Test Report

Part 15 Subpart C 15.247

Equipment under test	Ultra-low power & Long-range Wireless LAN Module
Model name	NRM7292B-A1SE
FCC ID	2A32R-NRM7292B
Applicant	SRF Co.,Ltd
Manufacturer	SRF Co.,Ltd
Date of test(s)	2022.01.03~2022.01.14
Date of issue	2022.01.18

Issued to
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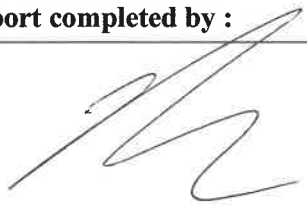
Test and report completed by :	**Report approval by :**
	
Gu-Bong, Kang Test engineer	Young-Jin, Lee Technical manager

Revision history

Revision	Date of issue	Test report No.	Description
-	2022.01.18	KES-RF1-22T0010	Initial

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1. General information

Applicant:	SRF Co.,Ltd
Applicant address:	#303,311, business Incubation Center 155 Ansan Danhak-ro, Sangnok-gu,Ansan-si, Gyeonggi-do, South Korea
Test site:	KES Co., Ltd.
Test site address:	☐ 3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Korea ☒ 473-29, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
Test Facility	FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s):	15.247
FCC ID:	2A32R-NRM7292B
Test device serial No.:	☒ Production ☐ Pre-production ☐ Engineering

1.1. EUT description

Equipment under test	Ultra-low power & Long-range Wireless LAN Module
Frequency range	802.11ah_1 ㎒ : 903.5 ㎒ ~ 926.5 ㎒ 802.11ah_2 ㎒ : 905 ㎒ ~ 925 ㎒ 802.11ah_4 ㎒ : 906 ㎒ ~ 922 ㎒
Model:	NRM7292B-A1SE
Modulation technique	OFDM
Number of channels	802.11ah_1 ㎒ : 903.5 ㎒ ~ 926.5 ㎒ // 24 ch 802.11ah_2 ㎒ : 905 ㎒ ~ 925 ㎒ // 11 ch 802.11ah_4 ㎒ : 906 ㎒ ~ 922 ㎒ // 5 ch
Antenna specification	Antenna type : Dipole Antenna (Female type), Peak gain : 1.68 ㏈i
Power source	DC 3.3 V
H/W Version	NRM7292B_A1SE v0.1
S/W Version	05.01.09

1.2. Test configuration

The **SRF Co.,Ltd // Ultra-low power & Long-range Wireless LAN Module // NRM7292B-A1SE // FCC ID: 2A32R-NRM7292B** was tested according to the specification of EUT, the EUT must comply with following standards and KDB documents.

FCC Part 15.247
KDB 558074 D01 v05 r02
ANSI C63.10-2013

1.3. Derivative Model Information

N/A

1.4. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
-	-	-	-	-

1.5. Sample calculation

Where relevant, the following sample calculation is provided

For all conducted test items :

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Offset(㏈) = RF cable loss(㏈) + attenuator factor(㏈).
= 0.54+ 10 = 10.54 (㏈)

For Radiation test :
Field strength level (㏈㎶/m) = Measured level (㏈㎶) + Antenna factor (㏈) + Cable loss (㏈) – Amplifier gain (㏈)

1.6. Measurement Uncertainty

Test Item		Uncertainty
Uncertainty for Conduction emission test		2.46 ㏈
Uncertainty for Radiation emission test (include Fundamental emission)	Below 1㎓	4.40 ㏈
	Above 1㎓	5.94 ㏈
Note. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.		

1.7. Frequency/channel operations

Ch.	Frequency (㎒)	Mode
01	903.5	802.11ah_1 ㎒
.	.	.
.	.	.
13	915.5	802.11ah_1 ㎒
.	.	.
.	.	.
24	926.5	802.11ah_1 ㎒

Ch.	Frequency (㎒)	Mode
01	905.0	802.11ah_2 ㎒
.	.	.
.	.	.
06	915.0	802.11ah_2 ㎒
.	.	.
.	.	.
11	925.0	802.11ah_2 ㎒

Ch.	Frequency (㎒)	Mode
01	906.0	802.11ah_4 ㎒
.	.	.
.	.	.
03	914.0	802.11ah_4 ㎒
.	.	.
.	.	.
05	922.0	802.11ah_4 ㎒

2. Summary of tests

Section in FCC Part 15	Test description	Test results
15.247(a)(2)	6 dB bandwidth	Pass
15.247(b)(3)	Output power	Pass
15.247(e)	Power spectral density	Pass
15.205, 15.209	Radiated restricted band and emission	Pass
15.247(d)	Conducted spurious emission and band edge	Pass
15.207(a)	AC Conducted emissions	Pass

Note.

1. This test has been performed with power setting below:
   802.11ah_1㎒ : 19
   802.11ah_2㎒ : 25
   802.11ah_4㎒ : 25

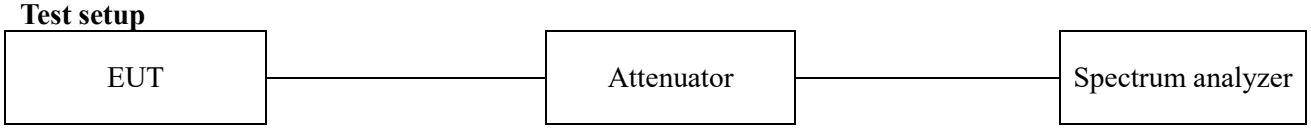
3. Test results

3.1. 6 dB bandwidth

Test procedure

ANSI C63.10-2013 - Section 11.8.2

Test setup



ANSI C63.10-2013 - Section 11.8.2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

Limit

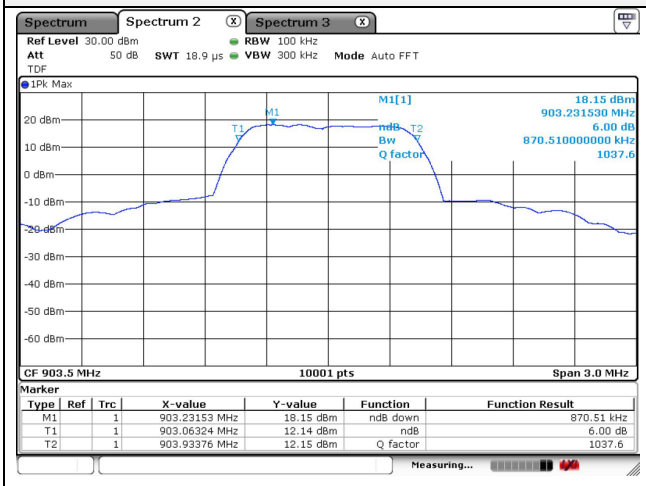
According to §15.247(a)(2), systems using digital modulation techniques may operate 902 ~ 928 MHz, 2 400 ~ 2 483.5 MHz, and 5 725 ~ 5 850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

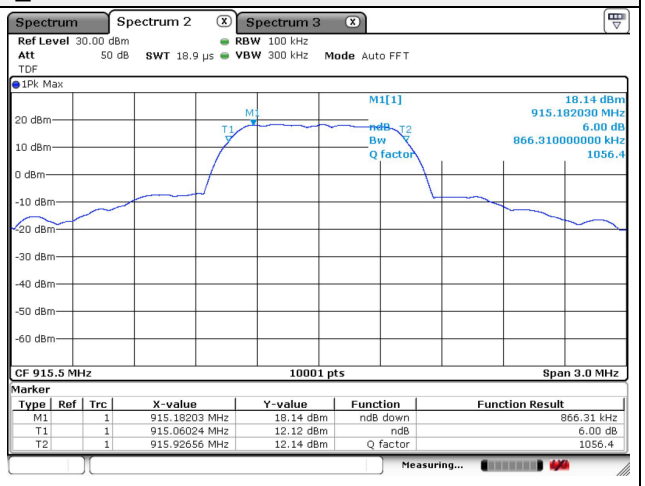
Test results

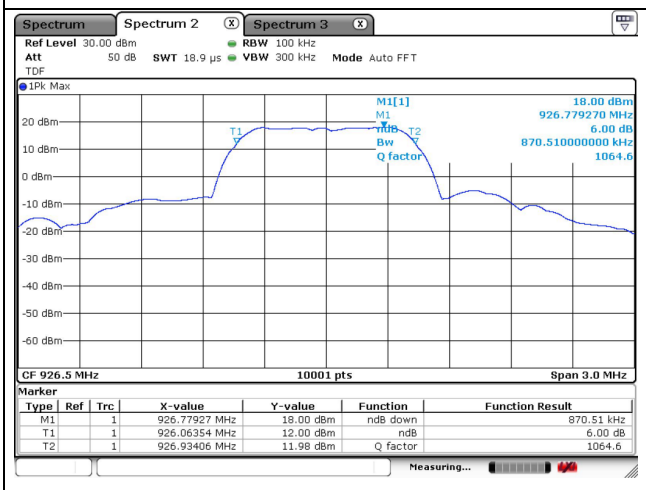
Mode : 802.11ah_1 ㎒

Frequency(㎒)	6 dB bandwidth(㎒)	Limit(㎒)
903.5	0.870 51	≥ 0.500
915.5	0.866 31	
926.5	0.870 51	

802.11ah_1 ㎒





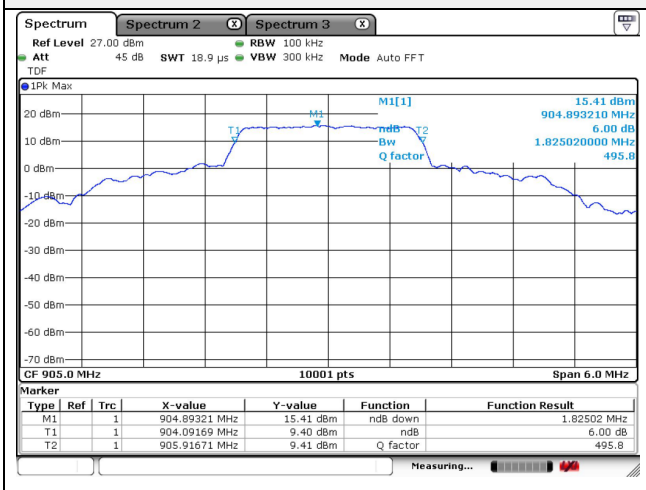


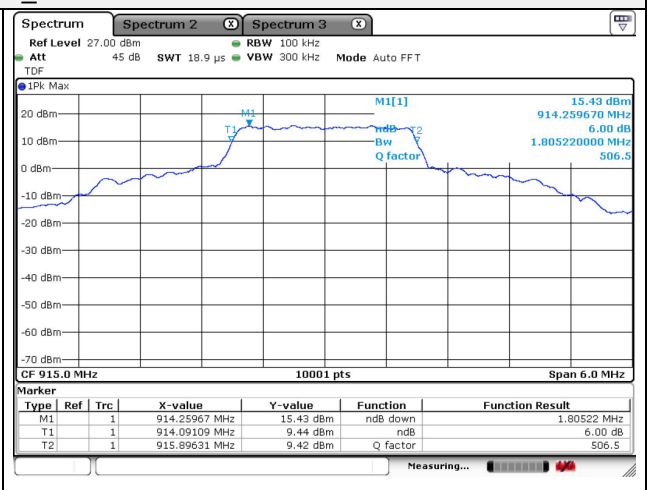
N/A

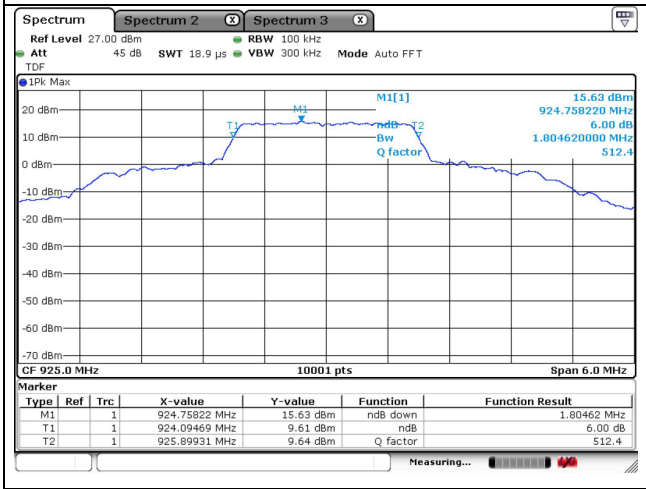
Mode : 802.11ah_2 ㎒

Frequency(㎒)	6 dB bandwidth(㎒)	Limit(㎒)
905.0	1.825 02	≥ 0.500
915.0	1.805 22	
925.0	1.804 62	

802.11ah_2 ㎒





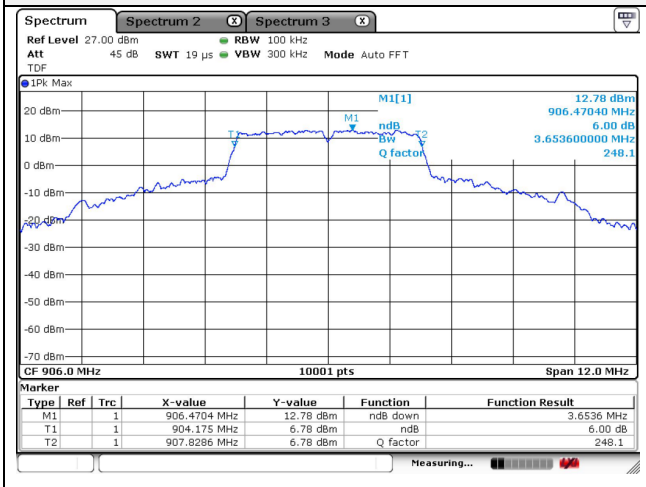


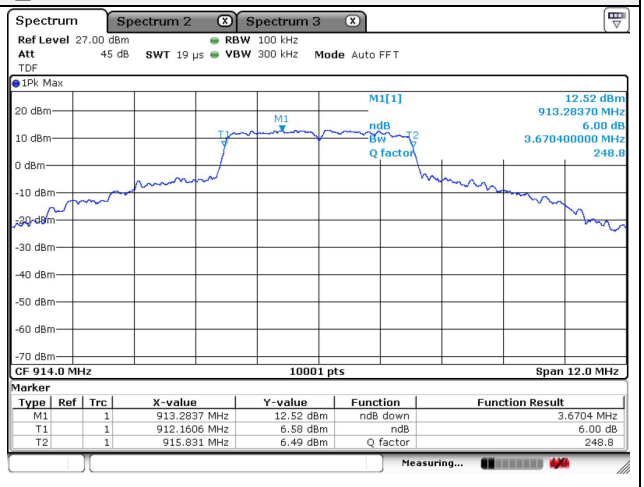
N/A

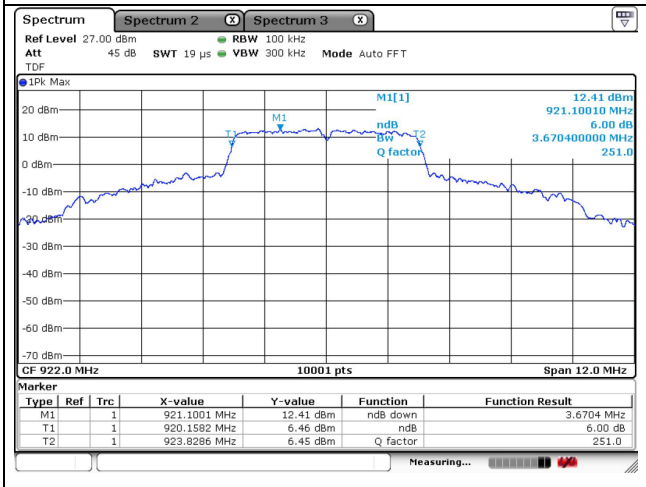
Mode : 802.11ah_4 ㎒

Frequency(㎒)	6 dB bandwidth(㎒)	Limit(㎒)
906.0	3.653 60	≥ 0.500
914.0	3.670 40	
922.0	3.670 40	

802.11ah_4 ㎒







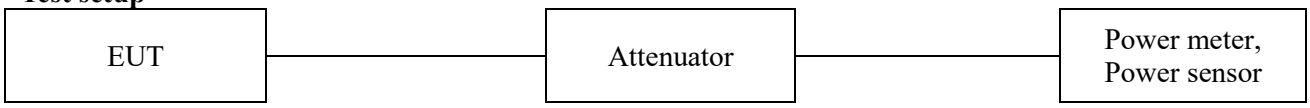
N/A

3.2. Output power

Test procedure

ANSI C63.10-2013 - Section 11.9.1.3 and 11.9.2.3.2

Test setup



ANSI C63.10-2013 - Section 11.9.1.3

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 ba ndwidth and shall use a fast-responding diode detector.

ANSI C63.10-2013 - Section 11.9.2.3.2

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. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Limit

According to §15.247(b)(3), For systems using digital modulation in the 902~928 ㎒, 2 400~2 483.5 ㎒, and 5 725~5 850 ㎒ 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 out-put power. Maximum Conducted Out-put 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.

Test results

Mode : 802.11ah

Mode	903.5 ㎒		915.5 ㎒		926.5 ㎒		
	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Limit (dBm)
1 ㎒	19.03	26.87	19.04	26.76	19.33	26.63	30.00

Mode	905.0 ㎒		915.0 ㎒		925.0 ㎒		
	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Limit (dBm)
2 ㎒	24.27	27.53	24.33	27.56	24.13	27.47	30.00

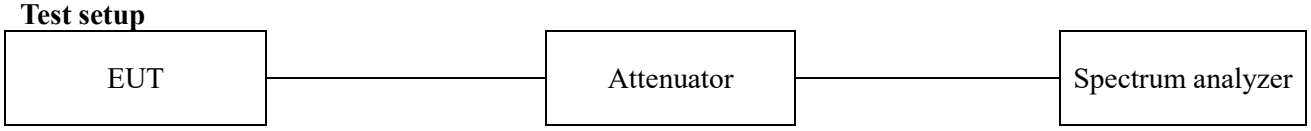
Mode	906.0 ㎒		914.0 ㎒		922.0 ㎒		
	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Average (dBm)	Peak (dBm)	Limit (dBm)
4 ㎒	24.09	27.53	24.04	27.51	24.10	27.54	30.00

3.3. Power spectral density

Test procedure

ANSI C63.10-2013 - Section 11.10.2

Test setup



Section 10.2 & ANSI C63.10-2013 - Section 11.10.2

a. Set analyzer center frequency to DTS channel center frequency.
b. Set the span to 1.5 times the DTS bandwidth.
c. Set the RBW to 3 ㎑ ≤ RBW ≤ 100 ㎑
d. Set the VBW ≥ [3 × RBW].
e. Detector = peak.
f. Sweep time = auto couple.
g. Trace mode = max hold.
h. Allow trace to fully stabilize.
i. Use the peak marker function to determine the maximum amplitude level within the RBW.
j. If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

Limit

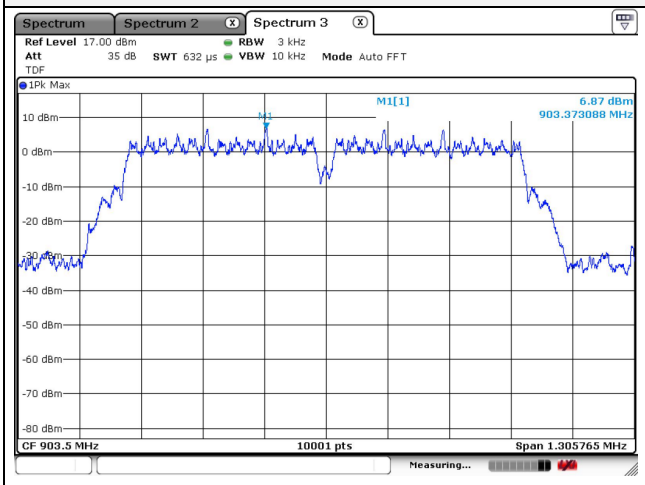
According to §15.247(e), For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance 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.

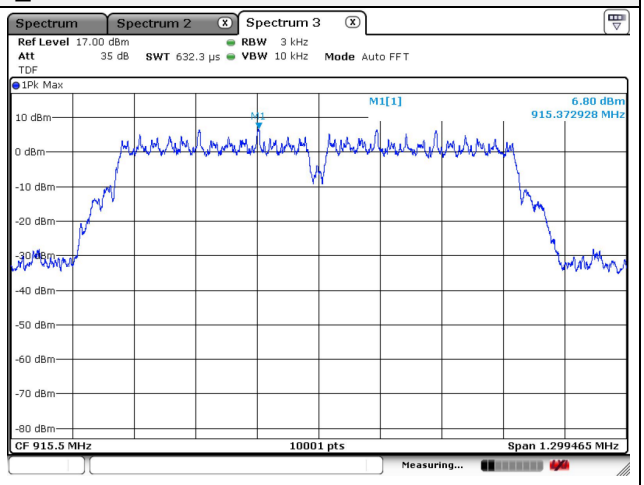
Results

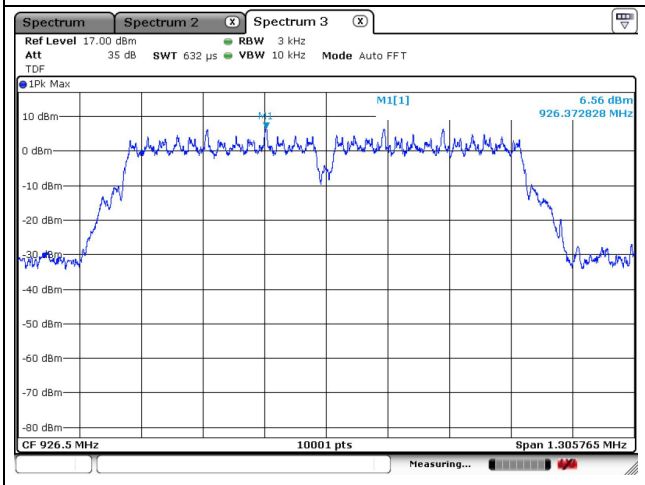
Mode : 802.11ah_1 ㎒

Frequency(㎒)	PSD (dBm)	Limit(dBm)
903.5	6.87	8
915.5	6.80	
926.5	6.56	

802.11ah_1 ㎒





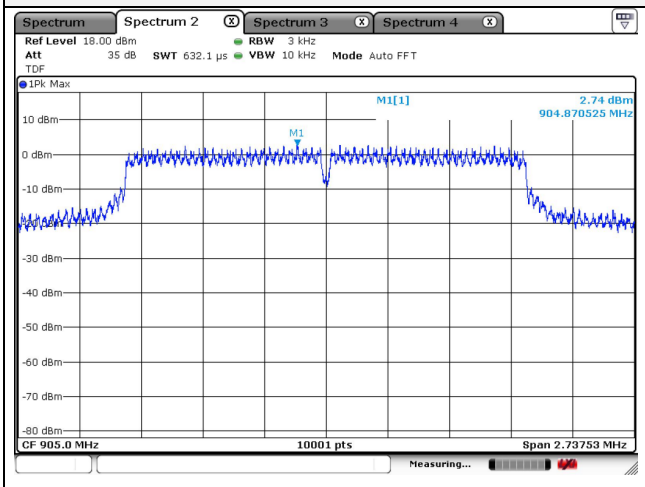


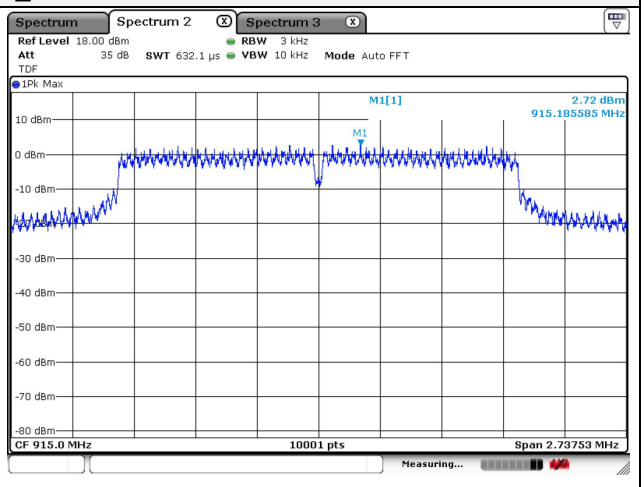
N/A

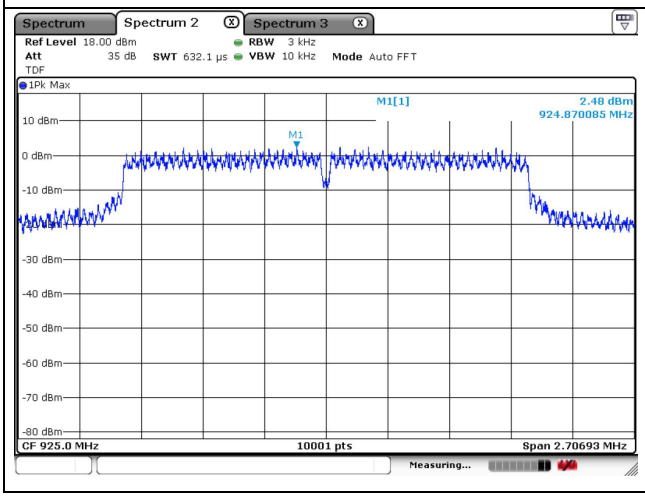
Mode : 802.11ah_2 MHz

Frequency(MHz)	PSD (dBm)	Limit(dBm)
905.0	2.74	8
915.0	2.72	
925.0	2.48	

802.11ah_2 MHz





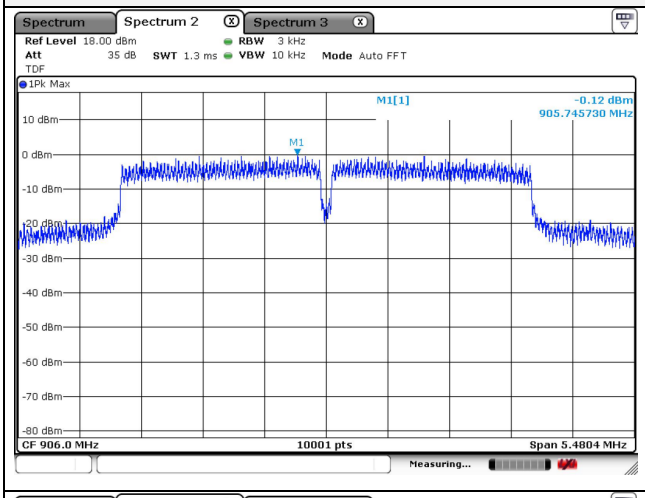


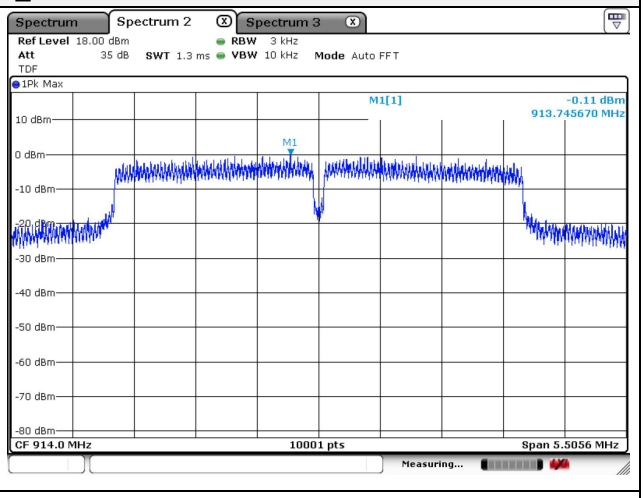
N/A

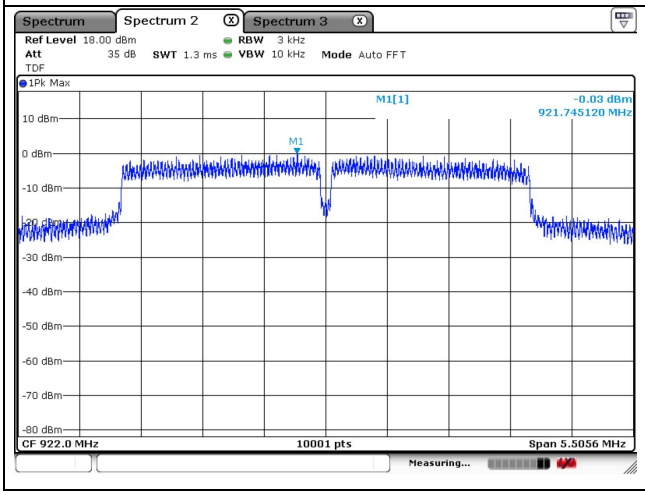
Mode : 802.11ah_4 ㎒

Frequency(㎒)	PSD (dBm)	Limit(dBm)
906.0	-0.12	8
914.0	-0.11	
922.0	-0.03	

802.11ah_4 ㎒





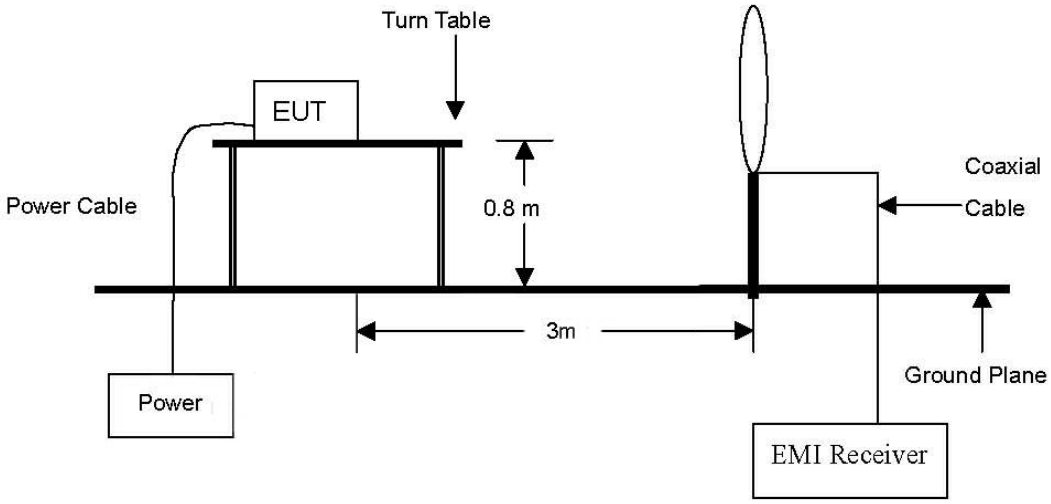


N/A

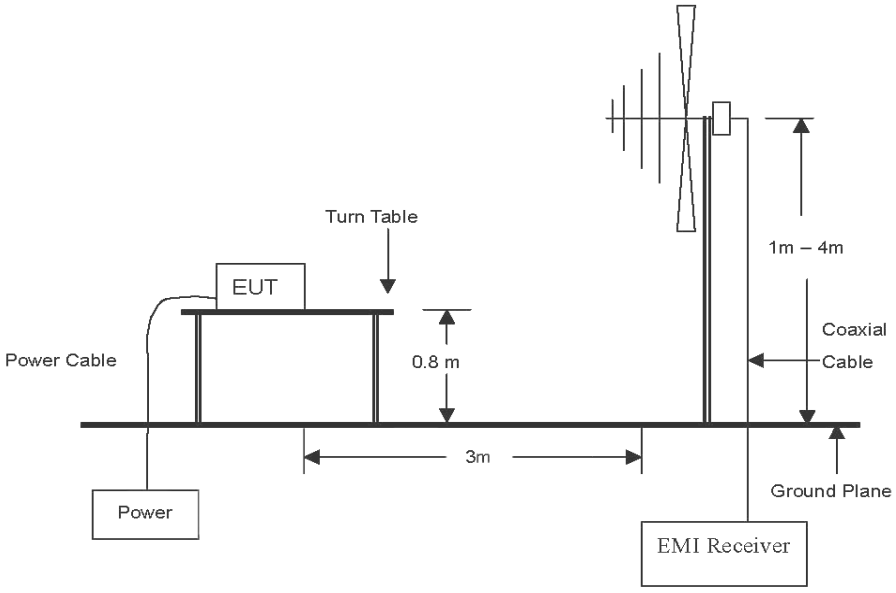
3.4. Radiated restricted band and emissions

Test setup

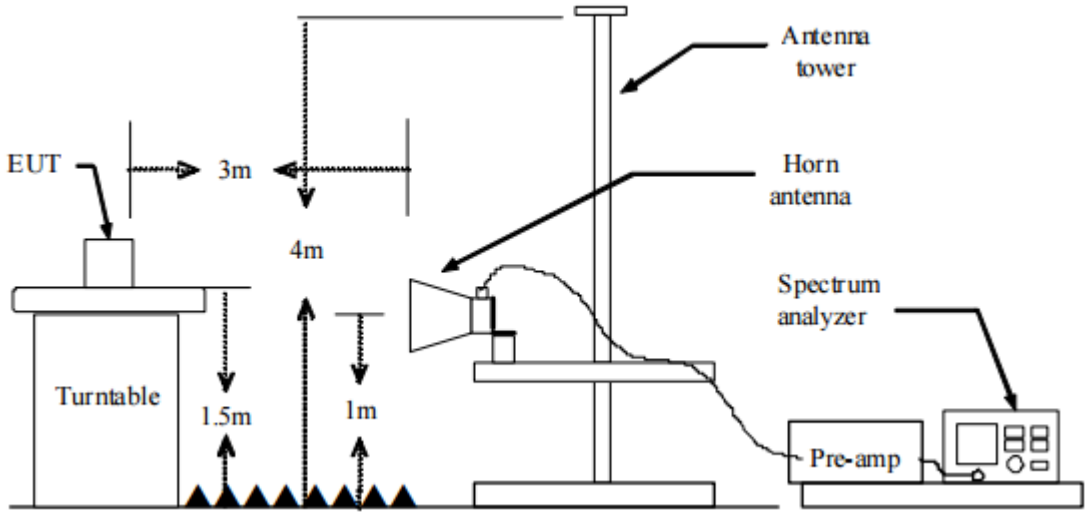
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 ㎑ to 30 ㎒ Emissions.



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



The diagram below shows the test setup that is utilized to make the measurements for emission from 1 ㎓ to the tenth harmonic of the highest fundamental frequency or to 40 ㎓ emissions, whichever is lower.



Test procedure

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013.

Test procedure 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, ground parallel and perpendicular of the antenna are set to make the measurement. It was determined that **parallel** was worst-case orientation; therefore, all final radiated testing was performed with the EUT in **parallel.**
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.

Test procedure above 30 ㎒

1. The EUT was placed on the top of a rotating table 1.5 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. The antenna is a bi-log antenna, a horn antenna ,and its height are 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.
3. 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.
4. The test receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

5. Spectrum analyzer settings for $f < 1$ ㎓:
   ① Span = wide enough to fully capture the emission being measured
   ② RBW = 100 ㎑
   ③ VBW ≥ RBW
   ④ Detector = quasi peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
6. Spectrum analyzer settings for $f \geq 1$ ㎓: Peak
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 ㎒
   ④ Detector = peak
   ⑤ Sweep time = auto
   ⑥ Trace = max hold
   ⑦ Trace was allowed to stabilize

7. Spectrum analyzer settings for $f \geq 1$ ㎓: Average
   ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
   ② RBW = 1 ㎒
   ③ VBW ≥ 3 × RBW
   ④ Detector = RMS, if span/(# of points in sweep) ≤ (RBW/2). Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied, then the detector mode shall be set to peak.
   ⑤ Averaging type = power(i.e., RMS)
      1) As an alternative, the detector and averaging type may be set for linear voltage averaging.
      2) Some instruments require linear display mode in order to use linear voltage averaging. Log or ㏈ averaging shall not be used.
   ⑥ Sweep = auto
   ⑦ Trace = max hold
   ⑧ Perform a trace average of at least 100 traces.
   ⑨ A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
      1) If power averaging (RMS) mode was used in step ⑤, then the applicable correction factor is 10 log(1/x), where x is the duty cycle.
      2) If linear voltage averaging mode was used in step ⑤, then the applicable correction factor is 20 log(1/x), where x is the duty cycle.
      3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.