



Test Report No. 7112310970

Applicant: Capacicom LTD.

Equipment Under Test:

IoT Repeater - BT Transceiver

Model: NBX-R1000-RF

FCC ID: 2AYPY- NBX-R1000-RF

Issued by:

The Standards Institution of Israel

Industry Division

Electrical & Electronics Laboratory

EMC Branch





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FCC ID: 2AYPY- NBX-R1000-RF

Applicant:

Capacicom LTD.

Address:

4 Haalon st., 4059300 Kfar Neter Israel

Sample for test selected by:

The customer

The date of test:

7-8/04 & 19/04/2021

Description of Equipment**under Test (EUT):** IoT Repeater - BT Transceiver**Model:**

NBX-R1000-RF

Software version :

1.0.0

Hardware version:

5

Manufactured by:

Capacicom LTD.

Reference Documents:

- ❖ CFR 47 FCC (2020). Rules and Regulations: Part 15. Radio frequency devices, Subpart C: Intentional radiators. Section 15.247 Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, 5725 - 5875 MHz

Test Results

The EUT was found to be in compliance with the following standard:

CFR47 Part 15 Subpart C
sections 15.203, 15.205, 15.207, 15.209 and 15.247

This Test Report contains 39 pages and may be used only in its entirety.

This Test Report applies only to the specimen tested and may not be applied to other specimens of the same product.

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1. Summary of Test Results

Description of test	FCC Ref. Section	Result
Carrier frequency separation	15.247 (a) (1)	Compliance
Number of hopping frequencies	15.247 (a) (1)(iii)	Compliance
Time of occupancy (dwell time)	15.247 (a) (1) (iii)	Compliance
Maximum peak conducted output power	15.247 (b) (1)	Compliance
Occupied bandwidth	15.247 (a) (1)	Compliance
Band-edge compliance of RF conducted emission	15.247 (d)	Compliance
Radiated emission in restricted and non-restricted bands	15.247 (d), 15.209, 15.205	Compliance
Unwanted radiated emissions	15.209	Compliance
AC power line conducted emission measurements	15.207	Compliance
Antenna requirements	15.203	Compliance

Name: Eng. Yuri Rozenberg

Position: Head of Branch

Electrical & Electronics
Laboratory

November 7, 2021

Tested by: Alexander Konkov

Position: Testing Technician

Written by: Galit Gorodetsky

Position: Technical Writer

2. EUT Description

Note: All information in this section was provided by the customer.

2.1. General description:

The Equipment under Test (hereinafter: EUT) is a smart IoT LPWAN repeater system with a transceiver Module which operates in the sub-1GHz ISM frequency spectrum and IP M&C over ETH/WiFi/BT.

The EUT uses WiFi/BT transceiver chip is ESP32 from Espressif Systems. ESP32 is a single 2.4GHz Wi-Fi and Bluetooth combo chip. It uses the same 40MHz TCXO clock source.

The 2.4GHz transceiver uses built-in non detachable antenna printed on the PCB. The EUT has no internal power source. It uses PoE for DC power supply (10-48V).

The test data contained in this report pertains only to the emissions due to the EUT's Bluetooth transmitter.

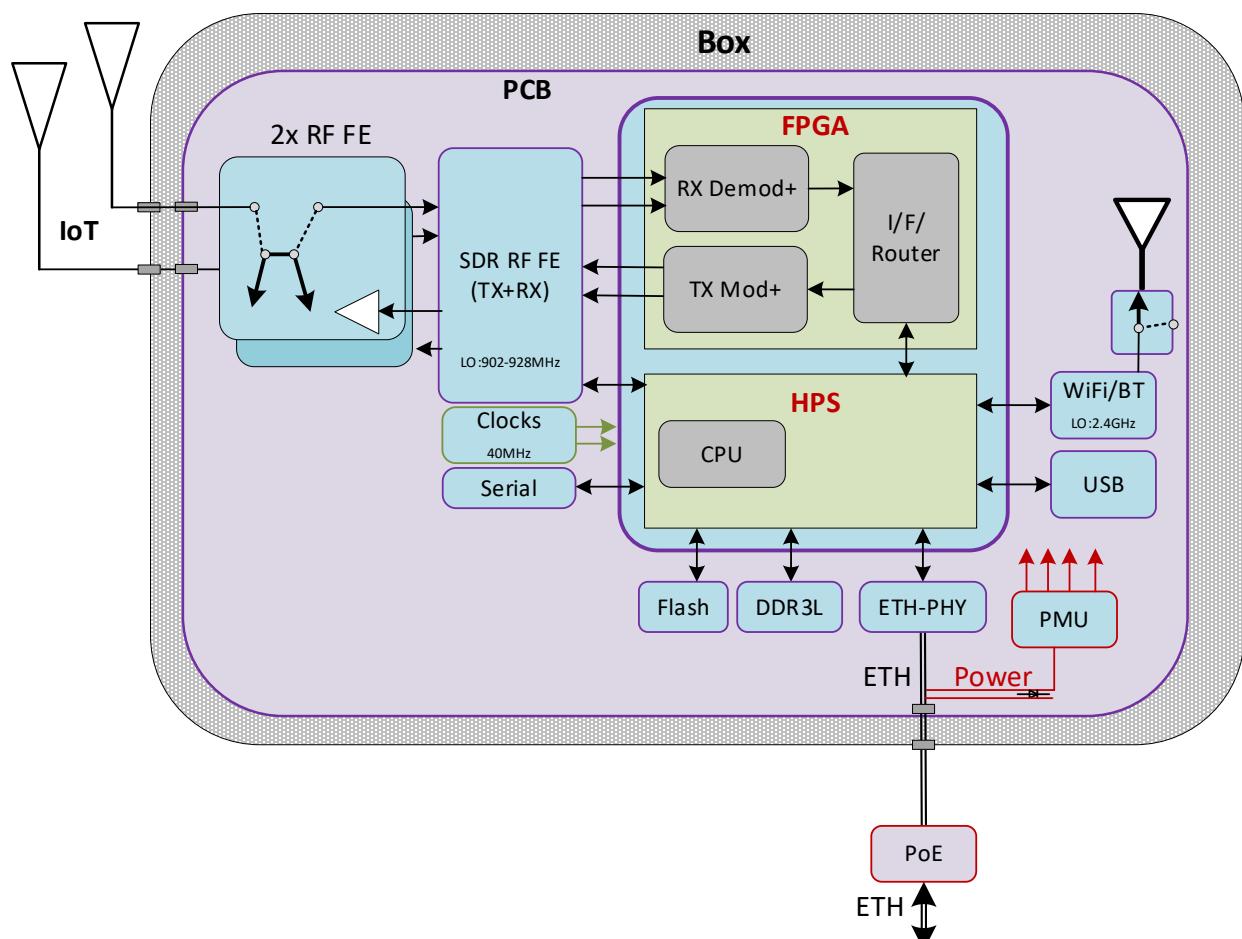


Figure 1. IoT Repeater block diagram



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2.2. BT Transmitter description:

Type of equipment	
Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)	

Intended use	fixed
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Assigned frequency range	from 2400MHz to 2483.5MHz	
Operating frequency range	from 2402MHz to 2480MHz	
RF channel spacing	1MHz (BT)	
Maximum rated output power	Effective radiated power (for equipment with no RF connector)	0dBm
transmitter output power is variable	No	

Antenna information	
Integral with temporary RF connector on board PCB antenna	
Antenna gain = 2dBi	

Transmitter 99% power bandwidth	
Type of modulation	$\pi/4$ DQPSK, 8DPSK
Type of multiplexing	FHSS
Modulating test signal (baseband)	PRBS

Transmitter power source	
Nominal rated voltage	24VDC Min. 10V / Max. 48V

Spread spectrum parameters for transmitters tested per FCC 15.247 only		
FHSS	total number of hops	79



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2.3. System test configuration

CH	Freq. MHz	CH	Freq. MHz
CH 0	2402	CH 41	2443
CH 1	2403	CH 42	2444
CH 2	2404	CH 43	2445
CH 3	2405	CH 44	2446
CH 4	2406	CH 45	2447
CH 5	2407	CH 46	2448
CH 6	2408	CH 47	2449
CH 7	2409	CH 48	2450
CH 8	2410	CH 49	2451
CH 9	2411	CH 50	2452
CH 10	2412	CH 51	2453
CH 11	2413	CH 52	2454
CH 12	2414	CH 53	2455
CH 13	2415	CH 54	2456
CH 14	2416	CH 55	2457
CH 15	2417	CH 56	2458
CH 16	2418	CH 57	2459
CH 17	2419	CH 58	2460
CH 18	2420	CH 59	2461
CH 19	2421	CH 60	2462
CH 20	2422	CH 61	2463
CH 21	2423	CH 62	2464
CH 22	2424	CH 63	2465
CH 23	2425	CH 64	2466
CH 24	2426	CH 65	2467
CH 25	2427	CH 66	2468
CH 26	2428	CH 67	2469
CH 27	2429	CH 68	2470
CH 28	2430	CH 69	2471
CH 29	2431	CH 70	2472
CH 30	2432	CH 71	2473
CH 31	2433	CH 72	2474
CH 32	2434	CH 73	2475
CH 33	2435	CH 74	2476
CH 34	2436	CH 75	2477
CH 35	2437	CH 76	2478
CH 36	2438	CH 77	2479
CH 37	2439	CH 78	2480
CH 38	2440		
CH 39	2441		
CH 40	2442		

2.4. Test setup:

The EUT was tested per the guidance ANSI C63.10: 2013.

The test setup is shown in Figure 2 and 3.

The EUT was connected with auxiliary Laptop via LAN-Power splitter.

Also EUT gets 19VDC power from the AC power adapter via LAN-Power splitter in order to use PoE technology. The EUT configured to transmit continuously, duty cycle $\geq 98\%$.

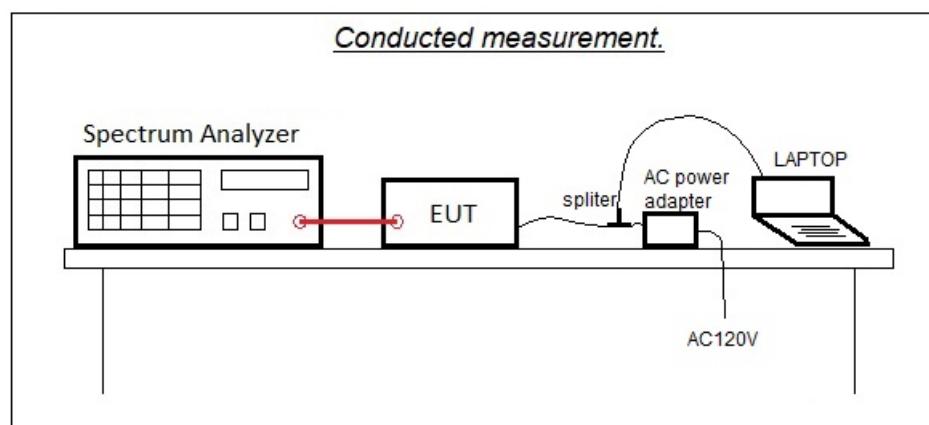


Figure 2. EUT conducted test setup

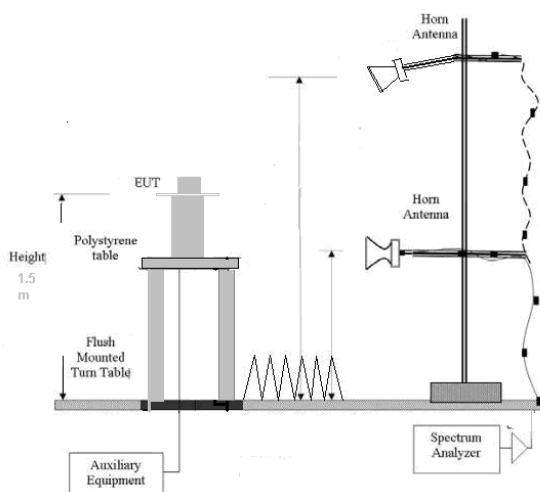


Figure 3. Radiated emission test setup above 1 GHz.



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3. Test specification, methods and procedures

- ❖ CFR 47 FCC Rules and Regulations: Part 15. Radio frequency devices, Subpart C: Intentional radiators (2020)
- ❖ ANSI C63.4:2014 American National Standard for Method of Measurement of Radio Noise Emissions from Low Voltage Electrical and Electronic Equipment in the Range 9 kHz to 40 GHz.
- ❖ ANSI C63.10: 2013 American National Standard for Testing of Unlicensed Wireless Devices

4. Testing Facility:

Laboratory Name: Standards Institution of Israel (SII)

Test site location: 42 Haim Levanon st., Tel-Aviv Israel

Laboratory Accreditations: ANAB AT-1359

5. Measurement uncertainty

The test equipment has been calibrated according to its recommended procedures and is within the manufacturer's published limit of error.

The laboratory calibrates its standards by a third party (traceable to NIST, USA) on a regular basis according to equipment manufacturer requirements.

Test description	Calculated uncertainty U_{LAB}
Conducted measurements	
Frequency error	37.6 Hz
Spurious emission	± 2.98 dB
Radiated measurements	
Electric field strength in a SAR at 3 m distance 30 MHz – 1.0 GHz	± 4.32 dB
Electric field strength in a FAR at 3 m distance 1.0 GHz – 18 GHz	± 4.47
Substitution measurements	
In a FAR at 3 m distance 1.0 GHz – 18 GHz	± 3.41 dB



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6. Transmitter characteristics - test results

6.1. Carrier frequency separation and Occupied bandwidth

Limits & methods:

FCC requirements	15.247(a)(1)		
Test procedure	ANSI 63.10 Section 7.8.2. and Section 7.8.7 Conducted measurement		
Operating Frequencies	2402MHz 2440 MHz 2480MHz		
Ambient Temperature	22°C	Relative Humidity	46%
		Air Pressure	1006hPa

Limit

Operating frequency range, MHz	Channel carrier frequency separation limit
2400 – 2483.5	25 kHz or 20 dB bandwidth, whichever is greater.

Results:

CHANNEL	Channel carrier frequency separation	Plot #
CH 00 – 01	1.007 MHz	1
CH 41 – 42	1.020 MHz	2
CH 78 – 79	1.021 MHz	3

Channel #	Frequency, MHz	Measured 20 dB bandwidth, MHz	Plot #
0	2402	1.308	4
38	2440	1.309	5
78	2480	1.308	6

Test procedure

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 2402MHz to 2480MHz frequency band and maximum transmitting data rate.

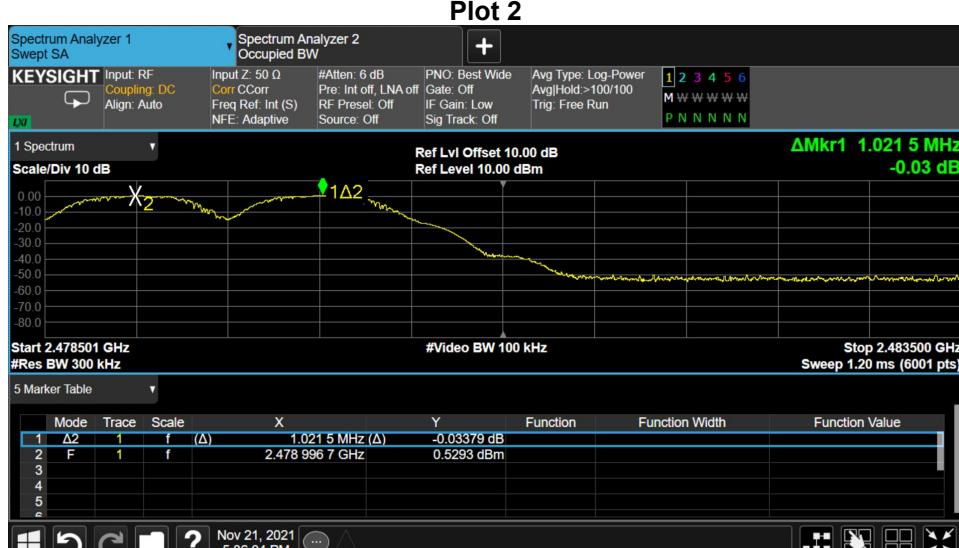
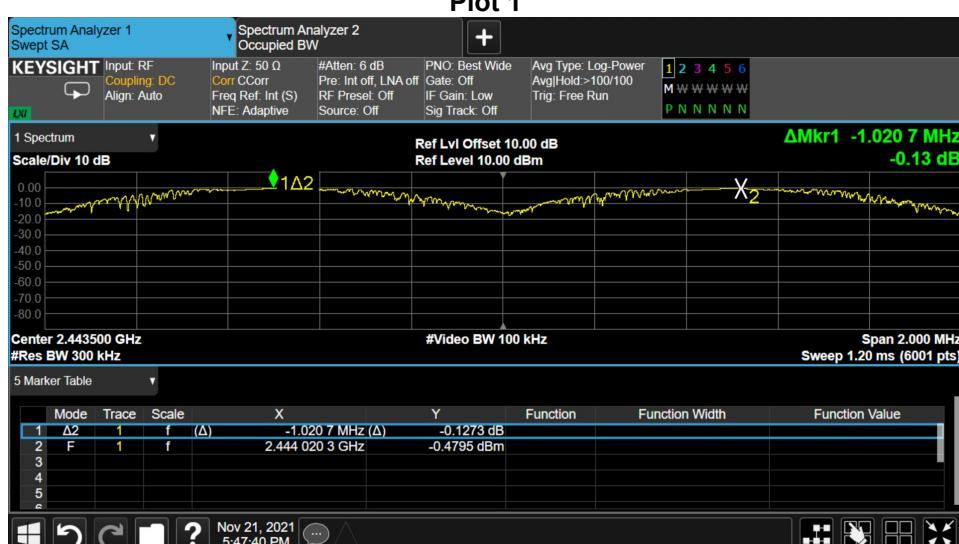
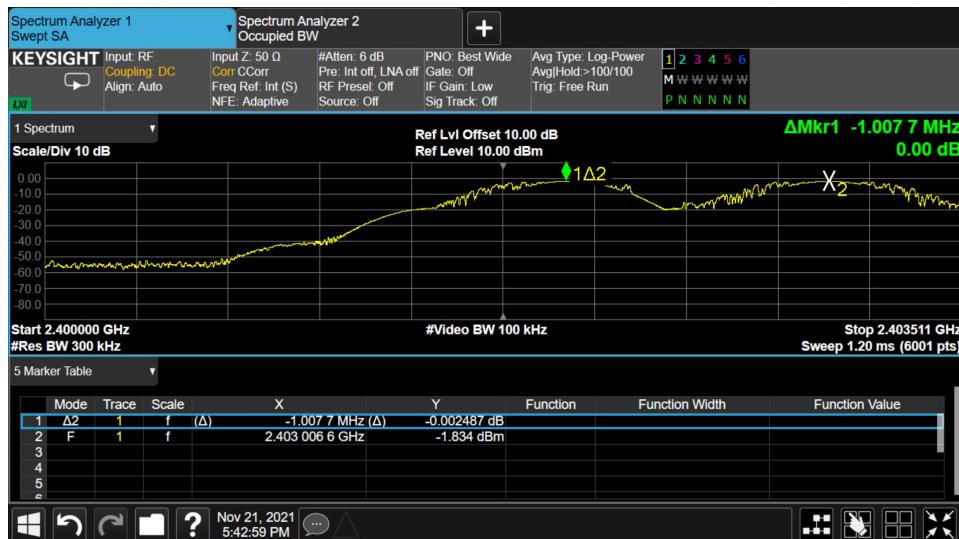


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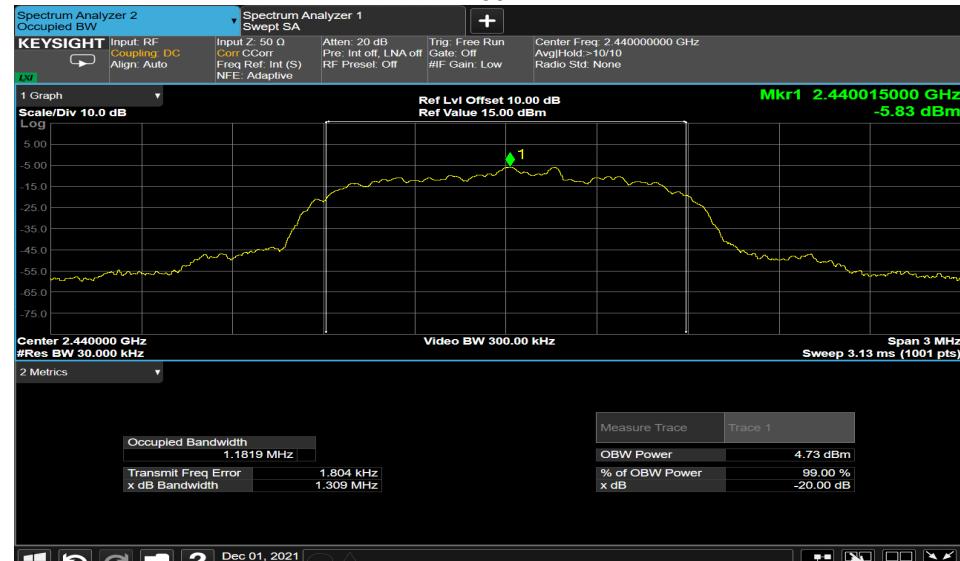
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Plot 4



Plot 5



Plot 6



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6.2. Number of hopping frequencies

Limits & methods:

FCC requirements	15.247(a)(1) (iii)		
Test procedure	ANSI 63.10 section 7.8.3. Conducted measurement		
Operating Frequencies	2402MHz 2440 MHz 2480MHz		
Ambient Temperature	22°C	Relative Humidity	46% Air Pressure 1006hPa

Limit

Operating frequency range, MHz	Number of hopping channels
2400 – 2483.5	minimum of 15 channels

Results:

Frequency band	Limit	Result	Verdict	Plot #
2.4 – 2.4835 GHz	minimum 15	79	Pass	7,8

Test procedure

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 2402MHz to 2480MHz frequency band and maximum transmitting data rate.

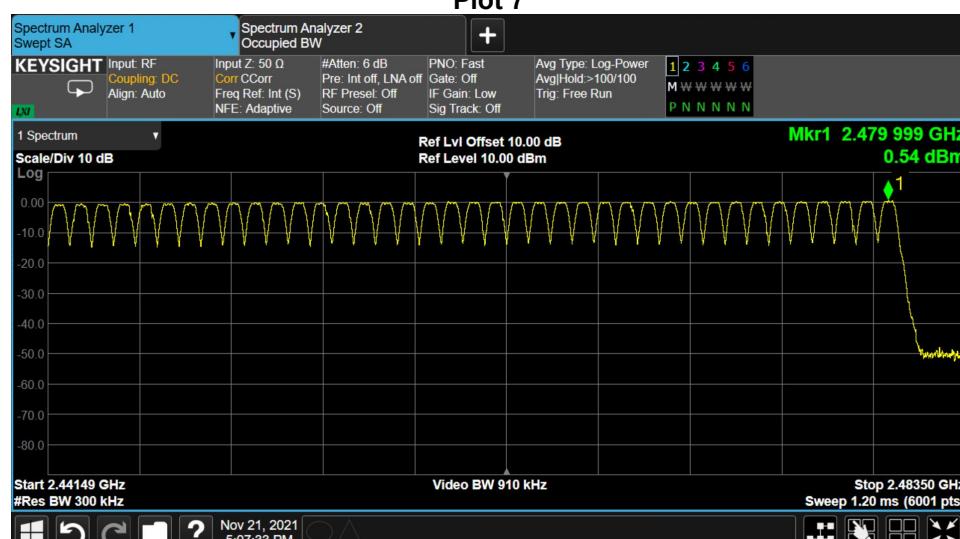
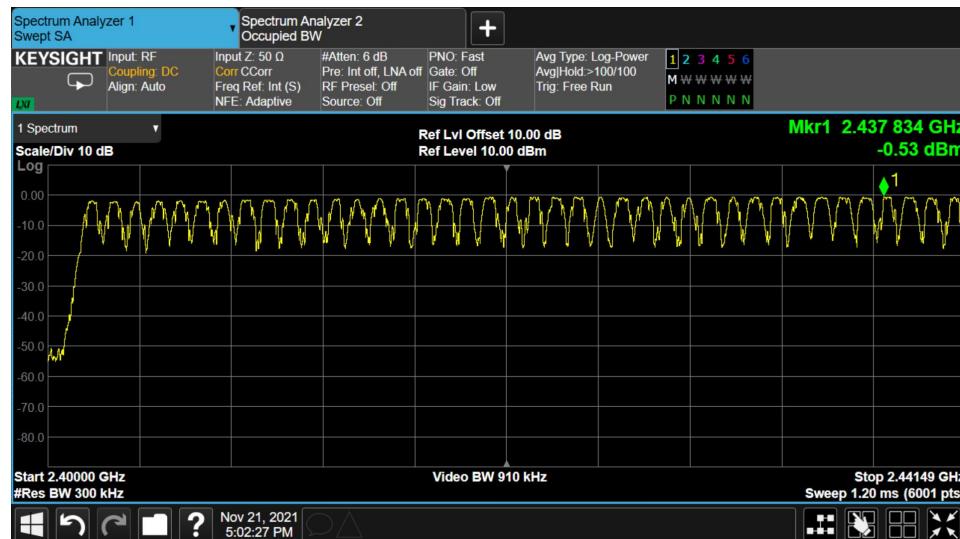


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6.3. Averaged time of occupancy (dwell time)

Limits & methods:

FCC requirements	15.247(a)(1) (iii)		
Test procedure	ANSI 63.10 Section 7.8.4 Conducted measurement		
Operating Frequencies	2402MHz 2440 MHz 2480MHz		
Ambient Temperature	22°C	Relative Humidity 46%	Air Pressure 1006hPa

Limit

Operating frequency range, MHz	Average time of occupancy
2400 – 2483.5	≤ 0.4 sec within the period of 0.4 sec

Results:

Carrier frequency	Limit	Result		Verdict	Plot #
2402 MHz	Maximum 0.4 sec within avg period of 0.4 sec	2.889 ms	the average time of occupancy equal $2.889 \text{ mS} * 5 = 14.445 \text{ mS}$	Pass	9,10

Test procedure

The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirements.

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 2402MHz to 2480MHz frequency band and maximum transmitting data rate

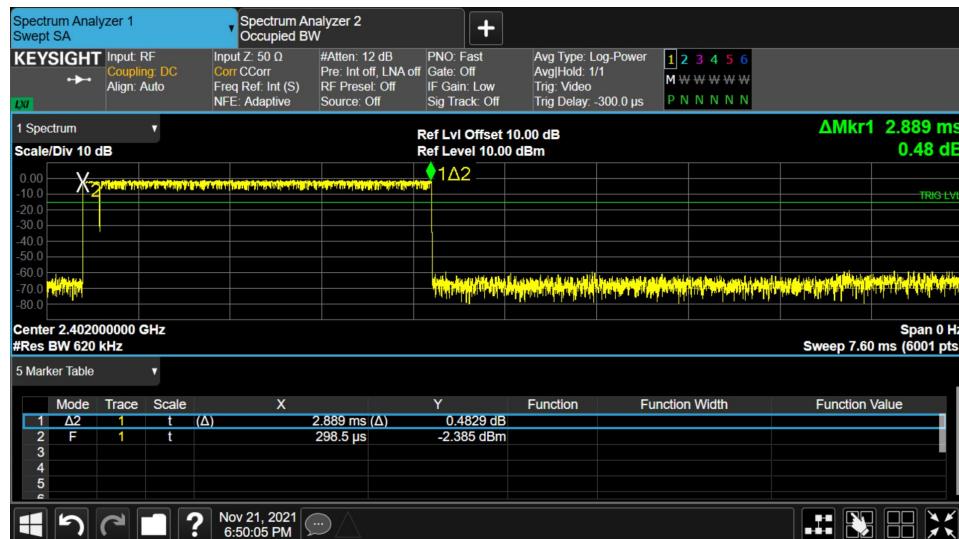


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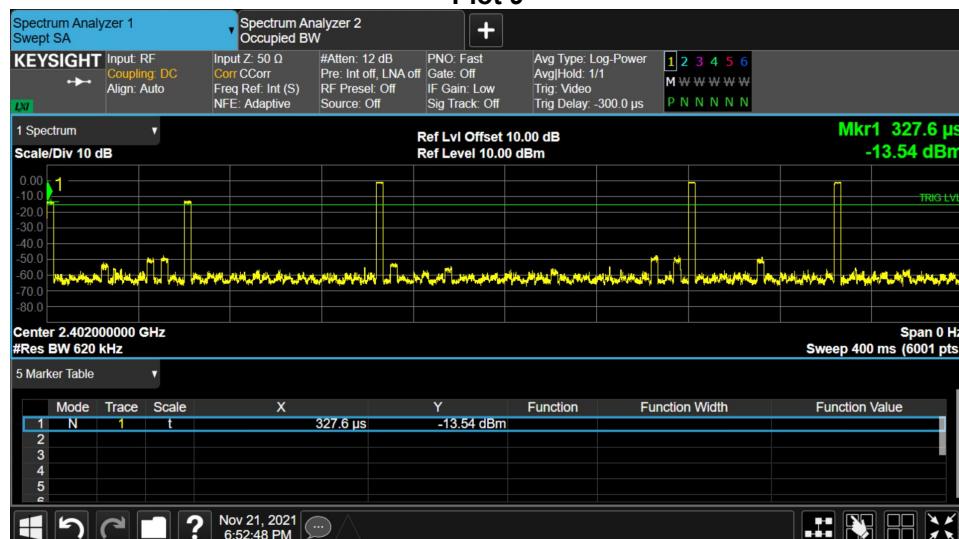
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Plot 9



Plot 10



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6.4. Output power test for frequency hopping spread spectrum (FHSS) devices

Limits & methods:

FCC requirements	15.247(b)(1)		
Test procedure	ANSI 63.10 Section 7.8.5 Conducted measurement		
Operating Frequencies	2402MHz 2440 MHz 2480MHz		
Ambient Temperature	22 ⁰ C	Relative Humidity	46%
		Air Pressure	1006hPa

Limit

Operating frequency range, MHz	Maximum Peak conducted output power
2400 – 2483.5	0.125 watts (21dBm)

Note: $P_{(W)} = 1W * 10^{(P(\text{dBm}) / 10)} / 1000 = 10^{((P(\text{dBm}) - 30) / 10)}$

Results:

Channel #	Frequency, MHz	Measured Power, dBm	Calculated Power, mW	Limit mW	Verdict	Plot #
0	2402	-0.50	0.891	125	Pass	11
38	2440	-2.20	0.603		Pass	12
78	2480	-0.93	0.807		Pass	13

Test procedure

The measurements were performed in hopping transmission mode of operation for carrier (channel) frequency at bottom, middle and at the top of 2402MHz to 2480MHz frequency band and maximum transmitting data rate.

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