TEST REPORT

Dt&C Co., Ltd.
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC2505-0026
2. Customer
   - Name (FCC) : MOTREX CO., LTD.
   - Address (FCC) : 1-1301, 56, Geumto-ro 80beon-gil, Sujeong-gu, Seongnam-si, Gyeonggi-do, South Korea
3. Use of Report : FCC Original Certification
4. Product Name / Model Name : SMART DISPLAY / MH310L-H01
   FCC ID : BP9-MH310L-H01
5. FCC Regulation(s): Part 15.247
   Test Method used: KDB558074 D01v05r02, ANSI C63.10-2013
6. Date of Test : 2025.04.21 ~ 2025.05.15
7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing
8. Testing Environment : See appended test report.
9. Test Result : Refer to the attached test result.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : SeungMin Gil	Technical Manager Name : JaeJin Lee

2025 . 05 . 19 .

Dt&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description	Revised by	Reviewed by
DRTFCC2505-0026	May, 19. 2025	Initial issue	SeungMin Gil	JaeJin Lee

Table of Contents

1. General Information

1.1. Description of EUT

Equipment Class	Digital Transmission System (DTS)
Product Name	SMART DISPLAY
Model Name	MH310L-H01
Add Model Name	MH310L-H02, MH310L-K01, MH310L-K02
Firmware Version Identification Number	Rev 01.
EUT Serial Number	Conducted : MTXNQ5PEAAR81F10001 , Radiated : NQ5PEMXPV0JA0001
Power Supply	DC 12 V
Modulation Technique	▪ 802.11b: CCK, DSSS ▪ 802.11g/n: OFDM
Antenna Specification	Antenna Type: Chip Antenna Gain: 0.8 dBi (PK)

Band	Mode	Tx. frequency(MHz)	Max. conducted power(dBm)
2.4 GHz	802.11b	2 412 ~ 2 462	8.11
	802.11g	2 412 ~ 2 462	15.34
	802.11n (HT20)	2 412 ~ 2 462	15.21

1.2. Declaration by the applicant / manufacturer

N/A

1.3. Testing Laboratory

Dt&C Co., Ltd.		
The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site complies with the requirements of Part 2.948 according to ANSI C63.4-2014. **- FCC & ISED MRA Designation No. : KR0034** **- ISED#: 5740A**		
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

1.4. Testing Environment

Ambient Condition	
▪ Temperature	+22 ℃ ~ +26 ℃
▪ Relative Humidity	+35 % ~ +47 %

1.5. Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C63.4-2014 and ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of *k* = 2 to indicate a 95 % level of confidence.

Parameter	Measurement uncertainty
Antenna-port conducted emission	1.0 dB (The confidence level is about 95 %, k = 2)
Radiated emission (1 GHz Below)	5.0 dB (The confidence level is about 95 %, k = 2)
Radiated emission (1 GHz ~ 18 GHz)	4.8 dB (The confidence level is about 95 %, k = 2)
Radiated emission (18 GHz Above)	5.8 dB (The confidence level is about 95 %, k = 2)

1.6. Test Equipment List

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal.Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent Technologies	N9020A	24/11/26	25/11/26	MY46471172
Spectrum Analyzer	Agilent Technologies	N9020A	24/06/03	25/06/03	US47360812
Spectrum Analyzer	Agilent Technologies	N9020A	24/11/26	25/11/26	MY50410399
DC Power Supply	Agilent Technologies	66332A	24/12/09	25/12/09	GB42110592
DC Power Supply	DIGITAL	DPR-303D	24/06/05	25/06/05	2090097
DC Power Supply	SM techno	SDP30-5D	24/06/05	25/06/05	305DMG304
Multimeter	FLUKE	17B	24/11/27	25/11/27	26030065WS
Signal Generator	Rohde Schwarz	SMBV100A	24/12/10	25/12/10	255571
Signal Generator	KEYSIGHT	M9383A	24/12/10	25/12/10	E76F804A28
Thermohygrometer	BODYCOM	BJ5478	24/12/17	25/12/17	090205-4
Thermohygrometer	BODYCOM	BJ5478	24/12/05	25/12/05	120612-2
Thermohygrometer	BODYCOM	BJ5478	24/06/05	25/06/05	N/A
Loop Antenna	ETS-Lindgren	6502	24/11/08	26/11/08	00060496
Hybrid Antenna	Schwarzbeck	VULB 9160	24/12/13	25/12/13	3362
Horn Antenna	ETS-Lindgren	3117	24/06/04	25/06/04	00143278
Horn Antenna	A.H.Systems Inc.	SAS-574	24/06/11	25/06/11	155
PreAmplifier	tsj	MLA-0118-B01-40	24/11/26	25/11/26	1852267
PreAmplifier	tsj	MLA-1840-J02-45	24/06/03	25/06/03	16966-10728
PreAmplifier	H.P	8447D	24/12/11	25/12/11	2944A07774
High Pass Filter	Wainwright Instruments	WHKX12-935-1000-15000-40SS	24/06/12	25/06/12	8
High Pass Filter	Wainwright Instruments	WHKX10-2838-3300-18000-60SS	24/06/12	25/06/12	1
High Pass Filter	Wainwright Instruments	WHNX8.0/26.5-6SS	24/06/12	25/06/12	3
Attenuator	Hefei Shunze	SS5T2.92-10-40	24/06/12	25/06/12	16012202
Attenuator	Aeroflex/Weinschel	56-3	24/06/12	25/06/12	Y2370
Attenuator	SMAJK	SMAJK-2-3	24/06/12	25/06/12	3
Attenuator	SMAJK	SMAJK-2-3	24/06/12	25/06/12	2
Attenuator	Aeroflex/Weinschel	86-10-11	24/06/03	25/06/03	408
Power Meter & Wide Bandwidth Sensor	Anritsu	ML2496A MA2490A	24/12/12	25/12/12	1338004 1249303
Cable	Dt&C	Cable	25/01/02	26/01/02	G-2
Cable	HUBER+SUHNER	SUCOFLEX 100	25/01/02	26/01/02	G-3
Cable	Dt&C	Cable	25/01/02	26/01/02	G-4
Cable	OMT	YSS21S	25/01/02	26/01/02	G-5
Cable	Junkosha	MWX241	25/01/02	26/01/02	mmW-1
Cable	Junkosha	MWX241	25/01/02	26/01/02	mmW-4
Cable	HUBER+SUHNER	SUCOFLEX100	25/01/02	26/01/02	M-01
Cable	HUBER+SUHNER	SUCOFLEX100	25/01/02	26/01/02	M-02
Cable	JUNKOSHA	MWX241/B	25/01/02	26/01/02	M-03
Cable	JUNKOSHA	J12J101757-00	25/01/02	26/01/02	M-07
Cable	HUBER+SUHNER	SUCOFLEX106	25/01/02	26/01/02	M-09
Cable	Dt&C	CABLE	25/01/02	26/01/02	RFC-46
Test Software (Radiated)	tsj	EMI Measurement	NA	NA	Version 2.00.0185
3m Semi Anechoic Chamber	SYC	3m-SAC	24/06/14(NSA) 24/06/19(VSWR)	25/06/14(NSA) 25/06/19(VSWR)	3m-SAC-1
3m Semi Anechoic Chamber	SYC	3m-SAC	25/01/14(NSA) 25/01/17(VSWR)	25/01/14(NSA) 25/01/17(VSWR)	3m-SAC-2

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017
Note2: The cable is not a regular calibration item, so it has been calibrated by Dt&C itself.

2. Test Methodology

The measurement procedures described in the ANSI C63.10-2013 and the guidance provided in KDB558074 D01v05r02 were used in measurement of the EUT.
The EUT was tested per the guidance of KDB558074 D01v05r02. And ANSI C63.10-2013 was used to reference appropriate EUT setup and maximizing procedures of radiated spurious emission and AC line conducted emission testing.

2.1. EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

2.2. EUT Exercise

The EUT was operated in the test mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

2.3. General Test Procedures

Conducted Emissions

The power-line conducted emission test procedure is not described on the KDB558074 D01v05r02.
So this test was fulfilled with the requirements in Section 6.2 of ANSI C63.10-2013.
The EUT is placed on the wooden table, which is 0.8 m above ground plane and the conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz using CISPR Quasi-peak and Average detector.

Radiated Emissions

Basically the radiated tests were performed with KDB558074 D01v05r02. But some requirements and procedures like test site requirements, EUT setup and maximizing procedure were fulfilled with the requirements in Section 5 and 6 of the ANSI C63.10-2013 as stated on section 12.1 of the KDB558074 D01v05r02.
The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

2.4. Instrument Calibration

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

2.5. Description of Test Modes

The EUT has been tested with the operating condition for maximizing the emission characteristics. A test program is used to control the EUT for staying in continuous transmitting.

Transmitting Configuration of EUT

Mode	Data rate
802.11b	1 Mbps ~ 11 Mbps
802.11g	6 Mbps ~ 54 Mbps
802.11n(HT20)	MCS 0 ~ MCS 7

EUT Operation test setup

- Test Software: Tera Term 4.105

- Power setting: Refer to the table below.

Test Mode

Test mode	Worst case data rate	Power setting	Tested Frequency (MHz)		
TM 1	802.11b 1 Mbps	6	2 412	2 437	2 462
TM 2	802.11g 6 Mbps	7	2 412	2 437	2 462
TM 3	802.11n(HT20) MCS 0	7	2 412	2 437	2 462

Note1: The worst case data rate was determined according to the power measurements.
Note2: The power measurement results for all modes and data rate were reported.

3. Antenna Requirements

▣ **According to Part 15.203**

“An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.”

The antenna is permanently attached.(Refer to Internal Photo file.)
Therefore this E.U.T complies with the requirement of Part 15.203

4. Summary of Test Result

FCC part section(s)	Test Description	Limit	Test Condition	Status Note 1
15.247(a)	6 dB Bandwidth	> 500 kHz	Conducted	C
15.247(b)	Maximum Peak Output Power	< 1 Watt		C
15.247(d)	Unwanted Emissions(Conducted)	20 dBc in any 100 kHz BW		C
15.247(e)	Power Spectral Density	< 8 dBm / 3 kHz		C
15.247(d) 15.205 15.209	Unwanted Emissions(Radiated)	Part 15.209 limits (Refer to section 5.5)	Radiated	C
15.207	AC Power-Line Conducted Emissions	Part 15.207 limits (Refer to section 5.6)	AC Line Conducted	NA Note 2
15.203	Antenna Requirements	Part 15.203 (Refer to section 3)	-	C

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable
Note 2: This device is installed in a car. Therefore the power source is a battery of car.

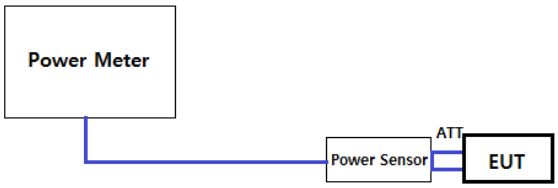
5. Test Result

5.1. Maximum Peak Conducted Output Power

▣ Test Requirements and limit, Part 15.247(b)

The maximum permissible conducted output power is 1 Watt.

5.1.1. Test Setup



5.1.2. Test Procedures

- **KDB558074 D01v05r02 - Section 8.3.1.3**
- **ANSI C63.10-2013 – Section 11.9.1.3**

RBW ≥ DTSPKPM1 Peak-reading power meter method

The maximum conducted output powers were measured using a broadband peak RF power meter which has greater video bandwidth than DUT's DTS bandwidth and utilize a fast-responding diode detector.

- **KDB558074 D01v05r02 - Section 8.3.2.3**
- **ANSI C63.10-2013 – Section 11.9.2.3**

Method AVGPM-G

The average conducted output powers were measured using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

5.1.3. Test Results

- Refer to the next page

Mode	Freq. (MHz)	Det.	Maximum Peak Conducted Output Power (dBm)							
			Data Rate (Mbps)							
			1	2	5.5	11	-	-	-	-
802.11b	2 412	PK	7.80	7.72	7.61	7.67	-	-	-	-
		AV	4.59	4.55	4.58	4.57	-	-	-	-
	2 437	PK	7.79	7.70	7.58	7.65	-	-	-	-
		AV	4.57	4.53	4.56	4.55	-	-	-	-
	2 462	PK	**8.11**	8.03	8.00	8.04	-	-	-	-
		AV	4.91	4.86	4.89	4.88	-	-	-	-

Mode	Freq. (MHz)	Det.	Maximum Peak Conducted Output Power (dBm)							
			Data Rate (Mbps)							
			6	9	12	18	24	36	48	54
802.11g	2 412	PK	15.23	14.81	14.23	13.19	13.03	13.03	14.18	12.33
		AV	5.20	4.84	4.81	4.49	4.41	4.11	4.59	4.37
	2 437	PK	**15.34**	14.94	14.35	13.32	13.27	13.28	14.33	12.58
		AV	5.38	4.92	4.90	4.61	4.58	4.32	4.77	4.51
	2 462	PK	15.27	14.80	14.26	13.41	13.10	13.09	14.21	12.36
		AV	5.28	4.91	4.87	4.53	4.50	4.16	4.66	4.43

Mode	Freq. (MHz)	Det.	Maximum Peak Conducted Output Power (dBm)							
			Data Rate (MCS)							
			0	1	2	3	4	5	6	7
802.11n (HT20)	2 412	PK	15.08	14.55	14.18	13.95	13.90	13.61	13.93	13.88
		AV	4.77	4.63	4.64	4.34	4.38	4.42	4.44	4.12
	2 437	PK	15.17	14.66	14.32	14.02	14.00	13.81	14.05	13.99
		AV	4.99	4.86	4.88	4.57	4.59	4.63	4.65	4.33
	2 462	PK	**15.21**	14.72	14.55	14.28	14.27	14.10	14.32	14.19
		AV	4.95	4.82	4.84	4.61	4.64	4.70	4.72	4.41

5.2. 6 dB Bandwidth

▣ Test Requirements and limit, Part 15.247(a)

The bandwidth at 6 dB down from the highest in-band spectral density is measured with a spectrum analyzer connected to the EUT's antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The minimum permissible 6 dB bandwidth is 500 kHz.

5.2.1. Test Setup

Refer to the APPENDIX I.

5.2.2. Test Procedures

- **KDB558074 D01v05r02 - Section 8.2**
- **ANSI C63.10-2013 – Section 11.8.2**

1. Set resolution bandwidth (RBW) = 100 kHz
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = **Peak**.
4. Trace mode = **max hold**.
5. Sweep = **auto couple**.
6. Allow the trace to stabilize.
7. Option 1 - Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

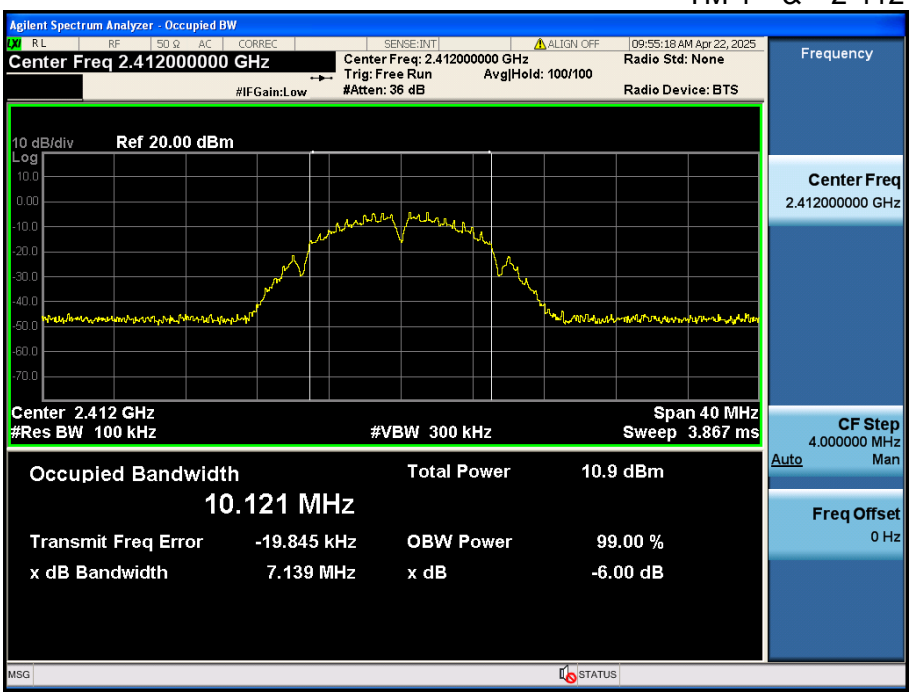
   Option 2 - The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW ≥ 3 × RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be ≥ 6 dB.

5.2.3. Test Results

Test Mode	Frequency (MHz)	Test Results (MHz)
TM 1	2 412	7.14
	2 437	7.13
	2 462	7.10
TM 2	2 412	16.01
	2 437	16.11
	2 462	15.70
TM 3	2 412	16.86
	2 437	17.02
	2 462	16.96

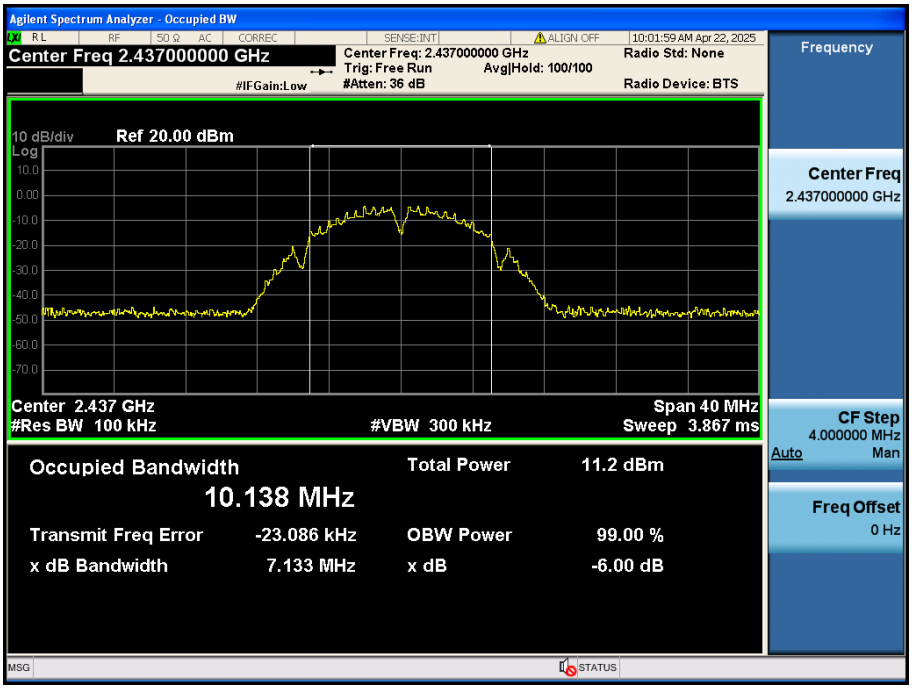
6 dB Bandwidth

TM 1 & 2 412 MHz



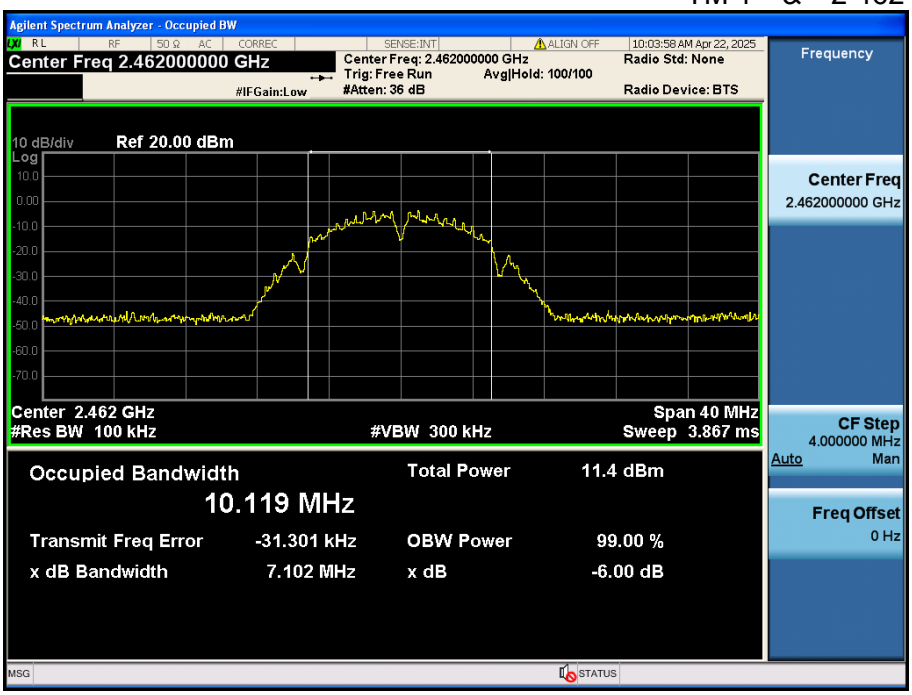
6 dB Bandwidth

TM 1 & 2 437 MHz



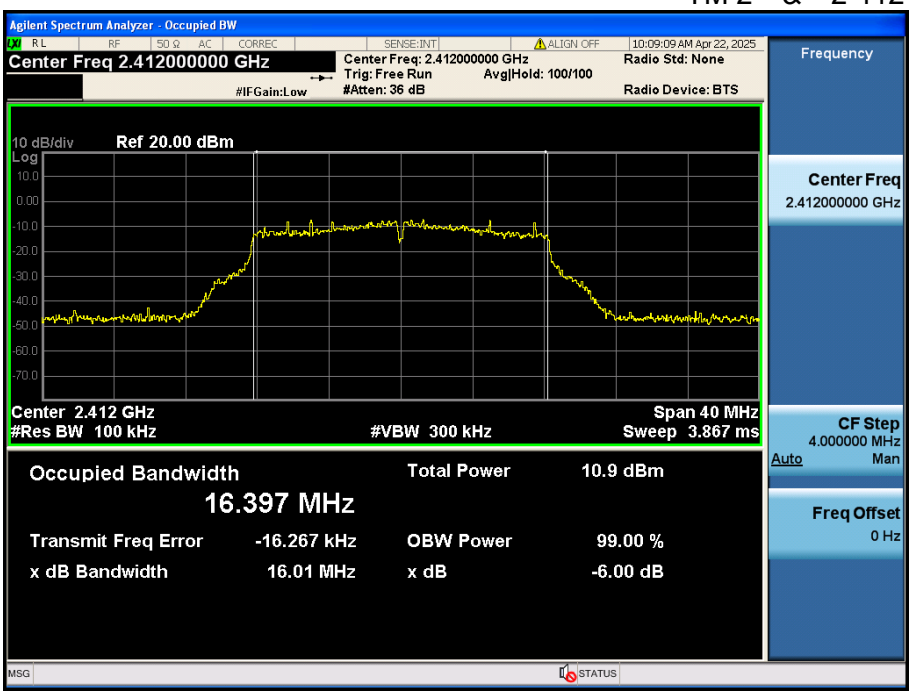
6 dB Bandwidth

TM 1 & 2 462 MHz



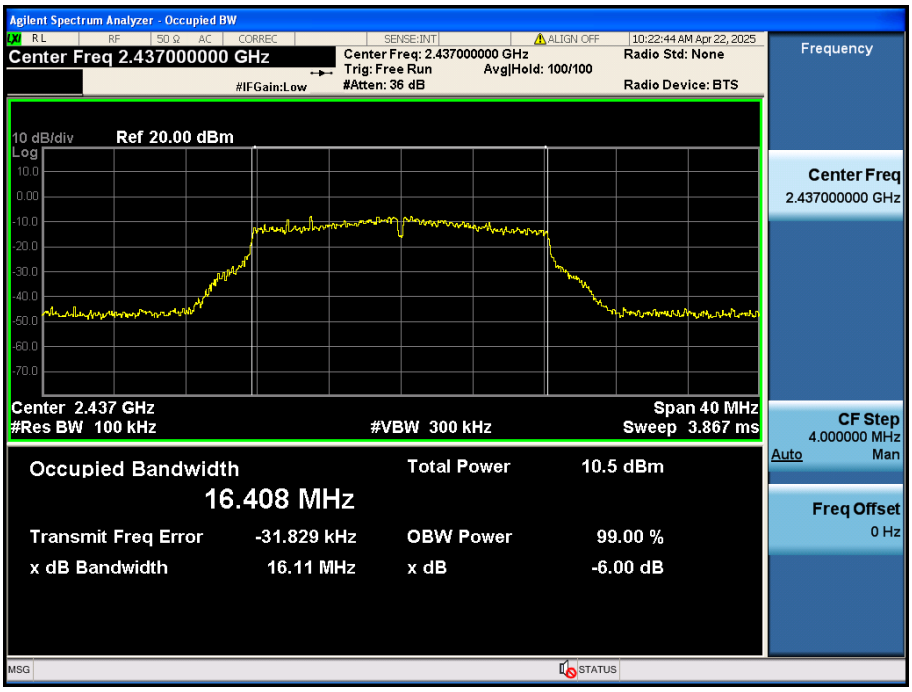
6 dB Bandwidth

TM 2 & 2 412 MHz



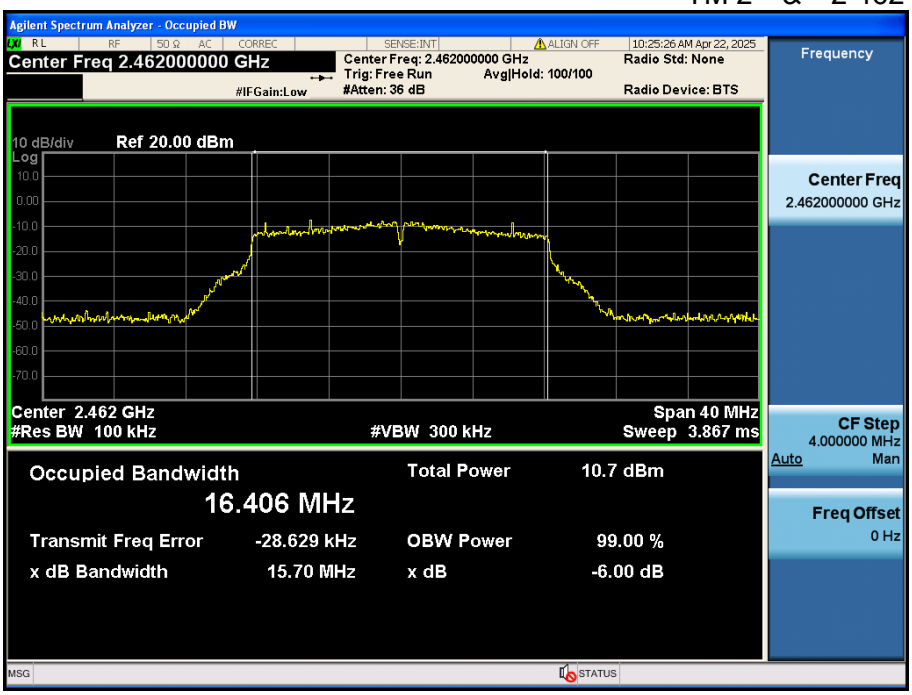
6 dB Bandwidth

TM 2 & 2 437 MHz



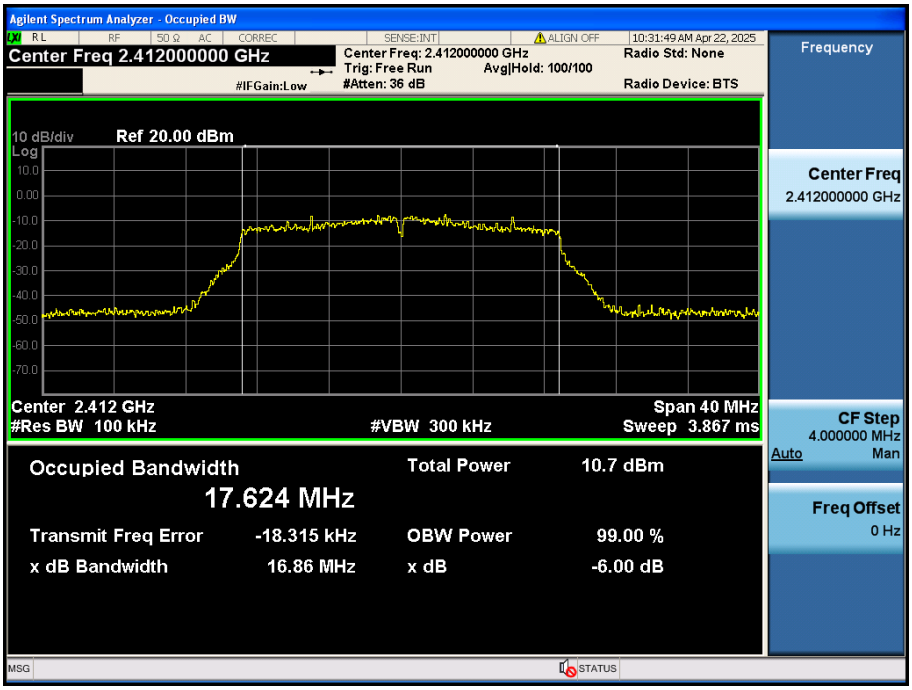
6 dB Bandwidth

TM 2 & 2 462 MHz



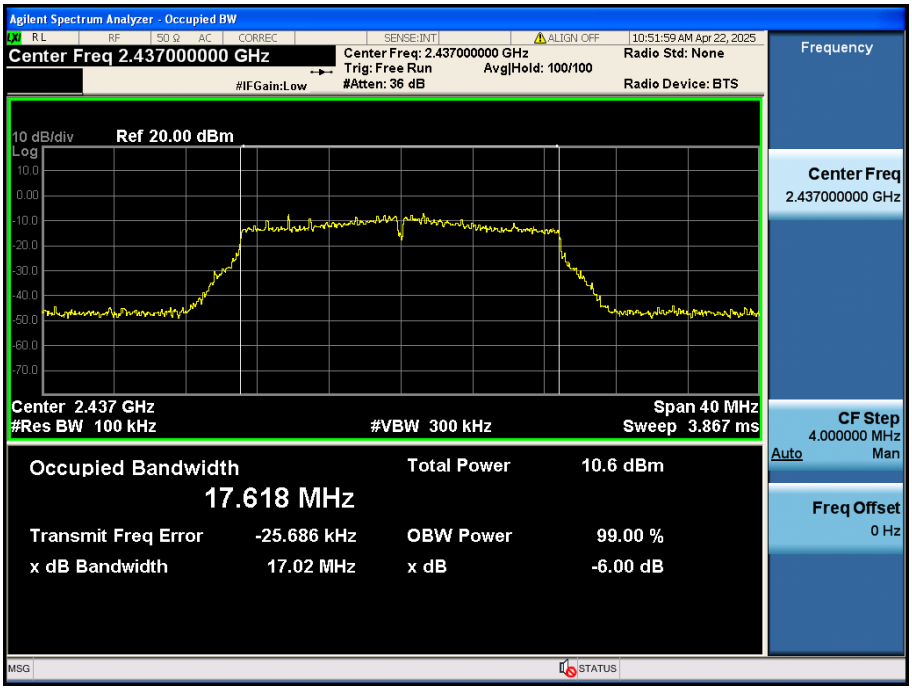
6 dB Bandwidth

TM 3 & 2 412 MHz



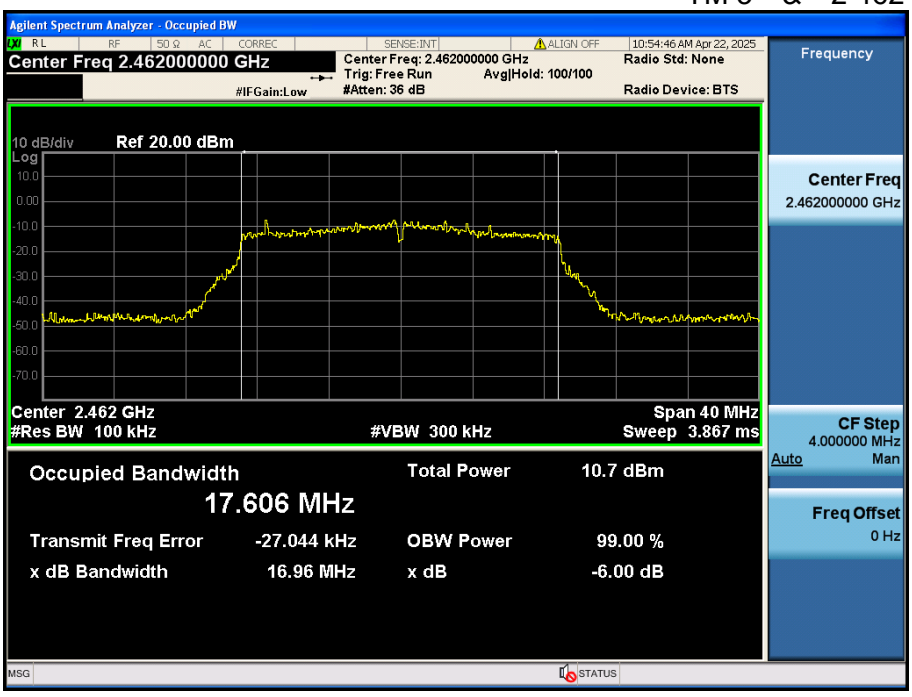
6 dB Bandwidth

TM 3 & 2 437 MHz



6 dB Bandwidth

TM 3 & 2 462 MHz



5.3. Power Spectral Density

▣ Test requirements and limit, Part 15.247(e)

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

5.3.1. Test Setup

Refer to the APPENDIX I.

5.3.2. Test Procedures

- **KDB558074 D01v05r02 - Section 8.4**
- **ANSI C63.10-2013 – Section 11.10.2**

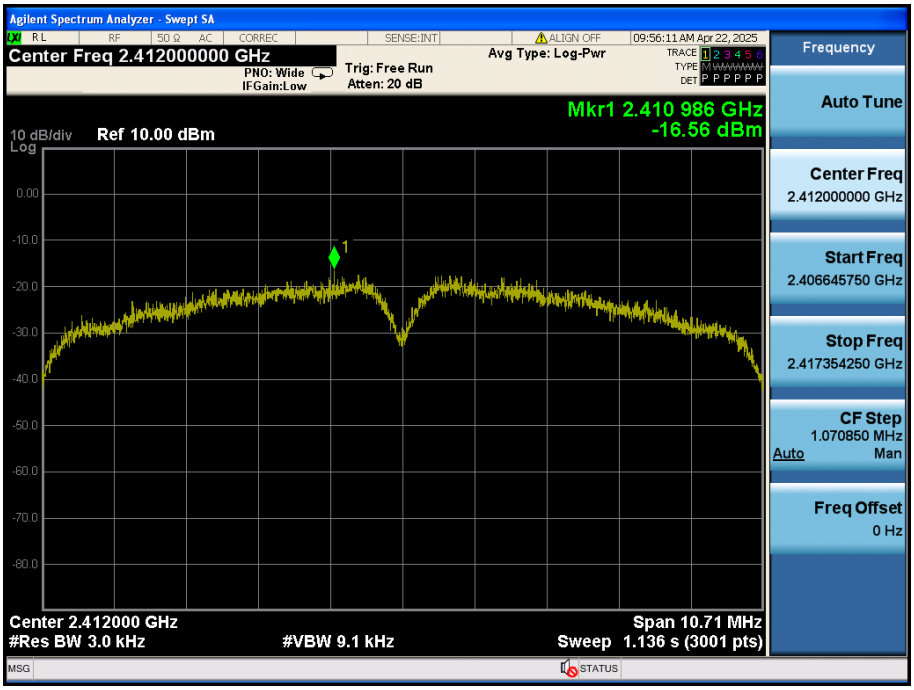
Method PKPSD (peak PSD)

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to **1.5 times** the DTS bandwidth.
3. Set the RBW : **3 kHz ≤ RBW ≤ 100 kHz**.
4. Set the VBW ≥ **3 x RBW.**
5. Detector = **peak.**
6. Sweep time = **auto couple.**
7. Trace mode = **max hold.**
8. Allow trace to fully stabilize.
9. Use the **peak marker function** to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

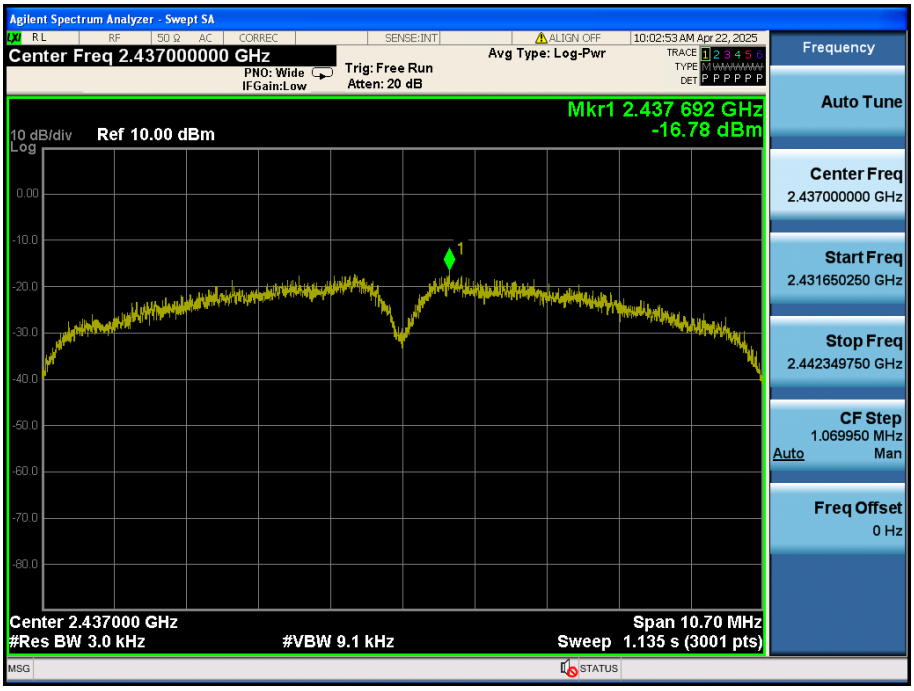
5.3.3. Test Results

Test Mode	Frequency (MHz)	RBW	PKPSD (dBm)	Limit (dBm / 3 kHz)
TM 1	2 412	3 kHz	-16.56	8.00
	2 437	3 kHz	-16.78	8.00
	2 462	3 kHz	-16.98	8.00
TM 2	2 412	3 kHz	-18.33	8.00
	2 437	3 kHz	-18.76	8.00
	2 462	3 kHz	-18.42	8.00
TM 3	2 412	3 kHz	-19.14	8.00
	2 437	3 kHz	-18.47	8.00
	2 462	3 kHz	-18.38	8.00

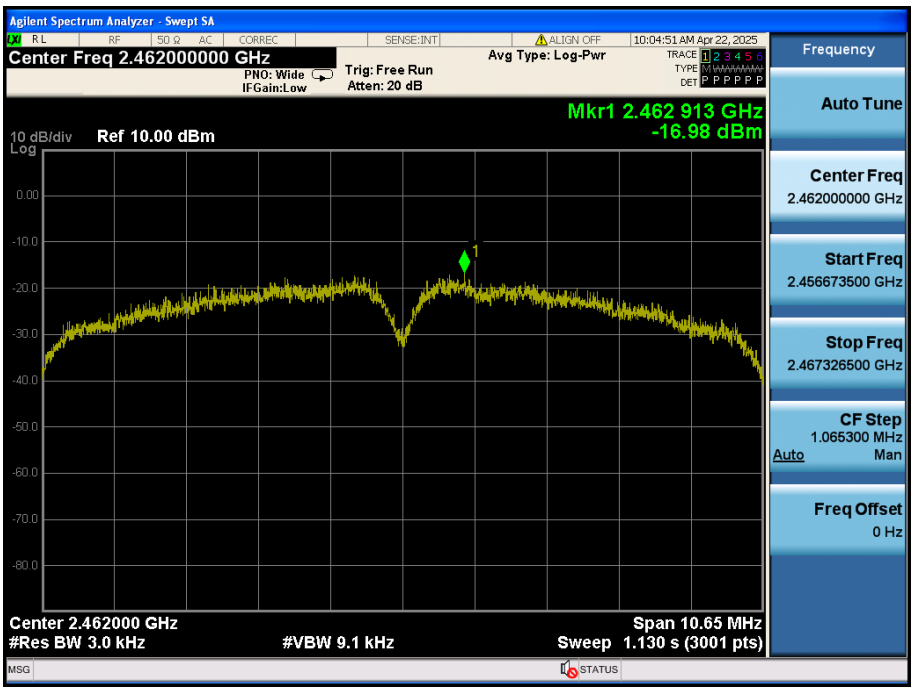
Power Spectral Density TM 1 & 2 412 MHz



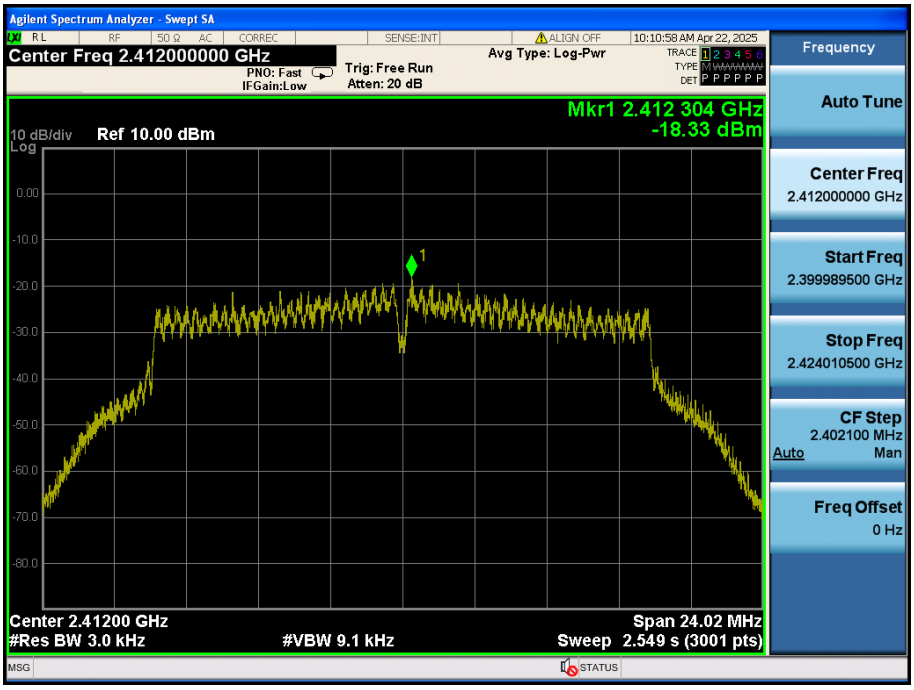
Power Spectral Density TM 1 & 2 437 MHz



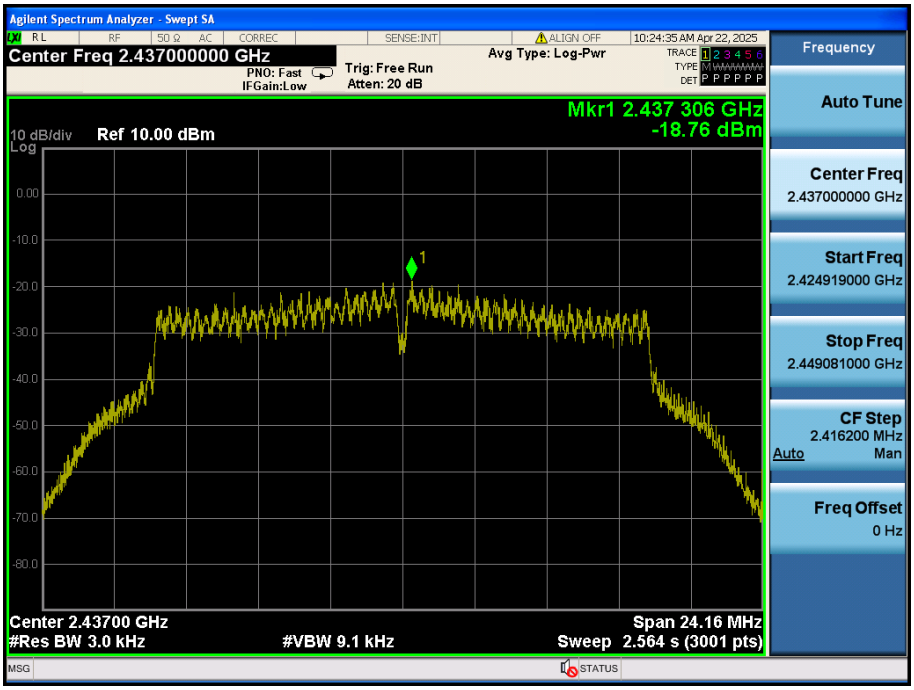
Power Spectral Density TM 1 & 2 462 MHz



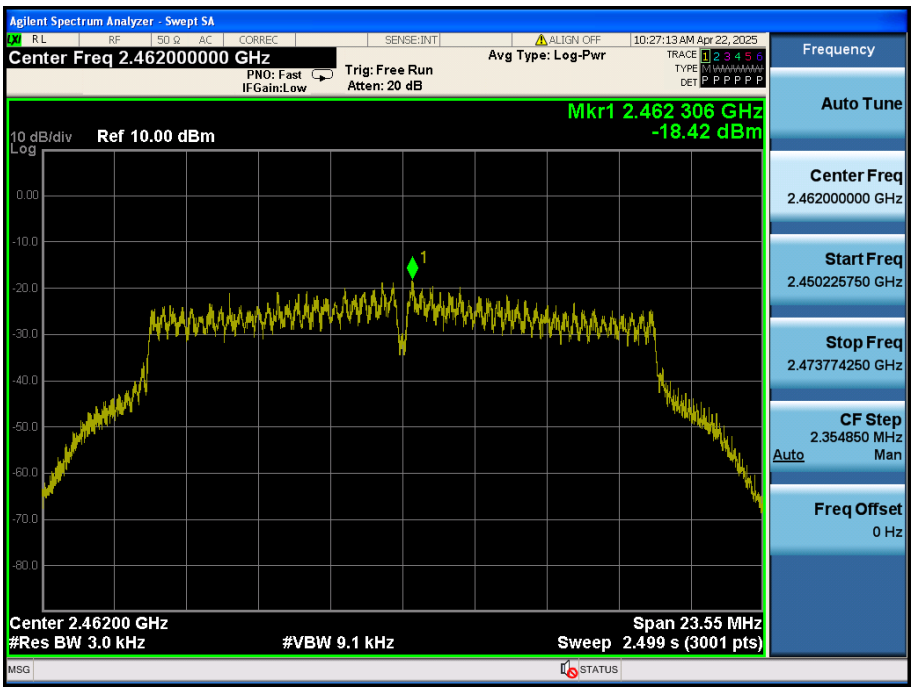
Power Spectral Density TM 2 & 2 412 MHz



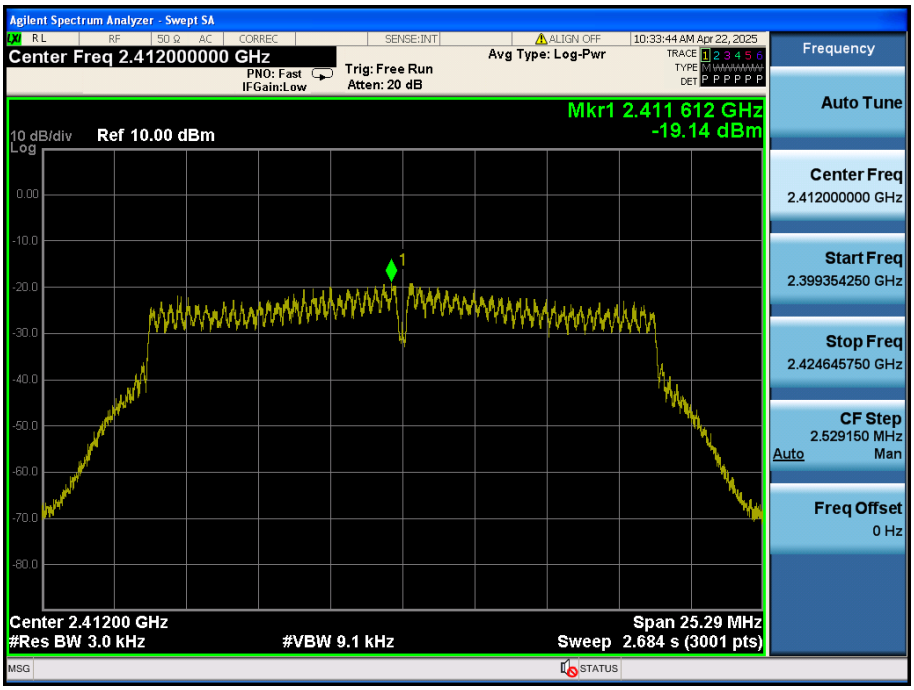
Power Spectral Density TM 2 & 2 437 MHz



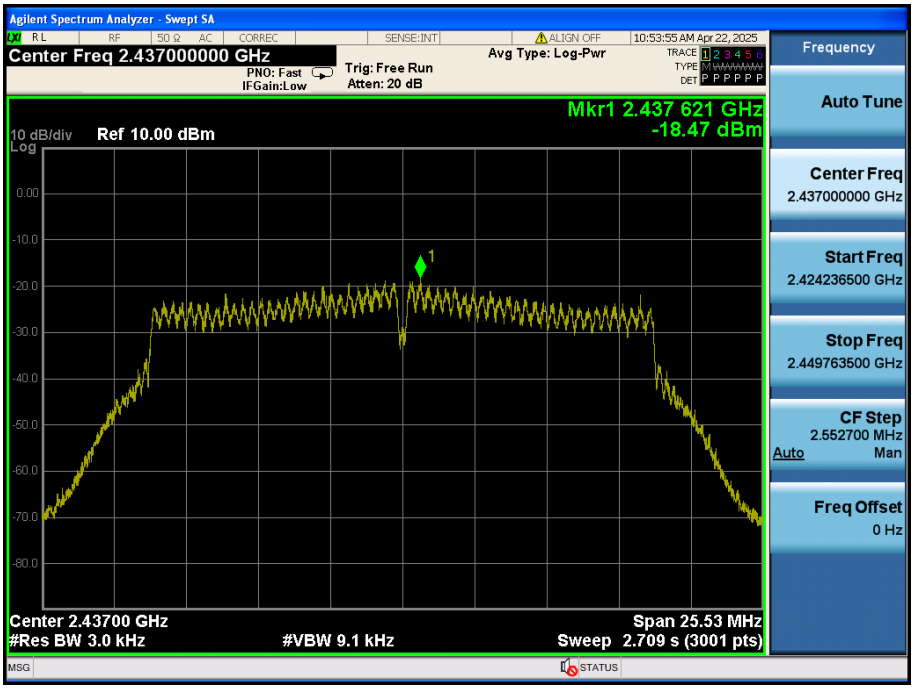
Power Spectral Density TM 2 & 2 462 MHz



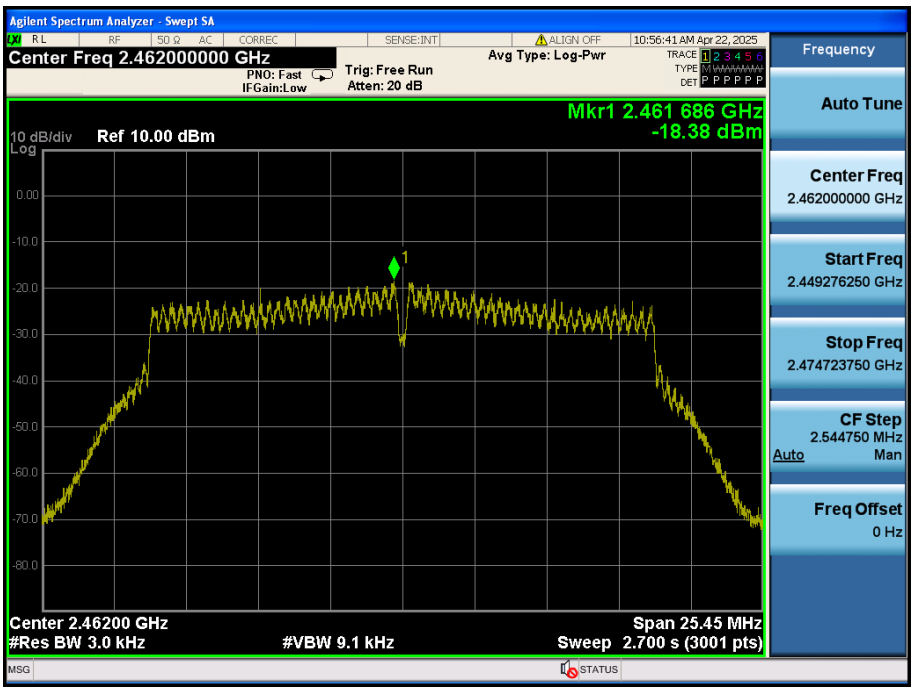
Power Spectral Density TM 3 & 2 412 MHz



Power Spectral Density TM 3 & 2 437 MHz



Power Spectral Density TM 3 & 2 462 MHz



5.4. Unwanted Emissions (Conducted)

▣ **Test requirements and limit, Part 15.247(d)**

In any 100 kHz bandwidth outside of the authorized frequency band, the power shall be attenuated according to the following conditions :

If the peak output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the peak conducted output power measured within any 100 kHz outside the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum measured in-band peak PSD level.

If the average output power procedure is used to measure the fundamental emission power to demonstrate compliance to 15.247(b)(3) requirements, then the power in any 100 kHz outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum measured inband average PSD level.

In either case, attenuation to levels below the general emission limits specified in §15.209(a) is not required.

5.4.1. Test Setup

Refer to the APPENDIX I including path loss

5.4.2. Test Procedures

- **KDB558074 D01v05r02 - Section 8.5**
- **ANSI C63.10-2013 – Section 11.11**

Reference level measurement

1. Set instrument center frequency to DTS channel center frequency.
2. Set the span to ≥ 1.5 times the DTS bandwidth.
3. Set the RBW = 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum PSD level

LIMIT LINE = 20 dB below of the reference level.

Emission level measurement

1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.(Actual 1 MHz , See below note)
3. Set the VBW ≥ 3 x RBW.(Actual 3 MHz, See below note)
4. Detector = peak.
5. Ensure that the number of measurement points ≥ span / RBW
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
9. Use the peak marker function to determine the maximum amplitude level.

Note: The unwanted emission(conducted) was tested with below settings.

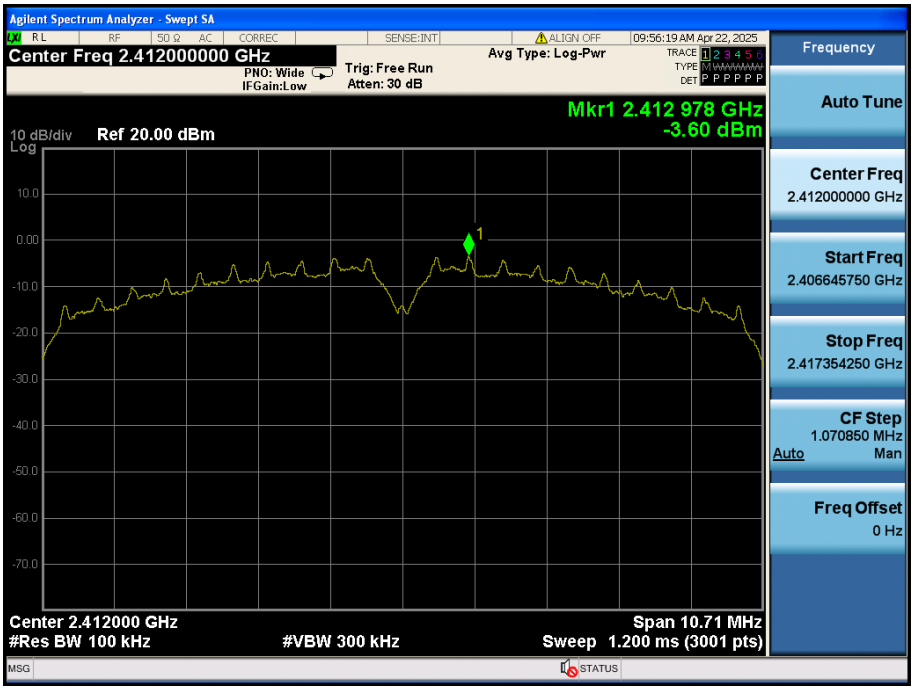
Frequency range	RBW	VBW	Detector	Trace	Sweep Point
9 kHz ~ 30 MHz	100 kHz	300 kHz	Peak	Max Hold	40 001
30 MHz ~ 10 GHz	1 MHz	3 MHz			
10 GHz ~ 25 GHz	1 MHz	3 MHz			

If the emission level with above setting was close to the limit (ie, less than 3 dB margin) then zoom scan is required using RBW = 100 kHz, VBW = 300 kHz, SPAN = 100 MHz and BINS = 2 001 to get accurate emission level within 100 kHz BW.

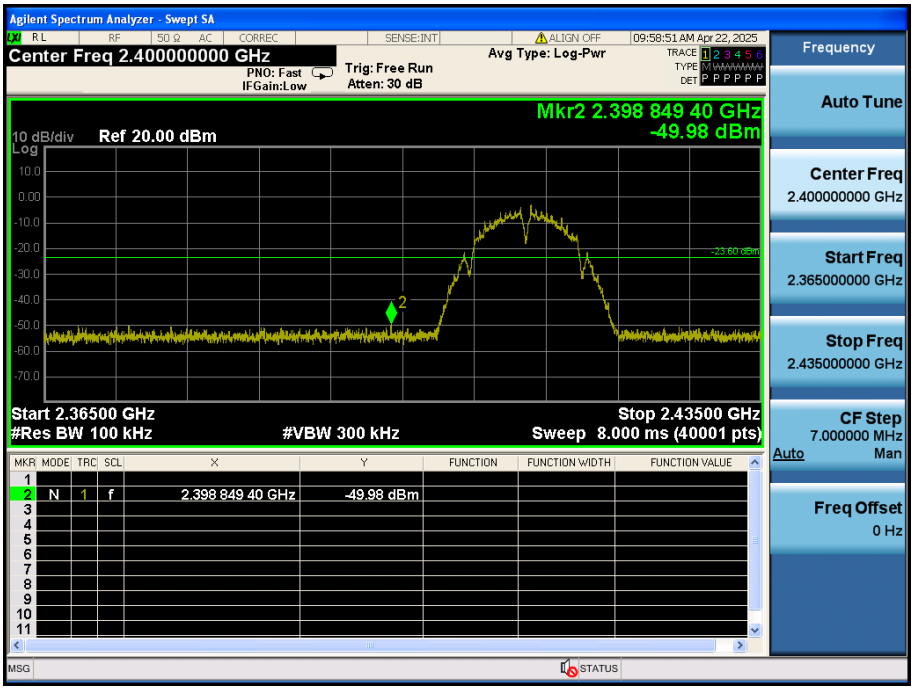
5.4.3. Test Results

TM 1 & 2 412 MHz

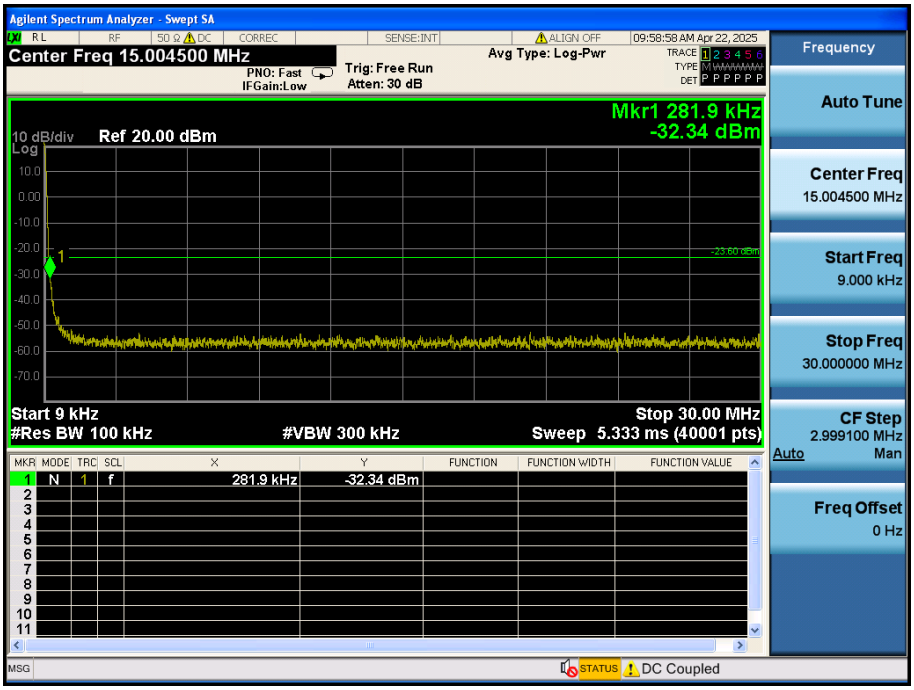
Reference

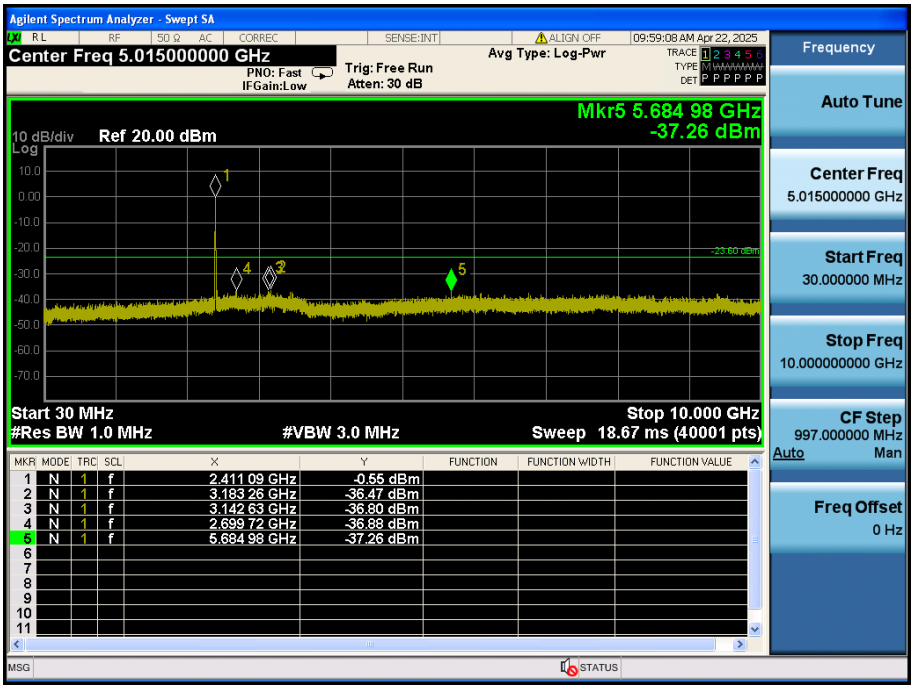


Low Band-edge

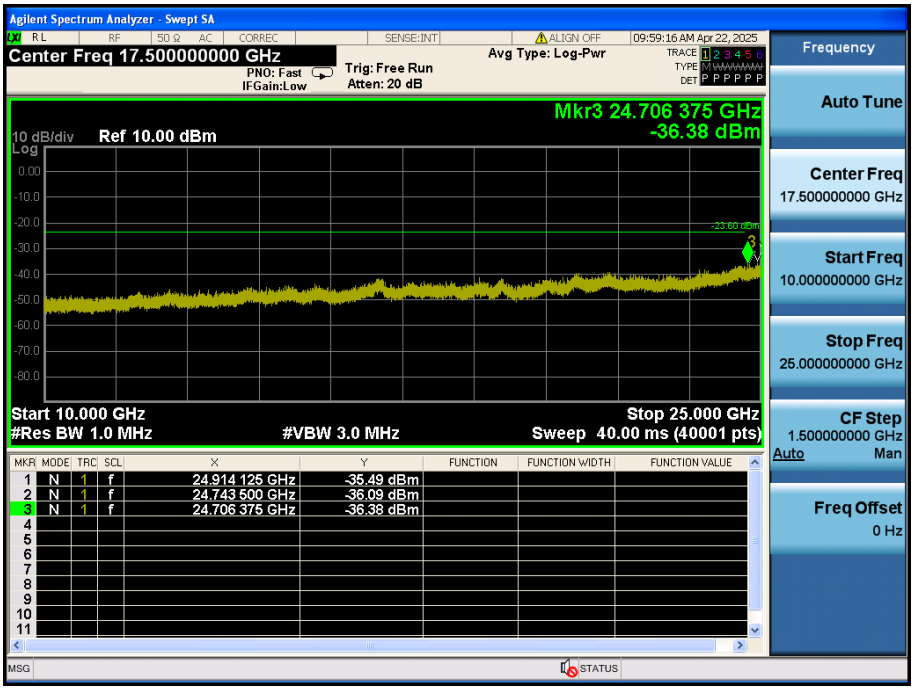


Conducted Spurious Emissions





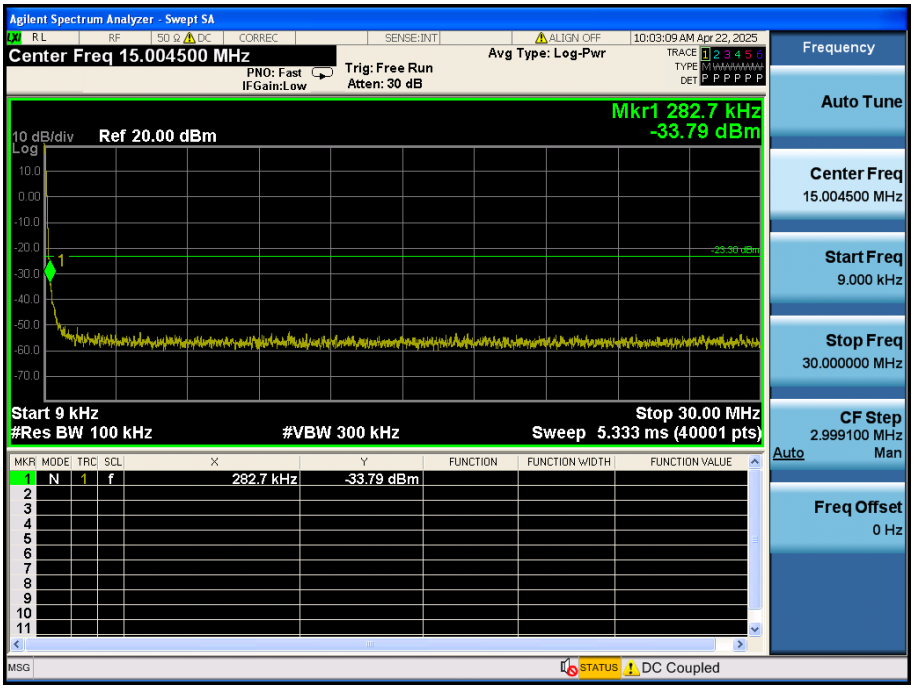
Conducted Spurious Emissions



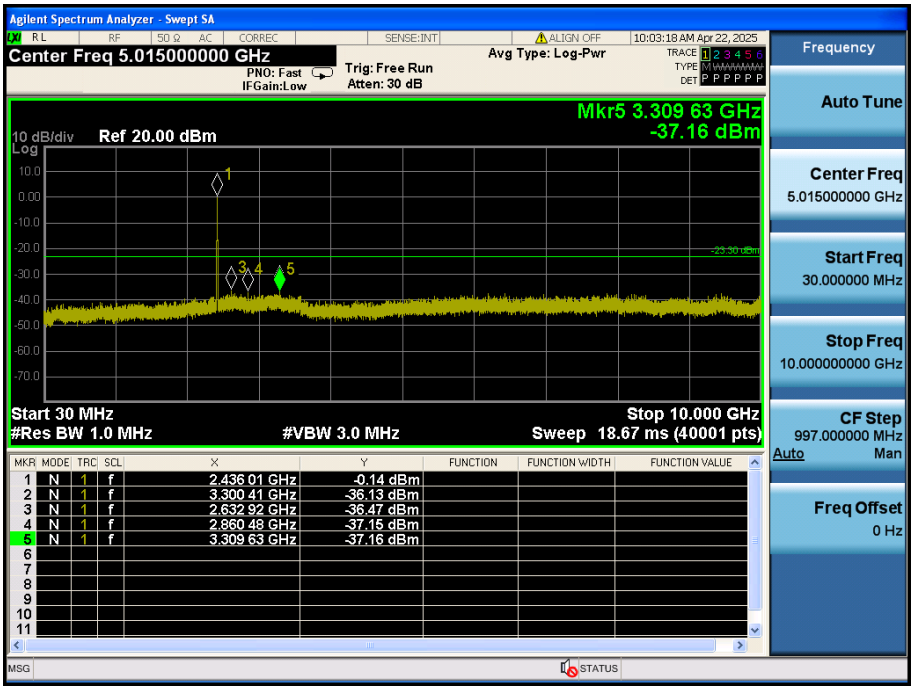
TM 1 & 2 437 MHz

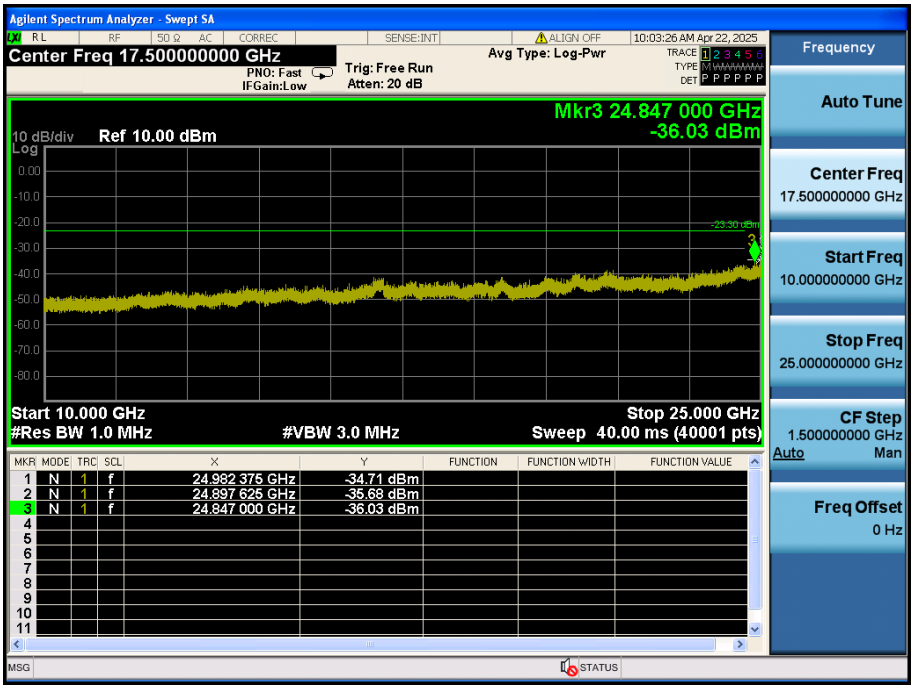
Reference

Conducted Spurious Emissions



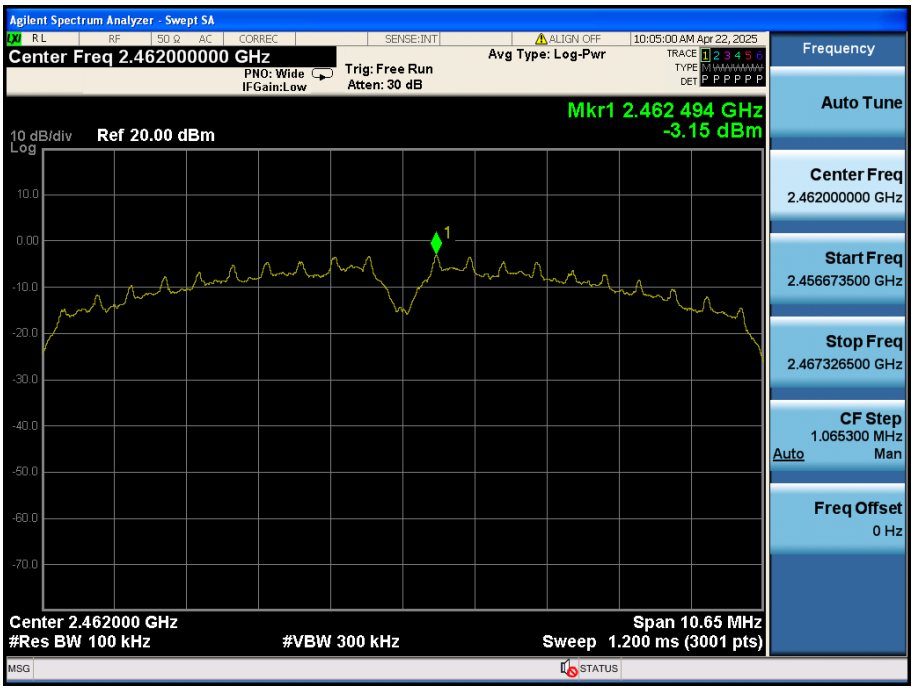
Conducted Spurious Emissions



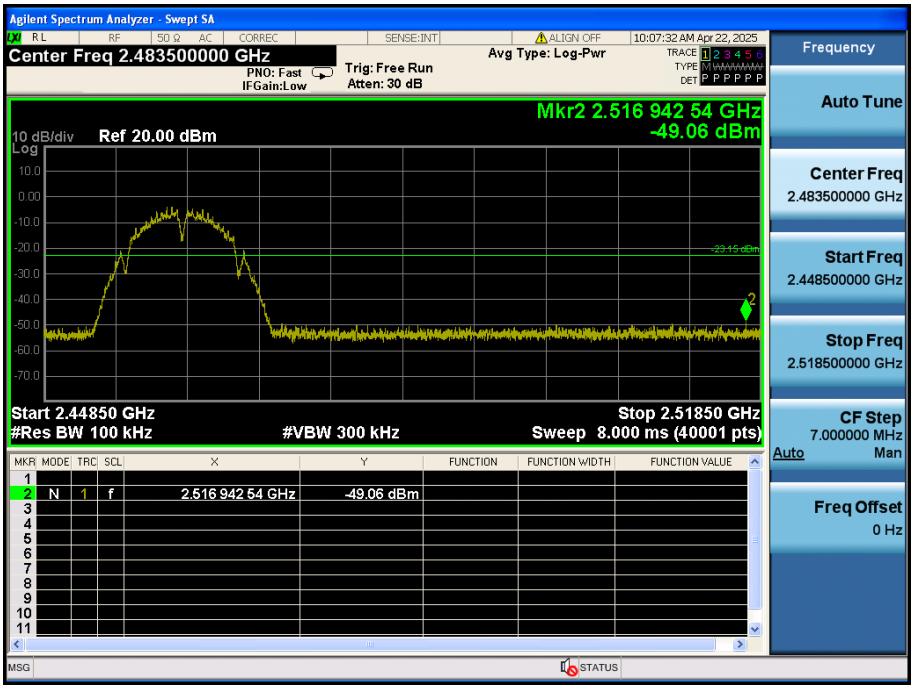


TM 1 & 2 462 MHz

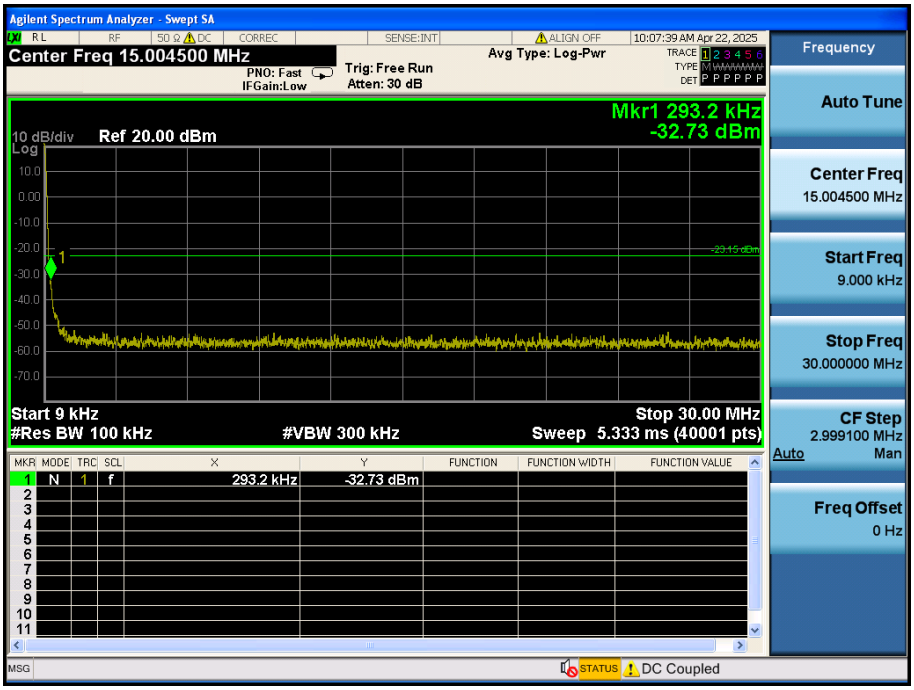
Reference



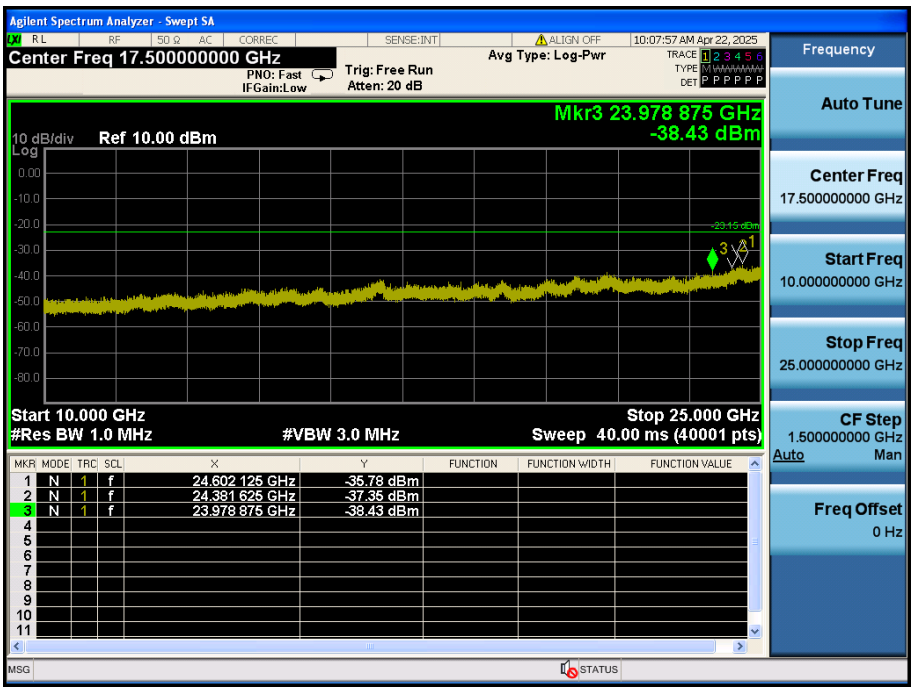
High Band-edge



Conducted Spurious Emissions



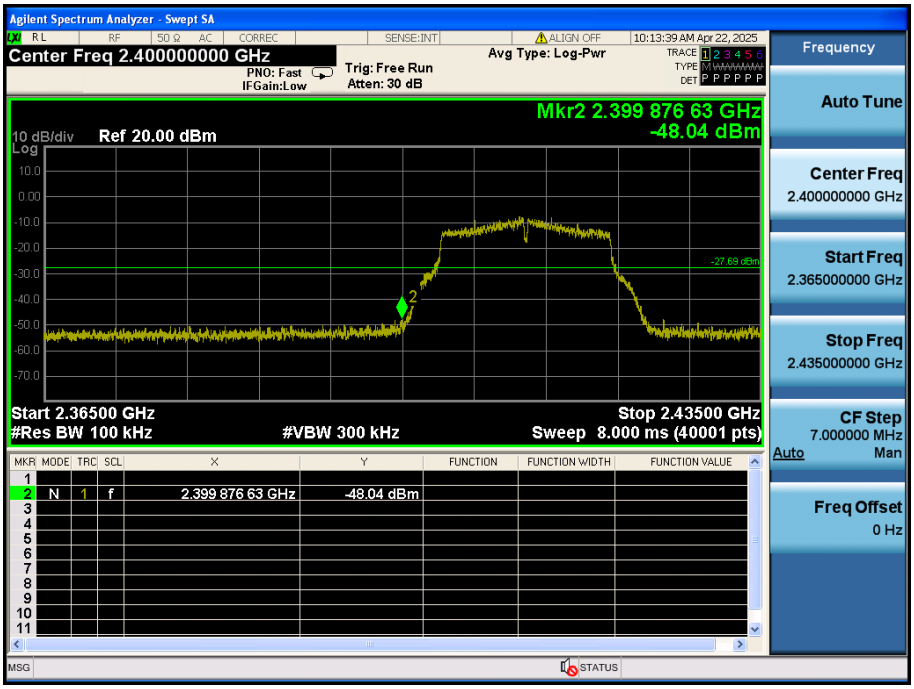
Conducted Spurious Emissions



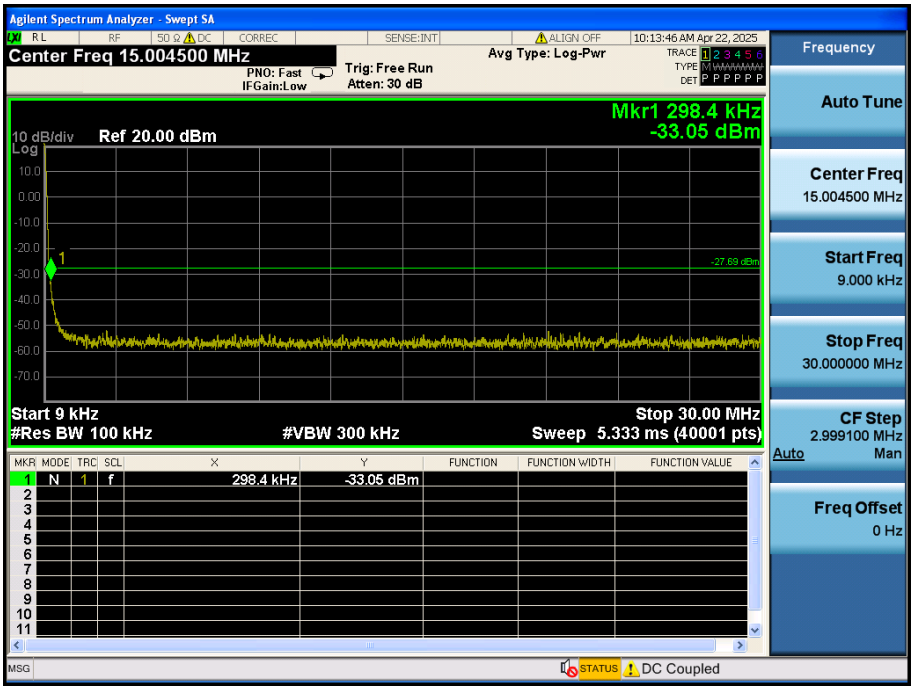
TM 2 & 2 412 MHz

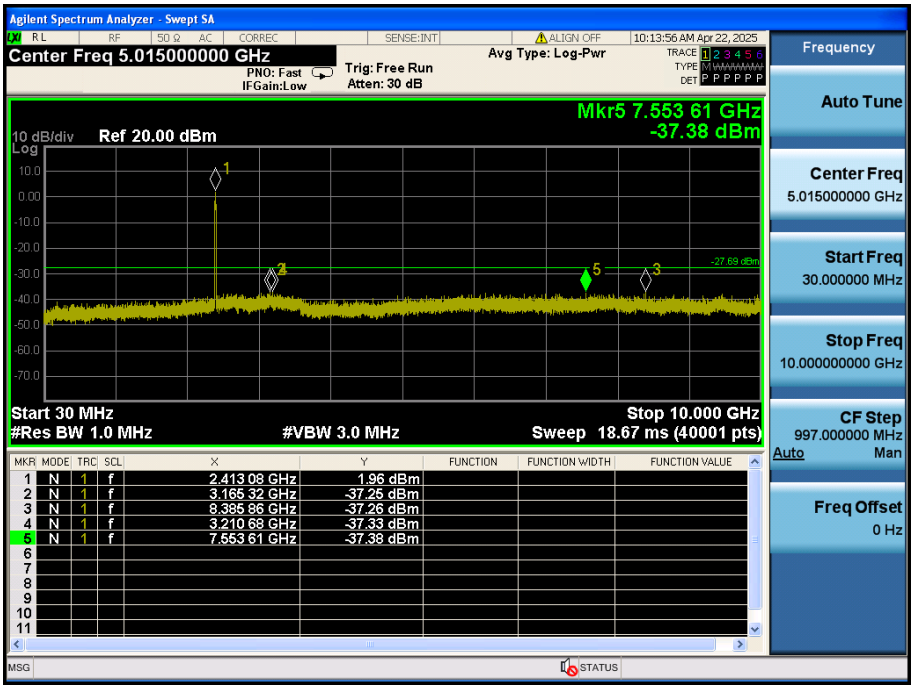
Reference

Low Band-edge

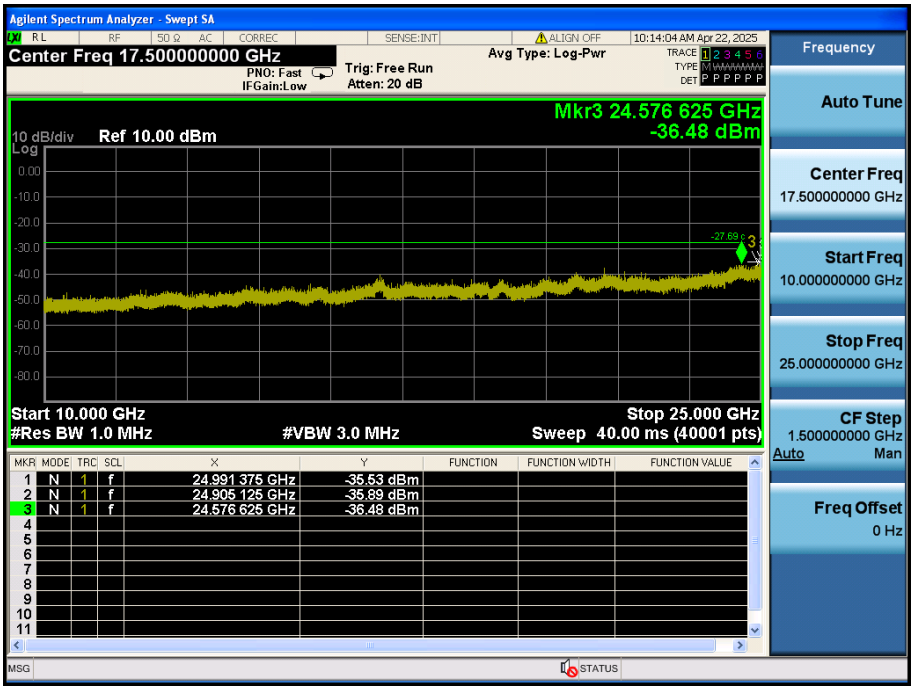


Conducted Spurious Emissions





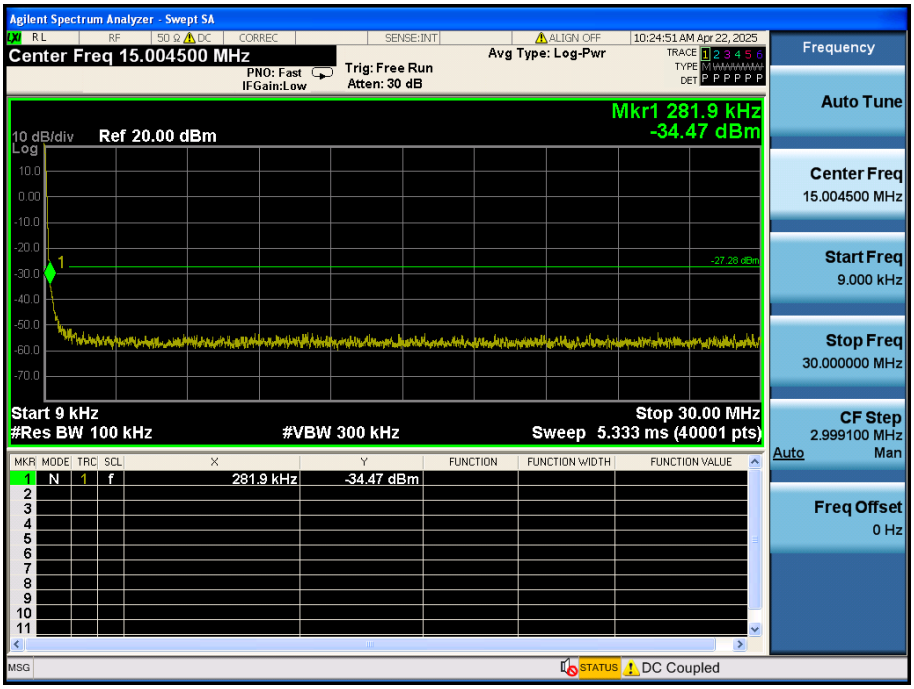
Conducted Spurious Emissions



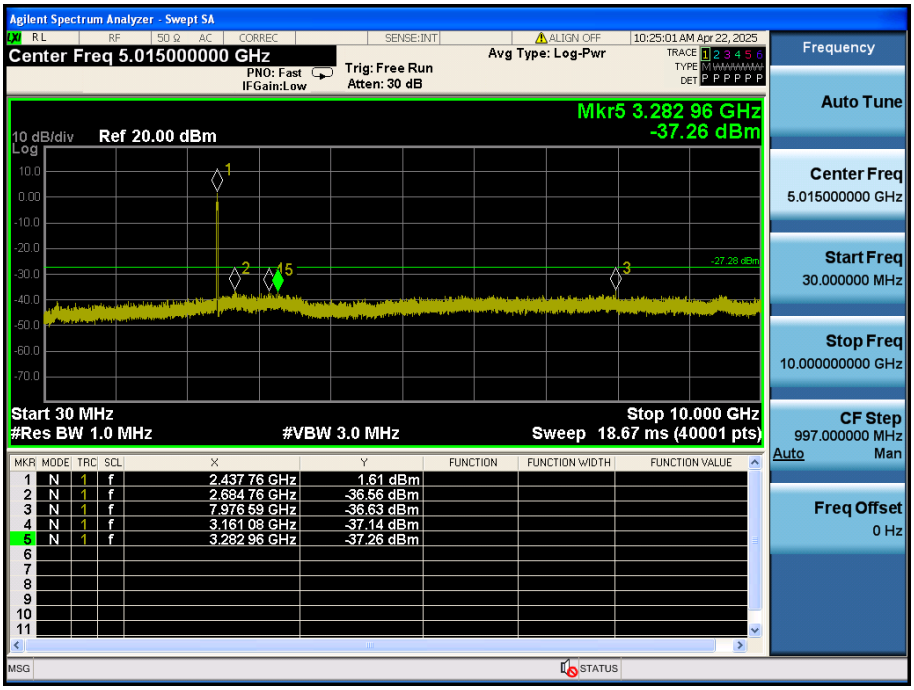
TM 2 & 2 437 MHz

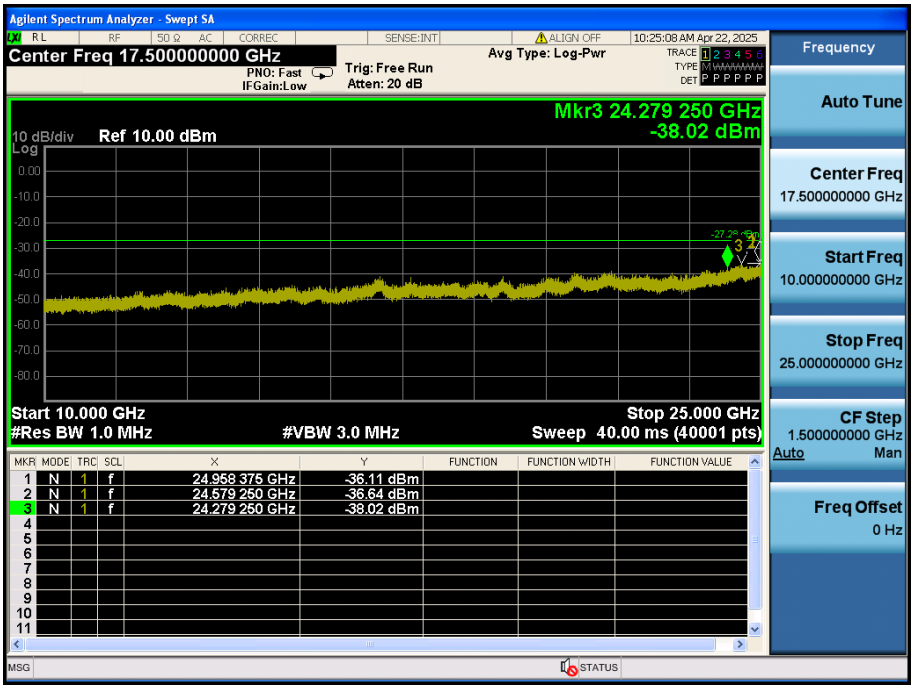
Reference

Conducted Spurious Emissions



Conducted Spurious Emissions

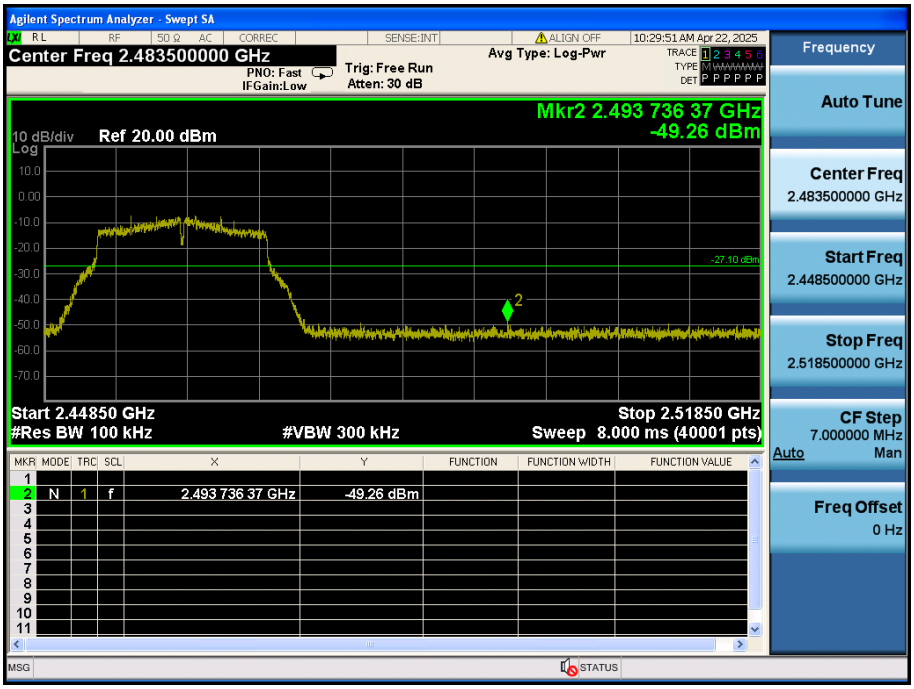




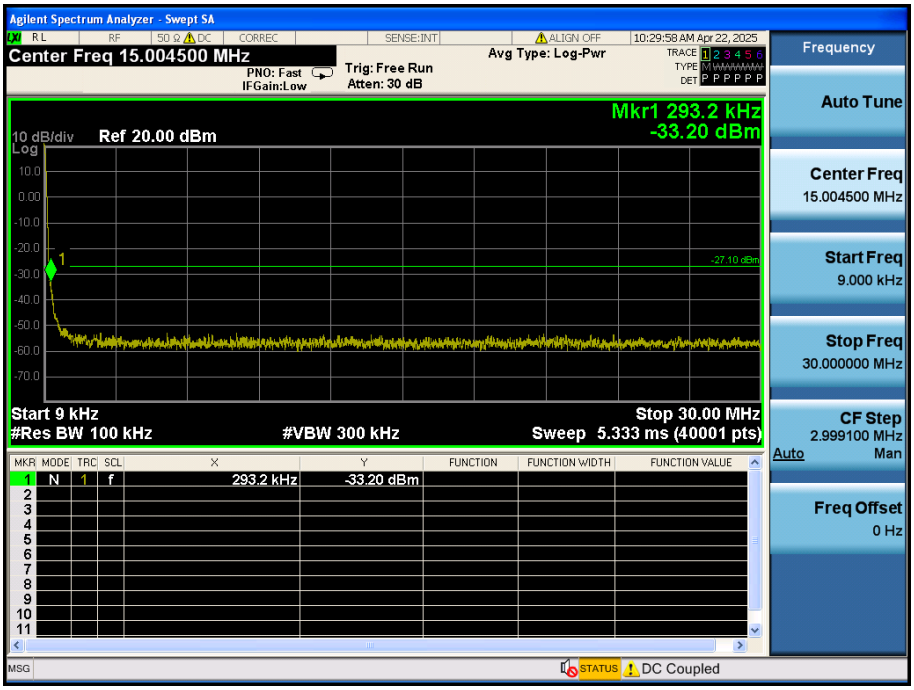
TM 2 & 2 462 MHz

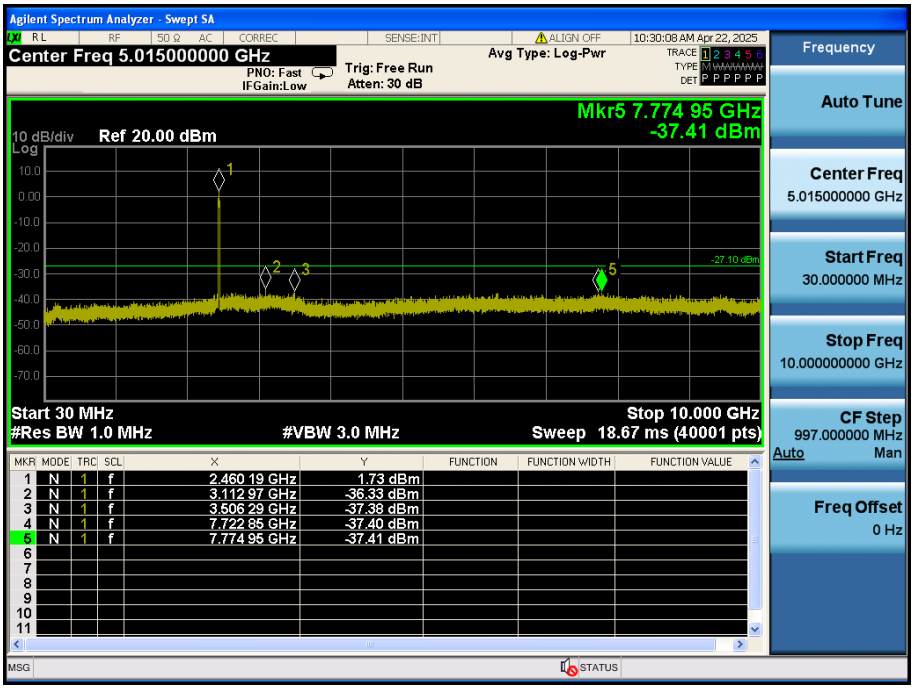
Reference

High Band-edge

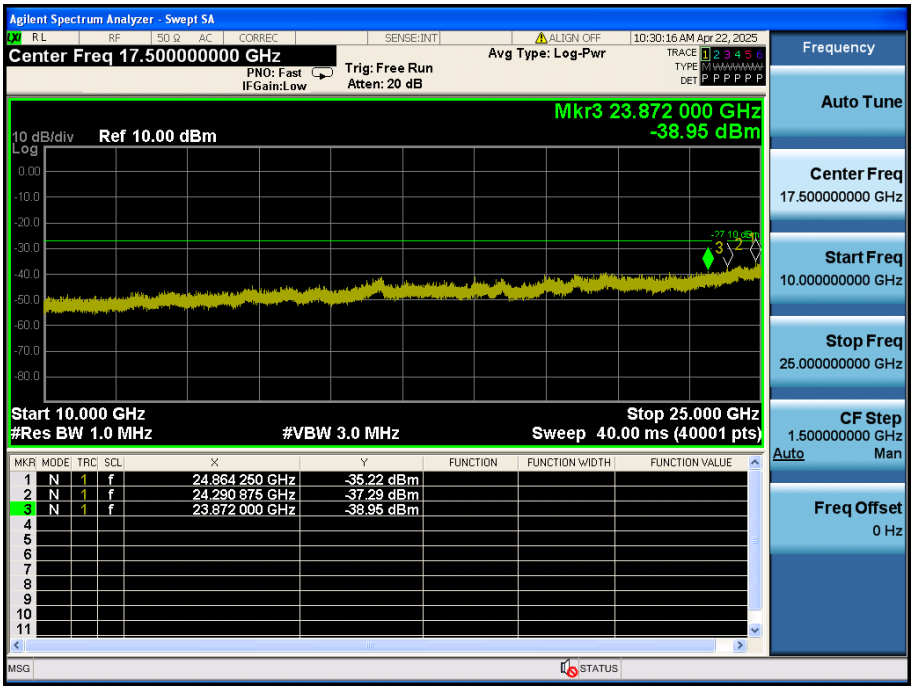


Conducted Spurious Emissions





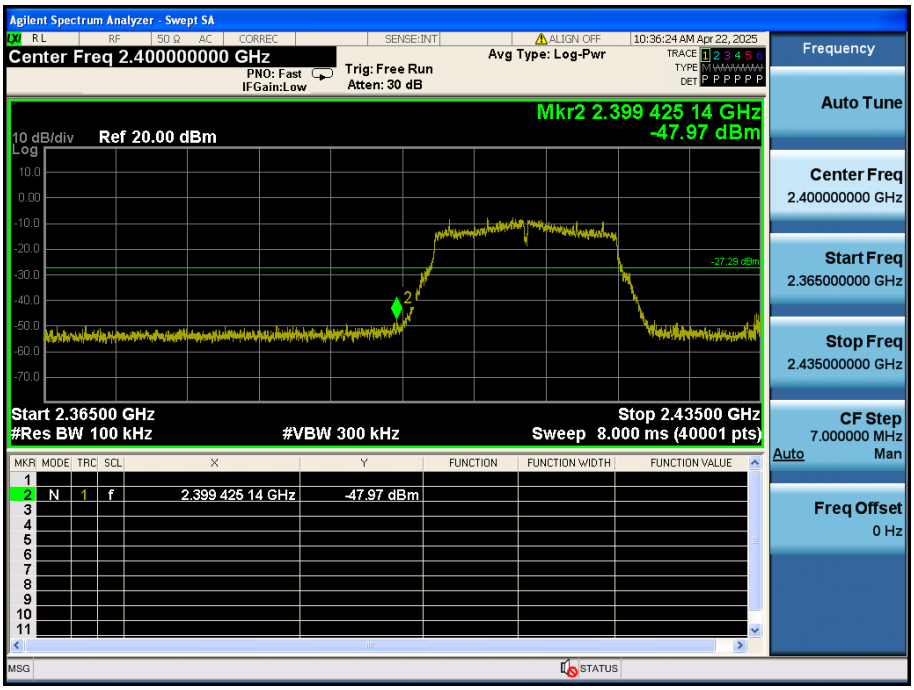
Conducted Spurious Emissions



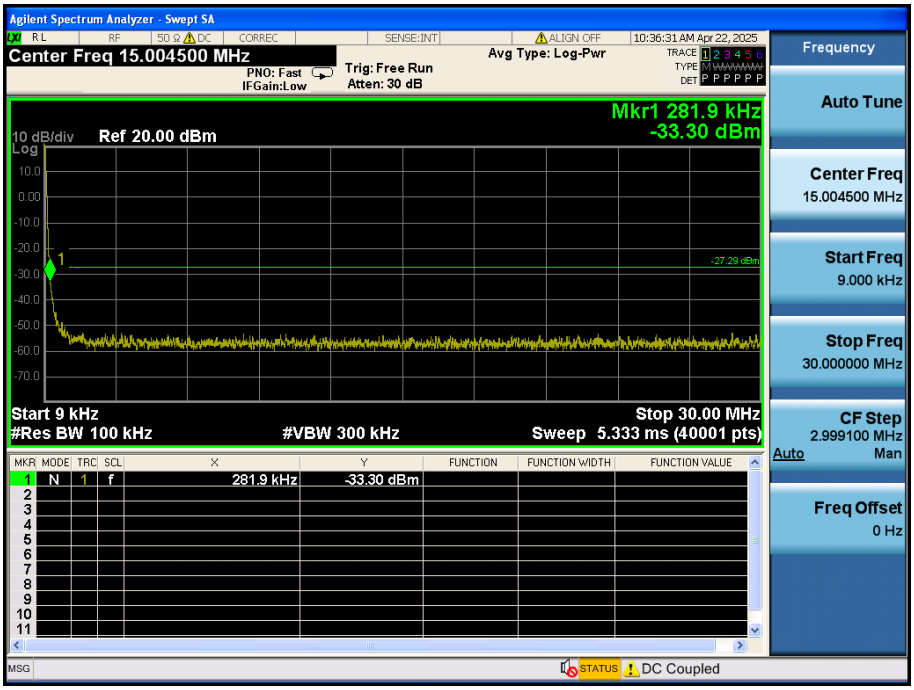
TM 3 & 2 412 MHz

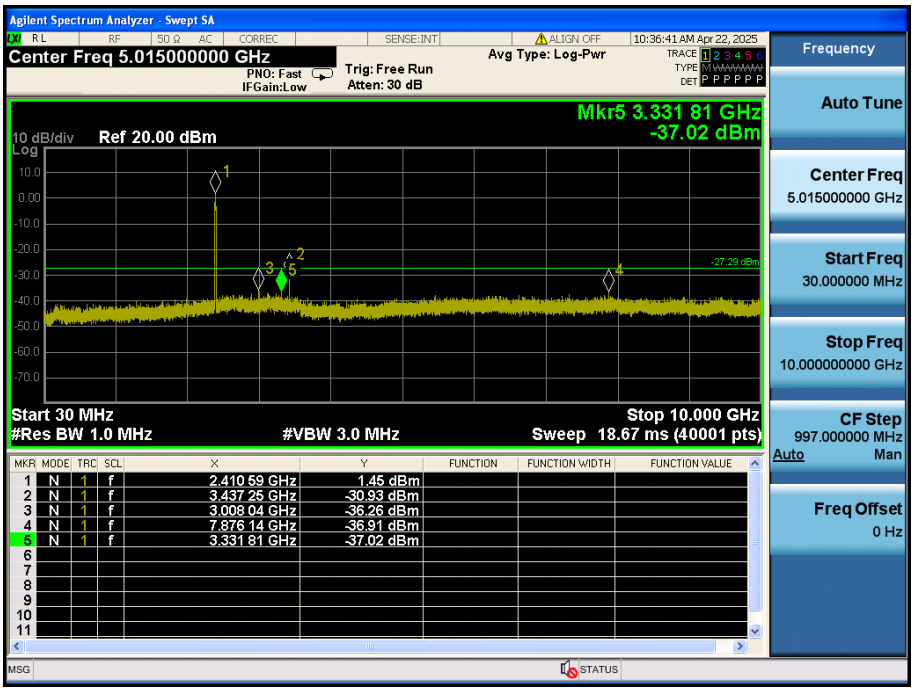
Reference

Low Band-edge

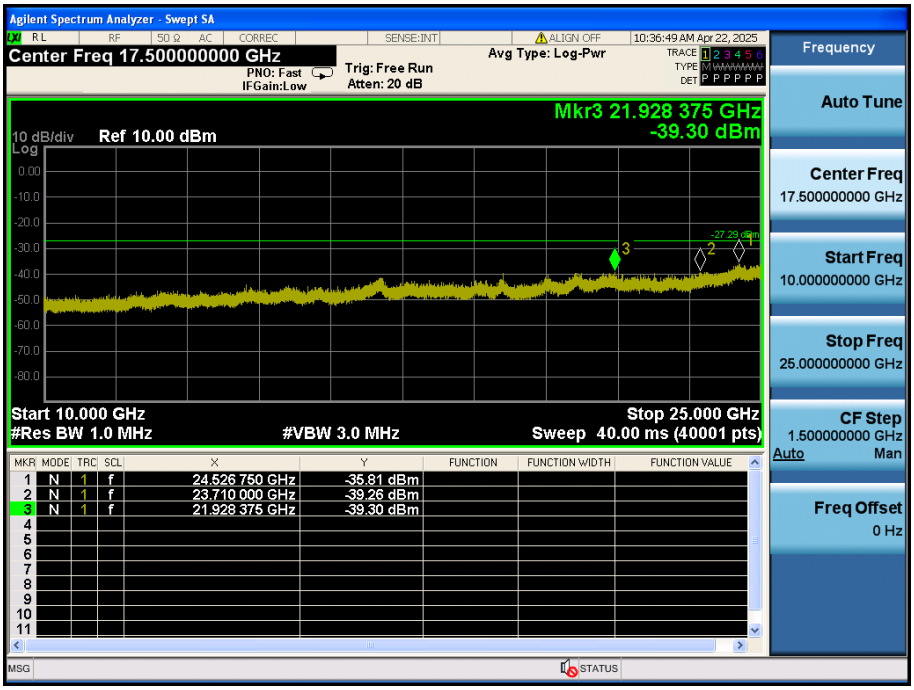


Conducted Spurious Emissions





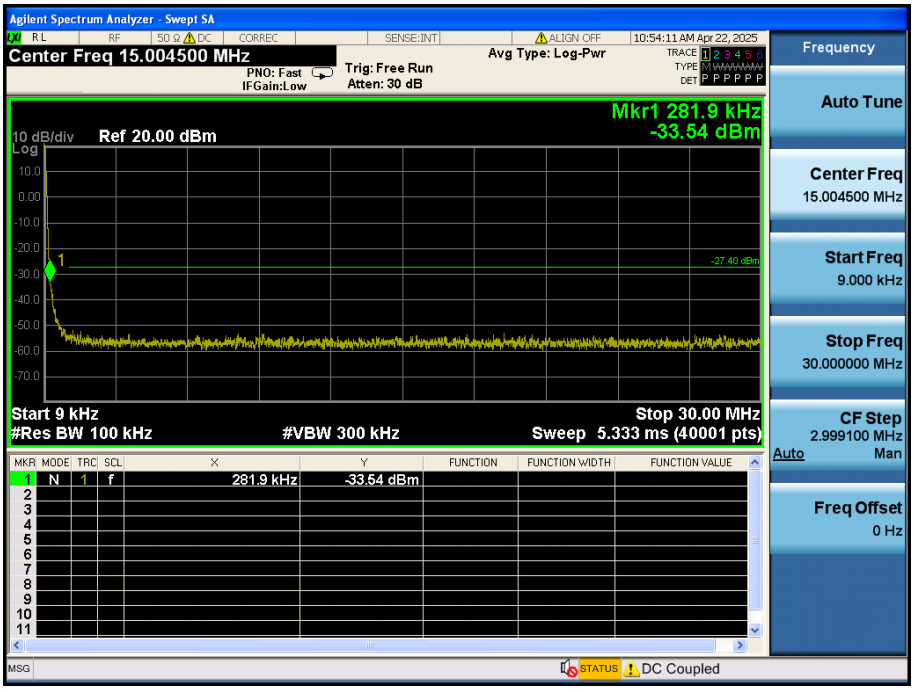
Conducted Spurious Emissions



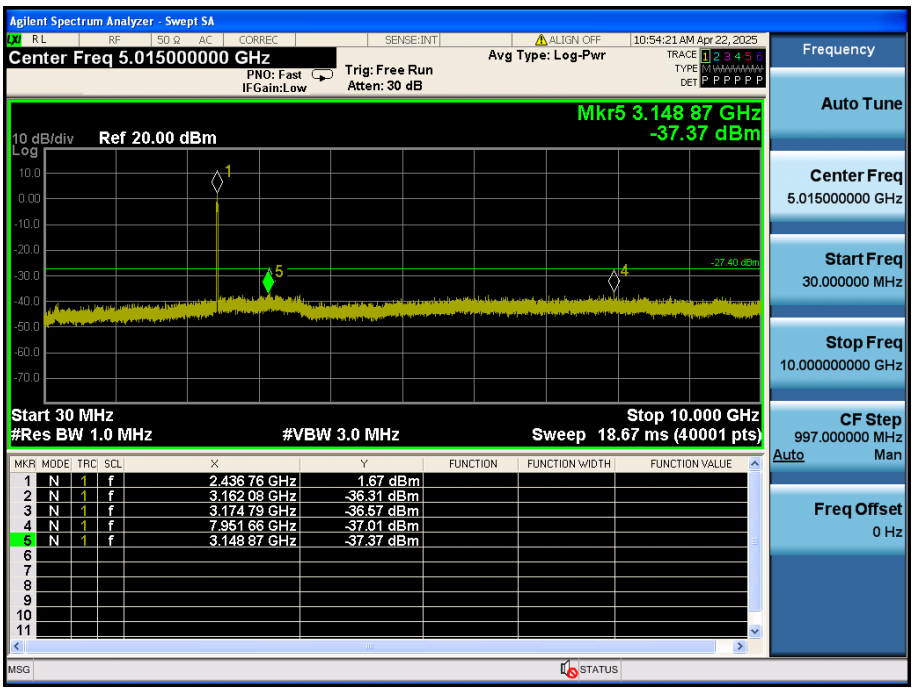
TM 3 & 2 437 MHz

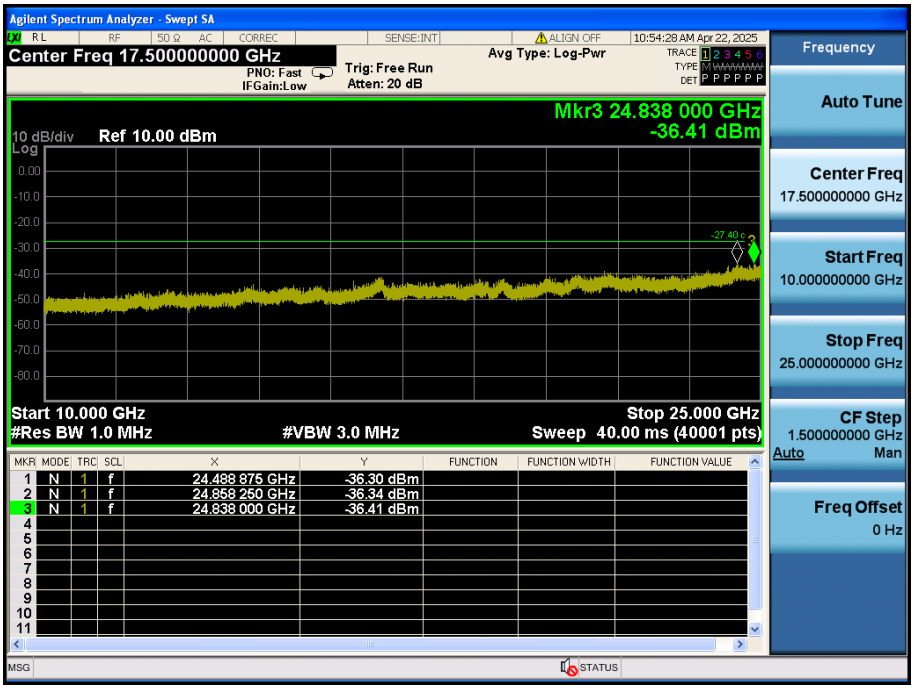
Reference

Conducted Spurious Emissions



Conducted Spurious Emissions

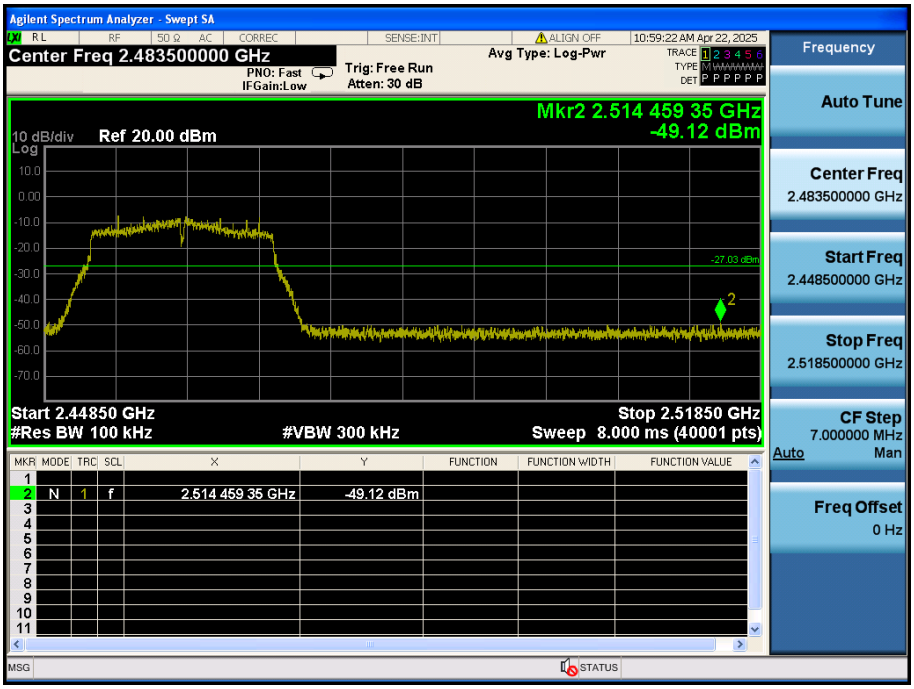




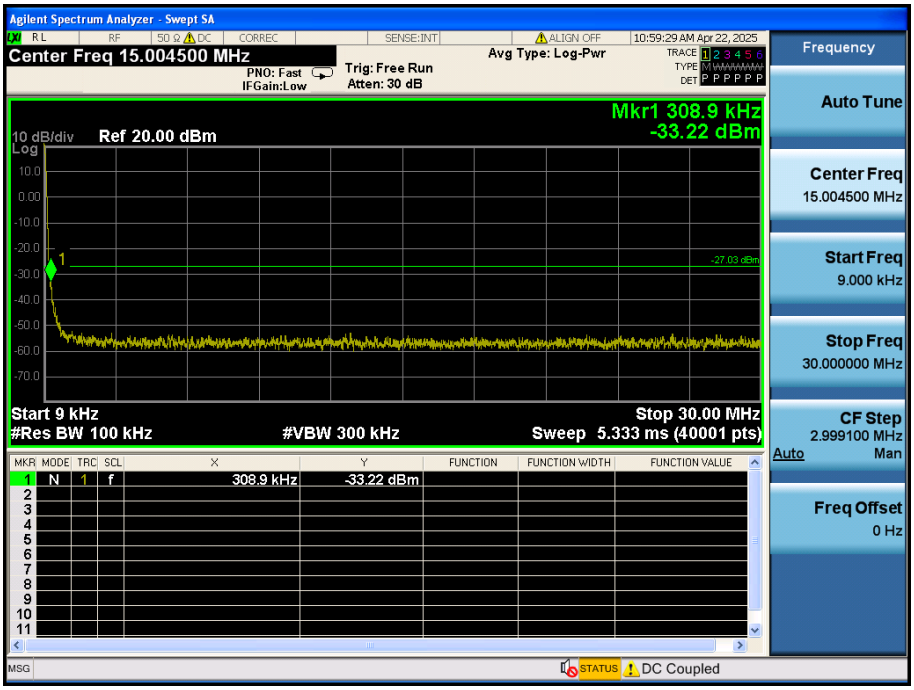
TM 3 & 2 462 MHz

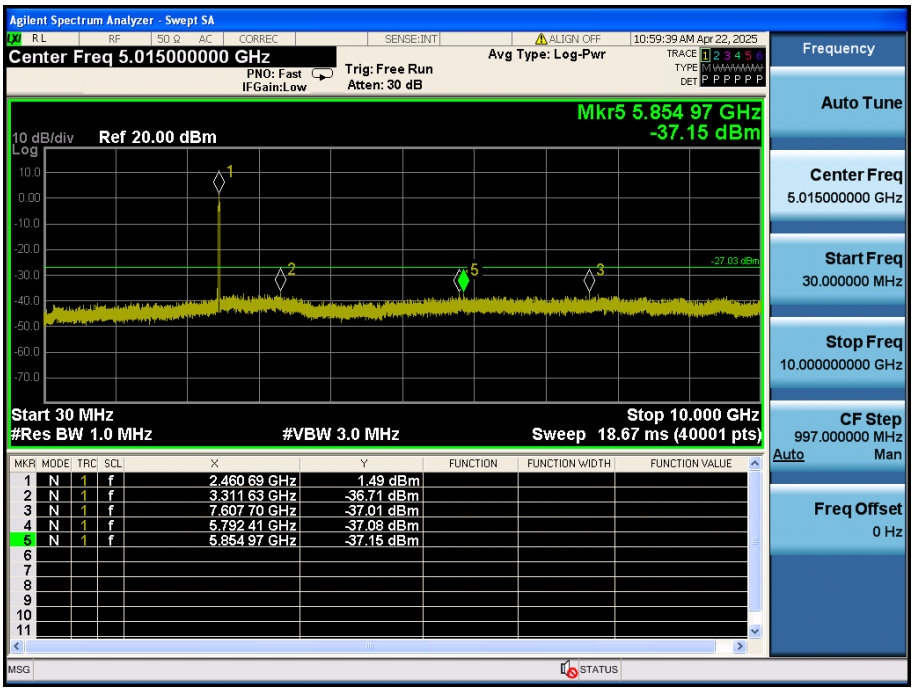
Reference

High Band-edge

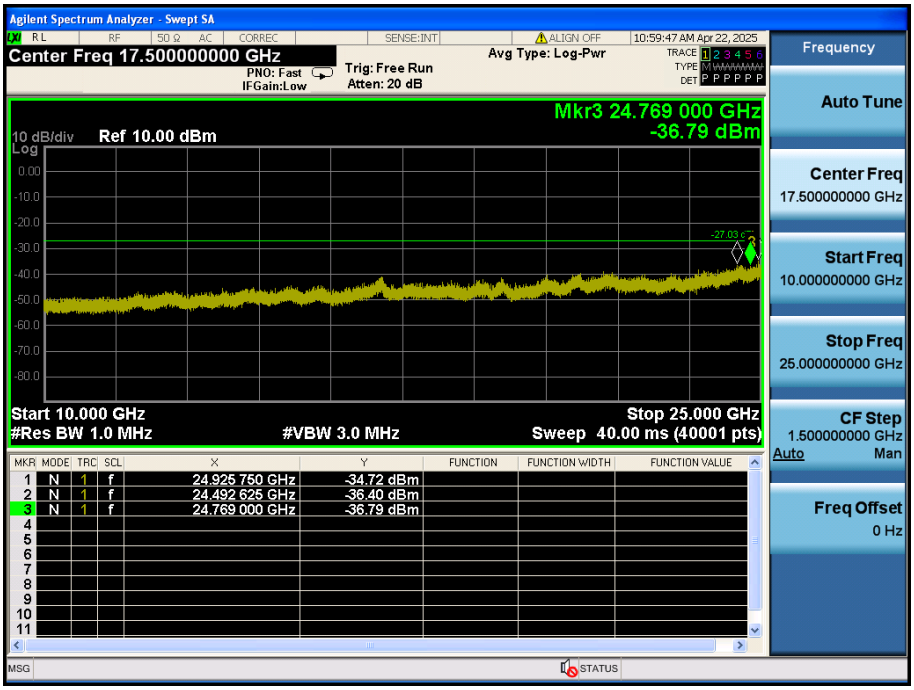


Conducted Spurious Emissions





Conducted Spurious Emissions



5.5. Unwanted Emissions (Radiated)

▣ **Test Requirements and limit,**

Part 15.247(d), Part 15.205, Part 15.209

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of Part 15.247 the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

- Part 15.209: General requirement

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
0.009 – 0.490	2 400 / F (kHz)	300
0.490 – 1.705	24 000 / F (kHz)	30
1.705 – 30.0	30	30

Frequency (MHz)	FCC Limit (uV/m)	Measurement Distance (m)
30 ~ 88	100 **	3
88 ~ 216	150 **	3
216 ~ 960	200 **	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §15.231 and 15.241.

- Part 15.205(a): Restricted band of operation

MHz	MHz	MHz	MHz	GHz	GHz
0.009 ~ 0.110	8.414 25 ~ 8.414 75	108 ~ 121.94	1 300 ~ 1 427	4.5 ~ 5.15	14.47 ~ 14.5
0.495 ~ 0.505	12.29 ~ 12.293	123 ~ 138	1 435 ~ 1 626.5	5.35 ~ 5.46	15.35 ~ 16.2
2.173 5 ~ 2.190 5	12.519 75 ~ 12.520 25	149.9 ~ 150.05	1 645.5 ~ 1 646.5	7.25 ~ 7.75	17.7 ~ 21.4
4.125 ~ 4.128	12.576 75 ~ 12.577 25	156.524 75 ~ 156.525 25	1 660 ~ 1 710	8.025 ~ 8.5	22.01 ~ 23.12
4.177 25 ~ 4.177 75	13.36 ~ 13.41	156.7 ~ 156.9	1 718.8 ~ 1 722.2	9.0 ~ 9.2	23.6 ~ 24.0
4.207 25 ~ 4.207 75	16.42 ~ 16.423	162.012 5 ~ 167.17	2 200 ~ 2 300	9.3 ~ 9.5	31.2 ~ 31.8
6.215 ~ 6.218	16.694 75 ~ 16.695 25	167.72 ~ 173.2	2 310 ~ 2 390	10.6 ~ 12.7	36.43 ~ 36.5
6.267 75 ~ 6.268 25	16.804 25 ~ 16.804 75	240 ~ 285	2 483.5 ~ 2 500	13.25 ~ 13.4	Above 38.6
6.311 75 ~ 6.312 25	25.5 ~ 25.67	322 ~ 335.4	2 655 ~ 2 900		
8.291 ~ 8.294	37.5 ~ 38.25	399.90 ~ 410	3 260 ~ 3 267		
8.362 ~ 8.366	73 ~ 74.6	608 ~ 614	3 332 ~ 3 339		
8.376 25 ~ 8.386 75	74.8 ~ 75.2	960 ~ 1 240	3 345.8 ~ 3 358		
			3 600 ~ 4 400		

5.5.1. Test Setup

Refer to the APPENDIX I.

5.5.2. Test Procedures

1. The EUT is placed on a non-conductive table. For emission measurements at or below 1 GHz, the table height is 80 cm. For emission measurements above 1 GHz, the table height is 1.5 m.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3 m away from the receiving antenna, which is varied from 1 m to 4 m to find out the highest emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.

Note: Measurement Instrument Setting for Radiated Emission Measurements.

- **KDB558074 D01v05r02 - Section 8.6**
- **ANSI C63.10-2013 – Section 11.12**

1. Frequency Range Below 1 GHz

RBW = 100 or 120 kHz, VBW = 3 x RBW, Detector = Peak or Quasi Peak

2. Frequency Range > 1 GHz

Peak Measurement > 1 GHz

RBW = 1 MHz, VBW = 3 MHz, Detector = Peak, Sweep time = Auto, Trace mode = Max Hold until the trace stabilizes

Average Measurement > 1 GHz

1. RBW = 1 MHz (unless otherwise specified).
2. VBW ≥ 3 x RBW.
3. Detector = RMS (Number of points ≥ 2 x Span / RBW)
4. Averaging type = power (i.e., RMS).
5. Sweep time = auto.
6. Perform a trace average of at least 100 traces.
7. A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:
   1) If power averaging (RMS) mode was used in step 4, then the applicable correction factor is 10 log(1 / D), where D is the duty cycle.
   2) If linear voltage averaging mode was used in step 4, then the applicable correction factor is 20 log(1 / D), where D is the duty cycle.
   3) If a specific emission is demonstrated to be continuous (≥ 98 percent duty cycle) rather than turning on and off with the transmit cycle, then no duty cycle correction is required for that emission.

Duty Cycle Correction factor

Test Mode	Date rate	T_{on}(ms)	T_{on+off} (ms)	D = T_{on} / (T_{on+off})	DCCF = 10 log(1/D) (dB)
TM 1	1 Mbps	12.410	12.510	0.992 0	0.03
TM 2	6 Mbps	2.064	2.166	0.952 9	0.21
TM 3	MCS 0	1.920	2.022	0.949 6	0.22

Note1: Where, T= Transmission duration / D= Duty cycle

Note2: Please refer to the appendix II for duty cycle plots.

5.5.3. Test Results

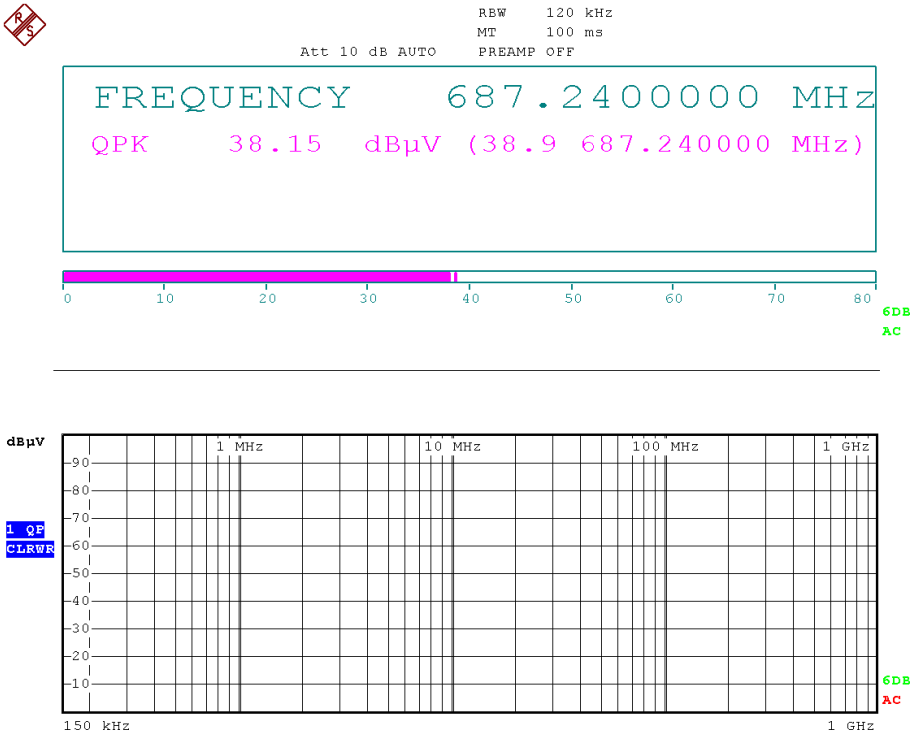
- **Test Notes**

1. The radiated emissions below 1 GHz were investigated 9 kHz to 1 GHz and the worst case data was reported.
2. Information of Distance Correction Factor
   For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.
   In this case, the distance factor is applied to the result.
   - Calculation of distance correction factor
   At frequencies below 30 MHz = 40 log(tested distance / specified distance)
   At frequencies at or above 30 MHz = 20 log(tested distance / specified distance)
   When distance factor is “N/A”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss, AL = Attenuator Loss,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

Radiated Emissions data(9 kHz ~ 1 GHz) : TM 1

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	687.24	H	X	QP	38.90	3.84	N/A	N/A	42.74	46.02	3.28
	700.62	H	X	QP	35.60	4.05	N/A	N/A	39.65	46.02	6.37
	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-

TM 1 & 2 412 MHz & X axis & Hor Detector Mode : QP



- **Test Notes**

1. The radiated emissions were investigated 1 GHz to 25 GHz. And no other spurious and harmonic emissions were found below listed frequencies.
2. Information of Distance Correction Factor
   For finding emissions, measurements may be performed at a distance closer than that specified in the regulations.
   In this case, the distance factor is applied to the result.
   - Calculation of distance correction factor
   At frequencies below 30 MHz = 40 log(tested distance / specified distance)
   At frequencies at or above 30 MHz = 20 log(tested distance / specified distance)
   When distance factor is “N/A”, the measurements were performed at the specified distance and distance factor is not applied.
3. Sample Calculation.
   Margin = Limit – Result / Result = Reading + TF+ DCCF + DCF / TF = AF + CL + HL + AL – AG
   Where, TF = Total Factor, AF = Antenna Factor, CL = Cable Loss, AG = Amplifier Gain, HL = High pass filter Loss, AL = Attenuator Loss,
   DCCF = Duty Cycle Correction Factor, DCF = Distance Correction Factor

Radiated Emissions data(1 GHz ~ 25 GHz) : TM 1

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2 388.15	H	X	PK	50.95	4.96	N/A	N/A	55.91	74.00	18.09
	2 387.75	H	X	AV	39.77	4.96	N/A	N/A	44.73	54.00	9.27
	4 824.64	H	X	PK	49.93	2.44	N/A	N/A	52.37	74.00	21.63
	4 824.87	H	X	AV	39.63	2.44	N/A	N/A	42.07	54.00	11.93
2 437	4 872.84	H	X	PK	50.26	2.36	N/A	N/A	52.62	74.00	21.38
	4 872.78	H	X	AV	39.79	2.36	N/A	N/A	42.15	54.00	11.85
2 462	2 487.55	H	X	PK	49.29	5.72	N/A	N/A	55.01	74.00	18.99
	2 487.88	H	X	AV	39.44	5.73	N/A	N/A	45.17	54.00	8.83
	4 924.55	H	X	PK	49.52	3.14	N/A	N/A	52.66	74.00	21.34
	4 924.08	H	X	AV	39.22	3.14	N/A	N/A	42.36	54.00	11.64

Radiated Emissions data(1 GHz ~ 25 GHz) : TM 2

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2 386.60	H	X	PK	49.64	4.95	N/A	N/A	54.59	74.00	19.41
	2 386.04	H	X	AV	40.18	4.95	0.21	N/A	45.34	54.00	8.66
	4 824.59	H	X	PK	49.52	2.44	N/A	N/A	51.96	74.00	22.04
	4 824.03	H	X	AV	39.47	2.44	0.21	N/A	42.12	54.00	11.88
2 437	4 874.72	H	X	PK	50.36	2.41	N/A	N/A	52.77	74.00	21.23
	4 874.04	H	X	AV	39.53	2.36	0.21	N/A	42.10	54.00	11.90
2 462	2 493.71	H	X	PK	50.00	5.84	N/A	N/A	55.84	74.00	18.16
	2 492.81	H	X	AV	39.74	5.82	0.21	N/A	45.77	54.00	8.23
	4 923.23	H	X	PK	49.35	3.13	N/A	N/A	52.48	74.00	21.52
	4 923.20	H	X	AV	39.10	3.13	0.21	N/A	42.44	54.00	11.56

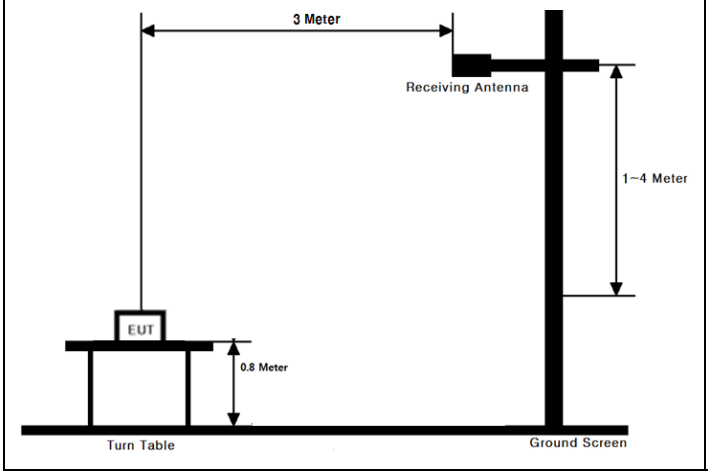
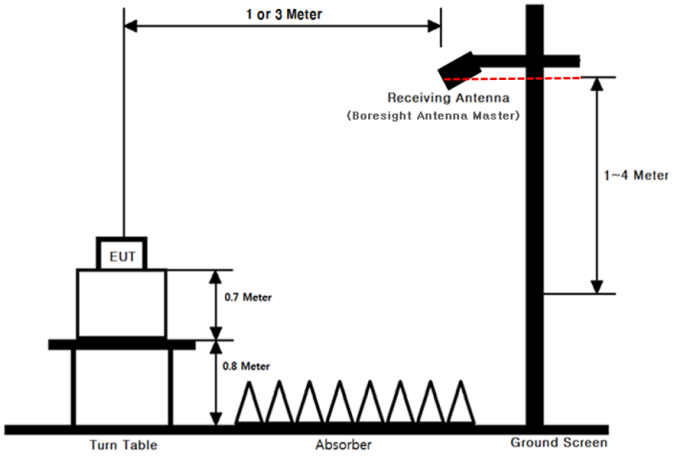
Radiated Emissions data(1 GHz ~ 25 GHz) : TM 3

Tested Frequency (MHz)	Frequency (MHz)	ANT Pol	EUT Position (Axis)	Detector Mode	Reading (dBuV)	TF (dB/m)	DCCF (dB)	DCF (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin(dB)
2 412	2374.08	H	X	PK	51.97	4.88	N/A	N/A	56.85	74.00	17.15
	2374.68	H	X	AV	41.86	4.89	0.22	N/A	46.97	54.00	7.03
	4824.17	H	X	PK	50.80	2.44	N/A	N/A	53.24	74.00	20.76
	4824.13	H	X	AV	39.61	2.44	0.22	N/A	42.27	54.00	11.73
2 437	4873.13	H	X	PK	49.68	2.36	N/A	N/A	52.04	74.00	21.96
	4873.98	H	X	AV	39.61	2.36	0.22	N/A	42.19	54.00	11.81
2 462	2495.29	H	X	PK	51.86	5.86	N/A	N/A	57.72	74.00	16.28
	2494.57	H	X	AV	41.84	5.85	0.22	N/A	47.91	54.00	6.09
	4923.44	H	X	PK	49.98	3.13	N/A	N/A	53.11	74.00	20.89
	4923.08	H	X	AV	39.14	3.13	0.22	N/A	42.49	54.00	11.51

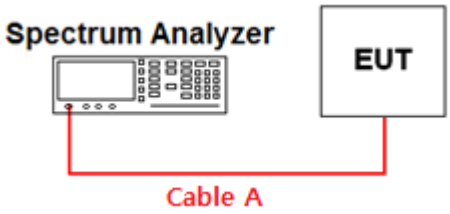
APPENDIX I

Test set up diagrams

- **Radiated Measurement**

Below 1 GHz	Above 1 GHz
	

- **Conducted Measurement**



Path loss information

Frequency (GHz)	Path Loss (dB)	Frequency (GHz)	Path Loss (dB)
0.03	9.16	15	11.28
1	9.57	20	12.31
2.412 & 2.437 & 2.462	9.98	25	14.27
5	10.03	-	-
10	10.70	-	-

Note 1: The path loss from EUT to Spectrum analyzer was measured and used for test.
Path loss (S/A's correction factor) = Cable A + Attenuator

APPENDIX II

Duty cycle plots

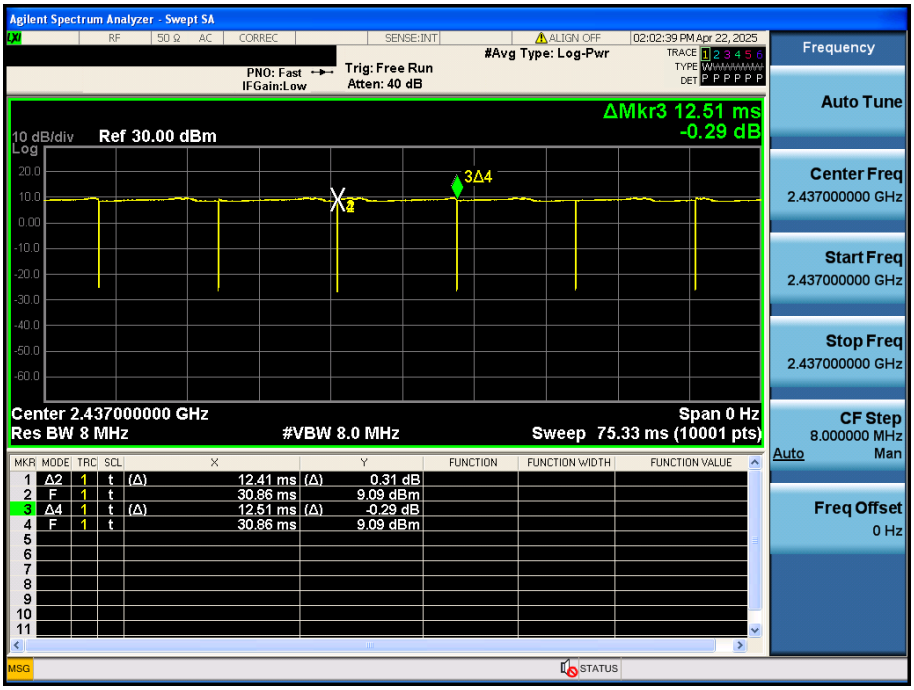
- **Test Procedures**

- KDB558074 D01v05r02 – Section 6

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set VBW ≥ RBW. Set detector = peak or average.

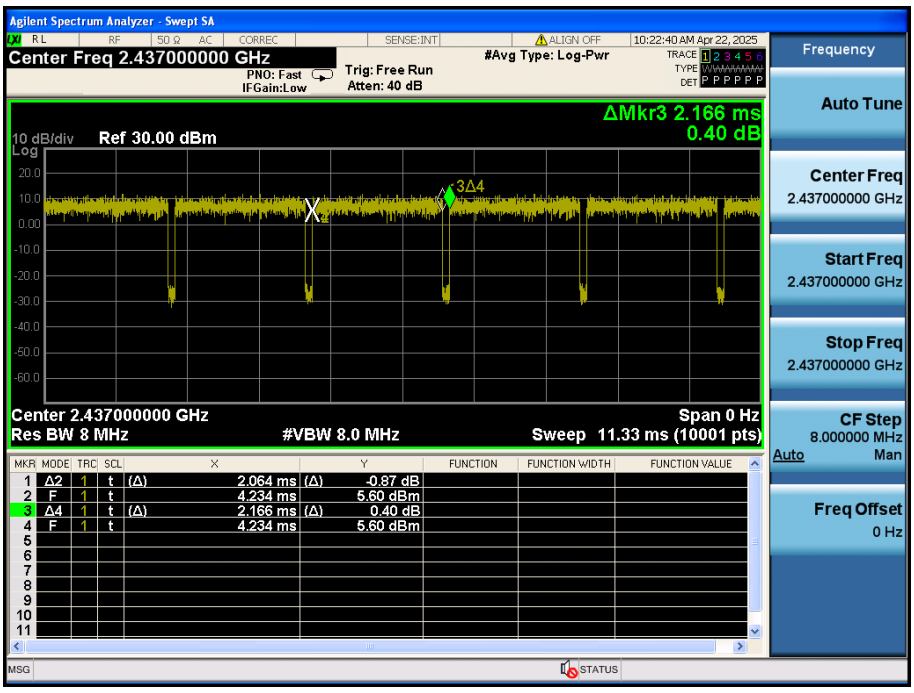
The zero-span measurement method shall not be used unless both RBW and VBW are > 50 /T and the number of sweep points across duration T exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if T ≤ 16.7 microseconds.)

Duty Cycle TM 1 & 2 437 MHz



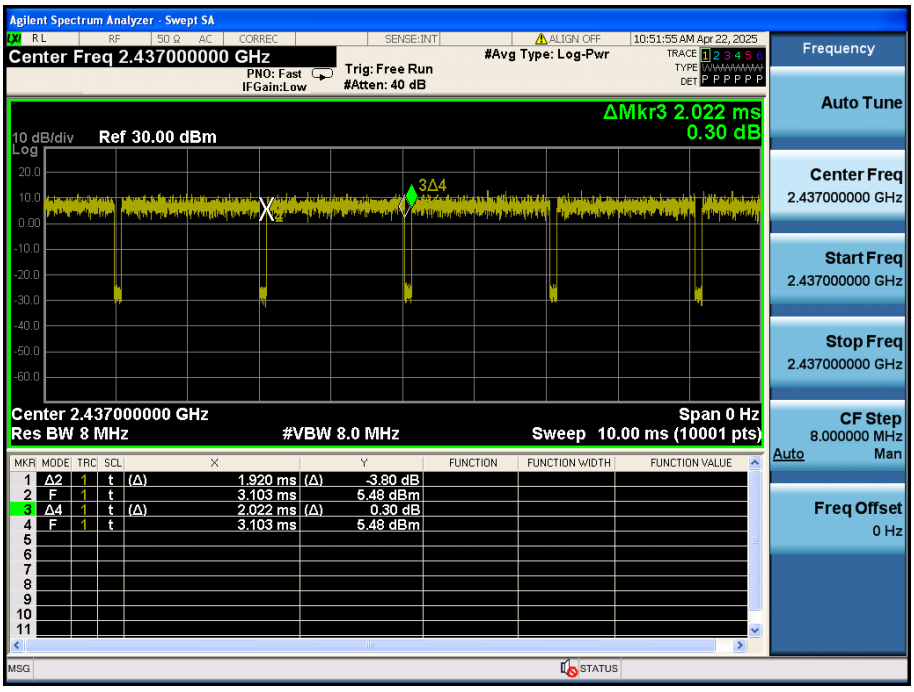
Duty Cycle

TM 2 & 2 437 MHz



Duty Cycle

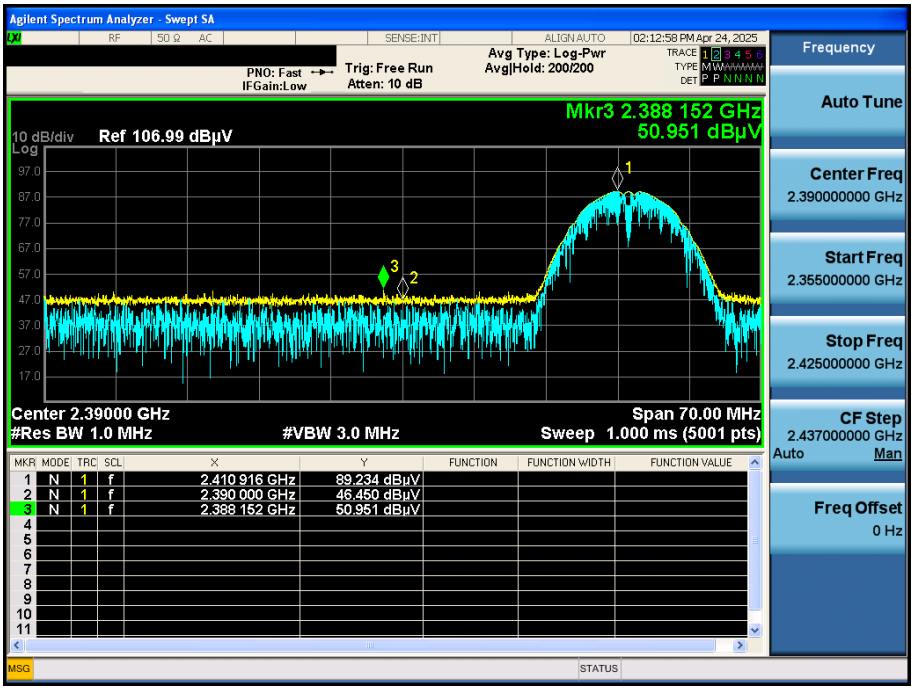
TM 3 & 2 437 MHz



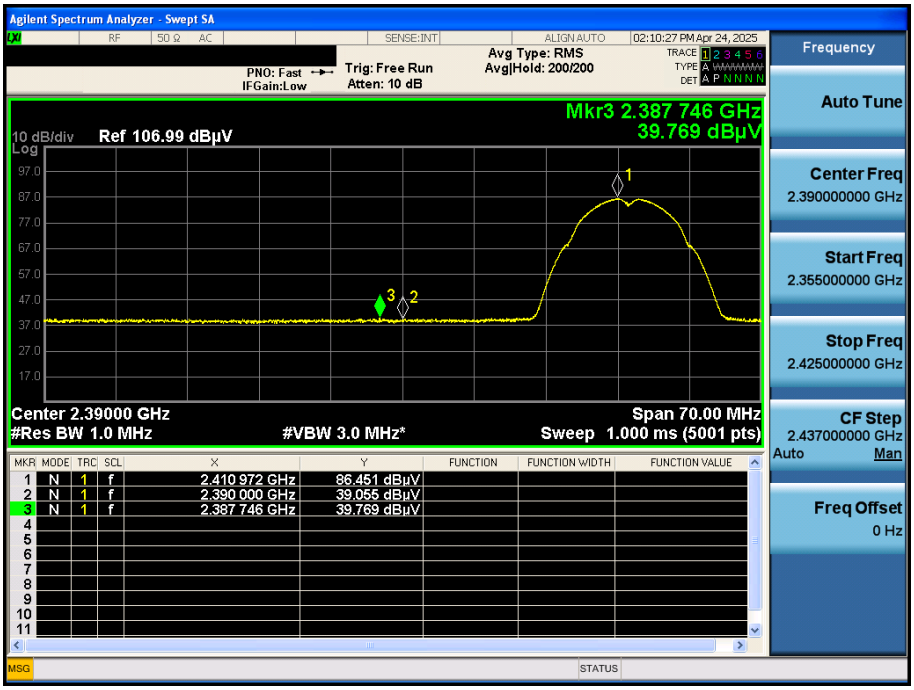
APPENDIX III

Unwanted Emissions (Radiated) Test Plot

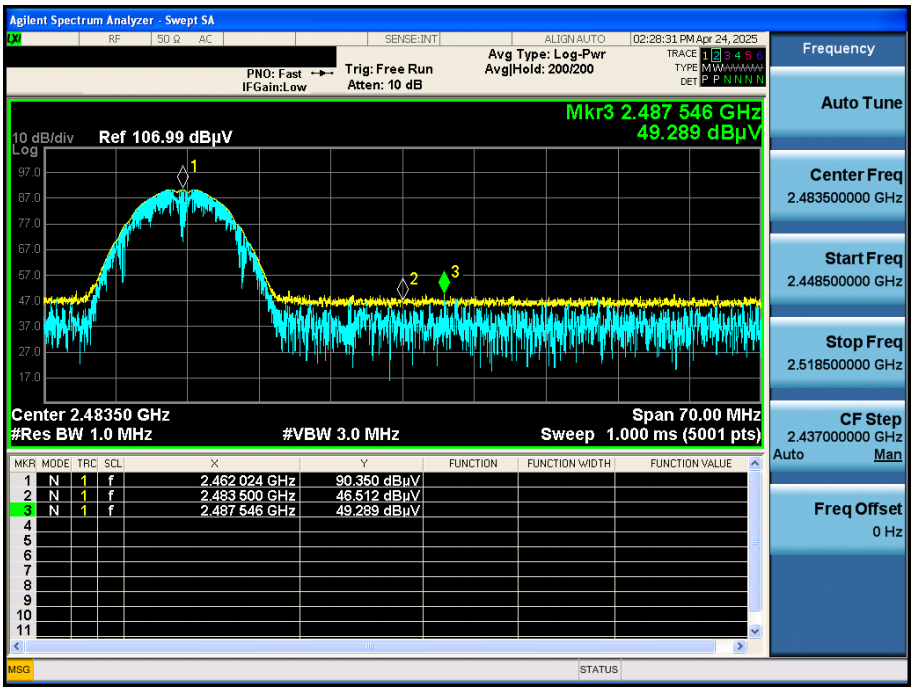
TM 1 & 2 412 MHz & X axis & Hor **Detector Mode : PK**



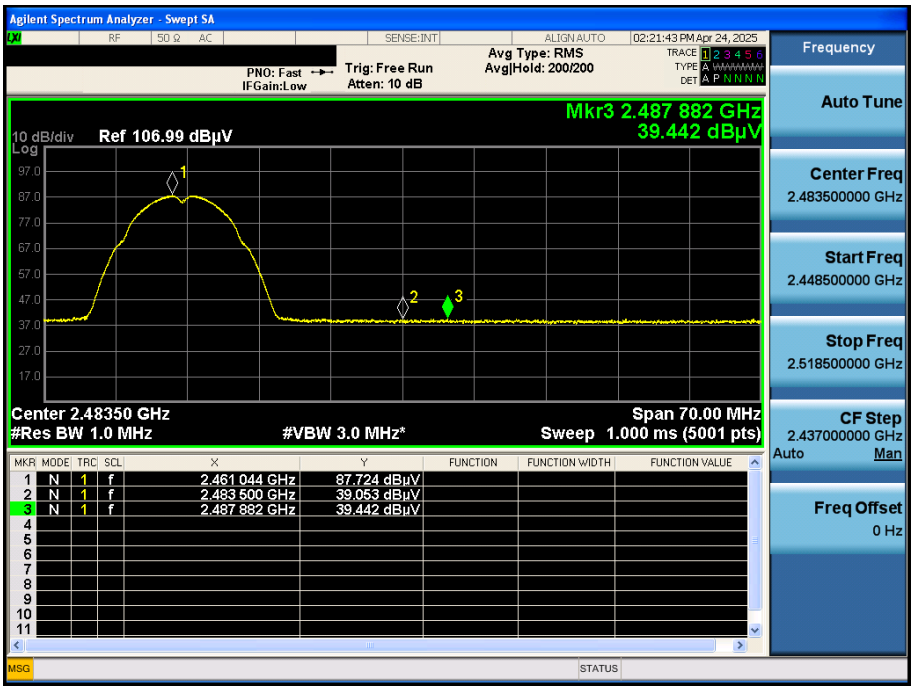
TM 1 & 2 412 MHz & X axis & Hor **Detector Mode : AV**



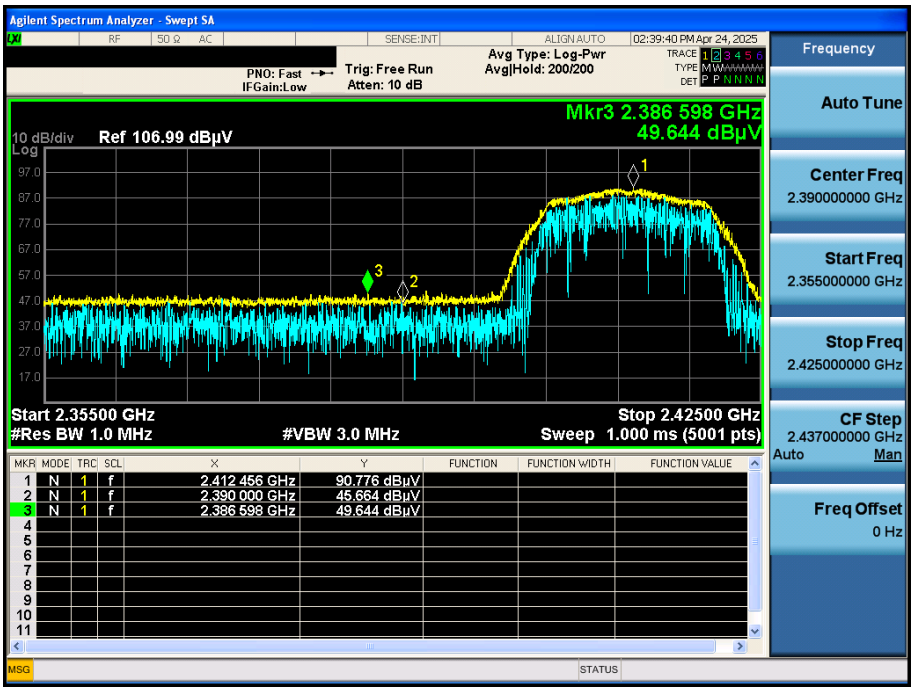
TM 1 & 2 462 MHz & X axis & Hor **Detector Mode : PK**



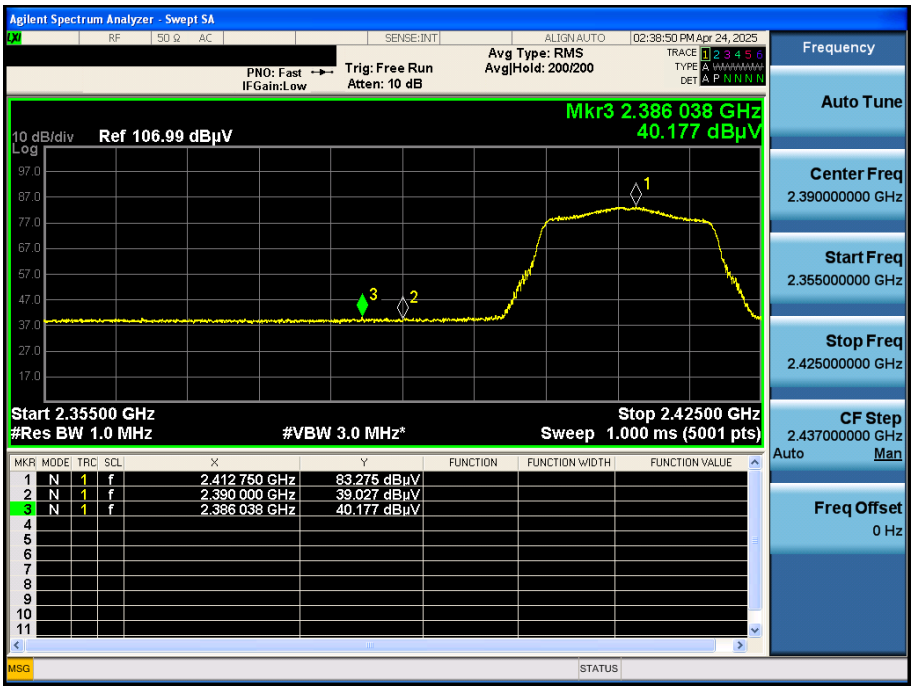
TM 1 & 2 462 MHz & X axis & Hor **Detector Mode : AV**



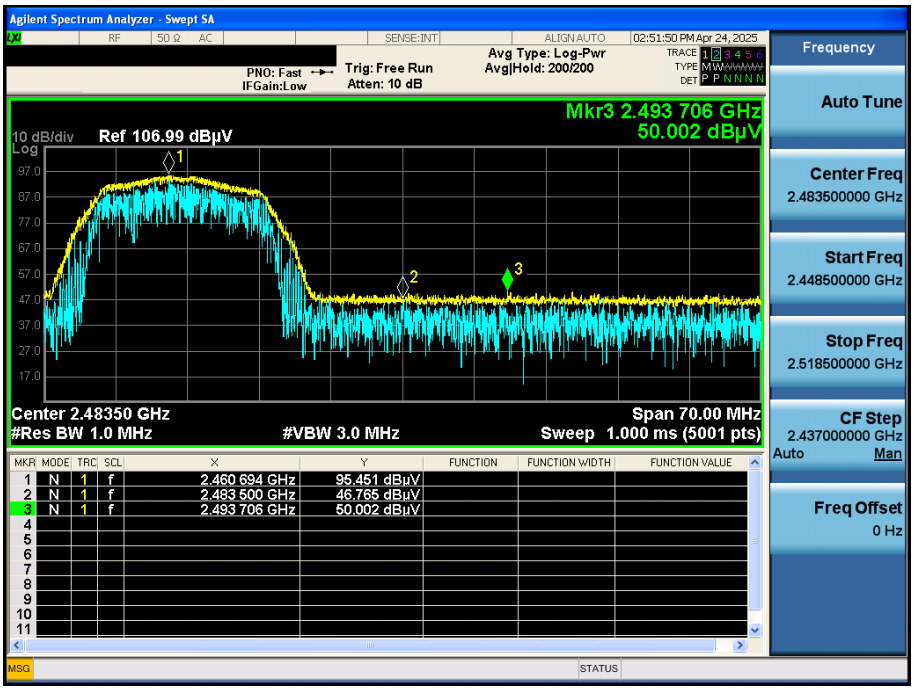
TM 2 & 2 412 MHz & X axis & Hor **Detector Mode : PK**



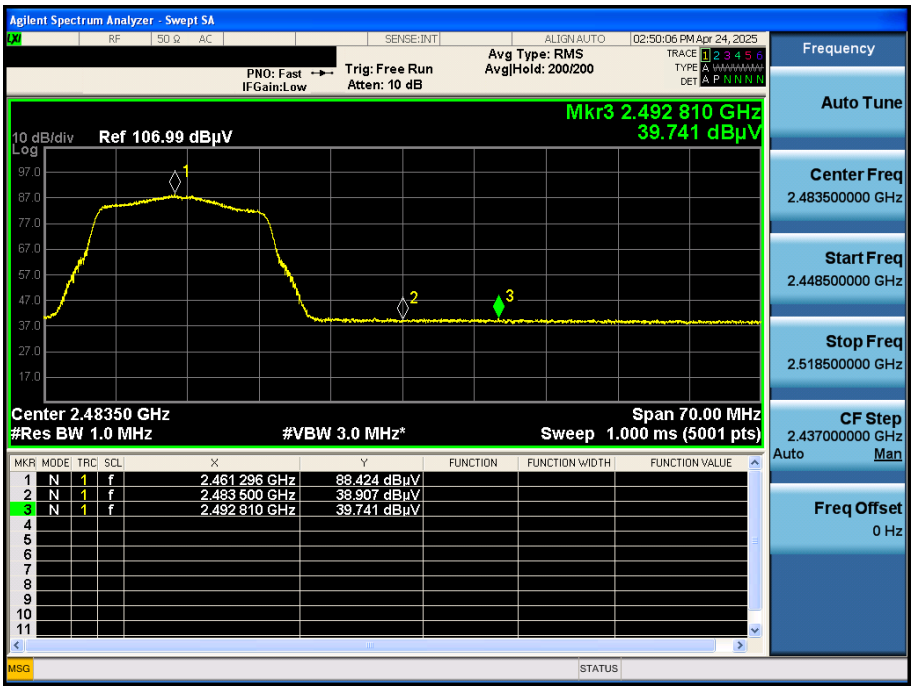
TM 2 & 2 412 MHz & X axis & Hor **Detector Mode : AV**



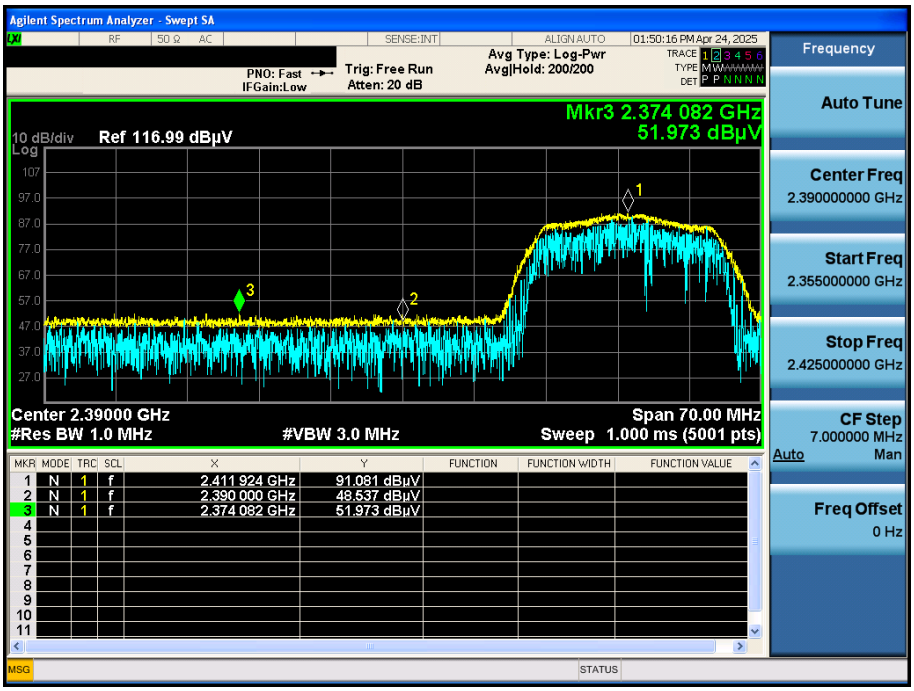
TM 2 & 2 462 MHz & X axis & Hor **Detector Mode : PK**



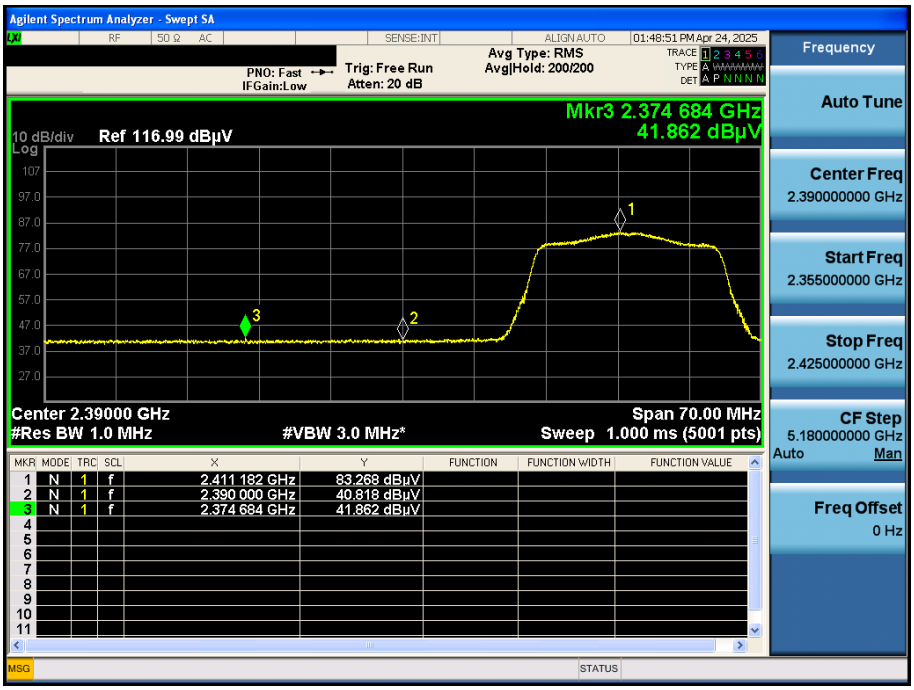
TM 2 & 2 462 MHz & X axis & Hor **Detector Mode : AV**



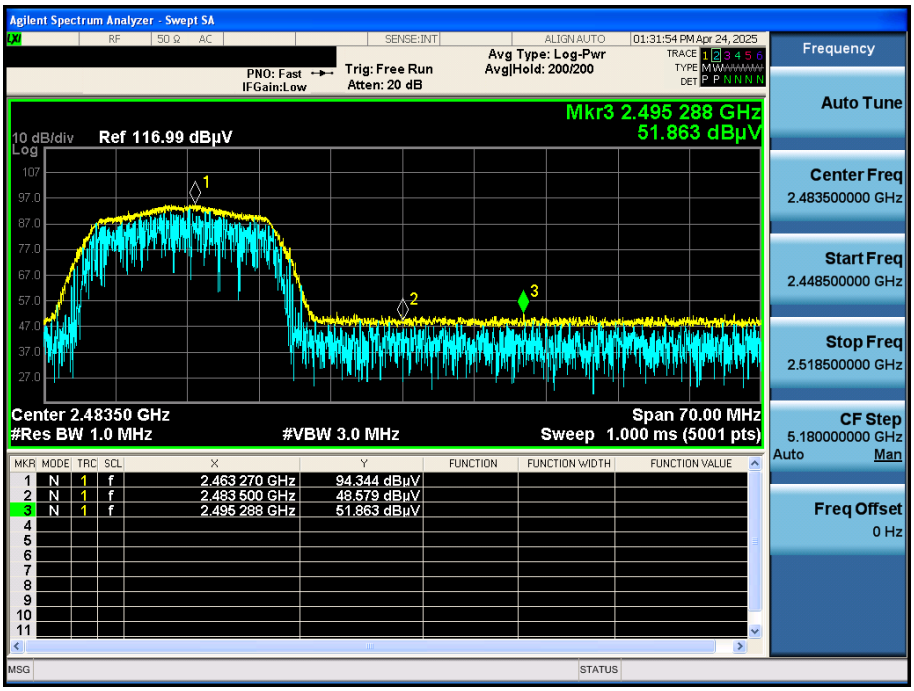
TM 3 & 2 412 MHz & X axis & Hor **Detector Mode : PK**



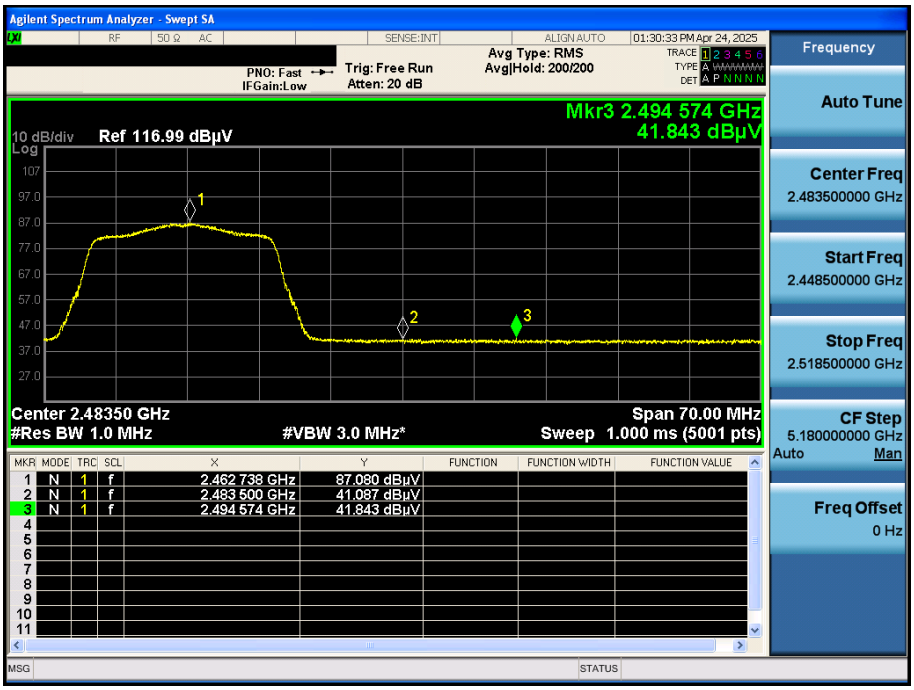
TM 3 & 2 412 MHz & X axis & Hor **Detector Mode : AV**



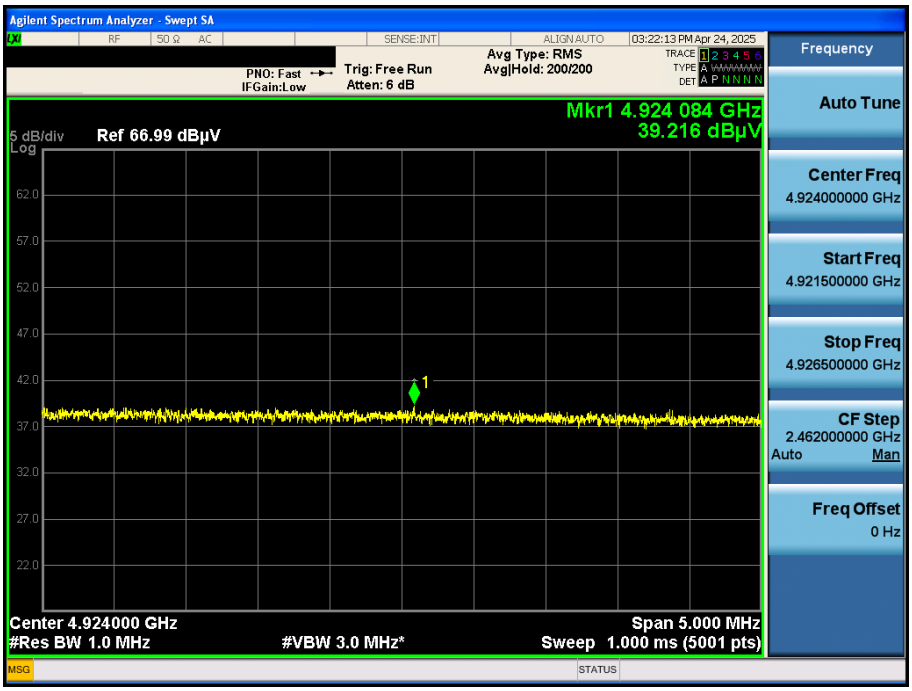
TM 3 & 2 462 MHz & X axis & Hor **Detector Mode : PK**



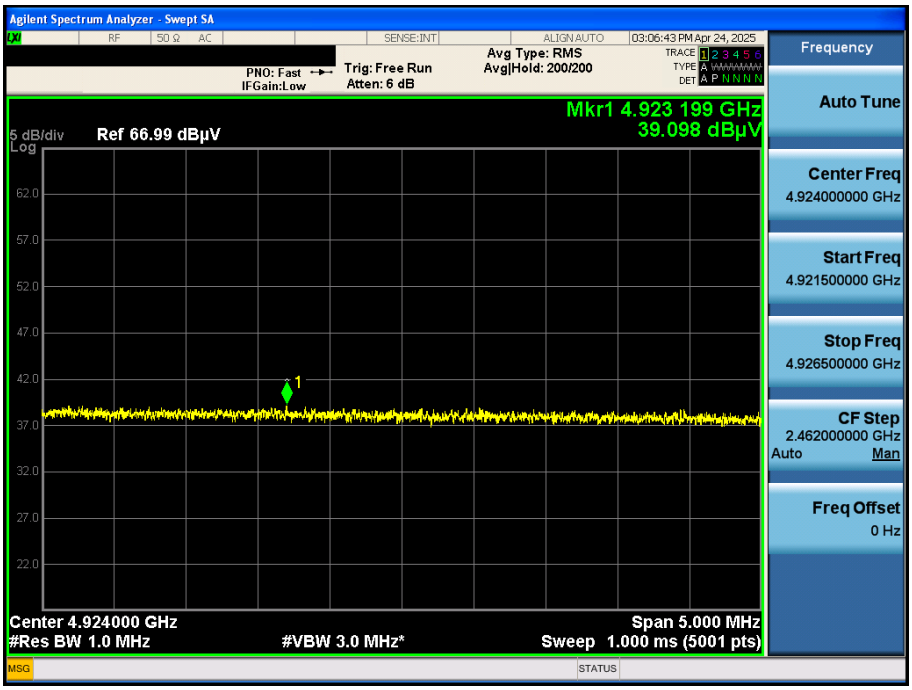
TM 3 & 2 462 MHz & X axis & Hor **Detector Mode : AV**



TM 1 & 2 462 MHz & X axis & Hor **Detector Mode : AV**



TM 2 & 2 462 MHz & X axis & Hor **Detector Mode : AV**



TM 3 & 2 462 MHz & X axis & Hor **Detector Mode : AV**