

FCC DSS RF TEST REPORT



Test Report Number.....	WAP-19052921-LC-FCC-DSS-G4L
Applicant.....	Ford Motor Company
Applicant Address.....	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Product Name.....	Vehicle Infotainment System
Model Number.....	SYNC-G4L
Family Product/Model.....	N/A
FCC ID.....	KMH-SYNCG4L
ISED ID.....	1422A-SYNCG4L
Date of EUT received.....	06/12/2019
Date of Test.....	06/12/2019 – 08/13/2019
Report Issue Date.....	08/14/2019
Test Standards.....	47CFR Part 15.247
Test Result.....	Pass

Issued By:

Vista Laboratories

1261 Puerta Del Sol, San Clemente, CA 92673 USA

www.vista-compliance.com

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Tested by:

Bruce Li/Test Engineer

Approved By:

David Zhang/Technical Manager

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



Laboratory Introduction

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17025 Product Testing Accreditation Certificate



17065 Product Certification Accreditation Certificate

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
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REVISION HISTORY

Revision	Issue Date	Description	Note
Original	08/14/2019	Original release	N/A

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1 General Information

1.1 Applicant

Applicant:	Ford Motor Company
Applicant address:	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124
Manufacturer:	Ford Motor Company
Manufacturer Address:	Building 5, 20300 Rotunda Dr., Dearborn, Michigan, United States 48124

1.2 Product information

Product Name	Vehicle Infotainment System
Model Number	SYNC-G4L
Family Model Number	N/A
Serial Number	1SN003G5 (Conducted), 1SN003GV (Radiated)
Frequency Band	BT BDR/EDR: 2402-2480MHz BLE: 2402-2480MHz 802.11b/g/n-20MHz: 2412-2462MHz 802.11a/n-20MHz: 5180-5320MHz, 5500-5720MHz, 5725-5825MHz 802.11n-40MHz: 5190-5310MHz, 5510-5710MHz, 5755-5795MHz 802.11ac: 5210-5290MHz, 5530-5690MHz, 5775MHz
Type of modulation	BT BDR/EDR: GFSK, $\pi/4$ DQPSK, 8DPSK BLE: GFSK 802.11b: DSSS (CCK, DQPSK, DBPSK) 802.11g: OFDM-CCK (BPSK, QPSK, 16QAM, 64QAM) 802.11a/n/ac: OFDM (BPSK, QPSK, 16QAM, 64QAM, 256QAM)
Equipment Class/ Category	DSS, DTS, UNII
Maximum output power	See test result
Antenna Information	PCB trace antenna (WiFi1 Antenna, WiFi2 Antenna, Bluetooth Antenna) Peak Gain: WiFi1 Antenna: 3.29 dBi @2.4GHz, 8.09 dBi @5GHz WiFi2 Antenna: 0.84 dBi @2.4GHz, 5.68 dBi @5GHz Bluetooth Antenna: 3.02 dBi @2.4GHz Directional Gain: WiFi1 & WiFi2 Antenna: 5.16 dBi @2.4GHz, 9.98 dBi @5GHz
Clock Frequencies	N/A
Port/Connectors	Micro USB, CAN bus
Input Power	Vehicle Battery powered: 12VDC
Power Adapter Manu/Model	N/A
Power Adapter SN	N/A
Hardware version	N/A
Software version	N/A
Simultaneous Transmission	BT/BLE and WLAN can transmit simultaneously
Additional Info	N/A

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1.3 Test standard and method

Test standard	47CFR Part 15.247
Test method	ANSI C63.10: 2013

1.4 Test Purpose and statement

The purpose of this test report is intended to demonstrate the compliance of product listed in section 1.2, received from company listed in section 1.1, to the requirements of standard and method listed in section 1.3. Based on our test results, we conclude that the product tested complies with the requirements of the standards indicated.

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2 Test site information

Lab performing tests	Vista Laboratories
Lab Address	1261 Puerta Del Sol, San Clemente, CA 92673 USA
Phone Number	+1 (949) 393-1123
Website	www.Vista-compliance.com

Test condition	Test Engineer	Test Environment	Test Date
RF conducted	Bruce Li	23.5°C / 58.2%/996 mbar	06/12/2019 – 08/14/2019
Radiated	Cameron Wu	23.5°C / 58.2%/996 mbar	06/12/2019 – 08/14/2019

3 Modification of EUT

The EUT is an engineering test sample loaded with RF testing firmware specifically designed to support the RF TX/RX measurement in different aspects.

4 Test configuration and operation

4.1 EUT test configuration

EUT is powered by external DC power supply for testing purpose. EUT's RF antenna port is connected to spectrum analyzer through RF test cable for measurement. The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc.

4.2 EUT test mode

Radio	Channel	Frequency (MHz)
BT BDR/EDR	0	2402
BT BDR/EDR	39	2441
BT BDR/EDR	78	2480

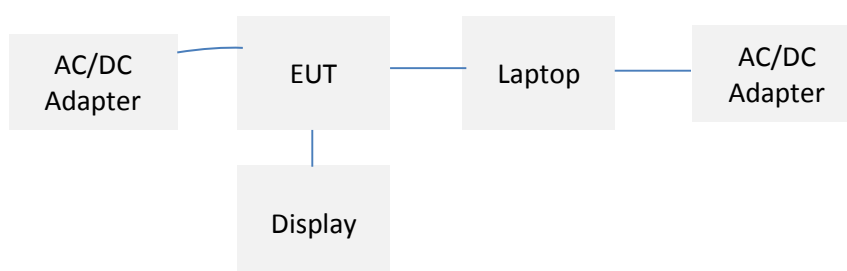
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4.3 Supporting Equipment

Index	Description	Model	S/N	Brand	Remark
1	AC/DC Adapter	HA45NM140	00285K	DELL	-
2	Laptop	Inspiron 15	245S2F2	DELL	-
3	Display	-	84007293	Ford	-
4	AC/DC Adapter	GST 60A12-P15	EB74QB1066	MEAN WELL	-

4.4 EUT setup diagram



4.5 EUT operation

The test software is used to set EUT to different transmission mode in terms of radio mode (WLAN, BLE), test channel, data rate, etc.

4.6 Test software

Index	Description	Remark
1	Diagnostic Engineering Tool V8.4.0	Load test firmware to EUT and provide basic control
2	PuTTY V0.70	Establish communication to EUT radio module
3	EMISoft Vasona 6.0049	EMC/Spurious emission test software used during testing

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5 EUT and test setup pictures

See associated filing

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6 Test Summary

FCC Rules	Test Item	Section	Verdict
§15.203	Antenna Requirement	8.1	Pass
§15.207 (a)	AC Power Line Conducted Emissions	N/A	N/A ¹⁾
§15.247 (a)(1)	20 dB Bandwidth	8.2	Pass
-	Occupied Bandwidth	8.3	Pass
§15.247 (a)(1)	Number of Hopping Channel	8.4	Pass
§15.247(b)(2)	Conducted Maximum Output Power	8.5	Pass
§15.247 (a)(1)	Chanel Separation	8.6	Pass
§15.247 (a)(1)	Time of Occupancy	8.7	Pass
§15.247(d)	Conducted Band-Edge & Unwanted Emissions	8.8	Pass
§15.247 (a)(1), §15.247 (g), §15.247 (h)	Frequency Hopping System Requirement	8.9	Pass
§15.205, §15.209, §15.247(d)	Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands	8.10	Pass

Note1: EUT is powered by Vehicle mains. It does not connect to public AC mains. This item is not applicable.

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7 Uncertainty of Measurement

Test item	Measurement Uncertainty (dB)
RF Output Power (Conducted)	±1.2 dB
Power Spectral Density	±0.9 dB
Unwanted Emission (conducted)	±2.6 dB
Occupied Channel Bandwidth	±5 %
Radiated Emission (9KHz-30MHz)	±3.5 dB
Radiated Emission (30MHz-1GHz)	±4.6 dB
Radiated Emission (1-18GHz)	±4.9 dB
Radiated Emission (18-40GHz)	±3.5 dB

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8 Test summary and result

8.1 Antenna Requirement

8.1.1 Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. 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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

8.1.2 Result

Analysis:

- EUT uses PCB trace antenna. No standard RF connector or coupling is used.

Conclusion:

EUT complies with antenna requirement in § 15.203.

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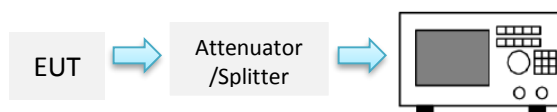
8.2 20 dB Bandwidth

8.2.1 Requirement

Per § 15.247 (a) (1) (i)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.2.2 Test setup



8.2.3 Test Procedure

According to section 6.9.2, in ANSI C63.10-2013:

Measurement is made with the occupied bandwidth measurement function incorporated in spectrum analyzer. The following setting are used per ANSI C63.10-2013.

1. Set Center Frequency = Nominal EUT channel center frequency.
2. Set Span to be between two times and five times of the OBW.
3. RBW shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times RBW.
4. Set detection mode to peak and trace mode to max hold.
5. Use the occupied bandwidth measurement function to place two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the “-xx dB down amplitude” determined.
6. The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labelled. Tabular data may be reported in addition to the plot(s).

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8.2.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Bandwidth (KHz)	Maximum Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	886.1	N/A	Pass
BT-GFSK	2441	1Mbps	933.5	N/A	Pass
BT-GFSK	2480	1Mbps	934.8	N/A	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1250	N/A	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1296	N/A	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1295	N/A	Pass
BT-8DPSK	2402	3Mbps	1260	N/A	Pass
BT-8DPSK	2441	3Mbps	1260	N/A	Pass
BT-8DPSK	2480	3Mbps	1260	N/A	Pass

8.2.5 Test Plots



BT-GFSK-20 dB BW-Low


BT- $\pi/4$ DQPSK-20 dB BW-Low


BT-GFSK-20 dB BW-Mid


BT- $\pi/4$ DQPSK-20 dB BW-Mid


BT-GFSK-20 dB BW-High


BT- $\pi/4$ DQPSK-20 dB BW-High

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BT-8DPSK-20 dB BW-Low



BT-8DPSK-20 dB BW-Mid



BT-8DPSK-20 dB BW-High

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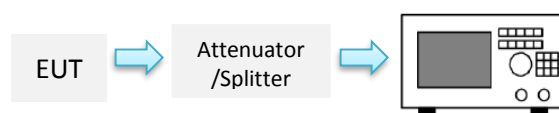
8.3 Occupied Bandwidth (99%)

8.3.1 Requirement

RSS-Gen §6.7

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.3.2 Test setup



8.3.3 Test Procedure

According to section RSS-Gen §6.7

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

1. Set RBW = 1% to 5% of the actual occupied BW.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Span = large enough to capture all products of the modulation process
7. Allow the trace to stabilize.
8. Use automatic bandwidth measurement capability on instrument to obtain BW result.

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8.3.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured 99% OBW (KHz)	Limit (KHz)	Result
BT-GFSK	2402	1Mbps	820.67	N/A	Pass
BT-GFSK	2441	1Mbps	838.99	N/A	Pass
BT-GFSK	2480	1Mbps	843.20	N/A	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1154.0	N/A	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1161.6	N/A	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1161.8	N/A	Pass
BT-8DPSK	2402	3Mbps	1153.2	N/A	Pass
BT-8DPSK	2441	3Mbps	1151.9	N/A	Pass
BT-8DPSK	2480	3Mbps	1152.4	N/A	Pass

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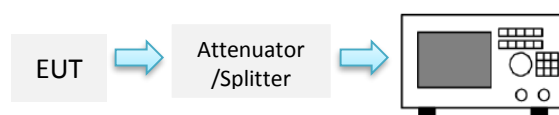
8.4 Number of Hopping Channel

8.4.1 Requirement

Per § 15.247 (a) (1) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.4.2 Test setup



8.4.3 Test Procedure

According to section 7.8.3, in ANSI C63.10-2013:

Measurement is made with spectrum analyzer. The following setting is used.

1. Set Span to be the frequency band of operation.
2. Set RBW to less 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
3. VBW $\geq$ RBW.
4. Sweep: Auto.
5. Detector function: Peak.
6. Trace: Max hold.
7. Allow the trace to stabilize.

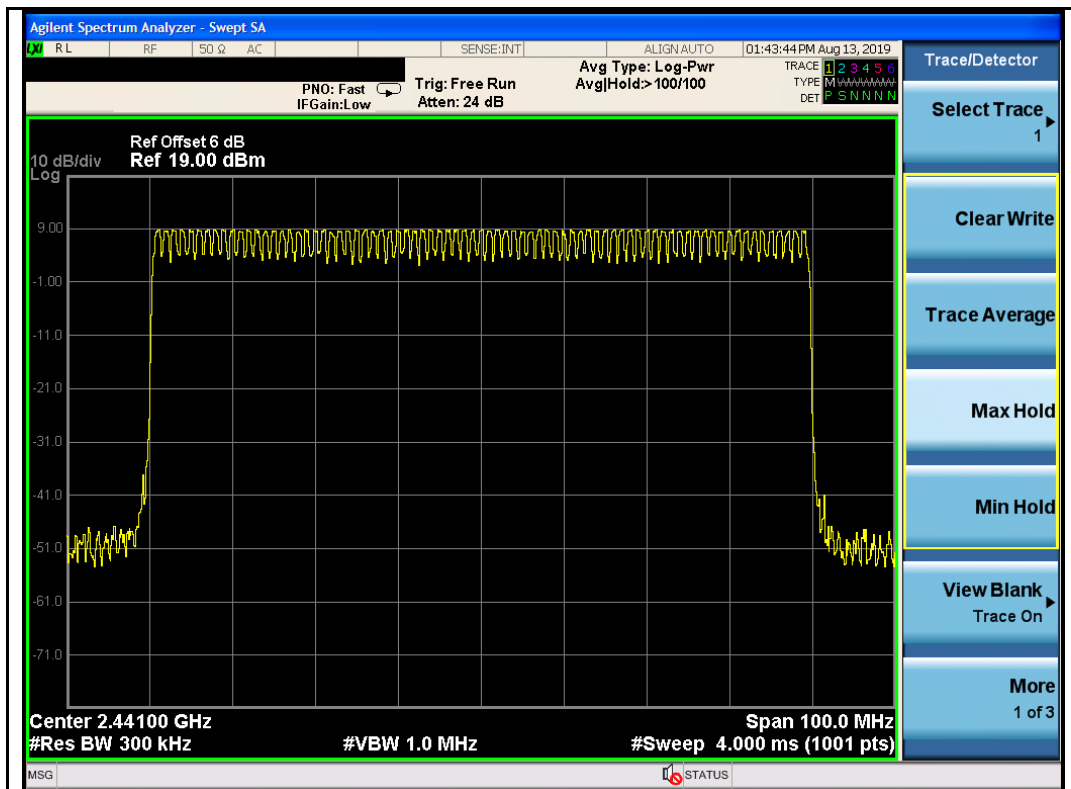
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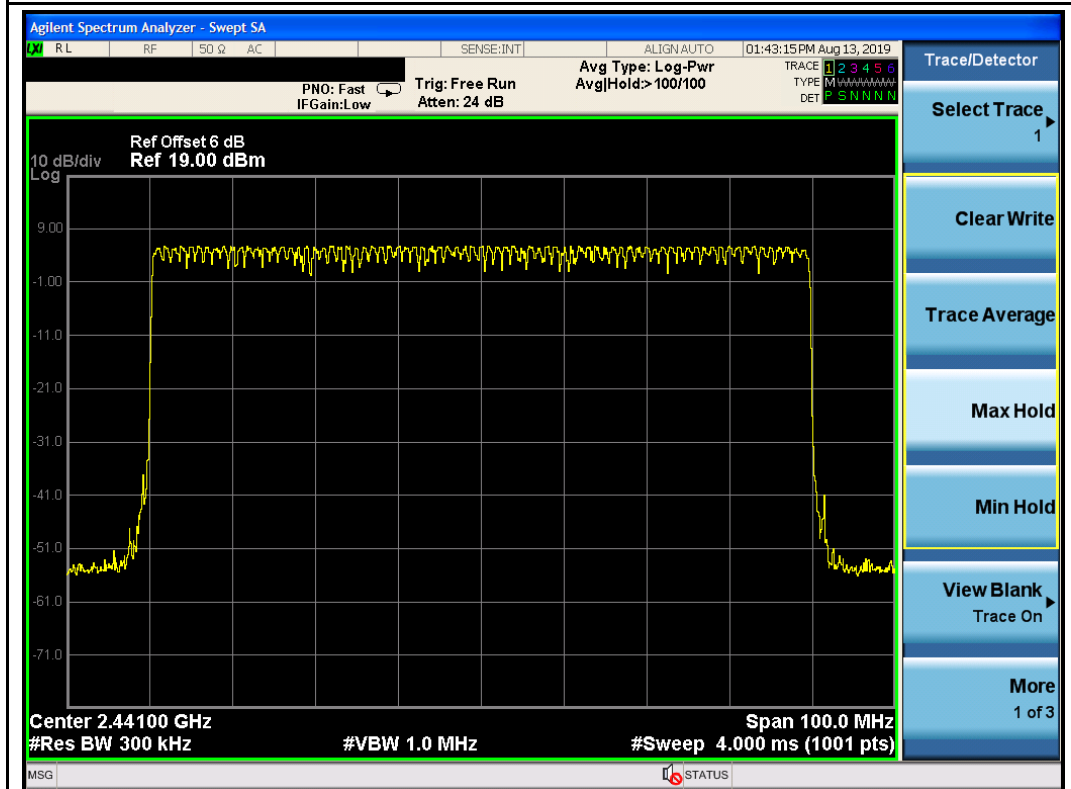
8.4.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Number	Minimum Limit	Result
BT-GFSK	2441	1Mbps	79	15	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	79	15	Pass
BT-8DPSK	2441	3Mbps	79	15	Pass

8.4.5 Test Plots

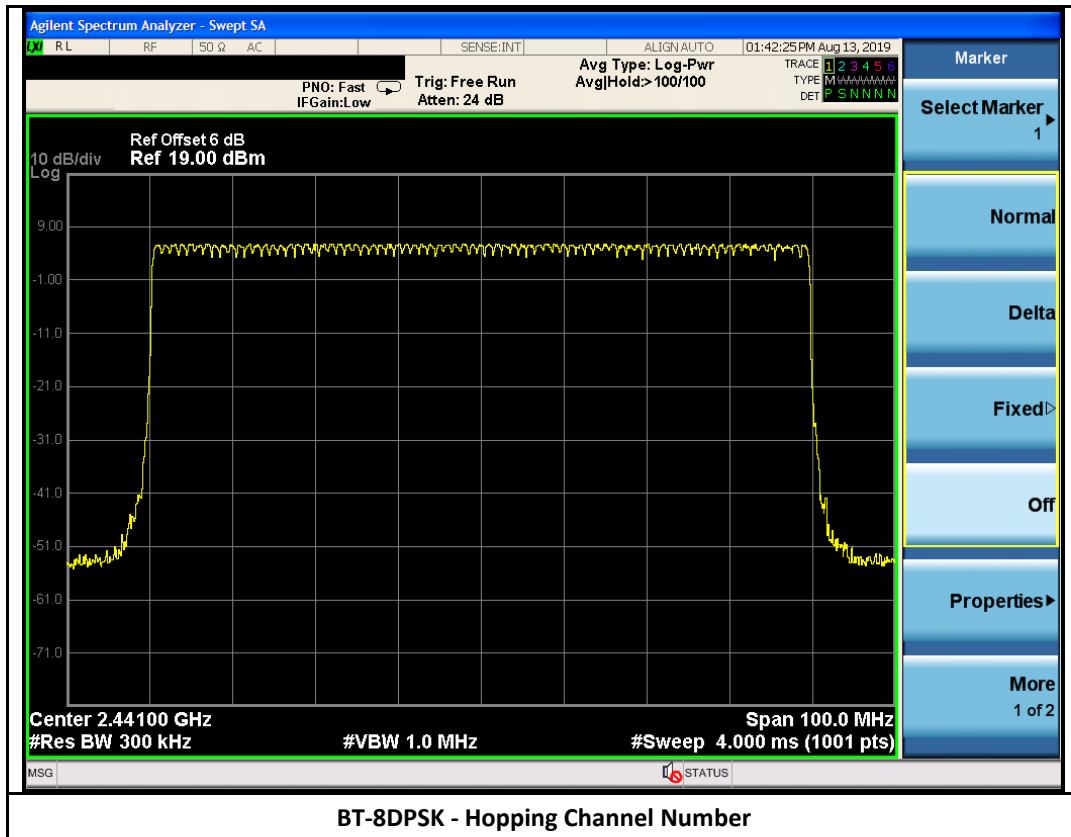


BT-GFSK- Hopping Channel Number



BT- $\pi/4$ DQPSK - Hopping Channel Number

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8.5 Maximum Output Power

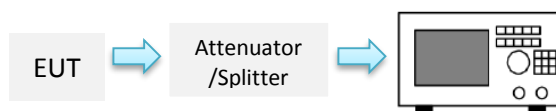
8.5.1 Requirement

Per § 15.247 (a)(1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

Per § 15.247 (b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

8.5.2 Test setup



8.5.3 Test Procedure

According to section 7.8.5 of ANSI C63.10-2013. The measurement was made with EUT directly connected to spectrum analyzer. The following setting is used.

1. Set the RBW > 20 dB BW
2. Set VBW ≥ RBW.
3. Set span to approximately five times the 20 dB bandwidth, centered on a hopping channel.
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.

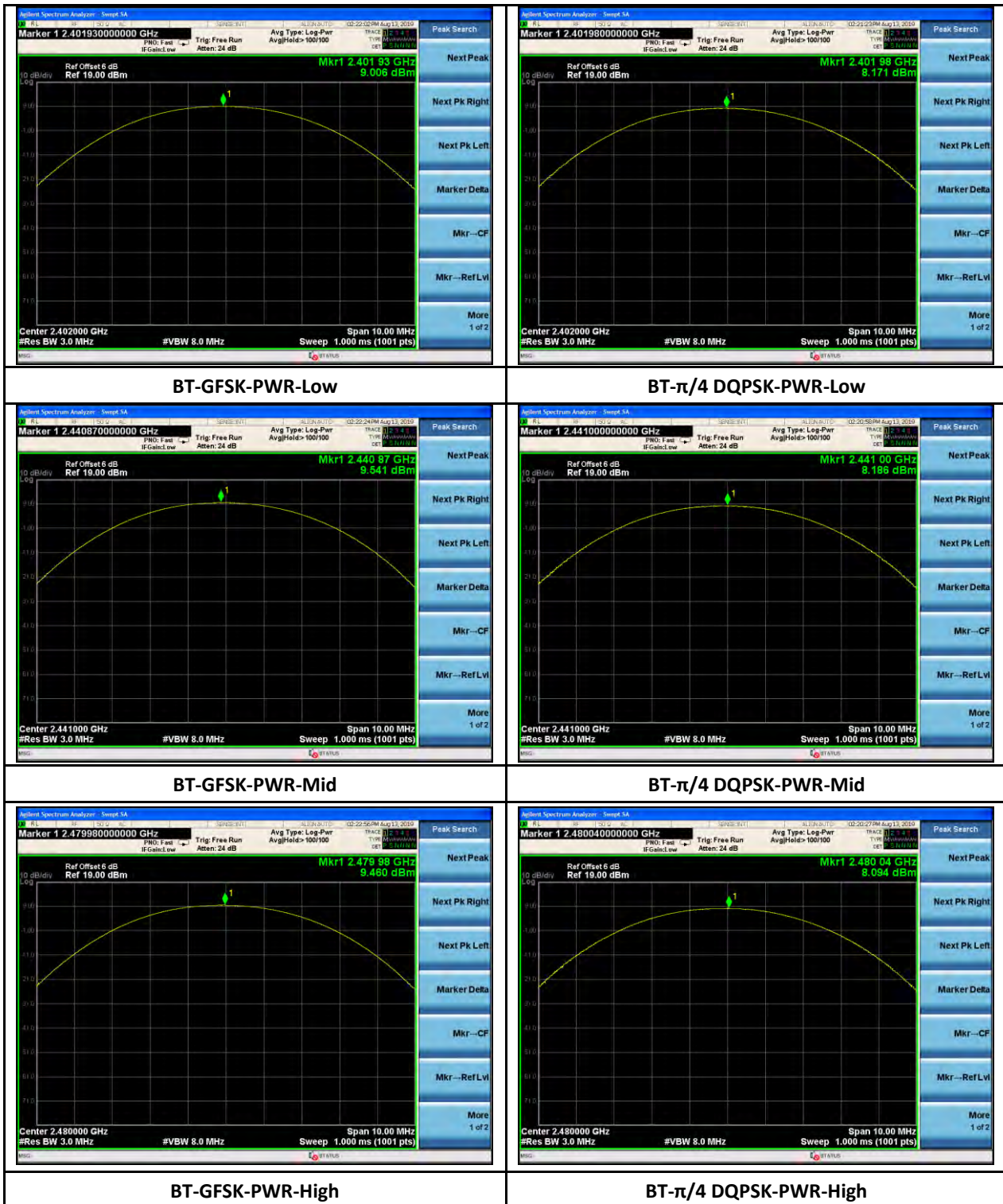
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8.5.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Measured Output Power (dBm)	Maximum Output Power (dBm)	Result
BT-GFSK	2402	1Mbps	9.006	21	Pass
BT-GFSK	2440	1Mbps	9.541	21	Pass
BT-GFSK	2480	1Mbps	9.460	21	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	8.171	21	Pass
BT- $\pi/4$ DQPSK	2440	2Mbps	8.186	21	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	8.094	21	Pass
BT-8DPSK	2402	3Mbps	8.423	21	Pass
BT-8DPSK	2440	3Mbps	8.456	21	Pass
BT-8DPSK	2480	3Mbps	8.397	21	Pass

8.5.5 Test Plots



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BT-8DPSK-PWR-Low



BT-8DPSK-PWR-Mid



BT-8DPSK-PWR-High

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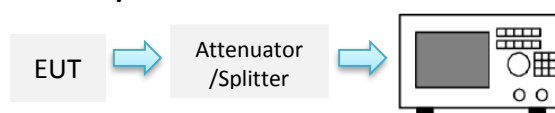
8.6 Channel Separation

8.6.1 Requirement

Per § 15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

8.6.2 Test setup



8.6.3 Test Procedure

According to section 7.8.2 of ANSI C63.10-2013. The measurement was made with spectrum analyzer. The following setting is used.

1. Set Span to wide enough to capture the peaks of two adjacent channels.
2. RBW: Start with the RBW set to approximately 30% of the channel spacing
3. VBW $\geq$ RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine separation between the peaks of adjacent channels.

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8.6.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Channel Separation (KHz)	2/3 of 20 dB Bandwidth (KHz)	Result
BT-GFSK	2402	1Mbps	980	590.7	Pass
BT-GFSK	2441	1Mbps	995	622.3	Pass
BT-GFSK	2480	1Mbps	1005	623.2	Pass
BT- $\pi/4$ DQPSK	2402	2Mbps	1010	833.3	Pass
BT- $\pi/4$ DQPSK	2441	2Mbps	1000	864.0	Pass
BT- $\pi/4$ DQPSK	2480	2Mbps	1005	863.3	Pass
BT-8DPSK	2402	3Mbps	975	840.0	Pass
BT-8DPSK	2441	3Mbps	1010	840.0	Pass
BT-8DPSK	2480	3Mbps	995	840.0	Pass

8.6.5 Test Plots





BT-8DPSK-Channel Separation-Low



BT-8DPSK-Channel Separation-Mid



BT-8DPSK-Channel Separation-High

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Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



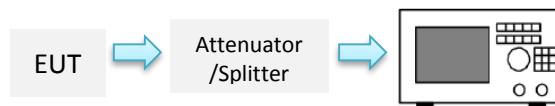
8.7 Time of Occupancy

8.7.1 Requirement

Per § 15.247 (a) (1) (iii)

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

8.7.2 Test setup



8.7.3 Test Procedure

According to section 7.8.4 of ANSI C63.10-2013. The measurement was made with spectrum analyzer. The following setting is used.

1. Set Span to zero, centered on a hopping channel.
2. RBW shall be $\leq$ channel spacing.
3. VBW $\geq$ RBW.
5. Detector = peak.
6. Sweep time = auto couple. As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the marker-delta function to determine the transmit time per hop.

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
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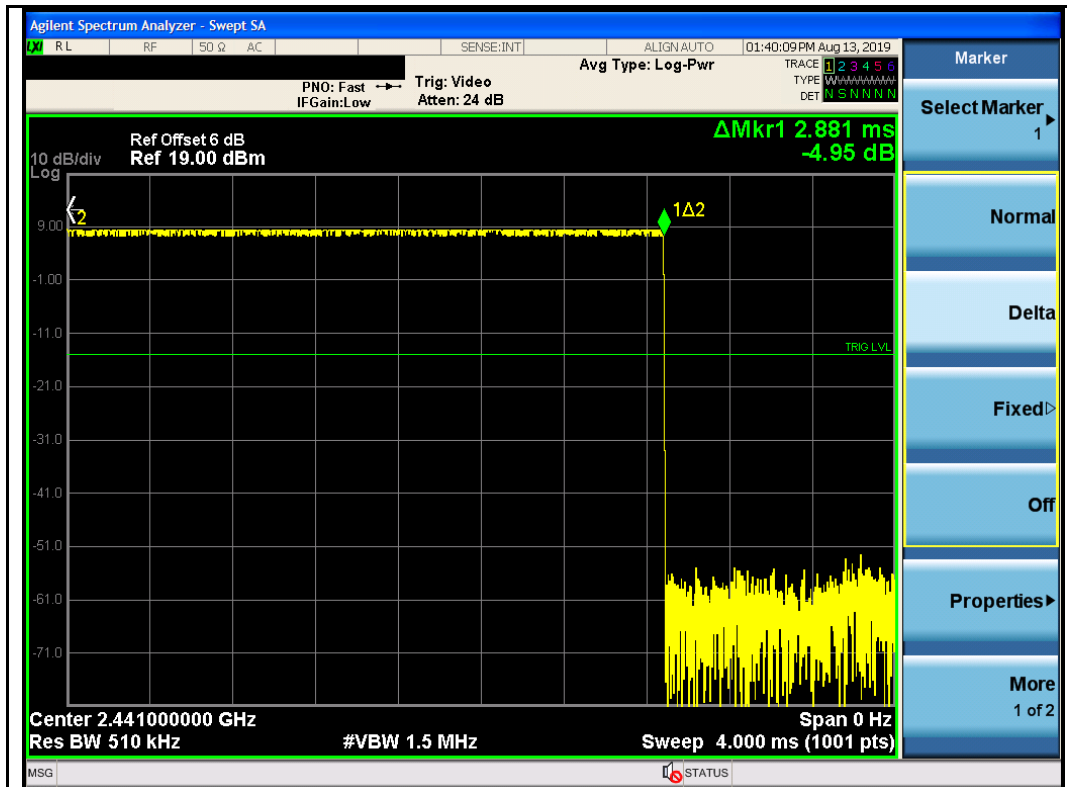
8.7.4 Test Result

Mode/ Bandwidth	Frequency (MHz)	Data rate	Packet	Burst Width (ms/hop/ch)	Dwell Time (s)	Limit (s)	Result
BT-GFSK	2402	1Mbps	DH5	2.881	0.3073	≤0.4	Pass
BT-π/4 DQPSK	2402	1Mbps	2DH5	2.881	0.3073	≤0.4	Pass
BT-8DPSK	2402	1Mbps	3DH5	2.881	0.3073	≤0.4	Pass

The test period: $T = 0.4 \text{ second} / \text{channel} * 79 \text{ channels} = 31.6 \text{ s}$

DH5 Dwell time = Burst Width (ms) * $(1600 / (6 * 79)) * 31.6$

8.7.5 Test Plots

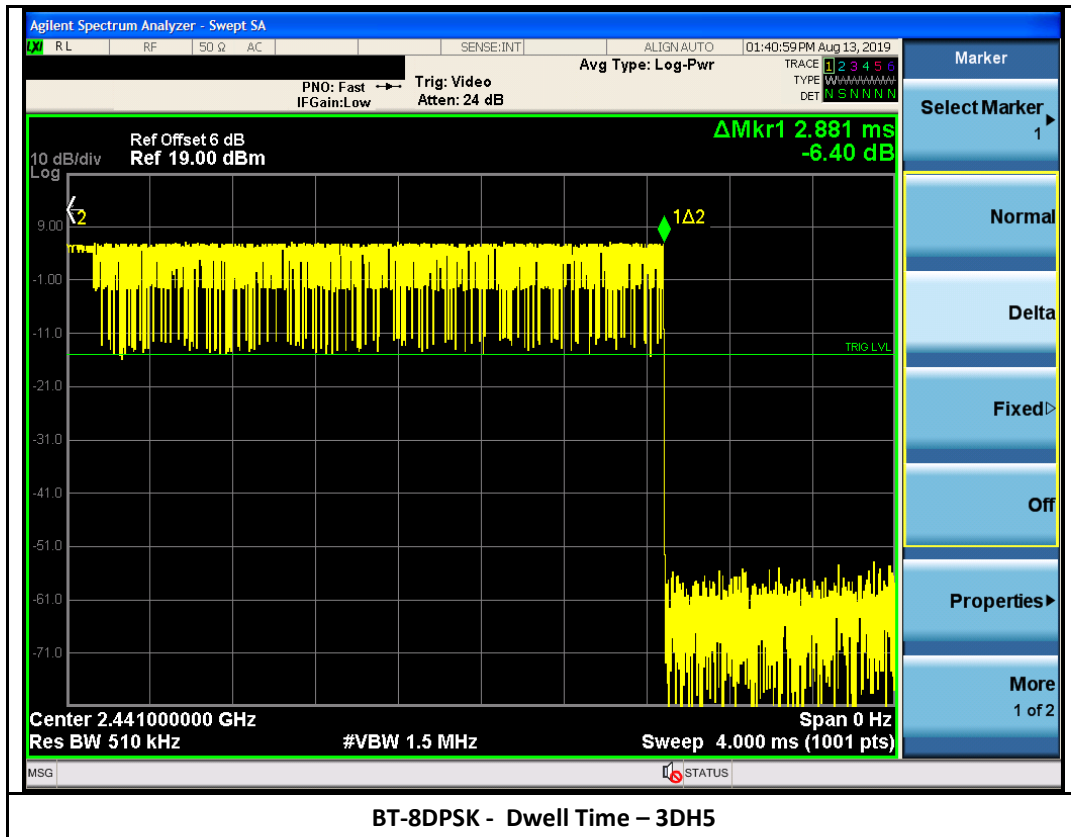


BT-GFSK- Dwell Time - DH5



BT- $\pi/4$ DQPSK - Dwell Time - 2DH5

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Model Number: SYNC-G4L



Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



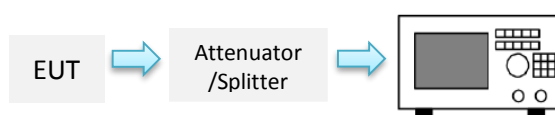
8.8 Conducted Band-Edge & Unwanted Emissions Measurement

8.8.1 Requirement

Per § 15.247 (d)

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.

8.8.2 Test setup



8.8.3 Test Procedure

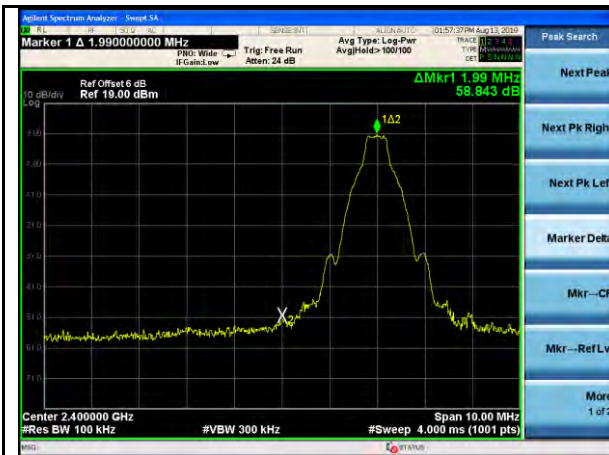
According to section 7.8.8 of ANSI C63.10-2013.

Connect the primary antenna port through an attenuator to the spectrum analyzer input; in the results, account for all losses between the unlicensed wireless device output and the spectrum analyzer. The instrument shall span 30 MHz to 10 times the operating frequency in GHz, with a resolution bandwidth of 100 kHz, video bandwidth of 300 kHz, and a coupled sweep time with a peak detector. The band 30 MHz to the highest frequency may be split into smaller spans, as long as the entire spectrum is covered. The following setting is used.

8.8.4 Test Result

See test plots

8.8.5 Test Plots



BT-GFSK-Band Edge-Low-Non hopping



BT-GFSK-Band Edge-Low-Hopping



BT-GFSK-Band Edge-High-Non hopping



BT-GFSK-Band Edge-High-Hopping



BT- $\pi/4$ DQPSK-Band Edge-Low-Non hopping



BT- $\pi/4$ DQPSK-Band Edge-Low-Hopping



BT- $\pi/4$ DQPSK-Band Edge-High-Non hopping



BT- $\pi/4$ DQPSK-Band Edge-High-Hopping



BT-8DPSK-Band Edge-Low-Non hopping



BT-8DPSK-Band Edge-Low-Hopping

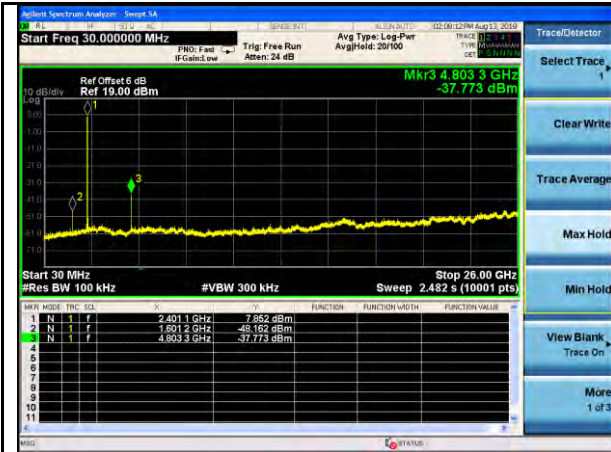


BT-8DPSK-Band Edge-High-Non hopping



BT-8DPSK-Band Edge-High-Hopping

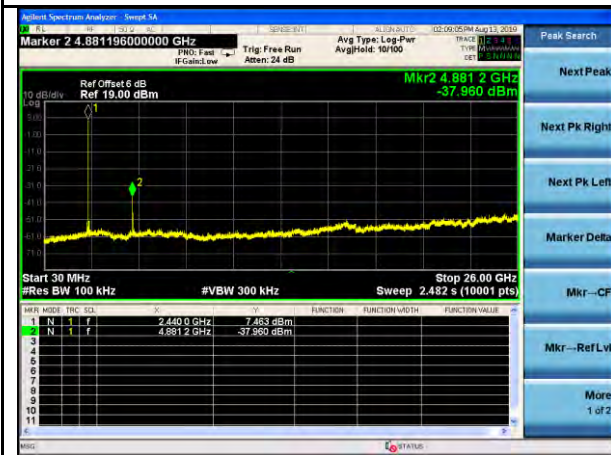
Report Number: WAP-19052921-LC-FCC-DSS-G4L
Product: Vehicle Infotainment System
Model Number: SYNC-G4L



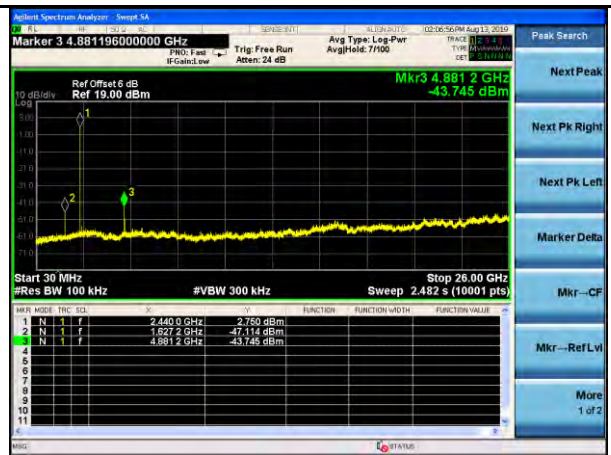
BT-GFSK-CSE-Low



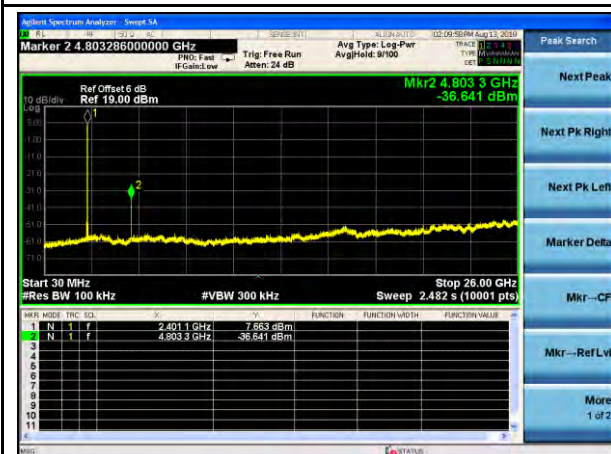
BT- $\pi/4$ DQPSK-CSE-Low



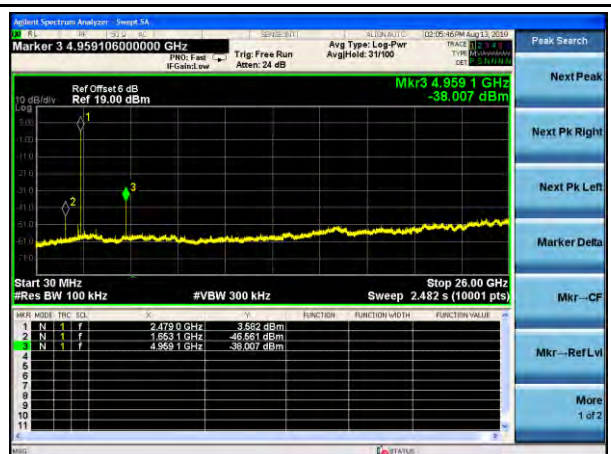
BT-GFSK-CSE-Mid



BT- $\pi/4$ DQPSK-CSE-Mid



BT-GFSK-CSE-High

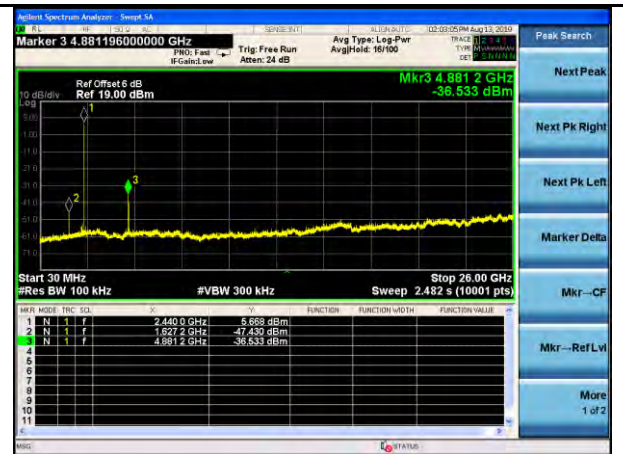


BT- $\pi/4$ DQPSK-CSE-High

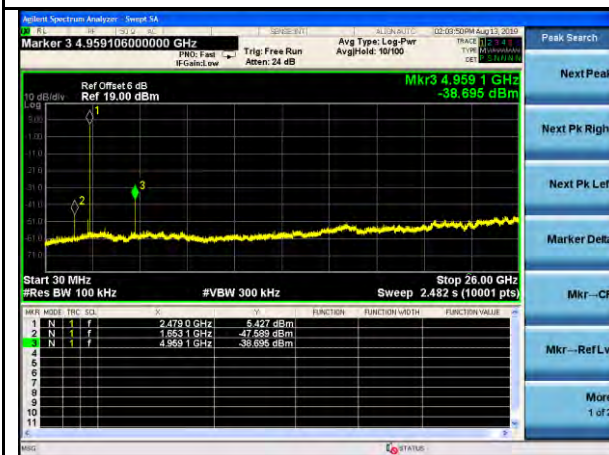
Report Number: WAP-19052921-LC-FCC-DSS-G4L
Product: Vehicle Infotainment System
Model Number: SYNC-G4L



BT-8DPSK-CSE-Low



BT-8DPSK-CSE-Mid



BT-8DPSK-CSE-High

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



8.9 Frequency Hopping System Requirement

8.9.1 Requirement

Per § 15.247 (a) (1)

the system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Per § 15.247 (g), frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

Per § 15.247 (h), the incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

8.9.2 Result

Analysis:

This device uses Bluetooth radio which operates in 2400-2483.5 MHz band. Bluetooth uses a radio technology called frequency-hopping spread spectrum, which chops up the data being sent and transmits chunks of it on up to 79 bands (1 MHz each; centered from 2402 to 2480MHz) in the range 2,400-2,483.5MHz. The transmitter switches hop frequencies 1,600 times per second to assure a high degree of data security. All Bluetooth devices participating in a given piconet are synchronized to the frequency-hopping channel for the piconet. The frequency hopping sequence is determined by the master's device address and the phase of the hopping sequence (the frequency to hop at a specific time) is determined by the master's internal clock. Therefore, all slaves in a piconet must know the master's device address and must synchronize their clocks with the master's clock.

Adaptive Frequency Hopping (AFH) was introduced in the Bluetooth specification to provide an effective way for a Bluetooth radio to counteract normal interference. AFH identifies "bad" channels, where either other wireless devices are interfering with the Bluetooth signal or the Bluetooth signal is interfering with another device. The AFH-enabled Bluetooth device will then communicate with other devices within its piconet to share details of any identified bad

channels. The devices will then switch to alternative available "good" channels, away from the areas of interference, thus having no impact on the bandwidth used.

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This device was tested with an Bluetooth system receiver to check that the device maintained hopping synchronization, and the device complied with these requirements for DA 00-705 and FCC Part 15.247 rule.

An example of Pseudorandom Frequency Hopping Sequence Table as below:

08, 24, 40, 56, 40, 56, 72, 09, 01, 09, 33, 41, 33, 41, 65, 73, 53, 69, 06, 22, 04, 20, 36, 52, 38, 46, 70, 78, 68, 76, 21, 29, 10, 26, 42, 58, 44, 60, 76, 13, 03, 11, 35, 43, 37, 45, 69, 77, 55, 71, 08, 24, 08, 24, 40, 56, 40, 48, 72, 01, 72, 01, 25, 33, 12, 28, 44, 60, 42, 58, 74, 11, 05, 13, 37, 45 etc.

The system receiver has input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shift frequencies in synchronization with the transmitted signals.

Conclusion:

EUT complies with frequency hopping system requirement in § 15.247.

8.10 Radiated Band-Edge & Spurious Emissions into Restricted Frequency Bands

8.10.1 Requirement

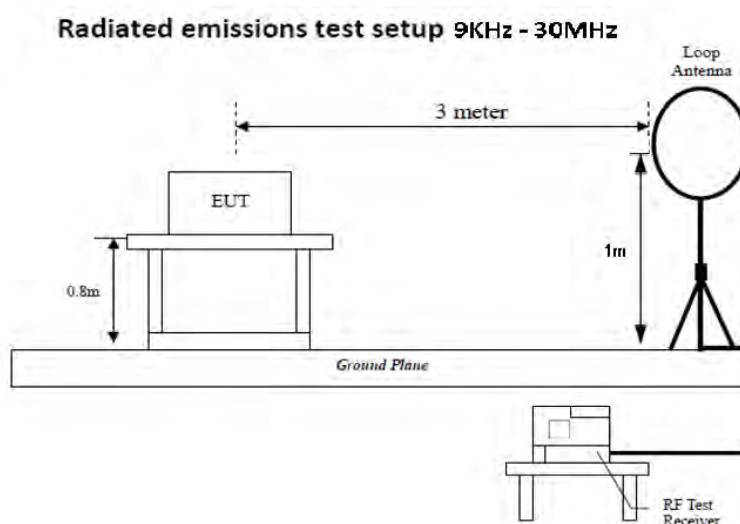
§ 15.247 (d)

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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

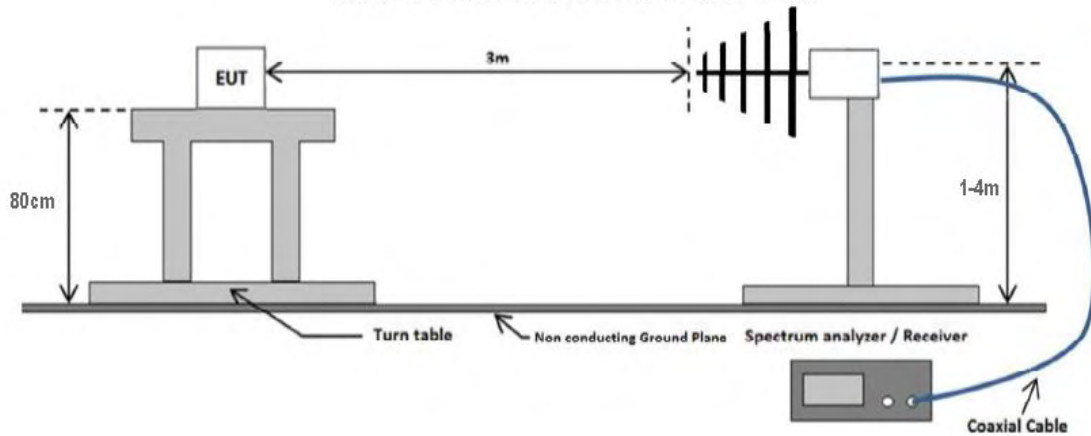
Attenuation below the general limits specified in §15.209(a) and RSS-Gen is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Frequency range (MHz)	Field Strength ($\mu\text{V}/\text{m}$)
0.009~0.490	2400/F(KHz)
0.490~1.705	24000/F(KHz)
1.705~30.0	30
30 – 88	100
88 – 216	150
216 960	200
Above 960	500

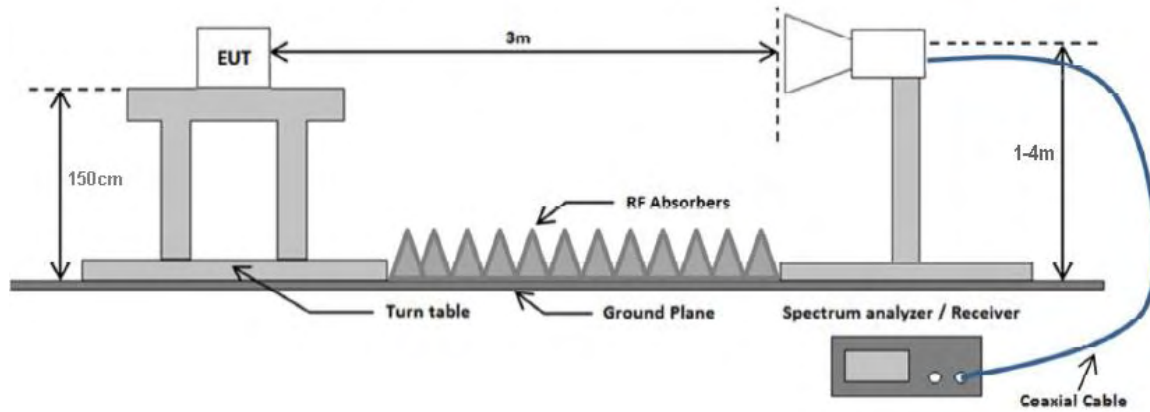
8.10.2 Test setup



Radiated emissions test setup 30 MHz - 1 GHz



Radiated emissions test setup above 1 GHz



Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



8.10.3 Test Procedure

According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05r02 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C62.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
 - a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
 - b. The EUT was then rotated to the direction that gave the maximum emission.
 - c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

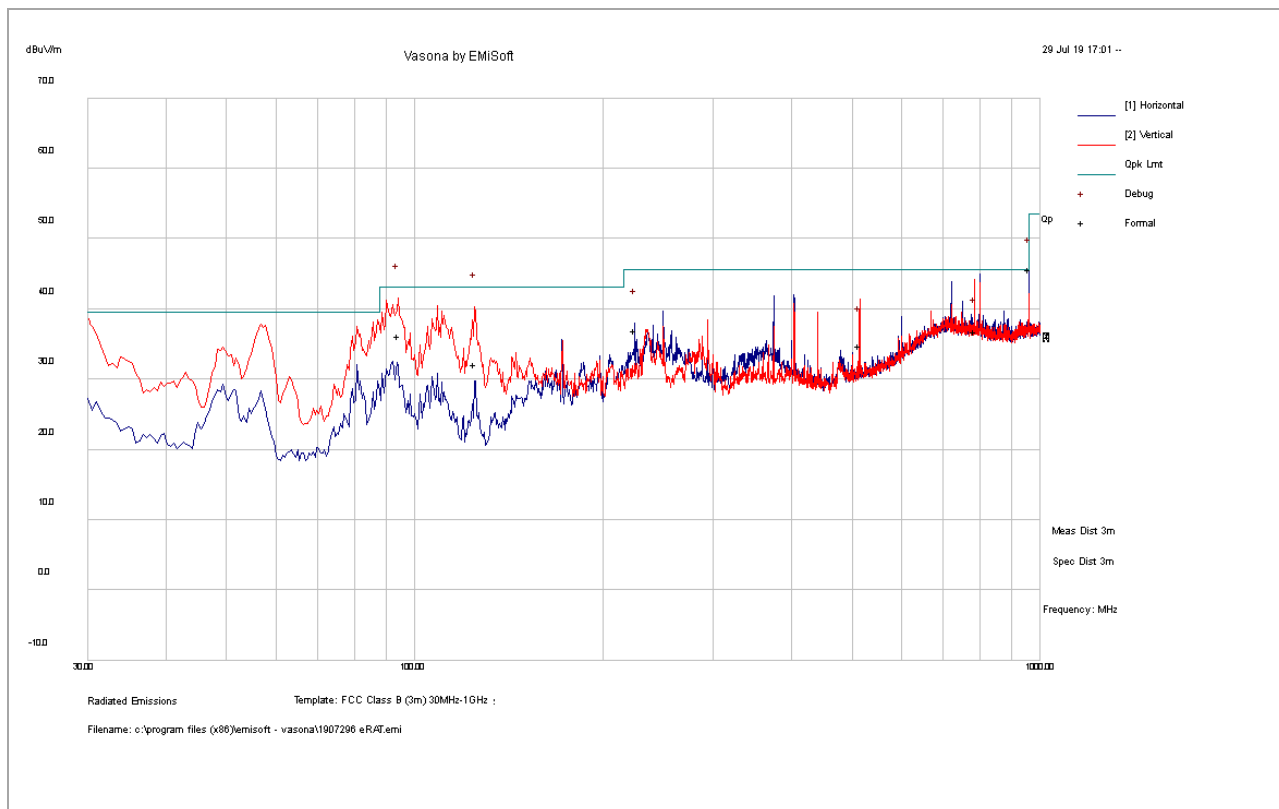
Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



8.10.4 Test Result

30-1000MHz test result

Test Standard:	15.209, 15.247	Mode:	BDR mode
Frequency Range:	30-1000MHz	Test Date:	07/29/2019
Antenna Type/Polarity:	Bi-Log/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
94.10	59.50	0.99	-24.22	36.27	QP	V	320	16	46.00	-9.73
124.73	53.79	1.39	-23.05	32.12	QP	V	174	203	46.00	-13.88
959.99	46.74	3.53	-6.59	43.68	QP	H	100	47	46.00	-2.32
225.02	55.23	2.26	-20.46	37.03	QP	H	306	175	46.00	-8.97
785.59	39.87	3.65	-6.72	36.80	QP	H	101	198	46.00	-9.20
514.55	44.25	2.86	-12.28	34.83	QP	H	113	310	46.00	-11.17

Note:

- 1) For below 1GHz, all different channels and modes were verified but only the worst case result is shown here.



Electromagnetic Compatibility
Radio Frequency
Product Certification
International Approval

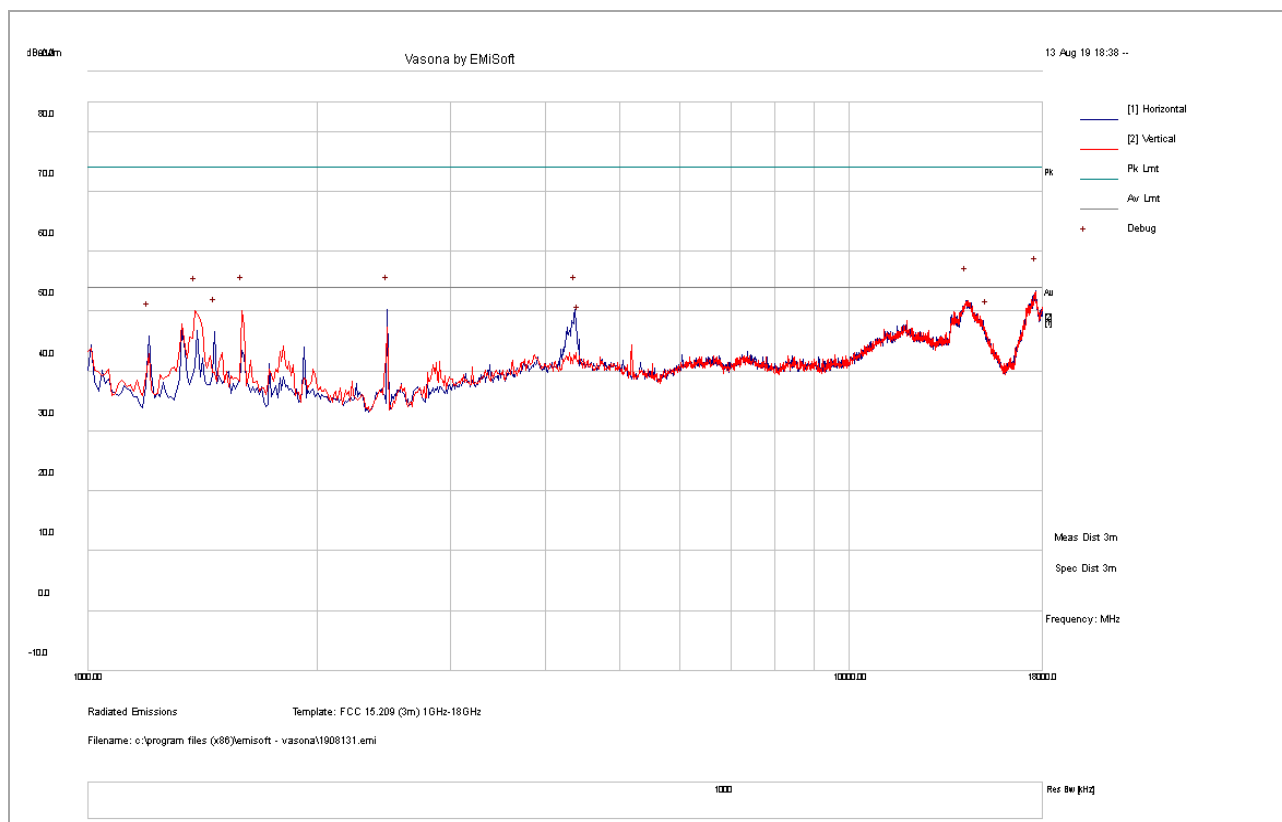
1261 Puerta Del Sol
San Clemente, CA, 92673
+1 (949) 393-1123
www.vista-compliance.com

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	BDR-GFSK-2402MHz
Frequency Range:	1GHz-18GHz	Test Date:	08/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



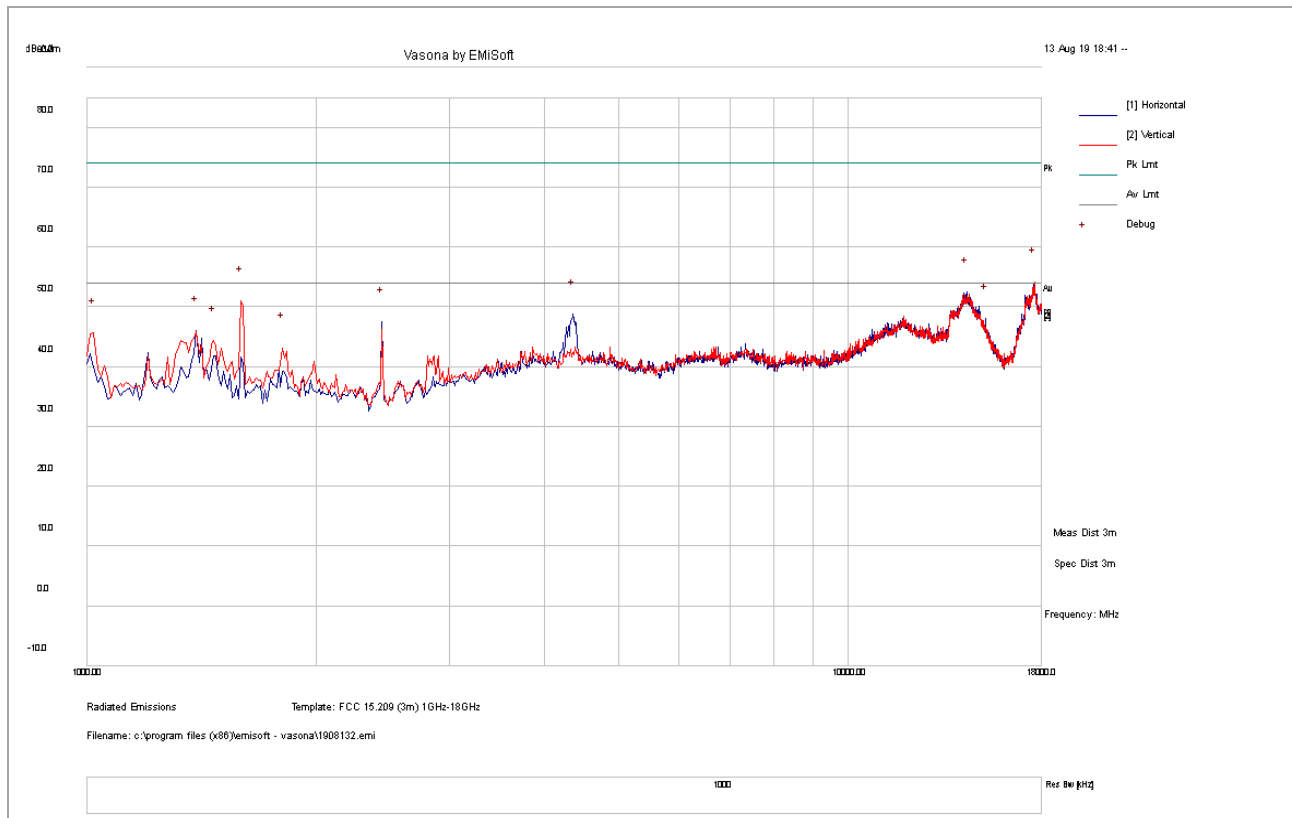
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
4368.13	28.24	13.14	8.90	50.28	PK	H	188	77	54	-3.72
2476.88	39.04	10.79	0.37	50.21	PK	H	257	186	54	-3.80
1595.00	42.79	10.73	-3.37	50.15	PK	V	117	274	54	-3.85
1382.50	43.10	10.66	-3.63	50.14	PK	V	125	44	54	-3.86
1467.50	39.50	10.81	-3.75	46.56	PK	H	181	161	54	-7.44
1201.88	39.65	10.31	-4.18	45.78	PK	H	184	153	54	-8.22
4421.25	22.92	13.20	9.10	45.22	PK	H	200	23	54	-8.78

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	BDR-GFSK-2441MHz
Frequency Range:	1GHz-18GHz	Test Date:	08/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



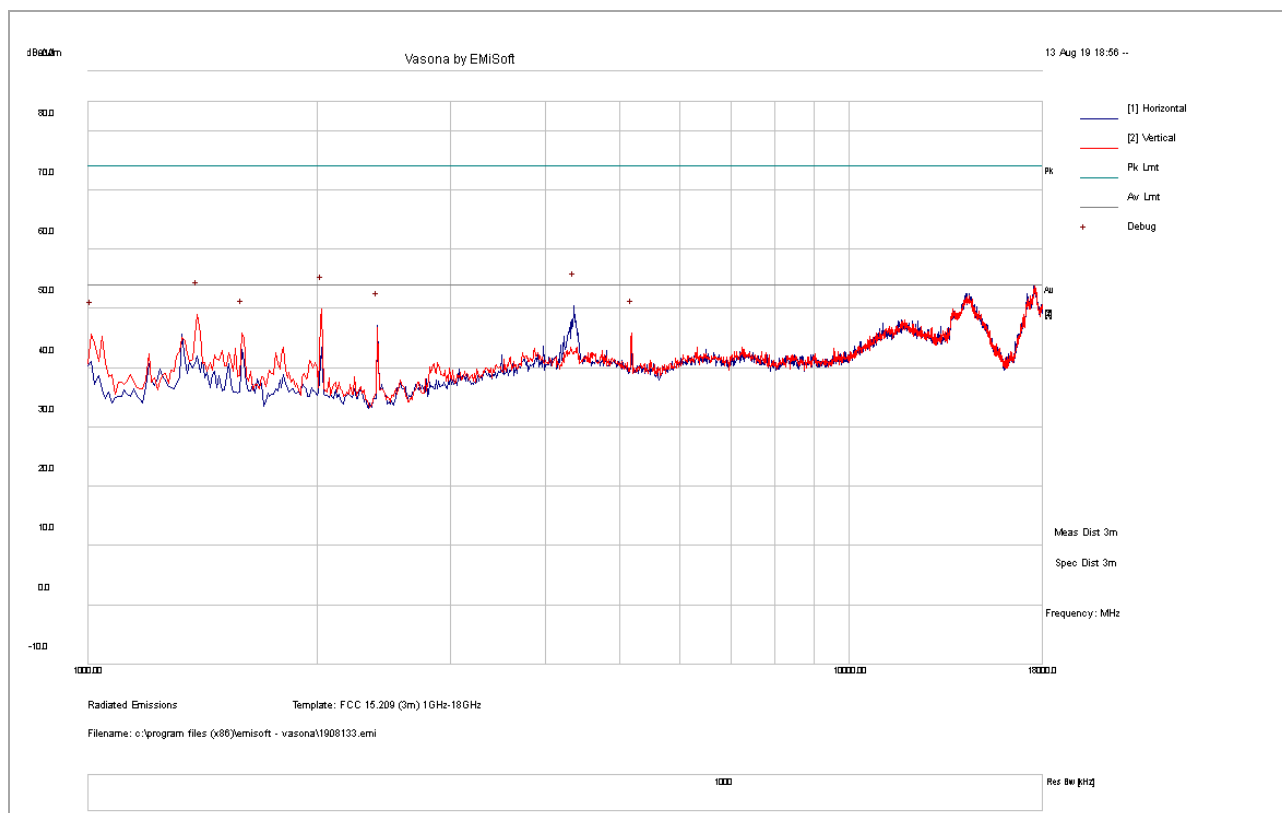
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
1595.00	43.55	10.73	-3.37	50.91	PK	V	185	184	54	-3.09
4357.50	26.74	13.13	8.84	48.71	PK	H	134	183	54	-5.30
2445.00	36.51	10.76	0.16	47.42	PK	H	101	222	54	-6.58
1393.13	38.88	10.68	-3.55	46.00	PK	H	158	184	54	-8.00
1021.25	41.11	9.90	-5.43	45.58	PK	V	232	175	54	-8.42
1467.50	37.26	10.81	-3.75	44.33	PK	V	111	275	54	-9.68
1807.50	34.24	10.47	-1.57	43.14	PK	V	115	261	54	-10.86

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	BDR-GFSK-2480MHz
Frequency Range:	1GHz-18GHz	Test Date:	08/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



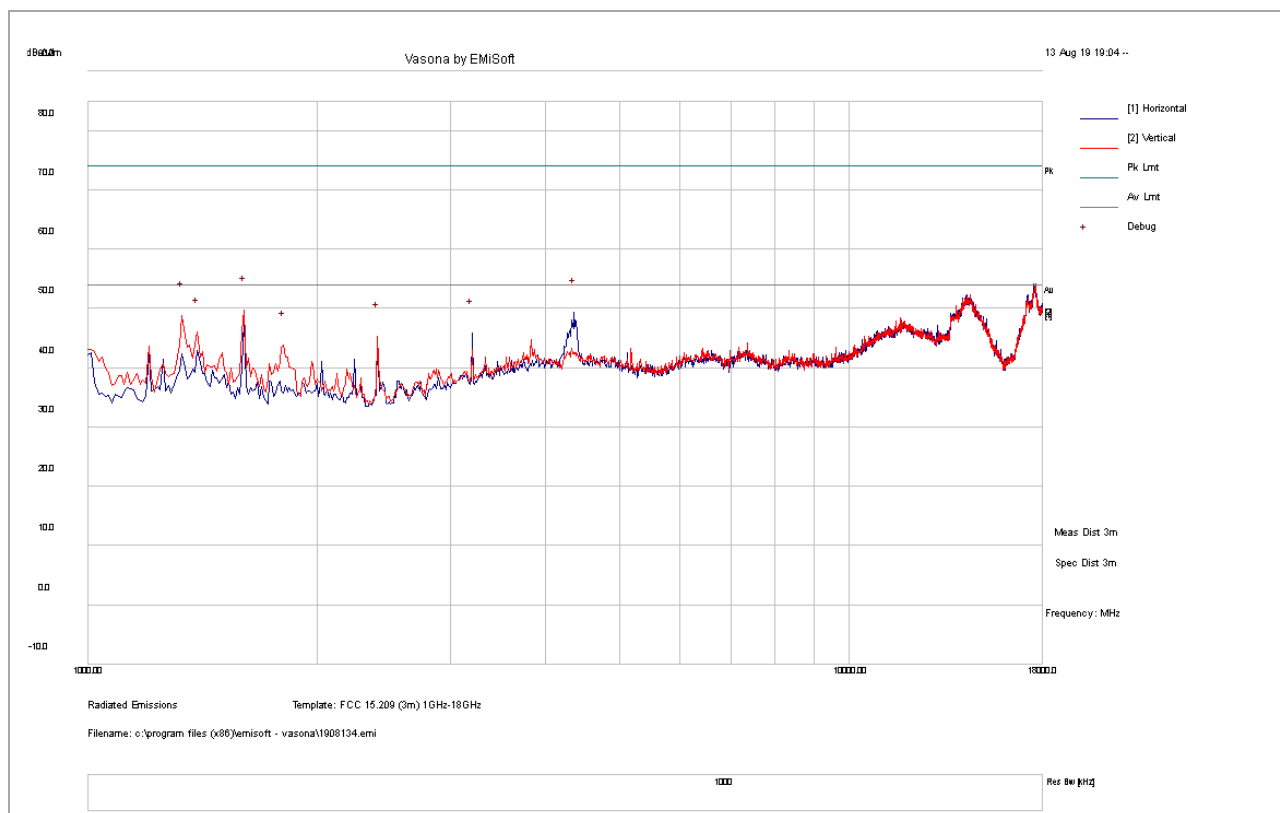
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
4357.50	28.46	13.13	8.84	50.43	PK	H	265	264	54	-3.57
2030.63	40.38	10.29	-0.82	49.85	PK	V	100	232	54	-4.15
1393.13	41.82	10.68	-3.55	48.94	PK	V	117	187	54	-5.06
2402.50	36.43	10.72	0.04	47.19	PK	H	125	274	54	-6.82
5186.25	22.04	13.45	10.35	45.84	PK	V	162	346	54	-8.16
1595.00	38.38	10.73	-3.37	45.75	PK	V	183	333	54	-8.25
1010.63	41.35	9.87	-5.57	45.65	PK	V	161	11	54	-8.35

Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	EDR-8DPSK-2402MHz
Frequency Range:	1GHz-18GHz	Test Date:	08/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



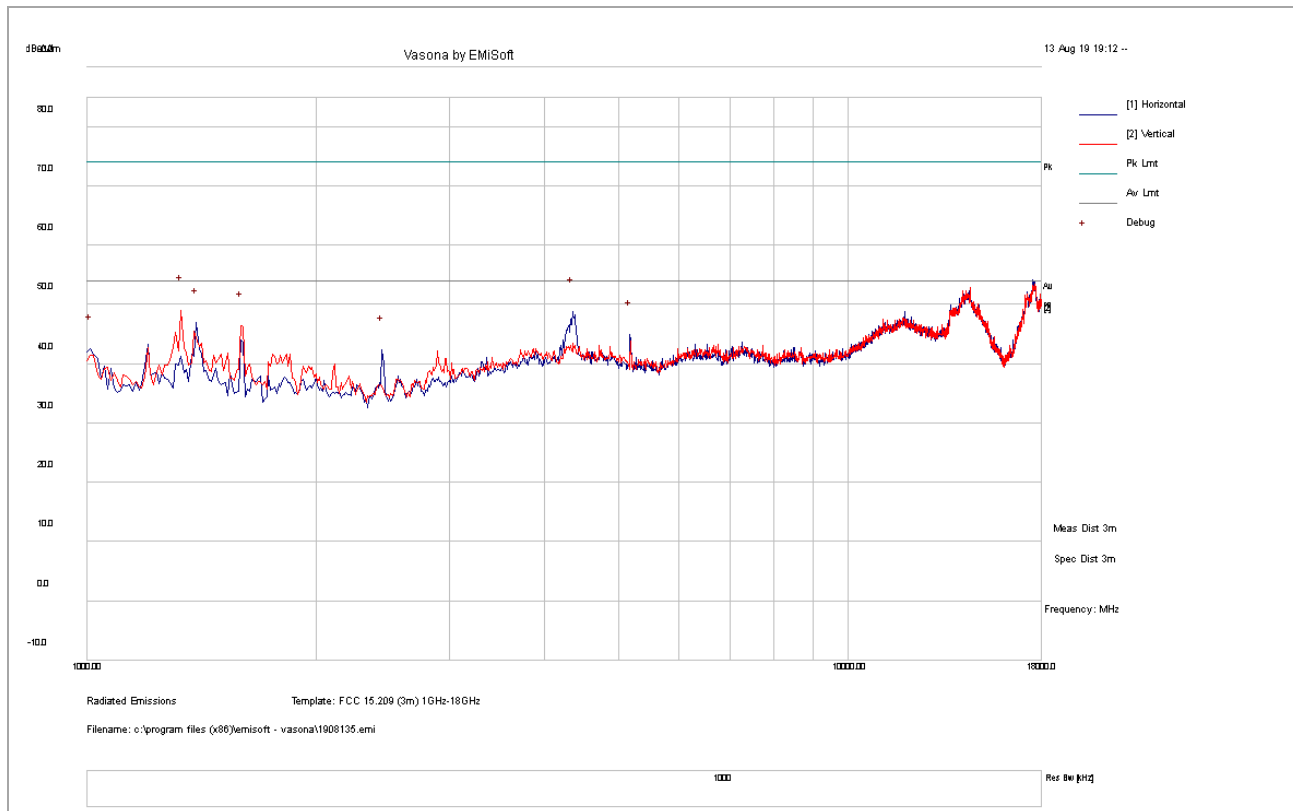
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
1605.63	42.26	10.72	-3.34	49.64	PK	V	100	244	54	-4.36
4357.50	27.40	13.13	8.84	49.37	PK	H	109	185	54	-4.63
1329.38	42.01	10.56	-3.81	48.76	PK	V	126	72	54	-5.24
1393.13	38.88	10.68	-3.55	46.01	PK	V	117	277	54	-8.00
3199.38	30.35	11.56	3.84	45.75	PK	H	126	168	54	-8.25
2402.50	34.53	10.72	0.04	45.29	PK	H	112	293	54	-8.71
1807.50	34.89	10.47	-1.57	43.78	PK	V	213	122	54	-10.22

Report Number: WAP-19052921-LC-FCC-DSS-G4L
Product: Vehicle Infotainment System
Model Number: SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	EDR-8DPSK-2441MHz
Frequency Range:	1GHz-18GHz	Test Date:	08/13/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



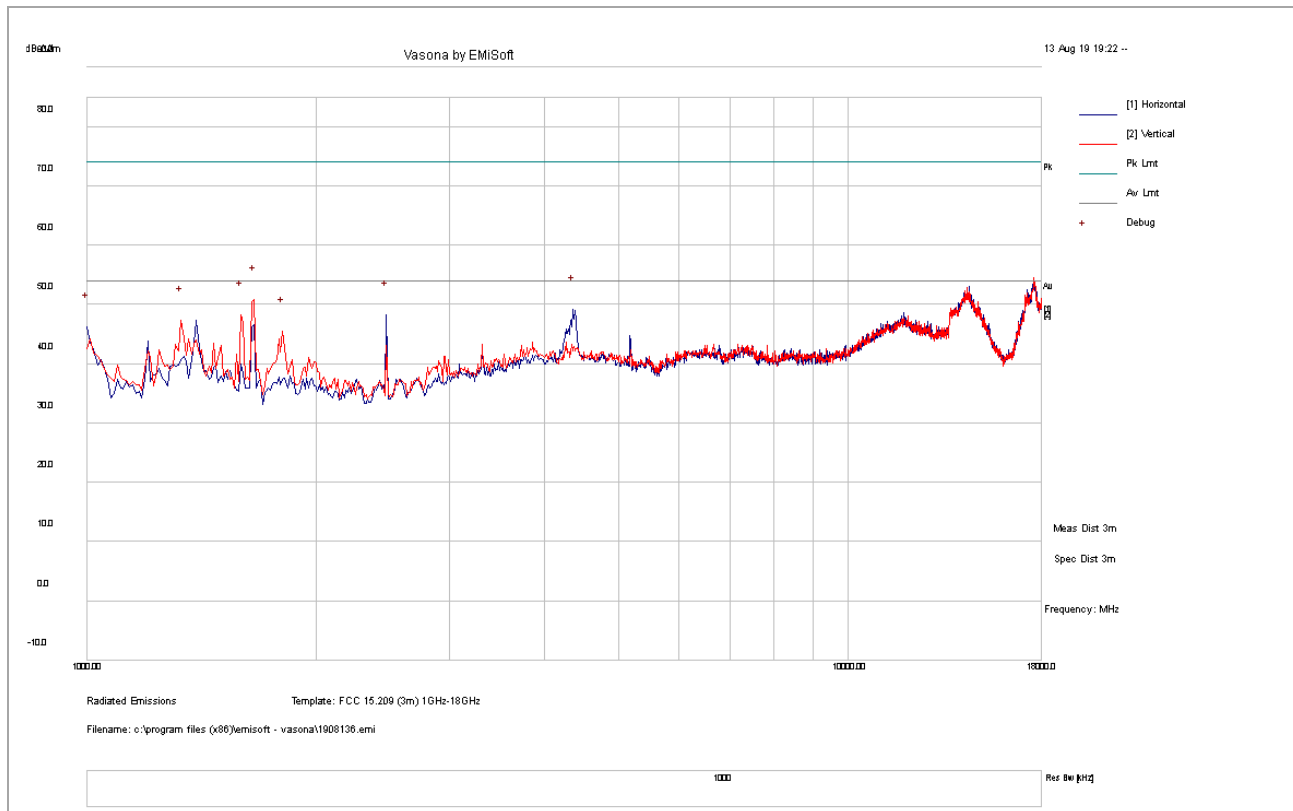
Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
1329.38	42.29	10.56	-3.81	49.04	PK	V	124	298	54	-4.96
4346.88	26.89	13.12	8.78	48.79	PK	H	110	184	54	-5.21
1393.13	39.72	10.68	-3.55	46.85	PK	H	103	274	54	-7.15
1595.00	39.04	10.73	-3.37	46.41	PK	V	257	15	54	-7.60
5175.63	21.07	13.45	10.33	44.85	PK	H	254	130	54	-9.15
1010.63	38.17	9.87	-5.57	42.47	PK	H	100	194	54	-11.53
2445.00	31.42	10.76	0.16	42.33	PK	H	221	87	54	-11.67

Report Number: WAP-19052921-LC-FCC-DSS-G4L
Product: Vehicle Infotainment System
Model Number: SYNC-G4L



1GHz – 18GHz test result

Test Standard:	15.209, 15.247	Mode:	EDR-8DPSK-2480MHz
Frequency Range:	1GHz-18GHz	Test Date:	07/02/2019
Antenna Type/Polarity:	Horn/Hor & Ver	Test Personnel:	Cameron Wu
Remark:	N/A	Test Result:	Pass



Frequency MHz	Raw dB	Cable dB	AF dB	Level dBuV/m	Det	Pol deg	Height cm	Table deg	Limit dBuV/m	Margin dB
1658.75	43.40	10.65	-3.29	50.75	PK	V	313	97	54	-3.25
4357.50	27.08	13.13	8.84	49.05	PK	H	99	232	54	-4.95
2476.88	37.11	10.79	0.37	48.28	PK	H	100	186	54	-5.72
1595.00	40.84	10.73	-3.37	48.20	PK	V	106	148	54	-5.80
1329.38	40.56	10.56	-3.81	47.30	PK	V	111	276	54	-6.70
1000.00	42.02	9.85	-5.72	46.15	PK	H	174	194	54	-7.86
1807.50	36.53	10.47	-1.57	45.42	PK	V	122	71	54	-8.58

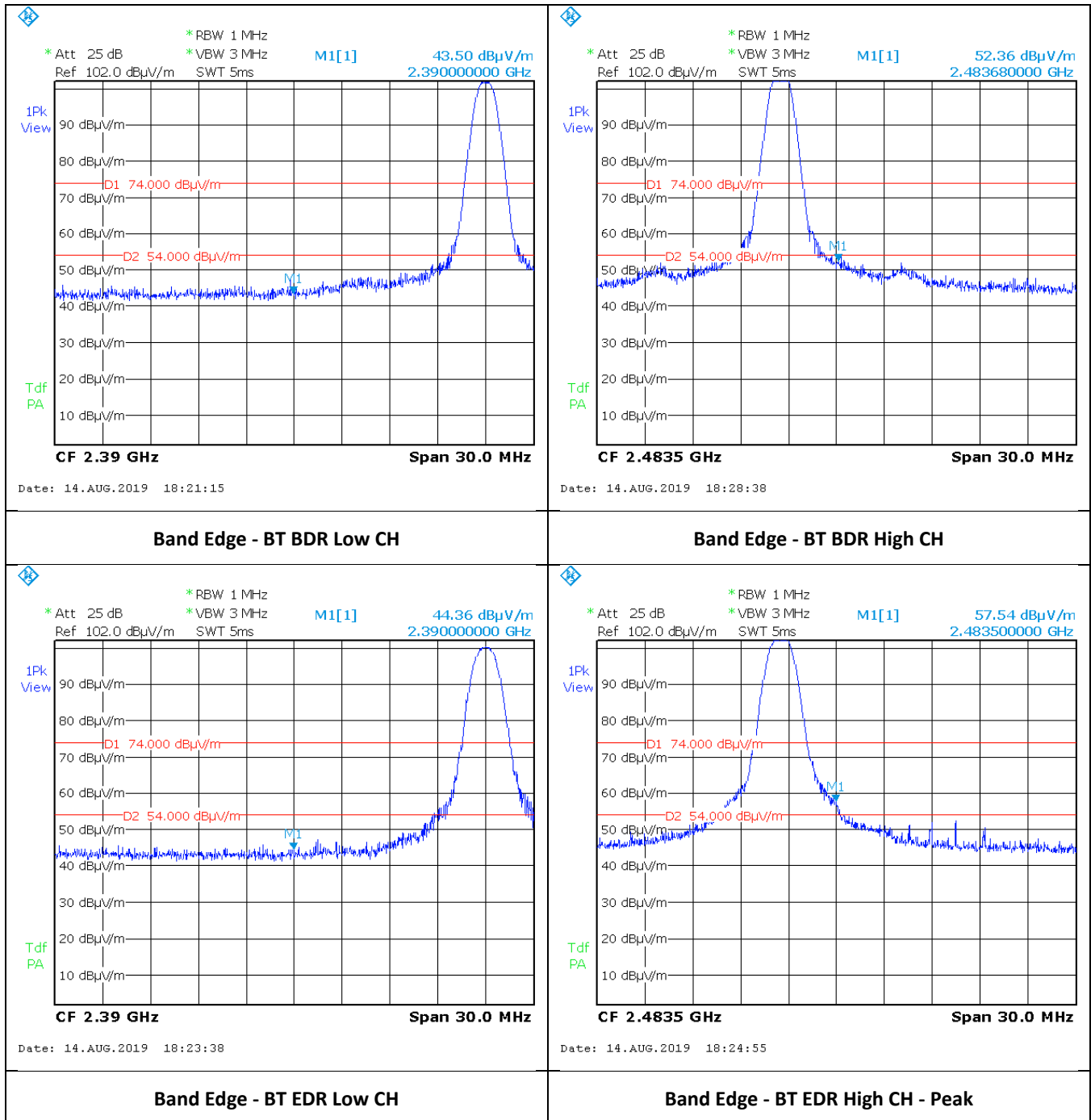
Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



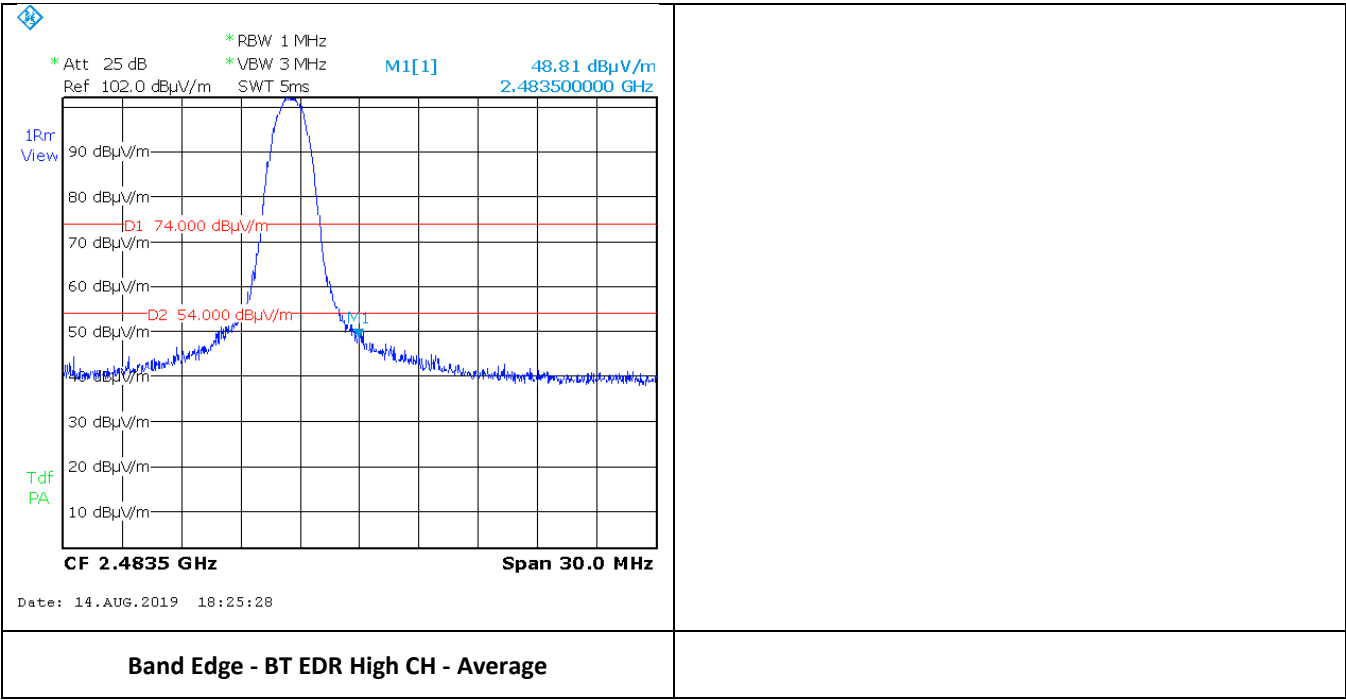
18GHz – 40GHz test result

Note: no substantial emission is found other than the noise floor. Different modes have been verified.

Restricted Band Measurement Plots:



Report Number: WAP-19052921-LC-FCC-DSS-G4L
Product: Vehicle Infotainment System
Model Number: SYNC-G4L



Report Number:	WAP-19052921-LC-FCC-DSS-G4L
Product:	Vehicle Infotainment System
Model Number:	SYNC-G4L



9 Test instrument list

Equipment	Manufacturer	Model	Serial Number	Cal. Date	Cal. Due
Semi-Anechoic Chamber	ETS-Lindgren	10M	VL001	5/11/2019	5/11/2020
Shielding Control Room	ETS-Lindgren	Series 81	VL006	N/A	N/A
Spectrum Analyzer	Keysight	N9020A	MY50110074	5/4/2019	5/4/2020
EMC Test Receiver	R&S	ESL6	100230	5/7/2019	5/7/2020
LISN (9KHz – 30MHz)	EMCO	3816/2	9705-1066	5/4/2019	5/4/2020
Bi-Log Antenna	ETS-Lindgren	3142E	217921	11/15/2018	11/15/2019
Horn Antenna (1-18GHz)	Electro-Metrics	EM-6961	6292	5/2/2019	5/2/2020
Horn Antenna (18-40GHz)	Com-Power	AH-840	101109	5/2/2019	5/2/2020
Preamplifier	RF Bay, Inc.	LPA-10-20	11180621	5/10/2019	5/10/2020
True RMS Multi-meter	UNI-T	UT181A	C173014829	5/10/2019	5/10/2020
Temp / Humidity / Pressure Meter	PCE Instruments	PCE-THB 40	R062028	5/9/2019	5/9/2020
RF Attenuator	Pasternack	PE7005-3	VL061	5/10/2019	5/10/2020
Preamplifier 100KHz - 40GHz	Aeroflex	33711-392-77150-11	064	5/10/2019	5/10/2020
EM Center Control	ETS-Lindgren	7006-001	160136	N/A	N/A
Turn Table	ETS-Lindgren	2181-3.03	VL002	N/A	N/A
Boresight Antenna Tower	ETS-Lindgren	2171B	VL003	N/A	N/A
Loop Antenna (9k-30MHz)	Com-Power	AL-130	121012	5/9/2019	5/9/2020
RE test cable(below 6GHz)	Vista	RE-6GHz-01	RE-6GHz-01	5/10/2019	5/10/2020
RE test cable (1-18GHz)	PhaseTrack	II-240	RE-18GHz-01	5/10/2019	5/10/2020
RE test cable (>18GHz)	Sucoflex	104	344903/4	5/10/2019	5/10/2020
Pulse limiter	Com-Power	LIT-930A	531727	5/15/2019	5/15/2020
CE test cable #1	FIRST RF	FRF-C-1002-001	CE-6GHz-01	5/10/2019	5/10/2020
CE test cable#2	FIRST RF	FRF-C-1002-001	CE-6GHz-02	5/9/2019	5/9/2020
Wideband Communication	R&S	CMW500	147508	5/8/2019	5/8/2020