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TEST REPORT

of

FCC Part 15 Subpart C §15.247
IC RSS-247 Issue 2 and RSS-Gen Issue 5

FCC ID: WA2ST730P
IC Certification: 21484-ST730P

Equipment Under Test	:	Tracking Device
Model Name	:	ST730P
Variant Model Name(s)	:	-
Applicant	:	Suntech International Ltd.
Manufacturer	:	Suntech International Ltd.
Date of Receipt	:	2020.12.11
Date of Test(s)	:	2020.12.03 ~ 2021.01.27
Date of Issue	:	2021.02.10

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

1) The results of this test report are effective only to the items tested.
2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
3) This test report cannot be reproduced, except in full, without prior written permission of the Company.

Tested by: Jinhyoung Cho

Technical Manager: Jungmin Yang

SGS Korea Co., Ltd. Gunpo Laboratory

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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1.2. Details of Applicant

Applicant	:	Suntech International Ltd.
Address	:	A-1705, 1706, Greatvalley, 32, Digital-ro 9-gil, Geumcheon-gu, Seoul, South Korea, 08512
Contact Person	:	Kim, Yo-han
Phone No.	:	+82 2 6327 5661

1.3. Details of Manufacturer

Company	:	Same as applicant
Address	:	Same as applicant

1.4. Description of EUT

Kind of Product	Tracking Device
Model Name	ST730P
Serial Number	Conducted Sample: 7329999991 Radiated Sample: 7329999992
Power Supply	DC 3.6 V
Frequency Range	902.137 5 ㎒ ~ 904.662 5 ㎒ (Sigfox)
Modulation Technique	DBPSK
Number of Channels	54 channels (Sigfox)
Antenna Type	PCB antenna
Antenna Gain	1.48 ㏈i
H/W Version	02
S/W Version	300T19

1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMR40	100272	Jun. 18, 2020	Annual	Jun. 18, 2021
Signal Generator	R&S	SMBV100A	255834	Jun. 03, 2020	Annual	Jun. 03, 2021
Spectrum Analyzer	R&S	FSV30	103101	Jun. 01, 2020	Annual	Jun. 01, 2021
Spectrum Analyzer	Agilent	N9030A	MY53120526	Jan. 09, 2020	Annual	Jan. 09, 2021
Attenuator	AEROFLEX / INMET	40AH2W-10	40G-3	Jun. 16, 2020	Annual	Jun. 16, 2021
High Pass Filter	Wainwright Instrument GmbH	WHKX1.5/15G-6SS	4	Jun. 11, 2020	Annual	Jun. 11, 2021
Power Sensor	R&S	NRP-Z81	100748	Jun. 01, 2020	Annual	Jun. 01, 2021
DC Power Supply	R&S	HMP2020	019922876	Apr. 27, 2020	Annual	Apr. 27, 2021
Preamplifier	H.P.	8447F	2944A03909	Aug. 06, 2020	Annual	Aug. 06, 2021
Signal Conditioning Unit	R&S	SCU-18	10117	Jun. 10, 2020	Annual	Jun. 10, 2021
Preamplifier	MITEQ Inc.	JS44-18004000-35-8P	1546891	May 08, 2020	Annual	May 08, 2021
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 22, 2019	Biennial	Aug. 22, 2021
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	396	Mar. 21, 2019	Biennial	Mar. 21, 2021
Horn Antenna	R&S	HF906	100326	Feb. 14, 2020	Annual	Feb. 14, 2021
Test Receiver	R&S	ESU26	100109	Feb. 18, 2020	Annual	Feb. 18, 2021
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/383 30516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/383 30516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	SFX086-NMNM-5M (5 m)	20200324001	Aug. 10, 2020	Semi-annual	Feb. 10, 2021
Coaxial Cable	RFONE	SFX086-NMNM-10M (10 m)	20200324001	Aug. 10, 2020	Semi-annual	Feb. 10, 2021
Coaxial Cable	Rosenberger	LA1-C006-1500	131014 10/20	Aug. 21, 2020	Semi-annual	Feb. 21, 2021

1.6. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part15 Subpart C, IC RSS-247 Issue 2 and RSS-Gen Issue 5			
Section in FCC	**Section in IC**	**Test Item(s)**	**Result**
15.205(a) 15.209 15.247(d)	RSS-247 Issue 2 5.5 RSS-Gen Issue 5 8.9	Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	Complied
15.247(a)(1)(i)	RSS-247 Issue 2 5.1(c) RSS-Gen Issue 5 6.7	20 ㏈ Bandwidth and 99 % Bandwidth	Complied
15.247(a)(1)(i) 15.247(b)(2)	RSS-247 Issue 2 5.1(c) 5.4(a)	Maximum Peak Conducted Output Power	Complied
15.247(a)(1)(i)	RSS-247 Issue 2 5.1(c)	Carrier Frequency Separation	Complied
15.247(a)(1)(i)	RSS-247 Issue 2 5.1(c)	Number of Hopping Frequencies	Complied
15.247(a)(1)(i)	RSS-247 Issue 2 5.1(c)	Time of Occupancy (Dwell Time)	Complied
15.207	RSS-Gen Issue 5 8.8	AC Power Line Conducted Emission	N/A[1)]

Note;

1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

1.7. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 15.247 Meas Guidance v05r02 were used in the measurement of the DUT.

1.8. Sample Calculation

Where relevant, the following sample calculation is provided:

1.8.1. Conducted Test

Offset value (㏈) = Attenuator (㏈) + Cable loss (㏈)

1.8.2. Radiation Test

Field strength level (㏈㎶/m) = Measured level (㏈㎶) + Antenna factor (㏈) + Cable loss (㏈) - Amplifier gain (㏈)

1.9. Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

Parameter	Uncertainty	
RF Output Power	± 0.44 dB	
Occupied Bandwidth	± 38.80 ㎑	
Conducted Spurious Emission	± 0.71 dB	
Radiated Emission, 9 ㎑ to 30 ㎒	H	± 3.66 dB
	V	± 3.66 dB
Radiated Emission, below 1 ㎓	H	± 4.90 dB
	V	± 4.82 dB
Radiated Emission, above 1 ㎓	H	± 3.62 dB
	V	± 3.64 dB

Uncertainty figures are valid to a confidence level of 95 %.

1.10. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501-RF-RTL001670	2021.02.10	Initial

1.11. Information of Software for test

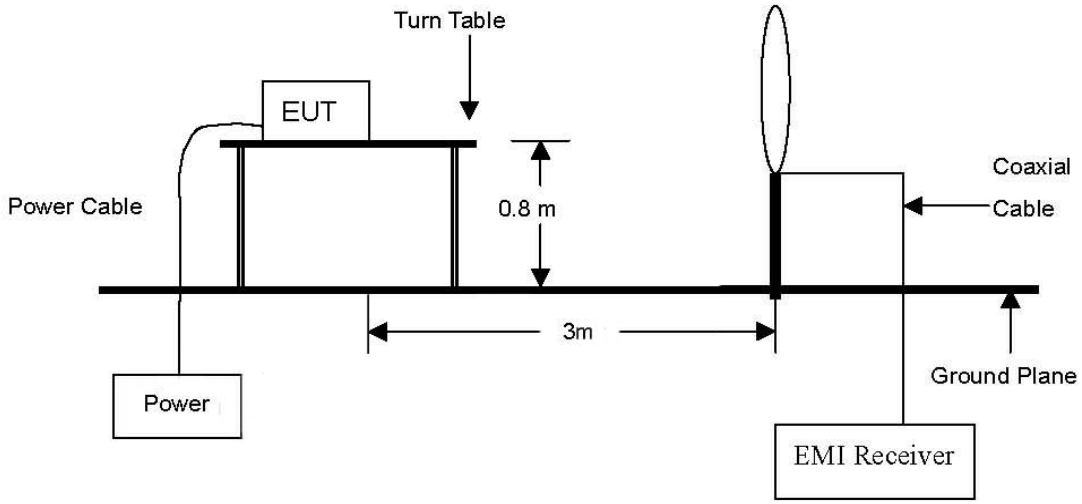
- Using the software of Putty to testing of EUT.

2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

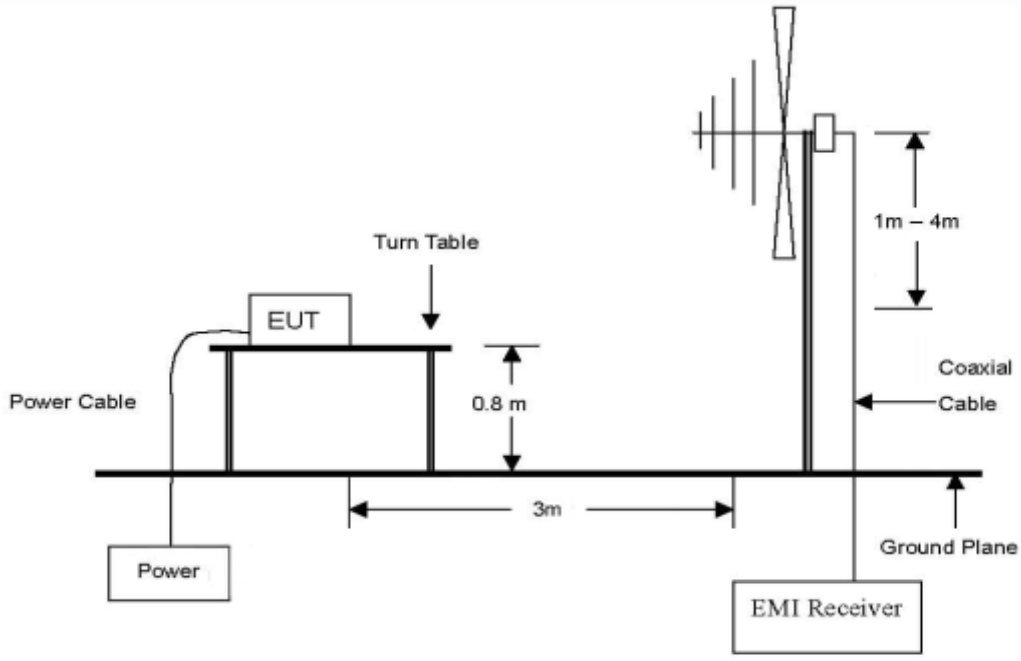
2.1. Test Setup

2.1.1. Transmitter Radiated Spurious Emissions

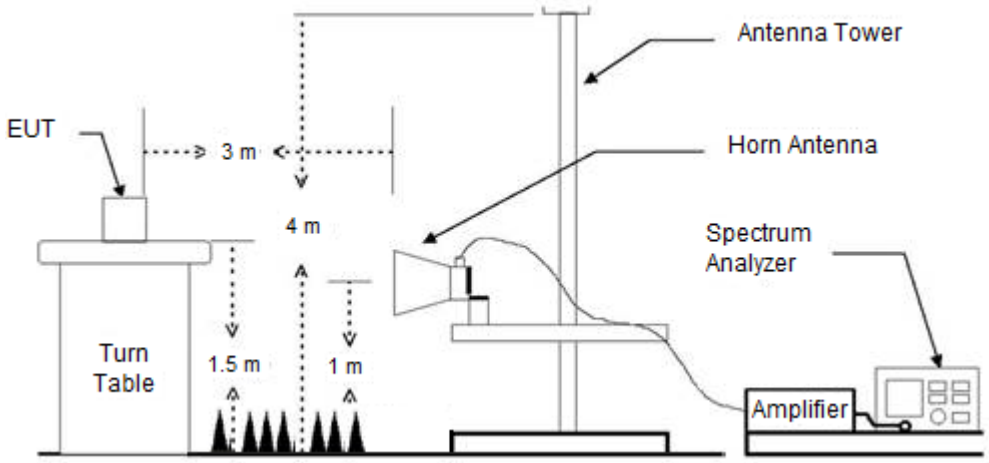
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 ㎒ to 1 ㎓.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated form 1 ㎓ to the 10th harmonic of the highest fundamental frequency or 40 ㎓, whichever is lower.



2.1.2. Conducted Spurious Emissions

2.2. Limit

2.2.1. FCC

According to §15.247(d), in any 100 ㎑ 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 ㏈ below that in the 100 ㎑ 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 ㏈ instead of 20 ㏈. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emission 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)).

According to §15.209(a), 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 (㎒)	Field Strength (㎶/m)	Measurement Distance (Meters)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	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 ㎒, 76-88 ㎒, 174-216 ㎒ or 470-806 ㎒. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

2.2.2. IC

According to RSS-247 Issue 2, 5.5, in any 100 ㎑ bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 ㏈ below that in the 100 ㎑ bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 ㏈ instead of 20 ㏈. Attenuation below the general field strength limits specified in RSS-Gen is not required.

According to RSS-Gen Issue 5, 8.9, except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 – General Field Strength Limits at frequencies above 30 ㎒

Frequency (㎒)	Field Strength (㎶/m at 3 m)
30-88	100
88-216	150
216-960	200
Above 960	500

Table 6 – General Field Strength Limits at frequencies below 30 ㎒

Frequency	Magnetic Field Strength (H-Field) (㎂/m)	Measurement Distance (meters)
9-490 ㎑ [1]	6.37/F (F in ㎑)	300
490-1 705 ㎑	63.7/F (F in ㎑)	30
1.705-30 ㎒	0.08	30

Note[1]: The emission limits for the ranges 9-90 ㎑ and 110-490 ㎑ are based on measurements employing a linear average detector.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

2.3.1. Test Procedures for emission below 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

2.3.2. Test Procedures for emission from above 30 ㎒

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 ㎓ and 1.5 meter above the ground at a 3 meter anechoic chamber test site above 1 ㎓. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 ㎓, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 ㎓, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note;

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 ㎑ for Peak detection (PK) and Quasi-peak detection (QP) at frequency below 1 ㎓.
2. For frequency above 1 ㎓, set spectrum analyzer detector to peak, and resolution bandwidth is 1 ㎒ and video bandwidth is 3 ㎒.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 ㎒ and the video bandwidth is $1/T_{on}$ ㎐ (T_{on} = On-time of the Pulsed emission) for Average detection (AV) at frequency above 1 ㎓. VBW = 10 ㎐ > $1/T_{on}$ ㎐, pulse width in seconds (T_{on} = 359 ㎳).
4. Definition of DUT Axis.
   Definition of the test orthogonal plan for EUT was described in the test setup photo.
   The test orthogonal plan of EUT is **X – axis** during radiation test.

2.3.3. Test Procedures for Conducted Spurious Emissions

2.3.3.1. Spurious RF Conducted Emissions

The transmitter output was connected to the spectrum analyzer.
RBW = 1 ㎒
VBW = 3 ㎒
Sweep = auto
Detector function = peak
Trace = max hold

2.3.3.2. TDF function

- For plots showing conducted spurious emissions from 9 ㎑ to 10 ㎓, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.
So, the reading values shown in plots were final result.

2.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

2.4.1. Radiated Spurious Emission below 1 000 ㎒

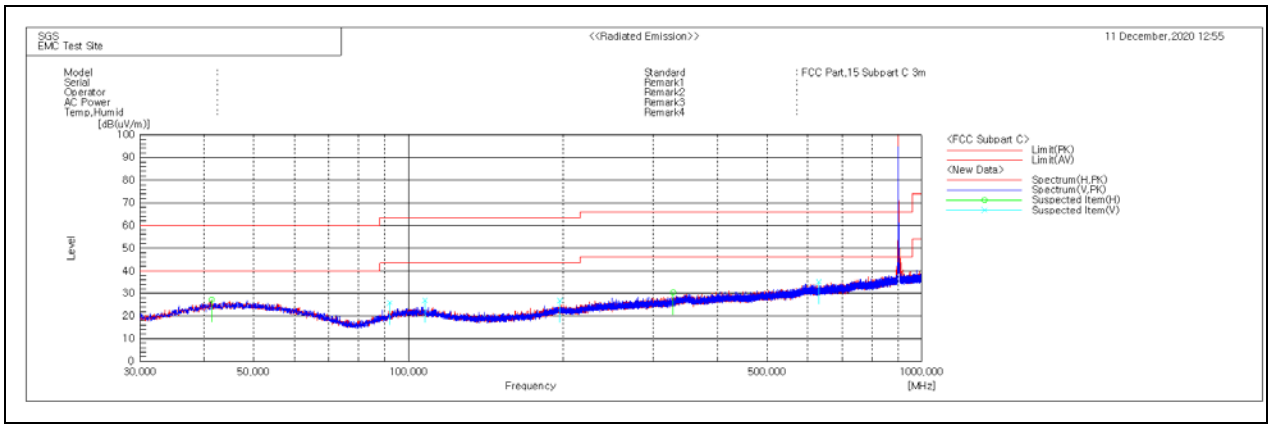
The frequency spectrum from 9 ㎑ to 1 000 ㎒ was investigated. All reading values are peak values.

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
41.36	34.20	Peak	H	20.24	-27.30	27.14	40.00	12.86
91.92	37.00	Peak	V	15.67	-26.78	25.89	43.50	17.61
107.72	36.80	Peak	V	16.76	-26.64	26.92	43.50	16.58
197.16	35.30	Peak	V	17.20	-25.73	26.77	43.50	16.73
328.15	35.70	Peak	H	19.89	-25.11	30.48	46.00	15.52
630.39	35.70	Peak	V	25.10	-25.64	**35.16**	46.00	10.84
Above 700.00	Not detected	-	-	-	-	-	-	-

Remark;

1. Spurious emissions for all channels and modes were investigated and almost the same below 1 ㎓.
2. Reported spurious emissions are in **Low channel** as worst case among other modes.
3. Radiated spurious emission measurement as below.
   (Actual = Reading + AF + AMP + CL)
4. According to §15.31(o), emission levels are not report much lower than the limits by over 20 ㏈.

- Test plot



2.4.2. Radiated Spurious Emission above 1 000 ㎒

The frequency spectrum above 1 000 ㎒ was investigated. All reading values are peak values.

A. Low Channel (902.137 5 ㎒)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 706.46	56.75	Peak	H	28.77	-37.93	47.59	74.00	26.41
*3 608.56	54.01	Peak	H	31.40	-37.10	48.31	74.00	25.69
*4 510.54	54.65	Peak	V	32.08	-36.28	50.45	74.00	23.55
*5 412.92	46.46	Peak	H	33.97	-35.04	45.39	74.00	28.61
6 314.96	44.74	Peak	H	34.83	-34.81	44.76	74.00	29.24
7 217.10	47.81	Peak	H	35.83	-33.65	49.99	74.00	24.01
*8 119.10	47.43	Peak	V	36.30	-33.36	50.37	74.00	23.63
Above 8 200.00	Not detected	-	-	-	-	-	-	-

B. Middle Channel (903.112 5 ㎒)

Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 710.10	54.14	Peak	H	28.76	-37.93	44.97	74.00	29.03
*3 613.72	51.86	Peak	H	31.46	-37.05	46.27	74.00	27.73
*4 517.00	53.13	Peak	V	32.07	-36.21	48.99	74.00	25.01
*5 420.82	44.99	Peak	H	33.96	-35.00	43.95	74.00	30.05
6 323.74	42.89	Peak	H	34.85	-34.84	42.90	74.00	31.10
7 227.24	47.65	Peak	H	35.85	-33.65	49.85	74.00	24.15
*8 130.74	46.82	Peak	V	36.30	-33.38	49.74	74.00	24.26
Above 8 200.00	Not detected	-	-	-	-	-	-	-

C. High Channel (904.662 5 ㎒)

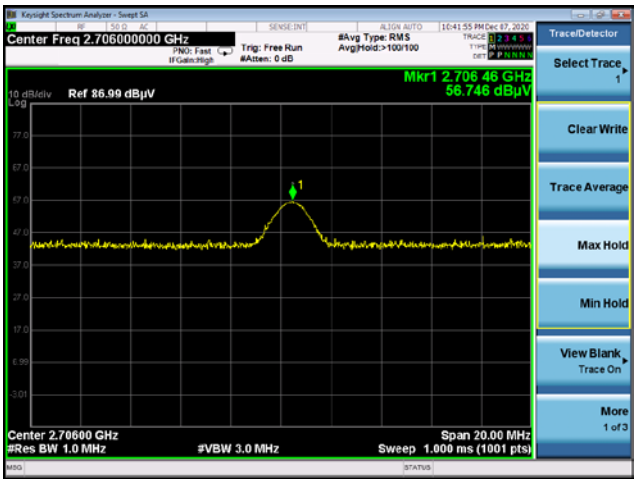
Radiated Emissions			Ant.	Correction Factors		Total	Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	Actual (dB㎶/m)	Limit (dB㎶/m)	Margin (dB)
*2 714.00	55.57	Peak	H	28.74	-37.93	46.38	74.00	27.62
*3 618.74	50.02	Peak	H	31.52	-37.00	44.54	74.00	29.46
*4 523.28	52.88	Peak	V	32.05	-36.15	48.78	74.00	25.22
*5 427.78	44.45	Peak	H	33.94	-34.98	43.41	74.00	30.59
6 331.84	43.52	Peak	H	34.86	-34.87	43.51	74.00	30.49
7 237.16	46.97	Peak	H	35.87	-33.65	49.19	74.00	24.81
*8 141.84	46.61	Peak	V	36.30	-33.42	49.49	74.00	24.51
Above 8 200.00	Not detected	-	-	-	-	-	-	-

Remark;

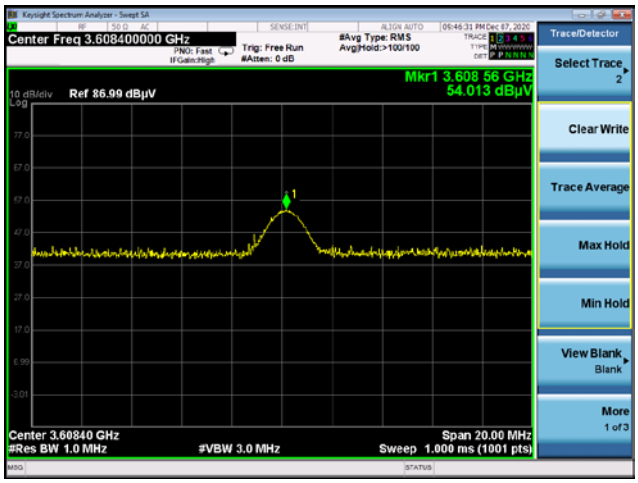
1. "*" means the restricted band.
2. Measuring frequencies from 1 ㎓ to the 10th harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 ㎒ were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + AMP.
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 ㏈.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.

- Test plots

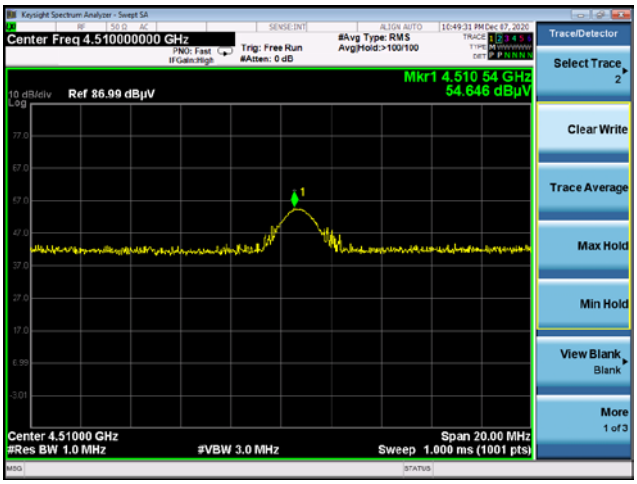
Low channel 3rd harmonic (Peak)



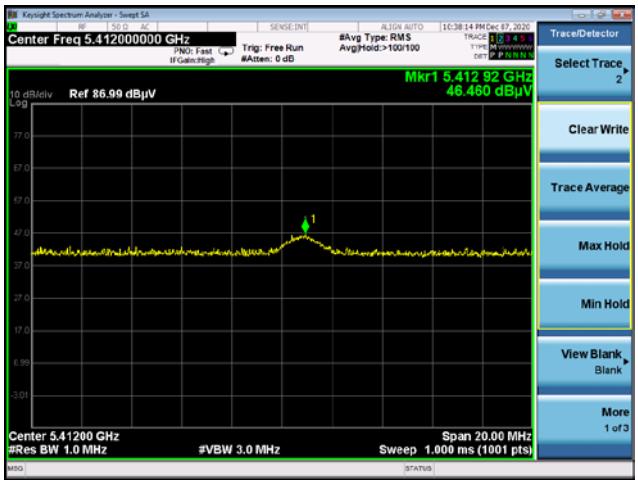
Low channel 4th harmonic (Peak)



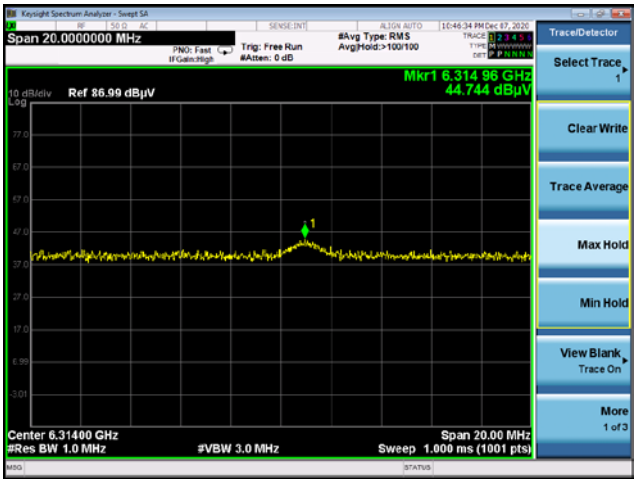
Low channel 5th harmonic (Peak)



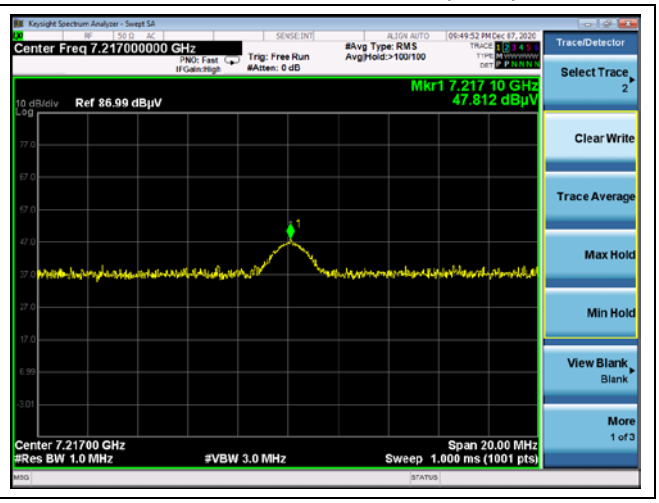
Low channel 6th harmonic (Peak)



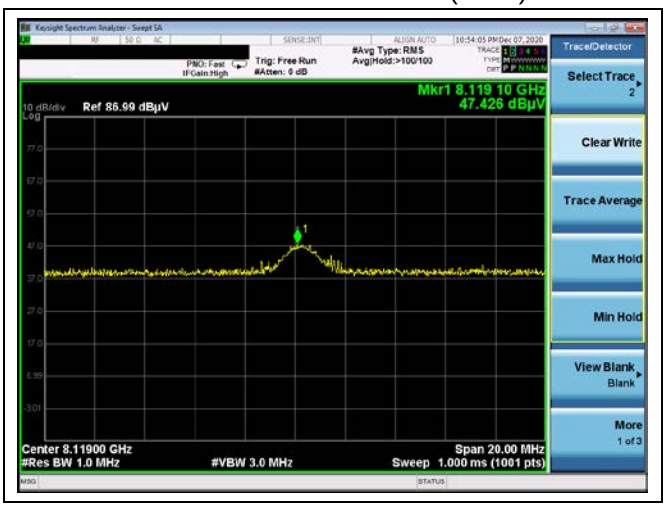
Low channel 7th harmonic (Peak)



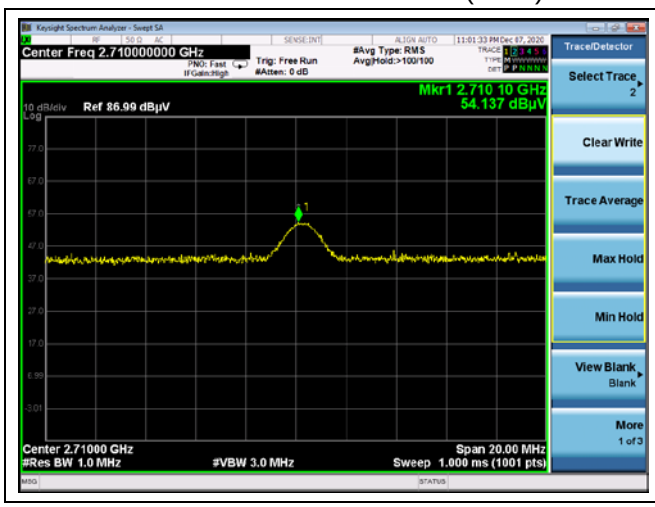
Low channel 8th harmonic (Peak)



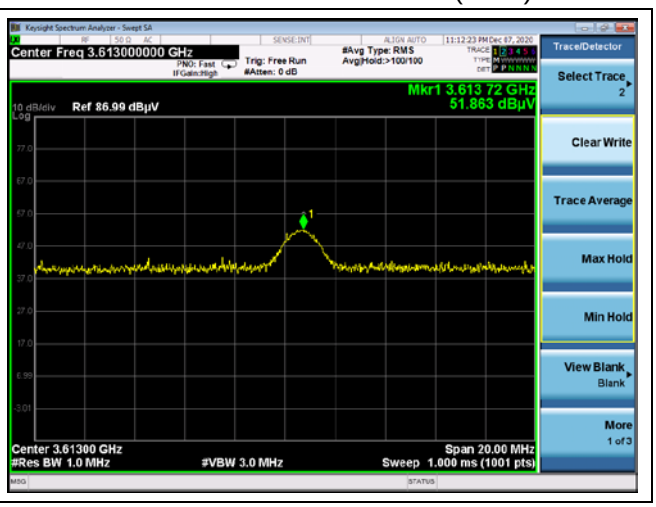
Low channel 9th harmonic (Peak)



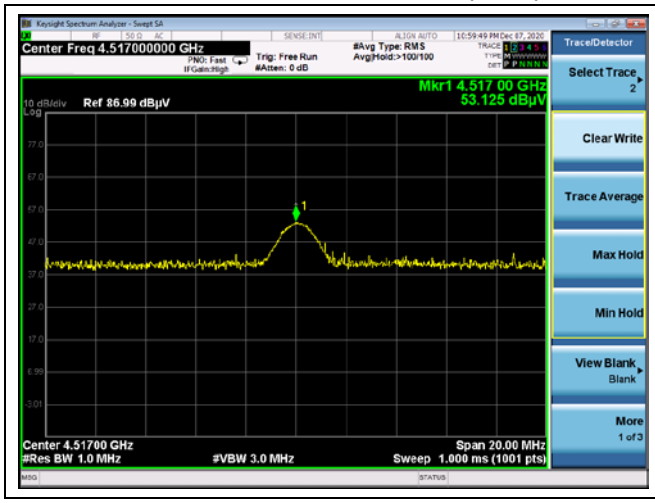
Middle channel 3rd harmonic (Peak)



Middle channel 4th harmonic (Peak)

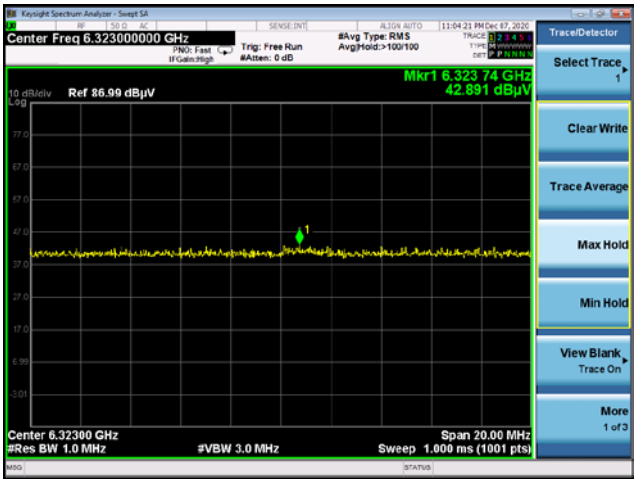


Middle channel 5th harmonic (Peak)

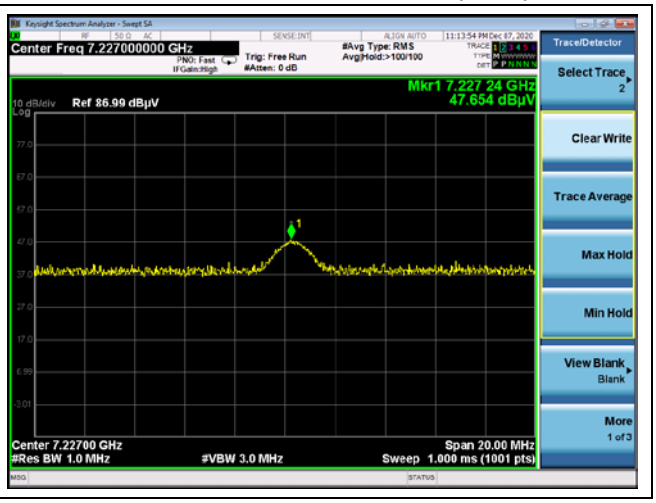


Middle channel 6th harmonic (Peak)

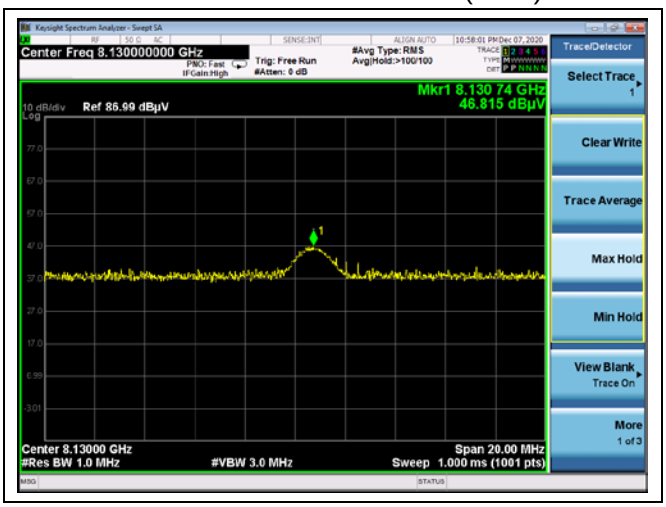
Middle channel 7th harmonic (Peak)



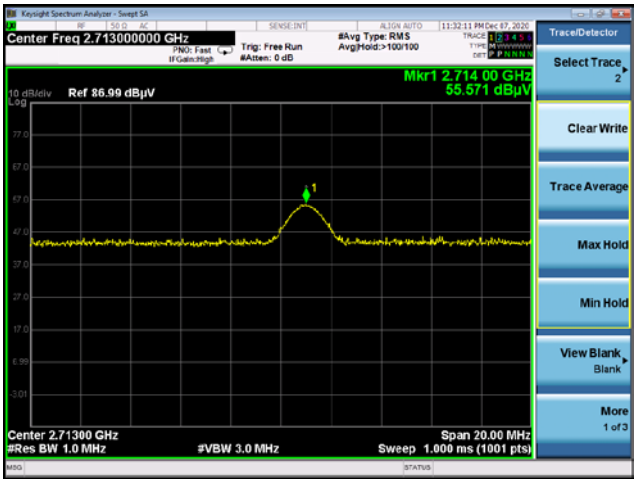
Middle channel 8th harmonic (Peak)



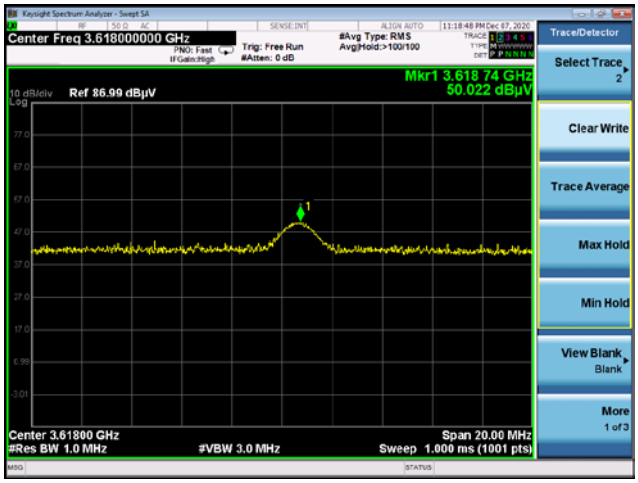
Middle channel 9th harmonic (Peak)



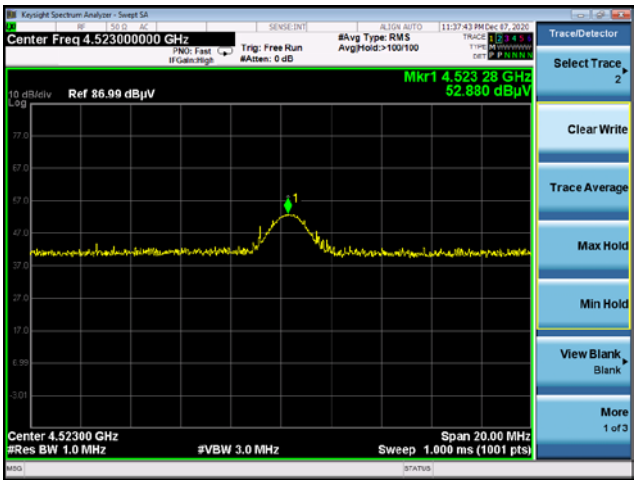
High channel 3rd harmonic (Peak)



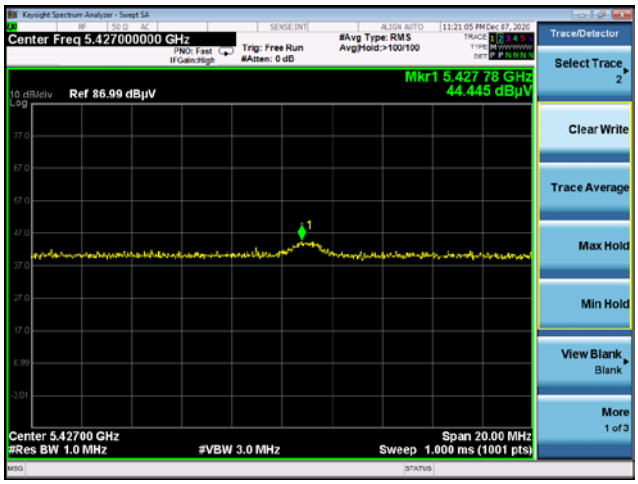
High channel 4th harmonic (Peak)



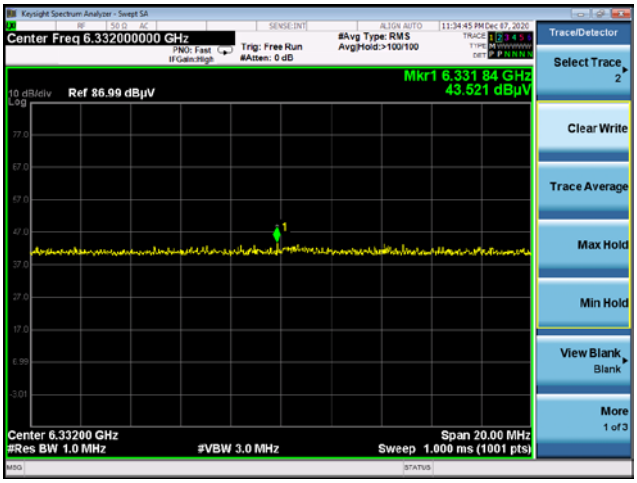
High channel 5th harmonic (Peak)



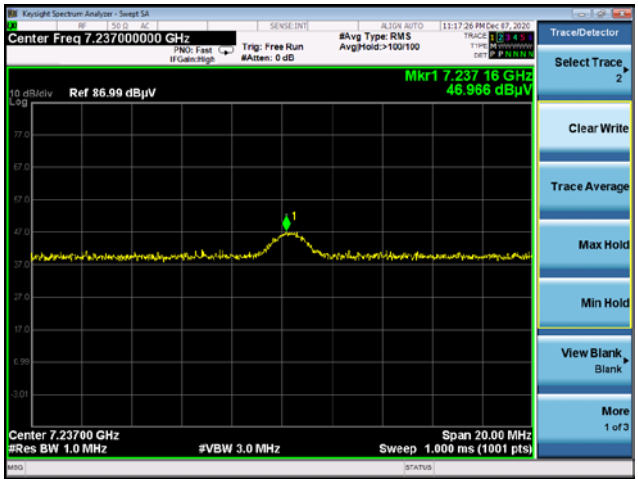
High channel 6th harmonic (Peak)



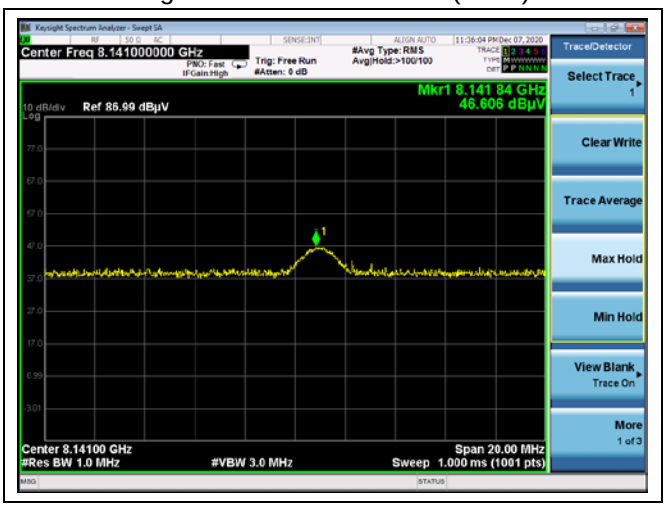
High channel 7th harmonic (Peak)



High channel 8th harmonic (Peak)

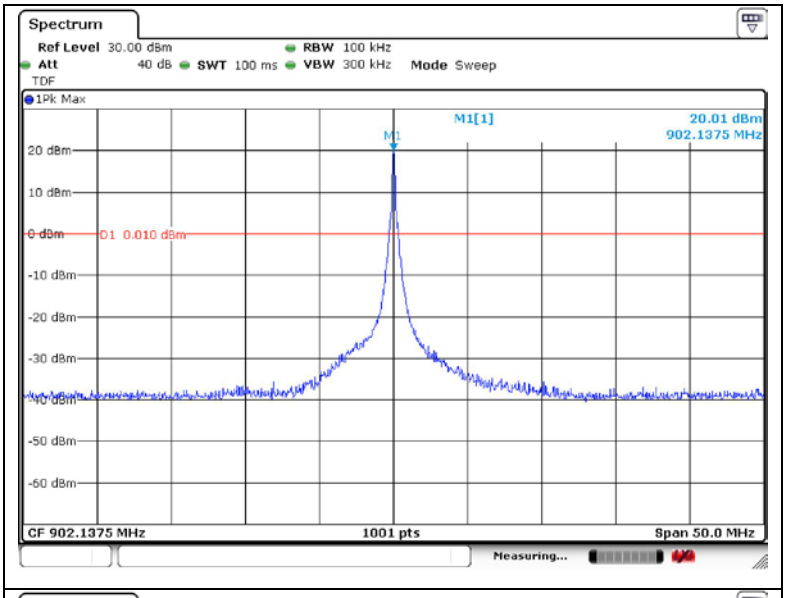


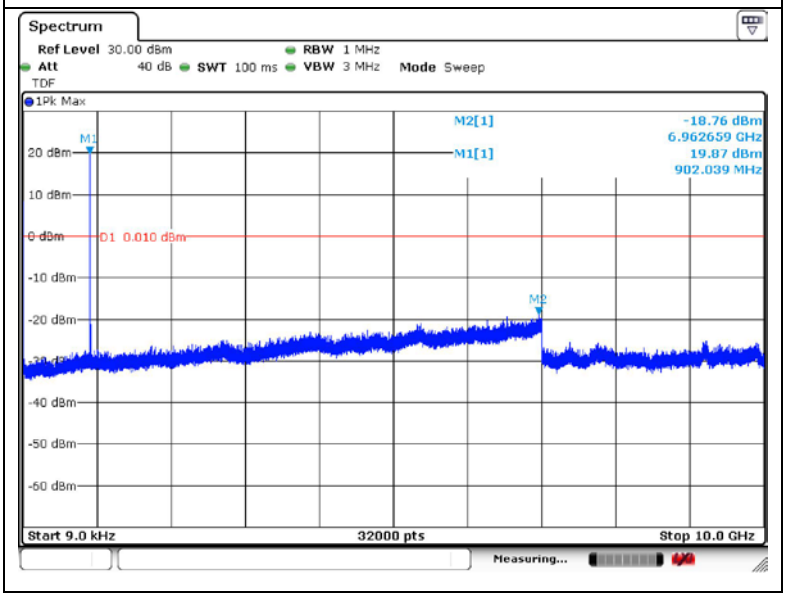
High channel 9th harmonic (Peak)



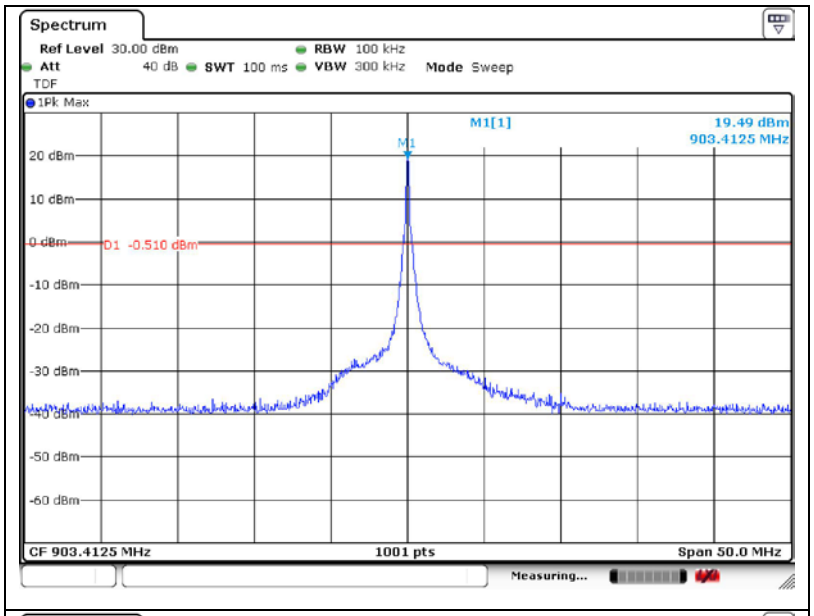
2.4.3. Plot of Spurious Conducted Emissions

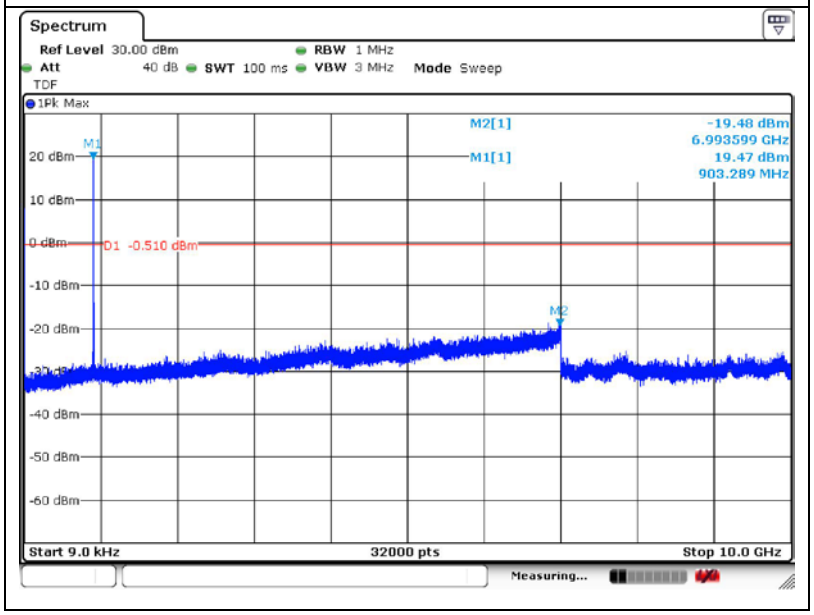
Low channel



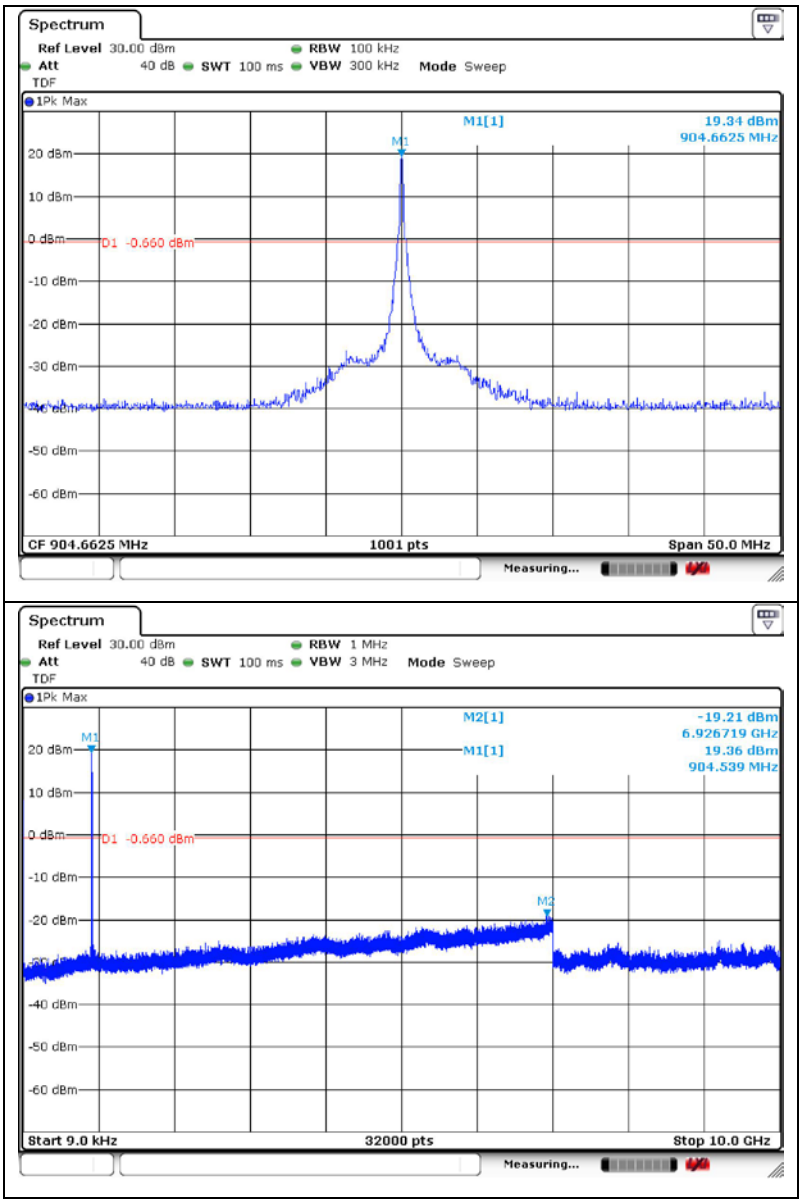


Middle channel





High channel



3. 20 dB Bandwidth and 99 % Bandwidth

3.1. Test Setup

3.2. Limit

Limit: Not Applicable

3.3. Test Procedure

3.3.1. 20 dB Bandwidth

The test follows ANSI C63.10-2013.

The 20 dB bandwidth was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency.

Use the following spectrum analyzer setting:

1. Span = approximately 2 to 5 times the 20 dB bandwidth.
2. RBW ≥ 1 % to 5 % of the 20 dB bandwidth.
3. VBW ≥ 3 x RBW
4. Sweep = auto
5. Detector = peak
6. Trace = max hold

The marker-to-peak function to set the mark to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is 20 dB bandwidth of the emission.

3.3.2. 99 % Bandwidth

● The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.

● The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.

● The resolution bandwidth (RBW) shall be in the range of 1 % to 5 % of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.

Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.

For the 99 % emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5 % of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99 % emission bandwidth).

3.4. Test Results

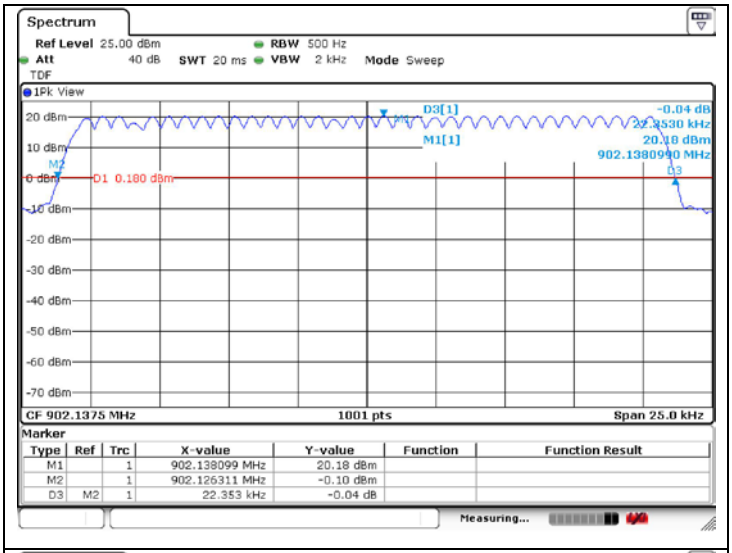
Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Frequency (㎒)	20 ㏈ Bandwidth (㎑)	99 % Bandwidth (㎑)
Sigfox	Low	902.137 5	22.353	21.104
	Middle	903.412 5	22.153	21.029
	High	904.662 5	22.303	21.054

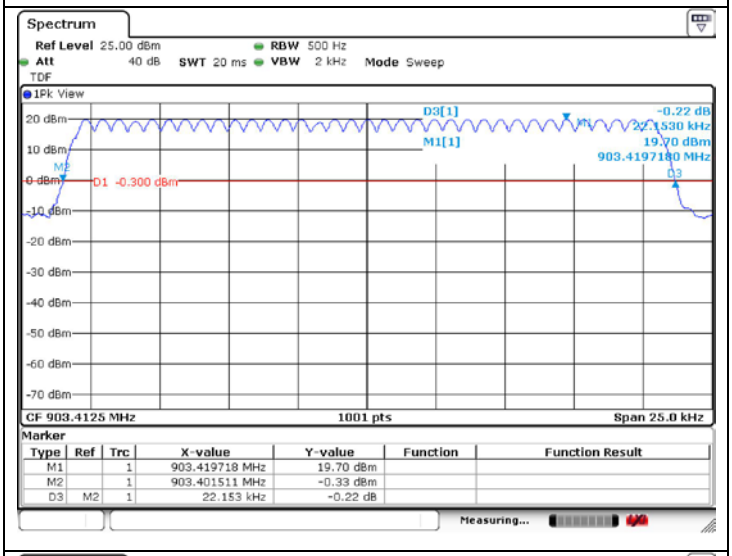
- Test plots

20 dB Bandwidth

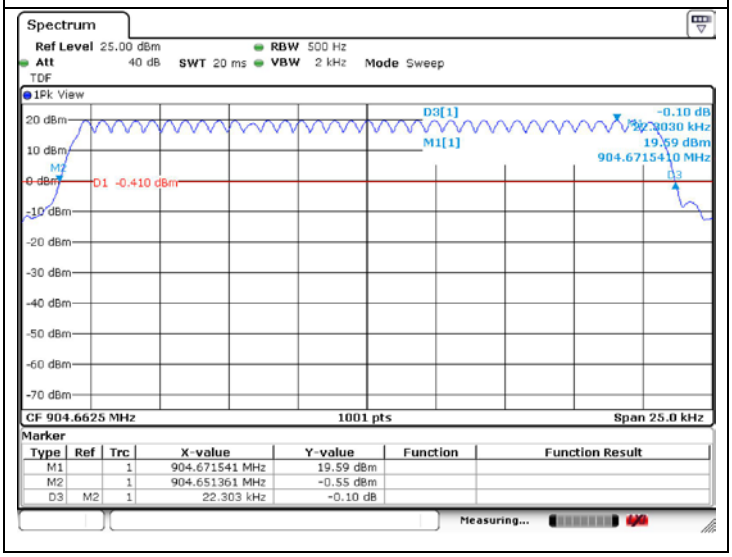
Low Channel



Middle Channel

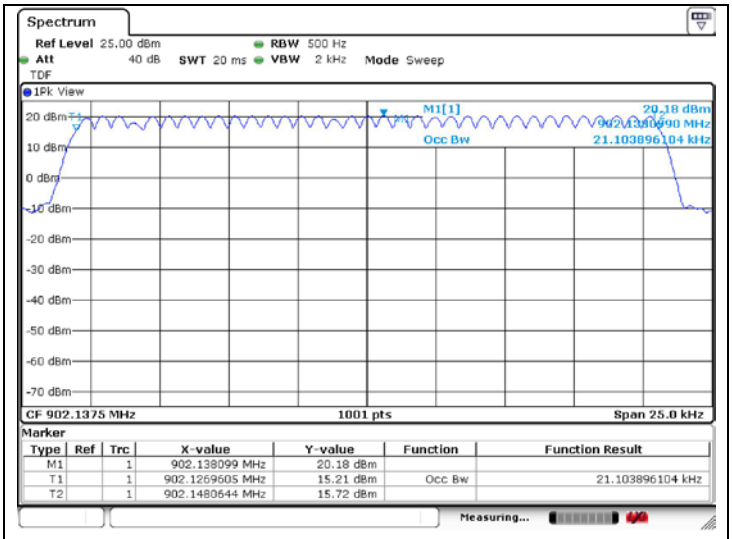


High Channel

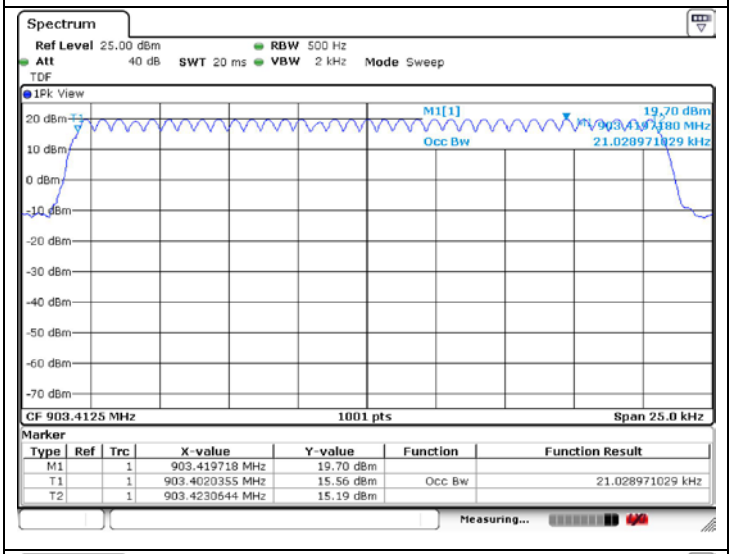


99 % Bandwidth

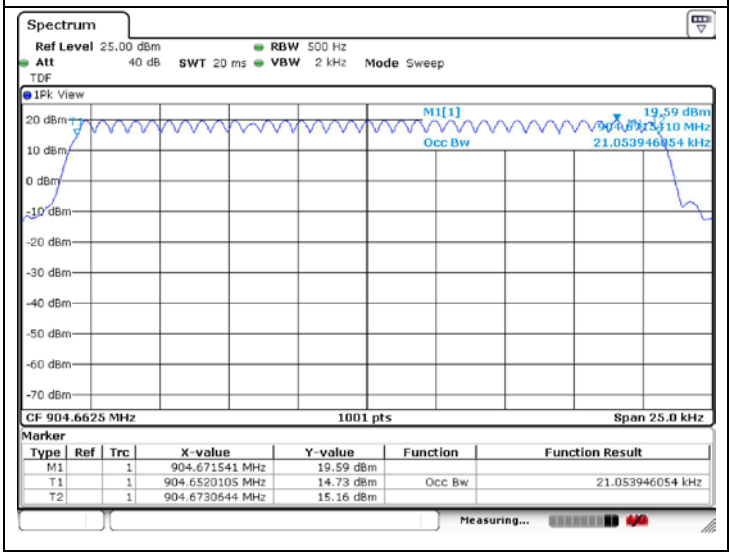
Low Channel



Middle Channel

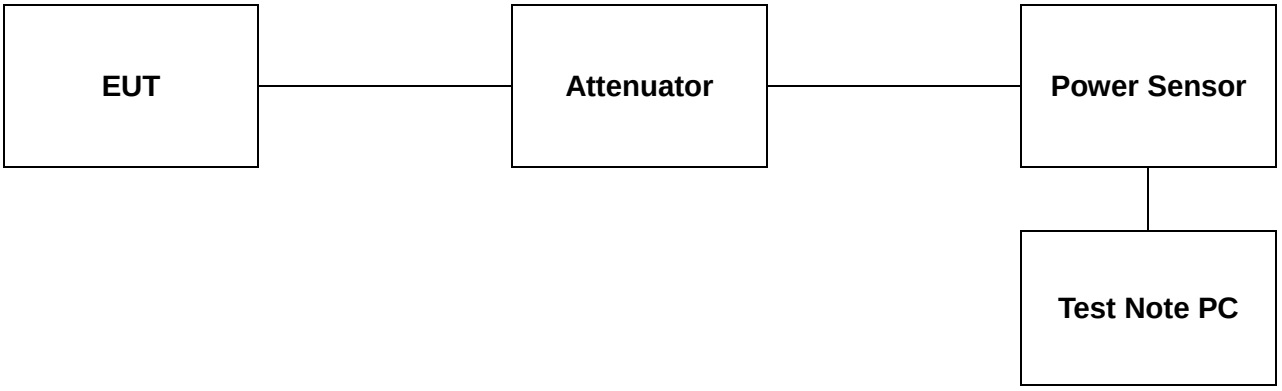


High Channel



4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

4.2.1. FCC

1. §15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel is 500 ㎑.
2. §15.247(b)(2), For frequency hopping systems operating in the 902-928 ㎒ 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.

4.2.2. IC

1. According to RSS-247 Issue 2, 5.1(c), for FHSs in the band 902-928 ㎒: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel shall be 500 ㎑.
2. According to RSS-247 Issue 2, 5.4(a), for FHSs operating in the band 902-928 ㎒, 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.

4.3. Test Procedure

The test follows section 11.9.1.3 of ANSI C63.10-2013.

PKPM1 Peak-reading power meter method
- The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

The test follows section 11.9.2.3.2 of ANSI C63.10-2013.

Method AVGPM-G (Measurement using a gated RF average-reading power meter)
- Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Test program: (S/W name: R&S Power Viewer, Version: 3.2.0)

1. Initially overall offset for attenuator and cable loss is measured per frequency.
2. Measured offset is inserted in test program in advance of measurement for output power.
3. Power for each frequency (channel) of device is investigated as final result.
4. Final result reported on this section from R&S power viewer program includes with several factors and test program shows only final result.

4.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Operation Mode	Channel	Frequency (㎒)	Average Power Result (㏈m)	Peak Power Result (㏈m)	Limit (㏈m)
Sigfox	Low	902.137 5	**19.54**	**19.87**	30
	Middle	903.412 5	19.18	19.52	
	High	904.662 5	19.12	19.34	

5. Carrier Frequency Separation

5.1. Test Setup

5.2. Limit

5.2.1. FCC

§15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel is 500 ㎑.

5.2.2. IC

According to RSS-247 Issue 2, 5.1(c), for FHSs in the band 902-928 ㎒: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel shall be 500 ㎑.

5.3. Test Procedure

The test follows ANSI C63.10-2013.

The device is operating in hopping mode between 79 channels and also supporting Adaptive Frequency Hopping with hopping between 20 channels. As compared with each operating mode, 79 channels are chosen as a representative for test.
Use the following spectrum analyzer settings:

1. Span: Wide enough to capture the peaks of two adjacent channels
2. RBW: Start with the RBW set to approximately 30 % of the channel spacing; adjust as necessary to best identify the center of each individual channel.
3. VBW ≥ RBW
4. Sweep: Auto
5. Detector: Peak
6. Trace: Max hold
7. Allow the trace to stabilize.

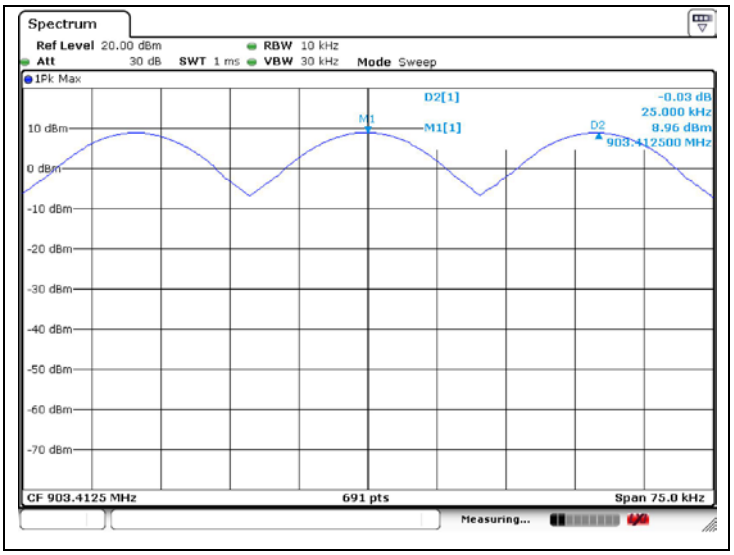
Use the marker-delta function to determine the between the peaks of the adjacent channels.

5.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

Operation Mode	Frequency (㎒)	Adjacent Hopping Channel Separation (㎑)
Sigfox	903.412 5	25

- Test plot



6. Number of Hopping Frequencies

6.1. Test Setup

6.2. Limit

6.2.1. FCC

§15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel is 500 ㎑.

6.2.2. IC

According to RSS-247 Issue 2, 5.1(c), for FHSs in the band 902-928 ㎒: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel shall be 500 ㎑.

6.3. Test Procedure

The test follows ANSI C63.10-2013.

The EUT shall have its hopping function enabled. Use the following spectrum analyzer settings:

1. Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
2. RBW: To identify clearly the individual channels, set the RBW to less than 30 % of the channel spacing or the 20 ㏈ bandwidth, whichever is smaller.
3. VBW ≥ RBW
4. Sweep: Auto
5. Detector function: Peak
6. Trace: Max hold
7. Allow the trace to stabilize.

6.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

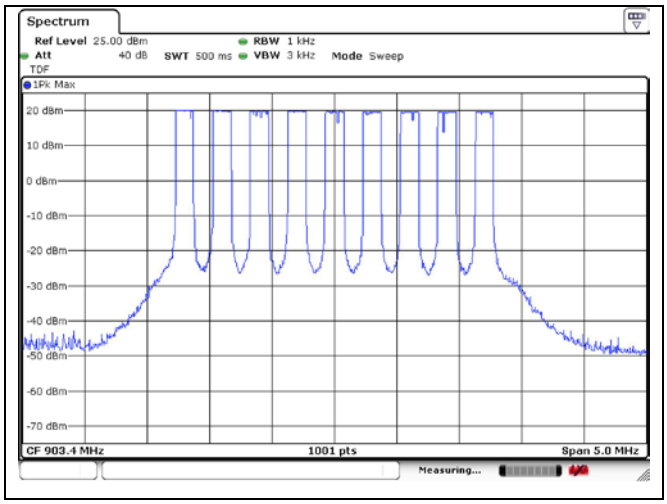
Operation Mode	Number of Hopping Frequency		Limit
Sigfox	Macro Channels	Micro Channels	≥ 50
	9	6	

Note;

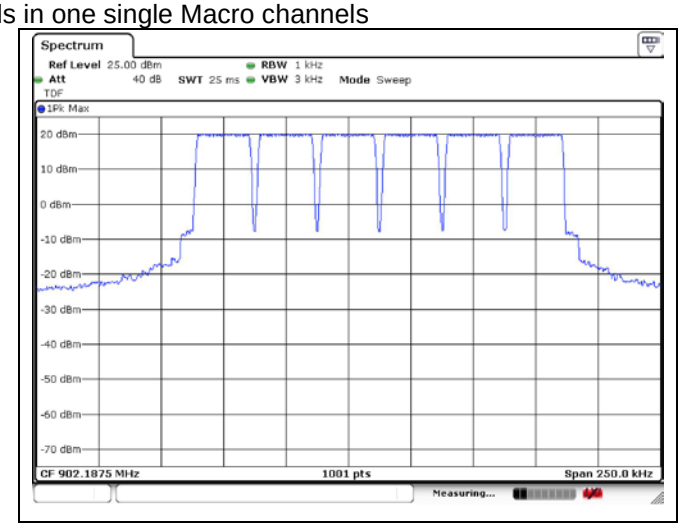
Number of Hopping Frequencies : Number of Macro channels x Number of Micro channels
9 x 6 = 54 channels

- Test plots

Number of Macro channels



Number of Micro channels in one single Macro channels



7. Time of Occupancy (Dwell Time)

7.1. Test Set up

7.2. Limit

7.2.1. FCC

§15.247(a)(1)(i), For frequency hopping systems operating in the 902-928 ㎒ band: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel is 500 ㎑.

7.2.2. IC

According to RSS-247 Issue 2, 5.1(c), for FHSs in the band 902-928 ㎒: if the 20 ㏈ bandwidth of the hopping channel is less than 250 ㎑, 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 ㏈ bandwidth of the hopping channel is 250 ㎑ 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 ㏈ bandwidth of the hopping channel shall be 500 ㎑.

7.3. Test Procedure

The test follows ANSI C63.10-2013.

The EUT must have its hopping function enabled. Use the following spectrum analyzer setting:

1. Span = Zero span, centered on a hopping channel.
2. RBW Shall be < channel spacing and where possible RBW should be set >> 1/T, where T is the expected dwell time per channel.
3. Sweep = As necessary to capture the entire dwell time per hopping channel.
4. Detector = Peak.
5. Trace = Max hold.

Use the marker-delta function to determine the dwell time. If this value varies with different modes of operation, then repeat this test for each variation.

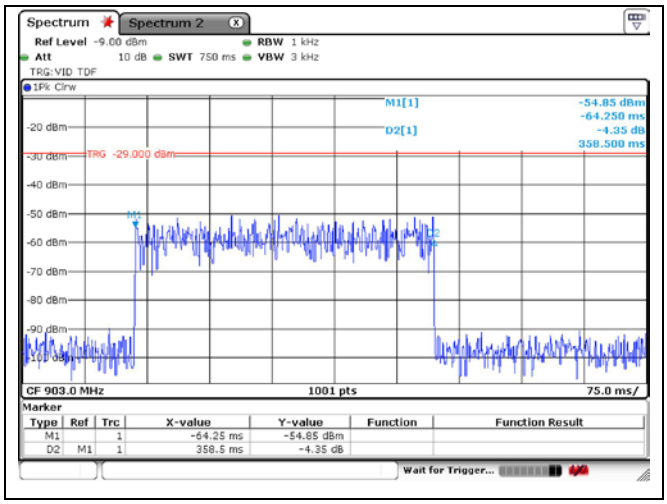
7.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

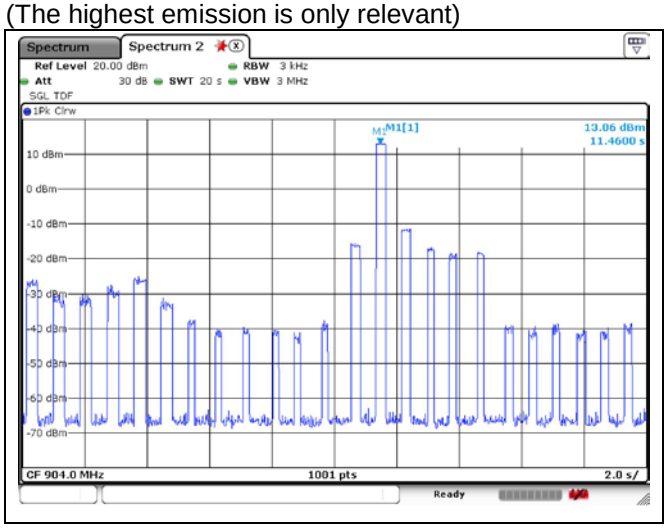
Operation Mode	Channel	Dwell Time (㎳)	Limit (㎳)
Sigfox	Mid	358.5	400

- Test plots

Time slot length



Hops / channel @ 20s = 1 (The highest emission is only relevant)



8. Antenna Requirement

8.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, 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. And according to FCC 47 CFR Section §15.247(b) if transmitting antennas of directional gain greater than 6 dBi are used, the power shall be reduced by the amount in dB that the gain of the antenna exceeds 6 dBi.

8.2. Antenna Connected Construction

Antenna used in this product is PCB antenna with gain of 1.48 dBi

- End of the Test Report -