TÜVRheinland®

LAB N° 1356 L

Test Report No.:	**IT21K3EN 001**	**Order No.:**	7976449	*Page 1 of 101*
Order date:	17-06-2021			
Client:	Move S.r.l. – Piazza Cavour 7 - 20121 Milano - Italy			
Test item:	Low Power Radio Module			
Identification / Type No.:	**MAMWLE-00** **MAMWLE-01**			
FCC ID:	**2A3LJ-MAMWLE**			
Trademark:	MOVE SOLUTIONS			
Order content:	Full tests according to the following standard:			
Test specification:	**FCC Cfr 47 part 15 – Subpart C - §15.247**			
Date of receipt:	24-08-2021			
Test sample No.:	Storage no.: A003116457-001			
Testing period:	03-09-2021 to 23-12-2021			
Place of testing:	TÜV Rheinland Italia S.r.l. Via E. Mattei, 3 20005 Pogliano Milanese (MI) - IT			
Testing laboratory:	TÜV Rheinland Italia S.r.l. Via E. Mattei,3 20005 Pogliano Milanese (MI) - IT			
Test result:	*Pass*			

Tested by:	Roberto Radice	**Authorized by:**	Andrea Bortolotti
Date: 28-12-2021	(Laboratory technician)	**Date:** 28-12-2021	*(Reviewer)*
Position	Expert	**Position**	Expert
Other:	---		
Condition of the test item at delivery:	*Test item complete and undamaged*		

1	*The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.* *Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.*
2	*As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged.*
3	*Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.* *Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.*
4	*The measurement uncertainty of the measurement procedures listed in this test report does not include the compliance of the respective limit values / operating conditions. For emission tests the requirements, CISPR 16-4-2 / EN55016-4-2 (chapter 4.2) apply in their current form.*
5	*Unless otherwise agreed with the customer, a conformity assessment is always carried out based on the applied standards.* *At the customer's request, the statement on the conformity of the product tested in this test report is carried out according to the criteria/requirements of the applied standards.* *Evaluation conditions deviating from these are documented separately in the respective chapters.*

6	*Description*	Low Power Radio Module
7	*Model name*	**MAMWLE-00** **MAMWLE-01**
8	*Serial number*	Not present
9	*Manufacturer*	Move S.r.l. - Piazza Cavour 7 - 20121 Milano - Italy
10	*Trademark*	MOVE SOLUTIONS
11	*Power supply*	DC power supply
12	*Rated voltage*	+3,3V
13	*Rated frequency*	D.C.
14	*Rated current*	----
15	*Maximum power consumption*	----
16	*Modulation type*	☐ Frequency hopping (FHSS) equipment ☐ Wideband data transmission (non-FHSS equipment) ☒ Direct Sequence Spread Spectrum (DSSS equipment) ☐ Others:
17	*Hardware version*	MAMWLE_V1.1
18	*Software version*	LoRaWAN_AT_Slave v1.1
19	*Dimensions*	----
20	*Weight*	----
21	*Test sample obtaining*	☒ Sampling by customer ☐ Sampling by TÜV Rheinland Group ☐ others:

22 *Applied basic standards*

Reference document		
Title 47 Part 15 Subpart C		Radio Frequency Device – Intentional Radiators
Title 47 Part 15 Subpart C § 15.203		Radio frequency devices – Intentional Radiators Antenna requirement
Title 47 Part 15 Subpart C § 15.205		Radio frequency devices – Intentional Radiators Restricted bands of operation
Title 47 Part 15 Subpart C § 15.207		Radio frequency devices – Intentional Radiators Conducted Limits
Title 47 Part 15 Subpart C § 15.209		Radio frequency devices – Intentional Radiators Radiated Emissions Limits
Title 47 Part 15 Subpart C § 15.247		Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.
558074 D01 DTS Meas Guidance v05r02 - April 02,2019		Guidance for performing compliance measurements on digital transmission systems (DTS) operating under §15.247
ANSI C63.4	2014	Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10	2020	American National Standard for Testing Unlicensed Wireless Devices

23 *Equipment used during test*

Equipment under test

No.	***Product type***	***Manufacturer***	***Model***	***Comments***
1	Low Power Radio Module	Move S.r.l.	**MAMWLE-00 (Coax. Antenna)** **MAMWLE-01 (PAD Antenna)**	None

Auxiliary Equipment / Peripherals

No.	***Product type***	***Manufacturer***	***Model***	***Comments***
1	Demo board	**Move solutions**	---	Provided by applicant
1	Personal computer	**Dell**	---	To send command on demo board

24 *Input/Output ports*

No.	Name	Type	Cable length	Cable shielded	Comments
1	Enclosure	Open frame board	—	—	—
2	AC power port	Port not present			
3	DC power port	+3.3V via USB cable connected to a demo board	---	---	---
4	I/O port	Signal D+ and D-	---	---	To send command from Personal computer to demo board provided by applicant.
5	Telecommunication port	Port not present			

25 *Used radio technologies and frequencies*

Radio Type	☒ Transreceiver ☐ Receiver only
Radio technology	☐ Short – Range Device ☐ WiFi ☐ Bluetooth Low Energy ☐ GPS / GNSS ☐ GSM/ GPRS (2G) ☐ UTRA (UMTS, 3G) ☐ E-UTRA (LTE, 4G) ☒ Other: Lora module
Equipment type	☒ Without audio speech (data only) ☐ With audio speech
Antenna type	☒ External (dedicated antenna) ☐ Intergrated antenna
Short –Range Band / Frequency	---
WiFi Channel / Frequency	---
Bluetooth Channel / Frequency	---
GPS / GNSS Band / Frequency	---
GSM Bands / Frequency	---
Utra Bands / Frequency	---
E-Utra Bands / Frequency	---
Other Bands / Frequency	902 – 928MHz

26 *Radio module identification*

Module manufacturer	STMicroelectronics
Module type	STM32WL System-On-Chip
Frequency Band	902 – 915MHz (Upstream)
Number of channel	64
Channel bandwith	125kHz
Channel Separation	200kHz
Modulation	LoRa®
Antenna	Dedicated Antenna: Ant. S.r.l. mod. Chinook 868-915- GSM900-GSM1800 (P/N: B01-000)
Antenna Gain	2.15dBi

27 *Operating modes*

No.	*Description*
1	Continuous LORA Modulation RF Transmission (Upstream) RF setting during tests: Frequency: 902,3MHz (low channel); 908,7MHz (mid channel); 914,9MHz (high channel); Modulation: LORA; Bandwidth: 125kHz; Spreading Factor DR0 to DR3 (SF10 to SF7) Power Setting: ⇒ +15dBm (max. power declared)
2	Continuous LORA Modulation RF Transmission (Upstream) RF setting during tests: Frequency: Hopping mode from channel 1 (902,3MHz) to channel 64 (914,9MHz) Power Setting: ⇒ +15dBm (max. power declared)

28 *Channel list*

Channel	Frequency	Channel	Frequency	Channel	Frequency	Channel	Frequency
1	**902,3 MHz**	2	902,5 MHz	3	902,7 MHz	4	902,9 MHz
5	903,1 MHz	6	903,3 MHz	7	903,5 MHz	8	903,7 MHz
9	903,9 MHz	10	904,1 MHz	11	904,3 MHz	12	904,5 MHz
13	904,7 MHz	14	904,9 MHz	15	905,1 MHz	16	905,3 MHz
17	905,5 MHz	18	905,7 MHz	19	905,9 MHz	20	906,1 MHz
21	906,3 MHz	22	906,5 MHz	23	906,7 MHz	24	906,9 MHz
25	907,1 MHz	26	907,3 MHz	27	907,5 MHz	28	907,7 MHz
29	907,9 MHz	30	908,1 MHz	31	908,3 MHz	**32**	**908,5 MHz**
33	908,7 MHz	34	908,9 MHz	35	909,1 MHz	36	909,3 MHz
37	909,5 MHz	38	909,7 MHz	39	909,9 MHz	40	910,1 MHz
41	910,3 MHz	42	910,5 MHz	43	910,7 MHz	44	910,9 MHz
45	911,1 MHz	46	911,3 MHz	47	911,5 MHz	48	911,7 MHz
49	911,9 MHz	50	912,1 MHz	51	912,3 MHz	52	912,5 MHz
53	912,7 MHz	54	912,9 MHz	55	913,1 MHz	56	913,3 MHz
57	913,5 MHz	58	913,7 MHz	59	913,9 MHz	60	914,1 MHz
61	914,3 MHz	62	914,5 MHz	63	914,7 MHz	**64**	**914,9 MHz**

29 *Summary of tests result*

Port	Test	Operating condition	Result
Enclosure	Radiated emisison (9KHz – 10GHz)	1	PASS
AC mains power port	Conducted emission	1	PASS
Antenna connector	Antenna requirement	1	PASS
	RF power output (conducted) for frequency hopping systems	1	PASS
	20 dB maximum Bandwidth	1	PASS
	Out-of-band emissions	1	PASS
	100 kHz Bandwidth of Frequency Band Edges	1, 2	PASS
	Carrier frequency (Hopping Channel) Separation	2	PASS
	Number of Hopping Channels Used	2	PASS
	Time occupancy (Dwell Time) of Each Ch. within a 0,4 x N.ch (sec) Period	2	PASS
	Additional provisions to the general radiated emission limitations	1, 2	PASS
Note: test has been executed conducted on MAMWLE-00 (worst case condition) and radiated on both MAMWLE-00 and MAMWLE-01 module.			

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBµV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBµV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

30	*EUT configuration*
	The test setup was made in accordance with mentioned standards. *Measurements and tests were executed under "worst case" conditions. Typical EUT arrangements or operating modes were chosen or assumed which let suspect maximum emission or susceptibility (a so called "unfavourable configuration").* *Details of test setup or adjustments are (particularly) shown inside the photo documentation.* *As far as not mentioned otherwise these statements are valid for all following tests.*
31	*Climatic conditions*

Ambient Temperature	15 - 35 °C
Relative Humidity	30 - 60 %
Air pressure	860 - 1060 mbar

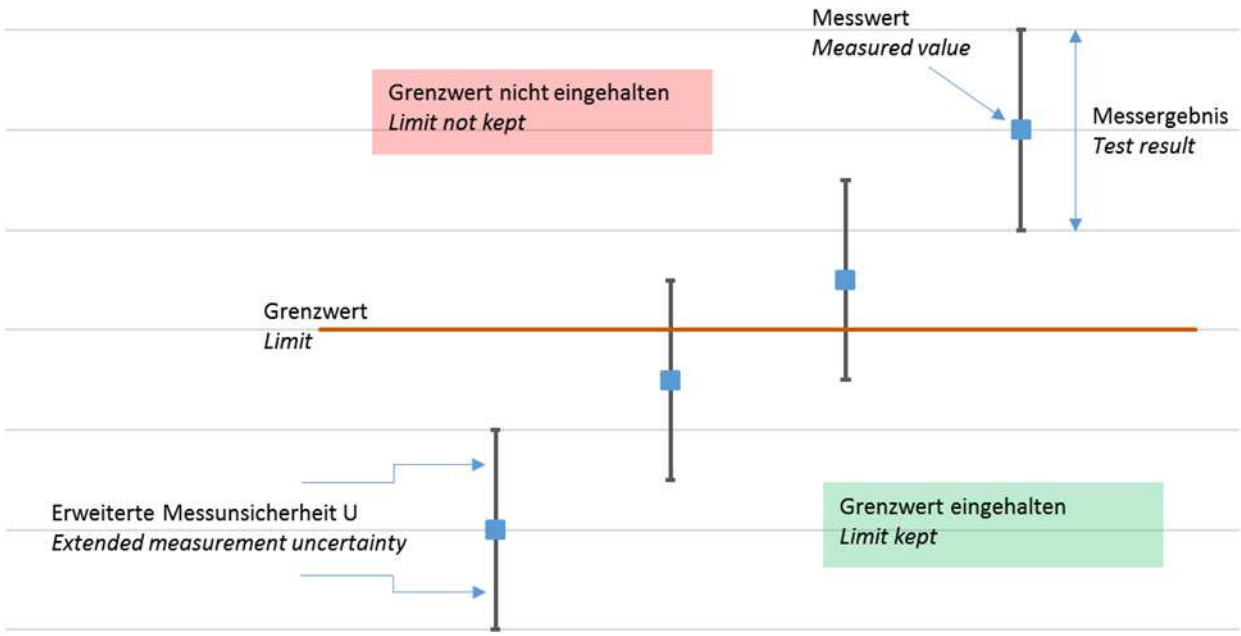
32 *Statement of the measurement uncertainty*

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4 "Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements" and is documented in the quality system acc. to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation.

The manufacturer has the sole responsibility of continued compliance of the device.

Test Method	Uncertainty (95%)	Coverage factor k
RF Conducted discontinuous emissions - range (150 kHz - 30MHz)	3,3 dB	2,0
RF Radiated emissions – range (30 – 1000) MHz	4,9 dB	2,0
RF Radiated emissions – range (1 – 8) GHz	5,1 dB	2,0
RF Radiated emissions – range (8 – 40) GHz	5,4 dB	2,0
Carrier Power (conducted) (1 – 8) GHz	1,5 dB	2,0
Occupied Bandwidth (OBW) (conducted)	514.4×1.00^{-9}	2,0
Power Spectral Density (PSD) (conducted)	1,5 dB	2,0
Transmitter unwanted emissions (conducted) range (0 – 1) GHz	0.92 dB	2,0
Transmitter unwanted emissions (conducted) range (1 – 8) GHz	1,5 dB	2,0
Transmitter unwanted emissions (conducted) range (8 – 40) GHz	2,4 dB	2,0

33	***Example for interpretation of measuring results***



Measured value	***Limit***	***Extended measurement uncertainty*** **(k=2)**	***Test result***
48.9 dBµV @ 16.5 MHz	50 dBµV	2.2 dB	46.7 dBµV – 51.1 dBµV

Decision rule :	Statements of conformity (PASS or FAIL) to specifications are made in this report without taking measurement uncertainty into account. Where statements of conformity are made in this report, the following decision rules are applied: **PASS** – Results within limits/specifications **FAIL** – Results exceed limits/specifications

34	***Change history***

Test report number	**List of revisions**	**Date**
IT21K3EN 001	First edition	28-12-2021

EMISSION TEST

Conducted emission test (150KHz – 30MHz)	
Test date	23-12-2021
Applied Standard	Title 47 Part 15 Subpart C §15.207
Test method	par. 6.2 Conducted emission measurements of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.	N°1
Operating mode	1
Tested terminals	AC Mains of auxiliary equipment
Result	PASS

Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of Emission (MHz)	Conducted Limit (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56 *	56 to 46 *
0.5-5	56	46
5-30	60	50

* Decreases with the logarithm of the frequency.

Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provision for, the use of battery chargers which permit operating while charging, AC adaptors or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
Semi-anechoic Chamber	ETS Lindgren	FACT3	2782378	05/2020	05/2022
Single-phase LISN 16A	Rohde&Schwarz	ENV216	2782895	05/2021	05/2022
EMI Receiver	Rohde&Schwarz	ESW44	2782867	06/2021	06/2022
Stabilized Power Supply	Elettrotest	TPS T 30K60S	2782385	10/2021	10/2022
Software EMC32	Rohde&Schwarz	10.60.15	---	---	---

Test parameter of

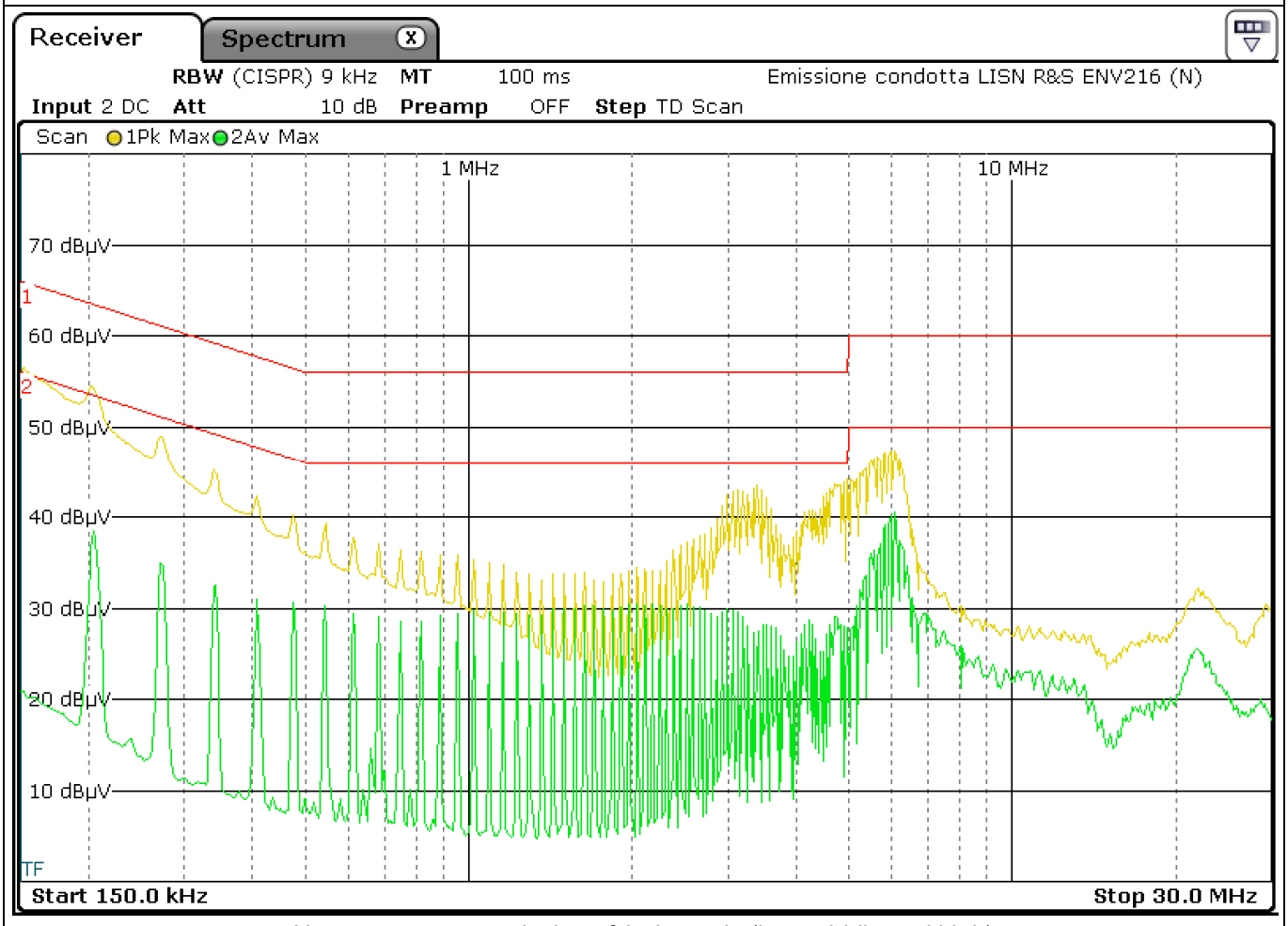
Pre Scan

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
Receiver: [ESW 44]					
150 kHz - 30 MHz	FFT	PK ; AVG	9 kHz	100 ms	0 dB

Final Test

Subrange	Step Size	Detectors	IF BW	Meas. Time	Preamp
Receiver: [ESW 44]					
150 kHz - 30 MHz	Single Freq.	QPK ; AVG	9 kHz	1 s	0 dB

Graphical presentation of



Note: worst case emission of 3 channels (low, middle and high)

Radiated emission test (9KHz – 10GHz)	
Test date	03-09-2021 to 23-12-2021
Applied Standard	Title 47 Part 15 Subpart C §15.205; §15.209; §15.247
Test method	Par. 8.6 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 11.12.1 Radiated emission measurements of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-00** **MAMWLE-01**
Test sample No.	N°2
Operating mode	1
Tested terminals	Enclosure
Result	PASS

Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

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:

Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(300m/3m) (Below 30MHz)

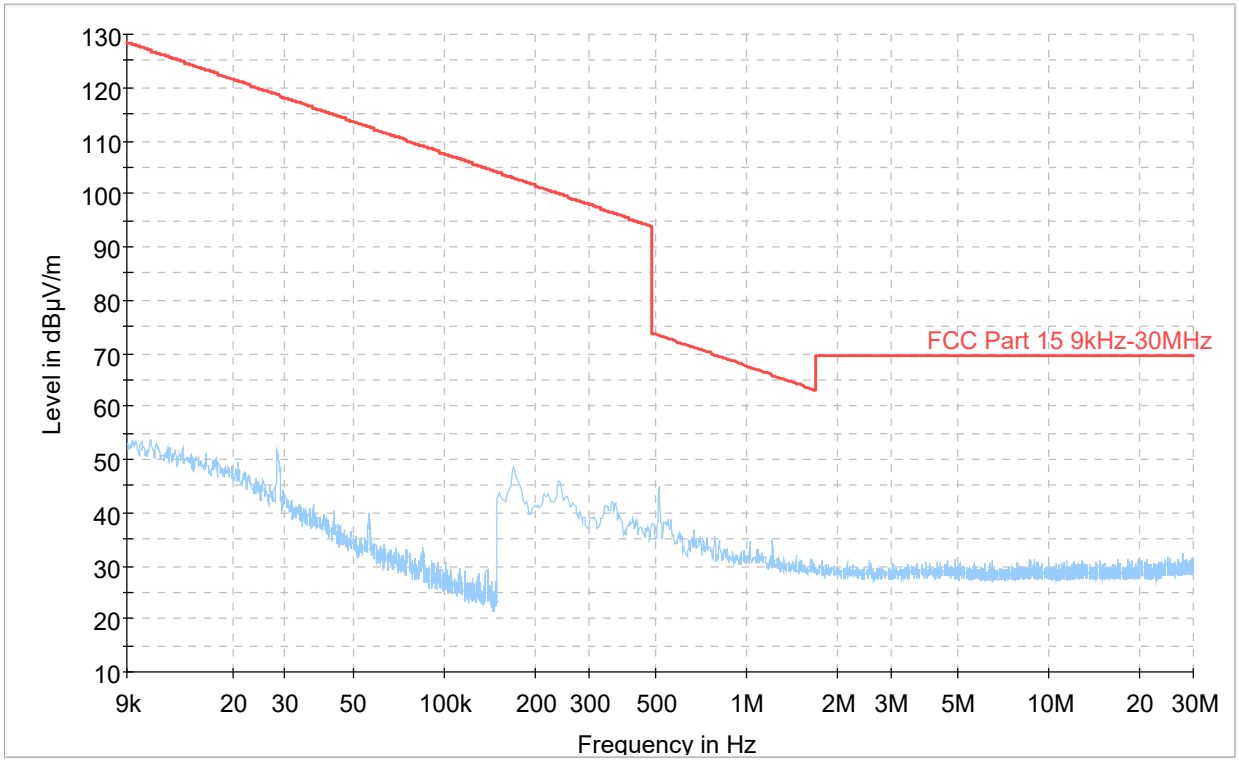
Limit 3m(dBµV/m)=Limit 300m(dBµV/m)+40Log(30m/3m) (Below 30MHz)

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
Semi-anechoic Chamber	ETS Lindgren	FACT3	2782378	05/2020	05/2022
Active Loop Antenna	Rohde&Schwarz	HFH2-Z2E	9015215	05/2020	05/2023
BiConiLog Antenna	ETS Lindgren	3142-E	2782348	08/2020	08/2023
Antenna Horn with external Preamplifier	ETS Lindgren	3117-PA	2782349	08/2020	08/2023
Highpass Filter	Wainwright Instr.	WHKX10-1170-1300-150	2782705	12/2019	12/2021
EMI Receiver	Rohde&Schwarz	ESW44	2782867	06/2021	06/2022
Software EMC32	Rohde&Schwarz	10.60.15	---	---	---

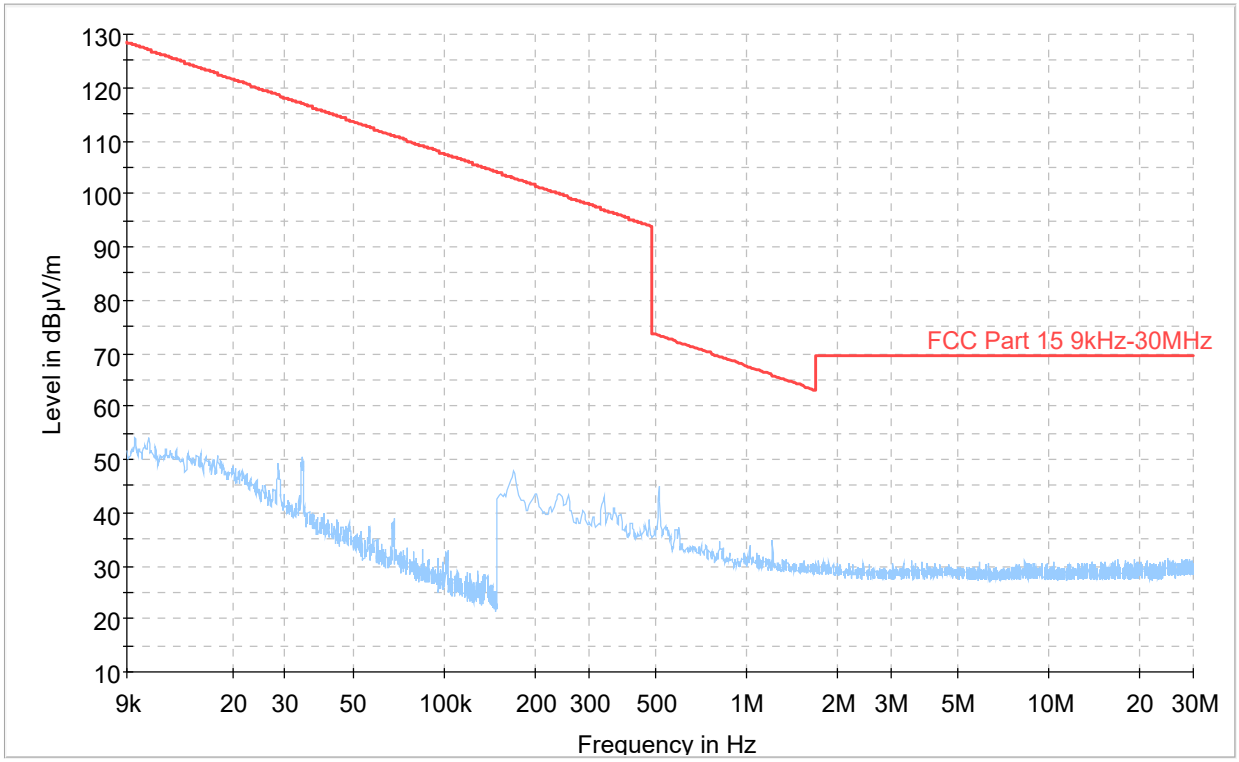
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (blue trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)

Full Spectrum

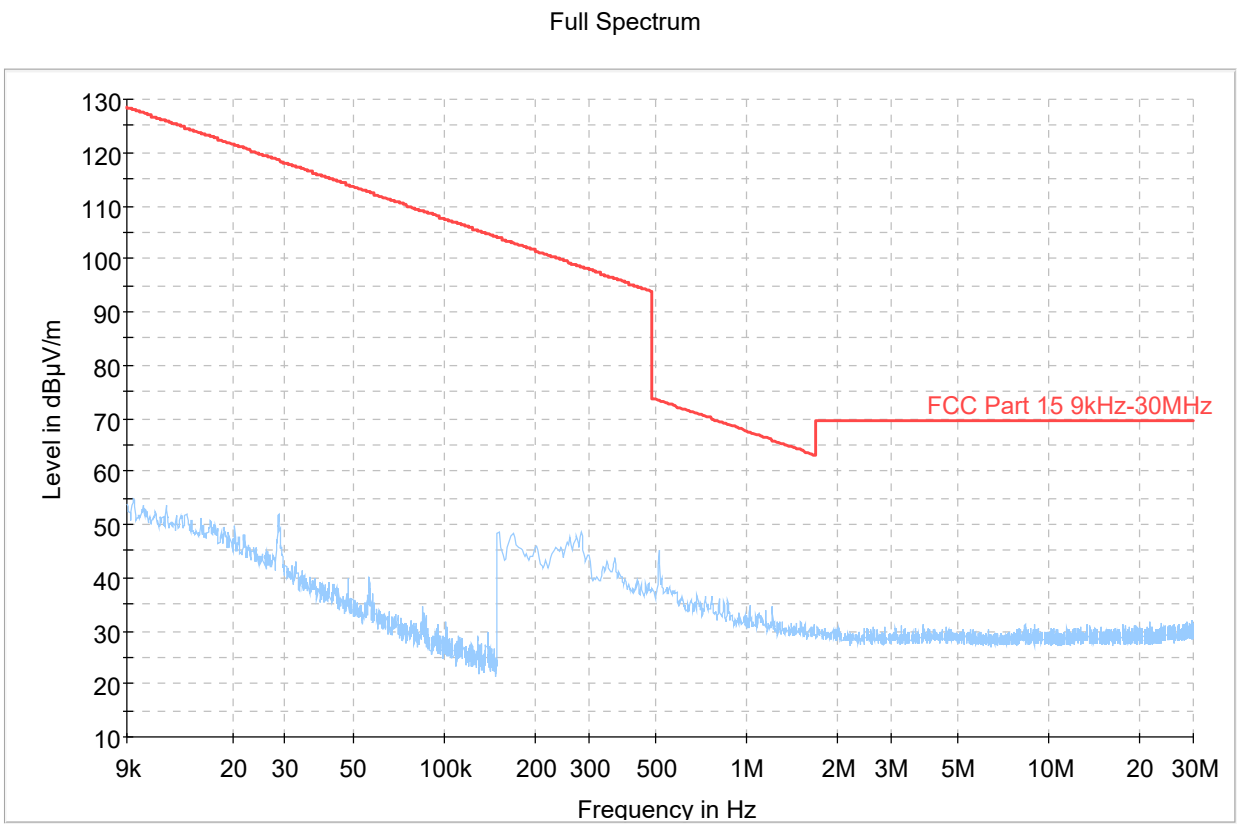


Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (blue trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)

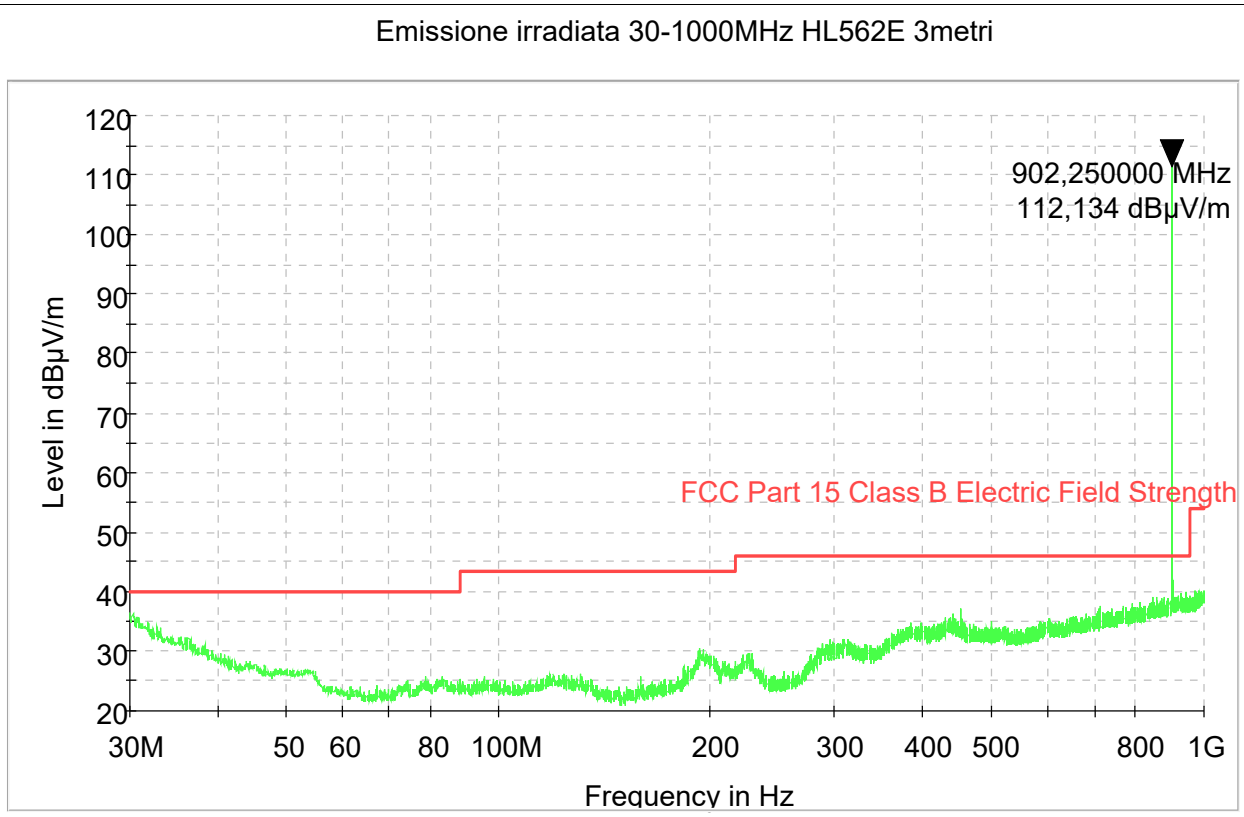
Full Spectrum



Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (blue trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)



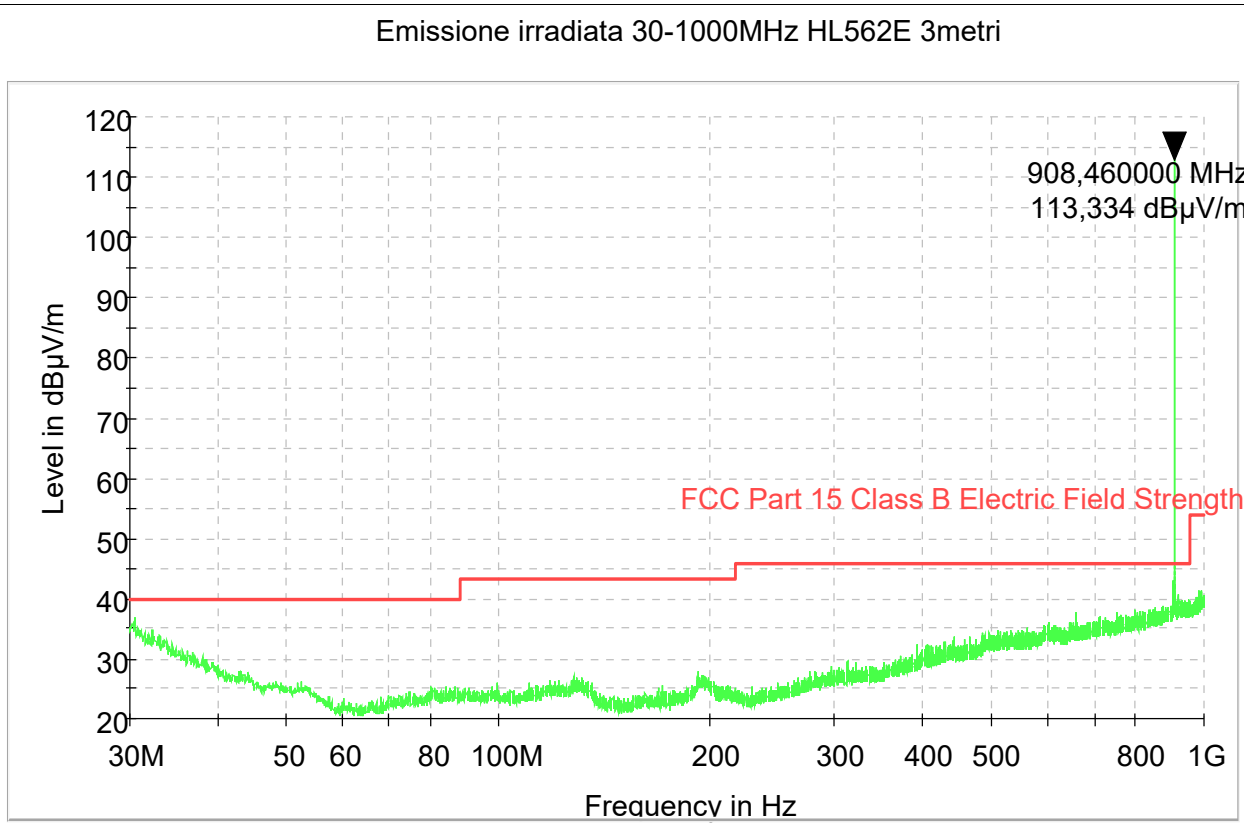
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)



Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
902.25	85.83	23.59	2.71	**112.13**

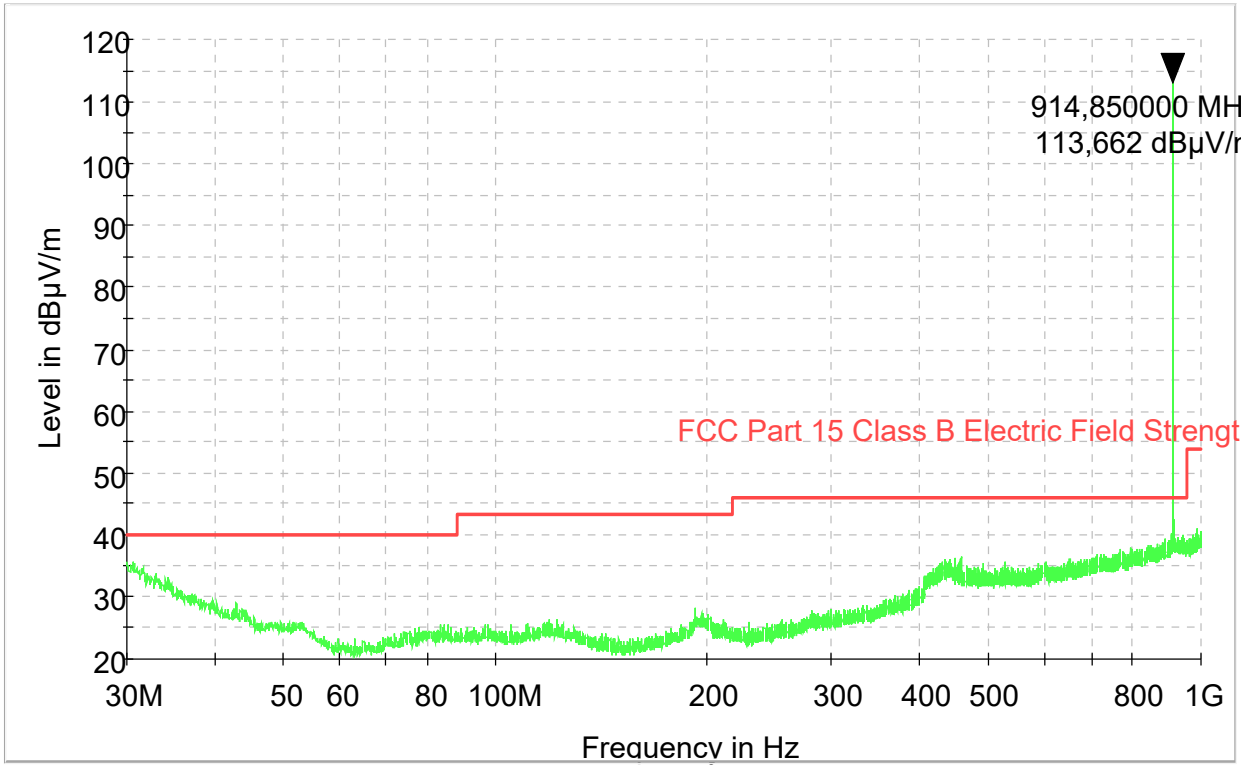
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)



Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
908.46	86.57	24.05	2.71	**113.33**

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)

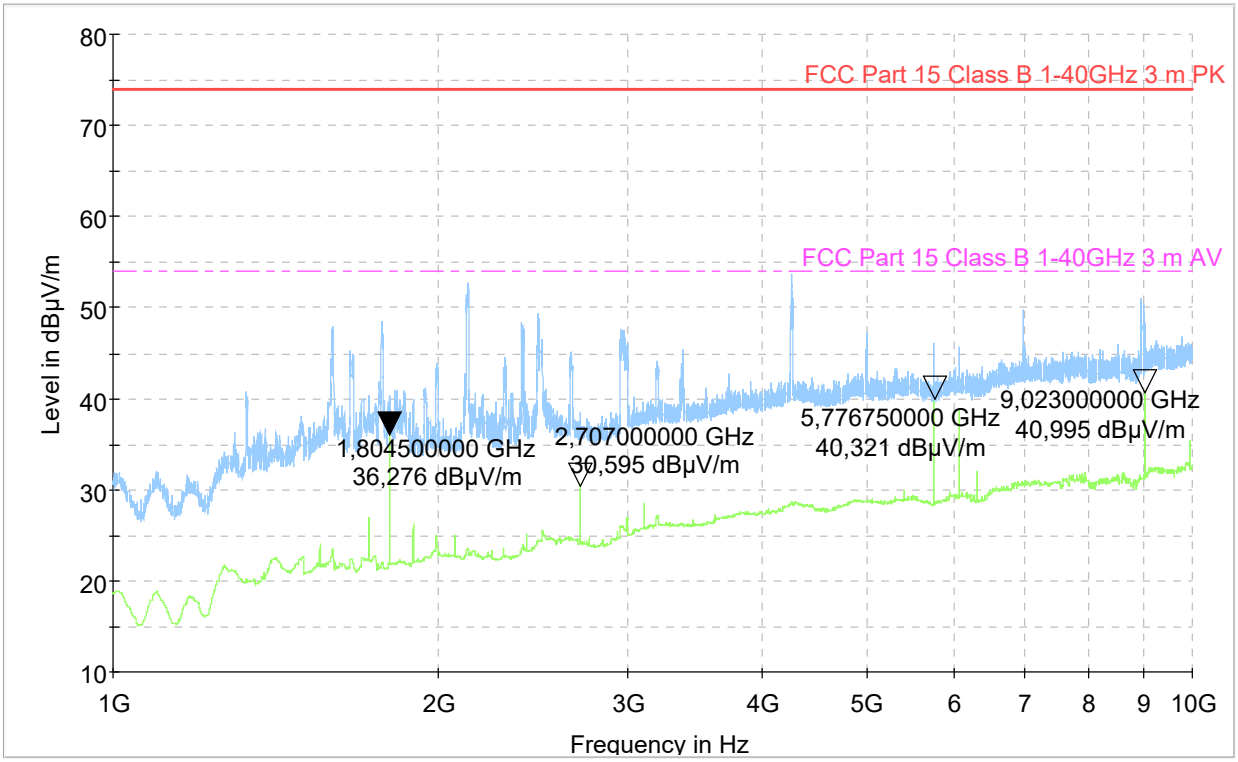


Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
914.85	86.36	24.57	2.73	**113.66**

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)

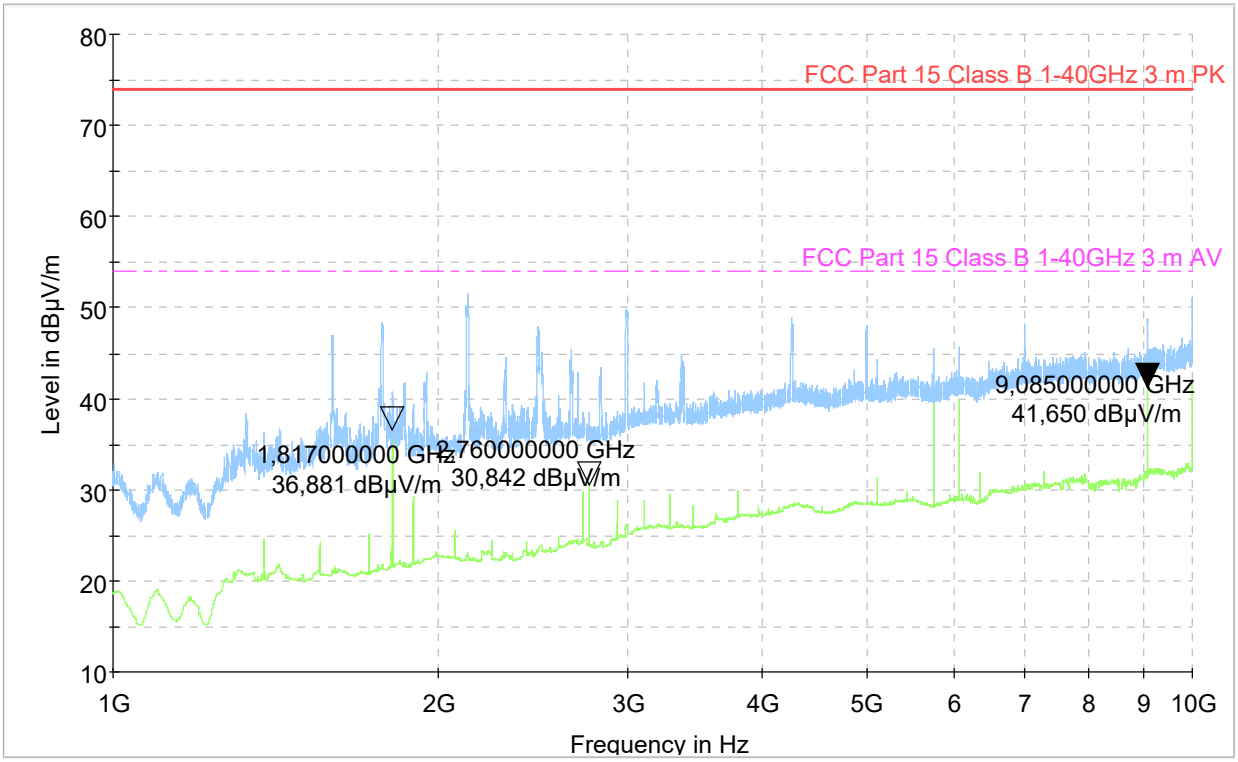
Full Spectrum



HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
1804.5	47.48	-14.07	2.87	**36.28**
2707.0*	39.79	-12.79	3.59	**30.59**
5776.7	43.72	-9.21	5.81	**40.32**
9023.0*	42.19	-8.21	7.01	**40.99**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)

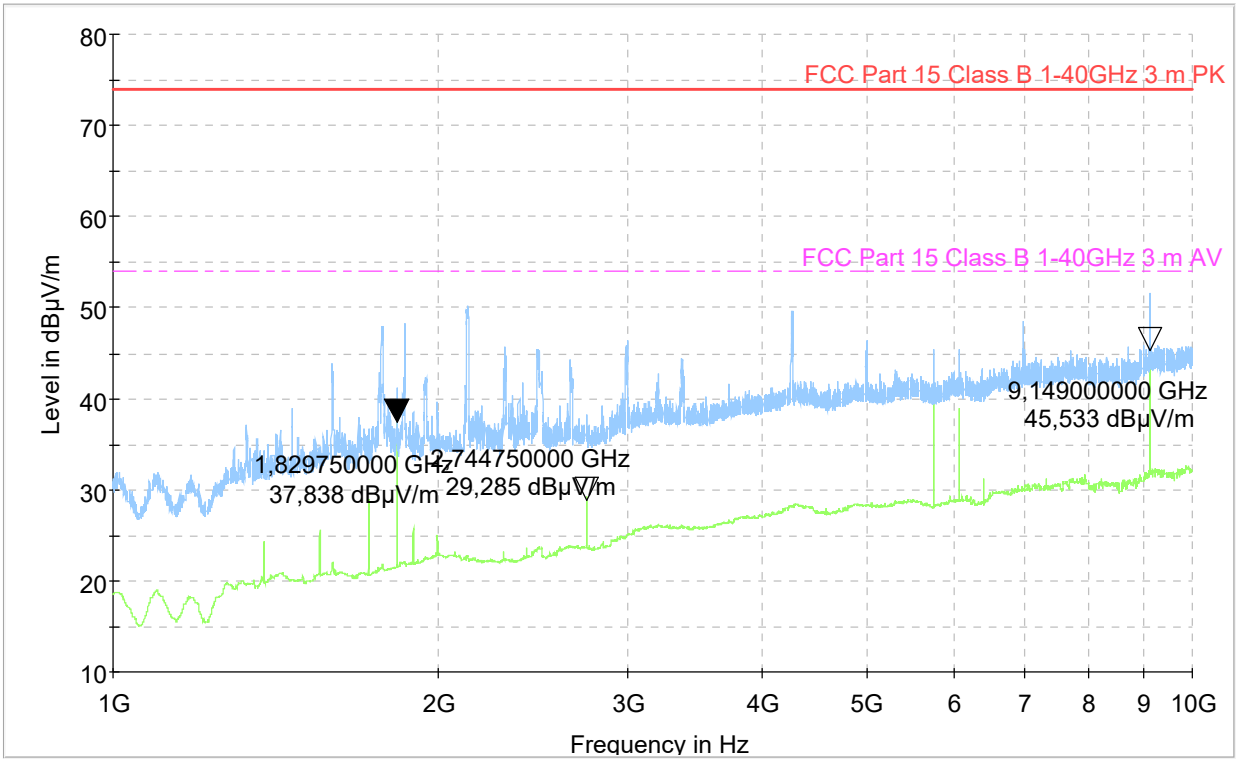
Full Spectrum



HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
1817.0	47.98	-14.12	3.02	**36.88**
2760.0*	39.82	-12.58	3.60	**30.84**
9085.0*	42.55	-8.26	7.36	**41.65**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)

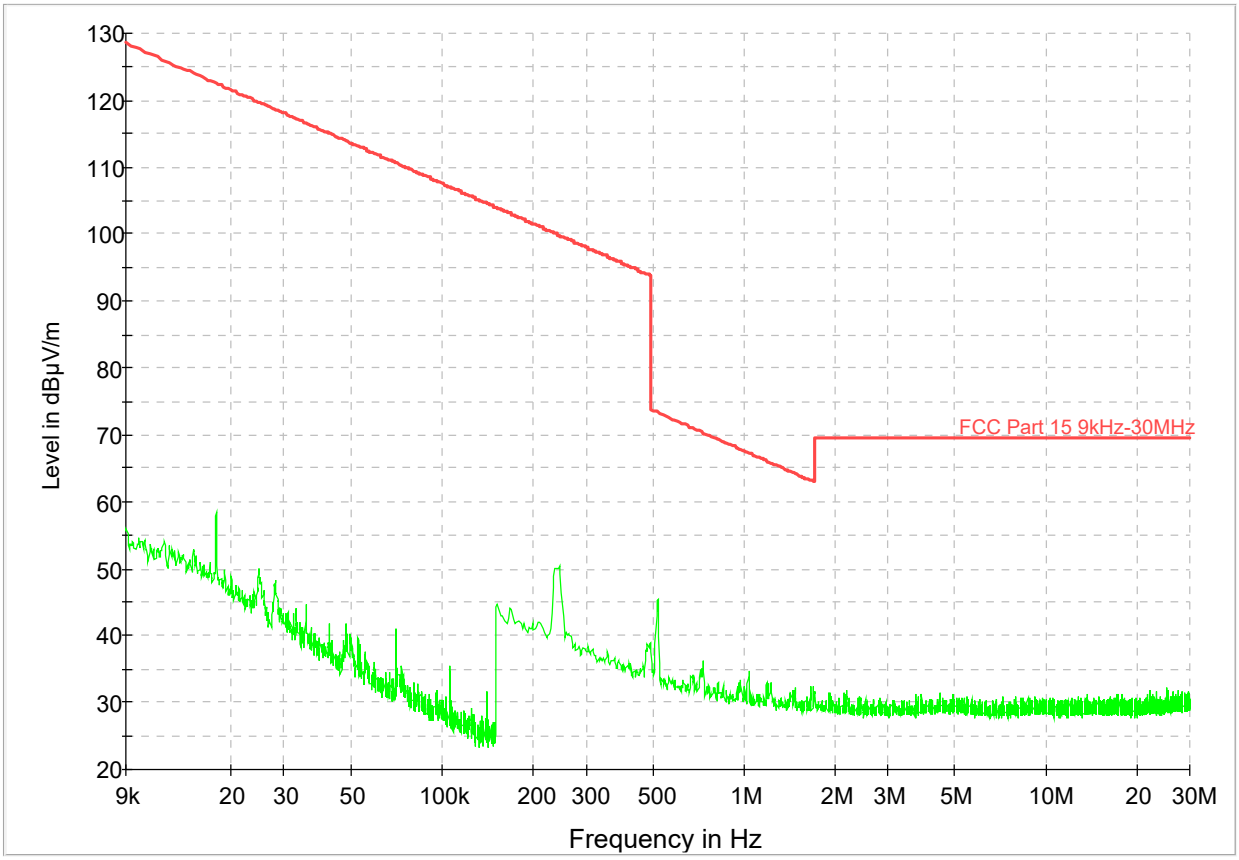
Full Spectrum



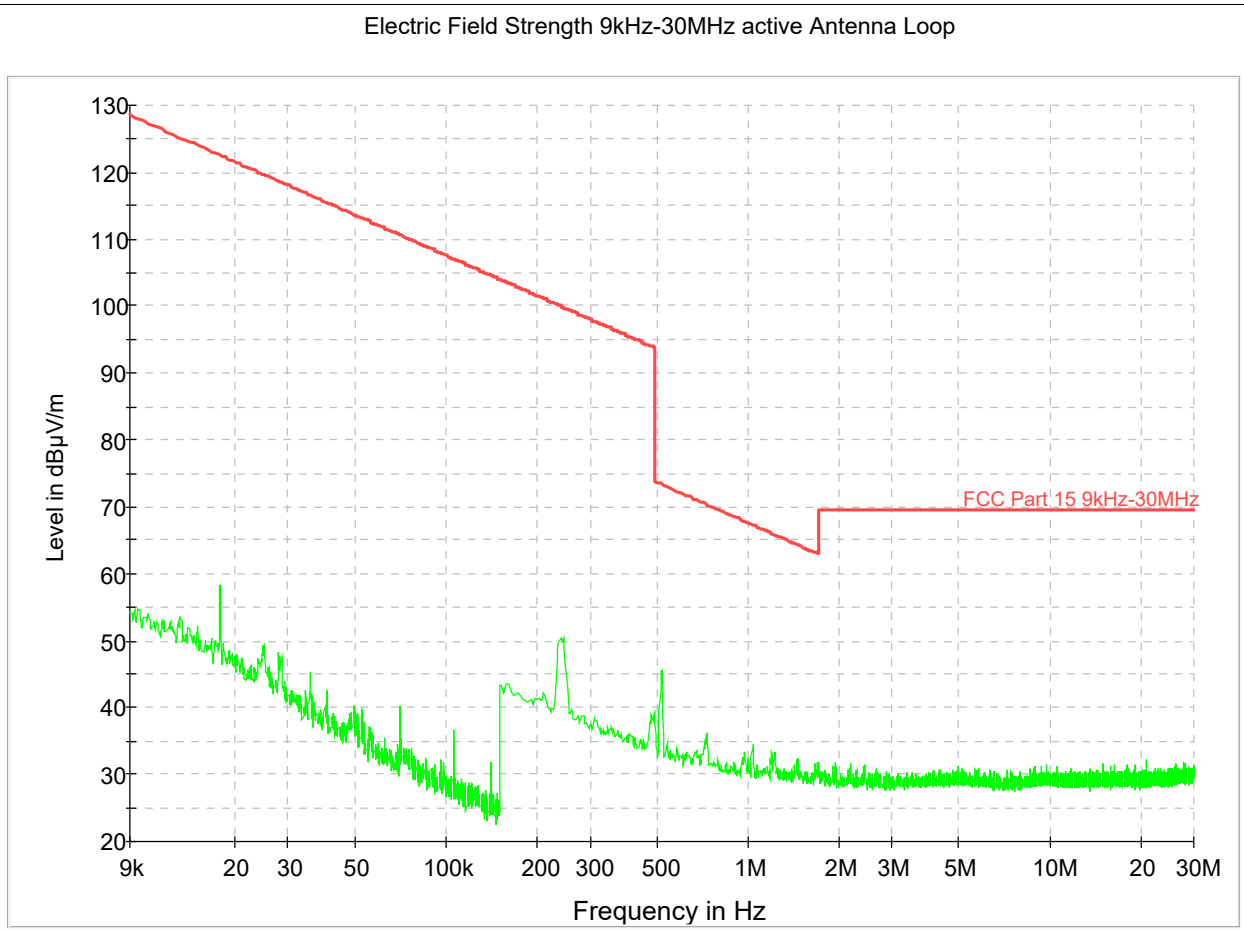
HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
1829.7	48.84	-14.12	3.12	**37.84**
2744.7*	38.48	-12.58	3.38	**29.28**
9149.0*	45.93	-7.81	7.41	**45.53**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)

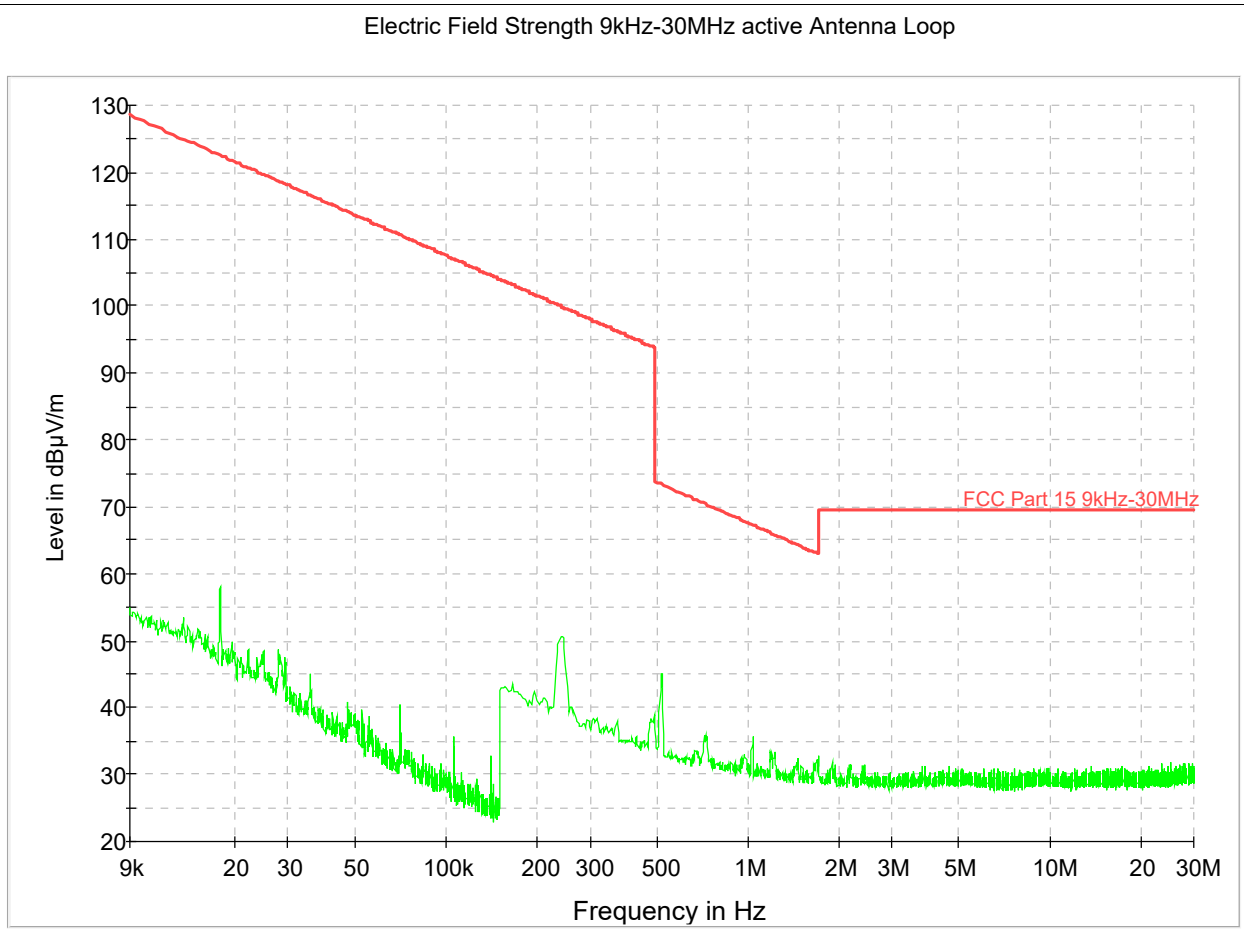
Electric Field Strength 9kHz-30MHz active Antenna Loop



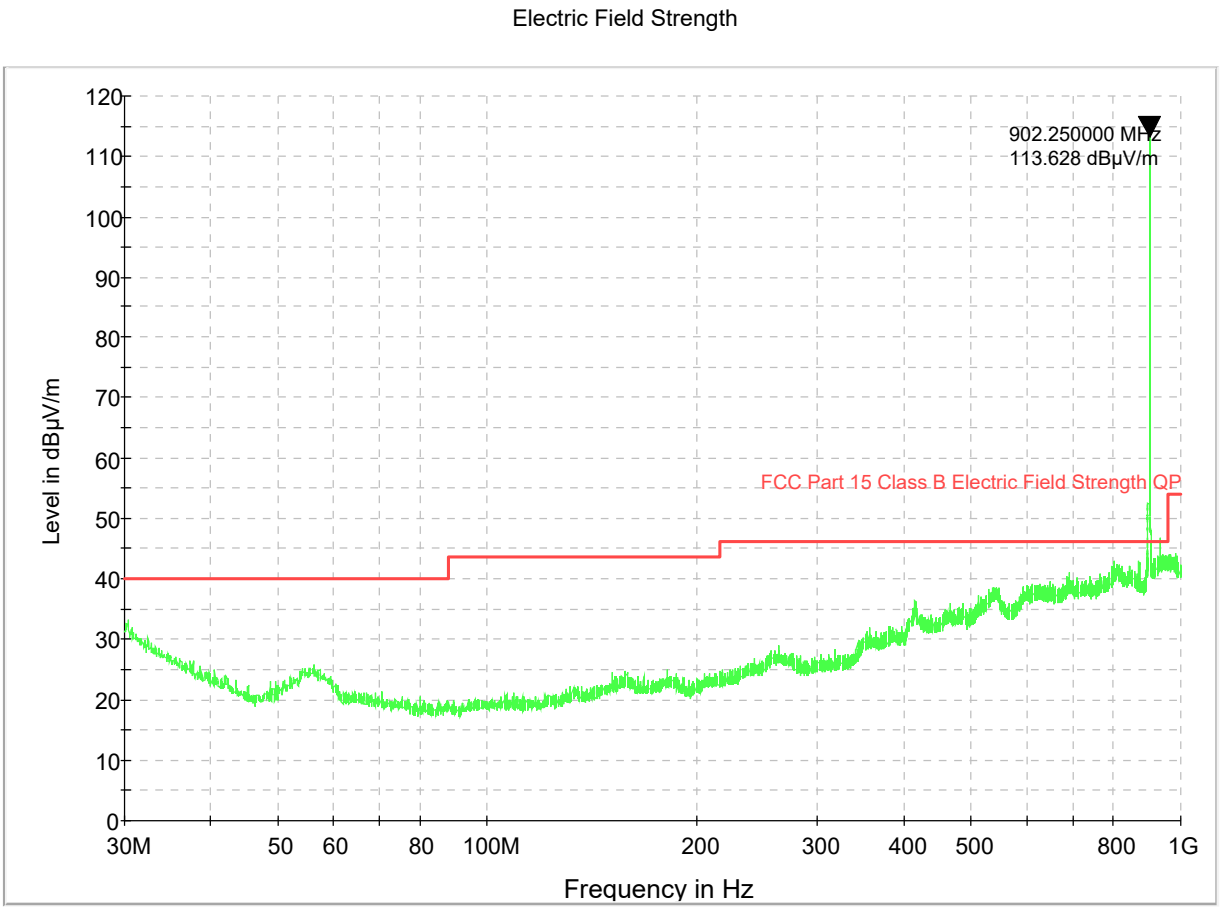
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)



Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 9KHz-30MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)



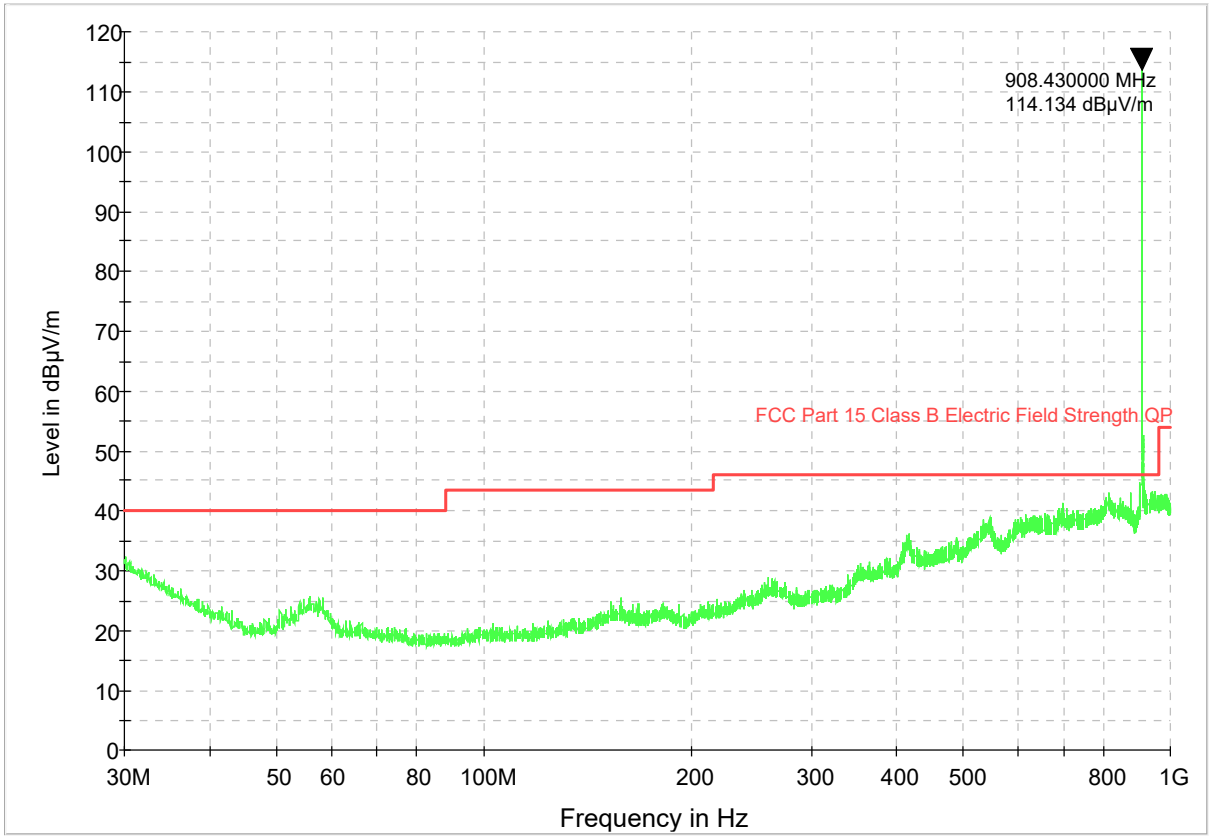
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)



Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
902.25	87.33	23.59	2.71	**113.63**

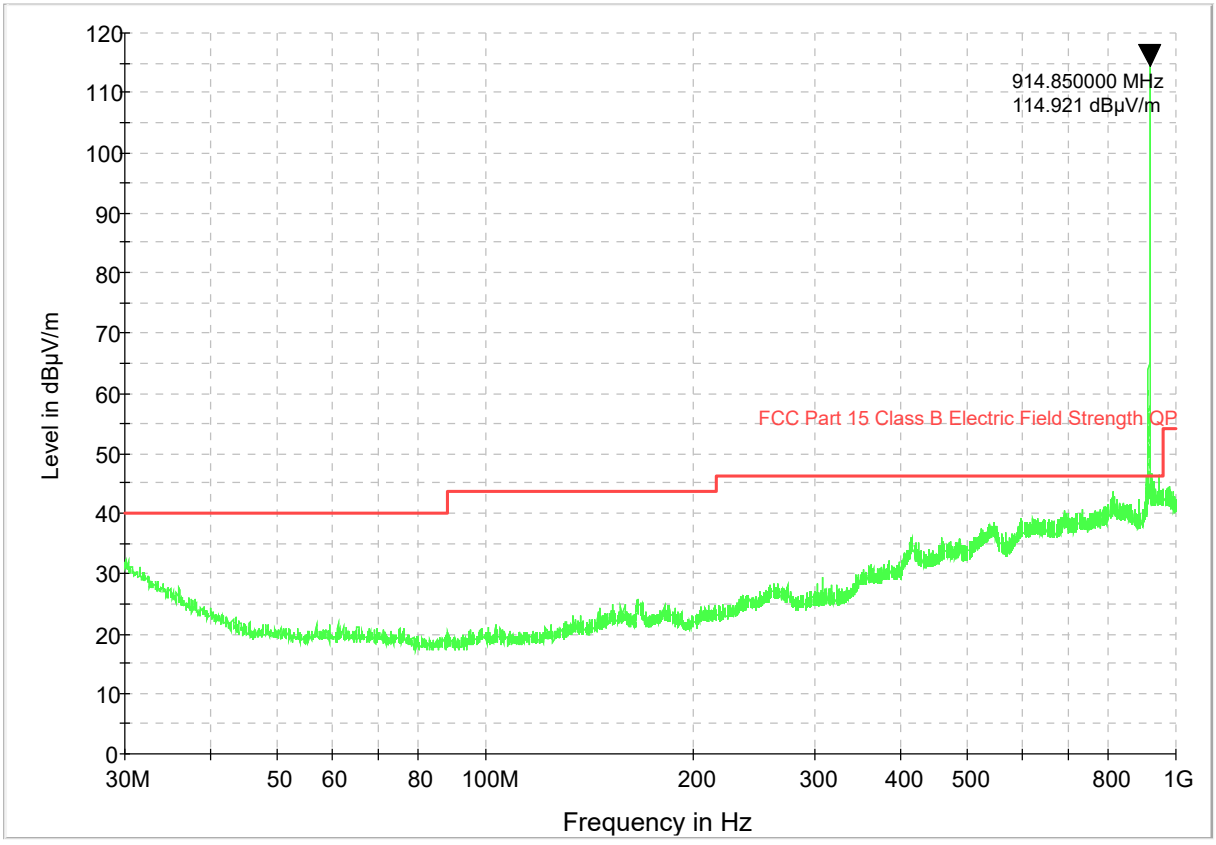
Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)



Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
908.43	87.37	24.05	2.71	**114.13**

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 30-1000MHz
Trace: Peak (green trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)

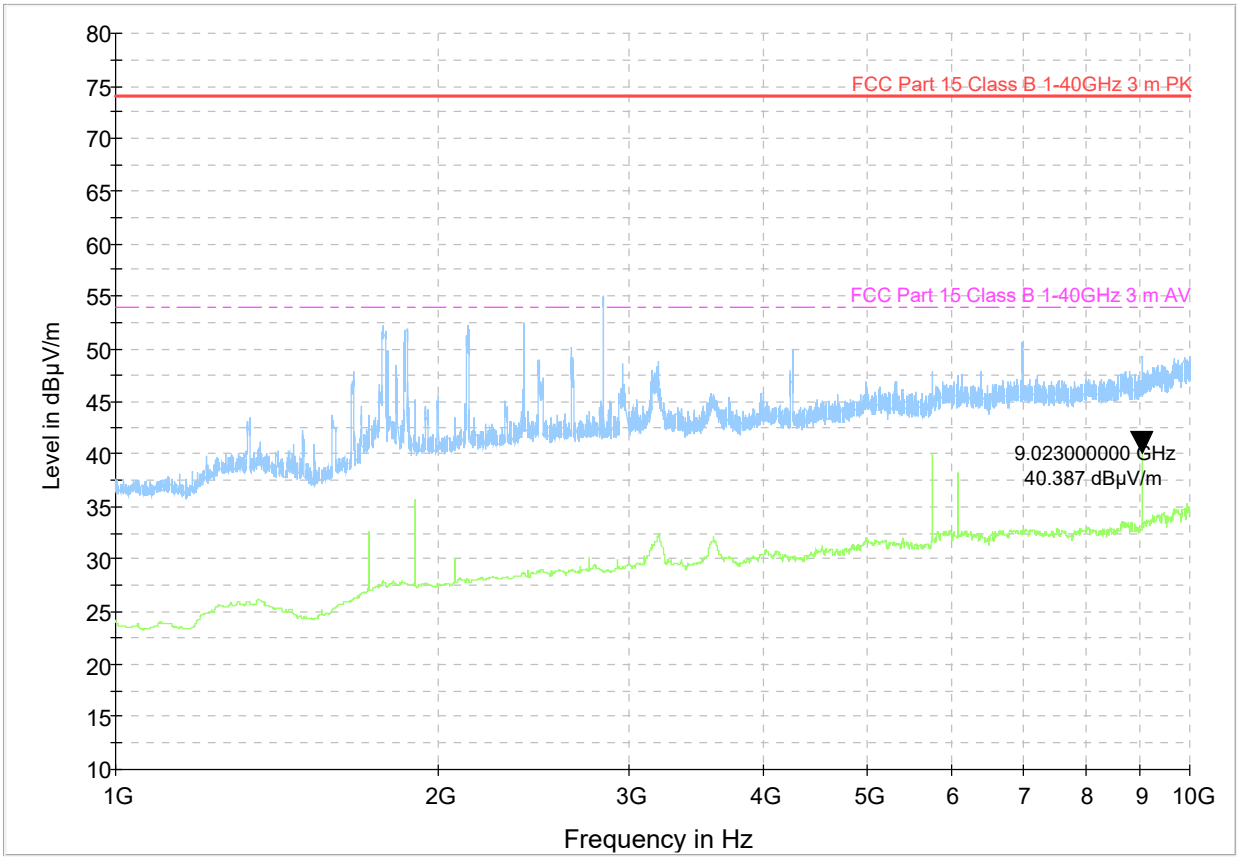


Note: marked fundamental frequency not related to limit

FUNDAMENTAL LEVEL (PK)				
Frequency	**Reading value**	**Antenna Factor**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
914.85	87.62	24.57	2.73	**114.92**

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: low
Data Rate: Worst case (DR3) (See test RF conducted power output)

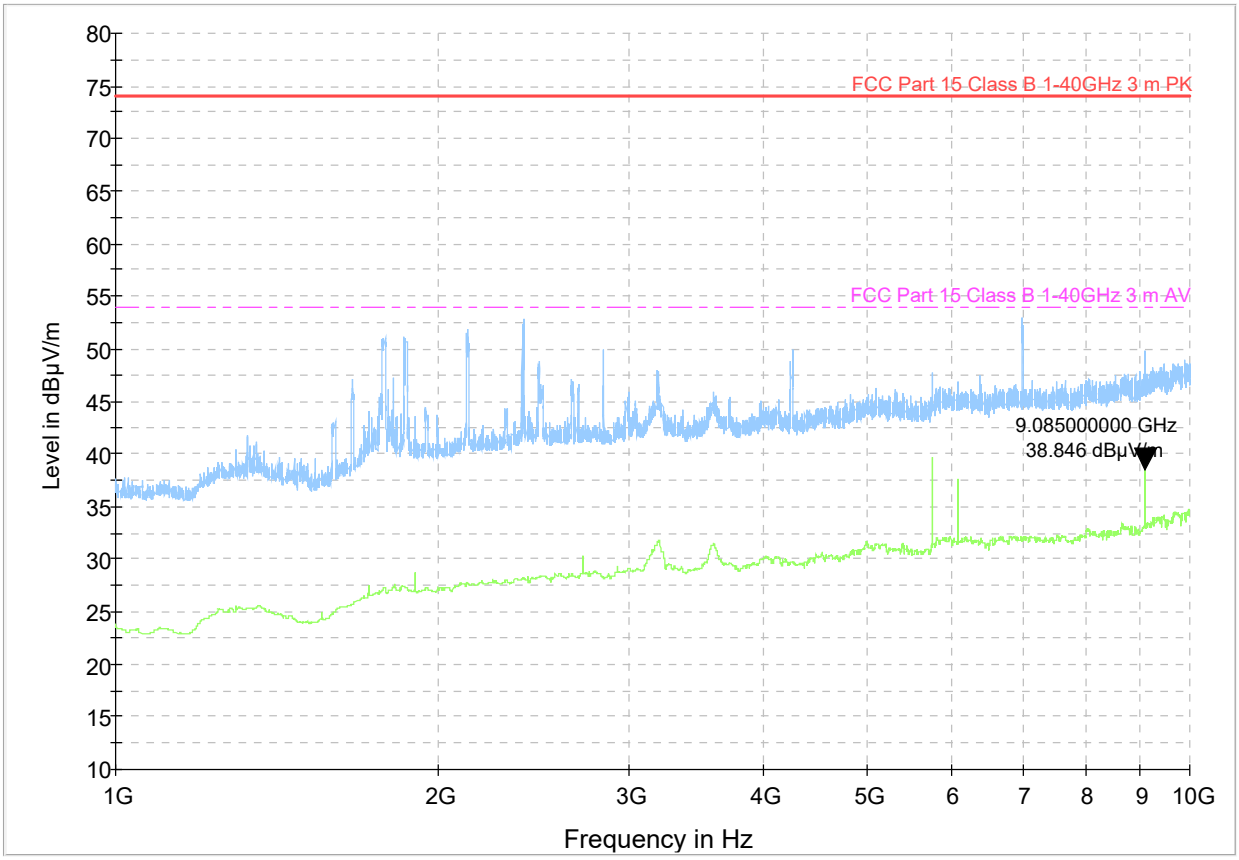
Full Spectrum



HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
9023.0*	41.59	-8.21	7.01	**40.39**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: middle
Data Rate: Worst case (DR3) (See test RF conducted power output)

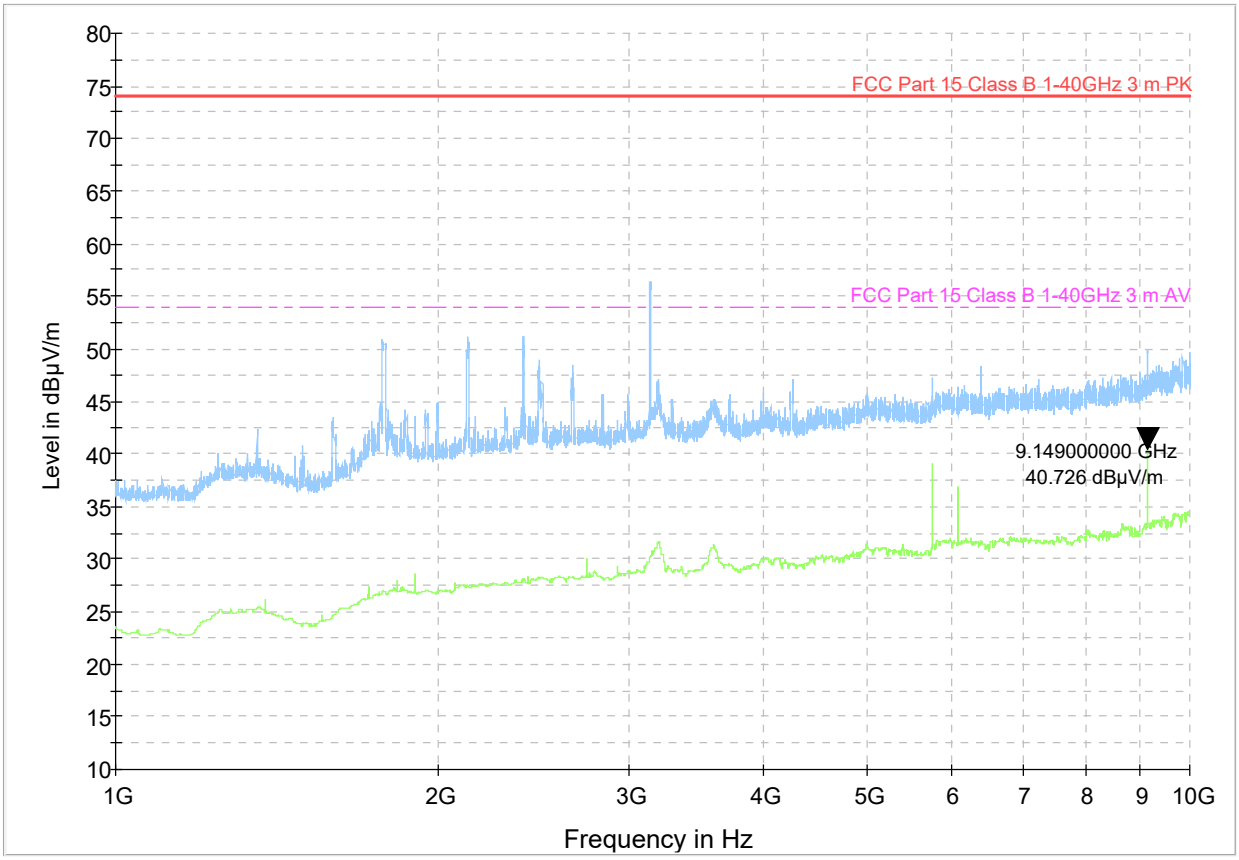
Full Spectrum



HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
9085.0*	39.75	-8.26	7.36	**38.85**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-01***
Operation mode: 1
Frequency: 1000-10000MHz
Trace: Peak (blue trace); Average (green trace)
Measurement distance: 3m.
Channel: high
Data Rate: Worst case (DR3) (See test RF conducted power output)

Full Spectrum



HARMONIC LEVEL (AV)				
Frequency	**Reading value**	**Antenna Factor with pre-Amplifier**	**Cable Loss**	**Correcting reading**
(MHz)	**(dBµV)**	**(dB3/m)**	**(dB)**	**(dBµV/m)**
9149.0*	41.13	-7.81	7.41	**40.73**
Note*: Restricted band of operation (section 15.205)				

Graphical presentation of radiated emission measurement
Module: ***MAMWLE-00 & MAMWLE-01***
Low Channel (902,3 MHz) & High Channel (914,9 MHz)
Frequency: Restricted band near fundamental frequency
Note: radiated emission outside the frequency band attenuation below the general limit specified in FCC section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in FCC section 15.205(a), must also comply with the radiated emission limit specified in FCC section 15.209(a) **The adjacent to the restricted frequency band (608-614 MHz and 960-1240MHz) is far away the fundamental, it is noise only.**

Antenna requirements	
Test date	10-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.203
Test method	§ 5.8 of ANSI C63.10
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-00** **MAMWLE-01**
Test sample No.:	N°2
Operating mode	1 and 2
Tested terminals	Antenna
Result	PASS

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

Antenna specifications	
N° of authorized antenna types	1
Antenna type	Dedicated Antenna Ant. S.r.l. mod. Chinook 868-915- GSM900-GSM1800 (P/N: B01-000) On model **MAMWLE-00** the connector is ufl type On model **MAMWLE-01** the connector is SMA type
Maximum total gain	2.15 dBi
External power amplifiers	Not present

RF power output, radiated (EIRP)	
Test date	03-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.3.2.2 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.9.1.1 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	1
Tested terminals	SMA antenna connector
Result	PASS

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

(2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) 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.

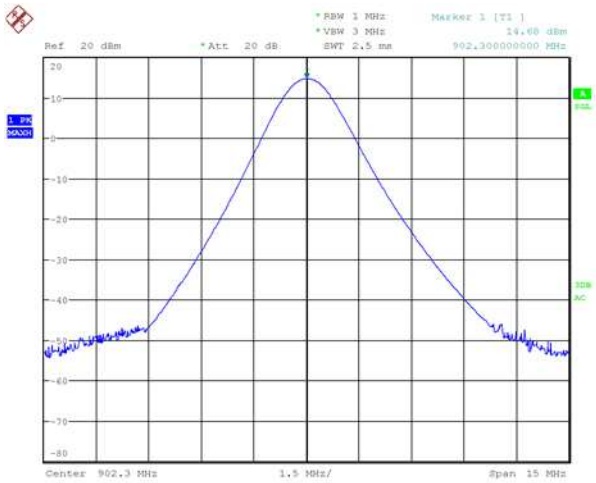
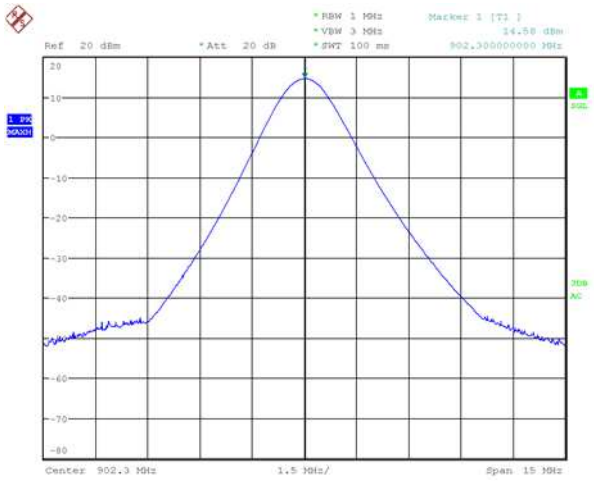
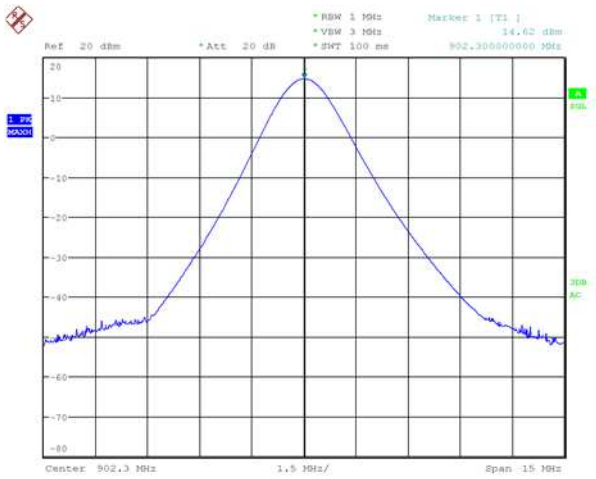
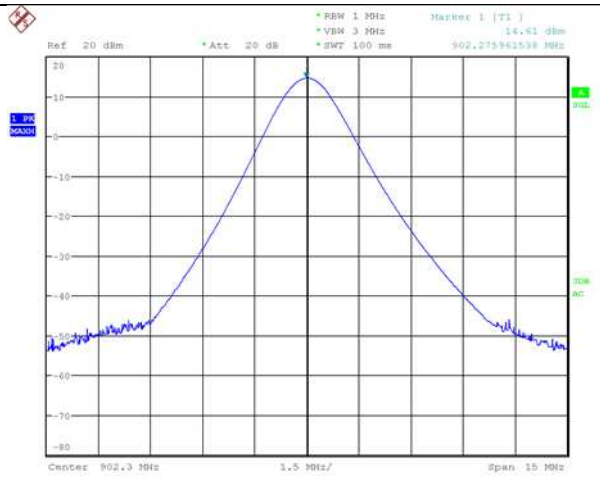
Note: since it was not possible to put in an antenna connector, test was carried out in a radiated manner According to Par. 2.3 of KDB 412172 D01 Determining ERP and EIRP v01r01

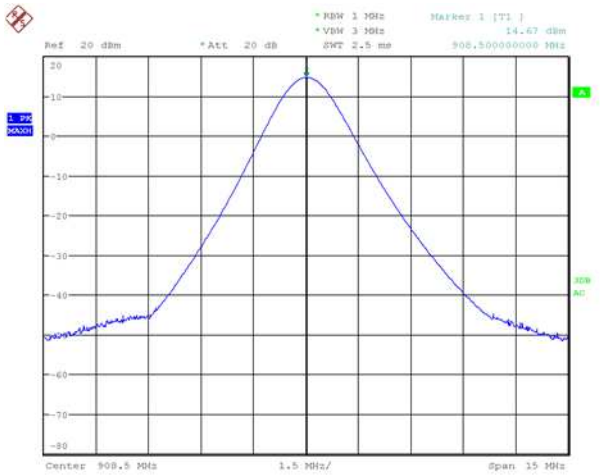
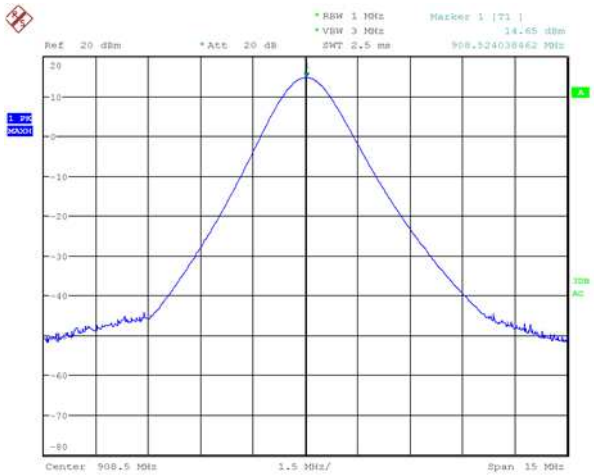
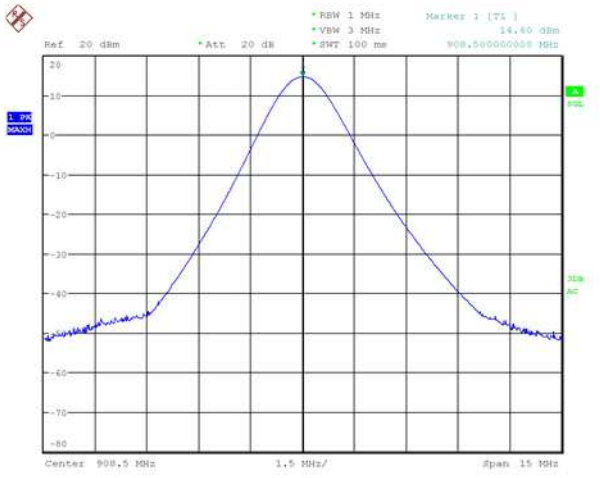
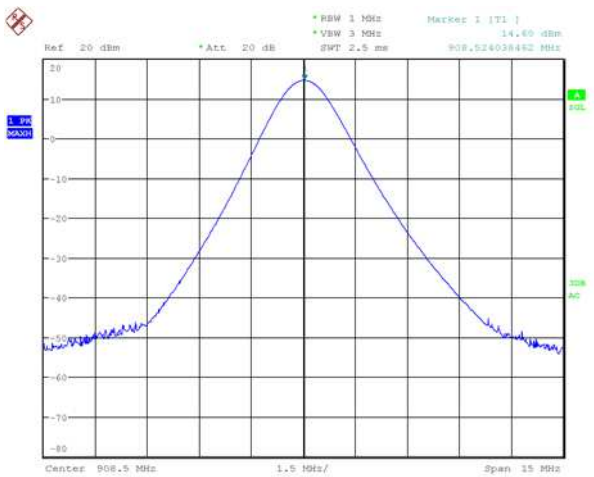
Used test equipment

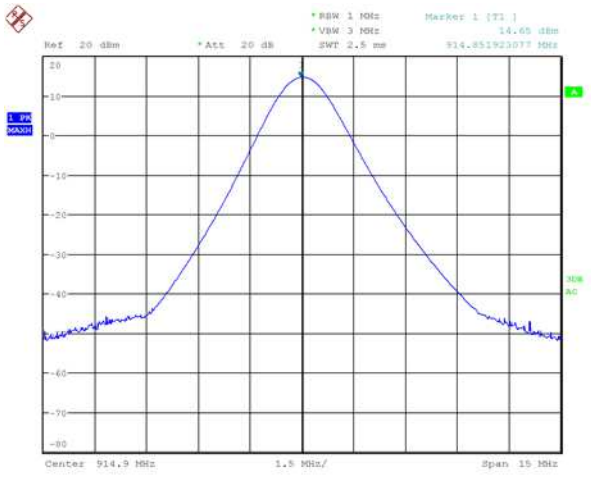
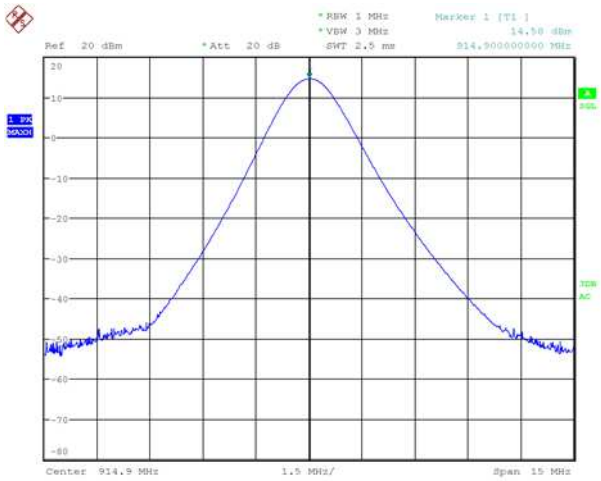
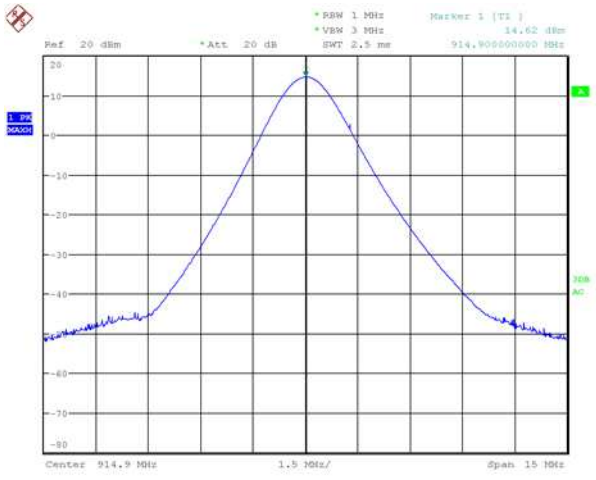
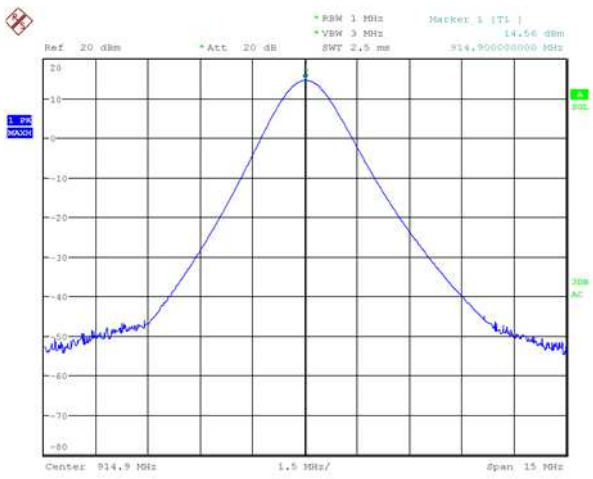
Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

Measurement data of RF power output, conducted measurement

Test conditions			Frequency (MHz)	Ch.	Conducted Output Power		Antenna Gain	Limits (W)		Result
Temperature	Voltage	Modulation			dBm	mW	dBi	Conducted	Radiated	
Tnom +22°C	3.3 V dc	Lora	902.3	1	14.68	29.38	2.15	1	4	PASS
Tnom +22°C	3.3 V dc	Lora	908.5	32	14.67	29.31	2.15	1	4	PASS
Tnom +22°C	3.3 V dc	Lora	914.9	64	14.65	29.17	2.15	1	4	PASS

Graphical Results of RF power output, conducted measurement	
Channel low (902.3MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

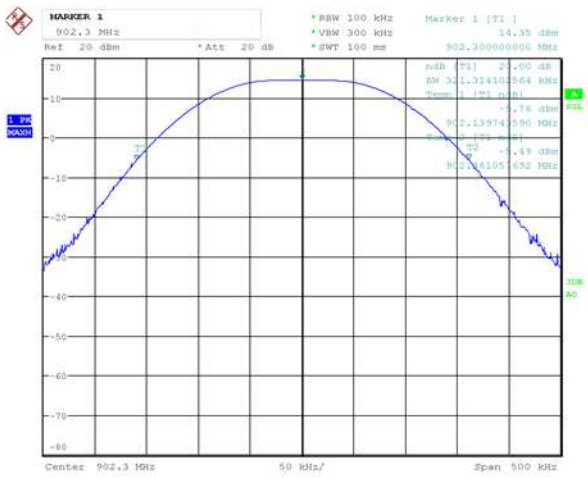
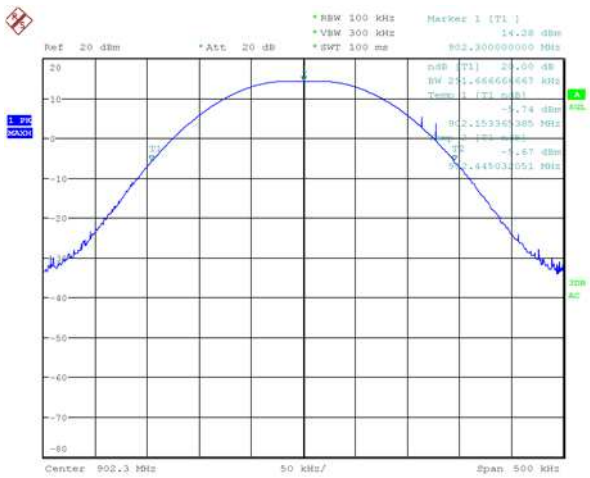
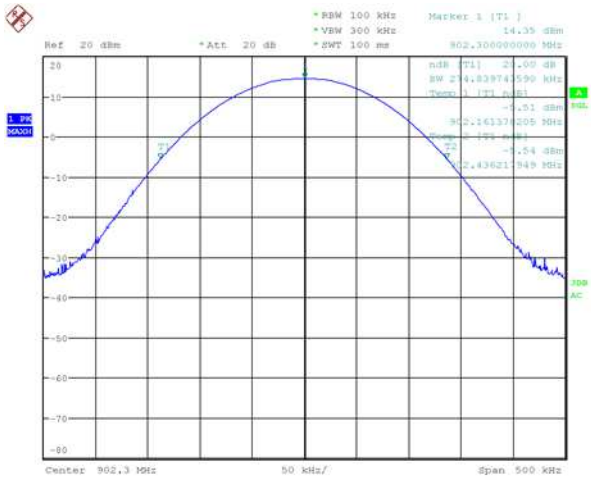
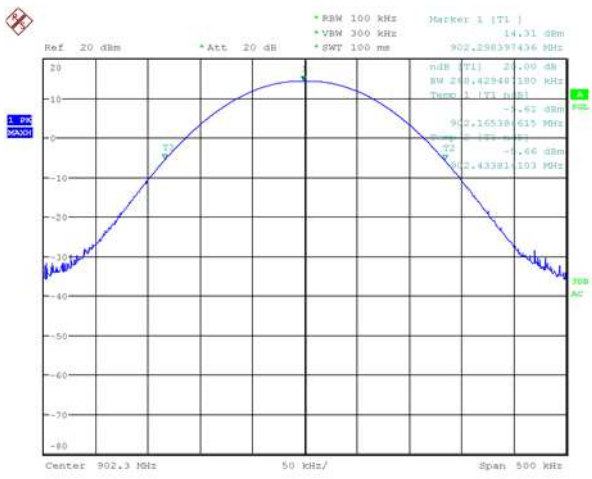
Graphical Results of RF power output, conducted measurement	
Channel middle (908.5 MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

Graphical Results of RF power output, conducted measurement	
Channel high (914.9 MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

20 dB Bandwidth	
Test date	08-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.2 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.8.1 Option 2 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	1
Tested terminals	SMA antenna connector
Result	PASS
For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.	

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

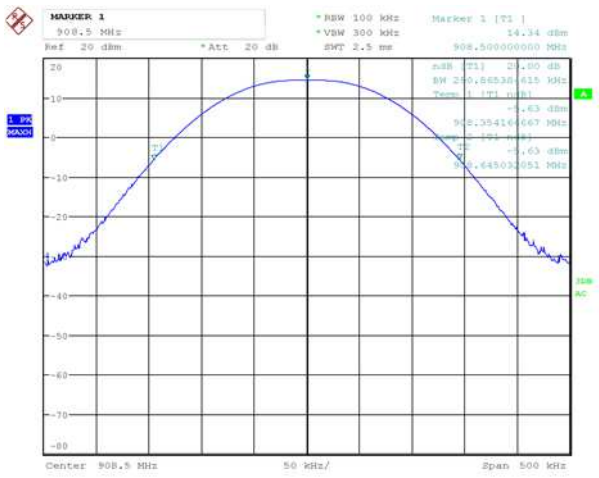
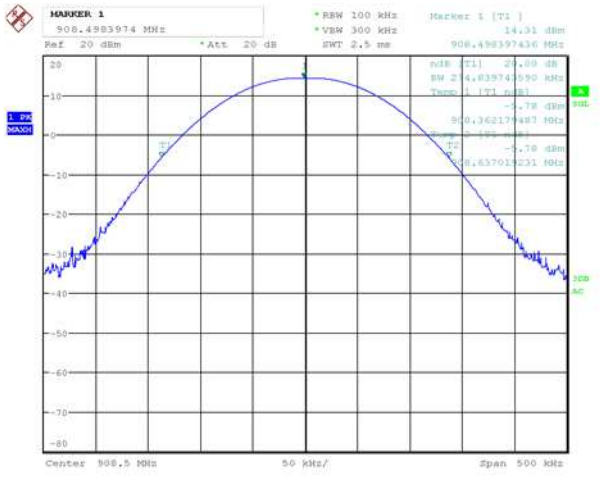
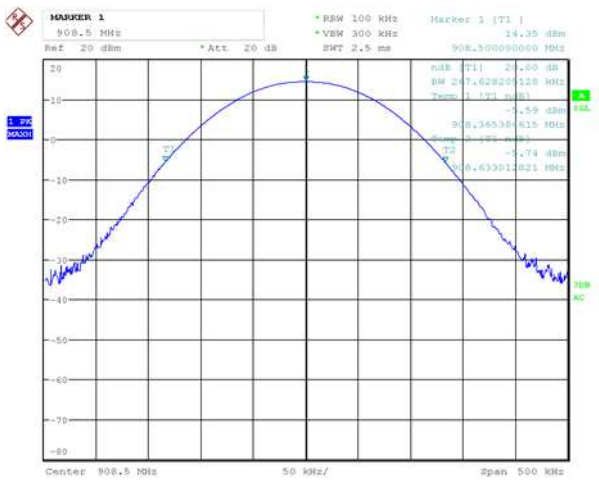
Graphical presentation of 20dB Bandwidth conducted measurement	
Channel low (902.3 MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

Measurement data of 20dB bandwidth

Operation Mode: #1 – Channel Low (902,3 MHz)

Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -20dB (kHz)	Limit (kHz)
Low	902,3	DR3	321,314102	500
		DR2	291,666666	
		DR1	274,839743	
		DR0	268,429487	

Bandwidth at -20dB (Fmin and Fmax)				
DR3	Fmin	902,139743 MHz	Fmax	902,461057 MHz
DR2		902,153365 MHz		902,445032 MHz
DR1		902,161378 MHz		902,436218 MHz
DR0		902,165384 MHz		902,433814 MHz

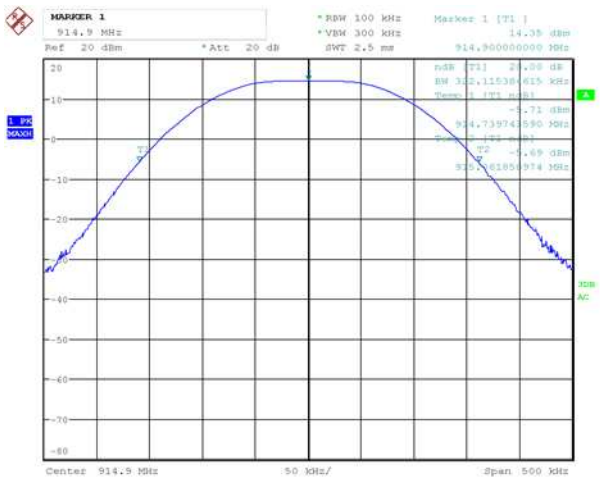
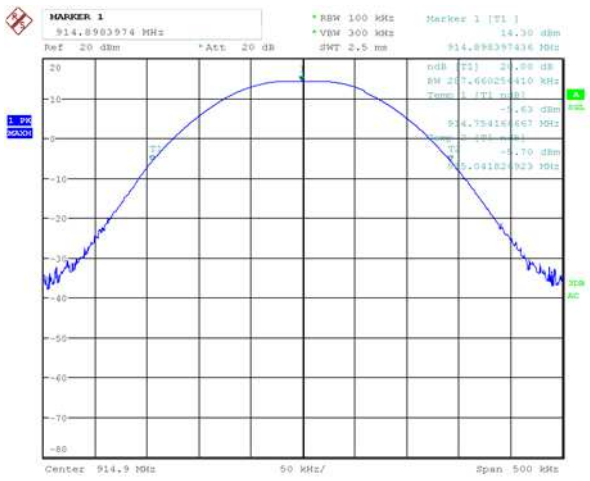
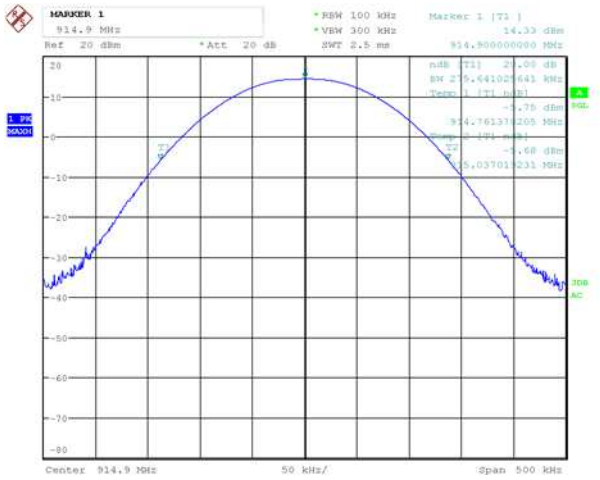
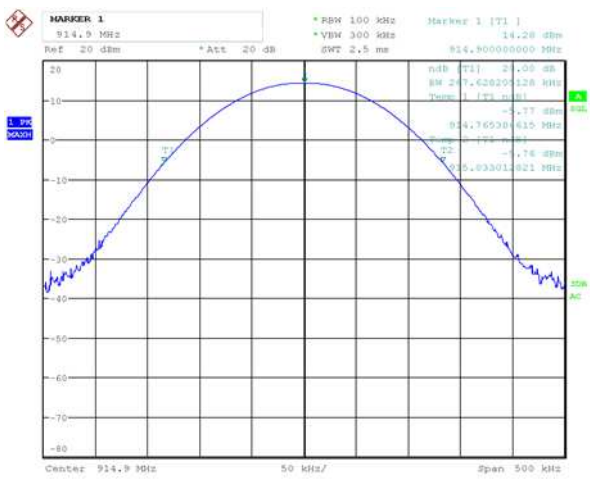
Graphical presentation of 20dB Bandwidth conducted measurement	
Channel middle (908.5 MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

Measurement data of 20dB bandwidth

Operation Mode: #1 – Channel middle (908,5 MHz)

Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -20dB (kHz)	Limit (kHz)
Middle	908,5	DR3	322,115384	500
		DR2	290,865384	
		DR1	274,839743	
		DR0	267,628205	

Bandwidth at -20dB (Fmin and Fmax)				
DR3	Fmin	908,339743 MHz	Fmax	908,661859 MHz
DR2		908,354166 MHz		908,645032 MHz
DR1		908,362179 MHz		908,637019 MHz
DR0		908,365384 MHz		908,633012 MHz

Graphical presentation of 20dB Bandwidth conducted measurement	
Channel high (914.9 MHz)	
	
Data rate: DR3	Data rate: DR2
	
Data rate: DR1	Data rate: DR0

Measurement data of 20dB bandwidth

Operation Mode: #1 – Channel high (914,9 MHz)

Channel (No.)	Frequency (MHz)	Data rate	Channel Bandwidth at -20dB (kHz)	Limit (kHz)
High	914,9	DR3	322,115384	500
		DR2	287,660256	
		DR1	275,641025	
		DR0	267,628205	

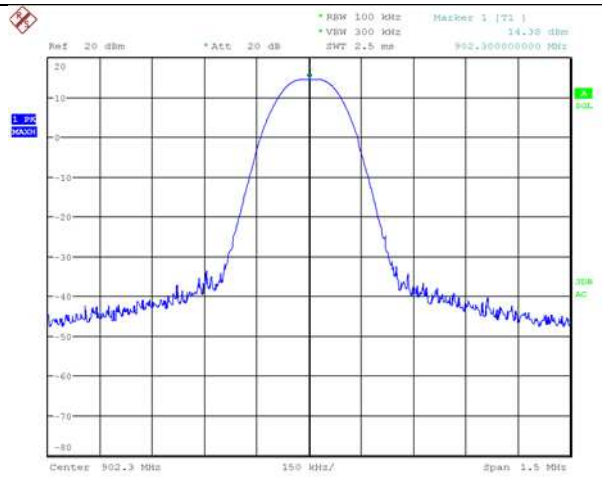
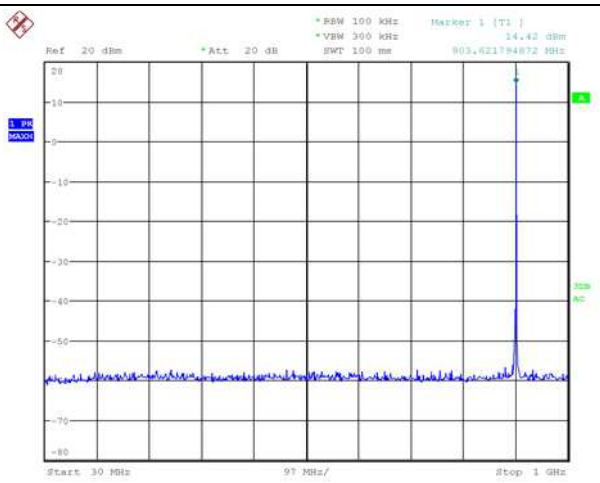
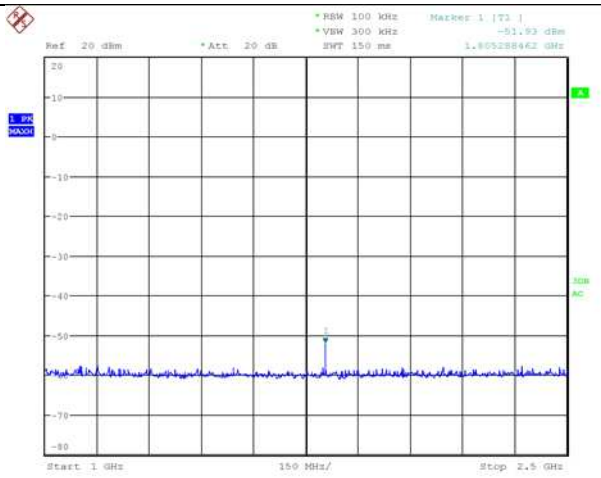
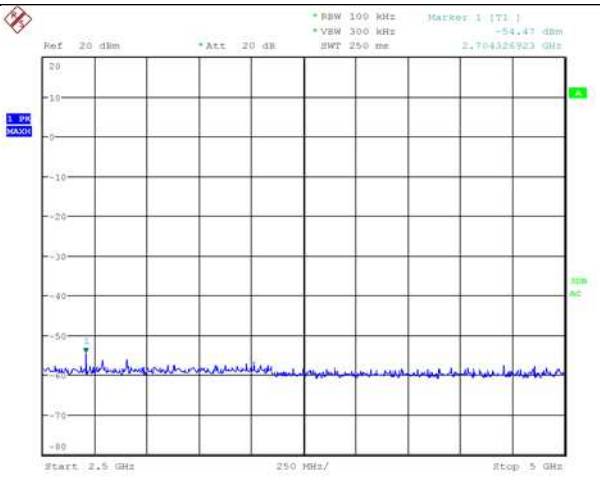
Bandwidth at -20dB (Fmin and Fmax)				
DR3	Fmin	914,739743 MHz	Fmax	915,061858 MHz
DR2		914,754166 MHz		915,041827 MHz
DR1		914,761378 MHz		915,037019 MHz
DR0		914,765384 MHz		915,033012 MHz

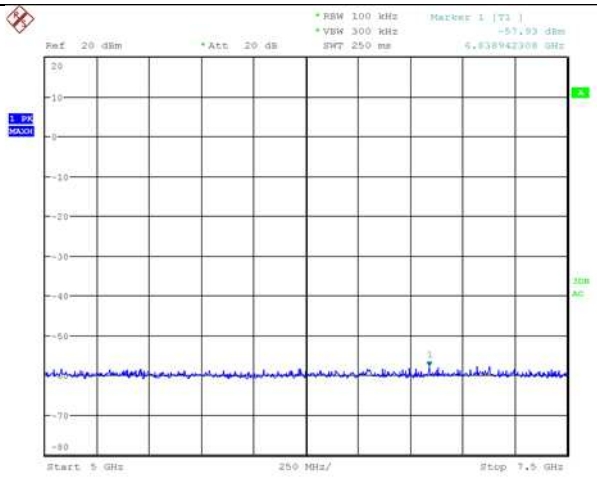
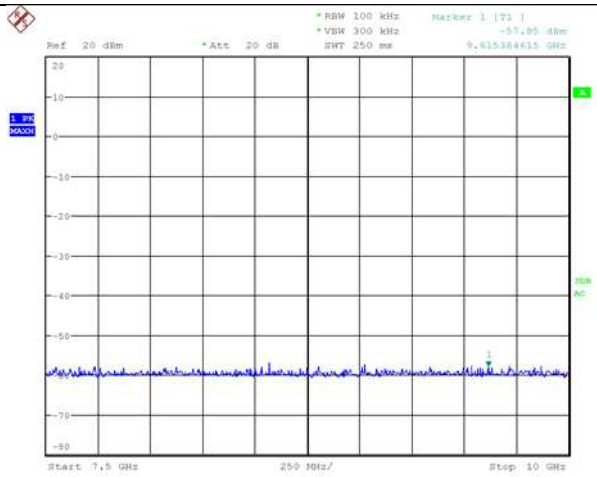
Out-of-band emissions	
Test date	08-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.5 of KDB 558074 D01 15.247 Meas. Guidance v05r02 (and par. 11.11 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	1
Tested terminals	SMA antenna connector
Result	PASS

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

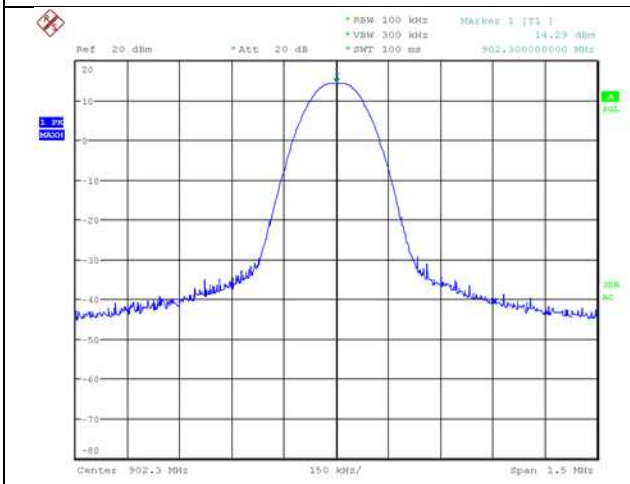
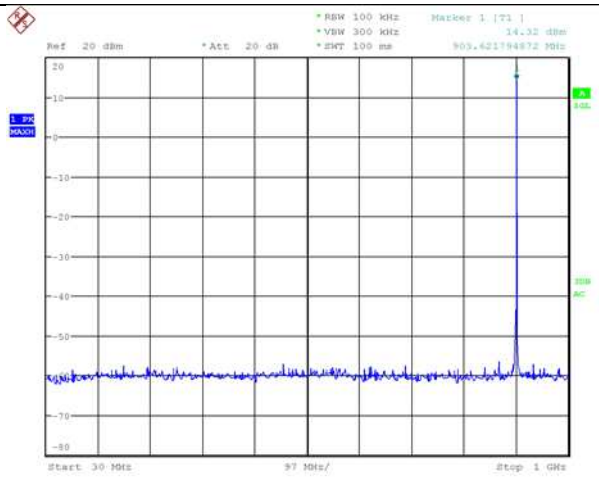
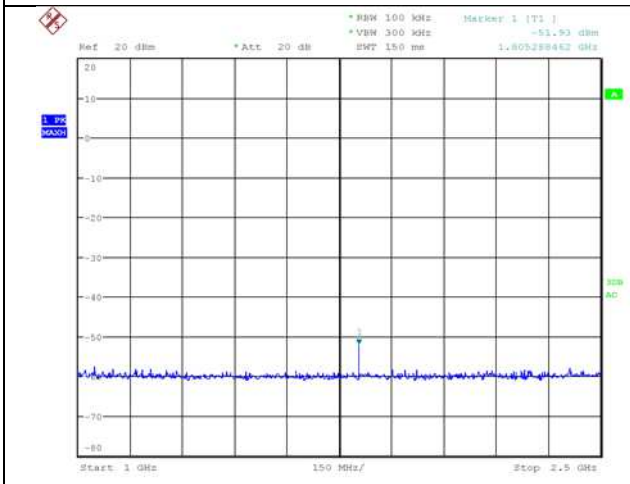
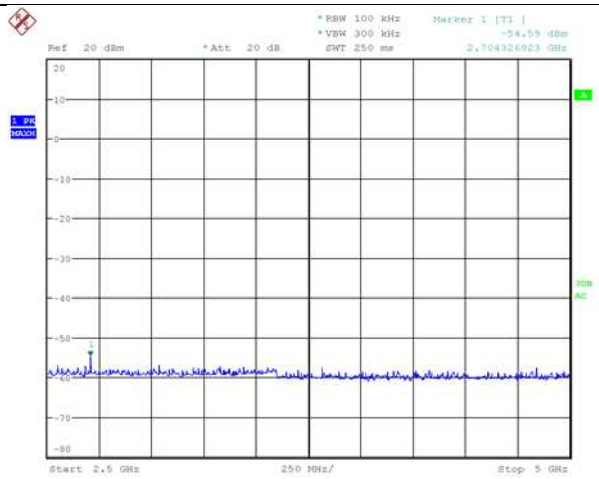
Used test equipment

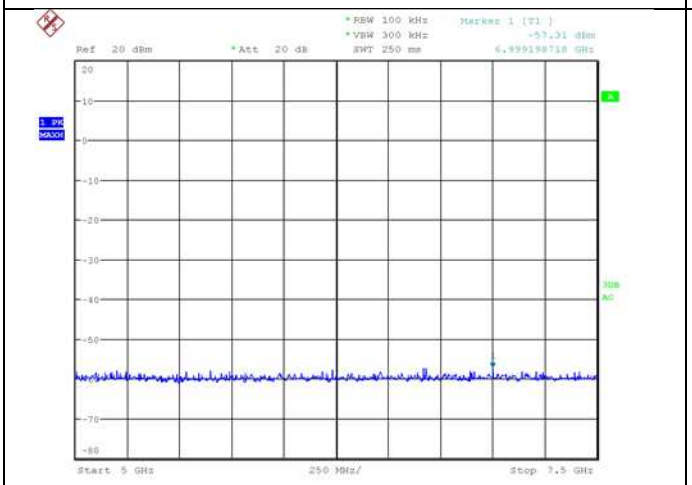
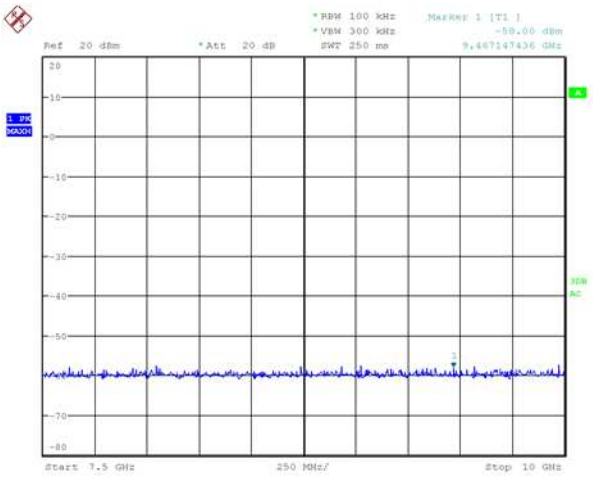
Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

Graphical presentation of spurious emission	
Operation mode: 1	
Channel low (902.3MHz)	
Data Rate: DR3	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

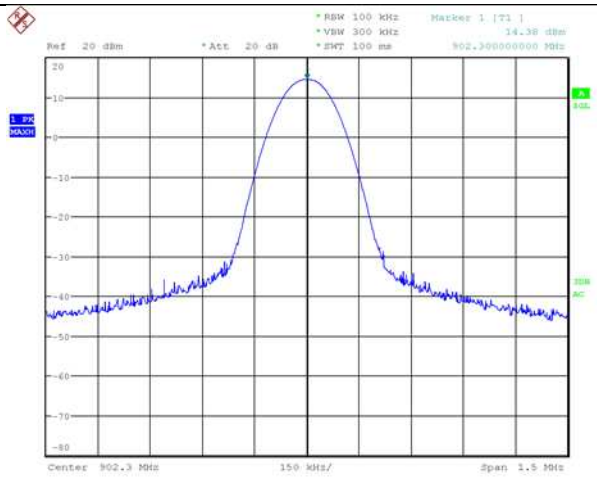
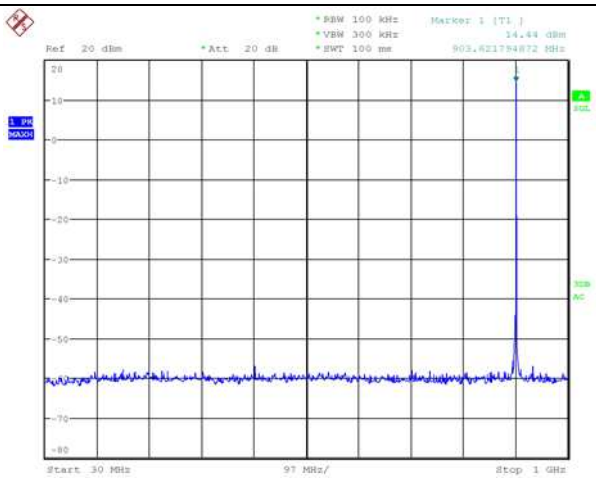
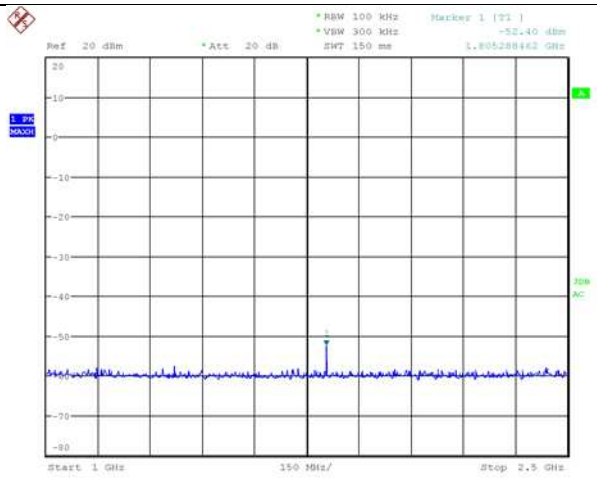
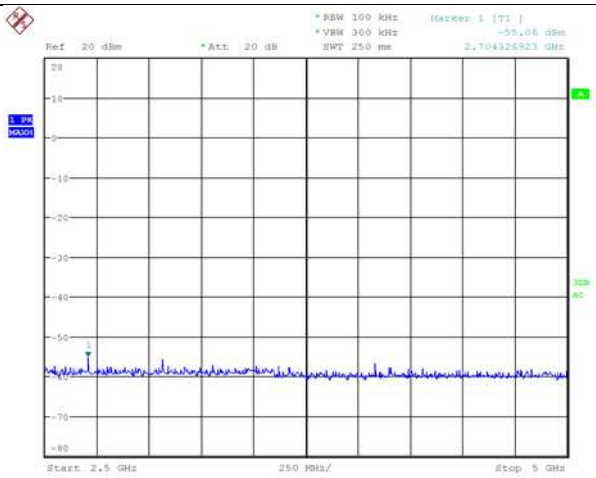
5-7.5GHz	7.5-10GHz
	

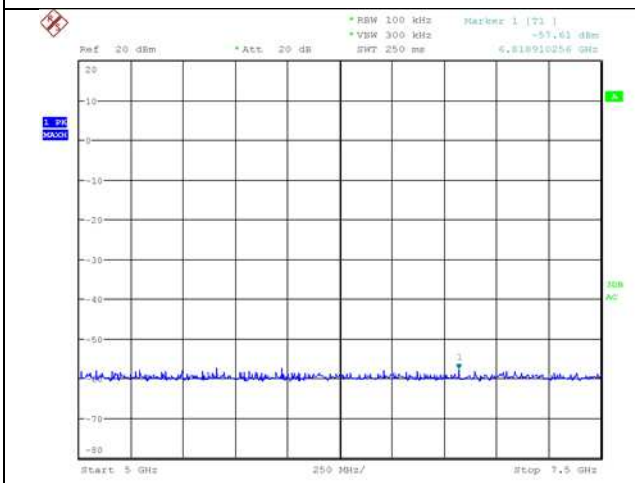
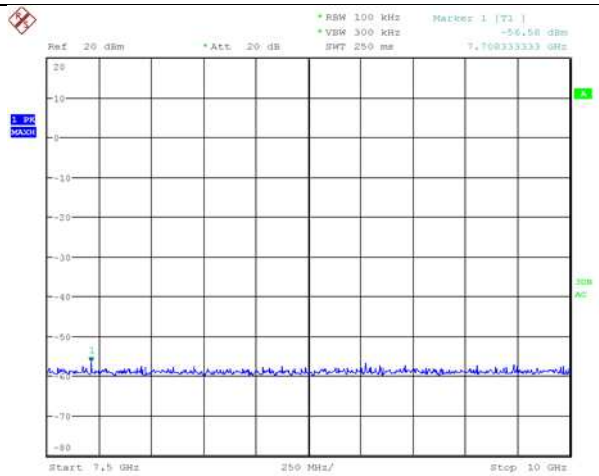
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1805.288	**-51.93**	**14.38**	**66.31**	**-5.62**	**46.31**
2704.327	**-54.47**		**68.85**		**48.85**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel low (902.3MHz)	
Data Rate: DR2	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

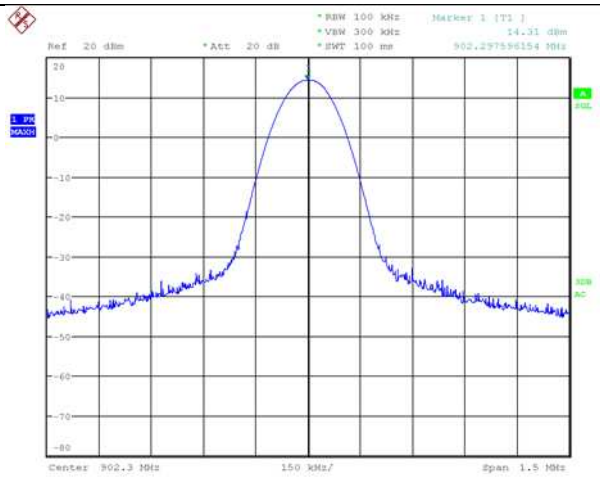
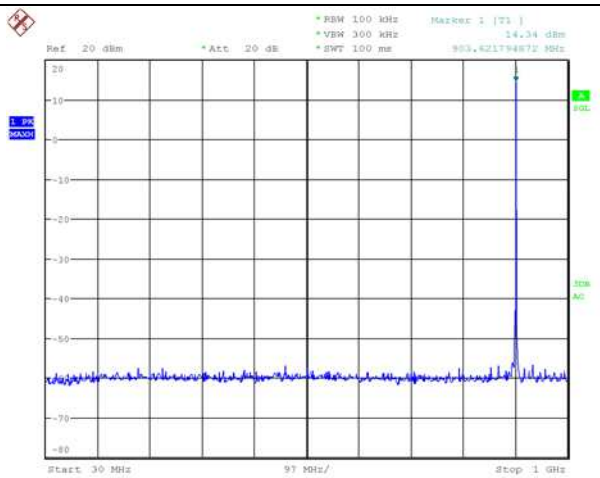
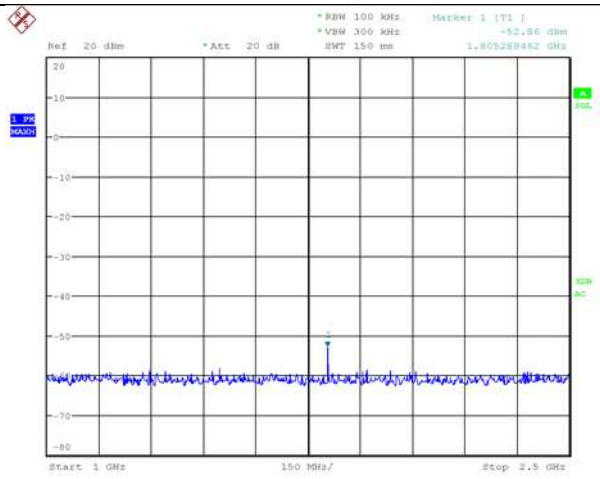
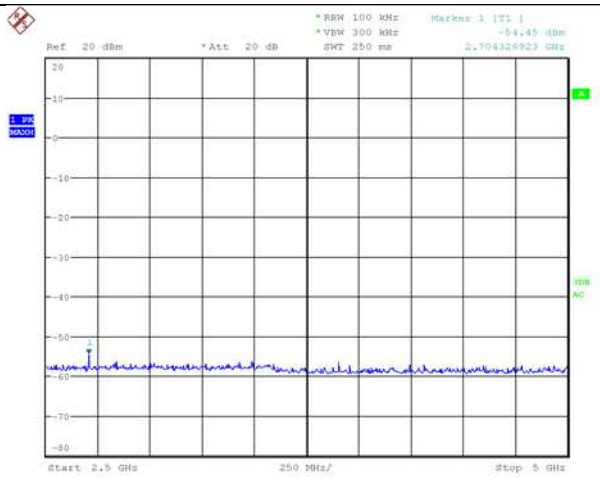
5-7.5GHz	7.5-10GHz
	

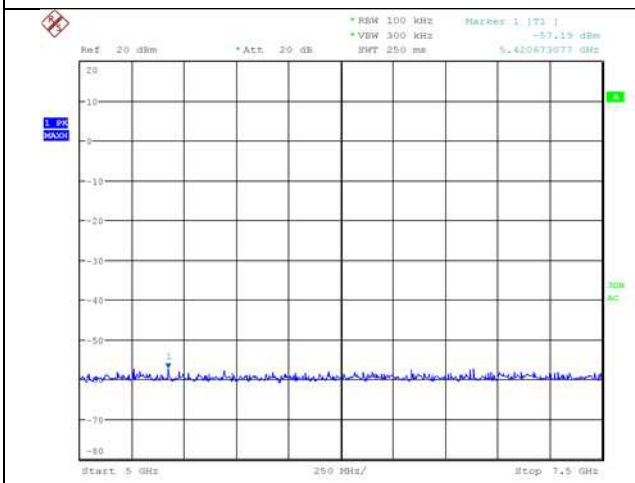
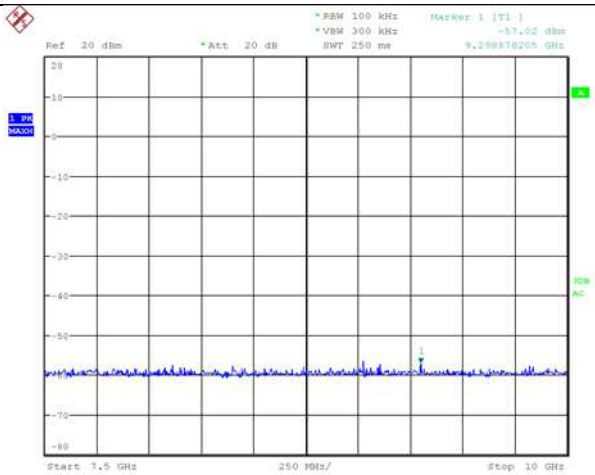
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1805.288	**-51.93**	**14.29**	**66.22**	**-5.71**	**46.22**
2704.327	**-54.59**		**68.88**		**48.88**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel low (902.3MHz)	
Data Rate: DR1	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

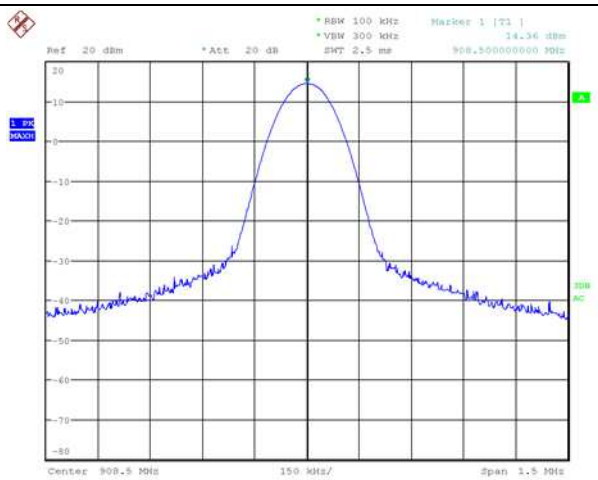
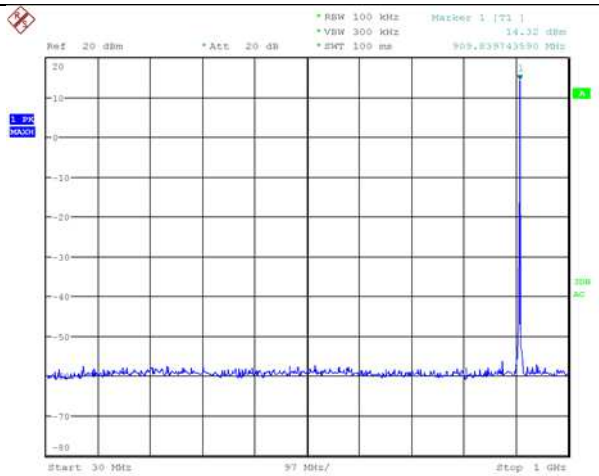
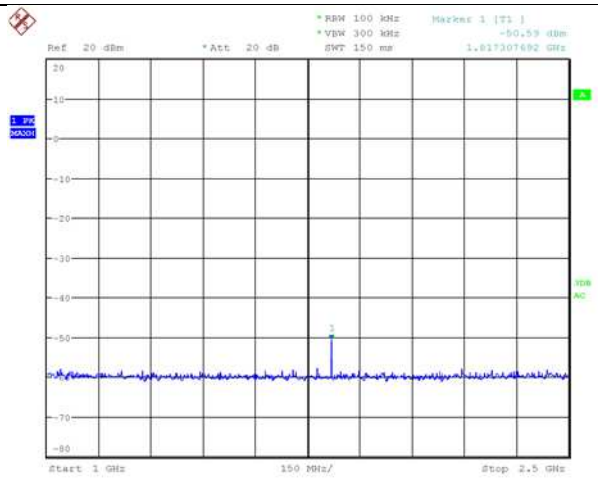
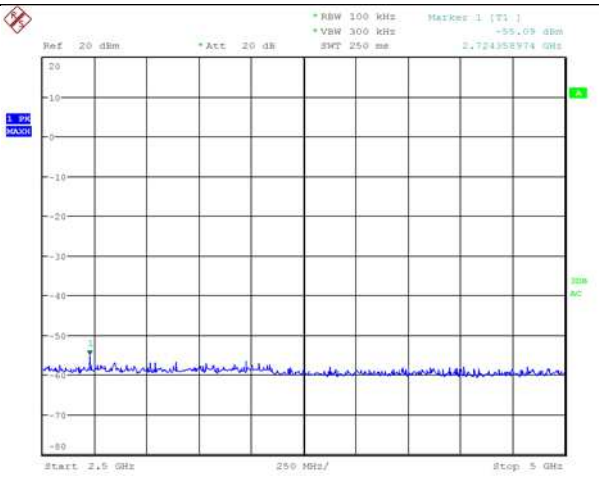
5-7.5GHz	7.5-10GHz
	

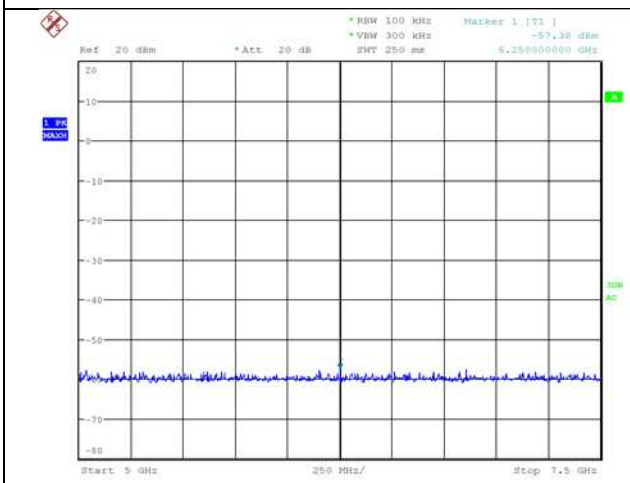
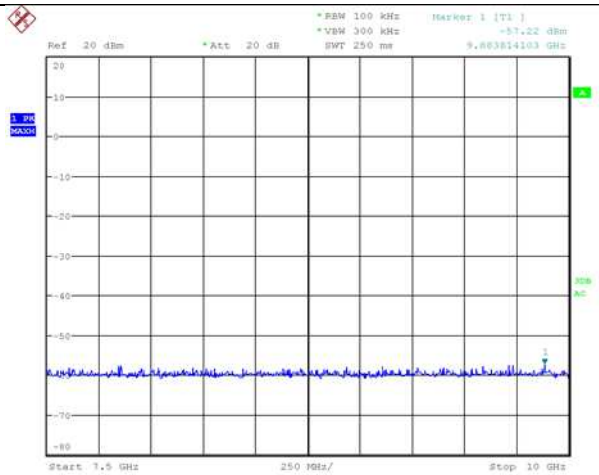
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1805.288	**-52.40**	**14.38**	**66.78**	**-5.62**	**46.78**
2704.327	**-55.06**		**69.44**		**49.44**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel low (902.3MHz)	
Data Rate: DR0	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

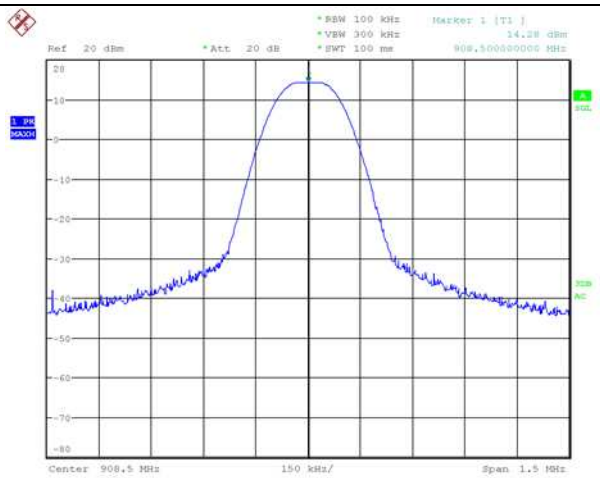
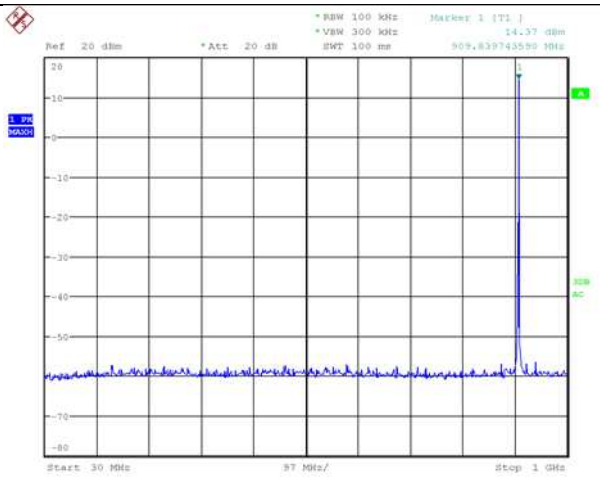
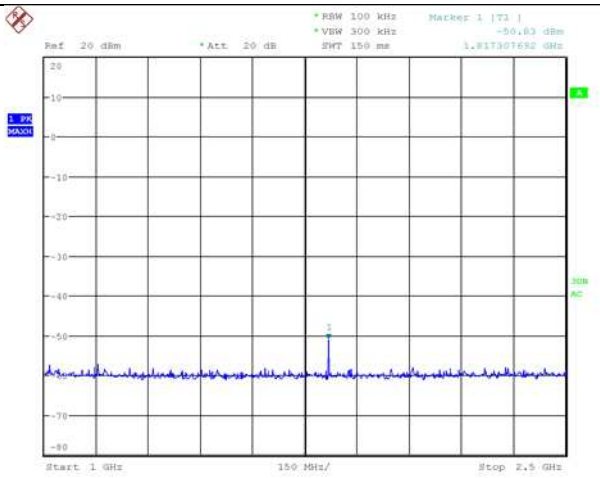
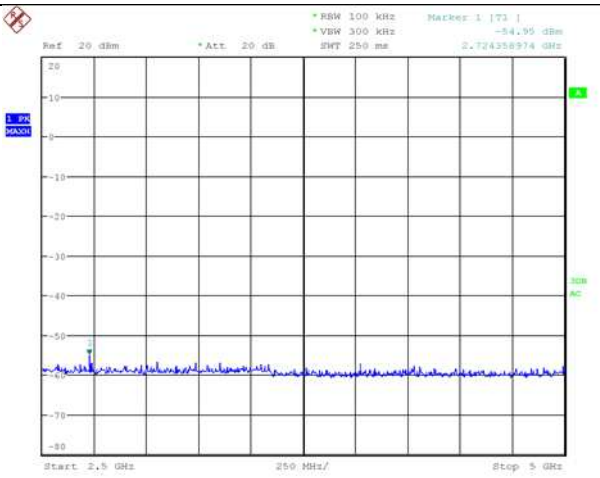
5-7.5GHz	7.5-10GHz
	

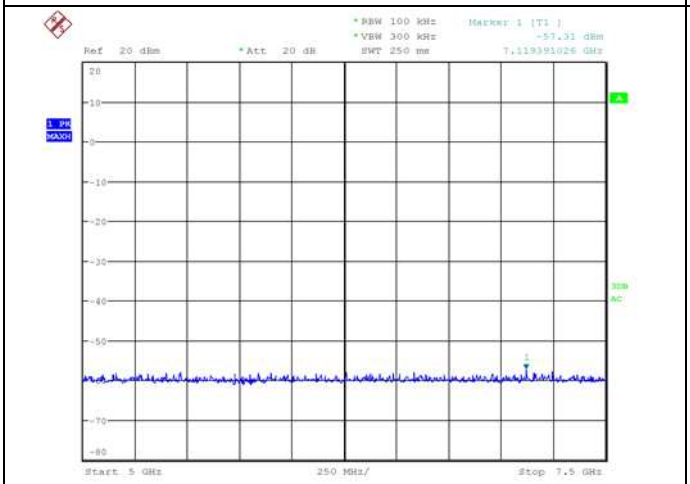
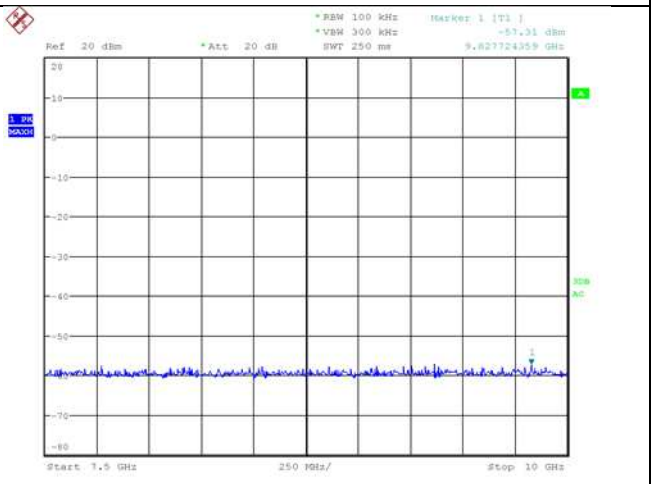
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1805.288	**-52.86**	**14.31**	**67.17**	**-5.69**	**47.17**
2704.327	**-54.45**		**68.76**		**48.76**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel middle (908.5MHz)	
Data Rate: DR3	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

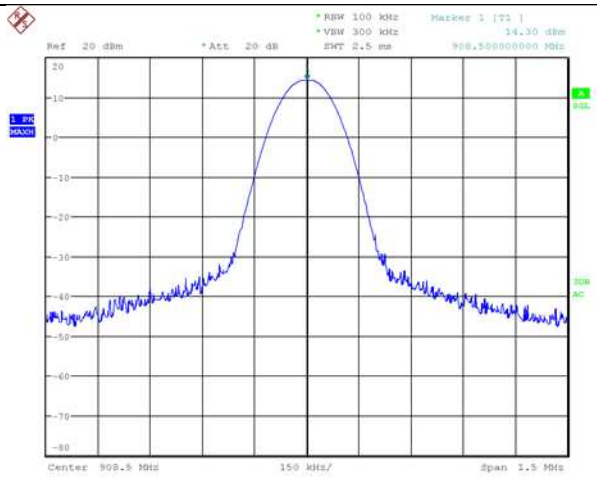
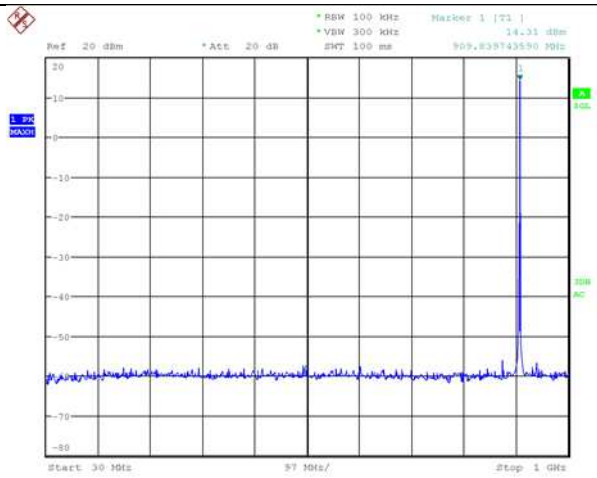
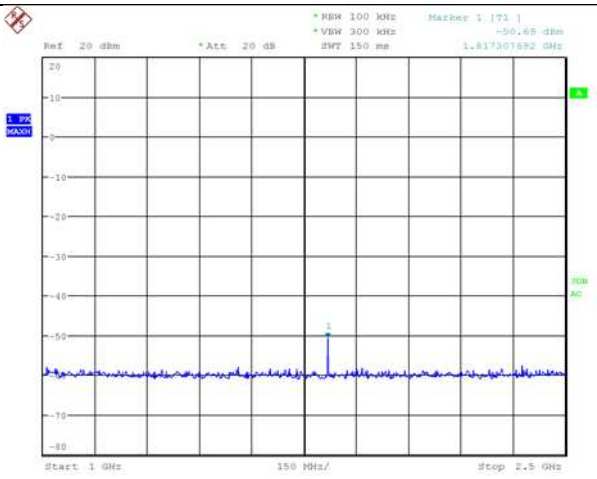
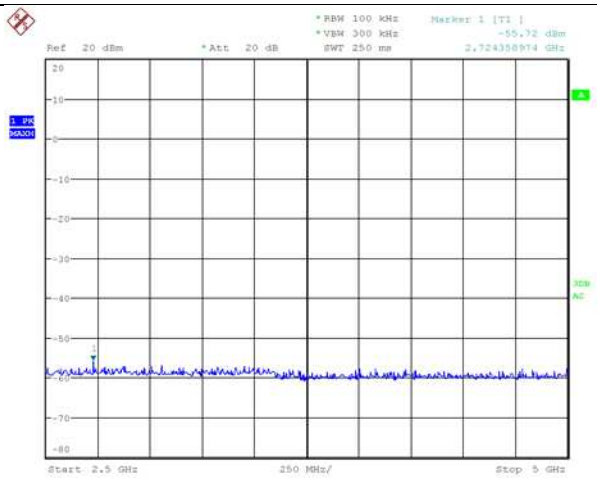
5-7.5GHz	7.5-10GHz
	

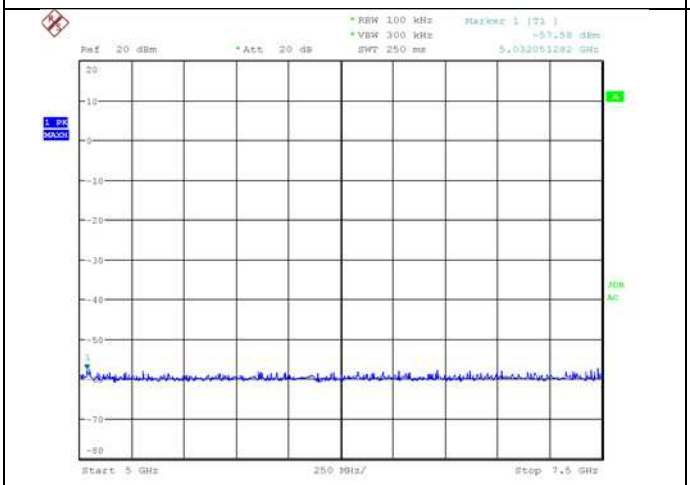
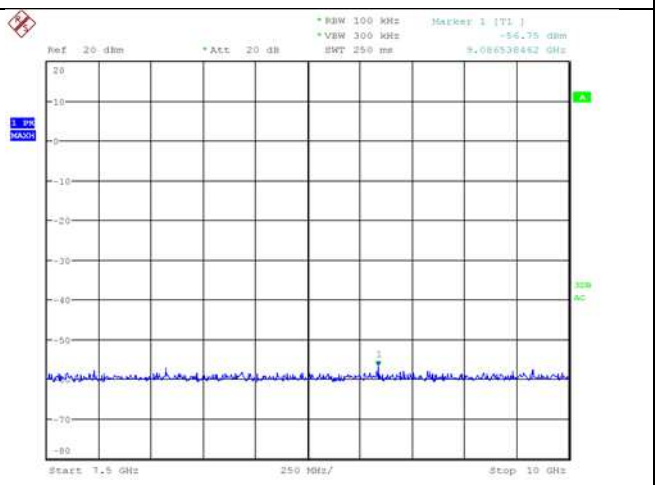
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1817.307	**-50.59**	**14.36**	**64.95**	**-5.64**	**44.95**
2724.359	**-55.09**		**69.45**		**49.45**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel middle (908.5MHz)	
Data Rate: DR2	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

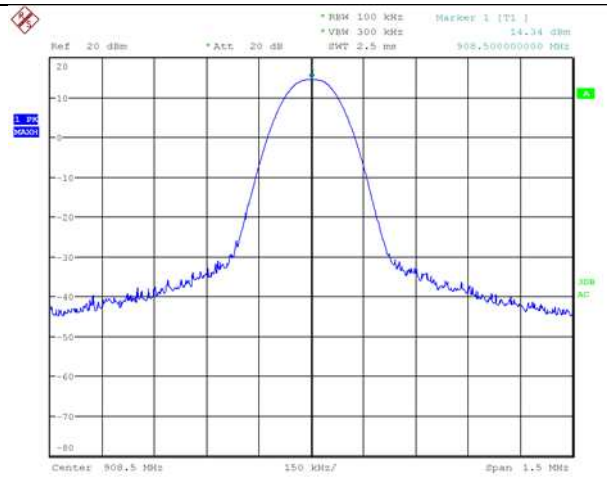
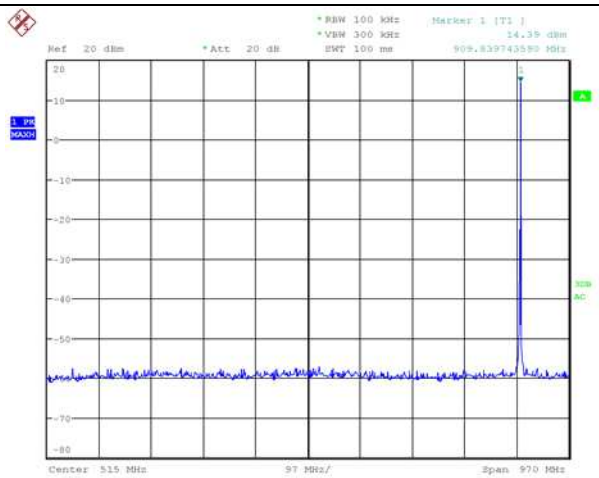
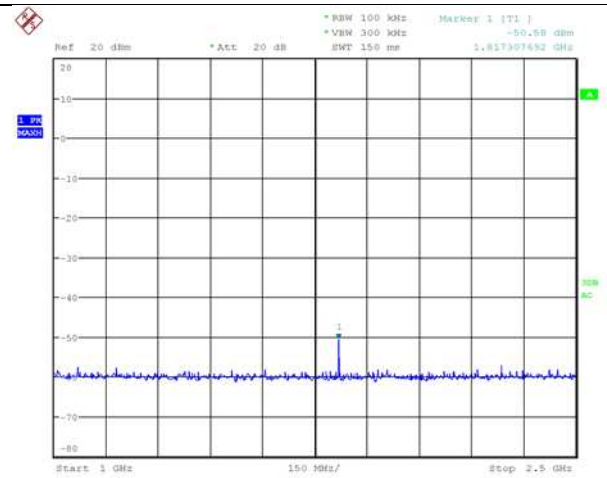
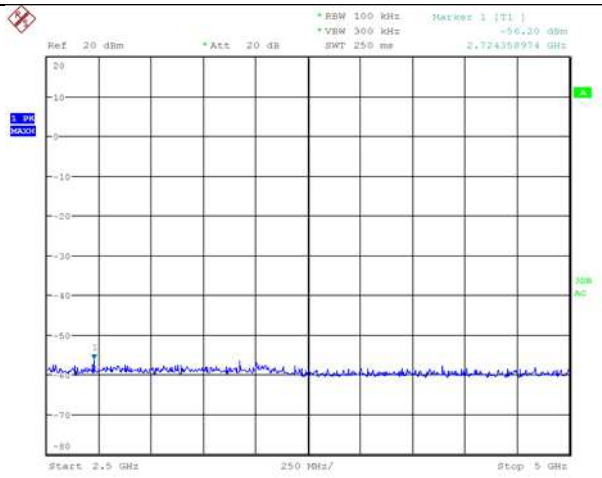
5-7.5GHz	7.5-10GHz
	

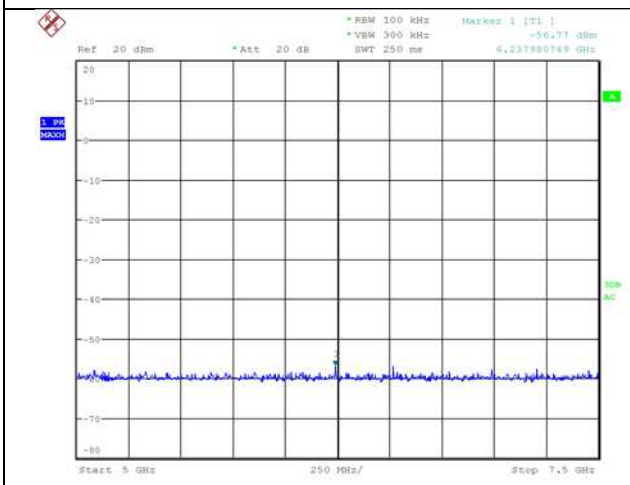
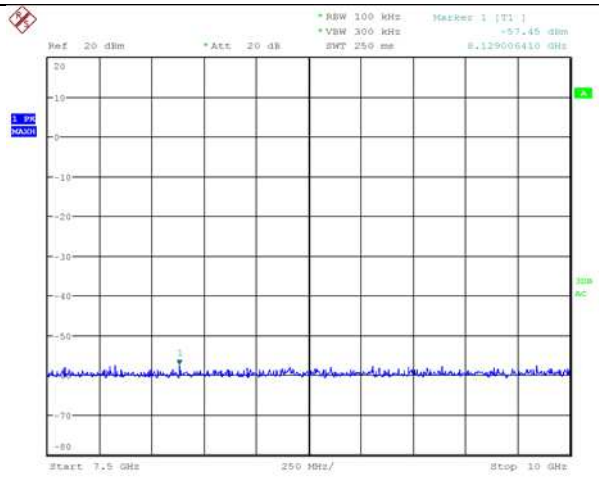
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1817.307	**-50.83**	**14.28**	**65.11**	**-5.72**	**45.11**
2724.359	**-54.95**		**69.23**		**49.23**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel middle (908.5MHz)	
Data Rate: DR1	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

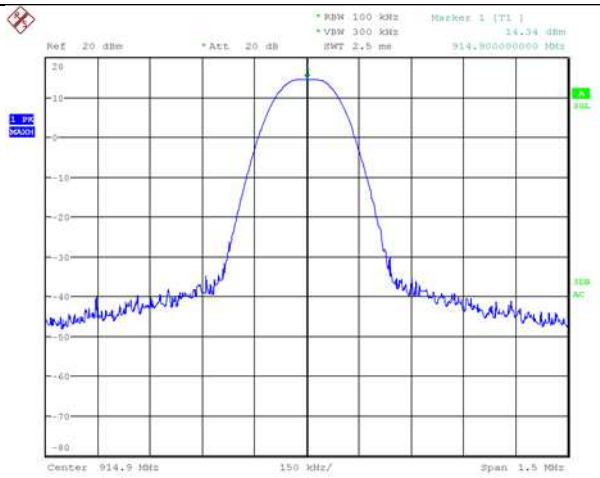
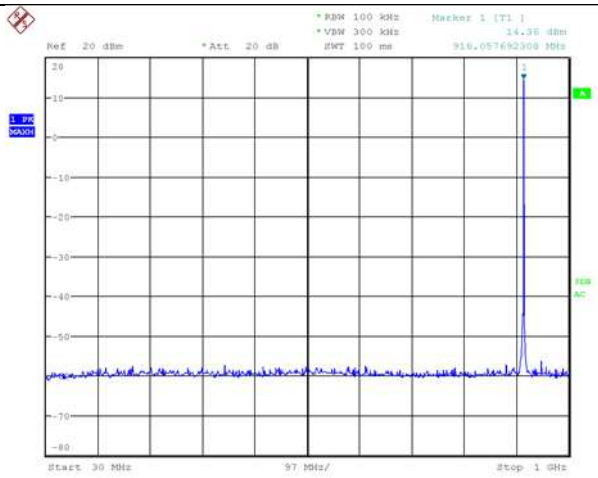
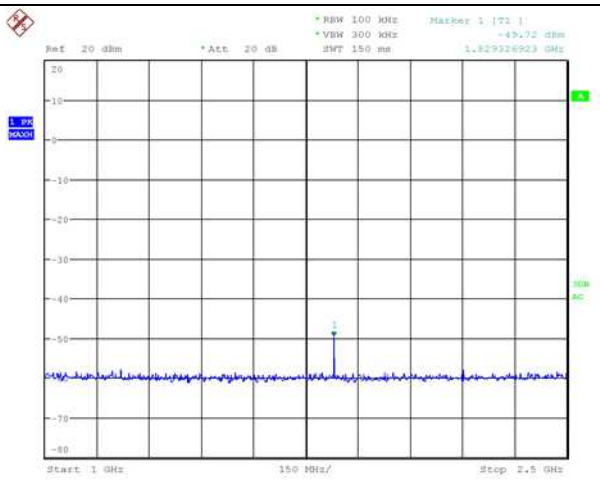
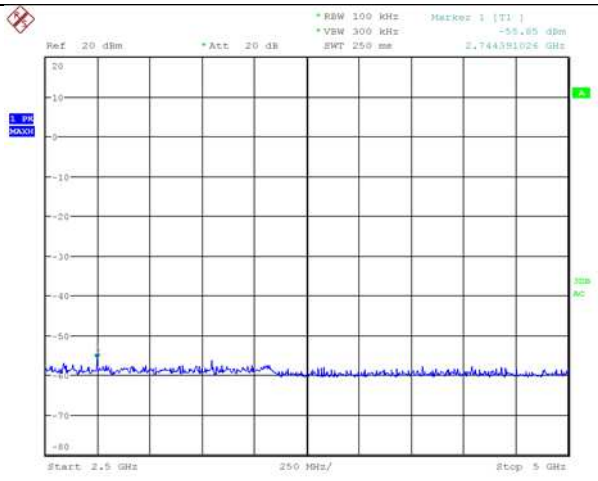
5-7.5GHz	7.5-10GHz
	

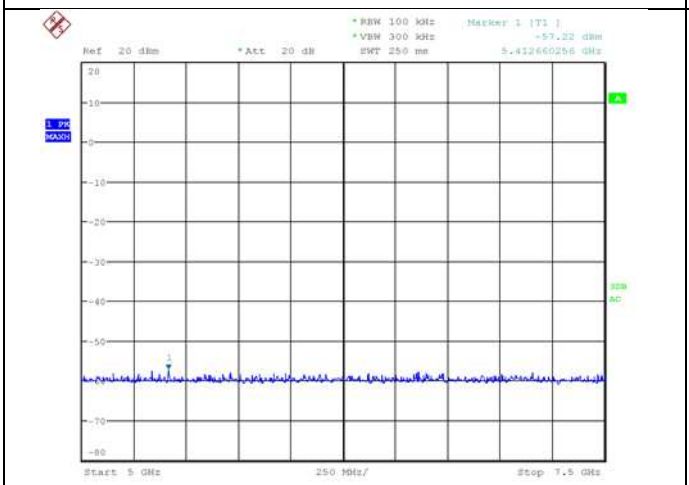
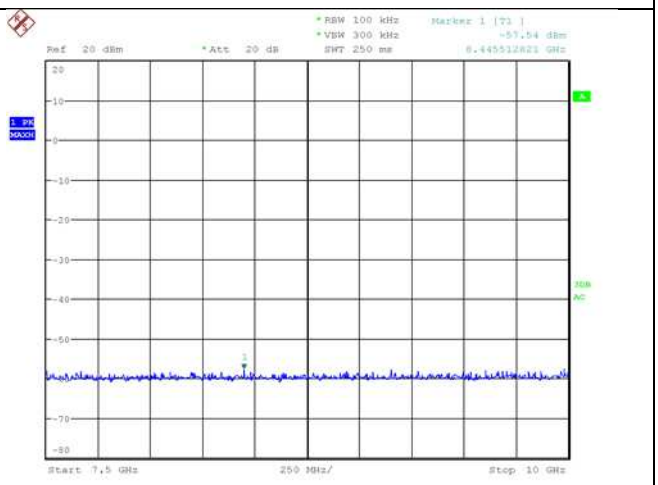
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1817.307	**-50.69**	**14.30**	**64.99**	**-5.70**	**44.99**
2724.359	**-55.72**		**70.02**		**50.02**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel middle (908.5MHz)	
Data Rate: DR0	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

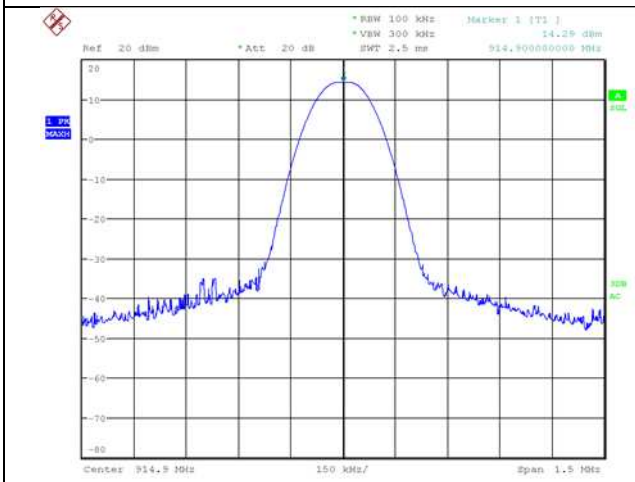
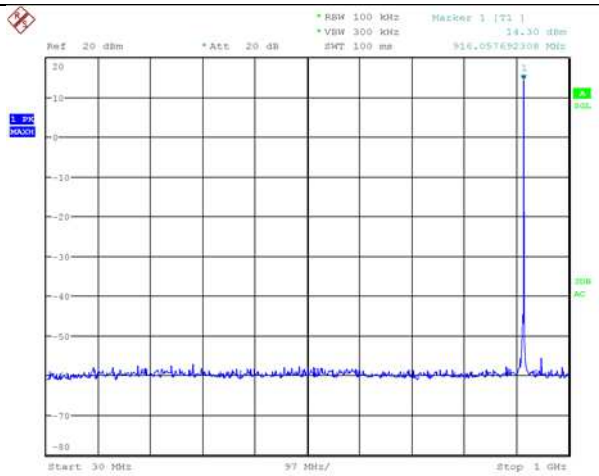
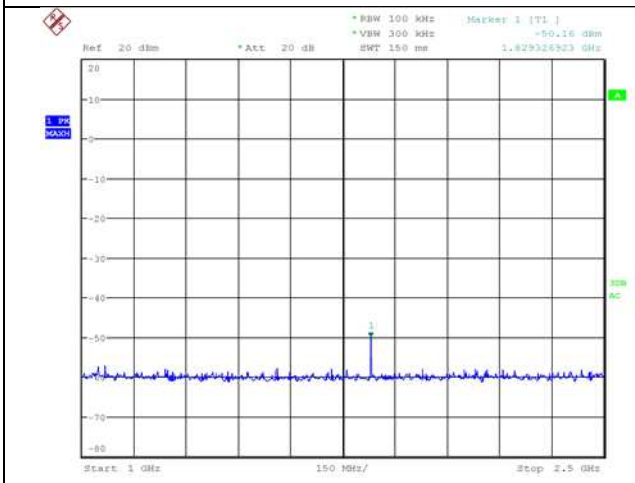
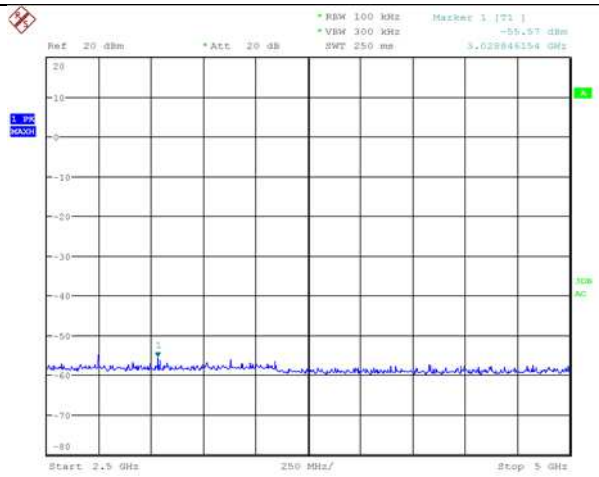
5-7.5GHz	7.5-10GHz
	

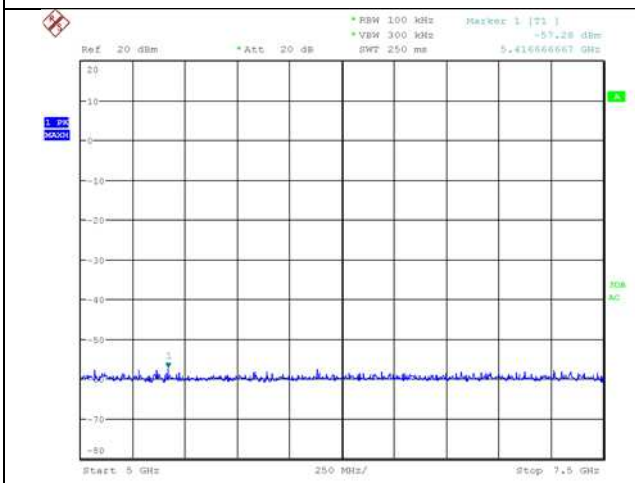
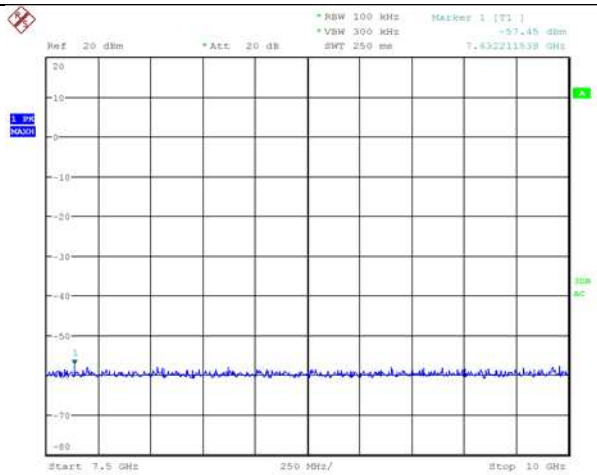
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1817.307	**-50.58**	**14.34**	**64.92**	**-5.66**	**44.92**
2724.359	**-56.20**		**70.54**		**50.54**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel high (914.9MHz)	
Data Rate: DR3	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

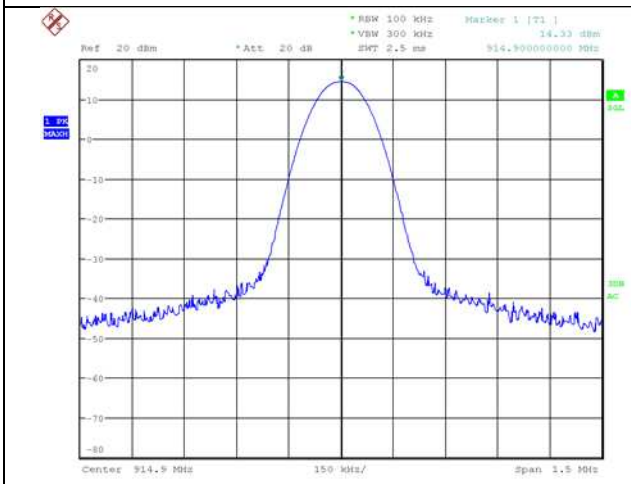
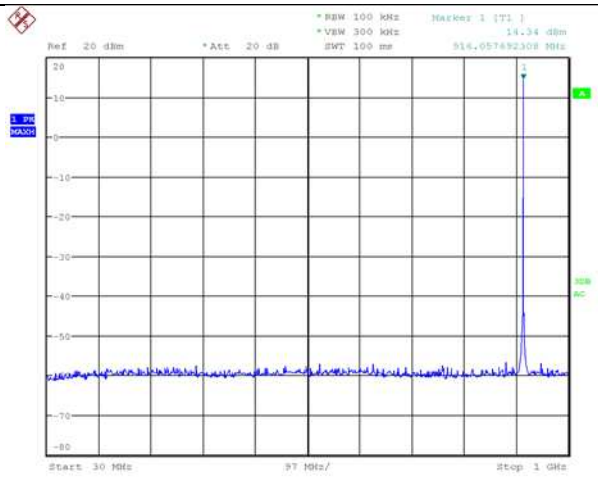
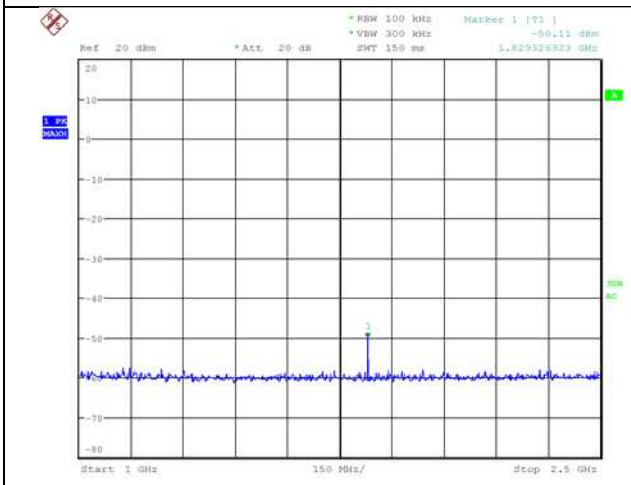
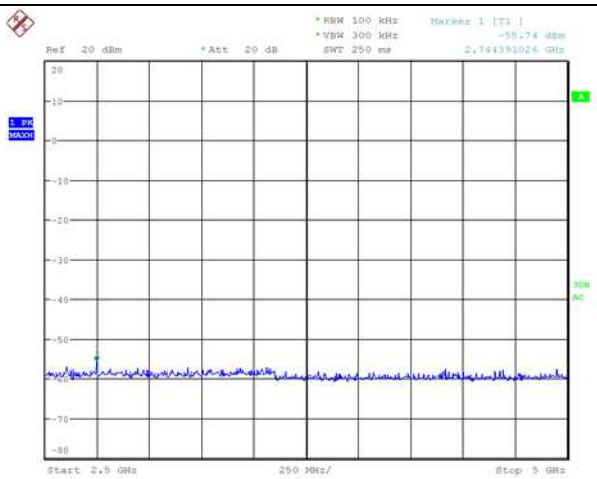
5-7.5GHz	7.5-10GHz
	

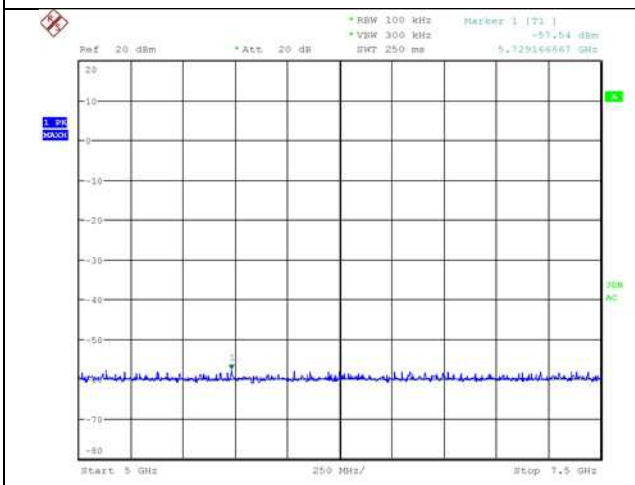
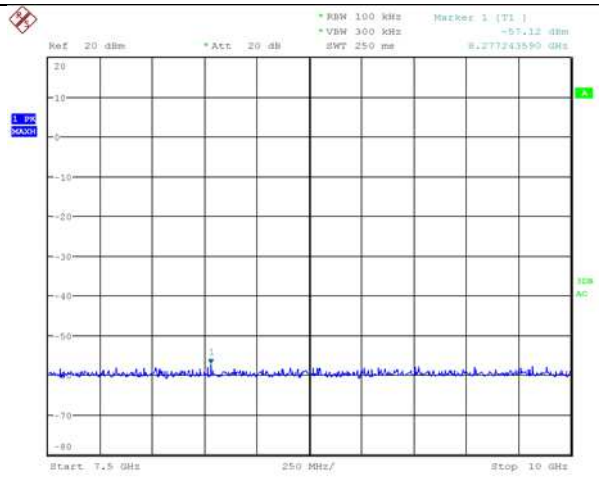
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1829.327	**-49.72**	**14.34**	**64.06**	**-5.66**	**44.06**
2744.391	**-55.85**		**70.19**		**50.19**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel high (914.9MHz)	
Data Rate: DR2	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

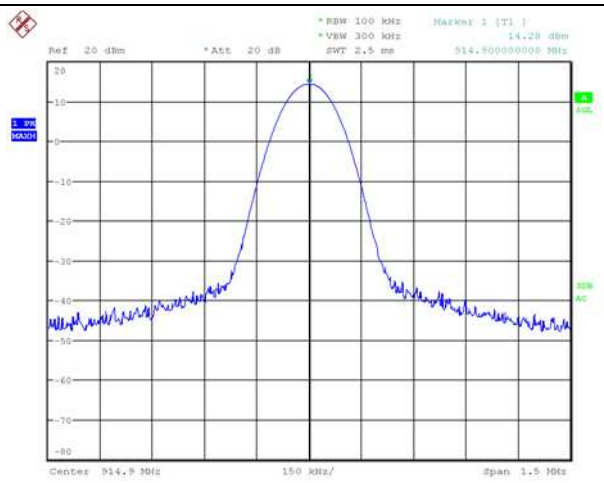
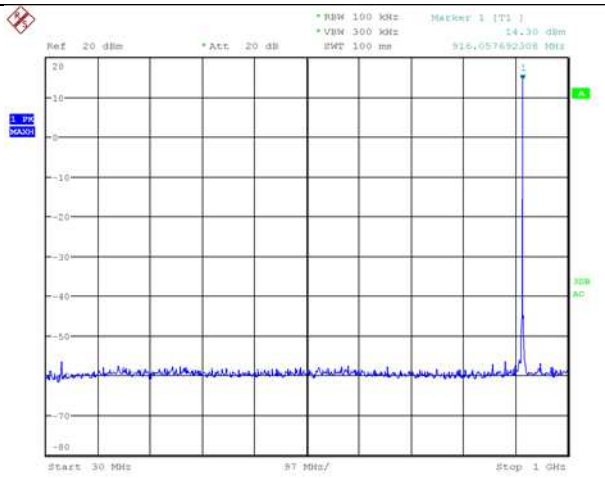
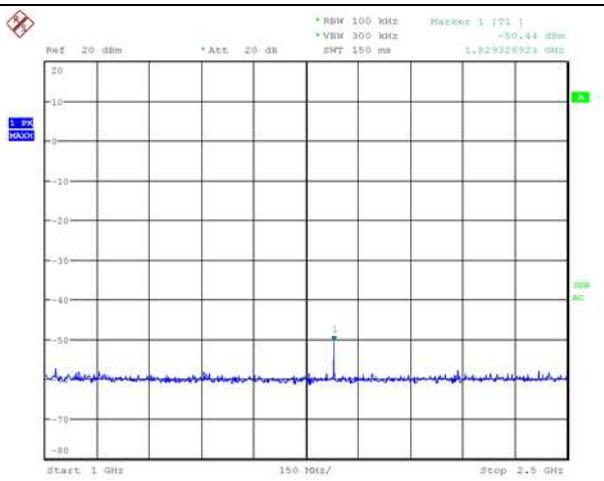
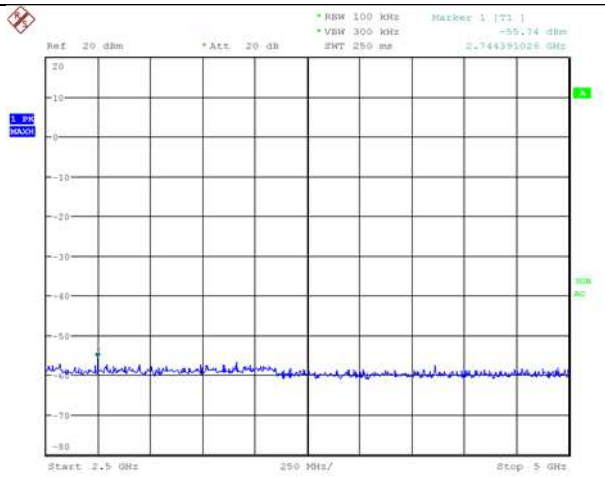
5-7.5GHz	7.5-10GHz
	

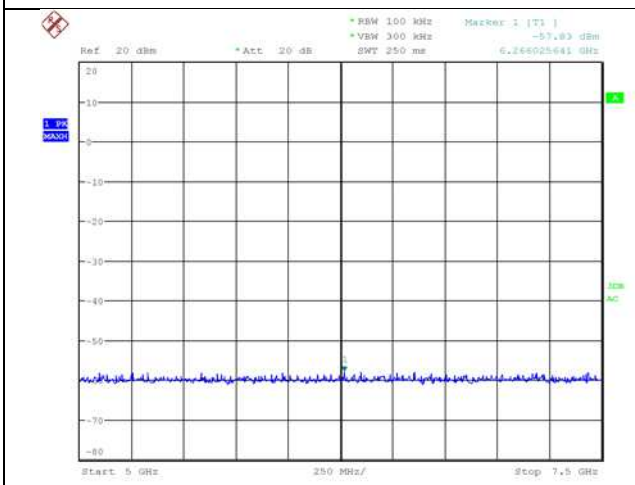
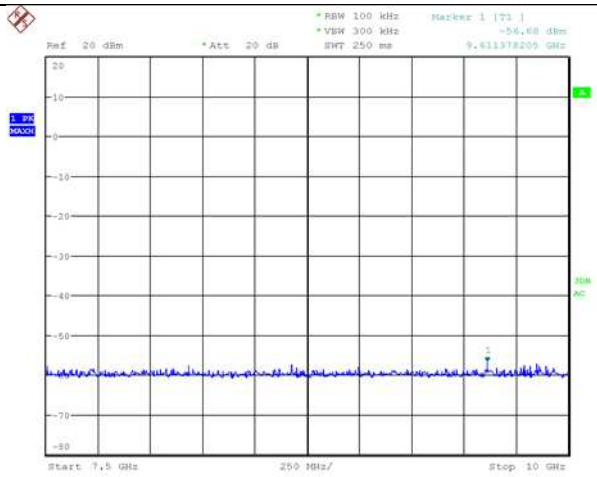
Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1829.327	**-50.16**	**14.29**	**64.45**	**-5.71**	**44.45**
3028.846	**-55.57**		**70.06**		**50.06**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel high (914.9MHz)	
Data Rate: DR1	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

5-7.5GHz	7.5-10GHz
	

Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1829.327	**-50.11**	**14.33**	**64.44**	**-5.67**	**44.44**
2744.391	**-55.74**		**70.07**		**50.07**

Graphical presentation of spurious emission	
Operation mode: 1	
Channel high (914.9MHz)	
Data Rate: DR0	
Fundamental	30MHz-1GHz
	
1-2.5GHz	2.5-5GHz
	

5-7.5GHz	7.5-10GHz
	

Frequency (MHz)	Measured power (dBm)	Fundamental Level (dBm)	Difference Peak / Spurious (dB)	Peak Limit at PK power –20dB (dBm)	Margin (dB)
1829.327	**-50.44**	**14.28**	**64.72**	**-5.72**	**44.72**
2744.391	**-55.74**		**70.02**		**50.02**

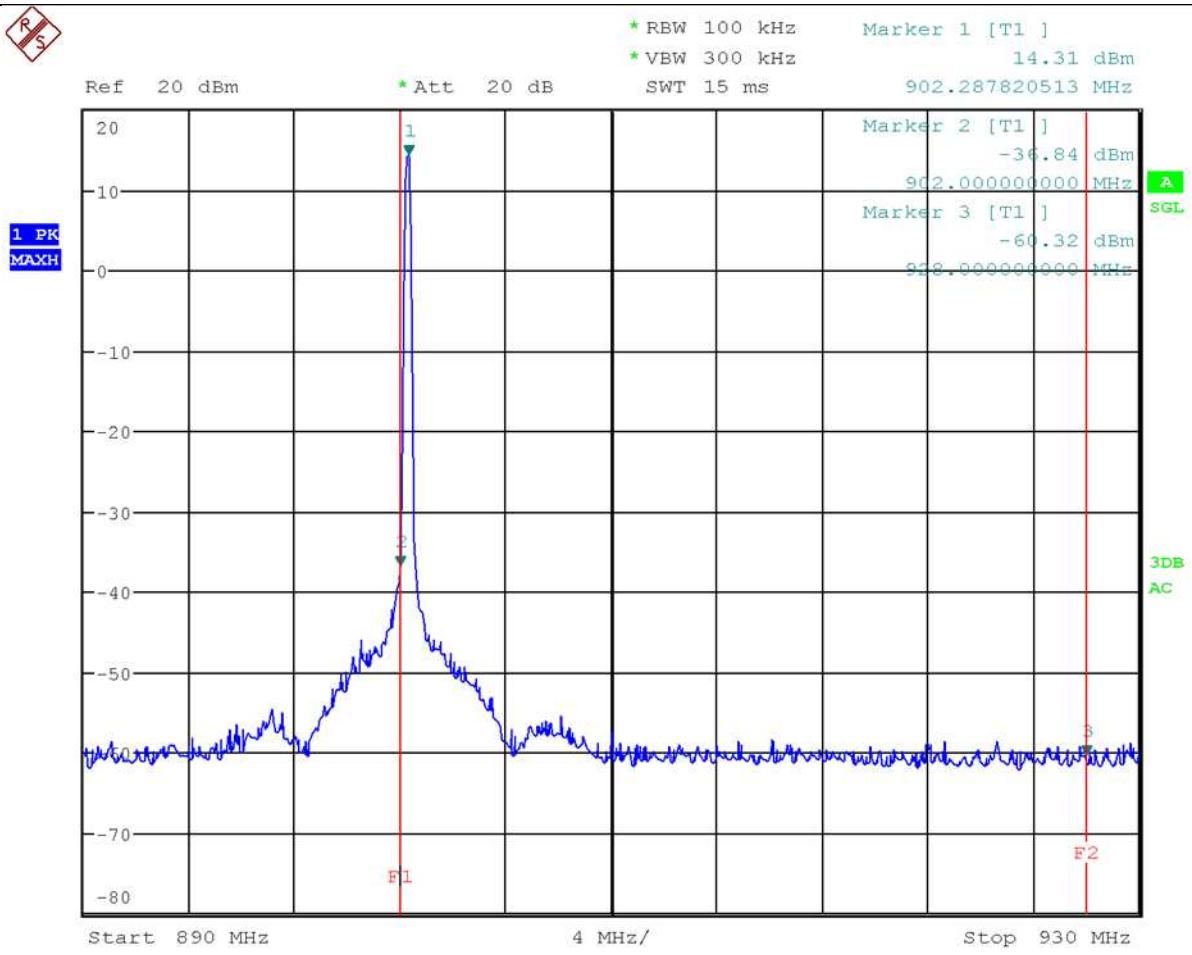
100kHz Bandwidth of Frequency Band Edges	
Test date	08-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 8.7.2 (Marker-Delta method) of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 6.10.4 of ANSI C63.10)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	1, 2
Tested terminals	SMA antenna connector
Result	Within the limit

(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

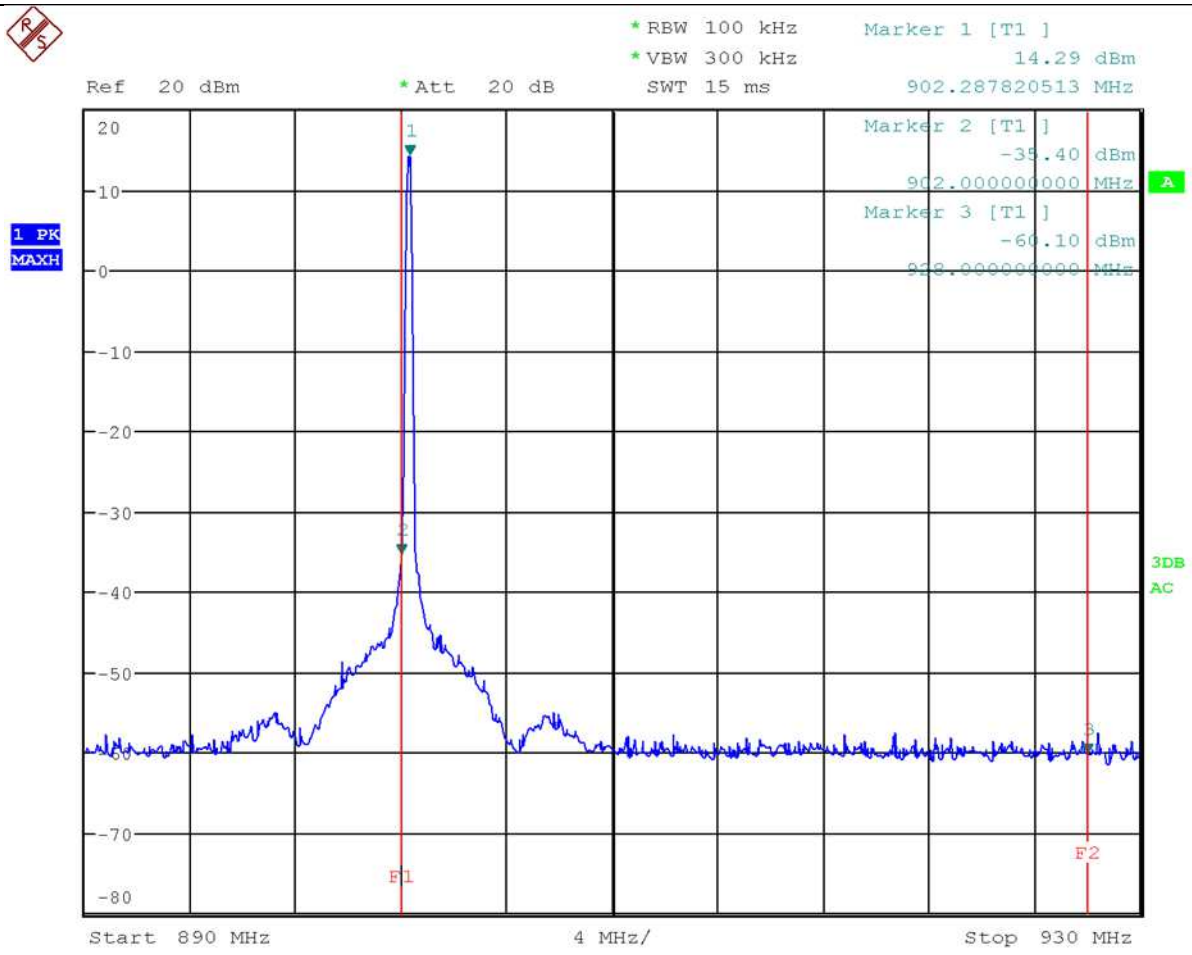
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel low (902.3MHz)
Data Rate: DR3



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-36.84**	**14.31**	**51.15**	**-5.69**	**31.15**
928	**-60.32**	**14.31**	**74.63**	**-5.69**	**54.63**

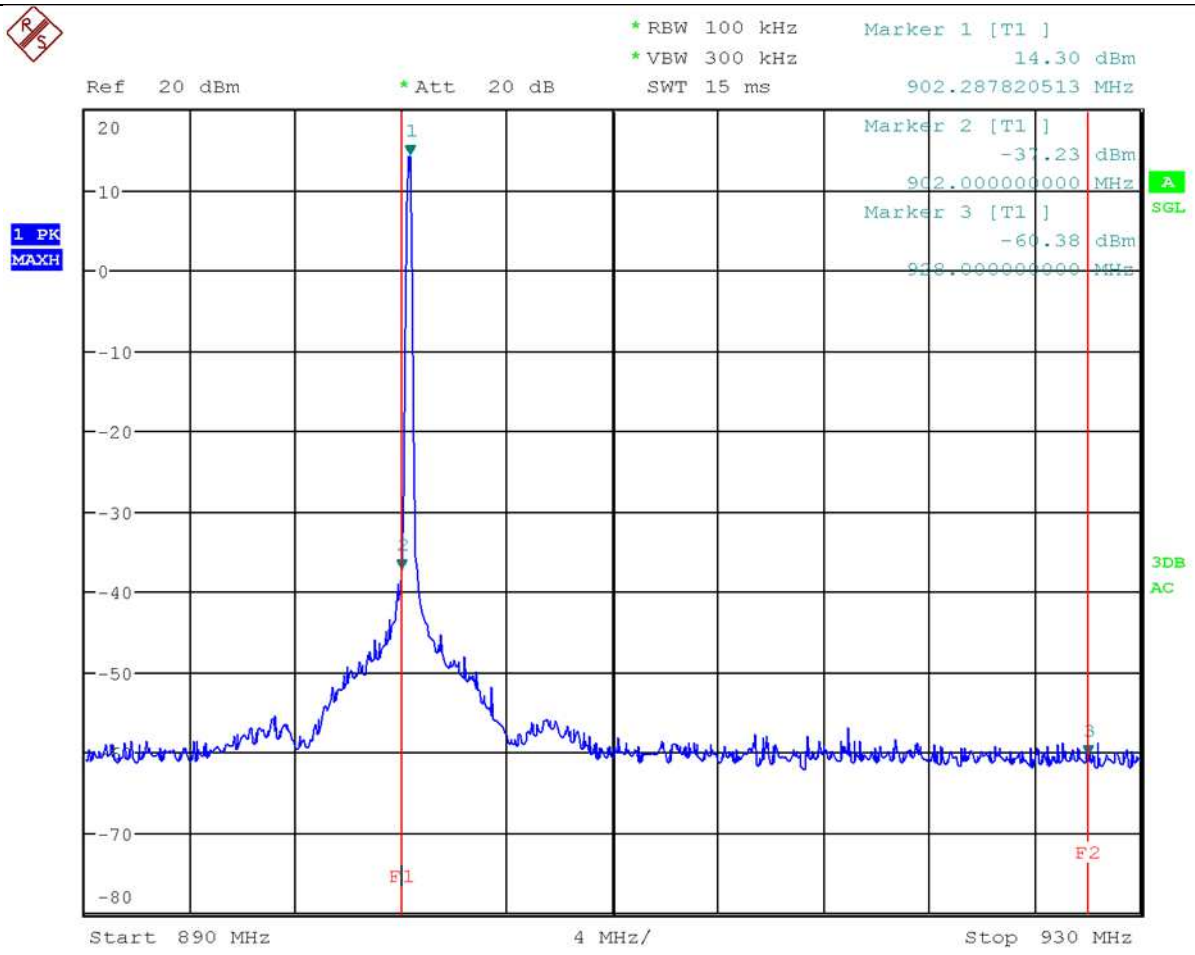
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel low (902.3MHz)
Data Rate: DR2



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-35.40**	**14.29**	**49.69**	**-5.71**	**29.69**
928	**-60.10**	**14.29**	**74.39**	**-5.71**	**54.39**

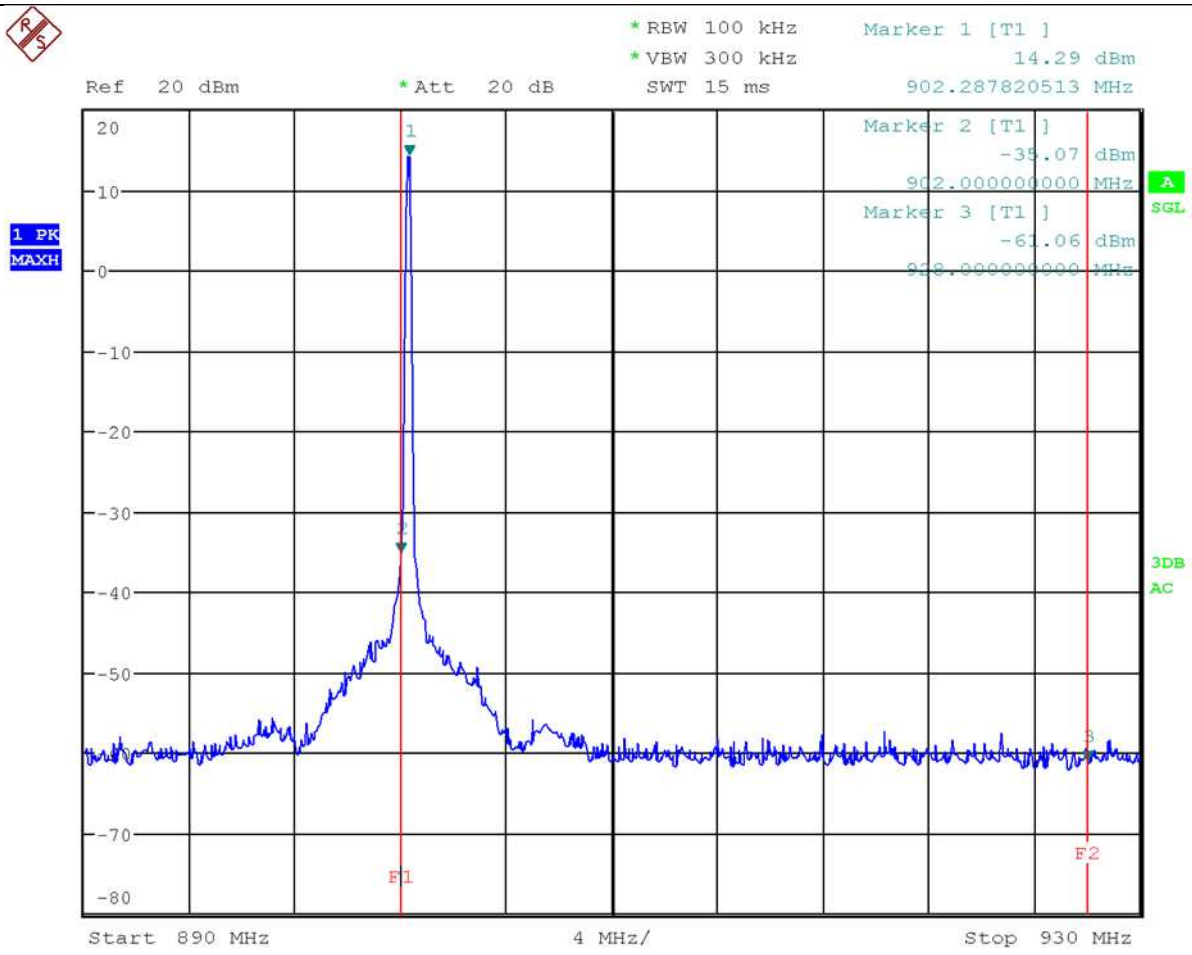
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel low (902.3MHz)
Data Rate: DR1



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-37.23**	**14.30**	**51.53**	**-5.70**	**31.53**
928	**-60.38**	**14.30**	**74.68**	**-5.70**	**54.68**

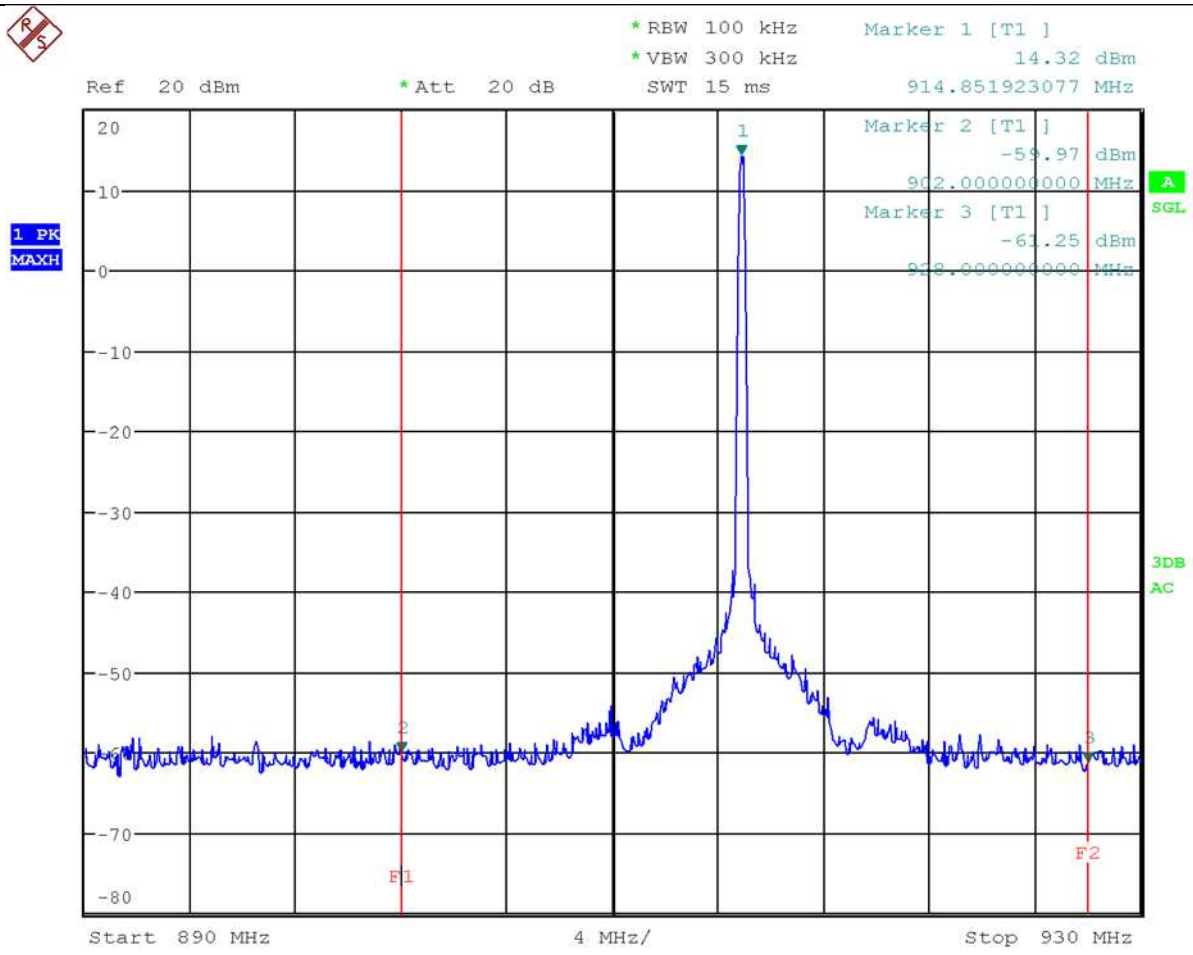
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel low (902.3MHz)
Data Rate: DR0



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-35.07**	**14.29**	**49.36**	**-5.71**	**29.36**
928	**-61.06**	**14.29**	**75.35**	**-5.71**	**55.35**

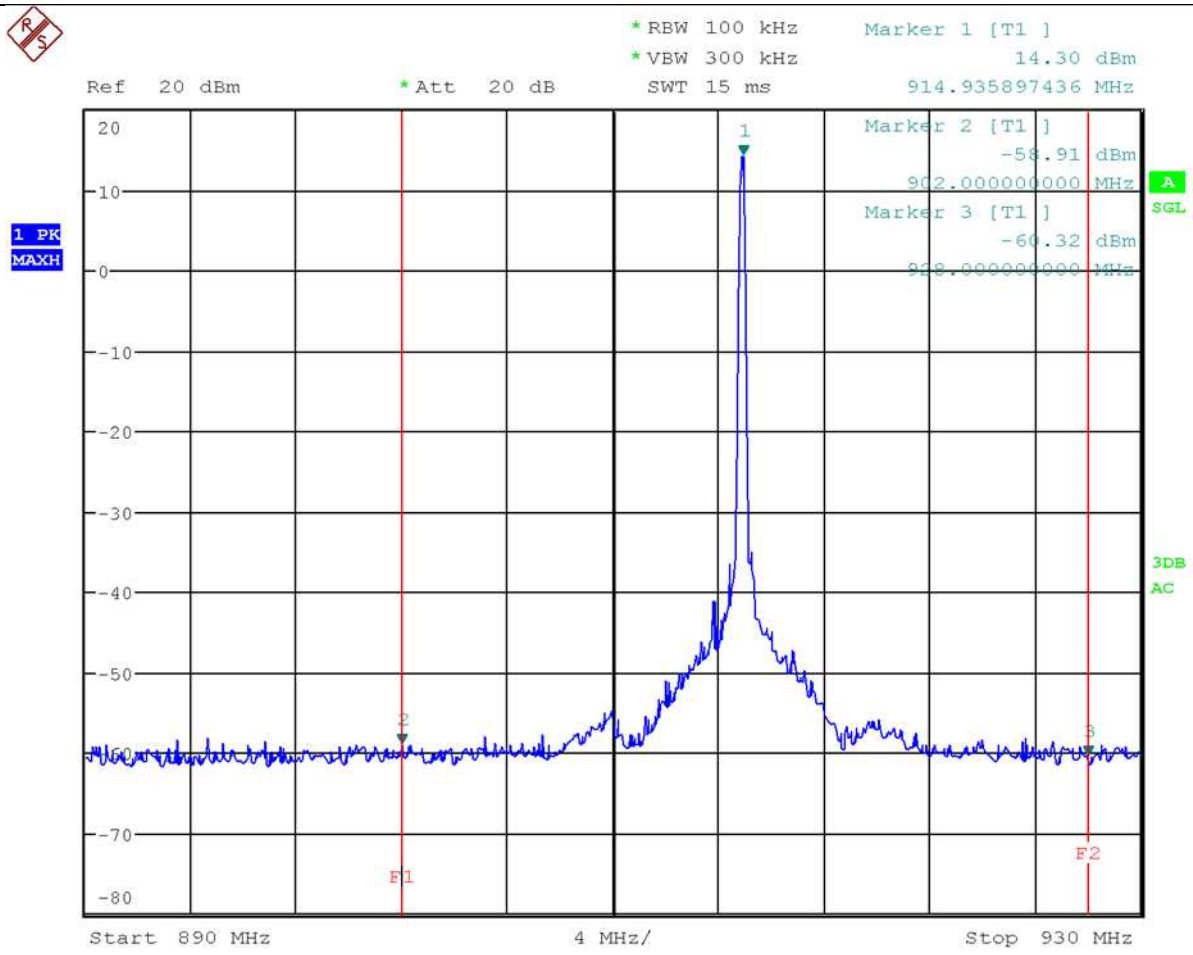
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel high (914.9MHz)
Data Rate: DR3



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-59.97**	**14.32**	**74.29**	**-5.68**	**54.29**
928	**-61.25**	**14.32**	**75.57**	**-5.68**	**55.57**

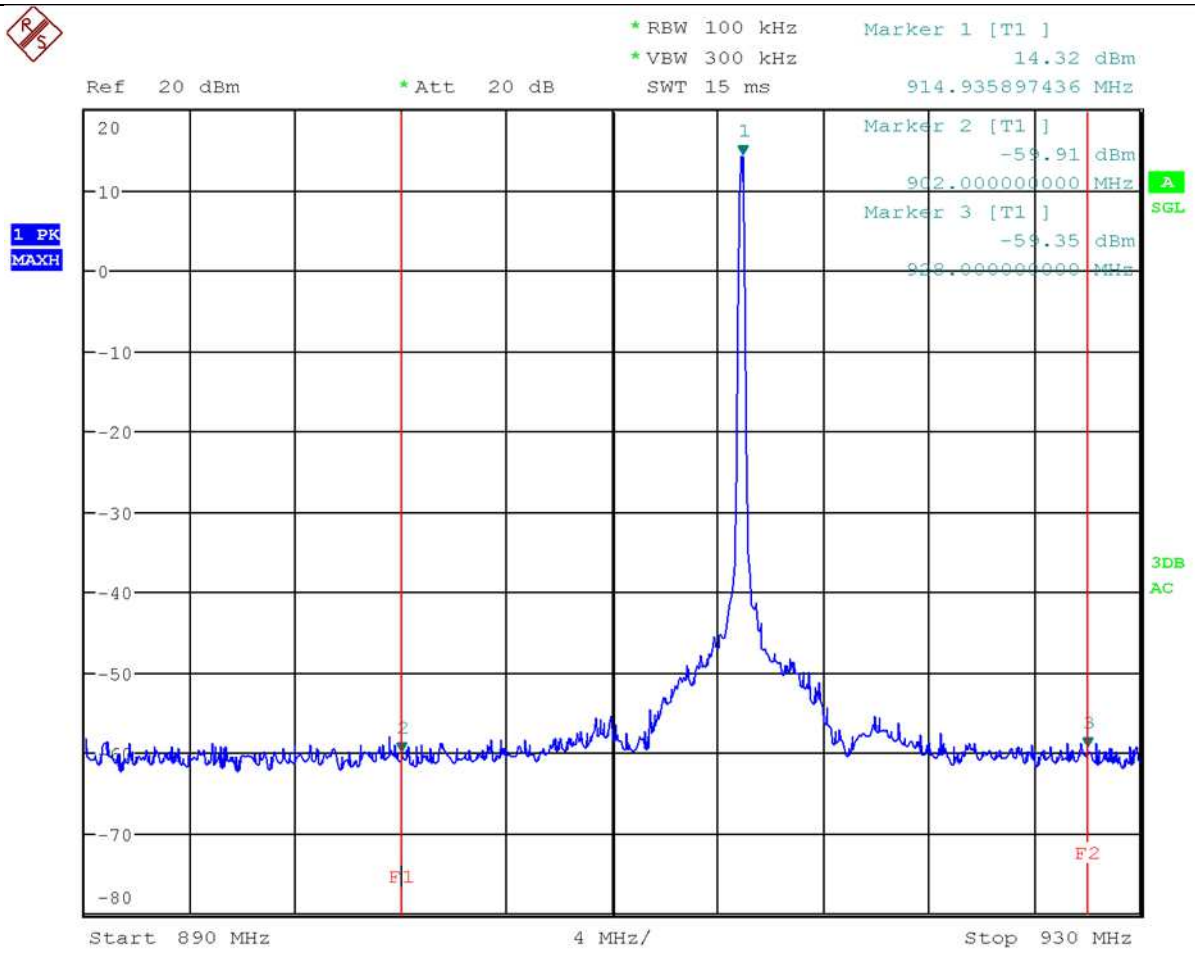
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel high (914.9MHz)
Data Rate: DR2



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-58.91**	**14.30**	**73.21**	**-5.70**	**53.21**
928	**-60.32**	**14.30**	**74.62**	**-5.70**	**54.62**

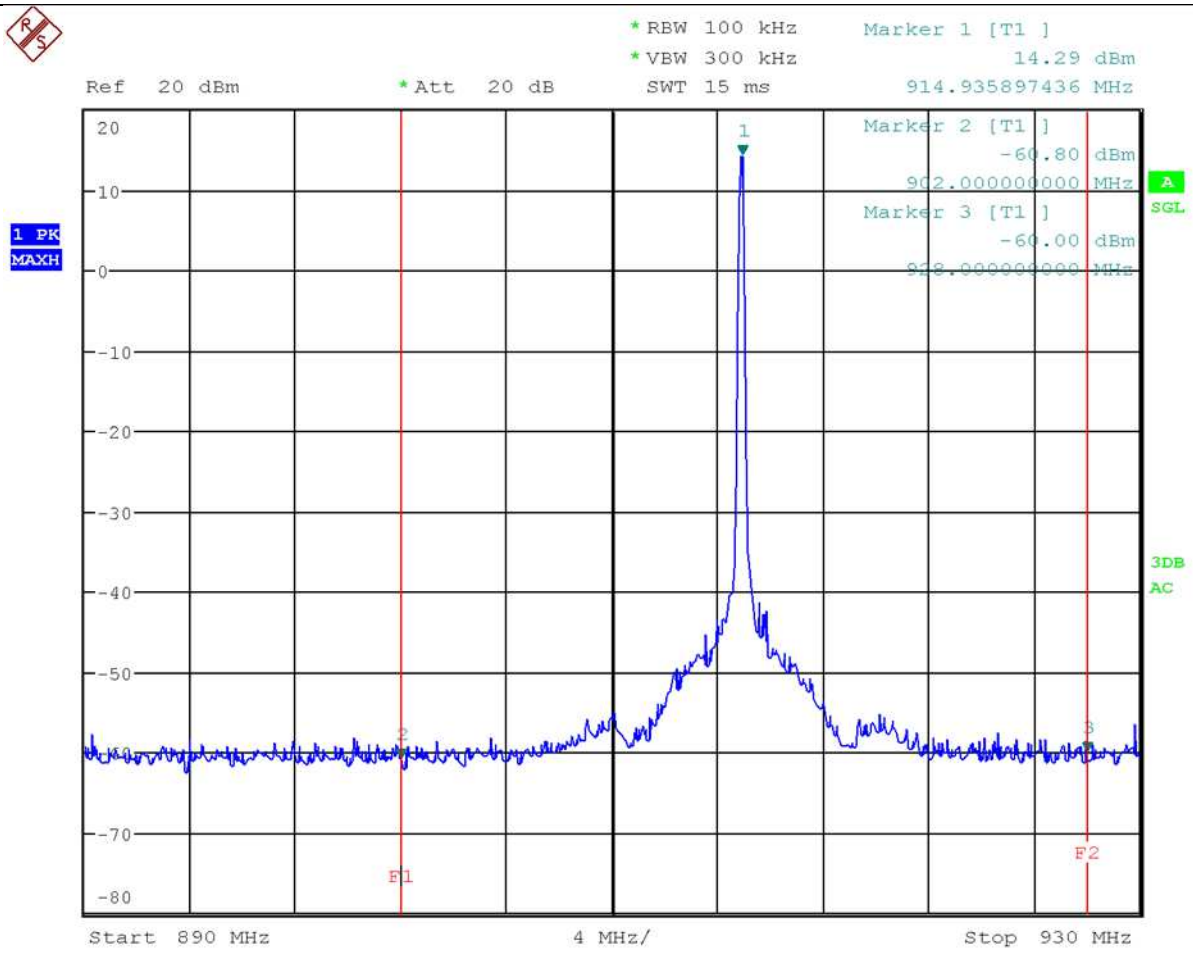
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel high (914.9MHz)
Data Rate: DR1



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-59.91**	**14.32**	**74.23**	**-5.68**	**54.23**
928	**-59.35**	**14.32**	**73.67**	**-5.68**	**53.67**

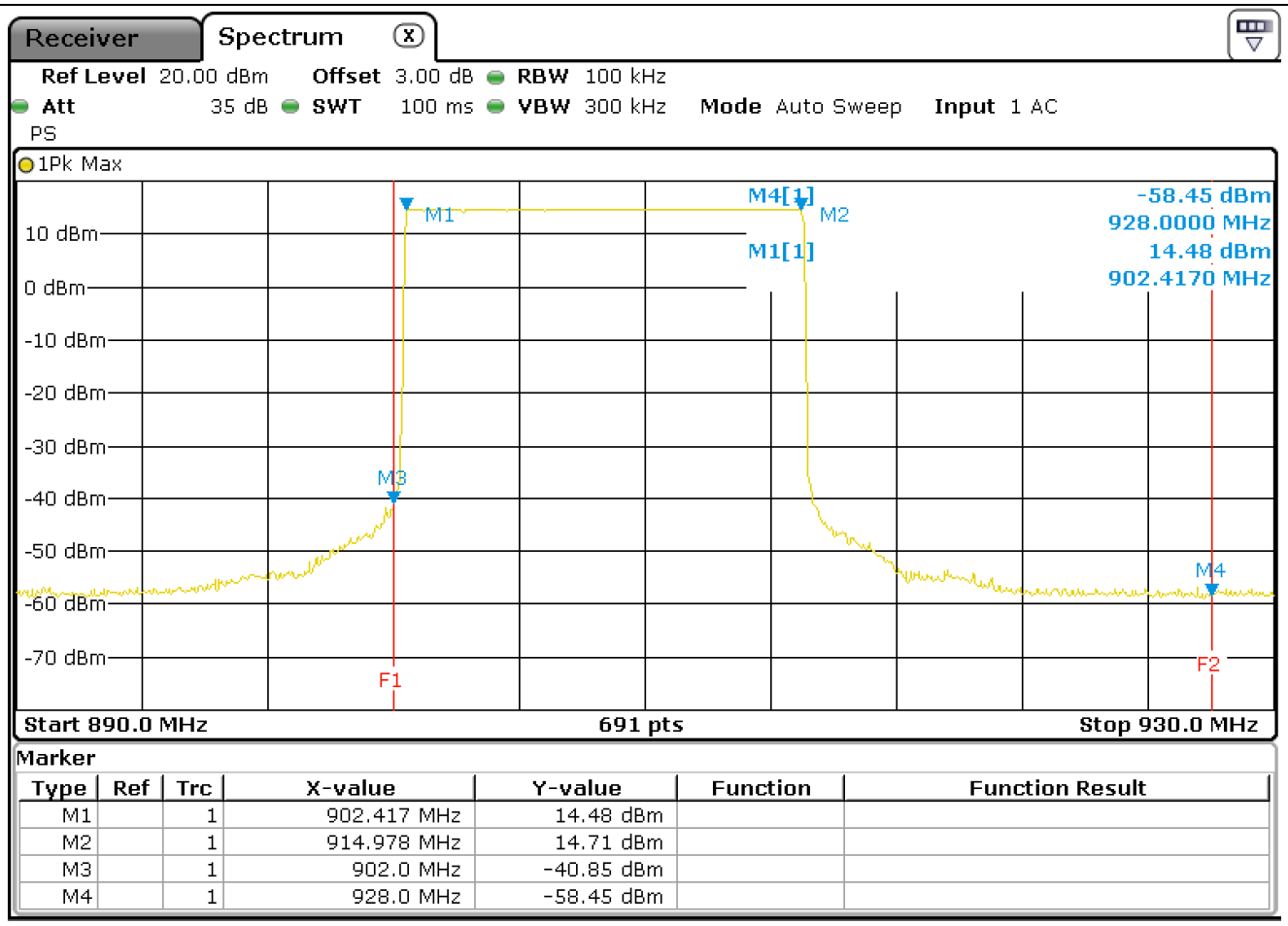
Graphical presentation of Band-Edge measurement
Operation mode: 1
Channel high (914.9MHz)
Data Rate: DR0



Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-60.80**	**14.29**	**75.09**	**-5.71**	**55.09**
928	**-60.00**	**14.29**	**74.29**	**-5.71**	**54.29**

Graphical presentation of Band-Edge measurement
Operation mode: 2
Hopping mode
Data Rate: DR4



Marker

Type	Ref	Trc	X-value	Y-value	Function	Function Result
M1		1	902.417 MHz	14.48 dBm		
M2		1	914.978 MHz	14.71 dBm		
M3		1	902.0 MHz	-40.85 dBm		
M4		1	928.0 MHz	-58.45 dBm		

Note: the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

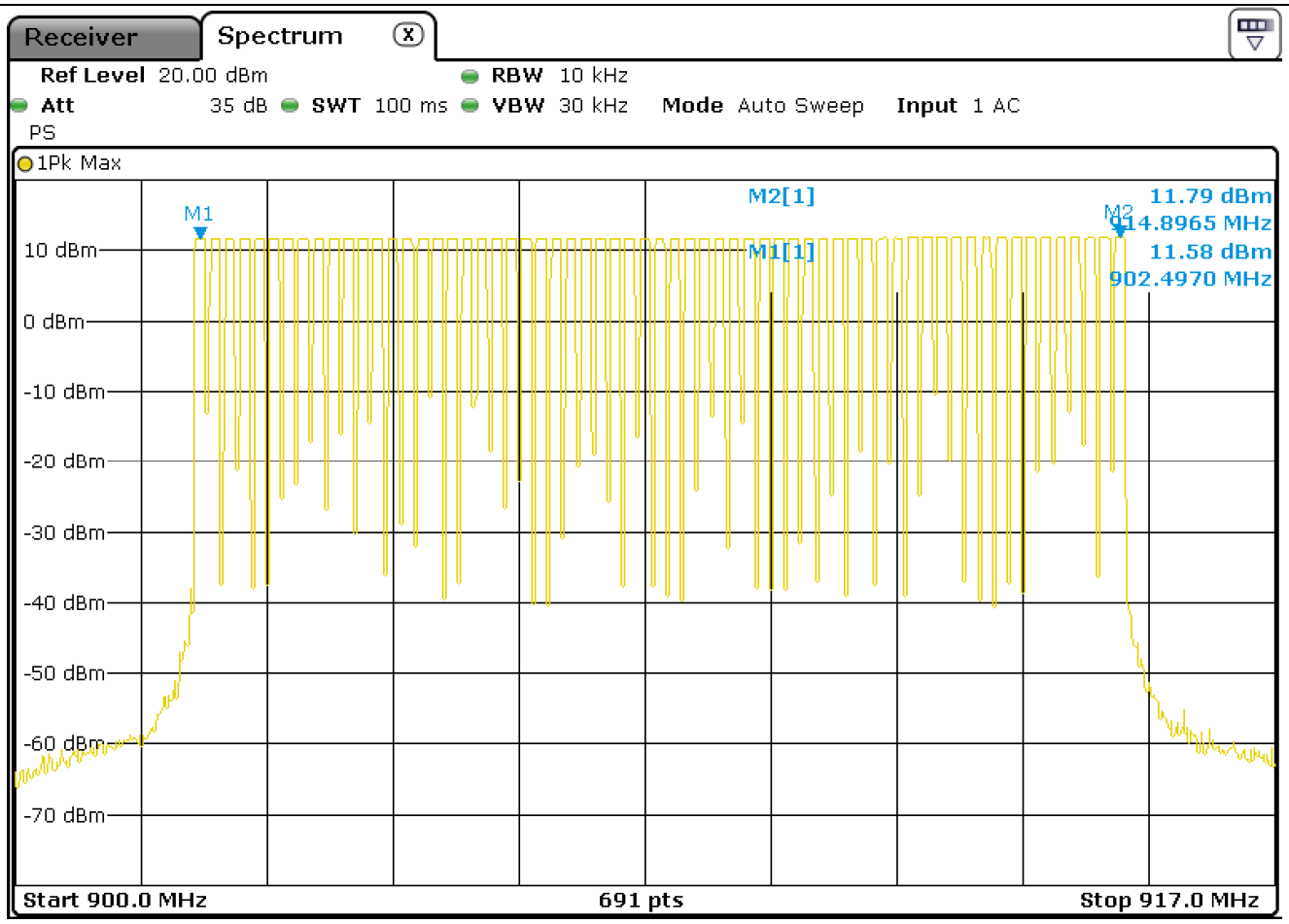
Frequency (MHz)	Measured power at the band edge (dBm)	Measured power at fundamental frequency (dBm)	Difference Peak / band edge (dB)	Peak Limit at PK power –20 dB (dBm)	Margin (dB)
902	**-40.85**	**14.48**	**55.33**	**-5.52**	**35.33**
928	**-58.45**	**14.71**	**73.16**	**-5.29**	**53.16**

Number of Hopping frequencies	
Test date	17-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 9 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 7.8.3 of ANSI C63.10.)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	2
Tested terminals	SMA antenna connector
Result	PASS
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.	

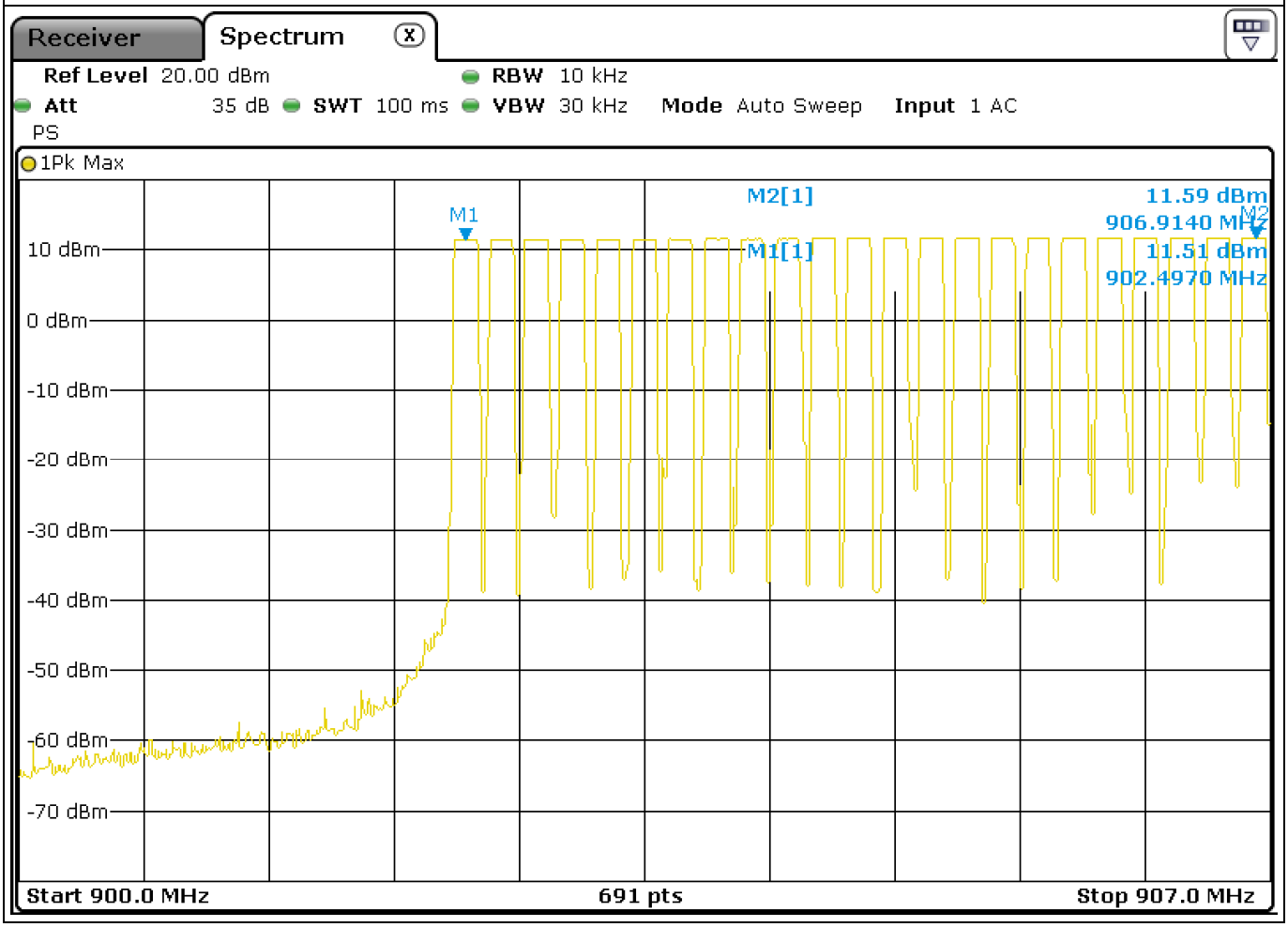
Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

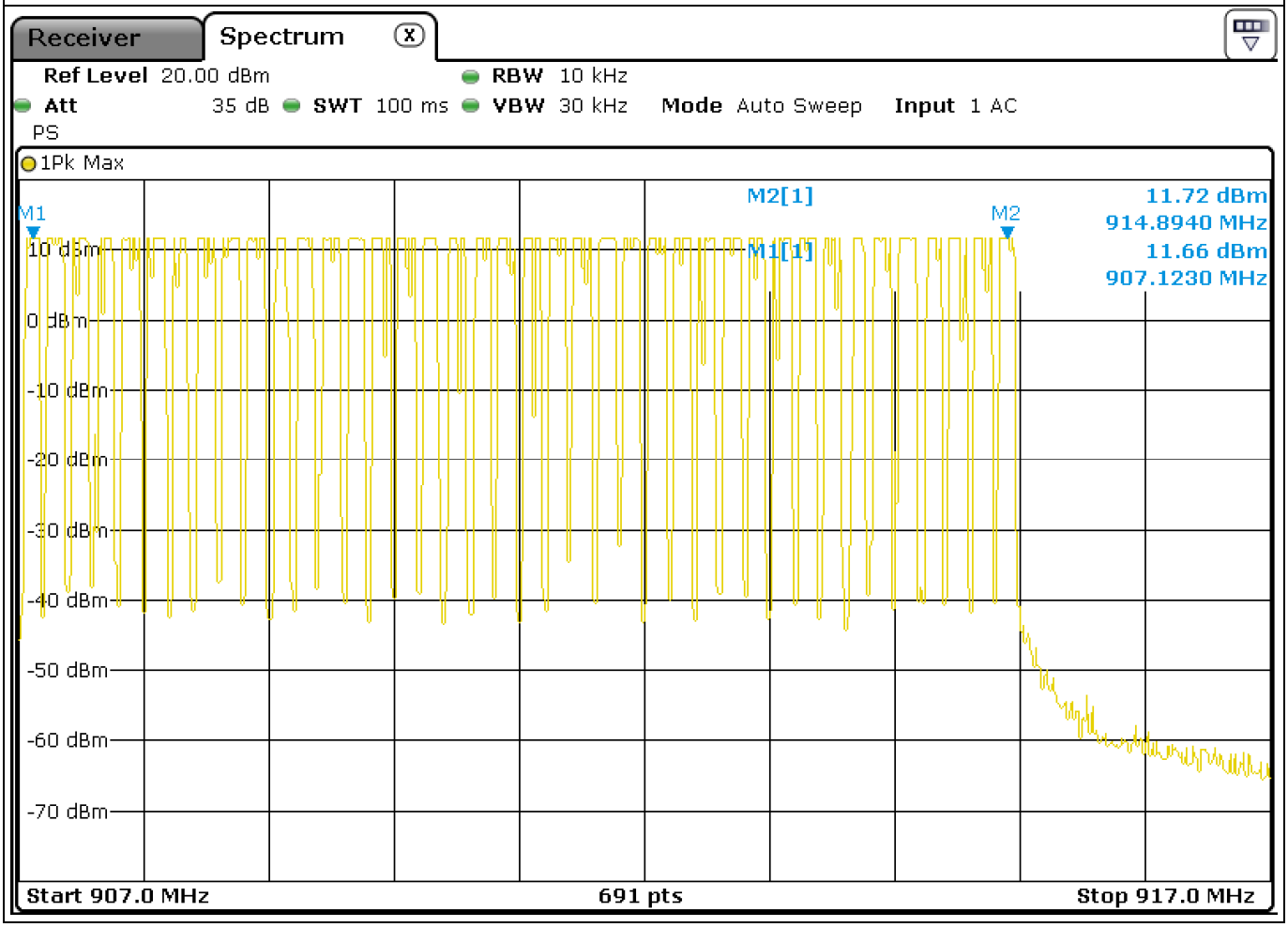
Graphical presentation of Number of Hopping frequencies
Operation mode: 2
Plot. 1: all 64 channels



Graphical presentation of Number of Hopping frequencies
Operation mode: 2
Plot. 2: N°1-23 channel



Graphical presentation of Number of Hopping frequencies
Operation mode: 2
Plot. 3: N°24-64 channel

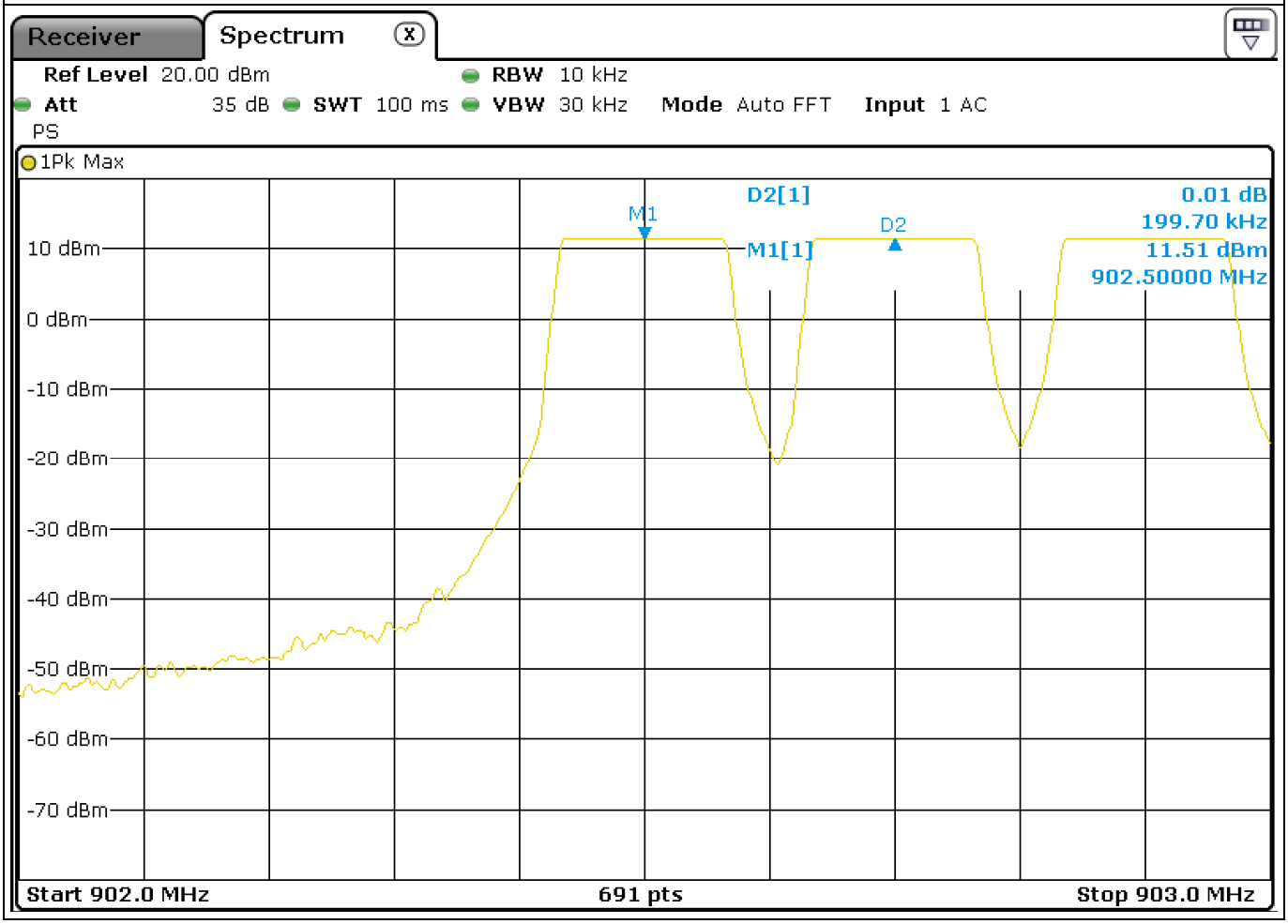


Carrier frequency separation	
Test date	17-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 9 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 7.8.2 of ANSI C63.10.)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	2
Tested terminals	SMA antenna connector
Result	PASS
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.	

Used test equipment

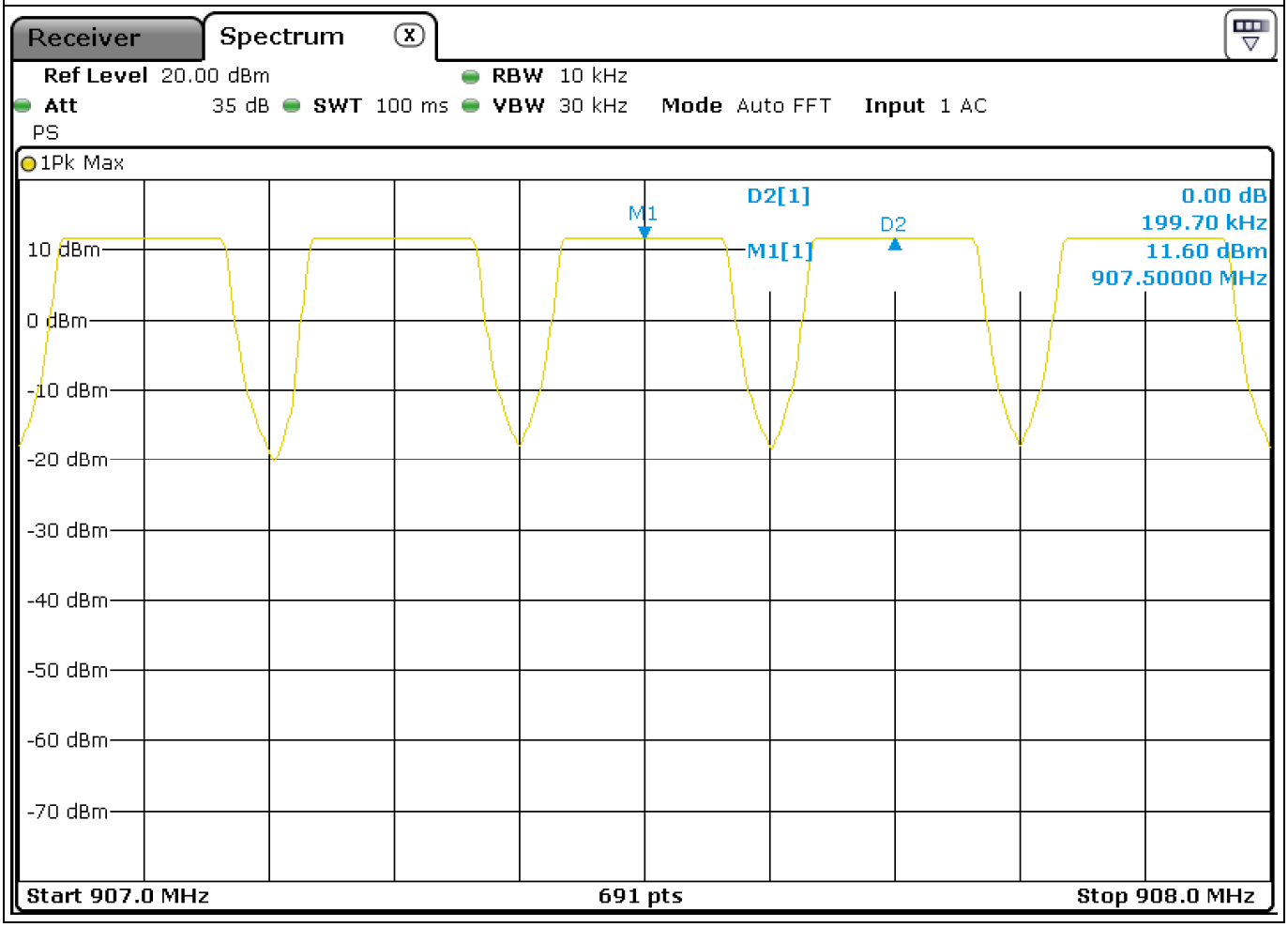
Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

Graphical presentation of Carrier frequency separation
Operation mode: 2
Plot. 1: channel 1 & channel 2 frequency separation



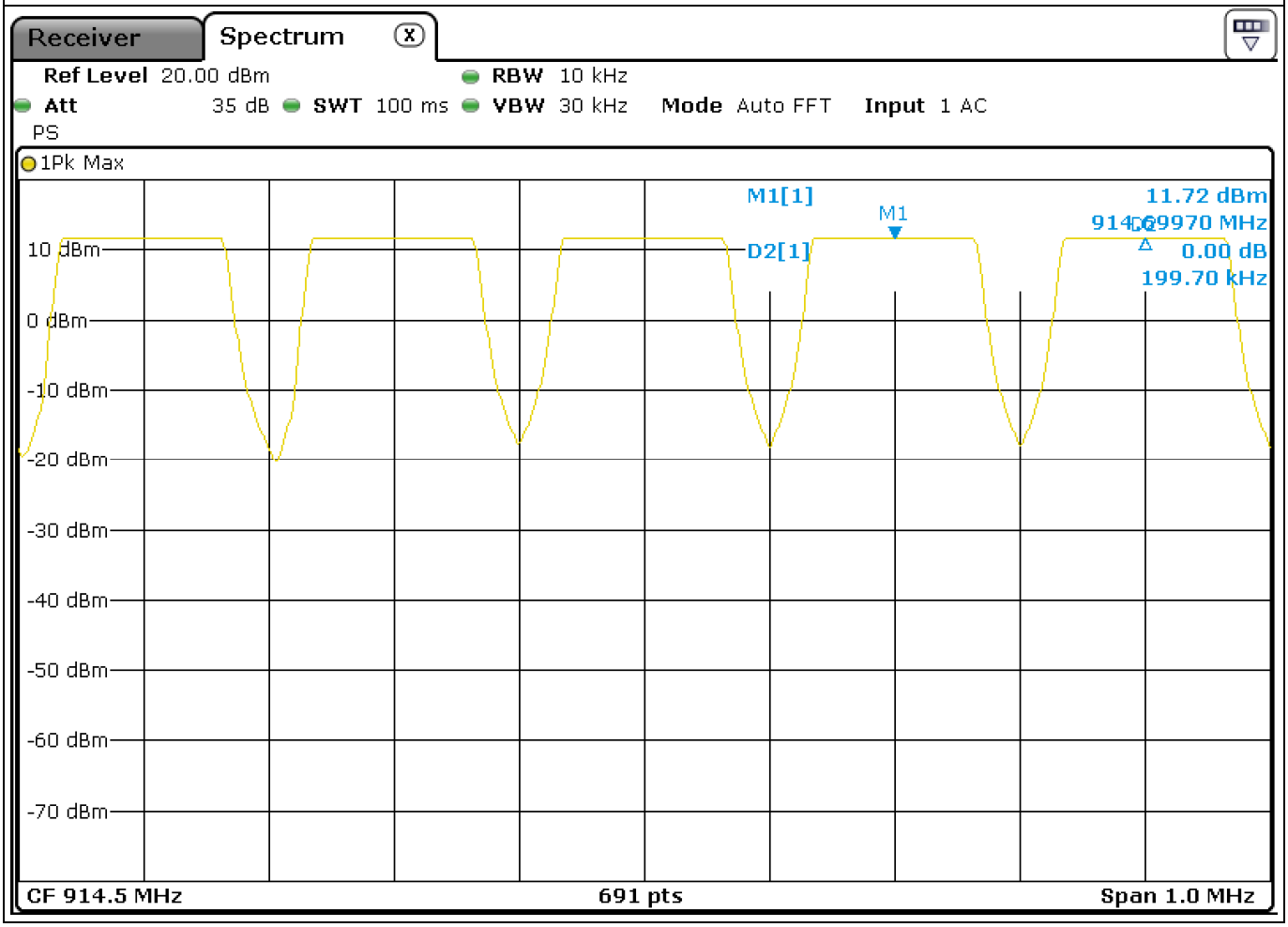
Channel (No.)	Carrier frequency separation (kHz)	Limit (kHz)	Plot (No.)
1-2	199,70	≥25kHz	1

Graphical presentation of Carrier frequency separation
Operation mode: 2
Plot. 1: channel 27 & channel 28 frequency separation



Channel (No.)	Carrier frequency separation (kHz)	Limit (kHz)	Plot (No.)
27-28	**199,70**	**≥25kHz**	**2**

Graphical presentation of Carrier frequency separation
Operation mode: 3
Plot. 1: channel 63 & channel 64 frequency separation



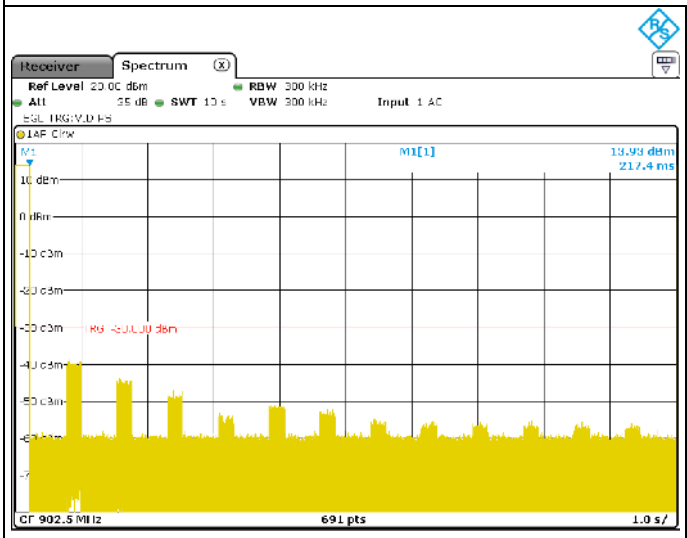
Channel (No.)	Carrier frequency separation (kHz)	Limit (kHz)	Plot (No.)
63-64	**199,70**	**≥25kHz**	**3**

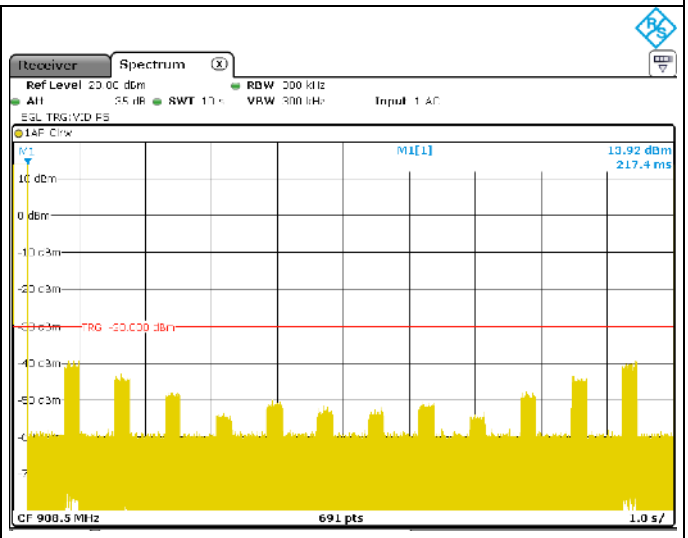
Average time of occupancy	
Test date	30-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.247
Test method	According to Par. 9 of KDB 558074 D01 15.247 Meas Guidance v05r02 (and par. 7.8.4 of ANSI C63.10.)
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	2
Tested terminals	SMA antenna connector
Result	PASS
For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10-second period. The maximum 20 dB bandwidth of the hopping channel shall be 500 kHz.	

Used test equipment

Type	Manufacturer	Model	ID	Last calibration	Next calibration
EMI Receiver	Rohde&Schwarz	ESU40	2782345	10/2020	10/2021

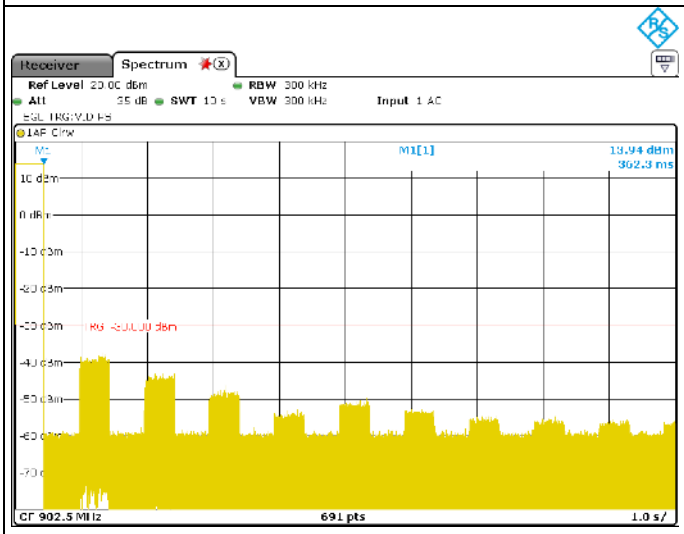
Graphical presentation of Average time of occupancy
Operation mode: 2
Plot. 1 & 2: Average time of occupancy with DR2 (SF10 Payload 51bytes)

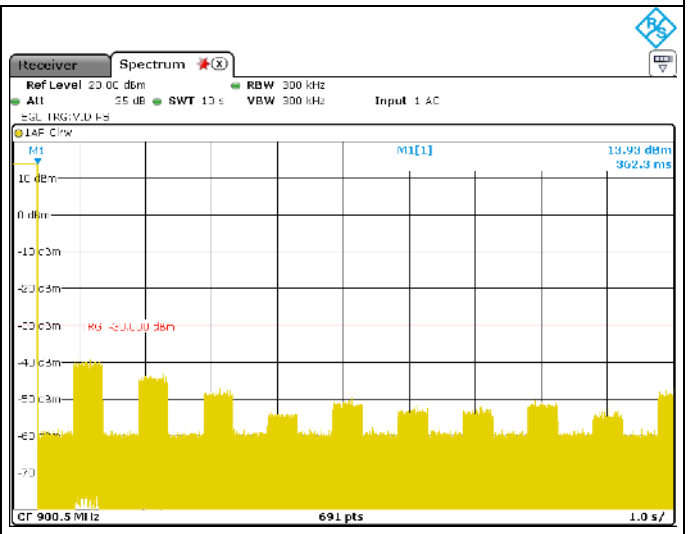




Single packet duration (ms)	N° of hops in 10s	Limit of Average time of occupancy (ms) in a period of 10s	Plot (No.)
217,40	1	400	1÷2

Graphical presentation of Average time of occupancy
Operation mode: 2
Plot. 3 & 4: Average time of occupancy with DR3 (SF9 Payload 115bytes)





Single packet duration (ms)	N° of hops in 10s	Limit of Average time of occupancy (ms) in a period of 10s	Plot (No.)
362,30	1	400	1÷2

Additional provisions to the general radiated emission limitations.	
Test date	08-09-2021
Applied Standard	Title 47 Part 15 Subpart C §15.215
Test method	---
Temperature	22° C
Humidity	42%
Air pressure	1027 mbar
Tested by	Roberto Radice
Model	**MAMWLE-01**
Test sample No.:	N°1
Operating mode	1
Tested terminals	SMA antenna connector
Result	Within the limit

(A) The regulations in §§ 15.217-15.257 provide alternatives to the general radiated emission limits for intentional radiators operating in specified frequency bands. Unless otherwise stated, there are no restrictions as to the types of operation permitted under these sections.	
(B) In most cases, unwanted emissions outside of the frequency bands shown in these alternative provisions must be attenuated to the emission limits shown in Section 15.209. In no case shall the level of the unwanted emissions from an intentional radiator operating under these additional provisions exceed the field strength of the fundamental emission.	VERDICT PASS
(C) Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.	VERDICT PASS

PHOTOGRAPHIC DOCUMENTATION	
See the Annex below:	
IT21K3EN 001 Annex 1	External photos
IT21K3EN 001 Annex 2	Internal photos (without shield)
IT21K3EN 001 Annex 3	Test Set-up photos

SAR EVALUATION	
See the Annex below:	
IT21K3EN 001 Annex 4	SAR Evaluation

DERIVED MODELS ASSESSMENT	
See the Annex below:	
IT21K3EN 001 Annex 5	Derived models assessment

---END OF TEST REPORT---