FCC / IC BT LE REPORT

Certification

Applicant Name: Safetrust Inc	**Date of Issue:** July 24, 2019
Address: 8116 Mill Creek Rd. Fremont, CA 94539, U.S.A.	**Test Site/Location:** EMCE Engineering 1726 Ringwood Avenue San Jose, California USA **Report No.:** EMCE-R-1907-F004-1

FCC ID:	**2ANI5SA200**
IC:	**23133-SA200**
APPLICANT:	**Safetrust Inc**

Model:	SA200
EUT Type:	SABRE Module
RF Peak Output Power:	1.74 dBm (1.49 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation type	GFSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247
IC Rule Part(s):	RSS-247 Issue 2 (February 2017), RSS-Gen Issue 5(April 2018)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

Steve In
Test Engineer
Certification Division

Billy Kim
Technical Manager
Certification Division

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Version

TEST REPORT NO.	DATE	DESCRIPTION
EMCE-R-1907-F004	July 12, 2019	- First Approval Report
EMCE-R-1907-F004-1	July 24, 2019	Revised Test Procedure of Radiated spurious emissions

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1. EUT DESCRIPTION

Model	SA200
EUT Type	SABRE Module
Power Supply	DC 5.0 V
Frequency Range	2402 MHz - 2480 MHz
Max. RF Output Power	Peak : 1.74 dBm (1.49 mW)
	Average : 1.12 dBm (1.29 mW)
Modulation Type	GFSK
Number of Channels	40 Channels
Antenna Specification	Antenna type: Chip antenna Peak Gain :2.0 dBi
Firmware Version	N/A
Haedware Version	SA200
Date(s) of Tests	June 10, 2019 ~ July 11, 2019

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2. METHODOLOGY

FCC KDB 558074 D01 DTS Meas Guidance v05r01 dated February 11 , 2019 entitled “Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C / the RSS-GEN issue 5, RSS-247 issue 2.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

See Section from 9.1 to 9.2.(KDB 558074 v05r01)

DESCRIPTION OF TEST MODES

The EUT has been tested under operating condition. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

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3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC (Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at 1726 Ringwood Avenue, San Jose, California 95131, USA.

The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.

Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.

All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

* The antennas of this E.U.T are permanently attached.

* The E.U.T Complies with the requirement of §15.203

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6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	2.55
Radiated Disturbance (9 kHz ~ 30 MHz)	3.20
Radiated Disturbance (30 MHz ~ 1 GHz)	4.73
Radiated Disturbance (1 GHz ~ 18 GHz)	5.21
Radiated Disturbance (18 GHz ~ 40 GHz)	5.18

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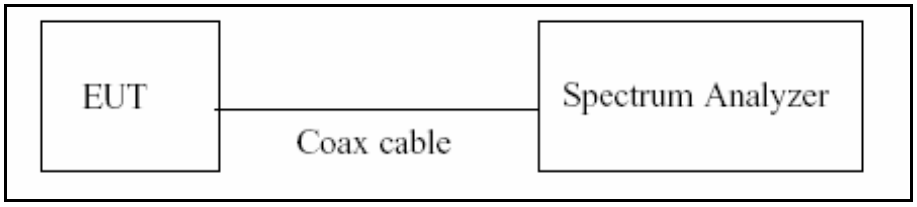
7. DESCRIPTION OF TESTS

7.1. Duty Cycle

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6.0)b) in KDB 558074 v05r01.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

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7.2. 6dB Bandwidth

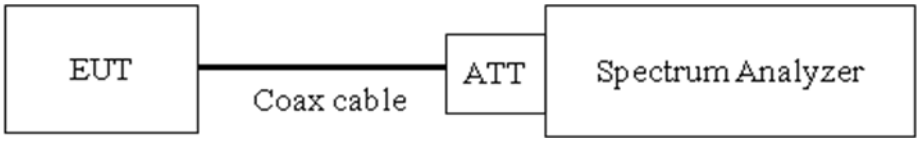
Limit

Test Requirements and limit, §15.247(a)(2) / RSS-247(Issue 2) Section 5.2.

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the receive antenna while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.2 in KDB 558074 v05r01, Procedure 11.8.1 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

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7.3. Output Power

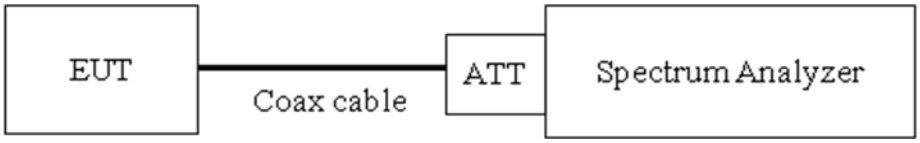
Limit

Test Requirements and limit, §15.247(b)(3) / RSS-247(Issue2) Section 5.4.4.

A transmitter antenna terminal of EUT is connected to the input of a Spectrum Analyzer. Measurement is made while the EUT is operating in transmission mode at the appropriate frequencies.

The maximum permissible conducted output power is 1 Watt.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

This EUT TX condition is actual operating mode by BT LE mode test program.

The Spectrum Analyzer is set to

- Peak Power (Procedure 8.3.1.1 in KDB 558074 v05r01, Procedure 11.9.1.1 in ANSI 63.10-2013)
  1) RBW ≥ DTS Bandwidth
  2) VBW ≥ 3 x RBW
  3) SPAN ≥ 3 x RBW
  4) Detector Mode = Peak
  5) Sweep = auto couple
  6) race Mode = max hold
  7) Allow trace to fully stabilize.
  8) Use peak marker function to determine the peak amplitude level

- Average Power (Procedure 8.3.2.2 in KDB 558074 v05r01, Procedure 11.9.2.2 in ANSI 63.10-2013)
  1) We use the spectrum analyzer's integrated band power measurement function.
  2) Measure the duty cycle
  3) Set span to at least 1.5 times the OBW
  4) RBW = 1-5 % of the OBW, not to exceed 1 MHz.
  5) VBW ≥ 3 x RBW.
  6) Number of points in sweep ≥ 2 x span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
  7) Sweep time = auto.

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8) Detector = RMS(i.e., power averaging)
9) Do not use sweep triggering. Allow the sweep to “free run”.
10) Trace average at least 100 traces in power averaging(RMS) mode.
11) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function with band limits set equal to the OBW band edges.
12) Add 10 log (1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times.

Sample Calculation

▪ Conducted Output Power(Peak) = Reading Value + ATT loss + Cable loss

▪ Conducted Output Power(Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

Note :

1. The power results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 20.5 dB is offset for 2.4 GHz Band.

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7.4. Power Spectral Density

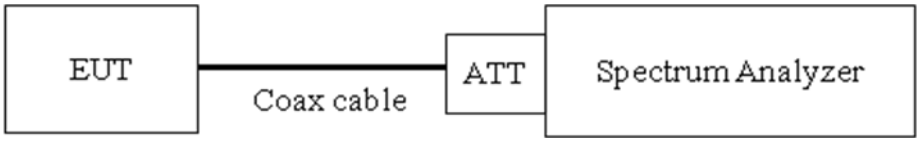
Limit

Test Requirements and limit, §15.247(e) / RSS-247(Issue 2) Section 5.2.

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

Minimum Standard – The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3kHz BW.

Test Configuration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to Procedure 8.4 in KDB 558074 v05r01, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

1) Set analyzer center frequency to DTS channel center frequency.
2) Span = 1.5 times the DTS channel bandwidth.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple
6) Detector = peak
7) Trace Mode = max hold
8) Allow trace to fully stabilize.
9) Use the peak marker function to determine the maximum amplitude level within the RBW.
   If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

Sample Calculation

▪ Power Spectral Density = Reading Value + ATT loss + Cable loss

Note :

1. The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 20.5 dB is offset for 2.4 GHz Band.

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7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

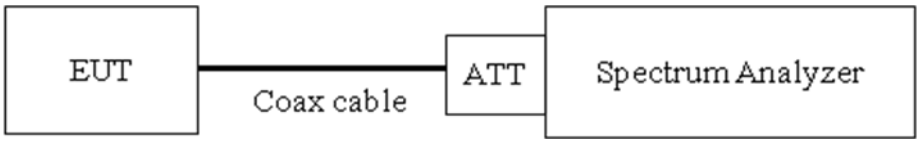
Limit

Test Requirements and limit, §15.247(d) / RSS-247(Issue 2) Section 5.5.

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

[Conducted > 20 dBc]

Test Configuration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 v05r01, Procedure 11.11 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Set span to encompass the spectrum to be examined
4) Detector = Peak
5) Trace Mode = max hold
6) Sweep time = auto couple
7) Ensure that the number of measurement points ≥ 2*Span/RBW
8) Allow trace to fully stabilize.
9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

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Note :

1. The maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1(KDB558074 v05r01), so the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz (i.e., 20 dBc).

2. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.
3. Spectrum offset = Attenuator loss + Cable loss
4. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 20.5 dB is offset for 2.4 GHz Band.
5. In case of conducted spurious emissions test, please check factors blow table.
6. In order to simplify the report, attached plots were only the worst case channel and data rate.

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Factors for frequency

Freq [MHz]	Factor [dB]	Freq [MHz]	Factor [dB]
30	20.13	11000	21.19
100	20.31	12000	21.32
200	20.21	13000	21.44
300	20.16	14000	21.39
400	20.22	15000	21.51
500	20.15	16000	21.66
600	20.26	17000	21.72
700	20.17	18000	21.88
800	20.23	19000	21.92
900	20.21	20000	22.04
1000	20.19	21000	22.17
2000	20.38	22000	22.31
2400*	20.42	23000	22.57
2500*	20.51	24000	22.41
3000	20.53	25000	22.53
4000	20.61		
5000	20.97		
6000	20.73		
7000	21.01		
8000	20.88		
9000	21.11		
10000	21.21		

Note : 1. '*' is fundamental frequency range.

2. Factor = Attenuator loss + Cable loss + EUT Cable loss

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7.6. Radiated Test

Limit

FCC

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30

IC

Frequency (MHz)	Field Strength (uA/m)	Measurement Distance (m)
0.009 – 0.490	6.37/F(kHz)	300
0.490 – 1.705	63.7/F(kHz)	30
1.705 – 30	0.08	30

FCC&IC

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

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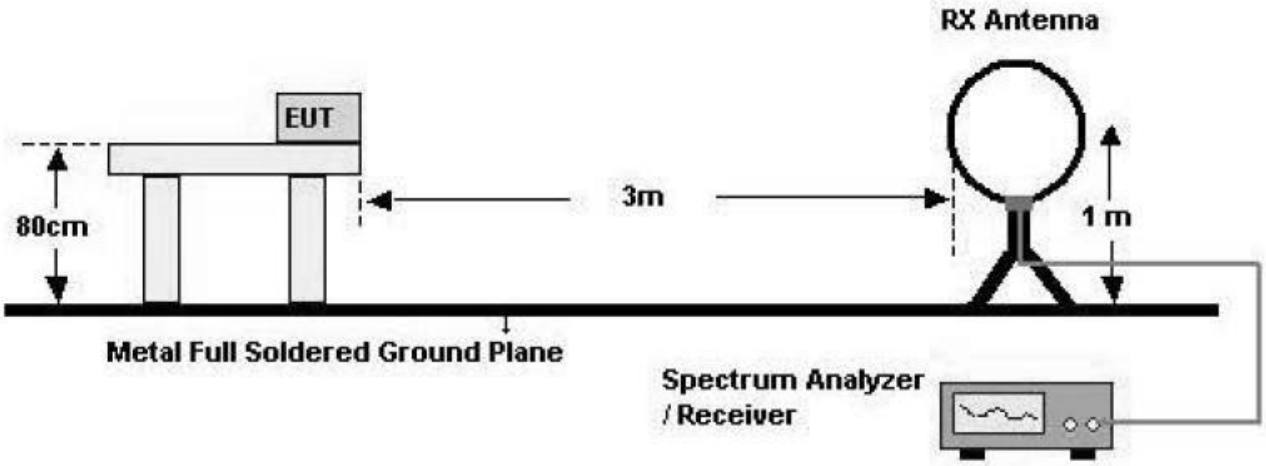
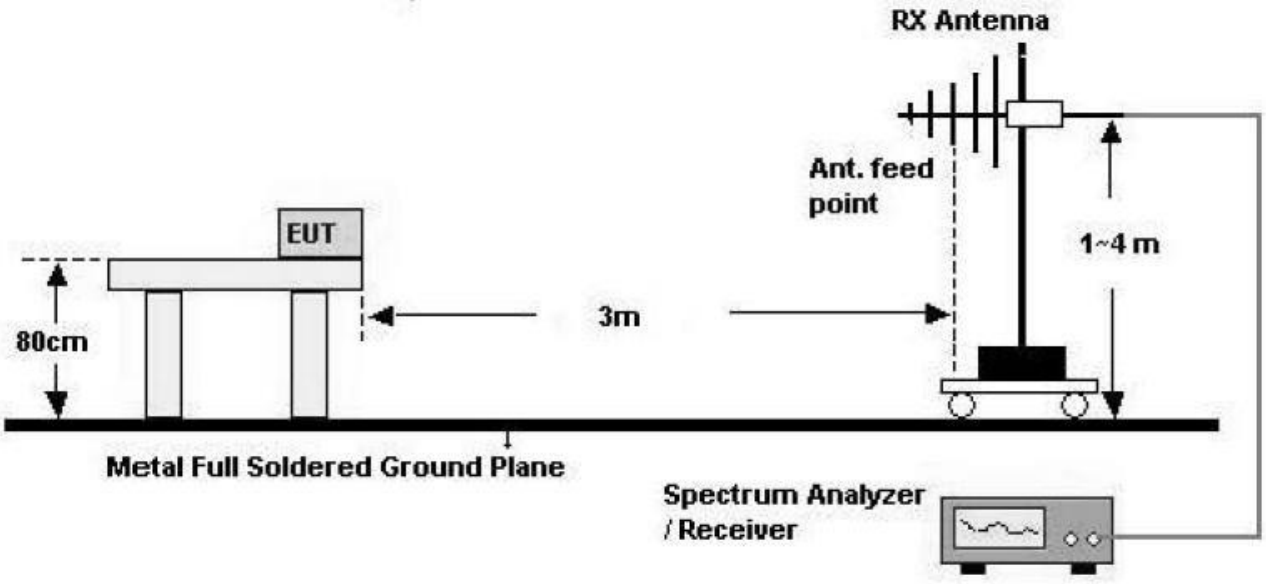
Test Configuration

Below 30 MHz



30 MHz - 1 GHz



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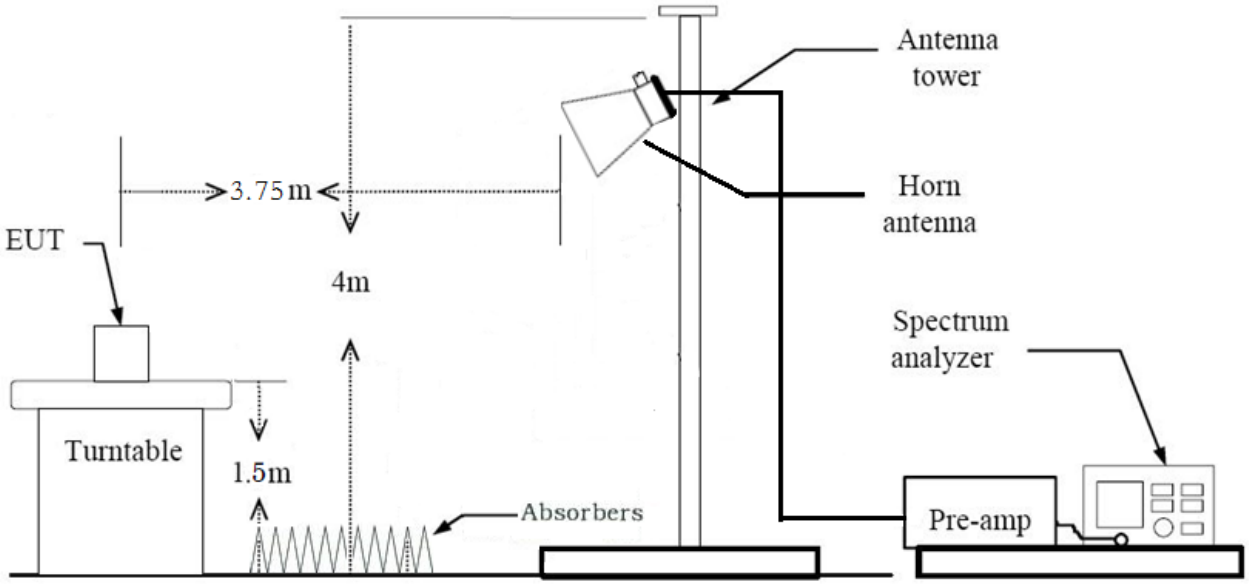
Above 1 GHz



Test Procedure of Radiated spurious emissions(Below 30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor(0.009 MHz – 0.490 MHz) = 40*log(3 m/300 m) = - 80 dB

   Measurement Distance : 3 m
7. Distance Correction Factor(0.490 MHz – 30 MHz) = 40*log(3 m/30 m) = - 40 dB

   Measurement Distance : 3 m
8. Spectrum Setting
   - Frequency Range = 9 kHz ~ 30 MHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 9 kHz
   - VBW ≥ 3*RBW
9. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

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10. Although these tests were performed at a test site other than an open field site, adequate comparison measurements were confirmed against an open field site. Therefore, sufficient test were made to demonstrate that the alternative site produces Result that correlate with the one of test made in an open field site based on KDB 414788

Sample validation

Reference-signal Frequency [kHz]	Reading [dBuV]	Measurement Distance [m]	Extrapolation Factor	Total [dBuV/m]
135	70.1	3	80.0	-9.9
135	47.4	10	59.1	-11.7

Test Procedure of Radiated spurious emissions(Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting
   (1) Measurement Type(Peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 100 kHz
      - VBW ≥ 3*RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range : 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz
   *In general, (1) is used mainly
6. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L)

Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.

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6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. The unit was tested with its standard battery.
10. Spectrum Setting
    (1) Measurement Type(Peak):
        - Measured Frequency Range : 1 GHz – 25 GHz
        - Detector = Peak
        - Trace = Maxhold
        - RBW = 1 MHz
        - VBW ≥ 3*RBW
    (2) Measurement Type(Average):
        - We performed using a reduced video BW method was done with the analyzer in linear mode
        - Measured Frequency Range : 1 GHz – 25 GHz
        - Detector = Peak
        - Trace = Maxhold
        - RBW = 1 MHz
        - VBW ≥ 1/τ Hz, where τ = pulse width in seconds
          The actual setting value of VBW = 1 kHz
11. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
12. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

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Test Procedure of Radiated Restricted Band Edge

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting
   (1) Measurement Type(Peak):
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 1 MHz
      - VBW ≥ 3*RBW
   (2) Measurement Type(Average):
      - We performed using a reduced video BW method was done with the analyzer in linear mode
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 1 MHz
      - VBW ≥ 1/τ Hz, where τ = pulse width in seconds
        The actual setting value of VBW = 1 kHz

10. Total

= Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

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7.7. AC Power line Conducted Emissions

Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

*Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

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7.8. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.
2. EUT Axis
   - Radiated Spurious Emissions : Y
   - Radiated Restricted Band Edge : Y
3. All packet length of operation were investigated and the test results are worst case in highest packet length. (Worst case : 37 Byte)

Conducted test

1. The EUT was configured with packet length of highest power.
   (Packet length of highest power : 37 Byte)

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8. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	IC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	RSS-247, 5.2.(a)	> 500 kHz	Conducted	PASS
Occupied Bandwidth	N/A	RSS-GEN, 6.7	N/A		PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	RSS-247, 5.4.(d)	< 1 Watt		N/A
Power Spectral Density	§15.247(e)	RSS-247, 5.2.(b)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§15.247(d)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	RSS-GEN, 8.8	cf. Section 7.7		PASS
Radiated Spurious Emissions	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9 RSS-GEN, 8.10	cf. Section 7.6		PASS
Receiver Spurious Emissions	N/A	RSS-GEN, 7.3	cf. Section 7.8		PASS

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9. TEST RESULT

9.1 DUTY CYCLE

T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
1	1	1	0

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9.2 6 dB BANDWIDTH MEASUREMENT

Channel	6 dB Bandwidth (kHz)	Limit (kHz)
	ANT1	
0	740.0	> 500
19	753.7	
39	746.7	

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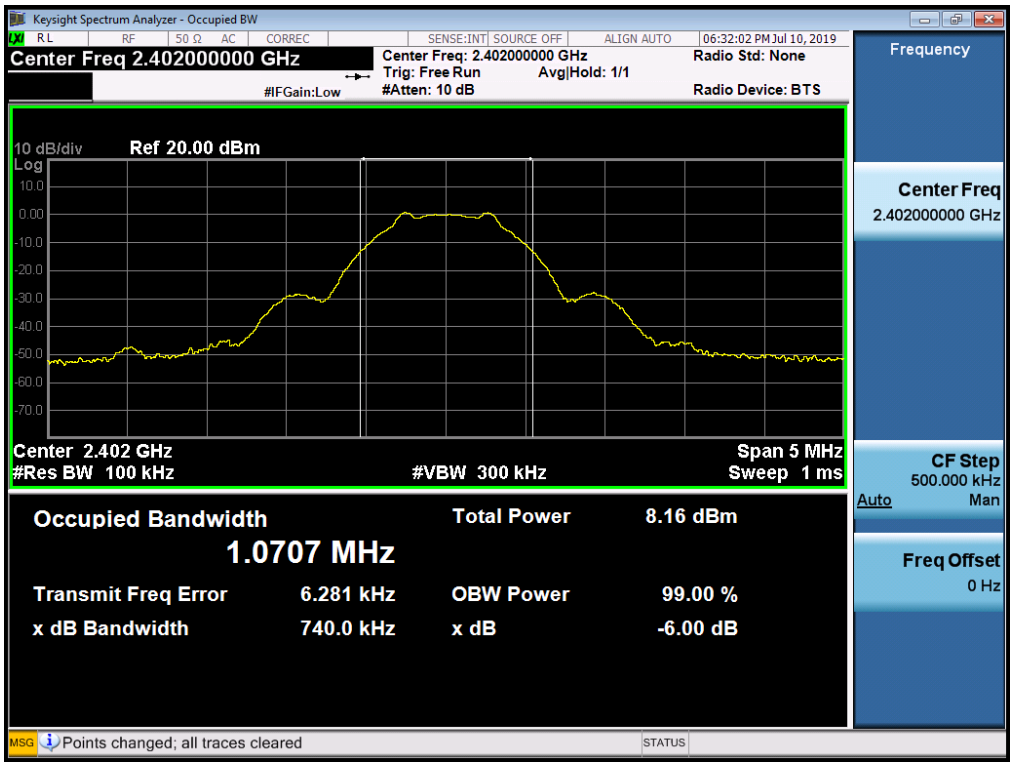
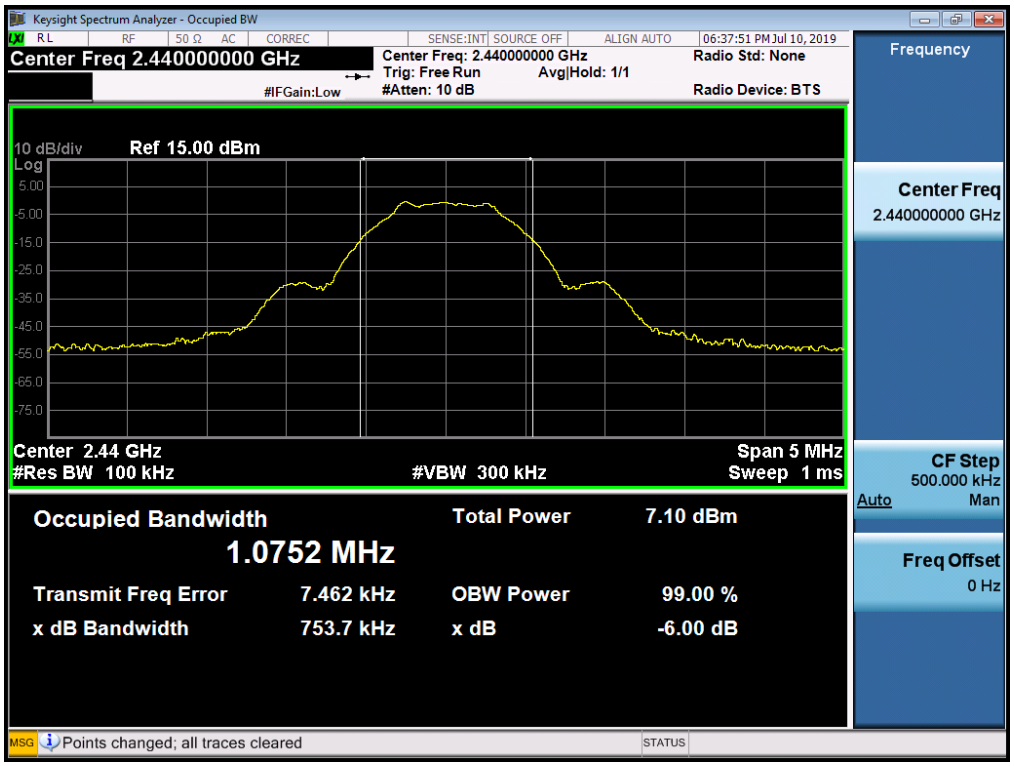
▣ Test Plots

ANT1

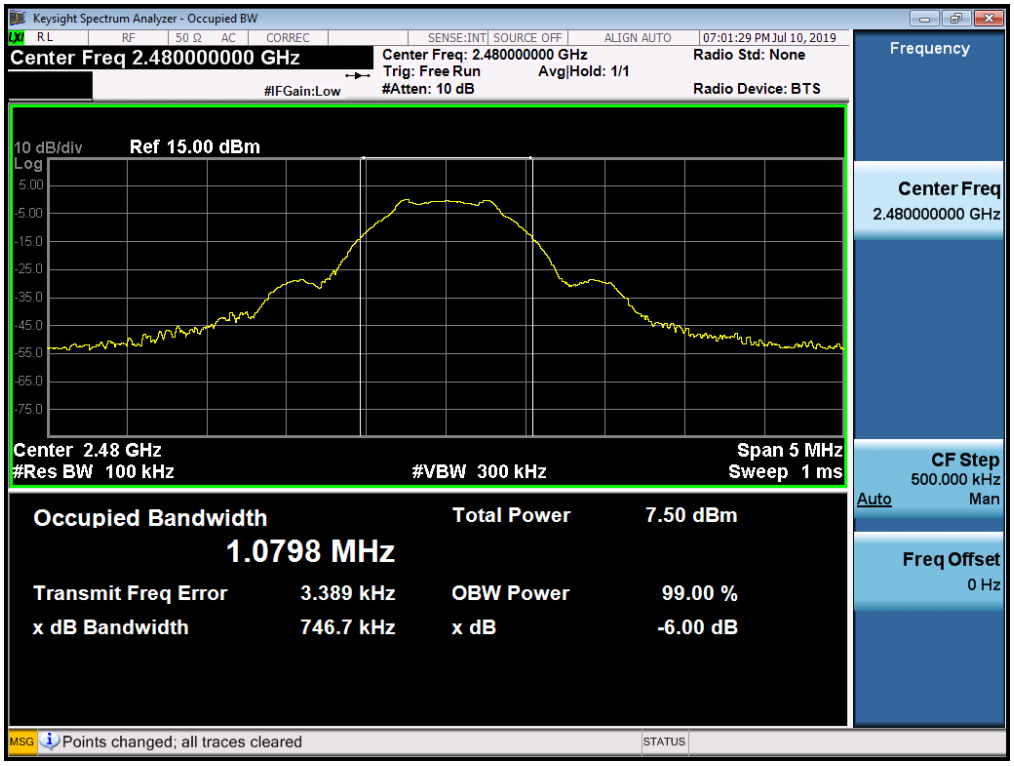
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)



6 dB Bandwidth plot (High-CH 39)



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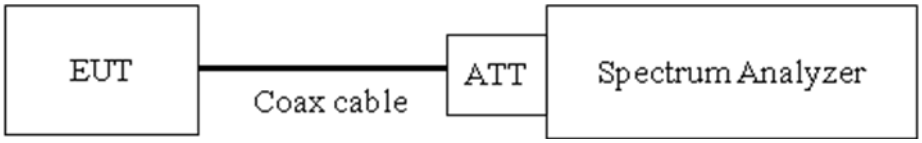
9.3 99% BANDWIDTH

Limit, RSS-Gen(Issue 5) Section 6.7

The 99 % bandwidth is used to determine the conducted power limits.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer.

RBW = 1% ~ 5% of the occupied bandwidth

VBW ≒ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

▣ TEST RESULTS

LE Mode		Measured Bandwidth (kHz)	
Frequency [MHz]	Channel No.	ANT1	ANT2
2402	0	1063.7	1065.5
2440	19	1059.8	1064.6
2480	39	1072.9	1058.4

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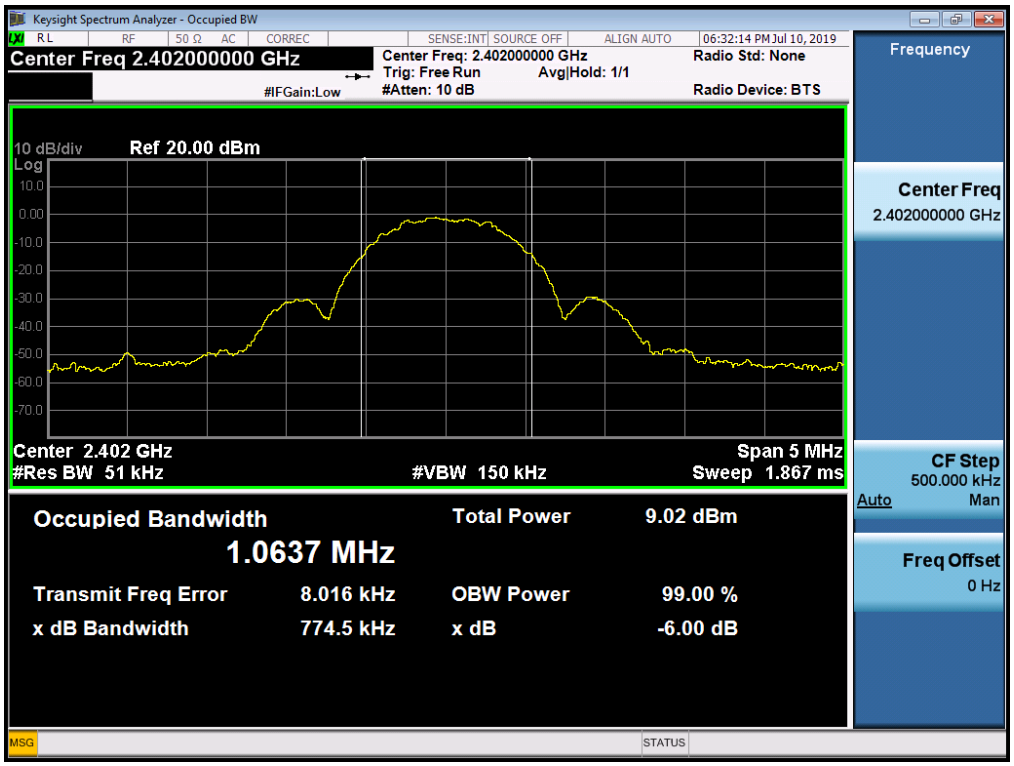
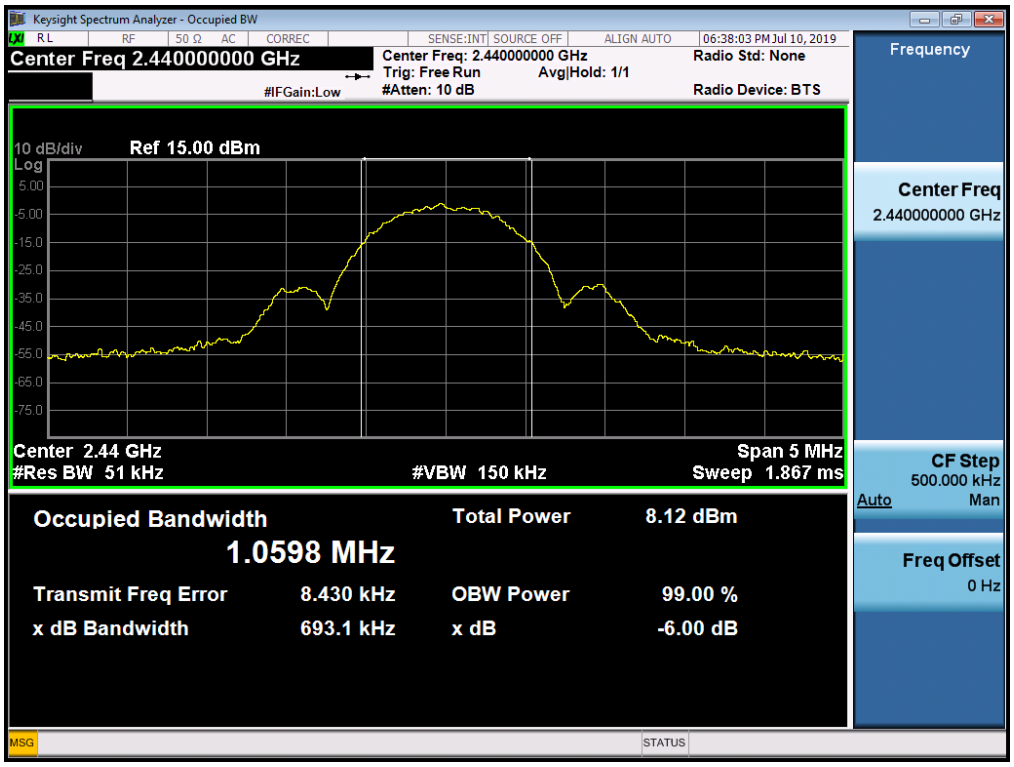
▣ RESULT PLOTS

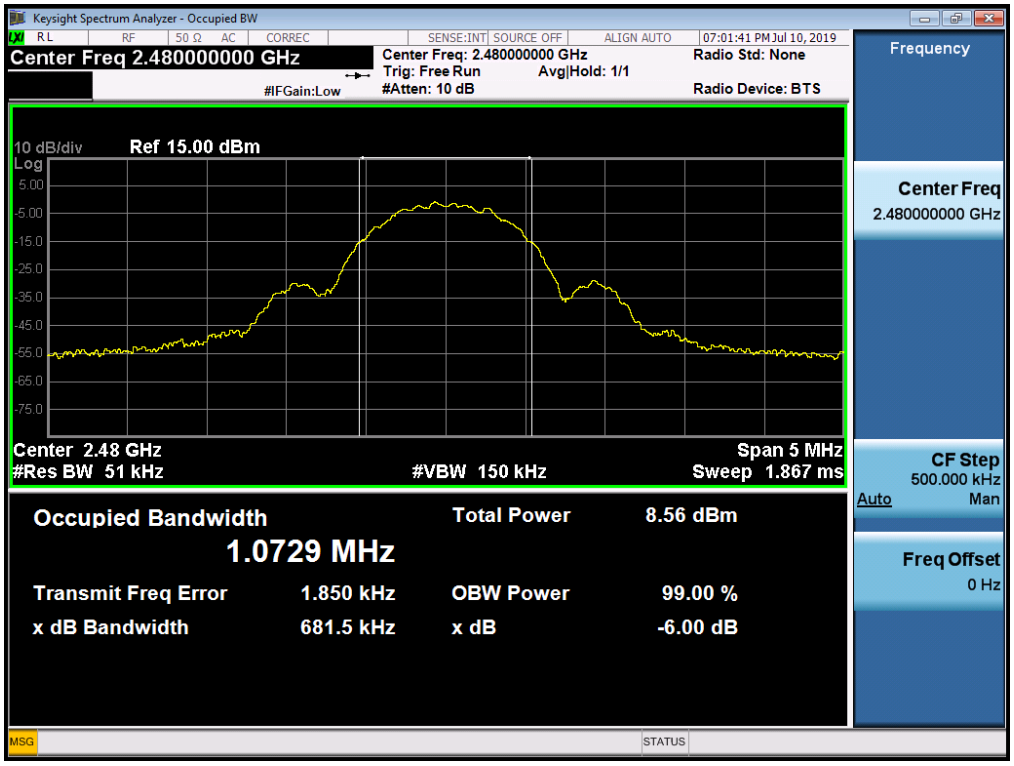
99% Bandwidth plot (Low-CH 0)



99% Bandwidth plot (Mid-CH 19)



99% Bandwidth plot (High-CH 39)



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9.4 OUTPUT POWER

Peak Power

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.	ANT1	
2402	0	1.743	30
2440	19	0.731	30
2480	39	0.976	30

Average Power

LE Mode		Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency[MHz]	Channel No.	ANT1	
2402	0	1.12	30
2440	19	0.25	30
2480	39	0.50	30

Note :

1. Spectrum reading values are not plot data.

   The power results in plot is already including the actual values of loss for the attenuator and cable combination.

2. Spectrum offset = Attenuator loss + Cable loss

3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest twentieth dB.

   So, 20.42 dB is offset for 2.4 GHz Band.

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▣ Test Plots

Peak Power

Conducted Output Power (Low-CH 0)

Conducted Output Power (Mid-CH 19)

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Conducted Output Power (High-CH 39)

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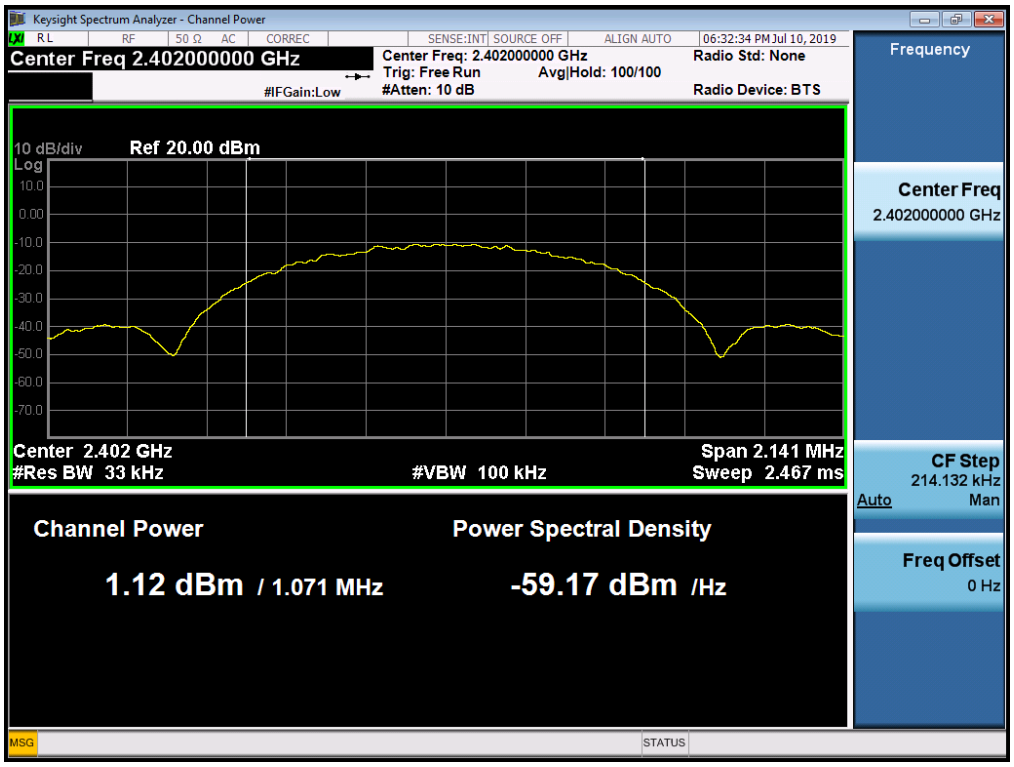
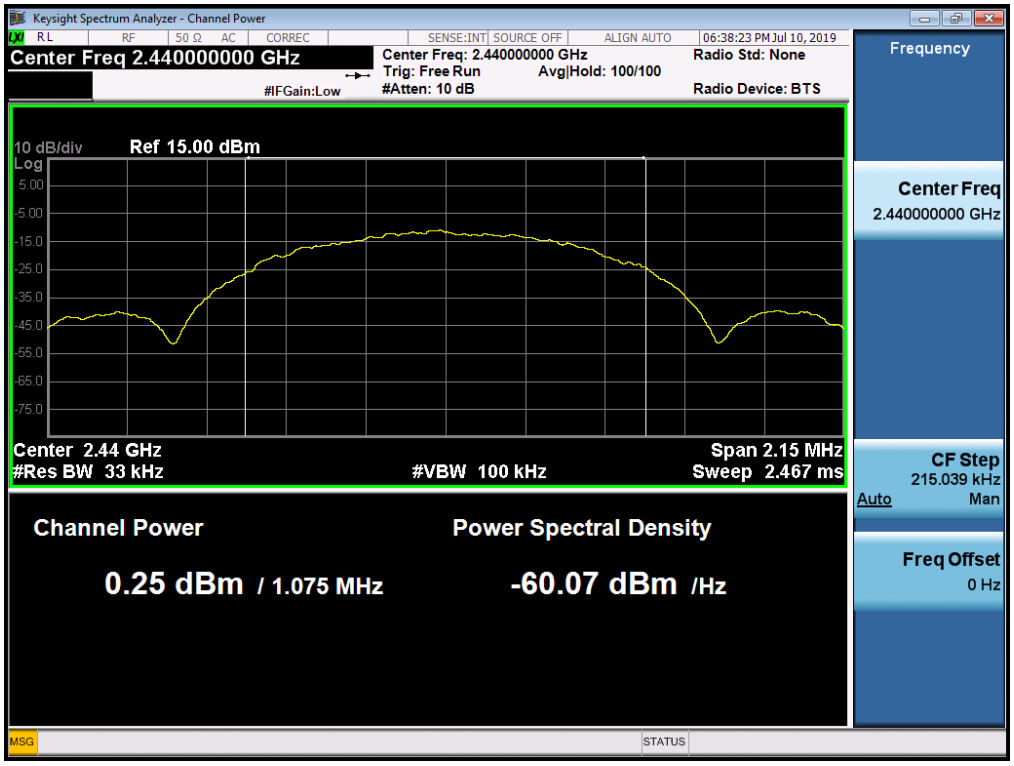
Average Power

ANT1

Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



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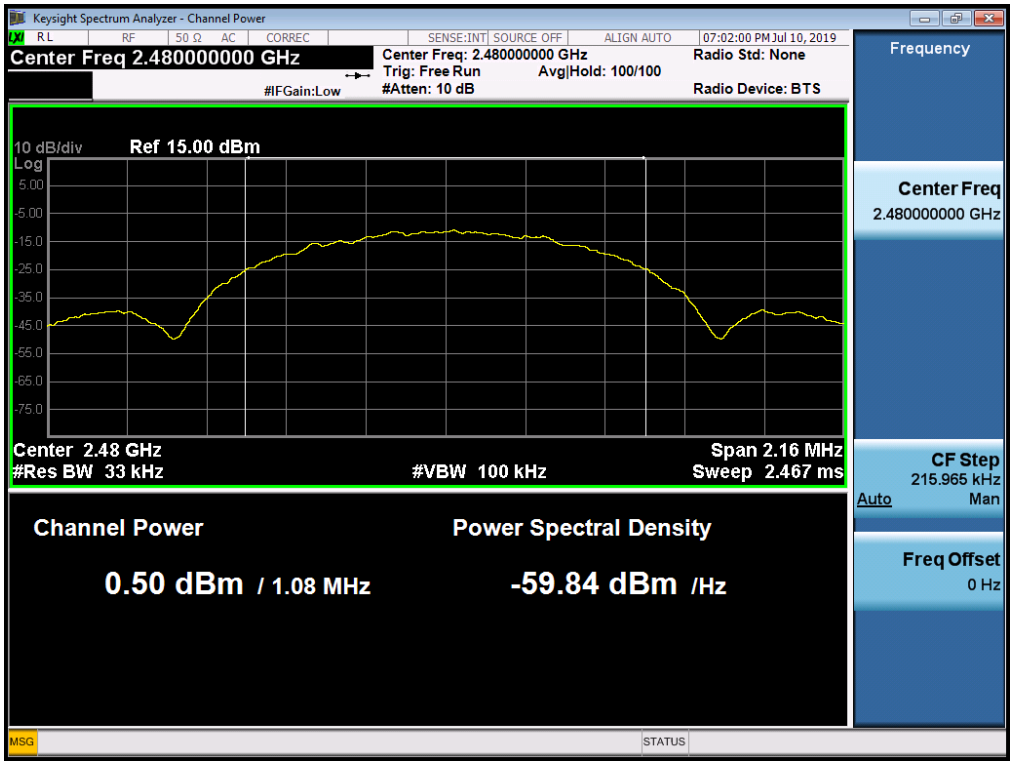
Conducted Output Power (High-CH 39)



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9.5 POWER SPECTRAL DENSITY

Frequency (MHz)	Channel No.	PSD (dBm)	
		ANT1	Limit (dBm)
2402	0	-12.0	8.000
2440	19	-12.9	8.000
2480	39	-12.6	8.000

Note :

1. Spectrum reading values are not plot data.
   The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest twentieth dB.
   So, 20.42 dB is offset for 2.4 GHz Band.

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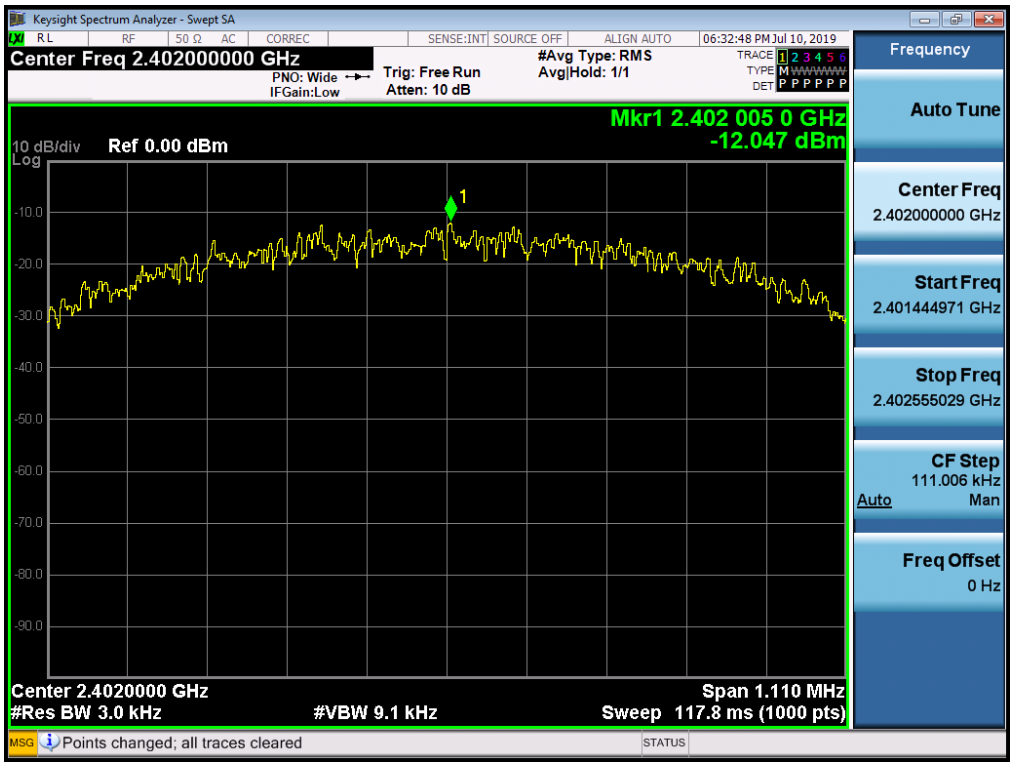
▣ Test Plots

Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)

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Power Spectral Density (High-CH 39)

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9.6 Conducted Band Edge & Conducted Spurious Emissions

▣ TEST RESULTS

Out of Band Emissions at the Band Edge

Frequency [MHz]	Channel No.	Position	Test Result		
			Measured Level [dB]	Limit [dBc]	Pass/Fail
2402	0	Lower	32.41	20	Pass
2480	39	Upper	36.06	20	Pass

Conducted Spurious Emissions

Frequency [MHz]	Channel No.	Position	Test Result		
			Measured Level [dB]	Limit [dBc]	Pass/Fail
2402	0	Lower	24.23	20	Pass
2440	19	Middle	27.43	20	Pass
2480	39	Upper	28.93	20	Pass

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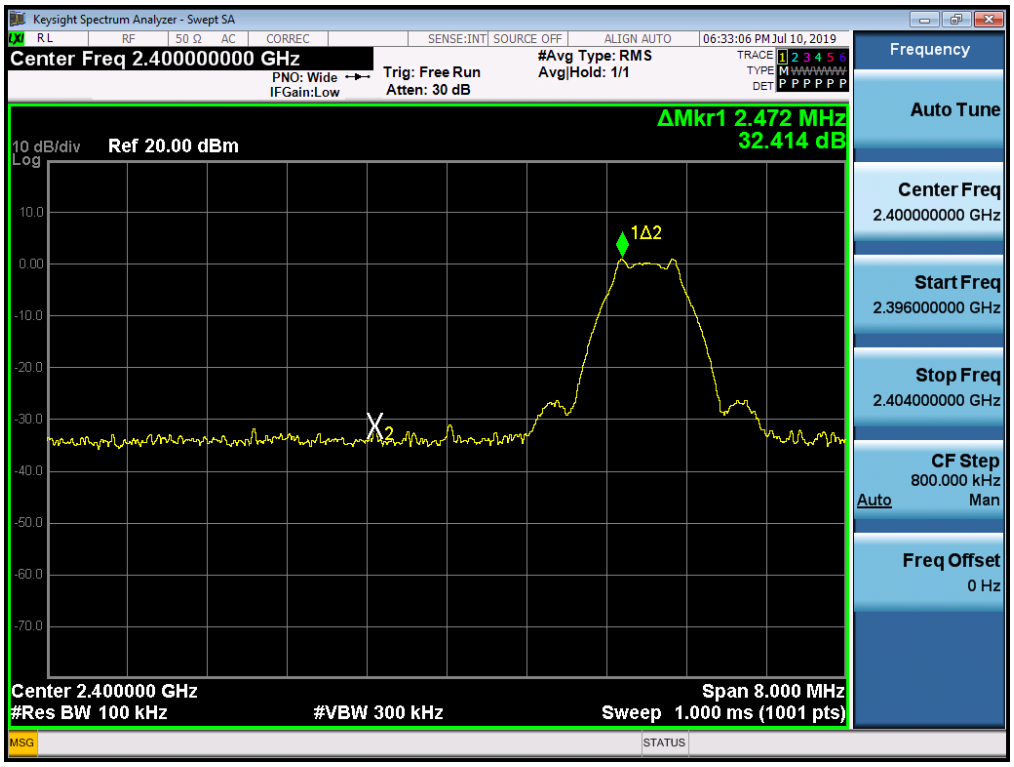
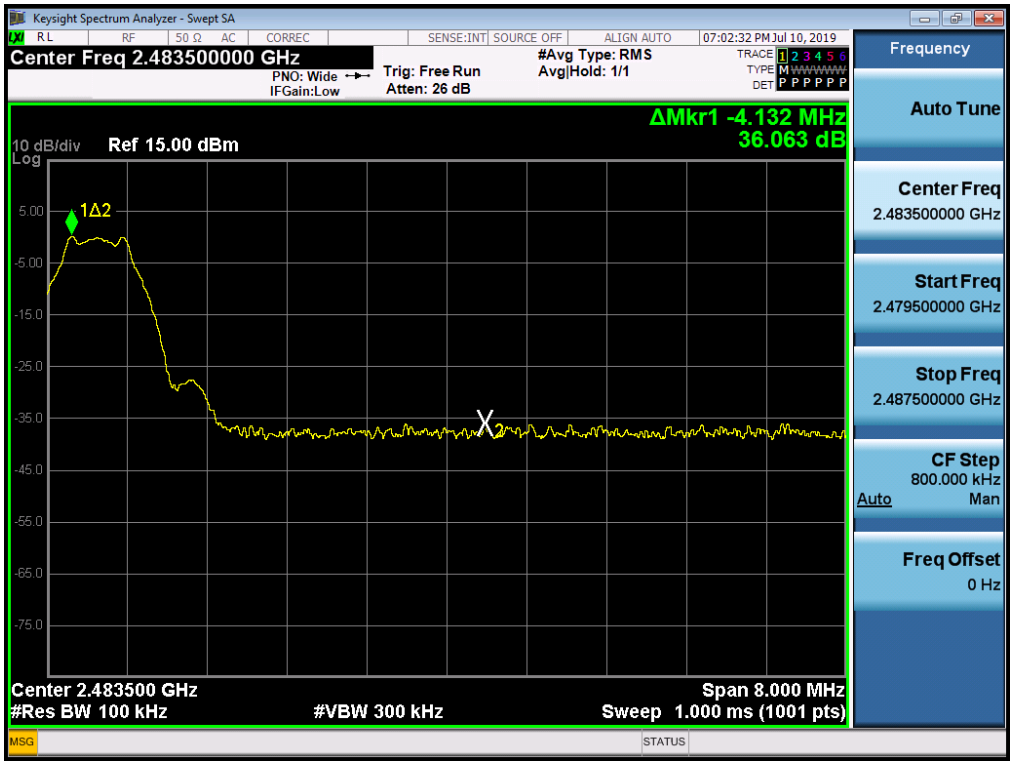
▣ Test Plots(BandEdge)

Low-CH 0



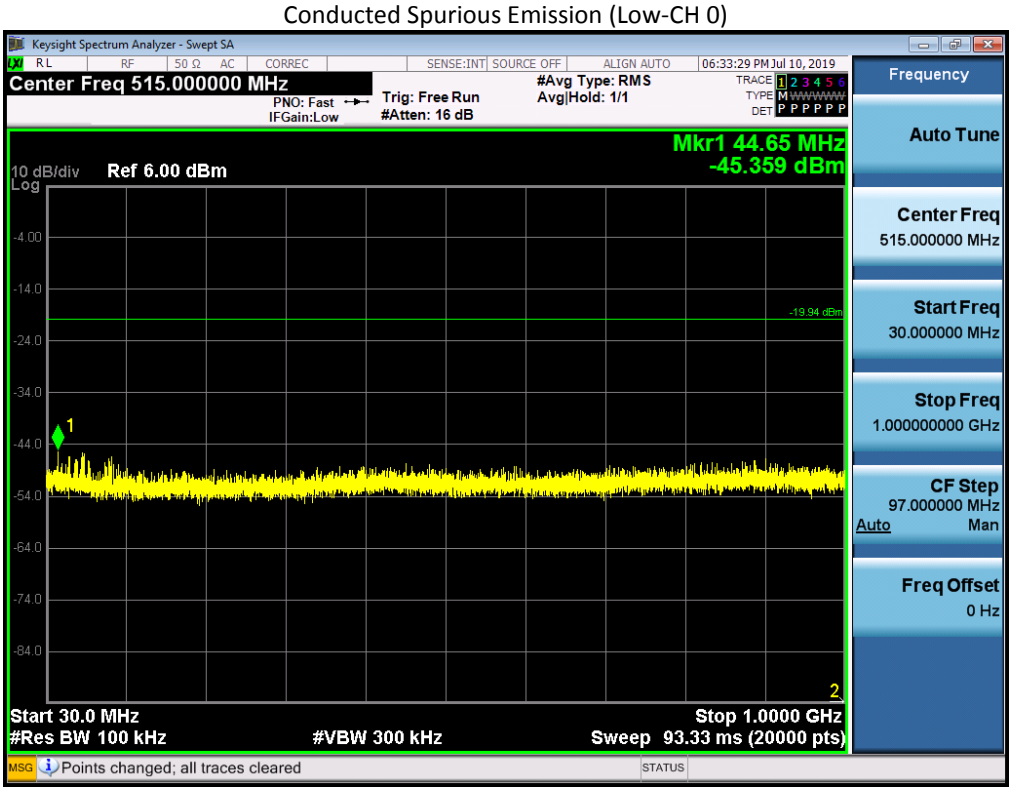
High-CH 39



▣ Test Plots(Conducted Spurious Emission)

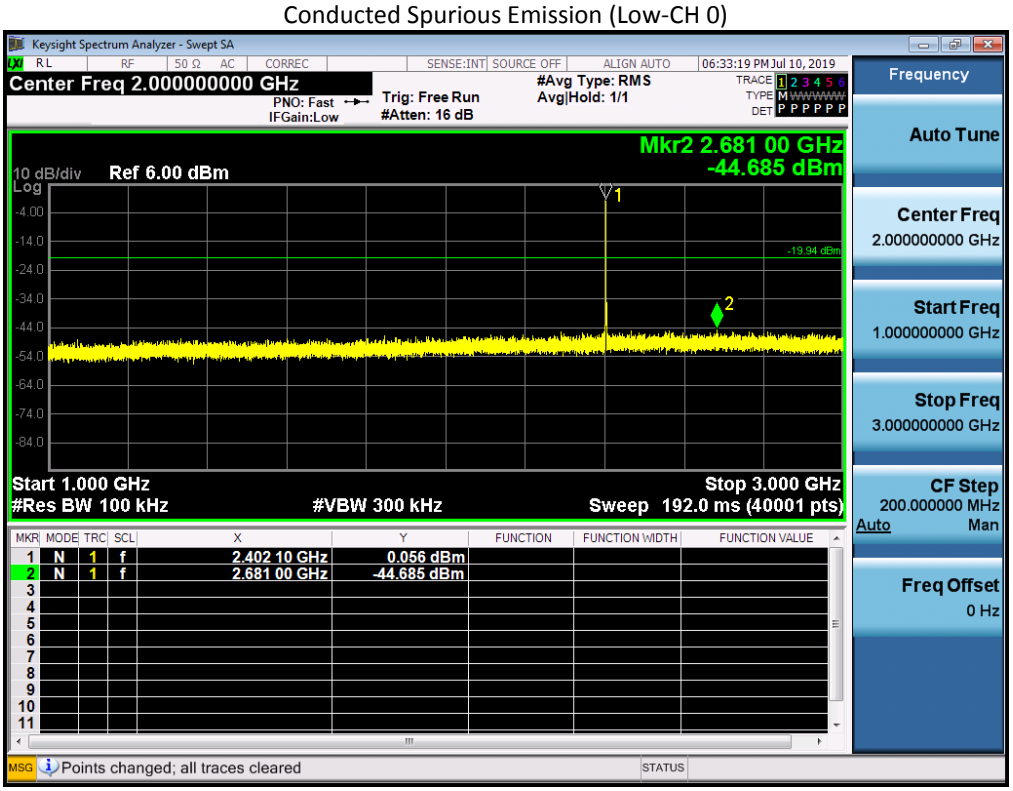
30 MHz ~ 1 GHz

Conducted Spurious Emission (Low-CH 0)



1 GHz ~ 3 GHz

Conducted Spurious Emission (Low-CH 0)



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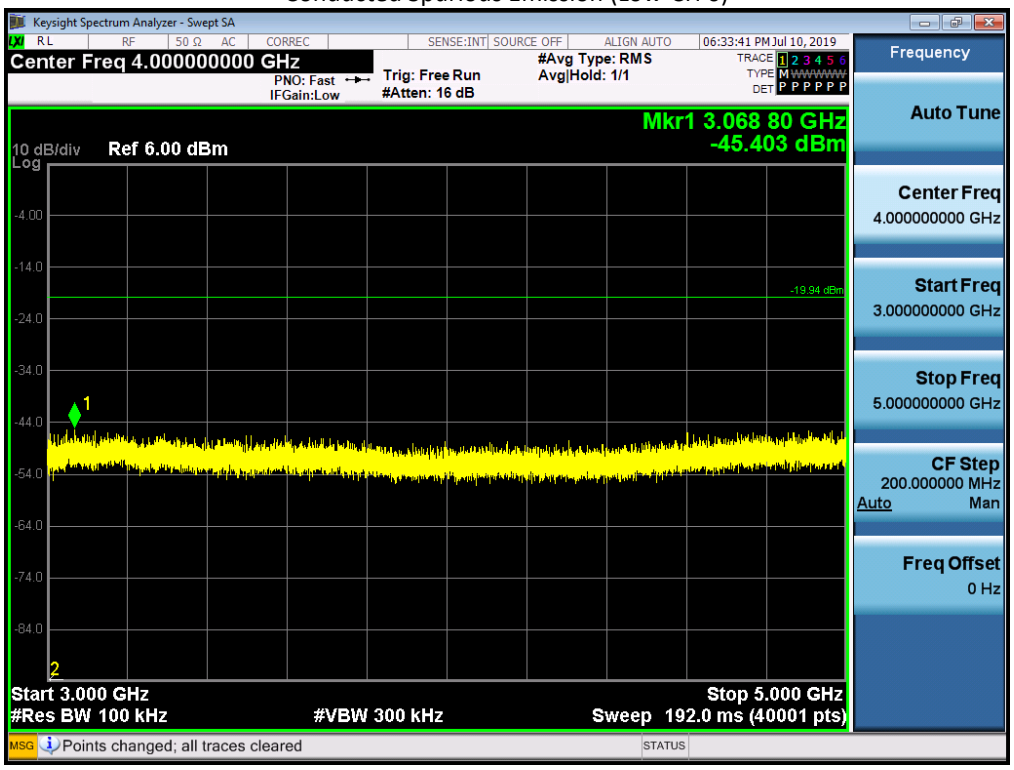
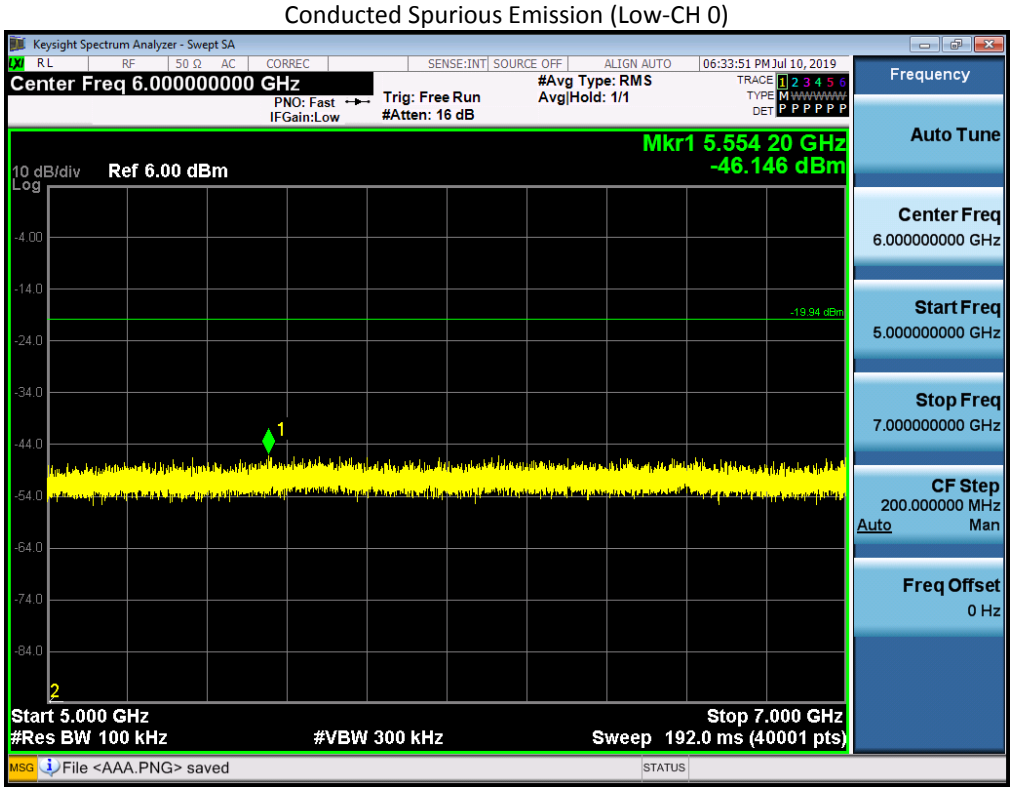
3 GHz ~ 5 GHz

Conducted Spurious Emission (Low-CH 0)



5 GHz ~ 7 GHz

Conducted Spurious Emission (Low-CH 0)



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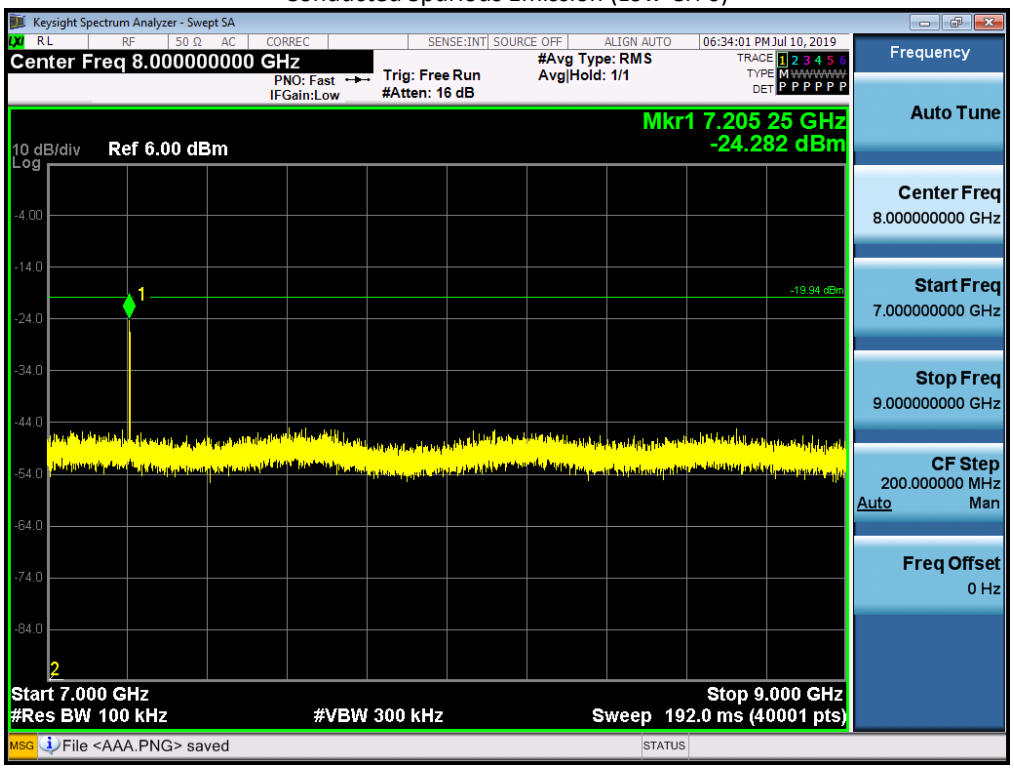
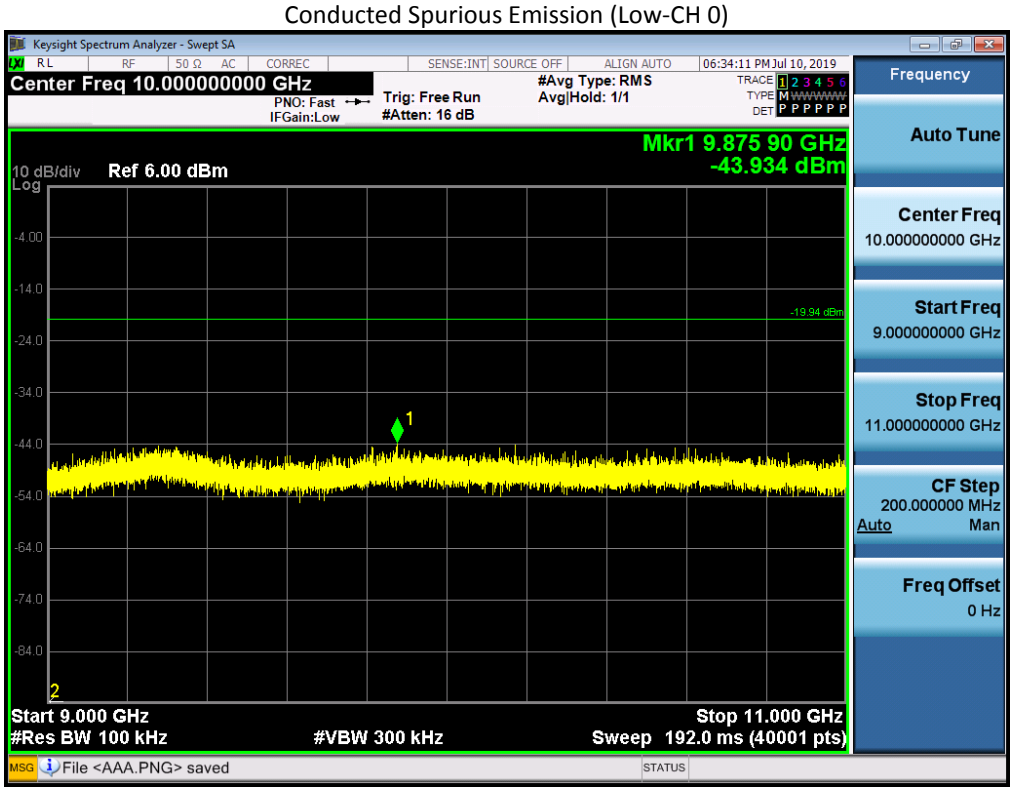
7 GHz ~ 9 GHz

Conducted Spurious Emission (Low-CH 0)



9 GHz ~ 11 GHz

Conducted Spurious Emission (Low-CH 0)



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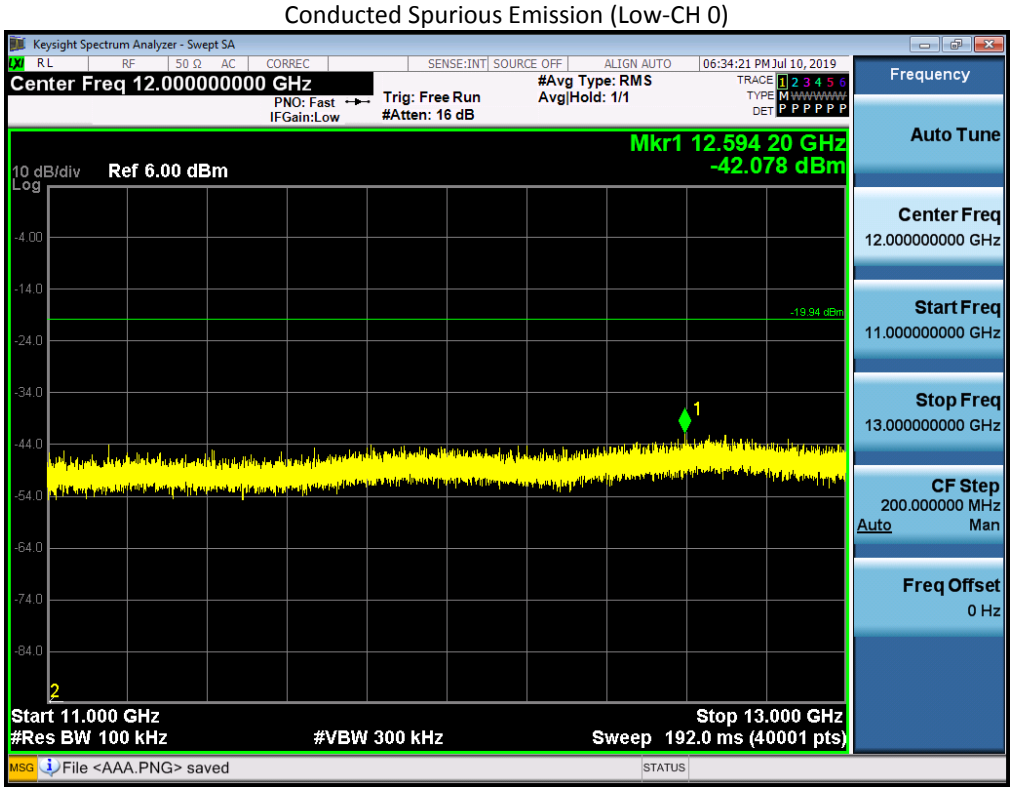
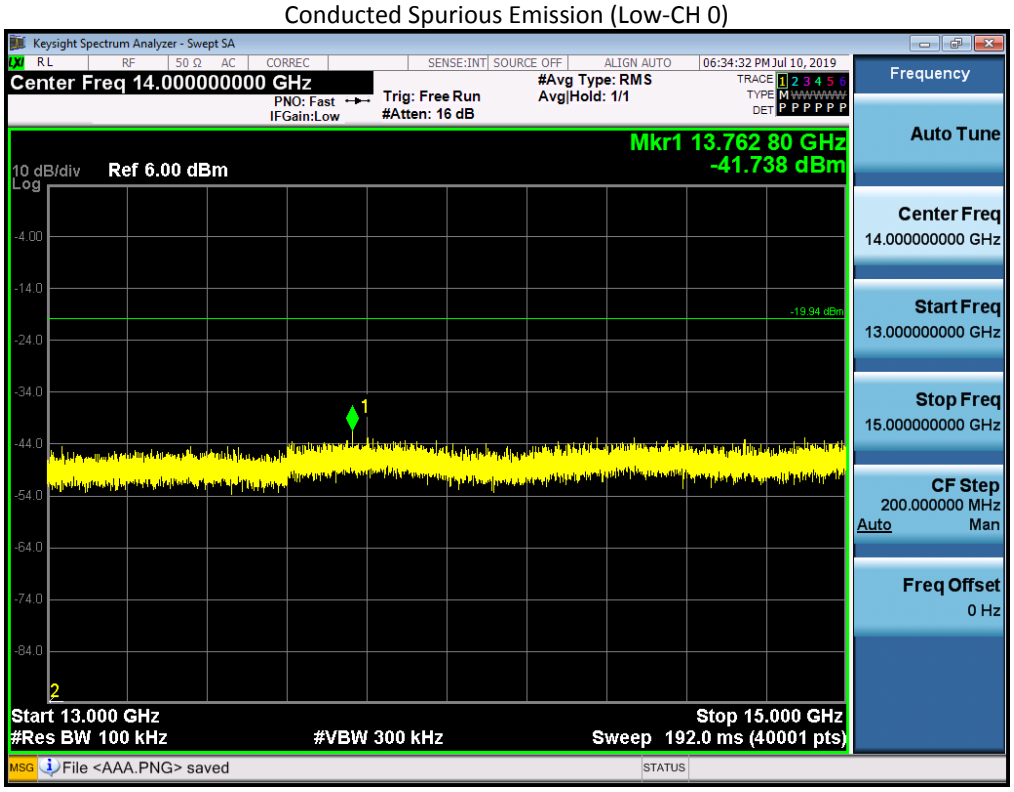
11 GHz ~ 13 GHz

Conducted Spurious Emission (Low-CH 0)



13 GHz ~ 15 GHz

Conducted Spurious Emission (Low-CH 0)



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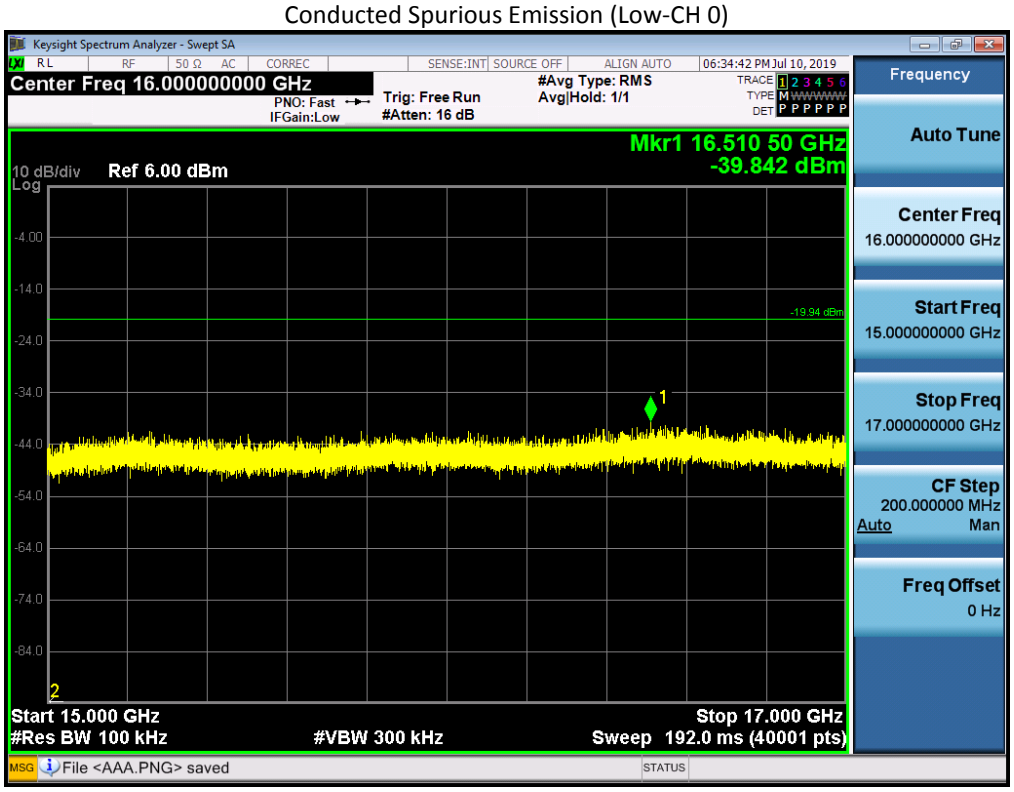
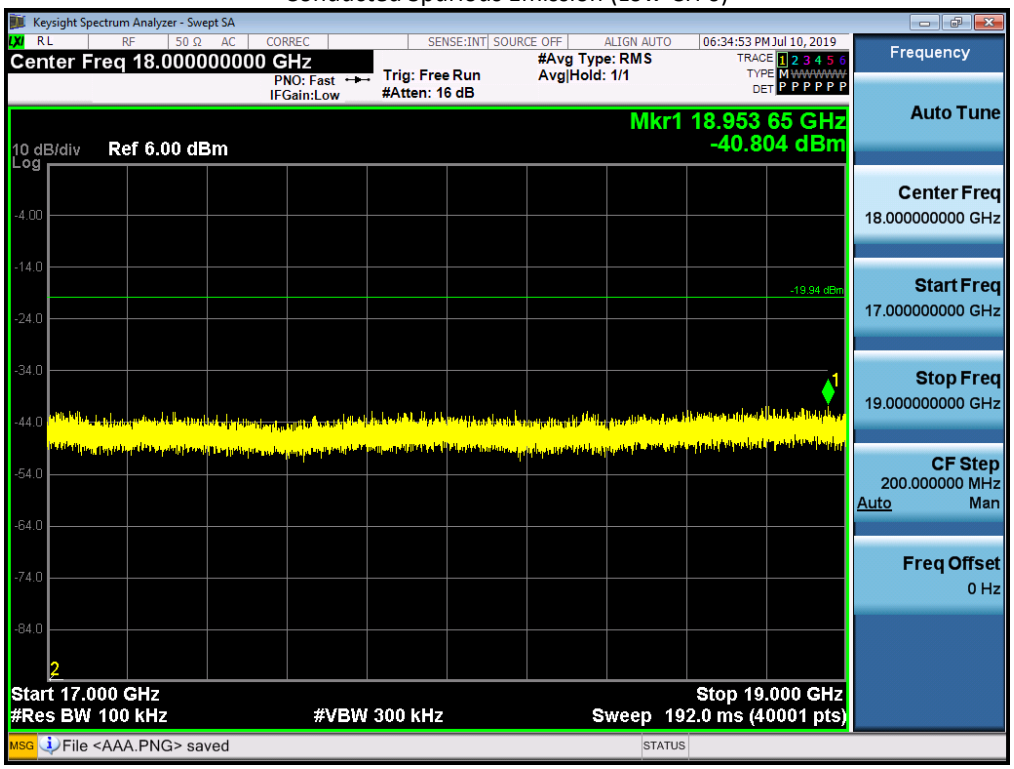
15 GHz ~ 17 GHz

Conducted Spurious Emission (Low-CH 0)



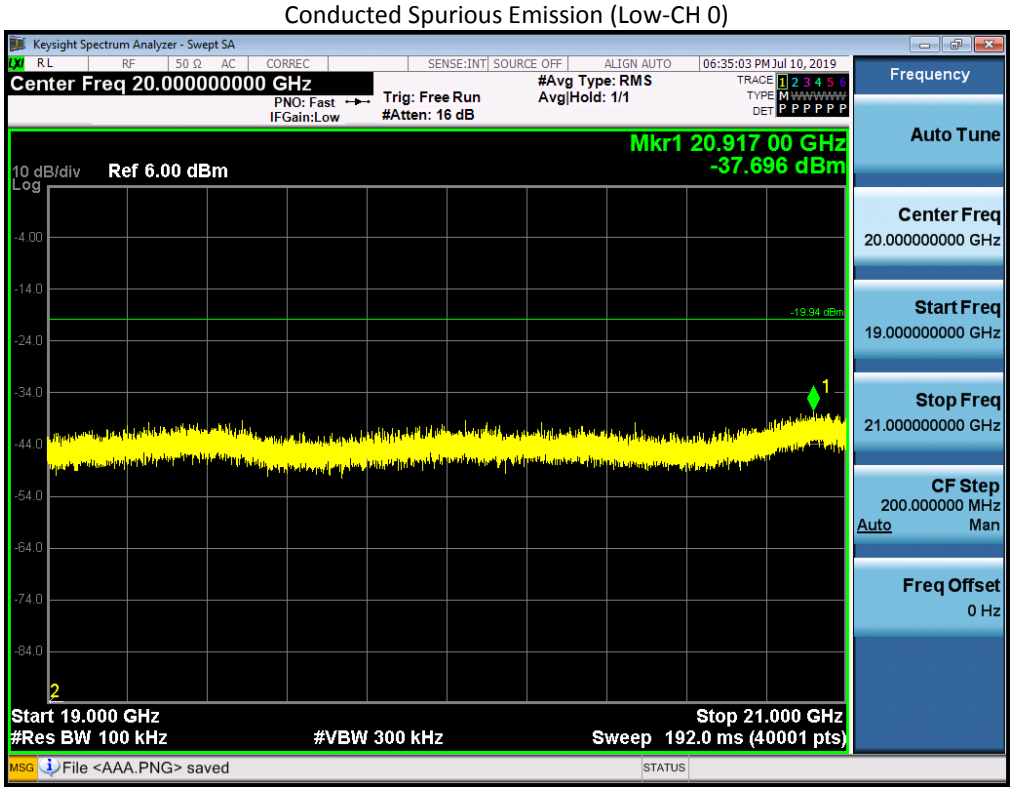
17 GHz ~ 19 GHz

Conducted Spurious Emission (Low-CH 0)



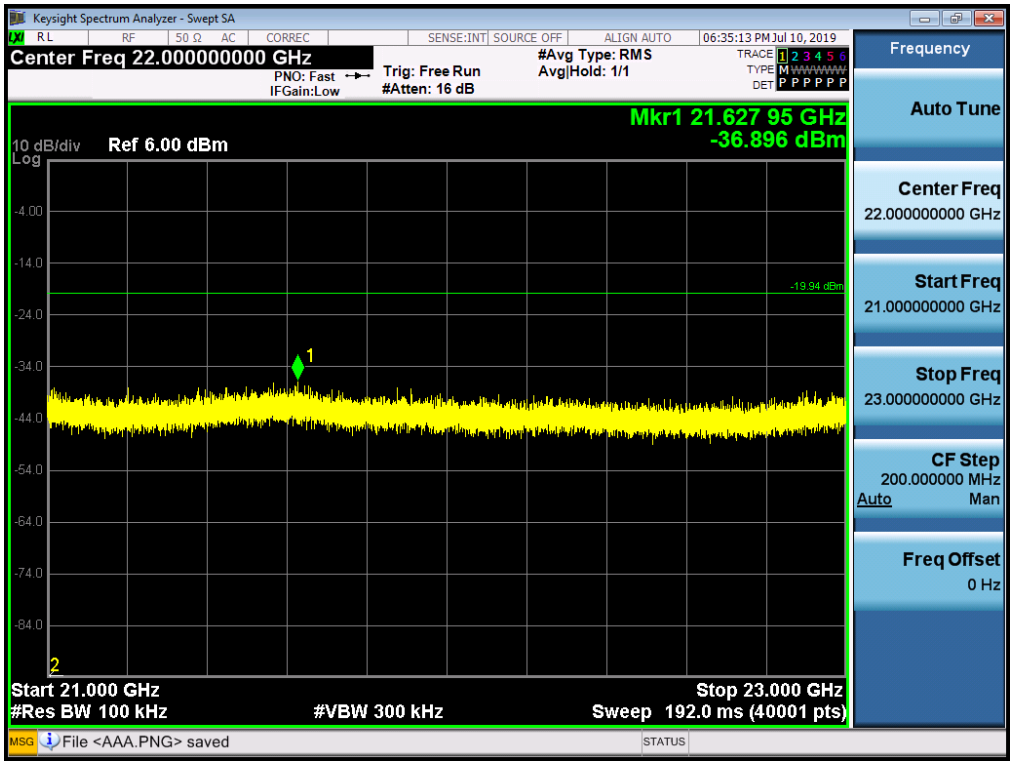
19 GHz ~ 21 GHz

Conducted Spurious Emission (Low-CH 0)



21 GHz ~ 23 GHz

Conducted Spurious Emission (Low-CH 0)



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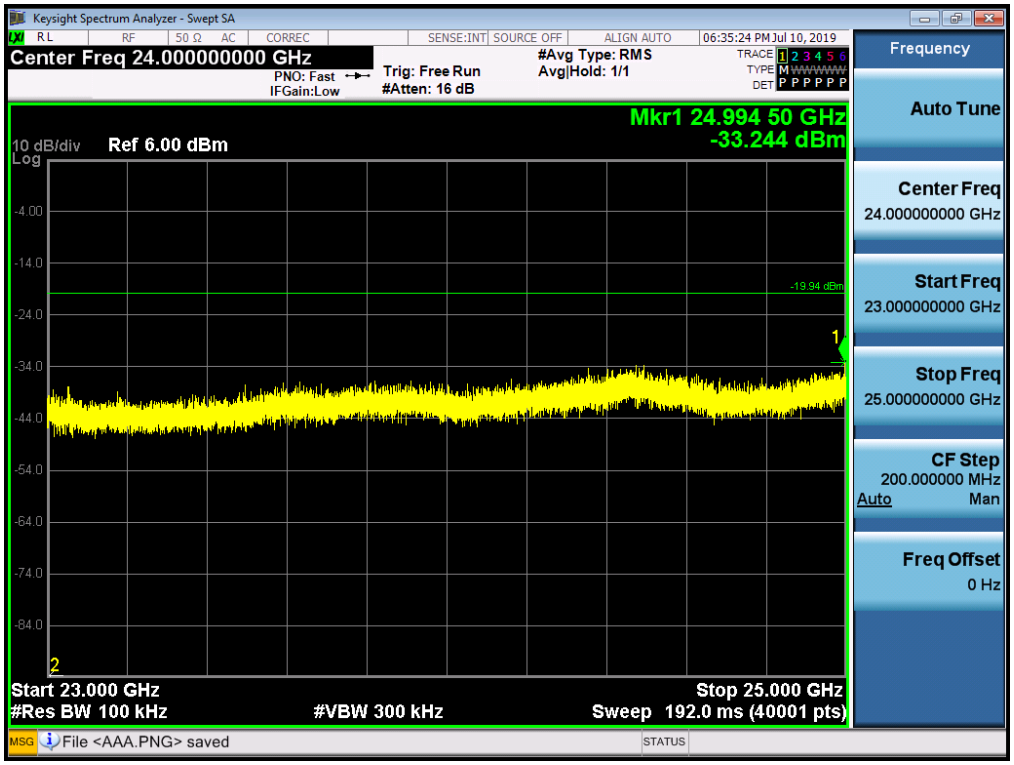
23 GHz ~ 25 GHz

Conducted Spurious Emission (Low-CH 0)



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9.7 RADIATED SPURIOUS EMISSIONS

9 kHz – 30MHz

CH 0

Frequency [kHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
12	H	28.5	20.7	49.2	126.02	76.82	QP
12	H	28.1	20.7	48.8	126.02	77.22	QP
20	H	28.5	19.9	48.4	121.58	73.18	QP
20	H	21.4	19.9	41.3	121.58	80.28	QP
36	H	23.9	20.8	44.7	116.39	71.69	QP

CH 19

Frequency [kHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
20	V	27.5	20.6	48.1	121.58	73.48	QP
20	H	28.1	20.6	48.7	121.58	72.88	QP

CH 39

Frequency [kHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
20	V	28.5	20.6	49.1	121.58	72.48	QP
20	H	29.1	20.6	49.7	121.58	71.88	QP

Notes:

1. The measurement distance is 3 meters.
2. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. Corrected reading: Antenna Factor + Cable loss + Read Level
5. The other operating Modes are attenuated more than 20 dB below the permissible limits.
   In order to simplify the report, attached worst-case mode.

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Frequency Range : Below 1 GHz

CH 0

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
83.9	V	56.7	-22.9	33.8	40	6.2	QP
120.0	V	57.4	-16.0	41.4	43.5	2.1	QP
566.4	V	44.7	-9.4	35.3	46	10.7	QP
565.9	H	45.4	-9.4	36.0	46	10.0	QP

CH 19

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
120.0	V	57.5	-16.0	41.5	43.5	2.0	QP
396.1	V	46.0	-13.4	32.6	46	13.4	QP
563.5	V	41.1	-9.4	31.7	46	14.3	QP
584.0	H	42.3	-9.3	33.0	46	13.0	QP

CH 39

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
72.0	V	55.0	-21.8	33.2	40	6.8	QP
120.0	V	57.4	-16.0	41.4	43.5	2.1	QP
357.3	V	49.1	-14.1	35.0	46	11.0	QP
455.2	H	34.6	-11.5	23.1	46	22.9	QP

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Frequency Range : Above 1 GHz

Operation Mode: CH Low

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4804	H	53.0	52.3	-4.1	48.9	48.2	54	74	5.1	25.8
4804	V	54.5	58.8	-4.1	50.4	54.7	54	74	3.6	19.3
7206	V	49.9	54.9	0.8	50.7	55.7	54	74	3.3	18.3
7206	H	50.5	55.8	0.8	51.3	56.6	54	74	2.7	17.4

Operation Mode: CH Mid

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4880	H	49.0	50.9	-4.1	44.9	46.8	54	74	9.1	27.2
4880	V	53.2	58.7	-4.1	49.1	54.6	54	74	4.9	19.4
7320	V	50.8	57.9	1.1	51.9	59.0	54	74	2.1	15.0
7320	H	47.1	55.1	1.1	48.2	56.2	54	74	5.8	17.8

Operation Mode: CH High

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4960	H	55.9	61.1	-3.9	52.0	57.2	54	74	2.0	16.8
4960	V	53.0	58.5	-3.9	49.1	54.6	54	74	4.9	19.4
7440	V	45.6	54.9	1.2	46.8	56.1	54	74	7.2	17.9
7440	H	41.2	50.2	1.2	42.4	51.4	54	74	11.6	22.6

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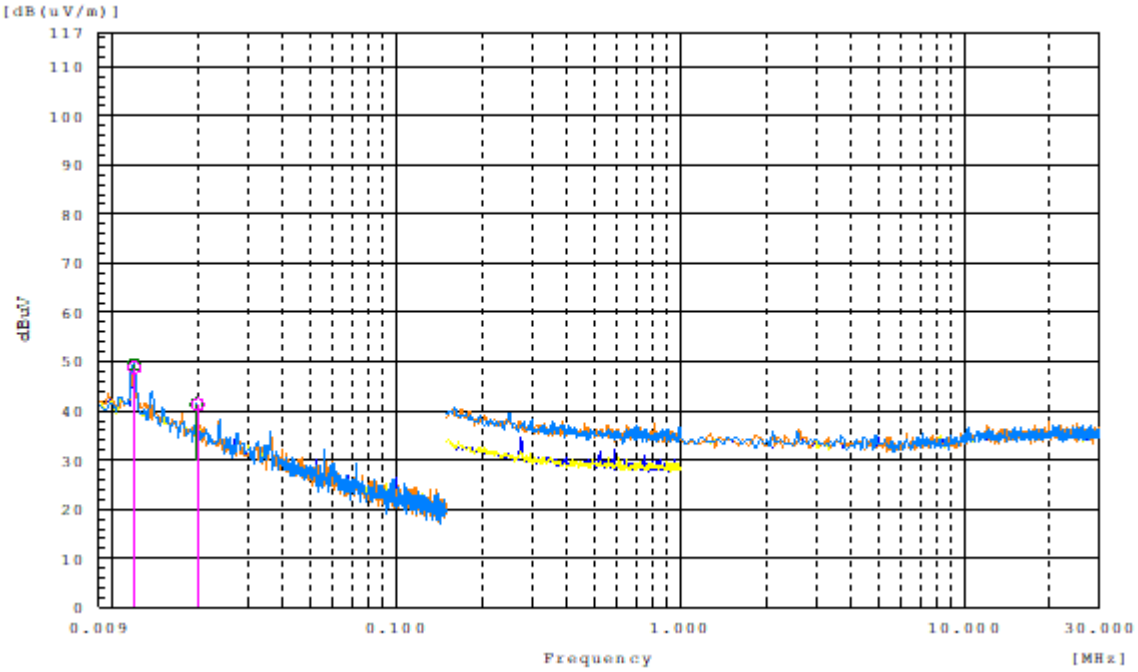
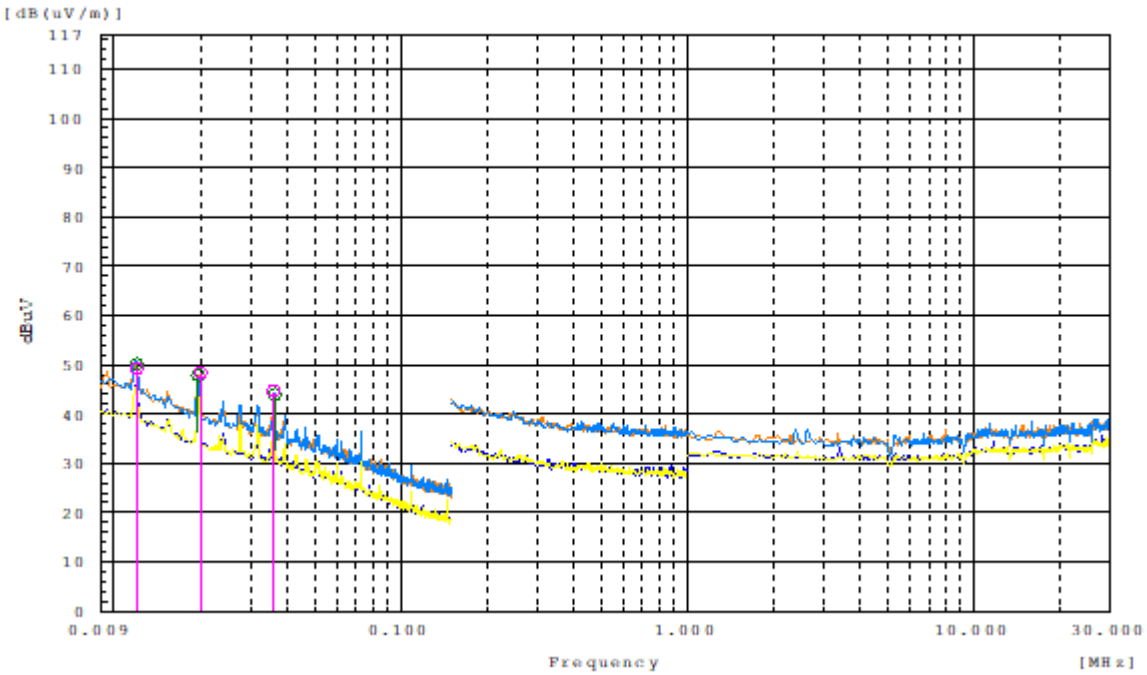
▣ Test Plots (Worst case)

Radiated Spurious Emissions plot – Vertical



Radiated Spurious Emissions plot – Horizontal



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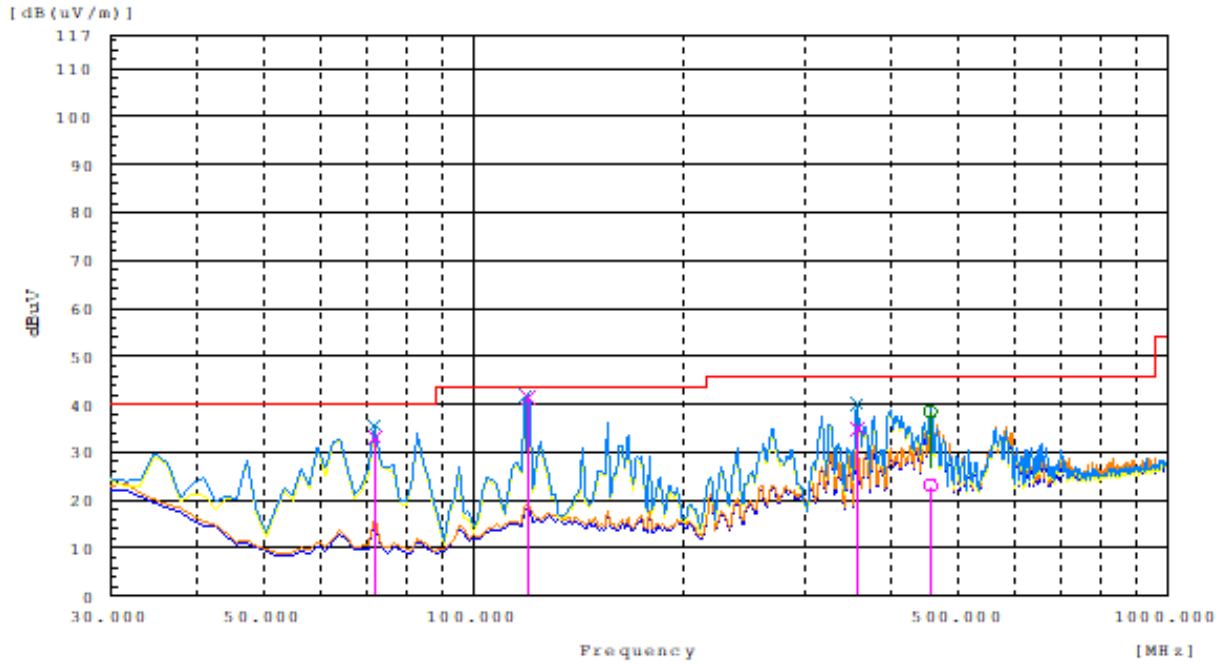
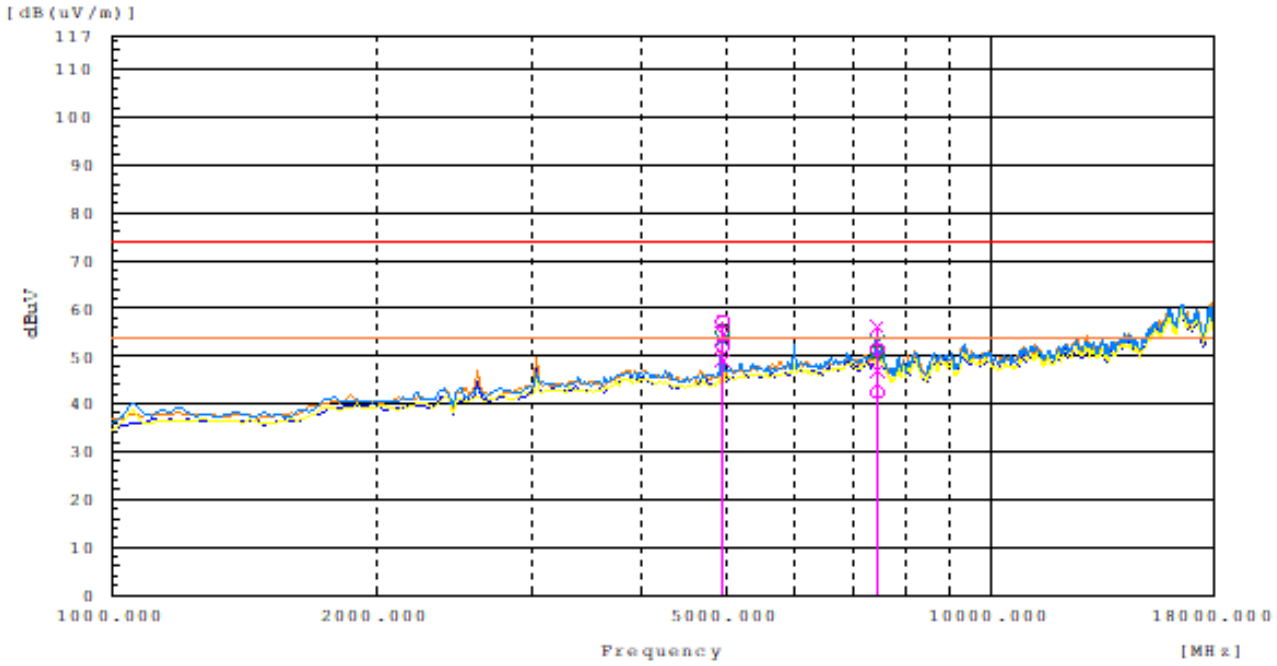
Radiated Spurious Emissions plot (Ch.39)



Radiated Spurious Emissions plot (Ch.39)



Note:

Plot of worst case are only reported.

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9.8 RADIATED RESTRICTED BAND EDGES

Ant1

Operating Frequency 2402 MHz

Channel No. 0

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2390	H	43.5	55.6	-12.8	30.7	42.8	54	74	23.3	31.2
2390	V	43.4	55.2	-12.8	30.6	42.4	54	74	23.4	31.6

Operating Frequency 2480 MHz

Channel No. 39

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2483.5	H	48.0	60.2	-12.1	35.9	48.1	54	74	18.1	25.9
2483.5	V	43.6	55.5	-12.1	31.5	43.4	54	74	22.5	30.6

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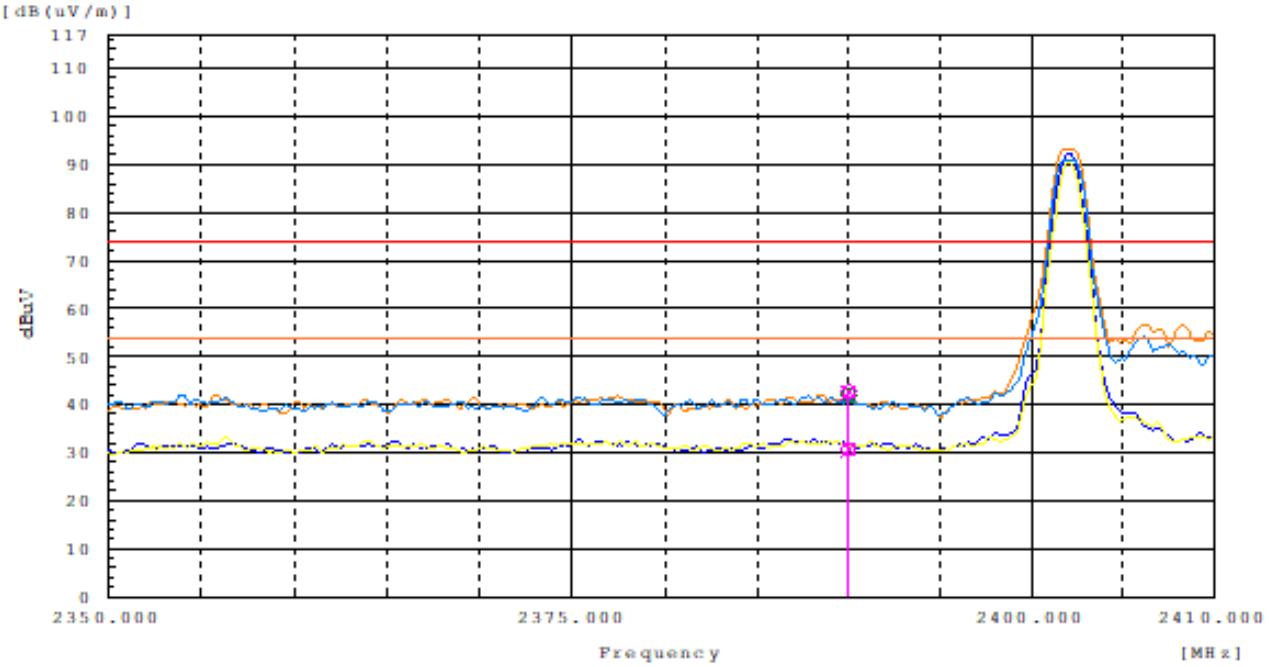
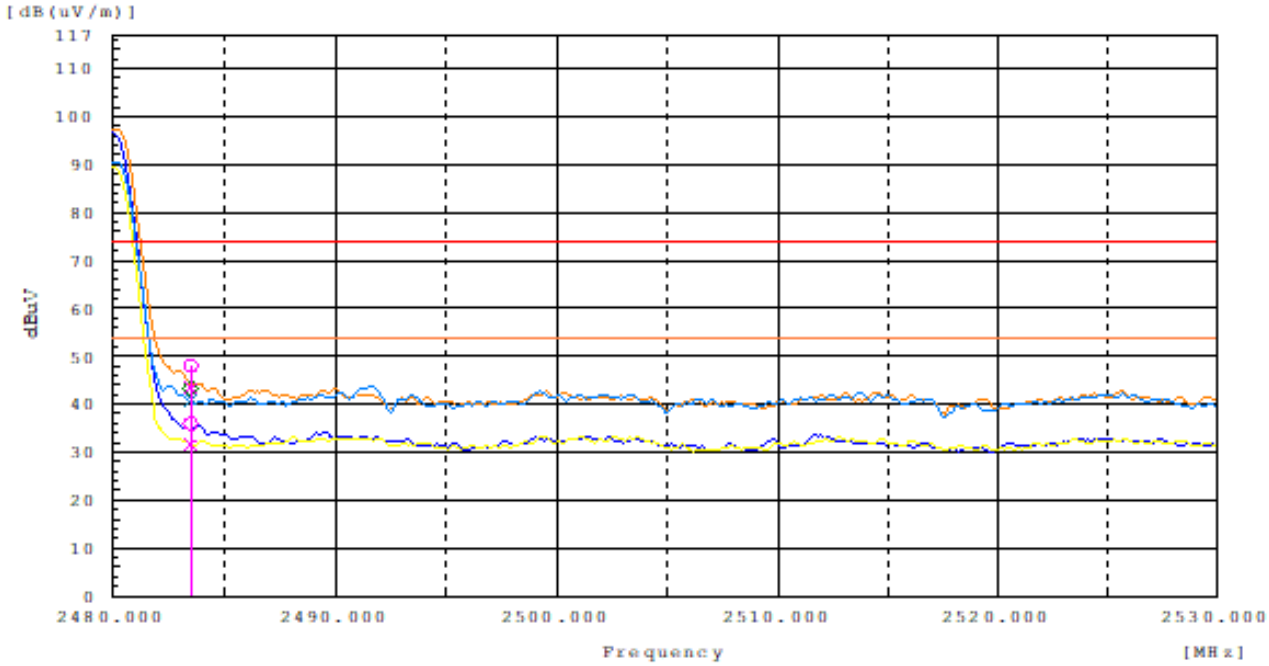
▣ Test Plots (Worst case : X-H)

Radiated Restricted Band Edges plot (Ch.0)



Radiated Restricted Band Edges plot (Ch.39)



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9.8 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

Frequency	Reading	A.F.+C.L.	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	(H/V)	dBuV/m	dBuV/m	dB
63.3	57.7	-22.1	V	35.6	40	4.4
120.0	57.2	-16.0	V	41.2	43.5	2.3
361.6	53.7	-13.9	V	39.8	46	6.2

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Frequency MHz	Polarization	Reading dB(uV)		Level dB(uV/m)	Limit dB(uV/m)	Margin dB
		AV	Factor	AV	AV	AV
5985.577	H	38.3	-1.4	36.9	54	17.1
5985.577	V	38.4	-1.4	37.0	54	17.0
16528.85	V	34.0	15.7	49.7	54	4.3
16528.85	H	34.2	15.7	49.9	54	4.1

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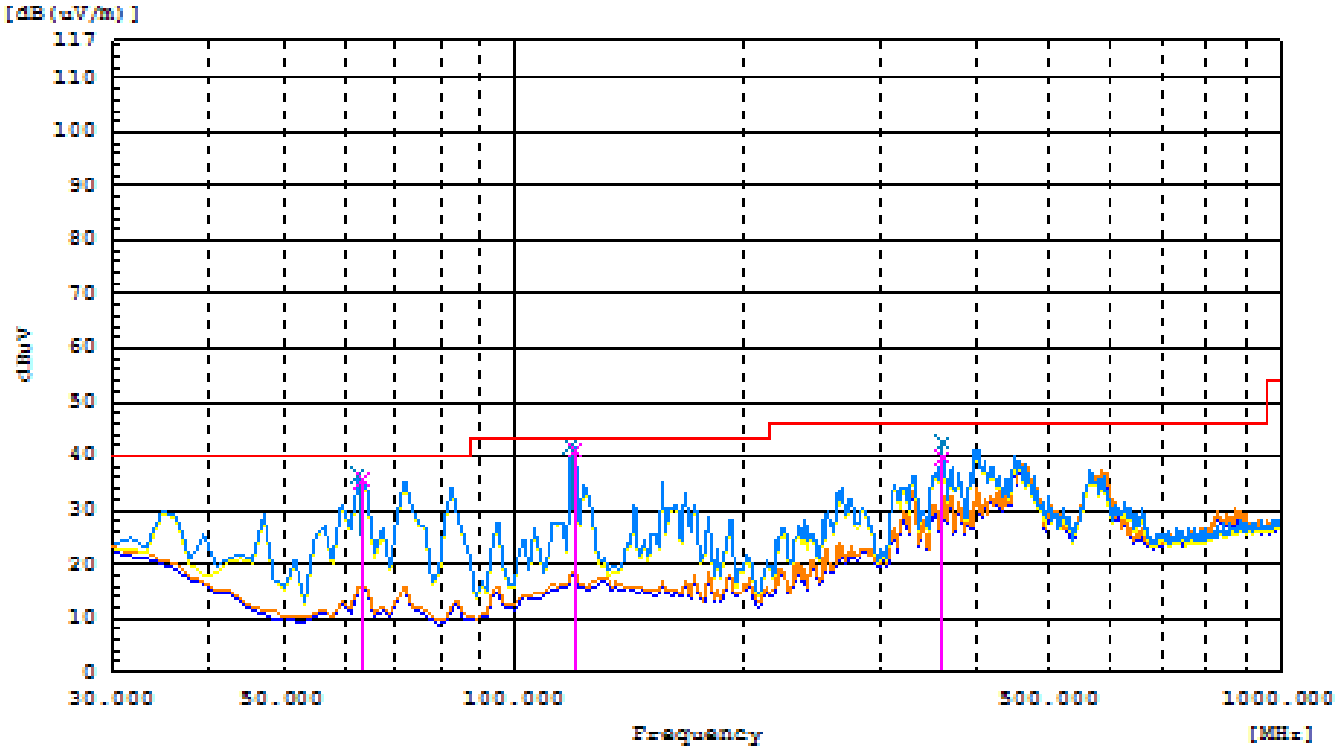
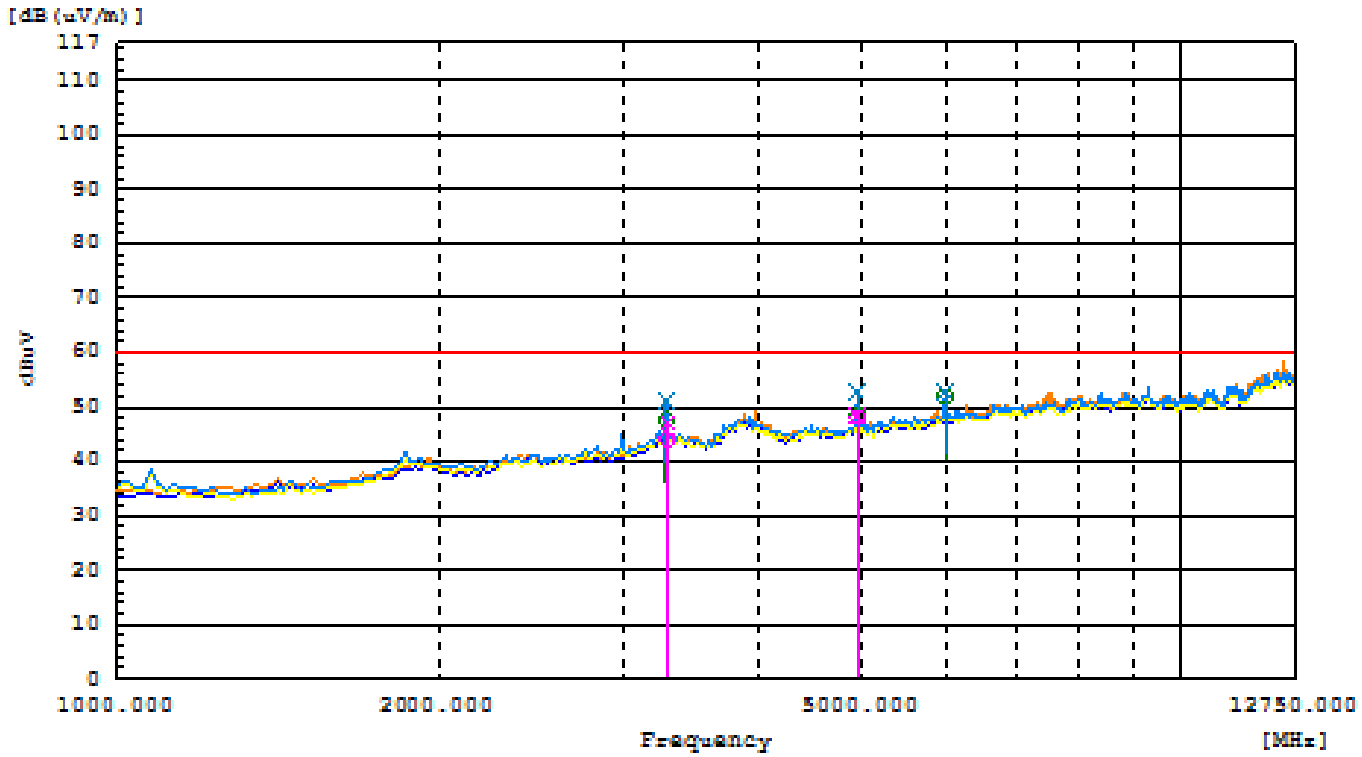
Below 1 GHz



Above 1 GHz



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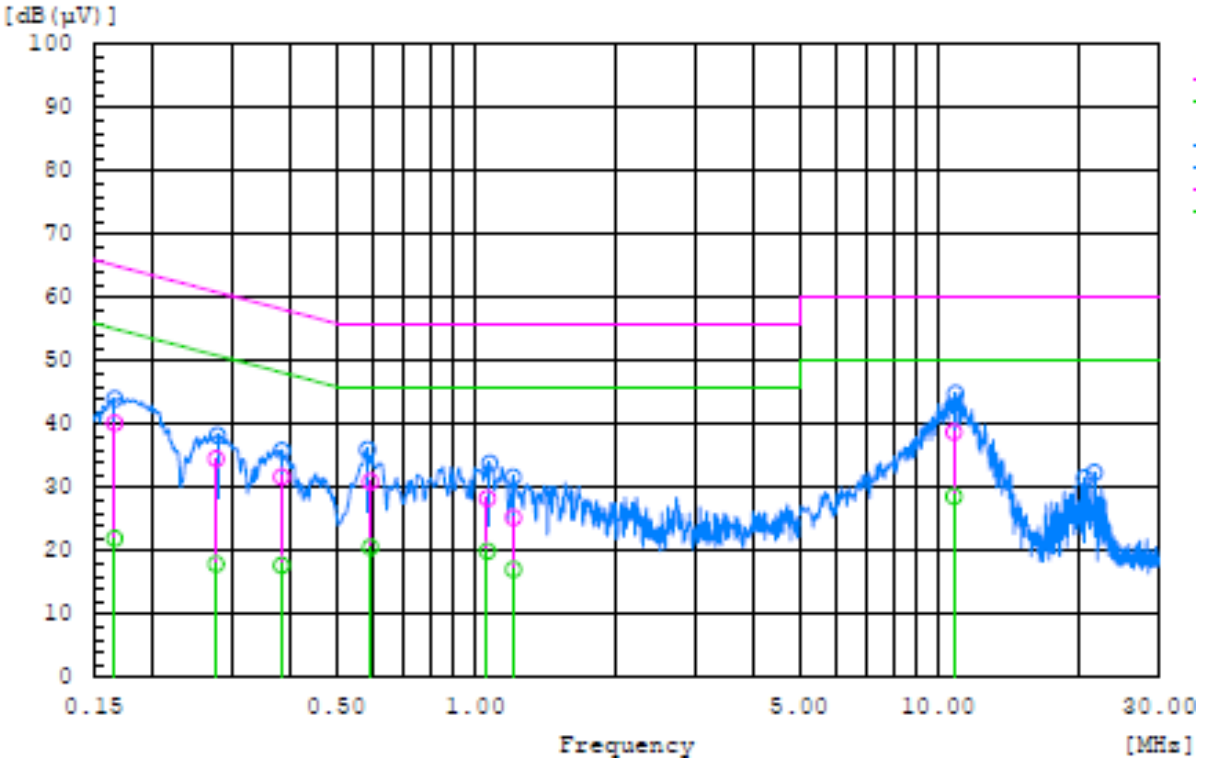
9.9 POWERLINE CONDUCTED EMISSIONS

Conducted Emissions (Line 1)



Frequency	Line	Reading		Factor	Level		Limit		Margin	
MHz		dB(µV)		dB	dB(µV)		dB(µV)		dB	
		QP	AV		QP	AV	QP	AV	QP	AV
0.166	L1	30.7	12.4	9.6	40.3	22	65.1	55.1	24.8	33.1
0.381	L1	22.2	8.2	9.6	31.8	17.8	58.3	48.3	26.5	30.5
0.276	L1	25	8.4	9.6	34.6	18	60.9	50.9	26.3	32.9
0.593	L1	21.4	11.1	9.6	31	20.7	56	46	25	25.3
1.061	L1	18.7	10.3	9.7	28.4	20	56	46	27.6	26
1.208	L1	15.6	7.4	9.7	25.3	17.1	56	46	30.7	28.9
10.781	L1	28.8	18.7	10	38.8	28.7	60	50	21.2	21.3

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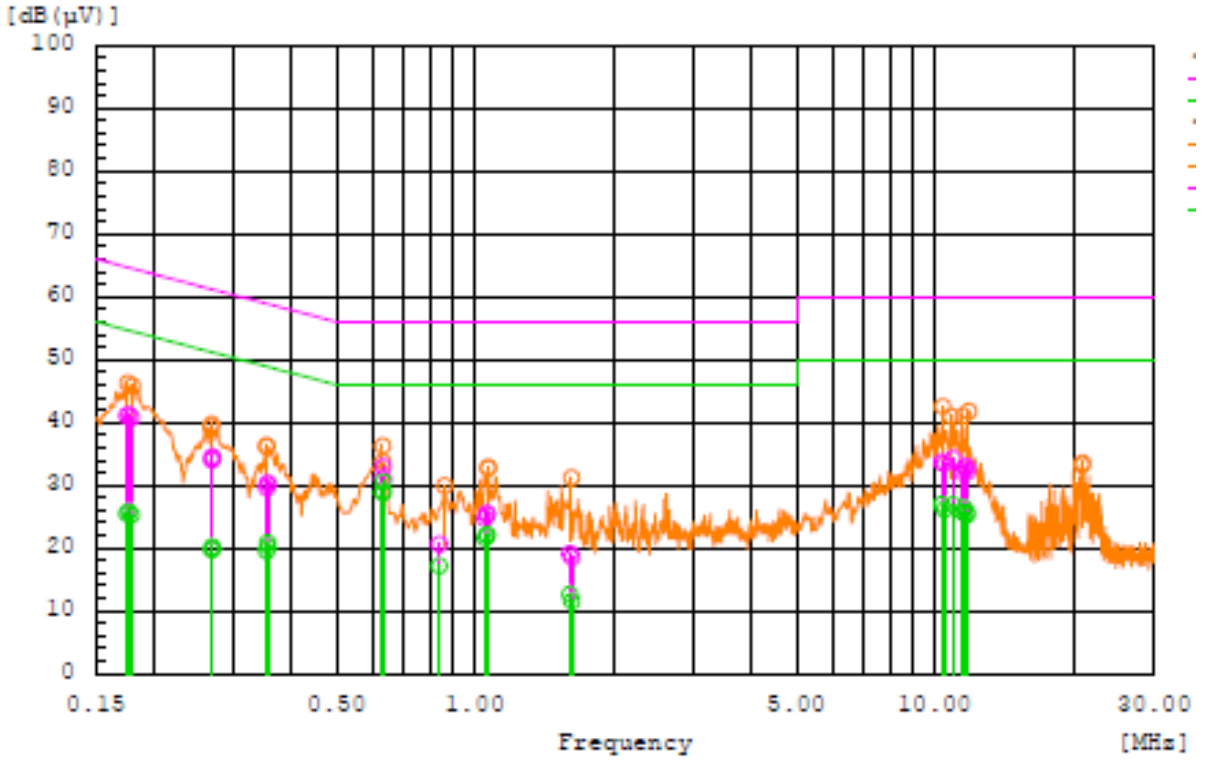
Conducted Emissions (Line 2)



Frequency	Line	Reading		Factor	Level		Limit		Margin	
MHz		dB(µV)		dB	dB(µV)		dB(µV)		dB	
		QP	AV		QP	AV	QP	AV	QP	AV
0.631	N	23.4	21	9.6	33	30.6	56	46	23	15.4
0.632	N	21.4	19.4	9.6	31	29	56	46	25	17
0.63	N	21.5	19.3	9.6	31.1	28.9	56	46	24.9	17.1
10.342	N	23.7	17	10	33.7	27	60	50	26.3	23
11.748	N	22.1	15.3	10	32.1	25.3	60	50	27.9	24.7
11.494	N	22	15.7	10	32	25.7	60	50	28	24.3
10.948	N	24.3	16.9	10	34.3	26.9	60	50	25.7	23.1

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10. LIST OF TEST EQUIPMENT

No.	Instrument	Model No.	Due to Calibration	Manufacture	Serial No.
☒	Signal Analyzer (20 Hz ~ 40.0 GHz)	ESU40	2019-12-20	ROHDE & SCHWARZ	100529
☒	Signal Analyzer (3 Hz ~ 40 GHz)	N9020A	2019-11-09	AGILENT	MY52091291
☒	BI-LOG Antenna (30 MHz ~ 1 GHz)	JB6	2020-11-29	Sunol	A071116
☒	Attenuator (20 dB, DC ~ 26.5 GHz)	8493C	2019-12-20	HP	09072
☒	DC power supply	6655A	2020-01-23	HP	KR94907553
☒	POWER AMP (1 GHz ~ 18 GHz)	CBLU1183540B-01	2020-01-18	CERNEX	27974
☒	POWER AMP (0.3GHz ~ 1GHz)	PAM-103A	2020-01-18	Com-Power Corporation	18020005
☒	Horn Antenna (1 GHz ~ 18 GHz)	DRH-118	2020-05-24	Sunol	A070516
☒	Loop Antenna (0.009 ~ 30 MHz)	HLA 6121	2020-08-27	Teseq	43964
☒	Horn Antenna (18 GHz ~ 40 GHz)	DRH-1840	2020-02-20	Sunol	17120
☒	POWER AMP (18 GHz ~ 40 GHz)	CBL184050-45-01	2020-02-20	CERNEX,Inc.	43964

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date.

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11. ANNEX A_ TEST SETUP PHOTO

Please refer to test setup photo file no. as follows;

No.	Description
1	EMCE-R-1907-F004-P

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