



IMQ S.p.A. - Società con Socio Unico
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LAB N° 0121

TEST REPORT

No. ARSQ00009-01a

performed in accordance with

FCC Rules: Code of Federal Regulations (CFR) no. 47
Part 15 Subpart C Section 15.247

PRODUCT	Ultra-low power RF-ready module
MODEL(s) TESTED	SPSGPE-915
FCC ID	S9NSPSGPE
TRADE MARK(s)	STMicroelectronics

APPLICANT	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)
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Tested by	Roberto Radice	
Approved by	Giovanni Di Turi <i>[Laboratory manager]</i>	

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2016-09-19	First edition Digital signed - ARSQ00009-01a_TR_FCC 15.247_STMICROELECTRONICS_Modulo PSGPE-915

The results of tests and checks reported in this Test Report refer exclusively to the samples tested and described in the Report itself.
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1. GENERAL DATA

SAMPLE		
Samples received on	2016-06-09	(item sent and sampling by applicant)
IMQ reference samples	BEM	82175
Samples tested No.	1	
Object under analysis recognition	Not carried out Except where stated, characteristics of products were taken from client description and were not verified by the laboratory	
TEST LOCATION		
Testing dates	2016-06-09 ÷ 2016-07-19	
Testing laboratory	IMQ S.p.A. - Via Quintiliano, 43 – I-20138 Milano	
ENVIRONMENTAL CONDITIONING		
Parameter	Measured	
Ambient Temperature	20 ÷ 25 °C	
Relative Humidity	50 ÷ 60 %	
Atmospheric Pressure	900 ÷ 1000 mbar	
REMARKS		
Throughout this report a point is used as the decimal separator. The ability or reliability of this product to perform its intended function in a particular application has not been investigated. Unless otherwise specified, warnings, installation instruction and/or user manual provided with the sample have been checked in Italian or English version only. IMQ declines any responsibility derived from missing or wrong information provided aside by the applicant.		

2. REFERENCE DOCUMENT

	DOCUMENT	DATE	TITLE
☒	47 CFR Part 15	2015	Radio Frequency Device
☒	ANSI C63.4	2014	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 for Testing Unlicensed Wireless Devices

3. EQUIPMENT UNDER TEST (EUT) DETAILS

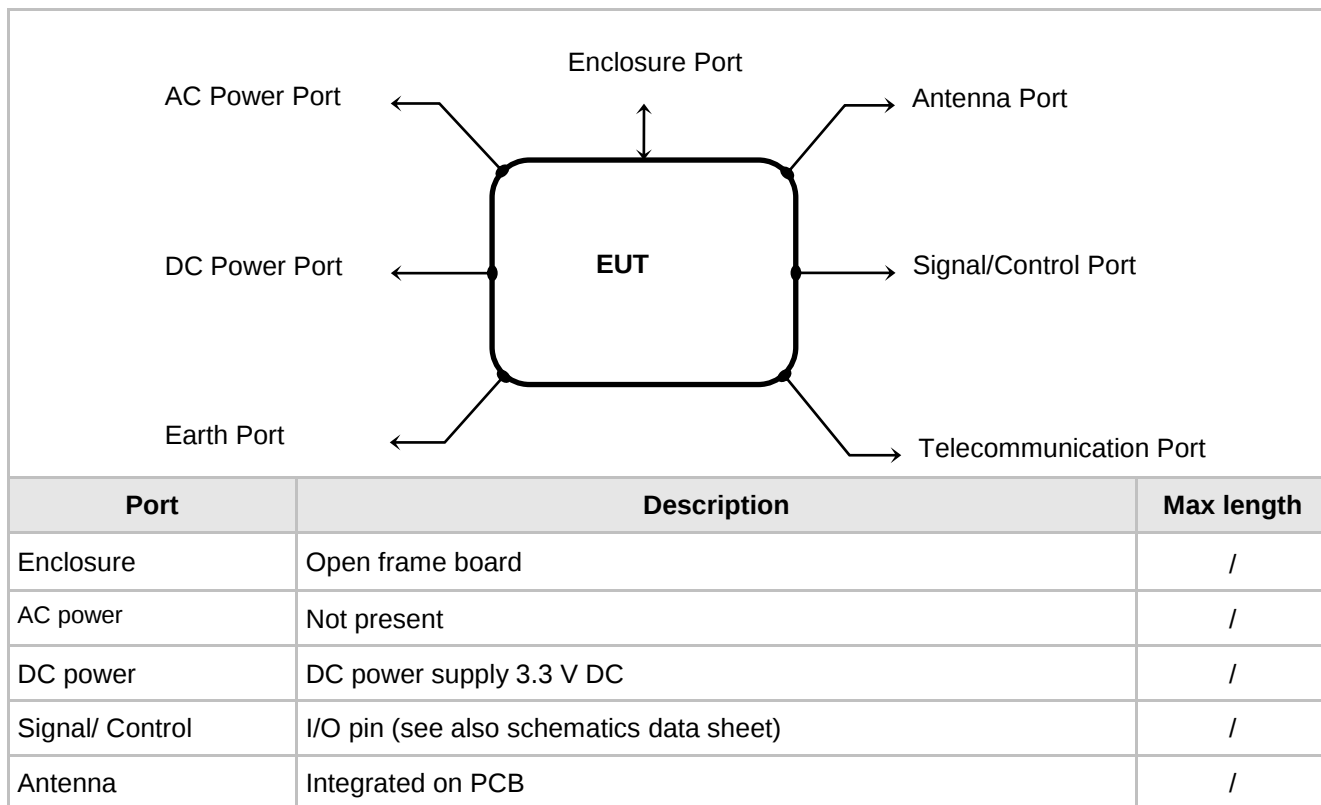
GENERAL DATA

MODEL (basic)	Description
SPSGPE-915	Ultra-low power RF-ready module
FCC ID	S9NSPSGPE
Manufacturer	STMicroelectronics S.r.l. ~ Centro Direzionale Colleoni - Palazzo Andromeda 3 I-20864 Agrate Brianza (MB)
Equipment classification	According to the definition 15.3 (o) EUT is a Intentional Radiator operating within the bands 902 ÷ 928 MHz so it shall fulfill provisions of 47CFR Part 15 Subpart C – Intentional radiators – and Section 15.247
Type of equipment	Radio module
Operating frequency	902 ÷ 928 MHz
Equipment Class	DSS
Max radiated power	102,70 dBμV/m (at 3m. distance)
Modulation	GFSK
Channel Spacing	340kHz
Channel bandwidth	92.30kHz
Antenna	Dedicated antenna (LINK Mod. ANT-916-CW-HW) peak gain: +1.2 dBi
Number of channels	75

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	902.20	2	902.54	3	902.88	4	903.22
5	903.56	6	903.90	7	904.24	8	904.58
9	904.92	10	905.26	11	905.60	12	905.94
13	906.28	14	906.62	15	906.96	16	907.30
17	907.64	18	907.98	19	908.32	20	908.66
21	909.00	22	909.34	23	909.68	24	910.02
25	910.36	26	910.70	27	911.04	28	911.38
29	911.72	30	912.06	31	912.40	32	912.74
33	913.08	34	913.42	35	913.76	36	914.10
37	914.44	38	914.78	39	915.12	40	915.46
41	915.80	42	916.14	43	916.48	44	916.82
45	917.16	46	917.50	47	917.84	48	918.18
49	918.52	50	918.86	51	919.20	52	919.54
53	919.88	54	920.22	55	920.56	56	920.90
57	921.24	58	921.58	59	921.92	60	922.26
61	922.60	62	922.94	63	923.28	64	923.62
65	923.96	66	924.30	67	924.64	68	924.98
69	925.32	70	925.66	71	926.00	72	926.34
73	926.68	74	927.02	75	927.36		

4. TEST CONFIGURATION OF EQUIPMENT UNDER TEST

EUT PORTS





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STATE OF THE EUT DURING TESTS

Ref.	Mode	Description
#1	Operating	Continuous transmission (single channel transmission 902.20MHz, 915.12MHz, 927.36MHz). The EUT is installed on module device board (dongle). The dongle is powered from the USB cable port. The EUT is in continuously transmitting with max. RF power setting (+11dBm)
#2	Operating	Continuous transmission on pseudo-random sequence on all channel (hopping mode) The EUT is installed on module device board (dongle). The dongle is powered from the USB cable port. The EUT is in continuously transmitting with max. RF power setting (+11dBm)

SUPPORT EQUIPMENT

Defined as equipment needed for correct operation or loading of the EUT, but not considered as tested:

Equipment	Manufacturer	Model
Dongle furnished by manufacturer for supply and management of radio module	/	PE.STONE.DIM
Software used for testing: PE.STONE.RADIO.TESTER 1.8 (Paradox Engineering) This software was running on PC connected via USB to the Dongle. It was used to enable the test operation modes #1 and #2		

ELECTROMAGNETICALLY RELEVANT COMPONENTS

Component	No.	Manufacturer	Model
Low data rate, low power sub-1GHz transceiver (U1)	1	ST	SPIRIT1
Ultralow power ARM-based 32-bit MCU (U2)	1	ST	STM32L151
Crystal (X1)	1	NDK	8MHz
Crystal (X2)	1	NDK	50MHz

RFI SUPPRESSION DEVICES

Component	No.	Manufacturer	Model
Capacitors (C21)	1	MURATA	1,0uF 10V
Capacitors (C22, C23, C25, C26,C27,C28,C29)	7	TDK	100nF 10V

EMI PROTECTION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EUT TECHNICAL DOCUMENTATION

Document	Reference
Wiring diagram	ELB-PED-0083_Rev01
Bill of materials	ELB-PED-0083_Rev01
Preliminary_Datasheet	2016-09

5. METHODS OF MEASUREMENT

All compliance measurements have been carried out using the procedures described in the standard ANSI C63.4-2014, ANSI C63.10-2013 and Section 15.31 of CFR47 Part 15 (2015) – Subpart A (General).

Additional test requirements have been adopted according to the reference Section indicated in the § 6 of this test report.

FREQUENCY RANGE INVESTIGATED

Conducted emission tests: from 150 kHz to 30MHz

Radiated emission tests: from 9 kHz to tenth harmonic of fundamental.

6. SUMMARY OF TEST RESULTS

POSSIBLE TEST CASE VERDICTS	
Test object does meet the requirement	PASS
Test object does not meet the requirement	FAIL
Test case does not apply to the test object	N.A.
Test not performed	N.P.

CFR47 Part 15	TITLE	RESULT
§ 15.203	Antenna Requirements	PASS
§ 15.247 (b)(4)(i)		
§ 15.207 (a)	Power Line Conducted Emission	PASS
§ 15.209 (a) (f)	Radiated Emission	PASS
§ 15.247 (d)	Out-of-band emissions	PASS
§ 15.247 (d)	100 kHz Bandwidth of Frequency Band Edges	PASS
§ 15.247 (a)	Frequency Hopping Spread Spectrum Specifications	
§ 15.247(a)	20 dB Bandwidth	PASS
§ 15.247(a)(1)	Carrier frequency (Hopping Channel) Separation	PASS
§ 15.247(a)(1)(iii)	Number of Hopping Channels Used	PASS
§ 15.247(a)(1)(iii)	Time occupancy (Dwell Time) of Each Ch. within a 0,4 x Nch (sec) Period	PASS
§ 15.247(a)(2)	6dB Minimum Bandwidth	N.A.
§ 15.247(b)	Maximum Peak Output Power	
§ 15.247(b) (1)	Peak Output Power, radiated (EIRP)	PASS
§ 15.247(b) (3)	RF power output, radiated (EIRP)	N.A.
§ 15.247(b) (4)	Antenna gain	N.A.
§ 15.247(c)	Operation with directional antenna gains greater than 6 dBi	N.A.
§ 15.247 (e)	Power Spectral Density	N.A.
§ 15.247 (f)	Hybrid systems	N.A.
§ 15.247 (g)	FHSS Transmission characteristics	PASS
§ 15.247 (h)	Recognition of occupied channel and multiple transmission system	N.A.
§ 15.247(i) (§ 47CFR 1.1307(b)(1))	RF humane exposure	PASS



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7. TEST RESULTS

7.1 ANTENNA REQUIREMENTS

TEST REQUIREMENT

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

Antenna specifications	
N° of authorized antenna types	1
Antenna type	Dedicated antennal LINK Mod. ANT-916-CW-HW
Maximum total gain	+1.2 dBi
External power amplifiers	Not present

TEST RESULT

The EUT meets the requirements of section 15.203 and 15.204



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7.2 POWER LINE CONDUCTED EMISSION

TEST REQUIREMENT

Test setup	ANSI C63.4
Test facility	Shielded chamber
Frequency range	150 kHz – 30 MHz
IF bandwidth	9 kHz
EMC class	B
EUT operating condition	#1

LIMITS

Band of operations	Quasi-Peak (dBμV)	Average Limit (dBμV)
0.15 ÷ 0.5	66 ÷ 56	56 ÷ 46
0.5 ÷ 5	56	46
5 ÷ 30	60	50

TEST RESULT

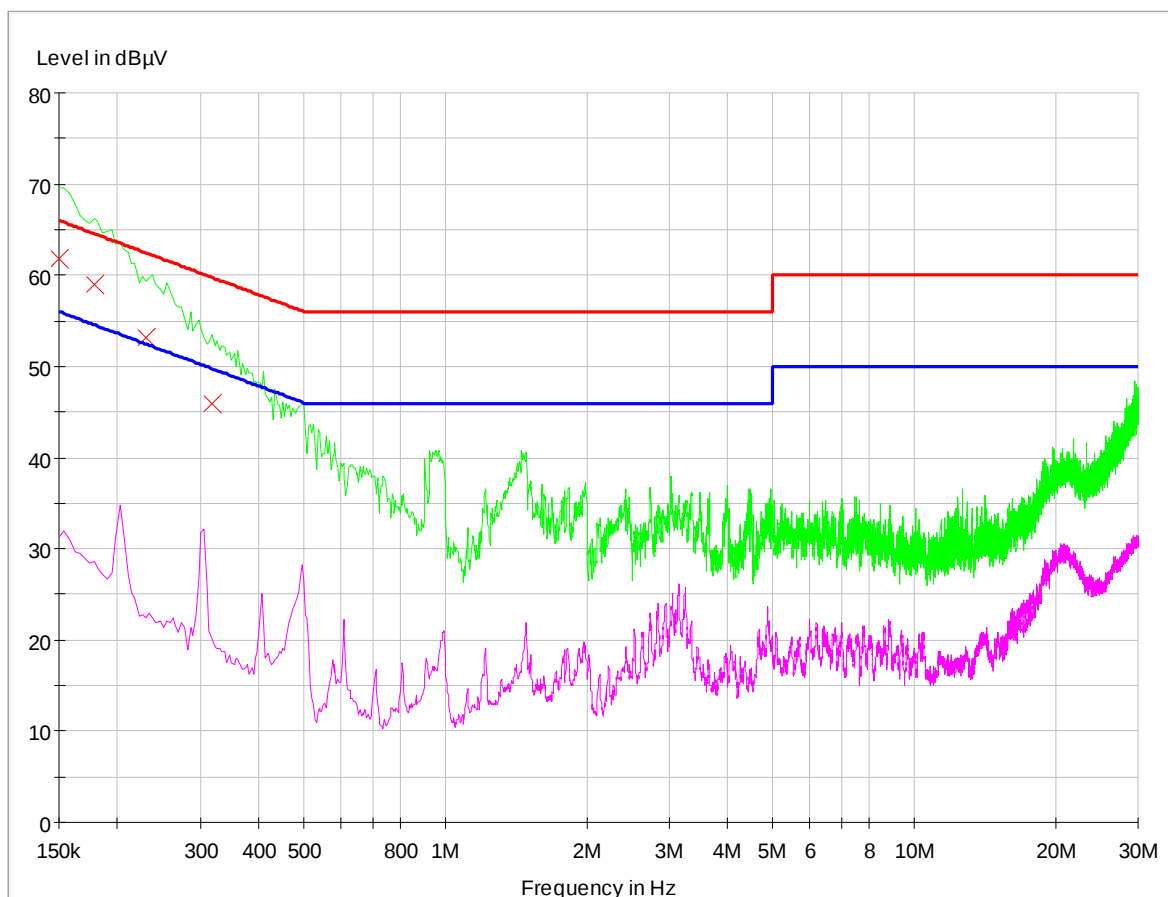
The EUT meets the requirements of sections 15.207 (a).

TEST PROCEDURE

- 1) The EUT was placed on a wooden table of size, 80 cm by 80 cm, raised 80 cm in which is located 40 cm away from the vertical wall the shielded room.
- 2) Each EUT power cord input cord was individually connected through a 50Ω/50μH LISN to the input power source.
- 3) Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
- 4) The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
- 5) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 9 kHz during the measurements.
- 6) The measurements with Quasi-Peak detector are performed only for frequencies for which the Peak values are $\geq$ (Q.P. limit - 6 dB).

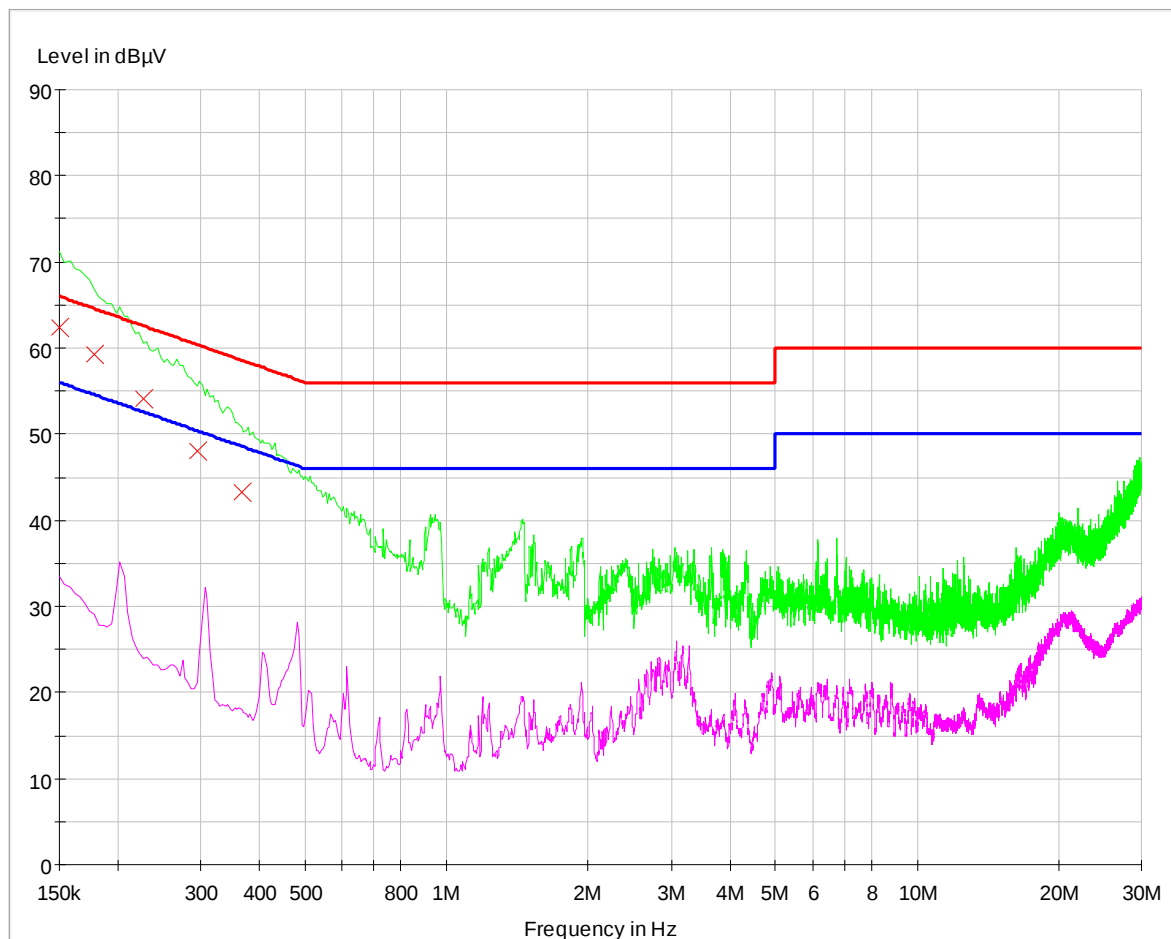
MEASUREMENTS RESULT: Conducted disturbance on AC power supply of Personal Computer where the dongle is connected.

Test condition: Lower channel (902.20MHz)



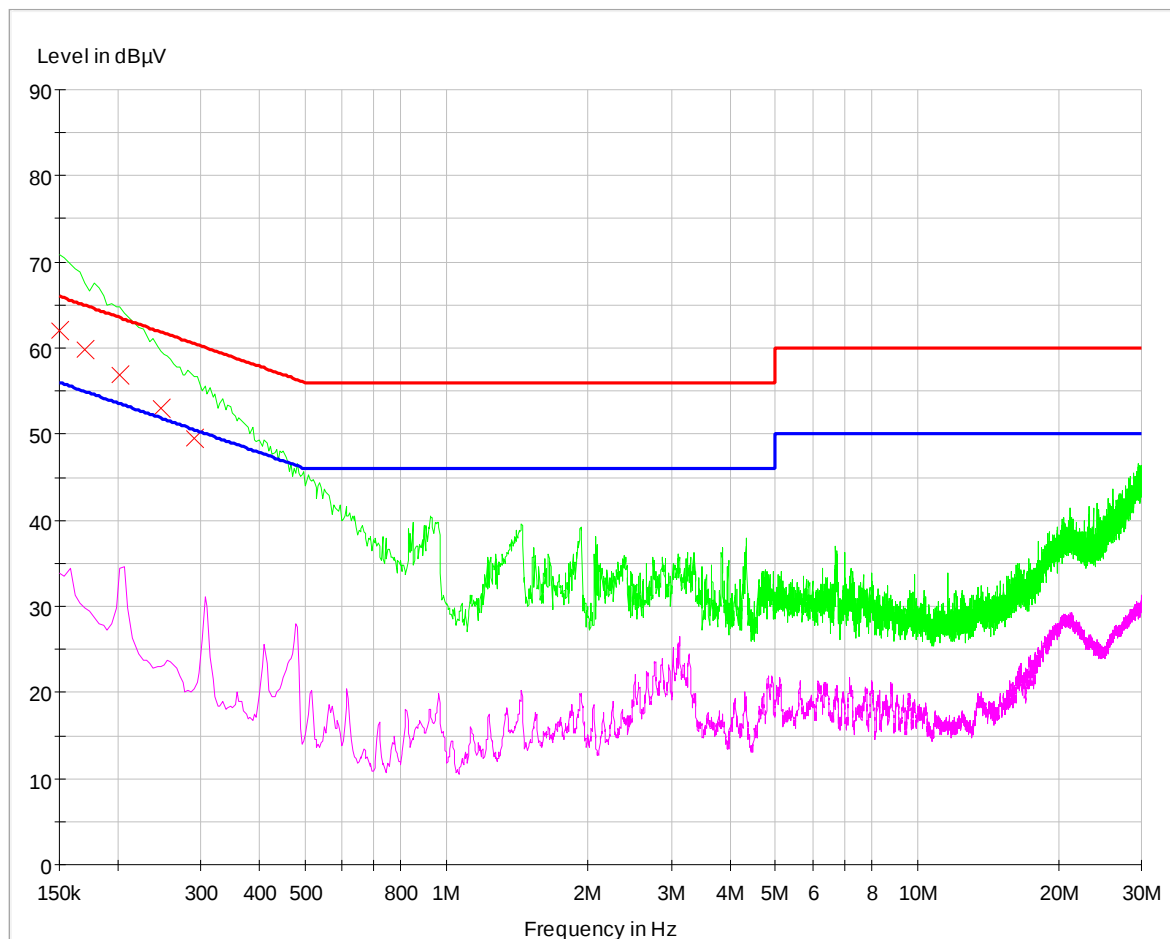
Frequency MHz	MaxPeak dBμV	QuasiPeak dBμV	Average dBμV	Meas. Time ms	Bandwidth kHz	Filter	Line	Corr. dB
0,150000	---	61,8	---	1000,0	9,000	Off	N	9,8
0,178000	---	58,9	---	1000,0	9,000	Off	N	9,8
0,230000	---	53,2	---	1000,0	9,000	Off	N	9,8
0,318000	---	45,9	---	1000,0	9,000	Off	N	9,8

Test condition: Middle channel (915.12MHz)



Frequency	MaxPeak	QuasiPeak	Average	Meas. Time	Bandwidth	Filter	Line	Corr.
MHz	dBμV	dBμV	dBμV	ms	kHz			dB
0,150000	---	62,4	---	1000,0	9,000	Off	N	9,8
0,178000	---	59,3	---	1000,0	9,000	Off	N	9,8
0,226000	---	54,1	---	1000,0	9,000	Off	N	9,8
0,294000	---	48,1	---	1000,0	9,000	Off	N	9,8
0,366000	---	43,3	---	1000,0	9,000	Off	N	9,8

Test condition: Middle channel (927.36MHz)



Frequency	MaxPeak	QuasiPeak	Average	Meas. Time	Bandwidth	Filter	Line	Corr.
MHz	dBμV	dBμV	dBμV	ms	kHz			dB
0,150000	---	62,0	---	1000,0	9,000	Off	L1	9,8
0,170000	---	59,8	---	1000,0	9,000	Off	L1	9,8
0,202000	---	57,0	---	1000,0	9,000	Off	L1	9,8
0,246000	---	53,0	---	1000,0	9,000	Off	L1	9,8
0,290000	---	49,5	---	1000,0	9,000	Off	L1	9,8

7.3 RADIATED DISTURBANCES

TEST REQUIREMENT

Test setup	ANSI C63.4
Test facility	Semi-anechoic chamber
Test distance	3 meters
Frequency range	9 kHz to tenth harmonic of fundamental
IF bandwidth (below 30 MHz)	9 kHz
IF bandwidth (below 1,000 MHz)	120 kHz
IF bandwidth (above 1,000 MHz)	1 MHz
EMC class	B
EUT operating condition	#1

Remark: In accordance with part 15.31 (f) (2), where the measurement distance was specified to be 30 or 300 meters, a correction factor was applied in order to permit measurement to be performed at a separation distance. The applied formula for limits at 3 meter is: Extrapolation (dB) = $40\log(300\text{meter} / 3\text{meter}) = +80\text{db}$
Extrapolation (dB) = $40\log(30\text{meter} / 3\text{meter}) = +40\text{db}$

LIMITS

Band of operations	Peak (dB μ V/m)	Average Limit (dB μ V/m)
Restricted bands (§ 15.205)	74	54
Other bands	According to 15.209 or fundamental -20dB (which is greater)	

TEST RESULT

The EUT has been tested in 3 orthogonal axes at the frequencies lowest, middle and highest.

The results reported are worst case.

The measurement of spurious emission of EUT in receiver mode is deemed to be fulfilled as no limits are exceeded in transmitter mode (condition considered more burdensome).

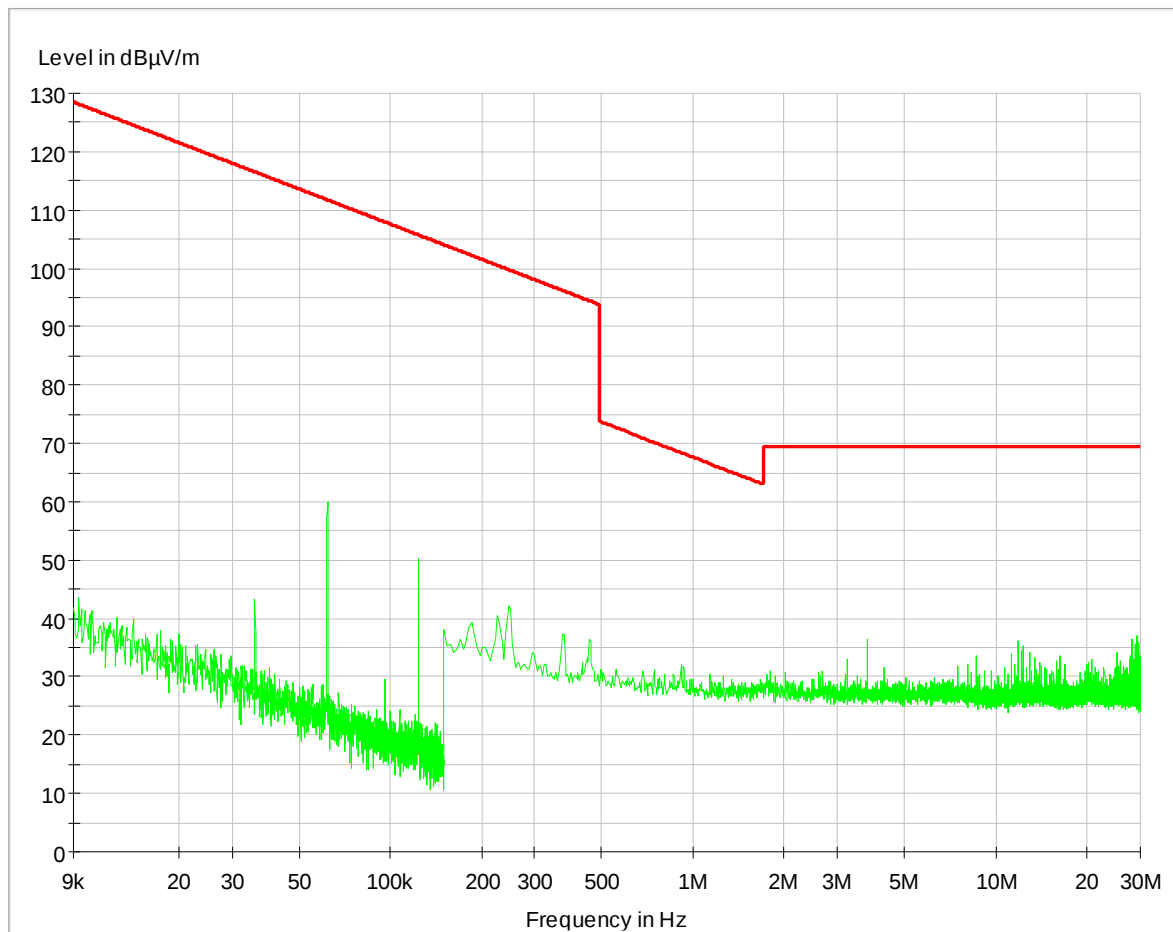
The EUT meets the requirements of sections 15.205 (b), 15.209 and 15.247.

TEST PROCEDURE

- 1) The EUT was placed on turntable which is 0.8 m above the ground plane
- 2) The turntable shall rotate from 0° to 360° degrees to determine the position of maximum emission level.
- 3) The EUT is positioned 3 m away from the receiving antenna which varied from 1 to 4 m to find the highest emission.
- 4) The measurements were made with the detector set to PEAK and AVERAGE amplitude within a bandwidth of 100 kHz below 1000 MHz and 1 MHz above 1000 MHz.
- 5) The receiving antenna was positioned in both horizontal and vertical polarization.
- 6) The measurements with Quasi-Peak detector, below 1000 MHz are performed only for frequencies for which the Peak values are $\geq$ (Q.P. limit - 6 dB).

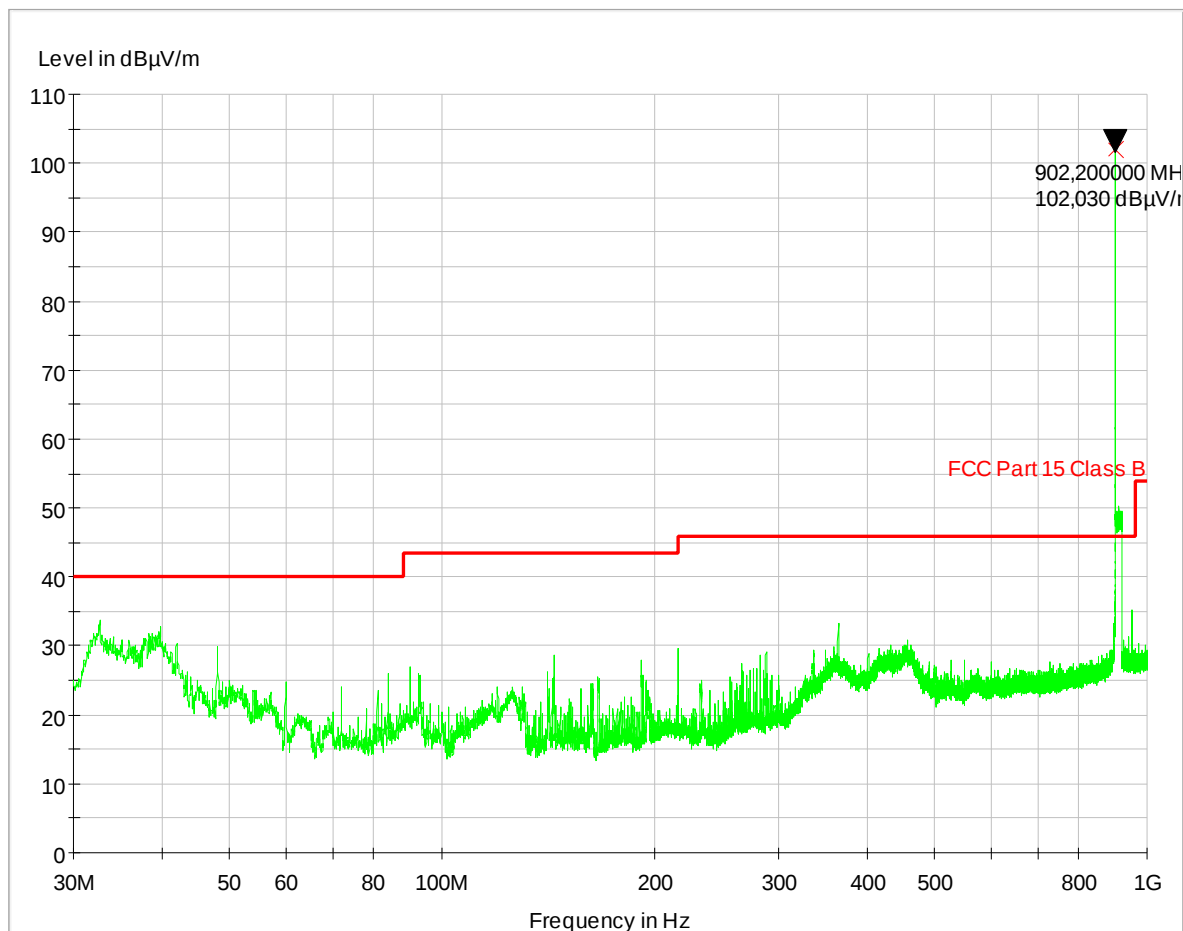
MEASUREMENTS RESULTS - RADIATED
(LOWER CHANNEL 902.20MHZ)

9 kHz±30 MHz



NOTE: The measures above are the worst case on 3 axes X Y and Z

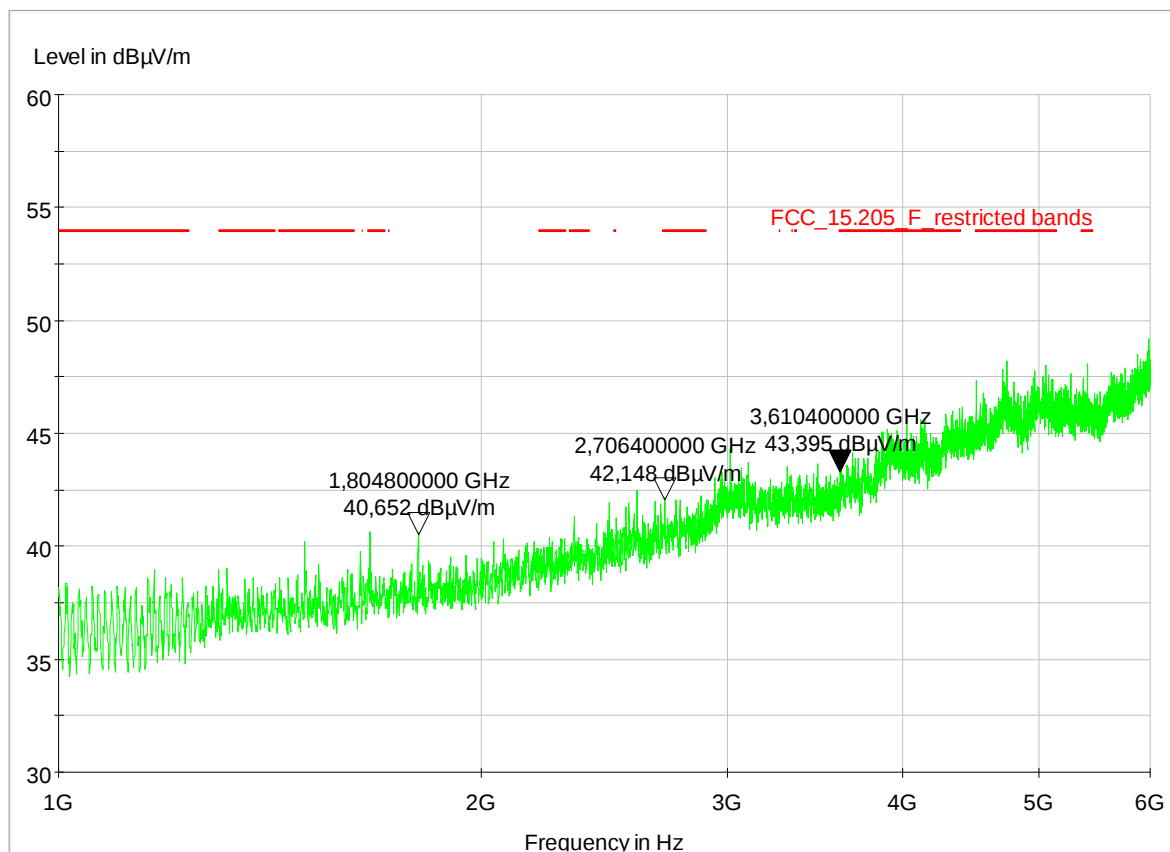
30÷1.000 MHz



Frequency	QuasiPeak	Meas. Time	Bandwidth	Height	Polarization	Corr.
MHz	dBμV/m	ms	kHz	cm		dB
902,200000	102,03	1000,0	120,000	120,0	V	23,8

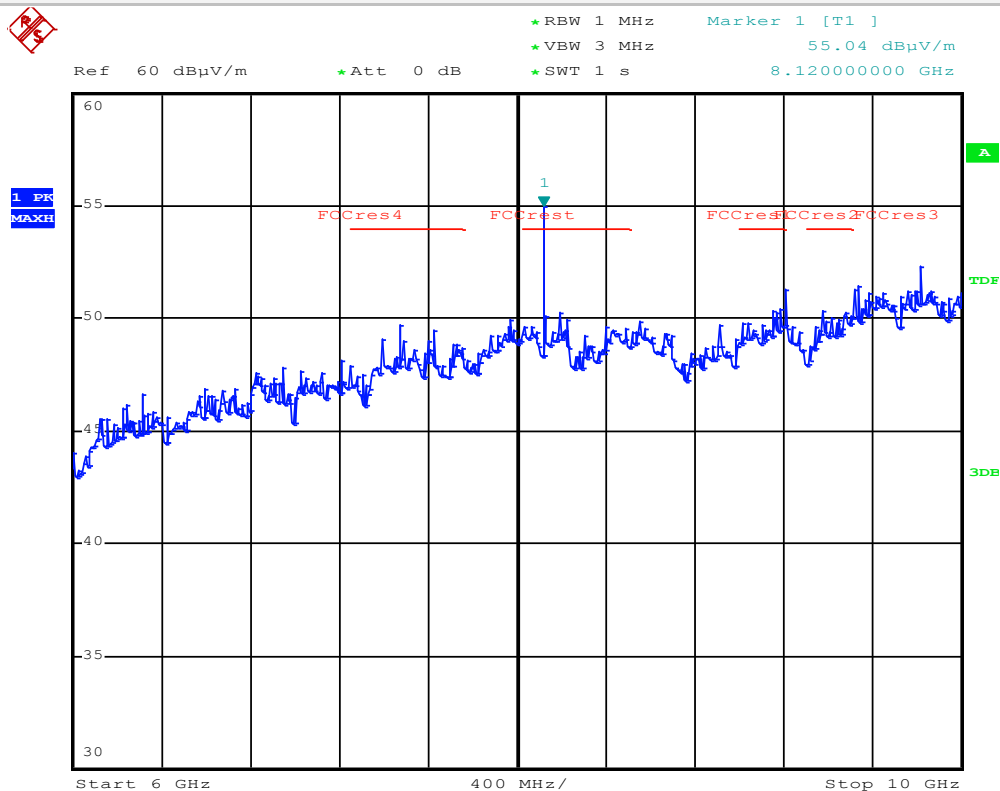
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

1000÷6.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

6000÷10.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

8.120 MHz (single measure in Average)

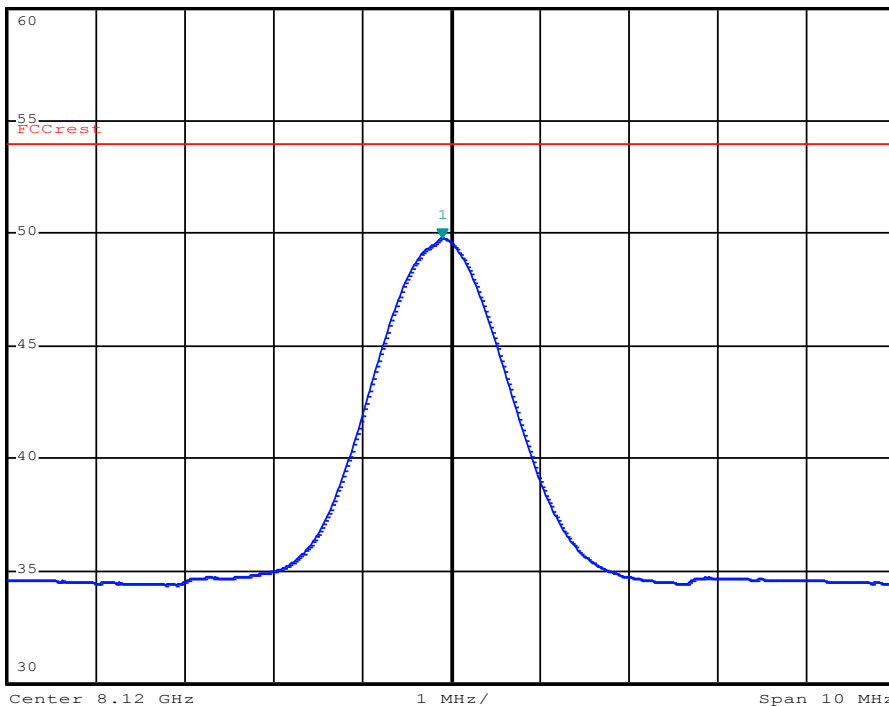


*RBW 1 MHz Marker 1 [T1]
*VBW 10 Hz 49.79 dBμV/m
SWT 2.5 s 8.119900000 GHz

Ref 60 dBμV/m

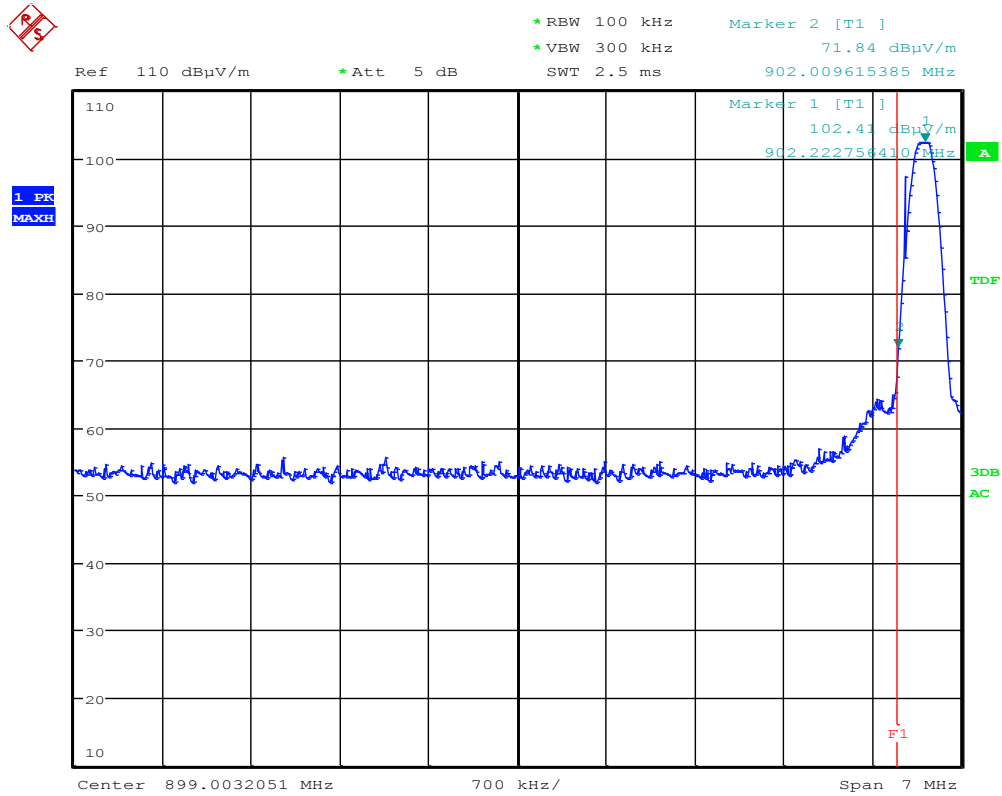
*Att 0 dB

1 PK
MAXH



Radiated Band-edge compliance - Lower band edge

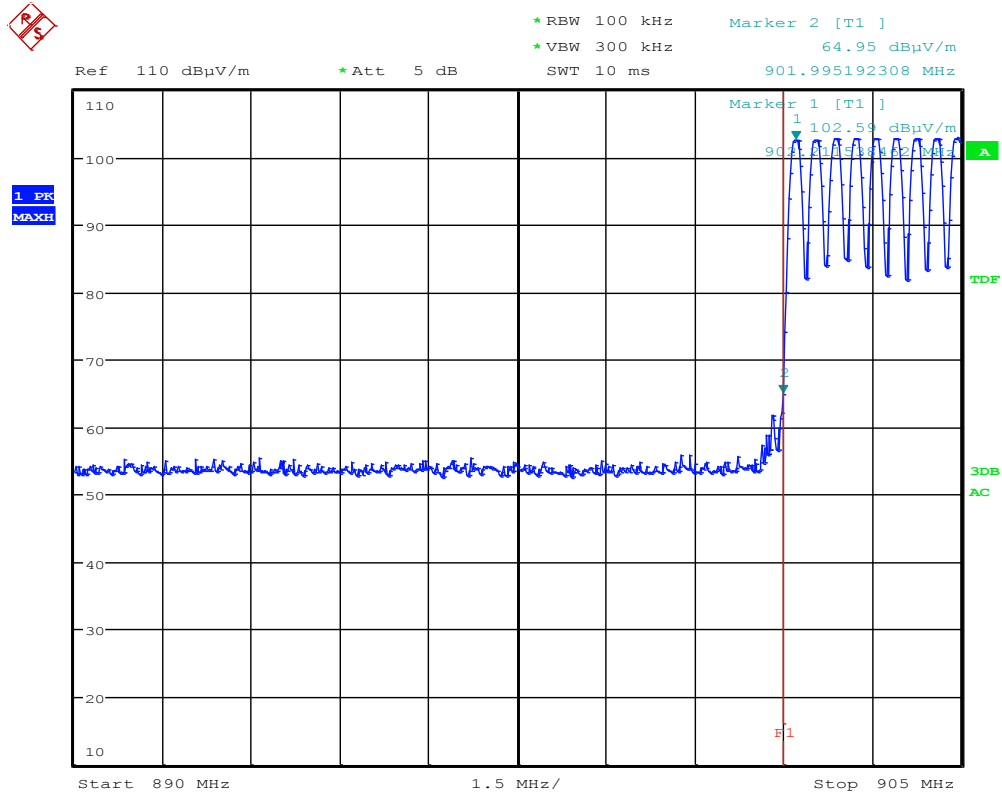
Peak



Measured power (dBμV/m)	Measured power at the band edge (dBμV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dB)	Margin (dB)
102.41	71.84	30.57	82.41	10.57

Radiated Band-edge compliance - Lower band edge (Hopping)

Peak

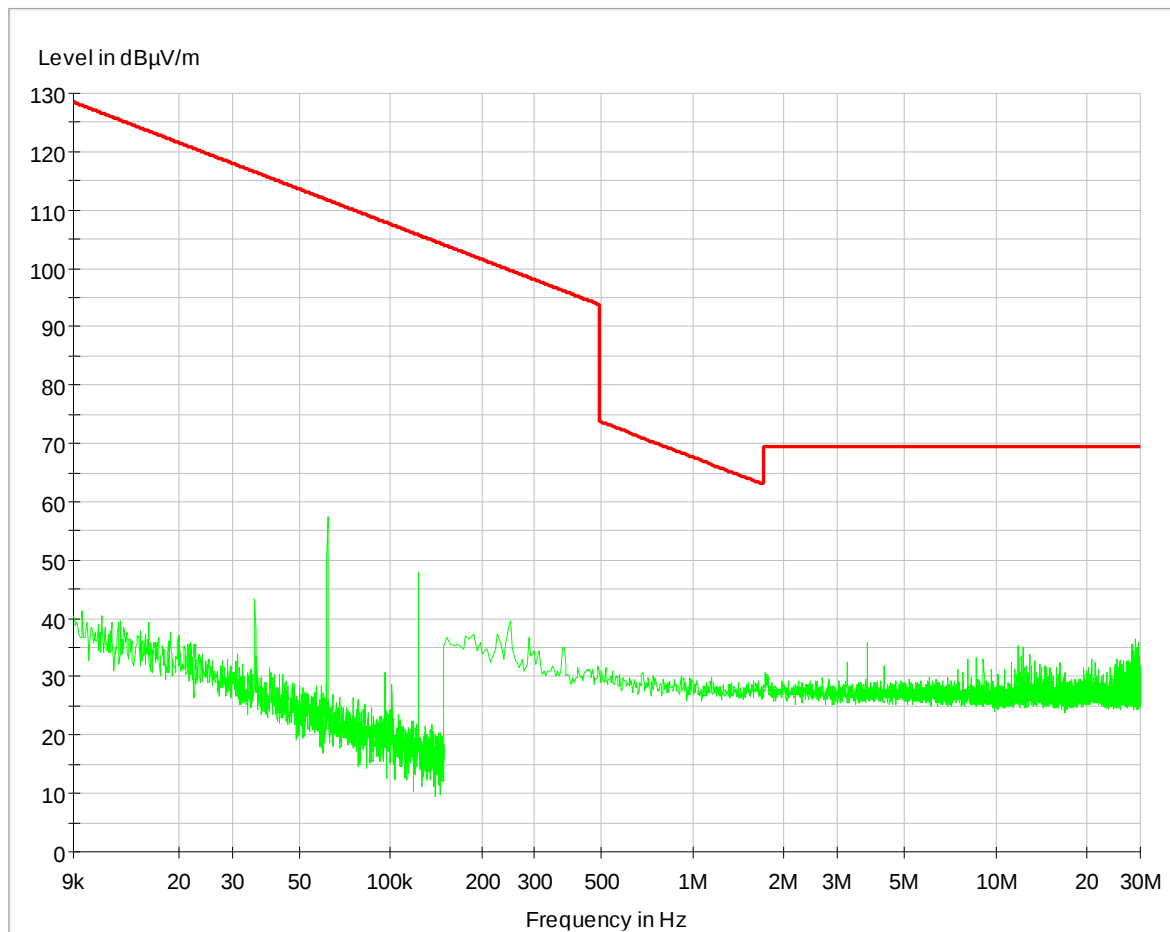


Measured power (dBμV/m)	Measured power at the band edge (dBμV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dB)	Margin (dB)
102.59	64.95	37.64	82.59	17.64

MEASUREMENTS RESULTS - RADIATED

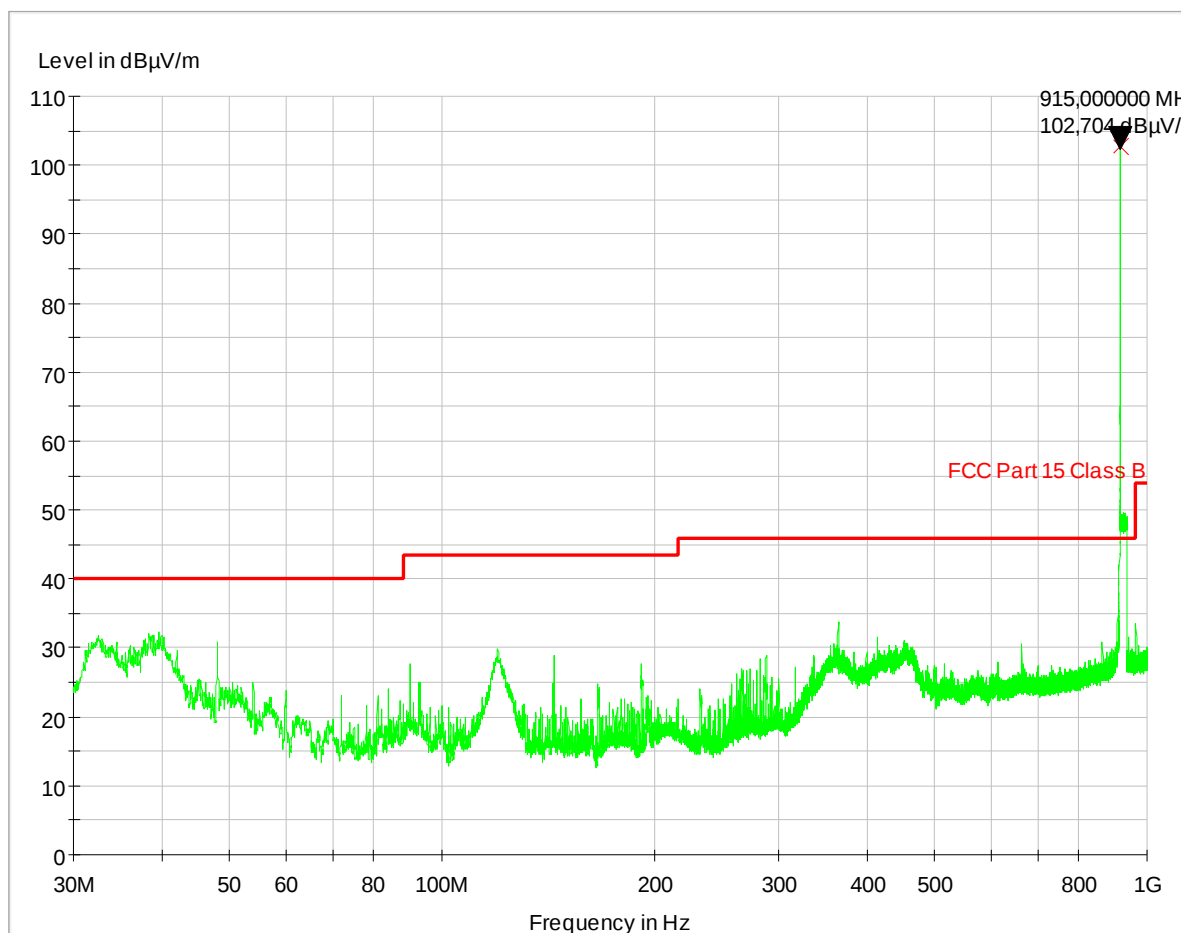
(MIDDLE CHANNEL 915.12MHZ)

9 kHz±30 MHz



NOTE: The measures above are the worst case on 3 axes X Y and Z

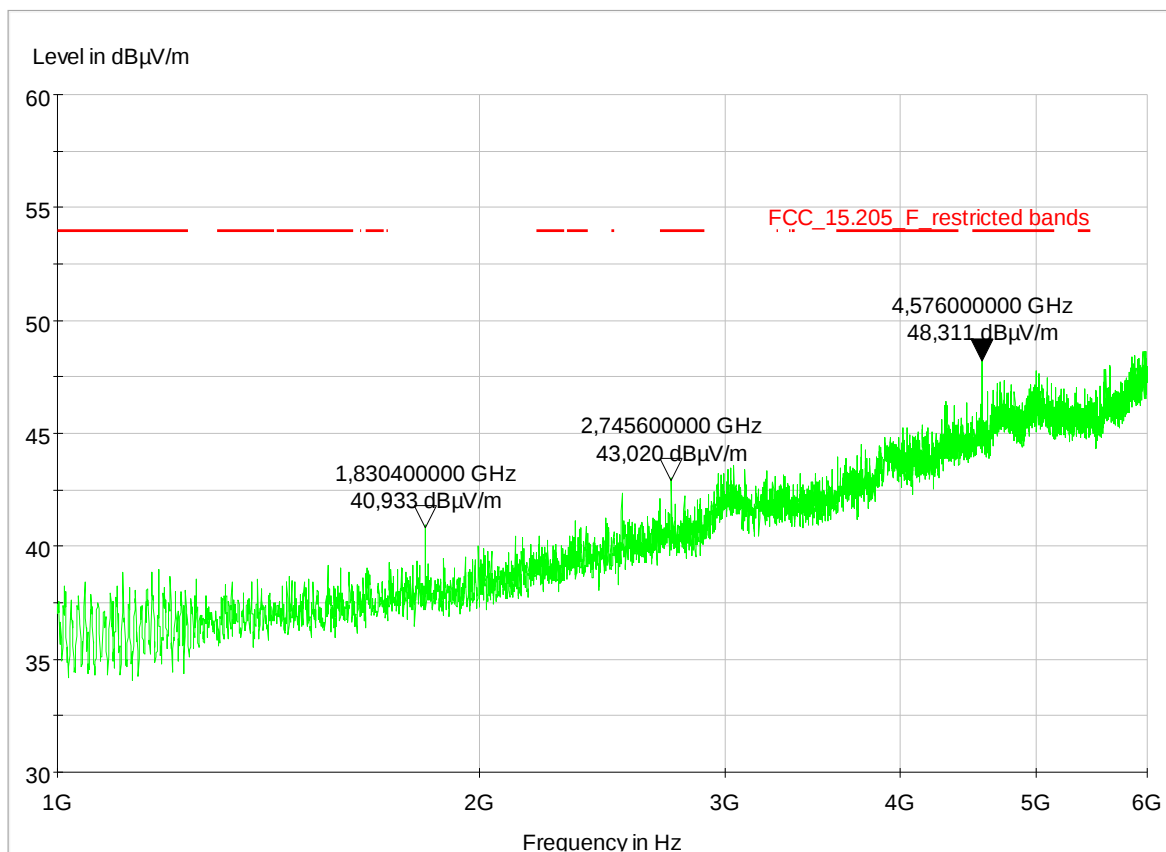
30÷1.000 MHz



Frequency MHz	QuasiPeak dB μ V/m	Meas. Time ms	Bandwidth kHz	Height cm	Polarization	Corr. dB
915,000000	102,7	1000,0	120,000	120,0	V	24,1

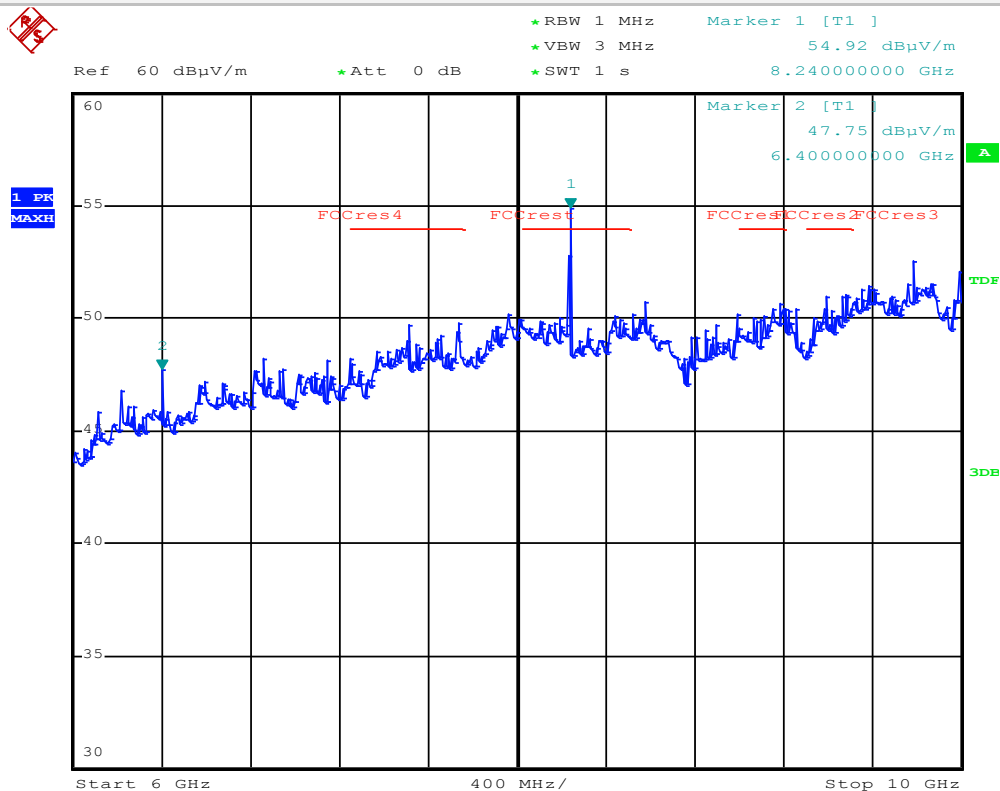
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

1000÷6.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

6000÷10.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

8.236 MHz (single measure in Average)

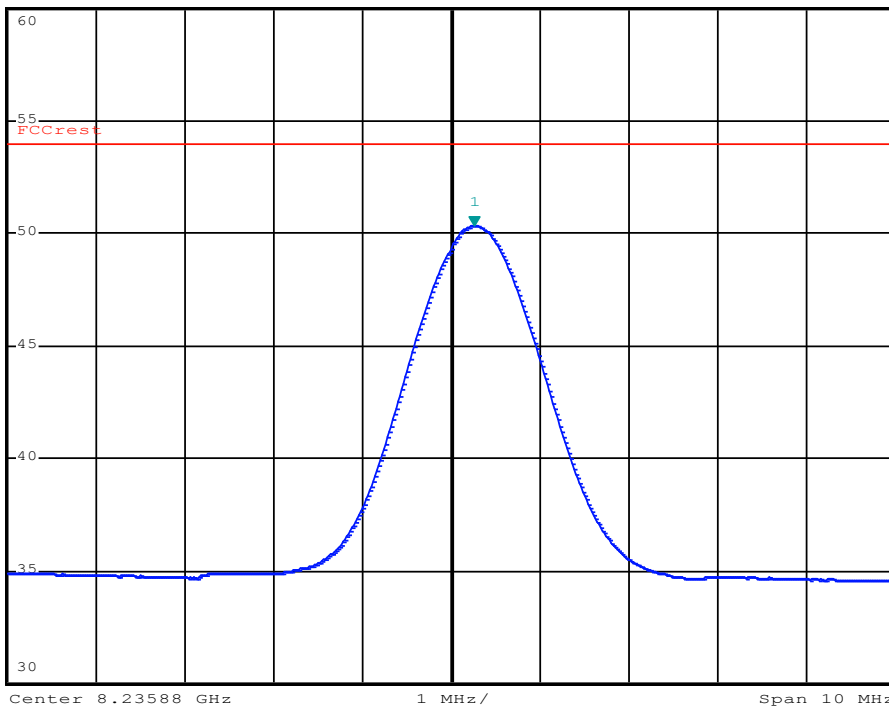


*RBW 1 MHz Marker 1 [T1]
*VBW 10 Hz 50.34 dBμV/m
SWT 2.5 s 8.236140000 GHz

Ref 60 dBμV/m

*Att 0 dB

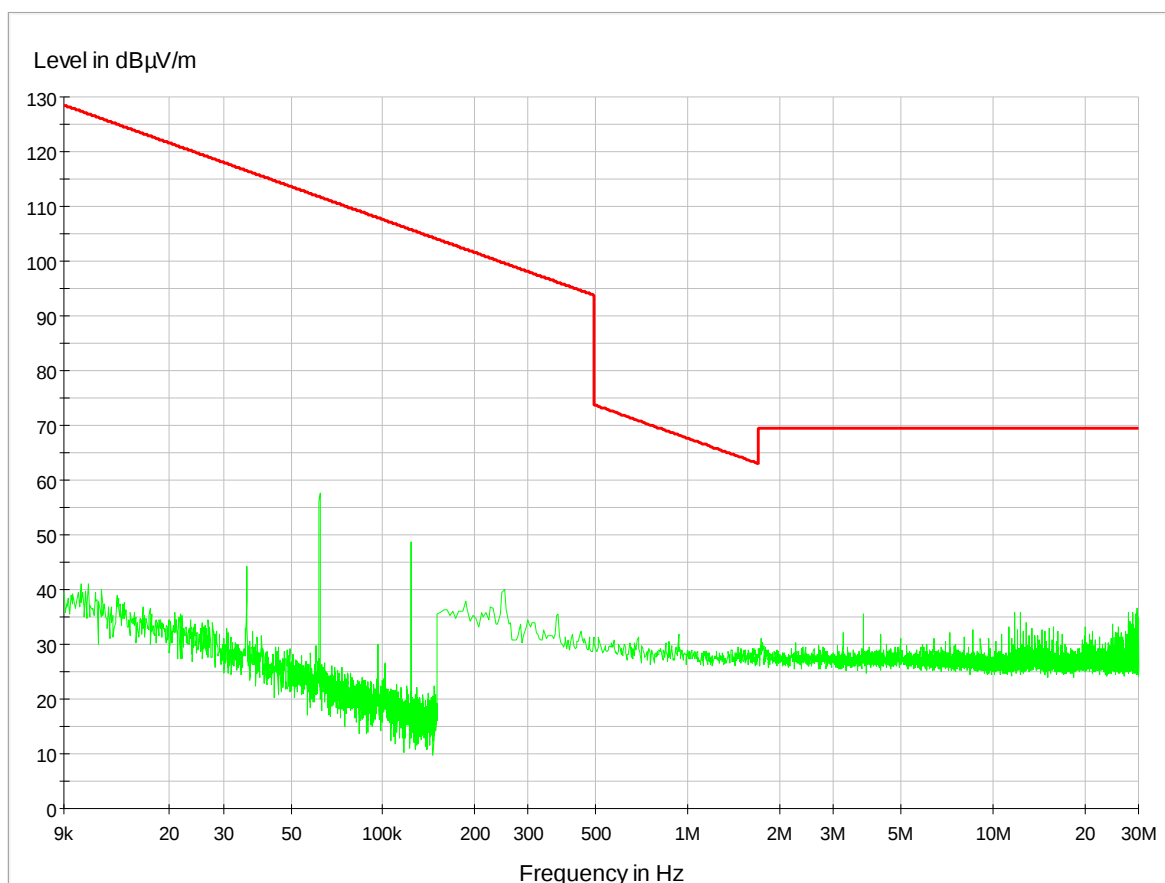
1 PK
MAXH



MEASUREMENTS RESULTS - RADIATED

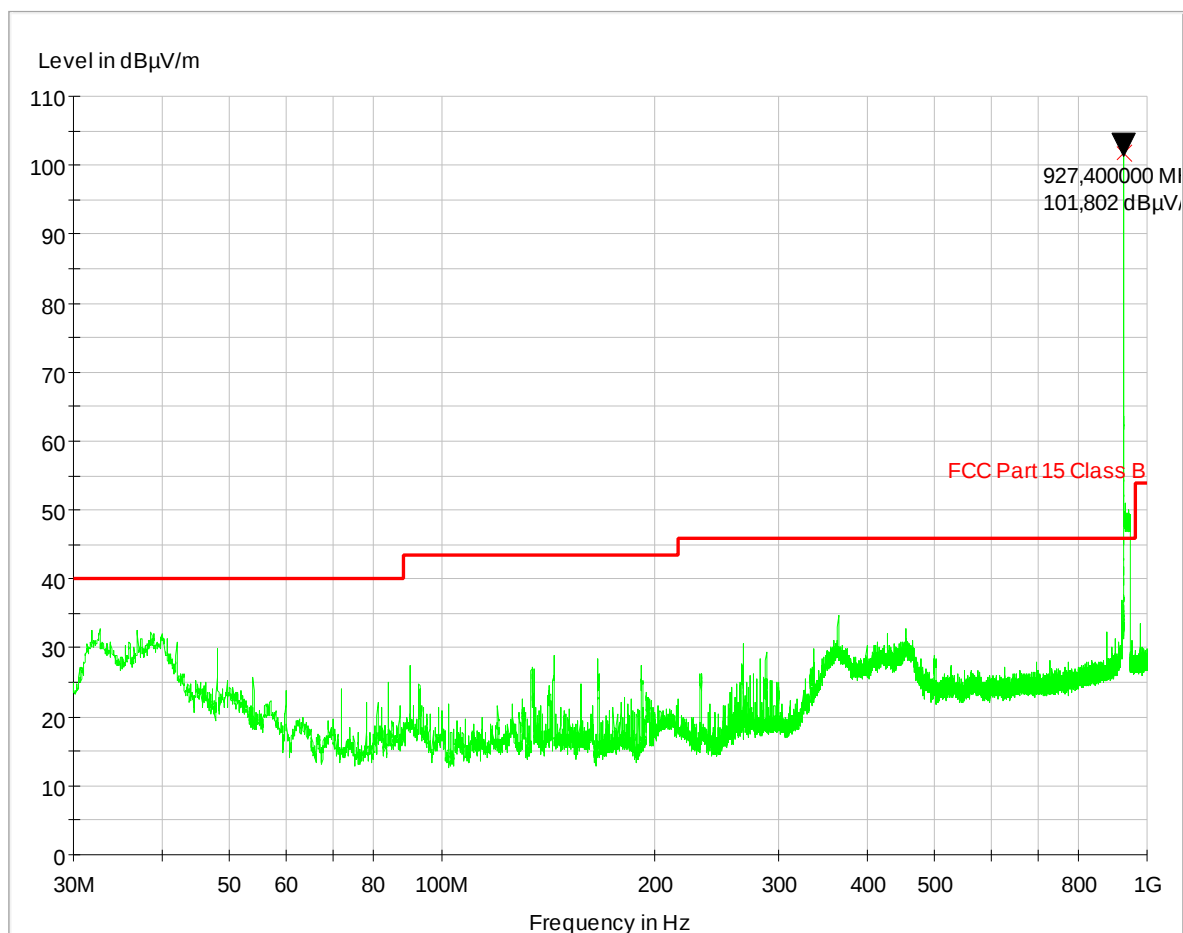
(HIGHER CHANNEL 927.36MHZ)

9 kHz÷30 MHz



NOTE: The measures above are the worst case on 3 axes X Y and Z

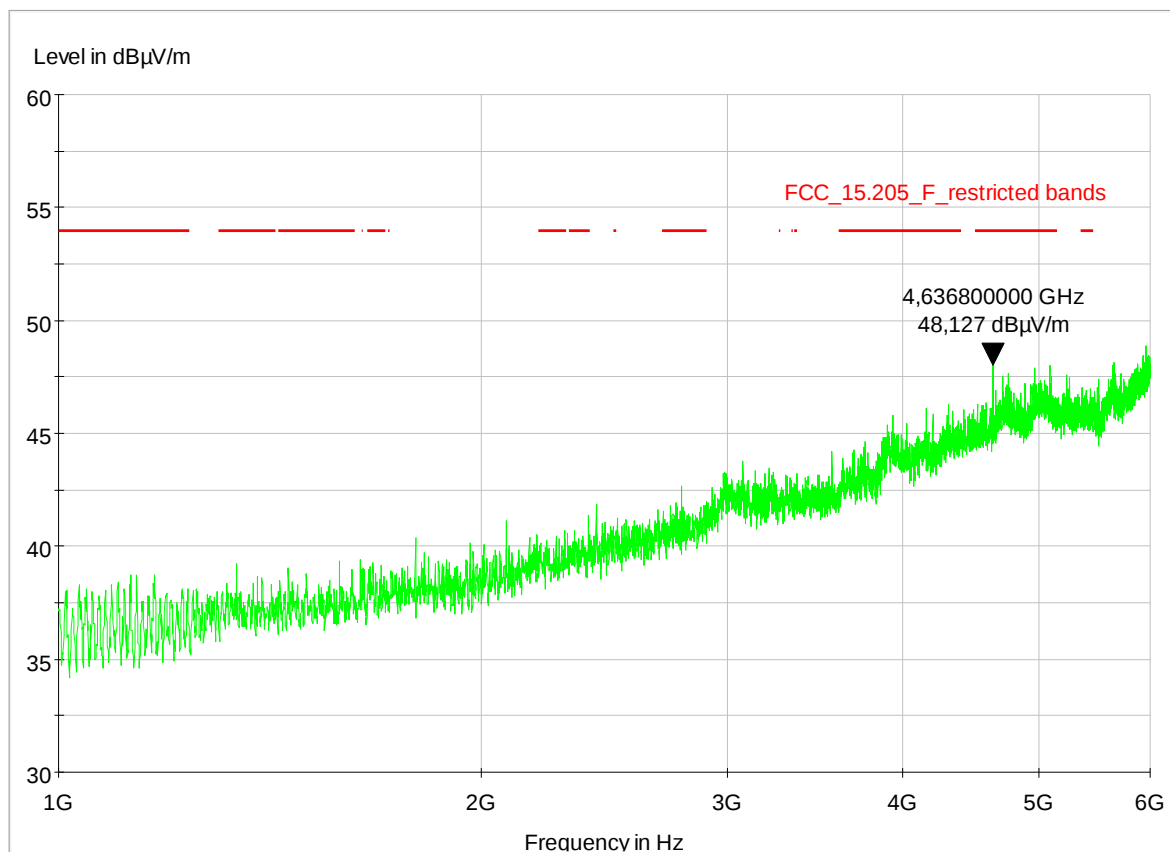
30÷1.000 MHz



Frequency MHz	QuasiPeak dB μ V/m	Meas. Time ms	Bandwidth kHz	Height cm	Polarization	Corr. dB
927,400000	101,8	1000,0	120,000	120,0	V	24,3

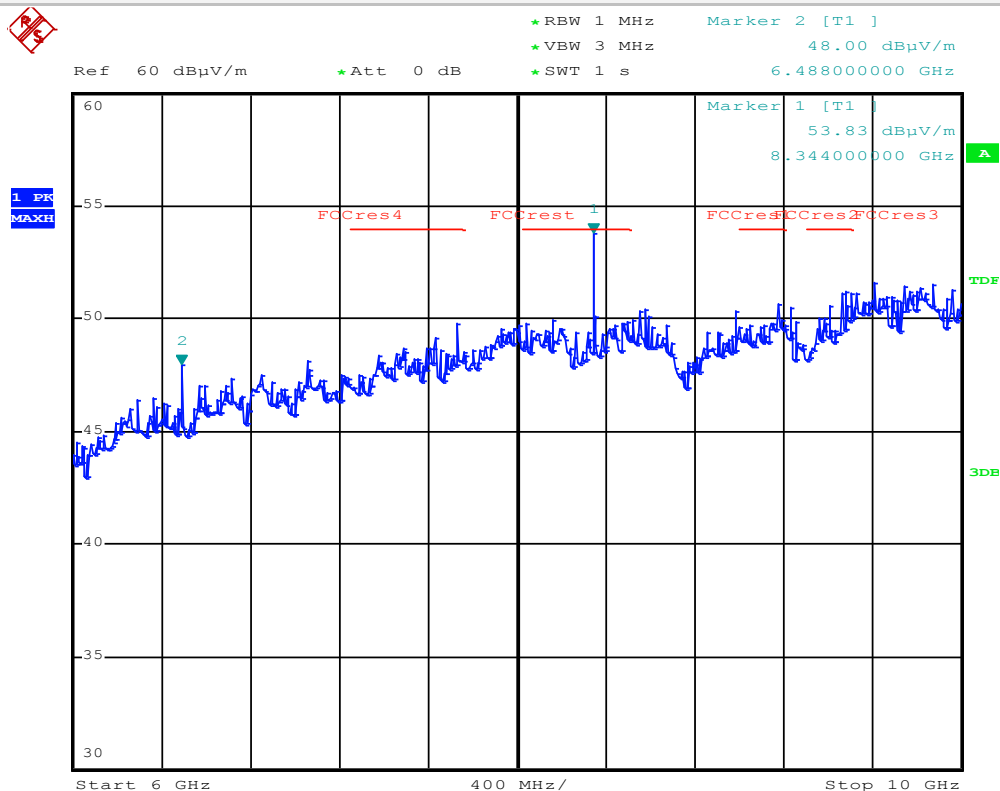
NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

1000÷6.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

6000÷10.000 MHz (Peak detector)



NOTE: The measures above are the worst case on 3 axes X Y and Z and both polarization.

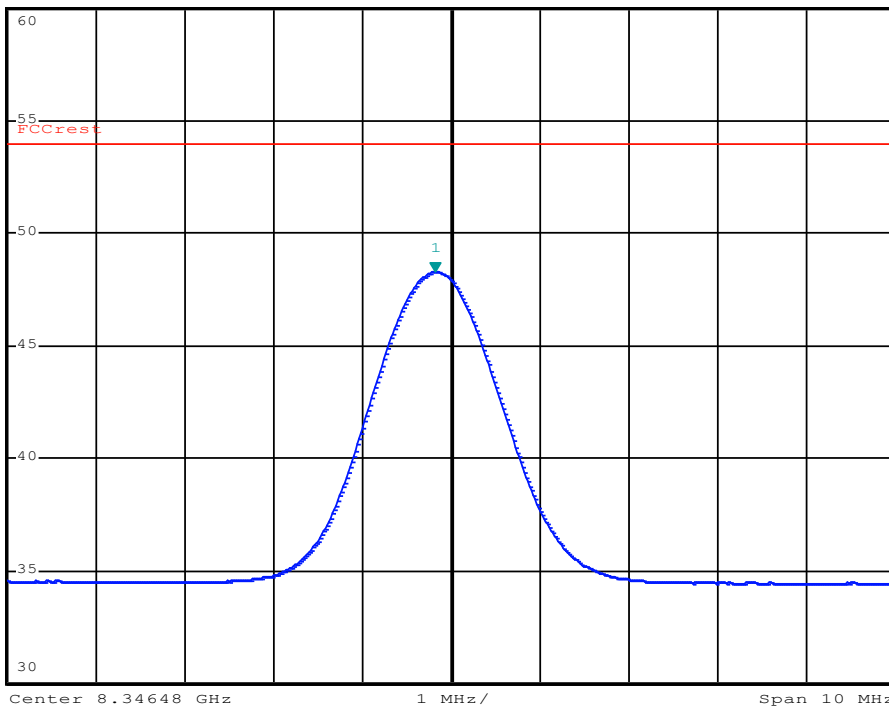
8.346 MHz (single measure in Average)



*RBW 1 MHz Marker 1 [T1]
*VBW 10 Hz 48.31 dBμV/m
*Att 0 dB SWT 2.5 s 8.346300000 GHz

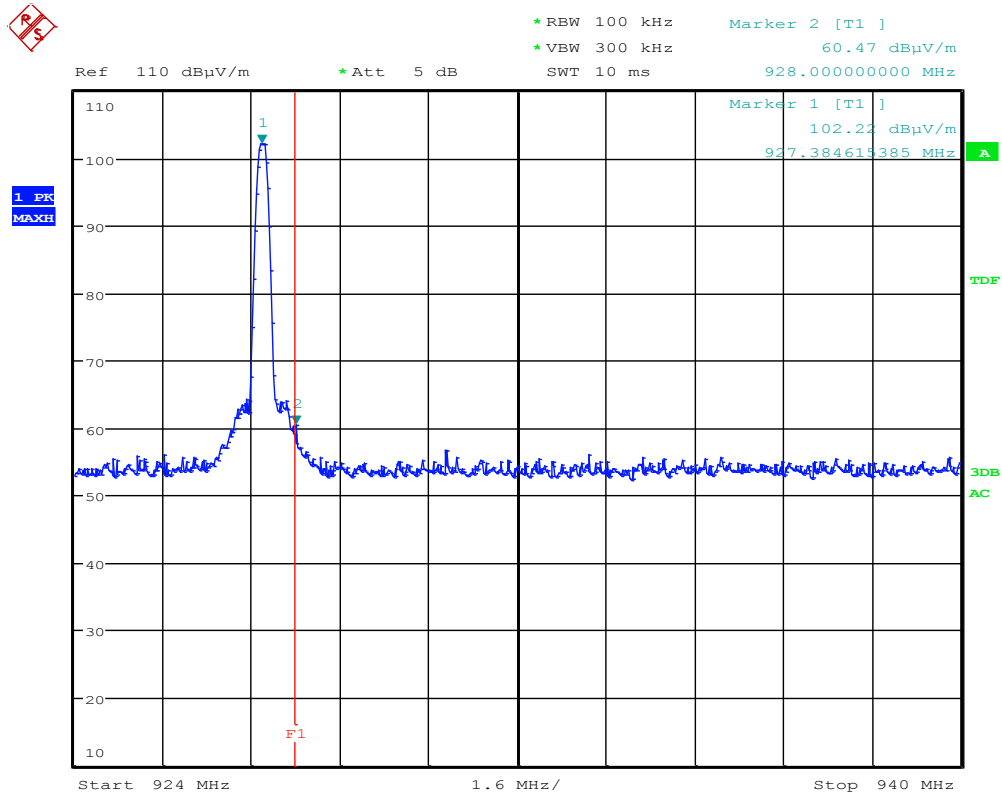
Ref 60 dBμV/m

1 PK
MAXH



Radiated Band-edge compliance - Higher band edge

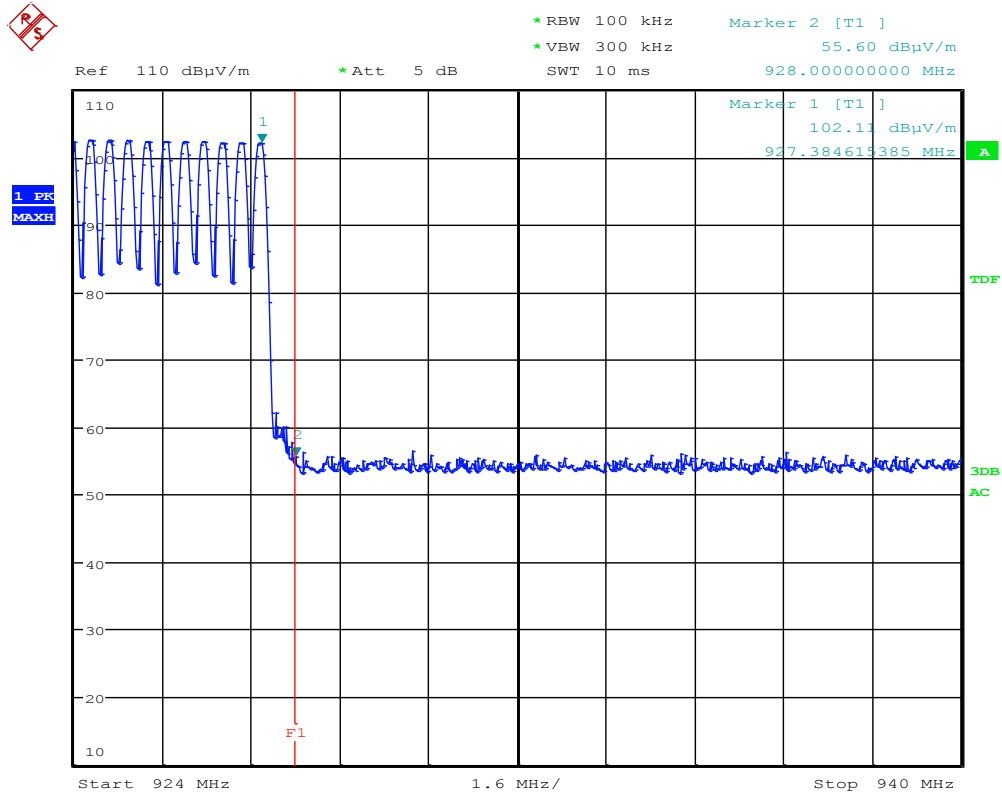
Peak



Measured power (dBμV/m)	Measured power at the band edge (dBμV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dB)	Margin (dB)
102.22	60.47	41.75	82.22	21.75

Radiated Band-edge compliance - Higher band edge (Hopping mode)

Peak



Measured power (dBμV/m)	Measured power at the band edge (dBμV/m)	Difference Peak / band edge (dB)	Peak Limit at PK power -20 dB (dB)	Margin (dB)
102.11	55.60	46.51	82.11	26.51

7.4 OUT-OF-BAND EMISSIONS

TEST REQUIREMENT

Spectrum analyzer settings

Span	/
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	as necessary to capture the entire dwell time
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1
Remark	None

TEST PROCEDURE

A spectrum analyzer is connected to the antenna port of the transmitter.
The measure has been executed with the lowest transmit channel, the highest transmit channel and one located somewhere in the middle of the band.
The measurement takes into account the loss generated by the used cable.

LIMITS

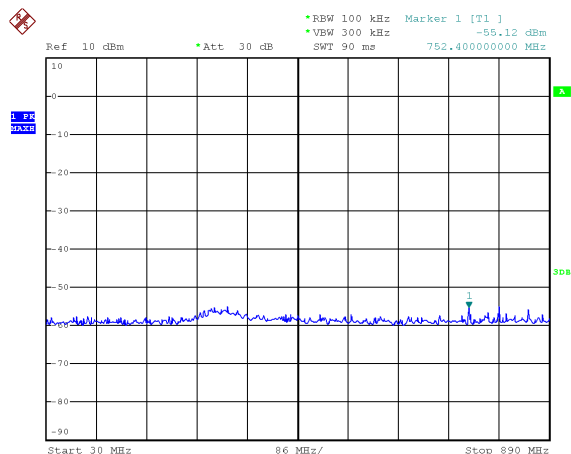
-20 dB below peak output power

TEST RESULT

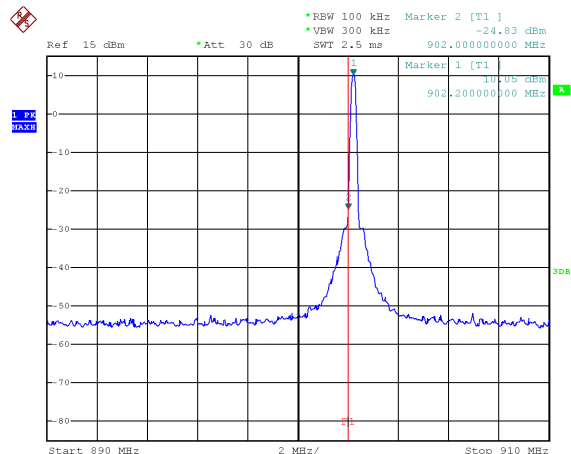
The EUT meets the requirements of sections 15.247 (d)
All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

MEASUREMENTS RESULTS - CONDUCTED (LOWER CHANNEL 902.20MHZ)

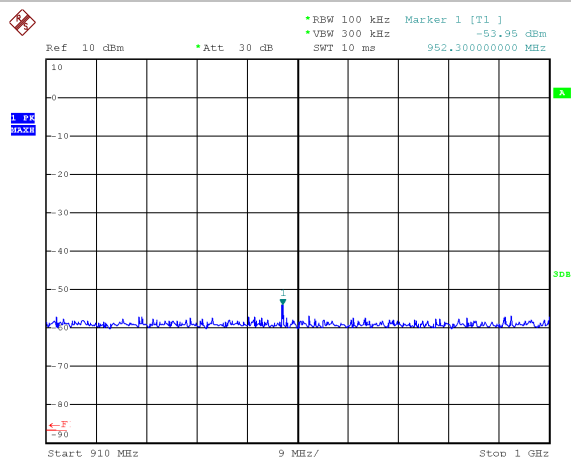
Plot 1 (30÷890MHz)



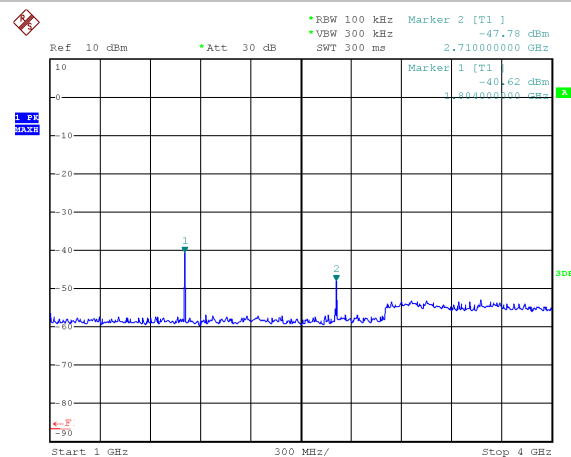
Plot 2 (890÷910MHz)



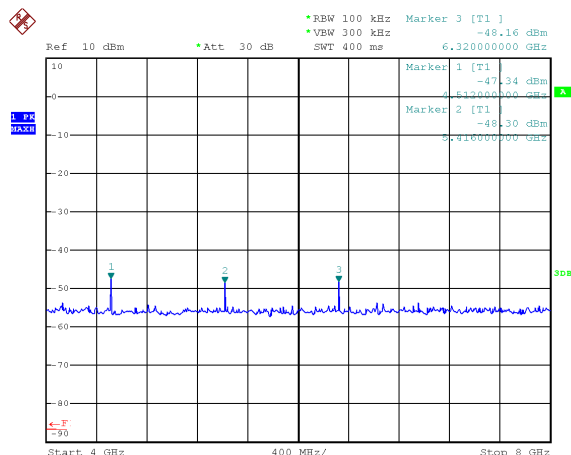
Plot 3 (910÷1000MHz)



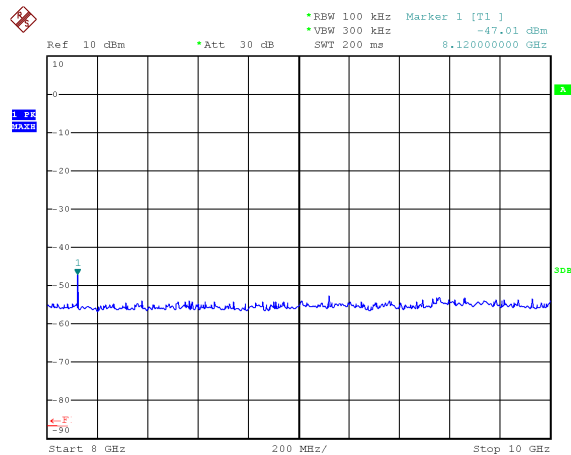
Plot 4 (1÷4GHz)



Plot 5 (4÷8GHz)



Plot 6 (8÷10GHz)





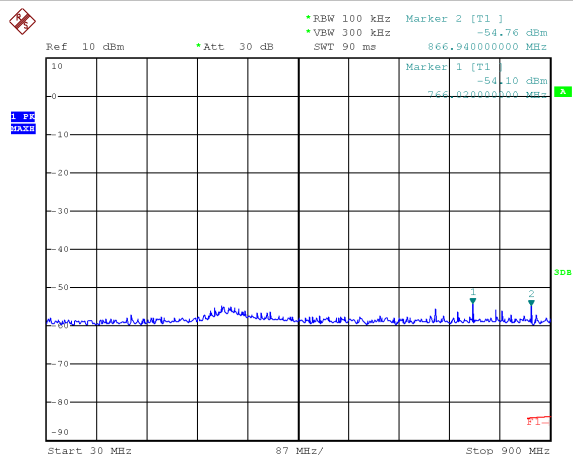
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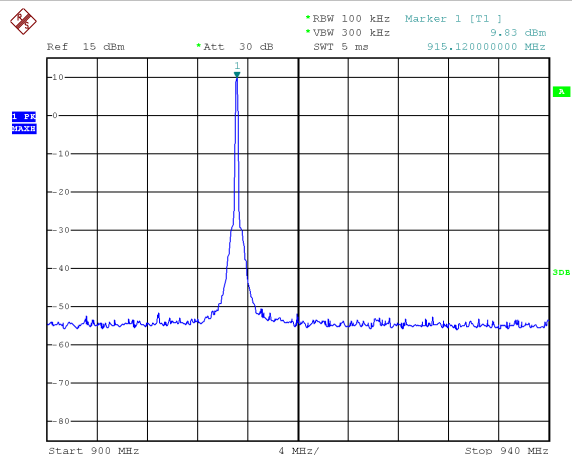
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(MIDDLE CHANNEL 915.12MHZ)

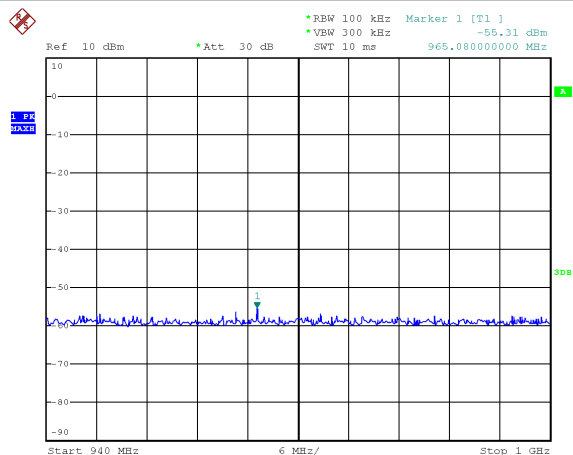
Plot 1 (30÷900MHz)



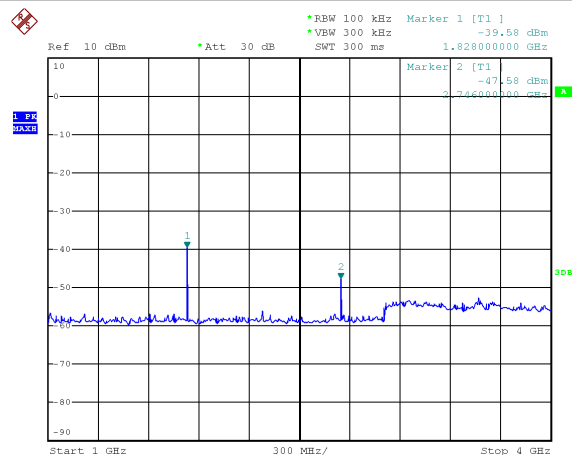
Plot 2 (900÷940MHz)



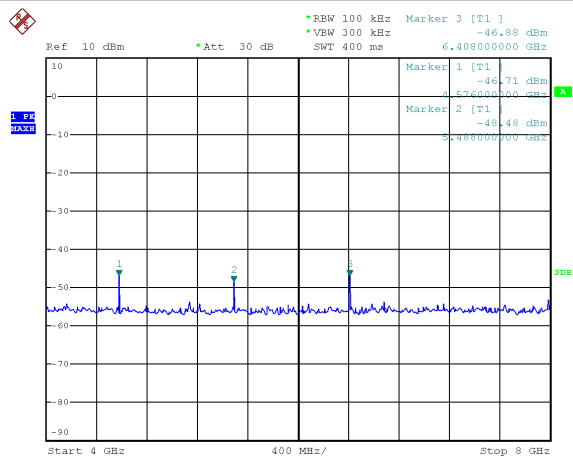
Plot 3 (940÷1000MHz)



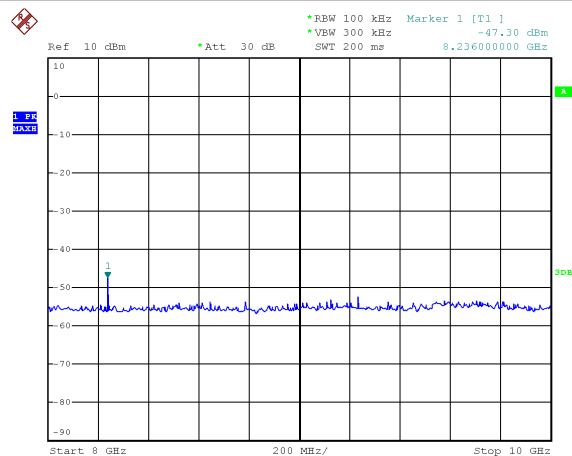
Plot 4 (1÷4GHz)



Plot 5 (4÷8GHz)

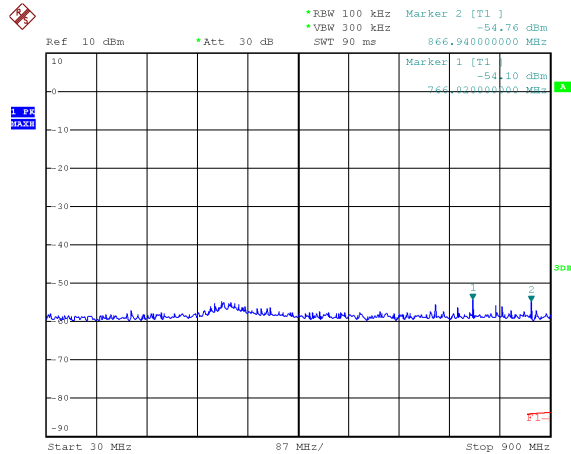


Plot 6 (8÷10GHz)

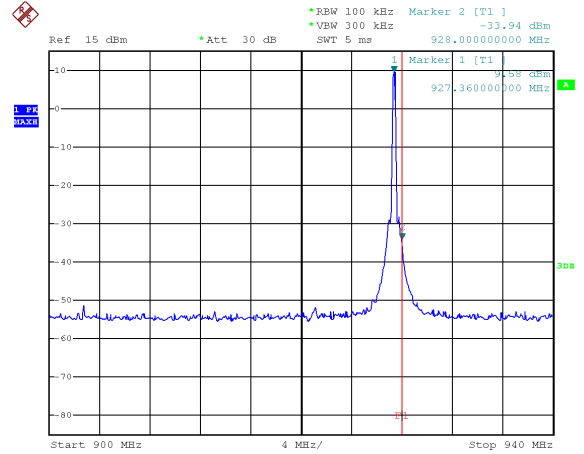


(HIGHER CHANNEL 927.36MHZ)

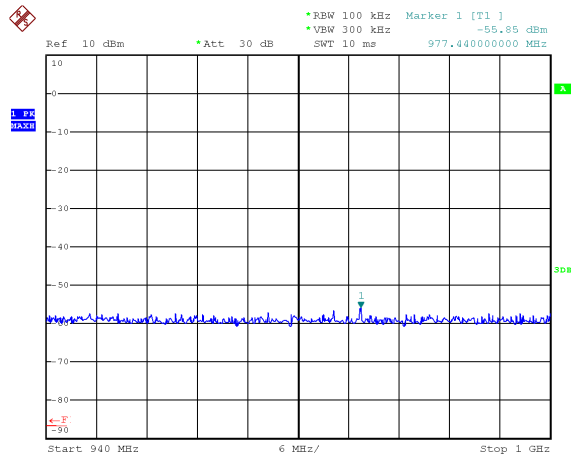
Plot 1 (30÷900MHz)



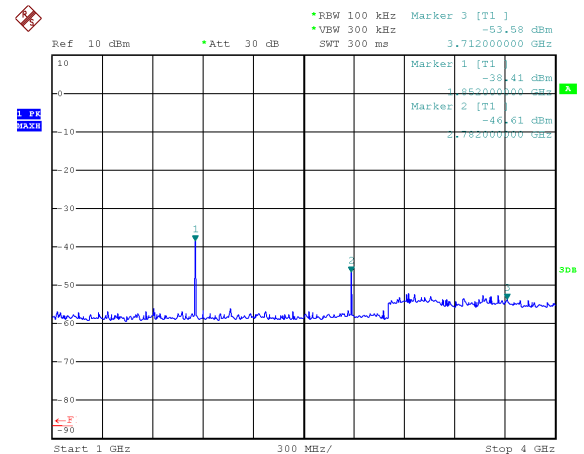
Plot 2 (900÷940MHz)



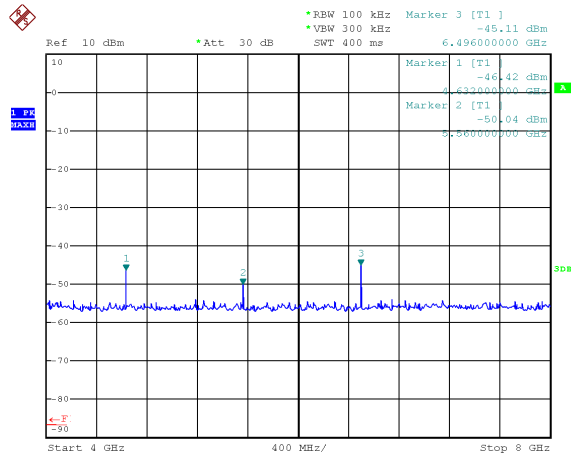
Plot 3 (940÷1000MHz)



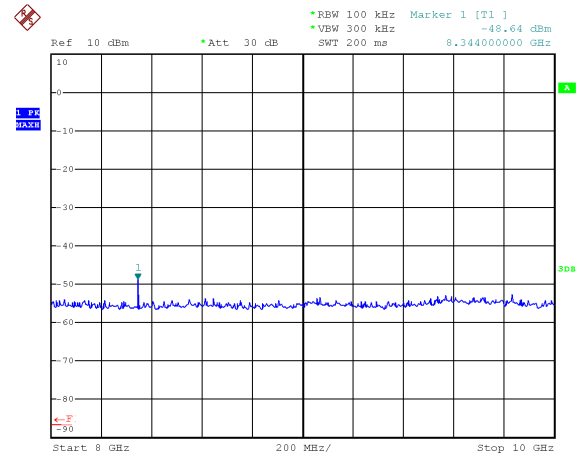
Plot 4 (1÷4GHz)



Plot 5 (4÷8GHz)



Plot 6 (8÷10GHz)



7.5 -20dB BANDWIDTH

TEST REQUIREMENT

Spectrum analyzer settings

Span	Wide enough to capture the peak level of the emission
Resolution bandwidth (RBW)	3 kHz
Video bandwidth (VBW)	10 kHz
Sweep time (SWT)	AUTO
Detector function	Peak
Trace	max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#1
Remark	None

TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. After trace stabilisation, the 2 marker shall be sets -20dB respect to the signal peak. The delta level between 2 marker is the -20dB bandwidth.

LIMITS

None; for reporting purpose only

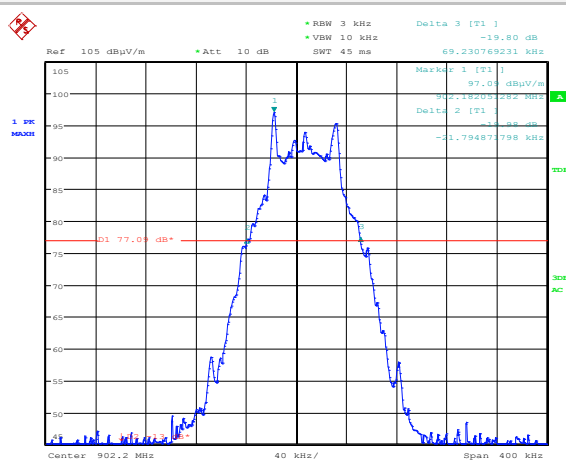
TEST RESULT

The EUT meets the requirements of sections 15.247 (a)

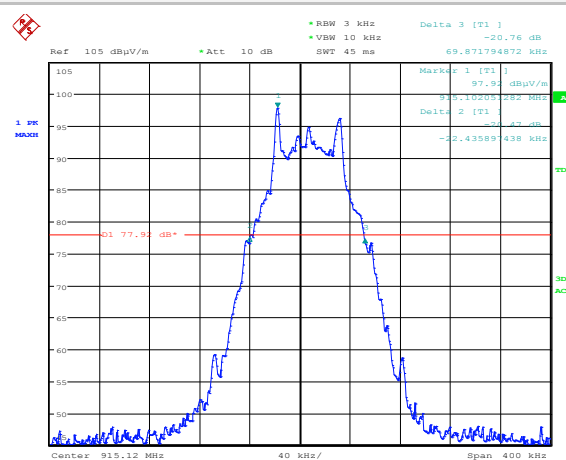
MEASUREMENTS RESULTS

Channel (No.)	Frequency (MHz)	Channel Bandwidth at -20dB (kHz)	Plot (No.)
Low	902.20	91.02	1
Middle	915.12	92.30	2
High	927.36	89.74	3

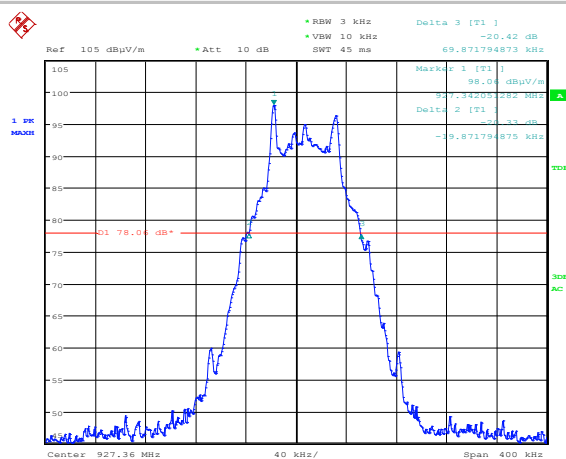
Plot 1



Plot 2



Plot 3





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7.6 CARRIER FREQUENCY SEPARATION

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	Wide enough to capture the peaks of two adjacent channels
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	AUTO
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#2 (Hopping mode)
Remark	None

TEST PROCEDURE
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. Resolution bandwidth setting at 100kHz and the Video Bandwidth at 300kHz. Once the trace is stabilized, by the marker-delta function the separation between the peaks of the adjacent channels was determined.

LIMITS
≥ 25 kHz

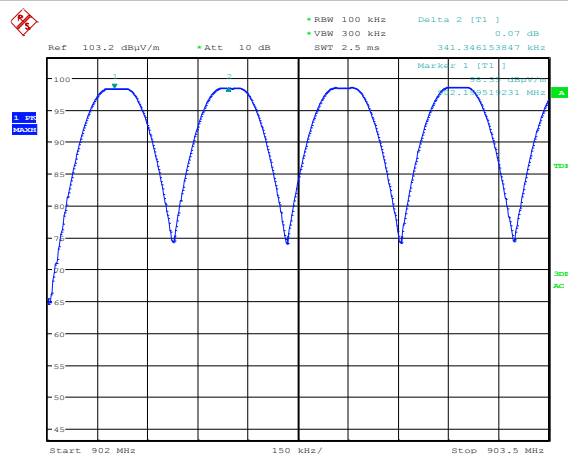
TEST RESULT
The EUT meets the requirements of section 15.247 (a) (1)

MEASUREMENTS RESULTS

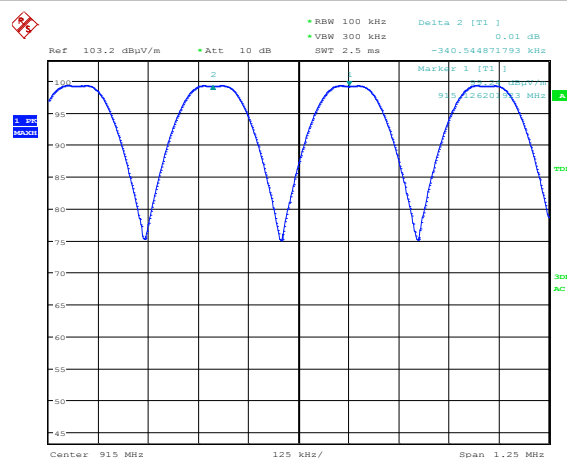
HOPPING MODE

Channel (No.)	Frequency (MHz)	Channel frequency separation (kHz)	Plot (No.)
Low	902.20	341.34	1
Middle	915.12	340.54	2
High	927.36	340.54	3

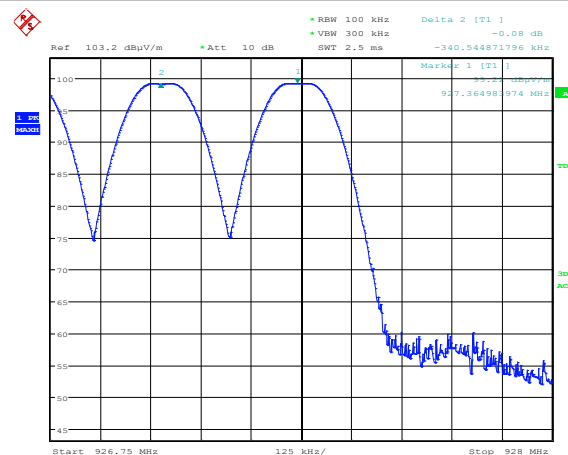
Plot 1



Plot 2



Plot 3



7.7 NUMBER OF HOPPING FREQUENCIES

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	Wide enough to capture the peaks of all channels
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	AUTO
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#2 (Hopping mode)
Remark	None

TEST PROCEDURE
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. Resolution bandwidth setting at 100kHz and the Video Bandwidth at 300kHz. Once the trace is stabilized, by the marker-delta function the separation between the first peak and the last peak. The spectrum was broken in two plots to show all the hopping channels.

LIMITS
At least 15 hopping channels

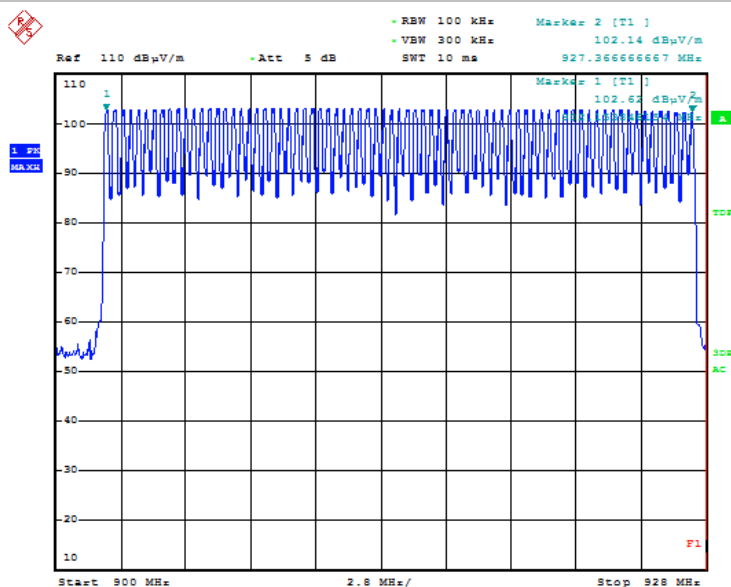
TEST RESULT
The EUT meets the requirements of section 15.247 (a) (1) (iii)

MEASUREMENTS RESULTS

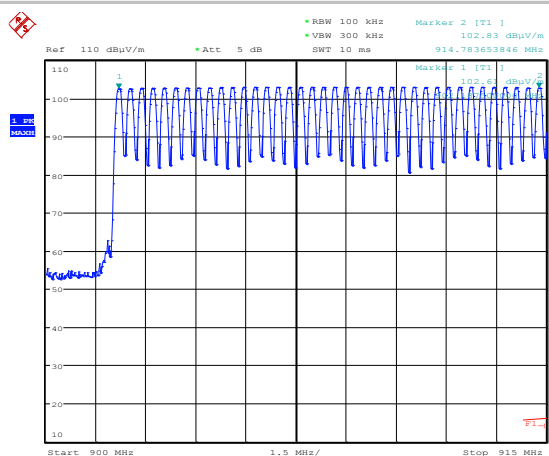
HOPPING MODE

Channel (No.)	Frequency (MHz)	N° of Hopping Channel	Plot (No.)
All channels	902.20÷927.36	75	1
Low to Middle	902.20÷914.78	38	2
Middle to High	915.12÷927.36	37	3

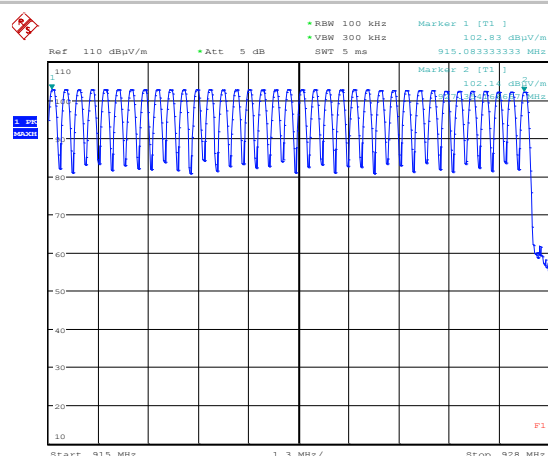
Plot 1



Plot 2



Plot 3





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7.8 TIME OCCUPANCY (DWEELL TIME)

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	Zero span, centred on a hopping channel
Resolution bandwidth (RBW)	100 kHz / 1MHz
Video bandwidth (VBW)	300 kHz / 10Hz
Sweep time (SWT)	AUTO (single packet) / 40s. (for dwell time)
Detector function	Peak
Trace	Max hold
Attenuator	/
Deviation to test procedure	None
EUT operating condition	#2 (Hopping mode)
Remark	None

TEST PROCEDURE
The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector. Resolution bandwidth setting at 100kHz and the Video Bandwidth at 300kHz. The average time of occupancy is obtained by measuring first the dwell time of a single packet with the delta marker function, using a zero span centered on a hopping channel and then counting time between the next hop.

LIMITS
The average time of occupancy on any channel shall not be greater than 0.4s within a period of 20s.

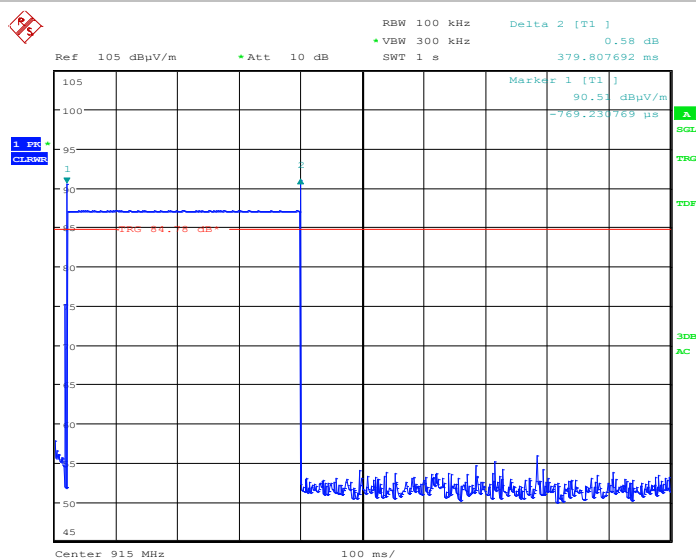
TEST RESULT
The EUT meets the requirements of section 15.247 (a) (1) (iii)

MEASUREMENTS RESULTS

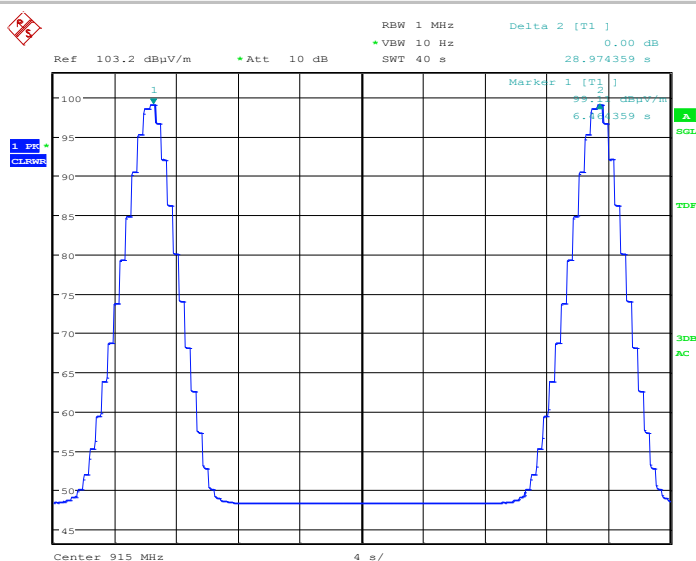
HOPPING MODE

Channel (No.)	Single packet duration (ms)	Time between next hop (s)	Limit of single packet (ms)	Limit of Average time of occupancy (s)	Plot (No.)
Middle channel	379.80	29	400	20	1÷2

Plot 1 (single packet duration)



Plot 2 (Time between 2 transmissions)





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7.9 MAXIMUM PEAK OUTPUT POWER (DE FACTO EIRP)

TEST REQUIREMENT

Spectrum analyzer settings

Resolution bandwidth (RBW)	3 MHz
Video bandwidth (VBW)	10 MHz
Sweep time (SWT)	2,5 ms
Detector function	Peak
Trace	max hold
Test distance	/
EUT operating condition	#1
Remark	none

TEST PROCEDURE

Conducted measurements:

The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector type SMA.

Radiated measurements:

As the EUT is supplied with a dedicated antenna, the effective radiated power is measured in a 3 m anechoic chamber with the substitution antenna method.

The field strength levels shall be converted to equivalent conducted power levels for comparison to the applicable output power limit refer to KDB 412172.

LIMITS

1 Watt (30dBm)

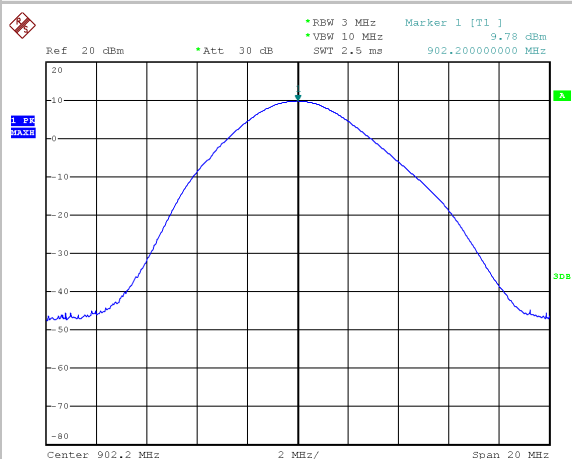
TEST RESULT

The EUT meets the requirements of sections 15.247 (b) (1)

MEASUREMENTS RESULTS (CONDUCTED)

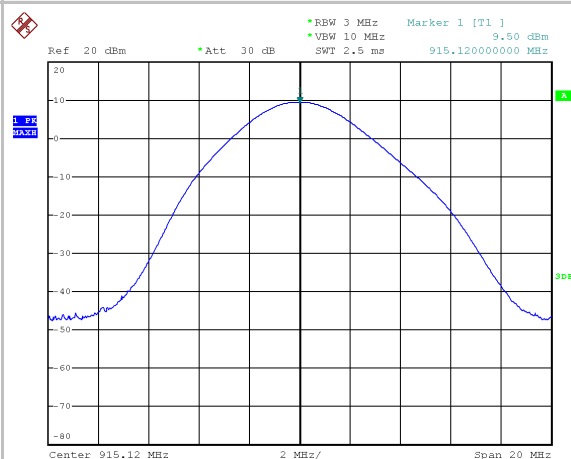
Channel (No.)	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Plot (No.)
Low	902.20	+9.78	+30	1
Middle	915.12	+9.50	+30	2
High	927.36	+9.26	+30	3

Plot 1



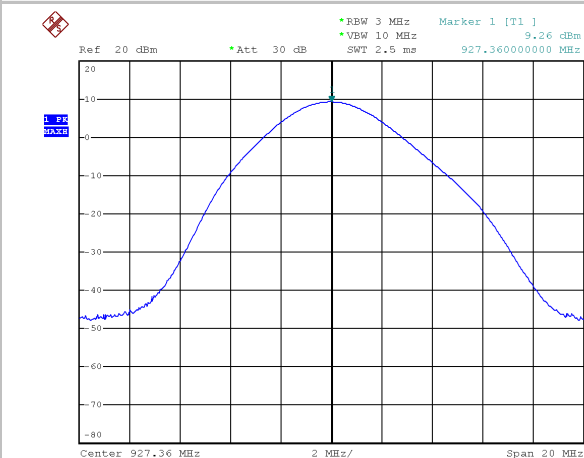
Date: 19.JUL.2016 10:55:43

Plot 2



Date: 19.JUL.2016 10:58:51

Plot 3





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MEASUREMENTS RESULTS (RADIATED)

Channel (No.)	Frequency (MHz)	Radiated Output Power (at 3m. distance) (QP) (dBμV/m)	Calculated E.I.R.P (dBm)	Limit (dBm)
Low	902.20	102.03	6.80	+30
Middle	912.15	102.70	7.47	+30
High	927.36	101.80	6.57	+30

7.10 RF EXPOSURE EVALUATION

TEST REQUIREMENT

Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines § 1.1307(b)(1).

EUT classification (fixed, mobile or portable devices)

Portable according to § 2.1093(b) of this Chapter

LIMITS

According to § 2.1093 of this Chapter, by means of the following guidelines: OET Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies (447498 D01 General RF Exposure Guidance v06)

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

447498 D01 General RF Exposure Guidance v06 – Appendix A

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	SAR Test Exclusion Threshold (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

The test separation distances ≥ 5 mm is applied to determine SAR test exclusion.

SAR Test Exclusion Thresholds for 100 MHz – 6 GHz and ≤ 50 mm

447498 D01 General RF Exposure Guidance v06 – Appendix A

Channel No.	Frequency (MHz)	Conducted Output Power	E.I.R.P.	Distance	$\frac{\text{max. power (mW)}}{\text{min.distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
		(dBm)	(mW)	(mm)		
Lowest	902.20	9.78	9.50	5	1.80	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

Channel No.	Frequency (MHz)	Conducted Output Power	E.I.R.P.	Distance	$\frac{\text{max. power (mW)}}{\text{min.distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
		(dBm)	(mW)	(mm)		
Middle	915.12	9.50	8.91	5	1.70	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

Channel No.	Frequency (MHz)	Conducted Output Power	E.I.R.P.	Distance	$\frac{\text{max. power (mW)}}{\text{min.distance (mm)}} \times \sqrt{f(\text{GHz})}$	Limits
		(dBm)	(mW)	(mm)		
Highest	927.36	9.26	8.43	5	1.62	≤ 3.0 for 1-g head SAR or ≤ 7.5 for 10-g extremity SAR

TEST RESULT

This value is less than the low threshold limit. No SAR test is required.

8. MEASUREMENTS AND TESTS UNCERTAINTY

Unless otherwise stated the uncertainties for the tests and measurements are evaluated in according to IMQ Operational Instruction IO-LAB-001 and IO-LAB-004. and requirement of NIST Technical Note 1297 and NIS 81: 1994 "The Treatment of Uncertainty in EMC Measurements"

The expanded uncertainty was calculated for all measurements and tests listed in this test report according to CISPR 16-4-2 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4-2: Uncertainty in EMC Measurements", with UKAS document LAB 34 and is documented in the quality system accordance to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation.

Internal Procedure PI-037 ensures that the requirements for traceability of calibrations, of all test equipment requiring calibration, and calibration intervals are met.

Methods/Standard	Parameter	Expanded Uncertainty	Unit	Confidence level	Coverage Factor	Degree of freedom
Continuous disturbance	QP detector 9 – 150 kHz	2,47	dB	95%	2,00	25
	QP detector 150 k – 30 MHz	2,61	dB	95%	2,00	26
	QP detector using Voltage Probe	2,45	dB	95%	2,00	26
	QP detector using ISN	3,15	dB	95%	2,00	> 60
	QP detector using Current Probe	2,15	dB	95%	2,00	35
Radiated disturbance	QP detector (30 MHz - 100 MHz) H polarization	4,33	dB	95%	2,00	> 60
	QP detector (30 MHz - 100 MHz) V polarization	4,22	dB	95%	2,00	> 60
	QP detector (100 MHz - 200 MHz) H polarization	3,40	dB	95%	2,00	> 60
	QP detector (100 MHz - 200 MHz) V polarization	4,76	dB	95%	2,00	> 60
	QP detector (200 MHz - 1000 MHz) H polarization	3,91	dB	95%	2,00	> 60
	QP detector (200 MHz - 1000 MHz) V polarization	3,82	dB	95%	2,00	> 60
	P detector 1-6 GHz	4,77	dB	95%	2,00	> 60
	P detector 6 – 18 GHz	5,14	dB	95%	2,00	> 60

9. LIST OF MEASURING EQUIPMENT AND CALIBRATION INFORMATION

IMQ Serial Number	Instrument	Manufacturer	Type	Last Cal.	Cal. Period.	Calibration Company
P01709	Shielded semi-anechoic chamber	SIDT	/	03-15	24	IMQ
P02486	Turntable controller unit	FRANKONIA	FCTAM01	/	/	/
P02488	Mast antenna	FRANKONIA	FAM4	/	/	/
S05563	EMI Receiver	ROHDE & SCHWARZ	ESCI 7	01-16	12	Rohde & Schwarz
S03631	LISN 1 PHASE	ROHDE & SCHWARZ	ENV216	03-16	12	I.N.R.I.M.
S02508	Loop Antenna	ROHDE & SCHWARZ	HFH2-Z2	01-15	24	SEIBERSDORF
S06463	Log antenna	ARA	VULB9160	04-16	36	SEIBERSDORF
S04272	Horn antenna	SCHWARZBECK	BBHA 9120D	07-14	36	NPL
S03629	Spectrum Analyzer	Rohde & Schwarz	FSP40	04-16	12	Rohde & Schwarz
S03542	Preamplifier	Hewlett Packard	HP 8449B	04-16	24	IMQ
W-00199/E	Software	ROHDE & SCHWARZ	EMC32 Ver. 6.30	/	/	/
H-00165	PC	/	/	/	/	/

END OF TEST REPORT