Test Report No. 7191159159-EEC17/02
dated 30 Mar 2017

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
OF A
Compact Stereo System
[Model : SC-HC295]
[FCC ID : ACJ-B21R1401]

TEST FACILITY	TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, No. 1 Science Park Drive, Singapore 118221 TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, 13 International Business Park #01-01, Singapore 609932
FCC REG. NO.	99142 (3m and 10m Semi-Anechoic Chamber, Science Park) 160581 (3m and 10m Semi-Anechoic Chamber, International Business Park)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park) 2932N-1 (10m Semi-Anechoic Chamber, International Business Park)
PREPARED FOR	Panasonic AVC Networks Singapore 202 Bedok South Avenue 1 Singapore 469332 Tel : +65 6240 1891 Fax : +65 6245 8804
QUOTATION NUMBER	2191059105
JOB NUMBER	7191159159
TEST PERIOD	13 Jan 2017 – 29 Mar 2017

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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

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.

Transmit Channel	Frequency (GHz)
Channel 01	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 **COMPACT STEREO SYSTEM.**
Applicant	:	Panasonic AVC Networks Singapore 202, Bedok South Avenue 1 Singapore 469332
Manufacturer	:	Panasonic Corporation 1003, Oaza Kadoma-City, Osaka, 571 8501
Factory (ies)	:	Panasonic AVC Networks Johore Malaysia Sdn. Bhd. 1E, Plo 460, Jalan Bandar, 81700 Pasir Gudang, Johor, Malaysia
Model Number(s)	:	SC-HC295
FCC ID	:	ACJ-B21R1401
Serial Number(s)	:	MM7AD001088
Microprocessor(s)	:	BM94801KUT-Z Rohm Semiconductor Pte Ltd
Operating Frequency	:	FM 87.5MHz - 108MHz Bluetooth - 2402MHz (lower channel) to 2480MHz (upper channel) - 79 channels
Clock / Oscillator Frequency	:	128kHz (FM), 26MHz (Bluetooth), 16MHz & 32kHz
Modulation	:	1Mbps: Gaussian Frequency Shift Keying (GFSK) 2Mbps: π/4 Differential-Quadrature Phase Shift Keying (DQPSK) 3Mbps: 8 Differential Phase-Shift Keying (DPSK)
Antenna Gain	:	2.0dBi (Max)
Port / Connectors	:	Refer to manufacturer's user manual / operating manual
Rated Input Power	:	120V 60Hz 22W
Accessories	:	Remote Control (AA Battery) FM Antenna AC Cord

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Nokia E63 Smart Phone	M/N: E63-1 S/N: Nil FCC ID: Nil	Nil
USB Thumb Drive	M/N: Nil S/N: Nil FCC ID: Nil	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. 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.

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
Rohde & Schwarz EMI Test Receiver (9kHz-3GHz)	ESCI	100477	07 Mar 2018
Schaffner LISN 2-Line V-Network (EUT) (9kHz-30MHz)	NNB41	04/10151	31 Oct 2017
Schaffner LISN 2-Line V-Network (AE) (9kHz-30MHz)	NNB41	04/10152	26 Jun 2017

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

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

Test Input Power	120V 60Hz	Temperature	24ºC
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	Channel
0.1868	48.0	64.2	16.2	28.8	54.2	25.4	Neutral	0
0.2591	43.4	61.5	18.1	24.1	51.5	27.4	Neutral	0
0.2727	38.6	61.0	22.4	19.1	51.0	31.9	Neutral	0
0.5943	34.6	56.0	21.4	15.2	46.0	30.8	Neutral	0
0.9416	37.0	56.0	19.0	17.2	46.0	28.8	Neutral	0
1.1376	39.2	56.0	16.8	20.7	46.0	25.3	Neutral	0

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	11 Oct 2017
Schaffner Bilog Antenna –(30MHz-2GHz)	CBL6112B	2947	19 Oct 2017
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2017
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	18 Oct 2017
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	11 Mar 2018
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	12 Oct 2017
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441056	22 Jul 2017
EMCO Loop Ant (ext)_red_00134413	6502	134413	28 Oct 2017
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2017

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 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	120V 60Hz	Temperature	23ºC
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit Lim Kay Tak

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

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
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Spurious Emissions ranging from 9kHz – 30MHz *See Note 4, 5

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

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
191.9450	32.4	43.5	11.1	100	31	H	0
287.9790	39.1	46.0	6.9	106	247	V	0
383.9940	40.3	46.0	5.7	226	340	H	0
479.9690	33.7	46.0	12.3	106	268	V	0
516.0890	34.2	46.0	11.8	181	235	H	0
671.9660	34.7	46.0	11.3	111	22	H	0

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

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 2	AV Limit (dBµV/m)	AV Margin (dB) *See Note 3	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
3.6009	37.7	74.0	36.3	--	54.0	16.3	400	285	H	0
4.8963	46.2	74.0	27.8	--	54.0	7.8	300	173	V	0
5.0481	42.4	74.0	31.6	--	54.0	11.6	200	174	V	0
7.2387	50.9	74.0	23.1	--	54.0	3.1	300	26	H	0
7.4209	47.2	74.0	26.8	--	54.0	6.8	300	341	V	0
14.0888	52.8	74.0	21.2	--	54.0	1.2	200	317	H	0

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 2	AV Limit (dBµV/m)	AV Margin (dB) *See Note 3	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
2.9228	37.1	74.0	36.9	--	54.0	16.9	300	173	V	39
4.8356	44.0	74.0	30.0	--	54.0	10.0	300	167	V	39
4.9570	46.4	74.0	27.6	--	54.0	7.6	300	313	V	39
7.2023	48.6	74.0	25.4	--	54.0	5.4	400	354	V	39
7.3480	46.1	74.0	27.9	--	54.0	7.9	200	200	H	39
12.0121	50.3	74.0	23.7	--	54.0	3.7	300	1	V	39

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m) *See Note 2	AV Limit (dBµV/m)	AV Margin (dB) *See Note 3	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.9817	49.2	74.0	24.8	--	54.0	4.8	300	134	H	78
4.7242	34.4	74.0	39.6	--	54.0	19.6	200	28	H	78
4.9368	41.9	74.0	32.1	--	54.0	12.1	300	132	V	78
5.0886	46.9	74.0	27.1	--	54.0	7.1	300	173	V	78
7.2994	45.1	74.0	28.9	--	54.0	8.9	100	353	V	78
11.2463	46.7	74.0	27.3	--	54.0	7.3	200	359	H	78

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. As the measured peak shows compliance to the average limit, as such no average measurement was required.
3. The average margin indicates the margin of the measured peak value below the average limit.
4. "--" indicates no emissions were found and shows compliance to the limits.
5. The measurement was done at 3m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
6. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
7. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a "negative" margin indicates a FAIL.
8. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 3MHz
9. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
10. The channel in the table refers to the transmit channel of the EUT.
11. 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	10 Dec 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

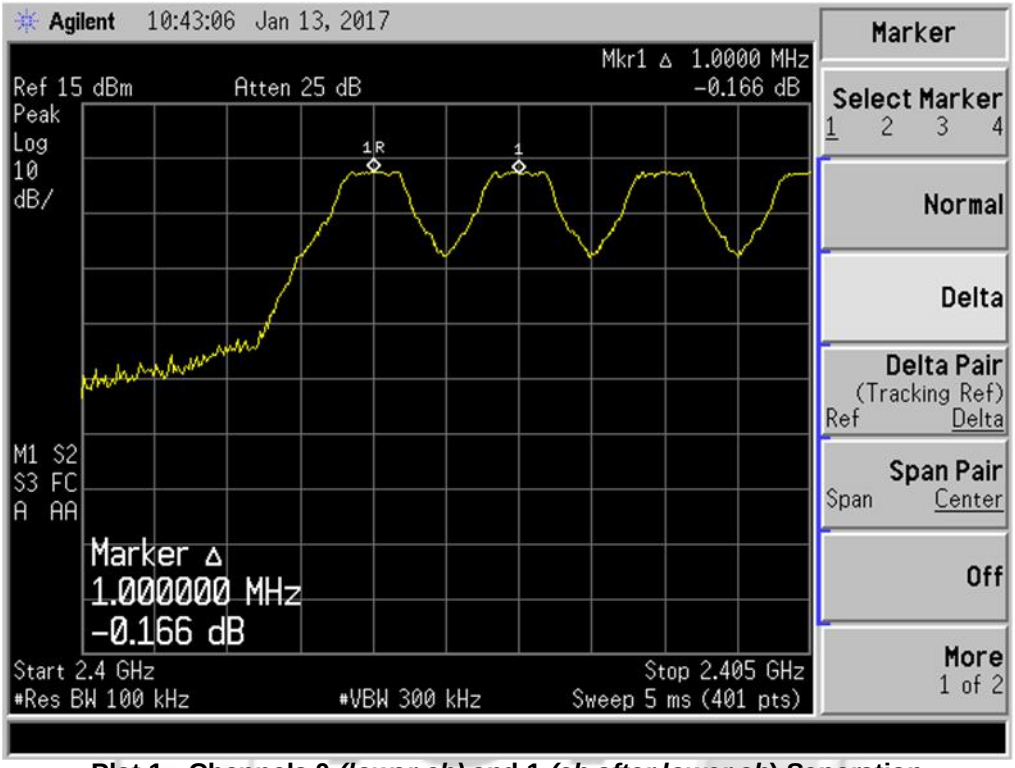
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.405GHz.
3. The spectrum analyser was set 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

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

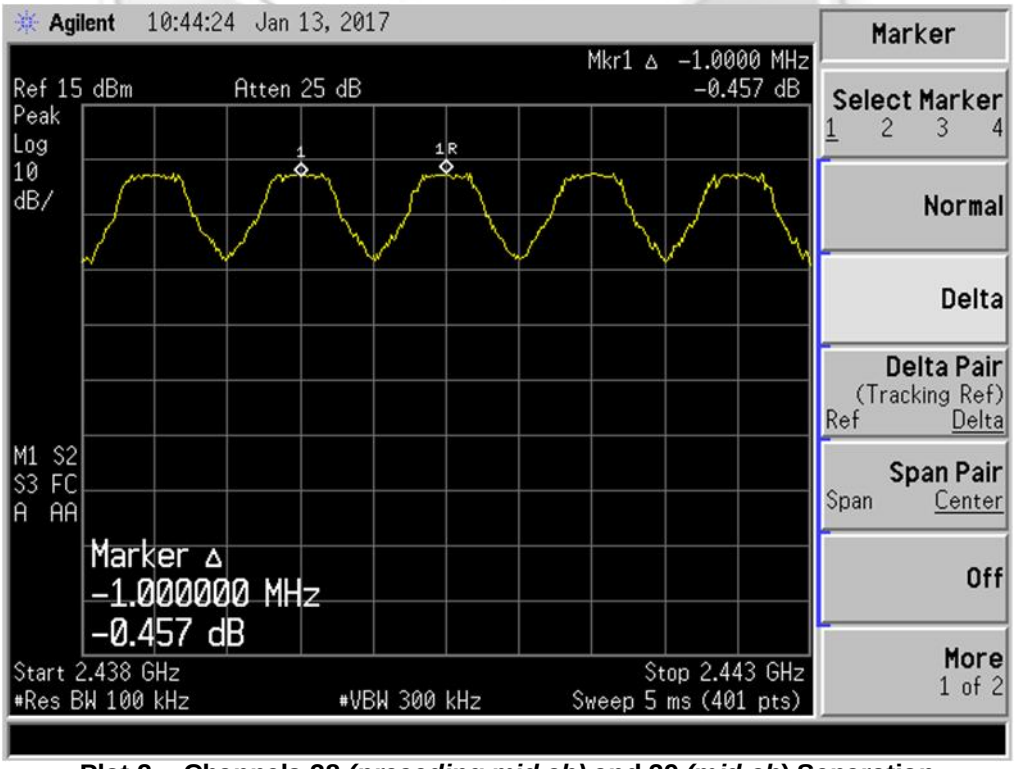
Test Input Power	5Vdc	Temperature	26°C
Attached Plots	1 – 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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 Plots

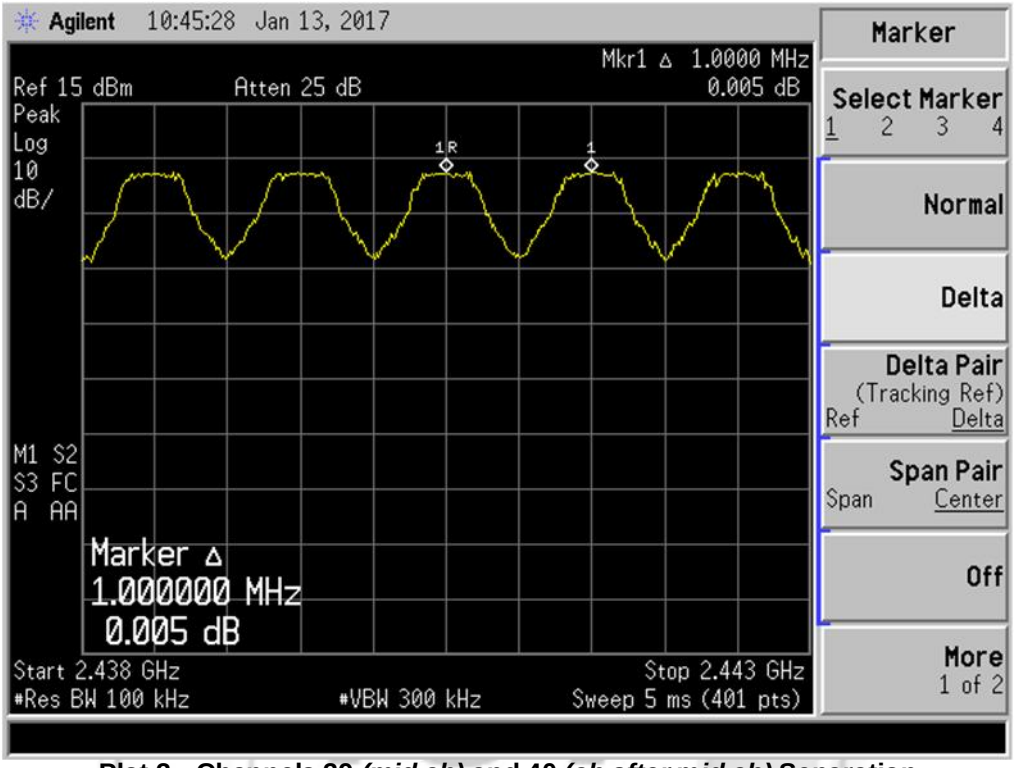


Plot 1 - Channels 0 *(lower ch)* and 1 *(ch after lower ch)* Separation

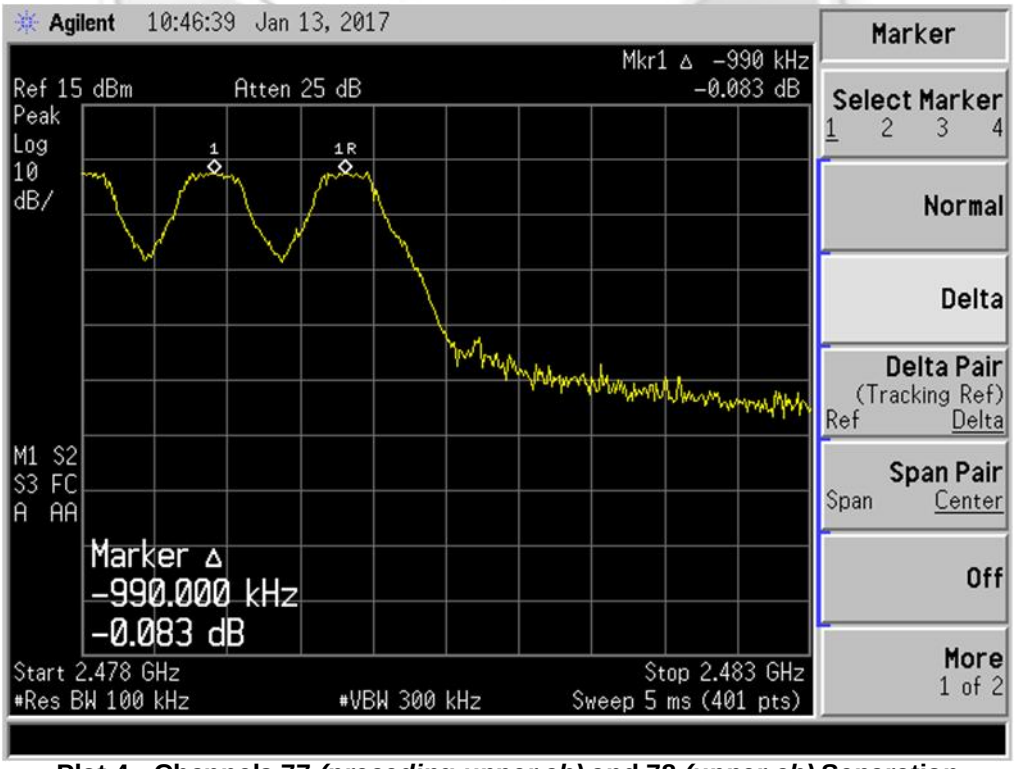


Plot 2 – Channels 38 *(preceding mid ch)* and 39 *(mid ch)* Separation

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	10 Dec 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.
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	26°C
Attached Plots	5 – 13 (20dB Bandwidth)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

GFSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	0.997	0.916
39 *(mid ch)*	2.441	1.002	0.912
78 *(upper ch)*	2.480	1.002	0.921

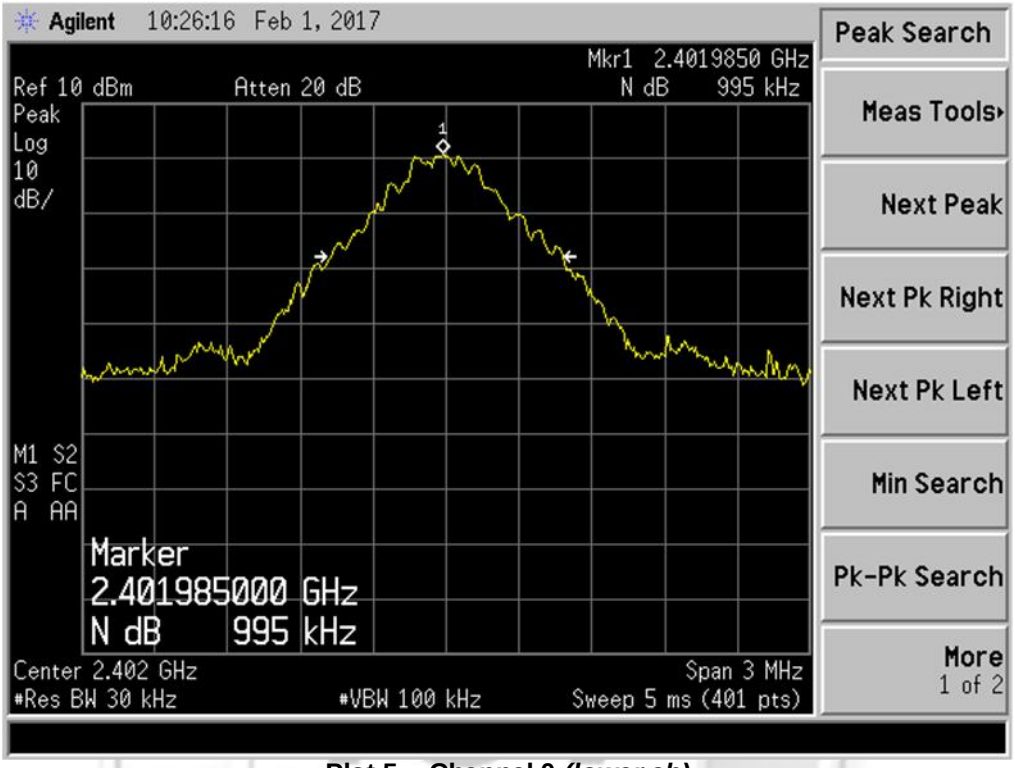
(π/4)DQPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	1.362	1.191
39 *(mid ch)*	2.441	1.362	1.194
78 *(upper ch)*	2.480	1.354	1.193

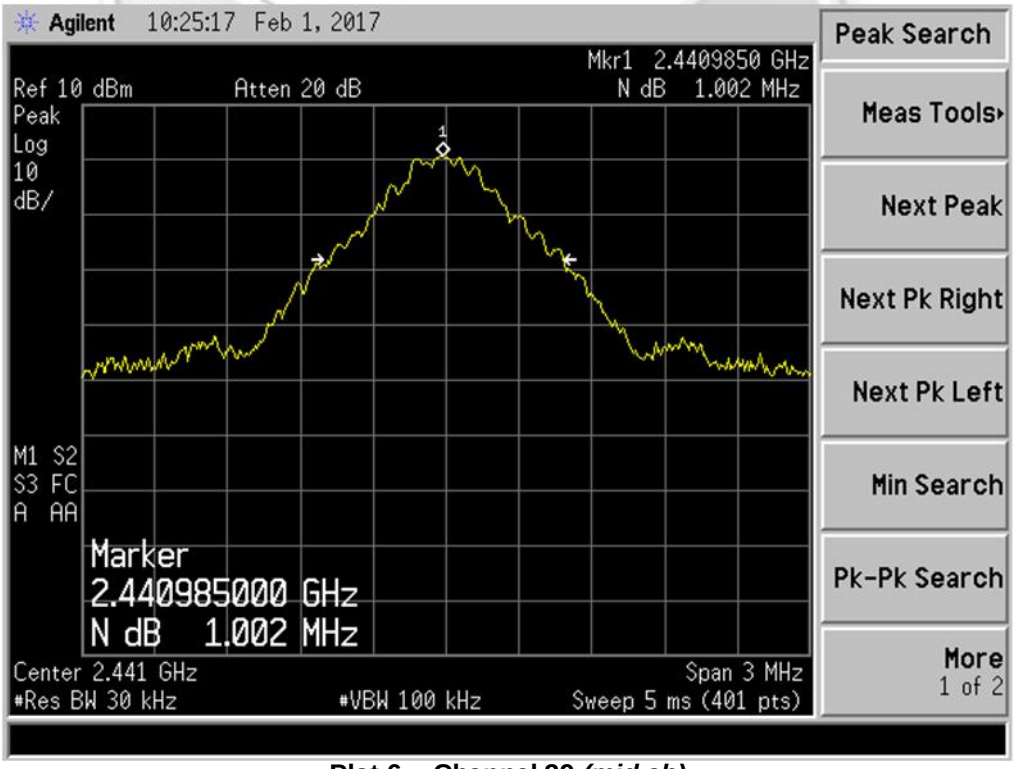
8DPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	1.339	1.199
39 *(mid ch)*	2.441	1.339	1.197
78 *(upper ch)*	2.480	1.347	1.198

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

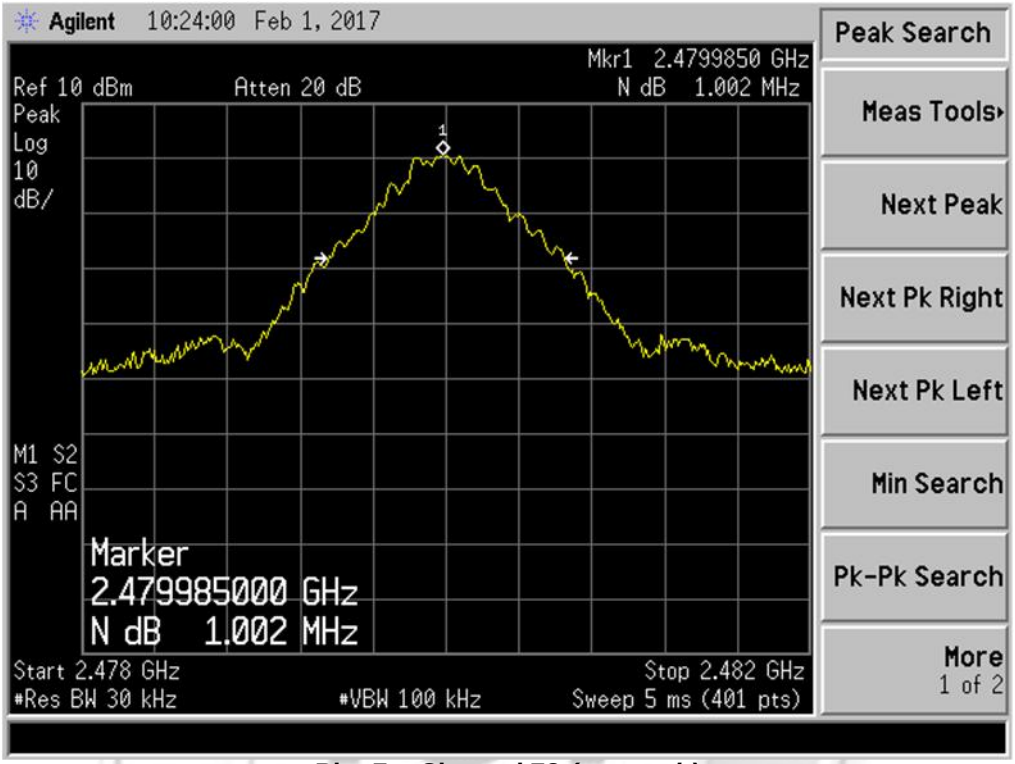


Plot 5 – Channel 0 *(lower ch)*



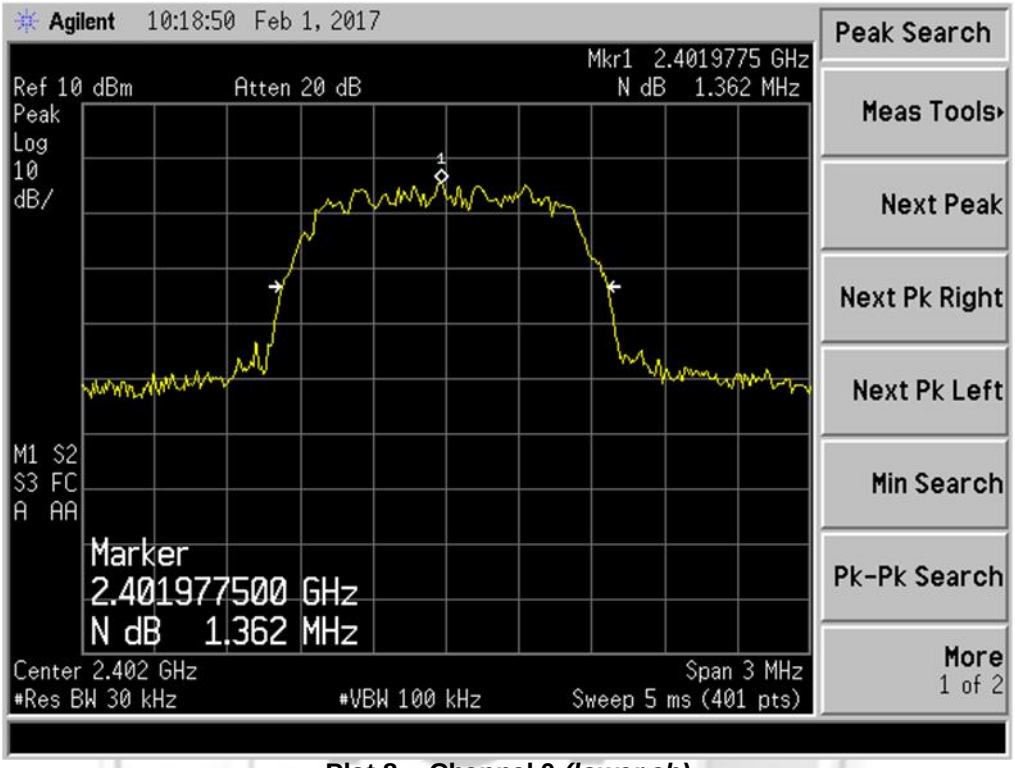
Plot 6 – Channel 39 *(mid ch)*

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

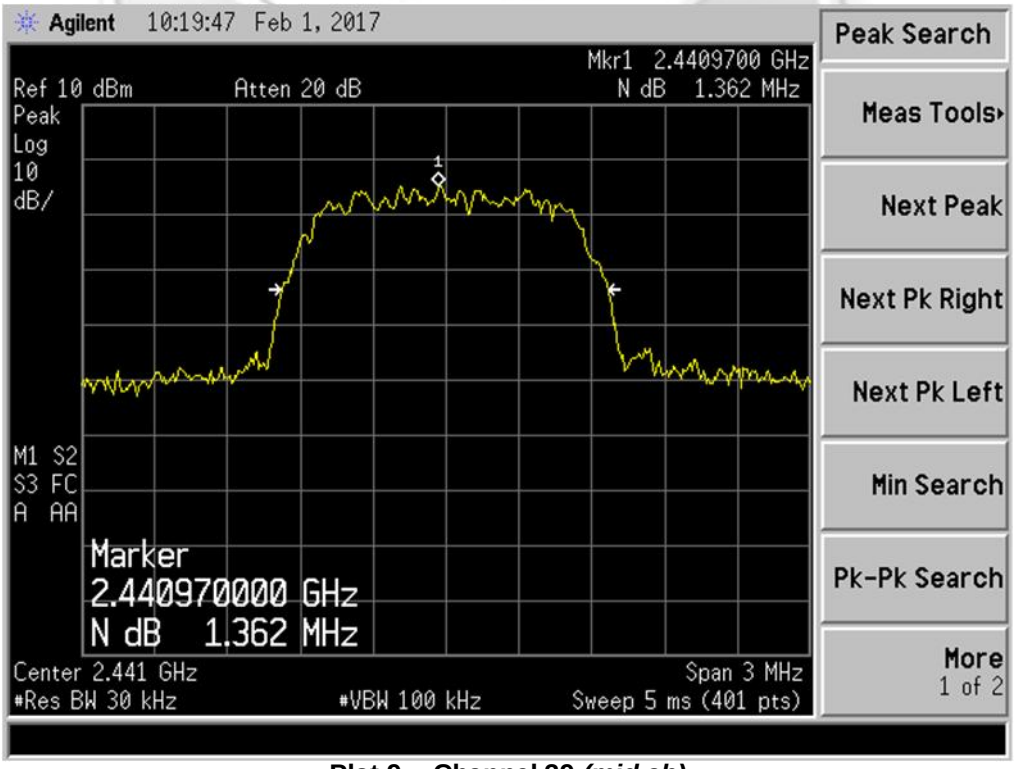


Plot 7 – Channel 78 *(upper ch)*

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

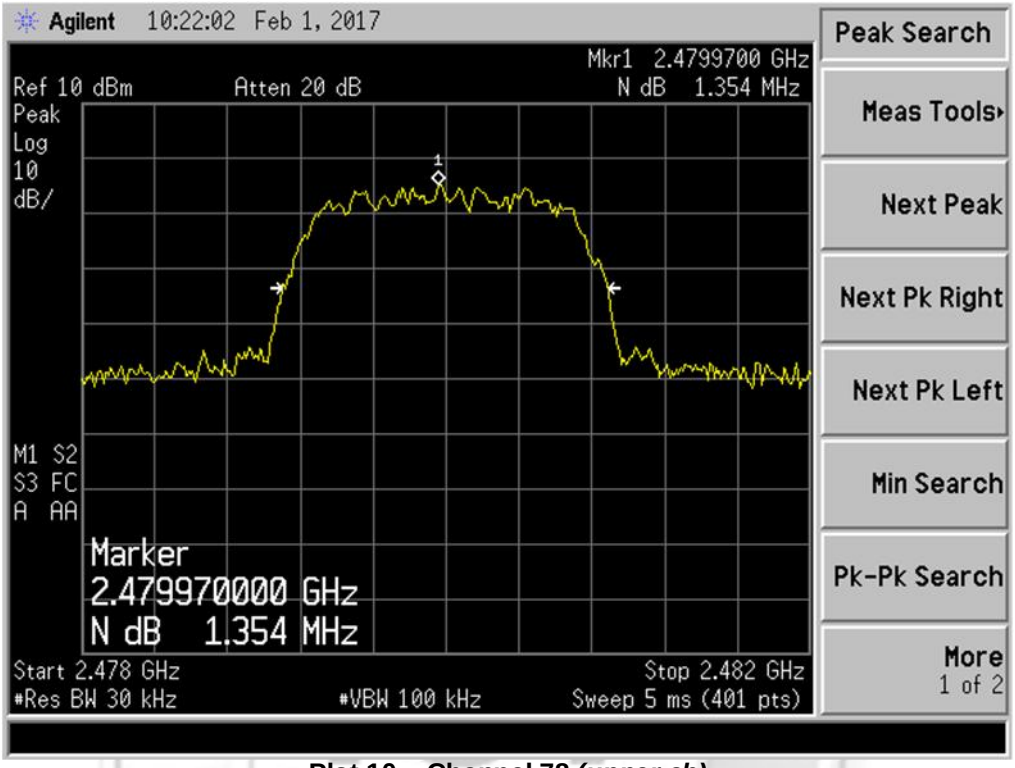


Plot 8 – Channel 0 *(lower ch)*



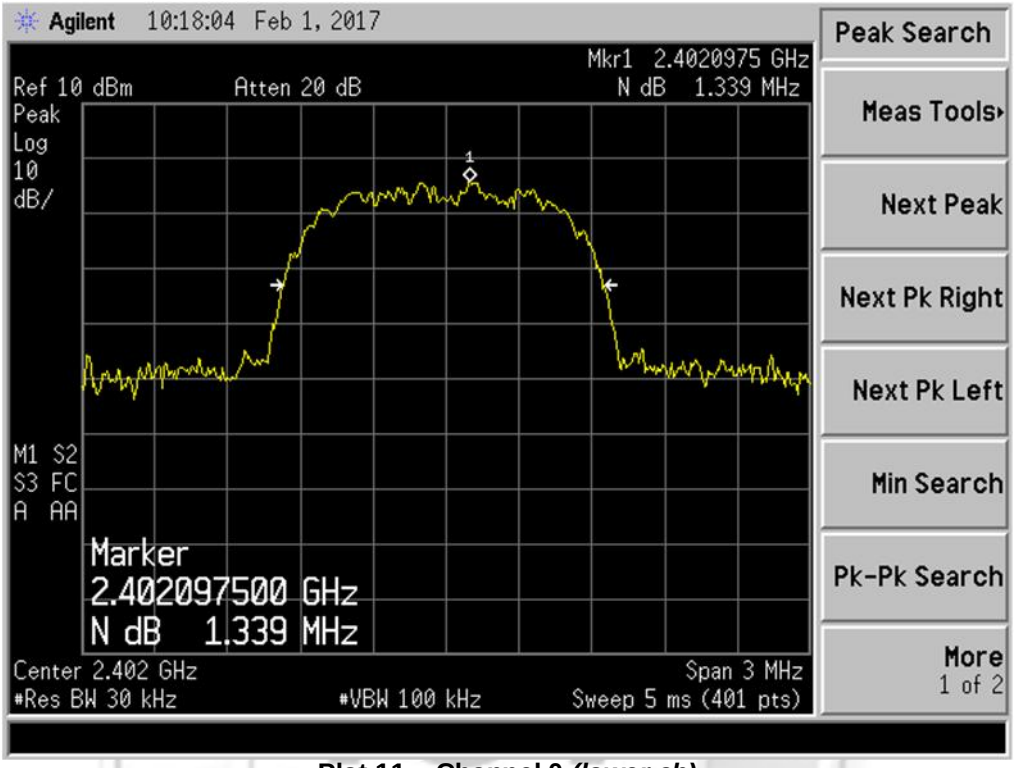
Plot 9 – Channel 39 *(mid ch)*

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

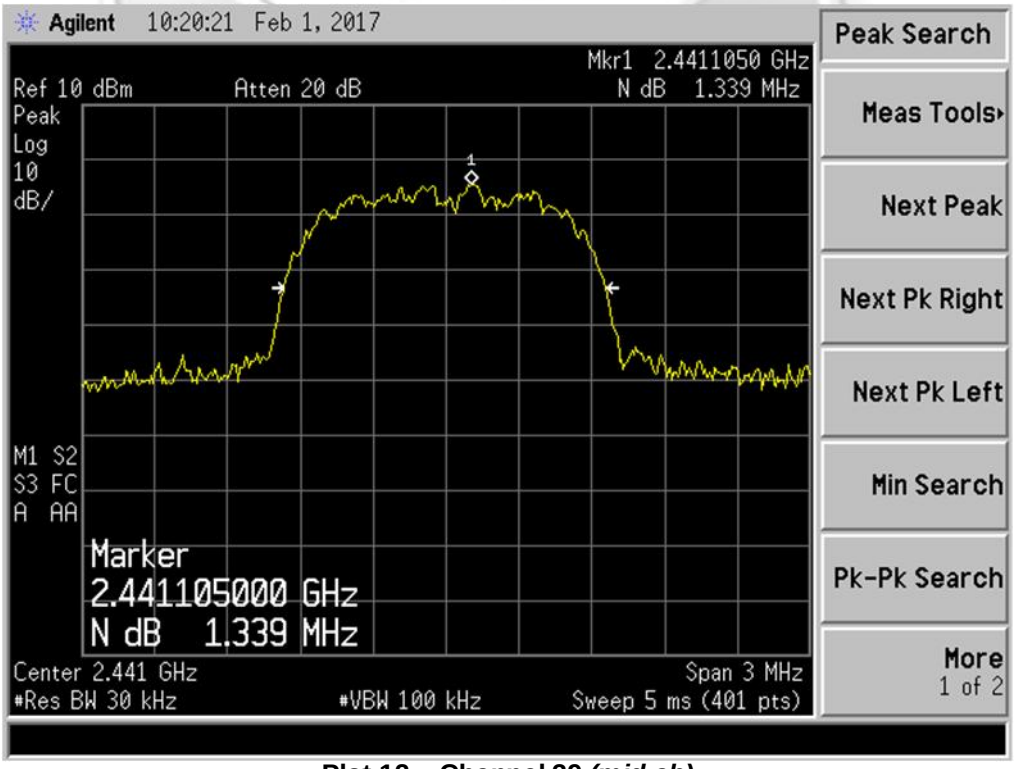


Plot 10 – Channel 78 *(upper ch)*

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

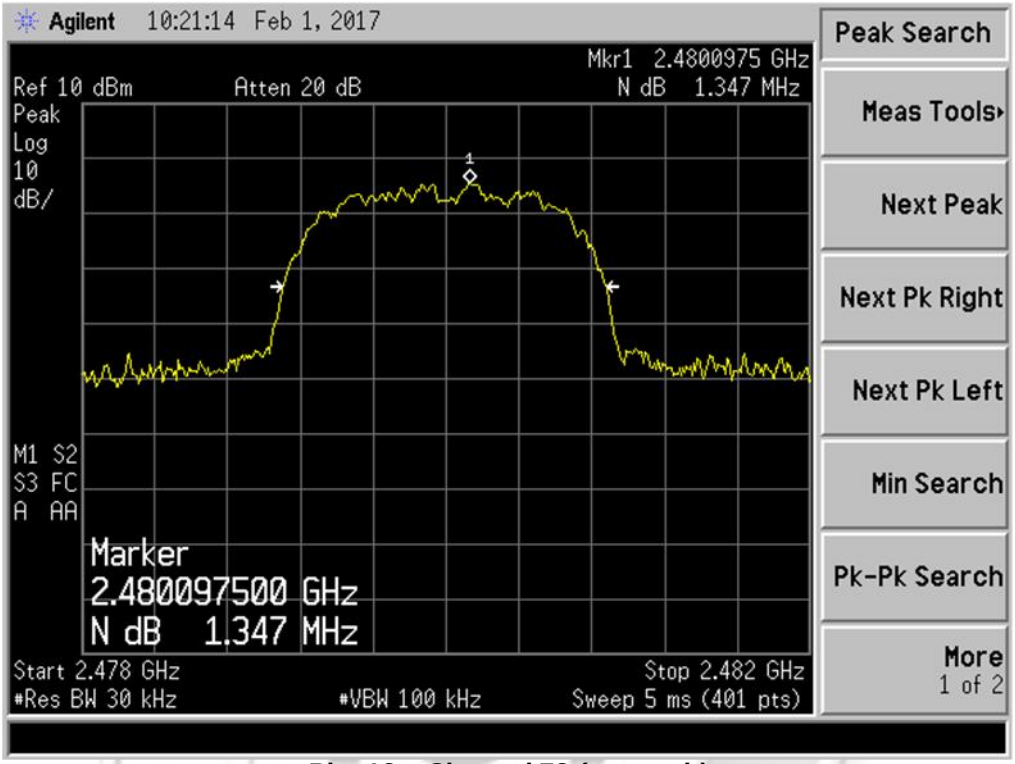


Plot 11 – Channel 0 *(lower ch)*



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	10 Dec 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.

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

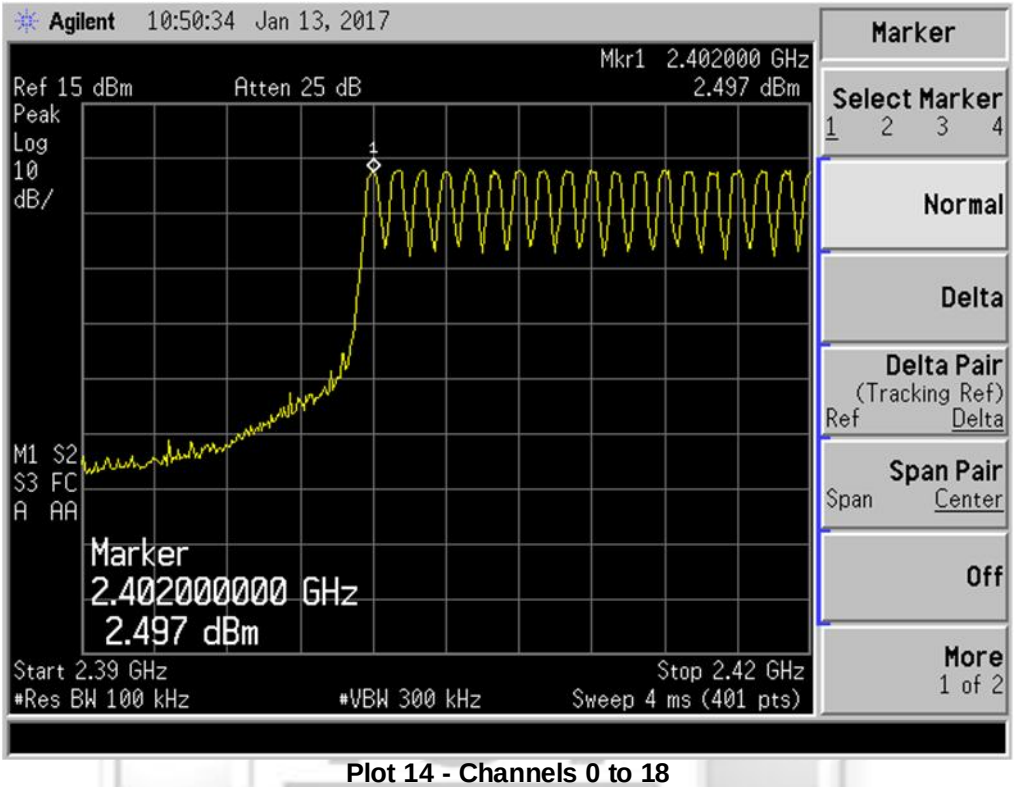
Test Input Power	5Vdc	Temperature	26ºC
Attached Plots	23 – 26	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

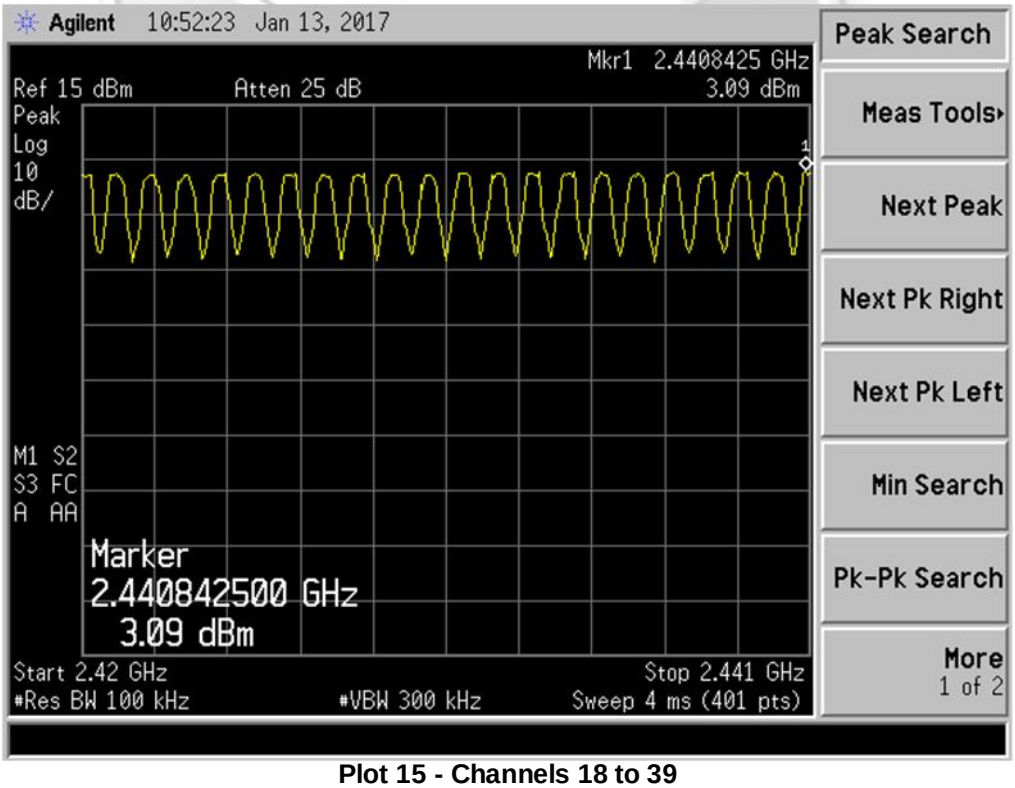
Test Input Power	5Vdc	Temperature	26ºC
Attached Plots	14 – 17	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

Number Of Hopping Frequencies Plots

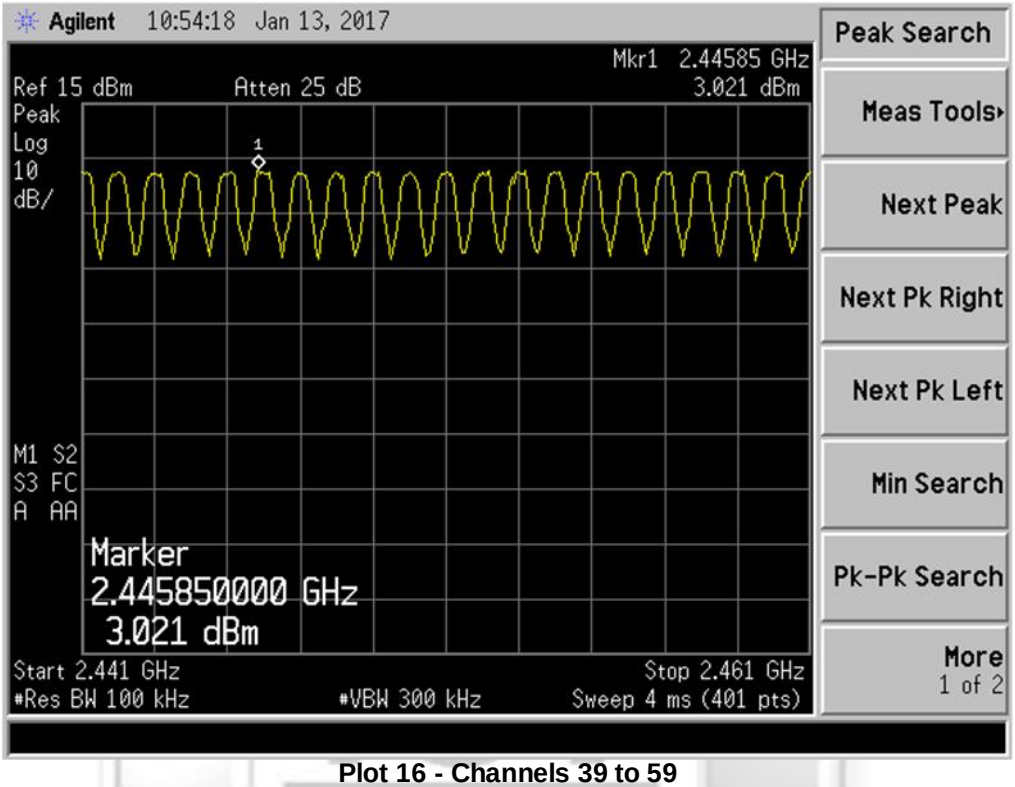


Plot 14 - Channels 0 to 18

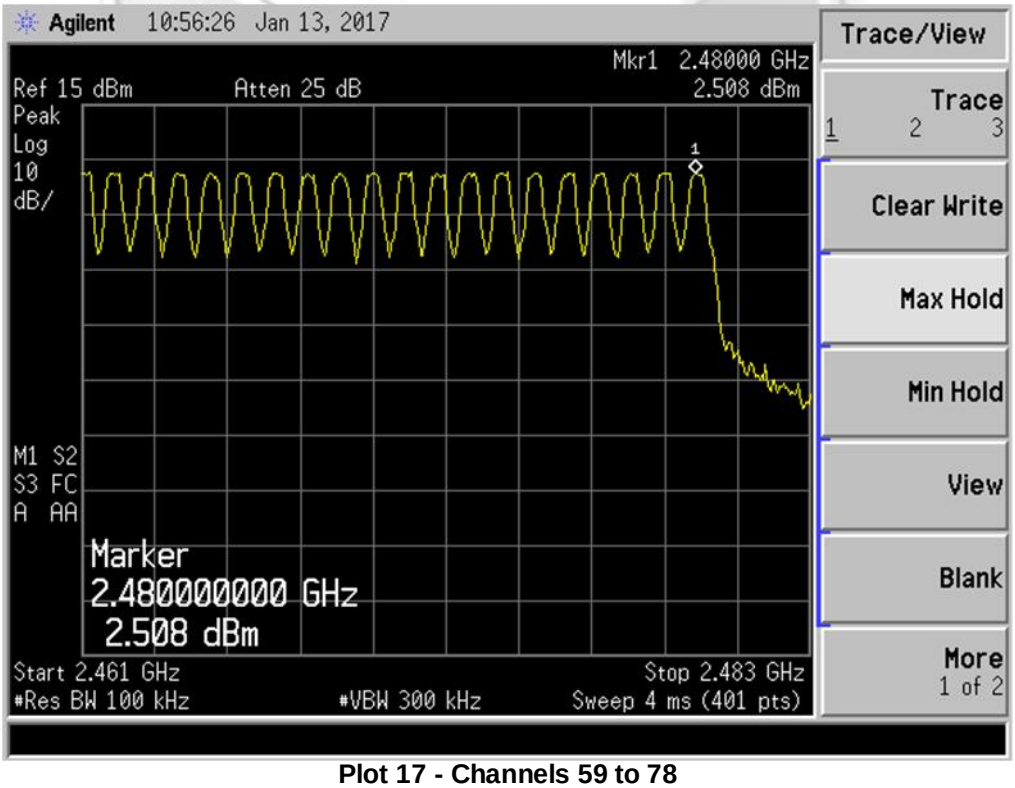


Plot 15 - Channels 18 to 39

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	10 Dec 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 = [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	26ºC
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

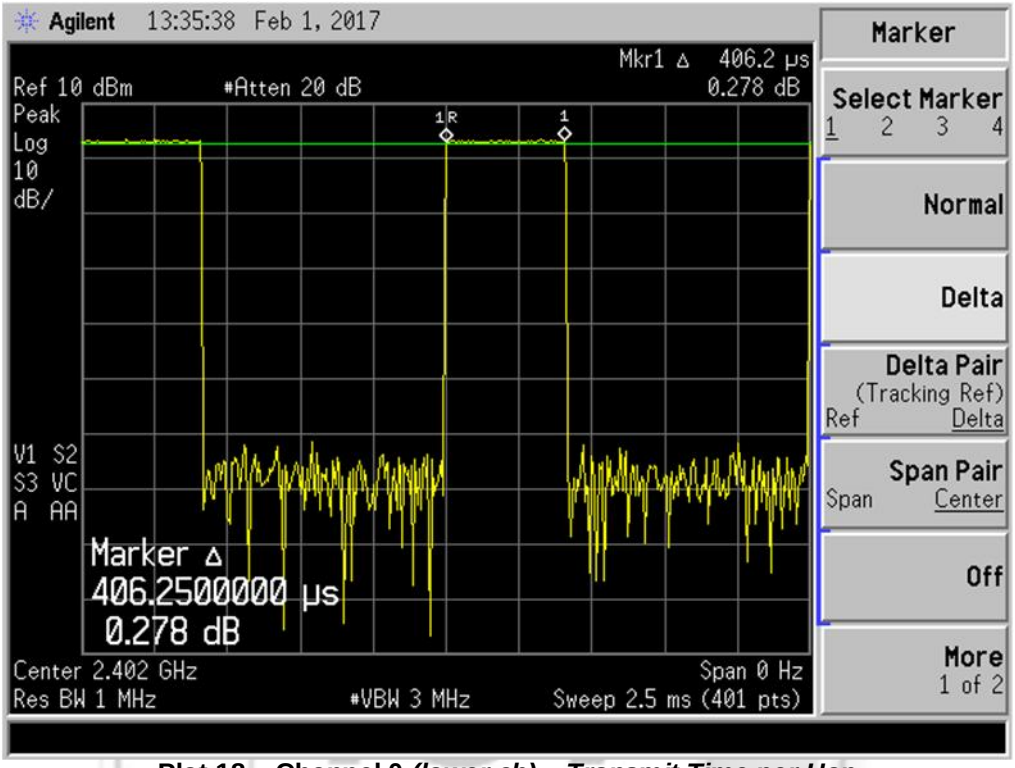
DH5

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

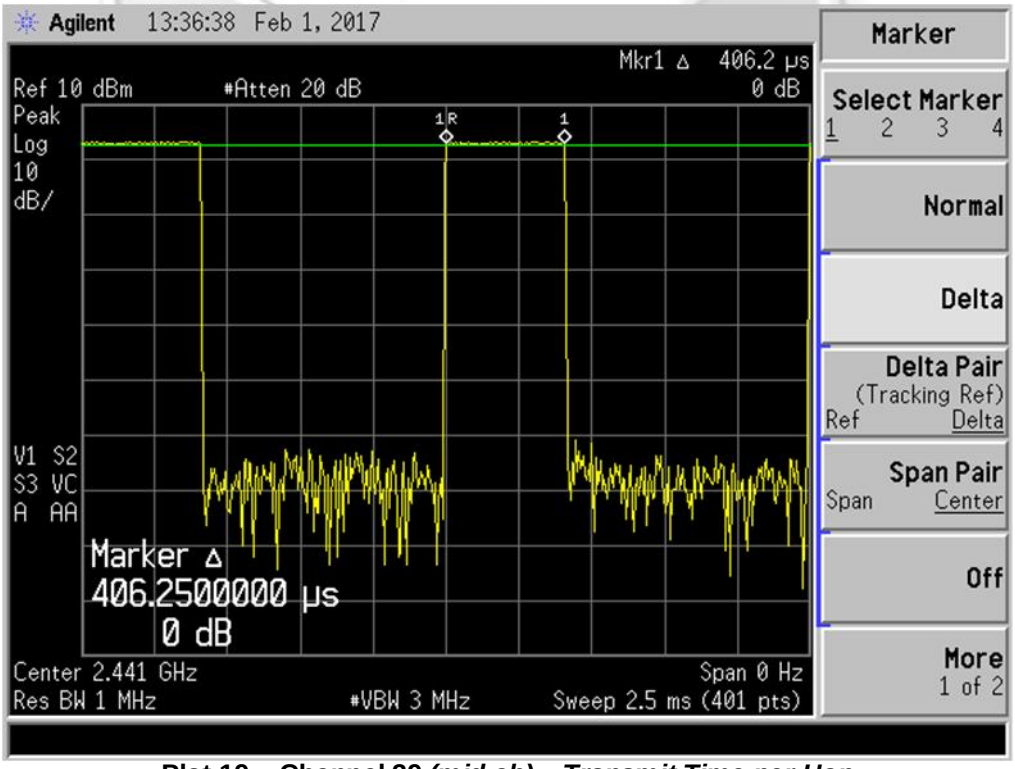
Notes

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 Plots – DH1

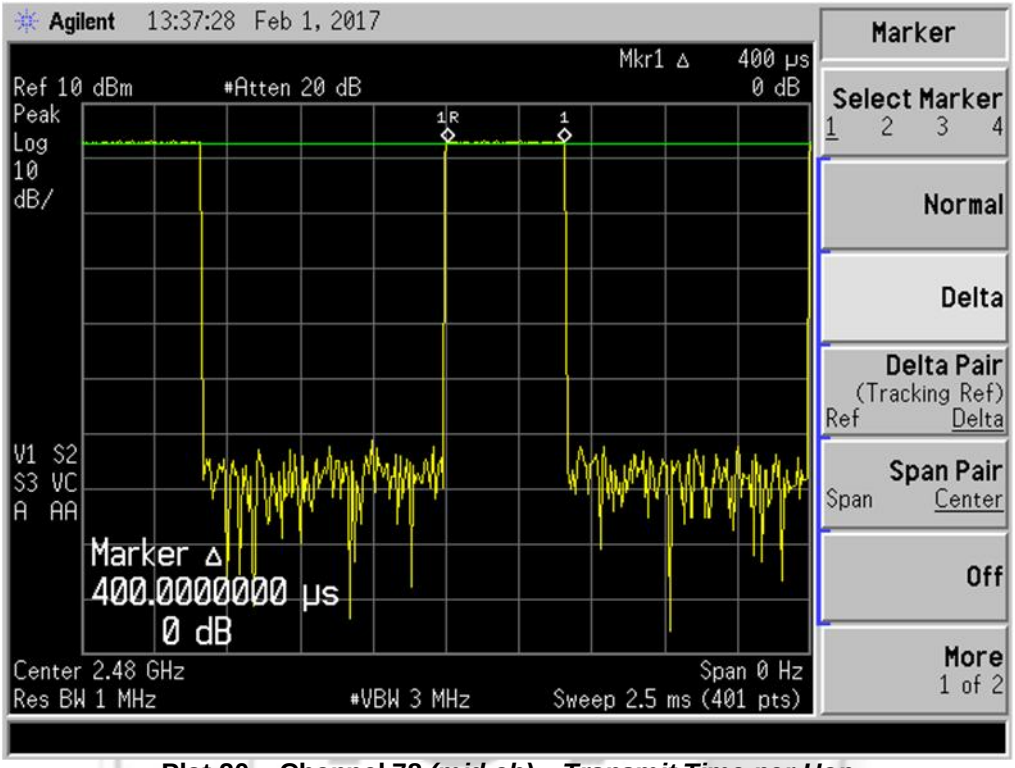


Plot 18 – Channel 0 *(lower ch) – Transmit Time per Hop*



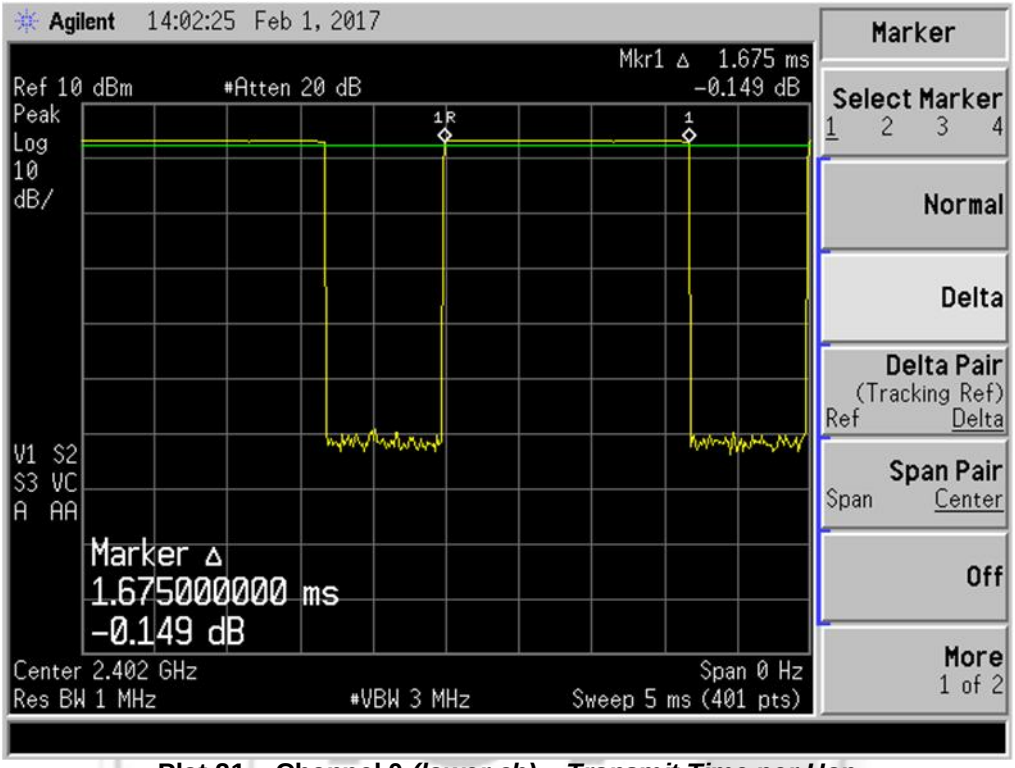
Plot 19 – Channel 39 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH1

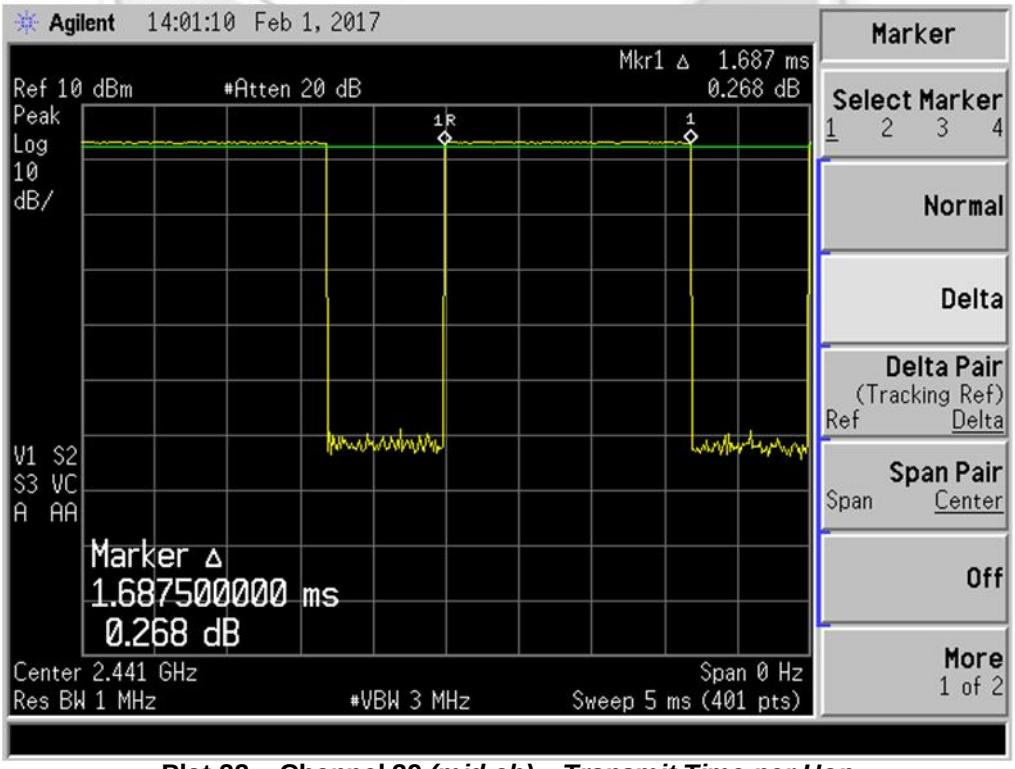


Plot 20 – Channel 78 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH3

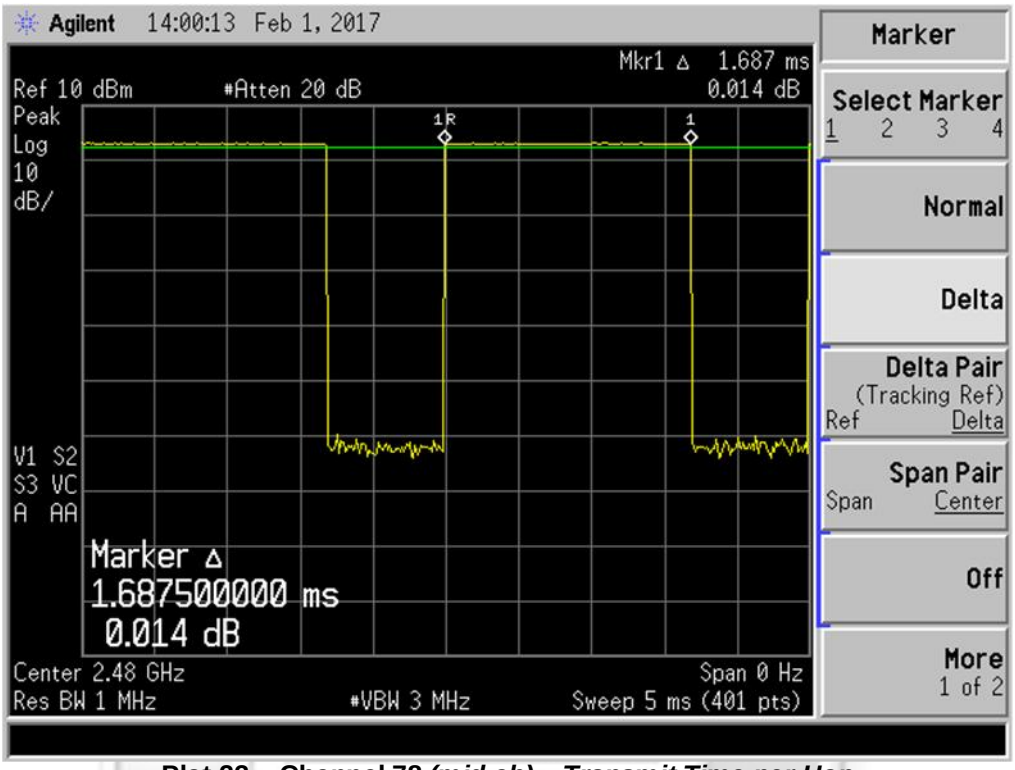


Plot 21 – Channel 0 *(lower ch) – Transmit Time per Hop*



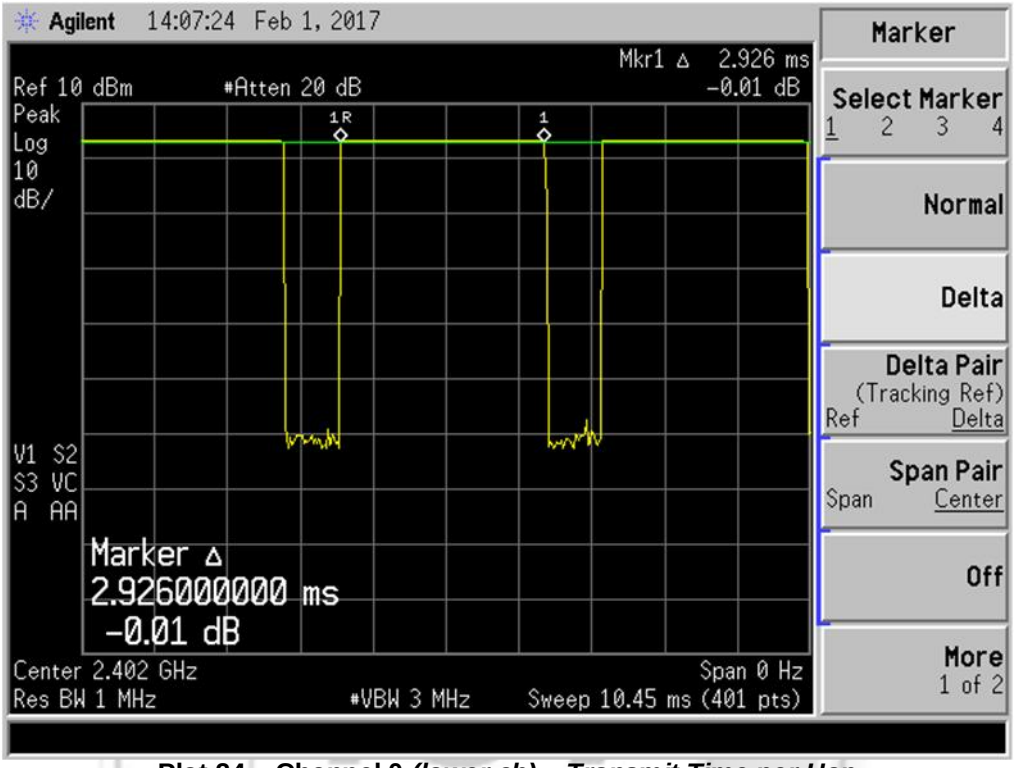
Plot 22 – Channel 39 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH3

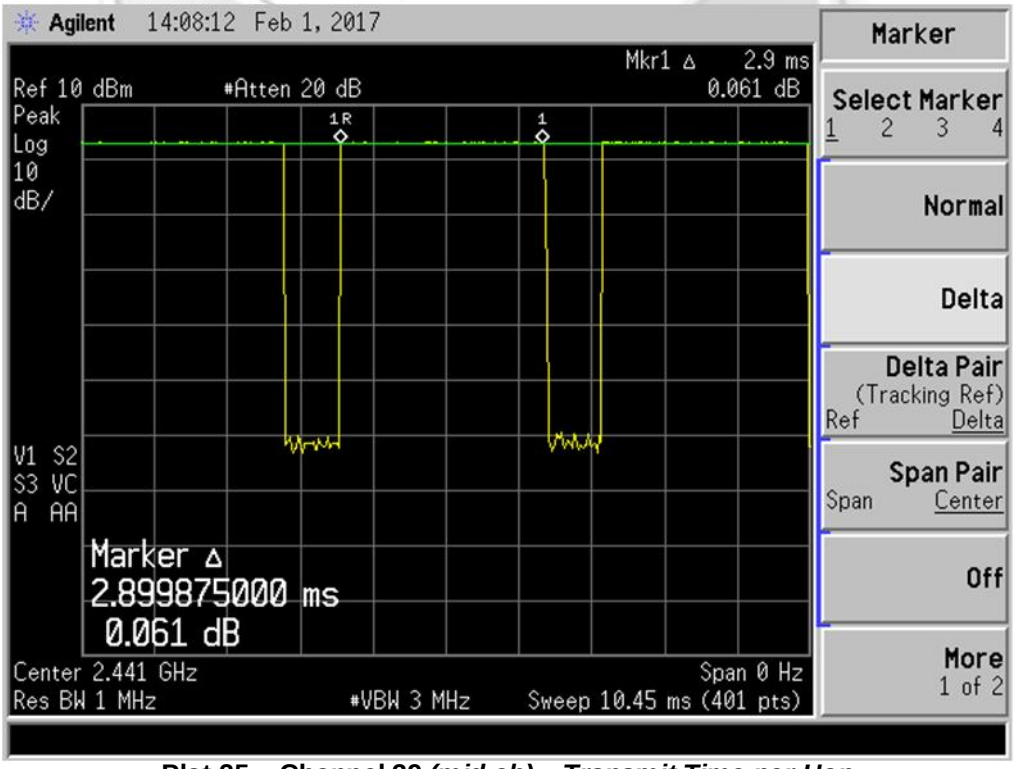


Plot 23 – Channel 78 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH5

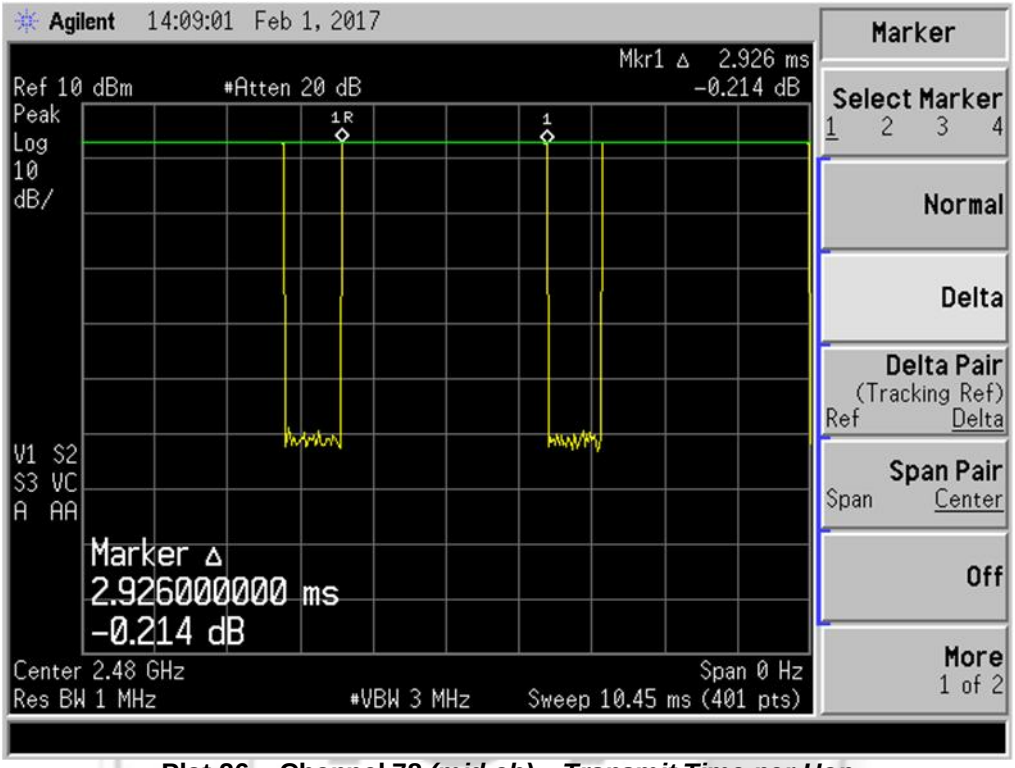


Plot 24 – Channel 0 *(lower ch) – Transmit Time per Hop*



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

Average Frequency Dwell Time Plots – DH5



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

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	14 Aug 2017
Agilent Power Sensor	E9304A	MY41496637	28 May 2017
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.

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

Test Input Power	5Vdc	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 *(lower ch)*	2.402	0.00134	1.0
39 *(mid ch)*	2.441	0.00133	1.0
78 (upper ch)	2.480	0.00131	1.0

(π/4) DQPSK

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

8DPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0 *(lower ch)*	2.402	0.00087	1.0
39 *(mid ch)*	2.441	0.00086	1.0
78 (upper ch)	2.480	0.00085	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	10 Dec 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

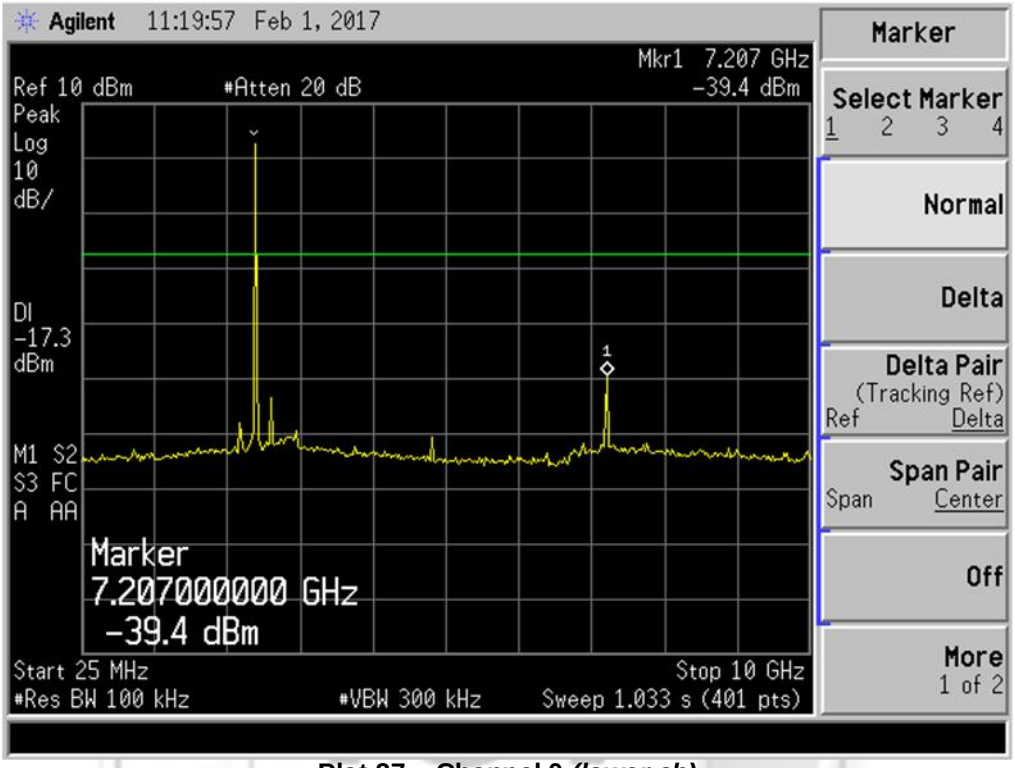
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and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

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

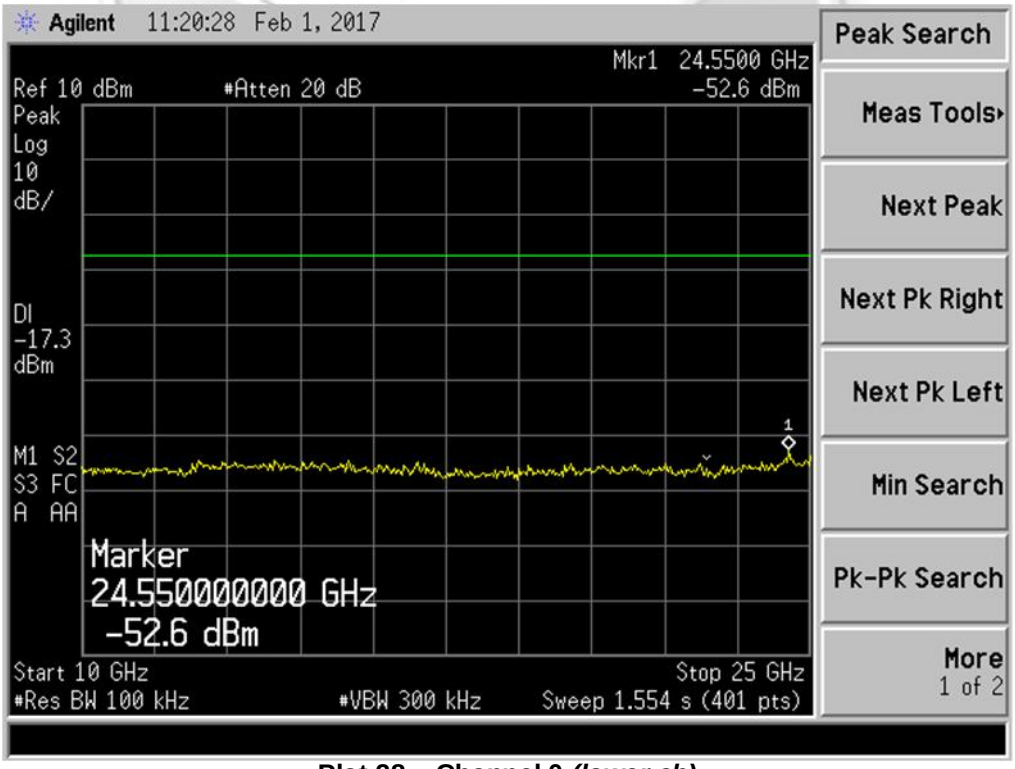
Test Input Power	5Vdc	Temperature	26°C
Attached Plots	27 – 32 (GFSK)	Relative Humidity	60%
	33 – 38 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	39 – 44 (8DPSK)	Tested By	Chang Wai Kit

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

RF Conducted Spurious Emissions Plots – GFSK

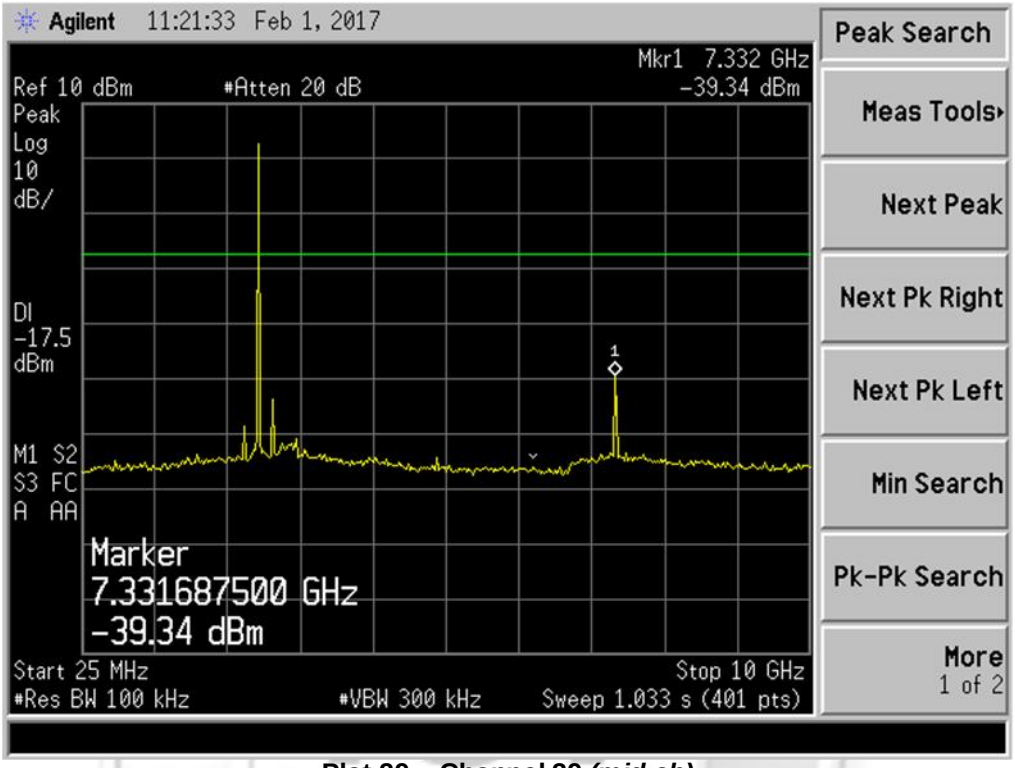


Plot 27 – Channel 0 *(lower ch)*

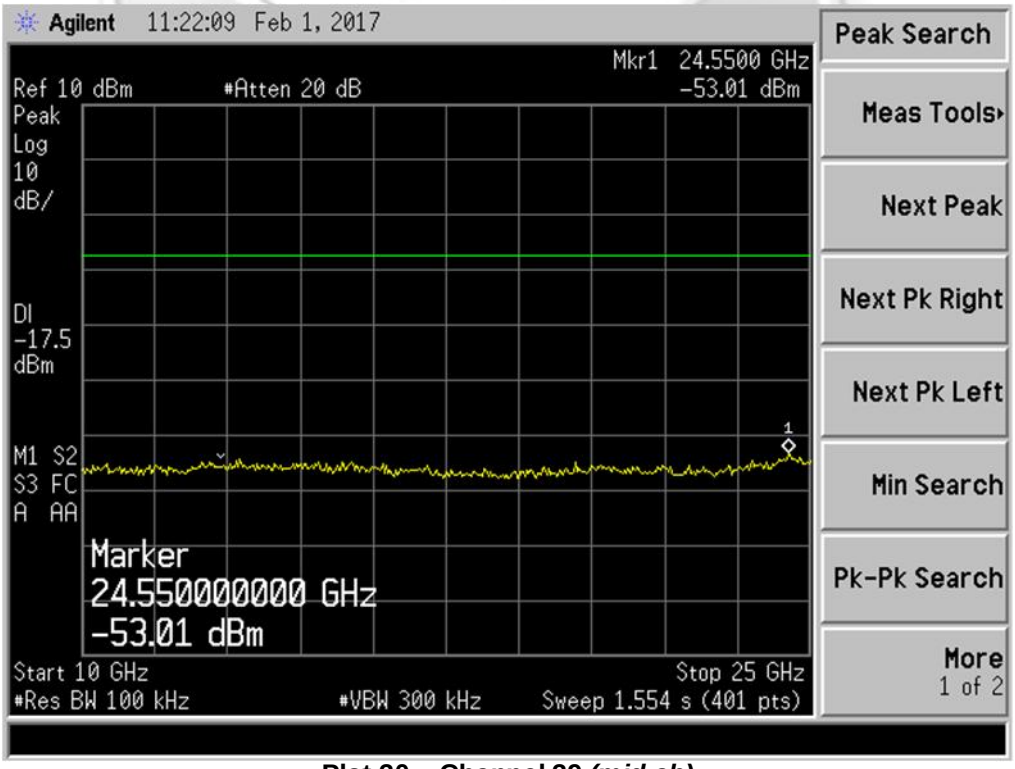


Plot 28 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – GFSK

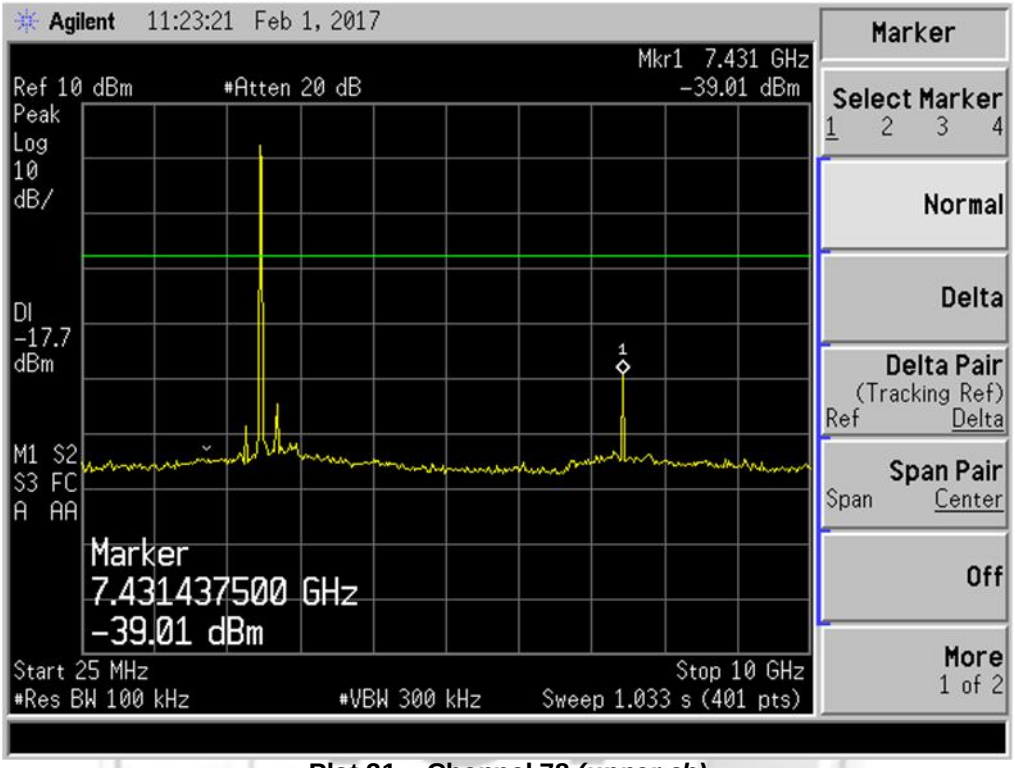


Plot 29 – Channel 39 *(mid ch)*

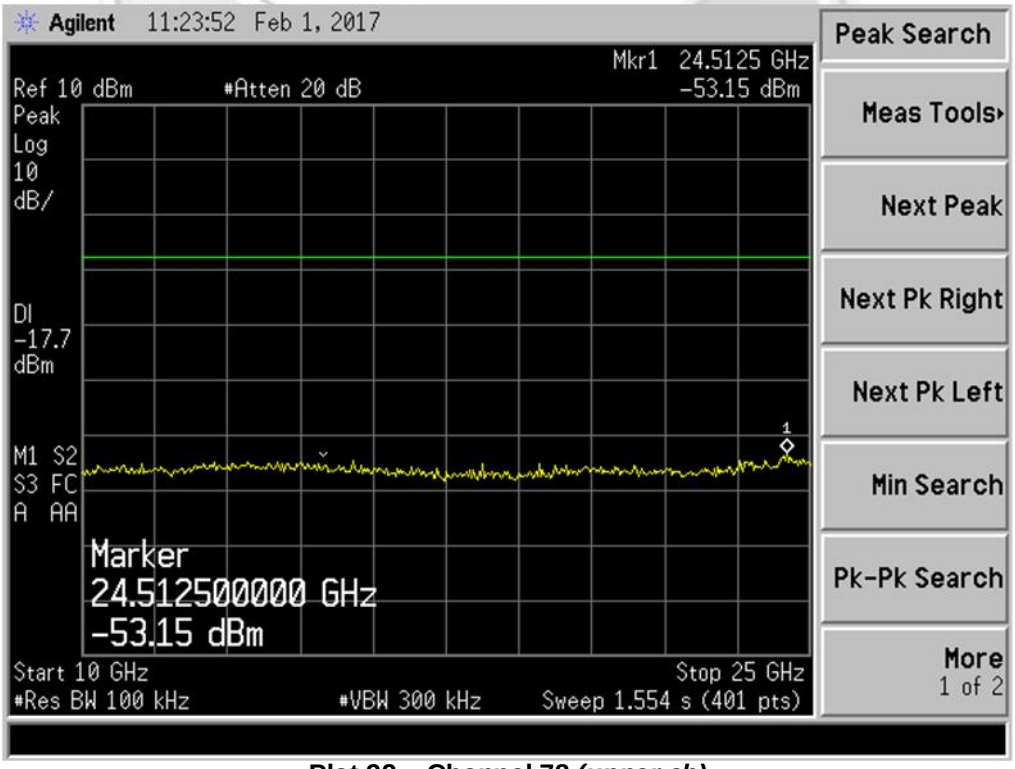


Plot 30 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – GFSK

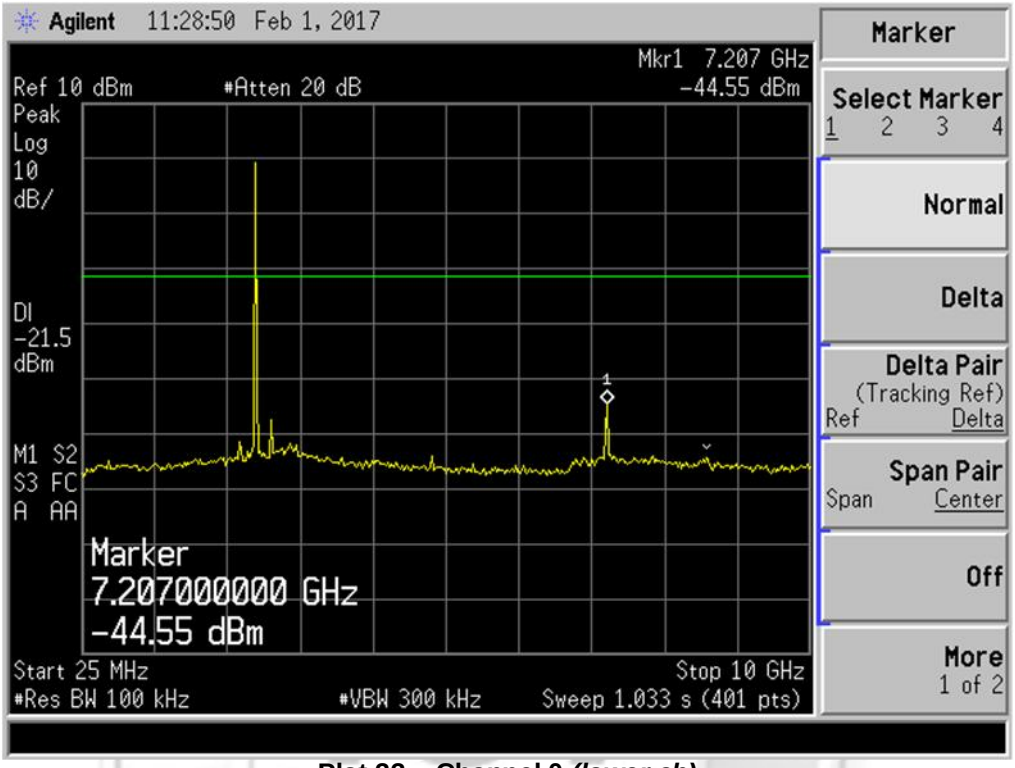


Plot 31 – Channel 78 *(upper ch)*

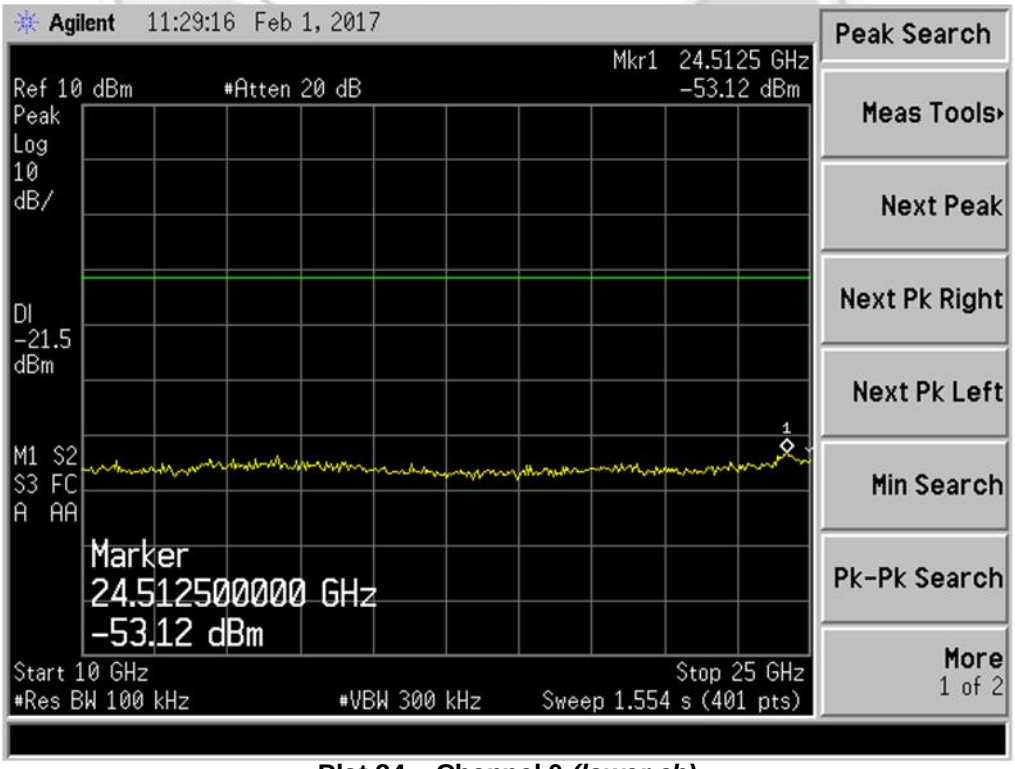


Plot 32 – Channel 78 *(upper ch)*

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

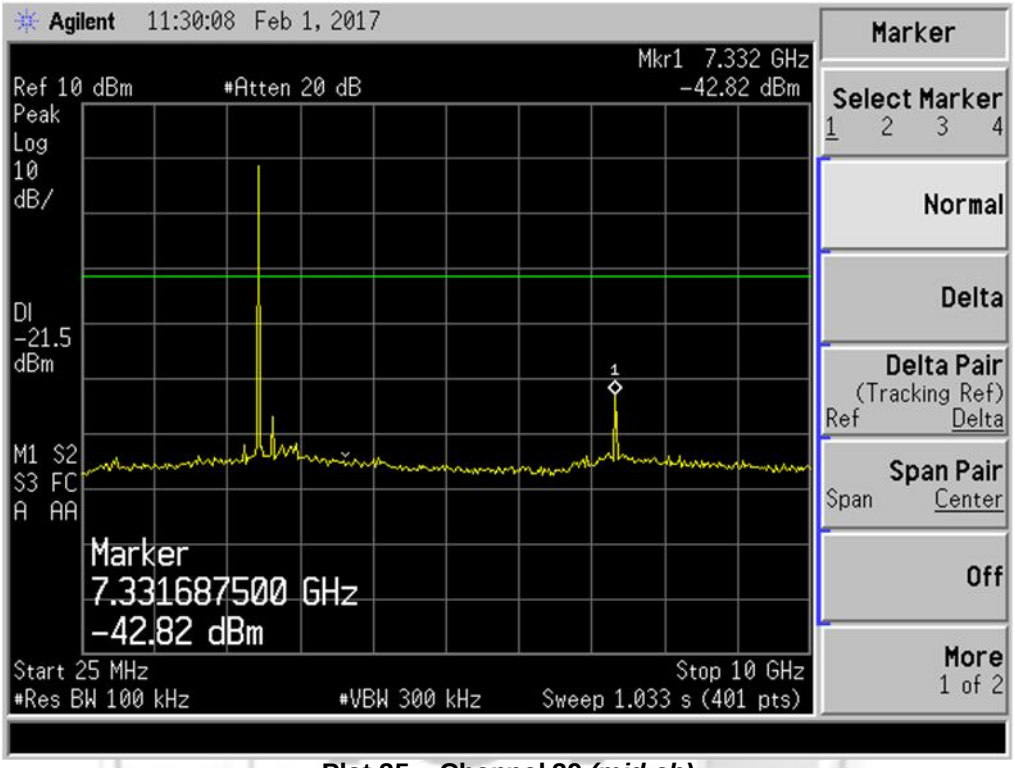


Plot 33 – Channel 0 *(lower ch)*

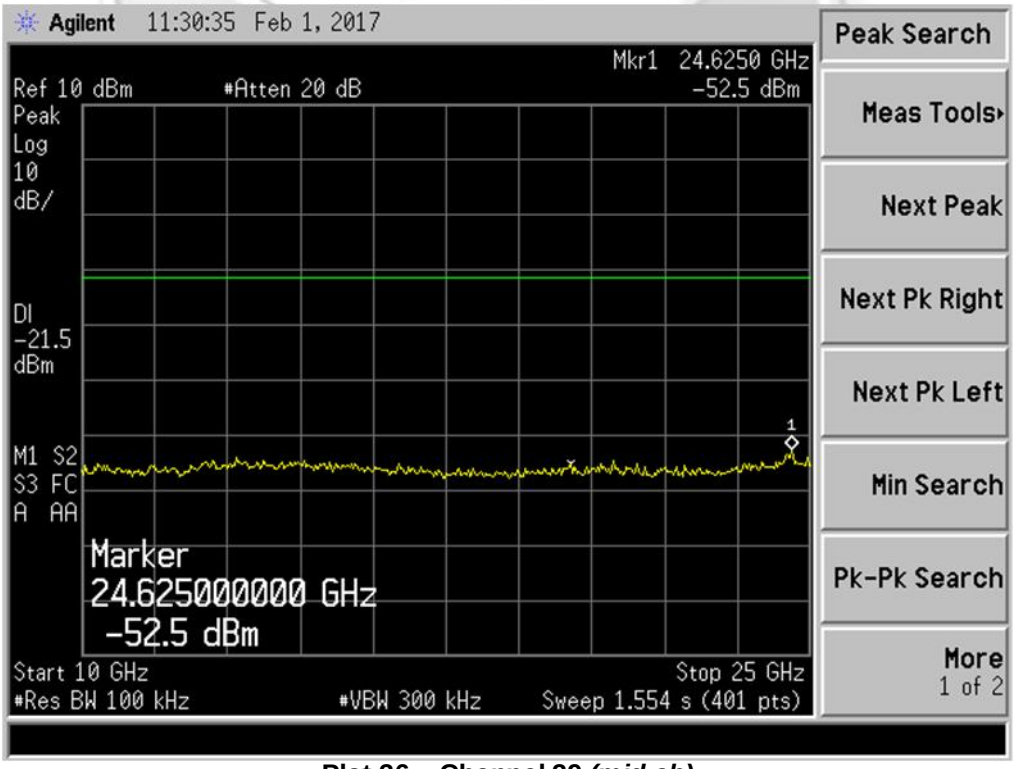


Plot 34 – Channel 0 *(lower ch)*

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

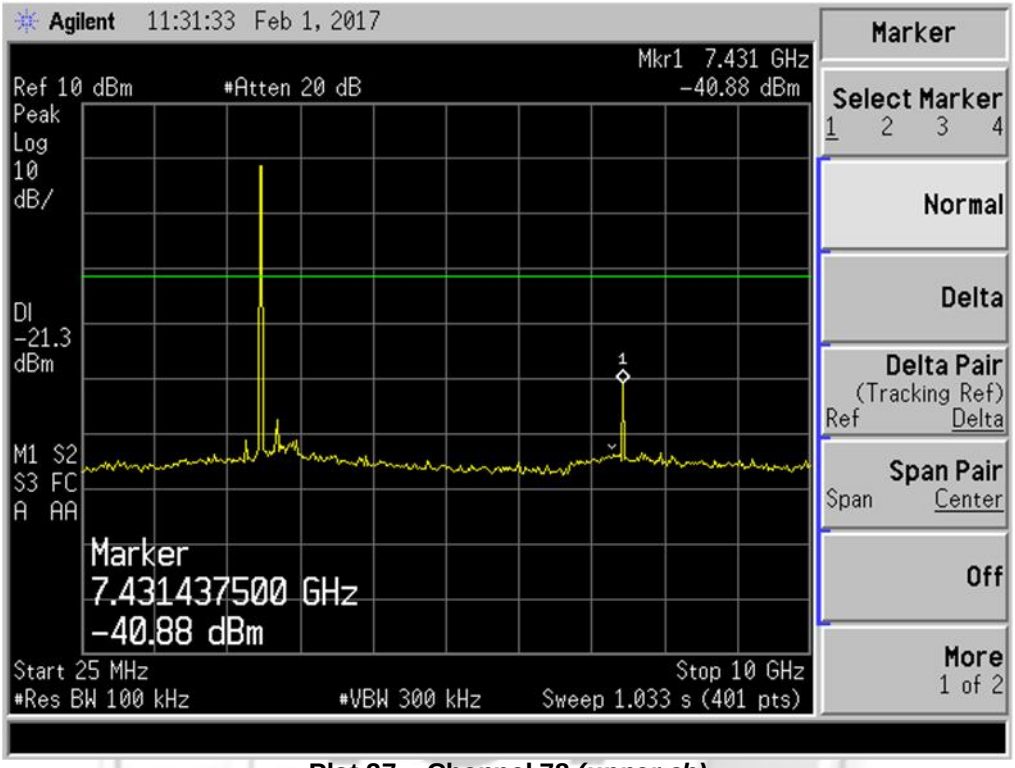


Plot 35 – Channel 39 *(mid ch)*

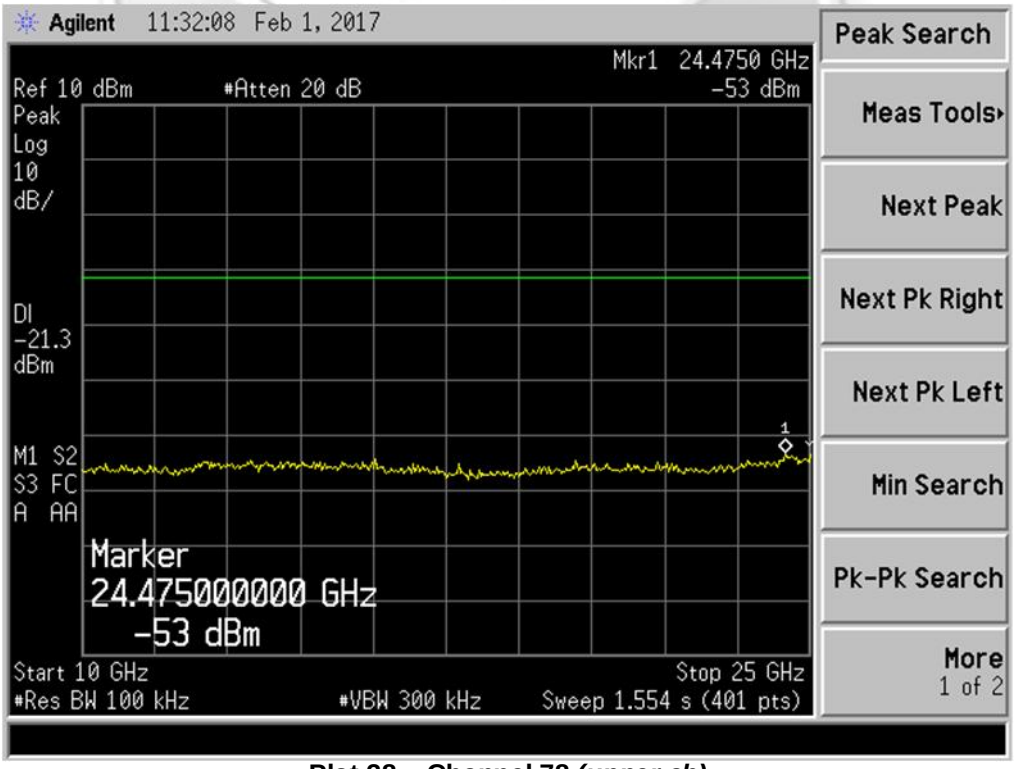


Plot 36 – Channel 39 *(mid ch)*

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

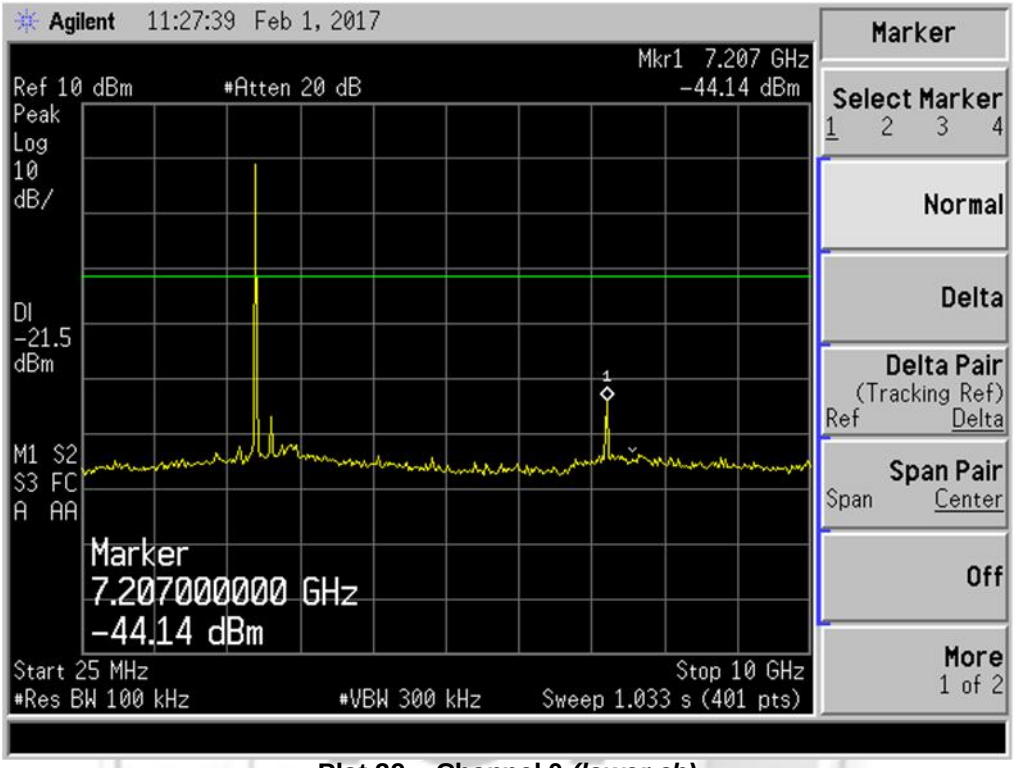


Plot 37 – Channel 78 *(upper ch)*

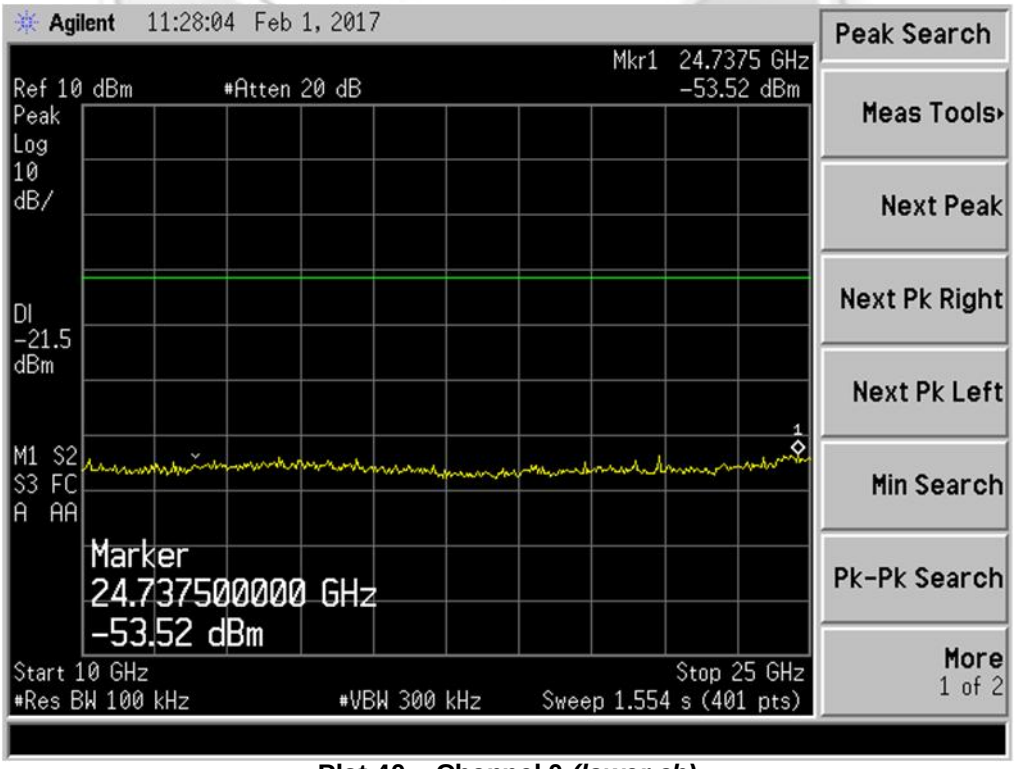


Plot 38 – Channel 78 *(upper ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

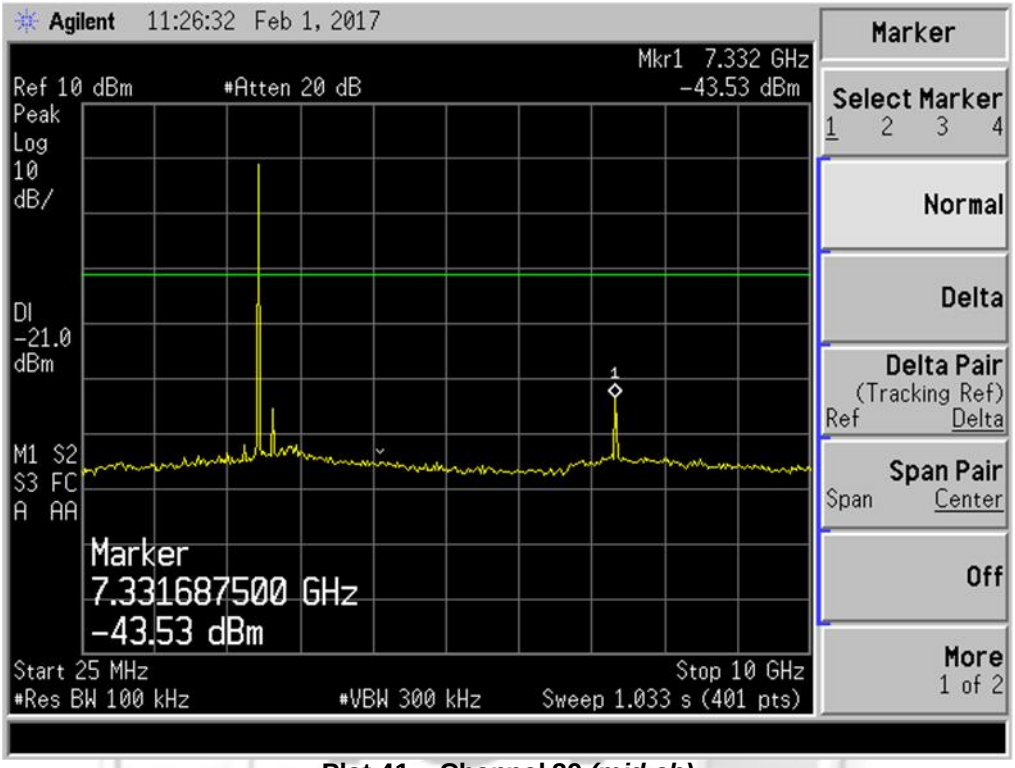


Plot 39 – Channel 0 *(lower ch)*

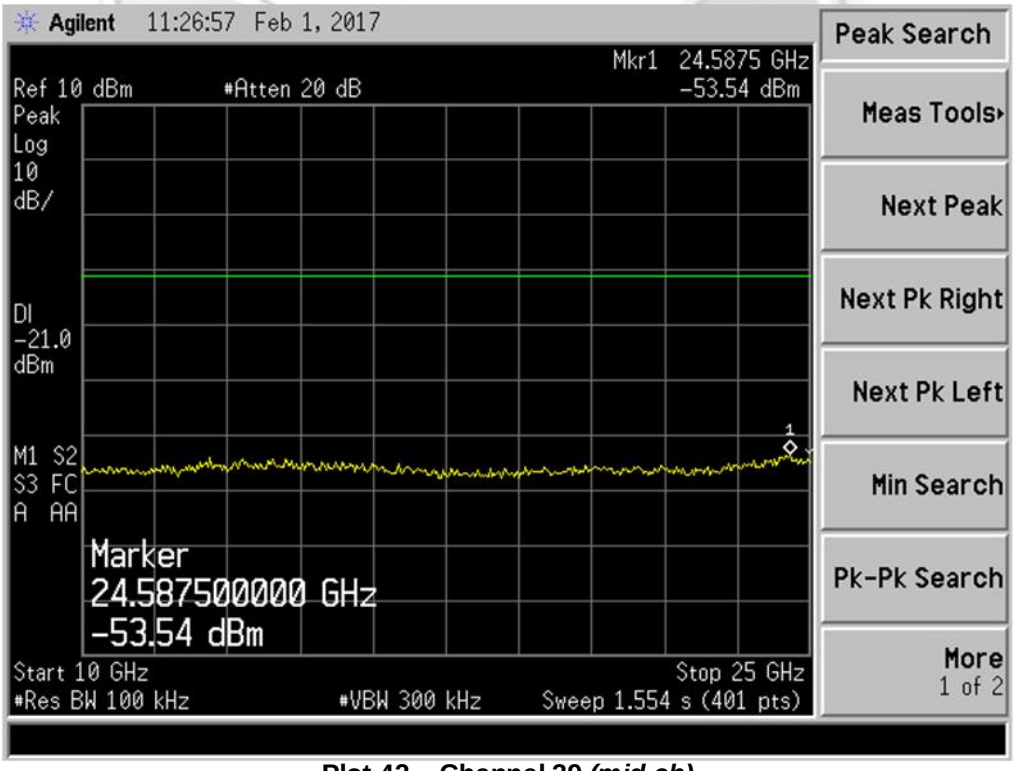


Plot 40 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

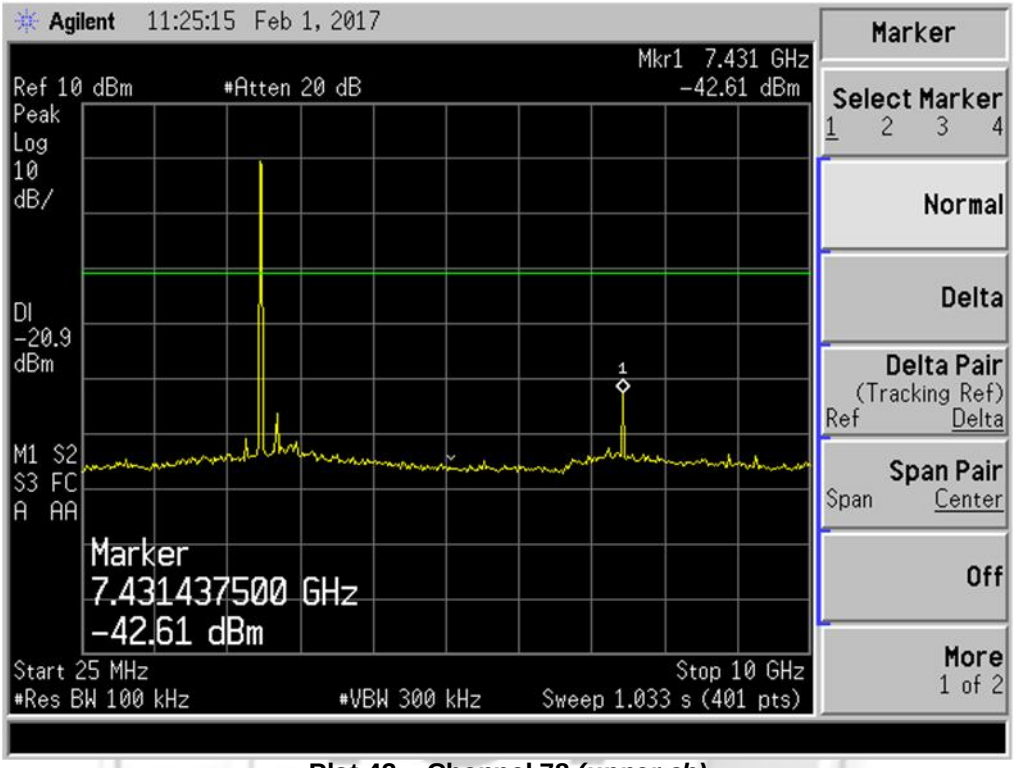


Plot 41 – Channel 39 *(mid ch)*

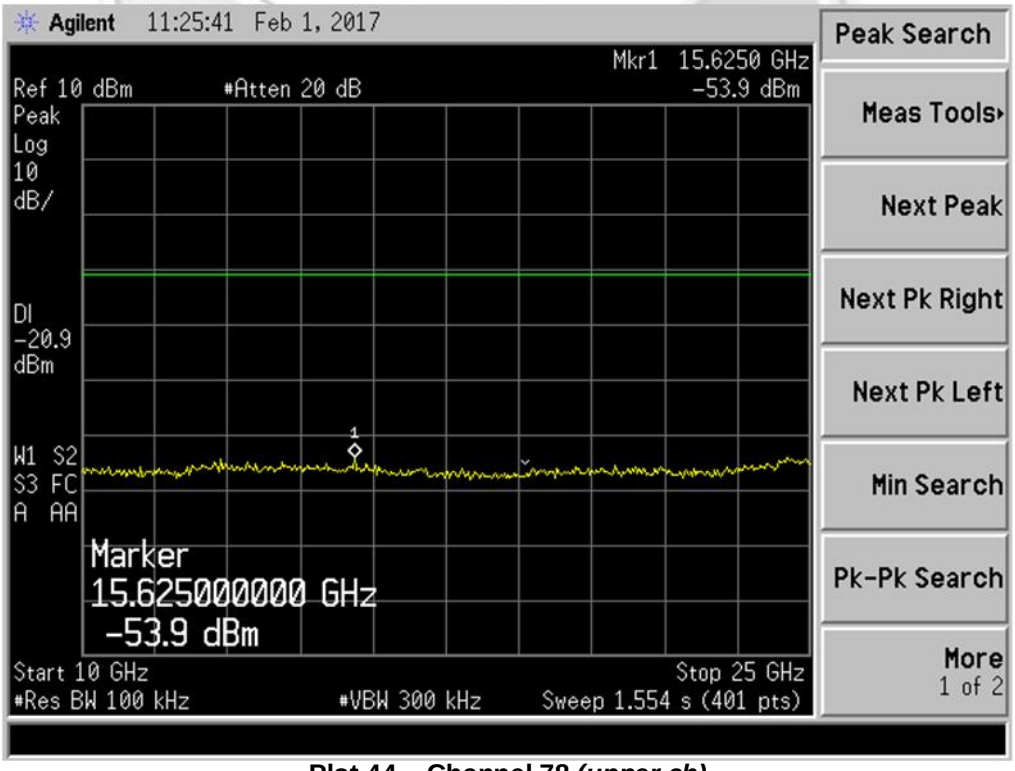


Plot 42 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – 8DPSK



Plot 43 – Channel 78 *(upper ch)*



Plot 44 – Channel 78 *(upper ch)*

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
Agilent Spectrum Analyzer	E4440A	MY45304764	10 Dec 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

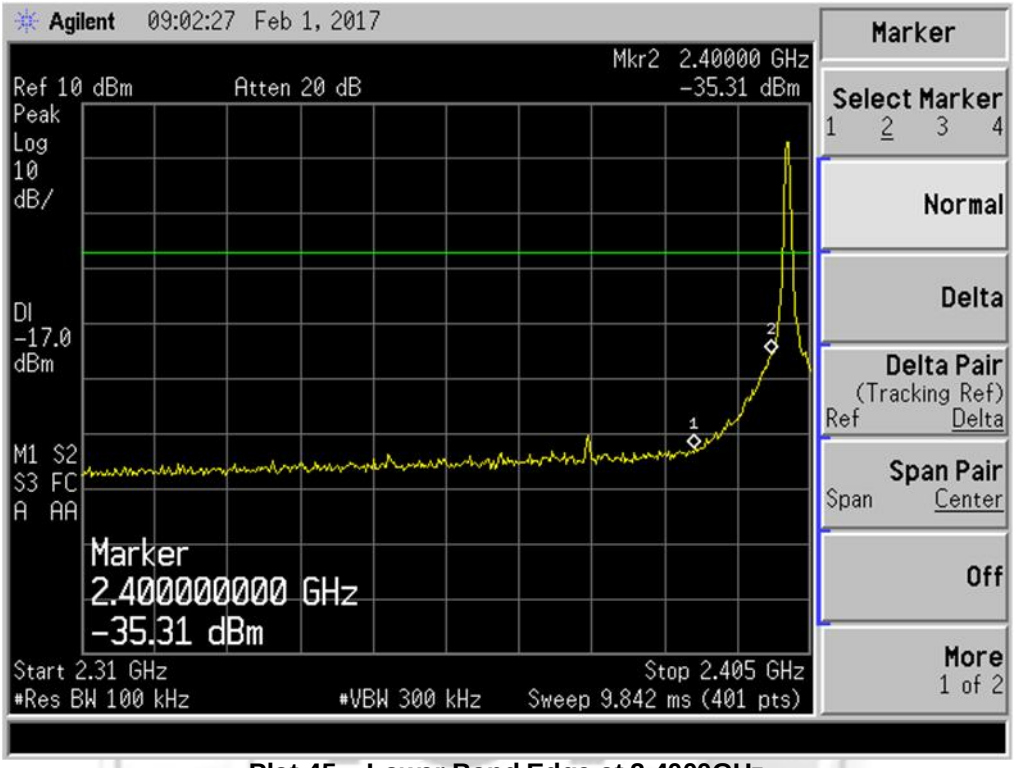
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band,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

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

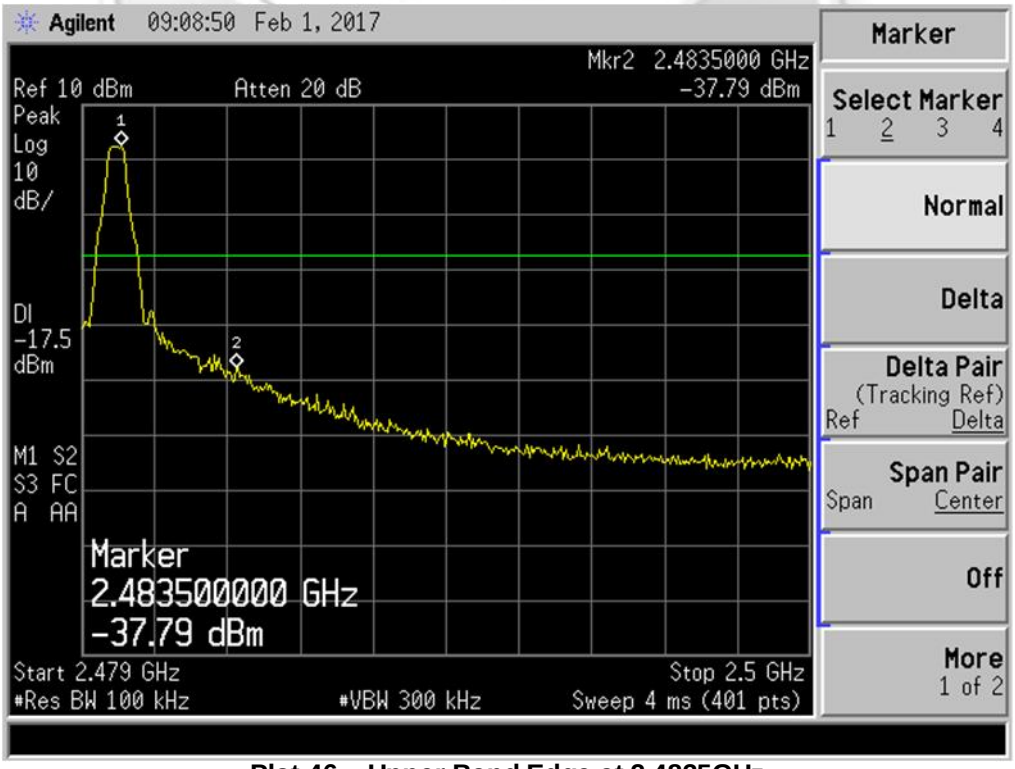
Test Input Power	5Vdc	Temperature	26°C
Attached Plots	45 – 46 (GFSK)	Relative Humidity	60%
	47 – 48 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	49 – 50 (8DPSK)	Tested By	Chang Wai Kit

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

Band Edge Compliance (Conducted) Plots – GFSK

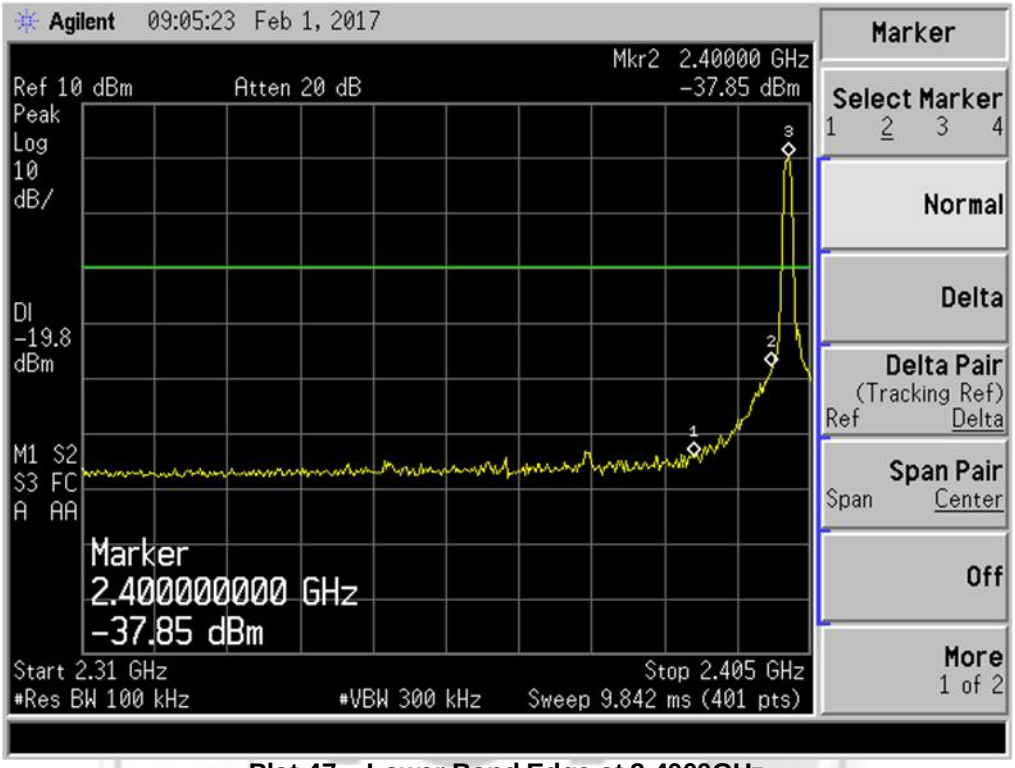


Plot 45 – Lower Band Edge at 2.4000GHz

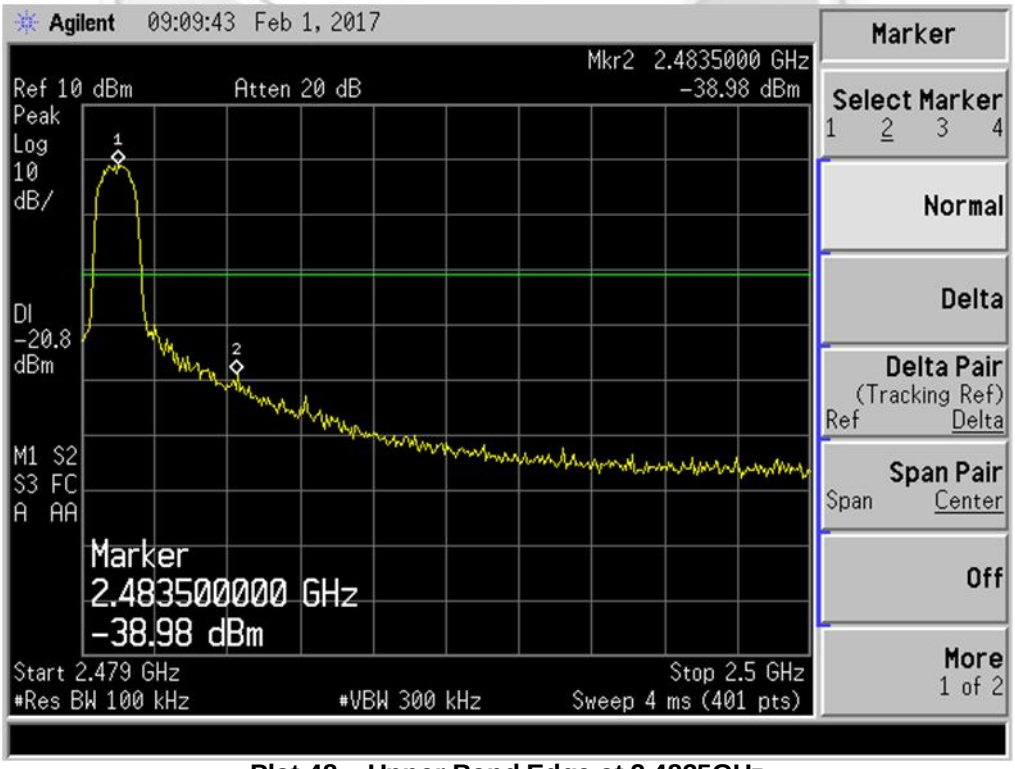


Plot 46 – Upper Band Edge at 2.4835GHz

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

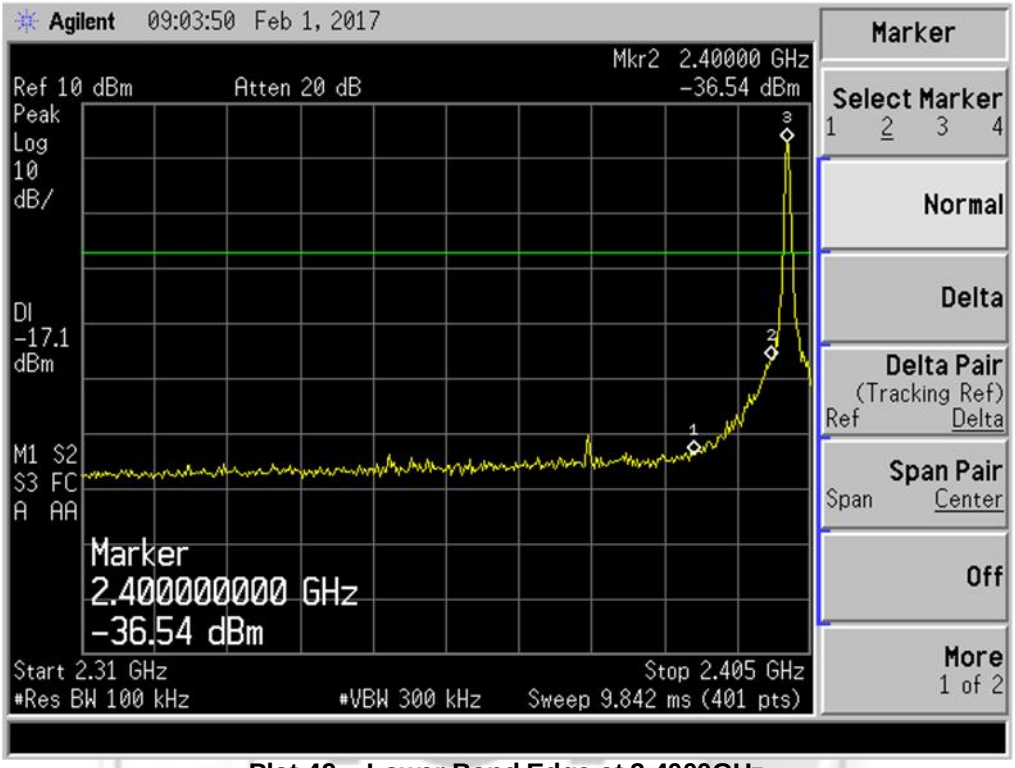


Plot 47 – Lower Band Edge at 2.4000GHz

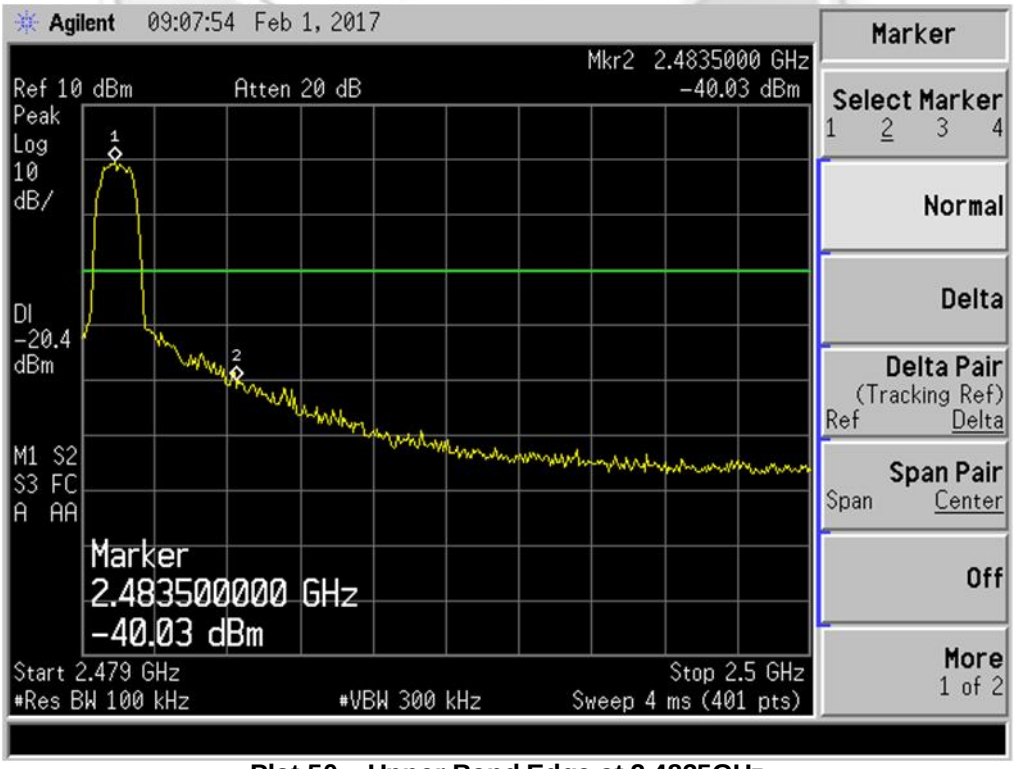


Plot 48 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – 8DPSK



Plot 49 – Lower Band Edge at 2.4000GHz



Plot 50 – Upper Band Edge at 2.4835GHz

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	20 Apr 2017
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	11 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

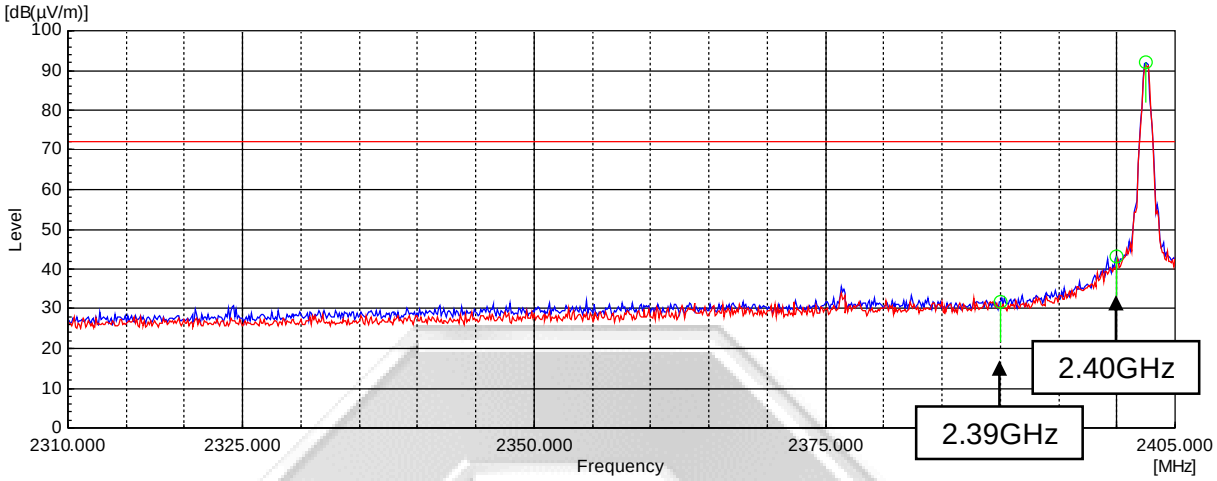
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band,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

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

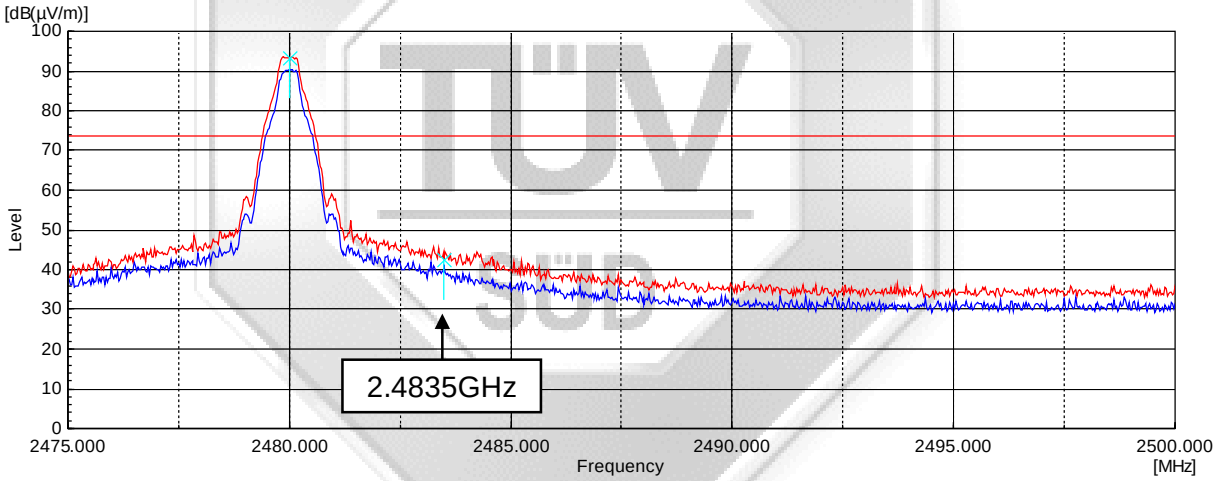
Test Input Power	120V 60Hz	Temperature	26ºC
Attached Plots	51 – 56 (GFSK)	Relative Humidity	60%
	57 – 62 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	63 – 68 (8DPSK)	Tested By	Chang Wai Kit

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

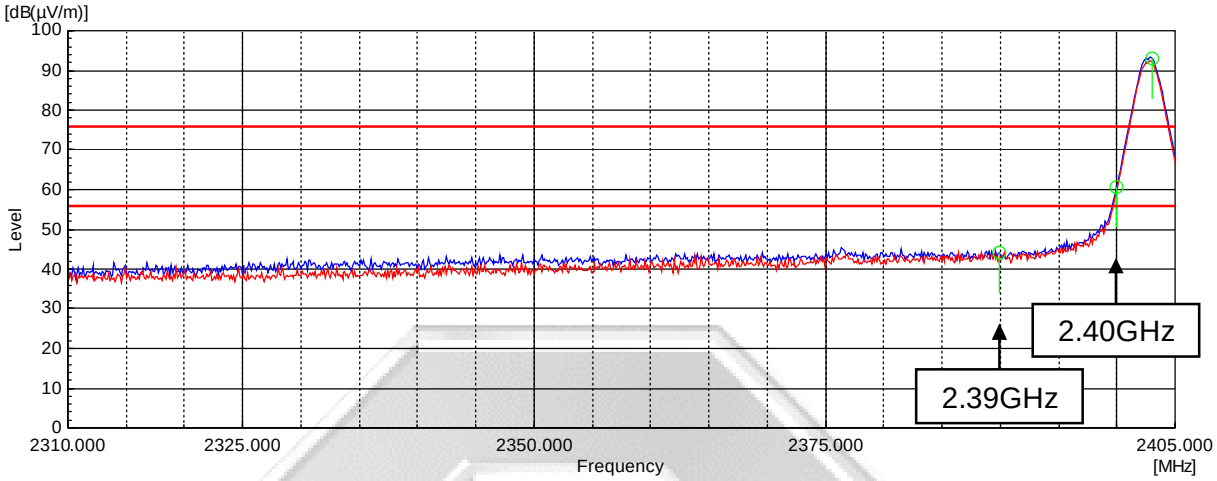


Plot 51 – Lower Band Edge at 2.4000GHz

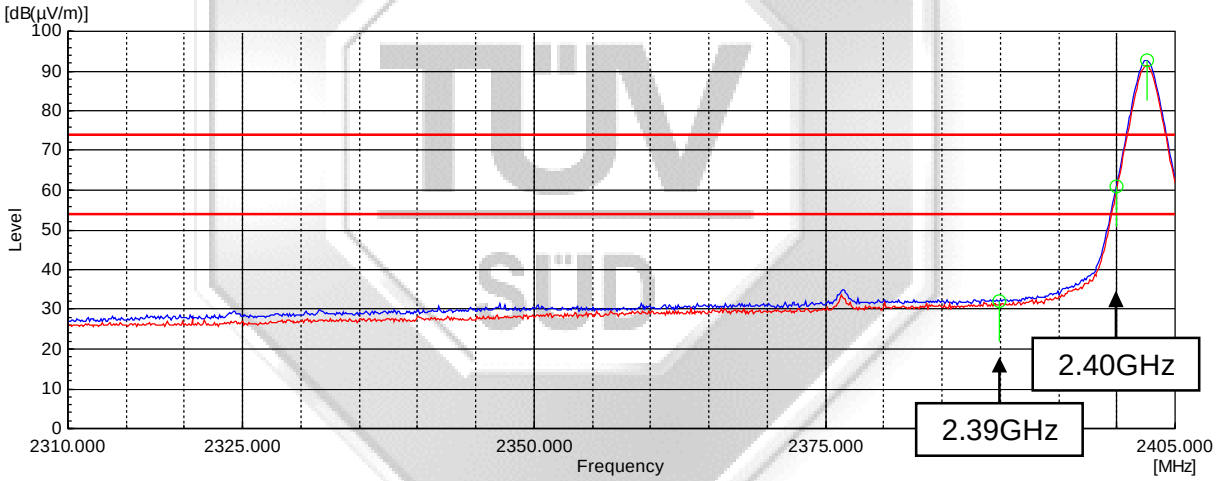


Plot 52 – Upper Band Edge at 2.4835GHz

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

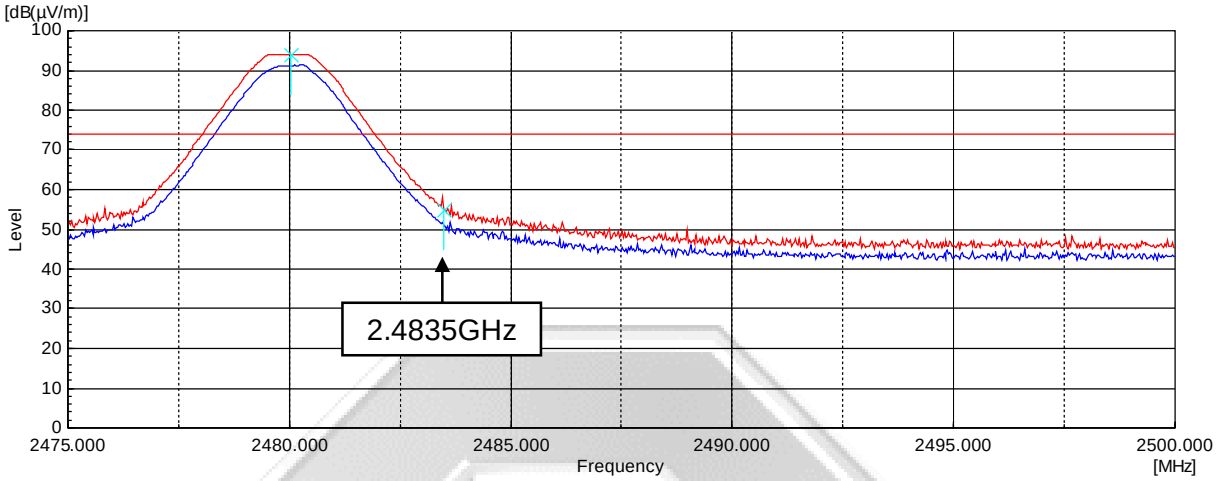


Plot 53 – Peak Plot at Lower Band Edge at 2.4000GHz

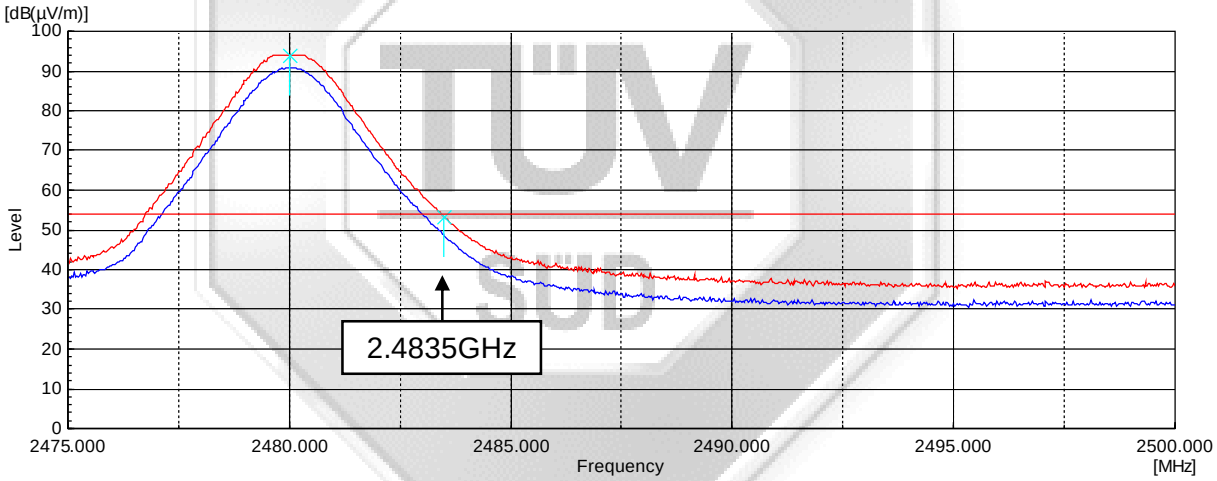


Plot 54 – Average Plot at Lower Band Edge at 2.4000GHz

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

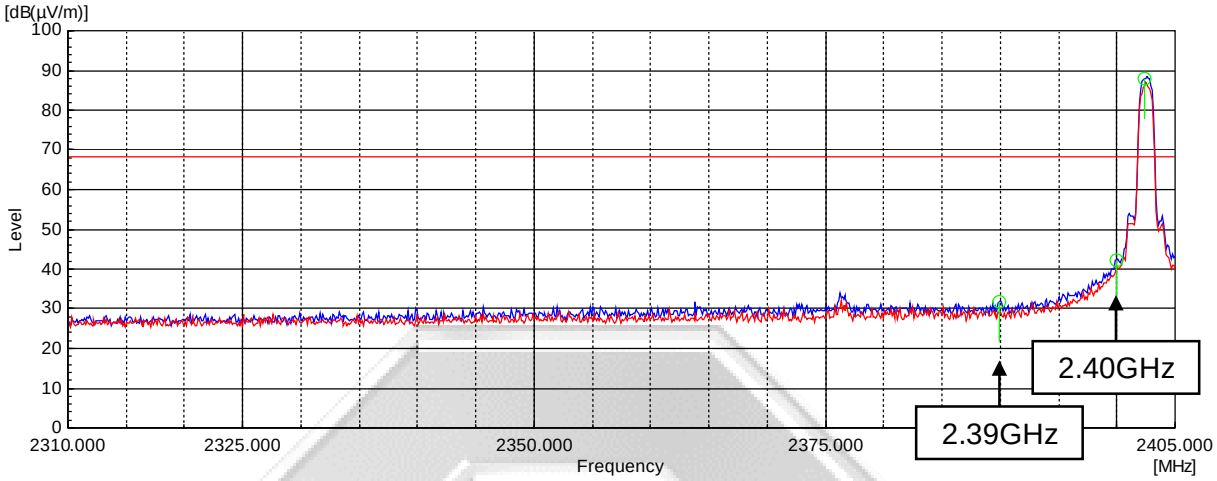


Plot 55 – Peak Plot at Upper Band Edge at 2.4835GHz

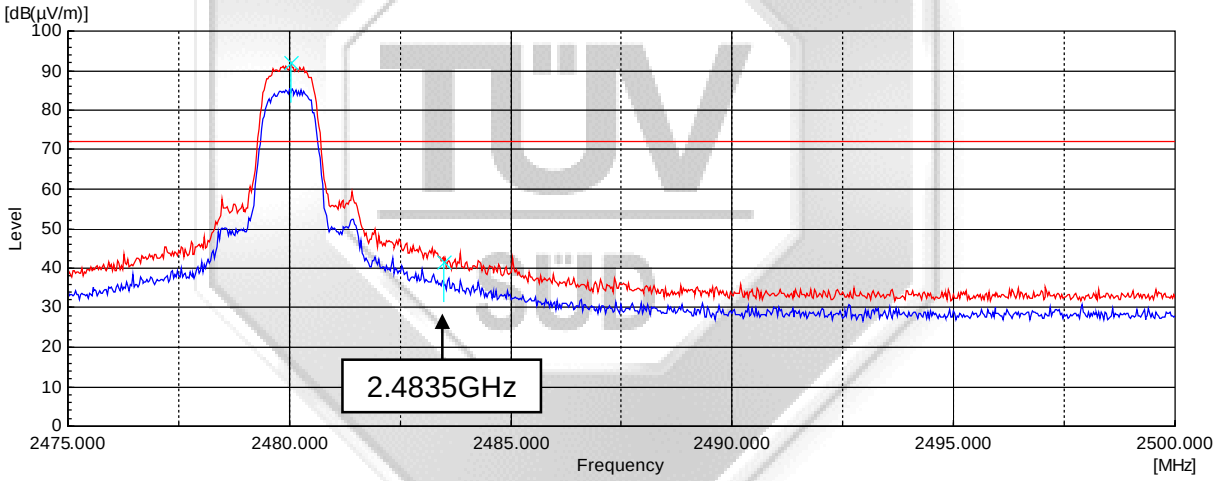


Plot 56 – Average Plot at Upper Band Edge at 2.4835GHz

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

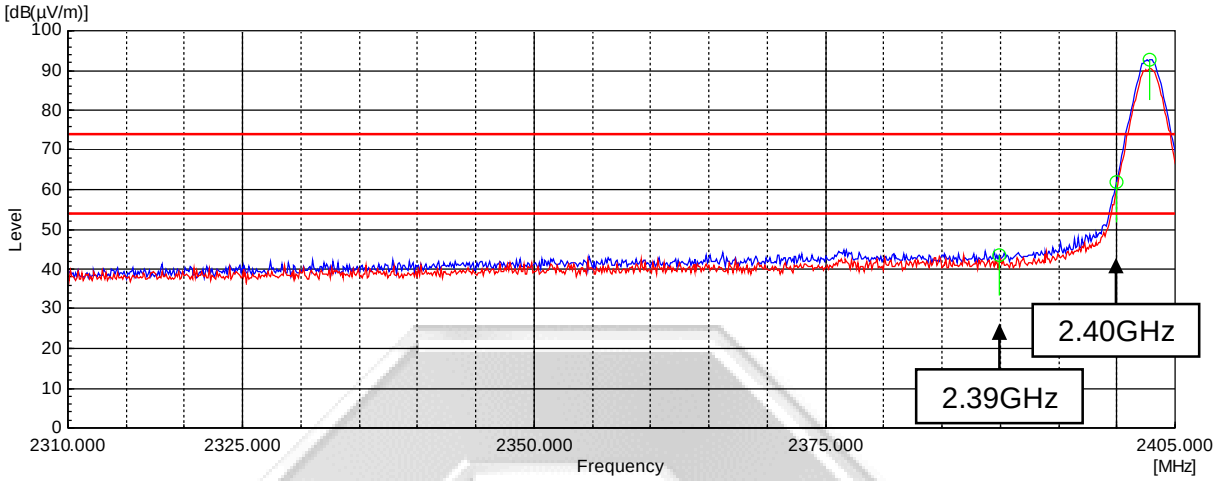


Plot 57 – Lower Band Edge at 2.4000GHz

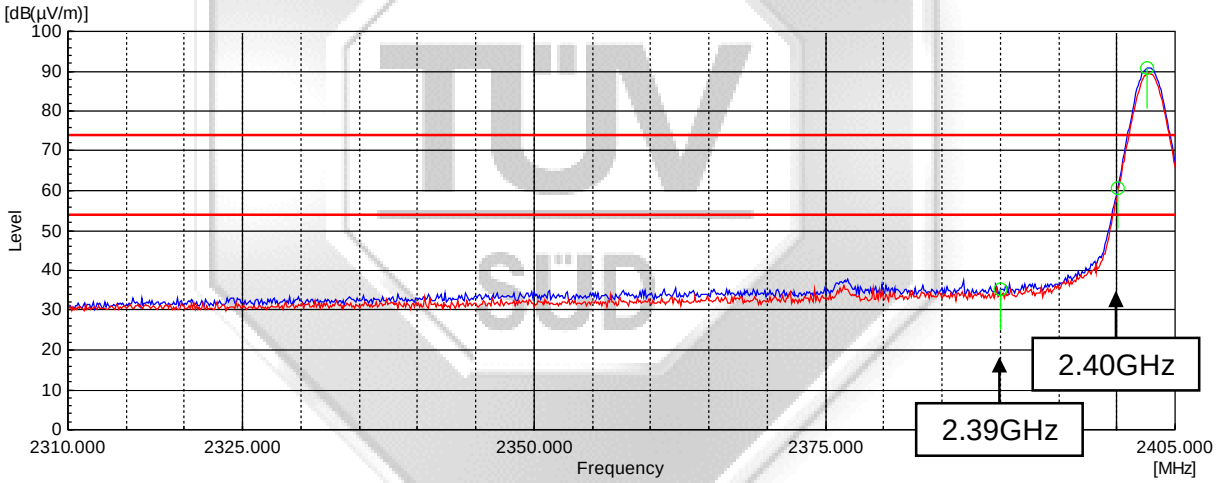


Plot 58 – Upper Band Edge at 2.4835GHz

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

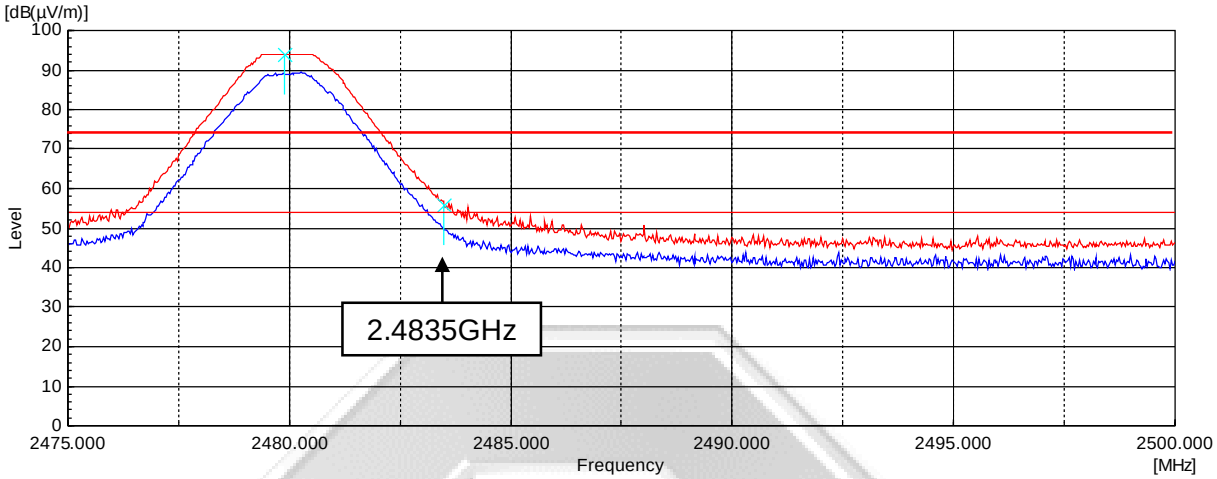


Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz

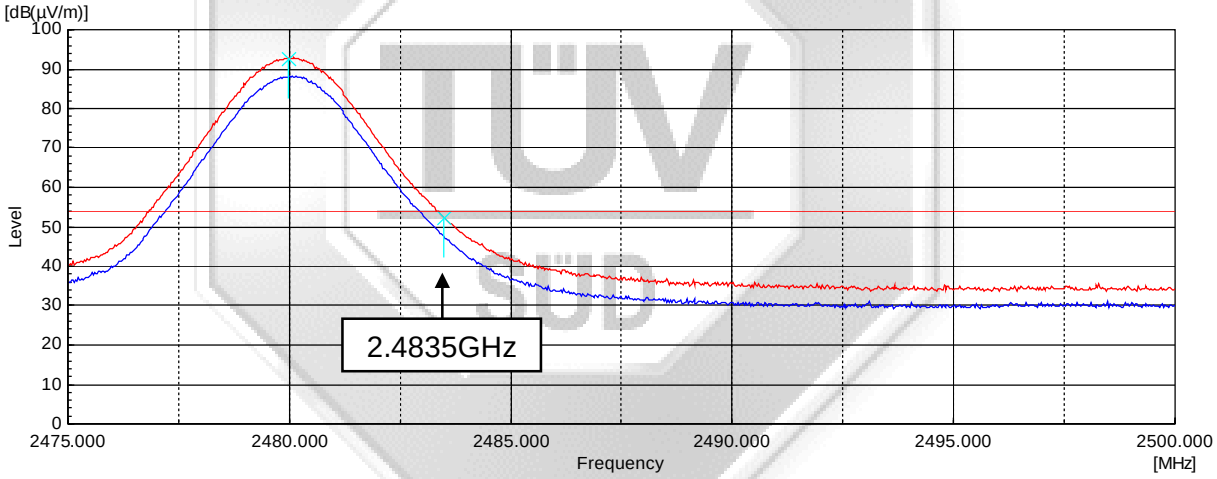


Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

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

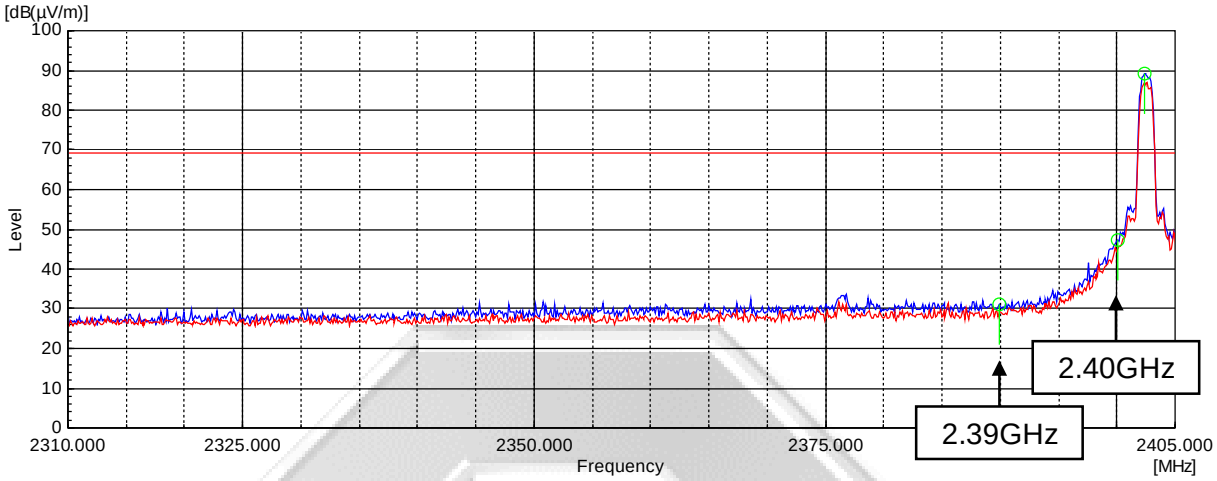


Plot 61 – Peak Plot at Upper Band Edge at 2.4835GHz

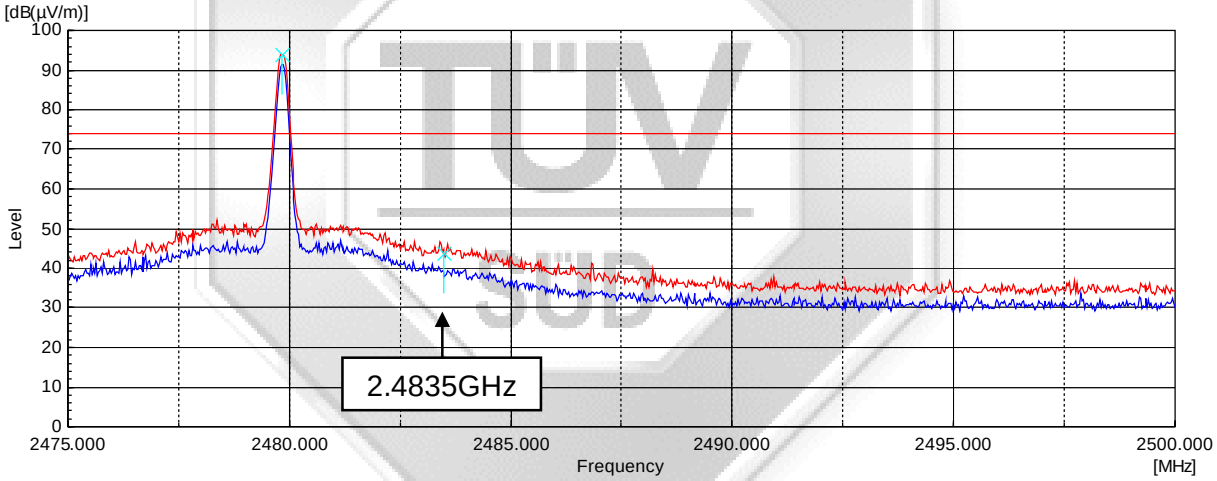


Plot 62 – Average Plot at Upper Band Edge at 2.4835GHz

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

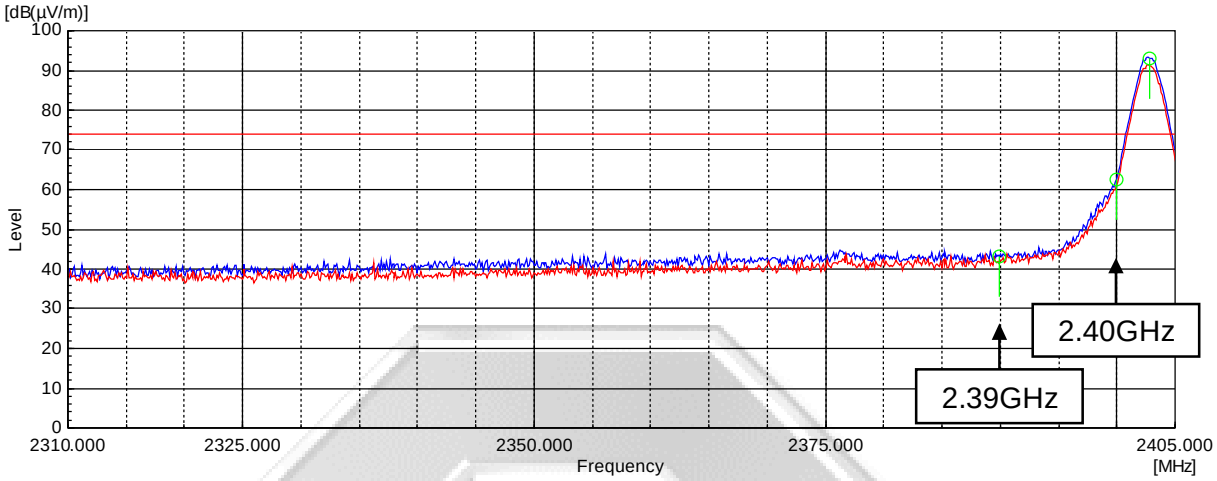


Plot 63 – Lower Band Edge at 2.4000GHz

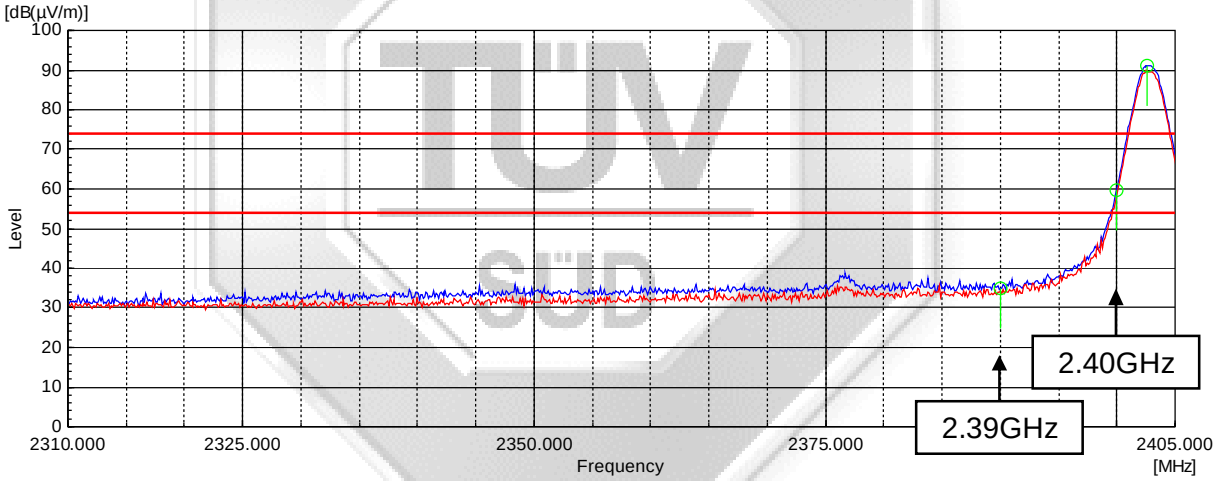


Plot 64 – Upper Band Edge at 2.4835GHz

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

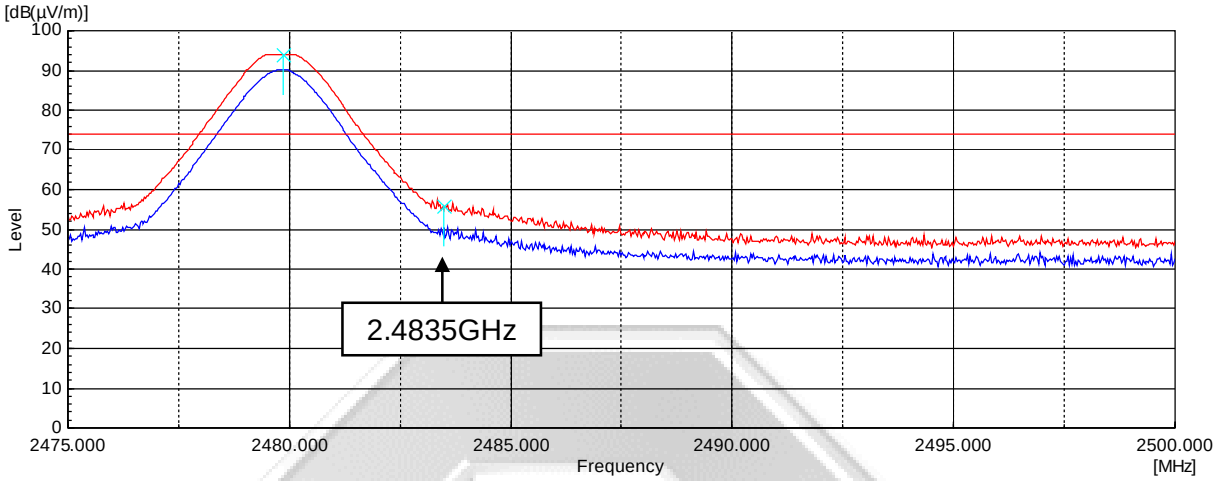


Plot 65 – Peak Plot at Lower Band Edge at 2.4000GHz

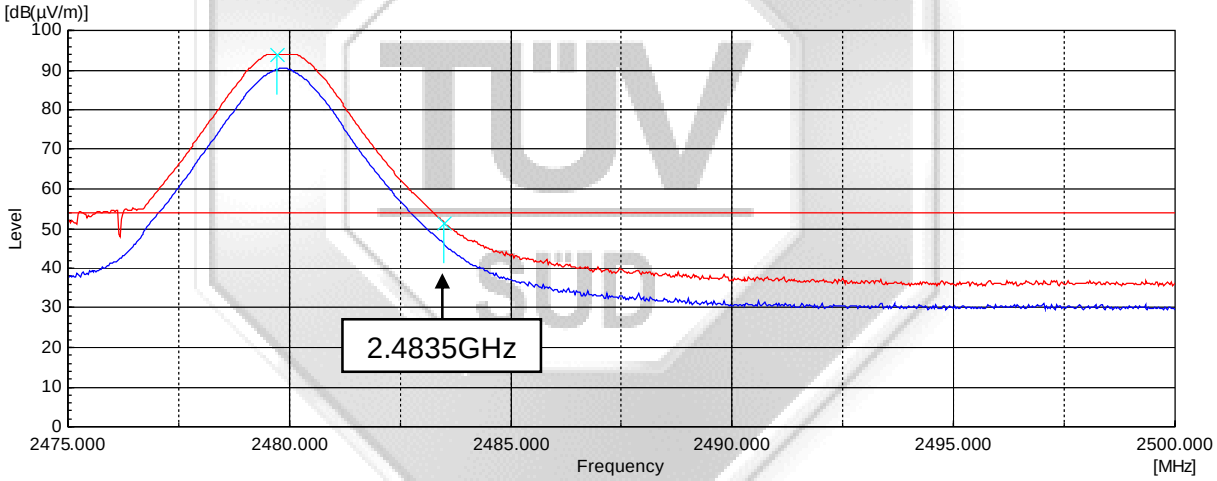


Plot 66 – Average Plot at Lower Band Edge at 2.4000GHz

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

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
Agilent Spectrum Analyzer	E4440A	MY45304764	10 Dec 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.

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

Test Input Power	5Vdc	Temperature	26°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	0.156	6.3
39 *(mid ch)*	2.441	0.159	6.3
78 *(upper ch)*	2.480	0.152	6.3

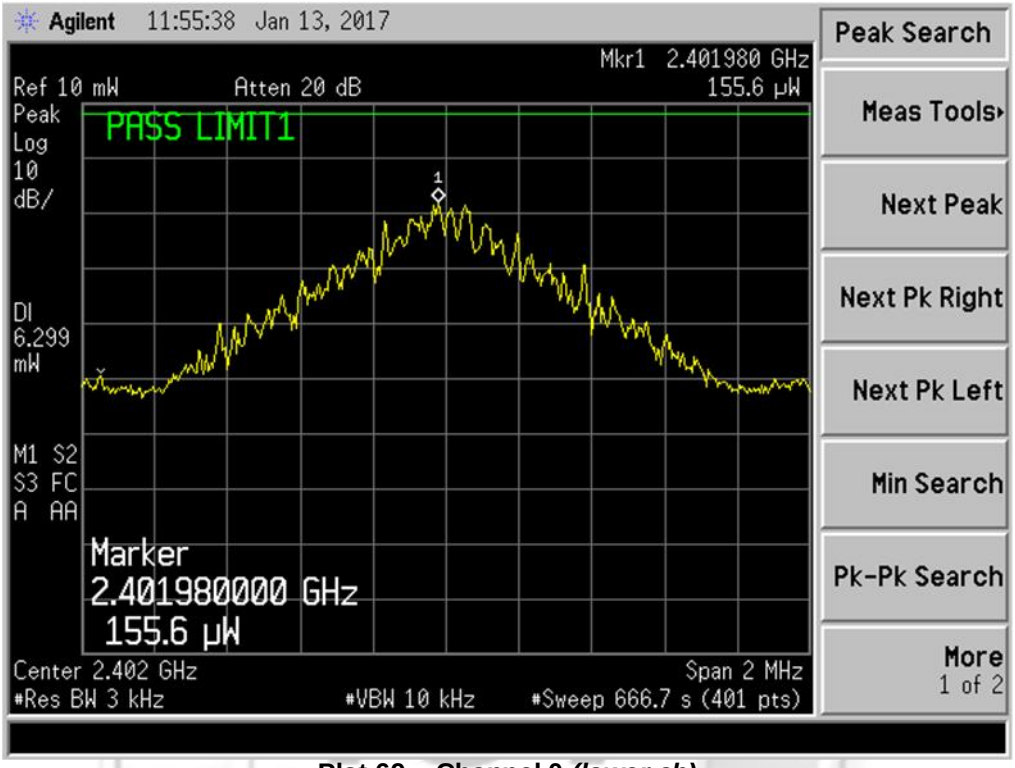
(π/4) DQPSK

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

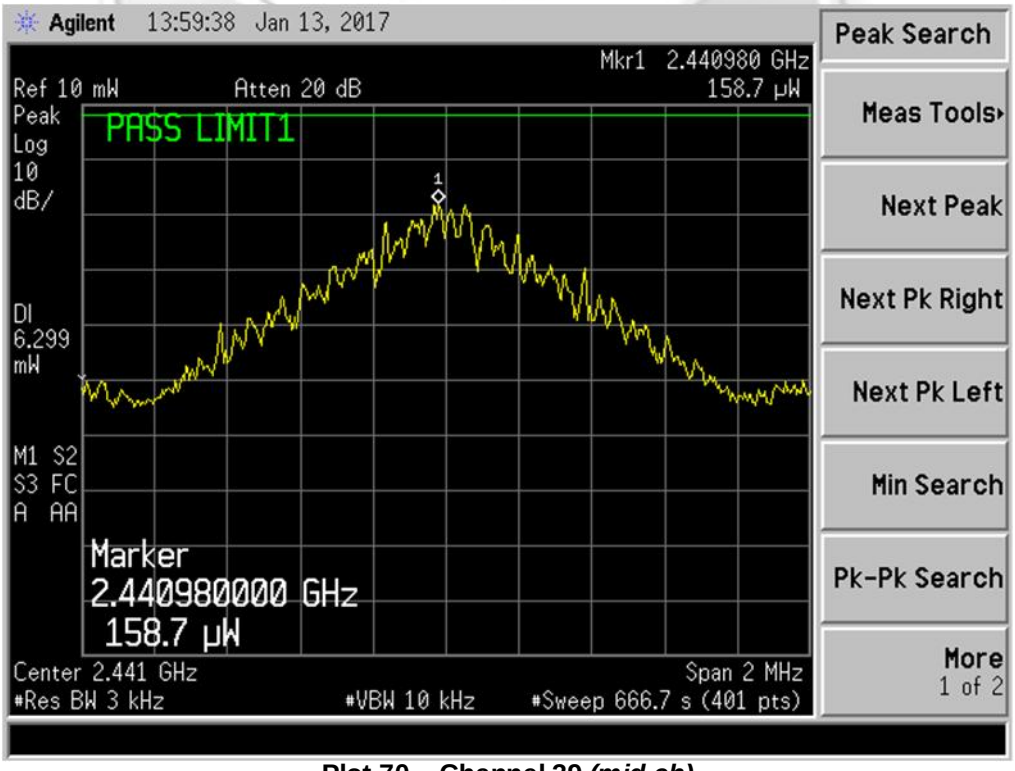
8DPSK

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

Peak Power Spectral Density Plots – GFSK

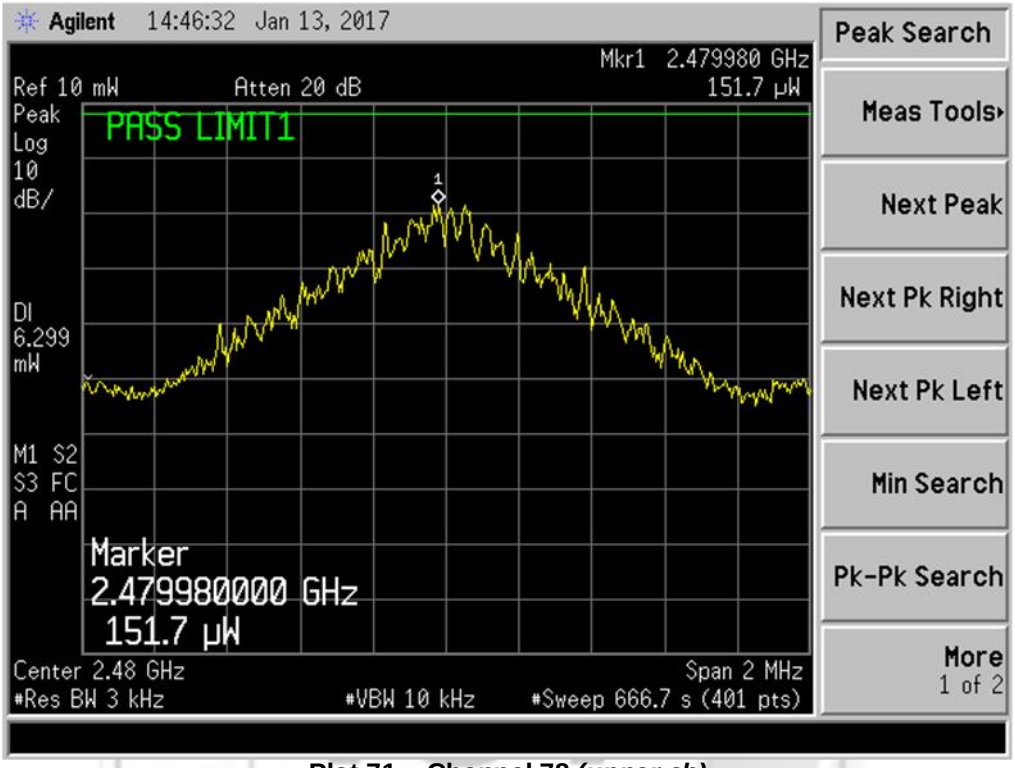


Plot 69 – Channel 0 *(lower ch)*



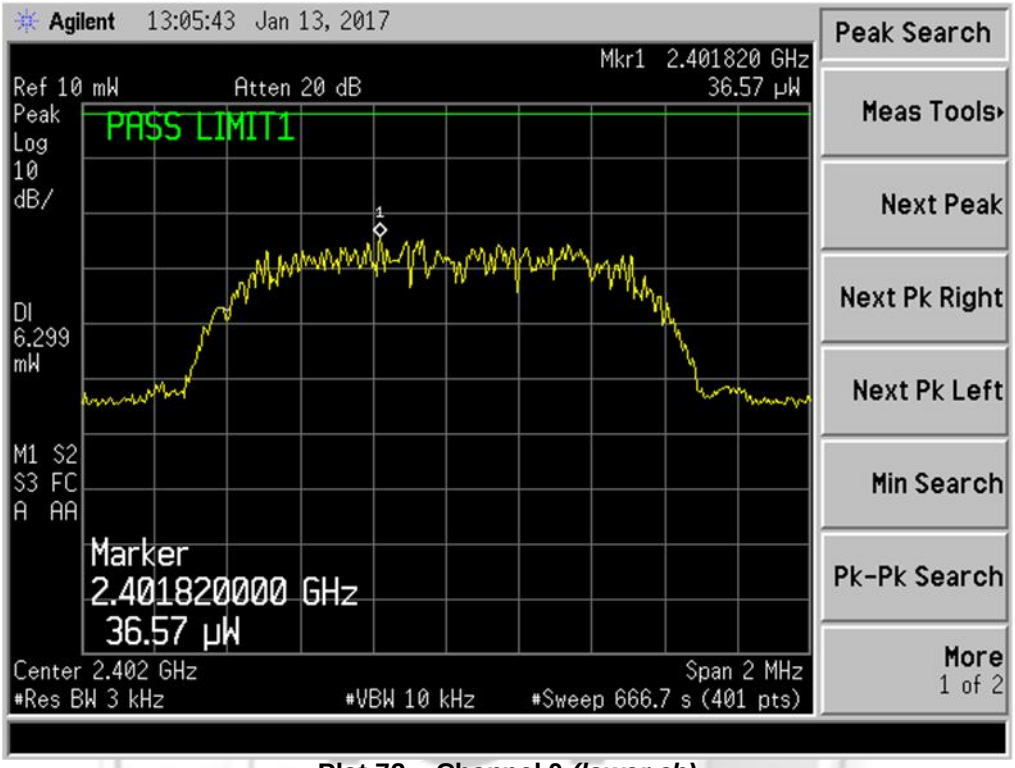
Plot 70 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – GFSK

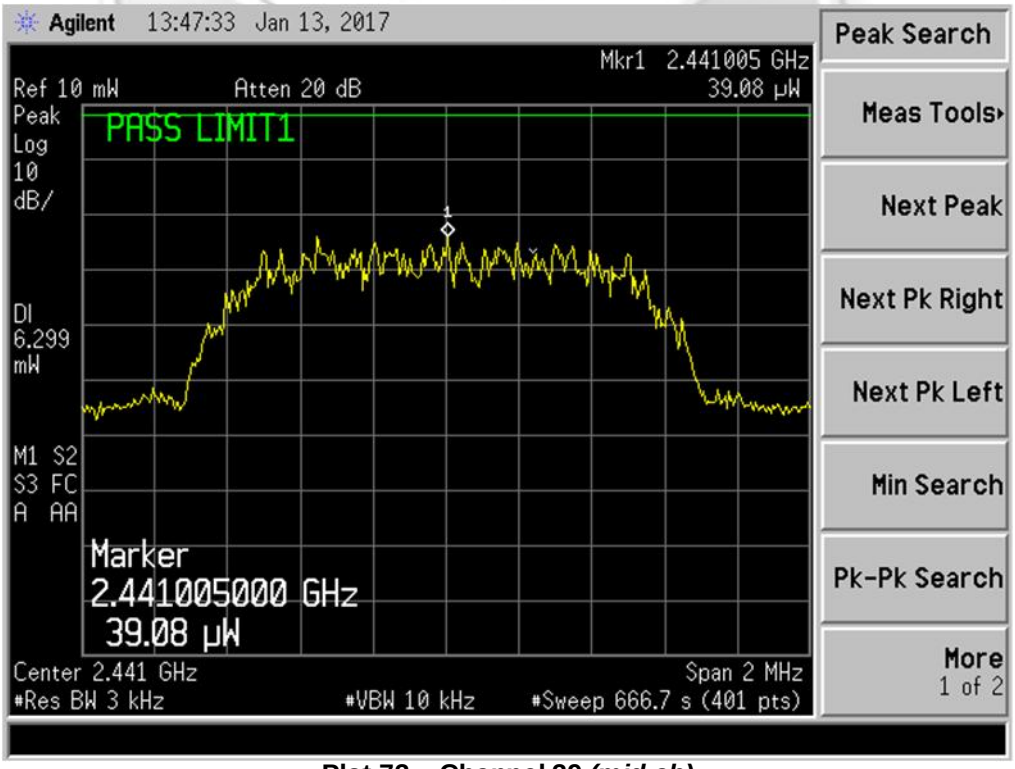


Plot 71 – Channel 78 *(upper ch)*

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

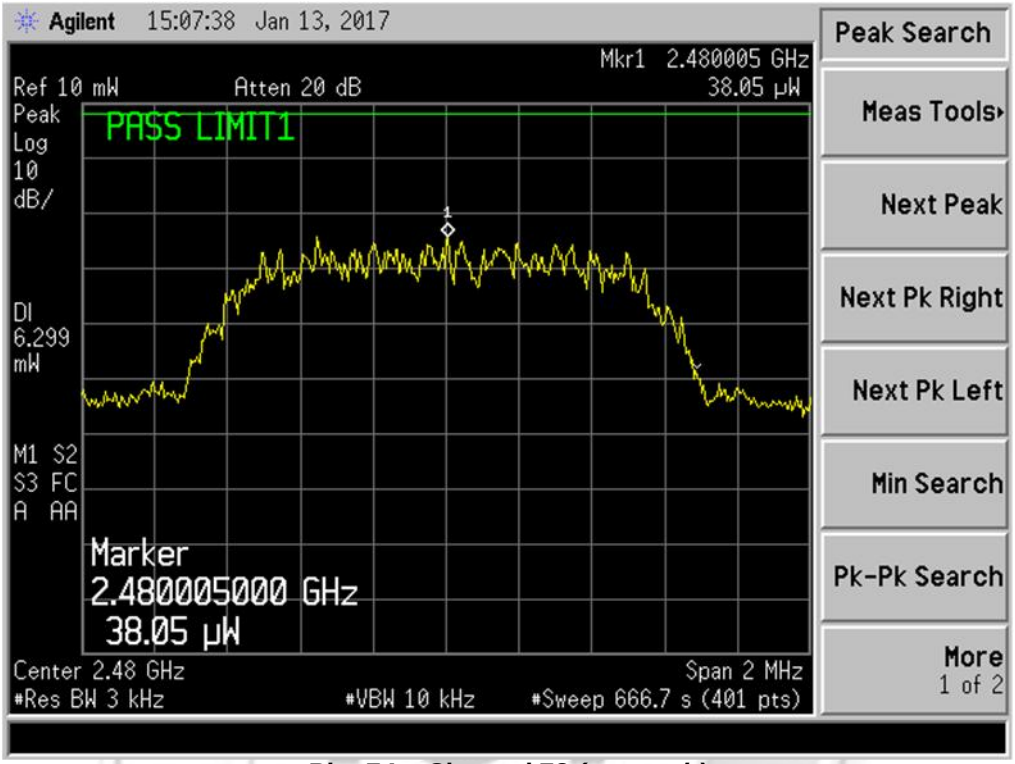


Plot 72 – Channel 0 *(lower ch)*



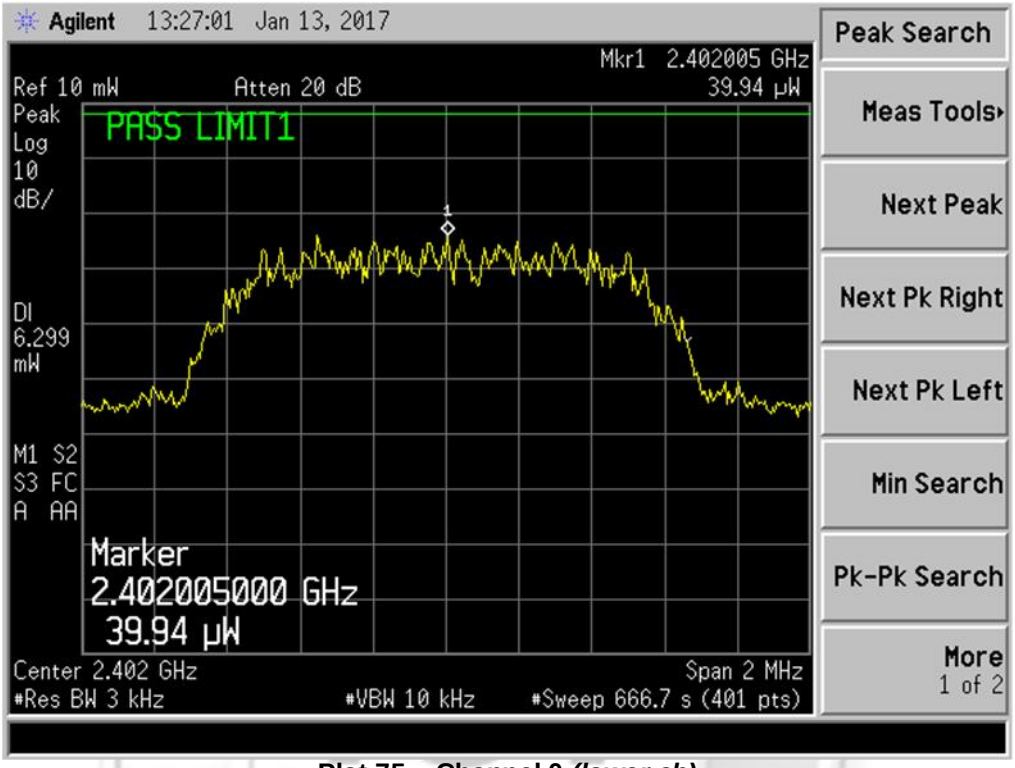
Plot 73 – Channel 39 *(mid ch)*

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

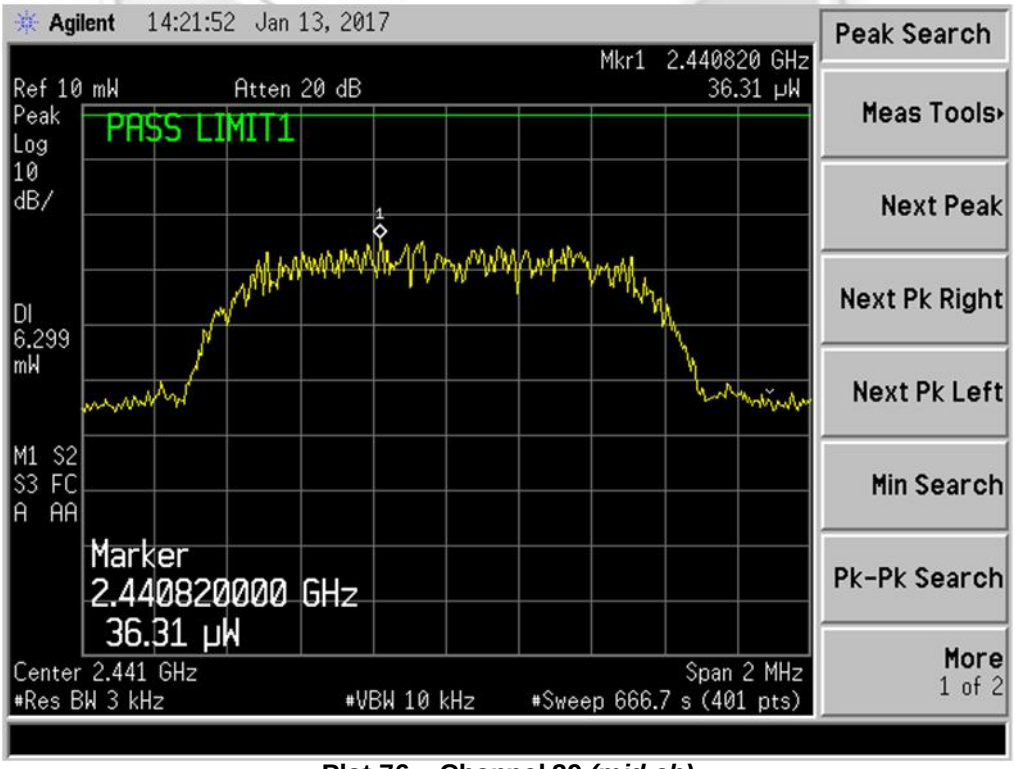


Plot 74 – Channel 78 *(upper ch)*

Peak Power Spectral Density Plots – 8DPSK

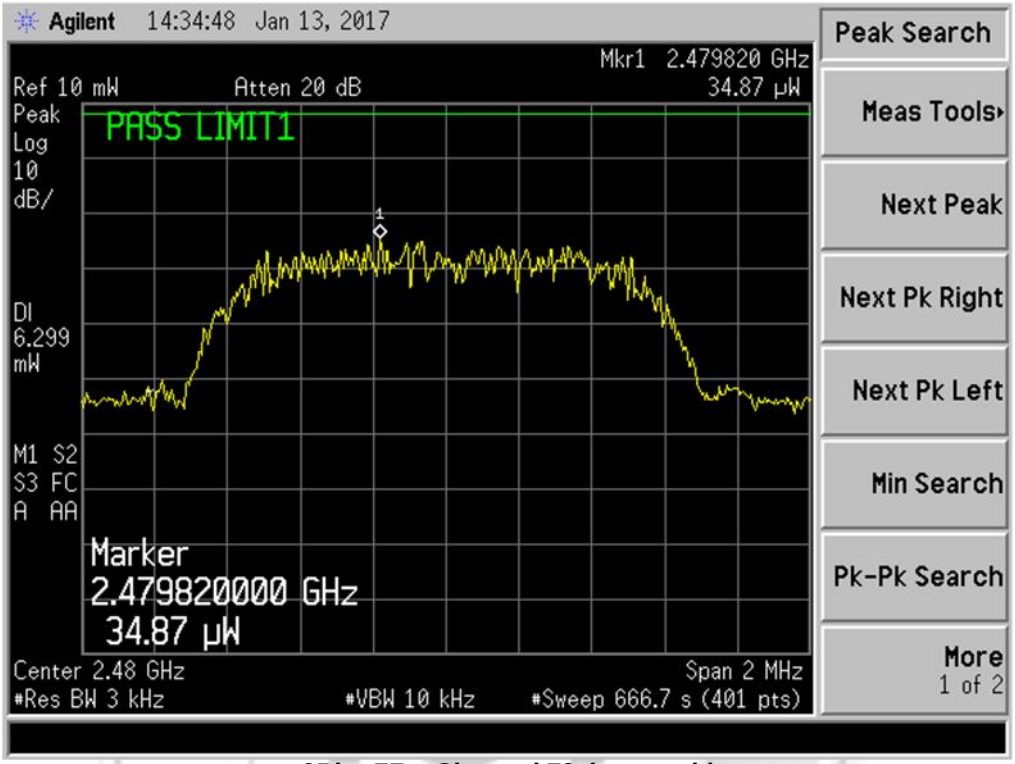


Plot 75 – Channel 0 *(lower ch)*



Plot 76 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – 8DPSK



0Plot 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 = 0.0018W
d = Test distance at 0.2m
G = Numerical isotropic gain, 1.58 (2.0dBi)

Substituting the relevant parameters into the formula:

$S = [(30GP) / 377d^2]$
$= 0.0057\ W/m^2$
$= 0.0006\ mW/cm^2$

∴ The power density of the EUT at 20cm distance is $0.0006mW/cm^2$ based on the above computation and found to be lower than the power density limit of $1.0mW/cm^2$.

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