



TEST REPORT

KCTL Inc. 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea TEL: 82-31-285-0894 FAX: 82-505-299-8311 www.kctl.co.kr	Report No.: KR22-SRF0007-B Page (1) of (55)	KCTL
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1. Client
 - Name : AMOSENSE CO., LTD.
 - Address : 19-1BL, 90, 4Sandan 5-gil, Jiksan-eup, Seobuk-gu, Cheonan-si, Chungcheongnam-do, South Korea
 - Date of Receipt : 2022-01-03
2. Use of Report : Certification
3. Name of Product / Model : UWB Module / ASMOP1BO0N21
4. Manufacturer / Country of Origin : AMOSENSE CO., LTD. / Korea
5. FCC ID : 2A36P-ASMOP1BO0N21
6. Date of Test : 2022-01-08 to 2022-02-11
7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing
 (Address: 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea)
8. Test method used : FCC Part 15 Subpart F, 15.519
9. Test Result : Refer to the test result in the test report

Affirmation	Tested by Name : Jungwon Seo (Signature)	Technical Manager Name : Heesu Ahn (Signature)
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2022-02-11

KCTL Inc.

As a test result of the sample which was submitted from the client, this report does not guarantee the whole product quality. This test report should not be used and copied without a written agreement by KCTL Inc.

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REPORT REVISION HISTORY

Date	Revision	Page No
2022-01-28	Originally issued	-
2022-02-09	Updated	4,7
2022-02-11	Updated	4, 33~48

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Note. The report No. KR22-SRF0007-A is superseded by the report No. KR22-SRF0007-B.

General remarks for test reports

Statement concerning the uncertainty of the measurement systems used for the tests

(may be required by the product standard or client)

☐ Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:

Procedure number, issue date and title:

Calculations leading to the reported values are on file with the testing laboratory that conducted the testing.

☒ Statement not required by the standard or client used for type testing

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1. General information

Client : AMOSENSE CO., LTD.
 Address : 19-1BL, 90, 4Sandan 5-gil, Jiksan-eup, Seobuk-gu, Cheonan-si,
 Chungcheongnam-do, South Korea
 Manufacturer : AMOSENSE CO., LTD.
 Address : 19-1BL, 90, 4Sandan 5-gil, Jiksan-eup, Seobuk-gu, Cheonan-si,
 Chungcheongnam-do, South Korea
 Laboratory : KCTL Inc.
 Address : 65, Sinwon-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Korea
 Accreditations : FCC Site Designation No: KR0040, FCC Site Registration No: 687132
 VCCI Registration No. : R-20080, G-20078, C-20059, T-20056
 CAB Identifier: KR0040, ISED Number: 8035A
 KOLAS No.: KT231

2. Device information

Equipment under test : UWB Module
 Model : ASMOP1BO0N21
 Frequency range : OFDM
 Modulation technique : 2 ch
 Number of channels : DC 1.8 V
 Power source : Dipole Antenna
 Antenna type : 3.58 dBi
 Antenna gain : 6 GHz ~ 8.5 GHz
 Software version : Rev1.0(A27/v03.08.01)
 Hardware version : Rev4.0
 Test device serial No. : N/A
 Operation temperature : -30 °C ~ 85 °C

Note. The device(module) was placed on a test board.

2.1. Accessory information

Equipment	Manufacturer	Model	Serial No.	Power source
Notebook	DELL	Inspiron 17R-5721	FB5L2X1	100-240 V~50-60 Hz, 1.7A

2.2. Frequency/channel operations

This device contains the following capabilities:

Ultra-Wideband

Ch.	Frequency (MHz)
5	6 489.6
9	7 987.2

Table 2.2.1. Ultra-Wideband



2.3. EUT Description

Channel	Configuration	Packet Length	Preamble	PLS
5	SP0	25	9	52
			10	
			11	
			12	
		65	9	
			10	
			11	
			12	
		125	9	
			10	
			11	
			12	
9	SP3	-	9	40
			10	
			11	
			12	
		25	9	
			10	
			11	
			12	
		65	9	
			10	
			11	
			12	
		125	9	
			10	
			11	
			12	
		-	9	
			10	
			11	
			12	

Notes:

Worst case Preamble : (Peak : CH9_SP0_BPRF 65_Preamble 10_PLS 52 / Average : CH5_SP0_BPRF 125_Preamble 10_PLS 40)

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3. Antenna requirement

Requirement of FCC part section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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 transmitter has permanently attached Dipole antenna on test board.
- The E.U.T Complies with the requirement of §15.203.
- The dipole antenna on test board is provided for testing.



4. Summary of tests

FCC Part section(s)	Parameter	Test Condition	Test results
15.503(a)	10 dB Bandwidth	Radiated	Pass
15.519(c)(e)	Peak Power & Maximum Average Emission		Pass
15.519(c)	Radiated Emissions Above 960 MHz		Pass
15.519(d)	Radiated Emission in the 1 164 – 1 240 MHz and 1 559 – 1 610 MHz GPS Bands		Pass
15.209	Radiated Emissions Below 960 MHz		Pass
15.519(a)(1)	Cease Transmission Time		Pass
15.207	AC Line Conducted Emission		Pass

Notes:

- All modes of operation and data rates were investigated. The test results shown in the following sections represent the worst case emissions.
- According to exploratory test no any obvious emission were detected from 9 kHz to 30 MHz. Although these tests were performed other than open field site, adequate comparison measurements were confirmed against 30 m open field site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.
- The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z. It was determined that **X** orientation was worst-case orientation. Therefore, all final radiated testing was performed with the EUT in **X** orientation
- The test procedure(s) in this report were performed in accordance as following.
 - ANSI C63.10-2013
 - KDB 393764 D01 UWB FAQ v02

5. Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of $k=2$ to indicated a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded uncertainty ($\pm$)	
Radiated spurious emissions	9 kHz ~ 30 MHz:	2.3 dB
	30 MHz ~ 1 000 MHz	2.2 dB
	1 GHz ~ 18 GHz	5.6 dB
	Above 18 GHz	5.7 dB
Conducted emissions	9 kHz ~ 150 kHz	3.7 dB
	150 kHz ~ 30 MHz	3.3 dB

6. Test results

6.1. 10 dB Bandwidth

Limit

According to §15.503(a), For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L . The frequency at which the highest radiated emission occurs is designated f_M .

Center frequency. The center frequency, f_C , equals $(f_H + f_L) / 2$.

Fractional bandwidth. The fractional bandwidth equals $2(f_H - f_L) / (f_H + f_L)$.

Ultra-wideband (UWB) transmitter. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth.

According to §15.519(b), The UWB bandwidth of a device operating under the provisions of this section must be contained between 3 100 MHz and 10 600 MHz.

Test procedure

ANSI C63.10 - Section 10.1

Test settings

RBW	1 MHz
VBW	1 MHz or greater.
Detector	Peak
Trace mode	Max-hold
Sweep	Auto couple
The trace was allowed to stabilize	

Test results

Channel	Configure	Packet length [Bytes]	Preamble	F _L [MHz]	F _H [MHz]	F _C [MHz]	BW [MHz]
5	SP0	25	9	6 268.28	6 833.26	6 550.77	564.98
			10	6 297.88	6 835.73	6 566.81	537.85
			11	6 250.53	6 835.91	6 543.22	585.38
			12	6 263.49	6 799.99	6 531.74	536.50
		65	9	6 239.53	6 833.01	6 536.27	593.47
			10	6 296.35	6 836.00	6 566.17	539.65
			11	6 230.57	6 846.29	6 538.43	615.73
			12	6 278.10	6 782.04	6 530.07	503.94
		125	9	6 275.13	6 800.87	6 538.00	525.74
			10	6 298.42	6 835.97	6 567.20	537.56
			11	6 240.12	6 848.19	6 544.15	608.07
			12	6 268.39	6 841.80	6 555.10	573.40
	SP3	-	9	6 247.51	6 791.07	6 519.29	543.56
			10	6 258.19	6 790.62	6 524.41	532.43
			11	6 249.99	6 795.12	6 522.56	545.12
			12	6 254.44	6 794.77	6 524.61	540.33
9	SP0	25	9	7 723.71	8 332.54	8 028.13	608.83
			10	7 727.83	8 237.23	7 982.53	509.40
			11	7 701.08	8 333.76	8 017.42	632.68
			12	7 677.90	8 339.62	8 008.76	661.72
		65	9	7 710.07	8 273.37	7 991.72	563.30
			10	7 717.89	8 334.35	8 026.12	616.46
			11	7 695.96	8 300.51	7 998.23	604.55
			12	7 712.91	8 294.84	8 003.87	581.93
		125	9	7 711.93	8 301.32	8 006.62	589.39
			10	7 727.90	8 295.50	8 011.70	567.60
			11	7 718.81	8 322.61	8 020.71	603.80
			12	7 729.70	8 267.57	7 998.64	537.87
	SP3	-	9	7 706.17	8 292.81	7 999.49	586.64
			10	7 710.03	8 287.21	7 998.62	577.18
			11	7 711.04	8 288.37	7 999.71	577.33
			12	7 699.00	8 287.62	7 993.31	588.62

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CH5

SP0 BPRF25 Preamble9



SP0 BPRF25 Preamble10



SP0 BPRF25 Preamble11



SP0 BPRF25 Preamble12



SP0 BPRF65 Preamble9



SP0 BPRF65 Preamble10



SP0 BPRF65 Preamble11



SP0 BPRF65 Preamble12



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SP0 BPRF125 Preamble10



SP0 BPRF125 Preamble11



SP0 BPRF125 Preamble12



SP3 Preamble9



SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



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CH9

SP0 BPRF25 Preamble9



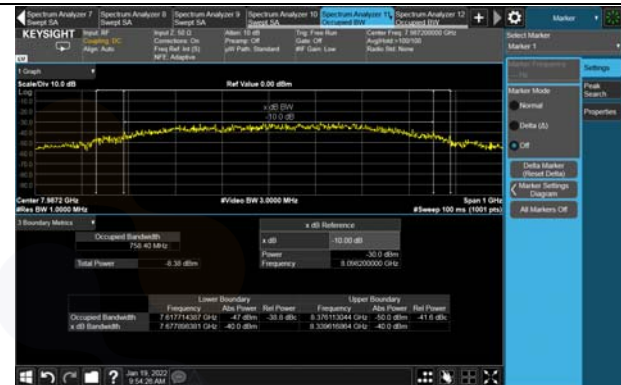
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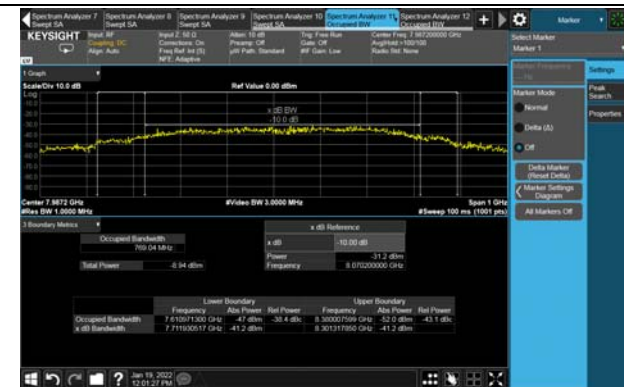
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SP0 BPRF125 Preamble11



SP0 BPRF125 Preamble12



SP3 Preamble9



SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



6.2. Peak Power & Maximum Average Emission

Limit

According to §15.519(c), The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
3 100-10 600	-41.3

According to §15.519(e) peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs, f_M . That limit is 0 dBm EIRP

Test procedure

ANSI C63.10 – Section 10.3.5 and 10.3.7

Test settings

Peak EIRP Measurements

RBW 50 MHz
 VBW 50 MHz
 Detector Peak
 Trace mode Max-hold
 Sweep Auto couple
 The trace was allowed to stabilize

Average EIRP Measurements

RBW 1 MHz
 VBW 3 MHz
 Detector Average(RMS)
 Trace mode Max-hold
 Sweep time No more than a 1 ms integration period over each measurement bin
 The trace was allowed to stabilize

Test results

CH.	Config.	Packet length [Bytes]	Preamble	Peak power [dBm/50MHz]	Peak limit [dBm/50MHz]	Margin [dB]	AV power [dBm/MHz]	AV limit [dBm/MHz]	Margin [dB]
5	SP0	25	9	-8.00	0.00	8.00	-44.43	-41.30	3.13
			10	-5.57		5.57	-44.26		2.96
			11	-7.25		7.25	-44.36		3.06
			12	-6.87		6.87	-44.32		3.02
		65	9	-7.03		7.03	-43.27		1.97
			10	-5.57		5.57	-43.25		1.95
			11	-7.72		7.72	-42.65		1.35
			12	-7.09		7.09	-43.30		2.00
		125	9	-8.17		8.17	-41.91		0.61
			10	-5.93		5.93	-41.69		0.39
			11	-8.15		8.15	-41.95		0.65
			12	-7.18		7.18	-41.98		0.68
	SP3	-	9	-16.64		16.64	-43.71		2.41
			10	-15.43		15.43	-43.74		2.44
			11	-17.54		17.54	-43.75		2.45
			12	-16.59		16.59	-43.69		2.39
9	SP0	25	9	-8.12	0.00	8.12	-44.97	-41.30	3.67
			10	-4.93		4.93	-45.08		3.78
			11	-8.63		8.63	-45.07		3.77
			12	-8.41		8.41	-44.91		3.61
		65	9	-6.10		6.10	-43.97		2.67
			10	-4.88		4.88	-44.23		2.93
			11	-7.51		7.51	-43.73		2.43
			12	-8.00		8.00	-43.85		2.55
		125	9	-7.78		7.78	-41.68		0.38
			10	-5.00		5.00	-42.56		1.26
			11	-8.95		8.95	-42.23		0.93
			12	-8.51		8.51	-42.47		1.17
	SP3	-	9	-16.43		16.43	-44.25		2.95
			10	-17.09		17.09	-44.32		3.02
			11	-17.21		17.21	-44.22		2.92
			12	-17.29		17.29	-44.43		3.13

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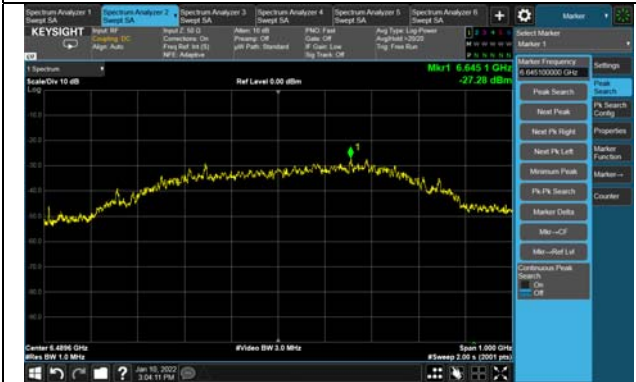
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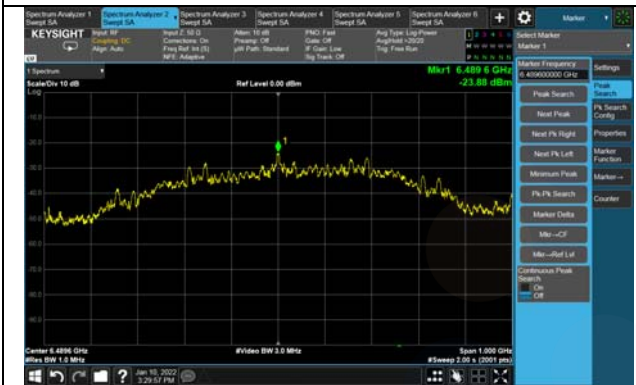
Peak power

CH5

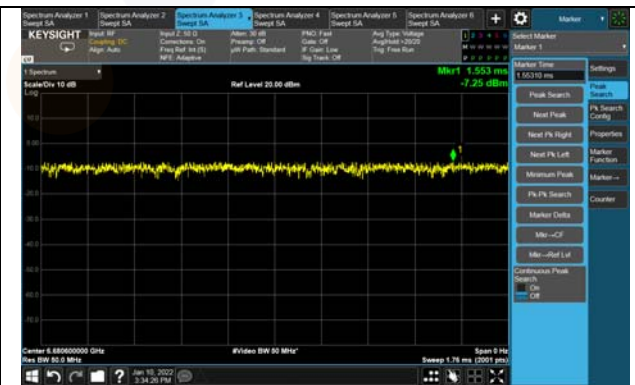
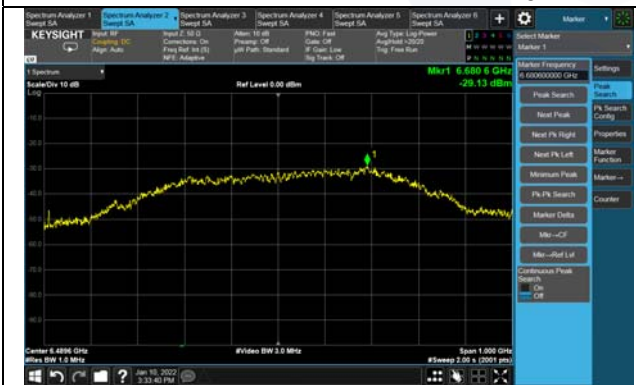
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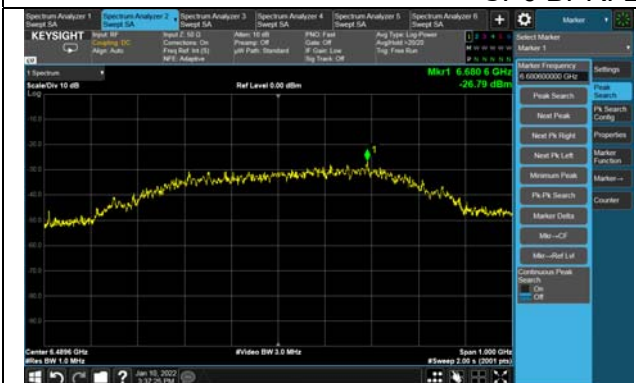
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SP0 BPRF25 Preamble12



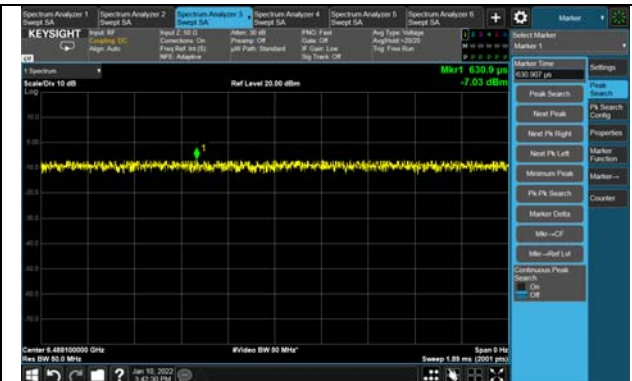
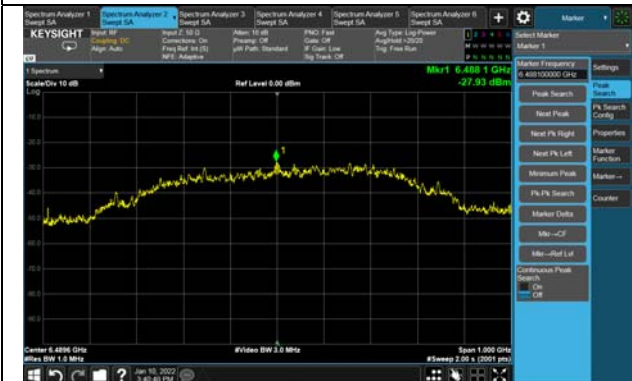
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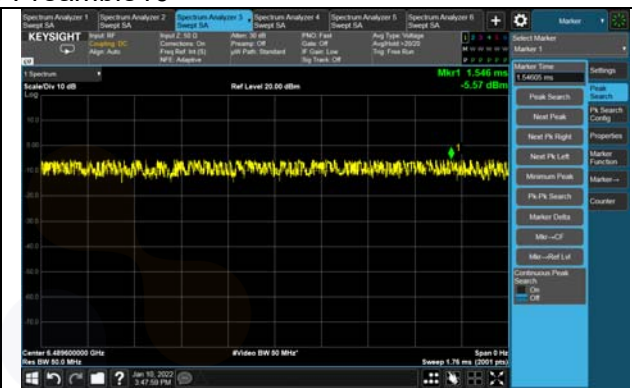
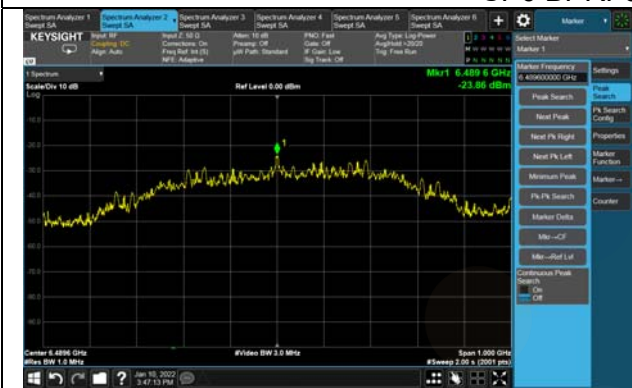
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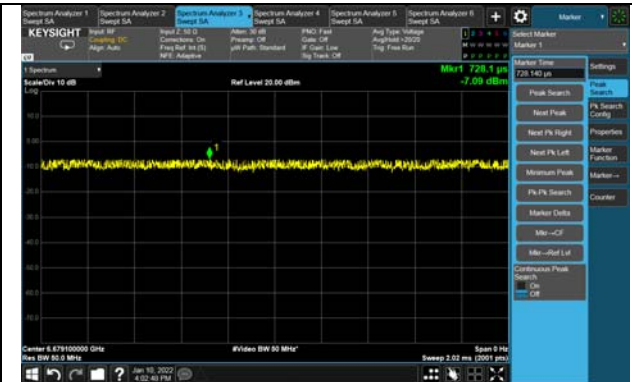
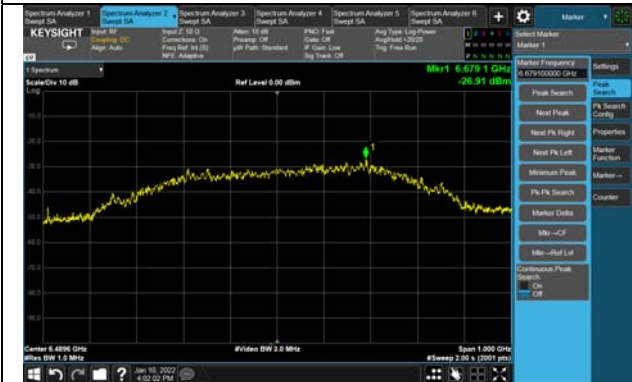
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SP0 BPRF65 Preamble11



SP0 BPRF65 Preamble12



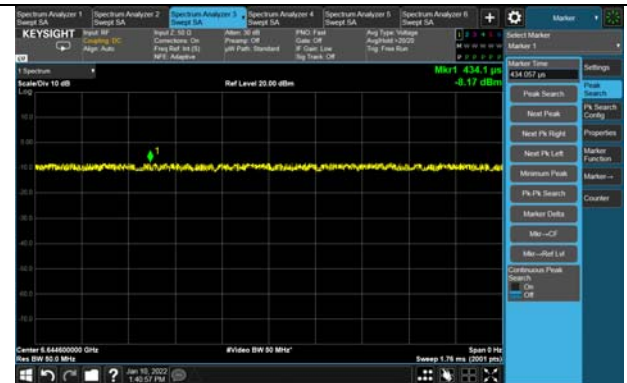
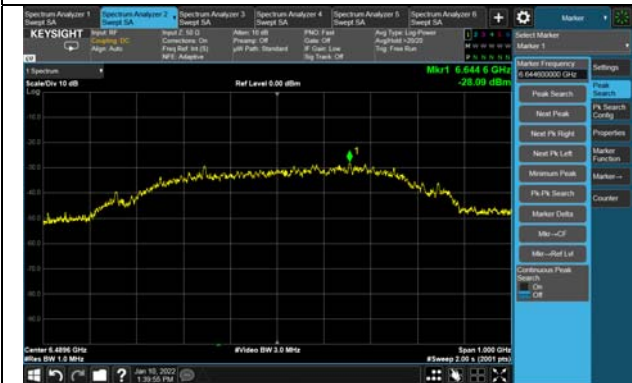
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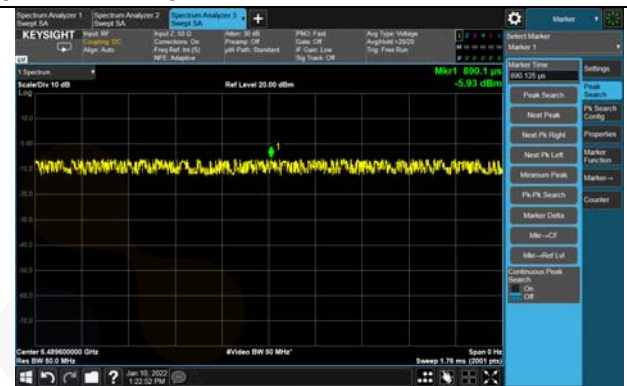
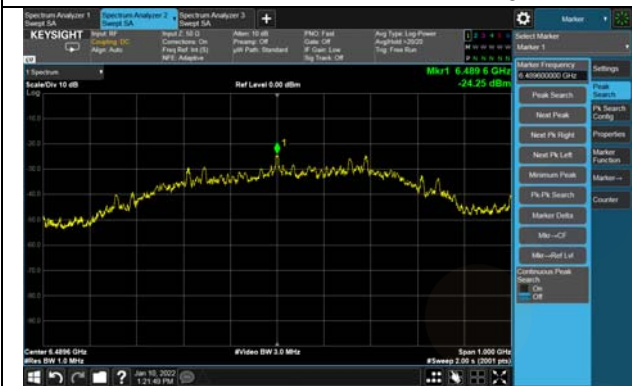
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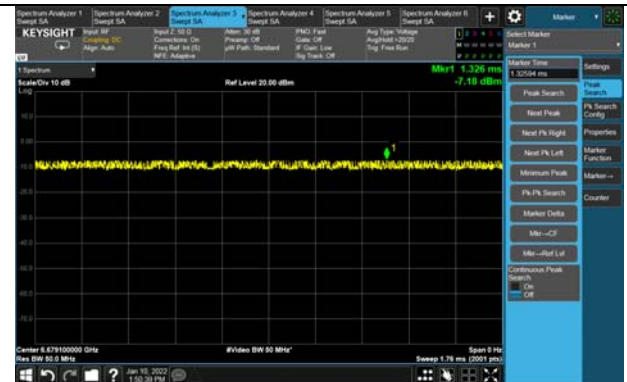
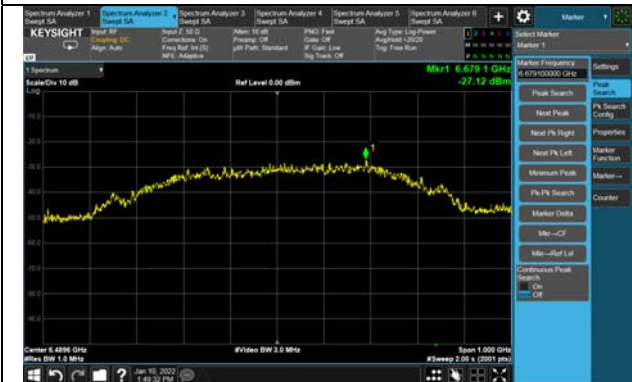
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SP0 BPRF125 Preamble12



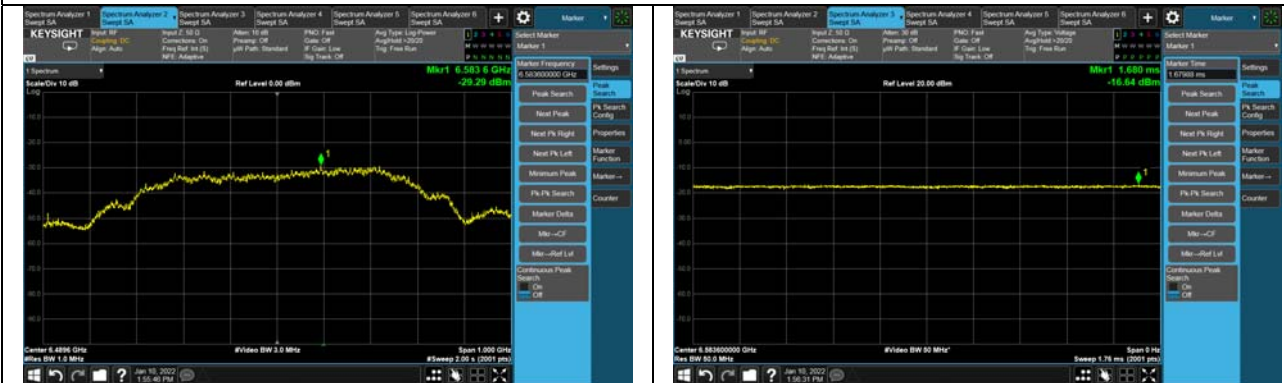
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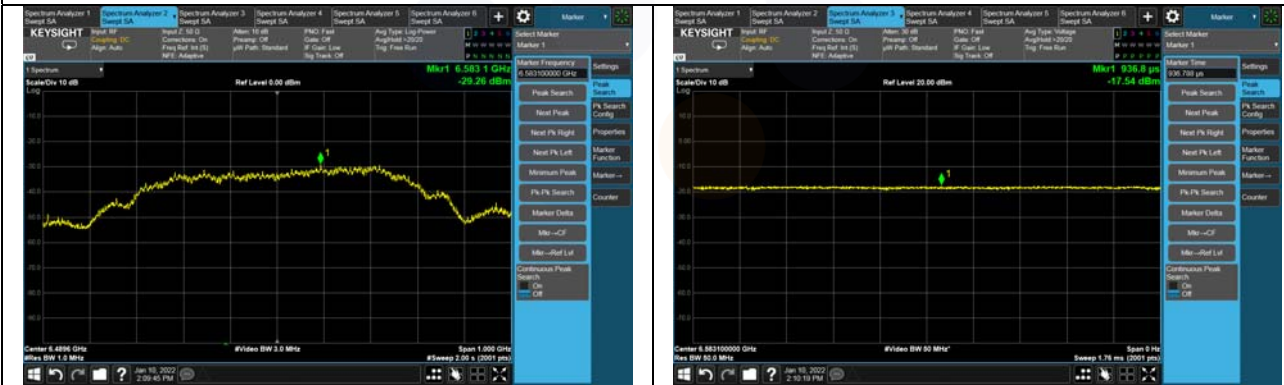
SP3 Preamble9



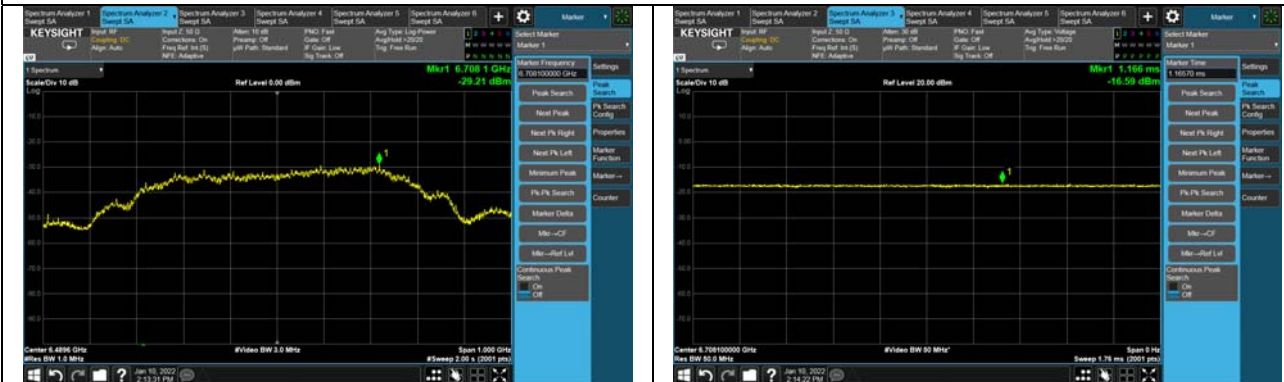
SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



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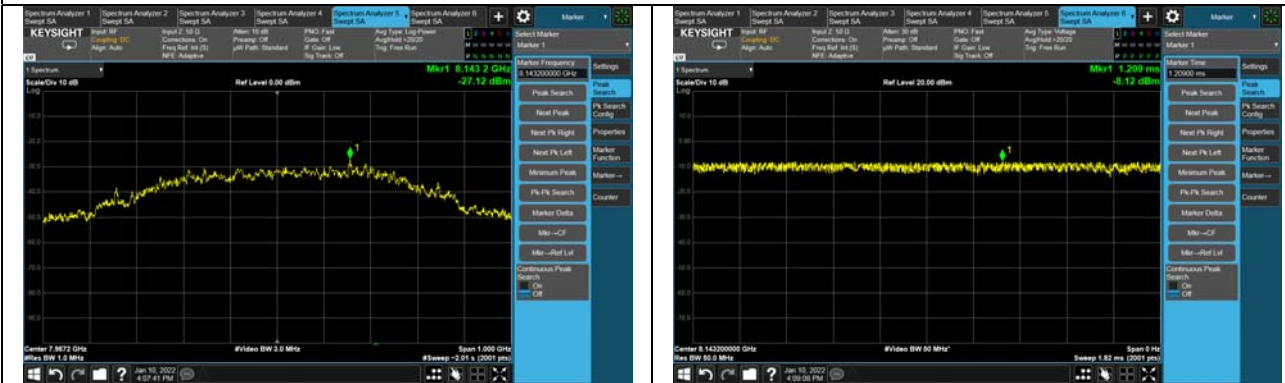
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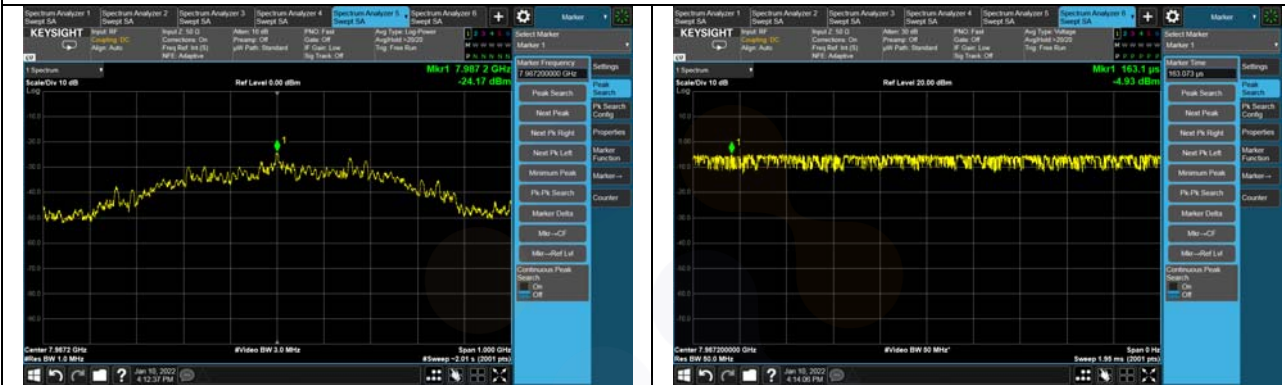


CH9

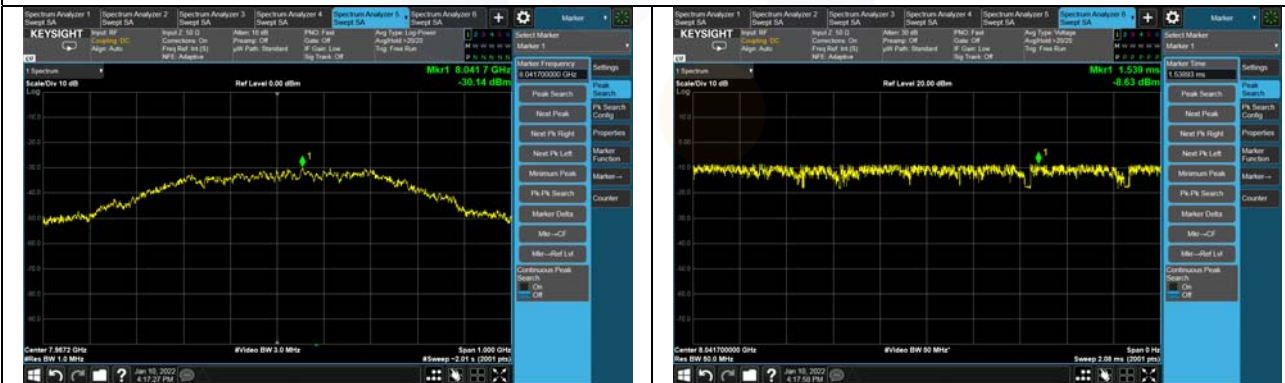
SP0 BPRF25 Preamble9



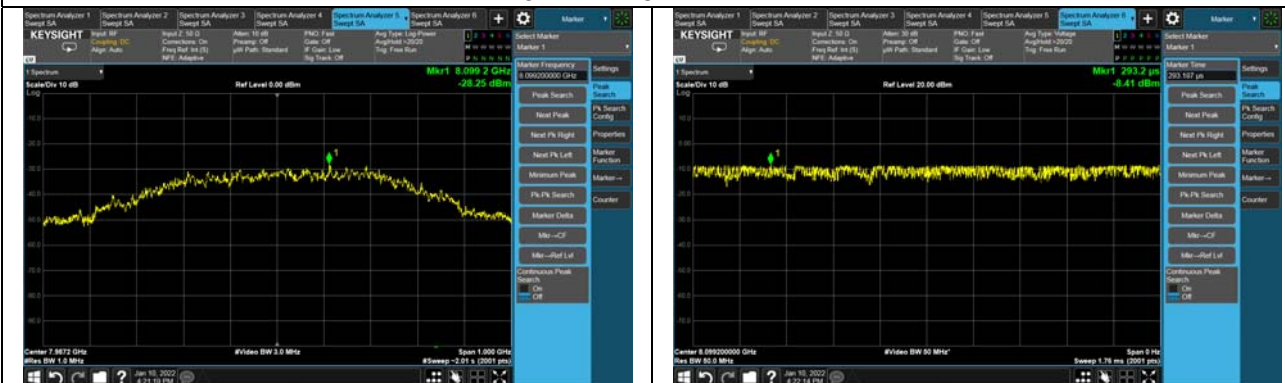
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SP0 BPRF25 Preamble11



SP0 BPRF25 Preamble12



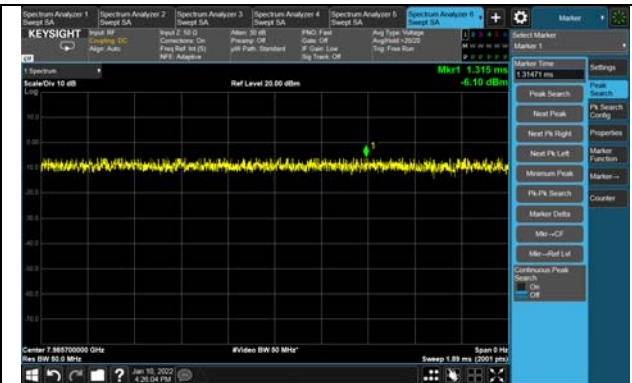
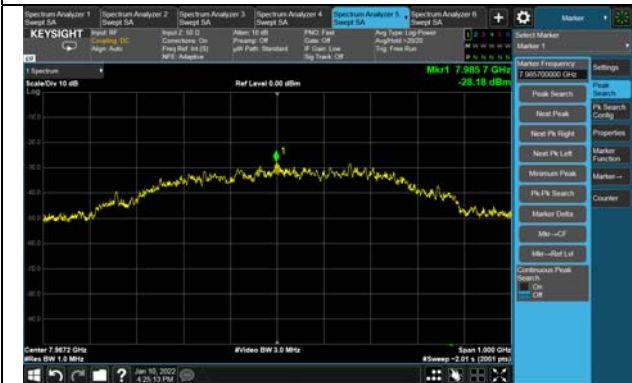
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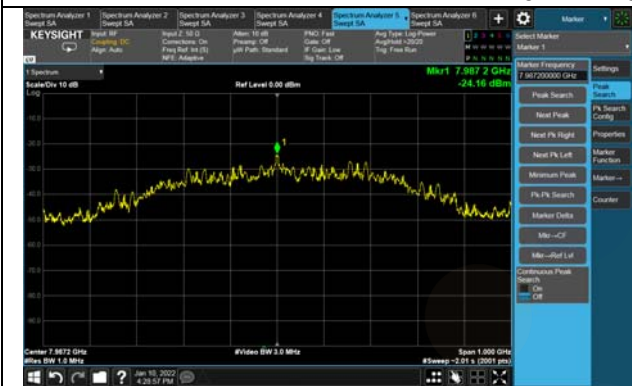
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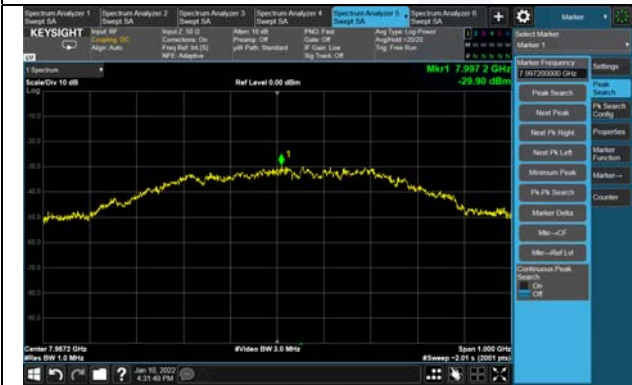
SP0 BPRF65 Preamble9



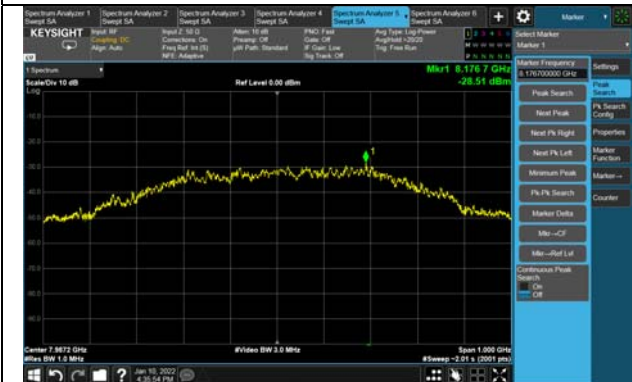
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SP0 BPRF65 Preamble11



SP0 BPRF65 Preamble12



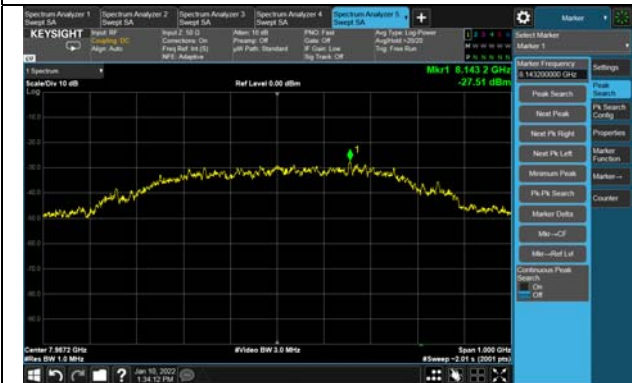
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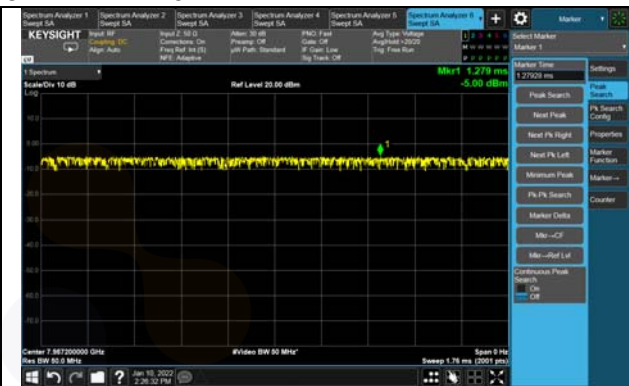
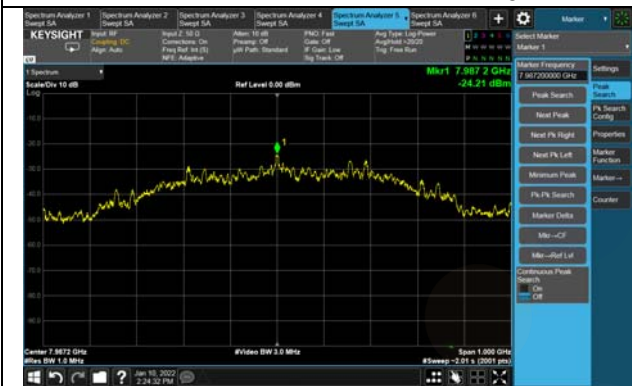
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SP0 BPRF125 Preamble9



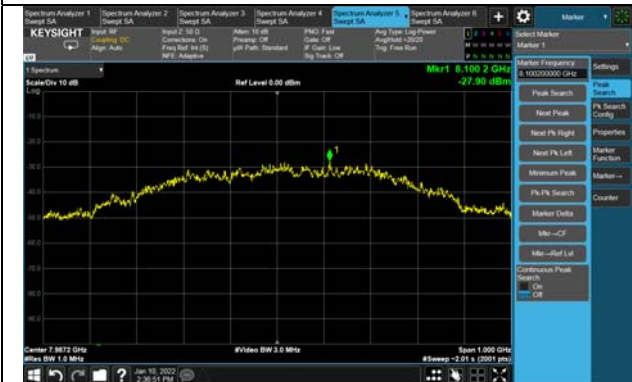
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SP0 BPRF125 Preamble11



SP0 BPRF125 Preamble12



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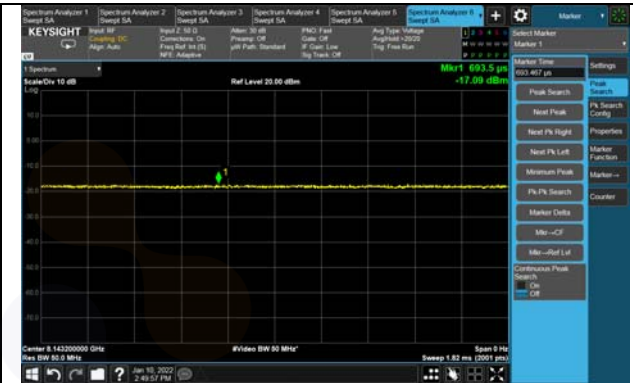
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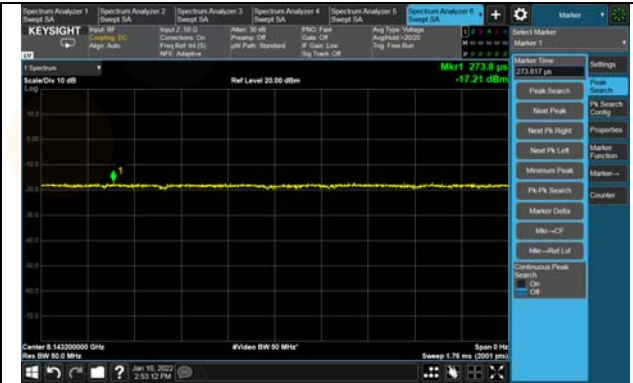
SP3 Preamble9



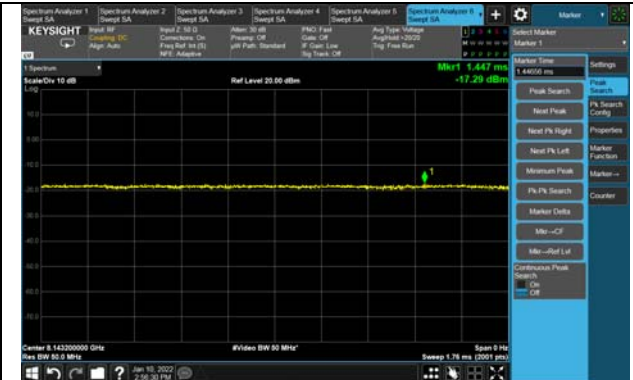
SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



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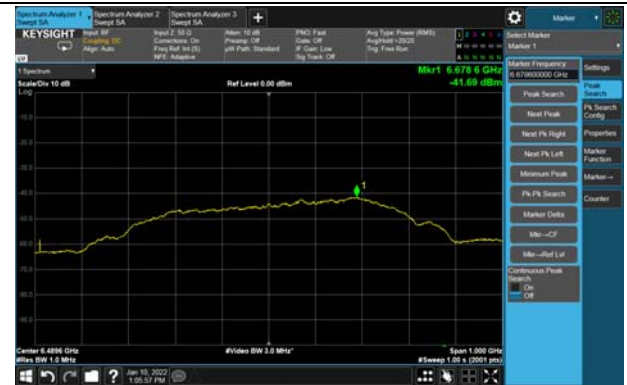
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SP0 BPRF125 Preamble9



SP0 BPRF125 Preamble10



SP0 BPRF125 Preamble11



SP0 BPRF125 Preamble12



SP3 Preamble9



SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



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CH9

SP0 BPRF25 Preamble9



SP0 BPRF25 Preamble10



SP0 BPRF25 Preamble11



SP0 BPRF25 Preamble12



SP0 BPRF65 Preamble9



SP0 BPRF65 Preamble10



SP0 BPRF65 Preamble11



SP0 BPRF65 Preamble12



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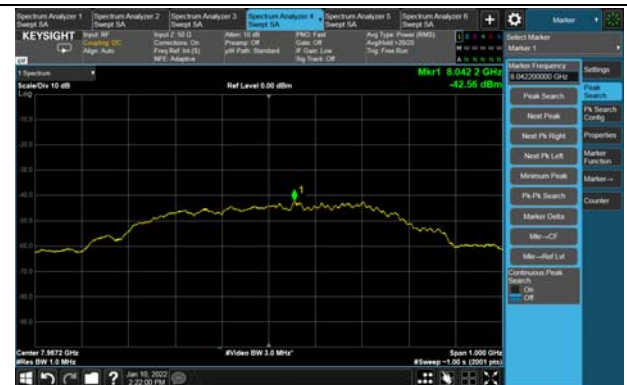
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SP0 BPRF125 Preamble9



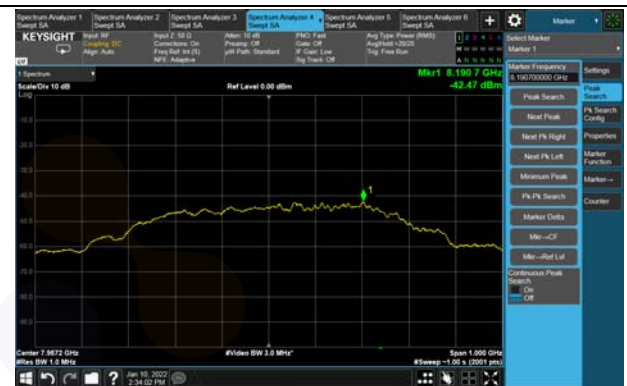
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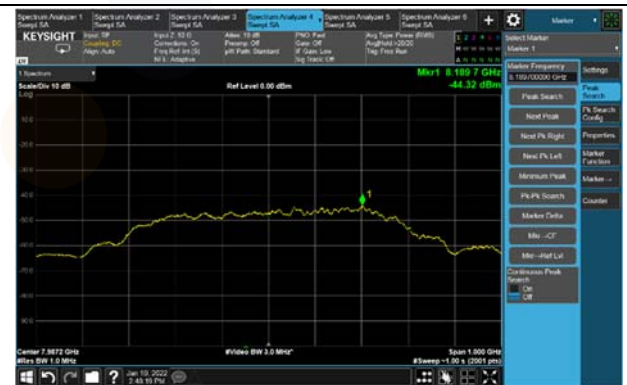
SP0 BPRF125 Preamble12



SP3 Preamble9



SP3 Preamble10



SP3 Preamble11



SP3 Preamble12



6.3. Cease Transmission Time Limit

According to section §15.519(a)(1), A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

Test Procedure

KDB 393764 D01 v02

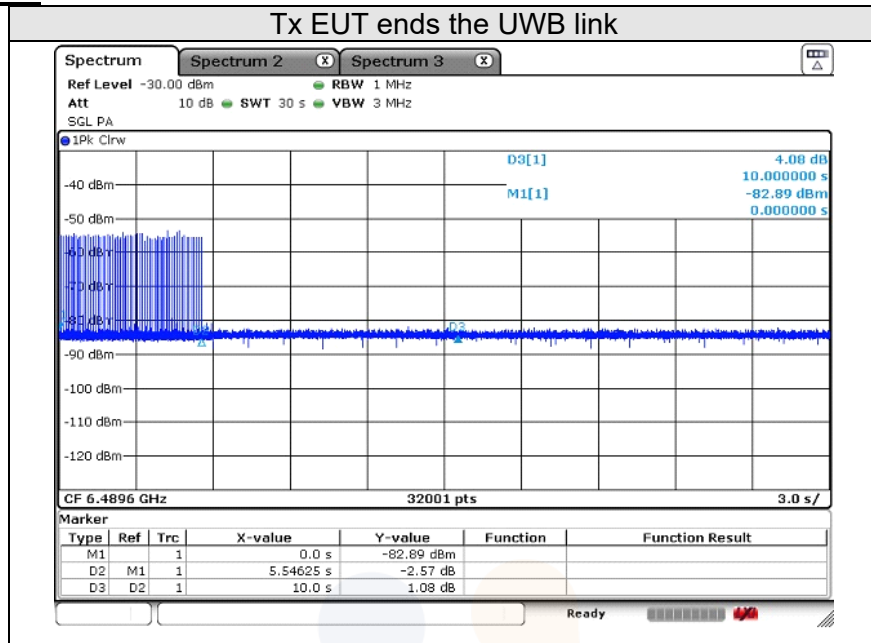
Test settings

RBW 1 MHz

VBW 3 MHz

Span Zero Span Mode

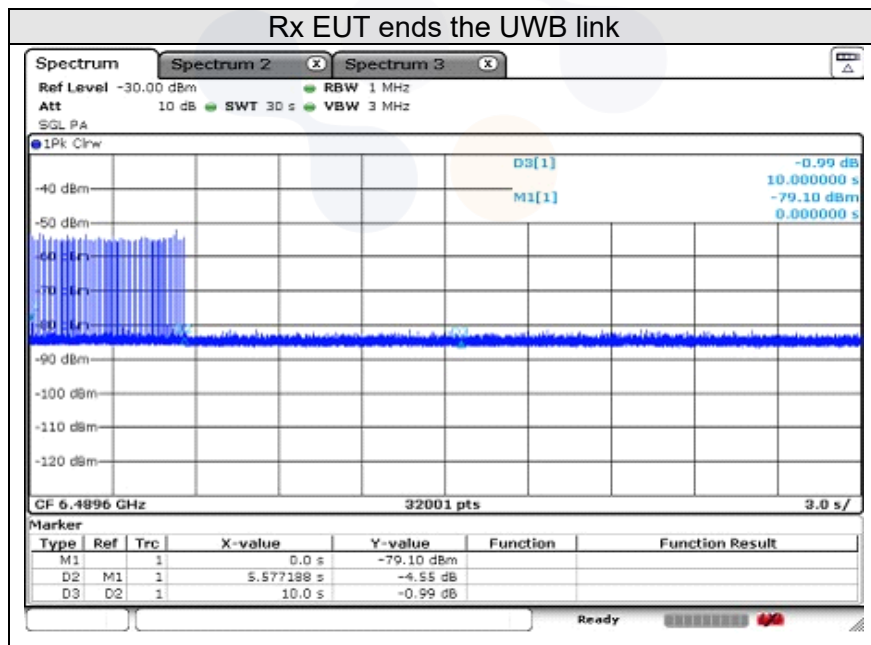
Sweep time shall be sufficient to demonstrate EUT's compliance with the rule part.

Test results :CH 5

*Marker 1 : Tx EUT and Rx EUT are linked.

*Marker 3 : Rx EUT ends UWB link.

*Marker 2Δ3 : “10s” after Tx EUT ends UWB link.

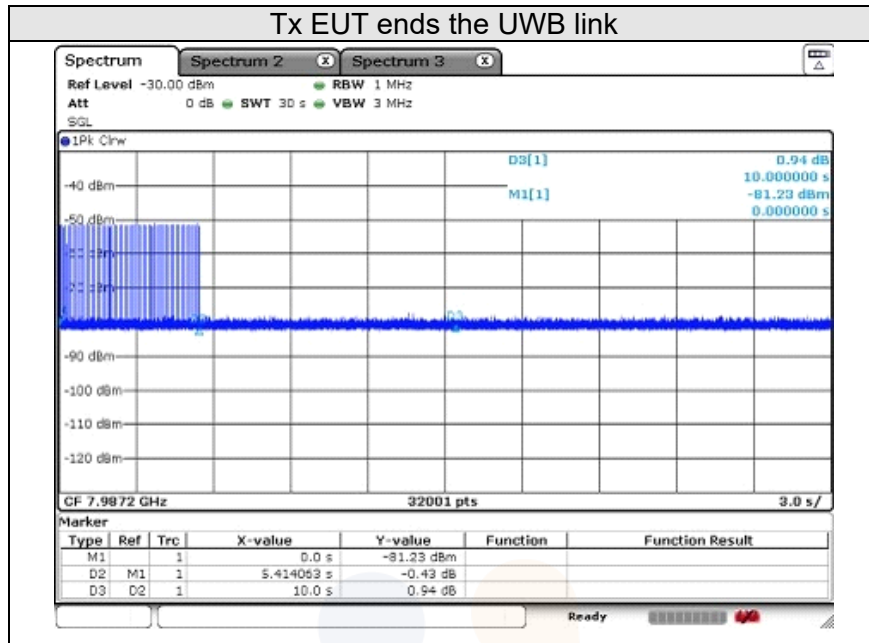
EUT detects “Tx EUT ends UWB link” and ceases transmitting within 10 seconds.

*Marker 1 : Tx EUT and Rx EUT are linked.

*Marker 3 : Tx EUT ends UWB link.

*Marker 2Δ3 : “10s” after Rx EUT ends UWB link.

Rx EUT ceases transmitting within 10 seconds.

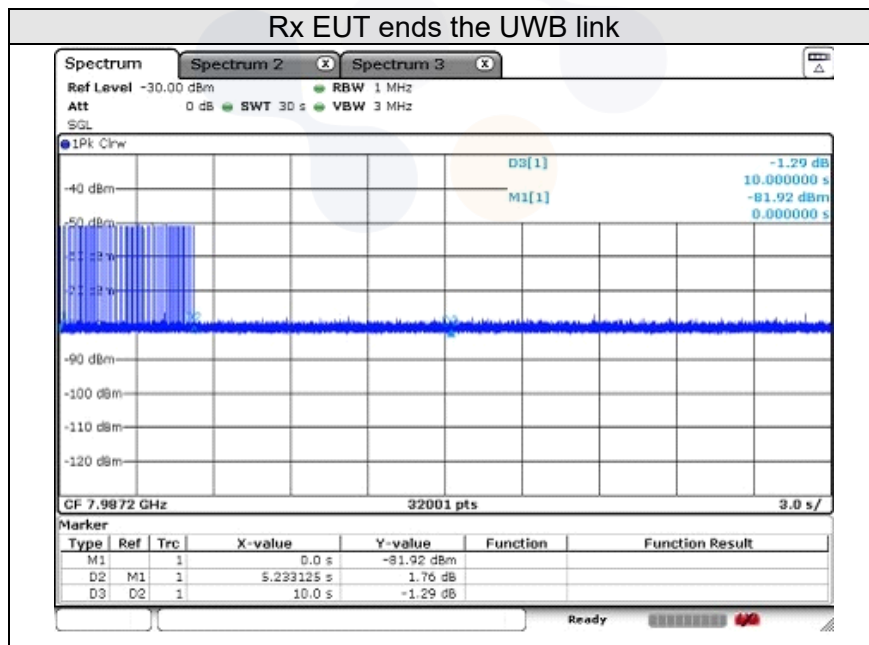
CH 9

*Marker 1 : Tx EUT and Rx EUT are linked.

*Marker 3 : Rx EUT ends UWB link.

*Marker 2Δ3 : “10s” after Tx EUT ends UWB link.

EUT detects “Tx EUT ends UWB link” and ceases transmitting within 10 seconds.



*Marker 1 : Tx EUT and Rx EUT are linked.

*Marker 3 : Tx EUT ends UWB link.

*Marker 2Δ3 : “10s” after Rx EUT ends UWB link.

Rx EUT ceases transmitting within 10 seconds.

6.4. Radiated Spurious Emission – Above 960 MHz

Limit

According to §15.519(c) The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency[MHz]	EIRP[dBm]
960-1 610	-75.3
1 610-1 990	-63.3
1 990-3 100	-61.3
3 100-10 600	-41.3
Above 10 600	-61.3

*FCC Radiated Spurious Emission Limit

Frequency[MHz]	EIRP[dBm]
1 164-1 240	-85.3
1 559-1 610	-85.3

*FCC Radiated Spurious Emission Limit for GPS Frequency bands

Test procedure

ANSI C63.10-2013 - Section 10.3
 KDB 393764 D01 v02

*The EUT is placed on a non-conducting table 80 cm above the ground plane for below 1 GHz and 150 cm for above 1 GHz. The antenna to EUT distance is 0.5 or 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

Test settings

RBW 1 MHz (30 kHz for emissions in the GPS band)
 VBW 3 MHz (100 kHz for emissions in the GPS band)
 Detector Average (RMS)
 Trace mode Max-hold
 Sweep time No more than a 1ms integration period over each measurement bin
 The trace was allowed to stabilize

*Emission was scanned up to 40 GHz; No emissions were detected above the noise floor which was at least 20 dB below the specification limit.

* It was recorded for the SP0_BPRF 125 Preamble 10 mode.

Test results

[CH 5]

960 MHz ~ 6 000 MHz

Frequency [MHz]	Pol. [V/H]	Reading [dBm]	Ant. Factor [dB]	Amp. + Cable [dB]	Conv. Factor [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
1 598.30	H	-77.83	28.37	-46.99	-3.82	-81.65	-75.30	6.35
1 013.95	V	-80.10	27.80	-48.12	-3.82	-83.92	-75.30	8.62
1 951.24	H	-70.44	30.77	-46.28	-3.82	-74.26	-63.30	10.96
1 899.94	V	-78.78	30.42	-46.36	-3.82	-82.60	-63.30	19.30
2 072.10	H	-71.30	31.26	-46.03	-3.82	-75.12	-61.30	13.82
2 493.50	V	-75.48	32.19	-45.36	-3.82	-79.30	-61.30	18.00
5 775.90	H	-75.22	34.93	-41.82	-3.82	-79.04	-41.30	37.74
6 000.00	V	-66.82	35.20	-41.51	-3.82	-70.64	-41.30	29.34

9 000 MHz ~ 18 000 MHz

Frequency [MHz]	Pol. [V/H]	Reading [dBm]	Ant. Factor [dB]	Amp. + Cable [dB]	Conv. Factor [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
9 502.30	H	-72.49	36.40	-39.05	-3.82	-76.31	-41.30	35.01
9 477.30	V	-72.49	36.38	-39.06	-3.82	-76.31	-41.30	35.01
14 998.60	H	-67.18	40.30	-35.17	-3.82	-71.00	-61.30	9.70
15 004.60	V	-67.07	40.10	-35.17	-3.82	-70.89	-61.30	9.59

1 164 MHz ~ 1 240 MHz_(For GPS Band)

Frequency [MHz]	Pol. [V/H]	Reading [dBm]	Ant. Factor [dB]	Amp. + Cable [dB]	Conv. Factor [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
1 200.02	H	-89.13	27.76	-47.94	-3.82	-92.95	-85.30	7.65
1 237.34	V	-92.10	27.75	-47.85	-3.82	-95.92	-85.30	10.62

1 559 MHz ~ 1 610 MHz_(For GPS Band)

Frequency [MHz]	Pol. [V/H]	Reading [dBm]	Ant. Factor [dB]	Amp. + Cable [dB]	Conv. Factor [dB]	Result [dBm]	Limit [dBm]	Margin [dB]
1 597.09	H	-84.00	28.36	-47.00	-3.82	-87.82	-85.30	2.52
1 559.87	V	-90.38	28.11	-47.05	-3.82	-94.20	-85.30	8.90

Notes:

Conversion Factor [dB] = 107 - 104.8 + 20*log(D_{Meas}) = -3.82 dB

D_{meas} = 0.5 m

Reading [dBm] = Analyzer Level + Ant. Factor + Amp. + Cable Loss

Result [dBm] = Reading + Conv. Factor

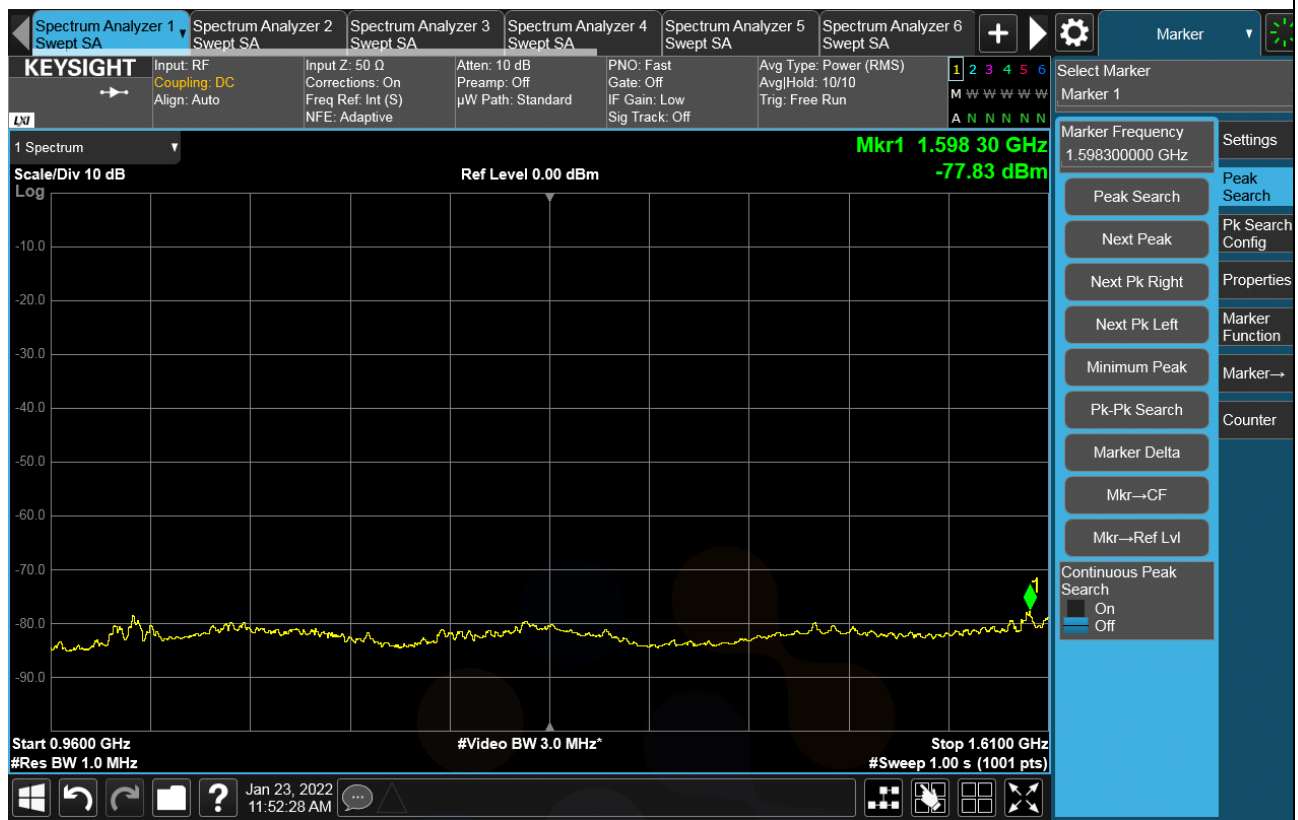
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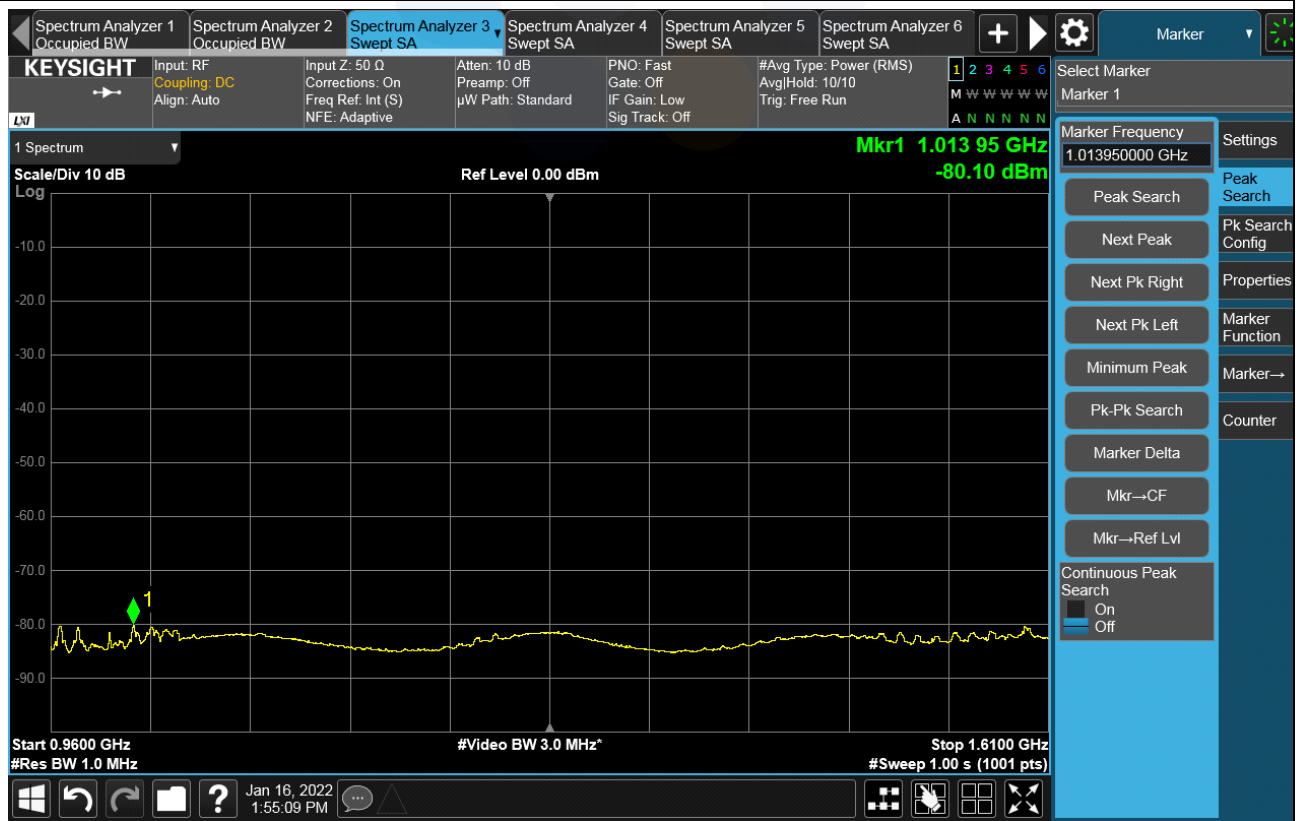
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960 MHz ~ 1 610 MHz Horizontal



960 MHz ~ 1 610 MHz Vertical



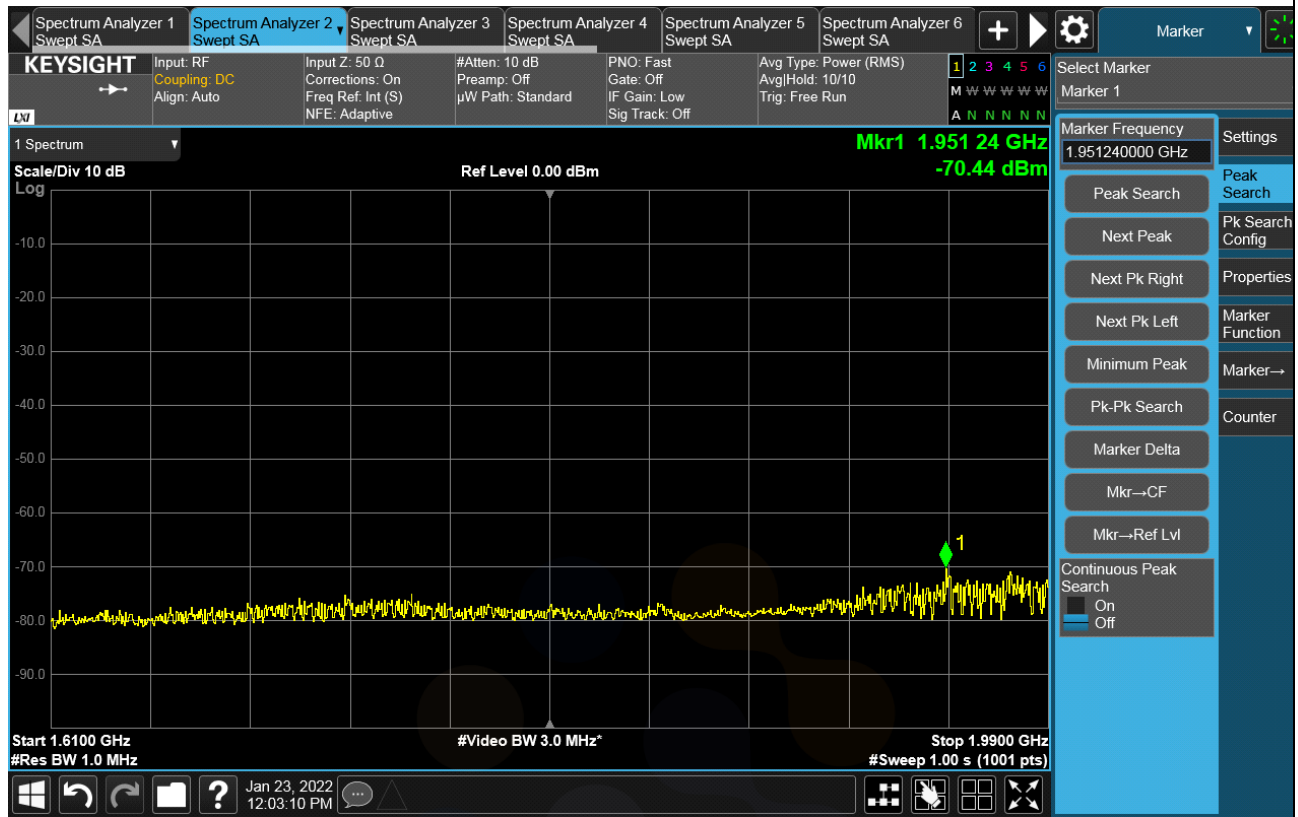
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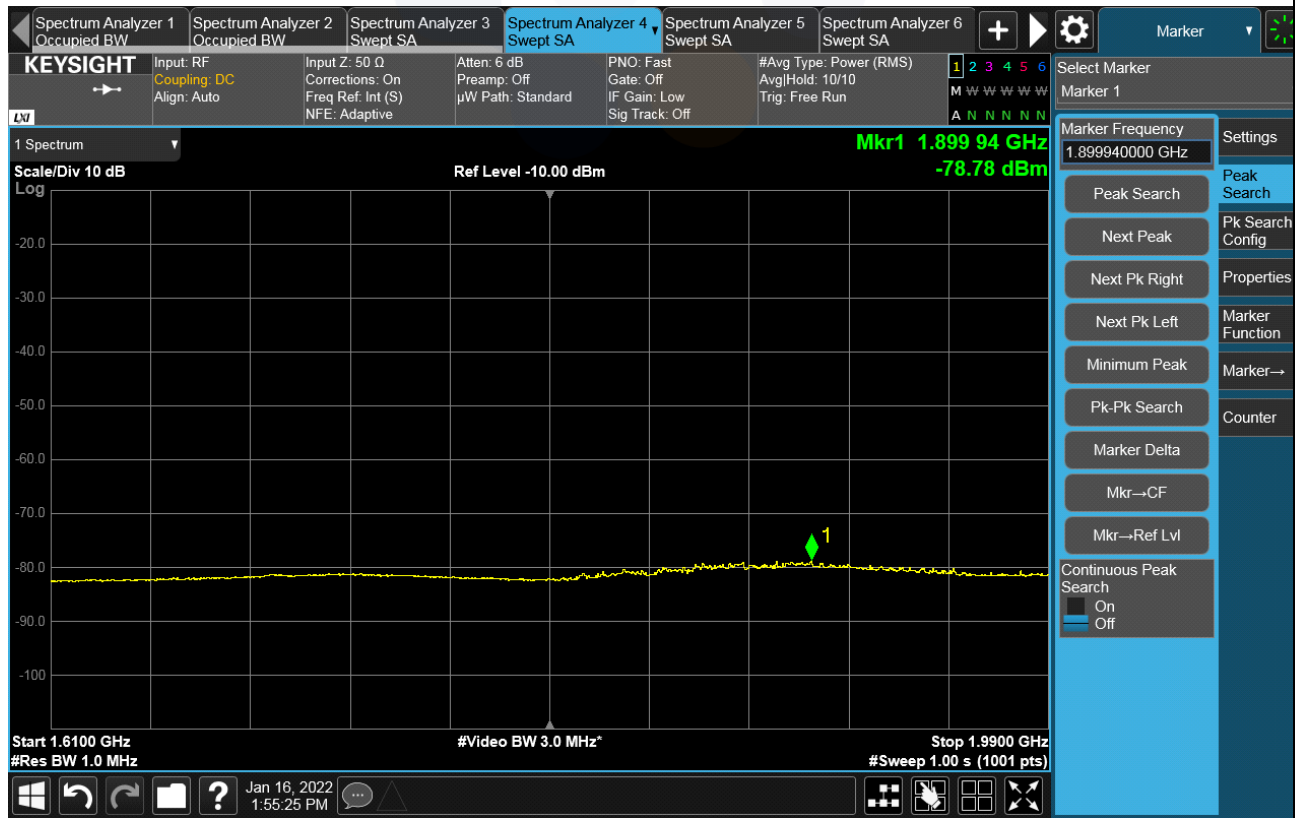
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1 610 MHz ~ 1 990 MHz Horizontal



1 610 MHz ~ 1 990 MHz Vertical



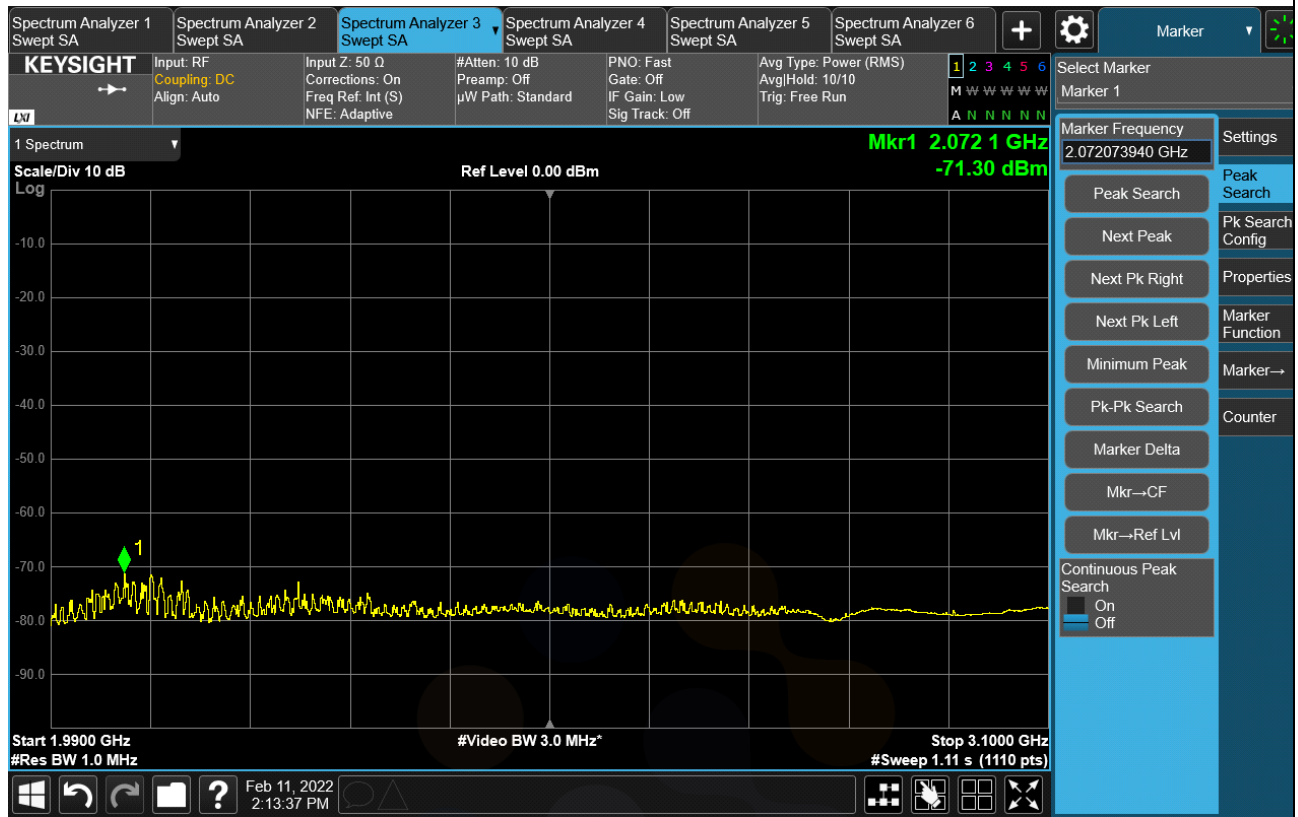
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1 990 MHz ~ 3 100 MHz Horizontal



1 990 MHz ~ 3 100 MHz Vertical

