Report on the Radio Testing of:

Digi-Pas® Digital Level

Model(s): DWL

In accordance with
47 CFR FCC Part 15C

PSB Singapore

Add value.
Inspire trust.

Prepared for:
JSB Tech Pte. Ltd.
100 Pasir Panjang Road
#06-02, 100 Pasir Panjang
Singapore 118518

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191273291-EEC21/01 | Issue: 01
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RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Foo Kai Maun	12 Dec 2021	
Authorised Signatory	Quek Keng Huat	03 Dec 2021	

Signatures in this approval box have checked this document in line with the requirements of TÜV SÜD PSB document control rules.

EXECUTIVE SUMMARY
A sample of this product was tested and found to be compliant with the mentioned standard(s).

TÜV SÜD PSB

ilac-MRA

Accredited Laboratory SAC-SINGLAS

LA-2007-0380-A LA-2007-0386-C
LA-2007-0381-F LA-2010-0464-D
LA-2007-0382-B LA-2018-0702-B
LA-2007-0383-G LA-2018-0703-G
LA-2007-0384-G LA-2020-0747-L
LA-2007-0385-E

The results reported herein have been performed in accordance with the terms of accreditation under the Singapore Accreditation Council. Inspections/Calibrations/Tests marked "Not SAC-SINGLAS Accredited" in this Report are not included in the SAC-SINGLAS Accreditation Schedule for our inspection body/laboratory.

Laboratory:
TÜV SÜD PSB Pte. Ltd.
15 International Business Park
TÜV SÜD @ IBP
Singapore 609937

Phone : +65-6778 7777
E-mail: info.sg@tuvsud.com
https://www.tuvsud.com/sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
15 International Business Park
TÜV SÜD @ IBP
Singapore 609937

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Contents

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1 Report Summary

1.1 Report Modification Record

Alterations and additions to this report will be issued to the holders of each copy in the form of a complete document.

Issue	Description of Change	Date of Issue
1	First Issue	12 Dec 2021

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1.2 Introduction

Applicant	:	JSB Tech Pte. Ltd. 100 Pasir Panjang Road #06-02, 100 Pasir Panjang Singapore 118518
Manufacturer	:	Same as applicant
Factory	:	Same as applicant
Model Number(s)	:	DWL
Serial Number(s)	:	i. 13A06762 (Conducted) ii. 13A04812 (Radiated)
Number of Samples Tested	:	2
Test Sample(s) Condition	:	Good
Quotation Reference	:	5568068
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	09 Nov 2021
Start of Test	:	10 Nov 2021
Finish of Test	:	01 Dec 2021

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1.3 Brief Summary of Results

A brief summary of the tests carried out in accordance with specifications as shown below.

Specification Clause	Test Description	Result	Comments/Base Standard
47 CFR FCC Part 15			
15.107(a), 15.207	Conducted Emissions	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2018
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(a)(2)	Spectrum Bandwidth (6dB Bandwidth Measurement)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(b)(3)	Maximum Peak Power	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	RF Conducted Spurious Emissions (Non-Restricted Bands)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	RF Conducted Spurious Emissions (Restricted Bands)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	Band Edge Compliance (Conducted)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(d)	Band Edge Compliance (Radiated)	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.247(e)	Peak Power Spectral Density	Pass	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
15.35(c)	Duty Cycle Factor Computation	Not Applicable *See Note 4	ANSI C63.10: 2013 KDB 558074 D01 DTS Measurement Guidance V05R02: 2019
2.1091	Maximum Permissible Exposure	Pass	

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Notes

1. All the measurements in section 15.247 were done based on conducted measurements except Band Edge Compliance (Radiated) test.

2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.

3. The maximum measured RF power of the Equipment Under Test is -3.01dBm.

4. The EUT was operated in continuous transmission, ie 100% duty cycle.

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1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **Digi-Pas® Digital Level.**
Microprocessor	:	Texas Instruments CC2541 SimpleLink™ Bluetooth® low energy system-on-chip (SoC)
Operating Frequency	:	3 x Advertising Channels only: i. 2402 MHz ii. 2426 MHz and iii. 2480 MHz only.
Clock / Oscillator Frequency	:	32kHz / 32MHz
Modulation	:	Gaussian Frequency Shift Keying (GFSK)
Antenna Gain	:	0dBi
Port / Connectors	:	1 x Micro USB-Type B
Rated Power	:	Input 5Vdc 500mA
Accessories	:	2 x AA Batteries

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1.4.2 Test Configuration and Modes of Operation

<table>
<tr><th>Mode(s)</th><th>Description</th></tr>
<tr><td>Maximum RF power transmission</td><td>The EUT was exercised in advertising mode, transmitting at lower, middle and upper channels as shown below one at a time with all supported modulation schemes were evaluated. For Band Edge Compliance, only lower and upper channels were evaluated.
<table>
<tr><th>Transmit Channel</th><th>Frequency (GHz)</th></tr>
<tr><td>Channel 37 (Lower Channel)</td><td>2.402</td></tr>
<tr><td>Channel 38 (Middle Channel)</td><td>2.426</td></tr>
<tr><td>Channel 39 (Upper Channel)</td><td>2.480</td></tr>
</table>
</td></tr>
</table>

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1.5 Deviations from the Standard

Nil.

1.6 EUT Modification Record

No modifications were made.

1.7 Test Location(s)

TÜV SÜD PSB Pte Ltd
Electrical & Electronics Centre (EEC), Product Services,
15 International Business Park
TÜV SÜD @ IBP
Singapore 609937

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1.8 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	SGAP01 (CAB Identifier) 2932N-1 (10m Semi-Anechoic Chamber)
VCCI	R-13324 (10m ANC), G-10203 (10mANC) C-14933 (C.E @ CEIBP) T-12403 (Telecom Ports @ CEIBP)
BSMI	SL2-IS-E-6001R *[CNS-13803 (ISM Equipment)]* SL2-IN-E-6001R *[CNS-13438 (IT Equipment)]* SL2-R1/R2-E-6001R *[CNS-13439 (Broadcast Receivers)]* SL2-A1-E-6001R *[CNS-13783-1 (Household Appliances)]* SL2-L1-E-6001R *[CNS-14115 (Lighting Equipment)]*
SABS	SABS/A-LAB/0030/2018
ASCA	TL-86

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1.9 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
AC Adaptor USB Charger (IQOS)	M/N: S52A21 S/N: 84460236240_S FCC ID: Nil	1.0m unshielded USB charging cable

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2 Test Details

2.1 Conducted Emissions

2.1.1 Test Limits

Frequency Range (MHz)	Limit Values (dBµV)	
	Quasi-peak (Q-P)	Average (AV)
0.15 - 0.5	66 – 56 *	56 – 46 *
0.5 - 5.0	56	46
5.0 - 30.0	60	50
* Decreasing linearly with the logarithm of the frequency		

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2.1.2 Test Setup

2.1.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.1.2.2 The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.

2.1.2.3 The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.

2.1.2.4 All other supporting equipment were powered separately from another LISN.

2.1.3 Test Method

2.1.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.1.3.2 A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.

2.1.3.3 High peaks, relative to the limit line, were then selected.

2.1.3.4 The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 9kHz. Both Quasi-peak and Average measurements were made.

2.1.3.5 The measurements were then repeated for the LIVE line.

Sample Calculation Example

At 20 MHz	Q-P limit = 60.0 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)	
Therefore, Q-P margin = 60.0 - 40.0 = 20.0	i.e. 20.0 dB below Q-P limit

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2.1.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Line Under Test	AC Mains	Relative Humidity	57%
Worst Mode	Transmitting @ CH37	Atmospheric Pressure	1010mbar
		Tested By	Chelmin Li
		Test Date	25 Nov 2021

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line	Channel
0.5562	36.7	56.0	19.3	19.2	46.0	26.8	Live	Lower
0.6801	28.5	56.0	27.5	14.2	46.0	31.8	Live	Lower
9.4292	28.4	60.0	31.6	16.3	50.0	33.7	Neutral	Lower
14.6597	24.7	60.0	35.3	15.3	50.0	34.7	Neutral	Lower
27.6836	22.9	60.0	37.1	16.8	50.0	33.2	Live	Lower
29.2164	18.9	60.0	41.1	13.6	50.0	36.4	Live	Lower

Notes

1.	All possible modes of operation were investigated from 150kHz to 30MHz. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 150kHz - 30MHz RBW: 9kHz VBW: 30kHz

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2.2 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

2.2.1 Test Limits

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490 *	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 – 88	40.0 @ 3m
88 – 216	43.5 @ 3m
216 – 960	46.0 @ 3m
Above 960 *	54.0 @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

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2.2.2 Test Setup

2.2.2.1 The EUT and supporting equipment were set up in accordance with the requirements of the standard as shown in the setup photos.

2.2.2.2 The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.

2.2.2.3 The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

2.2.3 Test Method

2.2.3.1 The EUT was switched on and allowed to warm up to its normal operating condition.

2.2.3.2 A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.

2.2.3.3 The test was carried out at the selected frequency points obtained from the pre-scan. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:

a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
b. The EUT was then rotated to the direction that gave the maximum emission.
c. Finally, the antenna height was adjusted to the height that gave the maximum emission

2.2.3.4 A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz.For frequency point in range of 9kHz – 90kHz, 110kHz – 49k0kHz and above 1GHz, both Peak and Average measurements were carried out.

2.2.3.5 The measurements were repeated for the next frequency point, until all selected frequency points were measured.

2.2.3.6 The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10th harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

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2.2.5 Test Results

Test Input Power	120V 60Hz	Temperature	24ºC
Test Distance	10m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	57%
Worst Mode	Transmitting @ CH37	Atmospheric Pressure	1010mbar
		Tested By	Mohamed Nazrulhizat
		Test Date	24 Nov 2021

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 6

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 6

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
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Spurious Emissions ranging from 30MHz – 1GHz

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
31.0120	30.7	40.0	9.3	100	233	V	Lower
63.9960	34.6	40.0	5.4	200	349	V	Lower
95.9990	24.7	43.5	18.8	100	99	V	Lower
128.0030	27.8	43.5	15.7	100	136	V	Lower
192.0100	28.4	43.5	15.1	100	114	V	Lower
416.0020	26.2	46.0	19.8	100	184	H	Lower

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m)	AV Margin (dB) *See Note 5	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
2.3496	38.8	74.0	35.2	--	54.0	15.2	300	274	V	Lower
2.6499	38.4	74.0	35.6	--	54.0	15.6	300	20	V	Lower
3.2403	39.0	74.0	35.0	--	54.0	15.0	100	158	V	Lower
4.8072	46.4	74.0	27.6	--	54.0	7.6	300	170	V	Lower
6.6174	47.7	74.0	26.3	--	54.0	6.3	100	272	H	Lower
8.0799	50.3	74.0	23.7	--	54.0	3.7	200	262	V	Lower

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m)	AV Margin (dB) *See Note 5	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
2.3202	38.5	74.0	35.5	--	54.0	15.5	300	118	V	Middle
2.6741	38.6	74.0	35.4	--	54.0	15.4	200	121	V	Middle
3.5785	40.5	74.0	33.5	--	54.0	13.5	100	224	V	Middle
4.8525	49.7	74.0	24.3	--	54.0	4.3	200	88	H	Middle
6.9983	48.7	74.0	25.3	--	54.0	5.3	200	91	V	Middle
8.1405	50.5	74.0	23.5	--	54.0	3.5	200	282	H	Middle

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Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 4	AV Limit (dBµV/m)	AV Margin (dB) *See Note 5	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
2.3049	39.1	74.0	34.9	--	54.0	14.9	100	128	V	Upper
2.6771	38.7	74.0	35.3	--	54.0	15.3	300	148	V	Upper
3.6558	40.6	74.0	33.4	--	54.0	13.4	300	178	V	Upper
4.9583	44.5	74.0	29.5	--	54.0	9.5	200	210	V	Upper
6.4865	47.9	74.0	26.1	--	54.0	6.1	300	282	V	Upper
8.9725	52.5	74.0	21.5	--	54.0	1.5	300	240	H	Upper

Notes

1.	All possible modes of operation were investigated. Only the worst case emissions measured, using the correct CISPR detectors, are reported. All other emissions were relatively insignificant.
2.	A "positive margin" indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative margin" indicates a FAIL.
3.	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 9kHz – 150kHz RBW: 200Hz VBW: 1kHz 150kHz – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	As the measured peak shows compliance to the average limit, as such no average measurement was required.
5.	The average margin indicates the margin of the measured peak value below the average limit.
6.	"--" indicates no emissions were found and shows compliance to the limits
7.	Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second
8.	The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33 (a) for intentional radiators & Section 15.33 (b) for unintentional radiators.
9.	The channel in the table refers to the transmit channel of the EUT.

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2.3 Spectrum Bandwidth (6db Bandwidth Measurement)

2.3.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that the minimum bandwidth of the EUT employing digital modulation techniques shall be at least 500kHz.

2.3.2 Test Setup

2.3.2.1 The EUT and supporting equipment were set up as shown in the set up photo.

2.3.2.2 The power supply for the EUT was connected to a filtered mains.

2.3.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.3.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.

2.3.2.5 All other supporting equipment were powered separately from another filtered mains.

2.3.3 Test Method

2.3.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.3.3.2 The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 6dB bandwidth of the transmitting frequency.

2.3.3.3 The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.

2.3.3.4 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 6dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser.

2.3.3.5 The 6dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$.

2.3.3.6 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.3.3.7 The measurements were repeated with the transmitting frequency was set to middle and upper channels respectively.

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2.3.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	1 – 6	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	15 Nov 2021

Channel	Channel Frequency (GHz)	6dB Bandwidth (MHz) *See Note 1	99% Bandwidth (MHz)	Limit (kHz)
Lower	2.402	0.670	1.038	≥ 500
Middle	2.426	0.659	1.054	≥ 500
Upper	2.480	0.673	1.045	≥ 500

Notes

1.	Only the largest measured bandwidths were reported. Refer to plots for all measured bandwidth.

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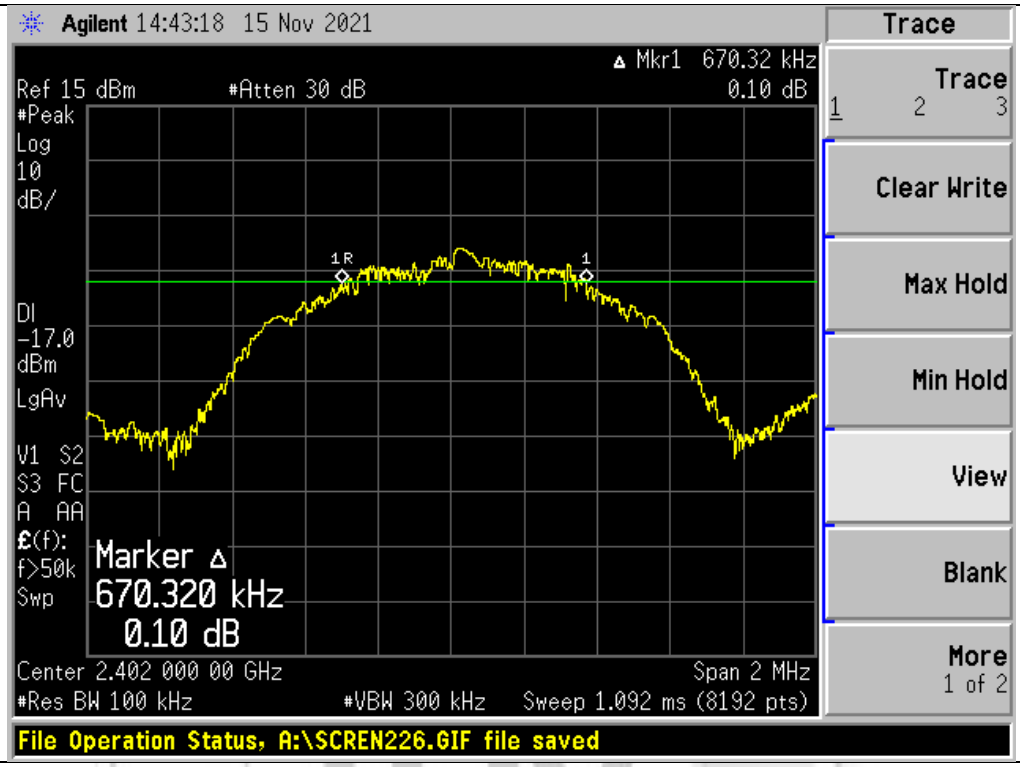
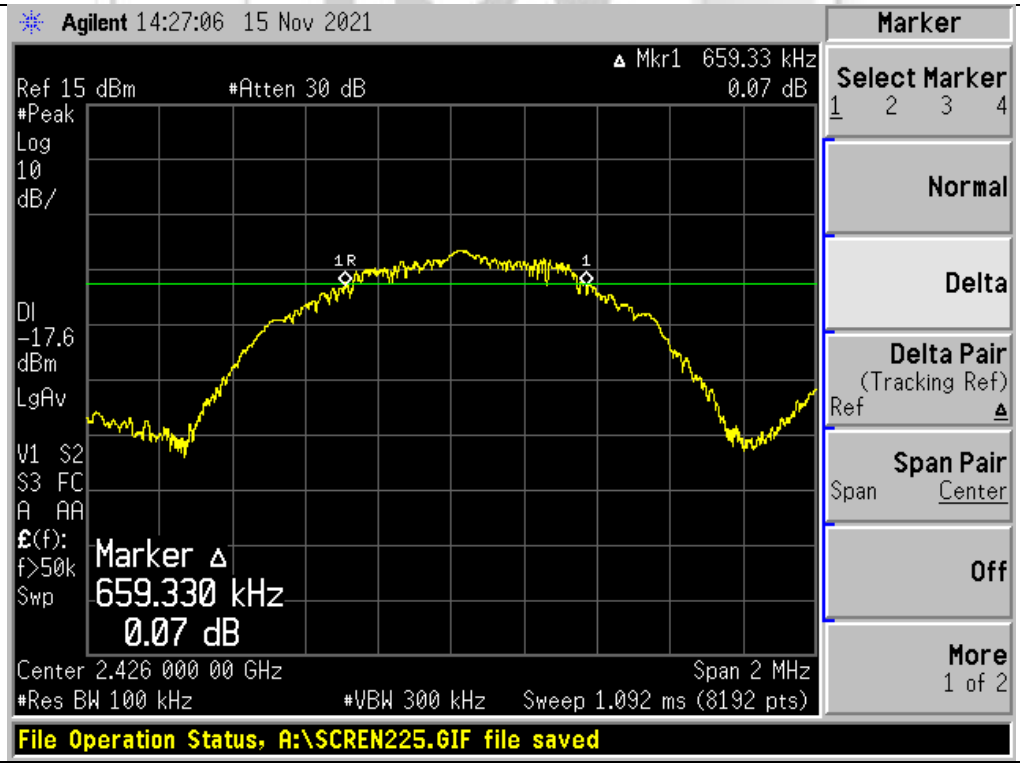
Spectrum Bandwidth (6dB Bandwidth Measurement) Plots



Plot 1 – Lower Channel



Plot 2 – Middle Channel

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Spectrum Bandwidth (6dB Bandwidth Measurement) Plots

Plot 3 – Upper Channel

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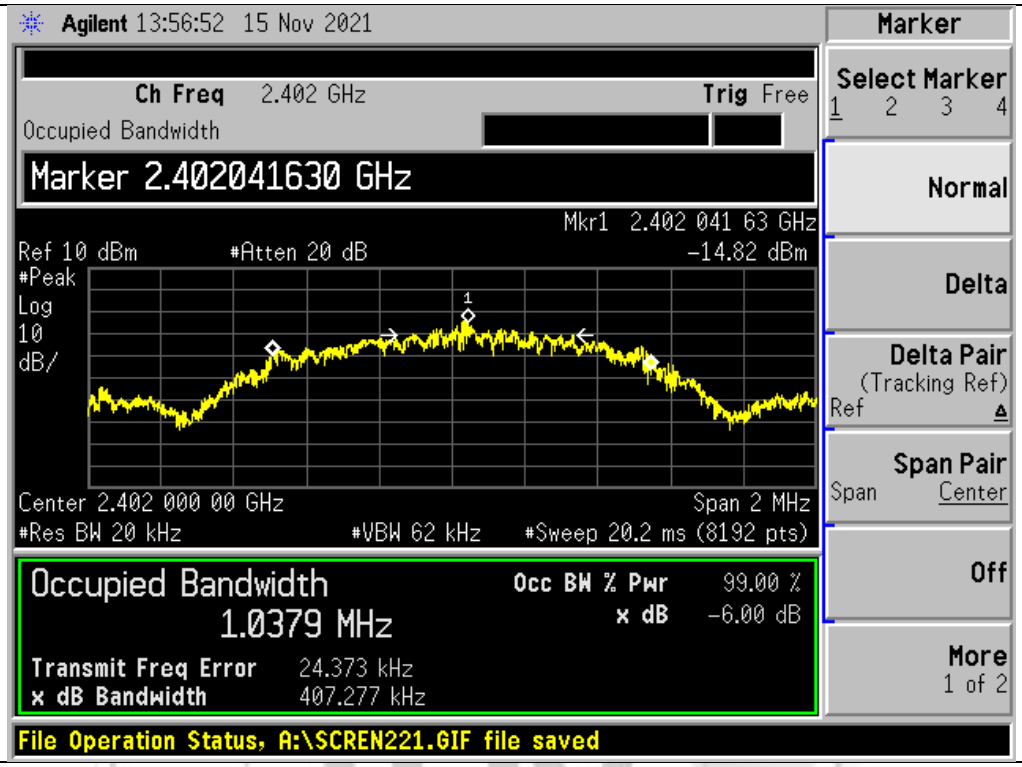
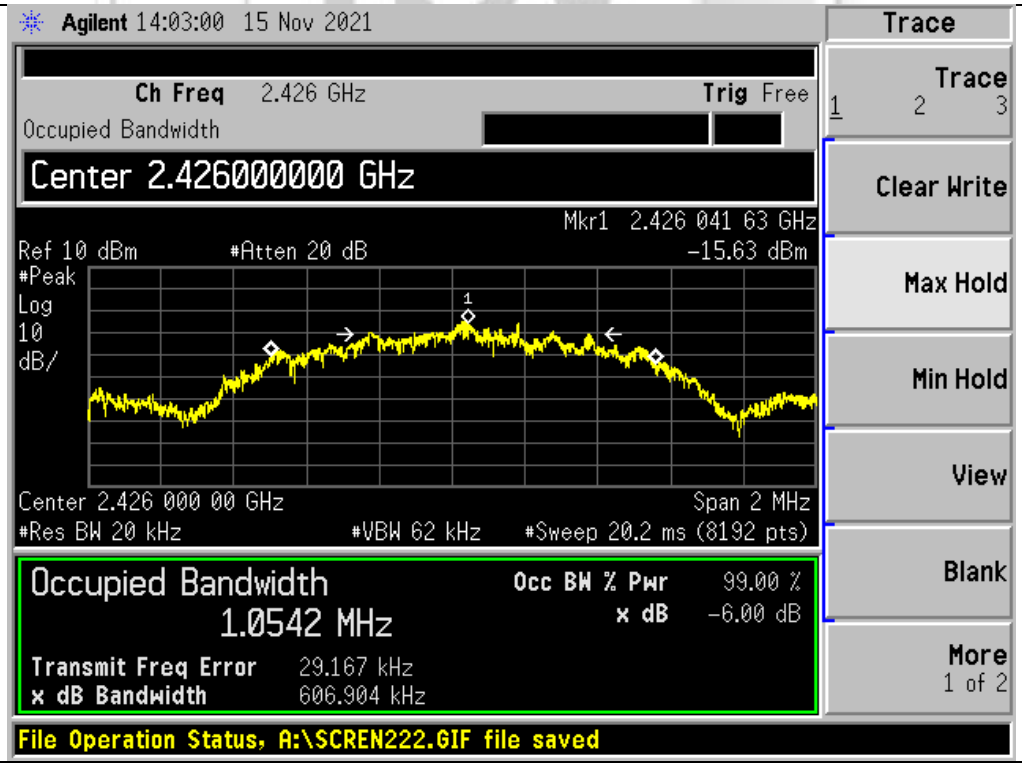
Spectrum Bandwidth (99% Bandwidth Measurement) Plots



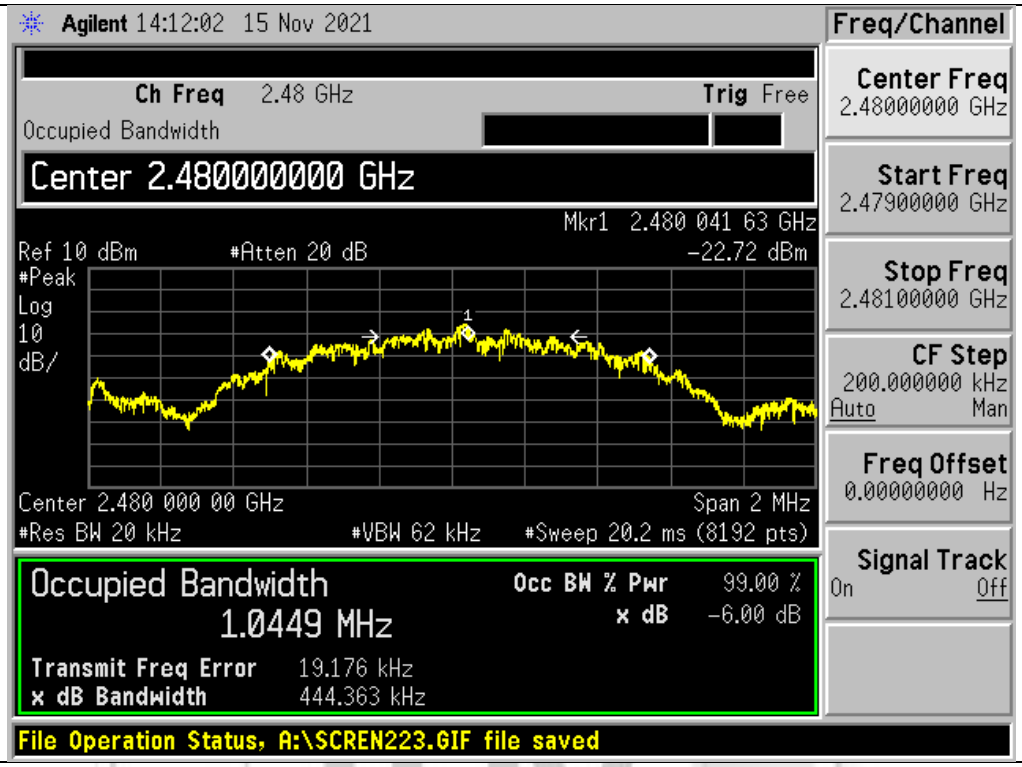
Plot 4 – Low Channel



Plot 5 – Middle Channel

PSB Singapore

Spectrum Bandwidth (99% Bandwidth Measurement) Plots



Plot 6 – High Channel

PSB Singapore

2.4 Maximum Peak Power

2.4.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the maximum peak power of the EUT employing digital modulation shall not exceed 1W (30dBm).

2.4.2 Test Setup

2.4.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.4.2.2 The power supply for the EUT was connected to a filtered mains.

2.4.2.3 The RF antenna connector was connected to a power meter.

2.4.2.4 All other supporting equipment were powered separately from another filtered mains.

2.4.3 Test Method

2.4.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.4.3.2 The maximum peak power of the transmitting frequency was detected and recorded.

2.4.3.3 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.4.3.4 The measurement was repeated with the transmitting frequency was set to middle channel and upper channels respectively.

PSB Singapore

2.4.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Antenna Gain	0.0 dBi	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	18 Nov 2021

Channel	Channel Frequency (GHz)	Maximum Peak Power (W) *See Note 1	Limit (W)
Lower	2.402	0.0005	1.0
Middle	2.426	0.0004	1.0
Upper	2.480	0.0003	1.0

Notes

1.	Only the highest measured peak power were reported.

PSB Singapore

2.5 RF Conducted Spurious Emissions (Non-Restricted Bands)

2.5.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

2.5.2 Test Setup

2.5.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.5.2.2 The power supply for the EUT was connected to a filtered mains.

2.5.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.5.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.

2.5.2.5 All other supporting equipment were powered separately from another filtered mains.

2.5.3 Test Method

2.5.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with transmitting frequency at lower channel.

2.5.3.2 The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.

2.5.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.5.3.4 The measurements were repeated with frequency span was set from 10GHz to 25GHz.

2.5.3.5 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.5.3.6 The measurements were repeated with the transmitting frequency was set to middle and upper channels respectively.

PSB Singapore

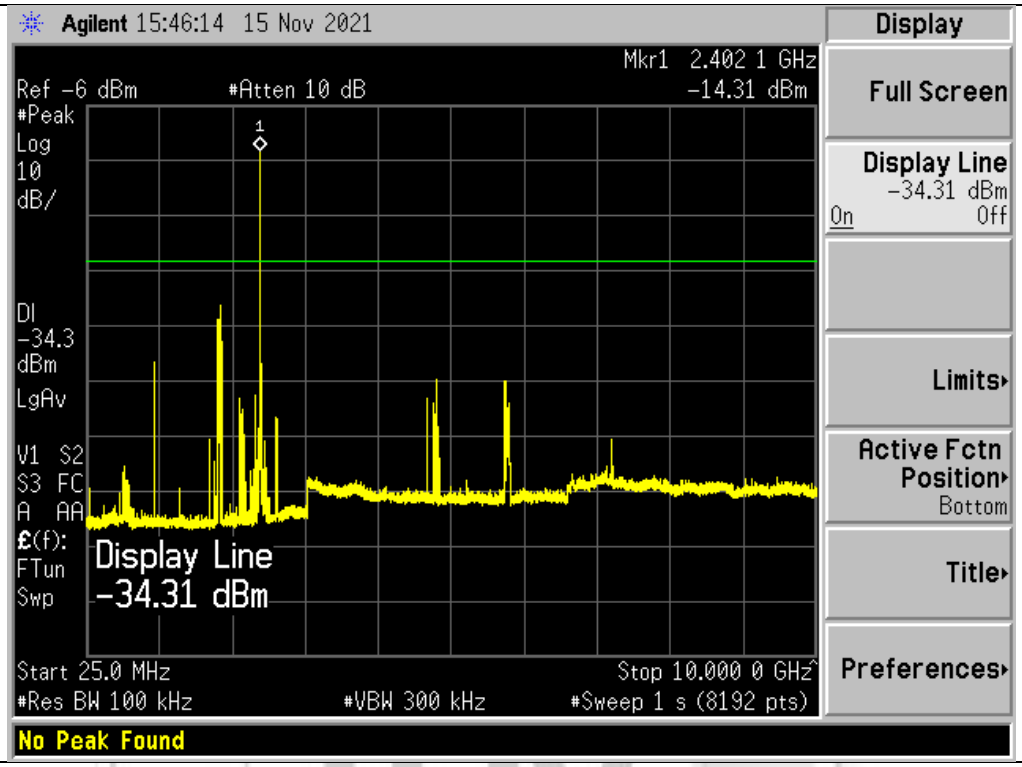
2.5.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	7 – 12	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	15 Nov 2021

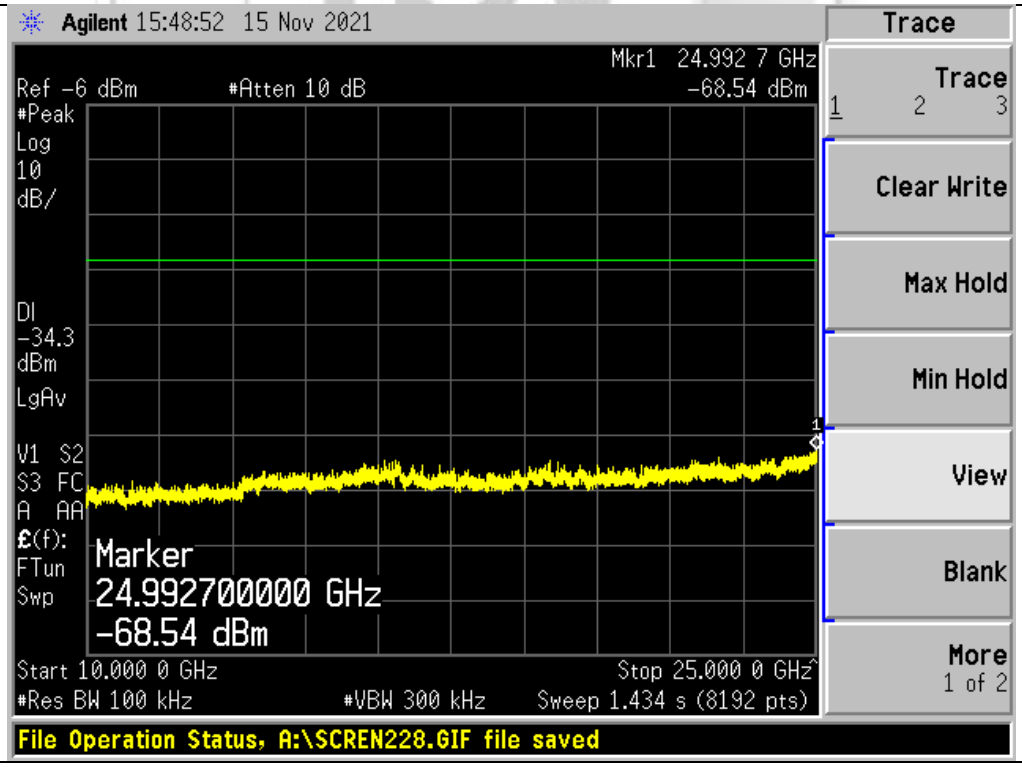
All spurious signals found were below the specified limit. Please refer to the attached plots.

PSB Singapore

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



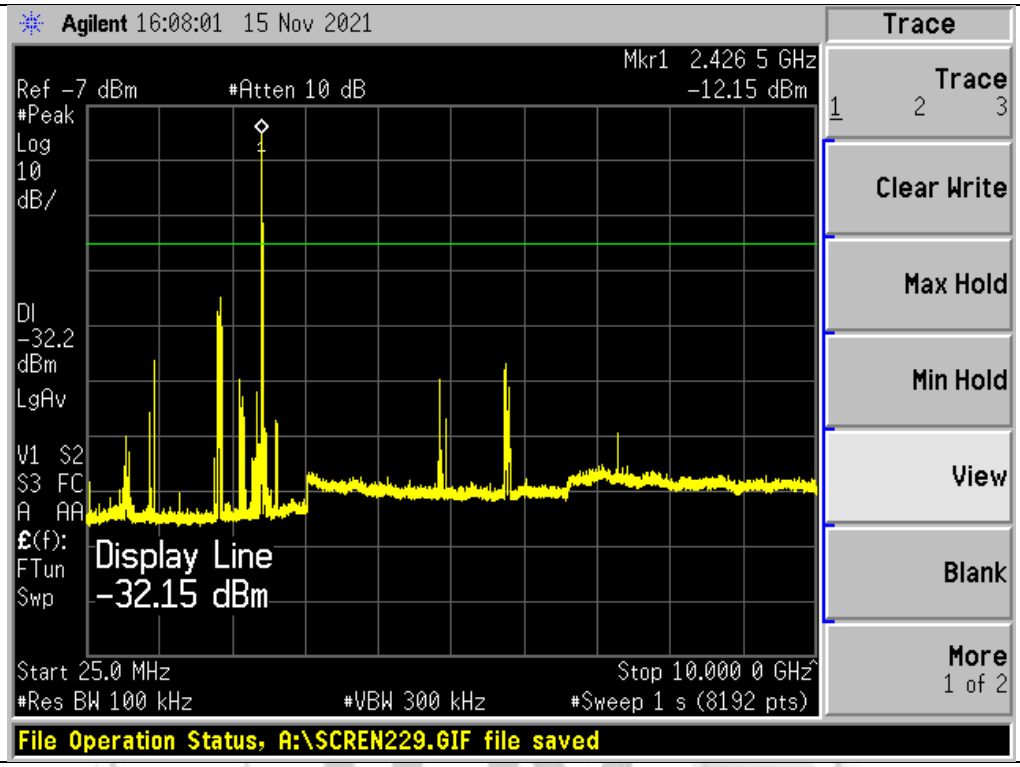
Plot 7 – Lower Channel



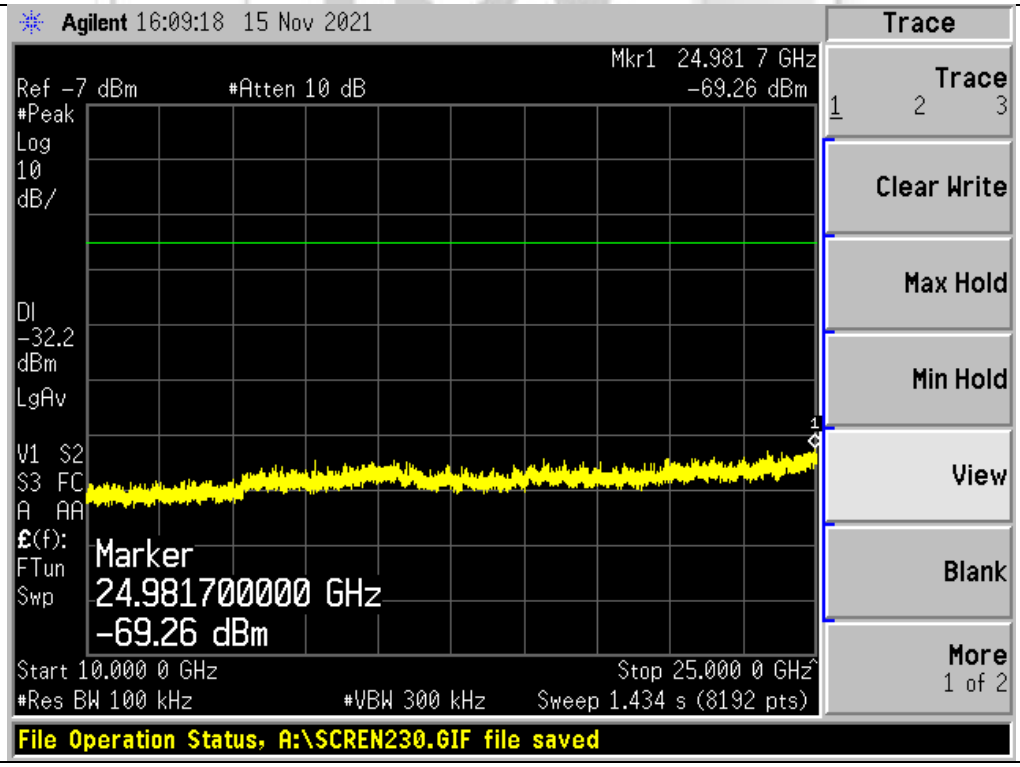
Plot 8 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



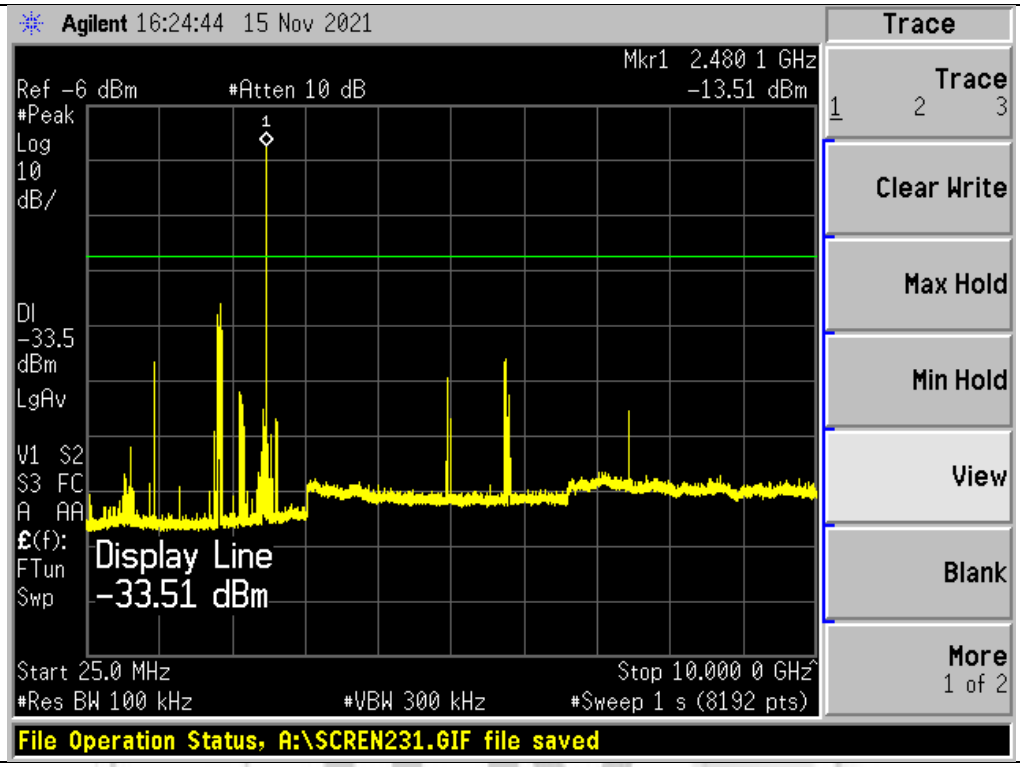
Plot 9 – Middle Channel



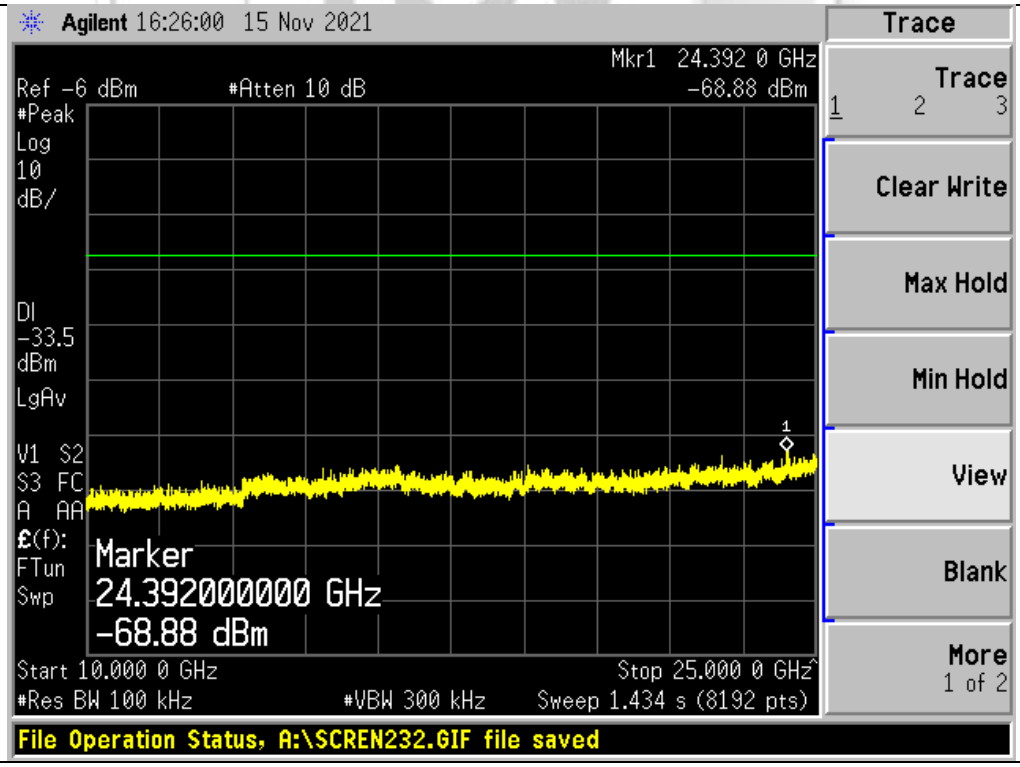
Plot 10 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



Plot 11 – Upper Channel



Plot 12 – Upper Channel

PSB Singapore

2.6 RF Conducted Spurious Emissions (Restricted Bands)

2.6.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that emissions which fall in the restricted bands must comply with the radiated emission limits specified in the table below:

Frequency Range (MHz)	EIRP (dBm)	Radiated Emissions (dBµV/m)
0.009 – 0.490	-6.7 – (-41.4) **	67.6 – 20logF* @ 300m **
0.490 – 1.705	-41.4 – (-52.3) **	87.6 – 20logF* @ 30m **
1.705 – 30	-45.7	29.5 @ 30m
30 - 88	-55.2	40.0 @ 3m
88 - 216	-51.7	43.5 @ 3m
216 - 960	-49.2	46.0 @ 3m
>960	-41.2 ***	54.0 @ 3m ***
* F is frequency in kHz.		
** Decreasing linearly with the logarithm of the frequency.		
*** Above 1GHz, a peak limit of 20dB above the average limit does apply.		

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MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

PSB Singapore

2.6.2 Test Setup

2.6.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.6.2.2 The power supply for the EUT was connected to a filtered mains.

2.6.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.6.2.4 The resolution bandwidth (RBW) of the spectrum analyser was set to the following settings. The video bandwidth (VBW) was set to at least three times of the RBW.

Frequency (MHz)	RBW (kHz)
0.009 – 0.150	0.2
0.150 – 30.0	9.0
30.0 - 1000	100.0
> 1000	1000.0

2.6.2.5 The detector of the spectrum analyser was set to peak detection mode.

2.6.2.6 All other supporting equipment were powered separately from another filtered mains.

2.6.3 Test Method

Measurement in the range 9kHz – 1000MHz

2.6.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with the transmitting frequency was set to lower channel.

2.6.3.2 The start and stop frequencies of the spectrum analyser were set according to the supported RBW.

2.6.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected. The antenna gain of the EUT was added to the captured spurious emissions.

2.6.3.4 No further measurement was required if all the captured emissions complied to the limits. Else, the spectrum analyser was set to zoom to the captured emission with the detector of the spectrum analyser was set to quasi-peak. The emission level of the captured frequency was measured.

2.6.3.5 The measurements were repeated until all the captured emissions which exceeding the limits were measured.

2.6.3.6 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.6.3.7 The measurements were repeated with the transmitting frequency was set to middle and upper channels respectively

PSB Singapore

Measurement above 1000MHz

2.6.3.8 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, with the transmitting frequency was set to lower channel.

2.6.3.9 The start and stop frequencies of the spectrum analyser were set according to the supported frequency band of the set RBW with the number of points in a sweep was set to equal or greater than 2 times of the ratio of span over RBW.

2.6.3.10 The detector of the spectrum analyser was set to power average (RMS) mode with the sweep time was set to equal or greater than 10 times of the product of number of measurement points in a sweep and transmission symbol time.

2.6.3.11 The spectrum analyser was then allowed to capture any spurious emissions within a single sweep. The peak marker function of the spectrum analyser was used to locate the highest power level. The antenna gain of the EUT was added to the captured spurious emissions.

2.6.3.12 The measurements were repeated until all the required frequency bands were measured.

2.6.3.13 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.6.3.14 The measurements were repeated with the transmitting frequency was set to middle and upper channels respectively.

2.6.3.15 The measurements were repeated with the detector of the spectrum analyser was set to peak detecting mode. The sweep time was set to auto coupler.

PSB Singapore

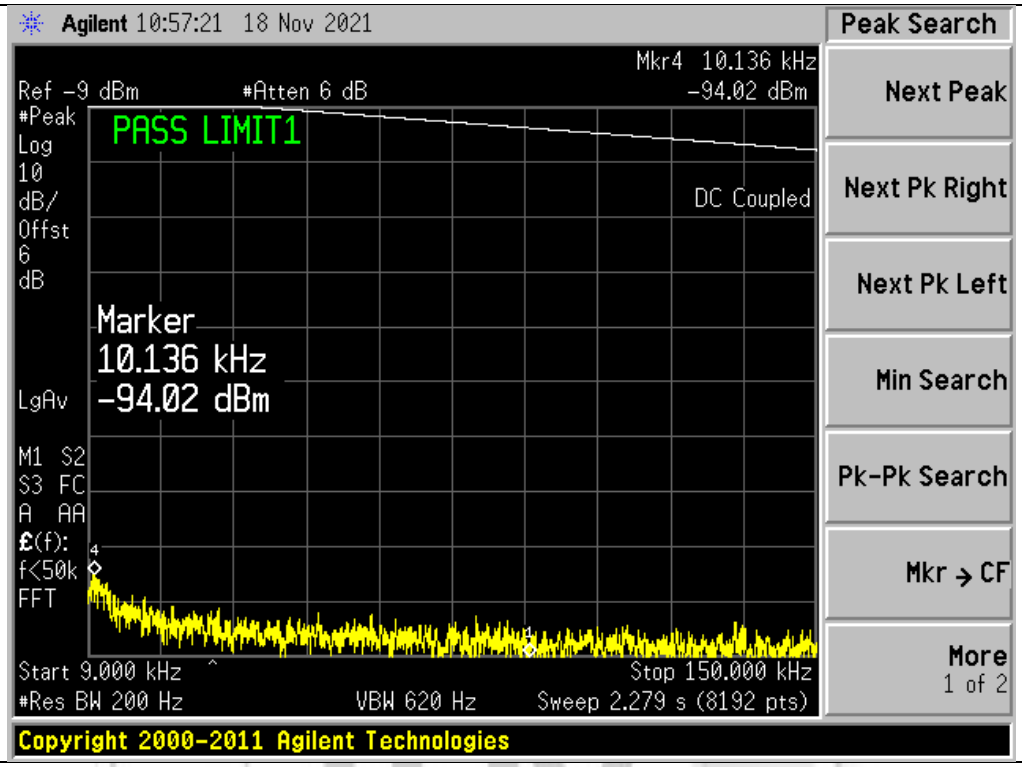
2.6.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	13 – 39 (Peak)	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	18 Nov 2021

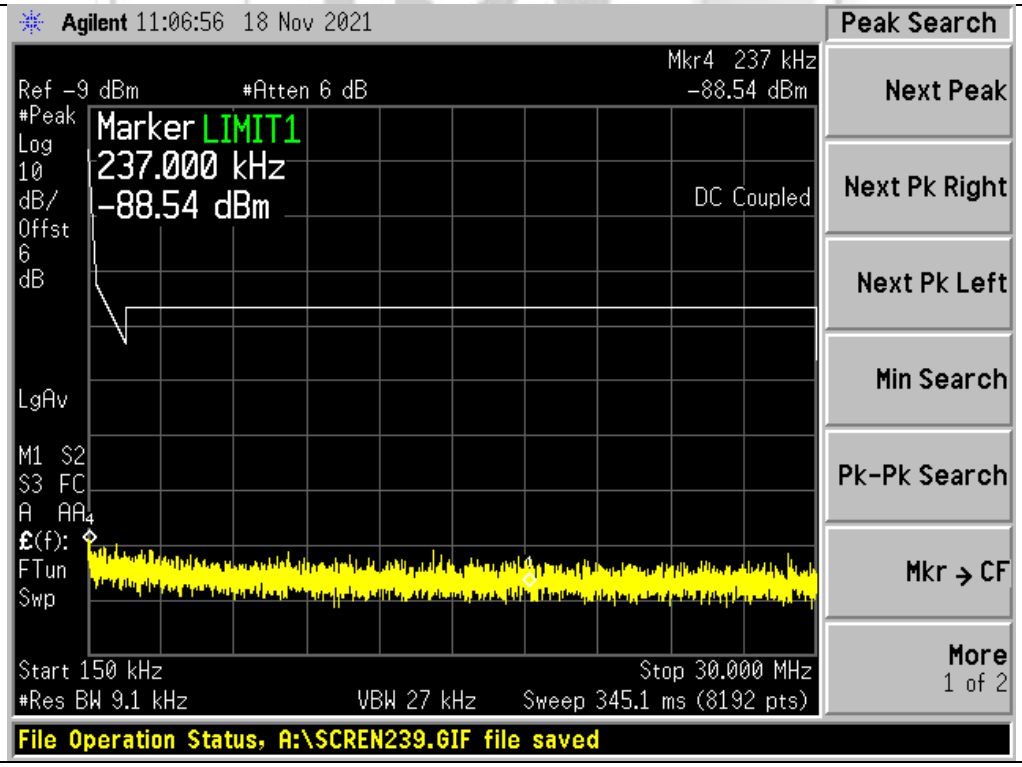
All spurious signals found were below the specified limit. Please refer to the attached plots.

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



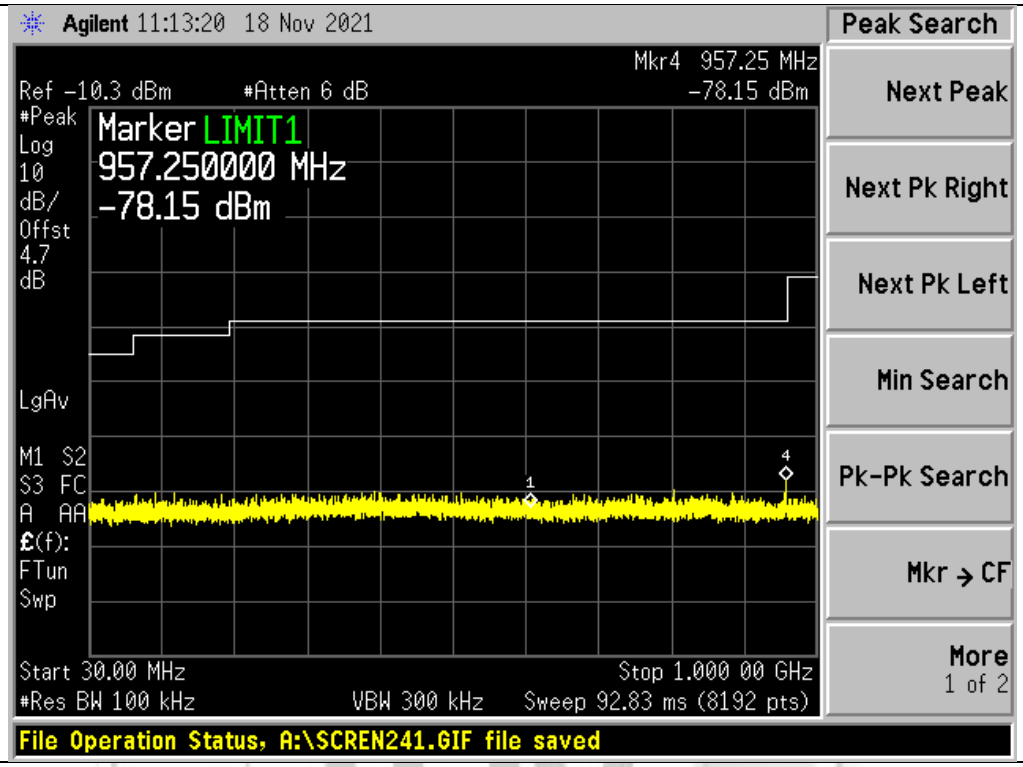
Plot 13 – Lower Channel



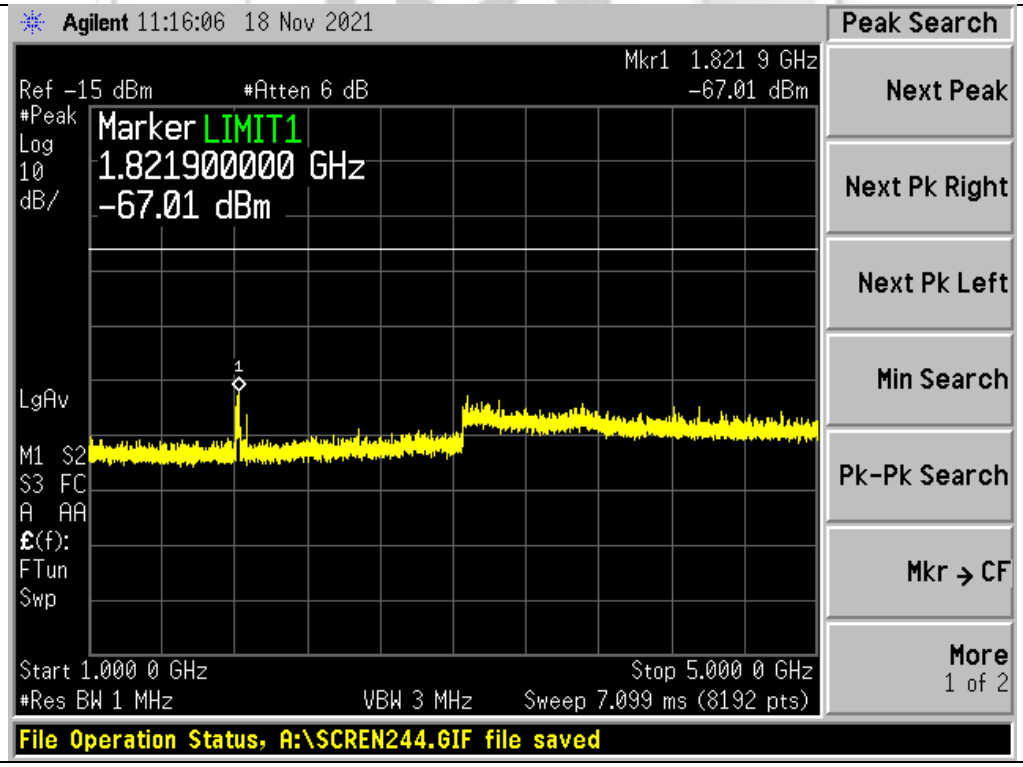
Plot 14 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



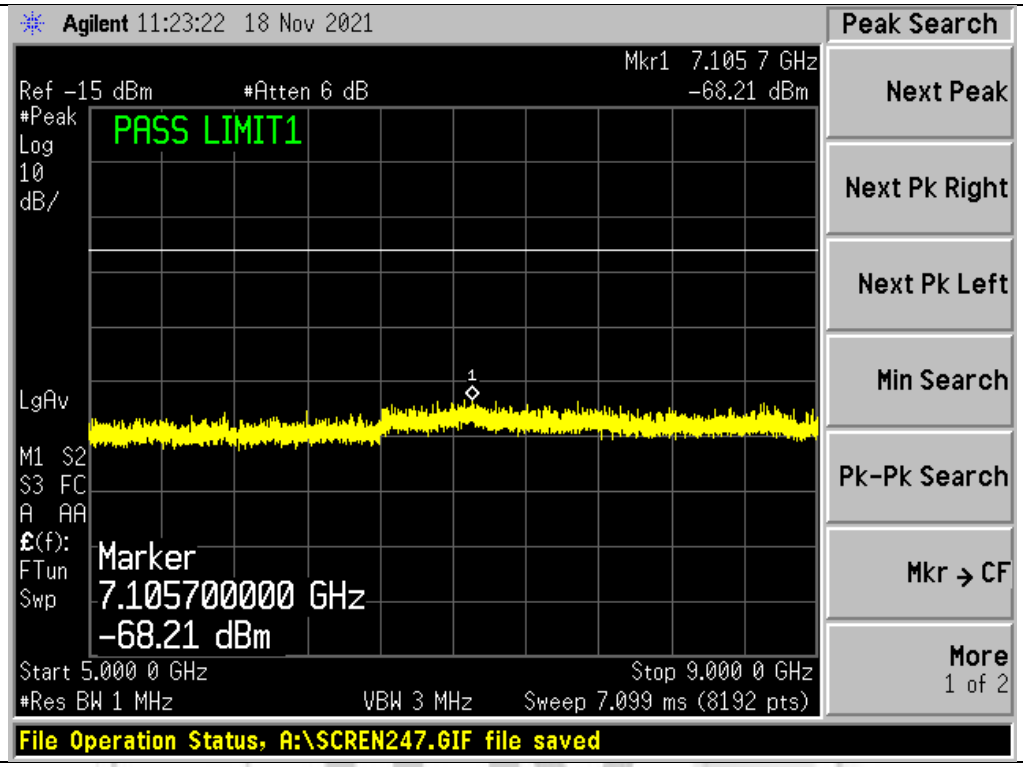
Plot 15 – Lower Channel



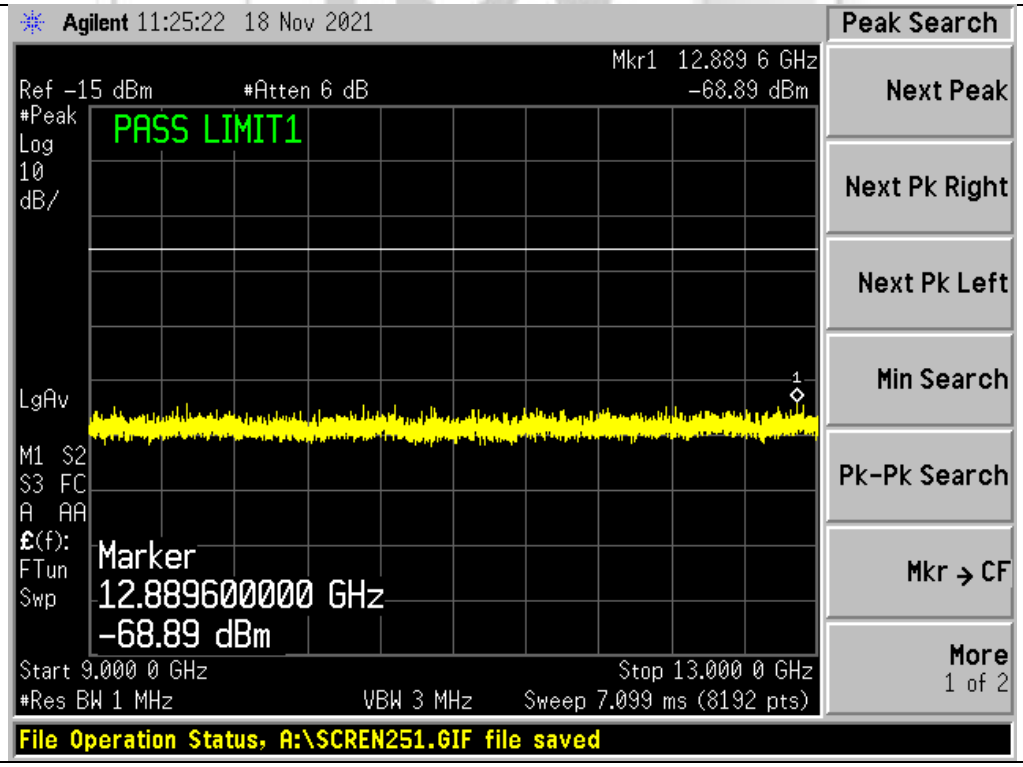
Plot 16 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



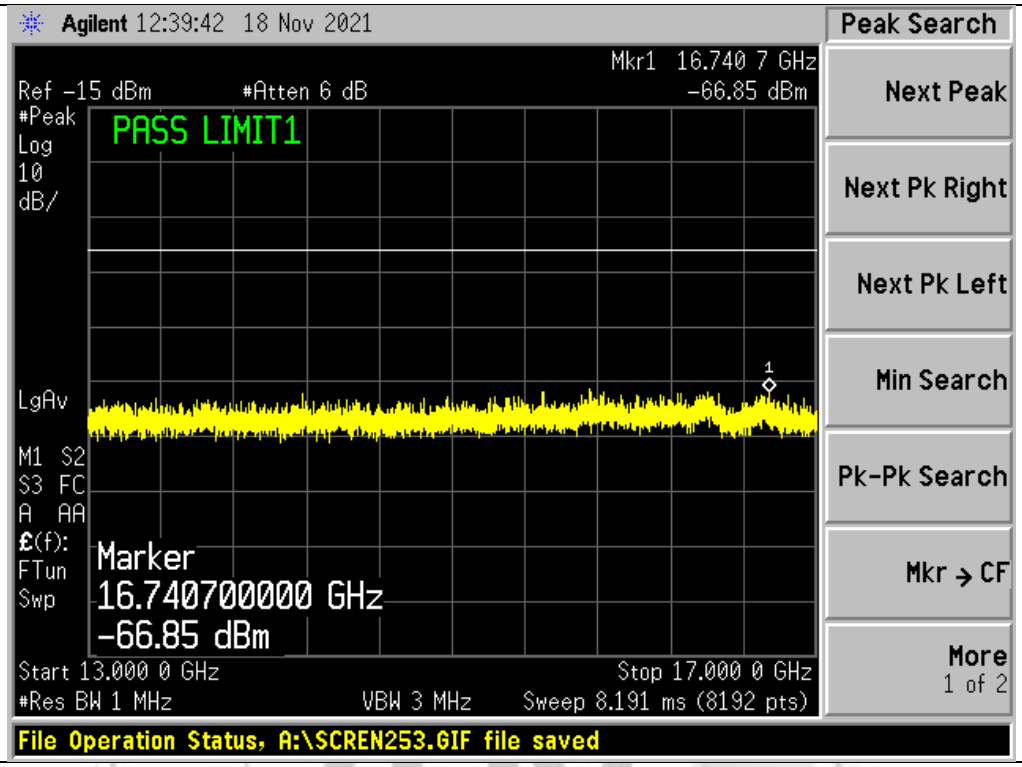
Plot 17 – Lower Channel



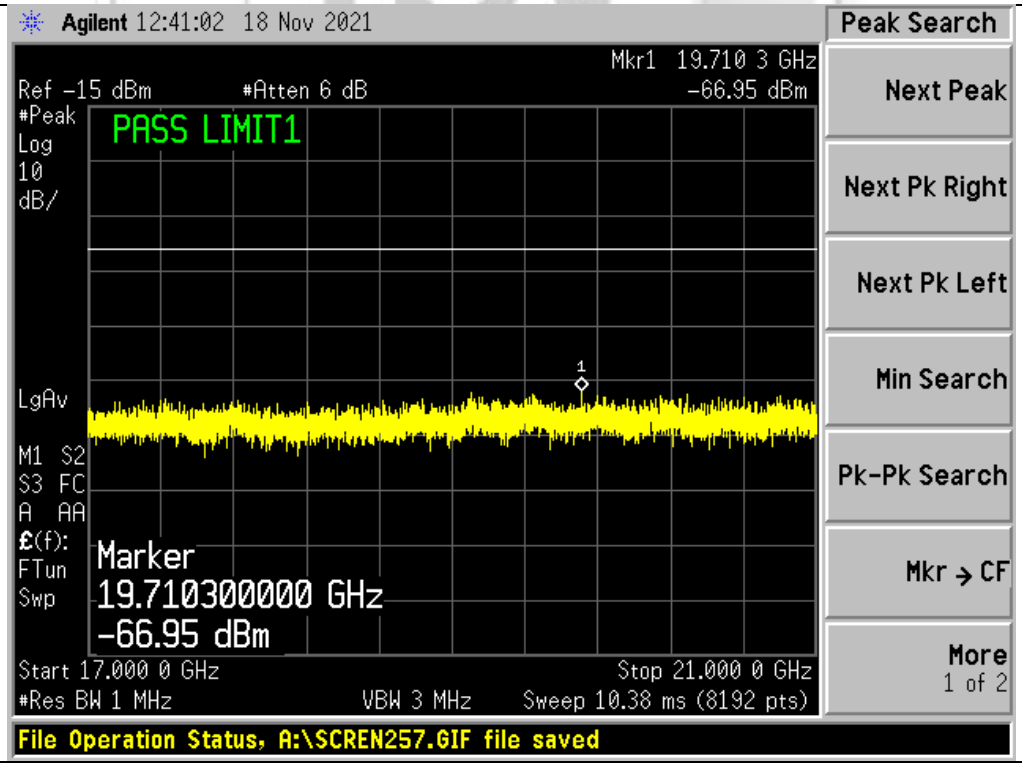
Plot 18 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



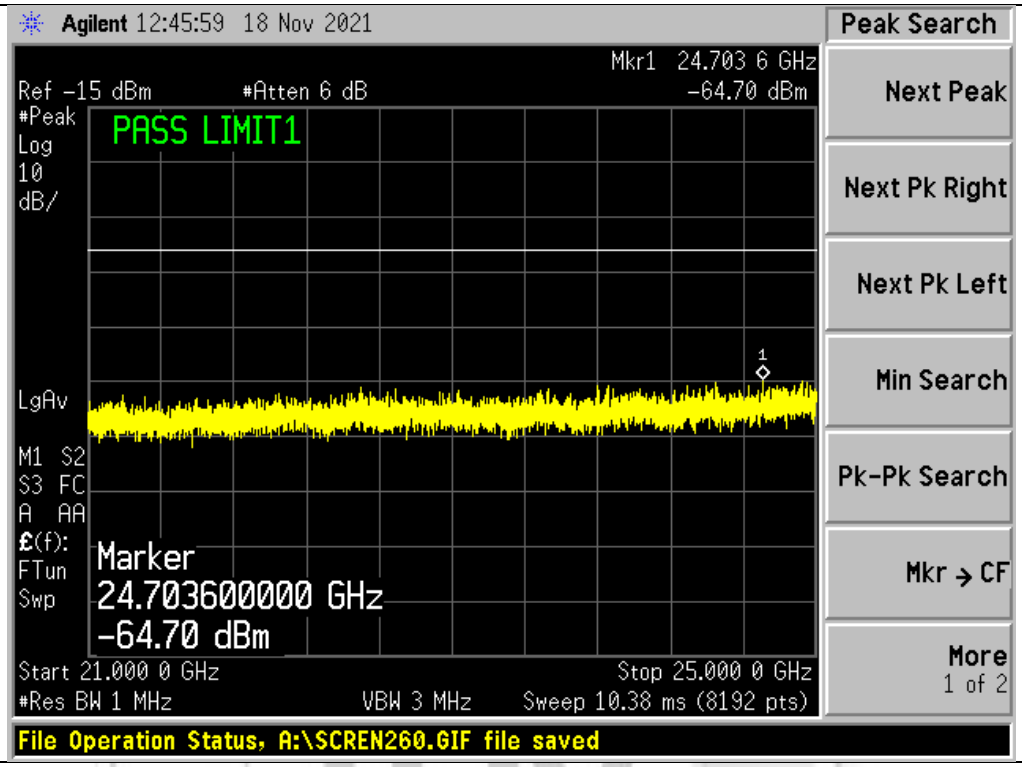
Plot 19 – Lower Channel



Plot 20 – Lower Channel

PSB Singapore

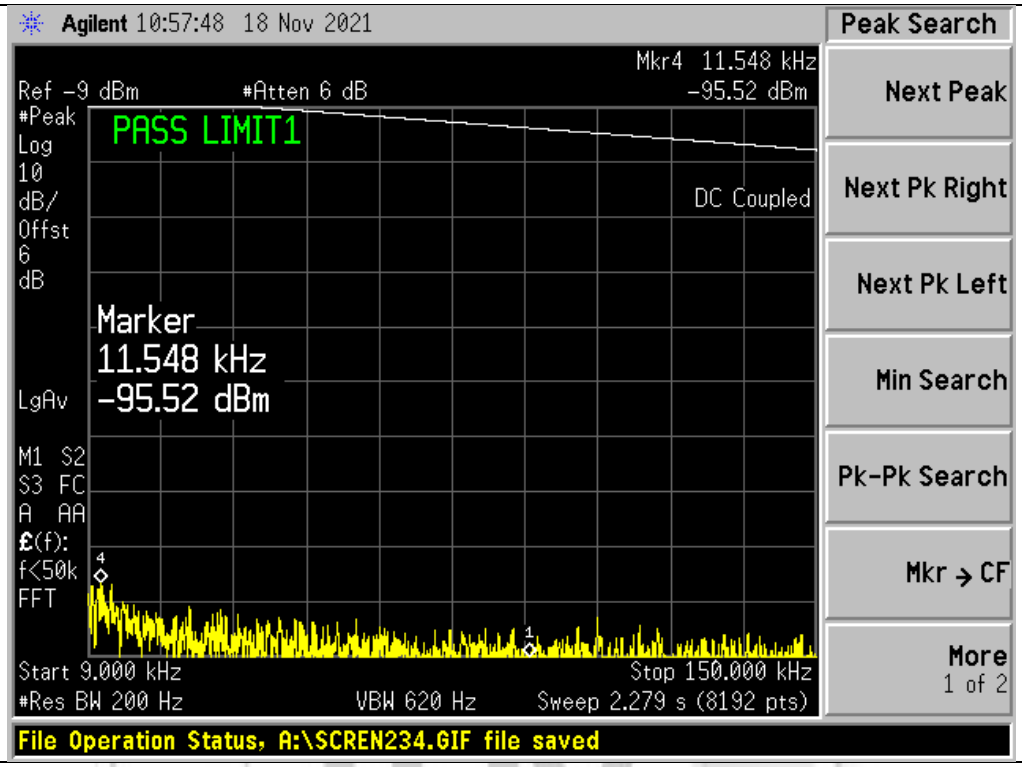
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



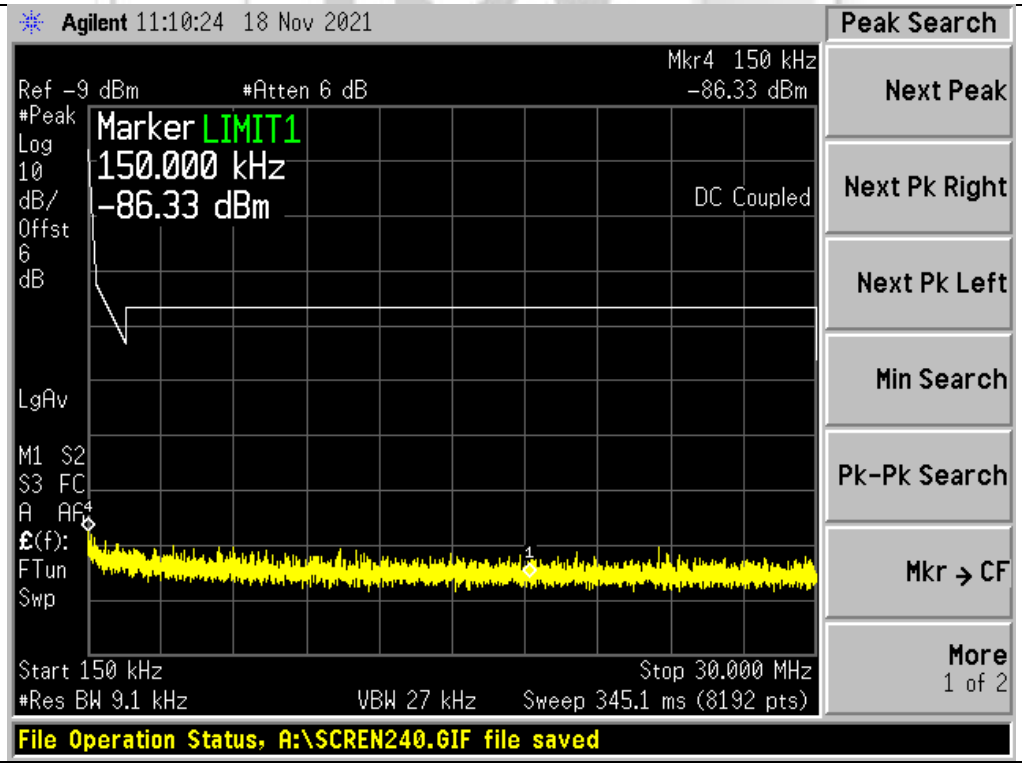
Plot 21 – Lower Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



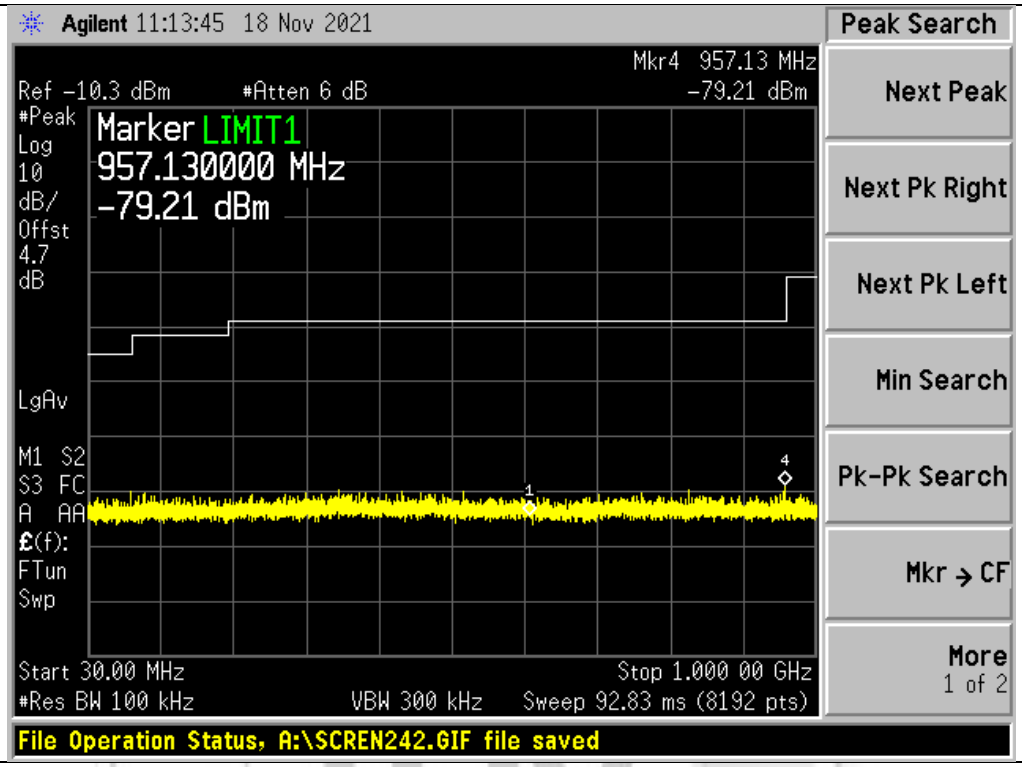
Plot 22 – Middle Channel



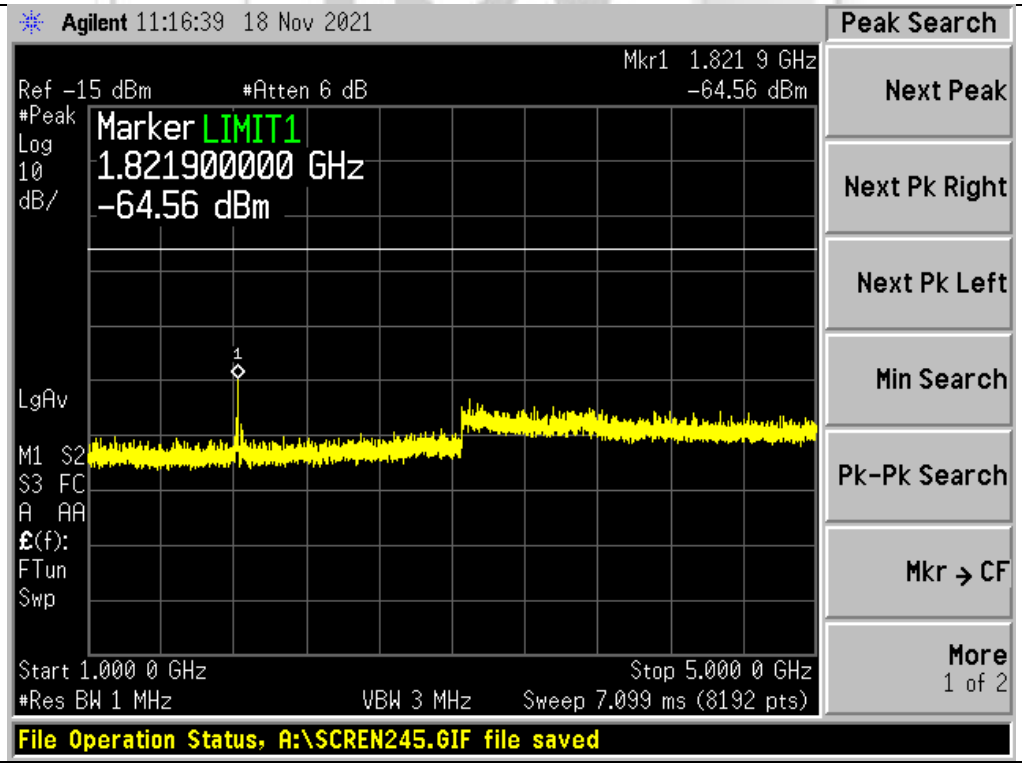
Plot 23 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



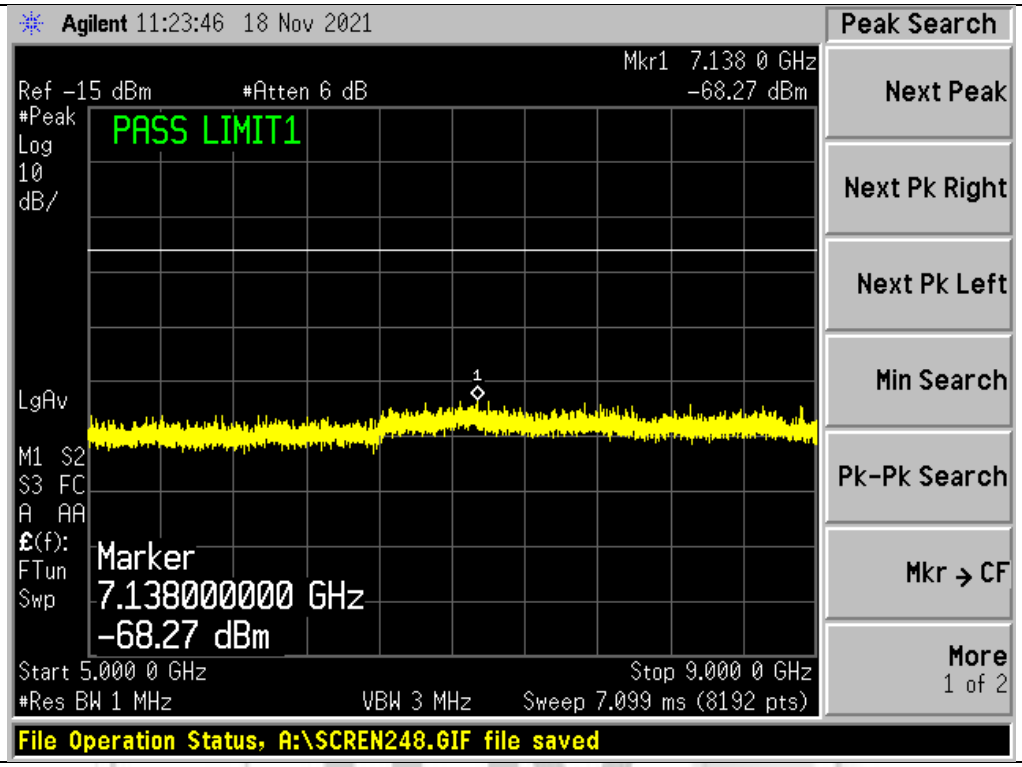
Plot 24 – Middle Channel



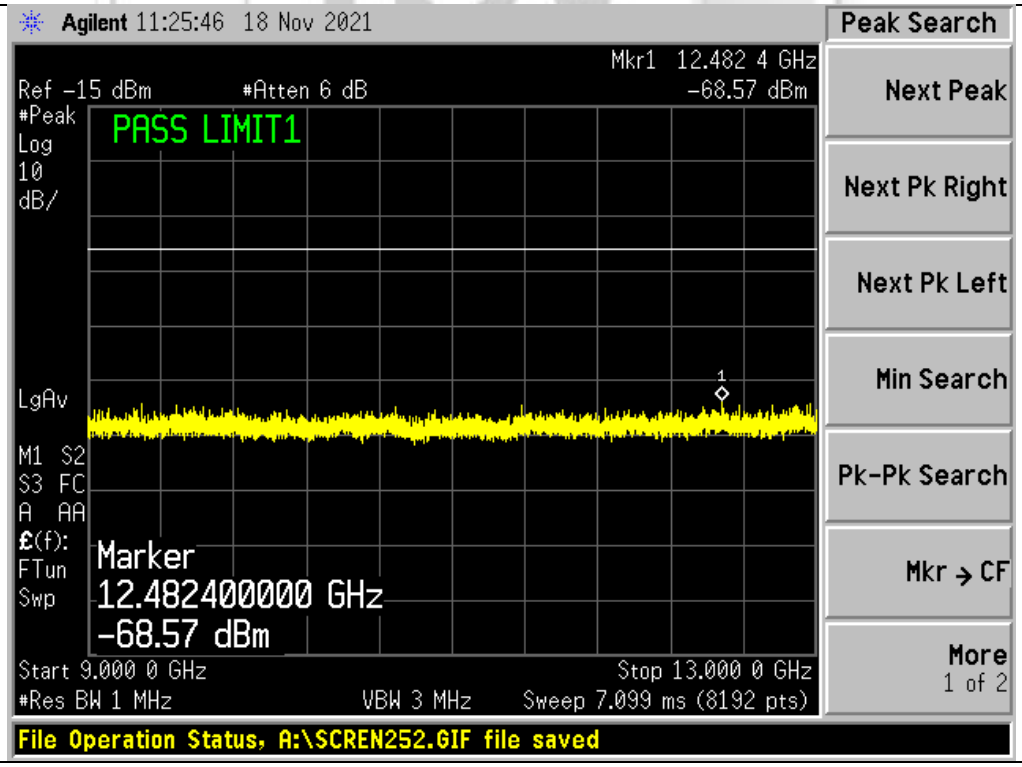
Plot 25 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



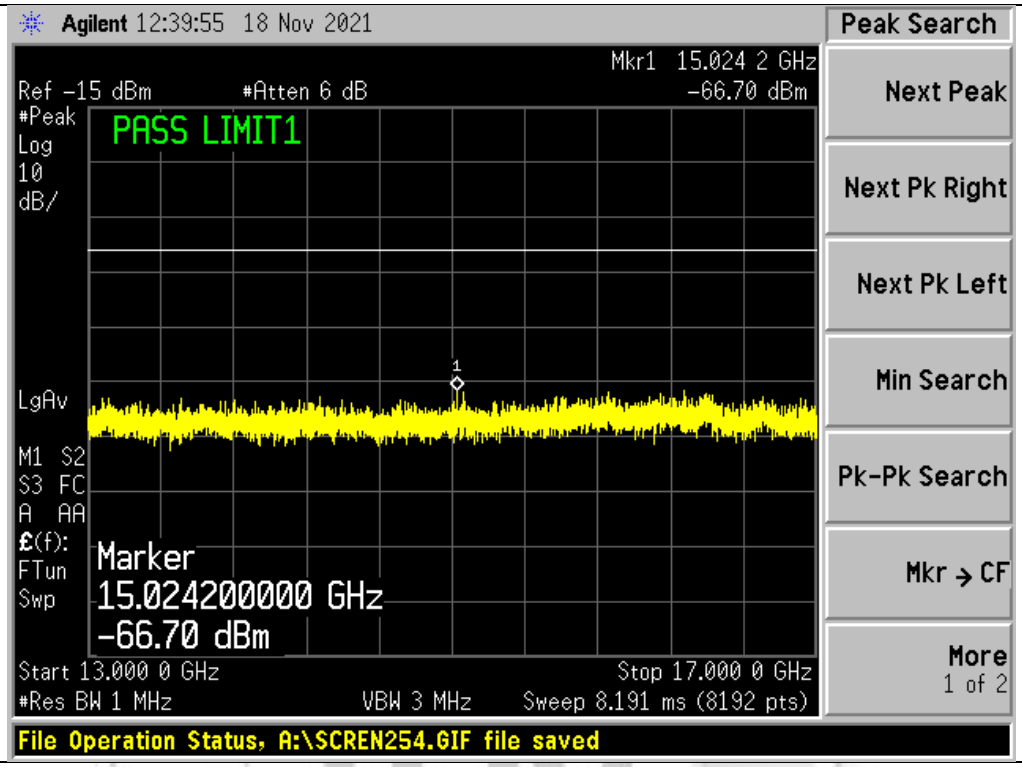
Plot 26 – Middle Channel



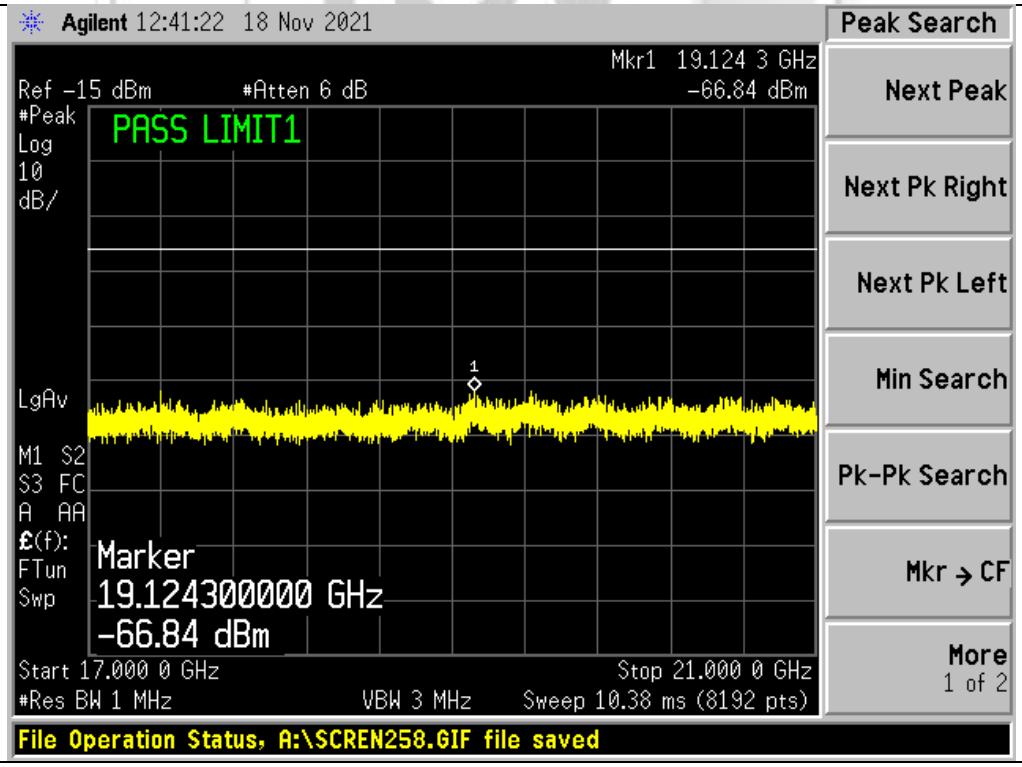
Plot 27 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



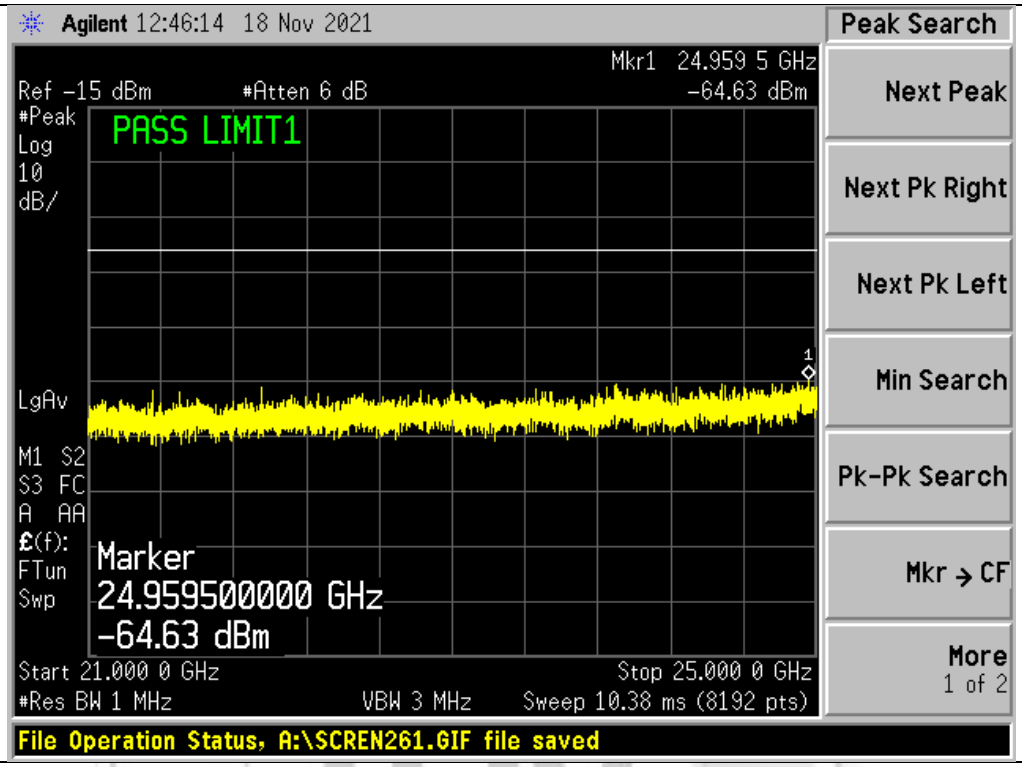
Plot 28 – Middle Channel



Plot 29 – Middle Channel

PSB Singapore

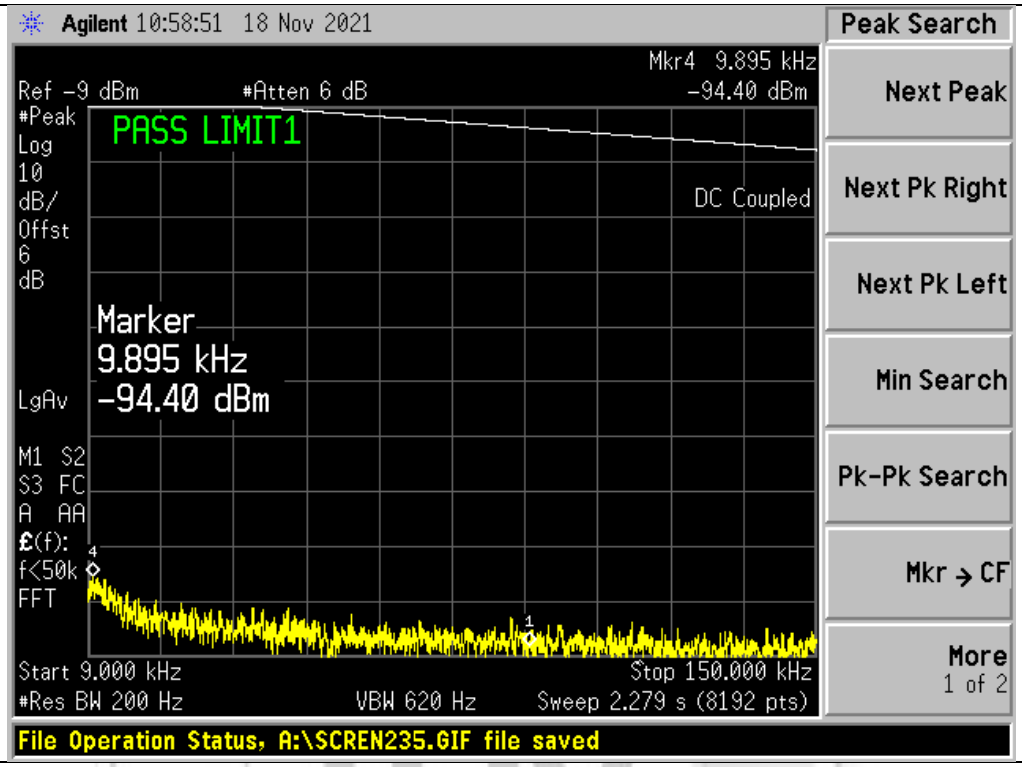
RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



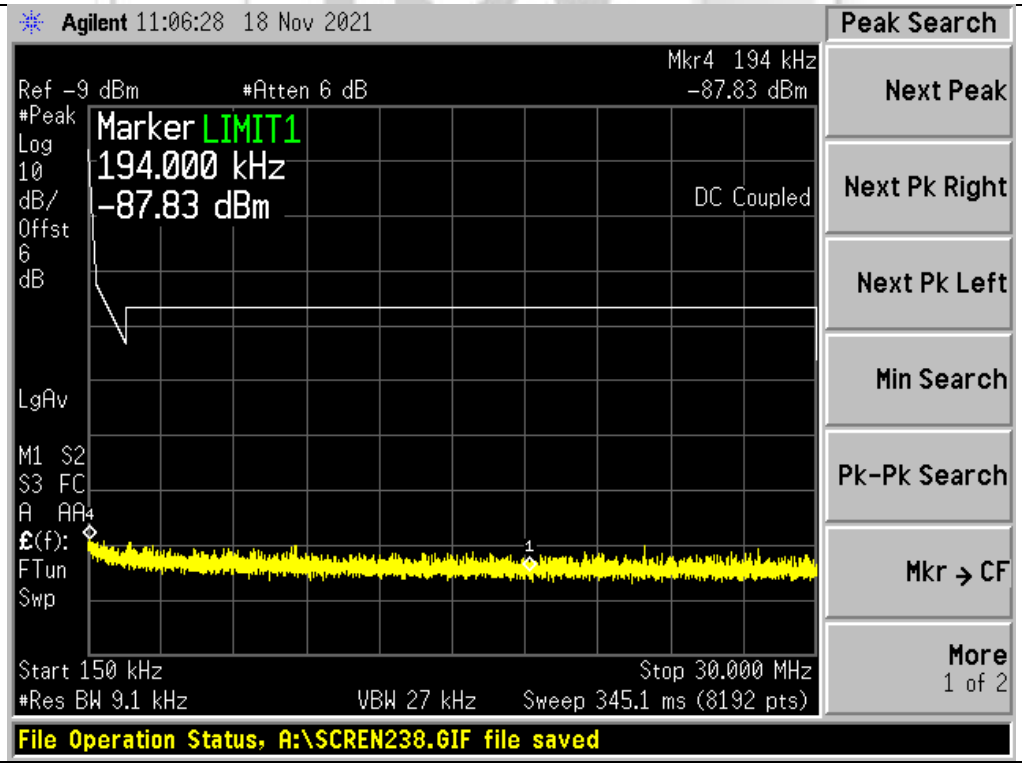
Plot 30 – Middle Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



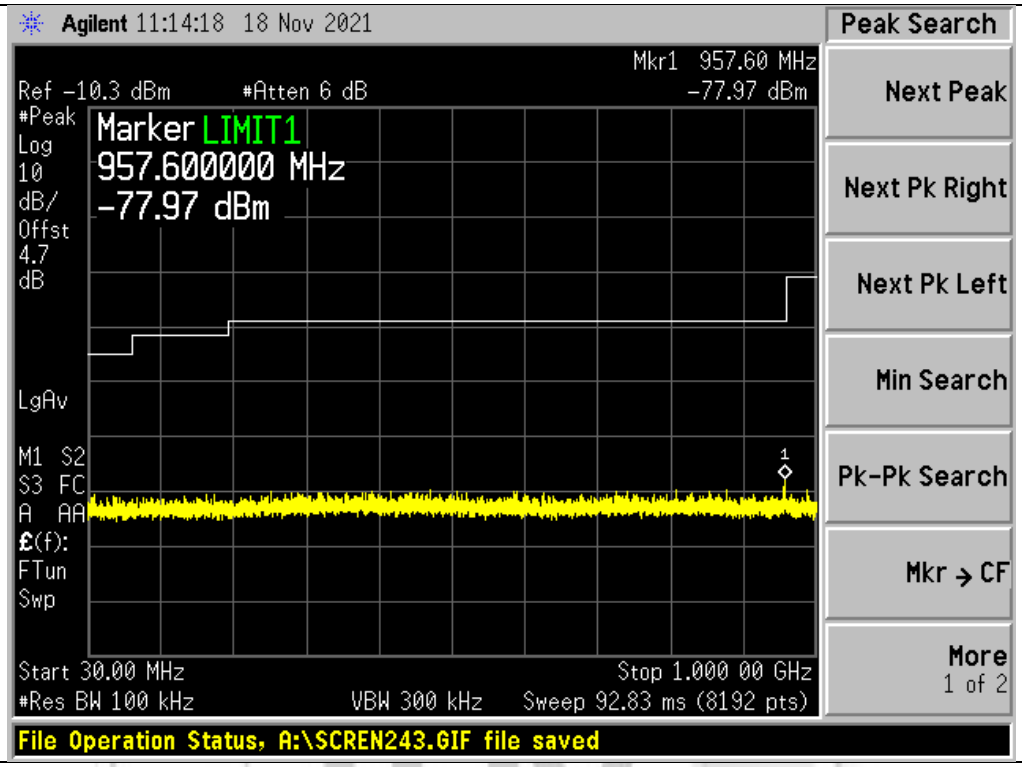
Plot 31 – Upper Channel



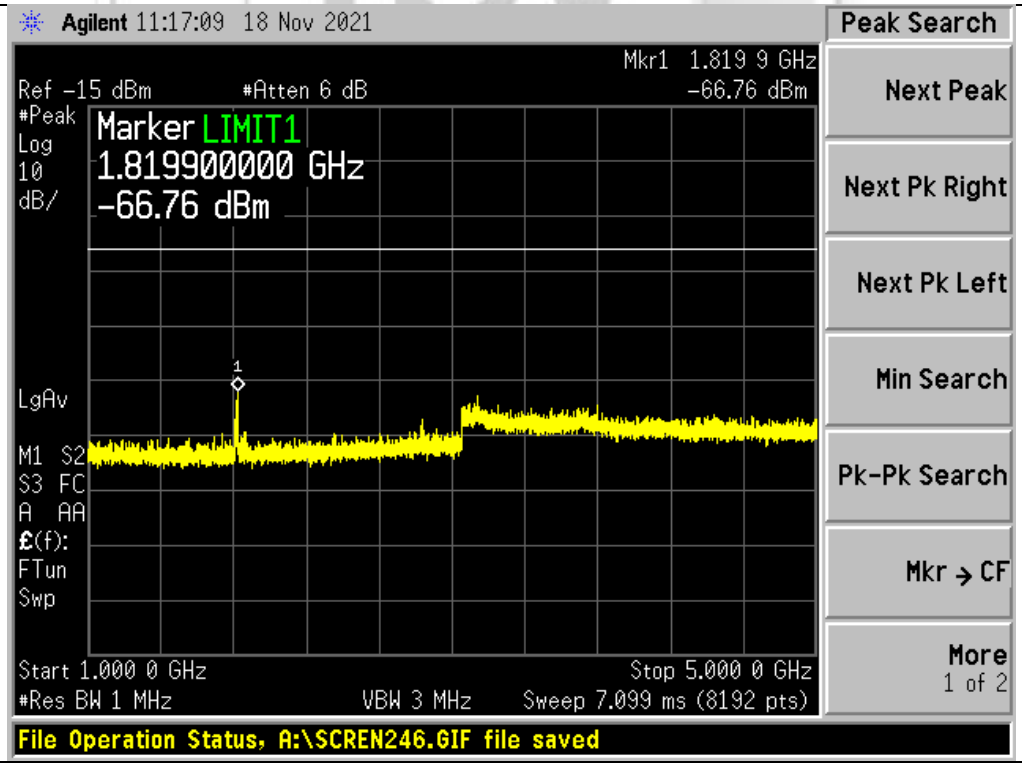
Plot 32 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



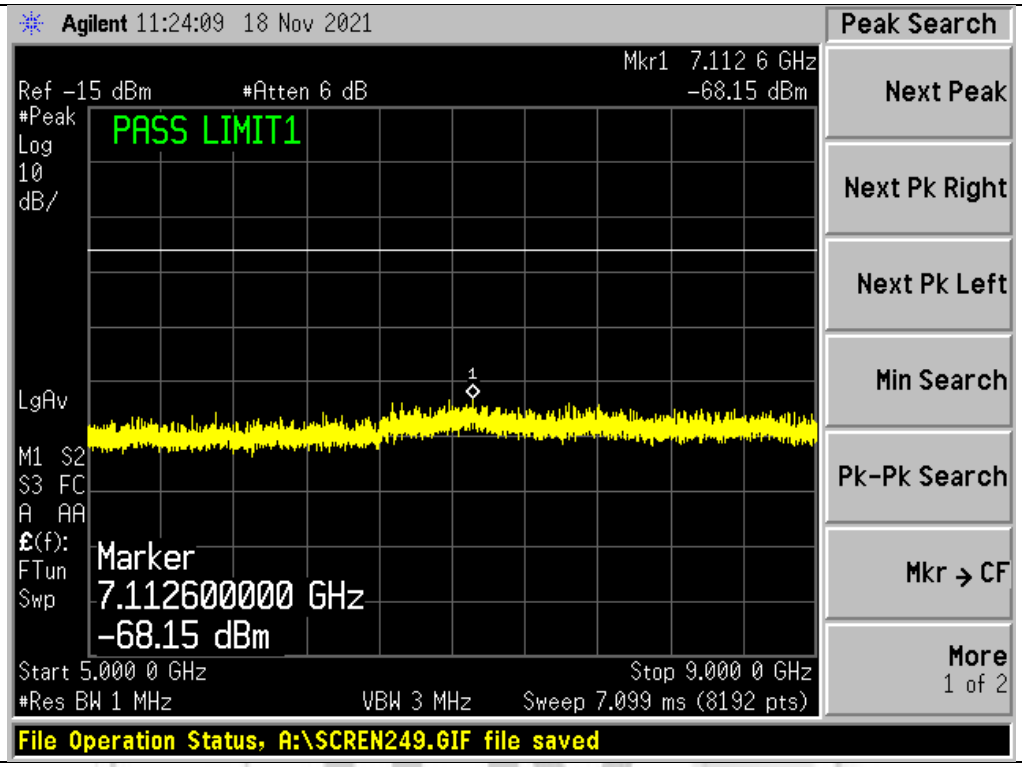
Plot 33 – Upper Channel



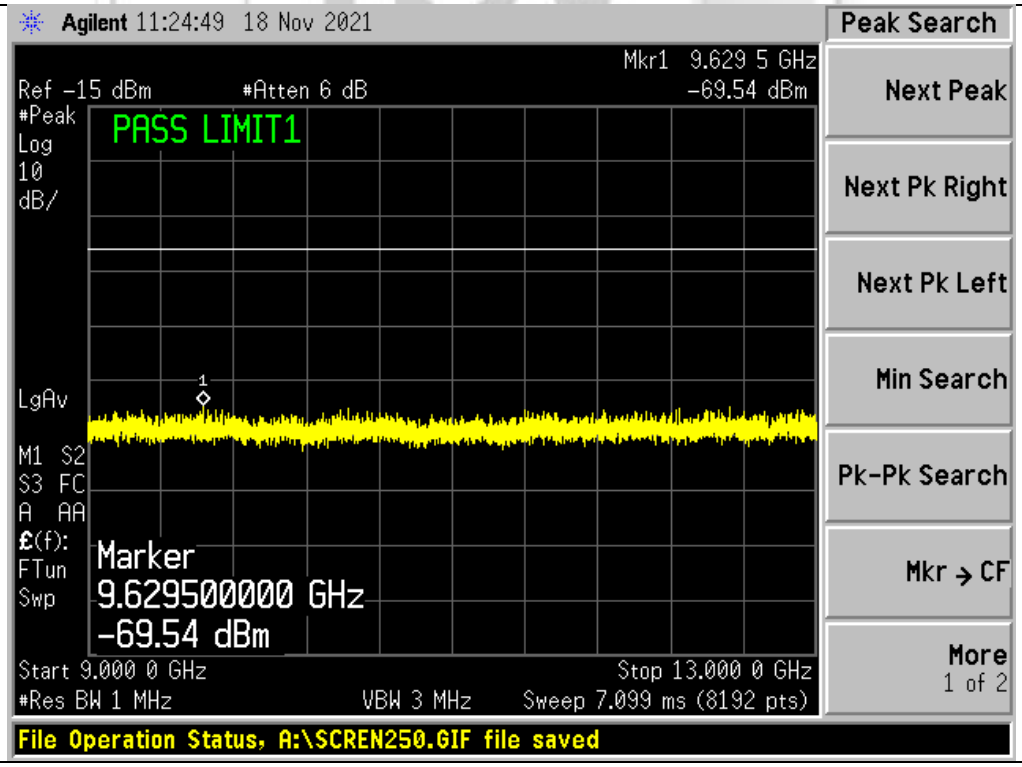
Plot 34 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



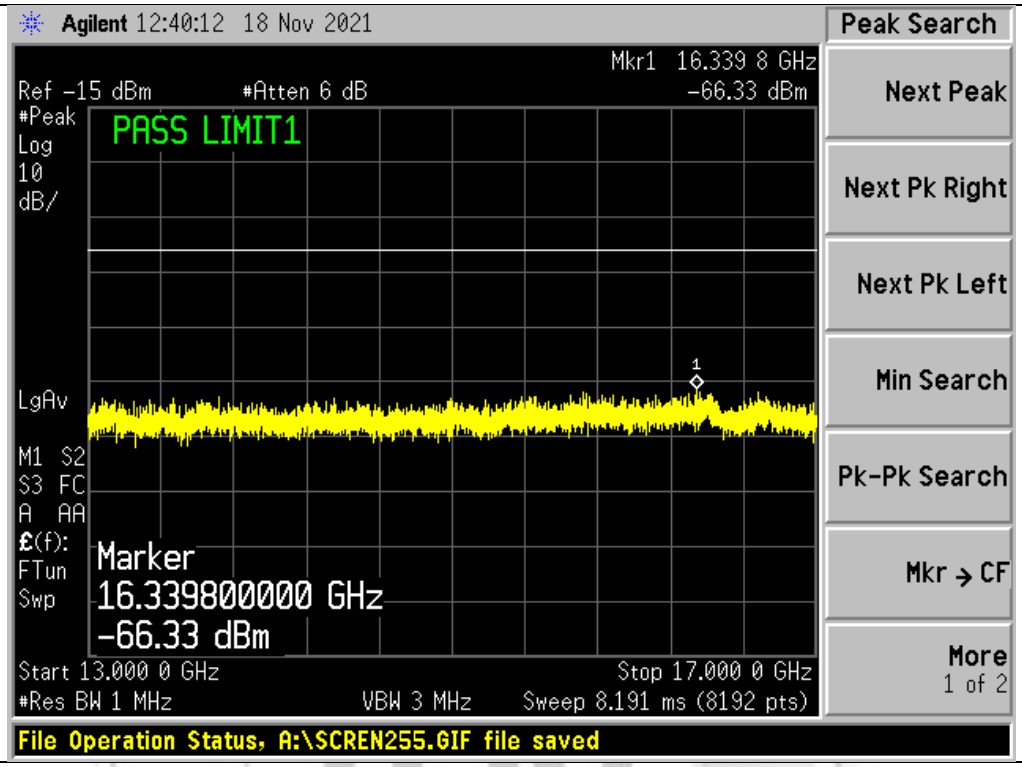
Plot 35 – Upper Channel



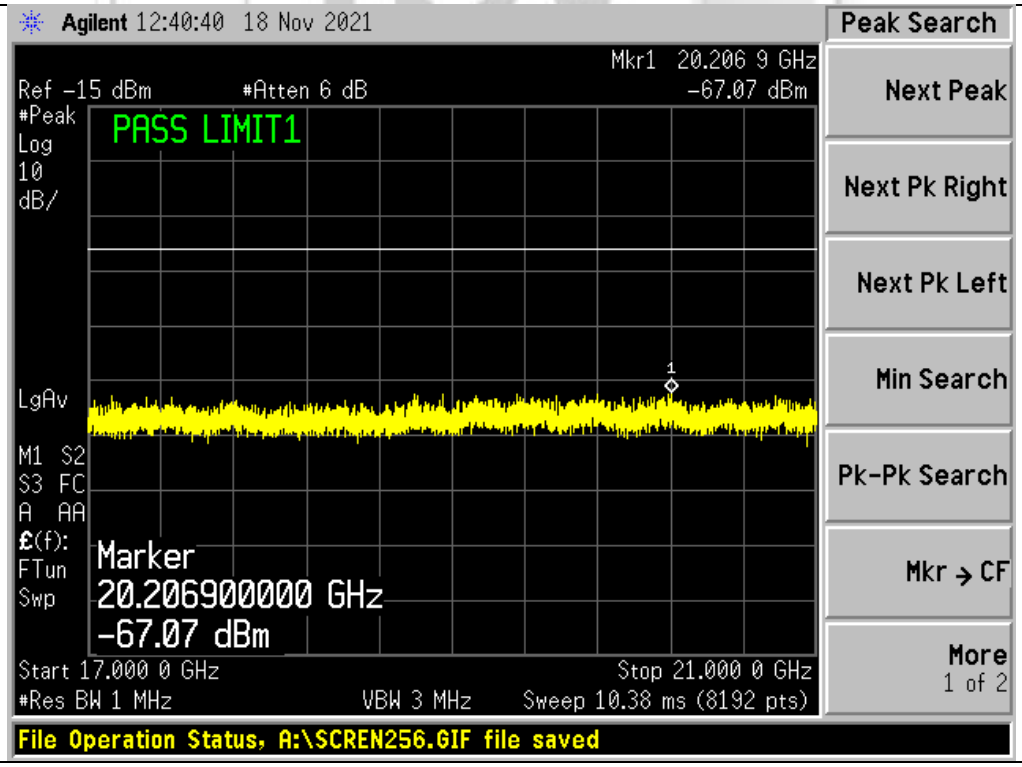
Plot 36 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



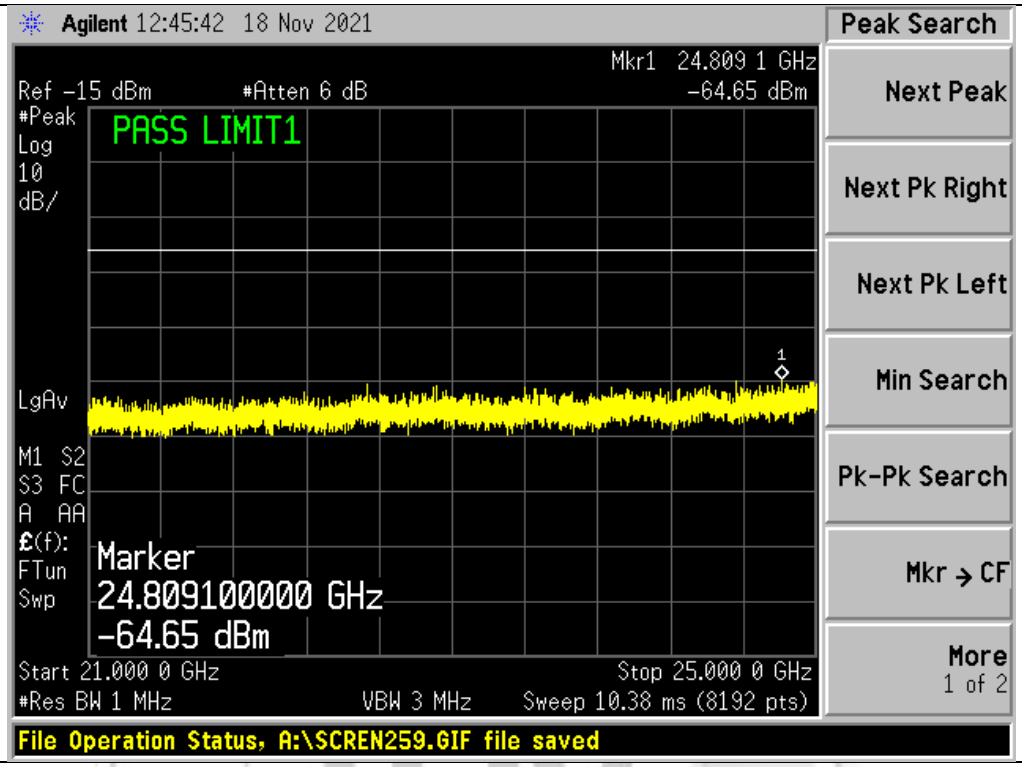
Plot 37 – Upper Channel



Plot 38 – Upper Channel

PSB Singapore

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 39 – Upper Channel

PSB Singapore

2.7 Band Edge Compliance (Conducted)

2.7.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

2.7.2 Test Setup

2.7.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.7.2.2 The power supply for the EUT was connected to a filtered mains.

2.7.2.3 The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.

2.7.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.

2.7.2.5 All other supporting equipment were powered separately from another filtered mains.

2.7.3 Test Method

2.7.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.

2.7.3.2 The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge (within 2MHz of the band edge).

2.7.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.7.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.7.3.5 The measurements were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

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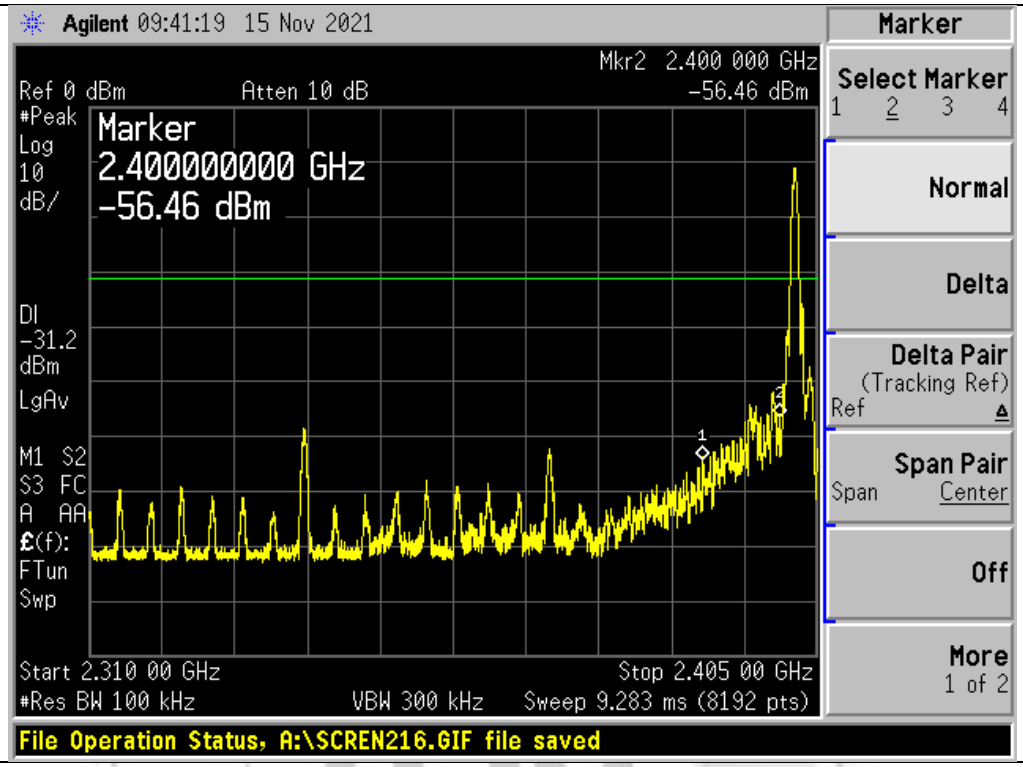
2.7.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	40 – 41	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	15 Nov 2021

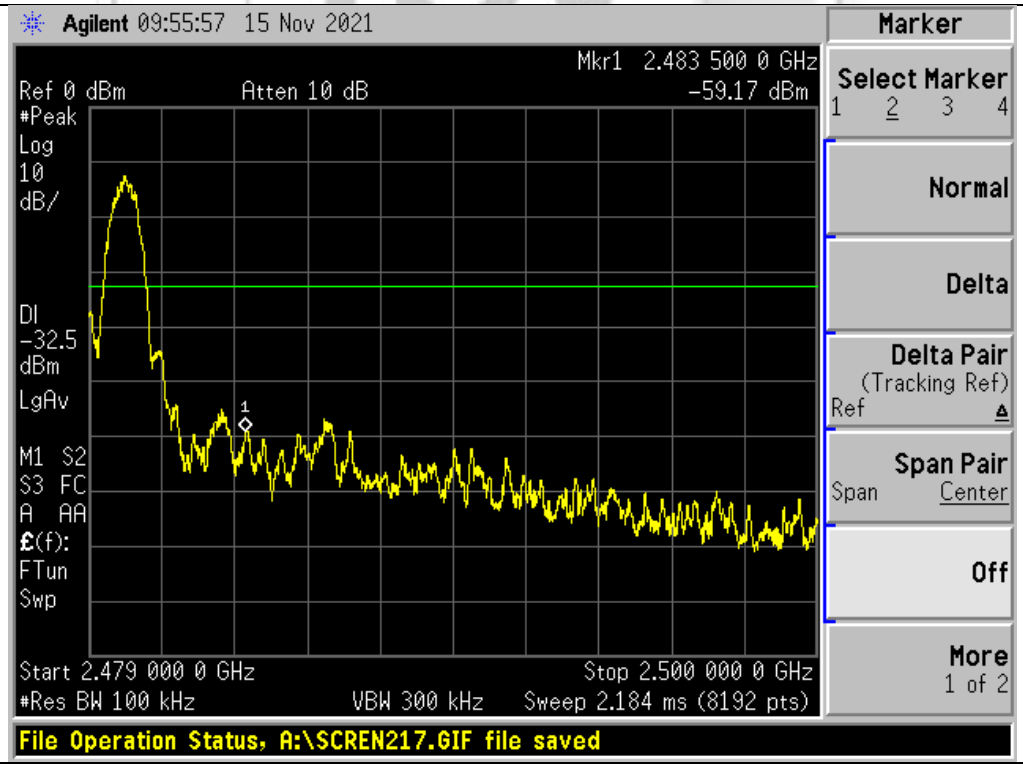
No significant signal was found and they were below the specified limit.

PSB Singapore

Band Edge Compliance (Conducted) Plots



Plot 40 – Lower Band Edge at 2.4000GHz



Plot 41 – Upper Band Edge at 2.4835GHz

PSB Singapore

2.8 Band Edge Compliance (Radiated)

2.8.1 Test Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands shall comply to the radiated emission limits specified in 15.209.

2.8.2 Test Setup

2.8.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.8.2.2 The power supply for the EUT was connected to a filtered mains.

2.8.2.3 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz to show compliance of spurious at band edges are at least 20dB below the carriers. For restricted band spurious at band edges, peak and average measurement plots were taken using the following setting:

a. Peak Plot:
RBW = 1MHz, VBW = 3RBW

b. Average Plot
RBW = 1MHz, VBW = 10Hz

2.8.2.4 All other supporting equipment were powered separately from another filtered mains.

2.8.3 Test Method

2.8.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.

2.8.3.2 The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.

2.8.3.3 The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.

2.8.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.8.3.5 The measurements were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

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2.8.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	42 – 47	Relative Humidity	57%
		Atmospheric Pressure	1010mbar
		Tested By	Mohamed Nazrulhizat
		Test Date	24 Nov 2021

No significant signal was found and they were below the specified limit.

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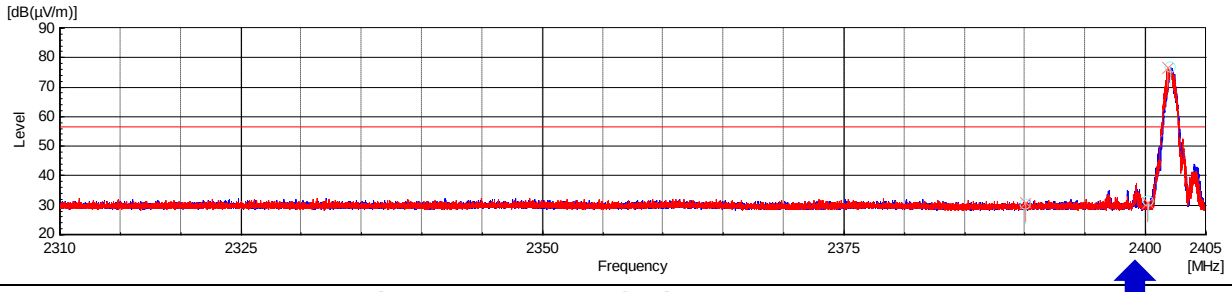
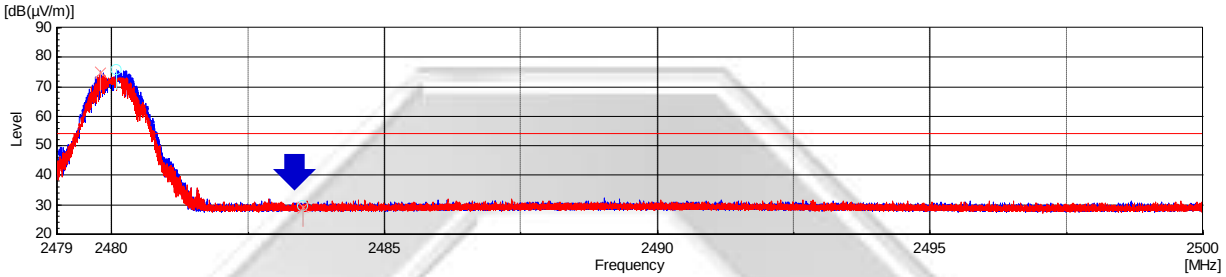
Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge)



Plot 42 – Lower Band Edge at 2.4000GHz



Plot 43 – Upper Band Edge at 2.4835GHz

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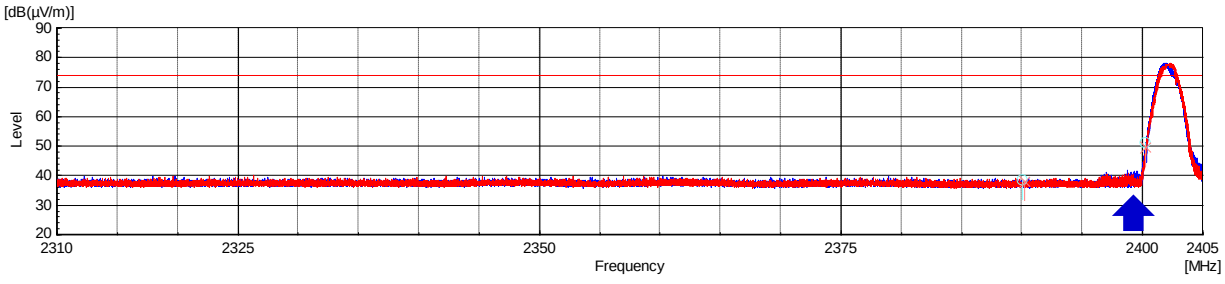
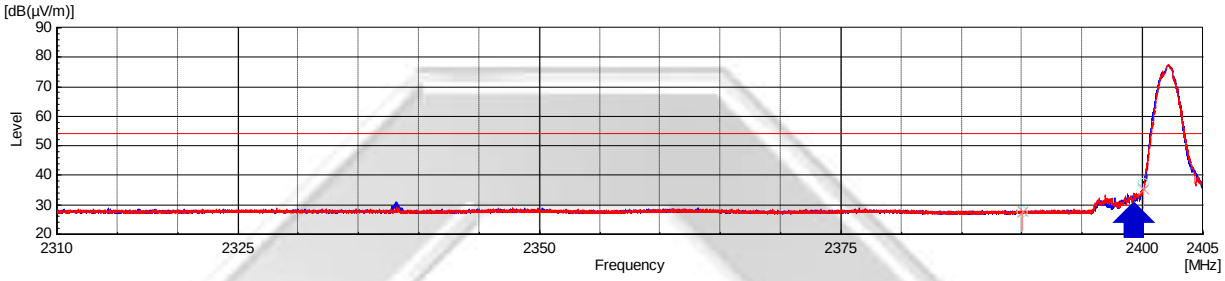
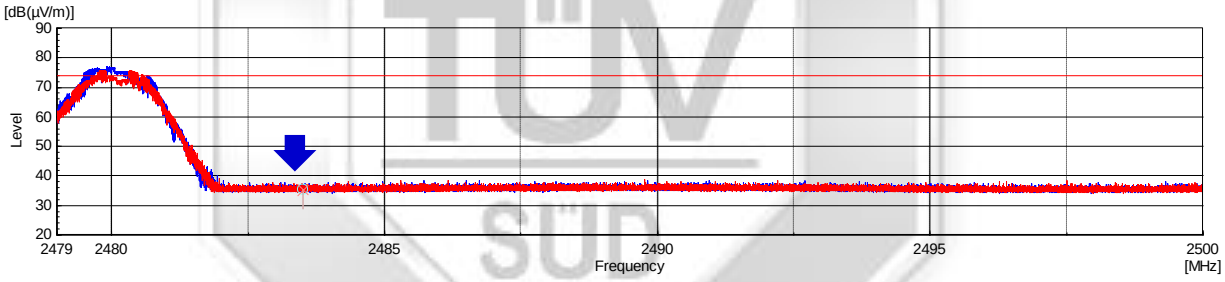
Band Edge Compliance (Radiated) Plots (Restricted Band)



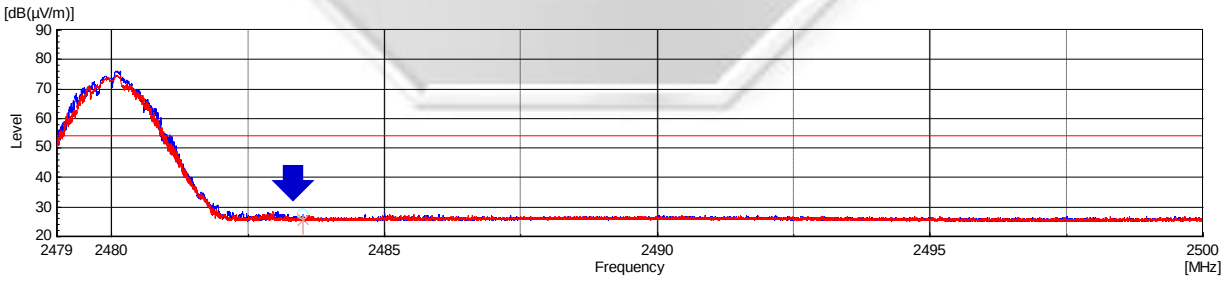
Plot 44 – Peak Plot at Lower Band Edge at 2.4000GHz



Plot 45 – Average Plot at Lower Band Edge at 2.4000GHz



Plot 46 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 47 – Average Plot at Upper Band Edge at 2.4835GHz

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2.9 Peak Power Spectral Density

2.9.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the peak power spectral density conducted from the intentional radiator (EUT) to the antenna shall not be greater than 8dBm (6.3mW) in any 3kHz band during any time interval of continuous transmission.

2.9.2 Test Setup

2.9.2.1 The EUT and supporting equipment were set up as shown in the setup photo.

2.9.2.2 The power supply for the EUT was connected to a filtered mains.

2.9.2.3 The RF antenna connector was connected to the spectrum via a low-loss coaxial cable.

2.9.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were set to the following:
RBW = 3kHz
VBW = 3RBW
Span = 1.5 times the channel bandwidth (6dB Bandwidth)
Sweep time = auto couple

2.9.2.5 All other supporting equipment were powered separately from another filtered mains.

2.9.3 Test Method

2.9.3.1 The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.

2.9.3.2 The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser.

2.9.3.3 The peak power density of the transmitting frequency was plotted and recorded.

2.9.3.4 The measurements were repeated if the EUT supports more than one modulation and data rate.

2.9.3.5 The measurement was repeated with the transmitting frequency was set to middle channel and upper channels respectively.

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2.9.4 Test Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	48 – 50	Relative Humidity	60%
		Atmospheric Pressure	1018mbar
		Tested By	Chelmin Li
		Test Date	15 Nov 2021

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW) *See Note 1	Limit (mW)
Lower	2.402	0.004	6.3
Middle	2.426	0.004	6.3
Upper	2.480	0.002	6.3

Notes

1.	Only the highest measured peak power spectral density was reported. Refer to plots for all measured peak power spectral density.

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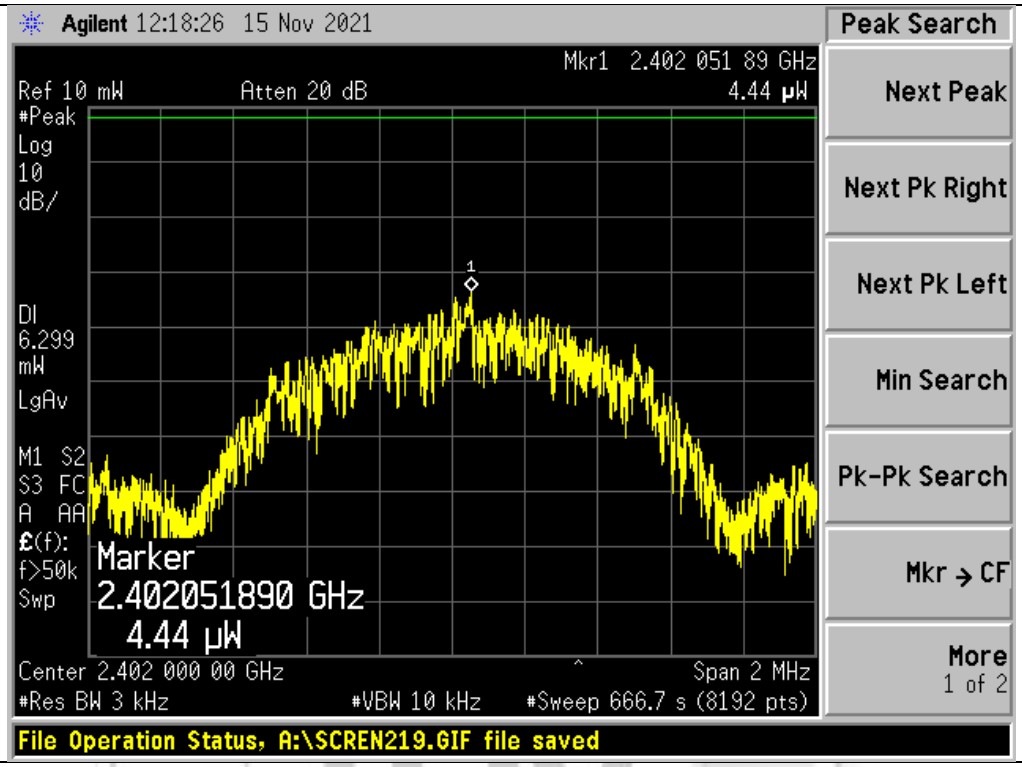
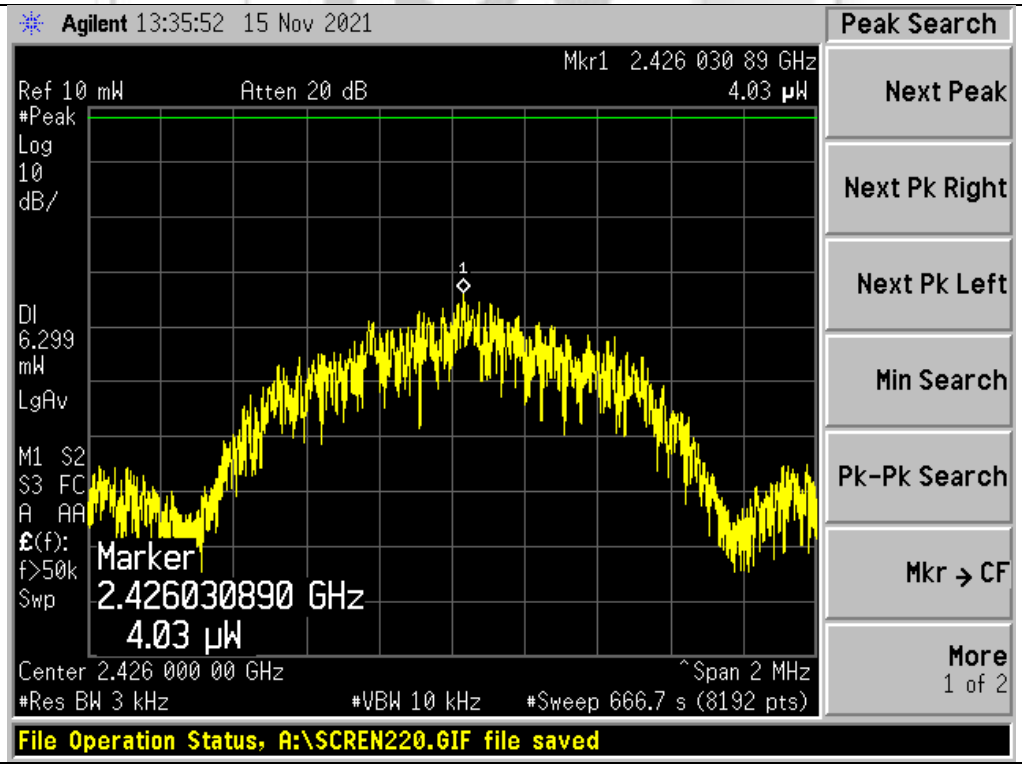
Peak Power Spectral Density Plots



Plot 48 – Lower Channel



Plot 49 – Middle Channel

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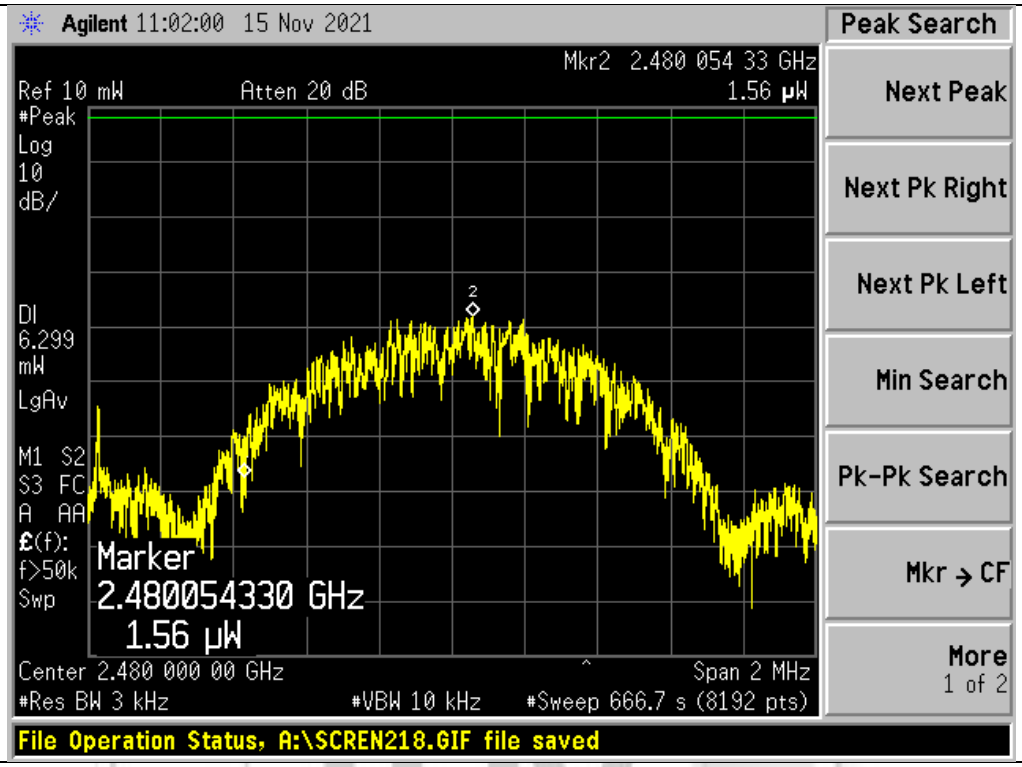
Peak Power Spectral Density Plots



Plot 50 – Upper Channel

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4 Test Equipment

Instrument	Model	S/No	Cal Due Date
Conducted Emissions			
Rohde & Schwarz EMI Test Receiver (9kHz - 3GHz)	ESCI	100477	19 Feb 2022
AFJ LISN	AFJ LT32C/10	32031929295	27 Aug 2022
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)			
R&S EMI Test Receiver (9kHz - 26.5GHz)	ESR26	101714	11 May 2022
Com-Power Preamplifier (1MHz - 1GHz)	PAM-103	441162	01 Feb 2022
Schaffner Bilog Antenna (30MHz - 2GHz)	CBL6112B	2593	18 Mar 2022
HP Preamplifier (1GHz - 26.5GHz)	8449B	3008A1078	01 Jun 2022
TDK-RF Horn Antenna (1GHz - 18GHz)	HRN-0118	130256	18 Apr 2022
ETS Horn Antenna (18GHz - 40GHz)	3116	0004-2474	09 Oct 2022
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2022
Spectrum Bandwidth (6dB Bandwidth Measurement)			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022
Maximum Peak Power			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022
RF Conducted Spurious Emissions (Non-Restricted Bands)			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022
RF Conducted Spurious Emissions (Restricted Bands)			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2022
Band Edge Compliance (Conducted)			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022

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Instrument	Model	S/No	Cal Due Date
Band Edge Compliance (Radiated)			
R&S EMI Test Receiver (9kHz - 26.5GHz)	ESR26	101714	11 May 2022
HP Preamplifier (1GHz - 26.5GHz)	8449B	3008A1078	01 Jun 2022
TDK-RF Horn Antenna (1GHz - 18GHz)	HRN-0118	130256	18 Apr 2022
Peak Power Spectral Density			
Agilent Spectrum Analyzer	E4440A	MY45304764	13 Oct 2022

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5 Measurement Uncertainty

All measured results are traceable to the SI units. The uncertainty of the measurement is at a confidence level of approximately 95%, with a coverage factor of 2.

Test Name	**Measurement Uncertainty**
Conducted Emissions at Mains Terminals	1.0dB (9kHz to 30MHz)
Radiated Emissions	10m Anechoic Chamber (Lab 4) 2.6dB (9kHz to 30MHz @ 10m) 3.5dB (30MHz to 1GHz @ 10m) 4.0dB (30MHz to 1GHz @ 3m) 4.8dB (>1GHz to 40GHz @ 3m) 3m RF Chamber (Lab7) 4.0dB (30MHz to 1GHz @ 3m) 4.5dB (>1GHz to 40GHz @ 3m)
Maximum Permissible Exposure	15% (0.1MHz – 18GHz)

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6 Annex A – FCC Label and Position

Labelling requirements per Section 2.925 & 15.19

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.

Physical Location of FCC Label on EUT

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Effective 26 January 2021

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End of the Test Report