FCC Test Report

Report No.: AGC00174211202FE02

FCC ID	:	XPYANNAB4
APPLICATION PURPOSE	:	Original Equipment
PRODUCT DESIGNATION	:	ANNA-B4
BRAND NAME	:	u-blox
MODEL NAME	:	ANNA-B402, ANNA-B412
APPLICANT	:	u-blox AG
DATE OF ISSUE	:	Mar. 11, 2022
STANDARD(S)	:	FCC Part 15.247
REPORT VERSION	:	V1.0

*A*ttestation of *G*lobal *C*ompliance (Shenzhen) Co., Ltd

REPORT REVISE RECORD

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Mar. 11, 2022	Valid	Initial Release

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1. VERIFICATION OF COMPLIANCE

Applicant	u-blox AG
Address	Zuercherstrasse 68, Thalwil 8800, Switzerland
Manufacturer	u-blox AG
Address	Zuercherstrasse 68, Thalwil 8800, Switzerland
Product Designation	ANNA-B4
Brand Name	u-blox
Test Model	ANNA-B402
Series Model	ANNA-B412
Difference description	All the same except for the model names and use. (Compared to ANNA-B402, there is an additional SWD protection circuit on ANNA-B412. This SWD protection circuit will NOT affect radio characteristics.)
Date of test	Jan. 05, 2022 to Mar. 11, 2022
Deviation	No any deviation from the test method
Condition of Test Sample	Normal
Test Result	Pass
Report Template	AGCRT-US-BLE/RF

We hereby certify that:

The above equipment was tested by Attestation of Global Compliance (Shenzhen) Co., Ltd. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 (2013) and the energy emitted by the sample EUT tested as described in this report is in compliance with radiated emission limits of FCC part 15.247.

Prepared By	Cool Cheng (Project Engineer)	Mar. 11, 2022
Reviewed By	Calvin Liu (Reviewer)	Mar. 11, 2022
Approved By	Max Zhang (Authorized Officer)	Mar. 11, 2022

2. GENERAL INFORMATION

2.1. PRODUCT DESCRIPTION

The EUT is designed as a “ANNA-B4”. It is designed by way of utilizing the GFSK technology to achieve the system operation.
A major technical description of EUT is described as following

Operation Frequency	2.402GHz to 2.480GHz
RF Output Power	BLE 1M: 6.844dBm (Max) BLE 2M: 6.829dBm (Max)
Bluetooth Version	V5.1
Modulation	BR☐GFSK, EDR☐π /4-DQPSK, ☐8DPSK BLE☒GFSK 1Mbps ☒GFSK 2Mbps
Number of channels	40 Channels
Antenna Designation	See section 2.8 and 2.9 of the report (Comply with requirements of the FCC part 15.203)
Antenna Gain	Antenna 1: 5dBi(FXP72.07.0053A) Antenna 2: 4dBi(FXP74.07.0100A) Antenna 3: 2.5dBi(FXP75.07.0045B) Antenna 4: 0.9dBi(PC17.07.0070A) Antenna 5: 0.5dBi(AT1608-A2R4NAA)
Hardware Version	A
Software Version	V1.0
Power Supply	DC 3.3V by control board
Note: 1. All antennas have been tested, and antenna 1 has the worst test data so it is recorded in this report. 2. All the models would be marketed with the CRYSTAL A(EPSON FA-118T) or the CRYSTAL B(Taisaw TZ 3124CIW-B4017). Both of them have the same size and radio parameters. The version of the CRYSTAL A had been tested with all the items and the version of the CRYSTAL B only had been tested with bandwidth test and RF output power test for the difference.	

2.2. TABLE OF CARRIER FREQUENCYS

Frequency Band	Channel Number	Frequency
2400~2483.5MHz	0	2402 MHz
	1	2404 MHz
	:	:
	38	2478 MHz
	39	2480 MHz

2.3. RELATED SUBMITTAL(S)/GRANT(S)

This submittal(s) (test report) is intended for **FCC ID: XPYANNAB4** filing to comply with the FCC Part 15.247 requirements.

2.4. TEST METHODOLOGY

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10 (2013).

Radiated testing was performed at an antenna to EUT distance 3 meters.

2.5. SPECIAL ACCESSORIES

Refer to section 5.2.

2.6. EQUIPMENT MODIFICATIONS

Not available for this EUT intended for grant.

2.7. ANTENNA REQUIREMENT

This intentional radiator is designed with a permanently attached antenna of an antenna to ensure that no antenna other than that furnished by the responsible party shall be used with the device.
For more information of the antenna, please refer to the APPENDIX B: PHOTOGRAPHS OF EUT.

2.8. DESCRIPTION OF AVAILABLE ANTENNAS

Dedicated Antenna				
Model No	ANNA-B402		ANNA-B412	
Antenna Type	Frequency Band (GHz)	Max Peak Gain (dBi)	Frequency Band (GHz)	Max Peak Gain (dBi)
FPC antenna	2400~2483.5	5	2400~2483.5	5
FPC antenna	2400~2483.5	4	2400~2483.5	4
FPC antenna	2400~2483.5	2.5	2400~2483.5	2.5
FPC antenna	2400~2483.5	0.9	2400~2483.5	0.9
Multilayer Chip antenna	2400~2483.5	0.5	2400~2483.5	0.5

2.9. DESCRIPTION OF ANTENNA RF PORT

Antenna RF Port		
Model No	ANNA-B402	ANNA-B412
ANNA-B4 two model versions series use	Version tailored for OEMs	Pre-flashed u-blox Connectivity Software version

EVK-ANNA-B402U/B412U
ANNA-B4 module
Reference design for module with U.FL connector

EVK-ANNA-B402C/B412C
ANNA-B4 module
Antenna reference design for module being mounted at the corner of the board

EVK-ANNA-B402E/B412E
ANNA-B4 module
Antenna reference design for module being mounted on edge of the board

3. MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement y ±U, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

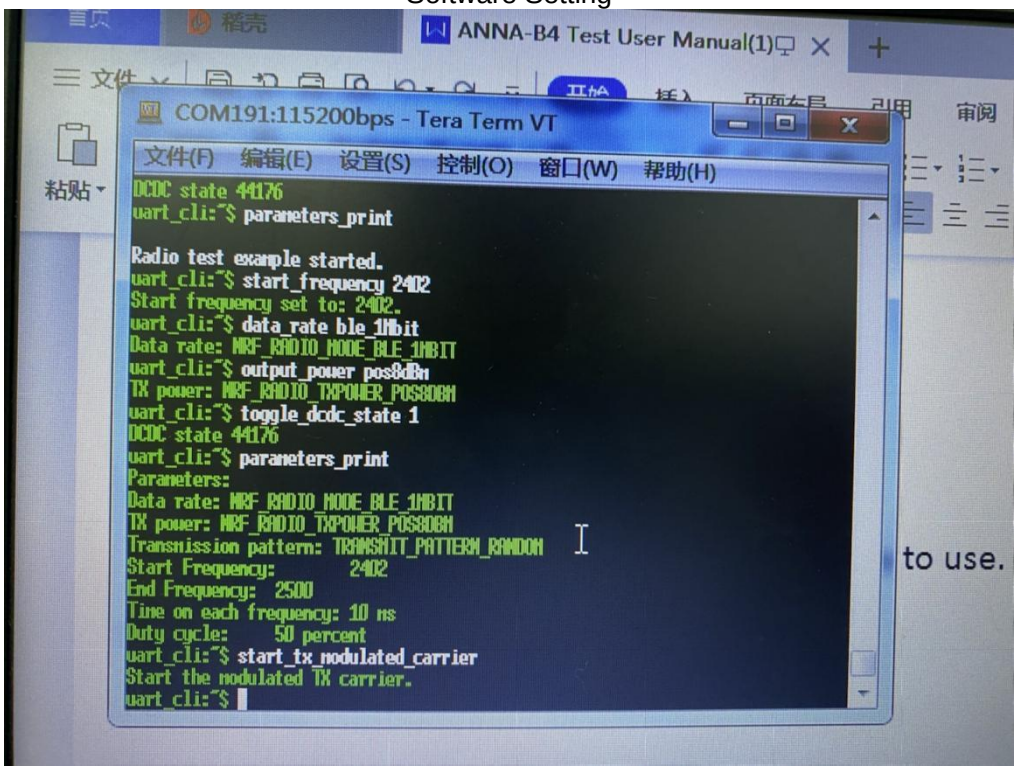
Item	Measurement Uncertainty
Uncertainty of Conducted Emission for AC Port	U_c = ±2.9 dB
Uncertainty of Radiated Emission below 1GHz	U_c = ±3.8 dB
Uncertainty of Radiated Emission above 1GHz	U_c = ±4.4 dB
Uncertainty of total RF power, conducted	U_c = ±0.8 dB
Uncertainty of RF power density, conducted	U_c = ±2.6 dB
Uncertainty of spurious emissions, conducted	U_c = ±2 %
Uncertainty of Occupied Channel Bandwidth	U_c = ±2 %

4. DESCRIPTION OF TEST MODES

NO.	TEST MODE DESCRIPTION
1	Low channel TX (BLE 1M)
2	Middle channel TX (BLE 1M)
3	High channel TX (BLE 1M)
4	Low channel TX (BLE 2M)
5	Middle channel TX (BLE 2M)
6	High channel TX (BLE 2M)

Note: 1. Only the result of the worst case was recorded in the report, if no other cases.
2. For Radiated Emission, 3axis were chosen for testing for each applicable mode.
3. For Conducted Test method, a temporary antenna connector is provided by the manufacture.

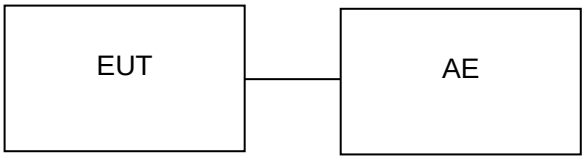
Software Setting



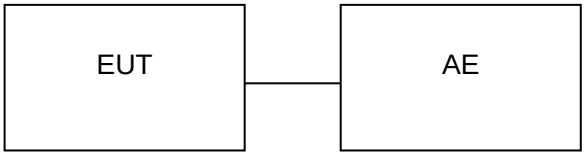
5. SYSTEM TEST CONFIGURATION

5.1. CONFIGURATION OF TESTED SYSTEM

Radiated Emission Configure:



Conducted Emission Configure:



5.2. EQUIPMENT USED IN TESTED SYSTEM

Item	Equipment	Model No.	ID or Specification	Remark
1	ANNA-B4	ANNA-B402	XPYANNAB4	EUT
2	Mobile phone	Mate 30	N/A	AE
3	PC	N/A	N/A	AE
4	PC adapter	HW-059200CHQ	1.5m unshielded	AE

5.3. SUMMARY OF TEST RESULTS

FCC RULES	DESCRIPTION OF TEST	RESULT
15.247 (b)(3)	Peak Output Power	Compliant
15.247 (a)(2)	6 dB Bandwidth	Compliant
15.247 (d)	Conducted Spurious Emission	Compliant
15.247 (e)	Maximum Conducted Output Power Density	Compliant
15.209	Radiated Emission	Compliant
15.207	Conducted Emission	Compliant

6. TEST FACILITY

Test Site	Attestation of Global Compliance (Shenzhen) Co., Ltd
Location	1-2/F, Building 19, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China
Designation Number	CN1259
FCC Test Firm Registration Number	975832
A2LA Cert. No.	5054.02
Description	Attestation of Global Compliance (Shenzhen) Co., Ltd is accredited by A2LA

TEST EQUIPMENT OF CONDUCTED EMISSION TEST

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
Test Receiver	R&S	ESPI	101206	May.11, 2021	May.10, 2022
Artificial power network	R&S	ESH2-Z5	100086	Jun. 09, 2021	Jun. 08, 2022
Test Software	FARA	EZ-EMC(Ver. AGC-CON03A1)	N/A	N/A	N/A

TEST EQUIPMENT OF RADIATED EMISSION TEST

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Due
Test Receiver	R&S	ESCI	100034	Sep. 06, 2021	Sep. 05, 2022
EXA Signal Analyzer	Aglient	N9010A	MY53470504	Nov. 17, 2021	Nov. 16, 2022
2.4GHz Filter	EM Electronics	2400-2500MHz	N/A	Mar. 23, 2020	Mar. 22, 2022
Attenuator	ZHINAN	E-002	N/A	Sep. 03, 2020	Sep. 02, 2022
Horn Antenna	SCHWARZBECK	BBHA9170	768	Oct. 31, 2021	Oct. 30, 2023
Active loop antenna (9K-30MHz)	ZHINAN	ZN30900C	18051	May 22, 2020	May 21, 2022
preamplifier	ChengYi	EMC184045SE	980508	Oct. 29, 2021	Oct. 28, 2023
preamplifier	ChengYi	EMC184045SE	980508	Oct. 29, 2021	Oct. 28, 2023
Double-Ridged Waveguide Horn	ETS LINDGREN	3117	00154520	Sep. 06, 2021	Sep. 05, 2023
Preamplifier Assembly	ETS LINDGREN	3117PA	00225134	Sep. 03, 2020	Sep. 02, 2022
Wideband Antenna	SCHWARZBECK	VULB9168	494	Jan. 08, 2021	Jan. 07, 2023
Test Software	FARA	EZ-EMC(Ver.RA-03A)	N/A	N/A	N/A

7. PEAK OUTPUT POWER

7.1. MEASUREMENT PROCEDURE

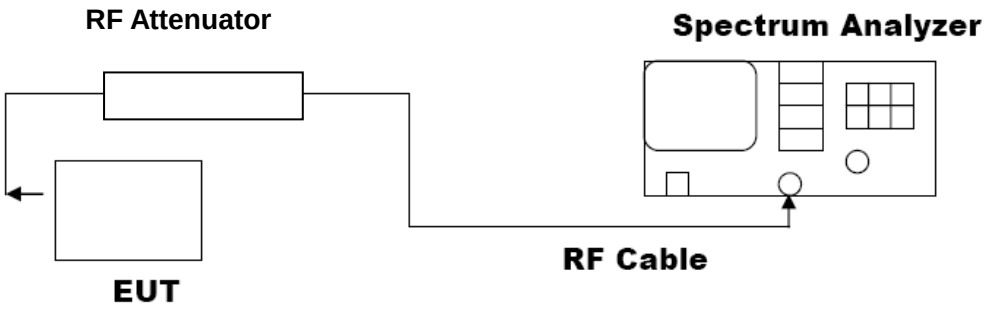
For peak power test:

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
2. RBW≥DTS bandwidth.
3. VBW≥3*RBW.
4. SPAN≥VBW.
5. Sweep: Auto.
6. Detector function: Peak.
7. Trace: Max hold.

Allow trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power, after any corrections for external attenuators and cables.

7.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

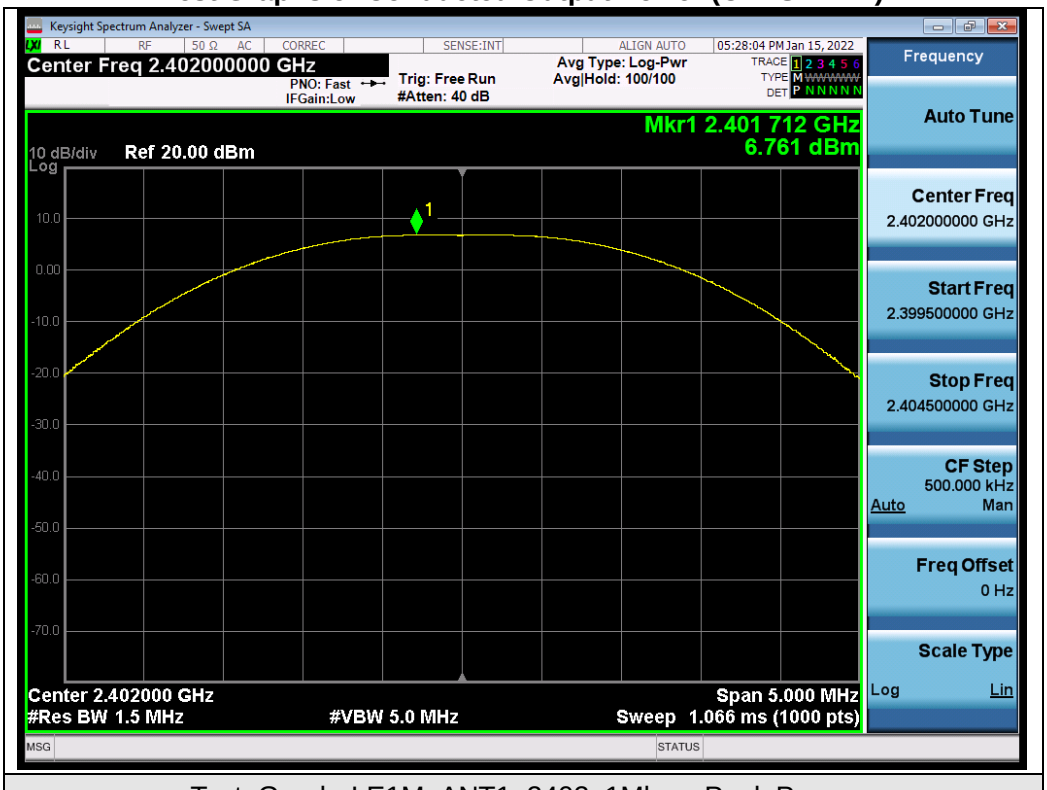
PEAK POWER TEST SETUP



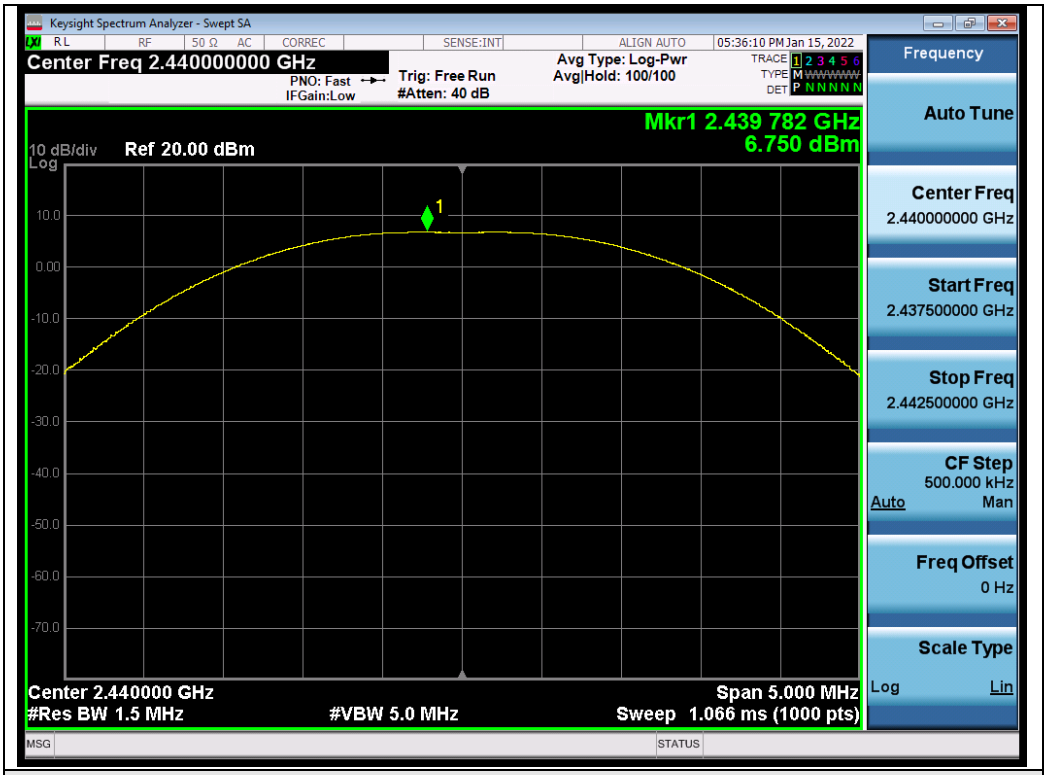
7.3. LIMITS AND MEASUREMENT RESULT

Test Data of Conducted Output Power (CRYSTAL A)				
Test Mode	Test Channel (MHz)	Peak Power (dBm)	Limits (dBm)	Pass or Fail
GFSK 1M	2402	6.761	⩽30	Pass
	2440	6.750	⩽30	Pass
	2480	6.844	⩽30	Pass
GFSK 2M	2402	6.747	⩽30	Pass
	2440	6.732	⩽30	Pass
	2480	6.829	⩽30	Pass
Test Data of Conducted Output Power (CRYSTAL B)				
Test Mode	Test Channel (MHz)	Peak Power (dBm)	Limits (dBm)	Pass or Fail
GFSK 1M	2402	6.658	⩽30	Pass
	2440	6.772	⩽30	Pass
	2480	6.844	⩽30	Pass
GFSK 2M	2402	6.658	⩽30	Pass
	2440	6.779	⩽30	Pass
	2480	6.864	⩽30	Pass

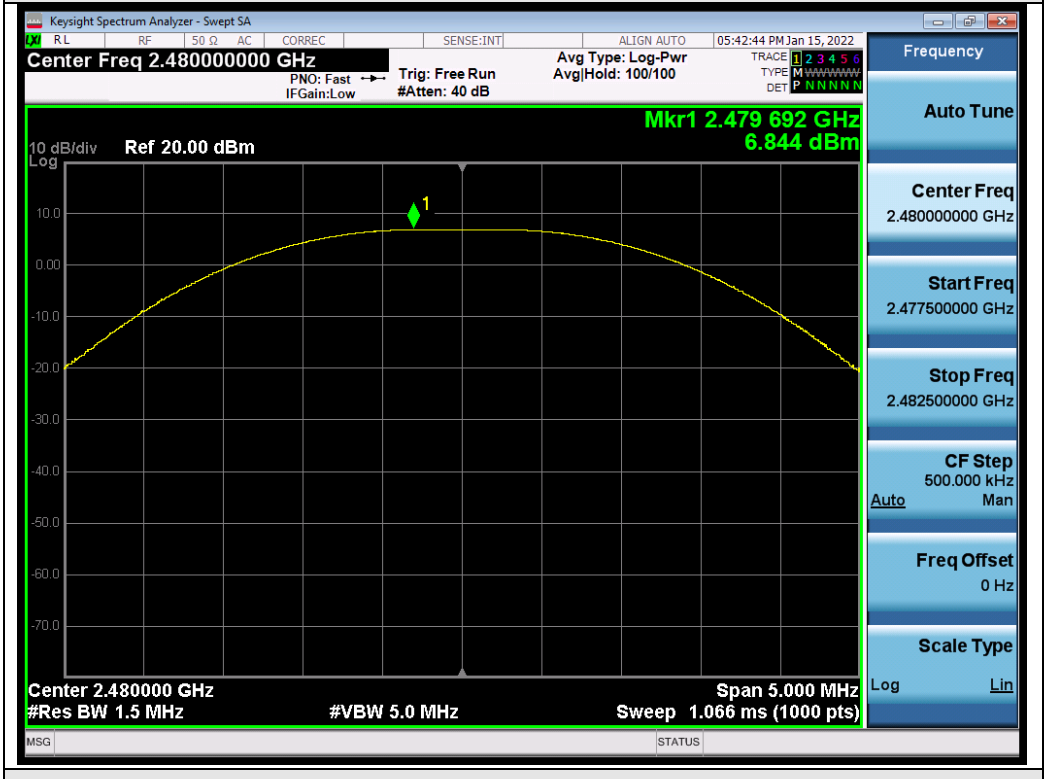
Test Graphs of Conducted Output Power (CRYSTAL A)



Test_Graph_LE1M_ANT1_2402_1Mbps_Peak Power

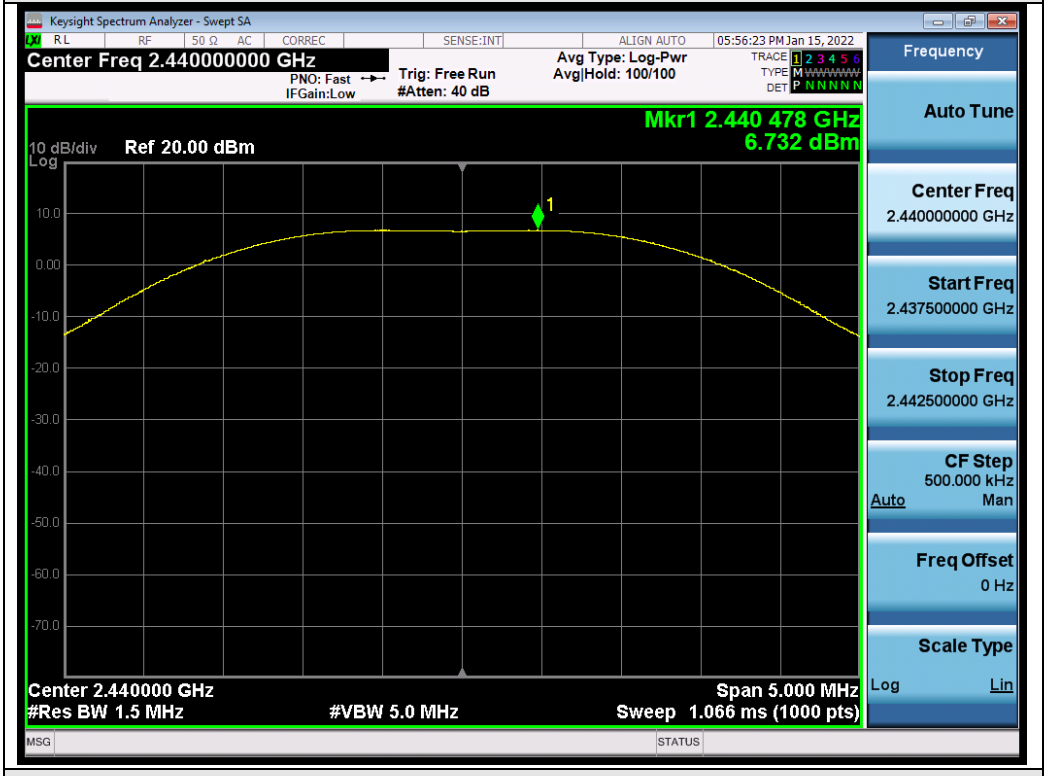


Test_Graph_LE1M_ANT1_2440_1Mbps_Peak Power

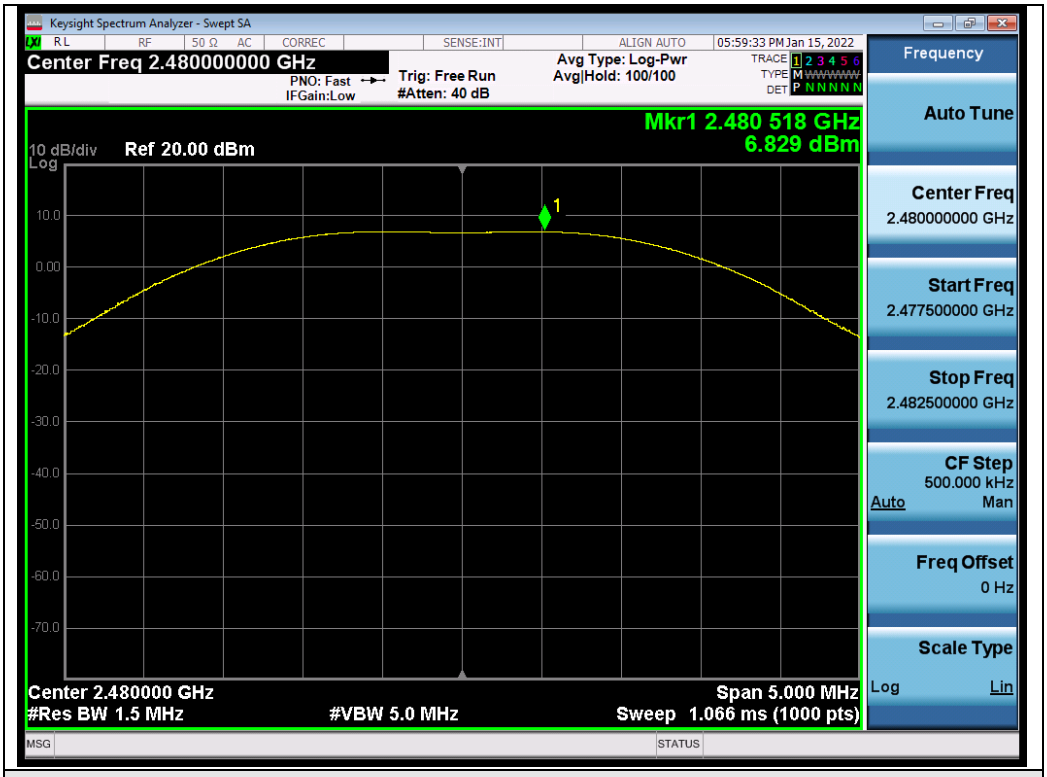


Test_Graph_LE1M_ANT1_2480_1Mbps_Peak Power

Test_Graph_LE2M_ANT1_2402_2Mbps_Peak Power

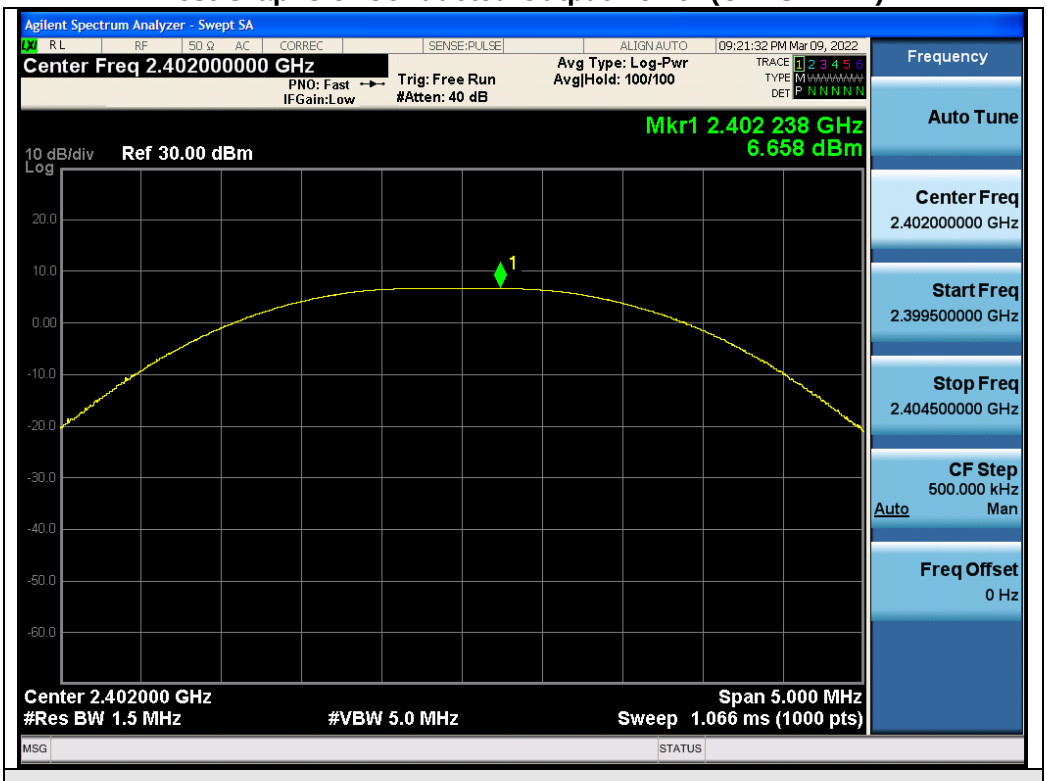


Test_Graph_LE2M_ANT1_2440_2Mbps_Peak Power

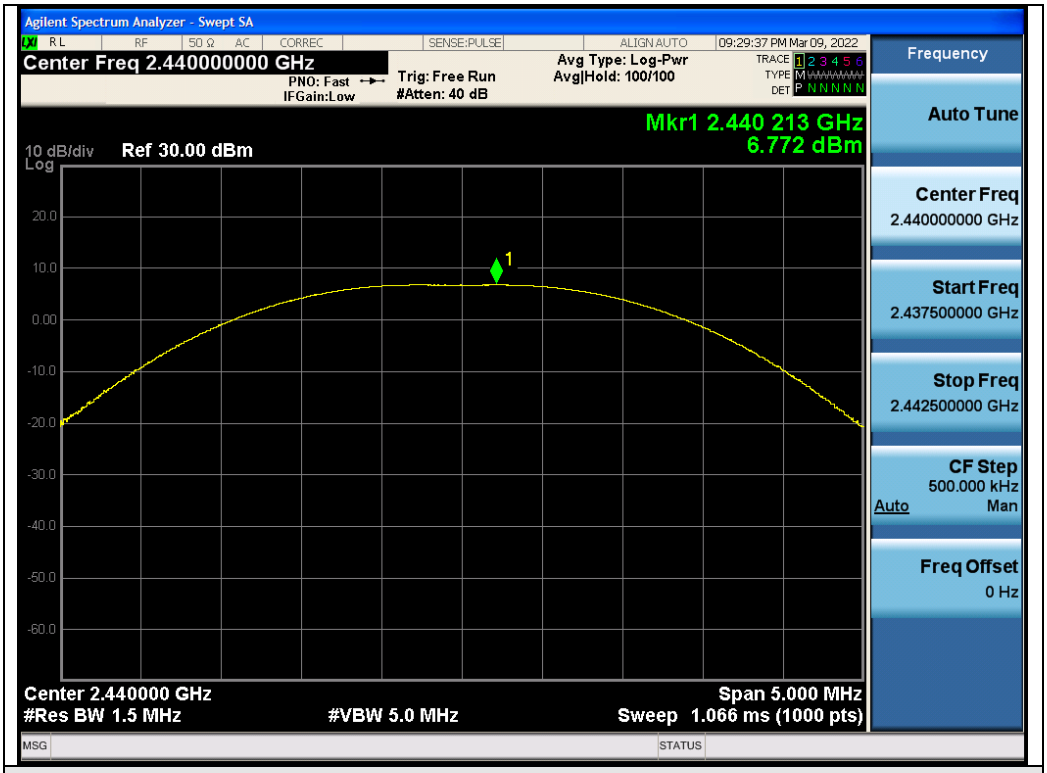


Test_Graph_LE2M_ANT1_2480_2Mbps_Peak Power

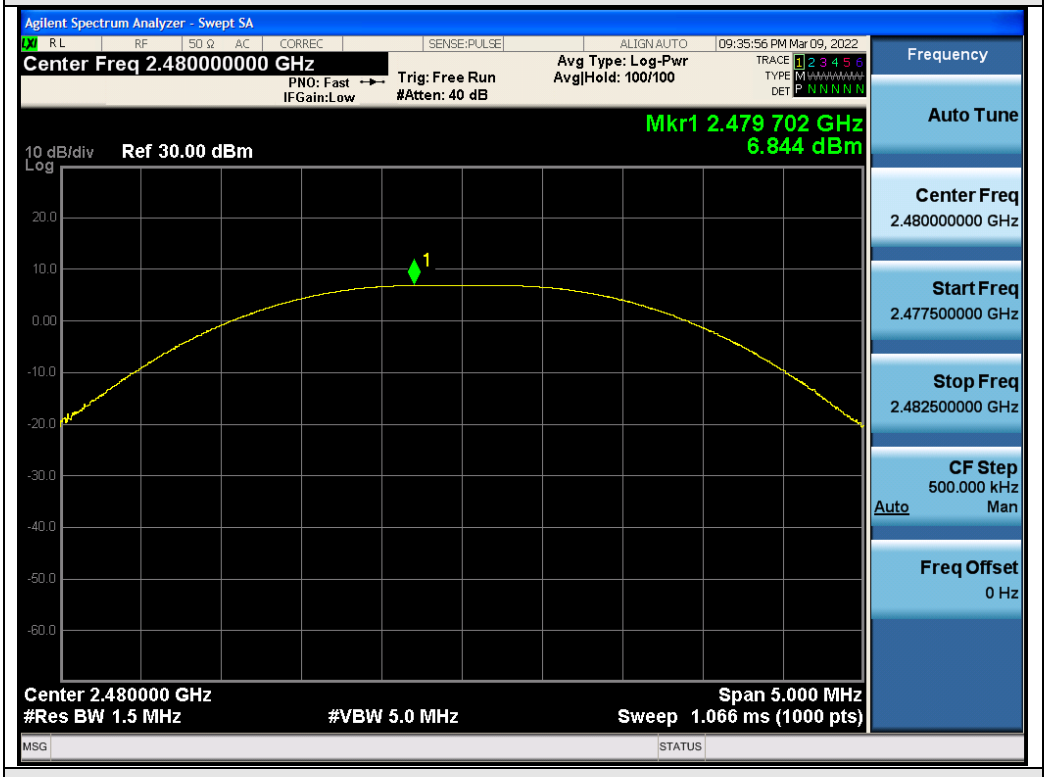
Test Graphs of Conducted Output Power (CRYSTAL B)



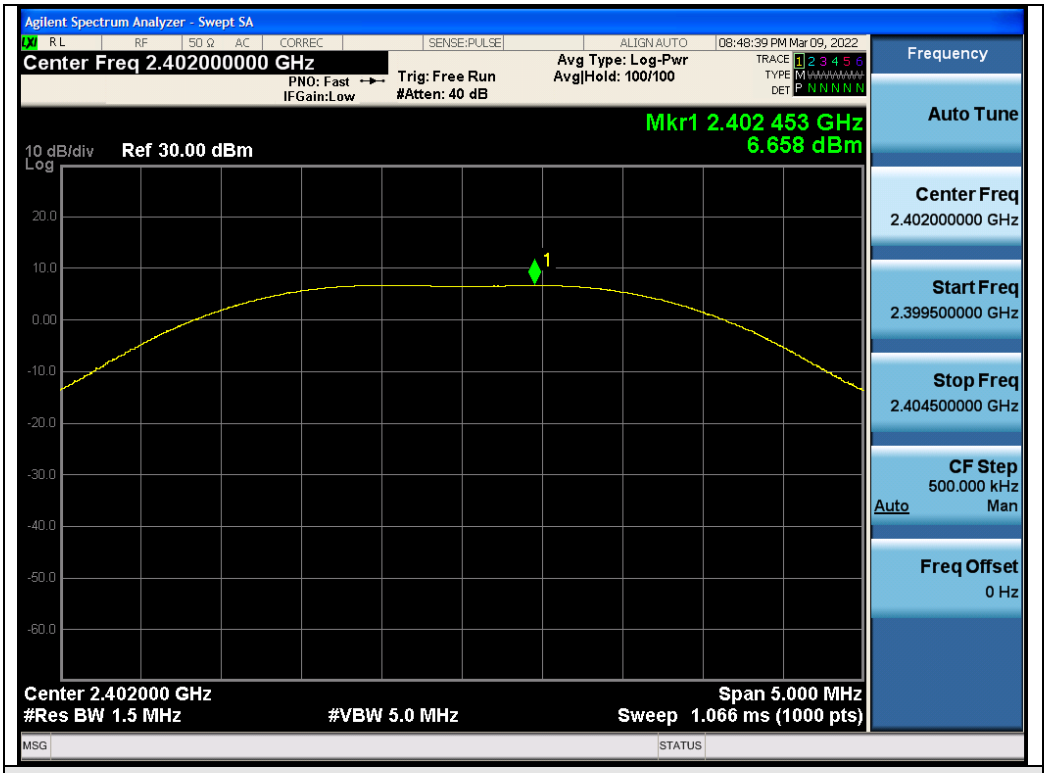
Test_Graph_LE1M_ANT1_2402_1Mbps_Peak Power



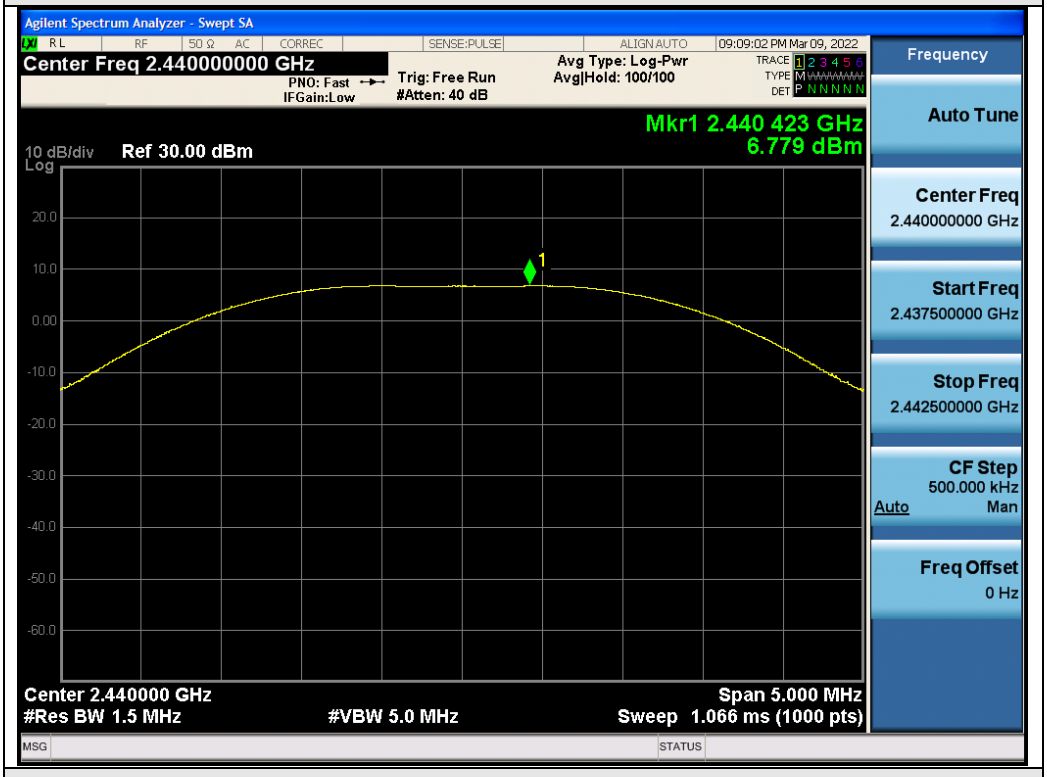
Test_Graph_LE1M_ANT1_2440_1Mbps_Peak Power



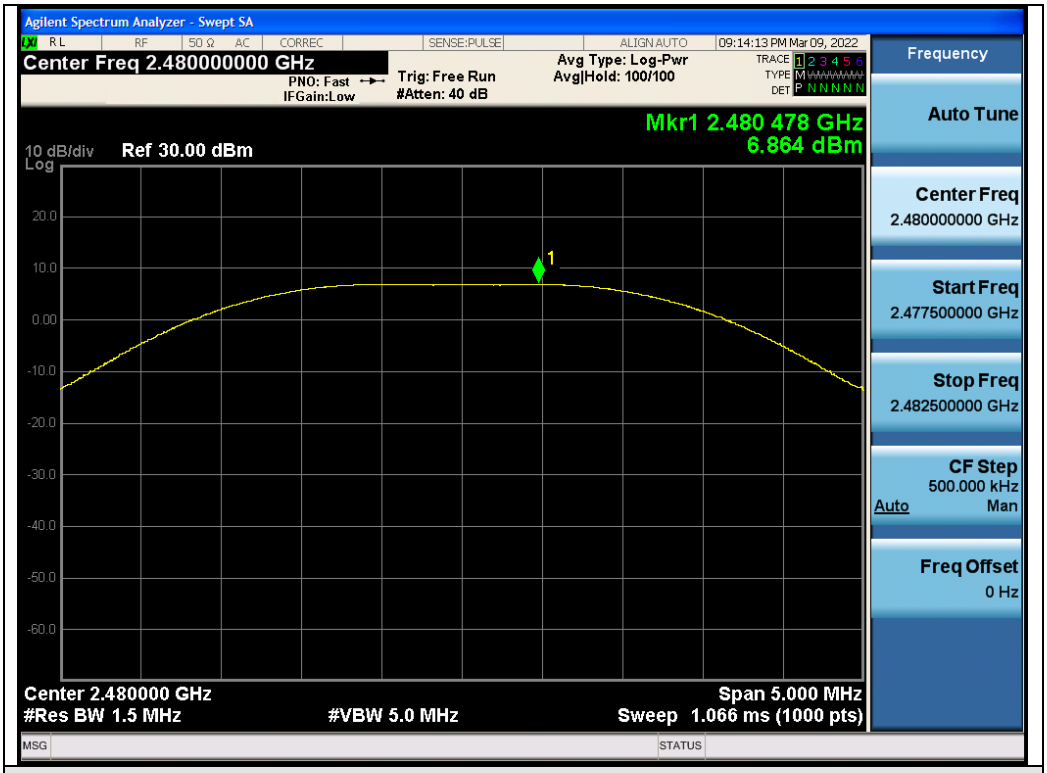
Test_Graph_LE1M_ANT1_2480_1Mbps_Peak Power



Test_Graph_LE2M_ANT1_2402_2Mbps_Peak Power



Test_Graph_LE2M_ANT1_2440_2Mbps_Peak Power



Test_Graph_LE2M_ANT1_2480_2Mbps_Peak Power

8. BANDWIDTH

8.1. MEASUREMENT PROCEDURE

6dB bandwidth:

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
2. Set the EUT Work on the top, the middle and the bottom operation frequency individually.
3. Set SPA Centre Frequency = Operation Frequency, RBW= 100 kHz, VBW≥3×RBW.
4. Set SPA Trace 1 Max hold, then View.

Occupied bandwidth:

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
2, Set the EUT Work on the top, the middle and the bottom operation frequency individually.
3. Set Span = approximately 2 to 5 times the 20 dB bandwidth, centered on a hoping channel
   The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW and video bandwidth (VBW) shall be approximately three times RBW; Sweep = auto; Detector function = peak
4. Set SPA Trace 1 Max hold, then View.

Note: The EUT was tested according to ANSI C63.10 for compliance to FCC PART 15.247 requirements.

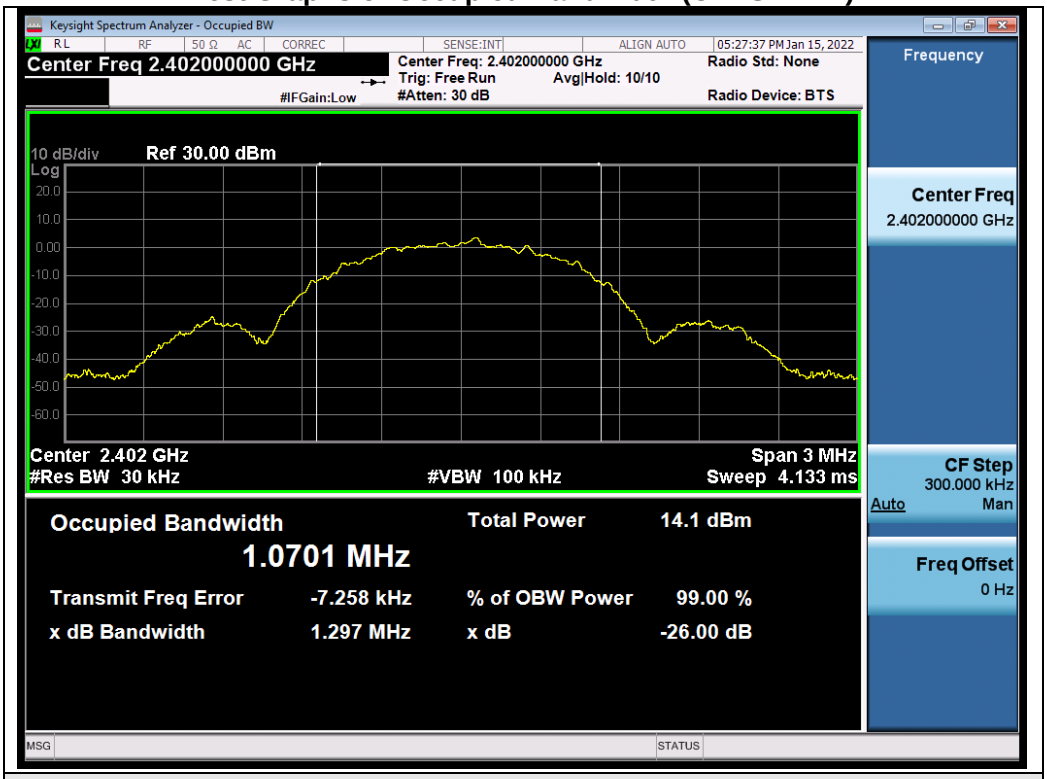
8.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

The same as described in section 7.2.

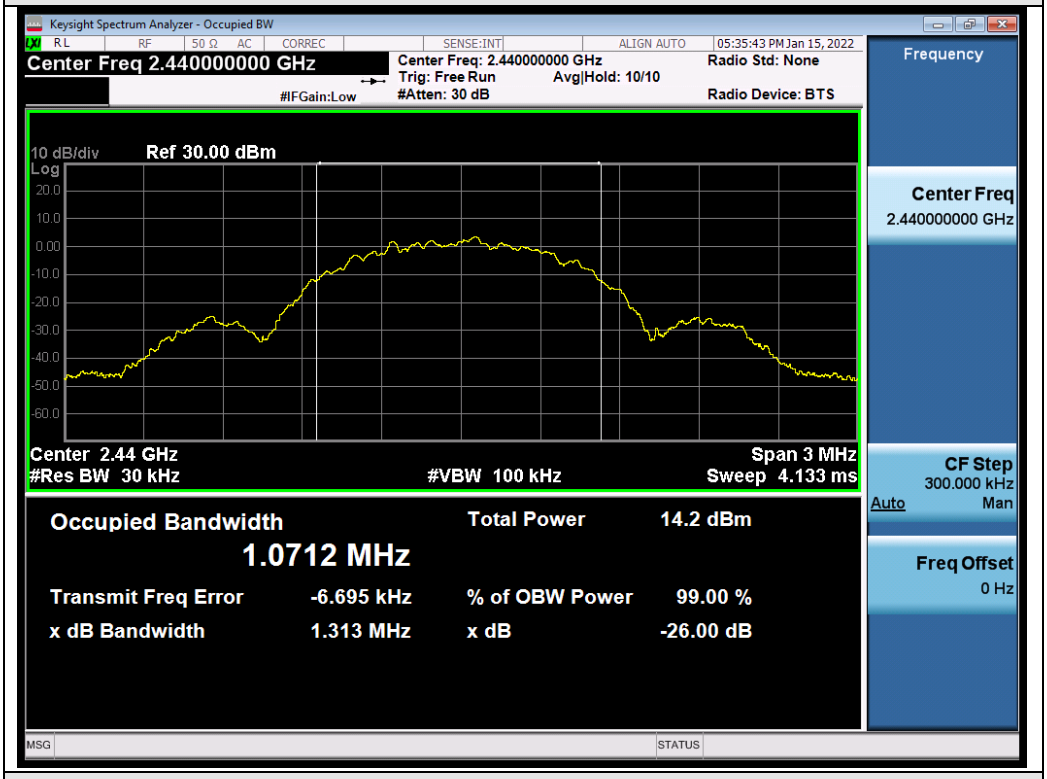
8.3. LIMITS AND MEASUREMENT RESULTS

Test Data of Occupied Bandwidth and DTS Bandwidth (CRYSTAL A)					
Test Mode	Test Channel (MHz)	99% Occupied Bandwidth (MHz)	-6dB Bandwidth (MHz)	Limits (MHz)	Pass or Fail
GFSK 1M	2402	1.070	0.717	≥0.5	Pass
	2440	1.071	0.754	≥0.5	Pass
	2480	1.067	0.724	≥0.5	Pass
GFSK 2M	2402	2.060	1.285	≥0.5	Pass
	2440	2.090	1.237	≥0.5	Pass
	2480	2.086	1.315	≥0.5	Pass
Test Data of Occupied Bandwidth and DTS Bandwidth (CRYSTAL B)					
Test Mode	Test Channel (MHz)	99% Occupied Bandwidth (MHz)	-6dB Bandwidth (MHz)	Limits (MHz)	Pass or Fail
GFSK 1M	2402	1.062	0.729	≥0.5	Pass
	2440	1.067	0.715	≥0.5	Pass
	2480	1.066	0.717	≥0.5	Pass
GFSK 2M	2402	2.068	1.276	≥0.5	Pass
	2440	2.057	1.176	≥0.5	Pass
	2480	2.057	1.211	≥0.5	Pass

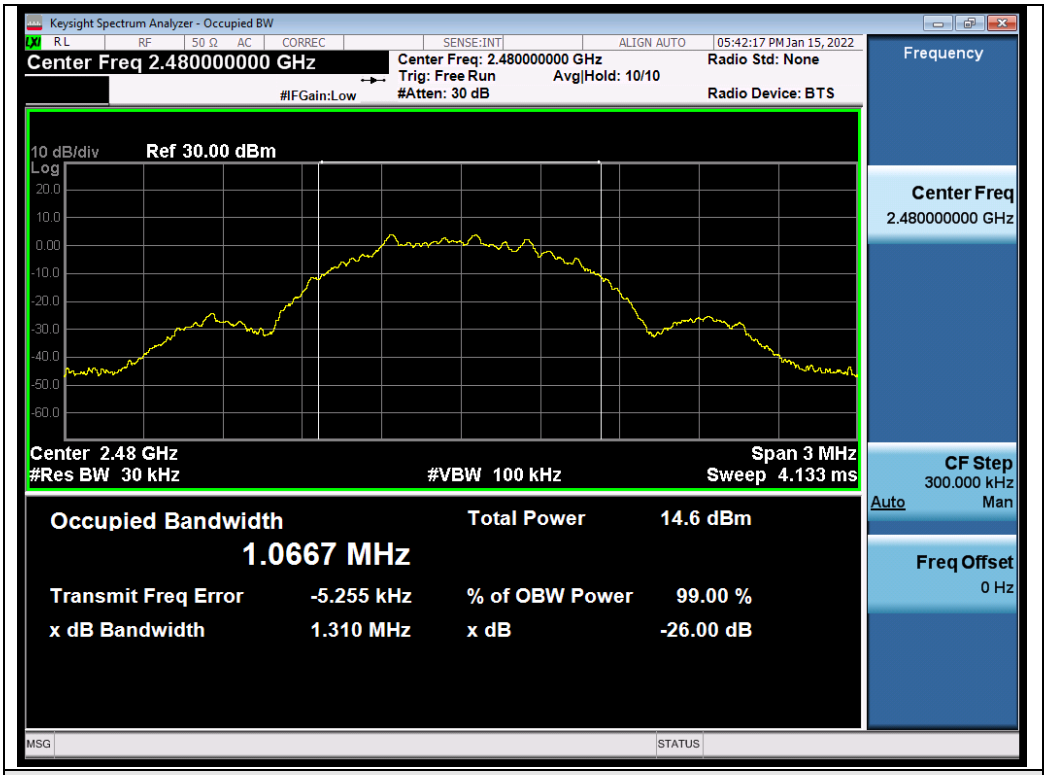
Test Graphs of Occupied Bandwidth (CRYSTAL A)



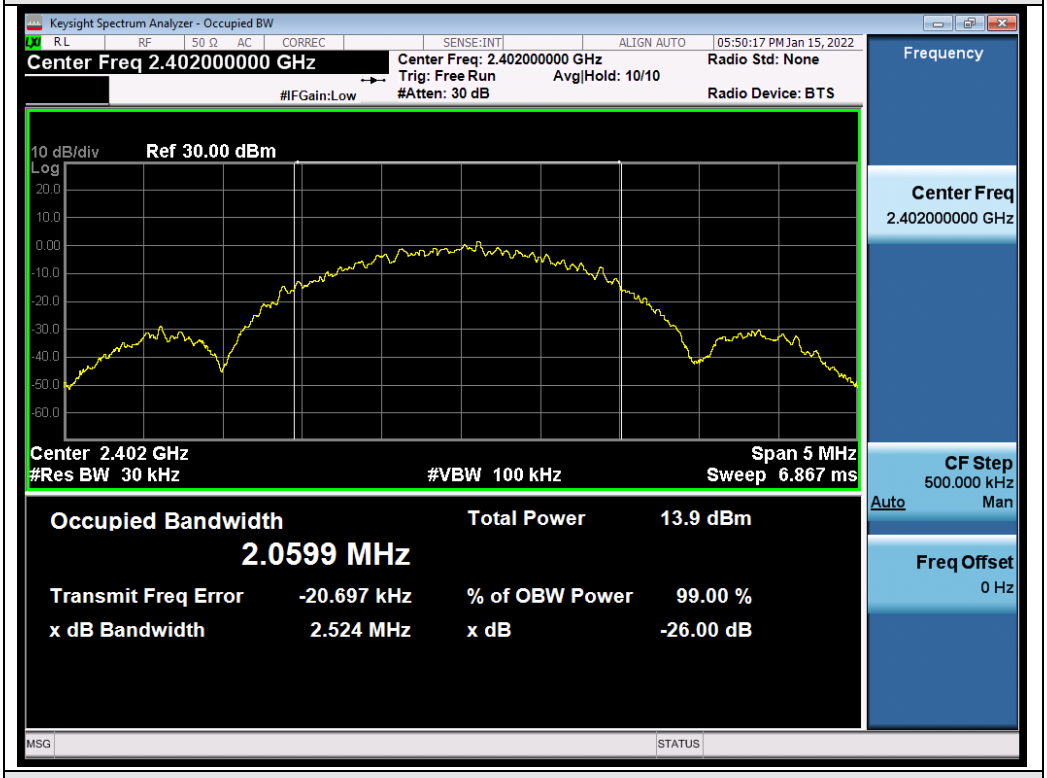
Test_Graph_LE1M_ANT1_2402_1Mbps_OBW



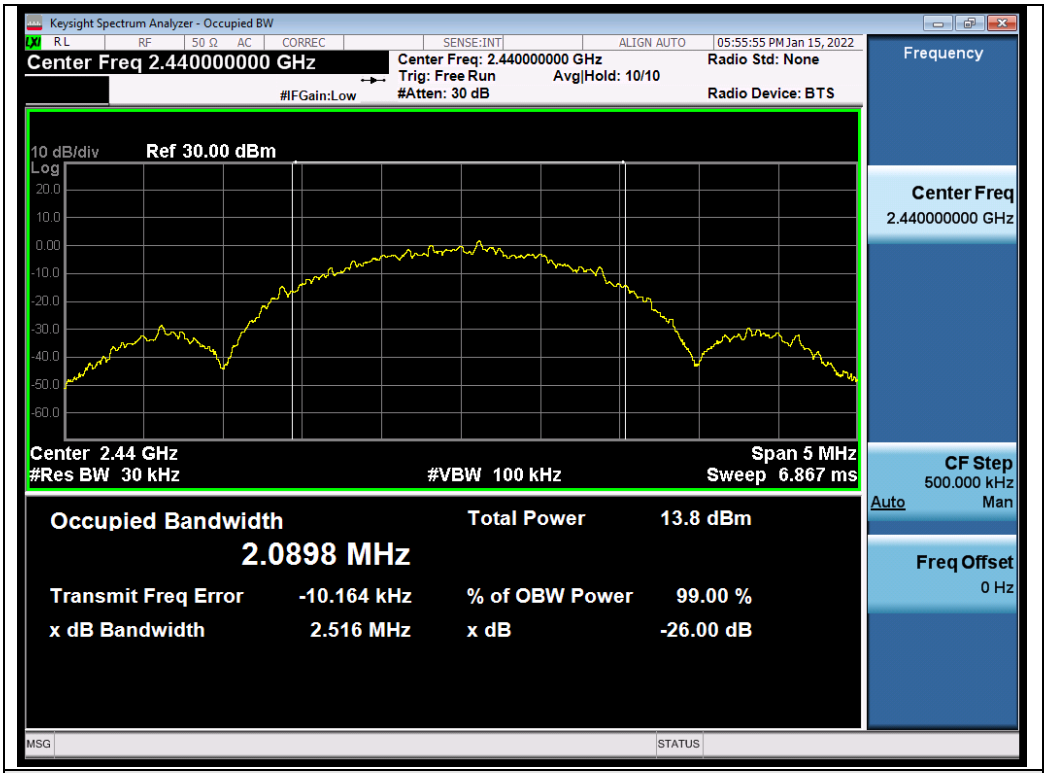
Test_Graph_LE1M_ANT1_2440_1Mbps_OBW



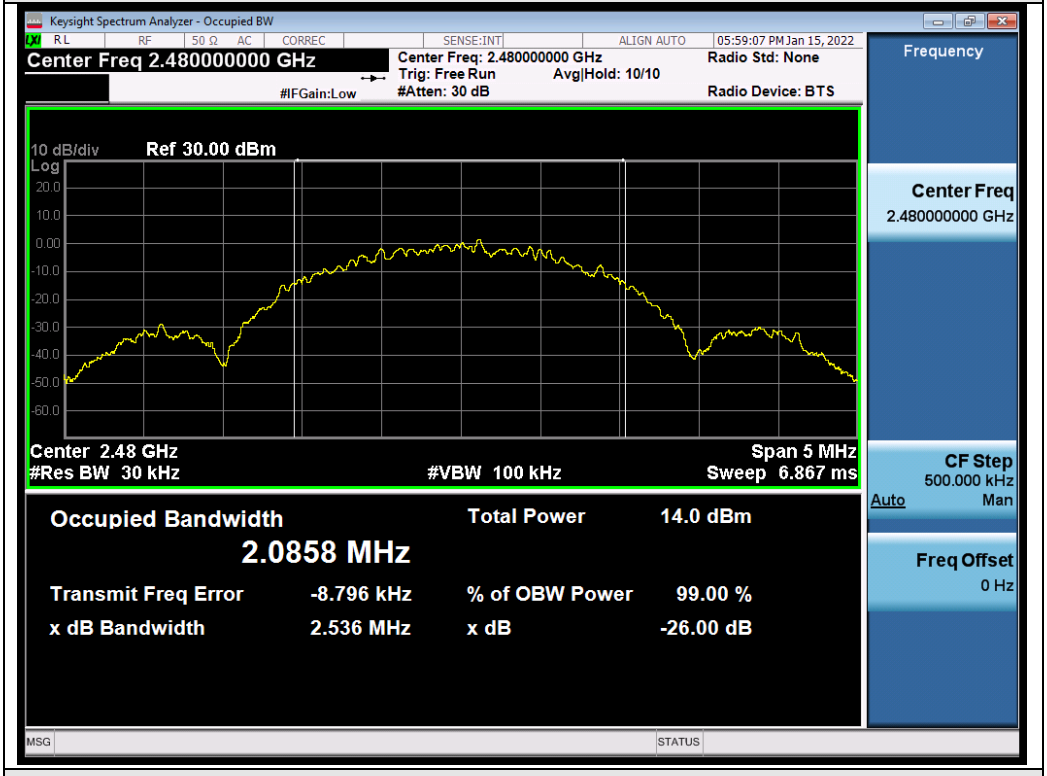
Test_Graph_LE1M_ANT1_2480_1Mbps_OBW



Test_Graph_LE2M_ANT1_2402_2Mbps_OBW

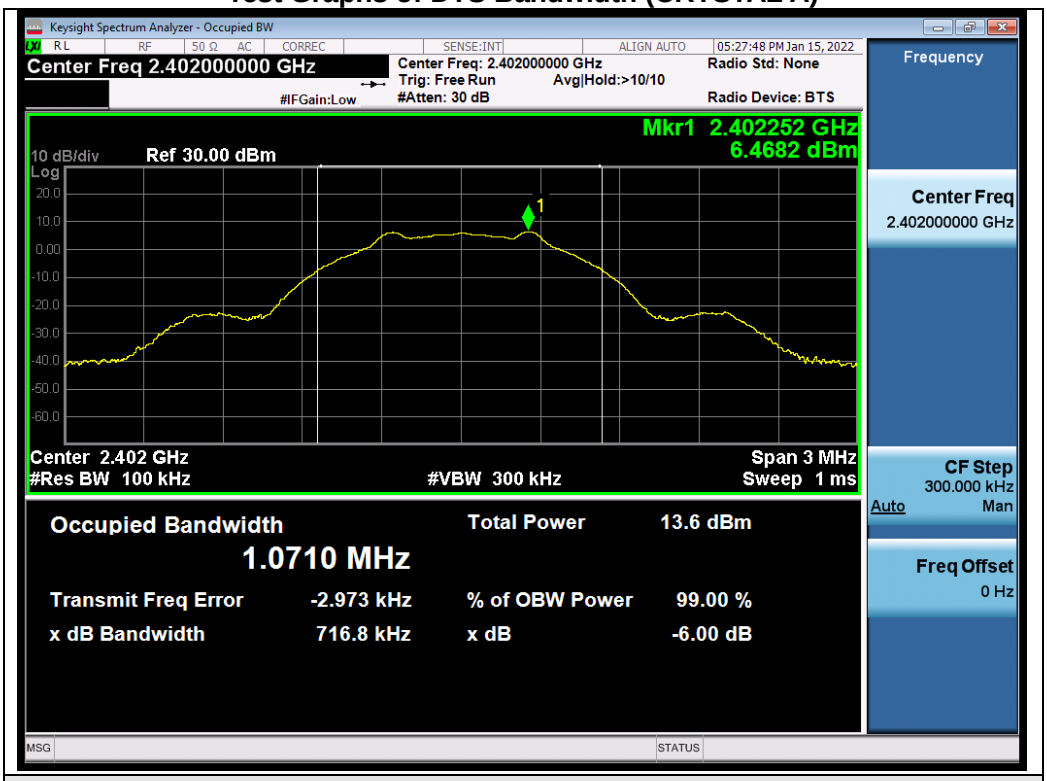


Test_Graph_LE2M_ANT1_2440_2Mbps_OBW

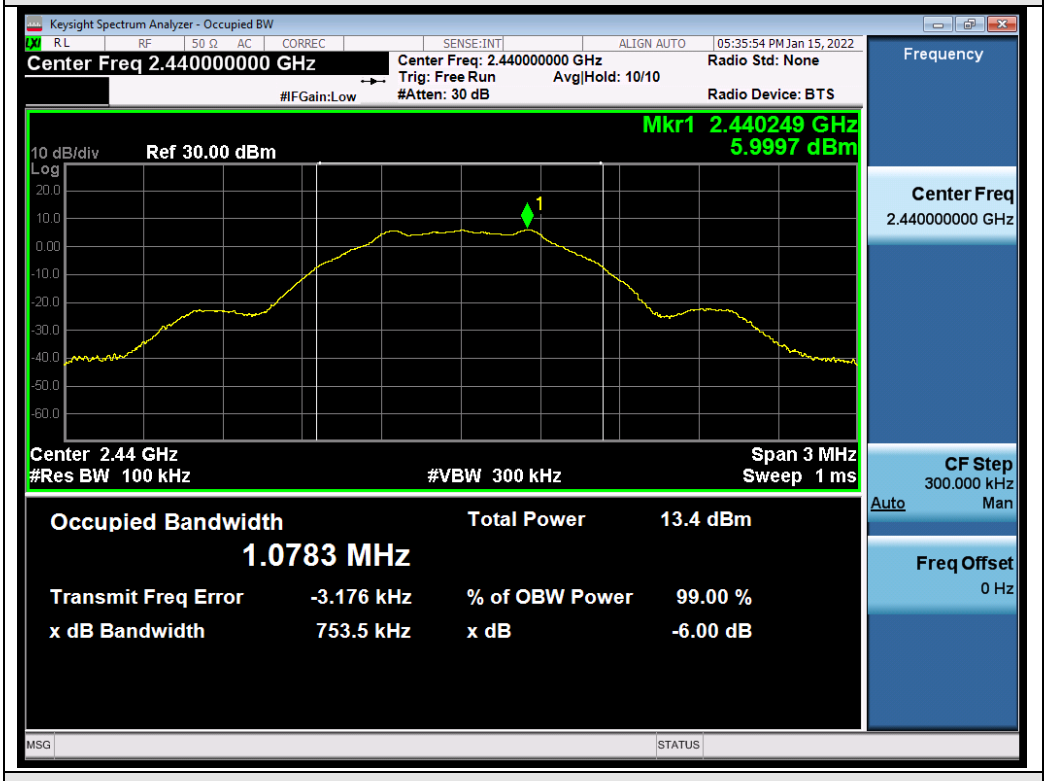


Test_Graph_LE2M_ANT1_2480_2Mbps_OBW

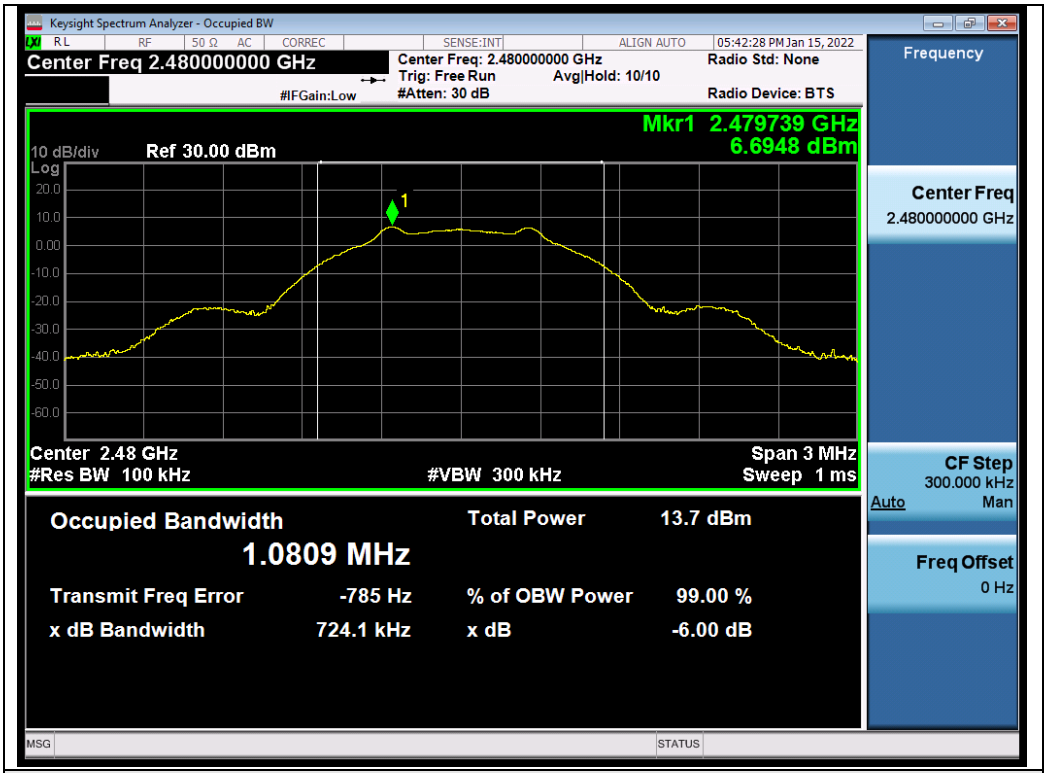
Test Graphs of DTS Bandwidth (CRYSTAL A)



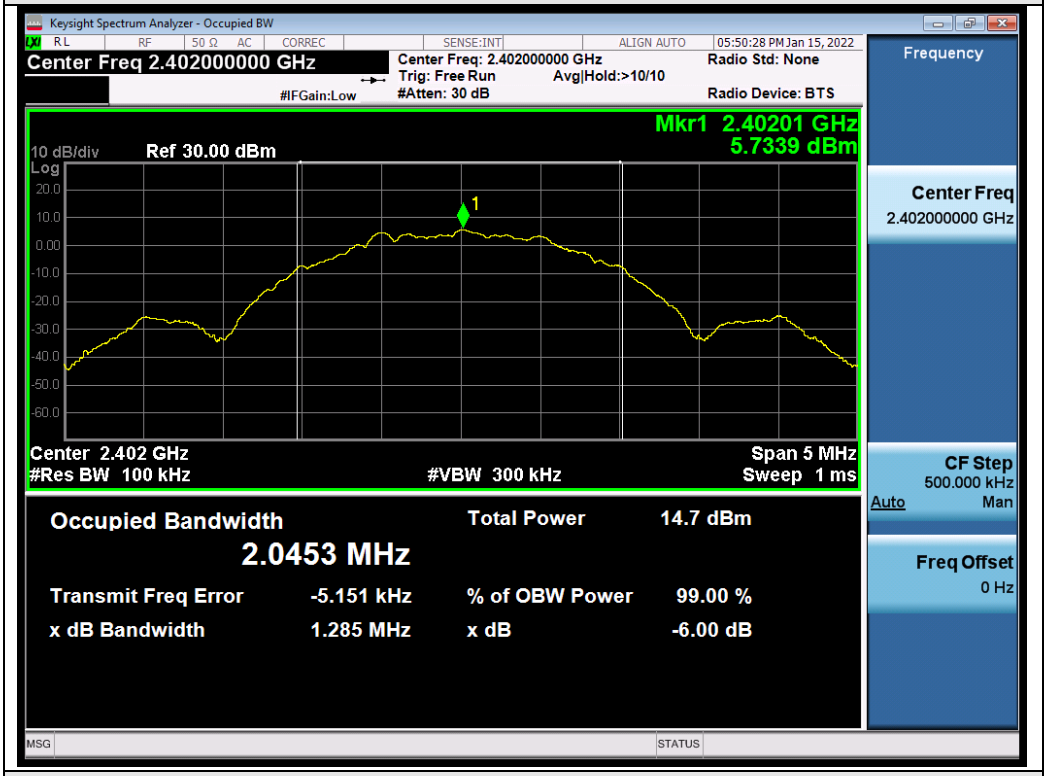
Test_Graph_LE1M_ANT1_2402_1Mbps_DTSBW



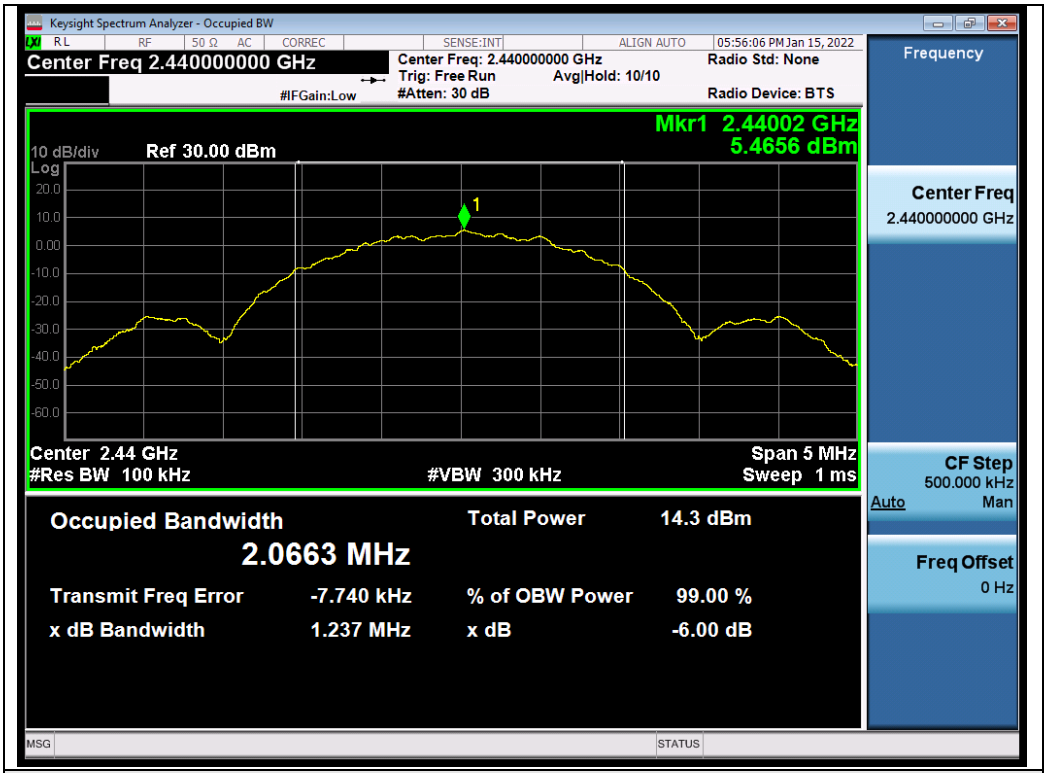
Test_Graph_LE1M_ANT1_2440_1Mbps_DTSBW



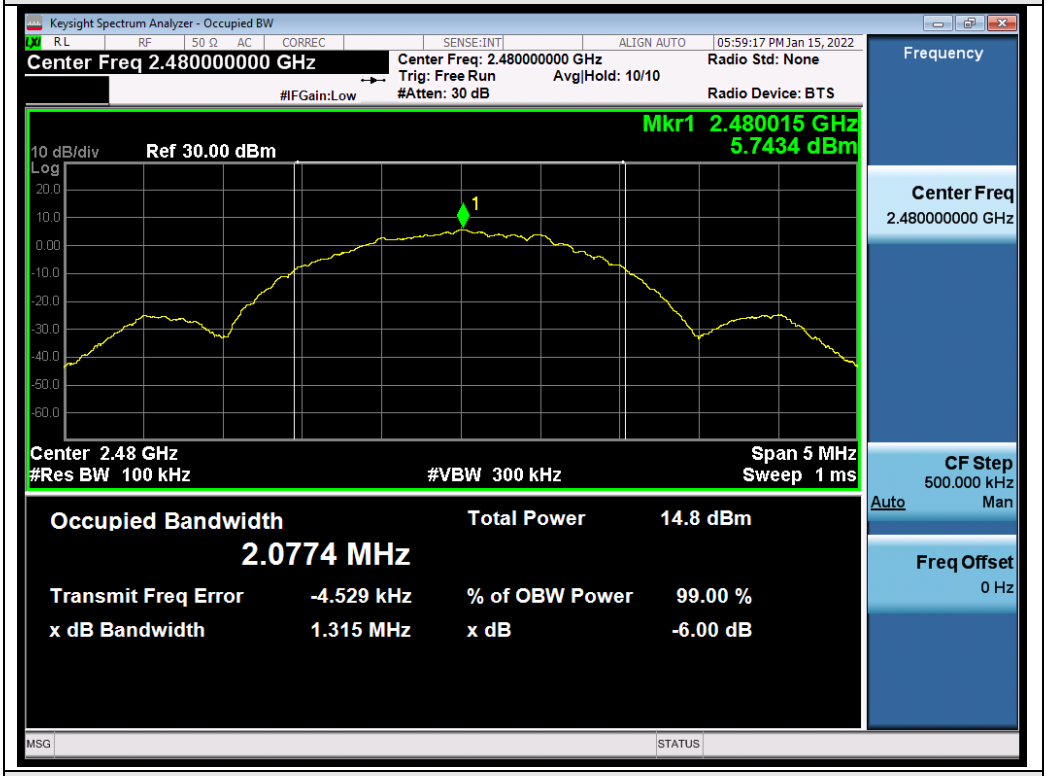
Test_Graph_LE1M_ANT1_2480_1Mbps_DTSBW



Test_Graph_LE2M_ANT1_2402_2Mbps_DTSBW

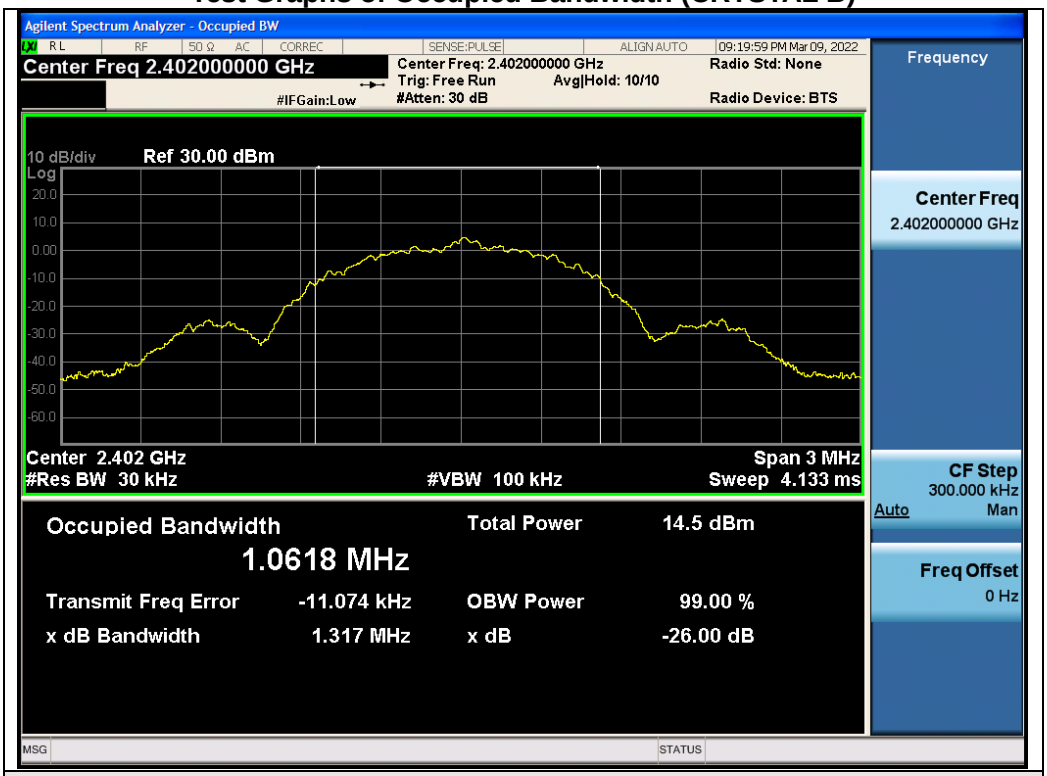


Test_Graph_LE2M_ANT1_2440_2Mbps_DTSBW

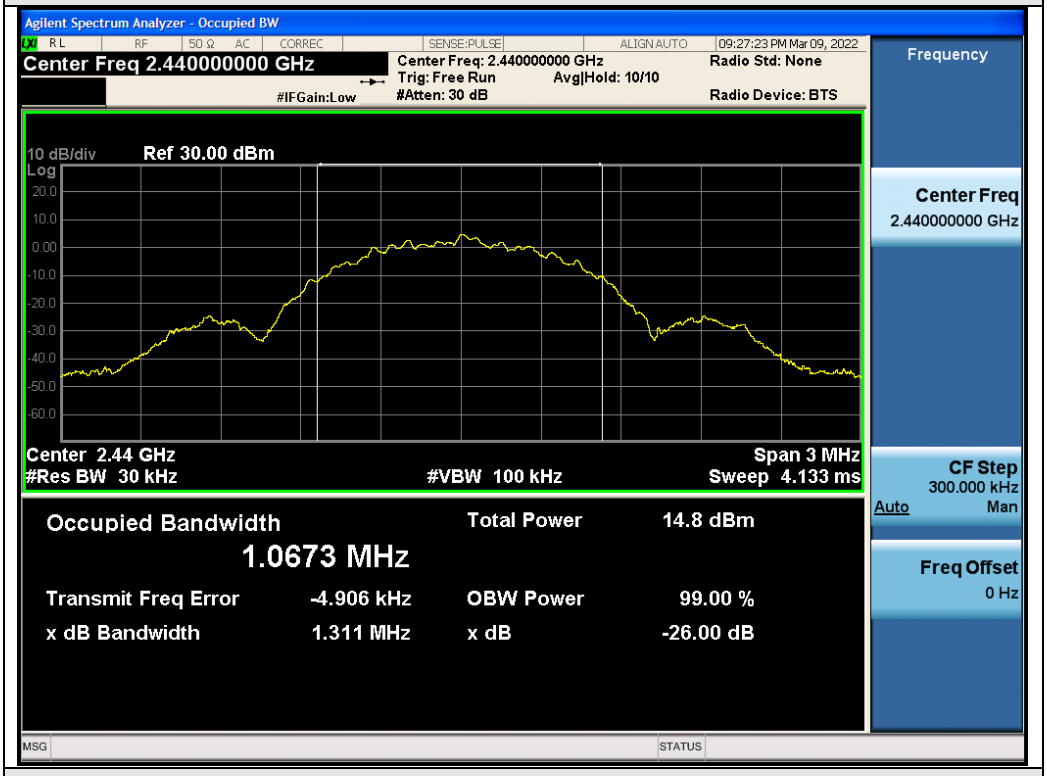


Test_Graph_LE2M_ANT1_2480_2Mbps_DTSBW

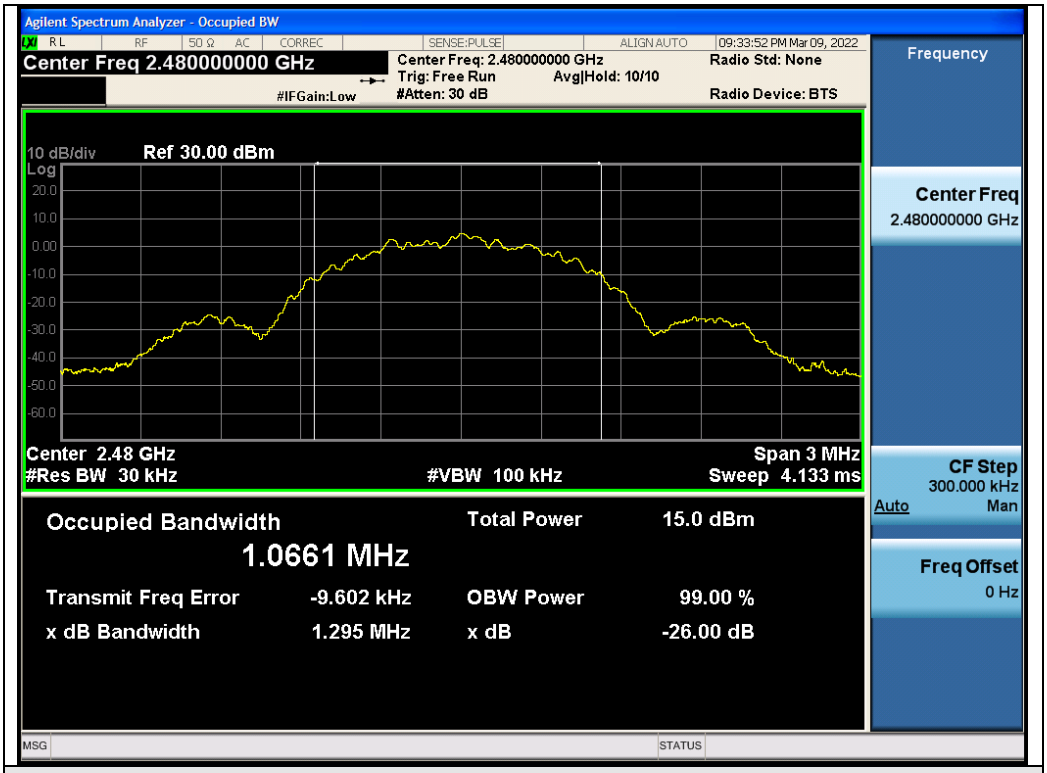
Test Graphs of Occupied Bandwidth (CRYSTAL B)



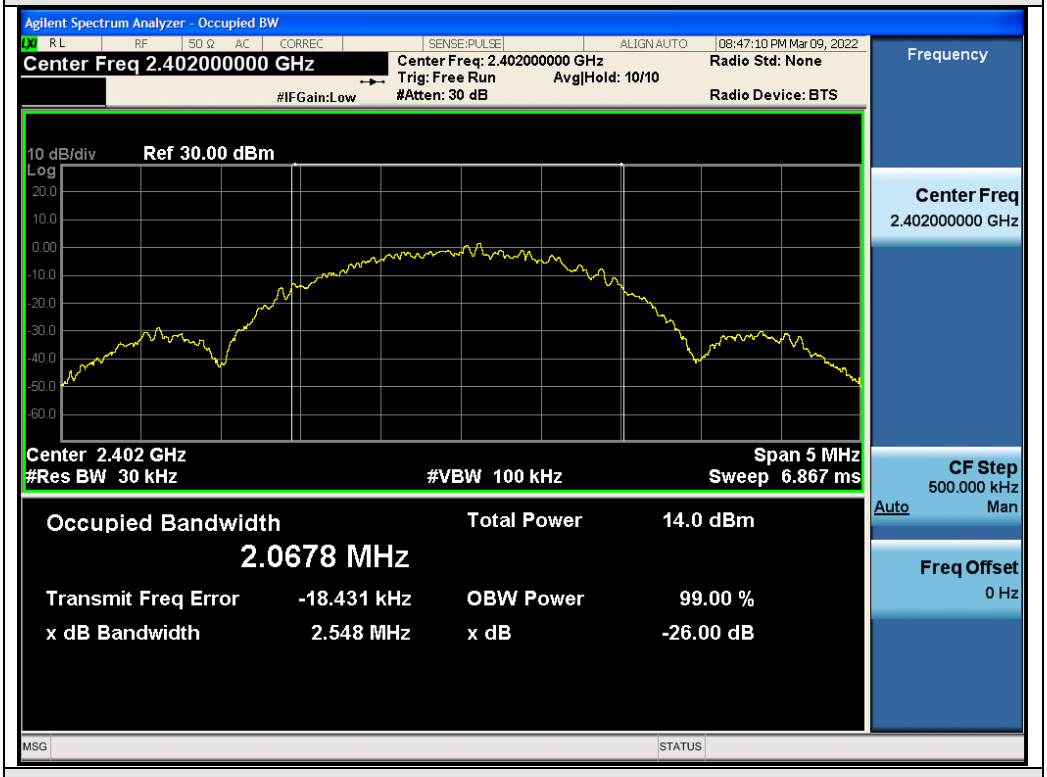
Test_Graph_LE1M_ANT1_2402_1Mbps_OBW



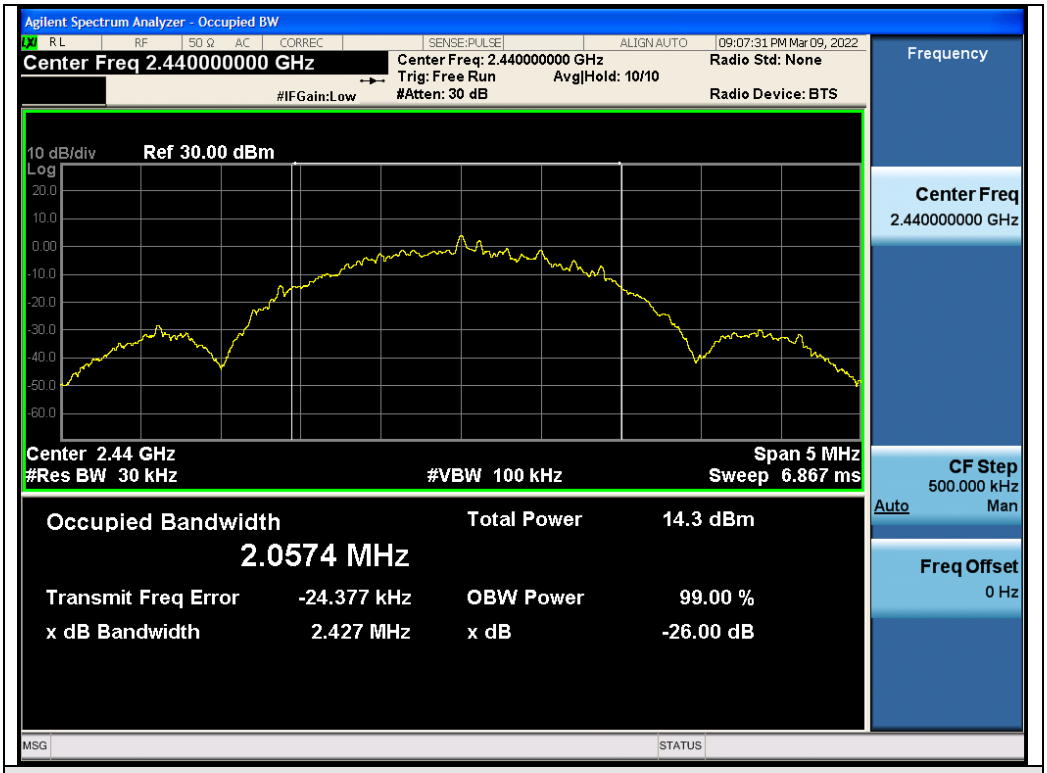
Test_Graph_LE1M_ANT1_2440_1Mbps_OBW



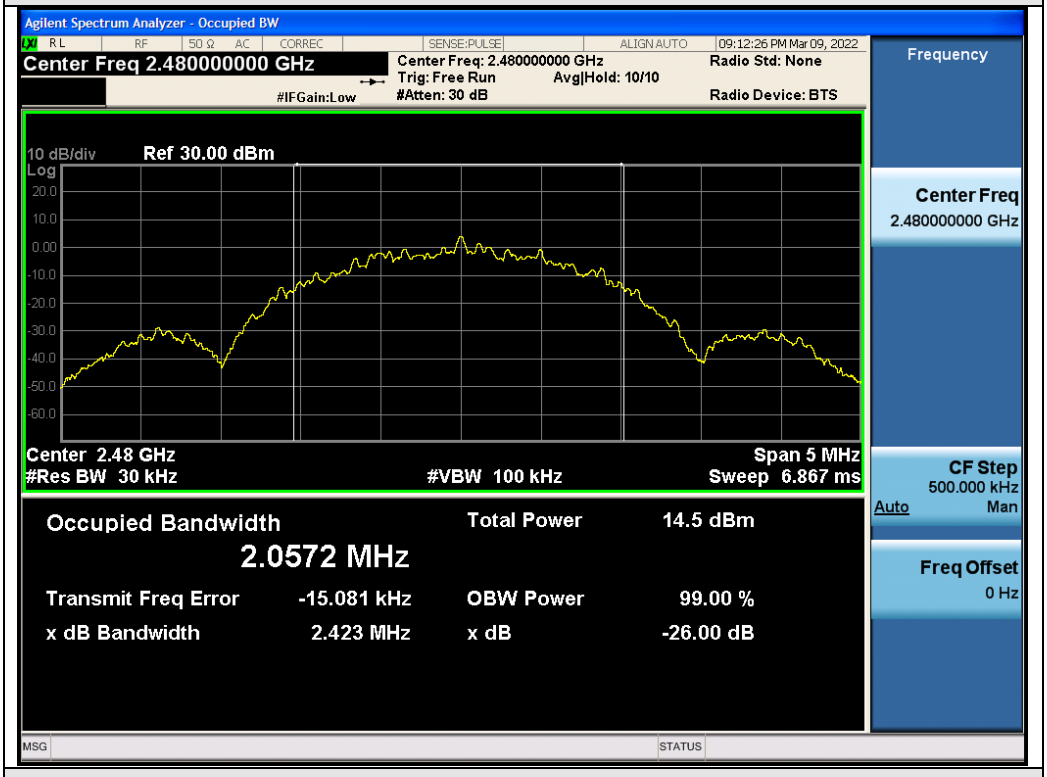
Test_Graph_LE1M_ANT1_2480_1Mbps_OBW



Test_Graph_LE2M_ANT1_2402_2Mbps_OBW

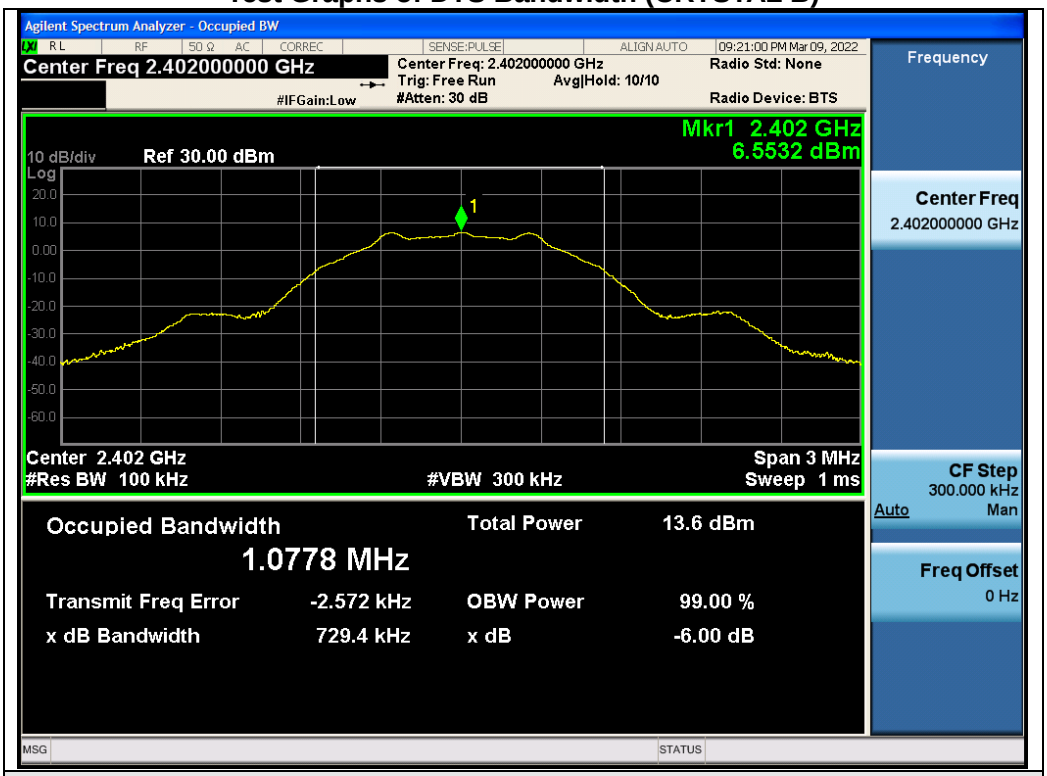


Test_Graph_LE2M_ANT1_2440_2Mbps_OBW

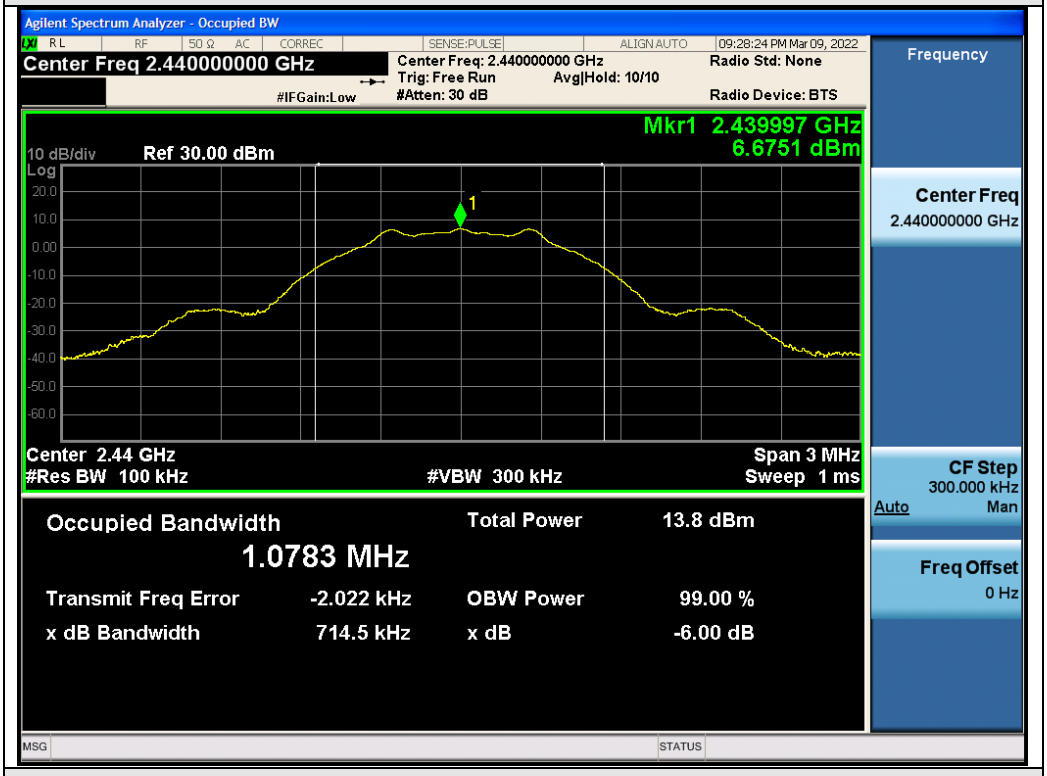


Test_Graph_LE2M_ANT1_2480_2Mbps_OBW

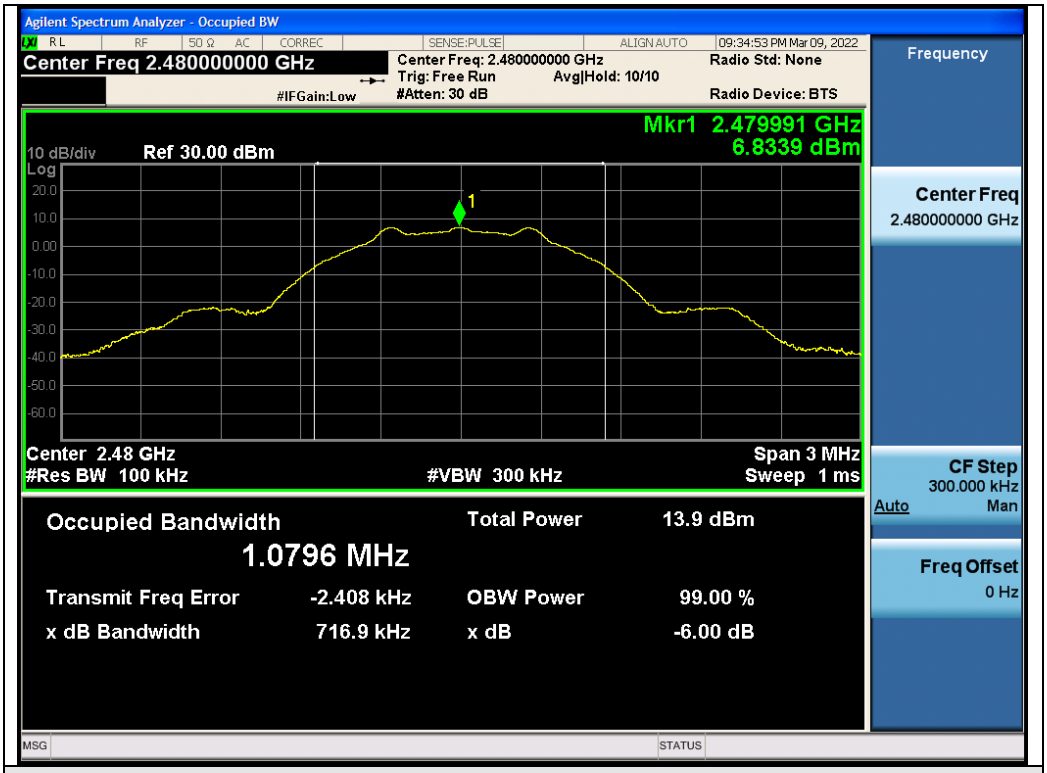
Test Graphs of DTS Bandwidth (CRYSTAL B)



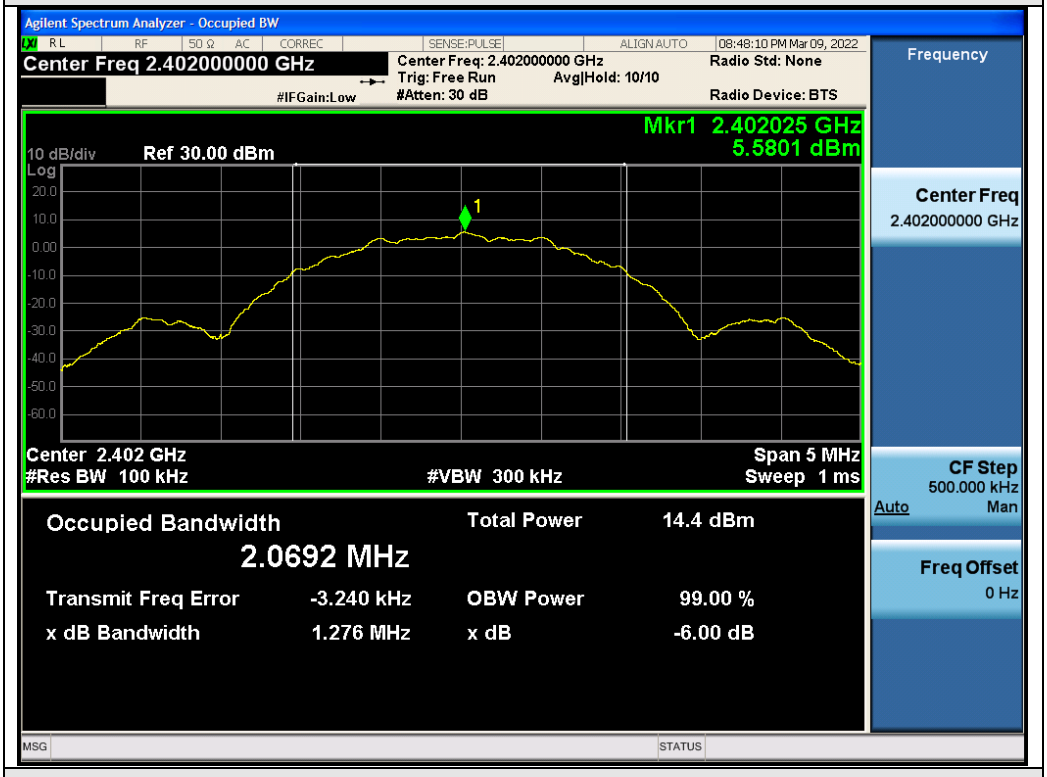
Test_Graph_LE1M_ANT1_2402_1Mbps_DTSBW



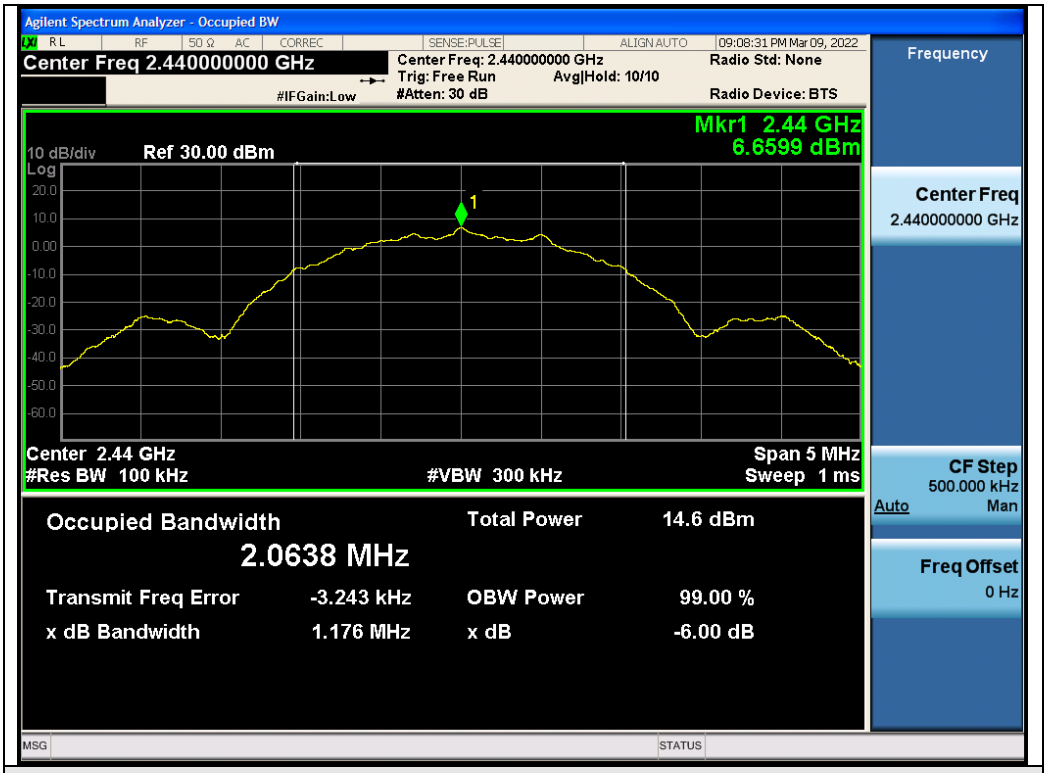
Test_Graph_LE1M_ANT1_2440_1Mbps_DTSBW



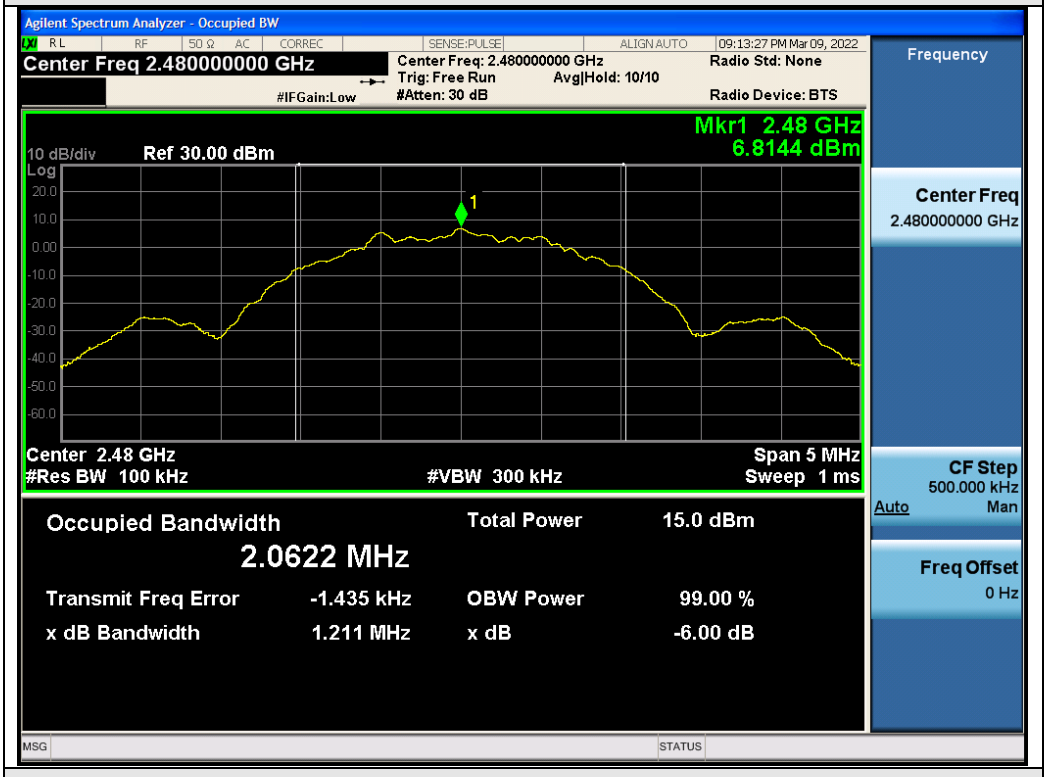
Test_Graph_LE1M_ANT1_2480_1Mbps_DTSBW



Test_Graph_LE2M_ANT1_2402_2Mbps_DTSBW



Test_Graph_LE2M_ANT1_2440_2Mbps_DTSBW



Test_Graph_LE2M_ANT1_2480_2Mbps_DTSBW

9. CONDUCTED SPURIOUS EMISSION

9.1. MEASUREMENT PROCEDURE

1. Connect EUT RF output port to the Spectrum Analyzer through an RF attenuator
2, Set the EUT Work on the top, the middle and the bottom operation frequency individually.
3. Set SPA Trace 1 Max hold, then View.

Note: The EUT was tested according to ANSI C63.10 for compliance to FCC PART 15.247 requirements.

9.2. TEST SET-UP (BLOCK DIAGRAM OF CONFIGURATION)

The same as described in section 7.2.

9.3. MEASUREMENT EQUIPMENT USED

The same as described in section 6.

9.4. LIMITS AND MEASUREMENT RESULT

LIMITS AND MEASUREMENT RESULT		
Applicable Limits	**Measurement Result**	
	Test Data	**Criteria**
In any 100 kHz Bandwidth Outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produce by the intentional radiator shall be at least 20 dB below that in 100KHz bandwidth within the band that contains the highest level of the desired power.	At least -20dBc than the reference level	PASS

Test Graphs of Spurious Emissions in Non-Restricted Frequency Bands

Test_Graph_LE1M_ANT1_2402_1Mbps_Reference Level

Test_Graph_LE1M_ANT1_2402_1Mbps_Lower Band Emissions