Test Report No. 7191115747-EEC15/10
dated 28 Jul 2015

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
OF A
MICRO COMPONENT SYSTEM
[Model : MCR-B043]
[FCC ID : A6RMCRB043A]

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	Yamaha Electronics Manufacturing (M) Sdn Bhd Plot 7, Kinta Free Trade Zone Jalan Kuala Kangsar 31200 Chemor, Perak Malaysia Tel :+605 291 2111 Fax : +605 291 4239
QUOTATION NUMBER	2191019853
JOB NUMBER	7191115747
TEST PERIOD	11 Jun 2015 – 16 Jul 2015

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TÜV SÜD PSB

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LA-2007-0381-F
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LA-2007-0383-G
LA-2007-0383-G-1
LA-2007-0384-G
LA-2007-0385-E
LA-2007-0386-C
LA-2010-0464-D
FFT-2013-0002-A

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

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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	Refer to page 77 for details

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.

Transmit Channel	Frequency (GHz)
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 **MICRO COMPONENT SYSTEM.**
Applicant	:	Yamaha Electronics Manufacturing (M) Sdn Bhd Plot 7, Kinta Free Trade Zone Jalan Kuala Kangsar 31200 Chemor, Perak Malaysia
Manufacturer	:	Yamaha Electronics Manufacturing (M) Sdn Bhd Plot 7, Kinta Free Trade Zone Jalan Kuala Kangsar 31200 Chemor, Perak Malaysia
Factory (ies)	:	Yamaha Electronics Manufacturing (M) Sdn Bhd Plot 7, Kinta Free Trade Zone Jalan Kuala Kangsar 31200 Chemor, Perak Malaysia
Model Number(s)	:	MCR-B043 – Main unit NS-BP83 – Speaker unit
FCC ID	:	A6RMCRB043A
Serial Number(s)	:	Y010885RT – Main unit Y000202 & Y000205 – Speaker unit
Operating Frequency	:	FM 87.5MHz – 108MHz Bluetooth 2.402GHz - 2.480GHz
Clock / Oscillator Frequency	:	36.864MHz
Microprocessor(s)	:	Refer to manufacturer
Teletext Mode	:	Not applicable
Colour System(s)	:	Not applicable
TV System(s)	:	Not applicable
Modulation	:	FHSS (GFSK, Pi/4 DQPSK, 8DPSK)
Antenna Gain	:	2.54 dBi
IF Frequency	:	45kHz (AM), 128kHz (FM)
Port / Connectors	:	Refer to manufacturer's user manual / operating manual
Rated Input Power	:	120V 60Hz 30W
Accessories	:	Refer to manufacturer's user manual / operating manual

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Lenovo Laptop	M/N: R400 (7440-C97) S/N: L3-ALB2F 09/03 FCC ID: Nil	2.50m unshielded power cable
Lenovo AC/DC Adapter	M/N: 42T4432 S/N: 11S42T4432Z1ZF3J0170HL FCC ID: DoC	2.50m unshielded power cable
Samsung Mobile Phone	M/N: GT-S7272 S/N: S7272GSMH FCC ID: A3LGTS7272	Nil

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. Peak Power Spectral Density** **7. 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.
47 CFR FCC Part 15
1. Carrier Frequency Separation **2. Number of Hopping Frequencies** **3. Average Frequency Dwell Time** **4. Band Edge Compliance (Conducted)** **5. Band Edge Compliance (Radiated)**
The EUT was exercised by operating in maximum continuous transmission with frequency hopping on.

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

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

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	11 Feb 2016
Agilent EMC Analyzer-SA7	E7403A	US41160167	28 May 2016
Schaffner LISN –LISN10 (EUT)	NNB42	04/10055	31 Oct 2015

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 50Ω/50μH 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 dBμV
Transducer factor of LISN, pulse limiter & cable loss at 20 MHz = 11.2 dB
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV (Calibrated for system losses)
Therefore, Q-P margin = 60.0 - 40.0 = 20.0 i.e. 20.0 dB below Q-P limit

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

Test Input Power	120V 60Hz	Temperature	24°C
Line Under Test	AC Mains	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Frequency (MHz)	Q-P Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line
0.1623	49.8	65.3	15.5	39.5	55.3	15.8	Neutral
0.1990	46.7	63.7	17.0	36.4	53.7	17.3	Live
0.2235	43.5	62.7	19.2	33.2	52.7	19.5	Neutral
0.7623	37.5	56.0	18.5	27.0	46.0	19.0	Live
0.8848	40.4	56.0	15.6	29.9	46.0	16.1	Live
0.9460	38.3	56.0	17.7	27.8	46.0	18.2	Live

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 ±2.2dB.

47 CFR FCC Part 15.205 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									

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

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

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016
Schaffner Bilog Antenna –(30MHz-2GHz) BL3 (Ref)	CBL6112D	2549	29 Jan 2016
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	02 Oct 2015
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	02 Oct 2015
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2015
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	13 Oct 2015
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2015

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.
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 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

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

Test Input Power	5Vdc	Temperature	24°C
Test Distance	3m (≥30MHz – 25GHz)	Relative Humidity	60%
Modulation	GFSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit, Dylan Lin

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
30.4030	27.0	40.0	13.0	400	322	V	0
230.0010	33.0	46.0	13.0	128	314	H	0
235.0060	31.7	46.0	14.3	100	314	H	0
240.0090	32.8	46.0	13.2	100	318	H	0
245.0120	29.3	46.0	16.7	100	317	H	0
699.5950	33.2	46.0	12.8	115	225	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
1.5961	54.3	74.0	19.7	31.9	54.0	22.1	255	334	V	78
7.4824	65.7	74.0	8.3	28.9	54.0	25.1	130	39	V	78
19.5554	54.1	74.0	19.9	39.8	54.0	14.2	100	102	V	78
19.6811	54.9	74.0	19.1	39.1	54.0	14.9	100	150	V	78
19.9717	55.4	74.0	18.6	41.4	54.0	12.6	100	284	V	78
20.0189	55.6	74.0	18.4	41.2	54.0	12.8	100	307	V	78

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

Test Input Power	5Vdc	Temperature	24°C
Test Distance	3m (≥30MHz – 25GHz)	Relative Humidity	60%
Modulation	((π/4) DQPSK)	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit, Dylan Lin

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
30.3630	27.7	40.0	12.3	397	340	V	0
230.0100	31.7	46.0	14.3	122	313	H	0
240.0000	33.6	46.0	12.4	100	314	H	0
255.0020	30.8	46.0	15.2	108	328	H	0
499.6160	24.7	46.0	21.3	100	173	V	0
698.3660	29.0	46.0	17.0	100	232	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
4.8043	58.7	74.0	15.3	29.8	54.0	24.2	259	53	V	0
7.2279	65.4	74.0	8.6	27.9	54.0	26.1	148	319	V	0
19.8853	57.4	74.0	16.6	41.0	54.0	13.0	100	307	V	0
19.9246	57.6	74.0	16.4	41.5	54.0	12.5	400	187	V	0
19.9639	58.3	74.0	15.7	41.9	54.0	12.1	400	187	V	0
20.0189	57.7	74.0	16.3	42.2	54.0	11.8	100	199	V	0

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

Test Input Power	5Vdc	Temperature	24°C
Test Distance	3m (≥30MHz – 25GHz)	Relative Humidity	60%
Modulation	8DPSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit, Dylan Lin

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
30.1760	28.0	40.0	12.0	400	16	V	0
230.0050	31.3	46.0	14.7	121	318	H	0
239.9960	32.3	46.0	13.7	129	171	H	0
254.9950	31.0	46.0	15.0	184	221	V	0
260.0070	31.1	46.0	14.9	107	333	H	0
699.3090	32.0	46.0	14.0	100	229	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
7.2060	65.4	74.0	8.6	38.0	54.0	16.0	287	176	H	0
19.6182	56.7	74.0	17.3	40.7	54.0	13.3	100	175	V	0
19.6968	57.2	74.0	16.8	41.8	54.0	12.2	100	332	V	0
19.7282	56.5	74.0	17.5	41.7	54.0	12.3	100	102	V	0
19.9482	57.8	74.0	16.2	41.6	54.0	12.4	400	356	V	0
20.0189	57.4	74.0	16.6	42.6	54.0	11.4	400	187	V	0

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. 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.
3. 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.
4. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
5. 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.
6. The channel in the table refers to the transmit channel of the EUT.
7. 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 ±4.0dB.

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

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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

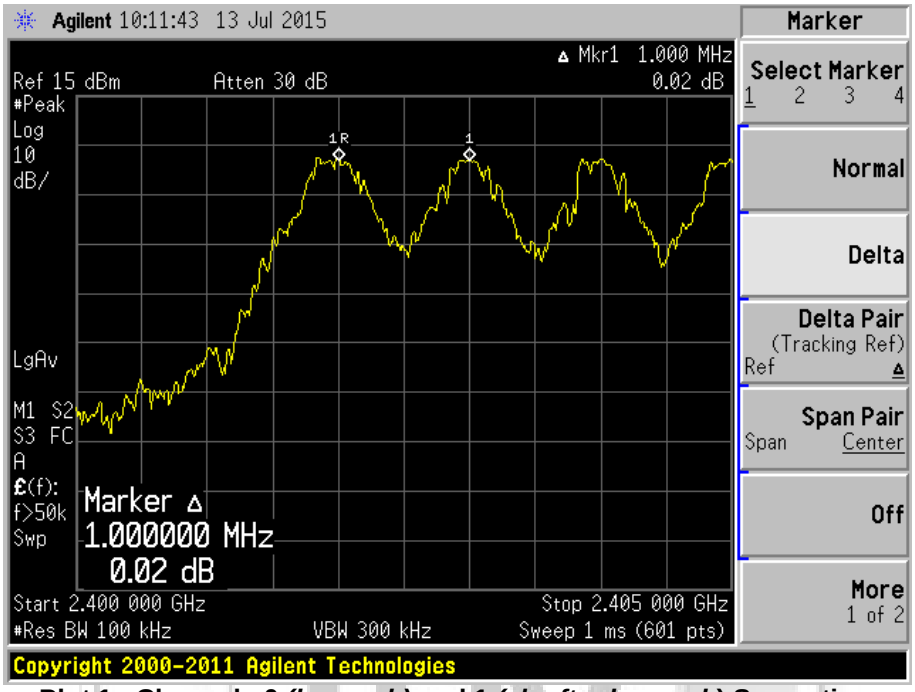
CARRIER FREQUENCY SEPARATION TEST

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

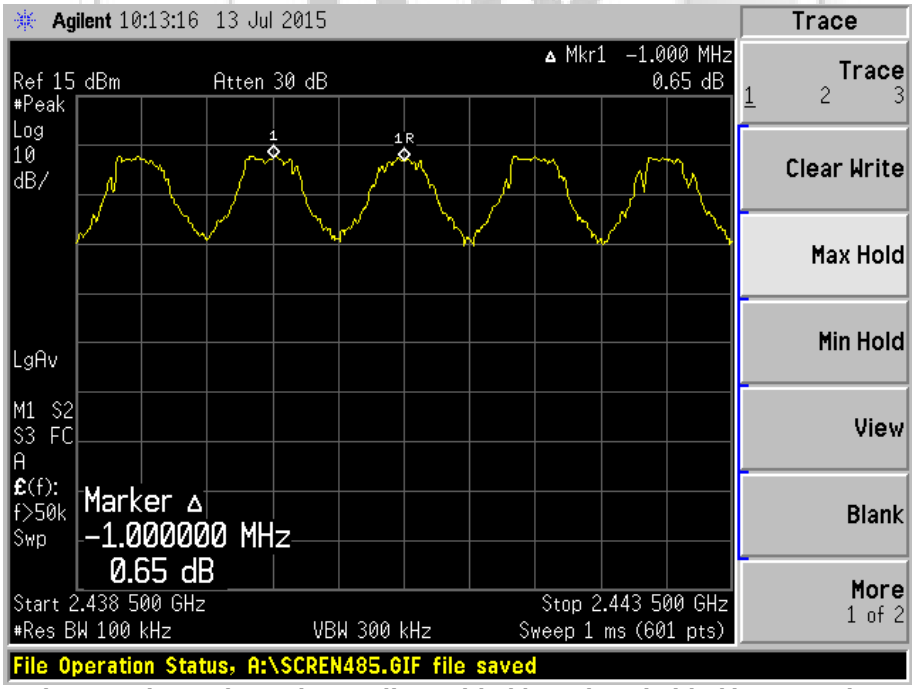
Test Input Power	5Vdc	Temperature	24°C
Attached Plots	1 – 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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)	1.008

Carrier Frequency Separation Plots

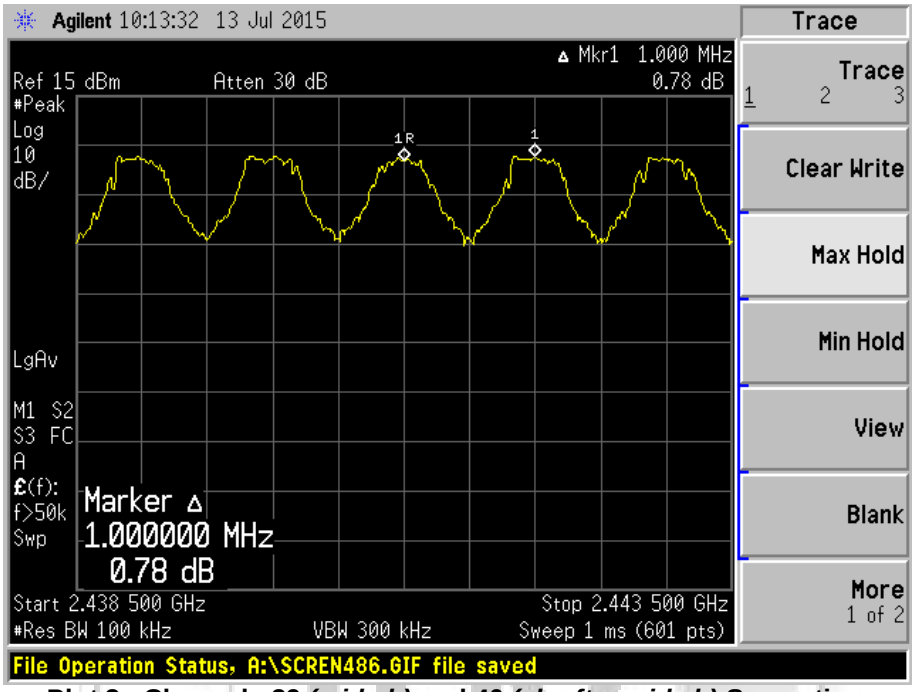


Plot 1 - Channels 0 *(lower ch)* and 1 *(ch after lower ch)* Separation

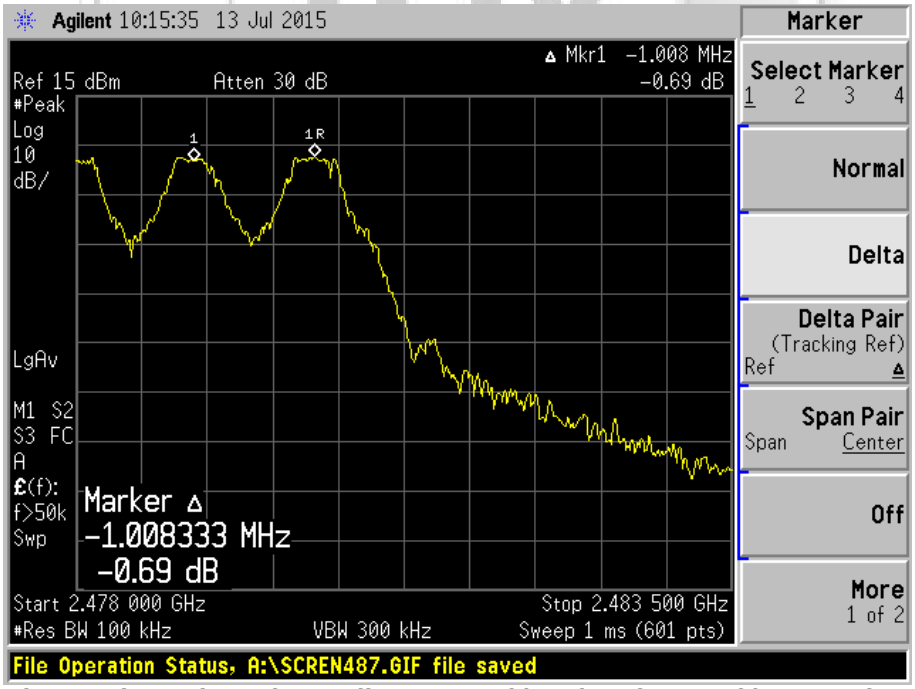


Plot 2 – Channels 38 *(preceding mid ch)* and 39 *(mid ch)* Separation

Carrier Frequency Separation 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

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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 wide enough to capture the 20dB bandwidth of the transmitting frequency.
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. 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.
5. The 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$.
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	5Vdc	Temperature	24°C
Attached Plots	5 – 7 (GFSK)	Relative Humidity	60%
	8 – 10 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	11 – 13 (8DPSK)	Tested By	Chang Wai Kit

GFSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	0.925
39 *(mid ch)*	2.441	0.935
78 *(upper ch)*	2.480	0.920

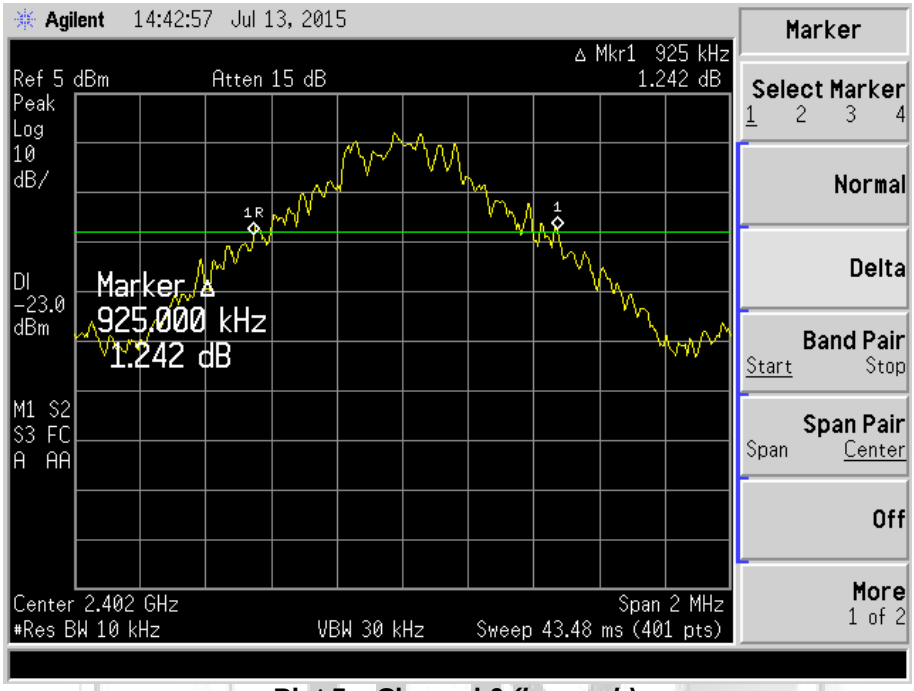
(π/4)DQPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	1.187
39 *(mid ch)*	2.441	1.187
78 *(upper ch)*	2.480	1.187

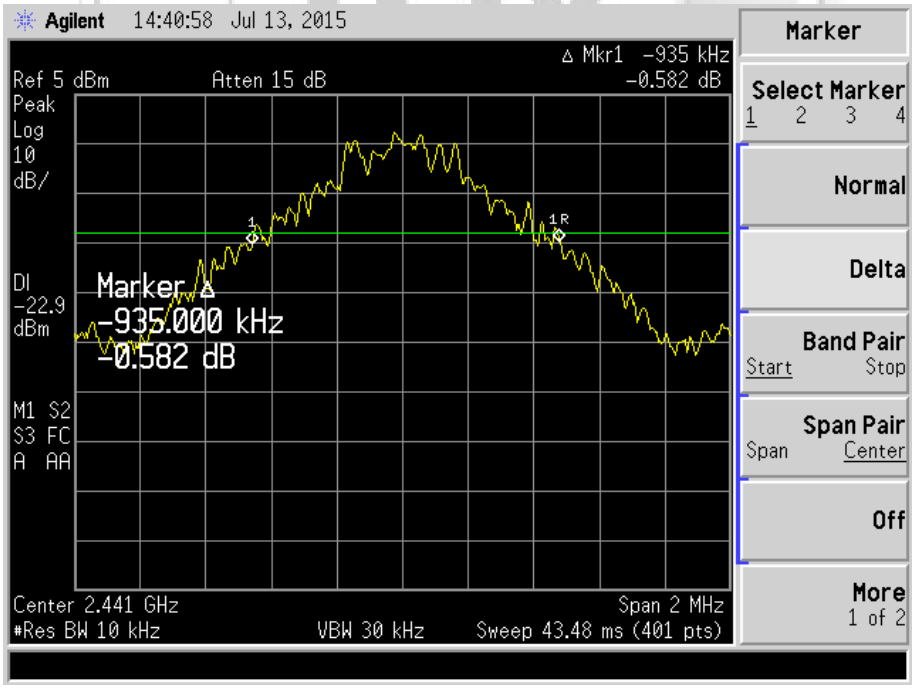
8DPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	1.267
39 *(mid ch)*	2.441	1.262
78 *(upper ch)*	2.480	1.267

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

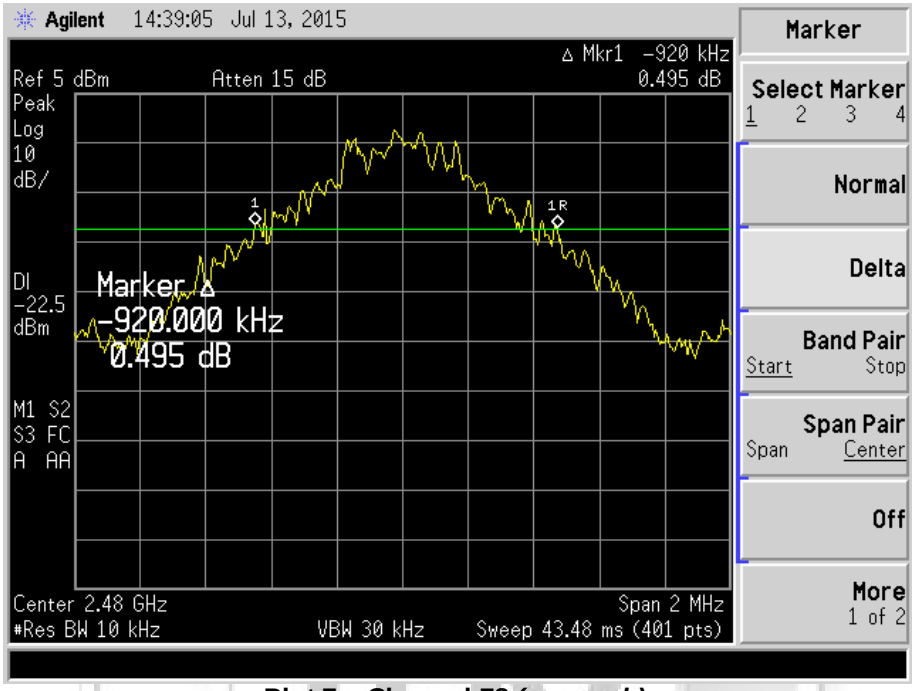


Plot 5 – Channel 0 *(lower ch)*



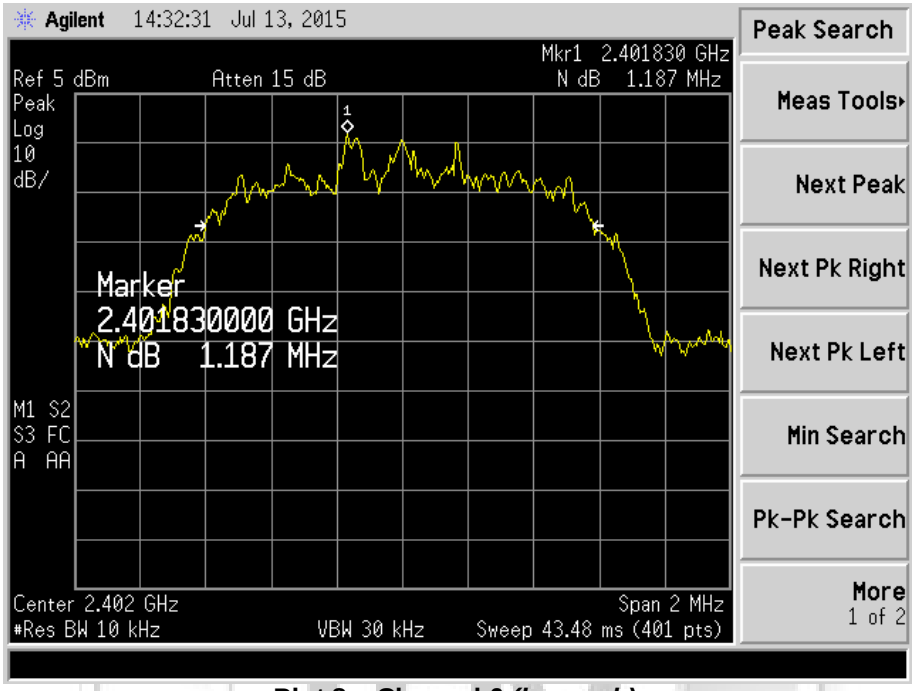
Plot 6 – Channel 39 *(mid ch)*

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

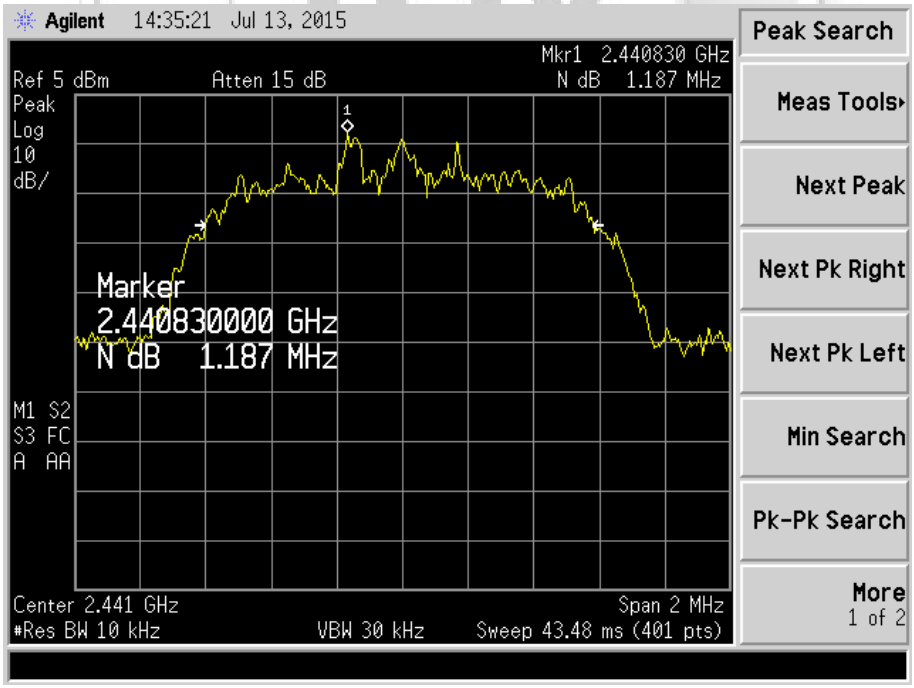


Plot 7 – Channel 78 *(upper ch)*

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

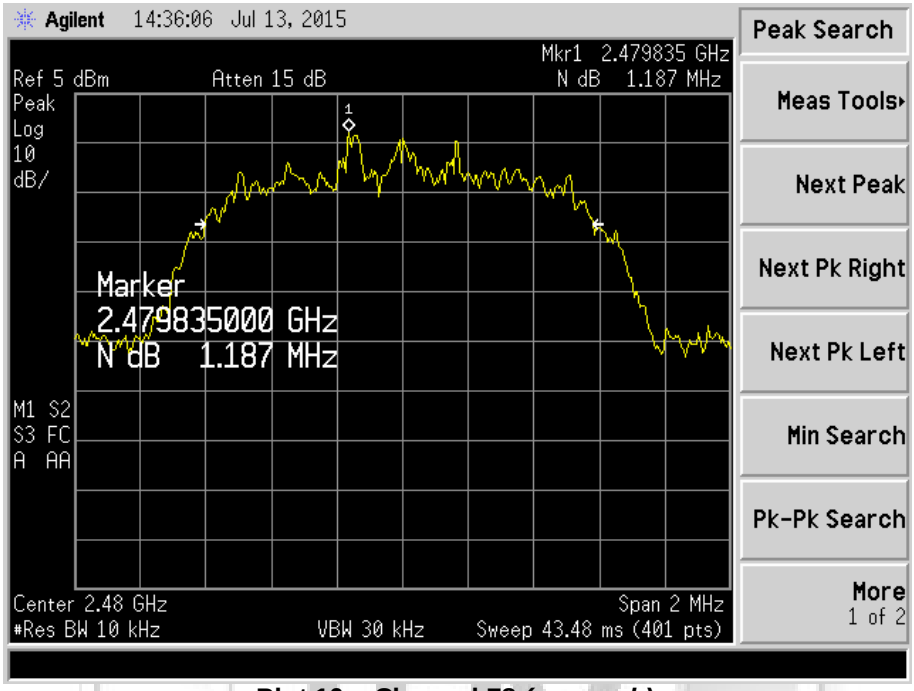


Plot 8 – Channel 0 *(lower ch)*



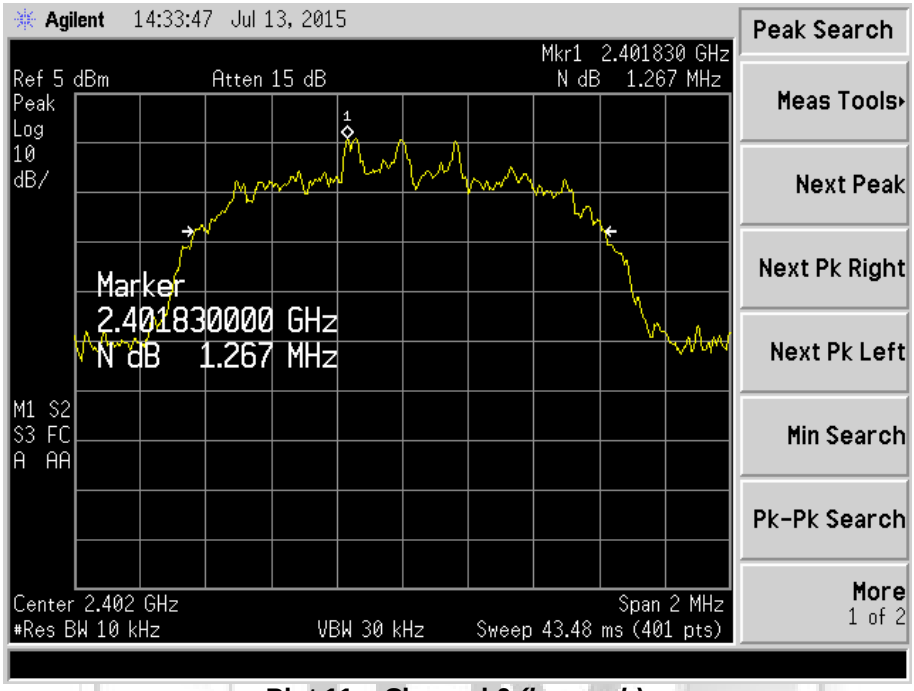
Plot 9 – Channel 39 *(mid ch)*

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

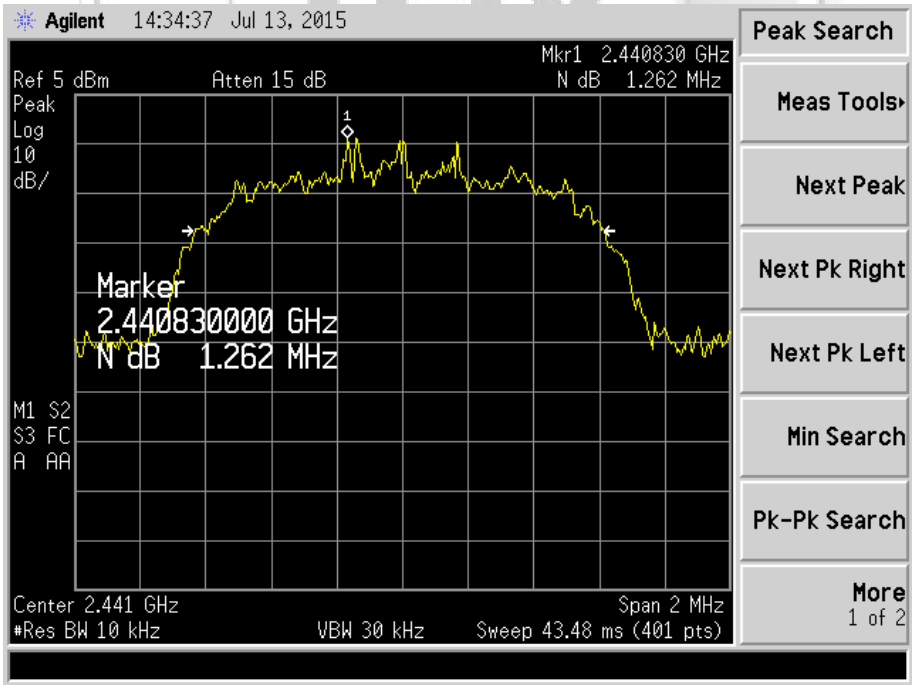


Plot 10 – Channel 78 *(upper ch)*

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

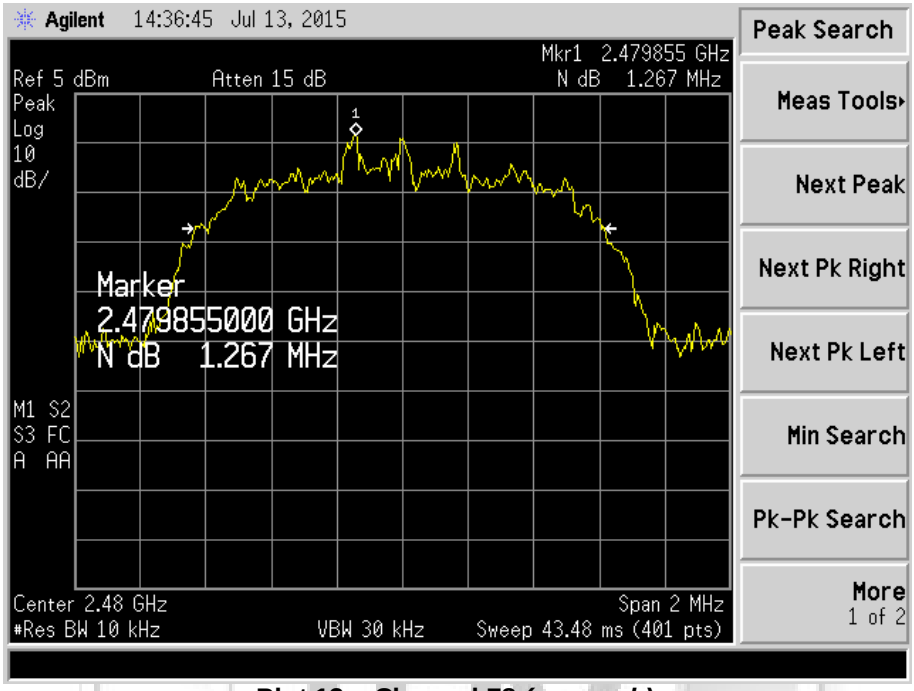


Plot 11 – Channel 0 *(lower ch)*



Plot 12 – Channel 39 *(mid ch)*

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



Plot 13 – Channel 78 *(upper ch)*

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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

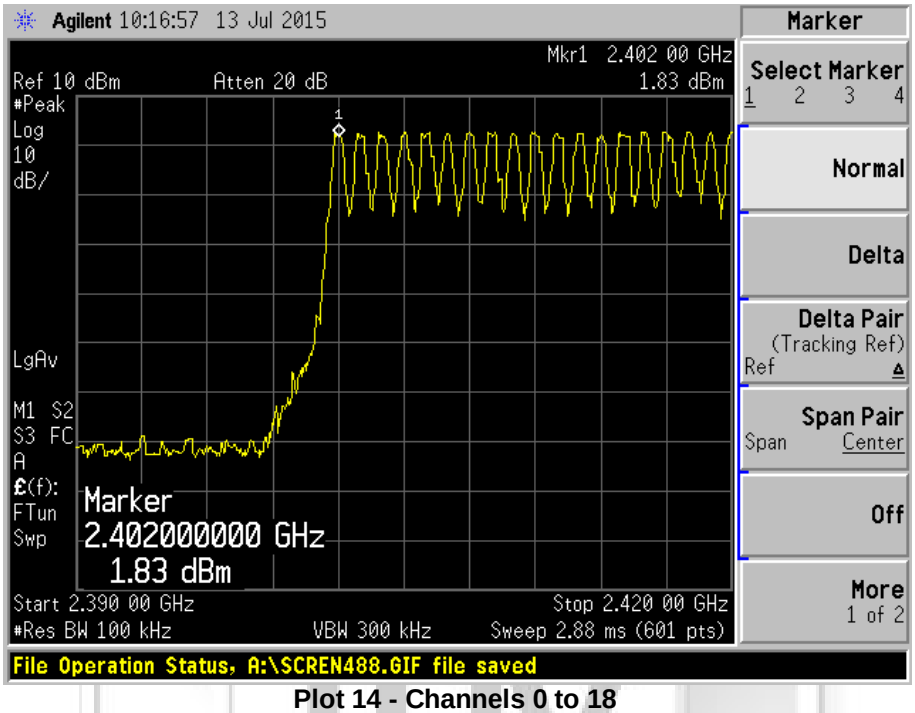
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.390GHz and 2.420GHz.
3. The spectrum analyser was set 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.

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

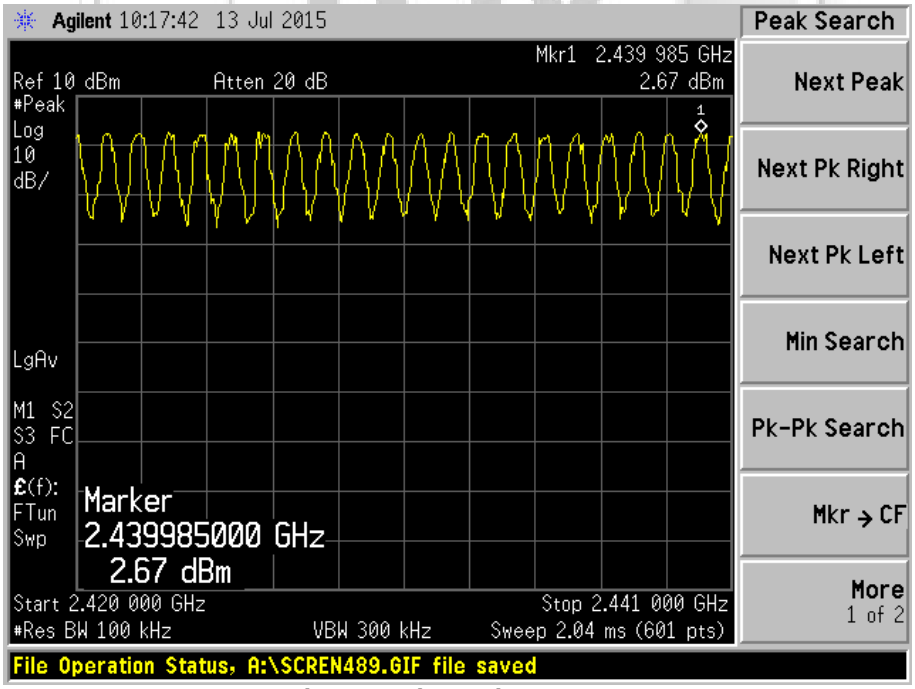
Test Input Power	5Vdc	Temperature	24°C
Attached Plots	14 – 17	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

Number of Hopping Frequencies Plots

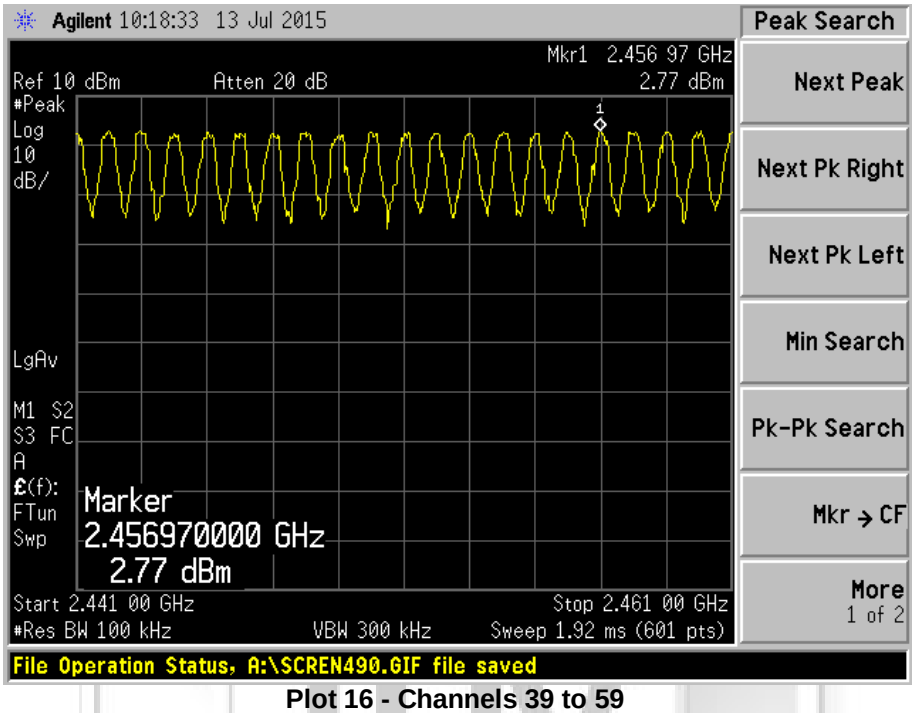


Plot 14 - Channels 0 to 18

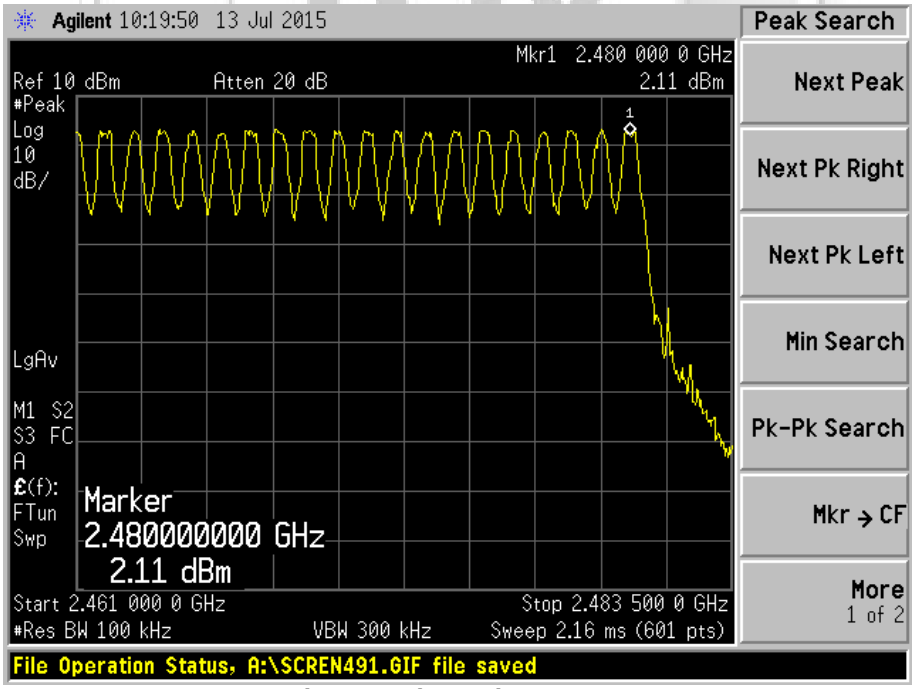


Plot 15 - Channels 18 to 39

Number of Hopping Frequencies Plots



Plot 16 - Channels 39 to 59



Plot 17 - Channels 59 to 78

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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 = [number of hops on spectrum analyser] x [period specified in the requirement / 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.

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

Test Input Power	5Vdc	Temperature	24°C
Attached Plots	18 – 20	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 (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	1.2500	0.200	0.4
39 *(mid ch)*	2.441	1.2500	0.200	0.4
78 *(upper ch)*	2.480	1.2500	0.200	0.4

Test Input Power	5Vdc	Temperature	24°C
Attached Plots	21 – 23	Relative Humidity	60%
Hopping Rate	533.3 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Chang Wai Kit

DH3

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	2.5000	0.133	0.4
39 *(mid ch)*	2.441	2.5000	0.133	0.4
78 *(upper ch)*	2.480	2.5000	0.133	0.4

Test Input Power	5Vdc	Temperature	24°C
Attached Plots	24 – 26	Relative Humidity	60%
Hopping Rate	320 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Chang Wai Kit

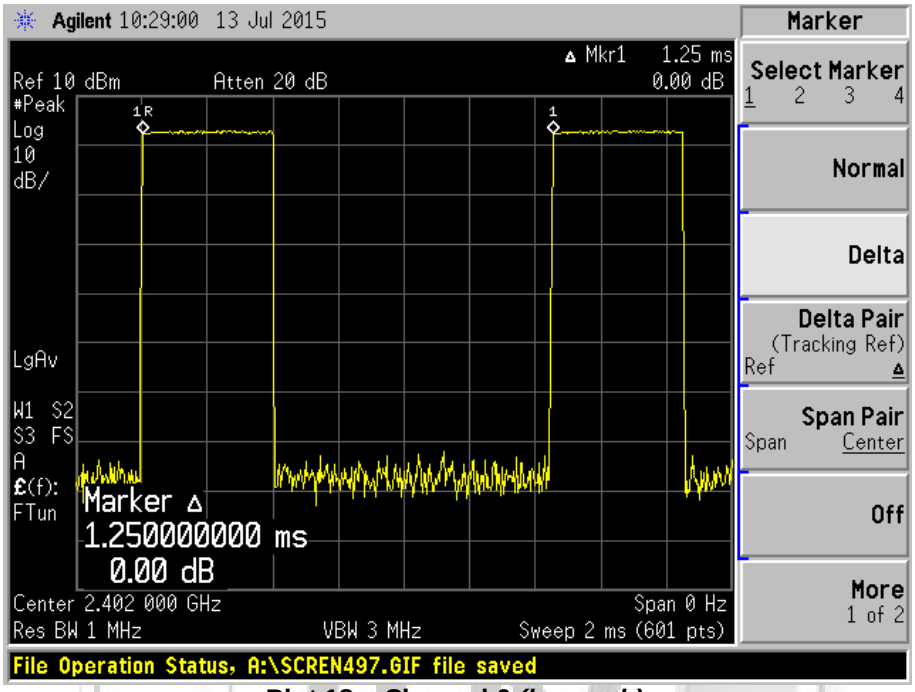
DH5

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	3.7600	0.12032	0.4
39 *(mid ch)*	2.441	3.7467	0.11989	0.4
78 *(upper ch)*	2.480	3.7467	0.11989	0.4

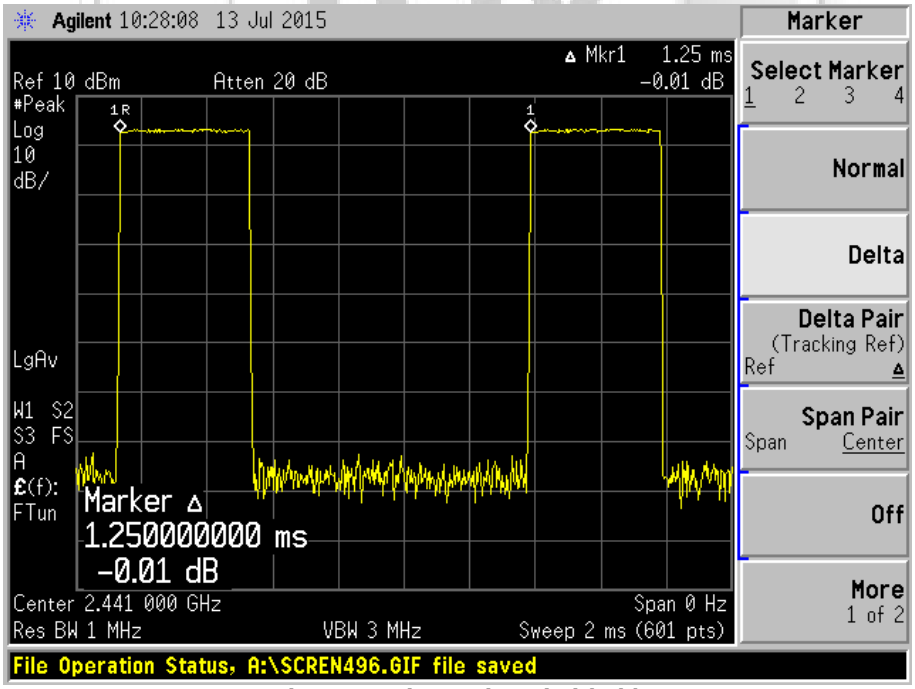
Notes

1. Nil.

Average Frequency Dwell Time Plots – DH1

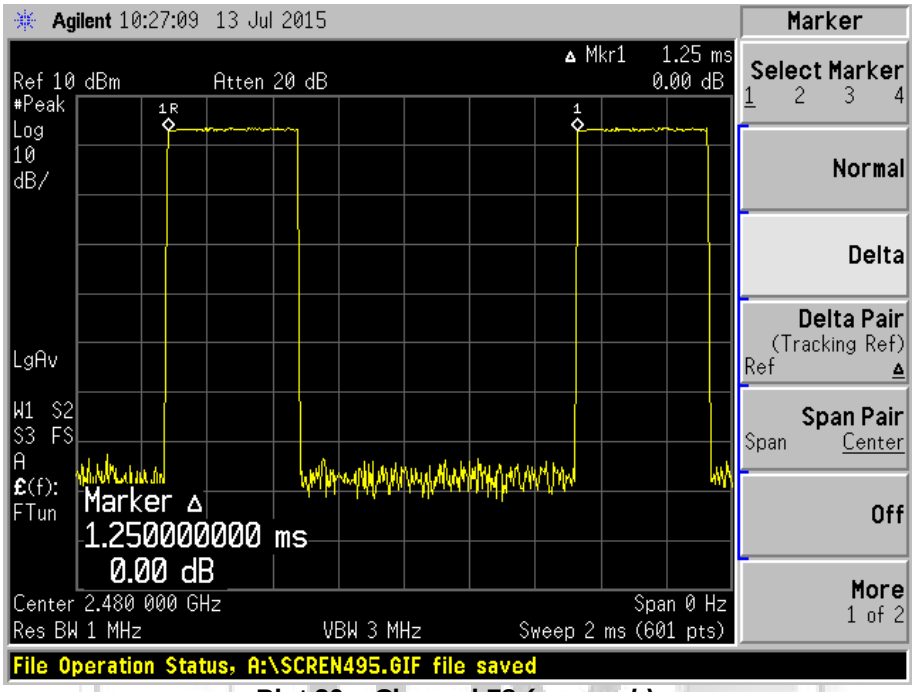


Plot 18 – Channel 0 *(lower ch)*



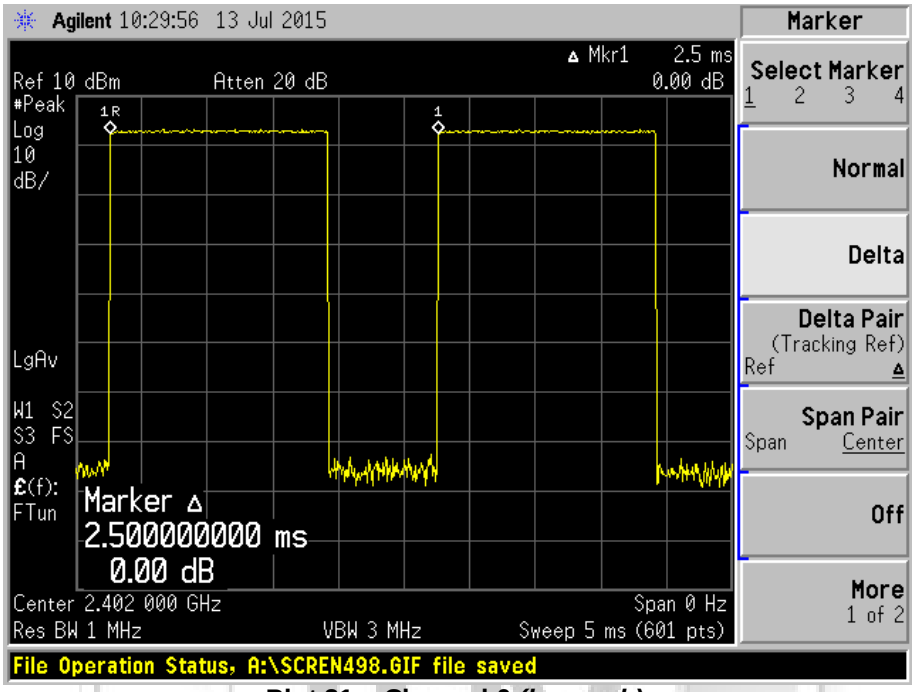
Plot 19 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH1

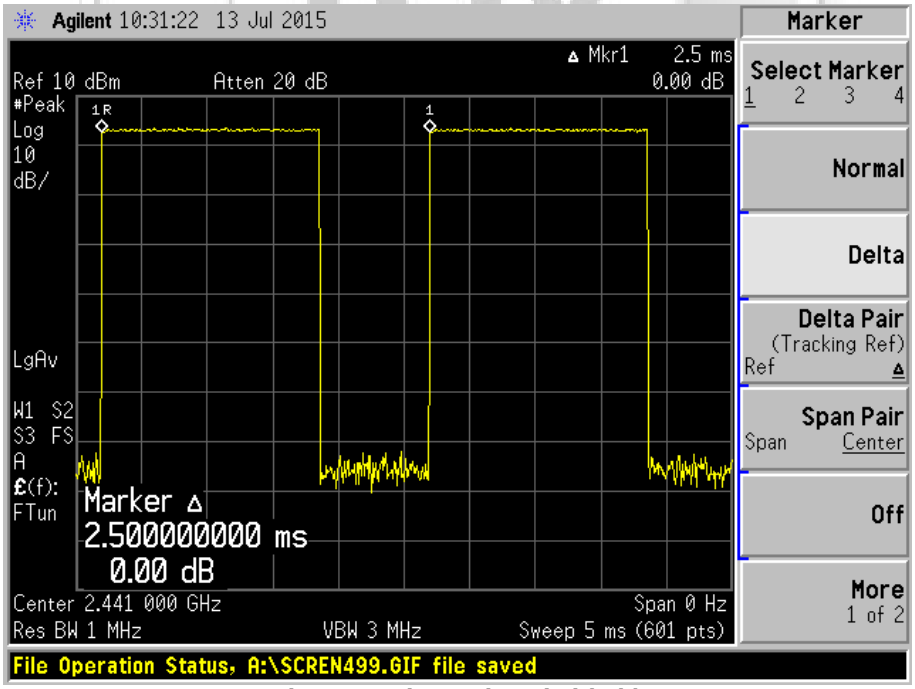


Plot 20 – Channel 78 *(upper ch)*

Average Frequency Dwell Time Plots – DH3

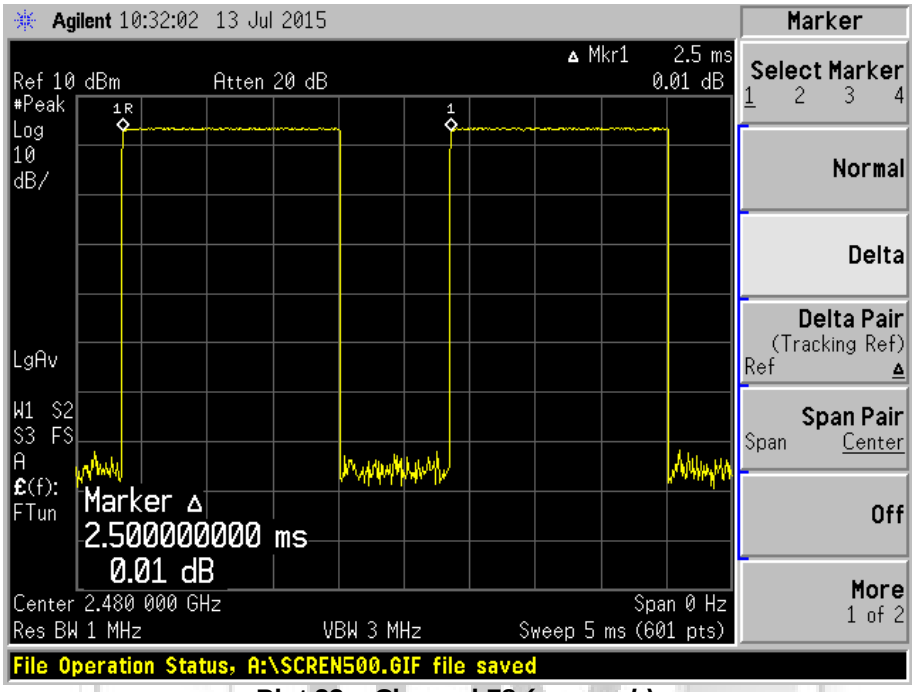


Plot 21 – Channel 0 *(lower ch)*



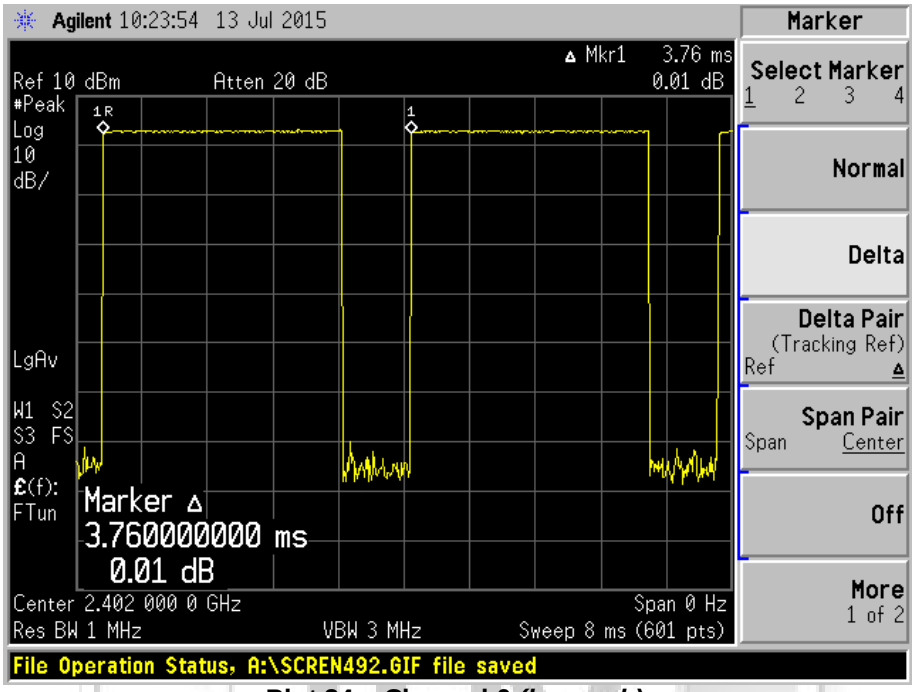
Plot 22 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH3

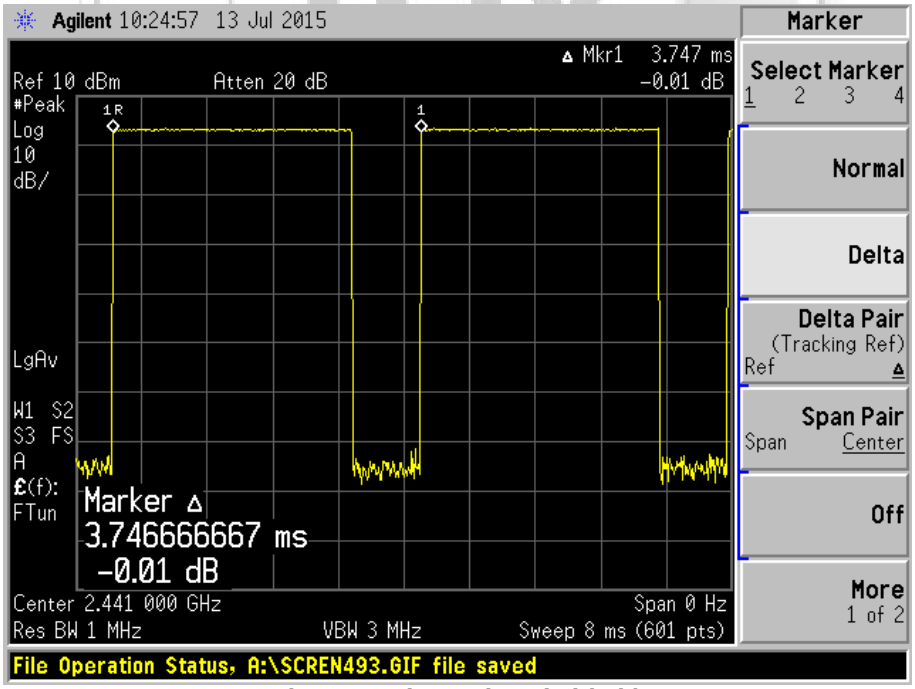


Plot 23 – Channel 78 *(upper ch)*

Average Frequency Dwell Time Plots – DH5

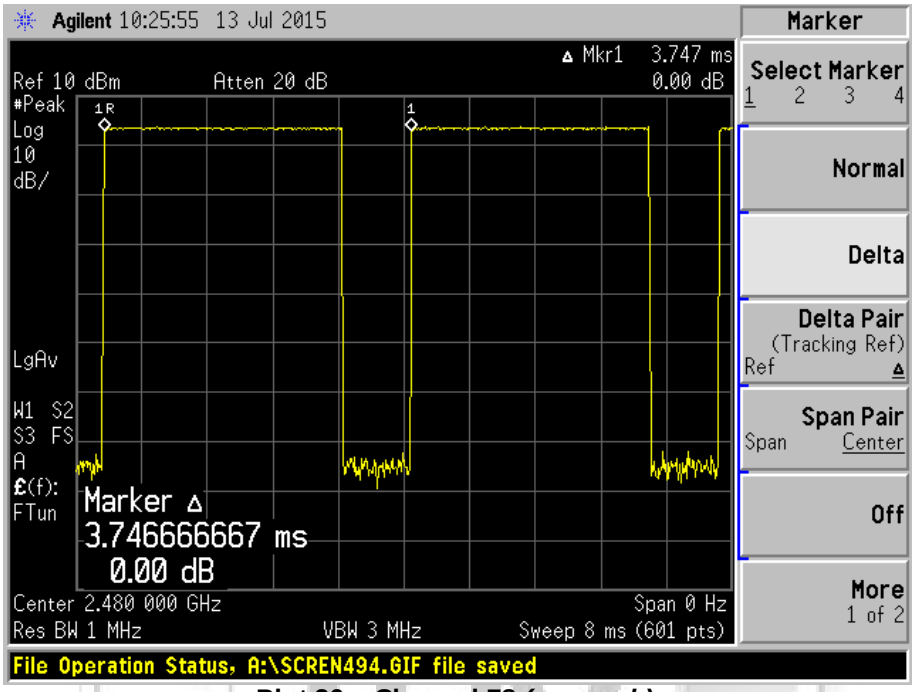


Plot 24 – Channel 0 *(lower ch)*



Plot 25 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH5



Plot 26 – Channel 78 *(upper ch)*

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
Agilent Power Meter	E4416A	GB41290618	18 Aug 2015
Agilent Power Sensor	8482A	MY41090429	27 Aug 2015

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 Universal Radio Communication Tester, which set into power analyser mode 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 Equivalent Isotropic Radiated Power (EIRP) of the EUT was computed by adding its antenna gain to the measured maximum peak power.
4. The steps 2 to 3 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) *(mid ch)* and Channel 78 (2.480GHz) *(upper ch)* respectively.

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

Test Input Power	5Vdc	Temperature	24°C
Antenna Gain	2.54dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

GFSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0012	0.0022	1.0
39 *(mid ch)*	2.441	0.0013	0.0023	1.0
78 (upper ch)	2.480	0.0014	0.0024	1.0

(π/4) DQPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0011	0.0019	1.0
39 *(mid ch)*	2.441	0.0010	0.0018	1.0
78 (upper ch)	2.480	0.0010	0.0019	1.0

8DPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0011	0.0019	1.0
39 *(mid ch)*	2.441	0.0010	0.0018	1.0
78 (upper ch)	2.480	0.0010	0.0019	1.0

Notes

1. Nil.

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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 300kHz.
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

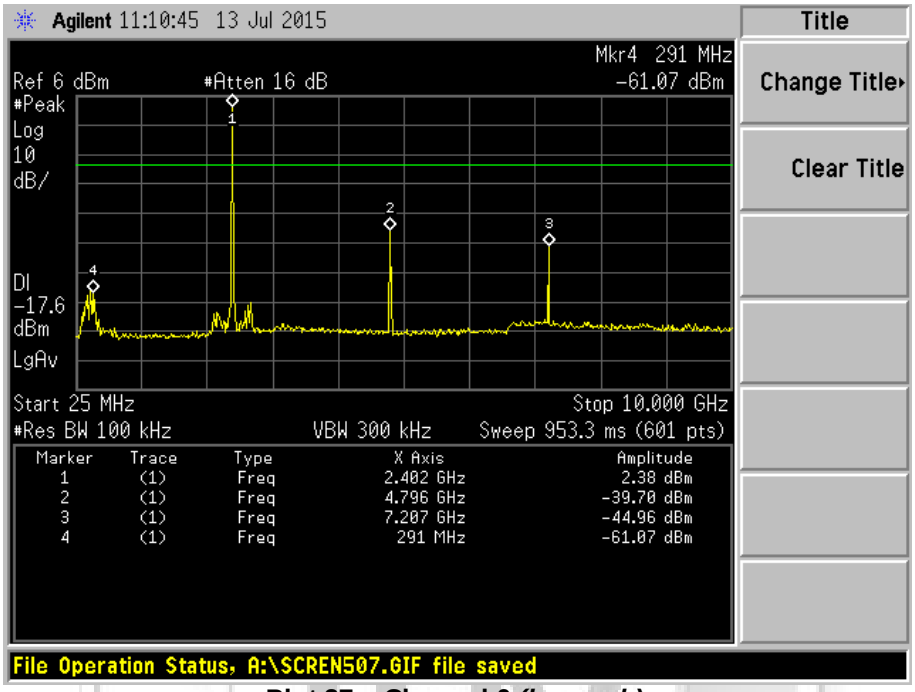
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 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.

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

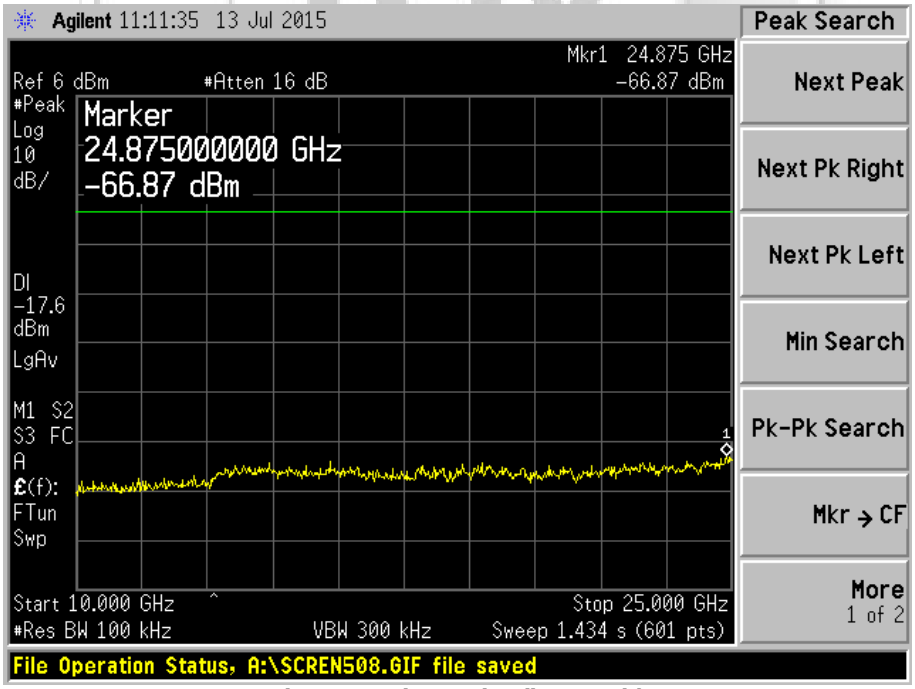
Test Input Power	5Vdc	Temperature	24°C
Attached Plots	27 – 32 (GFSK)	Relative Humidity	60%
	33 – 38 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	39 – 44 (8DPSK)	Tested By	Chang Wai Kit

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

RF Conducted Spurious Emissions Plots – GFSK

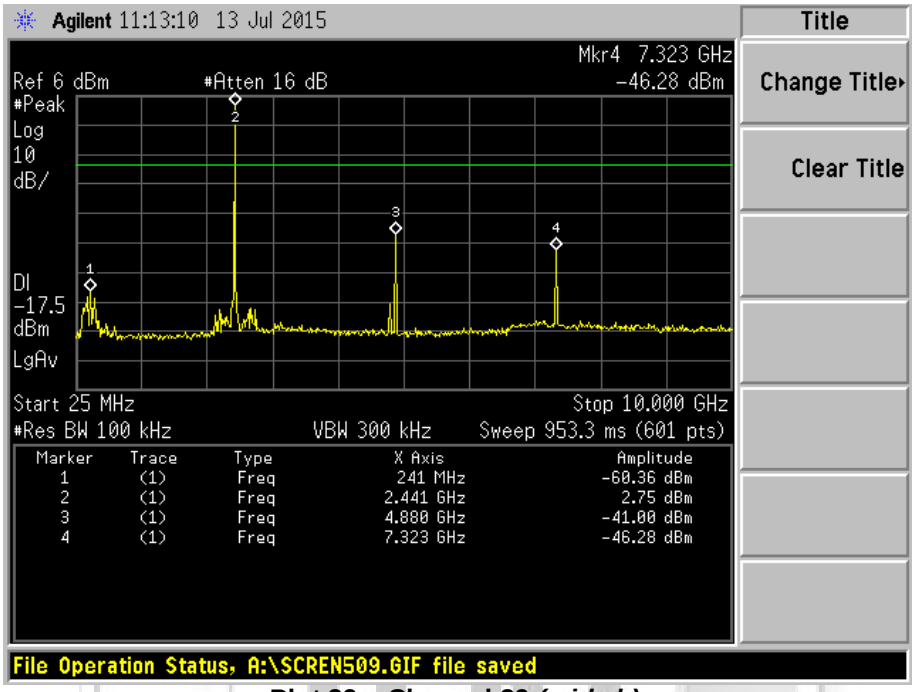


Plot 27 – Channel 0 *(lower ch)*

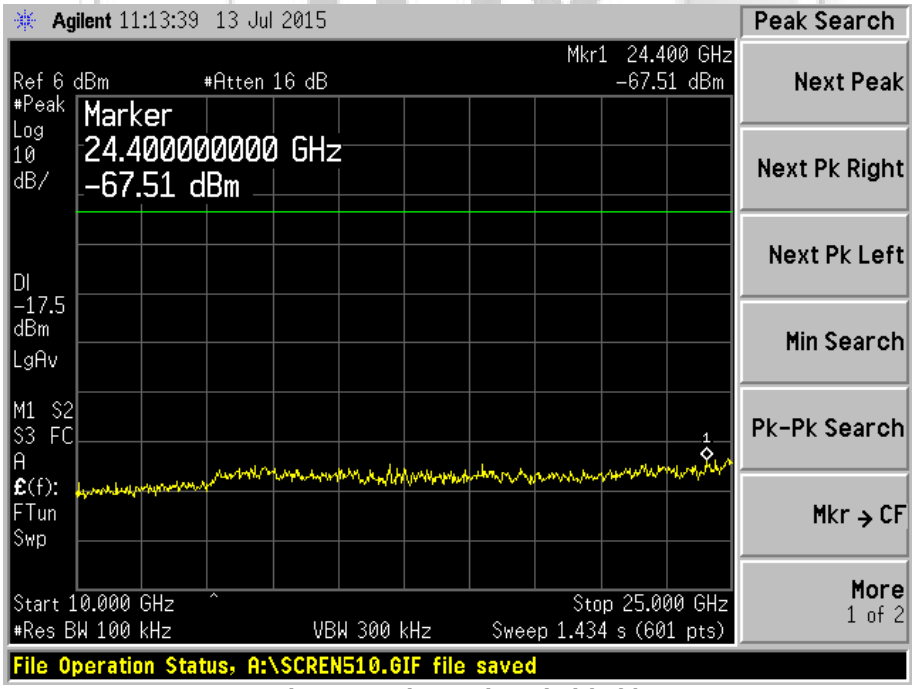


Plot 28 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – GFSK

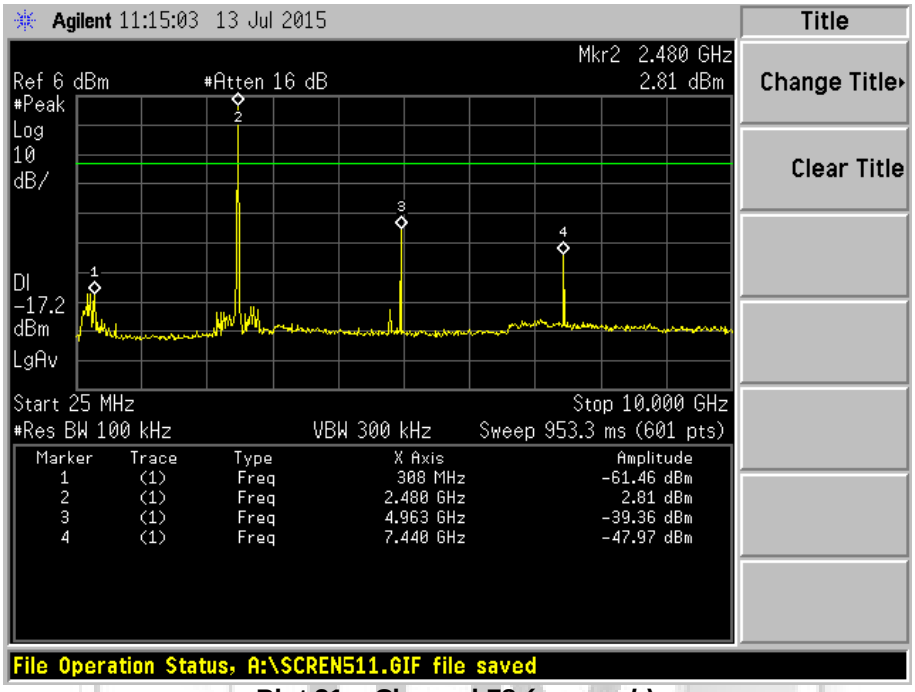


Plot 29 – Channel 39 *(mid ch)*

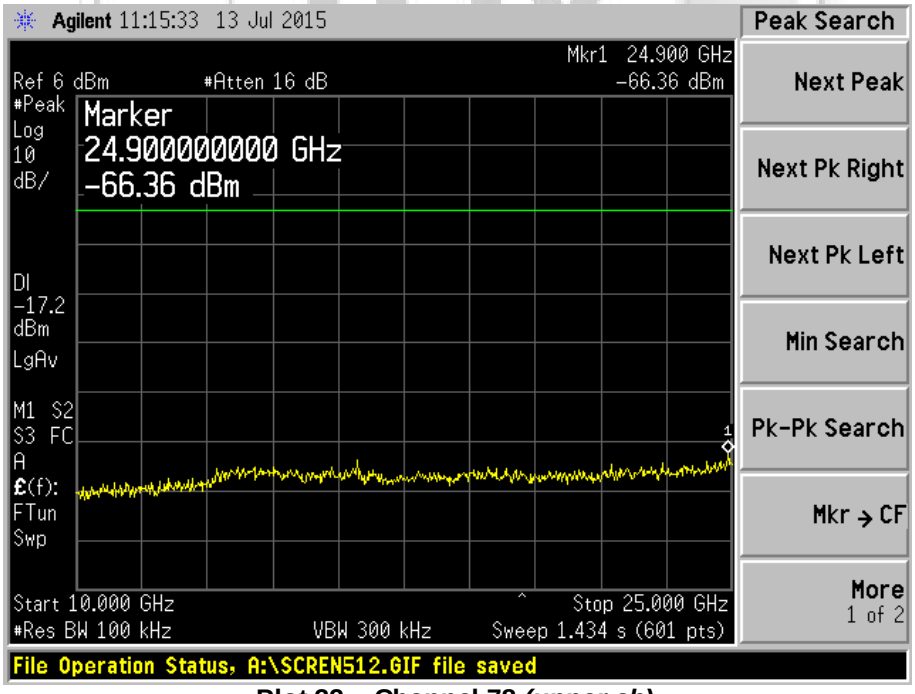


Plot 30 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – GFSK

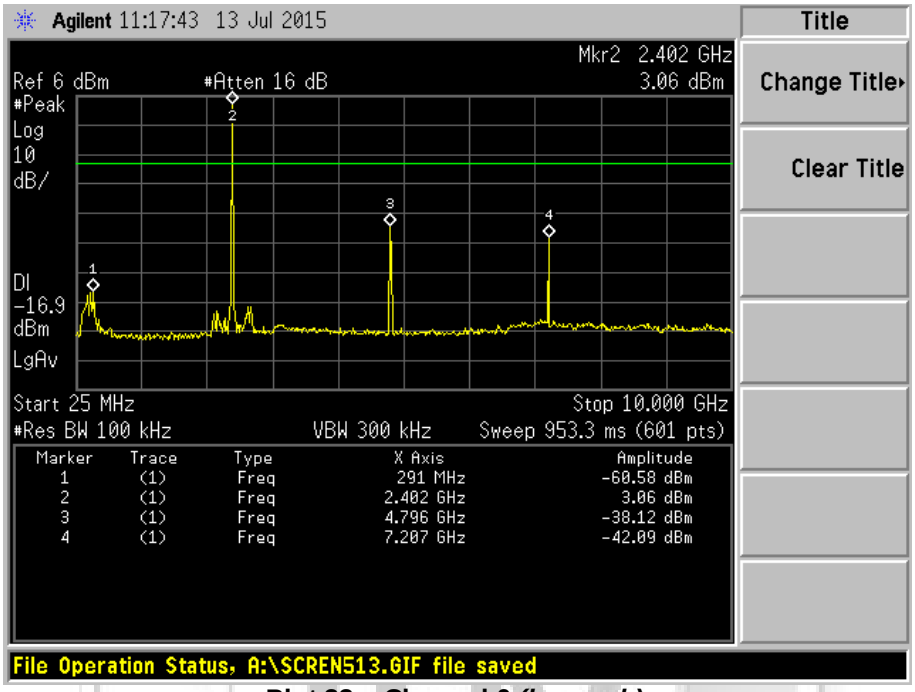


Plot 31 – Channel 78 *(upper ch)*

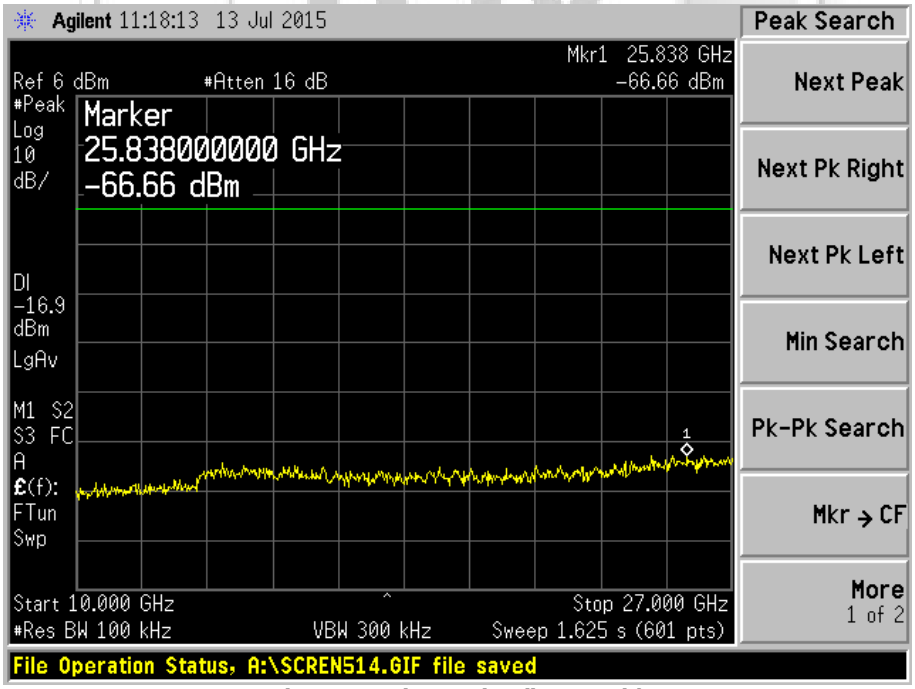


Plot 32 – Channel 78 *(upper ch)*

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

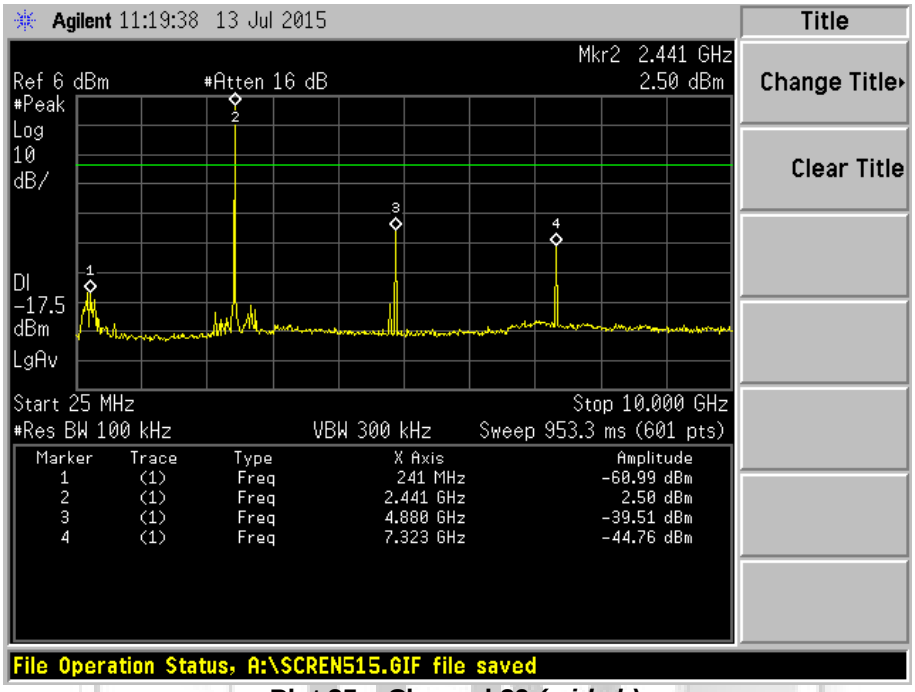


Plot 33 – Channel 0 *(lower ch)*

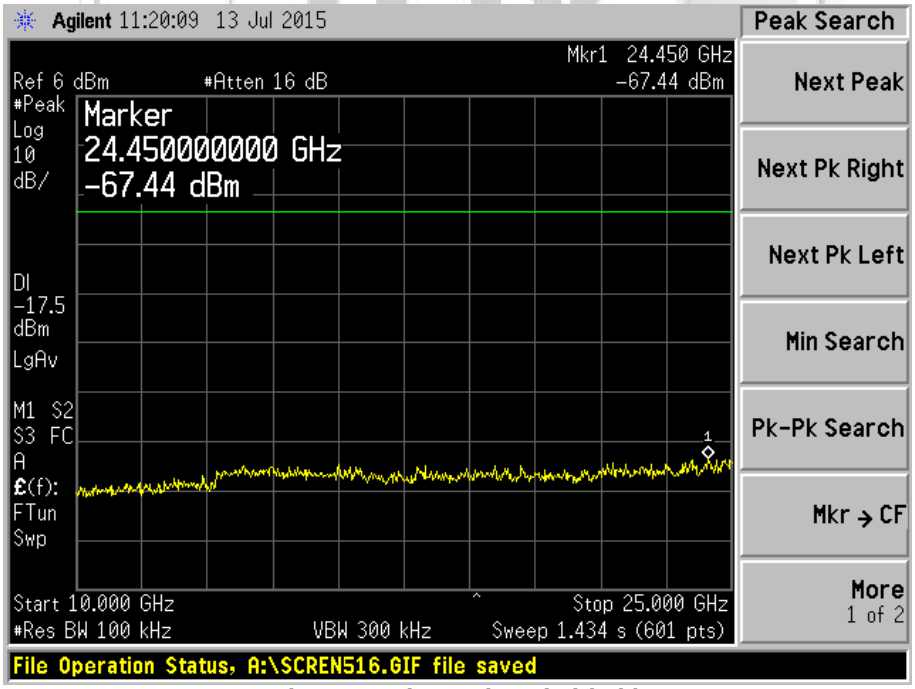


Plot 34 – Channel 0 *(lower ch)*

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

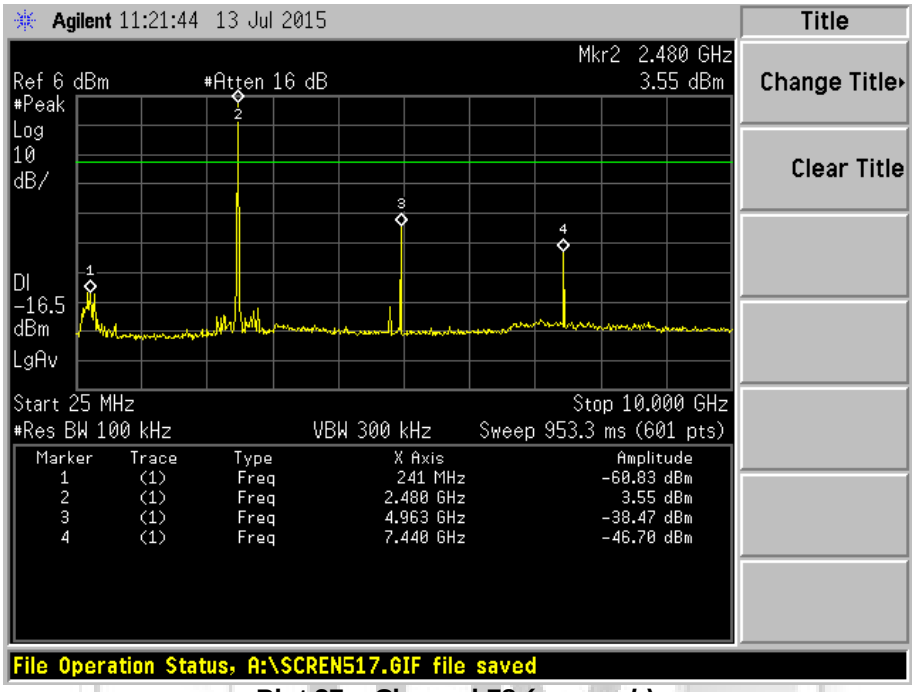


Plot 35 – Channel 39 *(mid ch)*

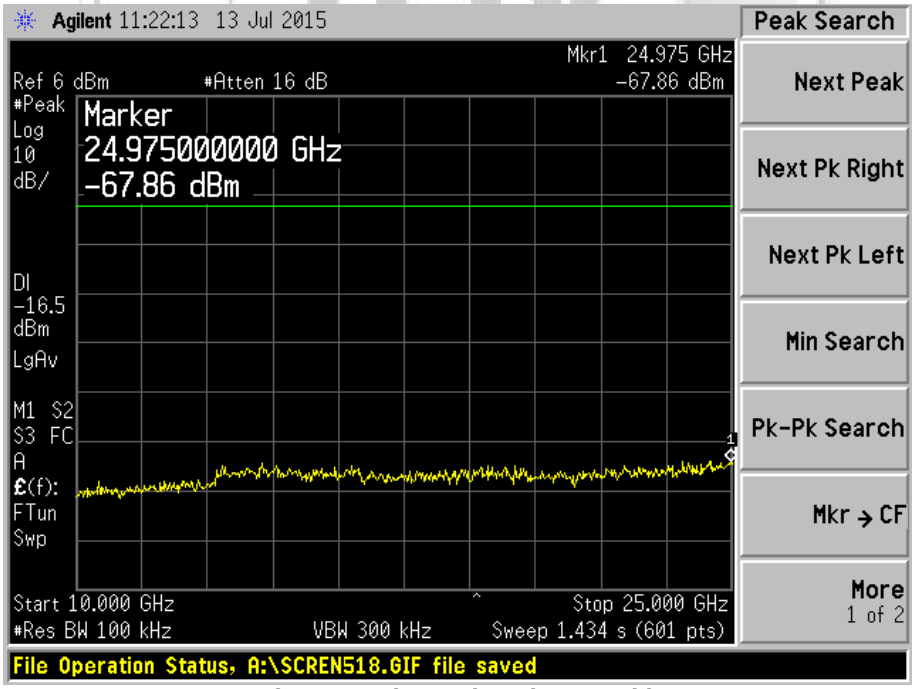


Plot 36 – Channel 39 *(mid ch)*

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

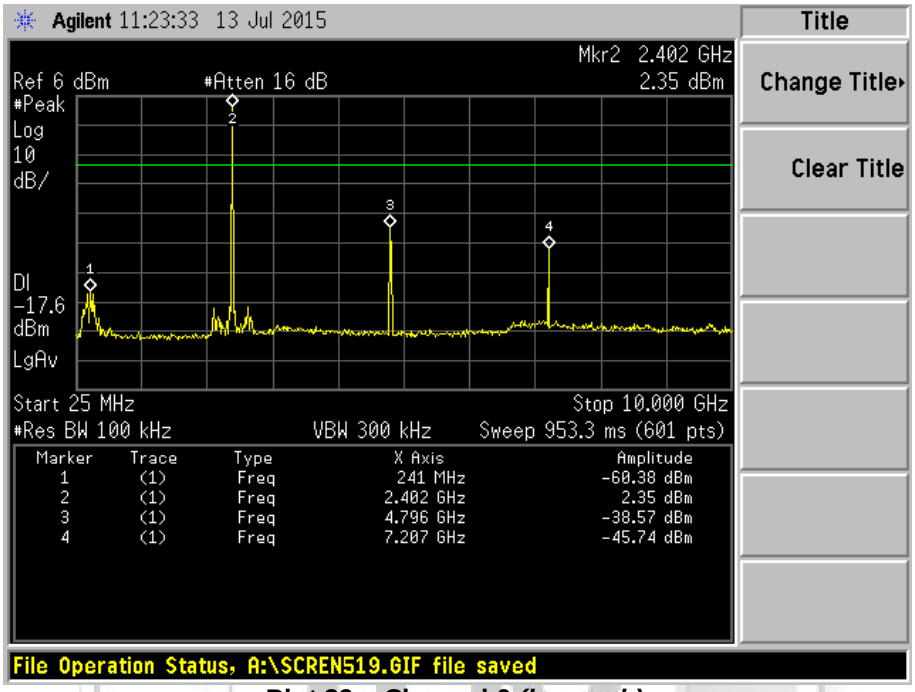


Plot 37 – Channel 78 *(upper ch)*

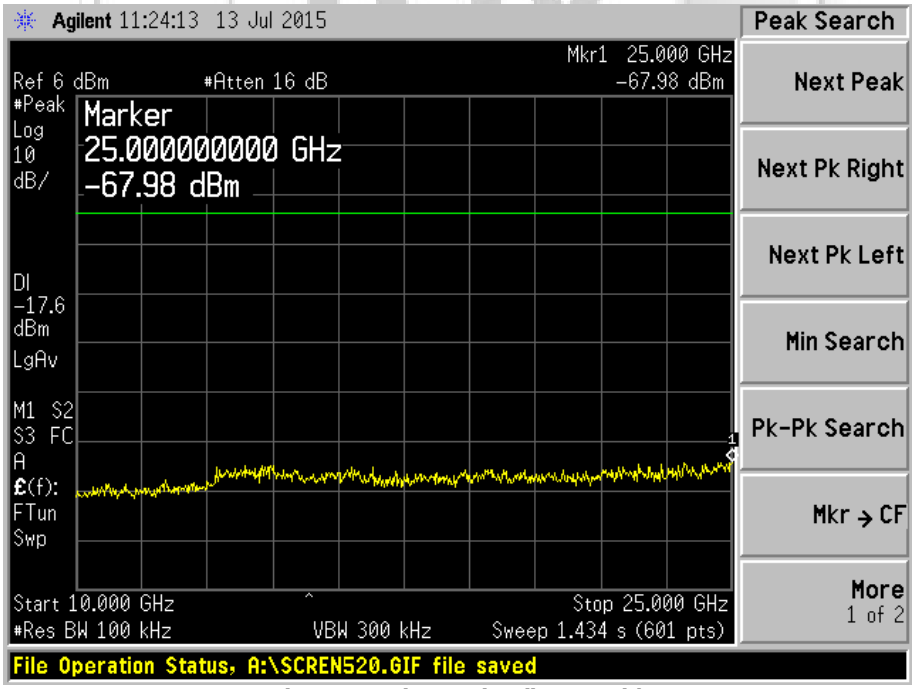


Plot 38 – Channel 78 *(upper ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

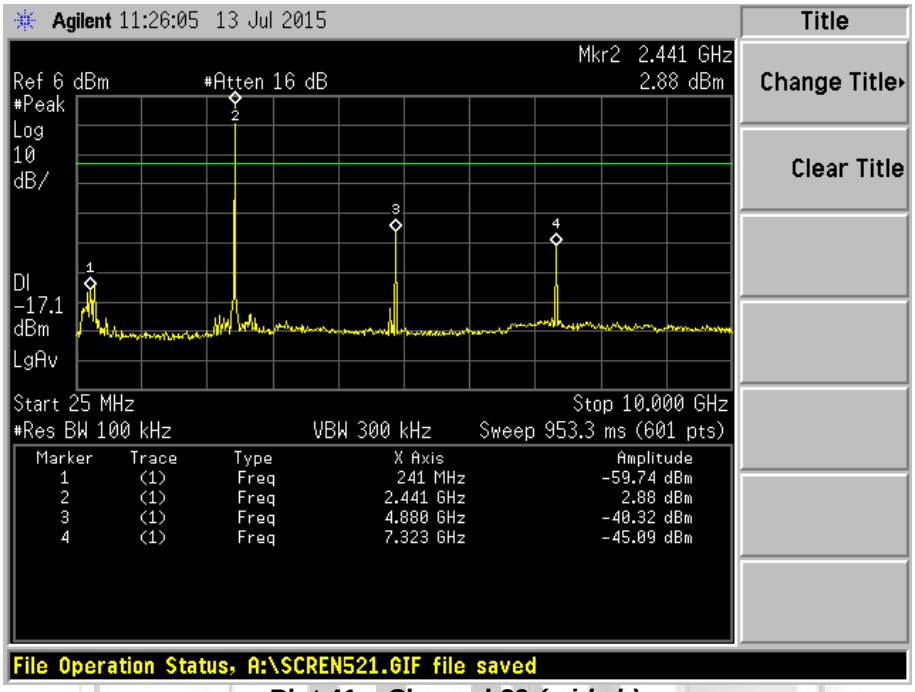


Plot 39 – Channel 0 *(lower ch)*

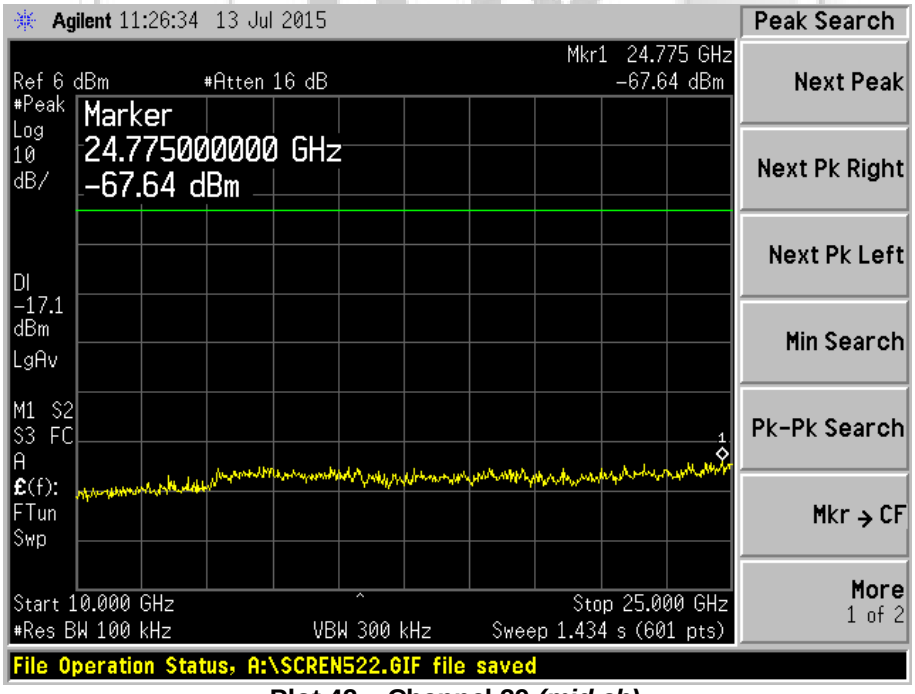


Plot 40 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

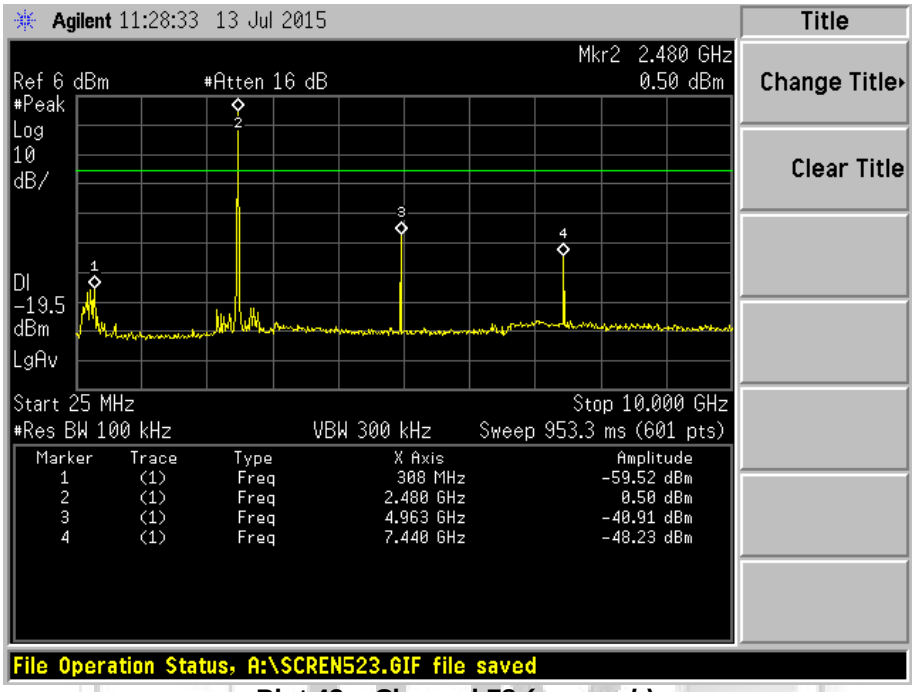


Plot 41 – Channel 39 *(mid ch)*

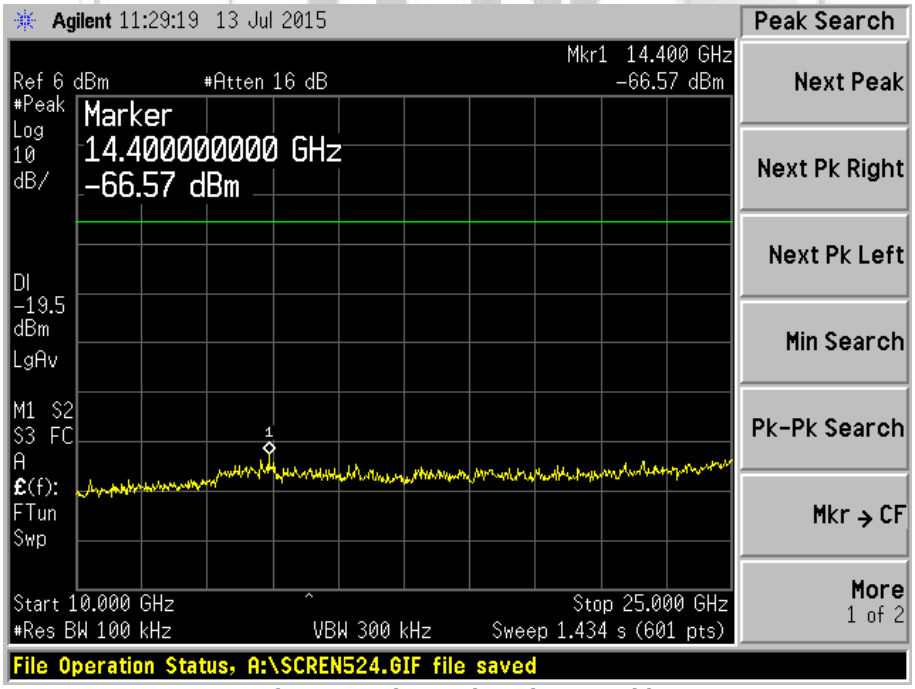


Plot 42 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – 8DPSK



Plot 43 – Channel 78 *(upper ch)*



Plot 44 – Channel 78 *(upper ch)*

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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

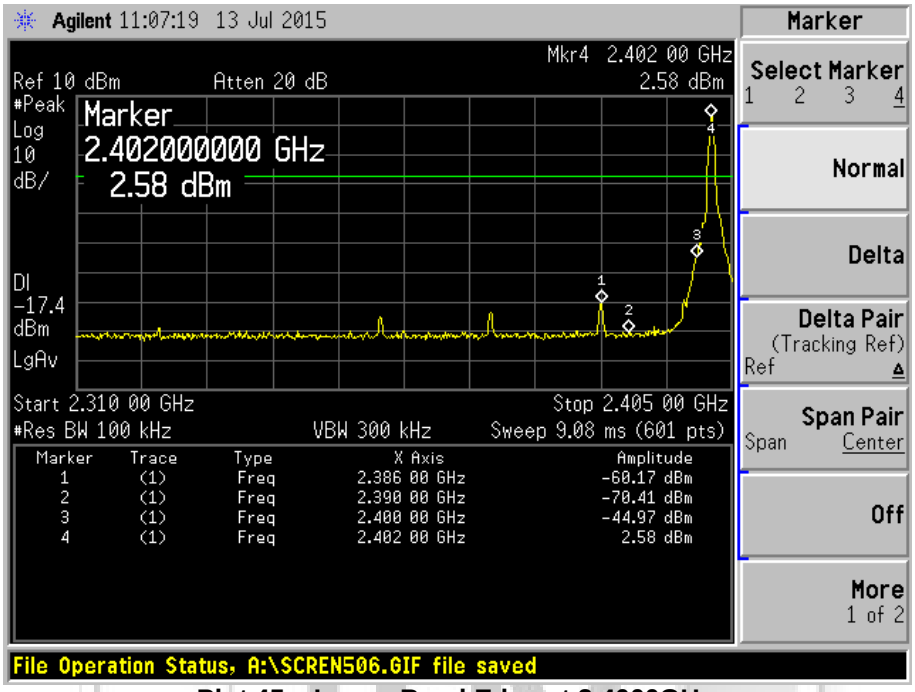
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 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 the any spurious emissions at the band-edge.

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

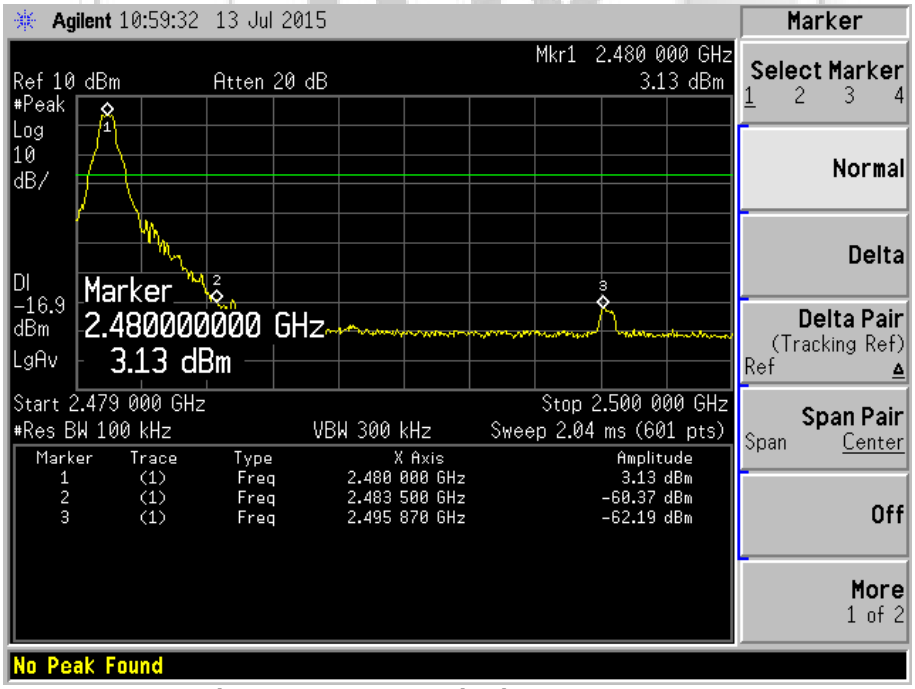
Test Input Power	5Vdc	Temperature	24°C
Attached Plots	45 – 46 (GFSK)	Relative Humidity	60%
	47 – 48 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	49 – 50 (8DPSK)	Tested By	Chang Wai Kit

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

Band Edge Compliance (Conducted) Plots – GFSK

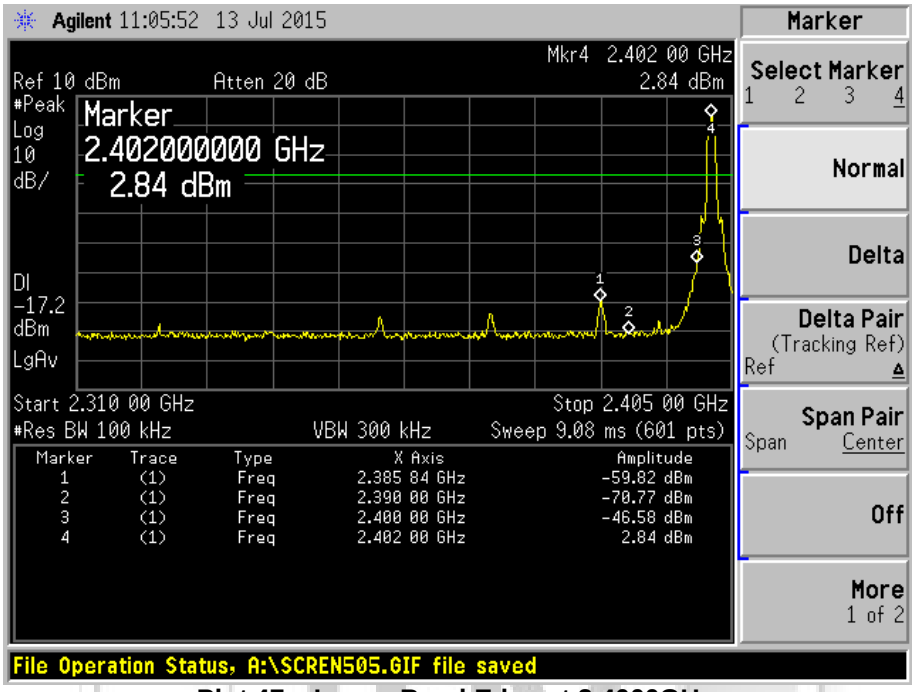


Plot 45 – Lower Band Edge at 2.4000GHz

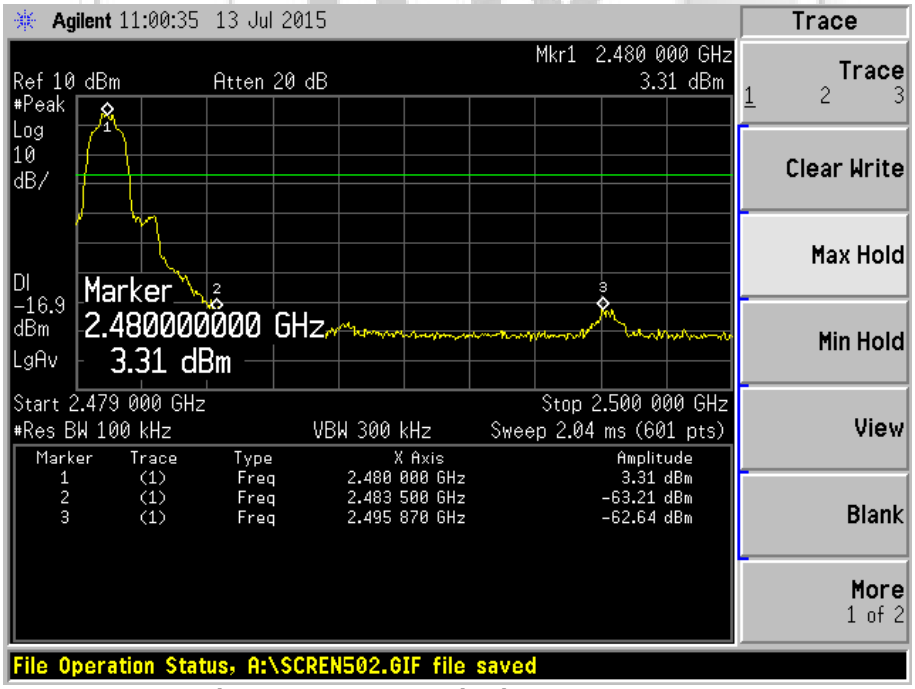


Plot 46 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – (π/4) DQPSK

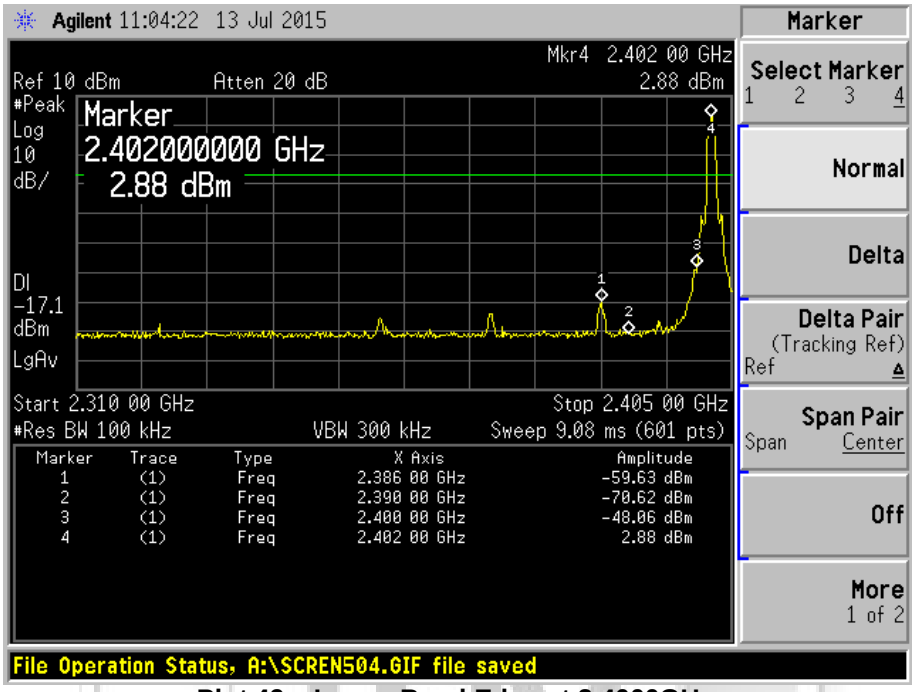


Plot 47 – Lower Band Edge at 2.4000GHz

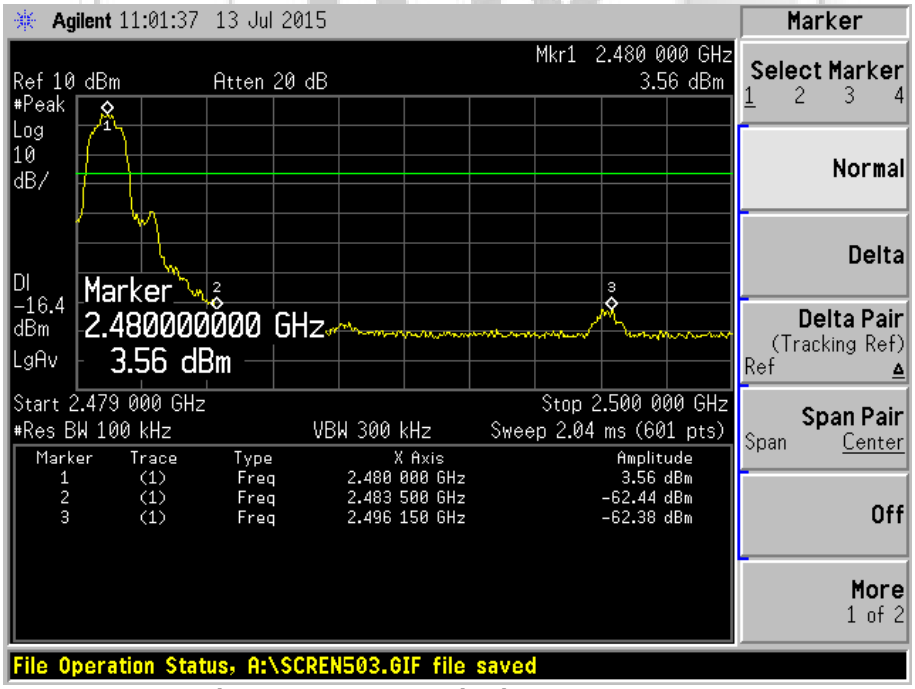


Plot 48 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – 8DPSK



Plot 49 – Lower Band Edge at 2.4000GHz



Plot 50 – Upper Band Edge at 2.4835GHz

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	14 Jul 2016
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2015

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 = VBW = 1MHz
   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

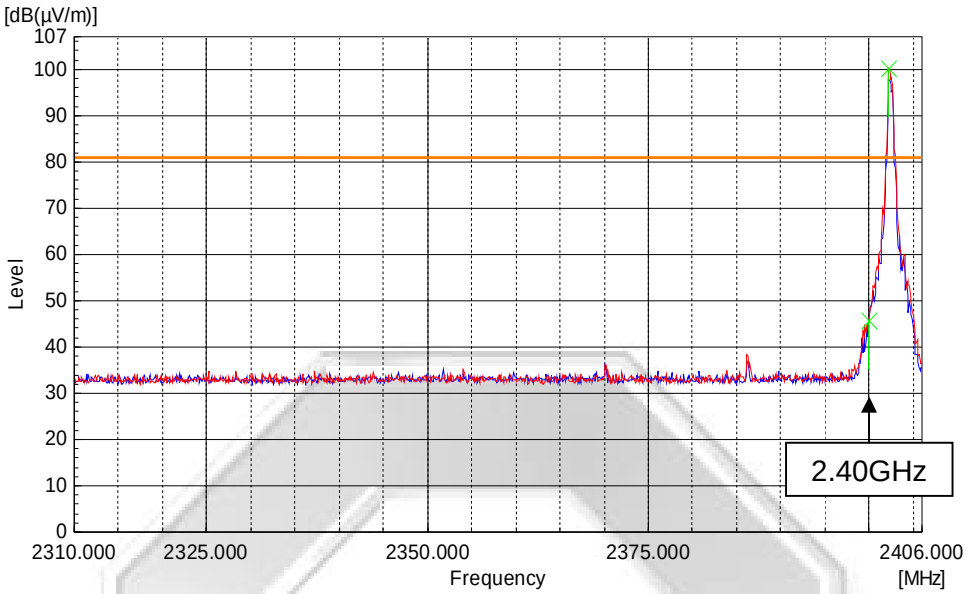
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 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.

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

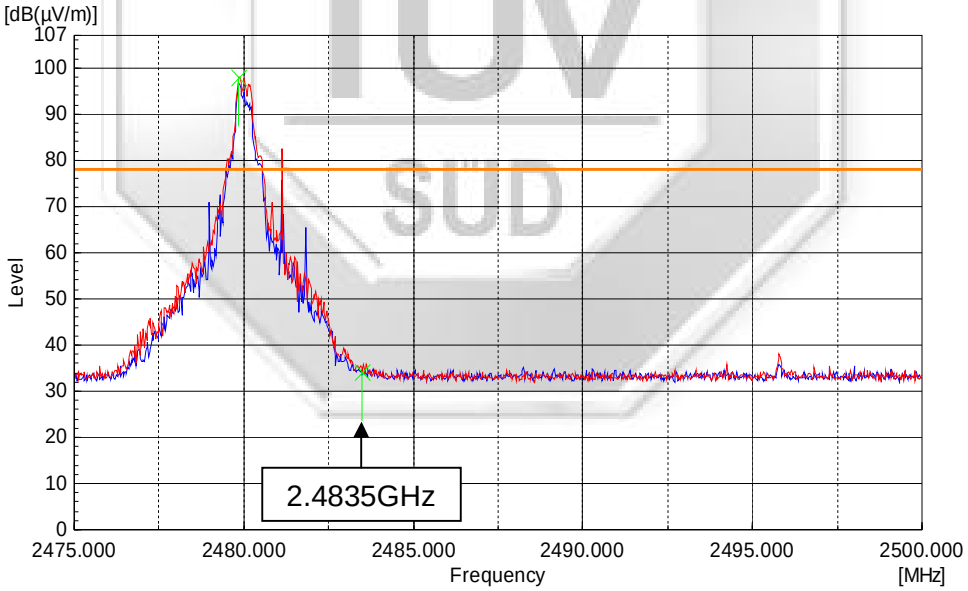
Test Input Power	5Vdc	Temperature	24°C
Attached Plots	51 – 56 (GFSK)	Relative Humidity	60%
	57 – 62 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	63 – 68 (8DPSK)	Tested By	Dylan Lin

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

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

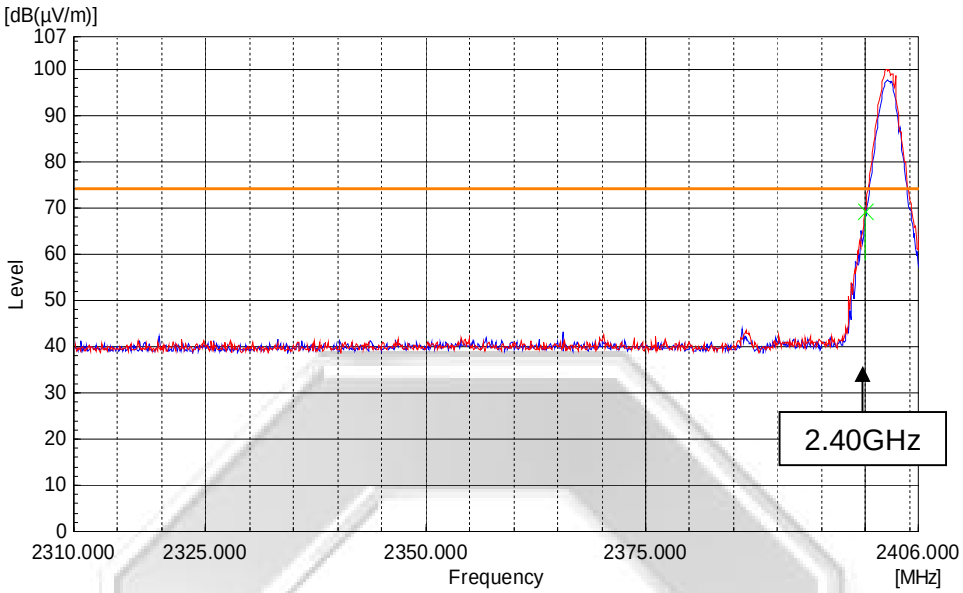


Plot 51 – Lower Band Edge at 2.4000GHz

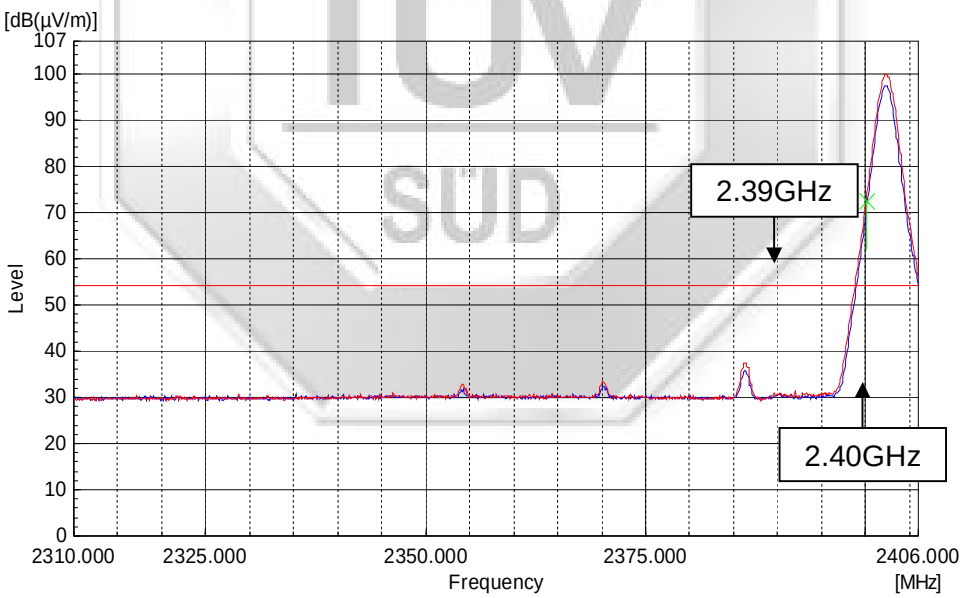


Plot 52 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – GFSK

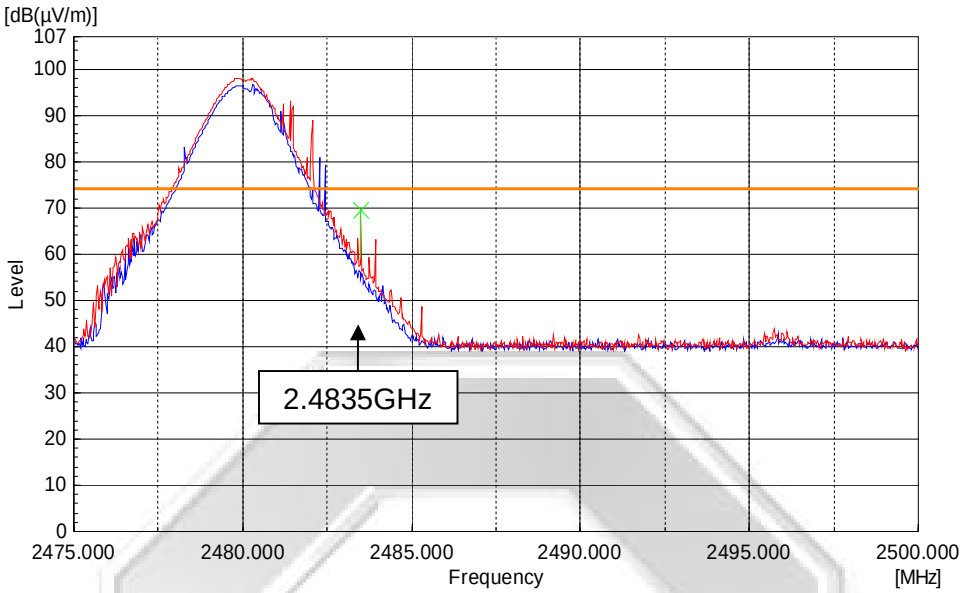


Plot 53 – Peak Plot at Lower Band Edge at 2.4000GHz

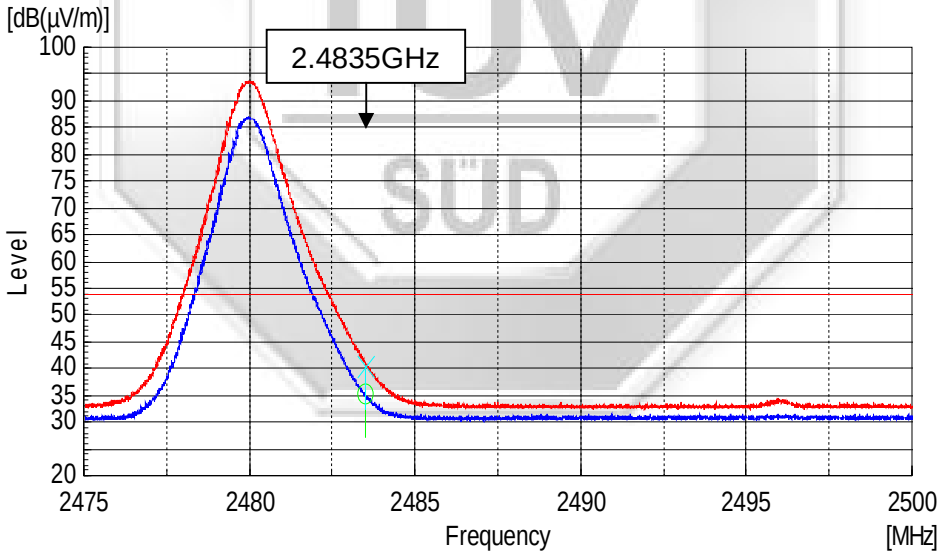


Plot 54 – Average Plot at Lower Band Edge at 2.4000GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – GFSK

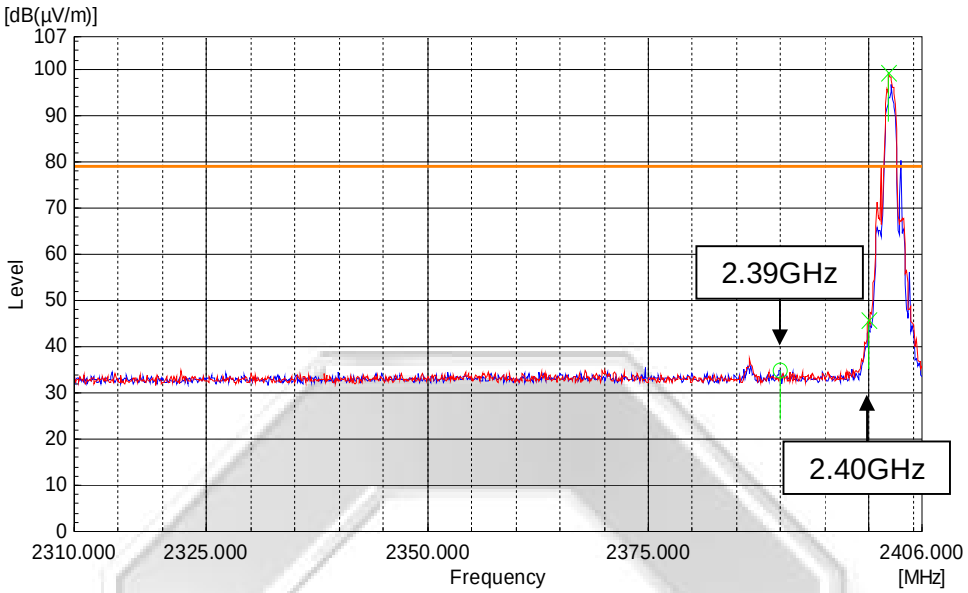


Plot 55 – Peak Plot at Upper Band Edge at 2.4835GHz

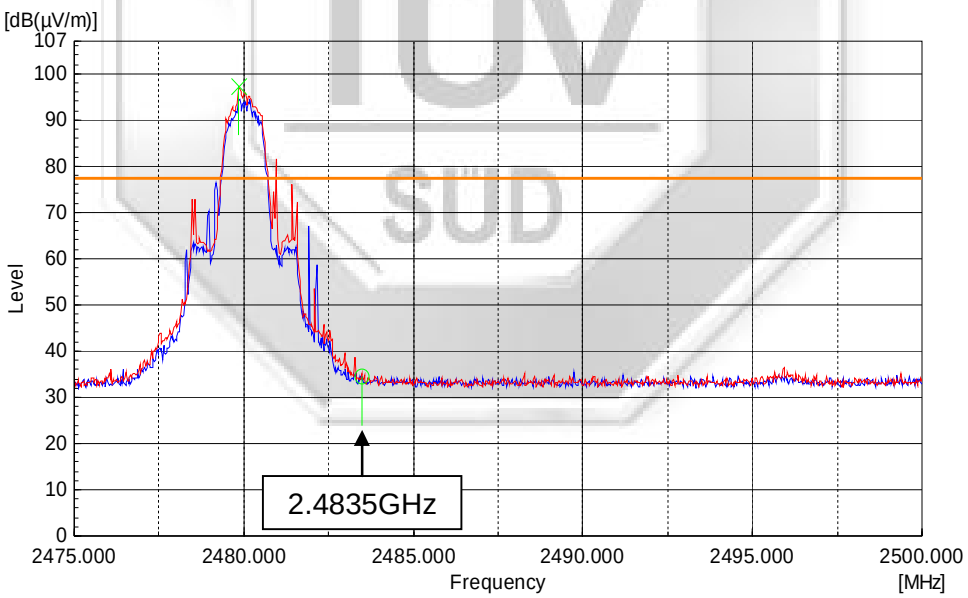


Plot 56 – Average Plot at Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge) – (π/4) DQPSK

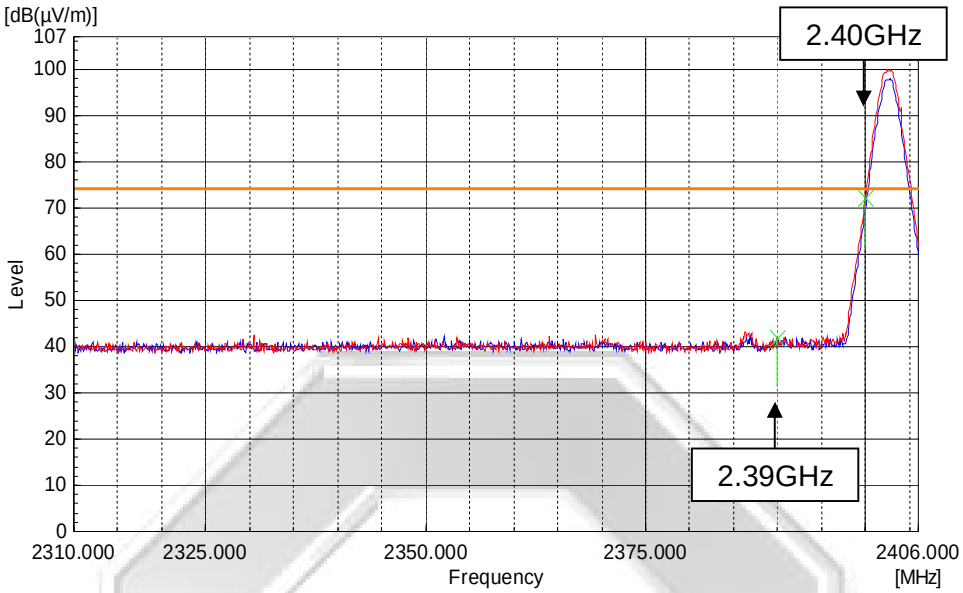


Plot 57 – Lower Band Edge at 2.4000GHz

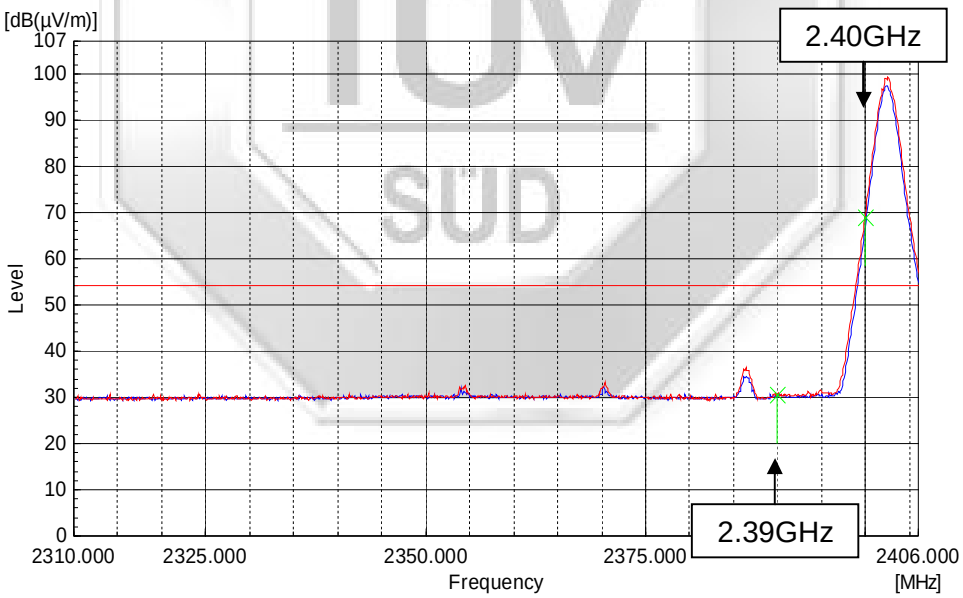


Plot 58 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – (π/4) DQPSK

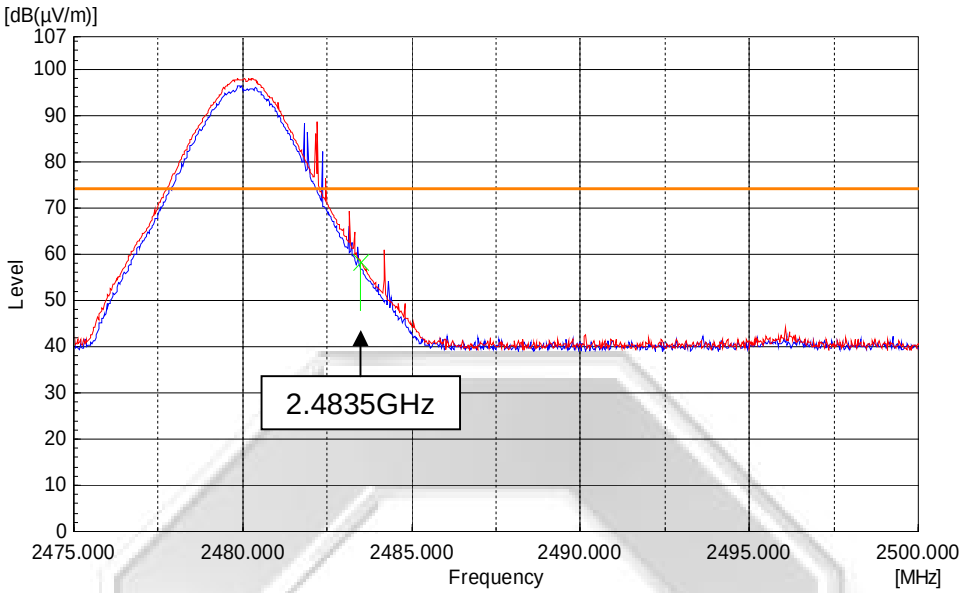


Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz

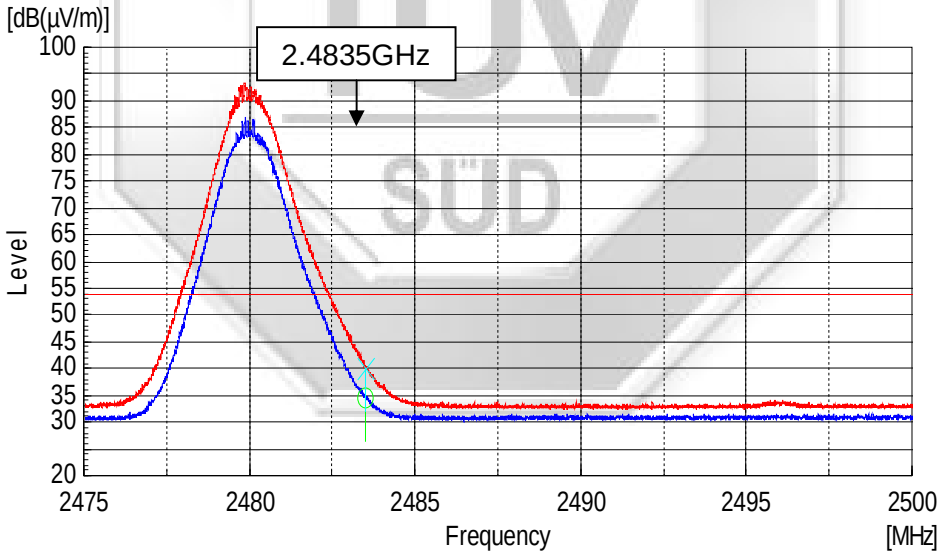


Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – (π/4) DQPSK

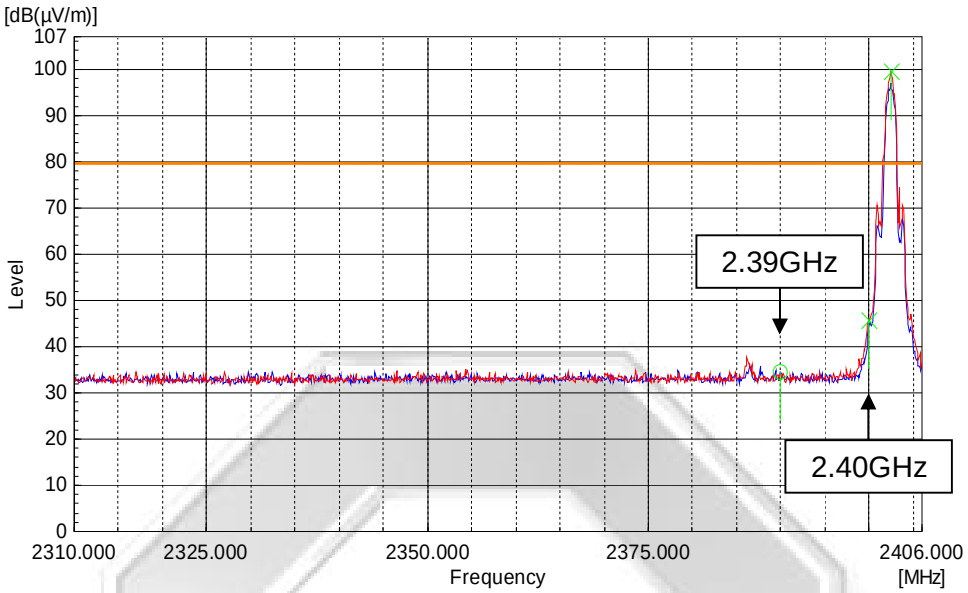


Plot 61 – Peak Plot at Upper Band Edge at 2.4835GHz

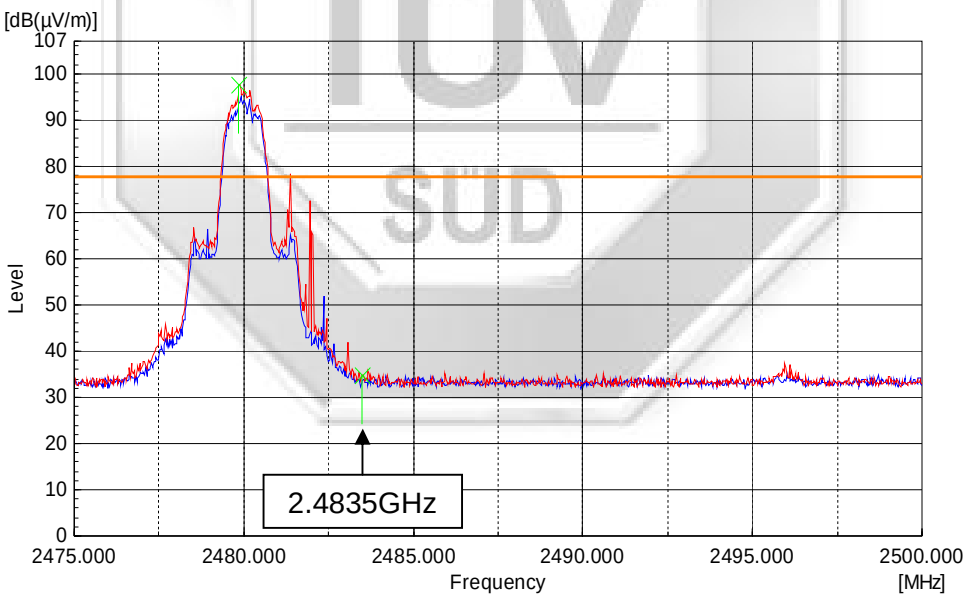


Plot 62 – Average Plot at Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (20dB Delta from Carrier at Band Edge) – 8DPSK

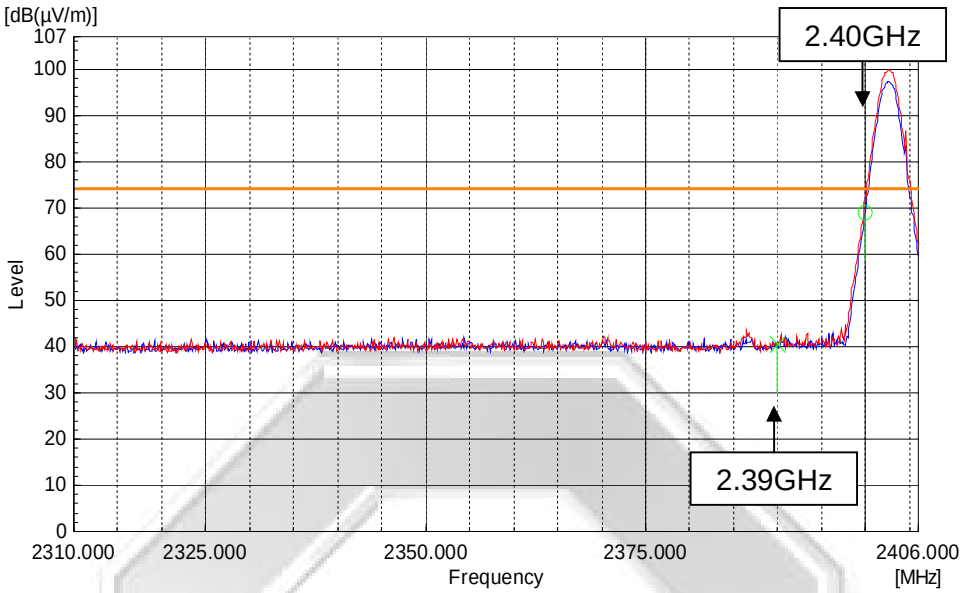


Plot 63 – Lower Band Edge at 2.4000GHz

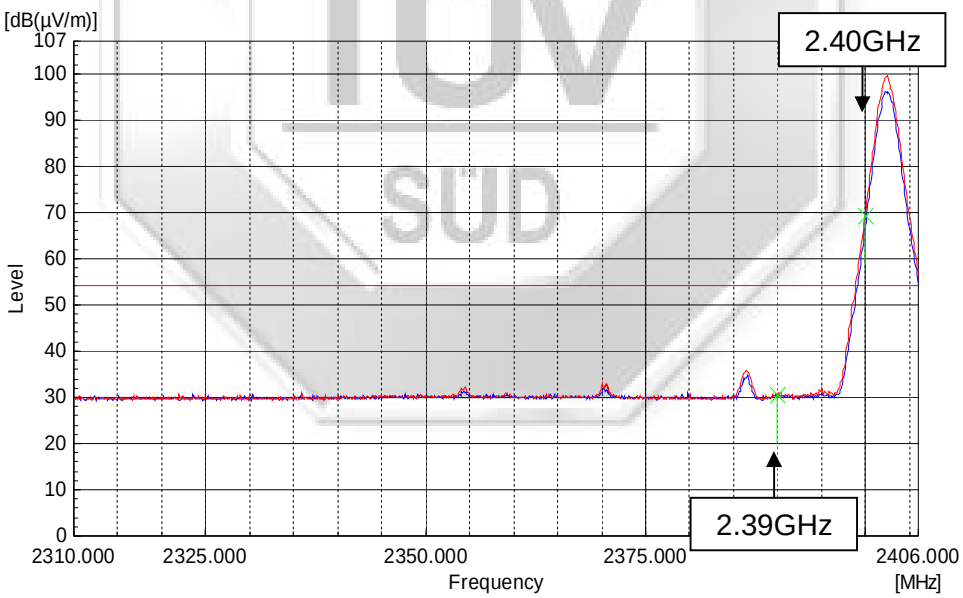


Plot 64 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – 8DPSK

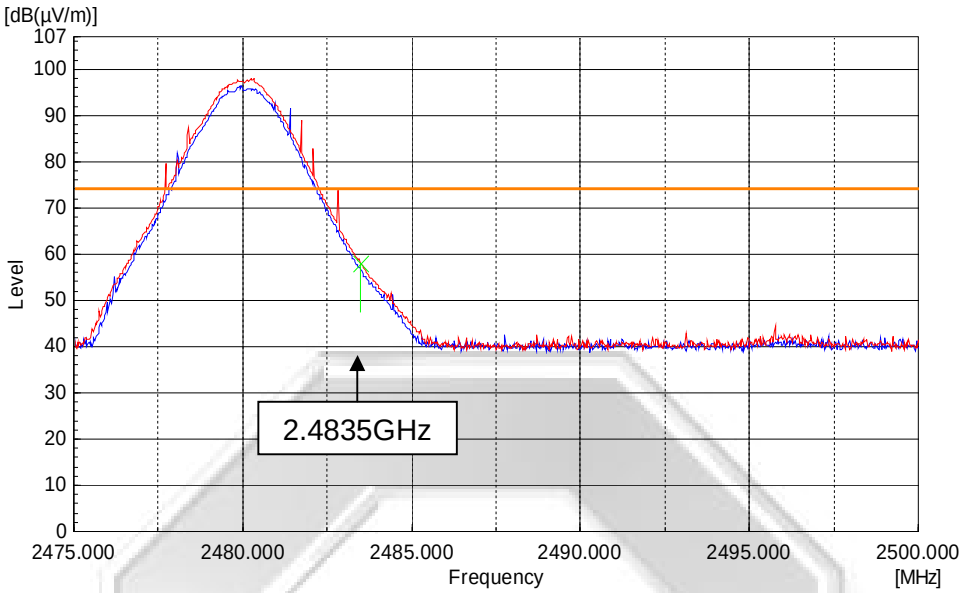


Plot 65 – Peak Plot at Lower Band Edge at 2.4000GHz

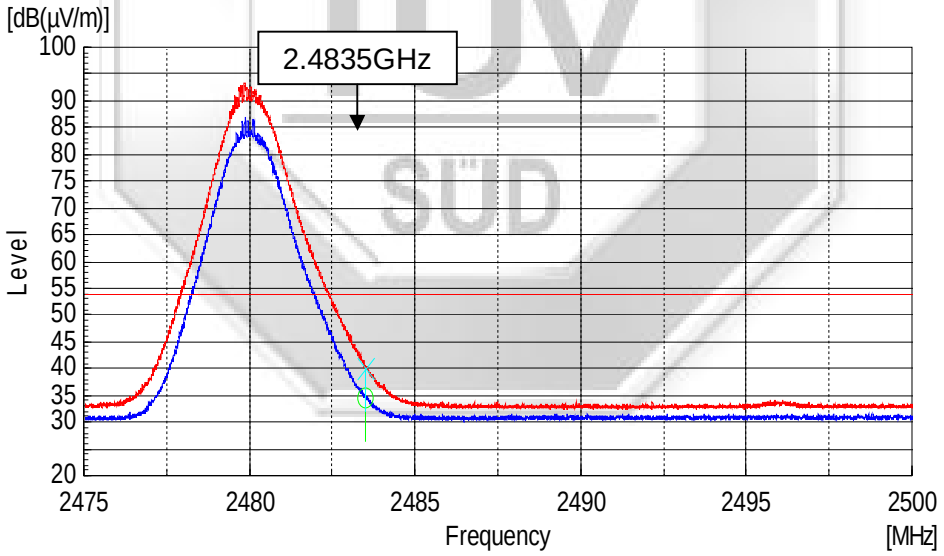


Plot 66 – Average Plot at Lower Band Edge at 2.4000GHz

Band Edge Compliance (Radiated) Plots (Restricted Band) – 8DPSK



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



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

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
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015

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.

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

Test Input Power	5Vdc	Temperature	24°C
Attached Plots	69 – 71 (GFSK)	Relative Humidity	60%
	72 – 74 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	75 – 77 (8DPSK)	Tested By	Chang Wai Kit

GFSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.151	6.3
39 *(mid ch)*	2.441	0.148	6.3
78 *(upper ch)*	2.480	0.158	6.3

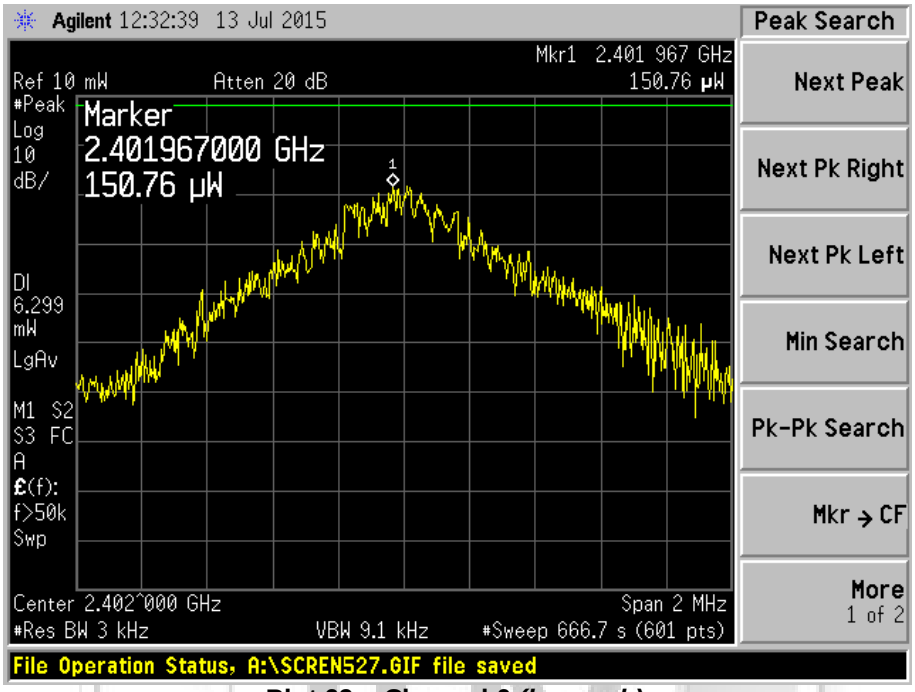
(π/4) DQPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.113	6.3
39 *(mid ch)*	2.441	0.119	6.3
78 *(upper ch)*	2.480	0.124	6.3

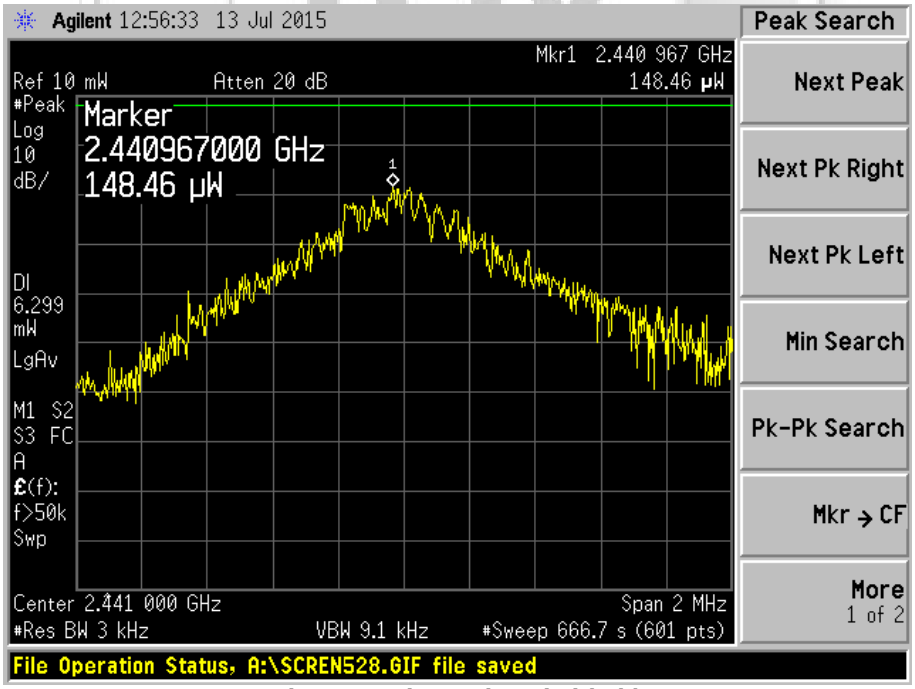
8DPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.089	6.3
39 *(mid ch)*	2.441	0.096	6.3
78 *(upper ch)*	2.480	0.102	6.3

Peak Power Spectral Density Plots – GFSK

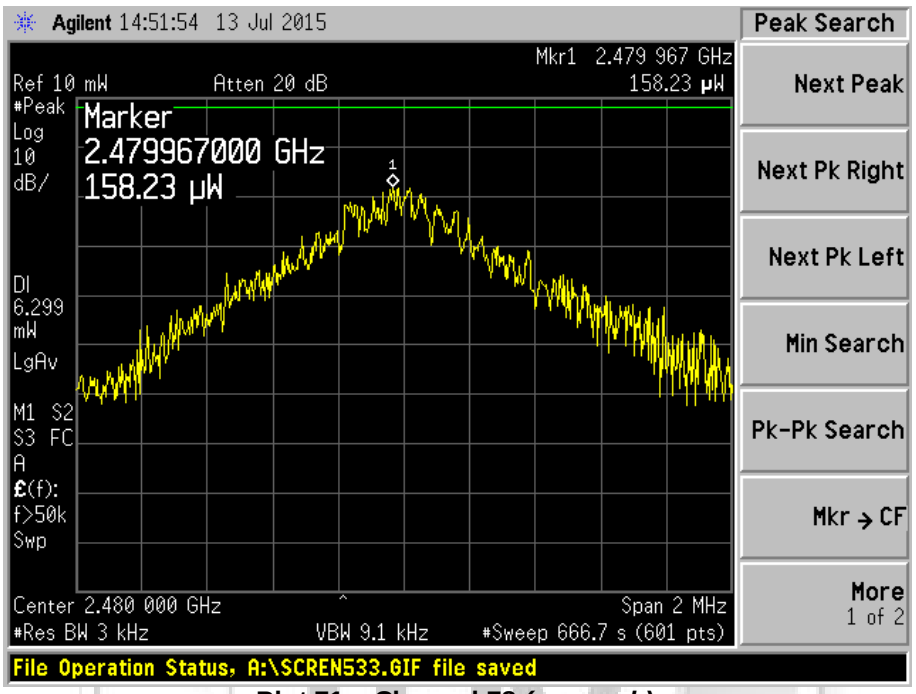


Plot 69 – Channel 0 *(lower ch)*



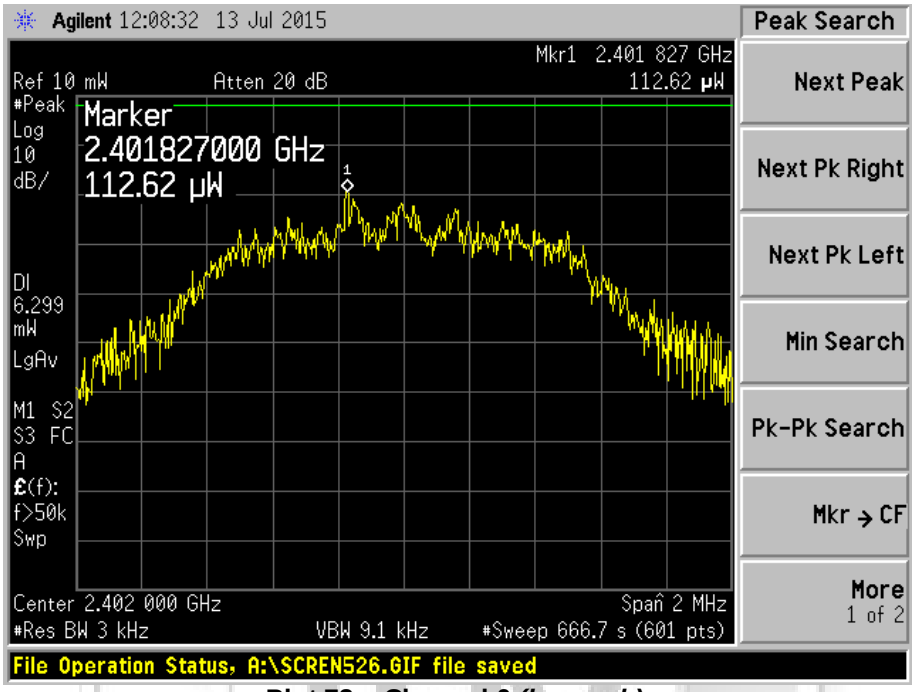
Plot 70 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – GFSK

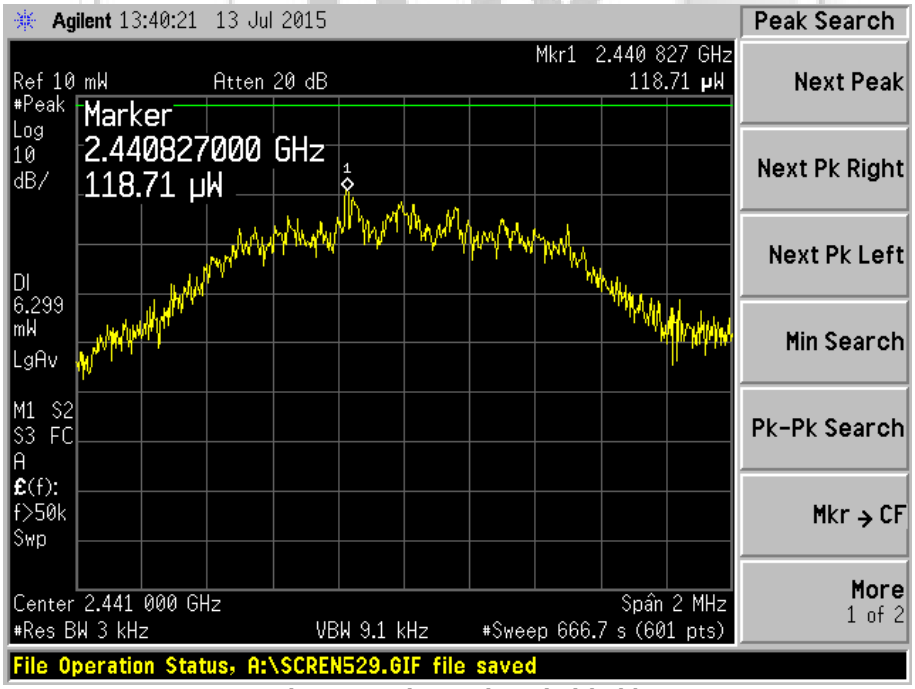


Plot 71 – Channel 78 *(upper ch)*

Peak Power Spectral Density Plots – (π/4) DQPSK

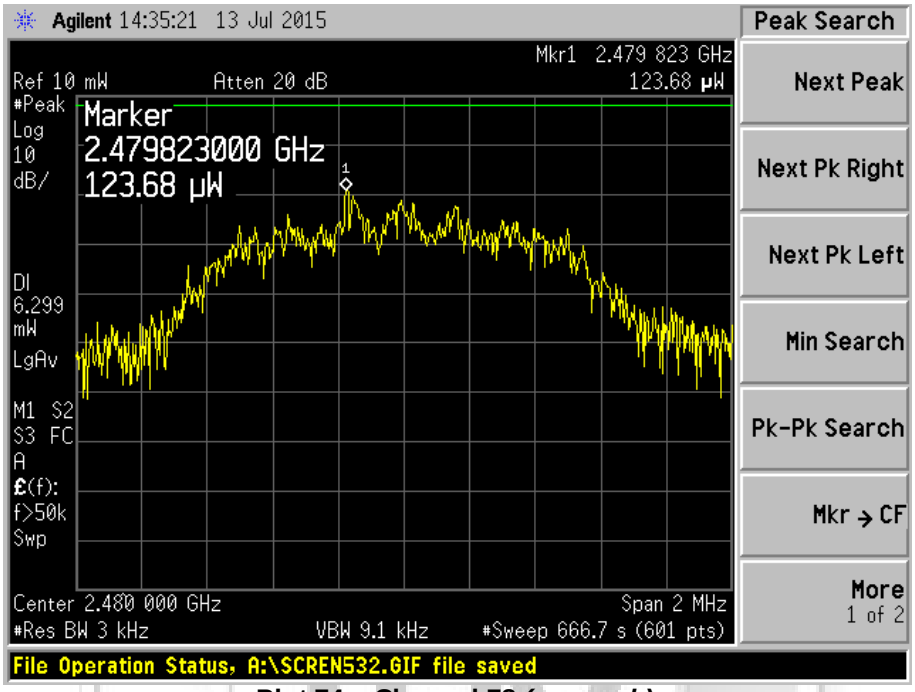


Plot 72 – Channel 0 *(lower ch)*



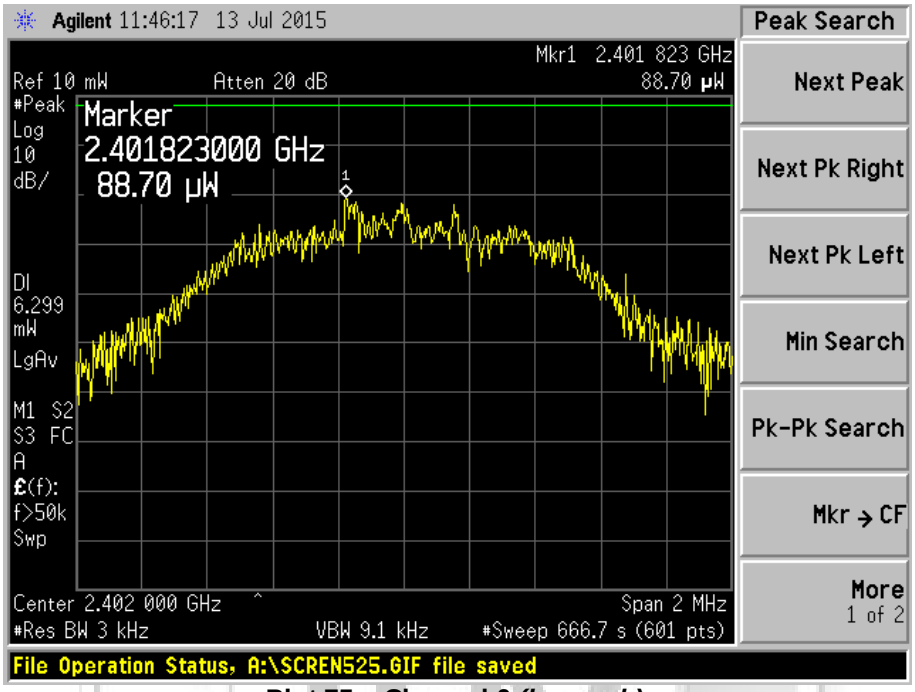
Plot 73 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – (π/4) DQPSK

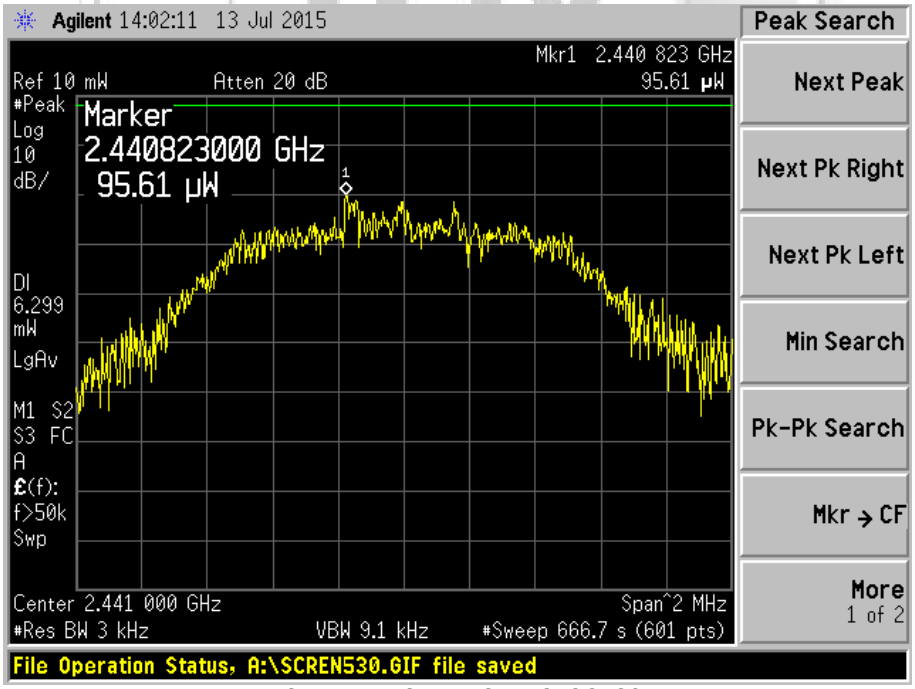


Plot 74 – Channel 78 *(upper ch)*

Peak Power Spectral Density Plots – 8DPSK

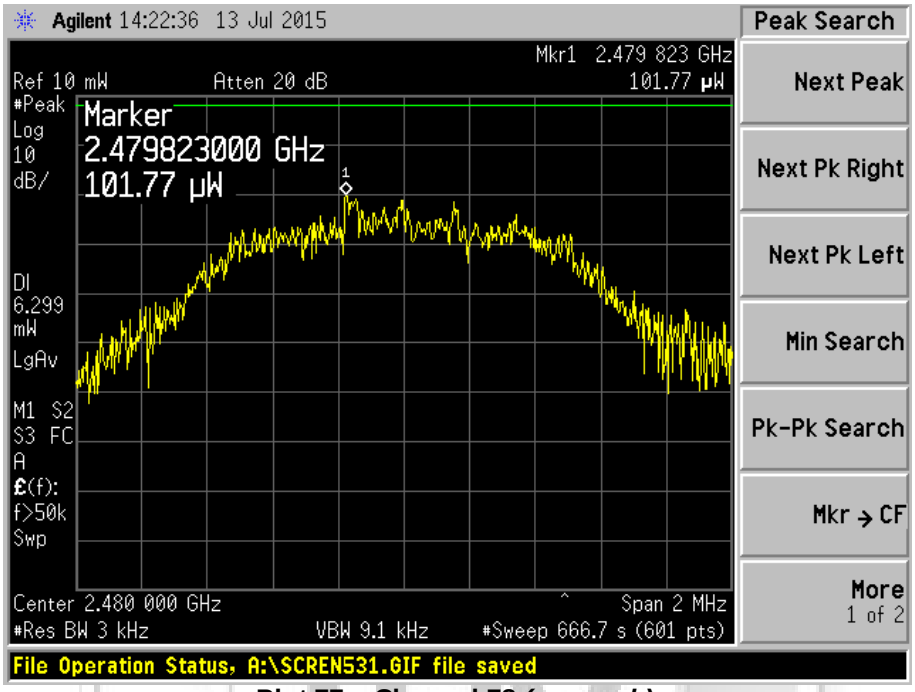


Plot 75 – Channel 0 *(lower ch)*



Plot 76 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – 8DPSK



Plot 77 – Channel 78 *(upper ch)*

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^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				

47 CFR FCC Part 1.1310 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 = 0.0014W *(maximum peak measured from Maximum Peak Power)*
d = Test distance at 0.2m
G = Numerical isotropic gain, 1.79 (2.54dBi)

Substituting the relevant parameters into the formula:

$S = [(30GP) / 377d^2]$
$= 0.0050\ W/m^2$
$= 0.0005\ mW/cm^2$

∴ The power density of the EUT at 20cm distance is $0.0050 mW/cm^2$ based on the above computation and found to be lower than the power density limit of $1.0 mW/cm^2$.

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