

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT



EUT Description VLP Positioning System
Applicant: Apsara Energy LLC
1350 Avenue of the Americas, New York, NY 10019, United States
Manufacturer: JSE s.r.o.
Prumyslova 190, 537 01 Chrudim, Czech Republic
Brand Name: KMCAPESE
Model No.: P-108-061/10G/6VL
Report Number: TERF2503000838ER
FCC ID 2BC5M-061EW6
Date of EUT Received: March 5, 2025
Date of Test: April 24, 2025~November 19, 2025
Issue Date: December 1, 2025

Approved By _____

Jim Chang

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Central RF Lab. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 and the energy emitted by the sample EUT comply with FCC rule part §15.407.

The results of this report relate only to the sample identified in this report.

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TERF2503000838ER	00	Original	Aug. 27, 2025	Candice Li	
TERF2503000838ER	01	Modify the modulation to DBPSK; Modify Section 2.1, 6.6, 7.2.2, 7.3, 7.5.6, 7.6.2, 7.6.3, 7.7.	Oct. 7, 2025	Candice Li	*
TERF2503000838ER	02	Modify Channel List, Conducted worst case table; modify section 1.4, 6.2.2, 7.2.1~7.2.2, 7.3, 7.6.1~7.6.3.	Oct. 21, 2025	Candice Li	*
TERF2503000838ER	03	Add the 6750MHz data in Section 7.6; Update Sections 1.4, 1.5, 3.3, 4.2, 4.4, 7.1, 7.2.2, and 7.3~7.5 with supplementary test data for device supporting 9 channels.	Nov. 26, 2025	Candice Li	*
TERF2503000838ER	04	Add a note on page 39; Add notes to TEST CONFIGURATION for output power.	Dec. 1, 2025	Candice Li	*

Note:

- 1、The remark "*" indicates modification of the report upon requests from certification body.

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1 GENERAL INFORMATION

1.1 Product Description

EUT Description	VLP Positioning System
Brand Name:	KMCAPSE
Model No.:	P-108-061/10G/6VL
Hardware Version:	098-REV05F
Firmware Version:	1.01
EUT Series No.:	25010003
Power Supply:	12 Vdc
Test Software (Name/Version)	xfce4-terminal/0.8.10

1.2 Modulation & Data Rate

RF Frequency:	6000~7000MHz
Channel Number:	9 channels
Channel List:	6000MHz, 6125MHz, 6250MHz, 6375MHz, 6500MHz, 6625MHz, 6750MHz, 6875MHz, 7000MHz
Modulation:	DBPSK / CSS(FMCW)
Data Rate:	123Mbps

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1.3 Antenna Designation

Antenna Type	Antenna Model No.	Freq. (MHz)	Peak Antenna Gain (dBi)
Horn Antenna	A-108-061	5925~6425	8.33
		6425~6525	8.41
		6525~6875	8.41
		6875~7125	8.36

Note:

1. Pre-scanned was done on the above antennas, measurements were demonstrated by using the antenna with the highest gain as the worst case scenarios.
2. The antenna information is provided by the applicant, and the laboratory shall not be held liable for the accuracy, completeness, or reliability of any applicant-supplied data.
3. The antenna complies with part 15.203 requirement and no consideration of replacement. Please see EUT photo for details.
4. The directional gain is calculated according to section F. 2). e). (ii) of FCC KDB 662911 D01.

1.4 Rated Power

SRD

Mode	Frequency Range	Channels	Rated Power (dBm) (Worst Case)
DBPSK	6000~7000	9	-9.71 dBm
FMCW	6000~7000	9	-13.13 dBm

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TRANSMIT RADIATED EMISSION TEST (ABOVE 1 GHz)					
MODE	FREQUENCY BAND (MHz)	AVAILABLE FREQUENCY	TESTED FREQUENCY	MODULATION	ANTENNA PORT
SRD	6000~7000	6000 to 7000	6000,6125,6250,6375,6500,6625,6750,6875,7000	DBPSK	Chain L
	6000~7000	6000 to 7000	6000,6125,6250,6375,6500,6625,6750,6875,7000	DBPSK	Chain R
	6000~7000	6000 to 7000	6000,6125,6250,6375,6500,6625,6750,6875,7000	FMCW	Chain L
	6000~7000	6000 to 7000	6000,6125,6250,6375,6500,6625,6750,6875,7000	FMCW	Chain R

Note:

The field strength of radiated emission was measured as the EUT positioned in different orthogonal planes (E1/E2/H) based on actual usage of the EUT to pre-scan the emissions for determining the worst case scenario.

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2 SUMMARY OF TEST RESULT

FCC Rules	Description Of Test	Result
§15.207	AC Power Line Conducted Emission	Compliant
§15.407(a)(11) §2.1049	Emission Bandwidth	Compliant
§15.407(a)(4~9)	Maximum Conducted Output Power	Compliant
§15.407(a)(4~9)	Power Spectral Density	Compliant
§15.407(b)(6)	In-band emission	Compliant
§15.205 §15.209 §15.407(b)(5),(b)(8), (b)(9)	Undesirable Radiated Emissions	Compliant
§15.407(d)(6)	contention-based protocol	Compliant
§15.407(a)(7)(8)	Test Demonstration of Proper Power Adjustment based on Associated AP	N/A Device only associated with indoor AP
§15.407(c)	Transmission in case of Absence of Information	Compliant
§15.407(d)(10)	Transmitter Power Control	N/A
§15.203	Antenna Requirement	Compliant

2.1 Test Methodology of Applied Standards

FCC Part 15, Subpart E §15.407

FCC KDB 987594 D02 U-NII 6 GHz EMC Measurement v03

FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

ANSI C63.10:2020.

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2.2 Measurement Uncertainty

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 1.54 dB
Emission Bandwidth	+/- 1.38 Hz
Output Power measurement	+/- 0.97 dB
Peak Power Spectral Density Measurement	+/- 0.61 dB
Frequency Stability	+/- 1.48 Hz
Temperature	+/- 0.6 °C
Humidity	+/- 3 %
DC / AC Power Source	+/- 1 %

Radiated Spurious Emission Measurement Uncertainty			
Polarization: Vertical	+/-	1.89 dB	9kHz~30MHz
	+/-	4.1 dB	30MHz - 1000MHz
	+/-	3.37 dB	1GHz - 18GHz
	+/-	3.83 dB	18GHz - 40GHz
Polarization: Horizontal	+/-	1.89 dB	9kHz~30MHz
	+/-	4.1 dB	30MHz - 1000MHz
	+/-	3.37 dB	1GHz - 18GHz
	+/-	3.83 dB	18GHz - 40GHz
Radiated Spurious Emission	+/-	2 dB	33GHz-50GHz
	+/-	1.59 dB	50GHz-60GHz
	+/-	1.71 dB	60GHz-90GHz
	+/-	1.64 dB	90GHz-140GHz
	+/-	3.84 dB	140GHz-220GHz

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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2.3 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation Number / Registration Number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan.	SAC 1	TW0027 / 891563	TW3702
		SAC 2		
		SAC 3		
		Conduction 1		
		Conducted 1		
		Conducted 2		
		Conducted 3		
		Conducted 4		
		Conducted 5		
		Conducted 6		
	No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333	Conduction C	TW0028 / 200037	
		SAC C		
		SAC D		
		SAC G		
		Conducted A		
		Conducted B		
		Conducted C		
		Conducted D		
		Conducted E		
		Conducted F		
		Conducted G		
Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.				

Temperature:	22-26	°C	Relative Humidity:	55-60	%
Test site	Conducted 1		Test Start:	05/05/2025	
Test Engineer:	Teddy Lu		Test Done:	11/19/2025	

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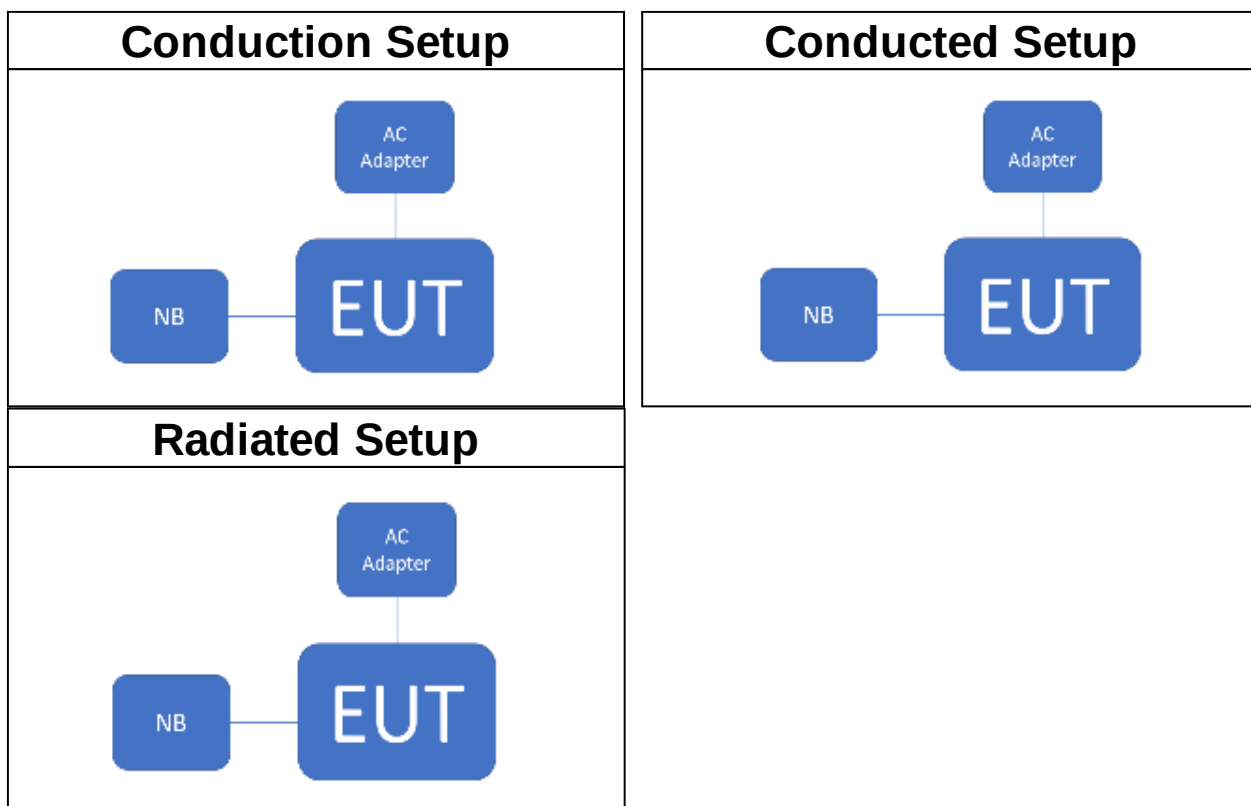
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3 CONTROL UNIT(S) AND PERIPHERAL(S)

3.1 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme. The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

3.2 Diagrams



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3.3 List

3.3.1 Conduction setup

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
AC Adapter	MEAN WELL	GST60A12	SC344Q3473	N/A	N/A
Notebook	Lenovo	E590	PF-1DG81X 19/08	N/A	N/A

3.3.2 Conducted Setup

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
AC Adapter	MEAN WELL	GST60A12	SC344Q3473	N/A	N/A
Notebook	Lenovo	E590	PF-1DG81X 19/08	N/A	N/A

3.3.3 CBP Setup

Conducted Emission Test Site: Conducted 5					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
AC Adapter	MEAN WELL	GST60A12	SC344Q3473	N/A	N/A
Notebook	Lenovo	E590	PF-1DG81X 19/08	N/A	N/A

3.3.4 Radiated Setup

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
AC Adapter	MEAN WELL	GST60A12	SC344Q3473	N/A	N/A
Notebook	Lenovo	E590	PF-1DG81X 19/08	N/A	N/A

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4 TEST INSTRUMENT

4.1 Emission from AC power line

AC Power-Line Conducted Emission Test Site: Conduction 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Coaxial Cables	EMC Instruments Corp.	EMCCFD300-BM-BM-3000	161207	06/22/2025	06/21/2026
EMI Test Receiver	R&S	ESCI 7	100759	08/28/2024	08/27/2025
Pulse Limiter	SCHWARZBECK	VTSD 9561F-N	793	06/22/2025	06/21/2026
LISN	SCHWARZBECK	NSLK 8127	1040	09/07/2024	09/06/2025
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

4.2 Conducted Measurement

Conducted Emission Test Site: Conducted 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
Attenuator	Mini-Circuits	BW-S10W2+	3	12/11/2024	12/10/2025
DC Block	Mini-Circuits	BLK-18-S+	2	12/11/2024	12/10/2025
Power Meter	Anritsu	ML2496A	1804001	04/18/2025	04/17/2026
Power Sensor	Anritsu	MA2411B	1726104	04/18/2025	04/17/2026
Power Sensor	Anritsu	MA2411B	1726107	04/18/2025	04/17/2026
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY57120290	04/10/2025	04/09/2026
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60240503	12/16/2024	12/15/2025
Test Software	SGS	Radio Test Software	Ver. 21	N.C.R	N.C.R

4.3 Contention Based Protocol Measurement

Conducted Emission Test Site: Conducted 5					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
DC Block	Mini-Circuits	BLK-18-S+	4	12/11/2024	12/10/2025
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071406	07/14/2025	07/13/2026
Frequency Extender	KEYSIGHT	N5182BX07	MY59360217	03/08/2025	03/07/2026
Manual Attenuator	HP	8494B	2812A17605+3308A2 2470	12/11/2024	12/10/2025
Signal Generator	KEYSIGHT	N5182B	MY59100743	03/08/2025	03/07/2026
Splitter	RF-Lambda	RFLT2W1G18G	11-JSPF412-020	12/11/2024	12/10/2025
Splitter	RF-Lambda	RFLT2W1G18G	21032900018	12/11/2024	12/10/2025

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4.4 Radiated Measurement

Radiated Emission Test Site: SAC 1					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL. (mm/dd/yyyy)	CAL DUE. (mm/dd/yyyy)
8.5G High Pass Filter	Titan	T04H85002500060S01	211112-2-9	12/11/2024	12/10/2025
Band Reject Filter 5905-6445	Titan	T04N5905644550S01	23040703-24	12/11/2024	12/10/2025
Band Reject Filter 6425-6525	Titan	T04N6425652550S01	23040703-25	12/11/2024	12/10/2025
Band Reject Filter 6875-7125	Titan	T04N6875712550S01	23040703-29	12/11/2024	12/10/2025
Bi-log Antenna	TESEO	CBL 6112D	35242 & AT-N0555	12/09/2024	12/08/2025
Coaxial Cable	EMCI	EMC104-SM-SM-8000+EMC106-SM-SM-7600	RX Cable 9K-18G(160125+150817)	07/14/2025	07/13/2026
Coaxial Cables	Huber Suhner	SUCOFLEX 102	RX Cable 18G-40G MY2630/2+805062/2	07/14/2025	07/13/2026
Coaxial Cables	EMCI	EMC104-SM-SM-600+EMC105-SM-SM-2000+EMC105-SM-SM-1500+EMC105-SM-SM-10000	RX Cable 9K-18G (220237+220909+220906+240801)	07/14/2025	07/13/2026
EMI Test Receiver	R&S	ESR 7	102525	02/08/2025	02/07/2026
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY60242081	10/23/2024	10/22/2025
EXA Spectrum Analyzer	KEYSIGHT	N9010B	MY59071570	07/04/2025	07/03/2026
Horn Antenna	SCHWARZBECK	BBHA9120D	D803	01/09/2025	01/08/2026
Horn Antenna	SCHWARZBECK	BBHA9170	184	12/20/2024	12/19/2025
Loop Antenna	COM-POWER	AL-130R	10160104	12/19/2024	12/18/2025
Pre-Amplifier	EMCI	EMC118A45SEE	980933	07/14/2025	07/13/2026
Pre-Amplifier	EMCI	EMC184045SEE	9080939	07/14/2025	07/13/2026
Pre-Amplifier	HP	8447D	2944A09469	07/14/2025	07/13/2026
Pre-Amplifier	EMCI	EMC330N	980826	07/14/2025	07/13/2026
Site Cal	SGS	SAC 1	N/A	07/14/2025	07/13/2026
Test Software	Audix	e3	Ver. 9.210616	N.C.R	N.C.R

NOTE: N.C.R refers to Not Calibrated Required.

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5 REGULATORY REQUIREMENTS

5.1 Emission Bandwidth

The maximum transmitter channel bandwidth for U-NII devices in the 5.925-7.125 GHz band is 320 megahertz.

5.2 Maximum Output Power

5.2.1 Duty Cycle

Pre-analysis Check: While conducting average power measurement, duty cycle of each mode shall be checked to ensure its duty cycle in order to compensate for the loss due to insufficient ratio of duty cycle.

All duty cycle is pre-scanned, and result as obtained below shows only the most representative ones where duty cycle is conducted as the given transmission with given virtual operation that expresses the percentage.

EUT CATEGORY		Equipment Class	§15.407(a)
V	Very low power devices	VLP	EIRP < 14dBm
	Standard Access Point	6SD	EIRP < 36dBm and antenna angle above 30 degrees < 21dBm EIRP for outdoor use
	indoor Access Point	6ID	EIRP < 30dBm
	Subordinate Device	6PP	EIRP < 30dBm
	Fixed Client	6FC	EIRP < 36dBm and antenna angle above 30 degrees < 21dBm EIRP for outdoor use
	Indoor Client	6XD	EIRP < 24dBm
	Standard Client	6FX	EIRP < 30dBm no more than 6 dB below its associated standard power access point's authorized trans-mit power
	Dual Client	6CD	Compliance both indoor client and standard client limit

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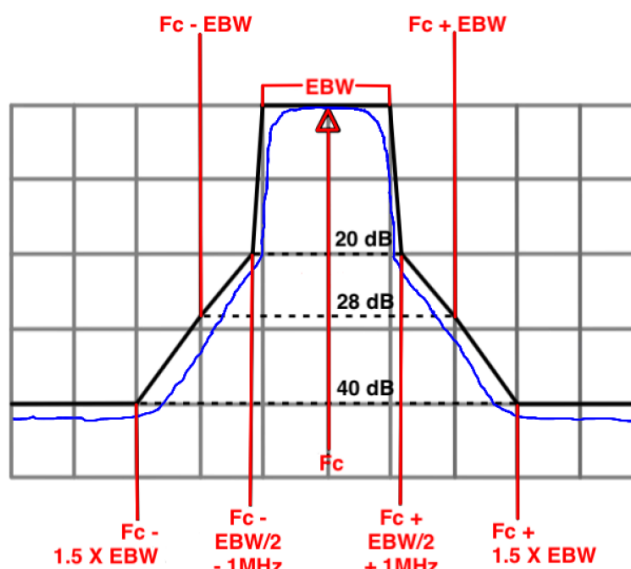
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5.3 Maximum Power Spectral Density

EUT CATEGORY		Equipment Class	§15.407(a)
V	Very low power devices	VLP	EIRP < -5dBm/MHz
	Standard Access Point	6SD	EIRP < 23dBm/MHz
	indoor Access Point	6ID	EIRP < 5dBm/MHz
	Subordinate Device	6PP	EIRP < 5dBm/MHz
	Fixed Client	6FC	EIRP < 23dBm/MHz
	Indoor Client	6XD	EIRP < -1dBm/MHz
	Standard Client	6FX	EIRP < 17dBm/MHz
	Dual Client	6CD	Compliance both indoor client and standard client limits

5.4 In-Band Emission

For transmitters operating within the 5.925-7.125 GHz bands: Power spectral density must be suppressed by 20 dB at 1 MHz outside of channel edge, by 28 dB at one channel bandwidth from the channel center, and by 40 dB at one- and one-half times the channel bandwidth away from channel center. At frequencies between one megahertz outside an unlicensed device's channel edge and one channel bandwidth from the center of the channel, the limits must be linearly interpolated between 20 dB and 28 dB suppression, and at frequencies between one and one- and one-half times an unlicensed device's channel bandwidth, the limits must be linearly interpolated between 28 dB and 40 dB suppression. Emissions removed from the channel center by more than one- and one-half times the channel bandwidth must be suppressed by at least 40 dB.



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5.5 Unwanted Emissions

For transmitters operating within the 5.925-7.125 GHz band: Any emissions outside of the 5.925-7.125 GHz band must not exceed an e.i.r.p. of -27 dBm/MHz and below 1 GHz must comply with the general field strength limits.

Measurements below and above 1000 MHz. Unwanted emissions outside of restricted bands are measured with a RMS detector. In addition, peak emissions must be limited to no more than 20 dB above the average limit

Above 1GHz and non-restricted limit

EIRP LIMIT	FIELD STRENGTH AT 3m
Peak: -7 (dBm/MHz) AV: -27 (dBm/MHz)	Peak: 88.2 (dBμV/m) AV: 68.2 (dBμV/m)

$$EIRP[dBm] = E[dB\mu V/m] + 20 \log(d[m]) - 104.7$$

$$E[dB\mu V/m] = EIRP[dBm] - 20 \log(d[m]) + 104.7$$

Below 1G and restricted limit

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note: The lower limit shall apply at the transition frequencies.

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5.6 Contention Based Protocol

Indoor access points, subordinate devices and client devices operating in the 5.925-7.125 GHz band (herein referred to as unlicensed devices) 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 low-power indoor 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). The -62 dBm (or lower) threshold is referenced to a 0 dBi antenna gain.

To ensure incumbent operations are reliably detected in the band, low power indoor devices must detect RF energy throughout their intended operating channel. For example, an 802.11 device that plans to transmit a 40 MHz- wide signal (on a primary 20 MHz channel and a secondary 20 MHz channel) must detect energy throughout the entire 40 MHz channel. Additionally, low-power indoor devices must detect co-channel energy with 90% or greater certainty.

5.7 Power Adjustment Based On Associated AP

A client device may connect to a Standard Power AP with a maximum power level of 30 dBm EIRP. A client may also connect to a Low Power indoor AP, but the power level is limited to a maximum of 24 dBm EIRP. If a client has the flexibility to connect to both APs, verification is needed to show that it can distinguish between the two configurations, and then control the power levels accordingly.

5.8 Transmitter Power Control

Very low power devices operating in the 5.925-7.125 GHz band shall employ a transmit power control (TPC) mechanism. A very low power device is required to have the capability to operate at least 6 dB below the maximum EIRP PSD value of -5 dBm/MHz.

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5.9 AC Power Line Conducted Emission

Frequency range within 150 kHz to 30 MHz shall not exceed the Limit table as below.

Frequency range MHz	Limits (dBuV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- 1.The lower limit shall apply at the transition frequencies
- 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

5.10 Transmission In The Absence Of Data

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization a description of how this requirement is met.

5.11 Antenna Requirements

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 manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§ 15.211, 15.213, 15.217, 15.219, 15.221, or § 15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with § 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

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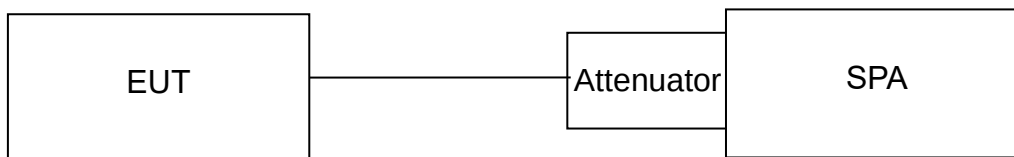
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6 TEST CONFIGURATION

6.1 Emission Bandwidth



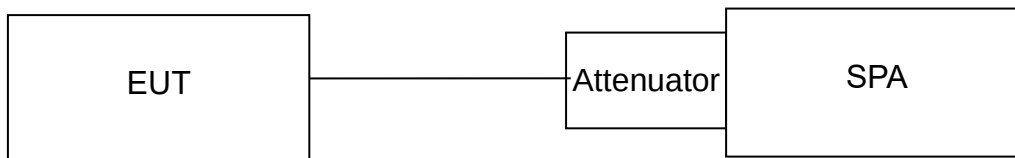
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the Antenna port to the spectrum analyzer.
 - 2.a. 26dB Band width Measurement: Set the spectrum analyzer as approximately 1% of emission BW Sweep=auto,
Detector = Peak,
Trace Mode = Max Hold,
Manually readjust RBW until the RBW/EBW ratio is approximately 1% based on EBW as observed on the result of pre-sequence measurement.
 - 2.b. Mark the peak frequency and -26dB (upper and lower) frequency.
3. Repeat the procedures as list above until all test default channels (low, middle, and high) are completed.
4. For 99% Bandwidth: Set the spectrum analyzer as
RBW=1% to 5% of the OBW,
VBW = 3*RBW,
Span = large enough to capture all products of the modulation process,
Detector=Sample,
Sweep=auto.
5. Turn on the 99% bandwidth function, max reading.
6. Repeat above procedures until all frequency of interest measured was complete.

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6.2 Maximum Output Power

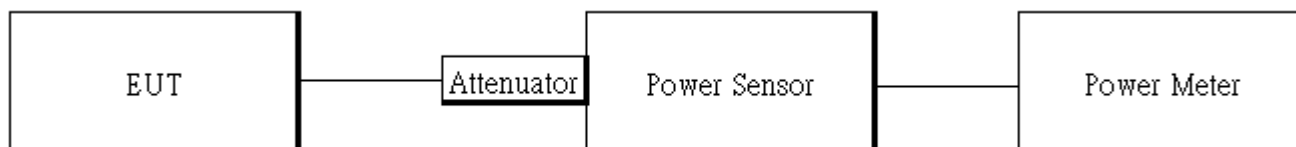
6.2.1 Duty Cycle



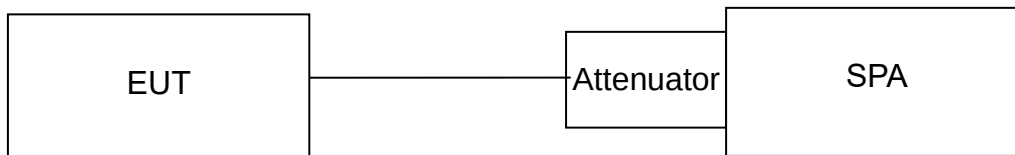
1. Set span = Zero
2. RBW = 8MHz
3. VBW = 8MHz,
4. Detector = Peak

6.2.2 Maximum Output Power

For DBPSK



For FMCW



1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the SPA and power meter.
3. Power Meter is used as the auxiliary test equipment to conduct the output power measurement.
4. Spectrum Analyzer is used as the auxiliary test equipment to conduct the output power measurement, setting as below.
 - Set span to encompass the EBW
 - RBW = 1MHz
 - VBW = 3MHz
 - Detector = RMS
 - Sweep points $\geq 2 \times \text{span} / \text{RBW}$. (This ensures that bin-to-bin spacing is $\leq \text{RBW}/2$, so that narrowband signals are not lost between frequency bins.)
 - Sweep time = auto, trigger set to "free run"
 - Trace average at least 100 traces in power averaging (rms) mode
 - Compute power by integrating the spectrum across the EBW or OBW of the

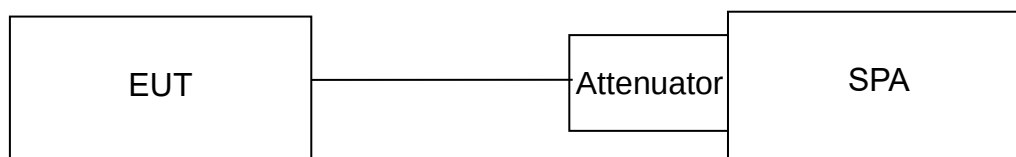
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signal using the instrument's band power measurement function with band limits set equal to the EBW or OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at 1 MHz intervals extending across the EBW or OBW of the spectrum.

- Record the max. reading and add $10 \log(1/\text{duty cycle})$.
- Repeat above procedures until all frequency (low, middle, and high channel) measured were complete.

6.3 Maximum Power Spectral Density

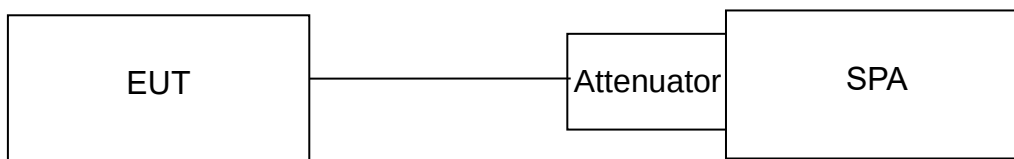


- Place the EUT on the table and set it in transmitting mode.
- Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to Spectrum.
- Set RBW=1MHz, VBW=3MHz, where span is enough to capture the entire bandwidth, Sweep time = Auto (1001 pts), detector = power averaging (rms), if available. Otherwise, use sample detector mode, traces 100 sweeps of video averaging. (SA-2 with the omission of procedure x, the integration with 26dB EBW bandwidth)
- User the cursor on spectrum to peak search the highest level of trace
- (1)Duty cycle $\geq 98\%$: Record the max. reading.
(2)Duty cycle $< 98\%$: Record the max. reading and add $10 \log(1/\text{duty cycle})$.
- Repeat above procedures until all default test channel (low, middle, and high) was complete.

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6.4 In-Band Emission



1. Place the EUT on the table and set it in transmitting mode.
2. Set the span to encompass the entire 26 dB EBW of the signal
3. Set RBW = same RBW used for 26 dB EBW measurement
4. Set VBW $\geq 3 \times$ RBW
5. Number of points in sweep $\geq [2 \times \text{span} / \text{RBW}]$.
6. Sweep time = auto.
7. Detector = RMS
8. Trace average at least 100 traces in power averaging (rms) mode
9. Use the peak search function on the instrument to find the peak of the spectrum.
10. For the purposes of developing the emission mask, the channel bandwidth is defined as the 26 dB EBW.

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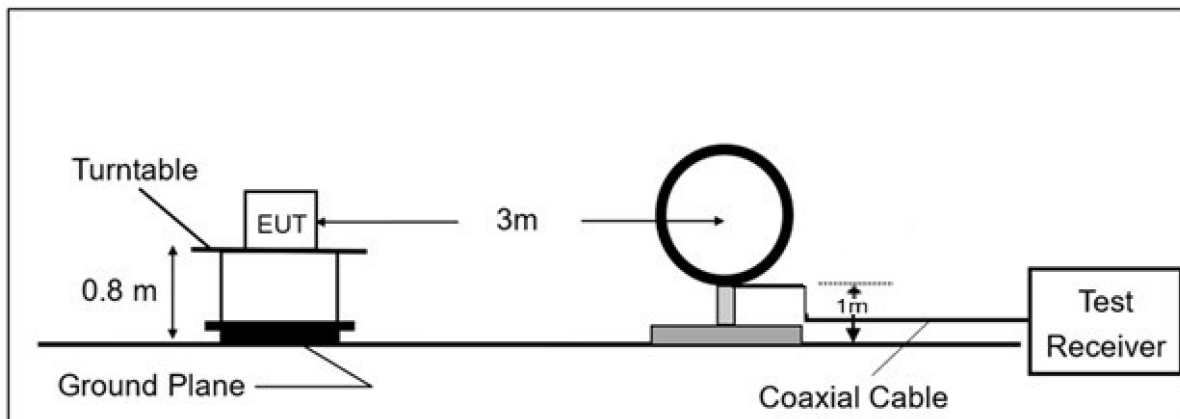
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6.5 Unwanted Emissions

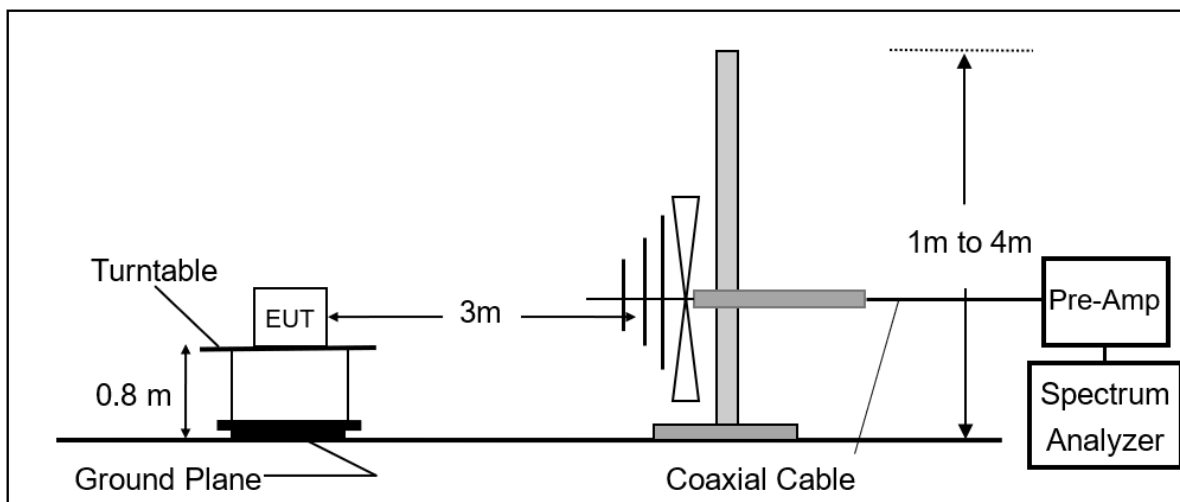
Radiated emission below 30MHz is measured in a 9m*6m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

Comparing data of both open-field test site and semi-Anechoic chamber, the result came out very similar.

Radiated Emission Test Set-Up, Frequency Below 30MHz.



Radiated Emission Test Set-Up, Frequency From 30MHz to 1000MHz.

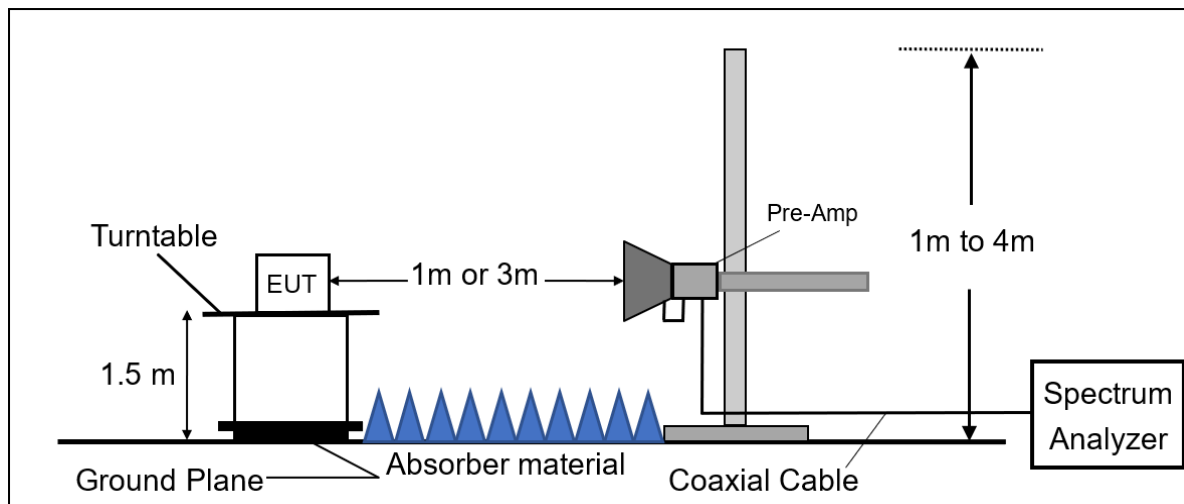


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Radiated Emission Test Set-Up, Frequency Above 1GHz.



1. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plane.
2. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
4. Set the spectrum analyzer as RBW=100 kHz and VBW=300 kHz for Peak Detector (PK) at frequency between 30MHz and 1 GHz.
5. Use receiver mode as RBW=120 kHz for Quasi-peak (QP) at frequency between 30MHz and 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector= Peak for Maximum Emission Measurements at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz, Detector= RMS correction factor is $[10 \log (1 / D)]$ for Average Emission measurements at frequency above 1 GHz **when $D \geq 98\%$** . If a specific emission is demonstrated to be continuous ($D \geq 98\%$) rather than turning ON and OFF with the transmit cycle, then no duty cycle correction is required for that emission, where D is the duty cycle.
8. Set the spectrum analyzer as RBW=1 MHz, VBW $\geq 1/T$ **when $D < 98\%$** for Average Emission Measurements at frequency above 1 GHz.
9. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within

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the 3dB illumination BW of the measurement antenna.

10. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
11. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
12. Repeat above procedures until all frequency measured were complete.

Note: The emissions from 9 kHz to 30MHz was pre-scanned as 20dB lower than the limits, and hence not reported.

6.5.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where *FS = Field Strength*

CL = Cable Attenuation Factor (Cable Loss)

RA = Reading Amplitude

AG = Amplifier Gain

AF = Antenna Factor

The limit of the emission level is expressed in dBuV/m, which converts $20 \cdot \log(uV/m)$

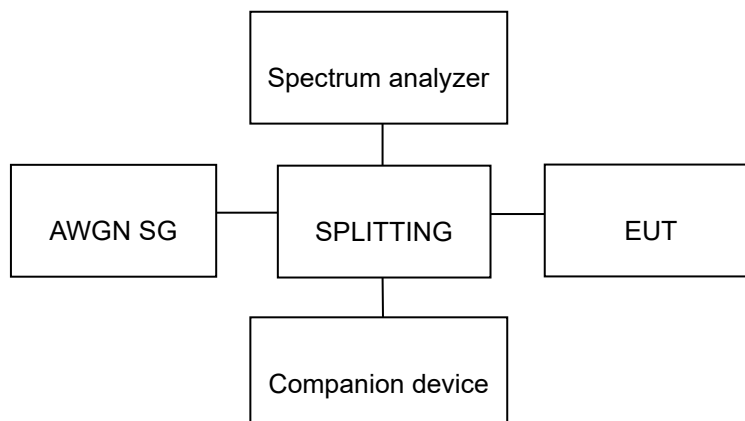
Actual FS(dBuV/m) = SPA. Reading level(dBuV) + Factor(dB)

Factor(dB) = Antenna Factor(dBuV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

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6.6 Contention Based Protocol



1. Configure the EUT to transmit with a constant duty cycle.
2. Set the operating parameters of the EUT including power level, operating frequency, modulation and bandwidth.
3. Set the signal analyzer center frequency to the nominal EUT channel center frequency. The span range of the signal analyzer shall be between two times and five times the OBW of the EUT. Connect the output port of the EUT to the signal analyzer, ensure that the attenuator provides enough attenuation to not overload the signal analyzer receiver.
4. Using an AWGN signal source a 10 MHz-wide AWGN signal. Use Table 1 to determine the center frequency of the 10 MHz AWGN signal relative to the EUT's channel bandwidth and center frequency.
5. Set the AWGN signal power to an extremely low level (more than 20 dB below -62 dBm threshold). Connect the AWGN signal source, via splitter, to the signal analyzer and the EUT.

For power of AWGN signal, set the spectrum analyzer as

Span > 99% OBW

RBW = 1 MHz

VBW ≥ 3 MHz

Sweep time = auto

Detector = Power averaging (rms)

6. Monitor the signal analyzer to verify if the AWGN signal has been detected and the EUT has ceased transmission. If the EUT continues to transmit, then incrementally increase the AWGN signal power level until the EUT stops transmitting.

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7. (Including all losses in the RF paths) Determine and record the AWGN signal power level (at the EUT's antenna port) at which the EUT ceased transmission. Repeat the procedure at least 10 times to verify the EUT can detect an AWGN signal with 90% (or better) level of certainty.
8. Refer to Table 1 to determine number of times the detection threshold testing needs to be repeated. If testing is required more than once, then go back to step 4, choose a different center frequency for the AWGN signal and repeat the process (as figure1).

Table 1. Criteria to determine number of times detection threshold test may be performed

If	Number of Tests	Placement of Incumbent Transmission
$BW_{EUT} \leq BW_{Inc}$	Once	Tune incumbent and EUT transmissions ($f_{c1} = f_{c2}$)
$BW_{Inc} < BW_{EUT} \leq 2BW_{Inc}$	Once	Incumbent transmission is contained within BW_{EUT}
$2BW_{Inc} < BW_{EUT} \leq 4BW_{Inc}$	Twice. Incumbent transmission is contained within BW_{EUT}	Incumbent transmission is located as closely as possible to the lower edge and upper edge, respectively, of the EUT channel
$BW_{EUT} > 4BW_{Inc}$	Three times	Incumbent transmission is located as closely as possible to the lower edge of the EUT channel, in the middle of EUT channel, and as closely as possible to the upper edge of the EUT channel

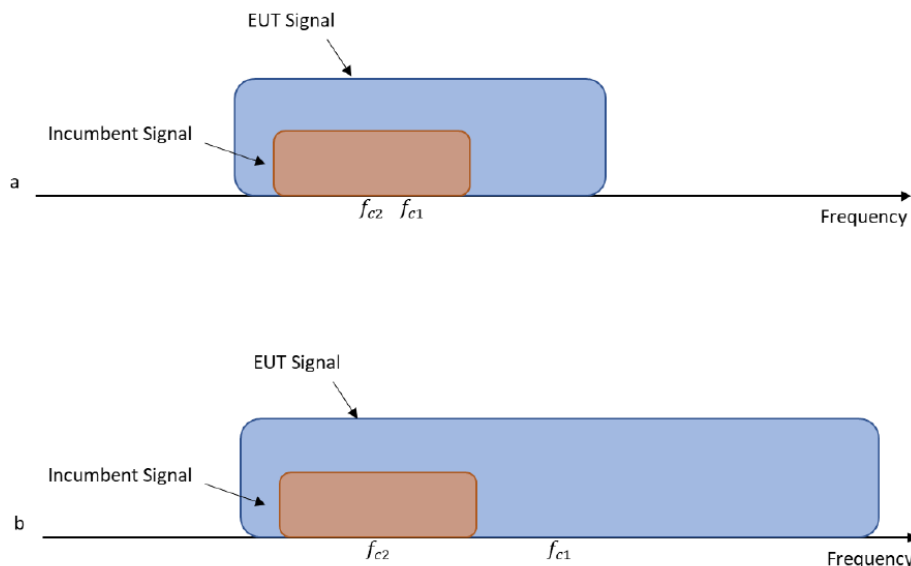


Figure 1. Two possible scenarios where a) center frequency of EUT transmission falls within incumbent's bandwidth, or b) outside of it

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6.7 Power Adjustment Based On Associated AP

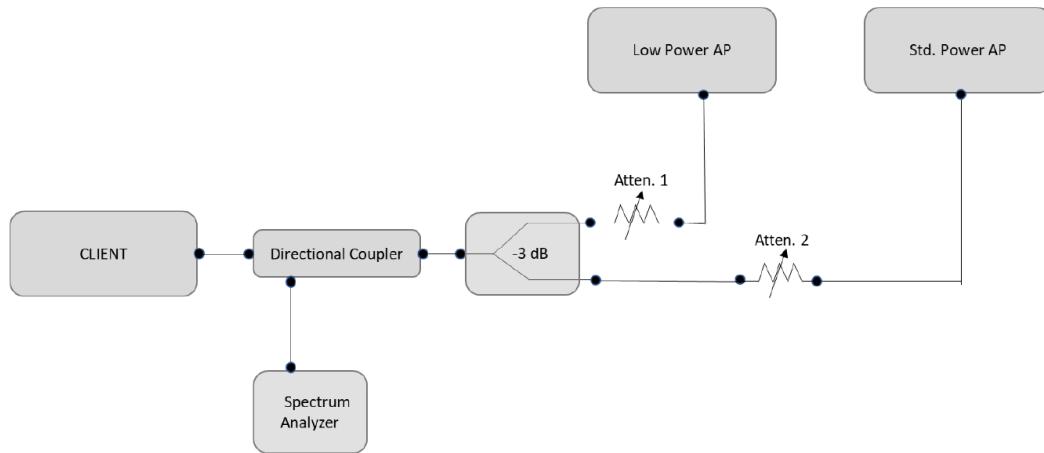


Figure 6. Test setup for conducted testing

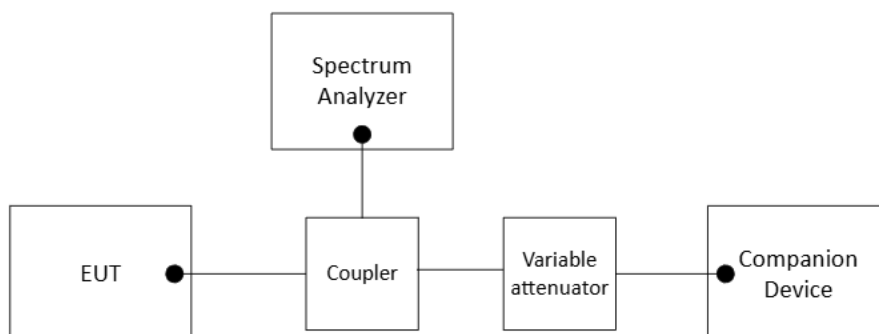
1. Adjust Atten 2 to Std Power AP so as to facilitate error free communication with the Client (Atten 1 should be set to High on the RF path to the Low Power AP).
2. Configure the Client and APs so that they associate and start sending data (stream data). It is important that the client is configured to transmit at its highest power level. Initially, because the attenuation on Atten 1 is set high, the Client will only associate with the Std Power AP.
3. Verify transmission between Client and Std Power AP. Additional attenuators may be required to protect measurement equipment. Measure the Client RF power using any of the methods in C63.10 for NII devices. Note – if the client RF power has been certified to never operate above 24 dBm EIRP then this test is not necessary.
4. Gradually increase Atten 2 while at the same time decreasing Atten 1. This simulates the Client moving from outdoors to indoors. At some level of attenuation the Client should associate with the Low Power indoor AP. Verify transmission between Client and Low Power AP.
5. Measure the RF power of the Client device using the same method as in step 4. Verify the power is no more than 24 dBm EIRP.

Note – measuring Client RF power reliably from a directional coupler measurement port may be tricky. Due to coupling, some energy from the AP will show up on the measurement port. Signal isolation techniques on the measurement analyzer will need to be used.

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6.8 Transmitter Power Control



1. Configure EUT and companion device for peer-to-peer communication
2. Set variable attenuator to a high RSSI level to enable TPC function of the device (noise free spectral environment)
3. Establish a link and start communication between EUT and companion device
4. Capture PSD from spectrum analyzer
5. Set variable attenuator to a low RSSI level to disable TPC function of the device (noisy spectral environment)
6. Capture PSD from spectrum analyzer
7. Compare the highest power from the step 4 to the highest power from the step 6 and determine the delta. For MIMO operations use the sum of the highest PSD from each individual antenna.

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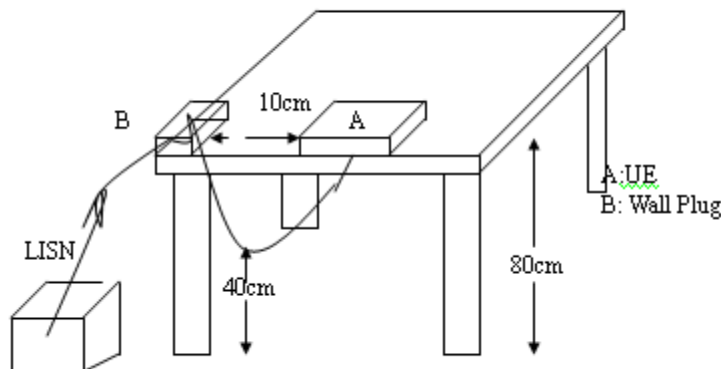
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6.9 AC Power Line Conducted Emission



1. The conducted emission tests were performed at the designated test site using a setup in accordance with ANSI C63.10.
2. The EUT was placed on a non-conductive table that is 0.8 meters above the ground plane. Conducted emissions were measured in the frequency range from 0.15 MHz to 30 MHz using CISPR Quasi-Peak and Average detector modes. The two LISNs provided 50 μ H / 50 ohm coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
3. The AC/DC power adaptor of the EUT was connected to the LISN. The EUT was positioned flush with the rear edge of the table, with a minimum 0.4-meter distance from the shielding wall.
4. The LISNs were connected to the power source and configured according to the test requirements.
5. The maximum emission levels were investigated for each mode of operation. The six highest emissions were further maximized to ensure compliance.
6. The above procedures were repeated for all power supply configurations of the EUT.

Level = Read Level + Factor

Factor = (LISN, ISN, or current probe)Factor + Cable Loss +Attenuator

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7 TEST RESULTS

7.1 Emission Bandwidth

DBPSK R

Frequency (MHz)	99% BW (MHz)	26dB BW (MHz)
6000	130.96	144.8
6125	131.14	143.60
6250	130.40	143.60
6375	130.62	143.70
6500	130.47	144.8
6625	130.43	142.70
6750	130.62	142.60
6875	130.35	143.30
7000	130.32	144.8

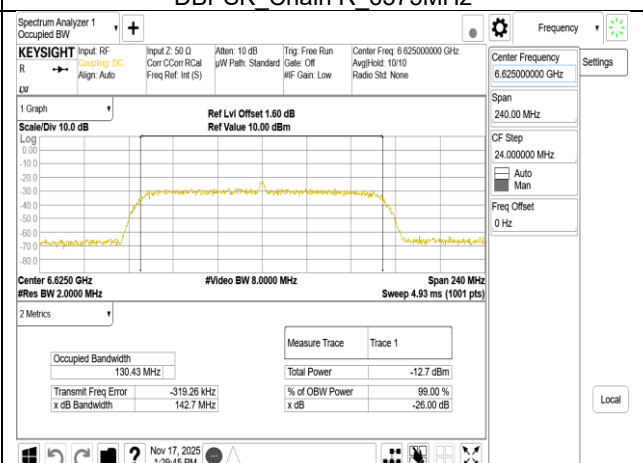
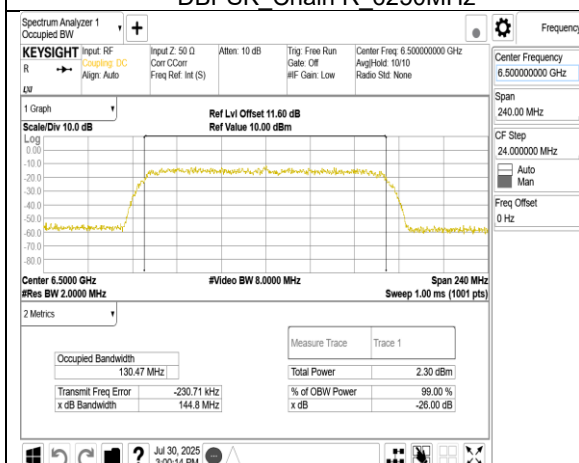
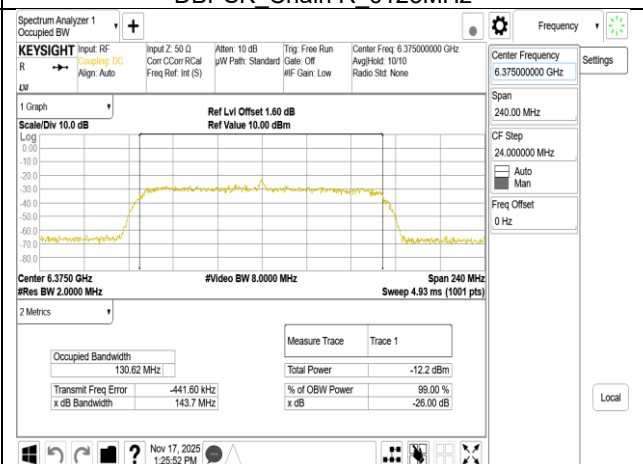
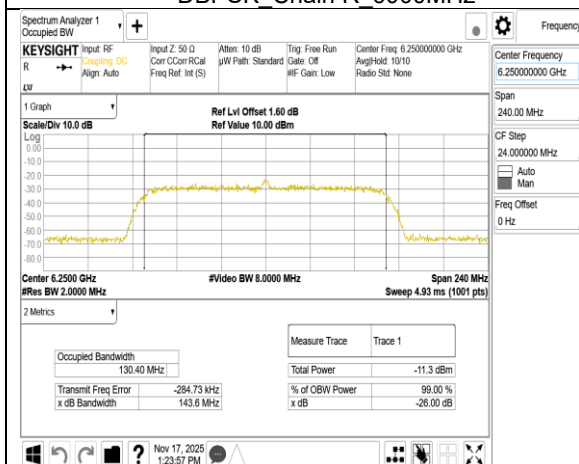
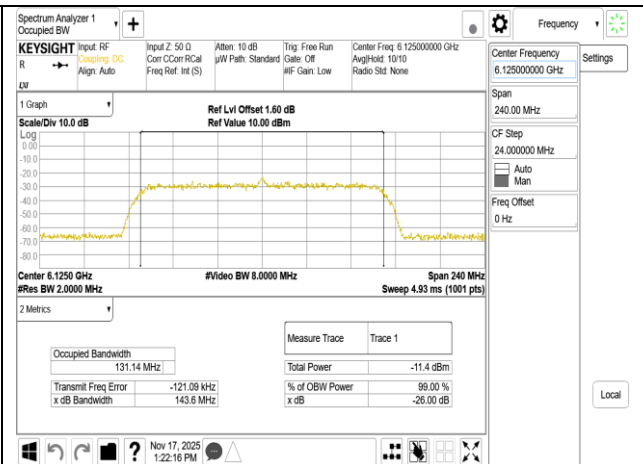
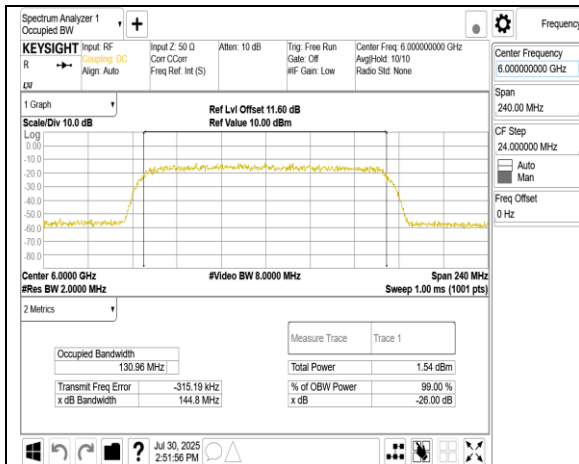
FMCW R

Frequency (MHz)	99% BW (MHz)	26dB BW (MHz)
6000	137.04	147.2
6125	135.61	147.3
6250	139.46	146.2
6375	135.76	147.1
6500	135.42	147.8
6625	136.29	143.9
6750	135.85	147.3
6875	136.25	146.6
7000	136.80	146.3

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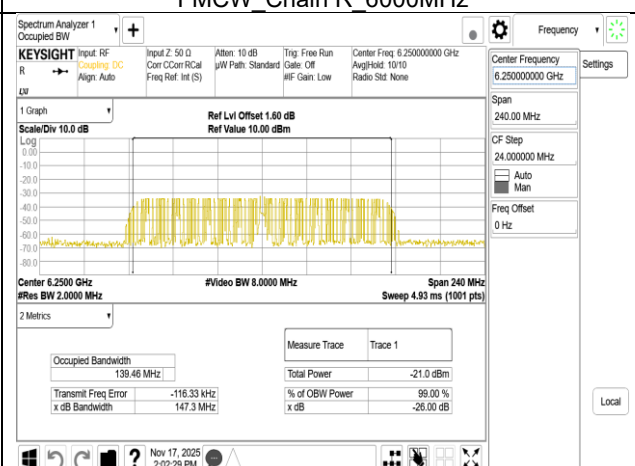
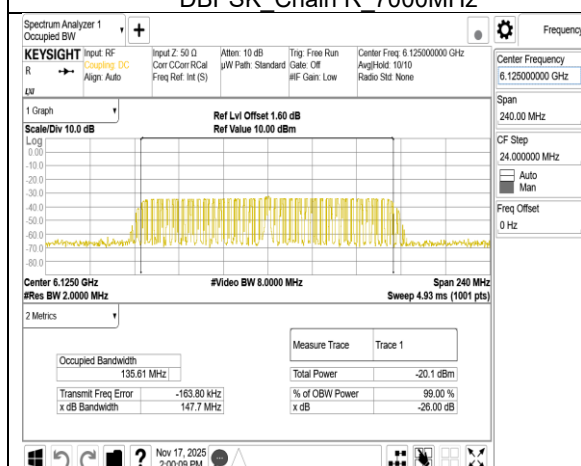
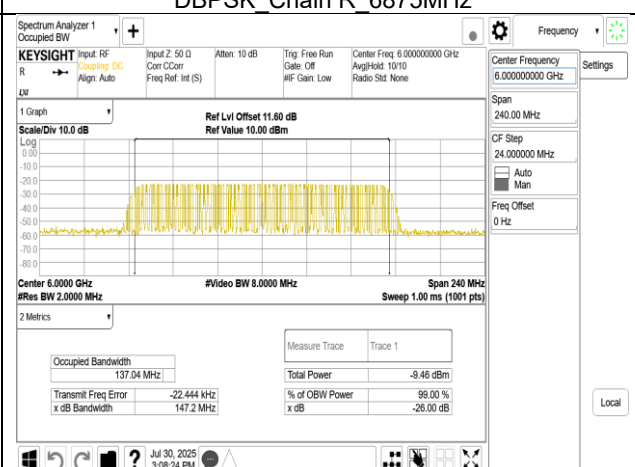
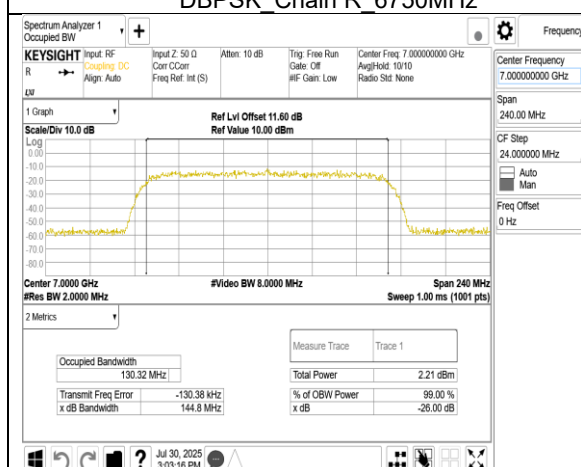
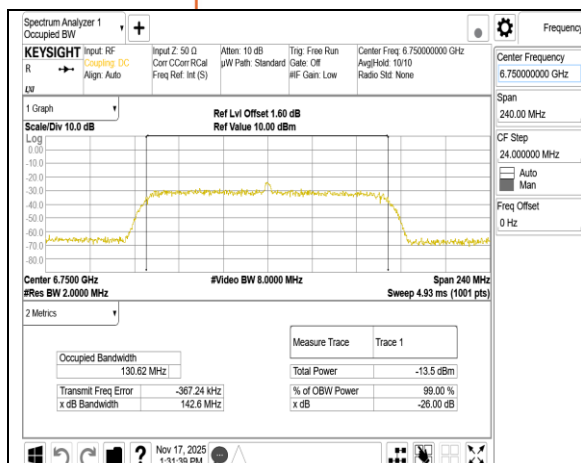
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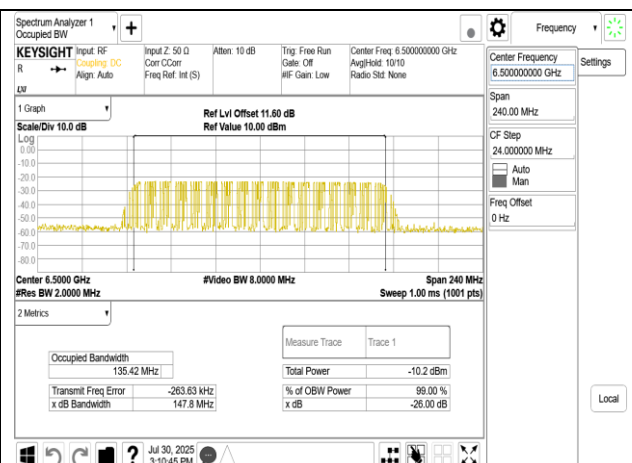
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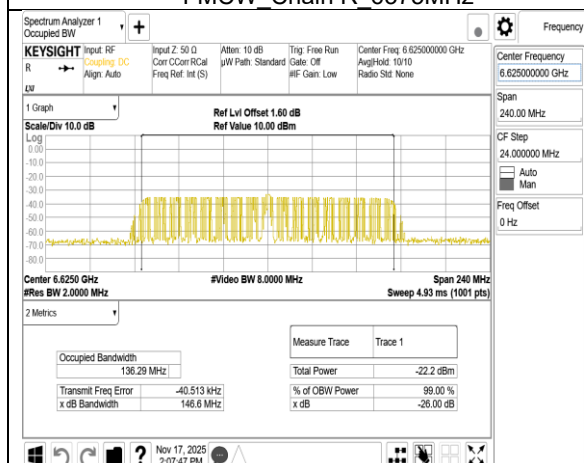
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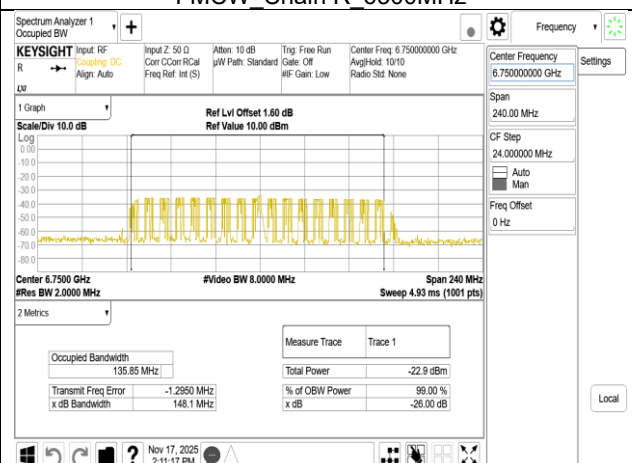
FMCW_Chain R_6375MHz



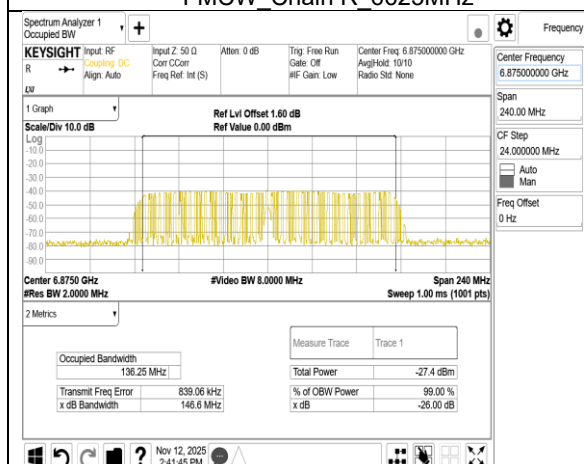
FMCW_Chain R_6500MHz



FMCW_Chain R_6625MHz



FMCW_Chain R_6750MHz



FMCW_Chain R_6875MHz



FMCW_Chain R_7000MHz

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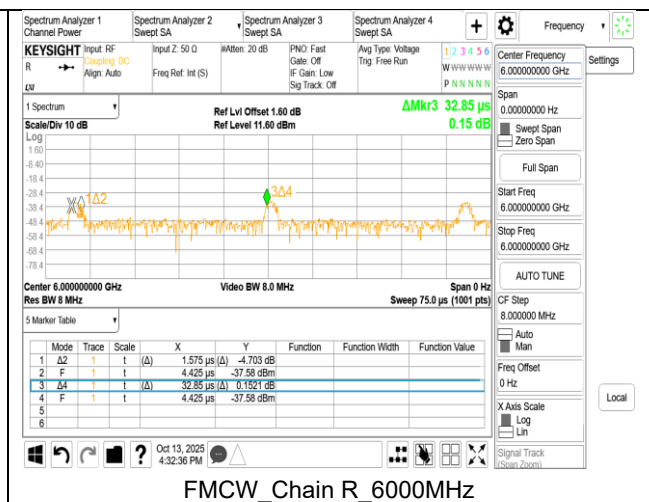
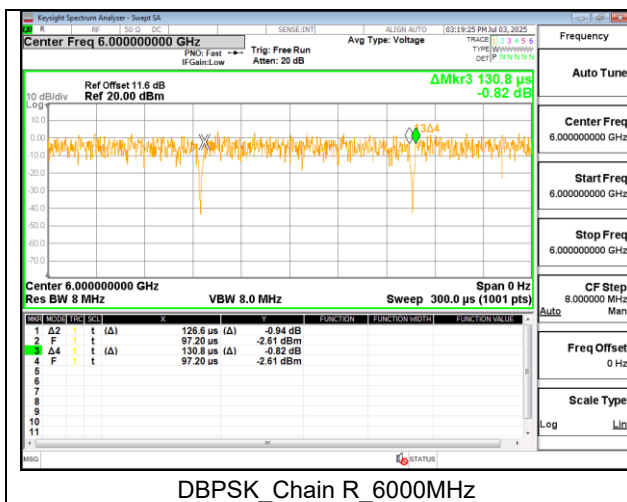
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7.2 Maximum Output Power

7.2.1 Duty Cycle

Mode	Duty Cycle (%) =Ton / (Ton+Toff)	Duty Factor (dB) =10*log (1/Duty Cycle)	1/T (kHz)	VBW setting (kHz)
DBPSK	96.78	0.14	7.90	8.00
FMCW	4.795	13.20	634.92	635.00



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7.2.2 Maximum Output Power

DBPSK L

Frequency (MHz)	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	REQUIRED EIRP LIMIT (dBm)	RESULT
6000	-19.34	8.33	-11.01	14	PASS
6125	-20.03	8.33	-11.70	14	PASS
6250	-20.15	8.33	-11.82	14	PASS
6375	-20.16	8.33	-11.83	14	PASS
6500	-18.37	8.41	-9.96	14	PASS
6625	-22.21	8.41	-13.80	14	PASS
6750	-22.76	8.41	-14.35	14	PASS
6875	-22.61	8.41	-14.20	14	PASS
7000	-18.46	8.36	-10.10	14	PASS

DBPSK R

Frequency (MHz)	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	REQUIRED EIRP LIMIT (dBm)	RESULT
6000	-19.15	8.33	-10.82	14	PASS
6125	-19.22	8.33	-10.89	14	PASS
6250	-19.36	8.33	-11.03	14	PASS
6375	-19.70	8.33	-11.37	14	PASS
6500	-18.12	8.41	-9.71	14	PASS
6625	-22.06	8.41	-13.65	14	PASS
6750	-22.56	8.41	-14.15	14	PASS
6875	-22.33	8.41	-13.92	14	PASS
7000	-18.60	8.36	-10.24	14	PASS

FMCWL

Frequency (MHz)	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	REQUIRED EIRP LIMIT (dBm)	RESULT
6000	-21.46	8.33	-13.13	14	PASS
6125	-21.77	8.33	-13.44	14	PASS
6250	-21.94	8.33	-13.61	14	PASS
6375	-22.29	8.33	-13.96	14	PASS
6500	-24.65	8.41	-16.24	14	PASS
6625	-23.23	8.41	-14.82	14	PASS
6750	-24.01	8.41	-15.60	14	PASS
6875	-24.43	8.41	-16.02	14	PASS
7000	-26.99	8.36	-18.63	14	PASS

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FMCW R

Frequency (MHz)	Avg. Output Power (dBm)	Antenna Gain (dBi)	EIRP (dBm)	REQUIRED EIRP LIMIT (dBm)	RESULT
6000	-21.77	8.33	-13.44	14	PASS
6125	-23.74	8.33	-15.41	14	PASS
6250	-23.27	8.33	-14.94	14	PASS
6375	-23.58	8.33	-15.25	14	PASS
6500	-23.13	8.41	-14.72	14	PASS
6625	-24.30	8.41	-15.89	14	PASS
6750	-25.18	8.41	-16.77	14	PASS
6875	-25.85	8.41	-17.44	14	PASS
7000	-25.22	8.36	-16.86	14	PASS

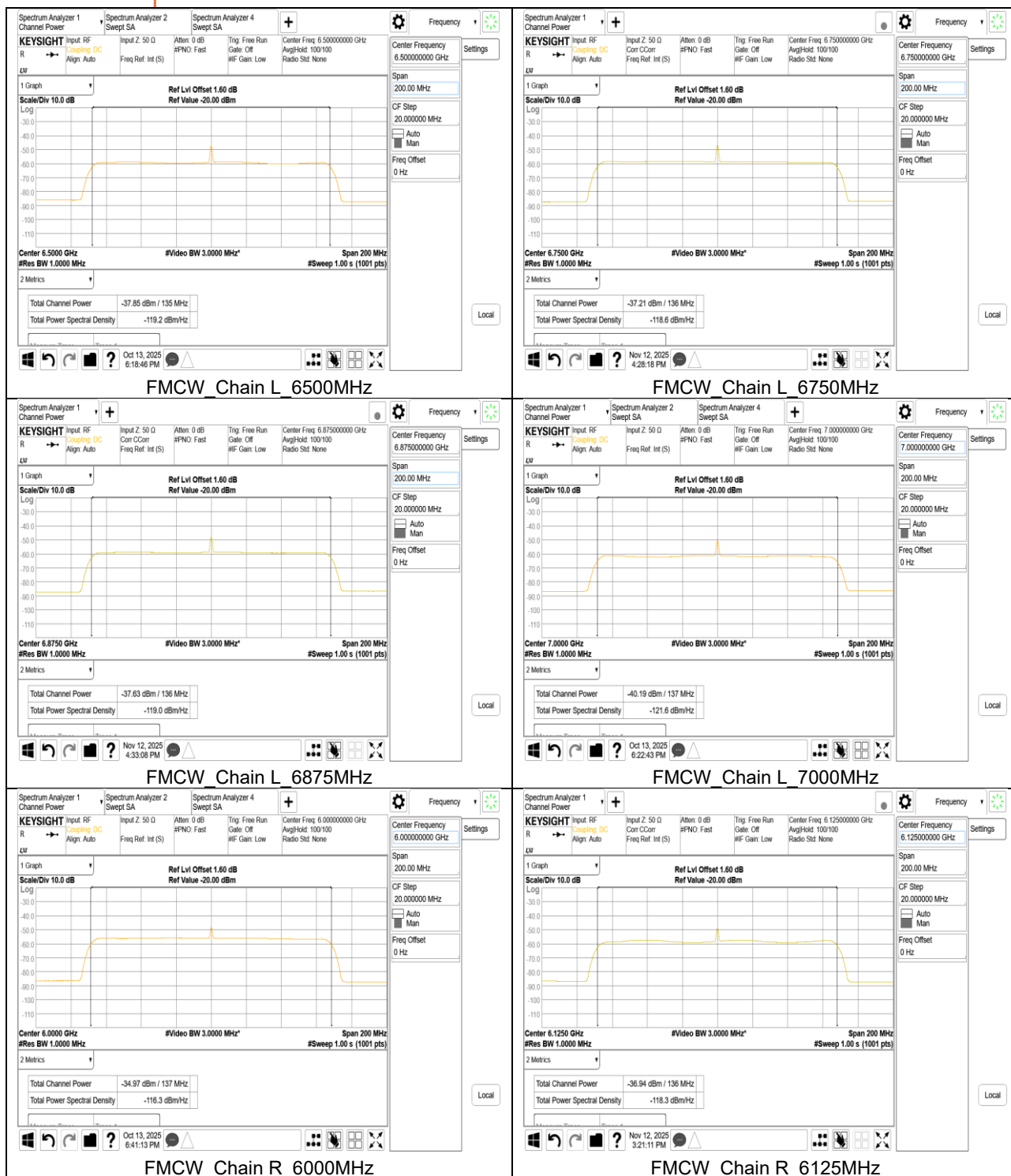
Note: average output power including the duty factor.



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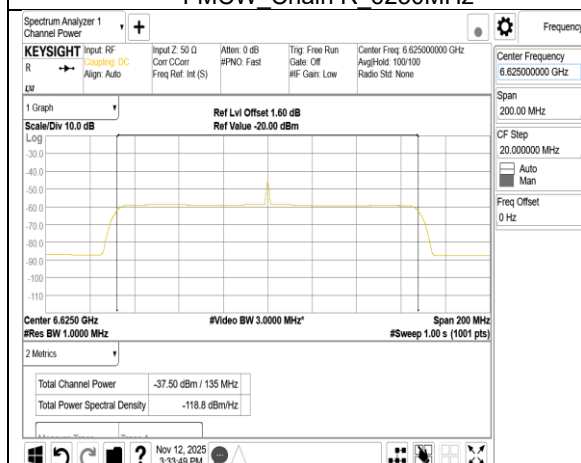
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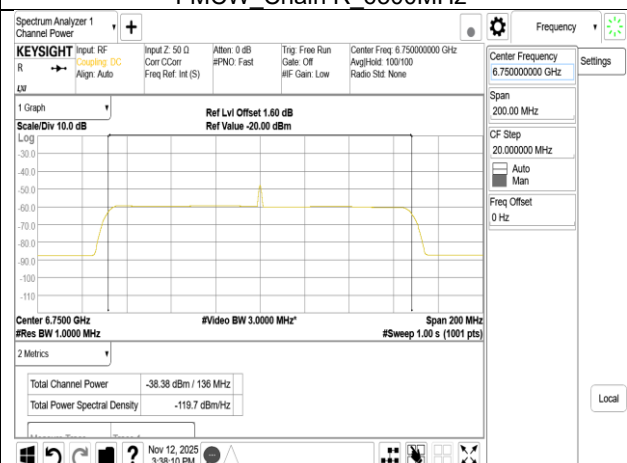
FMCW_Chain R_6250MHz



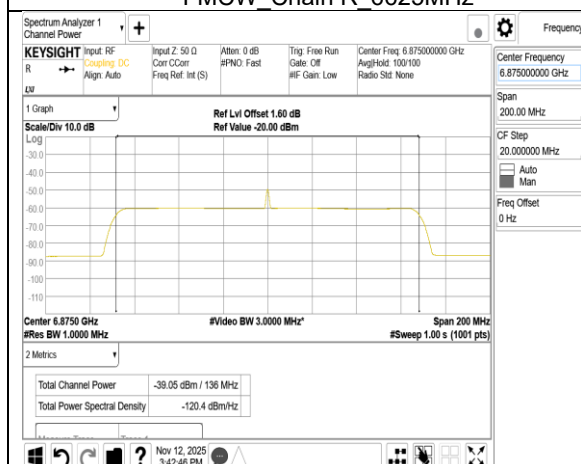
FMCW_Chain R_6500MHz



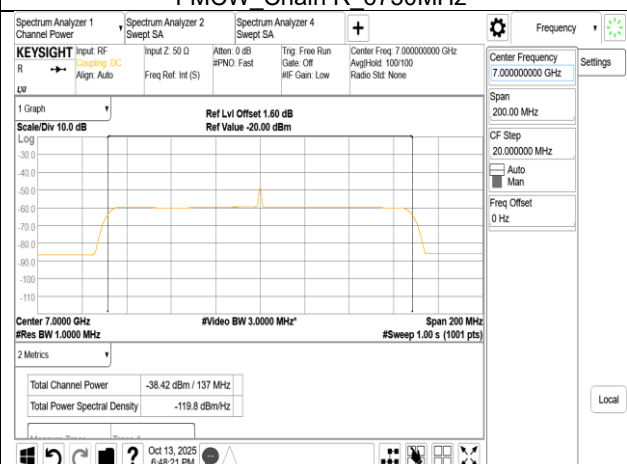
FMCW_Chain R_6625MHz



FMCW_Chain R_6750MHz



FMCW_Chain R_6875MHz



FMCW_Chain R_7000MHz

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7.3 Maximum Power Spectral Density

POWER DENSITY DBPSK L MODE							
Frequency (MHz)	PSD (dBm/MHz)	Duty Factor (dB)	Total Corr'd PSD(dBm/MHz)	Directional Gain(dBi)	EIRP PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
	Ch0 meas						
6000	-20.29	0.14	-20.15	8.33	-11.82	-5.00	-6.82
6125	-21.75	0.14	-21.61	8.33	-13.28	-5.00	-8.28
6250	-22.04	0.14	-21.90	8.33	-13.57	-5.00	-8.57
6375	-22.40	0.14	-22.26	8.33	-13.93	-5.00	-8.93
6500	-20.18	0.14	-20.04	8.41	-11.63	-5.00	-6.63
6625	-23.77	0.14	-23.63	8.41	-15.22	-5.00	-10.22
6750	-24.16	0.14	-24.02	8.41	-15.61	-5.00	-10.61
6875	-24.44	0.14	-24.30	8.41	-15.89	-5.00	-10.89
7000	-20.89	0.14	-20.75	8.36	-12.39	-5.00	-7.39
POWER DENSITY DBPSK R MODE							
Frequency (MHz)	PSD (dBm/MHz)	Duty Factor (dB)	Total Corr'd PSD(dBm/MHz)	Directional Gain(dBi)	EIRP PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
	Ch0 meas						
6000	-20.69	0.14	-20.55	8.33	-12.22	-5.00	-7.22
6125	-24.53	0.14	-24.39	8.33	-16.06	-5.00	-11.06
6250	-23.40	0.14	-23.26	8.33	-14.93	-5.00	-9.93
6375	-26.34	0.14	-26.20	8.33	-17.87	-5.00	-12.87
6500	-20.94	0.14	-20.80	8.41	-12.39	-5.00	-7.39
6625	-26.19	0.14	-26.05	8.41	-17.64	-5.00	-12.64
6750	-27.36	0.14	-27.22	8.41	-18.81	-5.00	-13.81
6875	-27.69	0.14	-27.55	8.41	-19.14	-5.00	-14.14
7000	-21.88	0.14	-21.74	8.36	-13.38	-5.00	-8.38
POWER DENSITY FMCW L MODE							
Frequency (MHz)	PSD (dBm/MHz)	Duty Factor (dB)	Total Corr'd PSD(dBm/MHz)	Directional Gain(dBi)	EIRP PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
	Ch0 meas						
6000	-35.43	13.20	-22.23	8.33	-13.90	-5.00	-8.90
6125	-34.90	13.20	-21.70	8.33	-13.37	-5.00	-8.37
6250	-34.77	13.20	-21.57	8.33	-13.24	-5.00	-8.24
6375	-34.94	13.20	-21.74	8.33	-13.41	-5.00	-8.41
6500	-35.56	13.20	-22.36	8.41	-13.95	-5.00	-8.95
6625	-36.04	13.20	-22.84	8.41	-14.43	-5.00	-9.43
6750	-36.70	13.20	-23.50	8.41	-15.09	-5.00	-10.09
6875	-37.23	13.20	-24.03	8.41	-15.62	-5.00	-10.62
7000	-37.65	13.20	-24.45	8.36	-16.09	-5.00	-11.09

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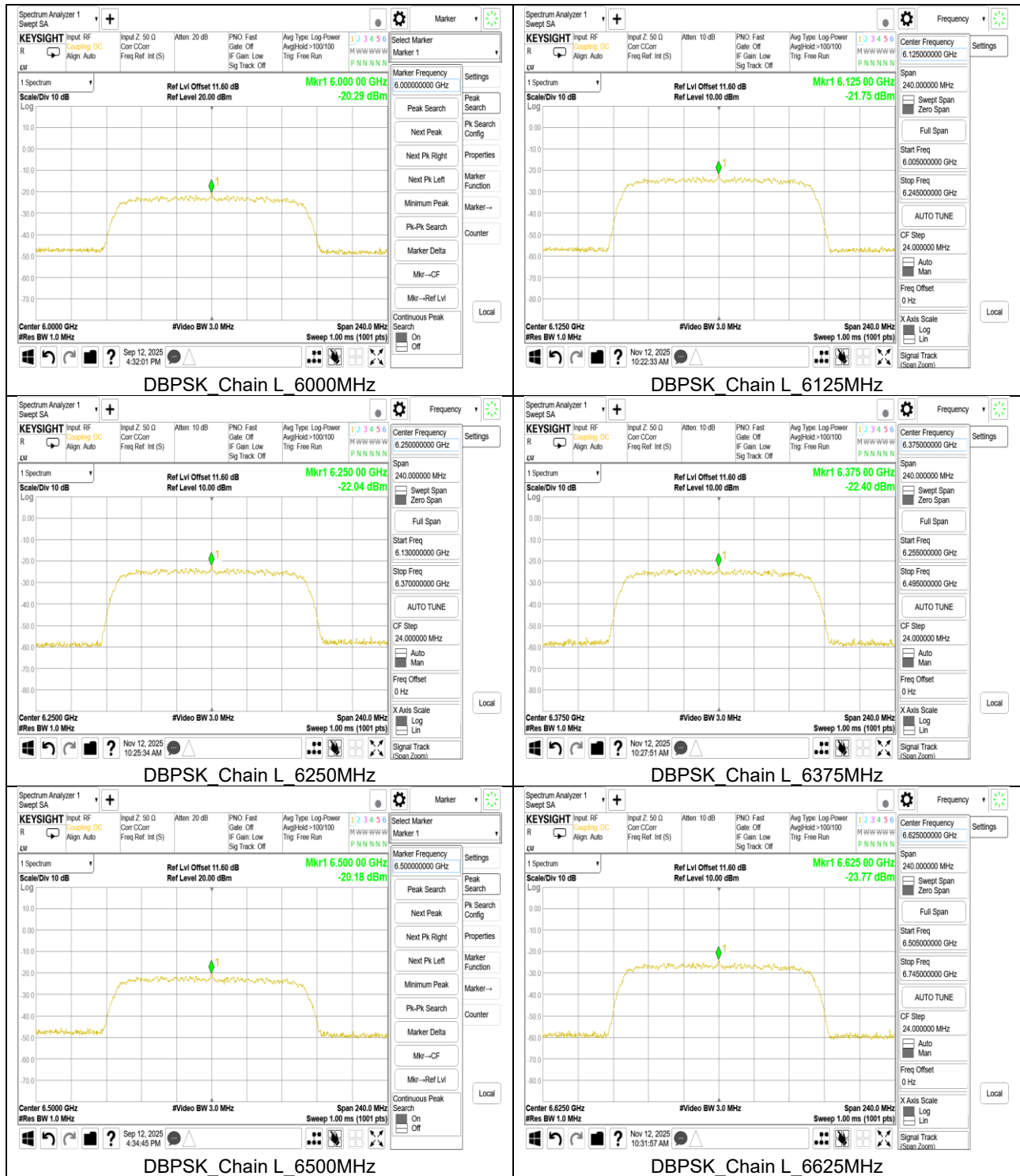
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POWER DENSITY FMCW R MODE							
Frequency (MHz)	PSD (dBm/MHz)	Duty Factor (dB)	Total Corr'd PSD(dBm/MHz)	Directional Gain(dBi)	EIRP PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
	Ch0 meas						
6000	-37.41	13.20	-24.21	8.33	-15.88	-5.00	-10.88
6125	-39.27	13.20	-26.07	8.33	-17.74	-5.00	-12.74
6250	-37.29	13.20	-24.09	8.33	-15.76	-5.00	-10.76
6375	-37.62	13.20	-24.42	8.33	-16.09	-5.00	-11.09
6500	-37.32	13.20	-24.12	8.41	-15.71	-5.00	-10.71
6625	-38.36	13.20	-25.16	8.41	-16.75	-5.00	-11.75
6750	-39.79	13.20	-26.59	8.41	-18.18	-5.00	-13.18
6875	-40.32	13.20	-27.12	8.41	-18.71	-5.00	-13.71
7000	-39.52	13.20	-26.32	8.36	-17.96	-5.00	-12.96

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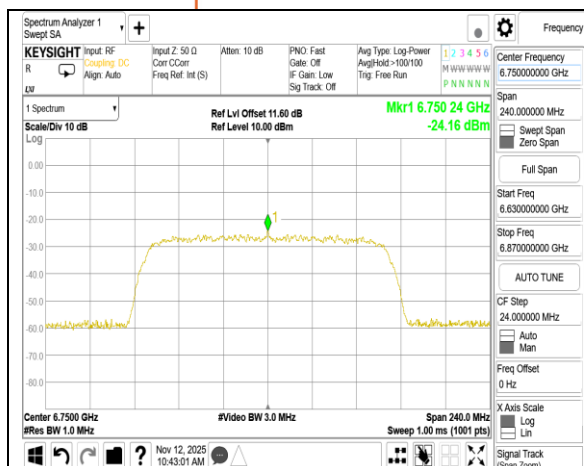
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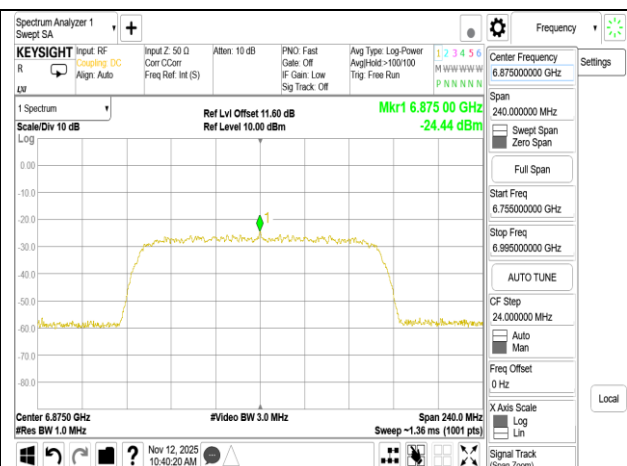
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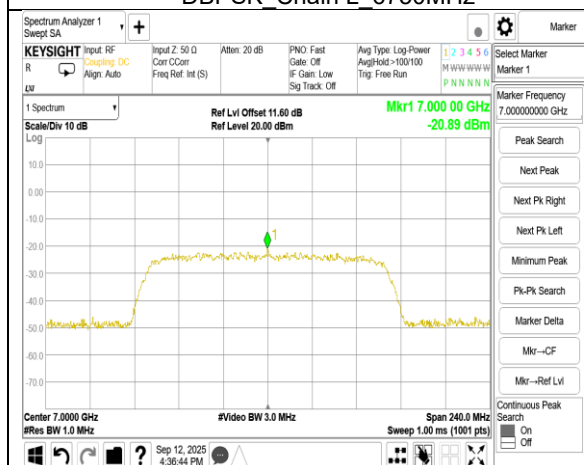
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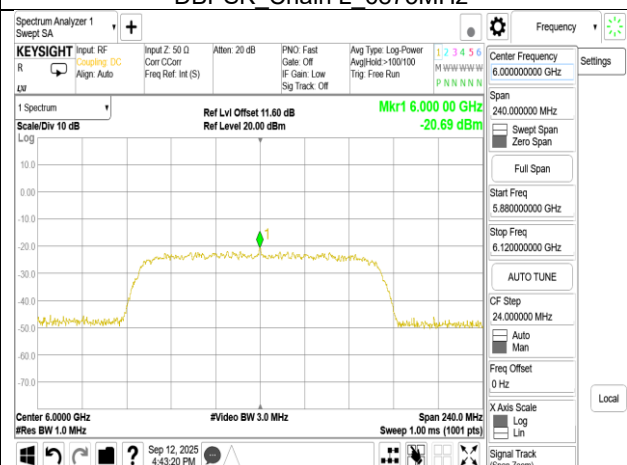
DBPSK_Chain L_6750MHz



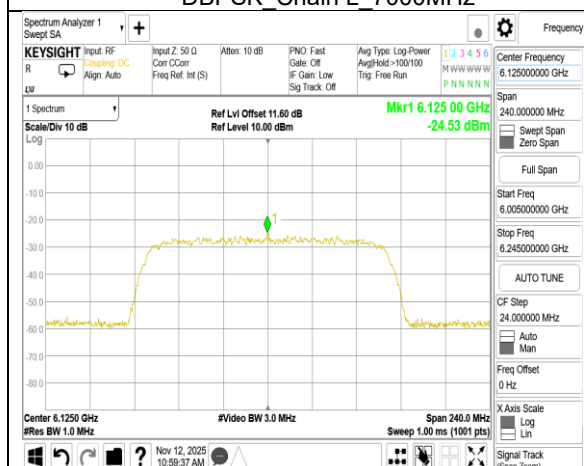
DBPSK_Chain L_6875MHz



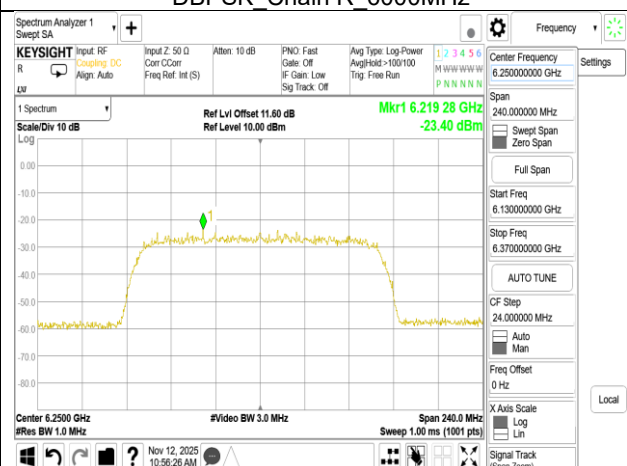
DBPSK_Chain L_7000MHz



DBPSK_Chain R_6000MHz



DBPSK_Chain R_6125MHz

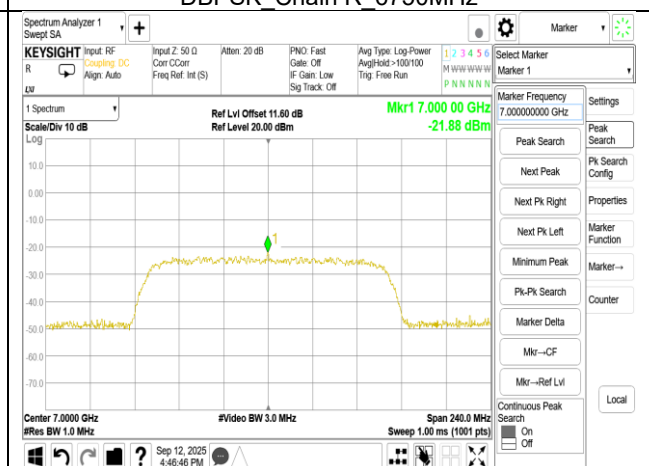
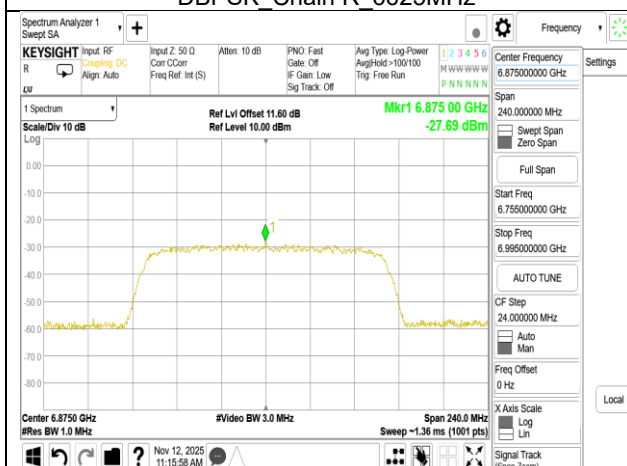
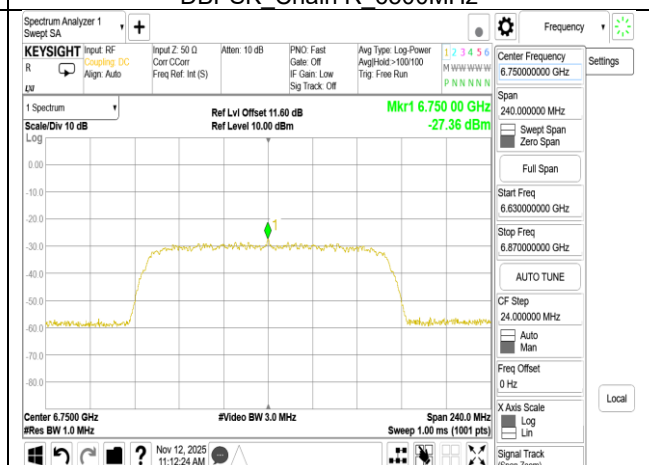
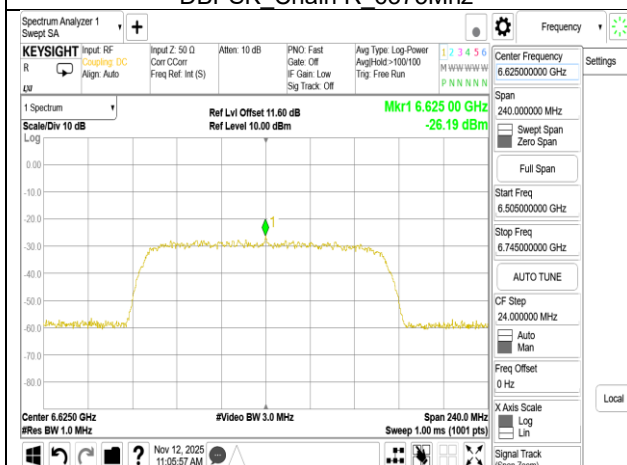
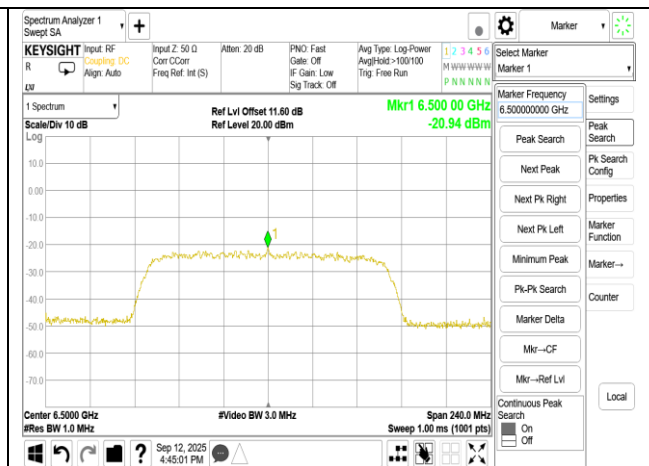
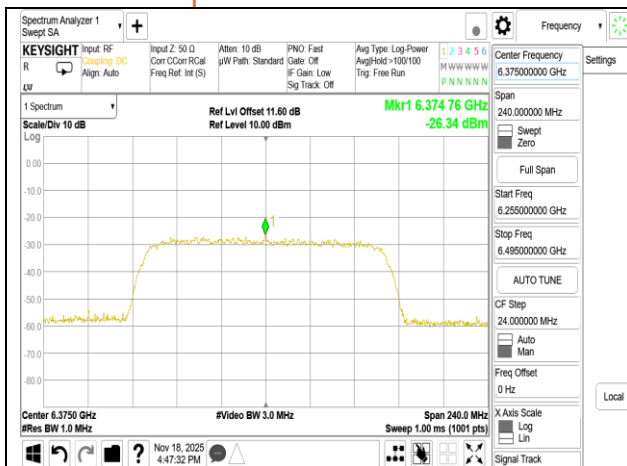


DBPSK_Chain R_6250MHz

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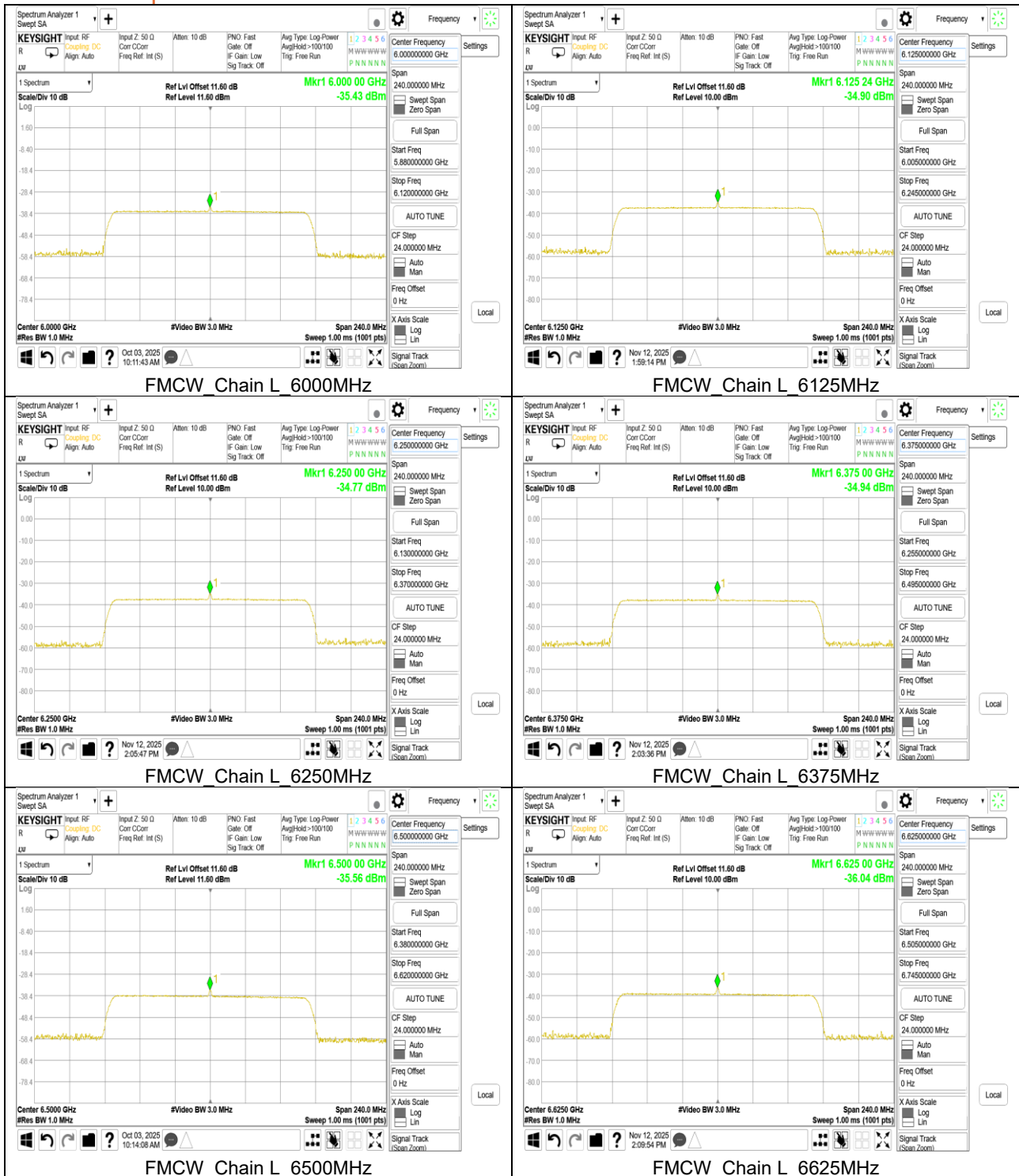
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