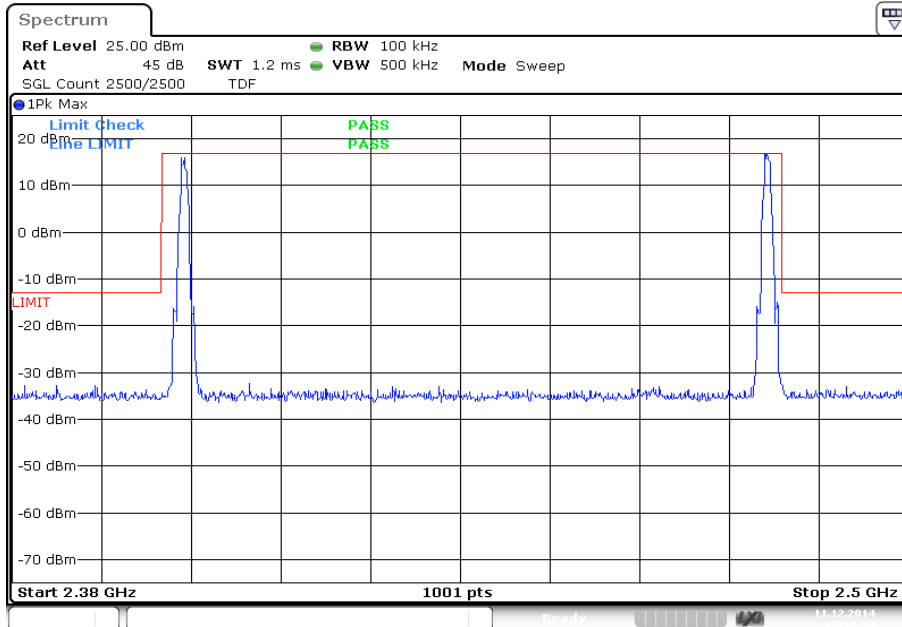
Limits:

FCC	IC
Band Edge Compliance Conducted	
<p>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.</p>	

Verdict: Passed

Plots: ANT 1 & ANT 2

Plot 1: Lowest + highest channel



Date: 11.DEC.2014 16:18:40

10.7 Band edge compliance radiated

Description:

Measurement of the radiated band edge compliance. The EUT is turned in the position that results in the maximum level at the band edge. Then a sweep over the corresponding restricted band is performed. The EUT is set to the lowest channel for the lower restricted band and to the highest channel for the upper restricted band. Measurement distance is 3m.

Measurement:

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

Limits:

FCC	IC
Band Edge Compliance Radiated	
<p>In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).</p>	
74 dB μ V/m Peak 54 dB μ V/m AVG	

Results:

Scenario	Band Edge Compliance Radiated [dB]	
	GFSK / ANT 1	GFSK / ANT 2
Modulation		
Lower Band Edge	> 20 dB (Peak) > 20 dB (AVG)	> 10 dB (Peak) > 10 dB (AVG)
Upper Band Edge	> 20 dB (Peak) > 20 dB (AVG)	71.77 (Peak) * 52.69 (AVG)
Measurement uncertainty	± 3 dB	

* Remeasured with Marker Delta Method

Verdict: Passed

10.8 TX spurious emissions conducted

Description:

Measurement of the conducted spurious emissions in transmit mode. The measurement is performed at the lowest, middle and highest channel.

Measurement:

Measurement parameter	
Detector:	Peak
Sweep time:	Auto
Resolution bandwidth:	100 kHz
Video bandwidth:	500 kHz
Span:	9 kHz to 25 GHz
Trace-Mode:	Max Hold

Limits:

FCC	IC
TX Spurious Emissions Conducted	
<p>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 30 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</p>	

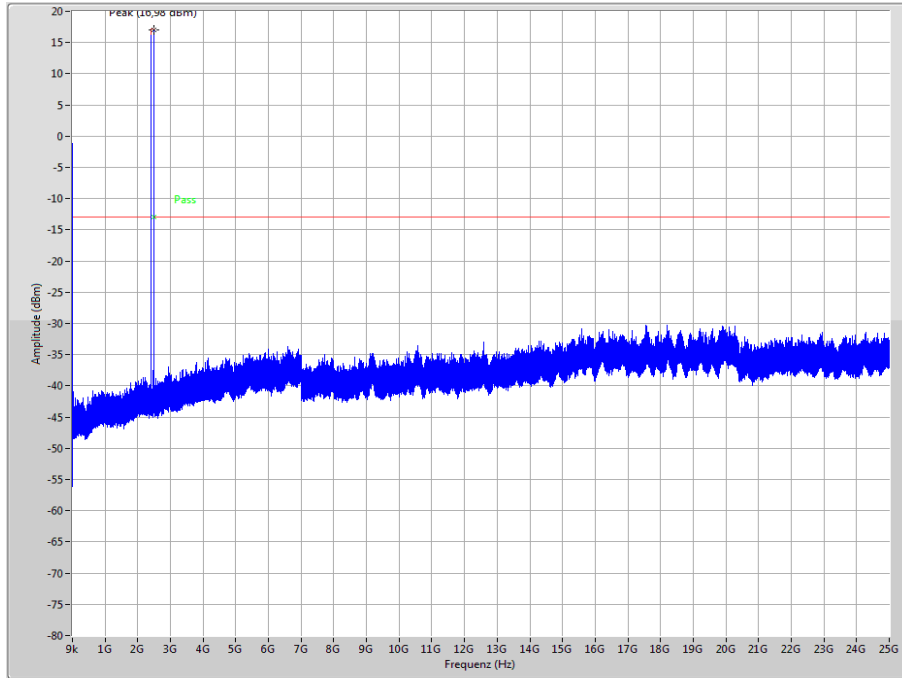
Results: ANT 1 & ANT 2

TX Spurious Emissions Conducted					
f [MHz]		amplitude of emission [dBm]	limit max. allowed emission power	actual attenuation below frequency of operation [dB]	results
Low channel		16.98	30 dBm		Operating frequency
No peaks detected. All detected emissions are below the -30 dBc criteria.			-30 dBc (average)		complies
Mid channel		16.74	30 dBm		Operating frequency
No peaks detected. All detected emissions are below the -30 dBc criteria.			-30 dBc (average)		complies
High channel		17.06	30 dBm		Operating frequency
No peaks detected. All detected emissions are below the -30 dBc criteria.			-30 dBc (average)		complies
Measurement uncertainty		± 3 dB			

Verdict: Passed

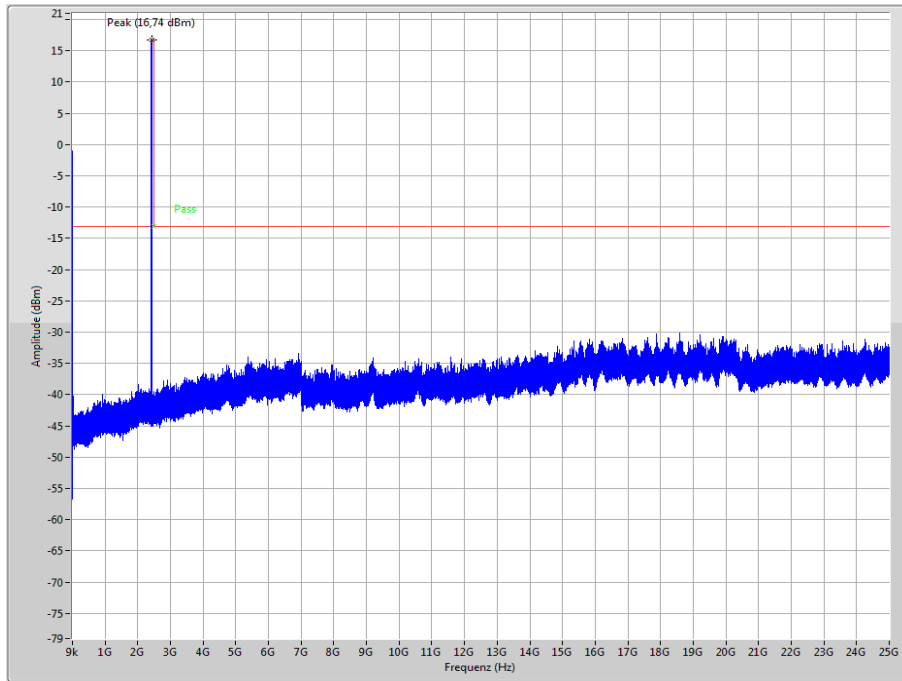
Plots: ANT 1 & ANT 2

Plot 1: TX mode, lowest channel, up to 25 GHz



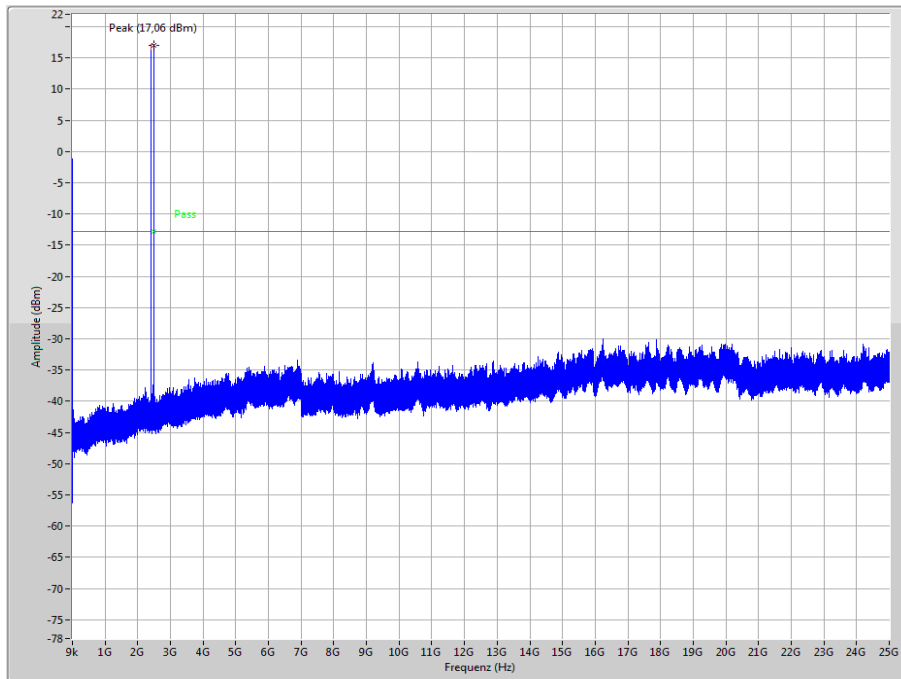
The peak at the beginning of the plot is the LO from the SA.

Plot 2: TX mode, middle channel, up to 25 GHz



The peak at the beginning of the plot is the LO from the SA.

Plot 3: TX mode, highest channel, up to 25 GHz



The peak at the beginning of the plot is the LO from the SA.

10.9 TX spurious emissions radiated

Description:

Measurement of the radiated spurious emissions in transmit mode. The measurement is performed at the lowest, middle and highest channel.

Measurement:

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

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		
<p>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)).</p>		
Frequency (MHz)	Field Strength (dB μ V/m)	Measurement distance
30 - 88	30.0	10
88 - 216	33.5	10
216 - 960	36.0	10
Above 960	54.0	3

Results: ANT 1

TX Spurious Emissions Radiated [dBµV/m]								
GFSK / ANT 1								
Lowest channel 2403 MHz			Middle channel 2443 MHz			Highest channel 2481 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.			For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.			For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.		
1 st harmonic	Peak	-/-	1 st harmonic	Peak	52.7	1 st harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
2 nd harmonic	Peak	58.4	2 nd harmonic	Peak	60.1	2 nd harmonic	Peak	59.3
	RMS	46.4		RMS	48.1		RMS	47.3
3 rd harmonic	Peak	-/-	3 rd harmonic	Peak	-/-	3 rd harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
4 th harmonic	Peak	58.8	4 th harmonic	Peak	57.9	4 th harmonic	Peak	61.7
	RMS	45.8		RMS	44.9		RMS	48.7
5 th harmonic	Peak	-/-	5 th harmonic	Peak	-/-	5 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
6 th harmonic	Peak	-/-	6 th harmonic	Peak	-/-	6 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
7 th harmonic	Peak	-/-	7 th harmonic	Peak	-/-	7 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
8 th harmonic	Peak	-/-	8 th harmonic	Peak	-/-	8 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
Measurement uncertainty			± 3 dB					

Verdict: Passed

Results: ANT 2 (only first harmonic finally measured)

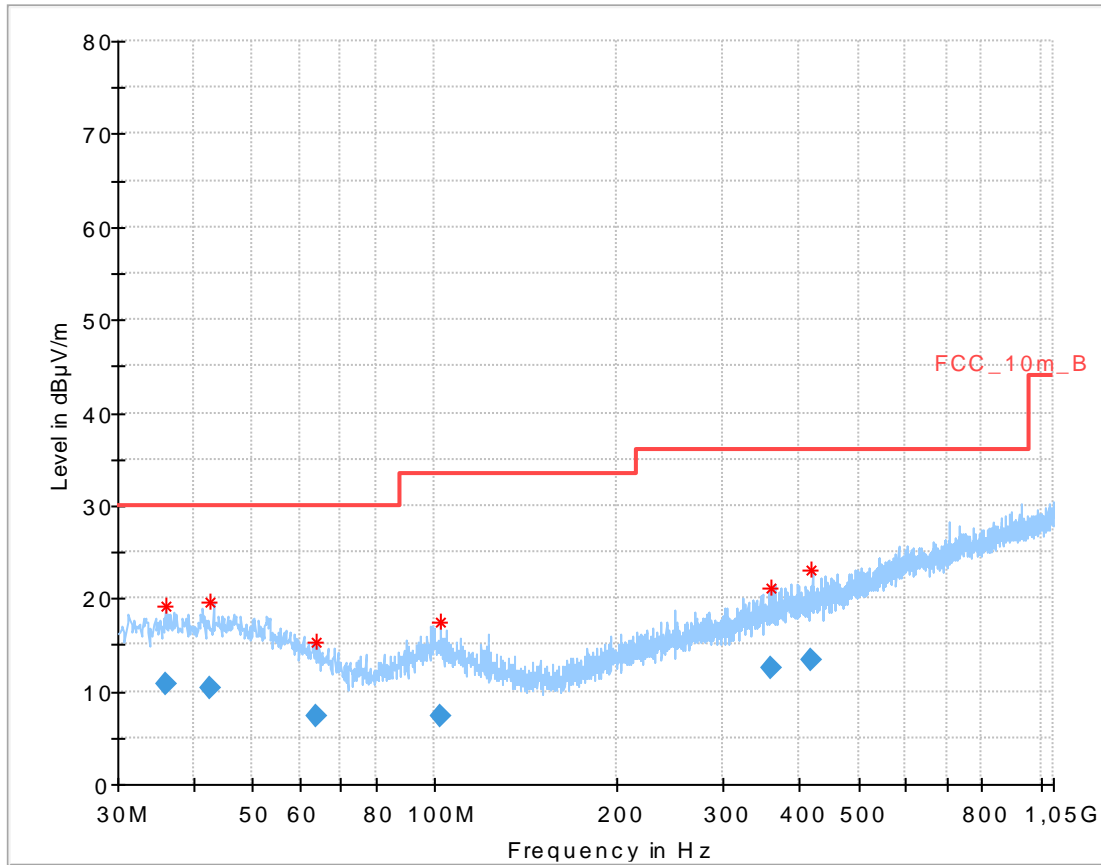
TX Spurious Emissions Radiated [dBµV/m]								
GFSK / ANT 2								
Lowest channel 2403 MHz			Middle channel 2443 MHz			Highest channel 2481 MHz		
F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]	F [MHz]	Detector	Level [dBµV/m]
For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.			For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.			For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.		
1 st harmonic	Peak	54.9	1 st harmonic	Peak	55.7	1 st harmonic	Peak	60.0
	RMS	43.9		RMS	44.7		RMS	49.0
2 nd harmonic	Peak	-/-	2 nd harmonic	Peak	63.0	2 nd harmonic	Peak	61.1
	RMS	-/-		RMS	51.0		RMS	49.1
3 rd harmonic	Peak	-/-	3 rd harmonic	Peak	-/-	3 rd harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
4 th harmonic	Peak	62.4	4 th harmonic	Peak	62.8	4 th harmonic	Peak	61.7
	RMS	49.4		RMS	49.8		RMS	48.7
5 th harmonic	Peak	-/-	5 th harmonic	Peak	-/-	5 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
6 th harmonic	Peak	-/-	6 th harmonic	Peak	-/-	6 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
7 th harmonic	Peak	-/-	7 th harmonic	Peak	-/-	7 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
8 th harmonic	Peak	-/-	8 th harmonic	Peak	-/-	8 th harmonic	Peak	-/-
	RMS	-/-		RMS	-/-		RMS	-/-
Measurement uncertainty			± 3 dB					

Verdict: Passed

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: ANT 1

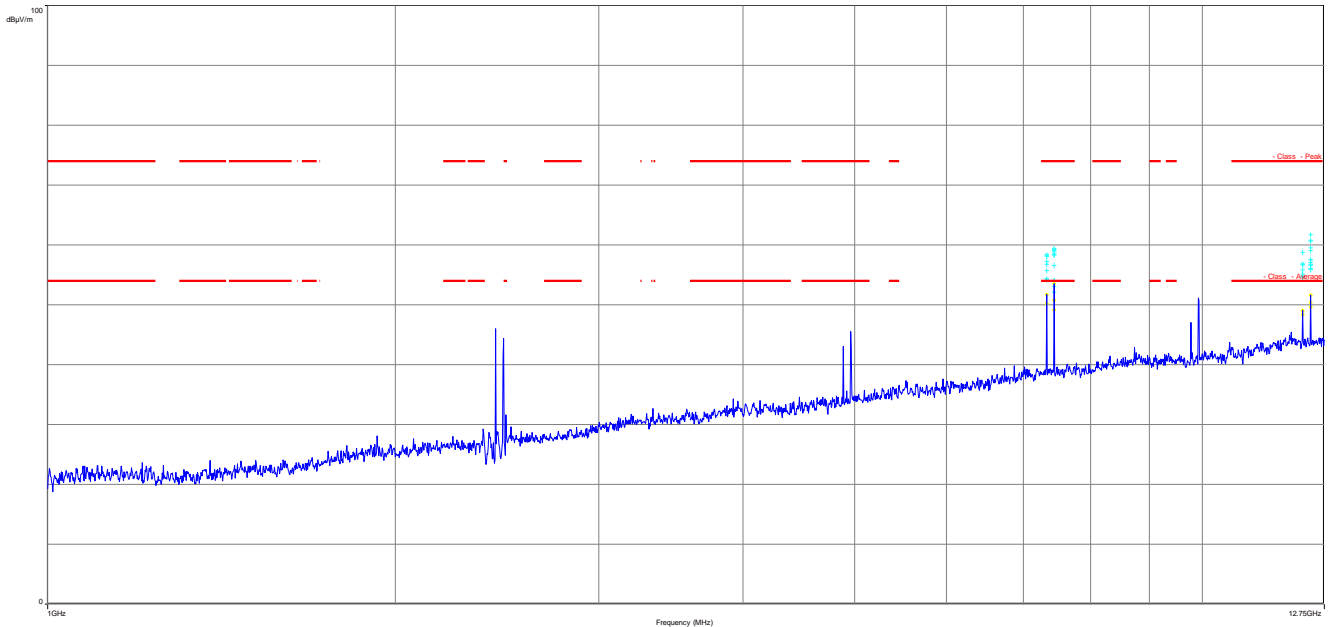
Plot 1: Lowest channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

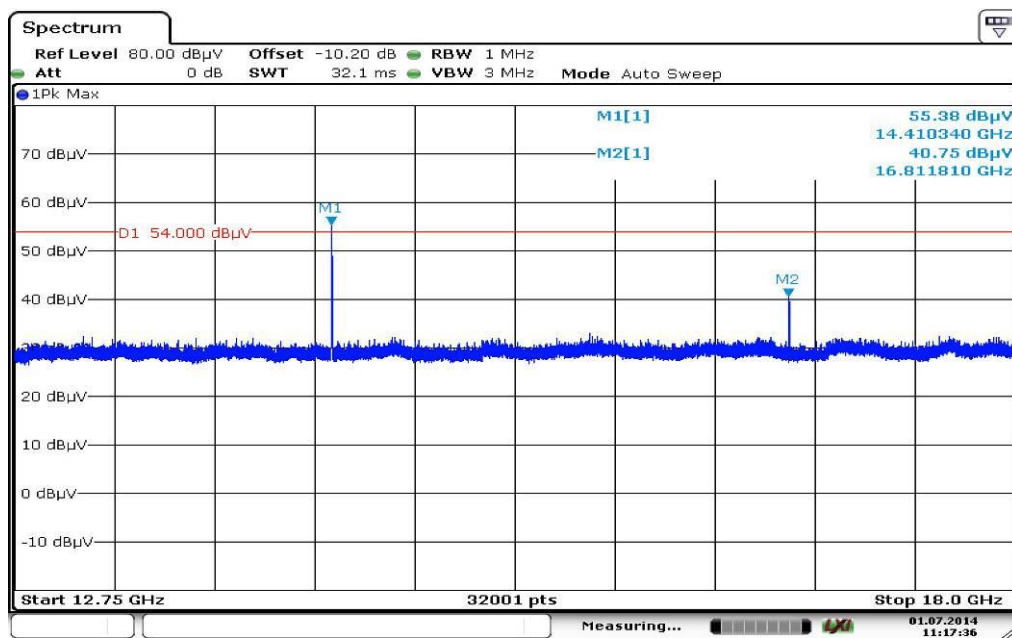
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.970000	10.77	30.00	19.23	1000.0	120.000	170.0	H	205	13.8
42.551100	10.42	30.00	19.58	1000.0	120.000	140.0	V	79	13.9
63.537300	7.42	30.00	22.58	1000.0	120.000	122.0	H	107	10.8
102.078150	7.38	33.50	26.12	1000.0	120.000	122.0	V	12	12.0
359.857200	12.43	36.00	23.57	1000.0	120.000	170.0	H	269	16.2
419.515950	13.34	36.00	22.66	1000.0	120.000	124.0	V	8	17.2

Plot 2: Lowest + highest channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



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

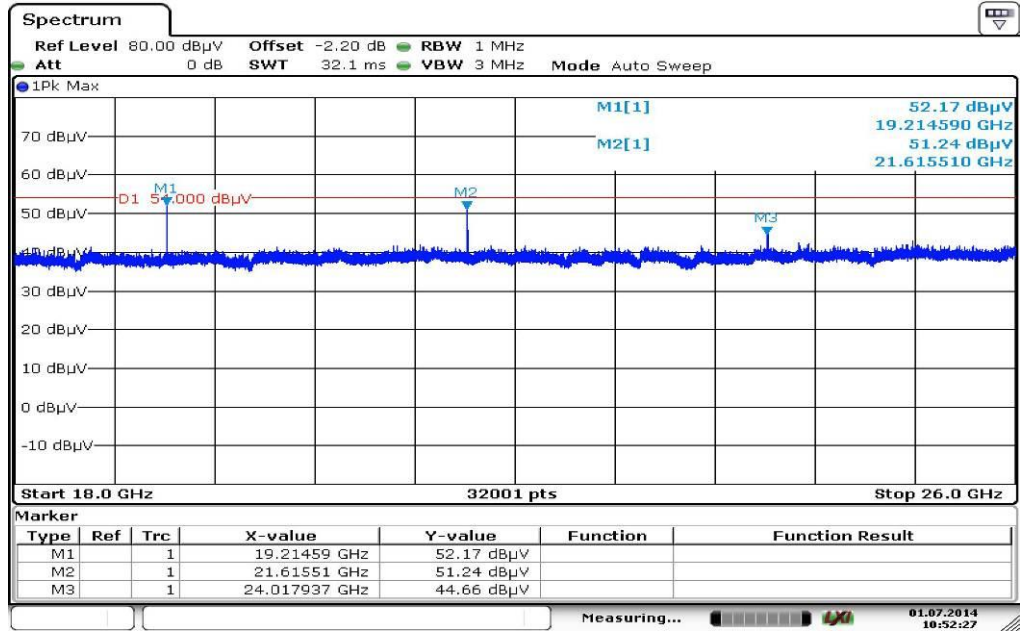
Plot 3: Lowest channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:17:36

Peak measurement – Peak to RMS ratio >10dB

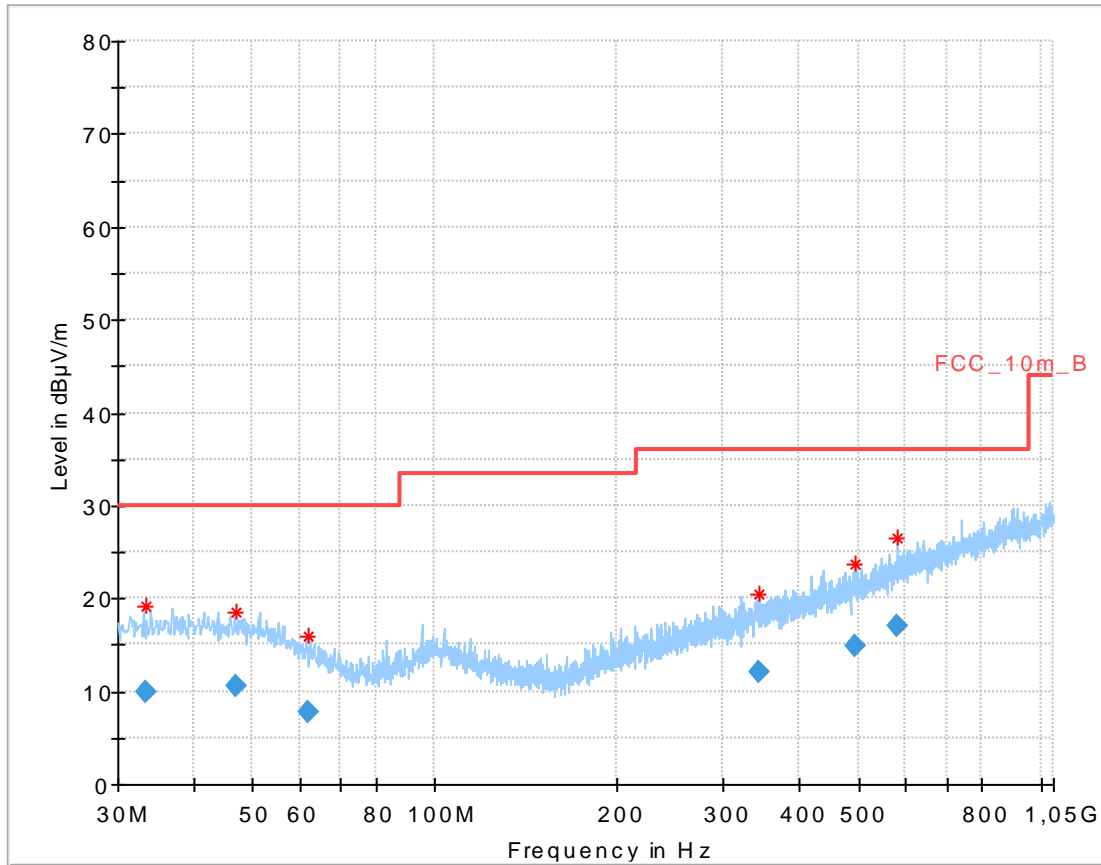
Plot 4: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 10:52:27

Peak measurement – Peak to RMS ratio >10dB

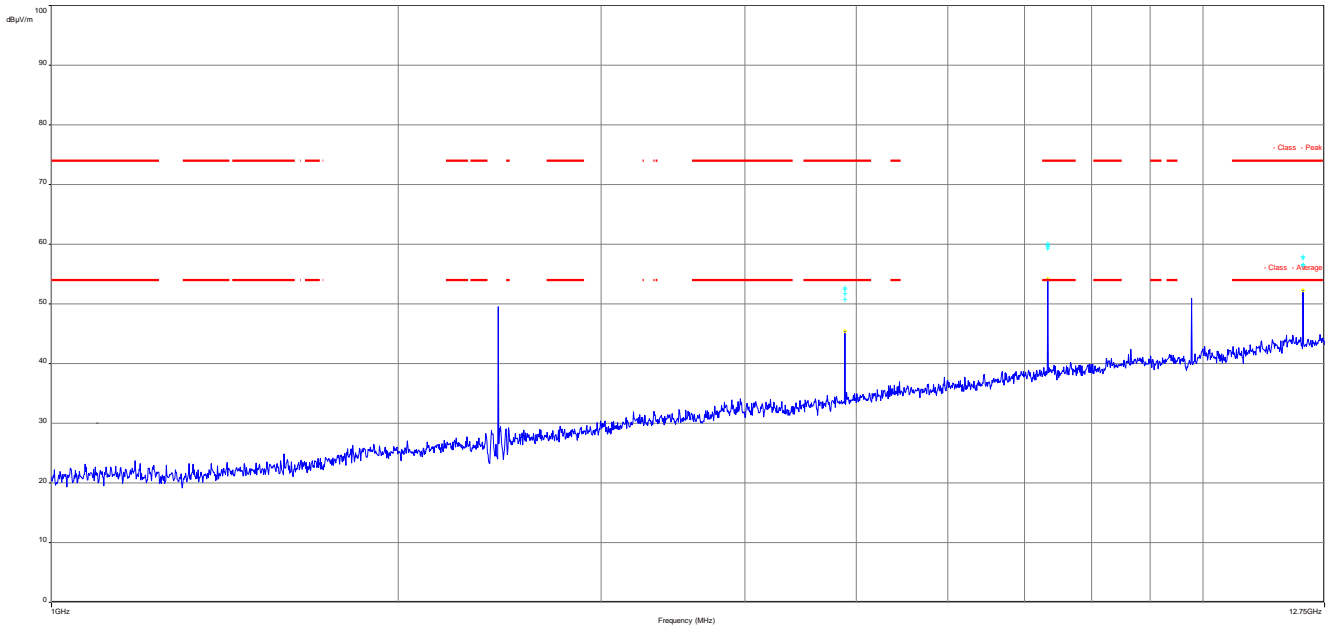
Plot 5: Middle channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

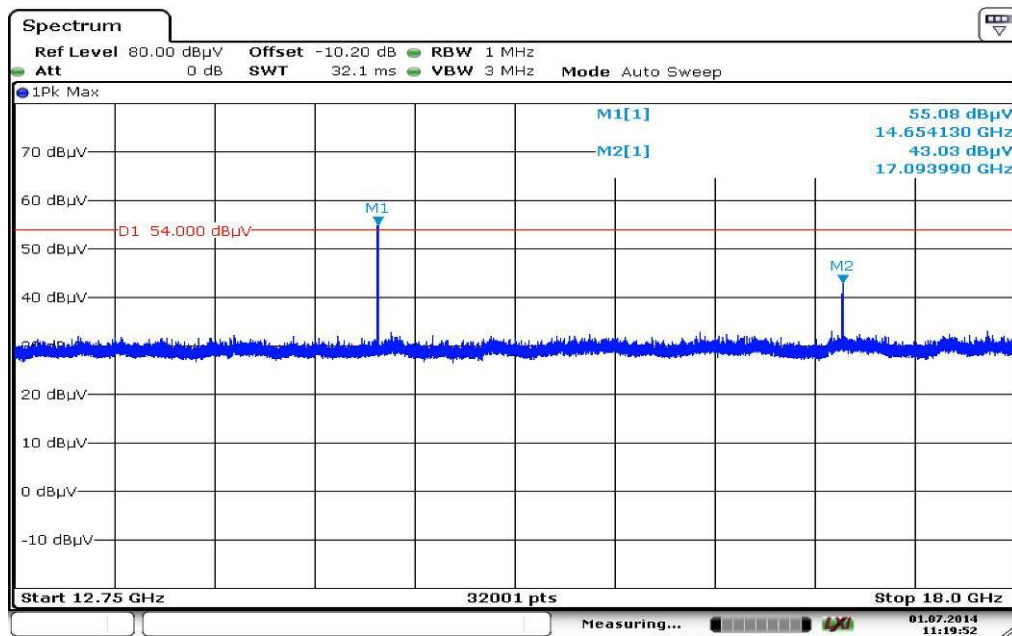
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
33.376350	10.02	30.00	19.98	1000.0	120.000	170.0	V	-7	13.6
47.089500	10.50	30.00	19.50	1000.0	120.000	140.0	H	183	13.8
61.869150	7.76	30.00	22.24	1000.0	120.000	170.0	V	183	11.1
342.184650	12.12	36.00	23.88	1000.0	120.000	170.0	H	282	15.8
492.750300	14.89	36.00	21.11	1000.0	120.000	170.0	V	183	18.6
578.918100	17.05	36.00	18.95	1000.0	120.000	170.0	H	25	20.1

Plot 6: Middle channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



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

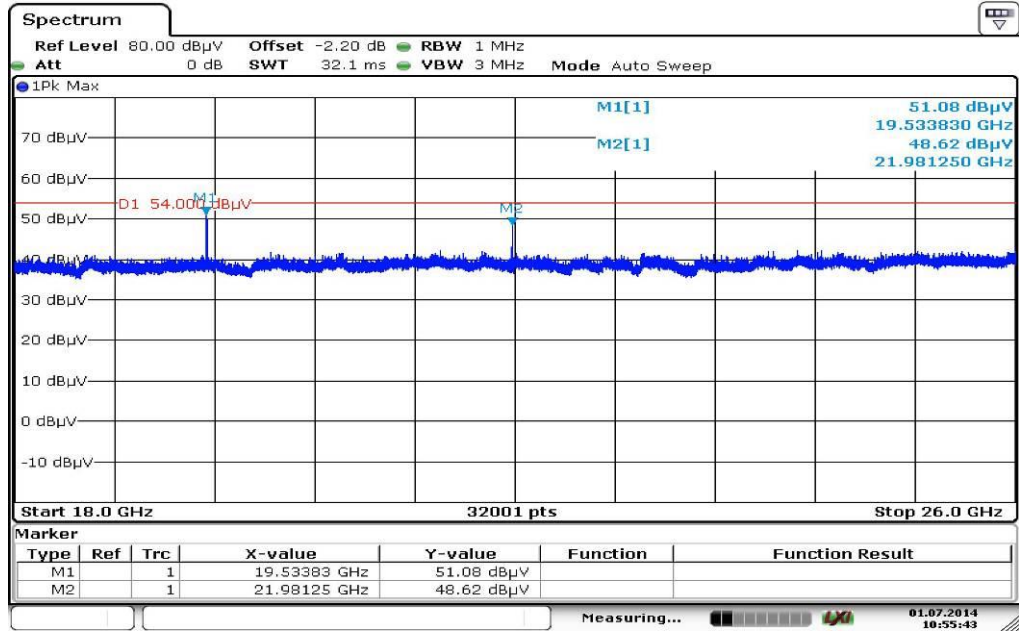
Plot 7: Middle channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:19:52

Peak measurement – Peak to RMS ratio >10dB

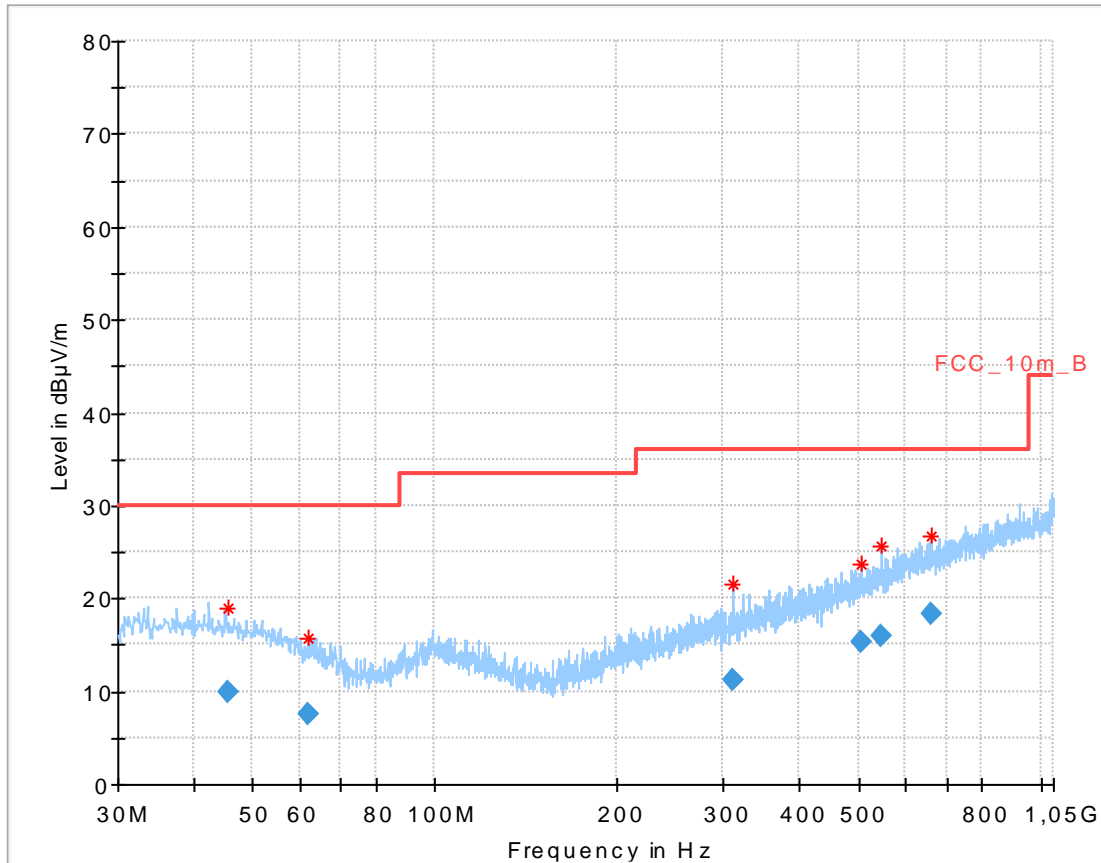
Plot 8: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 10:55:43

Peak measurement – Peak to RMS ratio >10dB

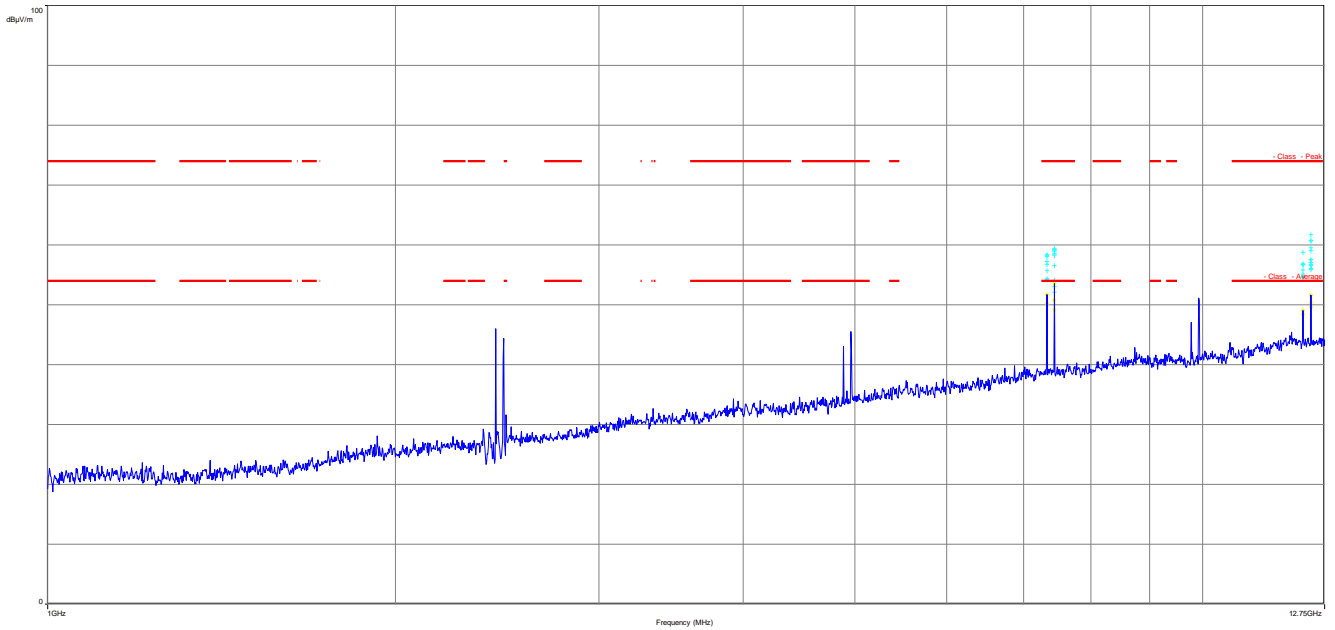
Plot 9: Highest channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

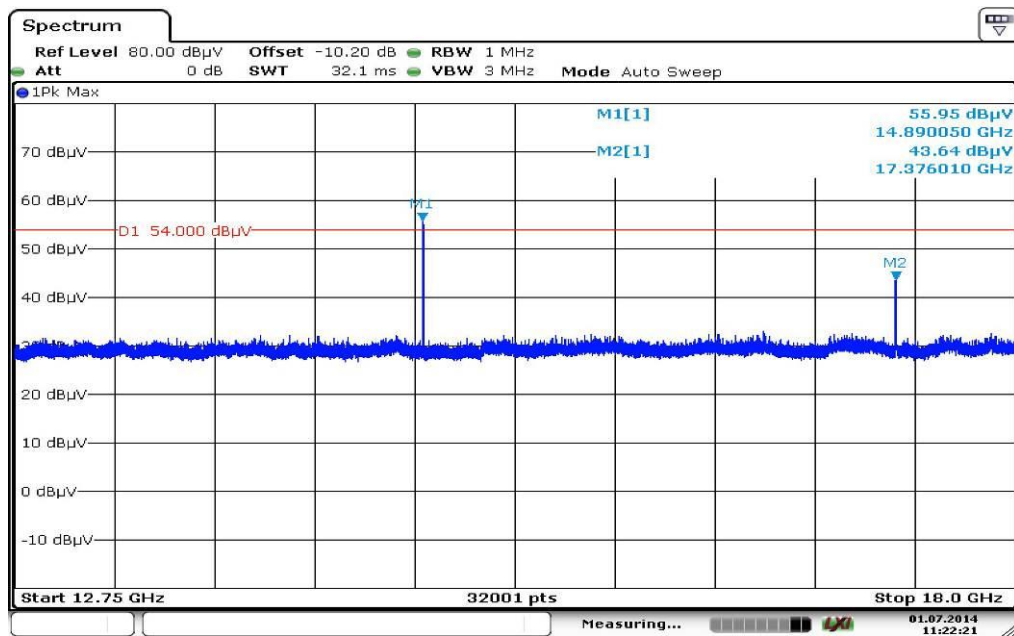
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
45.482550	9.89	30.00	20.11	1000.0	120.000	140.0	H	155	13.8
61.620000	7.52	30.00	22.48	1000.0	120.000	140.0	H	-2	11.2
311.274000	11.18	36.00	24.82	1000.0	120.000	170.0	V	12	14.8
507.236400	15.22	36.00	20.78	1000.0	120.000	170.0	H	183	18.8
546.835500	15.91	36.00	20.09	1000.0	120.000	170.0	H	93	19.3
658.554000	18.41	36.00	17.59	1000.0	120.000	170.0	H	282	21.2

Plot 10: Highest + lowest channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



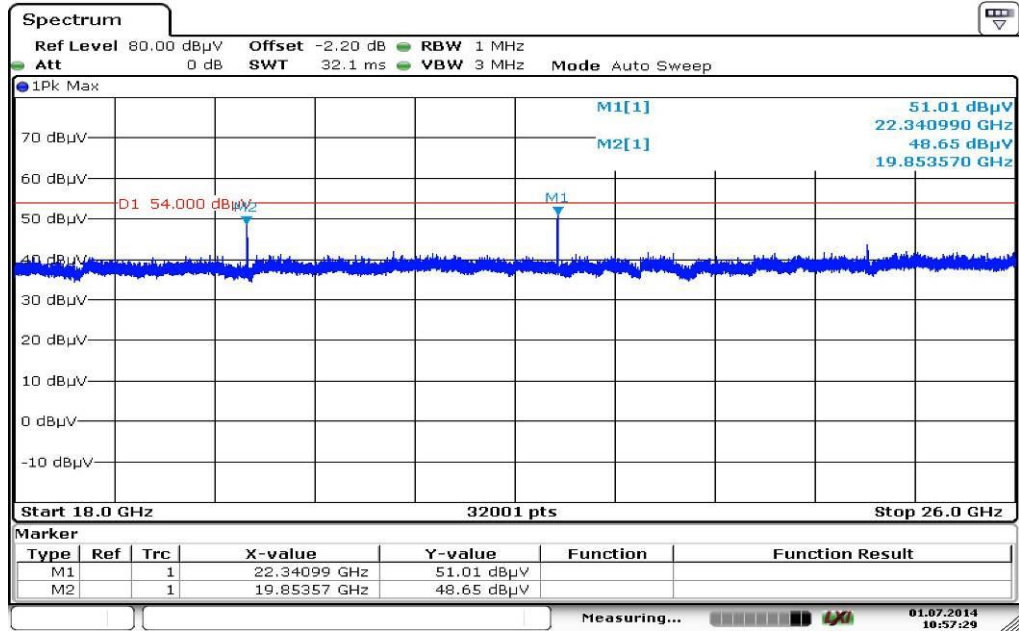
The carrier signal is notched with a 2.4 GHz band rejection filter.

Plot 11: Highest channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Peak measurement – Peak to RMS ratio >10dB

Plot 12: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization

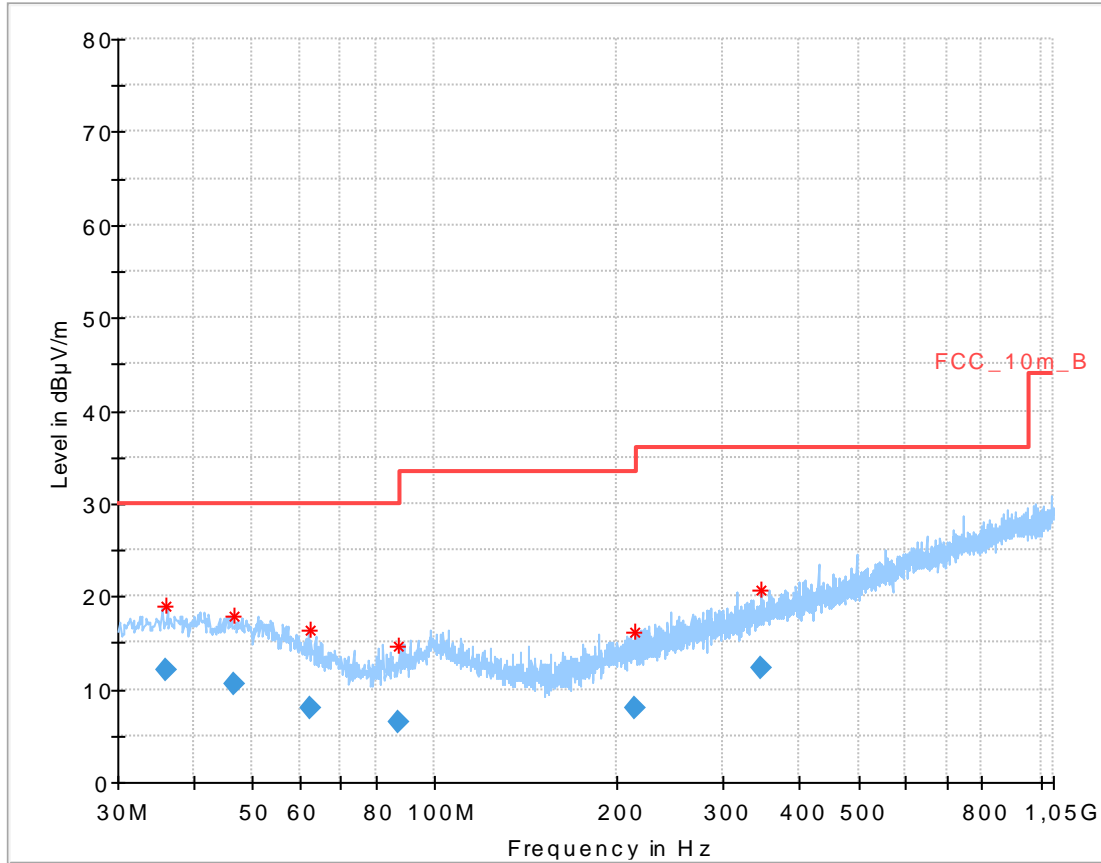


Date: 1.JUL.2014 10:57:29

Peak measurement – Peak to RMS ratio >10dB

Plots: ANT 2

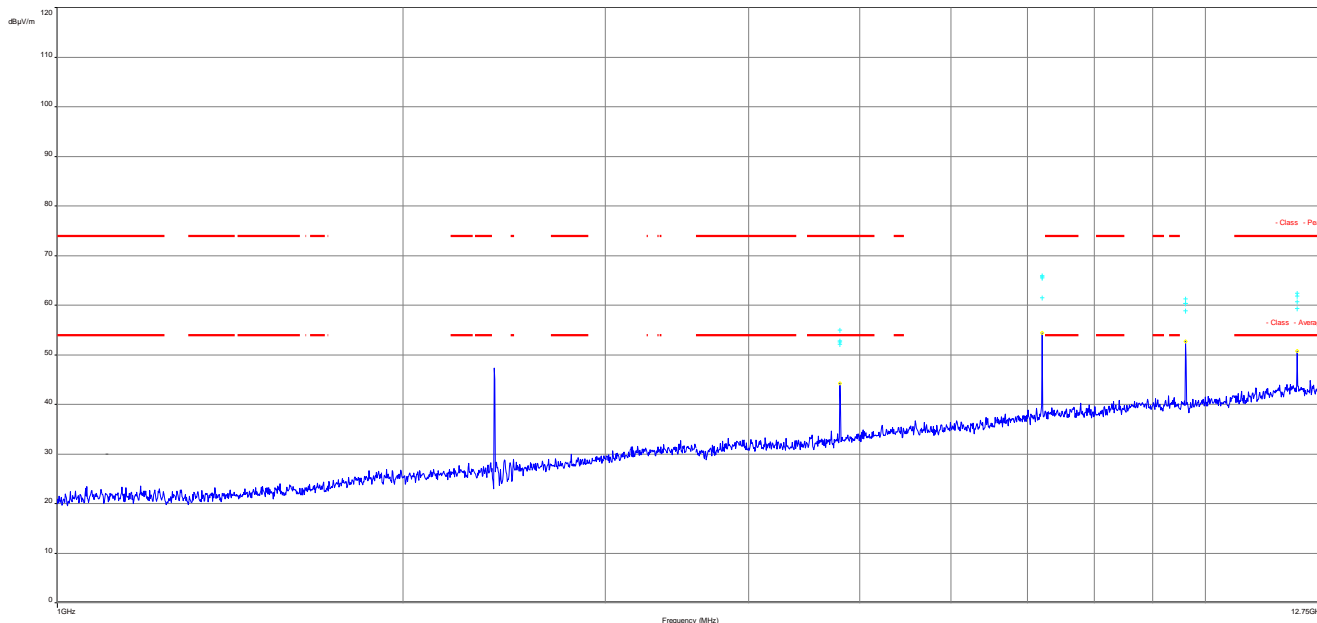
Plot 1: Lowest channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

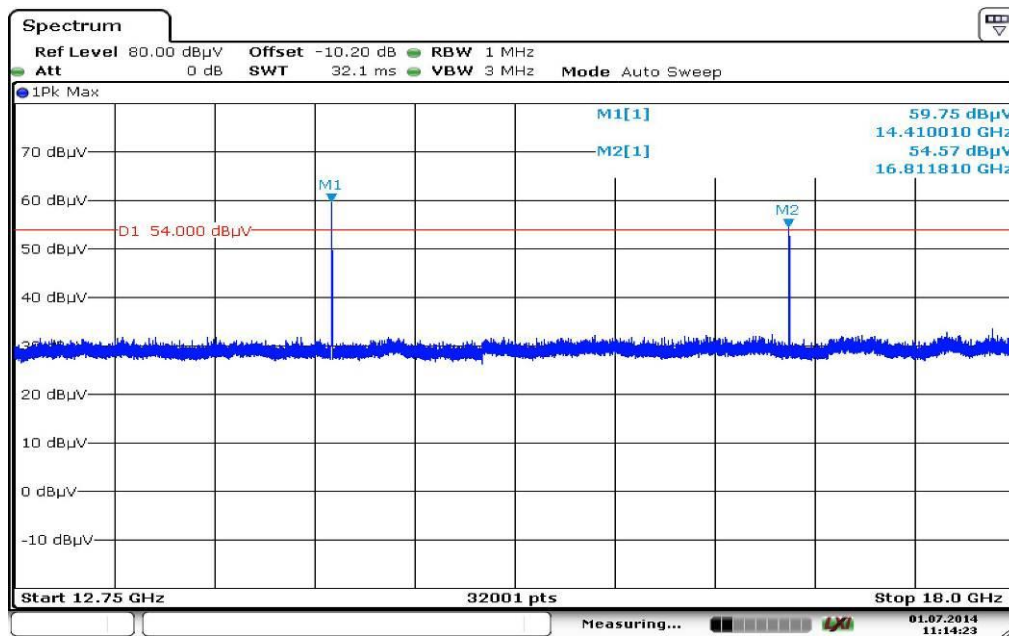
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.997000	12.00	30.00	18.00	1000.0	120.000	170.0	V	3	13.8
46.579650	10.52	30.00	19.48	1000.0	120.000	170.0	H	173	13.8
62.103900	7.92	30.00	22.08	1000.0	120.000	170.0	V	295	11.1
87.140100	6.42	30.00	23.58	1000.0	120.000	170.0	V	196	10.1
214.542600	7.94	33.50	25.56	1000.0	120.000	122.0	V	268	12.2
345.896550	12.22	36.00	23.78	1000.0	120.000	170.0	V	115	15.9

Plot 2: Lowest channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



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

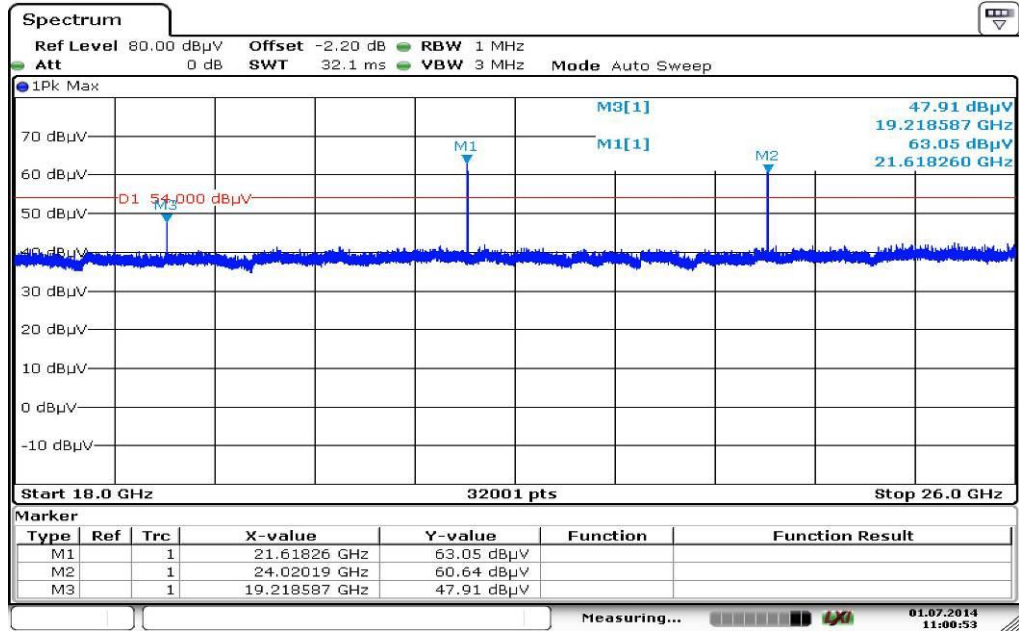
Plot 3: Lowest channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:14:23

Peak measurement – Peak to RMS ratio >10dB

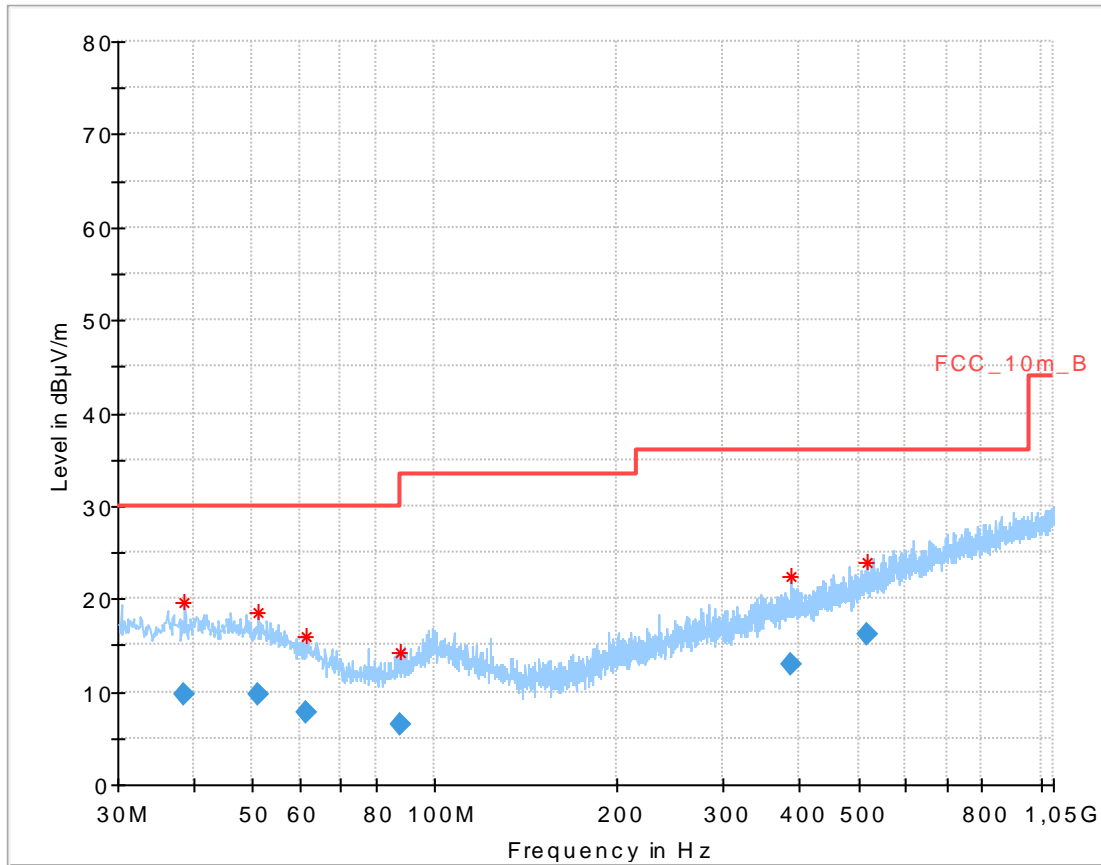
Plot 4: Lowest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:00:53

Peak measurement – Peak to RMS ratio >10dB

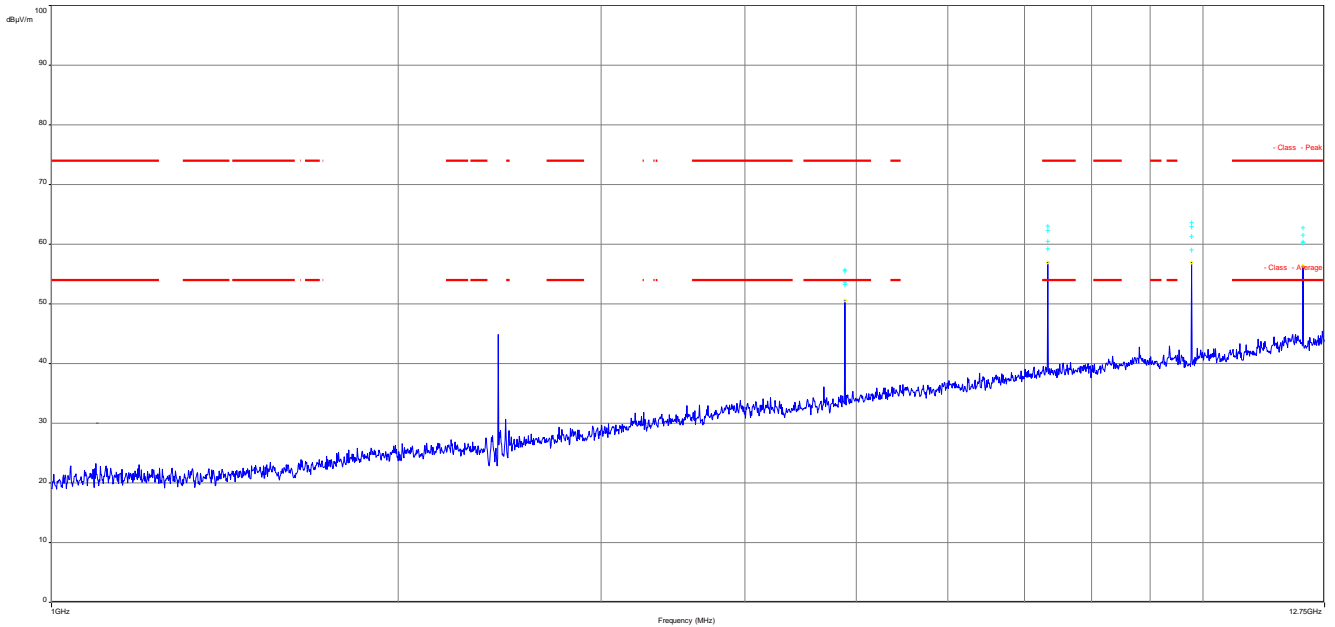
Plot 5: Middle channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

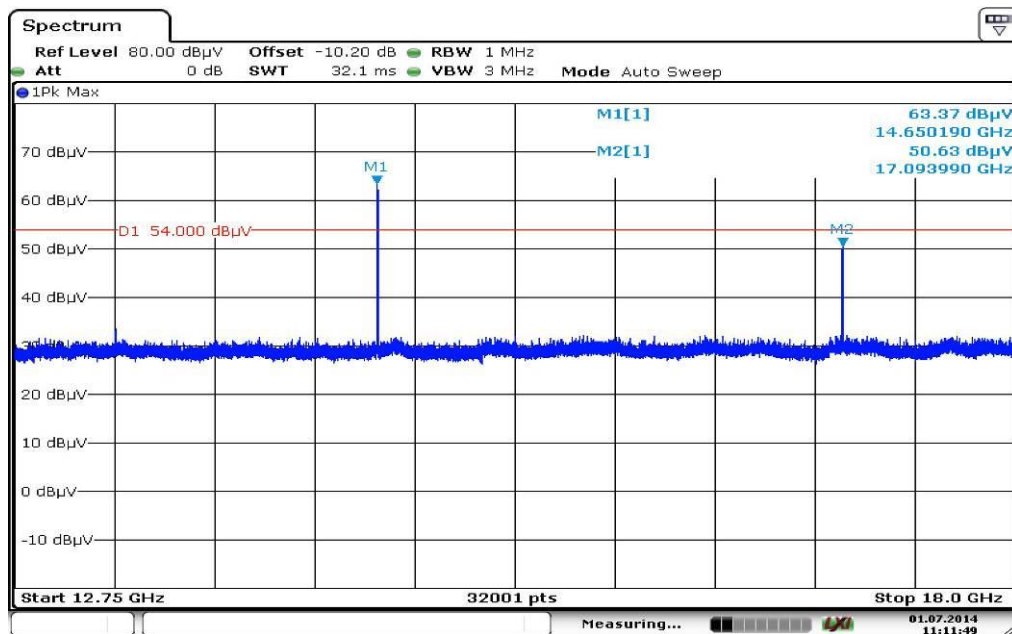
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
38.599500	9.69	30.00	20.31	1000.0	120.000	170.0	H	88	14.0
50.939550	9.67	30.00	20.33	1000.0	120.000	170.0	H	98	13.5
61.494600	7.66	30.00	22.34	1000.0	120.000	136.0	V	196	11.2
87.693300	6.55	30.00	23.45	1000.0	120.000	170.0	H	16	10.1
387.632250	12.96	36.00	23.04	1000.0	120.000	166.0	V	93	16.7
515.349900	16.24	36.00	19.76	1000.0	120.000	133.0	V	12	18.9

Plot 6: Middle channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



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

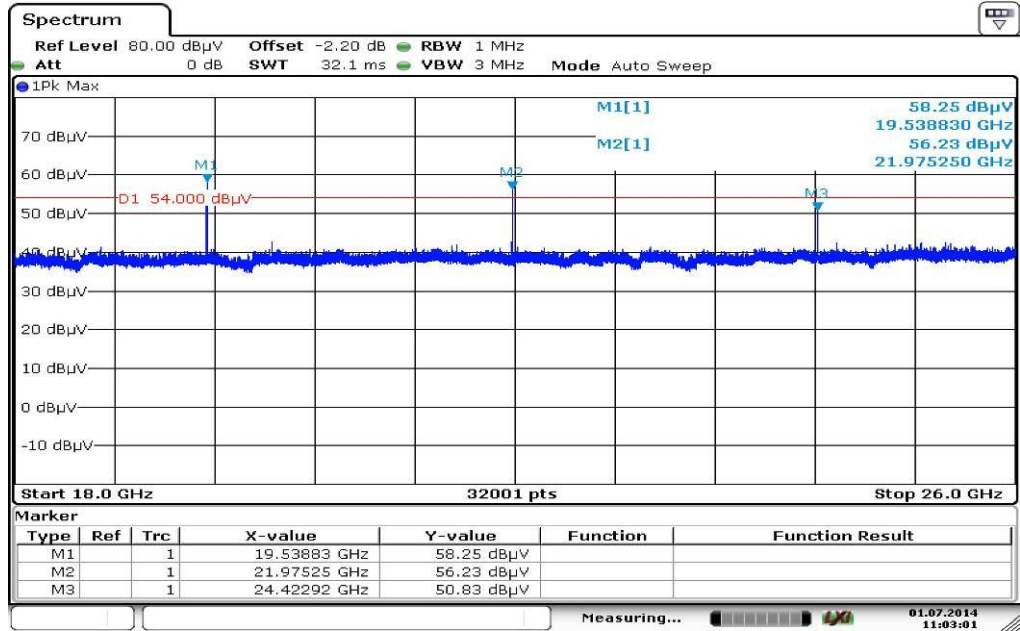
Plot 7: Middle channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:11:49

Peak measurement – Peak to RMS ratio >10dB

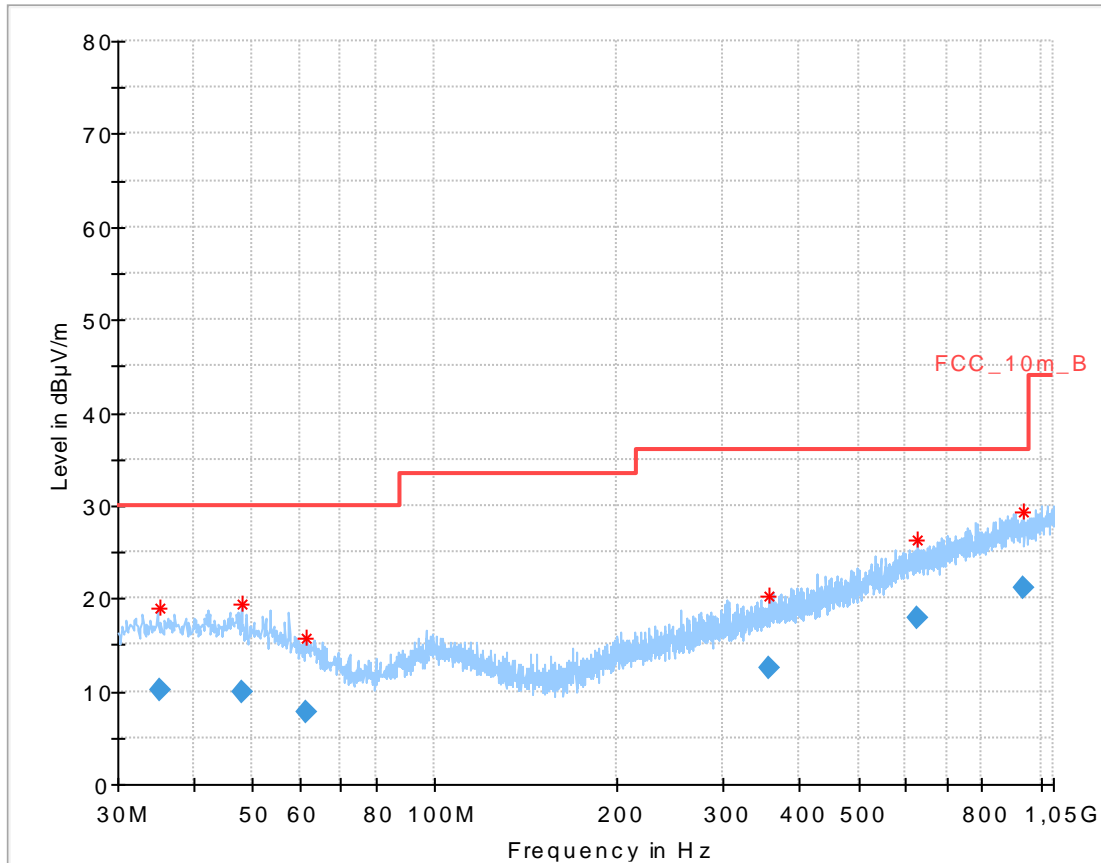
Plot 8: Middle channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:03:01

Peak measurement – Peak to RMS ratio >10dB

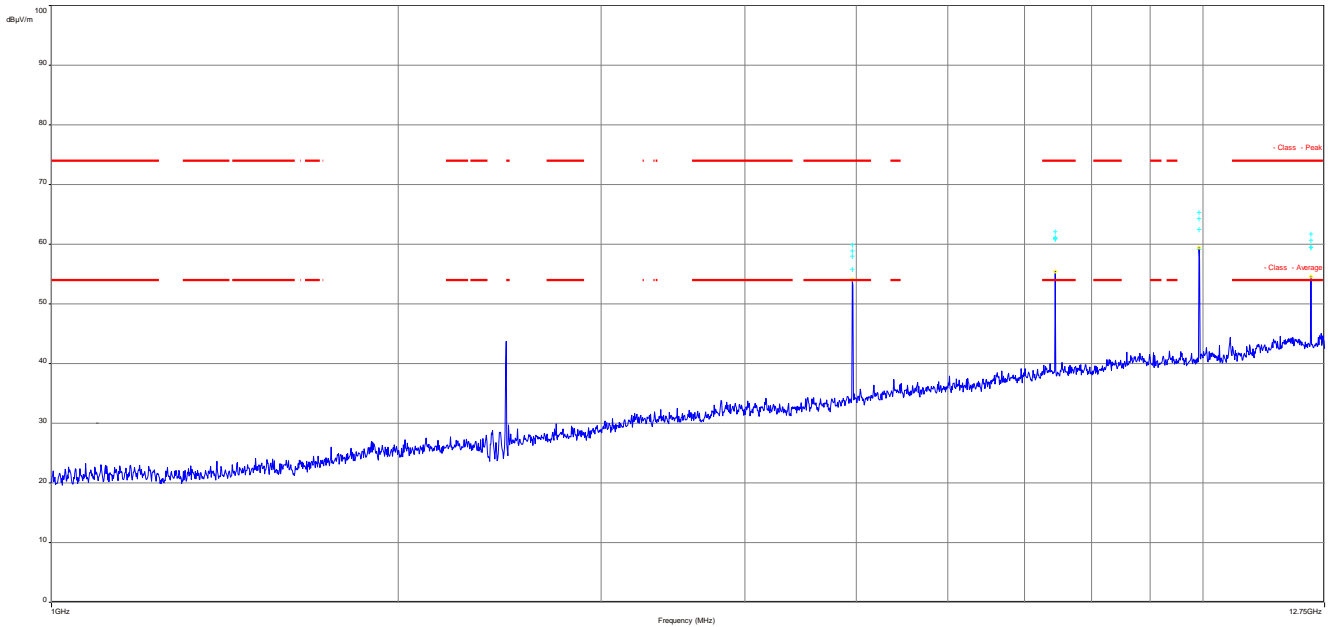
Plot 9: Highest channel, 30 MHz to 1 GHz, vertical & horizontal polarization



Final_Result:

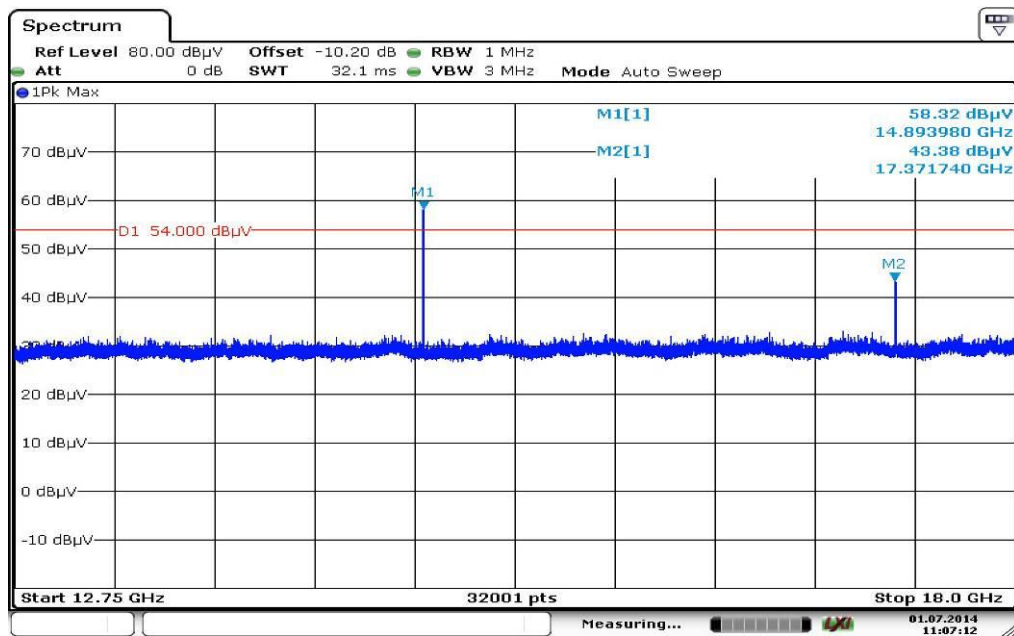
Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
35.333700	10.21	30.00	19.79	1000.0	120.000	170.0	V	245	13.8
48.274200	9.87	30.00	20.13	1000.0	120.000	98.0	V	91	13.7
61.303350	7.80	30.00	22.20	1000.0	120.000	170.0	V	178	11.3
355.968600	12.40	36.00	23.60	1000.0	120.000	170.0	H	193	16.1
626.500800	17.84	36.00	18.16	1000.0	120.000	170.0	V	89	20.9
936.393150	21.13	36.00	14.87	1000.0	120.000	170.0	H	174	24.2

Plot 10: Highest channel, 1 GHz to 12.75 GHz, vertical & horizontal polarization



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

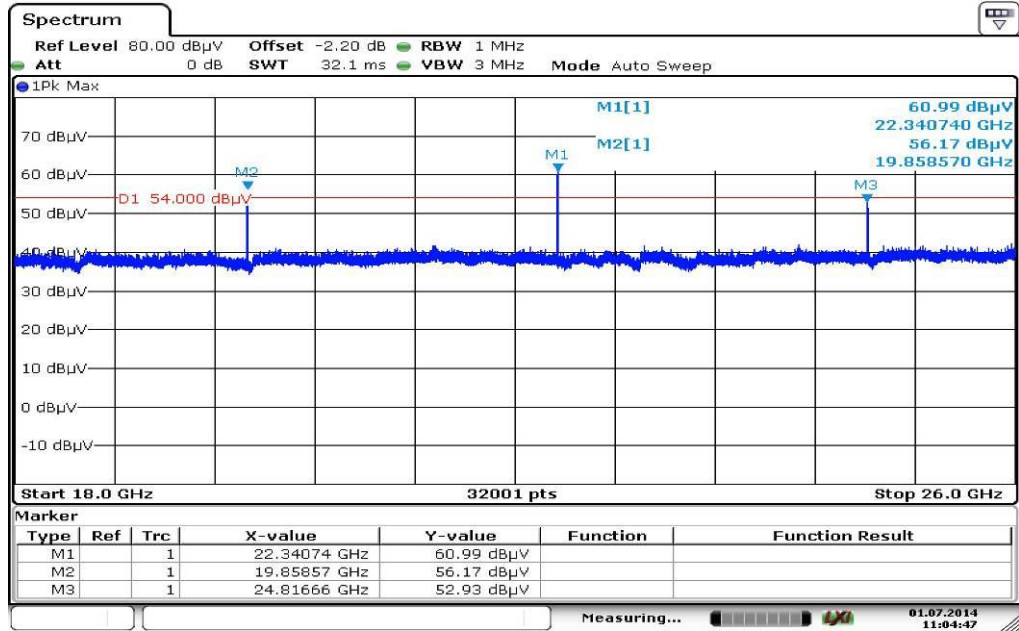
Plot 11: Highest channel, 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:07:12

Peak measurement – Peak to RMS ratio >10dB

Plot 12: Highest channel, 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 11:04:47

Peak measurement – Peak to RMS ratio >10dB

10.10 RX spurious emissions radiated

Description:

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

Measurement:

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

Limits:

FCC	IC	
RX Spurious Emissions Radiated		
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

Results:

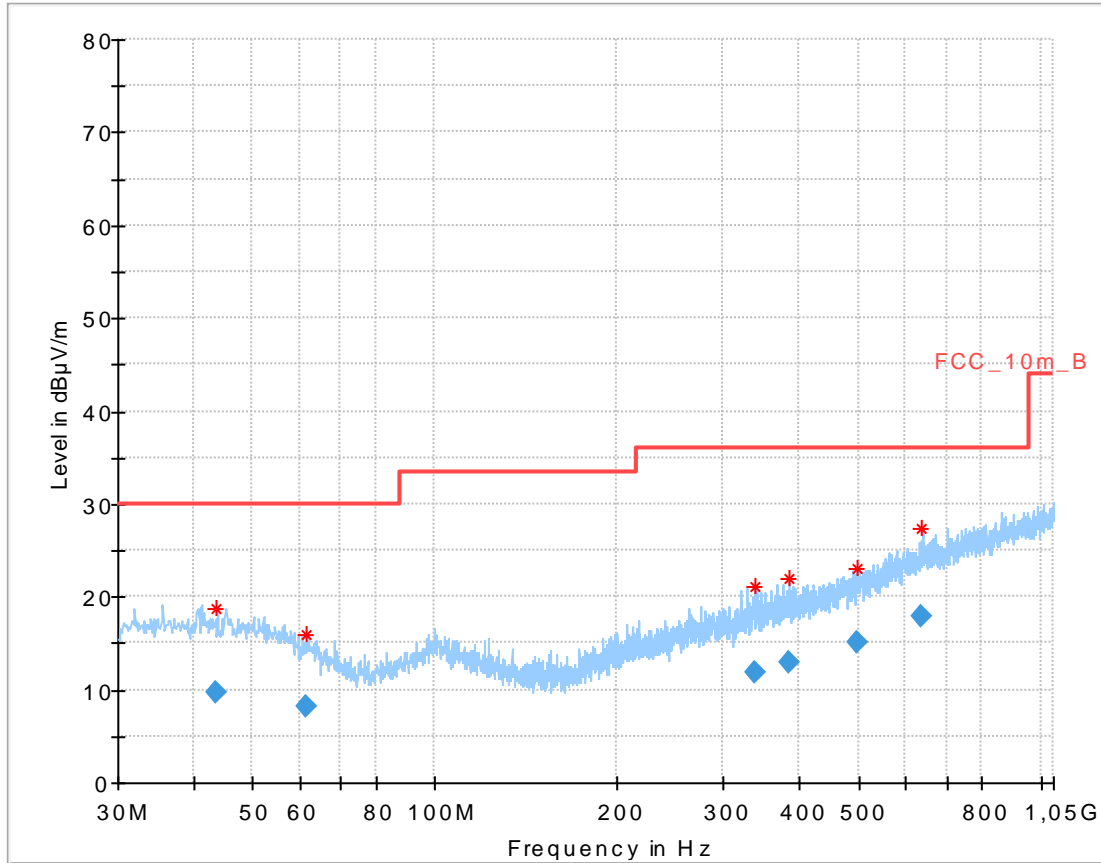
RX Spurious Emissions Radiated [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
For emissions below 1 GHz, please take a look at the table below the 1 GHz plot.		
No spurious emissions above 1 GHz detected.		
Measurement uncertainty	± 3 dB	

Verdict: Passed

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: RX / Idle – mode

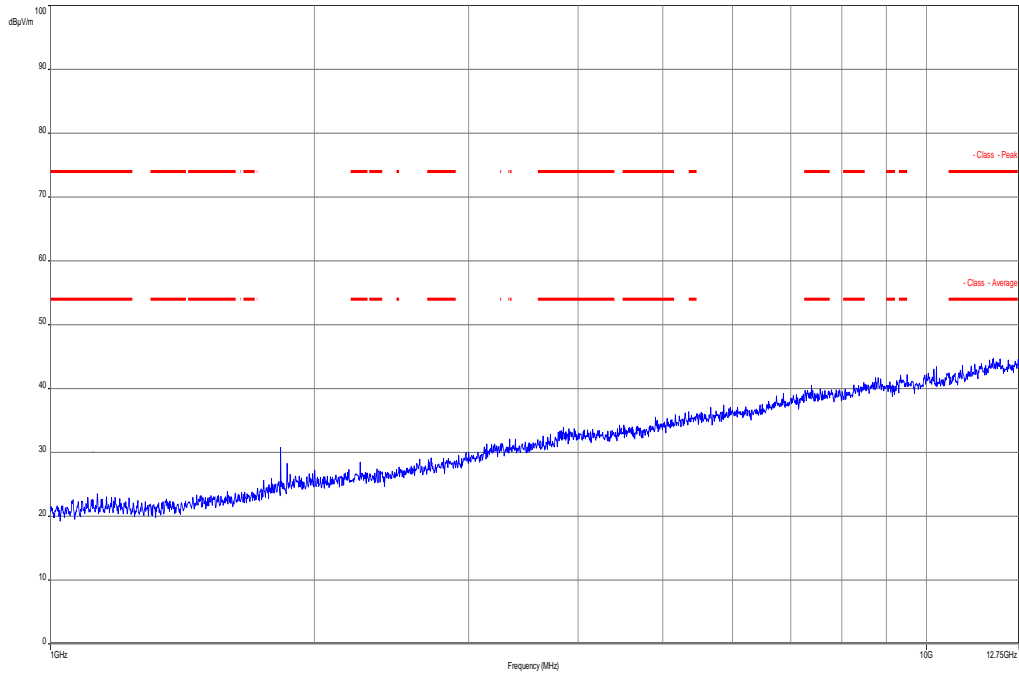
Plot 1: 30 MHz to 1 GHz, vertical & horizontal polarization



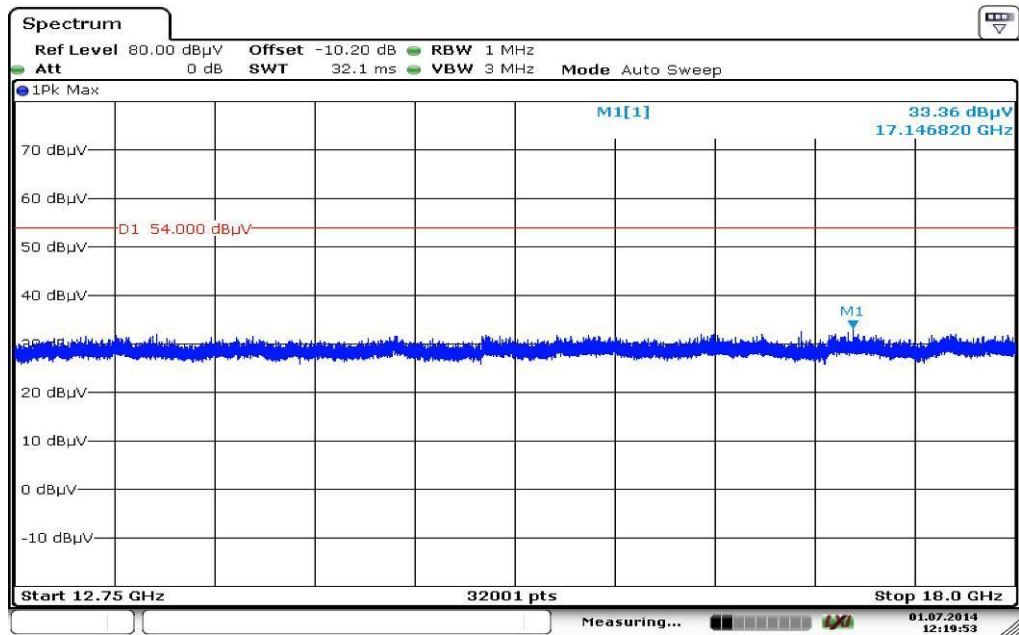
Final_Result:

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
43.505400	9.60	30.00	20.40	1000.0	120.000	170.0	V	183	13.9
61.581600	8.09	30.00	21.91	1000.0	120.000	160.0	V	295	11.2
338.314650	11.92	36.00	24.08	1000.0	120.000	170.0	V	25	15.7
385.461000	12.89	36.00	23.11	1000.0	120.000	98.0	V	268	16.6
498.731400	15.19	36.00	20.81	1000.0	120.000	170.0	V	7	18.7
637.273050	17.91	36.00	18.09	1000.0	120.000	170.0	V	25	21.0

Plot 2: 1 GHz to 12.75 GHz, vertical & horizontal polarization

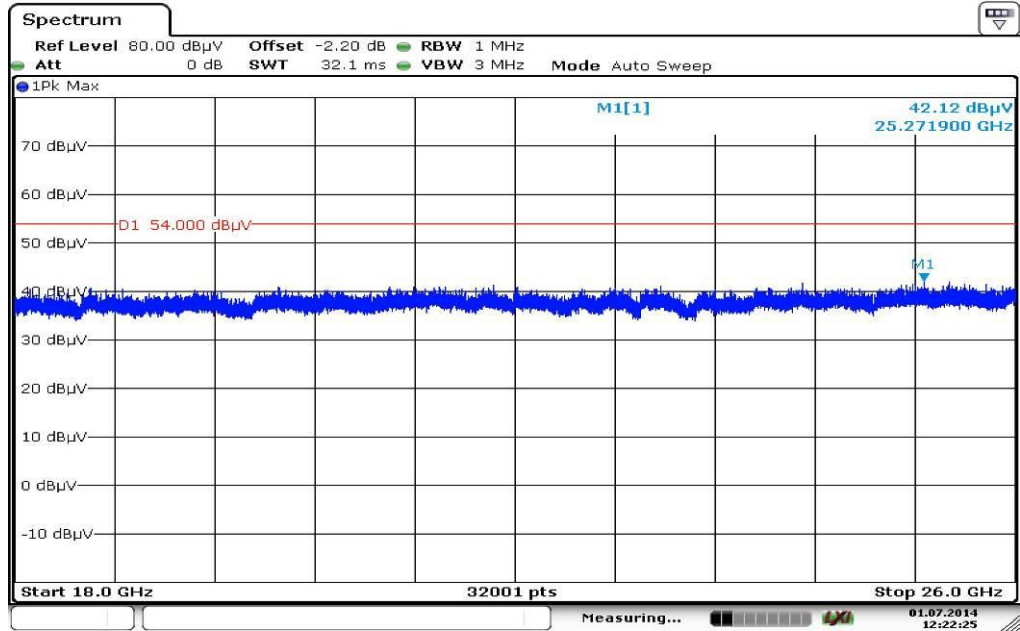


Plot 3: 12.75 GHz to 18 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 12:19:53

Plot 4: 18 GHz to 26 GHz, vertical & horizontal polarization



Date: 1.JUL.2014 12:22:25

10.11 Spurious emissions radiated < 30 MHz

Description:

Measurement of the radiated spurious emissions in transmit mode below 30 MHz. The EUT is set to the middle channel. This measurement is representative for all channels and modes. If peaks are found the lowest and highest channel 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

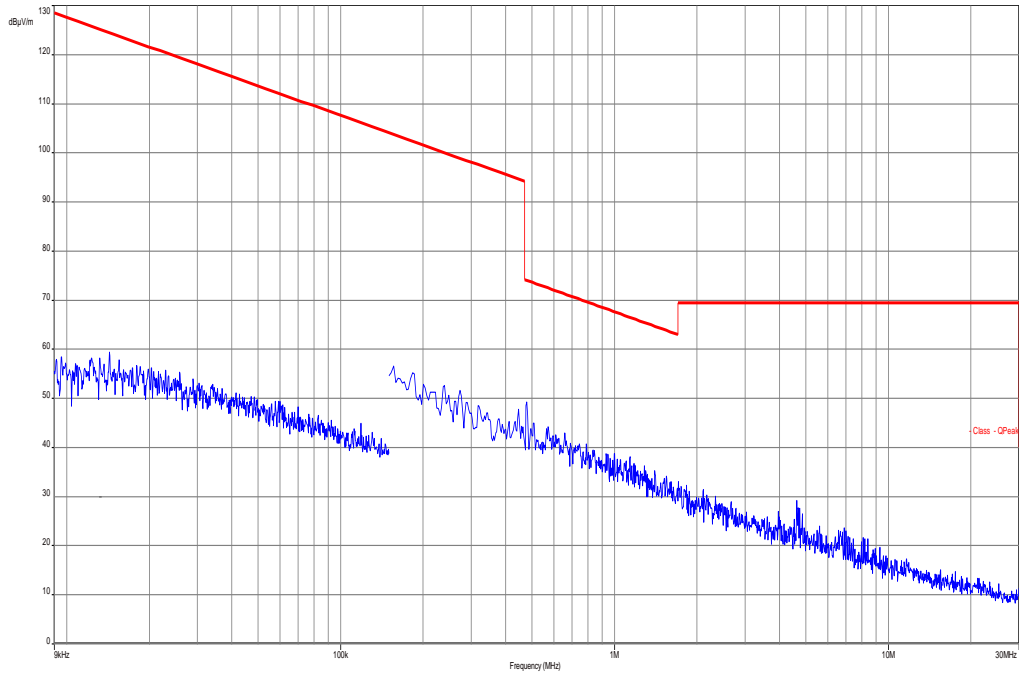
Results:

TX Spurious Emissions Radiated < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
No peaks detected.		
Measurement uncertainty	± 3 dB	

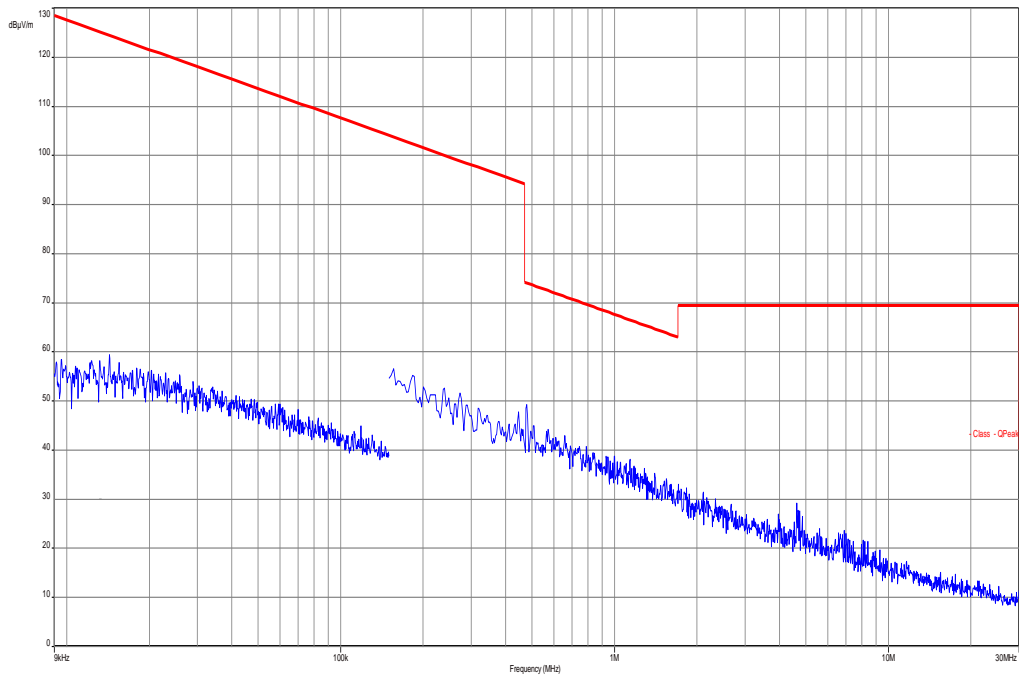
Verdict: Passed

Plots: TX mode

Plot 1: 9 kHz to 30 MHz, ANT 1

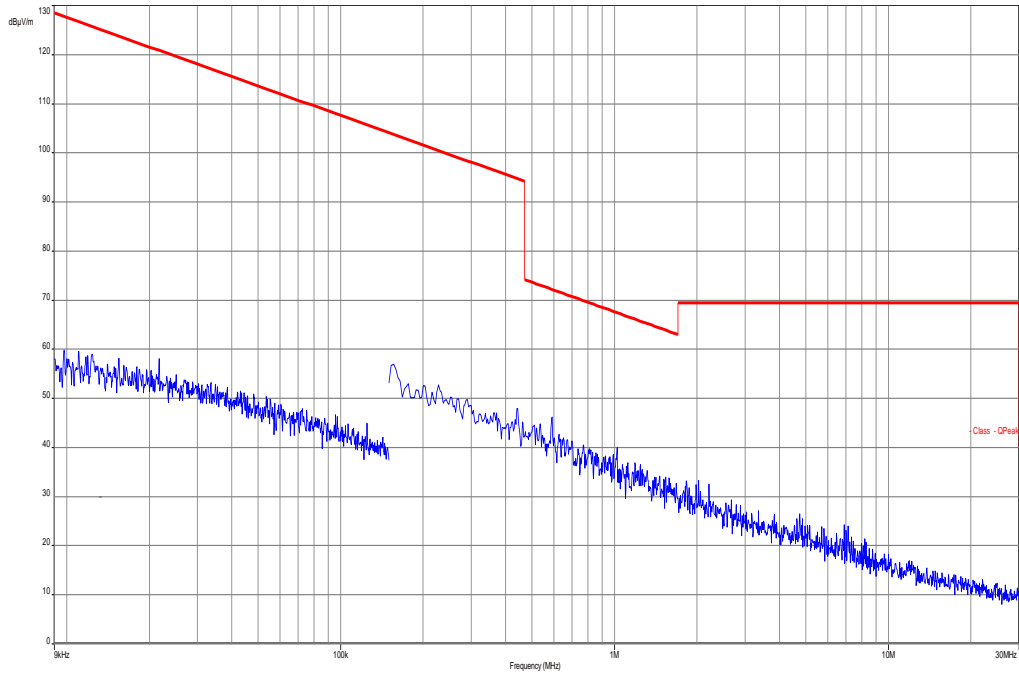


Plot 2: 9 kHz to 30 MHz, ANT 2



Plots: RX / Idle – mode

Plot 1: 9 kHz to 30 MHz



10.12 Spurious emissions conducted < 30 MHz

Description:

Measurement of the conducted spurious emissions in transmit mode below 30 MHz. The EUT is set to the middle channel. If peaks are found the lowest and highest channel will be measured too. 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:

Measurement parameter	
Detector:	Peak - Quasi Peak / Average
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 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

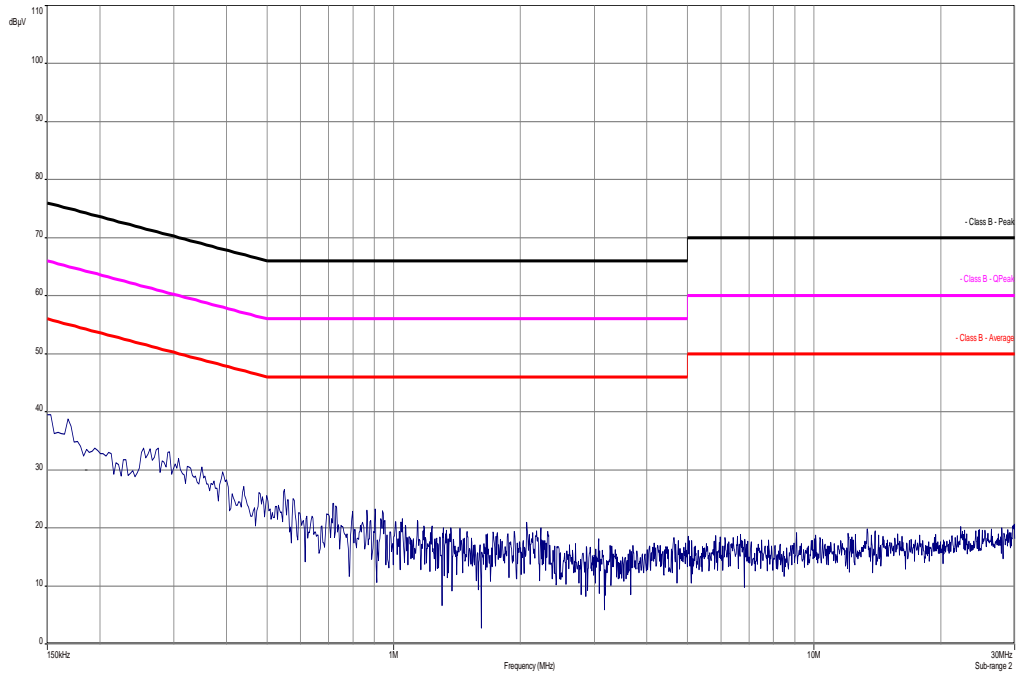
Results:

TX Spurious Emissions Conducted < 30 MHz [dBµV/m]		
F [MHz]	Detector	Level [dBµV/m]
No peaks detected.		
Measurement uncertainty	± 3 dB	

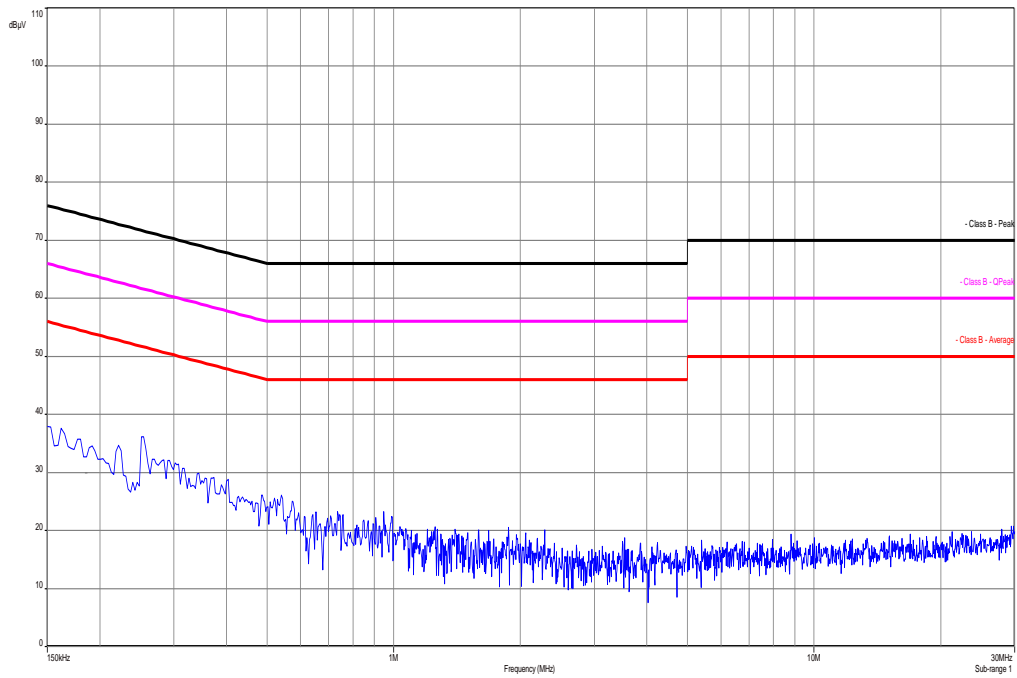
Verdict: Passed

Plots:

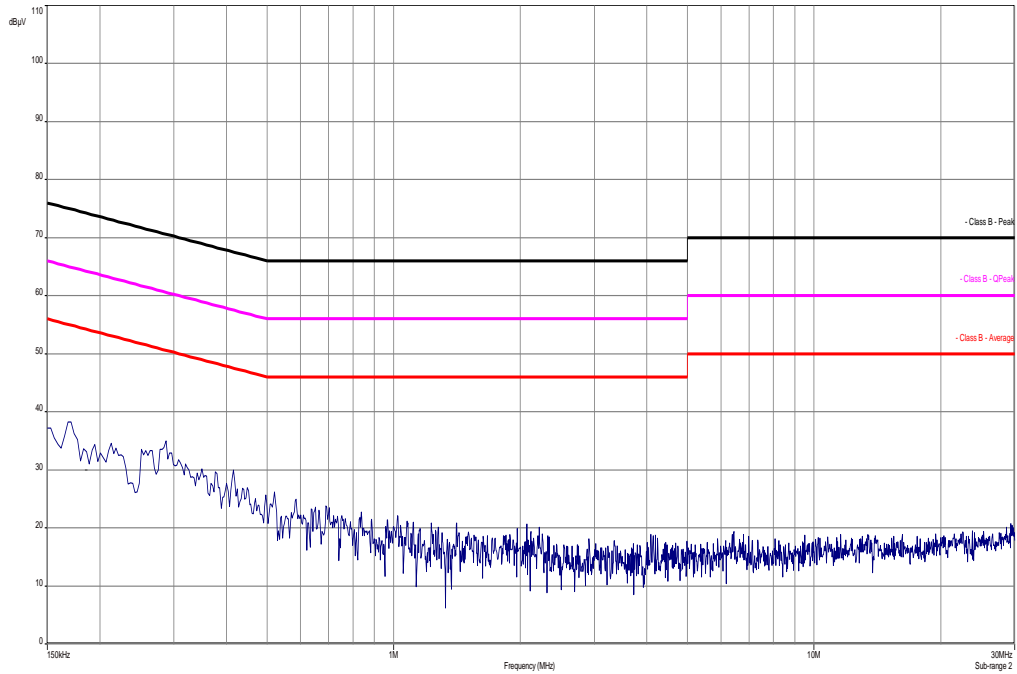
Plot 1: TX mode, 150 kHz to 30 MHz, phase line



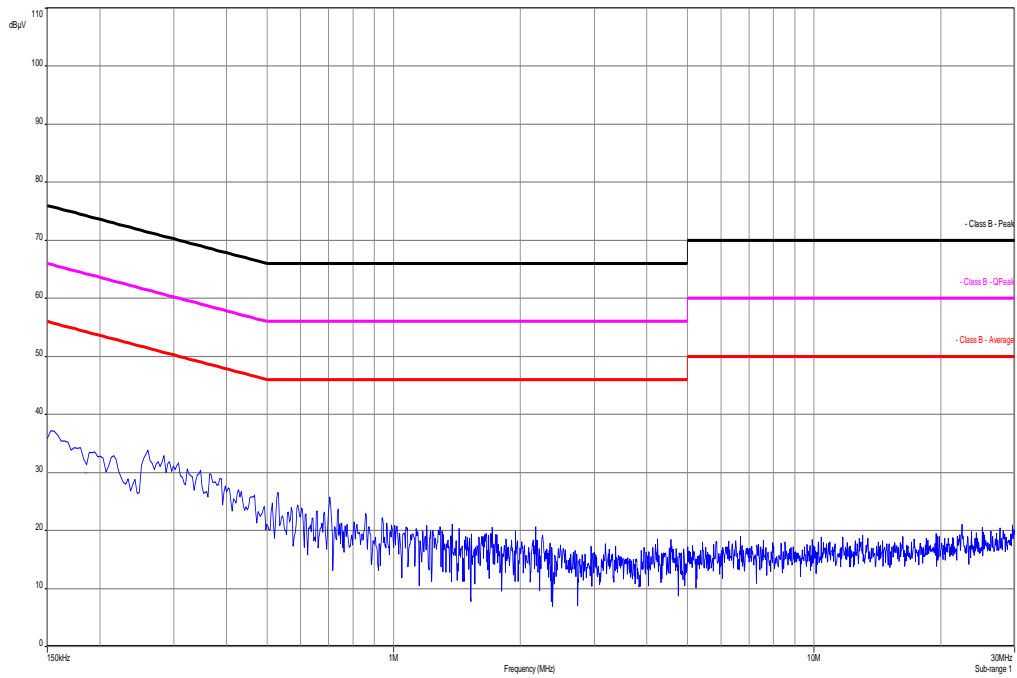
Plot 2: TX mode, 150 kHz to 30 MHz, neutral line



Plot 3: RX / Idle – mode, 150 kHz to 30 MHz, phase line



Plot 4: RX / Idle – mode, 150 kHz to 30 MHz, neutral line



11 Test equipment and ancillaries used for tests

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 signalling 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).

No.	Lab / Item	Equipment	Type	Manufact.	Serial No.	INV. No Cetecom	Kind of Calibration	Last Calibration	Next Calibration
1	45	Switch-Unit	3488A	HP Meßtechnik	2719A14505	300000368	g		
2	50	DC power supply, 60Vdc, 50A, 1200 W	6032A	HP Meßtechnik	2920A04466	300000580	ne		
3	n. a.	EMI Test Receiver	ESCI 3	R&S	100083	300003312	k	27.01.2014	27.01.2015
4	n. a.	Funkstörmessempfänger 20Hz-26,5GHz	ESU26	R&S	100037	300003555	k	28.02.2014	28.02.2015
5	n. a.	Antenna Tower	Model 2175	ETS-LINDGREN	64762	300003745	izw		
6	n. a.	Positioning Controller	Model 2090	ETS-LINDGREN	64672	300003746	izw		
7	n. a.	Turntable Interface-Box	Model 105637	ETS-LINDGREN	44583	300003747	izw		
8	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	295	300003787	k	22.04.2014	22.04.2016
9	n. a.	Double-Ridged Waveguide Horn Antenna 1-18,0GHz	3115	EMCO	8812-3088	300001032	vKI!	08.05.2013	08.05.2015
10	n. a.	Anechoic chamber	FAC 3/5m	MWB / TDK	87400/02	300000996	ev		
11	n. a.	Switch / Control Unit	3488A	HP Meßtechnik	*	300000199	ne		
12	9	Isolating Transformer	MPL IEC625 Bus Regeltrennravo	Erfi	91350	300001155	ne		
13	90	Active Loop Antenna 10 kHz to 30 MHz	6502	Kontron Psychotech	8905-2342	300000256	k	13.06.2013	13.06.2015
14	n. a.	Amplifier	js42-00502650-28-5a	Parzich GMBH	928979	300003143	ne		
15	n. a.	Band Reject filter	WRCG240/2483-2375/2505-50/10SS	Wainwright	11	300003351	ev		
16	n. a.	TRILOG Broadband Test-Antenna 30 MHz - 3 GHz	VULB9163	Schwarzbeck	371	300003854	vKI!	14.10.2011	14.10.2014
17	n. a.	MXE EMI Receiver 20 Hz bis 26,5 GHz	N9038A	Agilent Technologies	MY51210197	300004405	k	13.03.2014	13.03.2015
18	11b	Microwave System Amplifier, 0.5-26.5 GHz	83017A	HP Meßtechnik	00419	300002268	ev		
19	A026	Std. Gain Horn Antenna 12.4 to 18.0 GHz	639	Narda	8402	300000787	k	22.07.2013	22.07.2015
20	A029	Std. Gain Horn Antenna 18.0 to 26.5 GHz	638	Narda	8205	300002442	k	19.07.2013	19.07.2015
21	n. a.	Signal Analyzer 40 GHz	FSV40	R&S	101042	300004517	k	21.01.2014	21.01.2015

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

12 Observations

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

Annex A Document history

Version	Applied changes	Date of release
	Initial release	2014-07-10
A	Added conducted measurements and partial re-measured radiated measurements with new lower power levels	2015-01-23

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

