TELECOMMUNICATIONS & TELEMATICS FOR TRANSPORTS LABORATORY

IMQ CSQ

Telecommunications & Telematics for Transports Lab.

TEST REPORT

Ref. No. ARSL00124

Date: 2011-10-06

Measurements performed in accordance with:

FCC Rules : Code of Federal Regulations (CFR) no. 47

PART 15 – RADIO FREQUENCY DEVICES

PRODUCT	:	ZigBee module general purpose
TESTED MODEL	:	SPZB32W1A1.1 SPZB32W1C1.1
FCC ID	:	S9NZB32C1
APPLICANT	:	STMicroelectronics – Via C. Olivetti, 2 – I-20041 Agrate Brianza (MI)
MANUFACTURER	:	STMicroelectronics – Via C. Olivetti, 2 – I-20041 Agrate Brianza (MI)
TRADEMARK	:	STMicroelectronics
OTHER INFORMATION	Testing dates :	2011-05-10 ÷ 2011-06-01 & 2011-10-03 IMQ BEM: 59335
	Tested samples No. :	2
	Testing Laboratory :	IMQ S.p.A. Via Quintiliano, 43 I-20138 MILANO

Tested by :	R. Radice	Signature:	Roberto Radice	Date :	2011-10-06
Checked by:	M. De Angelis	Signature:	Mario De Angelis	Date :	2011-10-06

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2011-06-20	Test Results and Evaluation Report
Rev.1	2011-10-06	Measurements and Tests Data

CONTENTS

1 General Description of Equipment under Test 1-3
1.1 APPLICANT 1-3
1.2 MANUFACTURER 1-3
1.3 EQUIPMENT CLASSIFICATION 1-3
1.4 BASIC DESCRIPTION OF EQUIPMENT UNDER TEST 1-4
1.5 FEATURE OF EQUIPMENT UNDER TEST 1-5

2 Test Configuration of Equipment under Test 2-7
2.1 ENVIRONMENTAL CONDITIONS 2-7
2.2 DESCRIPTION OF SUPPORT EQUIPMENT 2-7
2.3 INTERFACE IDENTIFICATION AND CONNECTION DIAGRAM OF TEST SYSTEM 2-8

3 Operation of Equipment under Test 3-9
3.1 OPERATING TEST CONDITIONS 3-9

4 Tests Identification and Results 4-10
4.1 METHODS OF MEASUREMENT 4-12
4.2 FREQUENCY RANGE INVESTIGATED 4-12

5 Measurements and Tests Data 5-13

6 Additional Technical Information 6-67
6.1 ELECTROMAGNETICALLY RELEVANT COMPONENTS: 6-67
6.2 RFI SUPPRESSION DEVICES: 6-67
6.3 EMI PROTECTION DEVICES: 6-67

7 Technical Documentation 7-68

8 Photographic Documentation 8-69
8.1 EUT IDENTIFICATION 8-69
8.2 TEST SET-UP 8-74

9 Measurement and Test Equipment Instrumentation 9-77

1 GENERAL DESCRIPTION OF EQUIPMENT UNDER TEST

1.1 APPLICANT

NAME	STMicroelectronics
ADDRESS	Via C. Olivetti, 2 – I-20041 Agrate Brianza (MI)
COUNTRY	ITALY

1.2 MANUFACTURER

NAME	STMicroelectronics
ADDRESS	Via C. Olivetti, 2 – I-20041 Agrate Brianza (MI)
COUNTRY	ITALY

1.3 EQUIPMENT CLASSIFICATION

According to the definition 15.3 (o) EUT is a **Intentional Radiator operating within the bands 2400-2483,5 MHz** so it shall fulfil provisions of 47CFR Part 15 Subpart C – Intentional radiators – and Section 15.247.

1.4 BASIC DESCRIPTION OF EQUIPMENT UNDER TEST

Parameters	Value
Type of equipment :	ZigBee module general purpose
Model:	SPZB32W1A1.1 SPZB32W1C1.1
FCC ID. :	S9NZB32C1
Trade Name:	STMicroelectronics
Data cable :	/
Telecom cable :	/
Power supply type :	DC 3.3V
AC power input cable :	/
DC power input cable :	/

Model	Description
SPZB32W1C1.1	Provided with external ANTENOVA Antenna connected with RF reverse SMA connector
SPZB32W1A1.1	Provided with integrated RAINSUN Antenna
Remark: Between the two models no changes to the basic frequency determining and stabilizing circuitry (including clock and data rates), frequency multiplication stages, basic modulator circuit or maximum conducted output power. No simultaneous transmission is possible.	

1.5 FEATURE OF EQUIPMENT UNDER TEST

Power specification	+3.3 V dc
Operating frequency:	2405 ÷ 2480 MHz (16 Channels)
Maximum RF output power:	19,98 dBm
Modulation:	O-QPSK
Channel Spacing:	>1 MHz
Antenna:	Dedicated antenna (1 dBi gain) Rainsun p.n. AN0835 Dedicated antenna (2,2 dBi gain) Antenova mod. Titanic 2.4GHz Part No. 2010B6090-01
RX sensitivity:	-99 dBm
Main SW identification	/
Main HW Board identification	/
Peripherals included (for system application)	None
Interfaces :	None
Integrated interfaces :	None
AC adapter:	None

CHANNEL CONFIGURATION

Channel (No.)	Frequency (MHz)
11	2405.00
12	2410.00
13	2415.00
14	2420.00
15	2425.00
16	2430.00
17	2435.00
18	2440.00
19	2445.00
20	2450.00
21	2455.00
22	2460.00
23	2465.00
24	2470.00
25	2475.00
26	2480.00

2 TEST CONFIGURATION OF EQUIPMENT UNDER TEST

2.1 ENVIRONMENTAL CONDITIONS

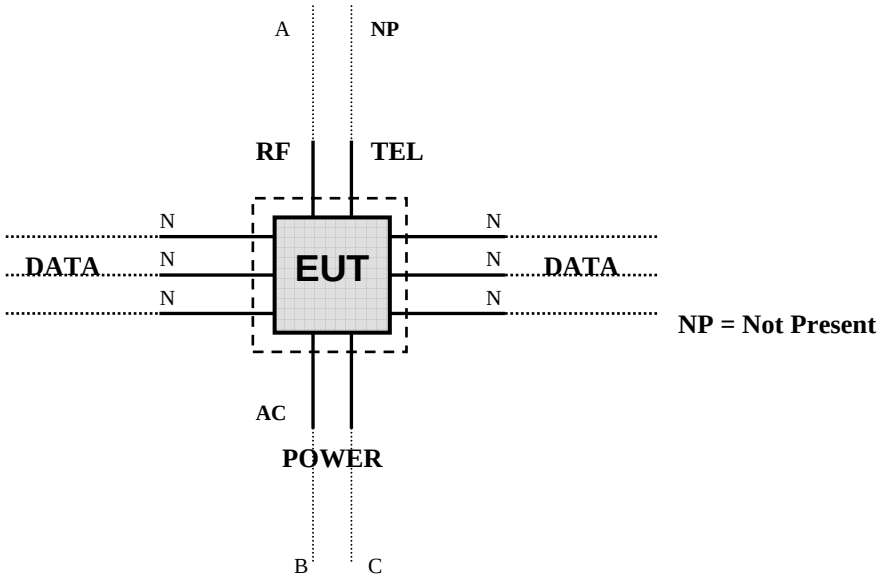
TEST CONDITIONS	MEASURED
Ambient Temperature	20 ÷ 25 °C
Relative Humidity	50 ÷ 60 %
Atmospheric Pressure	900 ÷ 1000 mbar

2.2 DESCRIPTION OF SUPPORT EQUIPMENT

Here following the details concerning equipment needed for correct operation or loading of the EUT:

EQUIPMENT	MANUFACTURER	MODEL
Personal Computer	IBM	----------
Test Jig (Dongle unit) not in testing	STMicroelectronics	----------

2.3 INTERFACE IDENTIFICATION AND CONNECTION DIAGRAM OF TEST SYSTEM



#	Interface	Description	Maximum length	Ref. Document
1	Enclosure	Open frame board	/	/
2	AC mains power input/output port	Port not present	/	/
3	DC power port	+5V dc via USB Port furnished on dongle unit board (not in testing); ZigBee module: +3.3 V dc	/	/
4	Signal / control port	Port not present	/	/
5	Antenna port (RF)	Dedicated SMD antenna integrated on ZigBee module & external dedicated Antenna	/	antenna description

3 OPERATION OF EQUIPMENT UNDER TEST

3.1 OPERATING TEST CONDITIONS

Ref.	Description
#1	Continuous transmission with Boost mode activated (single channel transmission)
MEASUREMENT SOFTWARE SETTING	
Software type	Ember inSight Development System
Firmware type	Ember Node Test Application v1.0
Channel setting	Calchan ob: Channel 11 (2405 MHz) Calchan 14: Channel 20 (2450 MHz) Calchan 1a: Channel 26 (2480 MHz)
Txpowermode	0 1 ⇒ default setting at +3dBm at input of RF Amplifier (Max Level)
Set Tx power	Setting at **-3dBm** (max. level setting during all tests; level at which all spurious emission measured are under limit)
Txtone	Command for carrier frequency only
Tx	Command for standard ZigBee transmission
End Test	Command for stop transmission

4 TESTS IDENTIFICATION AND RESULTS

TABLE 1 : SUMMARY OF TESTS

CFR47 Part 15 Section	Title	Operating condition	Result	Test No.
15.203 **15.247 (b)(4)(i)**	**Antenna Requirements**	/	PASS	1
15.207 (a)	**Conducted Emission**	#1	PASS	2
15.209 (a) (f)	**Radiated Emission**	#1	PASS	3
15.247 (a)	Frequency Hopping Spread Spectrum Specifications			
15.247(a)(1)(iii)	Number of Hopping Channels Used	Not applicable		
15.247(a)	20 dB Bandwidth	Not applicable		
15.247(a)(1)	Carrier frequency (Hopping Channel) Separation	Not applicable		
15.247(a)(1)(iii)	Time occupancy (Dwell Time) of Each Channel (ch) within a 0,4 x N_{ch} (sec) Period	Not applicable		
15.247(a)(2)	**6dB Minimum Bandwidth**	#1	PASS	4
15.247(b)	**Maximum Peak Output Power**			
15.247(b) (1)	**Peak Output Power (Conducted)**	#1	PASS	5
15.247(b) (3)	**RF power output, radiated (EIRP)**	#1	PASS	5
15.247(b) (4)	Antenna gain	Not applicable		
15.247(c)	Operation with directional antenna gains greater than 6 dBi	Not applicable		

CFR47 Part 15 Section	Title	Operating condition	Result	Test No.
15.247 (d)	**100 kHz Bandwidth of Frequency Band Edges**	#1	PASS	6
15.247 (d)	**Spurious Emission in restricted band near 2400-2483.5 MHz**	#1	PASS	7
15.247 (d)	**Conducted Emission**	#1	PASS	8
15.247 (e)	**Power Spectral Density**	#1	PASS	9
15.247 (f)	Hybrid systems	Not applicable		
15.247 (g)	FHSS Transmission characteristics	Not applicable		
15.247 (h)	Recognition of occupied channel and multiple transmission system	Not applicable		
15.247(i) (§ 47CFR 1.1307(b)(1))	**RF humane exposure**	#1	PASS	10

4.1 METHODS OF MEASUREMENT

All compliance measurements have been carried out using the procedures described in the standard ANSI C63.4-2009, ANSI C63.10-2009 and Section 15.31 of CFR47 Part 15 – Subpart A (General).

Additional test requirements have been adopted according to the reference Section indicated in the Test Table

4.2 FREQUENCY RANGE INVESTIGATED

a. Conducted emission tests : from 150 kHz to 30 MHz.

b. Radiated emission tests : from 2 MHz to tenth harmonic of fundamental

5 MEASUREMENTS AND TESTS DATA

TEST No. 1	Title "Antenna Requirements"	47CFR Part 15 Ref. Section
		15.203 / 15.204
TEST REQUIREMENTS	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	2
Antenna type	Dedicated SMD antenna integrated on ZigBee MODULE External dedicated antenna fitted with a reverse SMA connector and a blade made of flexible material that can be rotated 360 degree
Maximum total gain	2,2 dBi
External power amplifiers	Not present

Antenna Description		
No.	**Manufacturer**	**Model Type**
1	ANTENOVA	Titanic 2.4GHz Part No. 2010B6090-01
2	RAINSUN	p.n. AN0835

Test Result:

The transmitter meets the requirements of section 15.203 and 15.204

TEST No. 2	Title "Conducted emission"	47CFR Part 15 Ref. Section
		15.207
TEST REQUIREMENTS	Test setup	ANSI C63.4
	Limits of mains terminal disturbance voltage	15.207 (a)
	Frequency range	150 kHz – 30 MHz
	IF bandwidth	9 kHz
	EMC class	B

TEST DATA	PORT UNDER TEST	OPERATING CONDITION	RESULT
	AC mains power input port	#1	Complies
	Note: In search of max noise (phase(s) and neutral) for both the models type SPZB32W1A1.1 and SPZB32W1C1.1		

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 10 kHz during the measurements.
6) The measurements with Quasi-Peak detector are performed only for frequencies for which the Peak values are ≥ (Q.P. limit - 6 dB).

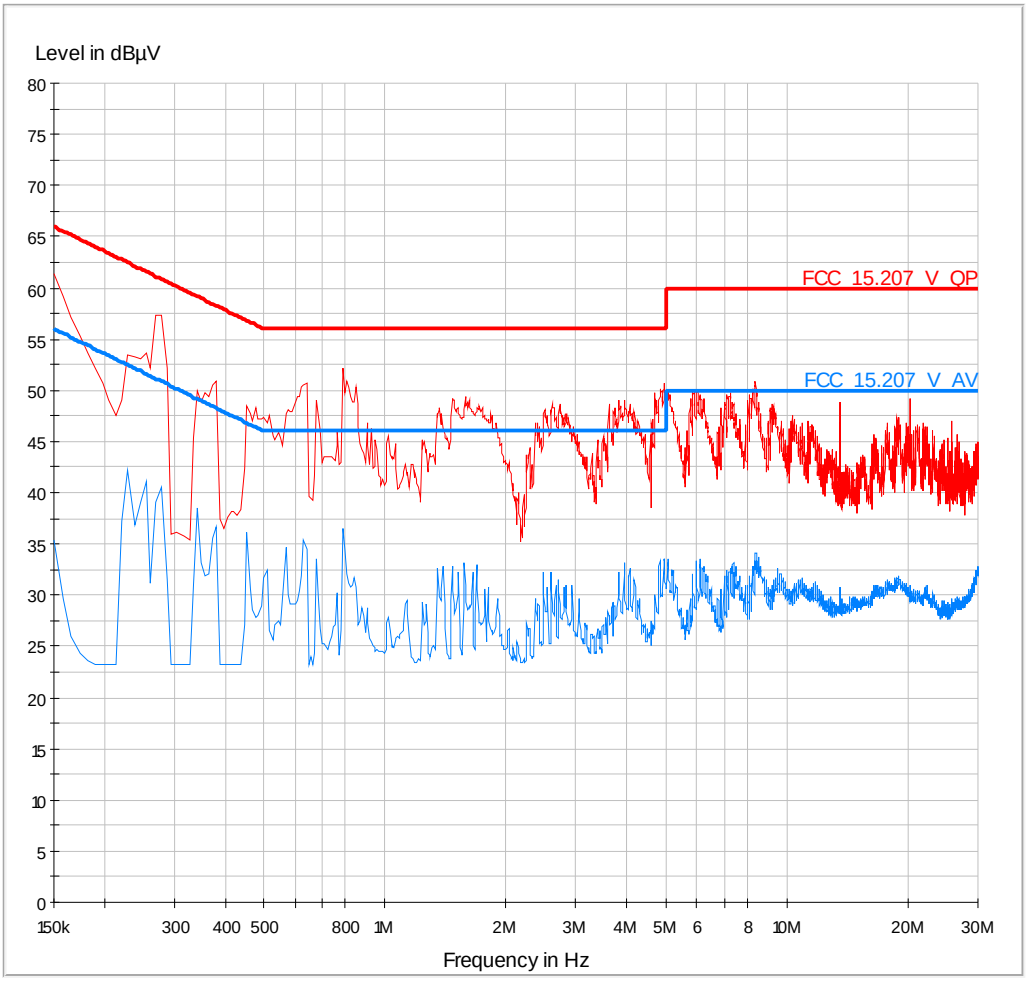
Test Result:

Within the specifications

MEASUREMENTS RESULTS

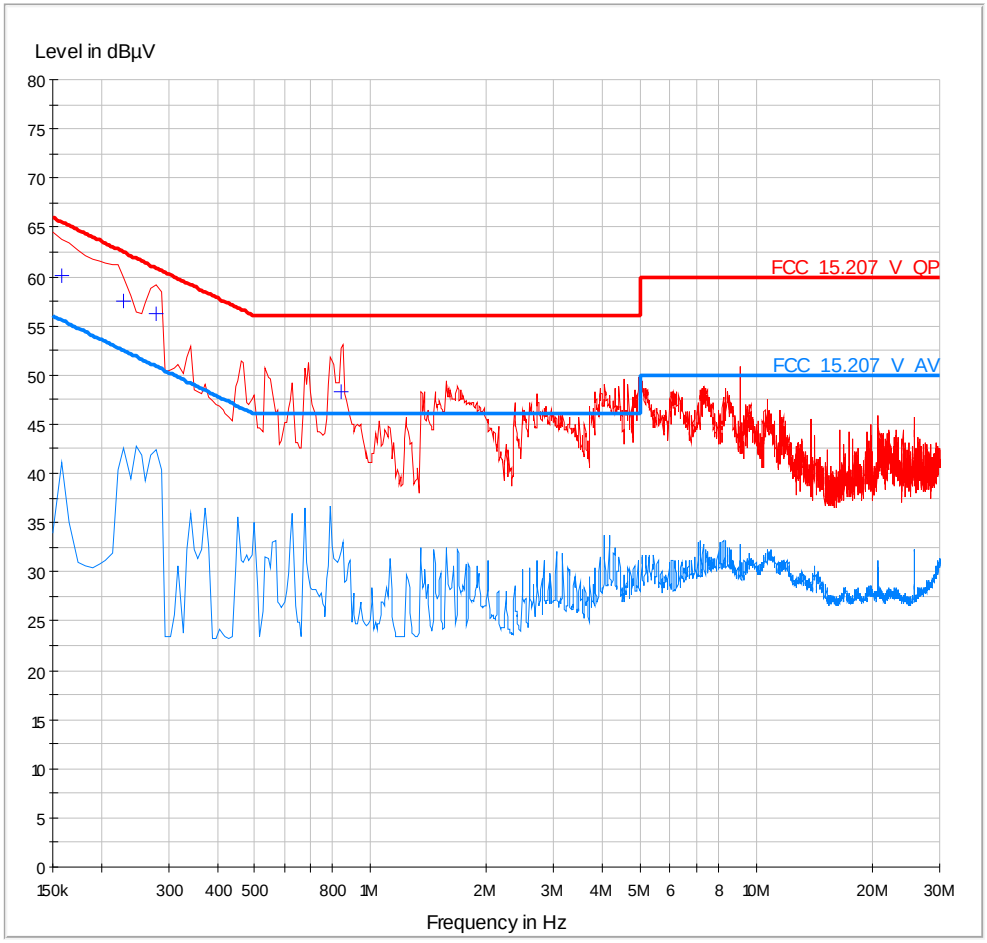
CONDUCTED DISTURBANCE ON AC MAINS POWER PORT OF PERSONAL COMPUTER AT WHICH ZIGBEE MODULE AND DEMO-BOARD IS CONNECTED

SPZB32W1C1.1 - MEASURE LINE: PHASE



CONDUCTED DISTURBANCE ON AC MAINS POWER PORT OF PERSONAL COMPUTER AT WHICH ZIGBEE MODULE AND DEMO-BOARD IS CONNECTED

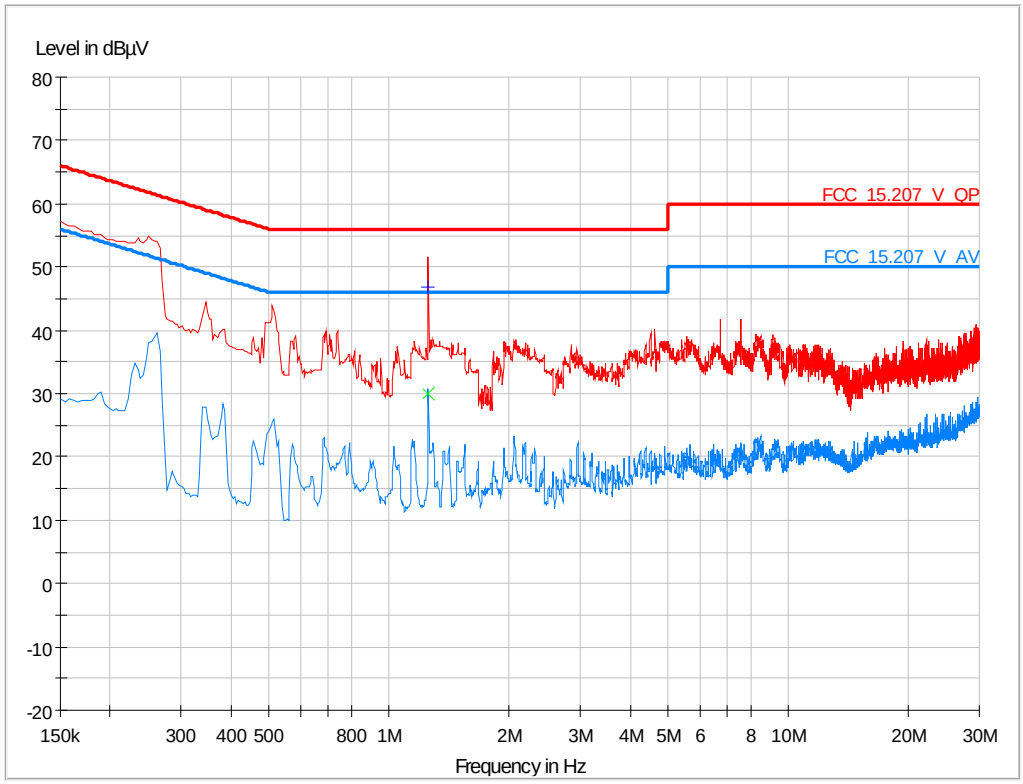
SPZB32W1C1.1 - MEASURE LINE: NEUTRAL



NOTE: (+) = Final measure with Quasi-Peak Detector

CONDUCTED DISTURBANCE ON AC MAINS POWER PORT OF PERSONAL COMPUTER AT WHICH ZIGBEE MODULE AND DEMO-BOARD IS CONNECTED

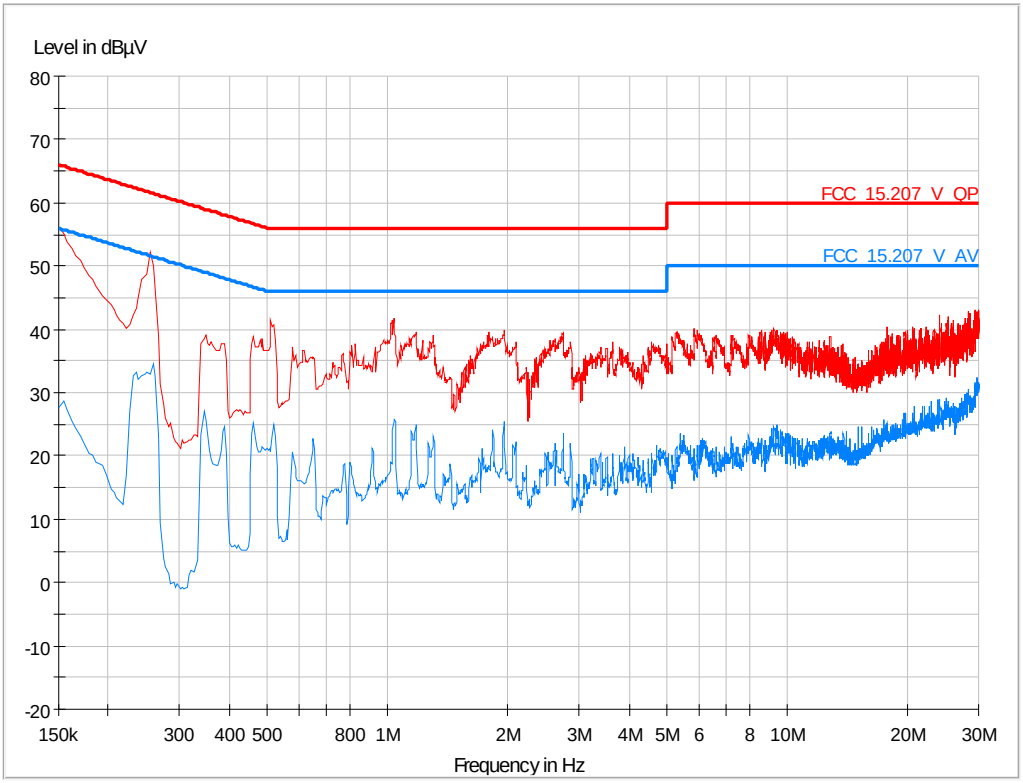
SPZB32W1A1.1 - MEASURE LINE: PHASE



NOTE: (+) = Final measure with Quasi-Peak Detector

CONDUCTED DISTURBANCE ON AC MAINS POWER PORT OF PERSONAL COMPUTER AT WHICH ZIGBEE MODULE AND DEMO-BOARD IS CONNECTED

SPZB32W1A1.1 - MEASURE LINE: NEUTRAL



TEST No. 3	Title "Radiated disturbances"	47CFR Part 15 Ref. Section
		15.209
TEST REQUIREMENTS	Test setup	ANSI C63.4
	Test facility	Anechoic chamber
	Test distance	3 m
	Limits for radiated disturbances	15.209 (a)
	Frequency range	2 MHz to tenth harmonic of fundamental
	IF bandwidth (below 30 MHz)	9 kHz
	IF bandwidth (below 1000 MHz)	120 kHz
	IF bandwidth (above 1000 MHz)	1 MHz
	EMC class	B
	(*) 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) = 40log (300meter / 3meter) = +80db Extrapolation (dB) = 40log (30meter / 3meter) = +40db	

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 ≥ (Q.P. limit - 6 dB).

LIMITS FOR SPURIOUS

Band of operations	Peak (dBµV/m)	Average Limit (dBµV/m)
Restricted bands (par. 15.205)	74,00	54,00
Other bands	According to 15.209 or fundamental –20dB (which is greater)	According to 15.209 or fundamental –20dB (which is greater)

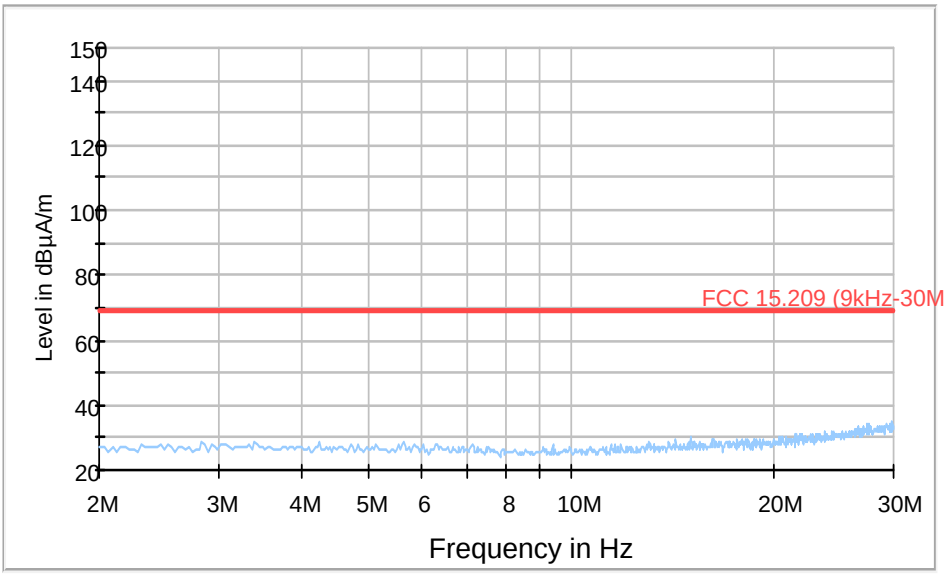
Tested samples

SAMPLE	
1)	Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2)	Model SPZB32W1A1.1 provided with RAINSUN Antenna

MEASUREMENTS RESULTS (2÷30 MHz)

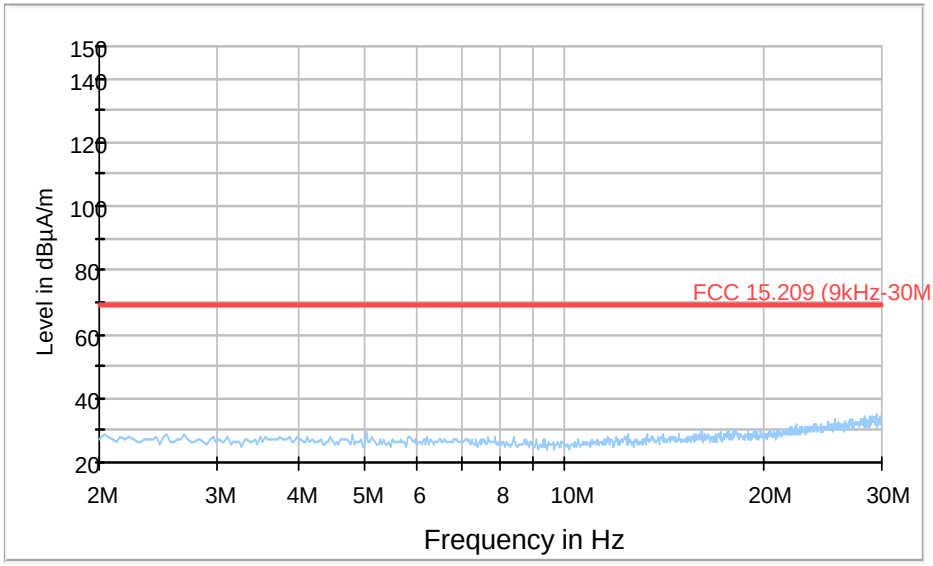
Model SPZB32W1A1.1

AUTOTEST 3m with Scans LOOP HFH2-Z2 ESMI 9kHz 30MHz (ris in dBuVm



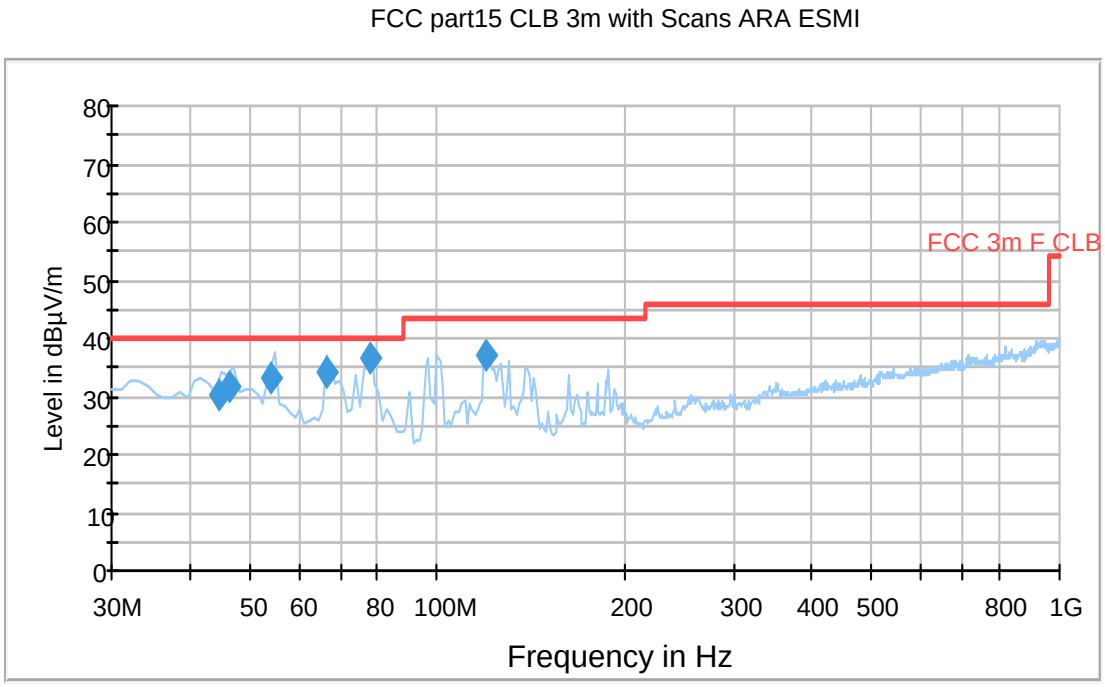
Model SPZB32W1C1.1

AUTOTEST 3m with Scans LOOP HFH2-Z2 ESMI 9kHz 30MHz (ris in dBuVm



MEASUREMENTS RESULTS (30÷1000 MHz)

Model SPZB32W1A1.1

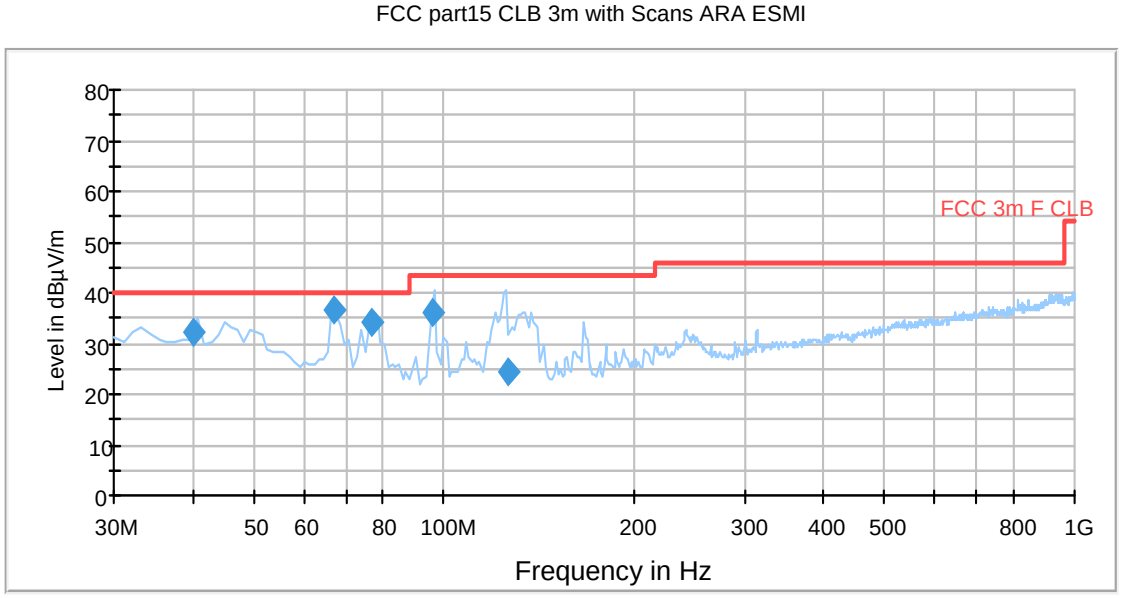


FINAL TEST (QUASI-PEAK DETECTOR)

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Correcting reading	Limit	Turntable position	Antenna height	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	(dBµV/m)	(°)	(cm)	(dB)
44,58	13,1	15,5	1,6	30,2	40,00	90	100	9,8
46,39	15,3	15,1	1,5	31,9	40,00	90	100	8,1
53,93	18,3	13,2	1,5	33,0	40,00	197	100	7,0
66,74	22,6	10,1	1,5	34,2	40,00	175	100	5,8
77,95	27,3	7,6	1,6	36,5	40,00	45	100	3,5
119,95	24,6	10,7	1,6	36,9	43,50	42	100	6,5

MEASUREMENTS RESULTS (30÷1000 MHz)

Model SPZB32W1C1.1



FINAL TEST (QUASI-PEAK DETECTOR)

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Correcting reading	Limit	Turntable position	Antenna height	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	(dBµV/m)	(°)	(cm)	(dB)
40,17	13,8	16,6	1,6	32,0	40,00	90	105	8,0
66,79	25,2	10,1	1,5	36,8	40,00	0	100	3,2
77,07	24,8	7,8	1,6	34,2	40,00	45	182	5,8

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Correcting reading	Limit	Turntable position	Antenna height	Margin
(MHz)	(dBµV)	(dB3/m)	(dB)	(dBµV/m)	(dBµV/m)	(°)	(cm)	(dB)
96,02	24,7	9,9	1,5	36,1	43,50	90	249	7,4
126,82	12,5	10,5	1,6	24,6	43,50	45	311	18,9

MEASUREMENTS RESULTS (1000 MHz to 24800 MHz)

Module type SPZB32W1A1.1:

Channel n°11: 2405,00 MHz) (with Dedicated SMD ante nna RAINSUN)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	107,27	27,40	3,55	-33,00	105,22	---	---	---
4810	46,65	31,54	5,44	-32,80	50,83	5.000	74,00	23,17
7215	52,35	36,06	6,90	-32,76	62,55	5.000	74,00	11,45
9620	40,14	38,08	9,36	-32,15	55,43	5.000	74,00	18,57
12025	41,38	39,10	11,55	-31,66	60,37	5.000	74,00	13,63
f>12025	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	108,17	27,40	3,55	-33,00	106,12	---	---	---
4810	49,01	31,54	5,44	-32,80	53,19	5.000	74,00	20,81
7215	55,33	36,06	6,90	-32,76	65,53	5.000	74,00	8,47
9620	45,06	38,08	9,36	-32,15	60,35	5.000	74,00	13,65
12025	37,53	39,10	11,55	-31,66	56,52	5.000	74,00	17,48
f>12025	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	72,50	27,40	3,55	-33,00	70,45	---	---	---
4810	24,94	31,54	5,44	-32,80	29,12	500	54,00	24,88
7215	30,53	36,06	6,90	-32,76	40,73	500	54,00	13,27
9620	17,06	38,08	9,36	-32,15	32,35	500	54,00	21,65
12025	17,25	39,10	11,55	-31,66	36,24	500	54,00	17,76
f>12025	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	73,30	27,40	3,55	-33,00	71,25	---	---	---
4810	27,16	31,54	5,44	-32,80	31,34	500	54,00	22,66
7215	32,34	36,06	6,90	-32,76	42,54	500	54,00	11,46
9620	22,17	38,08	9,36	-32,15	37,46	500	54,00	16,54
12025	15,13	39,10	11,55	-31,66	34,12	500	54,00	19,88
f>12025	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

Channel n°20: 2450,00 MHz (with Dedicated SMD anten na RAINSUN)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	109,19	27,40	3,55	-33,00	107,14	---	---	---
4900	40,83	31,54	5,44	-32,80	45,01	5.000	74,00	28,99
7350	48,58	36,06	6,90	-32,76	58,78	5.000	74,00	15,22
9800	40,68	38,08	9,36	-32,15	55,97	5.000	74,00	18,03
12250	38,13	39,10	11,55	-31,66	57,12	5.000	74,00	16,88
F<12250	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	110,74	27,40	3,55	-33,00	108,69	---	---	---
4900	47,5	31,54	5,44	-32,80	51,68	5.000	74,00	22,32
7350	51,31	36,06	6,90	-32,76	61,51	5.000	74,00	12,49
9800	43,66	38,08	9,36	-32,15	58,95	5.000	74,00	15,05
12250	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
F<12250	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	73,37	27,40	3,55	-33,00	71,32	---	---	---
4900	19,94	31,54	5,44	-32,80	24,12	500	54,00	29,88
7350	26,53	36,06	6,90	-32,76	36,73	500	54,00	17,27
9800	16,81	38,08	9,36	-32,15	32,10	500	54,00	21,90
12250	15,25	39,10	11,55	-31,66	34,24	500	54,00	19,76
F<12250	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	74,25	27,40	3,55	-33,00	72,20	---	---	---
4900	23,16	31,54	5,44	-32,80	27,34	500	54,00	26,66
7350	29,34	36,06	6,90	-32,76	39,54	500	54,00	14,46
9800	23,17	38,08	9,36	-32,15	38,46	500	54,00	15,54
12250	13,13	39,10	11,55	-31,66	32,12	500	54,00	21,88
F<12250	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

Channel n°26: 2480,00 MHz (with Dedicated SMD anten na RAINSUN)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	108,76	27,40	3,55	-33,00	106,71	---	---	---
4960	44,31	31,54	5,44	-32,80	48,49	5.000	74,00	25,51
7440	43,44	36,06	6,90	-32,76	53,64	5.000	74,00	20,36
9920	39,71	38,08	9,36	-32,15	55,00	5.000	74,00	19,00
12400	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
F<12400	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	111,96	27,40	3,55	-33,00	109,91	---	---	---
4960	48,93	31,54	5,44	-32,80	53,11	5.000	74,00	20,89
7440	44,62	36,06	6,90	-32,76	54,82	5.000	74,00	19,18
9920	40,58	38,08	9,36	-32,15	55,87	5.000	74,00	18,13
12400	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
F<12400	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	73,11	27,40	3,55	-33,00	71,06	---	---	---
4960	23,27	31,54	5,44	-32,80	27,45	500	54,00	26,55
7440	22,82	36,06	6,90	-32,76	33,02	500	54,00	20,98
9920	16,06	38,08	9,36	-32,15	31,35	500	54,00	22,65
12400	13,38	39,10	11,55	-31,66	32,37	500	54,00	21,63
F<12400	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	75,62	27,40	3,55	-33,00	73,57	---	---	---
4960	24,40	31,54	5,44	-32,80	28,58	500	54,00	25,42
7440	23,28	36,06	6,90	-32,76	33,48	500	54,00	20,52
9920	17,18	38,08	9,36	-32,15	32,47	500	54,00	21,53
12400	13,28	39,10	11,55	-31,66	32,27	500	54,00	21,73
F<12400	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

MEASUREMENTS RESULTS (1000 MHz to 24800 MHz)

Module type SPZB32W1C1.1:

Channel n°11: 2405,00 MHz (with Dedicated antenna A NTENOVA)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	114,02	27,40	3,55	-33,00	111,97	---	---	---
4810	42,91	31,54	5,44	-32,80	47,09	5.000	74,00	26,91
7215	53,84	36,06	6,90	-32,76	64,04	5.000	74,00	9,96
9620	40,06	38,08	9,36	-32,15	55,35	5.000	74,00	18,65
12025	40,34	39,10	11,55	-31,66	59,33	5.000	74,00	14,67
f>12025	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	113,91	27,40	3,55	-33,00	111,86	---	---	---
4810	45,50	31,54	5,44	-32,80	49,68	5.000	74,00	24,32
7215	55,50	36,06	6,90	-32,76	65,70	5.000	74,00	8,30
9620	39,48	38,08	9,36	-32,15	54,77	5.000	74,00	19,23
12025	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
f>12025	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level(dBµV/m) = Measured Level(dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	78,61	27,40	3,55	-33,00	76,56	---	---	---
4810	22,28	31,54	5,44	-32,80	26,46	500	54,00	27,54
7215	31,81	36,06	6,90	-32,76	42,01	500	54,00	11,99
9620	16,91	38,08	9,36	-32,15	32,20	500	54,00	21,80
12025	16,82	39,10	11,55	-31,66	35,81	500	54,00	18,19
f>12025	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2405	78,40	27,40	3,55	-33,00	76,35	---	---	---
4810	23,15	31,54	5,44	-32,80	27,33	500	54,00	26,67
7215	32,40	36,06	6,90	-32,76	42,60	500	54,00	11,40
9620	17,81	38,08	9,36	-32,15	33,10	500	54,00	20,90
12025	14,03	39,10	11,55	-31,66	33,02	500	54,00	20,98
f>12025	not significant	---	---	---	---	---	---	---

Channel n°20: 2450,00 MHz (with Dedicated antenna A NTENOVA)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	112,43	27,40	3,55	-33,00	110,38	---	---	---
4900	42,14	31,54	5,44	-32,80	46,32	5.000	74,00	27,68
7350	51,95	36,06	6,90	-32,76	62,15	5.000	74,00	11,85
9800	39,71	38,08	9,36	-32,15	55,00	5.000	74,00	19,00
12250	39,39	39,10	11,55	-31,66	58,38	5.000	74,00	15,62
F<12250	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	114,25	27,40	3,55	-33,00	112,20	---	---	---
4900	44,8	31,54	5,44	-32,80	48,98	5.000	74,00	25,02
7350	52,68	36,06	6,90	-32,76	62,88	5.000	74,00	11,12
9800	39,71	38,08	9,36	-32,15	55,00	5.000	74,00	19,00
12250	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
F<12250	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level(dBµV/m) = Measured Level(dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	76,41	27,40	3,55	-33,00	74,36	---	---	---
4900	21,29	31,54	5,44	-32,80	25,47	500	54,00	28,53
7350	29,16	36,06	6,90	-32,76	39,36	500	54,00	14,64
9800	16,73	38,08	9,36	-32,15	32,02	500	54,00	21,98
12250	15,83	39,10	11,55	-31,66	34,82	500	54,00	19,18
F<12250	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2450	78,26	27,40	3,55	-33,00	76,21	---	---	---
4900	20,71	31,54	5,44	-32,80	24,89	500	54,00	29,11
7350	30,27	36,06	6,90	-32,76	40,47	500	54,00	13,53
9800	19,92	38,08	9,36	-32,15	35,21	500	54,00	18,79
12250	13,16	39,10	11,55	-31,66	32,15	500	54,00	21,85
F<12250	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level(dBµV/m) = Measured Level(dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

Channel n°26: 2480,00 MHz (with Dedicated antenna A NTENOVA)

PEAK RESULT (RBW=1MHz; VBW=1MHz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	113,53	27,40	3,55	-33,00	111,48	---	---	---
4960	44,47	31,54	5,44	-32,80	48,65	5.000	74,00	25,35
7440	48,52	36,06	6,90	-32,76	58,72	5.000	74,00	15,28
9920	39,71	38,08	9,36	-32,15	55,00	5.000	74,00	19,00
12400	36,71	39,10	11,55	-31,66	55,70	5.000	74,00	18,30
F<12400	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	115,6	27,40	3,55	-33,00	113,55	---	---	---
4960	48,17	31,54	5,44	-32,80	52,35	5.000	74,00	21,65
7440	47,38	36,06	6,90	-32,76	57,58	5.000	74,00	16,42
9920	39,71	38,08	9,36	-32,15	55,00	5.000	74,00	19,00
12400	36,01	39,10	11,55	-31,66	55,00	5.000	74,00	19,00
F<12400	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level(dBµV/m) = Measured Level(dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

AVERAGE RESULT (RBW=1MHz; VBW=10Hz)

Antenna Polarization: Horizontal								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	77,48	27,40	3,55	-33,00	75,43	---	---	---
4960	23,34	31,54	5,44	-32,80	27,52	500	54,00	26,48
7440	26,88	36,06	6,90	-32,76	37,08	500	54,00	16,92
9920	15,98	38,08	9,36	-32,15	31,27	500	54,00	22,73
12400	13,16	39,10	11,55	-31,66	32,15	500	54,00	21,85
F<12400	not significant	---	---	---	---	---	---	---

Antenna Polarization: Vertical								
Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2480	79,46	27,40	3,55	-33,00	77,41	---	---	---
4960	24,05	31,54	5,44	-32,80	28,23	500	54,00	25,77
7440	25,03	36,06	6,90	-32,76	35,23	500	54,00	18,77
9920	17,42	38,08	9,36	-32,15	32,71	500	54,00	21,29
12400	13,22	39,10	11,55	-31,66	32,21	500	54,00	21,79
F<12400	not significant	---	---	---	---	---	---	---

Formula:

Calculated Level(dBµV/m) = Measured Level(dBµV) - Pre-amplifier Gain(dB) + Cable Loss(dB) + Antenna Factor (dBm^{-1})

TEST No.4	Title "6 dB Bandwidth"	47CFR Part 15 Ref. Section
		15.247 (a) (2)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	3 MHz
	Resolution (or IF) Bandwidth (RBW)	100 kHz
	Video (or Average) Bandwidth (VBW)	300 kHz
	Sweep time	2,5 ms
	Detector function	Peak
	Trace	max hold
	Attenuator	/
	LIMIT	**> 500 kHz**

The EUT is set to transmit has its maximum data rate.
The transmitter output was connected to the spectrum analyzer through a test fixture (radio frequency coupling device associated with the dedicated antenna of the equipment under test)
The Channel bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6 dB.

Test Result:

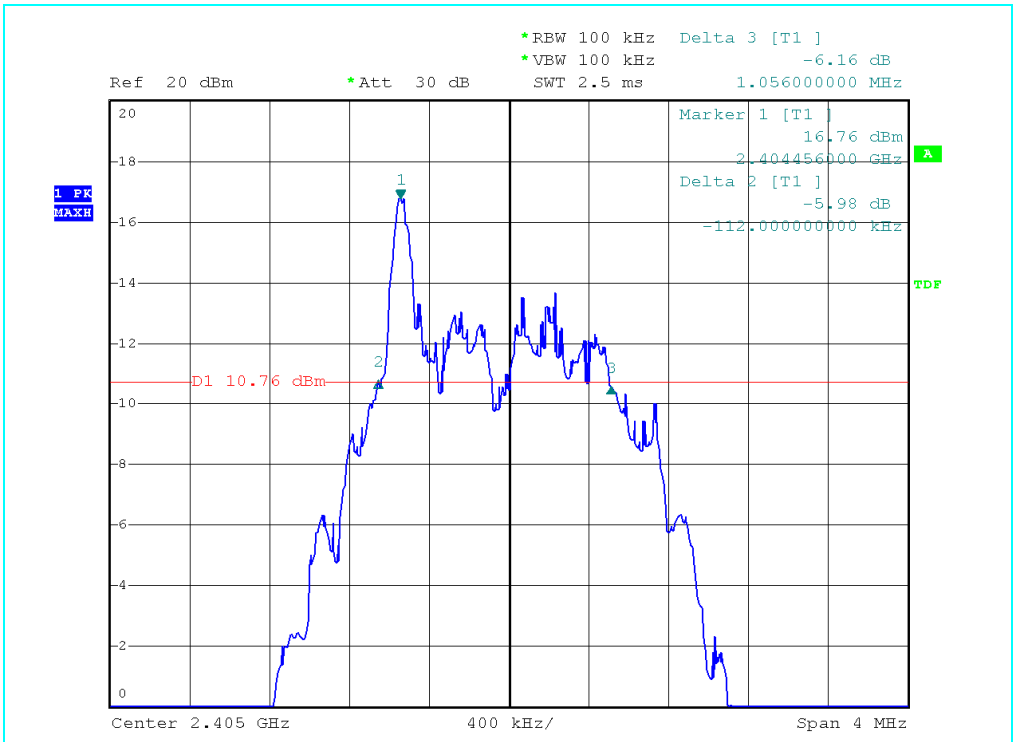
The Test results is identical for both the models type SPZB32W1A1.1 and SPZB32W1C1.1

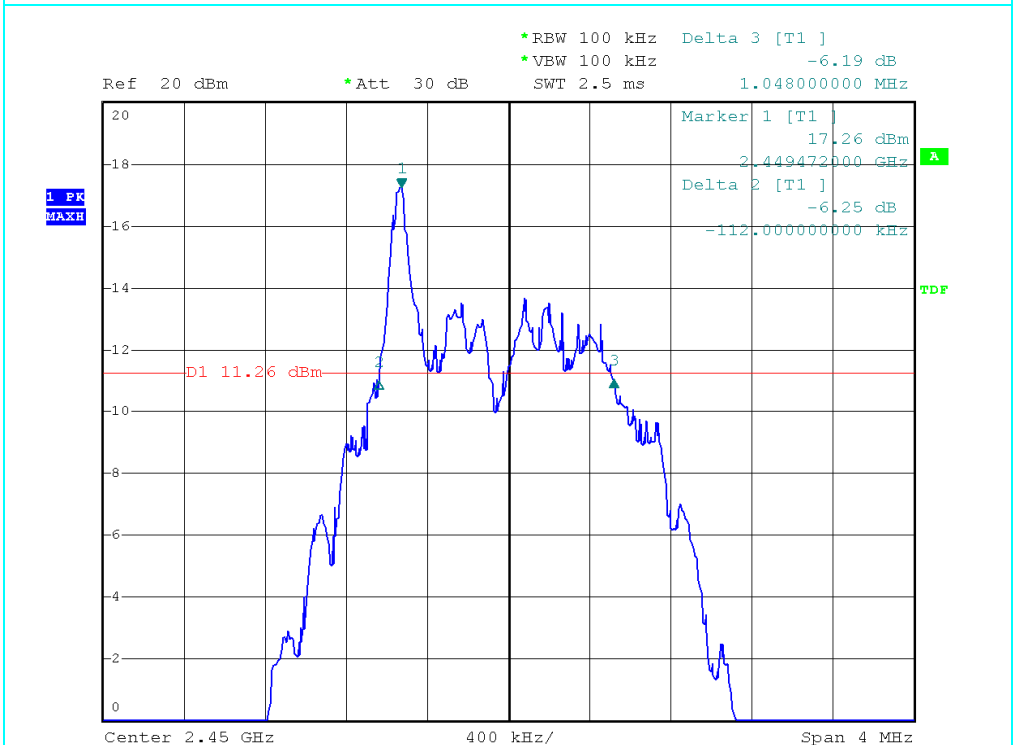
Channel (No.)	Frequency (MHz)	Channel Bandwidth (kHz)	Plot (No.)
11	2405,00	1168	1
20	2450,00	1160	2
26	2480,00	1216	3

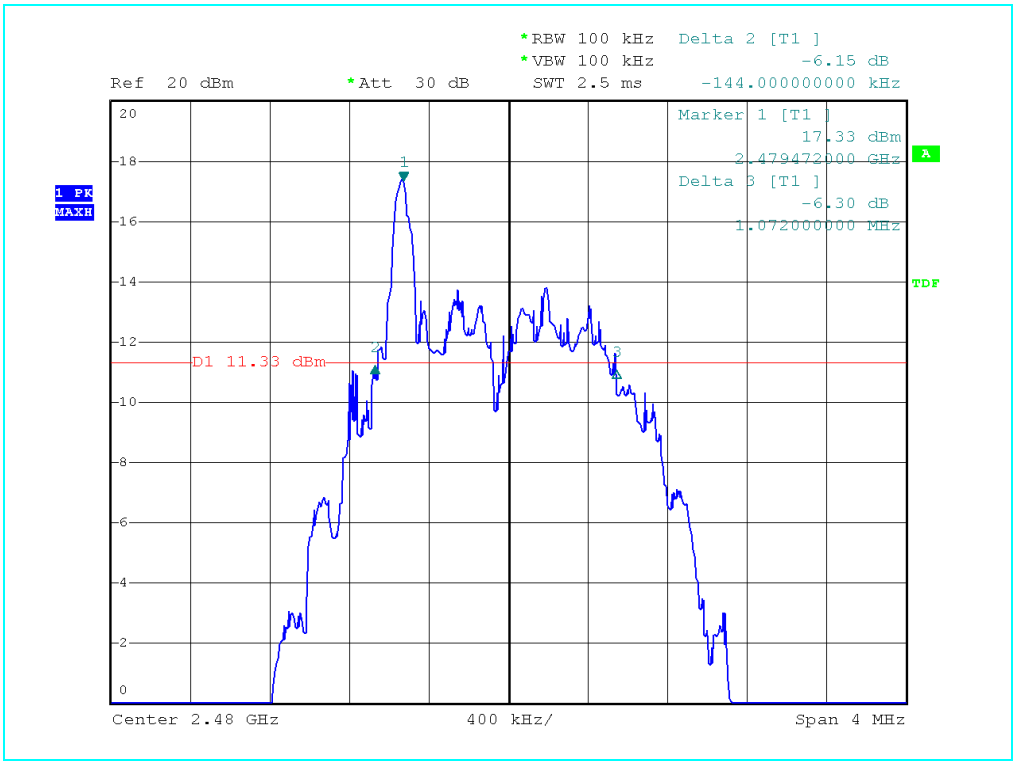
Tested samples

SAMPLE
1) Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2) Model SPZB32W1A1.1 provided with RAINSUN Antenna

- **Plot No. 1÷3:**


*RBW 100 kHz
*VBW 100 kHz
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
Delta 3 [T1]
-6.16 dB
1.056000000 MHz
Marker 1 [T1]
16.76 dBm
2.404456000 GHz
Delta 2 [T1]
-5.98 dB
-112.000000000 kHz
1 PK
MAXH
A
TDF
D1 10.76 dBm
Center 2.405 GHz
400 kHz/
Span 4 MHz


*RBW 100 kHz
*VBW 100 kHz
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
Delta 3 [T1]
-6.19 dB
1.048000000 MHz
Marker 1 [T1]
17.26 dBm
2.449472000 GHz
Delta 2 [T1]
-6.25 dB
-112.000000000 kHz
1 PK
MAXH
A
TDF
D1 11.26 dBm
Center 2.45 GHz
400 kHz/
Span 4 MHz



TEST No.5	Title " Maximum Peak Output Power with External Antenna (De Facto EIRP)"	47CFR Part 15 Ref. Section 15.247 (b) (1) (3)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	40 MHz
	Resolution (or IF) Bandwidth (RBW)	10 MHz
	Video (or Average) Bandwidth (VBW)	10 MHz
	Sweep time	2,5 ms
	Detector function	Peak
	Trace	max hold
	Attenuator	/
	LIMIT	**1 Watt (30dBm)**

Conducted measurements:

The transmitter output was connected to the spectrum analyzer via a low loss cable.

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.

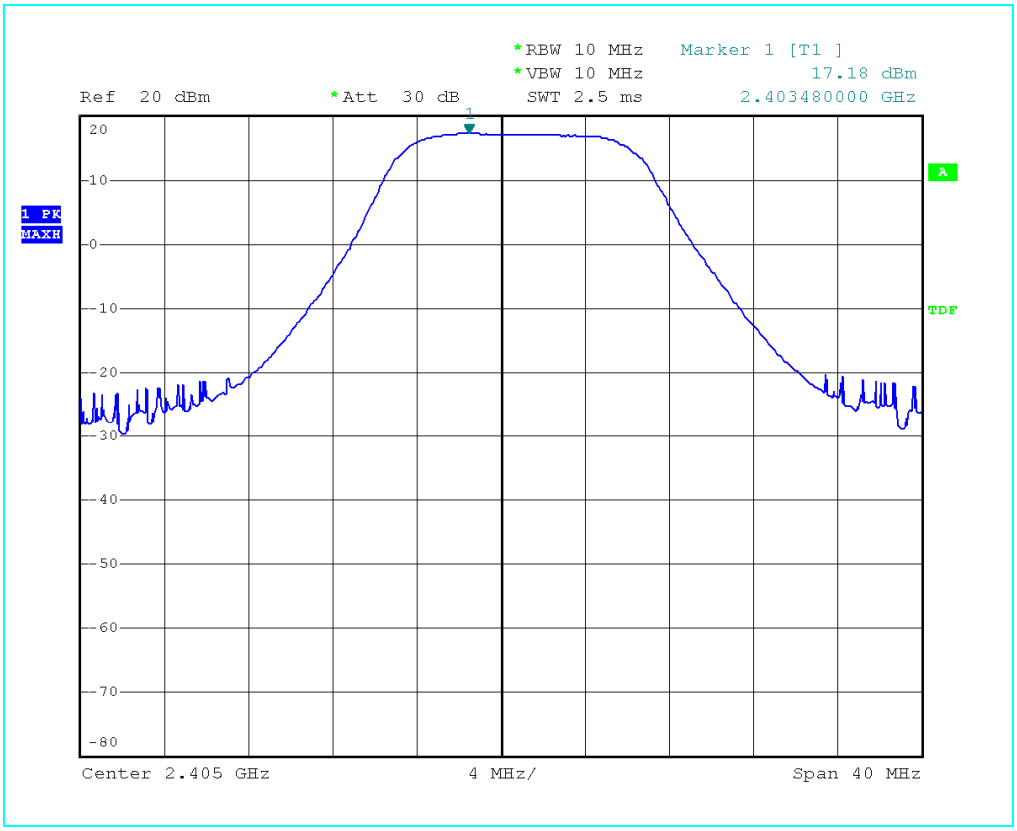
Tested samples

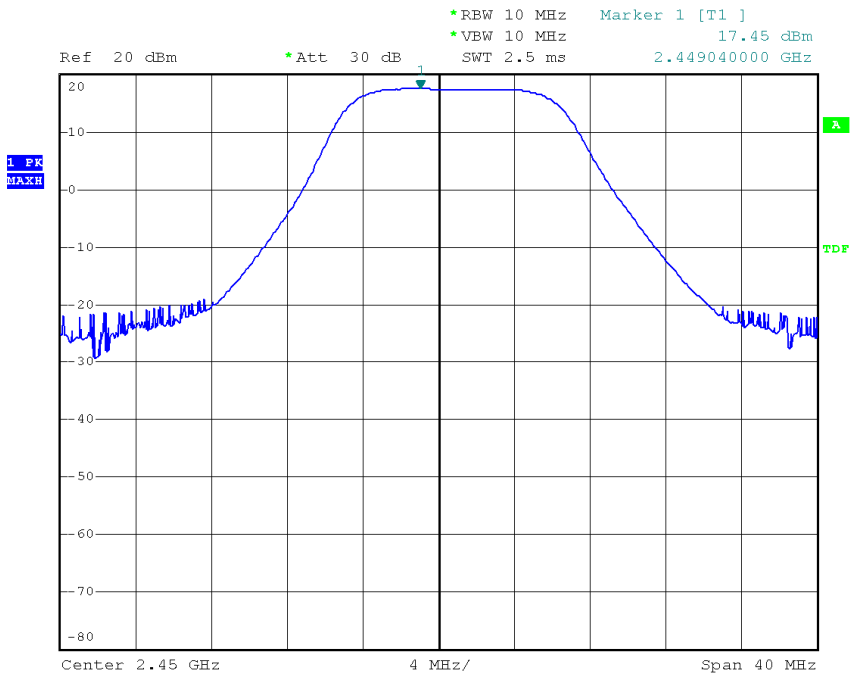
SAMPLE
1) Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2) Model SPZB32W1A1.1 provided with RAINSUN Antenna

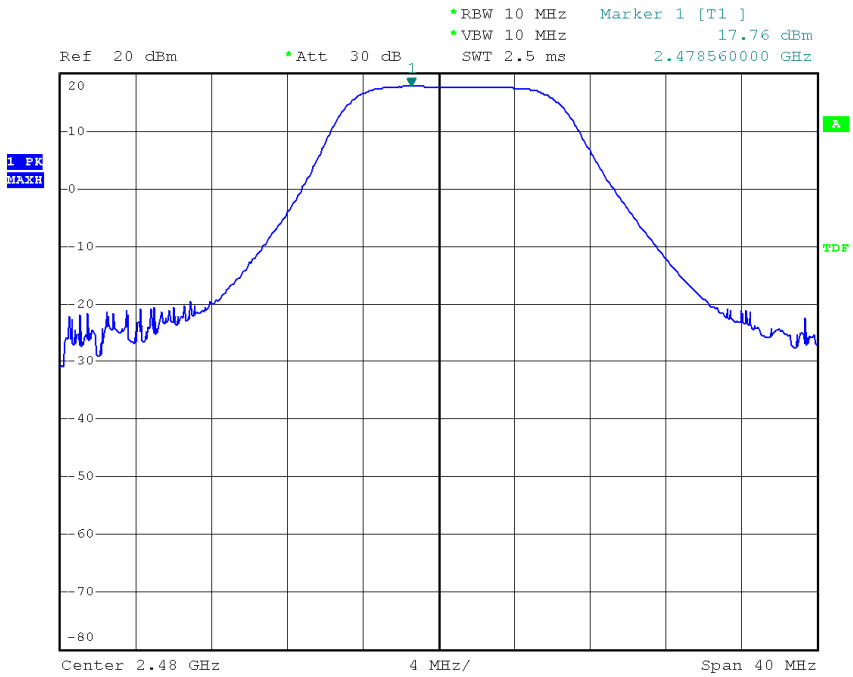
Test Result

Conducted measure (Peak detector) SPZB32W1C1.1

Channel (No.)	Frequency (MHz)	Measured Output Power (dBm)	Max. Antenna Gain (dB)	Calculated Radiated Output Power (dBm)
11	2405,00	17,18	2,2	19,38
20	2450,00	17,45		19,67
26	2480,00	17,76		19,98

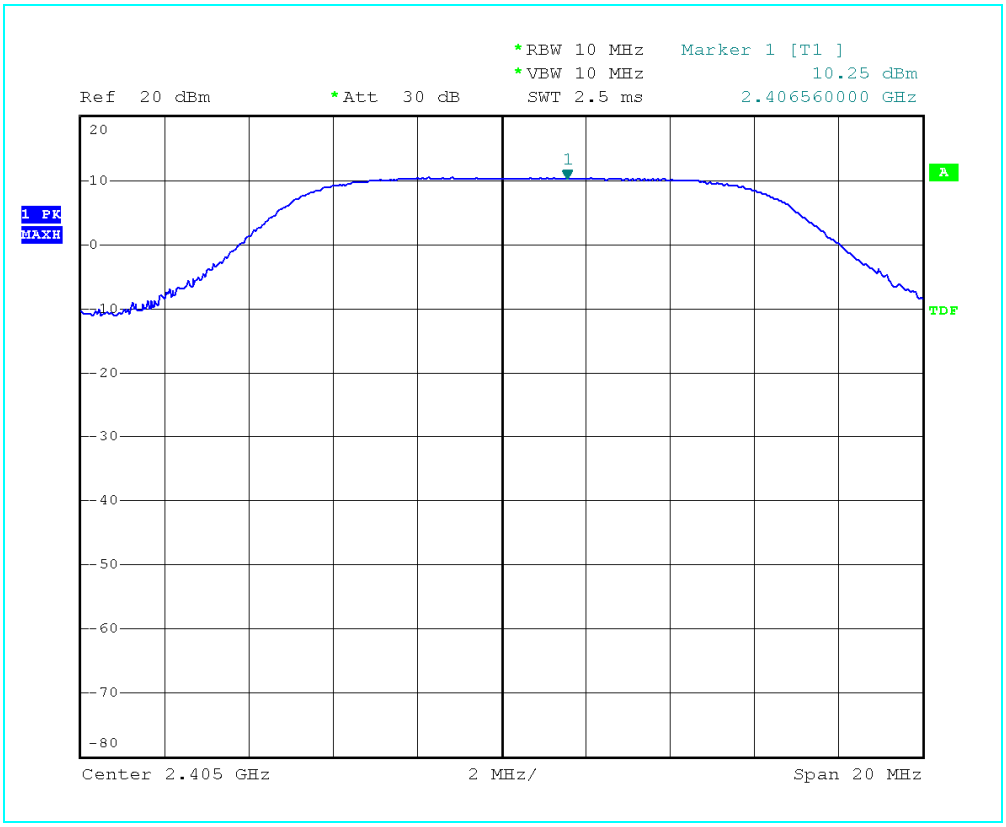


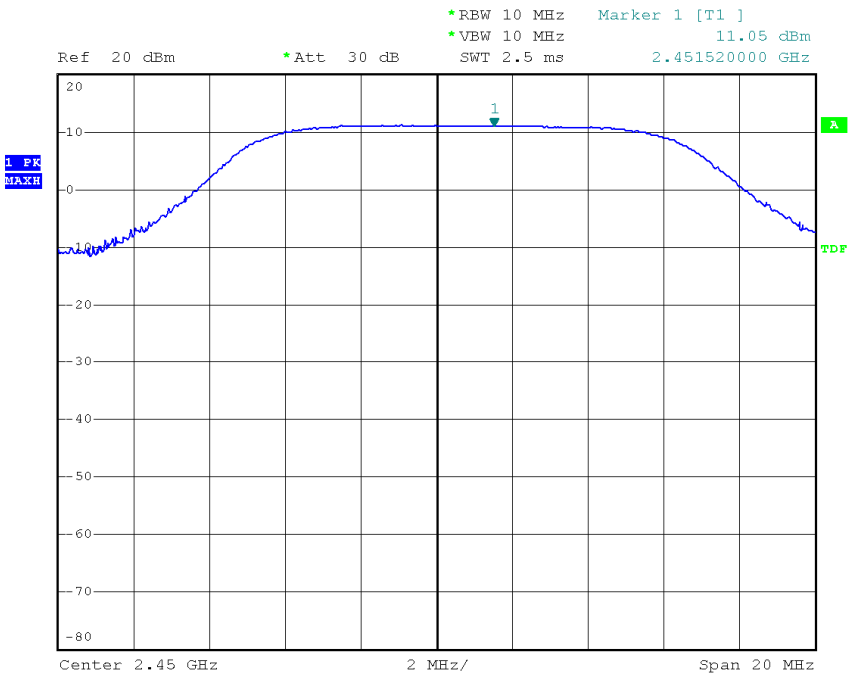

*RBW 10 MHz
*VBW 10 MHz
Marker 1 [T1]
17.45 dBm
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
2.449040000 GHz
1 PK
MAXH
A
TDF
Center 2.45 GHz
4 MHz/
Span 40 MHz

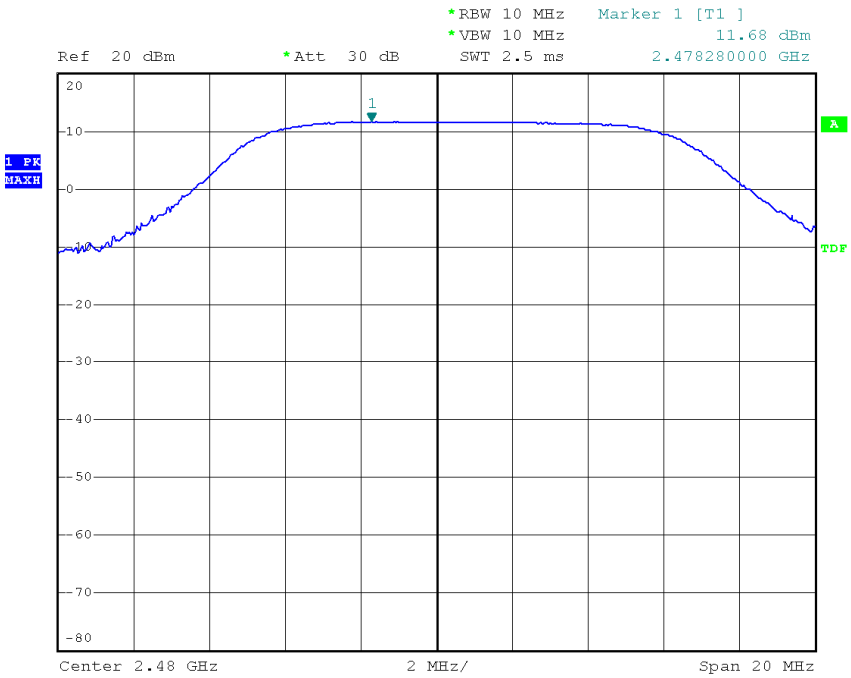

*RBW 10 MHz
*VBW 10 MHz
Marker 1 [T1]
17.76 dBm
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
2.478560000 GHz
1 PK
MAXH
A
TDF
Center 2.48 GHz
4 MHz/
Span 40 MHz

Radiated measure (Peak detector) SPZB32W1A1.1

Channel (No.)	Frequency (MHz)	Measured Output Power (dBm)
11	2405,00	10,25
20	2450,00	11,05
26	2480,00	11,68




*RBW 10 MHz
*VBW 10 MHz
Marker 1 [T1]
11.05 dBm
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
2.451520000 GHz
1 PK
MAXH
A
TDF
Center 2.45 GHz
2 MHz/
Span 20 MHz


*RBW 10 MHz
*VBW 10 MHz
Marker 1 [T1]
11.68 dBm
Ref 20 dBm
*Att 30 dB
SWT 2.5 ms
2.478280000 GHz
1 PK
MAXH
A
TDF
Center 2.48 GHz
2 MHz/
Span 20 MHz

TEST No. 6	Title "Band-edge Compliance of RF Conducted Emissions "	47CFR Part 15 Ref. Section 15.247 (d)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
	Resolution (or IF) Bandwidth (RBW)	1 MHz (100 kHz band-edge)
	Video (or Average) Bandwidth (VBW)	1 MHz (100 kHz band-edge)
	Sweep time	Auto
	Detector function	Peak
	Trace	Max hold
	Attenuator	/
	LIMIT	**> 20 dB below that in the 100 kHz bandwidth within the assigned band**

Only for measuring emissions up to 2 MHz removed from the band-edge the "delta" technique for Radiated emissions was used.

Delta technique: The transmitter output was connected to the spectrum analyzer through a test fixture (radio frequency coupling device associated with the dedicated antenna of the equipment under test)
Once the trace is stabilized, by the marker the emission at the band edge (or on the highest modulation product outside of the band, if this level is greater than that at the band edge) was set.
The "n" by the marker-delta function and the marker-to-peak function the peak of the in-band emission was selected. The marker-delta value displayed was compared with the limit specified in this Section.

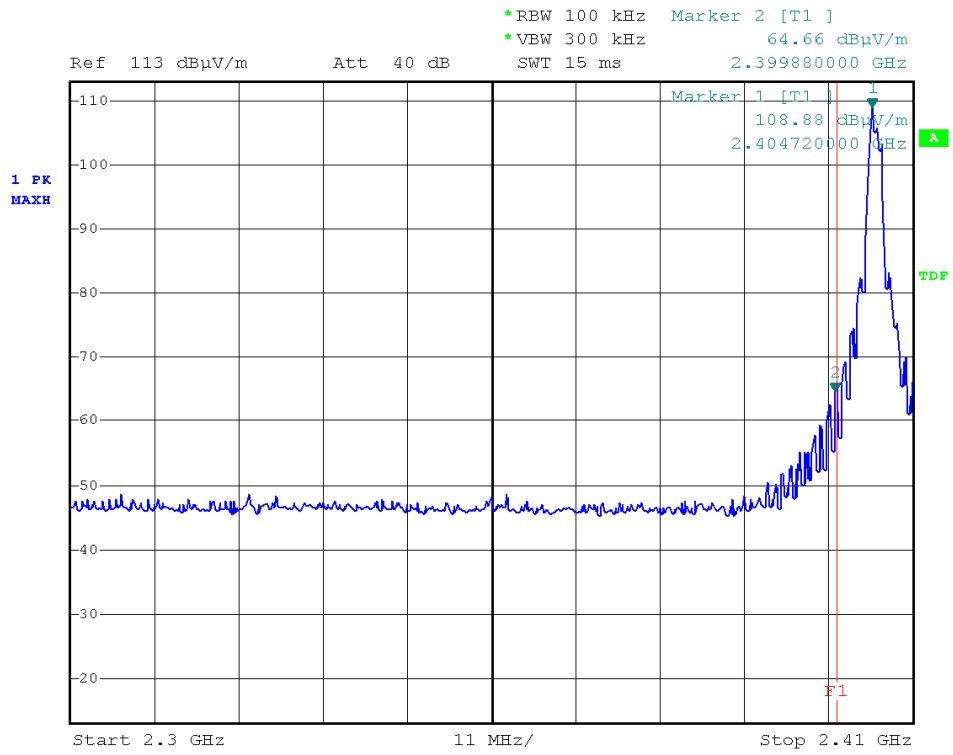
Tested samples

SAMPLE
1) Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2) Model SPZB32W1A1.1 provided with RAINSUN Antenna

Test Result:

Band-edge compliance, lower band edge, (Peak)

Model SPZB32W1C1.1 provided with ANTENOVA Antenna

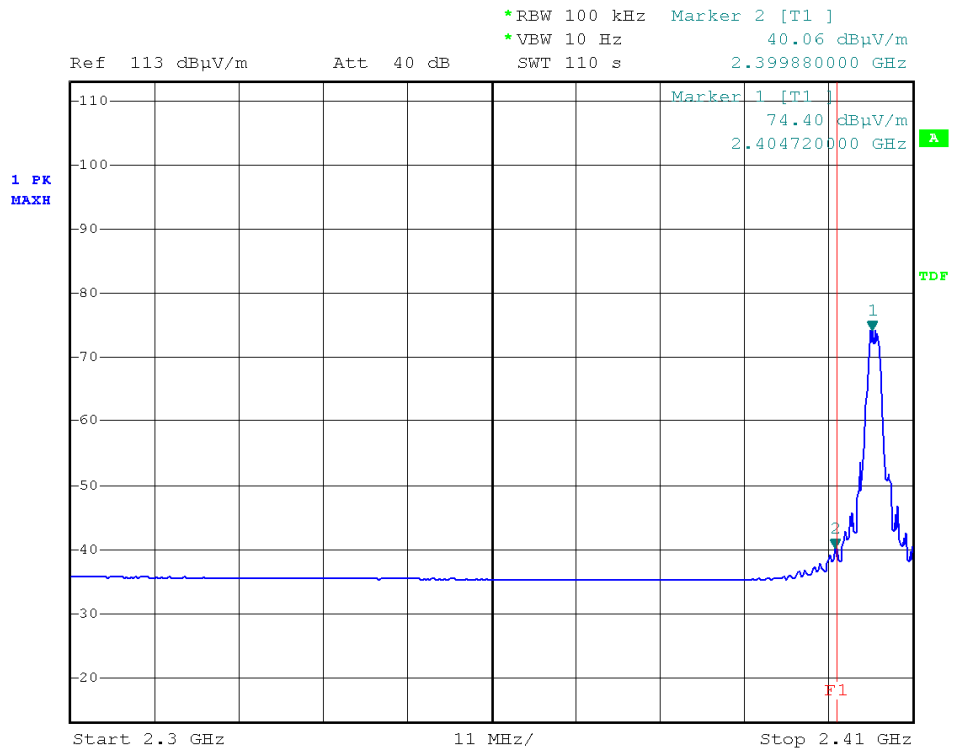


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Lower 2.405 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Peak	108,88	64,66	44,22	88,88	24,22
Within the limit					

Band-edge compliance, lower band edge, (Average)

Model SPZB32W1C1.1 provided with ANTENOVA Antenna

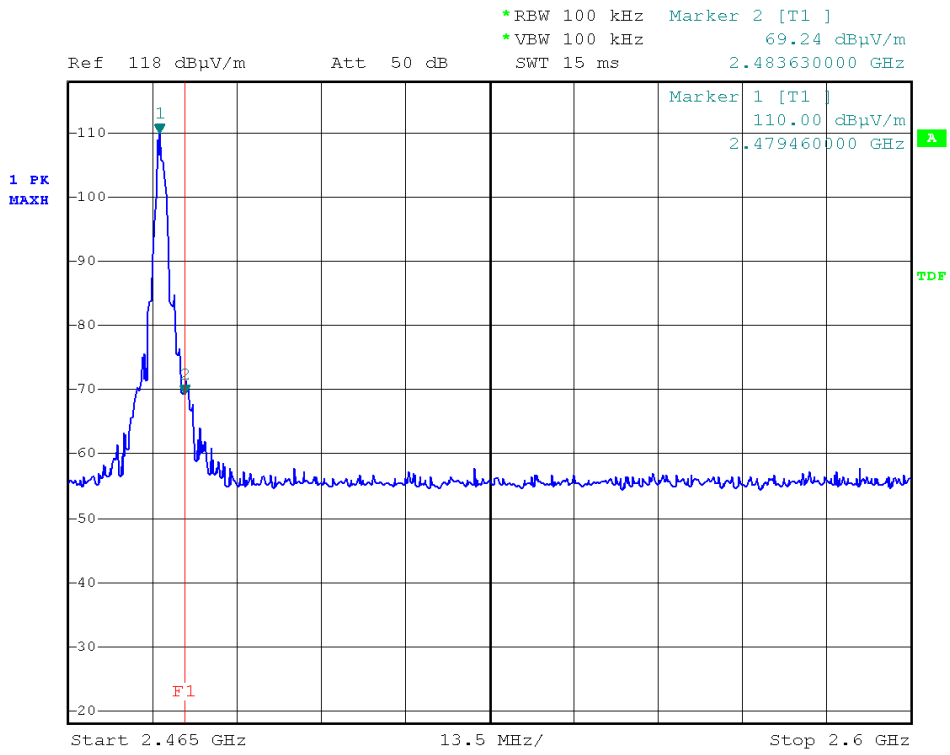


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Lower 2.405 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Average	74,40	40,06	34,34	54,40	14,34
Within the limit					

Band-edge compliance, upper band edge, (Peak)

Model SPZB32W1C1.1 provided with ANTENOVA Antenna

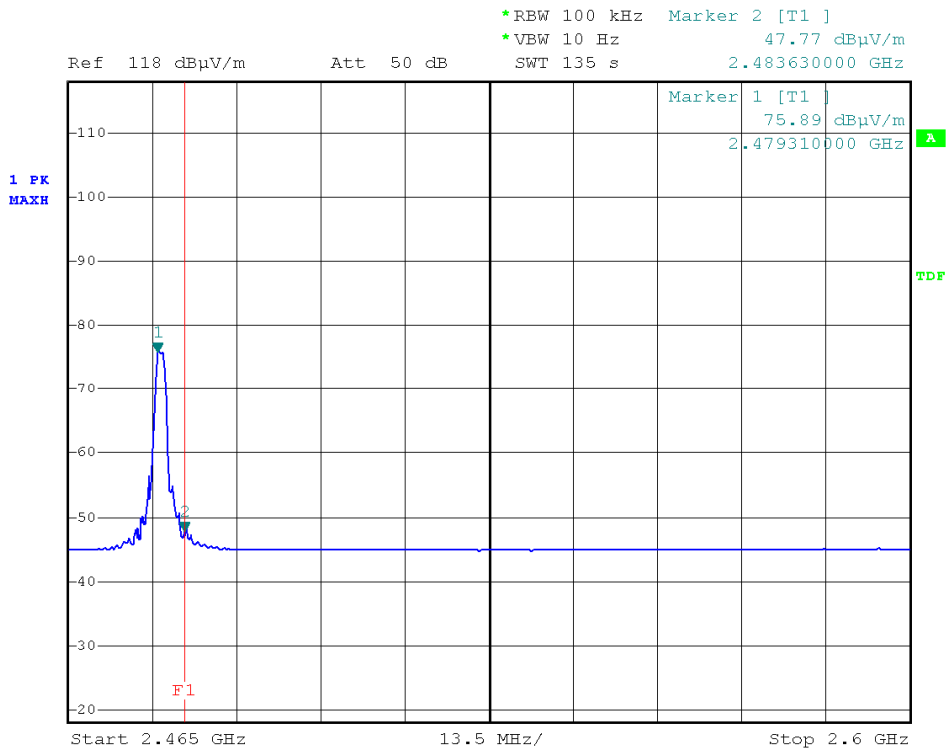


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Upper 2.480 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Peak	110,00	69,24	40,76	90,00	20,76
Within the limit					

Band-edge compliance, upper band edge, (Average)

Model SPZB32W1C1.1 provided with ANTENOVA Antenna

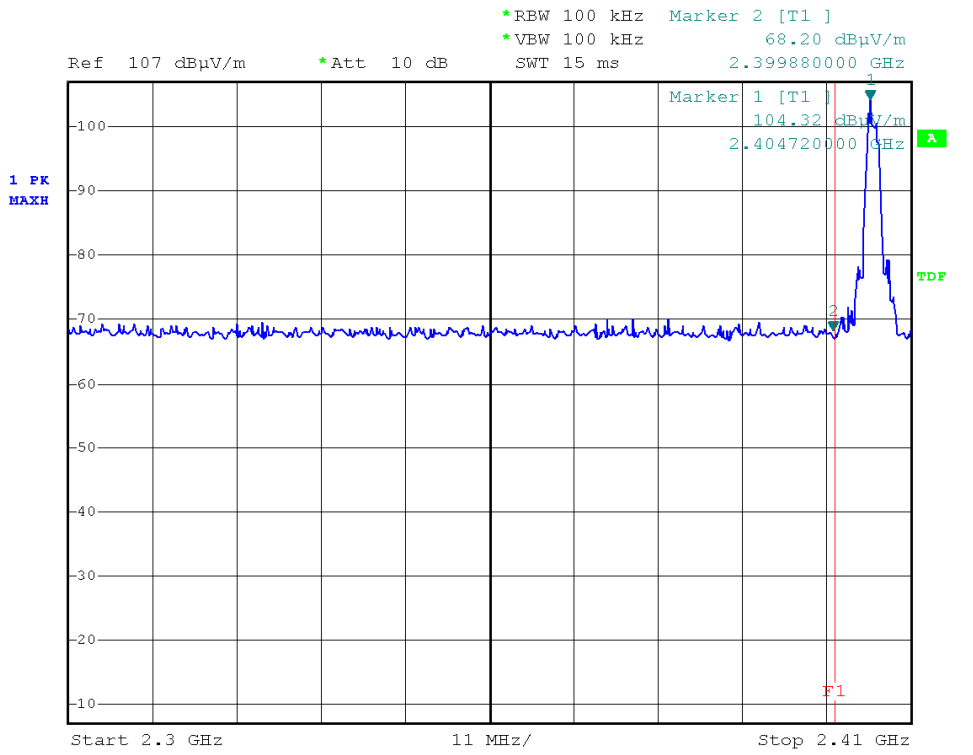


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Upper 2.480 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Average	75,89	47,77	28,12	55,89	8,12
Within the limit					

Band-edge compliance, lower band edge, (Peak)

Model SPZB32W1A1.1 provided with RAINSUN Antenna

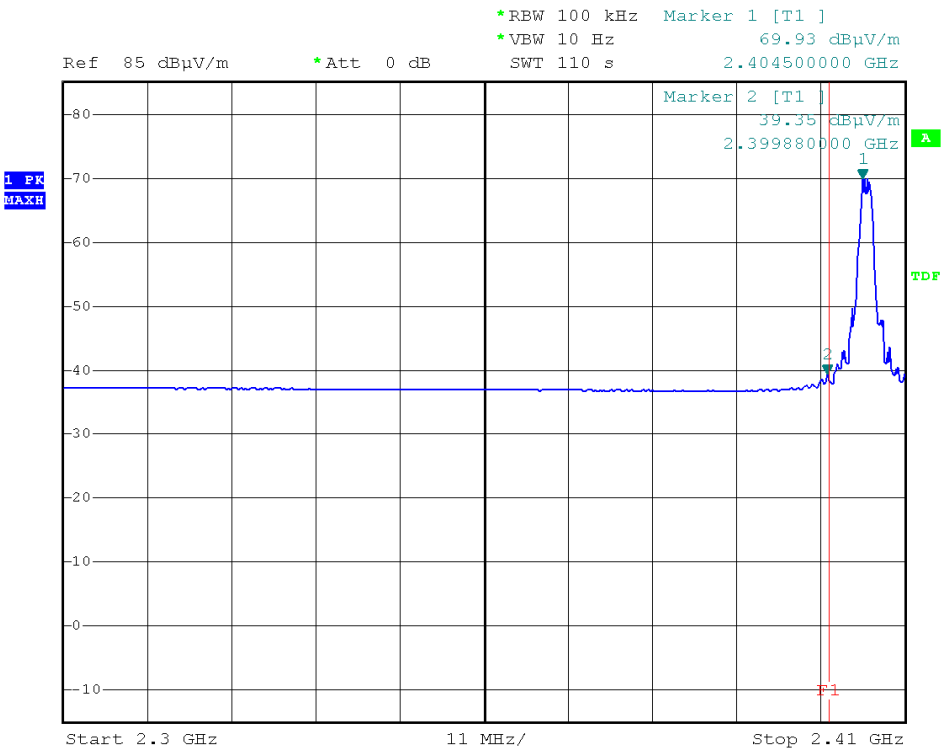


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Lower 2.405 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Peak	104,32	68,20	36,12	84,32	16,12
Within the limit					

Band-edge compliance, lower band edge, (Average)

Model SPZB32W1A1.1 provided with RAINSUN Antenna

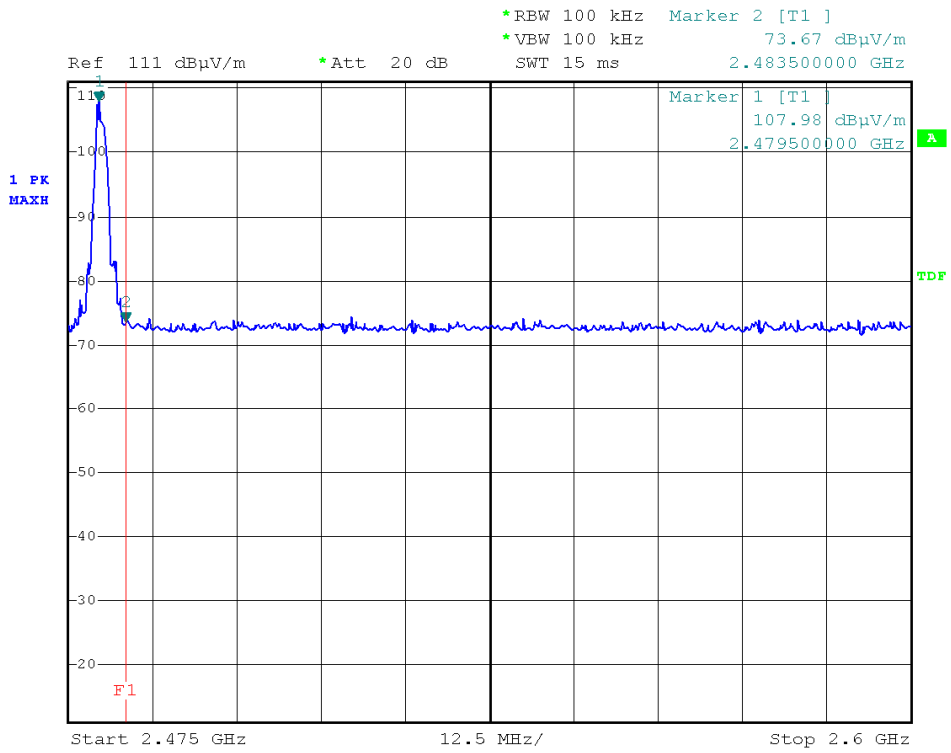


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Lower 2.405 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Average	69,93	39,35	30,58	49,93	10,58
Within the limit					

Band-edge compliance, upper band edge, (Peak)

Model SPZB32W1A1.1 provided with RAINSUN Antenna

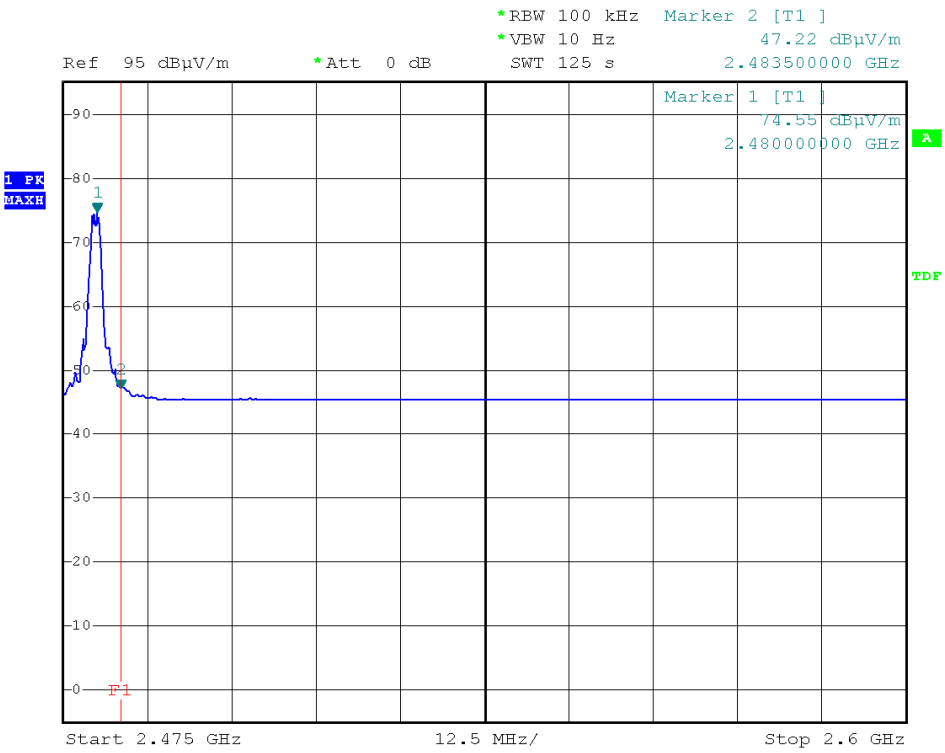


All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Upper 2.480 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Peak	107,98	73,67	34,31	87,98	14,31
Within the limit					

Band-edge compliance, upper band edge, (Average)

Model SPZB32W1A1.1 provided with RAINSUN Antenna



All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

Band-edge compliance to radiated emission test – Upper 2.480 MHz					
Mode	**Measured Level (dBµV/m)**	**Measured Level at the band edge (dBµV/m)**	**Difference Peak – band edge (dB)**	**Peak Limit at PK power –20 dB (dBµV/m)**	**Margin (dB)**
Average	74,55	47,22	27,33	54,55	7,33
Within the limit					

TEST No. 7	Title "Spurious Emission in restricted band near 2400-2483.5 MHz	47CFR Part 15 Ref. Section 15.247 (d)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation
	Resolution (or IF) Bandwidth (RBW)	1 MHz with peak detector
	Video (or Average) Bandwidth (VBW)	1 MHz with peak detector
	Resolution (or IF) Bandwidth (RBW)	1 MHz with average detector
	Video (or Average) Bandwidth (VBW)	10 Hz with average detector
	Sweep time	Auto
	Detector function	Peak and Average
	Trace	Max hold
	Attenuator	/
	LIMIT	**Peak = 5000 µV / m** **Average = 500 µV / m**

Tested samples

SAMPLE
1) Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2) Model SPZB32W1A1.1 provided with RAINSUN Antenna

Spurious Emission in restricted band near 2400-2483.5 MHz

Model SPZB32W1C1.1 provided with ANTENOVA Antenna

PEAK DETECTOR

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2387,34	60,83	27,40	3,55	-33,00	58,78	5.000	74,00	15,22
2395,48	66,07	27,40	3,55	-33,00	64,02	5.000	74,00	9,98
2492,81	68,63	27,65	3,95	-33,00	67,23	5.000	74,00	6,77
2503,88	68,35	27,65	3,95	-33,00	66,95	5.000	74,00	7,05

AVERAGE DETECTOR

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2387,34	30,34	27,40	3,55	-33,00	28,29	500	54,00	25,71
2395,48	31,12	27,40	3,55	-33,00	29,07	500	54,00	24,93
2492,81	30,15	27,65	3,95	-33,00	28,75	500	54,00	25,25
2503,88	29,50	27,65	3,95	-33,00	28,10	500	54,00	25,90

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain (dB) + Cable Loss (dB) + Antenna Factor (dBm^{-1})

Model SPZB32W1A1.1 provided with RAINSUN Antenna

PEAK DETECTOR

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2391,52	57,95	27,40	3,55	-33,00	55,90	5.000	74,00	18,10
2495,50	58,82	27,65	3,95	-33,00	57,42	5.000	74,00	16,58
2514,75	58,77	27,65	3,95	-33,00	57,37	5.000	74,00	16,63
2520,50	57,30	27,65	3,95	-33,00	55,90	5.000	74,00	18,10

AVERAGE DETECTOR

Frequency	Reading value	Antenna Factor	Cable Loss	Pre-Amp. Gain	Correcting reading	Limit	Limit	Margin
(MHz)	(dBµV)	(dB1/m)	(dB)	(dB)	(dBµV/m)	(µV/m)	(dBµV/m)	(dB)
2391,52	35,49	27,40	3,55	-33,00	33,44	500	54,00	20,56
2495,50	40,76	27,65	3,95	-33,00	39,36	500	54,00	14,64
2514,75	40,63	27,65	3,95	-33,00	39,23	500	54,00	14,77
2520,50	38,71	27,65	3,95	-33,00	37,31	500	54,00	16,69

Formula:

Calculated Level (dBµV/m) = Measured Level (dBµV) - Pre-amplifier Gain (dB) + Cable Loss (dB) + Antenna Factor (dBm^{-1})

TEST No.8	Title "Conducted Emissions outside the band 2400-2483.5 MHz"	47CFR Part 15 Ref. Section 15.247 (d)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	/
	Resolution (or IF) Bandwidth (RBW)	100 kHz
	Video (or Average) Bandwidth (VBW)	300 kHz
	Sweep time	as necessary to capture the entire dwell time per hopping channel
	Detector function	Peak
	Trace	max hold
	Attenuator	/
	LIMIT	**20 dB below from Conducted peak of RF or limit specified in section 15.209 for Restricted Band.**

The transmitter output was connected to the spectrum analyzer through an opportune RF attenuator.

The measure has been executed with the lowest transmit channel, the highest transmit channel and one located somewhere in the middle of the band.

Tested samples

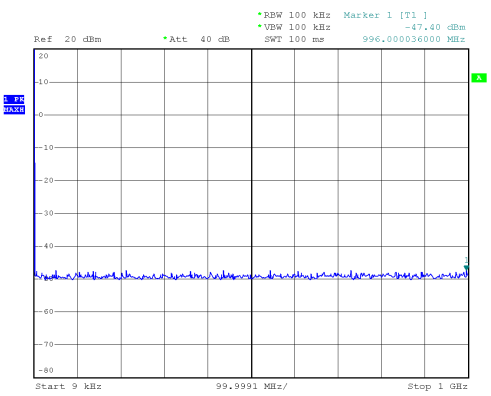
SAMPLE
1) Model SPZB32W1C1.1 provided with ANTENOVA Antenna
2) Model SPZB32W1A1.1 provided with RAINSUN Antenna

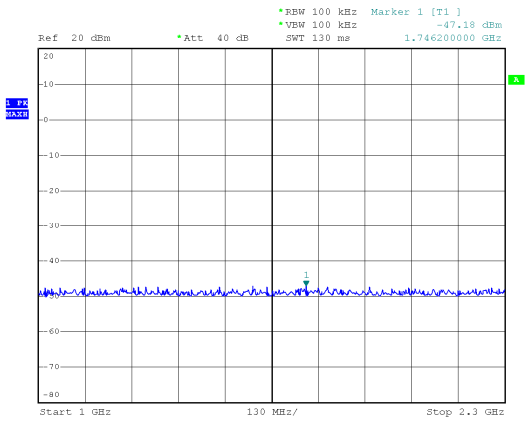
Test Result:

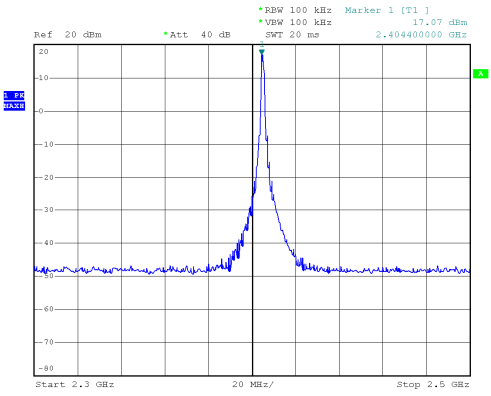
Within the specifications

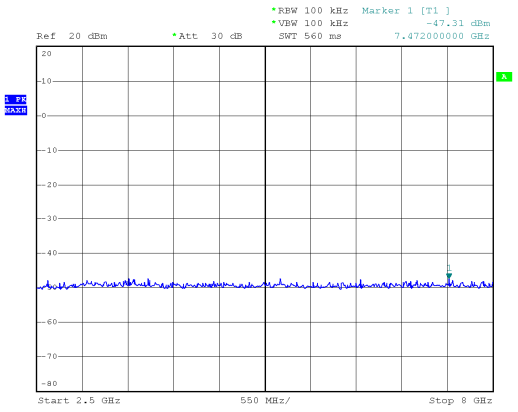
The Test results is identical for both the models type SPZB32W1C1.1 and SPZB32W1A1.1

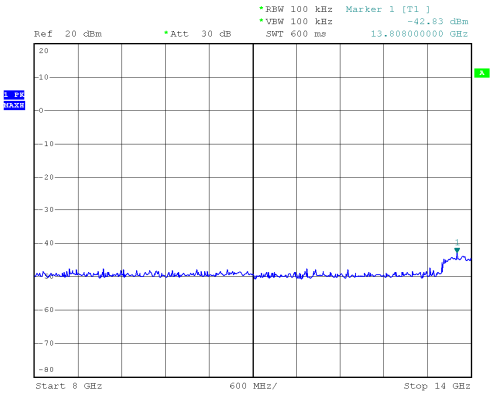
Test Result: Conducted measure (channel 11)

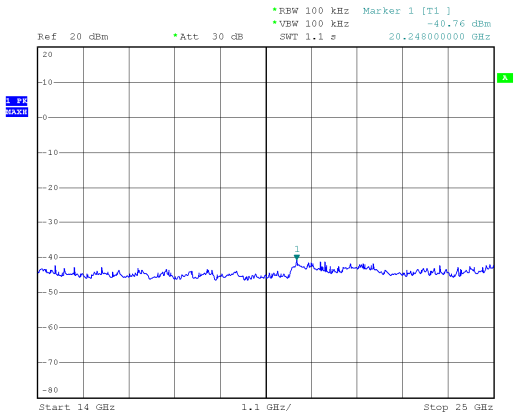






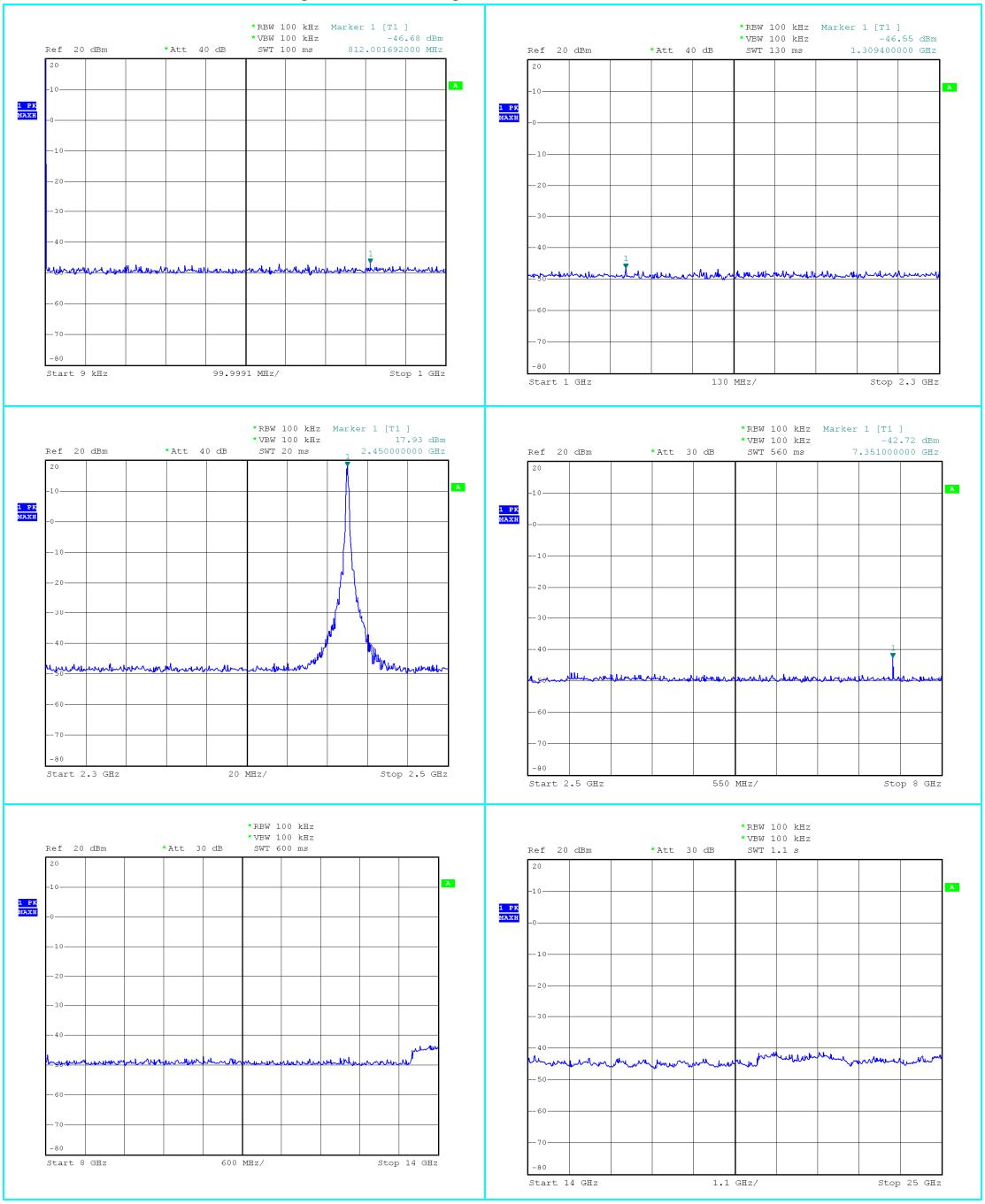






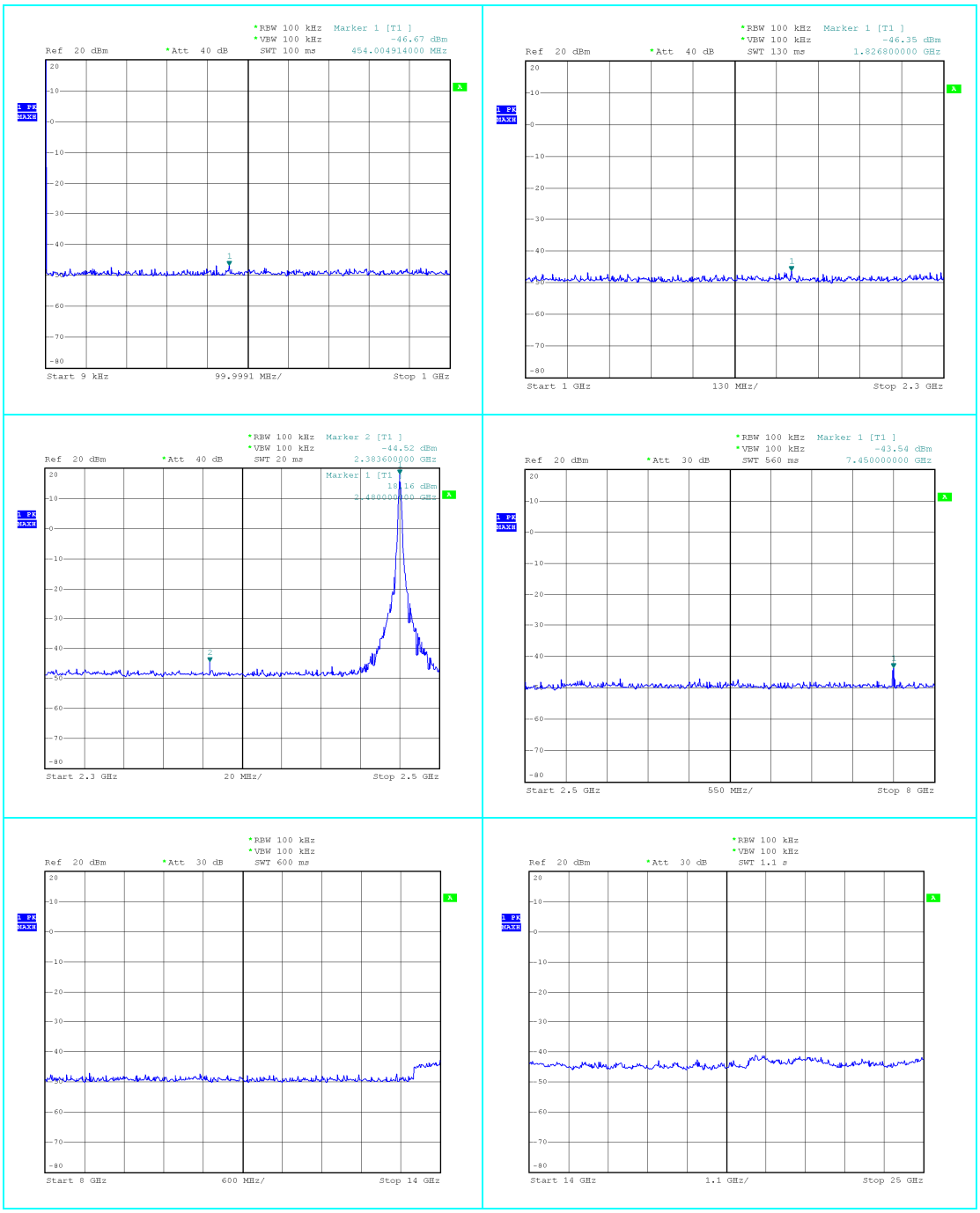
All out of band spurious emissions are more 20dB below the in band power of the fundamental.

Conducted measure (channel 20)



All out of band spurious emissions are more 20dB below the in band power of the fundamental.

Conducted measure (channel 26)



All out of band spurious emissions are more 20dB below the in band power of the fundamental.

TEST No.9	Title “ Transmitter Power Spectral Density”	47CFR Part 15 Ref. Section
		15.247 (e)
TEST SET-UP & REQUIREMENTS	**Spectrum analyzer settings**	
	Span	3 MHz
	Resolution (or IF) Bandwidth (RBW)	3 kHz
	Video (or Average) Bandwidth (VBW)	30 kHz
	Sweep time	340 ms
	Detector function	Peak
	Trace	max hold
	Attenuator	/
	LIMIT	8 dBm

The transmitter output was connected to the spectrum analyzer through a test fixture (radio frequency coupling device associated with the dedicated antenna of the equipment under test)

After trace stabilisation the marker shall be set on the signal peak. The indicated level is the power spectral density.

Test Result:

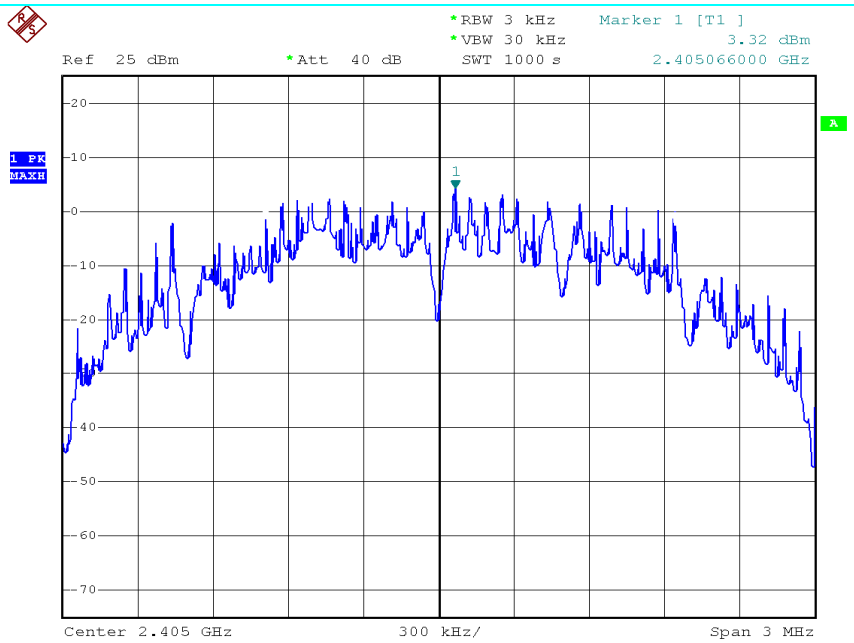
SPZB32W1C1.1

Channel (No.)	Power spectral density (dBm)	Plot (No.)
11	+3,32	1
20	+3,48	2
26	+3,84	3

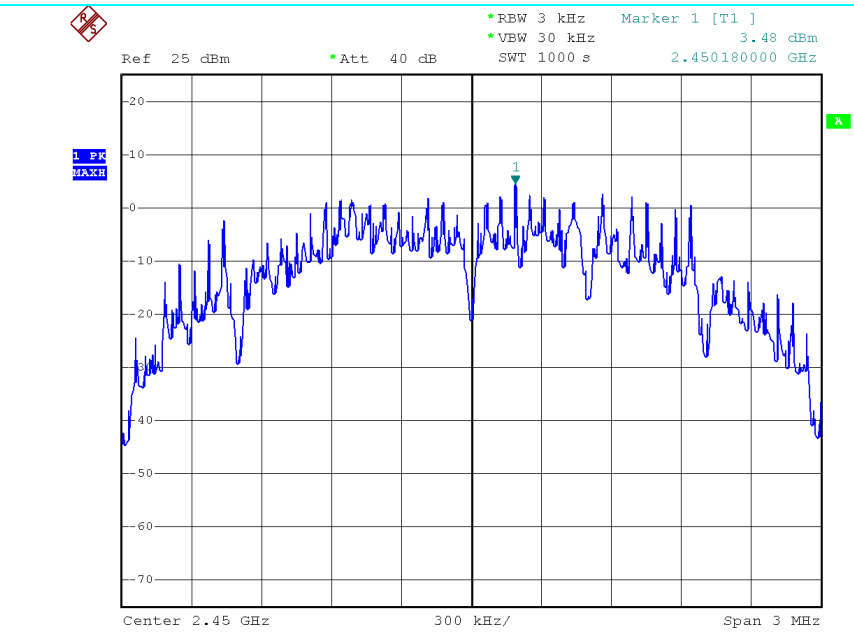
SPZB32W1A1.1

Channel (No.)	Power spectral density (dBm)	Plot (No.)
11	-1,12	4
20	-1,02	5
26	-1,22	6

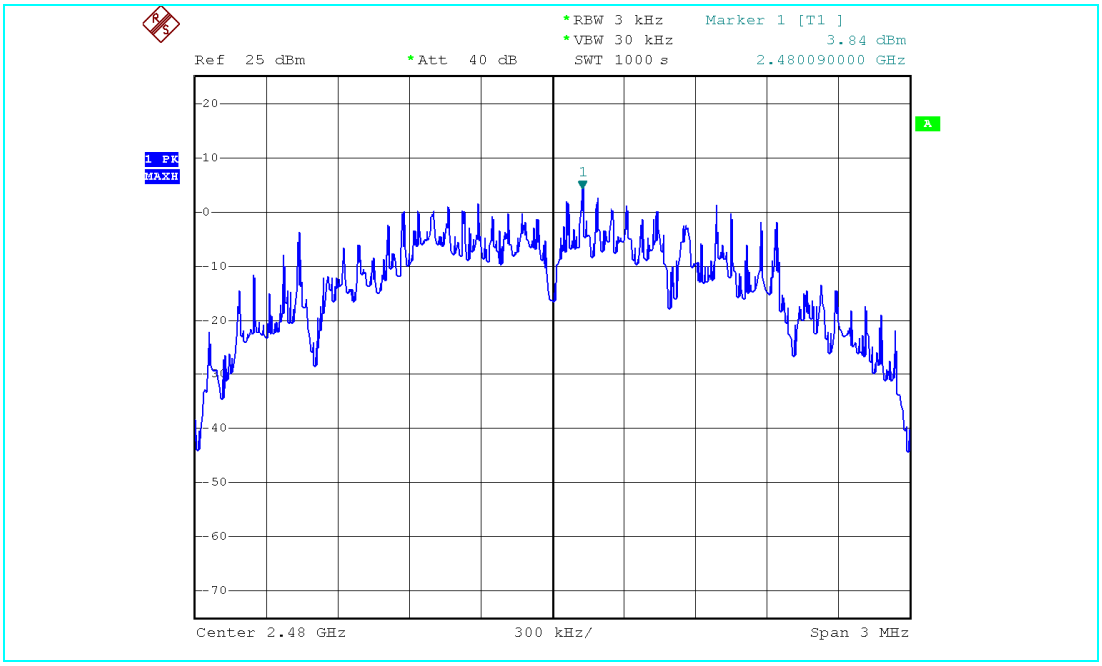
SPZB32W1C1.1
Plot No. 1:



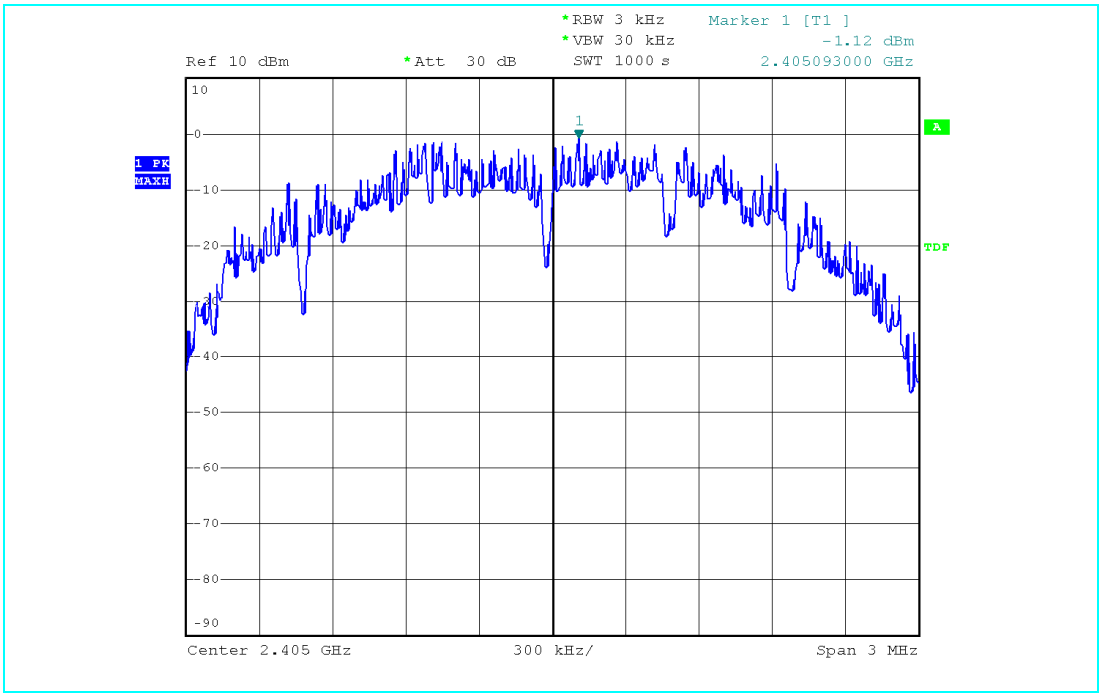
Plot No. 2:



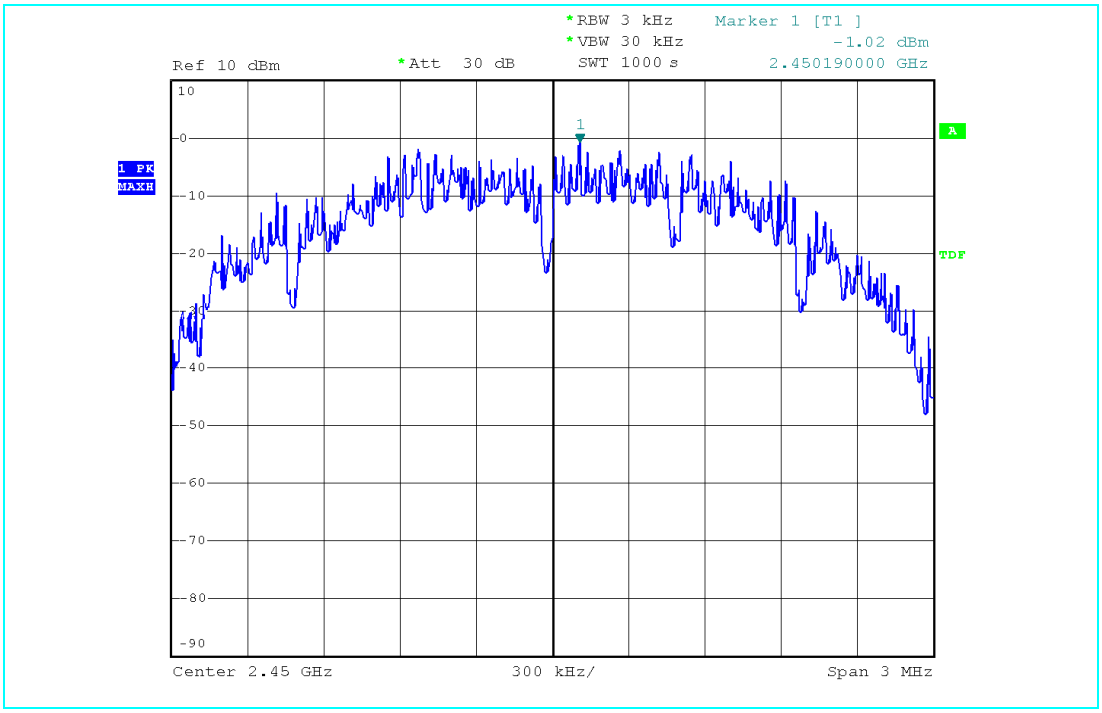
Plot No. 3:



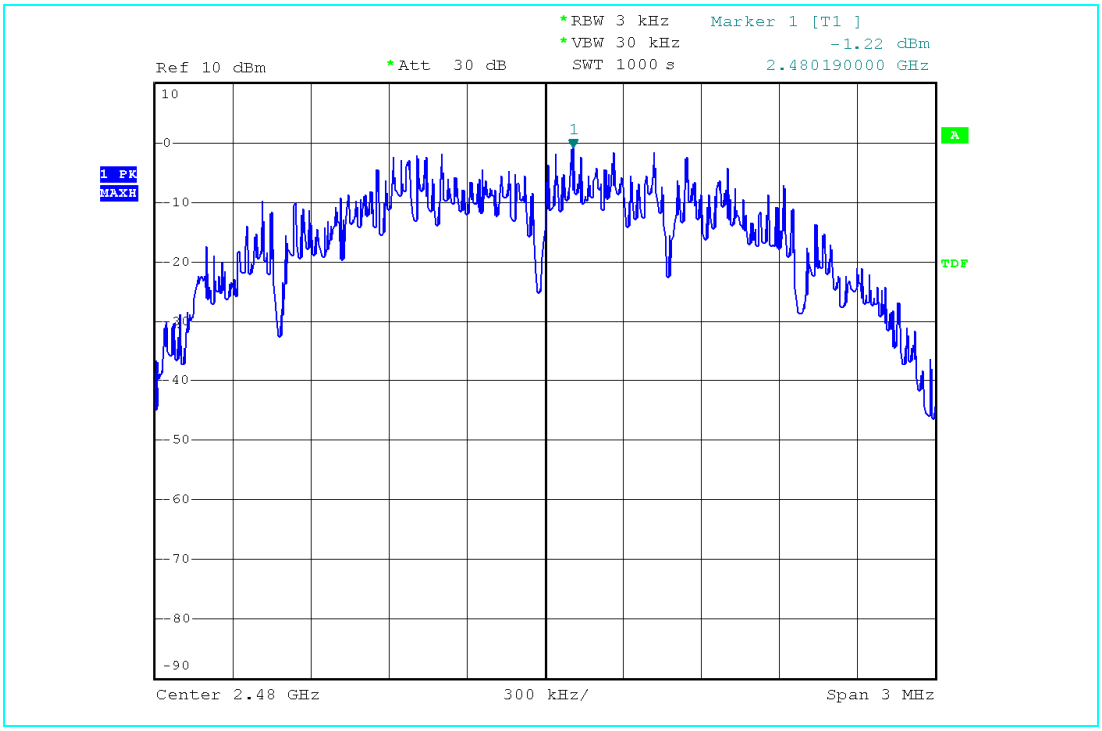
SPZB32W1A1.1
Plot No. 4:



Plot No. 5:



Plot No. 6:



TEST No.10	Title "RF Exposure Evaluation"	47CFR Part 15 Ref. Section
		15.247 (i)
TEST SET-UP & REQUIREMENTS	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. See § 1.1307(b)(1) of this Chapter.	
	EUT classification (fixed, mobile or portable devices)	Fixed, mobile or portable
	LIMITS	See table below

Limit for maximum permissible Exposure (MPE)

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm^2)	Avarage Time (minutes)
(A) Limits for Occupational/Controlled Exposure				
0.3÷3.0	614	1.63	(100)*	6
3.0÷30	1842/f	4.89/f	($900/f^2$)*	6
30÷300	61.4	0.163	1.0	6
300÷1500	--	--	f/300	6
1500÷100,000	--	--	5	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3÷3.0	614	1.63	(100)*	30
3.0÷30	824/f	2.19/f	($180/f^2$)*	30
30÷300	27.5	0.073	0.2	30
300÷1500	--	--	f/1500	30
1500÷100,000	--	--	1.0	30
F = Frequency in MHz *Plane-wave equivalent power density				

The distance from the device's transmitting antenna where the exposure level reaches the maximum permitted limit is calculated using the general equation:

$S = P*G/ 4\pi R^2$

Where:
S = Power Density (mW/cm^2)
P = Conducted power (mW)
G = Linear power gain relative to isotropic radiator (numeric gain)
R = Distance (cm)

RF Exposure evaluation Distance:

SPZB32W1A1.1

Channel	Frequency	Output power to antenna	Power density @ 20 cm	Distance where the exposure level reaches the limit	Limits
(No.)	(MHz)	(dBm)	(mW/cm^2)	(cm)	(mW/cm^2)
11	2405,00	10,25	0,002107	0,918	1
20	2450,00	11,05	0,002535	1,007	1
26	2480,00	11,68	0,002929	1,082	1

SPZB32W1C1.1

Channel	Frequency	Output power to antenna	Power density @ 20 cm	Distance where the exposure level reaches the limit	Limits
(No.)	(MHz)	(dBm)	(mW/cm^2)	(cm)	(mW/cm^2)
11	2405,00	19,38	0,017252	2,627	1
20	2450,00	19,67	0,018442	2,716	1
26	2480,00	19,98	0,019807	2,815	1

Test Result:

The EUT operates at low power level so it does not exceed the Commission's RF exposure guidelines limits; furthermore, Spread spectrum transmitters operate according to the Section 15.247 are categorically excluded from routine environmental evaluation.
RF exposure limit warning or SAR test are not required.

6 ADDITIONAL TECHNICAL INFORMATION

6.1 ELECTROMAGNETICALLY RELEVANT COMPONENTS:

Components	N°	Manufacturer	Type – Technical data
Radio Module			
See Technical document			
Host Equipment			
Test Jig		STM	/

6.2 RFI SUPPRESSION DEVICES:

Components	N°	Manufacturer	Type – Technical data
None			

6.3 EMI PROTECTION DEVICES:

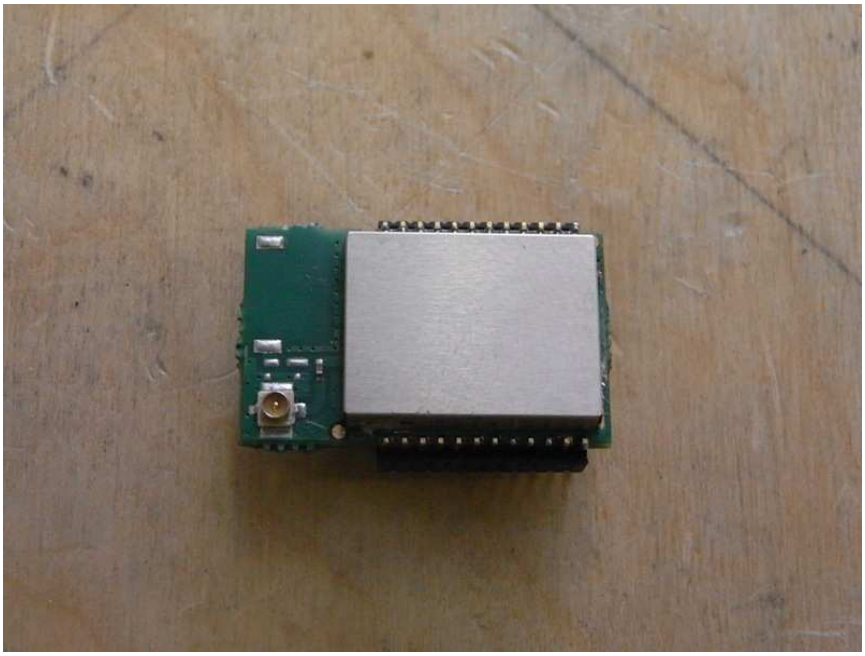
Components	N°	Manufacturer	Type – Technical data
None			

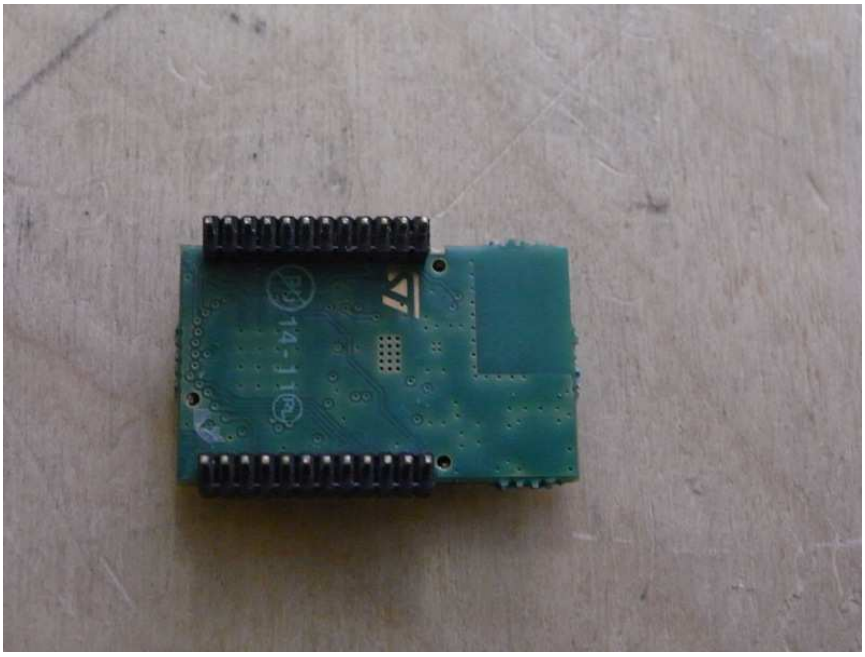
7 TECHNICAL DOCUMENTATION

DOCUMENT	REFERENCE
Bill of materials	ZigBee module CL1 with STM32W (antenna) – Doc. No. 8330310A Rev.A 09/05/2011 ZigBee module CL1 with STM32W (connector) – Doc. No. 8330311A Rev.A 09/05/2011
Electronic diagram	STM-STM32W108CB ZigBee (class 1 with SIGE-SE2432L) module – Rev. 1.0 24/03/2011
Manual	SPZB32W1A1.1 / SPZB32W1C1.1 – TentativeDatasheet_01
Component Layout	PC06A – Rev. V01 24/03/2011

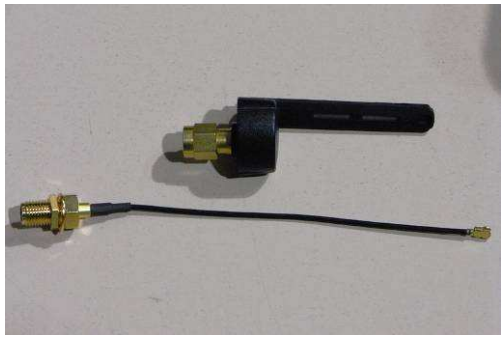
8 PHOTOGRAPHIC DOCUMENTATION

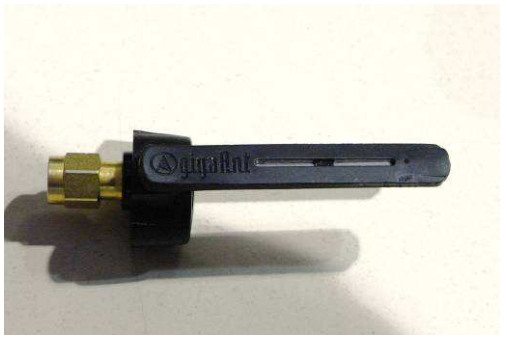
8.1 EUT IDENTIFICATION

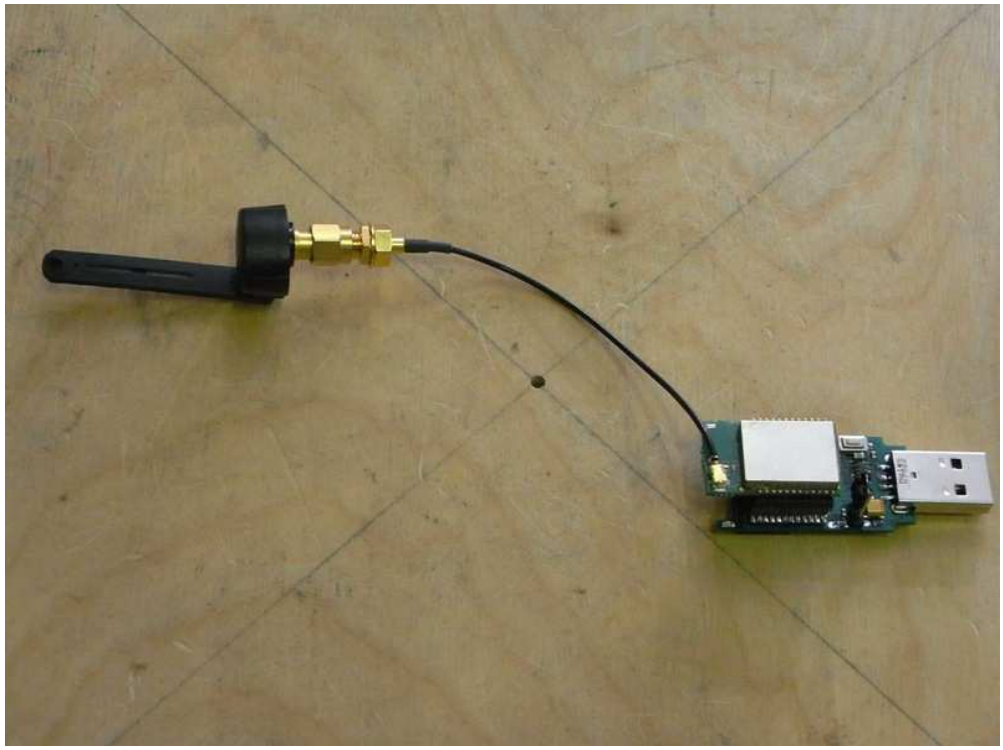




Model SPZB32W1C1.1

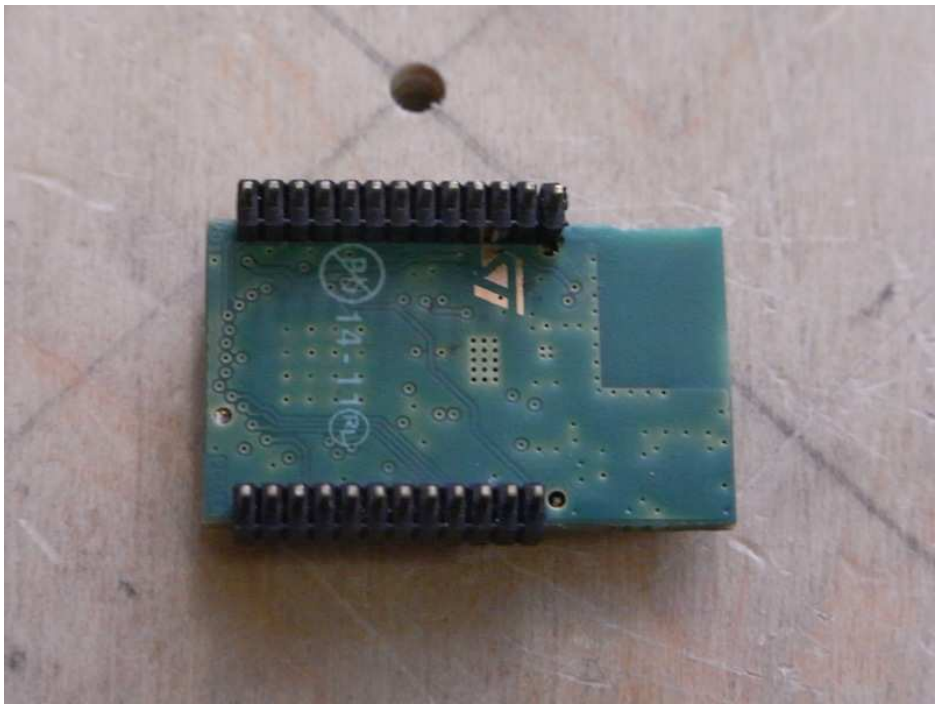






Model SPZB32W1C1.1

Equipment under test identification: Test jig + Radio module + Antenna



Model SPZB32W1A1.1

Model SPZB32W1A1.1

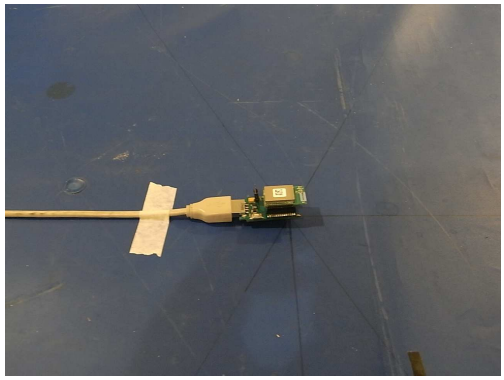
Radio module on Dongle unit (auxiliary equipment not in testing)

Dongle unit (front view)

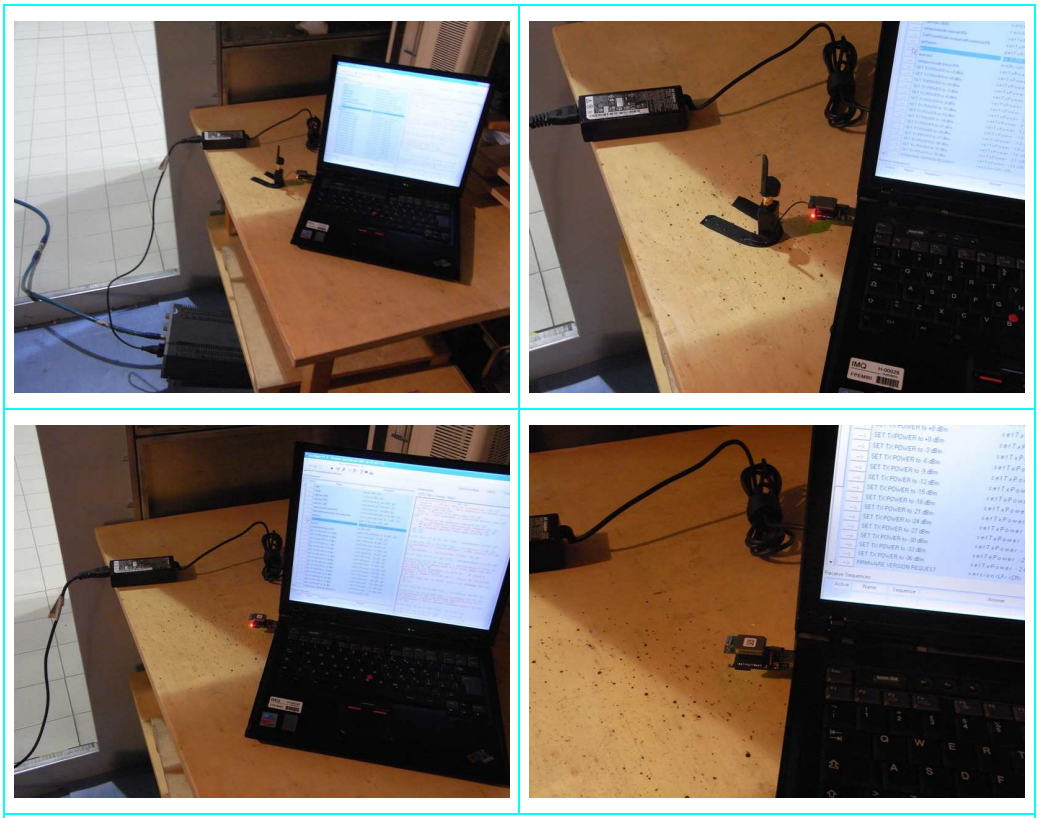
Dongle unit (rear view)

8.2 TEST SET-UP

Set up of Radiated emission test (ANTENOVA antenna)




Set up of Radiated emission test (RAINSUN antenna)



Set up of Conducted emission test

9 MEASUREMENT AND TEST EQUIPMENT INSTRUMENTATION

Instruments	Manufacturer	Model	IMQ serial number	Calibration data	Calibration interval (Month)
Emi Receiver	Rohde & Schwarz	ESHS	S-03494	05/2010	18
Emi Receiver	Rohde & Schwarz	ESCI	S-04355	01/2010	24
Artificial Mains V-network	Rohde & Schwarz	ENV216	S-03631	05/2011	12
Spectrum Analyzer	Rohde & Schwarz	FSP40	S-03629	11/2009	24
Loop Antenna	Rohde & Schwarz	HFH2-Z2	S-02508	12/2008	36
Antenna Bilog	ARA	LPD-2513	S-02385	07/2009	24
Antenna ridged horn 1÷18 GHz	Schwarzbeck	BBHA9120D	S-03464	07/2009	24
Antenna ridged horn 15÷40 GHz	Schwarzbeck	BBHA9170	S-03668	05/2010	24
Pre-amplifier 1-26.5 GHz	HP	HP 8449 B	S-03542	02/2011	24
Pre-amplifier 30-1000 MHz	BONN ELEKTRONIK	BLNA	S-04193	02/2011	24
Digital Oscilloscope	Yokogawa	DL7200	S-03745	05/2010	12
Band Reject Filter 2400÷2483 MHz	Wainwright	WRCG2400 / 2483	S-04308	/	/
Highpass Filter 3.4÷18 GHz	Wainwright	WHK3.4/18	S-04309	/	/
Crystal Detector	Agilent	8472B	S-04467	/	/
Software for test automation	Rohde & Schwarz	ES-K1 V.1.60	/	/	/

The IMQ instruments are tested and calibrated according to UNI EN 45001, the IMQ procedure IP-037 "Calibration test equipment and measurement" and according to plans set on IMQ operating instruction IO-FT-034 “Criteria for the calibration of test equipment and measurement” which are an integral part of the Quality Manual of IMQ.