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Sterling, VA 20164
United States of America

FCC LISTED,
REGISTRATION NUMBER:
2764.01

ISED LISTED
REGISTRATION NUMBER:
23595-1

Test Report No:
4218ERM.001A2

Test Report

USA FCC Part 15.247, 15.209, 15.207; & CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices.

(*) Identification of item tested	Multifunctional battery powered LoRaWAN Transmitter with input for Thermocouple, RTD, Vibration Sensor, Ratiometric Sensor or other.
(*) Trademark	NEON
(*) Model and /or type reference	DS-LD-02-00
Other identification of the product	FCC ID: 2ATYF-DS02B ICC ID:28385-DS02B HW version: F1 SW Version: V1.0.0
(*) Features	LoRaWAN
(*) Manufacturer	TWTG Schaardijk 386, 2909 LA Capelle aan den IJssel
Test method requested, standard	USA FCC Part 15.247 (6-1-20): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. / USA FCC Part 15.209 (6-28-21): Radiated emission limits; general requirements. CANADA RSS-247 Issue 3 (August 2023). CANADA RSS-Gen Issue 5 (February 2021). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 15.247 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Domingo Galvez EMC&RF Lab Manager Digitally signed by Domingo Galvez DN: cn=Domingo Galvez, o=Dekra Certification Inc., ou=Regulatory Lab Manager, email=domingo.galvez@dekra.com, c=US
Date of issue	05-03-2024
Report template No	FDT08_23 (*) “Data provided by the client”

Index

Index....2
Acronyms....3
Competences and guarantees....3
General conditions....4
Uncertainty....4
Data provided by the client....4
Usage of samples....5
Test sample description....6
Identification of the client....7
Testing period and place....7
Document history....8
Environmental conditions....8
Remarks and comments....8
Testing verdicts....9
Summary....9
List of equipment used during the test....11
Appendix A: Test results....12

Acronyms

Acronym ID	Acronym Description
# of Tx Chains	Number of Transmission Chains
26Ebw	Emission Bandwidth
Avg COT	Average Channel Occupancy Time
BW	Bandwidth
Equipment	Equipment Type
Freq	Frequency
Freq Sep	Frequency Separation
Inband Peak Lvl	Inband Peak Level
Lvl	Level
MP	Measurement Point
Mod	Modulation
NHC	Number of Hopping Channels
NHp	Number of hops over the period
Occ Ch BW	Occupied Channel Bandwidth
Peak Power	Maximum Peak Conducted Output Power
Port	Active Port

Competences and guarantees

DEKRA Certification Inc. is a testing laboratory accredited by A2LA (The American Association for Laboratory Accreditation), to perform the tests indicated in the Certificate 2764.01

DEKRA Certification Inc. is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Certification Inc. has a calibration and maintenance program for its measurement equipment.

DEKRA Certification Inc. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification at the time of performance of the test.

DEKRA Certification Inc. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

The results presented in this Test Report apply only to the particular item under test established in this document.

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Certification Inc.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Certification Inc.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Certification Inc. and the Accreditation Bodies.

Uncertainty

Uncertainty (factor k=2) was calculated according to the DEKRA Testing and Certification internal document PODT000.

Test case	Frequency (MHz)	U(k=2)	Units
RF Power and PSD	2402-2483	**0.88**	dB
Occupied Bandwidth		**1.87**	%
Dwell Time		**0.01**	%
Band Edge	30-7000	**0.64**	dB
Conducted Spurious Emission	30 - 1000	**0.48**	dB
	1000 - 40000	**0.94**	dB
Radiated Spurious Emission	30-180	**4.27**	dB
	180-1000	**3.14**	dB
	1000-18000	**3.3**	dB
	18000-40000	**3.49**	dB

Data provided by the client

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

2. The sample consists of a Multifunctional battery powered LoRaWAN Transmitter with input for Thermocouple, RTD, Vibration Sensor, Ratiometric Sensor or other.

DEKRA declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by: The client.

Sample S/01 is composed of the following elements and accessories and auxiliary equipment:

Id	Control Number	Description	Model	Serial Nº	Date of Reception	Application
S/01	4218/01	TWTG Neon Pressure sensor	DS-LD-02-00	LD020022AB00025	09/13/2023	Element Under Test
S/01	4218/05	Debug probe + 10 pin ribbon cable	J-Link	821010172	09/13/2023	Accessory
S/01	4218/06	USB type A (male) to Micro USB A cable	-	-	09/13/2023	Accessory
S/01	4218/08	RF Adapter cable			09/14/2023	Accessory
S/01	1484	Laptop	LENOVO / V14 G2 ITL	PF3Q2NKL	-	Auxiliary Element

Sample S/01 was used for the test(s): All Conducted tests indicated in appendix A.

Sample S/02 is composed of the following elements and accessories:

Id	Control Number	Description	Model	Serial Nº	Date of Reception	Application
S/02	4218/01	TWTG Neon Pressure sensor	DS-LD-02-00	LD020022AB00025	09/13/2023	Element Under Test
S/02	4218/03	RT sensor cable	DS-EC-02-AB03	-	09/13/2023	Accessory
S/02	4218/05	Debug probe + 10 pin ribbon cable	J-Link	821010172	09/13/2023	Accessory
S/02	4218/06	USB type A (male) to Micro USB A cable	-	-	09/13/2023	Accessory
S/02	1484	Laptop	LENOVO / V14 G2 ITL	PF3Q2NKL	-	Auxiliary Element

Sample S/02 was used for the test(s): All Radiated tests indicated in appendix A.

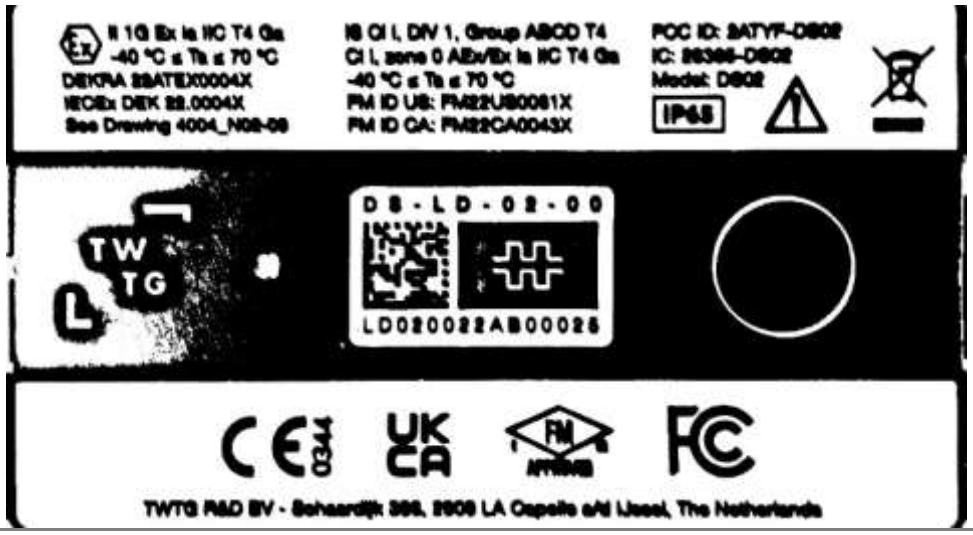
Test sample description

Ports…… :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)
	M12 connector DS-LD-02-00	>3 meter	☒	☒	☐
	M12 connector DS-TT-02-00	>3 meter	☒	☐	☐
	M12 connector DS-RT-02-00	>3 meter	☒	☒	☐
Supplementary information to the ports…… :	DS-TT-02-00 is used with thermocouples of RTD sensors, noise on cable may affect measurements.				

Rated power supply .....:	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: Internal Battery 3.6 V 17000 mAh LiSoCl4					
	☐	DC:					
Rated Power .....:	0.367 W						
Clock frequencies.....:	32 MHz, 32.768 kHz						
Other parameters .....:	Data not provided						
Software version .....:	1.0						
Hardware version .....:	F1						
Dimensions in cm (W x H x D) ....:	10.0x7.0x5.7						
Mounting position .....:	☐	Table top equipment					
	☐	Wall/Ceiling mounted equipment					
	☐	Floor standing equipment					
	☐	Hand-held equipment					
	☒	Other: Variable equipment					

Modules/parts.....:	Module/parts of test item	Type	Manufacturer
	DS-VB-02-00	Sensor	TWTG
	DS-PG-02-00	Sensor	TWTG
Accessories (not part of the test item) .....:	Description	Type	Manufacturer
	Data not provided		
Documents as provided by the applicant.....:	Description	File name	Issue date
	FDT30 information	FDT30_18 Declaration Equipment Data	10-09-2023

Copy of marking plate:



Identification of the client

TWTG
Schaardijk 386
2909 LA Capelle aan den IJssel

Testing period and place

Test Location	DEKRA Certification Inc.
Date (start)	09-18-2023
Date (finish)	04-15-2024

Document history

Report number	Date	Description
4218ERM.001	10-20-2023	First release.
4218ERM.001A1	10-24-2023	Second Release. The reference for RSS-247 standard is added in the section Test method requested, standard. This modification of the test report cancels and replaces the test report 4218ERM.001.
4218ERM.001A2	05-03-2024	Third Release. The model name, FCC ID, IC ID, version of RSS 247 is updated on first page. The RF output power for DTS and FHSS mode, antenna gain, limit for time of occupancy and its test results for FHSS mode are updated. This modification of the test report cancels and replaces the test report 4218ERM.001A1.

Environmental conditions

In the control chamber, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860mbar Max. = 1060mbar

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860mbar Max. = 1060mbar

In the chamber for conducted measurements, the following limits were not exceeded during the test:

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 30 % Max. = 75 %
Air pressure	Min. = 860mbar Max. = 1060mbar

Remarks and comments

The tests have been performed by the technical personnel: Ivy Yousuf Moutushi, Qi Zhang and Koji Nishimoto.

Testing verdicts

Fail	F
Inconclusive	I
Not applicable	N/A
Not measured	N/M
Pass	P

Summary

Annex A.1: DTS mode

Requirement – Test case FCC PART 15 PARAGRAPH / RSS-247	Verdict	Remark
RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6 dB Bandwidth	Pass	N/A
RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density	Pass	N/A
RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power	Pass	N/A
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted	Pass	N/A
FCC 2.1049 / 99dBw Occupied Channel Bandwidth 99%	Pass	N/A
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Conducted	N/A	Refer 1
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated	Pass	N/A
Supplementary information and remarks: 1. DUT has an integral antenna, and no conducted testing is required.		

Annex A.2: FHSS mode

Requirement – Test case FCC PART 15 PARAGRAPH / RSS-247	Verdict	Remark
RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) 20 dB Bandwidth	Pass	N/A
RSS-247 5.1 (b) / FCC 15.247 (a) (1) Carrier Frequency Separation	Pass	N/A
RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) Time of Occupancy (Dwell Time)	Pass	N/A
RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) Number of hopping channels	Pass	N/A
RSS-247 5.4 (a) / FCC 15.247 (b) (2) Maximum Peak Conducted output power & Antenna gain	Pass	N/A
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted	Pass	N/A
FCC 2.1049 / 99dBw Occupied Channel Bandwidth 99%	Pass	N/A
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Conducted	N/A	Refer 1
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated	Pass	N/A

Supplementary information and remarks:

1. DUT has an integral antenna, and no conducted testing is required

List of equipment used during the test

FCC 47 CFR Part 15.247 / RSS-247

Conducted Measurements

CONTROL NUMBER	DESCRIPTION	Serial No	LAST CALIBRATION	NEXT CALIBRATION
1107	ETHERNET SNMP THERMOMETER	60038026952	2022-10-18	2024-10-18
1313	WIRELESS MEASUREMENT SOFTWARE R&S WMS32	-	N/A	N/A
1397	Signal Analyzer 85GHz	101311	2022-05-26	2024-05-26

Radiated Measurements

CONTROL NUMBER	DESCRIPTION	Serial No	LAST CALIBRATION	NEXT CALIBRATION
1012	ESR26 EMI TEST RECEIVER	101478	2023-01-18	2025-01-18
1014	FSV40 Signal Analyzer 40GHz	101626	2022-08-01	2024-08-01
1057	3115 Double-Ridged Waveguide Horn Antenna 1-18 GHz	211373	2023-07-18	2026-07-18
1064	3142E Biconilog Antenna	208600	2021-12-13	2024-12-13
1111	Ethernet SNMP Thermometer-SAC	60038026577	2022-10-18	2024-10-18
1179	SEMI-ANECHOIC CHAMBER	F169021	N/A	N/A
1314	WIRELESS MEASUREMENT SOFTWARE R&S EMC32	1040-OT102236	N/A	N/A
1461	Low Noise Preamplifier (1-18GHz)	BLMA0118-4A	2022-06-01	2024-06-01

Appendix A: Test results

Appendix A

PRODUCT INFORMATION 14
DESCRIPTION OF TEST CONDITIONS 15
Appendix A.1: Test results – DTS Mode 19
Appendix A.2: Test results – FHSS Mode 42

PRODUCT INFORMATION

(*): Data provided by the client.

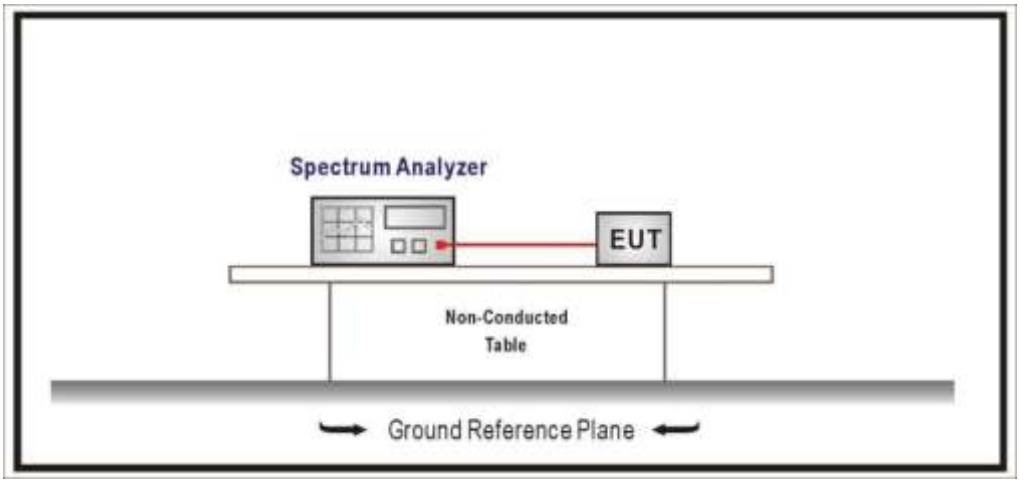
Information	Description
Modulation	LoRaWAN
Frequency band/Range	915 MHz
Maximum RF Output Power	15.92 dBm
Operation mode	
- Operating Frequency Range	902-928 MHz
- Channel Spacing	200 kHz
- Number of Channels	64 (125 kHz) + 8 (500 kHz)
- Nominal Channel Bandwidth	125kHz, 500kHz
Extreme operating conditions	
- Temperature range	-40 ºC to 80 ºC
Antenna type	Internal
Antenna gain	-3 dBi
Nominal Voltage	
- Supply Voltage	3.6 V
- Type of power source	Battery powered
Equipment type	LoRaWAN

DESCRIPTION OF TEST CONDITIONS

TEST CONDITIONS	DESCRIPTION
TC#01 DTS MODE	Power supply (V): Battery Operated: 3.6 V Type of power supply: DC voltage from internal rechargeable battery. Temperature (ºC): T_{nom} = +15 to + 35 T_{min} = N/A T_{max} = N/A The subscript nom indicates normal test conditions. The subscripts min and max indicates extreme test conditions (minimum and maximum respectively). N/A: Not Applicable. (*) Declared by applicant. Test Frequencies for Conducted tests: The Measurements were taken with a Spreading Factor of 10 as this constitutes the worst-case scenario. Lowest channel: 903.0 MHz Middle channel: 909.4 MHz Highest channel: 914.2 MHz Test Frequencies for Radiated tests: Lowest channel: 903.0 MHz Middle channel: 909.4 MHz Highest channel: 914.2 MHz

TEST CONDITIONS	DESCRIPTION
TC#02 FHSS MODE	Power supply (V): Battery Operated: 3.6V Type of power suppl: DC voltage from internal rechargeable battery. Temperature (ºC): T_{nom} = +15 to + 35 T_{min} = N/A T_{max} = N/A The subscript nom indicates normal test conditions. The subscripts min and max indicates extreme test conditions (minimum and maximum respectively). N/A: Not Applicable. (*) Declared by applicant. Test Frequencies for Conducted tests: The Measurements were taken with a Spreading Factor of 10 as this constitutes the worst-case scenario. Lowest channel: 902.3 MHz Middle channel: 908.7 MHz Highest channel: 914.9 MHz Test Frequencies for Radiated tests: Lowest channel: 902.3 MHz Middle channel: 908.7 MHz Highest channel: 914.9 MHz

CONDUCTED MEASUREMENTS:



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at 3 m for the frequency range 30-1000 MHz (Bilog antenna) and 1-18 GHz Double ridge horn antennas.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

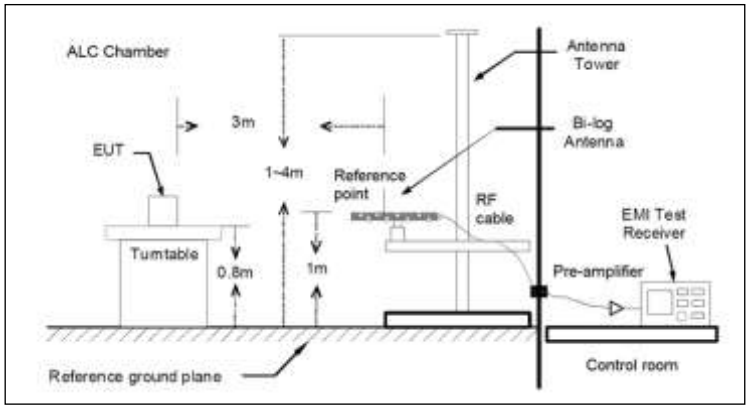


Fig A1: Radiated measurements Setup f < 1 GHz

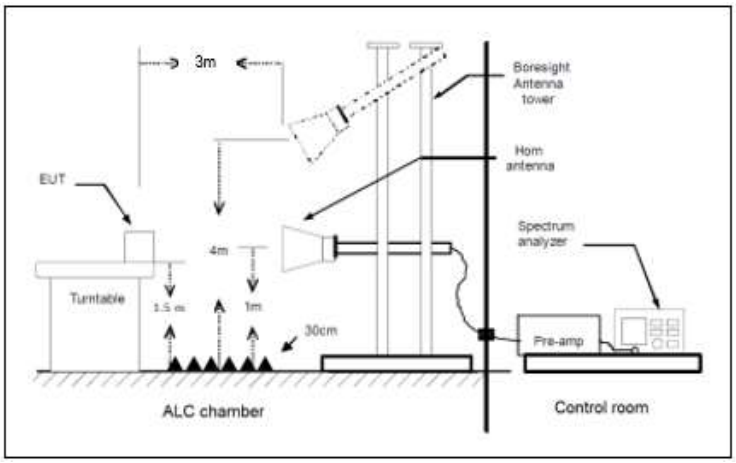


Fig A2: Radiated measurements setup f > 1 GHz

Appendix A.1: Test results – DTS Mode

Appendix A.1

Test Cases Details.....21
RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6dB Bandwidth.....21
RSS-247 5.2 (b) / FCC 15.247 (e) Power Spectral Density.....24
RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power & Antenna gain27
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted...30
RSS-247 5.2 (a) / RSS-GEN 6.7 FCC 15.247 (a) (2) 99dBw Occupied Channel Bandwidth 99%32
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated.....35

Test Cases Details

RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6dB Bandwidth

Limits

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test conditions modes: TC#01
Results

	Lowest frequency 903.0 MHz	Middle frequency 909.4 MHz	Highest frequency 914.2 MHz
6 dB Spectrum bandwidth (kHz)	631.6	631.6	634.2

Verdict

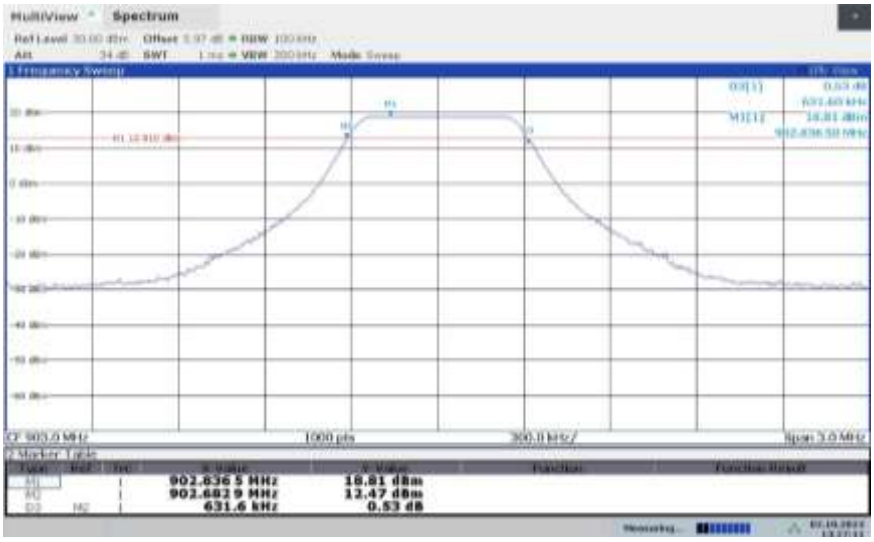
Pass

Results

Attachments

Frequency = 903.0 MHz, Bandwidth = 500 kHz

Images:

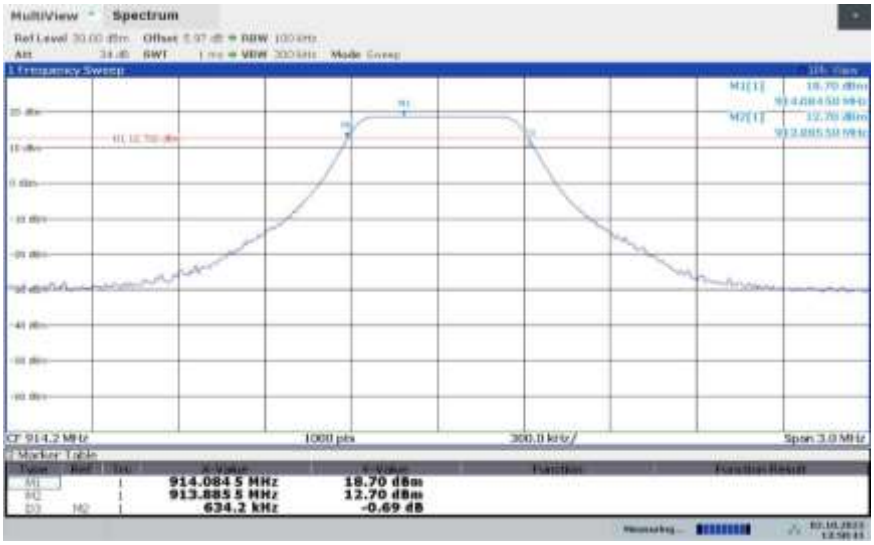


Frequency = 909.4 MHz, Bandwidth = 500 kHz

Images:

Frequency = 914.2 MHz, Bandwidth = 500 kHz

Images:



RSS-247 5.2 (b) / FCC 15.247 (e) Power Spectral Density

Limits

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

The maximum power spectral density level in the fundamental emission was measured using the method AVGPSD (Average PSD) according to Section 8.4 of KDB 558074 D01 15.247 Meas Guidance v05r02.

Test conditions modes: TC#01

Results

	Lowest frequency 903.0 MHz	Middle frequency 909.4 MHz	Highest frequency 914.2 MHz
Power spectral density (dBm)	-1.55	0.17	3.15

Verdict

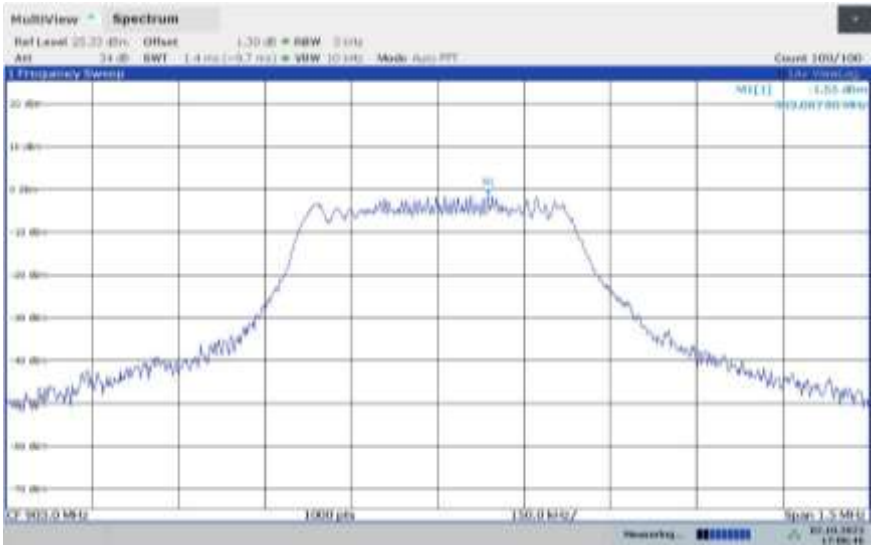
Pass

Results

Attachments

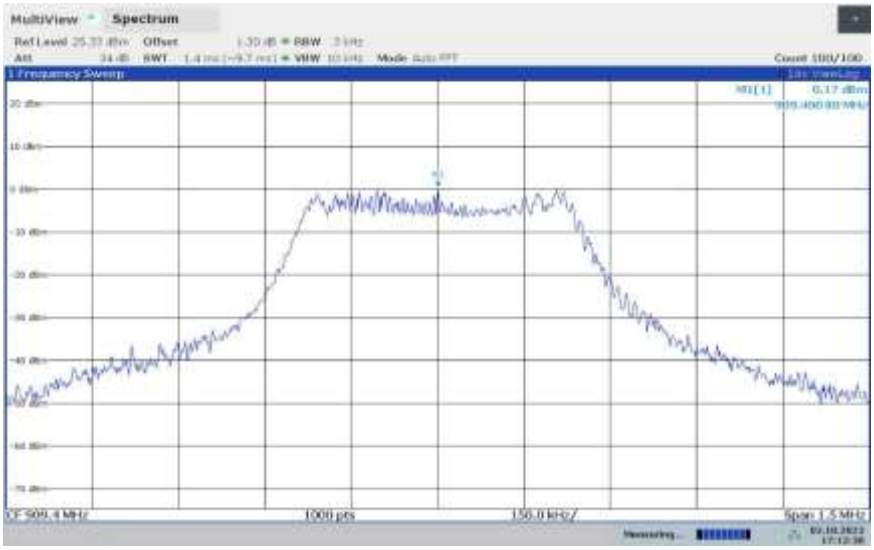
Frequency = 903.0 MHz, Bandwidth = 500 kHz

Images:



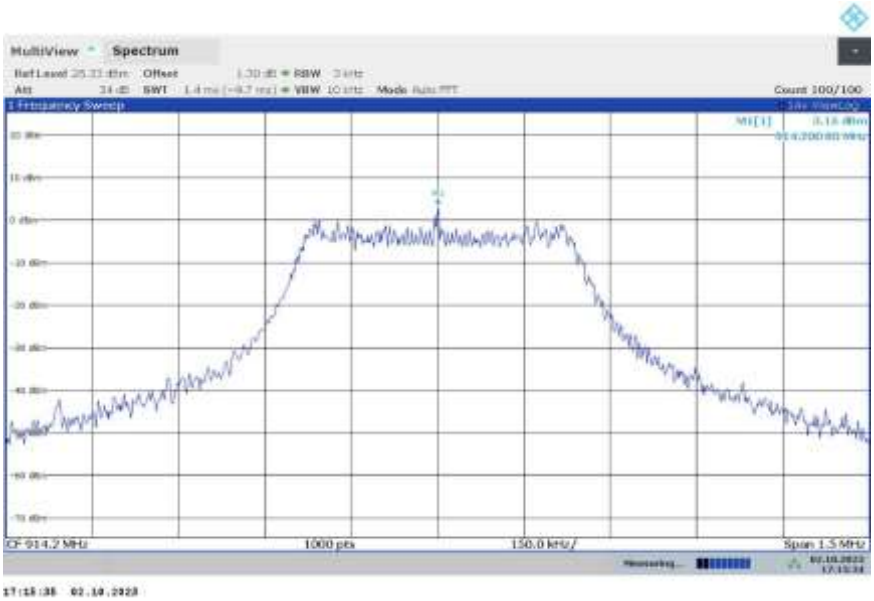
Frequency = 909.4 MHz, Bandwidth = 500 kHz

Images:



Frequency = 914.2 MHz, Bandwidth = 500 kHz

Images:



RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power & Antenna gain

Limits

§15.247(b)(3) and RSS-247 5.4(d):

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt (30 dBm). 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 signaling 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.

The maximum peak conducted output power was measured using the method using a power meter (PM) according to 8.3.2.3. measurement of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v05r02 dated 04/02/2019.

RSS-247 5.4(d): The e.i.r.p. shall not exceed 4 W (36 dBm)

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum declared antenna gain: -3 dBi

Test conditions modes: TC#01

Results

	Lowest frequency 903.0 MHz	Middle frequency 909.4 MHz	Highest frequency 914.2 MHz
Maximum conducted power (dBm)	15.68	15.74	15.92
Maximum EIRP power (dBm)	12.68	12.74	12.92

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power limit is not required to be reduced from the stated values.

Verdict

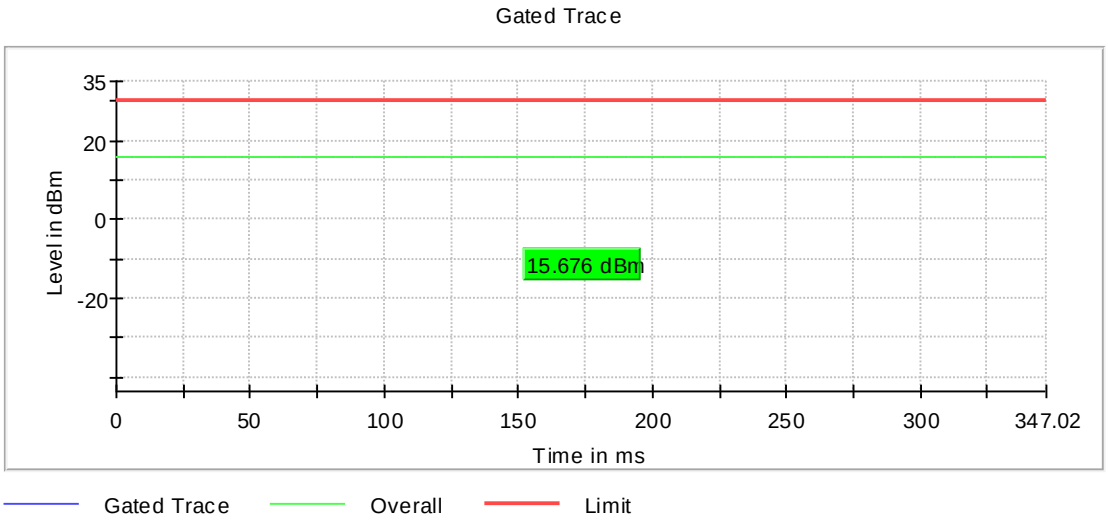
Pass

Results

Attachments

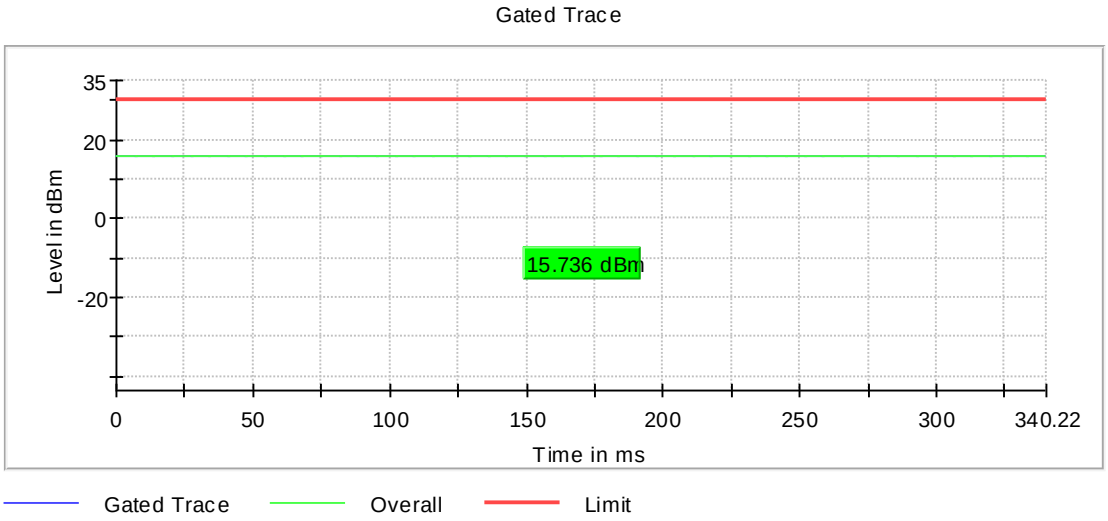
Frequency = 903.0 MHz, Bandwidth = 500 kHz

Images:



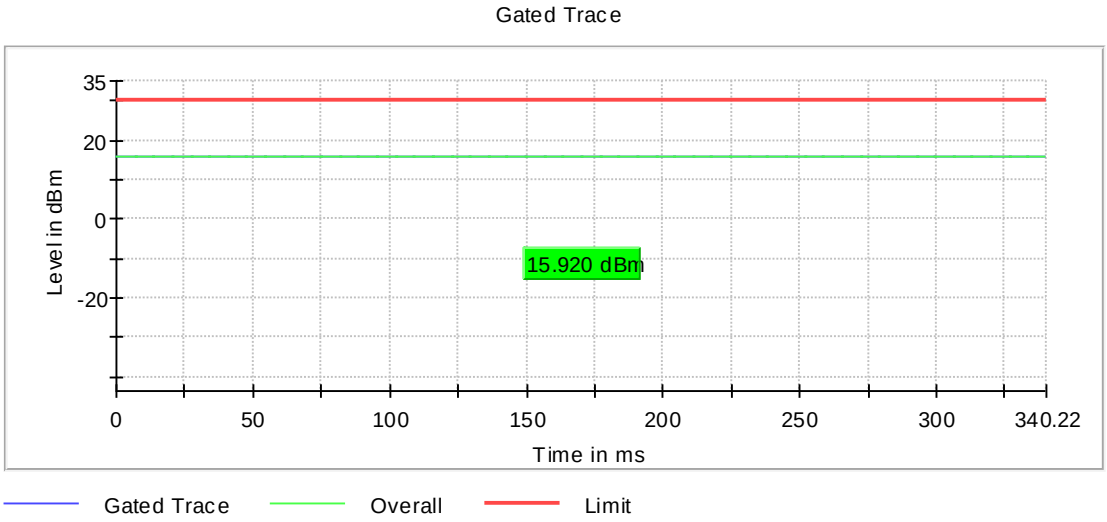
Frequency = 909.4 MHz, Bandwidth = 500 kHz

Images:



Frequency = 914.2 MHz, Bandwidth = 500 kHz

Images:



RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted

Limits

In any 100 kHz bandwidths outside the frequency band in which the 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Note: Radiated measurements are also used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Test conditions modes: TC#01

Results

Verdict

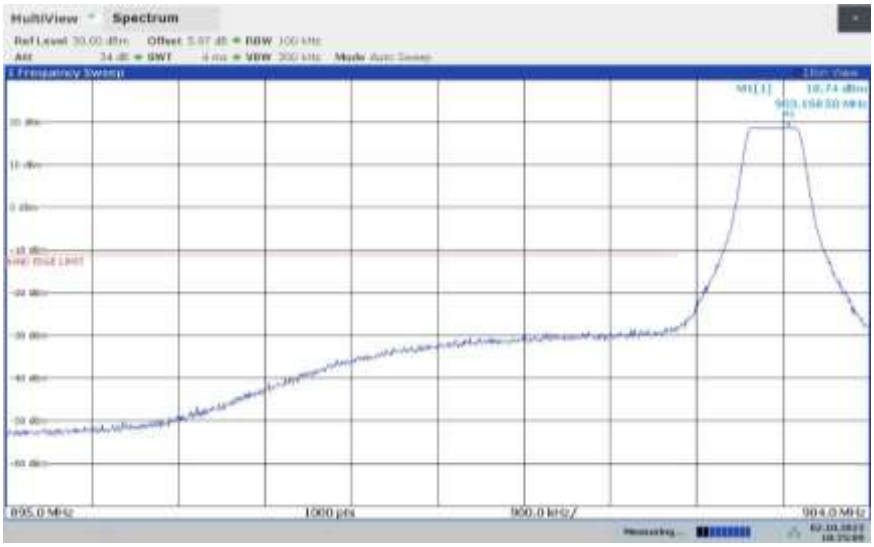
Pass

Results

Attachments

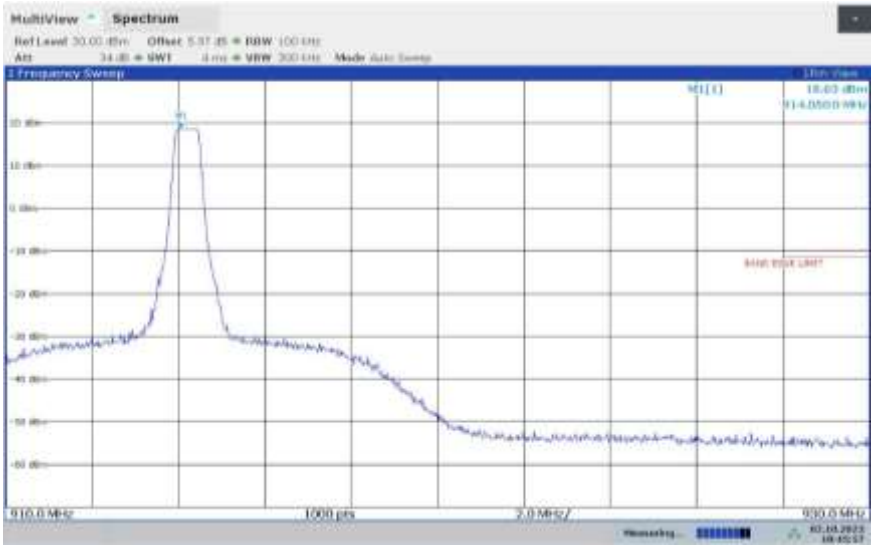
Frequency = 903.0 MHz, Bandwidth = 500 kHz

Images:



Frequency = 914.2 MHz, Bandwidth = 500 kHz

Images:



RSS-247 5.2 (a) / RSS-GEN 6.7 FCC 15.247 (a) (2) 99dBw Occupied Channel Bandwidth 99%

Limits

The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs

Test conditions modes: TC#01
Results

	Lowest frequency 903.0 MHz	Middle frequency 909.4 MHz	Highest frequency 914.2 MHz
99% bandwidth (kHz)	533.70	535.99	541.31

Verdict

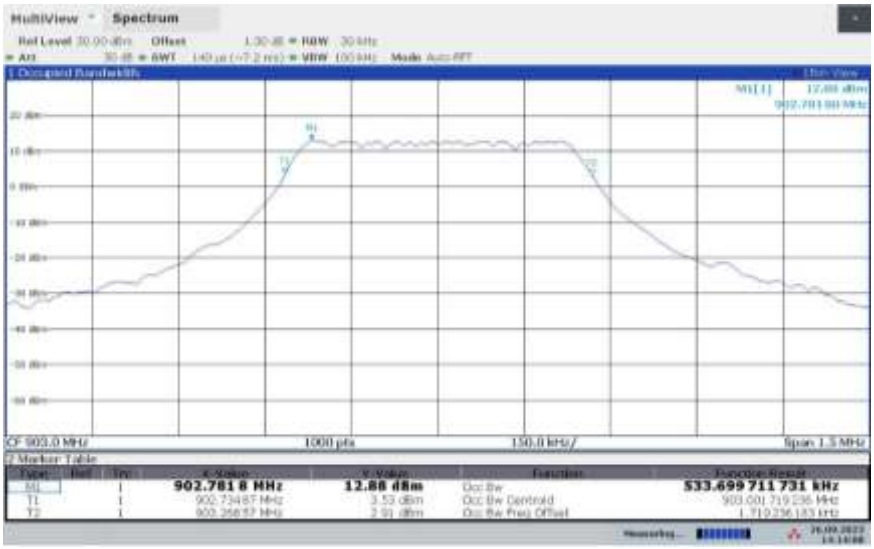
Pass

Results

Attachments

Frequency = 903.0 MHz, Bandwidth = 500 kHz

Images:



Frequency = 909.4 MHz, Bandwidth = 500 kHz

Images:

Frequency = 914.2 MHz, Bandwidth = 500 kHz

Images:

RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated

Limits

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)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
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	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

Verdict

Pass

Test conditions modes: TC#01

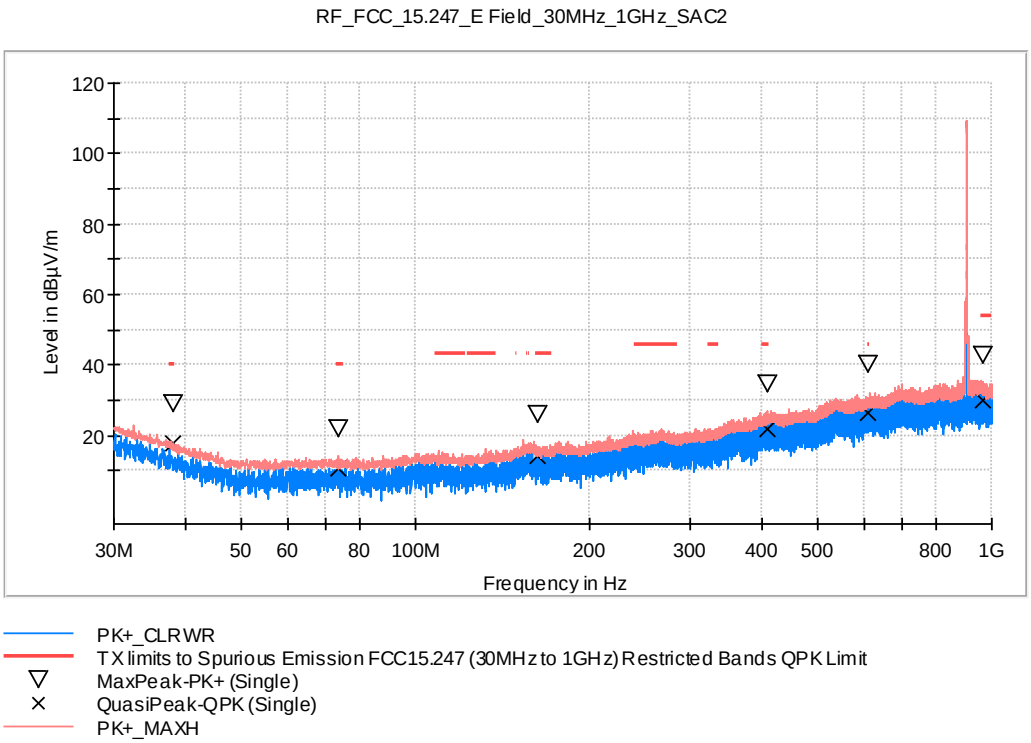
Results: Frequency range 0.03 - 1 GHz

Lowest Channel

Attachments

Frequency = 903.0 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [0.03, 1]

Images:



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)	Comments
37.954000	29.1	17.7	H	22.3	40.0	
73.456000	21.9	10.5	V	29.5	40.0	
163.423500	25.9	14.3	V	29.3	43.5	
408.300000	34.6	21.8	H	24.2	46.0	
608.653500	40.2	26.7	V	19.3	46.0	
902.806000	109.2	108.5	H	---	---	Fundament
963.673500	42.8	30.2	H	23.8	54.0	

Test conditions modes: TC#01

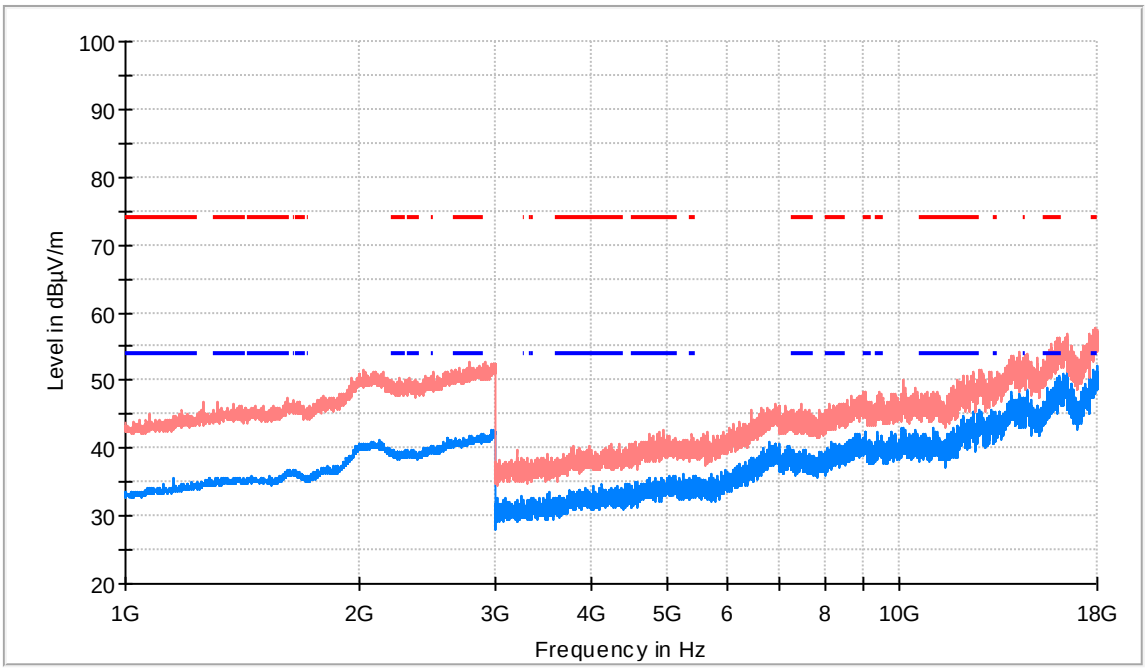
Results: Frequency range 1 - 18 GHz

Lowest Channel

Attachments

Frequency = 903.0 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2880.000000	51.1	42.3	H	11.7	54.0
16070.50000	55.8	50.6	H	3.4	54.0
17879.50000	57.7	49.2	V	4.8	54.0

Results: Frequency range 0.03 - 1 GHz

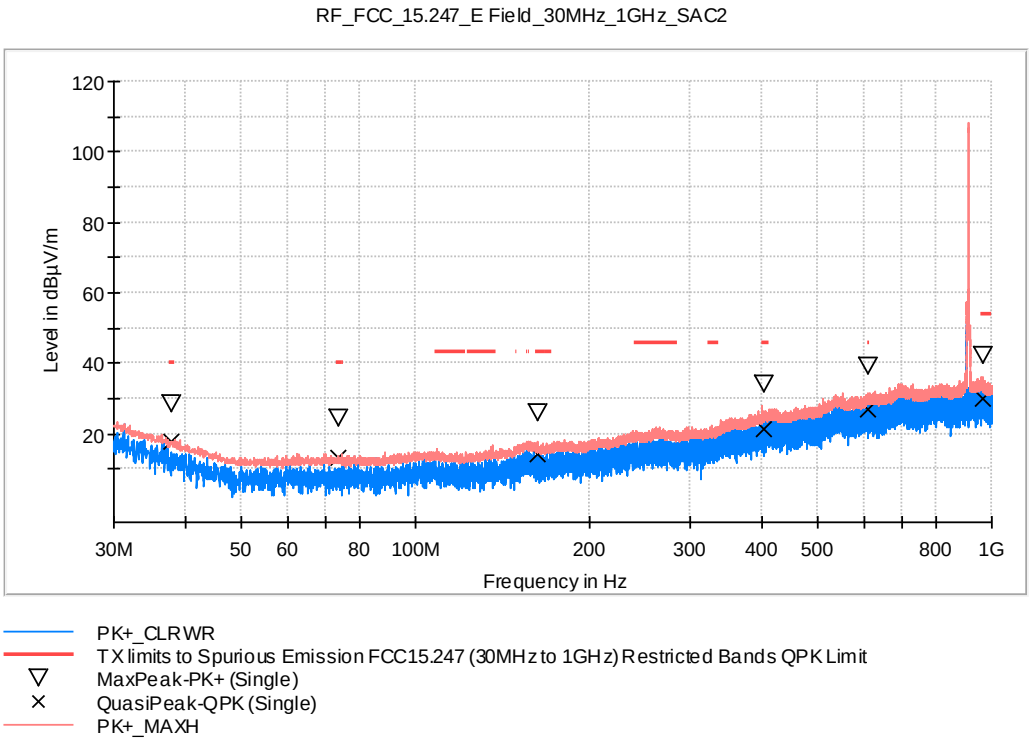
The spurious emissions below 1 GHz do not depend on the operating channel selected in the EUT.

Middle Channel

Attachments

Frequency = 909.4 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [0.03, 1]

Images:



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)	Comments
37.857000	28.3	17.7	H	22.3	40.0	
73.650000	24.5	13.5	V	26.5	40.0	
163.423500	26.1	14.4	V	29.1	43.5	
403.304500	34.3	21.6	V	24.4	46.0	
610.448000	39.4	26.8	H	19.2	46.0	
909.256500	108.5	107.8	H	---	---	Fundament
966.486500	42.4	30.1	V	23.9	54.0	

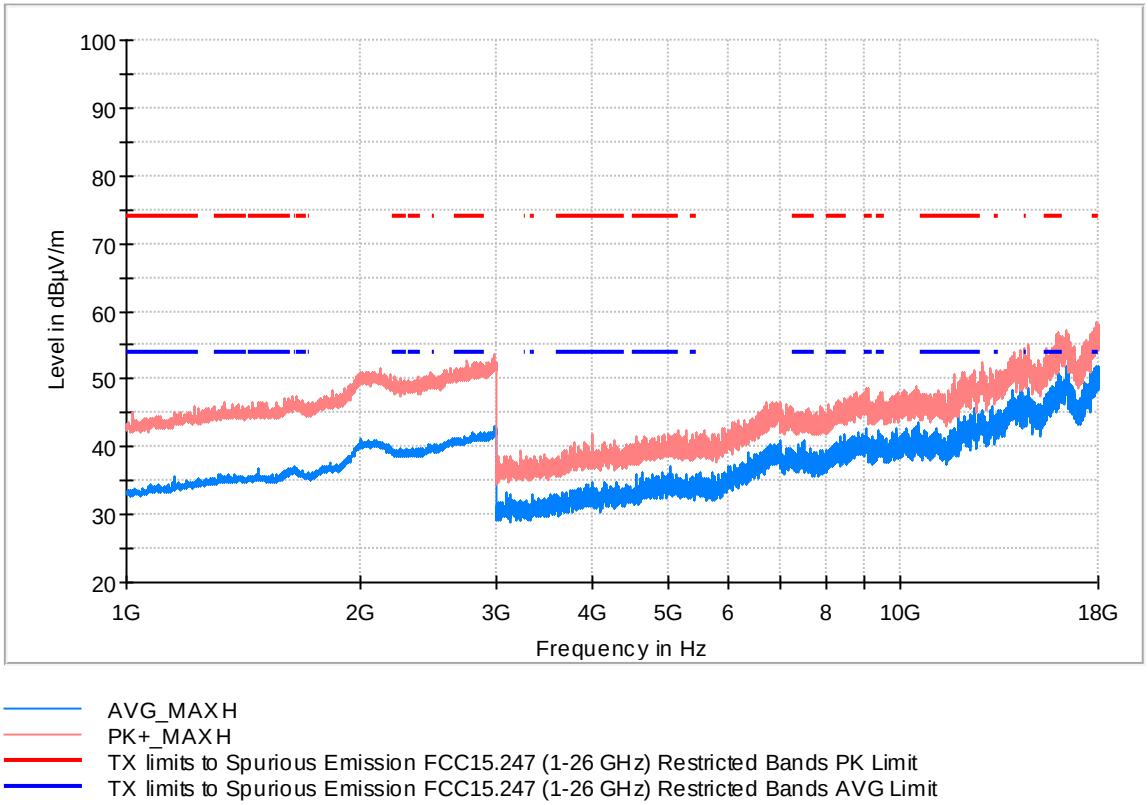
Results: Frequency range 1 - 18 GHz

Lowest Channel

Attachments

Frequency = 909.4 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2804.500000	51.1	42.1	H	11.9	54.0
15986.00000	54.1	50.9	H	3.1	54.0
17860.00000	58.3	49.9	V	4.1	54.0

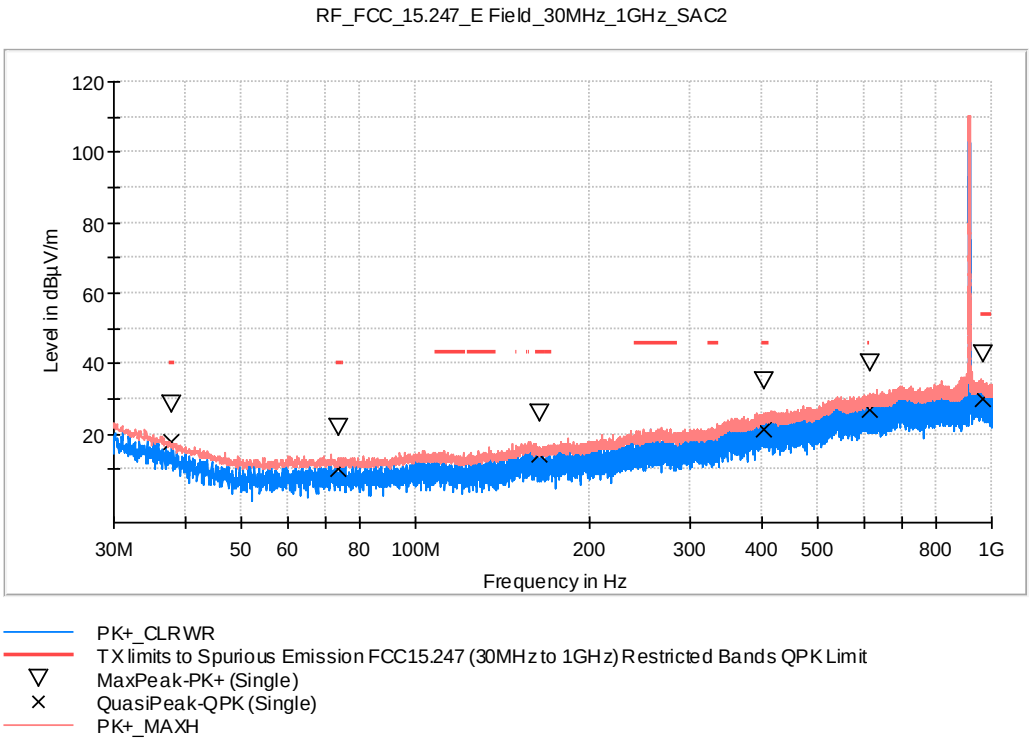
Results: Frequency range 0.03 - 1 GHz

Highest Channel

Attachments

Frequency = 914.2 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [0.03, 1]

Images:



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)	Comments
37.808500	28.5	17.8	H	22.2	40.0	
73.310500	22.1	10.5	H	29.5	40.0	
164.393500	26.0	14.3	H	29.2	43.5	
403.547000	35.3	21.6	V	24.4	46.0	
612.097000	40.0	26.8	V	19.2	46.0	
914.058000	110.3	109.6	H	---	---	Fundament
963.916000	42.6	30.2	V	23.8	54.0	

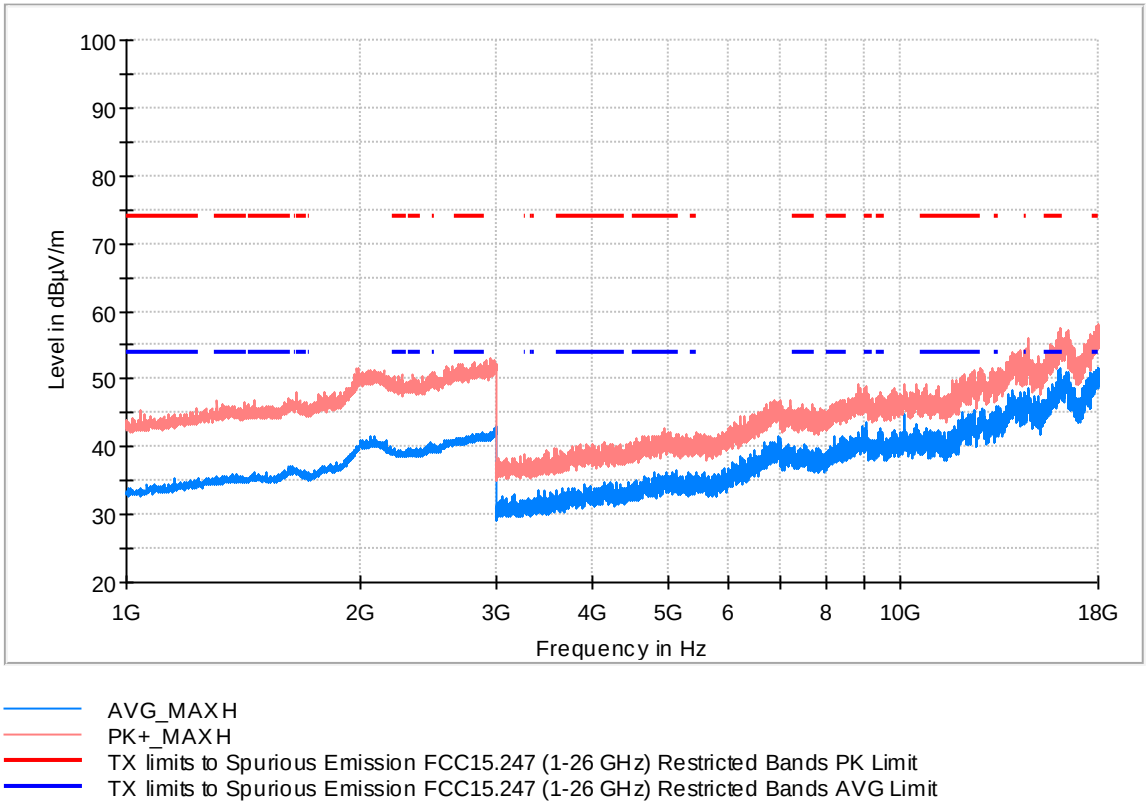
Results: Frequency range 1 - 18 GHz

Highest Channel

Attachments

Frequency = 914.2 MHz, Bandwidth = 500 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2810.000000	52.5	41.6	V	12.4	54.0
15975.50000	55.6	51.2	V	2.8	54.0
17995.00000	57.9	50.2	H	3.8	54.0

Appendix A.2: Test results – FHSS Mode

Appendix A.2

Test Cases Details.....44
RSS-247 5.1 (c) / FCC 15.247 (a) (1)(i) 20 dB Bandwidth.....44
RSS-247 5.1 (b) / FCC 15.247 (a) (1) Carrier Frequency Separation.....47
RSS-247 5.1 (c) / FCC 15.247 (a) (1)(i) Time of Occupancy (Dwell Time) 49
RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) Number of hopping channels 51
RSS-247 5.4 (a) / FCC 15.247 (b) (2) Maximum Peak Conducted output power & Antenna gain53
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted...56
RSS-247 5.2 (a) / RSS-GEN 6.7 FCC 15.247 (a) (2) 99dBw Occupied Channel Bandwidth 99%59
RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated.....62

Test Cases Details

RSS-247 5.1 (c) / FCC 15.247 (a) (1)(i) 20 dB Bandwidth

Limits

The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test conditions modes: TC#02
Results

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
20dB Spectrum bandwidth (kHz)	141.93	143.66	140.64

Verdict

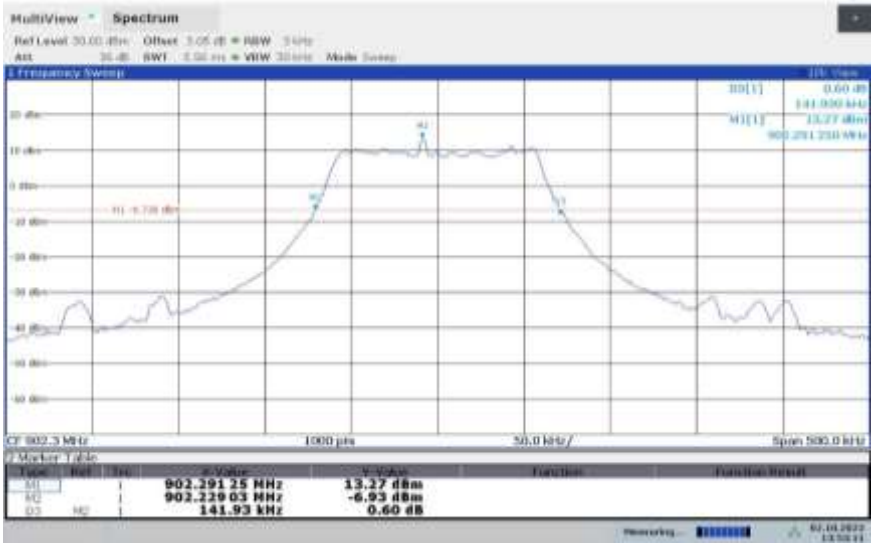
Pass

Results

Attachments

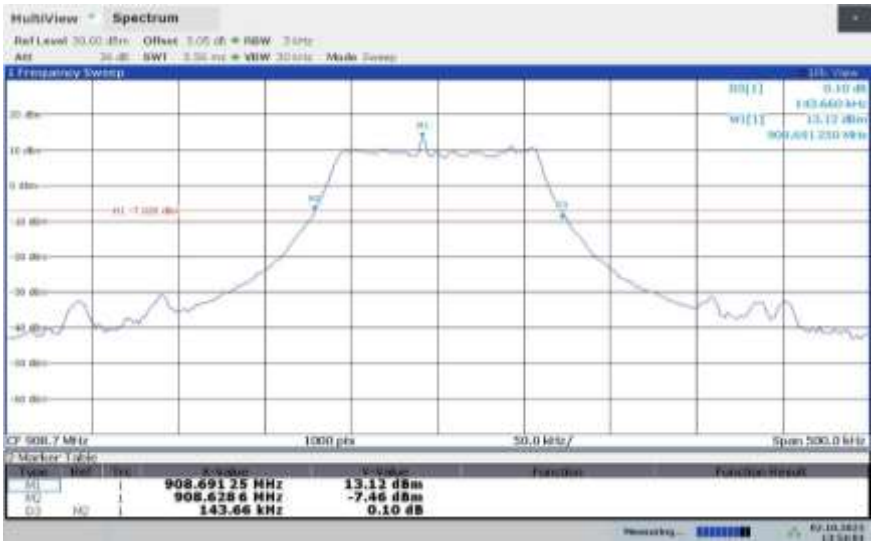
Frequency = 902.3 MHz, Bandwidth = 125 kHz

Images:



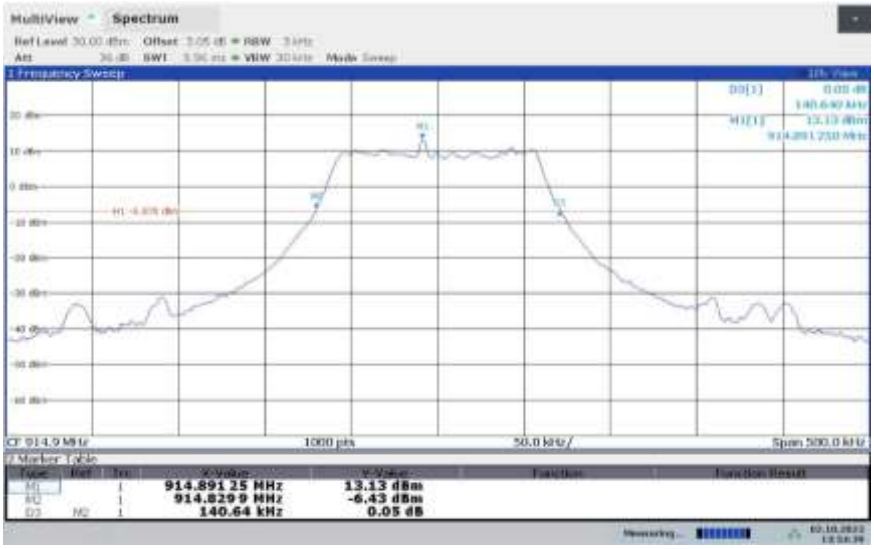
Frequency = 908.7 MHz, Bandwidth = 125 kHz

Images:



Frequency = 914.9 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.1 (b) / FCC 15.247 (a) (1) Carrier Frequency Separation

Limits

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

Test conditions modes: TC#02

Results

Equipment	# of Tx Chains	Freq Sep (kHz)
Frequency Hopping Spread Spectrum systems	1	228.65

Verdict

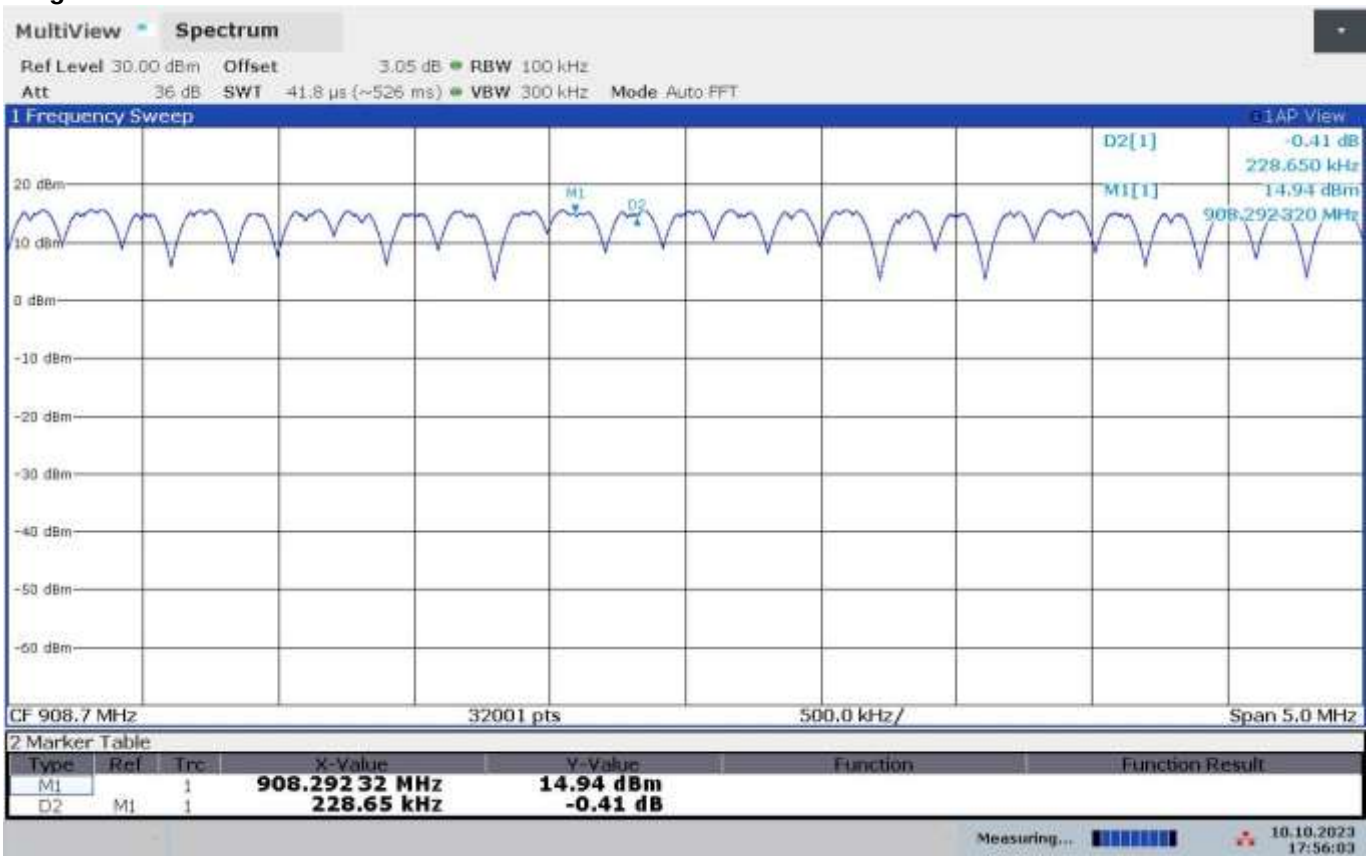
Pass

Results

Attachment

Frequency Range = 902-928 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) Time of Occupancy (Dwell Time)

Limits

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.

Test conditions modes: TC#02

Results

Average time of occupancy = 264.204 ms

Verdict

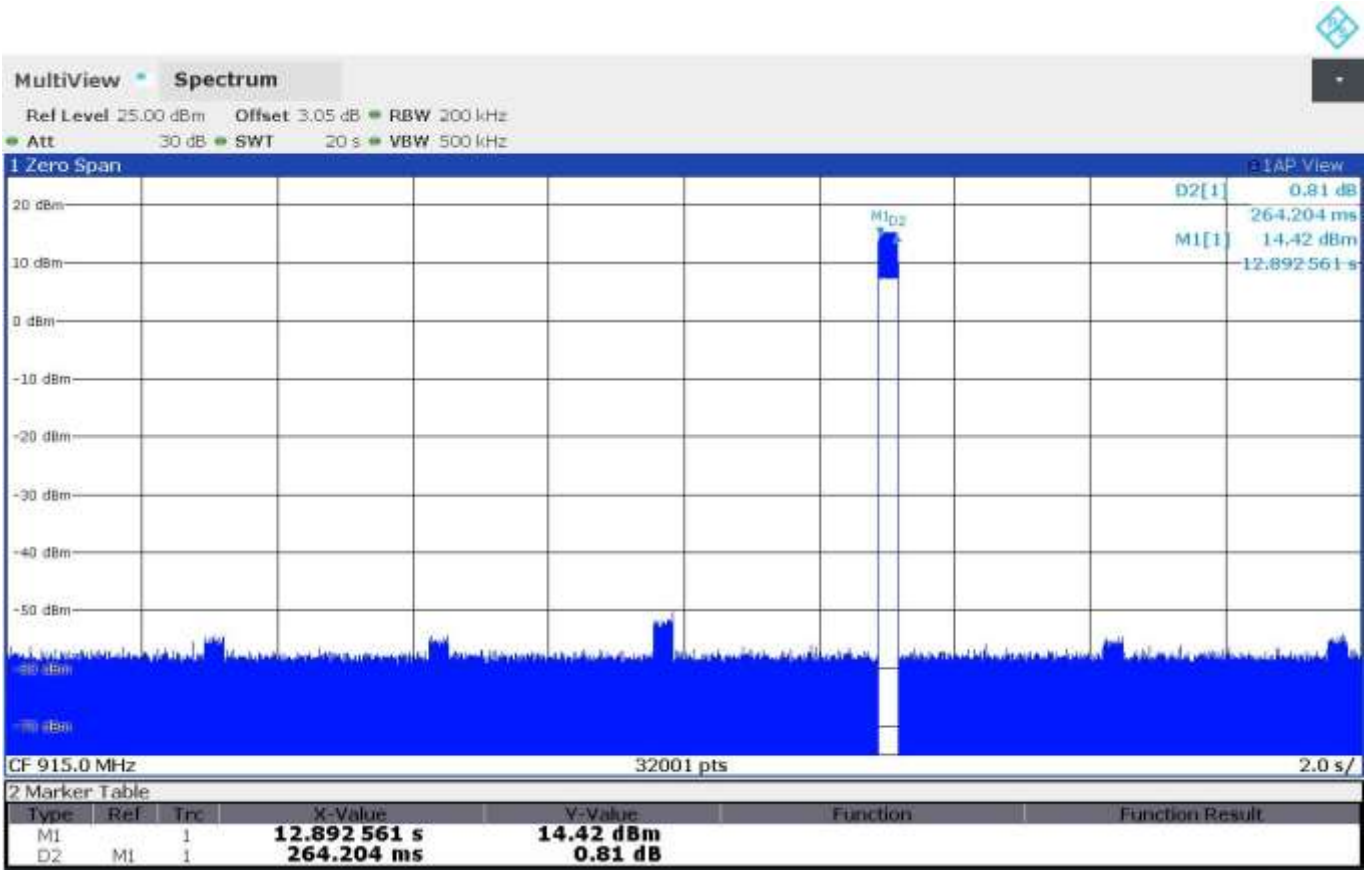
Pass

Results

Attachments

Frequency Range = 902-928 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.1 (c) / FCC 15.247 (a) (1) (i) Number of hopping channels

Limits

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.

Test conditions modes: TC#02

Results

Equipment	# of Tx Chains	NHC
Frequency Hopping Spread Spectrum systems	1	64

Verdict

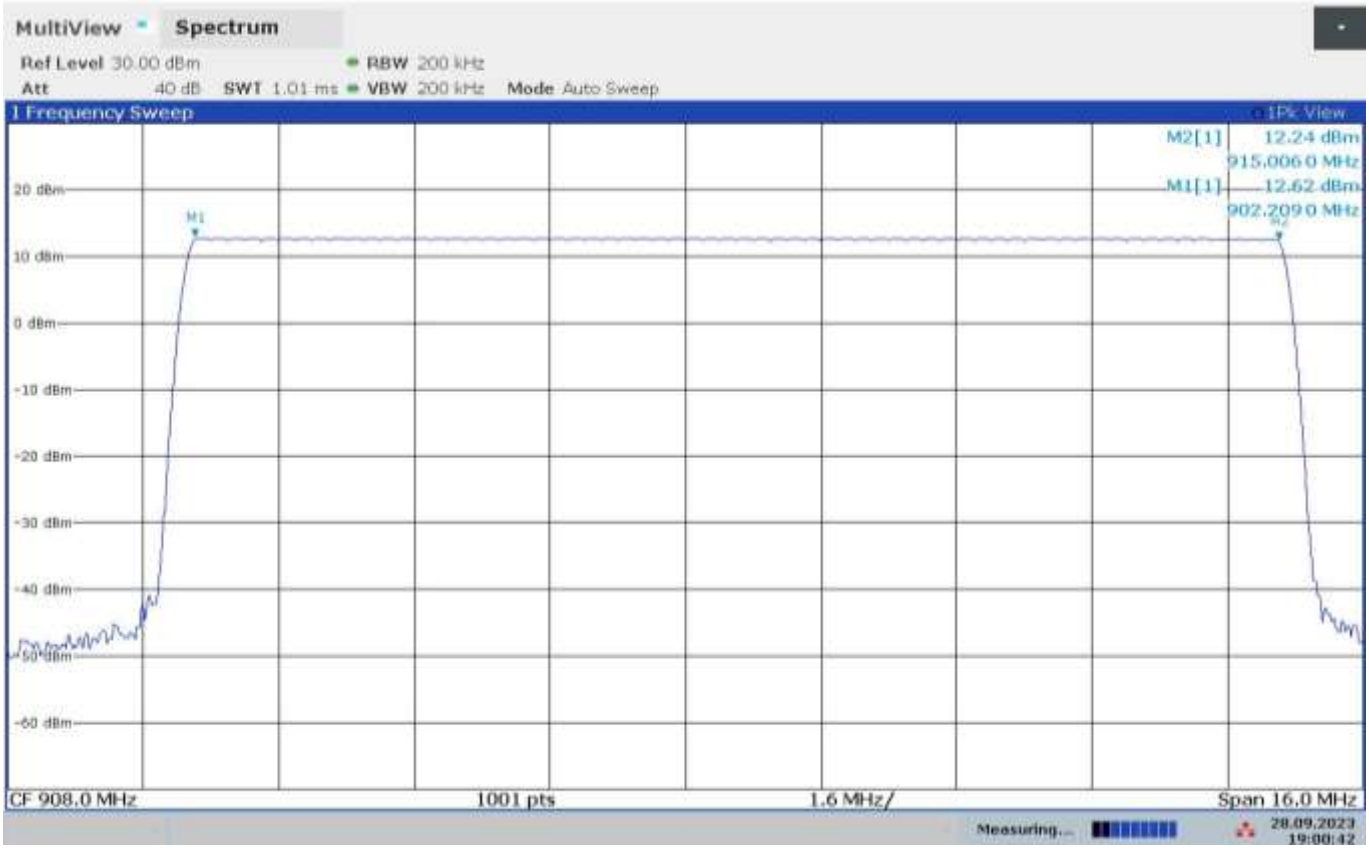
Pass

Results

Attachments

Frequency Range = 902-928 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.4 (a) / FCC 15.247 (b) (2) Maximum Peak Conducted output power & Antenna gain

Limits

§15.247(b)(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.

RSS-247 5.4(a): For FHSs operating in the band 902-928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

The maximum peak conducted output power was measured using the method according to section 9 of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v05 dated 04/02/2019.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

Maximum declared antenna gain: -3 dBi

Test conditions modes: TC#02

Results

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
Maximum conducted power (dBm)	14.08	14.03	13.93
Maximum EIRP power (dBm)	11.08	11.03	10.93

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power limit is not required to be reduced from the stated values.

Verdict

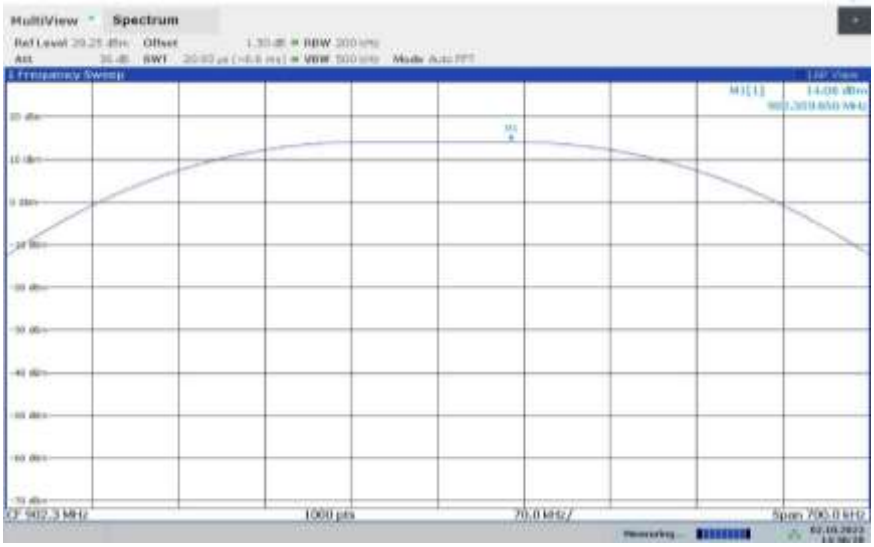
Pass

Results

Attachments

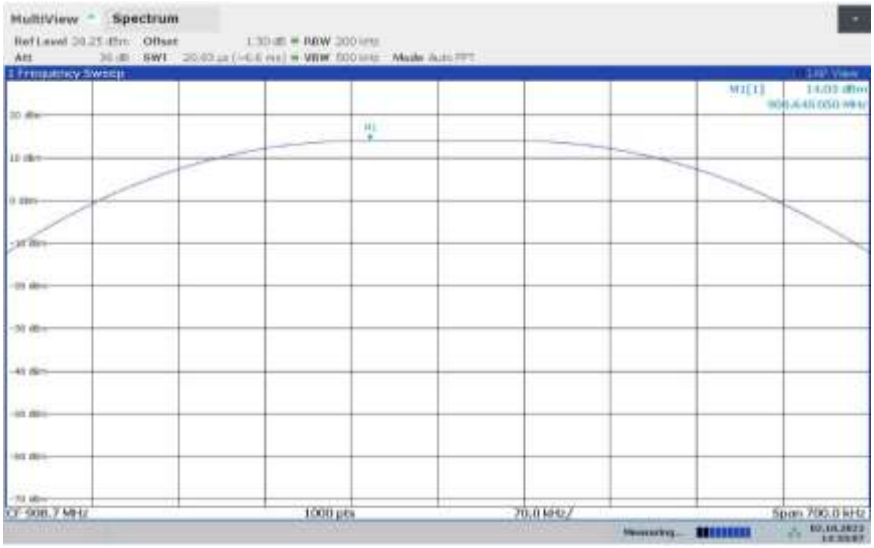
Frequency = 902.3 MHz, Bandwidth = 125 kHz

Images:



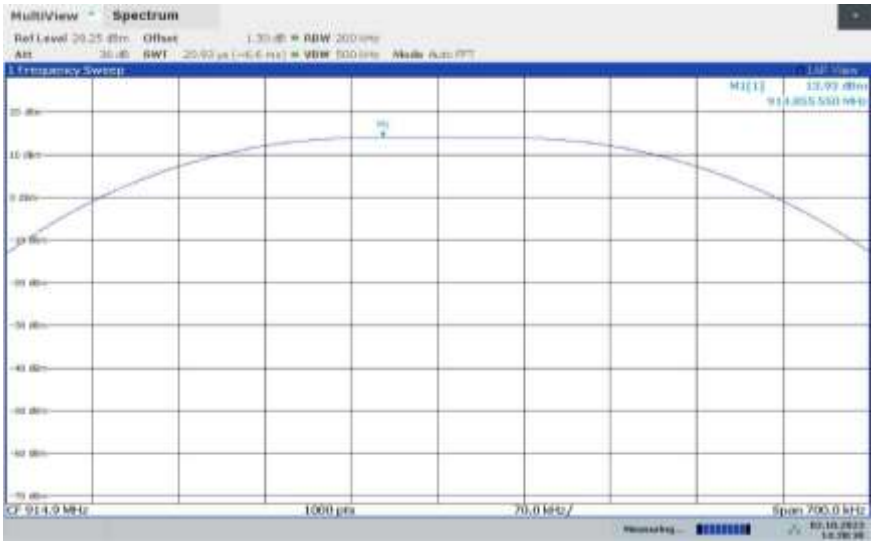
Frequency = 908.7 MHz, Bandwidth = 125 kHz

Images:



Frequency = 914.9 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter) - Conducted

Limits

In any 100 kHz bandwidths outside the frequency band in which the 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Note: Radiated measurements are also used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

Test conditions modes: TC#02

Results

Verdict

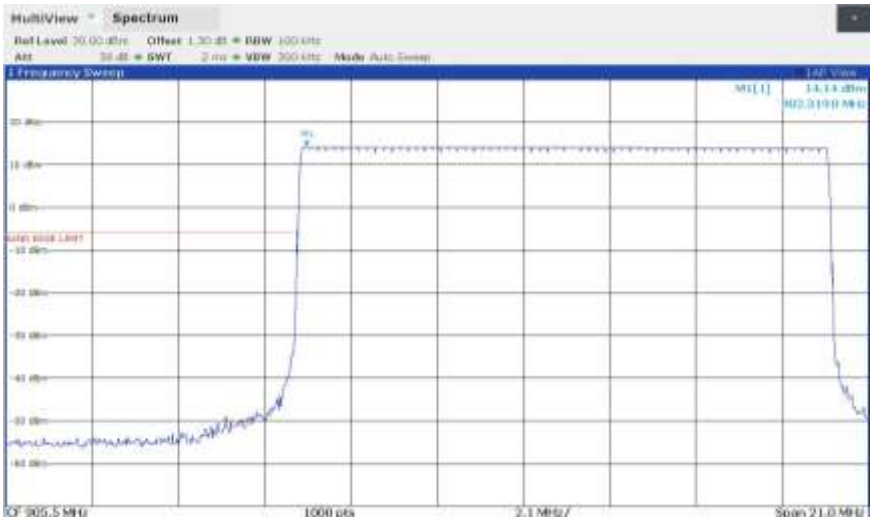
Pass

Results

Attachments

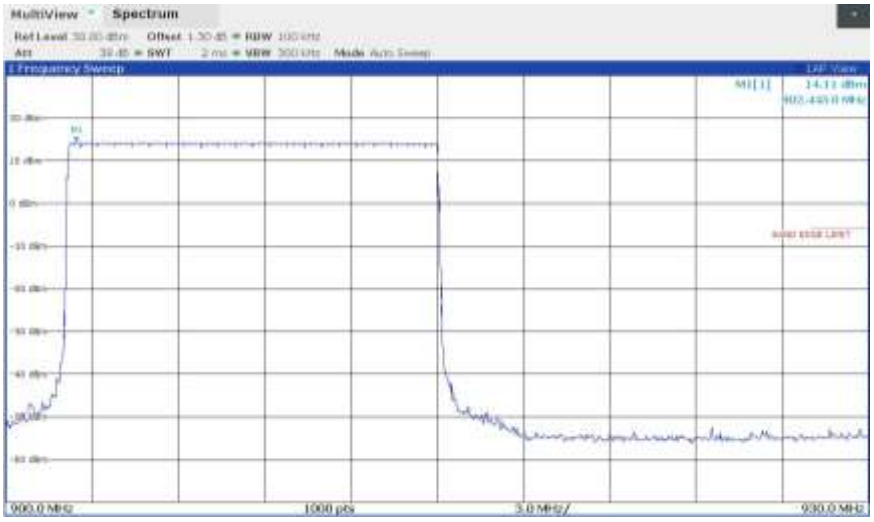
Frequency = 902-928 MHz, Bandwidth = 125 kHz

Images:



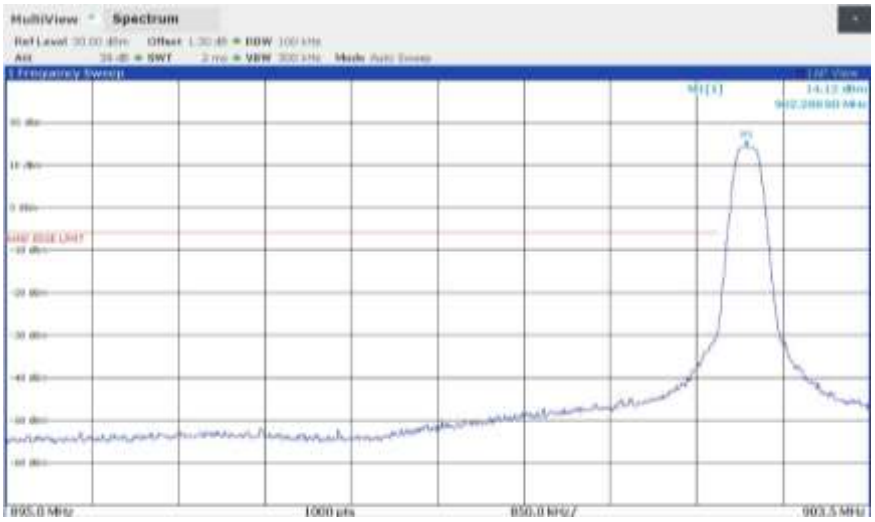
Frequency = 902-928 MHz, Bandwidth = 125 kHz

Images:



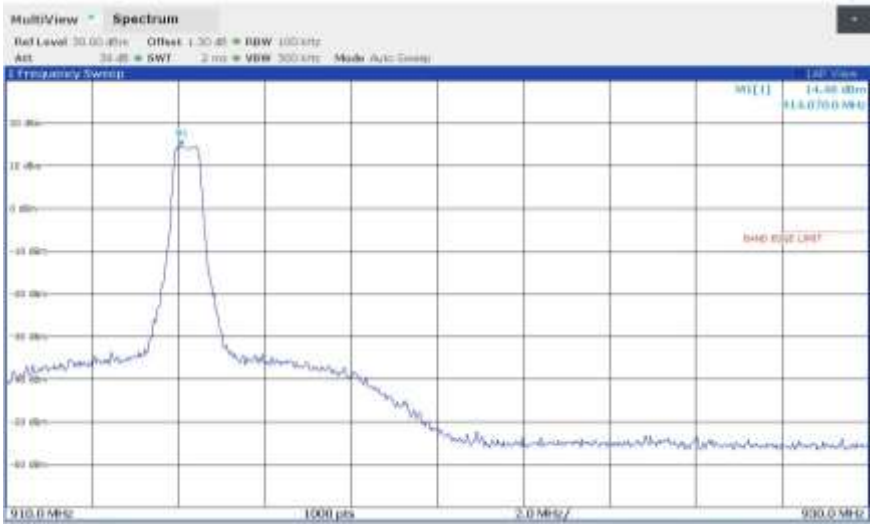
Frequency = 902.3 MHz, Bandwidth = 125 kHz

Images:



Frequency = 914.9 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.2 (a) / RSS-GEN 6.7 FCC 15.247 (a) (2) 99dBw Occupied Channel Bandwidth 99%

Limits

The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

Test conditions modes: TC#02

Results

	Lowest frequency 902.3 MHz	Middle frequency 908.7 MHz	Highest frequency 914.9 MHz
99% bandwidth (kHz)	127.17	126.89	127.36

Verdict

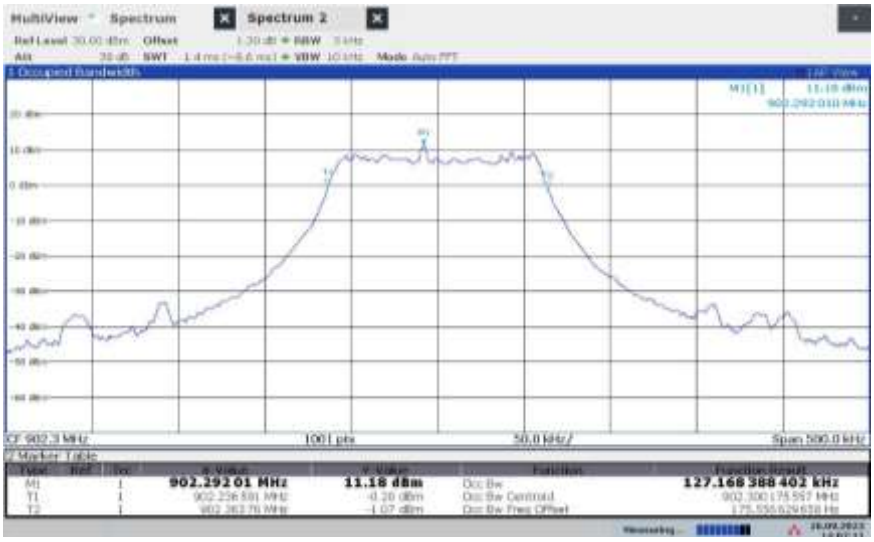
Pass

Results

Attachments

Frequency = 902.3 MHz, Bandwidth = 125 kHz

Images:

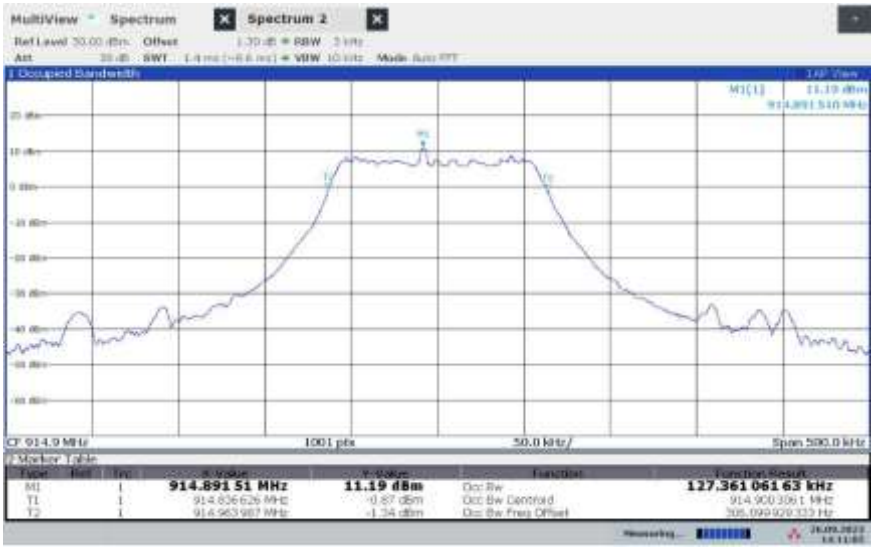


Frequency = 908.7 MHz, Bandwidth = 125 kHz

Images:

Frequency = 914.9 MHz, Bandwidth = 125 kHz

Images:



RSS-247 5.5 / FCC 15.247 (d) Emissions compliance (Transmitter) - Radiated

Limits

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)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
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	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247: Attenuation below the general field strength limits specified in RSS-Gen is not required.

Verdict

Pass

Test conditions modes: TC#02

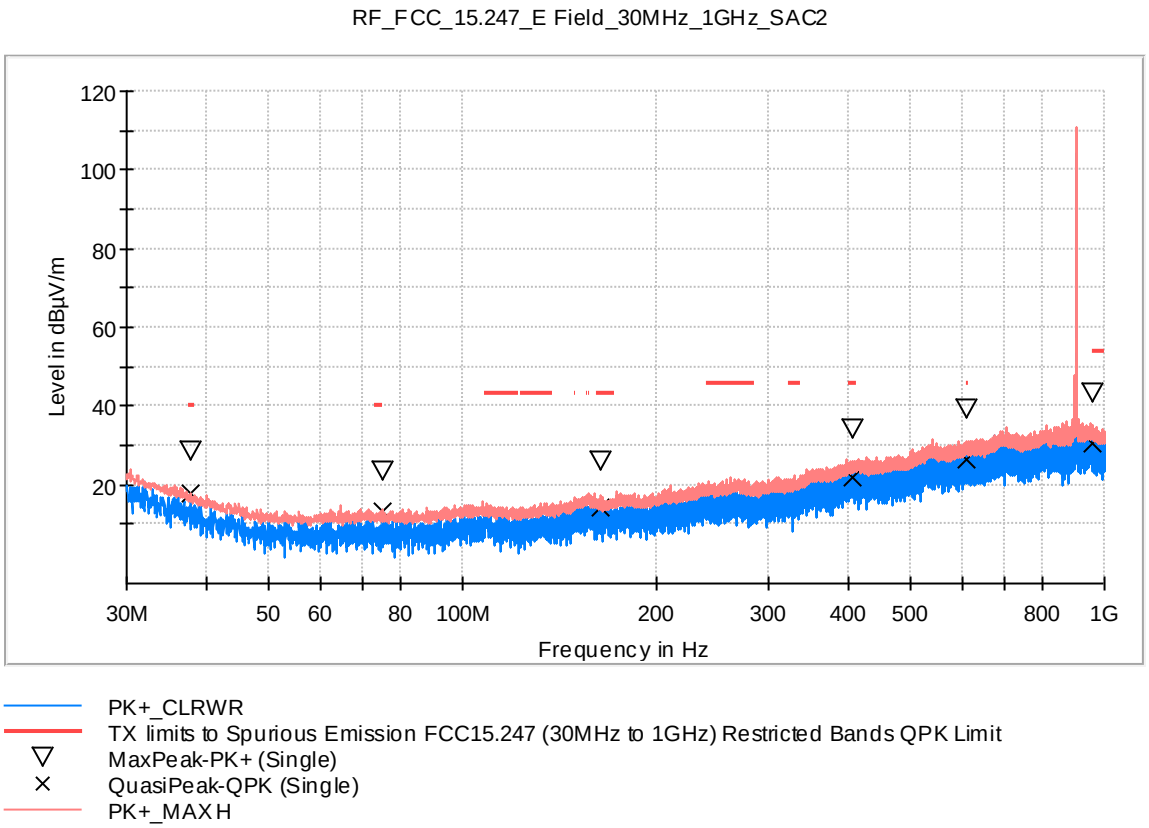
Results: Frequency range 0.03 - 1 GHz

Lowest Channel

Attachments

Frequency = 902.3 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [0.03, 1]

Images:



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Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)	Comment
37.663000	28.7	17.9	H	22.1	40.0	
74.911000	23.7	13.4	H	26.6	40.0	
163.617500	26.0	14.3	H	29.2	43.5	
404.711000	34.4	21.7	H	24.3	46.0	
609.720500	39.3	26.7	H	19.3	46.0	
902.369500	111.0	109.3	H	---	---	Fundament
960.812000	43.4	30.4	H	23.6	54.0	

Test conditions modes: TC#02

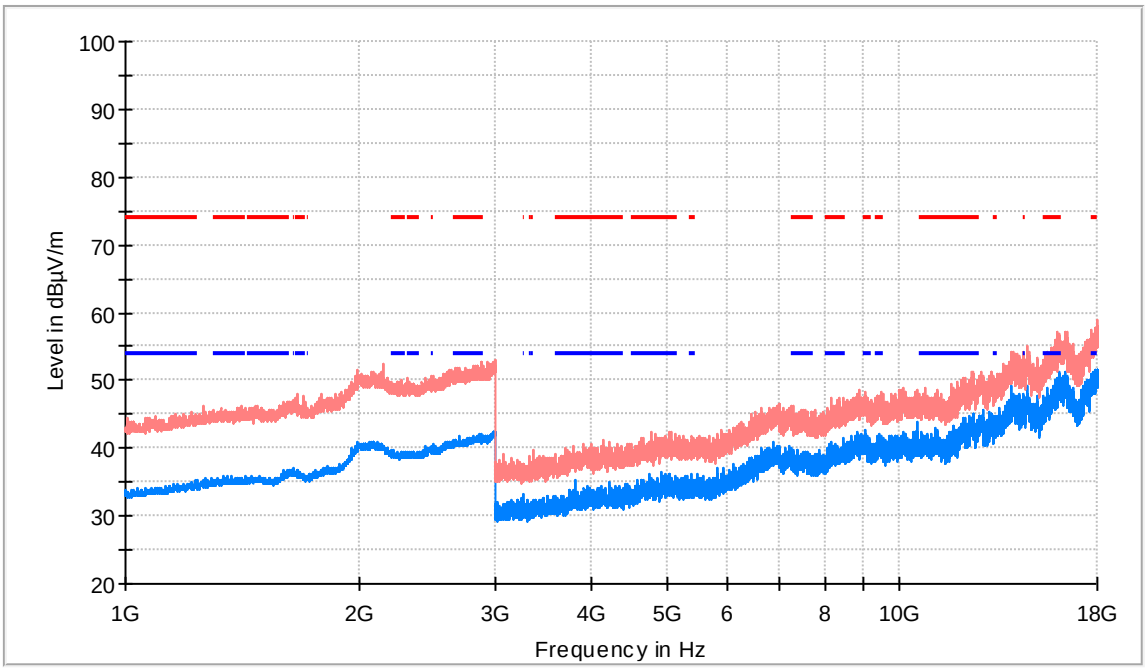
Results: Frequency range 1 - 18 GHz

Lowest Channel

Attachments

Frequency = 902.3 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2875.500000	52.8	41.7	H	12.3	54.0
16063.00000	56.3	51.0	H	3.0	54.0
17985.50000	58.9	50.6	H	3.4	54.0

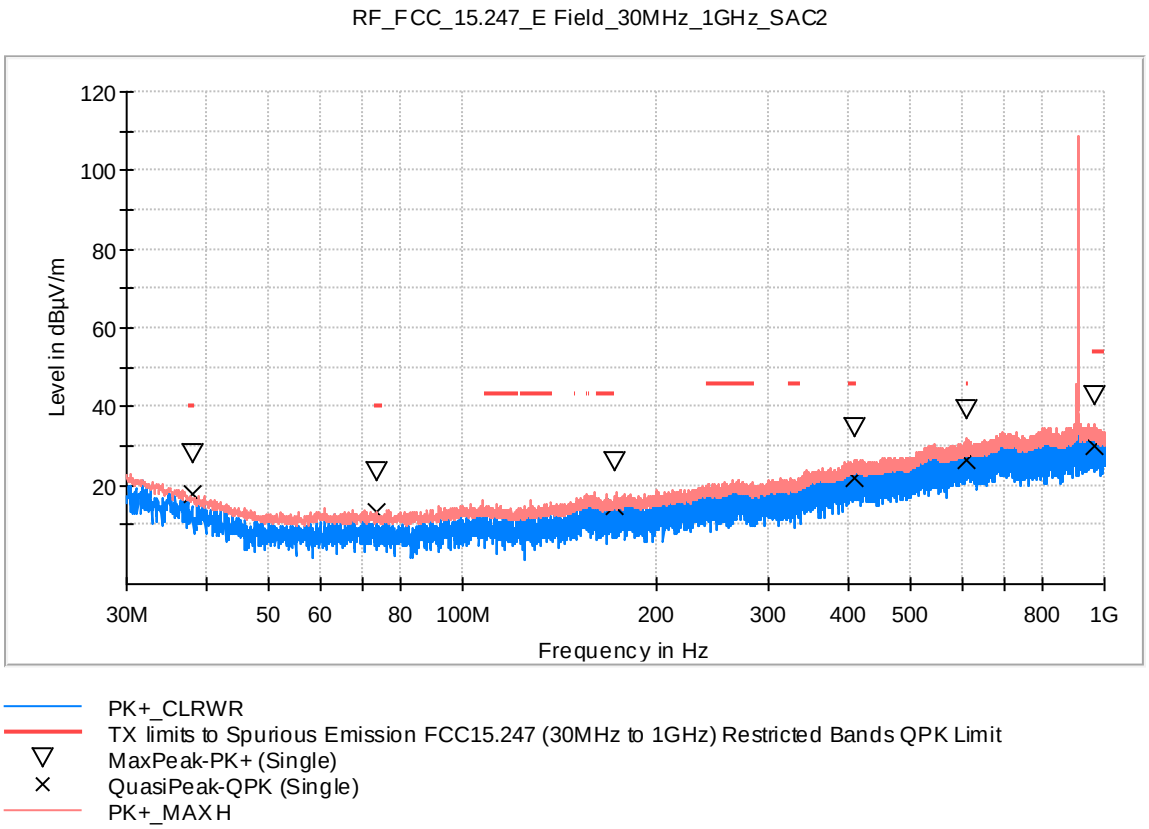
Results: Frequency range 0.03 - 1 GHz

Middle Channel

Attachments

Frequency = 908.7 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [0.03, 1]

Images:



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Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - QPK (dB)	Limit - QPK (dBµV/m)	Comment
37.905500	27.8	17.7	V	22.3	40.0	
73.698500	23.6	13.4	H	26.6	40.0	
172.493000	26.2	14.7	V	28.9	43.5	
408.009000	34.8	21.8	H	24.2	46.0	
610.060000	39.0	26.7	V	19.3	46.0	
908.674500	108.9	108.7	H	---	---	Fundament
965.516500	42.6	30.3	V	23.8	54.0	

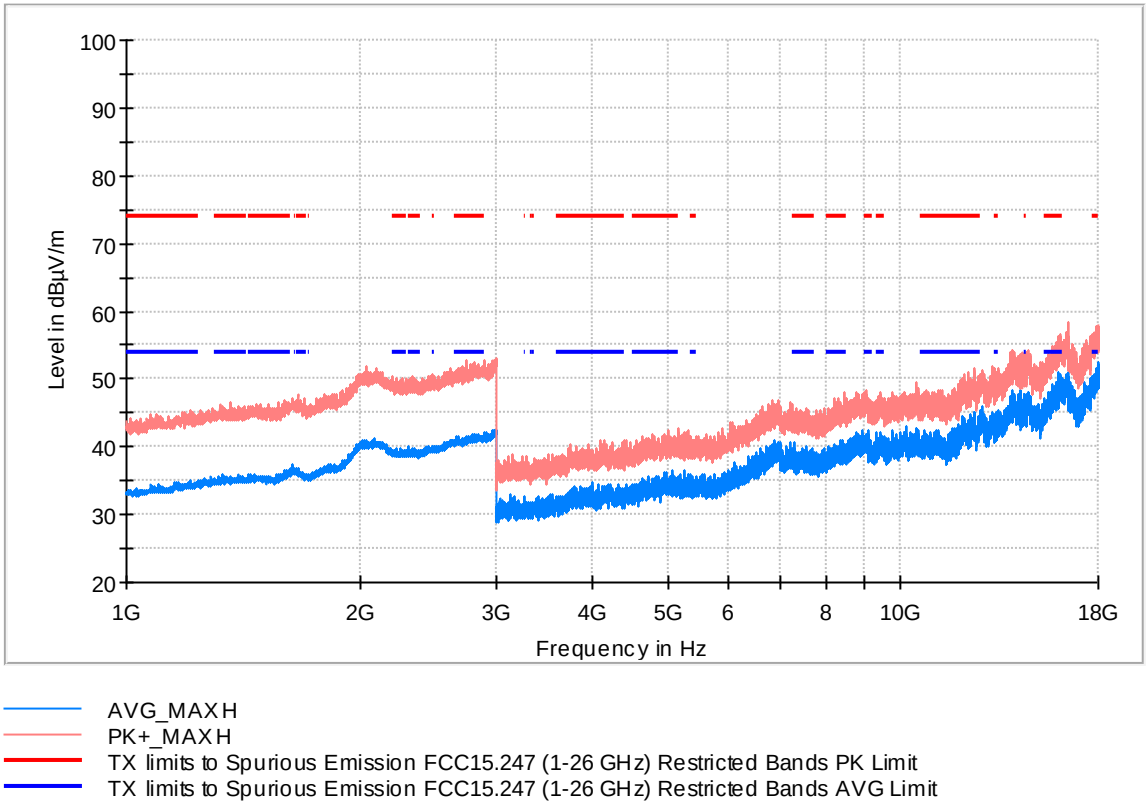
Results: Frequency range 1 - 18 GHz

Middle Channel

Attachments

Frequency = 908.7 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2893.000000	51.6	42.2	H	11.8	54.0
16088.00000	56.5	48.8	H	5.2	54.0
17927.00000	57.7	51.2	H	2.8	54.0

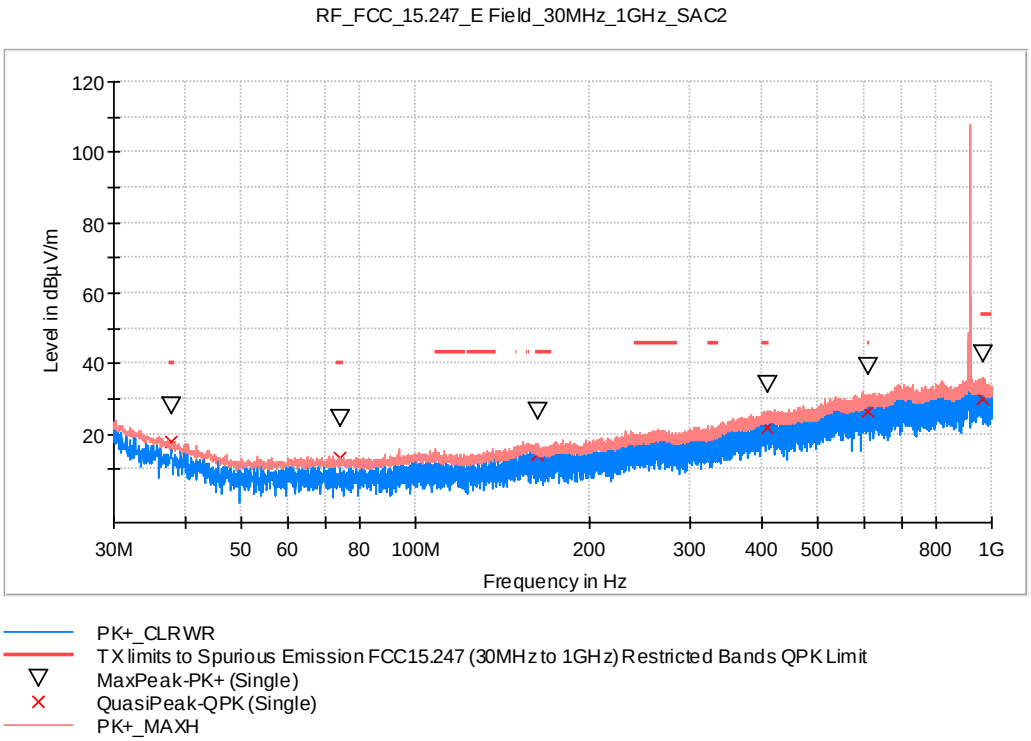
Results: Frequency range 0.03 - 1 GHz

Highest Channel

Attachments

Frequency = 914.9 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [0.03, 1]

Images:



Frequency (MHz)	MaxPeak (dBµV/m)	QuasiPeak (dBµV/m)	Pol	Margin - PK+ (dB)	Limit - PK+ (dBµV/m)	Comment
37.857000	28.2	17.7	H	22.3	40.0	
73.892500	24.6	13.4	H	26.6	40.0	
163.423500	26.6	14.3	H	29.2	43.5	
408.397000	34.4	22.0	V	24.0	46.0	
609.963000	39.1	26.7	H	19.3	46.0	
914.979500	107.0	106.5	H	---	---	Fundament
966.292500	42.6	30.2	V	23.8	54.0	

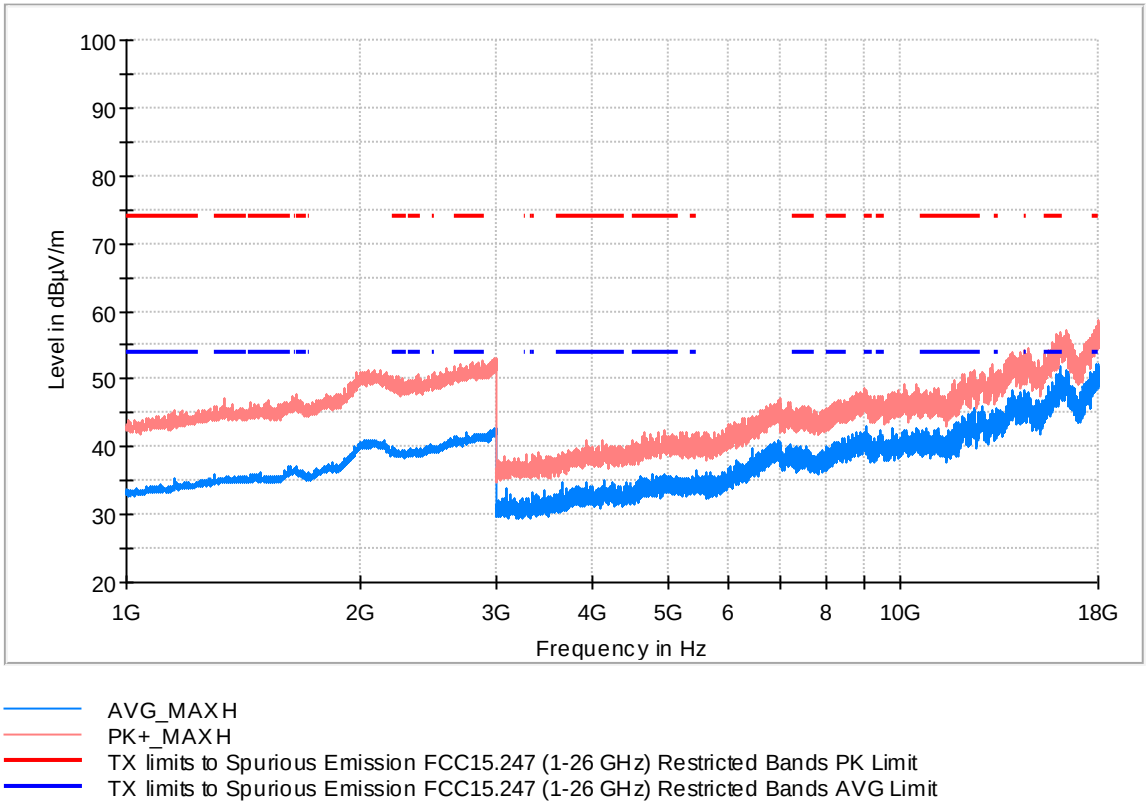
Results: Frequency range 1 - 18 GHz

Highest Channel

Attachments

Frequency = 914.9 MHz, Bandwidth = 125 kHz, Frequency Range GHz = [1, 18]

Images:



Frequency (MHz)	PK+_MAXH (dBµV/m)	AVG_MAXH (dBµV/m)	Pol	Margin - AVG (dB)	Limit - AVG (dBµV/m)
2890.500000	52.7	41.4	H	12.6	54.0
16066.50000	54.8	51.9	V	2.1	54.0
17995.50000	58.6	51.7	V	2.3	54.0