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FORMAL REPORT ON TESTING IN ACCORDANCE WITH  
47 CFR FCC Parts 15B & C  
OF A  
CD Stereo System  
[ Model : SC-UA3 ]  
[ FCC ID : ACJ-B21R1401 ]

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**TEST FACILITY**

TÜV SÜD PSB Pte Ltd  
Electrical & Electronics Centre (EEC), Product Services,  
No. 1 Science Park Drive, Singapore 118221

**FCC REG. NO.**

99142 (3m and 10m Semi-Anechoic Chamber, Science Park)

**IND. CANADA REG. NO.**

2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park)

**PREPARED FOR**

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**QUOTATION NUMBER**

2191062574

**JOB NUMBER**

7191162348

**TEST PERIOD**

13 Jan 2017 – 15 May 2017

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

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## TEST SUMMARY

The product was tested in accordance with the customer's specifications.

### Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Part 15		
15.107(a), 15.207	Conducted Emissions	Pass
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(1)	Carrier Frequency Separation	Pass
	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247(b)(1)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Pass
15.247(d)	Band Edge Compliance (Conducted)	Pass
15.247(d)	Band Edge Compliance (Radiated)	Pass
15.247(e)	Peak Power Spectral Density	Pass
1.1310	Maximum Permissible Exposure	Pass

## TEST SUMMARY

### Notes

1. Three channels as listed below, which respectively represent the lower, middle and upper channels of the Equipment Under Test (EUT) were chosen and tested. For each channel, the EUT was configured to operate in the test mode.

<u>Transmit Channel</u>	<u>Frequency (GHz)</u>
Channel 0	2.402
Channel 39	2.441
Channel 78	2.480

2. All the measurements in section 15.247 were done based on conducted measurements except Band Edge Compliance (Radiated) test.
3. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.
4. All test measurement procedures are according to ANSI C63.4: 2014 and ANSI C63.10: 2013.
5. The maximum measured RF power of the Equipment Under Test is 1.46dBm.

### Modifications

No modifications were made.



## PRODUCT DESCRIPTION

Description	: The Equipment Under Test (EUT) is a <b>CD Stereo System</b> .
Applicant	: Panasonic AVC Networks Singapore 202, Bedok South Avenue 1 Singapore 469332
Manufacturer	: Panasonic Corporation 1006 Oaza Kadonna, Kadoma-City, Osaka 571 8501 Japan
Factory (ies)	: Panasonic AVC Networks Johor Malaysia Sdn. Bhd. IE. Plo 460, Jalan Bandar, 81700 Pasir Gudang, Johor, Malaysia
Model Number(s)	: SC-UA3
FCC ID	: ACJ-B21R1401
Serial Number(s)	: Nil
Microprocessor(s)	: Rohm – BM94716EKU-Z
Operating Frequency	: FM 87.5MHz - 108MHz Bluetooth – 2.402GHz (lower channel) to 2.48GHz (upper channel) - 79 channels.
Local OSC Frequency	: 16.9MHz, 32.768kHz, 24.55MHz & 108MHz
Modulation	: 1Mbps: Gaussian Frequency Shift Keying (GFSK) 2Mbps: $\pi/4$ Differential-Quadrature Phase Shift Keying (DQPSK) 3Mbps: 8 Differential Phase-Shift Keying (DPSK)
Antenna Gain	: 2.0 dBi (Max)
IF Frequency	: FM 128kHz
Port / Connectors	: AUX, USB, Optical Out
Rated Input Power	: 100V-120V 60Hz 51W
Accessories	: i. Remote Control ii. AC Cord

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**SUPPORTING EQUIPMENT DESCRIPTION**

The EUT was tested as a stand-alone unit without any supporting equipment.



## EUT OPERATING CONDITIONS

### 47 CFR FCC Part 15

1. Conducted Emissions
2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)
3. Spectrum Bandwidth (20dB Bandwidth Measurement)
4. Maximum Peak Power
5. RF Conducted Spurious Emissions
6. Band Edge Compliance (Conducted)
7. Band Edge Compliance (Radiated)
8. Peak Power Spectral Density
9. Maximum Permissible Exposure

The EUT was exercised by operating in maximum continuous transmission with frequency hopping off, i.e transmitting at lower, middle and upper channels respectively at one time. For Band Edge Compliance, only lower and upper channels were evaluated.

### 47 CFR FCC Part 15

1. Carrier Frequency Separation
2. Number of Hopping Frequencies
3. Average Frequency Dwell Time
4. Band Edge Compliance (Conducted)

The EUT was exercised by operating in maximum continuous transmission with frequency hopping on.

CONDUCTED EMISSION TEST

**47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Limits**

Frequency Range (MHz)	Quasi-peak (Q-P)	Limit Values (dB $\mu$ V)
		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

**47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
Schaffner EMI Receiver	SMR4503	040	22 Mar 2018
Agilent EMC Analyzer-SA7	E7403A	US41160167	24 Aug 2017
Schaffner LISN –LISN10 (EUT)	NNB42	04/10055	04 Oct 2017



## **CONDUCTED EMISSION TEST**

### **47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Setup**

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a  $50\Omega/50\mu\text{H}$  EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another LISN.

### **47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Test Method**

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A scan was made on the NEUTRAL line over the required frequency range using an EMI test receiver.
3. High peaks, relative to the limit line, were then selected.
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.
5. Steps 2 to 4 were then repeated for the LIVE line.

### **Sample Calculation Example**

At 20 MHz

Q-P limit = 60.0 dB $\mu$ V

Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dB $\mu$ V  
(Calibrated for system losses)

Therefore, Q-P margin = 60.0 - 40.0 = 20.0

i.e. 20.0 dB below Q-P limit

## CONDUCTED EMISSION TEST

### 47 CFR FCC Parts 15.107(a) and 15.207 Conducted Emission Results

Operating Mode	BT Music Playback	Temperature	20°C
Test Input Power	120V 60Hz	Relative Humidity	52%
Line Under Test	AC Mains	Atmospheric Pressure	1030mbar
Class	B	Tested By	Chelmin Li

Frequency (MHz)	Q-P Value (dB $\mu$ V)	Q-P Limit (dB $\mu$ V)	Q-P Margin (dB)	AV Value (dB $\mu$ V)	AV Limit (dB $\mu$ V)	AV Margin (dB)	Line
0.3847	34.9	58.2	23.3	31.3	48.2	16.9	Live
2.3042	36.3	56.0	19.7	35.2	46.0	10.8	Neutral
24.1858	41.9	60.0	18.1	40.7	50.0	9.3	Neutral
26.2868	48.0	60.0	12.0	46.5	50.0	3.5	Live
27.8695	50.3	60.0	9.7	48.8	50.0	1.2	Neutral
28.9205	50.2	60.0	9.8	48.7	50.0	1.3	Neutral

#### 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:  
9kHz - 30MHz  
RBW: 9kHz      VBW: 30kHz
4. Conducted Emissions 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, in the range 9kHz – 30MHz is  $\pm 2.2\text{dB}$ .

**RADIATED EMISSION TEST**

**47 CFR FCC Part 15.205 Restricted Bands**

<b>MHz</b>	<b>MHz</b>	<b>MHz</b>	<b>GHz</b>
0.090	- 0.110	16.42	- 16.423
0.495	- 0.505	16.69475	- 16.69525
2.1735	- 2.1905	16.80425	- 16.80475
4.125	- 4.128	25.5	- 25.67
4.17725	- 4.17775	37.5	- 38.25
4.20725	- 4.20775	73	- 74.6
6.215	- 6.218	74.8	- 75.2
6.26775	- 6.26825	108	- 121.94
6.31175	- 6.31225	123	- 138
8.291	- 8.294	149.9	- 150.05
8.362	- 8.366	156.52475	- 156.52525
8.37625	- 8.38675	156.7	- 156.9
8.41425	- 8.41475	162.0125	- 167.17
12.29	- 12.293	167.72	- 173.2
12.51975	- 12.52025	240	- 285
12.57675	- 12.57725	322	- 335.4
13.36	- 13.41		
			Above 38.6

**47 CFR FCC Parts 15.109(a) and 15.209 Radiated Emission Limits**

<b>Frequency Range (MHz)</b>	<b>Quasi-Peak Limit Values (dB<math>\mu</math>V/m)</b>
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.

**47 CFR FCC Parts 15.109(a) and 15.209 Radiated Emission Test Instrumentation**

<b>Instrument</b>	<b>Model</b>	<b>S/No</b>	<b>Cal Due Date</b>
R&S Test Receiver (20Hz-26.5GHz) – ESMI3	ESMI	829179/002 829179/005	21 Apr 2018
TDK RF Solutions Hybrid Log Periodic Antenna (30MHz-3GHz)	HLP-3003C	130237	21 Oct 2017
Sonoma Preamplifier (9kHz – 1GHz)	310N	270640	27 Dec 2017
R&S Test Receiver – ESI1	ESI40	100010	11 Oct 2017
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	24 Mar 2018
ETS Horn Antenna(18GHz-40GHz) (Ref)	3116	0004-2474	18 Oct 2017
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	12 Oct 2017
EMCO Loop Ant (ext)_red_00134413	6502	134413	28 Oct 2017
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	BRM50701-02

## RADIATED EMISSION TEST

### **47 CFR FCC Parts 15.109(a) and 15.209 Radiated Emission Test Setup**

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table for measurement up to 1GHz. For measurement above 1GHz, 1.5m height table was used.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

### **47 CFR FCC Parts 15.109(a) and 15.209 Radiated Emission Test Method**

1. The EUT was switched on and allowed to warm up to its normal operating condition.
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.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. 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.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point in the range of 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10<sup>th</sup> 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 dB $\mu$ V/m

Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB

Q-P reading obtained directly from EMI Receiver = 40.0 dB $\mu$ V/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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**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results**

Operating Mode	BT Transmitting	Temperature	22°C
Test Input Power	120V 60Hz	Relative Humidity	55%
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Atmospheric Pressure	1017mbar
		Tested By	Chang Wai Kit, Derrick Ng

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) \*See Note 2 & 3

Freq (GHz)	Peak Value (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Peak Margin (dB)	AV Value (dB $\mu$ V/m)	AV Limit (dB $\mu$ V/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
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Spurious Emissions ranging from 9kHz – 30MHz \*See Note 2 & 3

Frequency (MHz)	Q-P Value (dB $\mu$ V/m)	Q-P Limit (dB $\mu$ V/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 (dB $\mu$ V/m)	Q-P Limit (dB $\mu$ V/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel (Worst)
32.0650	34.0	40.0	6.0	102	24	V	0
46.2610	34.3	40.0	5.7	100	21	V	0
68.0990	31.2	40.0	8.8	222	222	V	0
125.7930	33.0	43.5	10.5	278	278	V	0
168.2470	35.0	43.5	8.5	60	60	H	0
324.9990	35.4	46.0	10.6	294	294	H	0

**RADIATED EMISSION TEST**

**47 CFR FCC Parts 15.109(a), 15.205 and 15.209 Radiated Emission Results**

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Peak Margin (dB)	AV Value (dB $\mu$ V/m)	AV Limit (dB $\mu$ V/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.9359	32.2	74.0	41.8	19.2	54.0	34.8	198	271	V	0
4.9964	49.9	74.0	24.1	36.6	54.0	17.4	101	28	V	0
8.7743	41.3	74.0	32.7	28.1	54.0	25.9	100	272	H	0
9.6629	41.9	74.0	32.1	28.9	54.0	25.1	100	139	H	0
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Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Peak Margin (dB)	AV Value (dB $\mu$ V/m)	AV Limit (dB $\mu$ V/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
5.2826	49.7	74.0	24.3	36.5	54.0	17.5	101	78	V	39
5.5586	50.9	74.0	23.1	37.5	54.0	16.5	198	285	V	39
12.1677	42.0	74.0	32.0	28.9	54.0	25.1	100	189	H	39
13.5140	42.4	74.0	31.6	29.3	54.0	24.7	100	100	H	39
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Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dB $\mu$ V/m)	Peak Limit (dB $\mu$ V/m)	Peak Margin (dB)	AV Value (dB $\mu$ V/m)	AV Limit (dB $\mu$ V/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
5.6529	52.2	74.0	21.8	38.4	54.0	15.6	101	82	V	78
5.8751	49.3	74.0	24.7	36.4	54.0	17.6	101	176	V	78
16.0596	44.2	74.0	29.8	31.0	54.0	23.0	100	26	H	78
17.2716	44.4	74.0	29.6	31.1	54.0	22.9	100	300	H	78
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## RADIATED EMISSION TEST

### 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. "--" indicates no emissions were found and shows compliance to the limits.
3. 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.
4. 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.
5. 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.
6. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:

#### 30MHz - 1GHz

RBW: 120kHz      VBW: 1MHz

#### >1GHz

RBW: 1MHz      VBW: 3MHz

7. 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.
8. The channel in the table refers to the transmit channel of the EUT.
9. Radiated Emissions 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, in the range 30MHz – 25GHz is  $\pm 4.0\text{dB}$ .

## **CARRIER FREQUENCY SEPARATION TEST**

### **47 CFR FCC Part 15.247(a)(1) Carrier Frequency Separation 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).

### **47 CFR FCC Part 15.247(a)(1) Carrier Frequency Separation Test Instrumentation**

<b>Instrument</b>	<b>Model</b>	<b>S/No</b>	<b>Cal Due Date</b>
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### **47 CFR FCC Part 15.247(a)(1) Carrier Frequency Separation Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(a)(1) Carrier Frequency Separation Test Method**

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. The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.405GHz.
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.
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.
5. The steps 2 to 4 were repeated with the following start and stop frequencies settings:
  - a. 2.4385GHz to 2.4435GHz
  - b. 2.478GHz to 2.4835GHz



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#### CARRIER FREQUENCY SEPARATION TEST

##### 47 CFR FCC Part 15.247(a)(1) Carrier Frequency Separation Results

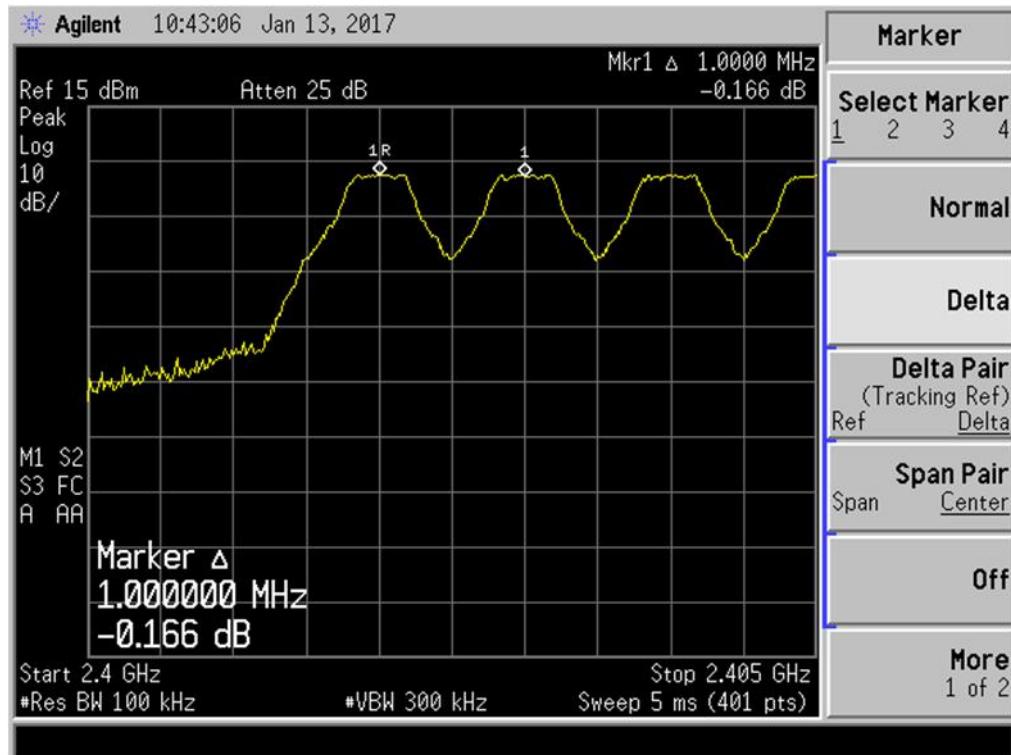
Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	1 – 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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)	0.990

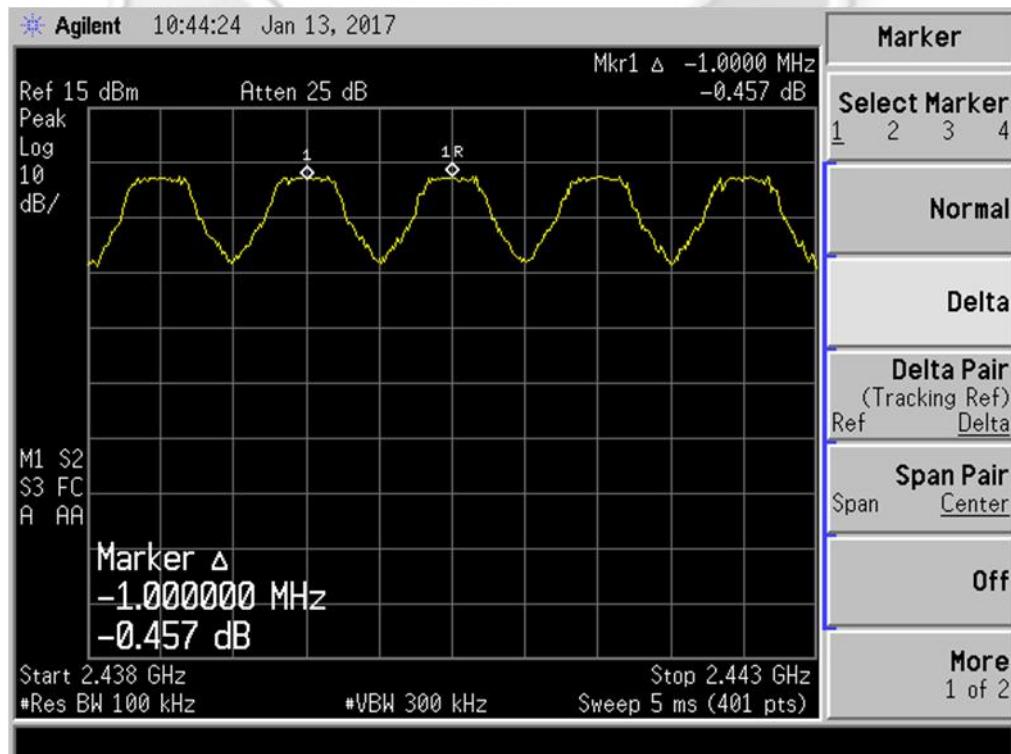


## CARRIER FREQUENCY SEPARATION TEST

### Carrier Frequency Separation Plots



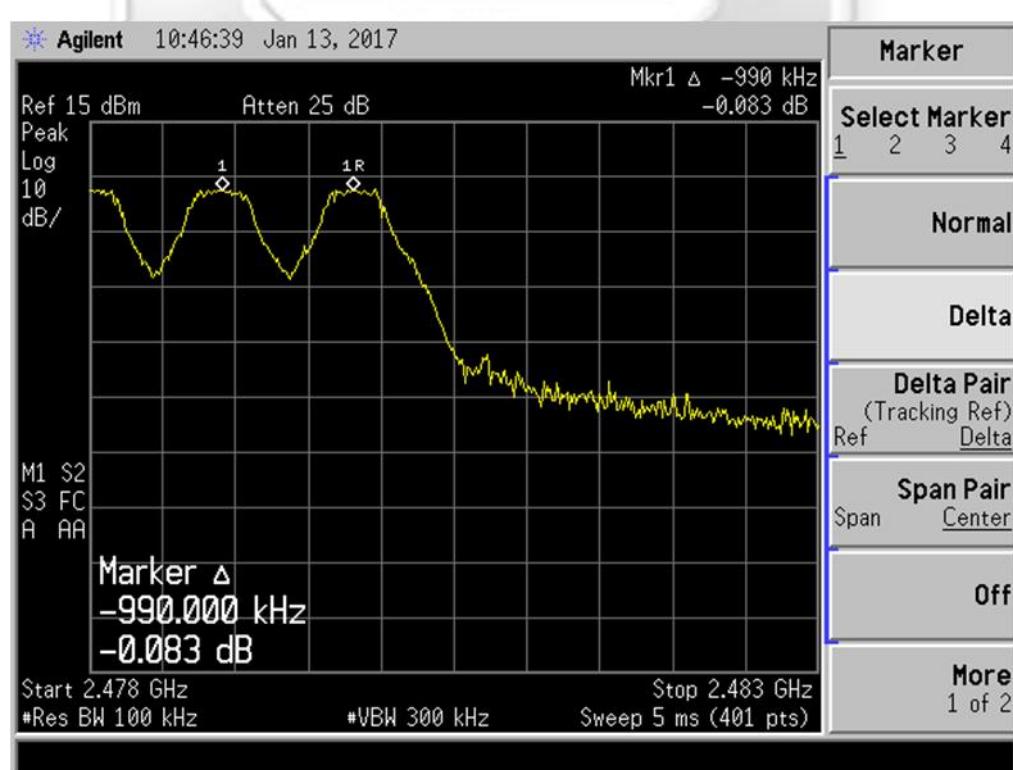
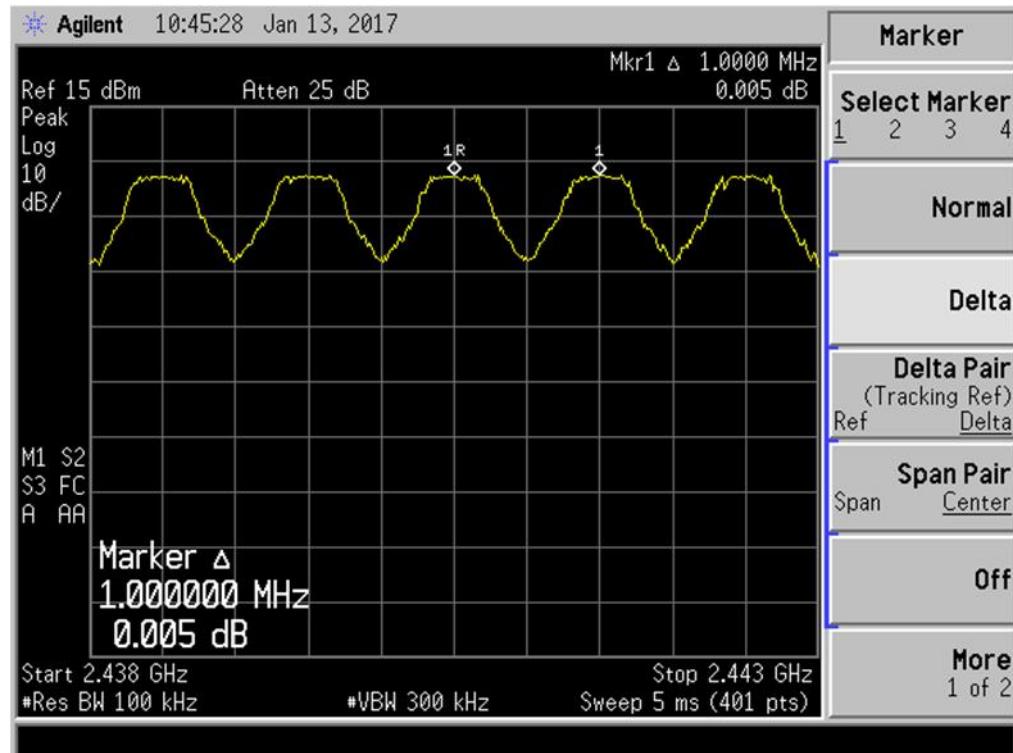
Plot 1 - Channels 0 (lower ch) and 1 (ch after lower ch) Separation



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

**CARRIER FREQUENCY SEPARATION TEST**

**Carrier Frequency Separation Plots**





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## **SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

### **47 CFR FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) 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.

### **47 CFR FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### **47 CFR FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 10kHz and 30kHz.
5. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Test Method**

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 Channel 0 (2.402GHz) (*lower ch*).
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. For 99% bandwidth measurement, the same frequency span was used.
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.
4. The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. For 6dB bandwidth measurement, 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. For 99% bandwidth measurement, the spectrum analyser power measurement was activated with bandwidth measurement as 99%.
5. For 6dB bandwidth measurement, the 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies,  $| f_H - f_L |$ . For 99% bandwidth measurement, the measured 99% bandwidth shown on the spectrum analyser was recorded.
6. The steps 2 to 5 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) (*mid ch*) and Channel 78 (2.480GHz) (*upper ch*) respectively.

**SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

**47 CFR FCC Part 15.247(a)(1) Spectrum Bandwidth (20dB Bandwidth Measurement) Results**

Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	5 – 13	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

**GFSK**

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 ( <i>lower ch</i> )	2.402	0.997
39 ( <i>mid ch</i> )	2.441	1.002
78 ( <i>upper ch</i> )	2.480	1.002

(π/4) DQPSK

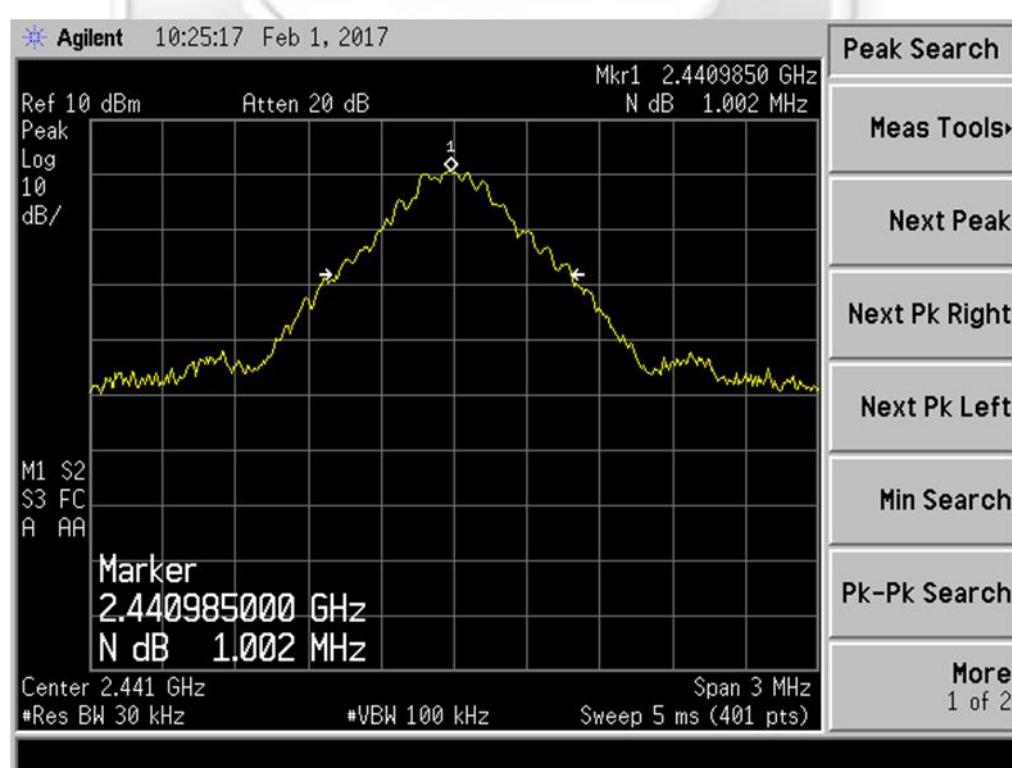
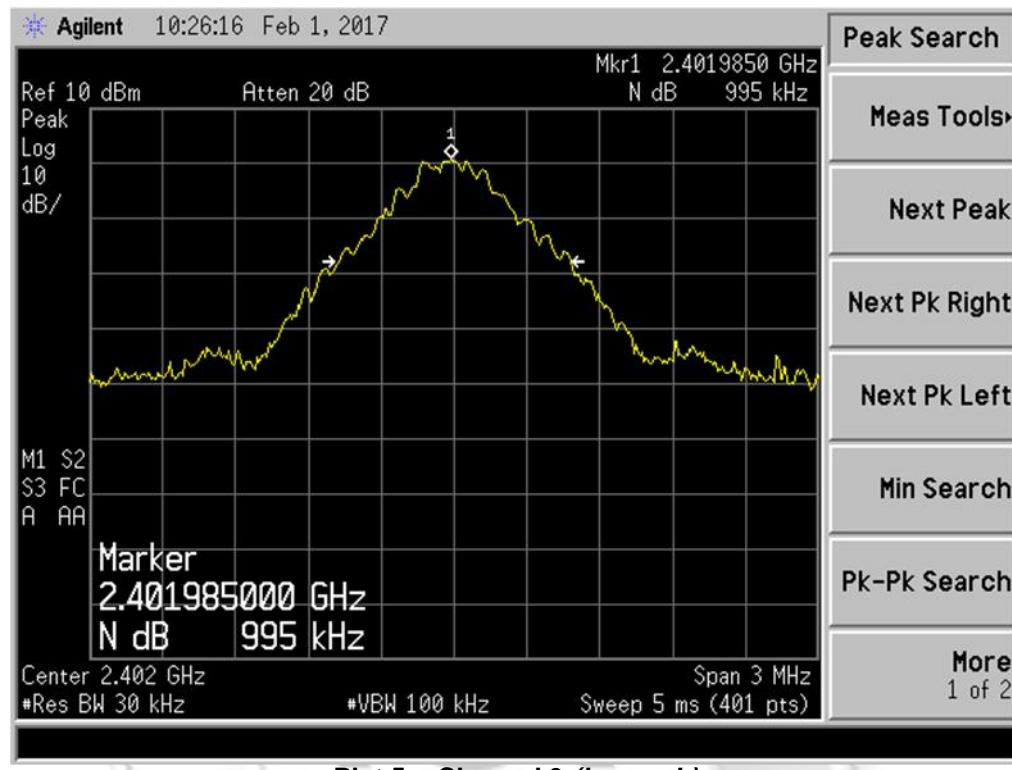
Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 ( <i>lower ch</i> )	2.402	1.362
39 ( <i>mid ch</i> )	2.441	1.362
78 ( <i>upper ch</i> )	2.480	1.354

**8DPSK**

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 ( <i>lower ch</i> )	2.402	1.362
39 ( <i>mid ch</i> )	2.441	1.362
78 ( <i>upper ch</i> )	2.480	1.354

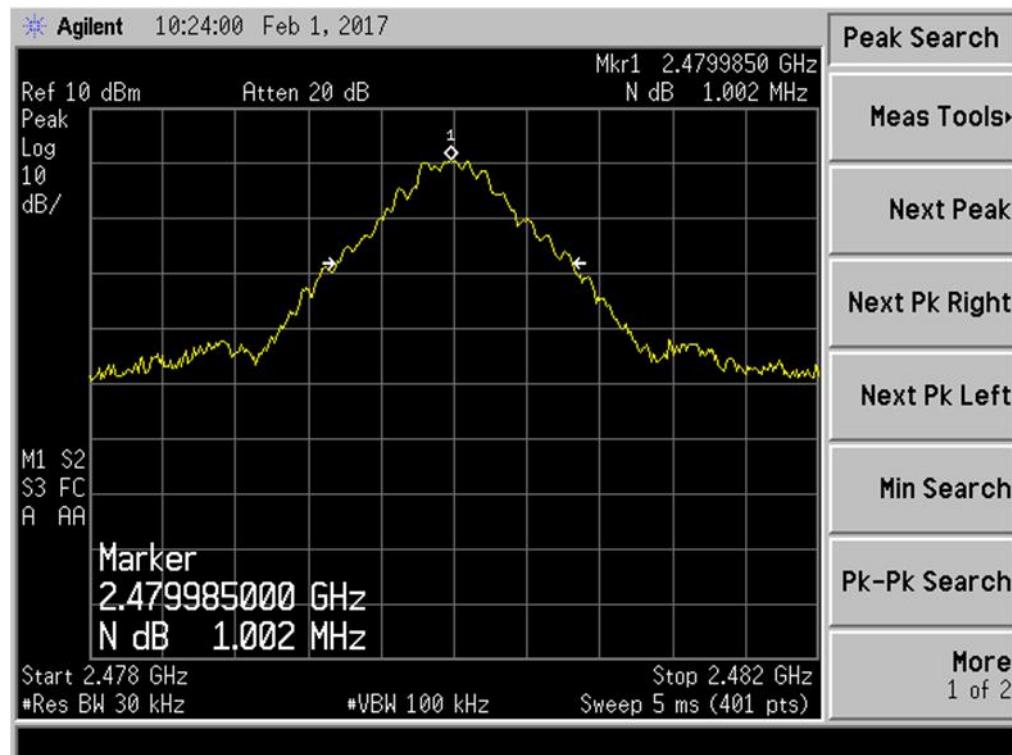
SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK



**SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

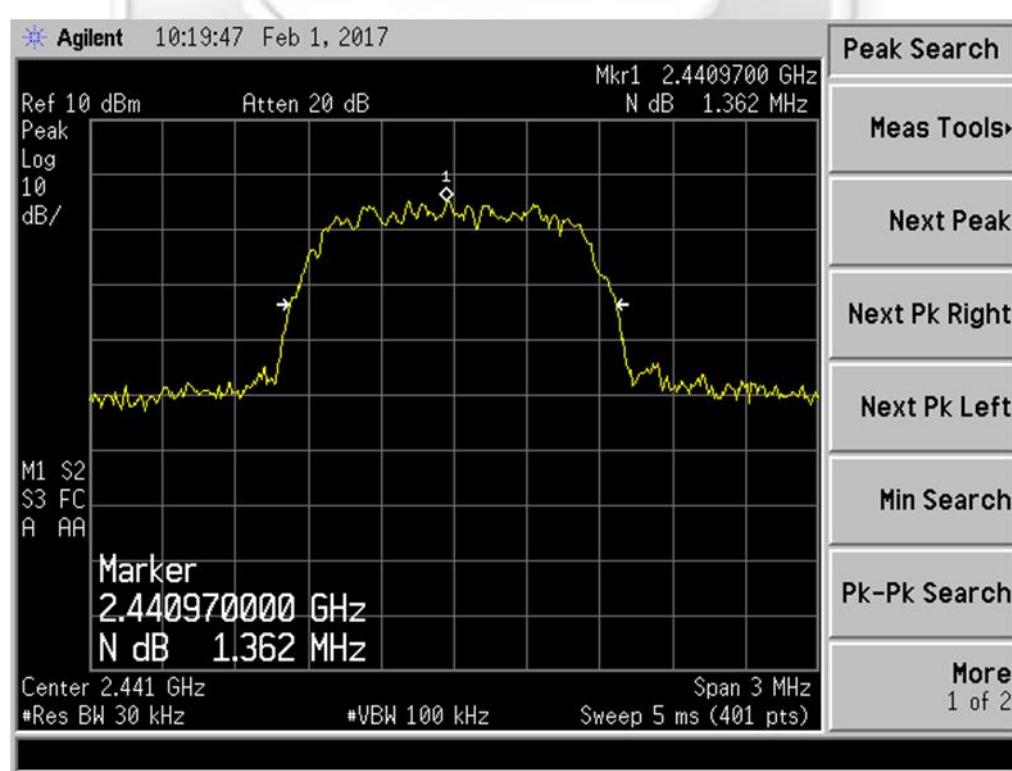
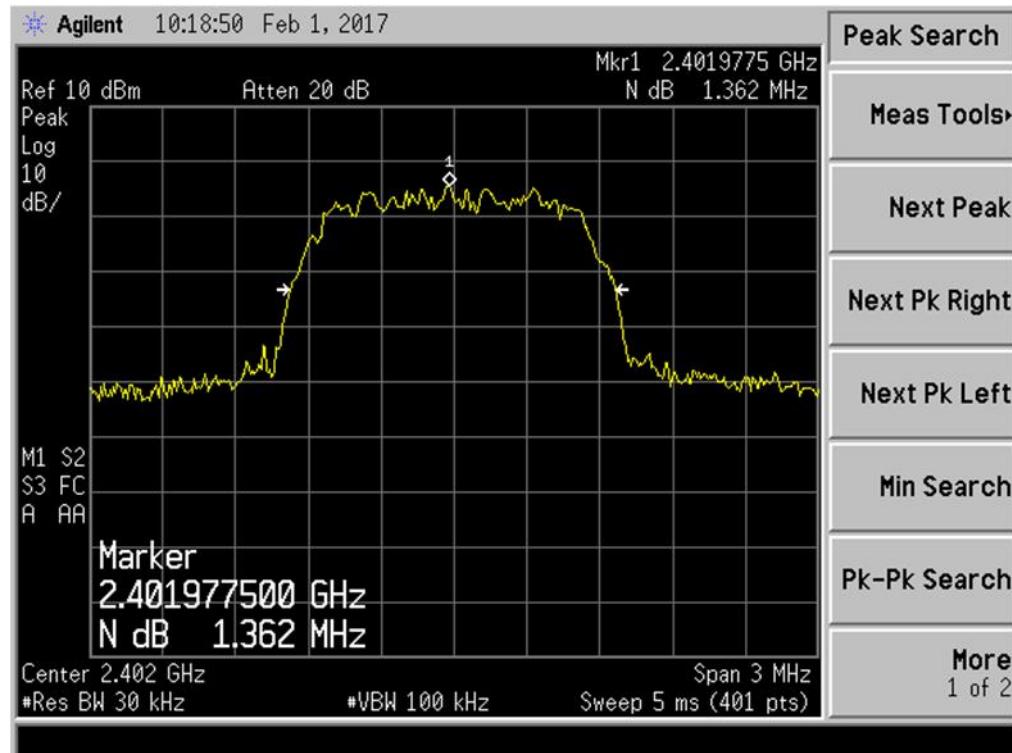
**Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK**



Plot 7 – Channel 78 (upper ch)

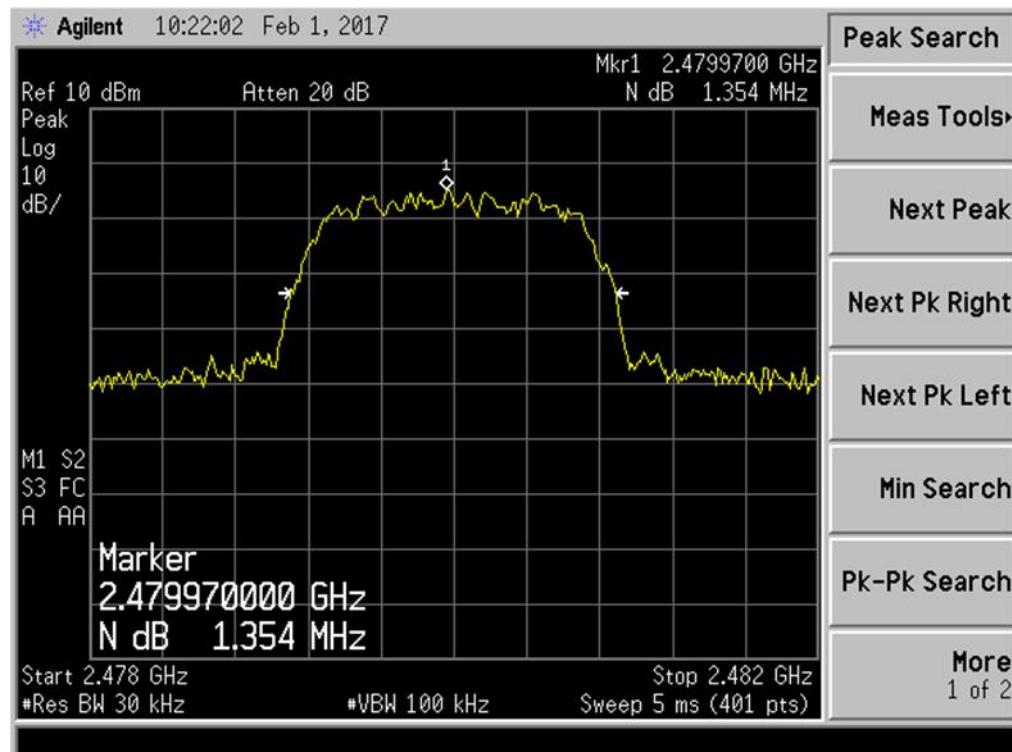
**SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

**Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – ( $\pi/4$ ) DQPSK**



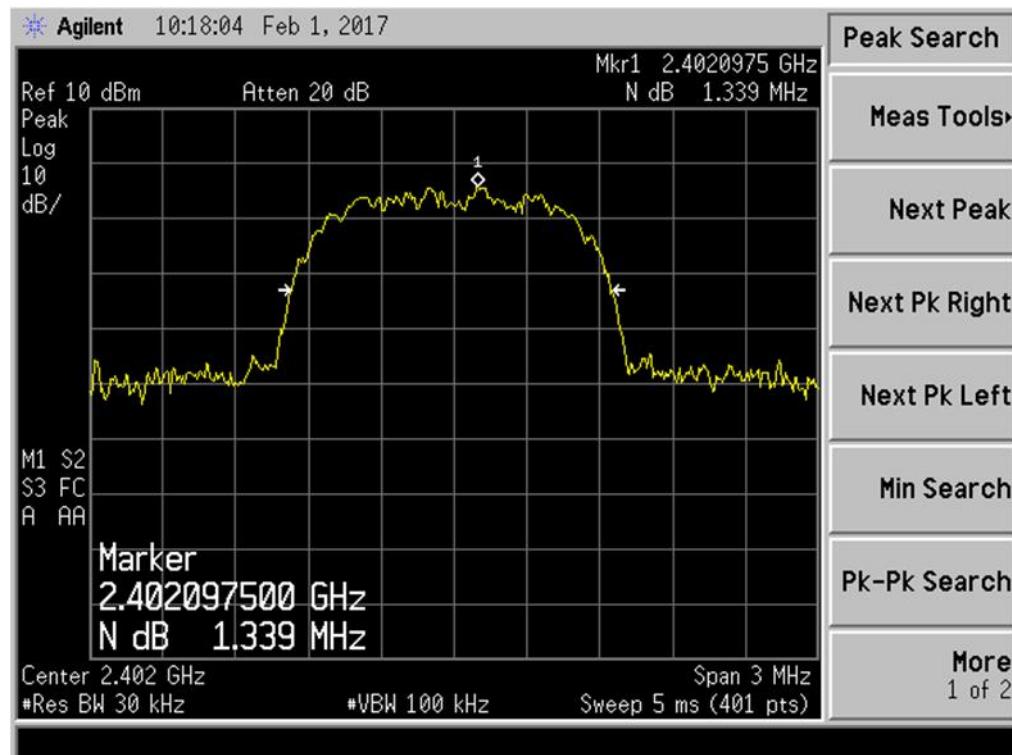
**SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

**Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – ( $\pi/4$ ) DQPSK**

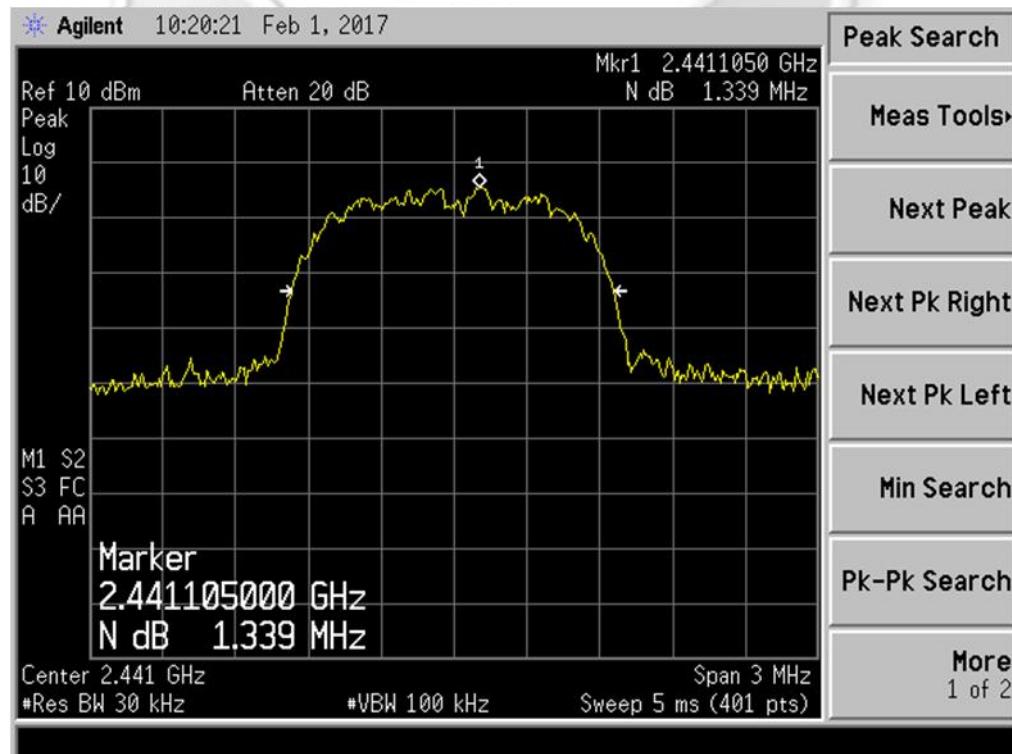


SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST

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



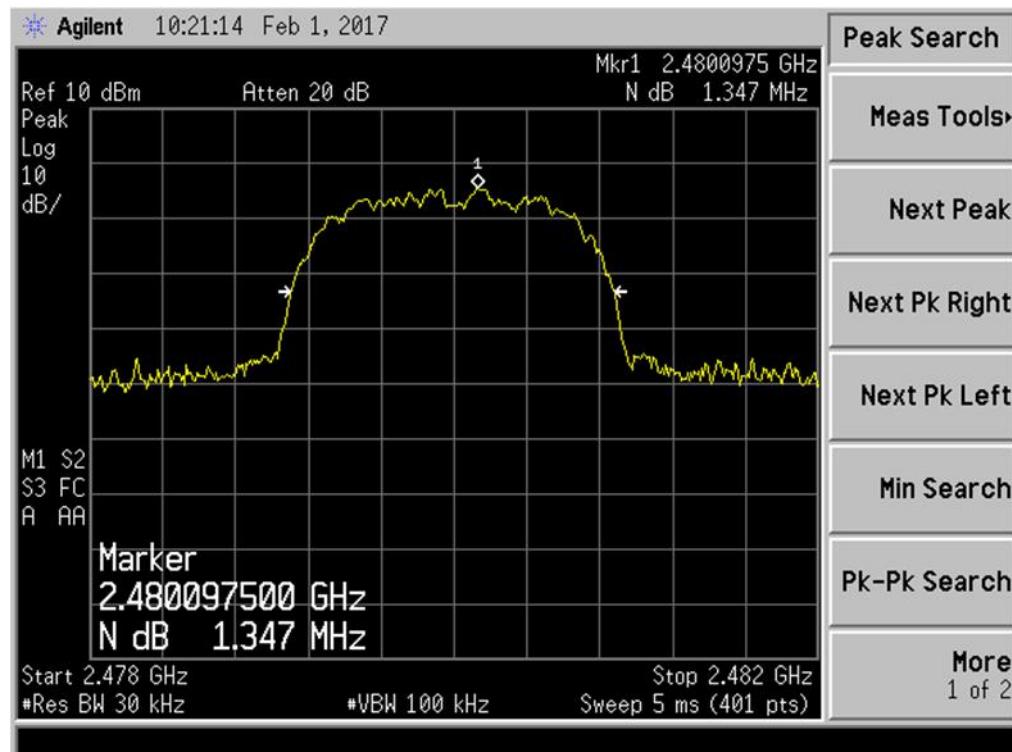
Plot 11 – Channel 0 (lower ch)



Plot 12 – Channel 39 (mid ch)

**SPECTRUM BANDWIDTH (20dB BANDWIDTH MEASUREMENT) TEST**

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



Plot 13 – Channel 78 (upper ch)



## NUMBER OF HOPPING FREQUENCIES TEST

### **47 CFR FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Limits**

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

### **47 CFR FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### **47 CFR FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Test Method**

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. The start and stop frequencies of the spectrum analyser were set to 2.39GHz and 2.42GHz.
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.
4. The numbers of transmitting frequencies were counted and recorded.
5. The steps 2 to 4 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
6. The total number of hopping frequencies is the sum of the number of the hopping frequencies found for each span.



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### NUMBER OF HOPPING FREQUENCIES TEST

#### 47 CFR FCC Part 15.247(a)(1)(iii) Number of Hopping Frequencies Results

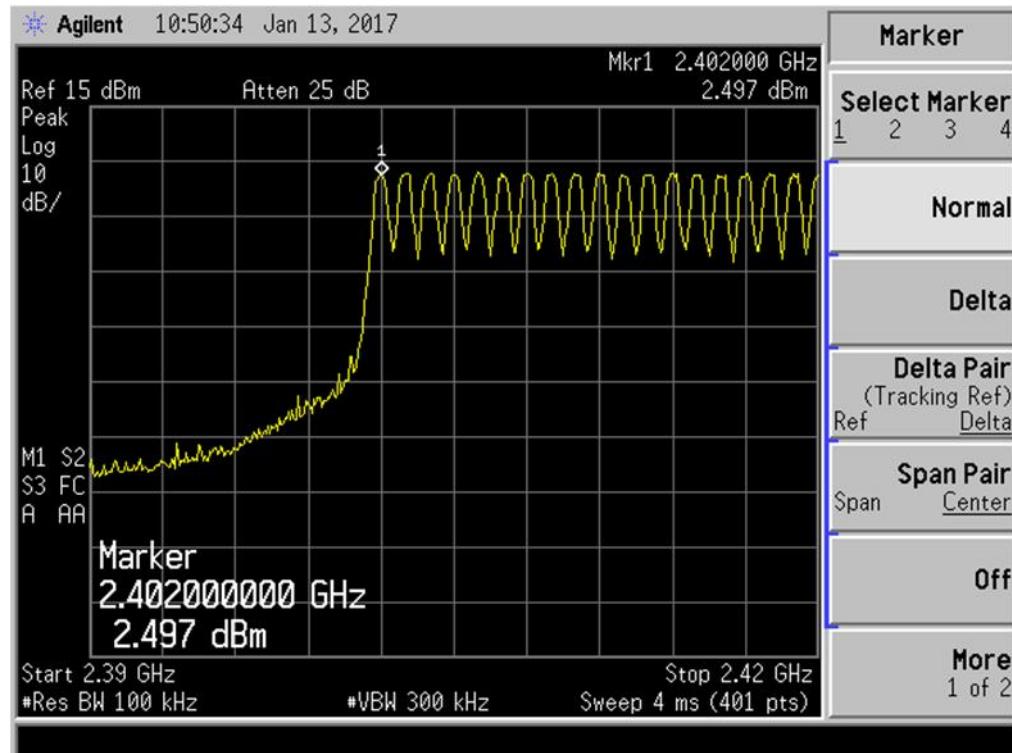
Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	14 – 17	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

The EUT was found to have 79 hopping frequencies. Please refer to the attached plots.

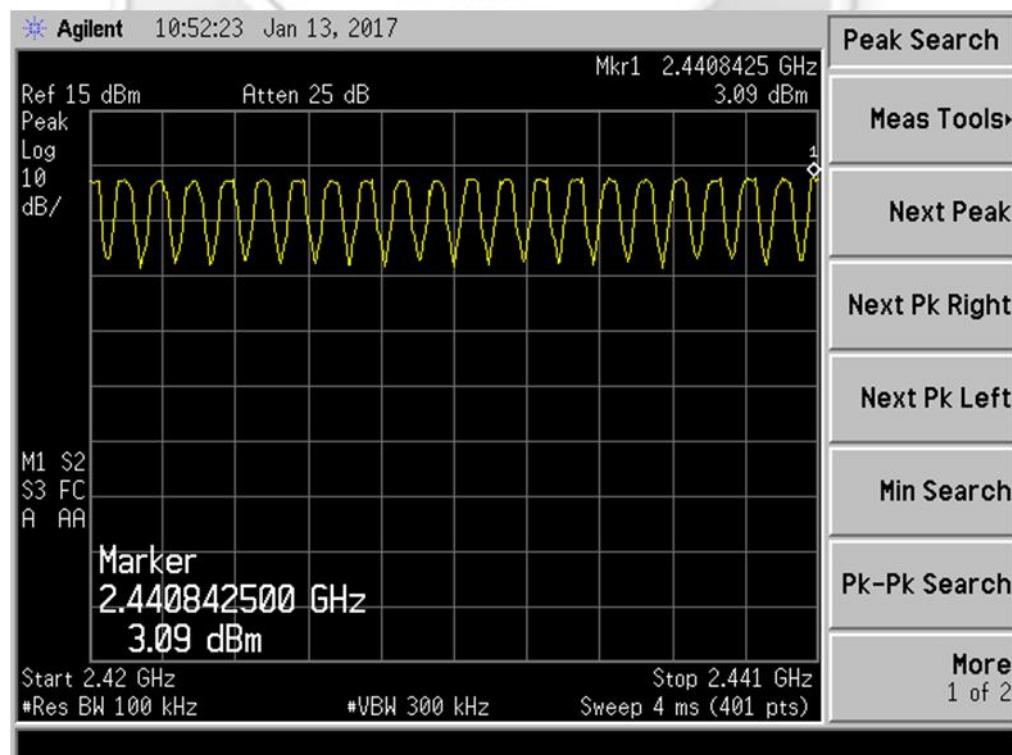


## NUMBER OF HOPPING FREQUENCIES TEST

### Number Of Hopping Frequencies Plots



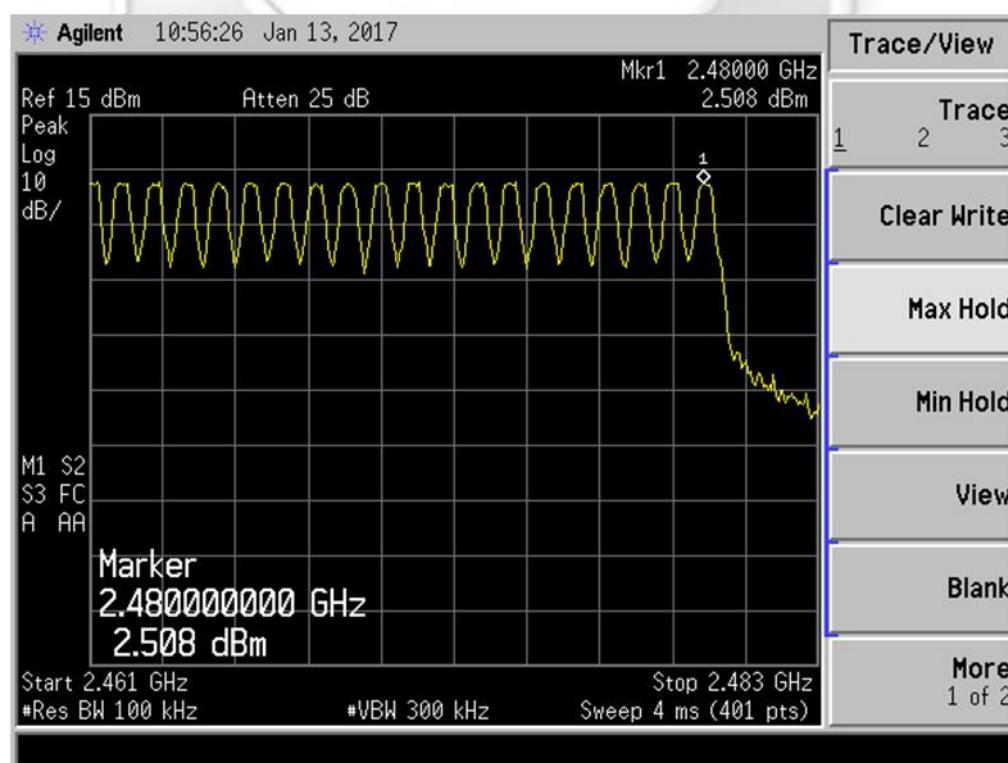
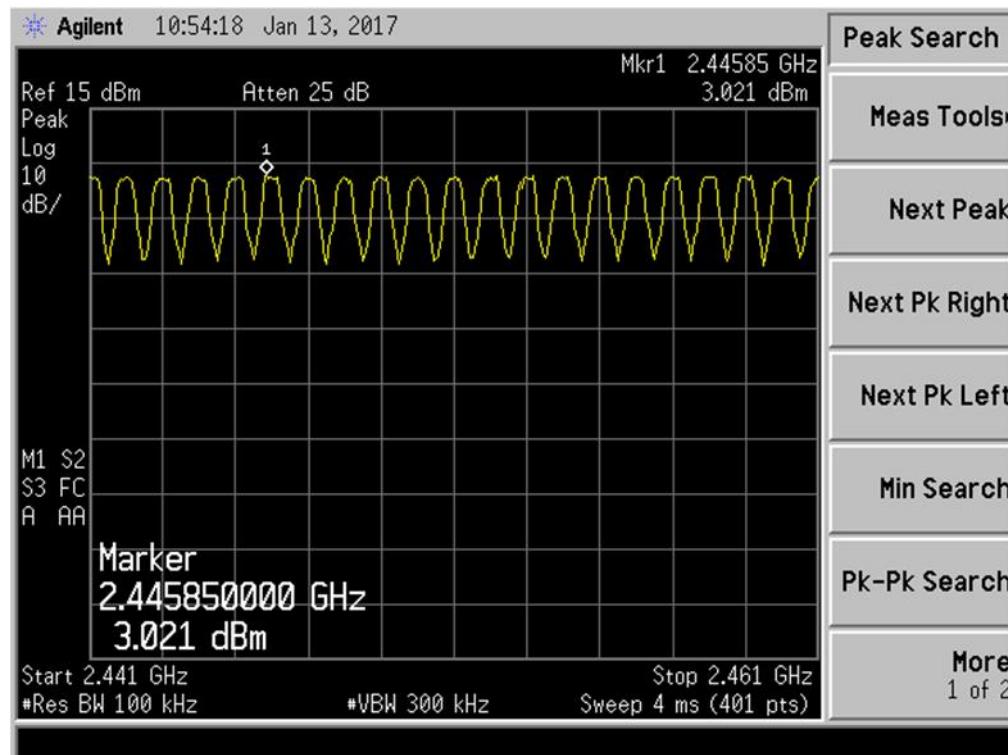
Plot 14 - Channels 0 to 18



Plot 15 - Channels 18 to 39

## NUMBER OF HOPPING FREQUENCIES TEST

### Number Of Hopping Frequencies Plots



## AVERAGE FREQUENCY DWELL TIME TEST

### 47 CFR FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time 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.

### 47 CFR FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### 47 CFR FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 1MHz and 3MHz.
5. All other supporting equipment were powered separately from another filtered mains.

### 47 CFR FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Test Method

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. The center frequency of the spectrum analyser was set to 2.402GHz (*lower ch*) with zero frequency span (spectrum analyser acts as an oscilloscope).
3. The sweep time of the spectrum analyser was adjusted until a stable signal can be seen on the spectrum analyser.
4. The duration (dwell time) of a packet (transmit time per hop) was measured using the marker-delta function of the spectrum analyser.
5. The measurement was repeated with the sweep time was set to equal to period specified in the requirement.
6. The number of hops in the period specified in the requirement, N was computed as below:  
$$N = [\text{number of hops on spectrum analyser}] \times [\text{period specified in the requirement} / \text{spectrum analyser sweep time}]$$
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.
8. The steps 2 to 7 were repeated with the center frequency of the spectrum analyser were set to 2.441GHz (*mid ch*) and 2.480GHz (*upper ch*) respectively.

AVERAGE FREQUENCY DWELL TIME TEST

**47 CFR FCC Part 15.247(a)(1)(iii) Average Frequency Dwell Time Results**

Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	18 – 20 (DH1) 21 – 23 (DH3) 24 – 26 (DH5)	Relative Humidity	60%
Hopping Rate	1600 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Chang Wai Kit

**DH1**

Channel	Channel Frequency (GHz)	Measured Time Slot Length (μs)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 (lower ch)	2.402	406.250	0.1300	0.4
39 (mid ch)	2.441	406.250	0.1300	0.4
78 (upper ch)	2.480	400.000	0.1280	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	1.6750	0.2680	0.4
39 (mid ch)	2.441	1.6875	0.2700	0.4
78 (upper ch)	2.480	1.6875	0.2700	0.4

**DH5**

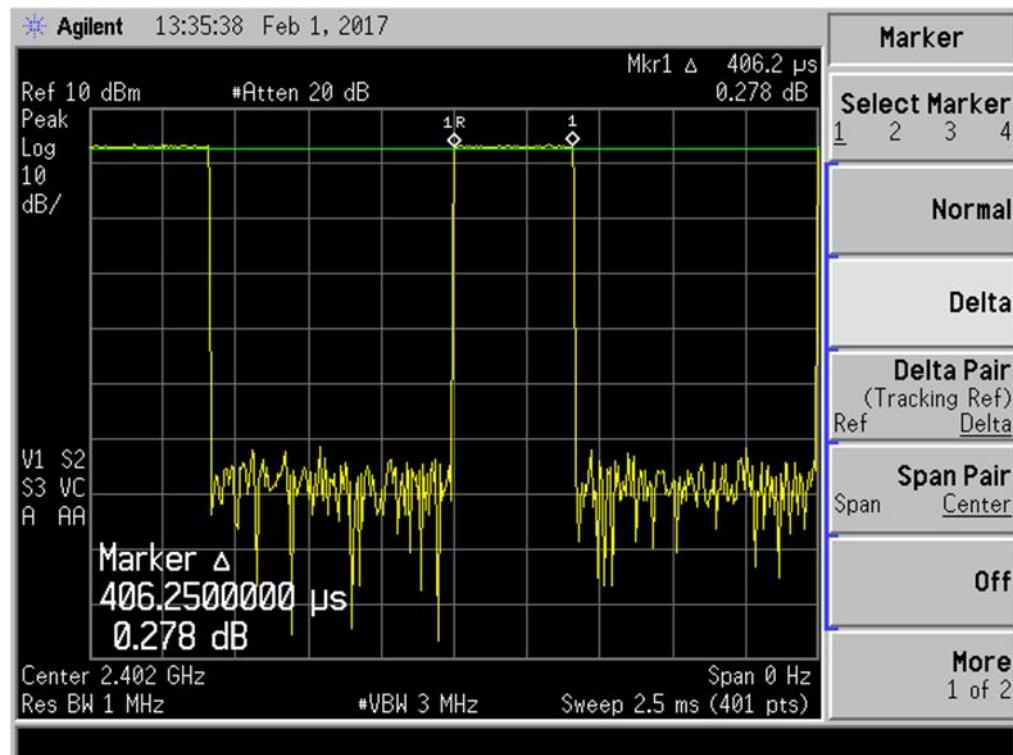
Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 (lower ch)	2.402	2.9260	0.3121	0.4
39 (mid ch)	2.441	2.8999	0.3093	0.4
78 (upper ch)	2.480	2.9260	0.3121	0.4

**Notes**

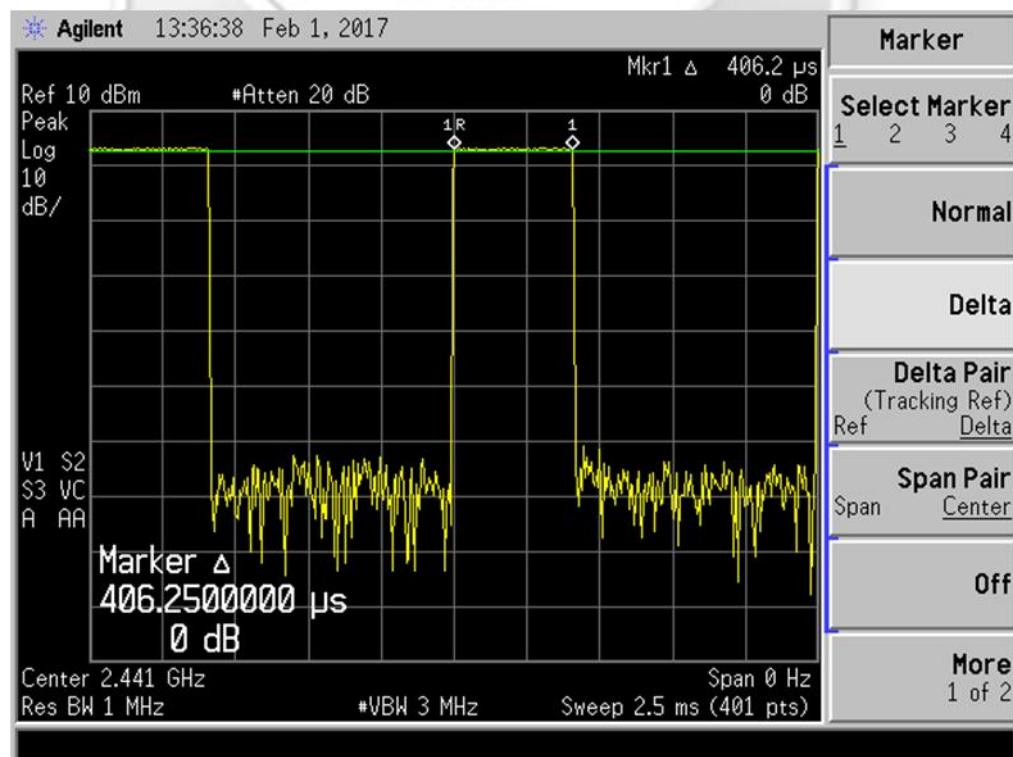
1. DH1 Dwell time = Measured Time Slot Length \*(1600/2/79) \*31.6  
DH3 Dwell time = Measured Time Slot Length \*(1600/4/79) \*31.6  
DH5 Dwell time = Measured Time Slot Length \*(1600/6/79) \*31.6

AVERAGE FREQUENCY DWELL TIME TEST

Average Frequency Dwell Time Plots – DH1



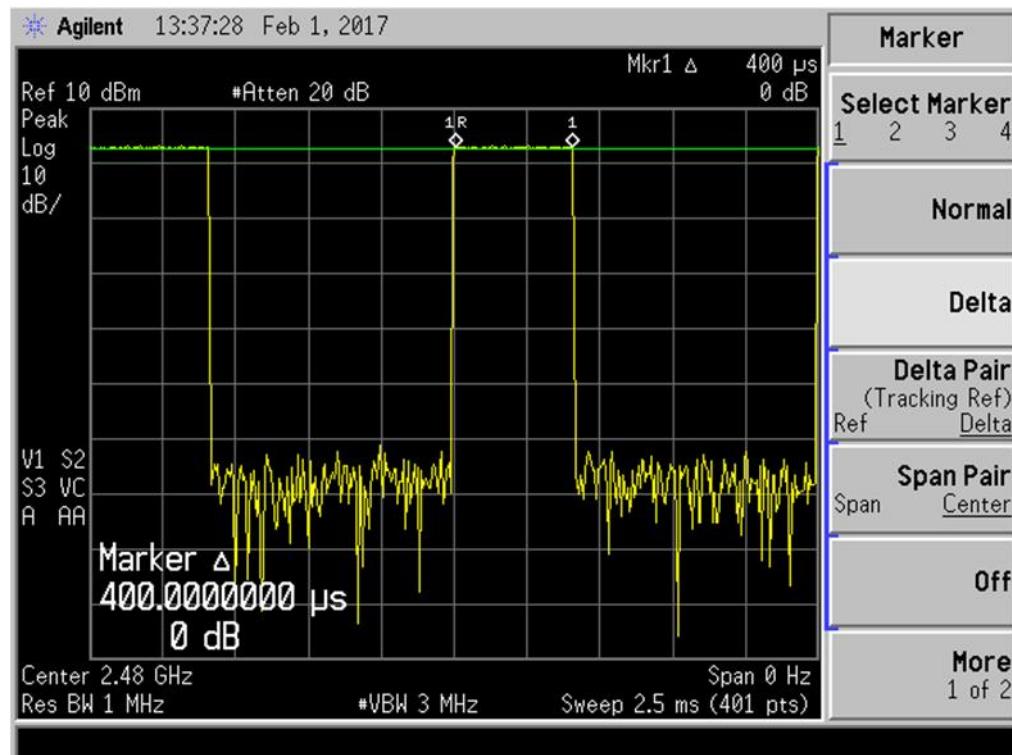
Plot 18 – Channel 0 (lower ch) – Transmit Time per Hop



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

## AVERAGE FREQUENCY DWELL TIME TEST

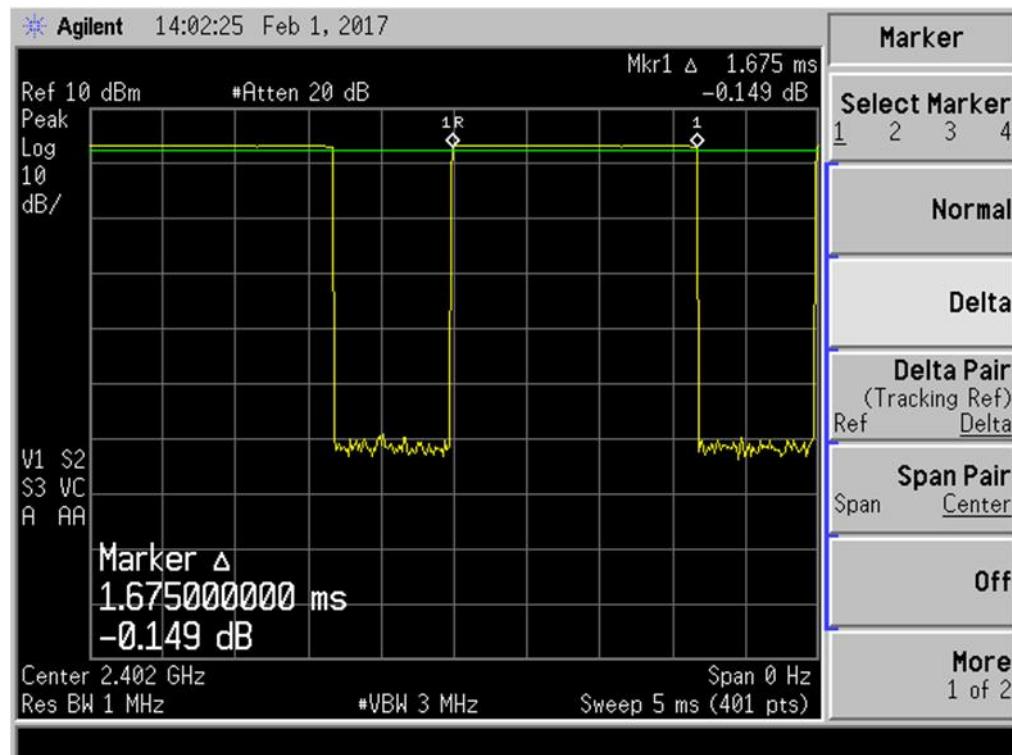
### Average Frequency Dwell Time Plots – DH1



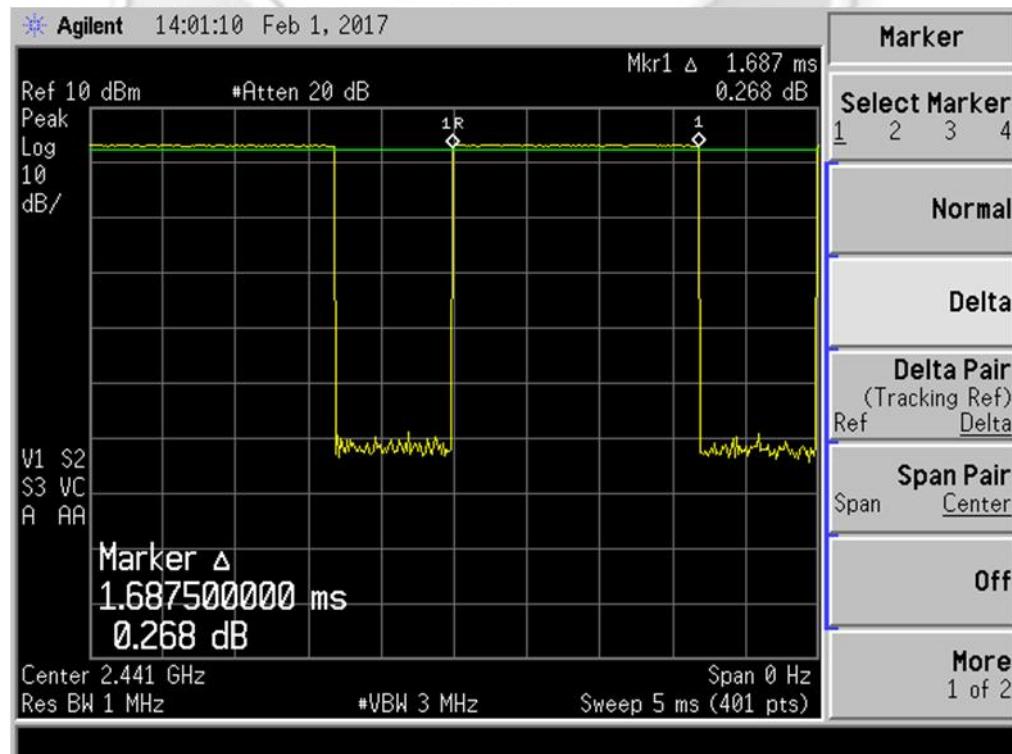
Plot 20 – Channel 78 (mid ch) – Transmit Time per Hop

AVERAGE FREQUENCY DWELL TIME TEST

Average Frequency Dwell Time Plots – DH3



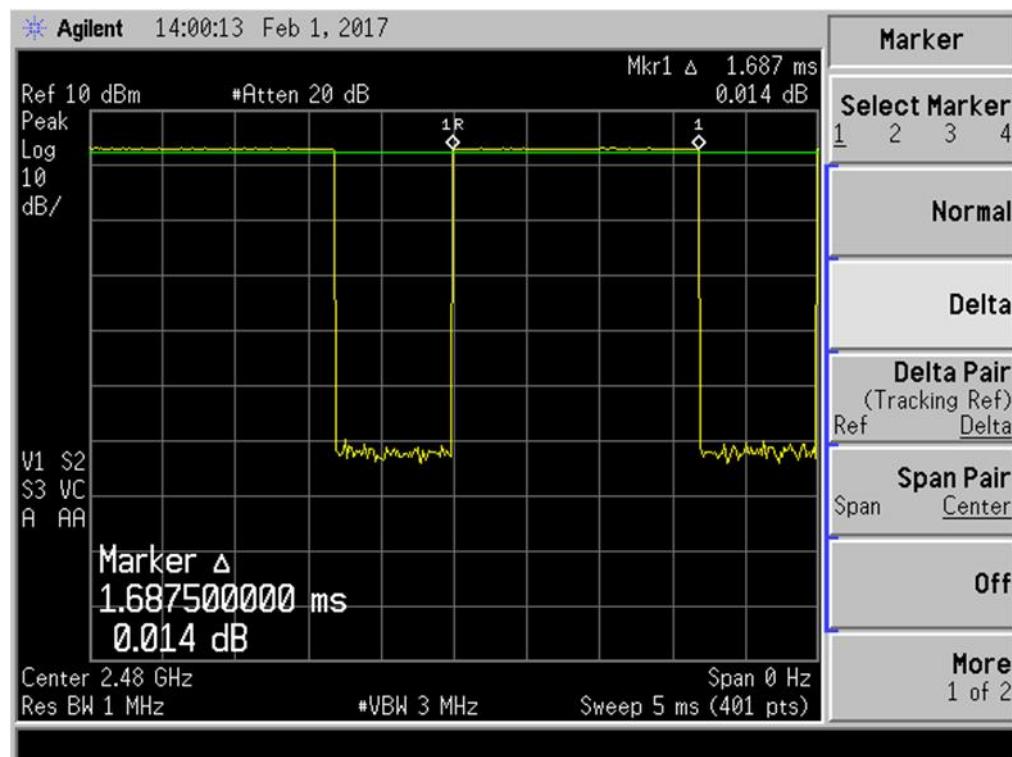
Plot 21 – Channel 0 (lower ch) – Transmit Time per Hop



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

AVERAGE FREQUENCY DWELL TIME TEST

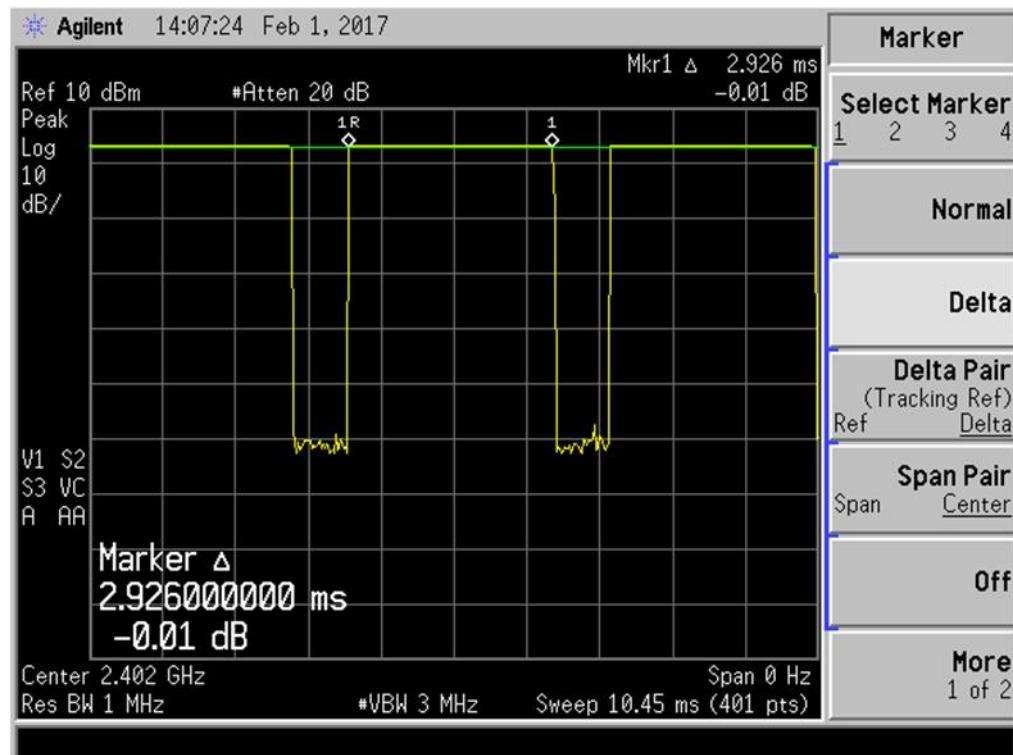
Average Frequency Dwell Time Plots – DH3



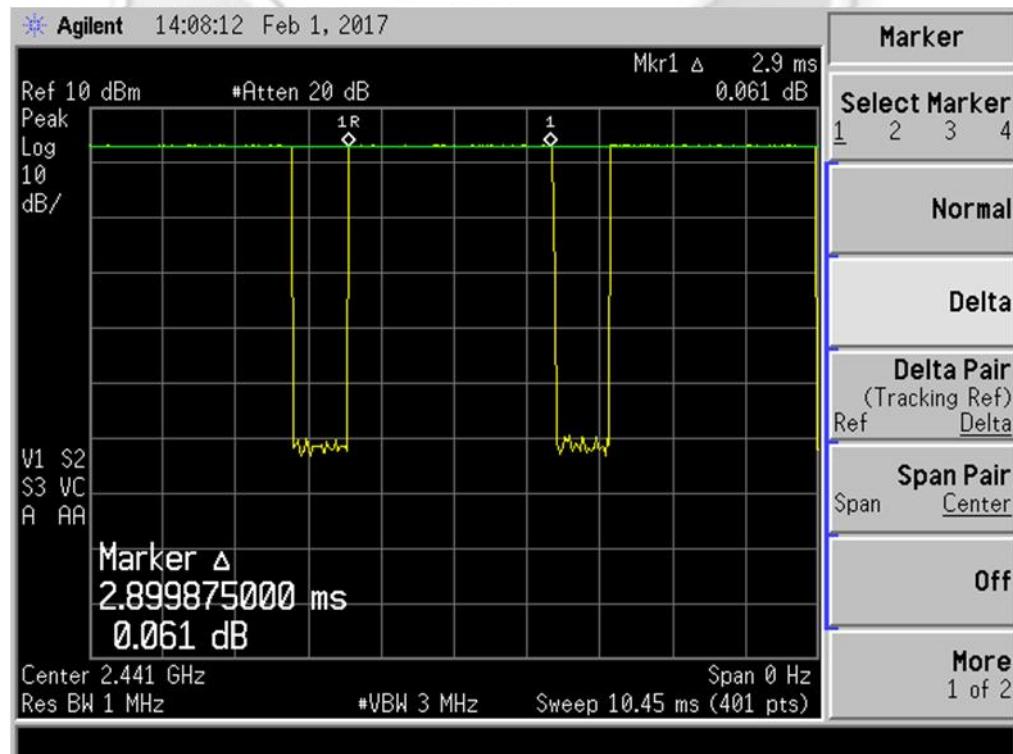
Plot 23 – Channel 78 (mid ch) – Transmit Time per Hop

AVERAGE FREQUENCY DWELL TIME TEST

Average Frequency Dwell Time Plots – DH5



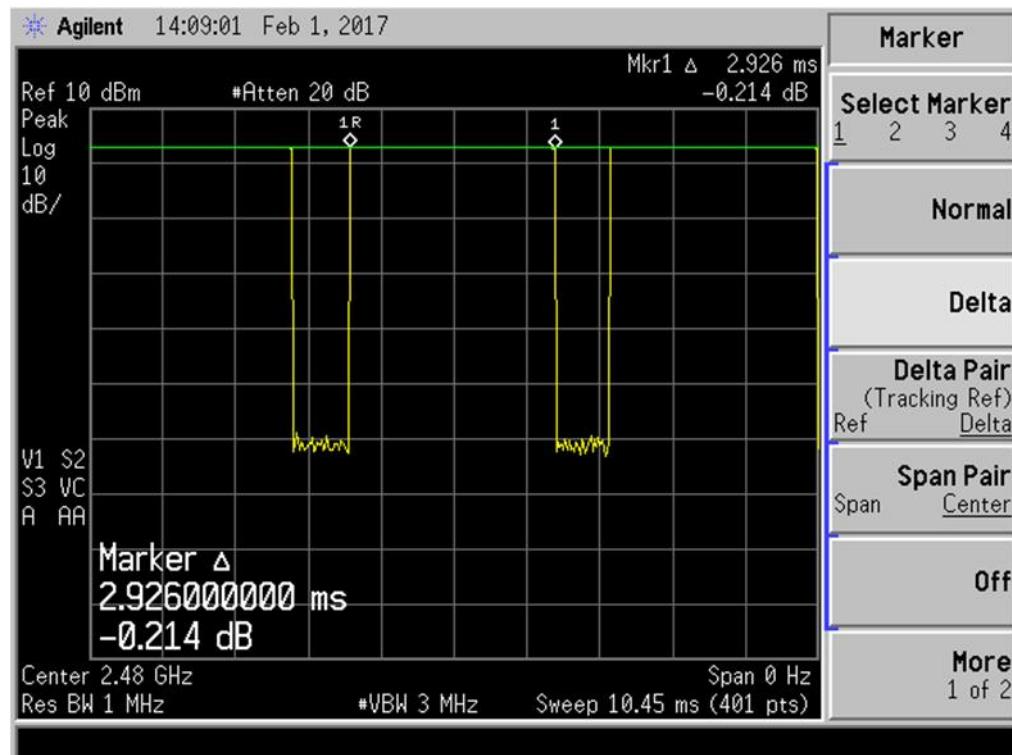
Plot 24 – Channel 0 (lower ch) – Transmit Time per Hop



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

## AVERAGE FREQUENCY DWELL TIME TEST

### Average Frequency Dwell Time Plots – DH5



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

## MAXIMUM PEAK POWER TEST

### 47 CFR FCC Part 15.247(b)(1) Maximum Peak Power 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).

### 47 CFR FCC Part 15.247(b)(1) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Boonton Electronics RF Power Meter	4532	72901	27 Aug 2018
Boonton Electronics Peak Power Sensor	56218-S/1	1417	27 Aug 2018
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### 47 CFR FCC Part 15.247(b)(1) Maximum Peak Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the Power Meter via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

### 47 CFR FCC Part 15.247(b)(1) Maximum Peak Power Test Method

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 Channel 0 (2.402GHz) (*lower ch*).
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The step 2 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) (*mid ch*) and Channel 78 (2.480GHz) (*upper ch*) respectively.

**MAXIMUM PEAK POWER TEST**

**47 CFR FCC Part 15.247(b)(1) Maximum Peak Power Results**

Test Input Power	120V 60Hz	Temperature	26°C
Antenna Gain	2.0 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

**GFSK**

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0 ( <i>lower ch</i> )	2.402	0.00134	1.0
39 ( <i>mid ch</i> )	2.441	0.00133	1.0
78 ( <i>upper ch</i> )	2.480	0.00131	1.0

**( $\pi/4$ ) DQPSK**

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0 ( <i>lower ch</i> )	2.402	0.00086	1.0
39 ( <i>mid ch</i> )	2.441	0.00086	1.0
78 ( <i>upper ch</i> )	2.480	0.00085	1.0

**8DPSK**

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0 ( <i>lower ch</i> )	2.402	0.00087	1.0
39 ( <i>mid ch</i> )	2.441	0.00086	1.0
78 ( <i>upper ch</i> )	2.480	0.00085	1.0

**Notes**

1. Nil.

## RF CONDUCTED SPURIOUS EMISSIONS TEST

### **47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions 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.

### **47 CFR FCC Part 15.247(d) RF Conducted Spurious Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### **47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 3 times of RBW.
5. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions Test Method**

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 Channel 0 (2.402GHz) (*lower ch*).
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.
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.
4. The steps 2 to 3 were repeated with frequency span was set from 10GHz to 25GHz.
5. The steps 2 to 4 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) (*mid ch*) and Channel 78 (2.480GHz) (*upper ch*) respectively.



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**RF CONDUCTED SPURIOUS EMISSIONS TEST**

**47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions Results**

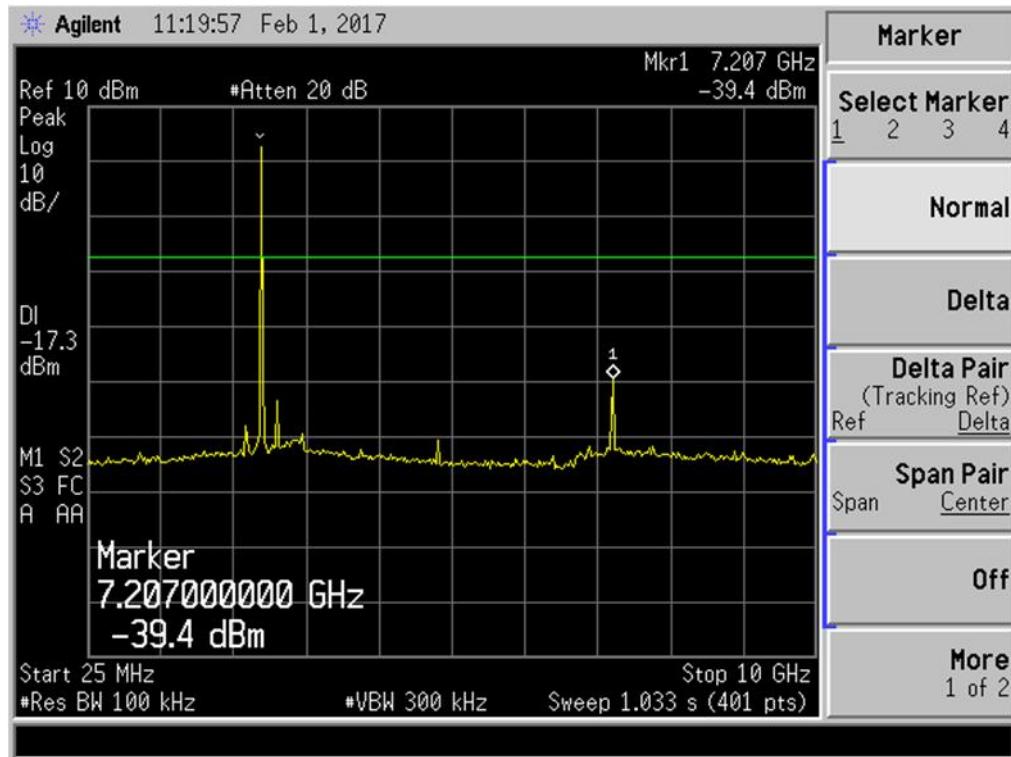
Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	27 – 44	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

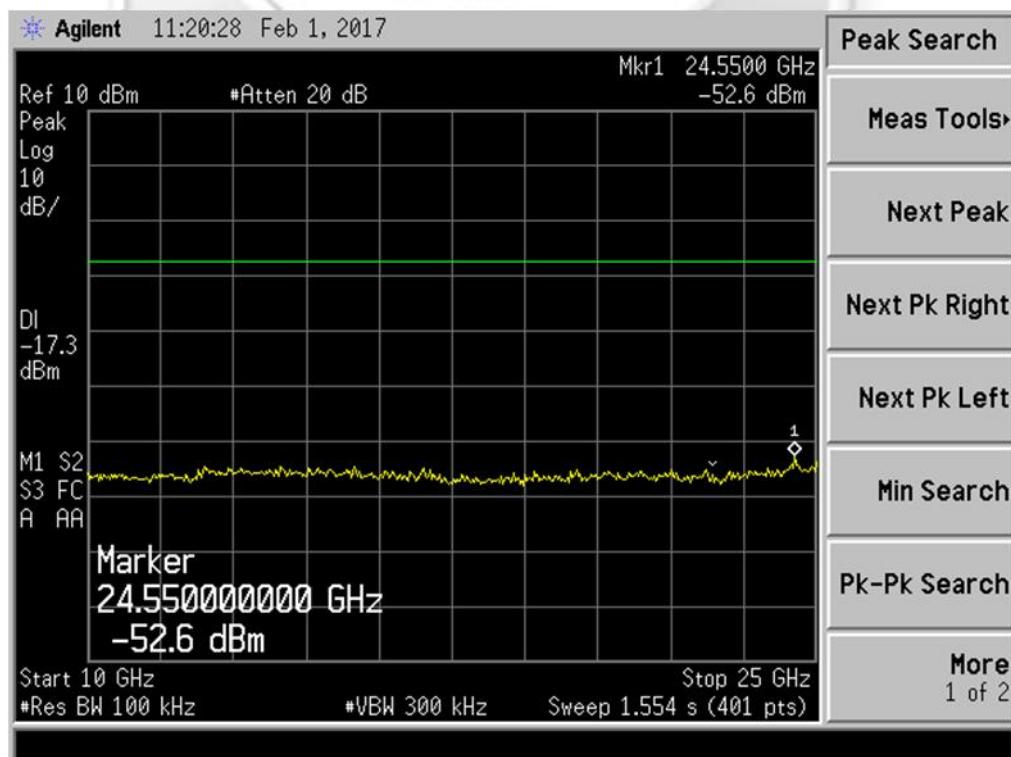


## RF CONDUCTED SPURIOUS EMISSIONS TEST

## RF Conducted Spurious Emissions Plots – GFSK



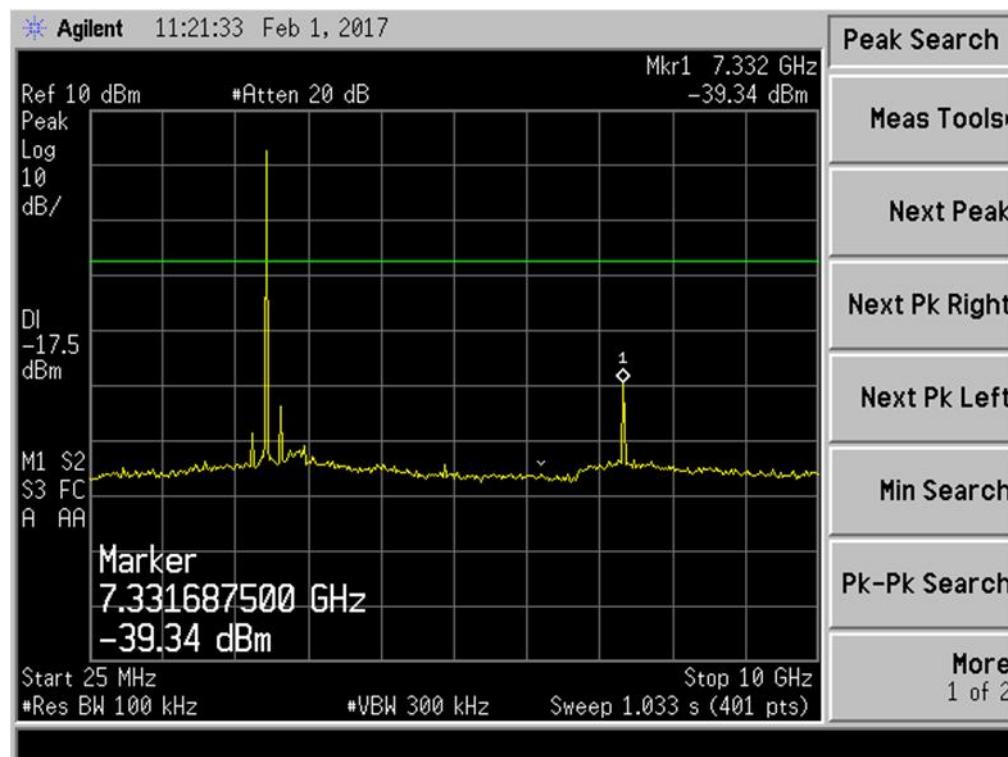
**Plot 27 – Channel 0 (lower ch)**



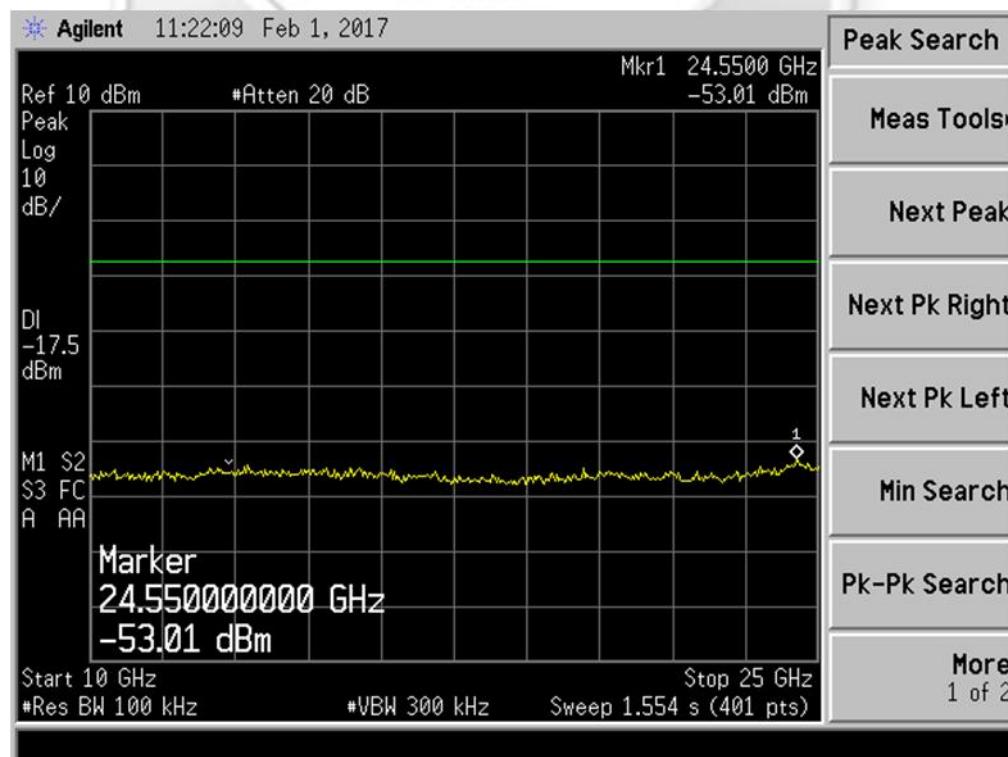
**Plot 28 – Channel 0 (lower ch)**

RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – GFSK



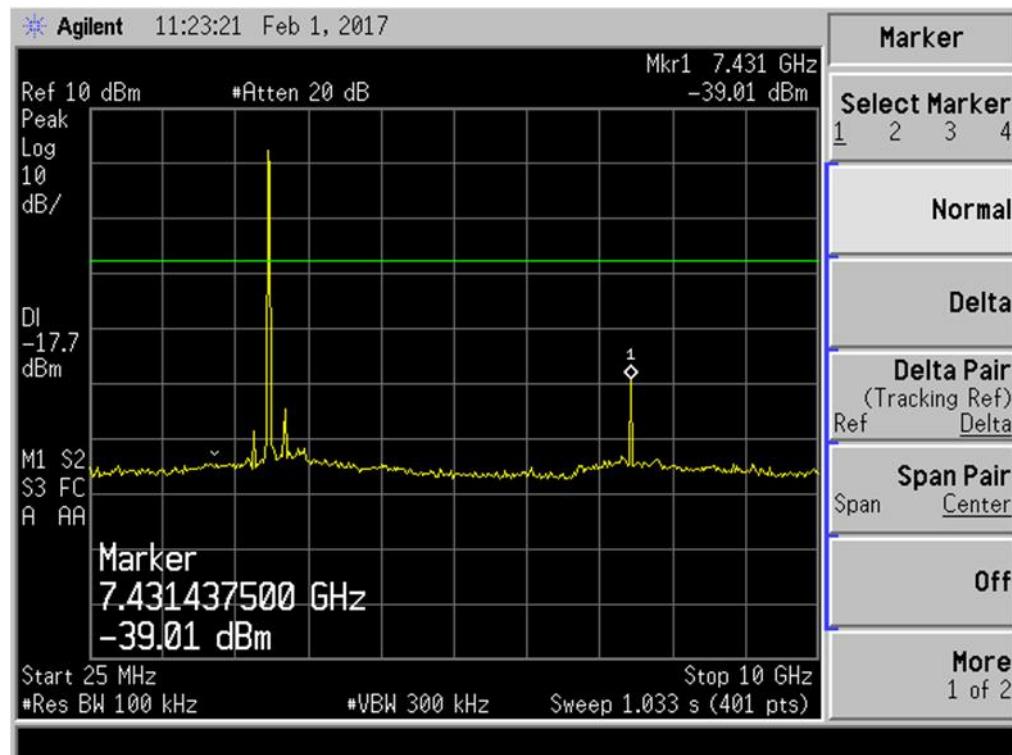
Plot 29 – Channel 39 (mid ch)



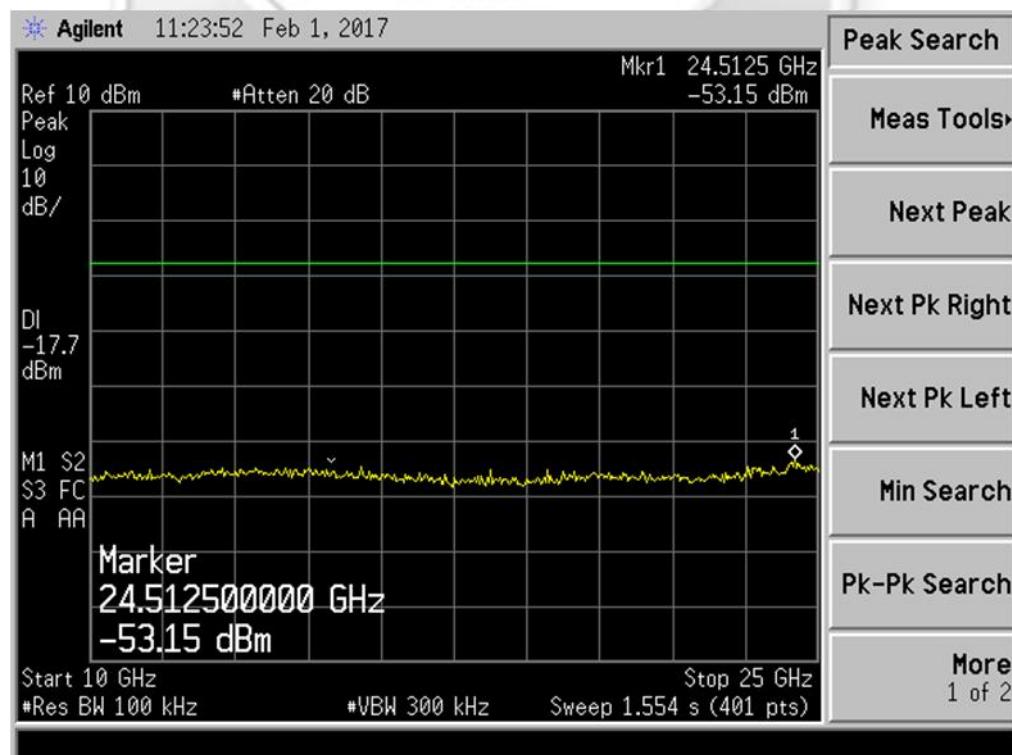
Plot 30 – Channel 39 (mid ch)

RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – GFSK



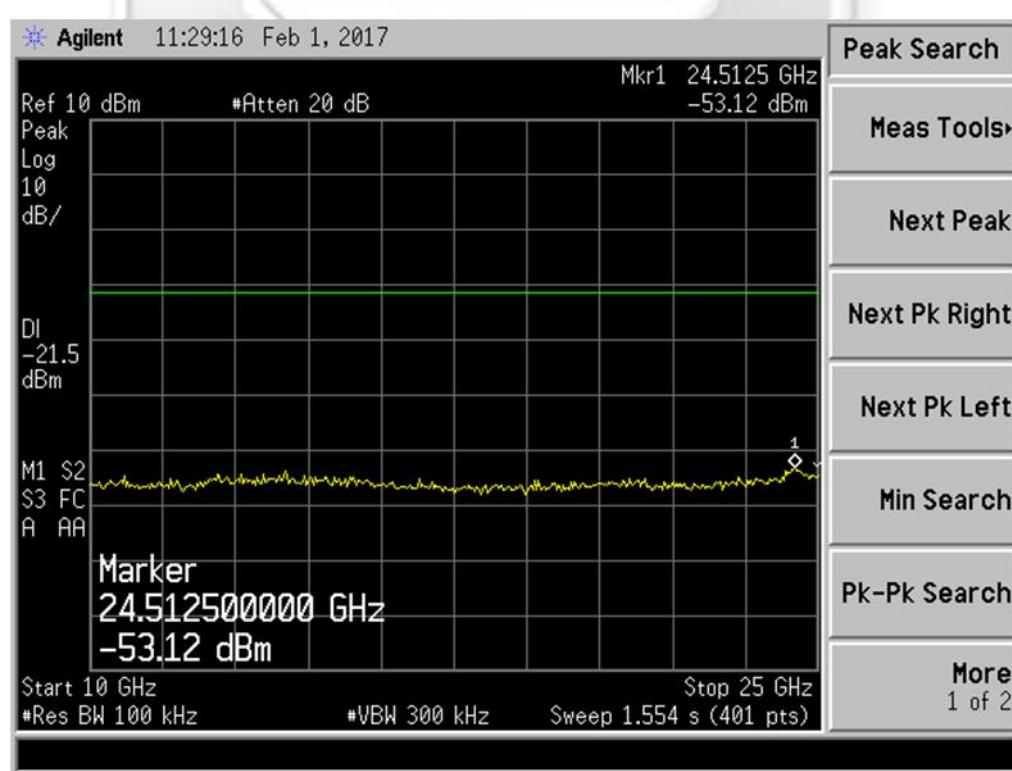
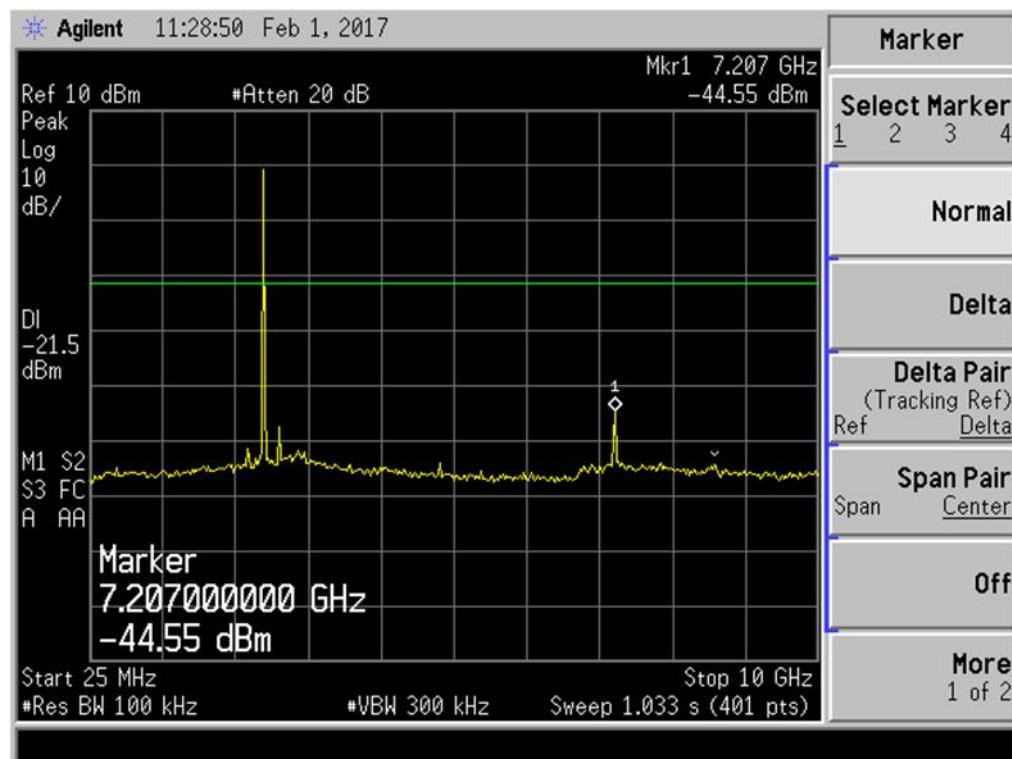
Plot 31 – Channel 78 (upper ch)



Plot 32 – Channel 78 (upper ch)

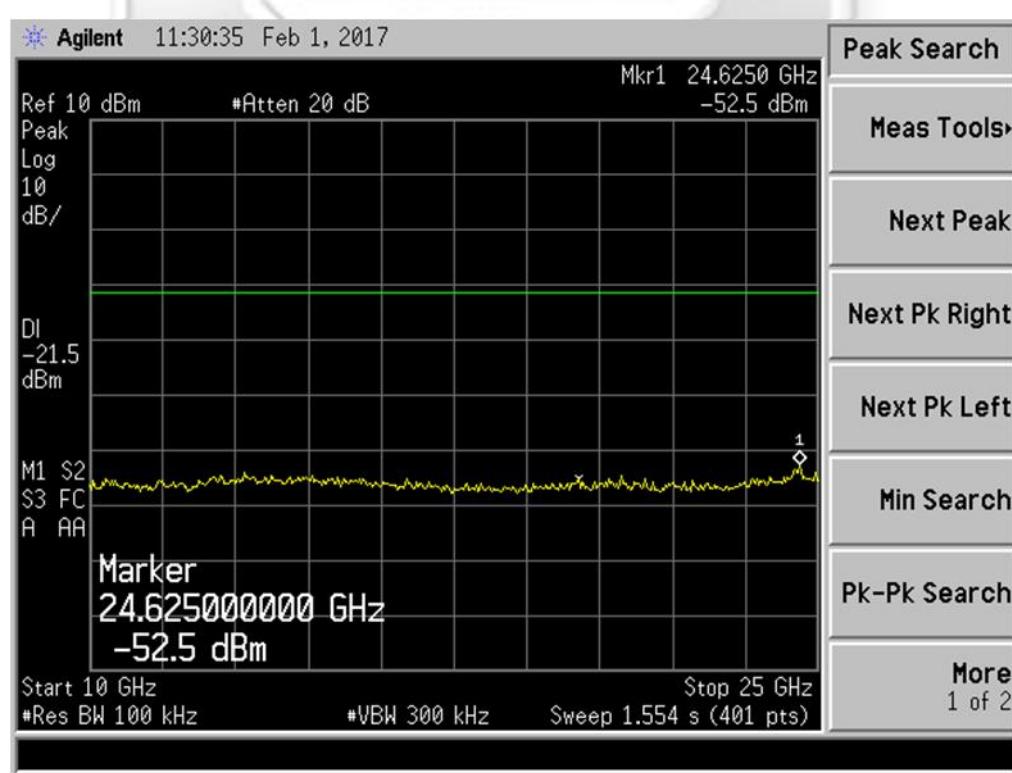
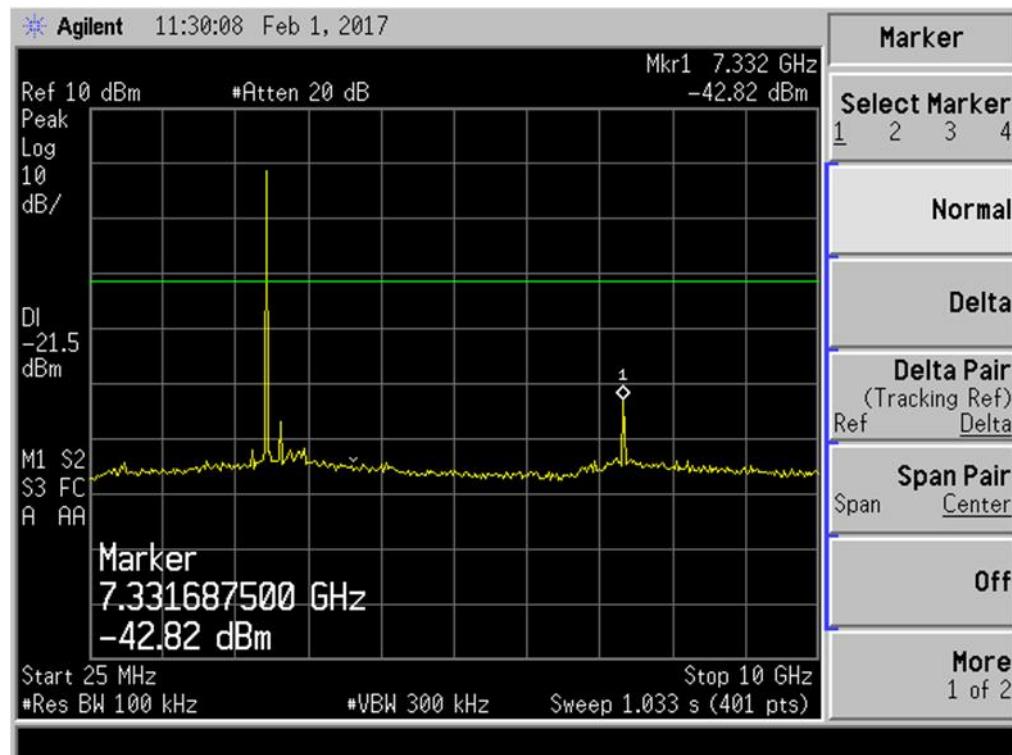
RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – ( $\pi/4$ ) DQPSK



RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – ( $\pi/4$ ) DQPSK

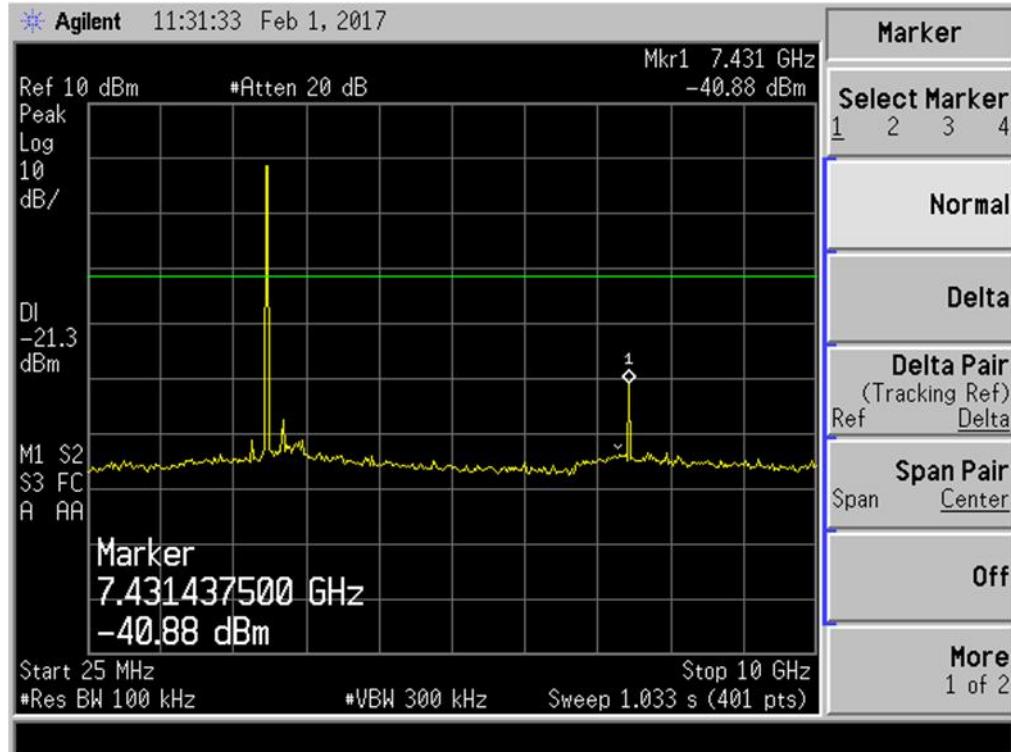




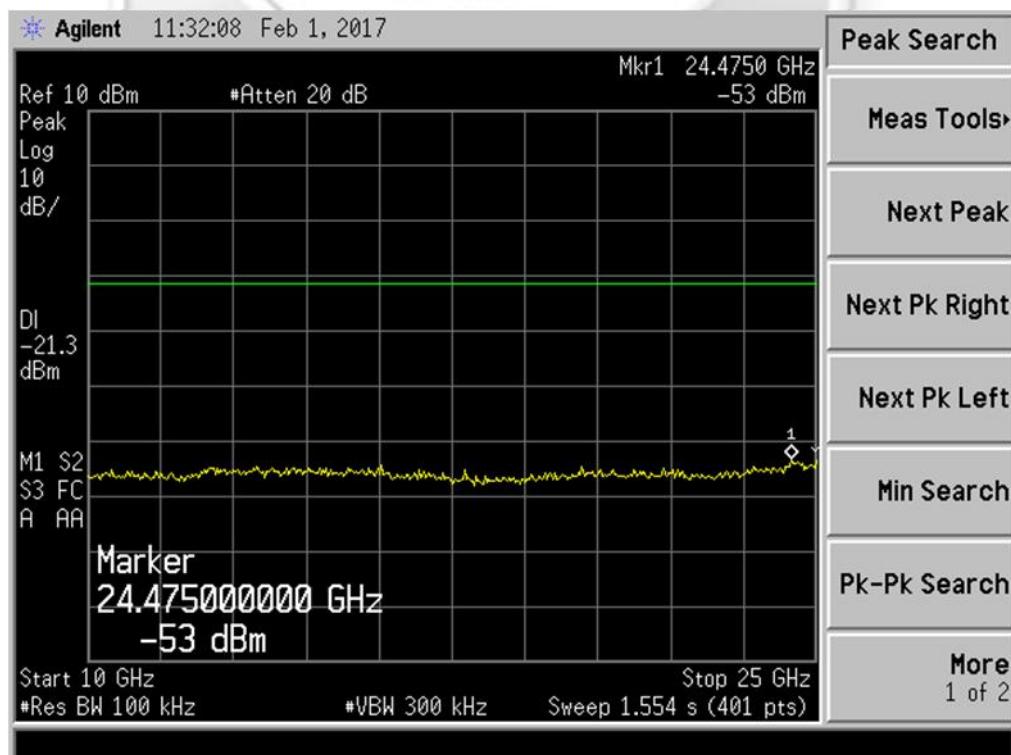
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## RF CONDUCTED SPURIOUS EMISSIONS TEST

## RF Conducted Spurious Emissions Plots – ( $\pi/4$ ) DQPSK



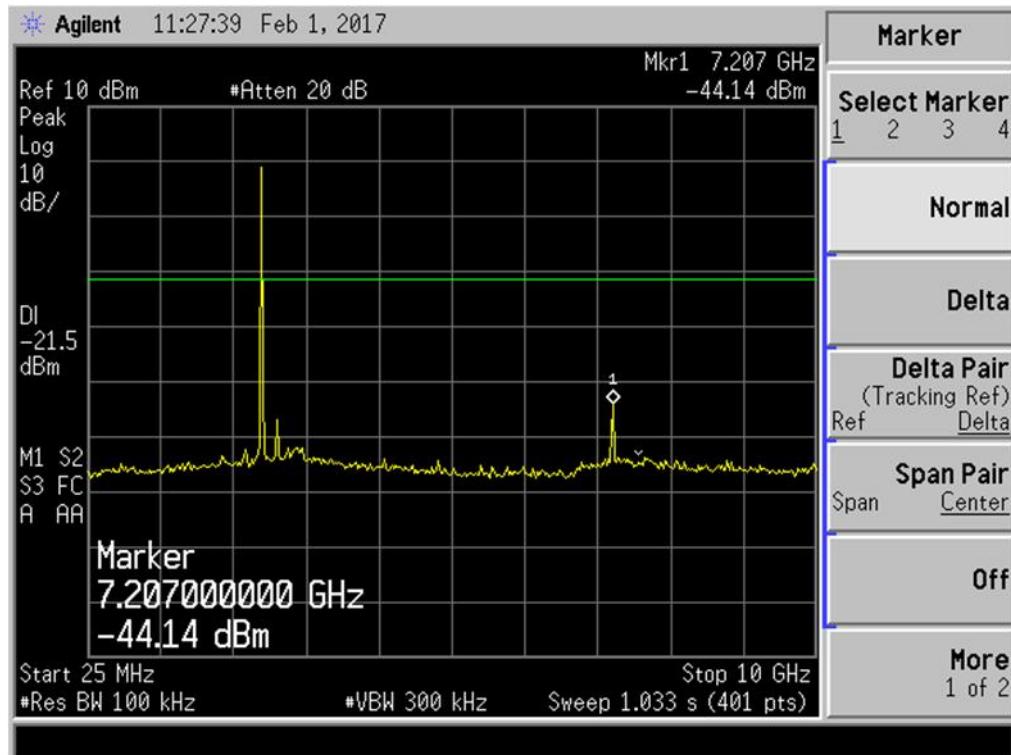
### Plot 37 – Channel 78 (upper ch)



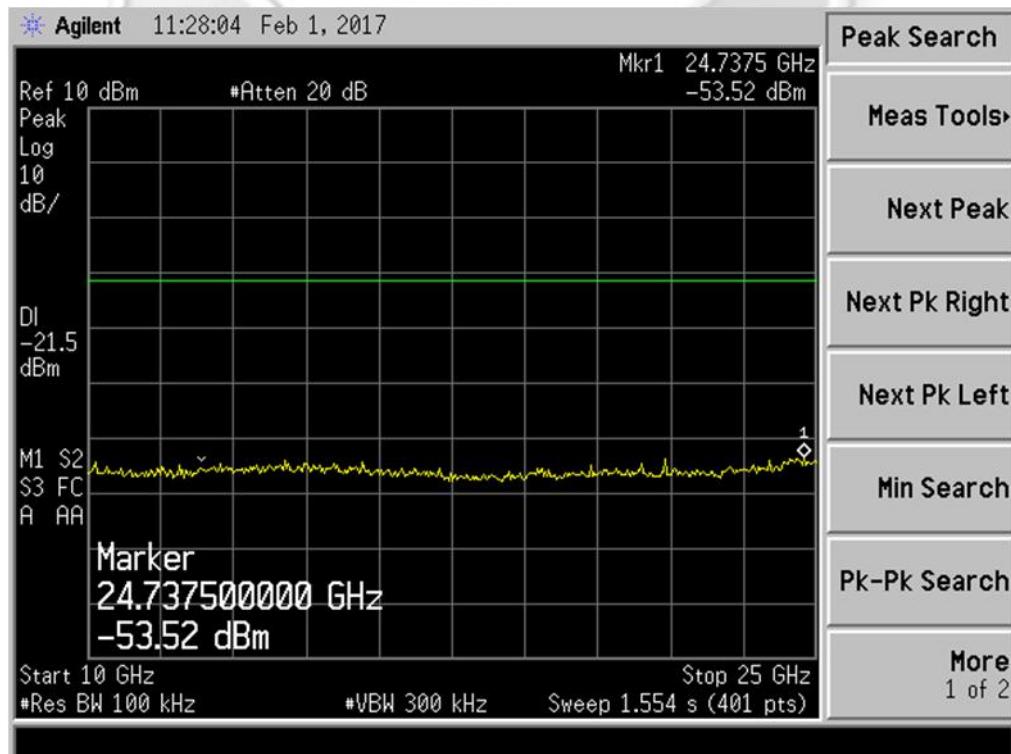
### Plot 38 – Channel 78 (upper ch)

## RF CONDUCTED SPURIOUS EMISSIONS TEST

## RF Conducted Spurious Emissions Plots – 8DPSK



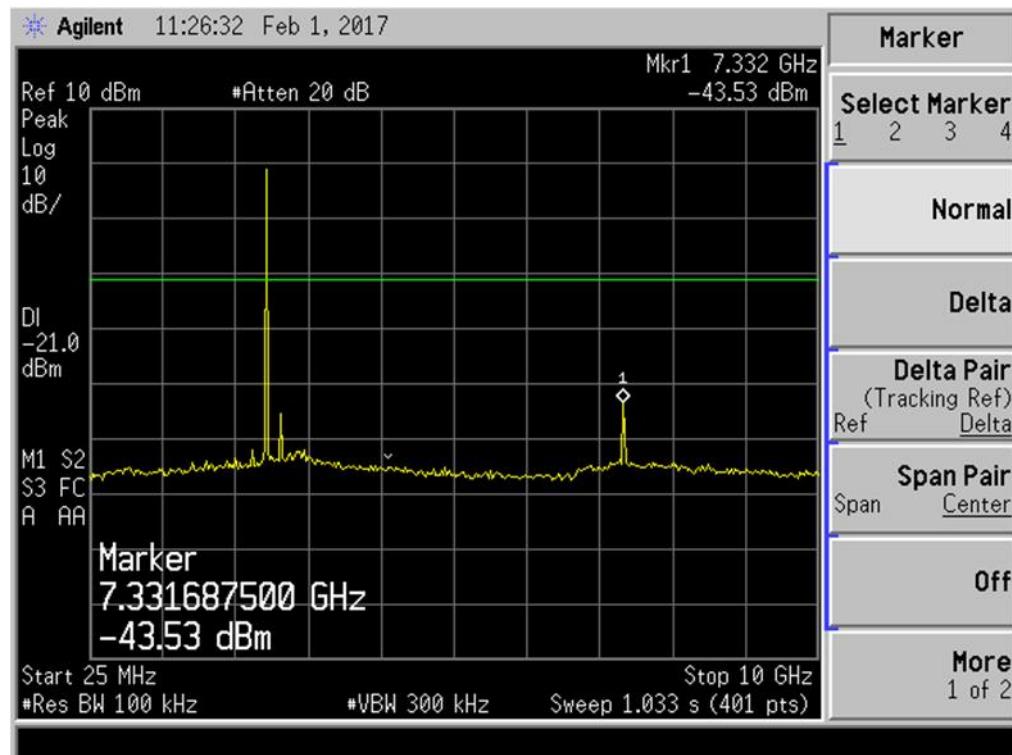
### Plot 39 – Channel 0 (*lower ch*)



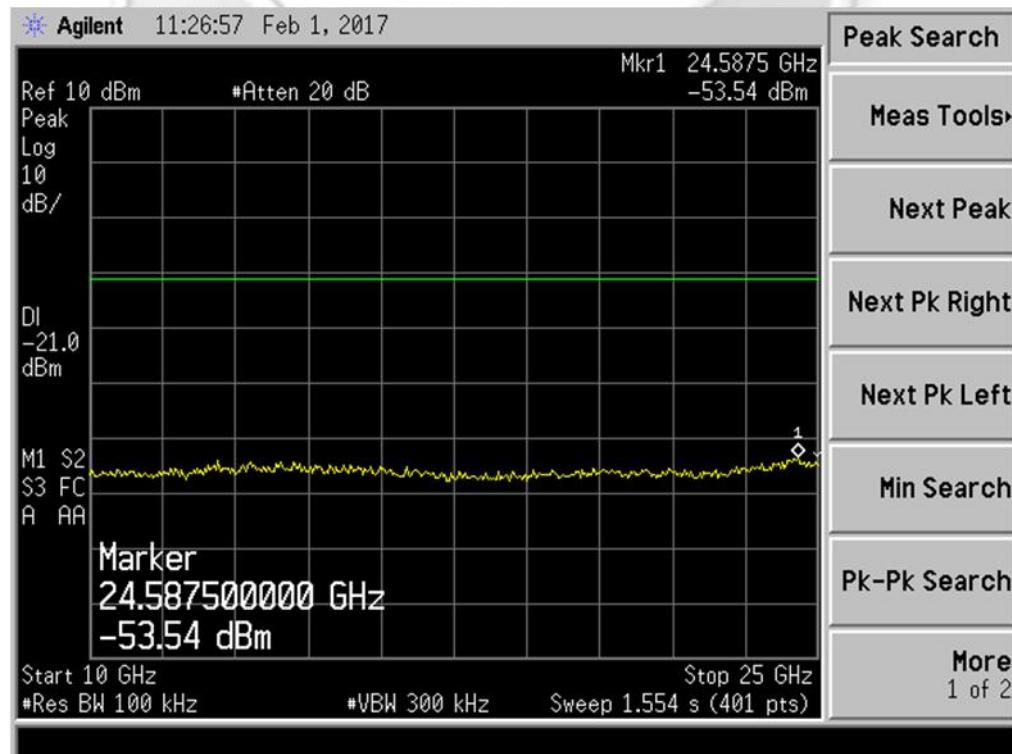
**Plot 40 – Channel 0 (lower ch)**

RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – 8DPSK



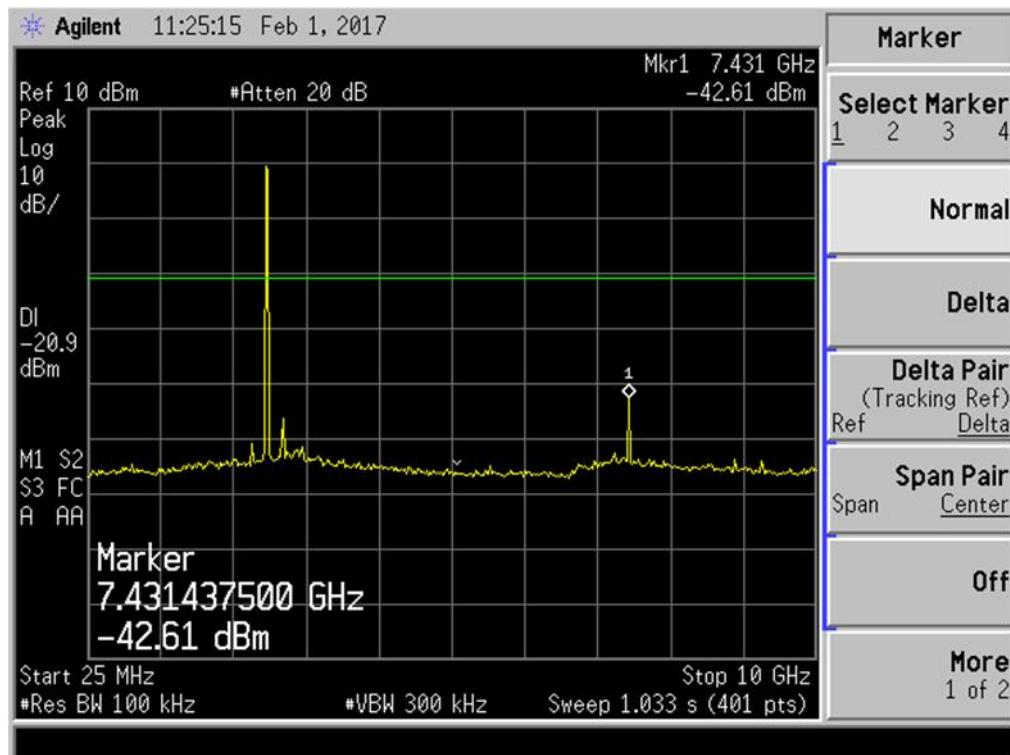
Plot 41 – Channel 39 (mid ch)



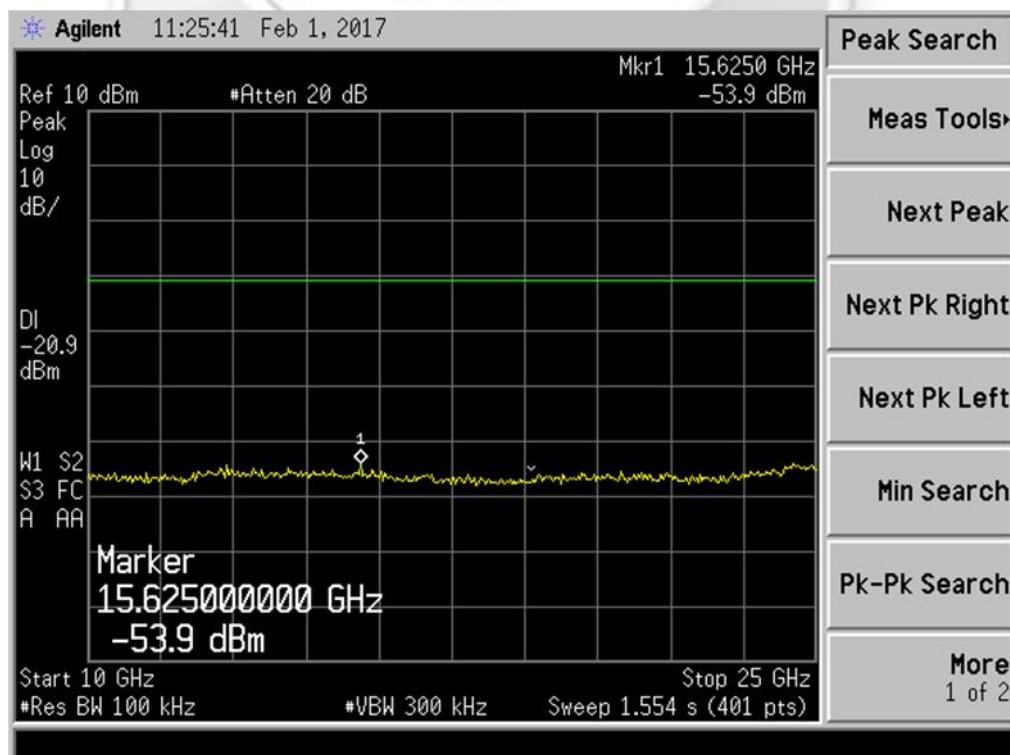
Plot 42 – Channel 39 (mid ch)

RF CONDUCTED SPURIOUS EMISSIONS TEST

RF Conducted Spurious Emissions Plots – 8DPSK



Plot 43 – Channel 78 (upper ch)



Plot 44 – Channel 78 (upper ch)

## **BAND EDGE COMPLIANCE (CONDUCTED) TEST**

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Conducted) 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.

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Conducted) Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Conducted) Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum analyser via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz.
5. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Conducted) Test Method**

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. 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.
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.
4. The steps 2 to 3 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 any spurious emissions at the band-edge.
5. The measurements were repeated with turning off the frequency hopping sequence of the EUT.

**BAND EDGE COMPLIANCE (CONDUCTED) TEST**

**47 CFR FCC Part 15.247(d) Band Edge Compliance (Conducted) Results**

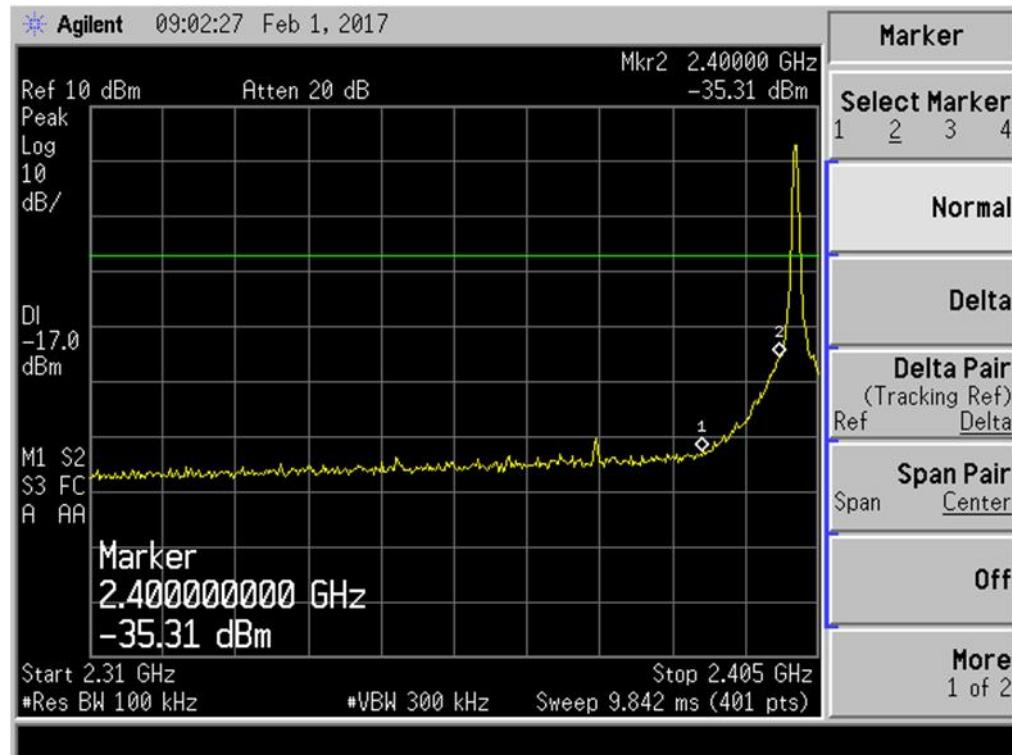
Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	45 – 50	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

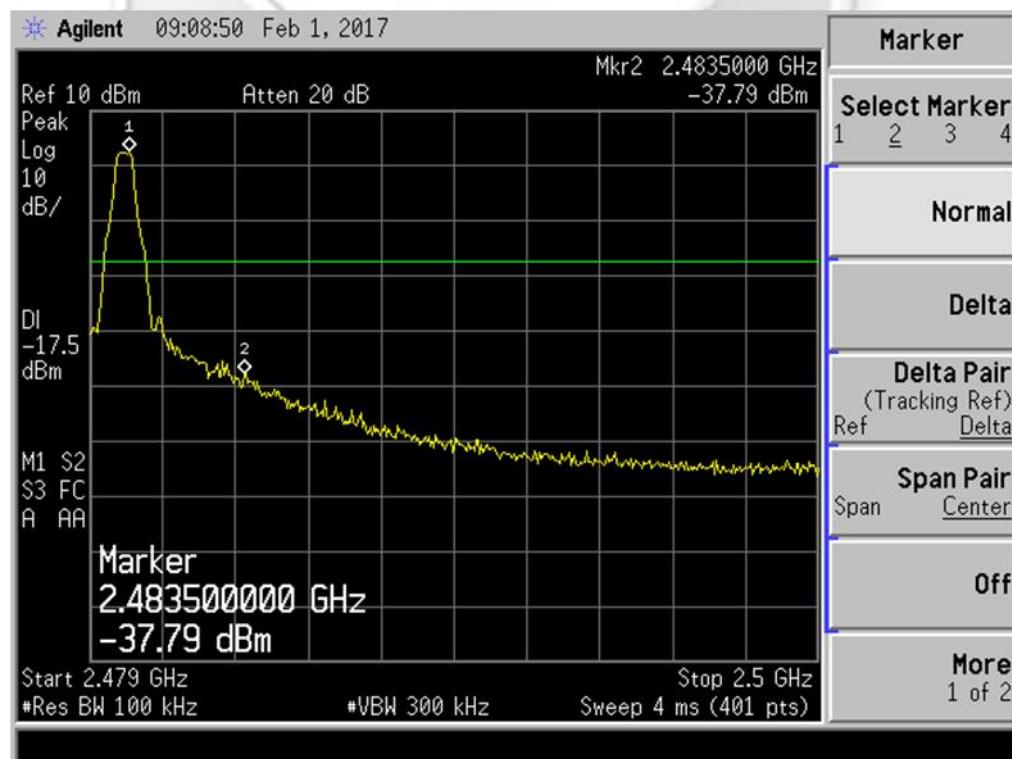


BAND EDGE COMPLIANCE (CONDUCTED) TEST

Band Edge Compliance (Conducted) Plots – GFSK



Plot 45 – Lower Band Edge at 2.4000GHz



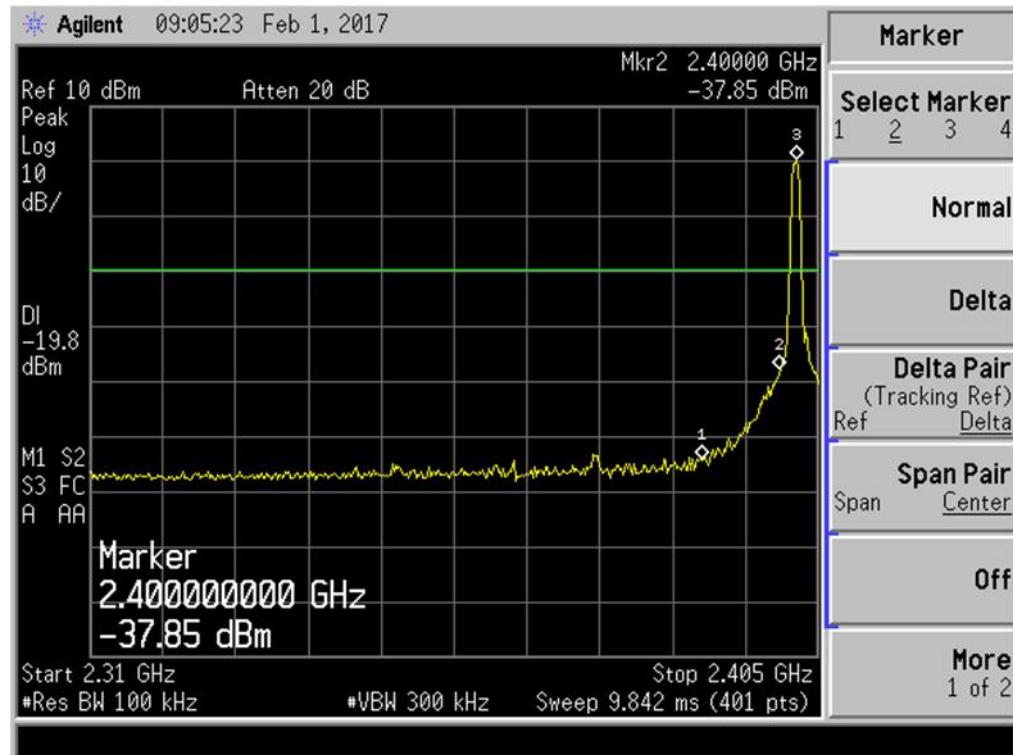
Plot 46 – Upper Band Edge at 2.4835GHz



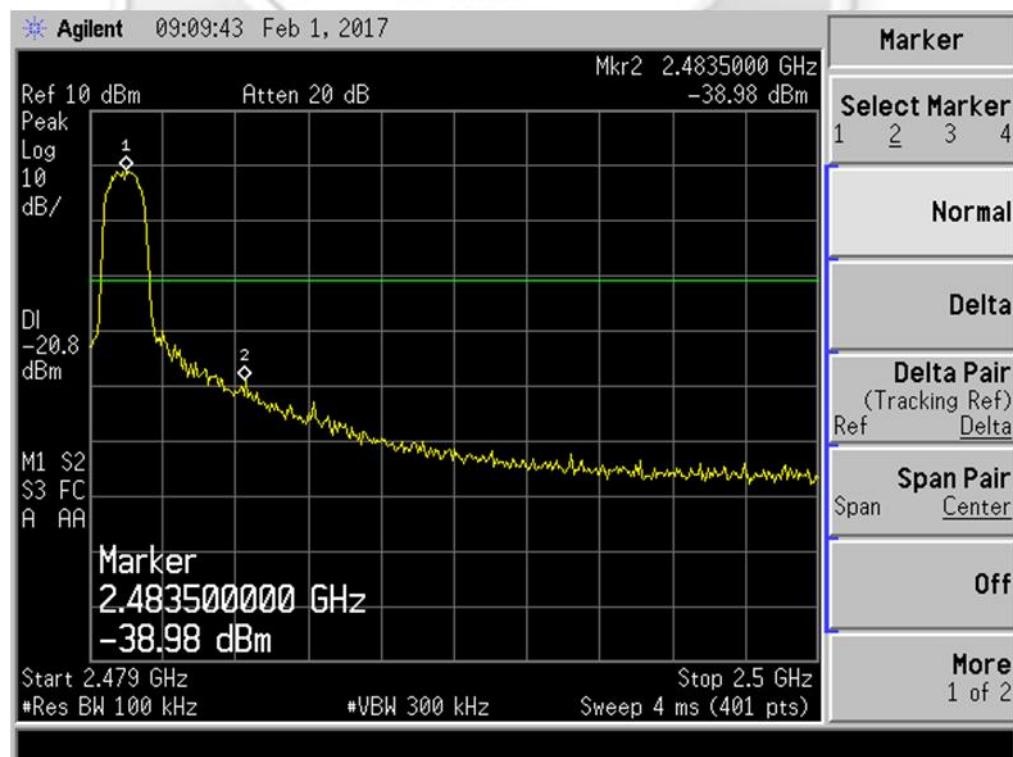
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## BAND EDGE COMPLIANCE (CONDUCTED) TEST

## Band Edge Compliance (Conducted) Plots – ( $\pi/4$ ) DQPSK



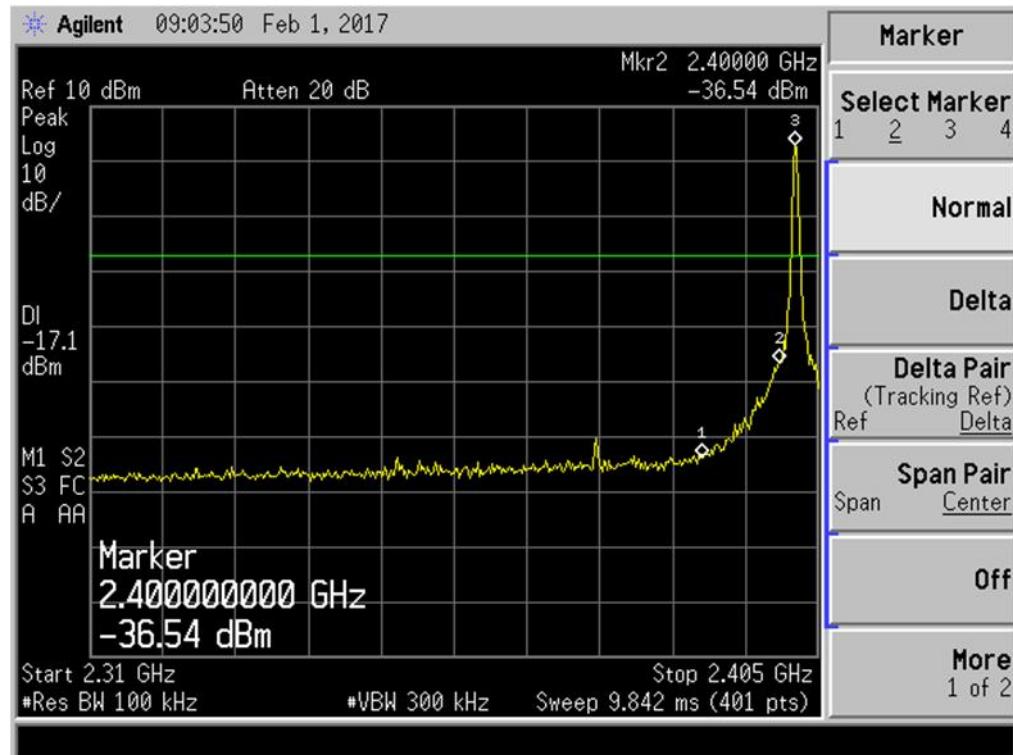
**Plot 47 – Lower Band Edge at 2.4000GHz**



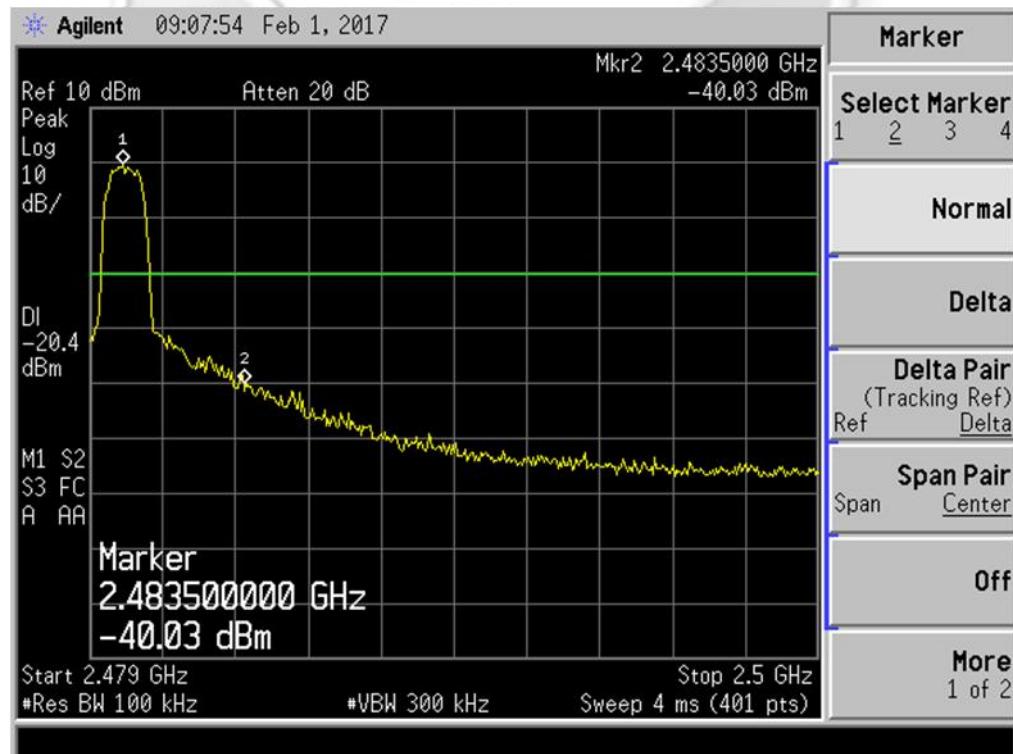
**Plot 48 – Upper Band Edge at 2.4835GHz**

BAND EDGE COMPLIANCE (CONDUCTED) TEST

Band Edge Compliance (Conducted) Plots – 8DPSK



Plot 49 – Lower Band Edge at 2.4000GHz



Plot 50 – Upper Band Edge at 2.4835GHz

## **BAND EDGE COMPLIANCE (RADIATED) TEST**

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Radiated) 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.

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Radiated) Test Instrumentation**

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	11 Oct 2017
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	24 Mar 2018
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Radiated) Test Setup**

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
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
4. All other supporting equipment were powered separately from another filtered mains.

### **47 CFR FCC Part 15.247(d) Band Edge Compliance (Radiated) Test Method**

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. 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.
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.
4. The steps 2 to 3 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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**BAND EDGE COMPLIANCE (RADIATED) TEST**

**47 CFR FCC Part 15.247(d) Band Edge Compliance (Radiated) Results**

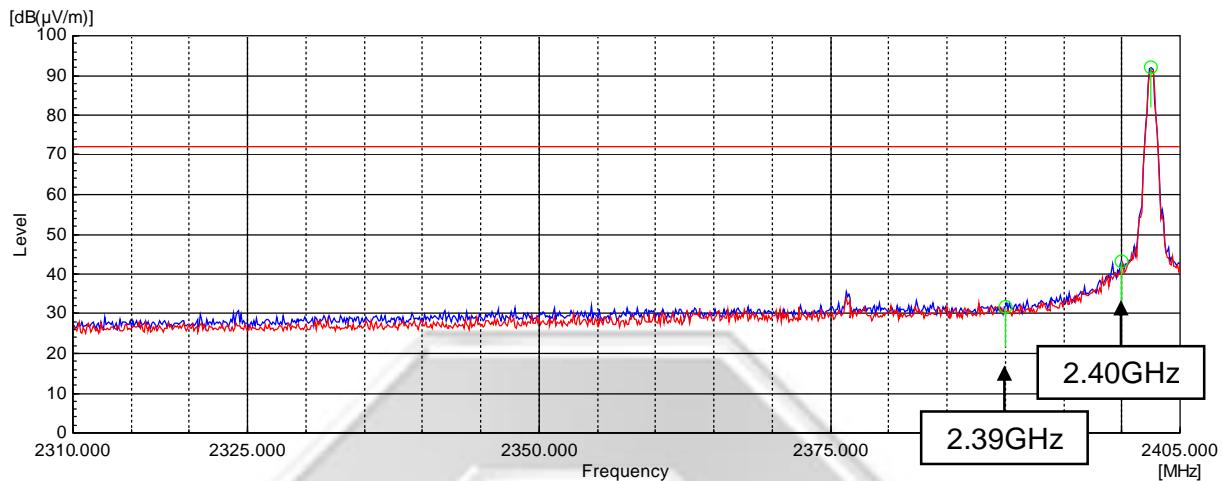
Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	51 – 68	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

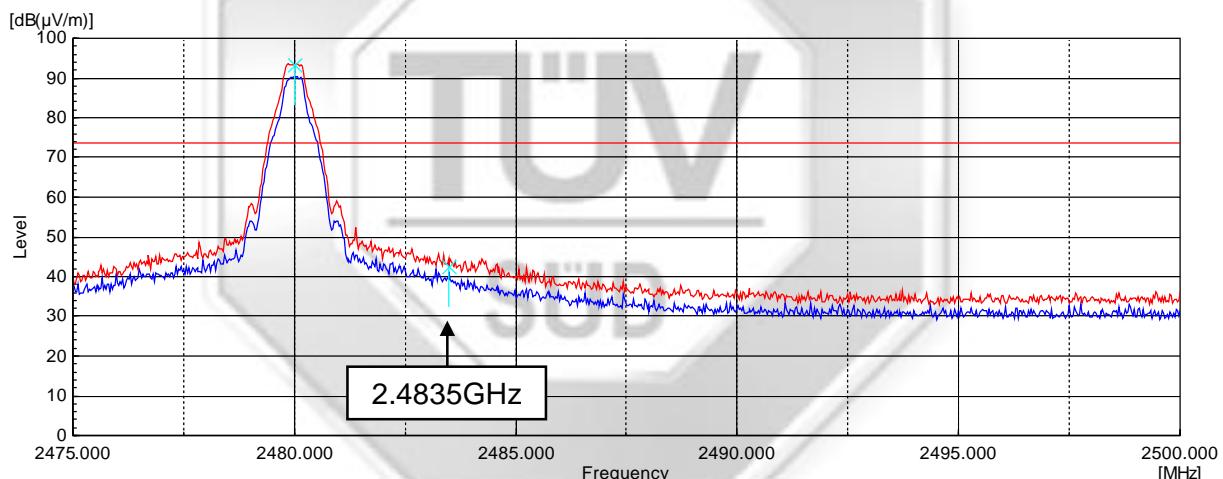


**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge) - BDR 1Mbps**



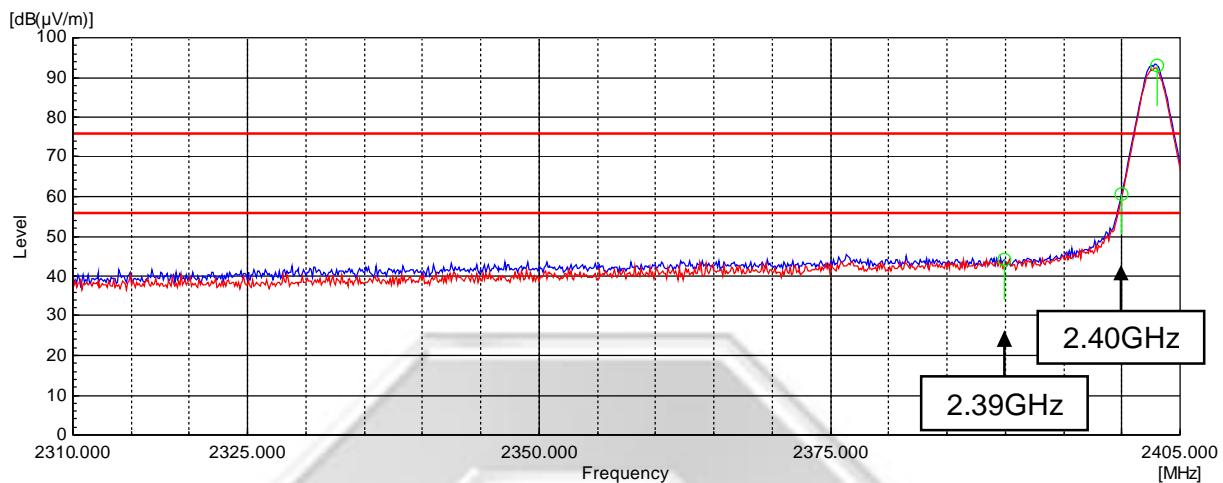
**Plot 51 – Lower Band Edge at 2.4000GHz**



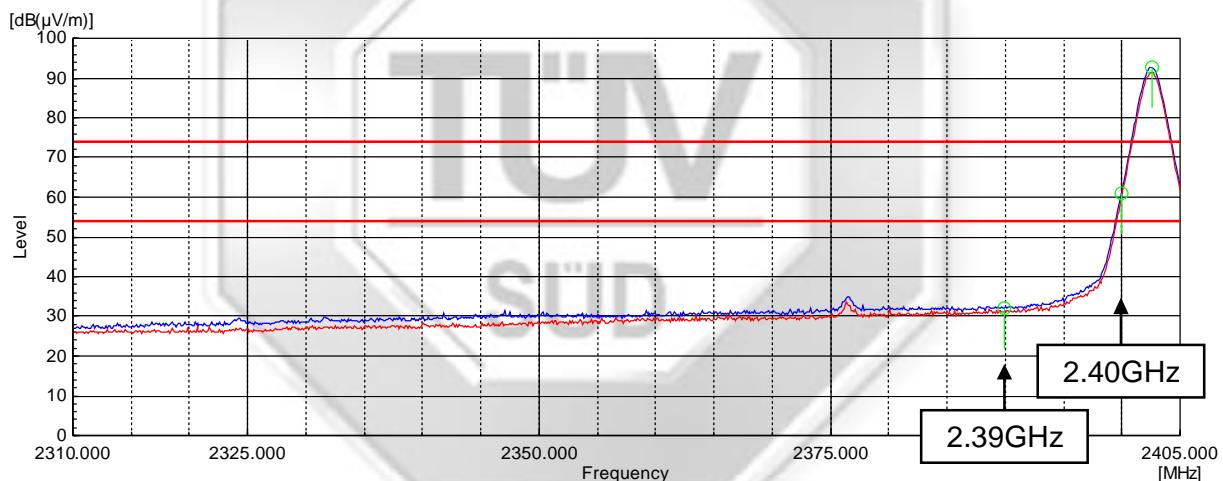
**Plot 52 – Upper Band Edge at 2.4835GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (Restricted Band) - BDR 1Mbps**



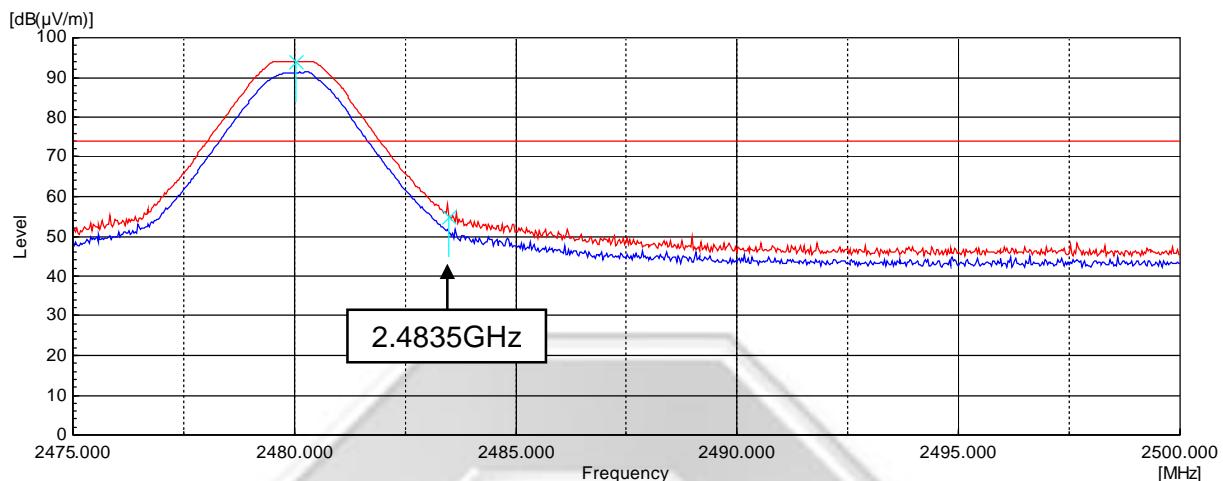
**Plot 53 – Peak Plot at Lower Band Edge at 2.4000GHz**



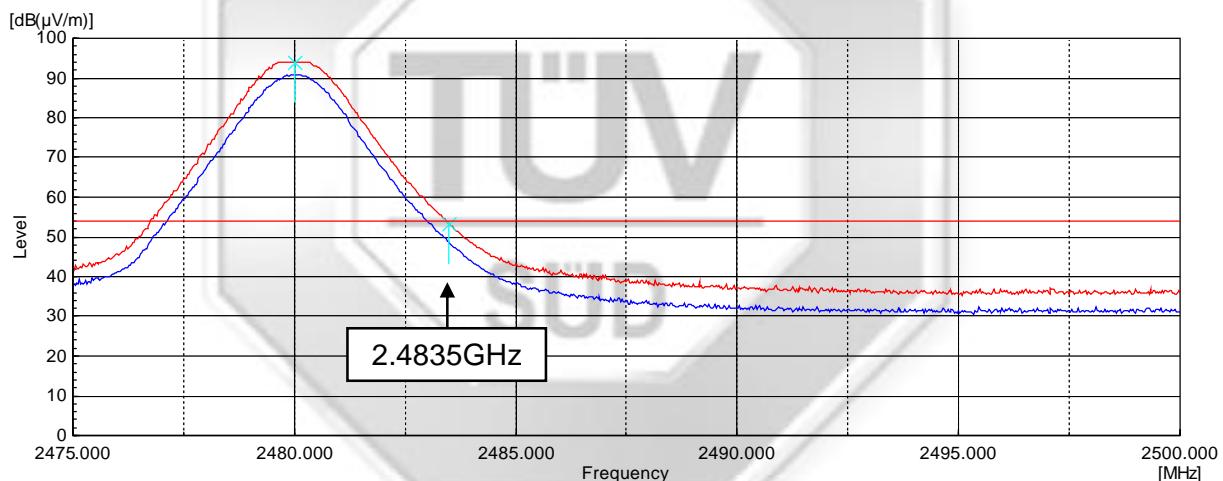
**Plot 54 – Average Plot at Lower Band Edge at 2.4000GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (Restricted Band) - BDR 1Mbps**



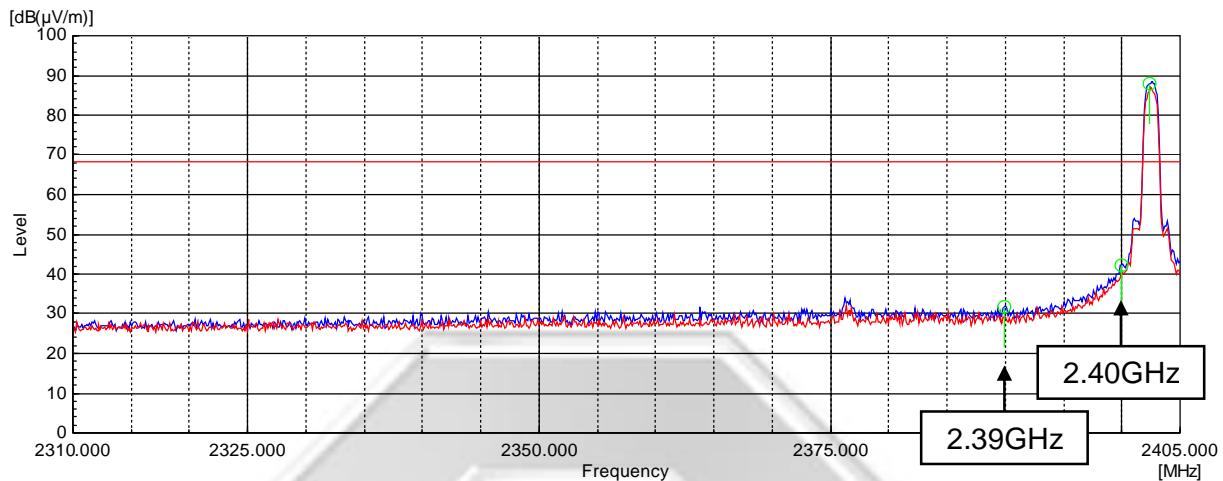
**Plot 55 – Peak Plot at Upper Band Edge at 2.4835GHz**



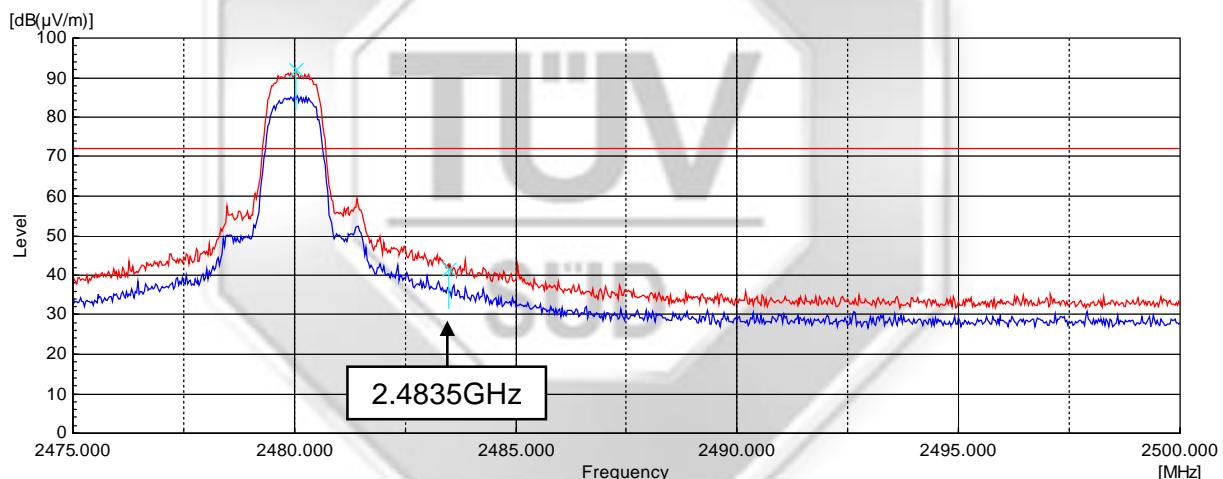
**Plot 56 – Average Plot at Upper Band Edge at 2.4835GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge) - EDR 2Mbps**



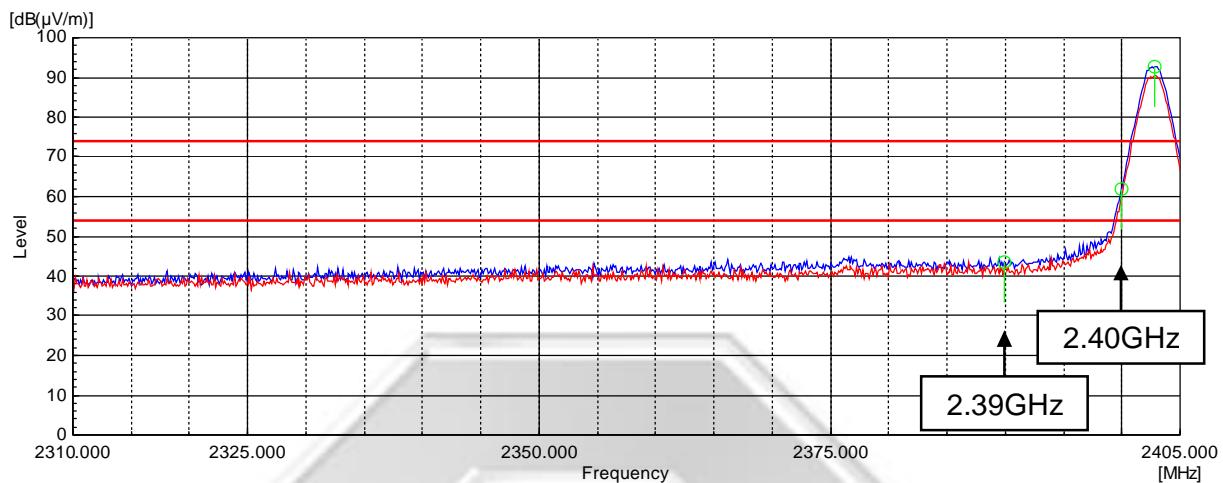
**Plot 57 – Lower Band Edge at 2.4000GHz**



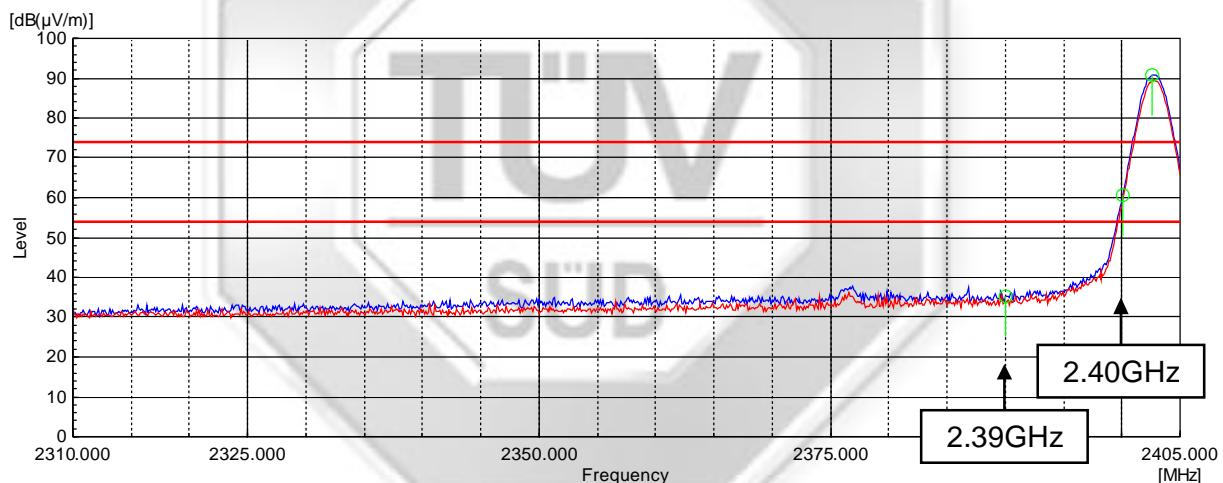
**Plot 58 – Upper Band Edge at 2.4835GHz**

## BAND EDGE COMPLIANCE (RADIATED) TEST

### Band Edge Compliance (Radiated) Plots (Restricted Band) - EDR 2Mbps



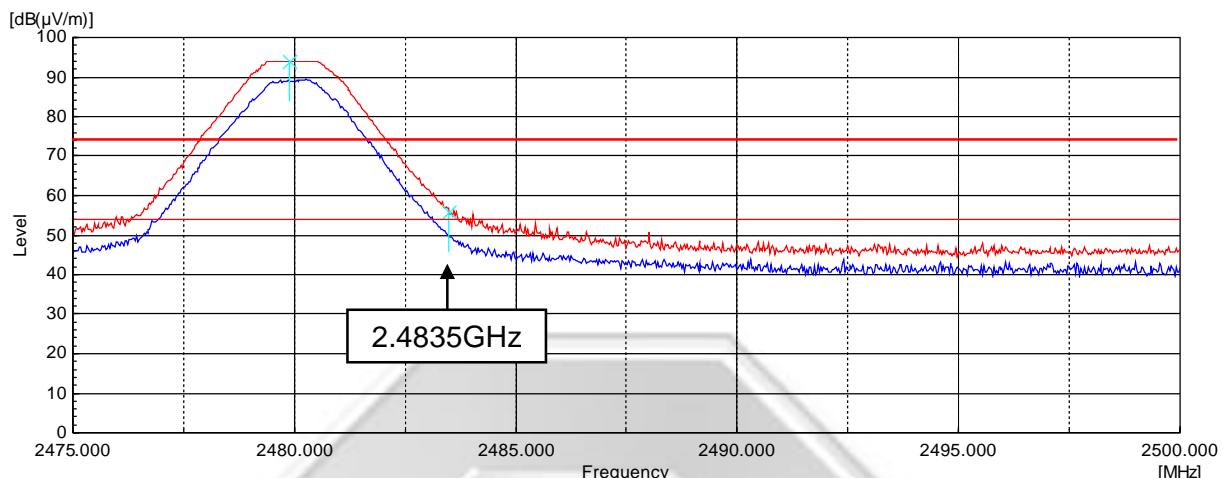
Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz



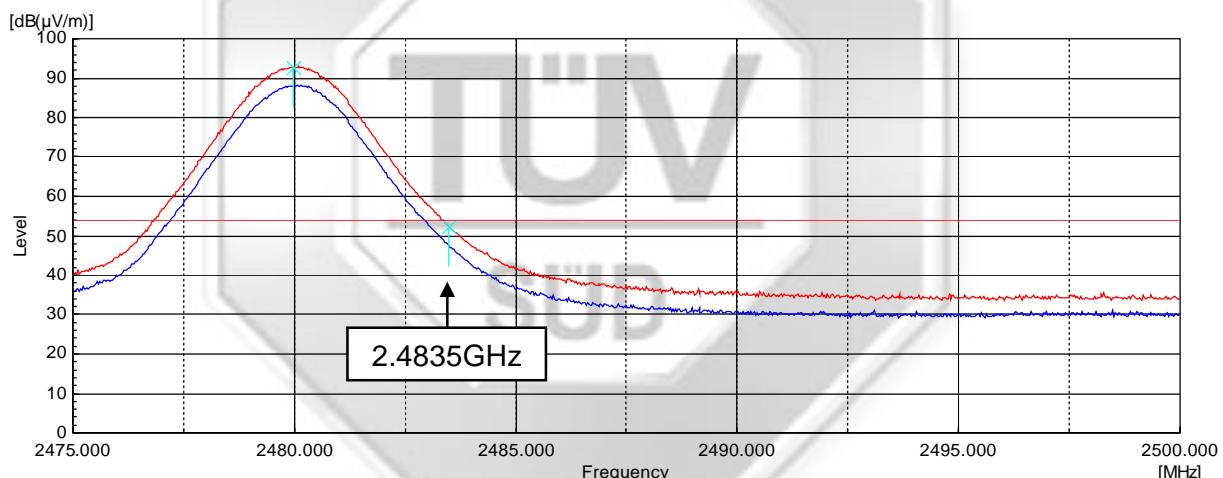
Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (Restricted Band) - EDR 2Mbps**



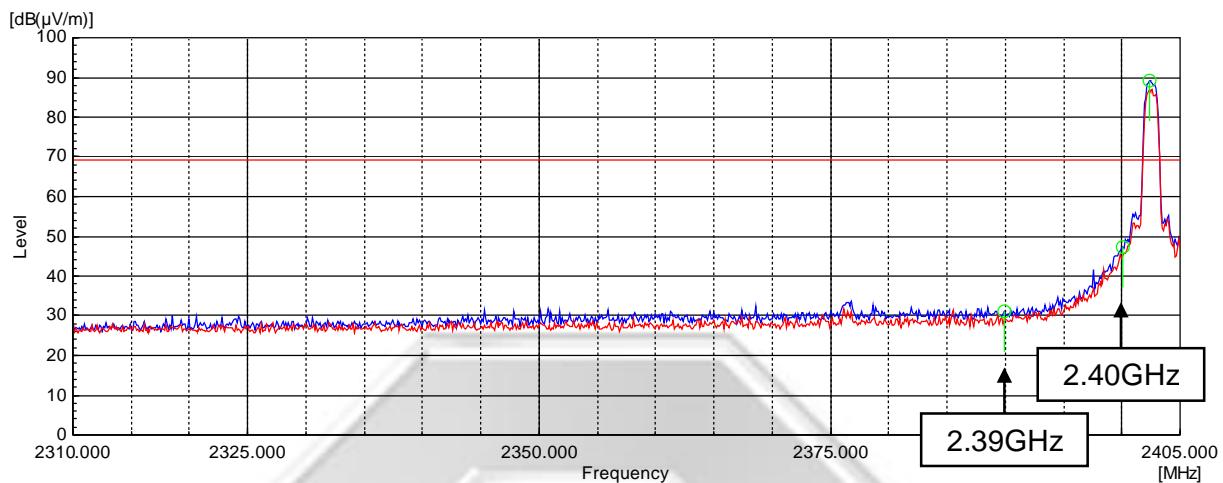
**Plot 61 – Peak Plot at Upper Band Edge at 2.4835GHz**



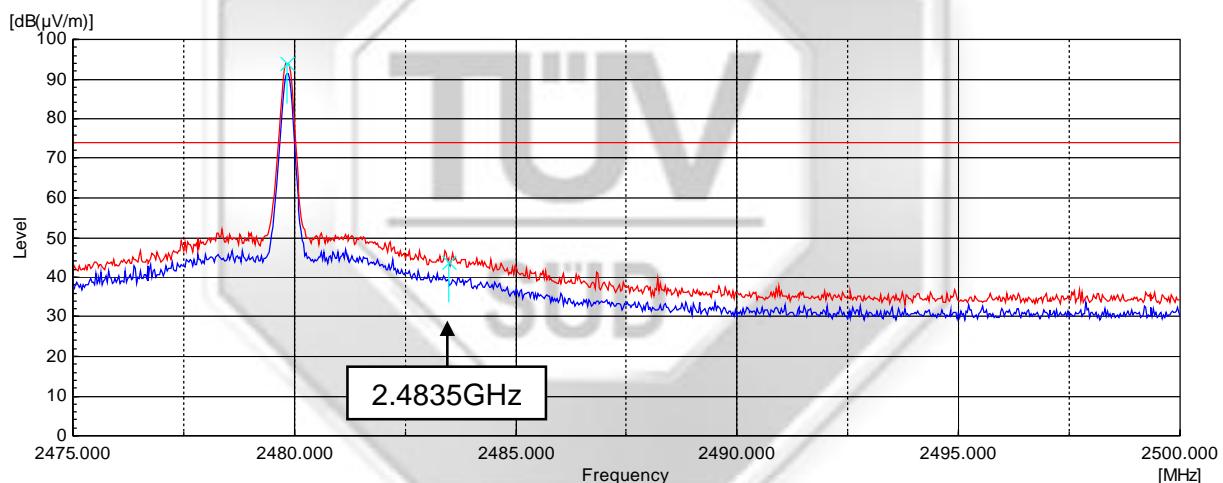
**Plot 62 – Average Plot at Upper Band Edge at 2.4835GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge) - EDR 3Mbps**



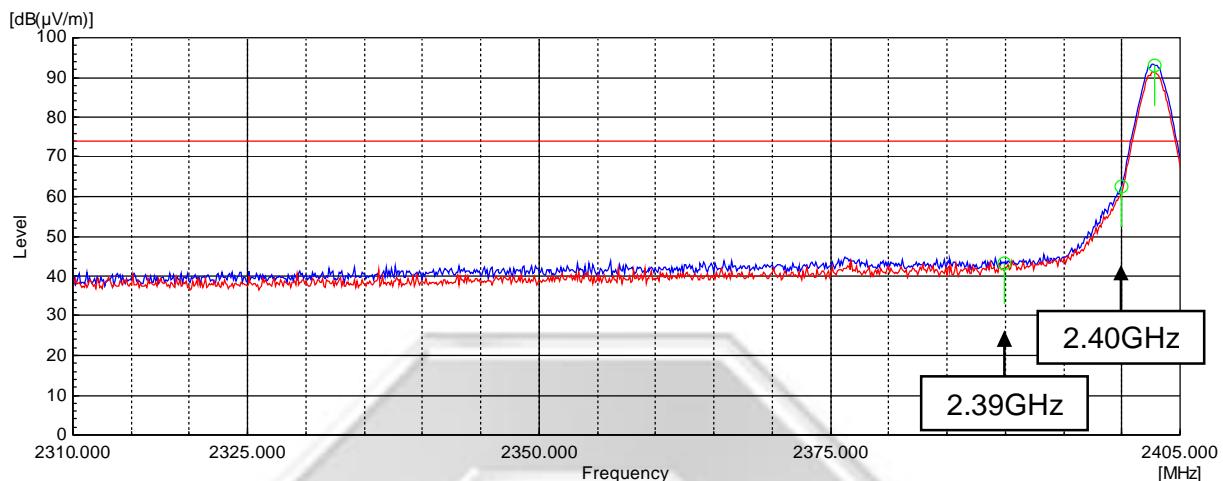
**Plot 63 – Lower Band Edge at 2.4000GHz**



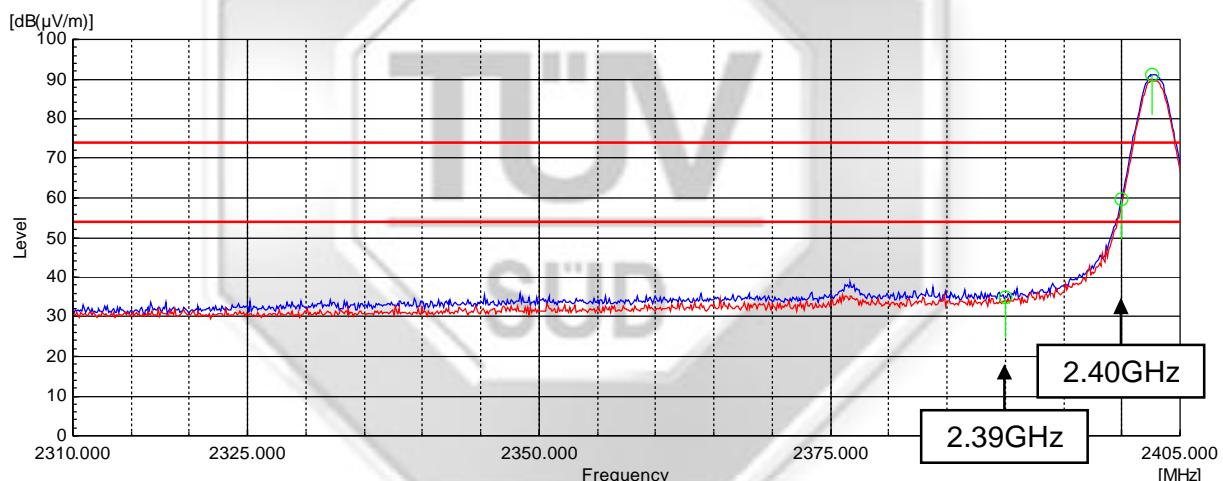
**Plot 64 – Upper Band Edge at 2.4835GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (Restricted Band) - EDR 3Mbps**



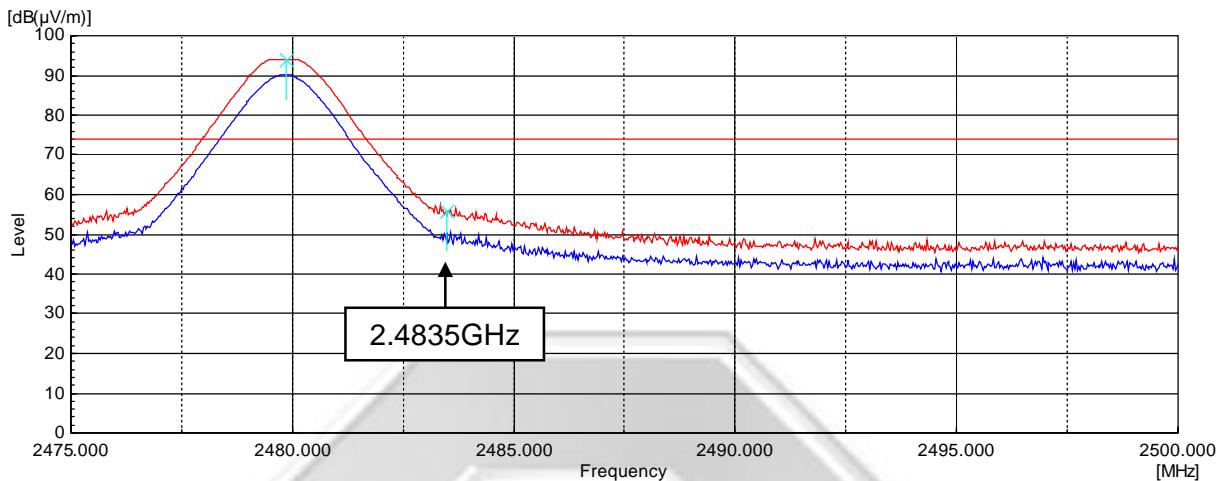
**Plot 65 – Peak Plot at Lower Band Edge at 2.4000GHz**



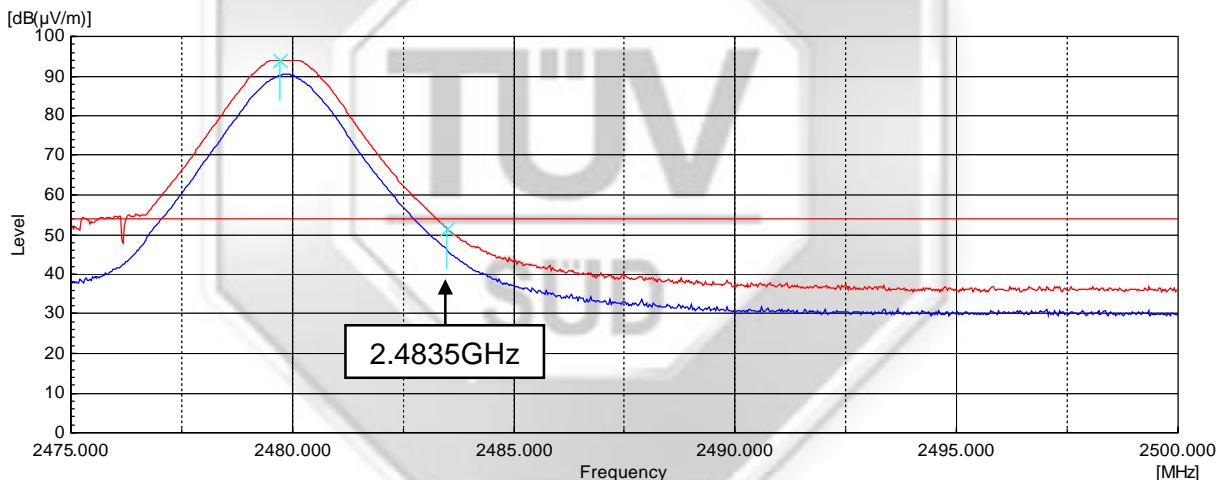
**Plot 66 – Average Plot at Lower Band Edge at 2.4000GHz**

**BAND EDGE COMPLIANCE (RADIATED) TEST**

**Band Edge Compliance (Radiated) Plots (Restricted Band) - EDR 3Mbps**



**Plot 67 – Peak Plot at Upper Band Edge at 2.4835GHz**



**Plot 68 – Average Plot at Upper Band Edge at 2.4835GHz**



## PEAK POWER SPECTRAL DENSITY TEST

### 47 CFR FCC Part 15.247(e) Peak Power Spectral Density 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.

### 47 CFR FCC Part 15.247(e) Peak Power Spectral Density Test Instrumentation

Instrument	Model	S/No	Cal Due Date
HP EMC Analyzer	E7405A	MY451060134	20 Aug 2017
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

### 47 CFR FCC Part 15.247(e) Peak Power Spectral Density Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the spectrum via a low-loss coaxial cable.
4. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 3kHz and 10kHz.
5. All other supporting equipment were powered separately from another filtered mains.

### 47 CFR FCC Part 15.247(e) Peak Power Spectral Density Test Method

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 Channel 0 (2.402GHz) (*lower ch*).
2. The sweep time of the spectrum analyser was set to the value of the ratio of the frequency span divided by the RBW.
3. The peak power density of the transmitting frequency was detected and recorded.
4. The step 3 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) (*mid ch*) and Channel 78 (2.480GHz) (*upper ch*) respectively.

PEAK POWER SPECTRAL DENSITY TEST

**47 CFR FCC Part 15.247(e) Peak Power Spectral Density Results**

Test Input Power	120V 60Hz	Temperature	26°C
Attached Plots	69 – 77	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

**GFSK**

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 ( <i>lower ch</i> )	2.402	0.156	6.3
39 ( <i>mid ch</i> )	2.441	0.159	6.3
78 ( <i>upper ch</i> )	2.480	0.152	6.3

**( $\pi/4$ ) DQPSK**

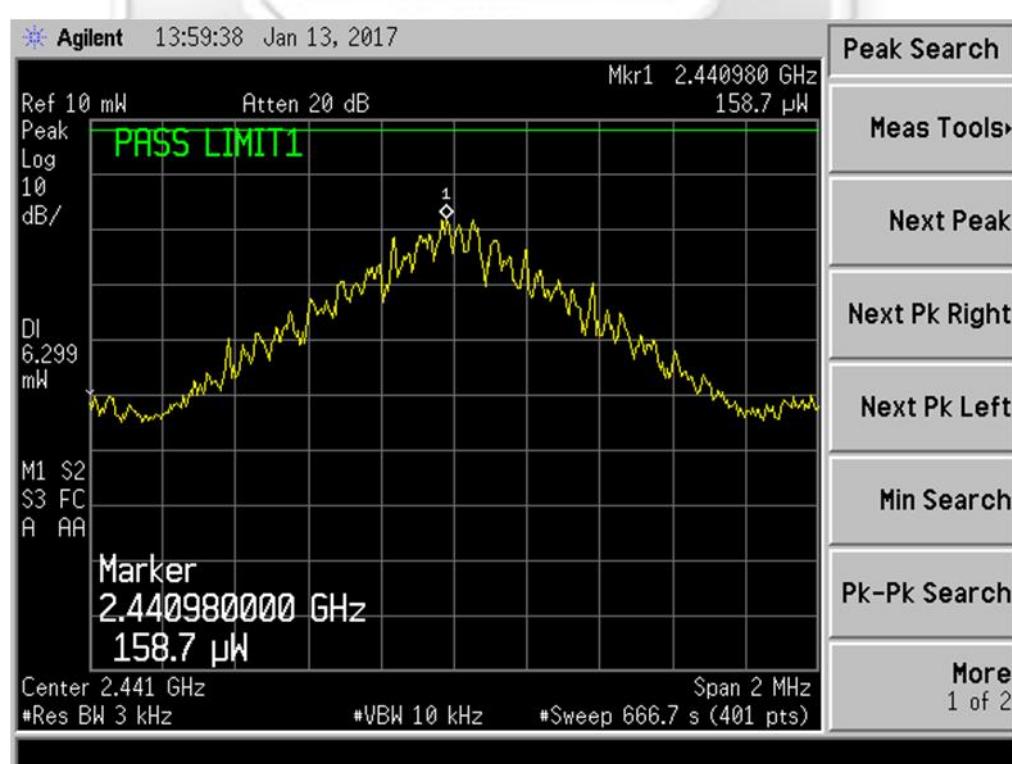
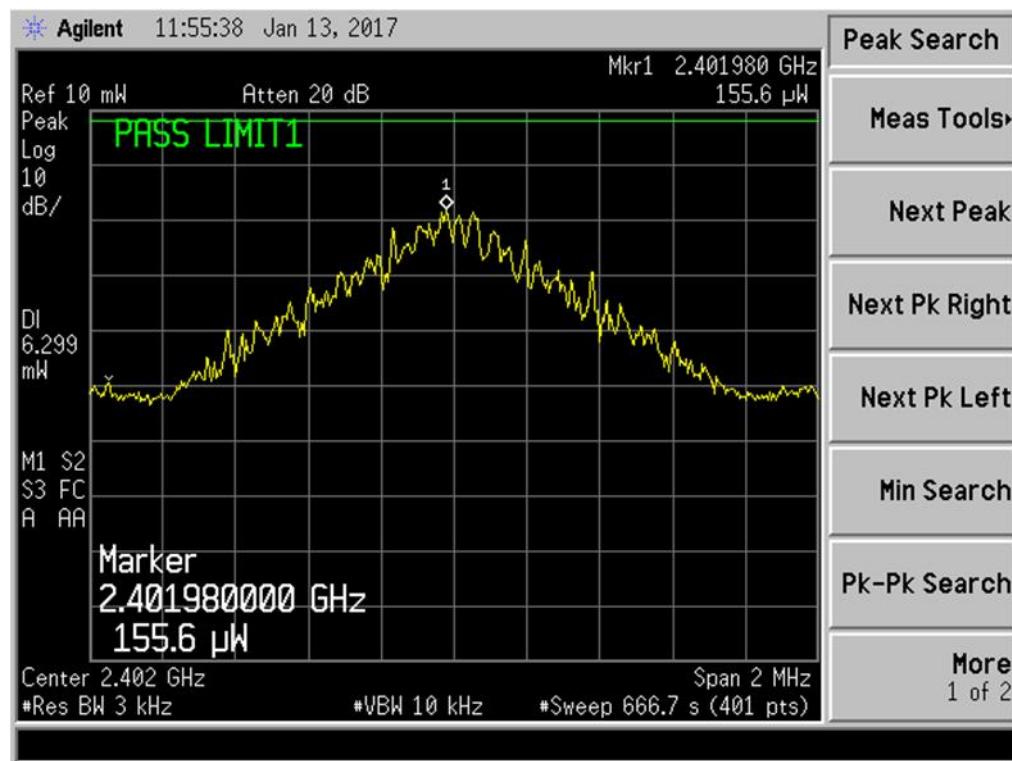
Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 ( <i>lower ch</i> )	2.402	0.037	6.3
39 ( <i>mid ch</i> )	2.441	0.040	6.3
78 ( <i>upper ch</i> )	2.480	0.038	6.3

**8DPSK**

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 ( <i>lower ch</i> )	2.402	0.040	6.3
39 ( <i>mid ch</i> )	2.441	0.036	6.3
78 ( <i>upper ch</i> )	2.480	0.035	6.3

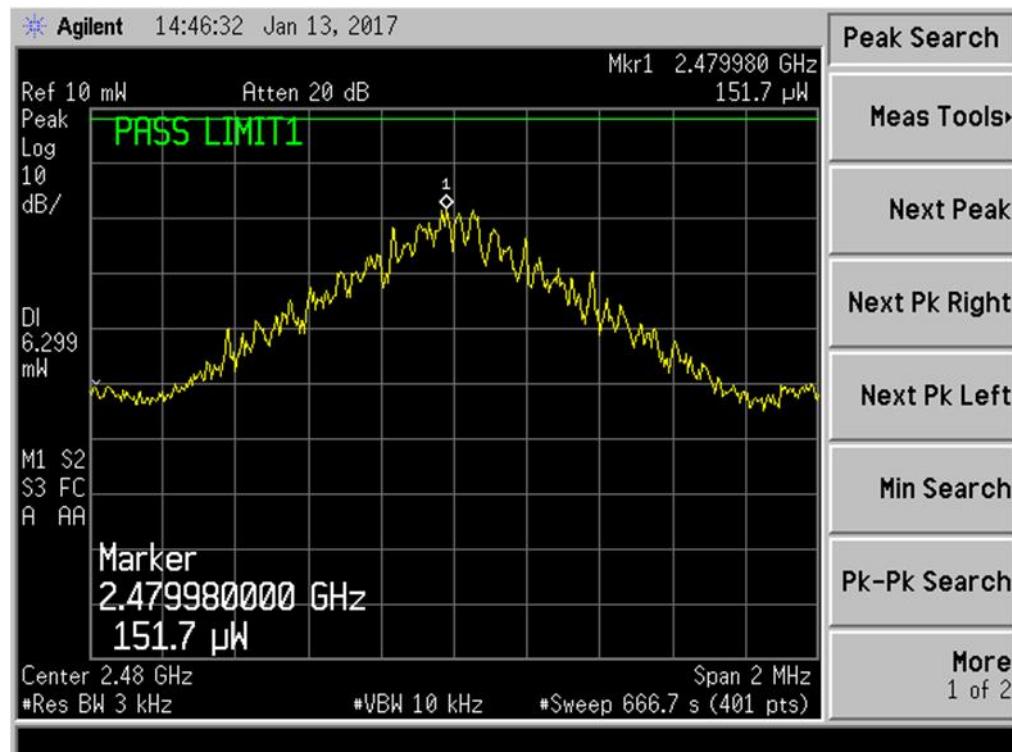
PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – GFSK



PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – GFSK

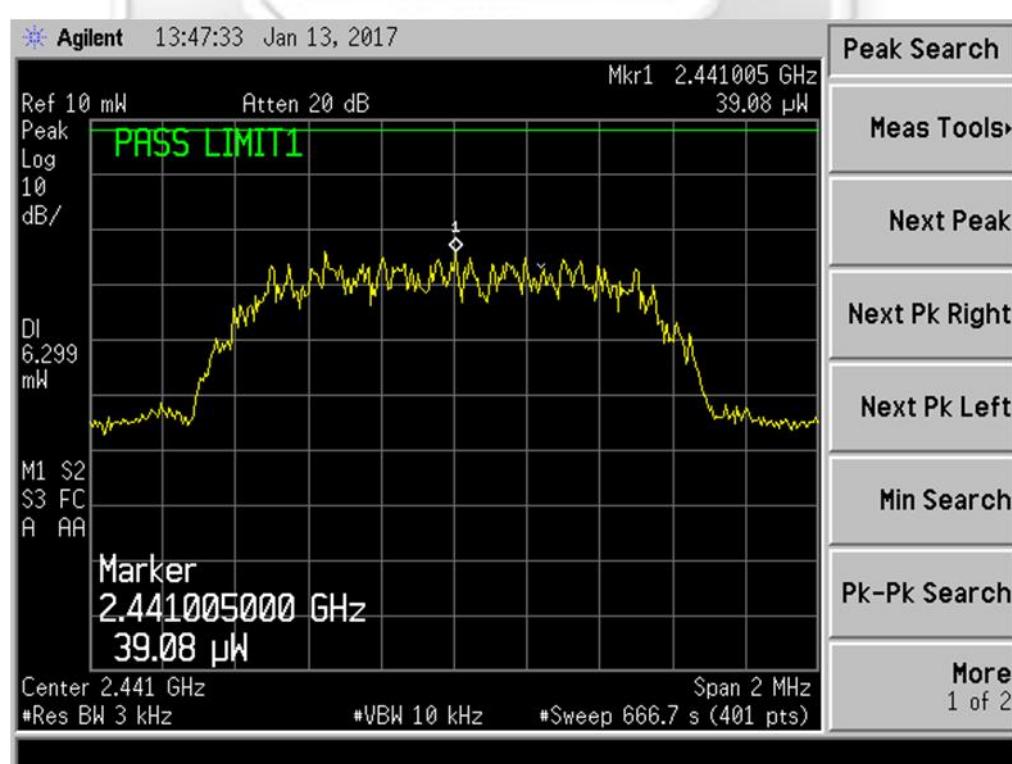
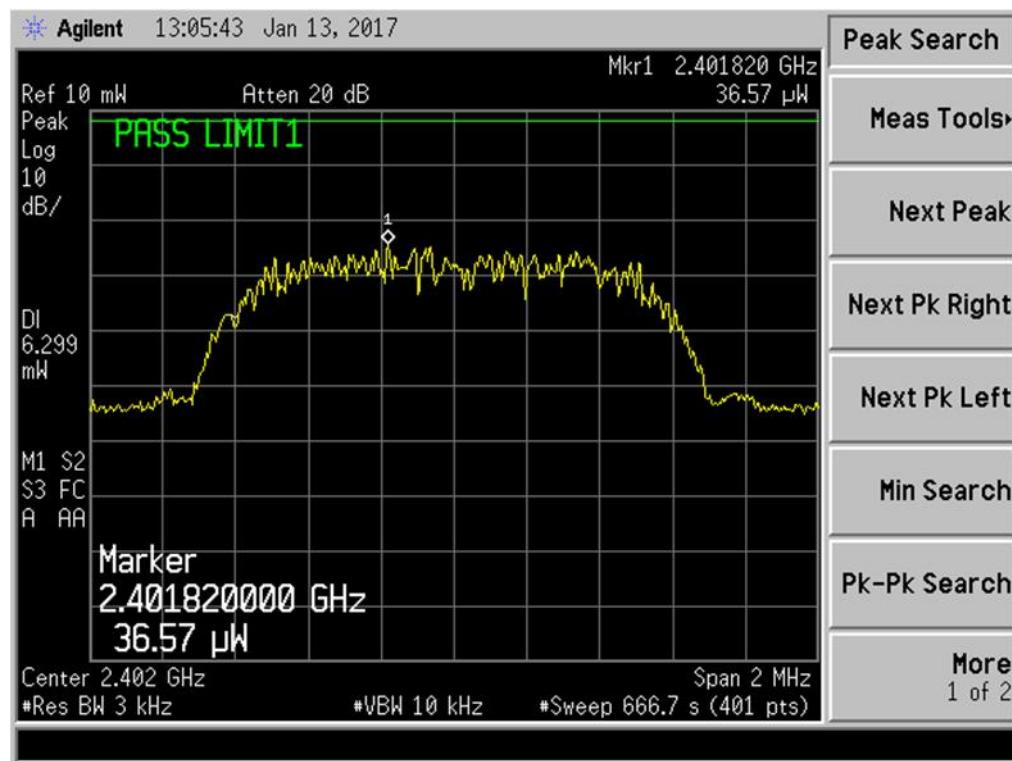


Plot 71 – Channel 78 (upper ch)

SÜD

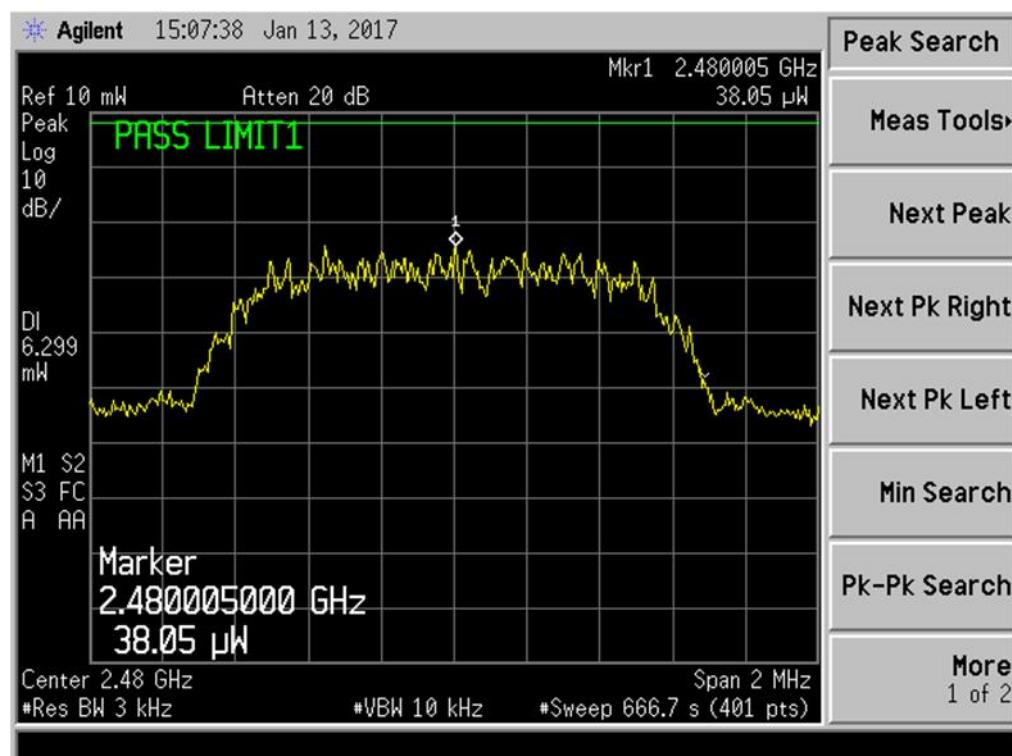
PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – ( $\pi/4$ ) DQPSK



PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – ( $\pi/4$ ) DQPSK

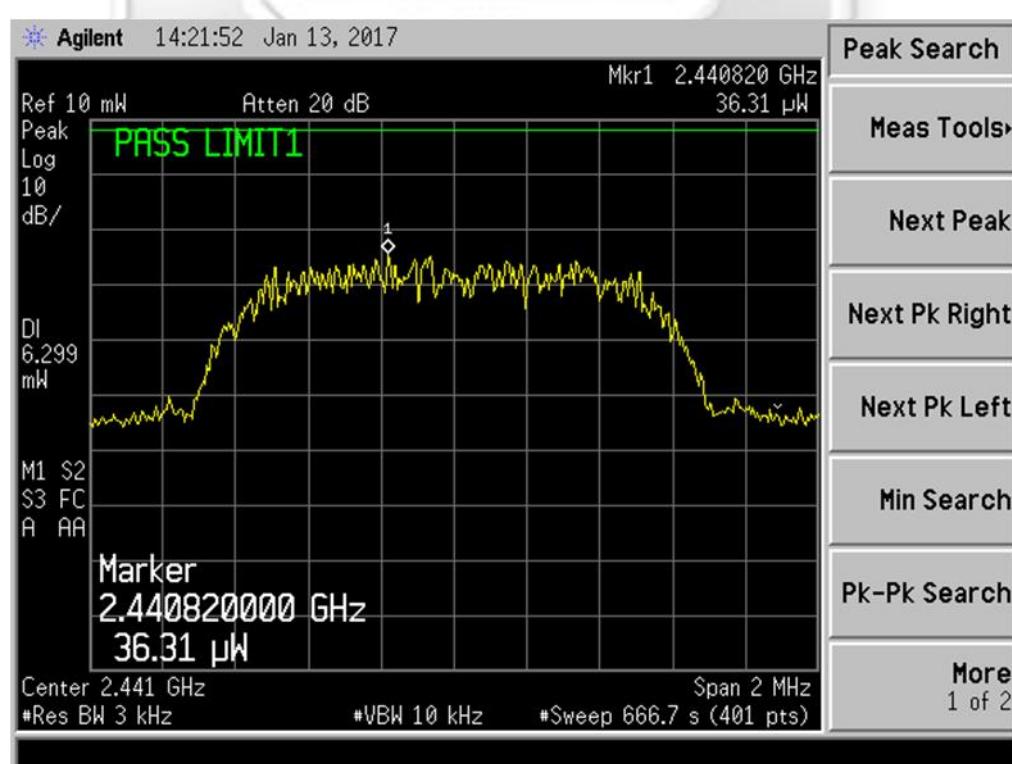
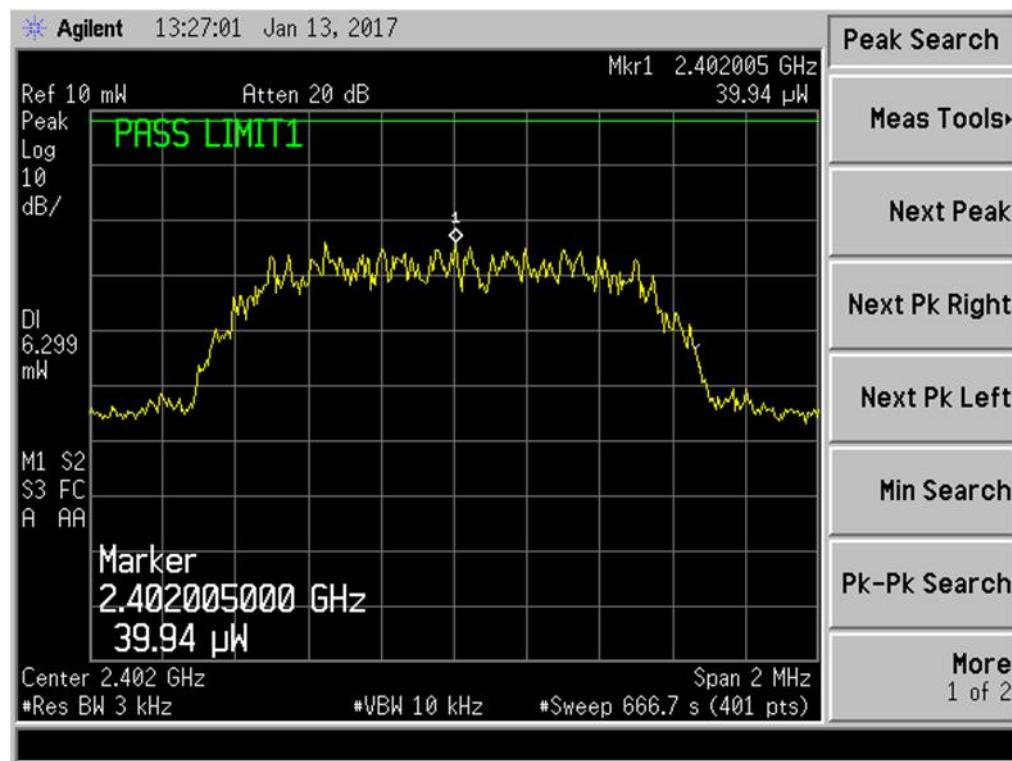


Plot 74 – Channel 78 (upper ch)



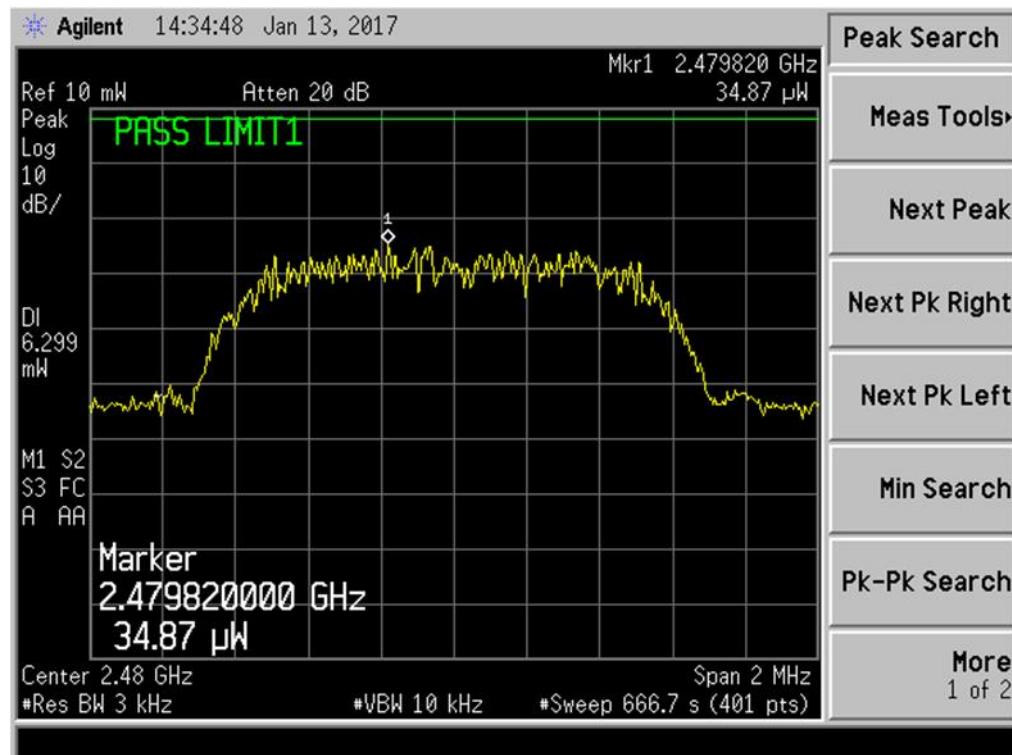
PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – 8DPSK



PEAK POWER SPECTRAL DENSITY TEST

Peak Power Spectral Density Plots – 8DPSK



### MAXIMUM PERMISSIBLE EXPOSURE (MPE) TEST

#### 47 CFR FCC Part 1.1310 Maximum Permissible Exposure (MPE) 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 <sup>2</sup> )	Average Time (min)
0.3 - 1.34	614	1.63	100 <small>Note 2</small>	30
1.34 - 30	824 / f	2.19 / f	180 / f <sup>2</sup> <small>Note 2</small>	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

#### 47 CFR FCC Part 1.1310 Maximum Permissible Exposure Computation

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

$$\begin{aligned} S &= (30GP) / (377d^2) \\ \text{where } S &= \text{Power density in W/m}^2 \\ P &= 0.0018W \\ d &= \text{Test distance at 0.2m} \\ G &= \text{Numerical isotropic gain, 1.58 (2.0dBi)} \end{aligned}$$

Substituting the relevant parameters into the formula:

$$\begin{aligned} S &= [(30GP) / 377d^2] \\ &= 0.0057 \text{ W/m}^2 \\ &= 0.006 \text{ mW/cm}^2 \end{aligned}$$

∴ The power density of the EUT at 20cm distance is 0.006mW/cm<sup>2</sup> based on the above computation and found to be lower than the power density limit of 1.0mW/cm<sup>2</sup>.



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