

TEST REPORT

REPORT NUMBER: 11685045-E34V3

COMPANY NAME: Sonos Inc.

EUT DESCRIPTION: 802.11b/g/n (3x3) 2.4GHz Wireless Router

MODEL: BOOST

SERIAL NUMBER: 1611-B8-E9-37-0D-B1-9A-8

ISSUE DATE: 20-Mar-18

DATE TESTED: 7/12/17; 3/2/18

APPLICABLE STANDARDS: JAPAN RADIO LAW RADIO EQUIPMENT REGULATIONS

TEST METHOD: Notice 88 of Ordinance Concerning Technical Regulations Conformity Certification of Specified Radio Equipment

Place of Testing: UL Verification Services Inc.
47173 BENICIA ST, FREMONT, CA 94538, USA

Test Result: Pass

Classification of Specified Radio Equipment: Article 2 Clause 1 Item 19

Type of radio wave, Frequency and antenna power: G1D 2412-2472MHz (Interval of 5MHz 13ch) 0.006963W/MHz

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For UL Verification Services Inc. By:



DAN CORONIA
PROJECT LEAD
UL Verification Services Inc.

Tested By:



GLENN ESCANO
WiSE LAB ENGINEER
UL Verification Services Inc.



NVLAP LAB CODE 200065-0

1. EUT Information

Report No. : 11685045-E34V3				
Applicant : Sonos Inc.				
Equipment Description: 802.11b/g/n (3x3) 2.4GHz Wireless Router				
Model No. : BOOST				
SerialNo. : 1611-B8-E9-37-0D-B1-9A-8				
The number of Tx Antenna : 3				
Max Antenna Gain :	2.21dBi	3.59dBi	4.34dBi	
	Chain 0	Chain 1	Chain 2	
Mode : IEEE802.11b				
Type of Radio wave : G1D				

Supply Voltage ☒ DC ☐ AC 5.00V _____ _____ Voltage Condition ☒ Non-Extreme ☐ Extreme Normal DC5V Normal-10% - Normal+10% -	Modulation ☒ DS (e.g. WLAN 11b) ☐ OFDM & OBW ≤ 26MHz (e.g. WLAN 11g, 11n HT20) ☐ OFDM & OBW 26-38MHz (e.g. WLAN 11n HT40) ☐ Other Modulation (e.g. GFSK, Not BT) EUT has ☒ ANT Connector ☐ No ANT Connector distance -
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The worst-case data rate for each mode is determined to be as follows, based on preliminary test of the chipset utilized in this radio.

All final tests were made at 5.5Mbps Long CCK.

Factors

	[MHz]	Other than for Power		For Power	
		Cable Loss [dB]	ATT/ [dB]	Cable Loss [dB]	ATT/ [dB]
Low Channel (Tx1)	2412	1.00	12.10	1.00	10.00
Middle Channel (Tx2)	2442	1.00	12.10	1.00	10.00
High Channel (Tx3)	2472	1.00	12.10	1.00	10.00

2.TEST Result

2.1. Frequency Tolerance

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Freq. [MHz]	Result [MHz]	Tolerance [kHz]	Tolerance [ppm]	Limit [ppm]
DC5V	2412	2411.9840	-16.0142	-6.64	±50.0
	2442	2441.9815	-18.5389	-7.59	±50.0
	2472	2471.9816	-18.4187	-7.45	±50.0

Tx1_Freq_Nom

Agilent 20:26:16 Jul 12, 2017

R L

Cntr1 2 411 983 985.844 Hz

Ref 30 dBm

*Atten 40 dB

21.05 dBm

*Peak
Log
10
dB/

LgAv

W1 S2

S3 FS

AA

£(f):

f<50k

Swp

Center 2.411 984 180 GHz

Span 30 kHz

*Res BW 300 Hz

*VBW 300 Hz

Sweep 401.9 ms (1201 pts)

Tx2_Freq_Nom

Agilent 20:27:52 Jul 12, 2017

R L

Cntr1 2 441 981 461.149 Hz

21.39 dBm

Ref 30 dBm

#Atten 40 dB

#Peak

Log

10

dB/

LgAv

W1 S2

S3 FS

AA

E(f):

f<50k

Swp

Center 2.441 981 531 GHz

Span 30 kHz

#Res BW 300 Hz

#VBW 300 Hz

Sweep 401.9 ms (1201 pts)

Tx3_Freq_Nom

Agilent 20:35:54 Jul 12, 2017

R L

Cntr1 2 471 981 581.304 Hz

20.87 dBm

Ref 30 dBm

#Atten 40 dB

#Peak

Log

10

dB/

LgAv

W1 S2

S3 FS

AA

E(f):

f<50k

Swp

Center 2.471 981 752 GHz

Span 30 kHz

#Res BW 300 Hz

#VBW 300 Hz

Sweep 401.9 ms (1201 pts)

2.2. Occupied Bandwidth / Spreading Bandwidth

Job No. 11685045-E34V3
 Remark1
 Remark2

[DATA]

99% Occupied Frequency Bandwidth

Voltage	Freq. [MHz]	Result [MHz]	Limit [MHz]
DC5V	2412	10.4630	26
	2442	10.4660	26
	2472	10.5530	26

Spreading Bandwidth

Voltage	Freq. [MHz]	Result [MHz]	Result [kHz]	Limit [kHz]
DC5V	2412	6.9481	6948.1	500
	2442	6.9082	6908.2	500
	2472	6.9419	6941.9	500

Spreading Factor

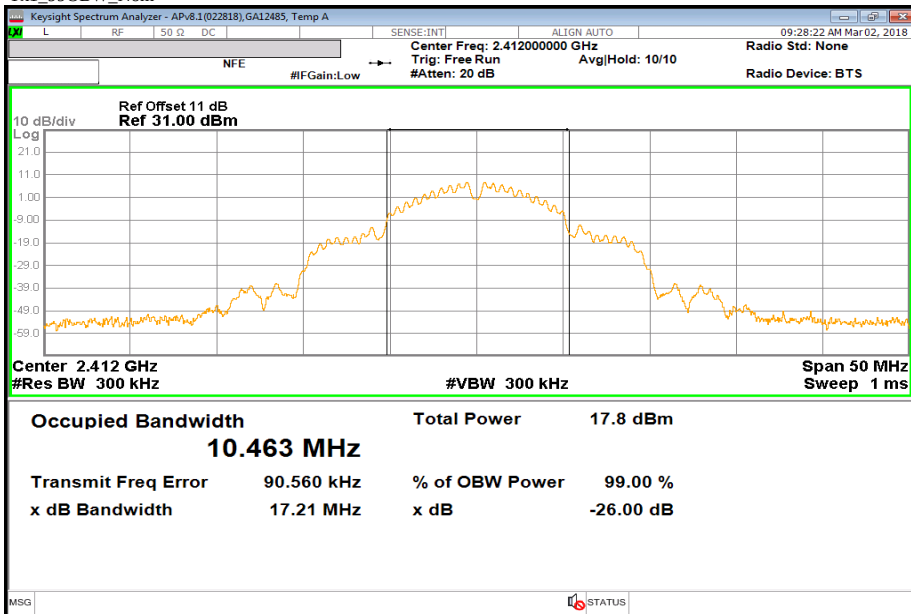
1Mbps, 2Mbps 6.91 (Limit: >5)
 5.5Mbps, 11Mbps 5.02 (Limit: >5)

Symbol Rate

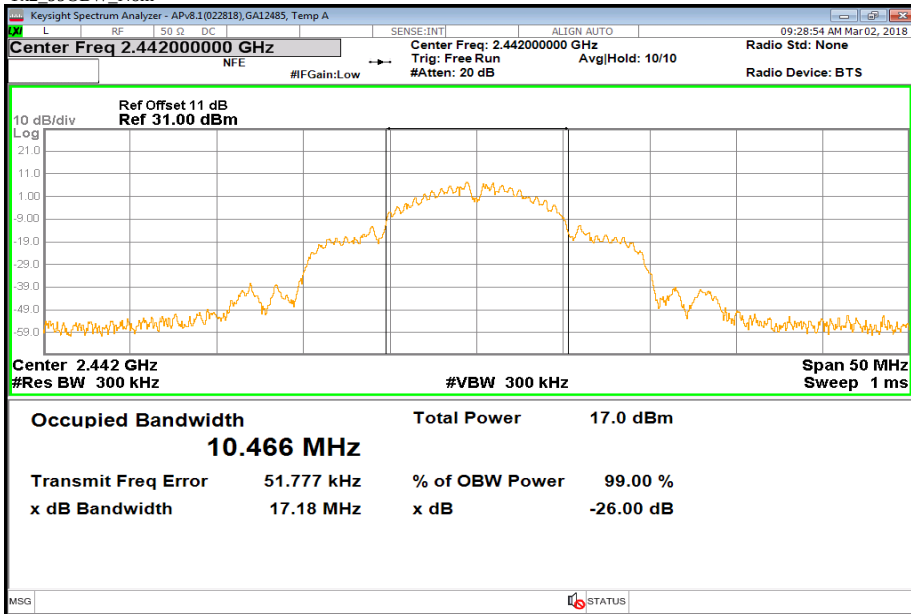
1 Msps
 1.375 Msps

99% Occupied Frequency Bandwidth

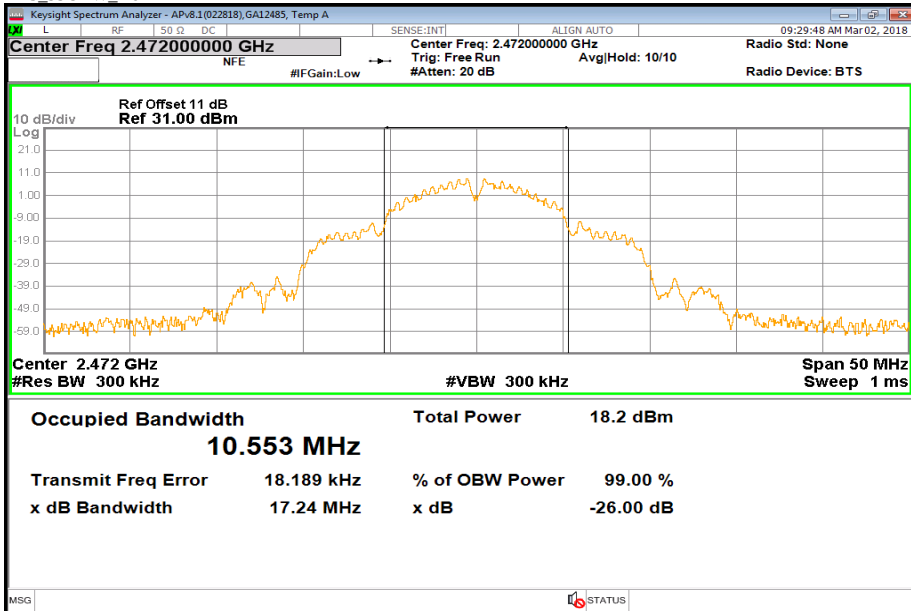
Tx1_99OBW_Nom



Tx2_990BW_Nom

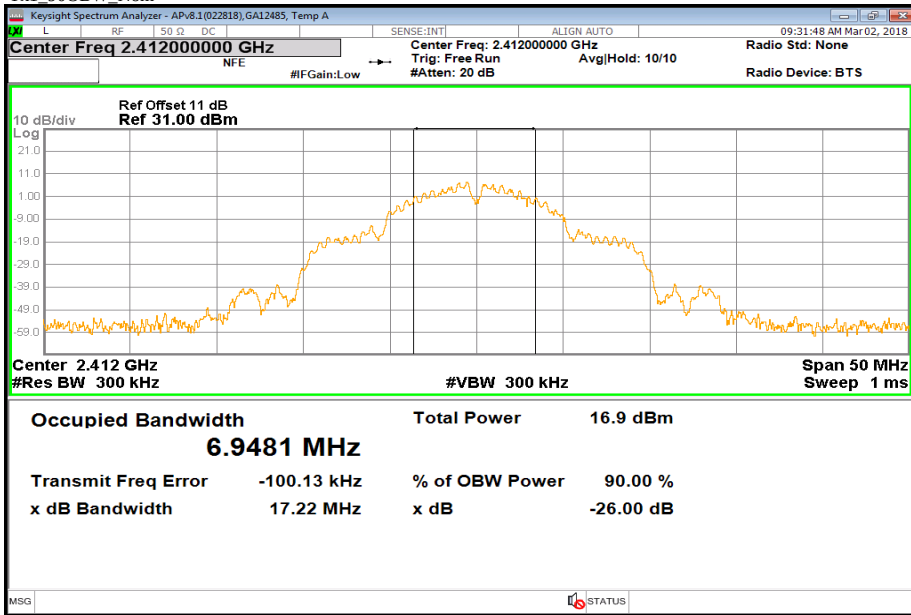


Tx3_990BW_Nom

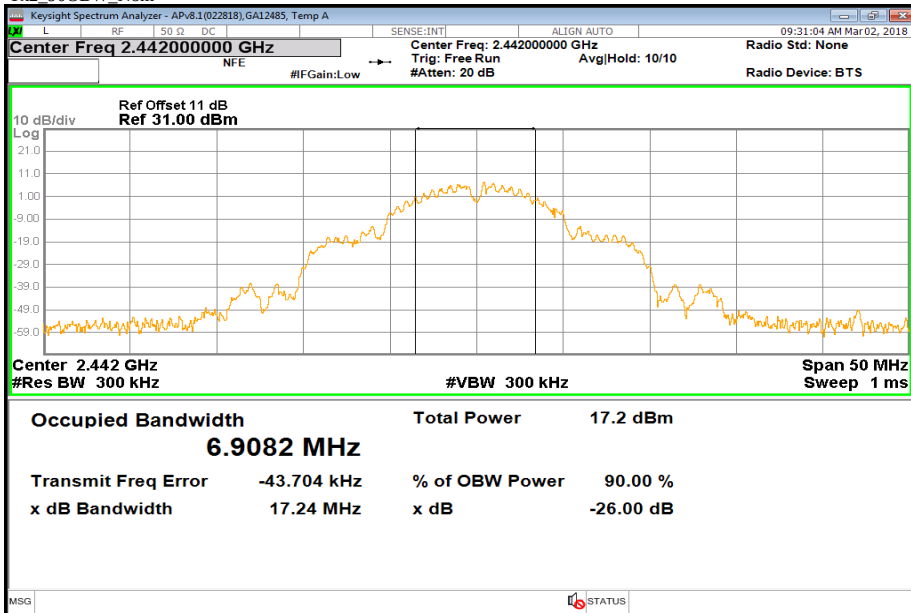


Spreading Bandwidth

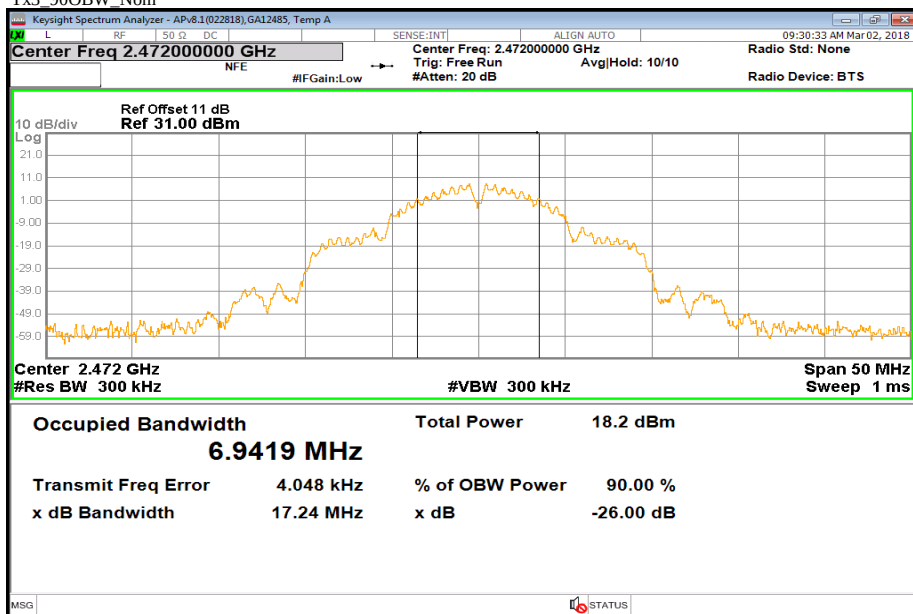
Tx1 900BW Nom



Tx2 900BW Nom



Tx3_900BW_Nom



2.3. Unwanted Emission Strength (Normal Voltage)

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Freq.	Freq.	S/A Reading	Cable Loss	Atten. Loss	Result	Result	Limit	Remark
	[MHz]	[MHz]	[dBm]	[dB]	[dB]	[dBm]	[uW]	[uW]	
DC5V	2412	476.20	-60.61	1.00	12.10	-47.51	0.018	2,500	♣1
		2284.00	-50.18	1.00	12.10	-37.08	0.196	2,500	♣1
		2333.50	-50.33	1.00	12.10	-37.23	0.189	2,500	♣1
		2399.67	-60.31	1.00	12.10	-47.21	0.019	25,000	♣2
		2399.99	-50.54	1.00	12.10	-37.44	0.181	25,000	♣2
		2495.00	-51.42	1.00	12.10	-38.32	0.147	25,000	♣3
		12299.00	-57.21	1.00	12.10	-44.11	0.039	2,500	♣4
	2442	554.60	-61.47	1.00	12.10	-48.37	0.015	2,500	♣1
		2361.00	-49.26	1.00	12.10	-36.16	0.242	2,500	♣1
		2505.00	-53.03	1.00	12.10	-39.93	0.102	2,500	♣4
		6922.00	-57.18	1.00	12.10	-44.08	0.039	2,500	♣4
	2472	30.00	-60.52	1.00	12.10	-47.42	0.018	2,500	♣1
		2284.00	-51.42	1.00	12.10	-38.32	0.147	2,500	♣1
		2483.51	-45.34	1.00	12.10	-32.24	0.597	25,000	♣3
		2485.17	-49.66	1.00	12.10	-36.56	0.221	25,000	♣3
		2549.00	-50.48	1.00	12.10	-37.38	0.183	2,500	♣4
		2552.00	-53.39	1.00	12.10	-40.29	0.094	2,500	♣4
		10190.00	-57.19	1.00	12.10	-44.09	0.039	2,500	♣4

Sample Calculation :

Result = Reading + Cable Loss + Attenuator

♣1:Freq Range1 (≥ 30MHz, < 2,387MHz)

♣2:Freq Range2 (2,387MHz以上, < 2,400MHz)

♣3:Freq Range3 (> 2,483.5MHz, ≤ 2,496.5MHz)

♣4:Freq Range4 (> 2,496.5MHz, ≤ 12.5GHz)

Tx1_SpuriousM_Nom

Agilent 21:20:39 Jul 12, 2017

R L

Mkr1 476.2 MHz

-60.61 dBm

Ref 10 dBm

*Atten 20 dB

*Peak

Log

10

dB/

LgAv

V1 S2

Start 30.0 MHz

Stop 1.000 0 GHz

*Res BW 1 MHz

*VBW 1 MHz

Sweep 1.68 ms (1201 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	476.2 MHz	-60.61 dBm

Tx1_SpuriousG_Nom

Agilent 21:20:26 Jul 12, 2017

R L

Mkr4 12.299 GHz

-57.21 dBm

Ref 10 dBm

#Atten 20 dB

#Peak

Log

10

dB/

LgAv

V1 S2

Start 1.000 GHz

Stop 12.500 GHz

#Res BW 1 MHz

#VBW 1 MHz

Sweep 19.2 ms (1201 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	2.412 GHz	-3.30 dBm
2	(1)	Freq	2.284 GHz	-50.18 dBm
3	(1)	Freq	2.495 GHz	-51.42 dBm
4	(1)	Freq	12.299 GHz	-57.21 dBm

Tx1_BandEdgeLow_Nom

Agilent 21:21:04 Jul 12, 2017

R L

Mkr4 2.399 67 GHz

-50.17 dBm

Ref 10 dBm

#Atten 20 dB

#Peak

Log

10

dB/

LgAv

V1 S2

Start 2.320 00 GHz

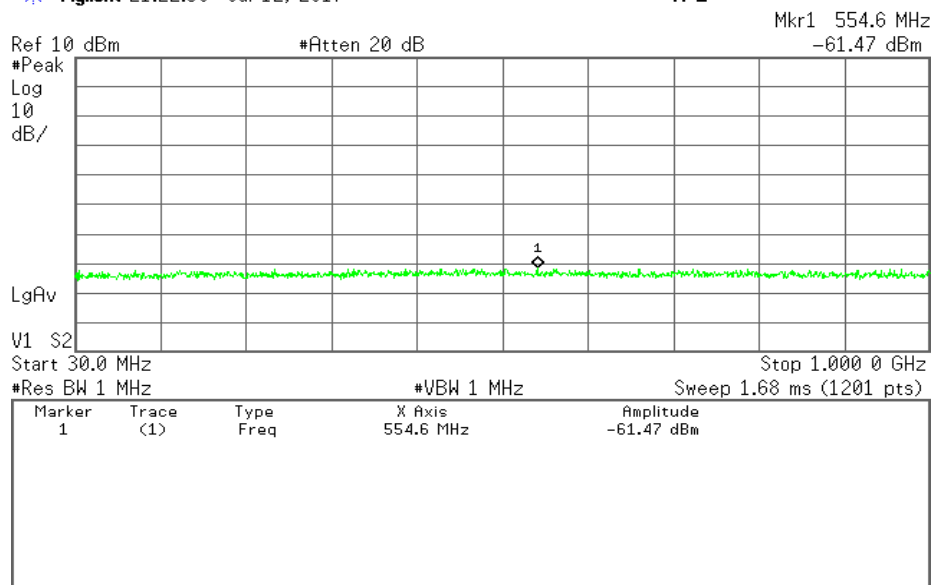
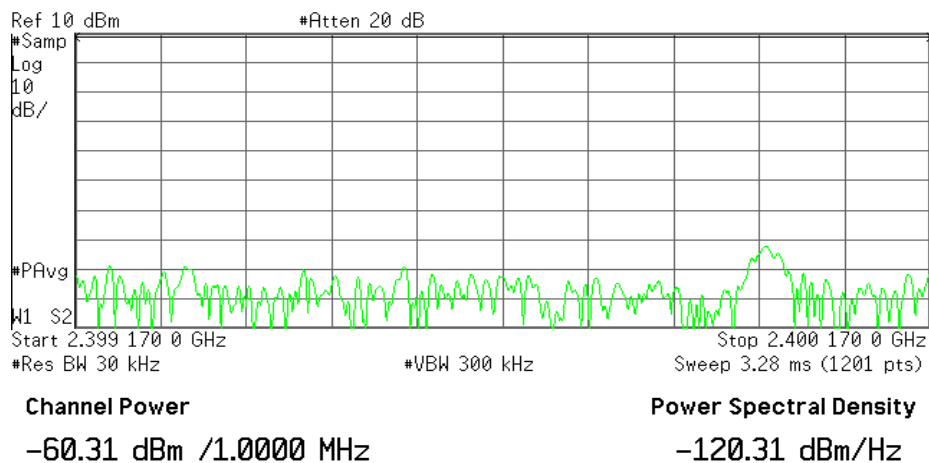
Stop 2.420 00 GHz

#Res BW 1 MHz

#VBW 1 MHz

Sweep 1.04 ms (1201 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	2.409 17 GHz	-2.93 dBm
2	(1)	Freq	2.399 99 GHz	-50.53 dBm
3	(1)	Freq	2.333 50 GHz	-50.33 dBm
4	(1)	Freq	2.399 67 GHz	-50.17 dBm

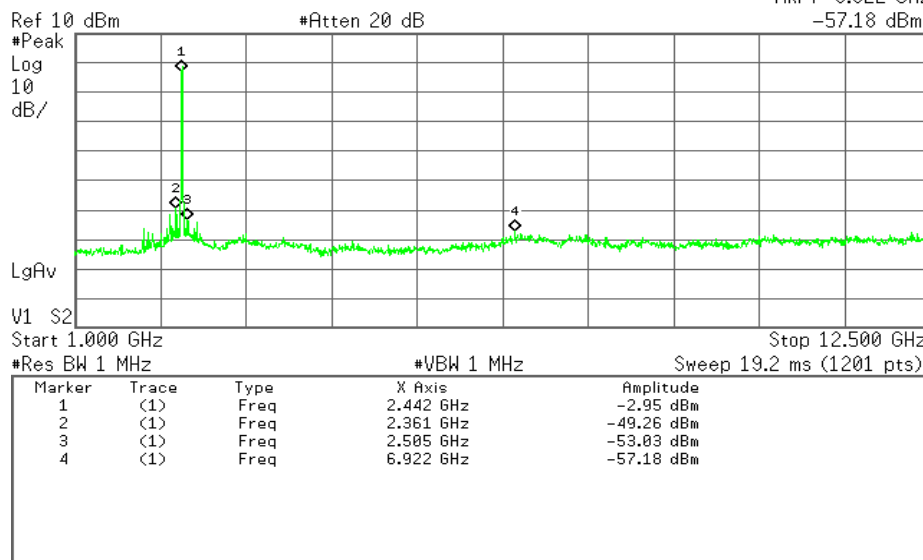


Tx2_SpuriousG_Nom

Agilent 21:22:25 Jul 12, 2017

R L

Mkr4 6.922 GHz
-57.18 dBm

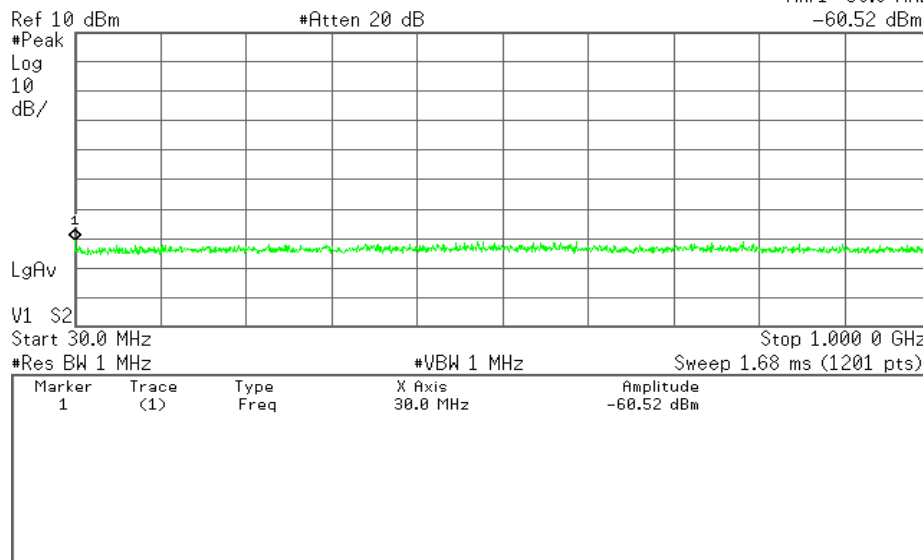


Tx3_SpuriousM_Nom

Agilent 21:24:05 Jul 12, 2017

R L

Mkr1 30.0 MHz
-60.52 dBm



Tx3_SpuriousG_Nom

Agilent 21:23:52 Jul 12, 2017

R L

Mkr4 10.190 GHz
-57.19 dBm

Ref 10 dBm

#Atten 20 dB

#Peak
Log
10
dB/

LgAv

V1 S2

Start 1.000 GHz

Stop 12.500 GHz

#Res BW 1 MHz

#VBW 1 MHz

Sweep 19.2 ms (1201 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	2.472 GHz	-6.18 dBm
2	(1)	Freq	2.284 GHz	-51.42 dBm
3	(1)	Freq	2.552 GHz	-53.39 dBm
4	(1)	Freq	10.190 GHz	-57.19 dBm

Tx3_BandEdgeHigh_Nom

Agilent 21:24:24 Jul 12, 2017

R L

Mkr4 2.485 17 GHz
-44.14 dBm

Ref 10 dBm

#Atten 20 dB

#Peak
Log
10
dB/

LgAv

V1 S2

Start 2.450 00 GHz

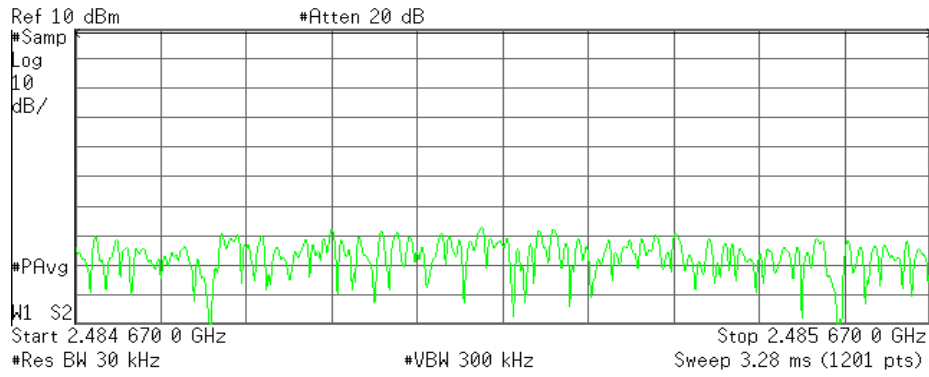
Stop 2.550 00 GHz

#Res BW 1 MHz

#VBW 1 MHz

Sweep 1.04 ms (1201 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(1)	Freq	2.469 25 GHz	-2.65 dBm
2	(1)	Freq	2.483 51 GHz	-45.34 dBm
3	(1)	Freq	2.549 00 GHz	-50.48 dBm
4	(1)	Freq	2.485 17 GHz	-44.14 dBm



Channel Power

-49.66 dBm /1.0000 MHz

Power Spectral Density

-109.66 dBm/Hz

2.4. Output Power

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Chain	Freq. [MHz]	Reading [dBm]	Cable Loss [dB]	Atten. Loss [dB]	Result [W/MHz]	Burst Rate	Output Power (A) [W/MHz]	Antenna Gain [dBi]	E.I.R.P. (A) [W/MHz]
DC5V	0	2412	-7.20	1.00	10.00	0.002399	1.02	0.002447	2.21	0.004071
		2442	-7.14	1.00	10.00	0.002434	1.02	0.002483	2.21	0.004130
		2472	-7.56	1.00	10.00	0.002210	1.02	0.002255	2.21	0.003751
DC5V	1	2412	-8.22	1.00	10.00	0.001896	1.02	0.001934	3.59	0.004421
		2442	-8.25	1.00	10.00	0.001884	1.02	0.001922	3.59	0.004392
		2472	-7.22	1.00	10.00	0.002386	1.02	0.002434	3.59	0.005563
DC5V	2	2412	-7.39	1.00	10.00	0.002298	1.02	0.002345	4.34	0.006370
		2442	-8.02	1.00	10.00	0.001984	1.02	0.002024	4.34	0.005499
		2472	-7.17	1.00	10.00	0.002416	1.02	0.002465	4.34	0.006696
DC5V	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-

Sample Calculation :

Output Power (A) = $10^{((\text{Reading [dBm]} + \text{Cable Loss} + \text{Atten. Loss}) / 10) * \text{Burst Rate}}$

E.I.R.P. (A) = Output Power (A) * $10^{(\text{Antenna Gain[dBi]}/10)}$

[Total Power / Result and Limit]

Voltage	Freq. [MHz]	Output Power				E.I.R.P.		
		Result (B)	Tolerance Result	Limit	Tolerance Limit	Result (B)	Result	Limit
		[W/MHz]	[%]	[W/MHz]	[%]	[W/MHz]	[dBm/MHz]	[dBm/MHz]
DC5V	2412	0.006727	-3.4	0.010000	+20 ~ -80	0.014862	11.72	12.14
	2442	0.006429	-7.7	0.010000	+20 ~ -80	0.014022	11.47	12.14
	2472	0.007154	2.7	0.010000	+20 ~ -80	0.016010	12.04	12.14

Sample Calculation :

Tolerance = Output Power Result (B) / Declared Output Power * 100 - 100.

Output Power Result (B) : Sum of all "Output Power (A)" at same Freq.

E.I.R.P. Result (B): Sum of all "E.I.R.P. (A)" at same Freq.

[Declared Output Power]

Average of Output Power Result (B)	0.006770	[W/MHz]	Average of E.I.R.P. Result(B)	0.014965	[W/MHz]
Declared Output Power	0.006963	[W/MHz]	E.I.R.P. for Declared Output Power	11.87	[dBm/MHz]
+20	0.008356	[W/MHz]			
Middle (Declared Output Power -30%)	0.004874	[W/MHz]			
-80	0.001393	[W/MHz]			

Sample Calculation :

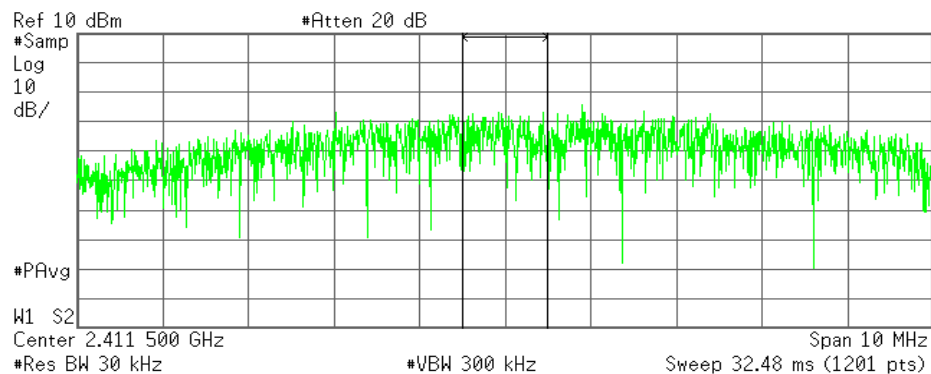
E.I.R.P. for Declared Output Power

= $10 * \log (\text{Average of E.I.R.P. Result (B)} * (\text{Declared Output Power} / \text{Average of Output Power Result (B)}) * 1000)$

Tx1_Power_Chain0_Nom

Agilent 20:54:55 Jul 12, 2017

R L



Channel Power

-7.20 dBm /1.0000 MHz

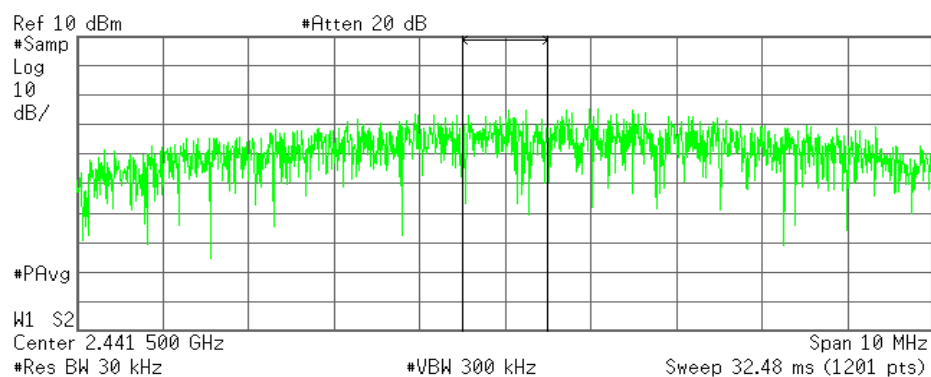
Power Spectral Density

-67.20 dBm/Hz

Tx2_Power_Chain0_Nom

Agilent 21:01:07 Jul 12, 2017

R L



Channel Power

-7.14 dBm /1.0000 MHz

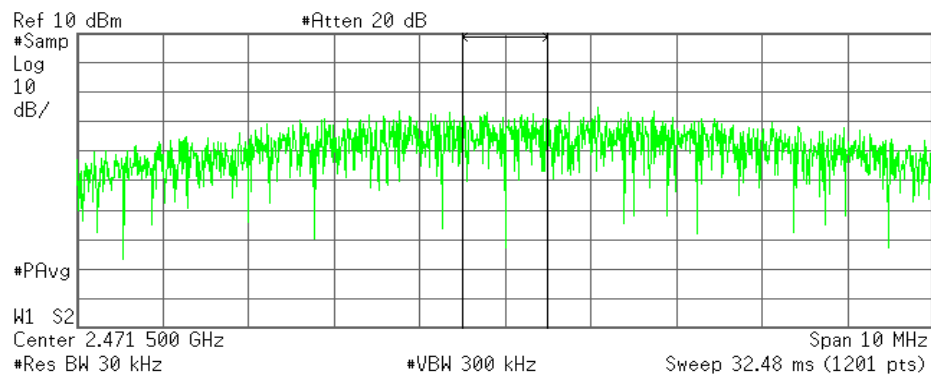
Power Spectral Density

-67.14 dBm/Hz

Tx3_Power_Chain0_Nom

Agilent 21:12:18 Jul 12, 2017

R L



Channel Power

-7.56 dBm /1.0000 MHz

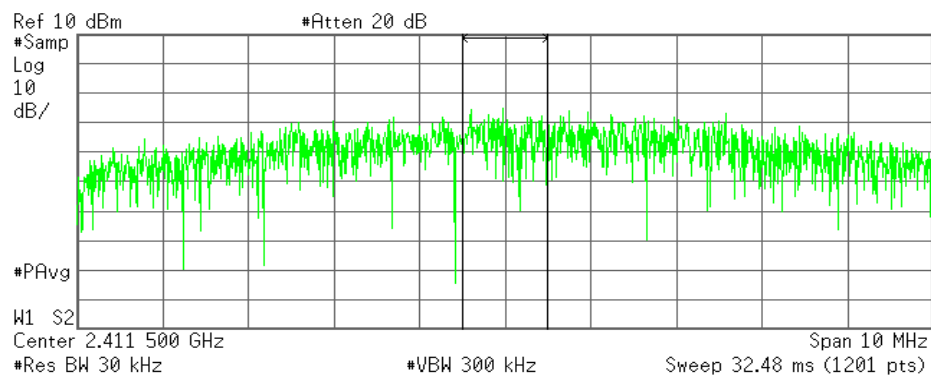
Power Spectral Density

-67.56 dBm/Hz

Tx1_Power_Chain1_Nom

Agilent 20:56:24 Jul 12, 2017

R L



Channel Power

-8.22 dBm /1.0000 MHz

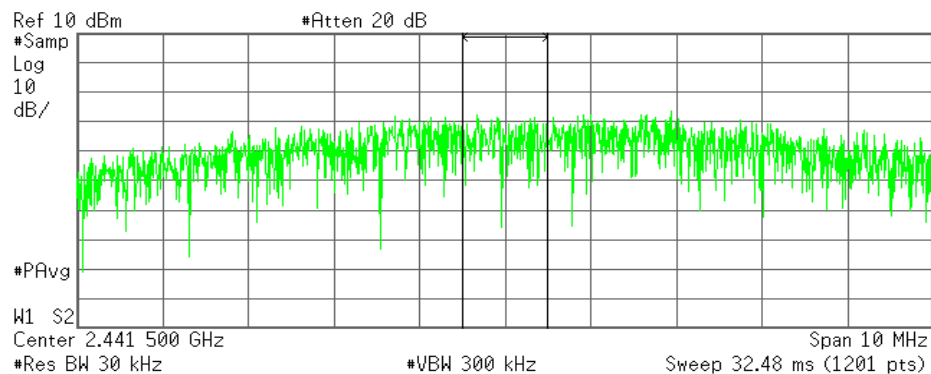
Power Spectral Density

-68.22 dBm/Hz

Tx2_Power_Chain1_Nom

Agilent 21:02:02 Jul 12, 2017

R L



Channel Power

-8.25 dBm /1.0000 MHz

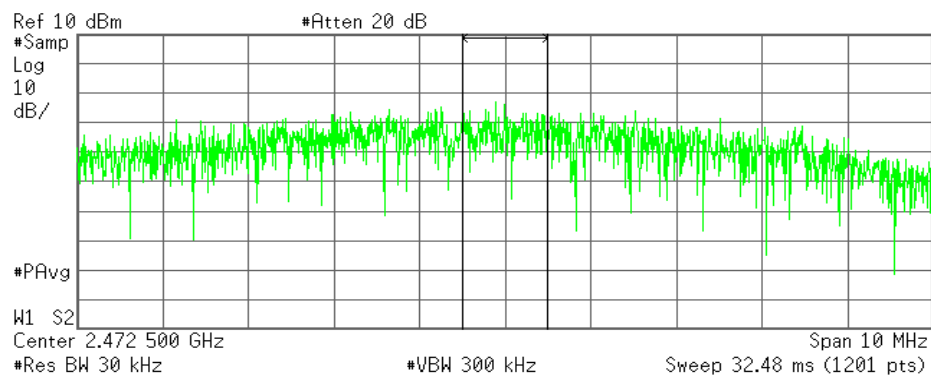
Power Spectral Density

-68.25 dBm/Hz

Tx3_Power_Chain1_Nom

Agilent 21:13:20 Jul 12, 2017

R L



Channel Power

-7.22 dBm /1.0000 MHz

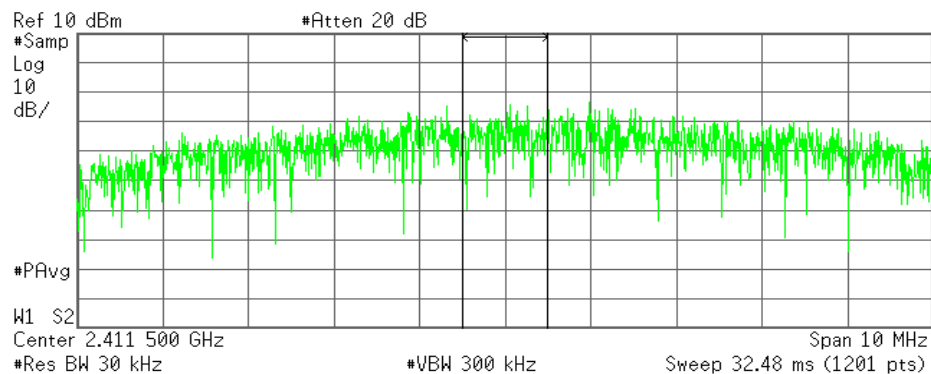
Power Spectral Density

-67.22 dBm/Hz

Tx1_Power_Chain2_Nom

Agilent 20:57:31 Jul 12, 2017

R L



Channel Power

-7.39 dBm /1.0000 MHz

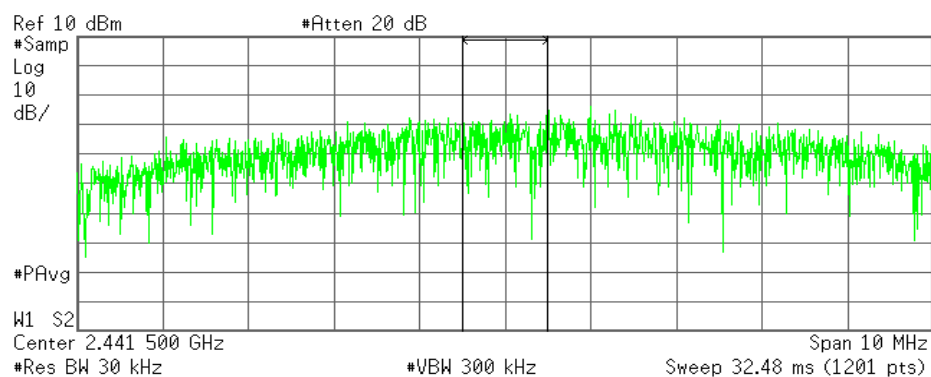
Power Spectral Density

-67.39 dBm/Hz

Tx2_Power_Chain2_Nom

Agilent 21:02:48 Jul 12, 2017

R L

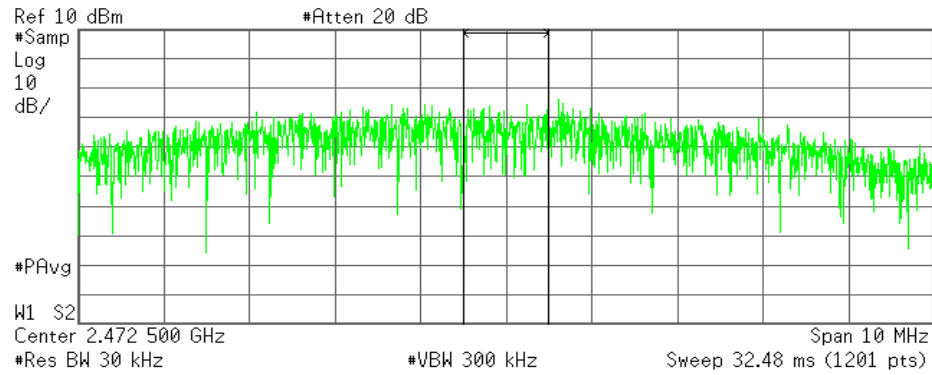


Channel Power

-8.02 dBm /1.0000 MHz

Power Spectral Density

-68.02 dBm/Hz

**Channel Power****-7.17 dBm /1.0000 MHz****Power Spectral Density****-67.17 dBm/Hz**

2.5. Secondary Radiated Emission Strength

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Freq.	Freq.	S/A Reading	Cable Loss	Atten. Loss	Result	Result	Limit	Remark
[V]	[MHz]	[MHz]	[dBm]	[dB]	[dB]	[dBm]	[nW]	[nW]	
DC5V	2442	721.1	-82.60	1.00	12.10	-69.50	0.112	4.000	◆5
		10430.0	-68.89	1.00	12.10	-55.79	2.639	20.000	◆6

The sum of the results exceeding 1/10 of the Limit [nW] : 2.639

Sample Calculation :

Result = Reading + Cable Loss

◆5:Freq Range5 (≥ 30MHz, <1GHz)

◆6:Freq Range6 (≥ 1GHz, ≤ 12.5GHz)

Rx1_SpuriousM_Nom

Agilent 20:36:58 Jul 12, 2017

R L

Mkr1 721.1 MHz

-82.60 dBm

Ref -10 dBm

#Atten 8 dB

#Peak
Log
10
dB/

LgAv

V1 S2
S3 FC
RA

E(f):
FTun
Swp

Start 30.0 MHz

Stop 1.000 0 GHz

#Res BW 100 kHz

#VBW 100 kHz

Sweep 117 ms (1201 pts)

Rx1_SpuriousG_Nom

Agilent 20:36:45 Jul 12, 2017

R L

Mkr1 10.430 GHz

-68.89 dBm

Ref -10 dBm

#Atten 8 dB

#Peak
Log
10
dB/

LgAv

V1 S2
S3 FC
RA

E(f):
FTun
Swp

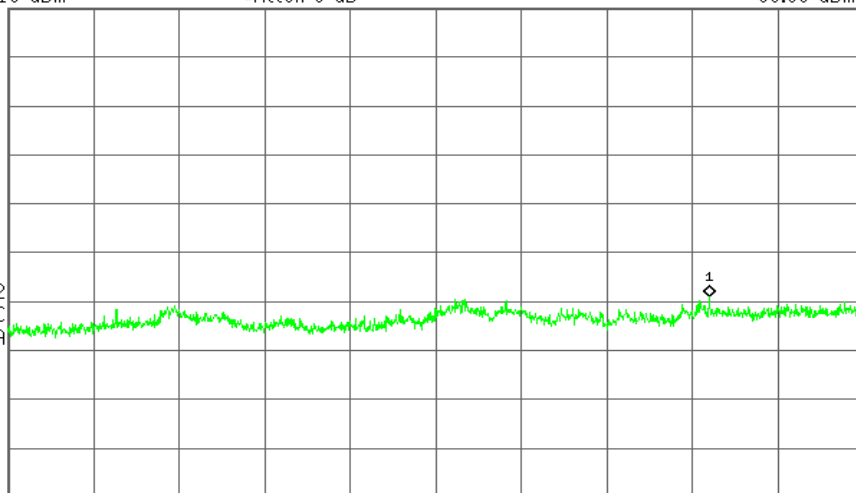
Start 1.000 GHz

Stop 12.500 GHz

#Res BW 1 MHz

#VBW 1 MHz

Sweep 19.2 ms (1201 pts)



2.6. Duty / Burst Rate

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Freq.	On Time	Period	Result (Duty)	Result (Burst Rate)
[V]	[MHz]	[msec]	[msec]	[%]	
DC5V	2442	2.371	2.419	98.0	1.020

Sample Calculation :

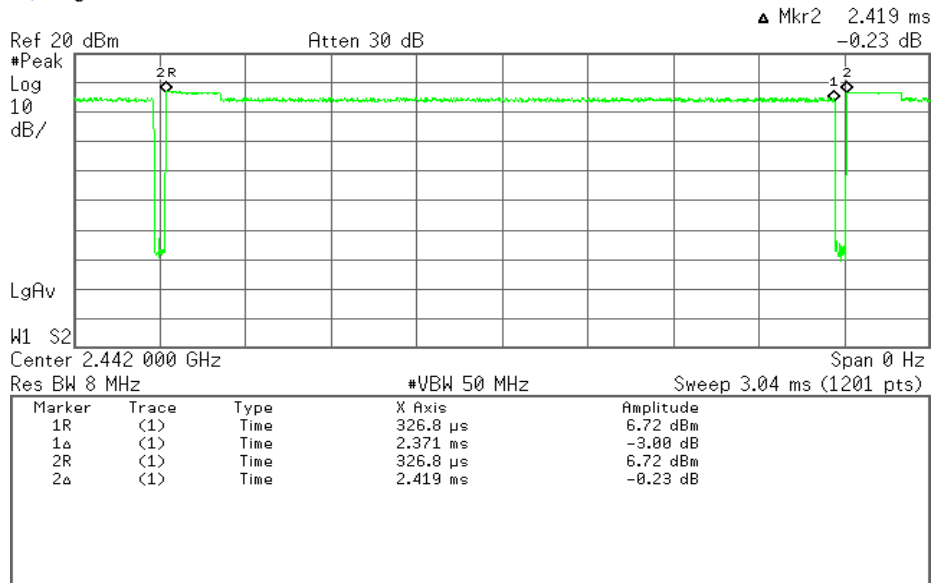
Result(Duty) = On Time / Period * 100

Result(Burst Rate) = Period / On Time

Tx2_Duty_Nom

Agilent 20:45:42 Jul 12, 2017

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Average Power

Job No. 11685045-E34V3

Remark1

Remark2

[DATA]

Voltage	Port No.	Freq.	Reading	Cable Loss	Atten. Loss	Burst Rate	Output Power Result
		[MHz]	[dBm]	[dB]	[dB]		[dBm]
DC5V	0	2412	0.09	1.00	10.00	1.02	11.18
		2442	0.05	1.00	10.00	1.02	11.14
		2472	-0.35	1.00	10.00	1.02	10.74
DC5V	1	2412	-0.87	1.00	10.00	1.02	10.22
		2442	-1.01	1.00	10.00	1.02	10.08
		2472	0.21	1.00	10.00	1.02	11.30
DC5V	2	2412	-0.41	1.00	10.00	1.02	10.68
		2442	-0.81	1.00	10.00	1.02	10.28
		2472	-0.13	1.00	10.00	1.02	10.96
DC5V	-	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-

Total Output Power

Voltage	Freq.	Power
	[MHz]	[mW]
DC5V	2412	35.31
	2442	33.83
	2472	37.80

3. Measurement Equipment

Use	Int. No.	Kind of Equipment	Model No.	Manufacturer	Serial No.	Calibration Authority	Calibration Date
X	T146	PSA	E4446A	Agilent	MY45300064	Keysight	7/13/2016
X	T905	PXA	N9030A	Keysight	MY53311010	Techmaster Electronics	2/3/2018
X	T1244	Power Meter	N1911A	Keysight	MY55196008	Keysight	4/5/2017
X	T1225	Wideband Power Sensor	N1921A	Keysight	MY55200003	Keysight	3/29/2017

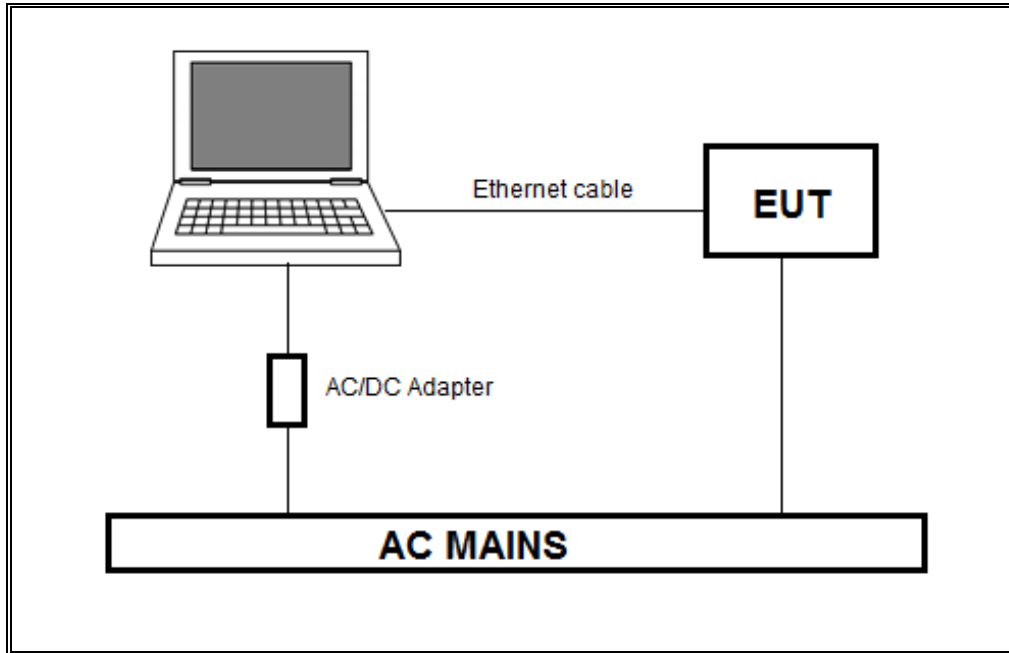
- Note :
1. The calibration of measurement equipment is valid for a one year period.
 2. "X" used equipment.
 3. All equipment is calibrated and traceable to ISO17025

4. Test Condition

Test Item	Date	Temp	Hum	Engineer	Test Room
Frequency Tolerance	7/12/2017	25°C	46.5%	Glenn Escano	Conducted B
Occupied Bandwidth	3/2/2018	25°C	46.2%	Steven Tran	Temp A
Unwanted Emission Strength	7/12/2017	25°C	46.5%	Glenn Escano	Conducted B
Output Power/ E.I.R.P	7/12/2017	25°C	46.5%	Glenn Escano	Conducted B
Secondary Radiated Emission Strength	7/12/2017	25°C	46.5%	Glenn Escano	Conducted B
Burst Length / Duty	7/12/2017	25°C	46.5%	Glenn Escano	Conducted B

5. TEST CONFIGURATION

TEST CirCuit



PHOTO

