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FCC BT LE REPORT

Certification

Applicant Name:
SAMSUNG Electronics Co., Ltd.

Address:
129, Samsung-ro, Yeongtong-gu,
Suwon-si, Gyeonggi-do, 16677, Rep. of Korea

Date of Issue:
March 13, 2019

Location:
HCT CO., LTD.,
74, Seoicheon-ro 578beon-gil, Majang-myeon,
Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA

Report No.: HCT-RF-1903-FC011

FCC ID:	**A3LSMA6060**
APPLICANT:	**SAMSUNG Electronics Co., Ltd.**

Model:	SM-A6060
EUT Type:	Mobile Phone
Average Output Power:	5.51 dBm (3.556 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation type	GFSK
FCC Classification:	Digital Transmission System(DTS)
FCC Rule Part(s):	Part 15.247

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.
HCT CO., LTD. Certifies that no party to this application has subject to a denial of Federal benefits that includes FCC benefits pursuant to section 5301 of the Anti-Drug Abuse Act of 1998,21 U.S. C.853(a)

Report prepared by : Jung Ki Lim
Engineer of Telecommunication testing center

Approved by : Kwon Jeong
Manager of Telecommunication testing center

Version

TEST REPORT NO.	DATE	DESCRIPTION
HCT-RF-1903-FC011	March 13, 2019	- First Approval Report

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1. EUT DESCRIPTION

Model	SM-A6060	
EUT Type	Mobile Phone	
Power Supply	DC 3.85 V	
Battery Information	Model: EB-BA606ABU Type: Li-ion battery	
Travel Adapter Information	Model : EP-TA200 Manufacture: DYREL	
Frequency Range	2402 MHz - 2480 MHz	
Max. RF Output Power	Peak (For information only)	1M Bit/s : 5.735 dBm (3.745 mW) 2M Bit/s : 6.328 dBm (4.293 mW) 125k Bit/s : 5.520 dBm (3.565 mW) 500k Bit/s : 5.498 dBm (3.547 mW)
	Average	1M Bit/s : 5.39 dBm (3.459 mW) 2M Bit/s : 5.51 dBm (3.556 mW) 125k Bit/s : 5.36 dBm (3.436 mW) 500k Bit/s : 5.38 dBm (3.451 mW)
Modulation Type	GFSK	
Bluetooth Version	5.0	
Number of Channels	40 Channels	
Antenna Specification	Antenna type: FPCB Peak Gain : -0.35 dBi	
Date(s) of Tests	January 31, 2019 ~ March 11, 2019	

2. TEST METHODOLOGY

FCC KDB 558074 D01 15.247 Meas Guidance v05r01 dated February 11, 2019 entitled “guidance for compliance measurements on digital transmission system, frequency hopping spread spectrum system, and hybrid system devices 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 purpse 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.

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 6.6.5 of ANSI C63.10. (Version: 2013)

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.

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 the 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383, Rep. of KOREA. The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

Detailed description of test facility was submitted to the Commission and accepted dated April 02, 2018 (Registration Number: KR0032).

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

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.

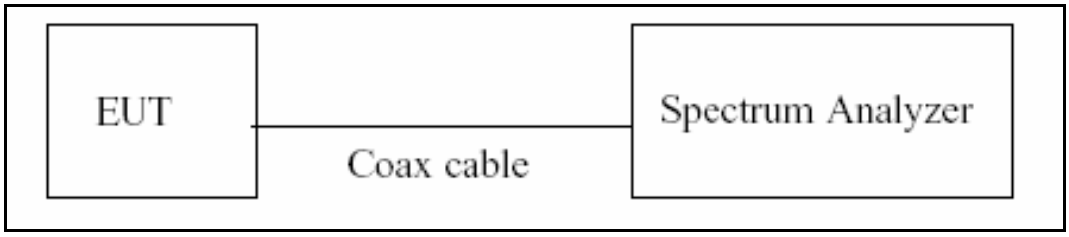
The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	1.82
Radiated Disturbance (9 kHz ~ 30 MHz)	3.40
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.70
Radiated Disturbance (18 GHz ~ 40 GHz)	5.71

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 availble 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*.

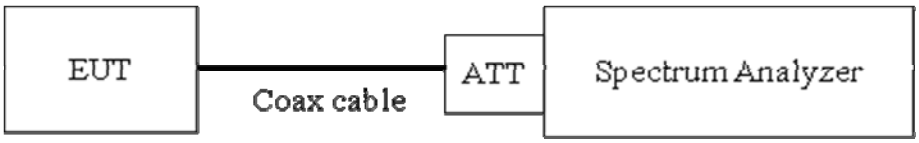
1. RBW = 8 MHz (the largest availble value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

7.2. 6dB Bandwidth

Limit

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)

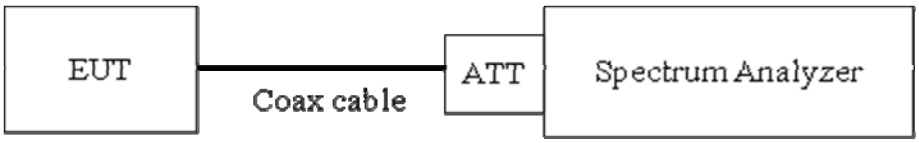
1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

7.3. Output Power

Limit

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.
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

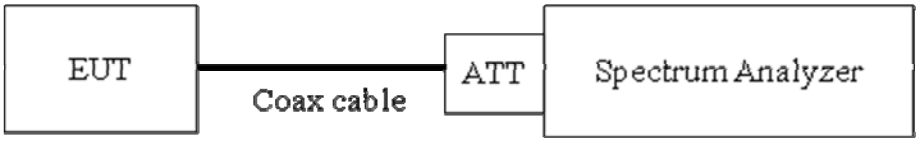
▪ Conducted Output Power(Average) = Reading Value + ATT loss + Cable loss + Duty Cycle Factor

7.4. Power Spectral Density

Limit

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) Set span to at least 1.5 times the OBW.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple
6) Detector = power averaging (rms) or sample detector (when rms not available).
7) Ensure that the number of measurement points in the sweep ≥[2 ×span / RBW].
8) Employ trace averaging (rms) modeover a minimum of 100 traces
9) Use the peak marker function to determine the maximum amplitude level.
10) 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

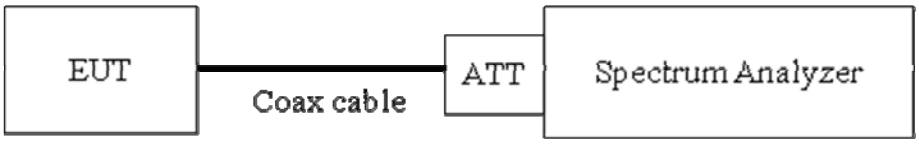
7.5. Conducted Band Edge(Out of Band Emissions) & Conducted Spurious Emissions

Limit

The maximum conducted (average) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz.

[Conducted > 30 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.

Factors for frequency

Freq(MHz)	Factor(dB)
30	11.30
100	9.83
200	10.19
300	10.13
400	10.23
500	10.25
600	10.32
700	10.35
800	10.35
900	10.34
1000	10.39
2000	10.64
2400*	10.65
2500*	10.67
3000	10.68
4000	10.89
5000	11.07
6000	11.06
7000	11.35
8000	11.32
9000	11.48
10000	11.56
11000	11.56
12000	11.68
13000	11.83
14000	11.90
15000	11.98
16000	12.04
17000	12.02
18000	12.08
19000	12.07
20000	12.14
21000	12.17
22000	12.31
23000	12.60
24000	12.34
25000	12.53
26000	12.02

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

2. Factor = Attenuator loss + Cable loss

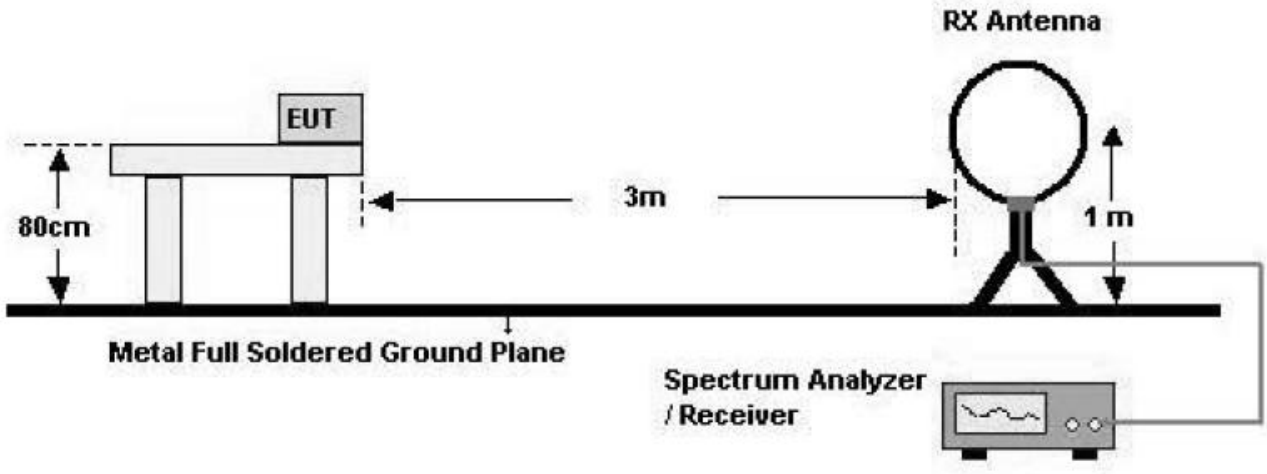
7.6. Radiated Test

Limit

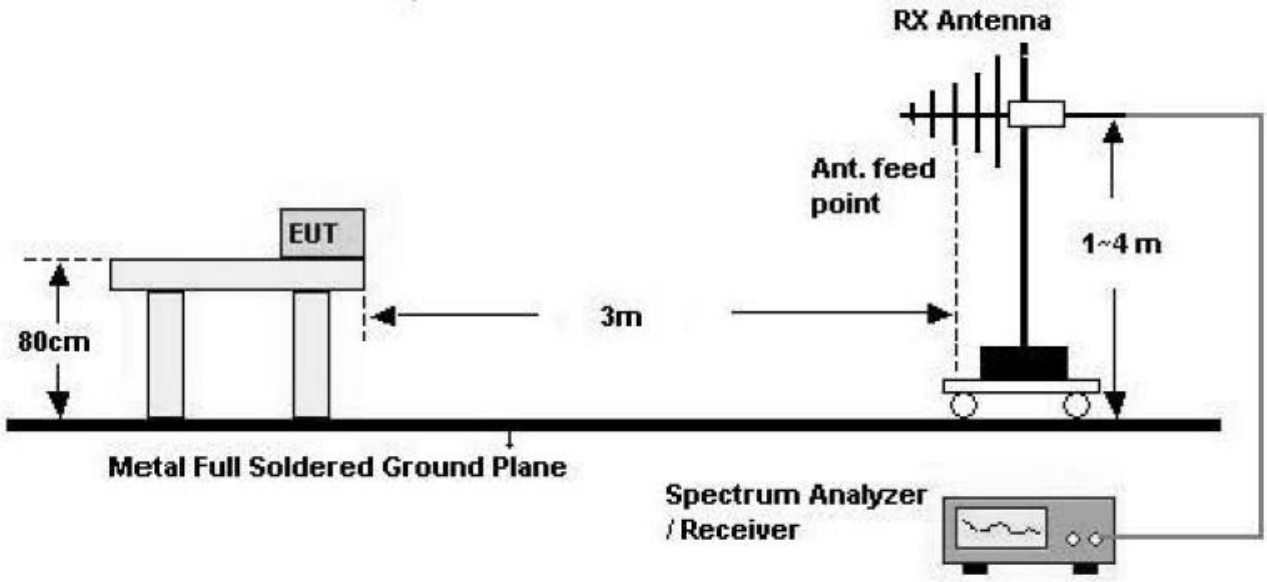
Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Test Configuration

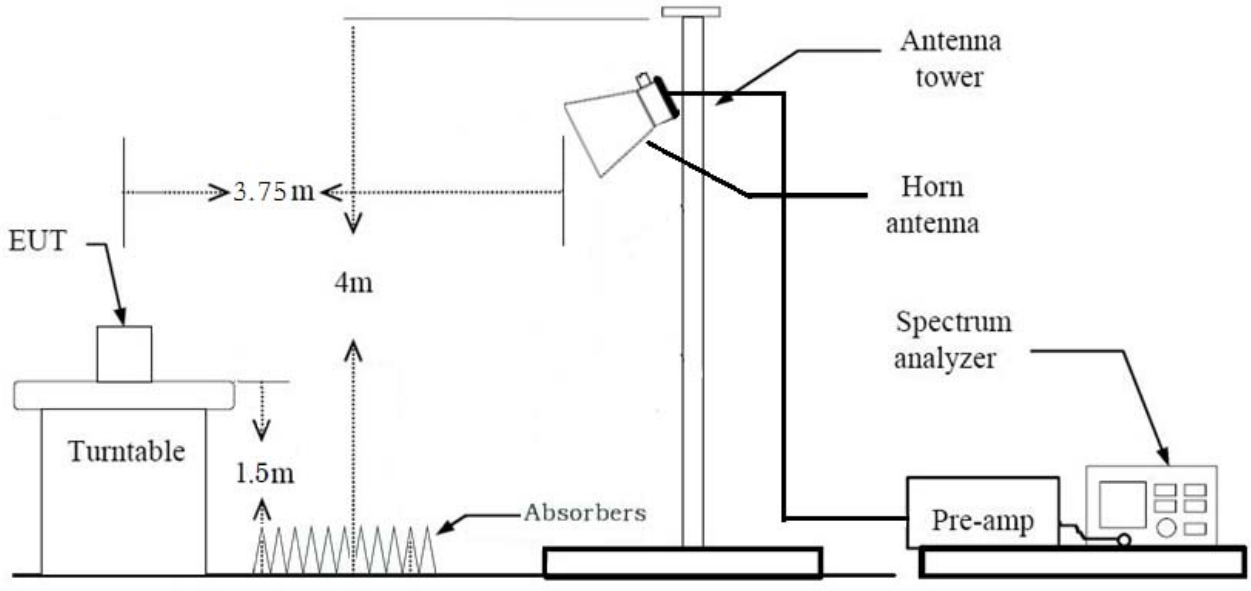
Below 30 MHz



30 MHz - 1 GHz


RX Antenna
Ant. feed point
1~4 m
EUT
80cm
3m
Metal Full Soldered Ground Plane
Spectrum Analyzer / Receiver

Above 1 GHz


Antenna tower
Horn antenna
3.75m
EUT
4m
Spectrum analyzer
Turntable
1.5m
Absorbers
Pre-amp

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)
10. The test results for below 30 MHz is correlated to an open site.
    The result on OFS is about 2 dB higher than semi-anechoic chamber(10 m chamber)

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. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. 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)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
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 (Method 8.6 in KDB 558074 v05r01, Procedure 11.12 in ANSI 63.10-2013)
   (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):
   - Duty cycle < 98%, duty cycle variations are less than ±2%
   - Measured Frequency Range : 1 GHz – 25 GHz
   - Detector = RMS
   - Averaging type = power (*i.e.*, RMS)
   - RBW = 1 MHz
   - VBW ≥ 3*RBW
   - Sweep time = auto.
   - Trace mode = average (at least 100 traces).
   - 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.
   - Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

10. 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.
11. Total(Measurement Type : Peak)
    = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

    Total(Measurement Type : Average)
    = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)
    + Duty Cycle Factor

Test Procedure of Radiated Restricted Band Edge

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
3. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
4. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
5. 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)
6. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
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):
   - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 1 MHz
   - VBW ≥ 3*RBW

   (2) Measurement Type(Average):
   - Duty cycle < 98%, duty cycle variations are less than ±2%
   - Measured Frequency Range : 2310 MHz ~ 2390 MHz/ 2483.5 MHz ~ 2500 MHz
   - Detector = RMS
   - Averaging type = power (*i.e.*, RMS)
   - RBW = 1 MHz
   - VBW ≥ 3*RBW
   - Sweep time = auto.
   - Trace mode = average (at least 100 traces).
   - 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.
   - Duty Cycle Factor (dB) : Please refer to the please refer to section 9.1.

10. 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.
11. Total(Measurement Type : Peak)
    = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F)

    Total(Measurement Type : Average)
    = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) + Distance Factor(D.F) + Duty Cycle Factor

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

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 : Z
3. All packet length of operation were investigated and the test results are worst case in lowest packet length.

*Worst case :

- LE 5.0(1M Bit/s) : 37 Byte
- LE 5.0(2M Bit/s) : 37 Byte

AC Power line Conducted Emissions

1. All modes of operation were investigated and the worst case configuration results are reported.

Conducted test

The EUT was configured with packet length of highest power.

* Packet length of highest power :

- LE 5.0(1M Bit/s) : 37 Byte
- LE 5.0(2M Bit/s) : 37 Byte
- LE 5.0(125k Bit/s) : 37 Byte
- LE 5.0(500k Bit/s) : 37 Byte

8. SUMMARY TEST OF RESULTS

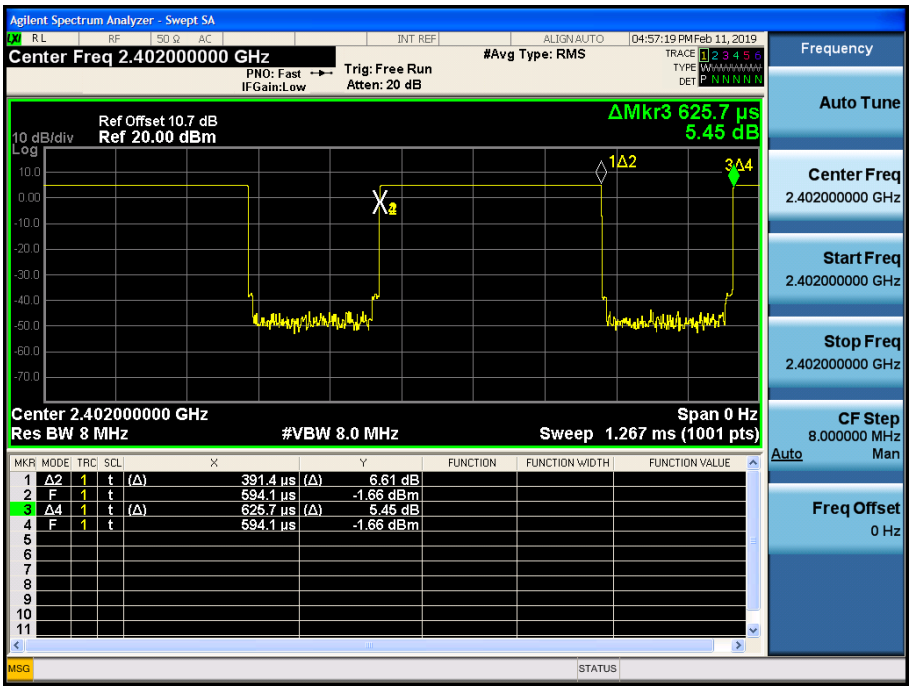
Test Description	FCC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	> 500 kHz	Conducted	PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	< 1 Watt		PASS
Power Spectral Density	§15.247(e)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§15.247(d)	Conducted > 30 dBc		PASS
AC Power line Conducted Emissions	§15.207	cf. Section 7.7		PASS
Radiated Spurious Emissions	§15.247(d), 15.205, 15.209	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 7.6		PASS

9. TEST RESULT

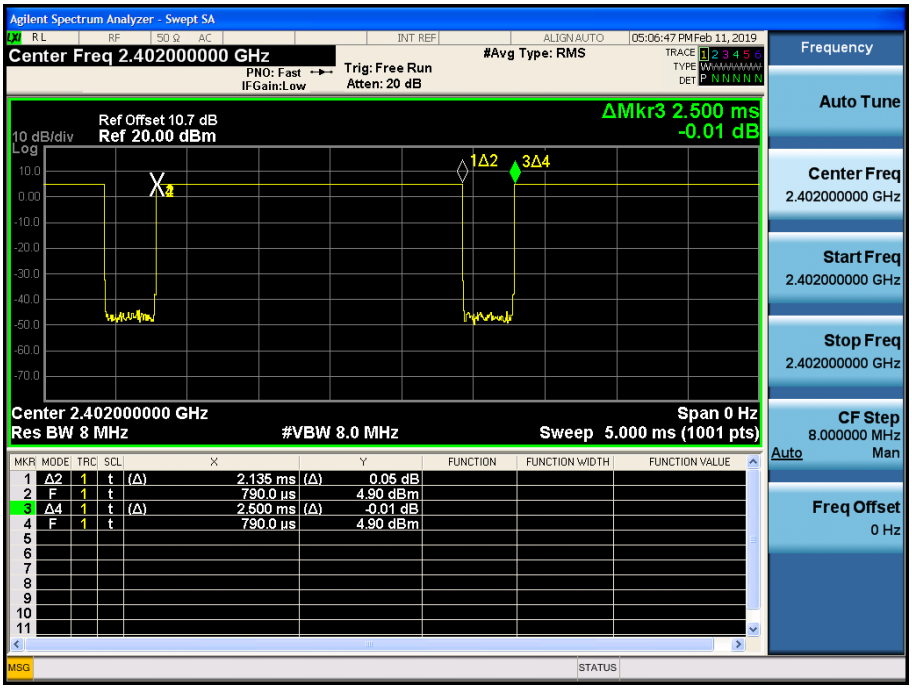
9.1 DUTY CYCLE

Data rate (Bit/s)	Packet length (Byte)	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
1M	37	0.3914	0.6257	0.6255	2.04
	255	2.1350	2.5000	0.8540	0.69
2M	37	0.2065	0.6245	0.3306	4.81
	255	1.0750	1.8750	0.5733	2.42
125k	37	3.1050	3.7500	0.8280	0.82
	255	17.0500	17.5000	0.9743	0.11
500k	37	1.0700	1.8767	0.5702	2.44
	255	4.5450	4.9950	0.9099	0.41

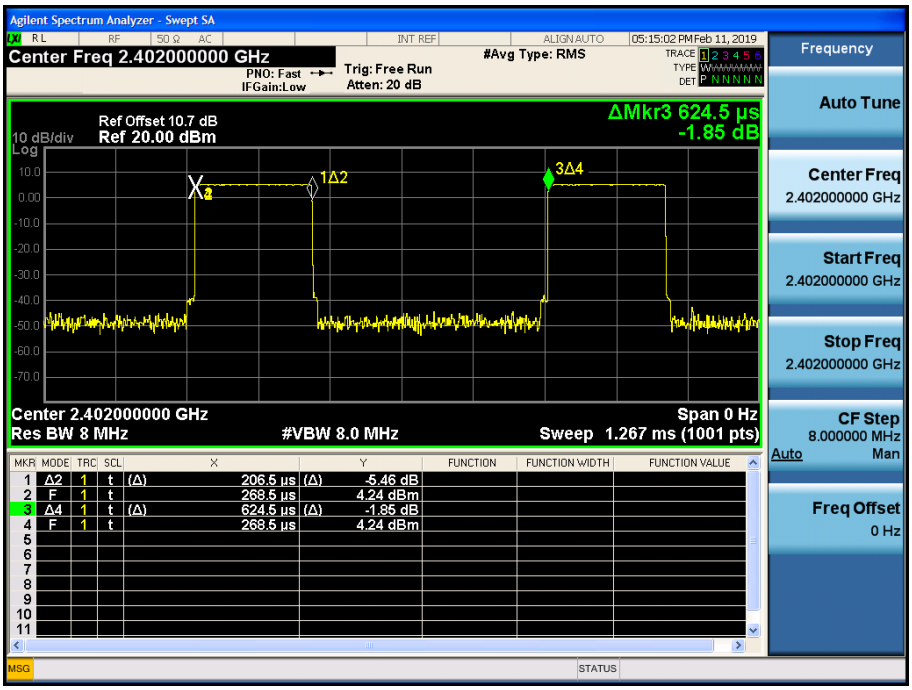
▣ 1M Bit/s (37 Byte) Test Plots



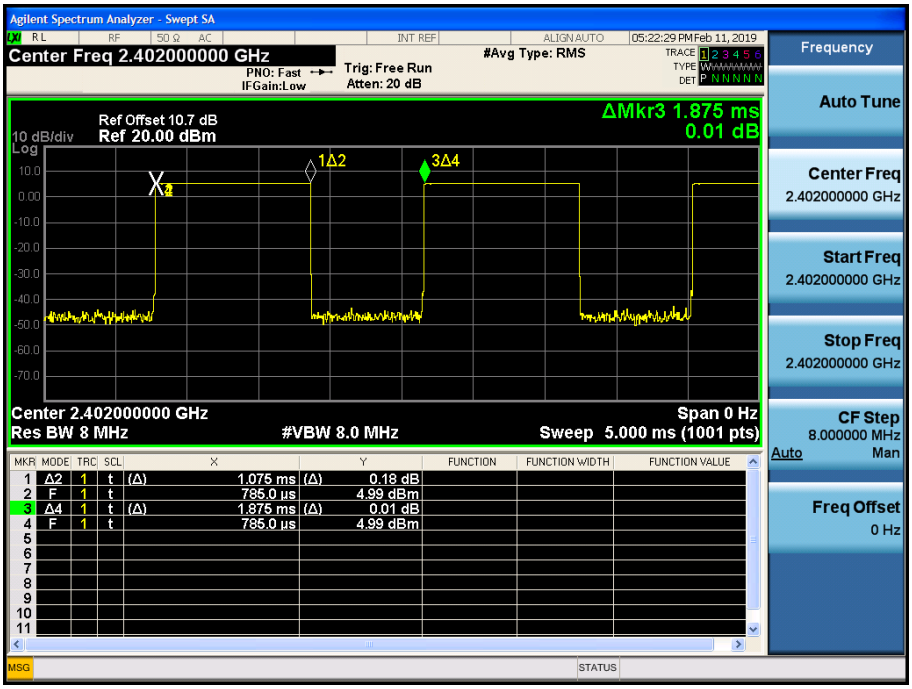
▣ 1M Bit/s (255 Byte) Test Plots



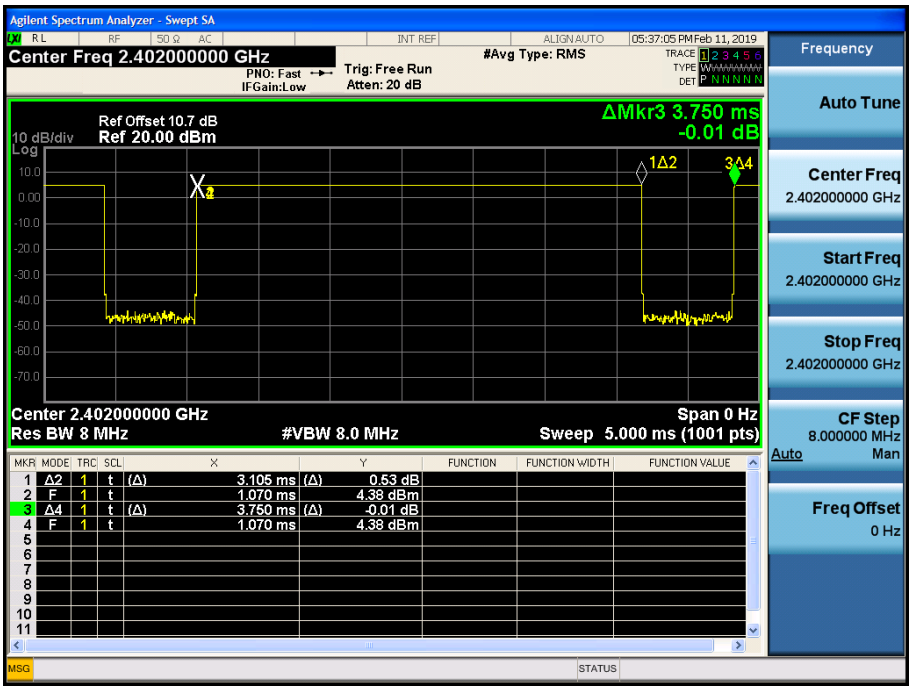
▣ 2M Bit/s (37 Byte) Test Plots



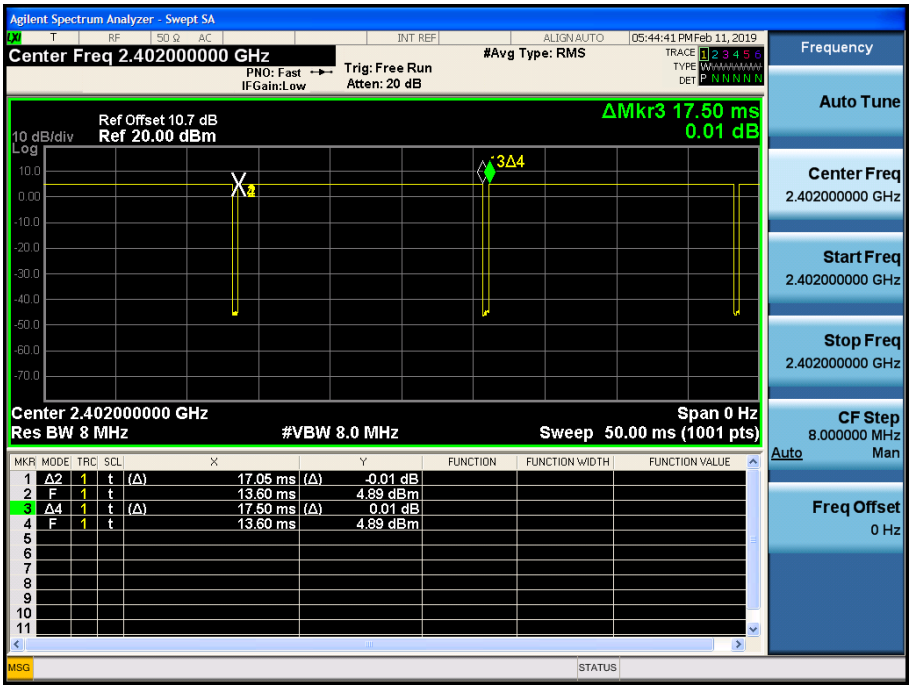
▣ 2M Bit/s (255 Byte) Test Plots



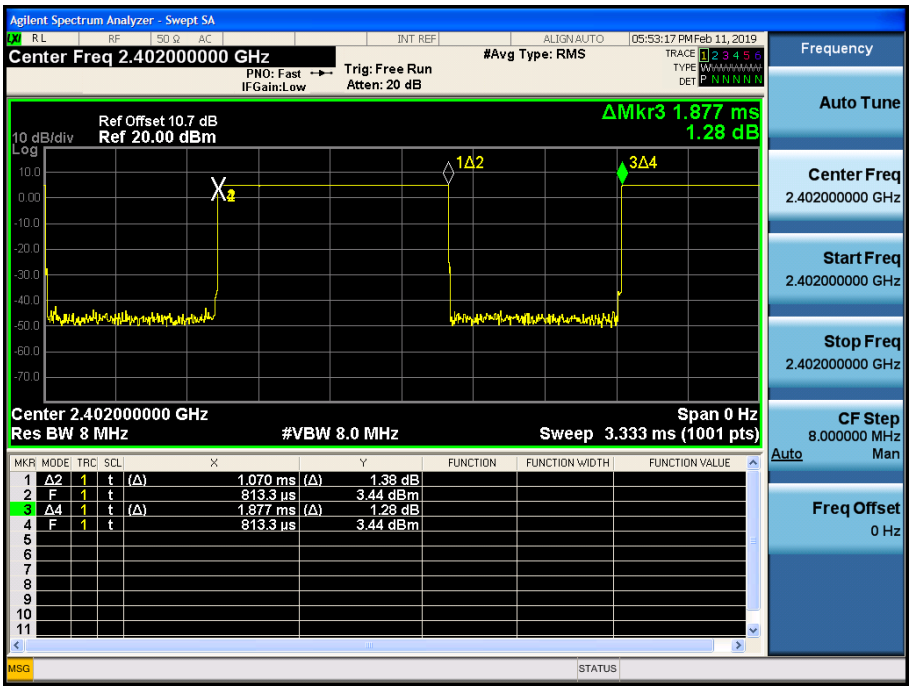
▣ 125k Bit/s (37 Byte) Test Plots



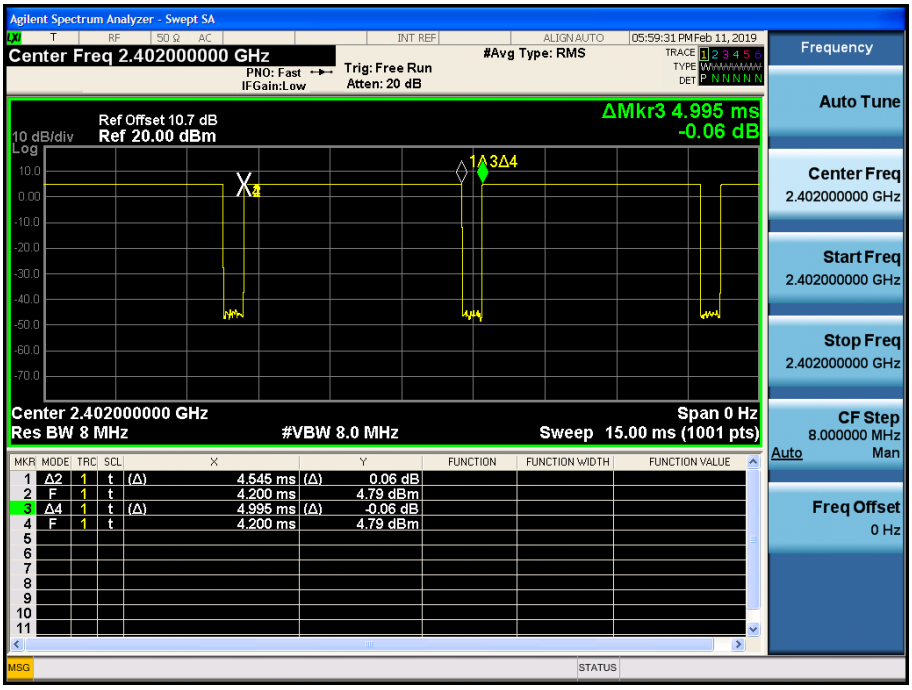
▣ 125k Bit/s (255 Byte) Test Plots



▣ 500k Bit/s (37 Byte) Test Plots



▣ 500k Bit/s (255 Byte) Test Plots

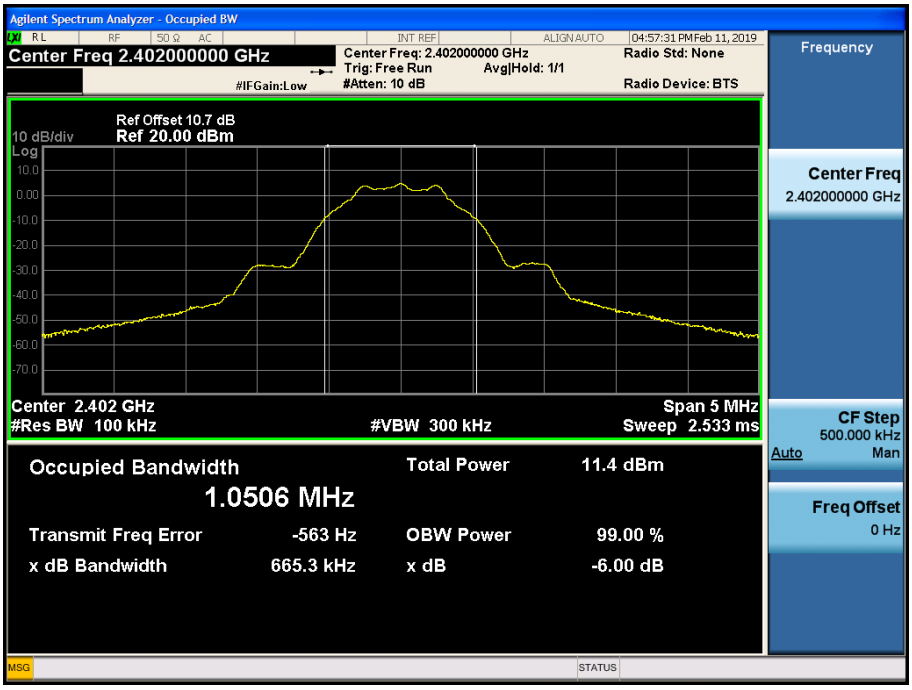


9.2 6dB BANDWIDTH

Mode (Bit/s)	Channel	6 dB Bandwidth (kHz)	99 % Measured Bandwidth [MHz]	Limit (kHz)
1M	0	665.3	1.0506	> 500
	19	666.4	1.0507	
	39	668.4	1.0485	
2M	0	1134.7	2.0642	> 500
	19	1134.3	2.0579	
	39	1136.1	2.0597	
125k	0	607.9	1.0372	> 500
	19	608.8	1.0388	
	39	609.1	1.0412	
500k	0	667.1	1.0477	> 500
	19	668.1	1.0477	
	39	664.1	1.0491	

▣ 1M Bit/s Test Plots

6 dB Bandwidth plot (Low-CH 0)

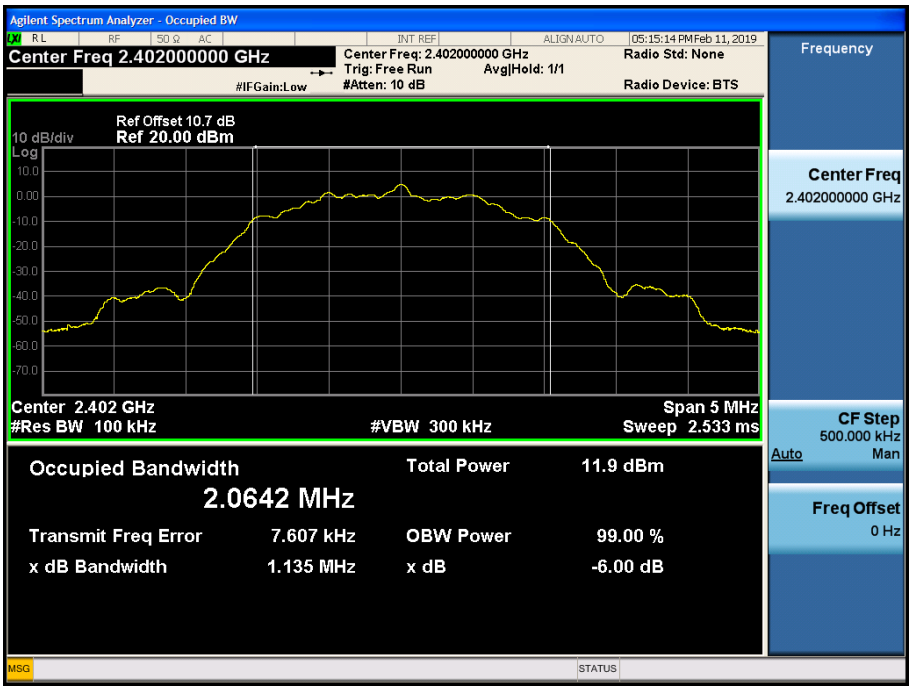


6 dB Bandwidth plot (Mid-CH 19)

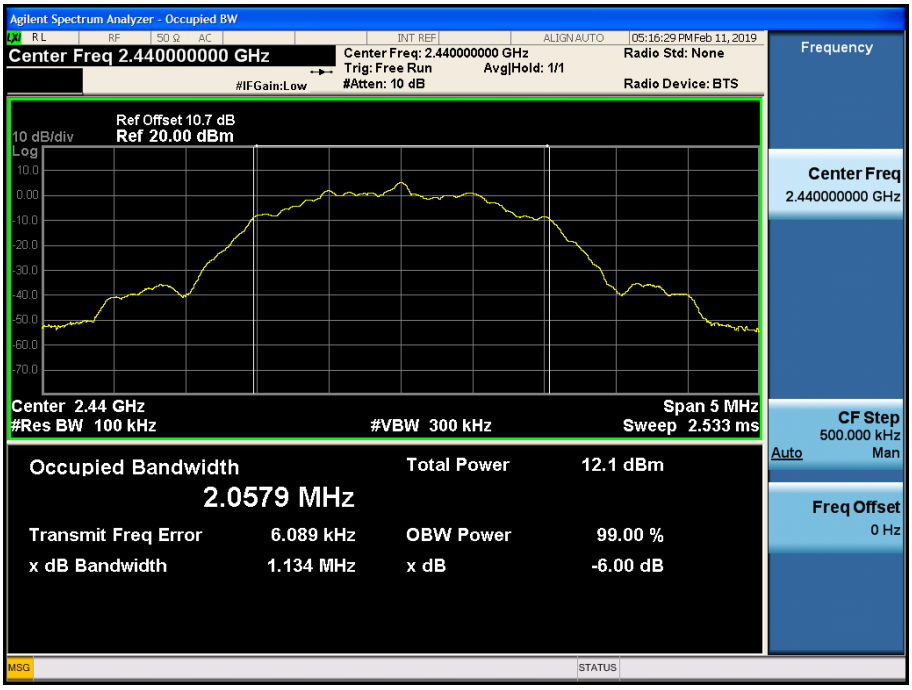
6 dB Bandwidth plot (High-CH 39)

▣ 2M Bit/s Test Plots

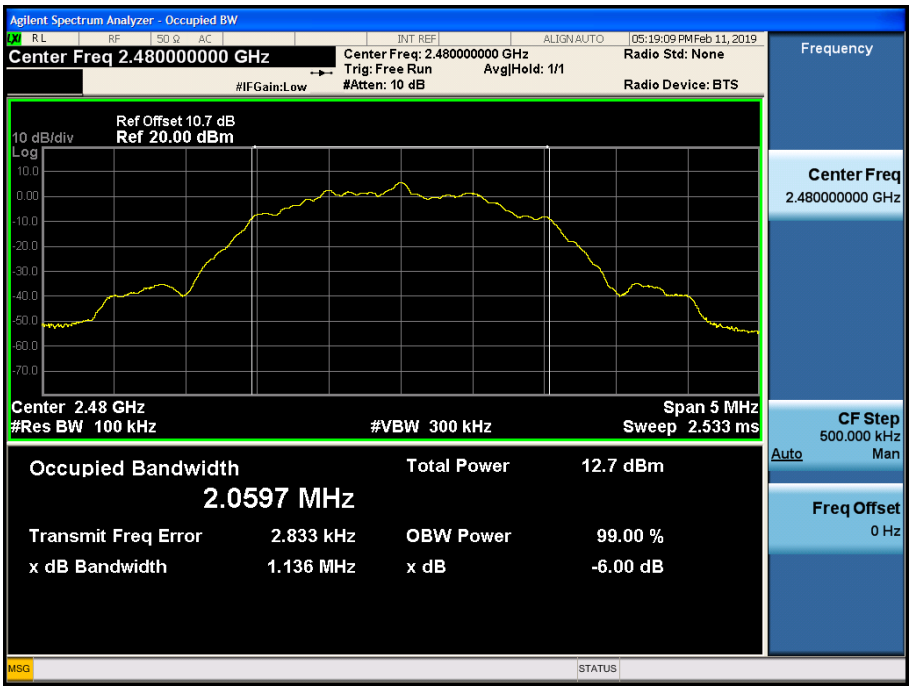
6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)



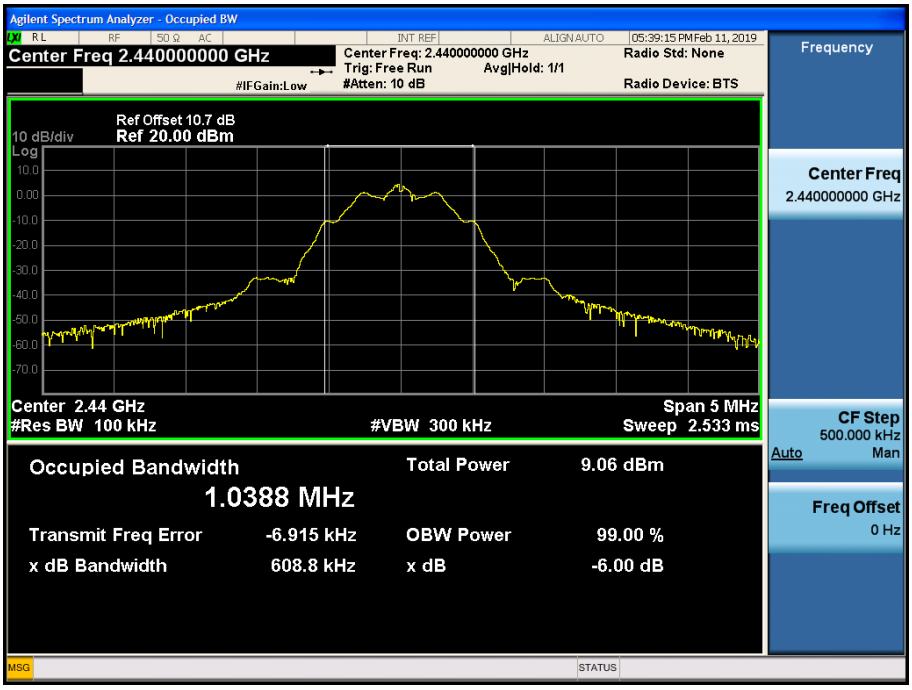
6 dB Bandwidth plot (High-CH 39)



▣ 125k Bit/s Test Plots

6 dB Bandwidth plot (Low-CH 0)

6 dB Bandwidth plot (Mid-CH 19)

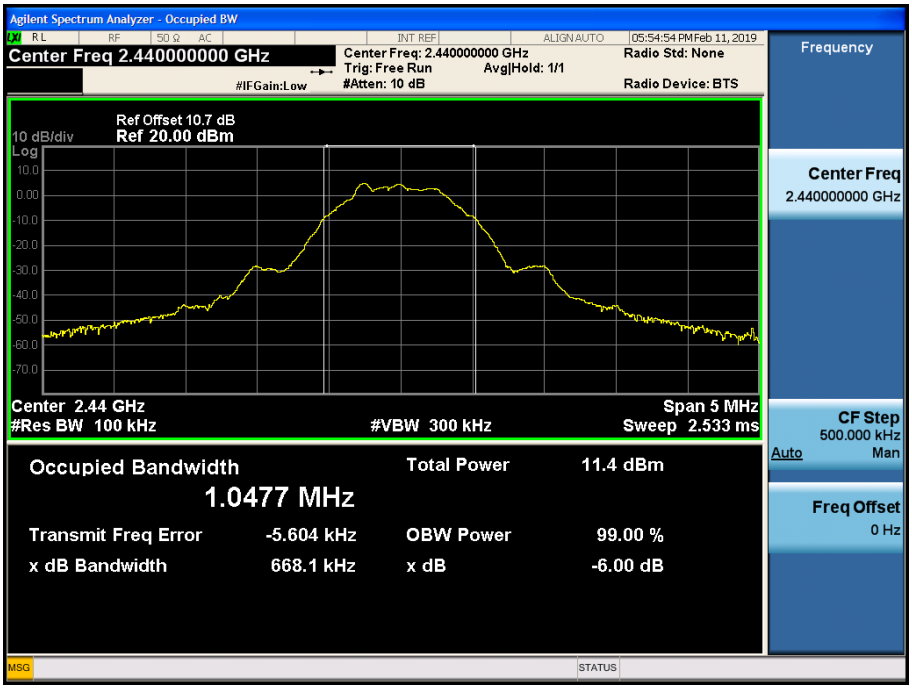


6 dB Bandwidth plot (High-CH 39)

▣ 500k Bit/s Test Plots

6 dB Bandwidth plot (Low-CH 0)

6 dB Bandwidth plot (Mid-CH 19)



6 dB Bandwidth plot (High-CH 39)

9.3 OUTPUT POWER

Peak Power

LE Mode		Data rate	Packet length	Measured	Limit
Frequency[MHz]	Channel No.	(Bit/s)	(Byte)	Power(dBm)	(dBm)
2402	0	1M	37	4.913	30
			255	4.913	
		2M	37	5.694	
			255	5.605	
		125k	37	4.830	
			255	4.719	
		500k	37	4.792	
			255	4.692	
2440	19	1M	37	5.185	
			255	5.172	
		2M	37	5.936	
			255	5.827	
		125k	37	5.040	
			255	4.925	
		500k	37	5.009	
			255	4.974	
2480	39	1M	37	5.735	
			255	5.732	
		2M	37	6.328	
			255	6.222	
		125k	37	5.520	
			255	5.404	
		500k	37	5.498	
			255	5.382	

Average Power

LE Mode		Data rate	Packet length	Measured	Duty Cycle Factor	Result	Limit
Frequency[MHz]	Channel No.	(Bit/s)	(Byte)	Power(dBm)	(dB)	(dBm)	(dBm)
2402	0	1M	37	2.58	2.04	4.62	30
			255	3.90	0.69	4.59	
		2M	37	-0.12	4.81	4.69	
			255	2.05	2.42	4.47	
		125k	37	3.67	0.82	4.49	
			255	4.36	0.11	4.47	
		500k	37	2.26	2.44	4.70	
			255	4.06	0.41	4.47	
2440	19	1M	37	2.77	2.04	4.81	
			255	4.08	0.69	4.77	
		2M	37	0.20	4.81	5.01	
			255	2.48	2.42	4.90	
		125k	37	4.01	0.82	4.83	
			255	4.60	0.11	4.71	
		500k	37	2.42	2.44	4.86	
			255	4.27	0.41	4.68	
2480	39	1M	37	3.35	2.04	5.39	
			255	4.63	0.69	5.32	
		2M	37	0.70	4.81	5.51	
			255	2.85	2.42	5.27	
		125k	37	4.54	0.82	5.36	
			255	5.19	0.11	5.30	
		500k	37	2.94	2.44	5.38	
			255	4.88	0.41	5.29	

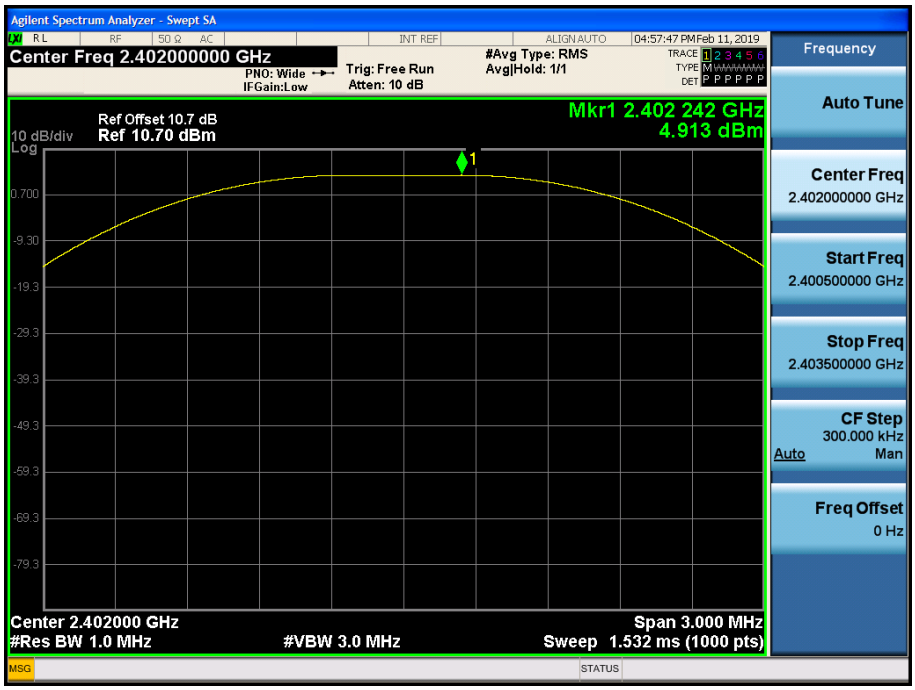
Note :

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 tenth dB.
   So, 10.7 dB is offset for 2.4 GHz Band.

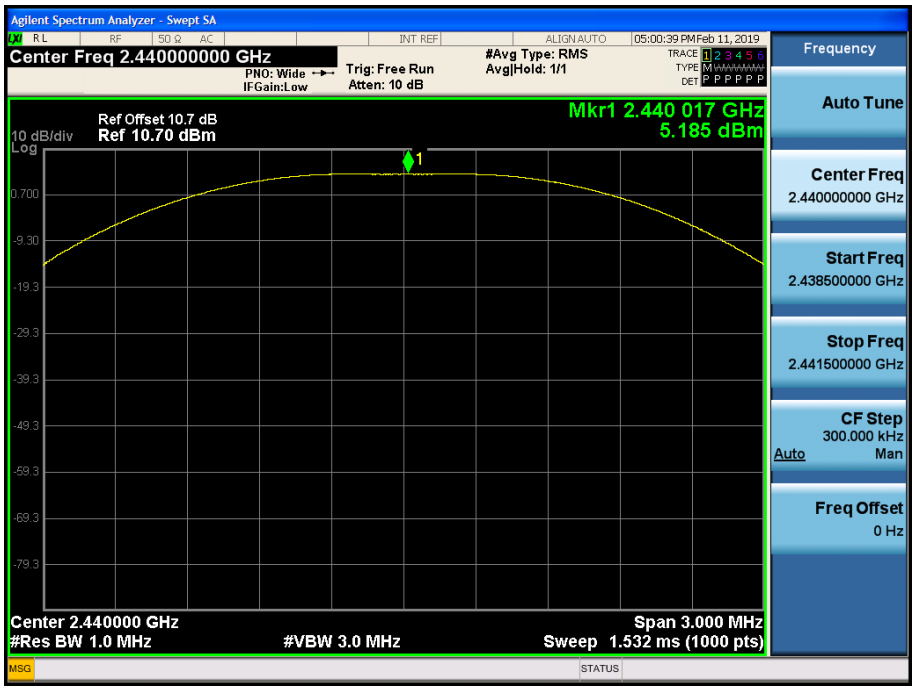
▣ 1M Bit/s(37 Byte) Test Plots

Peak Power

Conducted Output Power (Low-CH 0)



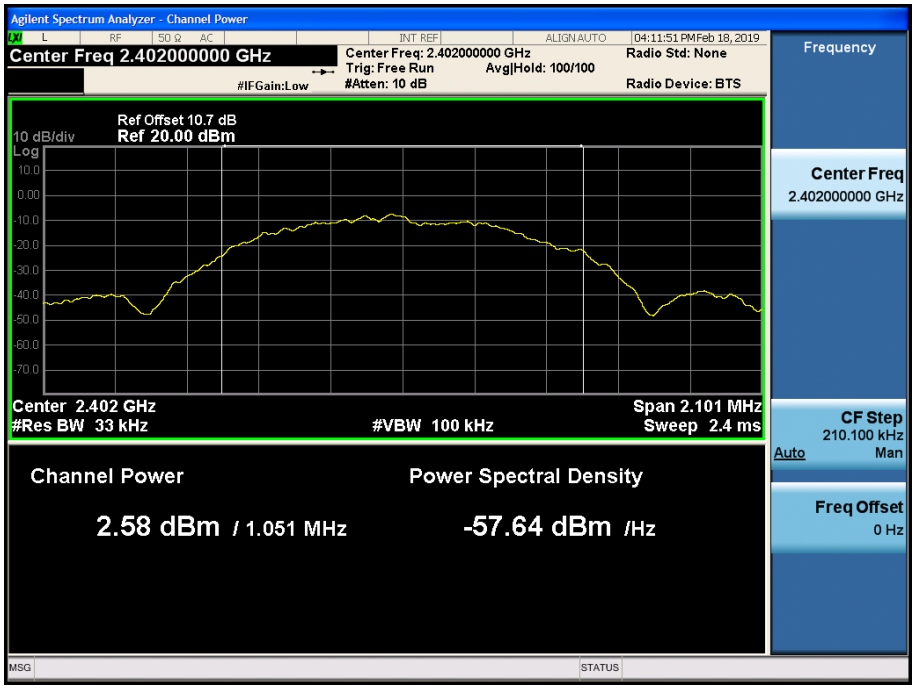
Conducted Output Power (Mid-CH 19)



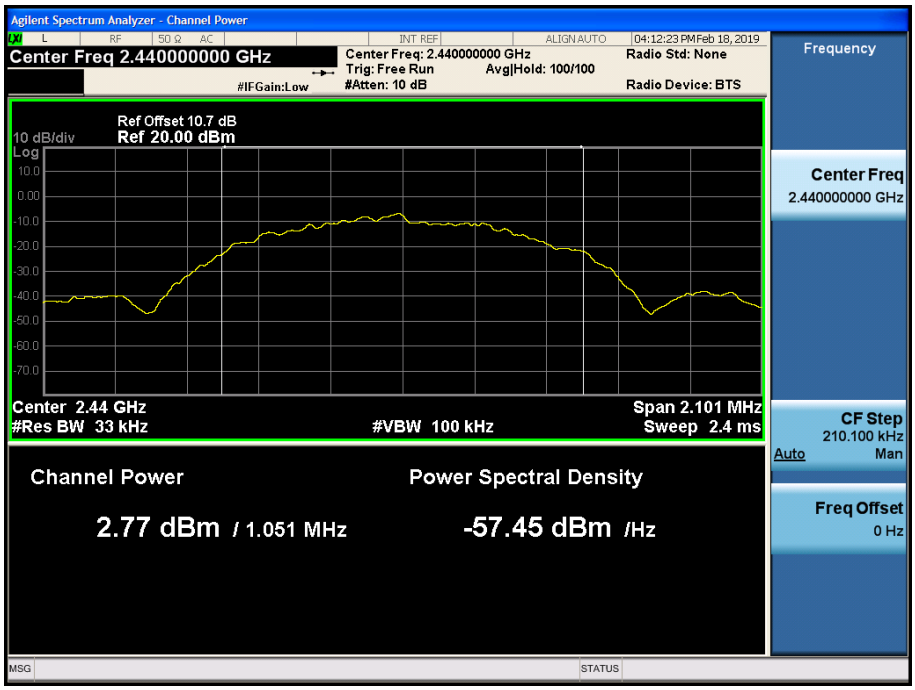
Conducted Output Power (High-CH 39)

Average Power

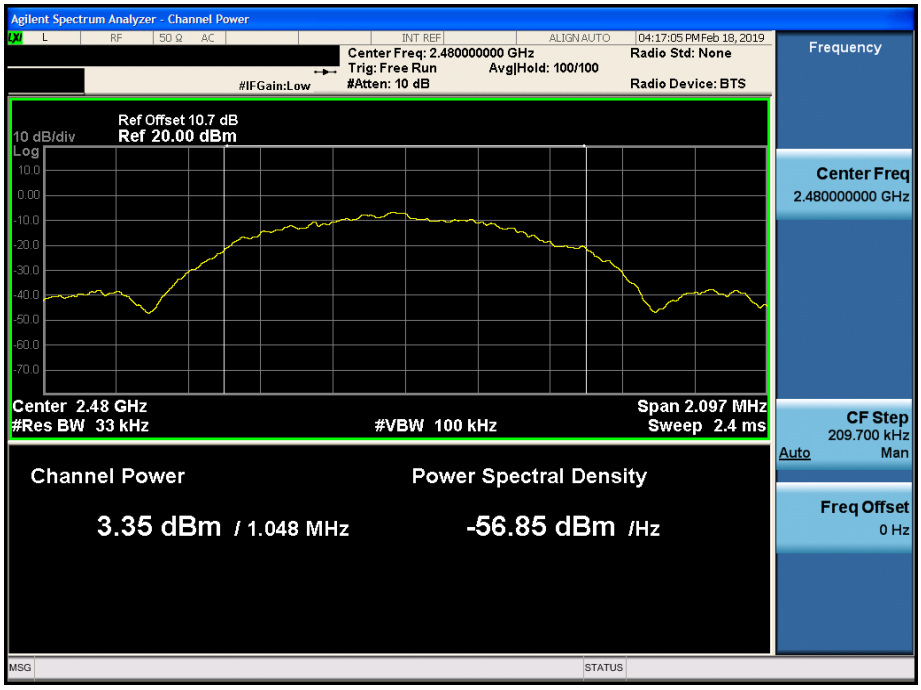
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



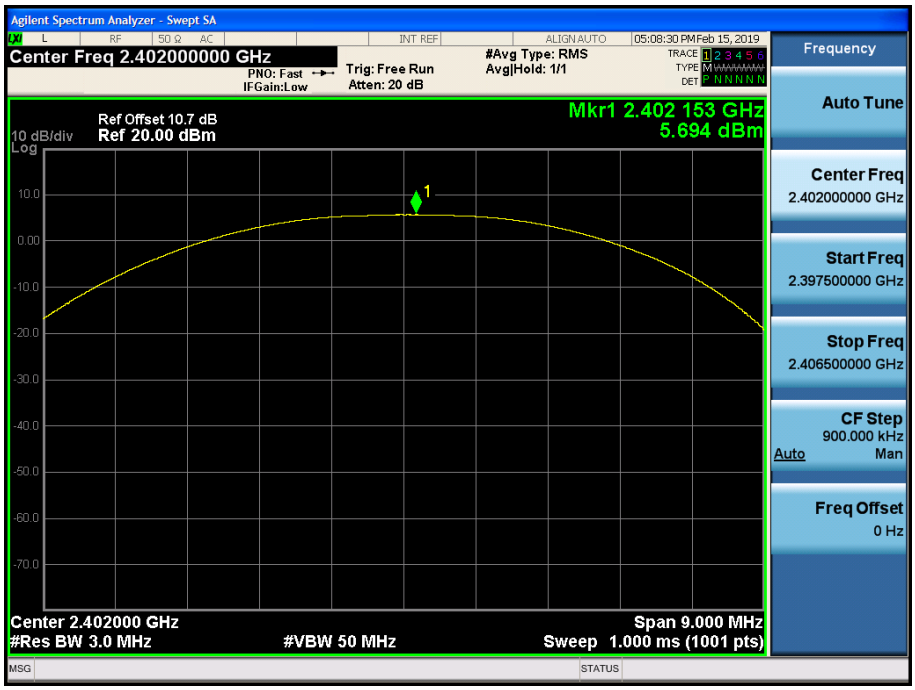
Conducted Output Power (High-CH 39)



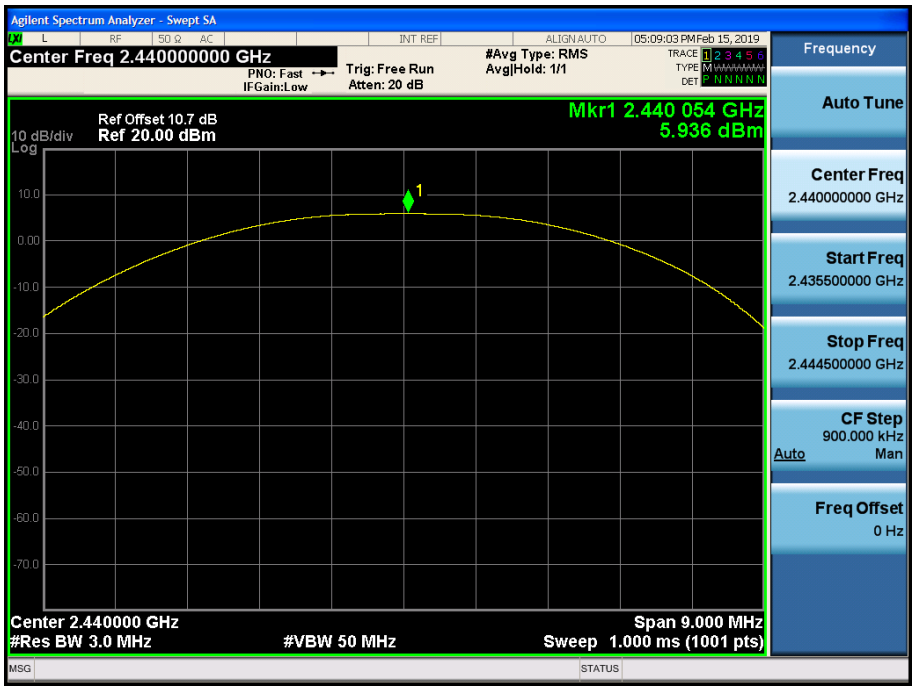
▣ 2M Bit/s(37 Byte) Test Plots

Peak Power

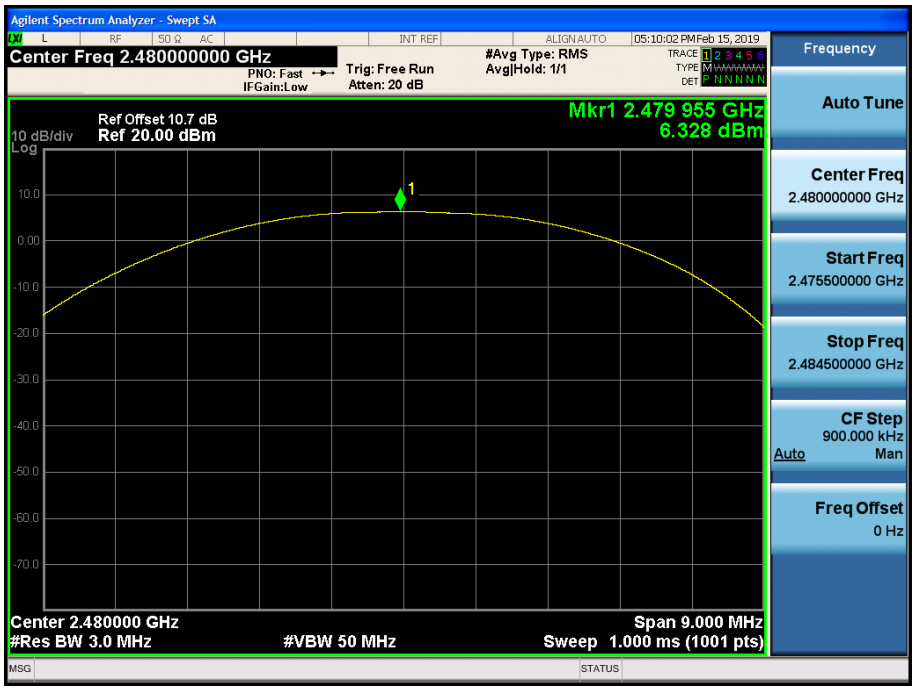
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

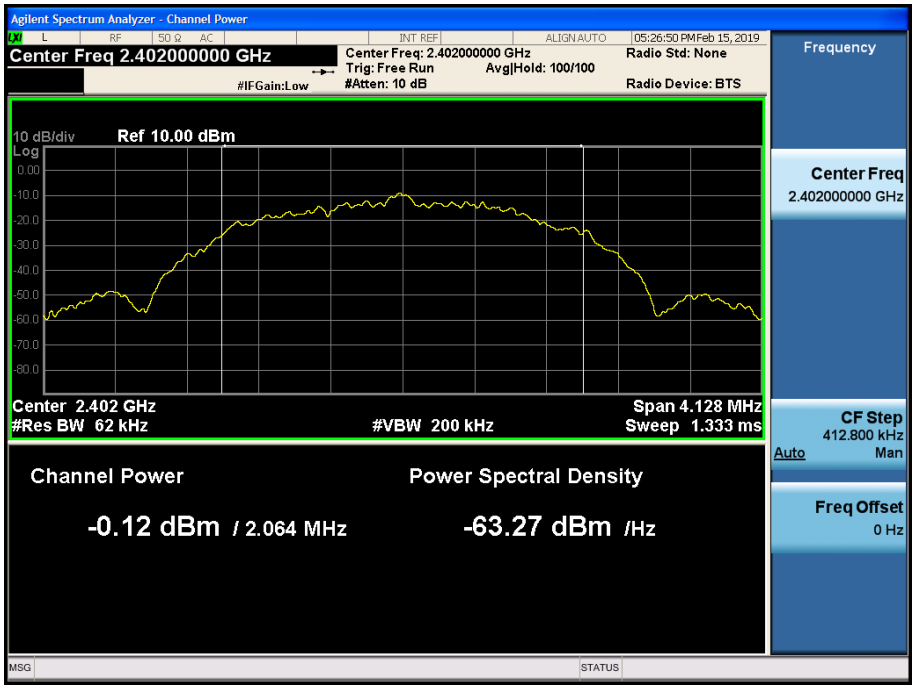


Conducted Output Power (High-CH 39)

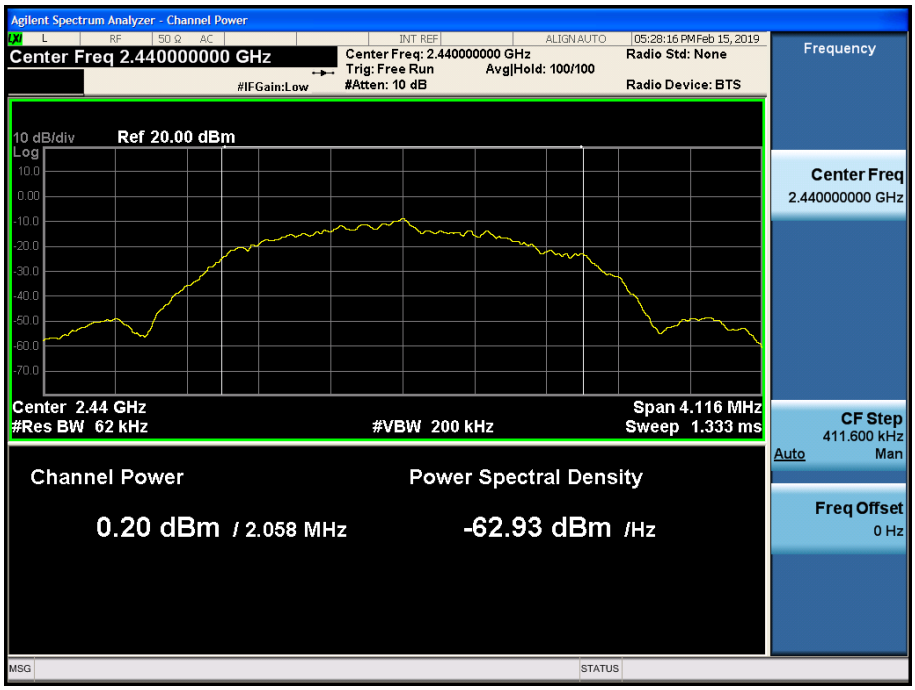


Average Power

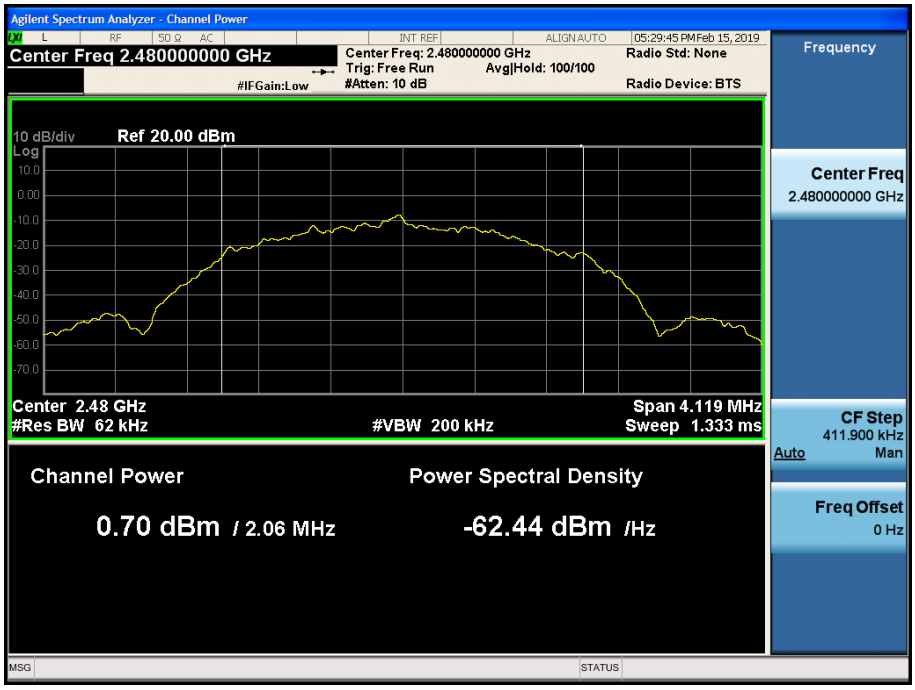
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



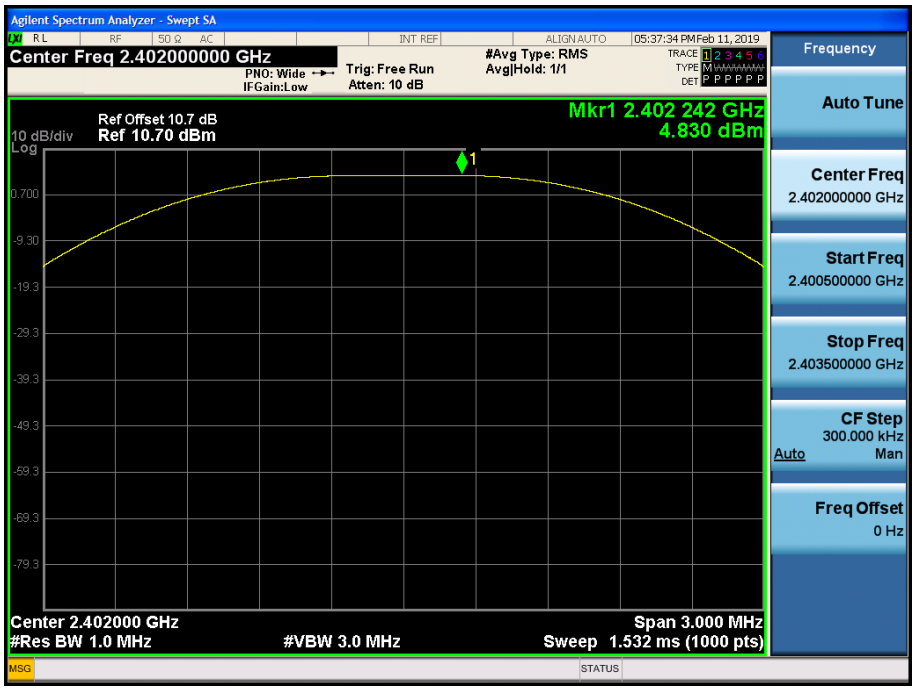
Conducted Output Power (High-CH 39)



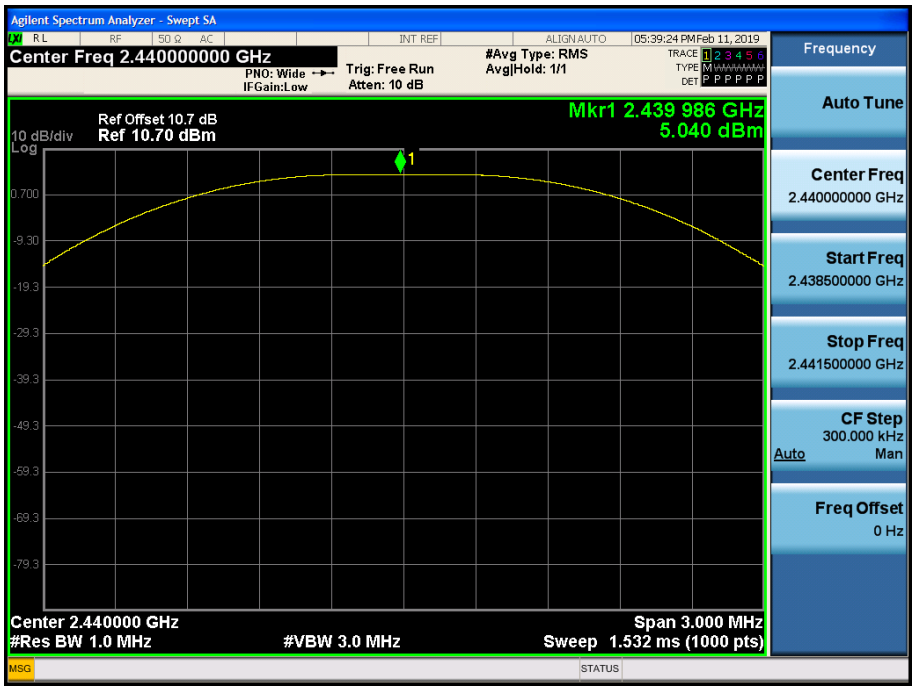
▣ 125k Bit/s(37 Byte) Test Plots

Peak Power

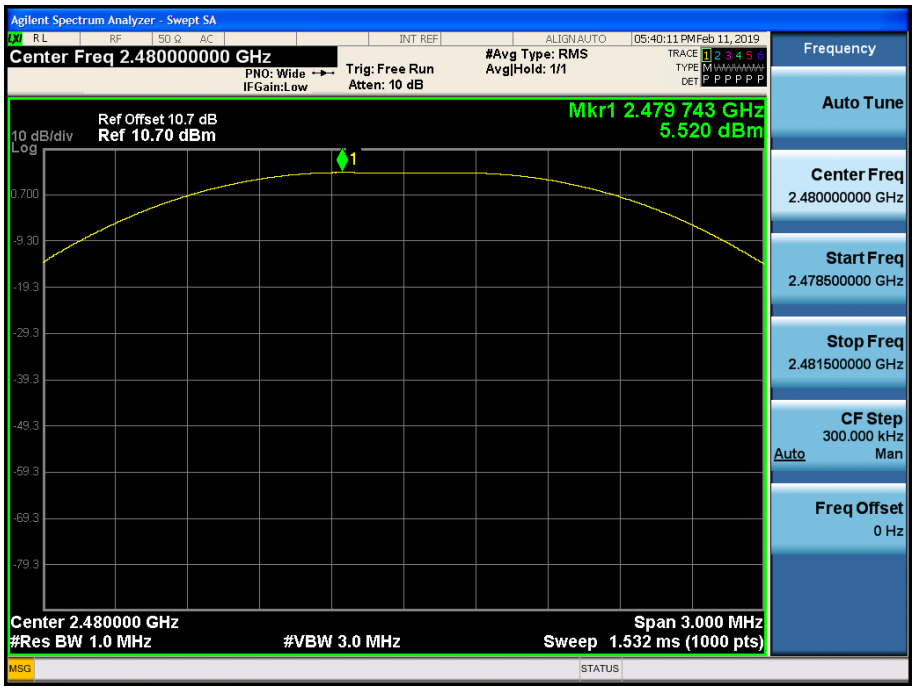
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)

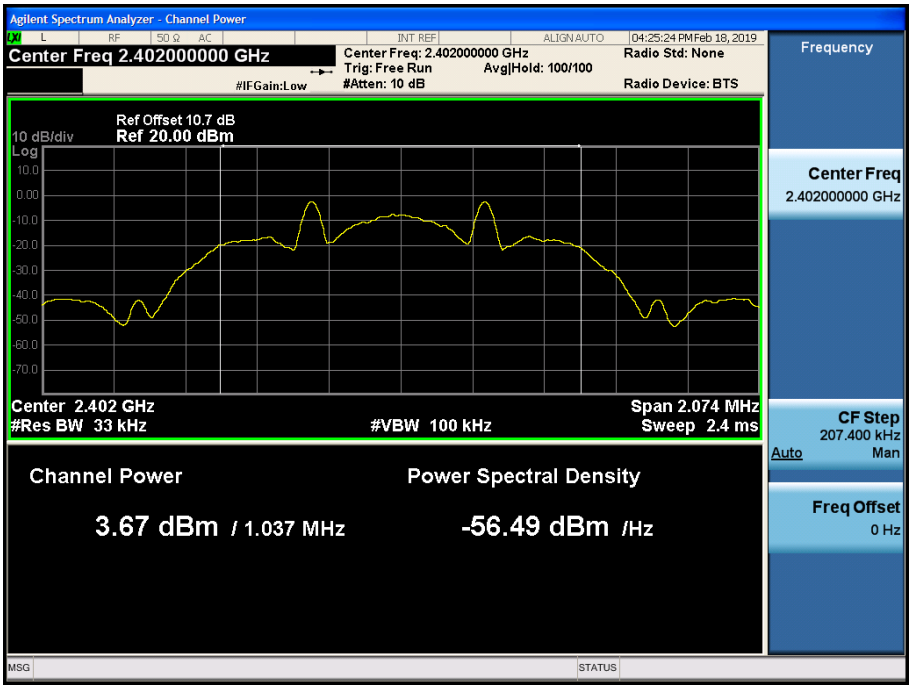


Conducted Output Power (High-CH 39)

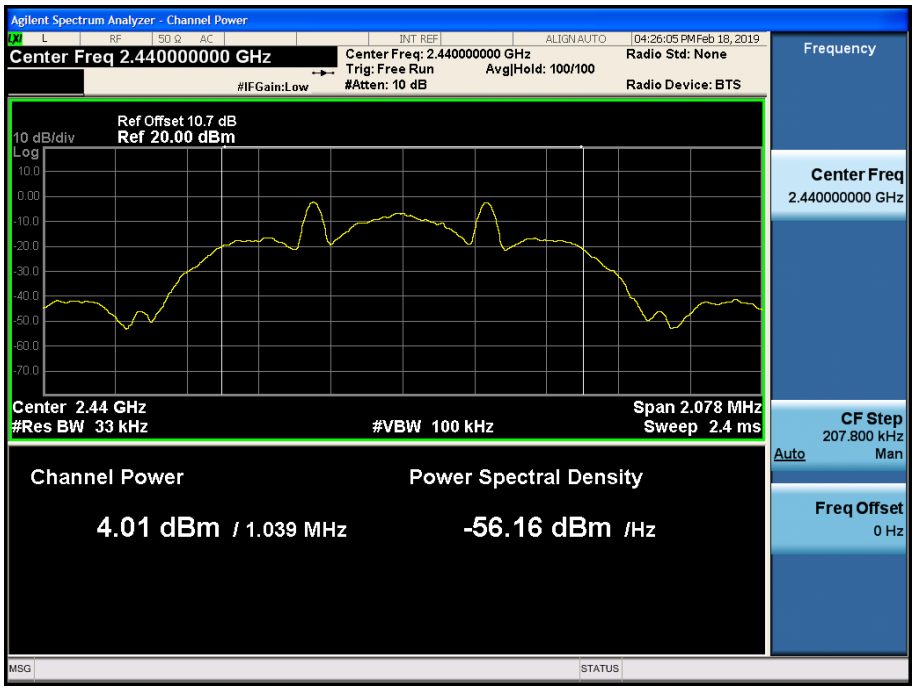


Average Power

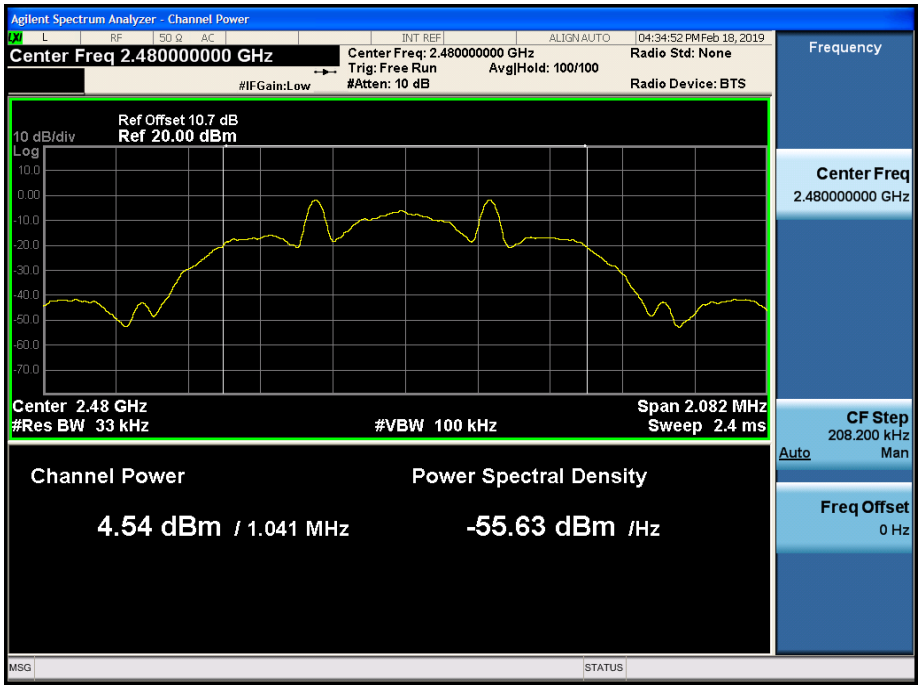
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



Conducted Output Power (High-CH 39)

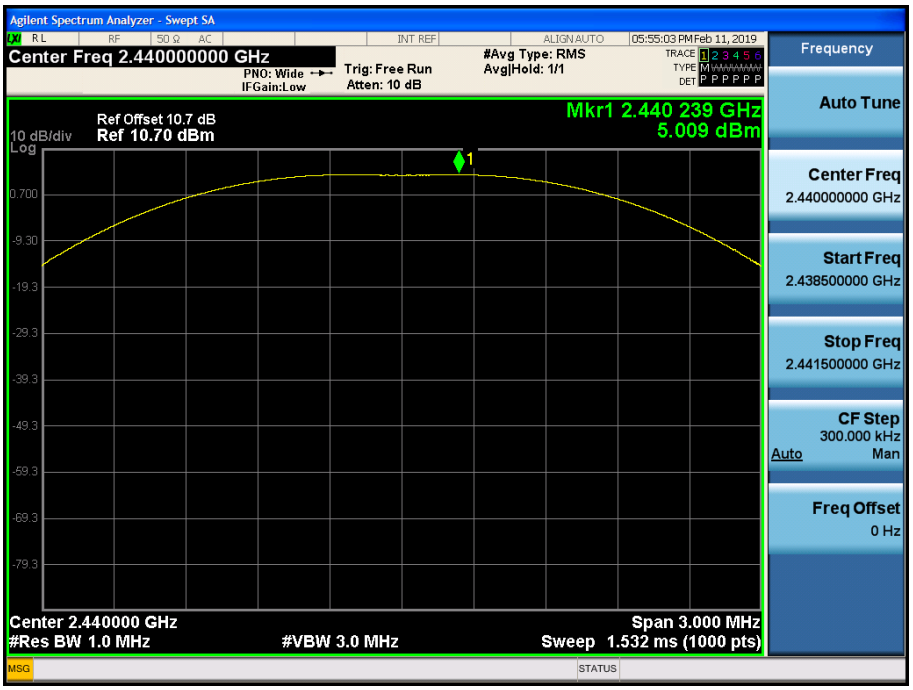


▣ 500k Bit/s(37 Byte) Test Plots

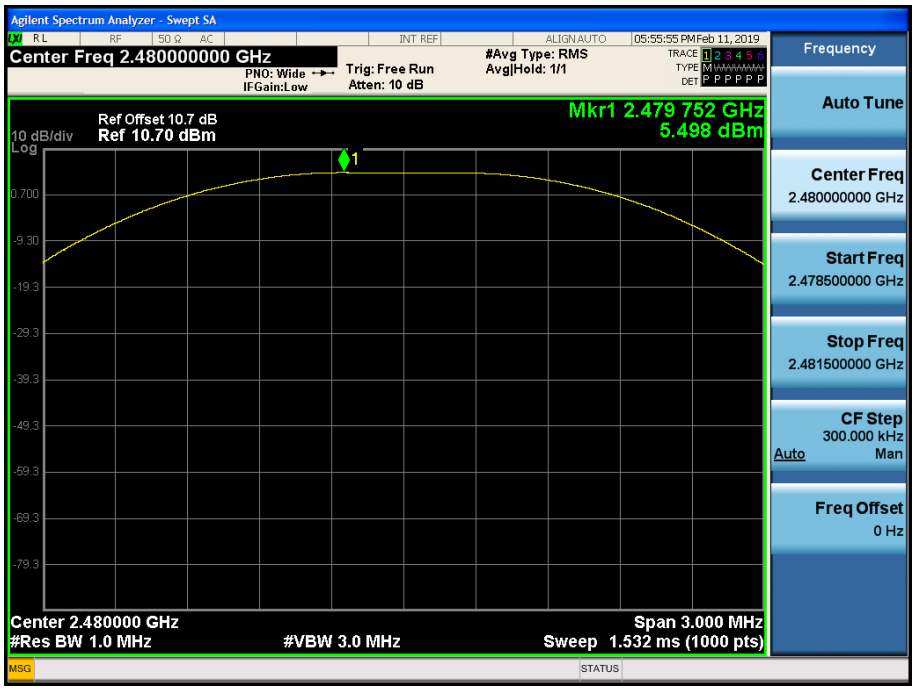
Peak Power

Conducted Output Power (Low-CH 0)

Conducted Output Power (Mid-CH 19)

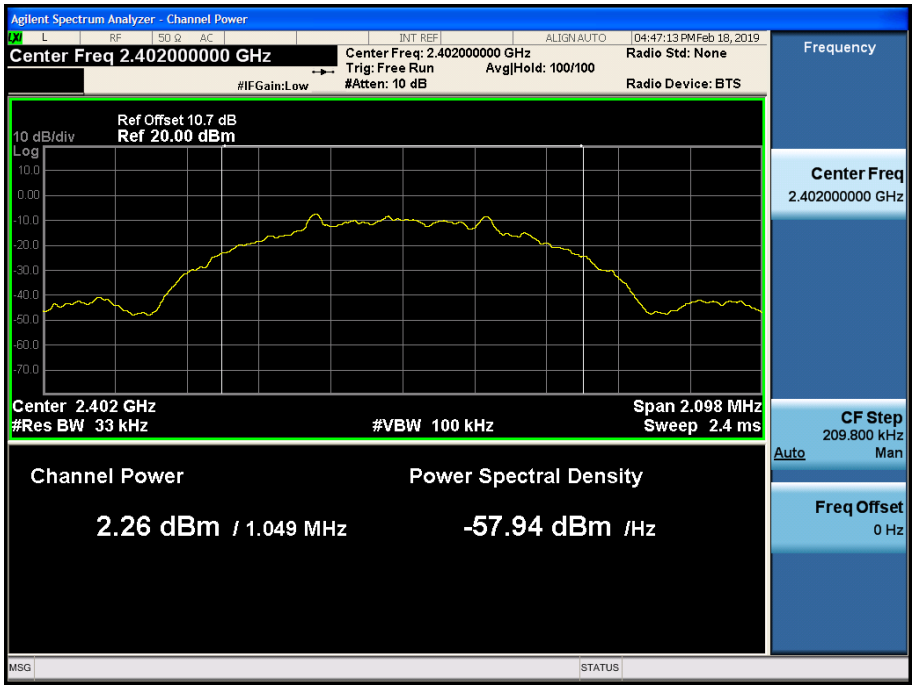


Conducted Output Power (High-CH 39)

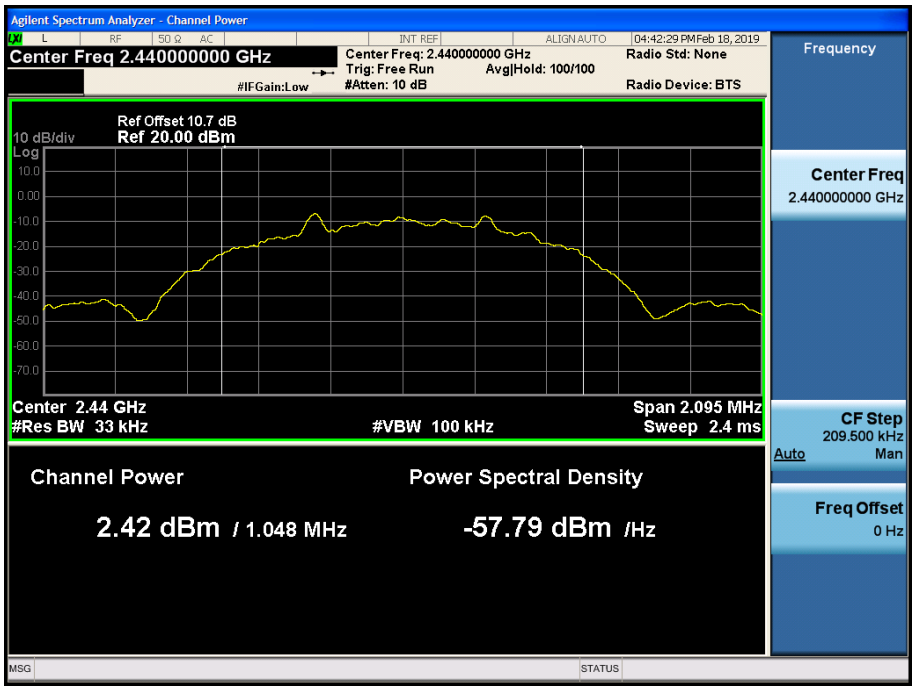


Average Power

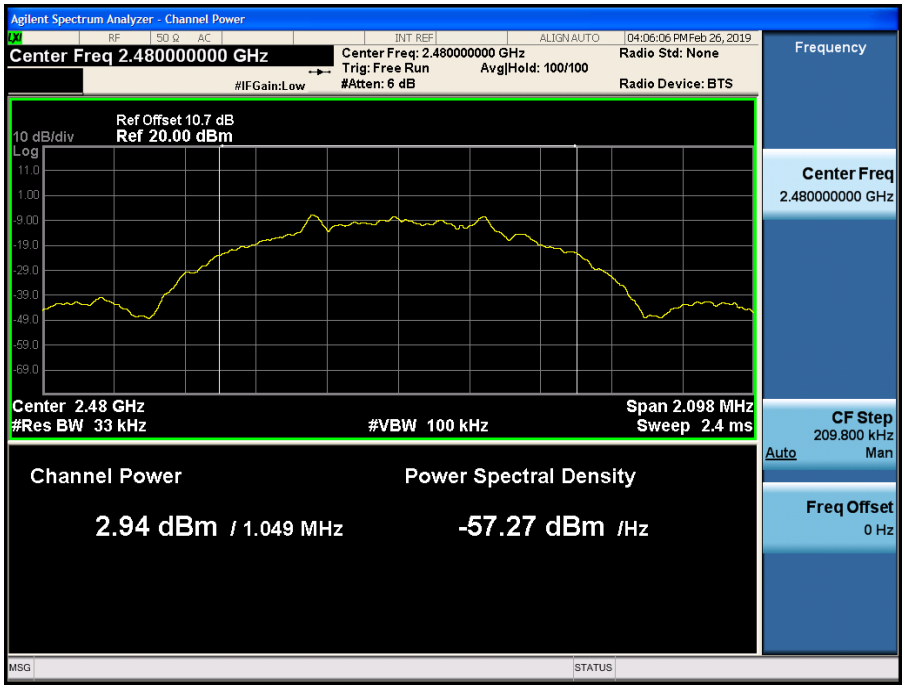
Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



Conducted Output Power (High-CH 39)



9.4 POWER SPECTRAL DENSITY

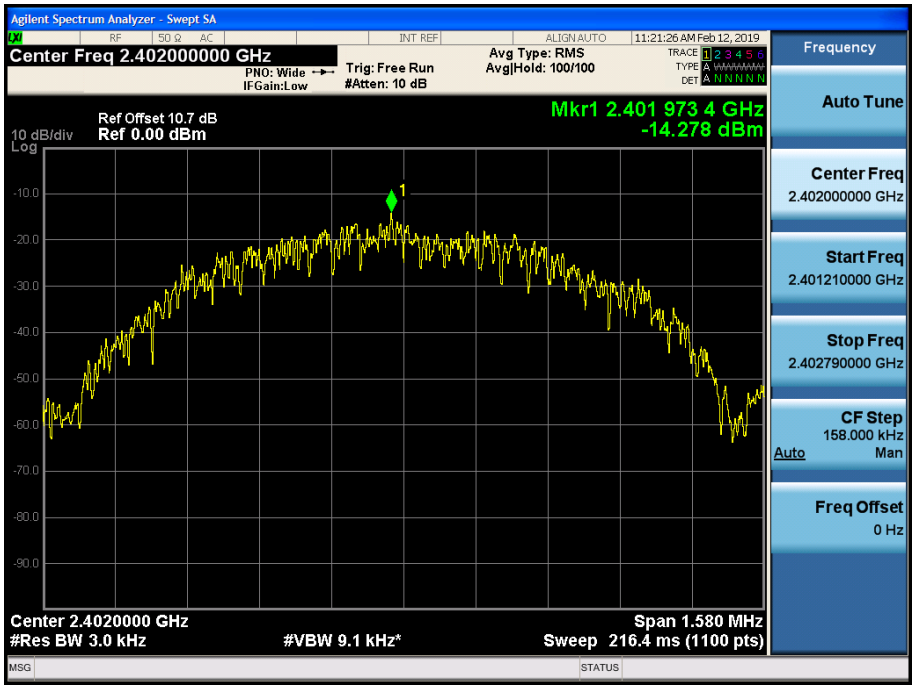
Frequency (MHz)	Channel No.	Mode	Test Result			
			Measured PSD (dBm)	Duty Cycle Factor	Measured PSD(dBm) + Duty Cycle Factor	Limit (dBm)
2402	0	1M Bit 37 Byte	-14.278	2.038	-12.240	8.000
2440	19		-13.865	2.038	-11.827	8.000
2480	39		-13.521	2.038	-11.483	8.000
2402	0	2M Bit 37 Byte	-18.578	4.807	-13.771	8.000
2440	19		-17.731	4.807	-12.924	8.000
2480	39		-17.548	4.807	-12.741	8.000
2402	0	125k Bit 37 Byte	-2.910	0.820	-2.090	8.000
2440	19		-2.970	0.820	-2.150	8.000
2480	39		-2.587	0.820	-1.767	8.000
2402	0	500k Bit 37 Byte	-9.498	2.440	-7.058	8.000
2440	19		-8.695	2.440	-6.255	8.000
2480	39		-8.445	2.440	-6.005	8.000

Note :

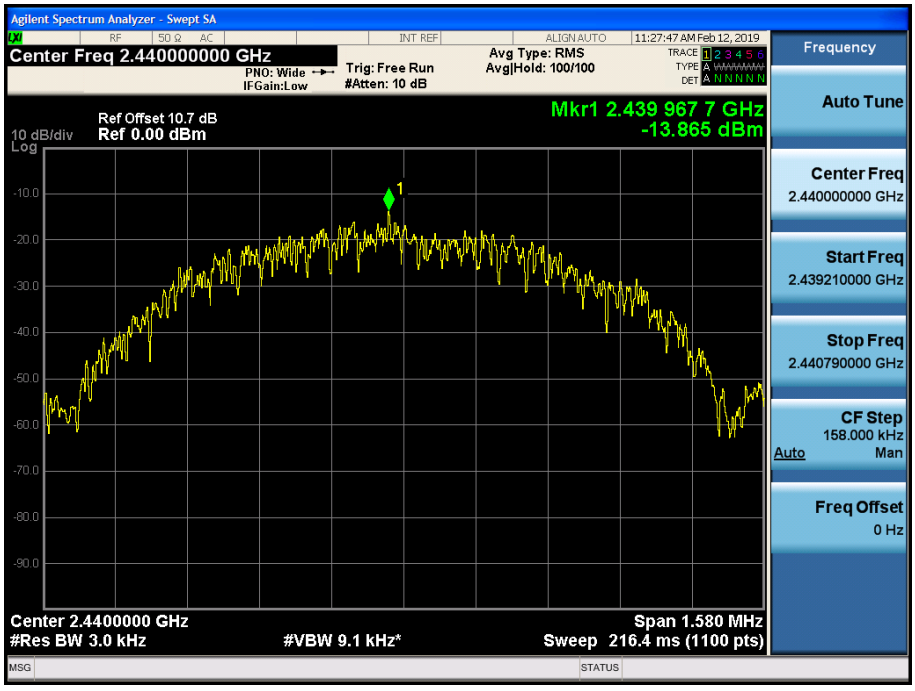
1. Spectrum reading values are not plot data.
   The PSD results in plot is already including the actual values of loss for the attenuator and cable combination.
2. Spectrum offset = Attenuator loss + Cable loss
3. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB.
   So, 10.7 dB is offset for 2.4 GHz Band.

▣ 1M Bit/s Test Plots

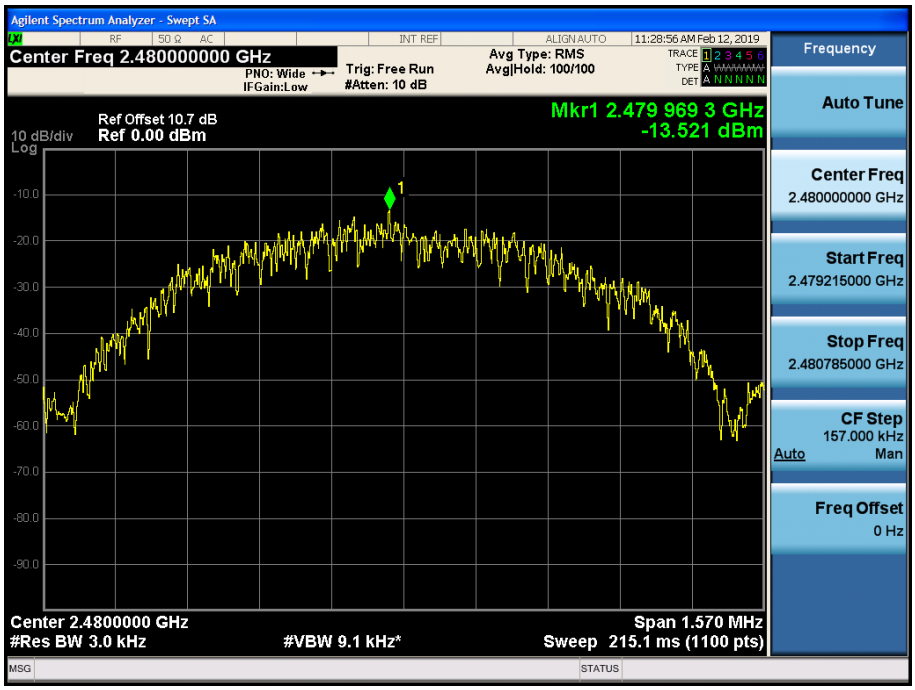
Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)

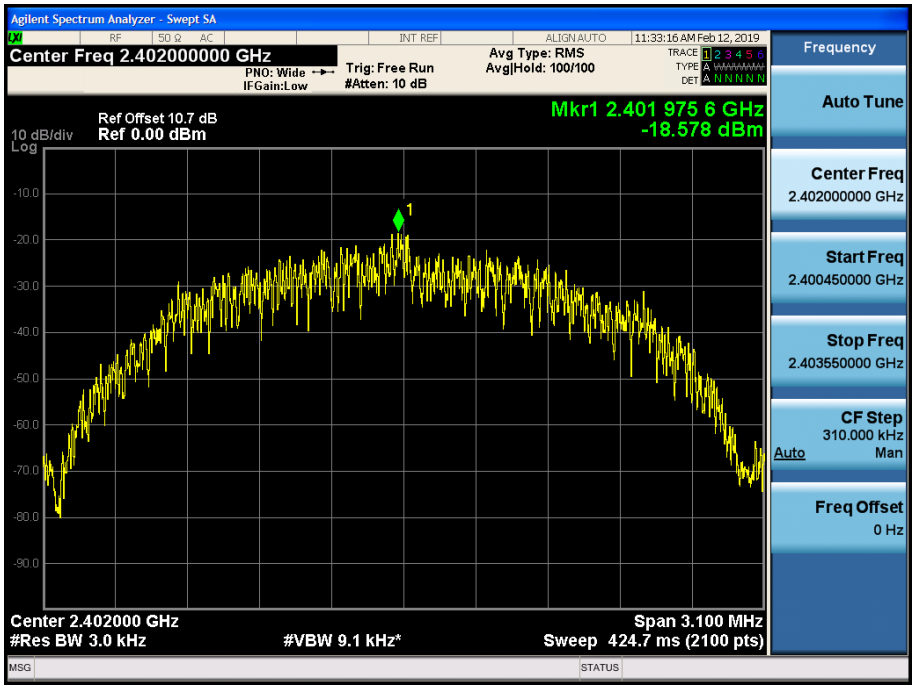


Power Spectral Density (High-CH 39)

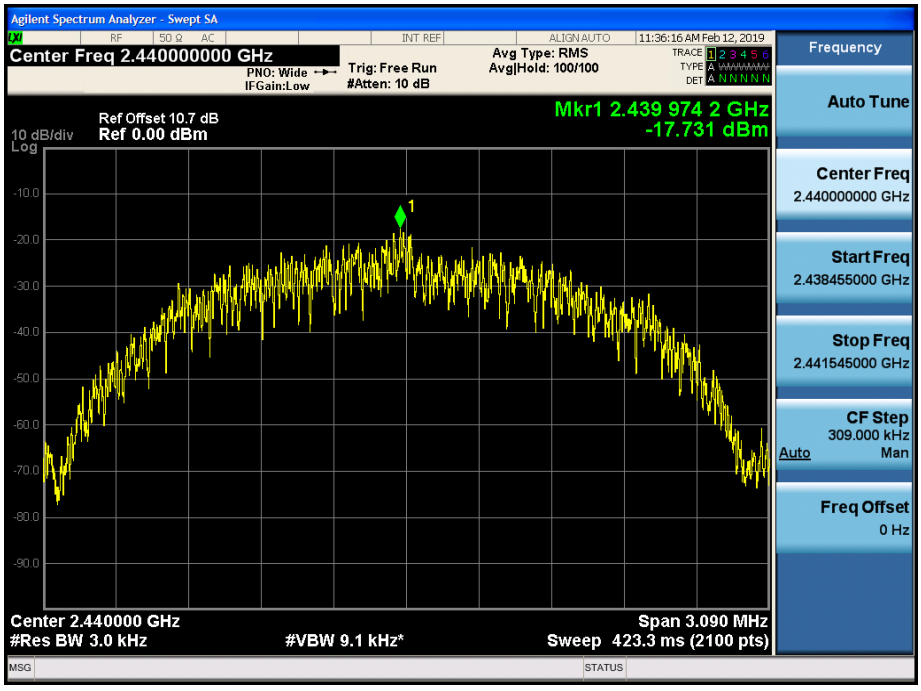


▣ 2M Bit/s Test Plots

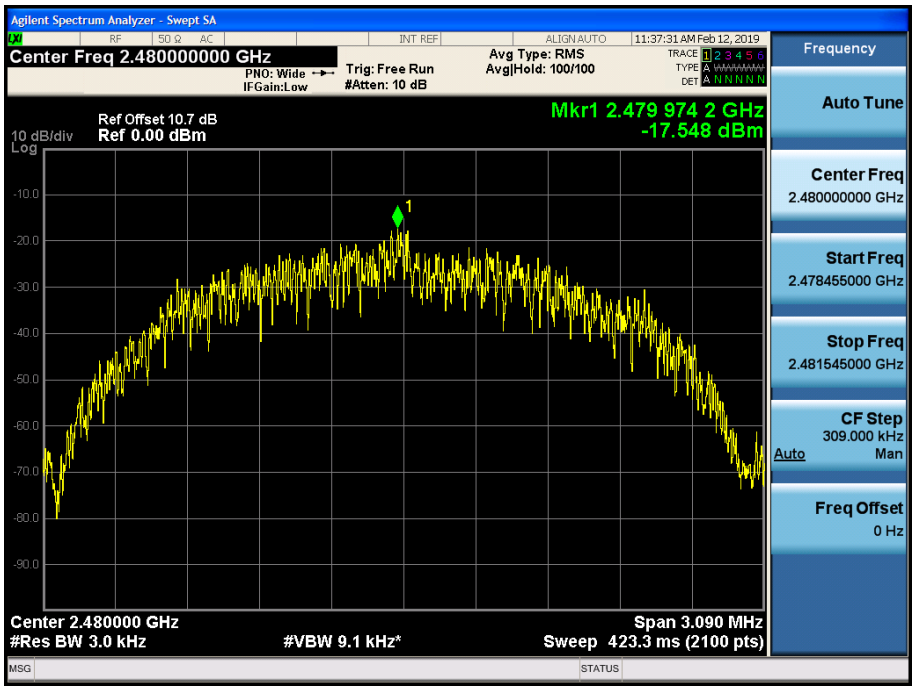
Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



Power Spectral Density (High-CH 39)



▣ 125k Bit/s Test Plots

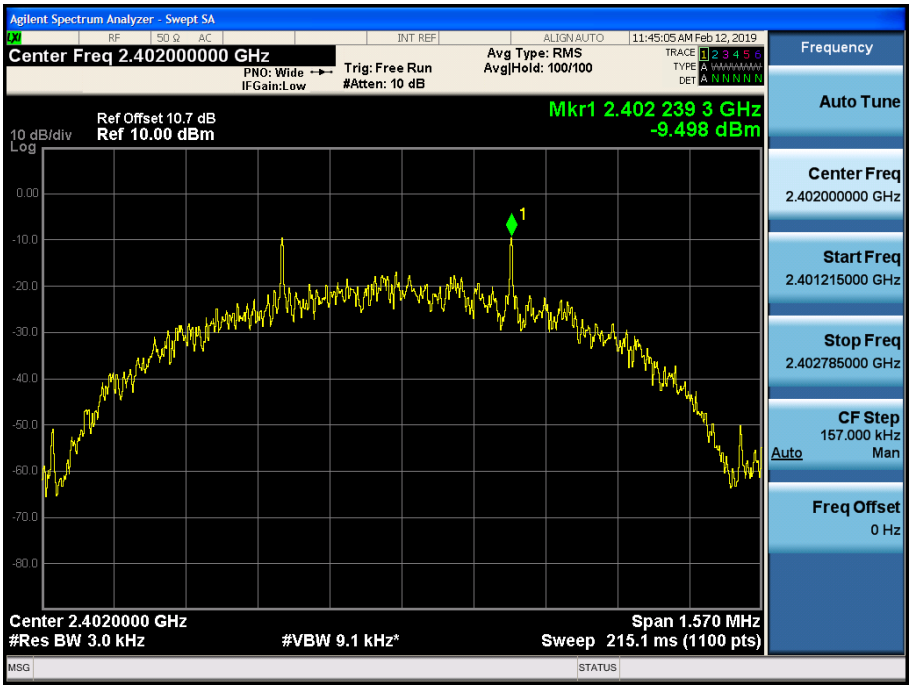
Power Spectral Density (Low-CH 0)

Power Spectral Density (Mid-CH 19)

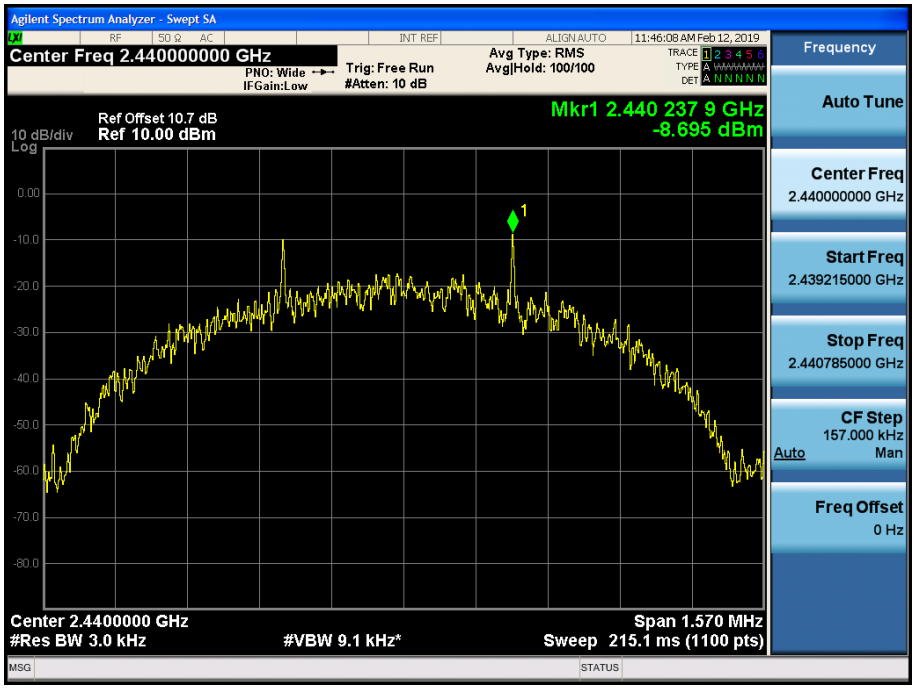
Power Spectral Density (High-CH 39)

▣ 500k Bit/s Test Plots

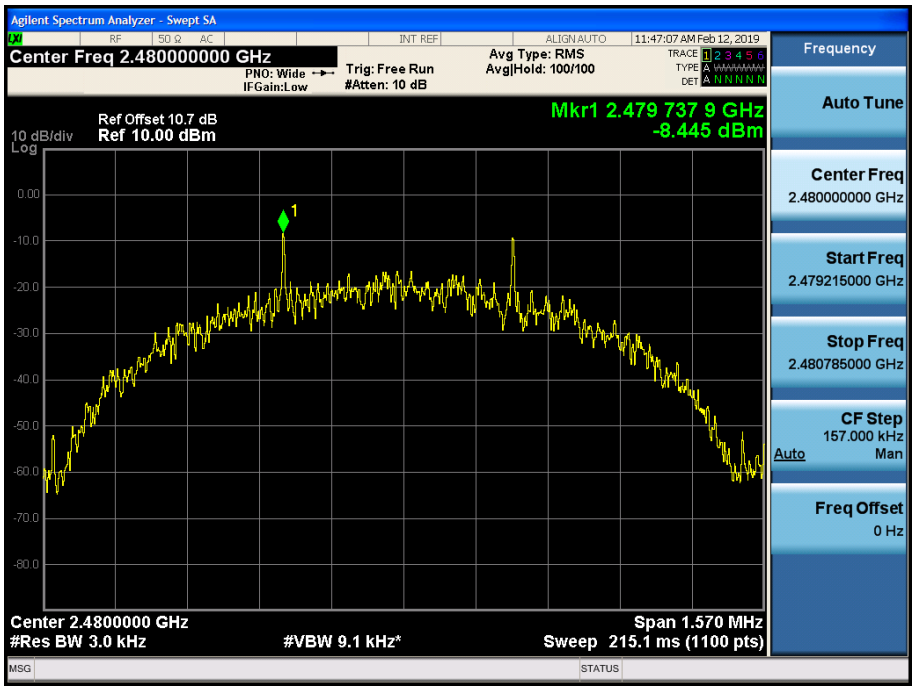
Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



Power Spectral Density (High-CH 39)



9.5 BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

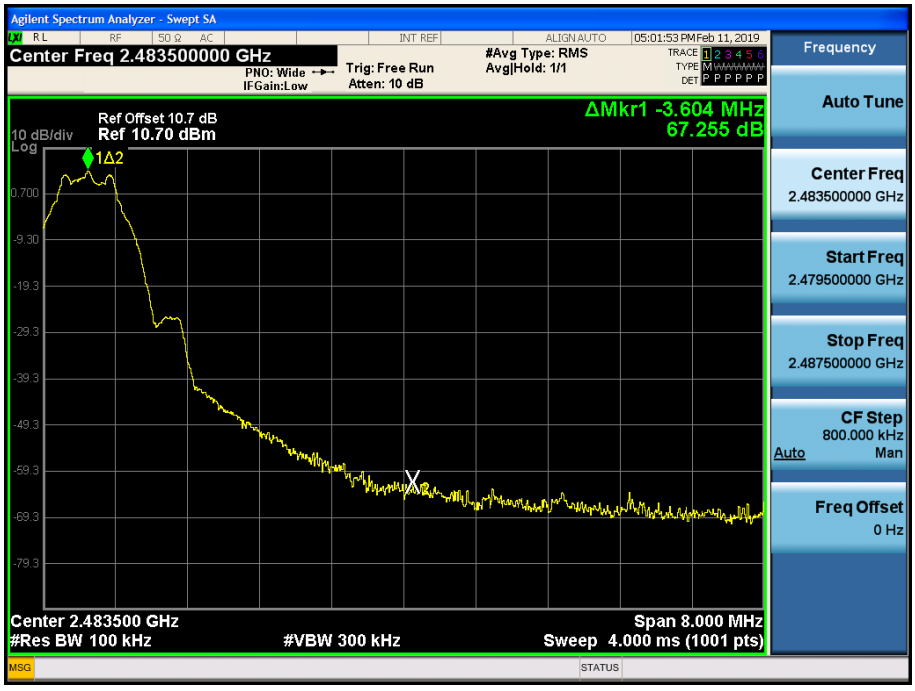
Test Result : please refer to the plot below.

In order to simplify the report, attached plots were only the worst case channel and data rate.

▣ 1M Bit/s Test Plots (BandEdge)

Low-CH 0

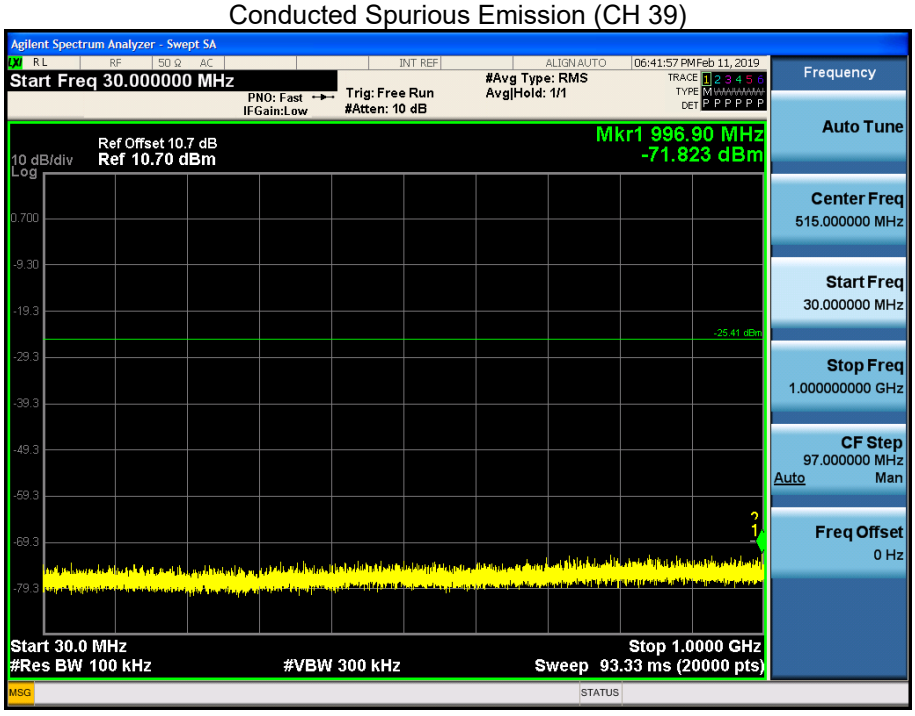
High-CH 39



▣ 1M Bit/s Test Plots (Conducted Spurious Emission)

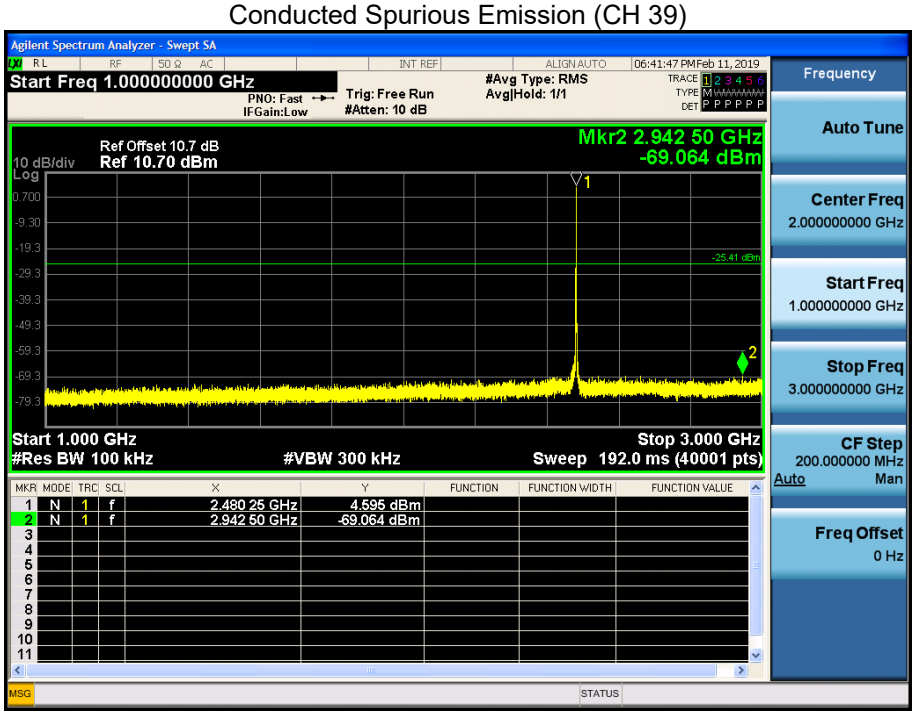
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 39)



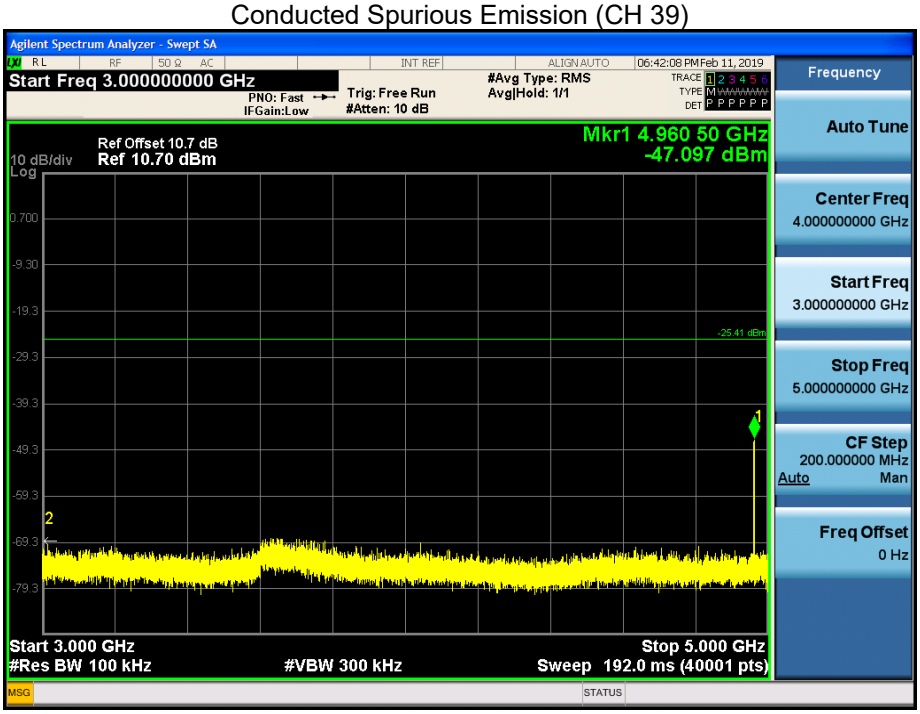
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 39)



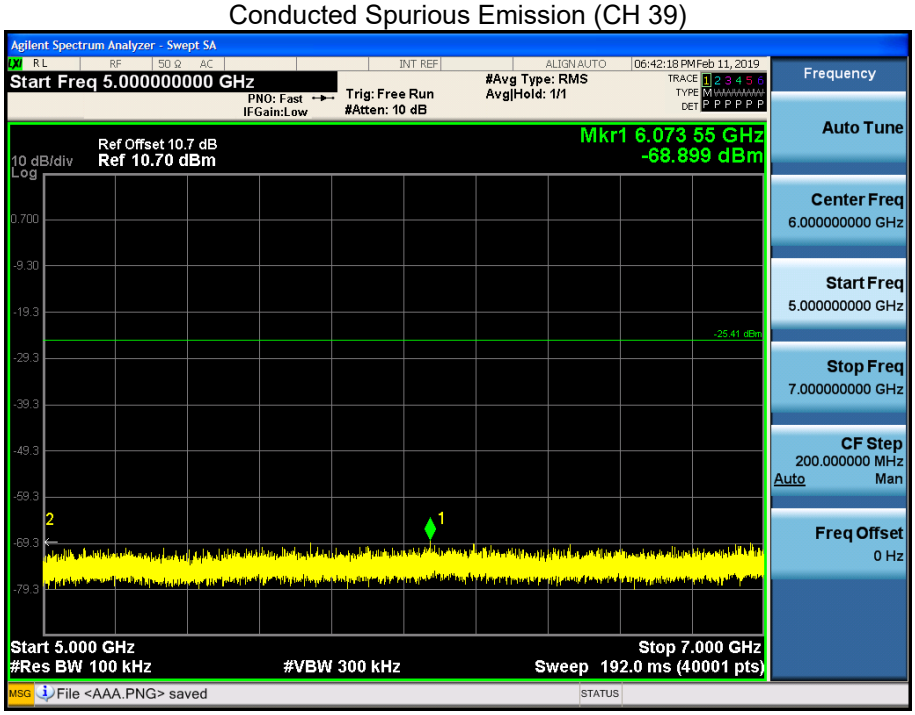
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 39)



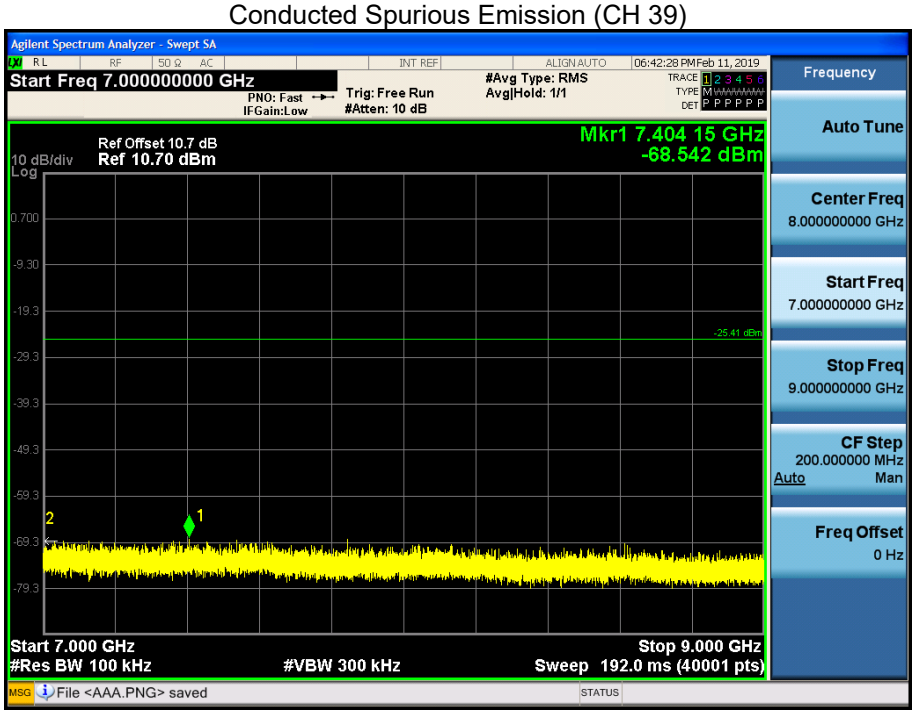
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 39)



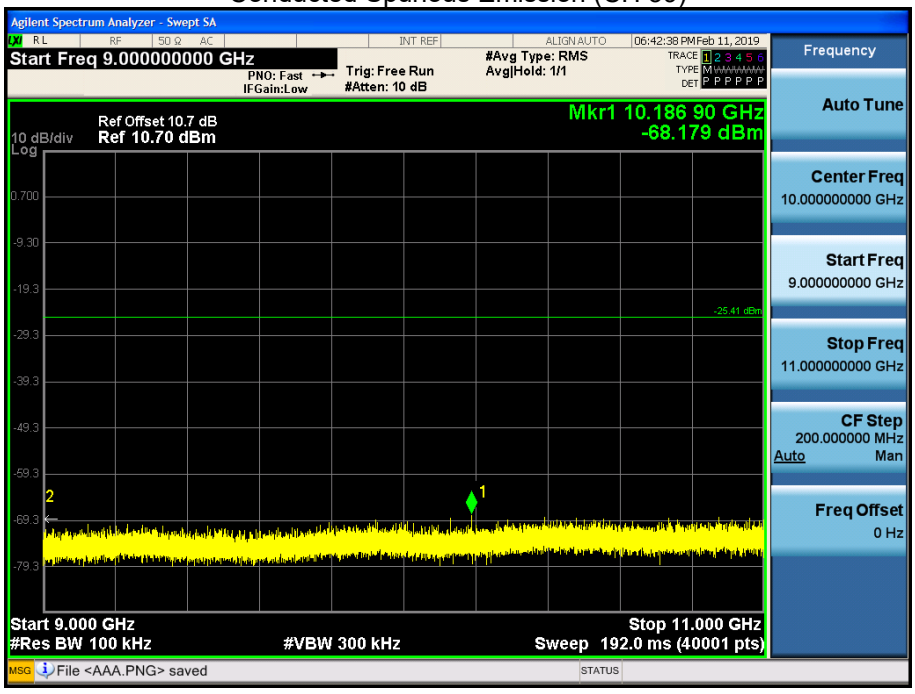
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 39)



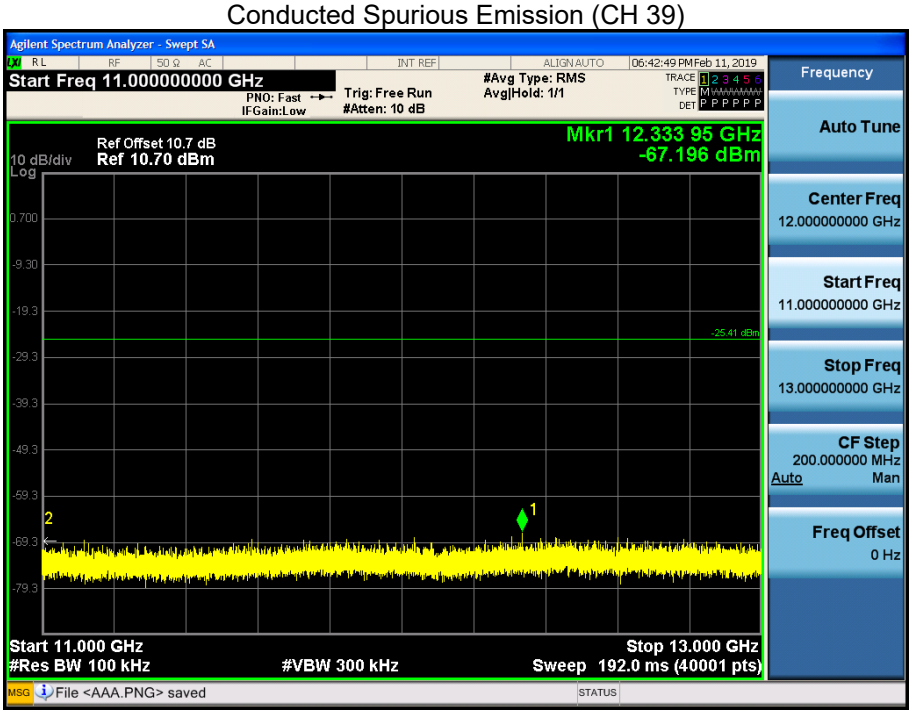
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 39)



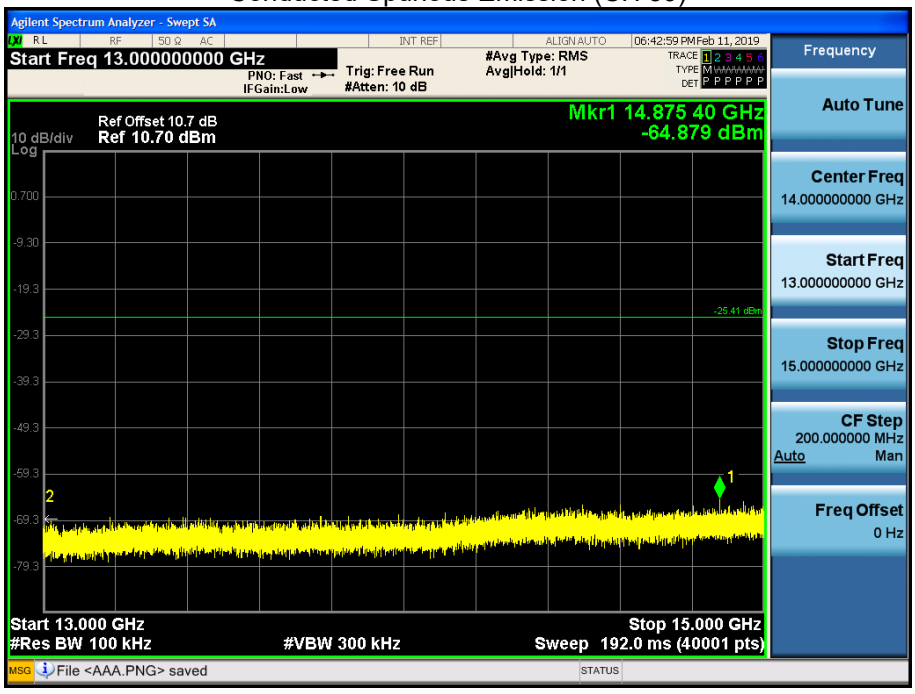
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 39)



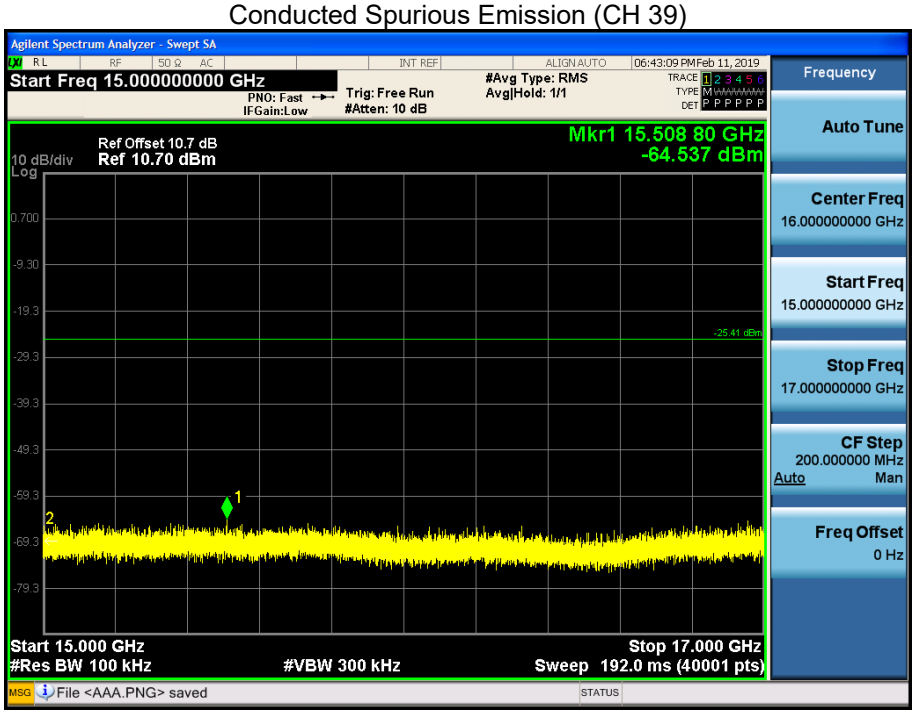
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 39)



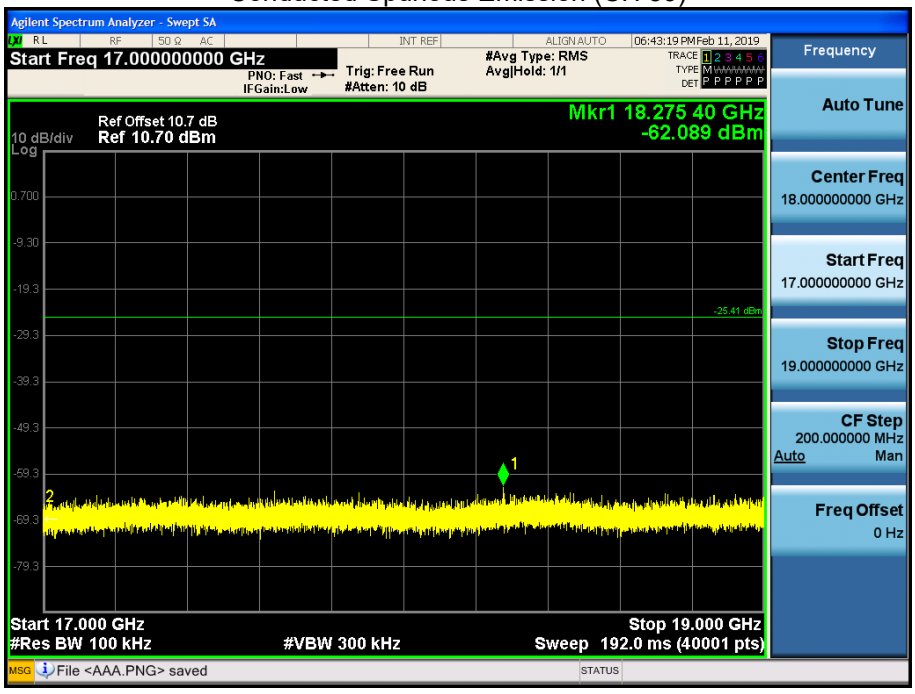
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 39)



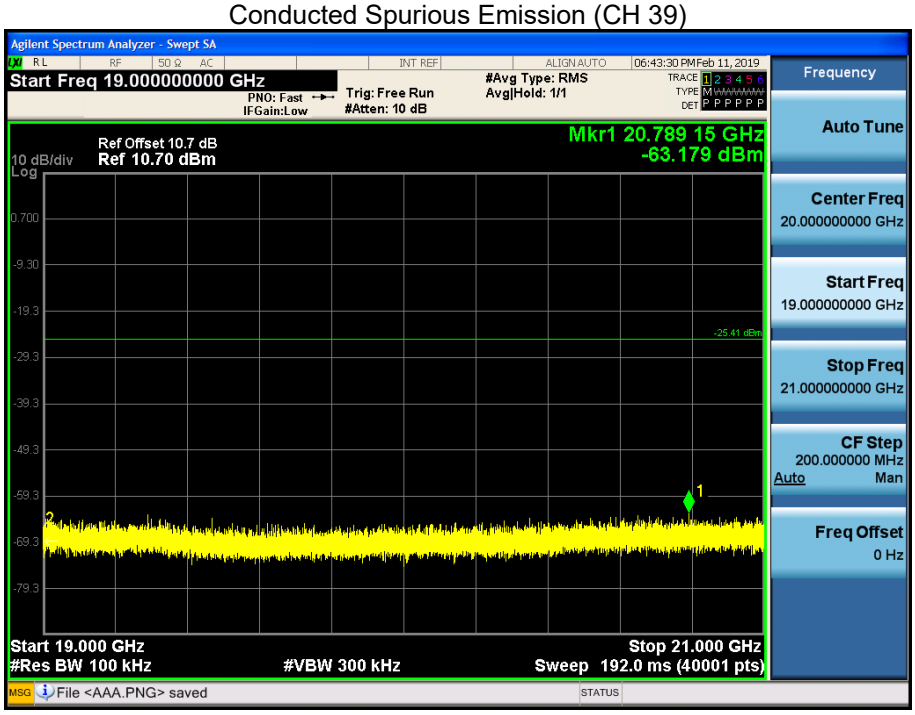
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 39)



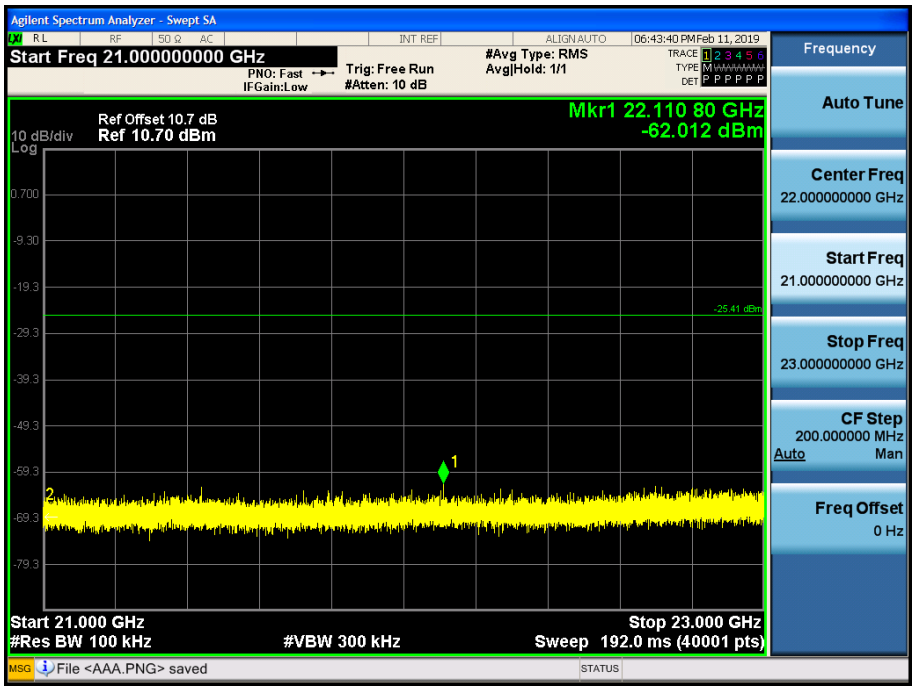
19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 39)



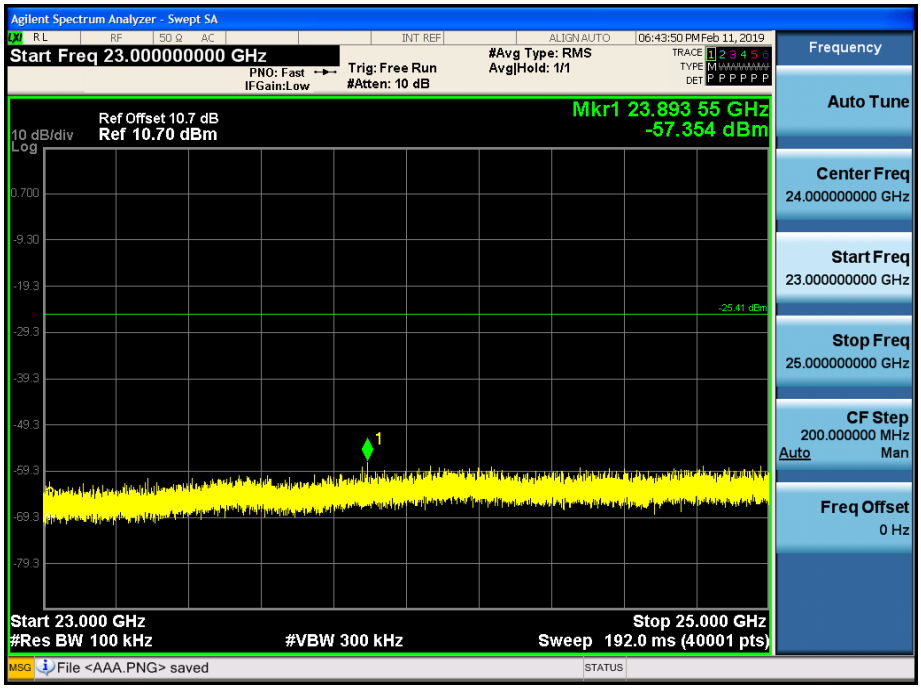
21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 39)



23 GHz ~ 25 GHz

Conducted Spurious Emission (CH 39)



▣ 2M Bit/s Test Plots (BandEdge)

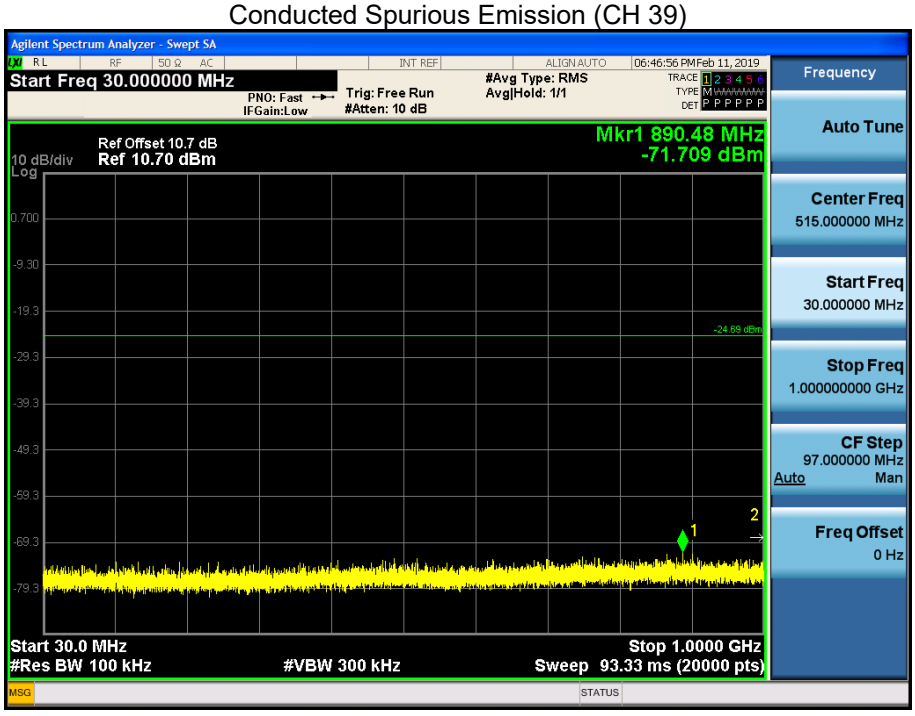
Low-CH 0

High-CH 39

▣ 2M Bit/s Test Plots (Conducted Spurious Emission)

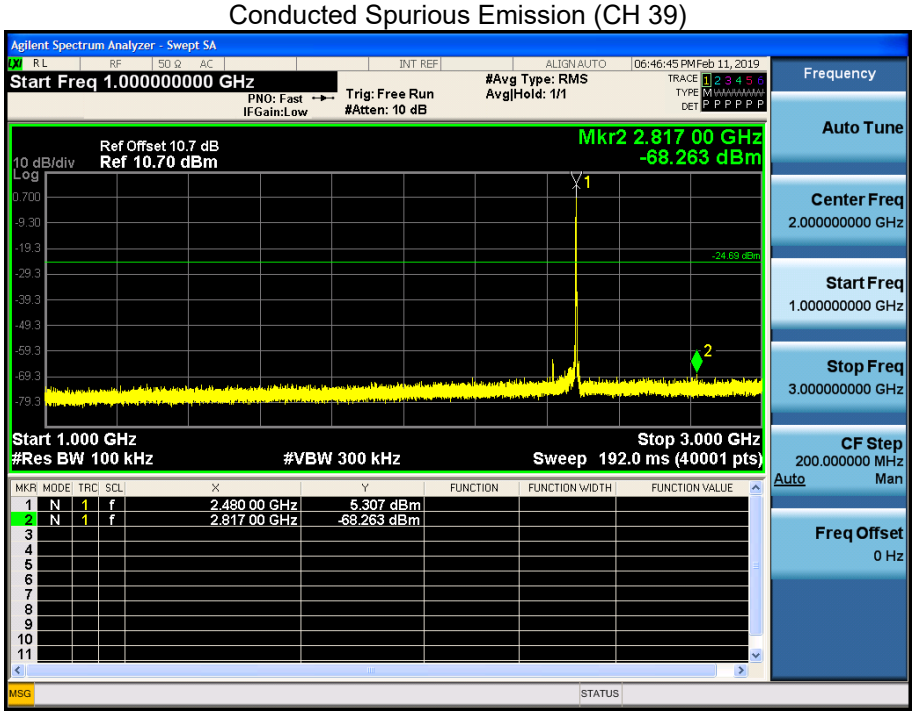
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 39)



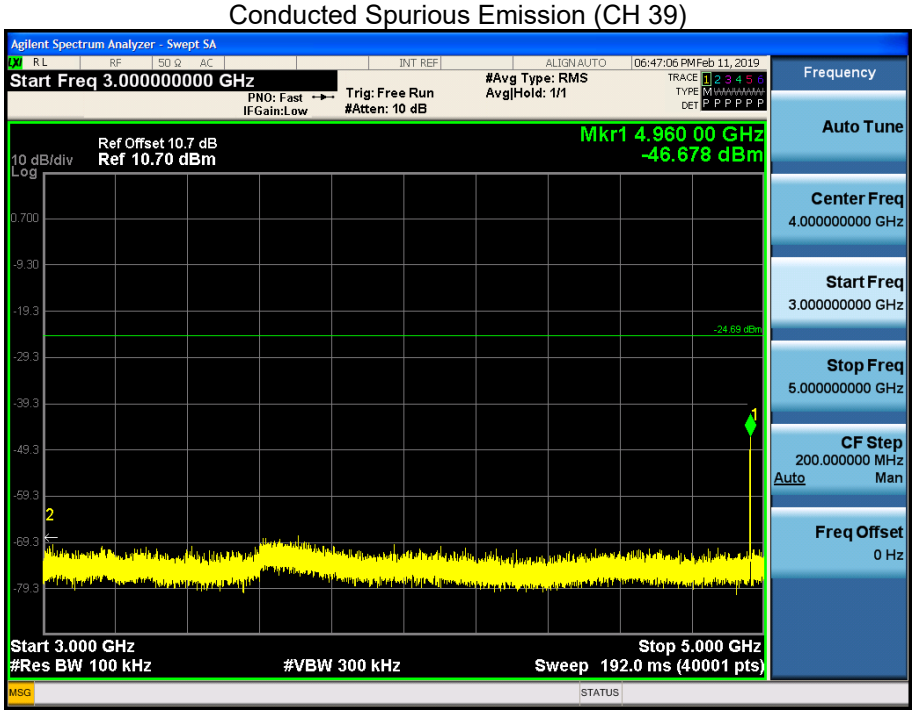
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 39)



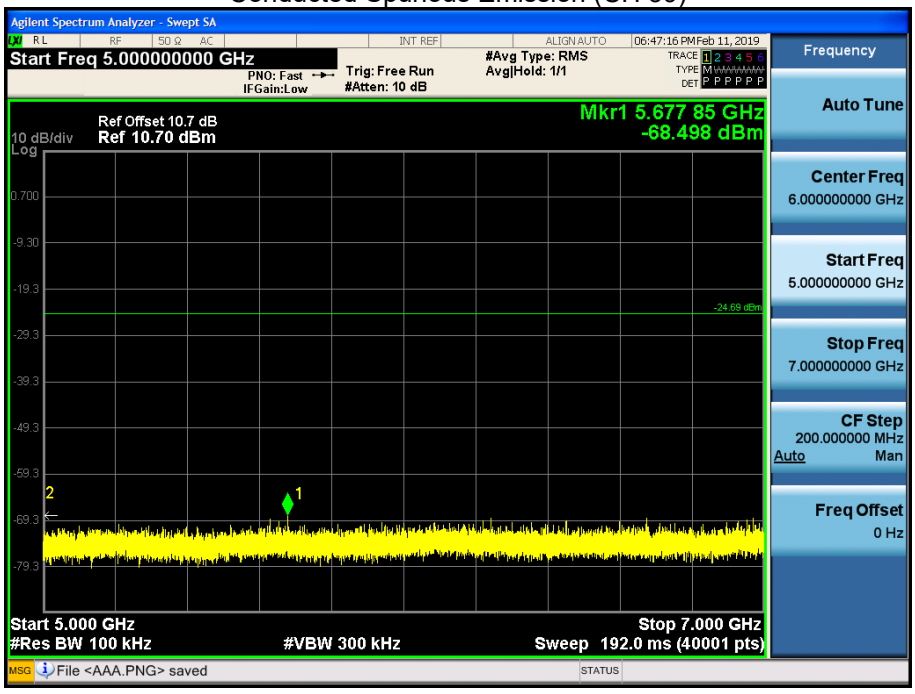
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 39)



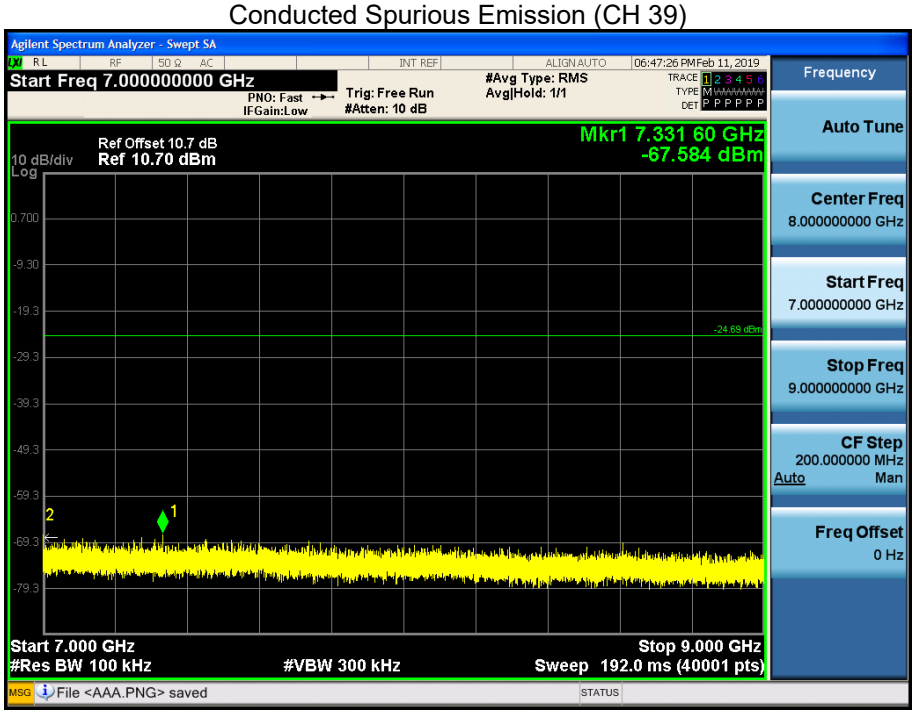
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 39)



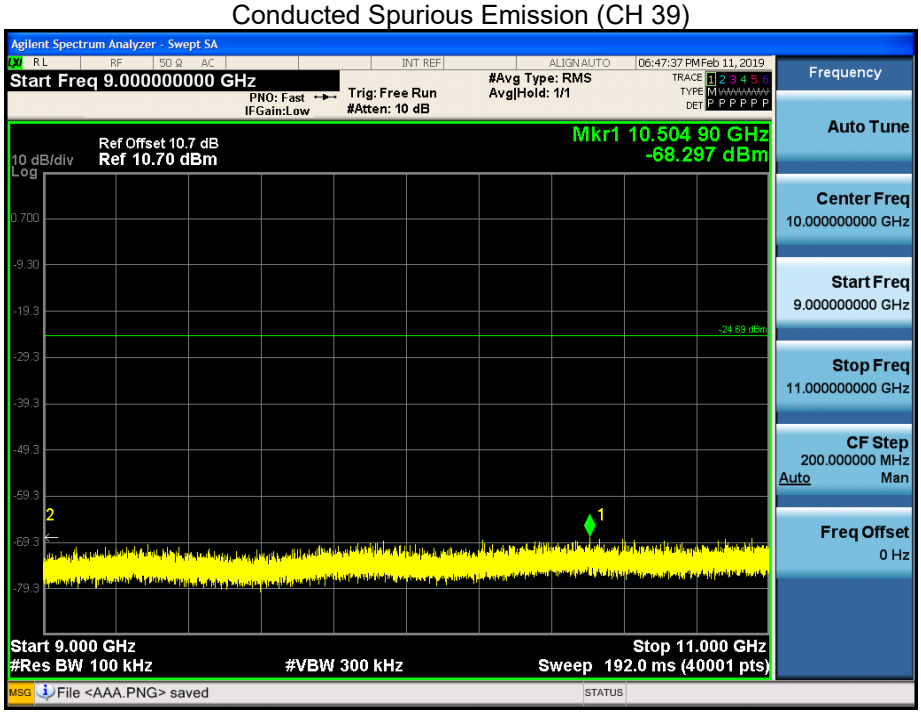
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 39)



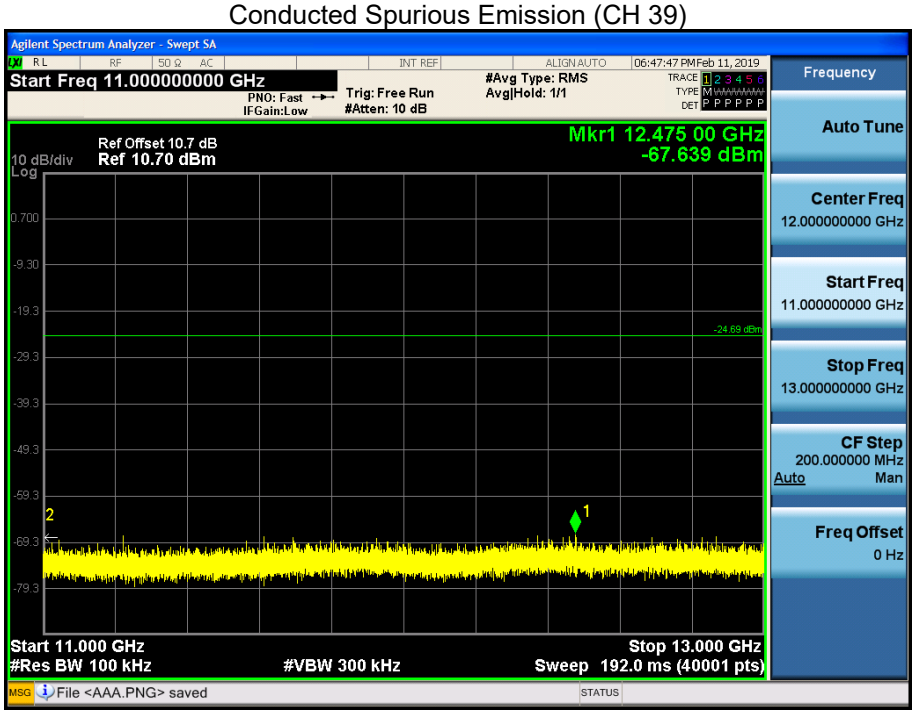
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 39)



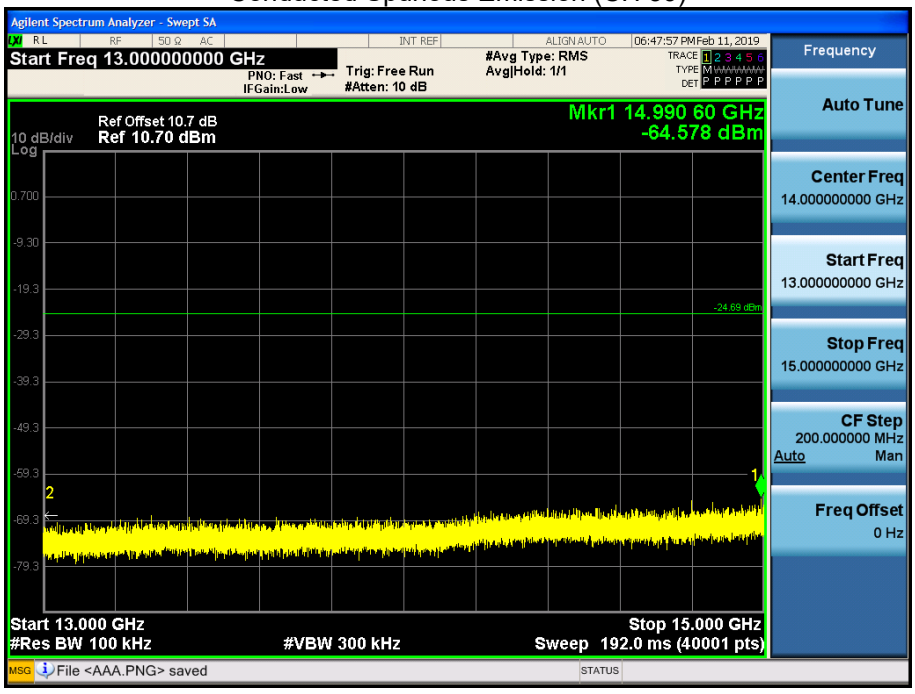
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 39)



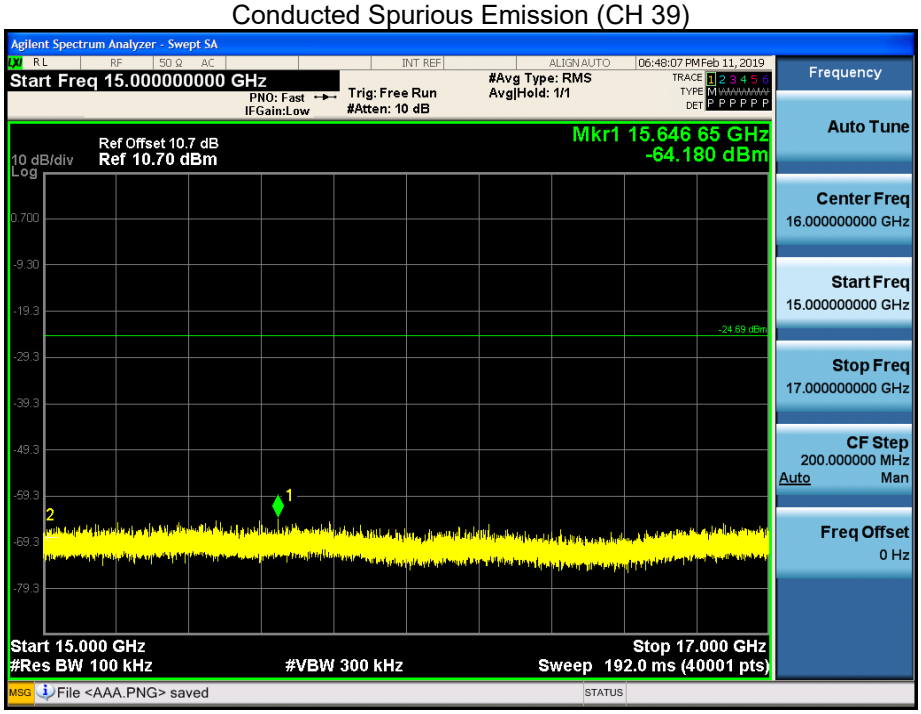
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 39)



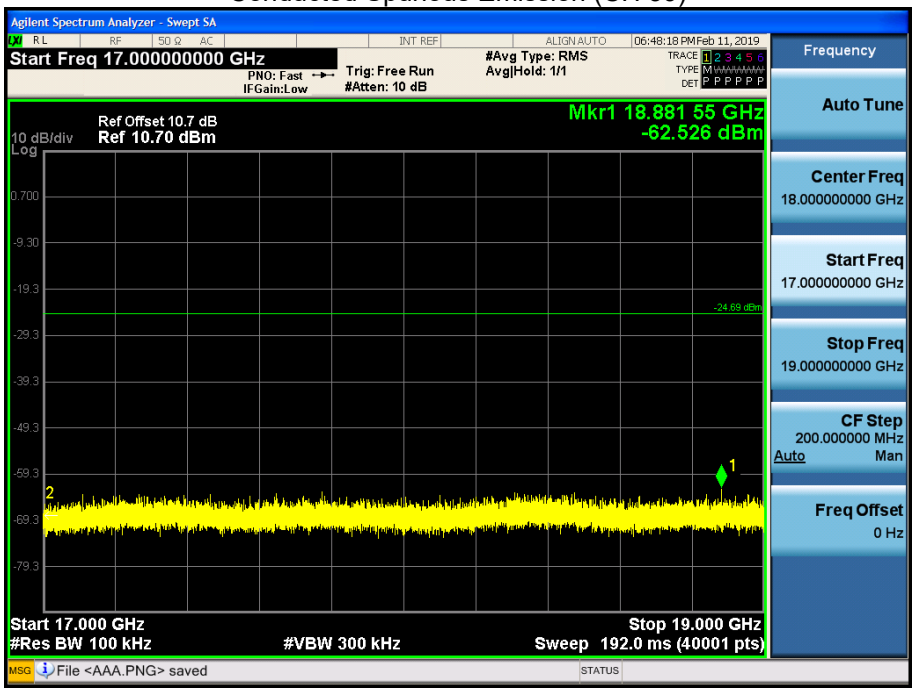
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 39)



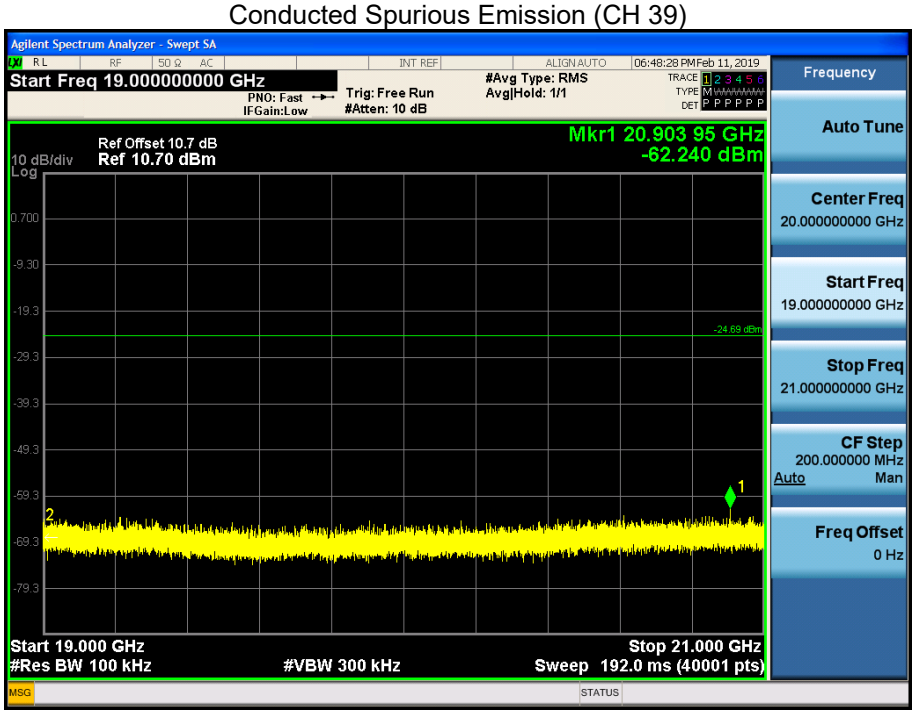
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 39)



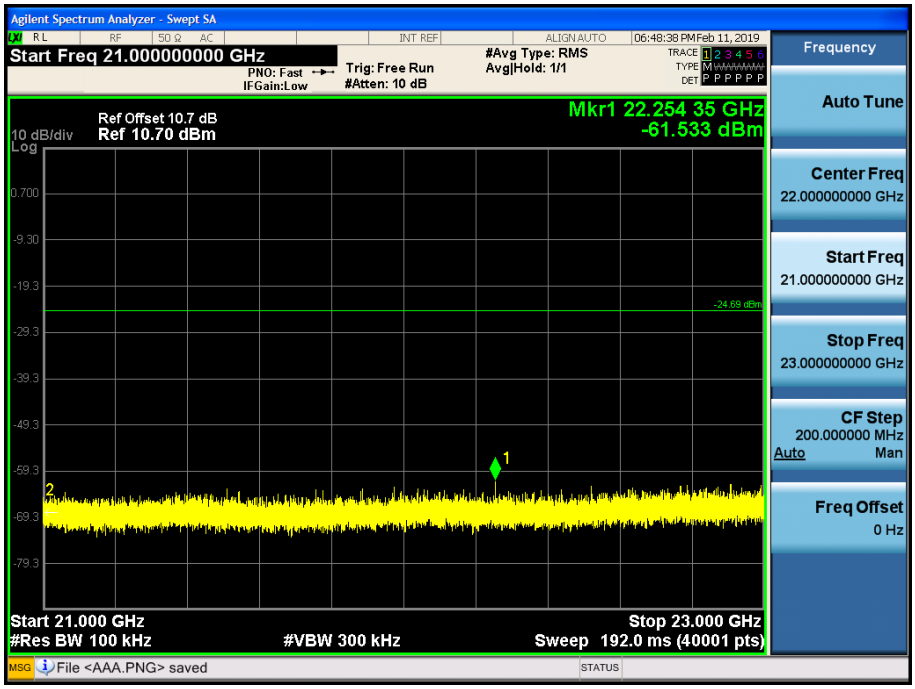
19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 39)



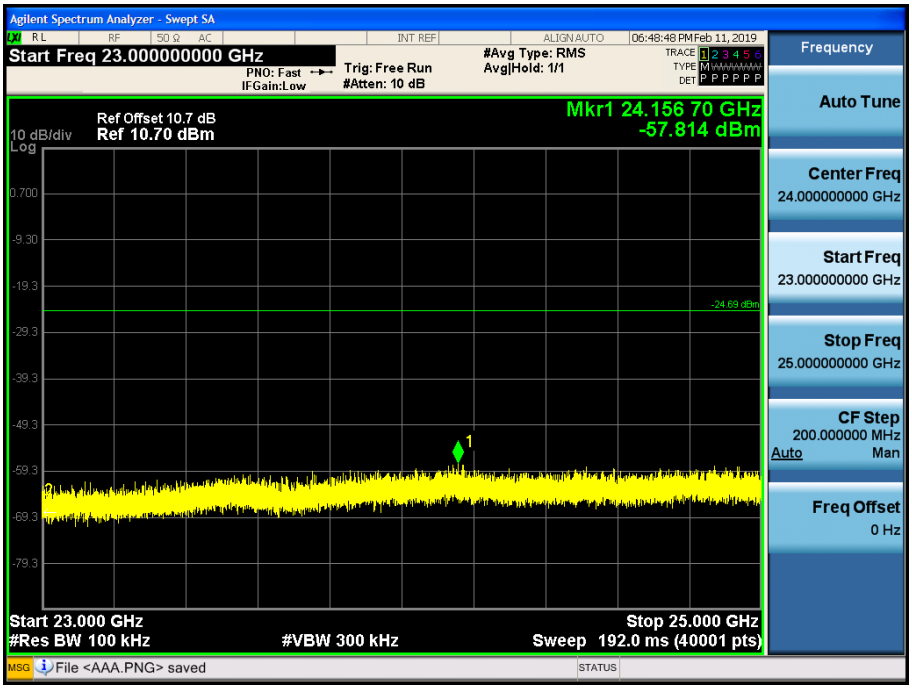
21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 39)



23 GHz ~ 25 GHz

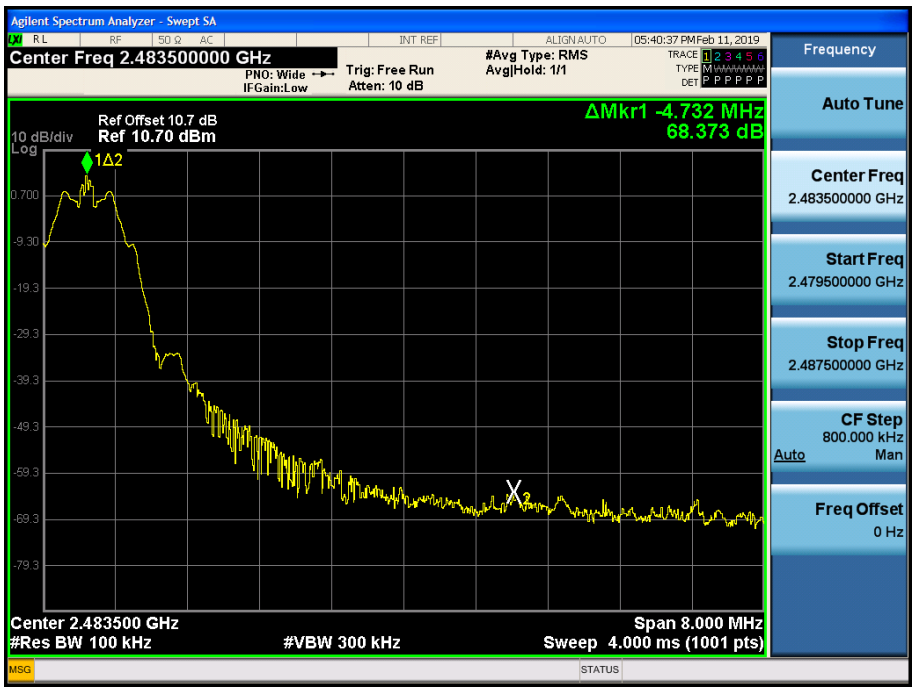
Conducted Spurious Emission (CH 39)



▣ 125k Bit/s Test Plots (BandEdge)

Low-CH 0

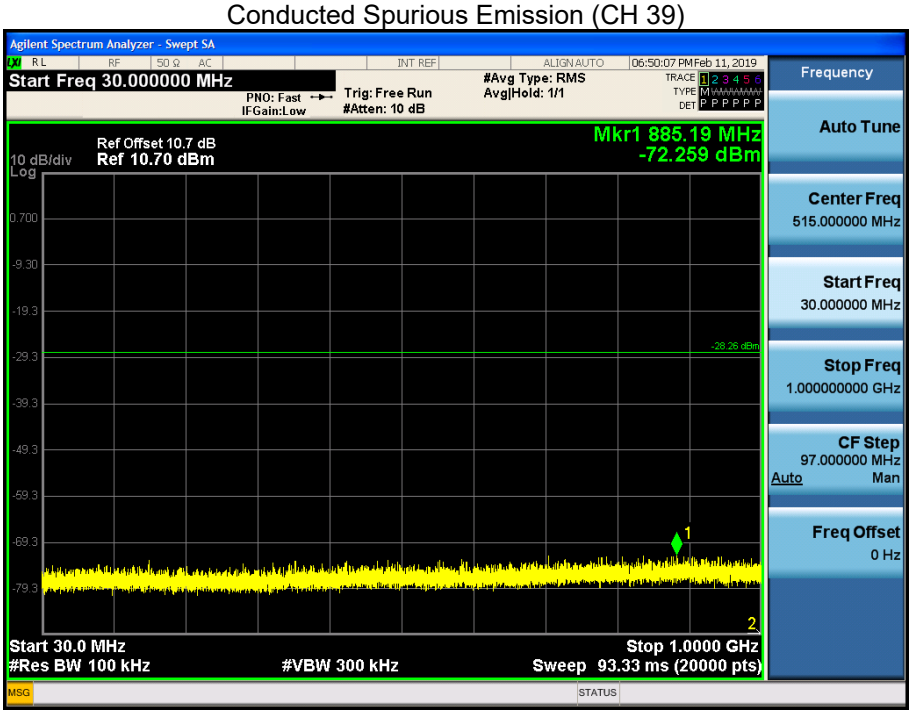
High-CH 39



▣ 125k Bit/s Test Plots (Conducted Spurious Emission)

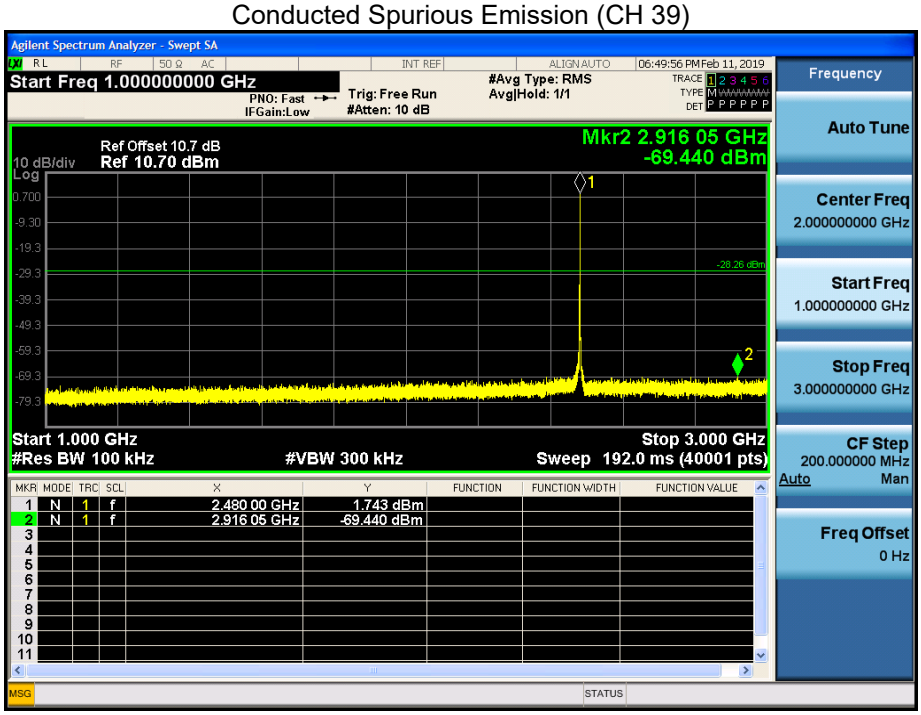
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 39)



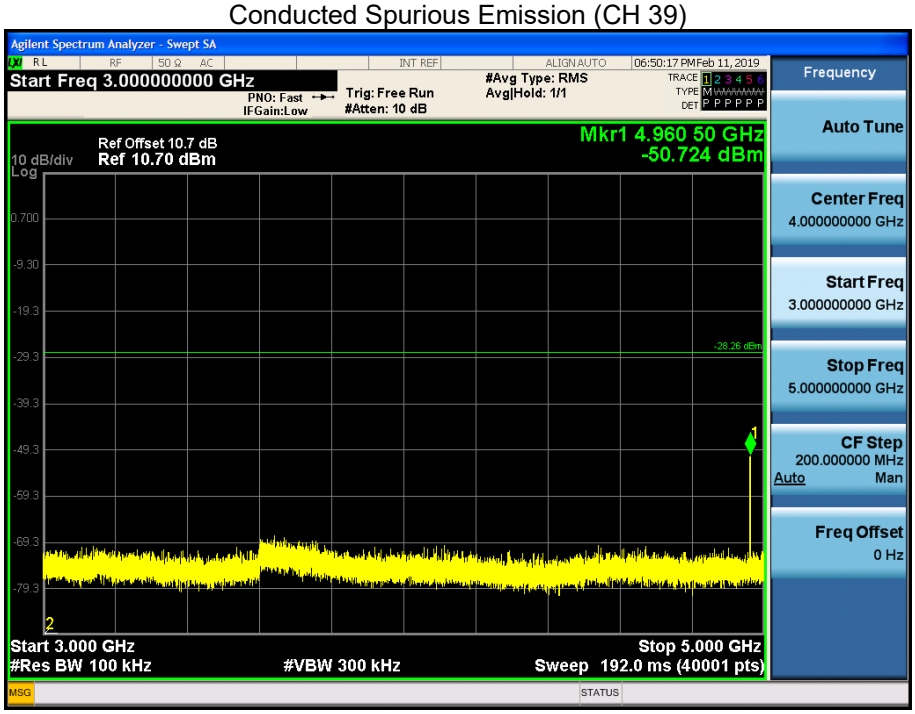
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 39)



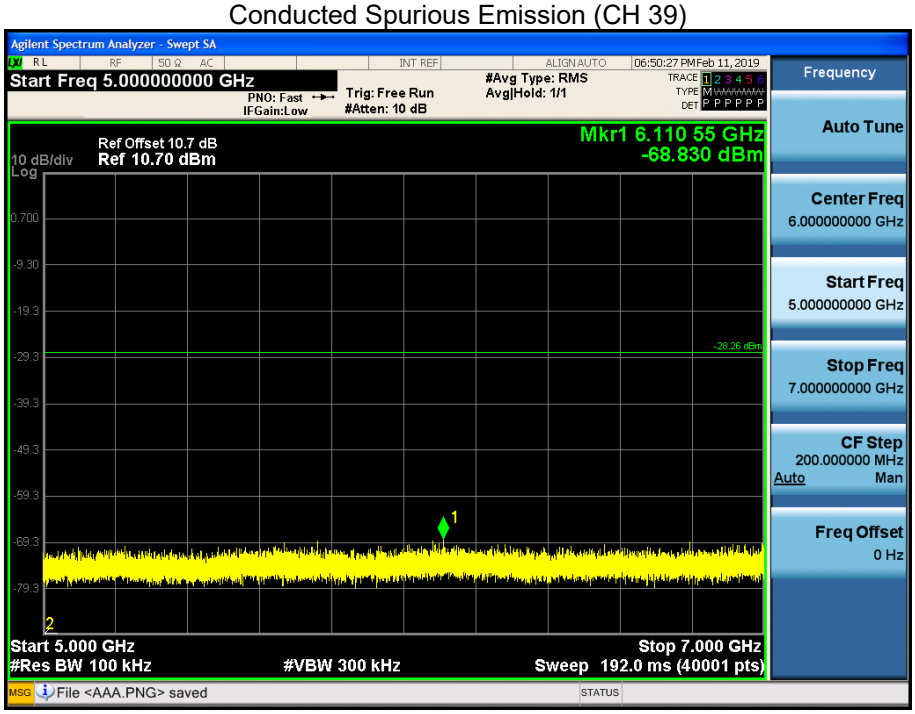
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 39)



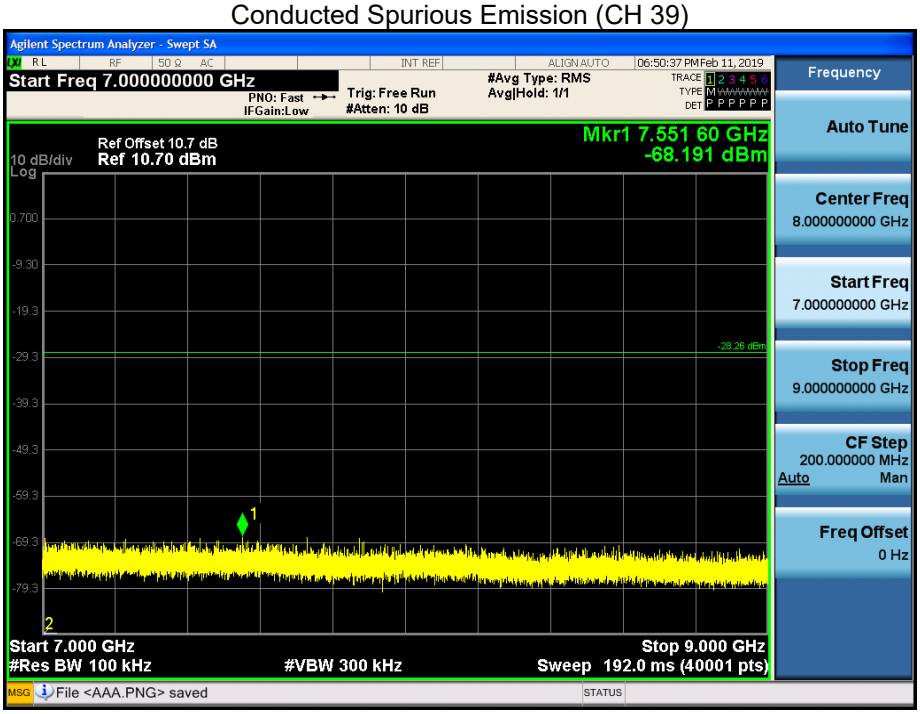
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 39)



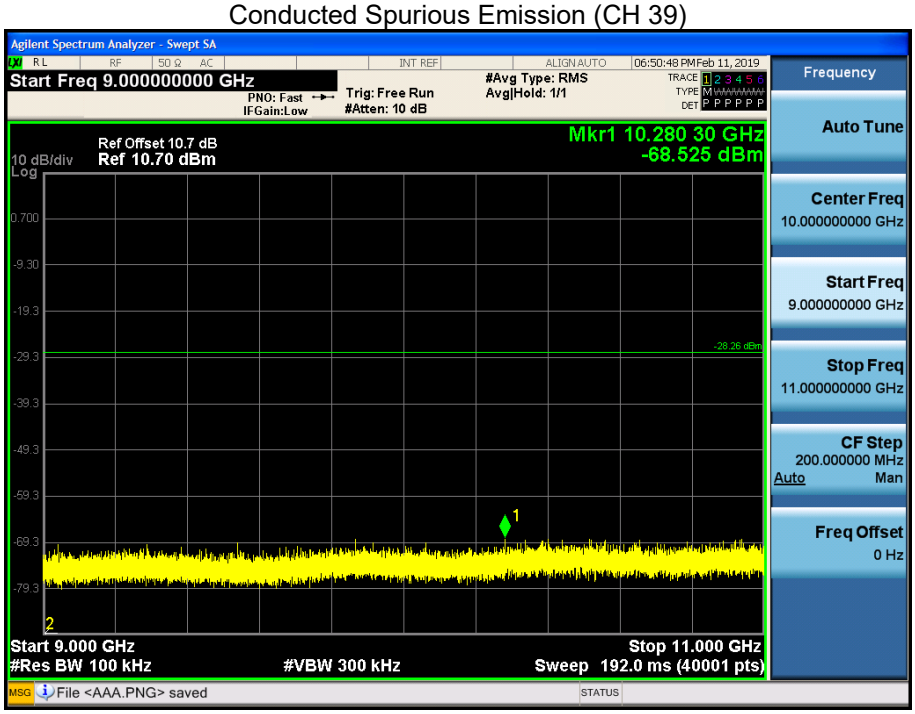
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 39)



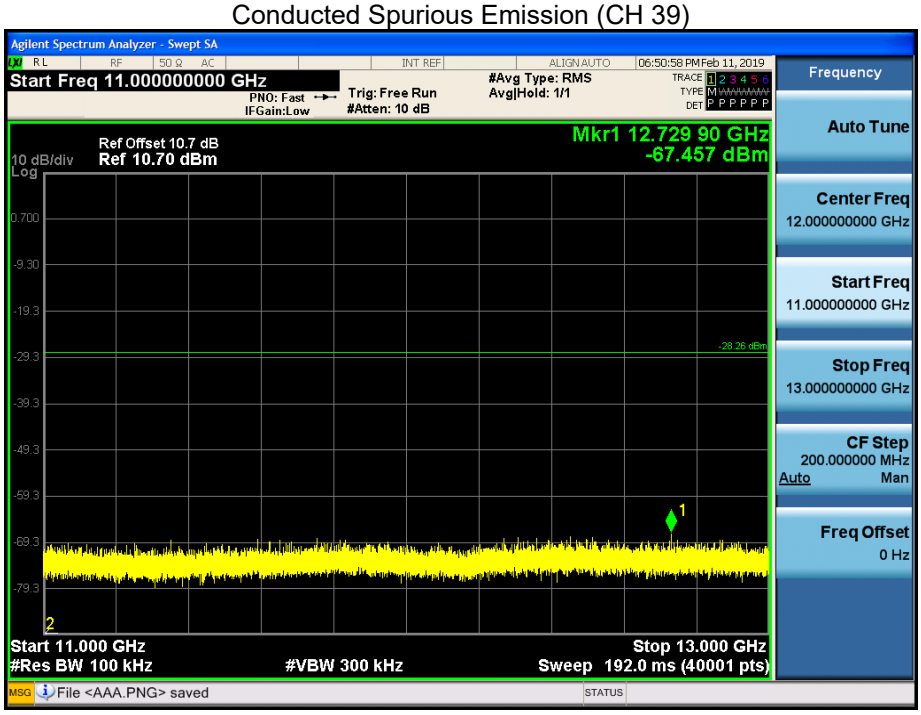
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 39)



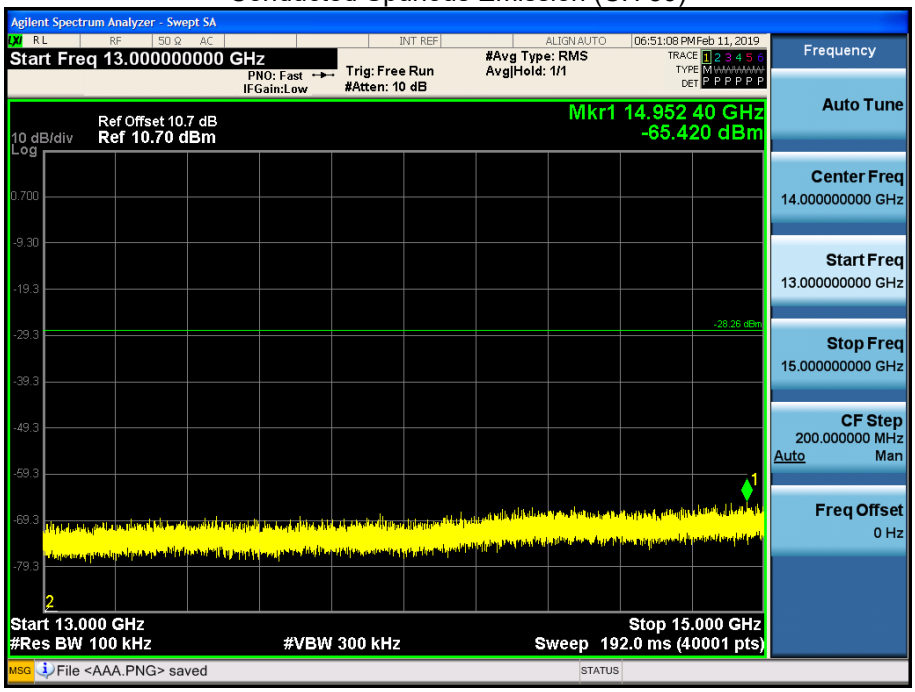
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 39)



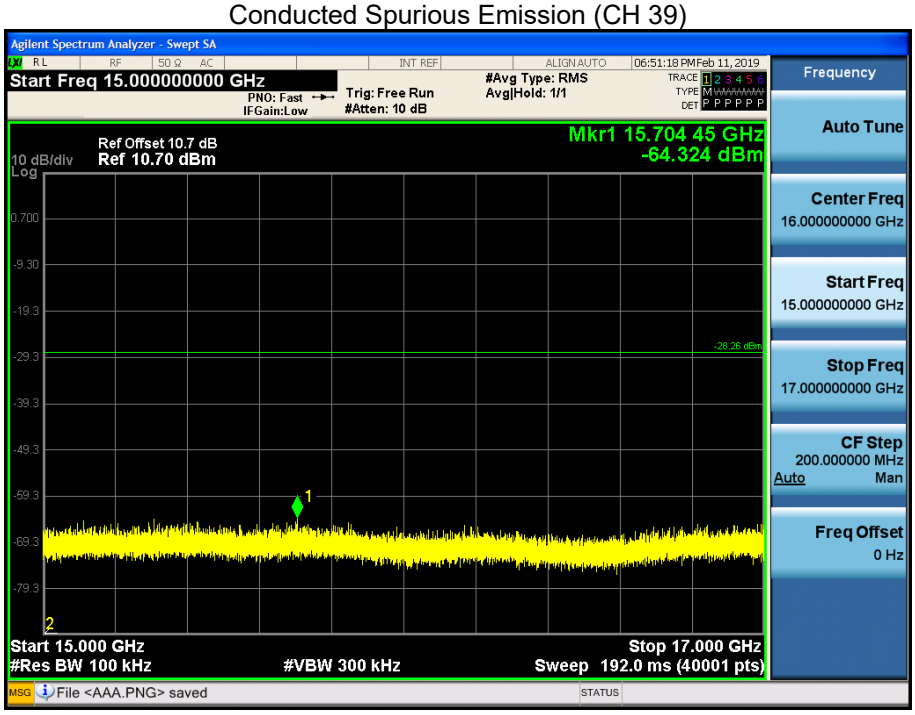
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 39)



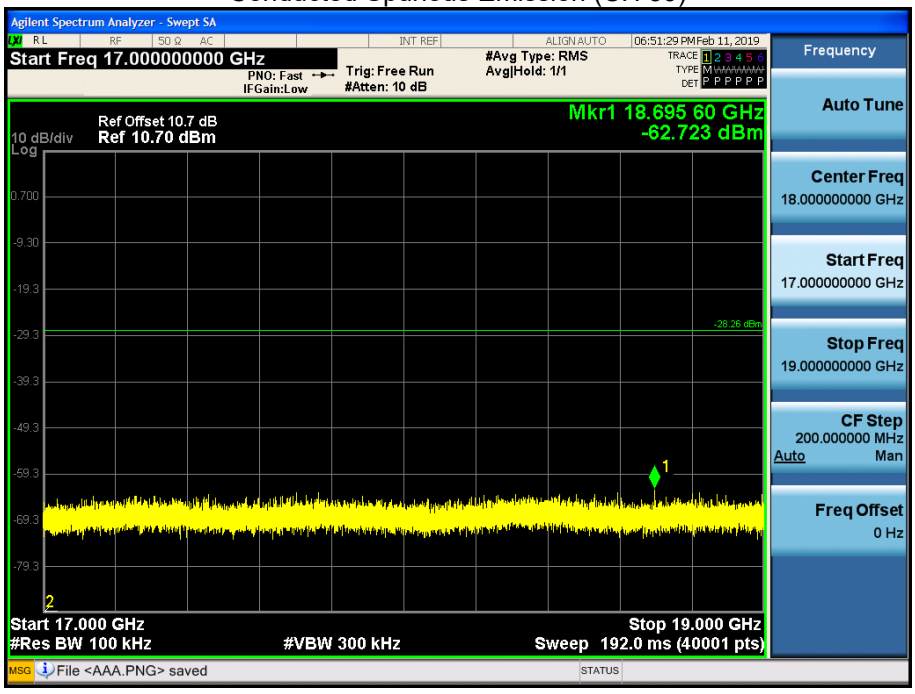
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 39)



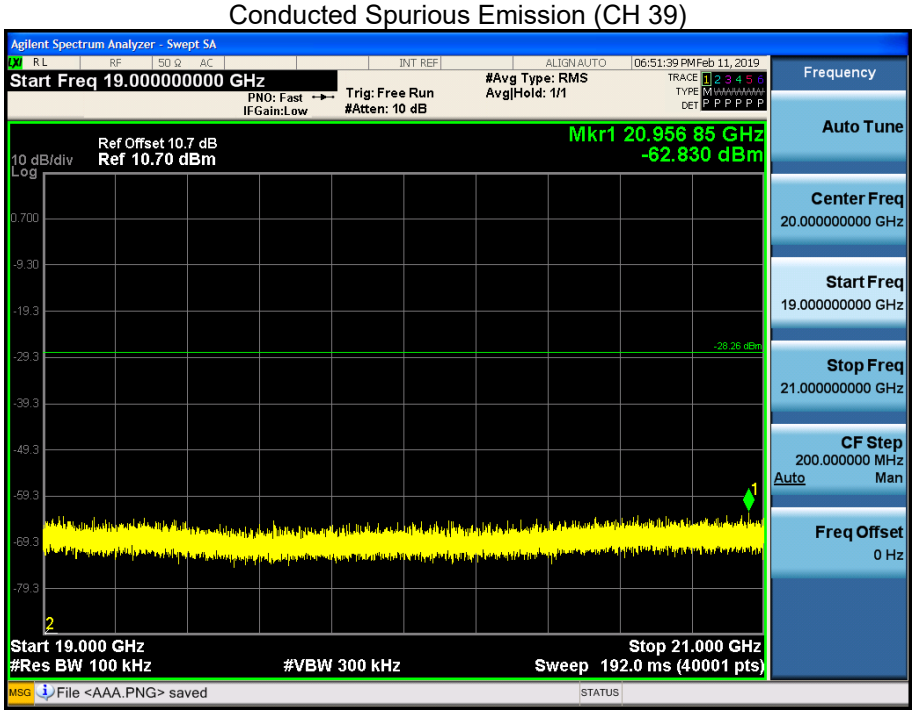
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 39)



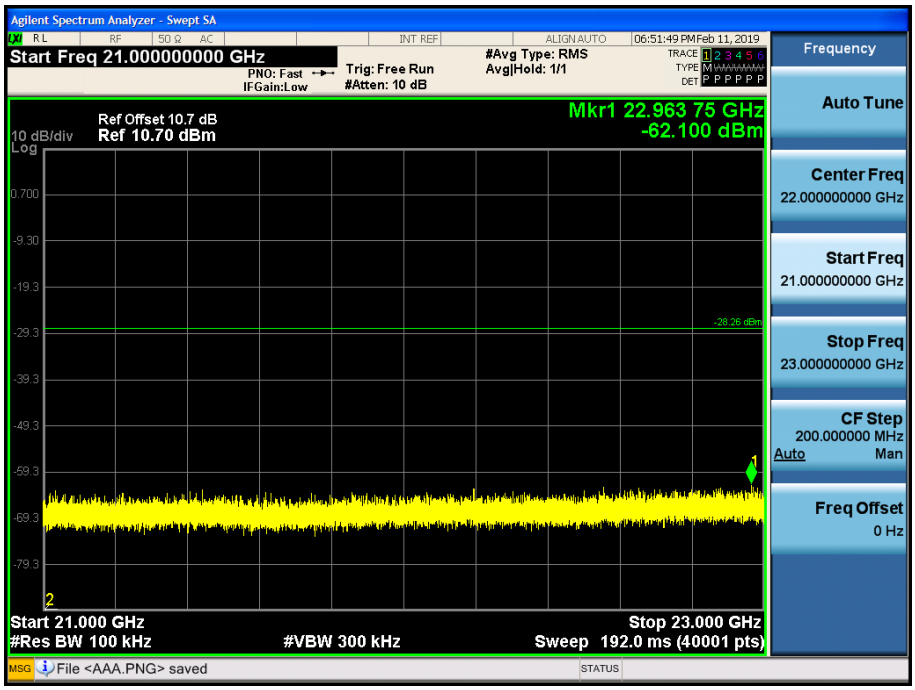
19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 39)



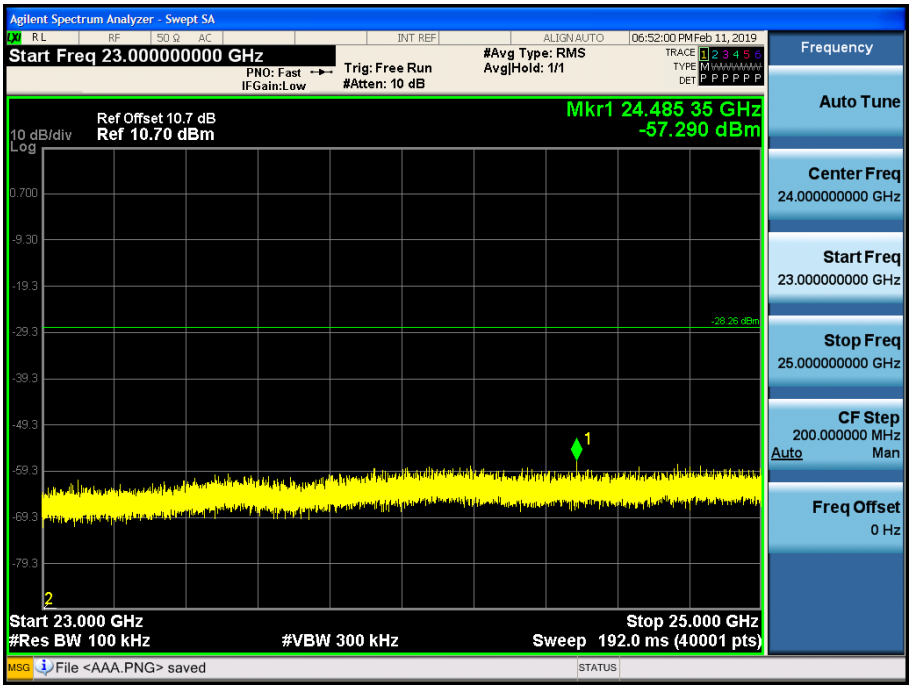
21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 39)



23 GHz ~ 25 GHz

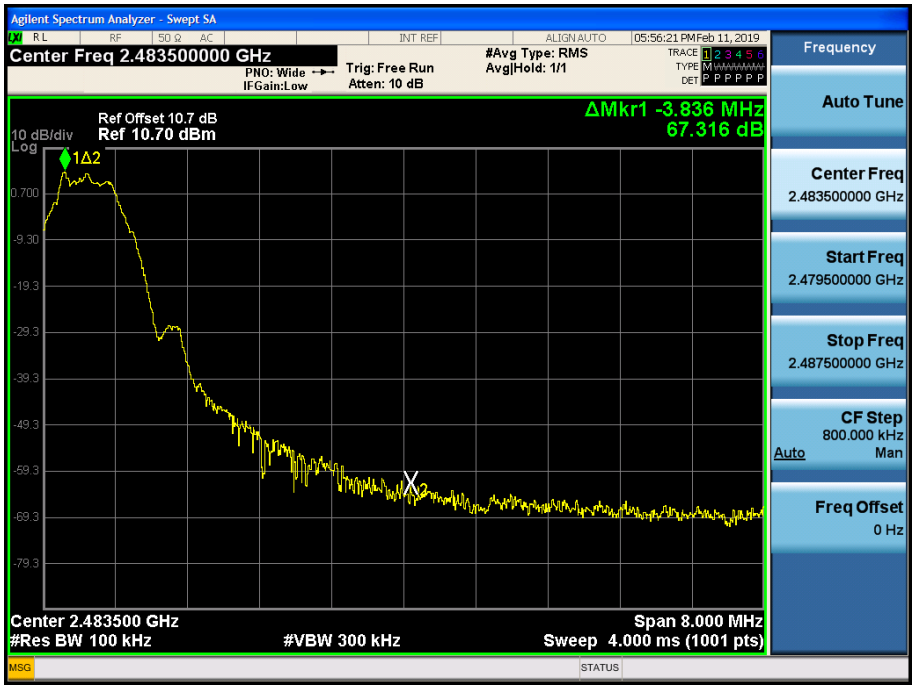
Conducted Spurious Emission (CH 39)



▣ 500k Bit/s Test Plots (BandEdge)

Low-CH 0

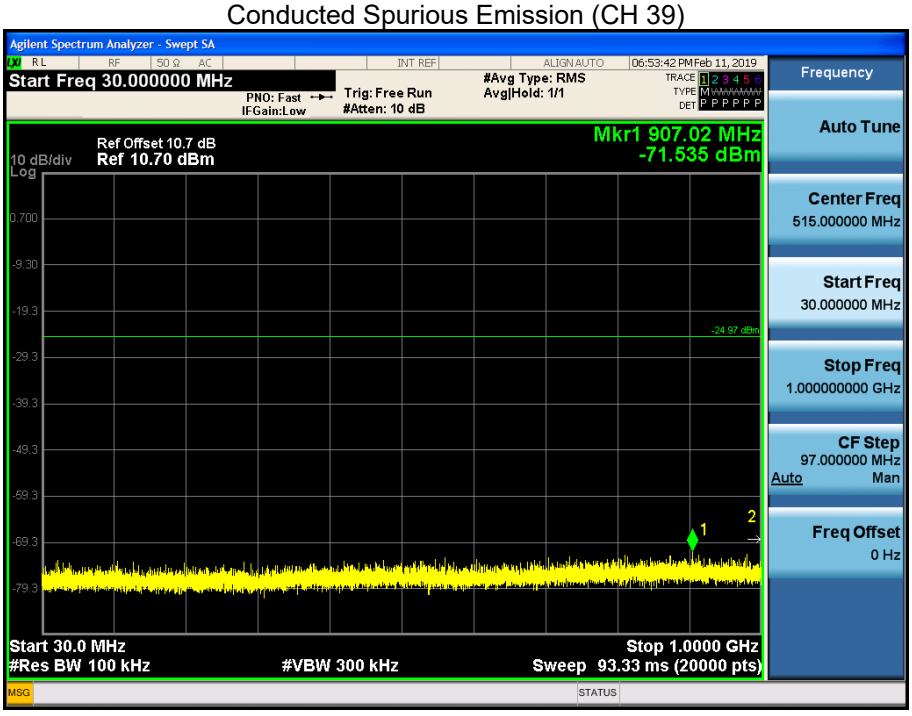
High-CH 39



▣ 500k Bit/s Test Plots (Conducted Spurious Emission)

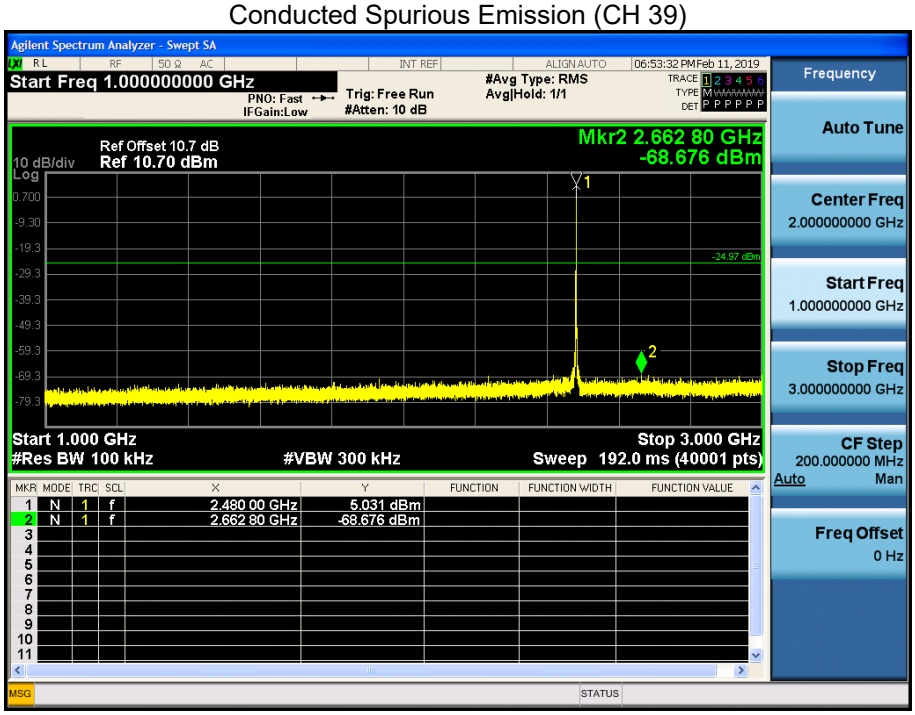
30 MHz ~ 1 GHz

Conducted Spurious Emission (CH 39)



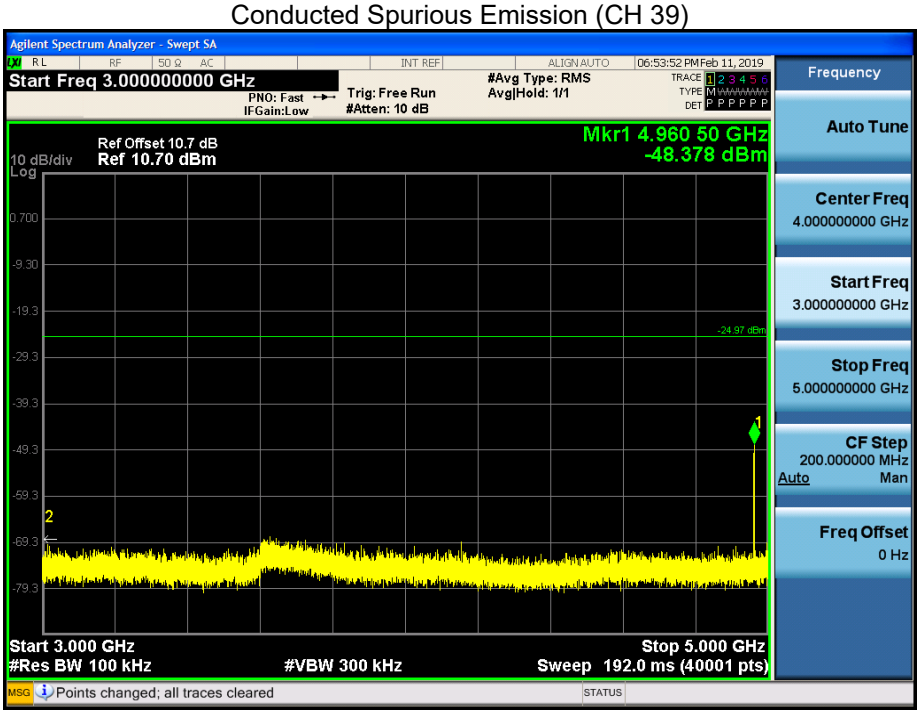
1 GHz ~ 3 GHz

Conducted Spurious Emission (CH 39)



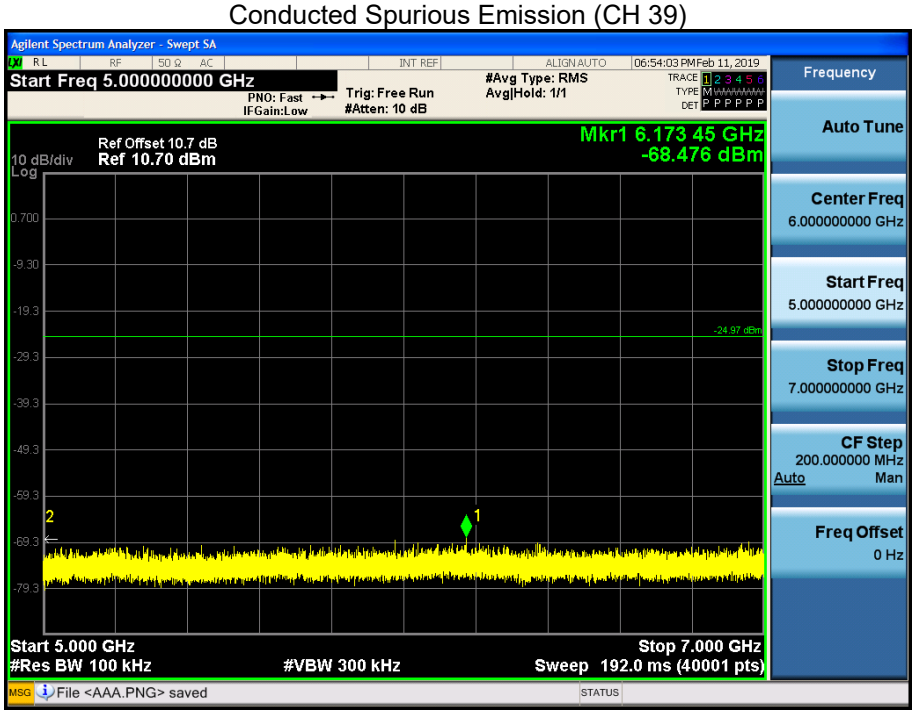
3 GHz ~ 5 GHz

Conducted Spurious Emission (CH 39)



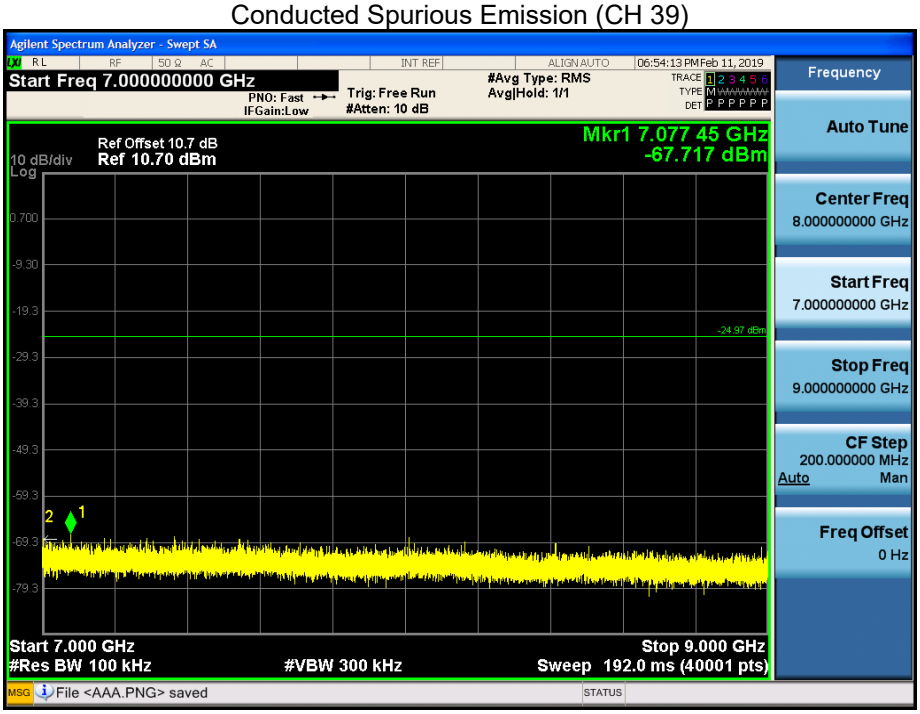
5 GHz ~ 7 GHz

Conducted Spurious Emission (CH 39)



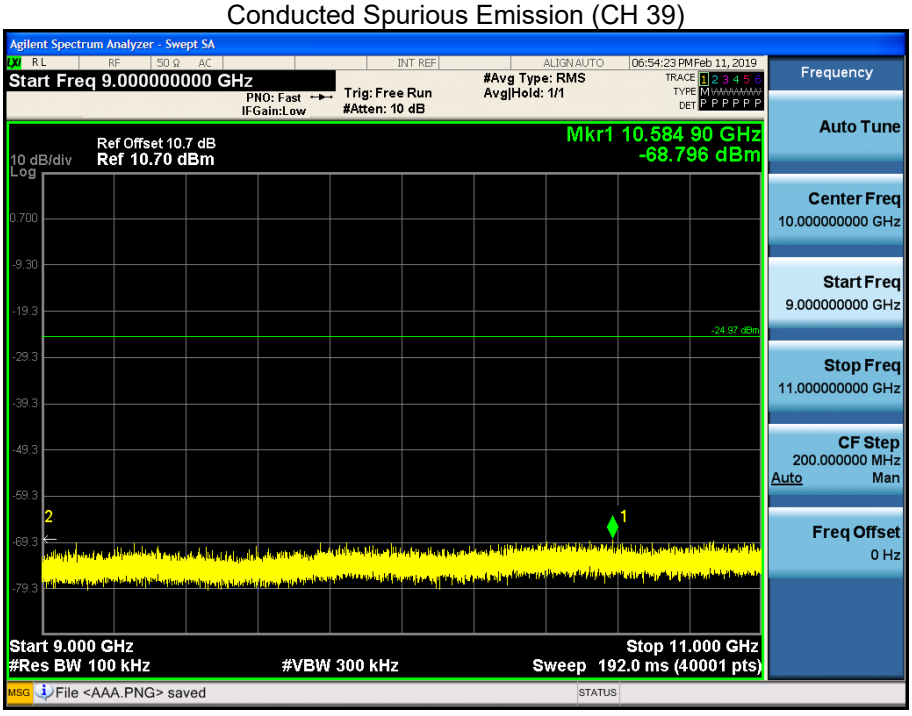
7 GHz ~ 9 GHz

Conducted Spurious Emission (CH 39)



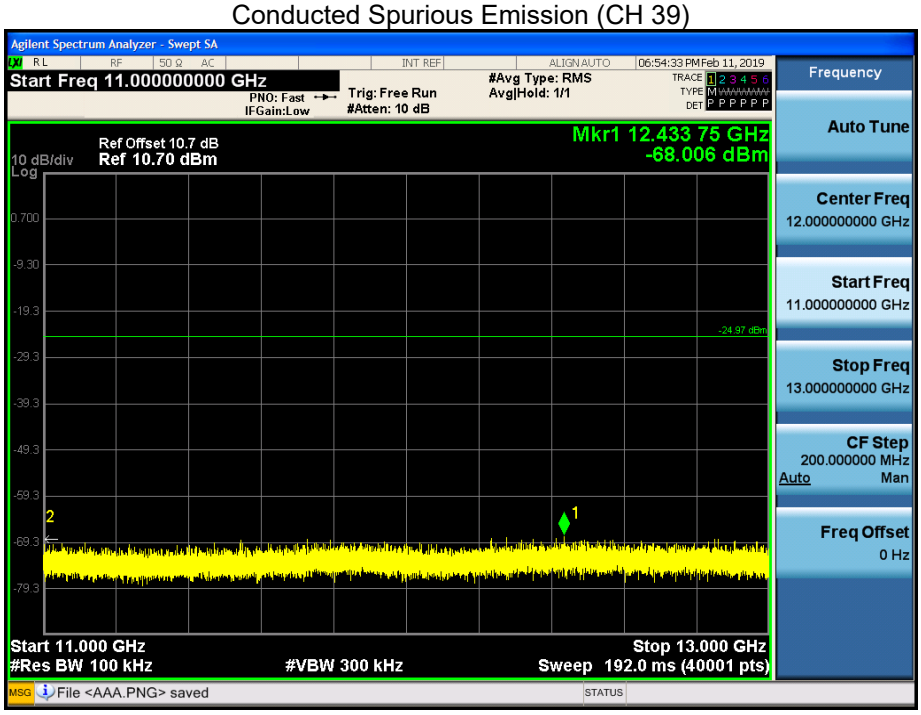
9 GHz ~ 11 GHz

Conducted Spurious Emission (CH 39)



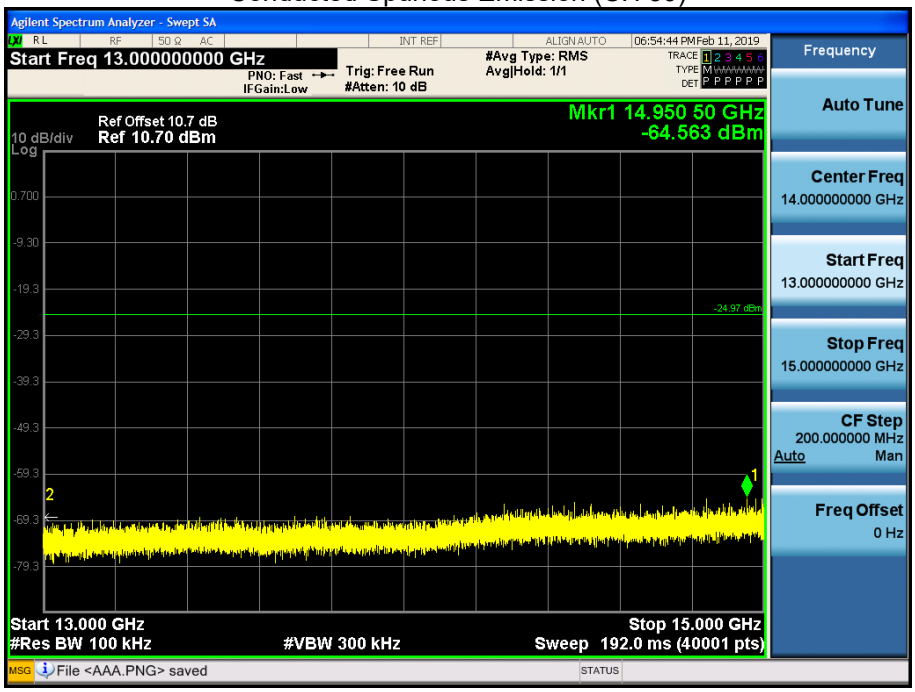
11 GHz ~ 13 GHz

Conducted Spurious Emission (CH 39)



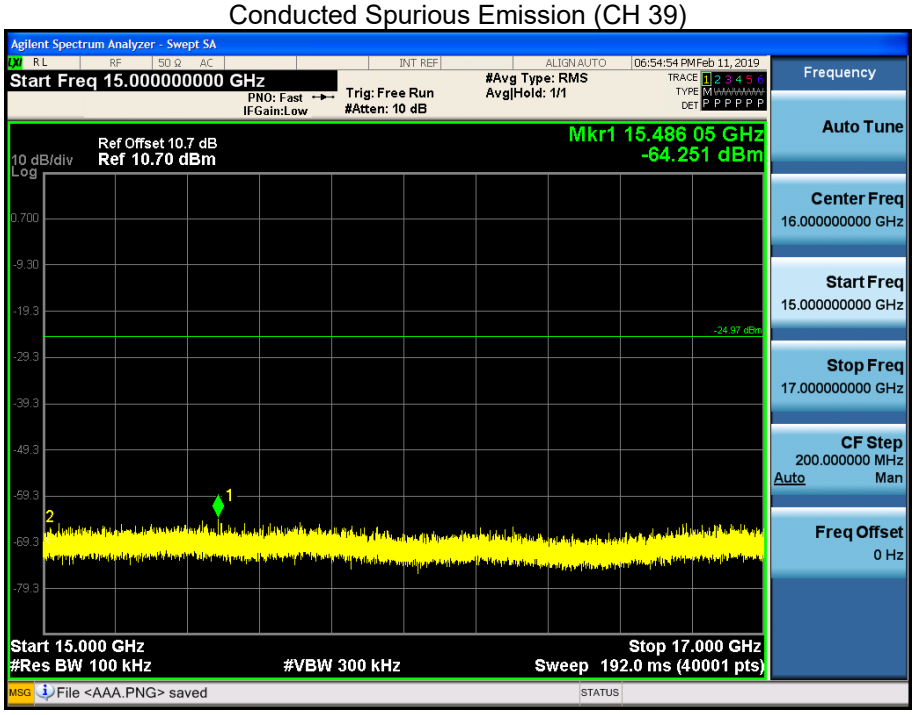
13 GHz ~ 15 GHz

Conducted Spurious Emission (CH 39)



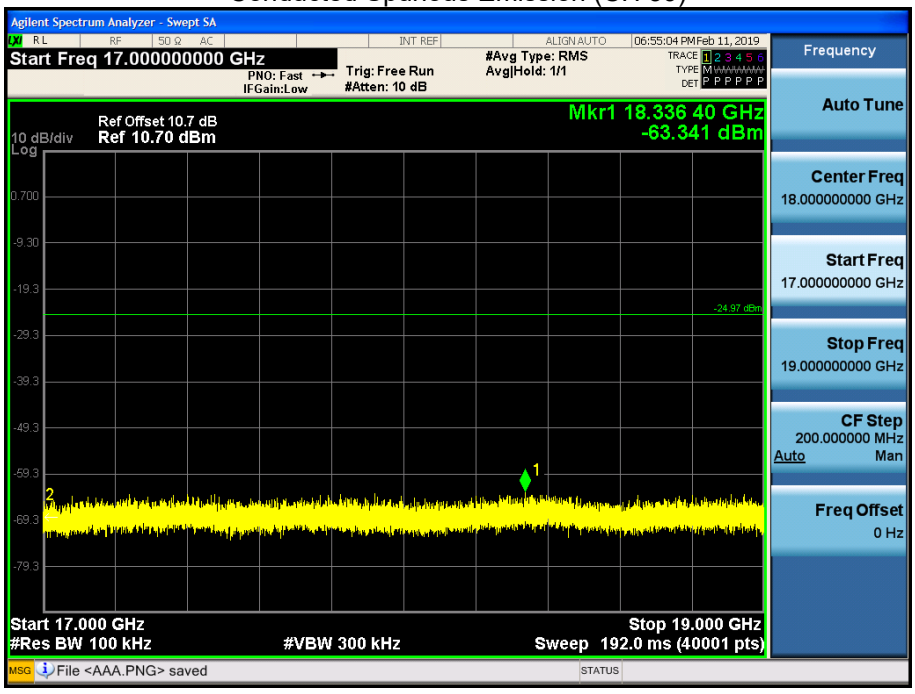
15 GHz ~ 17 GHz

Conducted Spurious Emission (CH 39)



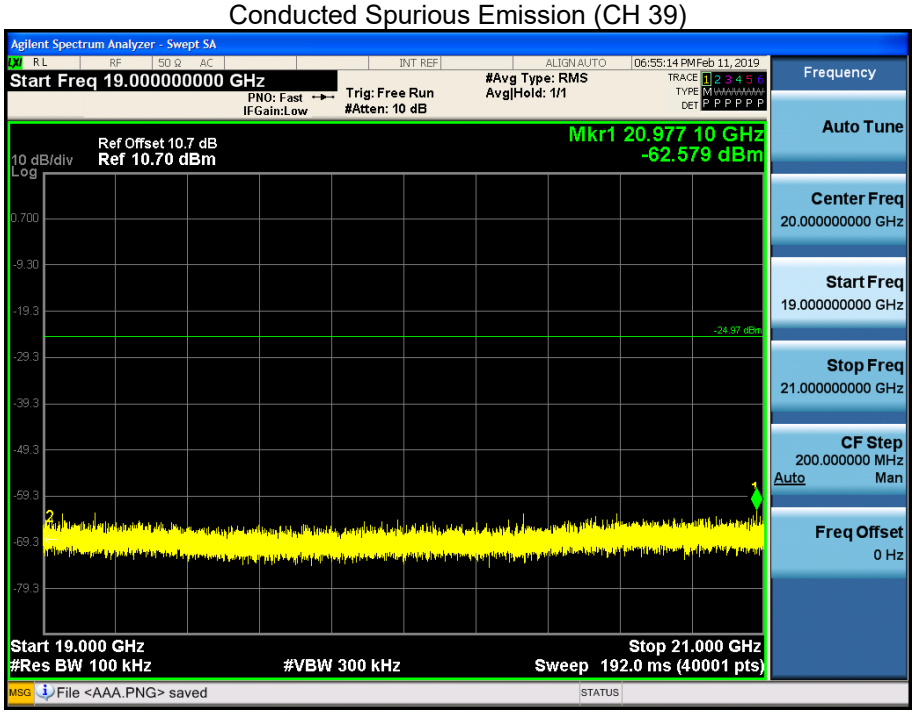
17 GHz ~ 19 GHz

Conducted Spurious Emission (CH 39)



19 GHz ~ 21 GHz

Conducted Spurious Emission (CH 39)



21 GHz ~ 23 GHz

Conducted Spurious Emission (CH 39)