Report on the Radio Testing of:

Bluetooth Module

Model(s): RSNE041B1

In accordance with
47 CFR FCC Part 15C

PSB Singapore

Add value.
Inspire trust.

Prepared for:
Panasonic AVC Networks Singapore
202 Bedok South Avenue 1
Singapore 469332

COMMERCIAL-IN-CONFIDENCE

Document Number: 7191189243-EEC18/04 | Issue: 01

RESPONSIBLE FOR	NAME	DATE	SIGNATURE
Project Management	Foo Kai Maun	03 Sep 2018	
Authorised Signatory	Quek Keng Huat	31 Aug 2018	

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

LA-2007-0380-A
LA-2007-0381-F
LA-2007-0382-B
LA-2007-0383-G
LA-2007-0384-G
LA-2007-0385-E
LA-2007-0386-C
LA-2010-0464-D

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.
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: enquiries@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118221

PSB Singapore

Contents

PSB Singapore

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	03 Sep 2018

PSB Singapore

1.2 Introduction

Applicant	:	Panasonic AVC Networks Singapore 202, Bedok South Avenue 1, Singapore 469332
Manufacturer	:	Panasonic Corporation 1006, Oaza Kadoma, Kadoma-City, Osaka 571 8501, Japan
Factory	:	Panasonic AVC Networks Johor Malaysia Sdn Bhd IE, PLO 460, Jalan Bandar, 81700 Pasir Gudang, Johor, Malaysia
Model Number(s)	:	RSNE041B1
Serial Number(s)	:	Nil
Number of Samples Tested	:	1
Test Sample(s) Condition	:	Good
Quotation Reference	:	5111822
Test Specification/Issue/Date	:	FCC 47 CFR Part 15C
Test Sample(s) Received Date	:	12 Jul 2018
Start of Test	:	12 Jul 2018
Finish of Test	:	15 Aug 2018

PSB Singapore

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	Not Applicable *See Note 4	ANSI C63.4: 2014 ANSI C63.10: 2013
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)	Pass	ANSI C63.4: 2014 ANSI C63.10: 2013
15.247(a)(1)	Carrier Frequency Separation	Pass	ANSI C63.10: 2013
	Spectrum Bandwidth (20dB Bandwidth Measurement)		
15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass	ANSI C63.10: 2013
	Average Frequency Dwell Time		
15.247(b)(1)	Maximum Peak Power	Pass	ANSI C63.10: 2013
15.247(d)	RF Conducted Spurious Emissions	Pass	ANSI C63.10: 2013
15.247(d)	Band Edge Compliance (Conducted)	Pass	ANSI C63.10: 2013
15.247(d)	Band Edge Compliance (Radiated)	Pass	ANSI C63.10: 2013
15.247(e)	Peak Power Spectral Density	Pass	ANSI C63.10: 2013
15.35(c)	Duty Cycle Factor Computation	Not Applicable *See Note 5	ANSI C63.10: 2013
2.1091	Maximum Permissible Exposure	Pass	

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 3.98dBm.

4. The Equipment Under Test (EUT) is a DC operated device and contains no provision for public utility connections.

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

PSB Singapore

1.4 Product Information

1.4.1 Technical Description

Description	:	The Equipment Under Test(s) (EUT(s)) is a **Bluetooth Module.**
Microprocessor	:	CSR8811
Operating Frequency	:	2.402GHz – 2.480GHz
Clock / Oscillator Frequency	:	26MHz
Modulation	:	GFSK, Gaussian Frequency Shift Keying (π/4) DQPSK, Differential Quadrature Phase Shift Keying 8DPSK, Differential Phase Shift Keying
Antenna Gain	:	2.0 dBi
Port / Connectors	:	Nil
Rated Power	:	3.3Vdc 500mA
Accessories	:	Nil

1.4.2 Test Configuration and Modes of Operation

Mode(s)	**Description**
a. Maximum RF power transmission with frequency hopping off b. Maximum RF power transmission with frequency hopping on	The EUT was exercised by operating in the mode “a”, i.e transmitting at lower, middle and upper channels as shown below one at a time. For Band Edge Compliance, only lower and upper channels were evaluated. Transmit Channel / Frequency (GHz) Channel 0 (Lower Channel) – 2.402 Channel 39 (Middle Channel) – 2.441 Channel 78 (upper Channel) – 2.480 The EUT was exercised by operating in maximum continuous transmission with frequency hopping on (mode ‘b”).

PSB Singapore

1.5 Test Facilities Registrations

Requirements	Registration Numbers
FCC	994109 (Test Firm Registration Number) SG0002 (Designation Number)
ISED	Science Park 2932I-1 (3m and 10m Semi-Anechoic Chamber) International Business Park 2932N-1 (10m Semi-Anechoic Chamber)
VCCI	Science Park R-1335 (10m ANC), G-29 (10m ANC) C-2306 (C.E @ Lab 3) T-1471 (Telecom Ports @ Lab 3) International Business Park R-3324 (10m ANC), G-203 (10mANC) C-4933 (C.E @ CEIBP) T-2403 (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/0029/2018

PSB Singapore

1.6 Supporting Equipment

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Fujitsu LifeBook	M/N: S6410 S/N: R7Y00054 FCC ID: DoC	Nil
Fujitsu AC Adapter	M/N: CP293662-01 S/N: 06919569A FCC ID: DoC	1.80m unshielded power cable
CSR (Cambridge Silicon Radio) Development Board	M/N: CNS10020V3A S/N: 416499 FCC ID: Nil	2.00m unshielded USB cable

PSB Singapore

2 Test Details

2.1 Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)

2.1.1 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									

PSB Singapore

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

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

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 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.

2.1.3.3 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 polarisation (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

2.1.3.4 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.

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

2.1.3.6 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

PSB Singapore

2.2.5 Test Results

Test Input Power	3Vdc	Temperature	24ºC
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	60%
Mode	Frequency Hopping Off	Atmospheric Pressure	1030mbar
		Tested By	Dylan Lin
		Test Date	17 Jul 2018

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Note 4 & 5

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
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--

Spurious Emissions ranging from 9kHz – 30MHz *See Note 4 & 5

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--

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
67.7610	31.5	40.0	8.5	200	169	V	78
192.0140	32.5	43.5	11.0	101	118	H	78
500.0190	33.8	46.0	12.2	101	98	V	78
630.4670	33.3	46.0	12.7	200	61	V	78
778.2790	32.1	46.0	13.9	300	350	H	78
842.2450	31.2	46.0	14.8	399	63	V	78

PSB Singapore

Spurious Emissions above 1GHz – 25GHz

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
3.5999	46.2	74.0	27.8	44.6	54.0	9.4	300	10	V	0
4.5067	46.3	74.0	27.7	39.0	54.0	15.0	101	4	V	0
4.8037	57.5	74.0	16.5	51.2	54.0	2.8	312	197	H	0
6.0029	46.5	74.0	27.5	38.9	54.0	15.1	200	75	V	0
7.2051	46.5	74.0	27.5	40.2	54.0	13.8	101	171	H	0
17.7439	55.3	74.0	18.7	44.7	54.0	9.3	200	117	H	0

Spurious Emissions above 1GHz – 25GHz

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
1.2479	48.7	74.0	25.3	33.0	54.0	21.0	101	100	H	39
1.9989	49.2	74.0	24.8	31.3	54.0	22.7	101	145	V	39
2.1618	49.2	74.0	24.8	33.0	54.0	21.0	300	227	V	39
2.9977	49.4	74.0	24.6	37.0	54.0	17.0	101	34	V	39
3.4582	51.9	74.0	22.1	36.3	54.0	17.7	101	87	V	39
8.0340	49.1	74.0	24.9	35.2	54.0	18.8	399	16	H	39

Spurious Emissions above 1GHz – 25GHz

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
3.5999	47.2	74.0	26.8	44.8	54.0	9.2	300	330	V	78
4.5067	57.0	74.0	17.0	39.1	54.0	14.9	101	9	V	78
4.9598	57.0	74.0	17.0	51.4	54.0	2.6	313	193	H	78
7.4420	51.0	74.0	23.0	47.4	54.0	6.6	300	167	H	78
17.7439	55.5	74.0	18.5	44.6	54.0	9.4	200	203	V	78
17.8350	55.8	74.0	18.2	44.6	54.0	9.4	399	99	H	78

PSB Singapore

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 – 30MHz RBW: 9kHz VBW: 30kHz 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
4.	"--" indicates no emissions were found and shows compliance to the limits.
5.	The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
6.	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.
7.	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.
8	EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings: 30MHz - 1GHz RBW: 120kHz VBW: 1MHz >1GHz RBW: 1MHz VBW: 3MHz
9.	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.
10.	The channel in the table refers to the transmit channel of the EUT.

PSB Singapore

2.2 Carrier Frequency Separation

2.2.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the adjacent carrier frequencies must be separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, the EUT may have hopping channel carrier frequencies that are separated by 25kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125mW (21dBm).

2.2.2 Test Setup

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

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

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

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

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

2.2.3 Test Method

2.2.3.1 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 frequency hopping sequence on.

2.2.3.2 The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.405Hz.

2.2.3.3 The spectrum analyser was set to max hold to capture the two adjacent transmitting frequencies within the span. The signal capturing was continuous until no further signals were detected.

2.2.3.4 The carrier frequency separation of the two adjacent transmitting / operating frequency was measured by finding the carrier frequency difference between the two adjacent channels.

2.2.3.5 The measurements were repeated with the following start and stop frequencies settings:
a. 2.438GHz to 2.443GHz
b. 2.478GHz to 2.4835GHz

PSB Singapore

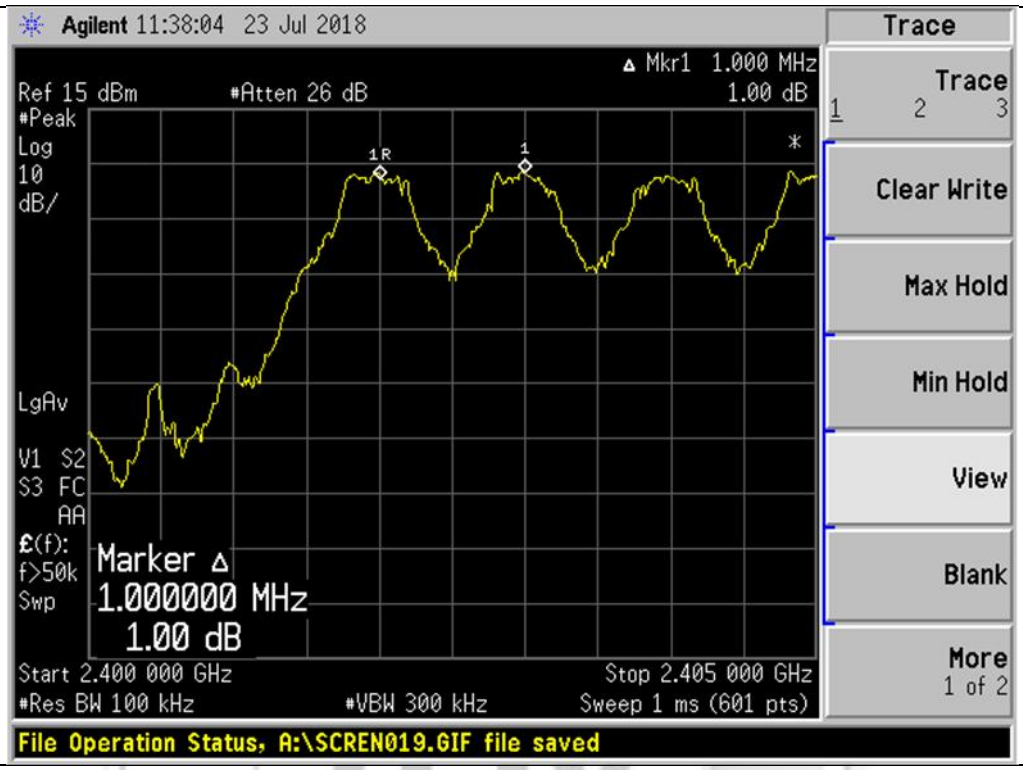
2.2.4 Test Results

Test Input Power	3.3Vdc	Temperature	25°C
Attached Plots	1 – 4	Relative Humidity	59%
Mode	Frequency Hopping On	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	23 Jul 2018

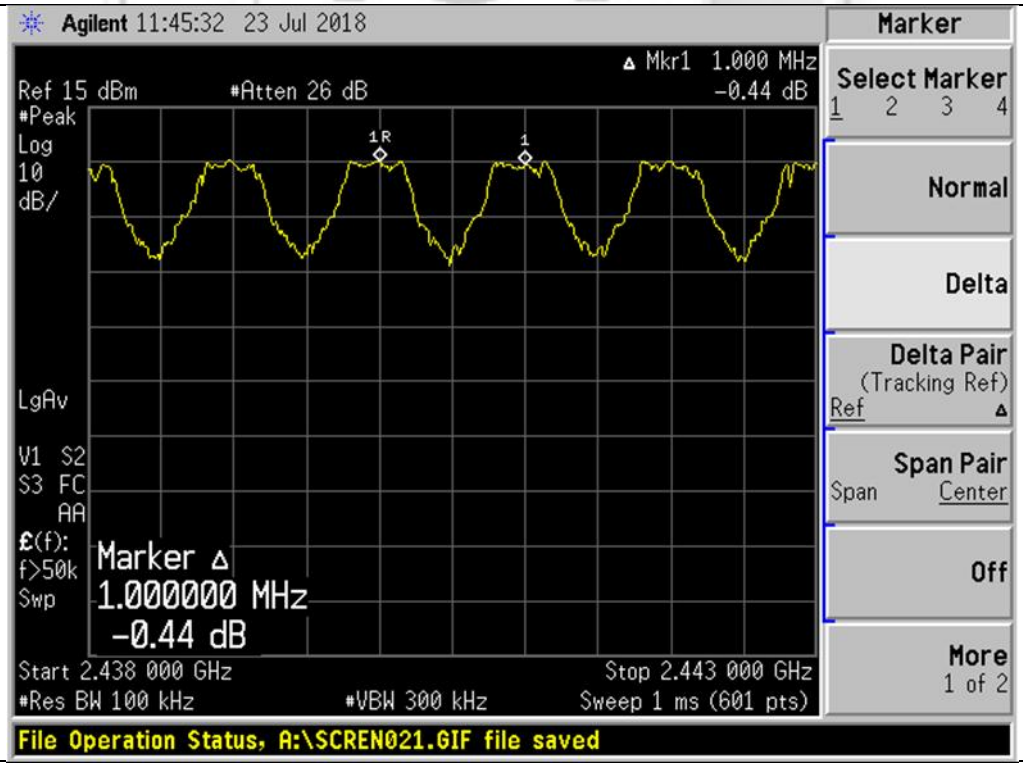
Adjacent Channels	Channel Separation (MHz)
0 and 1 (2.402GHz and 2.403GHz)	1.000
38 and 39 (2.440GHz and 2.441GHz)	1.000
39 and 40 (2.441GHz and 2.442GHz)	1.000
77 and 78 (2.479GHz and 2.480GHz)	1.008

PSB Singapore

Carrier Frequency Separation Plots



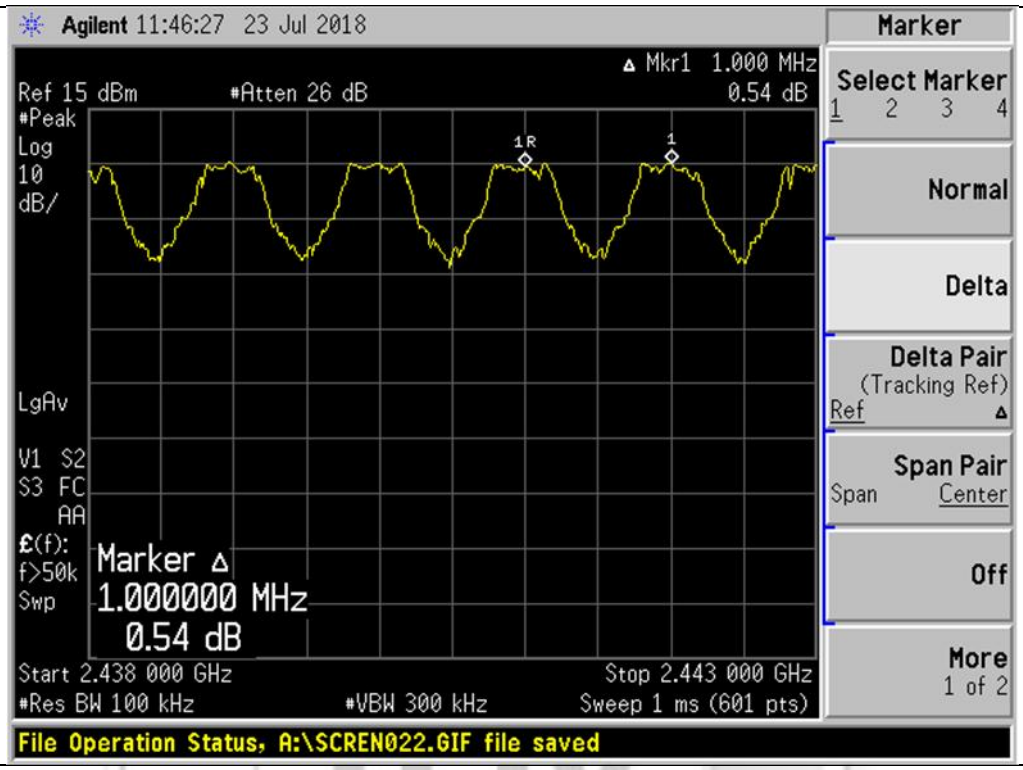
Plot 1 - Channels 0 *(lower ch)* and 1 *(ch after lower ch)* Separation



Plot 2 – Channels 38 *(preceding mid ch)* and 39 *(mid ch)* Separation

PSB Singapore

Carrier Frequency Separation Plots



Plot 3 - Channels 39 *(mid ch)* and 40 *(ch after mid ch)* Separation

Plot 4 - Channels 77 *(preceding upper ch)* and 78 *(upper ch)* Separation

PSB Singapore

2.3 Spectrum Bandwidth (20dB Bandwidth Measurement)

2.3.1 Test Limits

The EUT shows compliance to the requirements of this section, which states that the 20dB bandwidth of the hopping channel shall be the channel frequency separation by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

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 10kHz and 30kHz.

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

2.3.3 Test Method

2.3.3.1 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, non-hopping with transmitting frequency at lower channel.

2.3.3.2 The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span was set in between two to five times of the captured 20dB 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 20dB 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 20dB 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 with the transmitting frequency was set to middle channel and upper channel respectively.

PSB Singapore

2.3.4 Test Results

Test Input Power	3.3Vdc	Temperature	23ºC
Attached Plots	5 – 13	Relative Humidity	60%
Mode	Frequency Hopping Off	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	19 Jul 2018

GFSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
Lower	2.402	0.916
Middle	2.441	0.932
Upper	2.480	0.917

(π/4) DQPSK

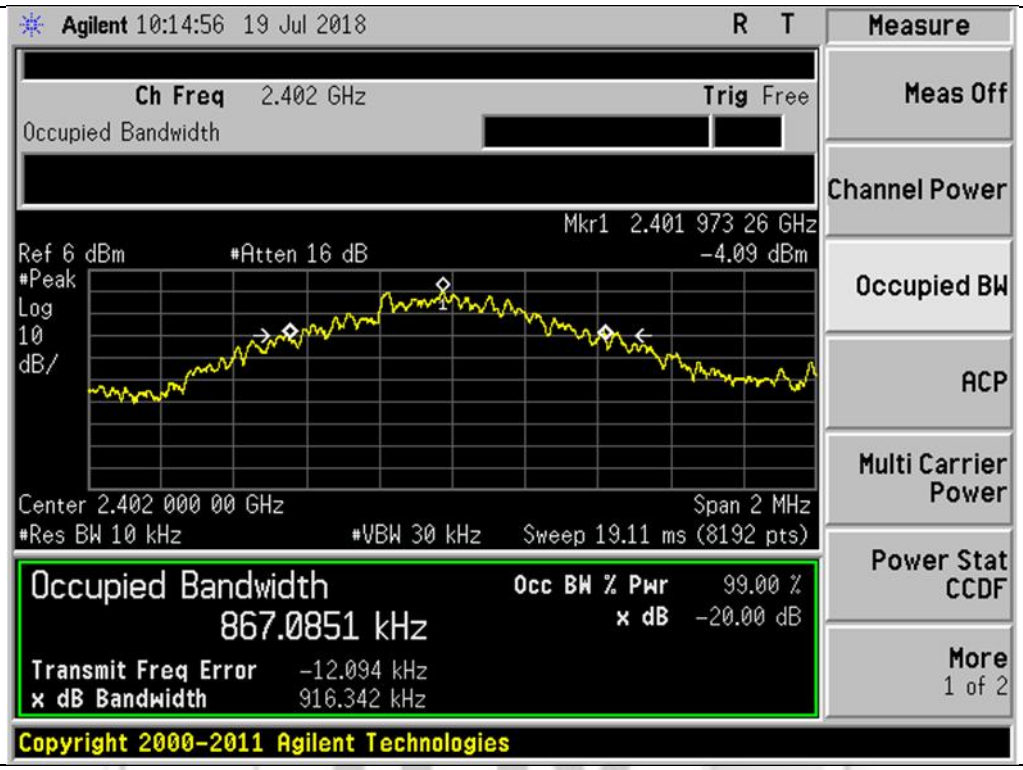
Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
Lower	2.402	1.316
Middle	2.441	1.284
Upper	2.480	1.284

8DPSK

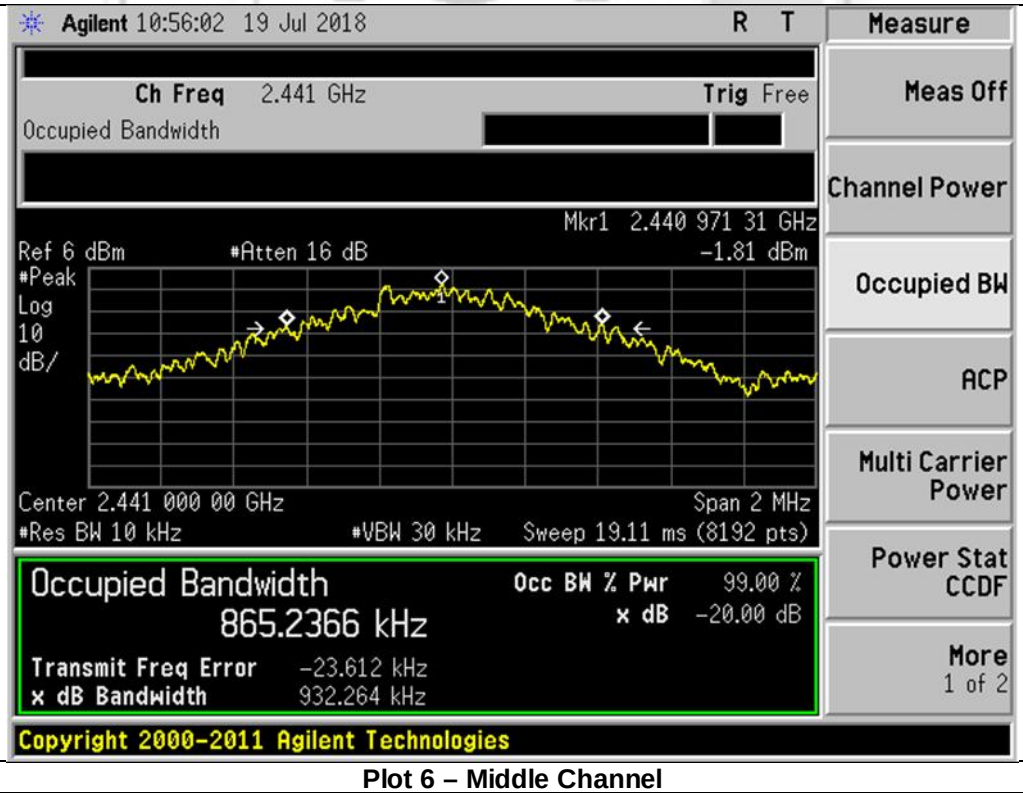
Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
Lower	2.402	1.263
Middle	2.441	1.245
Upper	2.480	1.235

PSB Singapore

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK



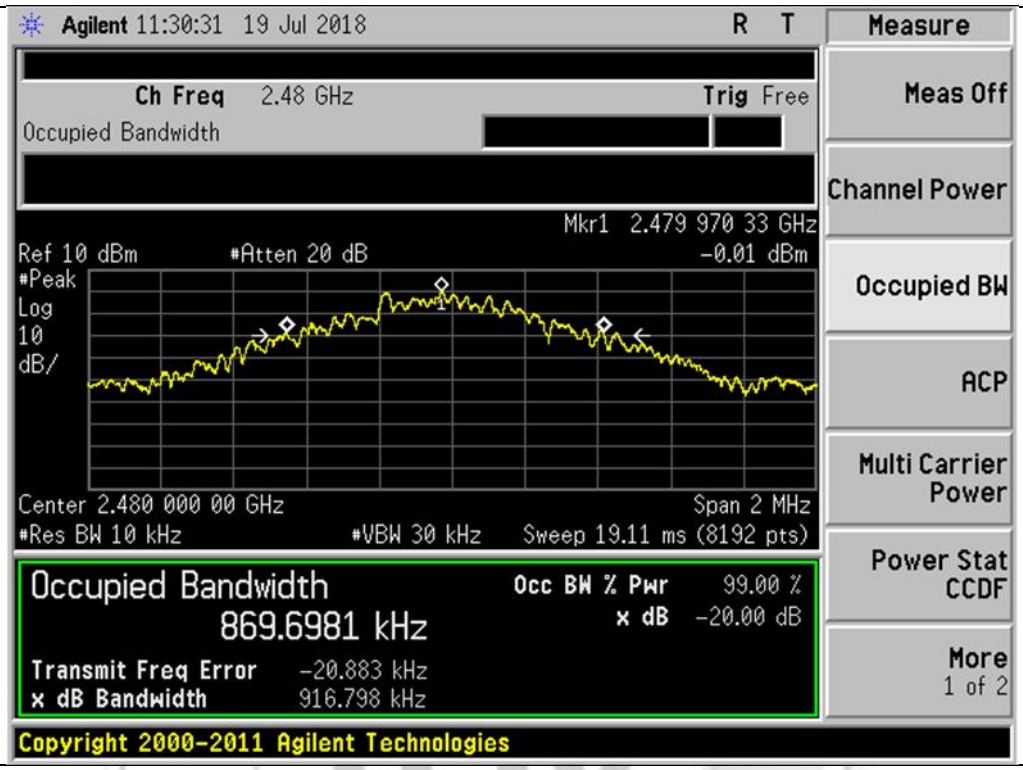
Plot 5 – Lower Channel



Plot 6 – Middle Channel

PSB Singapore

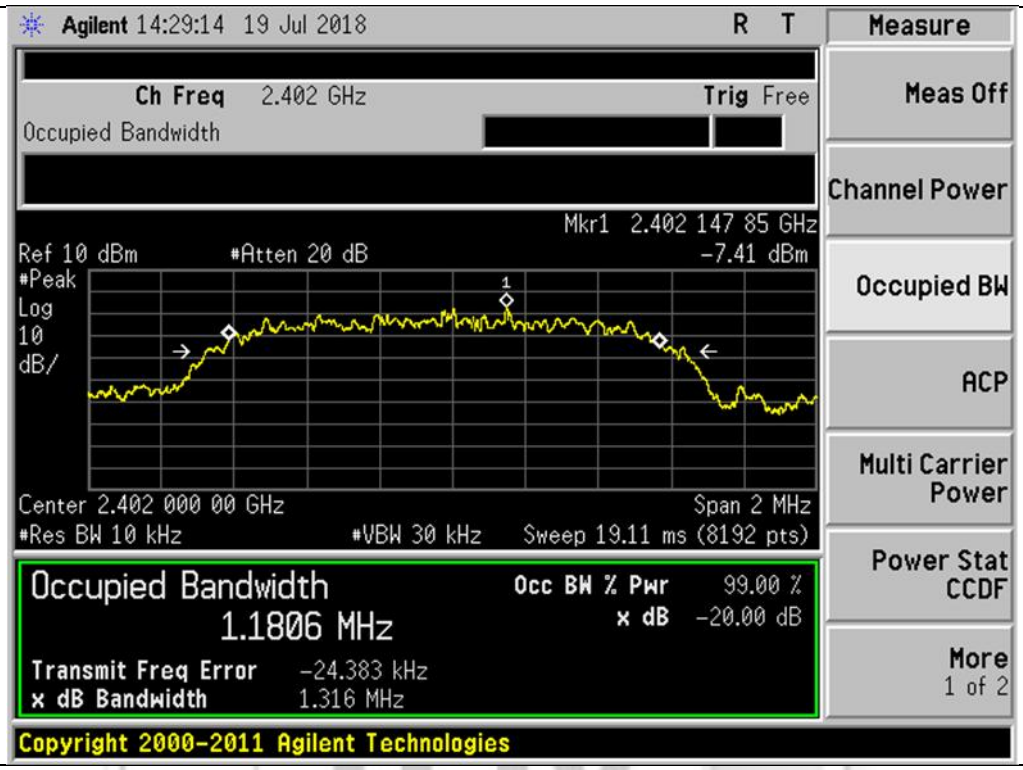
Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK



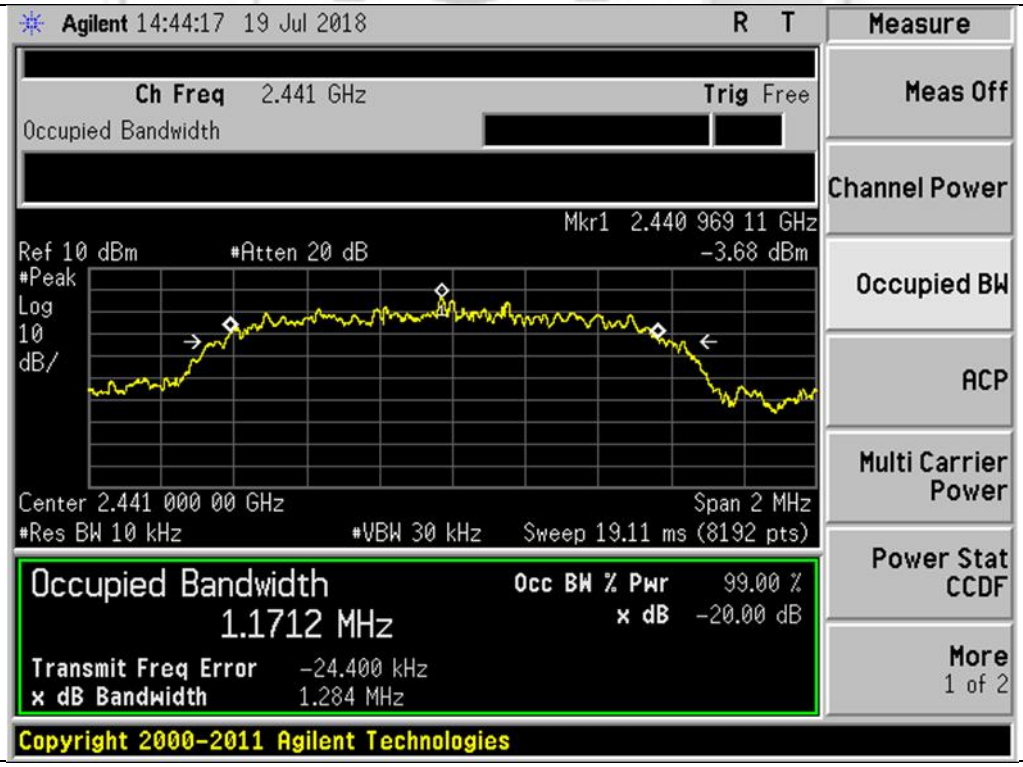
Plot 7 – Upper Channel

PSB Singapore

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – (π/4) DQPSK



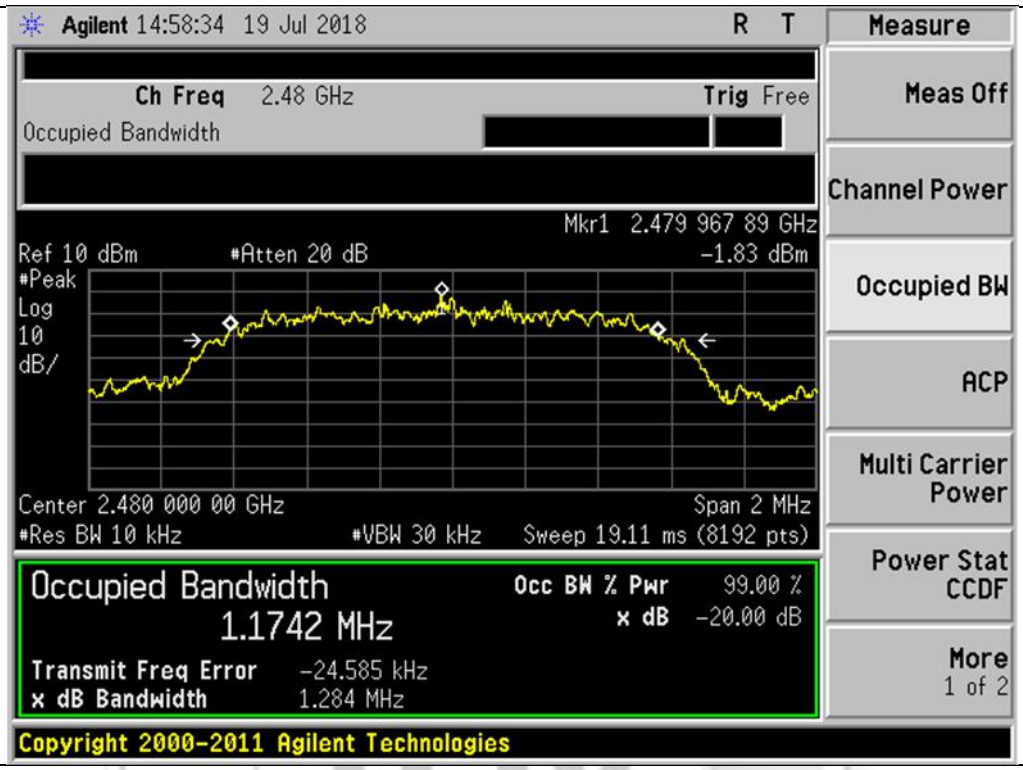
Plot 8 – Lower Channel



Plot 9 – Middle Channel

PSB Singapore

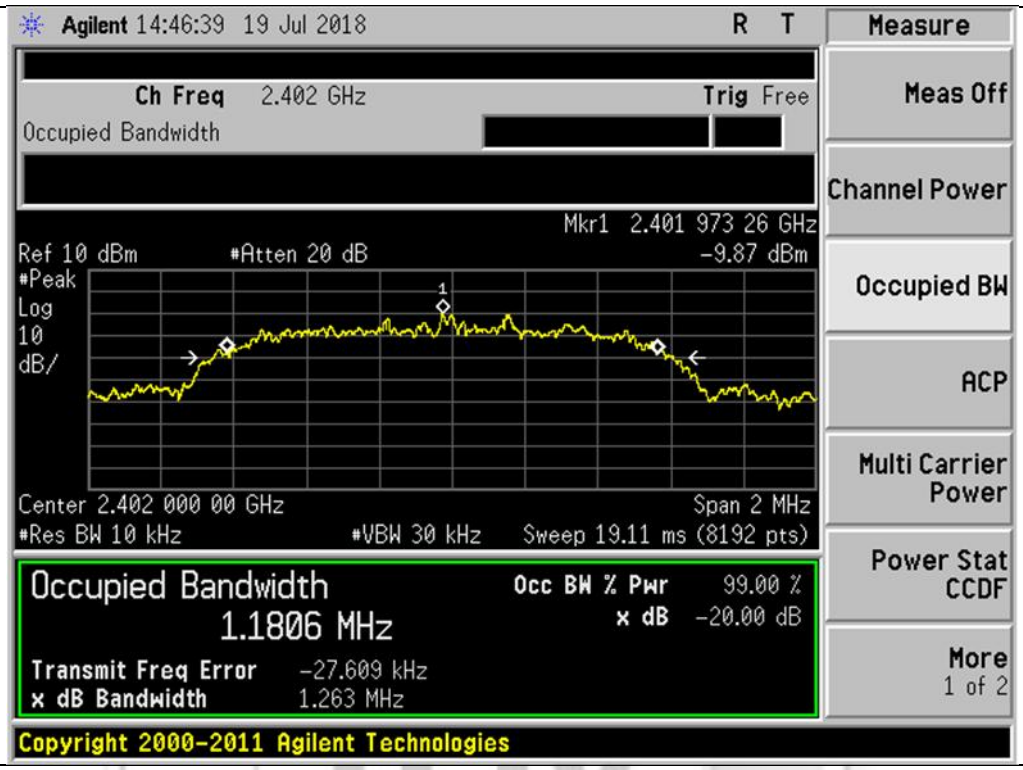
Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – (π/4) DQPSK



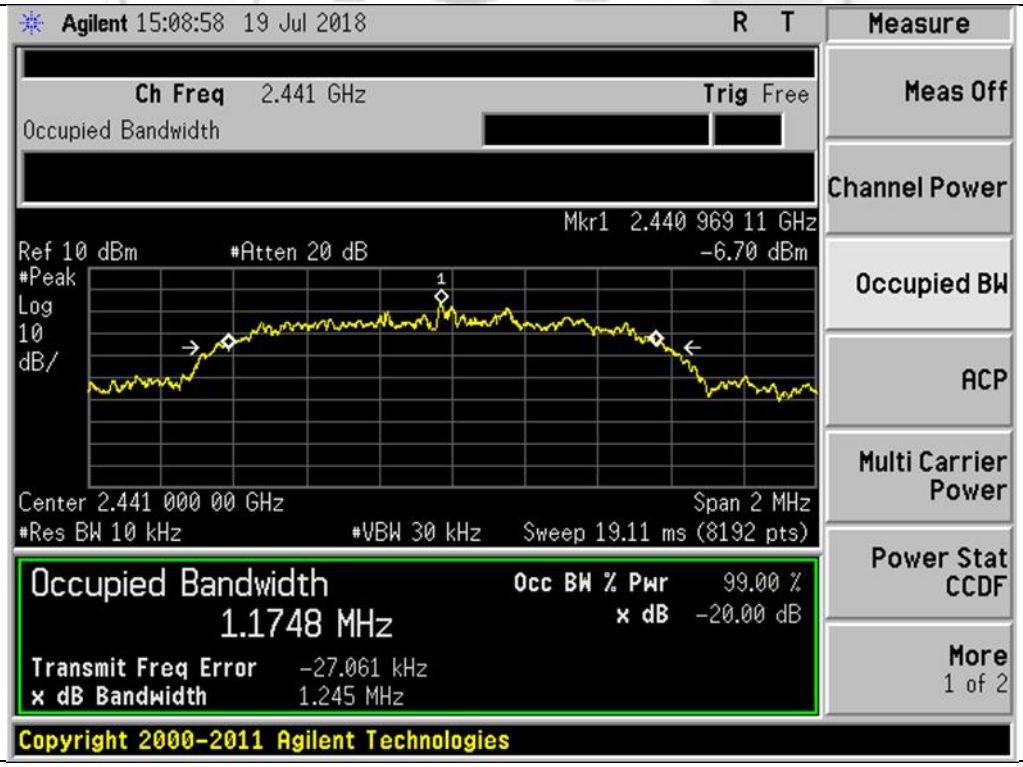
Plot 10 – Upper Channel

PSB Singapore

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – 8DPSK



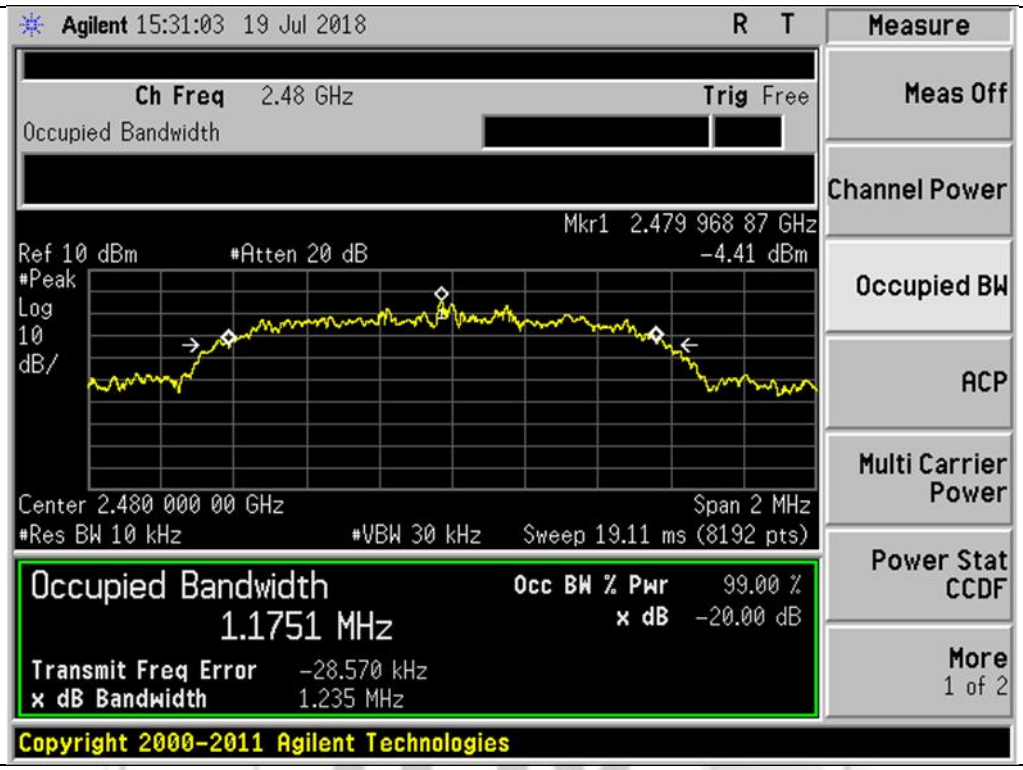
Plot 11 – Lower Channel



Plot 12 – Middle Channel

PSB Singapore

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – 8DPSK



Plot 13 – Upper Channel

PSB Singapore

2.4 Number of Hopping Frequencies

2.4.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the EUT shall use at least 15 channels.

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 the spectrum analyser via a low-loss coaxial cable.

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

2.4.2.5 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 with frequency hopping sequence on.

2.4.3.2 The start and stop frequencies of the spectrum analyser were set to 2.39GHz and 2.420GHz.

2.4.3.3 The spectrum analyser was set to max hold to capture all the transmitting frequencies within the span. The signal capturing was continuous until all the transmitting frequencies were captured and no further signals were detected.

2.4.3.4 The numbers of transmitting frequencies were counted and recorded.

2.4.3.5 The measurements were repeated with the following start and stop frequencies settings.

a. 2.420GHz to 2.441GHz
b. 2.441GHz to 2.461GHz
c. 2.461GHz to 2.4835GHz

2.4.3.6 The total number of hopping frequencies is the sum of the number of the hopping frequencies found for each span.

PSB Singapore

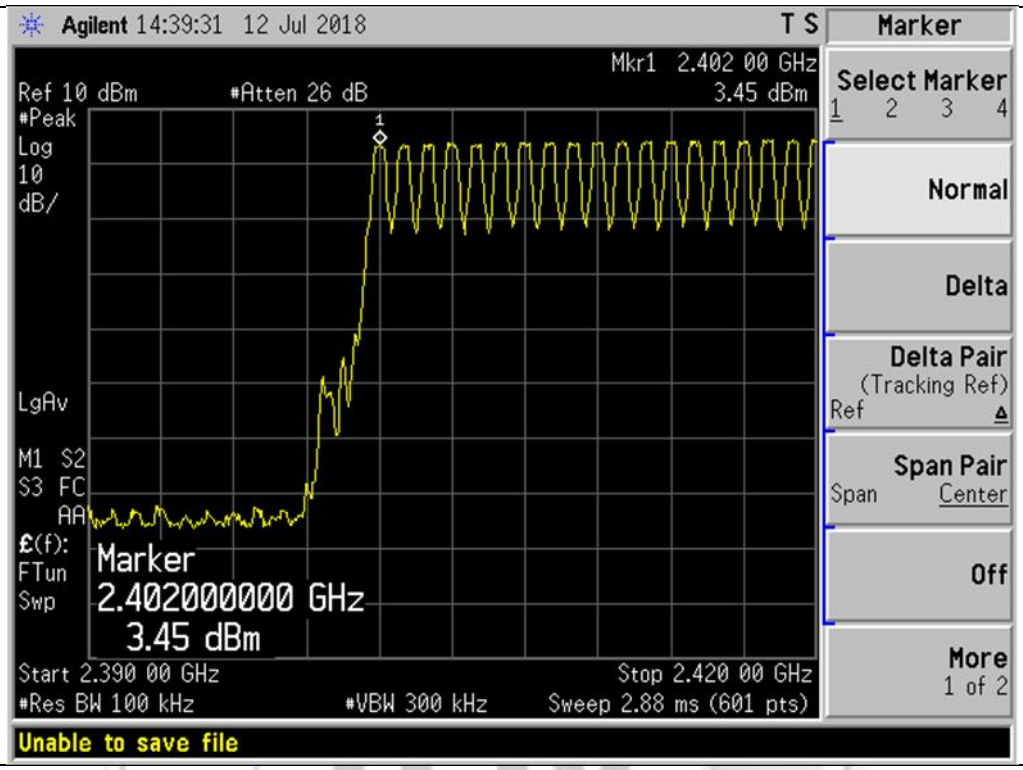
2.4.4 Test Results

Test Input Power	3.3Vdc	Temperature	24ºC
Attached Plots	14 – 17	Relative Humidity	60%
Mode	Frequency Hopping On	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	12 Jul 2018

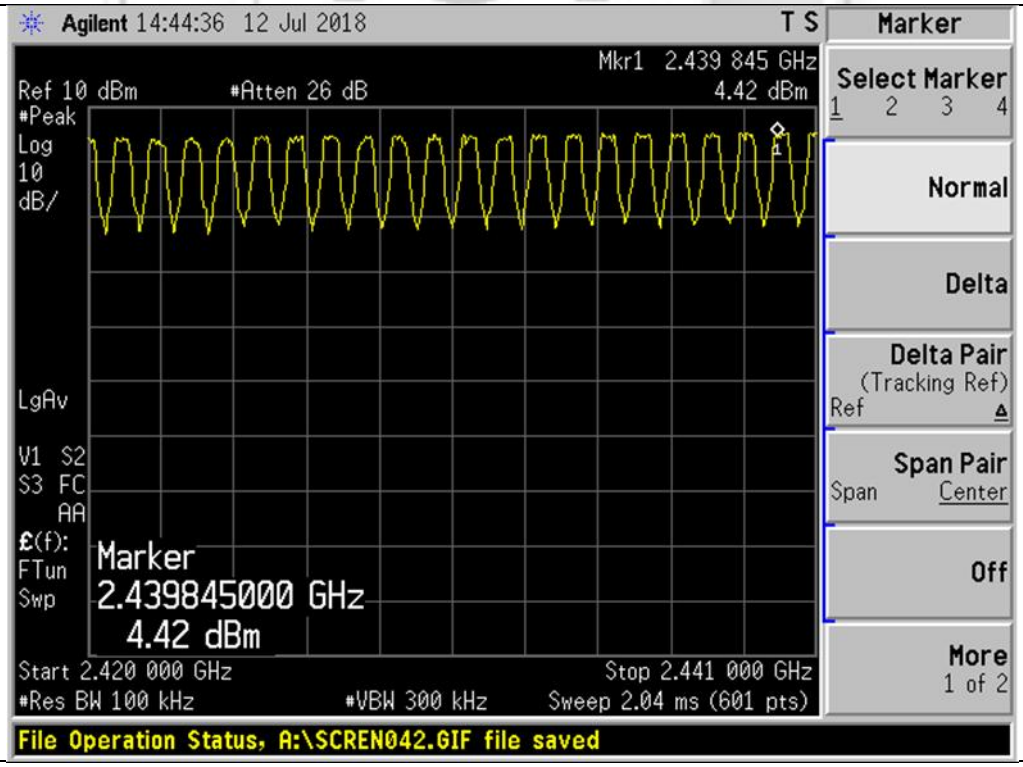
The EUT was found to have 79 *(total number of ch)* hopping frequencies. Please refer to the attached plots.

PSB Singapore

Number of Hopping Frequencies Plots



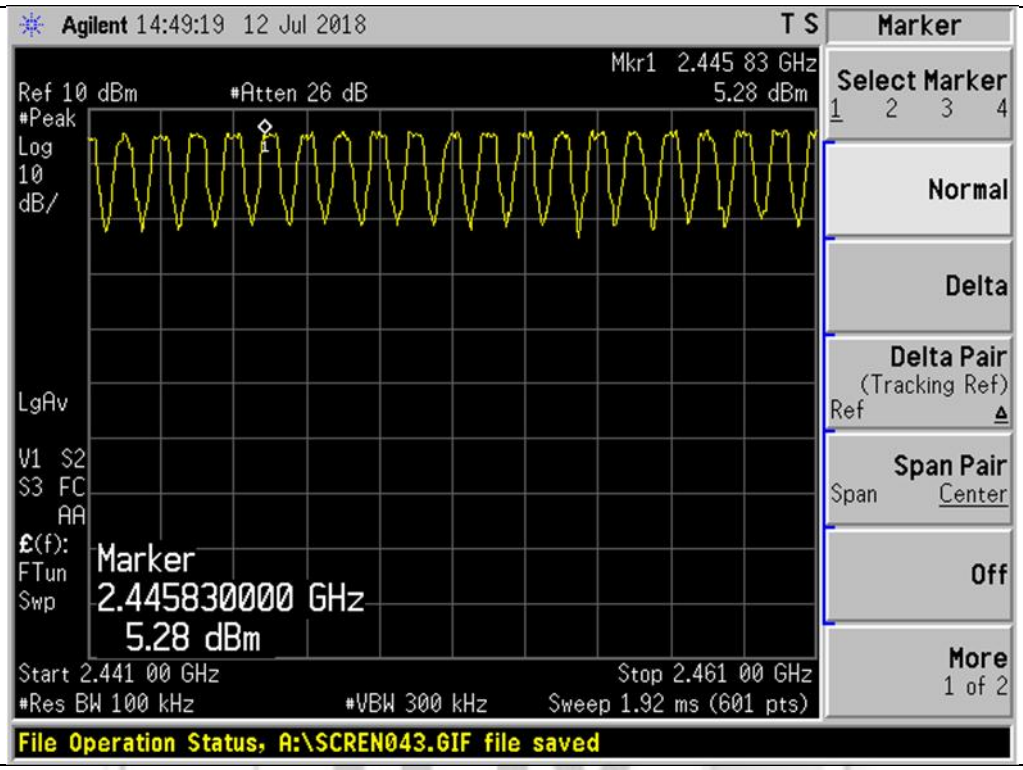
Plot 14 - Channels 0 to 18



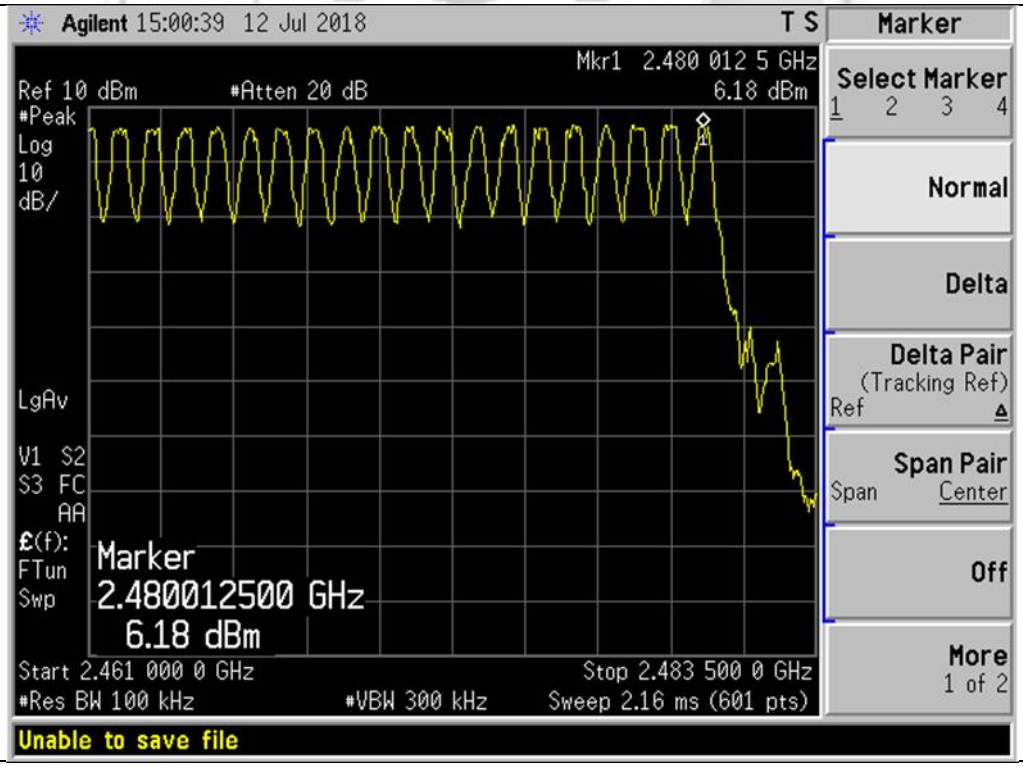
Plot 15 - Channels 18 to 39

PSB Singapore

Number of Hopping Frequencies Plots



Plot 16 - Channels 39 to 59



Plot 17 - Channels 59 to 78

PSB Singapore

2.5 Average Frequency Dwell Time

2.5.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

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 1MHz and 3MHz.

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 frequency hopping sequence on.

2.5.3.2 The center frequency of the spectrum analyser was set to lower channel with zero frequency span (spectrum analyser acts as an oscilloscope).

2.5.3.3 The sweep time of the spectrum analyser was adjusted until a stable signal can be seen on the spectrum analyser.

2.5.3.4 The duration (dwell time) of a packet (transmit time per hop) was measured using the marker-delta function of the spectrum analyser.

2.5.3.5 The measurement was repeated with the sweep time was set to equal to period specified in the requirement.

2.5.3.6 The number of hops in the period specified in the requirement, N was computed as below:
N = [number of hops on spectrum analyser] x [period specified in the requirement / spectrum analyser sweep time]

2.5.3.7 The average time of occupancy is calculated from the transmit time per hop multiplied by the number of hops in the period specified in the requirement, N.

2.5.3.8 The measurements were repeated with the center frequency of the spectrum analyser were set to middle channel and upper channel respectively.

PSB Singapore

2.5.4 Test Results

Test Input Power	3.3Vdc	Temperature	24ºC
Attached Plots	18 – 26	Relative Humidity	60%
Hopping Rate	1600 hops/s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Chelmin Li
Mode	Frequency Hopping On	Test Date	12 Jul 2018

DH1

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	0.3780	0.1210	0.4
39 *(mid ch)*	2.441	0.3738	0.1196	0.4
78 *(upper ch)*	2.480	0.3780	0.1210	0.4

DH3

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	1.6250	0.2600	0.4
39 *(mid ch)*	2.441	1.6333	0.2613	0.4
78 *(upper ch)*	2.480	1.6333	0.2613	0.4

DH5

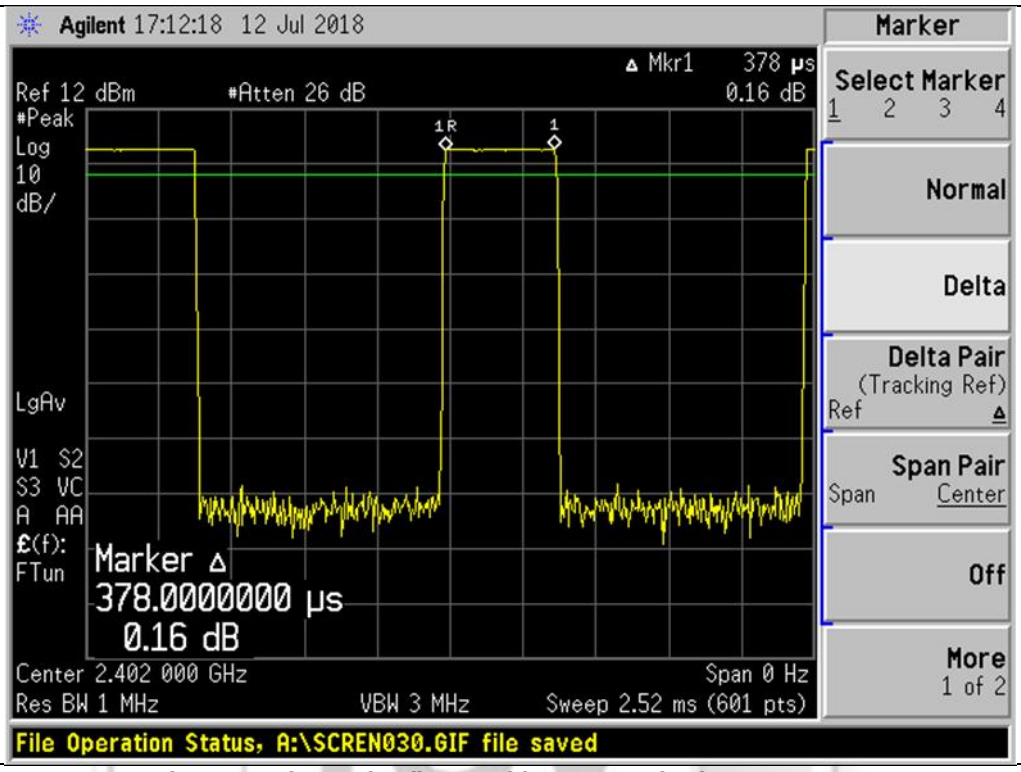
Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	2.882	0.3074	0.4
39 *(mid ch)*	2.441	2.882	0.3074	0.4
78 *(upper ch)*	2.480	2.882	0.3074	0.4

Notes

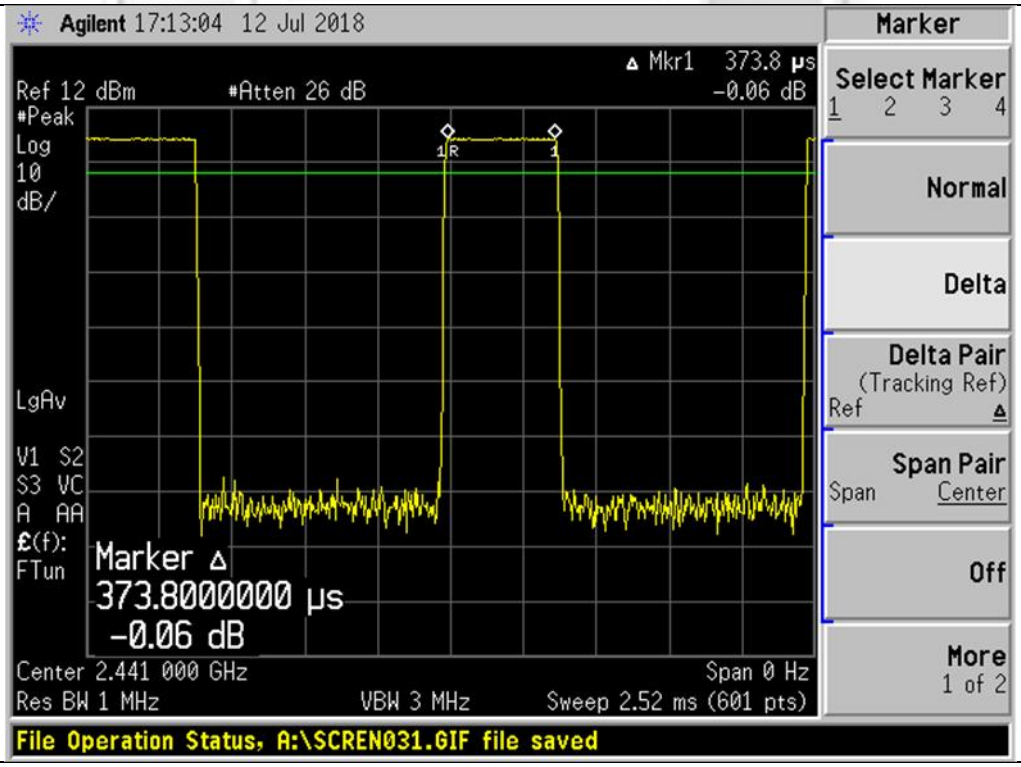
1.	DH1 Average Frequency Dwell time = Measured Time Slot Length *(1600/2/79) *31.6 DH3 Average Frequency Dwell time = Measured Time Slot Length *(1600/4/79) *31.6 DH5 Average Frequency Dwell time = Measured Time Slot Length *(1600/6/79) *31.6

PSB Singapore

Average Frequency Dwell Time Plots – DH1



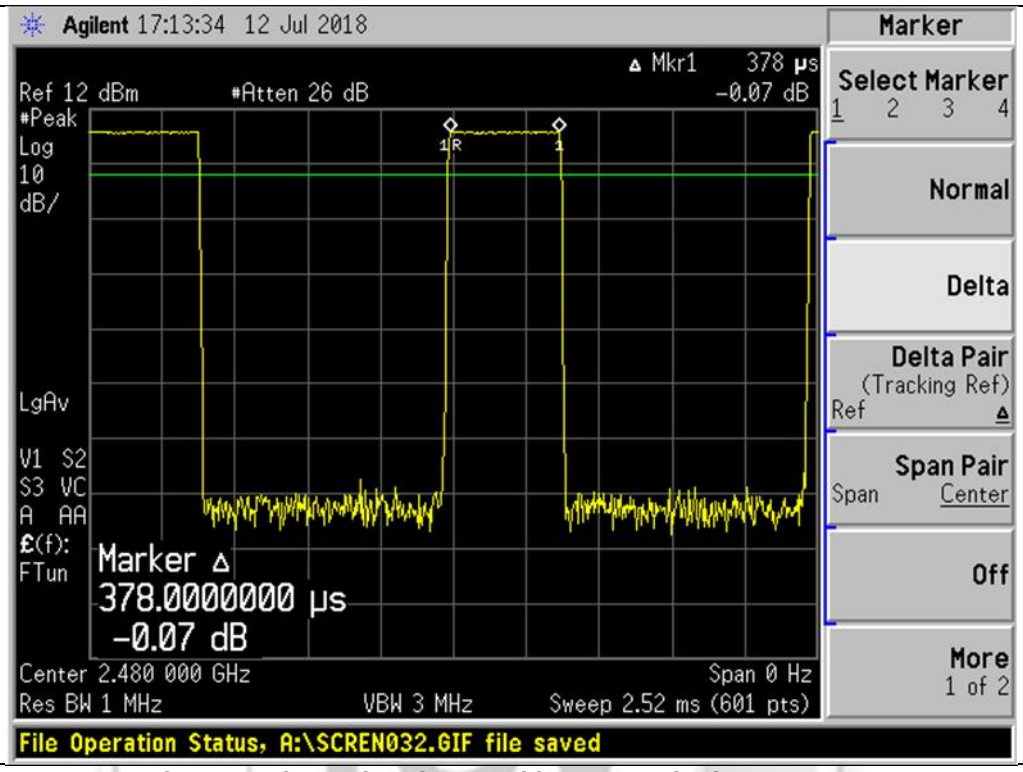
Plot 18 – Channel 0 *(lower ch) – Transmit Time per Hop*



Plot 19 – Channel 39 *(mid ch) – Transmit Time per Hop*

PSB Singapore

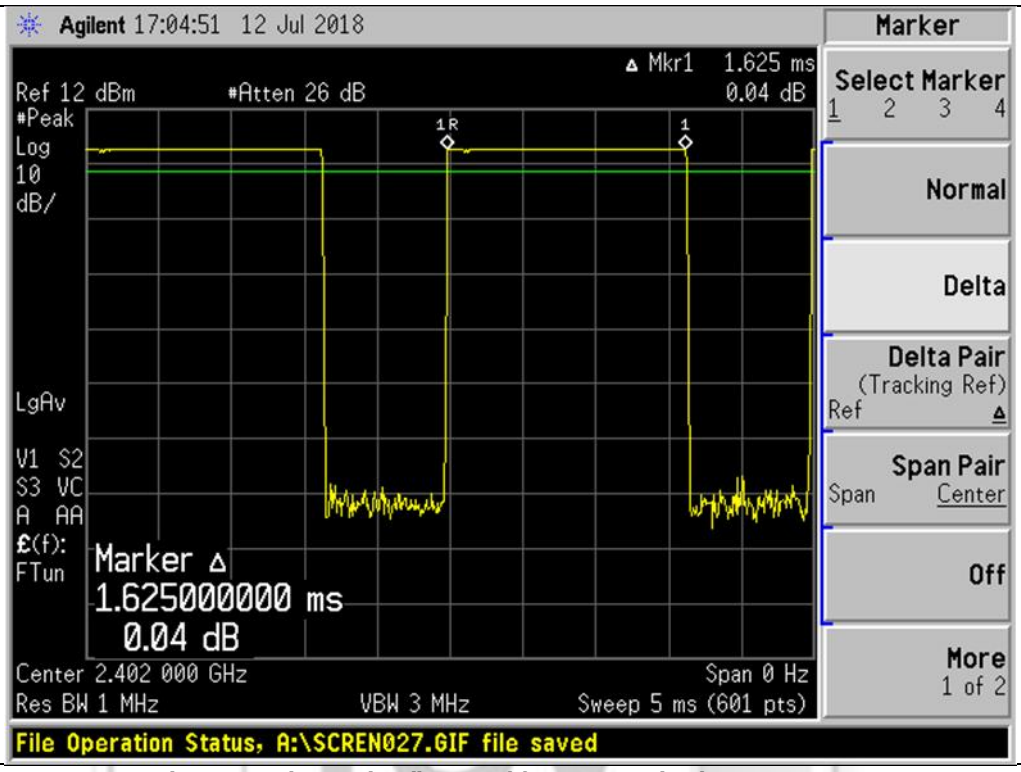
Average Frequency Dwell Time Plots – DH1



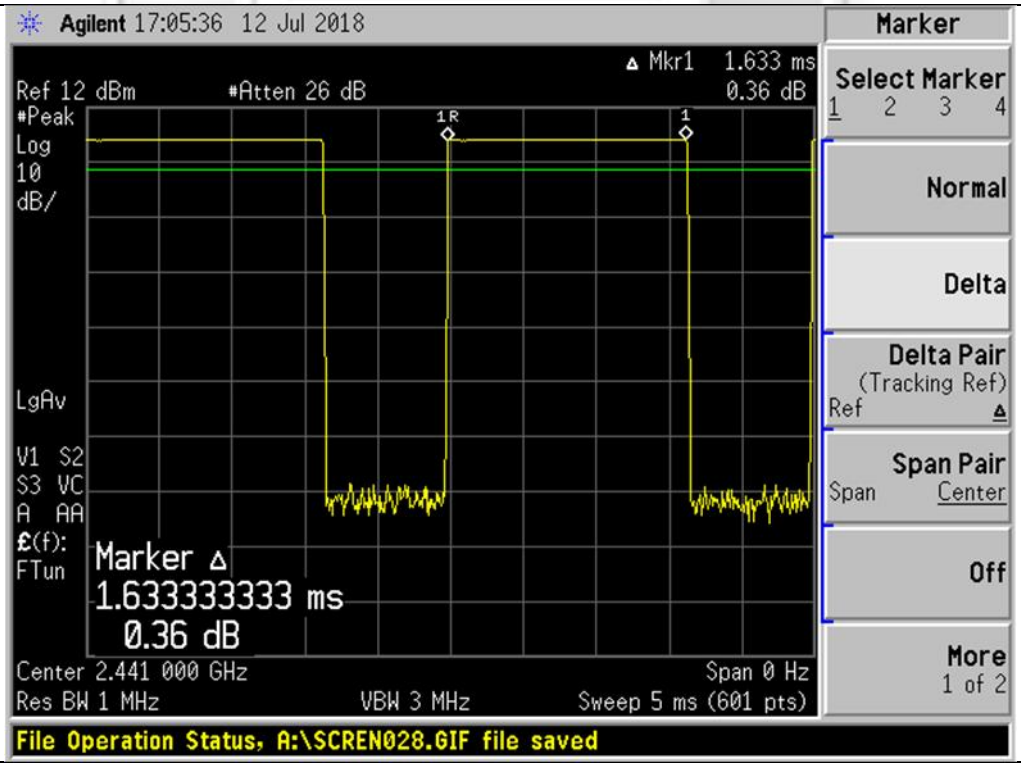
Plot 20 – Channel 78 *(upper ch)* – *Transmit Time per Hop*

PSB Singapore

Average Frequency Dwell Time Plots – DH3



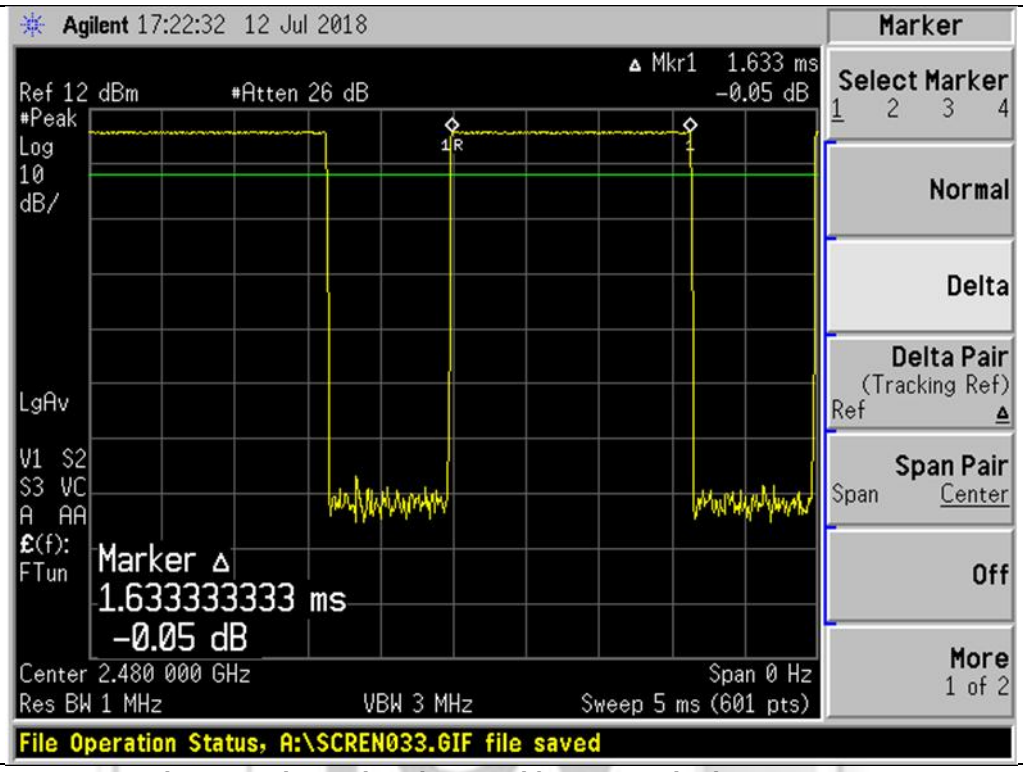
Plot 21 – Channel 0 *(lower ch) – Transmit Time per Hop*



Plot 22 – Channel 39 *(mid ch) – Transmit Time per Hop*

PSB Singapore

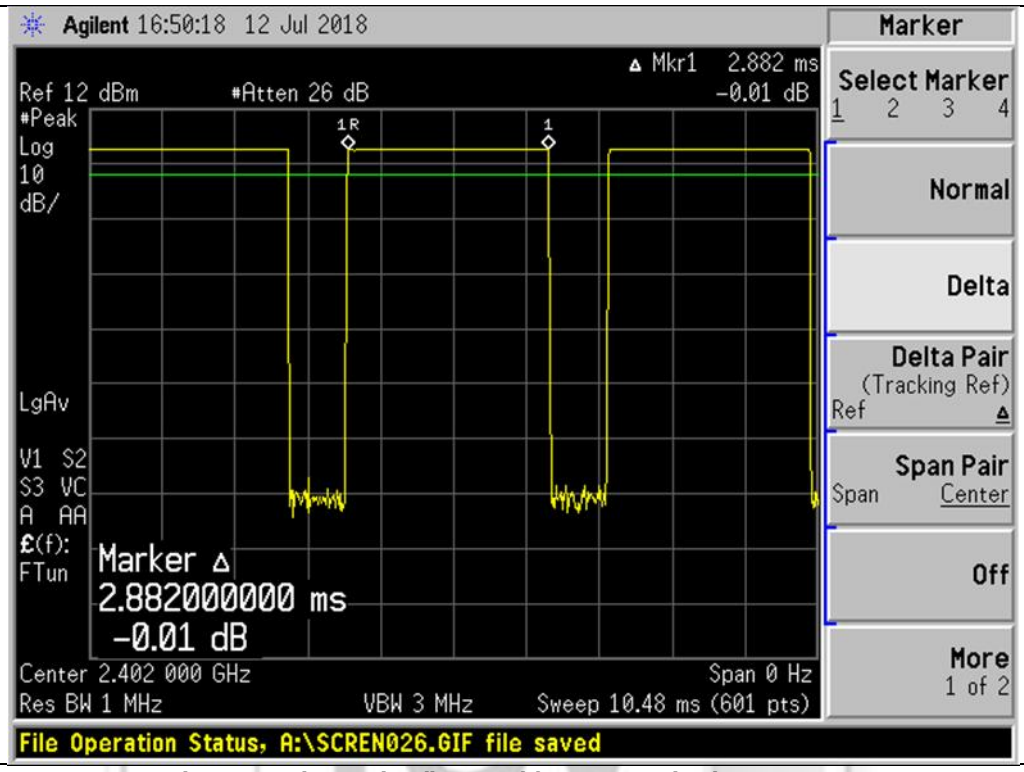
Average Frequency Dwell Time Plots – DH3



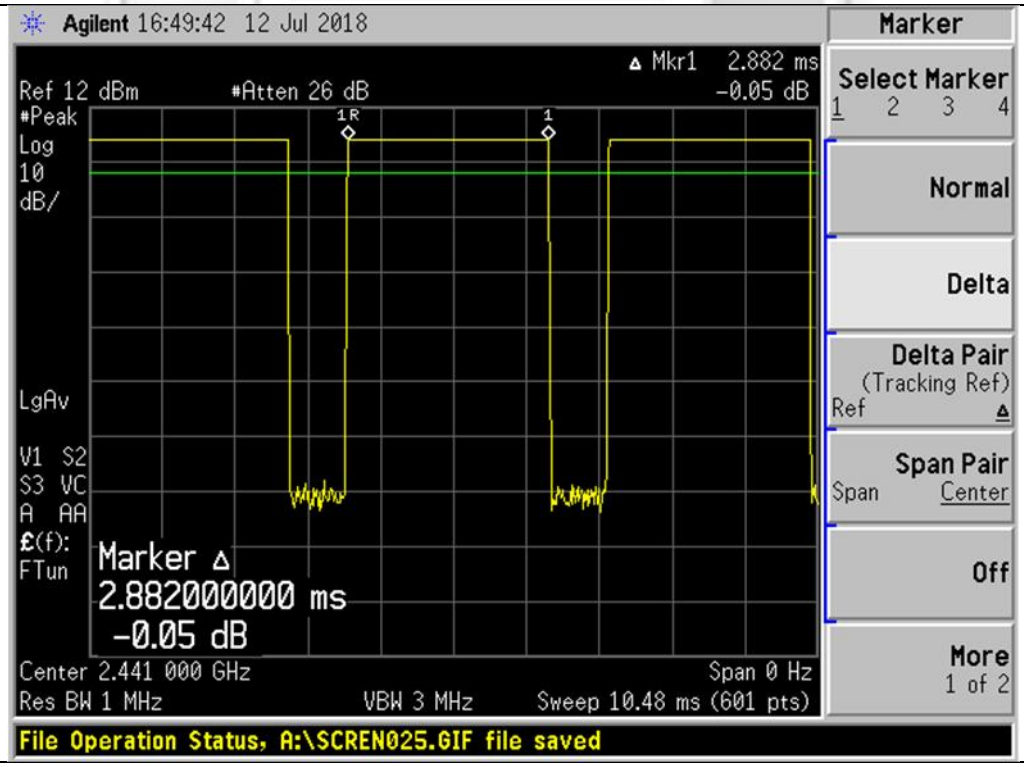
Plot 23 – Channel 78 *(upper ch)* – *Transmit Time per Hop*

PSB Singapore

Average Frequency Dwell Time Plots – DH5



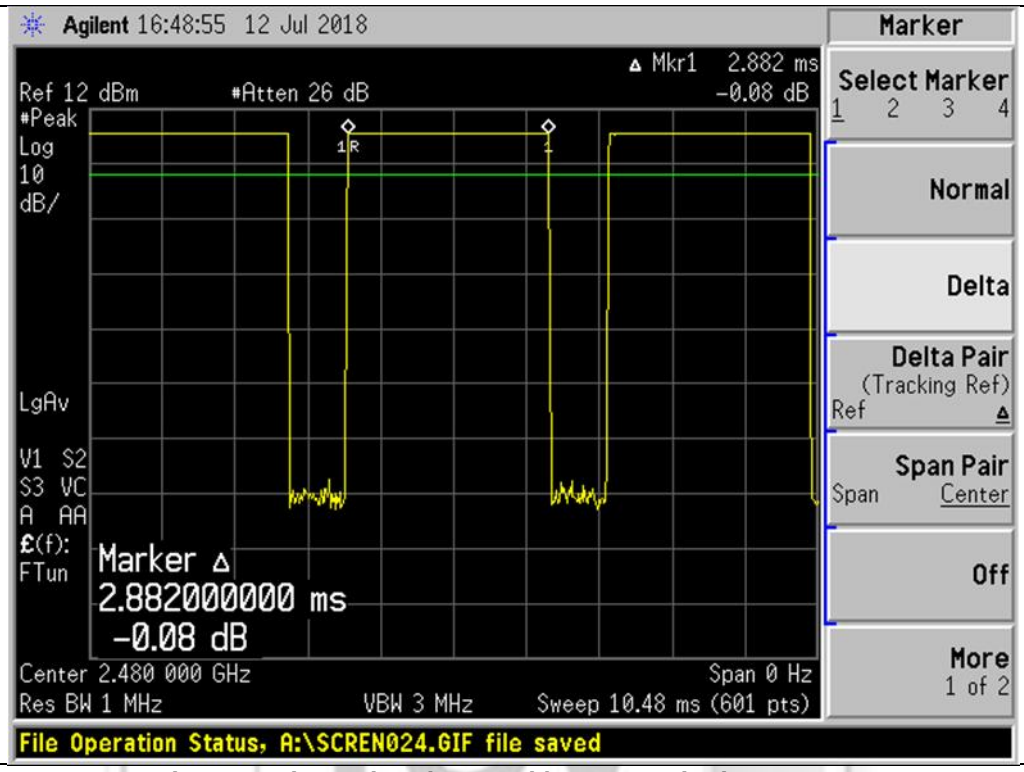
Plot 24 – Channel 0 *(lower ch)* – *Transmit Time per Hop*



Plot 25 – Channel 39 *(mid ch)* – *Transmit Time per Hop*

PSB Singapore

Average Frequency Dwell Time Plots – DH5



Plot 26 – Channel 78 *(upper ch)* – *Transmit Time per Hop*

PSB Singapore

2.6 Maximum Peak Power

2.6.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the EUT employing at least 75 non-overlapping hopping channels shall not exceed 1W (30dBm). For the EUT employs other frequency hopping systems, the peak power shall not greater than 0.125W (21dBm).

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 a power meter via a low-loss coaxial cable.

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

2.6.3 Test Method

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, non-hopping with transmitting frequency at lower channel.

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

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

PSB Singapore

2.6.4 Test Results

Test Input Power	3.3Vdc	Temperature	24ºC
Antenna Gain	2.0 dBi	Relative Humidity	58%
Mode	Frequency Hopping Off	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	12 Jul 2018

GFSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
Lower	2.402	0.0019	1.0
Middle	2.441	0.0025	1.0
Upper	2.480	0.0024	1.0

(π/4) DQPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
Lower	2.402	0.0009	1.0
Middle	2.441	0.0016	1.0
Upper	2.480	0.0018	1.0

8DPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
Lower	2.402	0.0011	1.0
Middle	2.441	0.0020	1.0
Upper	2.480	0.0023	1.0

Notes

1.	Nil.

PSB Singapore

2.7 RF Conducted Spurious Emissions

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 3 times of RBW.

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, non-hopping with transmitting frequency at lower channel.

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

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 with frequency span was set from 10GHz to 25GHz.

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

PSB Singapore

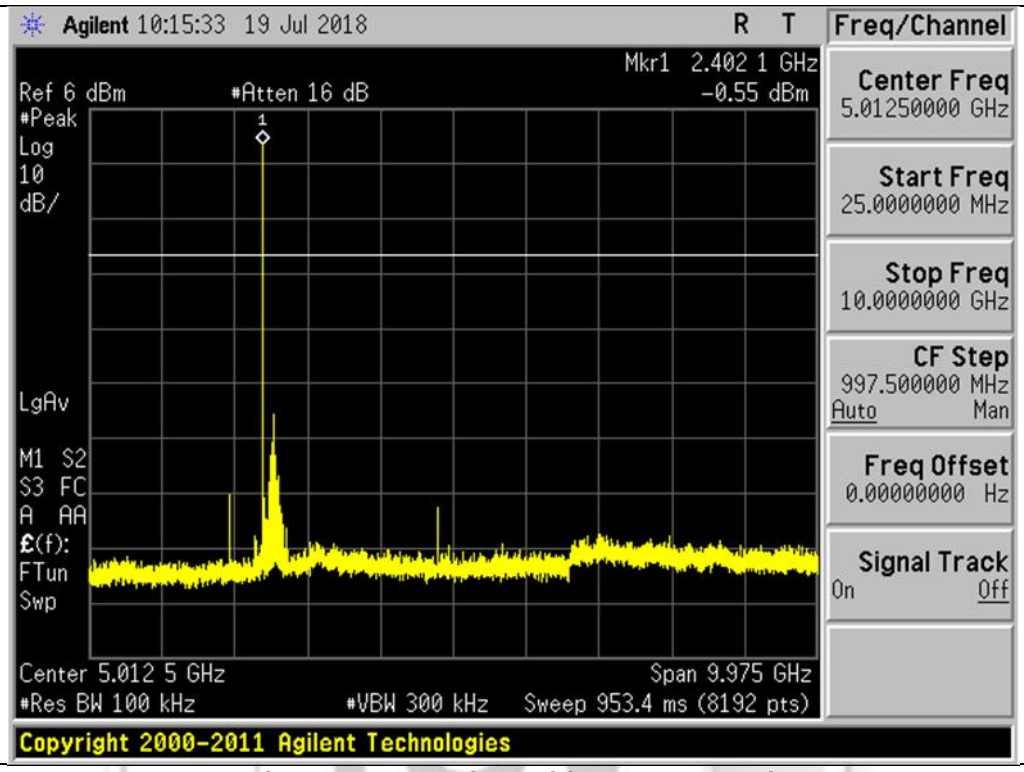
2.7.4 Test Results

Test Input Power	3.3Vdc	Temperature	24°C
Attached Plots	27 – 44	Relative Humidity	58%
Mode	Frequency Hopping Off	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	19 Jul 2018

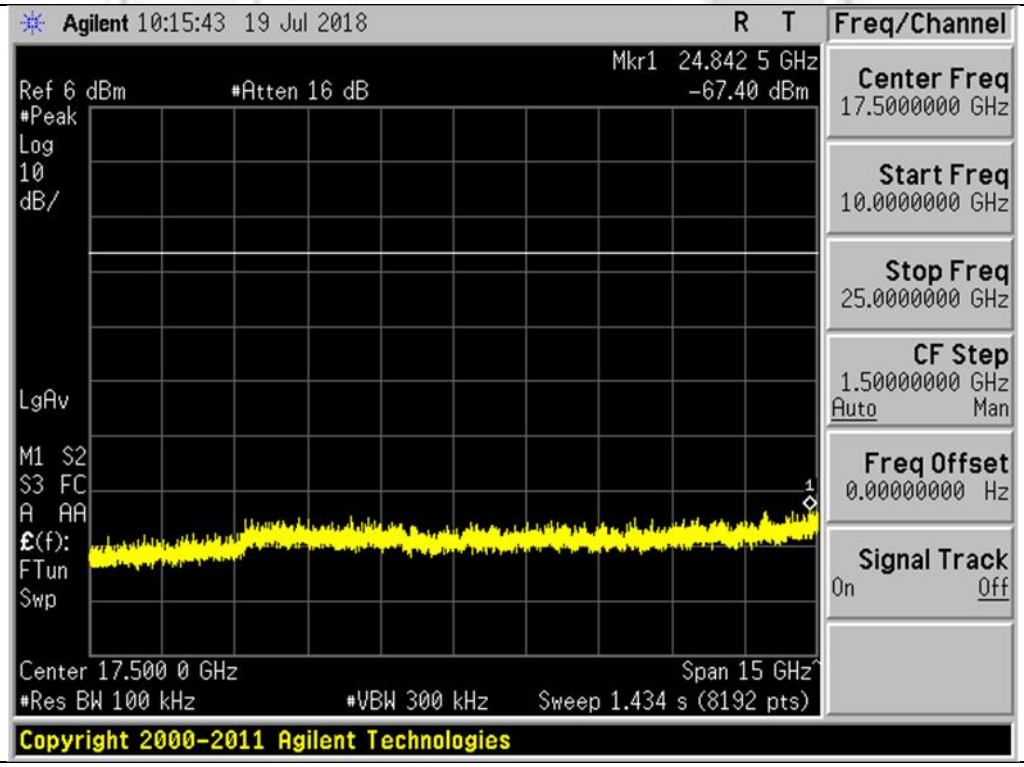
All spurious signals found were below the specified limit. Please refer to the attached plots.

PSB Singapore

RF Conducted Spurious Emissions Plots – GFSK



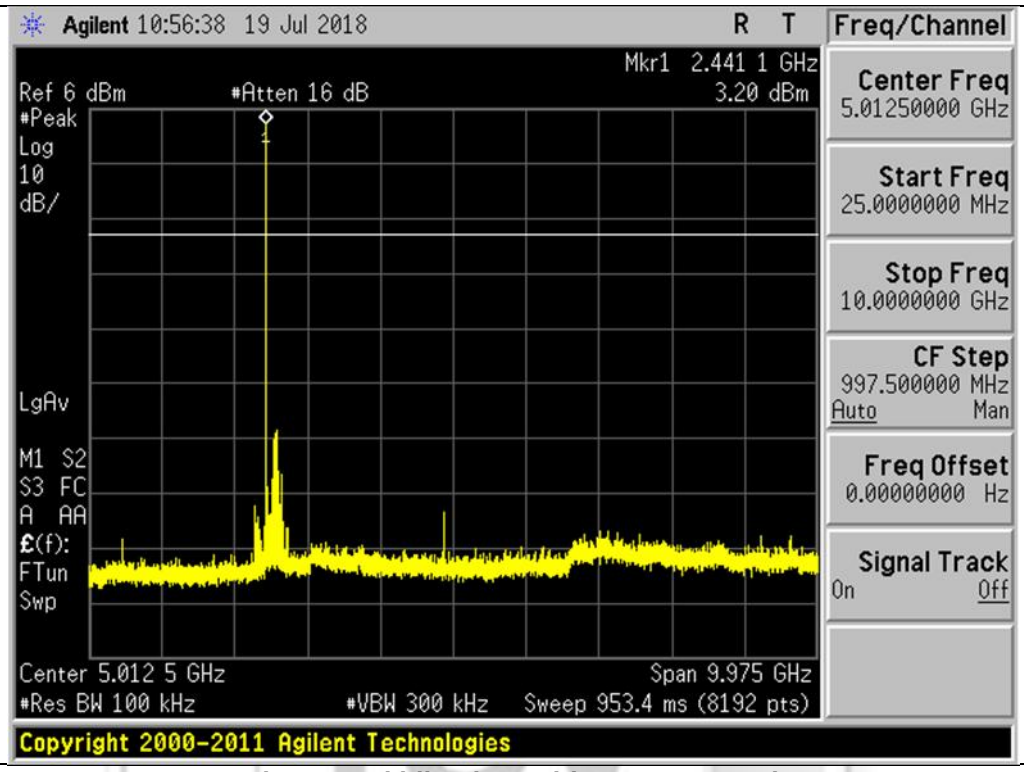
Plot 27 – Lower Channel (25MHz – 10GHz)



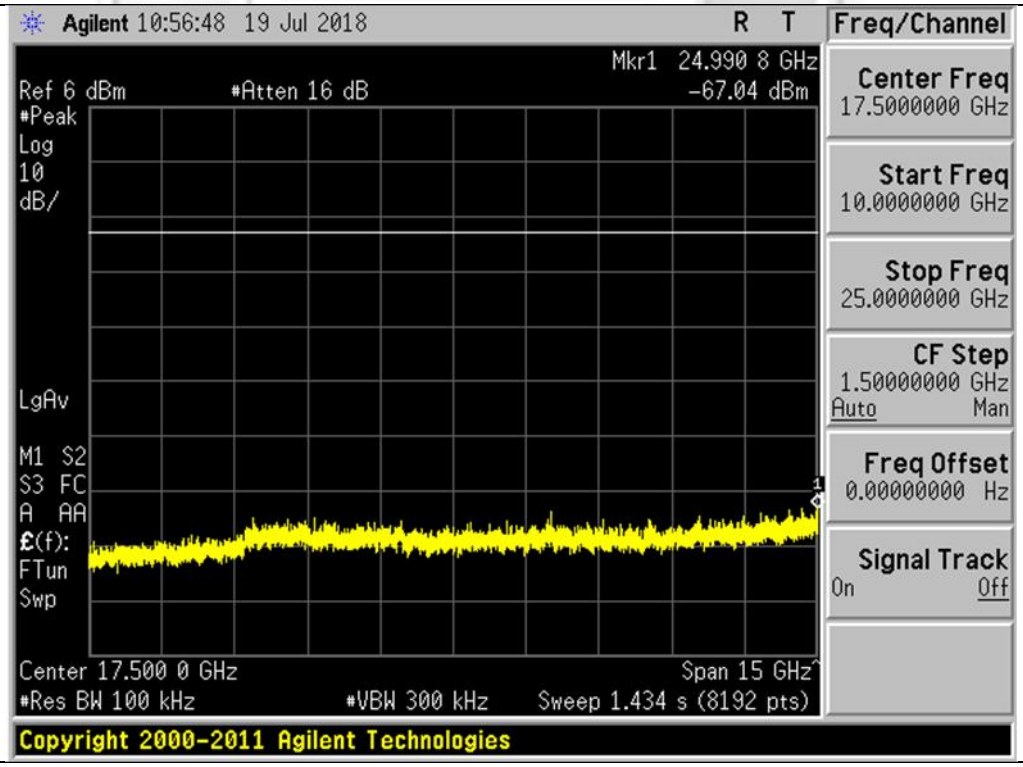
Plot 28 – Lower Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – GFSK



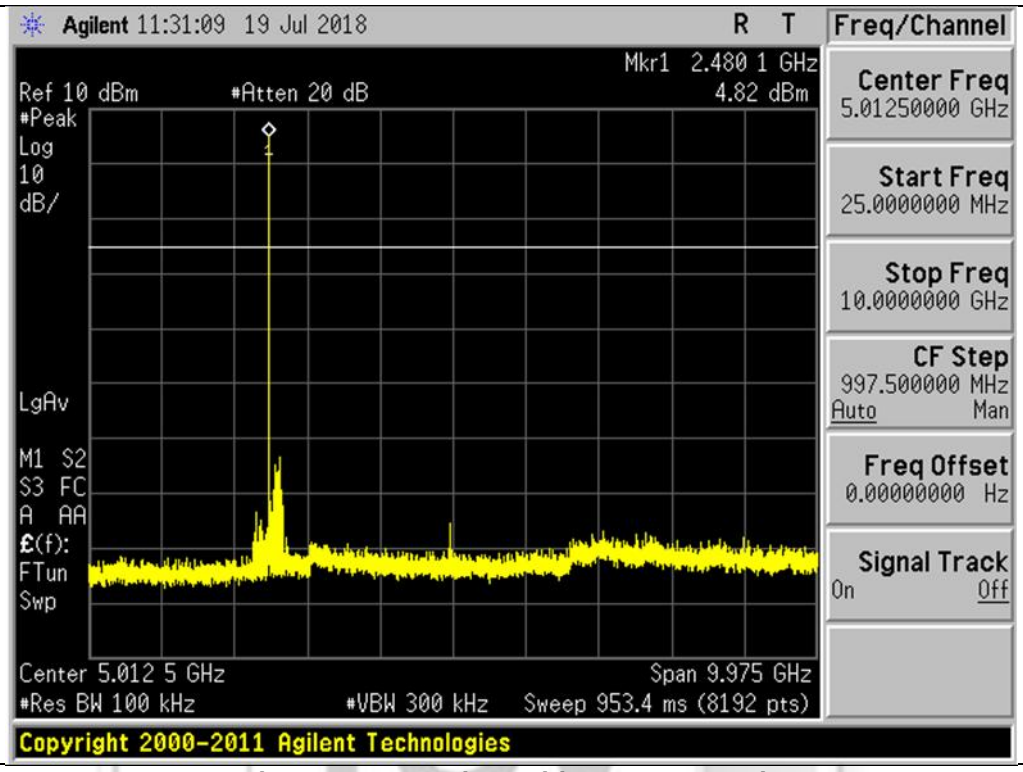
Plot 29 – Middle Channel (25MHz – 10GHz)



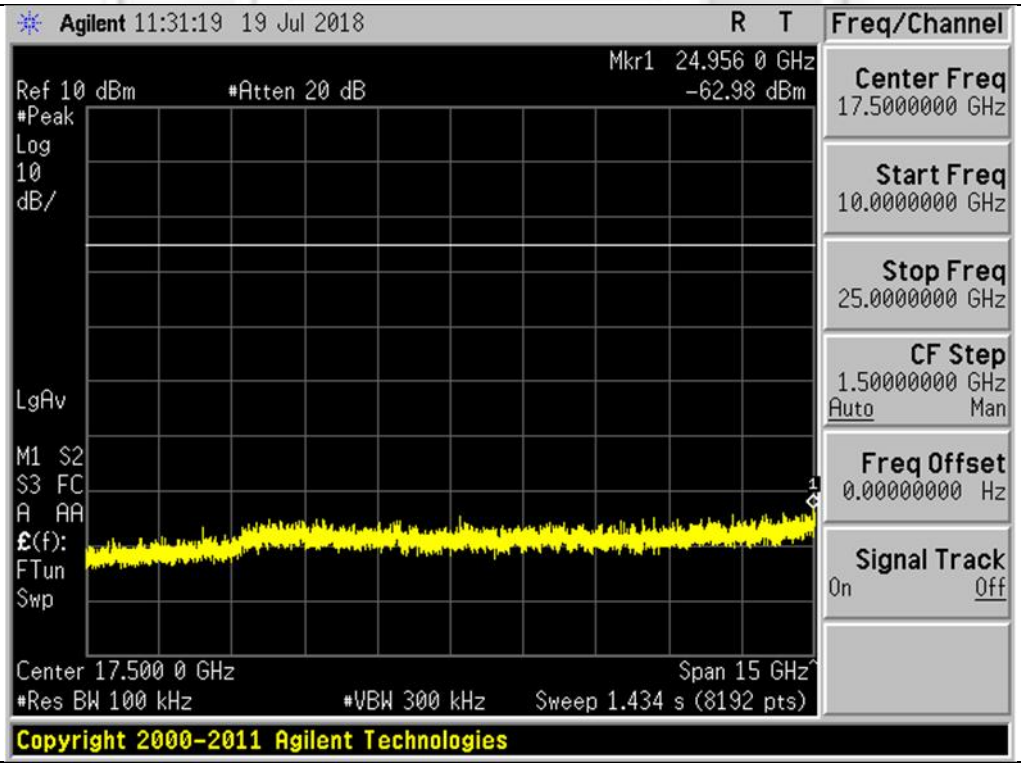
Plot 30 – Middle Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – GFSK



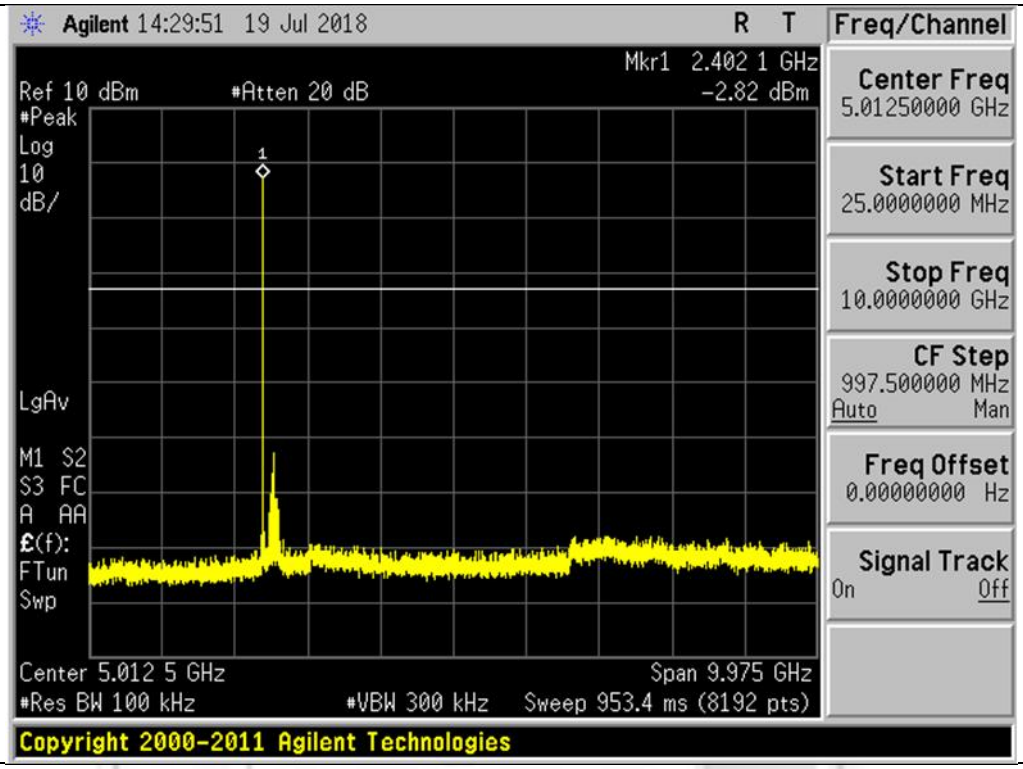
Plot 31 – Upper Channel (25MHz – 10GHz)



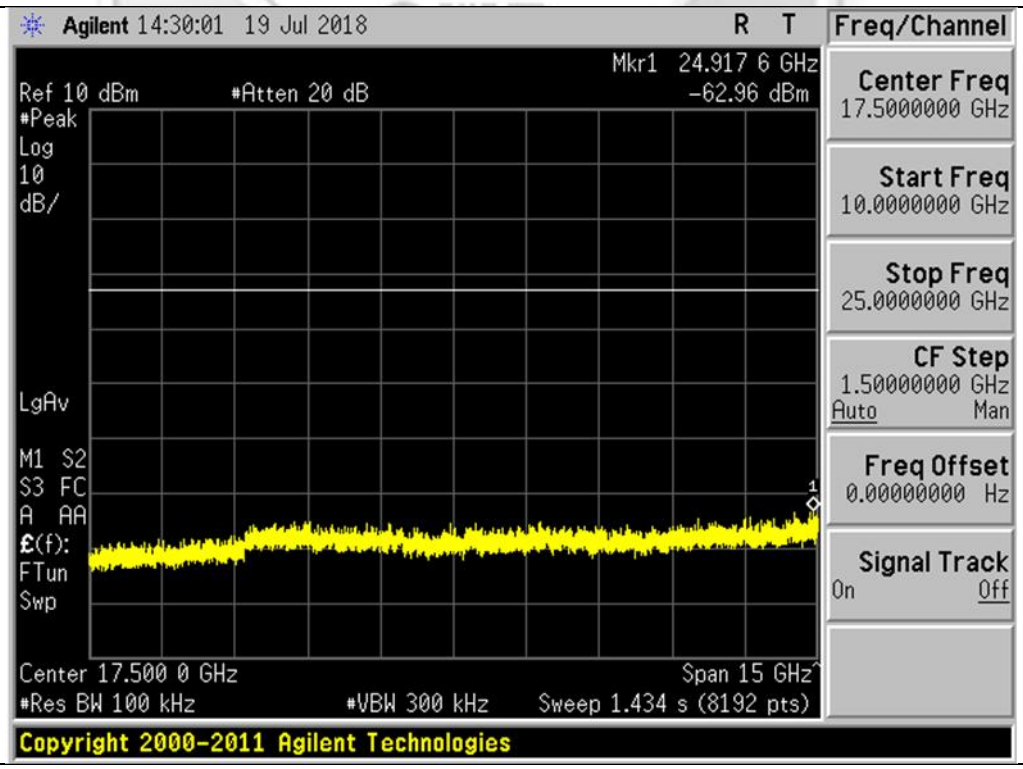
Plot 32 – Upper Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – (π/4) DQPSK



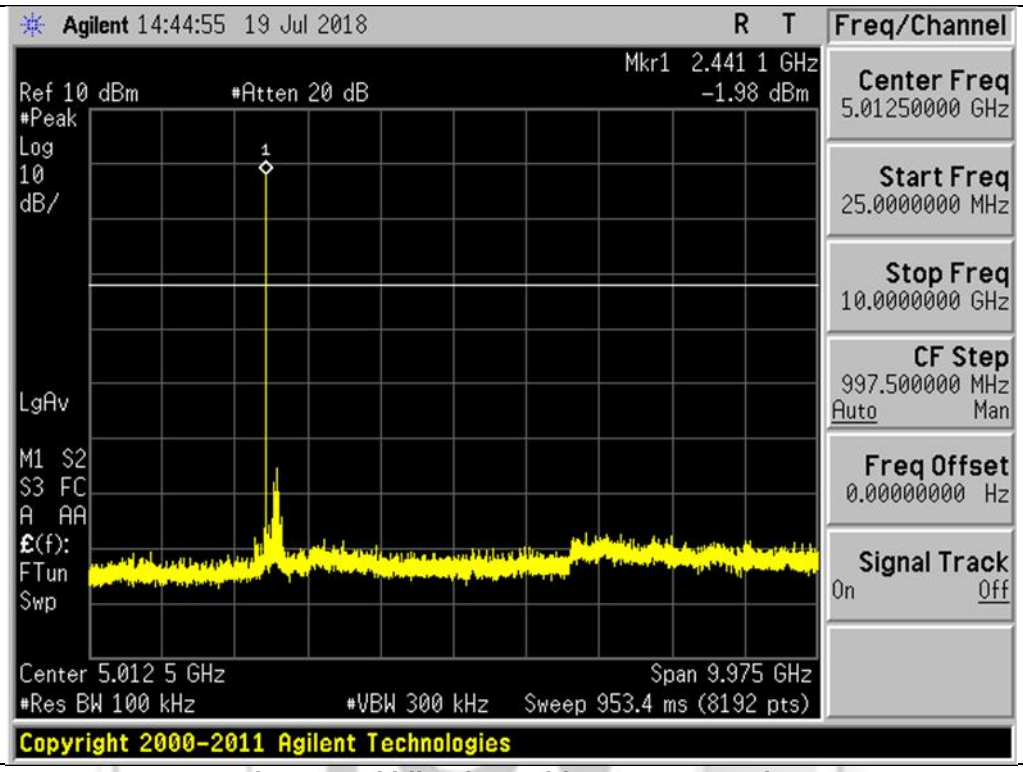
Plot 33 – Lower Channel (25MHz – 10GHz)



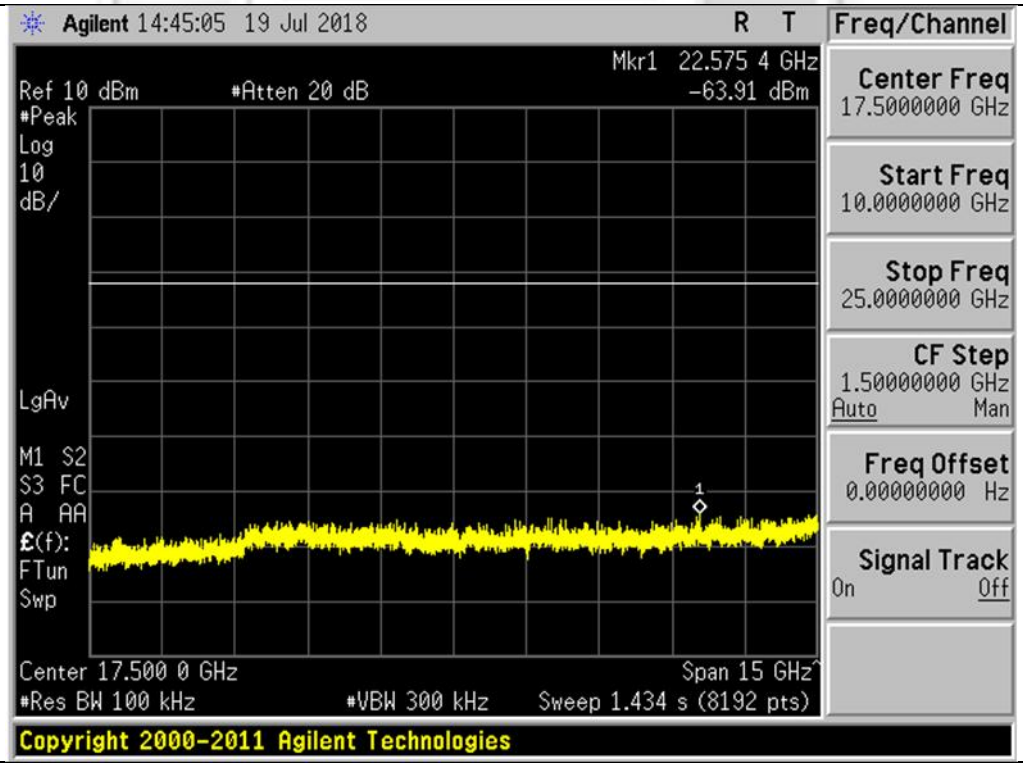
Plot 34 – Lower Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – (π/4) DQPSK



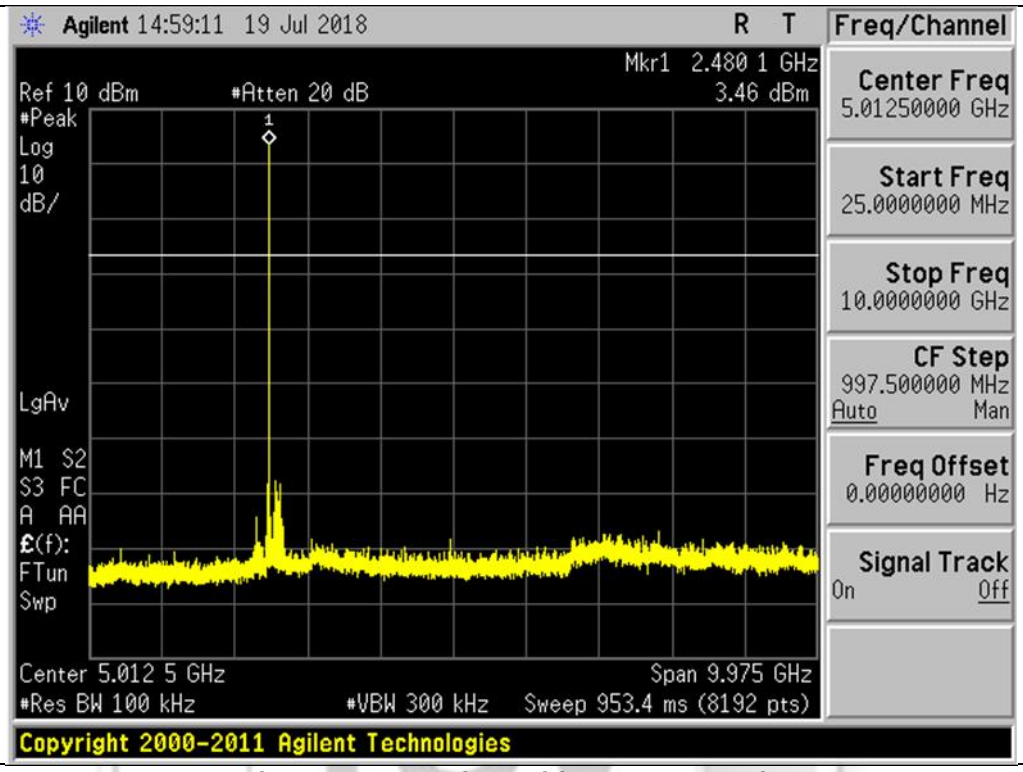
Plot 35 – Middle Channel (25MHz – 10GHz)



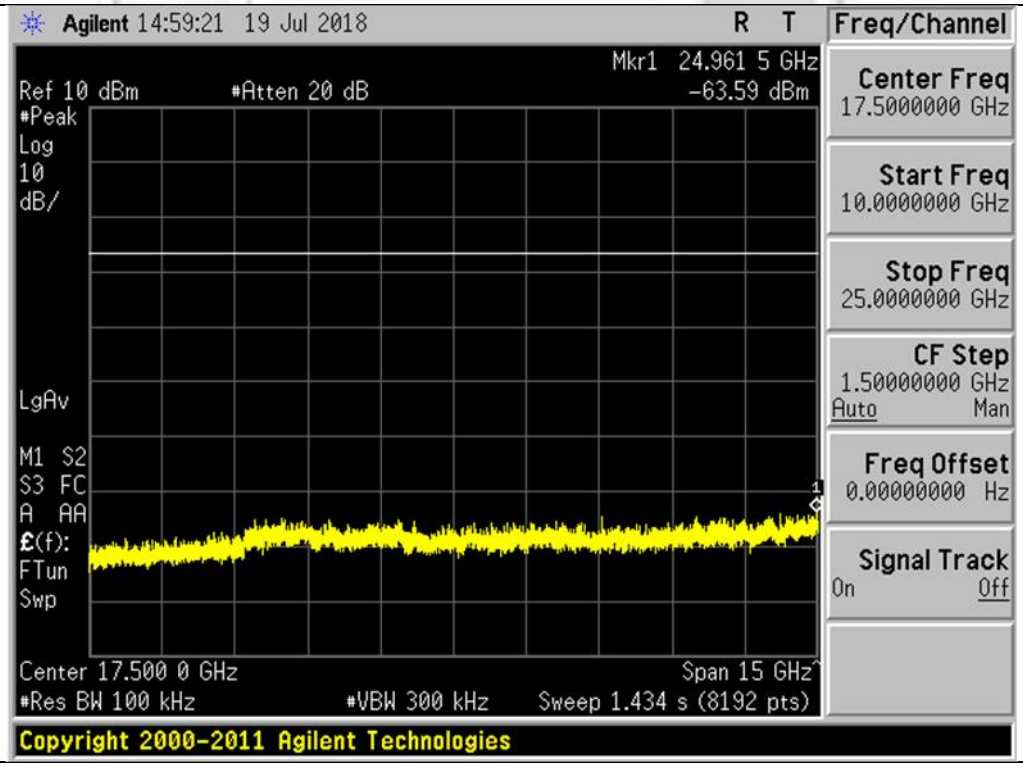
Plot 36 – Middle Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – (π/4) DQPSK



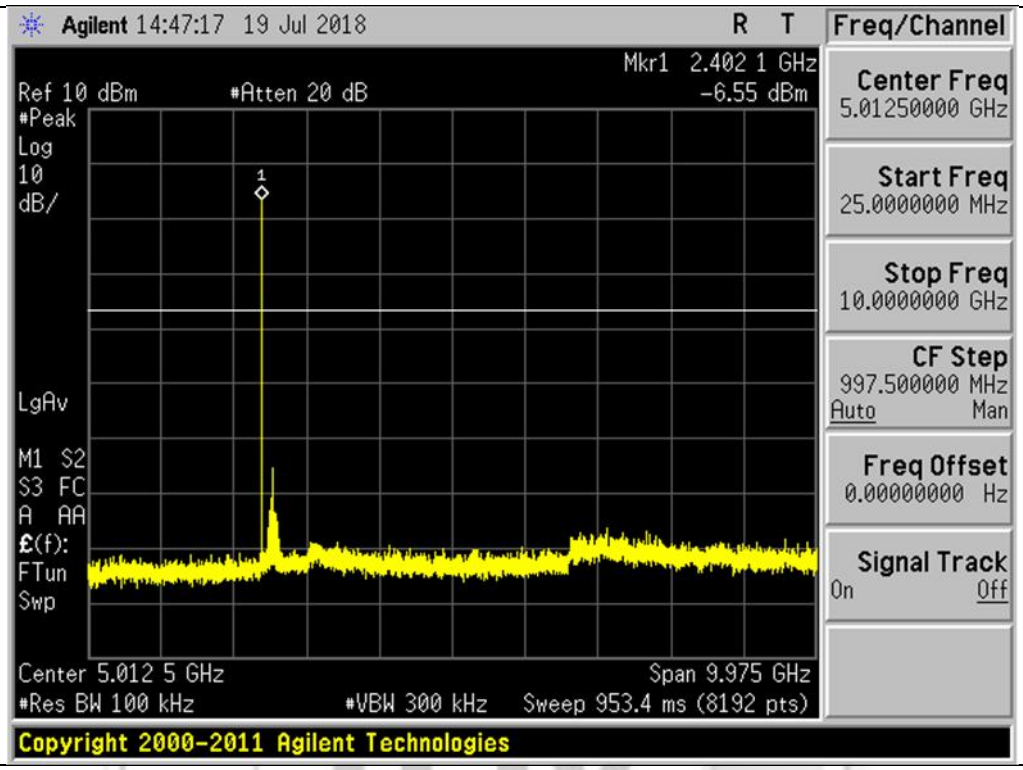
Plot 37 – Upper Channel (25MHz – 10GHz)



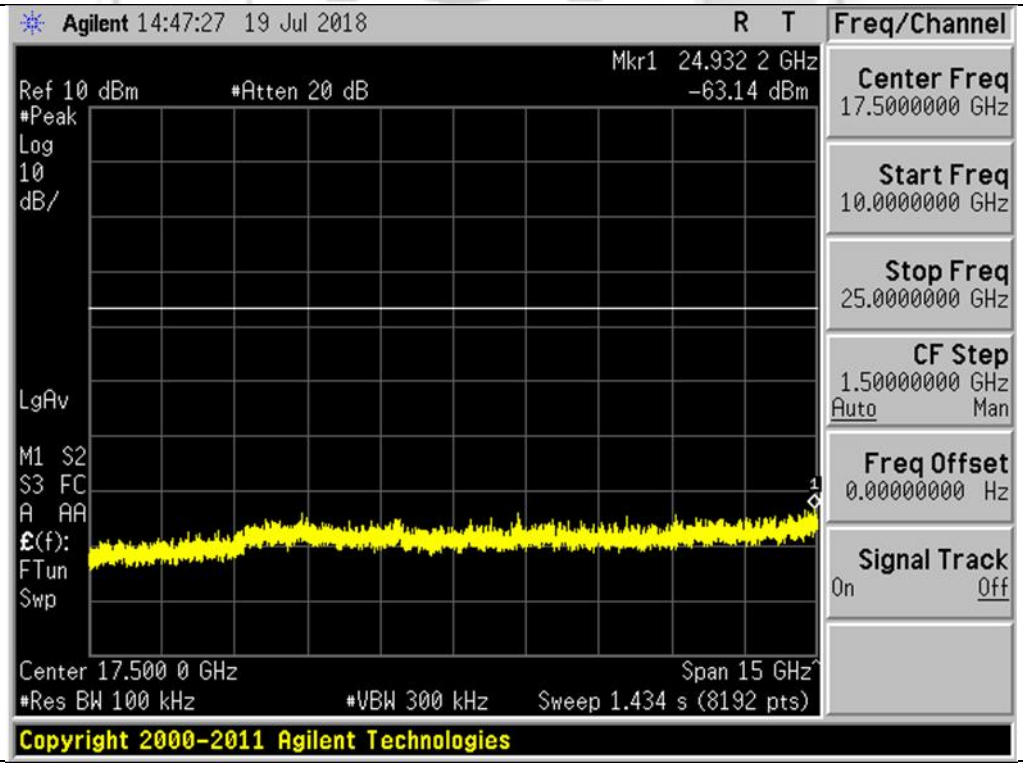
Plot 38 – Upper Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – 8DPSK



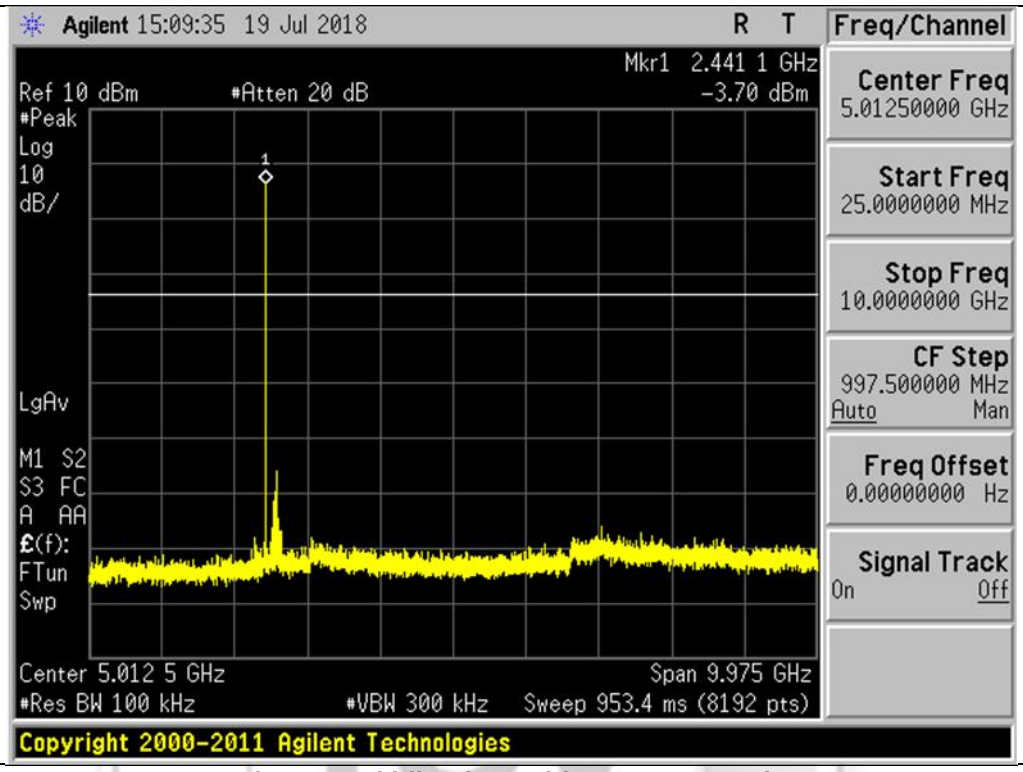
Plot 39 – Lower Channel (25MHz – 10GHz)



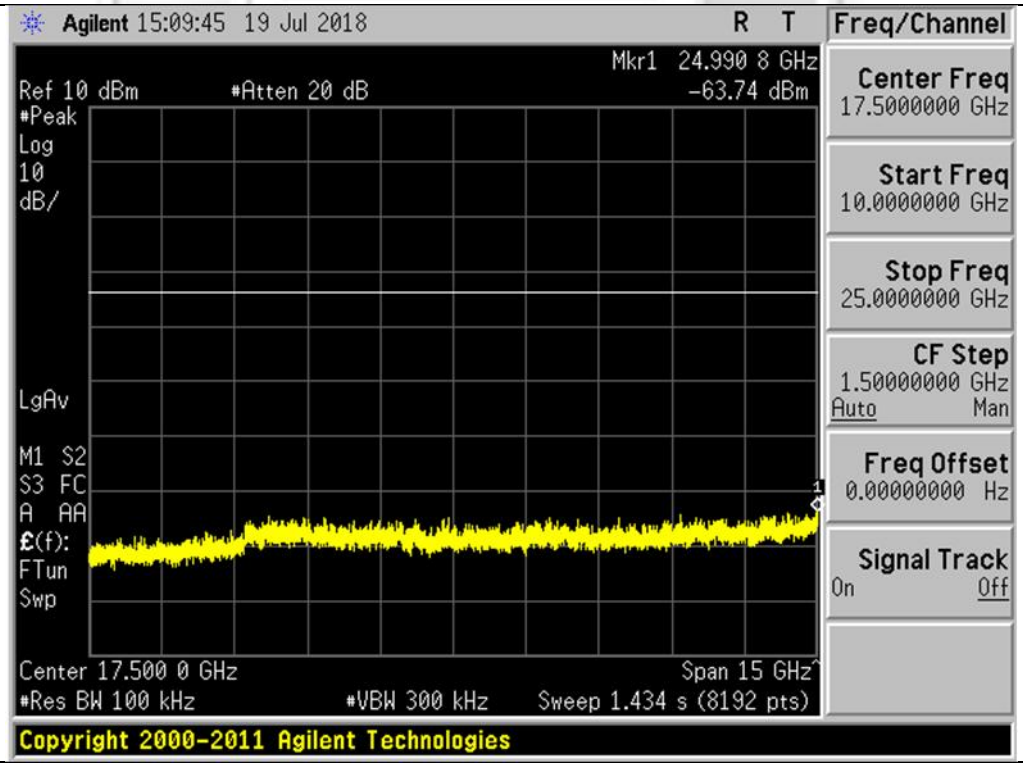
Plot 40 – Lower Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – 8DPSK



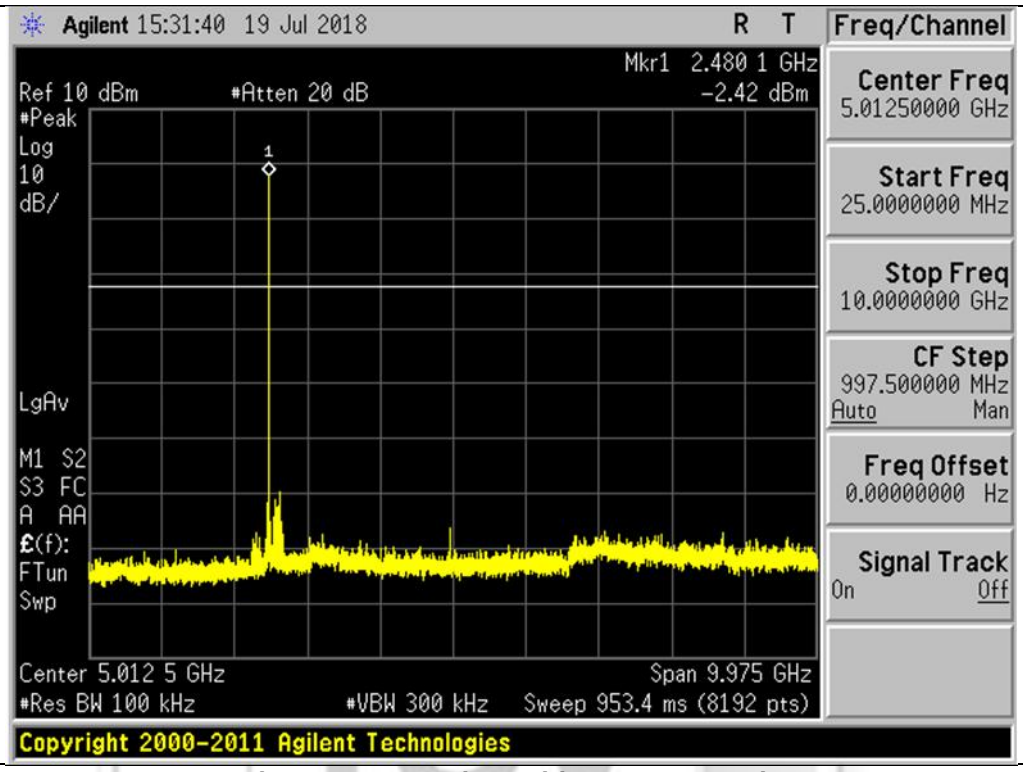
Plot 41 – Middle Channel (25MHz – 10GHz)



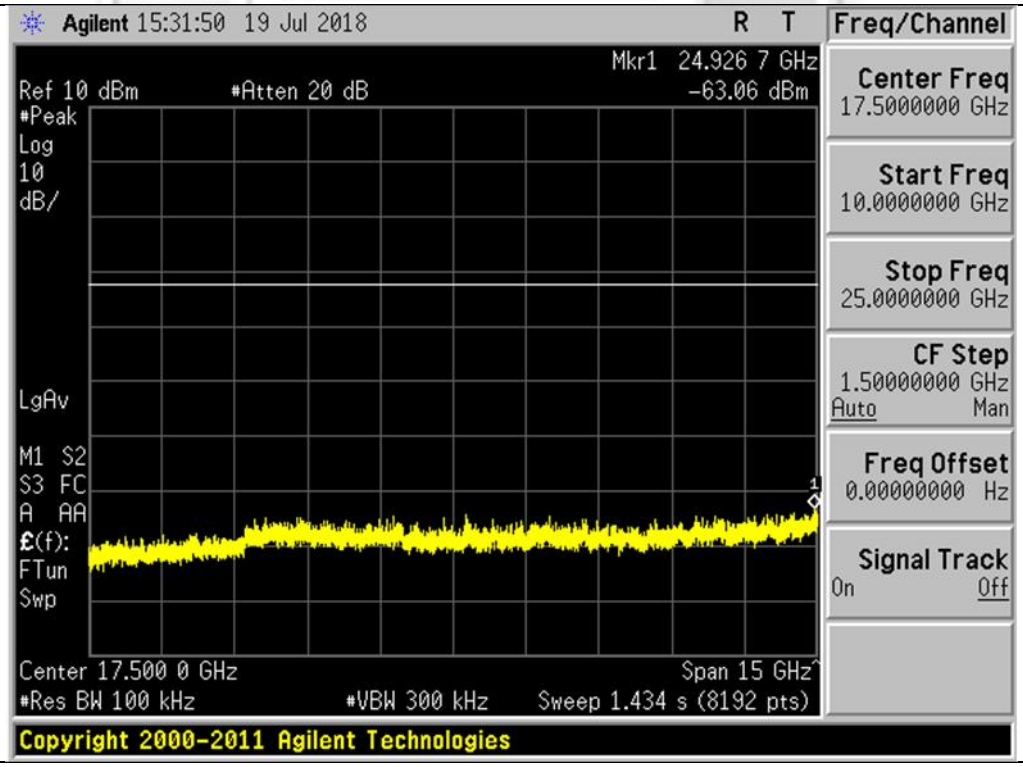
Plot 42 – Middle Channel (10GHz – 25GHz)

PSB Singapore

RF Conducted Spurious Emissions Plots – 8DPSK



Plot 43 – Upper Channel (25MHz – 10GHz)



Plot 44 – Upper Channel (10GHz – 25GHz)

PSB Singapore

2.8 Band Edge Compliance (Conducted)

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.

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

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

2.8.2.5 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 with frequency hopping sequence on.

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 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.

2.8.3.5 The measurements were repeated with turning off the frequency hopping sequence of the EUT.

PSB Singapore

2.8.4 Test Results

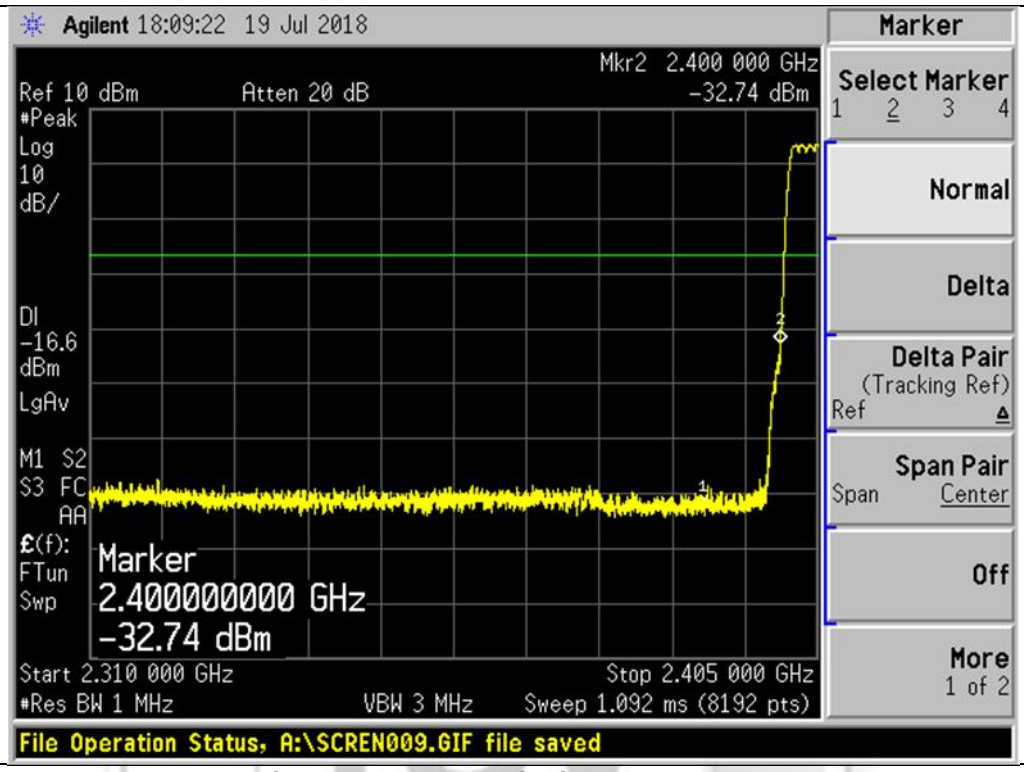
Test Input Power	3.3Vdc	Temperature	25ºC
Attached Plots	45 – 56	Relative Humidity	59%
Mode	Frequency Hopping On and Off	Atmospheric Pressure	1030mbar
		Tested By	25ºC
		Test Date	19 Jul 2018

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

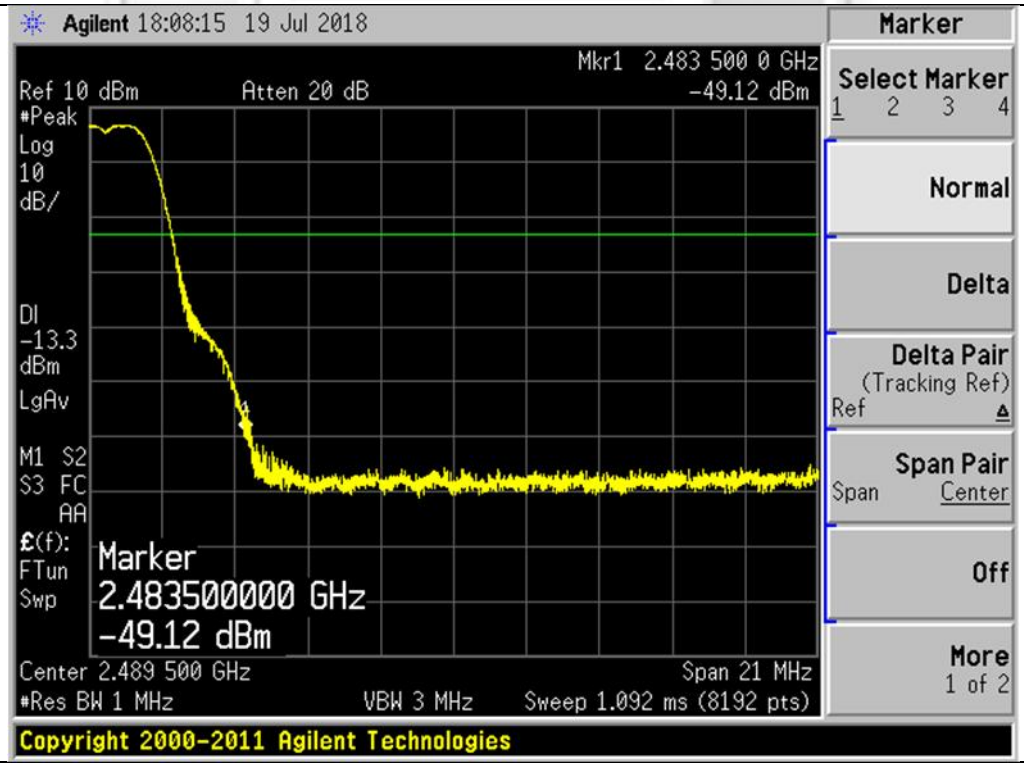
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping On

GFSK



Plot 45 – Lower Band Edge at 2.4000GHz

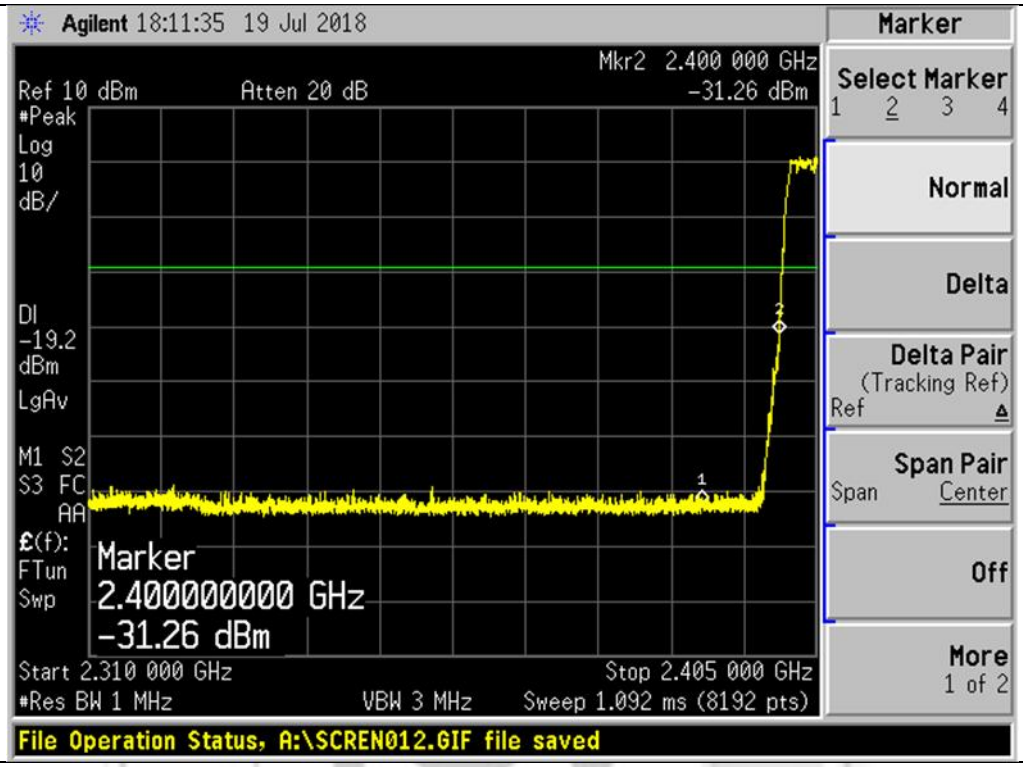


Plot 46 – Lower Band Edge at 2.4835GHz

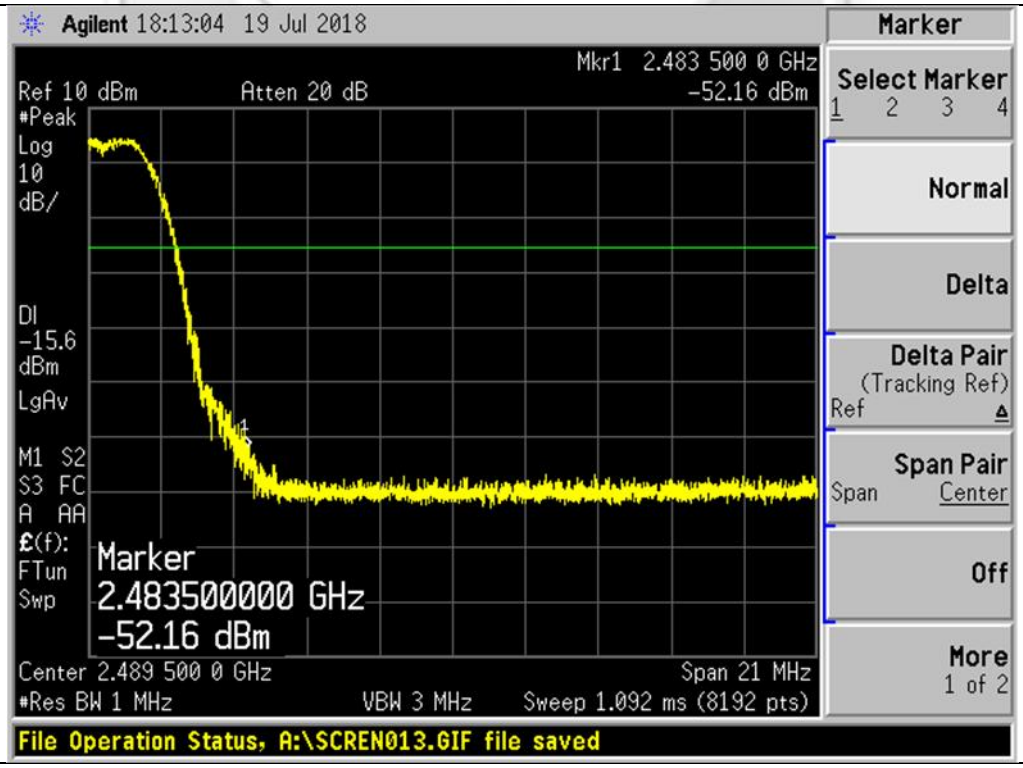
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping On

(π/4) DQPSK



Plot 47 – Lower Band Edge at 2.4000GHz

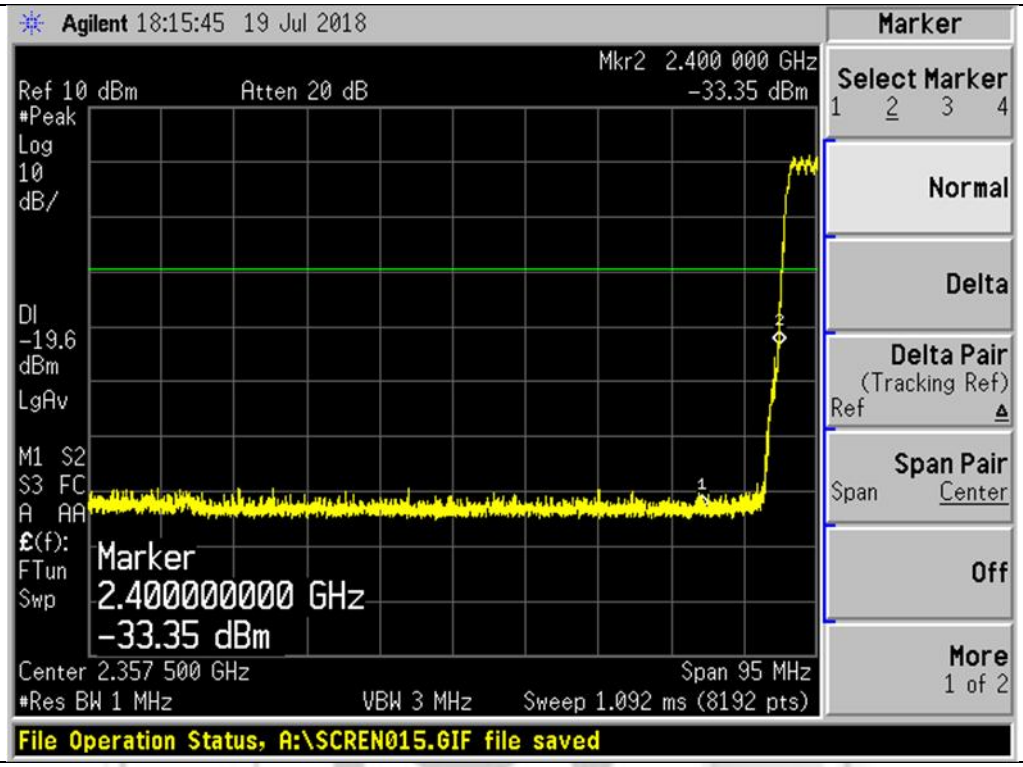


Plot 48 – Lower Band Edge at 2.4835GHz

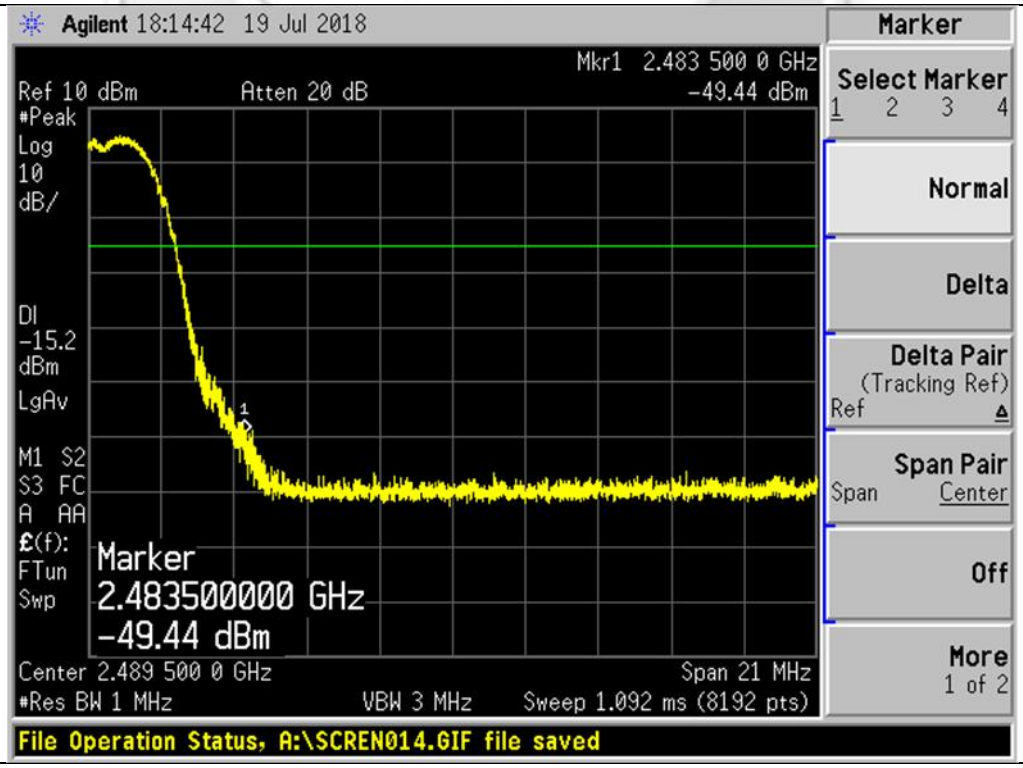
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping On

8DPSK



Plot 49 – Lower Band Edge at 2.4000GHz

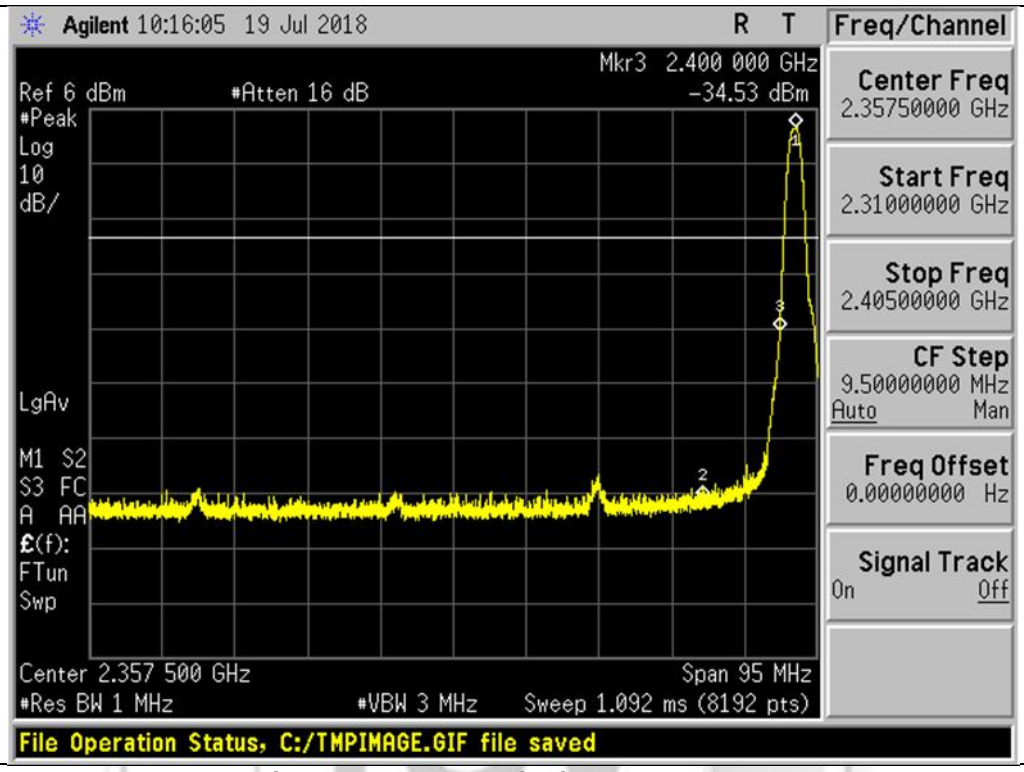


Plot 50 – Lower Band Edge at 2.4835GHz

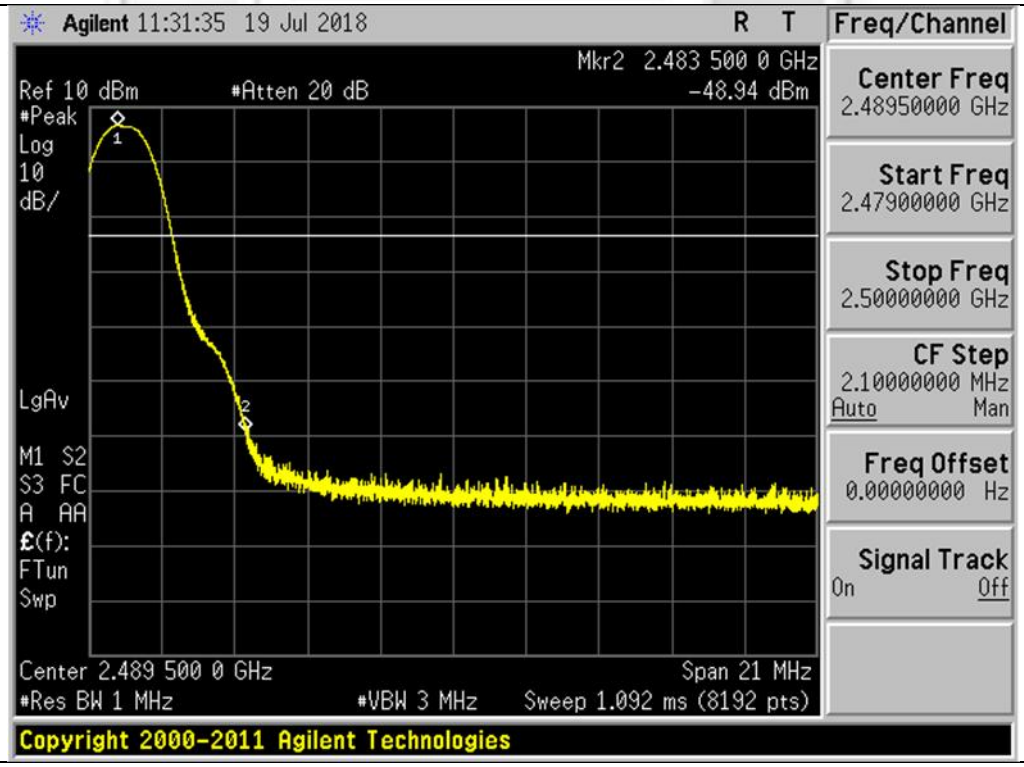
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping Off

GFSK



Plot 51 – Lower Band Edge at 2.4000GHz

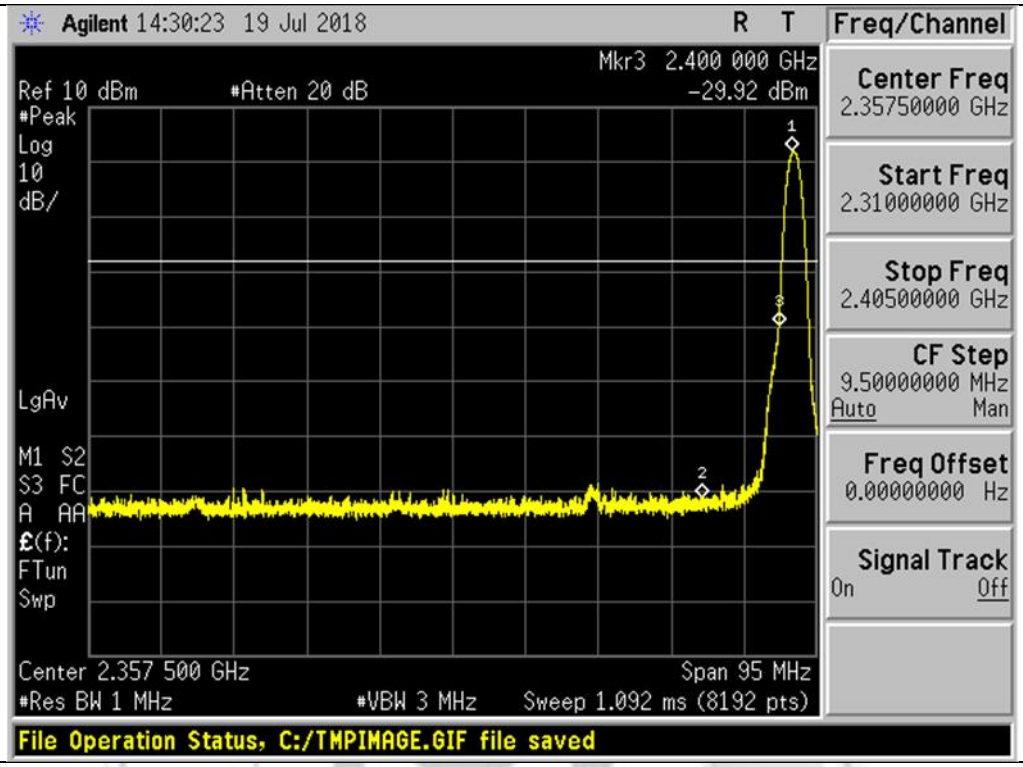


Plot 52 – Lower Band Edge at 2.4835GHz

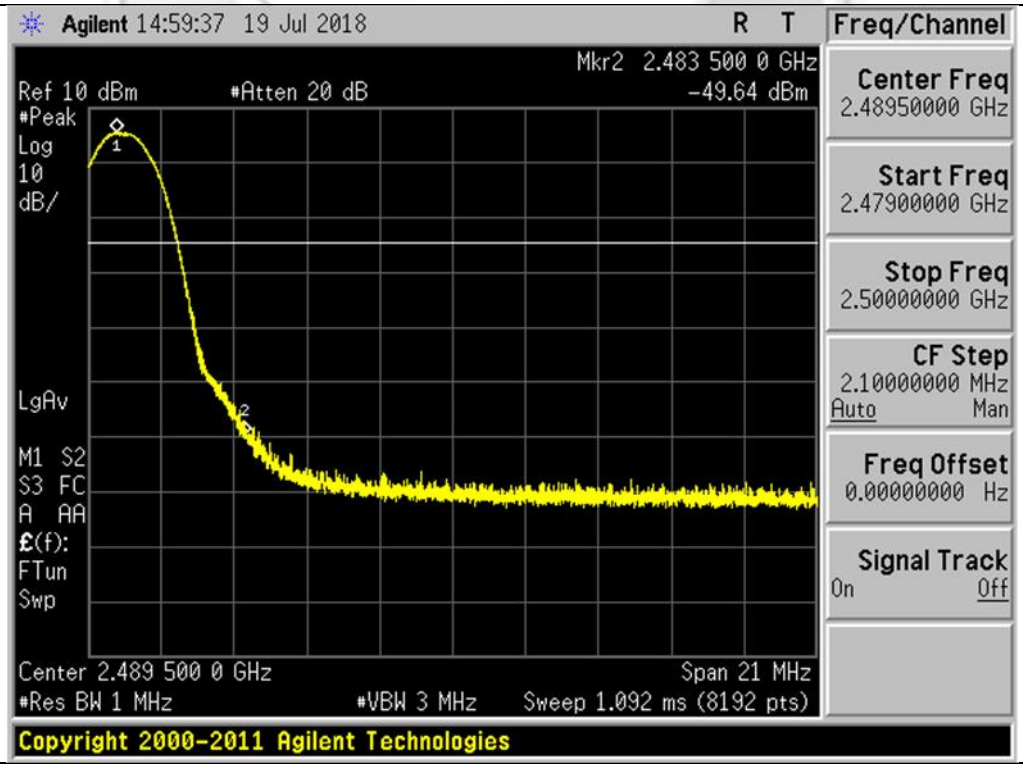
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping Off

(π/4) DQPSK



Plot 53 – Lower Band Edge at 2.4000GHz

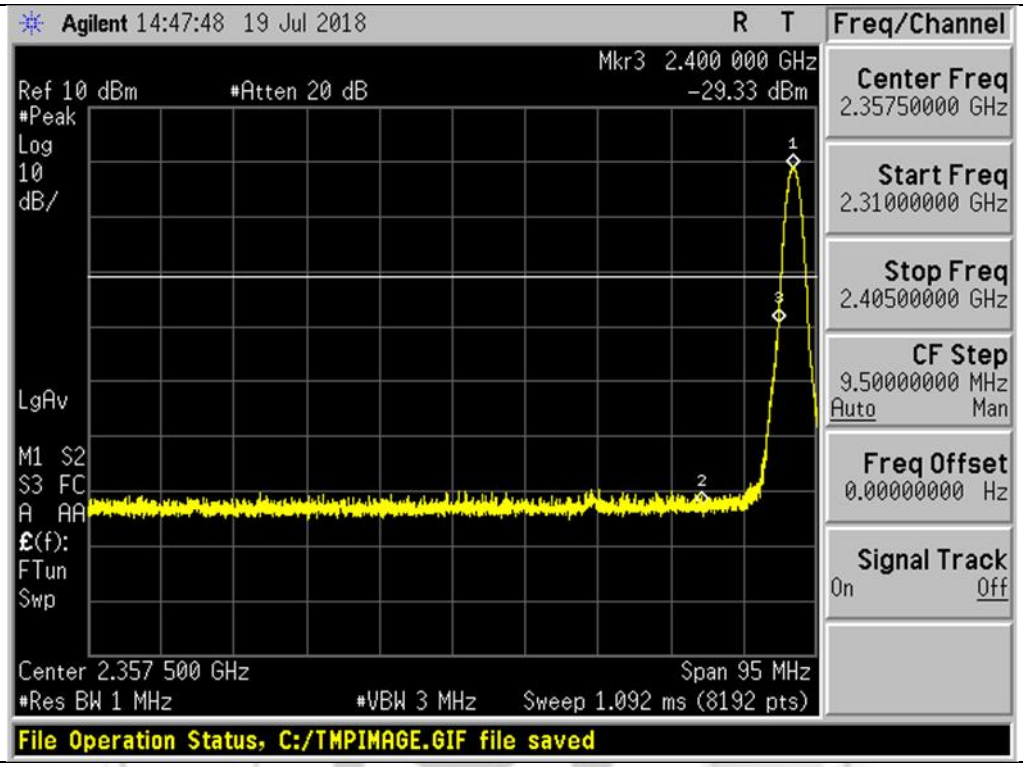


Plot 54 – Lower Band Edge at 2.4835GHz

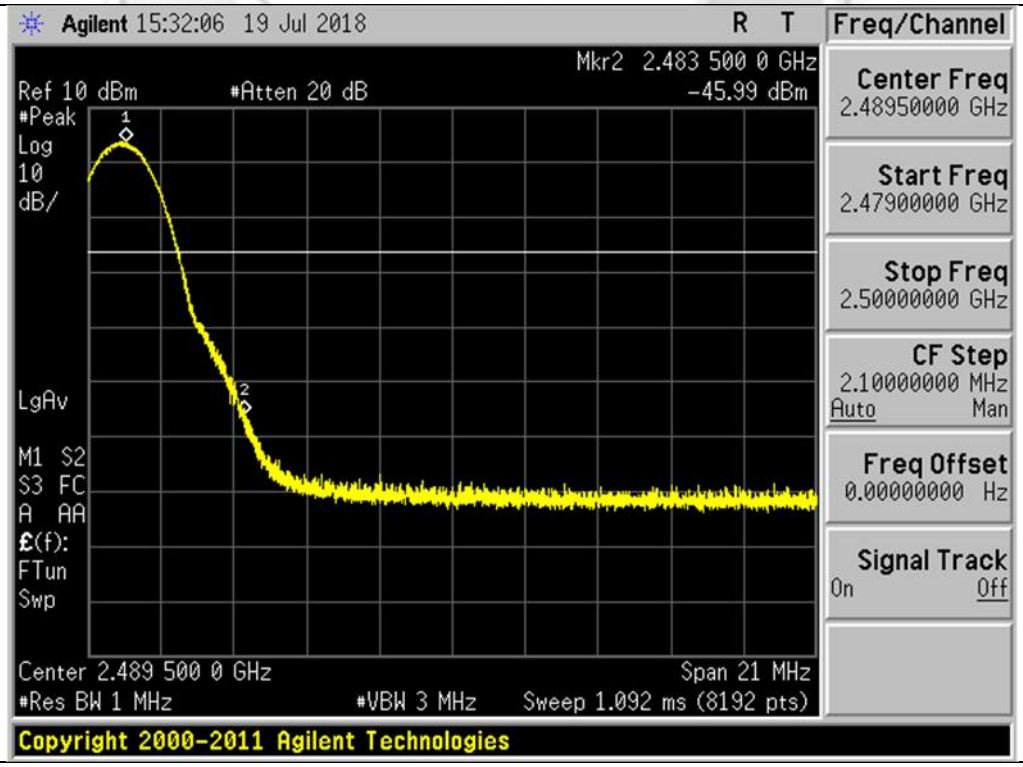
PSB Singapore

Band Edge Compliance (Conducted) Plots – Frequency Hopping Off

8DPSK



Plot 55 – Lower Band Edge at 2.4000GHz



Plot 56 – Lower Band Edge at 2.4835GHz

PSB Singapore

2.9 Band Edge Compliance (Radiated)

2.9.1 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.

2.9.2 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 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

2.9.2.4 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 with frequency hopping sequence on.

2.9.3.2 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.

2.9.3.3 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.

2.9.3.4 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.

PSB Singapore

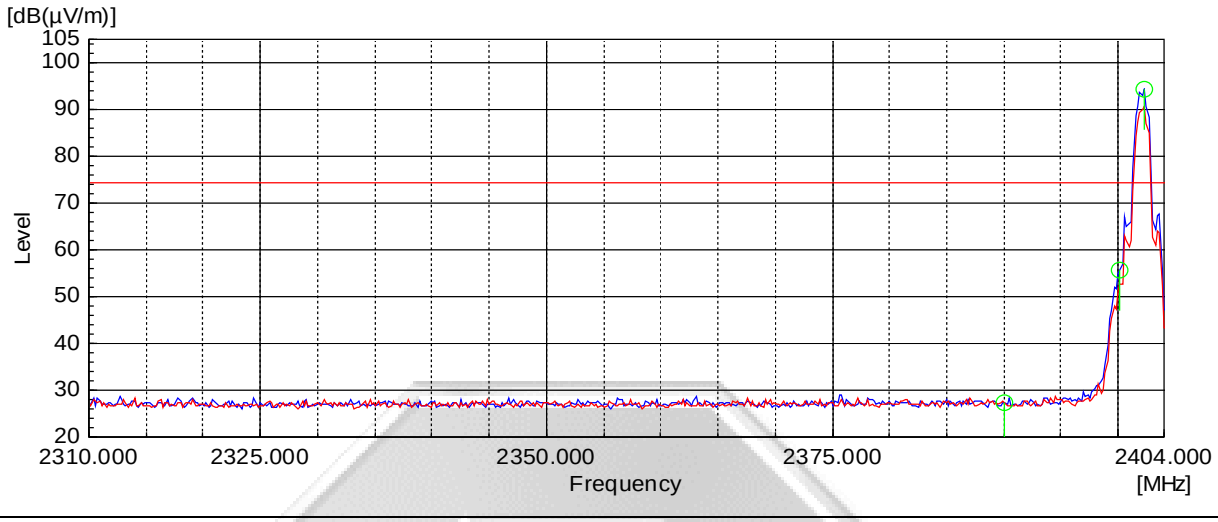
2.9.4 Test Results

Test Input Power	3.3Vdc	Temperature	24ºC
Attached Plots	57 – 62	Relative Humidity	60%
Mode	Frequency Hopping Off	Atmospheric Pressure	1030mbar
Modulation	GFSK (Worst)	Tested By	Dylan Lin
		Test Date	01 Aug 2018

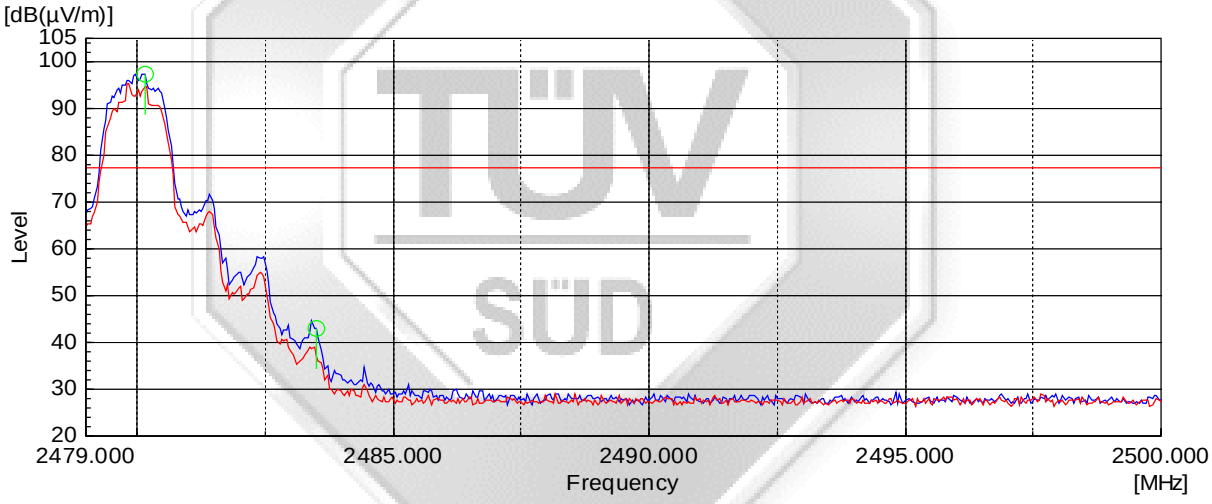
No significant signal was found and they were below the specified limit.

PSB Singapore

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



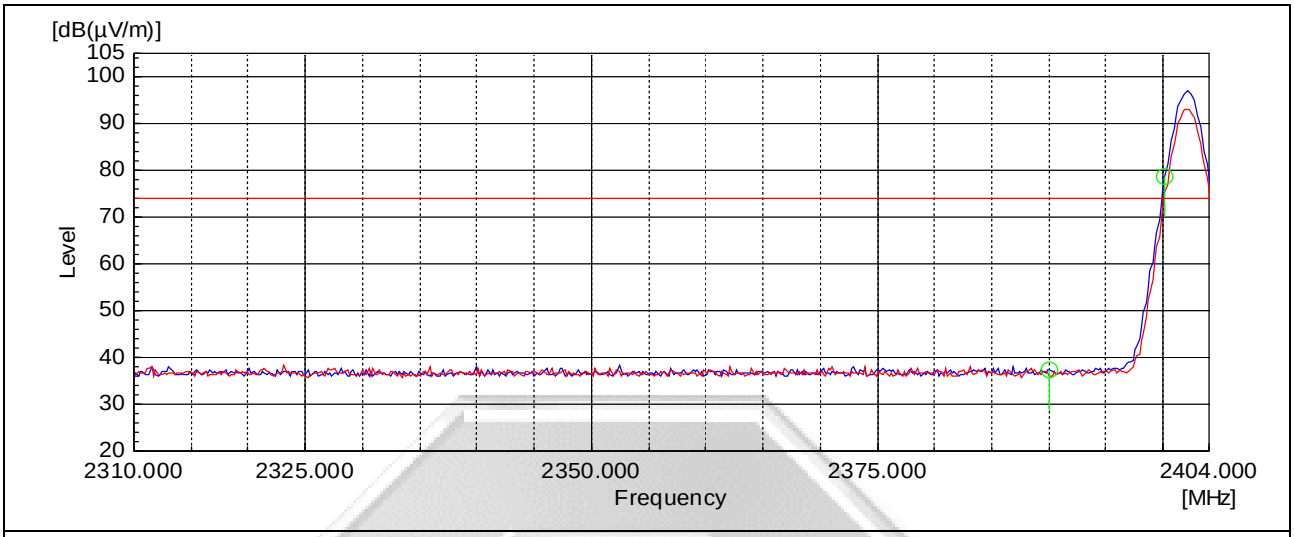
Plot 57 – Lower Band Edge at 2.4000GHz



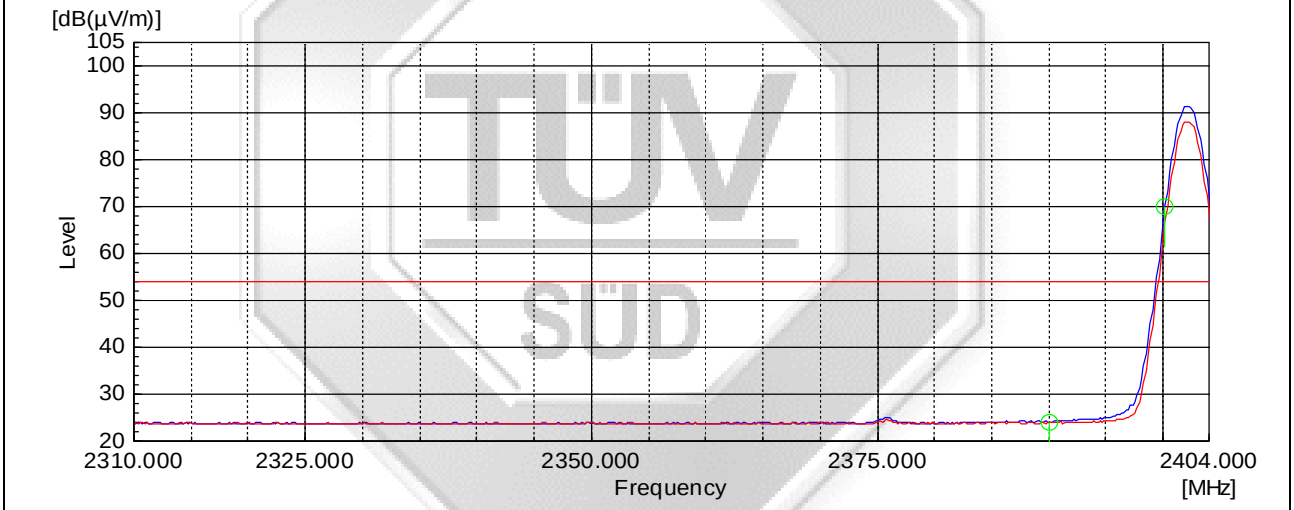
Plot 58 – Upper Band Edge at 2.4835GHz

PSB Singapore

Band Edge Compliance (Radiated) Plots (Restricted Band)



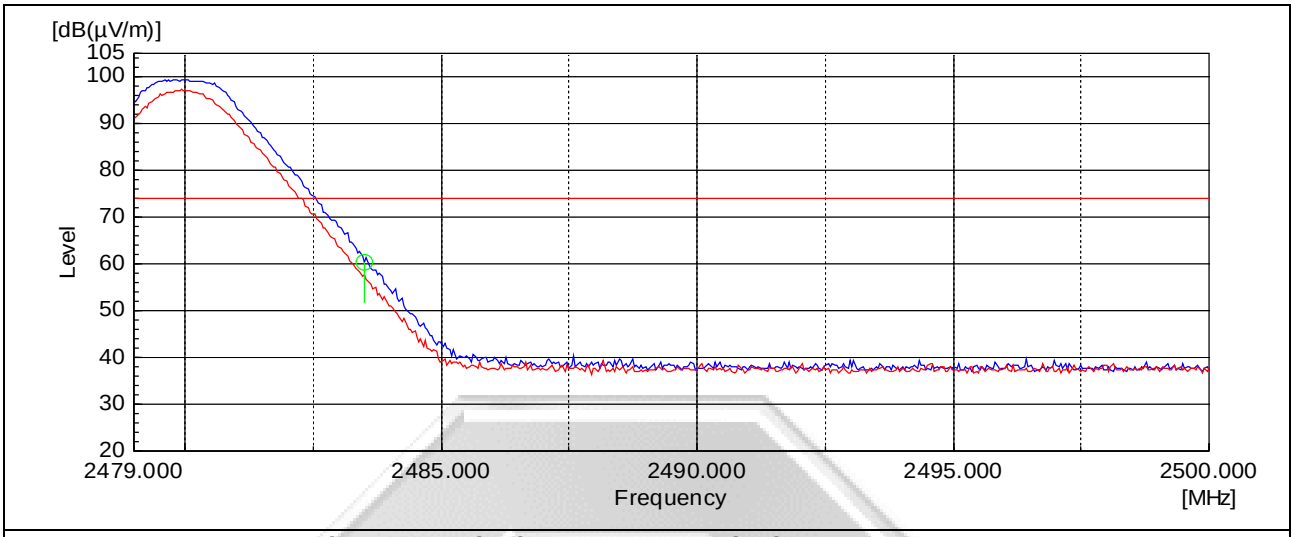
Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz



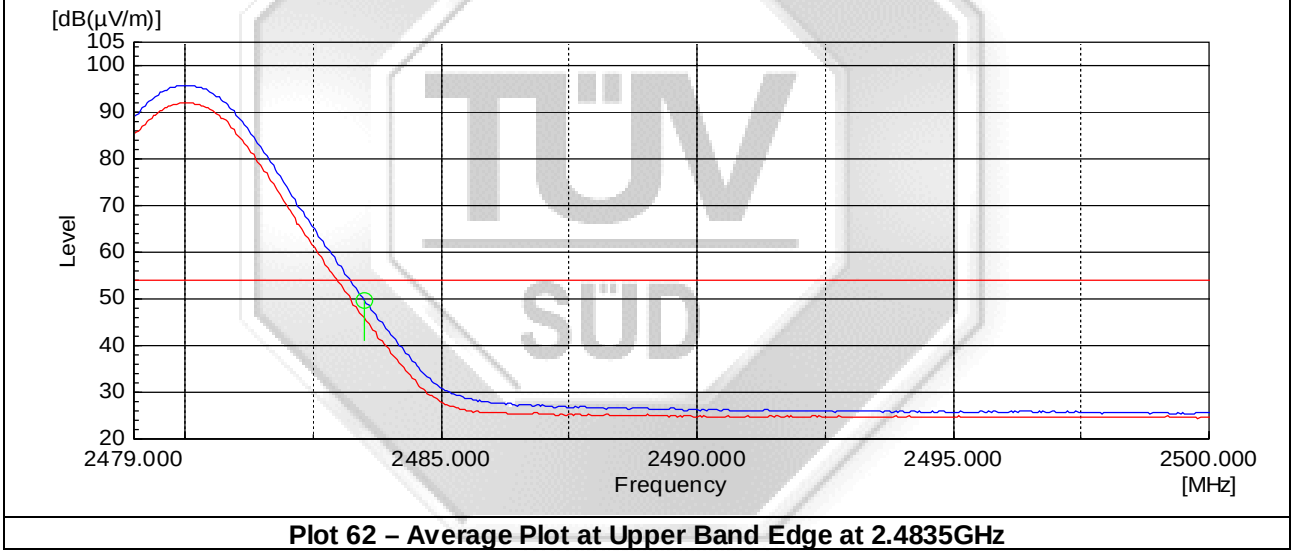
Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

PSB Singapore

Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 61 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 62 – Average Plot at Upper Band Edge at 2.4835GHz

PSB Singapore

2.10 Peak Power Spectral Density

2.10.1 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.

2.10.2 Test Setup

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

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

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

2.10.2.4 The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 3kHz and 10kHz.

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

2.10.3 Test Method

2.10.3.1 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, non-hopping with transmitting frequency at lower channel .

2.10.3.2 The sweep time of the spectrum analyser was set to the value of the ratio of the frequency span divided by the RBW.

2.10.3.3 The peak power density of the transmitting frequency was detected and recorded.

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

PSB Singapore

2.10.4 Test Results

Test Input Power	3.3Vdc	Temperature	24ºC
Attached Plots	63 – 71	Relative Humidity	58%
		Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li
		Test Date	19 Jul 2018

GFSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
Lower	2.402	0.081	6.3
Middle	2.441	0.131	6.3
Upper	2.480	0.199	6.3

(π/4) DQPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
Lower	2.402	0.052	6.3
Middle	2.441	0.077	6.3
Upper	2.480	0.118	6.3

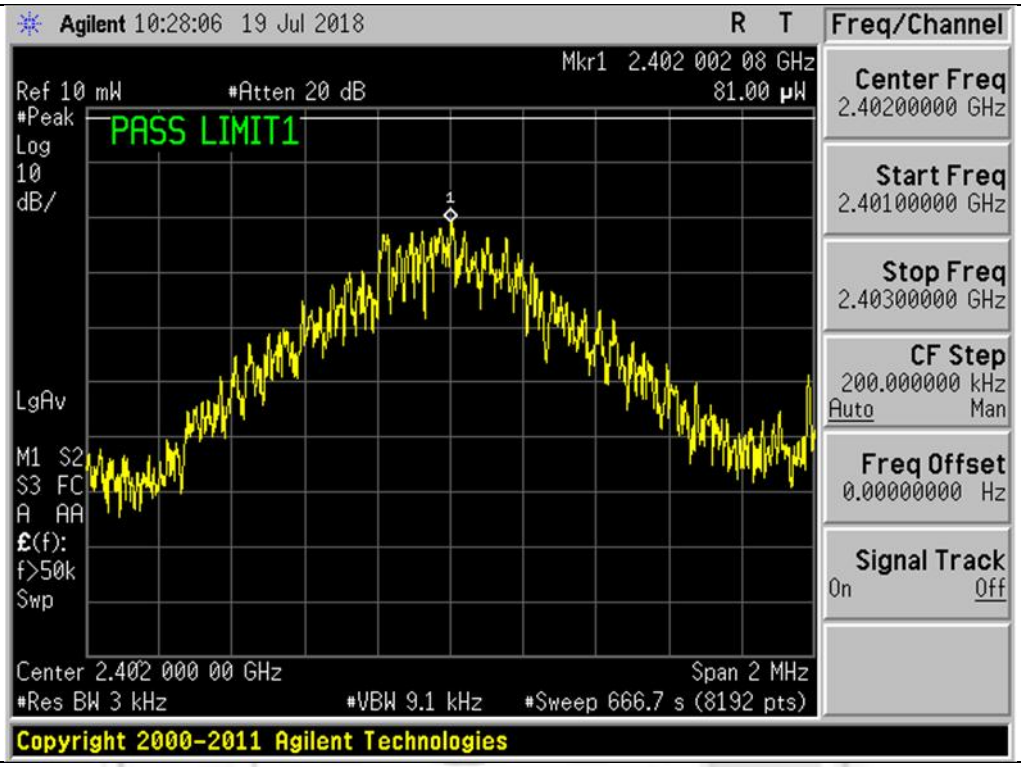
8DPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
Lower	2.402	0.022	6.3
Middle	2.441	0.038	6.3
Upper	2.480	0.065	6.3

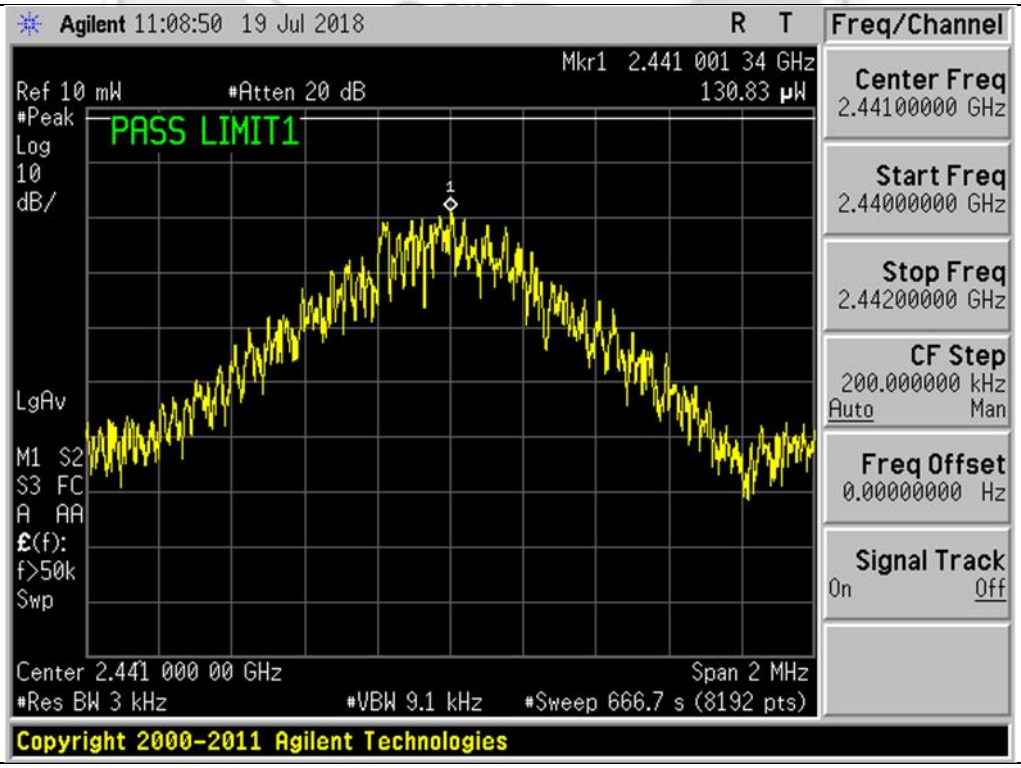
PSB Singapore

Peak Power Spectral Density Plots

GFSK



Plot 63 – Lower Channel

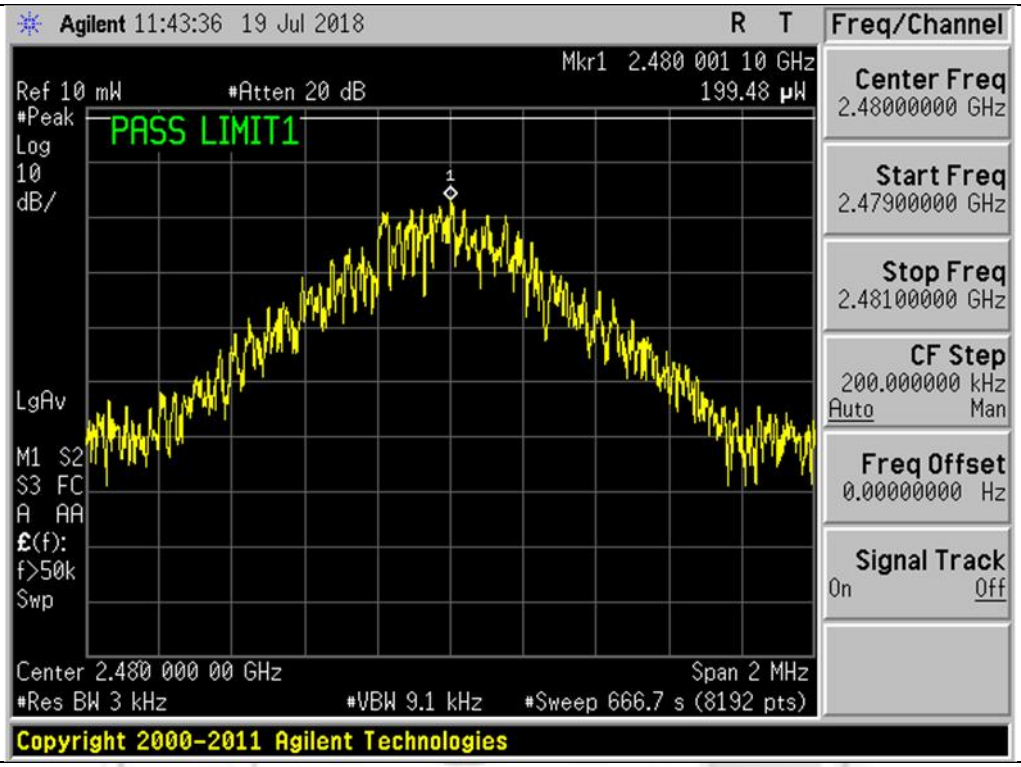


Plot 64 – Middle Channel

PSB Singapore

Peak Power Spectral Density Plots

GFSK

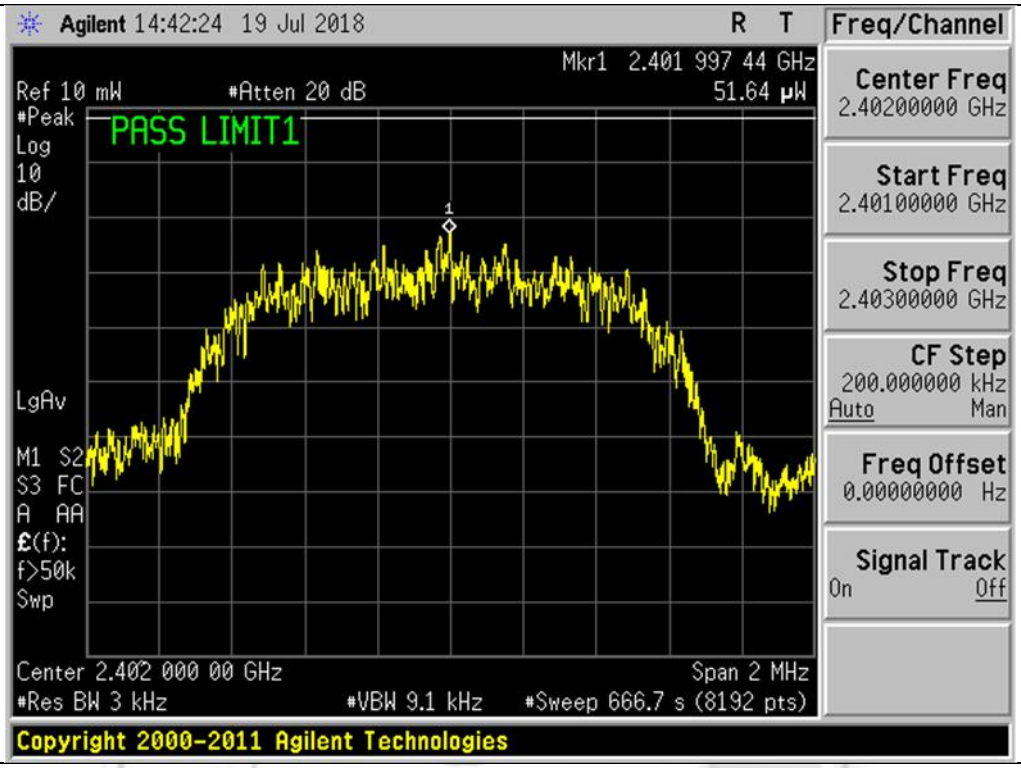


Plot 65 – Upper Channel

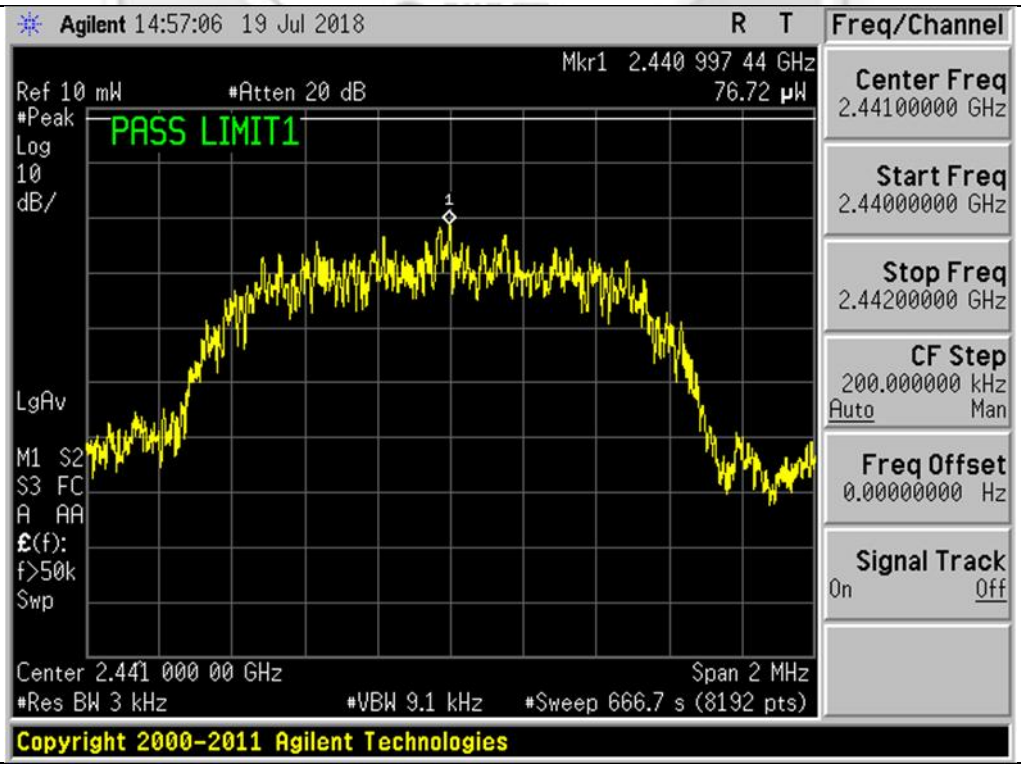
PSB Singapore

Peak Power Spectral Density Plots

(π/4) DQPSK



Plot 66 – Lower Channel

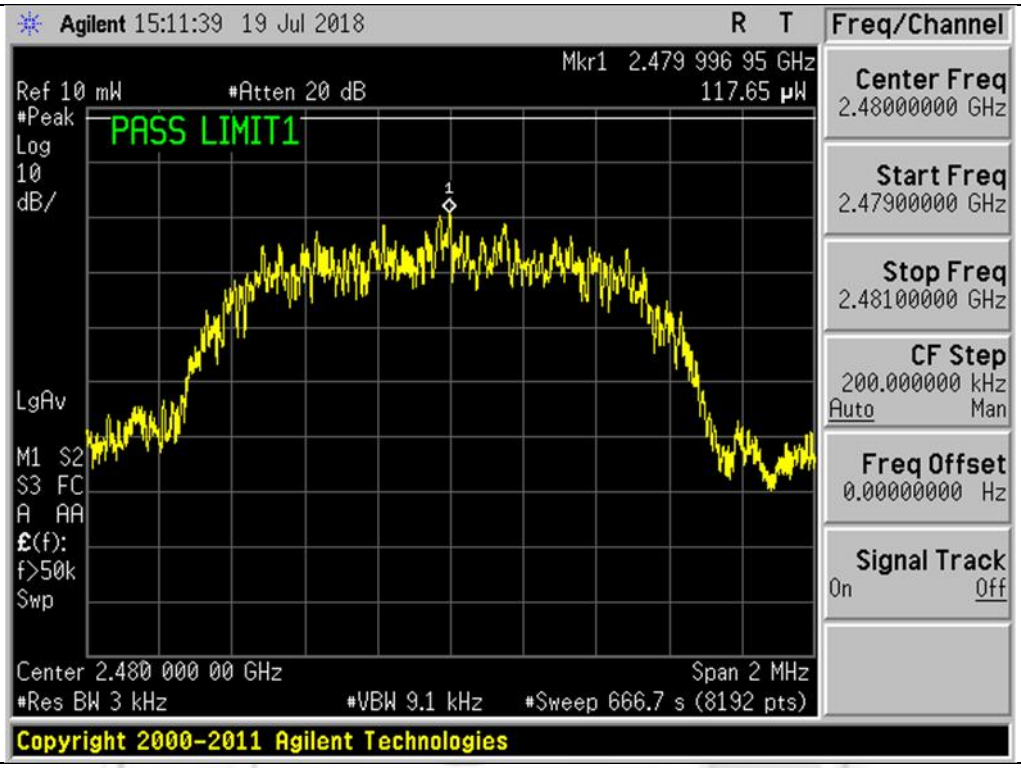


Plot 67 – Middle Channel

PSB Singapore

Peak Power Spectral Density Plots

(π/4) DQPSK

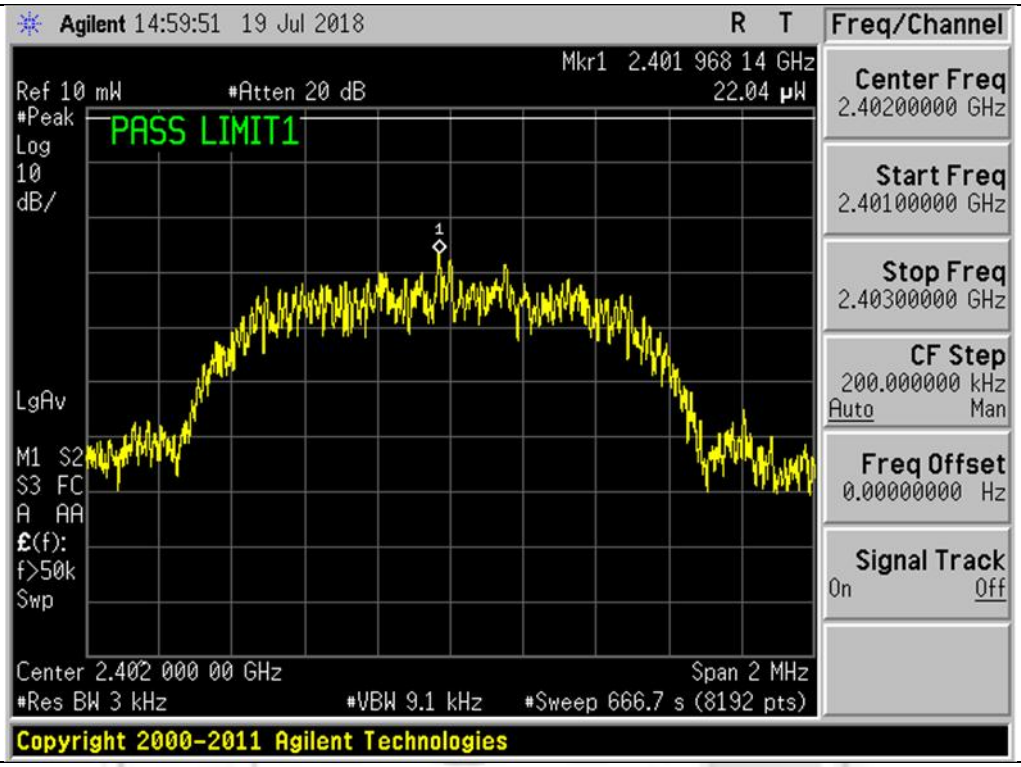


Plot 68 – Upper Channel

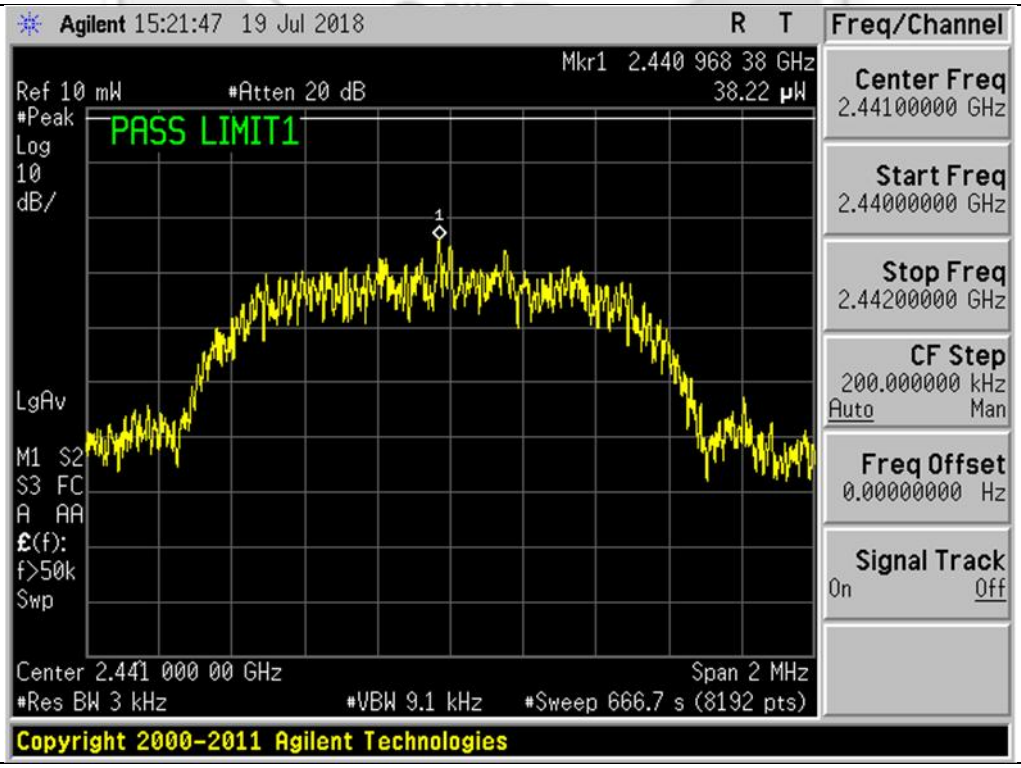
PSB Singapore

Peak Power Spectral Density Plots

8DPSK



Plot 69 – Lower Channel

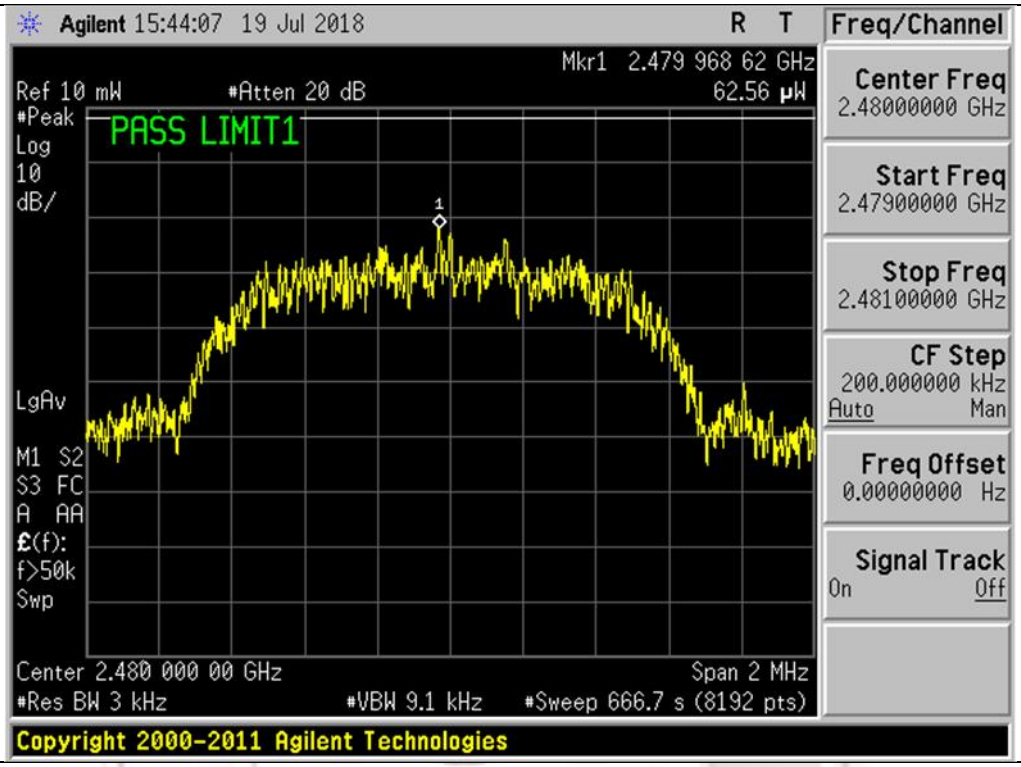


Plot 70 – Middle Channel

PSB Singapore

Peak Power Spectral Density Plots

8DPSK



Plot 71 – Upper Channel

PSB Singapore

2.11 Maximum Permissible Exposure (MPE)

2.11.1 Test Limits

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	180 / f^2 Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

Maximum Permissible Exposure Computation

The power density at 20cm distance was computed from the following formula:

$S = (30GP) / (377d^2)$

where S = Power density in W/m^2
P = 0.0025W
d = Test distance at 0.2m
G = Numerical isotropic gain, 1.58 (2.0 dBi)

Substituting the relevant parameters into the formula:

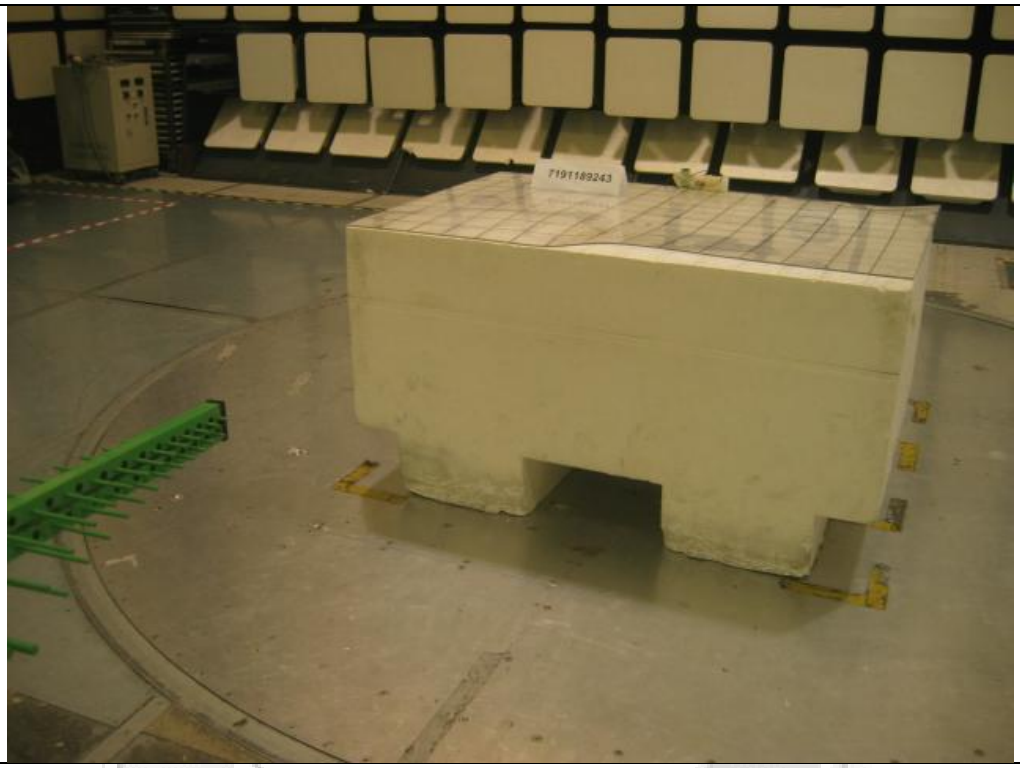
$S = [(30GP) / 377d^2]$
$= 0.0079\ W/m^2$
$= 0.0008\ mW/cm^2$

∴ The power density of the EUT at 20cm distance is $0.0008mW/cm^2$ based on the above computation and found to be lower than the power density limit of $1.0mW/cm^2$.

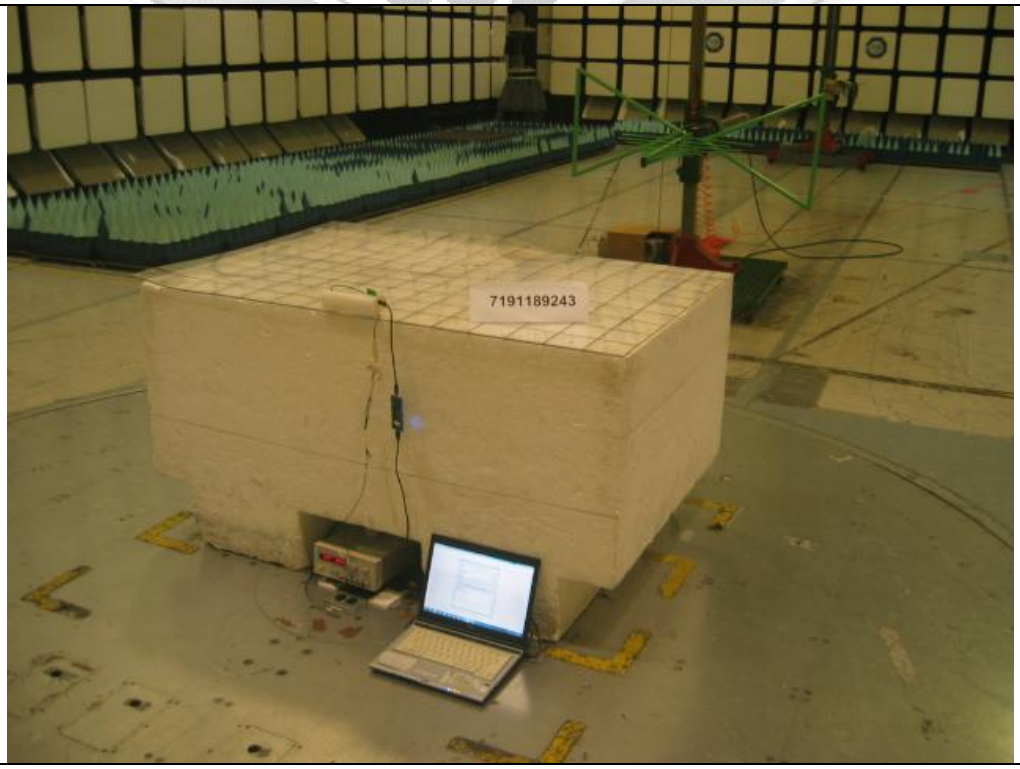
PSB Singapore

3 Photographs

TEST SETUP (30MHz to 1GHz)



Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Front View)

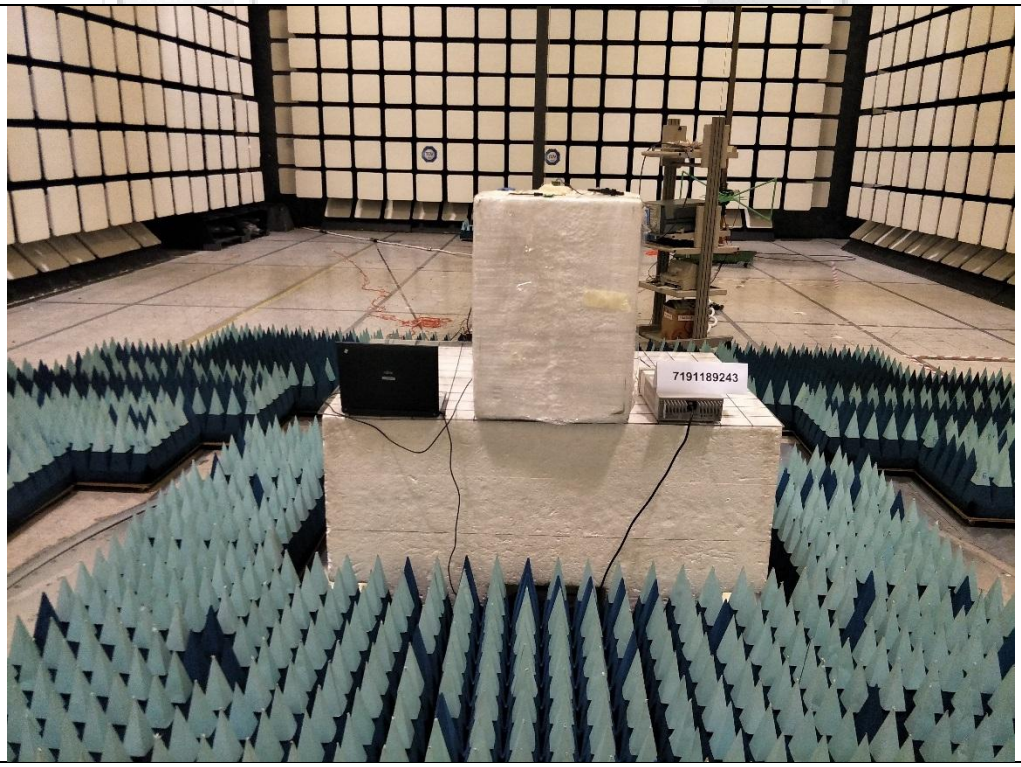


Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Rear View)

PSB Singapore

TEST SETUP (Above 1GHz)

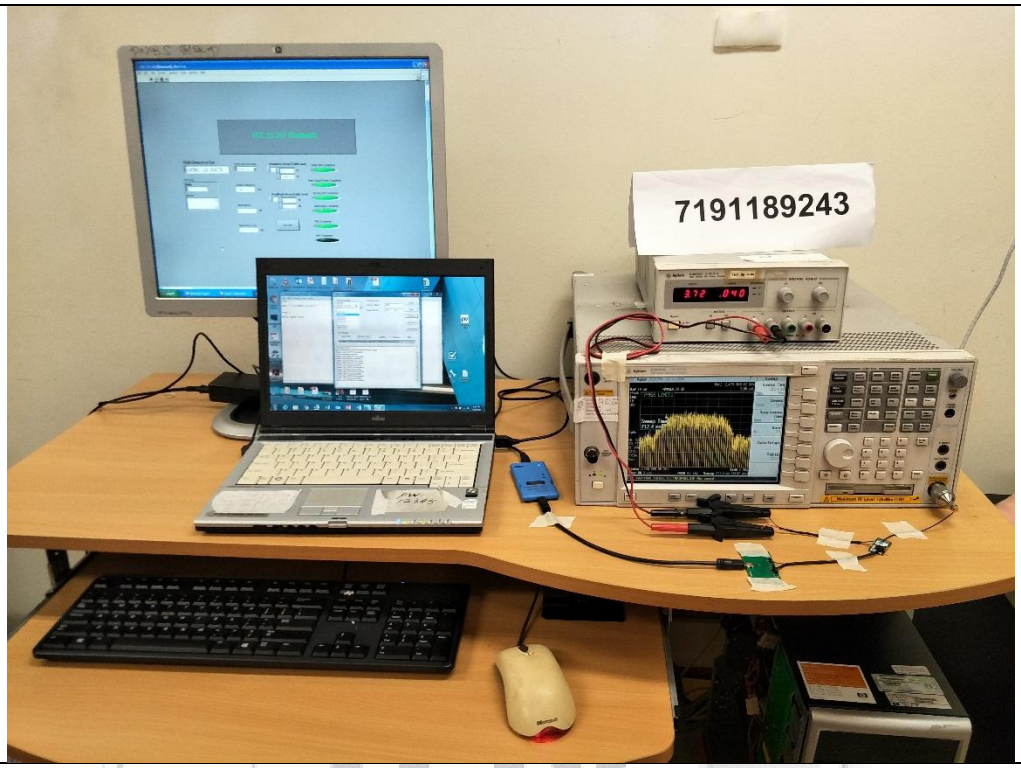
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Front View)



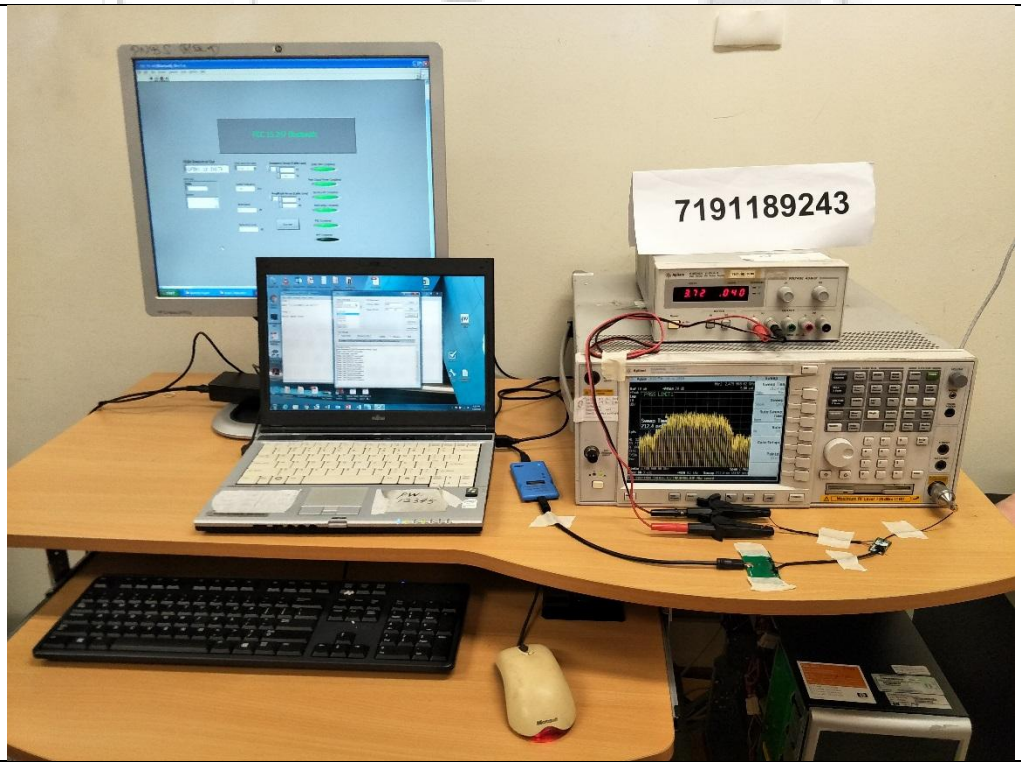
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement) Test Setup (Rear View)

PSB Singapore

TEST SETUP



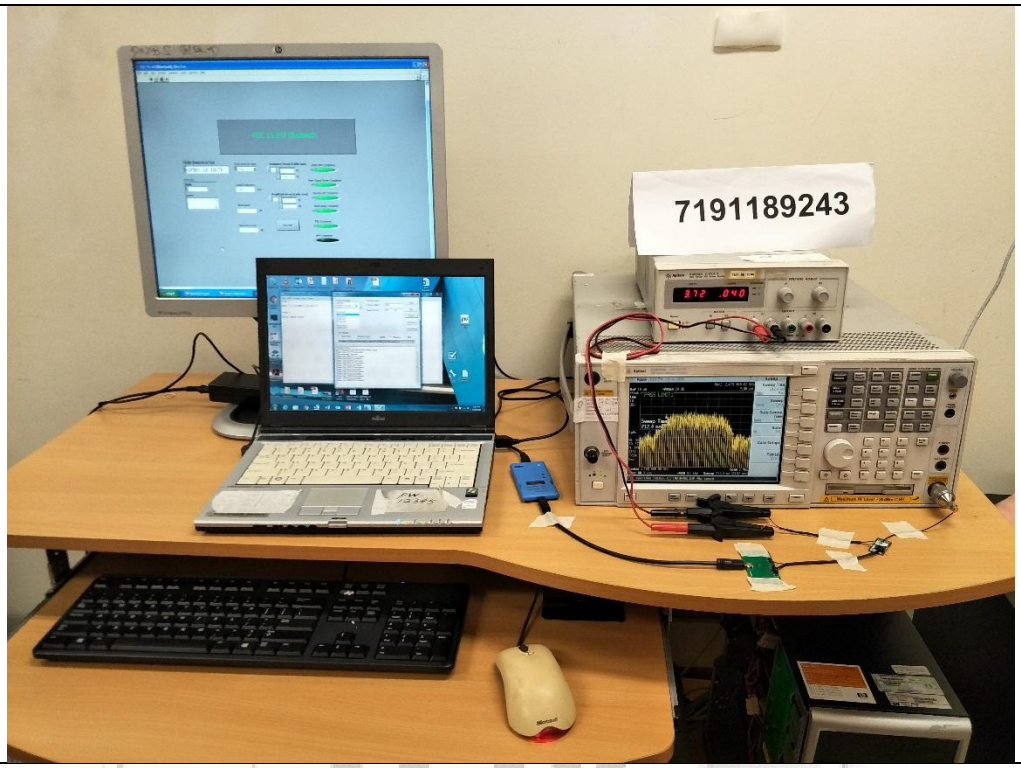
Carrier Frequency Separation Test Setup



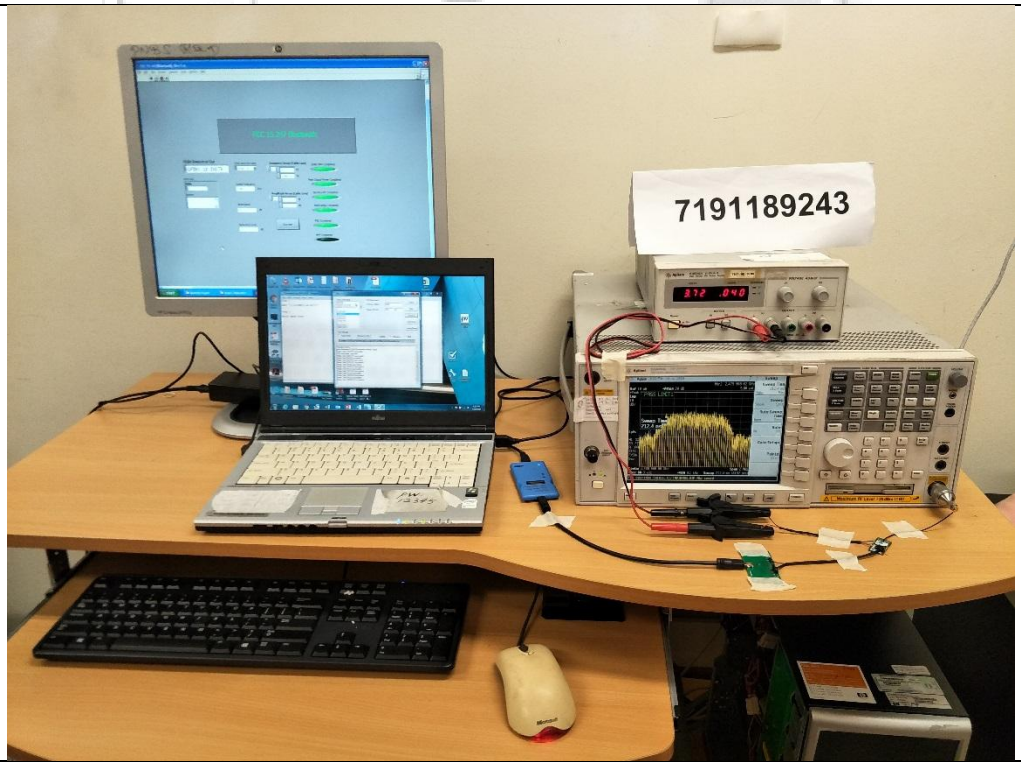
Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

PSB Singapore

TEST SETUP



Number of Hopping Frequencies Test Setup

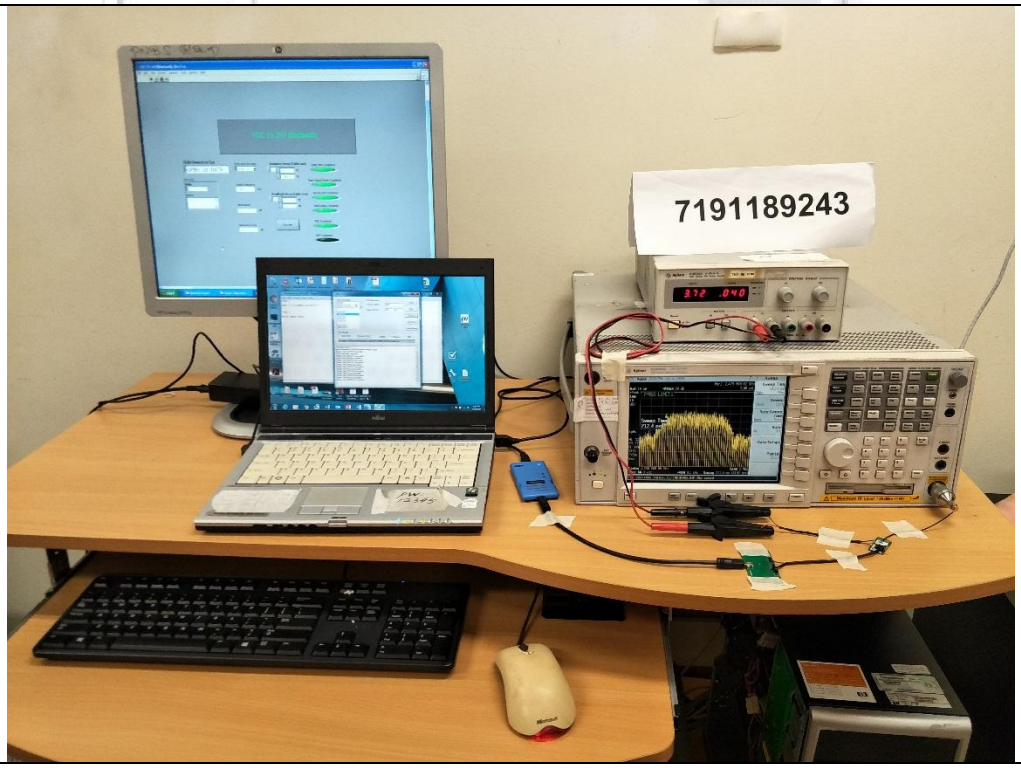


Average Frequency Dwell Time Test Setup

PSB Singapore

TEST SETUP

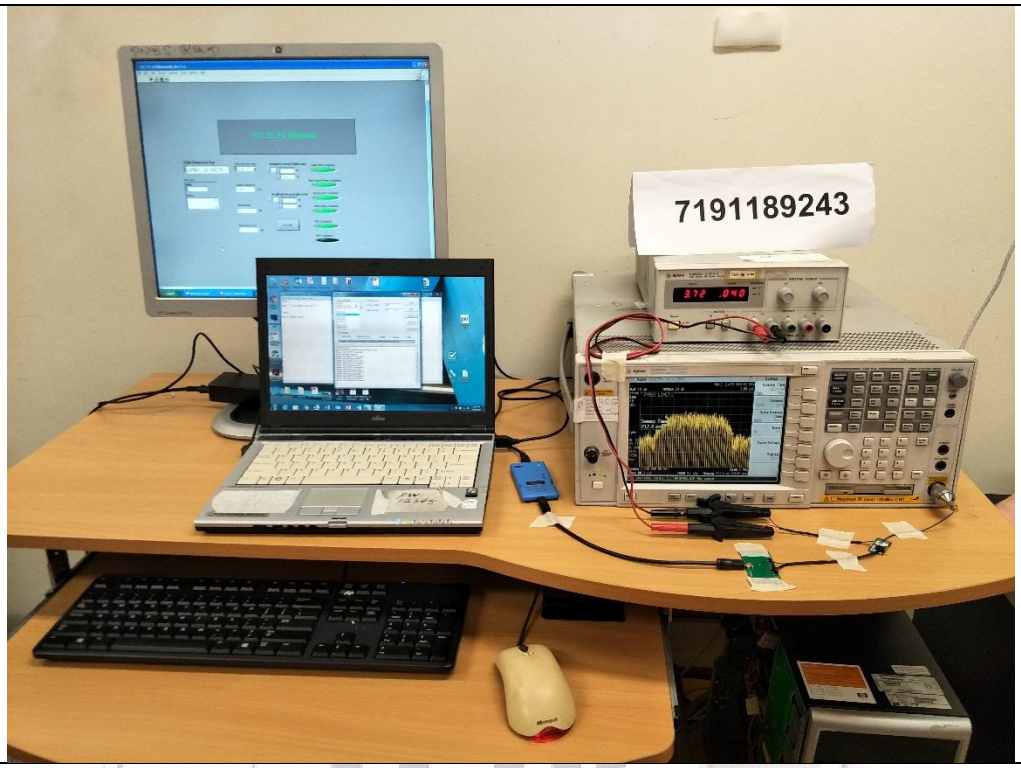
Maximum Peak Power Test Setup



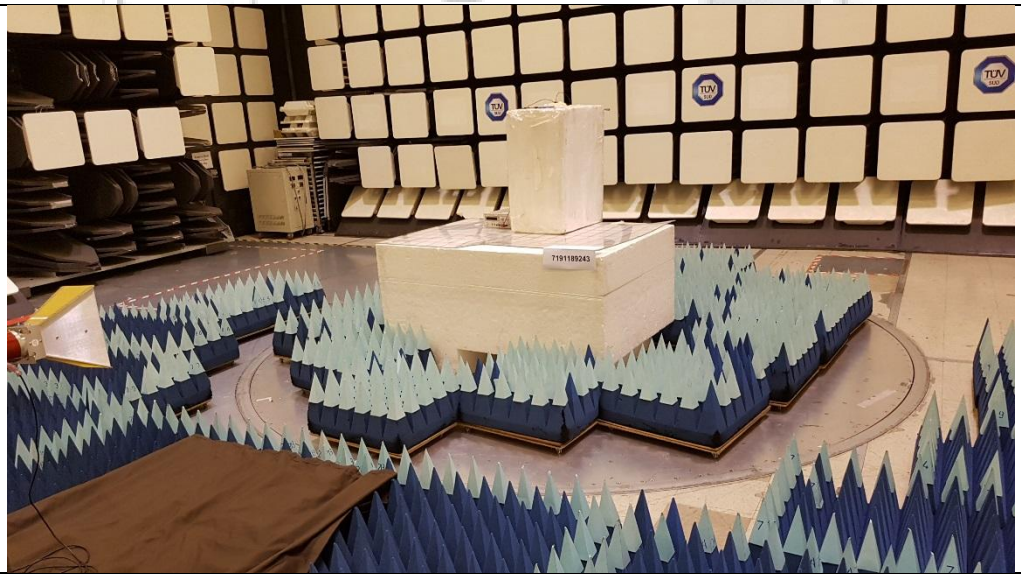
RF Conducted Spurious Emissions Test Setup

PSB Singapore

TEST SETUP



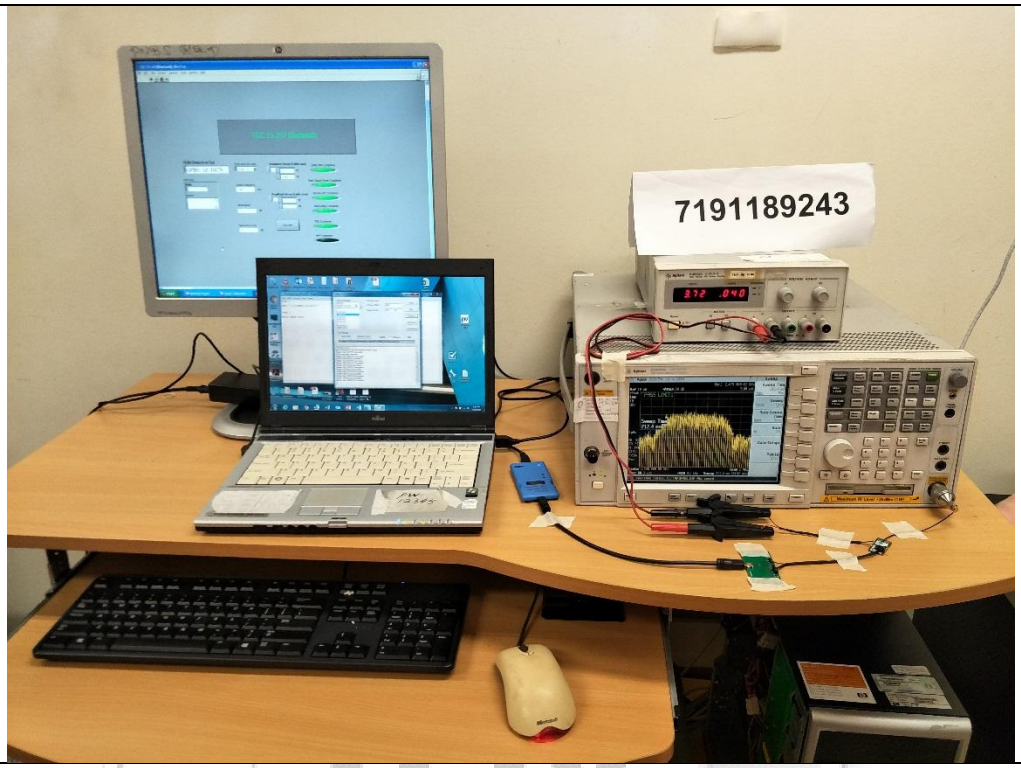
Band Edge Compliance (Conducted) Test Setup



Band Edge Compliance (Radiated) Test Setup

PSB Singapore

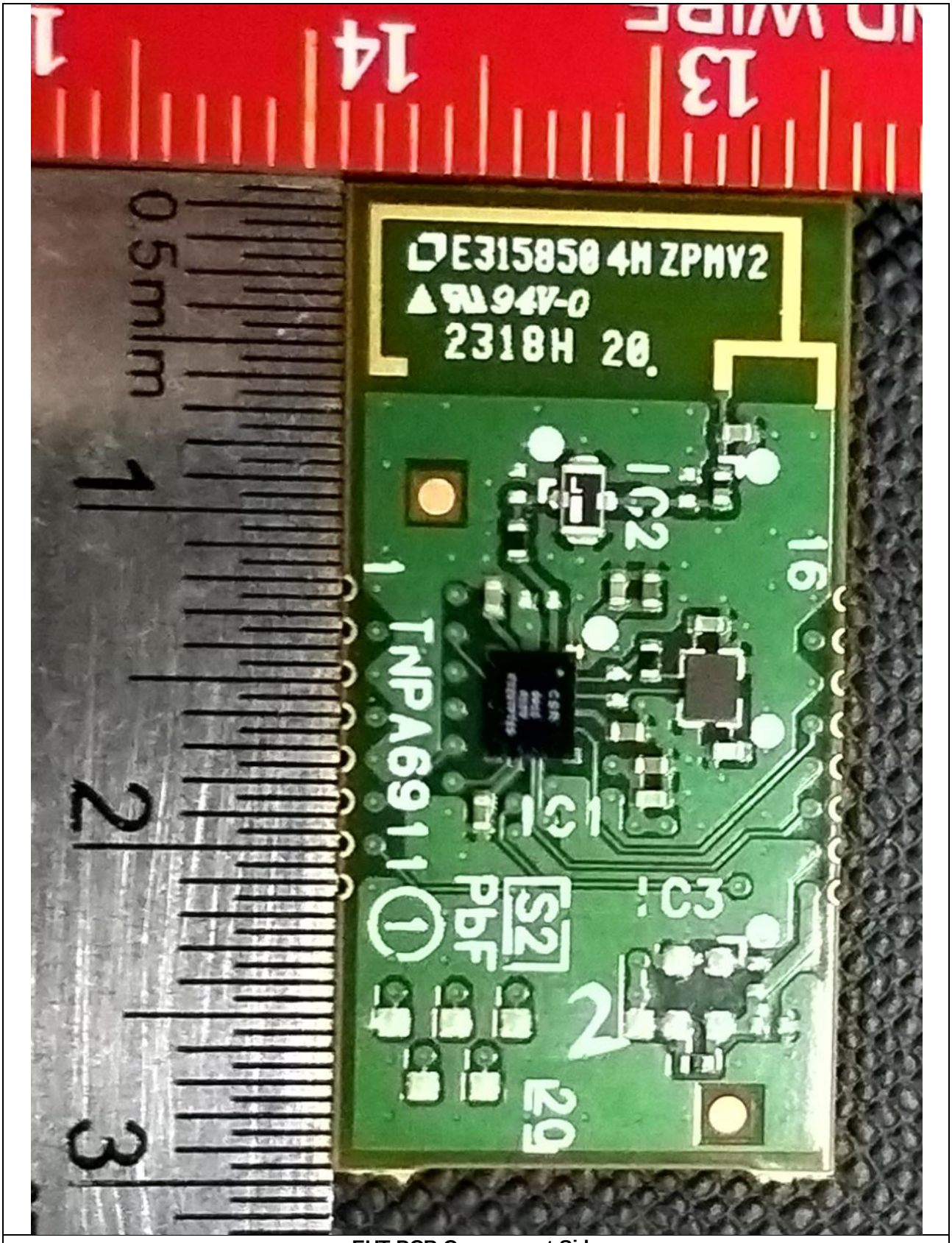
TEST SETUP



Peak Power Spectral Density Test Setup

PSB Singapore

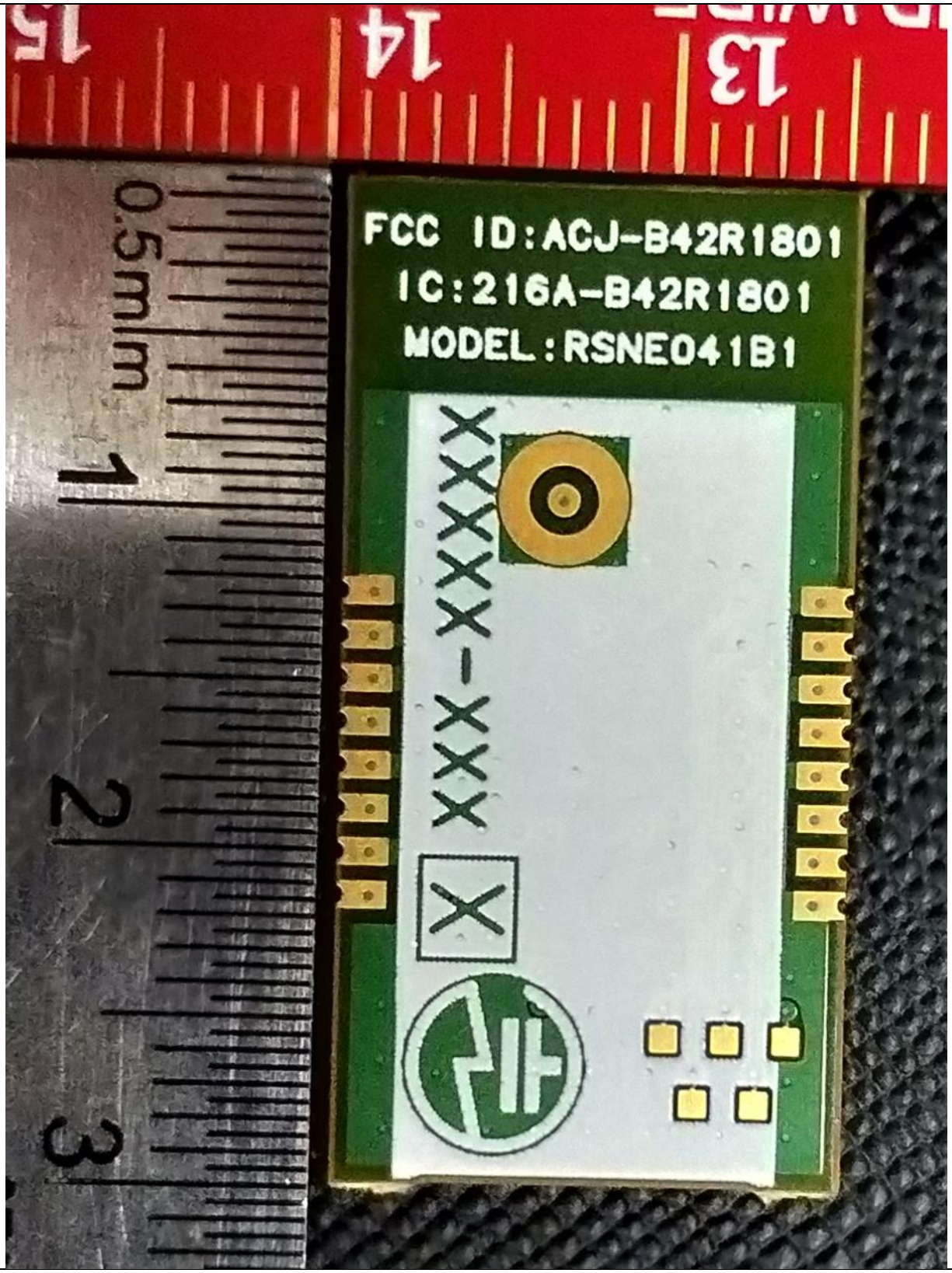
EUT PHOTOGRAPHS



EUT PCB Component Side

PSB Singapore

EUT PHOTOGRAPHS



EUT PCB Trace Side

PSB Singapore

4 Test Equipment

Instrument	Model	S/No	Cal Due Date
Radiated Emissions (Spurious Emissions Inclusive Restricted Bands Requirement)			
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
EMCO Loop Antenna	6502	134413	28 Oct 2018
Schaffner Bilog Antenna (30MHz - 2GHz)	CBL6112B	2597	20 Feb 2019
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
ETS Horn Antenna (18GHz - 40GHz)	3116	0004-2474	15 Nov 2018
Com-Power Preamplifier (1MHz - 1GHz)	PAM-103	441058	22 Sep 2018
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	09 Mar 2019
Agilent Preamplifier (1GHz - 26.5GHz) (PA18)	8449D	3008A02305	02 Oct 2018
Toyo Preamplifier (26.5GHz - 40GHz)	HAP26-40W	00000005	15 Nov 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Feb 2019
Carrier Frequency Separation			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Spectrum Bandwidth (20dB Bandwidth Measurement)			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Number of Hopping Frequencies			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Average Frequency Dwell Time			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Maximum Peak Power			
Boonton Electronics RF Power Meter	4532	72901	27 Feb 2019
Boonton Electronics Peak Power Sensor	56218-S/1	1417	27 Feb 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
RF Conducted Spurious Emissions			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor
Band Edge Compliance (Conducted)			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

PSB Singapore

Instrument	Model	S/No	Cal Due Date
Band Edge Compliance (Radiated)			
R&S Test Receiver – ESI1	ESI40	100010	25 Oct 2018
TDK-RF Horn Antenna	HRN-0118	130256	22 Feb 2019
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	09 Mar 2019
Peak Power Spectral Density			
Agilent Spectrum Analyzer	E4440A	MY45304764	09 Jan 2019
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

PSB Singapore

5 Measurement Uncertainty

All test measurements carried out are traceable to national standards. The uncertainty of the measurement at a confidence level of approximately 95%, with a coverage factor of 2.

Test Name	Measurement Uncertainty
Conducted Emissions at Mains Terminals	9kHz to 30MHz, ±2.1dB
Radiated Emissions	9kHz to 30MHz, ±3.8dB 30MHz to 1GHz, ±3.8dB >1GHz to 40GHz, ±4.5dB
Maximum Permissible Exposure	0.1MHz – 18GHz is ±15.0%

PSB Singapore

Please note that this Report is issued under the following terms :

1. This report applies to the sample of the specific product/equipment given at the time of its testing/calibration. The results are not used to indicate or imply that they are applicable to other similar items. In addition, such results must not be used to indicate or imply that TÜV SÜD PSB approves, recommends or endorses the manufacturer, supplier or user of such product/equipment, or that TÜV SÜD PSB in any way "guarantees" the later performance of the product/equipment. Unless otherwise stated in this report, no tests were conducted to determine long term effects of using the specific product/equipment.

2. The sample/s mentioned in this report is/are submitted/supplied/manufactured by the Client. TÜV SÜD PSB therefore assumes no responsibility for the accuracy of information on the brand name, model number, origin of manufacture, consignment or any information supplied.

3. Nothing in this report shall be interpreted to mean that TÜV SÜD PSB has verified or ascertained any endorsement or marks from any other testing authority or bodies that may be found on that sample.

4. This report shall not be reproduced wholly or in parts and no reference shall be made by the Client to TÜV SÜD PSB or to the report or results furnished by TÜV SÜD PSB in any advertisements or sales promotion.

5. Unless otherwise stated, the tests were carried out in TÜV SÜD PSB Pte Ltd, No.1 Science Park Drive Singapore 118221.

July 2011

PSB Singapore

End of the Test Report