## Amber Helm Development L.C.

92723 Michigan Hwy-152 Sister Lakes, Michigan 49047 USA Tel: 888-847-8027

# **EMC Test Report**

**GCESP-182249TX** Issued: July 19, 2018

regarding

USA: CFR Title 47, Part 15.247 (Emissions) IC RSS-247/GENe Canada: (Emissions)

for



GC-ESP32-PORT-N

Category: WLAN+BLE Module

Judgements: FCC 15.247, ISED RSS-247 Compliant Testing Completed: August 12, 2018



Prepared for:

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## **Revision History**

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r0	July 19, 2018	Initial Release.	J. Brunett
r1	August 15, 2018	Revised Conducted RF Plots	J. Brunett
r2	August 22, 2018	Assorted Corrections.	J. Brunett
r3	September 7, 2018	Assorted Corrections.	J. Brunett

## Contents

Re	tevision History		2
Ta	Cable of Contents		2
1	Test Report Scope and Limitations1.1 Laboratory Authorization1.2 Report Retention1.3 Subcontracted Testing1.4 Test Data1.5 Limitation of Results1.6 Copyright1.7 Endorsements1.8 Test Location1.9 Traceability and Equipment Used	· · · · · · · · · · · · · · · · · · ·	. 5 . 5 . 5 . 5 . 5 . 5
2	Test Specifications and Procedures         2.1       Test Specification and General Procedures		<b>7</b> 7
3	Configuration and Identification of the Equipment Under Test3.1Description and Declarations.3.1.1EUT Configuration.3.1.2Modes of Operation.3.1.3Variants.3.1.4Test Samples.3.1.5Functional Exerciser.3.1.6Modifications Made.3.1.7Production Intent.3.1.8Declared Exemptions and Additional Product Notes.	· · · · · · · · · · · · · · · · · · ·	. 8 . 8 . 9 . 9 . 9
4	Emissions         4.1       General Test Procedures         4.1.1       Radiated Test Setup and Procedures         4.1.2       Conducted Emissions Test Setup and Procedures         4.1.3       Power Supply Variation         4.1.4       Intentional Emissions         4.2       Intentional Emissions         4.2.1       Duty and Transmission Cycle, Pulsed Operation         4.2.2       Fundamental Emission Bandwidth         4.2.3       Effective Isotropic Radiated Power         4.2.4       Power Spectral Density         4.3       Unintentional Emissions         4.3.1       Transmit Chain Spurious Emissions         4.3.2       Relative Transmit Chain Spurious Emissions	· · · · · · · · · · · · · · · · · · ·	$\begin{array}{cccccccccccccccccccccccccccccccccccc$

5	nent Uncertainty and Accreditation Documents	39
	General Radiated Spurious	

### List of Tables

1	Test Site List.
2	Equipment List
3	EUT Declarations
4	Pulsed Emission Characteristics (Duty Cycle)
5	Intentional Emission Bandwidth 16
6	Radiated Power Results
7	Power Spectral Density Results
8	Transmit Chain Spurious Emissions
9	Radiated Digital Spurious Emissions
10	AC Mains Power Conducted Emissions Results
10	AC Mains Power Conducted Emissions Results
11	Measurement Uncertainty

## List of Figures

1	Photos of EUT.	8
2	EUT Test Configuration Diagram.	9
3	Radiated Emissions Diagram of the EUT.	10
4	Radiated Emissions Test Setup Photograph(s).	11
5	Conducted RF Test Setup Photograph(s).	12
6	Conducted Emissions Setup Diagram of the EUT.	12
7	Conducted Emissions Test Setup Photograph(s).	13
8	Pulsed Emission Characteristics (Duty Cycle).	
9	Intentional Emission Bandwidth.	17
9	Intentional Emission Bandwidth.	18
9	Intentional Emission Bandwidth.	19
10	Conducted RF Power Plots	21
10	Conducted RF Power Plots	22
10	Conducted RF Power Plots	23
11	Power Spectral Density Plots.	25
11	Power Spectral Density Plots	
11	Power Spectral Density Plots	27
12	Conducted Transmitter Emissions Measured.	33
12	Conducted Transmitter Emissions Measured.	34
12	Conducted Transmitter Emissions Measured.	35
13	Accreditation Documents	39

### 1 Test Report Scope and Limitations

#### 1.1 Laboratory Authorization

Test Facility description and attenuation characteristics are on file with the FCC Laboratory, Columbia, Maryland (FCC Reg. No: US5348 and US5356) and with ISED Canada, Ottawa, ON (File Ref. No: 3161A and 24249). Amber Helm Development L.C. holds accreditation under NVLAP Lab Code 200129-0.

#### **1.2** Report Retention

For equipment verified to comply with the regulations herein, the manufacturer is obliged to retain this report with the product records for the life of the product, and no less than ten years. A copy of this Report will remain on file with this laboratory until July 2028.

#### 1.3 Subcontracted Testing

This report does not contain data produced under subcontract.

#### 1.4 Test Data

This test report contains data included within the laboratories scope of accreditation.

#### 1.5 Limitation of Results

The test results contained in this report relate only to the item(s) tested. Any electrical or mechanical modification made to the test item subsequent to the test date shall invalidate the data presented in this report. Any electrical or mechanical modification made to the test item subsequent to this test date shall require reevaluation.

#### 1.6 Copyright

This report shall not be reproduced, except in full, without the written approval of Amber Helm Development L.C..

#### 1.7 Endorsements

This report shall not be used to claim product endorsement by any accrediting, regulatory, or governmental agency.

#### 1.8 Test Location

The EUT was fully tested by **Amber Helm Development L.C.**, headquartered at 92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA. Table 1 lists all sites employed herein. Specific test sites utilized are also listed in the test results sections of this report where needed.

Table 1: Test Site List.				
Description	Location	Quality Num.		
OATS (3m & 10m)	92723 Michigan Hwy-152, Sister Lakes, Michigan 49047 USA	OATSA		

#### 1.9 Traceability and Equipment Used

Pertinent test equipment used for measurements at this facility is listed in Table 2. The quality system employed at Amber Helm Development L.C. has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to the SI through NIST, other recognized national laboratories, accepted fundamental or natural physical constants, ratio type of calibration, or by comparison to consensus standards.

#### Table 2: Equipment List.

Description	Manufacturer/Model	$\mathbf{SN}$	Quality Num.	Last Cal By / Date Due
BiconiLog Antenna	EMCO / 3142	1169	BILO3142	Lib.Labs / May-2019
(3m) RG8 Coax	CS-3227 / CS-3227	C060914	CS3227	AHD / Sept-2018
EMI Receiver	HP / 85460A/85462A	3704A00422, 3807A00465	HP8546A	Std and Cal / May-2019
(3m) LMR-400 Coax	AHD / LMR400	C090804	LMR400	AHD / Sept-2018
(LCI) DS Coax	AHD / $RG58/U$	920809	RG58U	AHD / Dec-2018
(10-m) Amelco Coax	AHD / RG213U	9903-10ab	RG213U	AHD / Sept-2018
Double Ridged Horn	EMCO / 3115	2788	RH3115	Lib.Labs. / July-2018
Double Ridged Horn	Cobham / H-1798	190	RHCOB1840	Lib.Labs. / Jul 2018
LISN	Solar / 8012-50-R-24-BNC	962137	LISN7	AHD / May-2019
LISN	Solar / 8012-50-R-24-BNC	962138	LISN7	AHD / April-2021

#### Date: July 19, 2018

#### 2 Test Specifications and Procedures

#### 2.1 Test Specification and General Procedures

The ultimate goal of GridConnect, Inc. is to demonstrate that the Equipment Under Test (EUT) complies with the Rules and/or Directives below. Detailed in this report are the results of testing the GridConnect, Inc. GC-ESP32-PORT-N for compliance to:

Country/Region	Rules or Directive	Referenced Section(s)
United States	Code of Federal Regulations	CFR Title 47, Part $15.247$
Canada	ISED Canada	IC RSS-247/GENe

It has been determined that the equipment under test is subject to the rules and directives above at the date of this testing. In conjunction with these rules and directives, the following specifications and procedures are followed herein to demonstrate compliance (in whole or in part) with these regulations.

ANSI C63.4:2014	"Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" $$
ANSI C63.10:2013 (USA)	"American National Standard of Procedures for Compliance Testing of Unli- censed Wireless Devices"
TP0102RA	"AHD Internal Document TP0102 - Radiated Emissions Test Procedure"
ISED Canada	"The Measurement of Occupied Bandwidth"
ICES-003; Issue 6 (2016)	"Information Technology Equipment (ITE) Limits and methods of measure- men"

#### Date: July 19, 2018

## 3 Configuration and Identification of the Equipment Under Test

#### 3.1 Description and Declarations

The EUT is wireless transceiver. The EUT is approximately 1.5 x 1.8 x 0.3 cm in dimension, and is depicted in Figure 1. It is powered by 3.3 VDC external supply. This product is used as modular transceiver with WLAN and BLE modes. Table 3 outlines provider declared EUT specifications.

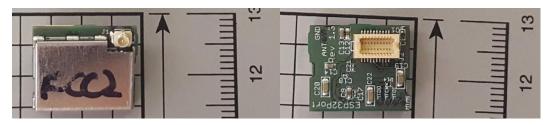


Figure 1: Photos of EUT.

Table :	3:	EUT	Declarations.
Table (		LOI	Dectarations.

General Declarations			
Equipment Type:	WLAN+BLE Module	Country of Origin:	Not Declared
Nominal Supply:	3.3 VDC	Oper. Temp Range:	not declared
Frequency Range:	2402 - 2480  MHz	Antenna Dimension:	Integral
Antenna Type:	Whip, Trace	Antenna Gain:	Whip (3 dBi), Trace (3.8 dBi)
Number of Channels:	40(BLE), 11(WLAN), 6(N40)	Channel Spacing:	2 MHz(BLE), 5 MHz(WLAN)
Alignment Range:	Not Declared	Type of Modulation:	GFSK, OFDM
United States			
FCC ID Number:	2AFC3ESP32P001	Classification:	DTS
Canada			
IC Number:	22503-ESP32P001	Classification:	Spread Spectrum
IC mulliper:	<b>Number:</b> 22503-ESP32P001		(24002483.5 MHz)

#### 3.1.1 EUT Configuration

The EUT is configured for testing as depicted in Figure 2.

#### 3.1.2 Modes of Operation

The EUT is capable of operating in BLE (1Mbps) or in 802.11 b, g, n(20), or n(40) SISO modes. Test samples were placed into worst-case operating states (highest data rate, highest operating power that may be employed in each mode) using a PC serial UART interface that could be attached and detached from the EUT interface board. The EUT could not be placed into full continuous transmission, so duty cycle is measured and applied to measured data in line with DTS guidelines.

#### 3.1.3 Variants

There is only a single version of the EUT.

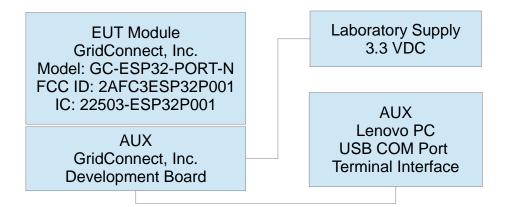


Figure 2: EUT Test Configuration Diagram.

#### 3.1.4 Test Samples

Two samples of the EUT were provided for emissions testing. Both sample modules were tested when mounted onto a development PCB which provided UART and dc power interface to the module.

#### 3.1.5 Functional Exerciser

Normal functionality was confirmed by measurement of transmitted signals.

#### 3.1.6 Modifications Made

There were no modifications made to the EUT by this laboratory. However, in order to bring the device into compliance with band edge and harmonic emissions limits, the manufacturer chose to have the maximum power setting on the WLAN chipset reduced to setting 2 (BK=-2) and the BLE power setting was reduced to setting 7 (2 less than max 9). Manufacturer states all modules manufactured will be firmware set with power setting levels equal to those tested herein.

#### 3.1.7 Production Intent

The EUT appears to be a production ready sample.

#### 3.1.8 Declared Exemptions and Additional Product Notes

None.

#### 4 Emissions

#### 4.1 General Test Procedures

#### 4.1.1 Radiated Test Setup and Procedures

Radiated electromagnetic emissions from the EUT are first pre-scanned in our screen room. Spectrum and modulation characteristics of all emissions are recorded. Instrumentation, including spectrum analyzers and other test equipment as detailed in Section 1.8 are employed. After pre-scan, emission measurements are made on the test site of record. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in relevant test standards are followed. Alternatively, a layout closest to normal use (as declared by the provider) is employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 3. All intentionally radiating elements that are not fixed-mounted in use are placed on the test table lying flat, on their side, and on their end (3-axes) and the resulting worst case emissions are recorded. If the EUT is fixed-mounted in use, measurements are made with the device oriented in the manner consistent with installation and then emissions are recorded. If the EUT exhibits spurious emissions due to internal receiver circuitry, such emissions are measured with an appropriate carrier signal applied.

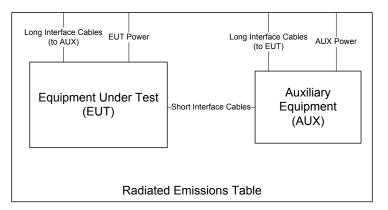


Figure 3: Radiated Emissions Diagram of the EUT.

For devices with intentional emissions below 30 MHz, a shielded loop antenna and/or E-field and H-Field broadband probes are used depending on the regulations. Shielded loops are placed at a 1 meter receive height at the desired measurement distance. For exposure in this band, the broadband probes employed are 10cm diameter single-axis shielded transducers and measurements are repeated and summed over three axes.

Emissions between 30 MHz and 1 GHz are measured using calibrated broadband antennas. For both horizontal and vertical polarizations, the test antenna is raised and lowered from 1 to 4 m in height until a maximum emission level is detected. The EUT is then rotated through  $360^{\circ}$  in azimuth until the highest emission is detected. The test antenna is then raised and lowered one last time from 1 to 4 m and the worst case value is recorded. Emissions above 1 GHz are characterized using standard gain or broadband ridge-horn antennas on our OATS with a  $4 \times 5$  m rectangle of ECCOSORB absorber covering the OATS ground screen and a 1.5m table height. Care is taken to ensure that test receiver resolution and video bandwidths meet the regulatory requirements, and that the emission bandwidth of the EUT is not reduced. Photographs of the test setup employed are depicted in Figure 4.

Where regulations allow for direct measurement of field strength, power values (dBm) measured on the test receiver / analyzer are converted to  $dB\mu V/m$  at the regulatory distance, using

$$E_{dist} = 107 + P_R + K_A - K_G + K_E - C_F$$

where  $P_R$  is the power recorded on spectrum analyzer, in dBm,  $K_A$  is the test antenna factor in dB/m,  $K_G$  is the combined pre-amplifier gain and cable loss in dB,  $K_E$  is duty correction factor (when applicable) in dB, and  $C_F$  is a distance conversion (employed only if limits are specified at alternate distance) in dB. This field strength value is then compared with the regulatory limit. If effective isotropic radiated power (EIRP) is computed, it is computed as

$$EIRP(dBm) = E_{3m}(dB\mu V/m) - 95.2.$$

When presenting data at each frequency, the highest measured emission under all possible EUT orientations (3-axes) is reported.

Where regulations call for substitution method measurements, the EUT is replaced by a substitution antenna if field strength measurements indicate the emission is close to the regulatory limit. This antenna is co-polarized with the test antenna and tuned (when necessary) to the emission frequency, after which the test antenna height is again optimized. The substitution antenna's signal level is adjusted such that its emission is equal to the level measured from the EUT. The signal level applied to the substitution antenna is then recorded. Effective isotropic radiated power (EIRP) and effective radiated power (ERP) in dBm are formulated from

$$EIRP = P_T - G_A = ERP + 2.16,\tag{1}$$

where  $P_T$  is the power applied to substitution antenna in dBm, including correction for cable loss, and  $G_A$  is the substitution antenna gain, in dBi.

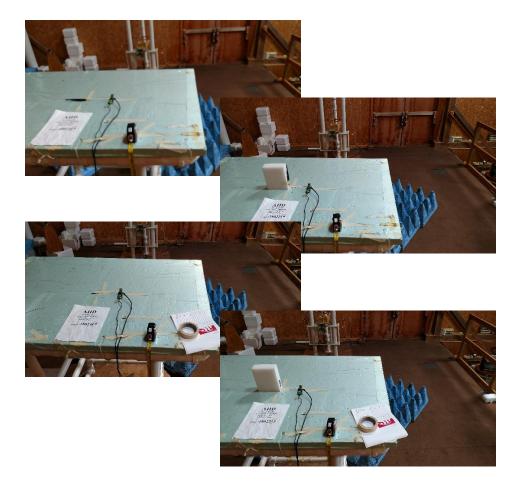


Figure 4: Radiated Emissions Test Setup Photograph(s).

#### 4.1.2 Conducted Emissions Test Setup and Procedures

**Transmit Antenna Port Conducted Emissions** At least one sample EUT supplied for testing was provided with a  $50\Omega$  antenna port. Conducted transmit chain emissions measurements (where applicable) are made by connecting the EUT antenna port directly to the test receiver port. Photographs of the test setup employed are depicted in Figure 5.

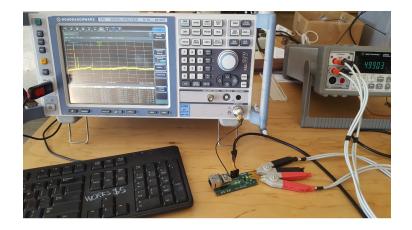


Figure 5: Conducted RF Test Setup Photograph(s).

**AC Port Conducted Spurious** For this device, AC power line conducted emissions are measured in our screen room. If the EUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 / CISPR 22 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. See Figure 6.

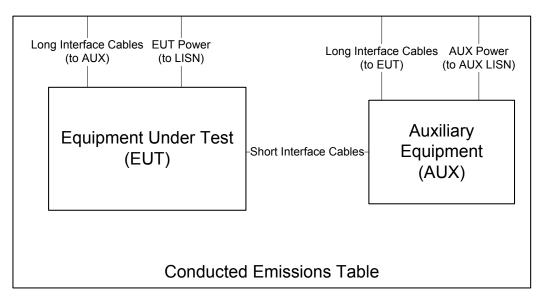


Figure 6: Conducted Emissions Setup Diagram of the EUT.

Conducted emissions are measured and recorded for each AC mains power source over the spectrum 0.15 MHz to 30 MHz for both the ungrounded (HI/PHASE) and grounded (LO/GND) conductors with the EUT placed in its highest current draw operating mode(s). The test receiver is set to peak-hold mode in order to record the

peak emissions throughout the course of functional operation. Only if an emission exceeds or is near the limit are quasi-peak and average detection applied. Photographs of the test setup employed are depicted in Figure 7.



Figure 7: Conducted Emissions Test Setup Photograph(s).

#### 4.1.3 Power Supply Variation

Tests at extreme supply voltages are made if required by the the procedures specified in the test standard, and results of this testing are detailed in this report.

In the case of this EUT, measurements of the worst-case radiated emissions are performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value for devices connecting to AC power mains.

-0.9

#### Intentional Emissions 4.2

802.11n(40)

135.0

#### Duty and Transmission Cycle, Pulsed Operation 4.2.1

The details and results of testing the EUT for pulsed operation are summarized in Table 4.

Table 4: Pulsed Emission Characteristics (Duty Cycle).

<b>Frequency Range</b> f > 1 000 MHz f > 1 000 MHz	<b>Det</b> Pk Pk	<b>IFBW</b> 1 MHz 28 MHz	VBW 28 MHz 28 MHz		Test Date: Test Engineer: EUT Meas. Distance:	11-Jun-18 Joseph Brunett GridConnect ESP32 Conducted
	Pulsed Operation / Duty Cycle					
Transmit Mode	Data Rate	Voltage	Oper. Freq	Pulse Length	Pulse Period	Worst Case Duty Factor
	(Mbps)	(V)	(MHz)	us	us	(dB)
BLE	1.0	3.3	2440.0	132.0	625.6	-6.8
802.11b	11.0	3.3	2437.0	592.8	673.6	-0.6
802.11g	54.0	3.3	2437.0	185.2	230.0	-0.9
802.11n(20)	65.0	3.3	2437.0	201.6	246.8	-0.9

201.2

247.2

3.3 \* Duty Cycle is measured in line with DTS procedures section 12.2.5.1 for averaging only over full-power transmission pulses.

2437.0

Report No.: GCESP-182249TX

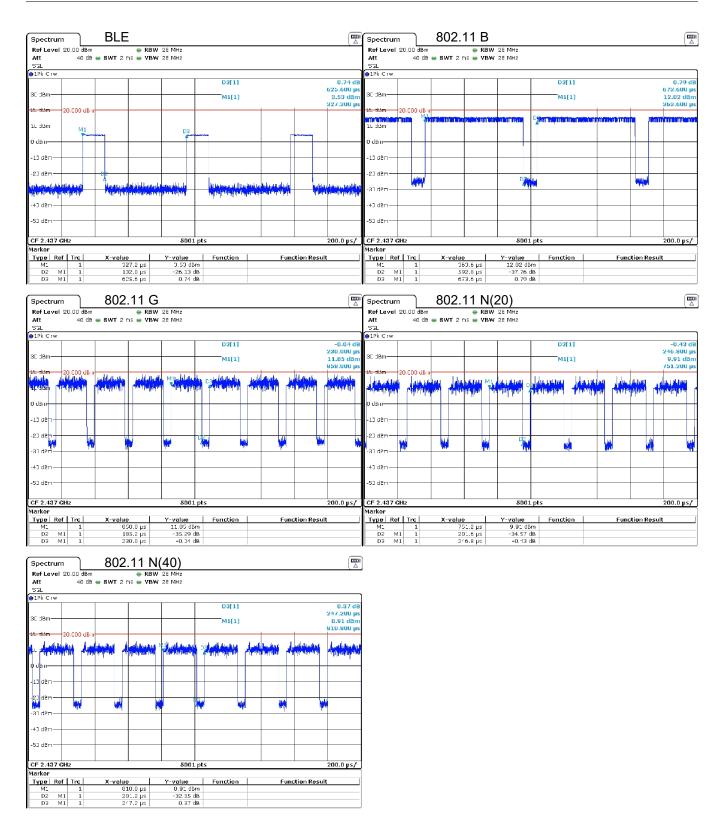


Figure 8: Pulsed Emission Characteristics (Duty Cycle).

#### 4.2.2 Fundamental Emission Bandwidth

Emission bandwidth (EBW) of the EUT is measured with the device placed in the test mode(s) with the shortest available packet length and minimum packet spacing. Radiated emissions are recorded following the test procedures listed in Section 2.1. The 6 dB bandwidth is measured for the lowest, middle, and highest channels available. The 99% emission bandwidth per IC test procedures is also reported. The results of this testing are summarized in Table 5. Plots showing measurements employed obtain the emission bandwidths reported are provided in Figure 9.

Table 5: Intentional Emission Bandwidth.

							Test Date: Test Engineer: EUT Meas. Distance:	06/11/18 Joseph Brunett GridConnect ESP32 Conducted
				Occupi	ed Bandwidth			
Transmit Mode	Data Rate*	Voltage	Oper. Freq	6 dB BW	6 dB BW Limit	99% OBW	20 dB BW	Pass/Fail
Transmit Mode	(Mbps)	(V)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)	
			2402.0	0.79	0.50	1.23	1.43	Pass
BLE	1.0	3.3	2440.0	0.66	0.50	1.04	1.18	Pass
			2480.0	0.60	0.50	1.04	1.18	Pass
			2412.0	8.09	0.50	11.19	12.83	Pass
802.11b	11.0	3.3	2437.0	7.81	0.50	11.17	12.83	Pass
			2462.0	8.53	0.50	11.19	12.89	Pass
			2412.0	16.57	0.50	16.60	17.83	Pass
802.11g	54.0	3.3	2437.0	16.60	0.50	16.60	17.92	Pass
			2462.0	16.59	0.50	16.60	17.92	Pass
			2412.0	17.35	0.50	17.53	18.70	Pass
802.11n(20)	65.0	3.3	2437.0	17.41	0.50	17.56	18.75	Pass
			2462.0	17.41	0.50	17.56	18.67	Pass
			2412.0	36.56	0.50	36.41	39.86	Pass
802.11n(40)	135.0	3.3	2437.0	36.56	0.50	36.41	39.86	Pass
			2462.0	36.56	0.50	36.46	39.90	Pass

Spectrum	E	BLE 1	MBP	S				Spectru	11	802.1 <sup>-</sup>	I B 11		S		
Ref Level 30.00 All 4		SWT 1 m	e RBW		nde Sweep			Ref Leve All	l 20.00 dBm 35 dB		● RBW	200 kHz 1 MHz - M	ade Sween		
●1Pk Yew								●1Pk Yew	1		1				
2C JBm					D5[1]		-0.14 d 1.42660 MH	2 10 19m					D5[1]		-0.1 12.8270
10 JBm				M1	Occ Bw M1[1]		1.234765235 MH 4.51 dBr	1 0 d3m		- N	Em			~~ <sup>D3</sup> ~~~~_T2	11.1888111891 7.86 c
0 d3m				~ ×	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		2.40187410 GH	10 dBm		And Marken				Pr a	2.4128790
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		X	$\geq$			NO5									
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							- March	-50 dPm							
-50 d2m								60 dem							
-60 d8m								70 dBm							
CF 2.402 GHz				1001	pts		Span 3.0 MHz		GHz			1001	pts		Span 20.0 M
Marker Type Ref Tric	1	X-value	: 1	Y-value	Function	Functio	n Result	Marker Type R	ef Tric	x-valu	· 1	Y-value	Function	Eun	ction Result
ML 1 TL 1	-	2.40187		4.51 dBr -9.38 dBr	n		1.234765235 MHz	M: T:	1		79 GHz	7.86 dB -5.98 dB	m		11.138811189 M
T2 1		2.402593	41 GHz	-9.30 dBr	n			T2	1	2.41763	44 GHz	-4.95 dB	m		
D2 M1 1 D0 D2 1		794	LE kHz -Σ kHz	-6.22 d	В			DO	41 1 D2 1	0.0	95 MHz 92 MHz	-6.11 c 0.27 c	IB		
D4 M1 1 D5 D1 1		-608 1.426	.4 kHz 6 MHz	-20.38 d -0.14 d					M1 1 D4 1		73 MHz 27 MHz	-20.15 c -0.11 c			
							(m	·							
Spectrum Ref Level 30.00	dBm		e RBW	100 kHz					n I 20.00 dBm	1	e RBW	200 kHz			
<b>ALL</b> 4		SWT 1 m		1 MHz Mo	ade Sweep			AU	35 dB			1 MHz M	ade Sweep		
●1Pk Yew					D5[1]		-0.41 d	●1Pk Yew					D5[1]		-0.44
20 JBm					Occ Bw		1.18080 MH 1.039960040 MH						M1 Occ Bw		12.8270 / 11.168831169 /
10 JBm				-	41M1[1]		6.30 dBr	1 0 d3m		T1	Demons	and some the	M1[1]	myn DB	6.75 0
0 d3m				~~~	D3		2.44002700 GH	10 dBm		and and a start of the				1	2.4378990
In dem			T1 V			F NS		21 dPm—	1	2					<b>A</b> ,
-20 d8m			×			K.		- 30 den							5
-30 dBm	~						$\sim$	-40,den-	$\mathbb{V}$						1 miles
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-50 dem								60 d8m							
-60 d8m								70 dem							
CF 2.44 GHz Marker				1D01	pts		Span 3.0 MHz	CF 2.437 Marker	GHz			1001	pts		Span 20.0 M
Type Ref Inc		X-valur		Y-value	Function	Functio	n Result	Type R		X-valu		Y-value	Function	Fun	ction Result
ML 1 TL 1		2.4400 2.439508	49 GHz	6.30 dBr -8.40 dBr	m Occ Bw		1.33995004 MHz	M1 T1	1	2.43146		6.75 dB -6.97 dB	m Occ Bw		11.158831169 M
T2 1 D2 M1 1		2.440548	.7 kHz	-7.95 dBr -6.21 d	в			T2 D2	1 1 1	2.44263	15 MHz	-6.22 dB -6.32 c			
DO D2 1 D4 M1 1		662	.1 kHz .4 kHz	0.07 d -20.13 d	в				D2 1 V1 1	7.0	12 MHz 93 MHz	0.15 c -20.41 c	IB		
D5 D1 1			8 MHz	-0.11 d					D1 1		27 MHz	-0.11 c			
Spectrum								Spectru	"						
Ref Level 30.00			e RBW				( <i>2</i>	Ref Leve	1 20.00 dBm		e RBW		• • •		
ALL 4. 1 Pk Yew	5 UB	SWI 1 m	s 💩 VBW	1 MHz Mo	ode Sweep			All O1Pk Yew	35 UB	SWI1m	s 🖶 VBW	1 MHz - M	ade Sweep		
					D5[1]		-0.09 d 1.18080 MH						D5[1] Mi		-0.22 12.8870 (
20 d8m					Occ Bw		1.039960040 MH	2 10 3811		D2		mon	M. Occ. Bw		11.188811189
1C JBm			1	<u> </u>	11M1[1]		6.84 dBr 2.48002100 GH	2		T1 AND	6000		MI[1] **	Land Barry T2	6.32 c 2.4628790
0 d3m	-		11	*	TI	2		- 10 dBm	1	र्र					-Q5
ID dPm-	+		X		~			- 20 dem-	1						
-20 d8n	_	-/				+	-	3U den							1
-30 d2n	f	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~				+ · · · ·	~~~~	-47 dÉn-	V						
43-BBFT-de	-+					+	manun	-50 dem—							<u> </u>
-50 dem								- 60 dem-		-					
-60 d8m								70 dem							
CF 2.48 GHz				1001	pts		Span 3.0 MHz	CF 2.462	GHz			1001	pts		Span 20.0 M
Marker	1	w						Marker							
Type Ref Trr: Mi 1	-	2.4300	21 GHz	Y-value 6.84 dBr		Functio	n Result	Type R ML	1	2.4528	79 GHz	Y-value 6.32 dB		Fun	ction Result
T1 1 T2 1		2.479508	49 GHz 45 GHz	-8.02 dBr -7.49 dBr			1.03995004 MHz	T1. T2	1	2.45544	55 GHz 44 GHz	-7.43 dB -6.52 dB			11.138811189 M
D2 M1 1 D0 D2 1	-	-311	7 kHz	-6.03 d	в			D2	41 1 D2 1	-5.3	55 MHz 01 MHz	-6.19 c	iB		
D4 M1 1		-590	.4 kHz	-20.21 d	в			D4	1 1	-7.1	53 MHz	-20.21 c	IB .		
D5 D4 1		1.180	8 MHz	-0.09 d	в			DS	D4 1	12.8	B7 MH2	-0.22 c	IB		

Figure 9(a): Intentional Emission Bandwidth.

Spectrum		802.	11 G :	54 MBF	S			Spe	ectrum		802.1	1 N(2	20) 65	MBPS	[î
Ref Level All		CWT 1	● RBW	300 kHz 1 MHz - <b>Mo</b>	da Guerr			Ref		20.00 dBm	SWT 1 m	RBW NBW		lade Sweep	
1Pk Max	33 05	3141 1 1	5 <b>-</b> 10W					●1Pk	Max	55 05	301 111	5 <b>- 1</b> 0W	1 Min2 (4)		
c 10m					D5[1]		-0. 17.8320	9 dB MHz and d	0.00					D5[1]	-0.41 18.7010 M
.C dBm					Occ BWII	16	603396603	MHz						0cត្តគ្រួw	17.532467532 M
I d3m		ter	~~~~	m		~~~~53	1.77 2.4166150		m		Bron-v	~~~~.	mm	M1X	0.12 dE ~~~~ Q子 2.415596D G
10 dBm	r	1				he		-10 0	den		ſ				
21 dPm		x									•				<u>05</u>
su dem								-30 0	den —						
1. den	as and						mon	-4) (	den	per l'					
50 den								-50 (	d Rep						- mar sales
60 den								-60 0							
70 dBm								-70 0	den						
F 2.412 G	Hz			1001	pts		Span 30.0	1Hz CF 2	2.412 GF	-lz			1001	L pts	Span 30.0 MH
arker Tume   Def	.	X-valu		Y-value	Function	Function		Mark		1 Tun 1	X-valur		Y-value	Function	Function Result
Type Ref ML	1	2.4166	15 GHz	1.77 dBn	1			P.	ne <u>Ref</u> Mi	1	2.4155	95 GHz	0.12 dB	lm -	
T1 T2	1	2.40375		-5.14 dBn -4.38 dBn		16	.633395603		T1 T2	1	2.40327		-6.39 dB -7.18 dB		17.532467532 MH
D2 M D0 D3		-12.8	27 MHz 70 MHz	-6.10 de 0.05 de	3				D2 M1 D3 D2		-12.19	98 MHz 50 MHz	-6.02 ( 0.09 (	dB	
D4 M	1 1	-13.4	27 MHz	-19.77 de	3			1	D4 M1	. 1	-12.85	57 MHz	-20.28 (	dB	
DS D-	1 1	17.8	82 MHz	-0.19 de	3				D5 D4	1	18.70	01 MHz	-0.11	dB	
Spectrum								Spe	ectrum						ĺ
Ref Level			e RBW	300 kHz						20.00 dBm		e RBW	300 kHz		
AU	35 dB	SWT 1 m	» 🖶 VBW	1 MHz Mo	ide Sweep			AU		35 dB	SWT 1 m	» 🖶 VBW	1 MH2 - M	lade Sweep	
1Pk Yew					D5[1]		-0.6	●1P# 2 dB	< Max					D5[1]	-0.54
.c d8m					Occ BW/1	16	17.9220 603396603		Bm						18.7610 M 17.562437562 M
d3m		62	~~~·		M1[1]		1.07	dBm 0 d3	m					Ocg.Bw M1[ <b>x</b> ]	-0.51 d
LD dem		X		Γ Υ			2.441645				Berner .		han		2.4405960 C
	c	4				ks				D.	(				h
en dem —	/							יר:		A					A A A A A A A A A A A A A A A A A A A
30 dBu	1						5	-31 0	den —	1					
12 de Dana							Provent and	-40 c	den	and the second s					Carl Contractions
50 dBm								-50 0							
60 den								-60 0	den —						
70 den								-70 0	den —						
F 2.437 G arker	HZ			1001	prs		Span 30.0	Mark	2.437 GH (er	12			1001	Lpes	Span 30.0 MF
Type Ref		X-valur		Y-value	Function	Function	turent		ne Rof		X-valur		Y-value	Function	Eunction Result
ML TL	1	2.4416 2.42375	82 GHz	1.07 dBn -5.53 dBn	n Occ Bw	16	.633395603	/Hz	M1 T1	1	2.4405	83 GHz	-0.51 dB -7.43 dB	im Occ Bw	17.552437562 Mi
T2 D2 M	1 1	2.44536	15 GHz 57 MHz	-5.03 dBn -6.17 dB					T2 D2 M1	1	2.44581	12 GHz 58 MHz	-7.83 dB -6.07 (		
DO D:	2 1	16.6	21 M CC	0.52 di	3				DD D2	1	17.43	D MHz	0.02 (	dB	
D4 M D5 D		-13.4	87 MHz 22 MHz	-20.30 dE -0.52 dE					D4 M1 D5 D1		-12.86	87 MHz 51 MHz	-20.70 (		
	_									_					
pectrum									ectrum						
tef Level	20.00 dBm 35 dB	SWT 1 m	● RBW	300 kHz 1 MHz - Mo	ide Sween			Ref		20.00 dBm 35 dB	SWT 1 m	● RBW		lade Sweep	
1Pk Max								●1Pk	< Max						
c daer				T	D5[1]		-0.3	9 dB MHz and	0.00					D5[1]	0.00 18.6710 M
C d8m					Occ Bygg	16	603396603	MHz						OrceBw	17.562437562 M
d3m		again-	m	m	M1[1].X	n the	0.70		m		5. m		mm		-0.64 d 2.4655960 0
LO dem		5		[					dem		r				
n dem —		2		+		NS NS				- Dj	1				1 <u>15</u>
su dem				+		$  \rightarrow \rangle$				-+					$\rightarrow$
Q dBp-	al a						Land and a	-40 0		and the second					
0 d2n								man	den —						
o den —									den						
								-70 0	d8n						
'D dBm				1001	pts		Span 30.0	1Hz CF 2	2.462 GF	-1z			1001	L pts	Span 30.0 Mi
	Hz							Mark							Function Description
70 dBm F 2.462 G arker Tune   Rof		¥.uale:	<u>, I</u>	Y-uplus	Eunction	Emetion	tocult		no Dof	I Tec I	¥		Y-uslue		
CF 2.462 G arker Type Rof Mi	Tm:	X-valur 2.4566	45 GHz	Y-value 0.70 dBr	Function	Function		1	ne Rof	1	2.4555	95 GHz	Y-value -0.64 dB	Function Sm	Function Result
CF 2.462 G arker Type   Ref	Tm:		45 GHz 82 GHz		n Occ Bw		esult.	MHz N				95 GHz 83 GHz		lm Sm Occ Bw	17.552437562 MH
CF 2.462 G arker Type   Ref M: T:	Tmr. 1 1 1 1	2.4566 2.45375 2.47336 -12.8	45 GHz 82 GHz	0.70 dBn -5.98 dBn	n Occ Bw n Occ Bw n				M1. T1.	1 1 1 . 1	2.4555 2.45324 2.47381 -12.25	95 GHz 83 GHz	-0.64 dB -7.44 dB	sm Occ Bw Sm Occ Bw Sm dB	

Figure 9(b): Intentional Emission Bandwidth.

LL 35 JB	⊜ RBW SWT 1 m∍ ⊜ VBW		Swaan	
LL 35 UB Pk Max	awi tilis 🖷 ABM	a ziminz Mode	e Sweep	
			D5[1]	-0.15 dB 39.8600 MHz
J8m		MI	Occ Bw	36.413586414 MHz
iam T1		- the second	M1[1]	-1.32 dBm 4 183040 GHz
		+ +		<u> </u>
) dem		+		
J dga		+		
) den				
) dem				
) dem				
) den				
2.422 GHz		1001 pts	5	Span 50.0 MHz
rker /pc   Rof   Trc	X-value	Y-value	Function	Eunction Result
ML 1	2.418304 GHz	-1.32 dBm		
T1 1 T2 1	2.4039181 GHz 2.4433317 GHz	-6.69 dBm -7.39 dBm	Occ Bw	36.413585414 MHz
D2 M1 1 D3 D2 1	-14.471 MHz 36.563 MHz	-7.04 dB 0.09 dB		
D4 M1 1 D5 D4 1	-16.069 MHz 39.86 MHz	-20.24 dB -0.15 dB		
00 UN 1	39.80 MH2	-0.15 UB		
ectrum				(IIII)
f Level 20.00 dBm		/ 500 kHz		(A
L 35 uB Pk Max	SWT 1 ms 🖶 VBW	/ 2 MHz Mode	sweep	
			D5[1]	-0.15 dB
d8m			Occ Bw	39.8600 MHz 36.413586414 MHz
IBm T1		MI Automatica	M1[1]	-1.32 dBm
		The second s		4183040 GHz
I dem - Ry				ige_
J dgpt				
) dBm				
) dēn		+ +		
) den				
) den				
		1001 pts	-	Span 50.0 MHz
2.422 GHz			-	
rker				
rker	X-value 2.418304 GHz	Y-value -1.32 dBm	Function	Function Result
rker <u>yne   Rof   Tnc                                      </u>	2.418304 GHz 2.4039181 GHz	-1.32 dBm -6.69 dBm	Function Occ Pw	Function Result 36.413585414 MHz
rker /pe Rcf Trr: ML 1 TL 1 T2 1 D2 M1 1	2.418304 GHz 2.4039181 GHz 2.4433317 GHz -14.471 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB		
T1         1           T2         1           D2         M1         1           D3         D2         1           D4         M1         1	2.418304 GHz 2.4039181 GHz 2.4403317 GHz -14.471 MHz D6.560 MHz -16.069 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB		
Ref         Tm:           M1         1           T1         1           T2         1           D2         M1           D3         D2         1	2.418304 GHz 2.4039181 GHz 2.4403317 GHz -14.471 MHz D6.560 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.04 dB 0.09 dB		
Ref         Tre:           M1         1           T1         1           T2         1           D2         M1           D0         D2           D0         D2           M1         1           D5         D4	2.418304 GHz 2.4039181 GHz 2.4403317 GHz -14.471 MHz D6.560 MHz -16.069 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB		36.413585414 MHz
rker mpc Rof Trc   M 1 1 T 1 1 T 2 1 D 2 M1 1 D D 2 1 D 4 M1 1 D 5 D 4 1 Exectrum	2.418304 GHz 2.4039181 GHz 2.44039181 GHz -14.471 MHz -6.560 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.24 dB 0.29 dB -20.24 dB -0.15 dB		
rker mp.e. Ref Tre:   mi. 1 T1. 1 T2. 1 D2. M1 1 D3. D2. 1 D4. M1 1 D5. D4. 1 b5. D4. 1 b6 Level 20.00 dBm L. 35 dB	2.418304 GHz 2.4039181 GHz 2.44039181 GHz -14.471 MHz -6.560 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB		36.413585414 MHz
rker mp.e. Ref Tre:   mi. 1 T1. 1 T2. 1 D2. M1 1 D3. D2. 1 D4. M1 1 D5. D4. 1 b5. D4. 1 b6 Level 20.00 dBm L. 35 dB	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB	Occ Pw	36.413585414 MHz
rker mp.e. Rof Tre: M: 1 T: 1 T2 1 D2 M1 1 D2 M1 1 D3 D2 1 D4 M1 1 D5 D1 1 exectrum of Level 20.00 dBm	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB	Occ Bw	36.413585414 MHz
rker mne Ref Trec mn 1 Tre T2 1 T2 1 T2 1 D2 M1 1 D3 D2 1 D4 M1 1 D5 D4 1 S	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.69 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB	Occ Pw	36.413585414 MHz
Ker         Trc         Imple         Ref         Trc         Imple         Ref         Trc         Imple	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Occ Pw	36.413585414 MHz
ter           trp:         mpf         Tre:         I           T:         1         1         1           T2         1         1         1           D2         1         1         1         1           D3         D2         1         1         1           D4         M1         1         1         1           D5         D1         1         1         1           ectrum         1         35 b1         35 b8         36           % Mex         38m         37         37         37           d2n         T         7         7         7         7	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
rker me Ref Tre M- 1 T- 1 T- 1 D2 M1 1 D0 D2 1 D4 M1 1 D5 D2 1 D4 M1 1 o5 D4 1 sectrum of Level 20.00 dBm 1 35 dB Sk Mex dBm	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
rker mne Ref Tre mne Ref Tre Tre Tre Tre Tre Tre Tre Tre	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
rker mne Ref Tre mne Ref Tre Tre Tre Tre Tre Tre Tre Tre	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
Ker           Imple         Rotf         Tmc           Imple         Imple         Imple           T1         1         Imple           T2         1         Imple           D0         D2         Imple           D4         M1         Imple           D5         D4         Imple           M1         Imple         State           State         Imple         State           Imple         State         Imple           Imple         Imple         Imple           <	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
rker rmne Ref Trec me Ref Trec T2 1 T2 1 T2 1 D2 D2 1 D4 M1 1 D5 D2 1 D4 M1 1 D5 D4 1 S5 D4	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
ker           mpre         Ref         Tre           m2         1         1           T2         1         1           D2         1         1           D3         D2         1           D4         M1         1           D5         D4         1           d5         D4         1           sectrum         dBm         35 UB           k         Mex         38           d8m         d8m         d8m	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Осс Рм	36.413585414 MHz
rker         rkef         rkef         Tre         mm         mm         1         mm         m         mm         mm         m <td>2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz</td> <td>-1.32 dBm -6.90 dBm -7.39 dBm -7.39 dB 0.39 dB -20.24 dB -0.15 dB 4 500 kHz 4 2 MHz Mode</td> <td>Occ Pw</td> <td>36.413585414 MHz</td>	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.39 dB 0.39 dB -20.24 dB -0.15 dB 4 500 kHz 4 2 MHz Mode	Occ Pw	36.413585414 MHz
rker         rker           mpn         Ref         Tmc           M1         1         1           T2         1         1           D2         1         1           D2         1         1           D3         D2         1           D4         M1         1           D5         D-1         35 dB           pk         Level 20.00 dBm         35 dB           pk         Mex         36 m           dbm         35 dB         36 m           dbm         1         35 dB           dbm         1         1           dbm         1         1           dbm         1         1           dbm         1         1           dbm <t< td=""><td>2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz</td><td>-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode</td><td>Occ Pw</td><td>36.413585414 MHz</td></t<>	2.418304 GHz 2.4039181 GHz 2.44039187 GHz -14.471 MHz -16.669 MHz -16.069 MHz -30.86 MHz	-1.32 dBm -6.90 dBm -7.39 dBm -7.34 dB 0.39 dB -20.24 dB -0.15 dB / 500 kHz / 2 MHz Mode	Occ Pw	36.413585414 MHz
rker	2.418304 GHz 2.403918 GHz 2.443317 GHz -14.471 MHz -06.653 MHz -10.609 MHz -30.86 MHz 	-1.32 dBm -6.69 dBm -7.39 dBm -7.39 dBm -7.39 dB -0.32 dB -0.35 dB -0	Occ Pw	36.413585414 MHz
rker           rmn         Ref         Tree           M1         1         1           T1         1         1           T2         1         1           D2         1         1           D2         1         1           D3         D2         1           D4         M1         1           D5         D4         1           Dectrum         35 UB           Pk Max         38 UB           Ben         38 UB           JBP         1           JdP         1	2.418304 GHz 2.403918 GHz 2.443317 GHz -14.471 MHz -06.653 MHz -16.669 MHz -30.86 MHz -30.86 MHz 	-1.32 dBm -6.90 dBm -7.39 dBm -7.39 dBm -7.39 dB -0.39 dB -0.27 dB -0.15 dB -0	Occ Pw           DS[1]           Occ Rw           MI[1]           Occ Rw           State	36.413585414 MHz
rker         rkef         Tre         ms         ms         1           M1         1 </td <td>2.418304 GHz 2.403918 GHz 2.443317 GHz -14.471 MHz -06.550 MHz -30.86 MHz -30.86 MHz -30.86 MHz </td> <td>-1.32 dBm -6.69 dBm -7.39 dBm -7.39 dBm -7.39 dBm -0.39 dB -0.22 dB -0.15 dB -</td> <td>Occ Pw           DS[1]           DS[1]           Occ Rw           M1[1]           S           Function</td> <td>36.413585414 MHz</td>	2.418304 GHz 2.403918 GHz 2.443317 GHz -14.471 MHz -06.550 MHz -30.86 MHz -30.86 MHz -30.86 MHz 	-1.32 dBm -6.69 dBm -7.39 dBm -7.39 dBm -7.39 dBm -0.39 dB -0.22 dB -0.15 dB -	Occ Pw           DS[1]           DS[1]           Occ Rw           M1[1]           S           Function	36.413585414 MHz

Figure 9(c): Intentional Emission Bandwidth.