

CE Test Report

Equipment : Lyra 24P Series - Bluetooth 5.3 PCB module
(Please refer to section 1.1.1 for more details)

Model No. : Lyra 24P

Brand Name : Laird Connectivity

Applicant : Laird Connectivity LLC

Address : W66N220 Commerce Court, Cedarburg, WI
53012 United States Of America

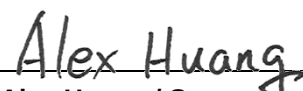
Standard : EN 300 328 V2.2.2 (2019-07)

Received Date : Dec. 30, 2022

Tested Date : Feb. 03 ~ May 30, 2023

We, International Certification Corporation, would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:


Alex Huang / Supervisor

Approved by:


Gary Chang / Manager

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Appendix A. RF Output Power

Appendix B. Accumulated Transmit Time, Minimum Frequency Occupation And Hopping Sequence

Appendix C. Hopping Frequency Separation

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Appendix F. Transmitter Spurious Emissions

Appendix G. Receiver Spurious Emissions

Appendix H. Receiver Blocking

Appendix I. Adaptivity And Unwanted Signal Parameters

Release Record

Report No.	Version	Description	Issued Date
ER2D3001	Rev. 01	Initial issue	Jul. 05, 2023

Summary of Test Results

Ref. Std. Clause	Test Items	Measured	Result
4.3.1.2	RF Output Power	EIRP (dBm): 19.50	Pass
4.3.1.3	Duty cycle, Tx-Sequence, Tx-gap	Meet the requirement of limit.	N/A
4.3.1.4	Dwell time, Minimum Frequency Occupation & Hopping Sequence	Meet the requirement of limit.	Pass
4.3.1.5	Hopping Frequency Separation	Meet the requirement of limit.	Pass
4.3.1.6	Medium Utilisation (MU) factor	Meet the requirement of limit.	N/A
4.3.1.7	Adaptivity	Meet the requirement of limit.	Pass
4.3.1.8	Occupied Channel Bandwidth	Meet the requirement of limit.	Pass
4.3.1.9	Transmitter unwanted emissions in the out of band domain	Meet the requirement of limit.	Pass
4.3.1.10	Transmitter unwanted emissions in the spurious domain	Meet the requirement of limit.	Pass
4.3.1.11	Receiver spurious emissions	Meet the requirement of limit.	Pass
4.3.1.12	Receiver Blocking	Meet the requirement of limit.	Pass
4.3.1.13	Geo-location capability	The device has no geo-location capability.	N/A

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Laird part number
Laird Connectivity	Lyra 24P	Lyra 24P Series - Bluetooth v5.3 PCB Module (20dBm) with integrated antenna	453-00145
Laird Connectivity	Lyra 24P	Lyra 24P Series - Bluetooth v5.3 PCB Module (20dBm) with RF Trace Pad	453-00148
Laird Connectivity	Lyra 24P	Lyra 24P Series - Bluetooth v5.3 PCB Module (10dBm) with integrated antenna	453-00142

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	Bluetooth Mode	Ch. Frequency (MHz)	Channel Number	Data Rate
2400-2483.5	LE	2402-2480	0-39 [40]	Coding rate 125kbps
				Coding rate 500kbps
				Symbol rate 1Mbps
		2404-2478	37	Symbol rate 2Mbps
Note: Bluetooth LE (Low energy) uses GFSK modulation.				

1.1.3 Antenna Details

Ant. No.	Brand	Model	Type	Connector	2400-2500MHz	Cable loss
					Gain (dBi)	
1	Laird	NanoBlue	PCB Dipole	IPEX MHF4	2	N/A
2	Laird	FlexPIFA	PCB Dipole	IPEX MHF4	2	N/A
3	Mag.Layers	EDA-8709-2G4C1-B27-CY	Dipole	IPEX MHF4	2.32	0.7
4	Laird	mFlexPIFA	PIFA	IPEX MHF4	2	N/A
5	Laird	Lyra 24P PCB Trace Antenna	PCB Trace	---	1.82	N/A

1.1.4 EUT Operational Condition

Power Supply Type	3.3Vdc from host		
SW Version	Lyra 24P RF trace pin (20dBm) : 480-00292-R24.4.0.1671533880 Lyra 24P Integrated antenna (20dBm) : 480-00263-R24.4.0.1669195240		
Operational Climatic	☒ Tnom (20°C)	☒ Tmax (105°C)	☒ Tmin (-40°C)
Operation Voltage	☒ Vnom (3.3 Vdc)	☒ Vmax (3.8 Vdc)	☒ Vmin (1.8Vdc)

1.1.5 Accessories

N/A

1.1.6 Channel List

BT-LE(Coding rate 125 kbps / Coding rate 500 kbps / Symbol rate 1 Mbps)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

BT-LE(Symbol rate 2Mbps)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2404	10	2424	20	2446	30	2466
1	2406	11	2428	21	2448	31	2468
2	2408	12	2430	22	2450	32	2470
3	2410	13	2432	23	2452	33	2472
4	2412	14	2434	24	2454	34	2474
5	2414	15	2436	25	2456	35	2476
6	2416	16	2438	26	2458	36	2478
7	2418	17	2440	27	2460	--	--
8	2420	18	2442	28	2462	--	--
9	2422	19	2444	29	2464	--	--

1.1.7 Test Tool and Duty Cycle

Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna

Test Tool	Simplicity Studio	
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)
BT-LE (Coding rate 125kbps)	84.14%	0.75
BT-LE (Coding rate 500kbps)	60.42%	2.19
BT-LE (Symbol rate 1Mbps)	85.91%	0.66
BT-LE (Symbol rate 2Mbps)	57.98%	2.37

Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Test Tool	Simplicity Studio	
Modulation Mode	Duty Cycle Of Test Signal (%)	Duty Factor (dB)
BT-LE (Coding rate 125kbps)	84.14%	0.75
BT-LE (Coding rate 500kbps)	60.42%	2.19
BT-LE (Symbol rate 1Mbps)	63.24%	1.99
BT-LE (Symbol rate 2Mbps)	33.09%	4.80

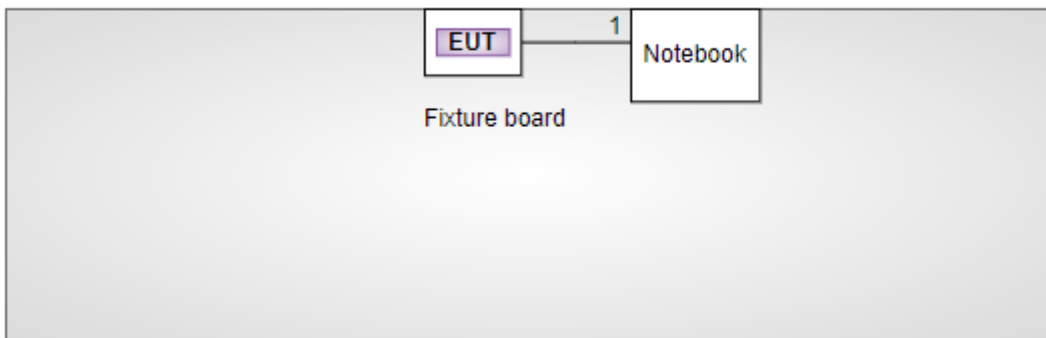
1.1.8 Power Index of Test Tool

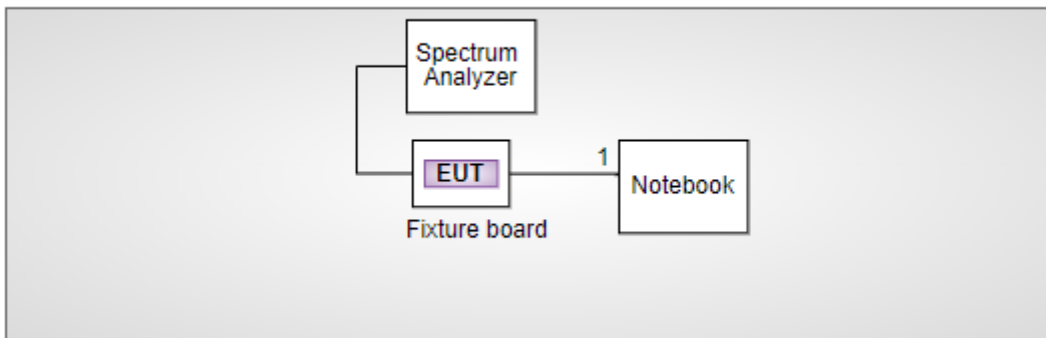
Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
BT-LE (Coding rate 125kbps)	17	17	17
BT-LE (Coding rate 500kbps)	17	17	17
BT-LE (Symbol rate 1Mbps)	17	17	17
Modulation Mode	2404	2440	2478
BT-LE (Symbol rate 2Mbps)	17	17	17

1.2 Local Support Equipment List

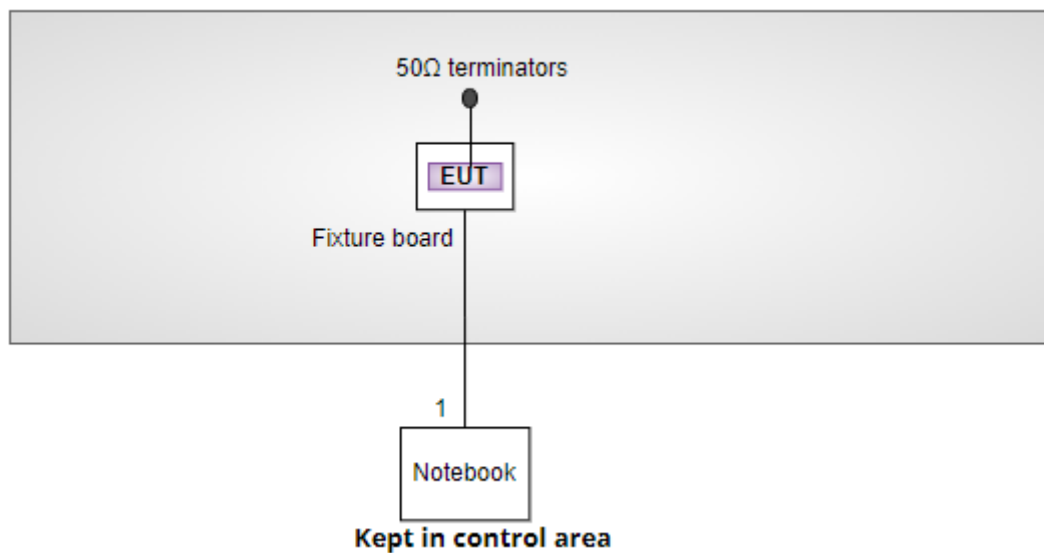
Support Equipment List					
No.	Equipment	Brand	Model	S/N	Remarks
1	Notebook	DELL	Latitude 5400	CXYCM33	---
2	Fixture board	Laird	DVK-Lyra 24P	---	Provided by applicant.

1.3 Test Setup Chart

Test Setup Diagram (Radiated, Laird part number: 453-00145)	
	
No.	Signal cable / Length (m)
1	USB, 1m shielded.

Test Setup Diagram (Conducted, Laird part number: 453-00148)	
	
No.	Signal cable / Length (m)
1	USB, 1m shielded.

Test Setup Diagram (Radiated, Laird part number: 453-00148)



No.	Signal cable / Length (m)
1	USB, 1m shielded.

1.4 Test Equipment List and Calibration Data

Test Item	Radiated Emissions				
Test Site	Fully –anechoic chamber 2 / (05CH02-WS)				
Test Date	Apr. 13 ~ Apr. 17, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	Agilent	N9010A	MY52221474	Nov. 07, 2022	Nov. 06, 2023
Bilog Antenna 30-1000MHz	SCHWARZBECK	VULB9168	9168-563	Mar. 10, 2023	Mar. 09, 2024
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	9120D-1205	Feb. 03, 2023	Feb. 02, 2024
Preamplifier	Agilent	83017A	MY53270013	Feb. 04, 2023	Feb. 03, 2024
Preamplifier	EMC	EMC02325	980146	Oct. 26, 2022	Oct. 25, 2023
RF cable-1M	EMC	EMC104-35M-35M-1000	S/N:210926	Oct. 12, 2022	Oct. 11, 2023
RF cable-1M	EMC	EMC104-35M-35M-1000	S/N:210927	Oct. 12, 2022	Oct. 11, 2023
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22621/4	Oct. 12, 2022	Oct. 11, 2023
RF cable-4M	HUBER+SUHNER	SUCOFLEX104	MY32489/4	Oct. 12, 2022	Oct. 11, 2023
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-002	Oct. 12, 2022	Oct. 11, 2023
LF cable-3M	EMC	EMC8D-NM-NM-3000	131102	Oct. 12, 2022	Oct. 11, 2023
LF cable-10M	EMC	EMC8D-NM-NM-10000	131101	Oct. 12, 2022	Oct. 11, 2023
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Test Date	Apr. 12 ~ May 19, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101486	Mar. 03, 2023	Mar. 02, 2024
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Jun. 22, 2022	Jun. 21, 2023
Power Sensor	Agilent	U2021XA	MY53480019	Mar. 07, 2023	Mar. 06, 2024
Power Sensor	Agilent	U2021XA	MY53510003	Mar. 07, 2023	Mar. 06, 2024
Power Sensor	Agilent	U2021XA	MY54070003	Mar. 27, 2023	Mar. 26, 2024
Power Sensor	Agilent	U2021XA	MY54060013	Mar. 27, 2023	Mar. 26, 2024
RF cable	EMC	EMC104-35M-35M-1000	210928	Oct. 14, 2022	Oct. 13, 2023
RF Cable	EMC	EMC104-35M-35M-1000	210929	Oct. 14, 2022	Oct. 13, 2023
RF Cable	EMC	EMC104-35M-35M-1000	210930	Oct. 14, 2022	Oct. 13, 2023
RF Cable	EMC	EMC104-35M-35M-1000	210931	Oct. 14, 2022	Oct. 13, 2023
Measurement Software	Sporton	SENSE	5.10.7	NA	NA
Measurement Software	Agilent	EN RF test	1.1501125	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Receiver Blocking				
Test Site	(05CH02-WS)				
Test Date	Feb. 03, 2023				
Instrument	Brand	Model No.	Serial No.	Calibration Date	Calibration Until
Wireless connectivity tester	ROHDE&SCHWARZ	CMW270	100856	Nov. 16, 2022	Nov. 15, 2023
Signal Generator	ROHDE&SCHWARZ	SMB100A	175727	Apr. 07, 2022	Apr. 06, 2023
RF Cable	HUBER+SUHNER	SUCOFLEX_104	500202/4	Oct. 13, 2022	Oct. 12, 2023
RF Cable	HUBER+SUHNER	SUCOFLEX_104	296088/4	Oct. 13, 2022	Oct. 12, 2023
RF Cable	HUBER+SUHNER	SUCOFLEX_104	329023/4	Oct. 13, 2022	Oct. 12, 2023
Combiner(1X2)	WOKEN	2WAYDIV	12101200003	Oct. 13, 2022	Oct. 12, 2023
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Adaptivity				
Test Site	TH01-WS				
Test Date	May 20 ~ May 30, 2023				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum	R&S	FSV7	101607	Feb. 03, 2023	Feb. 02, 2024
RF cable-4M	HUBER+SUHNER	SUCOFLEX_104	MY15686/4	Oct. 11, 2022	Oct. 10, 2023
RF cable-0.5M	HUBER+SUHNER	SUCOFLEX_104	296081/4	Oct. 13, 2022	Oct. 12, 2023
RF cable-0.2M	HUBER+SUHNER	SUCOFLEX_104	329023/4	Oct. 13, 2022	Oct. 12, 2023
RF cable-0.2M	HUBER+SUHNER	SUCOFLEX_104	329021/4	Oct. 13, 2022	Oct. 12, 2023
Vector Signal Generator	R&S	SMW200A	109619	Jul. 26, 2022	Jul. 25, 2023
Preamplifier	Burgeon	BPS-530	100219	Nov. 22, 2022	Nov. 21, 2023
Oscilloscope	National Instruments	USB-5133	F651FF	Aug. 16, 2022	Aug. 15, 2023
Combiner(1X2)	Woken	2WAYDIV-1	0120A02056002D	Oct. 14, 2022	Oct. 13, 2023
Combiner(1X2)	Woken	DOM2AEW1A22	0120A02201801O	Oct. 14, 2022	Oct. 13, 2023
Combiner(1X4)	Woken	4WAYDIV	0120A042011010	Oct. 13, 2022	Oct. 12, 2023
Direction Coupler	Marvelous Microwave	MVE4514-20	20	Oct. 13, 2022	Oct. 12, 2023
Attenuator	Warison	WATT-6SR1211	01	Oct. 13, 2022	Oct. 13, 2023
Wireless Connectivity Tester	ROHDE&SCHWARZ	CMW270	100856	Nov.16, 2022	Nov.15, 2023
Measurement Software	Sporton	Sporton_3	1.0.0.22	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

EN 300 328 V2.2.2 (2019-07)

1.6 Deviation from Test Standard and Measurement Procedure

None

1.7 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$)).

Measurement Uncertainty		
Parameters	Uncertainty	Limit
Occupied Channel Bandwidth	$\pm 0.0034 \%$	$\pm 5 \%$
RF output power, conducted	$\pm 0.592 \text{ dB}$	$\pm 1.5 \text{ dB}$
Power Spectral Density, conducted	$\pm 0.583 \text{ dB}$	$\pm 3 \text{ dB}$
Unwanted Emissions, conducted	$\pm 2.715 \text{ dB}$	$\pm 3 \text{ dB}$
All emissions, radiated	$\pm 3.14 \text{ dB}$	$\pm 6 \text{ dB}$
Temperature	$\pm 0.4 \text{ }^{\circ}\text{C}$	$\pm 3 \text{ }^{\circ}\text{C}$
Supply voltages	$\pm 0.15 \%$	$\pm 3 \%$
Time	$\pm 0.1 \%$	$\pm 5 \%$

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corporation
Test Site	TH01-WS
Address of Test Site	No.3-1, Lane 6, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)
Test Site	05CH02-WS
Address of Test Site	No.14-1, Lane 19, Wen San 3rd St., Kwei Shan Dist., Tao Yuan City 33381, Taiwan (R.O.C.)

2.2 The Worst Test Modes and Channel Details

Test item	Modulation Mode	Test Frequency (MHz)	Data Rate	Test method	TX/RX	Test Configuration
RF Output Power	GFSK	Hopping	BT-LE(Coding rate 125kbp) BT-LE(Coding rate 500kbp) BT-LE(Symbol rate 1Mbps) BT-LE(Symbol rate 2Mbps)	Conducted	TX	1, 2
Accumulated Transmit Time	GFSK	Hopping	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps) BT-LE(Symbol rate 2Mbps)	Conducted	TX	1, 2
Minimum Frequency Occupation	GFSK	2440	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps) BT-LE(Symbol rate 2Mbps)	Conducted	TX	1, 2
Hopping Sequence Hopping Frequency Separation Transmitter unwanted emissions in the OOB domain						1, 2
Occupied Channel Bandwidth	GFSK	2402 / 2440 / 2480	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps)	Conducted	TX	1, 2
		2404 / 2440 / 2478	BT-LE(Symbol rate 2Mbps)			
Transmitter Spurious Emissions	GFSK	2402 / 2440 / 2480	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps)	Radiated	TX	1, 2 ^{note3}
Receiver Spurious Emissions		2404 / 2440 / 2478	BT-LE(Symbol rate 2Mbps)		RX	
Transmitter Spurious Emissions	GFSK	2402 / 2480	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps)	Conducted	TX	2
Receiver Spurious Emissions		2404 / 2478	BT-LE(Symbol rate 2Mbps)		RX	
Receiver Blocking	GFSK	2402 / 2480	BT-LE(Symbol rate 1Mbps)	Conducted	RX	1, 2
Adaptivity	GFSK	2402 / 2480	BT-LE(Coding rate 125kbp) BT-LE(Symbol rate 1Mbps)	Conducted	TX	1, 2
		2404 / 2478	BT-LE(Symbol rate 2Mbps)			

NOTE:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **X-plane** results were found as the worst case and were shown in this report.
- The test configurations are listed as follows:
 - Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna
 - Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)
- The 50Ω terminators are connected to antenna port of EUT for radiated emission measurement.
- Chipset DCDC Bypass mode Mode A: DCDC OFF (LDO ON)
Chipset DCDC Regulation mode Mode B: DCDC ON
Mode B is the worst case

3 Transmitter Test Results

3.1 RF Output Power

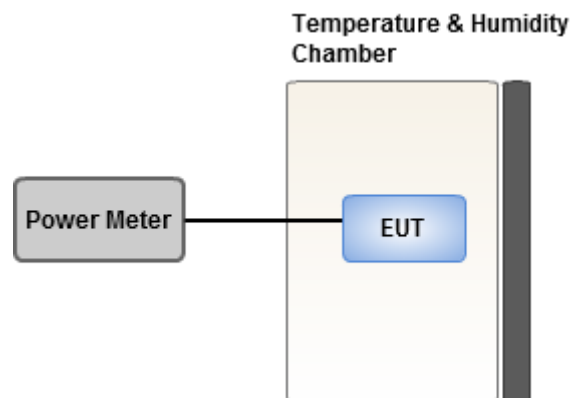
3.1.1 Limit of RF Output Power

The maximum RF output power shall be equal to or less than 20 dBm

3.1.2 Test Procedures

Reference to clause 5.4.2.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.1.3 Test Setup



3.1.4 Test Results

Ambient Condition	23°C / 61%	Tested By	Alan Tang
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Refer to Appendix A.

3.2 Accumulated Transmit Time, Minimum Frequency Occupation and Hopping Sequence

3.2.1 Limit of Accumulated Transmit Time, Minimum Frequency Occupation and Hopping Sequence

Adaptive mode

Adaptive Frequency Hopping equipment shall be capable of operating over a minimum of 70 % of the band 2.4GHz to 2.4835GHz. The Accumulated Transmit Time on any hopping frequency shall not be greater than 400 ms within any observation period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used. In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options:

Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.

Option 2: The occupation probability for each frequency shall be between $((1 / U) \times 25 \%)$ and 77 % where U is the number of hopping frequencies in use. The hopping sequence(s) shall contain at least N hopping frequencies at all times, where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

Non-Adaptive mode

The Accumulated Transmit Time on any hopping frequency shall not be greater than 15 ms within any observation period of 15 ms multiplied by the minimum number of hopping frequencies (N) that have to be used. Non-adaptive medical devices requiring reverse compatibility with other medical devices placed on the market that are compliant with version 1.7.1 or earlier versions of ETSI EN 300 328, are allowed to have an operating mode in which the maximum Accumulated Transmit Time is 400 ms within any observation period of 400 ms multiplied by the minimum number of hopping frequencies (N) that have to be used, only when communicating to these legacy devices already placed on the market. In order for the equipment to comply with the Frequency Occupation requirement, it shall meet either of the following two options:

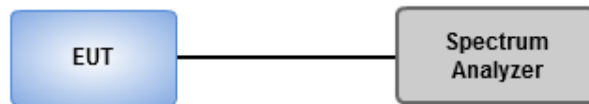
Option 1: Each hopping frequency of the hopping sequence shall be occupied at least once within a period not exceeding four times the product of the dwell time and the number of hopping frequencies in use.

Option 2: The occupation probability for each frequency shall be between $((1 / U) \times 25 \%)$ and 77 % where U is the number of hopping frequencies in use. The hopping sequence(s) shall contain at least N hopping frequencies where N is 15 or 15 divided by the minimum Hopping Frequency Separation in MHz, whichever is the greater.

3.2.2 Test Procedures

Reference to clause 5.4.4.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.2.3 Test Setup



3.2.4 Test Results

Ambient Condition	23°C / 61%	Tested By	Alan Tang
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Refer to Appendix B.

3.3 Hopping Frequency Separation

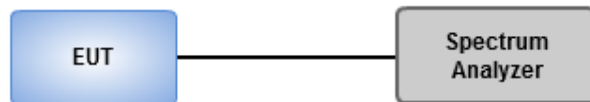
3.3.1 Limit of Hopping Frequency Separation

For adaptive Frequency Hopping equipment, the minimum Hopping Frequency Separation shall be 100 kHz.
For non-adaptive Frequency Hopping equipment, the Hopping Frequency Separation shall be equal or greater than the Occupied Channel Bandwidth, with a minimum separation of 100 kHz.

3.3.2 Test Procedures

Reference to clause 5.4.5.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.3.3 Test Setup



3.3.4 Test Results

Ambient Condition	23°C / 61%	Tested By	Alan Tang
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Refer to Appendix C.

3.4 Occupied Channel Bandwidth

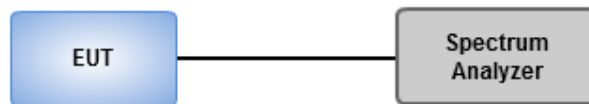
3.4.1 Limit of Occupied Channel Bandwidth

The Occupied Channel Bandwidth for each hopping frequency shall fall completely within 2.4~2.4835 GHz. For non-adaptive Frequency Hopping equipment with e.i.r.p greater than 10 dBm, the Occupied Channel Bandwidth for every occupied hopping frequency shall be equal to or less than the value declared by the supplier. This declared value shall not be greater than 5 MHz.

3.4.2 Test Procedures

Reference to clause 5.4.7.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.4.3 Test Setup



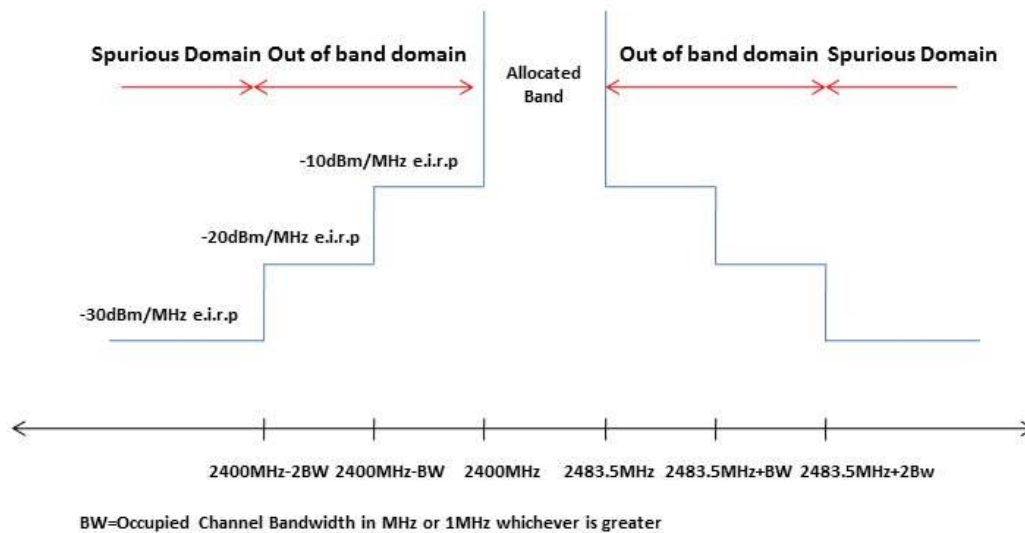
3.4.4 Test Results

Ambient Condition	23°C / 61%	Tested By	Alan Tang
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Refer to Appendix D.

3.5 Transmitter Unwanted Emissions in the Out-Of-Band Domain

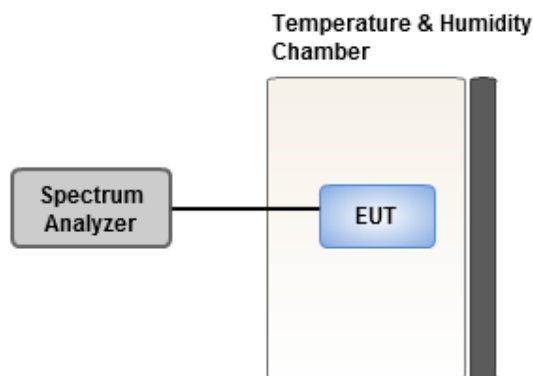
3.5.1 Limit of Transmitter Unwanted Emissions in the Out-Of-Band Domain



3.5.2 Test Procedures

Reference to clause 5.4.8.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.5.3 Test Setup



3.5.4 Test Results

Ambient Condition	23°C / 61%	Tested By	Alan Tang
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Refer to Appendix E.

3.6 Transmitter Unwanted Emissions in the Spurious Domain

3.6.1 Limit of Transmitter Unwanted Emissions in the Spurious Domain

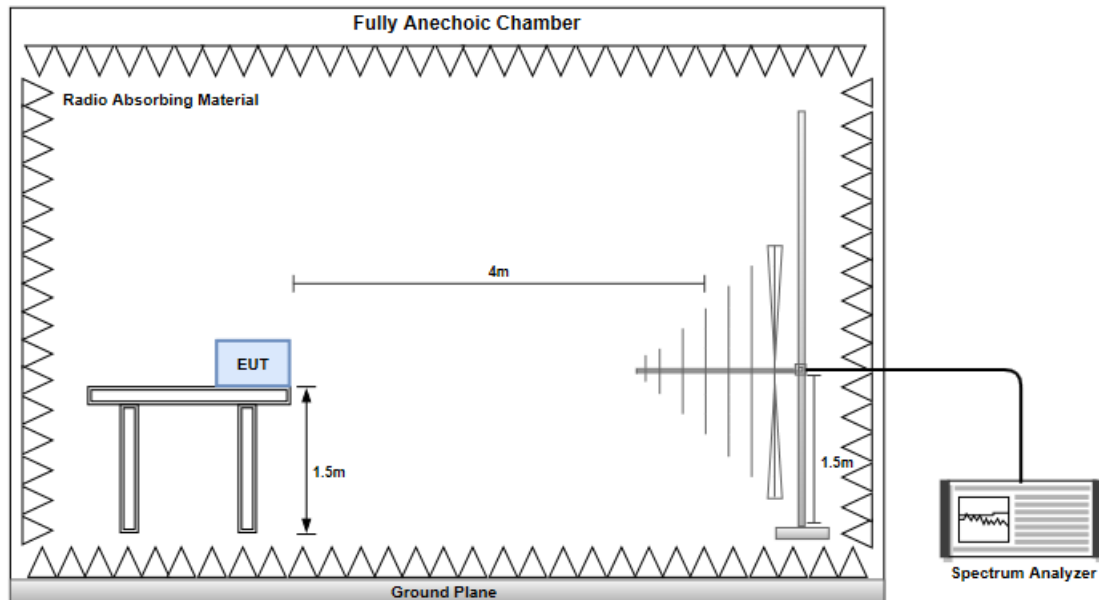
Frequency Range (MHz)	Maximum power (dBm)	Bandwidth (kHz)
30 to 47	-36	100
47 to 74	-54	100
74 to 87,5	-36	100
87,5 to 118	-54	100
118 to 174	-36	100
174 to 230	-54	100
230 to 470	-36	100
470 to 694	-54	100
694 to 1000	-36	100
1000 to 12750	-30	1000

3.6.2 Test Procedures

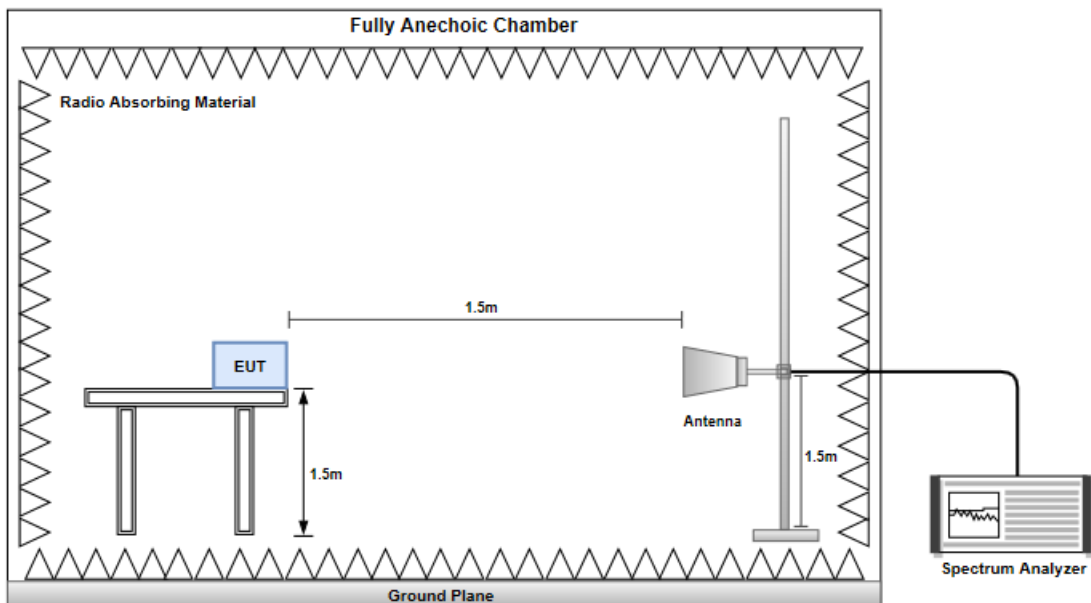
Reference to clause 5.4.9.2 of ETSI EN 300 328 V2.2.2 (2019-07).

3.6.3 Test Setup

Below 1GHz



Above 1 GHz



3.6.4 Test Results

Refer to Appendix F.

4 Receiver Test Results

4.1 Receiver Spurious Emissions

4.1.1 Limit of Receiver Spurious Emissions

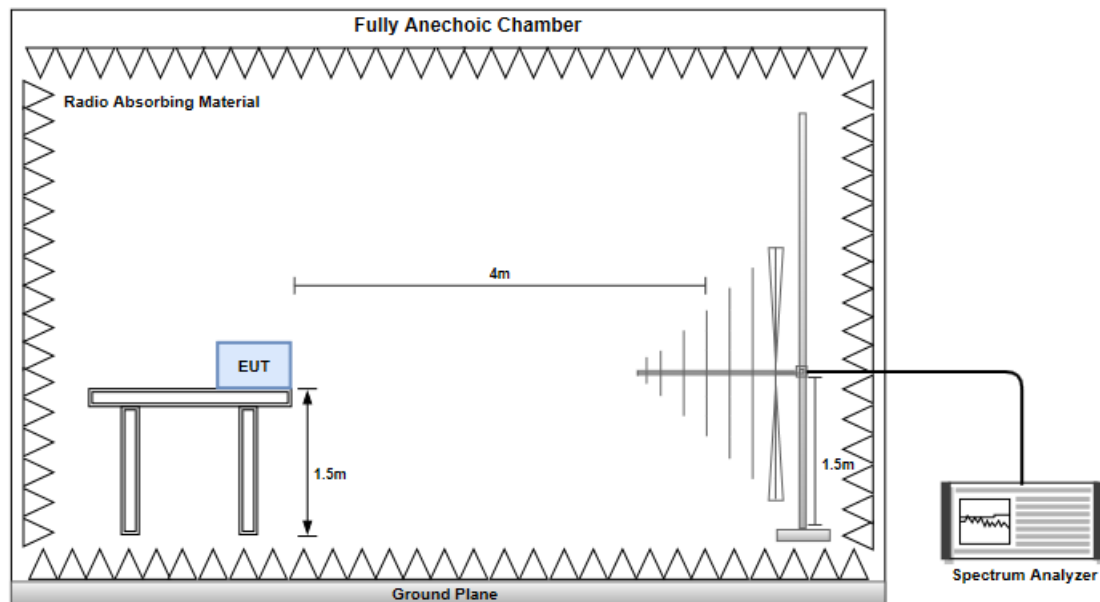
Frequency Range	Maximum power (dBm)	Measurement bandwidth(kHz)
30 MHz to 1 GHz	-57	100
Above 1 GHz to 12,75 GHz	-47	1000

4.1.2 Test Procedures

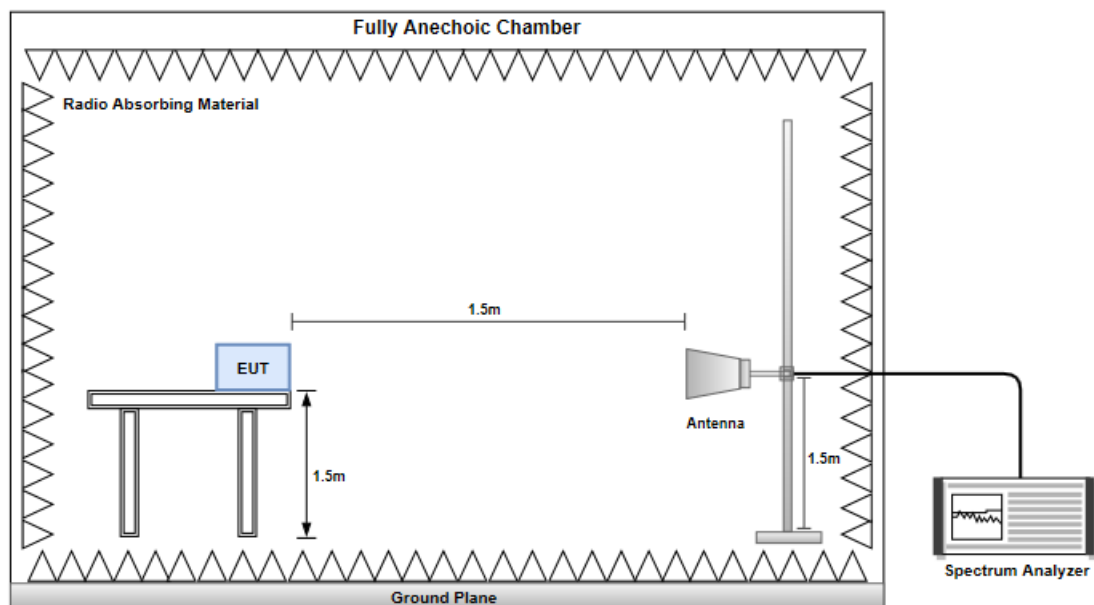
Reference to clause 5.4.10.2 of ETSI EN 300 328 V2.2.2 (2019-07).

4.1.3 Test Setup

Below 1GHz



Above 1 GHz



4.1.4 Test Results

Refer to Appendix I.

5 Receiver Blocking Test Results

5.1 Receiver Blocking

5.1.1 Limit of Receiver Blocking

Receiver Blocking Parameters for Receiver Category 1 Equipment Limit					
Wanted Signal Mean Power from Companion Device (dBm) (see notes 1 and 4)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm) (see note 4)	Type of Blocking Signal		
(-133 dBm + 10 × log10(OCBW)) or -68 dBm whichever is less (see note 2)	2 380 2 504	-34	CW		
(-139 dBm + 10 × log10(OCBW)) or -74 dBm whichever is less (see note 3)	2 300 2 330 2 360 2 524 2 584 2 674				
Note 1: OCBW is in Hz.					
Note 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P _{min} + 26 dB where P _{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.					
Note 3: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to P _{min} + 20 dB where P _{min} is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal.					
Note 4: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned.					

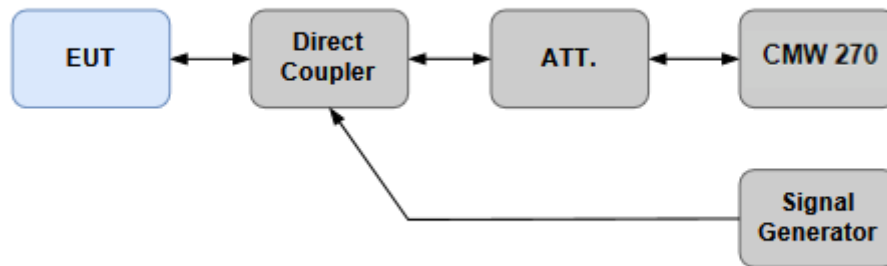
Receiver Blocking Parameters for Receiver Category 2 Equipment Limit			
Wanted Signal Mean Power from Companion Device (dBm) (see notes 1 and 3)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm) (see note 3)	Type of Blocking Signal
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 10 \text{ dB})$ or $(-74 \text{ dBm} + 10 \text{ dB})$ whichever is less (see note 2)	2 380 2 504 2 300 2 584	-34	CW
Note 1: OCBW is in Hz. Note 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative test may be performed using a wanted signal up to $P_{\min} + 26 \text{ dB}$ where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. Note 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned.			

Receiver Blocking Parameters for Receiver Category 3 Equipment Limit			
Wanted Signal Mean Power from Companion Device (dBm) (see notes 1 and 3)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm) (see note 3)	Type of Blocking Signal
$(-139 \text{ dBm} + 10 \times \log_{10}(\text{OCBW}) + 20 \text{ dB})$ or $(-74 \text{ dBm} + 20 \text{ dB})$ whichever is less	2 380 2 504 2 300 2 584	-34	CW
Note 1: OCBW is in Hz. Note 2: In case of radiated measurements using a companion device and the level of the wanted signal from the companion device cannot be determined, a relative the test may be performed using a wanted signal up to $P_{\min} + 30 \text{ dB}$ where $P_{\min}$ is the minimum level of wanted signal required to meet the minimum performance criteria as defined in clause 4.3.1.12.3 in the absence of any blocking signal. Note 3: The level specified is the level at the UUT receiver input assuming a 0 dBi antenna assembly gain. In case of conducted measurements, this level has to be corrected for the (in-band) antenna assembly gain (G). In case of radiated measurements, this level is equivalent to a power flux density (PFD) in front of the UUT antenna with the UUT being configured/positioned.			

5.1.2 Test Procedures

Reference to clause 5.4.11.2 of ETSI EN 300 328 V2.2.2 (2019-07).

5.1.3 Test Setup



5.1.4 Test Results

Ambient Condition	25°C / 65%	Tested By	Hugo Zhen
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Refer to Appendix J.

6 Adaptivity Test Results

6.1 Adaptivity and Unwanted Signal Parameters

6.1.1 Limit of Adaptivity and Unwanted Signal Parameters

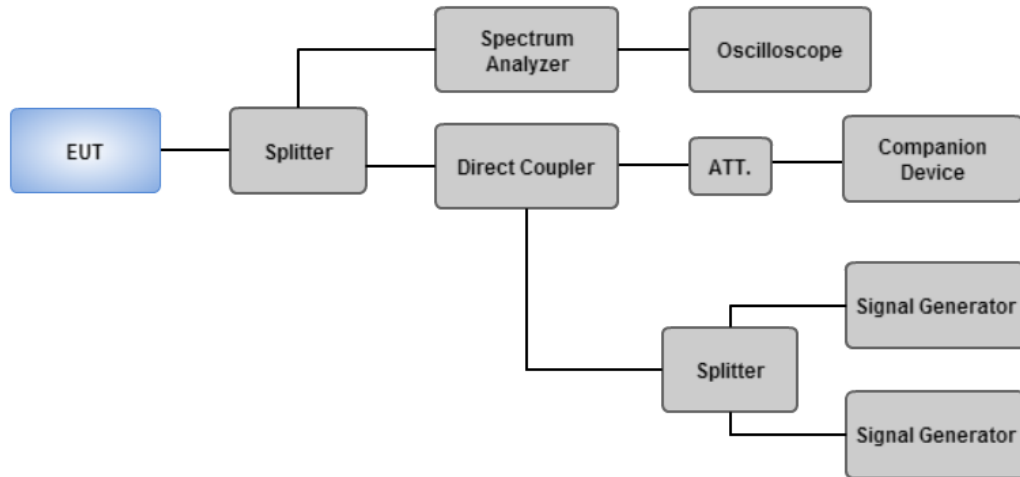
Adaptivity and Unwanted Signal Limit	
☒	Only for adaptive systems and RF Output Power > 10 dBm
☐	Adaptive Frequency Hopping using LBT and DAA: - Minimum Clear Channel Assessment (CCA) time = 18 us; - COT ≤ 60 ms - Idle Period = 5% of COT & ≥ 100 μs - TL = -70 dBm/MHz + 10 x log₁₀ (100mW/ Pout) / 1 MHz (Pout in mW e.i.r.p);
☒	Adaptive Frequency Hopping using other forms DAA (non-LBT based): - Minimum Clear Channel Assessment (CCA) time = 1 sec; - COT ≤ 40 ms - Idle Period = 5% of COT & ≥ 100 μs - TL = -70 dBm/MHz + 10 x log₁₀ (100mW/ Pout) / 1 MHz (Pout in mW e.i.r.p);
☒	Short Control Signalling Transmissions: Short Control Signalling Transmissions shall have a maximum duty cycle of 10 % within an observation period of 50 ms.

Unwanted Signal Parameters				
Equipment Type	Wanted Signal Mean Power from Companion Device	Unwanted Signal Frequency (MHz)	Unwanted CW Signal Mean power (dBm)	Type of Interfering Signal
LBT	sufficient to maintain the link (see note 2)	2395 or 2488,5 (see note 1)	-35	CW
Non-LBT	-30 dBm			
Note 1: The highest blocking frequency shall be used for testing operating channels within the range 2 400 MHz to 2 442 MHz, while the lowest blocking frequency shall be used for testing operating channels within the range 2 442 MHz to 2 483,5 MHz. See clause 5.4.6.1				
Note 2: A typical value which can be used in most cases is -50 dBm/MHz.				

6.1.2 Test Procedures

Reference to clause 5.4.6.2 of ETSI EN 300 328 V2.2.2 (2019-07).

6.1.3 Test Setup



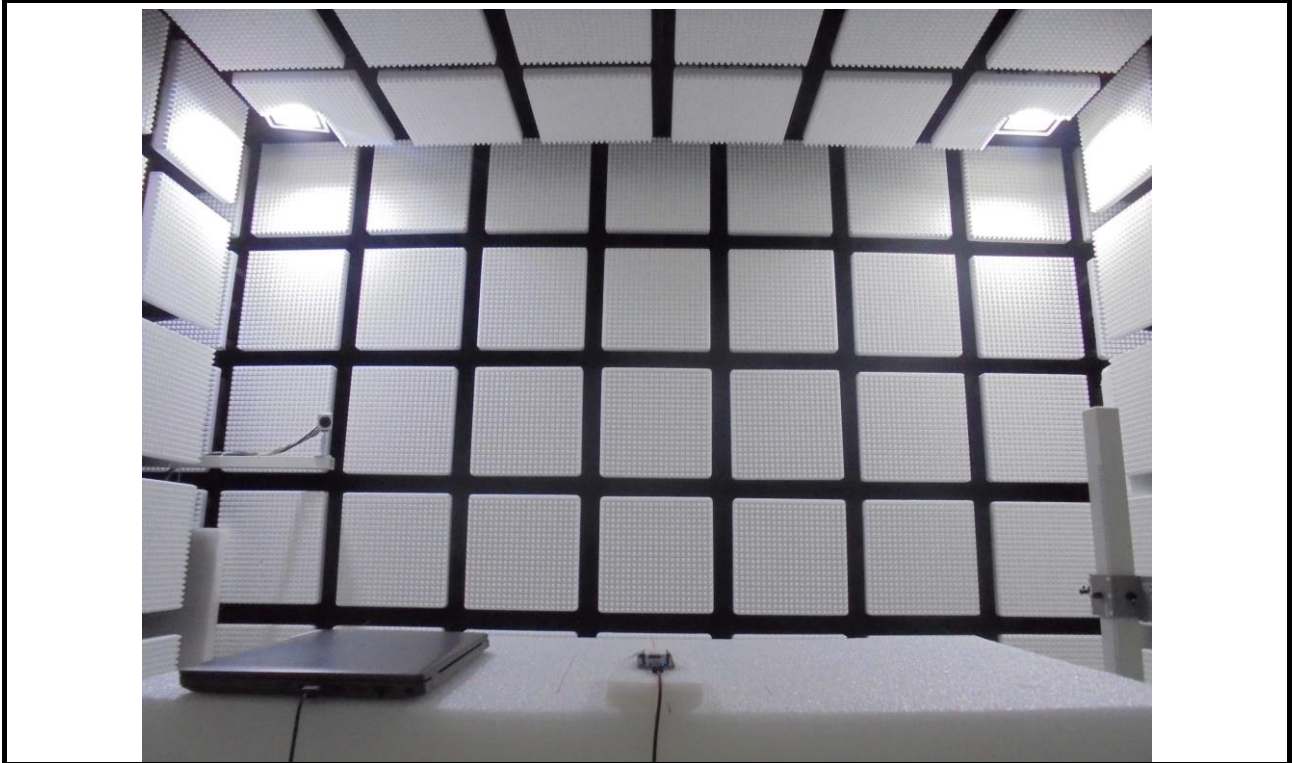
6.1.4 Test Results

Ambient Condition	23°C / 67%	Tested By	Jack Li
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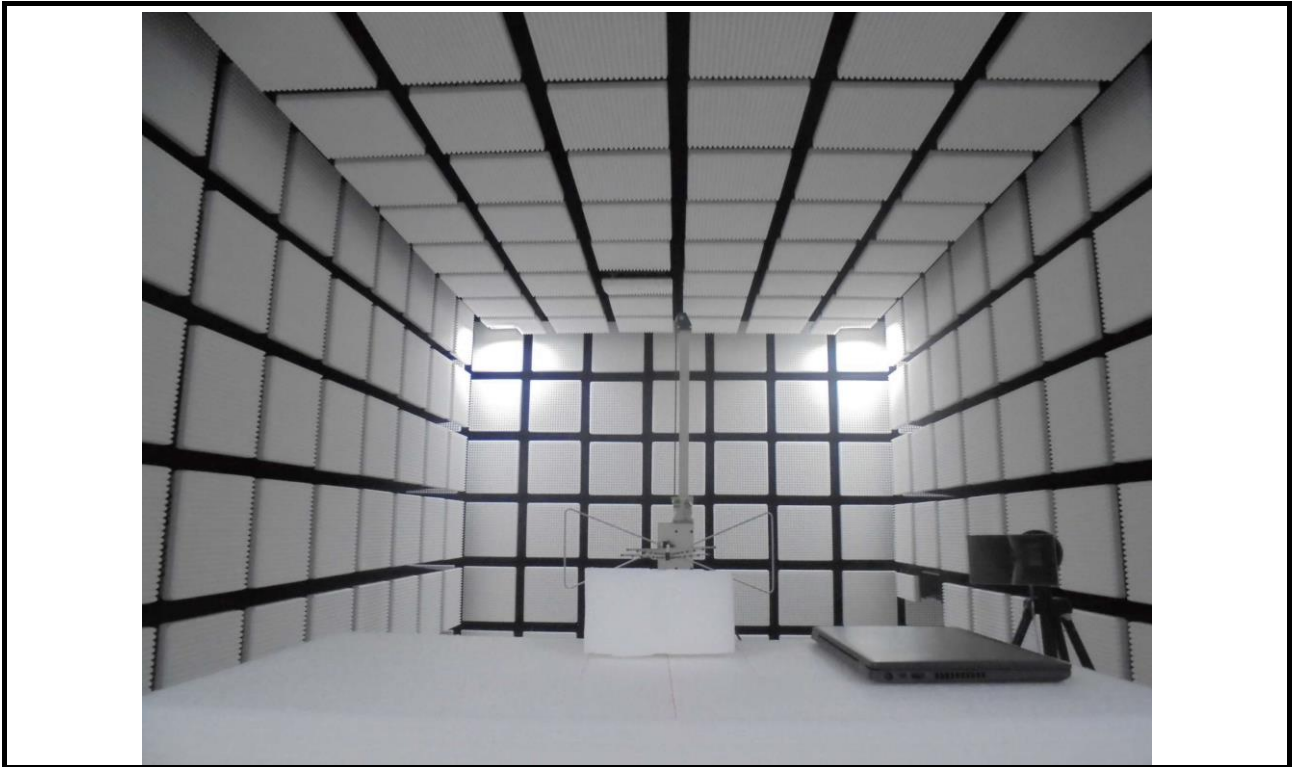
Refer to Appendix I.

7 Photographs of the Test Configuration

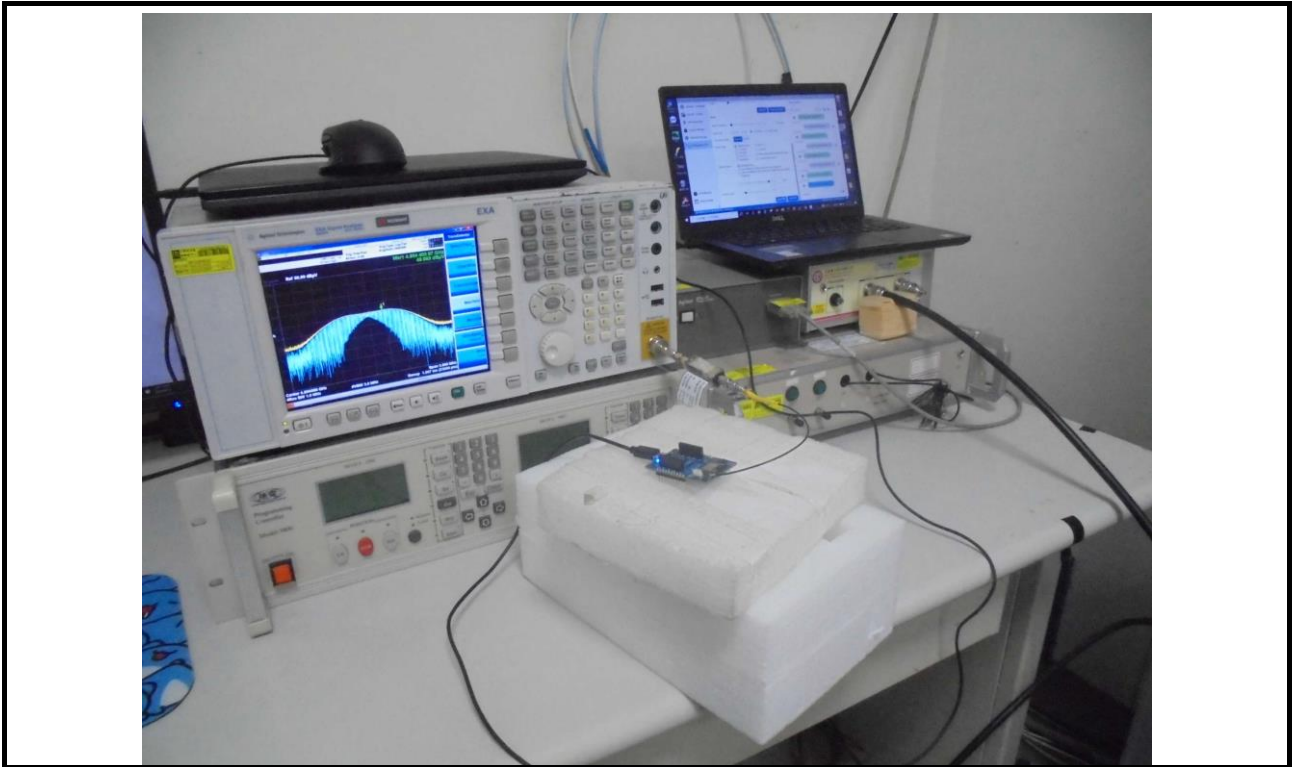
Spurious Emission Test (Radiated, Laird part number: 453-00145)



Spurious Emission Test (Radiated, Laird part number: 453-00148)



Spurious Emission Test (Conducted, Laird part number: 453-00148)



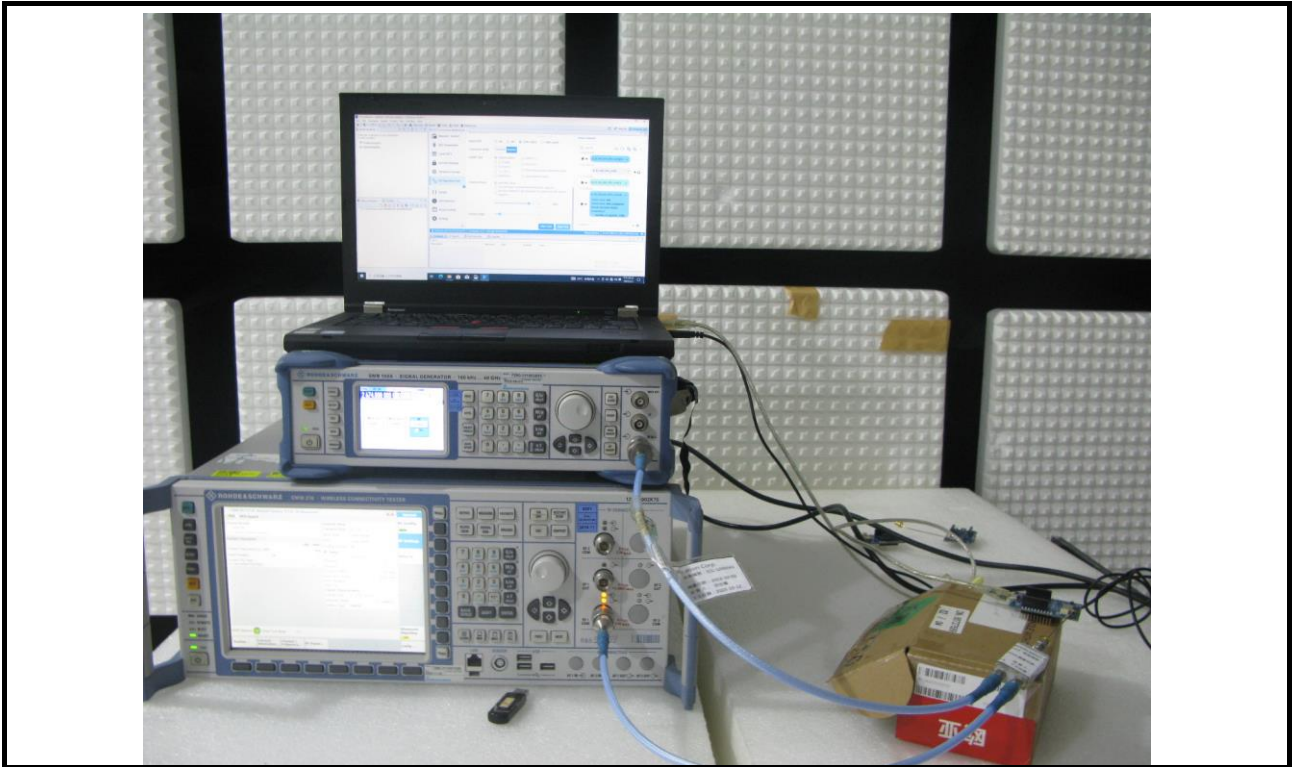
**Adaptivity, Unwanted Signal and Short Control Signalling Transmissions Test
(Laird part number: 453-00145)**



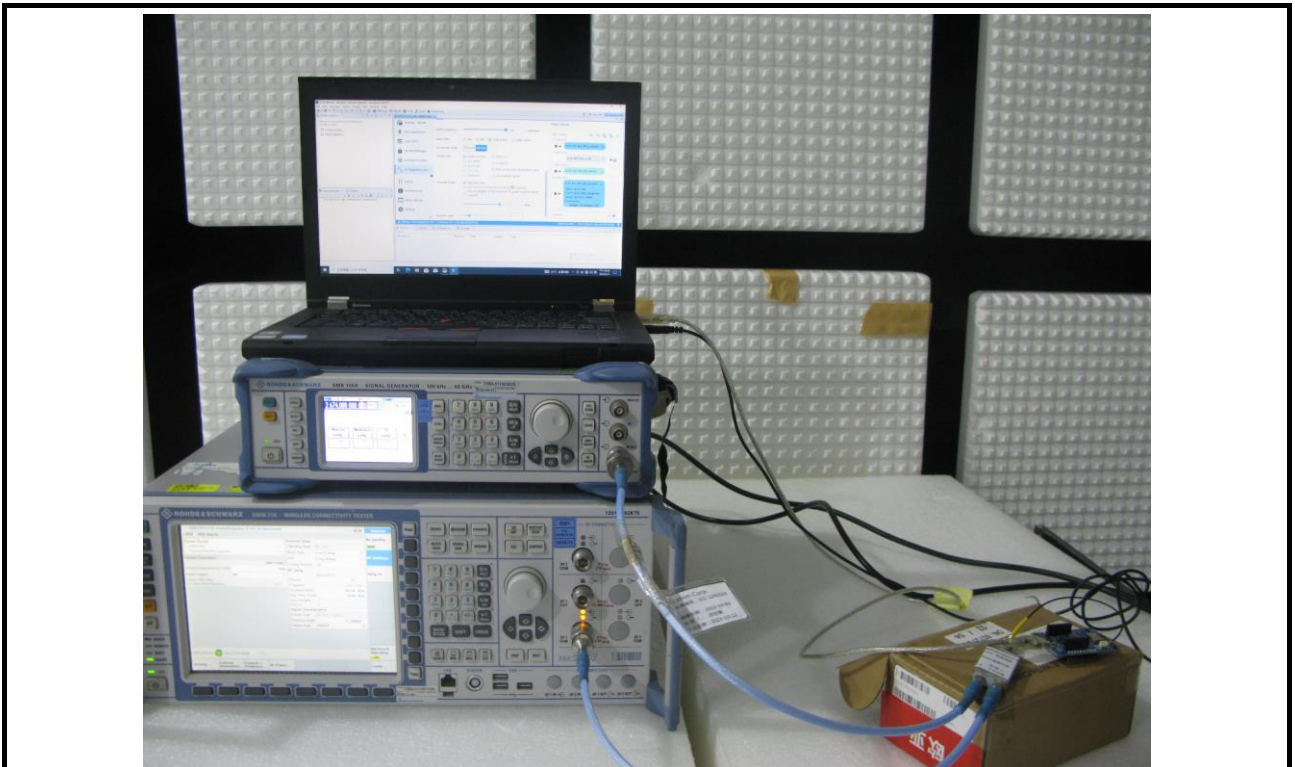
**Adaptivity, Unwanted Signal and Short Control Signalling Transmissions Test
(Laird part number: 453-00148)**



Receiver Blocking Test (Laird part number: 453-00145)



Receiver Blocking Test (Laird part number: 453-00148)



8 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corporation (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

Tel: 886-2-2601-1640

No.30-2, Ding Fwu Tsuen, Lin Kou
District, New Taipei City, Taiwan
(R.O.C.)

Kwei Shan

Tel: 886-3-271-8666

No.3-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)
No.2-1, Lane 6, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

Kwei Shan Site II

Tel: 886-3-271-8640

No.14-1, Lane 19, Wen San 3rd
St., Kwei Shan Dist., Tao Yuan
City 33381, Taiwan (R.O.C.)

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0345

Email: ICC_Service@icertifi.com.tw

==END==

**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna**

Condition	Modulation Mode	Freq. (MHz)	EIRP Power(dBm)	Limit (dBm)
TnomVnom	LE-125Kbps	Hopping	19.27	20
TminVnom	LE-125Kbps	Hopping	19.23	20
TmaxVnom	LE-125Kbps	Hopping	19.34	20
TnomVnom	LE-500Kbps	Hopping	19.27	20
TminVnom	LE-500Kbps	Hopping	19.23	20
TmaxVnom	LE-500Kbps	Hopping	19.34	20
TnomVnom	LE-1Mbps	Hopping	19.27	20
TminVnom	LE-1Mbps	Hopping	19.21	20
TmaxVnom	LE-1Mbps	Hopping	19.28	20
TnomVnom	LE-2Mbps	Hopping	19.30	20
TminVnom	LE-2Mbps	Hopping	19.27	20
TmaxVnom	LE-2Mbps	Hopping	19.36	20

Note:

- 1) Test method is conducted.
- 2) EIRP = Measured conducted power + Antenna gain. (1.82dBi)

**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)**

Condition	Modulation Mode	Freq. (MHz)	EIRP Power(dBm)	Limit (dBm)
TnomVnom	LE-125Kbps	Hopping	19.40	20
TminVnom	LE-125Kbps	Hopping	19.36	20
TmaxVnom	LE-125Kbps	Hopping	19.47	20
TnomVnom	LE-500Kbps	Hopping	19.40	20
TminVnom	LE-500Kbps	Hopping	19.36	20
TmaxVnom	LE-500Kbps	Hopping	19.47	20
TnomVnom	LE-1Mbps	Hopping	19.41	20
TminVnom	LE-1Mbps	Hopping	19.35	20
TmaxVnom	LE-1Mbps	Hopping	19.42	20
TnomVnom	LE-2Mbps	Hopping	19.44	20
TminVnom	LE-2Mbps	Hopping	19.41	20
TmaxVnom	LE-2Mbps	Hopping	19.50	20

Note:

- 1) Test method is conducted.
- 2) EIRP = Measured conducted power + Antenna gain. (2dBi)

**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna****Summary**

Mode	Max-Dwell (s)
2.4-2.4835GHz	-
BT-LE(125K)	153.69921
BT- LE -AFH(125K)	117.68792

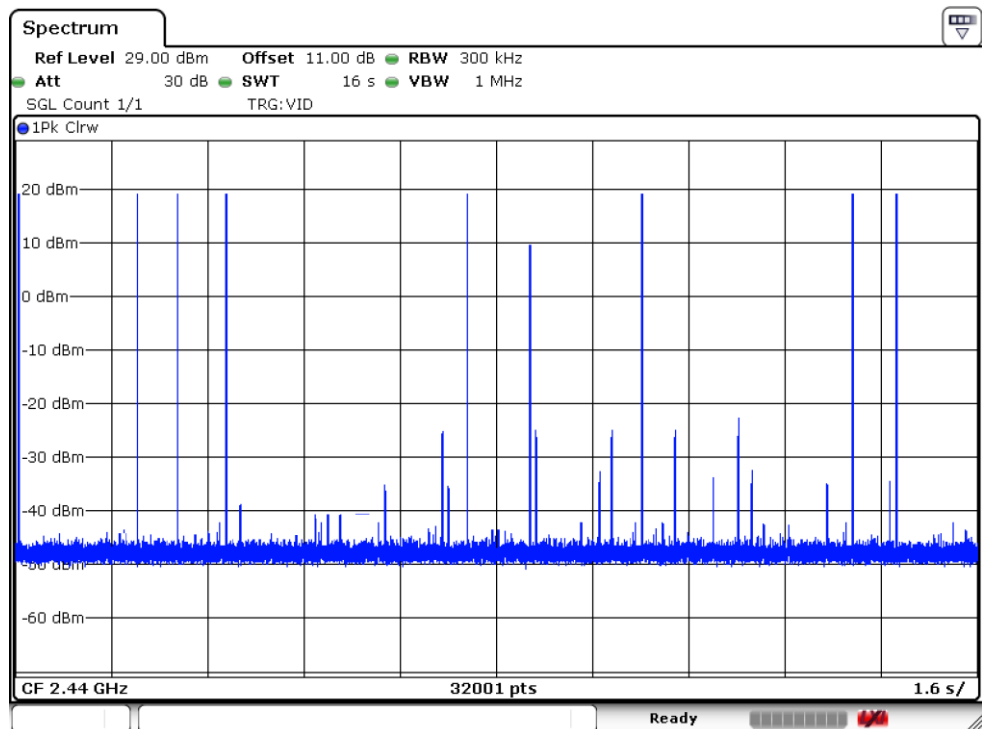
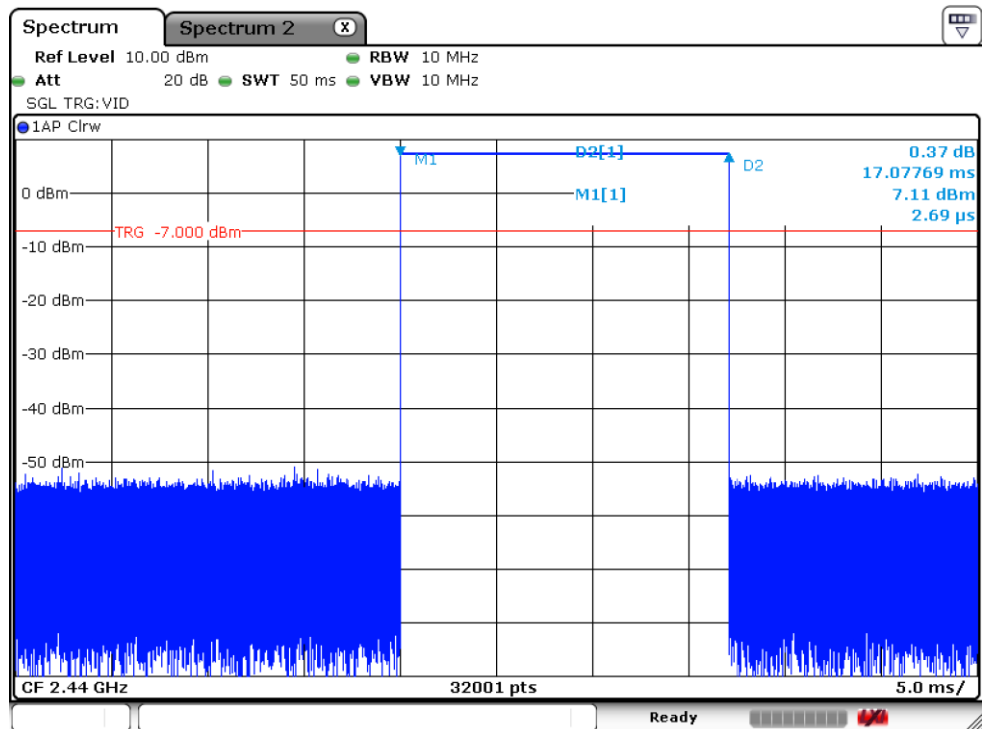
Result

Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(125K)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	9	153.69921	400	17.07769
BT- LE -AFH(125K)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	7	117.68792	400	16.81256

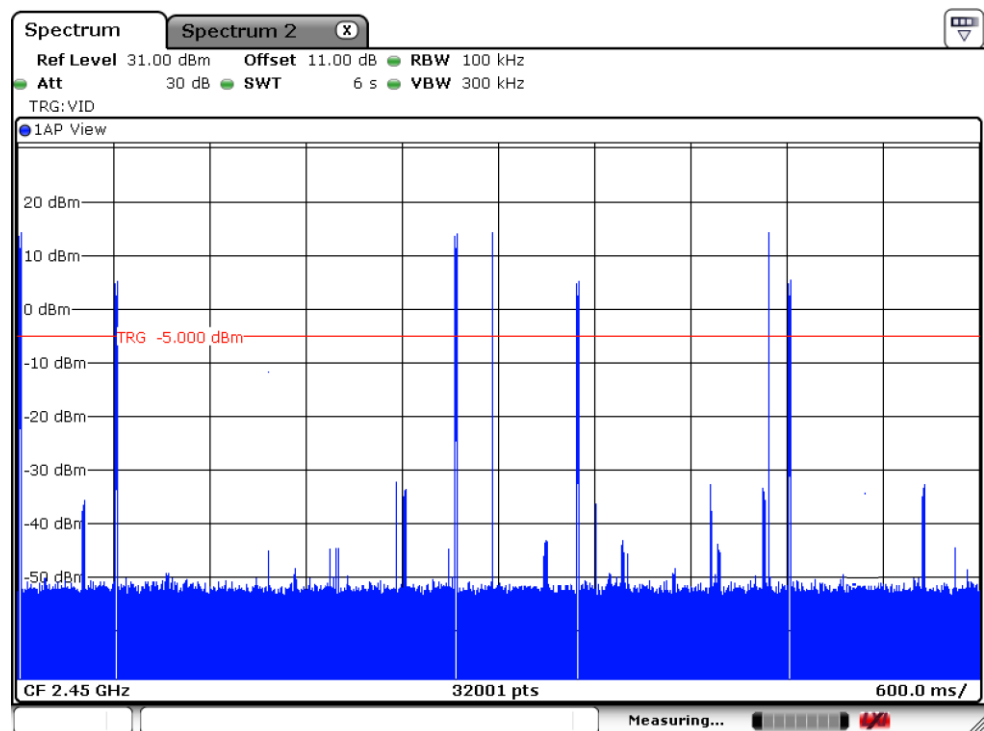
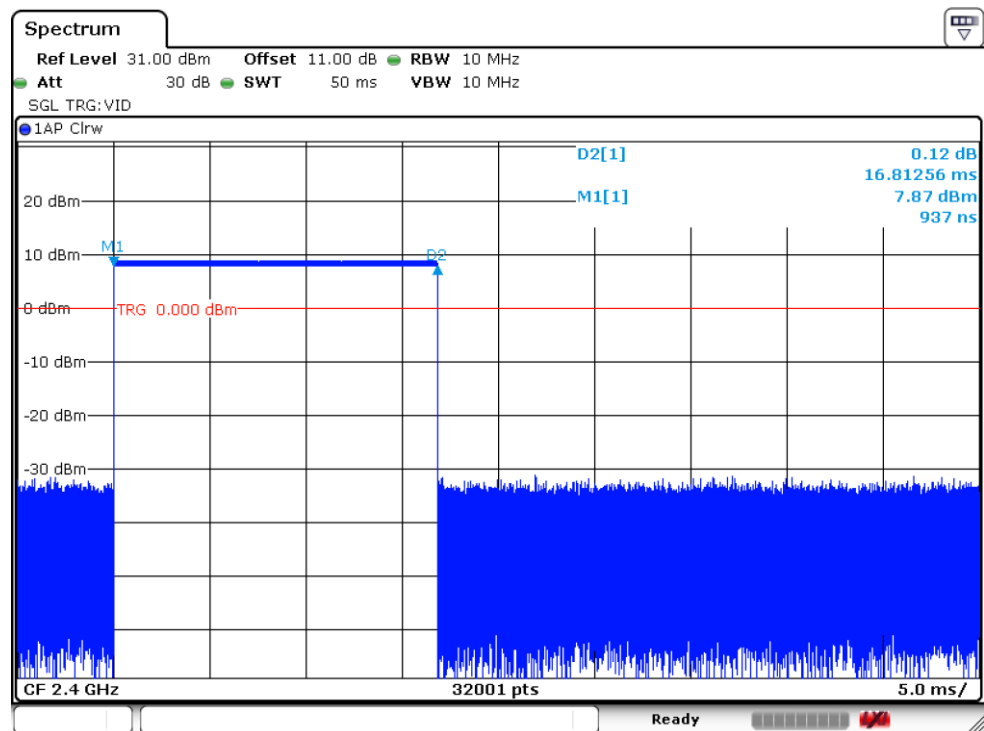
Note: BLE hops observed and connection interval is 26.25ms



TnomVnom : Non-AFH-DW



TnomVnom : AFH-DW



Summary

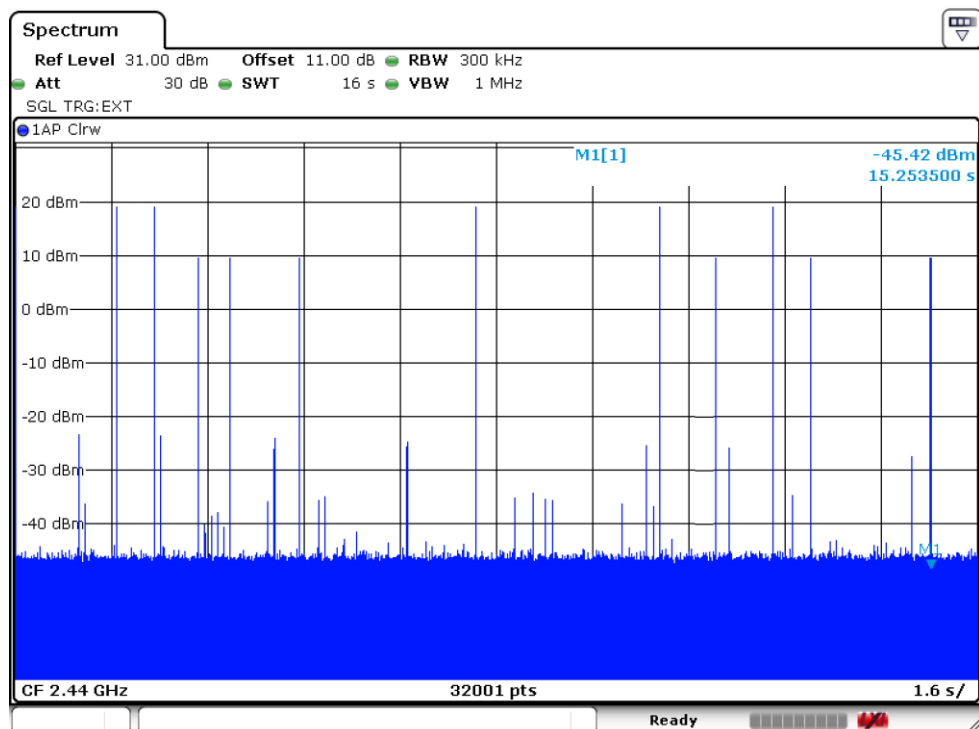
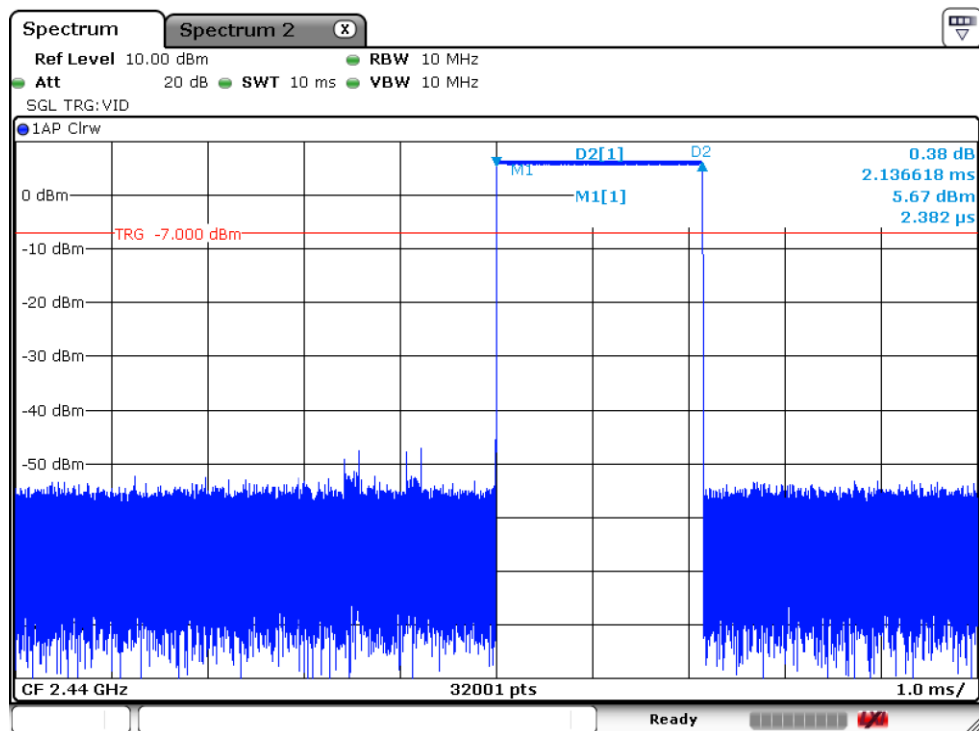
Mode	Max-Dwell (ms)
2.4-2.4835GHz	-
BT-LE(1Mbps)	25.639416
BT- LE -AFH(1Mbps)	12.665412

Result

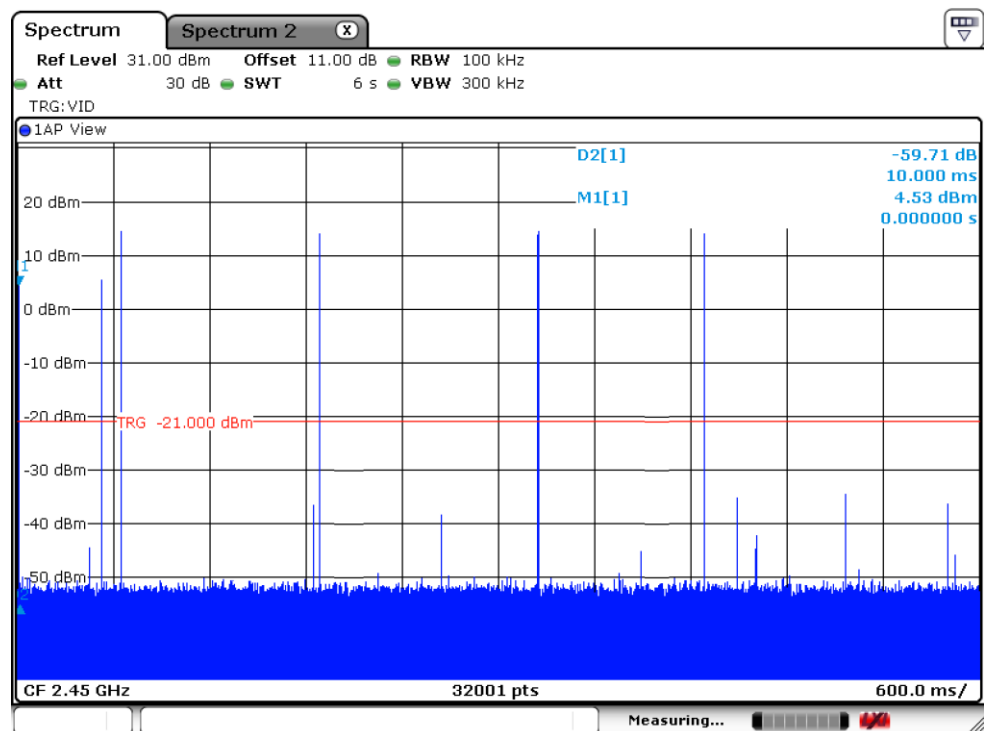
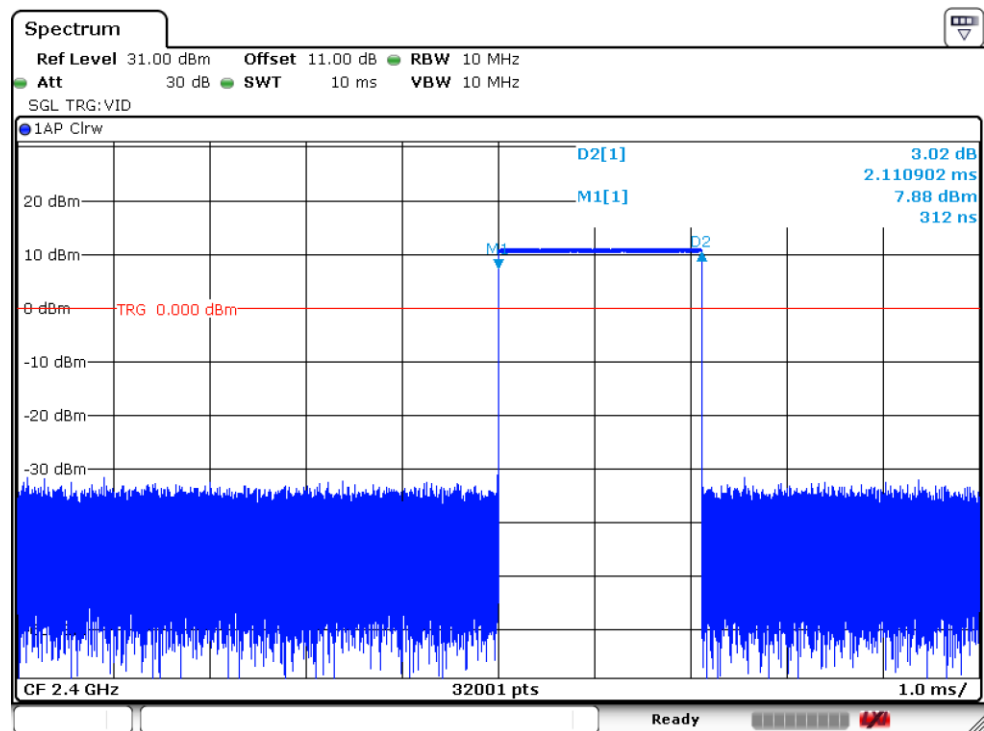
Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(1Mbps)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	12	25.639416	400	2.136618
BT- LE -AFH(1Mbps)	-			-	
Hopping Mode_TnomVnom	Pass	6	12.665412	400	2.110902

Note: BLE hops observed and connection interval is 26.25ms

TnomVnom : Non-AFH-DW



TnomVnom : AFH-DW



**Summary**

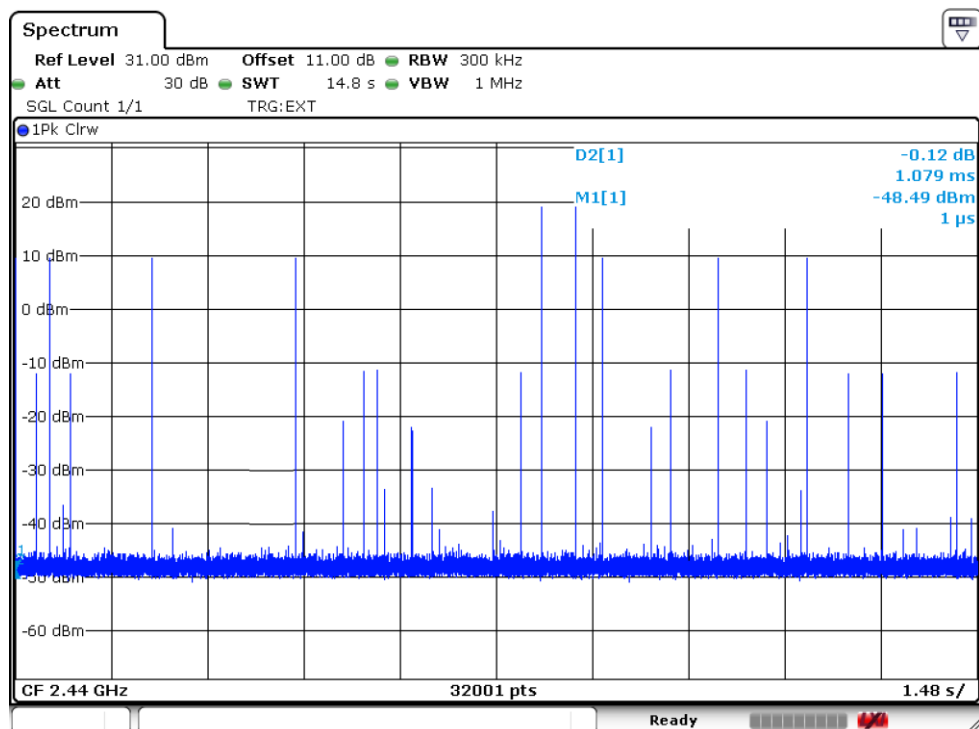
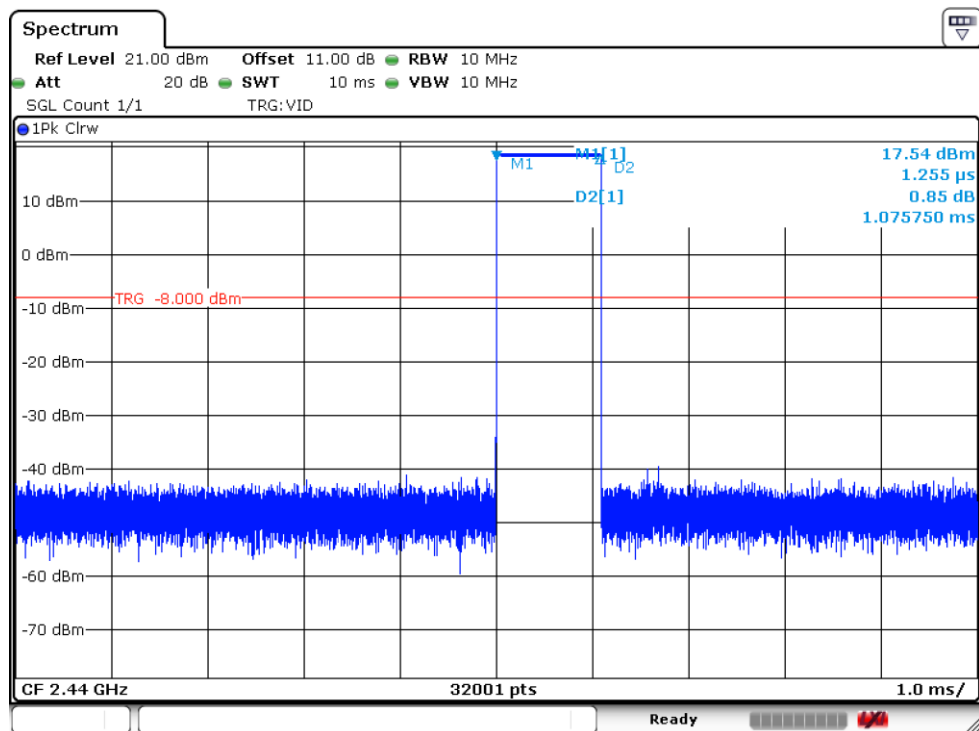
Mode	Max-Dwell (ms)
2.4-2.4835GHz	-
BT-LE(2Mbps)	9.68175
BT- LE -AFH(2Mbps)	7.48555

Result

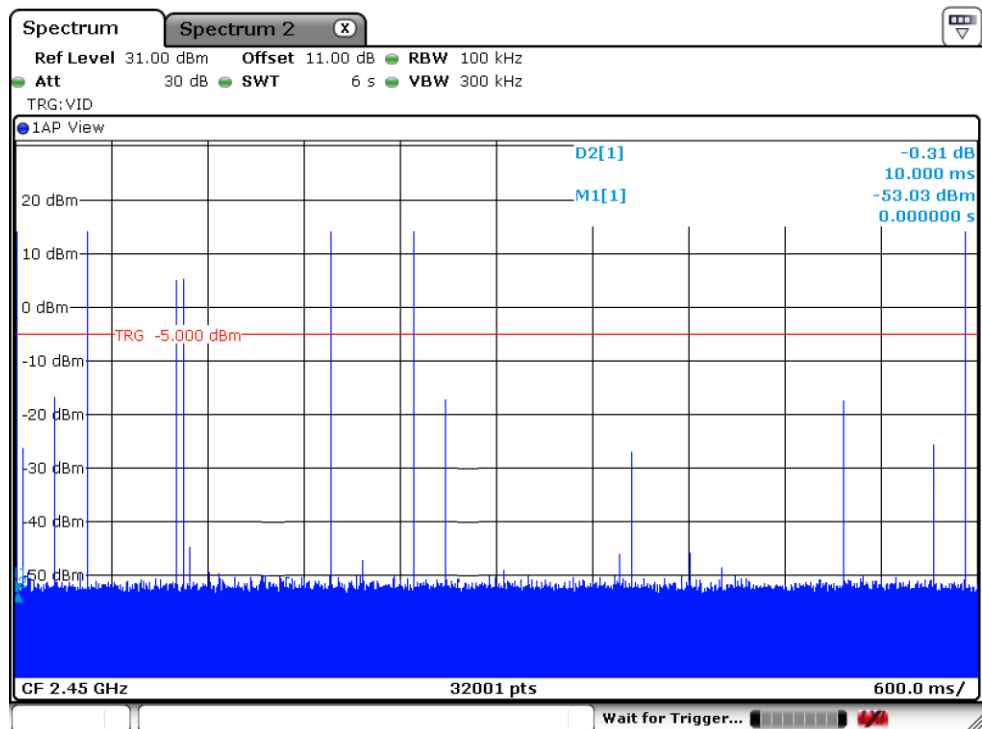
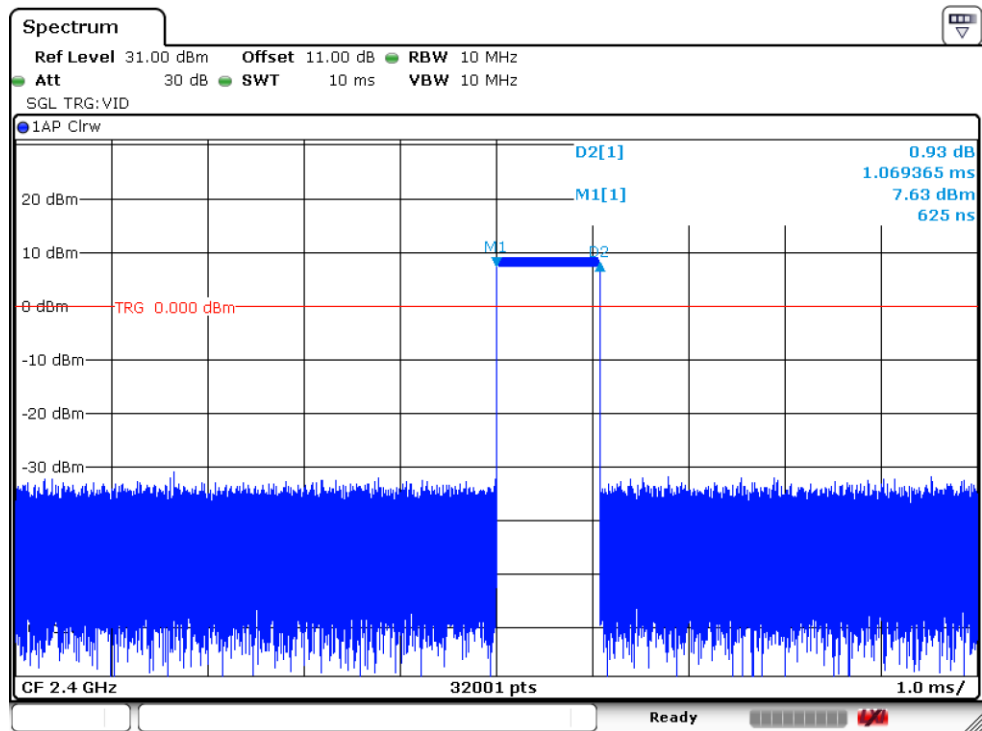
Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(2Mbps)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	9	9.68175	400	1.075750
BT- LE -AFH(2Mbps)	-			-	
Hopping Mode_TnomVnom	Pass	7	7.48555	400	1.069365

Note: BLE hops observed and connection interval is 26.25ms

TnomVnom : Non-AFH-DW



TnomVnom : AFH-DW



**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)****Summary**

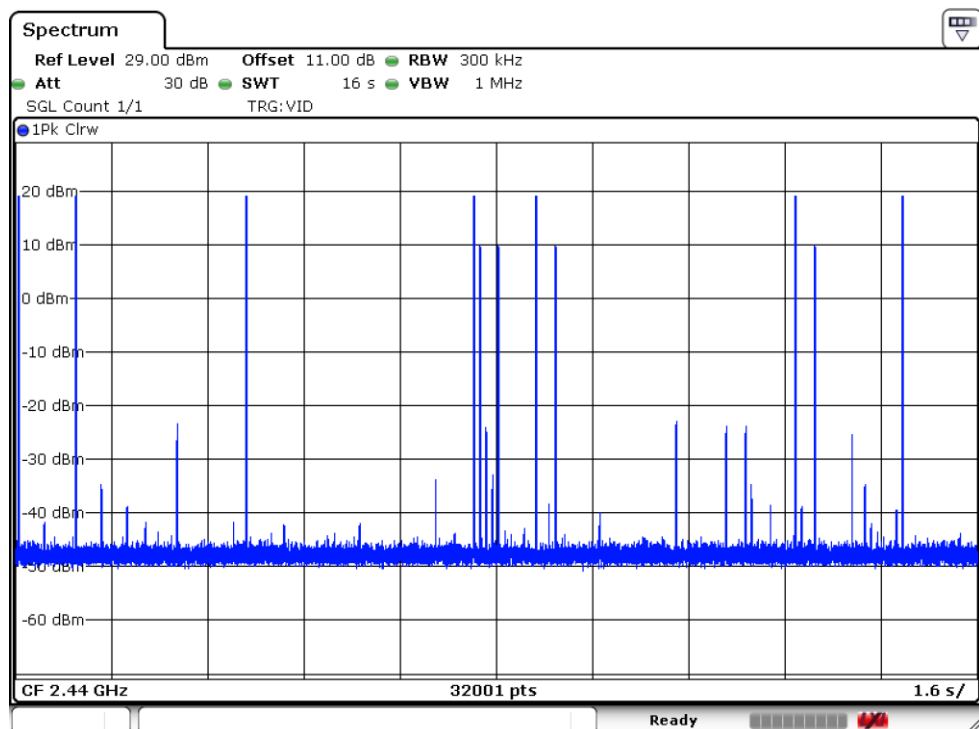
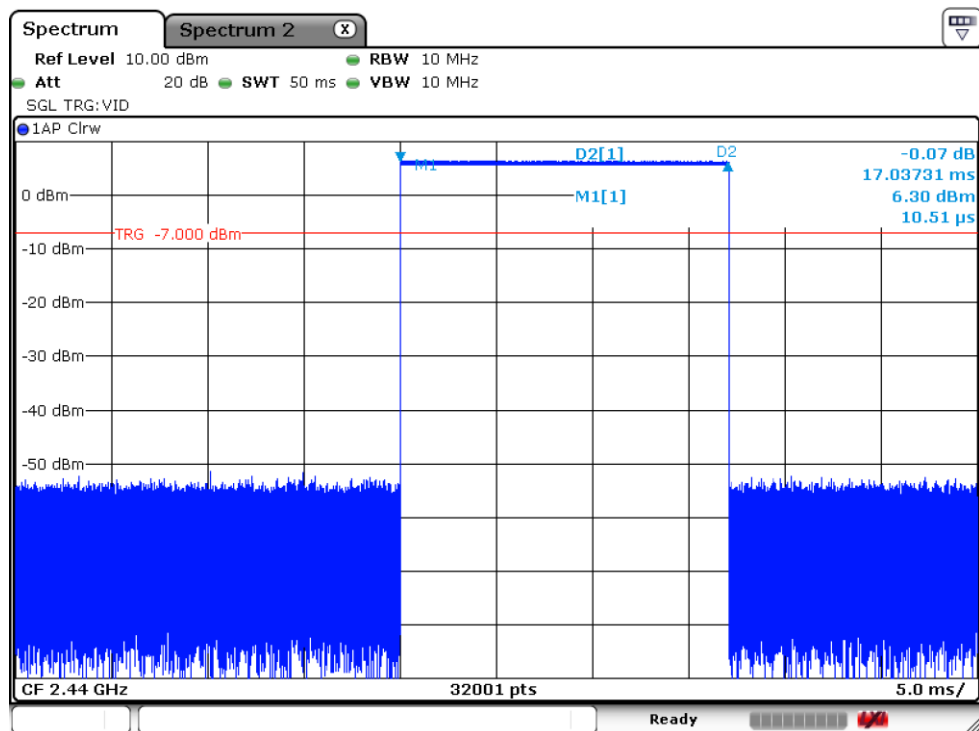
Mode	Max-Dwell (s)
2.4-2.4835GHz	-
BT-LE(125K)	187.41041
BT- LE -AFH(125K)	151.25904

Result

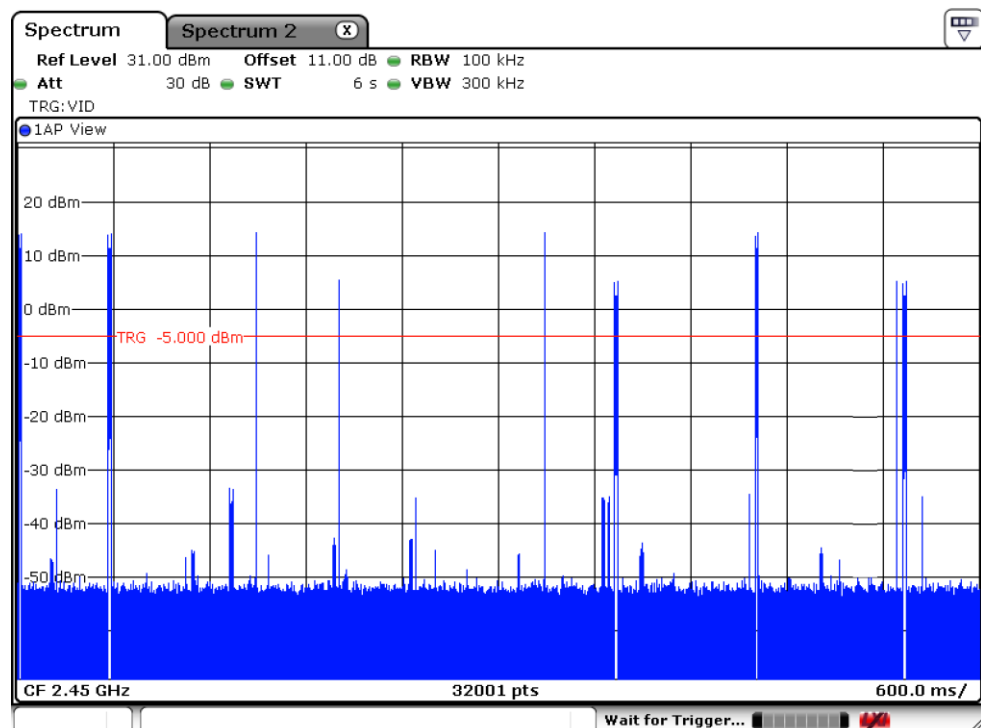
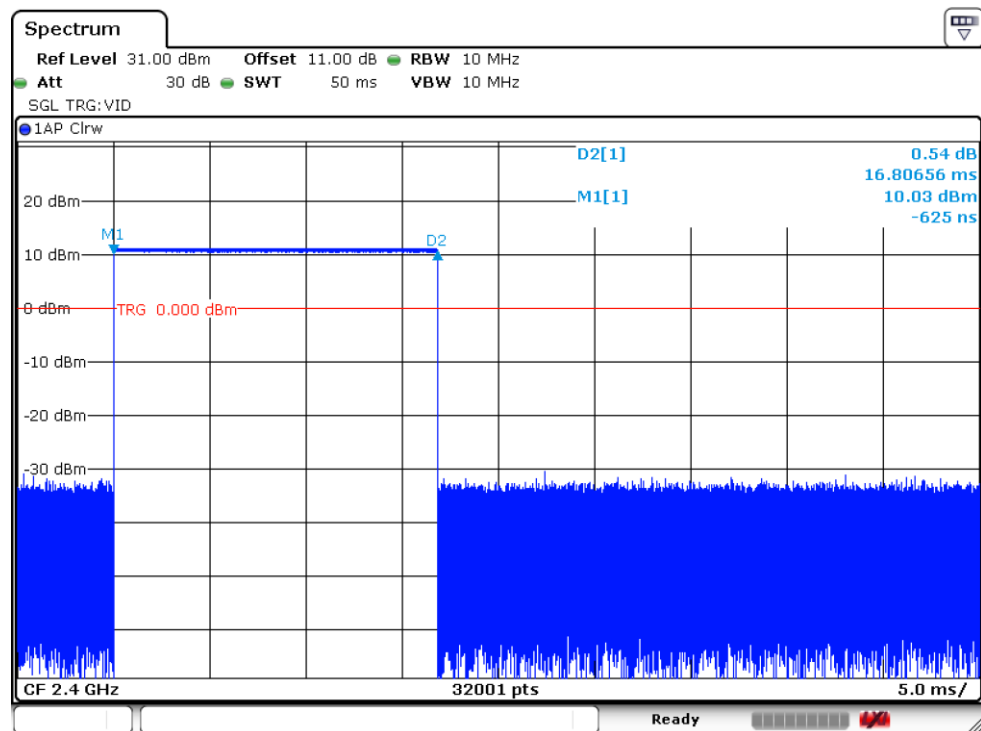
Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(125K)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	11	187.41041	400	17.03731
BT- LE -AFH(125K)	-				
Hopping Mode_TnomVnom	Pass	9	151.25904	400	16.80656

Note: BLE hops observed and connection interval is 26.25ms

TnomVnom : Non-AFH-DW



TnomVnom : AFH-DW



**Summary**

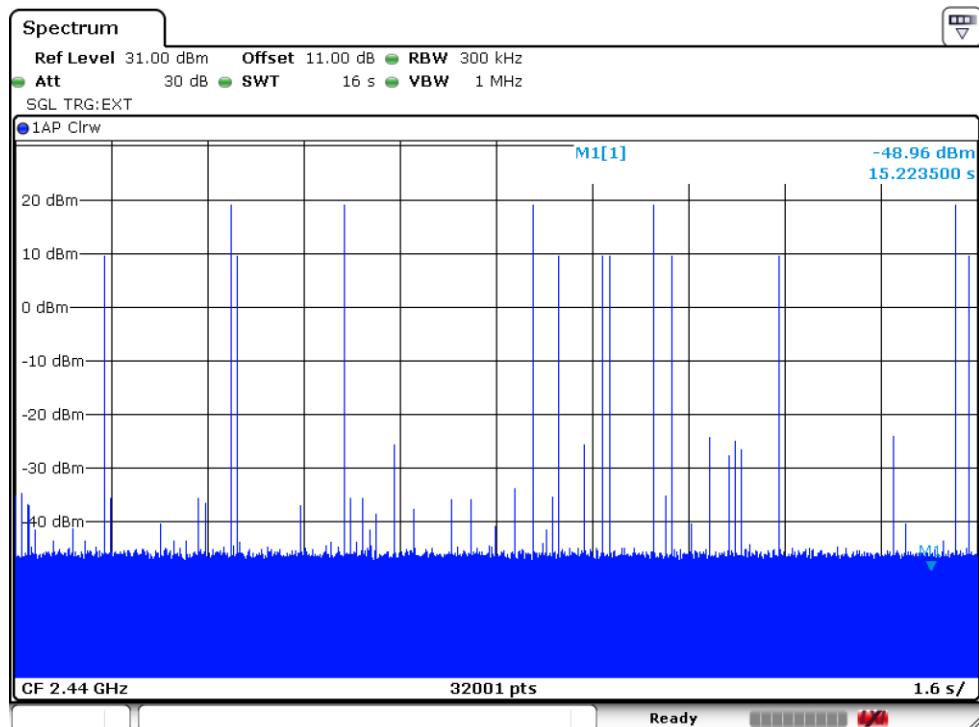
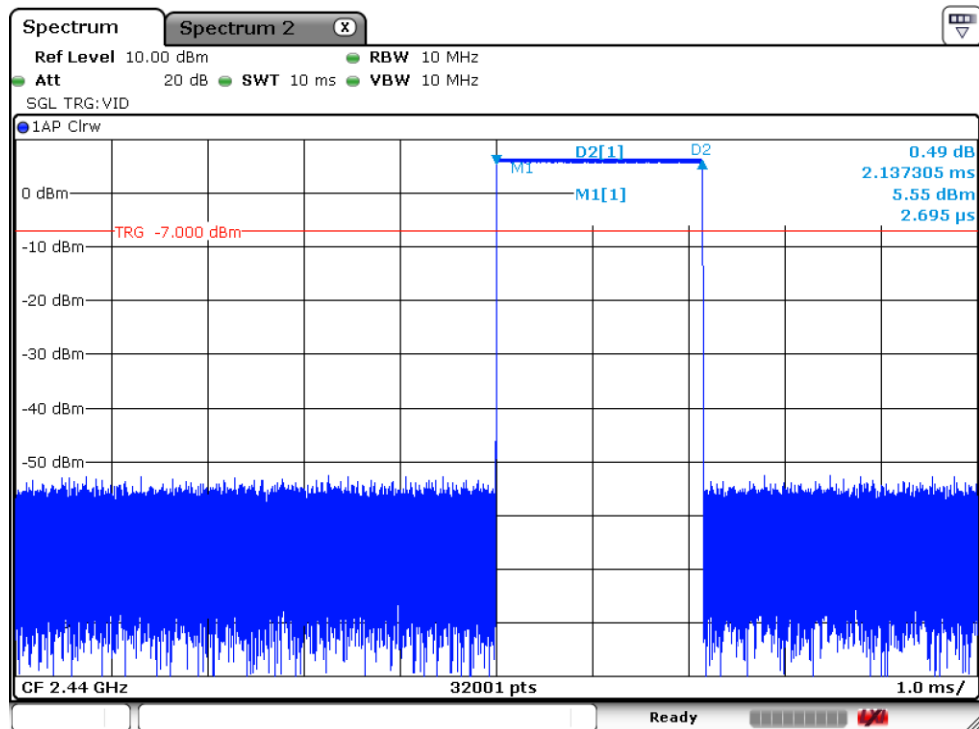
Mode	Max-Dwell (ms)
2.4-2.4835GHz	-
BT-LE(1Mbps)	27.784965
BT- LE -AFH(1Mbps)	14.759059

Result

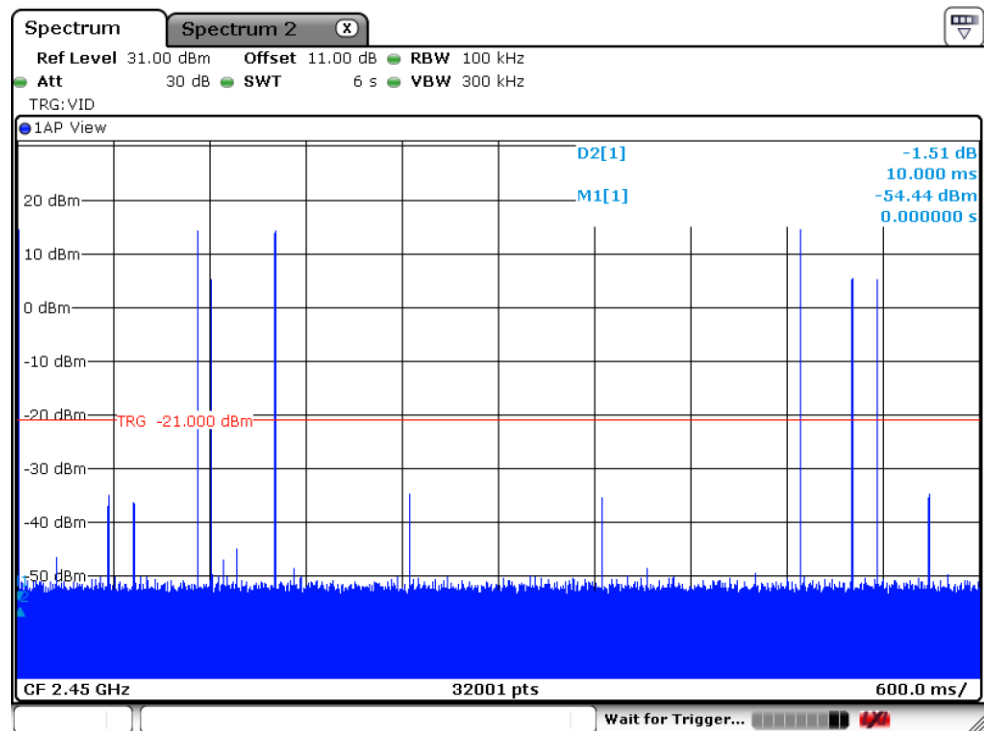
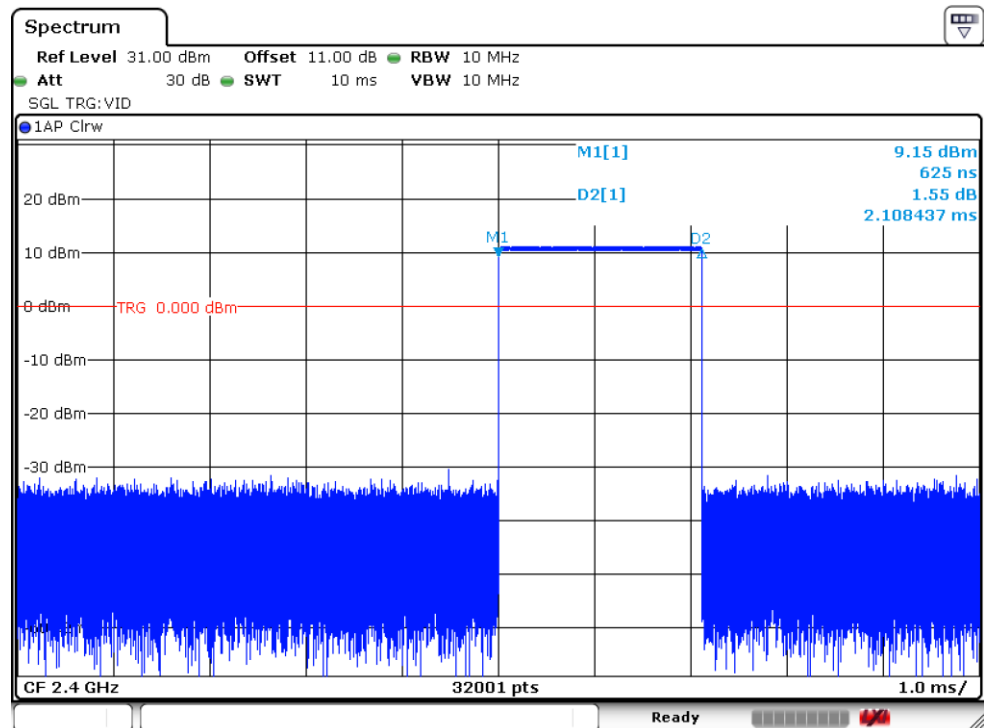
Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(1Mbps)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	13	27.784965	400	2.137305
BT- LE -AFH(1Mbps)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	7	14.759059	400	2.108437

Note: BLE hops observed and connection interval is 26.25ms

TnomVnom : Non-AFH-DW



TnomVnom : AFH-DW



**Summary**

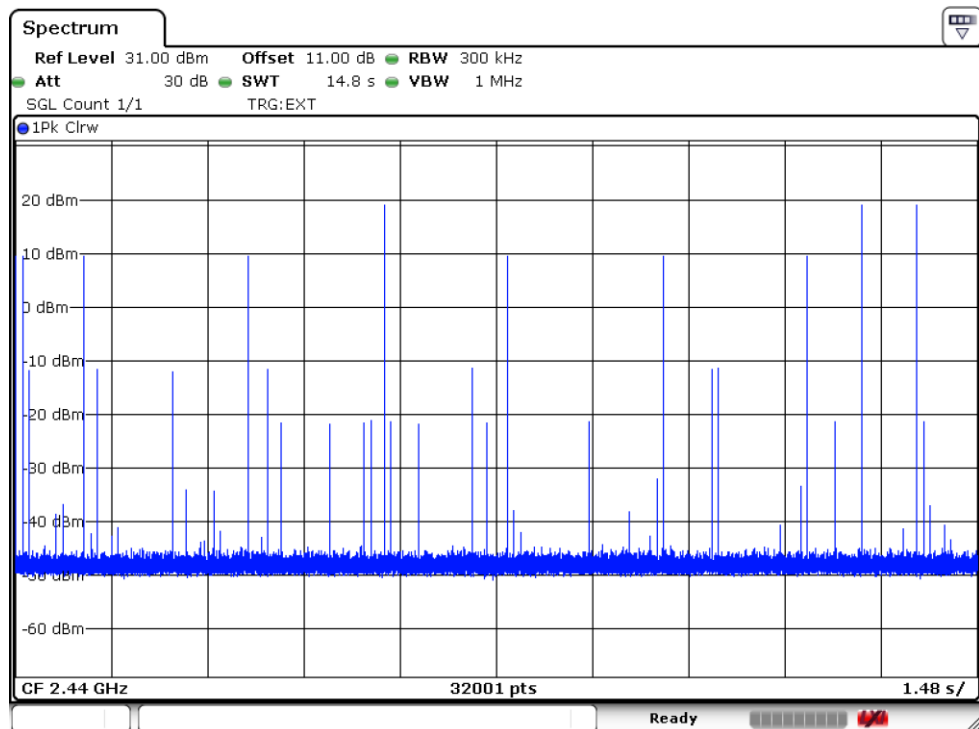
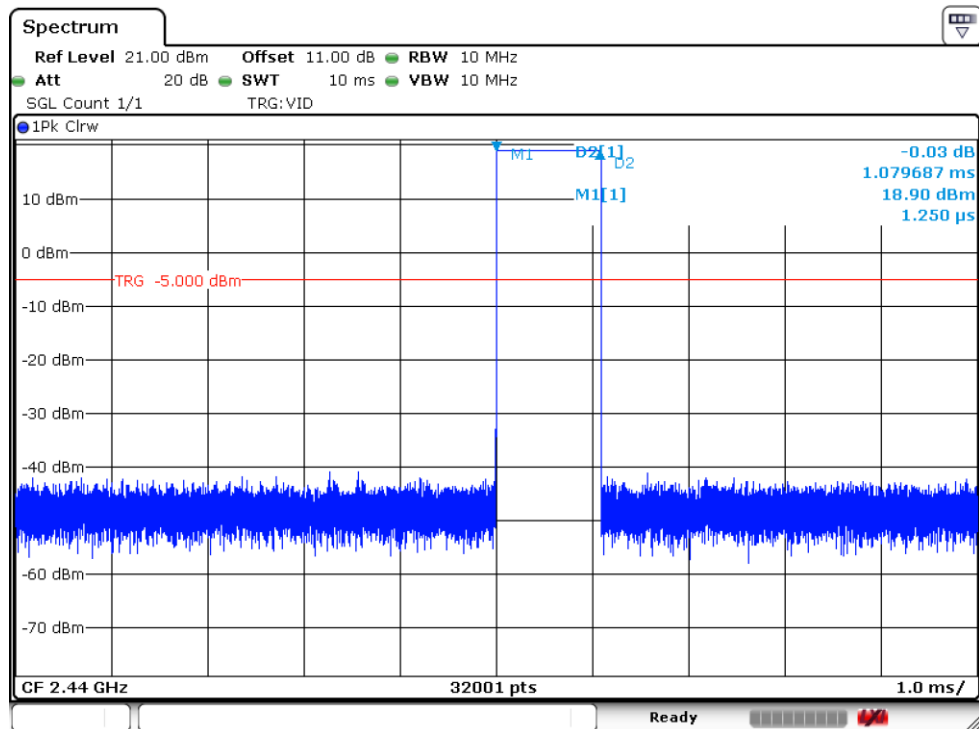
Mode	Max-Dwell (ms)
2.4-2.4835GHz	-
BT-LE(2Mbps)	10.79687
BT- LE -AFH(2Mbps)	9.621558

Result

Mode	Result	Number of Hopping Channel (N)	Dwell (ms)	Limit (ms)	Dwell Time per Hop (ms)
BT-LE(2Mbps)	-	-	-	-	-
Hopping Mode_TnomVnom	Pass	10	10.79687	400	1.079687
BT- LE -AFH(2Mbps)	-			-	
Hopping Mode_TnomVnom	Pass	9	9.621558	400	1.069062

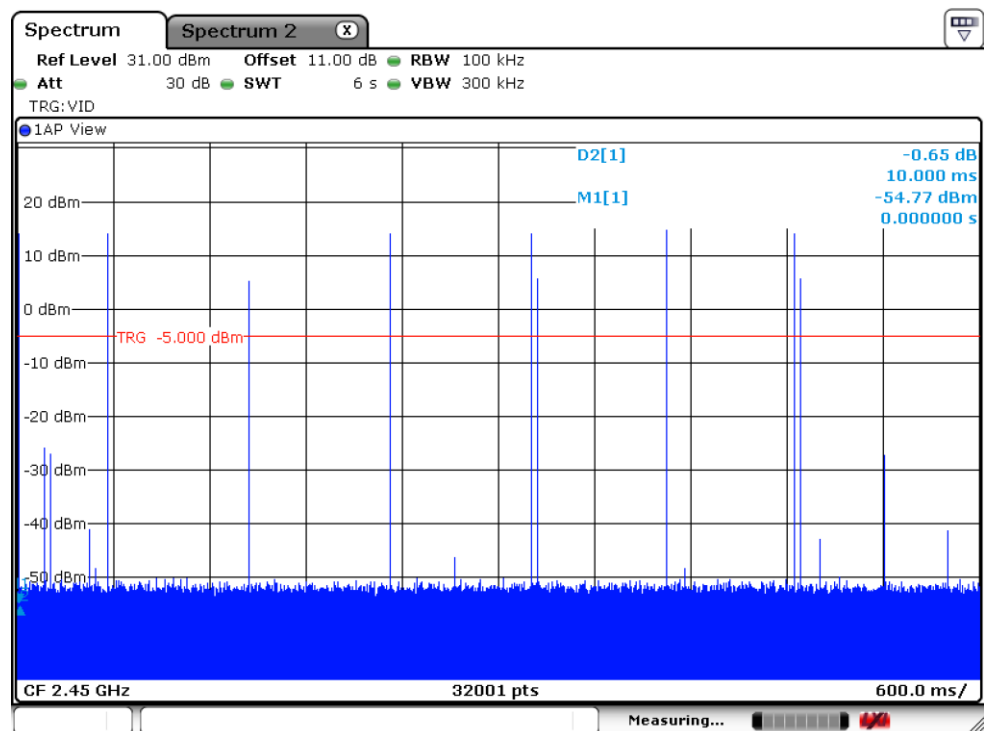
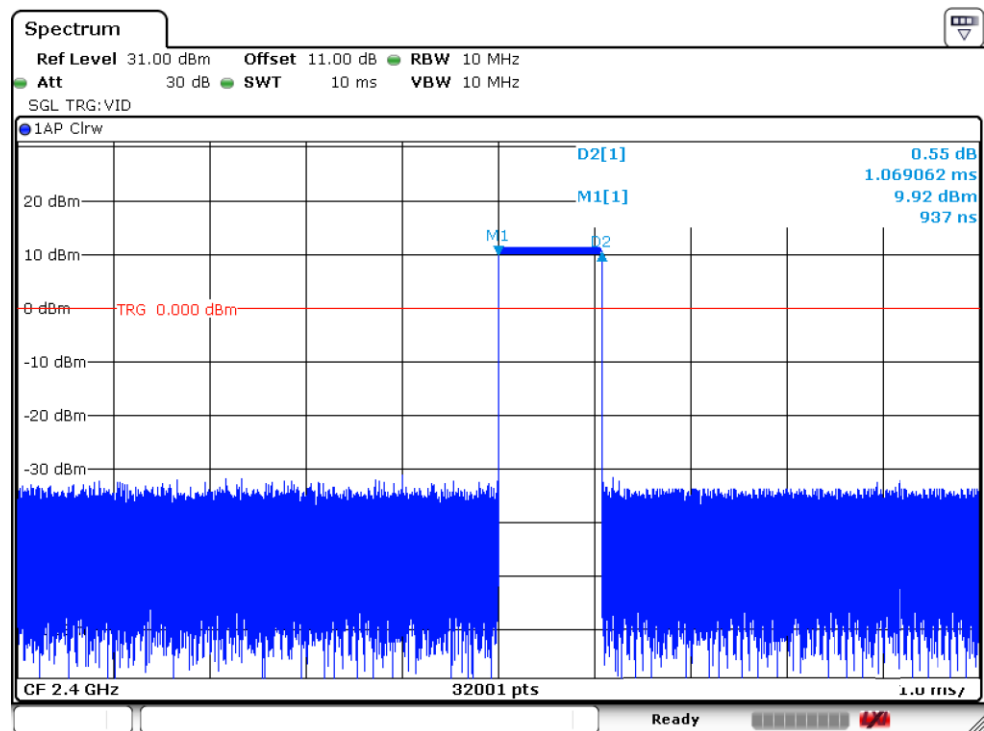
Note: BLE hops observed and connection interval is 26.25ms

TnomVnom : Non-AFH-DW





TnomVnom : AFH-DW



**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna****Summary**

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(125kbps)	40

Result

Mode	Result	Hopping No	Limit
BT-LE(125kbps)	-	-	-
2440MHz_Tnom	Pass	40	15



Summary

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(1Mbps)	40

Result

Mode	Result	Hopping No	Limit
BT-LE(1Mbps)	-	-	-
2440MHz_Tnom	Pass	40	15

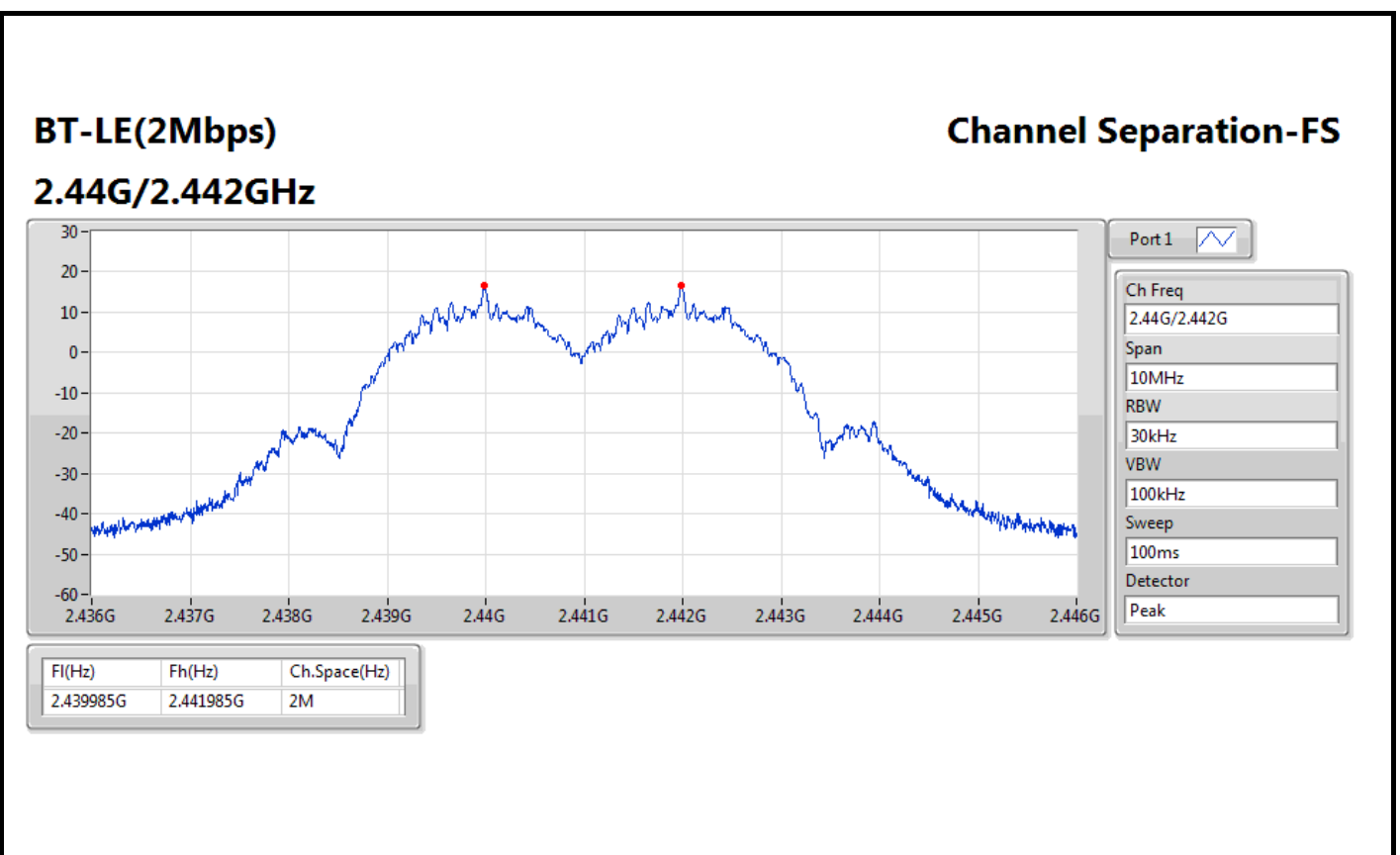


Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(2Mbps)	2M	2M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(2Mbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.439985G	2.441985G	2M	1





Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Summary

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(125kbps)	40

Result

Mode	Result	Hopping No	Limit
BT-LE(125kbps)	-	-	-
2440MHz_Tnom	Pass	40	15



Summary

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(1Mbps)	40

Result

Mode	Result	Hopping No	Limit
BT-LE(1Mbps)	-	-	-
2440MHz_Tnom	Pass	40	15

**Summary**

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(2Mbps)	37

Result

Mode	Result	Hopping No	Limit
BT-LE(2Mbps)	-	-	-
2440MHz_Tnom	Pass	37	15



Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna

Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	1.9975M	1.9975M

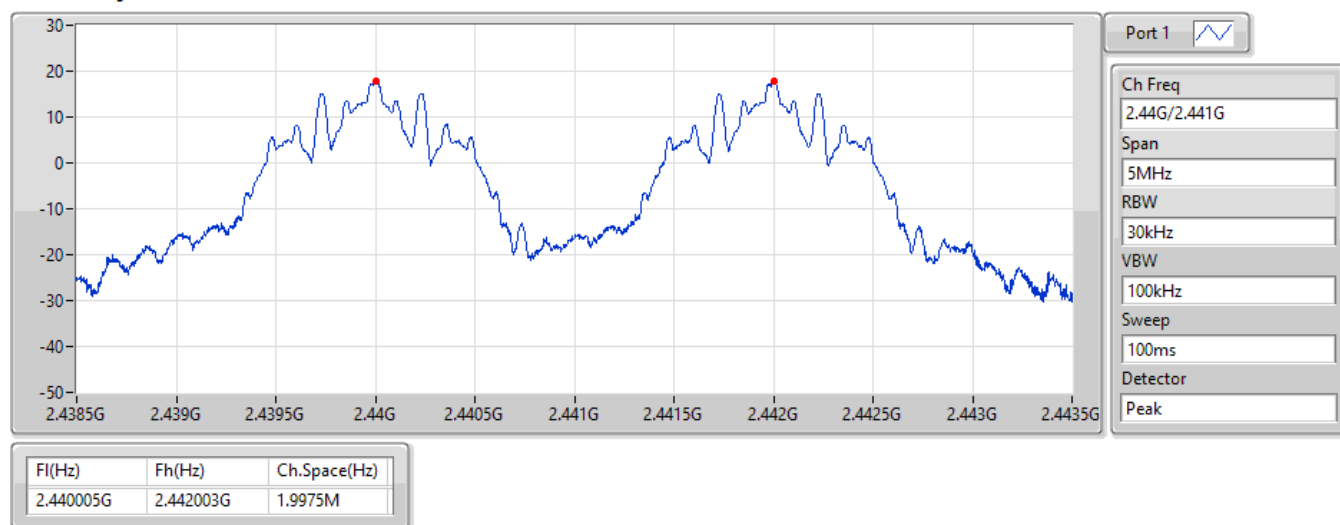
Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(125kbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.440005G	2.442003G	1.9975M	100k

BT-LE(125kbps)

2.44G/2.441GHz

Channel Separation-FS



Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	2.0025M	2.0025M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(1Mbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.439988G	2.44199G	2.0025M	100k

BT-LE(1Mbps)

2.44G/2.442GHz

Channel Separation-FS



**Summary**

Mode	Max-Hop No
2.4-2.4835GHz	-
BT-LE(2Mbps)	37

Result

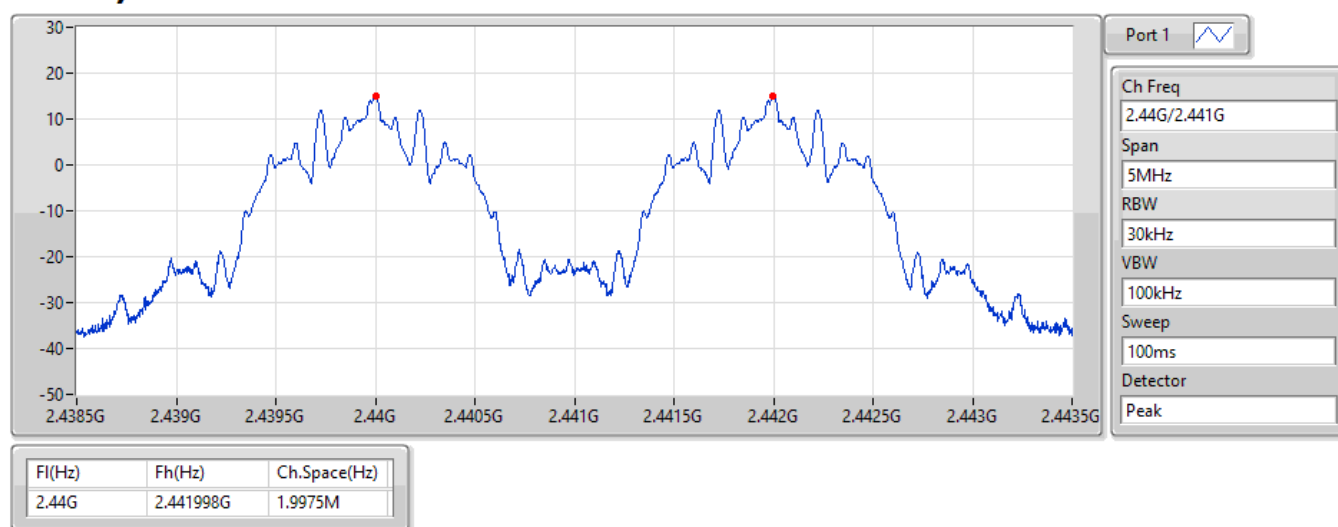
Mode	Result	Hopping No	Limit
BT-LE(2Mbps)	-	-	-
2440MHz_Tnom	Pass	37	15

**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)****Summary**

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(125kbps)	1.9975M	1.9975M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(125kbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.44G	2.441998G	1.9975M	100k

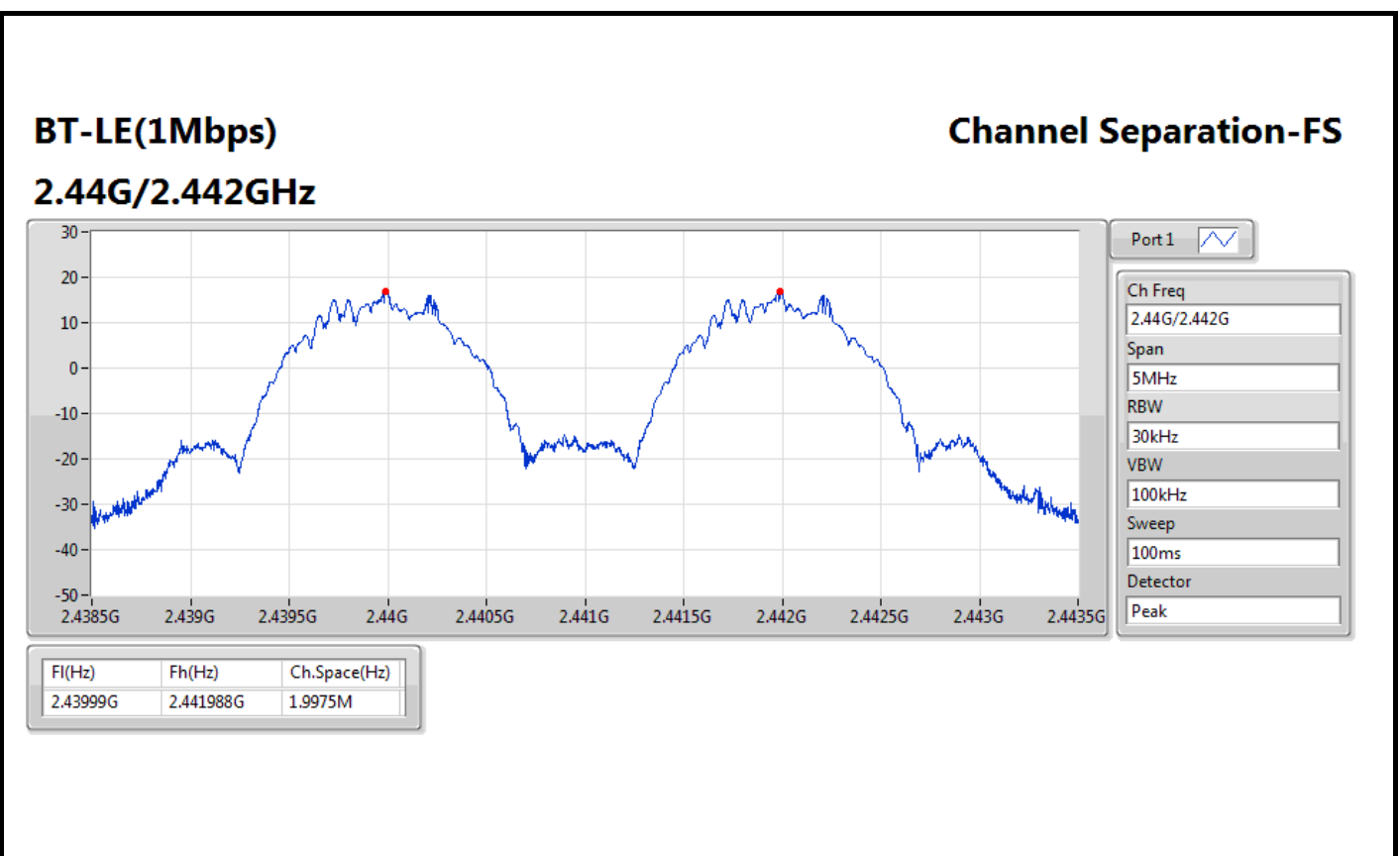
BT-LE(125kbps)**2.44G/2.441GHz****Channel Separation-FS**

Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	1.9975M	1.9975M

Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(1Mbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.43999G	2.441988G	1.9975M	100k



Summary

Mode	Max-Space (Hz)	Min-Space (Hz)
2.4-2.4835GHz	-	-
BT-LE(2Mbps)	2.005M	2.005M

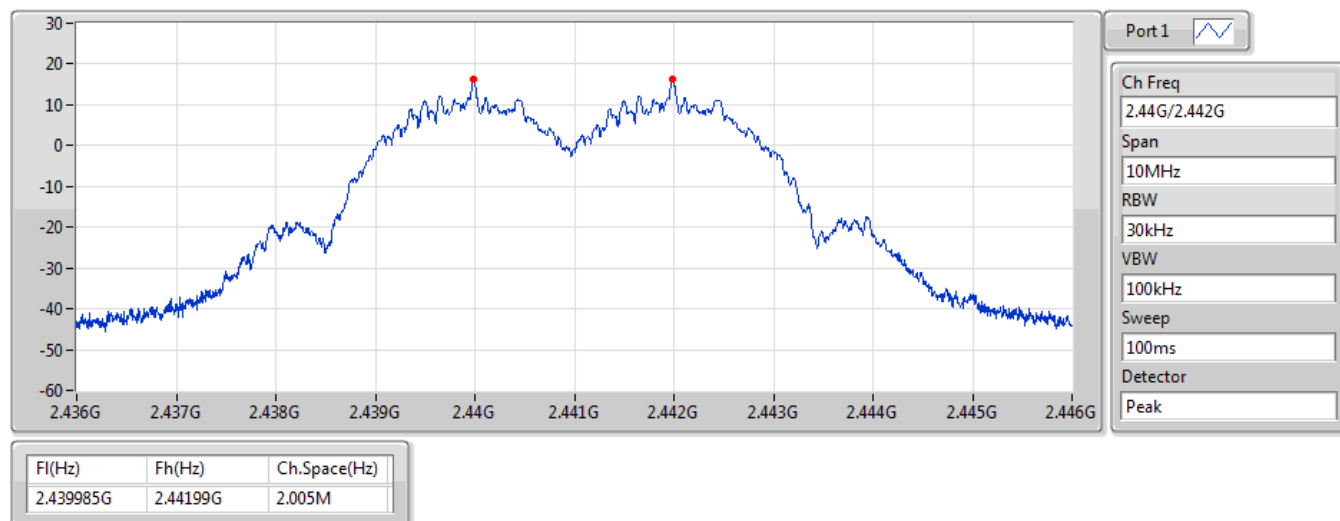
Result

Mode	Result	Fl (Hz)	Fh (Hz)	Ch.Space (Hz)	Limit (Hz)
BT-LE(2Mbps)	-	-	-	-	-
2440MHz_Tnom	Pass	2.439985G	2.44199G	2.005M	1

BT-LE(2Mbps)

2.44G/2.442GHz

Channel Separation-FS



**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna****Summary**

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(125kbps)	1.032M	1M03F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(125kbps)	-	-	-	-	-	-
2402MHz_Tnom	Pass	2.4-2.4835G	2.401471G	2.402503G	1.032M	1.054M
2440MHz_Tnom	Pass	2.4-2.4835G	2.43947G	2.440501G	1.031M	1.05M
2480MHz_Tnom	Pass	2.4-2.4835G	2.479471G	2.480499G	1.028M	1.046M

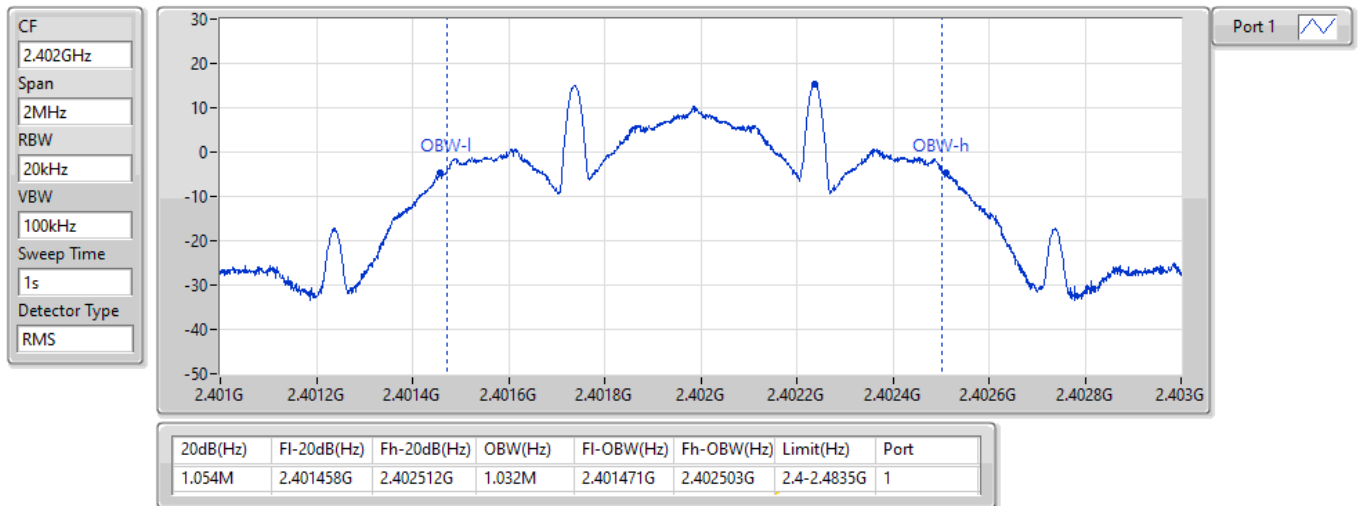
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(125kbps)

EBW-FS

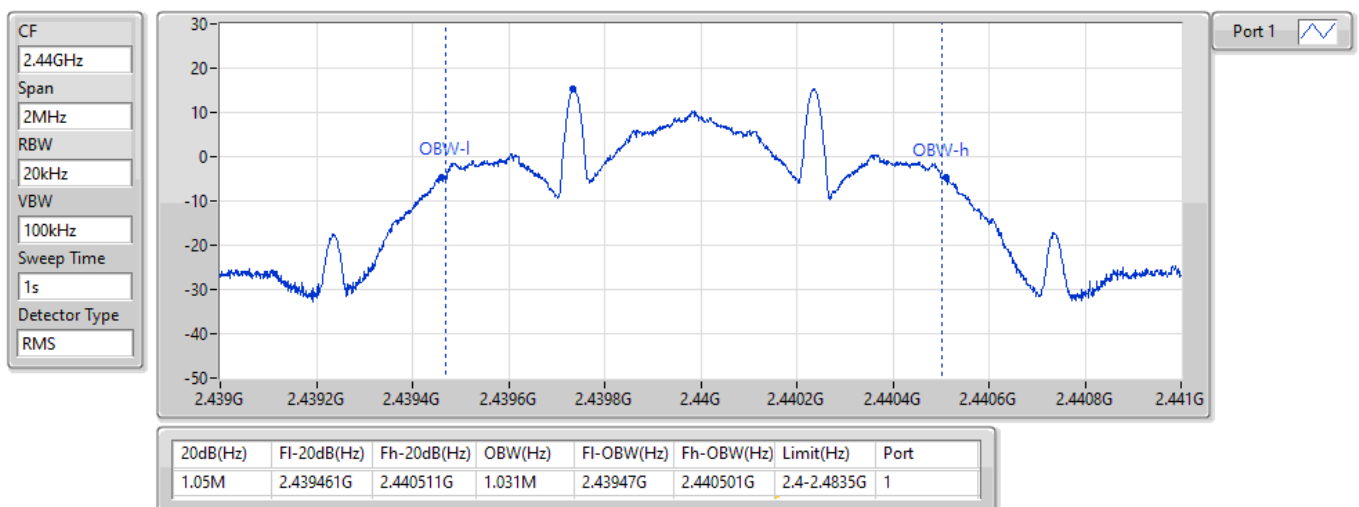
2402MHz



BT-LE(125kbps)

EBW-FS

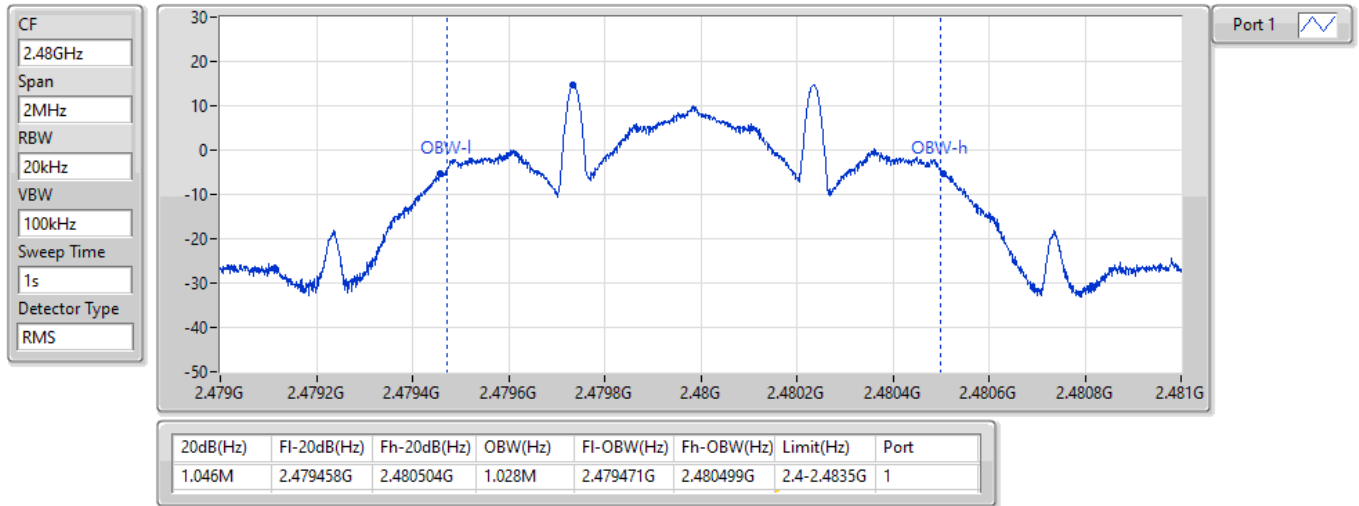
2440MHz



BT-LE(125kbps)

EBW-FS

2480MHz



**Summary**

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	1.031M	1M03F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(1Mbps)	-	-	-	-	-	-
2402MHz_Tnom	Pass	2.4-2.4835G	2.401472G	2.402502G	1.03M	1.169M
2440MHz_Tnom	Pass	2.4-2.4835G	2.439469G	2.440498G	1.03M	1.169M
2480MHz_Tnom	Pass	2.4-2.4835G	2.479469G	2.480499G	1.031M	1.171M

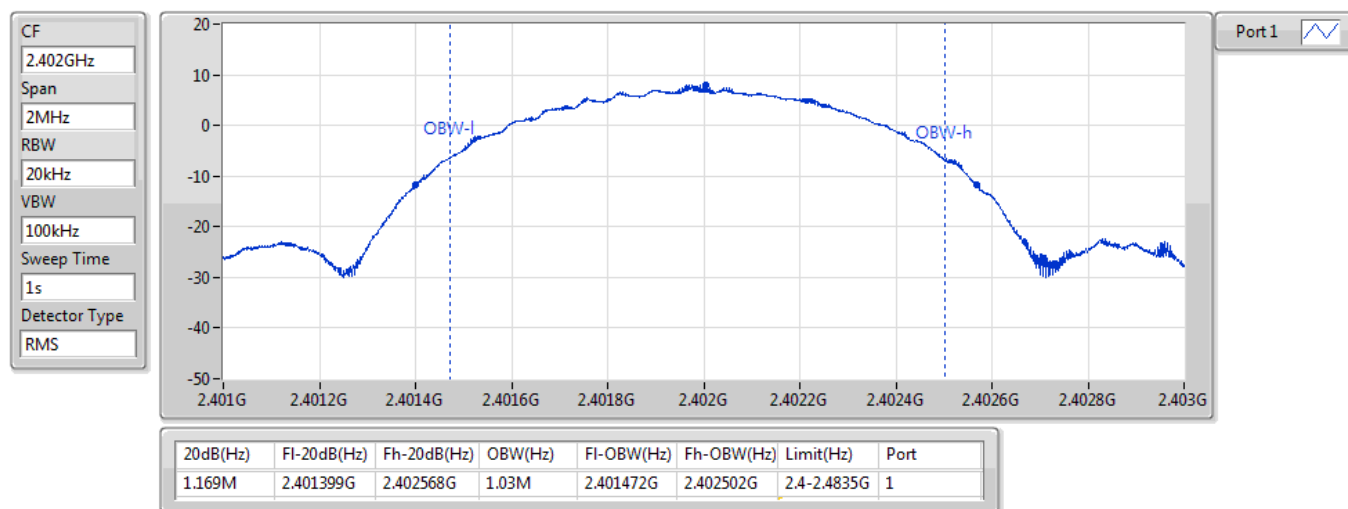
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(1Mbps)

EBW-FS

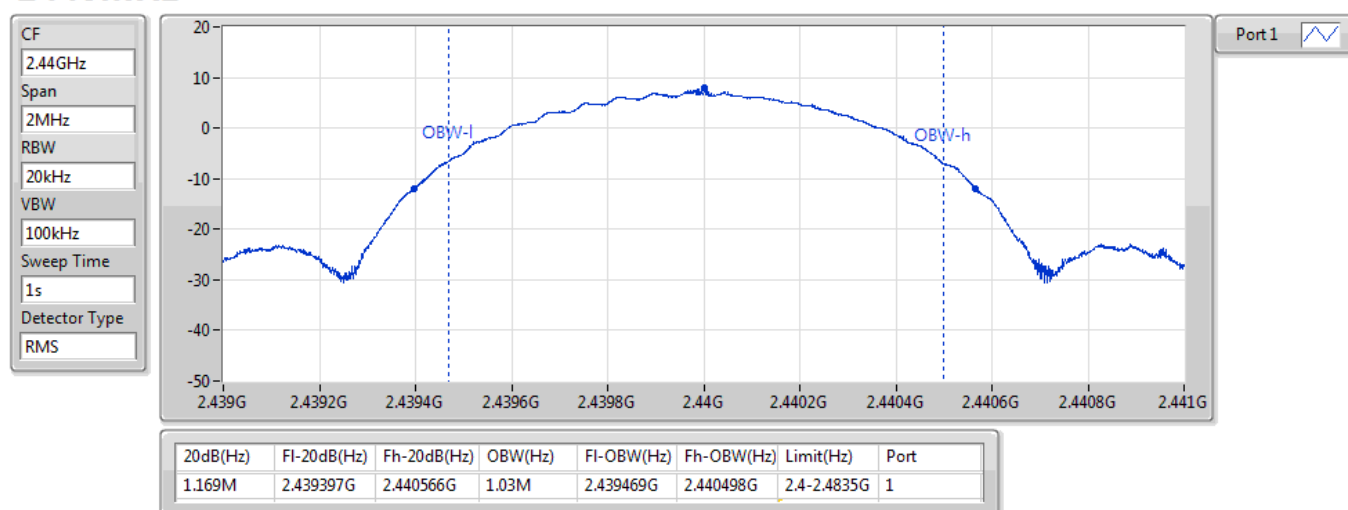
2402MHz



BT-LE(1Mbps)

EBW-FS

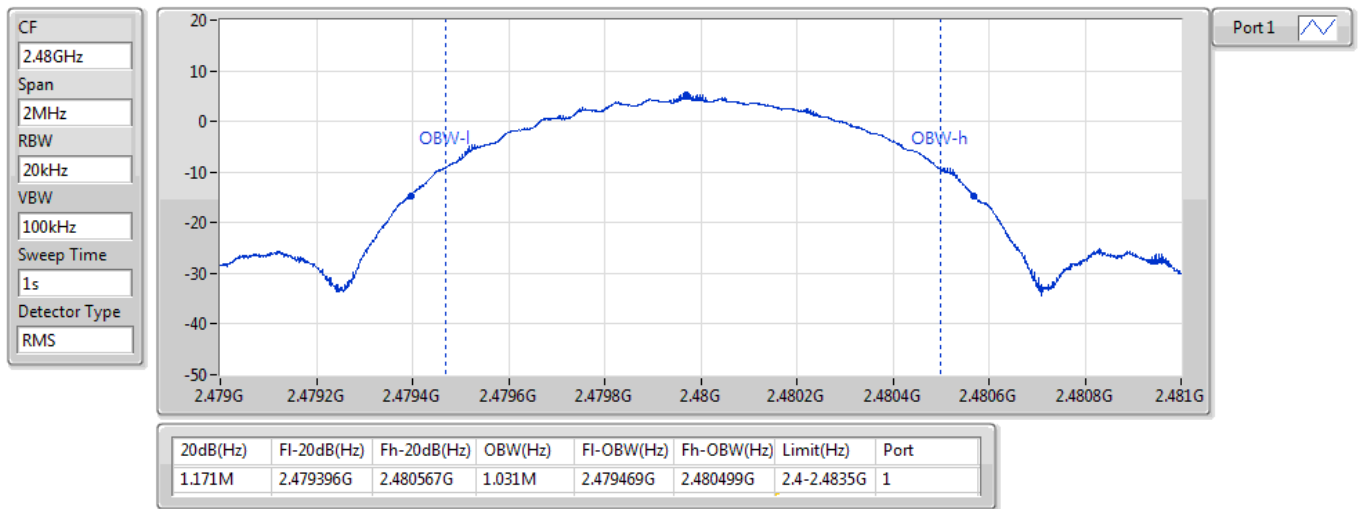
2440MHz



BT-LE(1Mbps)

EBW-FS

2480MHz



**Summary**

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(2Mbps)	2.096M	2M10F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(2Mbps)	-	-	-	-	-	-
2404MHz_Tnom	Pass	2.4-2.4835G	2.402944G	2.405027G	2.083M	2.344M
2440MHz_Tnom	Pass	2.4-2.4835G	2.438941G	2.441031G	2.09M	2.356M
2478MHz_Tnom	Pass	2.4-2.4835G	2.47694G	2.479035G	2.096M	2.358M

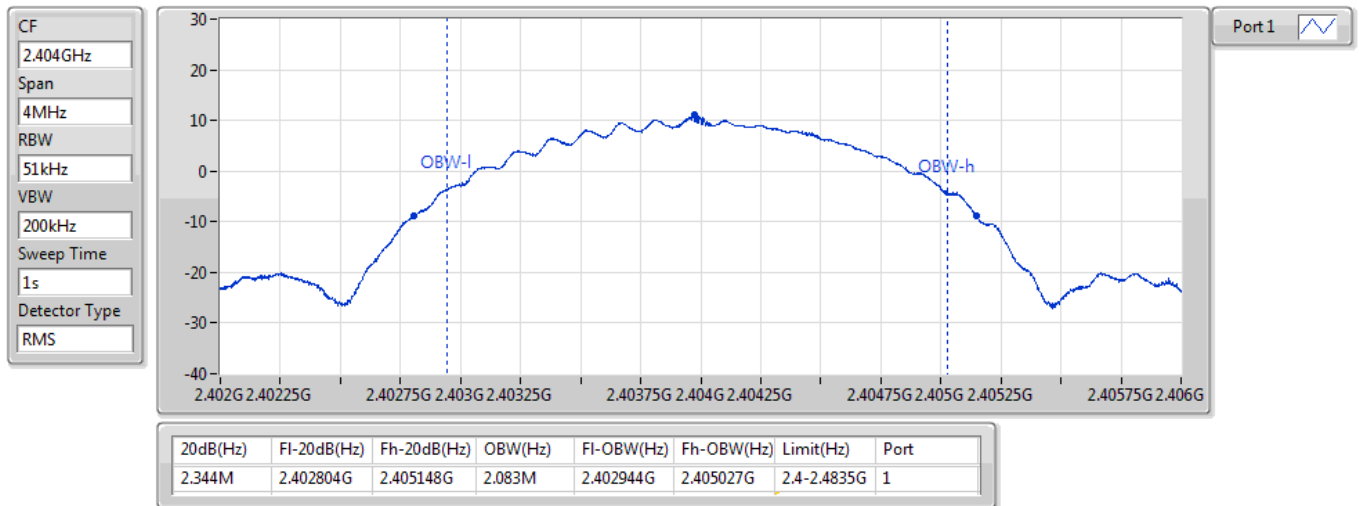
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(2Mbps)

EBW-FS

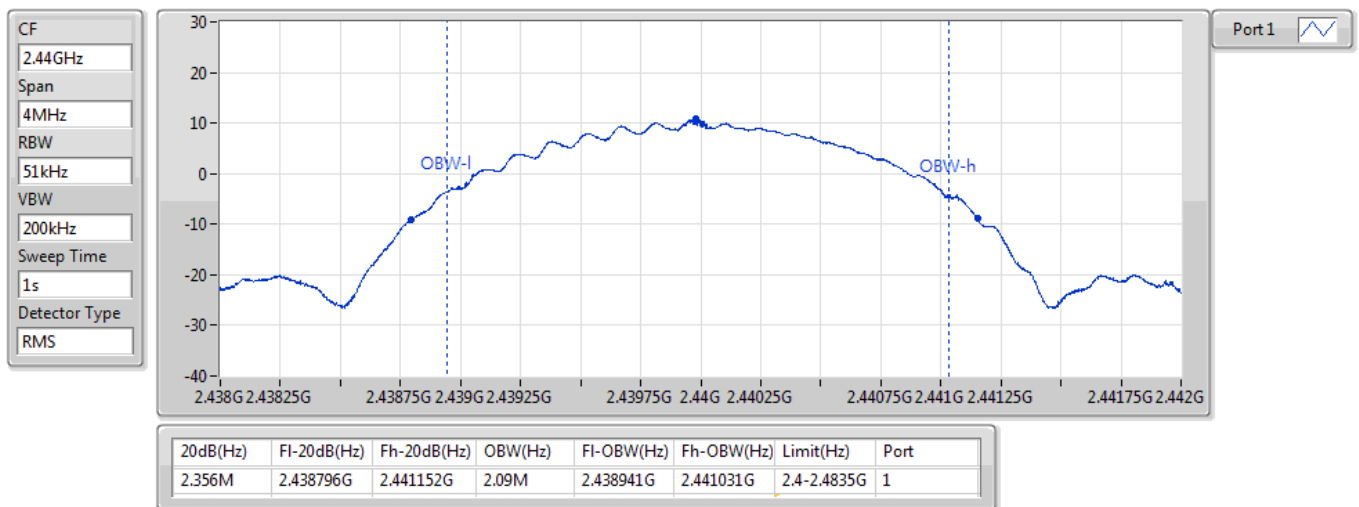
2404MHz



BT-LE(2Mbps)

EBW-FS

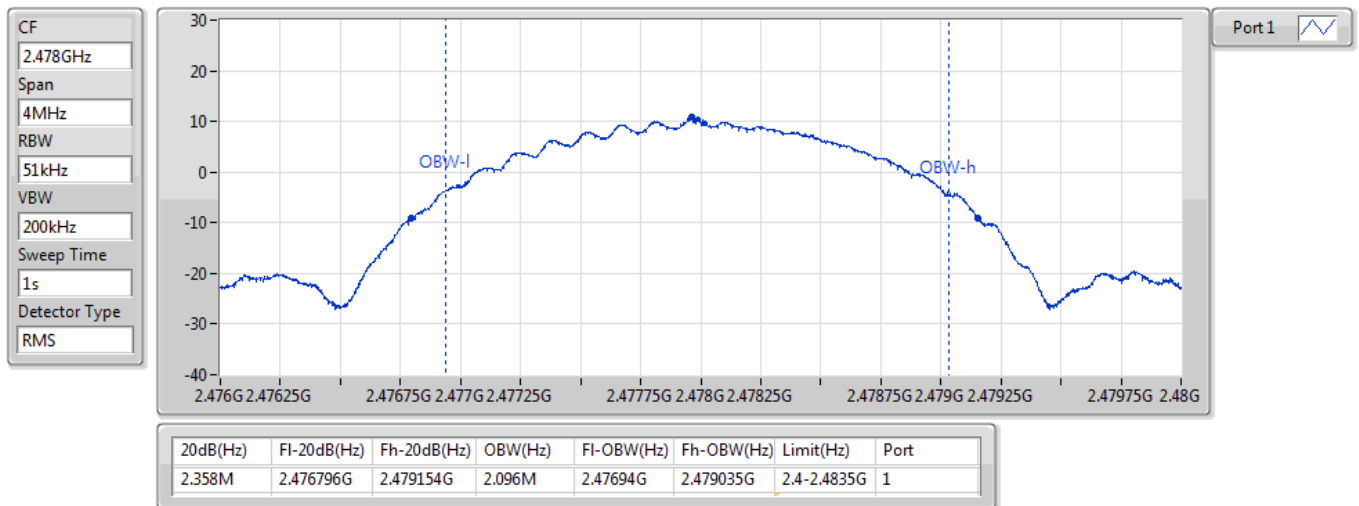
2440MHz



BT-LE(2Mbps)

EBW-FS

2478MHz



**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)****Summary**

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(125kbps)	1.033M	1M03F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(125kbps)	-	-	-	-	-	-
2402MHz_Tnom	Pass	2.4-2.4835G	2.401457G	2.40249G	1.033M	1.057M
2440MHz_Tnom	Pass	2.4-2.4835G	2.439457G	2.440489G	1.032M	1.052M
2480MHz_Tnom	Pass	2.4-2.4835G	2.479458G	2.480489G	1.03M	1.05M

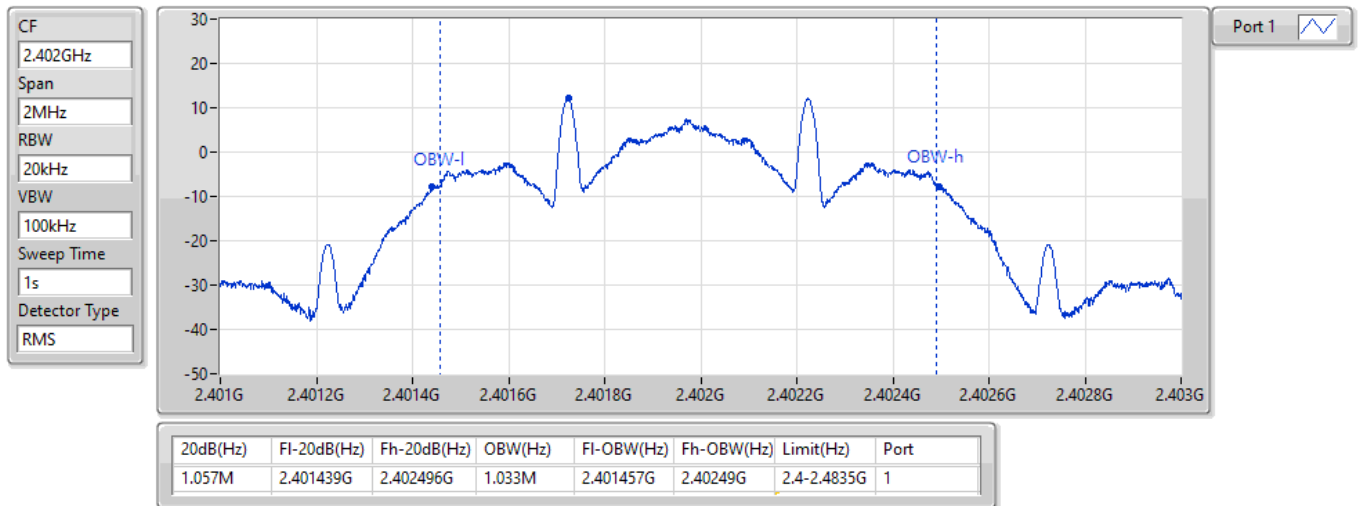
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(125kbps)

EBW-FS

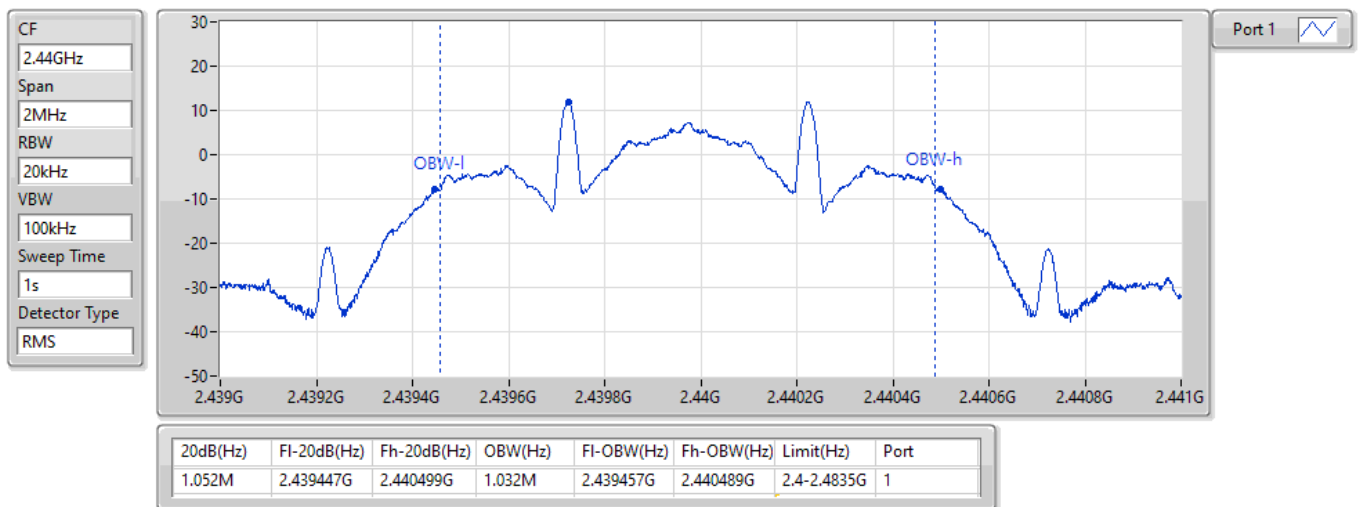
2402MHz



BT-LE(125kbps)

EBW-FS

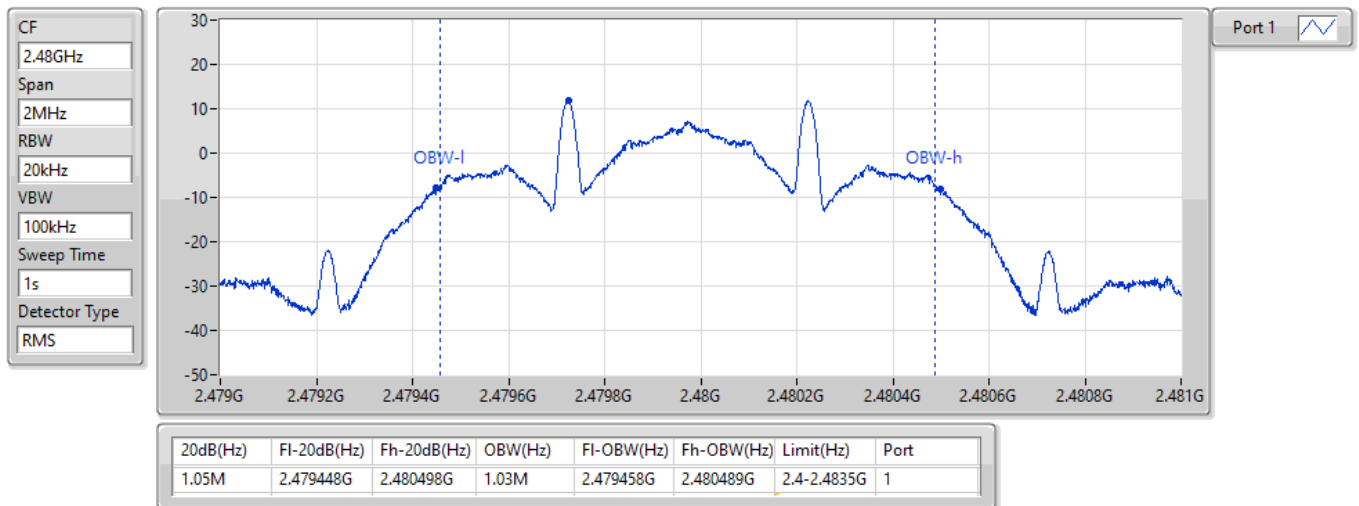
2440MHz



BT-LE(125kbps)

EBW-FS

2480MHz



Summary

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(1Mbps)	1.029M	1M03F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(1Mbps)	-	-	-	-	-	-
2402MHz_Tnom	Pass	2.4-2.4835G	2.401469G	2.402498G	1.028M	1.17M
2440MHz_Tnom	Pass	2.4-2.4835G	2.439468G	2.440498G	1.029M	1.173M
2480MHz_Tnom	Pass	2.4-2.4835G	2.479467G	2.480497G	1.029M	1.171M

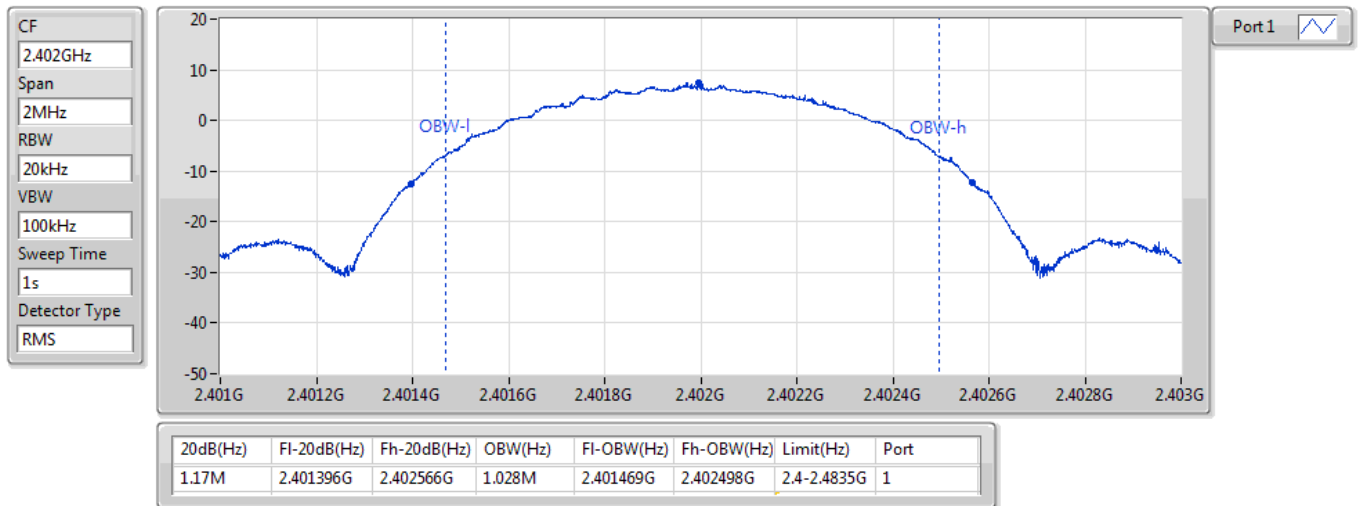
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(1Mbps)

EBW-FS

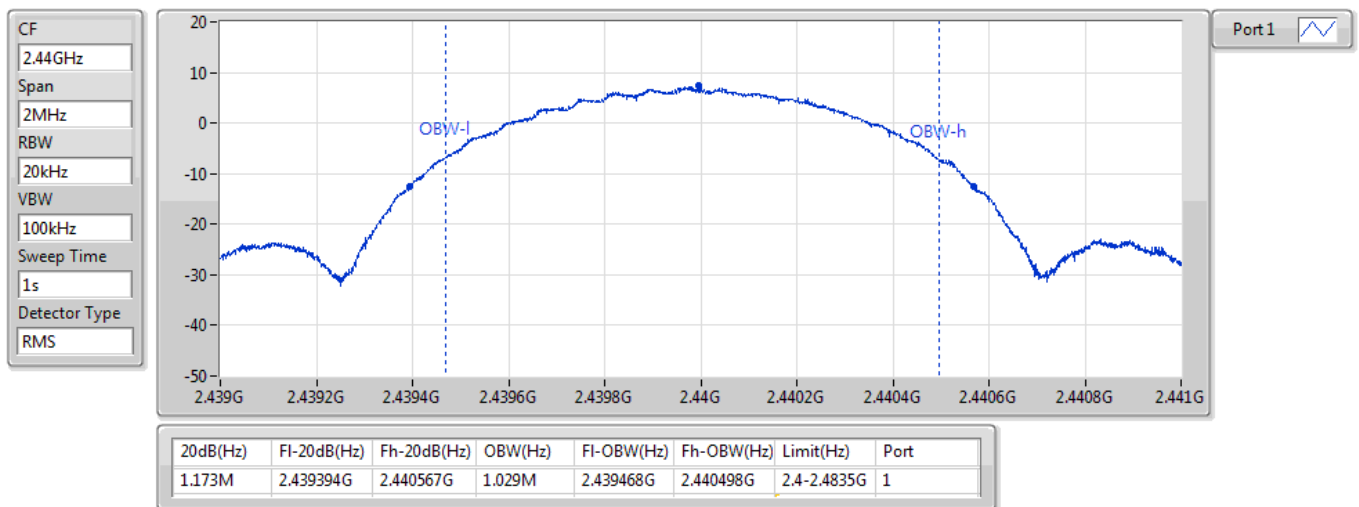
2402MHz



BT-LE(1Mbps)

EBW-FS

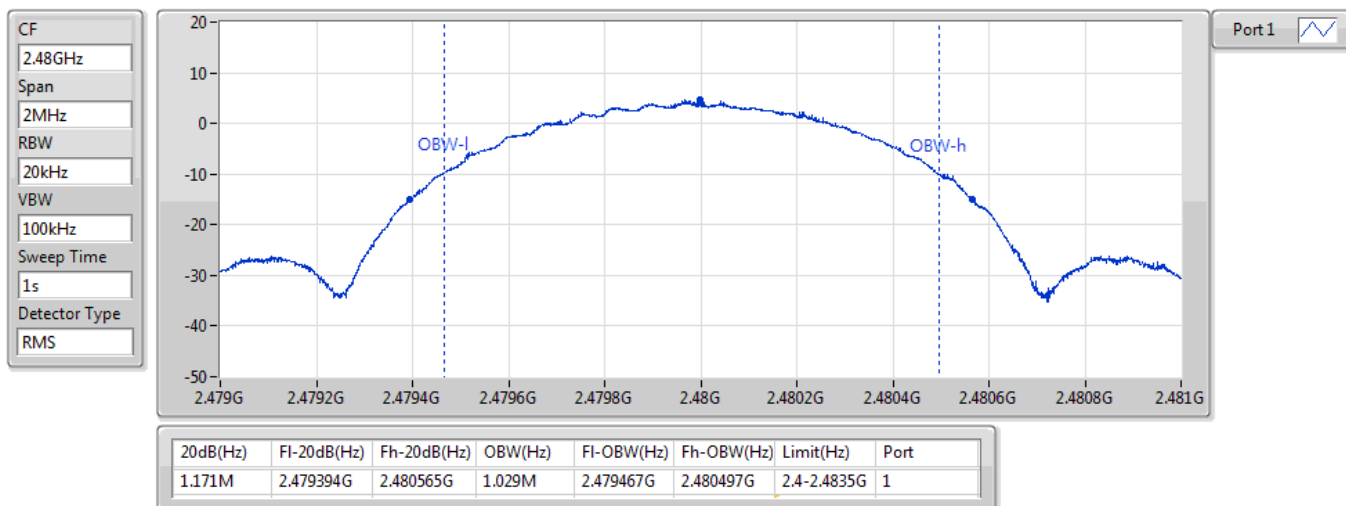
2440MHz



BT-LE(1Mbps)

EBW-FS

2480MHz



**Summary**

Mode	OBW (Hz)	ITU-Code
2.4-2.4835GHz	-	-
BT-LE(2Mbps)	2.101M	2M10F1D

OBW = 99% occupied bandwidth

Result

Mode	Result	Limit (Hz)	fl-OBW (Hz)	fh-OBW (Hz)	OBW (Hz)	N dB (Hz)
BT-LE(2Mbps)	-	-	-	-	-	-
2404MHz_Tnom	Pass	2.4-2.4835G	2.402951G	2.405027G	2.077M	2.344M
2440MHz_Tnom	Pass	2.4-2.4835G	2.438943G	2.441033G	2.091M	2.352M
2478MHz_Tnom	Pass	2.4-2.4835G	2.476937G	2.479037G	2.101M	2.364M

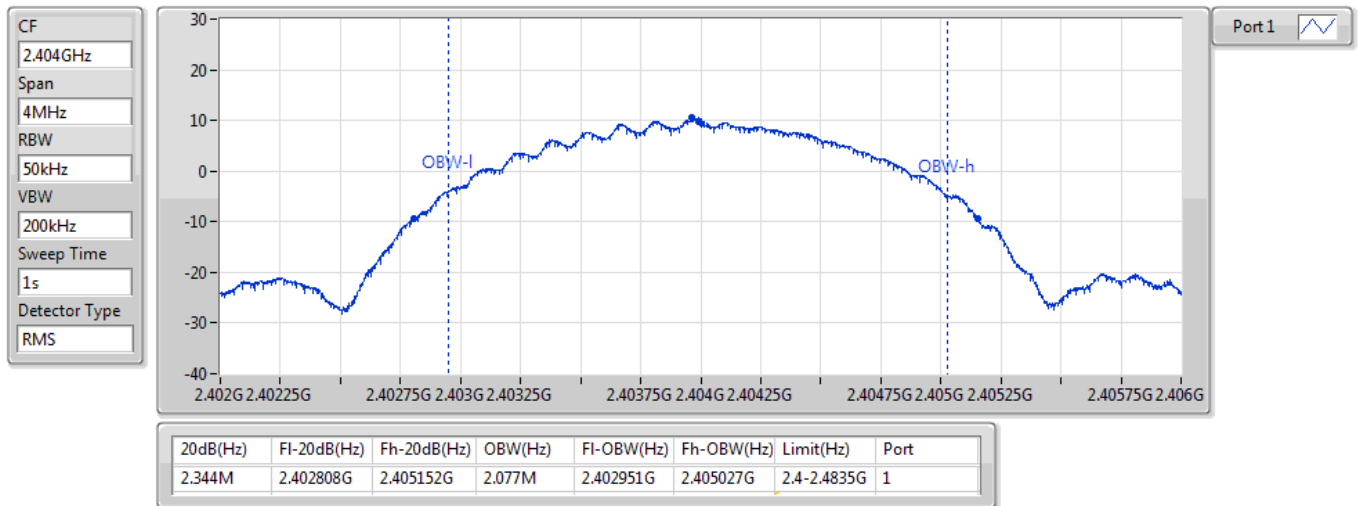
fl-OBW = fl lower edge 99% occupied bandwidth; fh-OBW = fh higher edge 99% occupied bandwidth; OBW = 99% occupied bandwidth;

N dB = 20dB down bandwidth

BT-LE(2Mbps)

EBW-FS

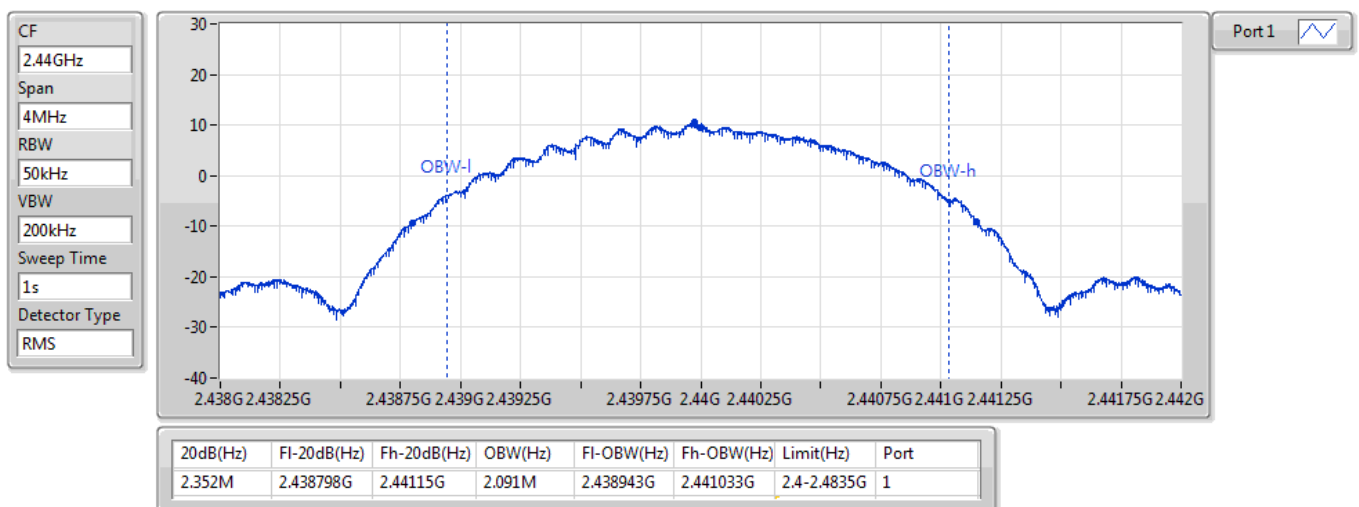
2404MHz



BT-LE(2Mbps)

EBW-FS

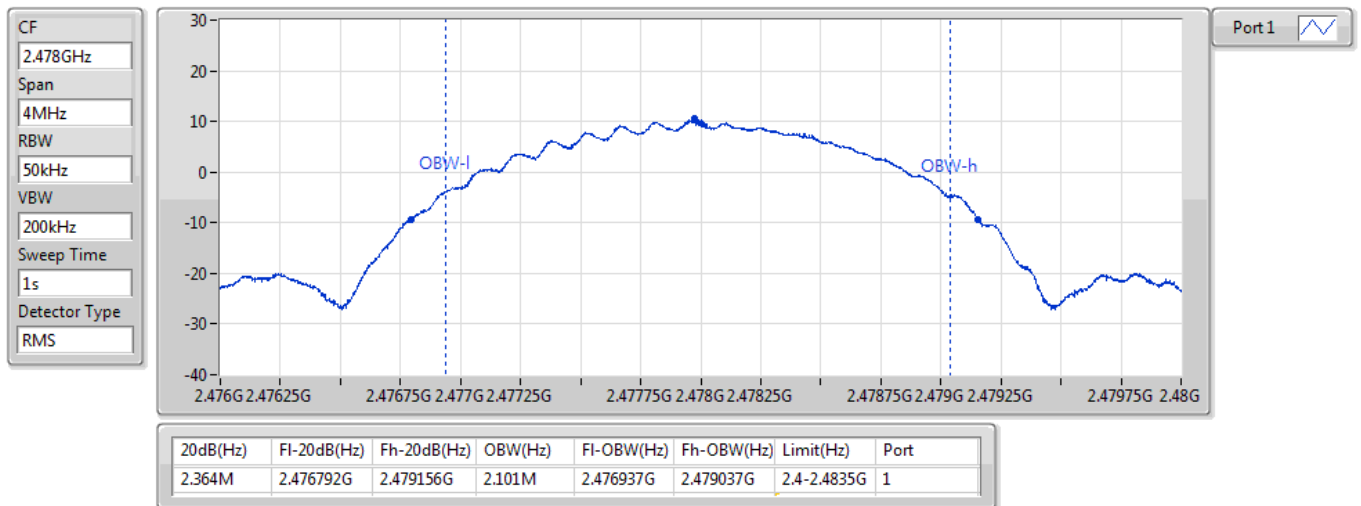
2440MHz



BT-LE(2Mbps)

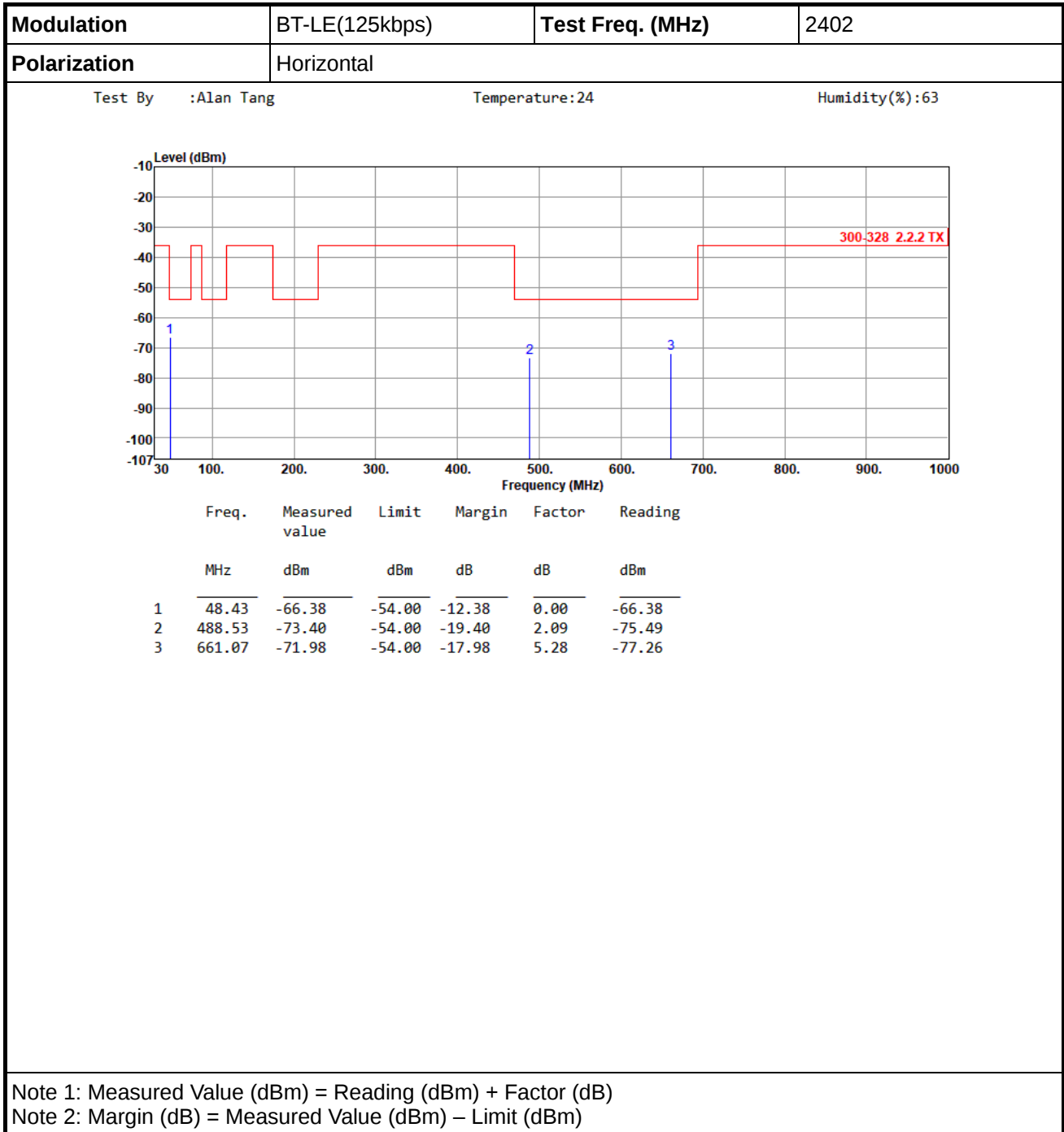
EBW-FS

2478MHz





Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna
Emissions (Below 1GHz)



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By : Alan Tang
Temperature: 24
Humidity(%): 63

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	48.43	-66.28	-54.00	-12.28	0.26	-66.54
2	491.37	-73.14	-54.00	-19.14	2.26	-75.40
3	631.97	-71.84	-54.00	-17.84	5.15	-76.99

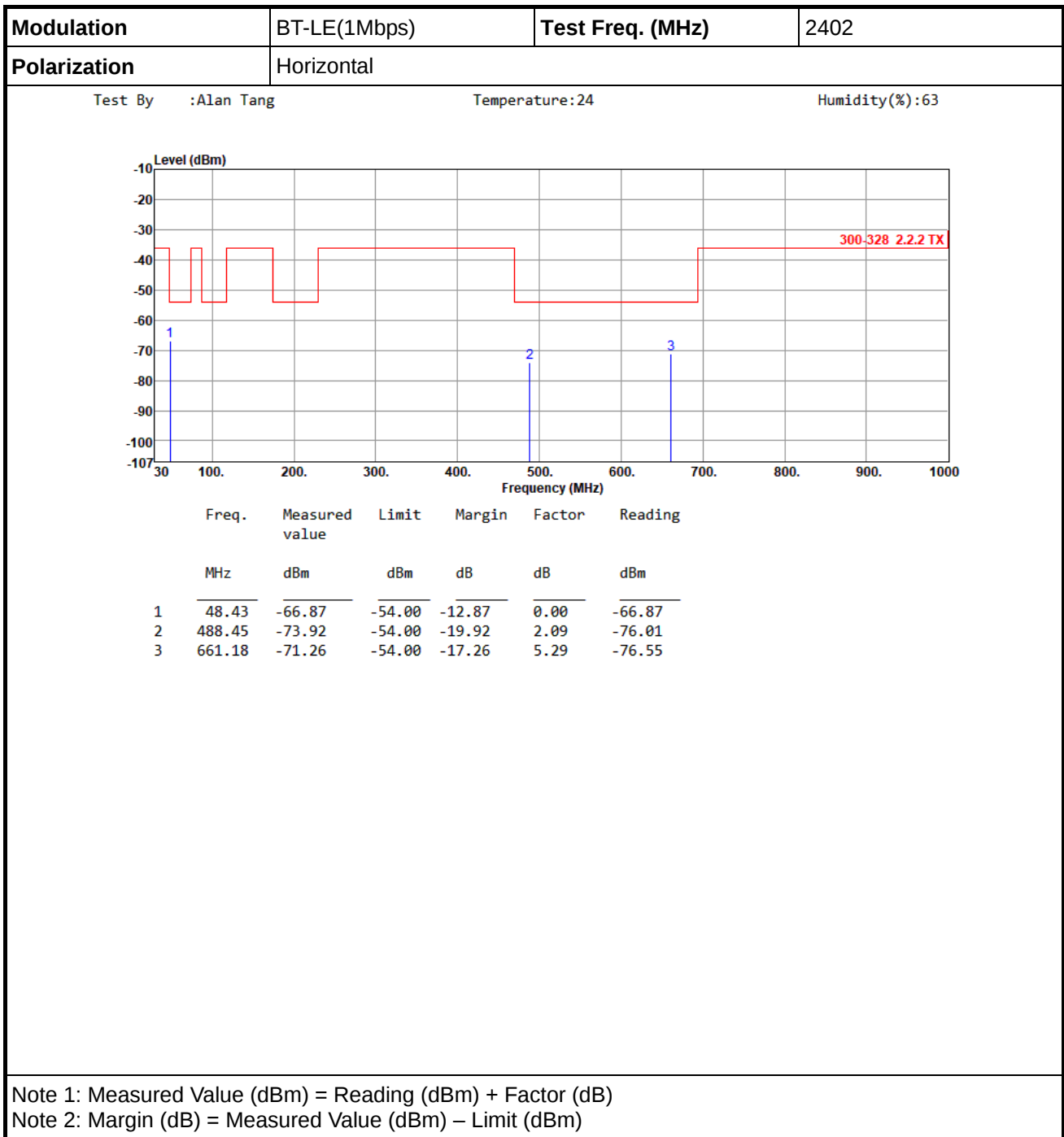
Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

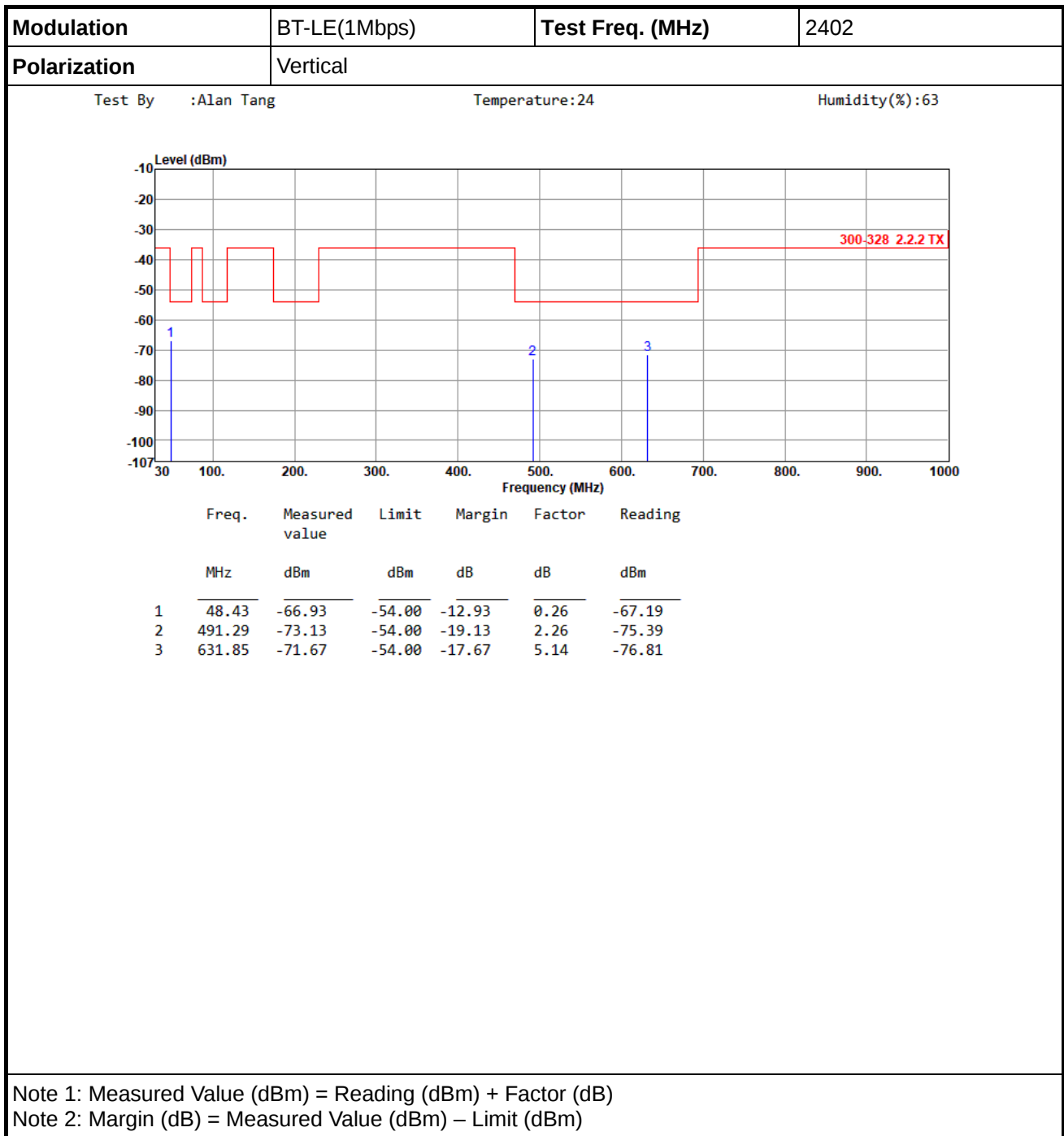
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

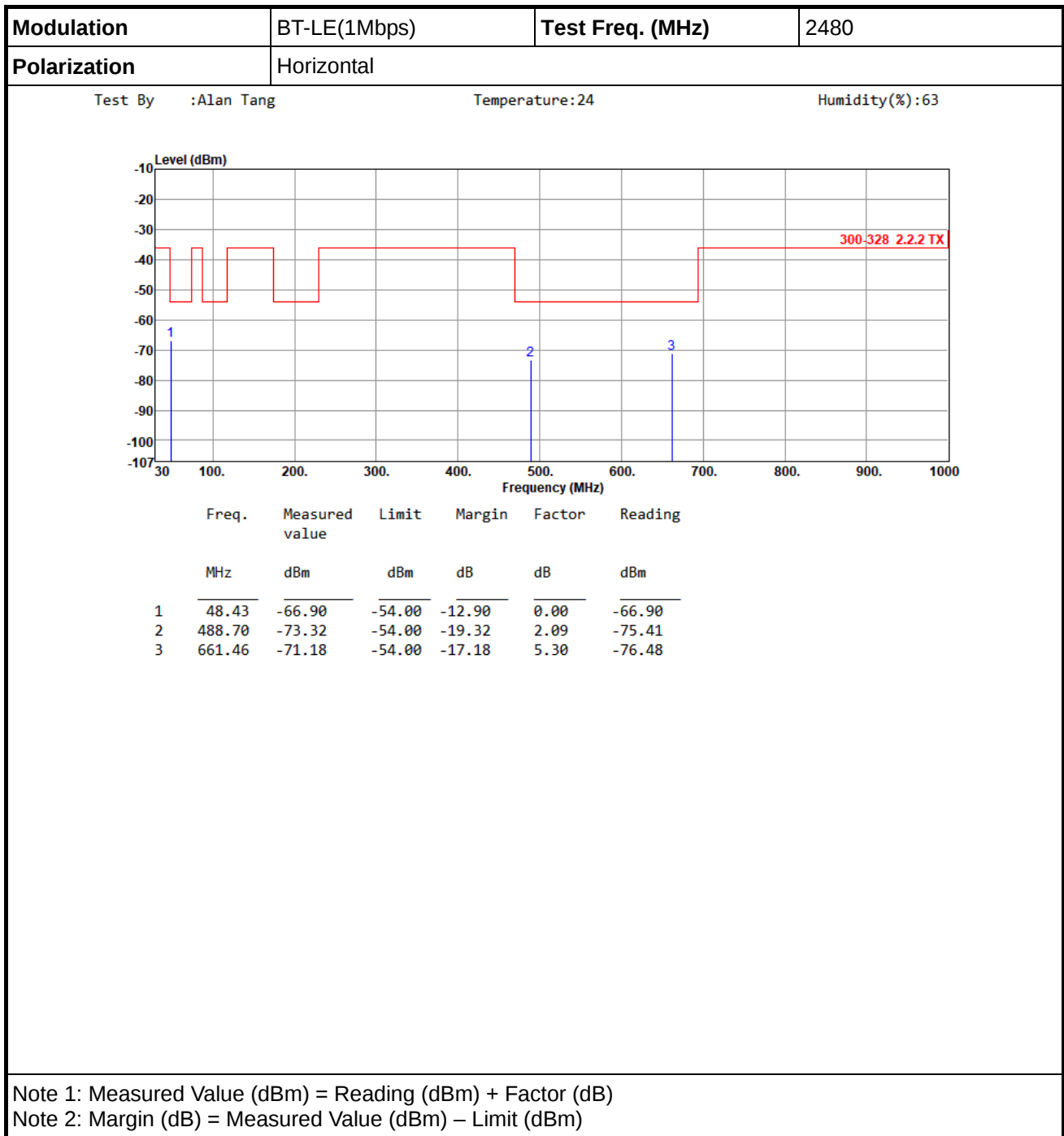


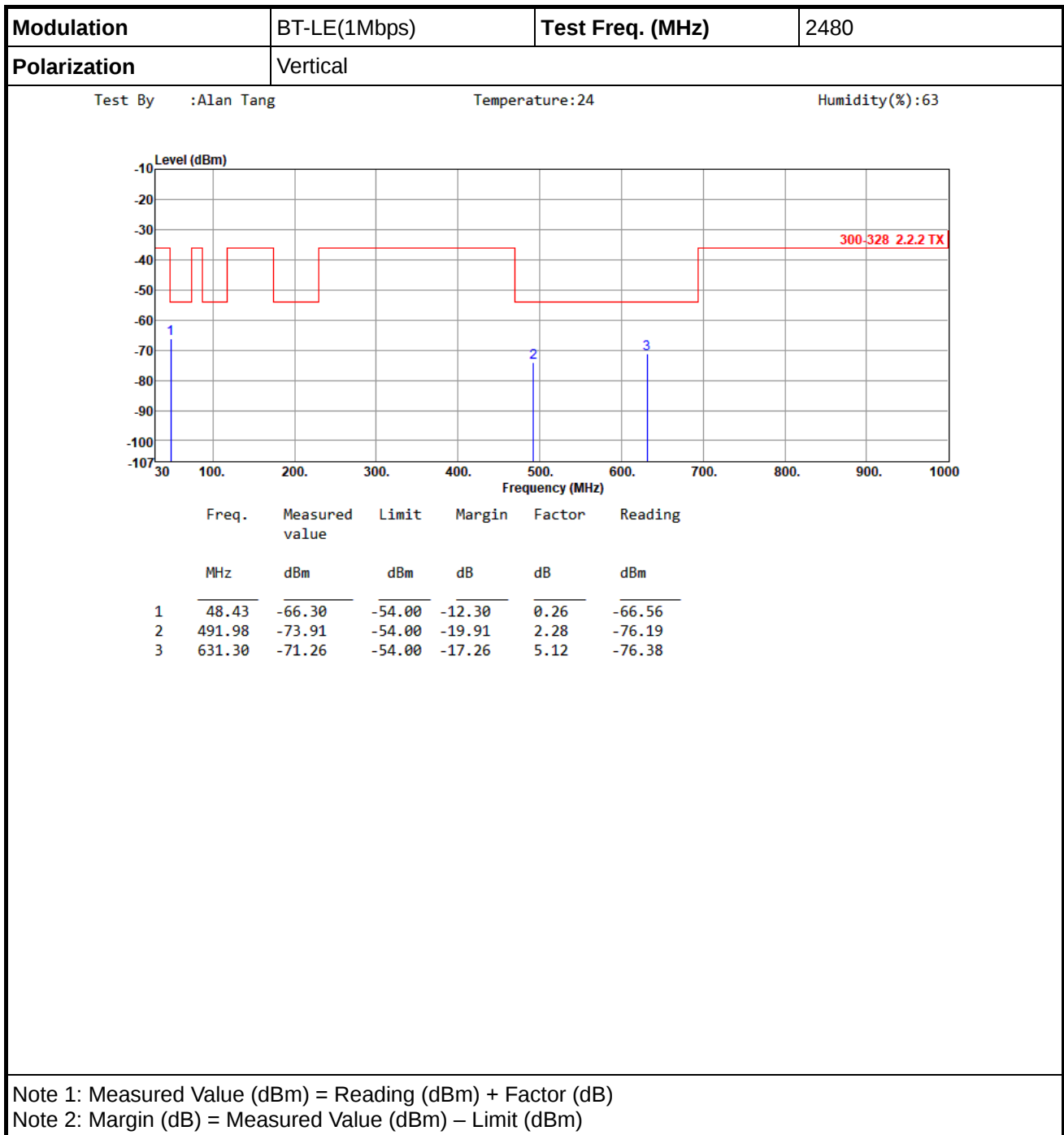
Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm)			









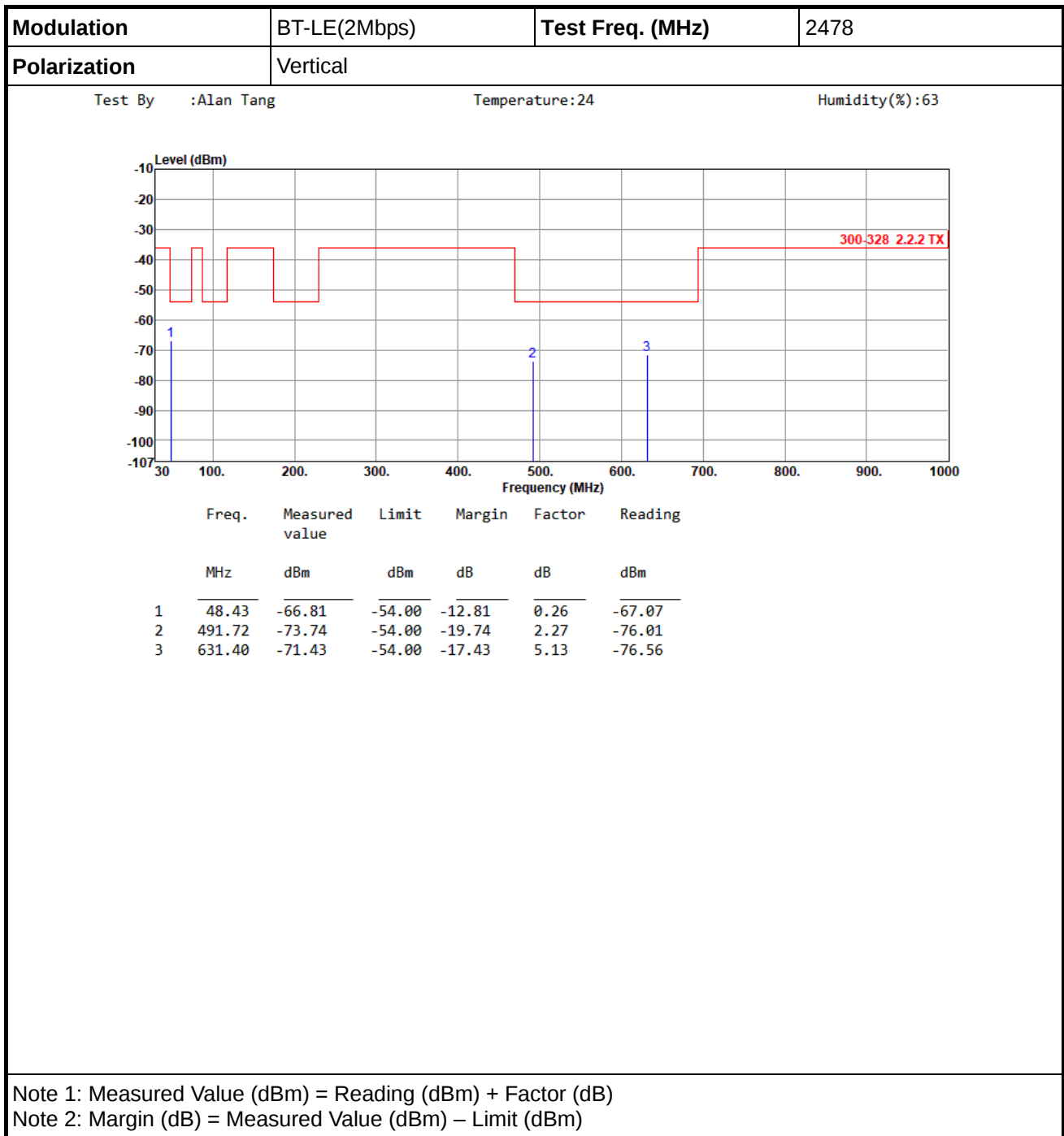
Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	48.43	-66.11	-54.00	-12.11	0.00	-66.11
2	488.63	-73.94	-54.00	-19.94	2.09	-76.03
3	661.76	-71.23	-54.00	-17.23	5.31	-76.54

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) </			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) </			





Emissions (Above 1GHz)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			

Page No. : 15 of 24



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) <			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			

Page No. : 21 of 24



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang			

Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Transmitter Conducted Unwanted Emissions (Below 1GHz)

Modulation		GFSK/125kbps		Test Freq. (MHz)		2402	
Polarization		Horizontal					
Test By		:Alan Tang		Temperature:22		Humidity(%):61	
Level (dBm)							

Page : 2 of 12

Page : 3 of 12



Modulation	GFSK/1Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	GFSK/2Mbps	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang		Temperature:22	Humidity(%):61
Level (dBm) </			



Modulation	GFSK/2Mbps	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Transmitter Conducted Unwanted Emissions (Above 1GHz)

Modulation	GFSK/125kbps	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/125kbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Page : 9 of 12



Modulation	GFSK/1Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	GFSK/2Mbps	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By : Alan Tang		Temperature: 22	Humidity(%): 61

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4808.00	-52.93	-30.00	-22.93	0.00	-52.93
2	7212.24	-69.31	-30.00	-39.31	0.00	-69.31
3	9615.79	-70.45	-30.00	-40.45	0.00	-70.45

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

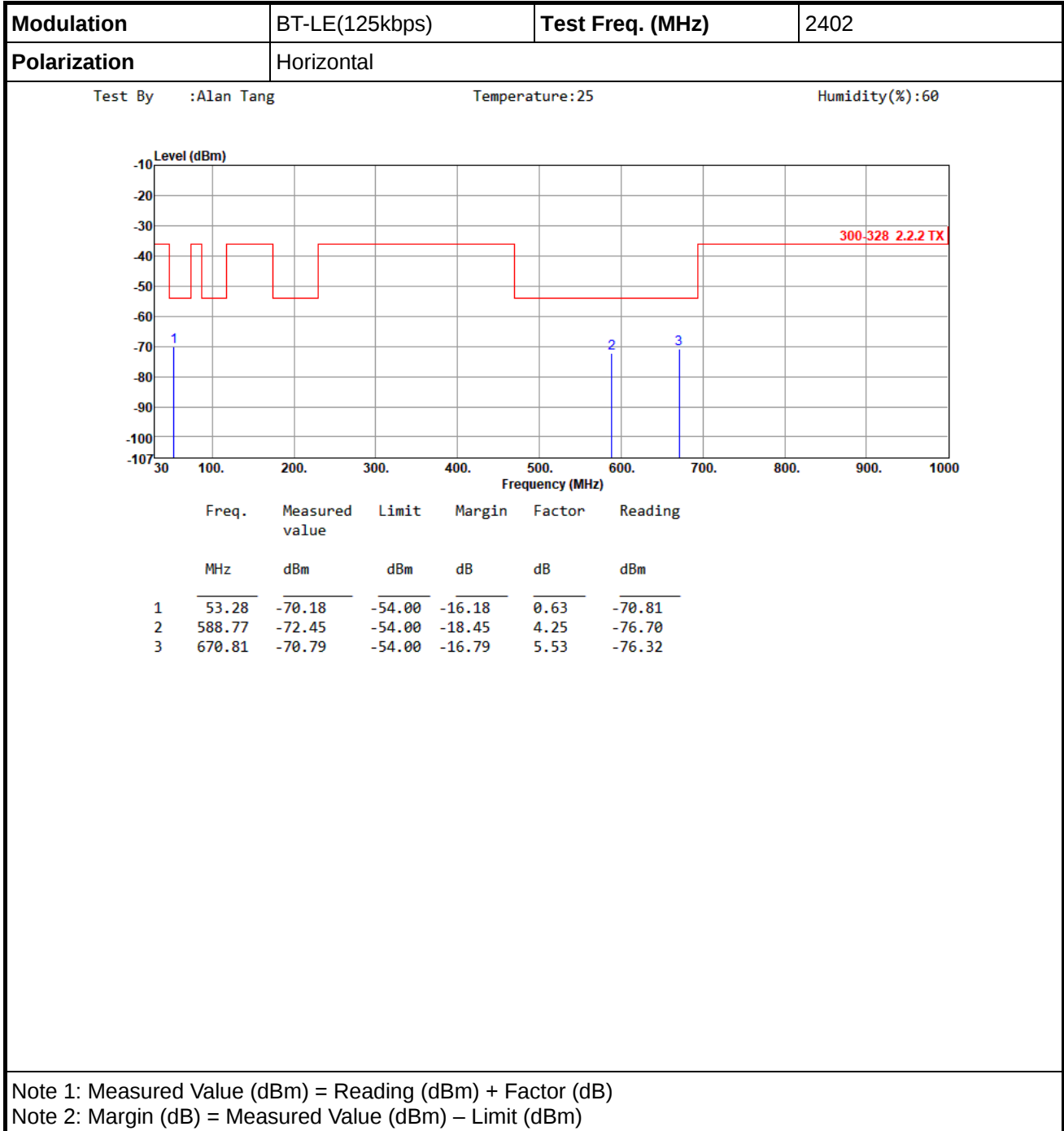


Modulation	GFSK/2Mbps	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Emissions (Below 1GHz)



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	110.48	-73.76	-54.00	-19.76	-2.90	-70.86
2	604.85	-71.58	-54.00	-17.58	5.27	-76.85
3	680.14	-71.25	-54.00	-17.25	5.74	-76.99

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	53.28	-70.84	-54.00	-16.84	0.63	-71.47
2	588.16	-72.93	-54.00	-18.93	4.24	-77.17
3	670.56	-70.74	-54.00	-16.74	5.52	-76.26

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	110.32	-73.95	-54.00	-19.95	-2.91	-71.04
2	604.18	-71.72	-54.00	-17.72	5.21	-76.93
3	680.61	-71.55	-54.00	-17.55	5.74	-77.29

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

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Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang		Temperature:25	Humidity(%):60
Level (dBm)			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

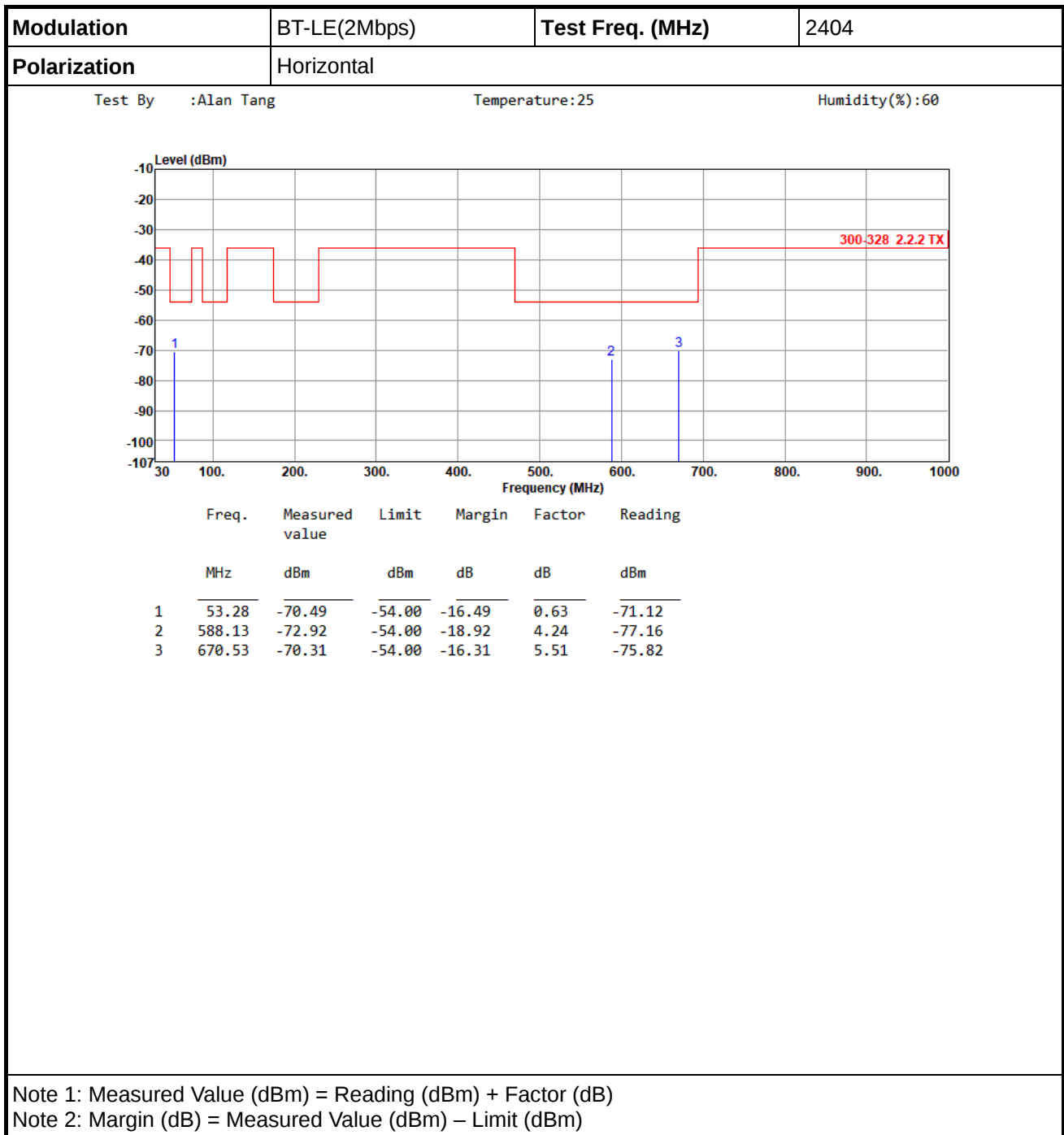
	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	53.28	-70.49	-54.00	-16.49	0.63	-71.12
2	588.38	-72.99	-54.00	-18.99	4.25	-77.24
3	670.58	-70.21	-54.00	-16.21	5.52	-75.73

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang		Temperature:25	Humidity(%):60
Level (dBm)			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	53.28	-70.04	-54.00	-16.04	0.63	-70.67
2	588.72	-72.09	-54.00	-18.09	4.25	-76.34
3	670.20	-70.91	-54.00	-16.91	5.50	-76.41

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang			



Emissions (Above 1GHz)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		

Test By : Alan Tang
Temperature: 22
Humidity(%): 61

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4960.39	-52.04	-30.00	-22.04	9.51	-61.55
2	7439.69	-47.16	-30.00	-17.16	15.83	-62.99
3	9920.29	-42.80	-30.00	-12.80	20.86	-63.66
4	12400.22	-43.81	-30.00	-13.81	20.14	-63.95

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang		Temperature:22	Humidity(%):61

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4808.01	-52.24	-30.00	-22.24	8.57	-60.81
2	7212.36	-46.29	-30.00	-16.29	14.73	-61.02
3	9616.33	-45.98	-30.00	-15.98	19.57	-65.55
4	12019.84	-44.78	-30.00	-14.78	19.82	-64.60

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		

Test By : Alan Tang
Temperature: 22
Humidity(%): 61

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4956.08	-53.75	-30.00	-23.75	9.26	-63.01
2	7434.15	-47.97	-30.00	-17.97	15.43	-63.40
3	9911.89	-45.03	-30.00	-15.03	20.68	-65.71
4	12390.10	-45.19	-30.00	-15.19	19.82	-65.01

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



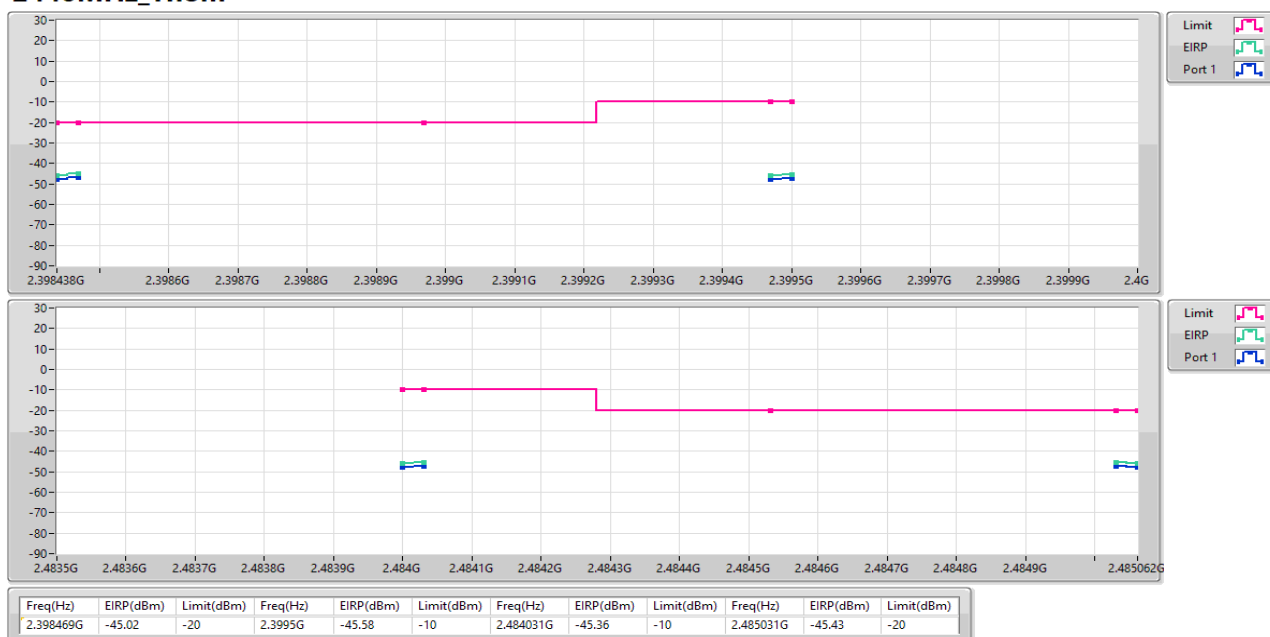
Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang			

**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna****Summary**

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(125kbps)	-45.36	-10	-45.02	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(125kbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.398469G	-45.02	-20	2.3995G	-45.58	-10
2440MHz_Tnom	Pass	2.485031G	-45.43	-20	2.484031G	-45.36	-10

BT-LE(125kbps)**2440MHz_Tnom****MASK-FS**

Summary

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(1Mbps)	-32.47	-10	-41.21	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(1Mbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.39847G	-41.21	-20	2.3995G	-32.47	-10
2440MHz_Tnom	Pass	2.48503G	-45.03	-20	2.484G	-42.98	-10

BT-LE(1Mbps) 2440MHz_Tnom

MASK-FS

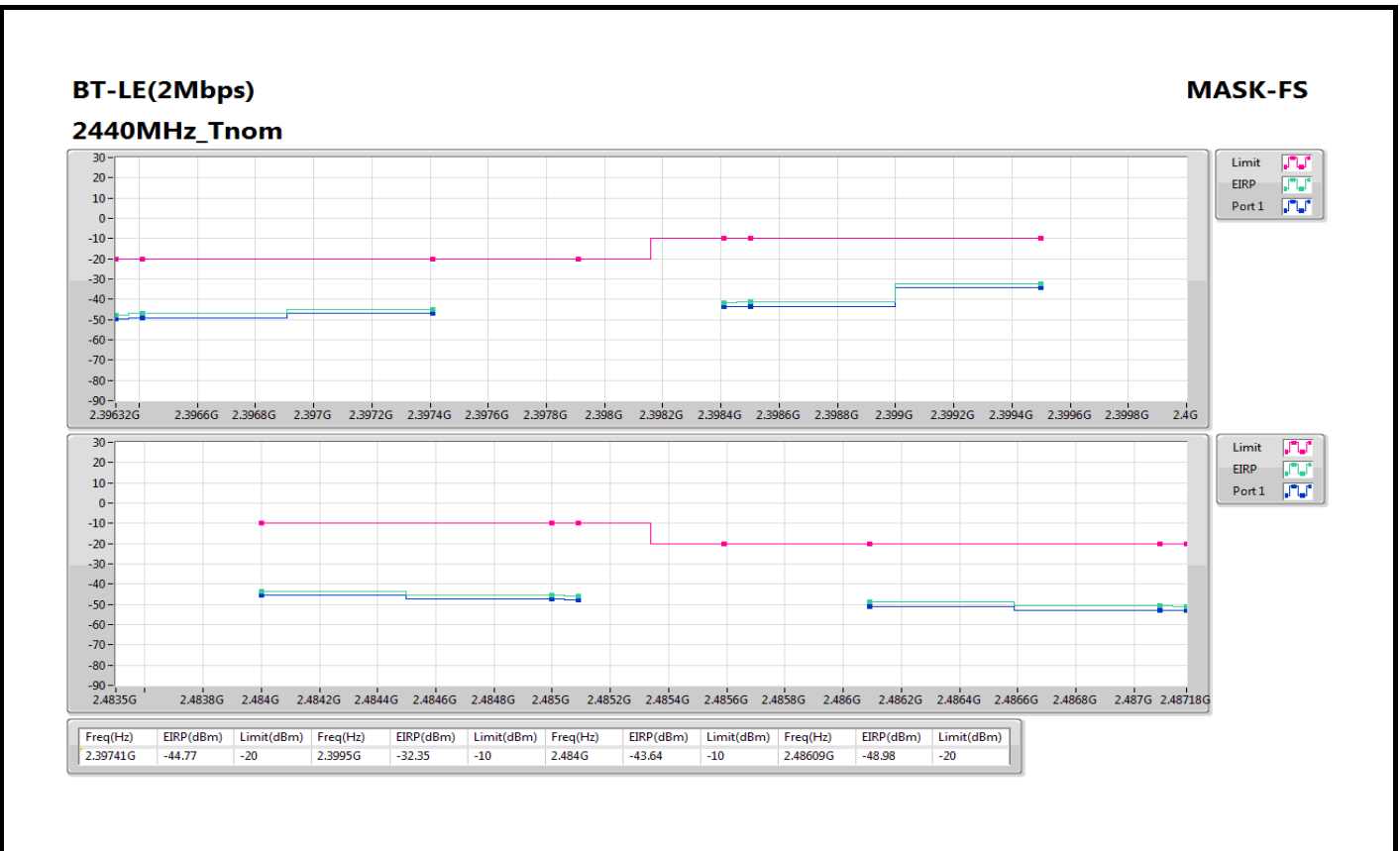


Summary

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(2Mbps)	-32.35	-10	-44.77	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(2Mbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.39741G	-44.77	-20	2.3995G	-32.35	-10
2440MHz_Tnom	Pass	2.48609G	-48.98	-20	2.484G	-43.64	-10

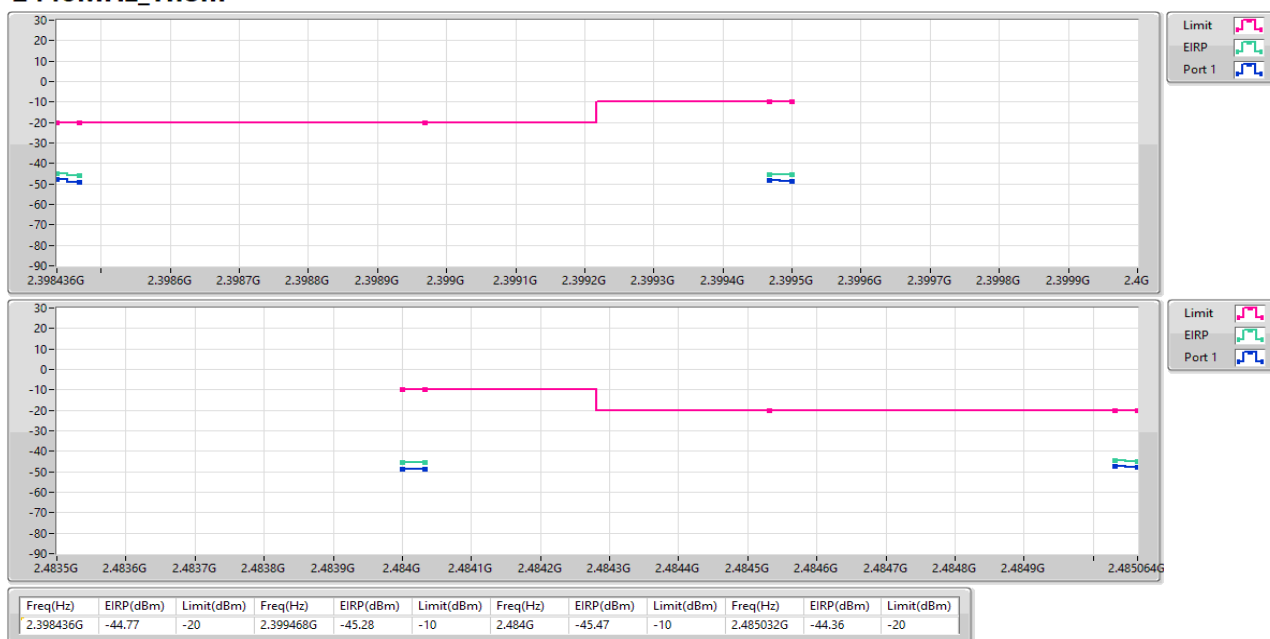


**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)****Summary**

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(125kbps)	-45.28	-10	-44.36	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(125kbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.398436G	-44.77	-20	2.399468G	-45.28	-10
2440MHz_Tnom	Pass	2.485032G	-44.36	-20	2.484G	-45.47	-10

BT-LE(125kbps)**2440MHz_Tnom****MASK-FS**

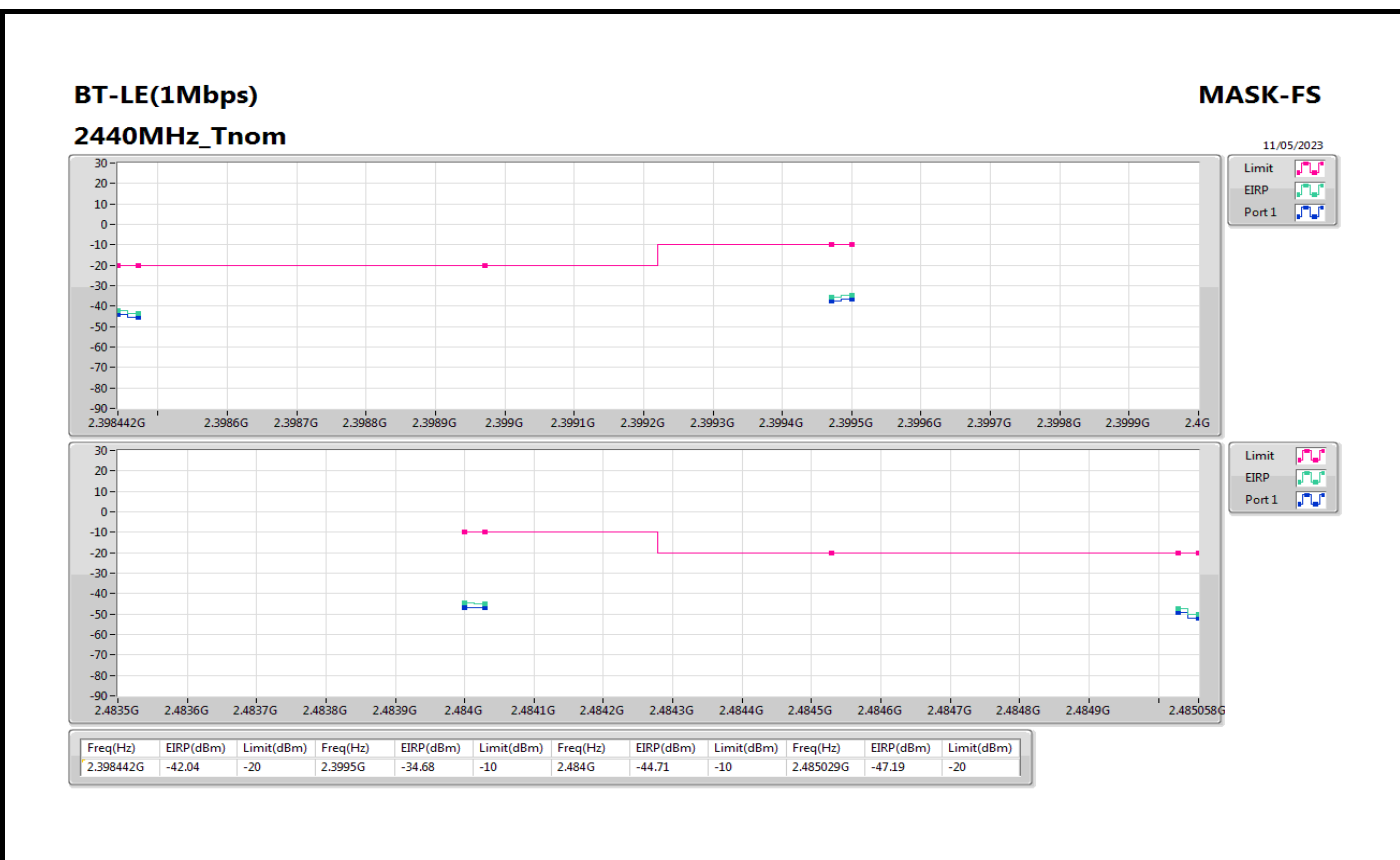


Summary

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(1Mbps)	-34.68	-10	-42.04	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(1Mbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.398442G	-42.04	-20	2.3995G	-34.68	-10
2440MHz_Tnom	Pass	2.485029G	-47.19	-20	2.484G	-44.71	-10



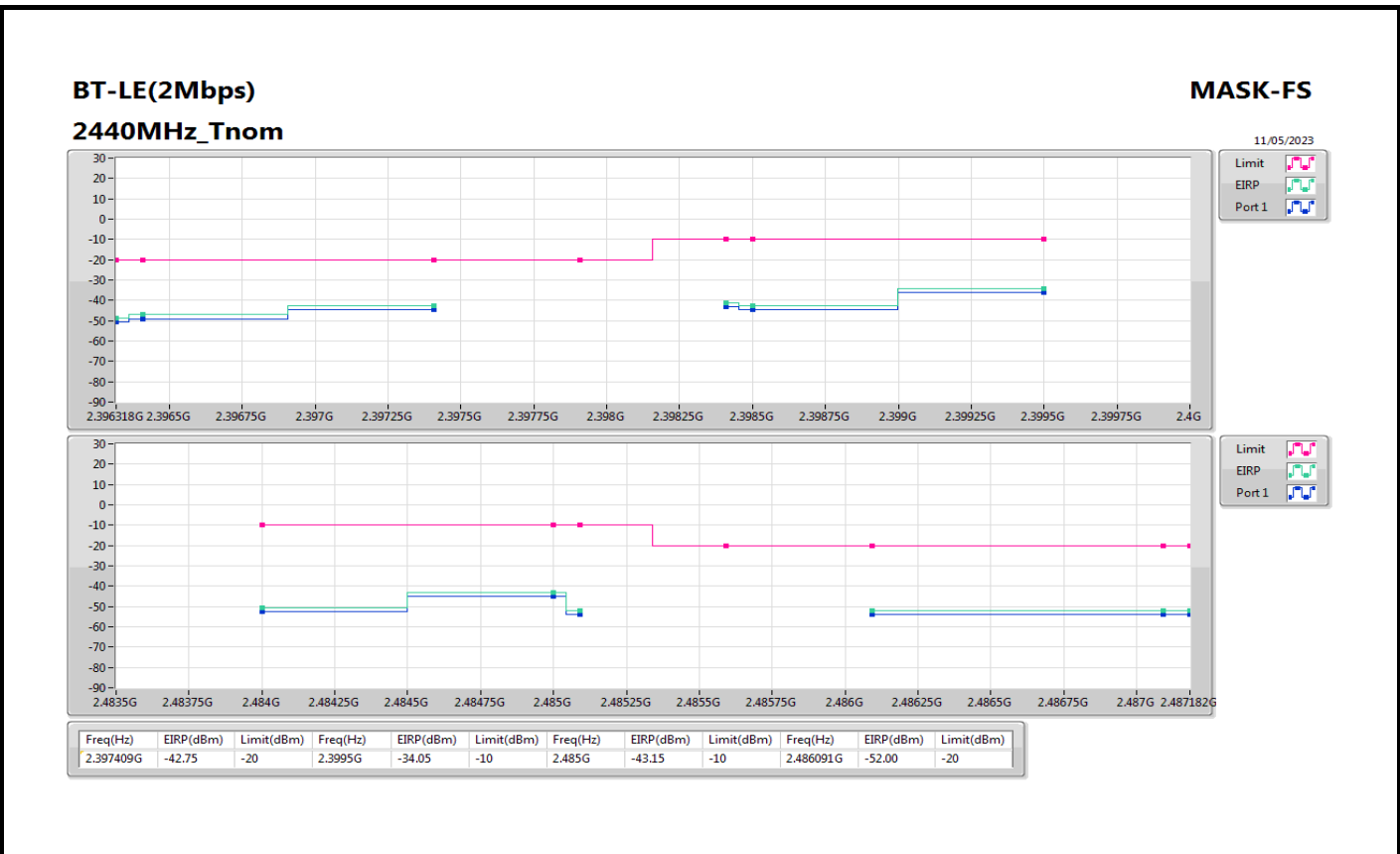


Summary

Mode	EIRP-A (dBm)	Limit-A (dBm)	EIRP-B (dBm)	Limit-B (dBm)
2.4-2.4835GHz	-	-	-	-
BT-LE(2Mbps)	-34.05	-10	-42.75	-20

Result

Mode	Result	Freq (Hz)	EIRP (dBm)	Limit (dBm)	Freq (Hz)	EIRP (dBm)	Limit (dBm)
BT-LE(2Mbps)	-	-	-	-	-	-	-
2440MHz_Tnom	Pass	2.397409G	-42.75	-20	2.3995G	-34.05	-10
2440MHz_Tnom	Pass	2.486091G	-52.00	-20	2.485G	-43.15	-10





Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna

Emissions (Below 1GHz)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) <			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang			

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Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang			



Emissions (Above 1GHz)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm)			

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) </			

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm)			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm)			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) </			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm) <			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		

Test By : Alan Tang
Temperature: 24
Humidity(%): 63

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4810.58	-54.43	-47.00	-7.43	8.57	-63.00

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang		Temperature:24	Humidity(%):63
Level (dBm)			



Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Receiver Conducted Unwanted Emissions (Below 1GHz)

Modulation	GFSK/125kbps	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/125kbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

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Modulation	GFSK/2Mbps	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/2Mbps	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Receiver Conducted Unwanted Emissions (Above 1GHz)

Modulation	GFSK/125kbps	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/125kbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/1Mbps	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/1Mbps	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	GFSK/2Mbps	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang			

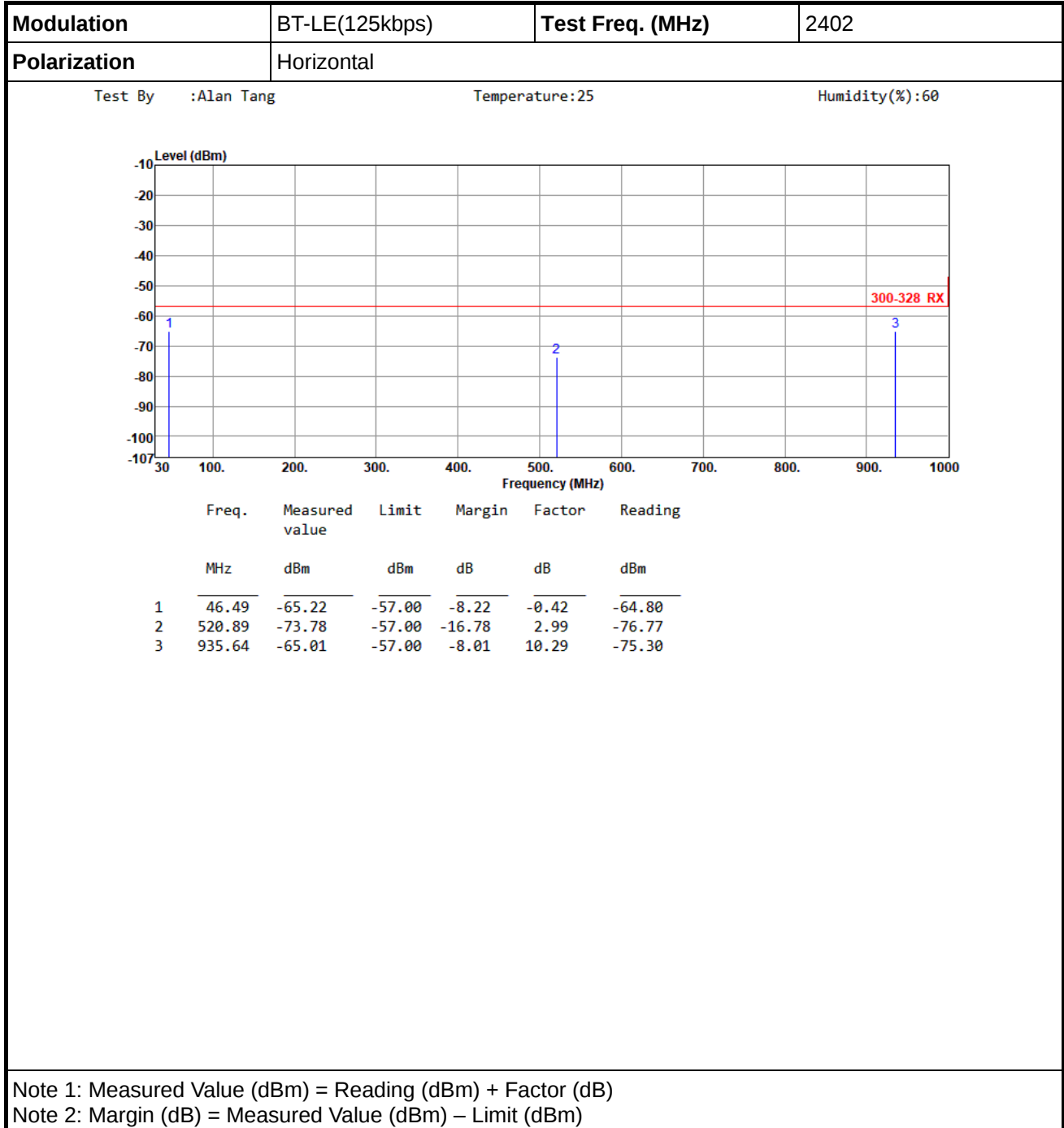


Modulation	GFSK/2Mbps	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Emissions (Below 1GHz)





Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang		Temperature:25	Humidity(%):60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	46.49	-65.30	-57.00	-8.30	-0.42	-64.88
2	520.72	-73.58	-57.00	-16.58	2.98	-76.56
3	935.67	-65.97	-57.00	-8.97	10.29	-76.26

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		

Test By :Alan Tang

Temperature:25

Humidity(%):60

The spectrum plot displays the signal level in dBm across a frequency range from 30 to 1000 MHz. A red horizontal line at -57 dBm indicates the noise floor or limit, labeled '300-328 RX'. Three distinct peaks are identified and labeled with blue numbers 1, 2, and 3.

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	46.49	-65.35	-57.00	-8.35	-0.42	-64.93
2	520.15	-73.03	-57.00	-16.03	2.98	-76.01
3	935.27	-65.63	-57.00	-8.63	10.28	-75.91

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		
Test By :Alan Tang			



Emissions (Above 1GHz)

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Alan Tang			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang		Temperature:25	Humidity(%):60
Level (dBm) <			



Modulation	BT-LE(125kbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Horizontal		

Test By :Alan Tang

Temperature:25

Humidity(%):60

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4805.23	-55.21	-47.00	-8.21	8.57	-63.78

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2402
Polarization	Vertical		

Test By : Alan Tang
Temperature: 25
Humidity(%): 60

The spectrum plot displays the signal level in dBm across a frequency range from 1000 to 12750 MHz. A red horizontal line at -50 dBm indicates a limit or reference level, labeled '300.328 RX'. A blue vertical line at 4805.75 MHz marks the measured frequency, labeled '1'.

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4805.75	-54.70	-47.00	-7.70	9.60	-64.30

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(1Mbps)	Test Freq. (MHz)	2480
Polarization	Vertical		
Test By : Alan Tang		Temperature: 25	Humidity(%): 60

The spectrum plot displays the signal level in dBm across a frequency range from 1000 to 12750 MHz. A red horizontal line at -50 dBm indicates a received signal at 300.328 MHz. A blue vertical line at 4961.74 MHz marks the test frequency, with a label '1' next to it.

	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4961.74	-55.08	-47.00	-8.08	9.51	-64.59

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)
Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)



Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Horizontal		
Test By :Alan Tang			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2404
Polarization	Vertical		
Test By :Alan Tang		Temperature:25	Humidity(%):60
Level (dBm)			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Horizontal		
Test By :Alan Tang		Temperature:25	Humidity(%):60
Level (dBm)			

Modulation	BT-LE(2Mbps)	Test Freq. (MHz)	2478
Polarization	Vertical		

Test By :Alan Tang

Temperature:25

Humidity(%):60

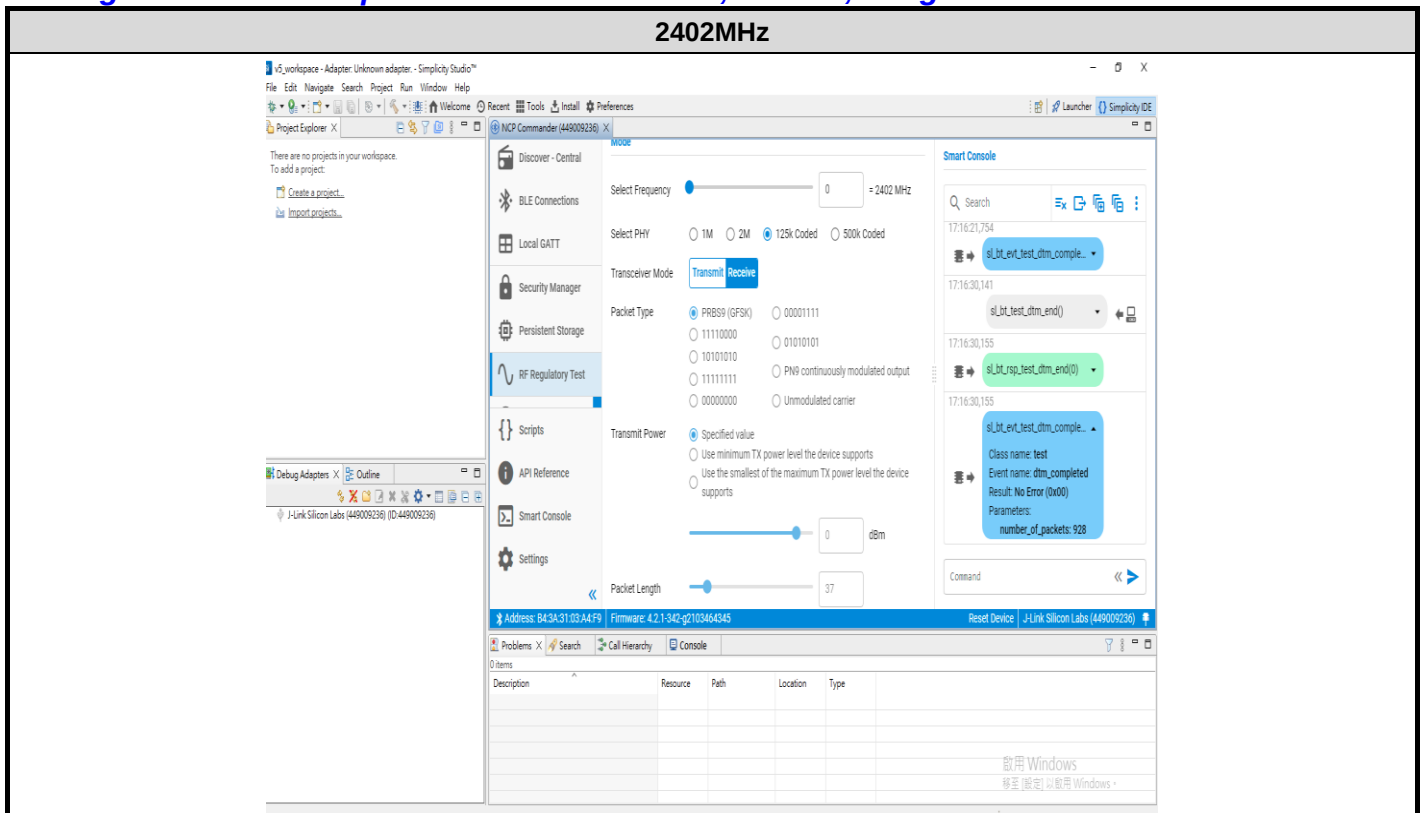
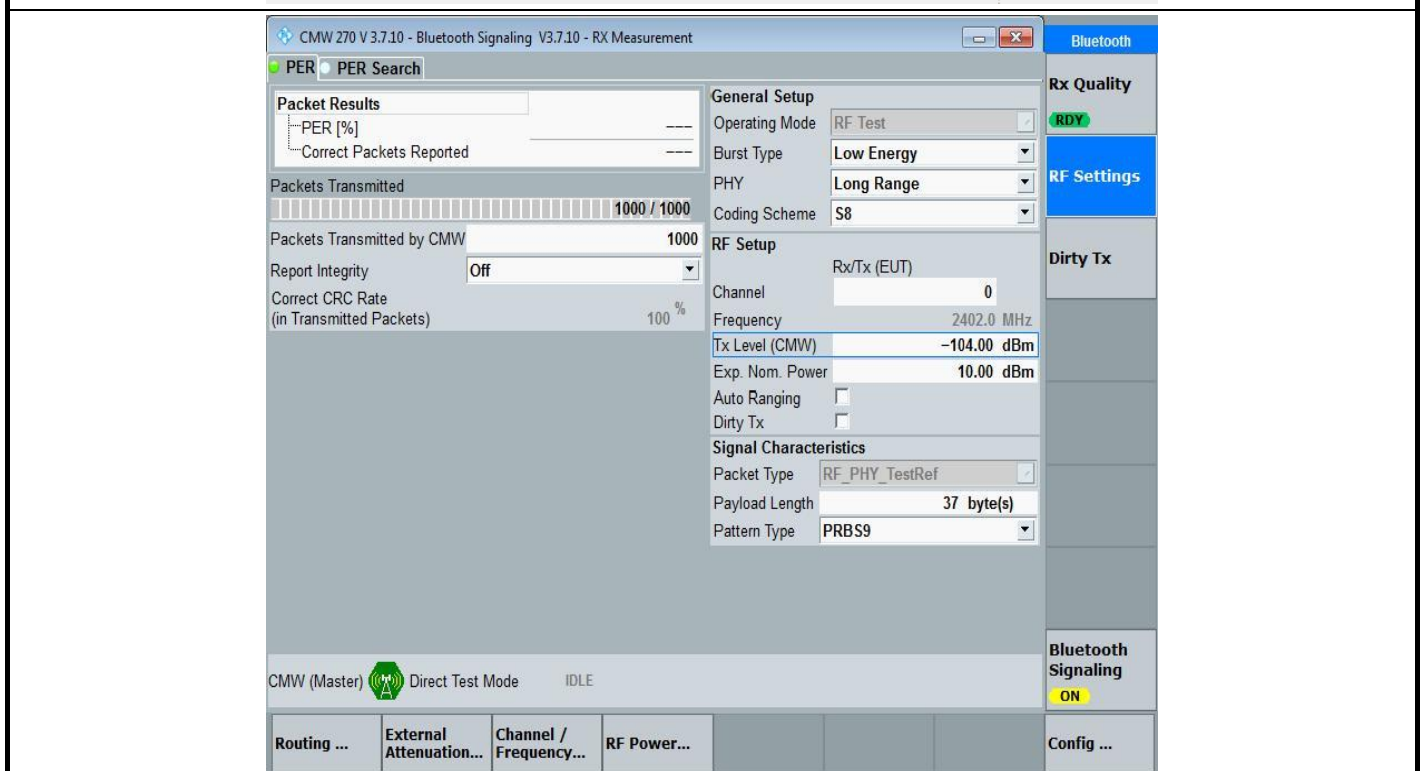
	Freq.	Measured value	Limit	Margin	Factor	Reading
	MHz	dBm	dBm	dB	dB	dBm
1	4958.52	-56.21	-47.00	-9.21	9.50	-65.71

Note 1: Measured Value (dBm) = Reading (dBm) + Factor (dB)

Note 2: Margin (dB) = Measured Value (dBm) – Limit (dBm)

Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna

2402MHz

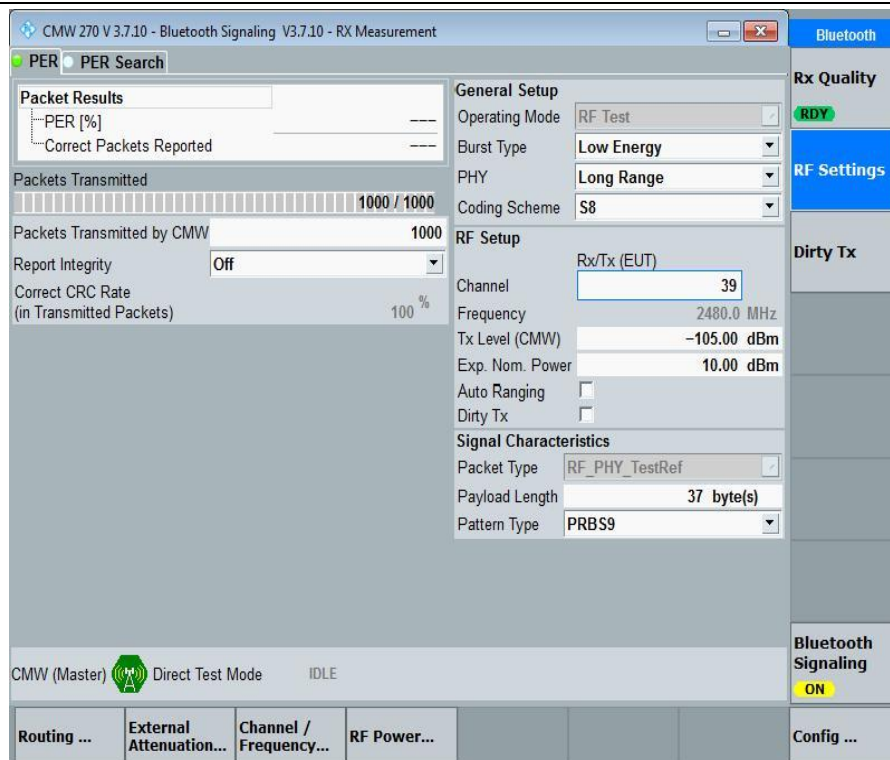
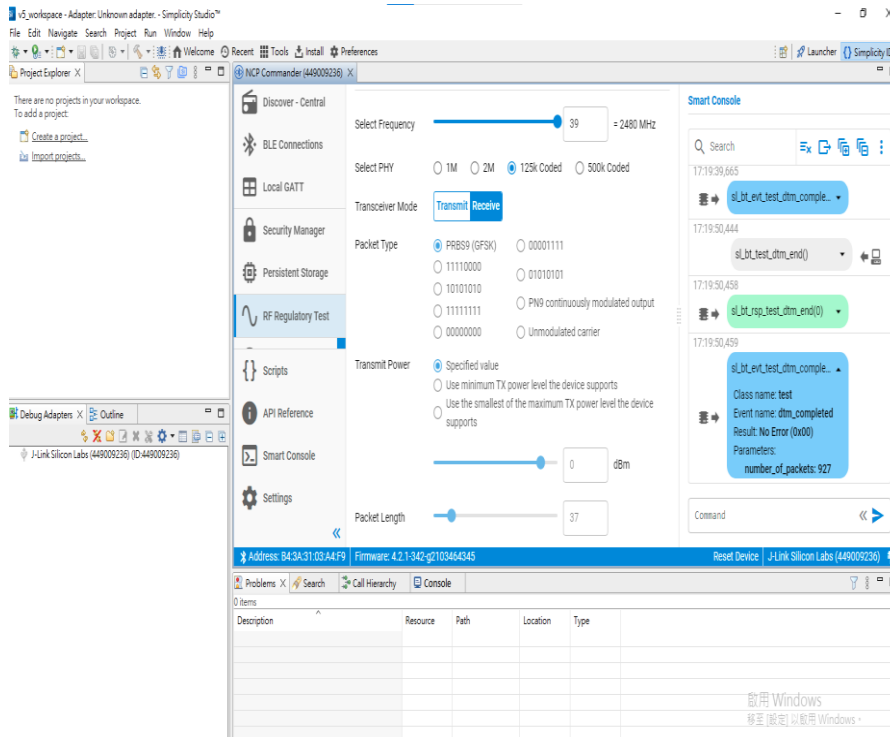



Packet Sent Numbers	1000
Packet Received Numbers	928
PER(%)	7.2



Receiver Category	1		
Performance Criteria Limit	PER ≤ 10 %		
Wanted Signal Mean Power from Companion Device (dBm)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Test Result
-71.04	2380	-32.18	Pass
-77.04	2300	-32.18	Pass
-77.04	2330	-32.18	Pass
-77.04	2360	-32.18	Pass

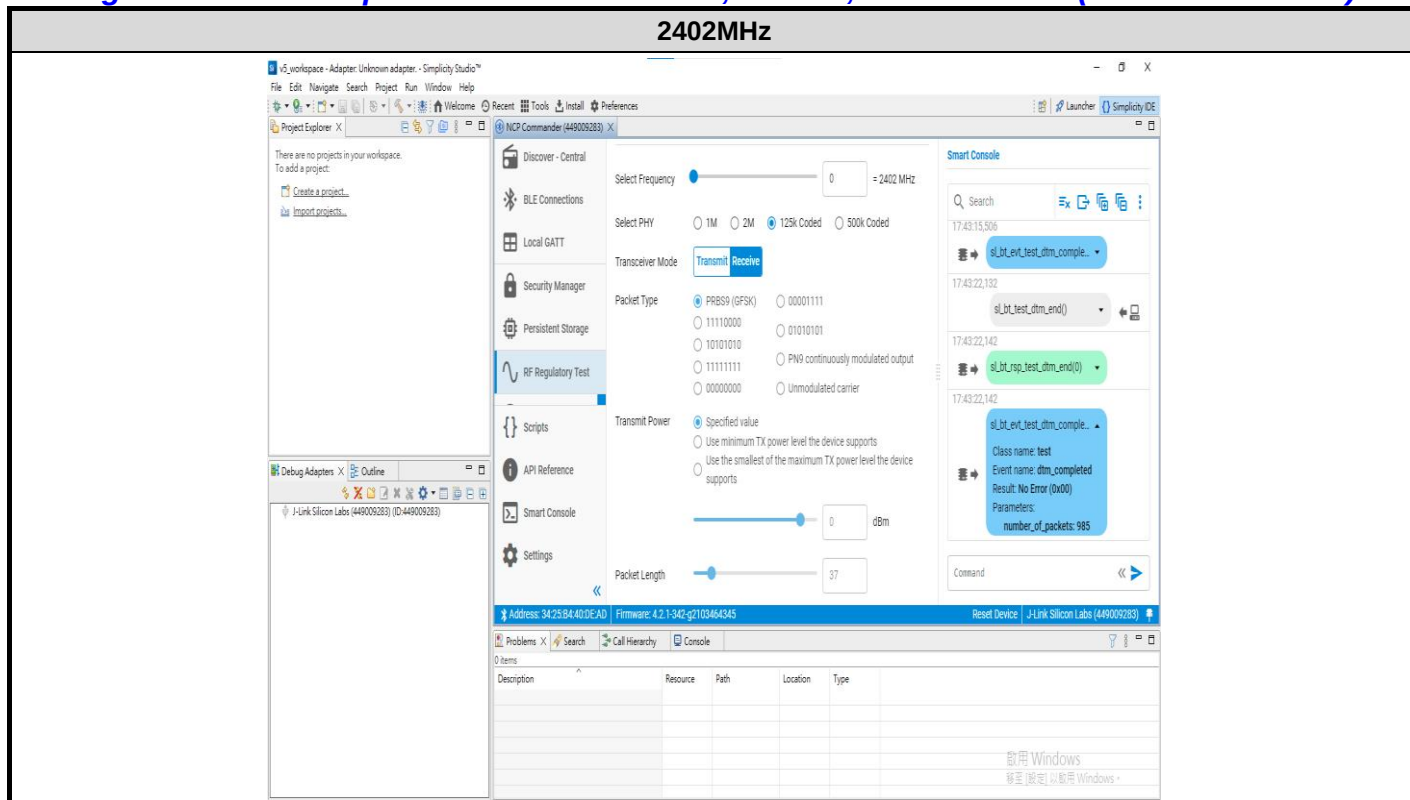
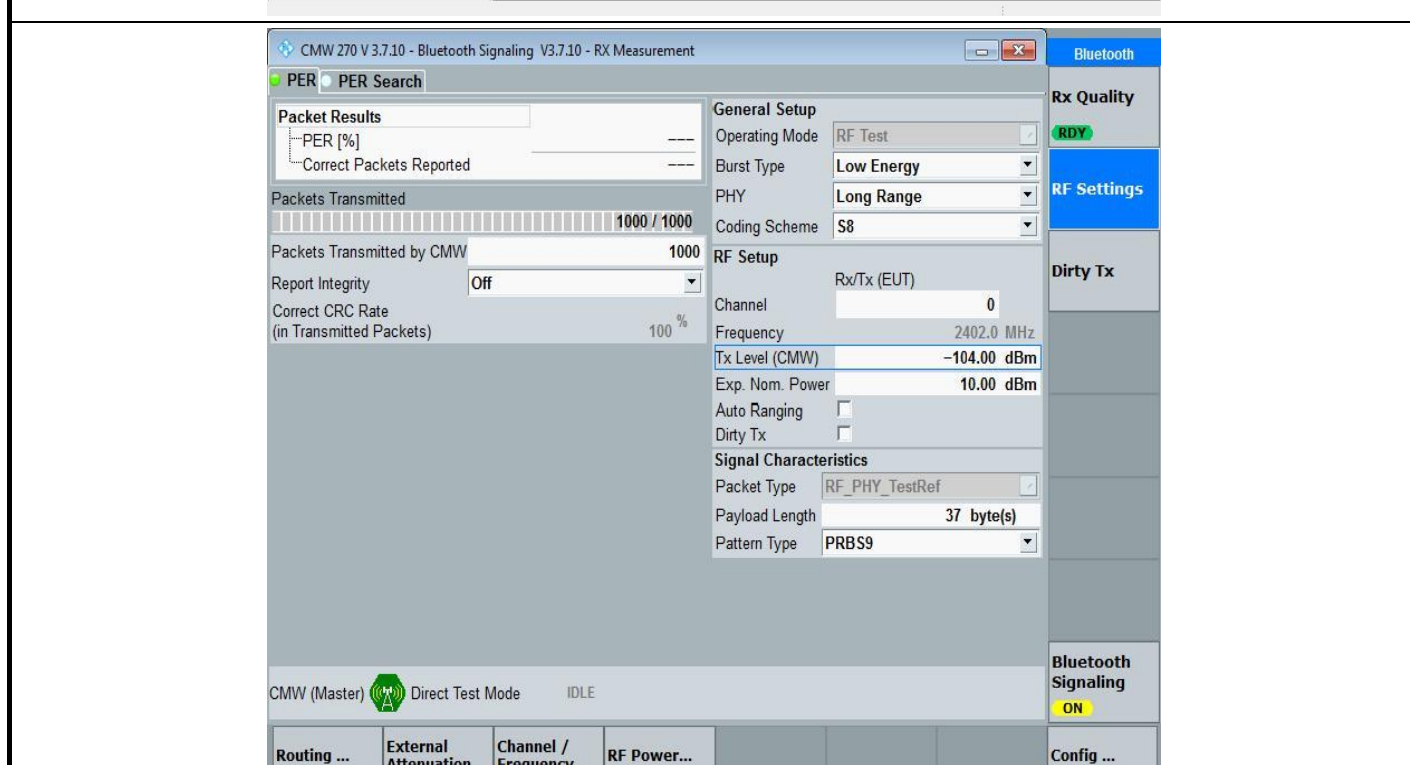
2480MHz



Packet Sent Numbers	1000
Packet Received Numbers	927
PER(%)	7.3

Receiver Category	1		
Performance Criteria Limit	PER ≤ 10 %		
Wanted Signal Mean Power from Companion Device (dBm)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Test Result
-71.06	2504	-32.18	Pass
-77.06	2524	-32.18	Pass
-77.06	2584	-32.18	Pass
-77.06	2674	-32.18	Pass

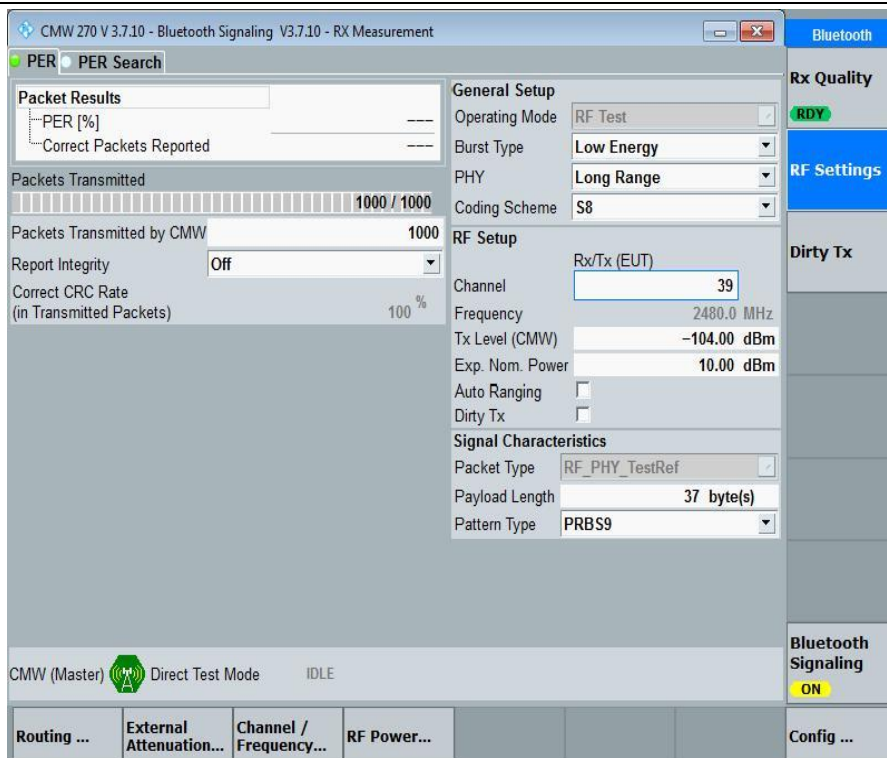
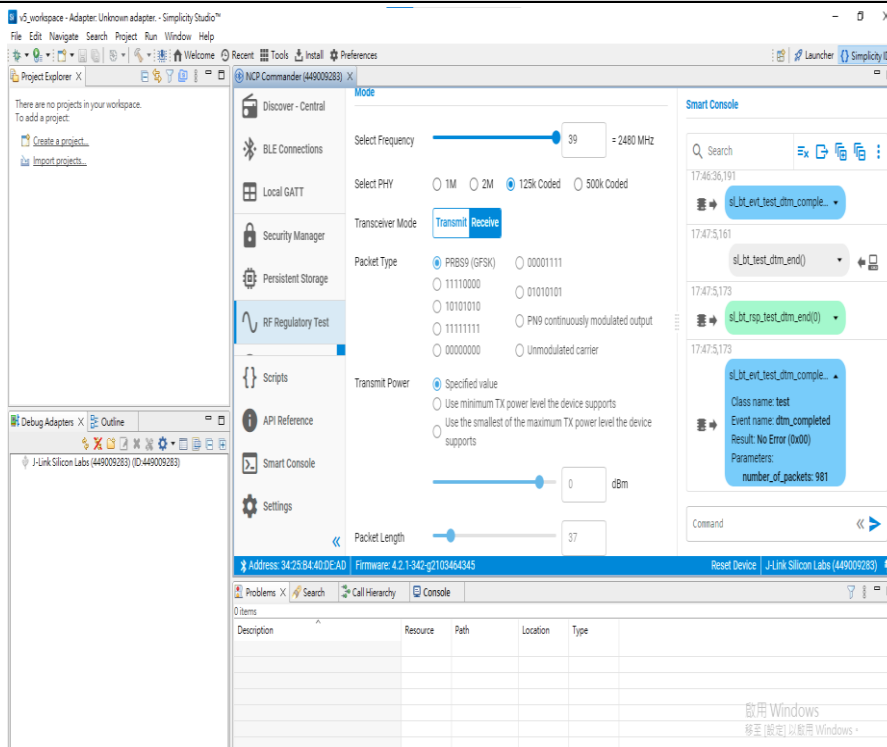
**Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)**

	
	
Packet Sent Numbers	1000
Packet Received Numbers	985
PER(%)	1.5

Receiver Category	1		
Performance Criteria Limit	PER ≤ 10 %		
Wanted Signal Mean Power from Companion Device (dBm)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Test Result
-70.86	2380	-32	Pass
-76.86	2300	-32	Pass
-76.86	2330	-32	Pass
-76.86	2360	-32	Pass



2480MHz



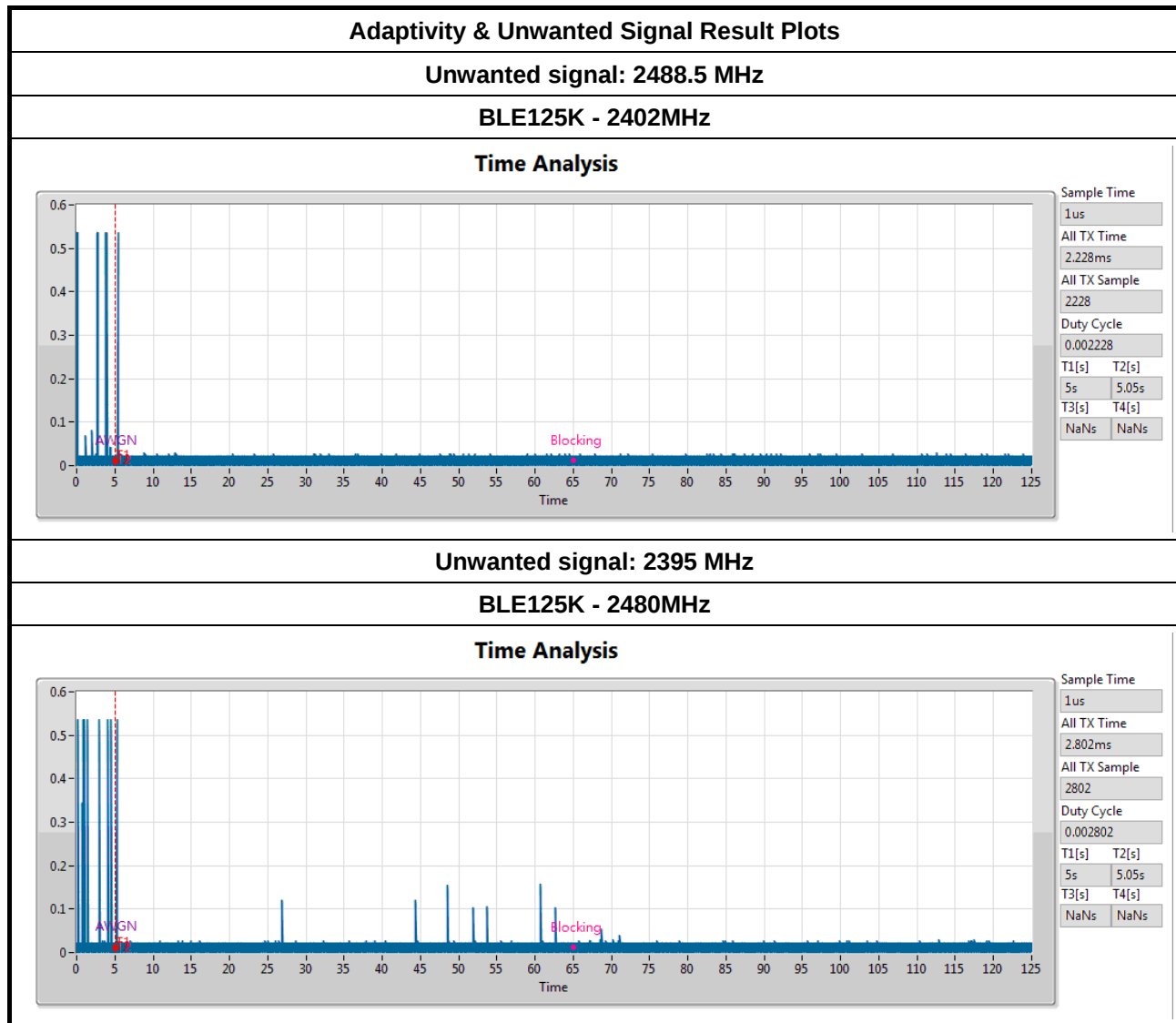
Packet Sent Numbers	1000
Packet Received Numbers	981
PER(%)	1.9

Receiver Category	1		
Performance Criteria Limit	PER ≤ 10 %		
Wanted Signal Mean Power from Companion Device (dBm)	Blocking Signal Frequency (MHz)	Blocking Signal Power (dBm)	Test Result
-70.87	2504	-32	Pass
-76.87	2524	-32	Pass
-76.87	2584	-32	Pass
-76.87	2674	-32	Pass

**Configuration 1: Laird part number: 453-00145, 20dBm, Integrated Antenna**

Adaptivity and Unwanted Signal Result						
Adaptivity Detection Threshold Level (dBm)			-67.54			
Unwanted Signal Level (dBm)			-33.18			
Modulation Mode	Freq. (MHz)	Short Control Signalling Transmissions (ms)	Channel Occupancy Time (ms)	Idle Period Time (µs)	Adaptivity	Unwanted Signal Test Status
BLE 125K	2402	0.105	0.139	2.33	Pass	Pass
BLE 125K	2480	0.131	0.139	2.33		
BLE 1M	2402	0.105	0.190	2.331		
BLE 1M	2480	0.145	0.147	2.332		
BLE 2M	2404	0.106	0.139	2.33		
BLE 2M	2478	0.134	0.139	2.33		
Limit		< 5 ms	< 40 ms	>100µs		
Result		Complied				

Test Result of Adaptivity and Unwanted Signal Plots

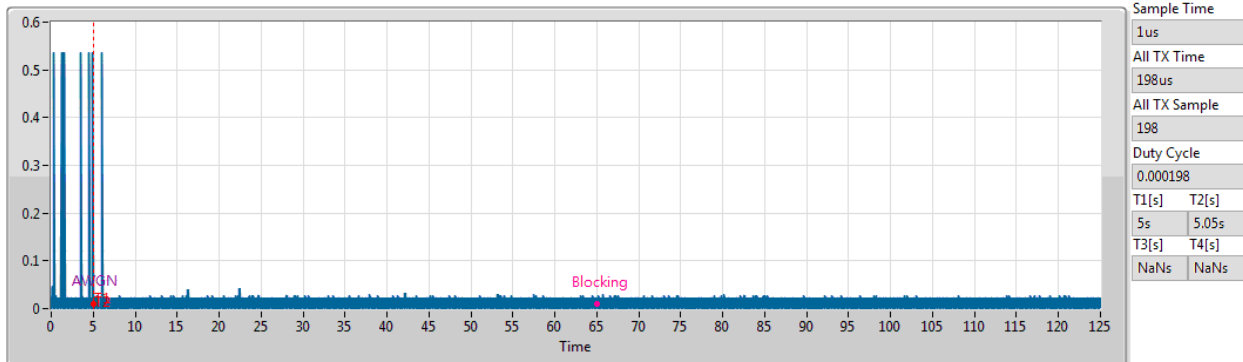


Adaptivity & Unwanted Signal Result Plots

Unwanted signal: 2488.5 MHz

BLE1M - 2402MHz

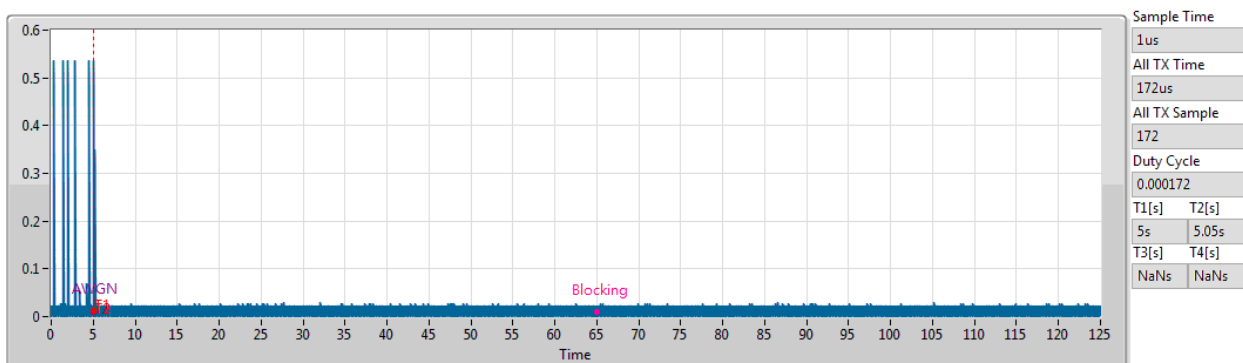
Time Analysis



Unwanted signal: 2395 MHz

BLE1M - 2480MHz

Time Analysis

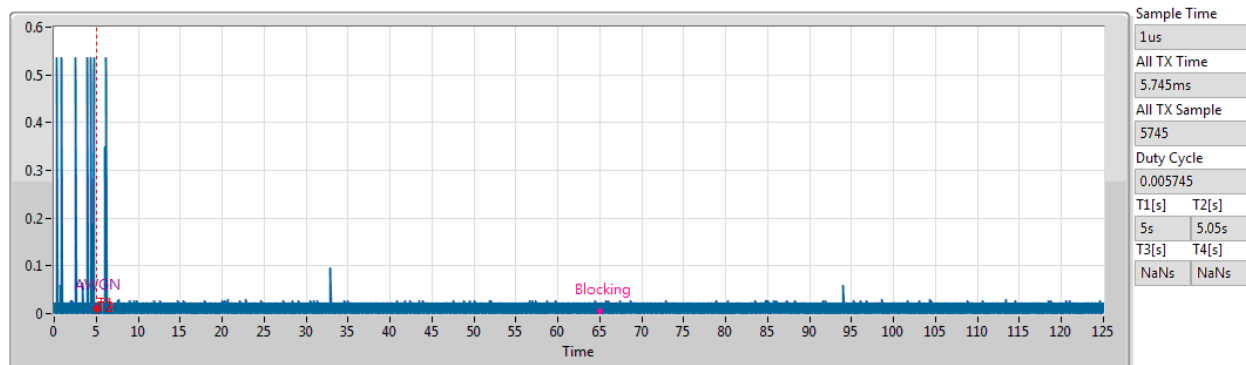


Adaptivity & Unwanted Signal Result Plots

Unwanted signal: 2488.5 MHz

BLE2M - 2404MHz

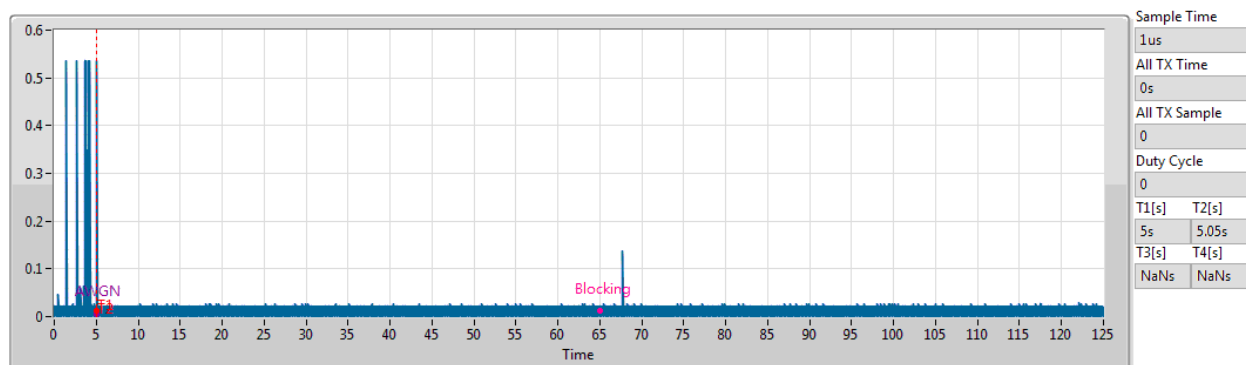
Time Analysis



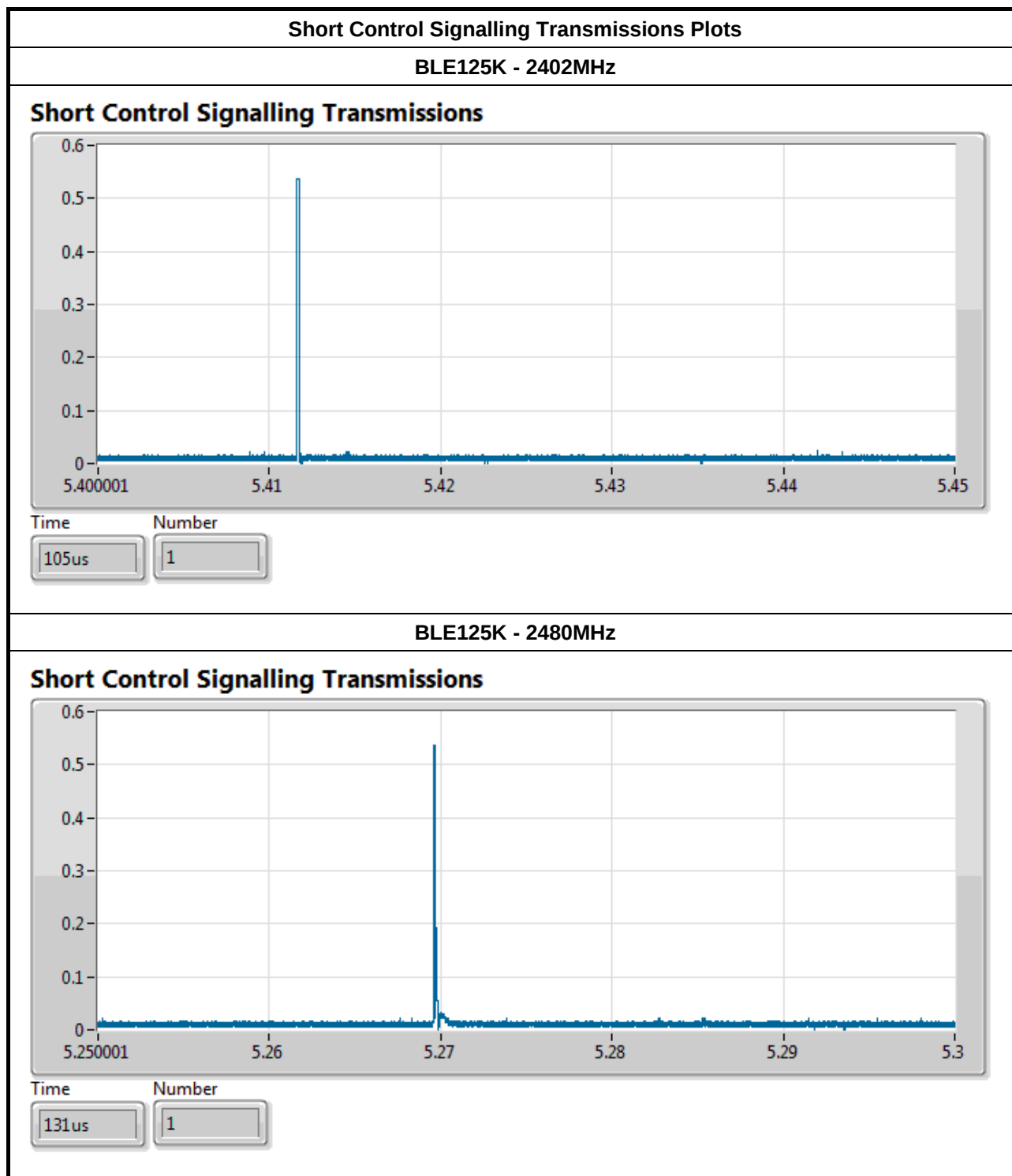
Unwanted signal: 2395 MHz

BLE2M - 2478MHz

Time Analysis



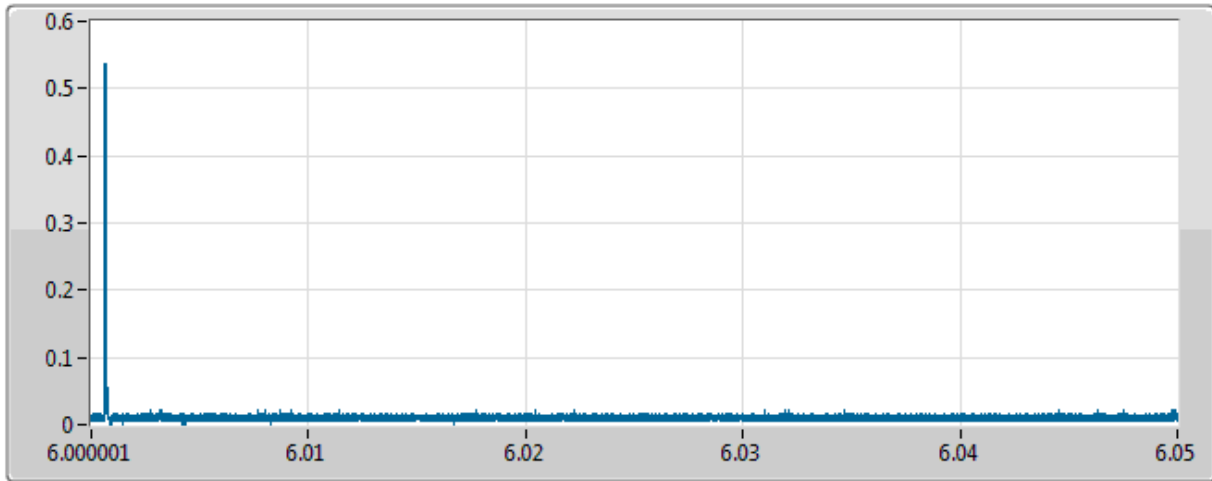
Test Result of Short Control Signalling Transmissions Plots



Short Control Signalling Transmissions Plots

BLE1M - 2402MHz

Short Control Signalling Transmissions



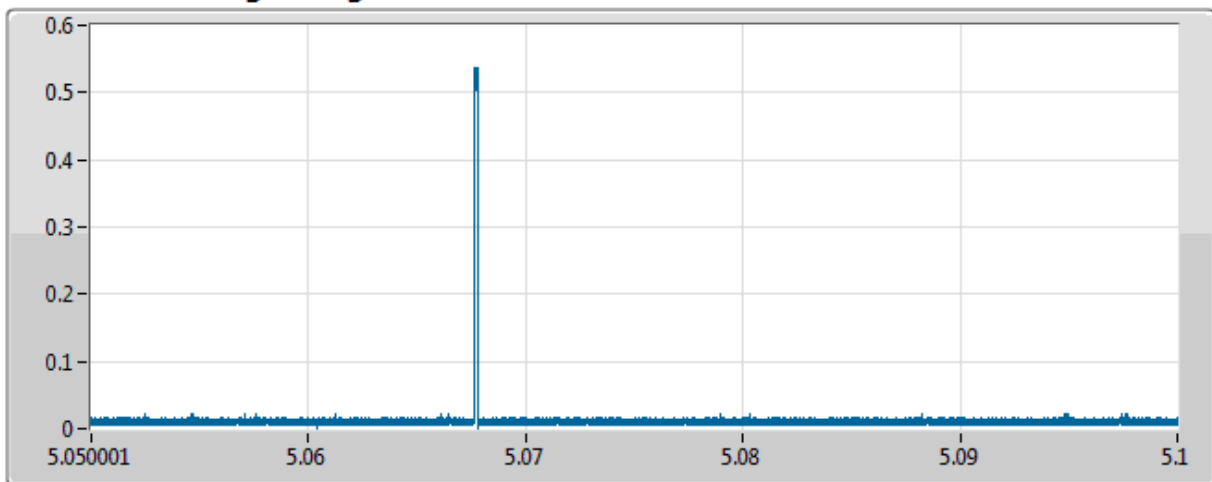
Time Number

105us

1

BLE1M - 2480MHz

Short Control Signalling Transmissions



Time Number

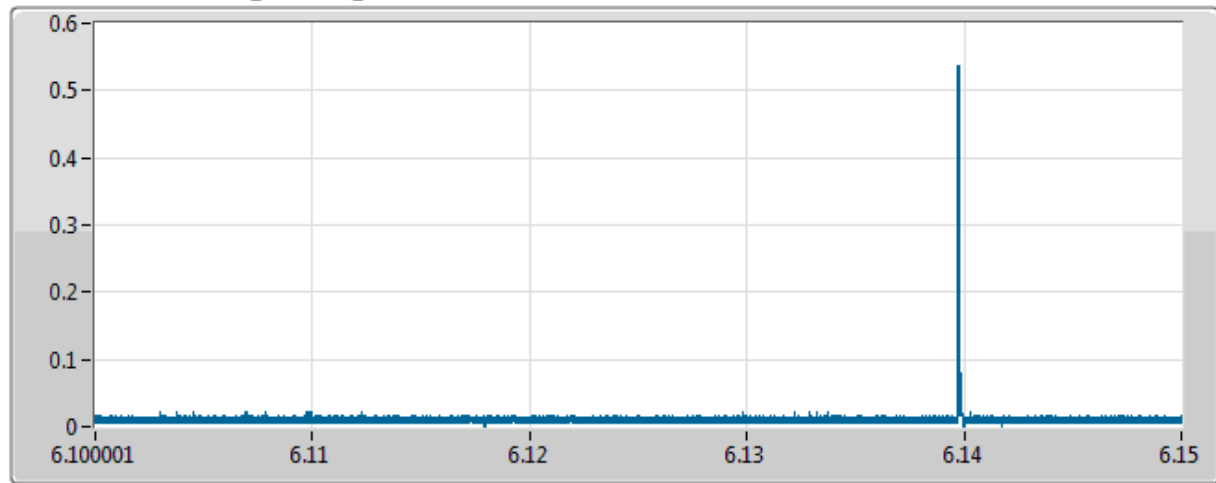
145us

1

Short Control Signalling Transmissions Plots

BLE2M - 2402MHz

Short Control Signalling Transmissions



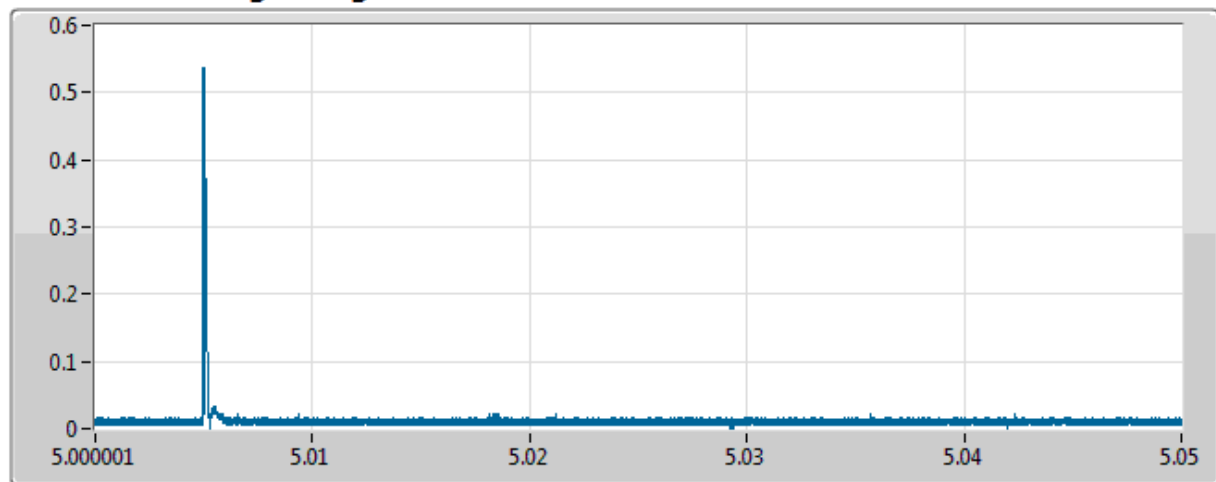
Time Number

106us

1

BLE2M - 2480MHz

Short Control Signalling Transmissions



Time Number

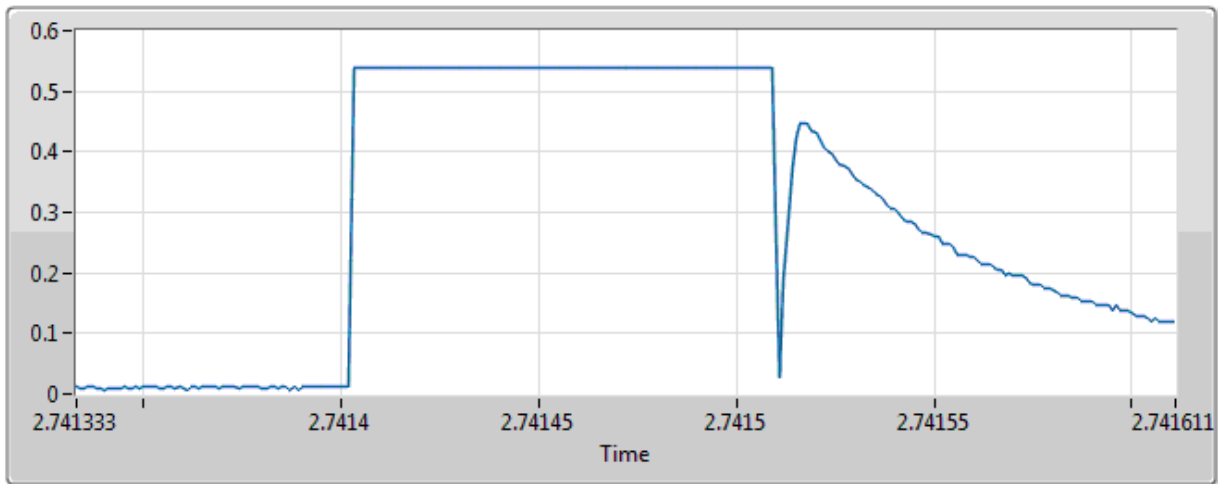
134us

1

Channel Occupancy Time

BLE125K - 2402MHz

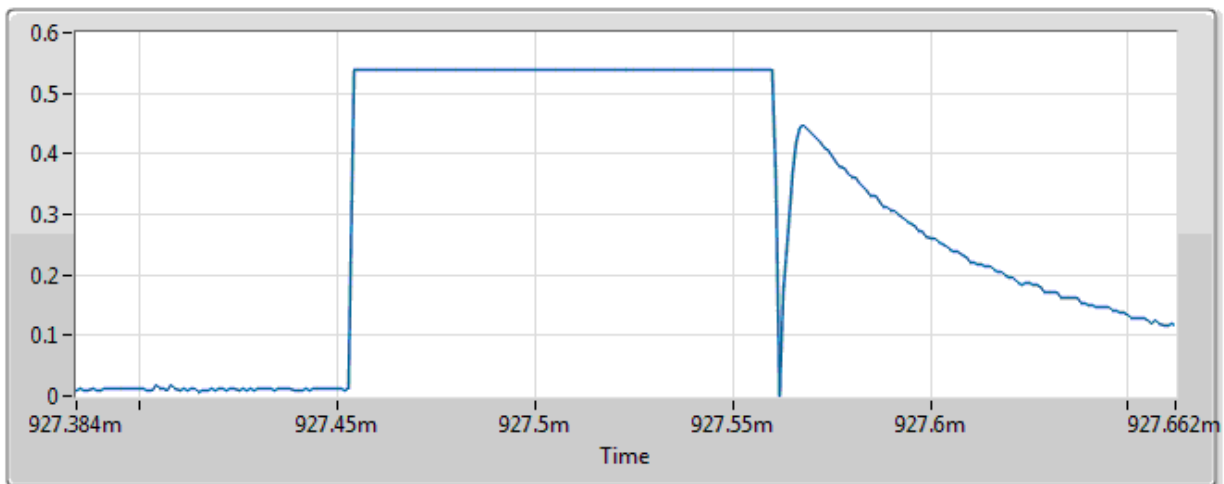
Max On Time



139us

BLE125K - 2480MHz

Max On Time

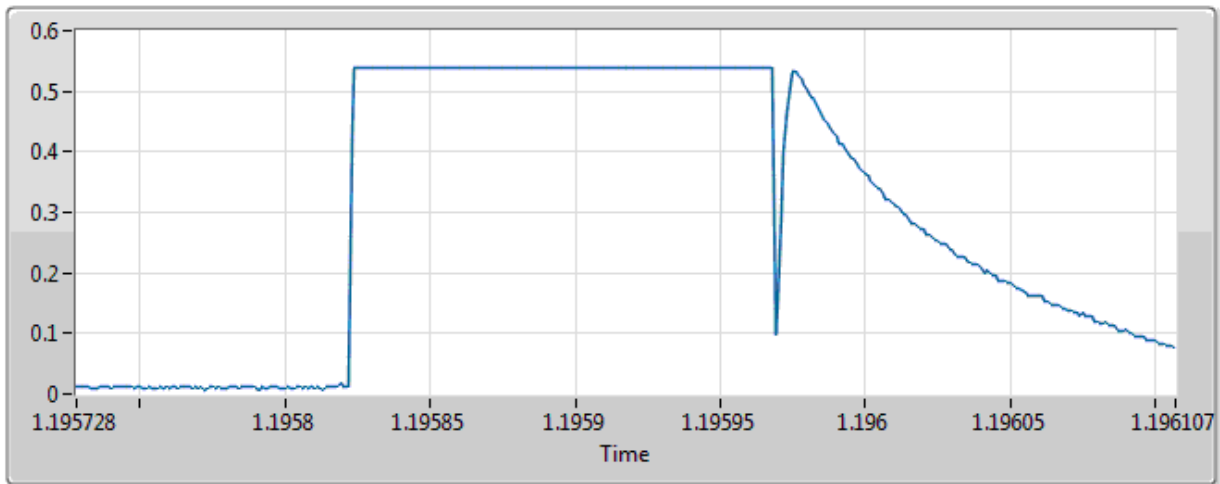


139us

Channel Occupancy Time

BLE1M - 2402MHz

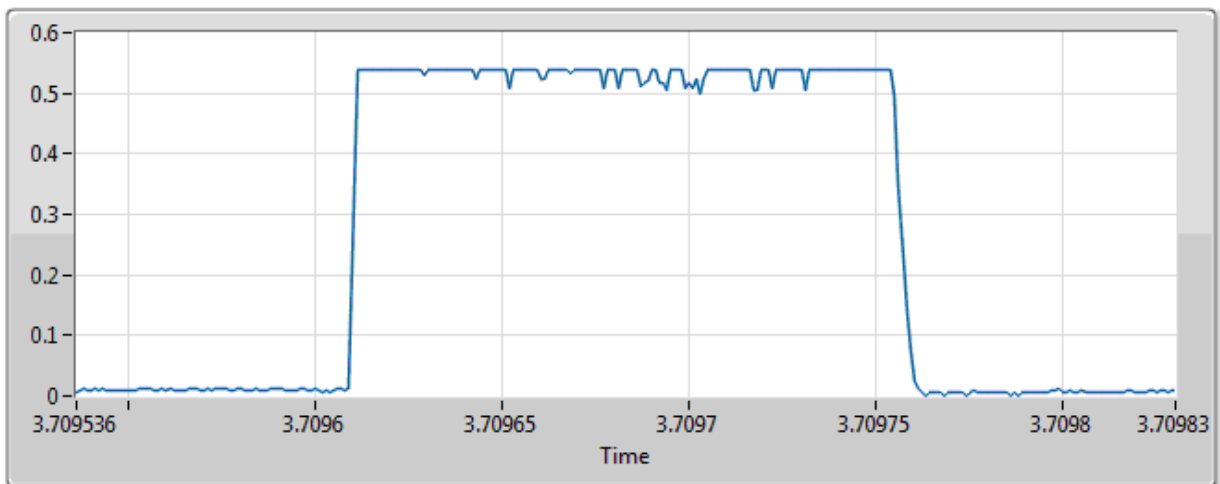
Max On Time



190us

BLE1M - 2480MHz

Max On Time

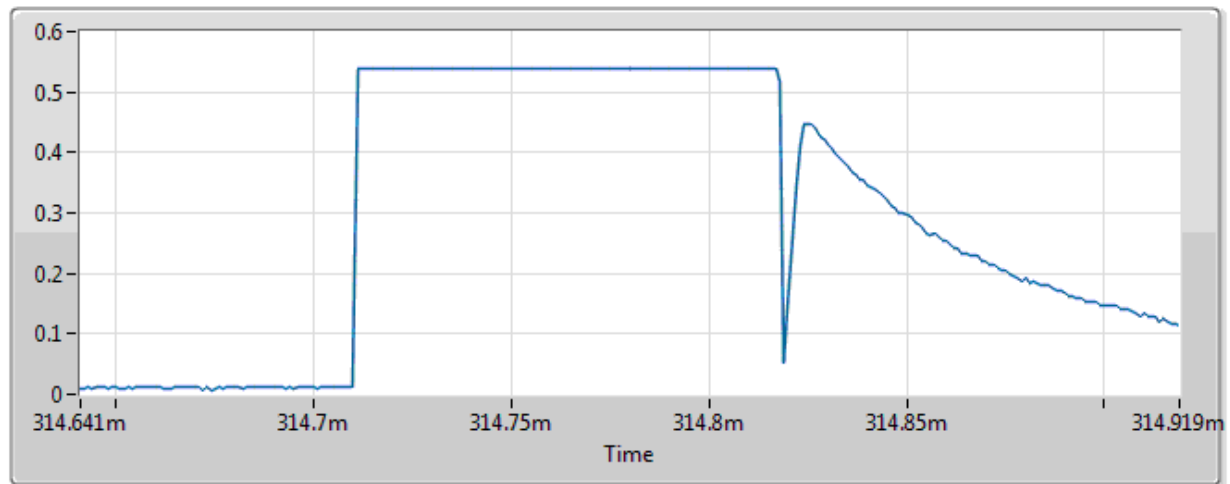


147us

Channel Occupancy Time

BLE2M - 2404MHz

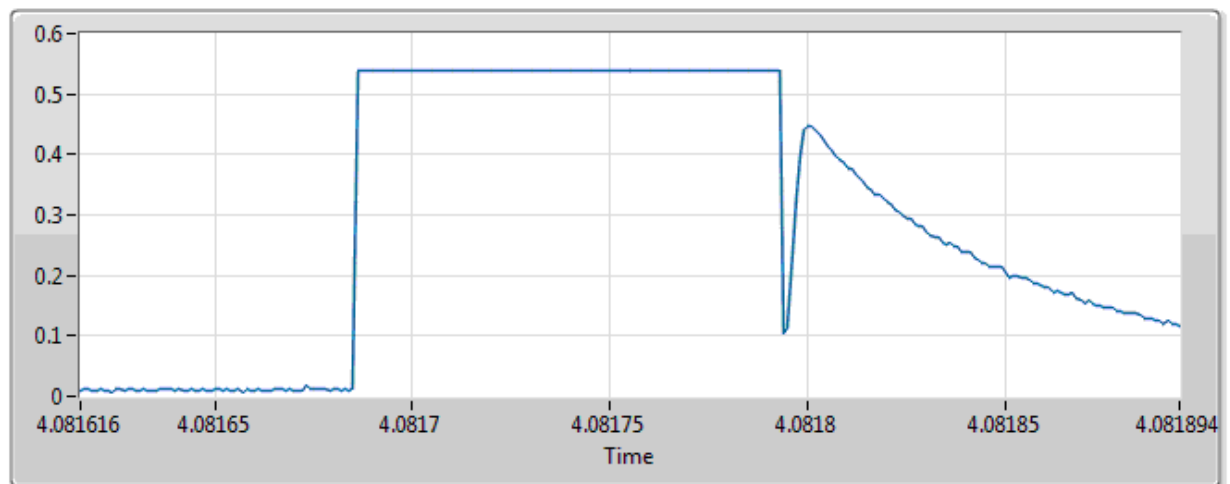
Max On Time



139us

BLE2M - 2478MHz

Max On Time

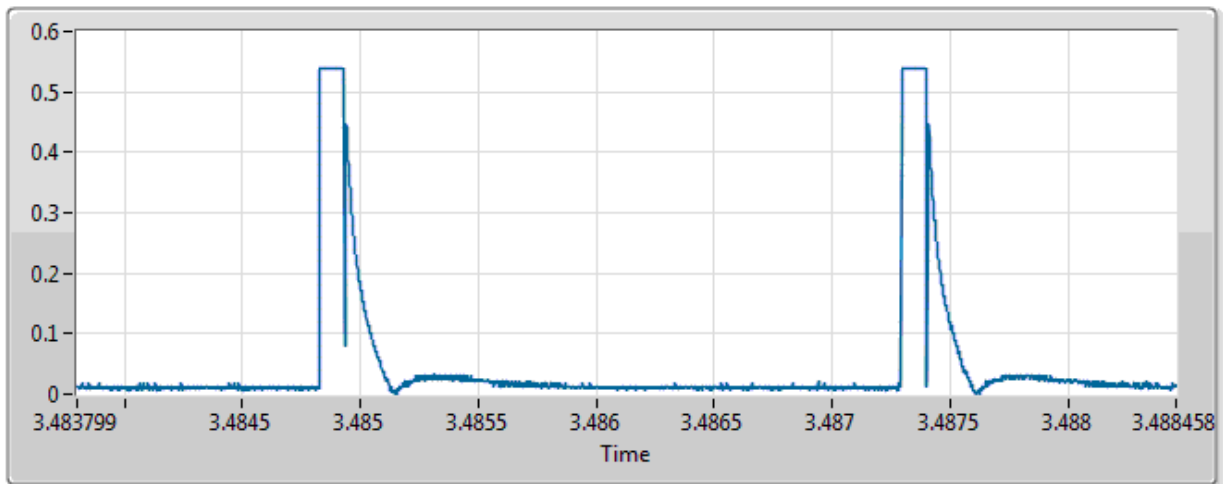


139us

Idle Period Time

BLE125K - 2402MHz

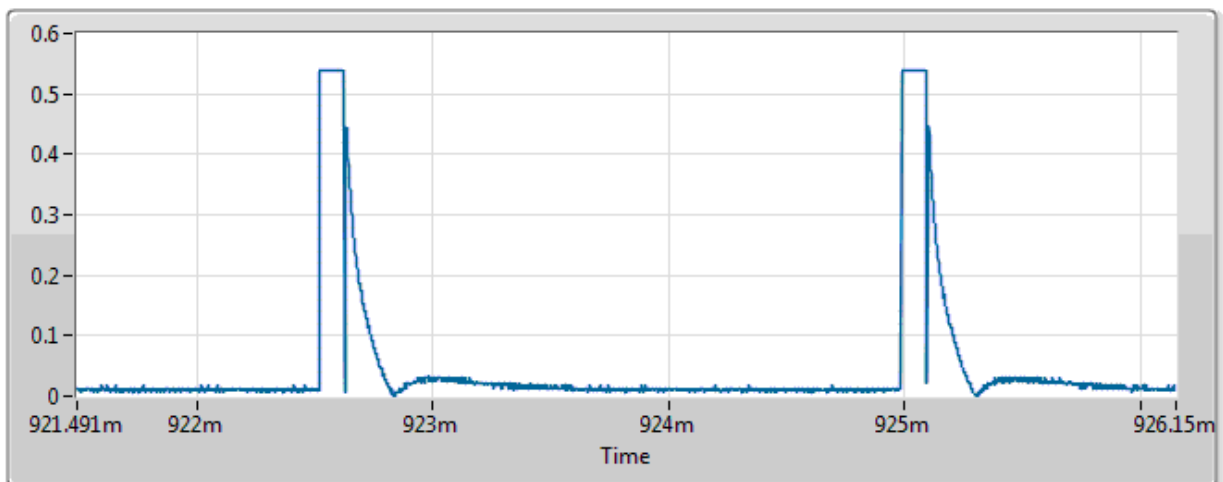
Min Off Time



2.33ms

BLE125K - 2480MHz

Min Off Time

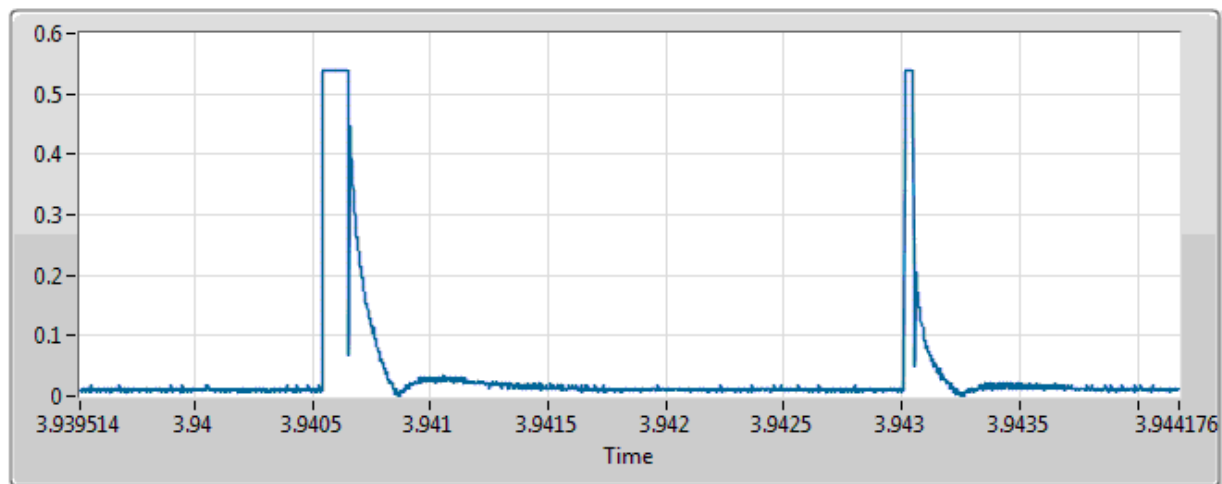


2.33ms

Idle Period Time

BLE 1M - 2402MHz

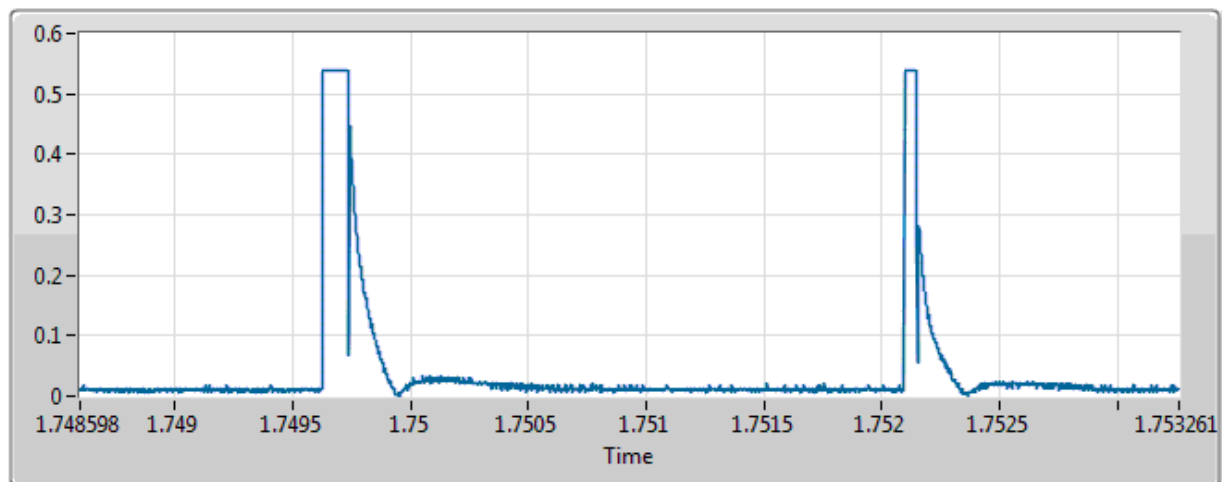
Min Off Time



2.331ms

BLE 1M - 2480MHz

Min Off Time

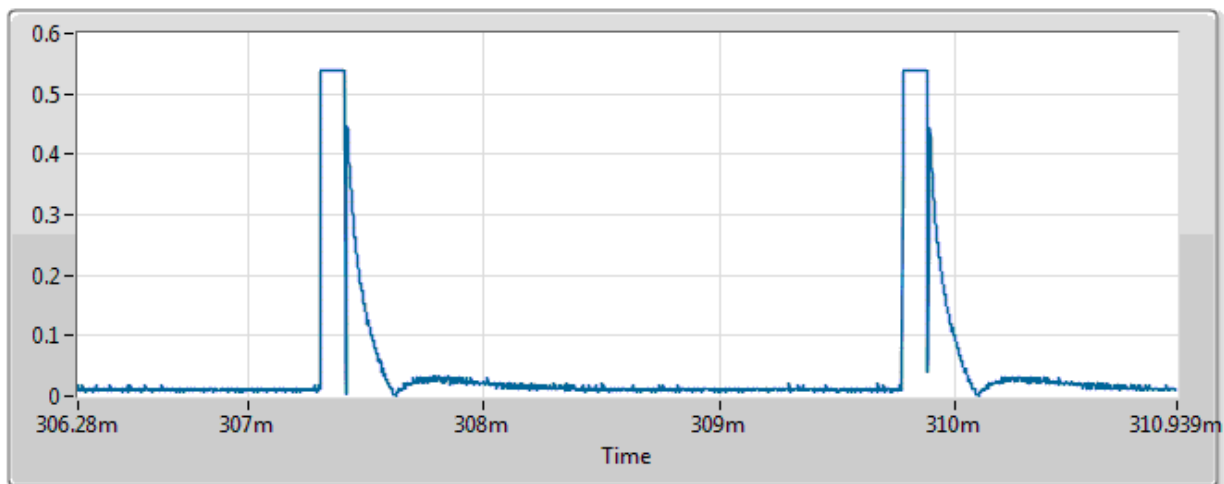


2.332ms

Idle Period Time

BLE 2M - 2404MHz

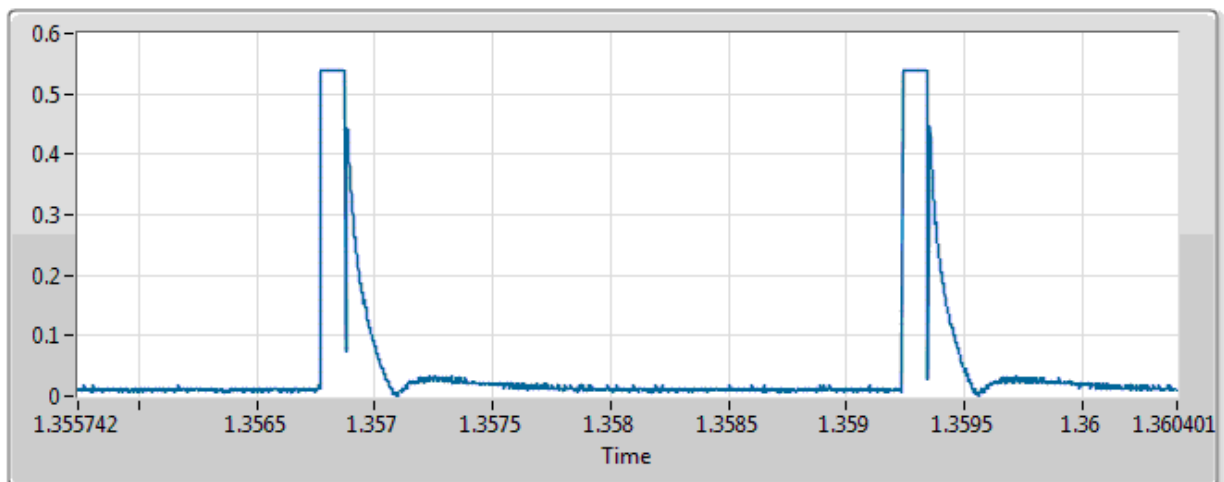
Min Off Time



2.33ms

BLE 2M - 2478MHz

Min Off Time

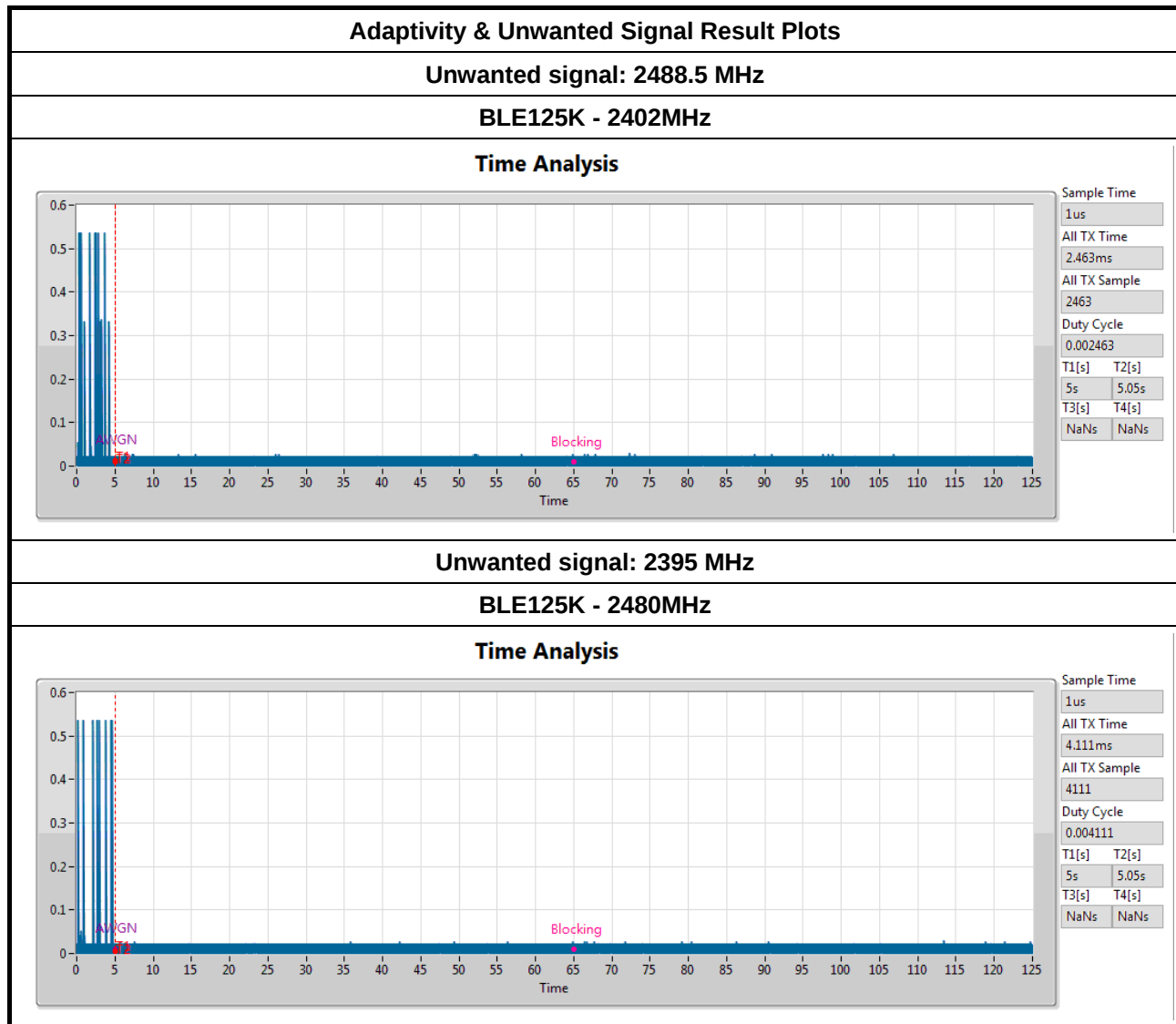


2.33ms

Configuration 2: Laird part number: 453-00148, 20dBm, RF Trace Pad (External antenna)

Adaptivity and Unwanted Signal Result						
Adaptivity Detection Threshold Level (dBm)			-67.88			
Unwanted Signal Level (dBm)			-33			
Modulation Mode	Freq. (MHz)	Short Control Signalling Transmissions (ms)	Channel Occupancy Time (ms)	Idle Period Time (μs)	Adaptivity	Unwanted Signal Test Status
BLE 125K	2402	0	0.139	2329	Pass	Pass
BLE 125K	2480	0	0.190	2329		
BLE 1M	2402	0	0.139	2329		
BLE 1M	2480	0	0.139	2329		
BLE 2M	2404	0	0.139	2330		
BLE 2M	2478	0.212	0.189	2329		
Limit		< 5 ms	< 40 ms	>100μs		
Result		Complied				

Test Result of Adaptivity and Unwanted Signal Plots

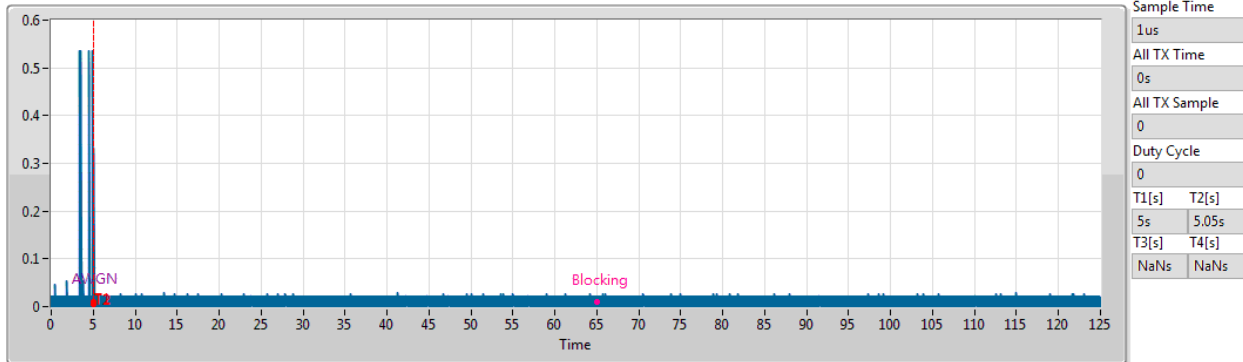


Adaptivity & Unwanted Signal Result Plots

Unwanted signal: 2488.5 MHz

BLE1M - 2402MHz

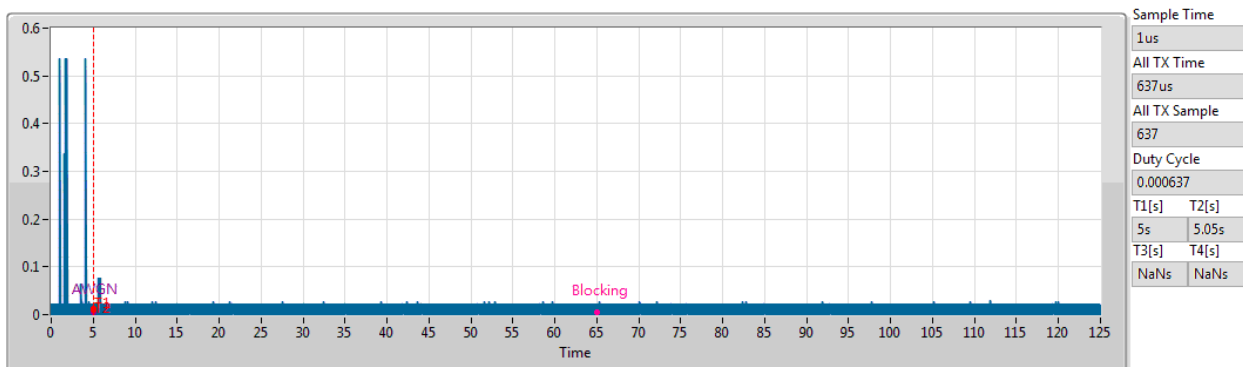
Time Analysis



Unwanted signal: 2395 MHz

BLE1M - 2480MHz

Time Analysis

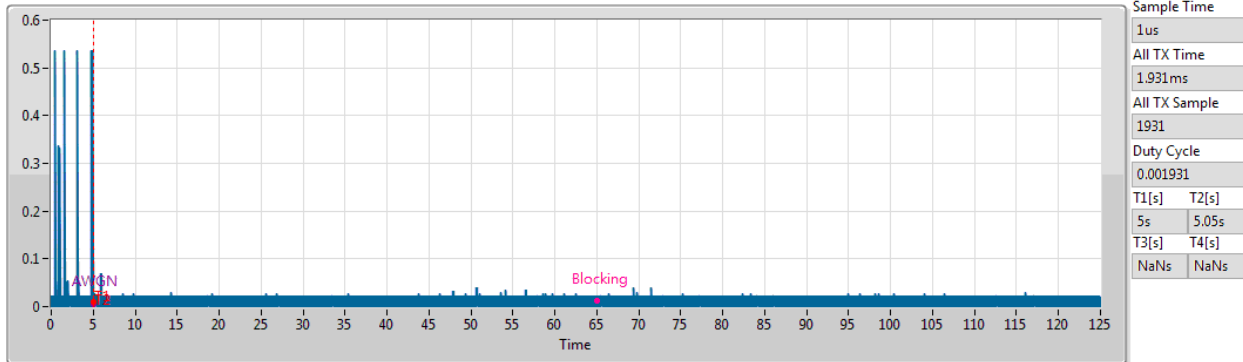


Adaptivity & Unwanted Signal Result Plots

Unwanted signal: 2488.5 MHz

BLE2M - 2404MHz

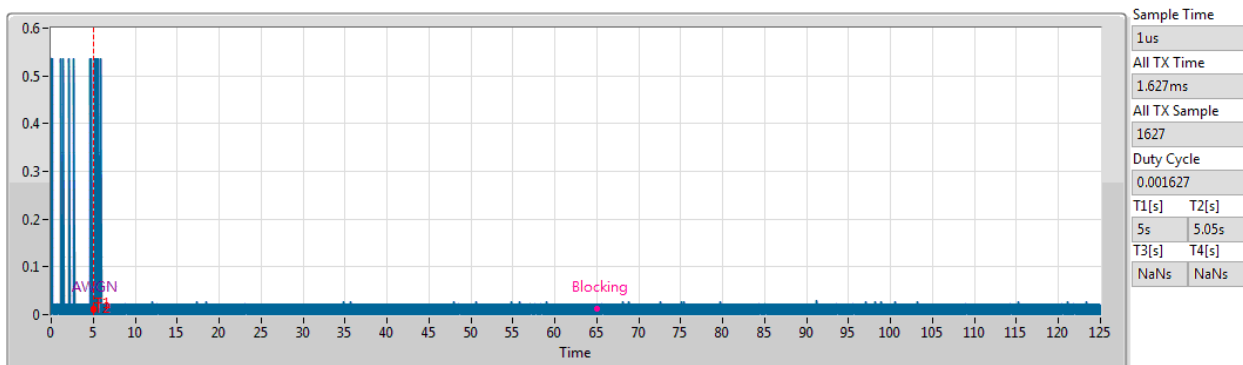
Time Analysis



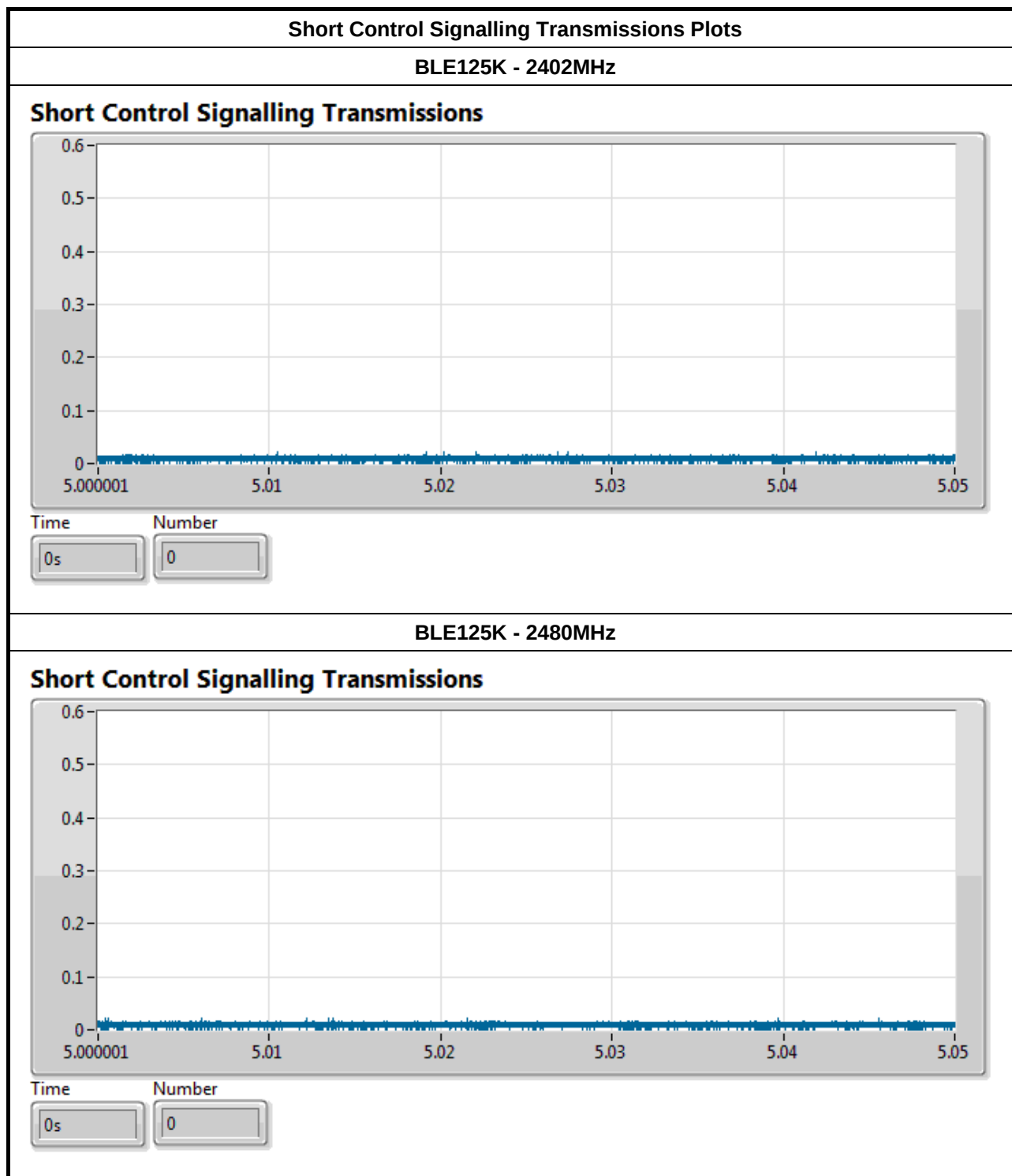
Unwanted signal: 2395 MHz

BLE2M - 2478MHz

Time Analysis



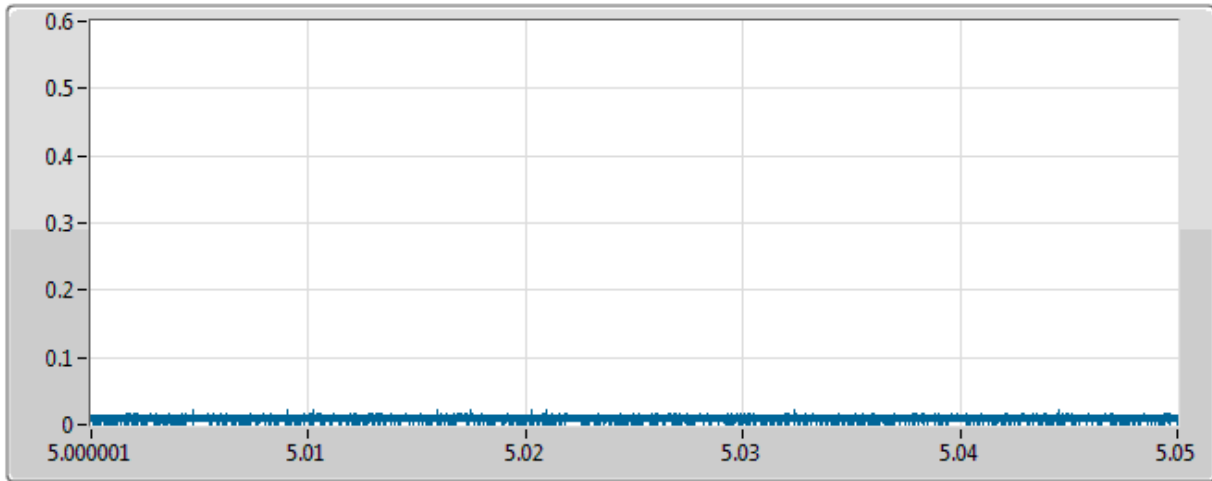
Test Result of Short Control Signalling Transmissions Plots



Short Control Signalling Transmissions Plots

BLE1M - 2402MHz

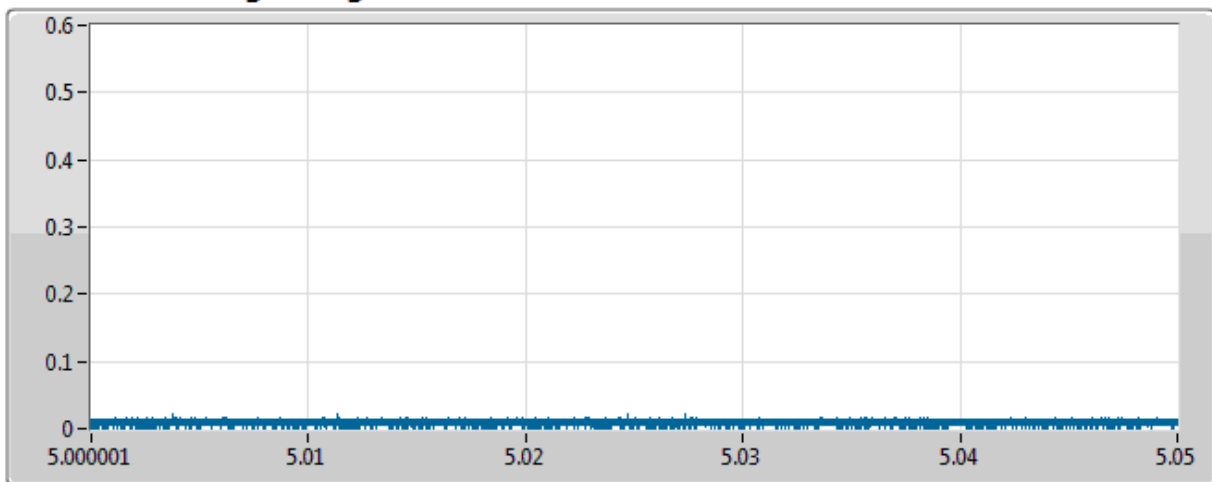
Short Control Signalling Transmissions



Time: 0s, Number: 0

BLE1M - 2480MHz

Short Control Signalling Transmissions

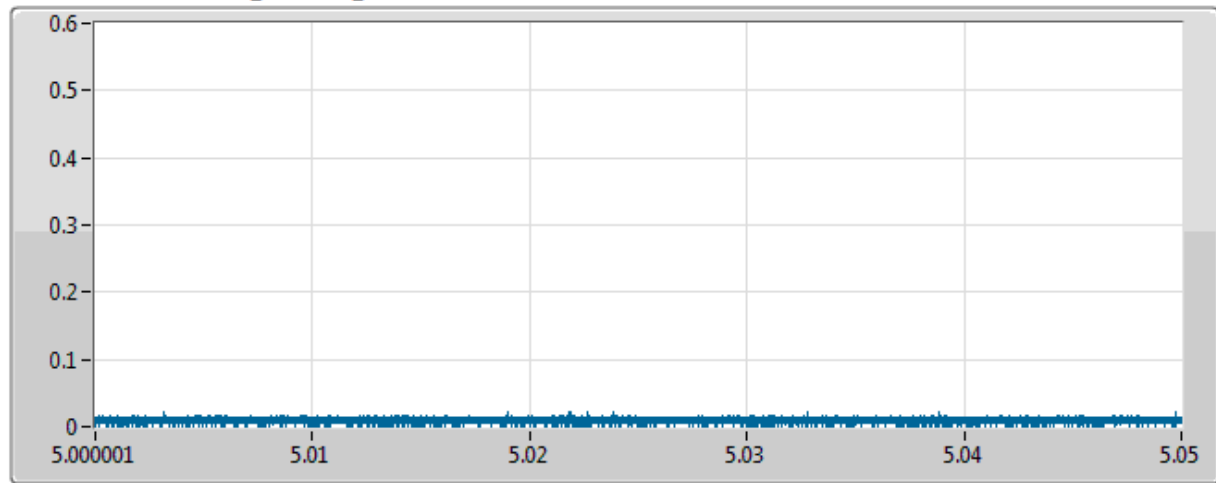


Time: 0s, Number: 0

Short Control Signalling Transmissions Plots

BLE2M - 2402MHz

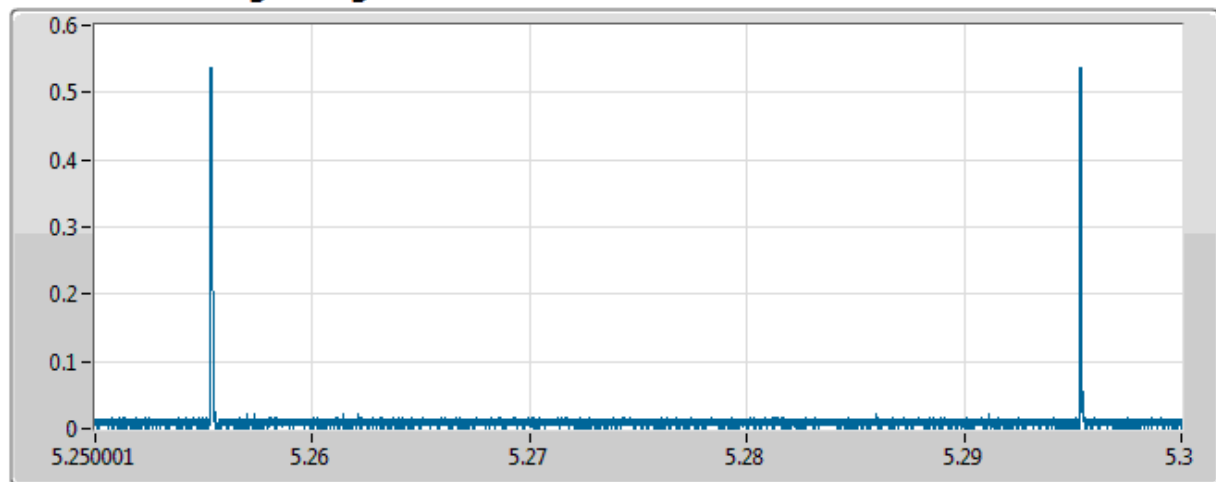
Short Control Signalling Transmissions



Time: 0s
Number: 0

BLE2M - 2480MHz

Short Control Signalling Transmissions

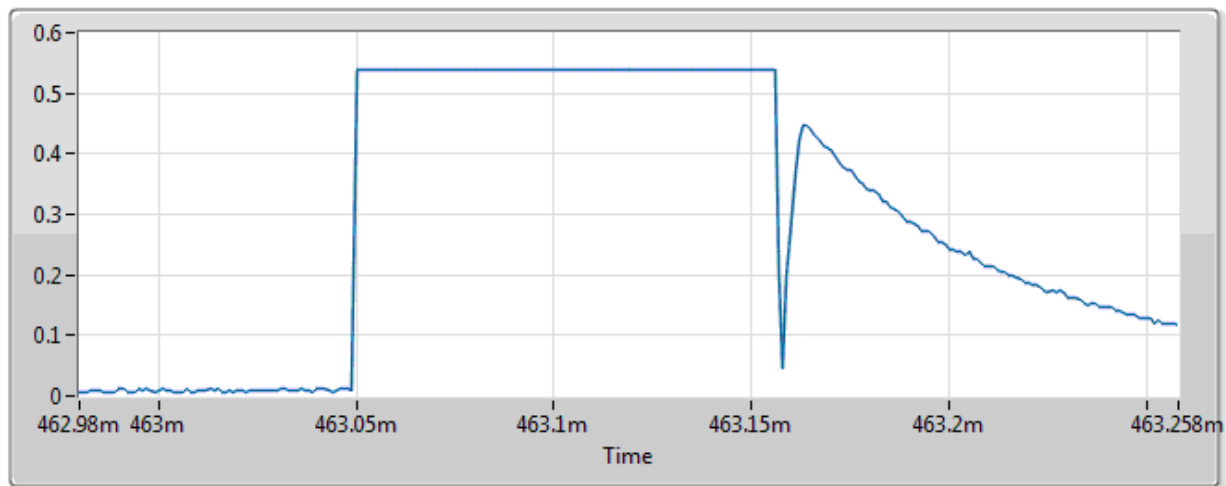


Time: 212us
Number: 2

Channel Occupancy Time

BLE125K - 2402MHz

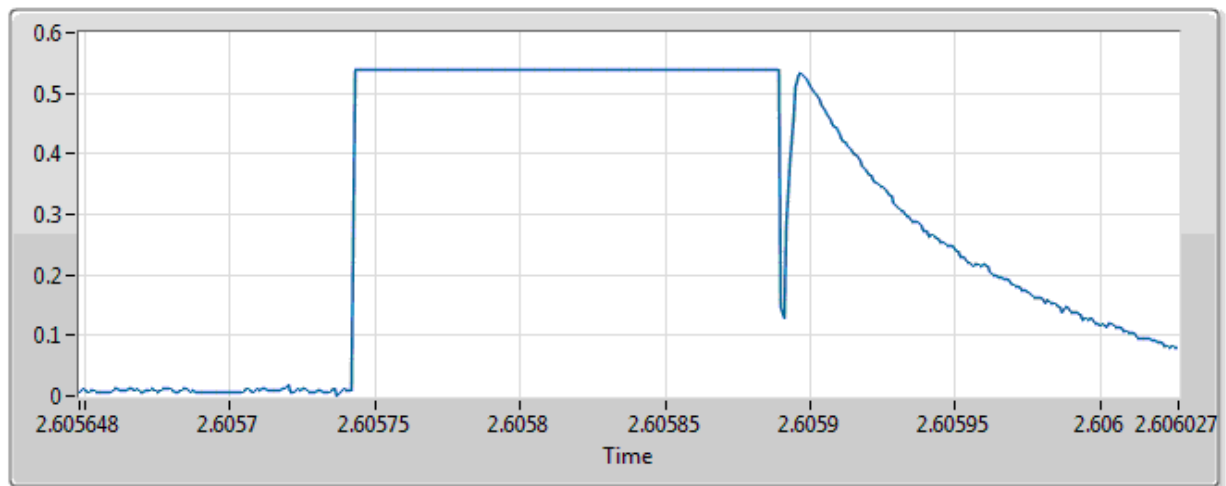
Max On Time



139us

BLE125K - 2480MHz

Max On Time

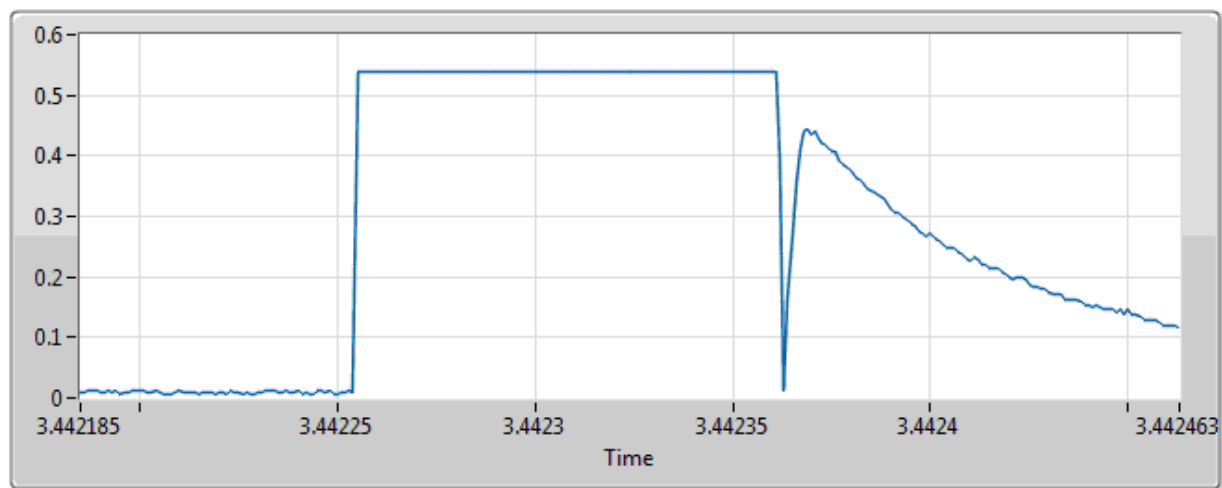


190us

Channel Occupancy Time

BLE1M - 2402MHz

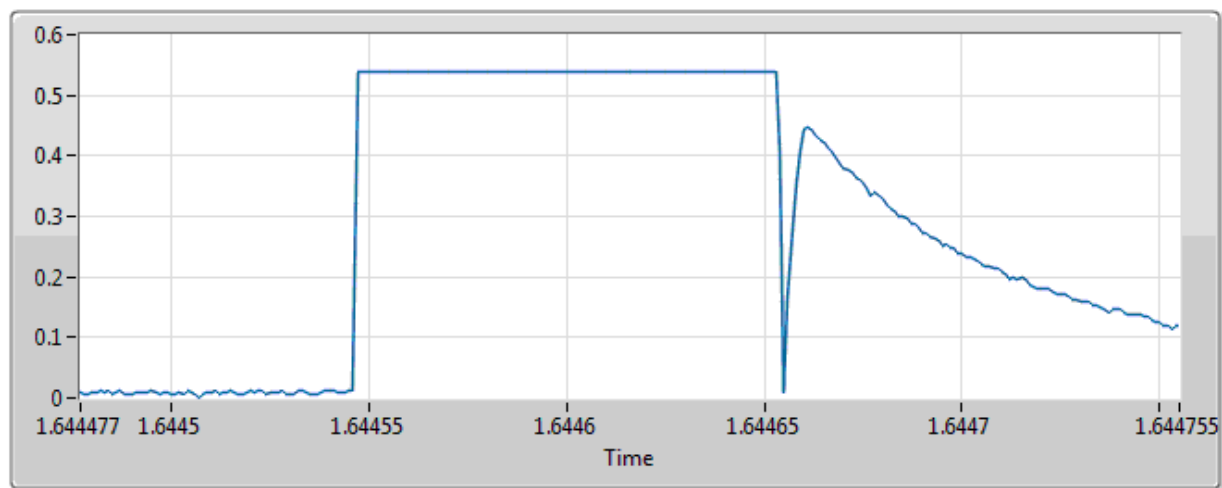
Max On Time



139us

BLE1M - 2480MHz

Max On Time

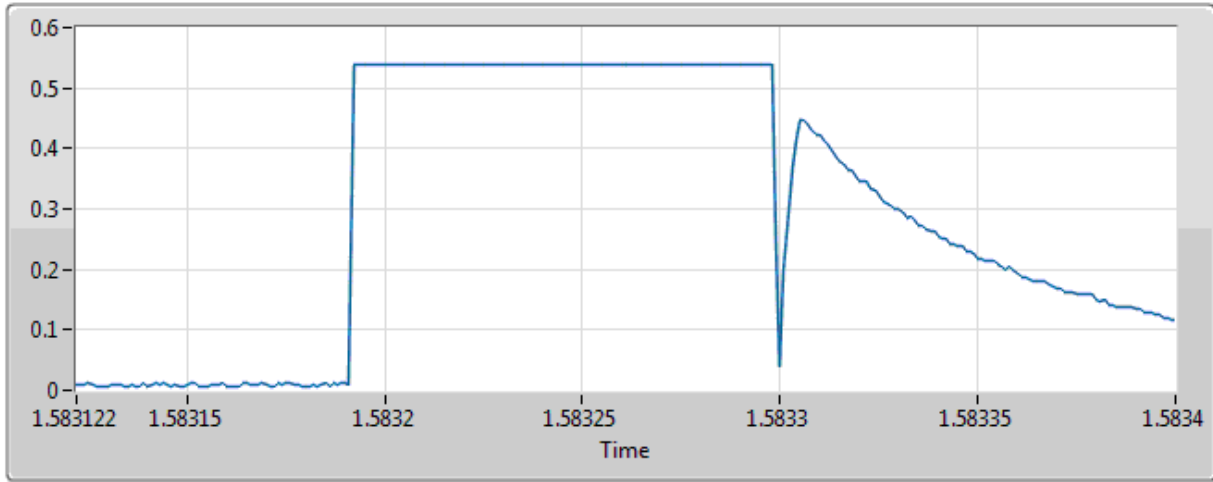


139us

Channel Occupancy Time

BLE2M - 2404MHz

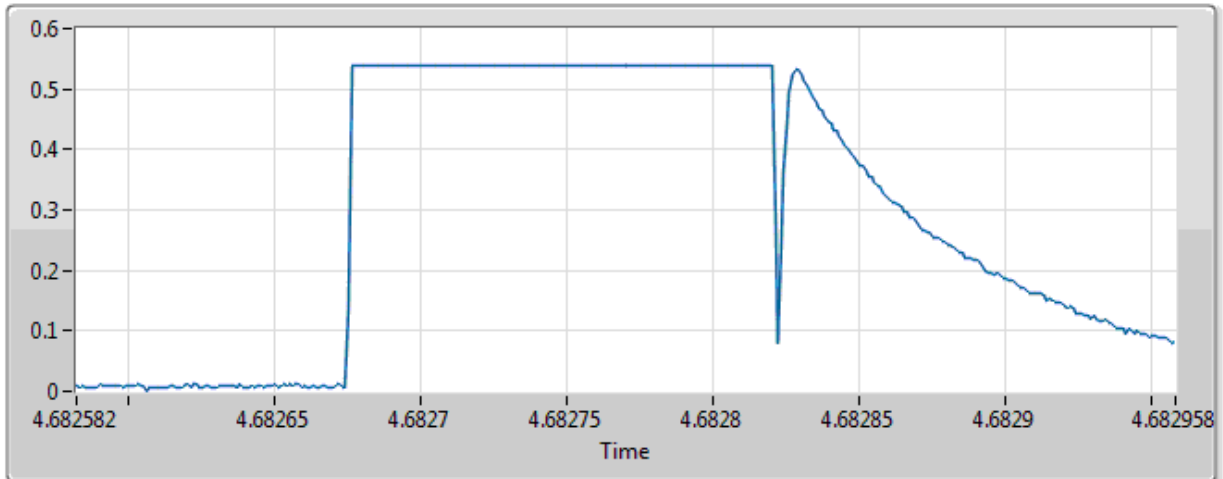
Max On Time



139us

BLE2M - 2478MHz

Max On Time

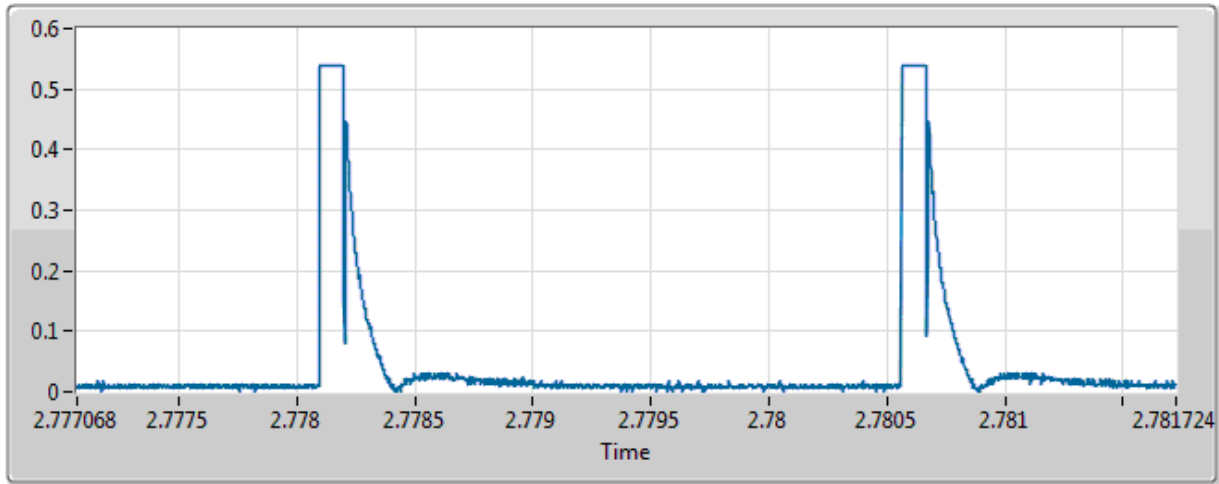


189us

Idle Period Time

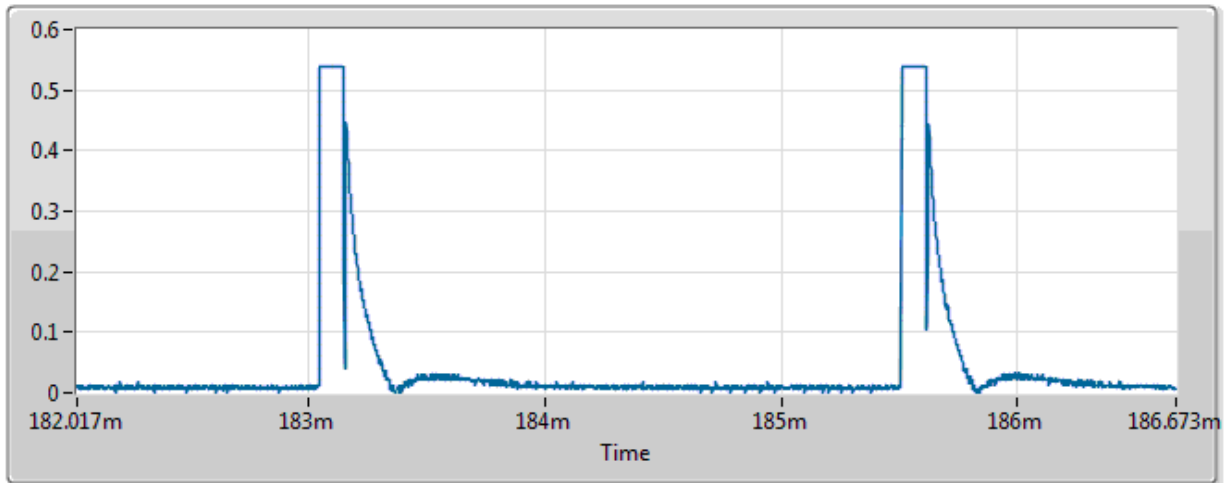
BLE125K - 2402MHz

Min Off Time



BLE125K - 2480MHz

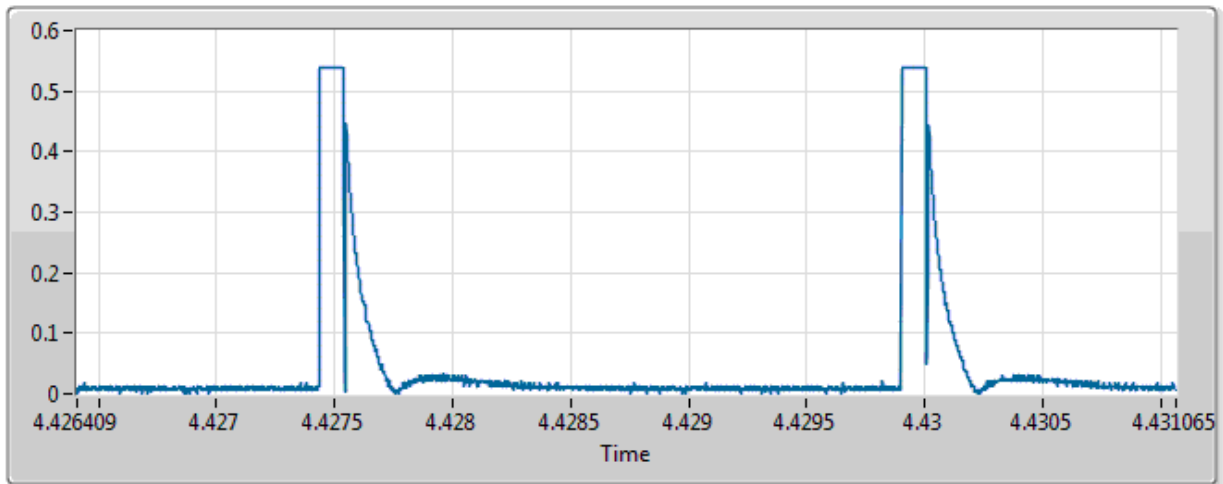
Min Off Time



Idle Period Time

BLE 1M - 2402MHz

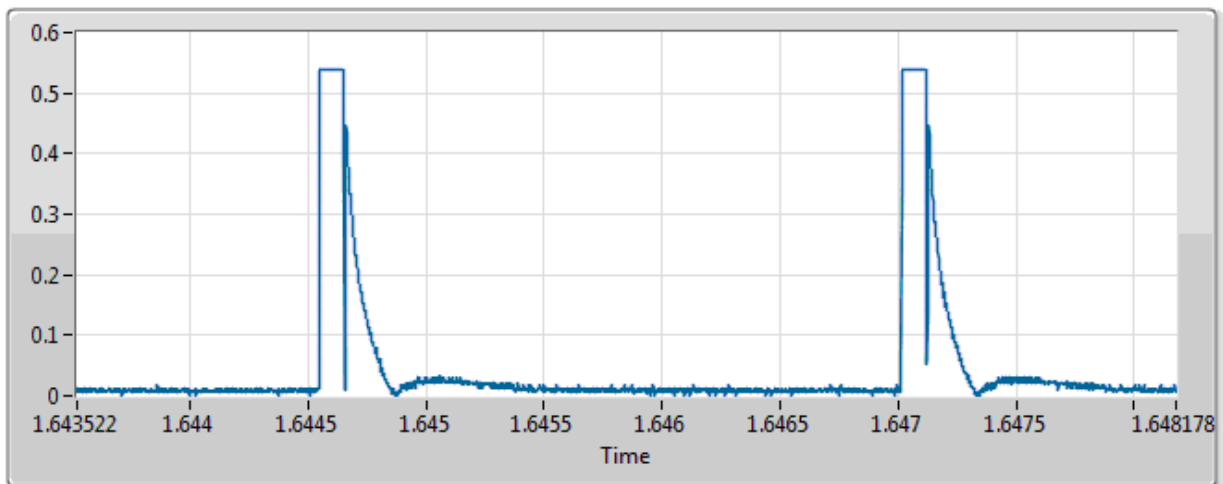
Min Off Time



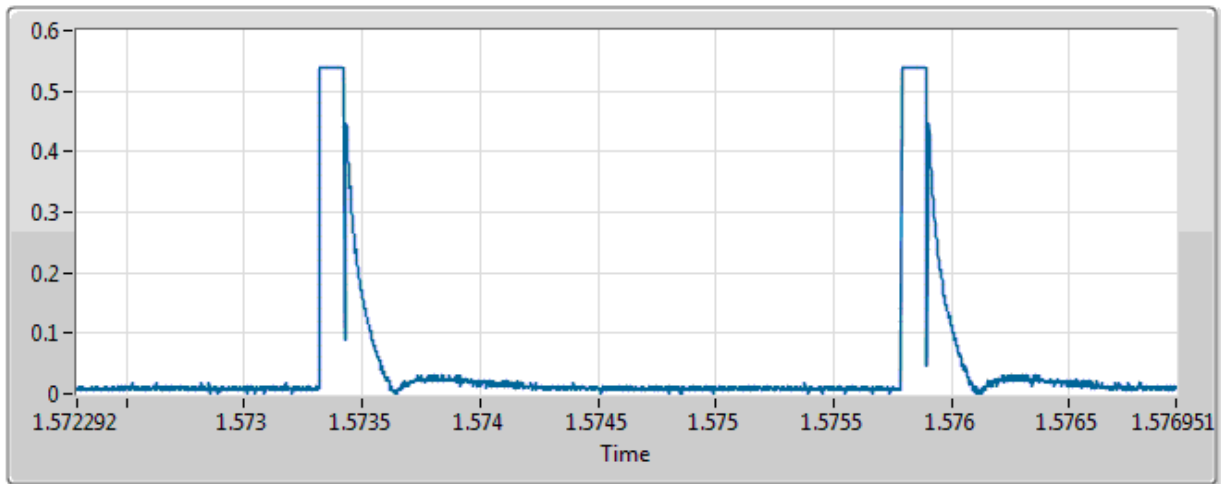
2.329ms

BLE 1M - 2480MHz

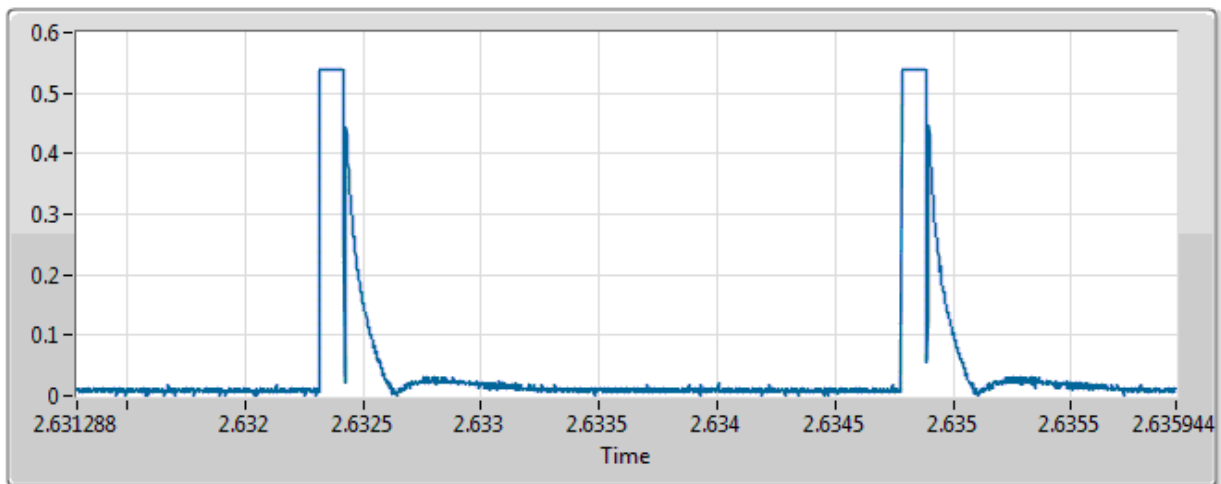
Min Off Time



2.329ms

Idle Period Time**BLE 2M - 2404MHz****Min Off Time**

2.33ms

BLE 2M - 2478MHz**Min Off Time**

2.329ms