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RTTE AND AUTOMOTIVE COMPONENTS LABORATORY

TEST REPORT
No. AE14S0259859-04

performed in accordance with

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

PRODUCT	RF radio module for wireless communication integrated in a sound system
MODEL(s) TESTED	WKBT0204AR
FCC ID	2AFJMESS-SSY
TRADE MARK(s)	EFFEGIBI

APPLICANT	EFFEGIBI S.r.l. ~ Via Gallo, 769 ~ I - 47522 Borello di Cesena (FC)

Approved by	Roberto Colombo *[Laboratory Manager]*	Roberto Colombo

Revision Sheet

Release No.	Date	Revision Description
Rev. 0	2014-10-31	First edition Digital signed - AE14S0259859-04_TR_FCC 15.247_EFFEGIBI_ESS sound system
Rev. 1	2015-02-12	Adjustment § 10 photographic documentation Digital signed - AE14S0259859-04 Rev.1_TR_FCC 15.247_EFFEGIBI_ESS sound system
Rev. 2	2015-09-31	Modified the FCC ID Digital signed - AE14S0259859-04 Rev.3_TR_FCC 15.247_EFFEGIBI_ESS sound system

1. GENERAL DATA

SAMPLE		
Samples received on	**2014-05-14**	**(item sent and sampling by applicant)**
IMQ reference samples	**BEM**	**73088**
Samples tested No.	1+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	2014-05-27 ÷ 2014-06-17	
Testing laboratory.	IMQ S.p.A. - Via Quintiliano, 43 – I-20138 Milano	
Testing site	Via Quintiliano, 43 – I-20138 Milano Viale Lombardia, 20 – I-20021 Bollate (MI)	
ENVIRONMENTAL CONDITIONING		
Parameter	***Measured***	
Ambient Temperature	25 ÷ 35 °C	
Relative Humidity	50 ÷ 60 %	
Atmospheric Pressure	900 ÷ 1000 mbar	

2. REFERENCE DOCUMENT

DOCUMENT		DATE	TITLE
☒	47 CFR Part 15	2008	Radio Frequency Device
☒	ANSI C63.4	2009	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	2009	American National Standard for Testing Unlicensed Wireless Devices

3. UNIT UNDER TEST (EUT) DETAILS

GENERAL DATA

MODEL (basic)	Description
WKBT0204AR	RF radio module for wireless communication. The module has been tested integrated on a sound system docking station (ESS DOCKING) and on a sound system receiver (ESS RECEIVER)

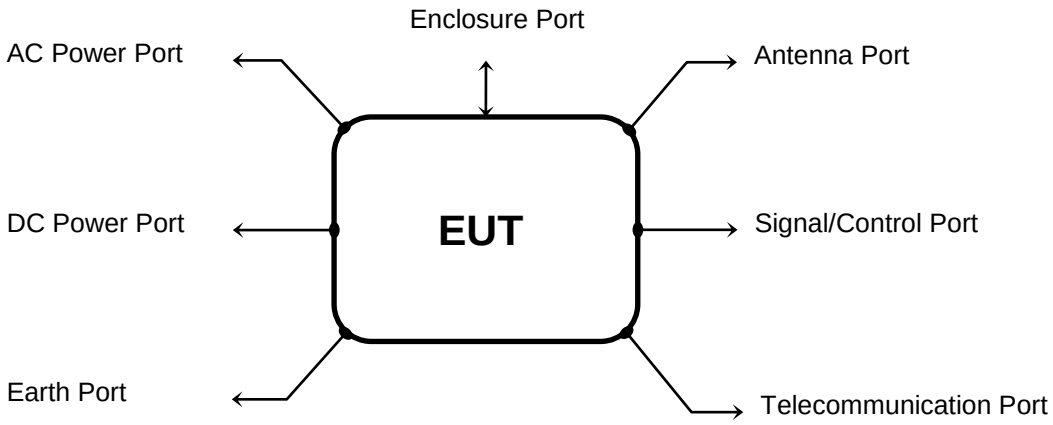
FCC ID	2AFJMESS-SSY

Manufacturer	EFFEGIBI S.r.l. ~ Via Gallo, 769 ~ I - 47522 Borello di Cesena (FC)

Type of equipment	RF radio module
Operating frequency:	2402 – 2480 MHz
Maximum RF radiated power:	3.68 dBm
Modulation:	GFSK, π/4DQPSK and 8DPSK
Channel Spacing:	1 MHz (79 channels)
Antenna:	Integral
RX sensitivity:	/
Main SW identification	/
Main HW Board identification	/
Peripherals included (for system application)	/
Interfaces :	/
Integrated interfaces :	/
AC adapter:	AC/DC adapter of ESS DOCKING trade Mean Well model FRA012-S05-I AC/DC adapter of ESS RECEIVER trade Comatec model 1465F
Data cable	/
Telecom cable	/
Power supply type :	/
AC power input cable :	/
DC power input cable :	/

4. TEST CONFGURATION OF UNIT UNDER TEST

EUT PORTS



Port	Description	Max length
Enclosure	ESS DOCKING: Plastic ESS RECEIVER: metal	/
AC power	ESS DOCKING trade Mean Well model FRA012-S05-I 230/5V ESS RECEIVER trade Comatec model 1465F 230/12V	/
DC power	/	/
Earth	/	/
Telecommunication	/	/
Signal	/	/
Control	/	/
Antenna	Integral	/

CHANNEL CONFIGURATION

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
1	2402	2	2403	3	2404	4	2405
5	2406	6	2407	7	2408	8	2409
9	2410	10	2411	11	2412	12	2413
13	2414	14	2415	15	2416	16	2417
17	2418	18	2419	19	2420	20	2421
21	2422	22	2423	23	2424	24	2425
25	2426	26	2427	27	2428	28	2429
29	2430	30	2431	31	2432	32	2433
33	2434	34	2435	35	2436	36	2437
37	2438	38	2439	39	2440	40	2441
41	2442	42	2443	43	2444	44	2445
45	2446	46	2447	47	2448	48	2449
49	2450	50	2451	51	2452	52	2453
53	2454	54	2455	55	2456	56	2457
57	2458	58	2459	59	2460	60	2461
61	2462	62	2463	63	2464	64	2465
65	2466	66	2467	67	2468	68	2469
69	2470	70	2471	71	2472	72	2473
73	2474	74	2475	75	2476	76	2477
77	2478	78	2479	79	2480	---	---

STATE OF THE EUT DURING TESTS

Ref.	Mode	Description
#1	Operating	Continuous transmission (single channel transmission) – GFSK modulation
#2	Operating	Continuous transmission (single channel transmission) – π/4DQPSK modulation
#3	Operating	Continuous transmission (single channel transmission) – 8DPSK modulation

SUPPORT EQUIPMENT

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

Equipment	Manufacturer	Model
/	/	/

ELECTROMAGNETICALLY RELEVANT COMPONENTS

Component	No.	Manufacturer	Model
/	/		/

RFI SUPPRESSION DEVICES

Component	No.	Manufacturer	Model
/	/		/

EMI PROTECTION DEVICES

Component	No.	Manufacturer	Model
/	/	/	/

EUT TECHNICAL DOCUMENTATION

Document	Reference
User guide	MACH000032 rev.01

5. 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 § 6 of this test report.
FREQUENCY RANGE INVESTIGATED
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
§ 15.35	Duty cycle	PASS
§ 15.203	Antenna Requirements	PASS
§ 15.207(a)	Conducted Emission	PASS
§ 15.209(a)(f)	Spurious Radiated Emission	PASS
§ 15.247(a)	**Frequency Hopping Spread Spectrum Specifications**	
§ 15.247(a)(1)	Hopping channel carrier frequency separation	PASS
§ 15.247(a)(1)	20 dB Bandwidth	PASS
§ 15.247(a)(1)(iii)	Number of Hopping Channels Used	PASS
§ 15.247(a)(1)(iii)	Time occupancy (Dwell Time)	PASS
§ 15.247(b)	**Maximum Peak Output Power**	
§ 15.247(b)(1)	Maximum peak conducted output power	PASS
§ 15.247(b)(3)	Maximum peak radiated output power (EIRP)	PASS
§ 15.247(b)(4)i	Antenna gain	PASS
§ 15.247(c)	Operation with directional antenna gains greater than 6 dBi	N.A.
§ 15.247(d)	100 kHz Bandwidth of Frequency Band Edges	PASS
§ 15.247(d)	Conducted Emission	PASS
§ 15.247(i)	RF humane exposure(§ 47CFR 1.1307(b)(1))	PASS

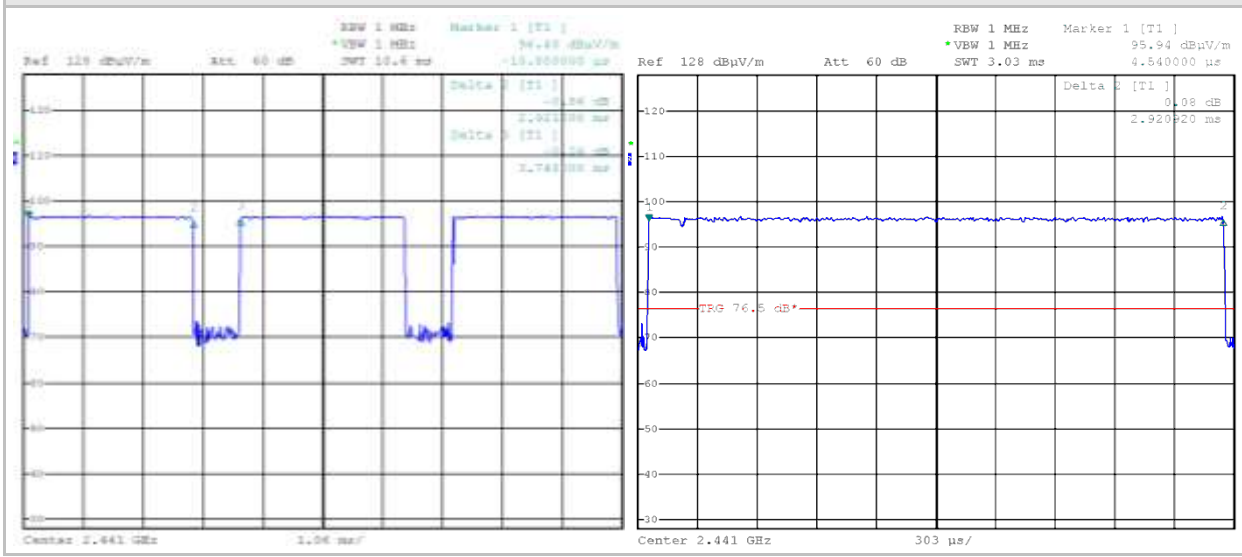
7. TEST RESULTS

7.1 DUTY CYCLE

TEST REQUIREMENT	
Test method	ANSI C63.4
Test requirement	FCC Part 15.35
Spectrum analyzer setting	RBW=1MHz – VBW=1MHz – SPAN=0Hz
EUT operating condition	#3

ESS DOCKING STATION and ESS RECEIVER – MODE 3DH5 (WORST CASE)

TEST RESULT



CORRECTION FACTOR TEST PROCEDURE

The EUT work time: T_{ON} = 2.92092 ms
The EUT work time: T = TON + TOFF = transmission period = 3.748 ms
The EUT duty cycle: D= TON / TON + TOFF = 2.92092 / 3.748 * 100 = 77.93%
Duty cycle correction factor (dB) = 20*Log_{10}(Duty Cycle) = 20* Log_{10}(0.7793) = -2.17 dB

7.2 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	Only integral antenna furnished by the responsible party.
Antenna type	Integral antenna (PCB strip)
External power amplifiers	Not present

TEST RESULT
The EUT meets the requirements of section 15.203 and 15.204

7.3 CONDUCTED EMISSIONS

TEST REQUIREMENT	
Test setup	ANSI C63.4
Frequency range	150 kHz ÷ 30 MHz
IF bandwidth	9 kHz
EMC class	B
Limits	Section 15.207 (a)
EUT operating condition	#1

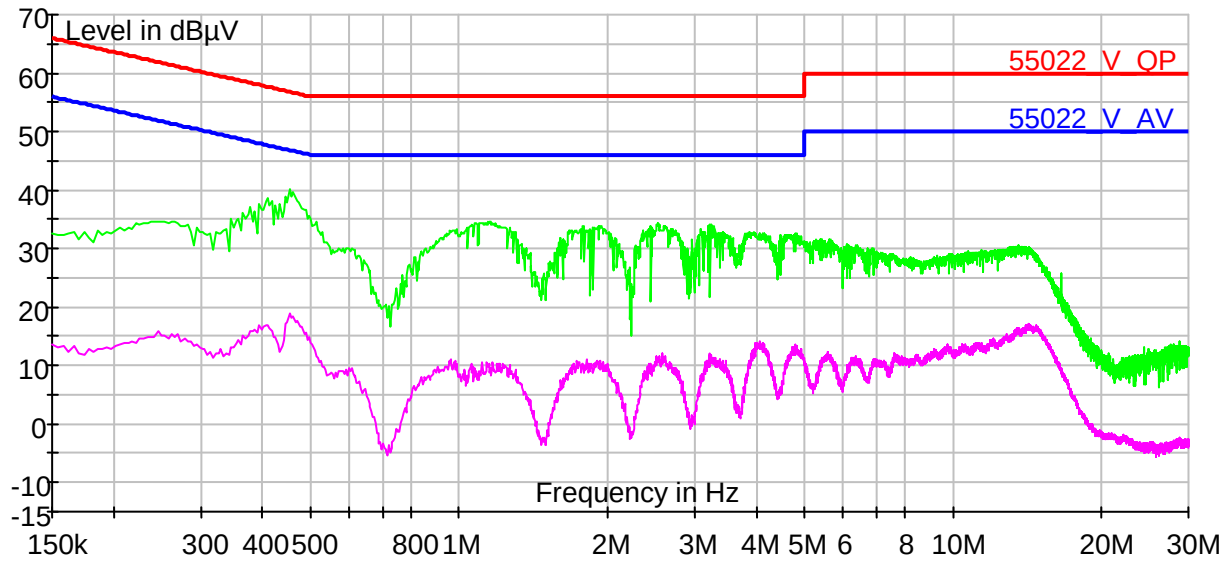
TEST RESULT
The EUT meets the requirements of sections 15.207.

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 ≥ (Q.P. limit - 6 dB).

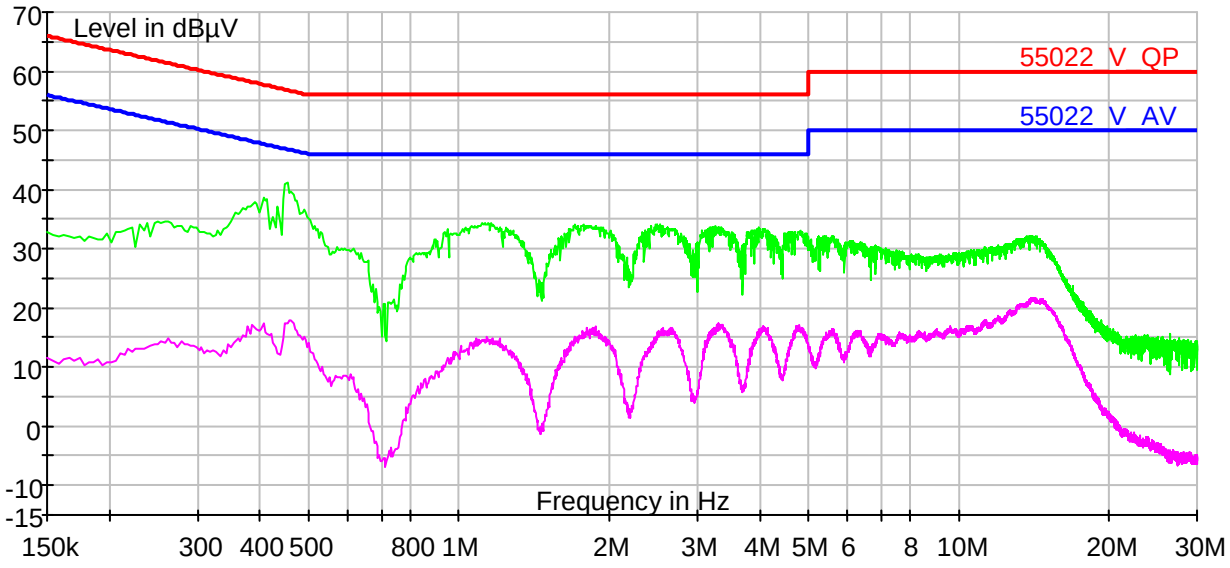
MEASUREMENTS RESULTS

AC/DC adapter of ESS DOCKING trade Mean Well model FRA012-S05-I

Port: AC of AC/DC adapter - Line: PHASE – Detectors: green line PEAK / purple line Average



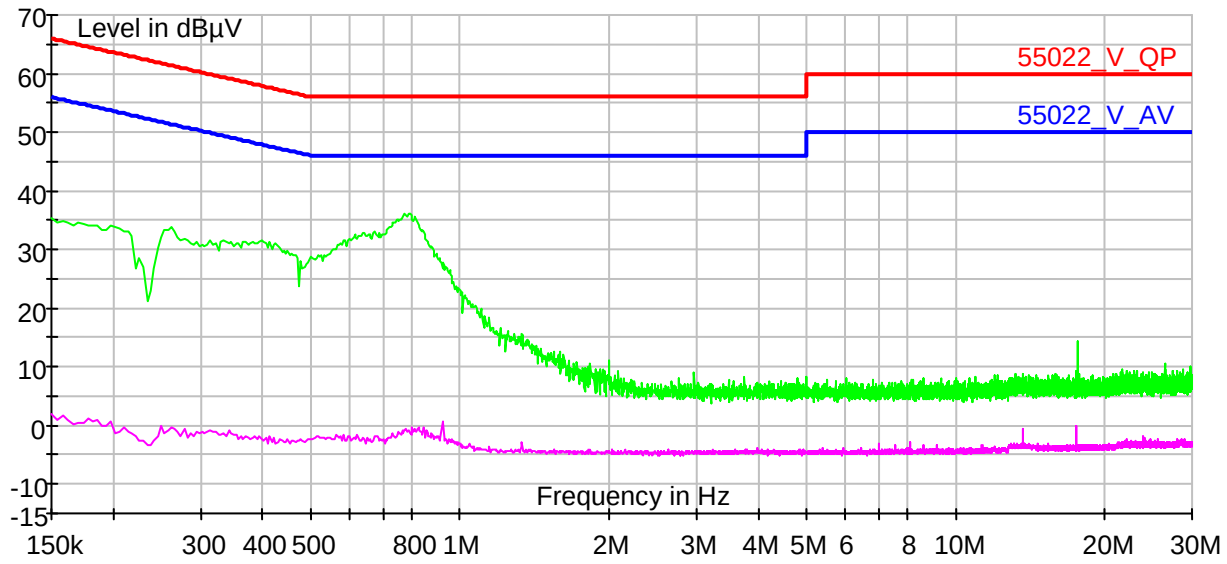
Port: AC of AC/DC adapter - Line: NEUTRAL – Detectors: green line PEAK / purple line Average



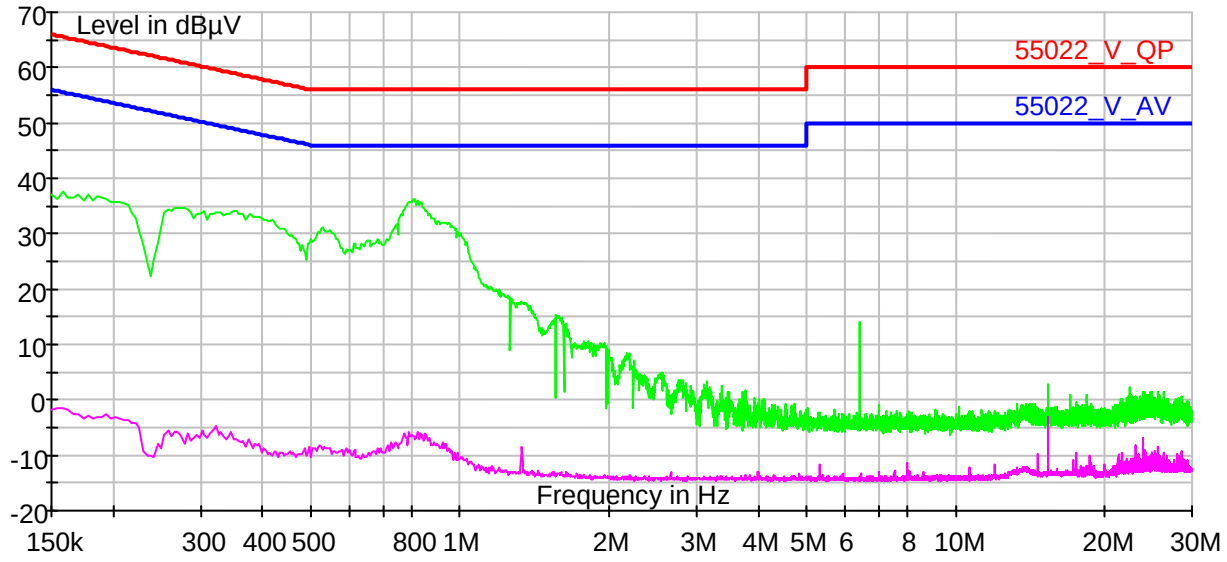
MEASUREMENTS RESULTS

AC/DC adapter of ESS RECEIVER trade Comatec model 1465F

Port: AC of AC/DC adapter - Line: PHASE – Detectors: green line PEAK / purple line Average



Port: AC of AC/DC adapter - Line: NEUTRAL – Detectors: green line PEAK / purple line Average



7.4 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) = 40log (300meter / 3meter) = +80dB; Extrapolation (dB) = 40log (30meter / 3meter) = +40dB	

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

TEST RESULT
The EUT meets the requirements of sections 15.209.

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 receiving antenna was positioned in both horizontal and vertical polarization. 5) The measurements were made with the detector set to PEAK amplitude within a bandwidth of 100 kHz below 1000 MHz and 1 MHz above 1000 MHz. 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).

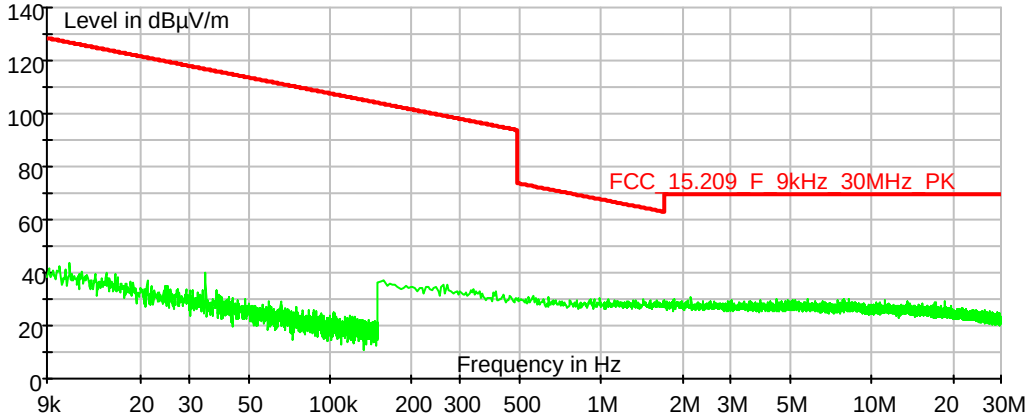
REMARK

All the modulation modes were tested, the data of the worst mode (GFSK) were recorded in the following plots.

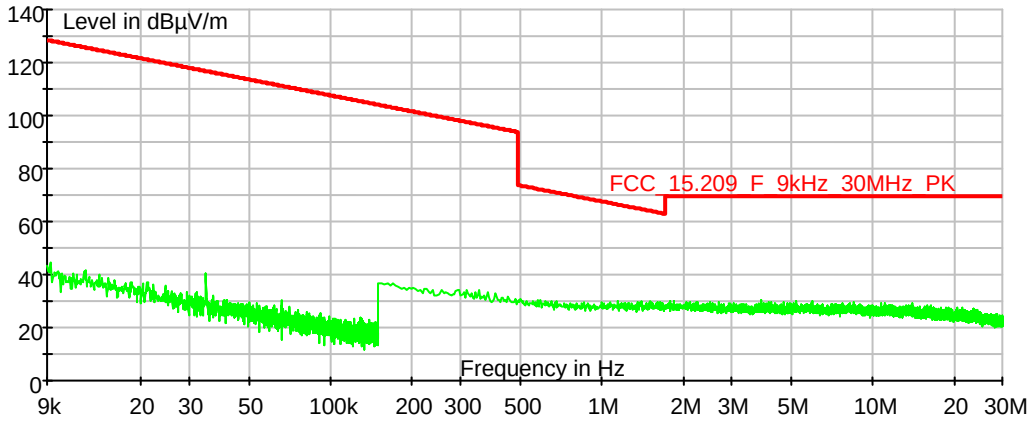
MEASUREMENTS RESULTS OF EUT: ESS DOCKING STATION

9 kHz÷30 MHz

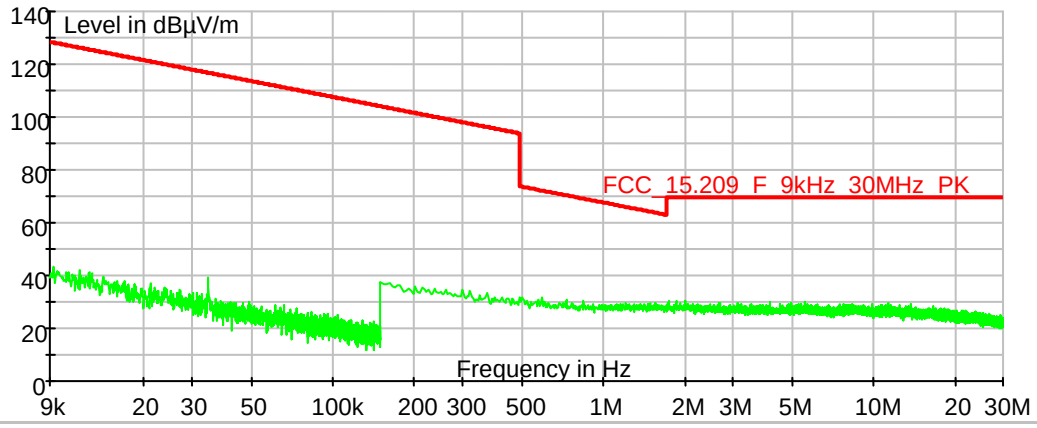
LOWER CHANNEL



MIDDLE CHANNEL

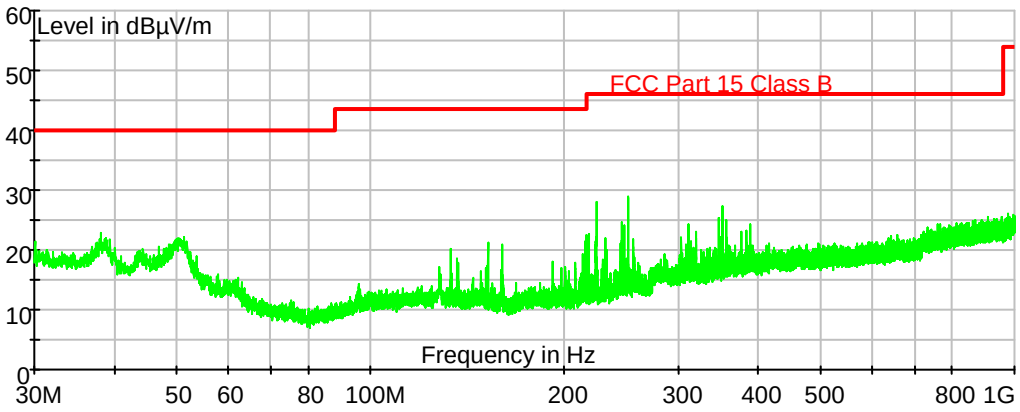


HIGHER CHANNEL

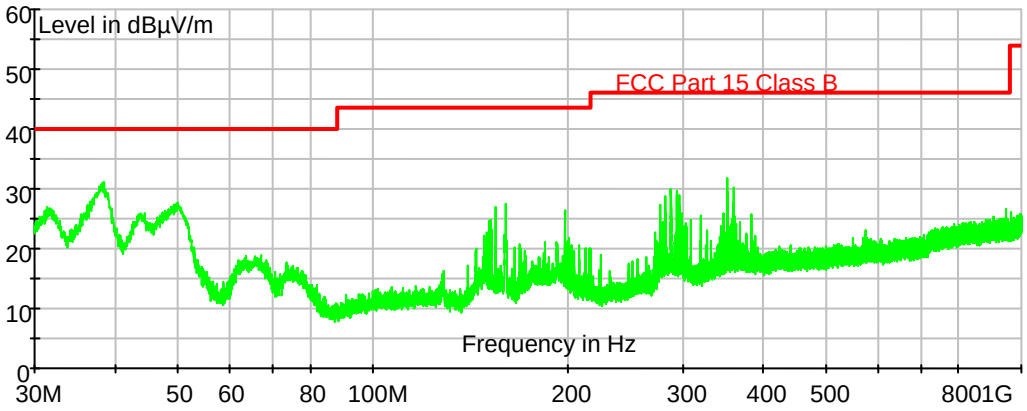


30÷1,000 MHz

LOWER CHANNEL – HORIZONTAL POLARIZATION

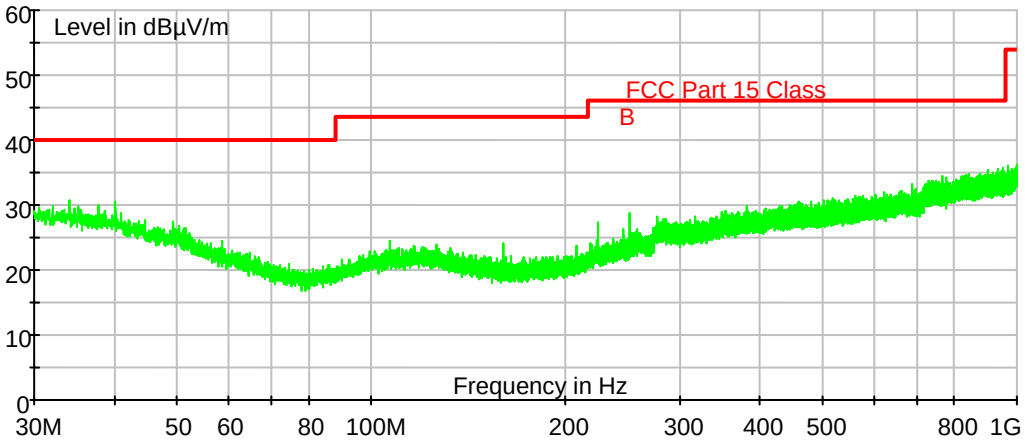


LOWER CHANNEL – VERTICAL POLARIZATION

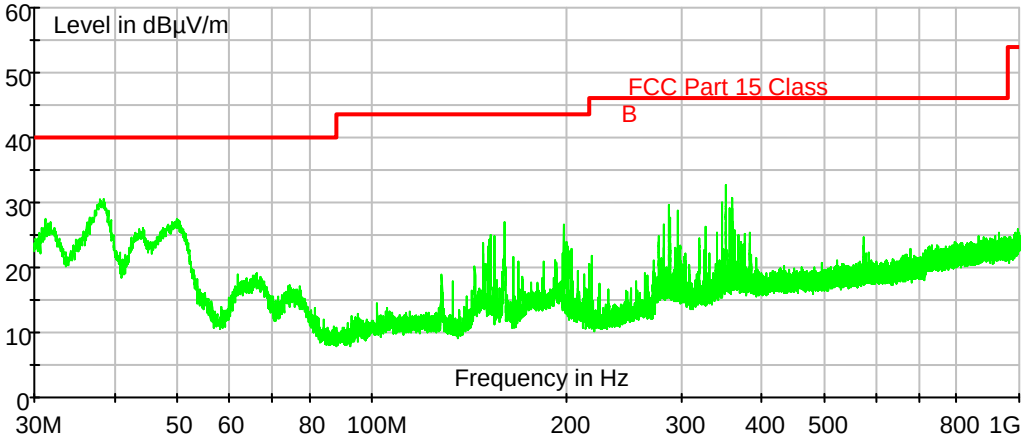


30÷1,000 MHz

MIDDLE CHANNEL – HORIZONTAL POLARIZATION

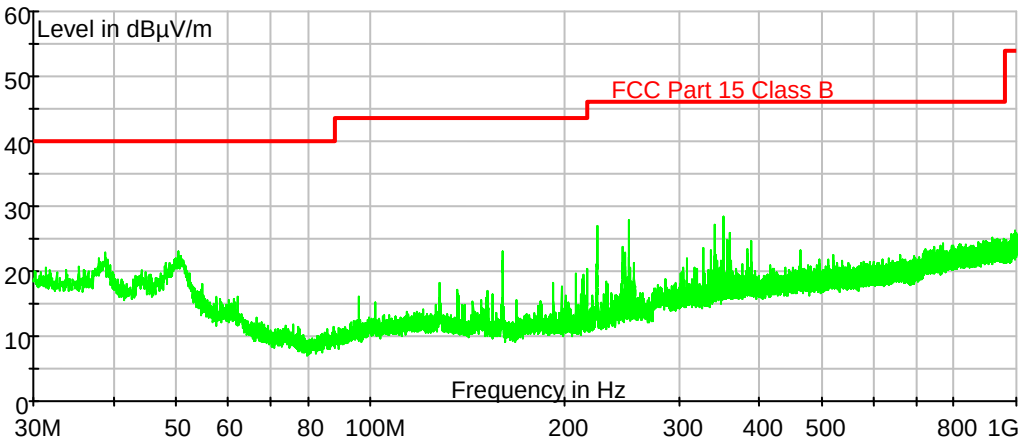


MIDDLE CHANNEL – VERTICAL POLARIZATION

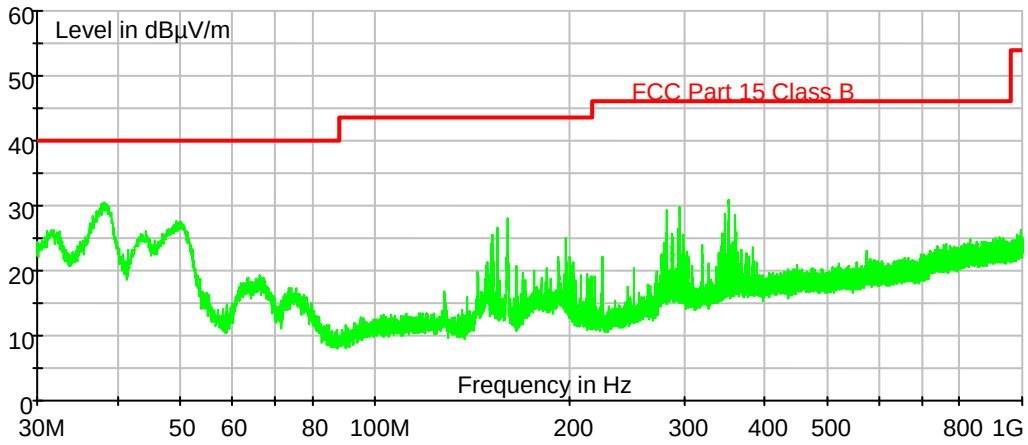


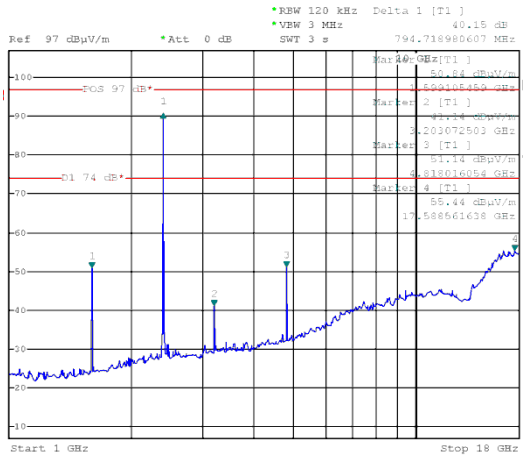
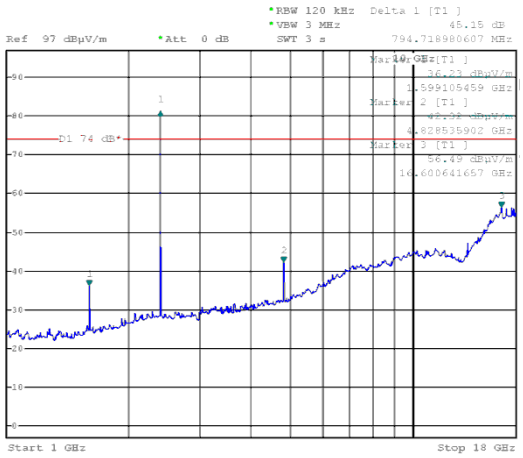
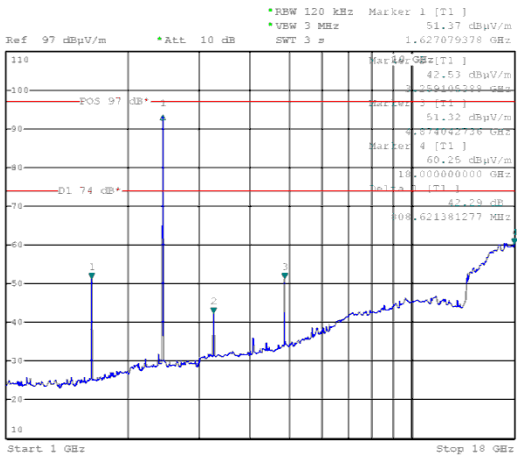
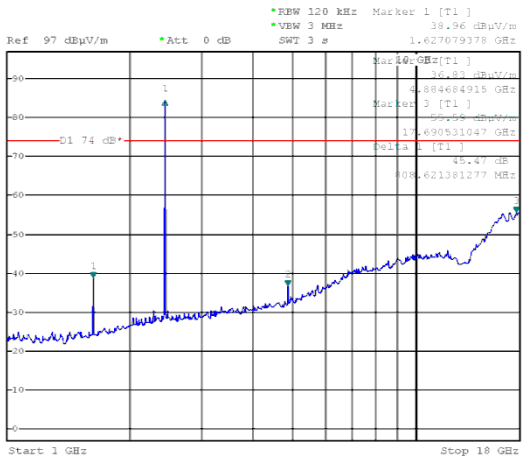
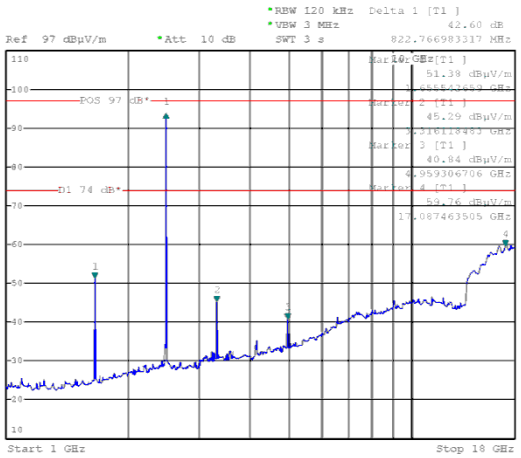
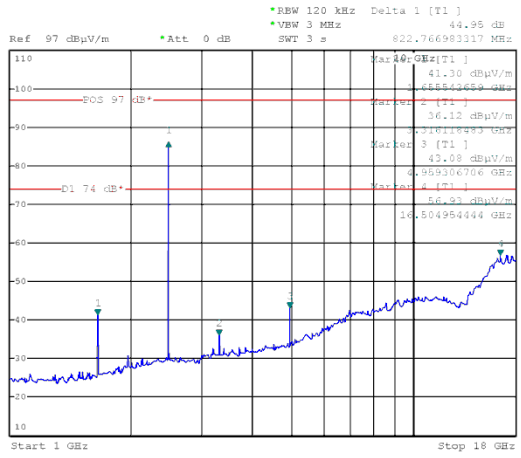
30÷1,000 MHz

HIGHER CHANNEL – HORIZONTAL POLARIZATION



HIGHER CHANNEL – VERTICAL POLARIZATION



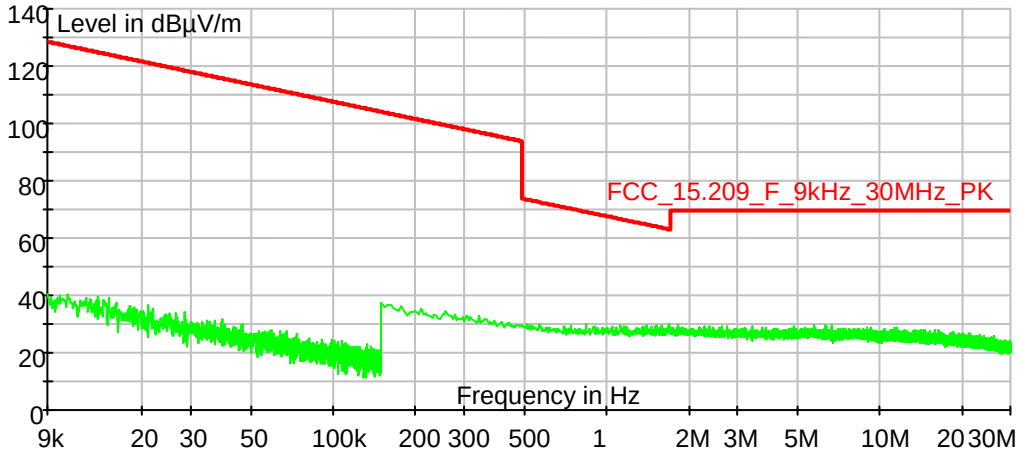
1GHz ÷ 18GHz	
LOWER CHANNEL – HORIZONTAL POLARIZATION	**LOWER CHANNEL – VERTICAL POLARIZATION**
	
MIDDLE CHANNEL – HORIZONTAL POLARIZATION	**MIDDLE CHANNEL – VERTICAL POLARIZATION**
	
HIGHER CHANNEL – HORIZONTAL POLARIZATION	**HIGHER CHANNEL – VERTICAL POLARIZATION**
	

The marker “Delta 1” points the fundamental frequency.

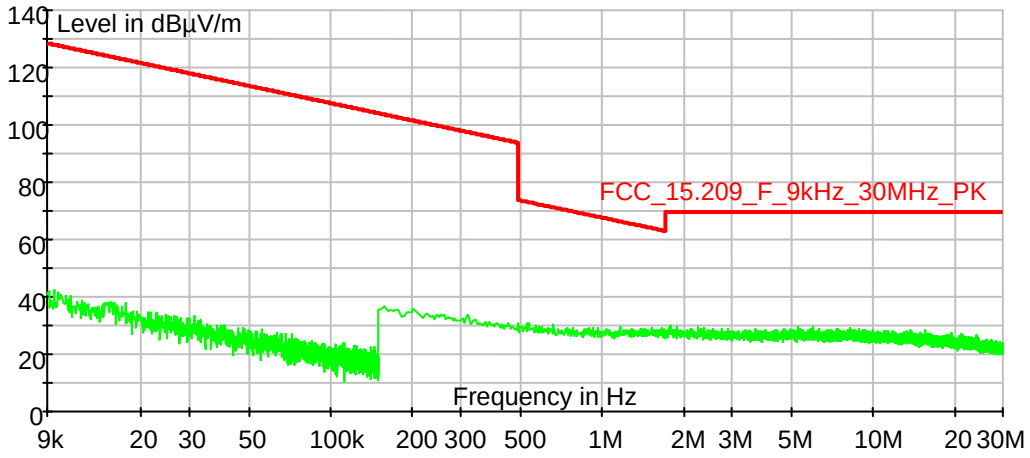
MEASUREMENTS RESULTS OF EUT: ESS RECEIVER

9 kHz÷30 MHz

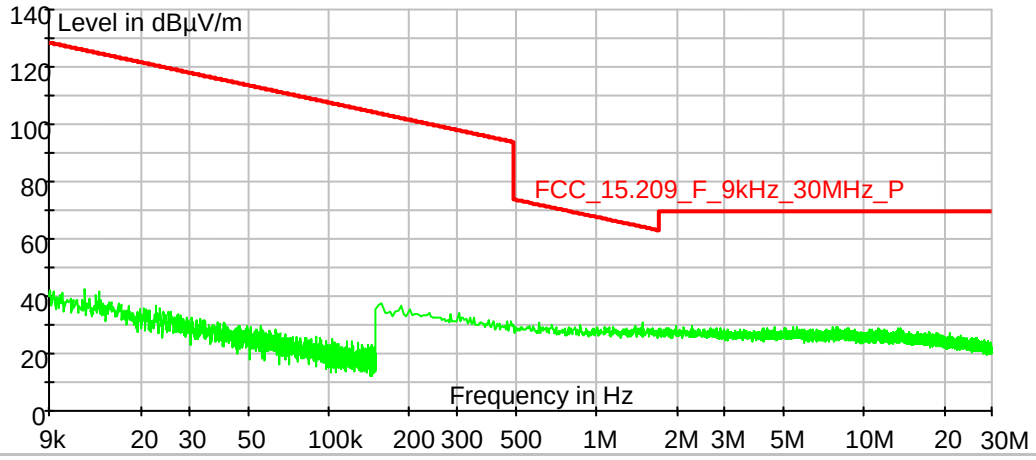
LOWER CHANNEL



MIDDLE CHANNEL

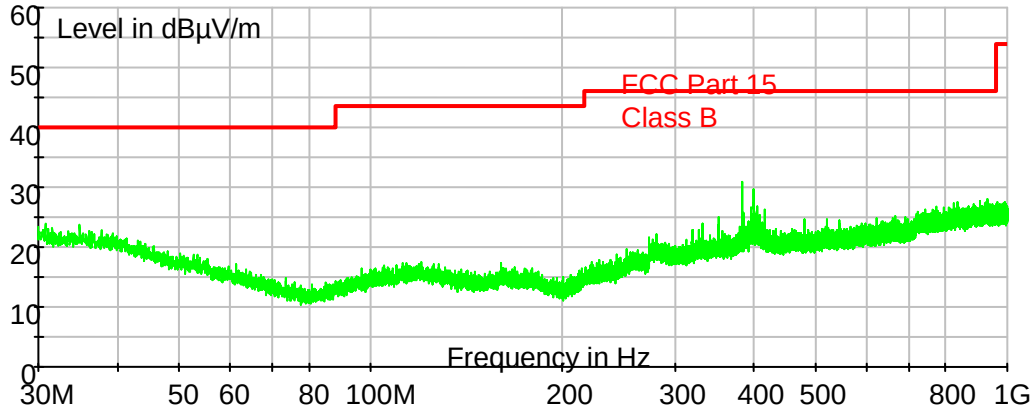


HIGHER CHANNEL

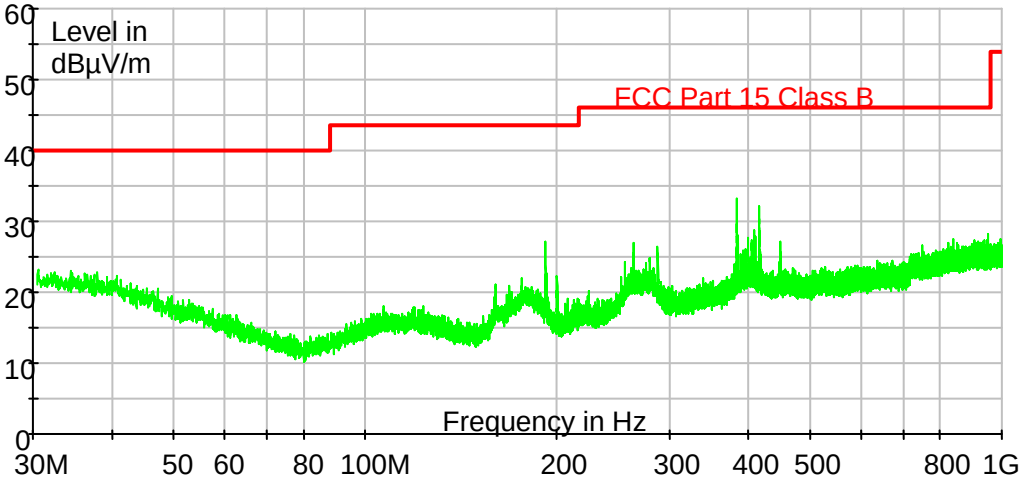


30÷1,000 MHz

LOWER CHANNEL – HORIZONTAL POLARIZATION

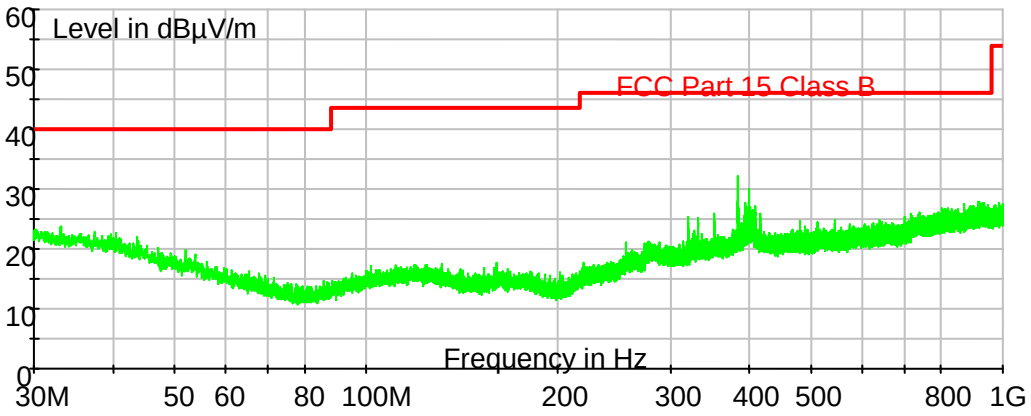


LOWER CHANNEL – VERTICAL POLARIZATION

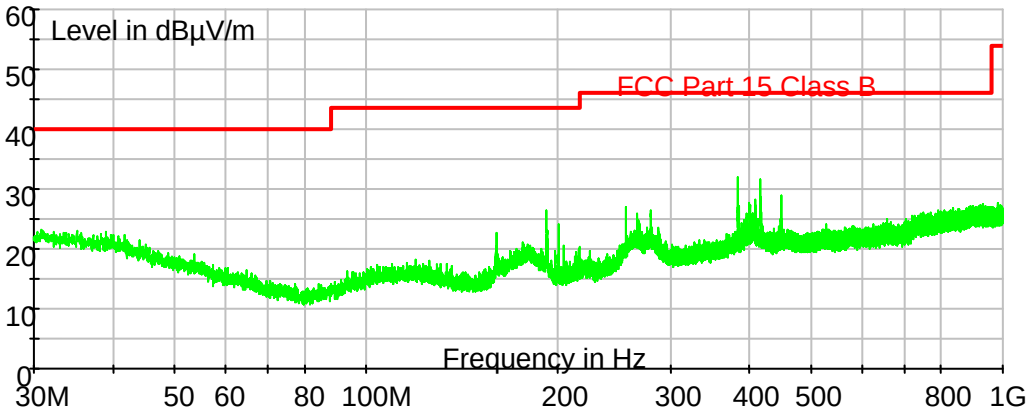


30÷1,000 MHz

MIDDLE CHANNEL – HORIZONTAL POLARIZATION

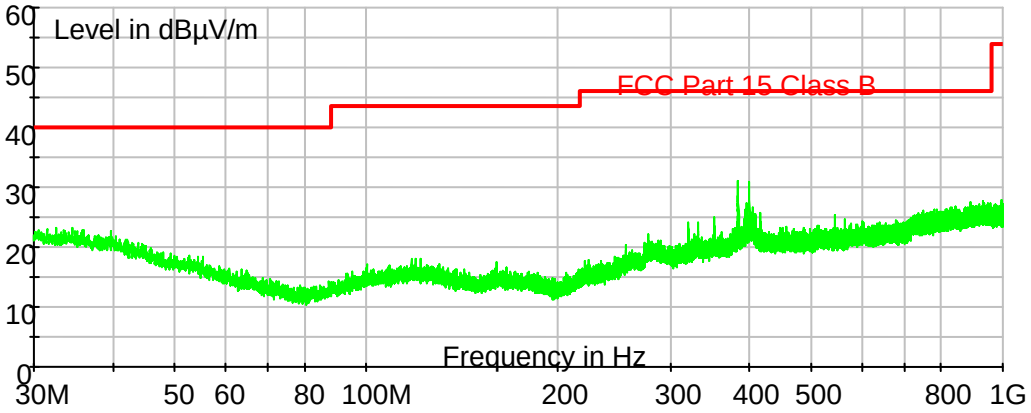


MIDDLE CHANNEL – VERTICAL POLARIZATION

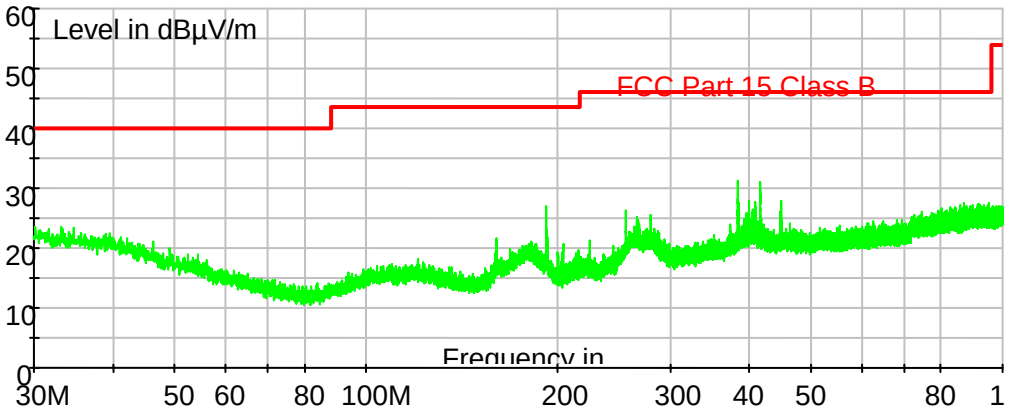


30÷1,000 MHz

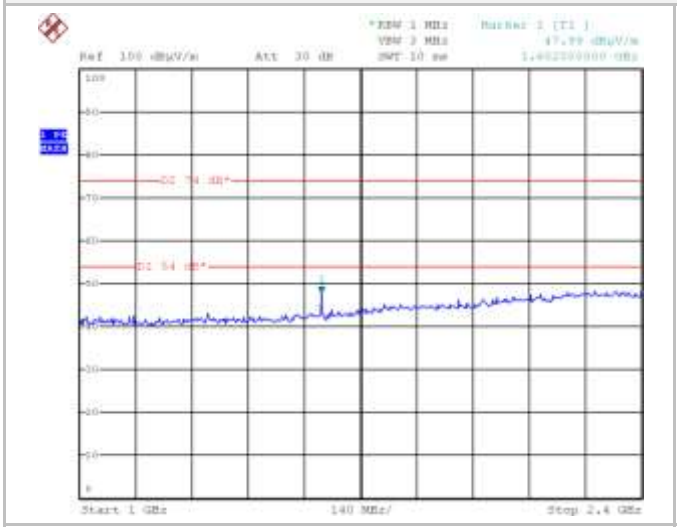
HIGHER CHANNEL – HORIZONTAL POLARIZATION

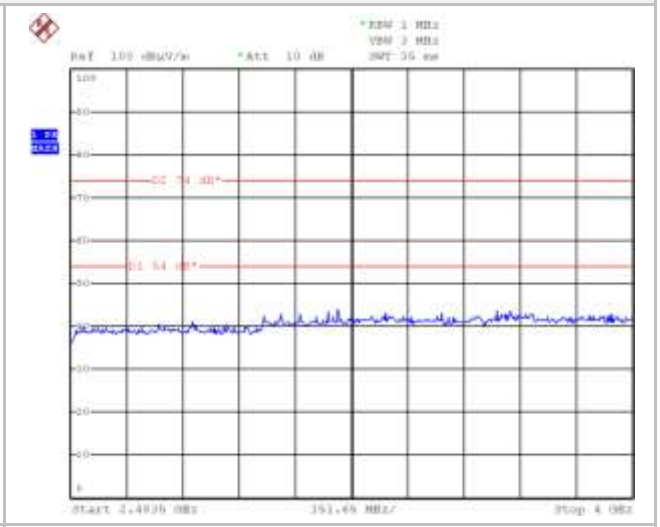


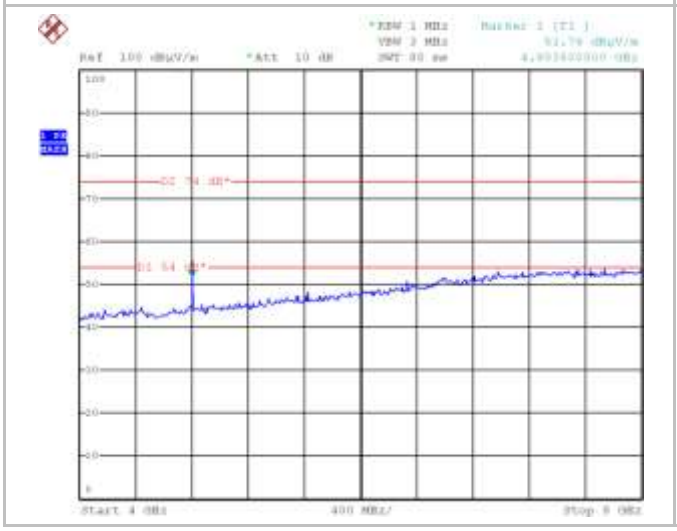
HIGHER CHANNEL – VERTICAL POLARIZATION

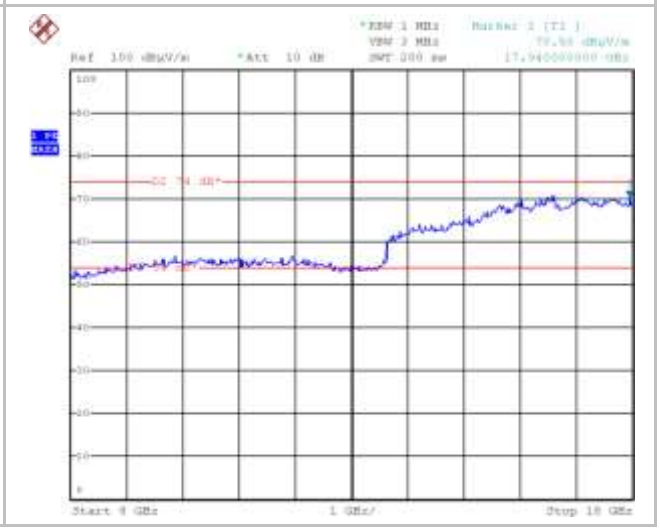


1GHz ÷ 18GHz
LOWER CHANNEL – HORIZONTAL POLARIZATION



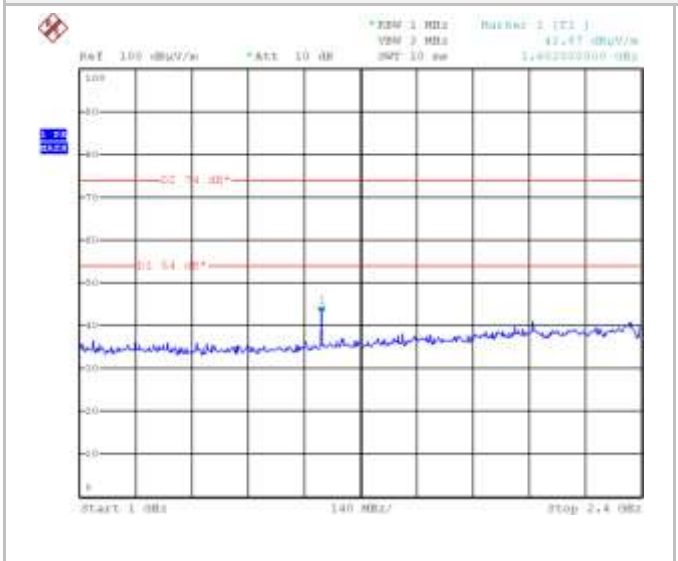


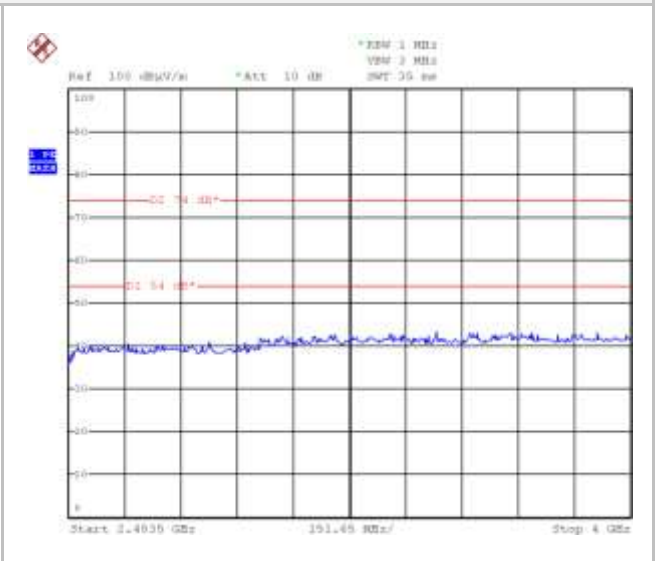


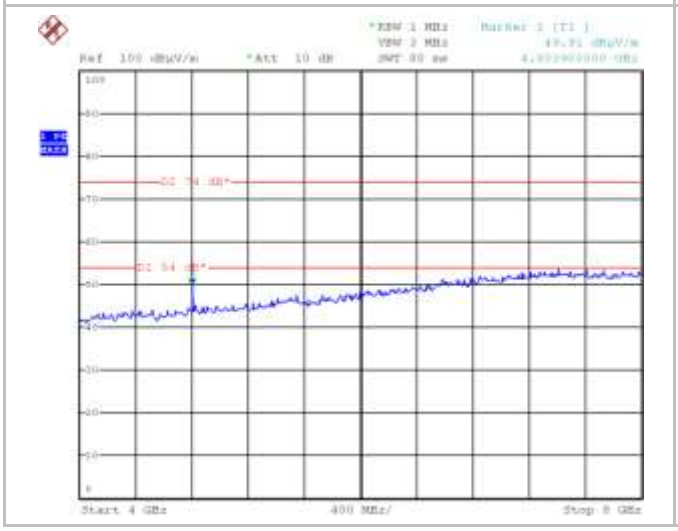


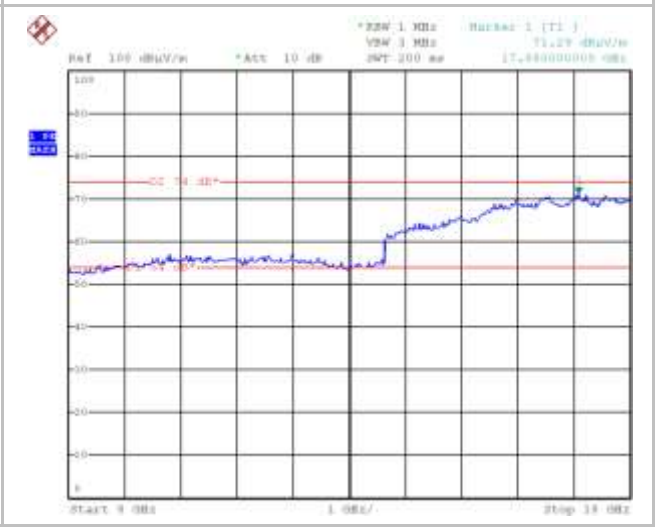
1GHz ÷ 18GHz

LOWER CHANNEL – VERTICAL POLARIZATION

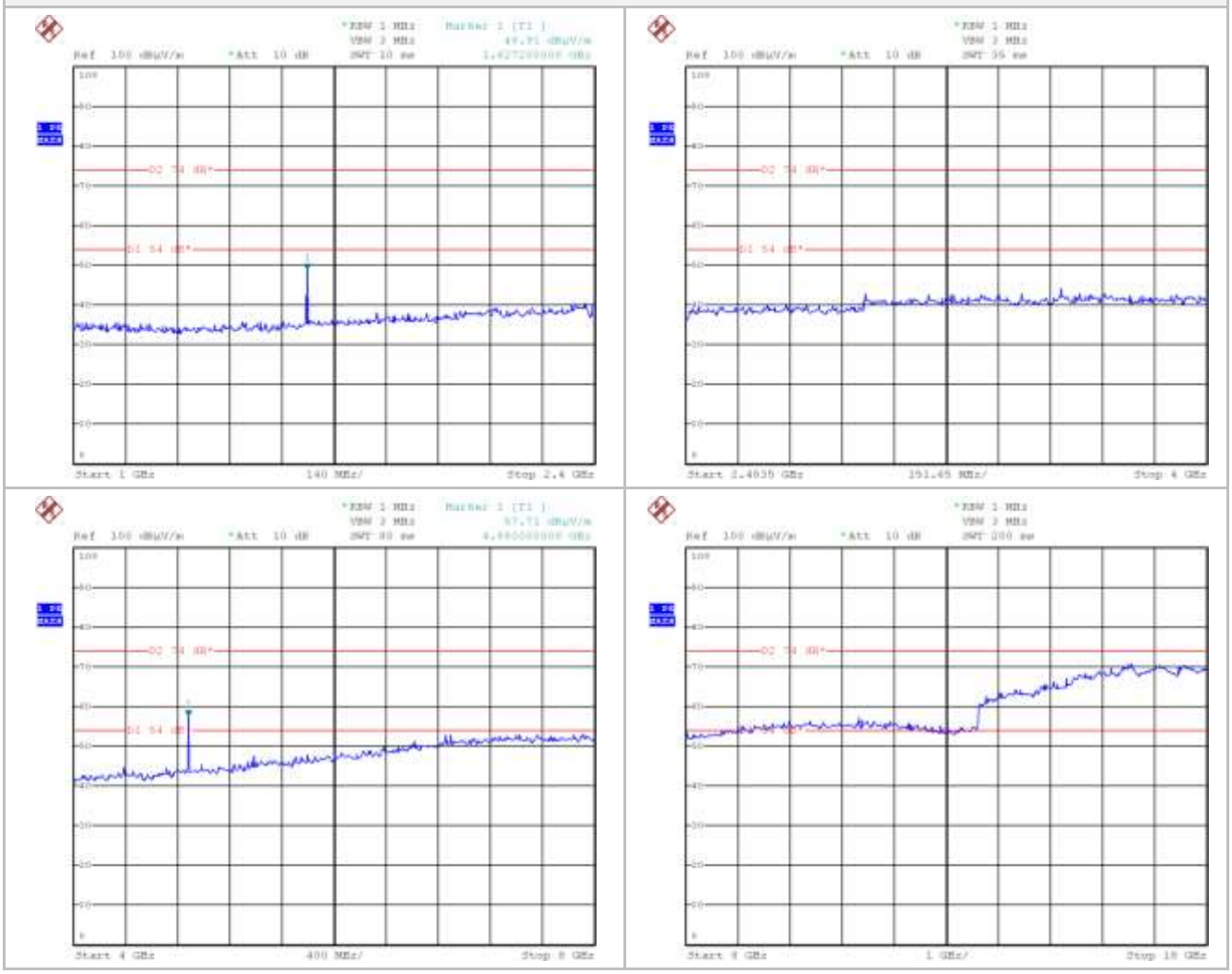




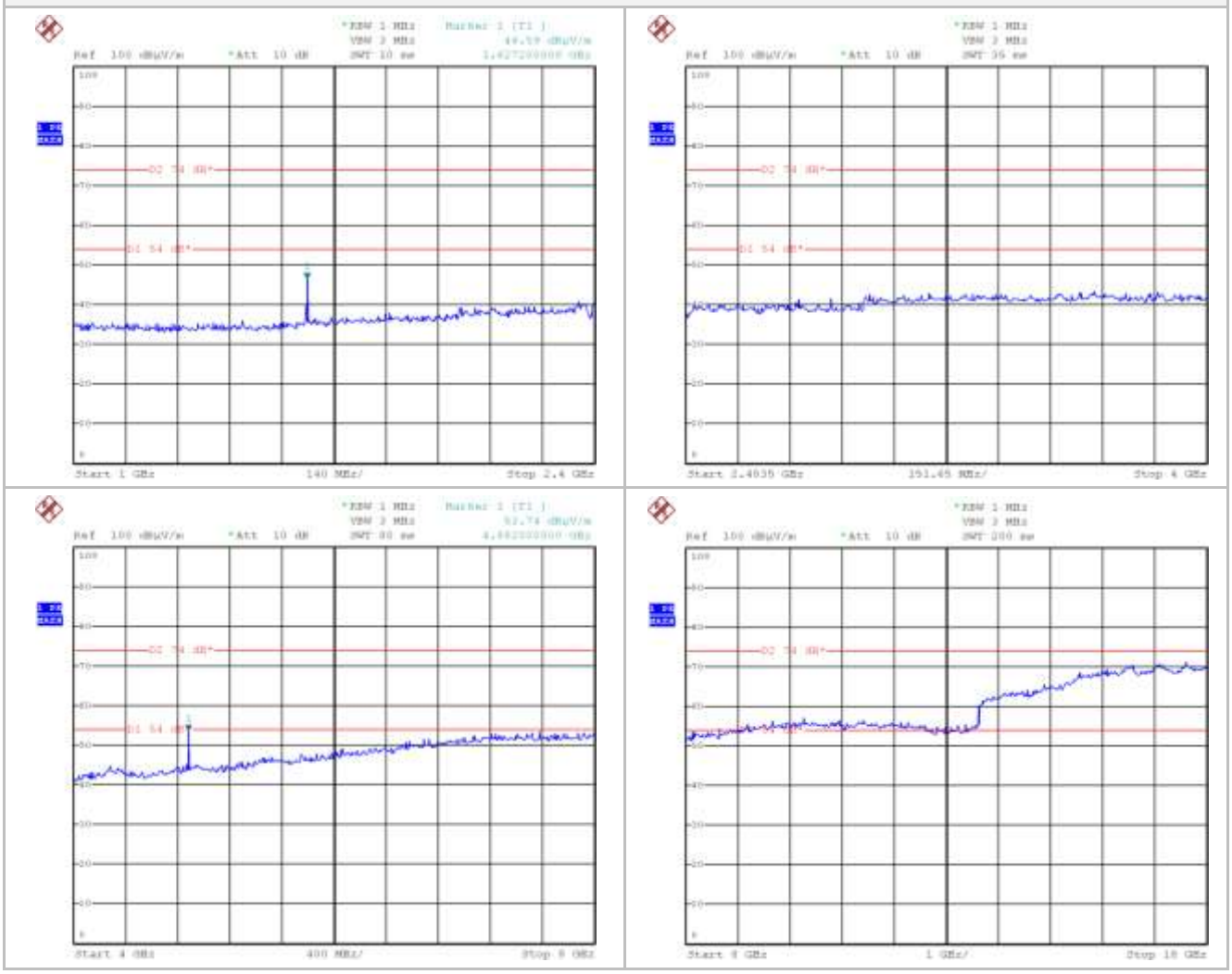




1GHz ÷ 18GHz
MIDDLE CHANNEL – HORIZONTAL POLARIZATION

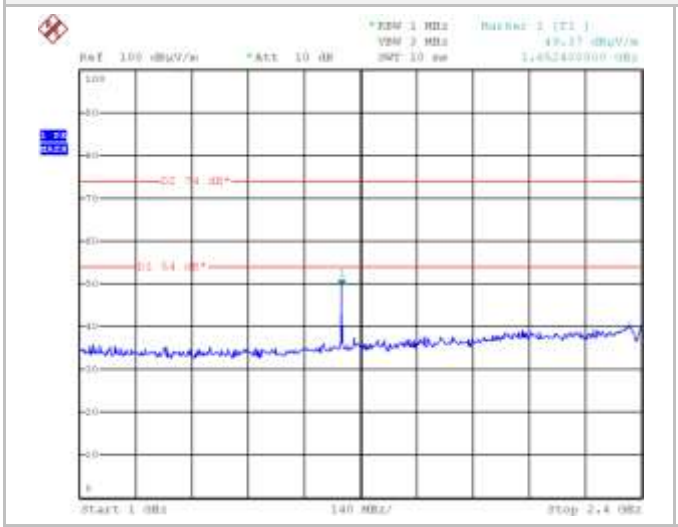


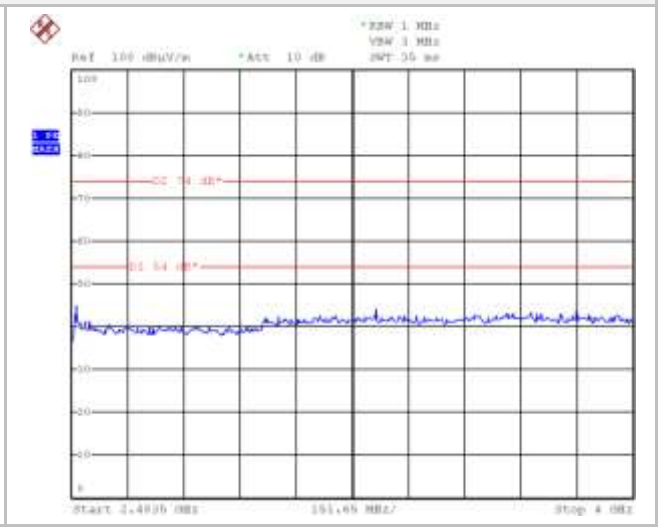
1GHz ÷ 18GHz
MIDDLE CHANNEL – VERTICAL POLARIZATION

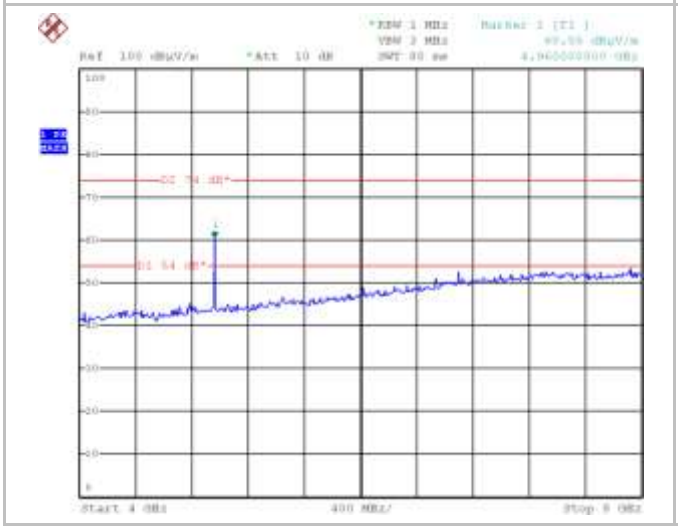


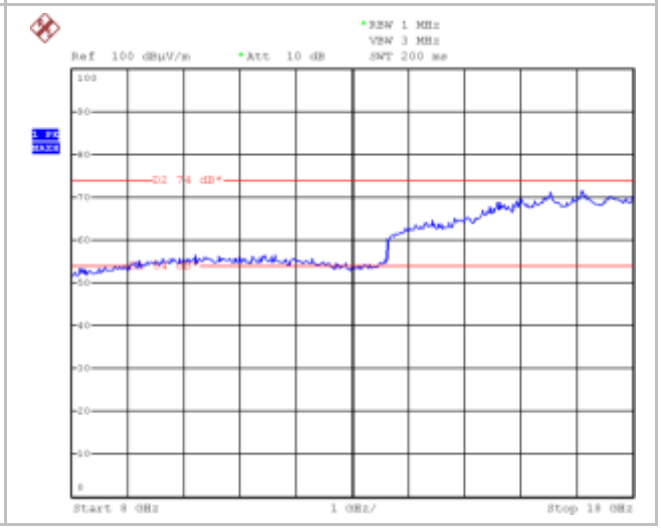
1GHz ÷ 18GHz

HIGHER CHANNEL – HORIZONTAL POLARIZATION



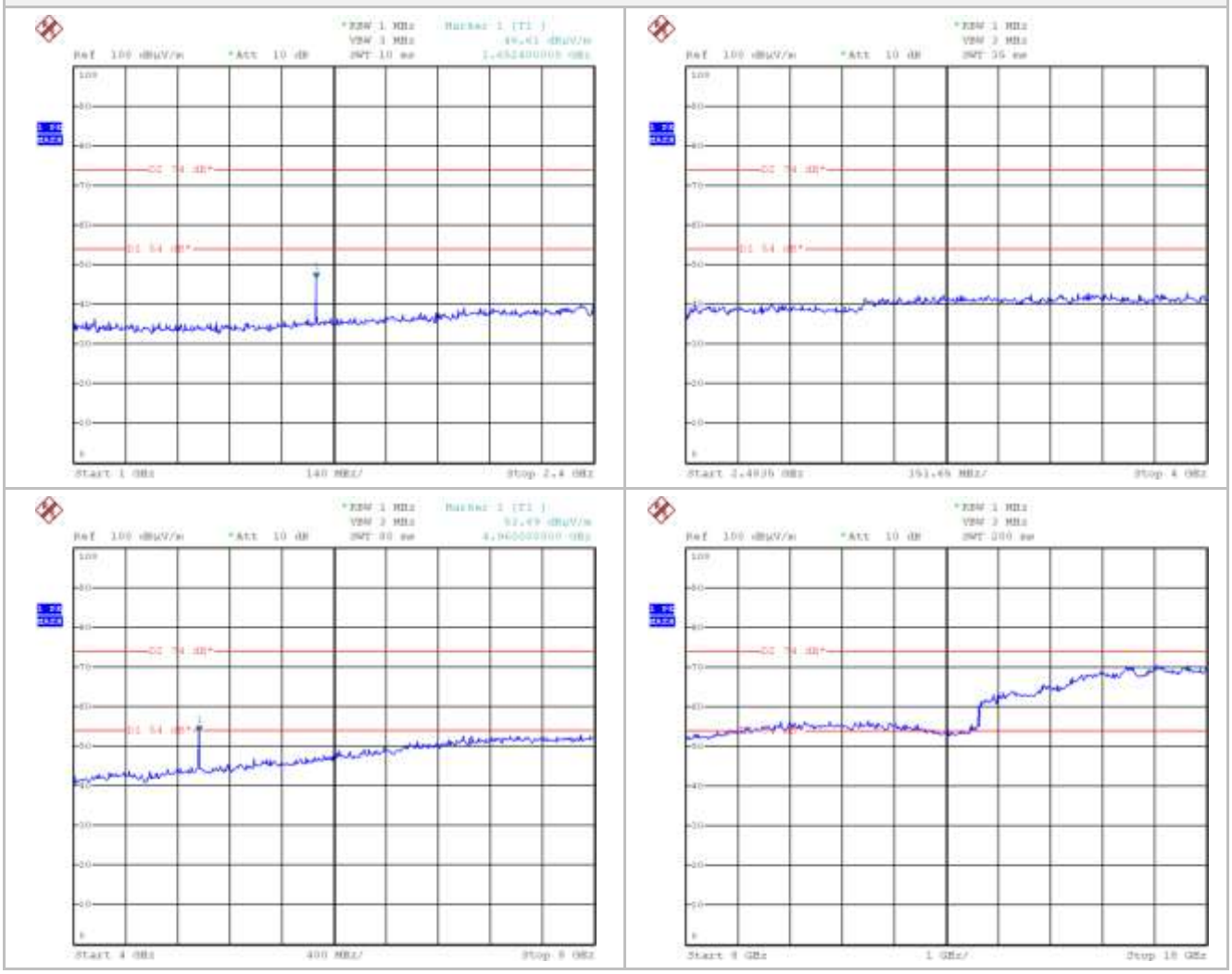






1GHz ÷ 18GHz

HIGHER CHANNEL – VERTICAL POLARIZATION



7.5 Hopping Channel Separation

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	3 MHz
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	2.5 ms
Detector function	Peak
EUT operating condition	#1, #2 & #3

TEST PROCEDURE

1- Remove the antenna from the RF port of EUT
2- The RF output was connected to the spectrum analyzer through a temporary RF connector type SMA.
3- Set the spectrum analyzer as above.
4- Allow the trace to stabilize.
5- Determine the separation between the peaks of the adjacent channels with delta marker function.

SUMMARY OF TEST RESULTS

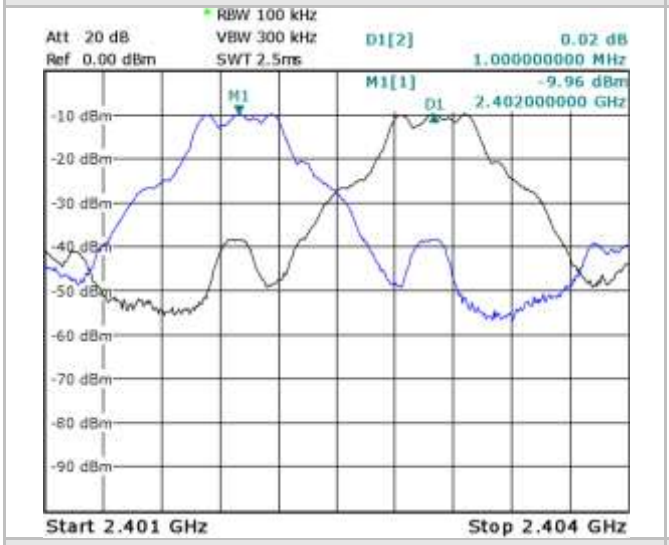
MODULATION	TESTED CHANNEL	SEPARATION (MHz)	Plot (No.)
GFSK	LOWER	1.000	1
	MIDDLE	1.000	2
	HIGHER	1.000	3
π/4DQPSK	LOWER	1.000	4
	MIDDLE	1.000	5
	HIGHER	1.000	6
8DPSK	LOWER	1.000	7
	MIDDLE	1.000	8
	HIGHER	1.000	9

TEST RESULT

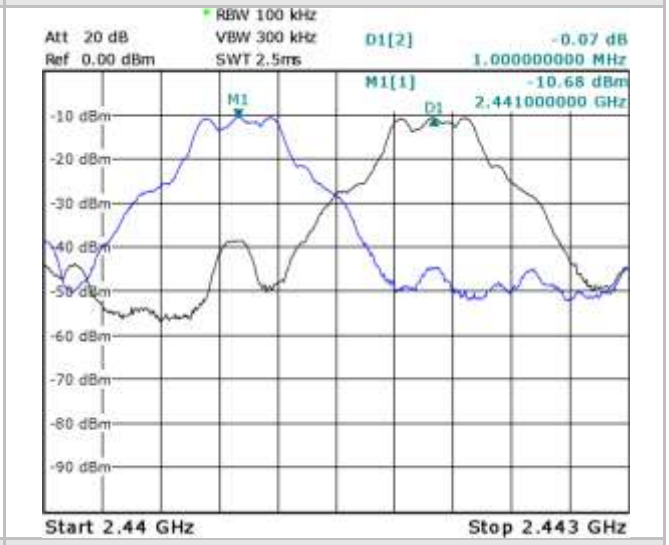
The EUT meets the requirements of sections 15.247 (a) (1)

MEASUREMENTS PLOTS

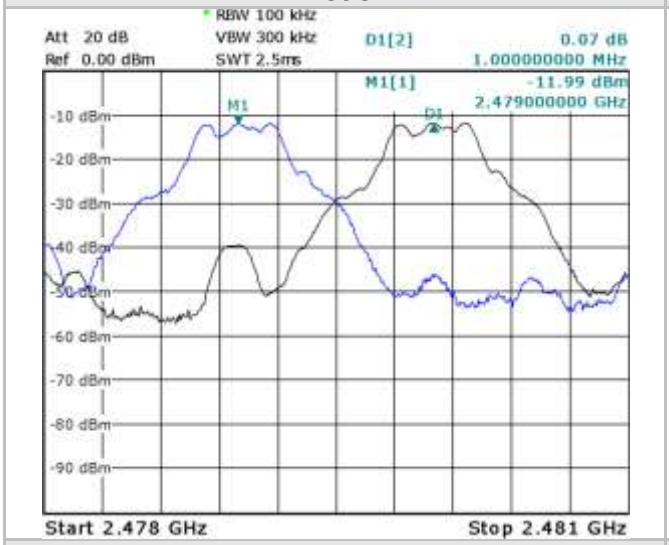
Plot 1



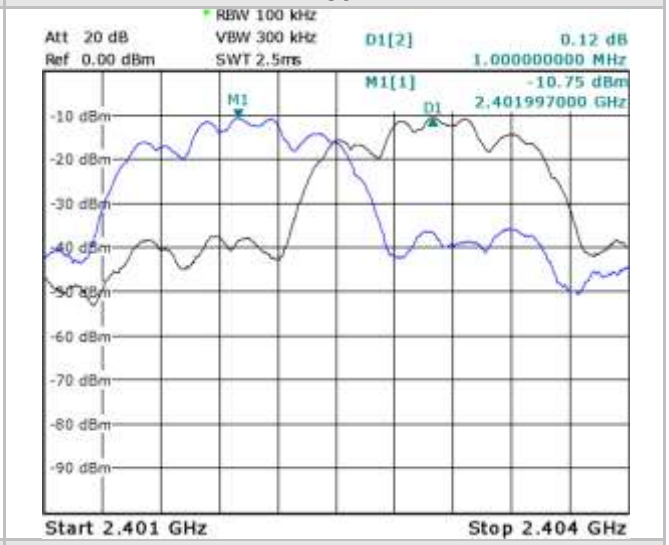
Plot 2



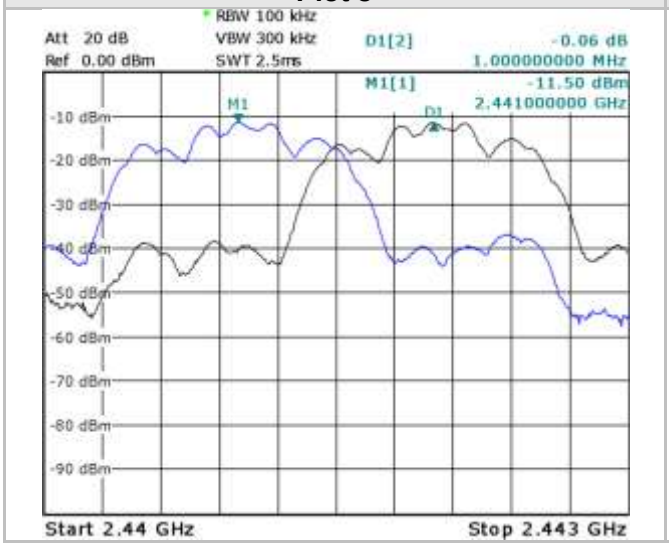
Plot 3



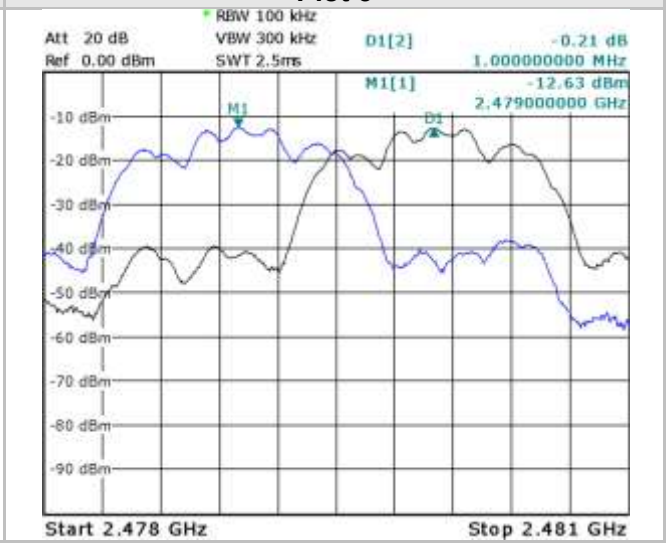
Plot 4



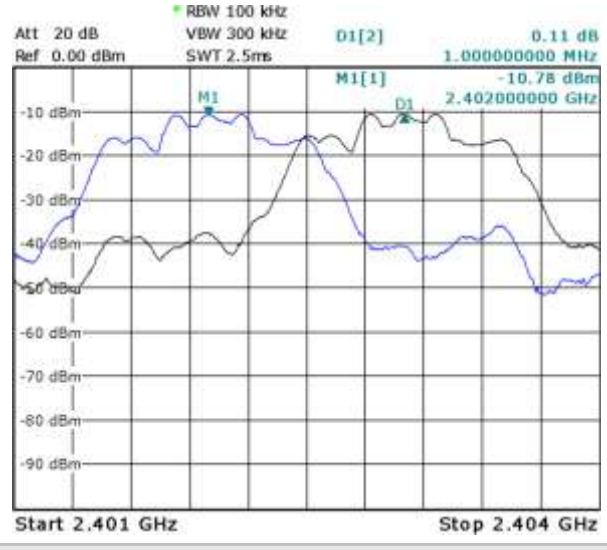
Plot 5



Plot 6

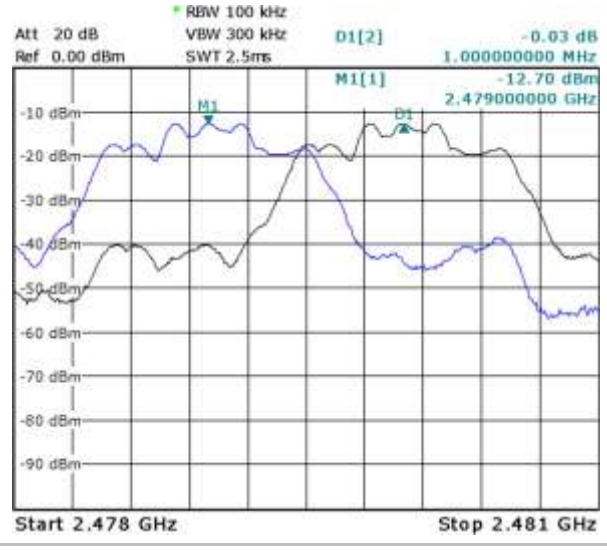


Plot 7



Plot 8

Plot 9



7.6 20dB Bandwidth Measurement

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	3 MHz
Resolution bandwidth (RBW)	30 kHz
Video bandwidth (VBW)	100 kHz
Sweep time (SWT)	5 ms
Detector function	Peak
EUT operating condition	#1, #2 & #3

TEST PROCEDURE

1- Remove the antenna from the RF port of EUT
2- The RF output was connected to the spectrum analyzer through a temporary RF connector type SMA.
3- Set the spectrum analyzer as above.
4- Allow the trace to stabilize.
5- Determine the separation between the -20dB point from the maximum peak with delta marker function.

SUMMARY OF TEST RESULTS

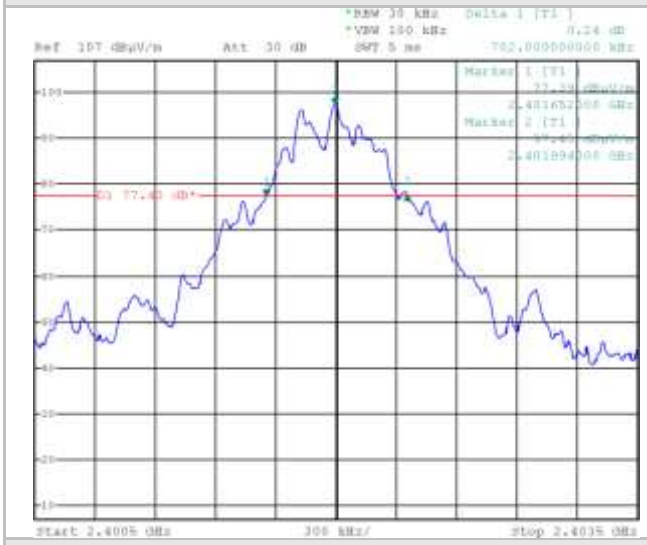
MODULATION	TESTED CHANNEL	SEPARATION (MHz)	Plot (No.)
GFSK	LOWER	0.702	1
	MIDDLE	0.702	2
	HIGHER	0.702	3
π/4DQPSK	LOWER	1.284	4
	MIDDLE	1.284	5
	HIGHER	1.290	6
8DPSK	LOWER	1.206	7
	MIDDLE	1.188	8
	HIGHER	1.194	9

TEST RESULT

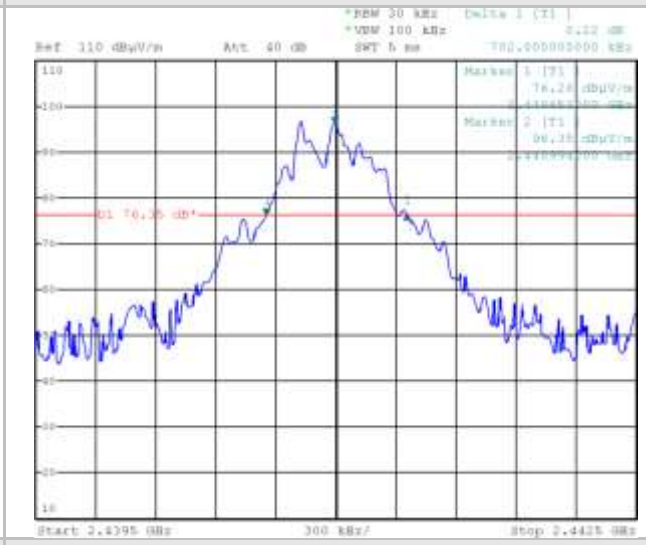
The EUT meets the requirements of sections 15.247 (a) (1)

MEASUREMENT PLOTS

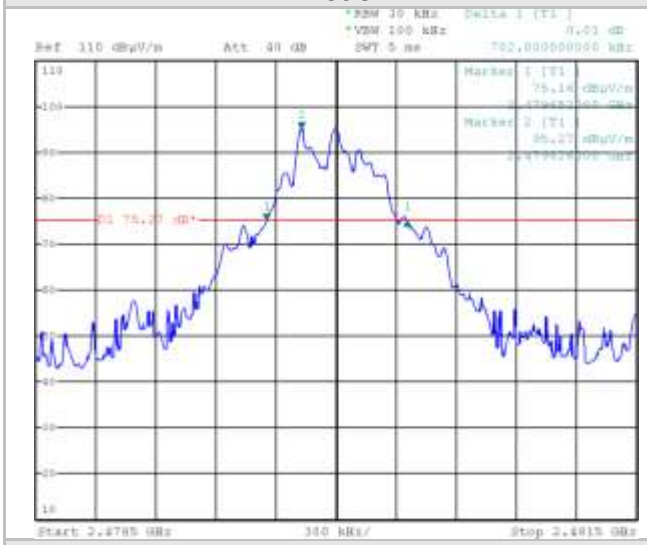
Plot 1



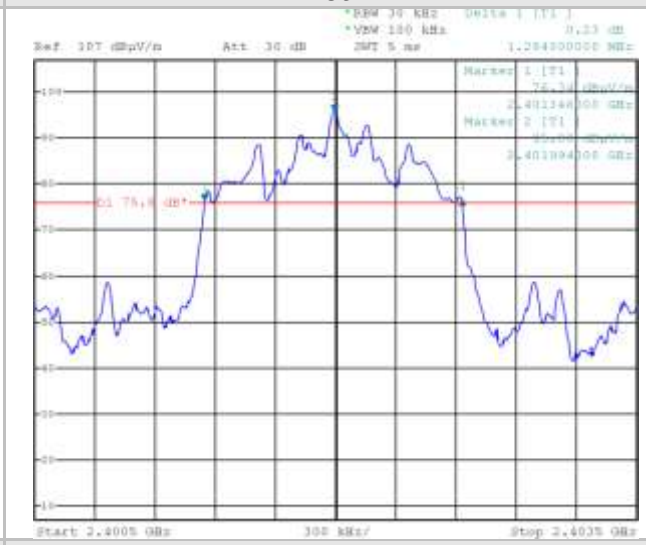
Plot 2



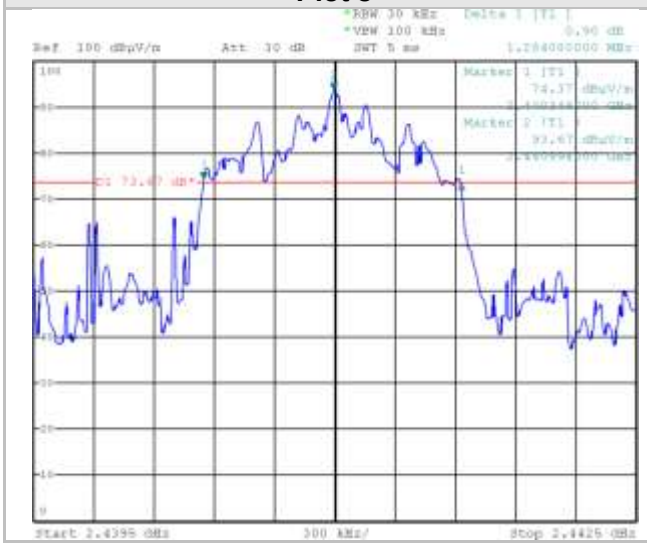
Plot 3



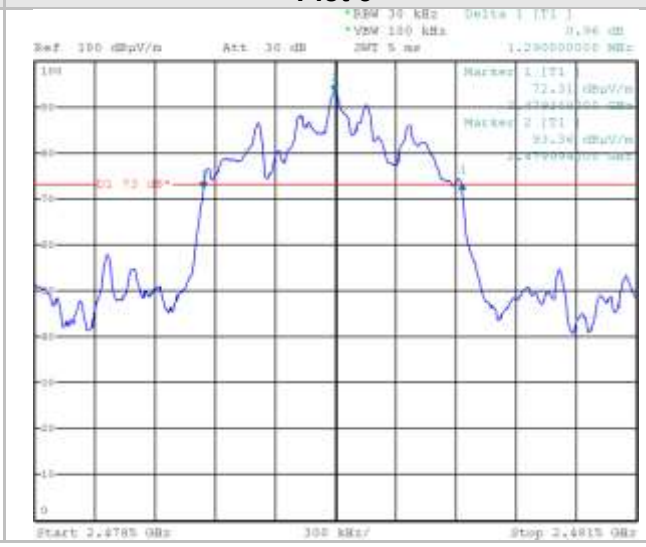
Plot 4



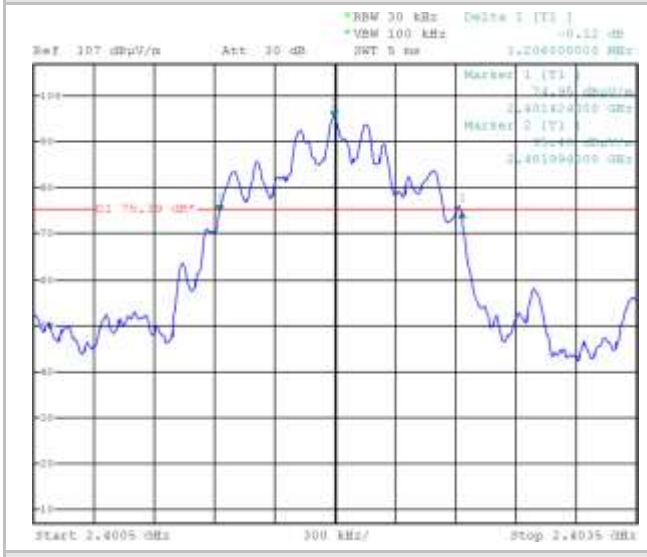
Plot 5



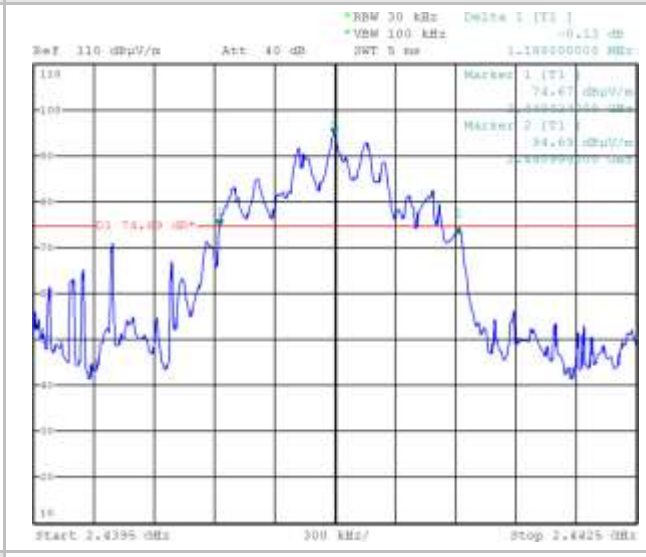
Plot 6



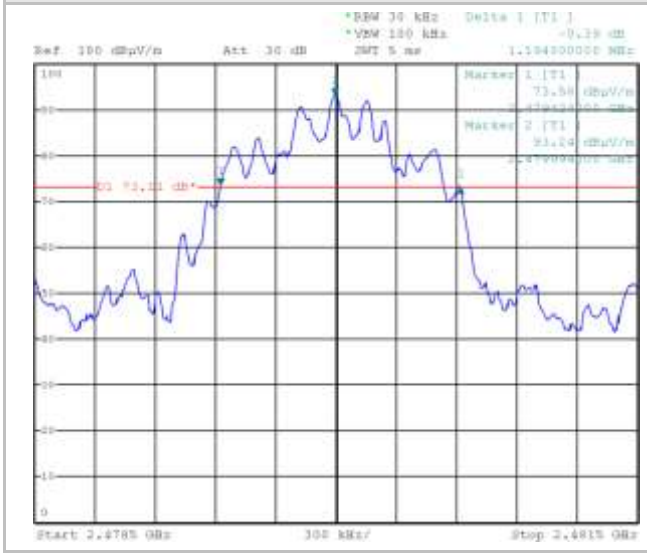
Plot 7



Plot 8



Plot 9



7.7 Number of Hopping Channels used

TEST REQUIREMENT	
Spectrum analyzer settings	
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	AUTO
Detector function	Peak
EUT operating condition	#1

TEST PROCEDURE

1- Remove the antenna from the RF port of EUT
2- The RF output was connected to the spectrum analyzer through a temporary RF connector type SMA.
3- Set the spectrum analyzer as above.
4- Allow the trace to stabilize.
5- Determine the separation between the -20dB point from the maximum peak with delta marker function.

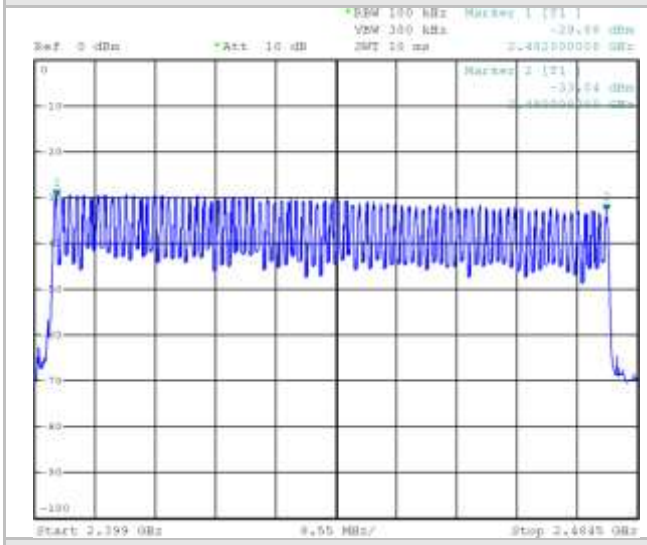
SUMMARY OF TEST RESULTS		
MODULATION	**TESTED CHANNEL**	**Plot (No.)**
GFSK	ALL	1
	From 1 to 20	2
	From 21 to 40	3
	From 41 to 60	4
	From 61 to 79	5

TEST RESULT

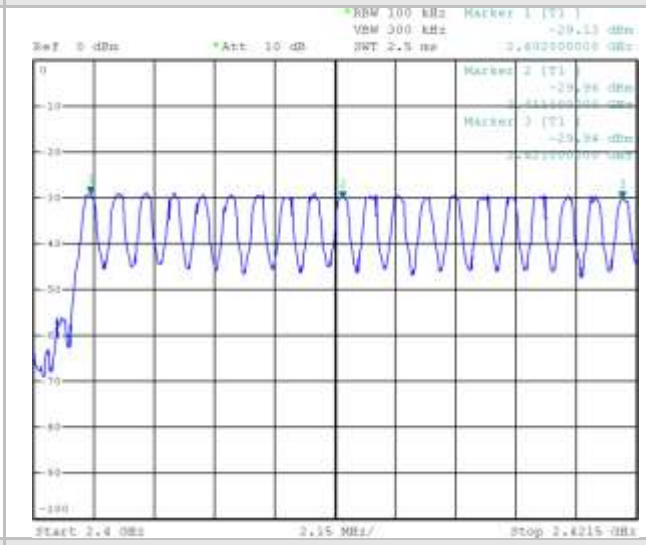
The EUT meets the requirements of sections 15.247 (a) (1)(iii)

MEASUREMENTS PLOTS

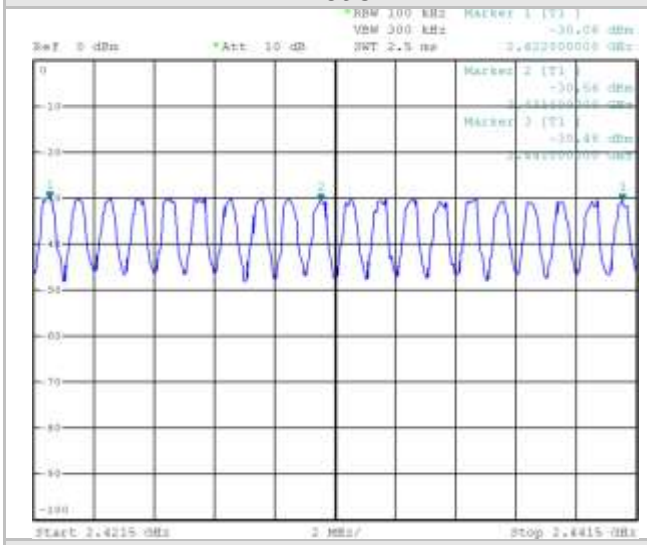
Plot 1



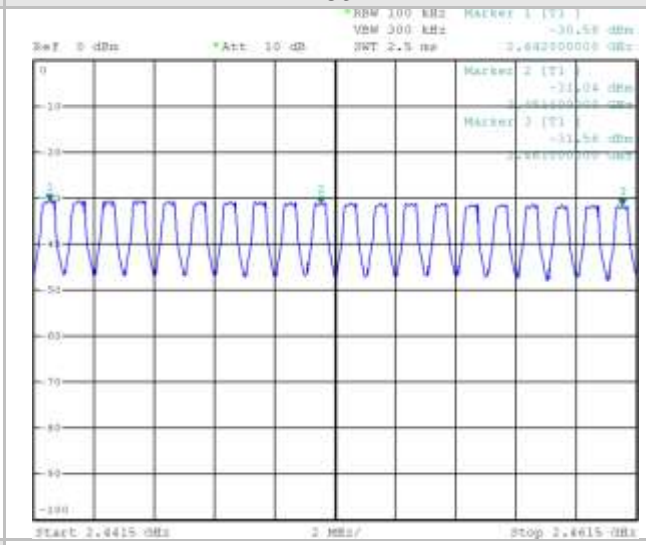
Plot 2



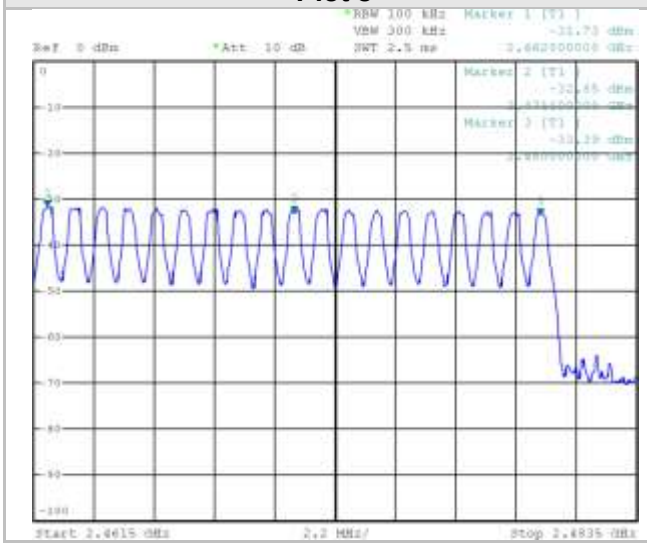
Plot 3



Plot 4



Plot 5



7.8 Time occupancy (Dwell Time) of each channel within a 0.4

TEST REQUIREMENT	
Spectrum analyzer settings	
Resolution bandwidth (RBW)	1 MHz
Video bandwidth (VBW)	3 MHz
Sweep time (SWT)	AUTO
Span	0 centered on hopping channel
Detector function	Peak
EUT operating condition	#1, #2 & #3

TEST PROCEDURE

1- Remove the antenna from the RF port of EUT
2- The RF output was connected to the spectrum analyzer through a temporary RF connector type SMA.
3- Set the spectrum analyzer as above.
4- Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation.

TEST RESULT

Dwell time = Pulse wide x (Hopping rate / Number of channels) x Period

The test period: T= 0.4(s) * 79 = 31.6 (s)

DH1 Packet permit maximum 1600 / 79 / 2 hops per second in each channel (1 time slot RX, 1 time slot TX).

DH3 Packet permit maximum 1600 / 79 / 4 hops per second in each channel (3 time slots RX, 1 time slot TX).

DH5 Packet permit maximum 1600 / 79 / 6 hops per second in each channel (5 time slots RX, 1 time slot TX).

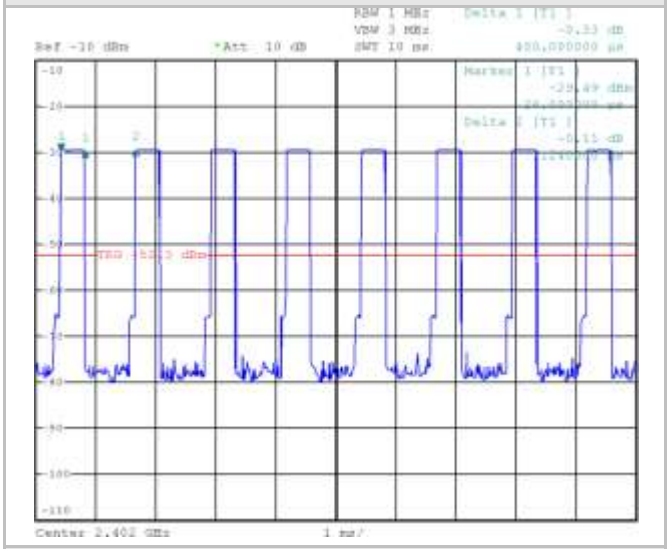
So, the Dwell Time can be calculated as follows:

Data Packet	Dwell Time(s)
DH1	1600/79/2*31.6*(MkrΔ)/1000
DH3	1600/79/4*31.6*(MkrΔ)/1000
DH5	1600/79/6*31.6*(MkrΔ)/1000
Remark	Mkr Delta is single pulse time

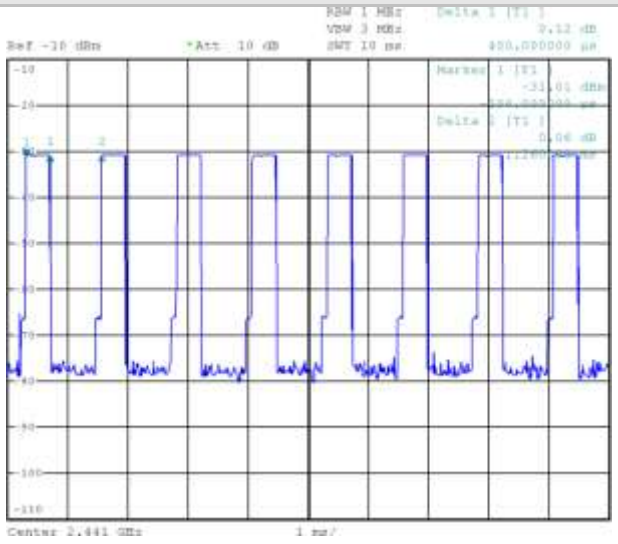
SUMMARY OF TEST RESULTS						
MODULATION	**TESTED CHANNEL**	**DATA PACKET**	**PLOT**	**Δ MARKER (ms)**	**DWELL TIME (s)**	**LIMITS (s)**
GFSK	LOWER	DH1	1	0.4000	0.1280	0.400
	MIDDLE		2	0.4000	0.1280	0.400
	HIGHER		3	0.4000	0.1280	0.400
	LOWER	DH3	4	1.6600	0.2656	0.400
	MIDDLE		5	1.6600	0.2656	0.400
	HIGHER		6	1.6600	0.2656	0.400
	LOWER	DH5	7	2.9000	0.3093	0.400
	MIDDLE		8	2.9000	0.3093	0.400
	HIGHER		9	2.9200	0.3115	0.400
π/4DQPSK	LOWER	DH1	10	0.4200	0.1344	0.400
	MIDDLE		11	0.4200	0.1344	0.400
	HIGHER		12	0.4200	0.1344	0.400
	LOWER	DH3	13	1.6600	0.2656	0.400
	MIDDLE		14	1.6600	0.2656	0.400
	HIGHER		15	1.6800	0.2688	0.400
	LOWER	DH5	16	2.9200	0.3115	0.400
	MIDDLE		17	2.9200	0.3115	0.400
	HIGHER		18	2.9200	0.3115	0.400
8DPSK	LOWER	DH1	19	0.4200	0.1344	0.400
	MIDDLE		20	0.4200	0.1344	0.400
	HIGHER		21	0.4200	0.1344	0.400
	LOWER	DH3	22	1.6600	0.2656	0.400
	MIDDLE		23	1.6600	0.2656	0.400
	HIGHER		24	1.6600	0.2656	0.400
	LOWER	DH5	25	2.9200	0.3115	0.400
	MIDDLE		26	2.9200	0.3115	0.400
	HIGHER		27	2.9200	0.3115	0.400
TEST RESULT						
The EUT meets the requirements of sections 15.247 (a) (1)(iii)						

MEASUREMENTS PLOTS

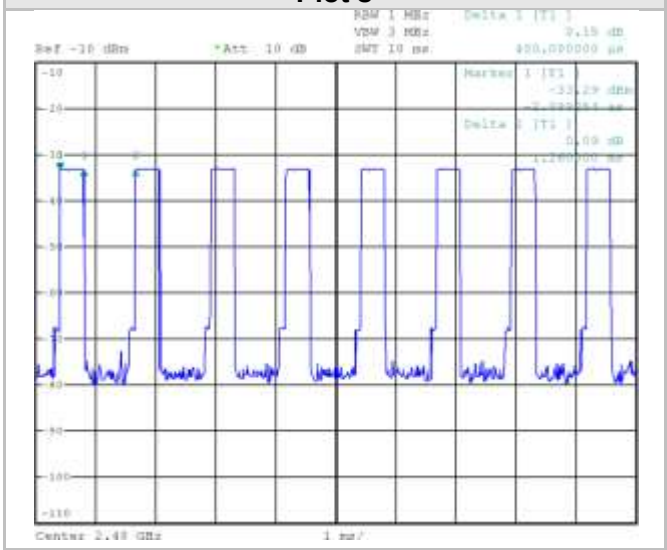
Plot 1



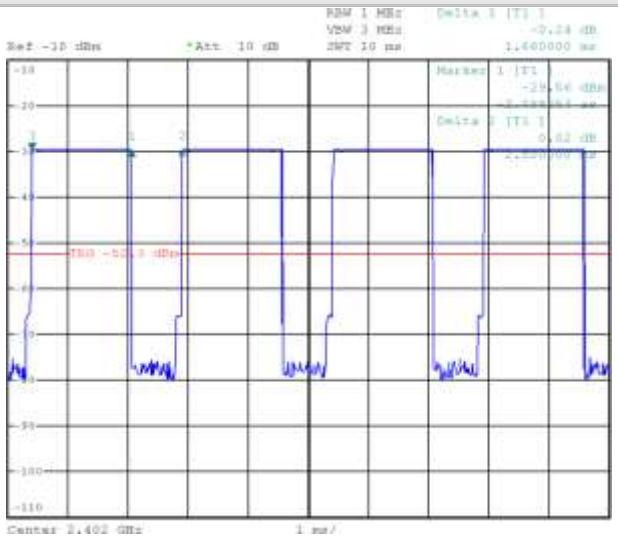
Plot 2



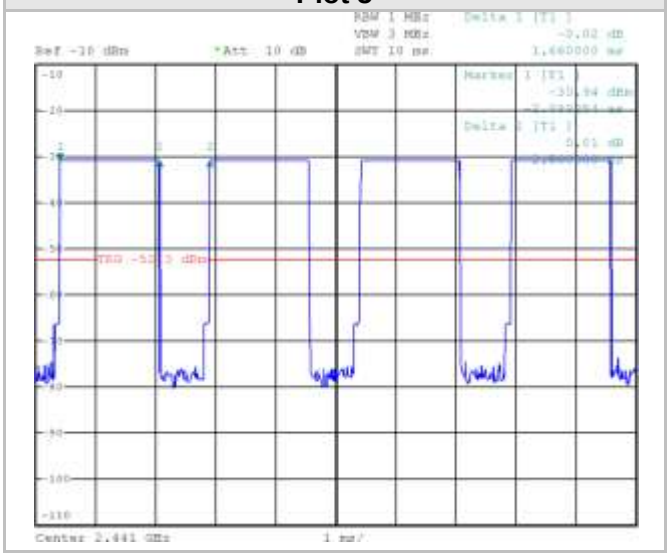
Plot 3



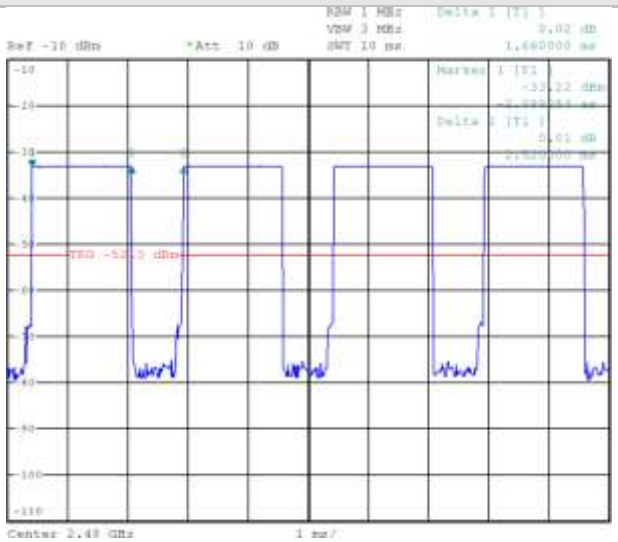
Plot 4



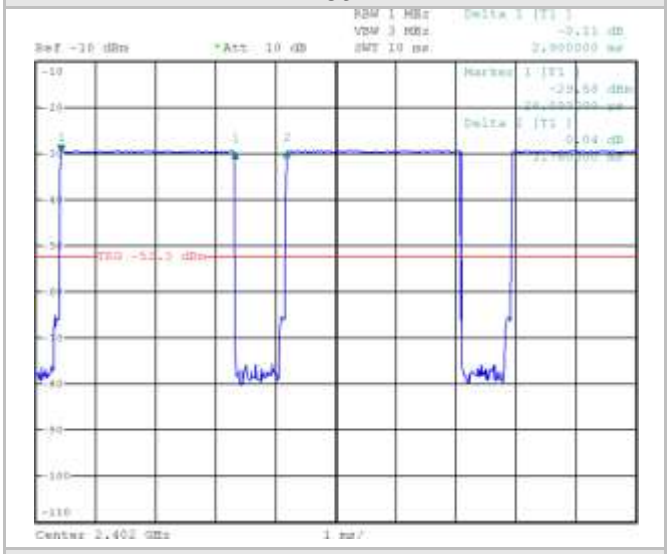
Plot 5



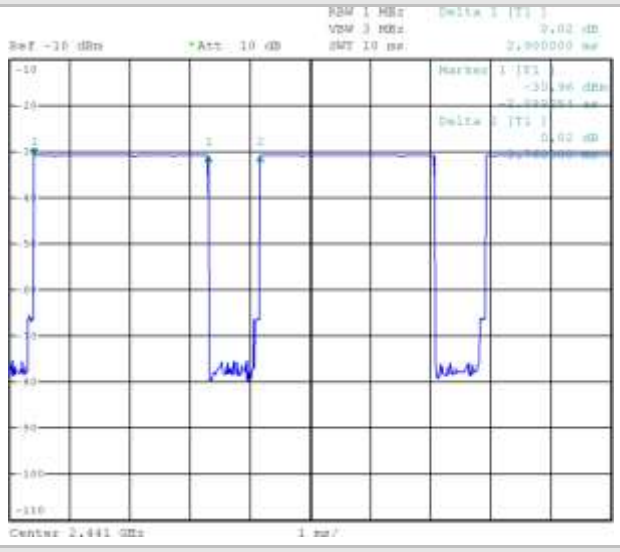
Plot 6



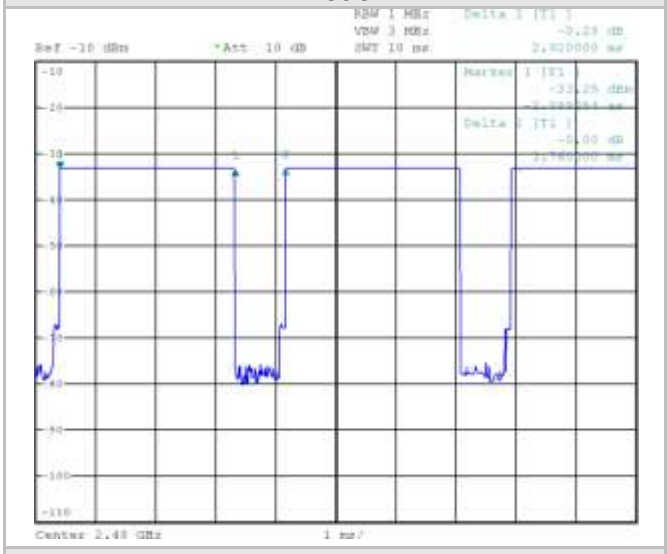
Plot 7



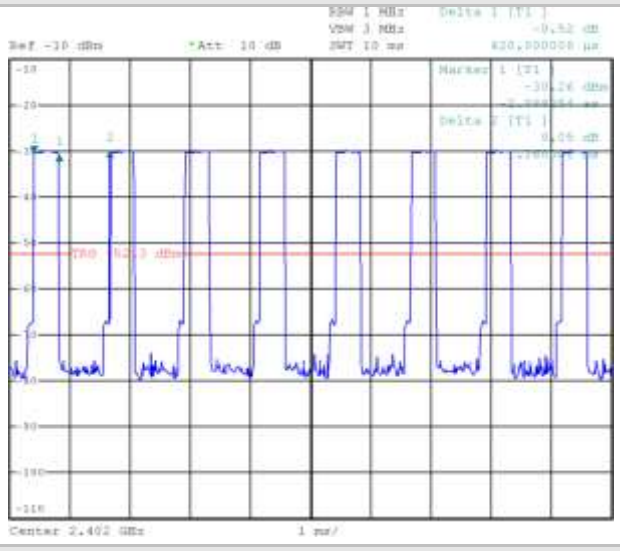
Plot 8



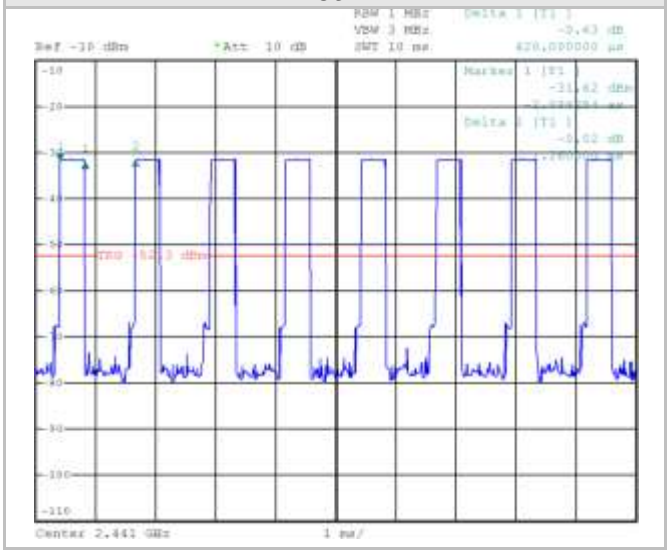
Plot 9



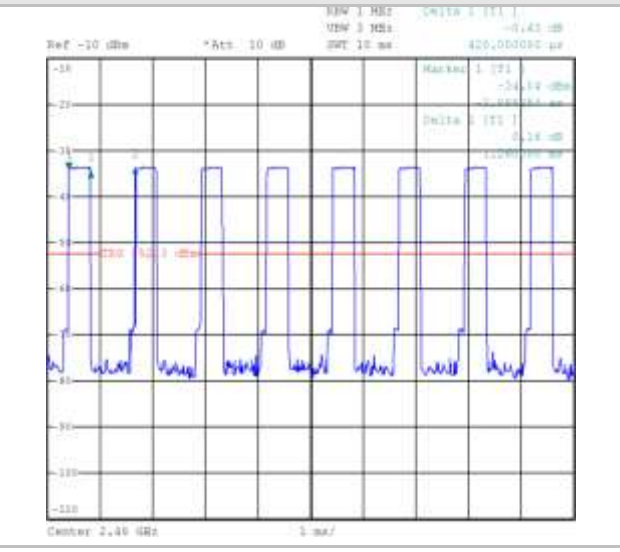
Plot 10



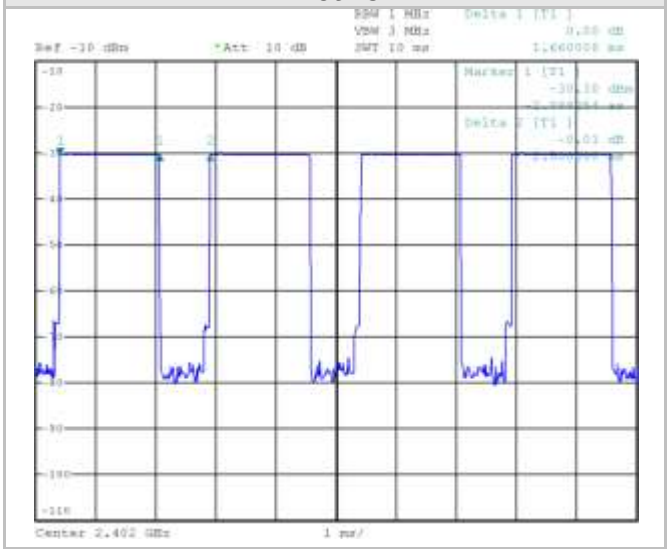
Plot 11



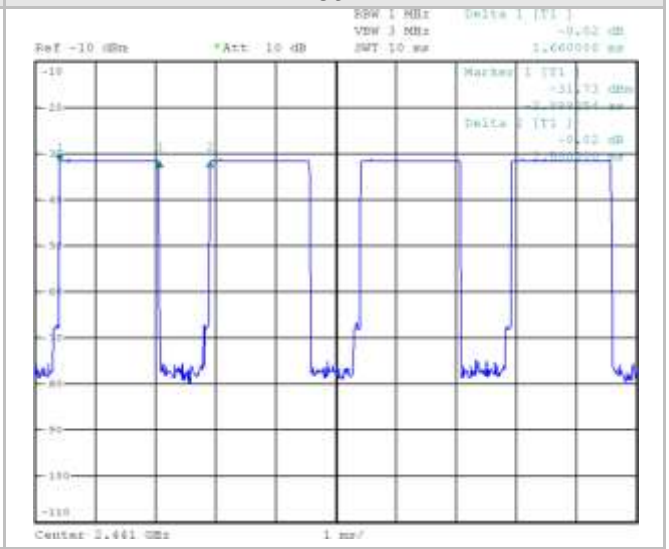
Plot 12



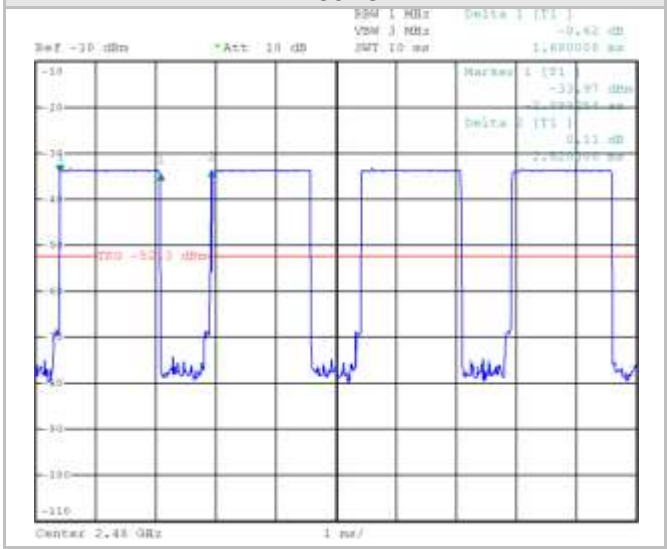
Plot 13



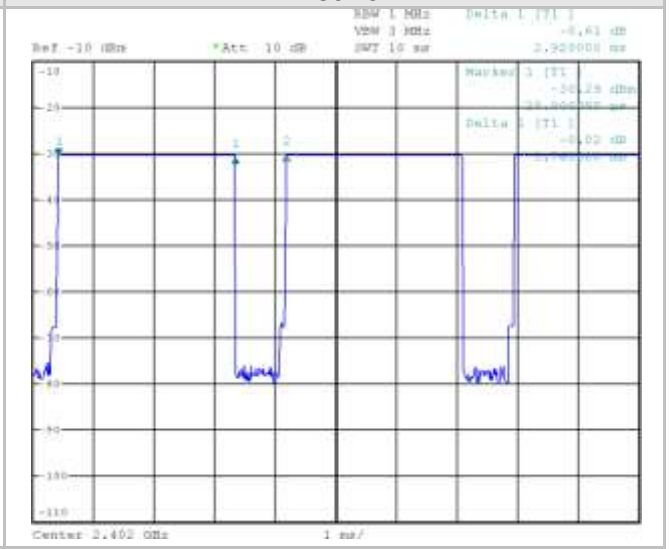
Plot 14



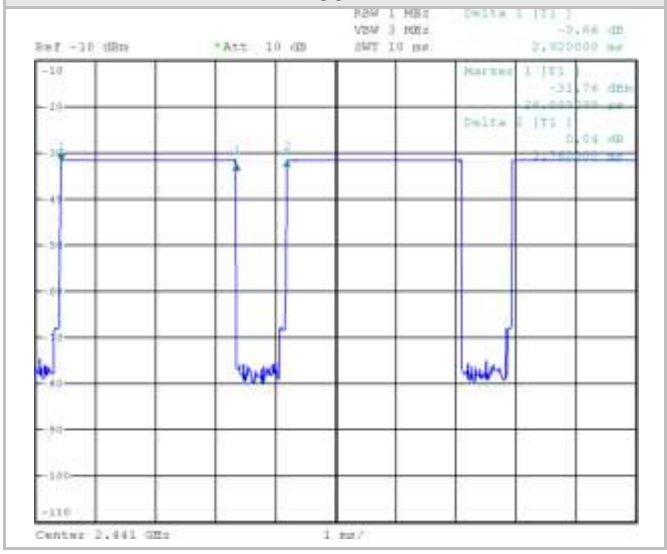
Plot 15



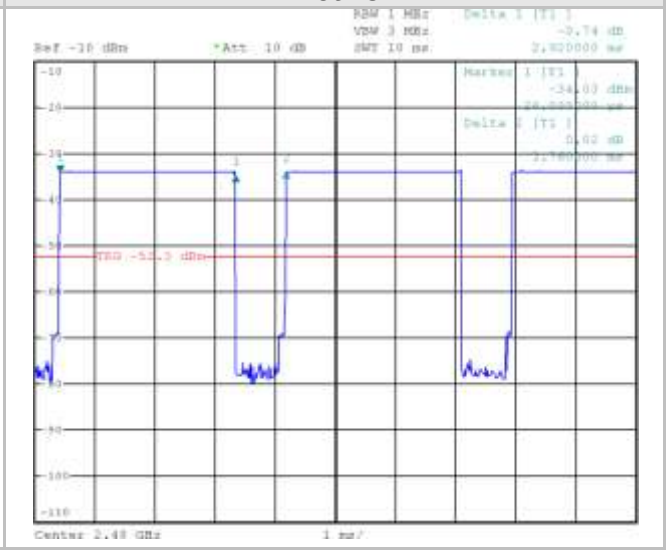
Plot 16



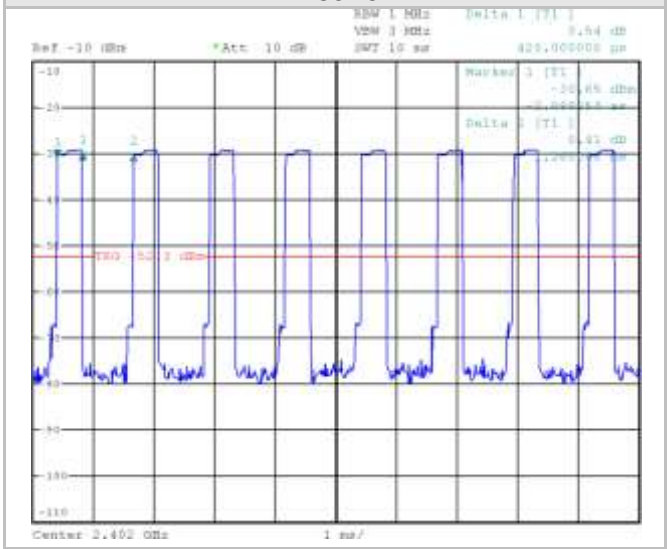
Plot 17



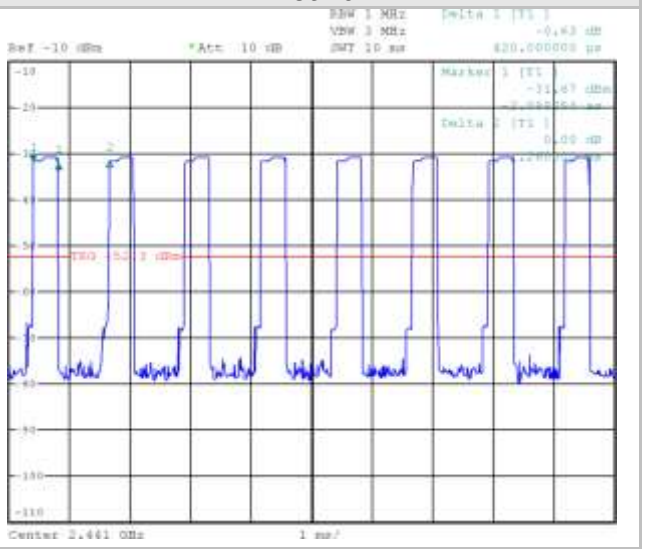
Plot 18



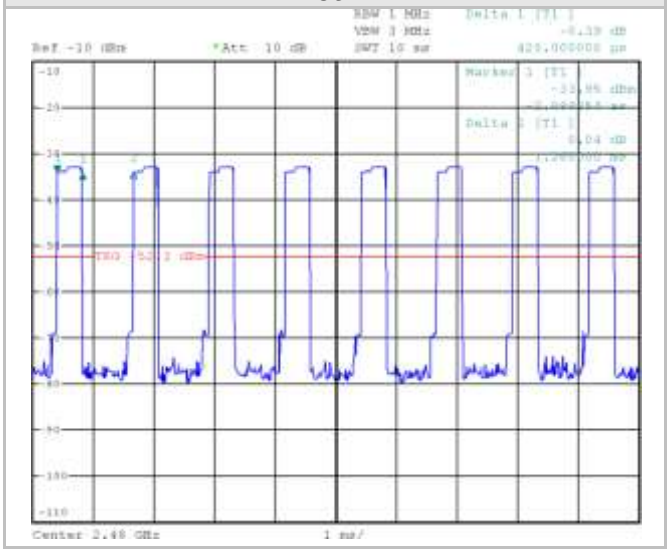
Plot 19



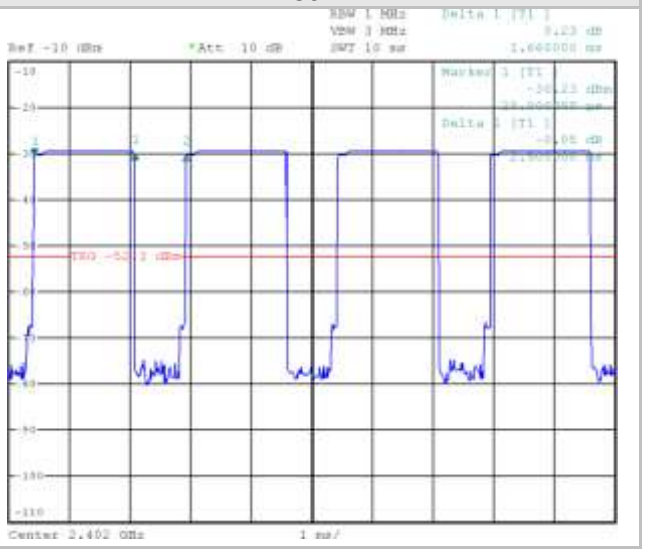
Plot 20



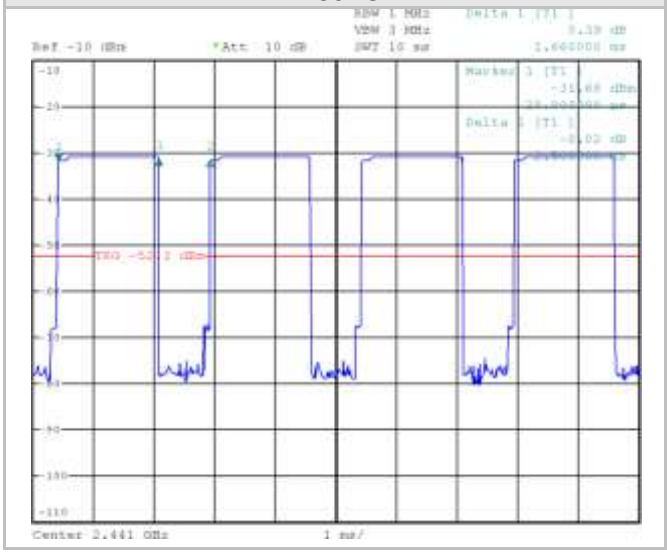
Plot 21



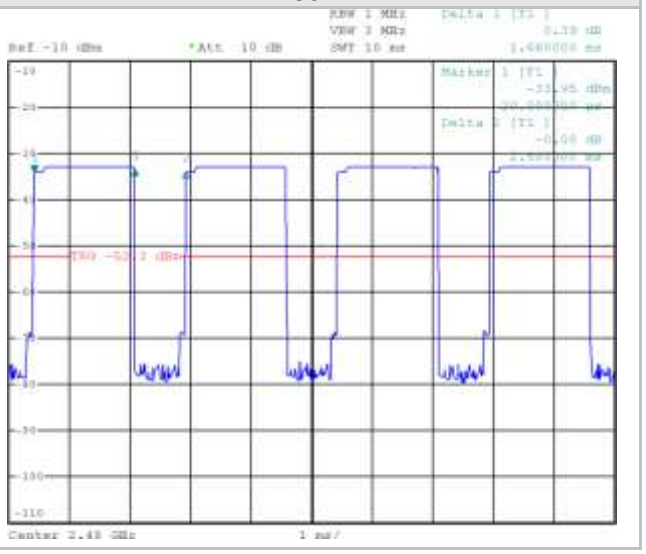
Plot 22



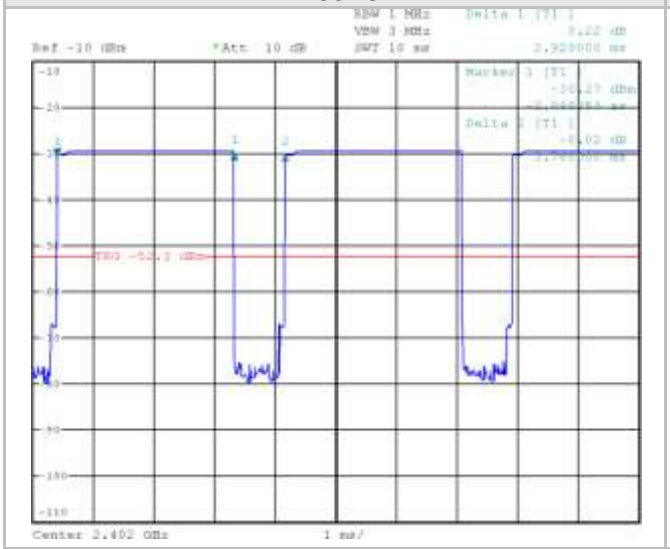
Plot 23



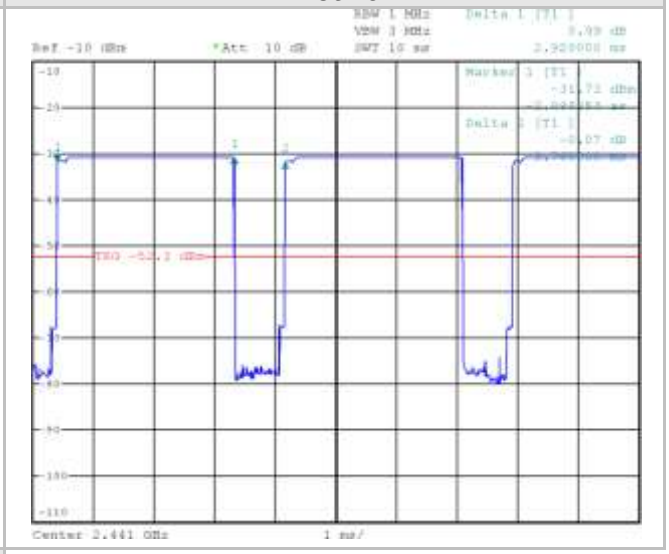
Plot 24



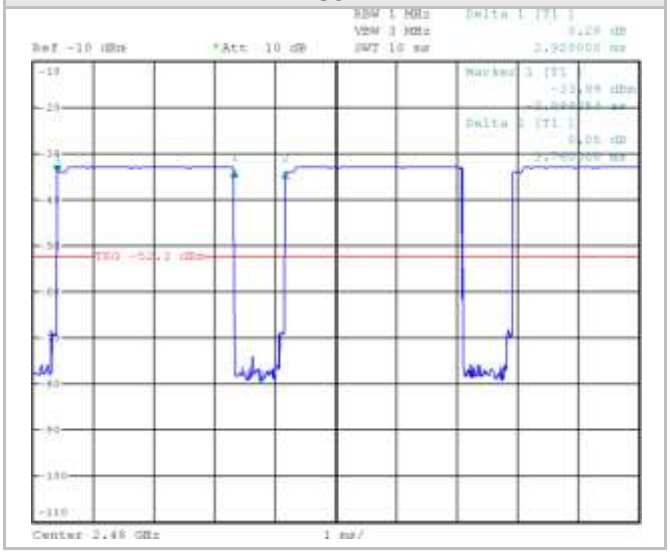
Plot 25



Plot 26



Plot 27



7.9 MAXIMUM PEAK OUTPUT POWER CONDUCTED

Spectrum analyzer settings	
Resolution bandwidth (RBW)	3 MHz
Video bandwidth (VBW)	3 MHz
Sweep time (SWT)	AUTO
Span	5 MHz
Detector function	Peak
EUT operating condition	#1, #2 & #3

TEST PROCEDURE

1- Remove the antenna from the RF port of EUT
2- The RF output was connected to the spectrum analyzer through a temporary RF connector type SMA.
3- Set the spectrum analyzer as above.
4- Use the marker function to determine the max RF power. If this value varies with different modes of operation (e.g.. data rate. modulation format. etc.). repeat this test for each variation.

SUMMARY OF TEST RESULTS

MODULATION	TESTED CHANNEL	RATED FREQUENCY (MHz)	OUTPUT POWER (dBm)	Plot (No.)
GFSK	LOWER	2402	5.20	1
	MIDDLE	2441	4.94	2
	HIGHER	2480	4.28	3
π/4DQPSK	LOWER	2402	4.25	4
	MIDDLE	2441	3.87	5
	HIGHER	2480	2.95	6
8DPSK	LOWER	2402	4.48	7
	MIDDLE	2441	4.08	8
	HIGHER	2480	3.19	9

LIMITS

1 Watt (30dBm)

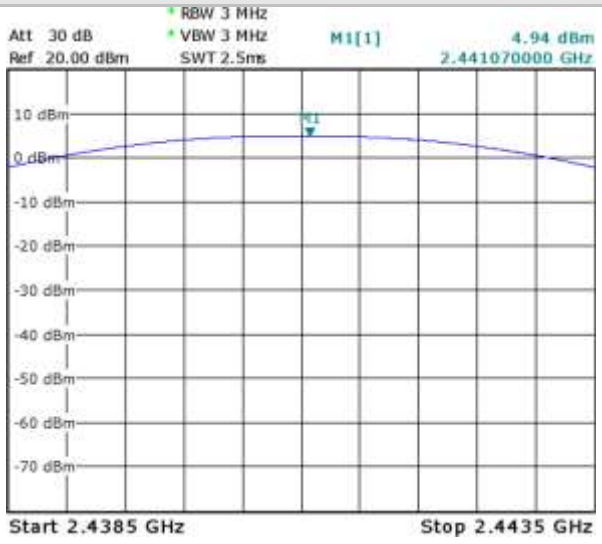
TEST RESULT

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

MEASUREMENTS PLOTS

Plot 1

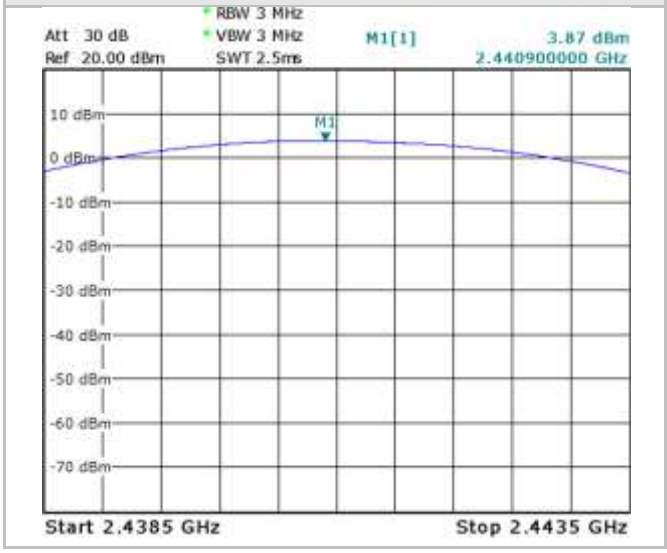
Plot 2



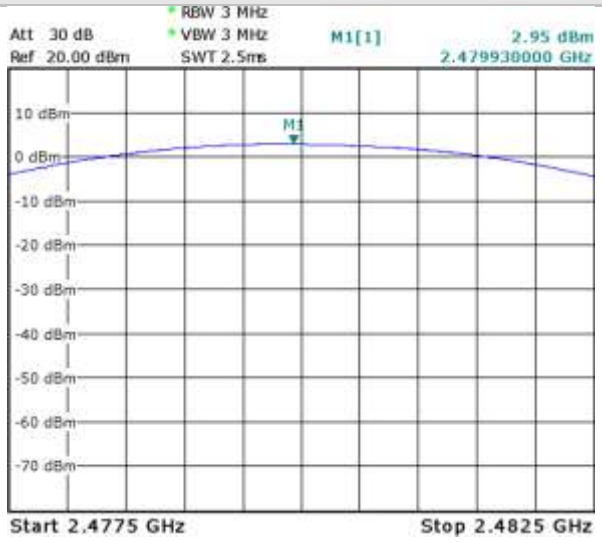
Plot 3

Plot 4

Plot 5



Plot 6



Plot 7

Plot 8

Plot 9

7.10 MAXIMUM PEAK OUTPUT POWER WITH ANTENNA (DE FACTO EIRP)

TEST REQUIREMENT	
Spectrum analyzer settings	
Resolution bandwidth (RBW)	3 MHz
Video bandwidth (VBW)	3 MHz
Sweep time (SWT)	AUTO
Span	9 MHz
Detector function	Peak
EUT operating condition	#1 (Only the GFSK modulation measurements was performed as the worst case. See also max power conducted measurement)

TEST PROCEDURE

1) The EUT was placed on turntable which is 1.5 m above the ground plane and the gap from EUT and receiving antenna as been filled by absorber material.
2) The turntable shall rotate from 0° to 360° degrees to determine the position of maximum emission level.
3) The EUT is positioned 1 m away from the receiving to find the highest emission.
4) The receiving antenna was positioned in both horizontal and vertical polarization.

SUMMARY OF TEST RESULTS

EUT	MODULATION	TESTED CHANNEL	FREQUENCY (MHz)	OUTPUT POWER (dBm)	Plot (No.)
DOCKING	GFSK	LOWER	2402	3.68	1
		MIDDLE	2441	3.59	2
		HIGHER	2480	3.27	3
RECEIVER	GFSK	LOWER	2402	3.04	4
		MIDDLE	2441	-0.37	5
		HIGHER	2480	0.02	6

LIMITS

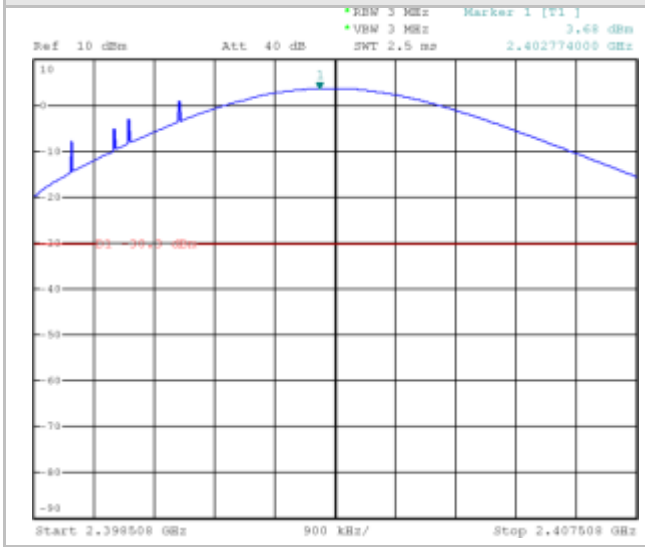
1 Watt (30dBm)

TEST RESULT

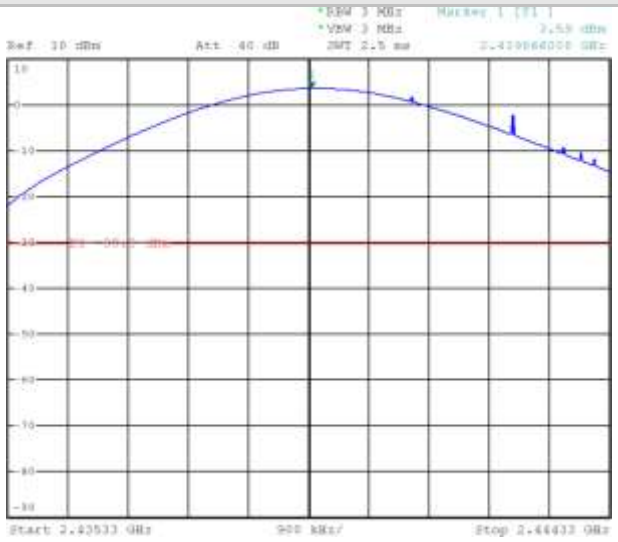
The EUT meets the requirements of sections 15.247 (b) (3)

MEASUREMENTS PLOTS

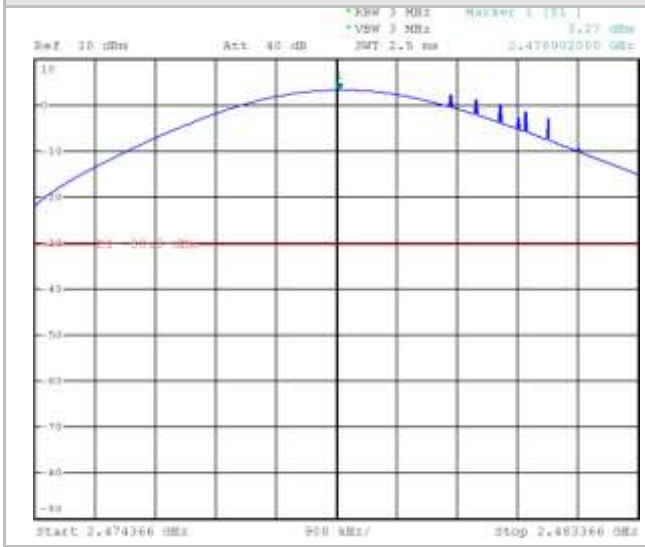
Plot 1



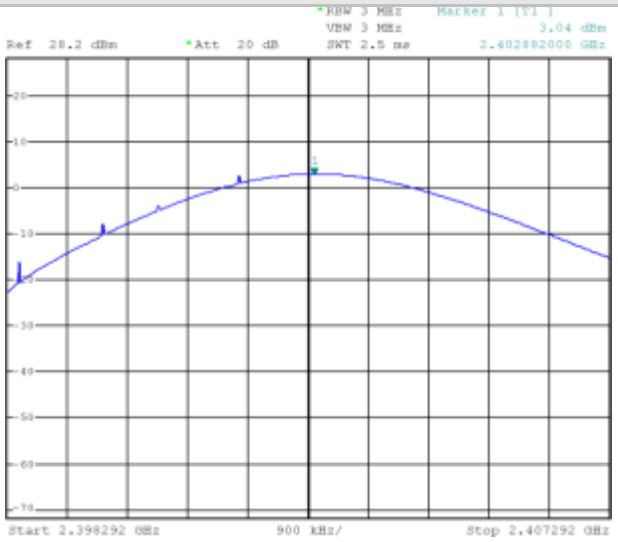
Plot 2



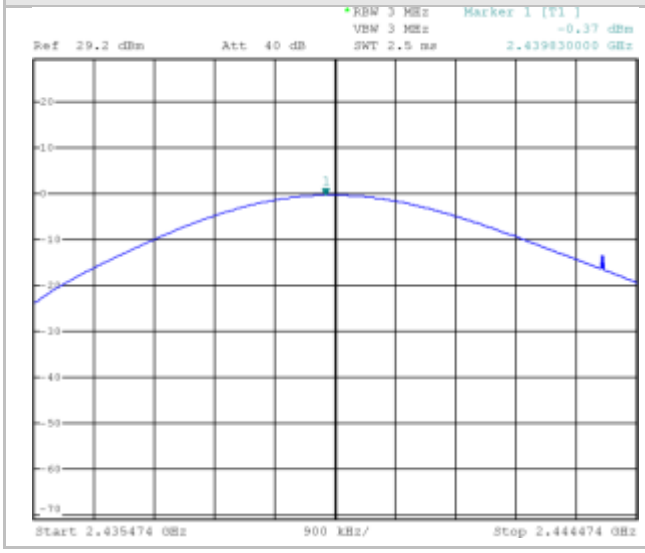
Plot 3



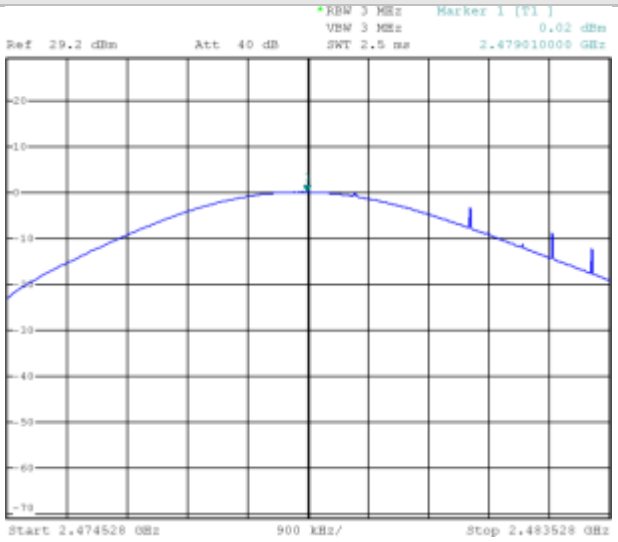
Plot 4



Plot 5



Plot 6



7.11 ANTENNA GAIN

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

Antenna specifications	
N° of authorized antenna types	Only integral antenna furnished by the responsible party.
Antenna type	Integral antenna (PCB strip)
Maximum total antenna gain	-1.01dBi
External power amplifiers	Not present

SUMMARY OF TEST RESULTS

EUT	MODULATION	CHANNEL	MAXIMUM OUTPUT POWER (dBm)		ANTENNA GAIN dBi	GAIN LIMIT dBi
			CONDUCTED	RADIATED		
DOCKING	GFSK	LOWER	5.20	3.68	-1.52	6
		MIDDLE	4.94	3.59	-1.35	6
		HIGHER	4.28	3.27	-1.01	6
RECEIVER	GFSK	LOWER	5.20	3.04	-2.16	6
		MIDDLE	4.94	-0.37	-5.31	6
		HIGHER	4.28	0.02	-4.26	6

TEST RESULT
The EUT meets the requirements of section 15.247(b)(4)i

7.12 BAND-EDGE COMPLIANCE OF RF RADIATED EMISSIONS

TEST REQUIREMENT	
Spectrum analyzer settings	
Resolution bandwidth (RBW)	1 MHz (Peak & Average detector)
Video bandwidth (VBW)	AUTO (Peak detector) – 10Hz Average detector
Sweep time (SWT)	Up to 1st restricted bands around assigned band
Detector function	Peak & Average
EUT operating condition	#1 (All the modulation modes were tested, the plots of the worst mode (GFSK) were recorded in the following pages.. See also max power conducted measurement)

TEST PROCEDURE

1) The EUT was placed on turntable which is 1.5 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 1 m away from the receiving to find the highest emission.
4) The receiving antenna was positioned in both horizontal and vertical polarization.

SUMMARY OF TEST RESULTS

PEAK MEASUREMENT

EUT	MODULATION	CHANNEL	READING	FACTOR	RESULT	LIMIT	MARGIN	Plot (No.)
DOCKING	GFSK	LOWER	69.82	-4.8	65.02	74	-8.98	1
		HIGHER	54.00	-5.2	48.80		-25.2	2
RECEIVER	GFSK	LOWER	68.94	-4.8	64.14		-9.86	3
		HIGHER	55.54	-5.2	50.34		-23.66	4

AVERAGE MEASUREMENT

EUT	MODULATION	CHANNEL	READING	FACTOR	RESULT	LIMIT	MARGIN	Plot (No.)
DOCKING	GFSK	LOWER	55.13	-4.8	50.33	54	-3.67	5
		HIGHER	41.91	-5.2	36.71		-17.29	6
RECEIVER	GFSK	LOWER	54.38	-4.8	49.58		-4.42	7
		HIGHER	43.35	-5.2	38.15		-15.85	8

LIMITS

The radiated emissions which fall in the restricted bands as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).
Out of band spurious emissions shall be at least 20 dB below peak output power.

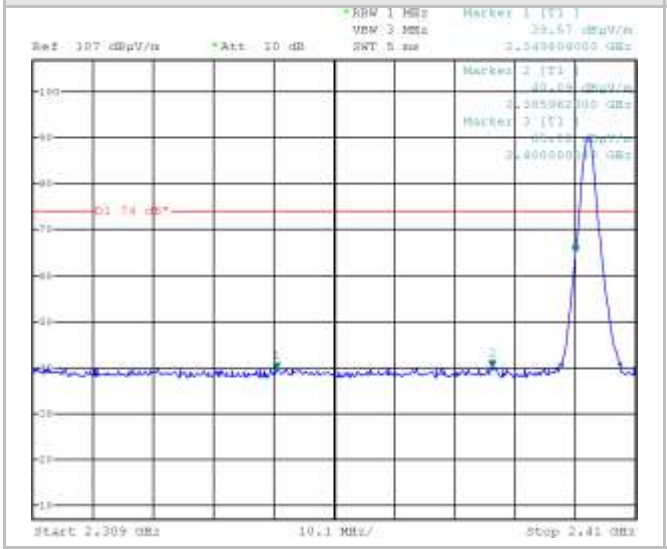
TEST RESULT

The EUT meets the requirements of sections 15.247 (d)

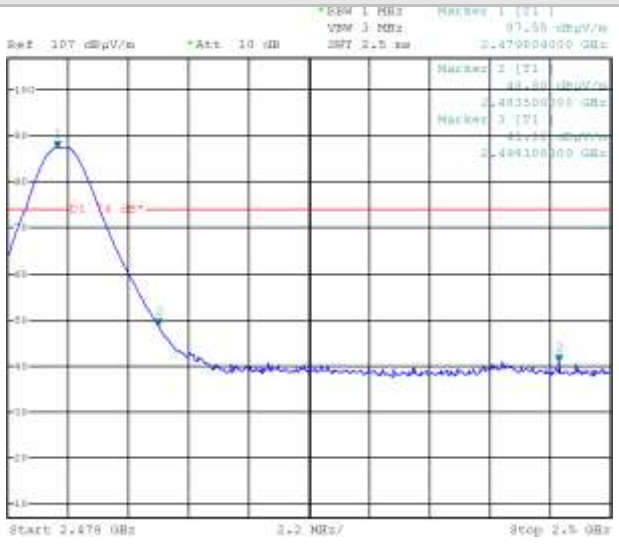
All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

MEASUREMENTS PLOTS

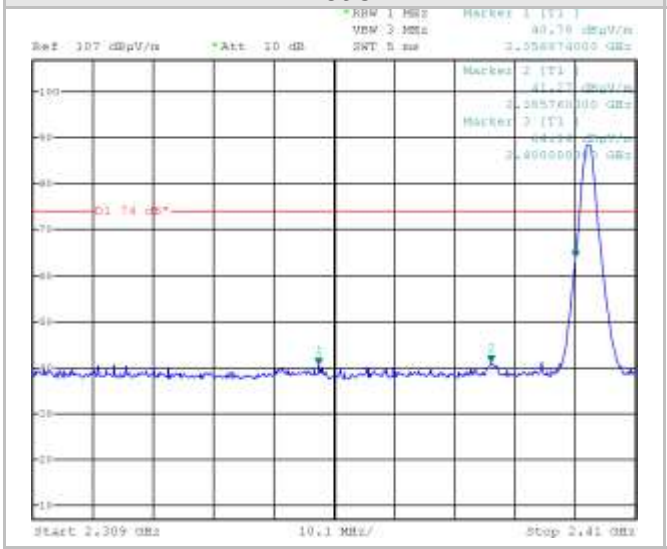
Plot 1



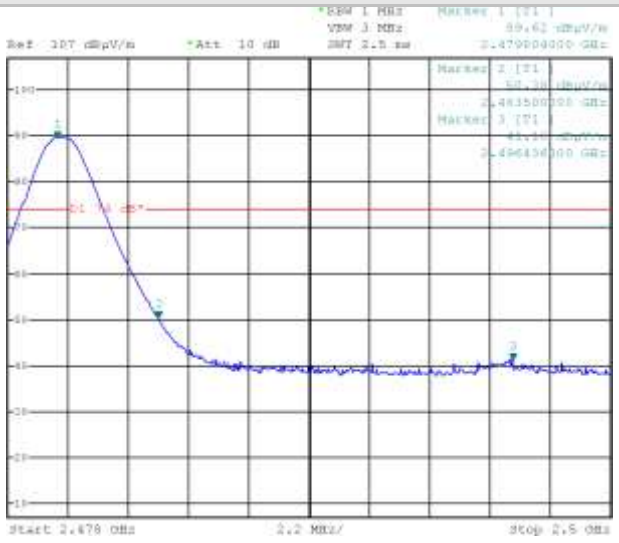
Plot 2



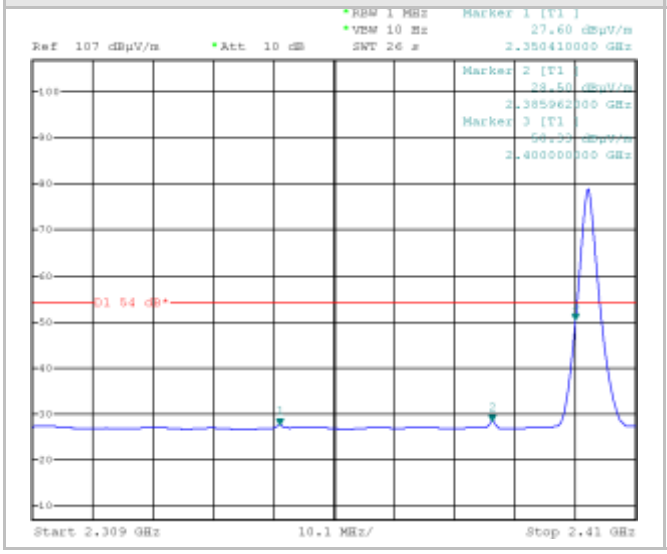
Plot 3



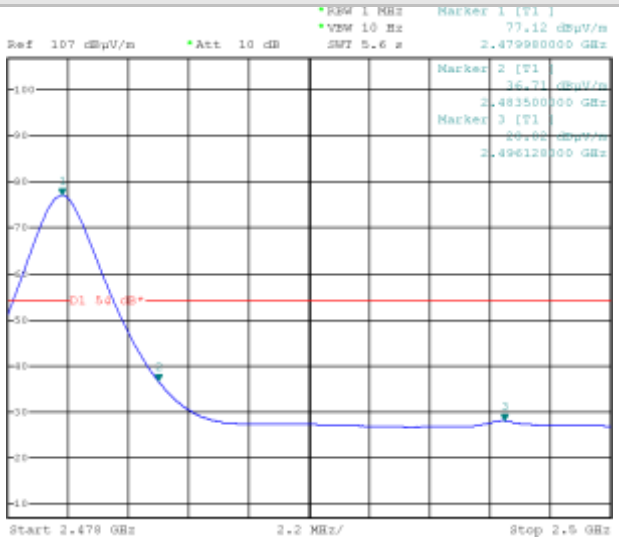
Plot 4

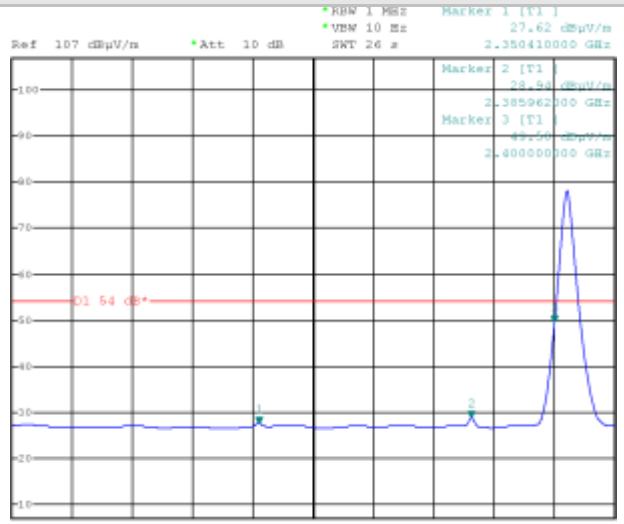
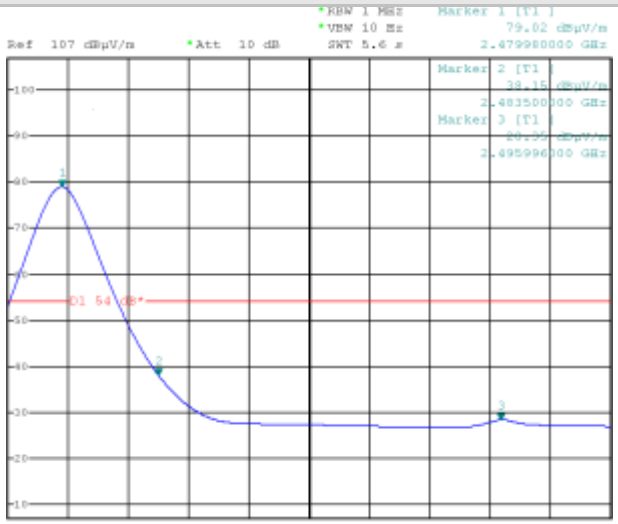


Plot 5



Plot 6



Plot 7	Plot 8
	

7.13 CONDUCTED EMISSIONS OUTSIDE THE BAND 2,400-2,483.5 MHz

TEST REQUIREMENT	
Spectrum analyzer settings	
Span	/
Resolution bandwidth (RBW)	100 kHz
Video bandwidth (VBW)	300 kHz
Sweep time (SWT)	AUTO
Detector function	Peak
Trace	Max hold
EUT operating condition	#1

TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through a temporary RF 50Ω connector type SMA. The measure has been executed at the lowest, middle and highest transmitter channel.
For emissions below 30MHz no emission higher than background level, so the data does not show in the report.

LIMITS

-20 dB below peak output power of fundamental, radiated emissions limit(§15.209a) and -33dBm in the restricted band (§15.205c)

SUMMARY OF TEST RESULTS

MODULATION	TESTED CHANNEL	MAX SPURIOUS POWER (dBm)	Limit -20dB(dBm)	Limit -33(dBm)	MARGIN	Plot (No.)
GFSK	LOWER	-40.29	--	-33	-7.29	1÷3
	MIDDLE	-42.96	--	-33	-7.96	4÷6
	HIGHER	-49.61	--	-33	-16.61	7÷9
π/4DQPSK	LOWER	-44.26	--	-33	-11.29	10÷12
	MIDDLE	-48.30	--	-33	-15.30	13÷15
	HIGHER	-50.15	-20.76	--	-29.39	16÷18
8DPSK	LOWER	-44.98	--	-33	-11.98	19÷21
	MIDDLE	-52.75	-17.82	--	-34.93	22÷24
	HIGHER	-51.64	-18.98	--	-32.66	25÷27

Into the following plots the red line points -20 dB below peak output power of fundamental.

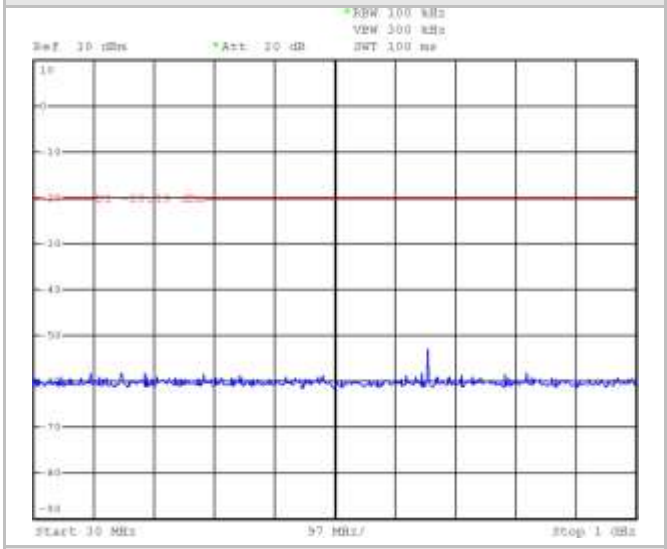
TEST RESULT

The EUT meets the requirements of sections 15.247 (d)

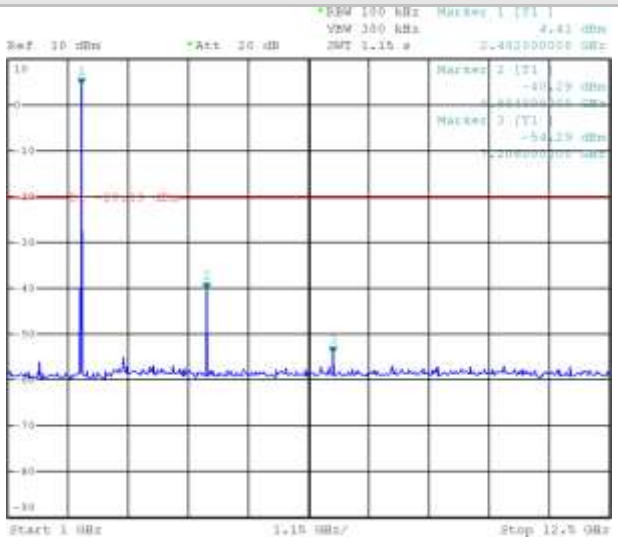
All out of band spurious emissions are more 20 dB below the in band power of the fundamental.

MEASUREMENTS PLOTS

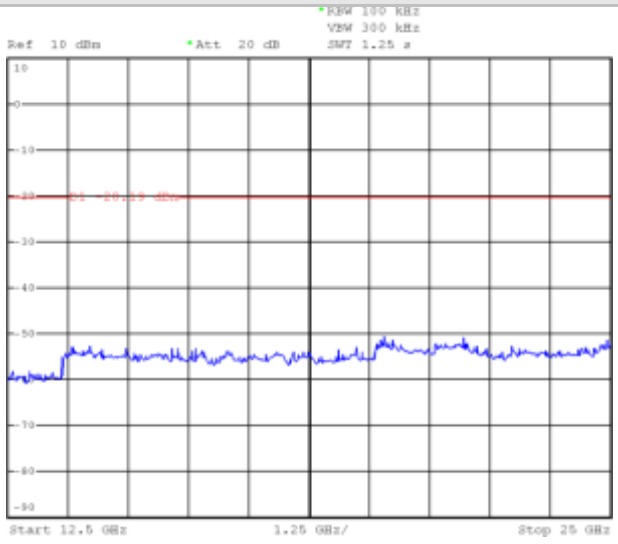
Plot 1



Plot 2



Plot 3



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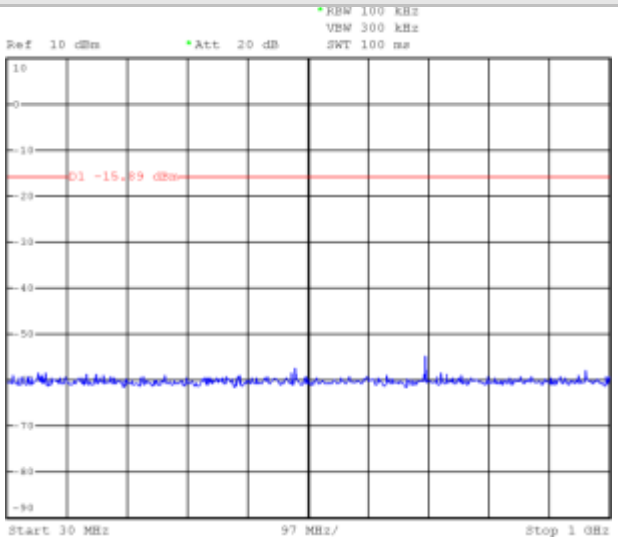

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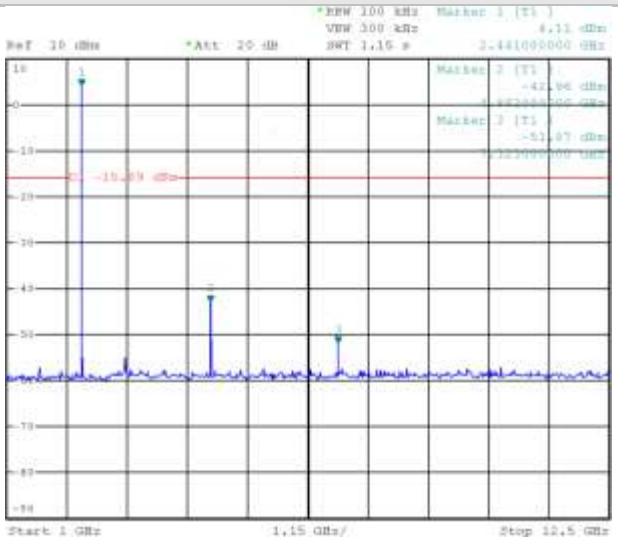

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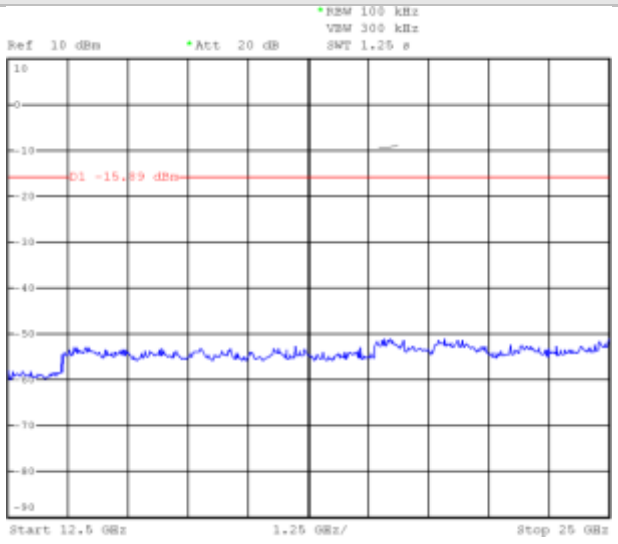

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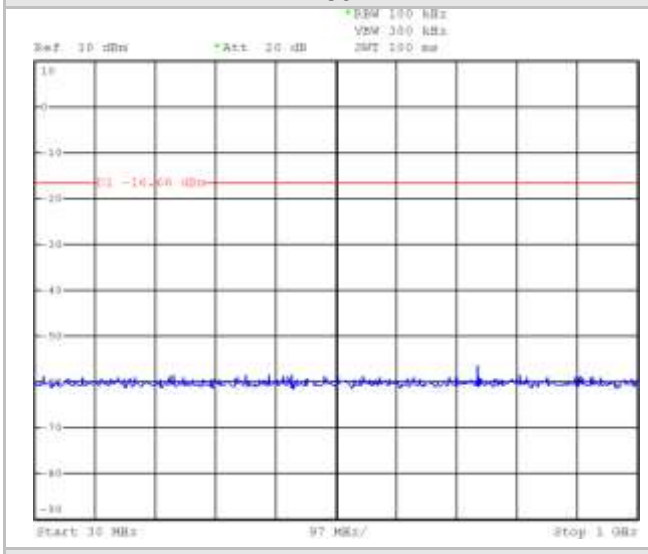

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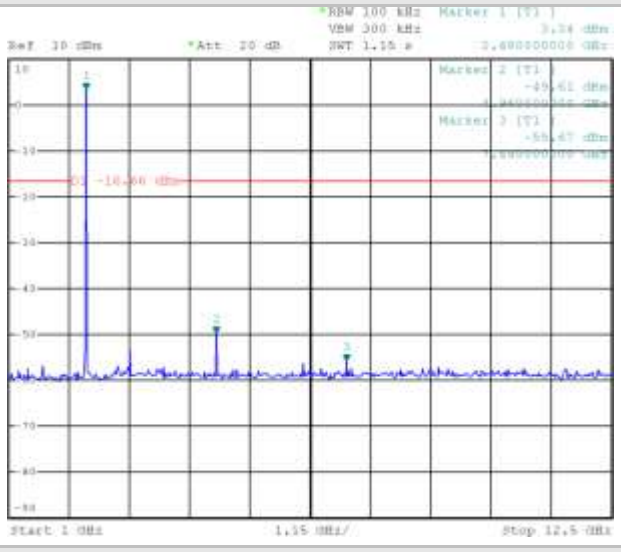

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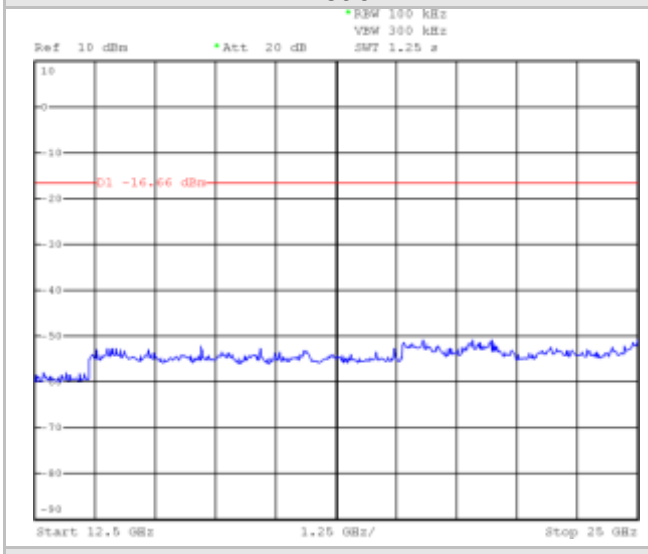

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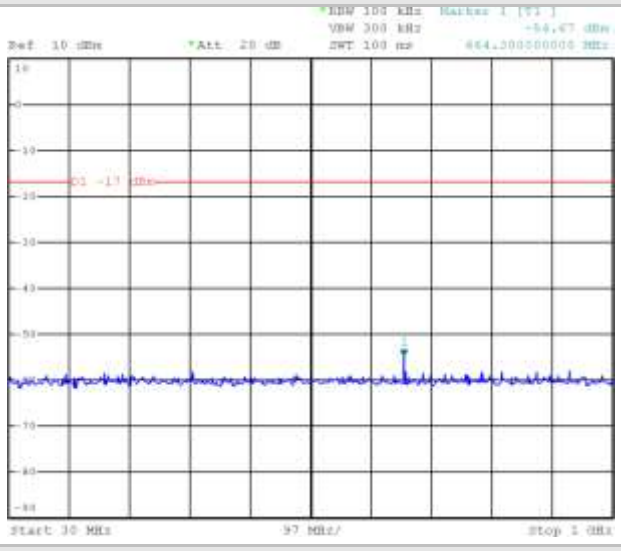

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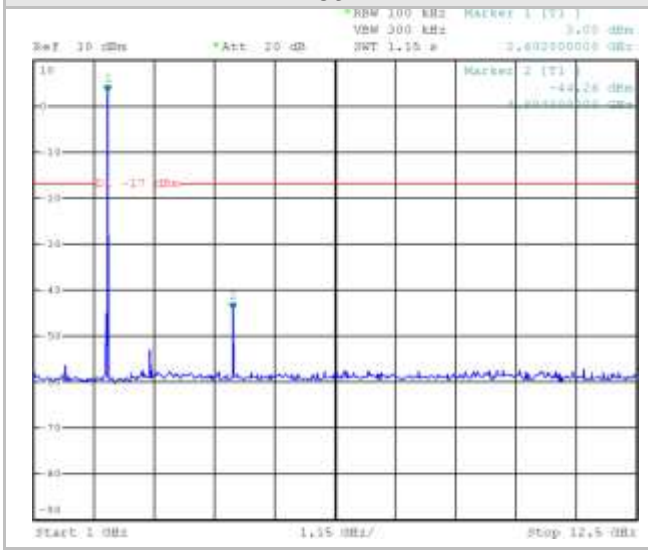

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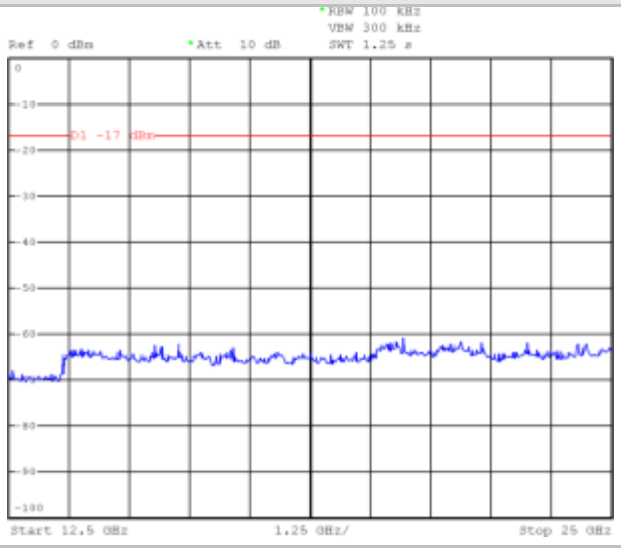

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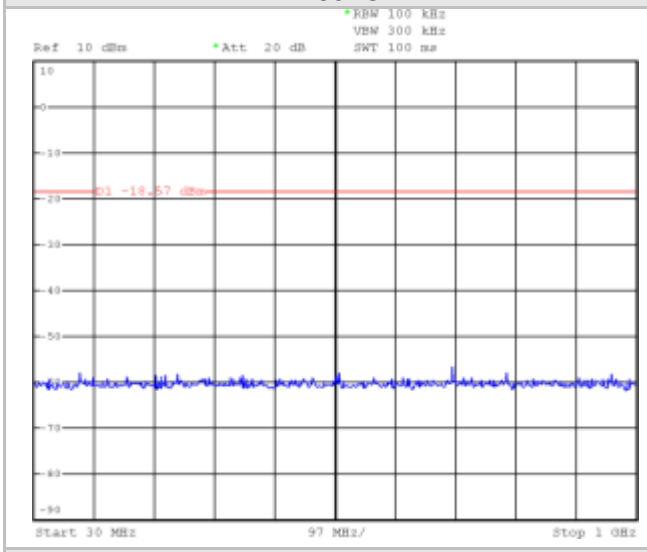

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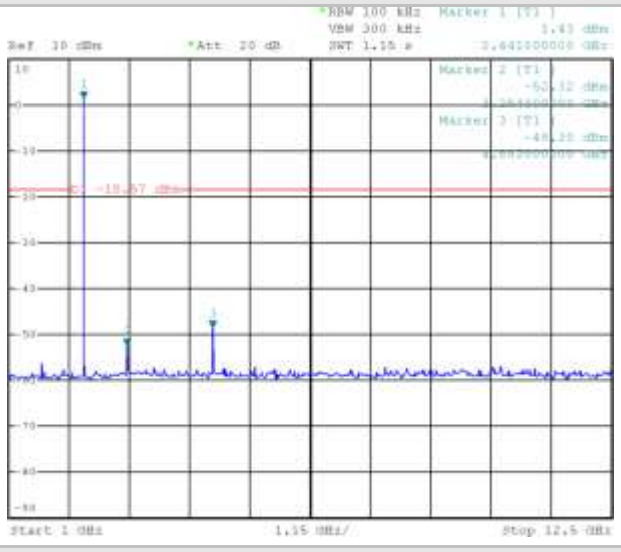

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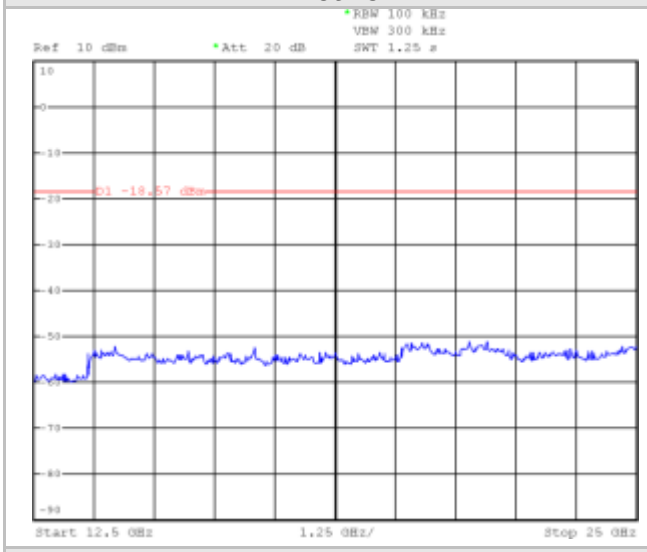

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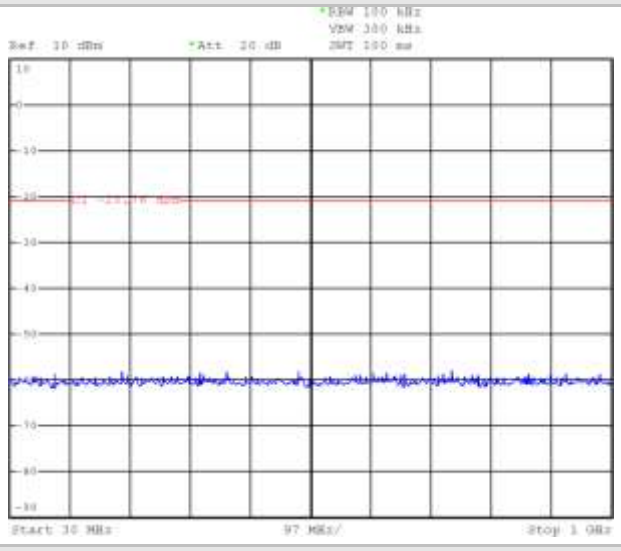

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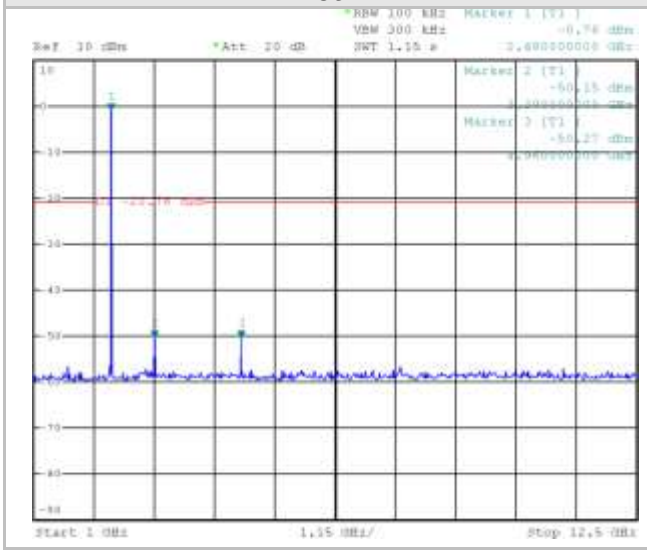

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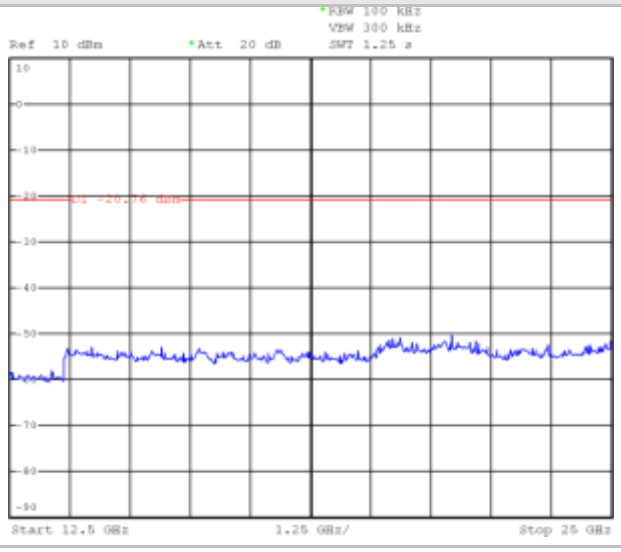

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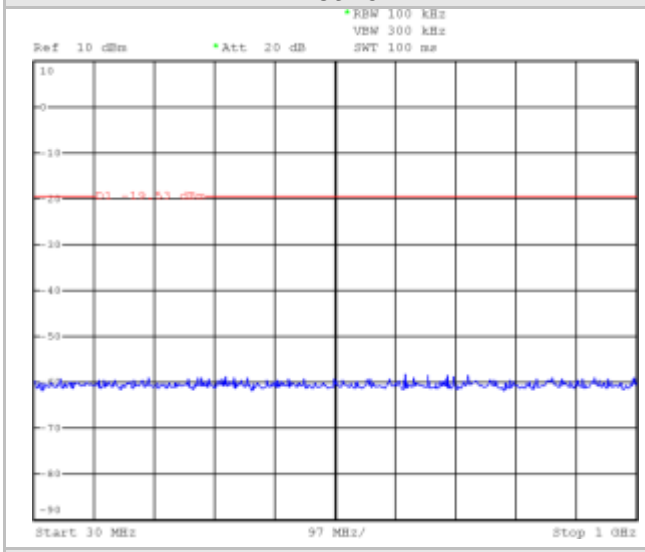

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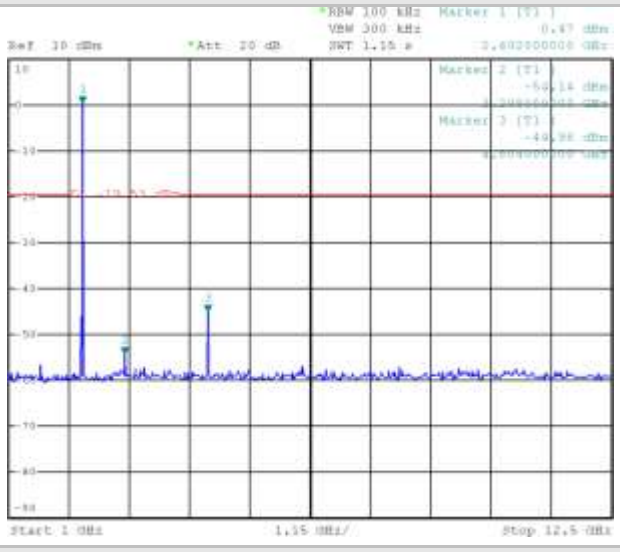

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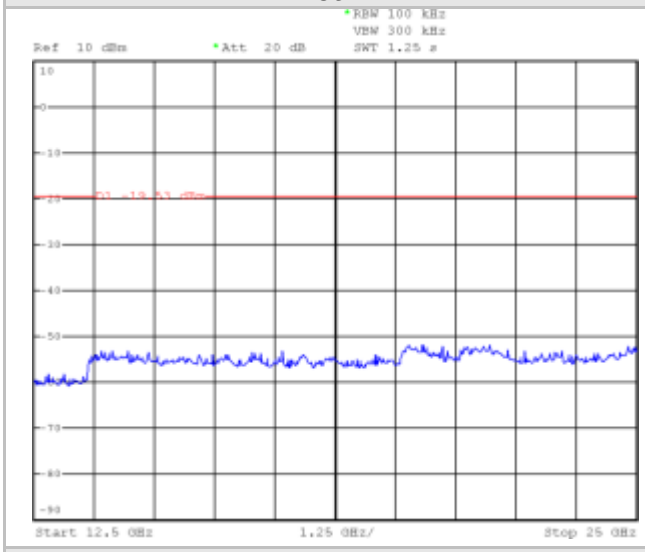

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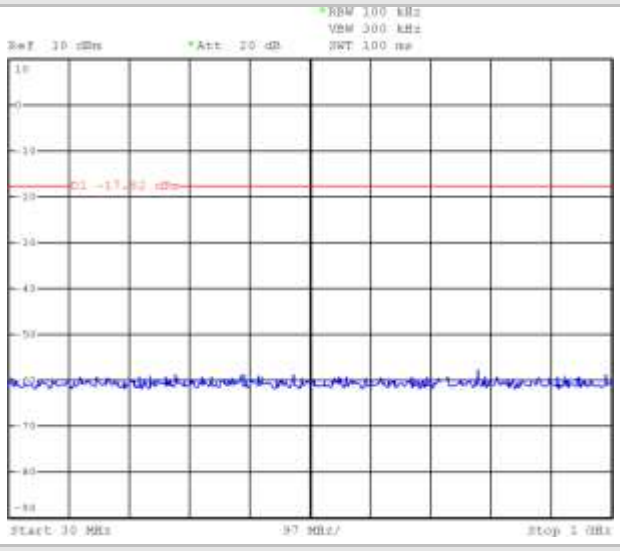

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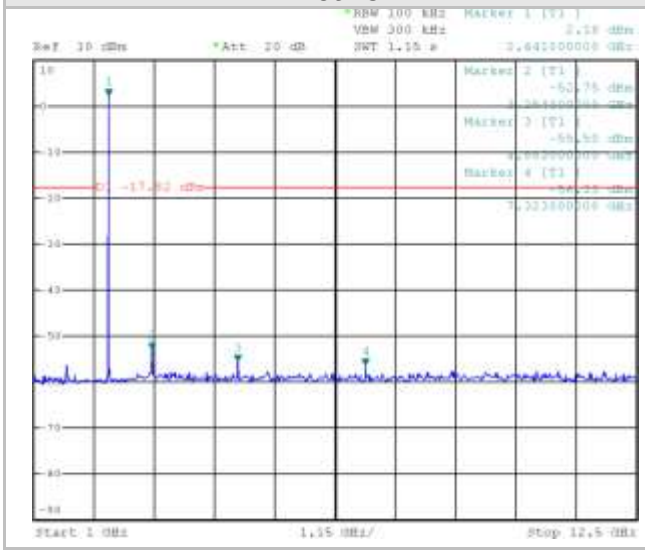

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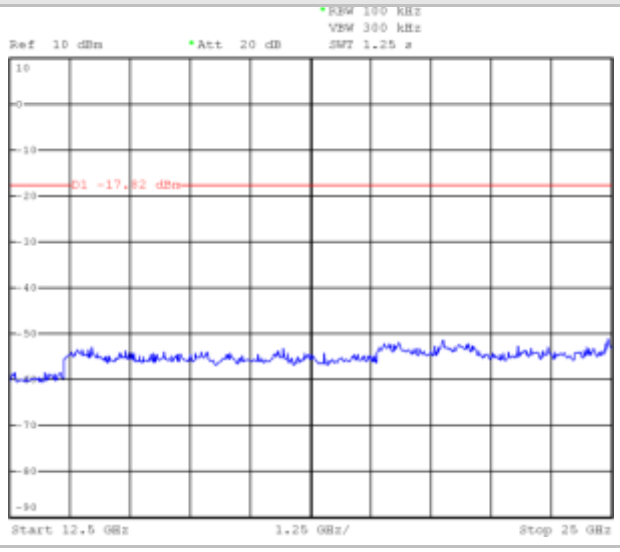

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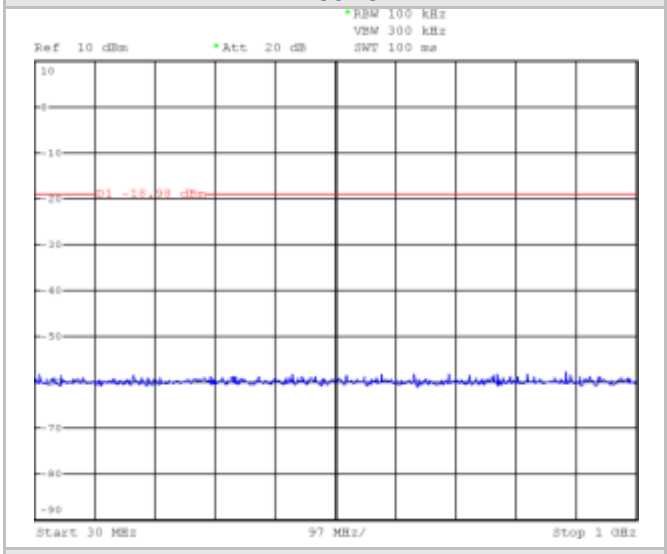

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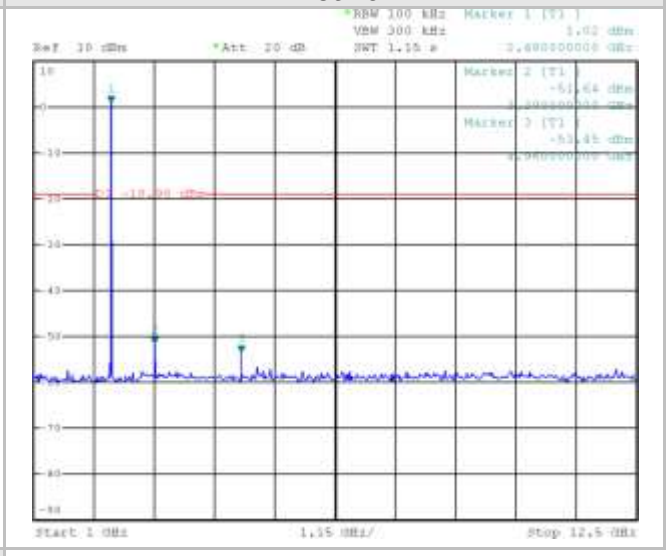

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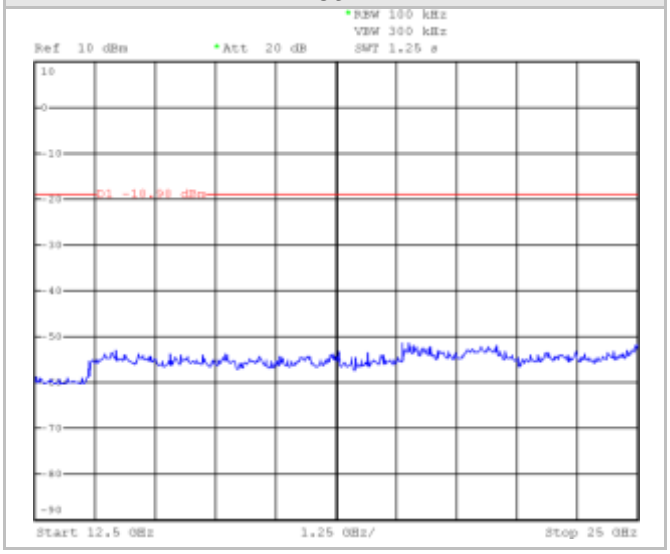


7.14 RF EXPOSURE EVALUATION

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)	Fixed according to § 2.1093(b) of this Chapter
LIMITS	According to § 2.1093 of this Chapter, by means of the following guidelines: OET Bulletin 65 and Mobile Portable RF Exposure v.04 (KDB no 447498)

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				

MPE Calculation method: $E(V/m)= \frac{\sqrt{30 \times P \times G}}{d}$ Power density $Pd(W/m^2)= \frac{E^2}{377}$

E= electric field (V/m)
P= Peak RF output power (W)
G= EUT antenna numeric gain (numeric), Gain numeric=$10^{(dBi/10)}$
d= Separation distance between radiator and human body (m)

The formula can be changed to: $Pd= \frac{30 \times P \times G}{377 \times d^2}$

Equipment	Max output power (dBm)	Peak output power (mW)	Power density (S)(mW/cm^2)	Limit of power density (S)(mW/cm^2)
DOCKING	3.68	2.333	0,000464462	1
RECEIVER	3.04	2.014	0,000400821	1

TEST RESULT
This value is less than the low threshold limit corresponding to the general population exposure category and therefore no SAR test is required.

8. MEASUREMENTS AND TESTS UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the IMQ procedure No. IO-DT-U01 and requirement of NIST Technical Note 1297 and NIS 81: 1994 “The Treatment of Uncertainty in EMC Measurements”

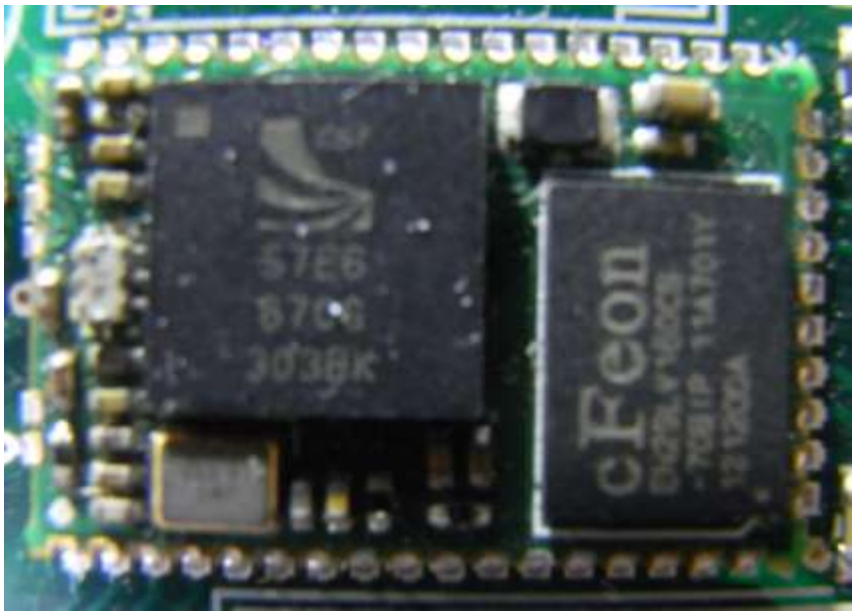
Methods	Expanded Uncertainty	Unit	confidence level	Coverage factor	Degree of freedom
Radiated emission (30 ÷ 1000 MHz)	4.39	dB	95 %	2	334
Radiated emission (above 1000 MHz)	5.14	dB	95 %	2	479

9. LIST OF MEASURING EQUIPMENT AND CALIBRATION INFORMATION

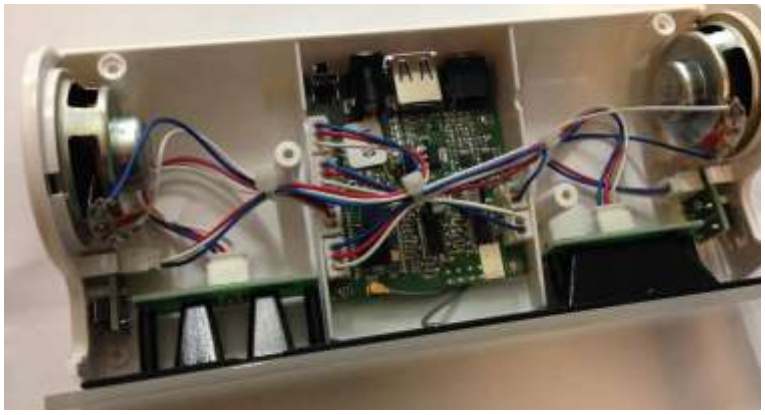
IMQ Serial Number	Instrument	Manufacturer	Type	Last Cal.	Cal. Period.	Calibration Company
P01709	Shielded semi-anechoic chamber	SIDT	/	03/2013	12	IMQ
S05562	EMI Receiver	Rohde & Schwarz	ESU 8	05/2014	12	ROHDE & SCHWARZ
S03629	Spectrum Analyzer	Rohde & Schwarz	FSP40	12/2013	12	I.N.RI.M.
S02508	Loop Antenna	Rohde & Schwarz	HFH2-Z2	01/2012	36	SEIBERSDORF
S06463	Bilog Antenna	Schwarzbeck	VULB9160	03/2013	36	NPL
S03463	Horn Antenna	Schwarzbeck	BBHA 9120D	09/2011	36	NPL
S03542	Preamplifier	Hewlett Packard	HP 8449B	06/2013	24	IMQ
S04193	Preamplifier	Bonn Elektronik	BLNA 0110-15C35	06/2013	24	IMQ
W-00124-ME+	Software for test automation	Rohde & Schwarz	EMC 32 Vers. 8.30	/	/	/

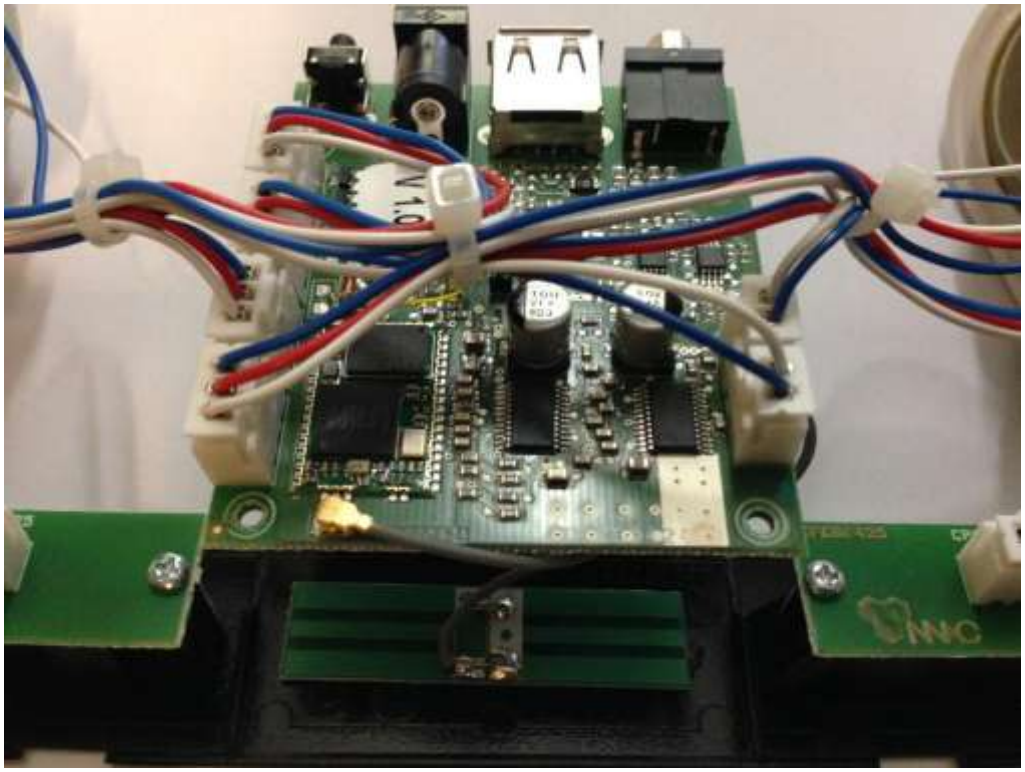
10. PHOTOGRAPHIC DOCUMENTATION

EUT IDENTIFICATION – RF RADIO MODULE

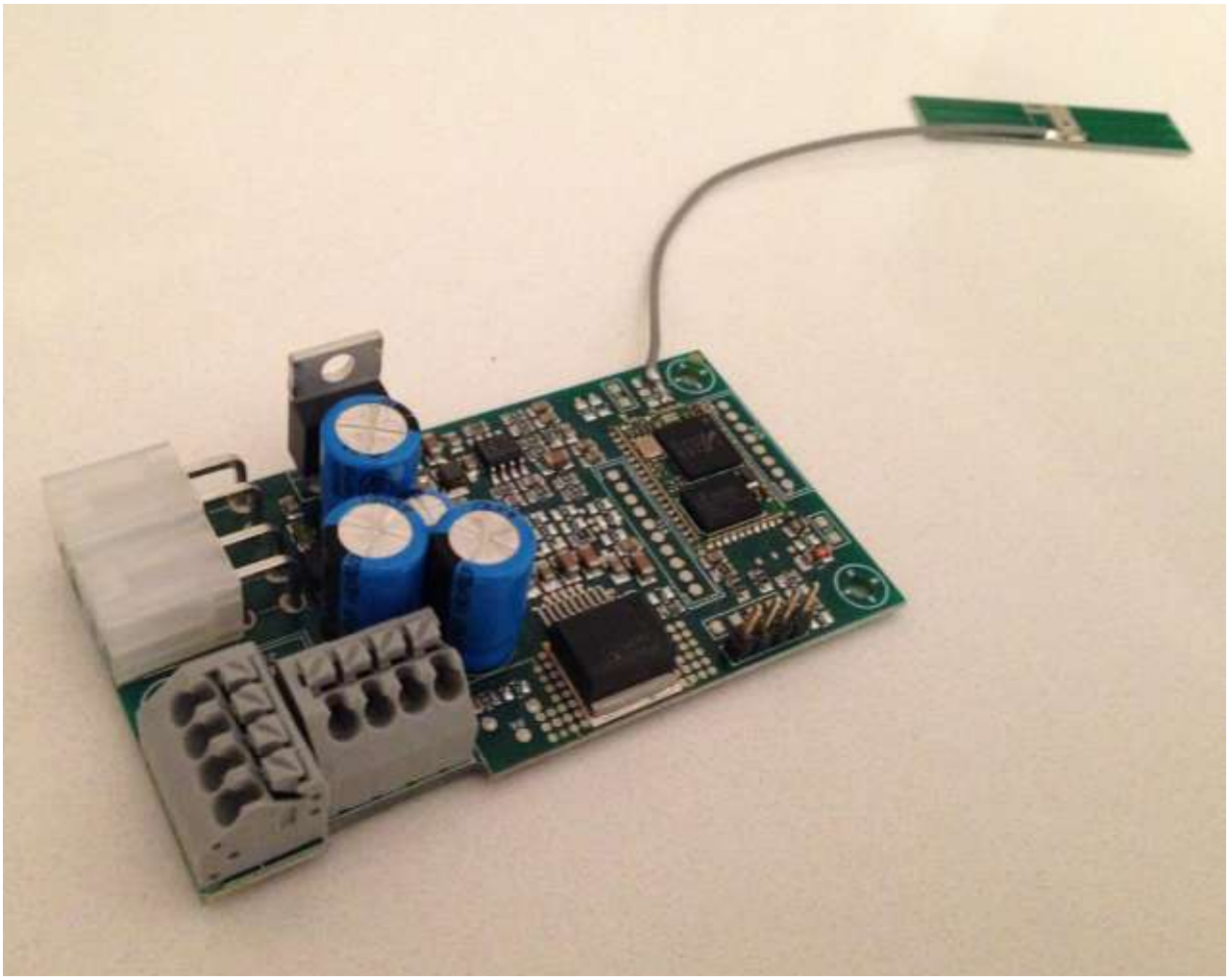


HOST EQUIPMENT - ESS DOCKING



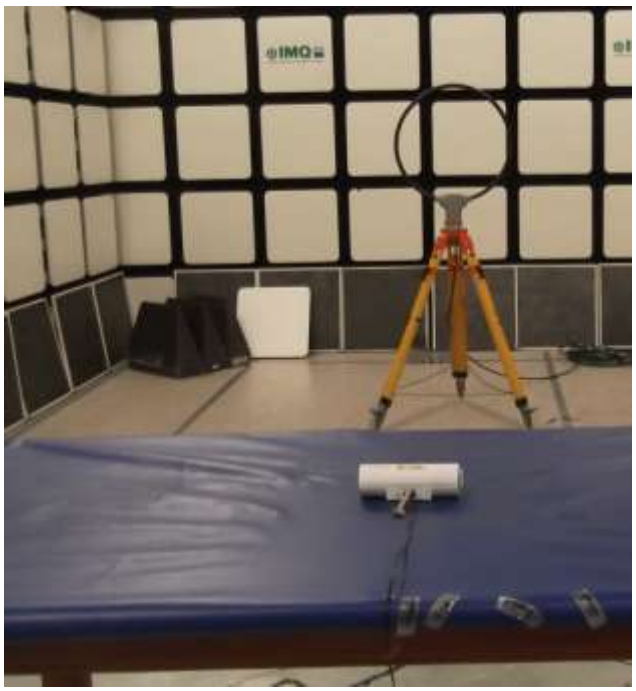


HOST EQUIPMENT – ESS RECEIVER

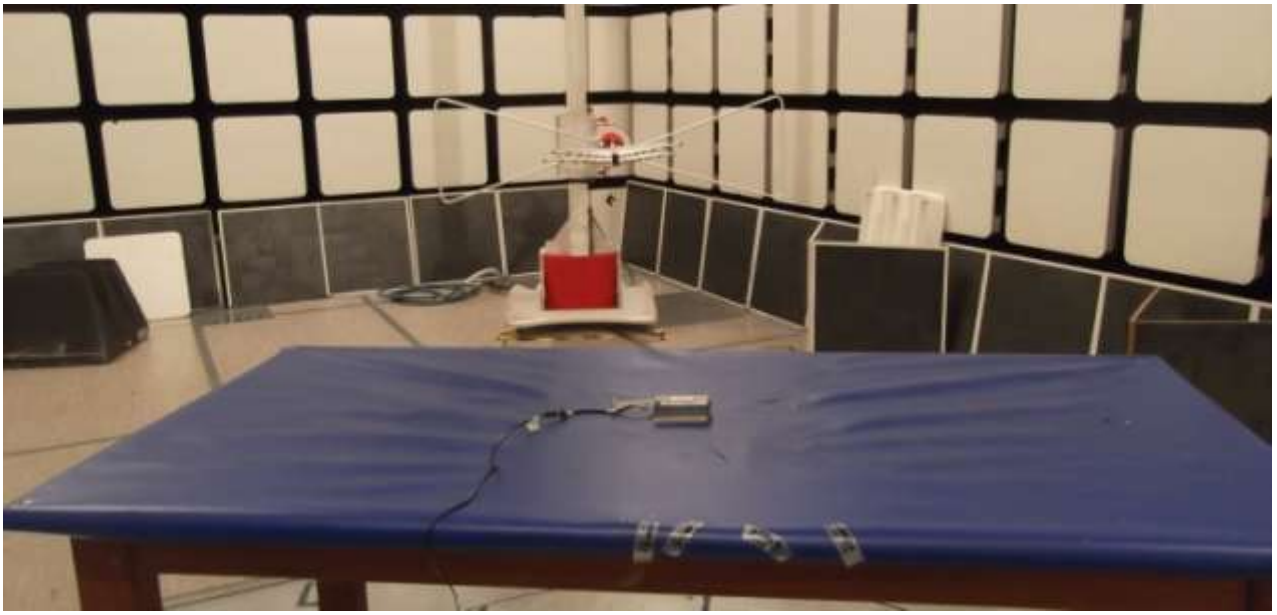


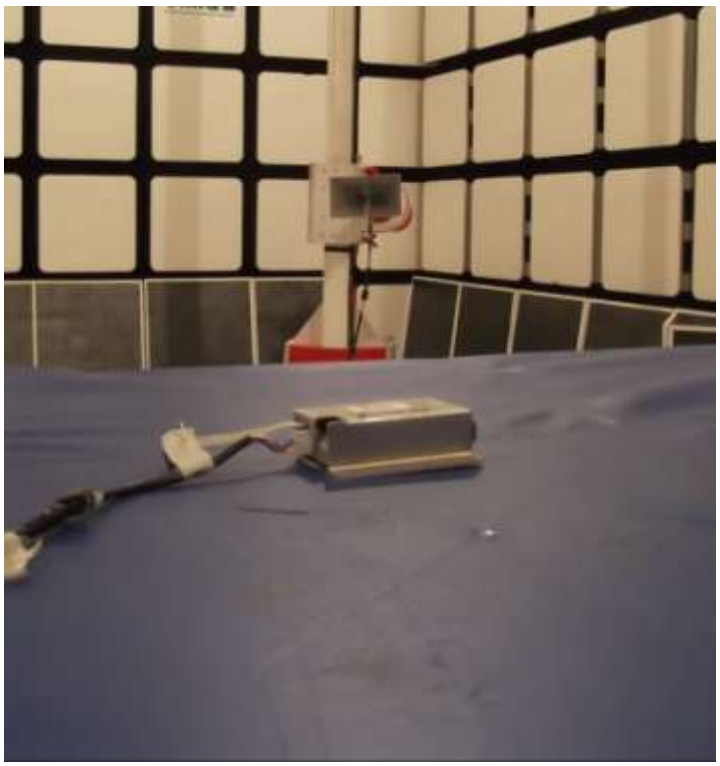
SET-UP

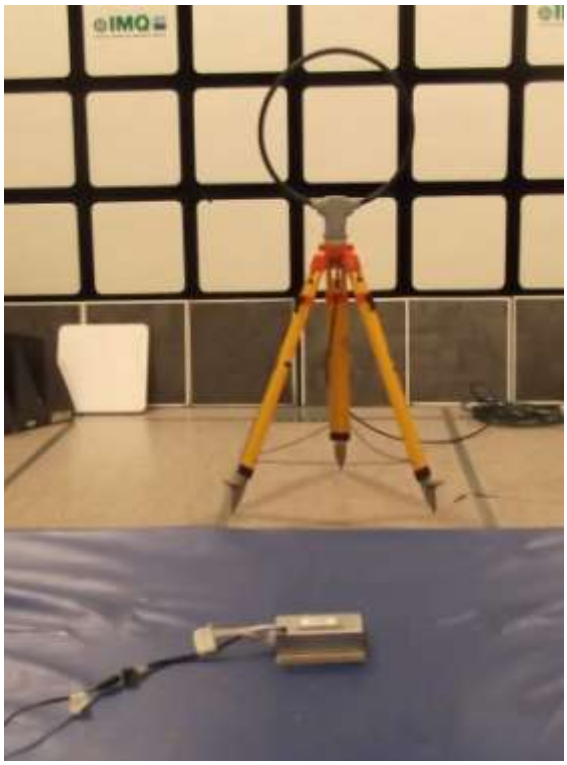
Test set-up radiated emission test - DOCKING



Test set-up radiated emission test - RECEIVER







END OF REPORT