FCC BT LE REPORT

Certification

Applicant Name:
Universal Electronics Inc.

Address:
201 E. Sandpointe Drive, 8th Floor
Santa Ana, CA 92707 USA

Date of Issue:
October 03,2018

Location:
EMCE Engineering
1726 Ringwood Avenue San Jose, California USA

Report No.: EMCE-R-1808-F003-1

FCC ID:	**MG3-F12165**
APPLICANT:	**Universal Electronics Inc.**

Model:	F1165BA00-00001
Additional Model:	N/A
EUT Type:	LATAM-Columbia CLARO BLE HCI Dongle 2018
RF Peak Output Power:	8.847 dBm (7.668 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.

Steve.In
Test Engineer
Certification Division

Billy Kim
Technical Manager
Certification Division

EMCE Engineering, Inc., 1726 Ringwood Avenue, San Jose, CA 95131, USA
TEL: +1-510-933-8848 FAX: +1-510-933-8849

Version

TEST REPORT NO.	DATE	DESCRIPTION
EMCE-R-1808-F003	August 27, 2018	First Approval Report
EMCE-R-1808-F003-1	October 03,2018	EUT Type typo revised.

EMCE Engineering, Inc., 1726 Ringwood Avenue, San Jose, CA 95131, USA
TEL: +1-510-933-8848 FAX: +1-510-933-8849

Table of Contents

EMCE Engineering, Inc., 1726 Ringwood Avenue, San Jose, CA 95131, USA
TEL: +1-510-933-8848 FAX: +1-510-933-8849

1. GENERAL INFORMATION

Applicant:	Universal Electronics Inc.
Address:	201 E. Sandpointe Drive, 8th Floor Santa Ana, CA 92707 USA
FCC ID:	MG3-F12165
EUT Type:	LATAM-Columbia CLARO BLE HCI Dongle 2018
Model:	F1165BA00-00001
Additional Model:	N/A
Date(s) of Tests:	August 10, 2018 ~ August 20, 2018
Place of Tests:	1726 Ringwood Avenue San Jose, California USA

2. EUT DESCRIPTION

Model	F1165BA00-00001	
Additional Model	N/A	
EUT Type	LATAM-Columbia CLARO BLE HCI Dongle 2018	
Power Supply	DC 5.0 V	
Frequency Range	TX: 2402 MHz ~ 2480 MHz RX: 2402 MHz ~ 2480 MHz	
Max. RF Output Power	Peak	8.847 dBm (7.668 mW)
	Average	8.310 dBm (6.776 mW)
BT Operating Mode	BT _Low Energy Mode	
Modulation Type	GFSK	
Number of Channels	40 Channels	
Antenna Specification	Antenna type:PCB trace antenna Peak Gain : -1.9 dBi	

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3. TEST METHODOLOGY

FCC KDB 558074 D01 DTS Meas Guidance v04 dated April 5, 2017 entitled “Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) ‘the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices’.

3.1 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.

3.2 EUT EXERCISE

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

3.3 GENERAL TEST PROCEDURES

Conducted Emissions

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

Radiated Emissions

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

Conducted Antenna Terminal

See Section from 9.1 to 9.2.(KDB 558074 v04)

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3.4 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.
Channel low, mid and high with highest data rate (worst case) is chosen for full testing.

4. 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 equipments, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

5. FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

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

5.2 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.”

6. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

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

* The antennas of this E.U.T are permanently attached.
* The E.U.T Complies with the requirement of §15.203

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7. 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)	1.68
Radiated Disturbance (9 kHz ~ 30 MHz)	3.20
Radiated Disturbance (30 MHz ~ 1 GHz)	4.80
Radiated Disturbance (1 GHz ~ 18 GHz)	5.58
Radiated Disturbance (18 GHz ~ 40 GHz)	5.71

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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 > 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	cf. Section 9.7		PASS
Radiated Spurious Emissions	§15.205, 15.209	cf. Section 9.6.1	RADIATED	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	cf. Section 9.6.2		PASS

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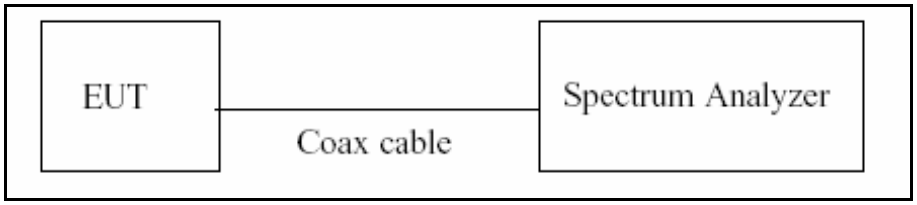
9. TEST RESULT

9.1 DUTY CYCLE

▣ TEST PROCEDURE

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

▣ 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 v04.

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)

LE Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
	0.4000	0.6493	0.6160	2.10

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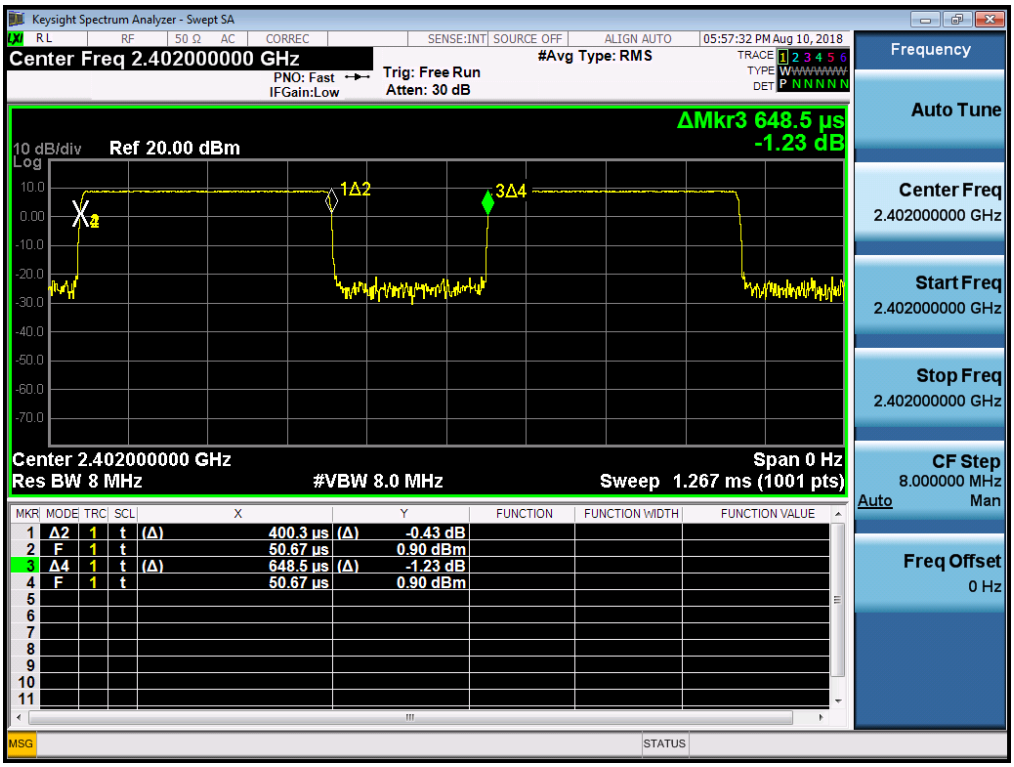
▣ Duty Cycle RESULT PLOTS



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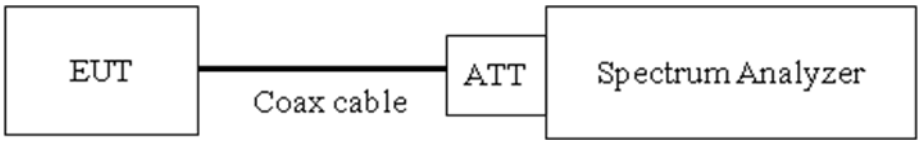
9.2 6 dB BANDWIDTH MEASUREMENT

Test Requirements and limit, §15.247(a)(2)

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

The minimum permissible 6 dB bandwidth is 500 kHz.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.1 in KDB 558074 v04)

RBW = 100 kHz

VBW ≥ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

▣ TEST RESULT

Mode	Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Pass/Fail
BT LE	0	705.1	> 500	Pass
	19	708.4		Pass
	39	710.6		Pass

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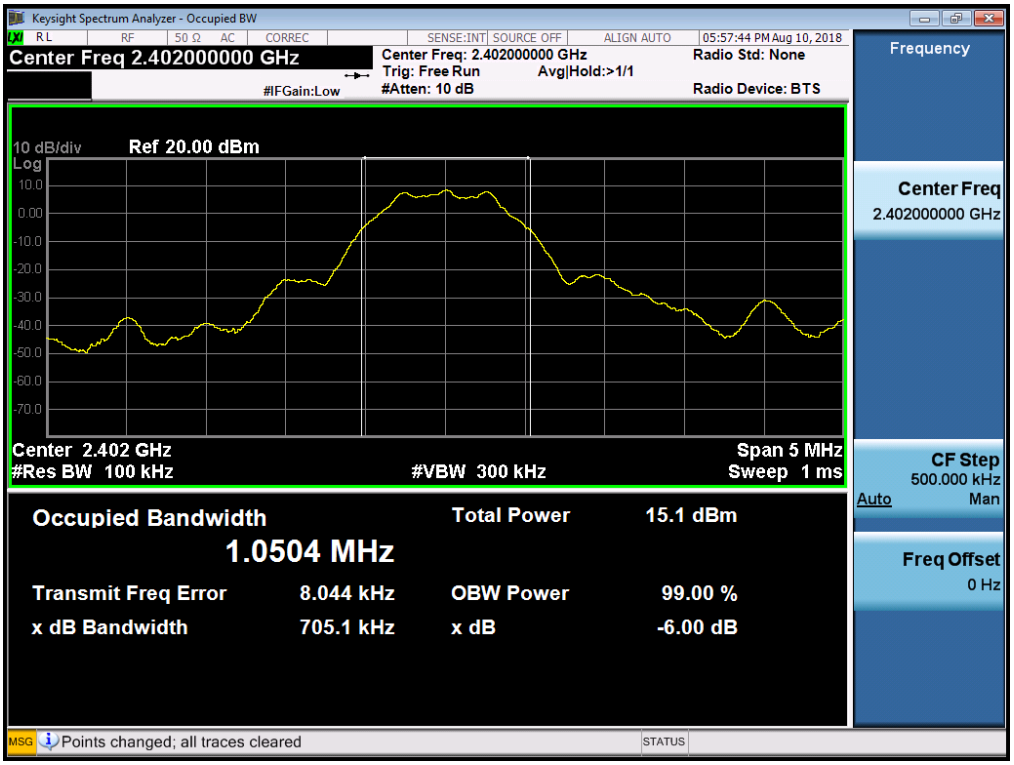
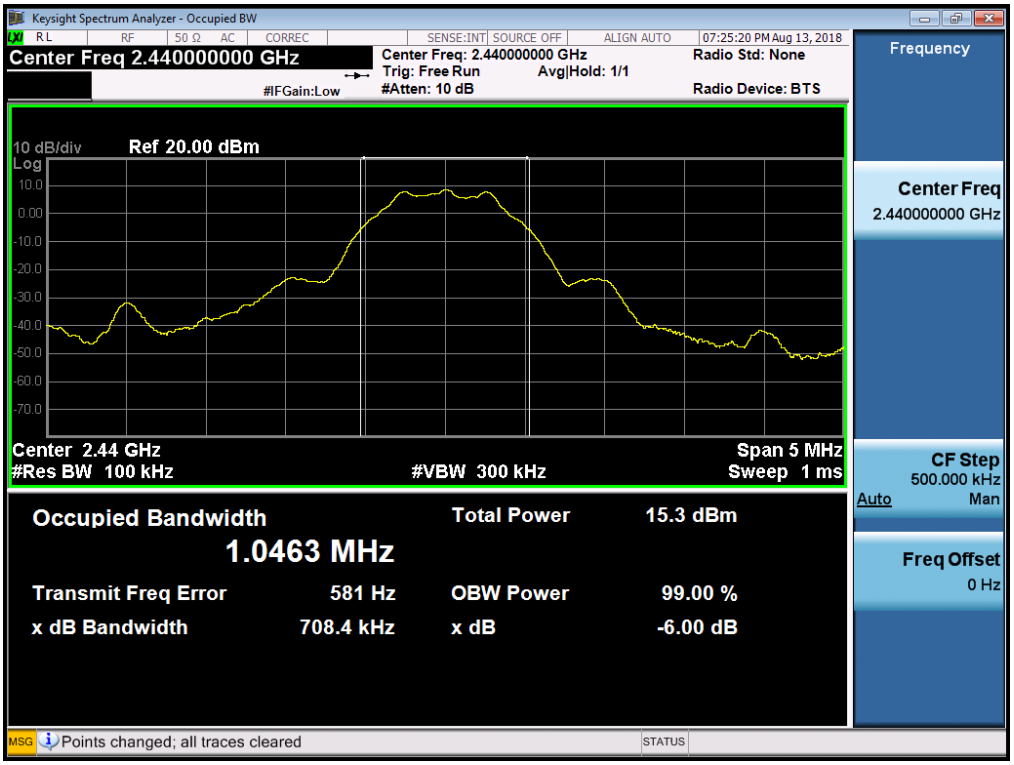
▣ RESULT PLOTS

6 dB Bandwidth plot (Low-CH 0)



6 dB Bandwidth plot (Mid-CH 19)



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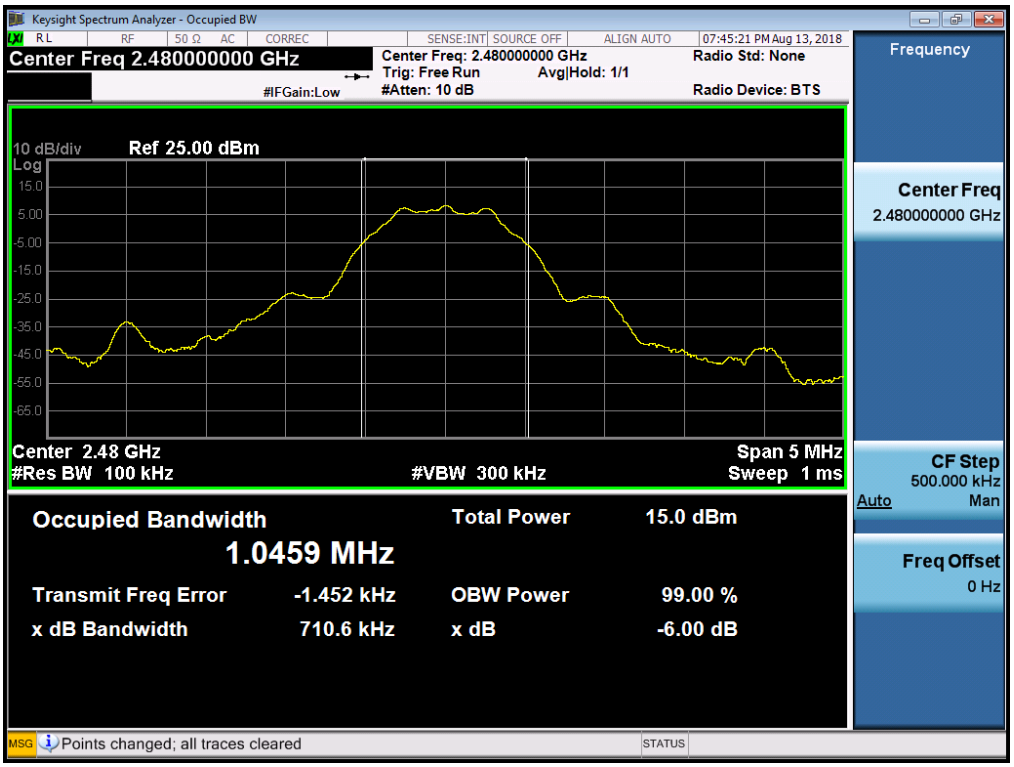
6 dB Bandwidth plot (High-CH 39)



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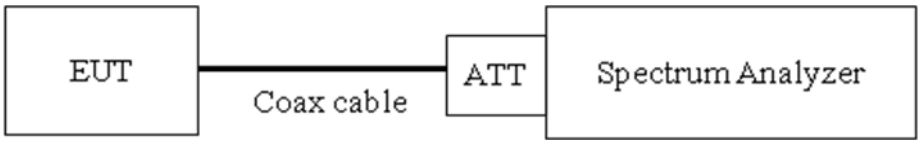
9.3 OUTPUT POWER MEASUREMENT

Test Requirements and limit, §15.247(b)(3)

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

The maximum permissible conducted output power is 1 Watt.

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the Spectrum Analyzer. We use the spectrum analyzer's integrated band power measurement function.

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

The Spectrum Analyzer is set to

- Peak Power (Procedure 9.1.1 in KDB 558074 v04)

  RBW ≥ DTS Bandwidth

  VBW ≥ 3 x RBW

  SPAN ≥ 3 x RBW

  Detector Mode = Peak

  Sweep = auto couple

  Trace Mode = max hold

  Allow trace to fully stabilize.

  Use peak marker function to determine the peak amplitude level

- Average Power (Procedure 9.2.2.4 in KDB 558074 v04)

  Measure the duty cycle

  Set span to at least 1.5 times the OBW

  RBW = 1-5 % of the OBW, not to exceed 1 MHz.

  VBW ≥ 3 x RBW.

  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.)

  Sweep time = auto.

  Detector = RMS(i.e., power averaging)

  Do not use sweep triggering. Allow the sweep to "free run".

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Trace average at least 100 traces in power averaging(RMS) mode.
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.
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

Output Power = Reading Value + ATT loss + Cable loss(1 ea) + Duty Cycle Factor

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, 20.42dB is offset for 2.4 GHz Band.

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▣ TEST RESULTS-Peak

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Limit (dBm)
Frequency[MHz]	Channel No.		
2402	0	8.645	30
2440	19	8.847	30
2480	39	8.655	30

▣ TEST RESULTS-Average

Conducted Output Power Measurements

LE Mode		Measured Power(dBm)	Duty Cycle Factor (dB)	Measured Power(dBm) + Duty Cycle Factor(dB)	Limit (dBm)
Frequency[MHz]	Channel No.				
2402	0	6.20	2.10	8.31	30
2440	19	6.15	2.10	8.25	30
2480	39	5.98	2.10	8.08	30

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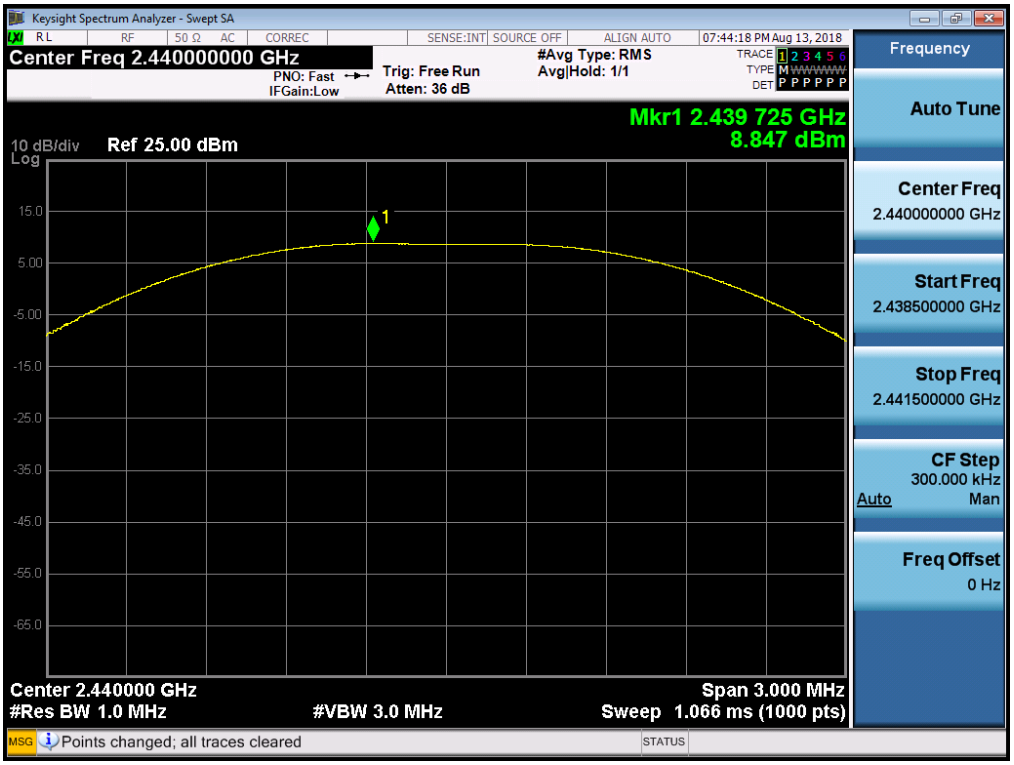
▣ RESULT PLOTS-Peak

Conducted Output Power (Low-CH 0)

Conducted Output Power (Mid-CH 19)



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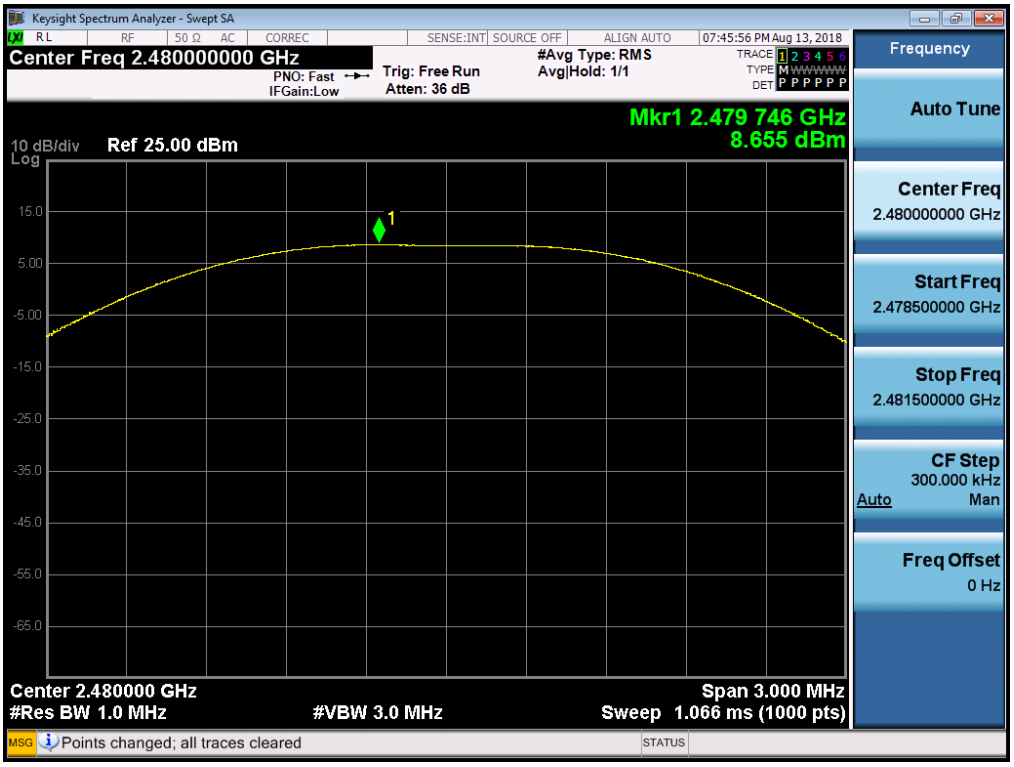
Conducted Output Power (High-CH 39)



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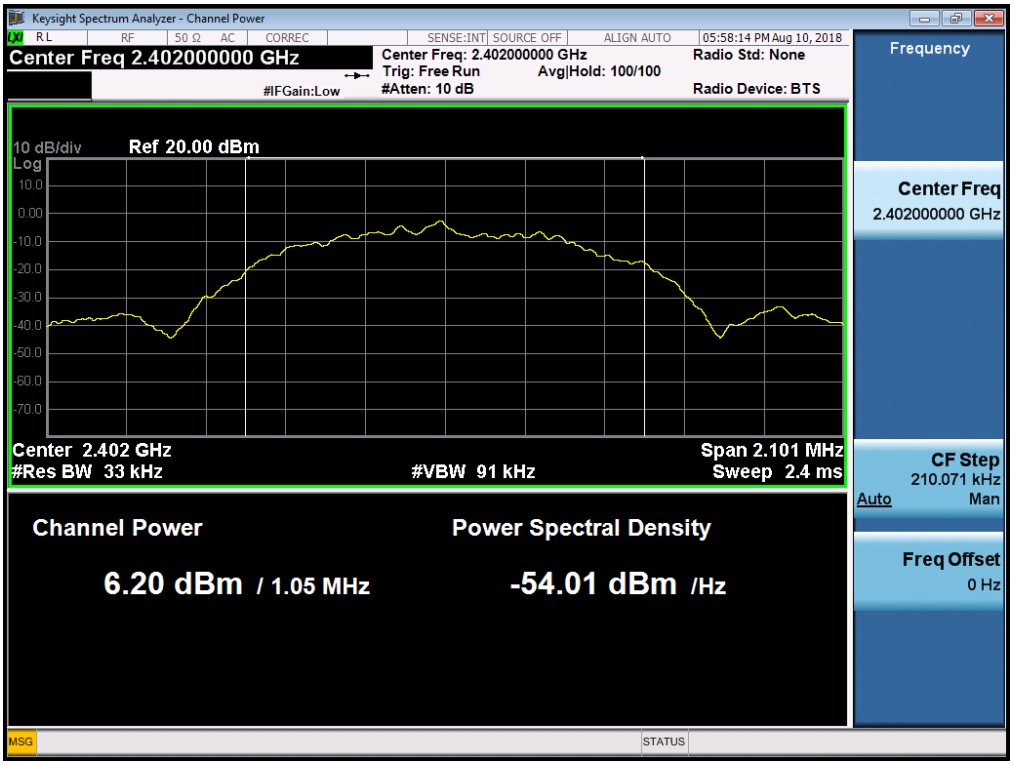
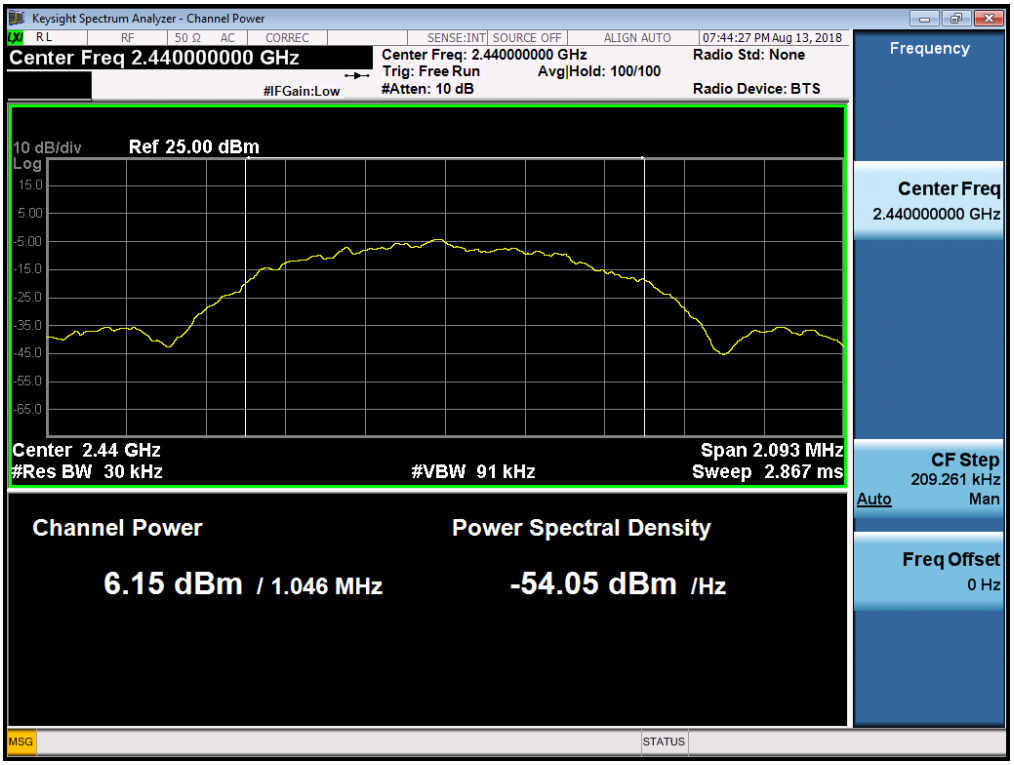
▣ RESULT PLOTS-Average

Conducted Output Power (Low-CH 0)



Conducted Output Power (Mid-CH 19)



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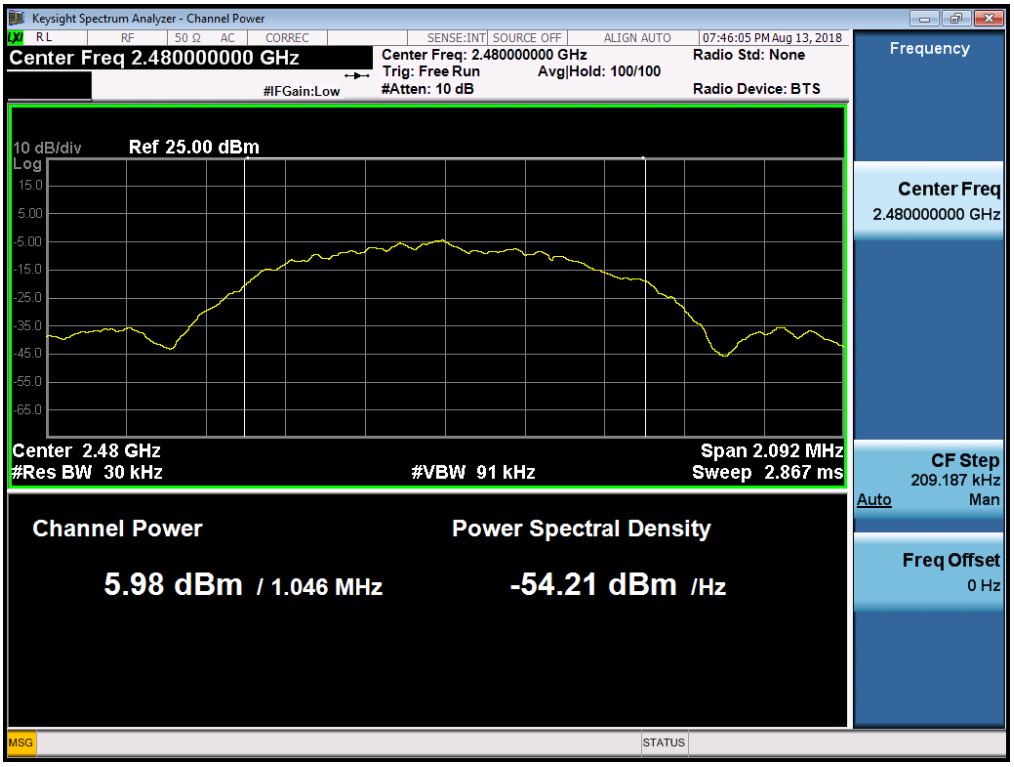
Conducted Output Power (High-CH 39)



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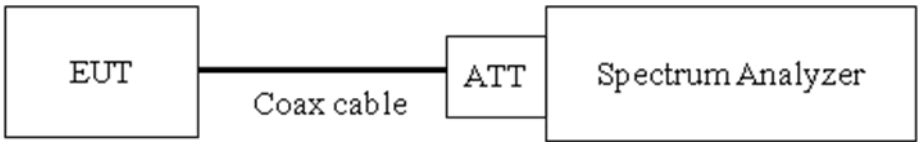
9.4 POWER SPECTRAL DENSITY

Test Requirements and limit, §15.247(e)

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

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

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

We tested according to Procedure 10.2 in KDB 558074, issued 04/05/2017

The spectrum analyzer is set to :

Set analyzer center frequency to DTS channel center frequency.

Span = 1.5 times the DTS channel bandwidth.

RBW = 3 kHz ≤ RBW ≤ 100 kHz.

VBW ≥ 3 x RBW.

Sweep = auto couple

Detector = peak

Trace Mode = max hold

Allow trace to fully stabilize.

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

PSD = Reading Value + ATT loss + Cable loss(1 ea)

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,20.42dB is offset for 2.4 GHz Band.

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▣ TEST RESULTS

Conducted Power Density Measurements

Frequency (MHz)	Channel No.	Mode	Test Result		
			PSD (dBm)	Limit (dBm)	Pass/ Fail
2402	0	LE	-7.079	8	Pass
2440	19		-6.815	8	Pass
2480	39		-7.244	8	Pass

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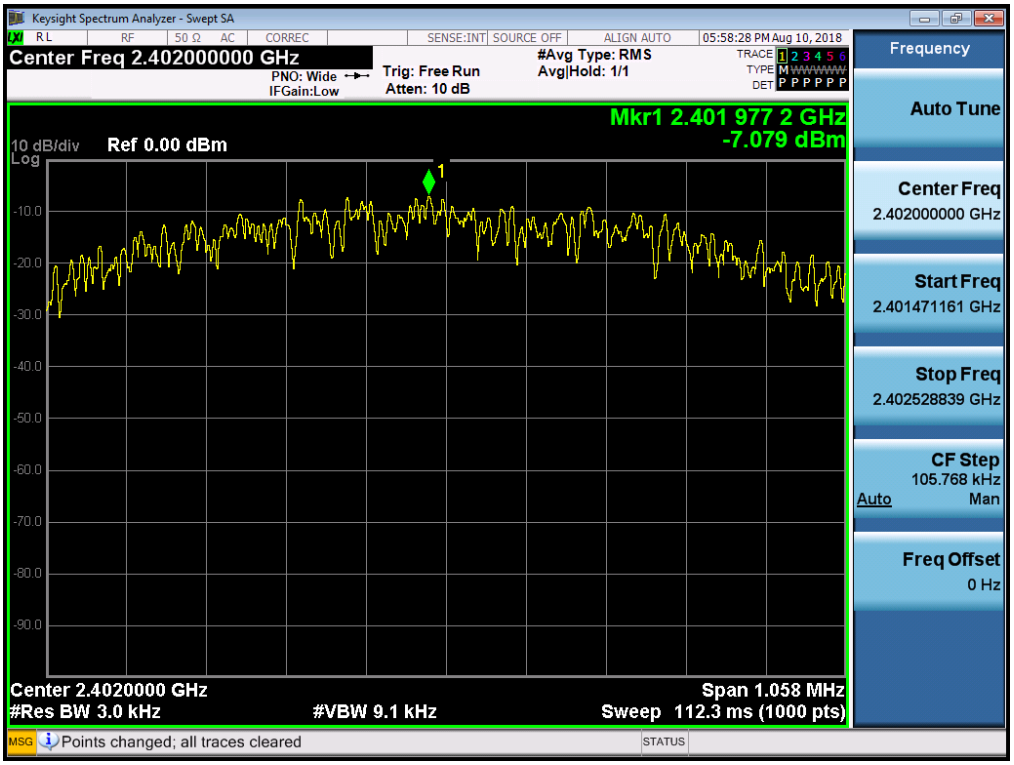
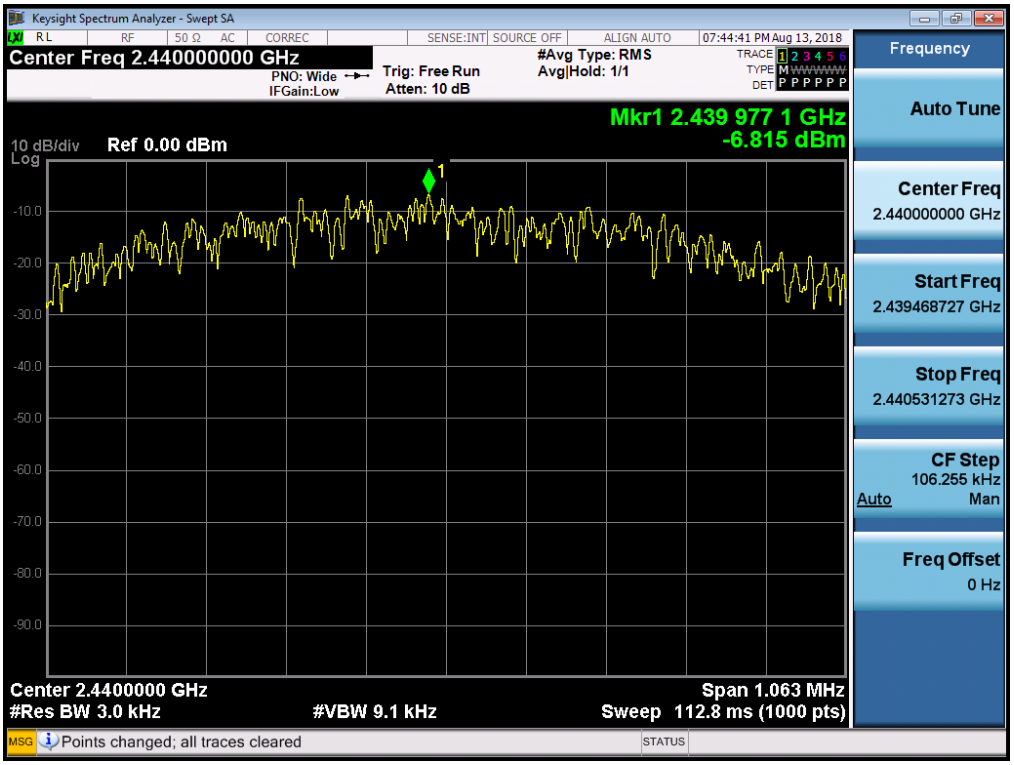
▣ RESULT PLOTS

Power Spectral Density (Low-CH 0)



Power Spectral Density (Mid-CH 19)



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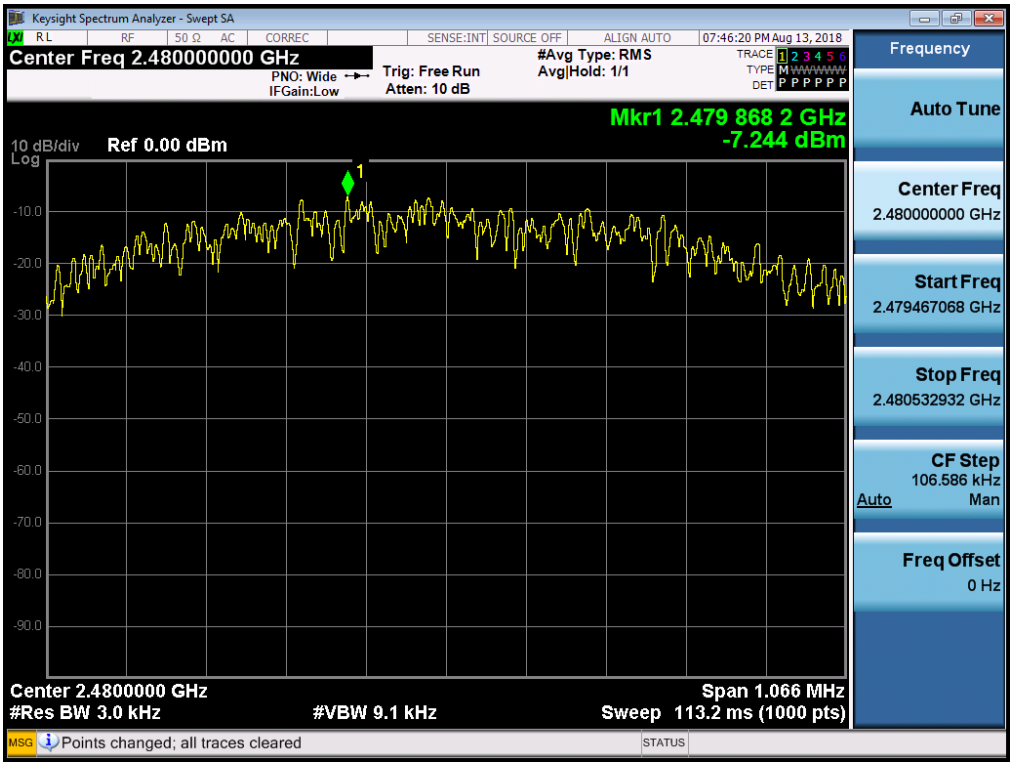
TEL: +1-510-933-8848 FAX: +1-510-933-8849

Power Spectral Density (High-CH 39)



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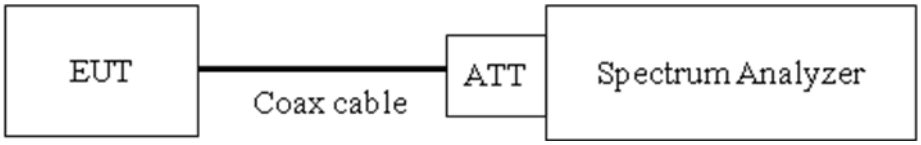
9.5 OUT OF BAND EMISSIONS AT THE BAND EDGE/ CONDUCTED SPURIOUS EMISSIONS

Test Requirements and limit, §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, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Limit : 20 dBc

▣ TEST CONFIGURATION



▣ TEST PROCEDURE

The transmitter output is connected to the spectrum analyzer. (Procedure 11.0 in KDB 558074 v04)

RBW = 100 kHz

VBW ≥ 3 x RBW

Set span to encompass the spectrum to be examined

Detector = Peak

Trace Mode = max hold

Sweep time = auto couple

Ensure that the number of measurement points ≥ 2*Span/RBW

Allow trace to fully stabilize.

Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 10th harmonic range with the transmitter set to the lowest, middle, and highest channels.

Note :

1. The maximum peak conducted output power procedure was used to demonstrate compliance as described in 9.1(KDB558074 v04), so the peak output power measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak

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PSD level in 100 kHz (i.e., 20 dBc).

2. The band edge results in plot is already including the actual values of loss for the attenuator and cable combination.
3. Spectrum offset = Attenuator loss + Cable loss + Spectrum loss
4. We apply to the offset in the 2.4 GHz range that was rounded off to the closest tenth dB. So, 20.42 dB is offset for 2.4 GHz Band.
5. In case of conducted spurious emissions test, please check factors blow table.
6. In order to simplify the report, attached plots were only the worst case channel and data rate.

▣ FACTORS FOR FREQUENCY

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

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

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

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▣ RESULT PLOTS

BandEdge (Low-CH 0)

BandEdge (High-CH 39)

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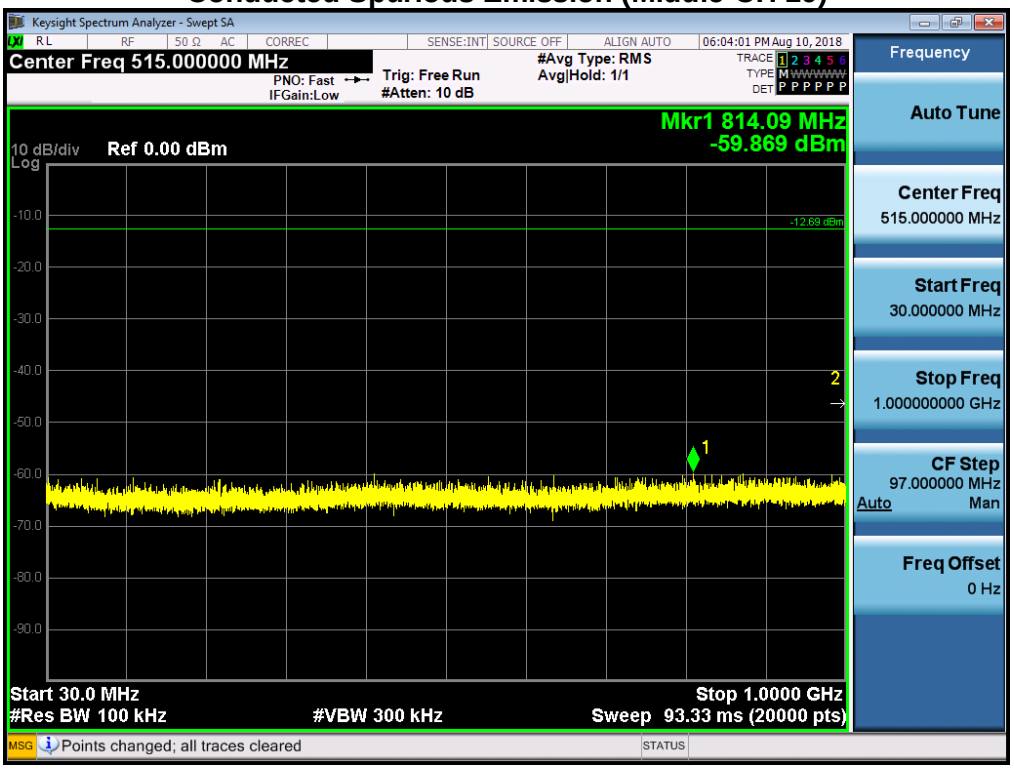
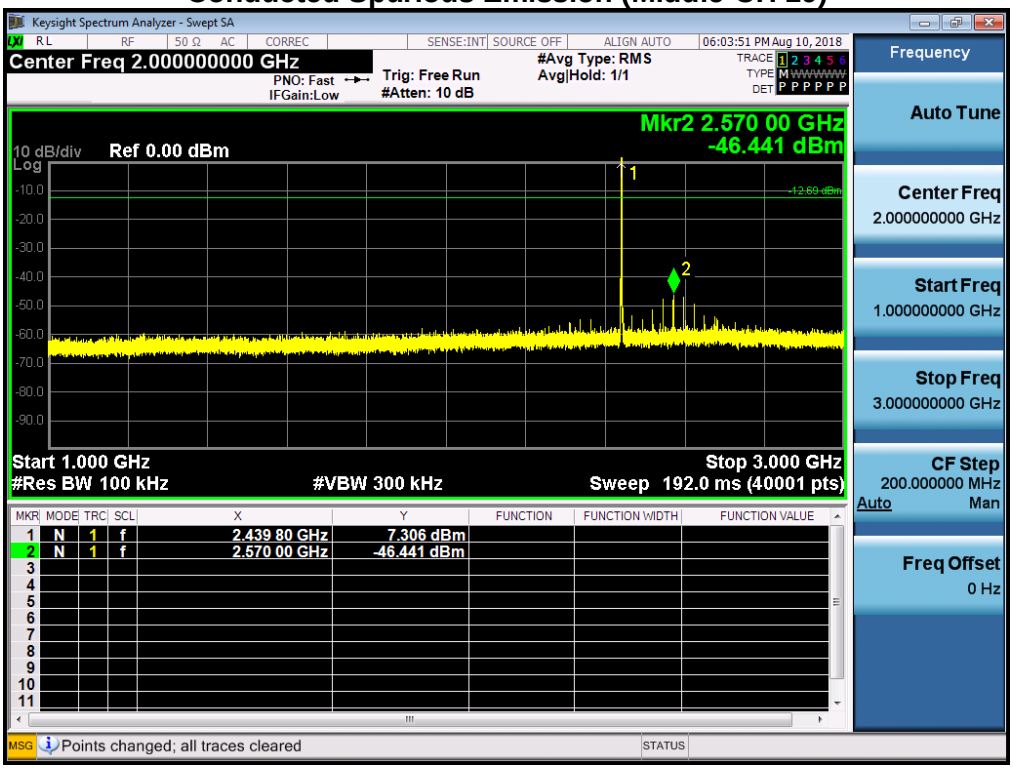
30 MHz ~ 1 GHz

Conducted Spurious Emission (Middle-CH 19)



1 GHz ~ 3 GHz

Conducted Spurious Emission (Middle-CH 19)



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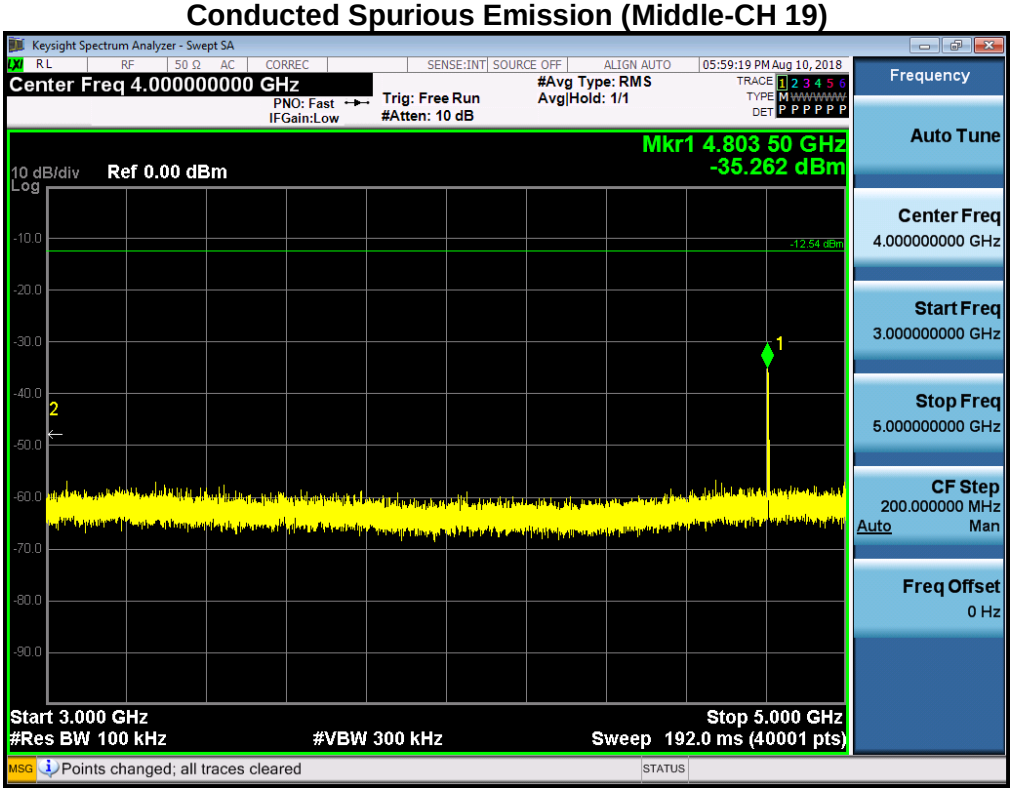
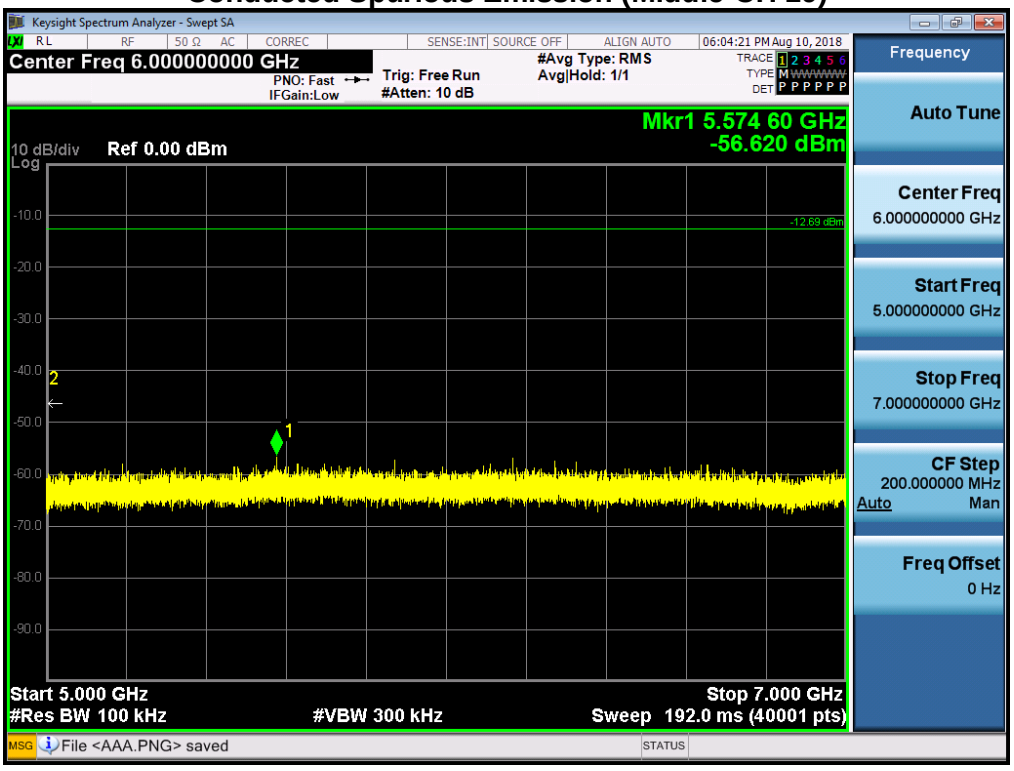
3 GHz ~ 5 GHz

Conducted Spurious Emission (Middle-CH 19)



5 GHz ~ 7 GHz

Conducted Spurious Emission (Middle-CH 19)



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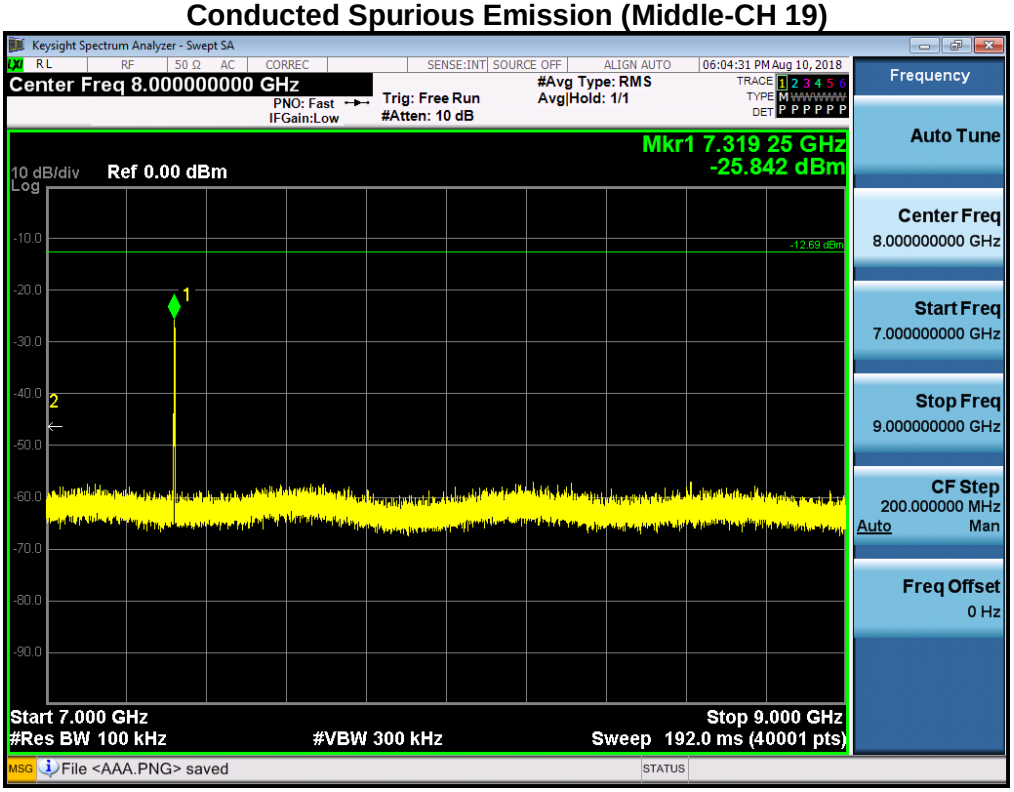
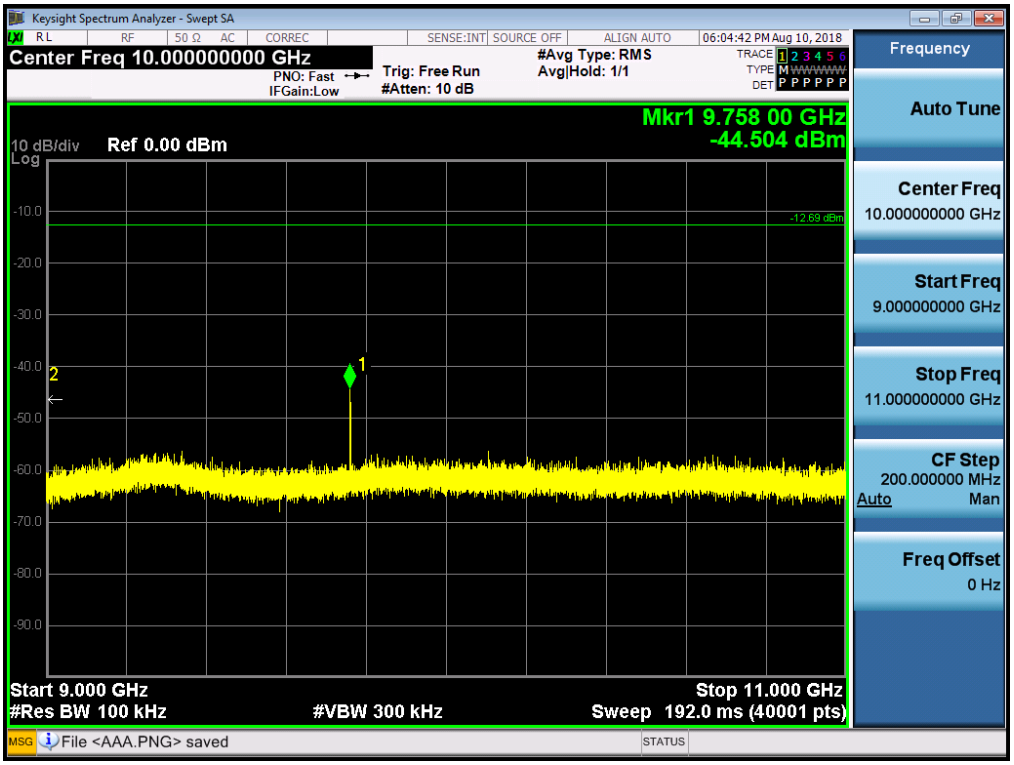
7 GHz ~ 9 GHz

Conducted Spurious Emission (Middle-CH 19)



9 GHz ~ 11 GHz

Conducted Spurious Emission (Middle-CH 19)



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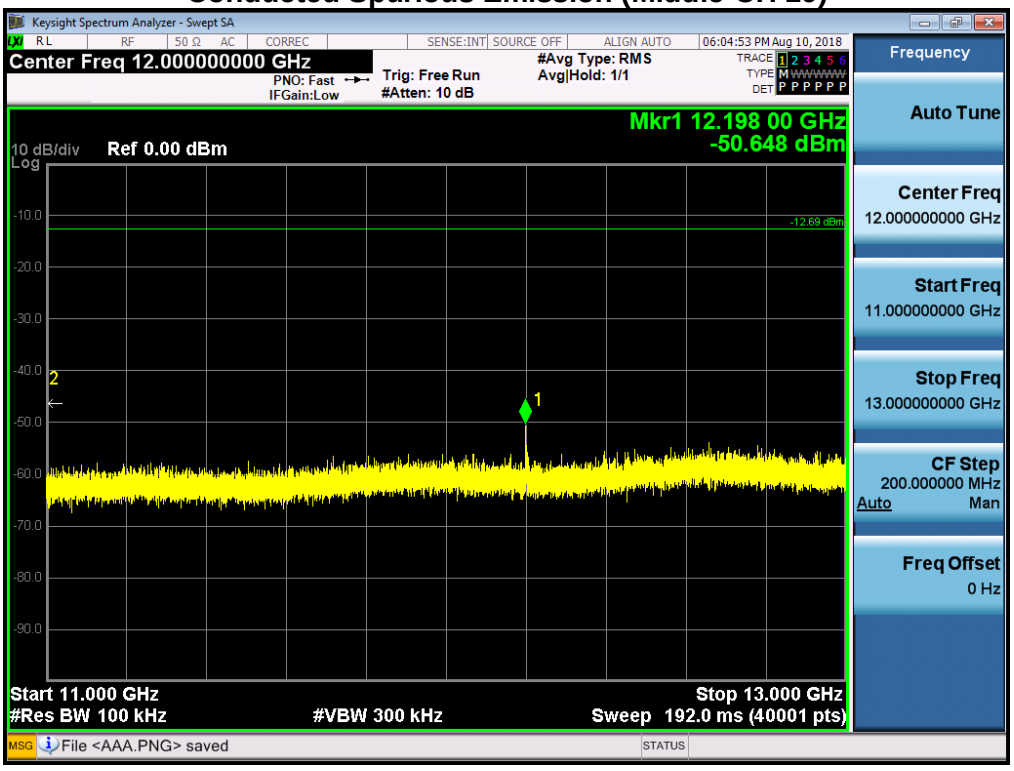
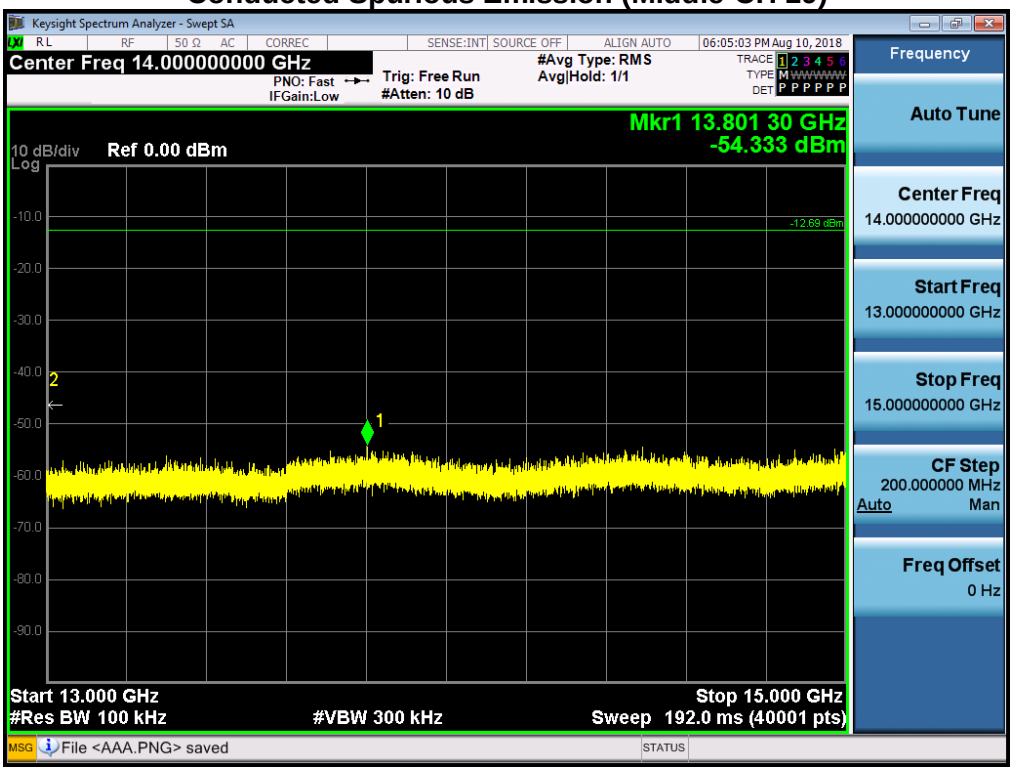
11 GHz ~ 13 GHz

Conducted Spurious Emission (Middle-CH 19)



13 GHz ~ 15 GHz

Conducted Spurious Emission (Middle-CH 19)



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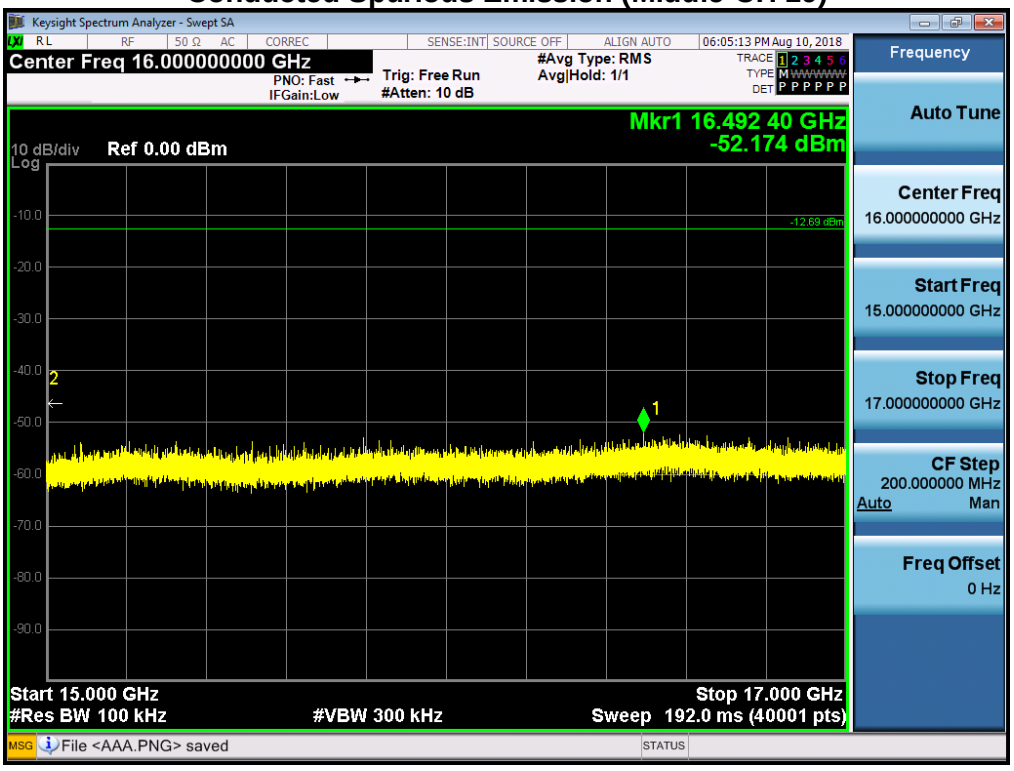
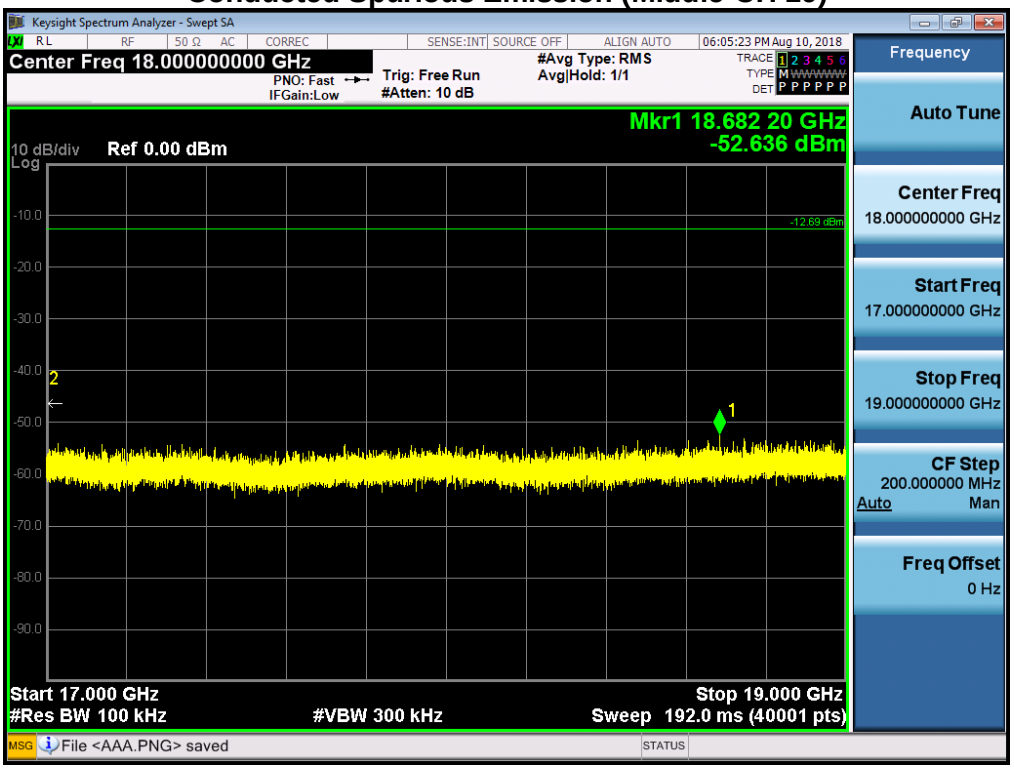
15 GHz ~ 17 GHz

Conducted Spurious Emission (Middle-CH 19)



17 GHz ~ 19 GHz

Conducted Spurious Emission (Middle-CH 19)



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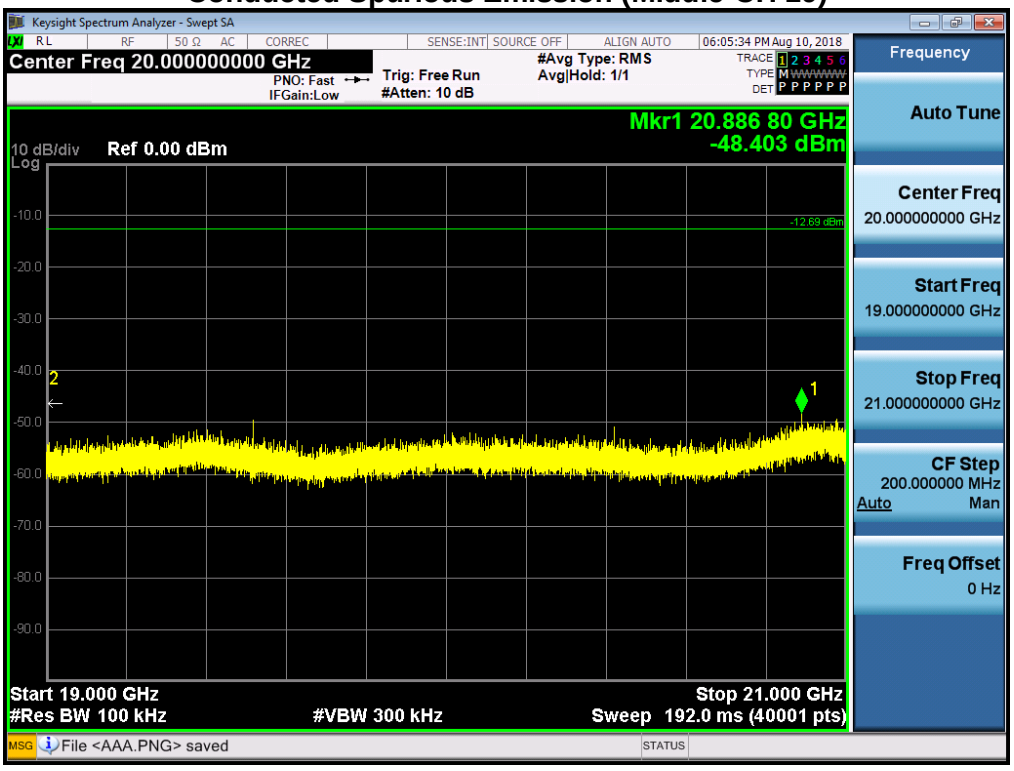
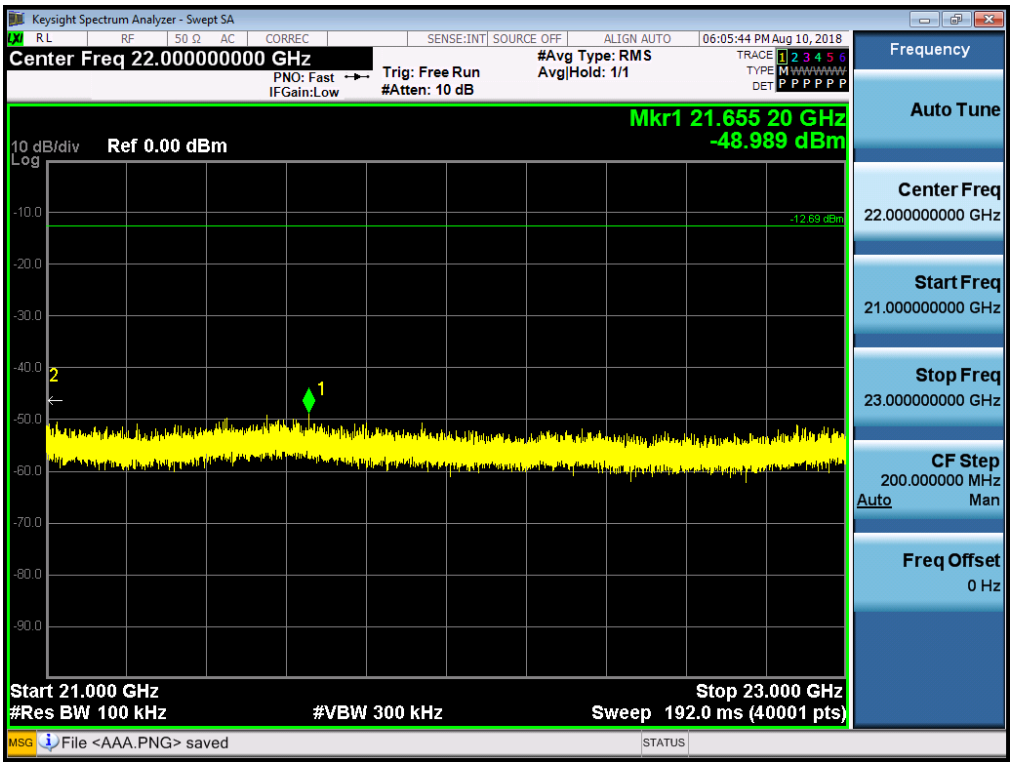
19 GHz ~ 21 GHz

Conducted Spurious Emission (Middle-CH 19)



21 GHz ~ 23 GHz

Conducted Spurious Emission (Middle-CH 19)



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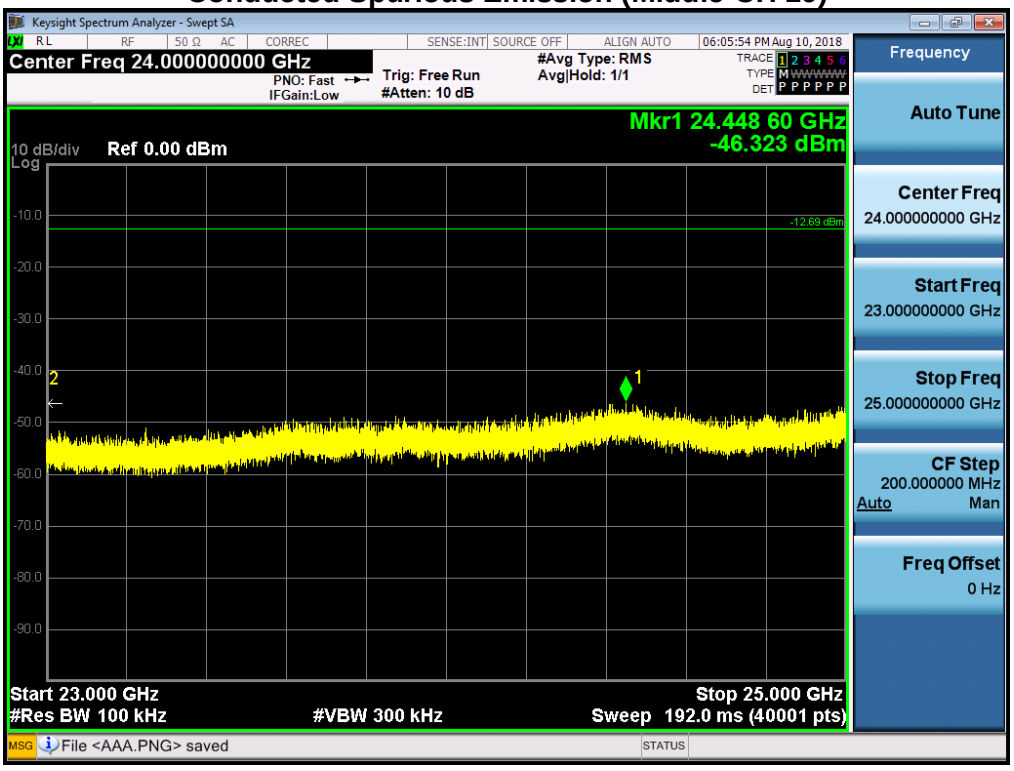
23 GHz ~ 25 GHz

Conducted Spurious Emission (Middle-CH 19)



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9.6 RADIATED MEASUREMENT.

9.6.1 RADIATED SPURIOUS EMISSIONS.

Test Requirements and limit, §15.205, §15.209

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

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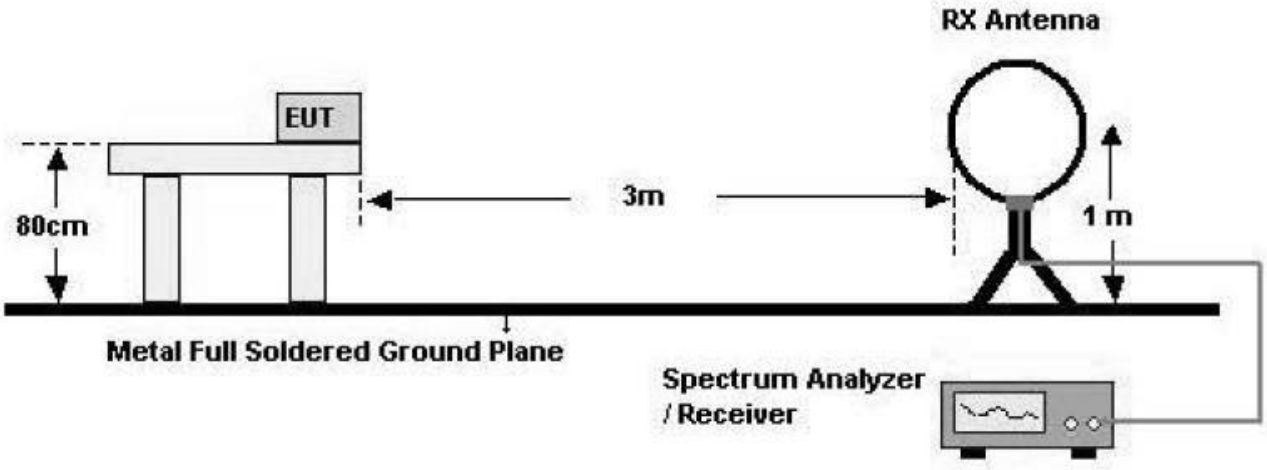
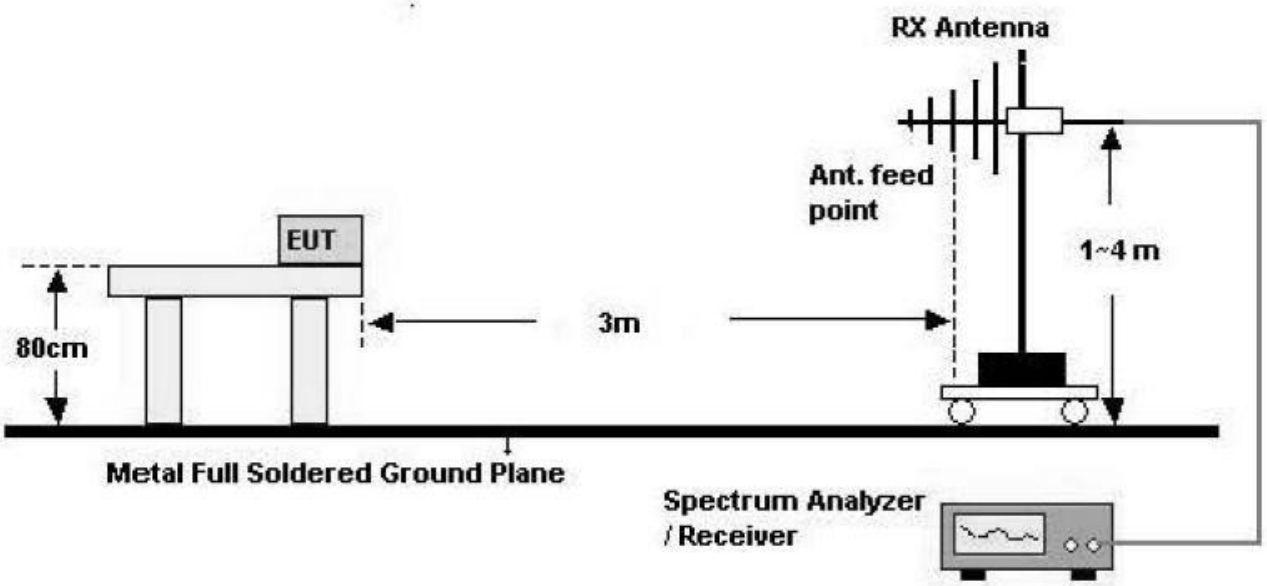
Test Configuration

Below 30 MHz



30 MHz - 1 GHz



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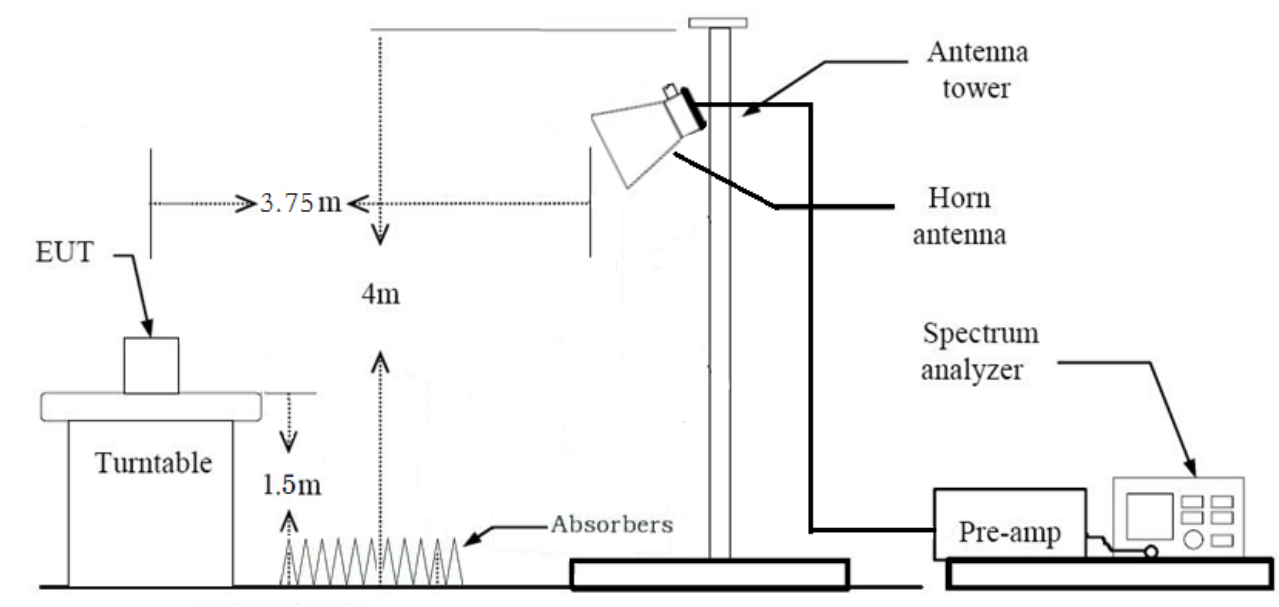
Above 1 GHz



TEST PROCEDURE USED

Method 12.1 in KDB 558074 v04

Spectrum Setting

- Peak

Peak emission levels are measured by setting the instrument as follows:

RBW = cf. Table 1.

VBW ≥ 3 x RBW.

Detector = Peak.

Sweep time = auto.

Trace mode = max hold.

Allow sweeps to continue until the trace stabilizes.

(Note that the required measurement time may be longer for low duty cycle applications).

Table 1 —RBW as a function of frequency

Frequency	RBW
9-150 kHz	200-300 Hz
0.15-30 MHz	9-10 kHz
30-1000 MHz	100-120 kHz
> 1000 MHz	1 MHz

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- Average (duty cycle < 98%, duty cycle variations are less than ±2%)

Set RBW = 1 MHz

Set VBW ≥ 3 x RBW

Detector = RMS.

Averaging type = power (*i.e.*, RMS).

Sweep time = auto.

Trace mode = average (at least 100 traces).

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle.

Note :

1. We are performed the RSE and radiated band edge using standard radiated method(RMS).
2. 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).
3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)

LE Mode	T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
	0.4000	0.6493	0.6160	2.10

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TEST RESULTS

9 kHz – 30MHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 9 kHz to the 30MHz.
2. The reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.
3. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
4. Limit line = specific Limits (dBuV) + Distance extrapolation factor
5. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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TEST RESULTS

Below 1 GHz

Operation Mode: Normal Mode

Frequency	Reading	Ant. factor	Cable loss	Ant. POL	Total	Limit	Margin
MHz	dBuV/m	dBm/m	dBm	(H/V)	dBuV/m	dBuV/m	dB
No Critical peaks found							

Notes:

1. Measuring frequencies from 30 MHz to the 1 GHz.
2. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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Above 1 GHz

Operation Mode: CH.0

Frequency [MHz]	Reading [dBuV/m]	Duty Cycle Factor [dB]	A.F.+C.L.-A.G.+D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4804	53.30	0.00	-7.07	H	46.23	73.98	27.75	PK
4804	40.60	2.10	-7.07	H	35.63	53.98	18.35	AV
4804	54.60	0.00	-7.07	V	47.53	73.98	26.45	PK
4804	42.30	2.10	-7.07	V	37.33	53.98	16.65	AV

*A.F. : Antenna Factor / C.L. : Cable Loss / A.G. : Amplifier Gain / D.F. : Distance Factor

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show 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.
3. Radiated emissions measured in frequency above 1000 MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor + Duty Cycle Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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Operation Mode: CH.19

Frequency [MHz]	Reading [dBuV/m]	Duty Cycle Factor [dB]	A.F.+C.L.-A.G.+D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4880	53.5	0.00	-6.87	H	46.63	73.98	27.35	PK
4880	40.3	2.10	-6.87	H	35.53	53.98	18.45	AV
4880	55.0	0.00	-6.87	V	48.13	73.98	25.85	PK
4880	42.5	2.10	-6.87	V	37.73	53.98	16.25	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show 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.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor + Duty Cycle Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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Operation Mode: CH.39

Frequency [MHz]	Reading [dBuV/m]	Duty Cycle Factor [dB]	A.F.+C.L.-A.G.+D.F. [dBm]	ANT. POL [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
4960	55.6	0.00	-6.47	H	49.13	73.98	24.85	PK
4960	42.7	2.10	-6.47	H	38.33	53.98	15.65	AV
4960	53.8	0.00	-6.47	V	47.33	73.98	26.65	PK
4960	40.1	2.10	-6.47	V	35.73	53.98	18.25	AV

Notes:

1. Measuring frequencies from 1 GHz to the 10th harmonic of highest fundamental frequency.
2. Measurements above show 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.
3. Radiated emissions measured in frequency above 1000MHz were made with an instrument using Peak detector mode and average detector mode of the emission shown in Actual FS column.
4. Total = Reading Value + Antenna Factor + Cable Loss - Amp Gain + Distance Factor + Duty Cycle Factor
5. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
6. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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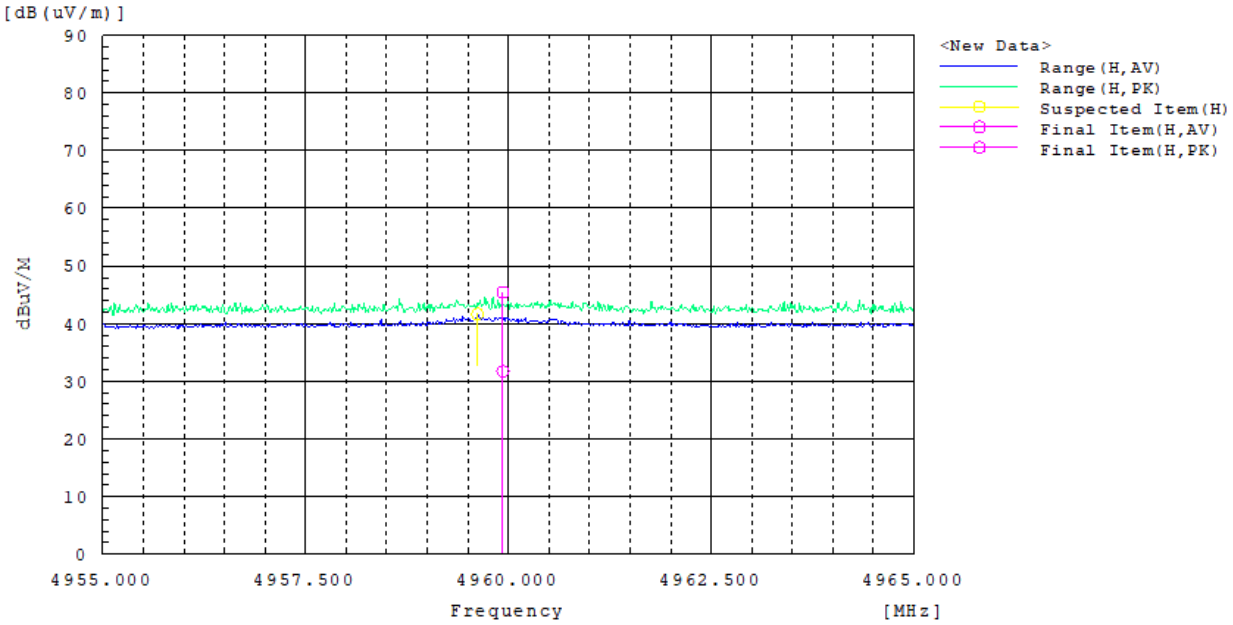
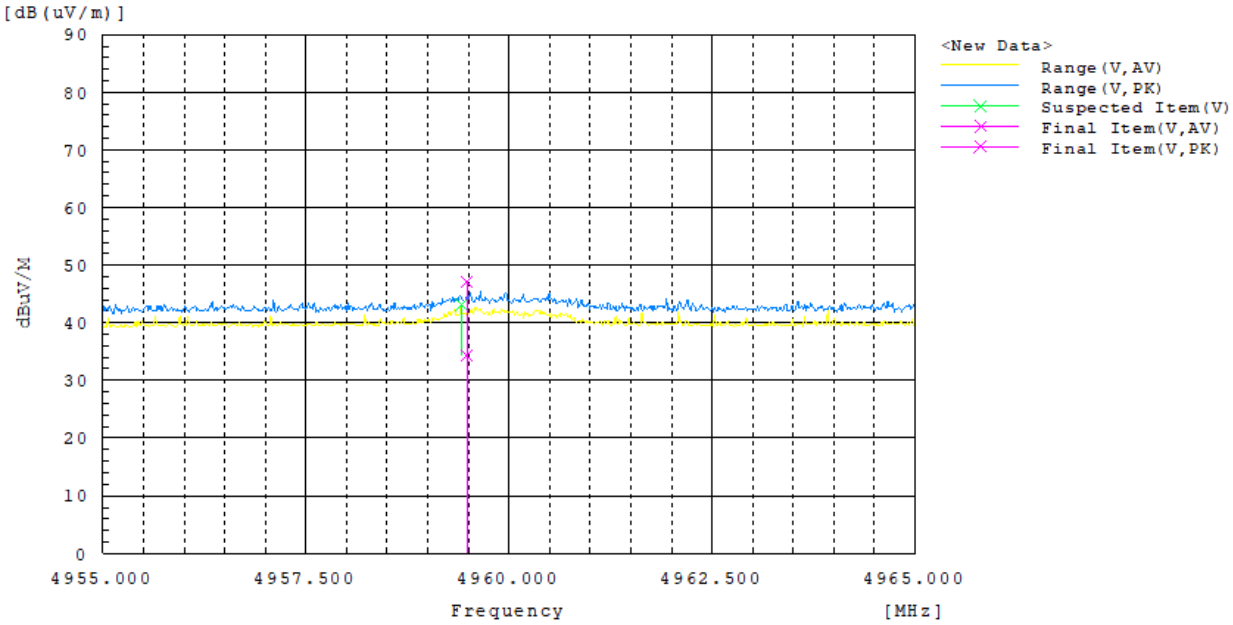
▣ RESULT PLOTS (Worst case)

Radiated Spurious Emissions plot – Y / Horizontal (Ch.39 2nd Harmonic)



Radiated Spurious Emissions plot – Y / Veritical (Ch.39 2nd Harmonic)



Note : Only the worst case plots for Radiated Spurious Emissions.

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9.6.2 RADIATED RESTRICTED BAND EDGES

Test Requirements and limit, §15.247(d) §15.205, §15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in section 15.209(a) (See section 15.205(c)).

Operation Mode	BT_LE
Operating Frequency	2402 MHz
Channel No.	0

Frequency [MHz]	Reading [dBuV/m]	Duty Cycle Factor [dB]	A.F.+C.L. -A.G.+D.F. [dB]	Ant. Pol. [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2390.0	57.80	0.00	-15.66	H	42.14	73.98	31.84	PK
2390.0	42.80	2.10	-15.66	H	27.14	53.98	26.84	AV
2390.0	60.20	0.00	-15.66	V	44.54	73.98	29.44	PK
2390.0	42.90	2.10	-15.66	V	27.24	53.98	26.74	AV

Notes:

1. Frequency range of measurement = 2310 MHz ~ 2390 MHz
2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor
3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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Operation Mode	BT_LE
Operating Frequency	2480 MHz
Channel No.	39

Frequency [MHz]	Reading [dBuV/m]	Duty Cycle Factor [dB]	A.F.+C.L. -A.G.+D.F. [dB]	Ant. Pol. [H/V]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
2483.5	61.8	0.00	-15.06	H	46.74	73.98	27.24	PK
2483.5	46.3	2.10	-15.06	H	33.34	53.98	20.64	AV
2483.5	58.4	0.00	-15.06	V	43.34	73.98	30.64	PK
2483.5	44.1	2.10	-15.06	V	31.14	53.98	22.84	AV

Notes:

1. Frequency range of measurement = 2483.5 MHz ~ 2500 MHz
2. Total = Reading Value + Antenna Factor + Cable Loss + Duty Cycle Factor + Distance Factor
3. Distance extrapolation factor = 20 log (test distance / specific distance) (dB)
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.

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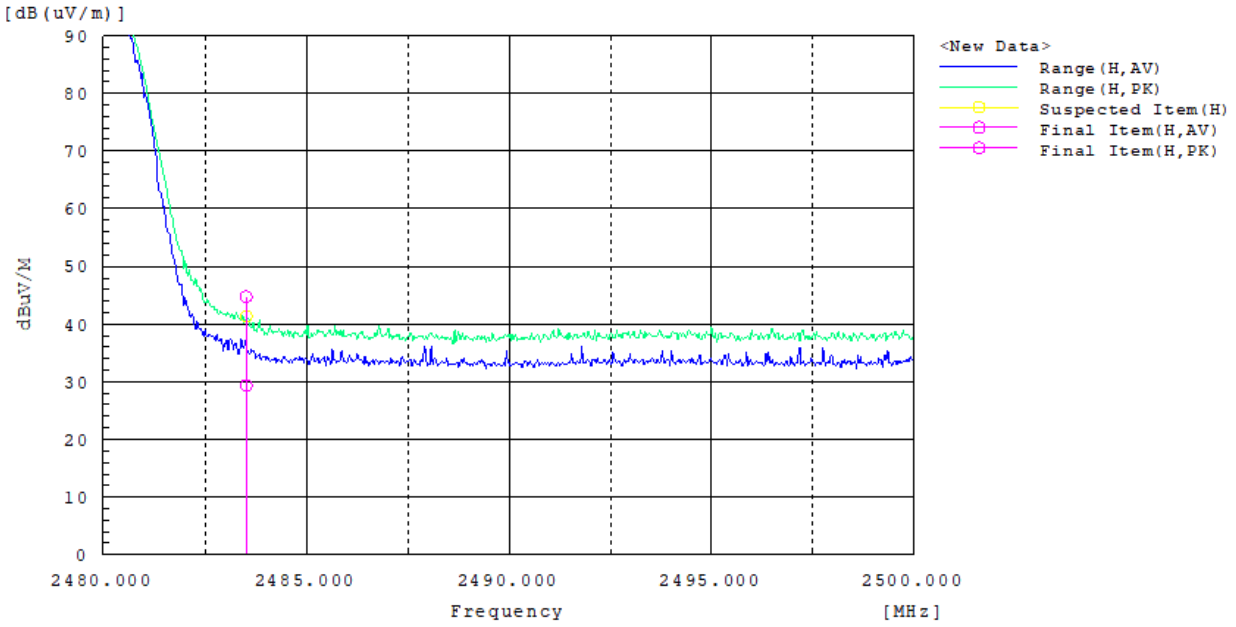
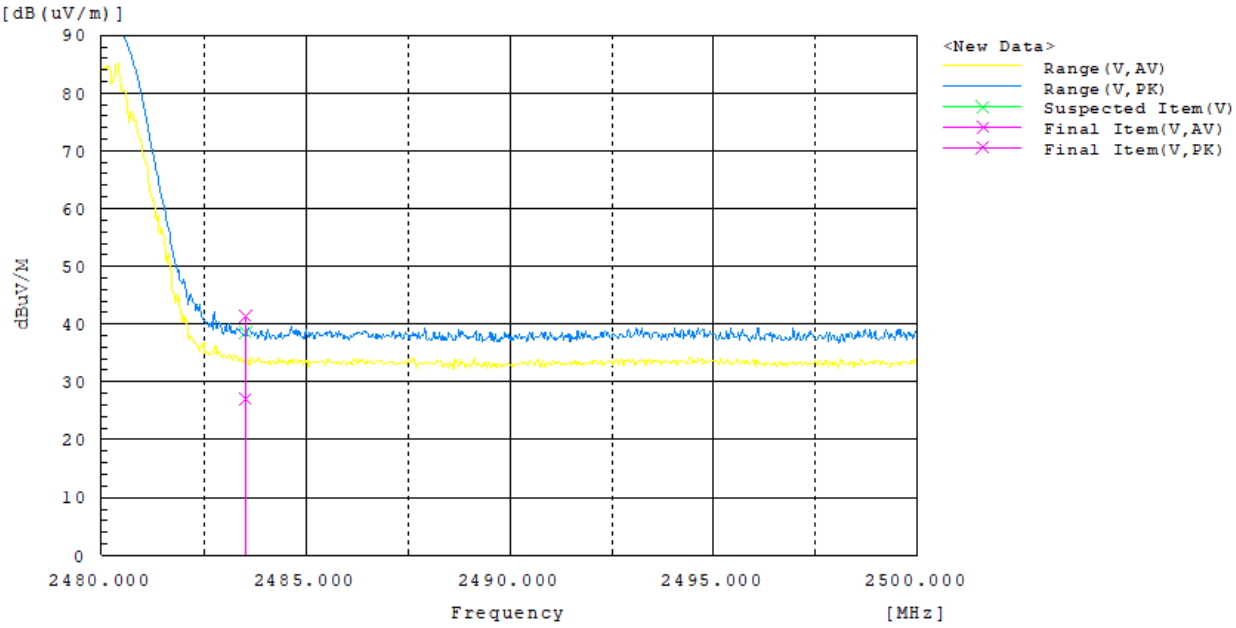
▣ RESULT PLOTS (Worst case)

Radiated Restricted Band Edges plot – Y / Horizontal (Ch.39)



Radiated Restricted Band Edges plot – Y / Veritical (Ch.39)



Note : Only the worst case plots for Radiated Restricted Band Edges.

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9.7 POWERLINE CONDUCTED EMISSIONS

Test Requirements and limit, §15.207

For an intentional radiator which 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 250 microvolts (The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz). The limits at specific frequency range is listed as follows:

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

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 Appendix 1 for the actual connections between EUT and support equipment.

TEST PROCEDURE

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

Sample Calculation

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

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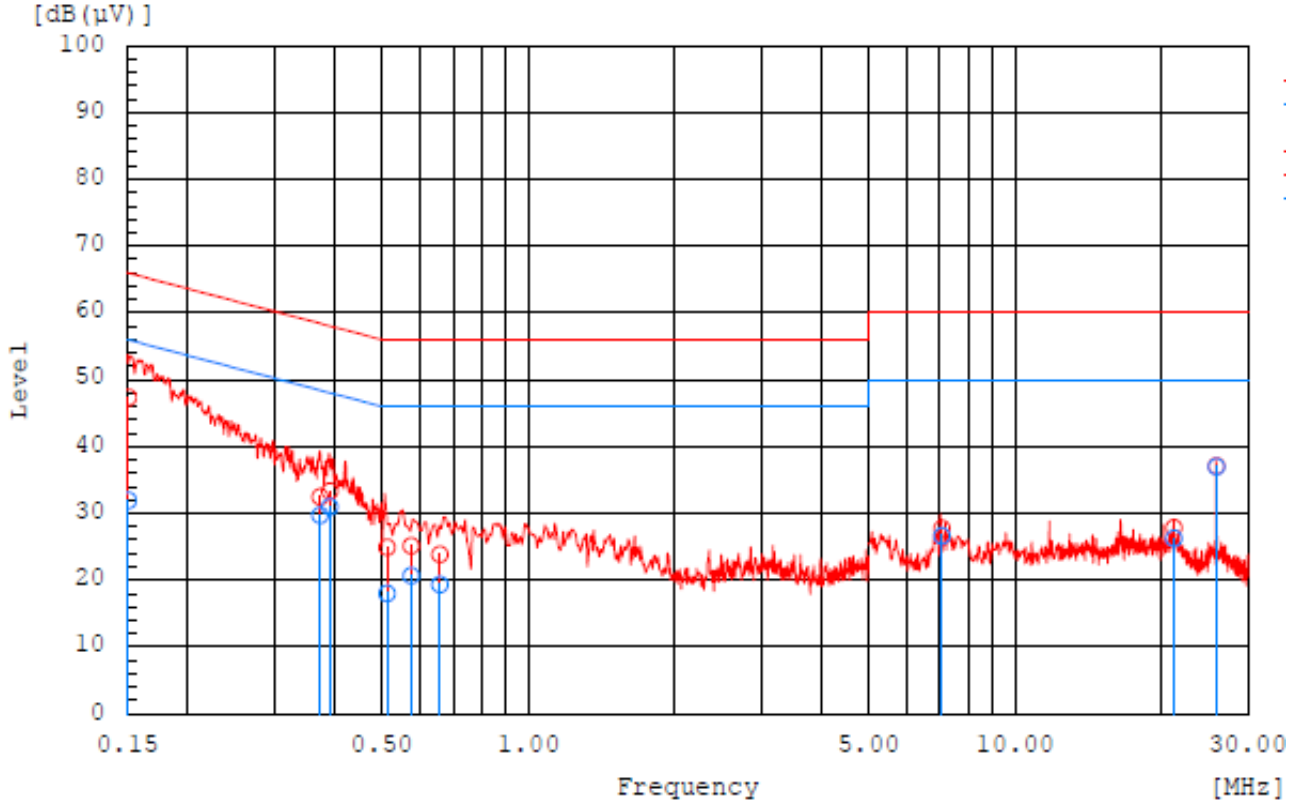
TEL: +1-510-933-8848 FAX: +1-510-933-8849

▣ RESULT PLOTS

Conducted Emissions (Line 1)



Frequency MHz	Line	Reading dB(µV) QP	Factor dB	Level dB(µV) QP	Limit dB(µV) QP	Margin dB QP	Pass/Fail
0.151	L1	37.7	9.7	47.4	66	18.6	Pass
0.373	L1	22.9	9.6	32.5	58.4	25.9	Pass
0.39	L1	23.8	9.6	33.4	58.1	24.7	Pass
0.511	L1	15.4	9.6	25	56	31	Pass
0.573	L1	15.4	9.7	25.1	56	30.9	Pass
0.657	L1	14.2	9.7	23.9	56	32.1	Pass
7.055	L1	17.3	10.5	27.8	60	32.2	Pass
21.168	L1	16.7	11.2	27.9	60	32.1	Pass
25.871	L1	25.9	11.2	37.1	60	22.9	Pass

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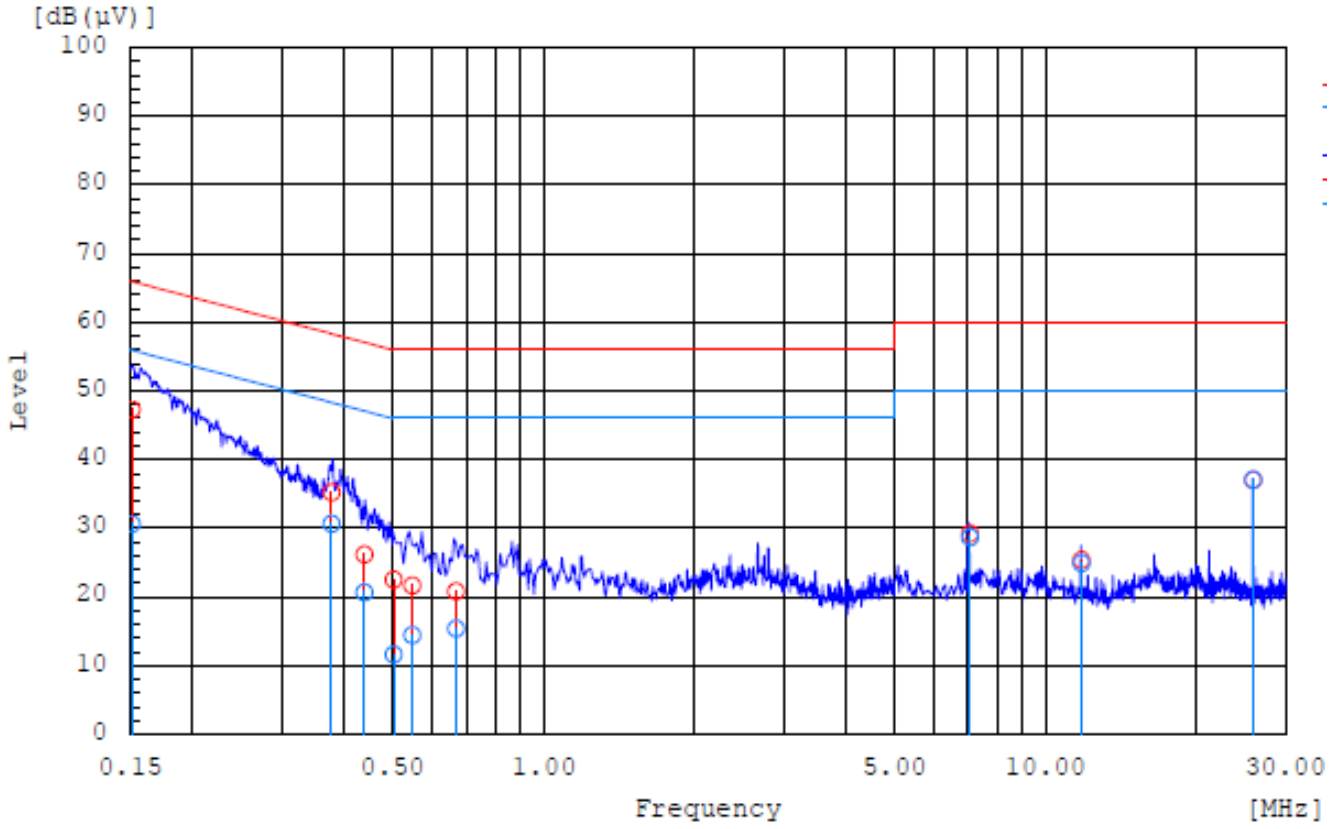
Conducted Emissions (Line 2)



Frequency MHz	Line	Reading dB(µV) QP	Factor dB	Level dB(µV) QP	Limit dB(µV) QP	Margin dB QP	Pass/Fail
0.151	N	37.7	9.7	47.4	66	18.6	Pass
0.378	N	25.7	9.6	35.3	58.3	23	Pass
0.439	N	16.6	9.6	26.2	57.1	30.9	Pass
0.501	N	12.9	9.7	22.6	56	33.4	Pass
0.547	N	12	9.7	21.7	56	34.3	Pass
0.668	N	11.2	9.7	20.9	56	35.1	Pass
7.056	N	18.7	10.5	29.2	60	30.8	Pass
11.76	N	14.7	10.8	25.5	60	34.5	Pass
25.872	N	25.8	11.3	37.1	60	22.9	Pass

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10. LIST OF TEST EQUIPMENT

No.	Instrument	Model No.	Due to Calibration	Manufacture	Serial No.
☒	Signal Analyzer (20 Hz ~ 40.0 GHz)	ESU40	2018-09-27	ROHDE & SCHWARZ	100529
☒	Signal Analyzer (20 Hz ~ 26.5 GHz)	N9020A	2018-10-12	AGILENT	MY52091291
☒	Power Meter	N1914A	2019-02-05	AGILENT	MY56500009
☒	Power Sensor	E9304A	2019-02-05	AGILENT	MY55320010
☒	BI-LOG Antenna (30 MHz ~ 1 GHz)	JB6	2019-06-27	Schwarzbeck	A060916
☒	Attenuator (20 dB, DC ~ 26.5 GHz)	8493C	2018-12-19	HP	09072
☒	DC power supply	6655A	2019-02-06	HP	KR94907553
☒	POWER AMP (1 GHz ~ 18 GHz)	CBL18405045-01	2019-02-05	CERNEX	27973
☒	POWER AMP (0.3GHz ~ 1GHz)	PAM-103A	2019-02-05	Com-Power Corporation	18020005
☒	Horn Antenna (1 GHz ~ 18 GHz)	DRH-118	2020-05-24	Sunol	A070516
☒	Power Divider-2way (DC ~ 26.5 GHz)	11636B	2018-12-19	HP	50820
☒	Loop Antenna (0.009 ~ 30 MHz)	HLA 6121	2018-09-27	Teseq	43964
☒	Horn Antenna (18 GHz ~ 40 GHz)	DRH-1840	2019-03-13	Sunol	17120
☒	POWER AMP (18 GHz ~ 40 GHz)	CBL184050-45-01	2019-02-05	CERNEX,Inc.	43964

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