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FCC ID: RWT-ER84

WLL JOB# 13970-01 Rev 1 May 30, 2015 Revised September 2, 2015

Prepared for:

Etymotic Research 61 Martin Lane Elk Grove Village, IL 60007

Prepared By:

Washington Laboratories, Ltd. 7560 Lindbergh Drive Gaithersburg, Maryland 20879



Testing Certificate AT-1448

FCC Certification Test Report for the Etymotic Research Companion Mic Product FCC ID: RWT-ER84

May 30, 2015 Revised September 2, 2015

WLL JOB# 13970-01 Rev 1

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Abstract

This report has been prepared on behalf of Etymotic Research to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System (DTS) Transmitter under Part 15.247 (10/2013) of the FCC Rules. This Certification Test Report documents the test configuration and test results for the Etymotic Research Companion Mic Product.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Etymotic Research Companion Mic Product complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247.

Revision History	Description of Change	Date
Rev 0	Initial Release	May 30, 2015
Rev 1	Corrected power levels in Table 8	September 2, 2015

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1 Introduction

1.1 Compliance Statement

The Etymotic Research Companion Mic Product complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 (10/2013). Even though this unit has hopping capabilities to avoid interference FCC rules allow this digitally modulated unit to be tested exclusively as a Digital Transmission System.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with "558074 D01 DTS Meas Guidance v03r02" June 5 2014 and ANSI C63.10-2009 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices".

1.3 Contract Information

Cust	omer:	TEM Consulting LP
		140 River Road
		Georgetown, TX 78628
On B	Sehalf of:	Etymotic Research
		61 Martin Lane
		Elk Grove Village, IL 60007
Purcl	hase Order Number:	Visa
Quot	ation Number:	68711
1.4	Test Dates	
Testi	ng was performed on the following date(s):	5/14/2015- 5/21/2015
1.5	Test and Support Personnel	
Wasł	nington Laboratories, LTD	James Ritter
Clier	nt Representative	Stephen Berger

1.6 Abbreviations

Α	Ampere	
ac	alternating current	
AM	Amplitude Modulation	
Amps	Amperes	
b/s	bits per second	
BW	BandWidth	
CE	Conducted Emission	
cm	centimeter	
CW	Continuous Wave	
dB	deciBel	
dc	direct current	
EMI	Electromagnetic Interference	
EUT	Equipment Under Test	
FM	Frequency Modulation	
G	\mathbf{g} iga – prefix for 10 ⁹ multiplier	
Hz	Hertz	
IF	Intermediate Frequency	
k	\mathbf{k} ilo – prefix for 10 ³ multiplier	
LISN	Line Impedance Stabilization Network	
Μ	$Mega - prefix$ for 10^6 multiplier	
m	meter	
μ	m icro – prefix for 10 ⁻⁶ multiplier	
NB	Narrowband	
QP	Quasi-Peak	
RE	Radiated Emissions	
RF	Radio Frequency	
rms	root-mean-square	
SN	Serial Number	
S/A	Spectrum Analyzer	
V	Volt	

2 Equipment Under Test

2.1 EUT Identification & Description

The Etymotic Research Companion Mic Product implements a low power RF transmitter to combine audio input from up to 4 devices to provide a composite audio to the user. The RF transmitter uses a digital modulation.

ITEM	DESCRIPTION
Manufacturer:	Etymotic Research
FCC ID:	RWT-ER84
Model:	CM4
EUT Name:	Companion Mic
FCC Rule Parts:	§15.247
Frequency Range:	2404-2480MHz
Maximum Output Power:	2.04mW (3.1dBm)
Modulation:	Digital modulation
Occupied Bandwidth:	876.4kHz
Keying:	Automatic, Manual
Type of Information:	audio
Number of Channels:	39
Power Output Level	Fixed
Antenna Connector	NA
Antenna Type	Internal Chip Antenna (0dBi)
Interface Cables:	Charging/Microphone
Power Source & Voltage:	3.7VDC Internal Battery

Table 1: Device Summary

2.2 Test Configuration

The Etymotic Research's Companion Mic Product was operated with the 3.7VDC shipped with the unit. A temporary antenna connector was used for conducted test at the output of the transmitter.

2.3 Testing Algorithm

Etymotic Research's Companion Mic Product was programmed for DTS operation in a test mode using the volume up down buttons to set the appropriate channel.

Worst case emission levels are provided in the test results data.

2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

D01 DTS Meas Guidance v03r02" June 5 2014 Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247.

ANSI C63.4-2009 Methods of Measurement of Radio Noise from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

ANSI C63.10-2009 "American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices"

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see

Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_{c} = \pm \sqrt{\frac{a^{2}}{div_{a}^{2}} + \frac{b^{2}}{div_{b}^{2}} + \frac{c^{2}}{div_{c}^{2}} + \dots}$$

Where $u_c = standard$ uncertainty

a, b, c,.. = individual uncertainty elements

Div_{a, b, c} = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U	= expanded uncertainty
k	= coverage factor
	$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc	= standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is <u>not</u> used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 2 below.

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

3 Test Equipment

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment

Test Name: Bench Conducted RF Tests		Test Date: :	5/15/2015
Asset # Manufacturer/Model		Description	Cal. Due
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	6/6/2015

Test Name:	Radiated Emissions	Test Date:	05/21/2015
Asset #	Manufacturer/Model	Description	Cal. Due
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	6/6/2015
644	SUNOL SCIENCES CORPORATION - JB1 925-833- 9936	BICONALOG ANTENNA	1/17/2016
559	HP - 8447D	AMPLIFIER	2/20/2016
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	6/6/2015
66	B&Z - BZ-01002650-401545-282525	PRE-AMPLIFIER RF. 1-26.5GHZ	10/23/2015
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	8/1/2016
282	ITC - 21X-3A1	WAVEGUIDE 6.8-15GHZ	10/22/2016
283	ITC - 21KU-3A1	WAVEGUIDE 9.8-20.5GHZ	8/1/2016

4 Test Summary

The Table Below shows the results of testing for compliance with a Digital Transmission System in accordance with FCC Part 15.247 10/2013. Full results are shown in section 5.

TX Test Summary (Digital Transmission System (DTS))				
FCC Rule Part	Description	Result		
15.247 (2)	6dB Bandwidth	Pass		
15.247 (2)(b)(3)	Transmit Output Power	Pass		
15.247 (e)	Power Spectral Density	Pass		
15.247 (d)	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass		
15.205 15.209	General Field Strength Limits (Restricted Bands & RE Limits)	Pass		
15.207	AC Conducted Emissions	NA (unit does not transmit when charging)		

Table 4: Test Summary Table

5 Test Results

5.1 Occupied Bandwidth:

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.

For Direct Sequence Spread Spectrum Systems, FCC Part 15.247 requires the minimum 6 dB bandwidth be at least 500 kHz.

D01 DTS Meas Guidance v03r02 DTS Bandwidth 8.1 Option 1 was used for the test method.

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

Table 5: Occupied Bandwidth Spectrum Analyzer Settings

At full modulation, the occupied bandwidth was measured as shown:

Table 6 provides a summary of the Occupied Bandwidth Results.

Table 6: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
Low Channel: 2404MHz	876.4kHz	>500kHz	Pass
Mid Channel: 2440MHz	861.4kHz	>500kHz	Pass
High Channel: 2480MHz	843.4kHz	>500kHz	Pass

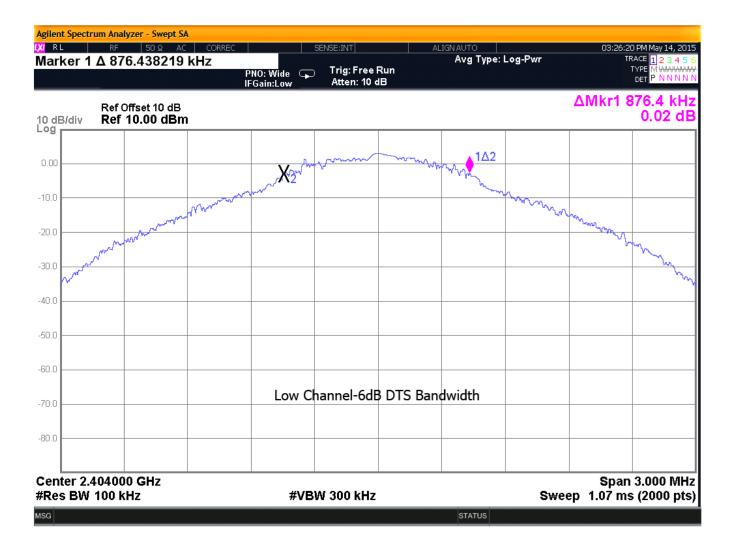


Figure 1: Occupied Bandwidth, Low Channel

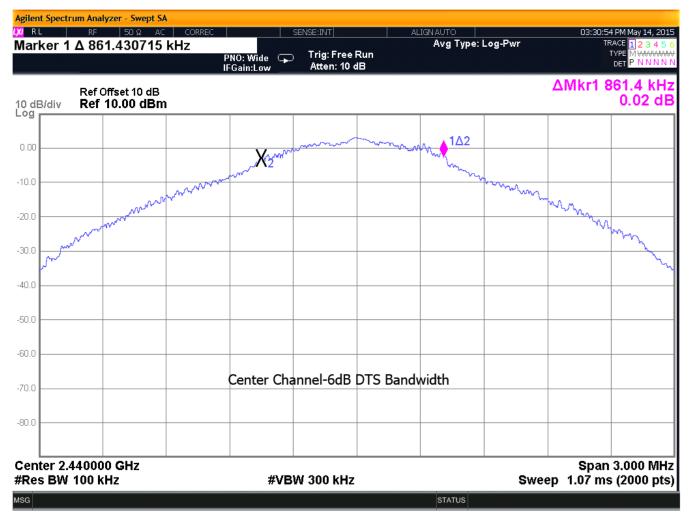


Figure 2: Occupied Bandwidth, Mid Channel

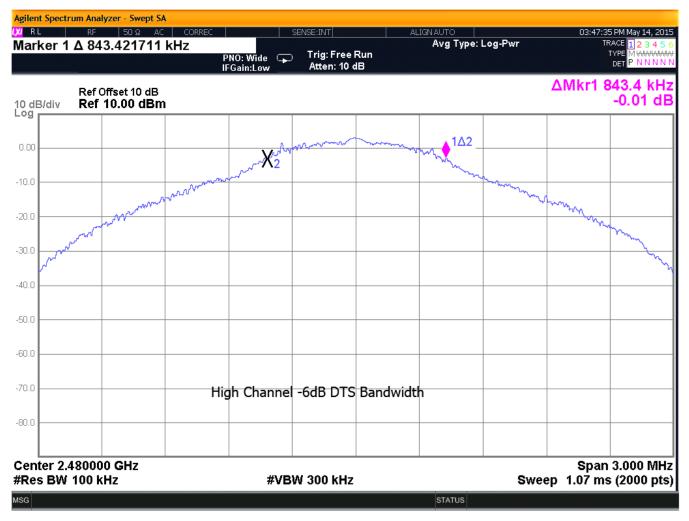


Figure 3: Occupied Bandwidth, High Channel

5.2 **RF Power Output:**

To measure the output power the frequency dwelled on a low, high and middle channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system.

D01 DTS Meas Guidance v03r02 Fundamental emission output power 9.1.1 RBW \geq DTS bandwidth was used for the test method.

Resolution Bandwidth	Video Bandwidth
2MHz	8MHz

Table 7: Spectrum Analyzer Settings

Table 8: RF Power Output

Frequency	Level	Limit	Pass/Fail
Low Channel: 2404MHz	3.10 dBm	30 dBm	Pass
Mid Channel: 2440MHz	3.07 dBm	30 dBm	Pass
High Channel: 2480MHz	2.92 dBm	30 dBm	Pass

.L F	A <mark>nalyzer - Swept SA</mark> RF 50 Ω AC CORF		GENSE:INT	ALIGNAUTO		0:22 PM May 14,
ker 1 2.4	103653576788 GH	Z PNO: Fast 🖵 IFGain:Low	Trig: Free Run Atten: 10 dB	Avg Type: Lo	>g-Pwr	TRACE 1234 TYPE MWWW DET PNN
	ef Offset 10 dB ef 10.00 dBm				Mkr1 2.403	653 6 G 3.10 dE
			↓ ¹			
					- Andrew - Andrew Andrew Andrew - Andr	
		Peak Powe	er- Low Chann	nel		
lter 2.404 s BW 2.0		#VB	W 8.0 MHz		Sp Sweep 1.07	an 5.000 N ms (2000 I
				STATUS		

Figure 4: RF Peak Power, Low Channel

RL			ENSE:INT		04:02:39 PM May 14,
rker 1	2.439648574287	FHZ PNO: Fast IFGain:Low	Trig: Free Run Atten: 10 dB	Avg Type: Log-	Pwr TRACE 123 TYPE MWWW DET PNNI
B/div	Ref Offset 10 dB Ref 10.00 dBm				Mkr1 2.439 648 6 G 3.07 dE
			↓1		
					and the state of t
<u> </u>		Peak Po	wer- Center Cha	anel	
<u> </u>					
<u> </u>					
	140000 GHz 2.0 MHz	#VB\	N 8.0 MHz		Span 5.000 M Sweep 1.07 ms (2000 p
				STATUS	

Figure 5: RF Peak Power, Mid Channel

	Ω AC CORRE		SENSE:INT				04:05:16 Pf	
(er 1 2.479631)	065533 GHz	PNO: Fast 🖵 IFGain:Low	Trig: Free l Atten: 10 d	Run IB	Avg Type:	Log-Pwr	TYP	E 1 2 3 E M WWA T P N N
Ref Offset 1 Vdiv Ref 10.00						Mk	r1 2.479 631 2.9	1 C 92 d
			↓ ¹					
								and that the second
		Peak Pow	er- High Cl	hannel				
er 2.480000 GHz BW 2.0 MHz	Z	#\/R	W 8.0 MHz			Swe	Span 5. eep 1.07 ms ()	000
		#VD			STATUS	500	, per 1.07 ma (2000

Figure 6: RF Peak Power, High Channel

5.3 Power Spectral Density

The spectrum analyzer was set to peak detect mode with a RBW of 100kHz ,VBW of 300kHz across a 1.32MHz span using an auto sweeptime. The frequency dwelled on a low, high and middle channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator and other losses in the system. The highest level detected was then recorded and compared to the limit of 8dBm. The following table and plots give the results for power spectral density testing.

The measurements were performed using D01 DTS Meas Guidance v03r02 Option 10.2 Method PKPSD (peak PSD).

Table 9: Spectrum Analyzer Settings

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

Table 10: Power Spectral Density

Frequency	Peak Level	Limit	Pass/Fail
Low Channel: 2404MHz	2.86dBm	8 dBm	Pass
Mid Channel: 2440MHz	2.91dBm	8 dBm	Pass
High Channel: 2480MHz	2.75dBm	8 dBm	Pass

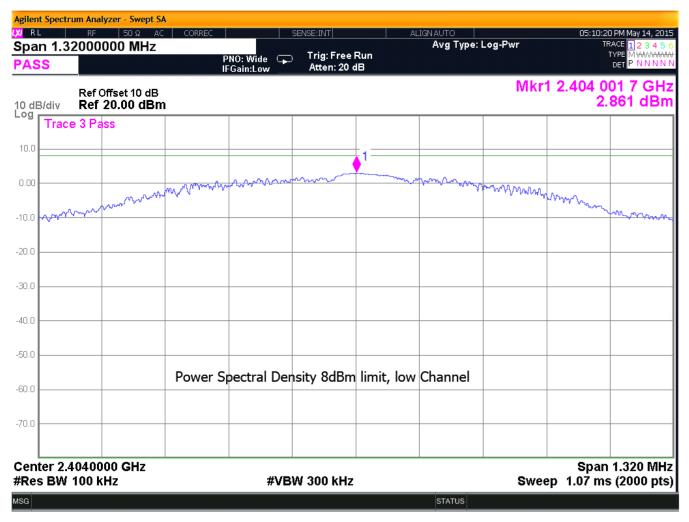


Figure 7: Power Spectral Density, Low Channel

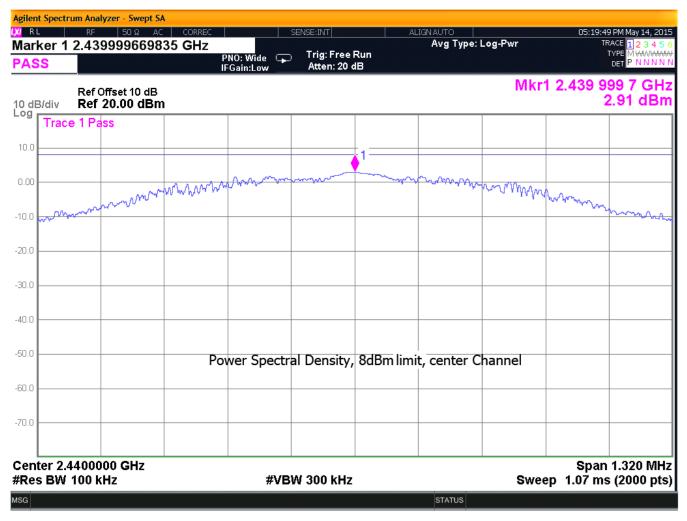


Figure 8: Power Spectral Density, Center Channel

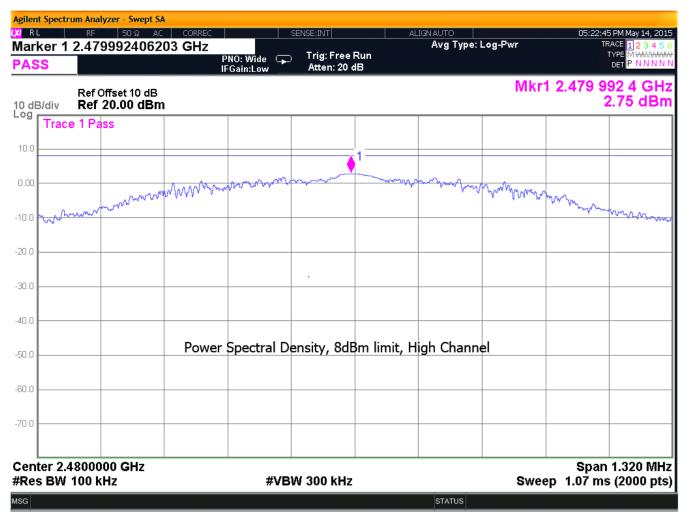


Figure 9: Power Spectral Density, High Channel

5.4 Conducted Spurious Emissions at Antenna Terminals

The EUT must comply with requirements for spurious emissions at antenna terminals. Per §15.247(d) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 100 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

The measurements were performed using D01 DTS Meas Guidance v03r02 section 11.0 Emissions in non-restricted frequency bands.

The following are plots of the conducted spurious emissions data.

Resolution Bandwidth	Video Bandwidth
100kHz	300kHz

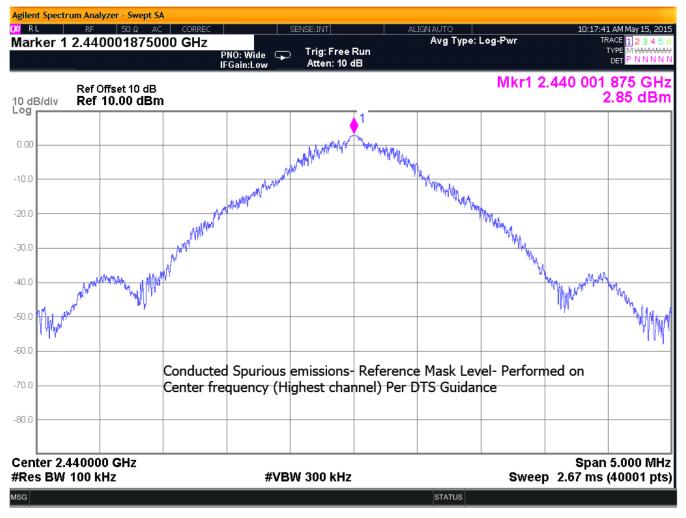


Figure 10: Reference level of Channel with Highest PSD for Mask

LXI RL	um Analyzer - Swept SA RF 50 Ω AC 2.31216450000		SENSE:INT			IGNAUTO	Log-Pwr	11:45:56 AM May 15, 2015 TRACE 11 2 3 4 5 6	
PASS		Р	NO: Fast 🖵 Gain:Low	Trig: Free Atten: 10 d	Run 18	Avg Hold:>1	100/100		
10 dB/div Log	Ref Offset 10 dB Ref 10.00 dBm						Iv	1kr1 2.31: -48.	2 16 GHz 330 dBm
Trac	e 1 Pass								
0.00									
-10.0									
-20.0									
-30.0									
-40.0									4
-50.0									
-70.0	(head along of the second s	alandary for the schola	1 giling hayakarata baha baha amananang panabahan aka	, la atralación de molanes plate Nacional anticidades por constantes en	Allahan mahani kanina maaning manajara kanina	falada (jelova) sadi balijalat Mangelesen serena serena serena	al villeg yn ygan de ^g lyn ffel yn f	مراجع معرفي ما محمل و المربي المراجع المراجع المراجع المربي . محمد مراجع محمد المراجع المحمد محمد محمد محمد محمد محمد محمد محمد	
-80.0		Conducte	d Spurious	s- Low Cha	nnel				
								0 4	
Start 30 N #Res BW			#VB	W 300 kHz			Swee	Stop p 221 ms	2.340 GHz (40001 pts)
MSG	STATUS								

Figure 11: Conducted Spurious Emissions, Low Channel 30 - 2340MHz

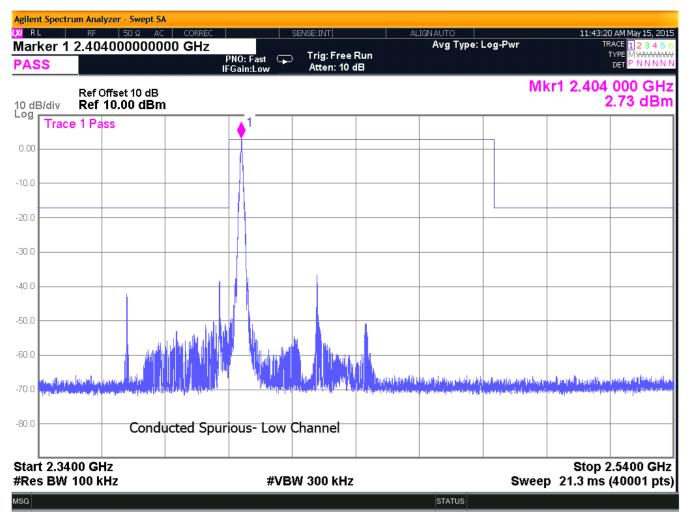


Figure 12: Conducted Spurious Emissions, Low Channel 2.54 – 2.54GHz

<mark>gilent Spect</mark> / RL	rum Analyzer - Swept SA RF 50 Ω AC	CORREC	SEN	ISE:INT	AL	IGN AUTO		12:13:55	5 PM May 15, 201
larker 1 <mark>ASS</mark>	3.72449800000			Trig: Free F Atten: 10 d	Run B	Avg Type: I Avg Hold:≻1	_og-Pwr 100/100		ACE 12345 IYPE MWWW DET PNNNN
) dB/div	Ref Offset 10 dB Ref 10.00 dBm						Mkr1	1 3.724 4 -62.	98 0 GH 906 dBr
Trac	e 1 Pass								
.00									
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).0	lanna a fha shi alaan da baaliyaa da yaa da daraa la aa Yaay saa taaba Cina ^{daa} maha yaa aa da baada da aa ay	teres al relation of the property of the prope		and a state of the		hin this of the system ().		n dharan dalaman dalaman dalaman dalaman Manana dalaman d	an an least a languad An tracactoria anna an
).0		Conduct	ed Spurid	ous-Low	Channel				
art 2.54	100 GHz							Stop 4	.0000 GH
	100 kHz		#VBW 300 kHz				Swee	p 141 ms	(40001 pt
G					STATUS				

Figure 13: Conducted Spurious Emissions, Low Channel 2.54 – 4GHz

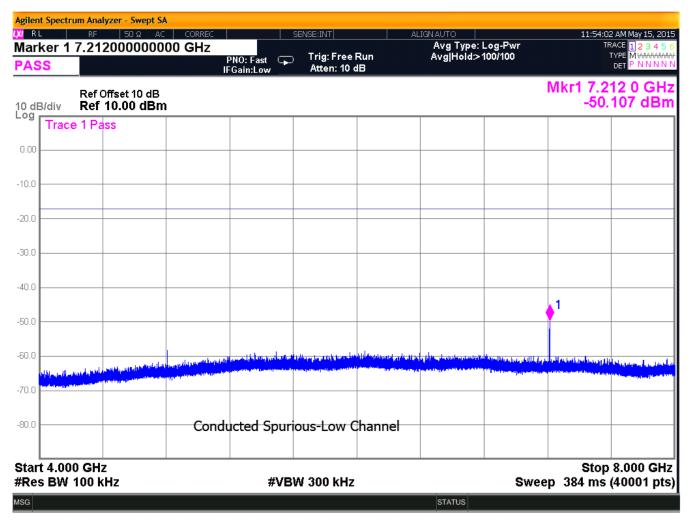


Figure 14: Conducted Spurious Emissions, Low Channel 4 - 8GHz

LXI RL	rum Analyzer - Swept S/ RF 50 Ω AC	CORREC		SENSE:INT	AL	IGN AUTO Avg Type: I	og-Pwr) AM May 15, 2015 ACE 123456
PASS		F	PNO: Fast 🖵 Gain:Low	Trig: Free Atten: 10 o		Avg Hold:>1	100/100		
10 dB/div Log	Ref Offset 10 dB Ref 10.00 dBm	ı							15 9 GHz 496 dBm
Trac	e 1 Pass								
0.00									
-10.0									
-20.0									
-30.0									
-40.0									
-50.0				1					
-60.0	In the second	half and a second and the	lalan paratal _{na b} atak _{na b} ah	a la malinistita	a ha dan su da ka	Latatege and faither age	ante de thete ar	n an dia mandra amin'ny fisiana dia mandra amin'ny fisiana dia mandra amin'ny fisiana dia mandra dia mandra di Na fisiana dia mandra di	and a language of the second
-70.0	tandar, ten data sa kana data sa Kana data sa kana da	In the state of th	an a statistic sector	appelland a particular	The second s				
-80.0		Conducte	d Spurious	_Low Cha	nnel				
Start 8.00 #Res BW			#VB	W 300 kHz			Swee	Stop 1 p 384 ms	2.000 GHz (40001 pts)
MSG						STATUS			(

Figure 15: Conducted Spurious Emissions, Low Channel 8 - 12GHz

LXI RL	<mark>rum Analyzer - Swept S/</mark> RF 50 Ω AC	CORREC		SENSE:INT	AL	IGN AUTO			7 AM May 15, 2015	
Marker 1 PASS	15.937800000	F	PNO: Fast 😱 Gain:Low	Trig: Free Atten: 10 o	Run 18	Avg Type: Avg Hold: 8	Log-Pwr 9/100		ACE 123456 TYPE M WWWWW DET PNNNN	
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm	ı					N		37 8 GHz 608 dBm	
Log	e 1 Pass									
0.00										
-10.0										
-20.0										
-30.0										
-40.0										
-50.0							Jugaran da da ta	ihoro, da ilitarillosta dinte il	allh, Bill, Aburrahlana	
-60.0	ومروحا واللقون وحفظه والمقاد	lashirin sinnasa	وحواجته بالالتوجية بتعرز لتدرقون		1999 - 19	Andrease and a second s	and the second party being a second party in a	<mark>na di kanana katati di katana</mark>	<u>, to a set a tradici danti dana s</u>	
-70.0		horisten and see a future of	and a second							
-80.0	Cor	nducted Sp	urious-Lov	v Channel						
#Res BW	Start 12.000 GHz Stop 16.000 GHz #Res BW 100 kHz #VBW 300 kHz Sweep 384 ms (40001 pts)									
MSG						STATUS				

Figure 16: Conducted Spurious Emissions, Low Channel 12 - 16GHz

KIRL	um Analyzer - Swept S/ RF 50 Ω AC 17.052700000	: CORREC		SENSE:INT	AL	IGNAUTO	og-Pwr		2 PM May 15, 201 ACE 1 2 3 4 5 1
ASS	_	F	PNO: Fast 😱 Gain:Low	Trig: Free Atten: 10 o	Run IB	Avg Hold: 7	0/100		IYPE MWWWW DET PNNNN
0 dB/div	Ref Offset 10 dB Ref 10.00 dBm	ı					IV	1kr1 17.0 -51.	52 7 GH: 715 dBn
Trace	e 1 Pass								
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10.0									
:0.0									
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0.0					i santin i				
0.0	Con	ducted Spu	urious- Lov	v Channel					
0.0									
tart 16.0 Res BW			#VB	W 300 kHz			Swee	Stop 2 p 384 ms	:0.000 GH: (40001 pts
SG						STATUS			

Figure 17: Conducted Spurious Emissions, Low Channel 16 - 20GHz

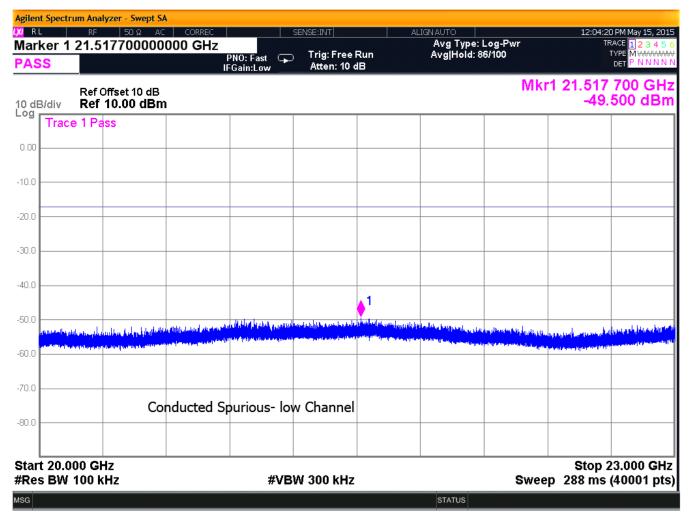


Figure 18: Conducted Spurious Emissions, Low Channel 20 - 23GHz

LXI RL	RF 50 Ω AC 24.963550000 AC	CORREC	NO: Fast Gain:Low	SENSE:INT Trig: Free l Atten: 10 c	Run	IGN AUTO Avg Type: Avg Hold: 9	Log-Pwr 3/100	TR	1 PM May 15, 2015 RACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N N
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm		Gam.cow				M		3 55 GHz 308 dBm
0.00	e 1 Pass								
-10.0									
-20.0									
-30.0									
-40.0								1. I. I	1
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-60.0									
-80.0		Cor	ducted Sp	urious-Lov	v Channel				
Start 23.0 #Res BW			#VB	W 300 kHz			Swee	Stop 2 p 192 ms	25.000 GHz (40001 pts)
MSG						STATUS			

Figure 19: Conducted Spurious Emissions, Low Channel 23-25GHz

LXI RL	r 1 2.03346	50Ω AC C	DRREC				IGNAUTO	_og-Pwr	TR	10:36:16 AM May 15, 2015 TRACE 12 3 4 5 6	
PASS			PNO: Fa IFGain:Lo		Trig: Free Atten: 10 d	Run B				DET P N N N N N	
10 dB/d Log	Ref Offse liv Ref 10. 0							N	/lkr1 2.03 -62	3 46 GHz 2.53 dBm	
Т	race 1 Pass										
0.00											
-10.0											
-20.0											
-30.0											
-40.0											
-50.0									.1		
-60.0	والمراسط محمد مادواللامان ماستعماد	and a state of the second state of the	19 LUNA DALANDAR	reeged as to be the second	patricky transfer	en de fond de foreigne gebou		madaquanti, almini	and a start of the start	anna a shekara a shek	
-70.0	n a g _u l fan an frank differen (na da a	ayrettategalikkitettate	nducted Sp								
-00.0			nucceu op	unous	Center C						
	80 MHz BW 100 kHz			#VBW	300 kHz			Swee	Stop 221 ms (2.340 GHz (40001 pts)	
MSG	SG STATUS										

Figure 20: Conducted Spurious Emissions, Center Channel 30 – 2340MHz

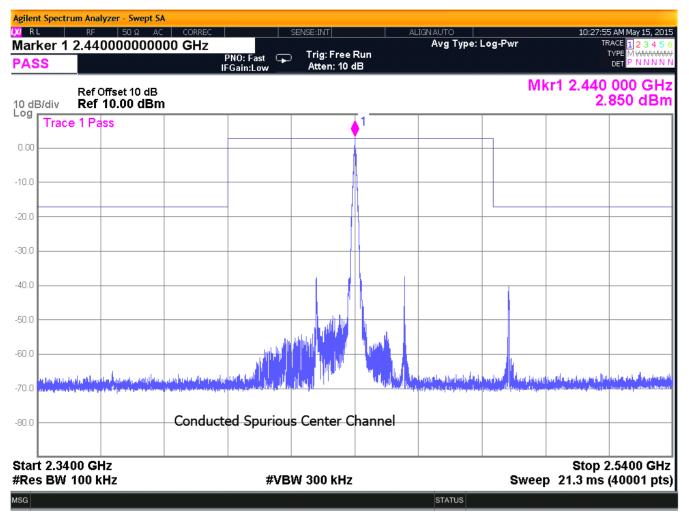


Figure 21: Conducted Spurious Emissions, Center Channel 2.3 – 2.54GHz

RL	rum Analyzer - Swept RF 50 Ω 2.556717000	AC CORREC		SENSE:INT	AL	IGNAUTO	Log-Pwr		9 AM May 15, 2
SS		F	PNO: Fast 🕞 Gain:Low) Trig: Free Atten: 10 (Run 18	Avg Hold:>	100/100		
dB/div	Ref Offset 10 dE Ref 10.00 dB						Mkr	1 2.556 7 -41.	17 0 GI 907 dB
Trac	e 1 Pass								
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1									
□									
all Handstop		Real of the second second			hadanka organish ka	a Markey (Stat, Stat, John Spreed A		na kilo ka kipingan king Panangan king	an a
		Conducted	Spurious	Center Ch	annel				
	400 GHz 100 kHz		#VB	W 300 kHz			Swee	، Stop p 141 ms	4.0000 G (40001 p
						STATUS			

Figure 22: Conducted Spurious Emissions, Center Channel 2.54 – 4GHz

RL	<mark>rum Analyzer - Swept S/</mark> RF 50 Ω AC	CORREC		SENSE:INT	AL				0 AM May 15, 20:
arker 1 <mark>ASS</mark>	7.3200000000		PNO: Fast 🖵 -Gain:Low	Trig: Free F Atten: 10 d	Run IB	Avg Type: Avg Hold:>	Log-Pwr 100/100		RACE 12345 TYPE MWWWW DET PNNNN
) dB/div	Ref Offset 10 dB Ref 10.00 dBm	1						Mkr1 7.3 -48.	20 0 GH 484 dBr
^{rg} Trac	e 1 Pass								
D.0									
D.0									
D.O 0.C									
D.O									
0.0								• '	
	ومعاده والمتراس ومعمد ألكا محدد والاحتداد	In the second		aler blans tradition and an					
D.O 2.000	A CONTRACT OF A								
0.0		Condu	cted Spuri	ous-Cente	r Channel				
art 4.00 Res BW	00 GHz 100 kHz		#VB	W 300 kHz			Swee	Stop p 384 ms	8.000 GH (40001 pt
G						STATUS			(

Figure 23: Conducted Spurious Emissions, Center Channel 4 - 8GHz

X/RL	um Analyzer - Swept S/ RF 50 Ω AC	CORREC		SENSE:INT	AL				5 AM May 15, 2015
Marker 1 PASS	11.816700000		PNO: Fast 🖵 Gain:Low) Trig: Free Atten: 10 (Run dB	Avg Type: Avg Hold:>*	100/100		RACE 123456 TYPE MWWWWW DET PNNNN
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm	ı					N		16 7 GHz 381 dBm
-og Trace	e 1 Pass								
0.00									
10.0									
20.0									
30.0									
40.0									
50.0									
60.0						and the state of the state of the		a ser an a das render	1 Municipal Annual Annu
70.0	te in the second se	dagtas, tildatas bilanga ditilang nagangan ditilang bilang bilangan nagangan ditilang bilang						Annual and a product products	
70.0									
80.0		Condu	icted Spuri	ous- Cente	er Channel				
Start 8.00 #Res BW		1	#VB	W 300 kHz	1		Swee	Stop 1 p 384 ms	 2.000 GHz (40001 pts)
ISG						STATUS			

Figure 24: Conducted Spurious Emissions, Center Channel 8-12GHz

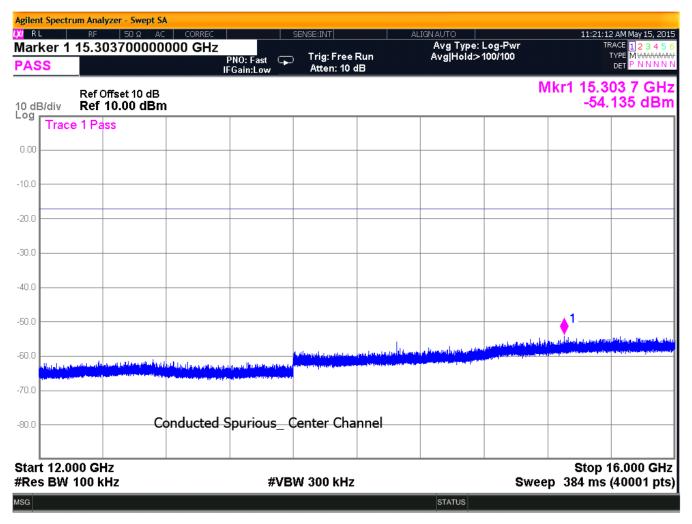


Figure 25: Conducted Spurious Emissions, Center Channel 12 - 16GHz

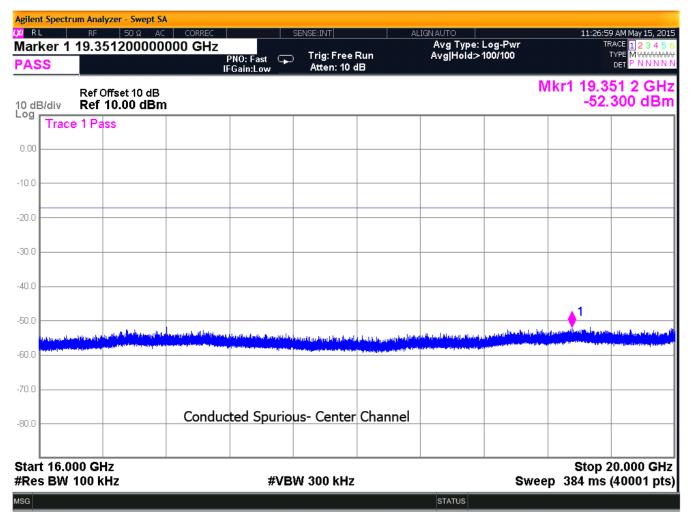


Figure 26: Conducted Spurious Emissions, Center Channel 16 - 20GHz

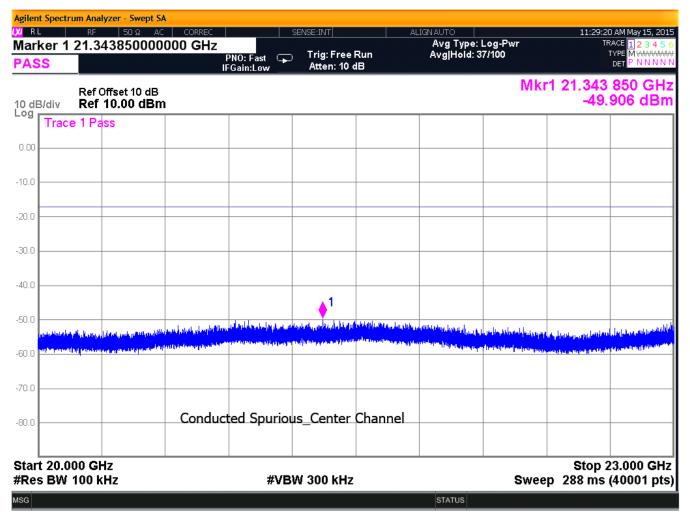


Figure 27: Conducted Spurious Emissions, Center Channel 20-23GHz

LXIRL	um Analyzer - Swept SA RF 50 Ω AC 24.888550000	CORREC 000 GHz	PNO: Fast	SENSE:INT) Trig: Free I Atten: 10 c	Run	IGN AUTO AVg Type: I Avg Type: 5	Log-Pwr 7/100	TR	9 AM May 15, 2015 RACE 1 2 3 4 5 6 TYPE M WWWWW DET P N N N N
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm		Gain:Low	Aπen: 10 c	18		M	(r1 24.88 -46.	
	e 1 Pass								
-10.0									
-20.0									
-30.0									
-40.0									1
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	and the state of t								
.80.0		Co	onducted S	Spurious_C	enter Char	nel			
								9 4 7	C 000 011-
Start 23.0 #Res BW			#VB	SW 300 kHz		STATUS	Swee	Stop 2 p 192 ms	25.000 GHz (40001 pts)

Figure 28: Conducted Spurious Emissions, Center Channel 23-25GHz

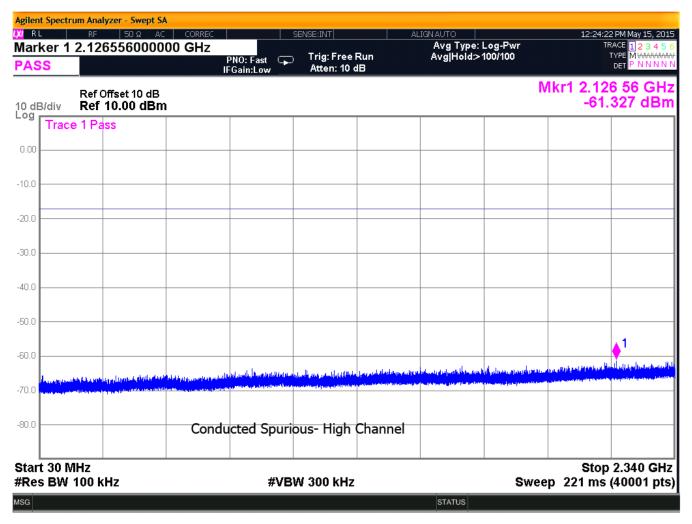


Figure 29: Conducted Spurious Emissions, High Channel 30 - 2340MHz

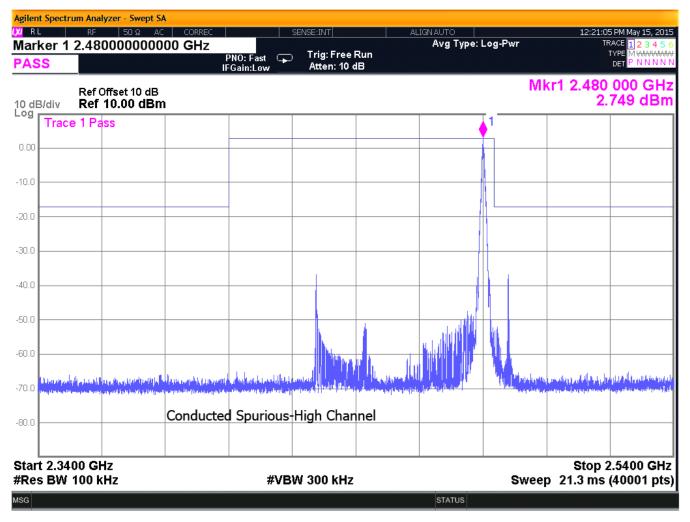


Figure 30: Conducted Spurious Emissions, High Channel 2.34 - 2.54GHz

RL	rum Analyzer - Swept S RF 50 Ω A	C CORREC		SENSE:INT	AL				0 PM May 15, 20
arker 1 <mark>ASS</mark>	2.5564980000		PNO: Fast 🖵 Gain:Low	Trig: Free Atten: 10 d		Avg Type: Avg Hold:>			RACE 12345 TYPE MWWW DET PNNNN
dB/div	Ref Offset 10 dB Ref 10.00 dBn						Mkr	1 2.556 4 -41.	98 0 GH 144 dBi
^{rg} Trac	e 1 Pass								
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.0	Cond	lucted Spur	ious_ High	Channel					
	100 GHz 100 kHz		#VB	W 300 kHz		-	Swee	Stop 4 p 141 ms	4.0000 GH (40001 pt
3						STATUS		-	· ·

Figure 31: Conducted Spurious Emissions, High Channel 2.54 – 4GHz

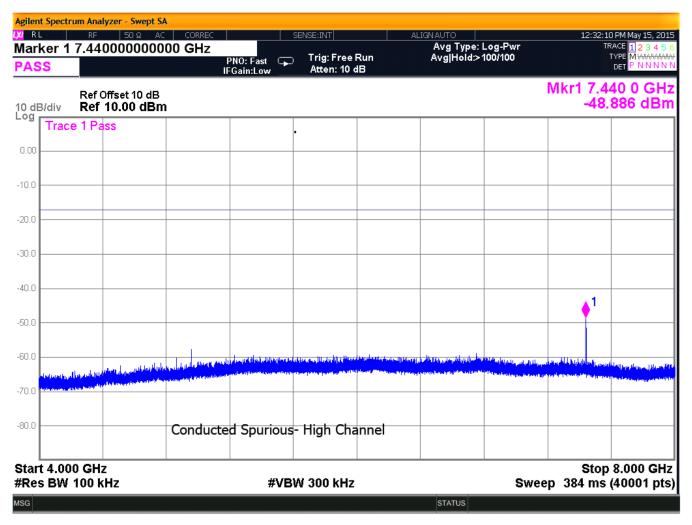


Figure 32: Conducted Spurious Emissions, High Channel 4 - 8GHz

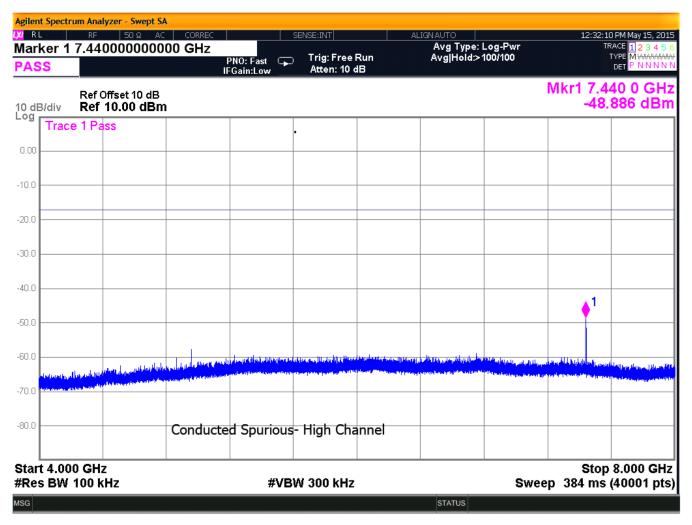


Figure 33: Conducted Spurious Emissions, High Channel 8 - 12GHz

LXIRL	r <mark>um Analyzer - Swept S/</mark> RF 50Ω AC 15.758800000	CORREC		SENSE:INT	AL	IGNAUTO	on-Pwir) PM May 15, 2015 ACE 123456
PASS	15.758800000	F	PNO: Fast 🖵 Gain:Low	Trig: Free Atten: 10 o		Avg Hold:>*	100/100		DET PNNNN
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm	1					N		58 8 GHz 339 dBm
Log Trac	e 1 Pass								
0.00									
-10.0									
-20.0									
-30.0									
-40.0									
-50.0								. e manunda stel statt differen	1
-60.0	u	a konstruction des	na	the of the test of the second s	اللفارية بسيعت وكاورا ليرب				ی هرو همگف هر در را ط یو هم و محمد ار
-70.0	and the first sector of the part of the sector of the sect								
-80.0		Condu	ucted Spur	ious- High	Channel				
Start 12.0 #Res BW		1	#VB	W 300 kHz	1	1	Swee	Stop 1 p 384 ms	6.000 GHz (40001 pts)
MSG						STATUS			(

Figure 34: Conducted Spurious Emissions, High Channel 12 - 16GHz

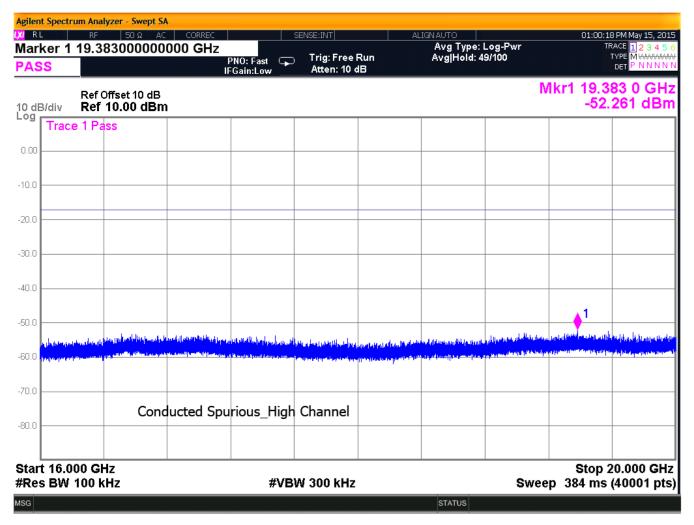


Figure 35: Conducted Spurious Emissions, High Channel 16 - 20GHz

LX/RL	um Analyzer - Swept SA RF 50 Ω AC CO 21.5384000000000	GHz PNO: Fast 😱	SENSE:INT	ALIGNAUTO Avg Type: Log-Pwr Avg Hold: 39/100	01:02:02 PM May 15, 2015 TRACE 1 2 3 4 5 6 TYPE MWWWWW DET P N N N N
10 dB/div	Ref Offset 10 dB Ref 10.00 dBm	IFGain:Low	Atten: 10 dB		Mkr1 21.538 400 GHz -49.482 dBm
0.00	e 1 Pass				
-10.0					
-20.0					
-30.0					
-40.0			1		
-50.0	langking ang pang pilang pang pang pang pang pang pang pang p	ار الاردار المراجع بالمعامل المراجع ال مراجع المراجع ا	na avala papal apola pia di balan barangi apo	a second s	مريحية المريحية الم
-60.0	a food point (191, 201 first brook strain and a			n a hand hand an paramala kan dalamata kan dalamata dalamata dalamata dalamata dalamata dalamata dalamata dalam	Ning and the state of the state
-70.0		Conducted S	purious- High Ch	annel	
-80.0			· · ·		
Start 20.0 #Res BW		#VB	W 300 kHz	S	Stop 23.000 GHz weep 288 ms (40001 pts)
MSG				STATUS	- • • •

Figure 36: Conducted Spurious Emissions, High Channel 20 - 23GHz

LXIRL	<mark>um Analyzer - Swept S/ RF 50 Ω AC 24.971350000</mark>	CORREC		SENSE:INT		IGN AUTO	Log-Pwr	TF	5 PM May 15, 2015 ACE 123456
PASS		F	PNO: Fast 🕞 Gain:Low	Trig: Free Atten: 10 o		Avg Hold: 5	9/100		
10 dB/div Log	Ref Offset 10 dB Ref 10.00 dBm	1					M		1 35 GHz 058 dBm
Trac	e 1 Pass								
0.00									
-10.0									
-20.0									
-30.0									
-40.0									1
-50.0	الإمامية والمتأمل المروا أتلمه التلالية ومشرعتها	n	والمعارير العالية المتلاف والعالية التعم	angude tapanjatela tapantat		and the second	golad kaskadagad godi a andari kashadaga sa sa sa	and the first state of the first state of the state of th	rostrativasiajariseidaajarja. Elistikelli heletikellineksi me
	land for the land of the second s In the second			a an	i i fraj i na sense i del con los federals I	and the state of the second			
-70.0									
	C	onducted S	Spurious_	High Chan	nel				
-80.0									
Start 23.0 #Res BW		1	#VB	W 300 kHz	1	1	Swee	Stop 2	25.000 GHz (40001 pts)
MSG			#*			STATUS	Givee	P 132 113	(+0001 pt3)

Figure 37: Conducted Spurious Emissions, High Channel 23 - 25GHz

5.4.1 Band Edge Compliance

Close-up plots of the upper and lower channels with respect to the nearest authorized band-edges are provided below. The tests were performed in the same manner as the above conducted spurious emissions tests

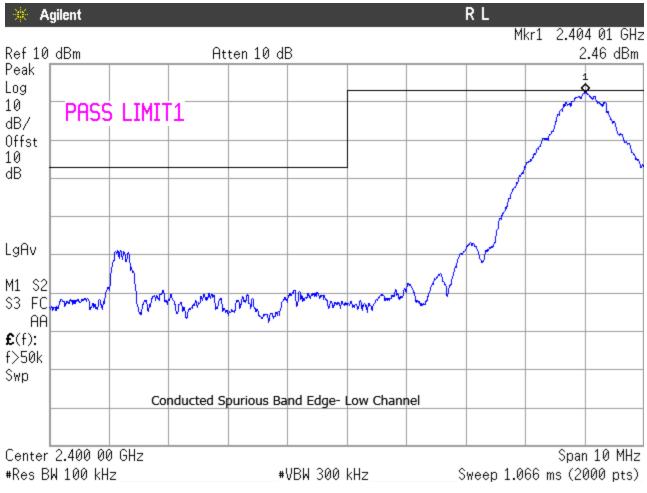


Figure 38: Lower Band-edge, Low Channel

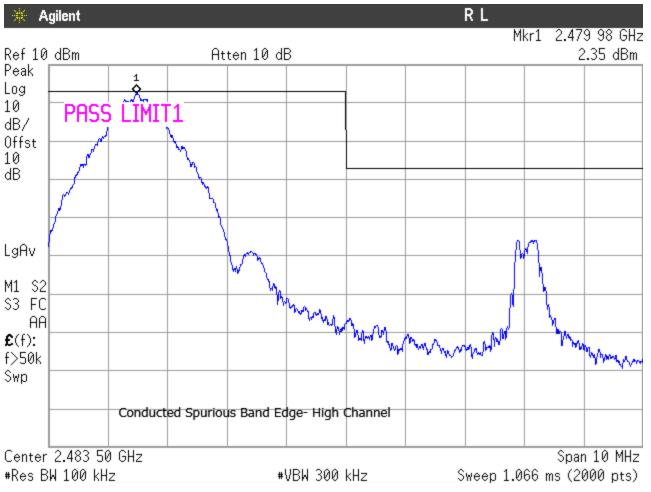


Figure 39: Upper Band-edge, High Channel

5.5 Radiated Spurious Emissions:

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

5.5.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The peripherals were placed on the table in accordance with ANSI C63.4. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured. Correction factors were then applied and the resulting value was compared to the limit.

The emissions were measured using the following resolution bandwidths:

Table 12: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	1MHz
>1000 MHz	1 MHz	3MHz

Detected signals above 1 GHz were averaged using an RMS detector with trace averaging and a duty cycle correction of 8.8dB added to the average reading per D01 DTS Meas Guidance v03r02 "12.2.5.2 Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction". Above 1 GHz RF absorbing material was placed on the open air test site between the Antenna and EUT in accordance with ANSI 63.4.

5.5.2 Duty Cycle Correction

DTS Guidance "12.2.5.2 Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction" states that for repetitive pulsing transmissions above 1GHz shall be measured with an RMS detector with trace averaging. For detected signals a duty cycle correction shall then be added to the result. Duty cycle determination was performed according to D01 DTS Meas Guidance v03r02 section 6.0 using method b (spectrum analyzer in zero span mode). D01 DTS Meas Guidance v03r02 section 12.2.5.2 states duty cycle correction using an RMS detector as: If power averaging (RMS) mode was used then the applicable correction factor is 10 log(1/x), where x is the duty cycle.

The duty cycle numbers are as follows:

On time = 327us, On and Off time =2.481ms, Duty cycle =0.132 (13.2%)10 log(1/x)= 10 log(1/0.132)= 8.8dB correction

Section 6.0 states in order to use this method VBW and RBW must be > than 50/T where T is the tx on time. As T= 327us then 50/T= 153kHz. The utilized RBW used was 1MHz and the VBW was 3MHz.

The following plots show the EUT transmission parameters.

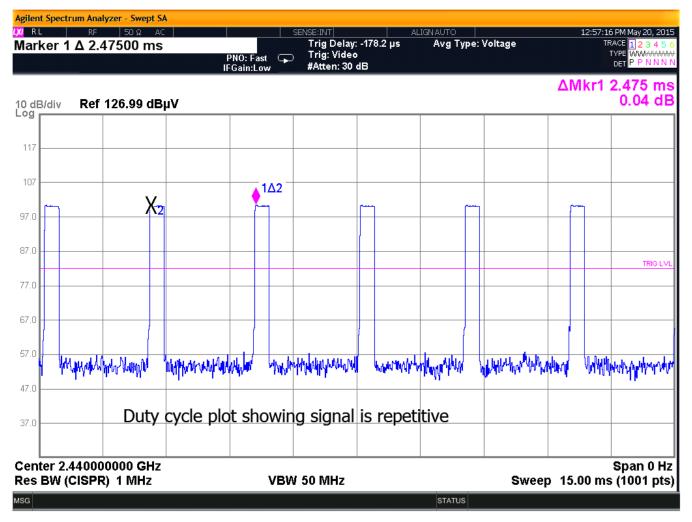


Figure 40: Plot Showing Transmission is Repetitive

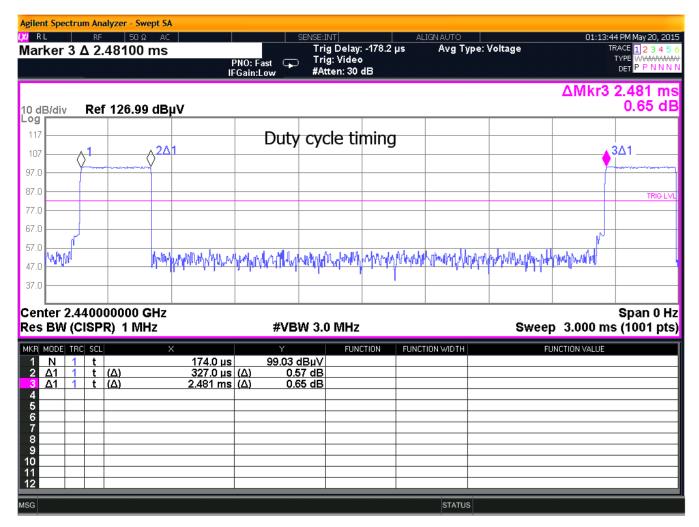


Figure 41: Duty Cycle Timing Plot

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)
Flat								
35.19	V	0.00	1.00	33.17	-6.2	22.2	100.0	-13.1
47.68	V	0.00	1.00	32.50	-14.9	7.6	100.0	-22.4
70.35	V	90.00	1.20	42.50	-15.4	22.5	100.0	-12.9
123.43	V	90.00	1.30	26.80	-9.1	7.7	150.0	-25.8
240.01	V	0.00	3.20	25.50	-11.3	5.1	200.0	-31.9
411.34	V	180.00	1.20	19.80	-6.7	4.5	200.0	-33.0
Upright								
35.19	V	350.00	1.00	32.50	-6.2	20.6	100.0	-13.7
47.68	V	0.00	1.00	33.20	-14.9	8.2	100.0	-21.7
70.35	V	350.00	1.00	41.90	-15.4	21.0	100.0	-13.5
123.43	V	0.00	1.40	27.20	-9.1	8.0	150.0	-25.4
240.01	V	0.00	3.00	26.60	-11.3	5.8	200.0	-30.7
411.34	V	0.00	2.90	18.50	-6.7	3.9	200.0	-34.3
On side								
35.19	V	10.00	1.00	33.20	-6.2	22.3	100.0	-13.0
47.68	V	10.00	1.00	34.10	-14.9	9.1	100.0	-20.8
70.35	V	0.00	1.00	40.20	-15.4	17.3	100.0	-15.2
123.43	V	10.00	1.00	26.90	-9.1	7.7	150.0	-25.7
240.01	V	10.00	2.50	26.50	-11.3	5.7	200.0	-30.8
411.34	V	350.00	3.00	19.20	-6.7	4.2	200.0	-33.6
Flat								
35.19	Н	0.00	4.00	30.19	-6.2	15.8	100.0	-16.0
49.84	Н	10.00	3.80	36.08	-15.8	10.3	100.0	-19.8
70.35	Н	90.00	3.50	39.31	-15.4	15.6	100.0	-16.1
123.43	Н	10.00	3.40	29.71	-9.1	10.7	150.0	-22.9
240.01	Н	10.00	2.30	23.38	-11.3	4.0	200.0	-34.0
411.34	Н	320.00	2.40	28.98	-6.7	12.9	200.0	-23.8
324.17	Н	90.00	2.50	25.30	-9.1	6.5	200.0	-29.8
Upright								
35.19	Н	10.00	4.00	29.50	-6.2	14.6	100.0	-16.7
49.84	H	10.00	4.00	35.20	-15.8	9.3	100.0	-20.6
70.35	H	120.00	4.00	38.20	-15.4	13.7	100.0	-17.2
123.43	H	0.00	3.20	26.80	-9.1	7.7	150.0	-25.8
240.01	Н	0.00	2.50	24.50	-11.3	4.6	200.0	-32.8
411.34	Н	180.00	2.50	27.50	-6.7	10.9	200.0	-25.3
324.17	H	270.00	2.30	25.80	-9.1	6.9	200.0	-29.3
On side								
35.19	Н	0.00	4.00	29.60	-6.2	14.7	100.0	-16.6

49.84	Н	0.00	4.00	33.50	-15.8	7.6	100.0	-22.3
70.35	Н	45.00	4.00	36.50	-15.4	11.3	100.0	-18.9
123.43	Н	10.00	3.80	27.20	-9.1	8.0	150.0	-25.4
240.01	Н	0.00	2.80	24.20	-11.3	4.4	200.0	-33.1
411.34	Н	190.00	1.90	25.60	-6.7	8.8	200.0	-27.2
324.17	Н	90.00	2.50	25.60	-9.1	6.7	200.0	-29.5

Emissions are the same on all channels

Table 14: Radiated Emission Test Data, High Frequency Data (>1GHz) (Restricted Bands)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Duty Cycle Correction (dB)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2390.00	V	10.00	2.30	72.50	0.00	-17.8	545.2	5000.0	-19.2	pk -bandedge TX at 2404MHz
2390.00	V	10.00	2.30	49.90	8.80	-17.8	111.3	500.0	-13.0	Avg -bandedge TX at 2404MHz
2483.50	V	90.00	2.70	77.25	0.00	-17.0	1025.8	5000.0	-13.8	pk -Bandedge US TX at 2480MHz
2483.50	V	90.00	2.70	54.55	8.80	-17.0	207.0	500.0	-7.7	Avg-bandedge US TX at 2480MHz
2390.00	Н	10.00	2.30	72.50	0.00	-17.8	545.2	5000.0	-19.2	pk -bandedge TX at 2404MHz
2390.00	Н	10.00	2.30	49.90	8.80	-17.8	111.3	500.0	-13.0	Avg -bandedge TX at 2404MHz
2483.50	Н	100.00	3.02	76.50	0.00	-17.0	940.9	5000.0	-14.5	pk -Bandedge US TX at 2480MHz
2483.50	Н	100.00	3.02	52.10	8.80	-17.0	156.2	500.0	-10.1	Avg-bandedge US TX at 2480MHz

No Harmonics or spurs were noted above 1GHz on any tested channel.