CERTIFICATE #3478.01

TEST REPORT

EUT Description	**WLAN and BT, 2x2 PCIe M.2 1625 SD adapter card**
Brand Name	**Intel® Wi-Fi 6E AX411**
Model Name	**AX411E2W**
FCC ID	**PD9AX411E2**
Date of Test Start/End	**2021-12-15 / 2022-01-13**
Features	**802.11ax, Tri-Band, 2x2 Wi-Fi 6E + Bluetooth® 5.2 + CDB** (see section 5)

Applicant	**Intel Mobile Communications**
Address	**100 Center Point Circle, Suite 200** **Columbia, South Carolina 29210** **USA**
Contact Person	**Steven Hackett**
Telephone/Fax/ Email	**steven.c.hackett@intel.com**

Reference Standards	**FCC CFR Title 47 Part 15 E** (see section 1)

Test Report identification	**220121-04.TR02**
Revision Control	**Rev. 00** **This test report revision replaces any previous test report revision** (see section 8)

The test results relate only to the samples tested.
Reference to accreditation shall be used only by full reproduction of test report.

Issued by	Reviewed by
Digitally signed by Z.OUACHICHA Date: 2022.03.18 19:01:03 +01'00'	Digitally signed by Z.OUACHICHA Date: 2022.03.18 19:01:21 +01'00'
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1. Standards, reference documents and applicable test methods

FCC	1. FCC Title 47 eCFR part 15 – Subpart E - Unlicensed National Information Infrastructure Devices. 2021-02-08 Online edition 2. FCC OET KDB 987594 D01 U-NII 6GHz General Requirements v01r02 3. FCC OET KDB 987594 D02 U-NII 6 GHz EMC Measurement v01r01 4. FCC OET KDB 987594 D03 U-NII 6 GHz QA v01 5. FCC OET KDB 789033 D02 v02r01 - General U-NII Test Procedures New Rules – Guidelines for compliance testing of Unlicensed National Information Infrastructure (U-NII) Devices. 6. FCC OET KDB 662911 D01 v02r01 - Emissions Testing of Transmitters with Multiple Outputs in the Same Band. 7. ANSI C63.10-2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

2. General conditions, competences and guarantees

- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an ISO/IEC 17025:2017 laboratory accredited by the American Association for Laboratory Accreditation (A2LA) with the certificate number 3478.01.
- ✓ Intel Corporation SAS Wireless RF Lab (Intel WRF Lab) is an Accredited Test Firm recognized by the FCC, with Designation Number FR0011.
- ✓ Intel WRF Lab declines any responsibility with respect to the identified information provided by the customer and that may affect the validity of results.
- ✓ Intel WRF Lab only provides testing services and is committed to providing reliable, unbiased test results and interpretations.
- ✓ Intel WRF Lab is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.
- ✓ Intel WRF Lab has developed calibration and proficiency programs for its measurement equipment to ensure correlated and reliable results to its customers.
- ✓ This report is only referred to the item that has undergone the test.
- ✓ This report does not imply an approval of the product by the Certification Bodies or competent Authorities.

3. Environmental Conditions

- ✓ At the site where the measurements were performed the following limits were not exceeded during the tests:

Temperature	23.8 ± 2.0ºC
Humidity	34.5% ± 6.7%

4. Test samples

Sample	Control #	Description	Model	Serial #	Date of receipt	Note
#01	210611-03.S17	WiFi 6E Module	AX411E2W	WFM:3413E8F11E13	2021-07-13	RF Conducted – Contention-based protocol
	170000-01.S18	Laptop	Latitude E5470	4L1BVF2	2019-05-23	
	191003-02.S04	Extender	PCB00651_01	-	2019-10-29	

5. EUT Features

The herein information is provided by the customer

Brand Name	Intel® Wi-Fi 6E AX411
Model Name	AX411E2W
Software Version	DRTU version: OEM_DRTU_12485_99_2100_64G
Driver Version	V1.6.2_99.0.63.5
Supported Radios	802.11b/g/n/ax 2.4GHz (2400.0 – 2483.5 MHz) 802.11a/n/ac/ax 5.2GHz (5150.0 – 5350.0 MHz) 5.6GHz (5470.0 – 5725.0 MHz) 5.8GHz (5725.0 – 5895.0 MHz) 6.0GHz (5925.0 - 7125.0MHz) Bluetooth 5.2 2.4GHz (2400.0 – 2483.5 MHz)
Antenna Information	

Transmitter	Ant A (Main) SISO Mode	Ant B(Aux) SISO Mode	Ant A (Main) MIMO Mode	Ant B (Aux) MIMO Mode
Manufacturer	Intel	Intel	Intel	Intel
PIFA antenna	PIFA antenna	PIFA antenna	PIFA antenna	PIFA antenna
SN	NA	NA	NA	NA
Max Antenna gain (dBi)	+5.59	+5.59	+5.59 (Completely uncorrelated)	+5.59 (Completely uncorrelated)

MIMO mode signal: Completely uncorrelated.

Additional information	The EUT class is a client connected to Low-Power Access point

6. Remarks and comments

1. As per applicant request, Contention based protocol test case has been tested using an antenna gain of -3.6dBi to show compliance with the lowest antenna gain to be used with module as per applicant host integration instructions
2. Original certification was done with a Max Antenna Gain of 5.59dBi (Refer to test Report 210611-03.TR38)

7. Test Verdicts summary

The statement of conformity to applicable standards in the table below are based on the measured values, without taking into account the measurement uncertainties.

7.1. 802.11 a/n/ac/ax – U-NII-5 to U-NII-8

FCC part	Test name	Verdict
15.407 (a) (10)	Channel bandwidth	NR
15.407 (a) (8)	Maximum output power	NR
15.407 (a) (2)	Power spectral density	NR
15.407 (b) (5)	Undesirable emissions limits: out of band (conducted)	NR
15.407 (b) (6)	In-Band Emissions (Mask)	NR
15.407 (d) (6)	Contention based protocol	P

P: Pass
F: Fail
NM: Not Measured
NA: Not Applicable
NR: Not Requested

8. Document Revision History

Revision #	Modified by	Revision Details
Rev. 00	C.Requin	First Issue

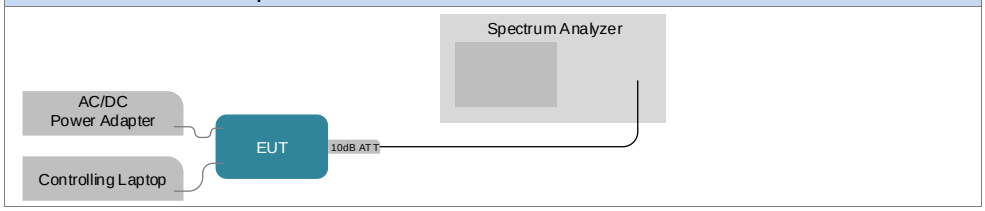
Annex A. Test & System Description

A.1 Measurement System

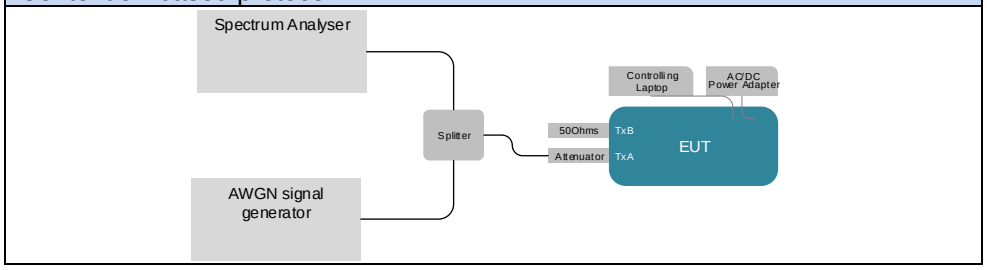
Measurements were performed using these following setup.

The DUT was installed in a test fixture and this test fixture is connected to a laptop computer and AC/DC power adapter. The laptop computer was used to configure the EUT to continuously transmit at a specified output power using all different modes and modulation schemes, using the Intel proprietary tool DRTU.

Conducted test setup



Contention-based protocol



A.2 Test Equipment List

Contention-based protocol

ID#	Device	Type/Model	Serial #	Manufacturer	Cal. Date	Cal. Due Date
098-000	Vector Signal generator	SMW200A	103732	Rohde & Schwarz	2020-07-20	2022-07-20
134-000	Spectrum Analyzer	FSV13	103308	Rohde & Schwarz	2021-04-21	2023-04-21
018-004	50 Ohm Load	-	-	-	2021-08-24	2022-02-24
018-000	2 Way SMA Power Divider	PE2084	-	Pasternack	2021-08-24	2022-02-24
349-000	Temp & Humidity Logger	RA12E-TH1-RAS	RA12-D4F8C3	Avtech	2021-07-30	2023-07-30
018-005	Cable SMA Male to SMA Male 45CM	FMC0202085-18	-	Fairview Microwave	2021-08-24	2022-02-24
018-006	Cable SMA Male to SMA Male 45CM	FMC0202085-18	-	Fairview Microwave	2021-08-24	2022-02-24
016-003	Cable SMA Male to SMA Male 45CM	FMC0202085-18	-	Fairview Microwave	2021-08-24	2022-02-24

A.3 Measurement Uncertainty Evaluation

The system uncertainty evaluation is shown in the table below with a coverage factor of k = 2 to indicate a 95% level of confidence:

Measurement type	Uncertainty	Unit
Contention Based Protocol	±1.36	dB

Annex B. Test Results

The herein test results were performed by:

Test case measurement	Test Personnel
Contention-based Protocol	Gregory Roustan

B.1 Test Conditions

For 802.11a mode the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, but not simultaneously.

For 802.11n20 & 802.11ax20 (20 MHz channel bandwidth), 802.11n40 & 802.11ax40 (40MHz channel bandwidth), 802.11ac80 & 802.11ax80 (80MHz channel bandwidth) and 802.11ac160 & 802.11ax160 (160MHz channel bandwidth) modes the EUT can transmit at both CHAIN A and CHAIN B RF outputs individually, and also simultaneously.

B.2 Test Results Tables

B.2.1 Contention-based protocol

Test limits

Indoor access points, subordinate devices and client devices operating in the 5.925-7.125 GHz band are required to use technologies that include a contention-based protocol to avoid co-channel interference with incumbent devices sharing the band. To ensure incumbent co-channel operations are detected in a technology-agnostic manner, unlicensed devices are required to detect co-channel radio frequency energy (energy detect) and avoid simultaneous transmission.
Unlicensed indoor low-power devices must detect co-channel radio frequency power that is at least -62 dBm or lower. Upon detection of energy in the band, unlicensed low power indoor devices must vacate the channel and stay off the channel as long as detected radio frequency power is equal to or greater than the threshold (-62 dBm).

Test procedure

The contention-based protocol setup shown in section *Test & System Description* was used to measure the contention-based protocol. The EUT ceased transmission when the AWGN source signal level described in table result below is set to transmit.
Incumbent signal is emulated by using a 10MHz bandwidth AWGN source generated by the vector signal generator.
The EUT is transmitting at the maximum possible payload and the spectrum analyzer monitors the transmissions in response to the AWGN signal. Insertion loss of the test setup were considered on the spectrum analyser reading.

Result Tables

Contention-based Protocol Threshold minimum level

UNII	Channel	Bandwidth [MHz]	EUT Freq [MHz] f_{c1}	Incumbent Placement/Frequency [MHz] f_{c2}		Threshold level of AWGN incumbent (dBm) at antenna level*see note below	Status of EUT transmision
5	45	20	6175	$f_{c1} = f_{c2}$	6175	-63.5	Ceased
						-64.5	Minimal
						-65.5	Minimal
						-66.5	Normal
6	105	20	6475	$f_{c1} = f_{c2}$	6475	-63.7	Ceased
						-64.7	Minimal
						-65.7	Minimal
						-66.7	Normal
7	149	20	6695	$f_{c1} = f_{c2}$	6695	-63.4	Ceased
						-64.4	Minimal
						-65.4	Minimal
						-66.4	Normal
8	209	20	6995	$f_{c1} = f_{c2}$	6995	-64.4	Ceased
						-65.4	Minimal
						-66.4	Minimal
						-67.4	Normal
5	15	160	6025	Lower Edge	5950	-62.0	Ceased
						-63.0	Minimal
						-64.0	Normal
				$f_{c1} = f_{c2}$	6025	-64.9	Ceased
						-65.9	Minimal
						-66.9	Normal
				Upper edge	6100	-62.8	Ceased
						-63.8	Minimal
						-64.8	Normal
6-7	111	160	6505	Lower Edge	6430	-62.1	Ceased
						-63.1	Minimal
						-64.1	Normal
				$f_{c1} = f_{c2}$	6505	-65.1	Ceased

						-66.1	Minimal
						-67.1	Normal
				Upper edge	6580	-62.3	Ceased
						-63.3	Minimal
						-64.3	Normal
7	143	160	6665	Lower Edge	6590	-62.3	Ceased
						-63.3	Minimal
						-64.3	Normal
				$f_{c1} = f_{c2}$	6665	-64.5	Ceased
						-65.5	Minimal
						-66.5	Normal
				Upper edge	6740	-62.5	Ceased
						-63.5	Minimal
						-64.5	Normal
8	207	160	6985	Lower Edge	6910	-62.1	Ceased
						-63.1	Minimal
						-64.1	Normal
				$f_{c1} = f_{c2}$	6985	-64.7	Ceased
						-65.7	Minimal
						-66.7	Normal
				Upper edge	7060	-62.9	Ceased
						-63.9	Minimal
						-64.9	Normal

Note : EUT antenna gain = -3.6dBi considered in the measurement path loss.

Summary table

Bandwidth	UNII Sub-band	Channel	EUT Freq [MHz] f_{c1}	Incumbent Placement/Frequency [MHz] f_{c2}		Incumbent Threshold level of AWGN interference at antenna level (dBm)*see note below	Number of iterations	Detection Probability (%)	Limit (%)	Verdict
20MHz	5	45	6175	$f_{c1} = f_{c2}$	6175	-63.5	10	100	90	Pass
	6	105	6475	$f_{c1} = f_{c2}$	6475	-63.7	10	100	90	Pass
	7	149	6695	$f_{c1} = f_{c2}$	6695	-63.4	10	100	90	Pass
	8	209	6995	$f_{c1} = f_{c2}$	6995	-64.4	10	100	90	Pass
160MHz	5	15	6025	Lower Edge	5950	-62.0	10	100	90	Pass
				$f_{c1} = f_{c2}$	6025	-64.9	10	100	90	Pass
				Upper edge	6100	-62.8	10	100	90	Pass
	6-7	111	6505	Lower Edge	6430	-62.1	10	100	90	Pass
				$f_{c1} = f_{c2}$	6505	-65.1	10	100	90	Pass
				Upper edge	6580	-62.3	10	100	90	Pass
	7	143	6665	Lower Edge	6590	-62.3	10	100	90	Pass
				$f_{c1} = f_{c2}$	6665	-64.5	10	100	90	Pass
				Upper edge	6740	-62.5	10	100	90	Pass
	8	207	6985	Lower Edge	6910	-62.1	10	100	90	Pass
				$f_{c1} = f_{c2}$	6985	-64.7	10	100	90	Pass
				Upper edge	7060	-62.9	10	100	90	Pass

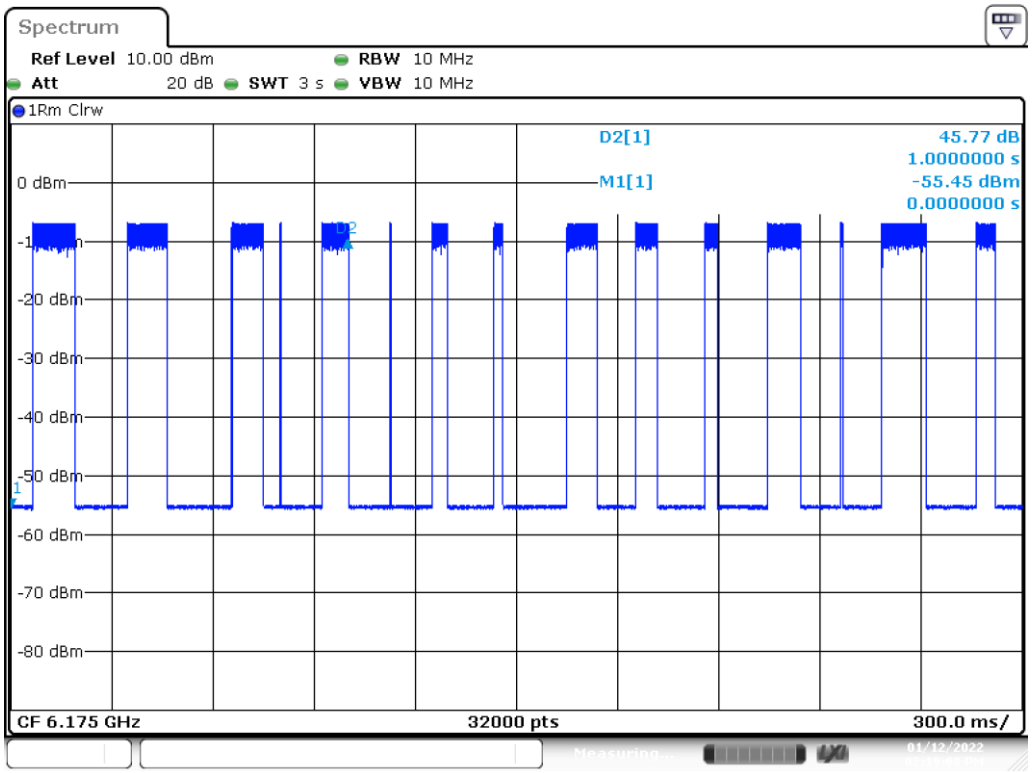
Note : EUT antenna gain = -3.6dBi considered in the measurement path loss.

See Section C.1.1 for the screenshot results.

Annex C. System Plots

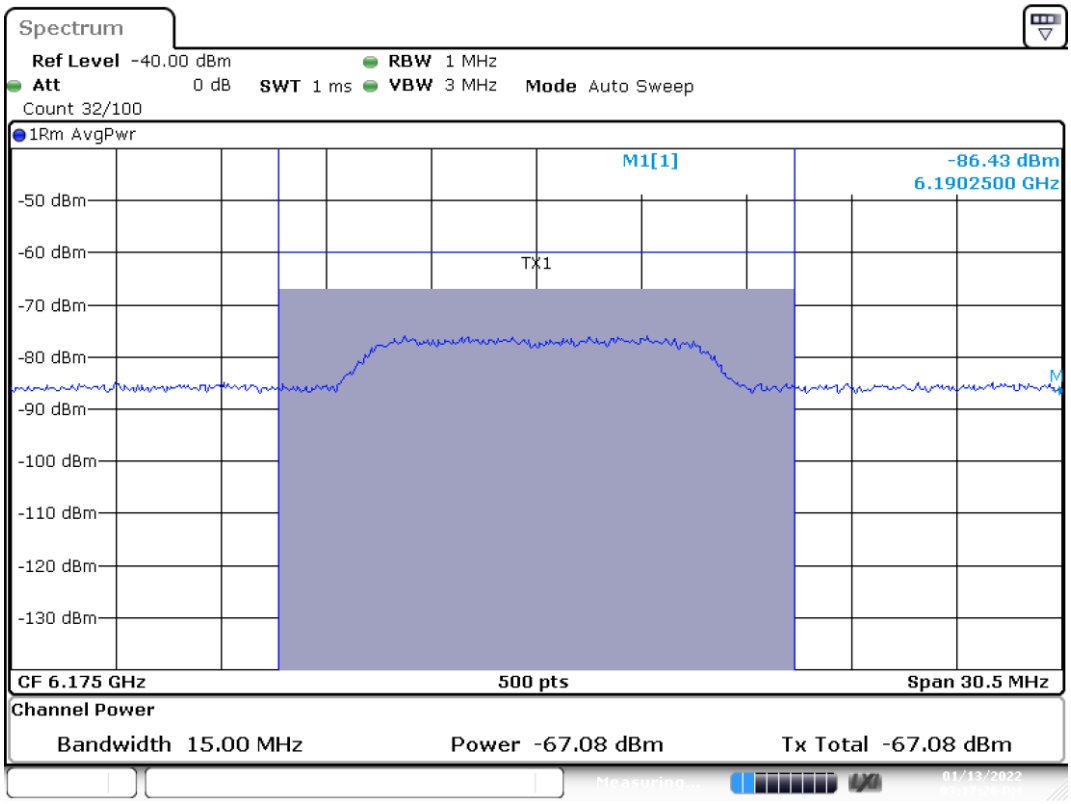
C.1.1 Contention-based protocol

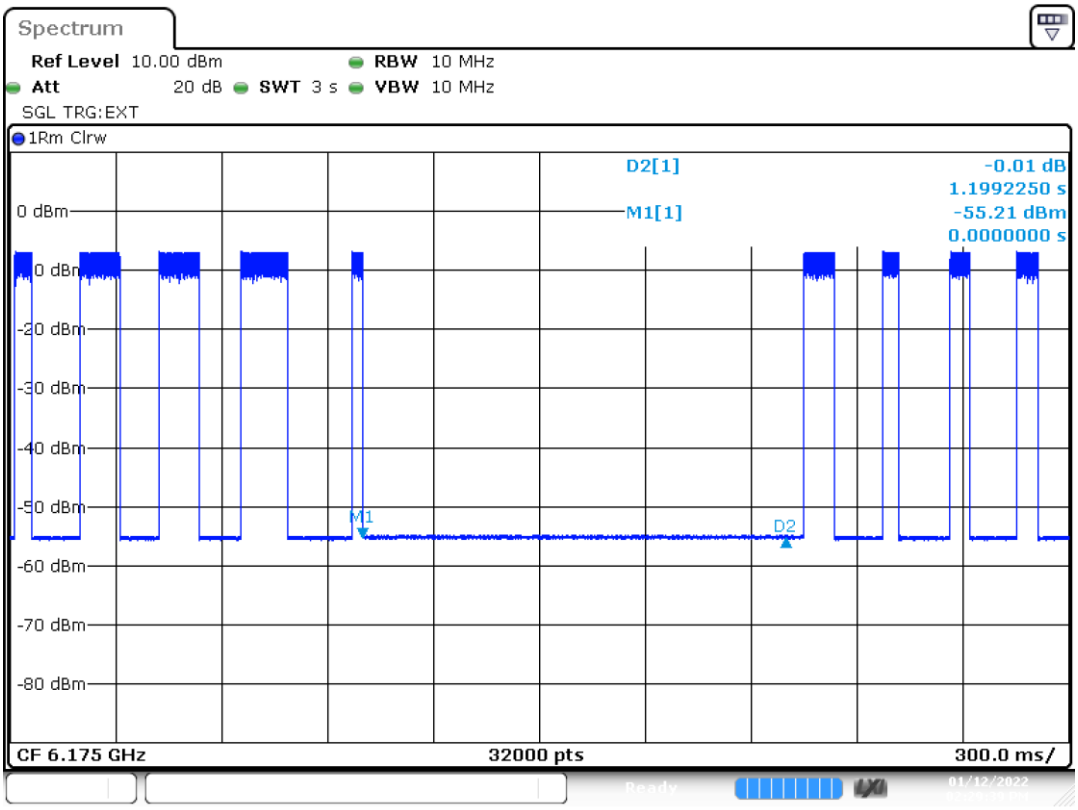
Example of EUT transmission plot

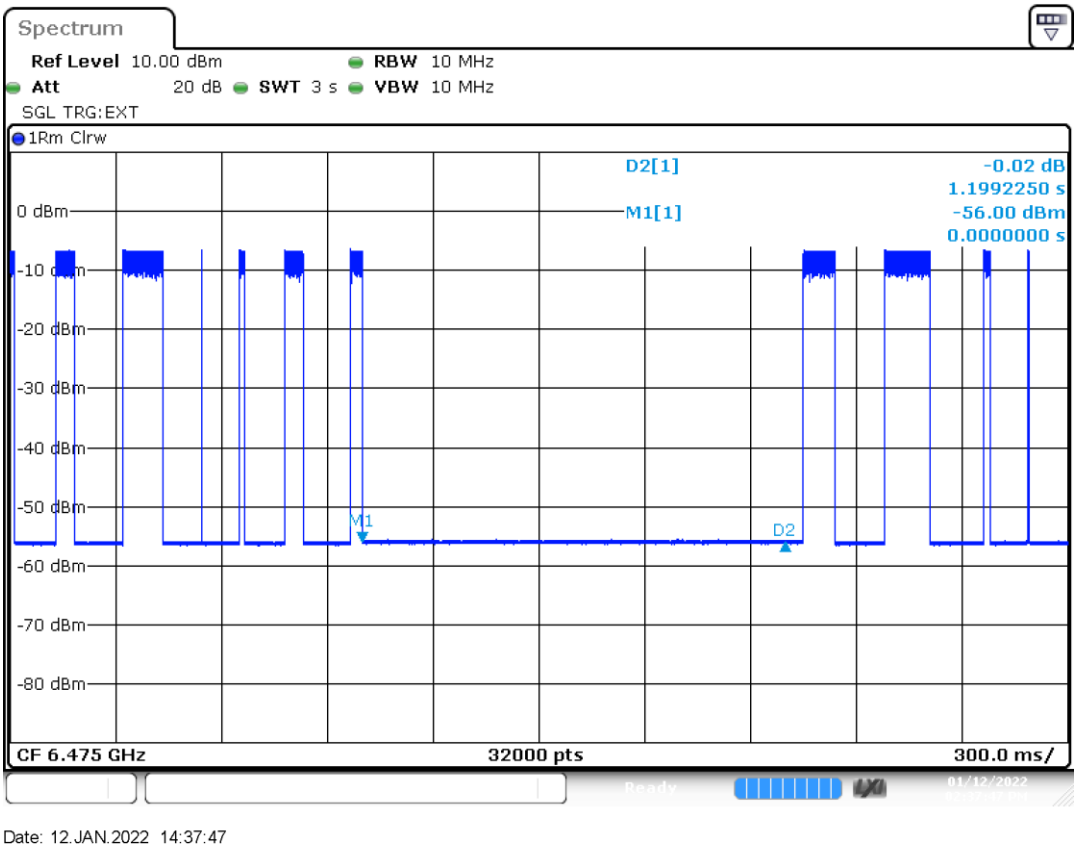


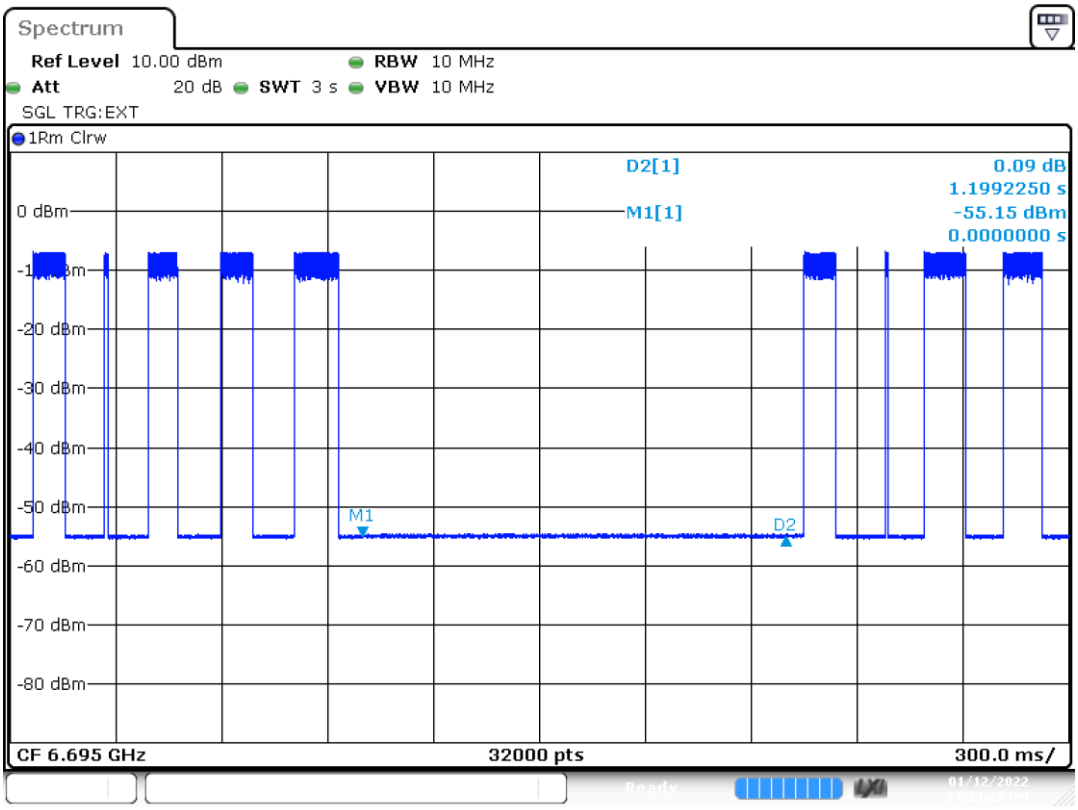
Date: 12.JAN.2022 14:19:08

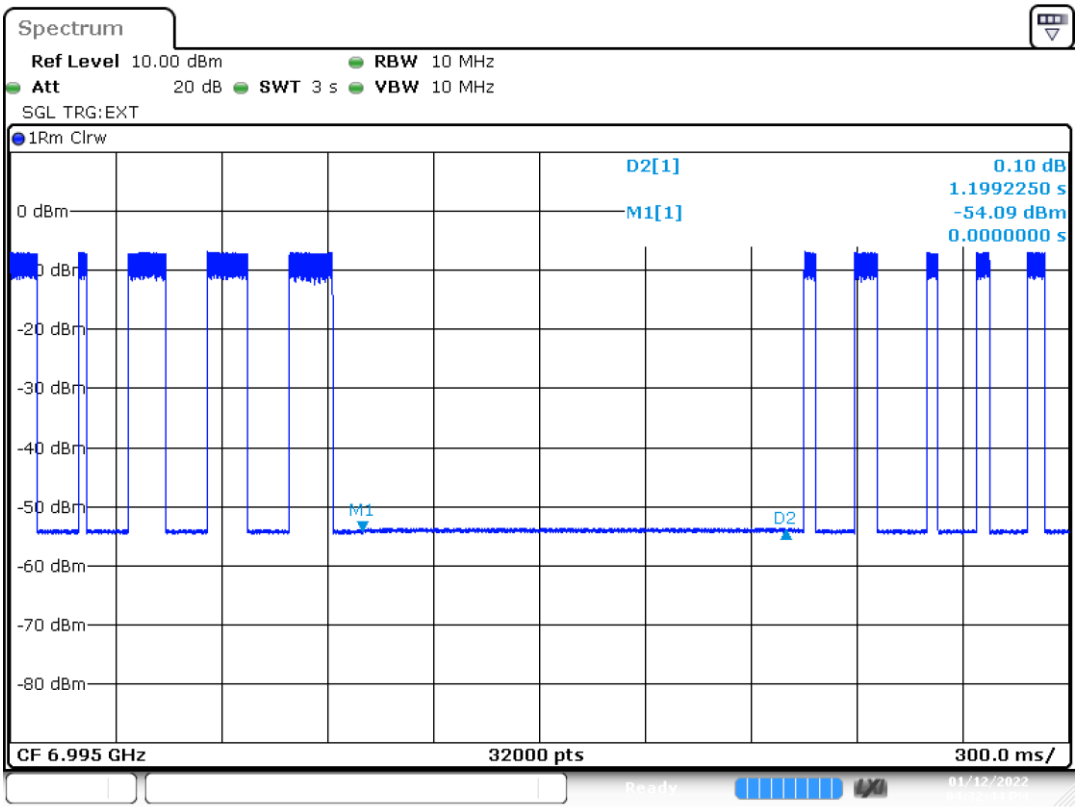
Example of incumbent measured power

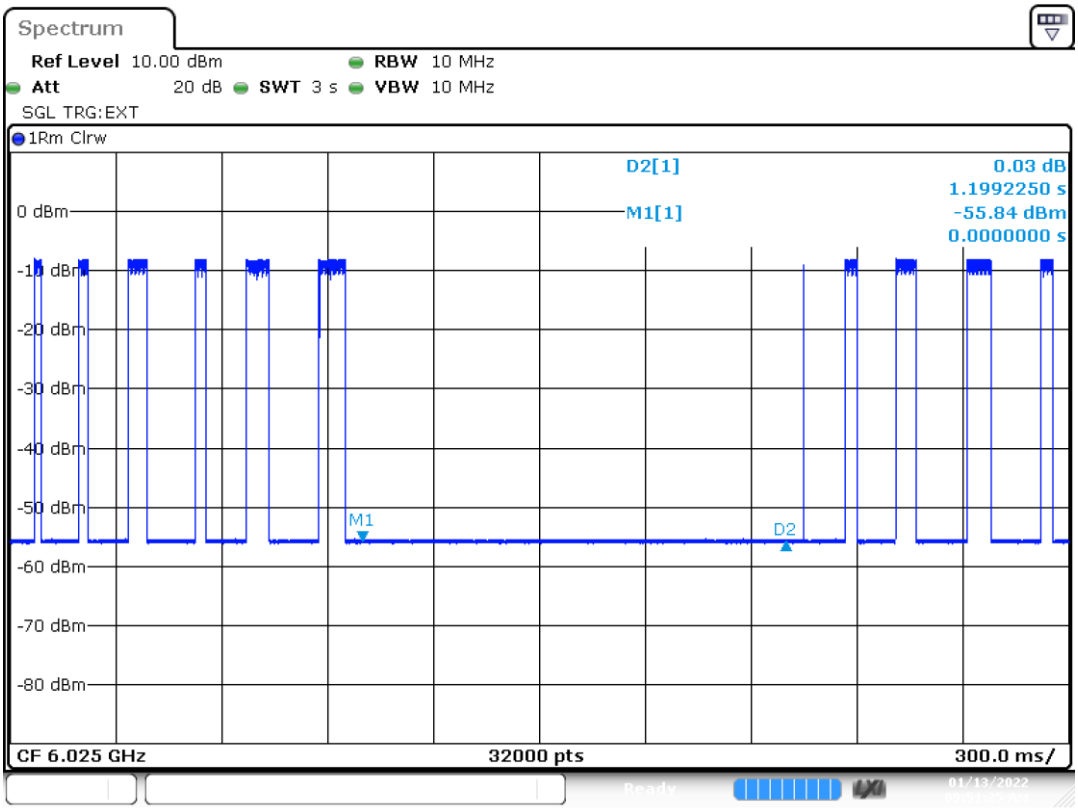


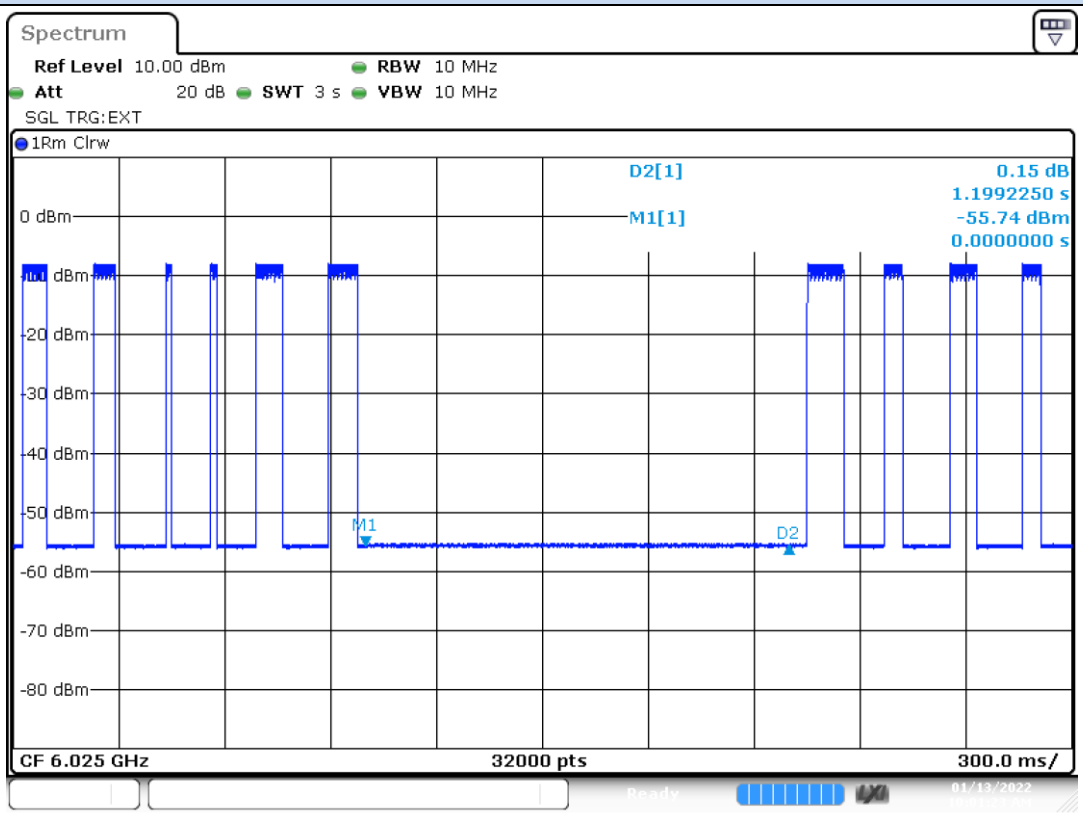
Channel 45 – Incumbent signal 6175 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

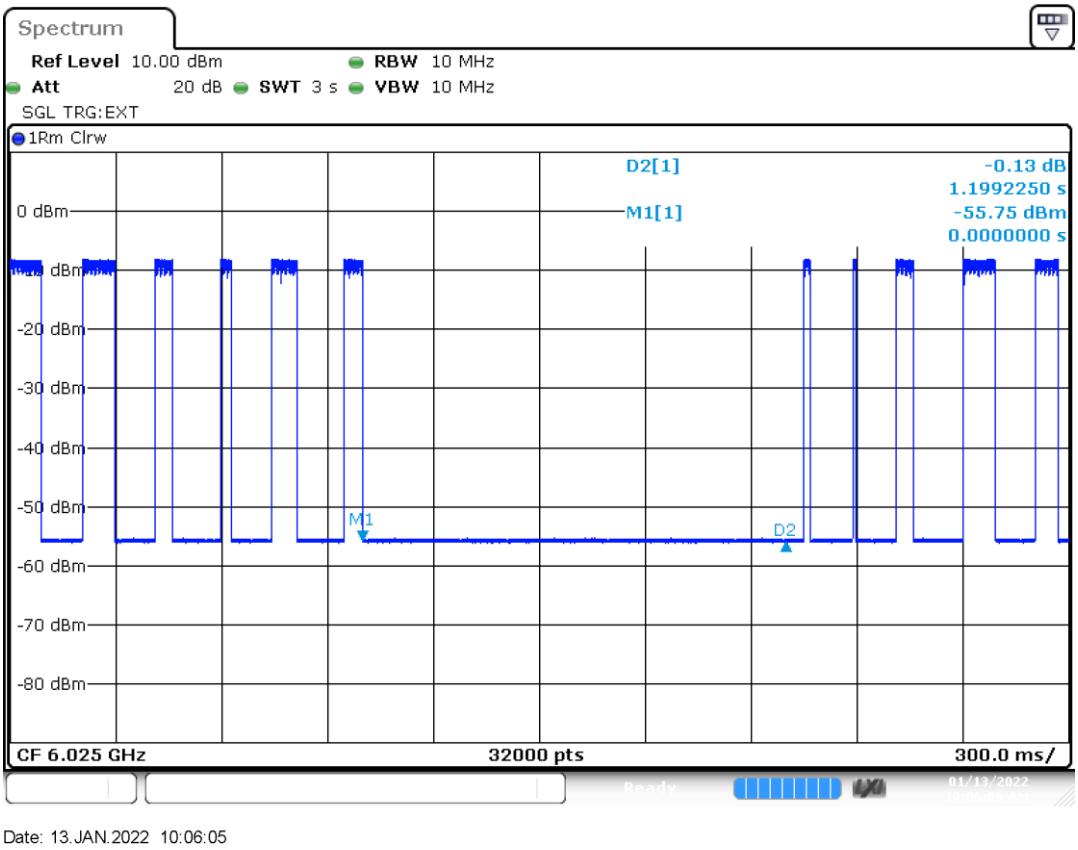
Channel 105 - Incumbent signal 6475 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

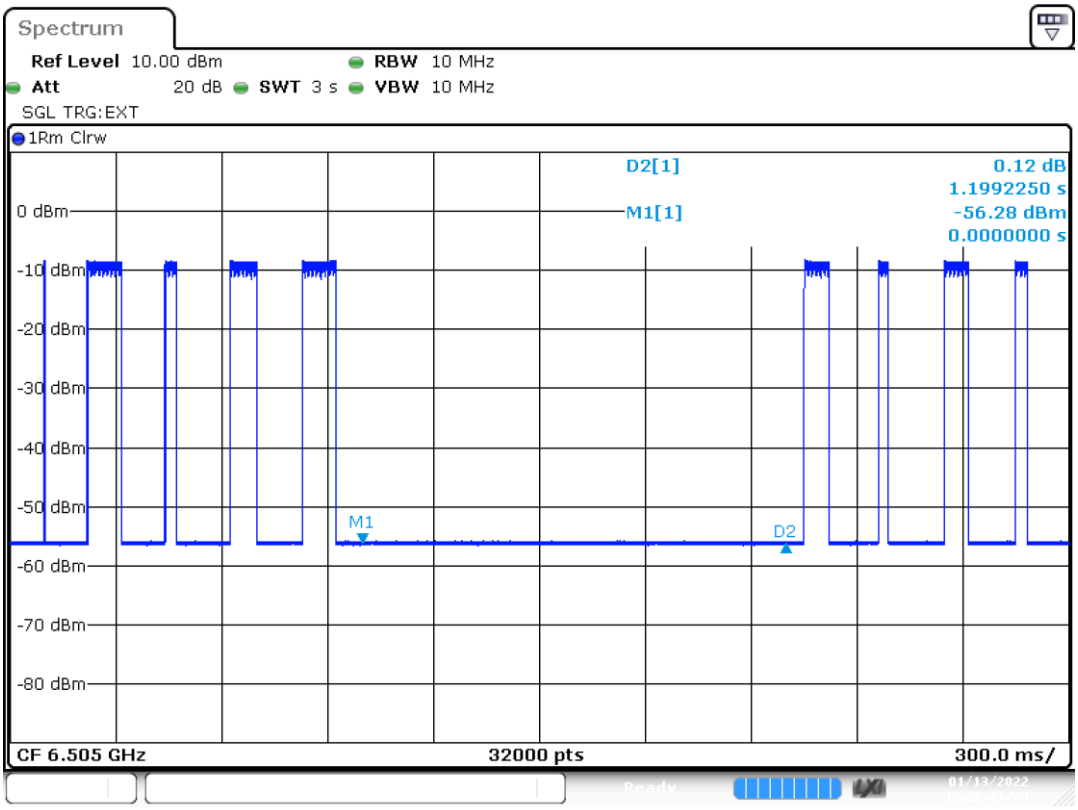
Channel 149 - Incumbent signal 6695 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

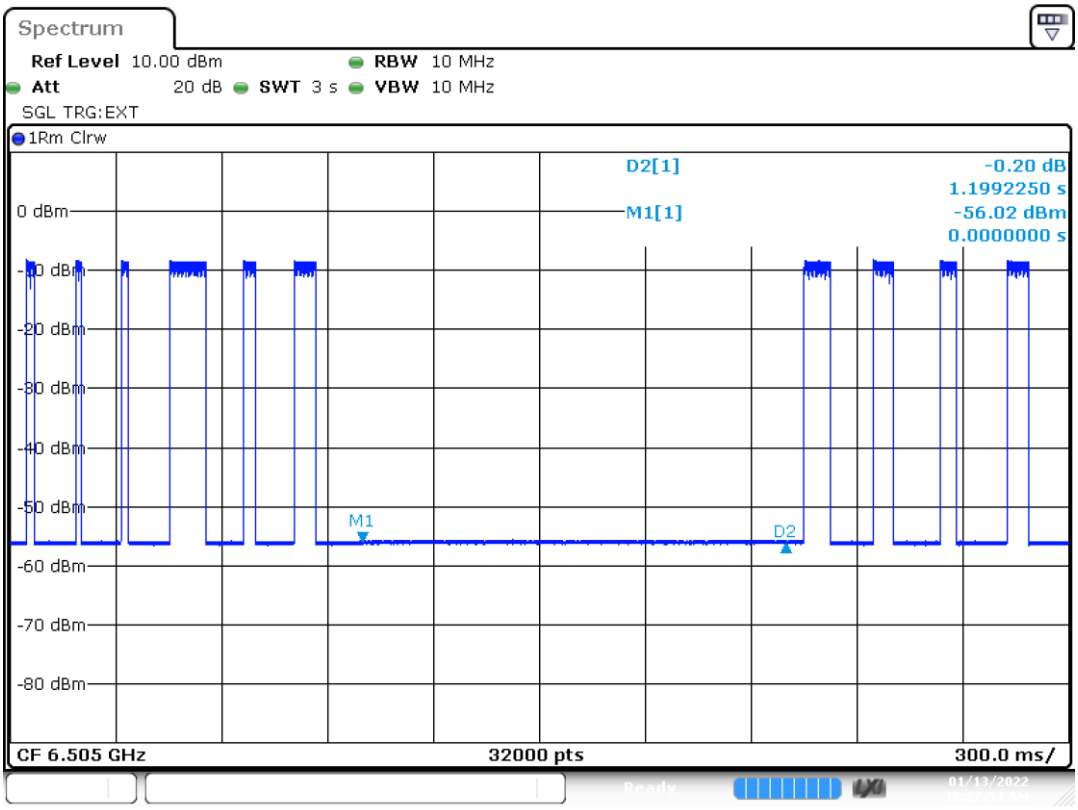
Channel 209 - Incumbent signal 6995 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

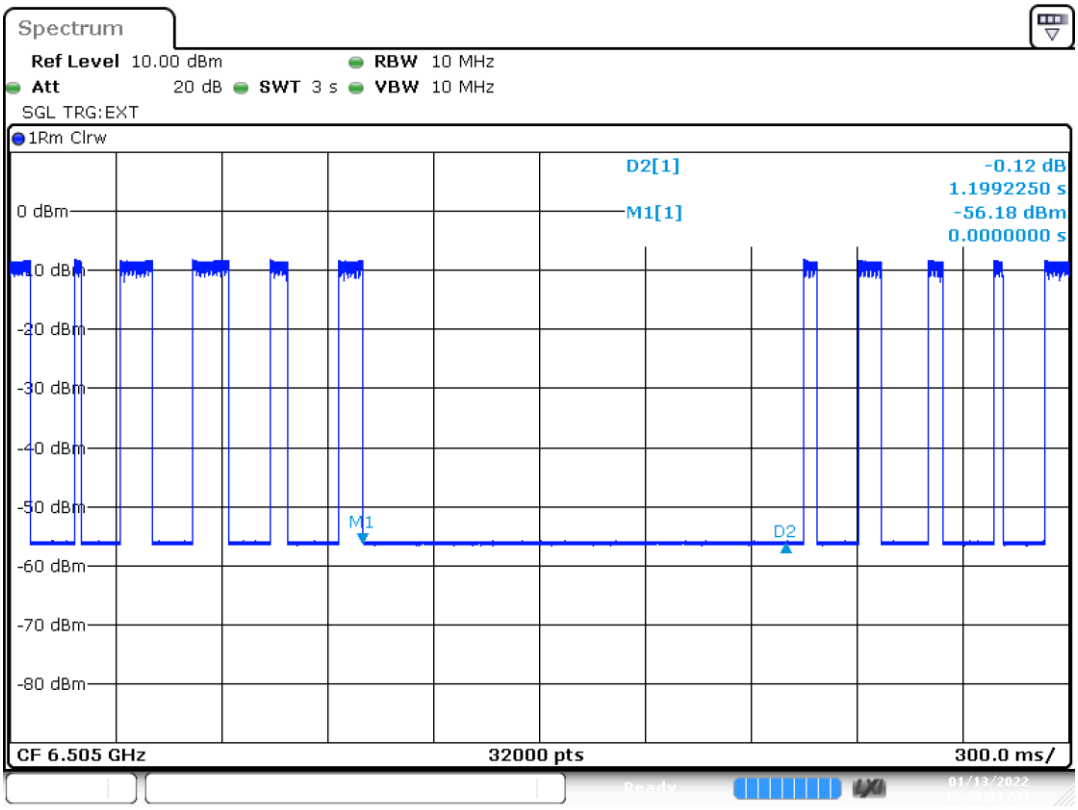
Channel 15 - Incumbent signal 5950 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

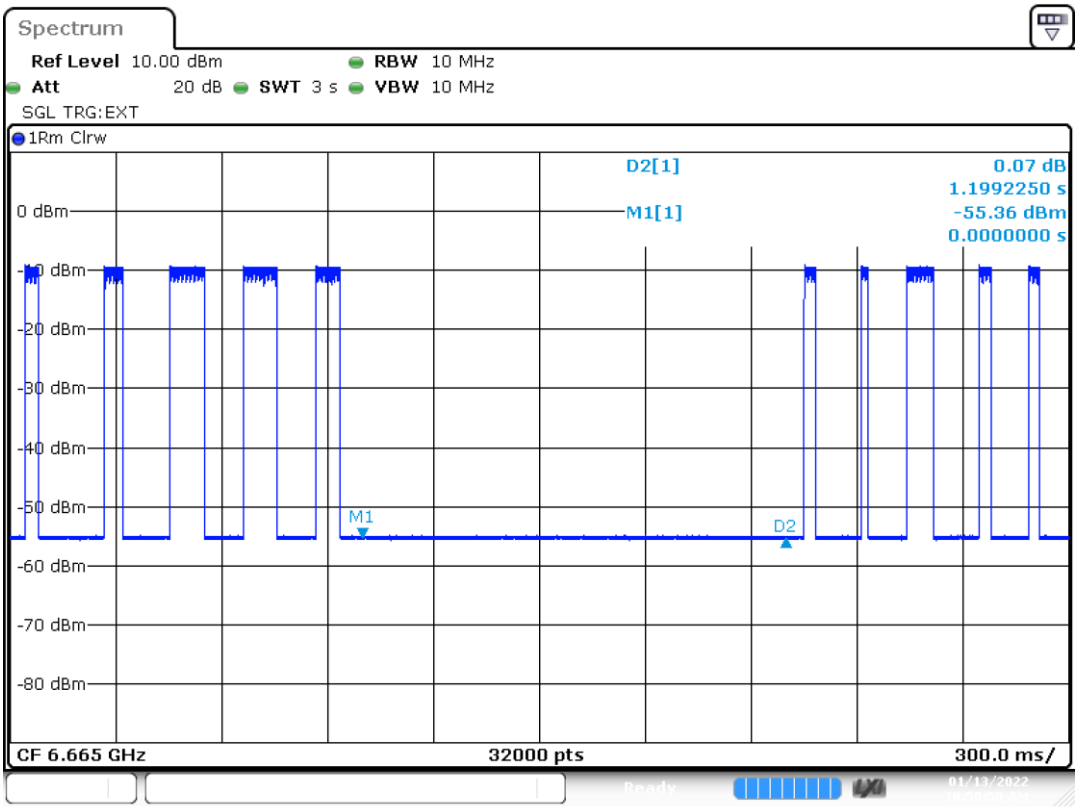
Channel 15 - Incumbent signal 6025 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

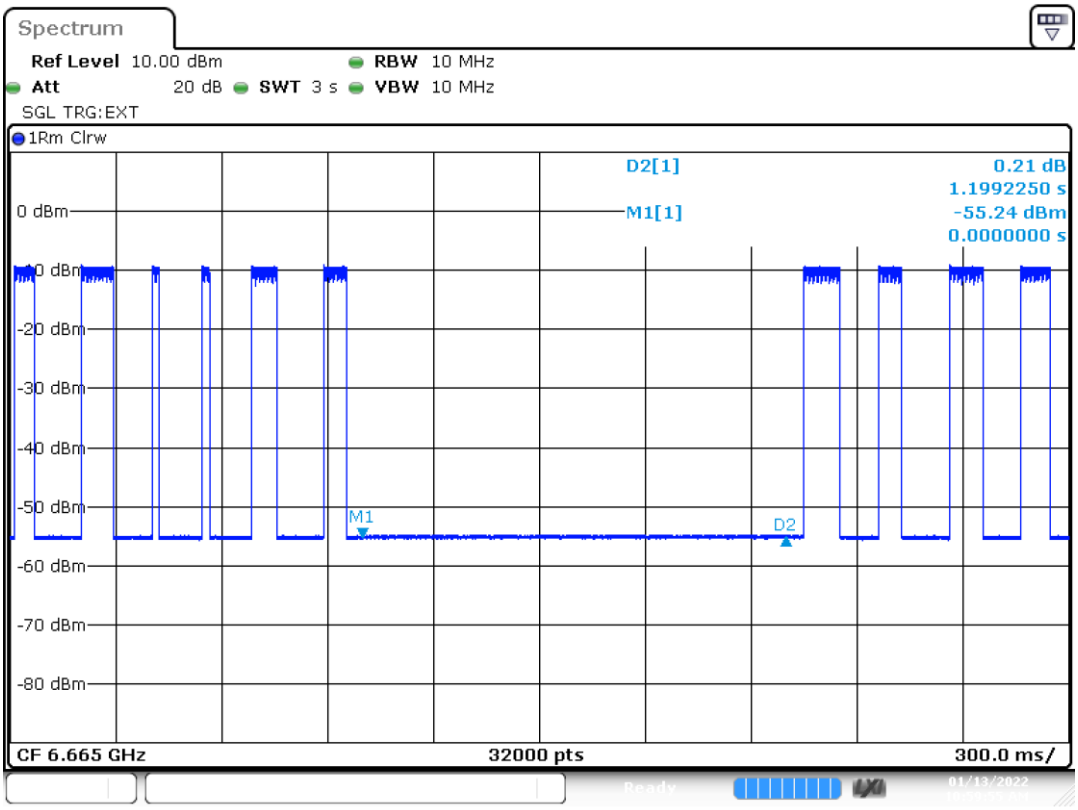
Channel 15 - Incumbent signal 6100 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

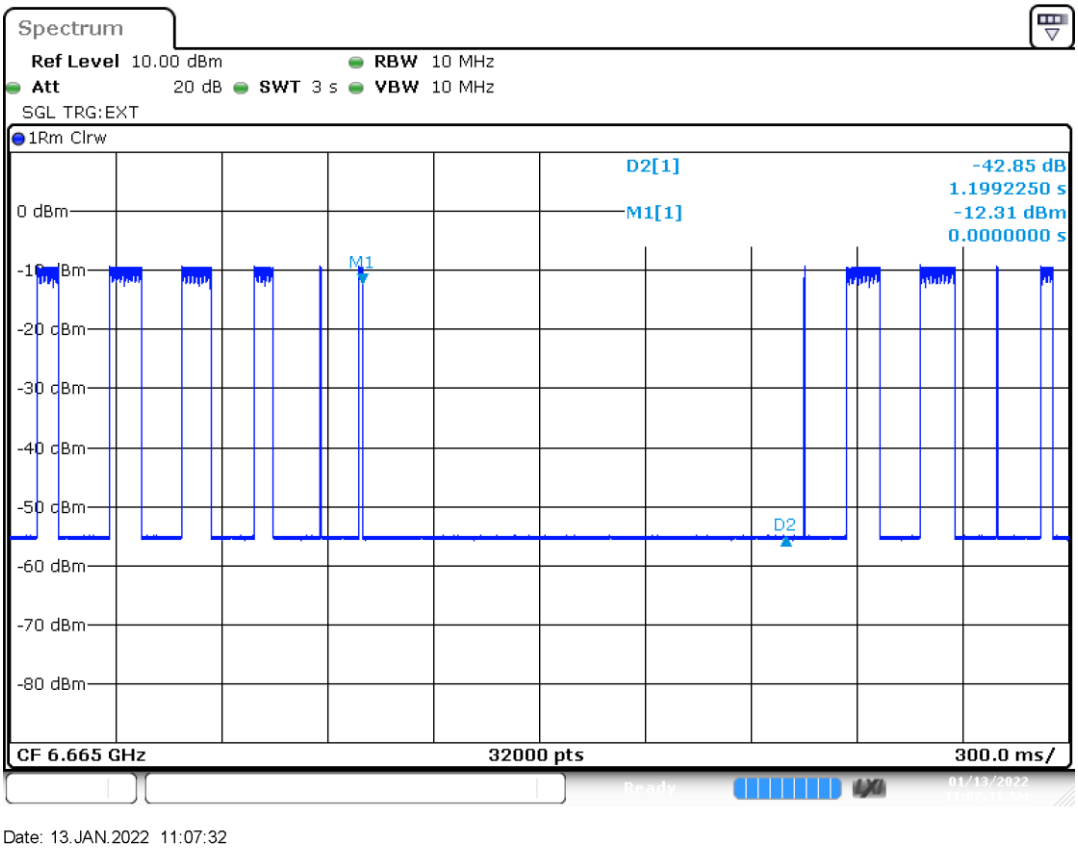
Channel 111 - Incumbent signal 6430 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

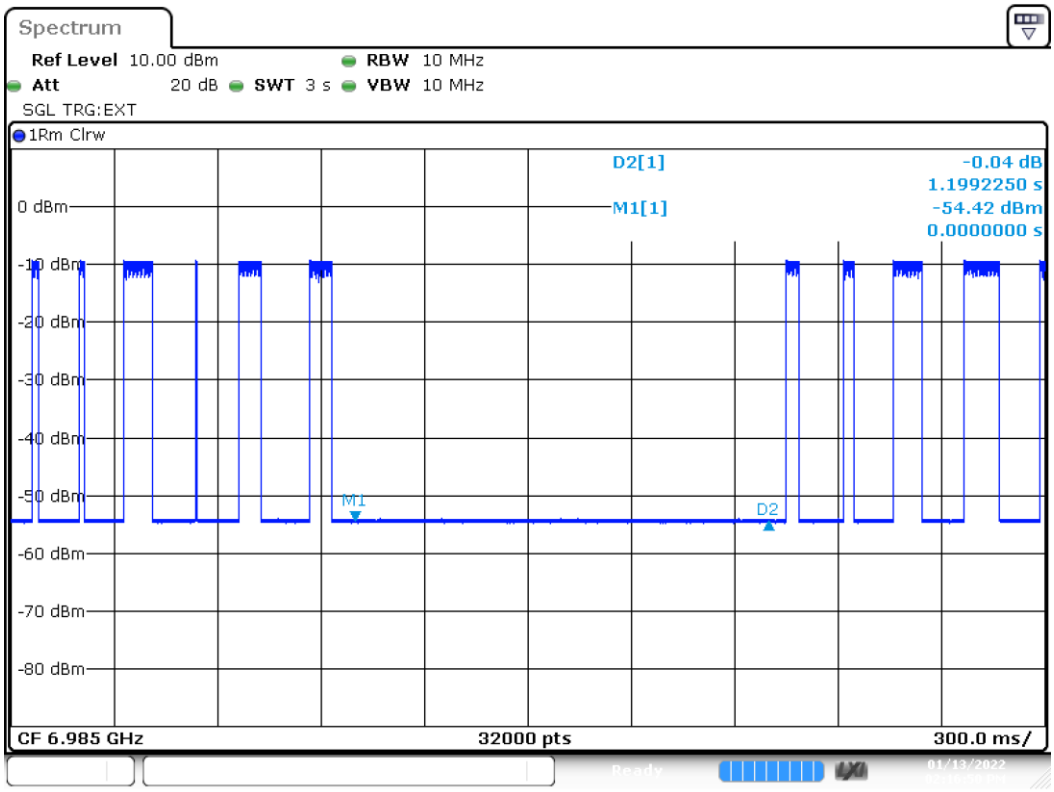
Channel 111 - Incumbent signal 6505 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

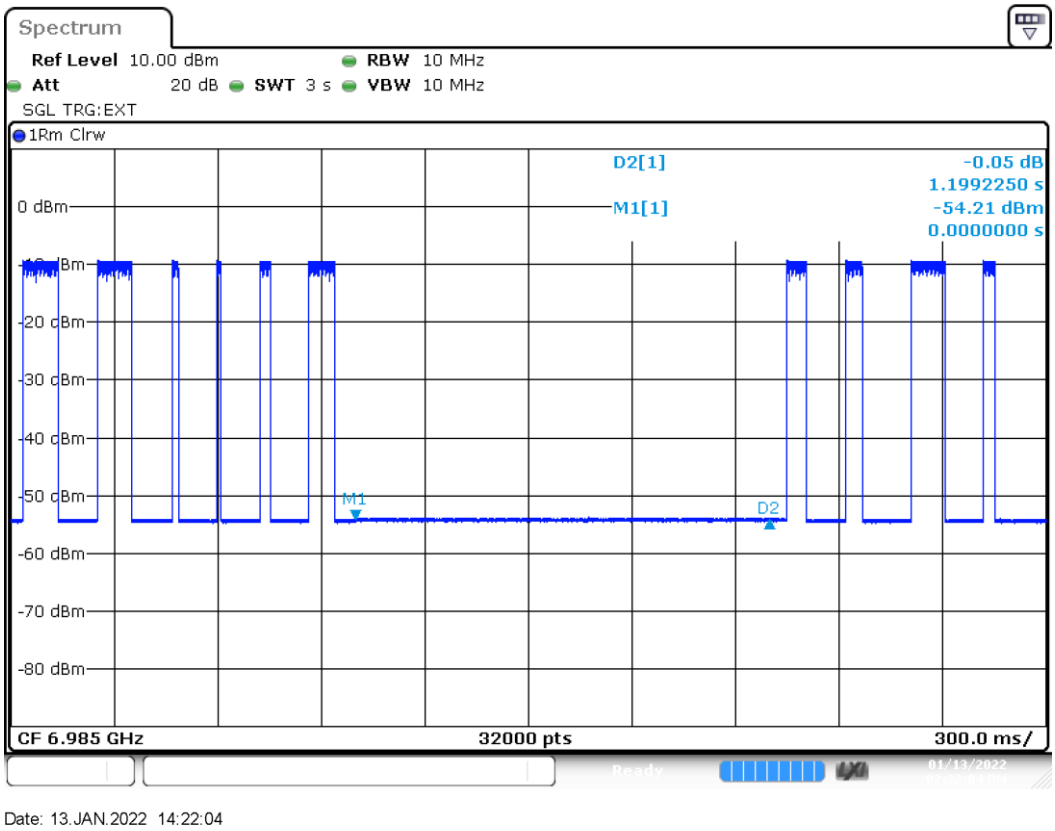
Channel 111 - Incumbent signal 6580 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

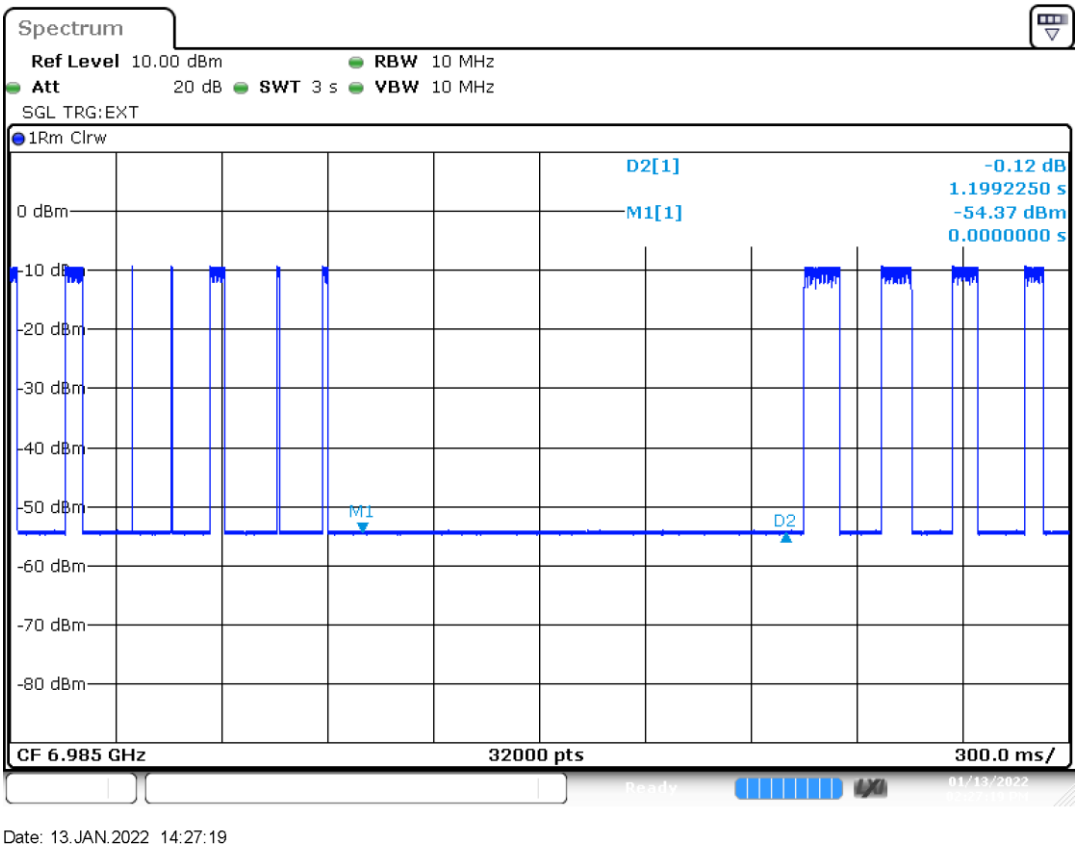
Channel 143 - Incumbent signal 6590 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

Channel 143 - Incumbent signal 6665 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

Channel 143 - Incumbent signal 6740 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

Channel 207 - Incumbent signal 6910 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

Channel 207 - Incumbent signal 6985 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal

Channel 207 - Incumbent signal 7060 MHz

Note - M1: Injection of AWGN signal, D2: Removal of AWGN signal