Test Report No. 7191166853-EEC17/02
dated 23 Oct 2017

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
(Bluetooth Classic)
OF AN
E-Log & Fleet Management Device [Model : DC700]
[FCC ID : A4C01006A]

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.	994109 (Test Firm Registration Number) SG0002 (Designation Number)
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	PCI Limited 35 Pioneer Road North Singapore 628475 Tel : +65 666 8312 Fax : +65 6362 6682
QUOTATION NUMBER	2191066483
JOB NUMBER	7191166853
TEST PERIOD	17 Aug 2017 – 22 Oct 2017

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

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

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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	Not Applicable *See Note 6
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(1)	Carrier Frequency Separation	Pass
	Spectrum Bandwidth (20dB Bandwidth Measurement)	Pass
15.247(a)(1)(iii)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247(b)(1)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions	Pass
15.247(d)	Band Edge Compliance (Conducted)	Pass
15.247(d)	Band Edge Compliance (Radiated)	Pass
15.247(e)	Peak Power Spectral Density	Pass
1.1310	Maximum Permissible Exposure	Pass

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 1.76dBm.

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

7. The EUT was tested using fully charged batteries with DC voltage of 12.5Vdc.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is an **E-Log And Fleet Management Device.** It consists of a. DC200S. b. Tablet.
Applicant	:	A4C-RM Acquisition LLC 855 Woods Drive Skokies IL 60077, USA
Manufacturer	:	PCI Limited 35 Pioneer Road North Singapore 628475
Factory (ies)	:	Pt PCI Elektronik Internasional Panbil Industrial Estate Factory C Lot 2-3 Jalan Ahmad Yani, Muka Kuning, Batam 29433 Indonesia
Model Number	:	DC700
FCC ID	:	A4C01006A
Serial Number	:	Nil
Microprocessor	:	a. STMicroelectronics STM32F767ZIT6 & IC ARM CORTEX M7 STM32 32-Bit LQFP144 b. MTK8163
Operating / Transmitting Frequency	:	a. PCS850 - 824MHz – 849MHz (uplink) - 869MHz – 894MHz (downlink) PCS1900 - 1850MHz – 1910MHz (uplink) - 1930MHz – 1990MHz (downlink) b. 2402MHz-2480MHz (Bluetooth)
Clock / Oscillator Frequency	:	16MHz & 1.3GHz
Modulation / Emissions Designator	:	a. PCS 850 - 300KGXW (PCS 850) b. PCS1900 - 300KGXW c. Bluetooth - Gaussian Frequency Shift Keying (GFSK) - π/4-Differential Quadrature Phase-Shift Keying (DQPSK) - 8 Differential Phase Shift Keying (DPSK)

Continued

Antenna Gain	:	a. DC200S - 0.11dBi (PCS 850) - 2.38dBi (PCS 1900) - 3 dBi (WLAN, Bluetooth) b. Tablet - 2.75dBi (WLAN, Bluetooth)
Port / Connectors	:	Micro USB, micro SD card slot, pogo pins (pinout is the same as mating DC200S)
Rated Input Power	:	a. 12Vdc & 24Vdc b. 5Vdc 2A
Accessories	:	Nil

SUPPORTING EQUIPMENT DESCRIPTION

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

47 CFR FCC Part 15
1. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement) **2. Spectrum Bandwidth (20dB Bandwidth Measurement)** **3. Maximum Peak Power** **4. RF Conducted Spurious Emissions** **5. Band Edge Compliance (Conducted)** **6. Band Edge Compliance (Radiated)** **7. Peak Power Spectral Density** **8. 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 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 EMI Test Receiver	ESU40	100355	14 Sep 2018
EMCO Loop Ant (ext)_red_00134413	6502	134413	28 Oct 2017
TDK RF Solutions Hybrid Log Periodic Antenna (30MHz-3GHz)	HLP-3003C	130237	21 Oct 2018
Eletro-Metrics Double Ridged Antenna (Horn) Antenna (1-18GHz)	EM-6961	6525	08 Apr 2018
ETS Horn Antenna (18GHz-40GHz) (Ref)	3116	0004-2474	18 Oct 2018
Sonoma Preamplifier (9kHz – 1GHz)	310N	270640	27 Dec 2017
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	12 Oct 2018
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	18 Oct 2018
Micro-tronics Bandstop Filter (2.4GHz)	BRM50701-02	007	13 Aug 2018

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	12.5Vdc	Temperature	24ºC
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	60%
Modulation	GFSK (Worst)	Atmospheric Pressure	1030mbar
		Tested By	Kelvin Cheng

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

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

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 (Worst)
30.4250	12.1	40.0	27.9	191	356	V	39
50.6890	1.7	40.0	38.3	356	161	V	39
56.5190	1.1	40.0	38.9	329	322	V	39
97.2120	18.4	43.5	25.1	161	14	V	39
196.2600	22.4	43.5	21.1	201	68	V	39
791.4320	28.4	46.0	17.6	182	214	H	39

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
1.1818	35.2	74.0	38.8	--	54.0	18.8	200	209	H	0
2.0050	38.7	74.0	35.3	--	54.0	15.3	100	252	H	0
2.1110	36.8	74.0	37.2	--	54.0	17.2	100	230	V	0
2.1211	37.4	74.0	36.6	--	54.0	16.6	100	219	V	0
2.1413	36.8	74.0	37.2	--	54.0	17.2	100	191	V	0
3.5606	39.5	74.0	34.5		54.0	14.5	100	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) *See Note 2	AV Limit (dBµV/m)	AV Margin (dB) *See Note 3	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.8686	35.8	74.0	38.2	--	54.0	18.2	100	185	V	39
1.8787	35.2	74.0	38.8	--	54.0	18.8	100	179	V	39
1.9343	37.0	74.0	37.0	--	54.0	17.0	100	230	V	39
2.1262	37.4	74.0	36.6	--	54.0	16.6	100	235	H	39
2.9544	37.3	74.0	36.7	--	54.0	16.7	100	315	V	39
3.1667	38.4	74.0	35.6	--	54.0	15.6	200	185	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
1.0202	33.2	74.0	40.8	--	54.0	20.8	100	111	V	78
1.1919	34.9	74.0	39.1	--	54.0	19.1	300	197	V	78
2.9342	37.7	74.0	36.3	--	54.0	16.3	100	247	V	78
3.1667	38.6	74.0	35.4	--	54.0	15.4	200	193	V	78
3.5606	38.8	74.0	35.2	--	54.0	15.2	200	217	V	78
4.3256	38.3	74.0	35.7	--	54.0	15.7	200	347	V	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. 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.
5. "--" indicates no emissions were found and shows compliance to the limits.
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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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

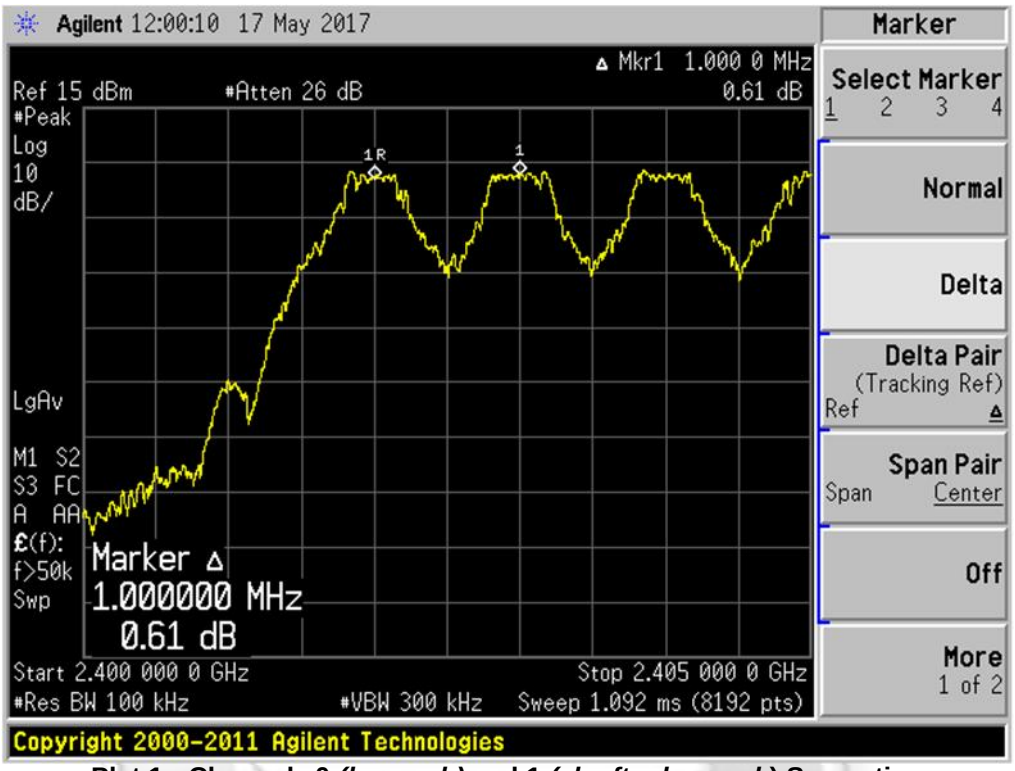
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.405GHz.
3. The spectrum analyser was set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

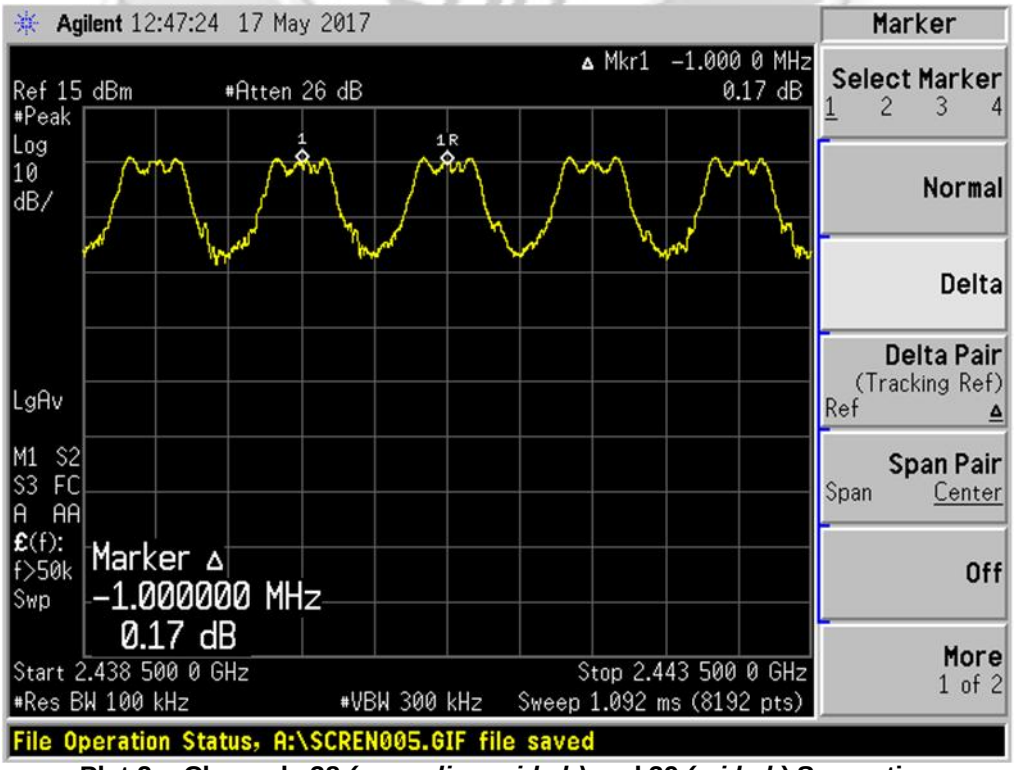
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	1 – 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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)	1.000

Carrier Frequency Separation Plots

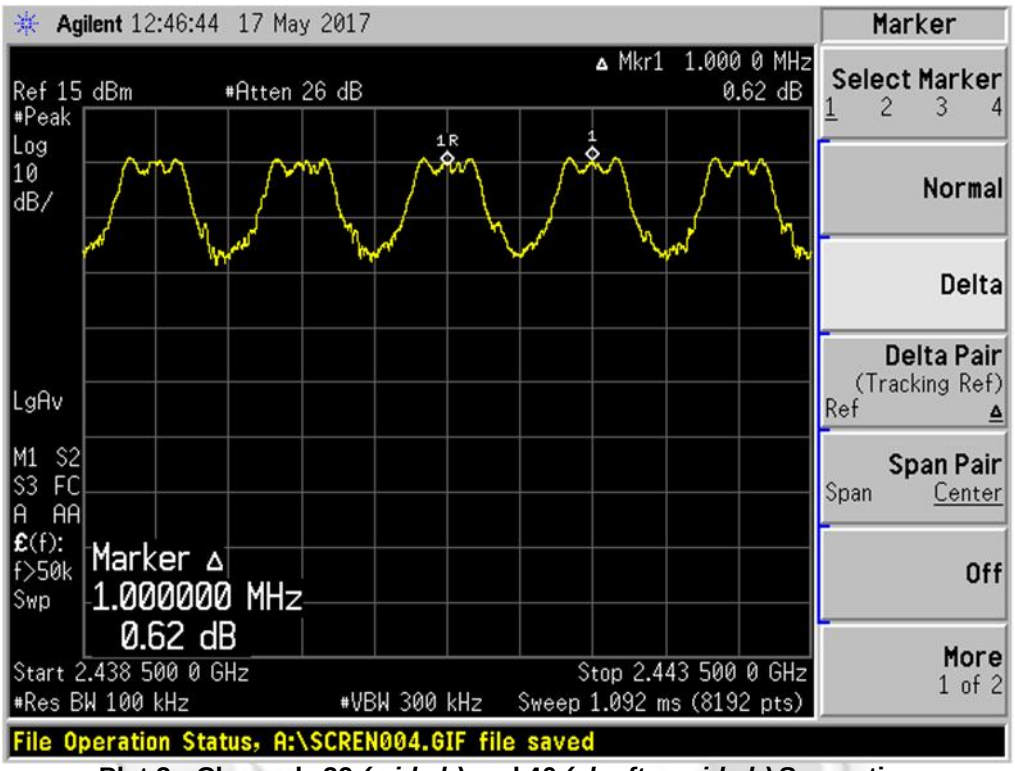


Plot 1 - Channels 0 *(lower ch)* and 1 *(ch after lower ch)* Separation

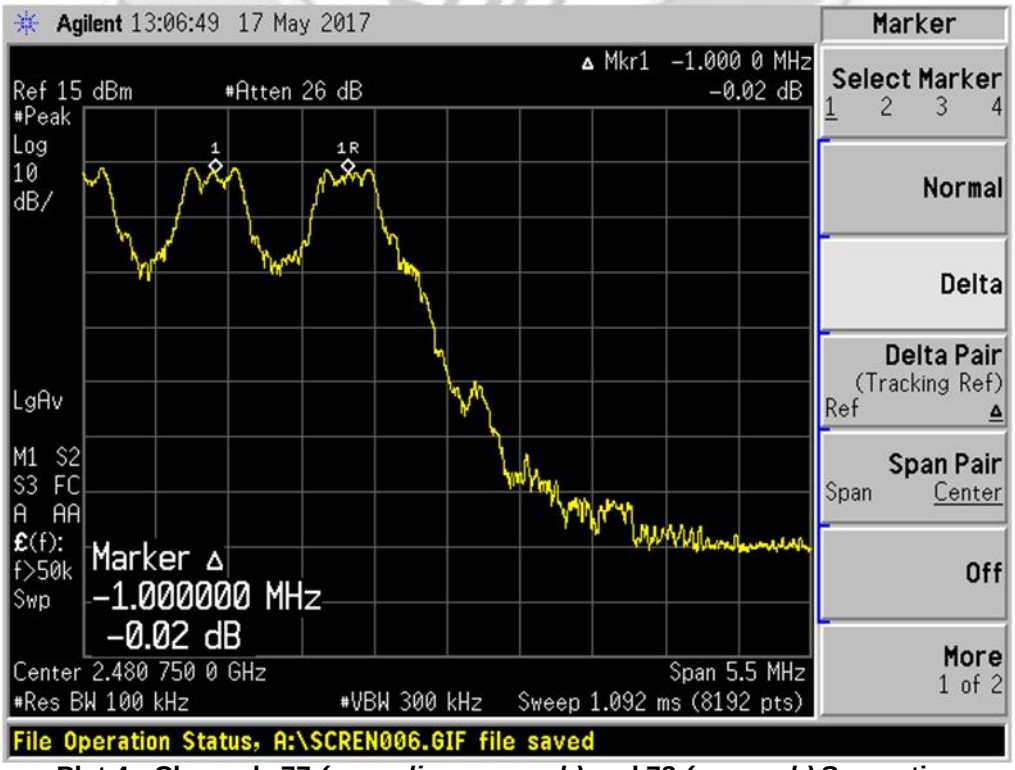


Plot 2 – Channels 38 *(preceding mid ch)* and 39 *(mid ch)* Separation

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

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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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, $| f_H - f_L |$.
1. 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.

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

Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	5 – 7	Relative Humidity	60%
Modulation	GFSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	0.776
39 *(mid ch)*	2.441	0.874
78 *(upper ch)*	2.480	0.877

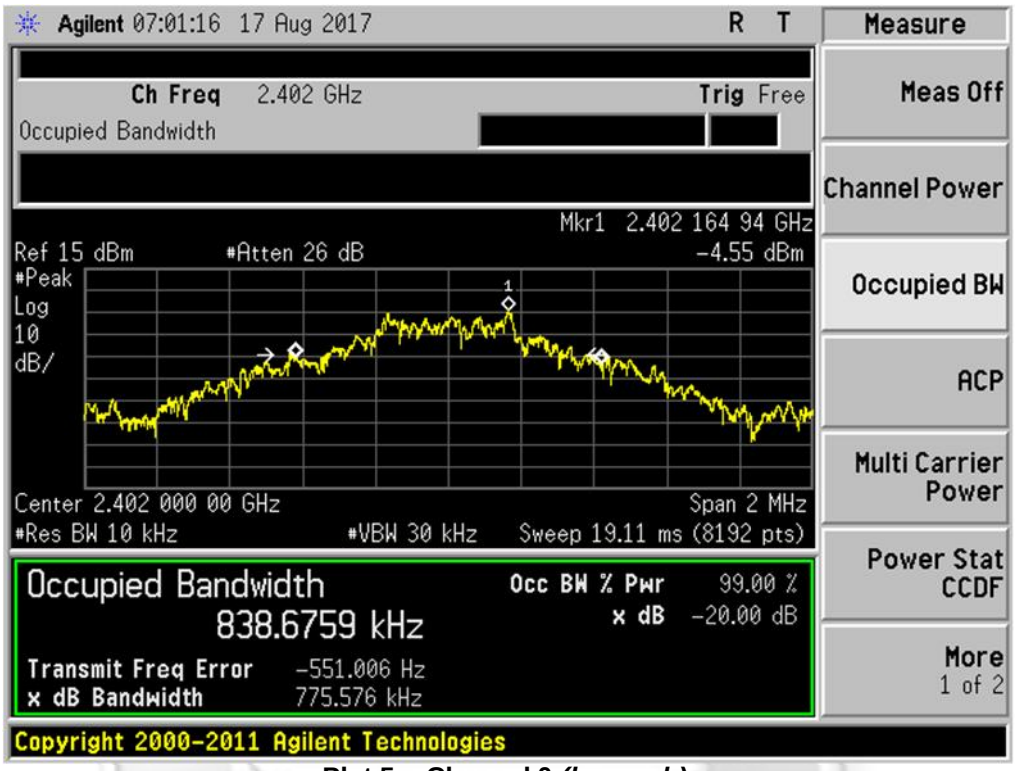
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	8 – 10	Relative Humidity	60%
Modulation	(π/4) DQPSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	1.073
39 *(mid ch)*	2.441	1.078
78 *(upper ch)*	2.480	1.093

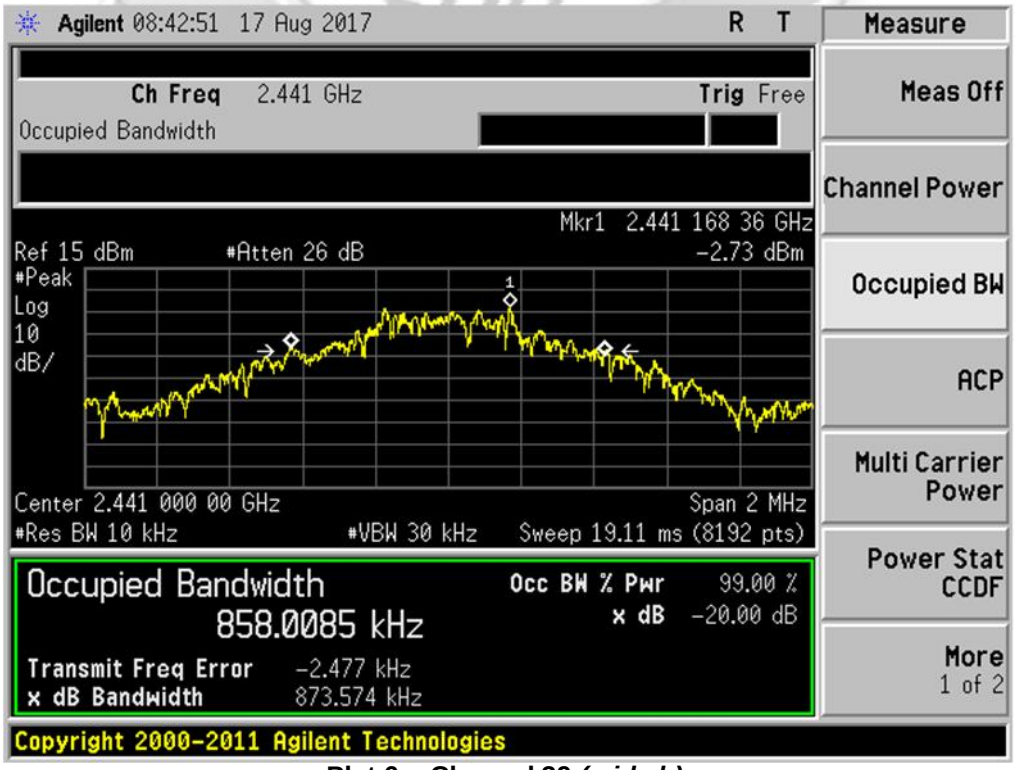
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	11 – 13	Relative Humidity	60%
Modulation	8DPSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)
0 *(lower ch)*	2.402	1.088
39 *(mid ch)*	2.441	1.084
78 *(upper ch)*	2.480	1.080

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

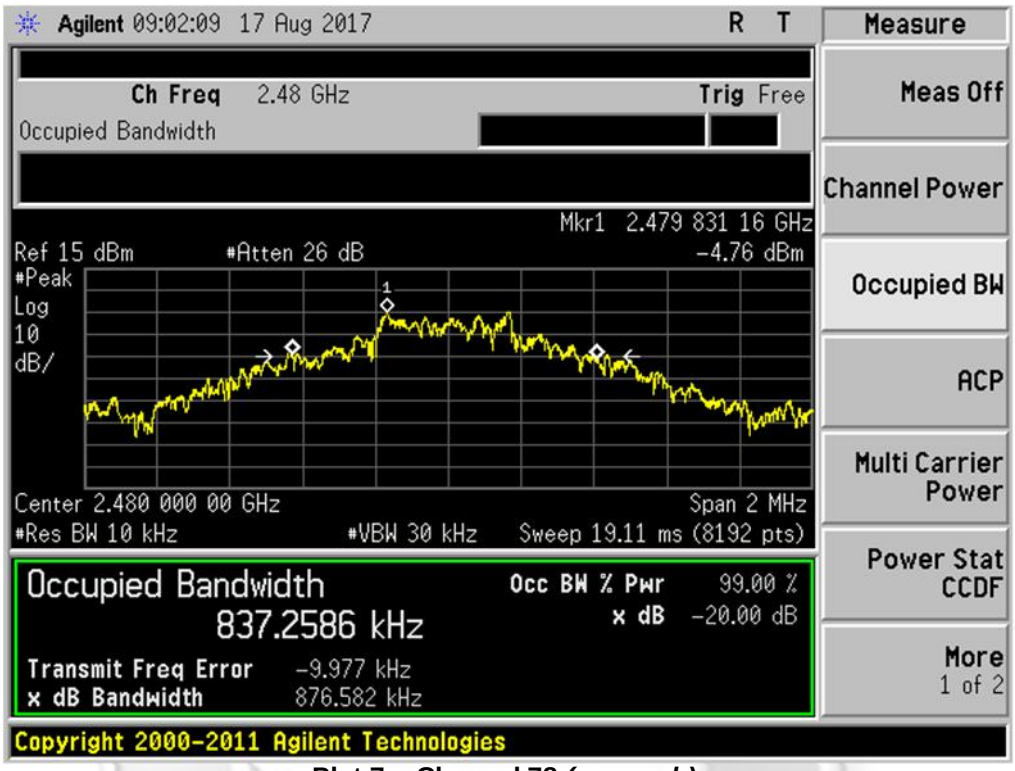


Plot 5 – Channel 0 *(lower ch)*



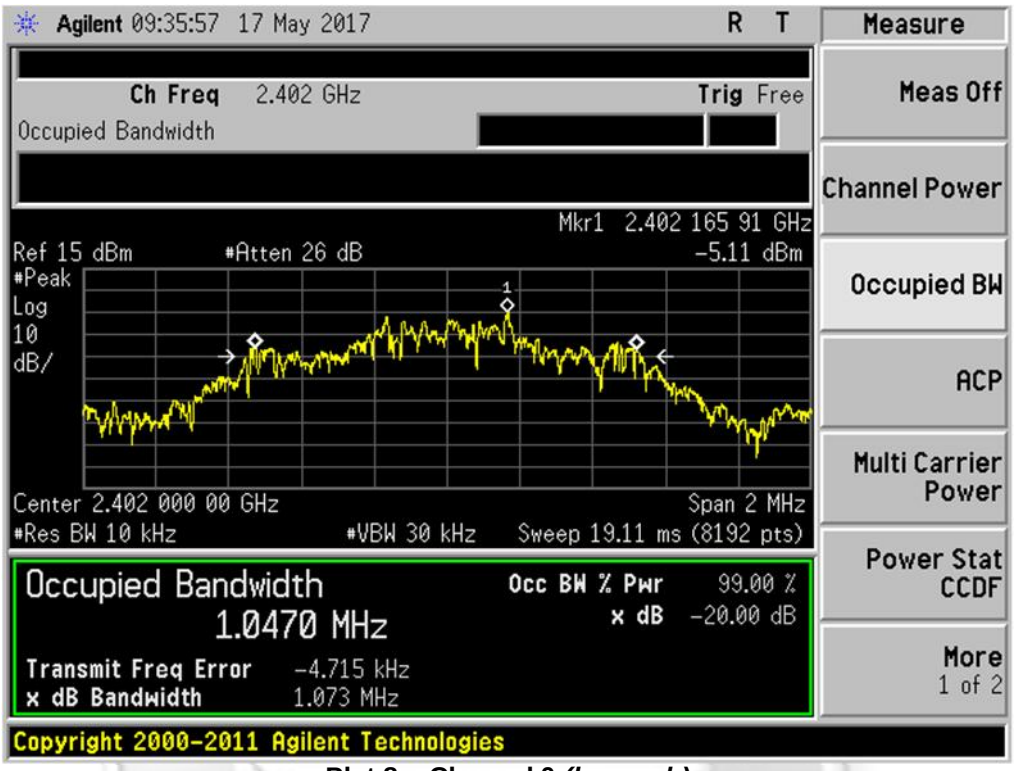
Plot 6 – Channel 39 *(mid ch)*

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

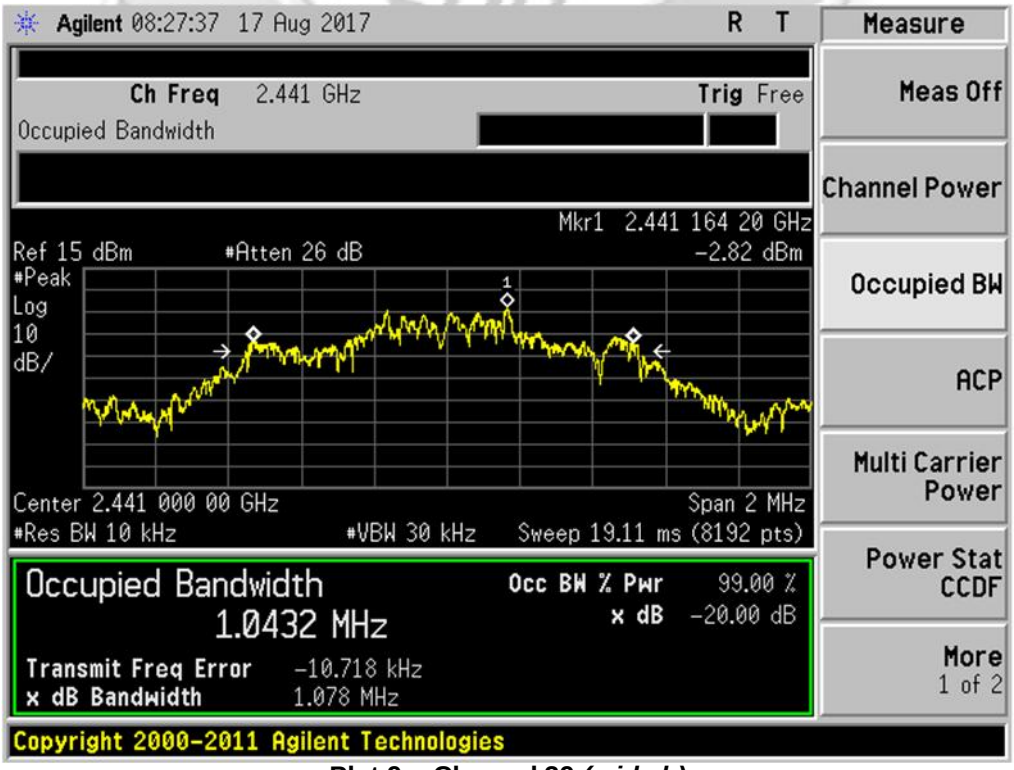


Plot 7 – Channel 78 *(upper ch)*

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

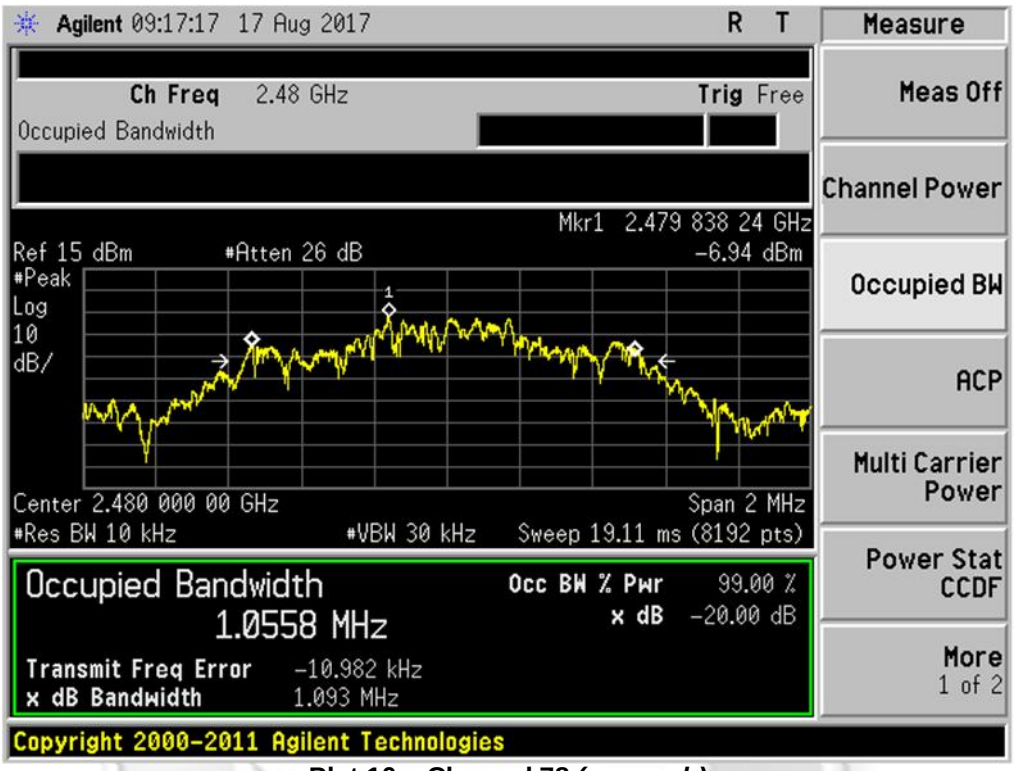


Plot 8 – Channel 0 *(lower ch)*



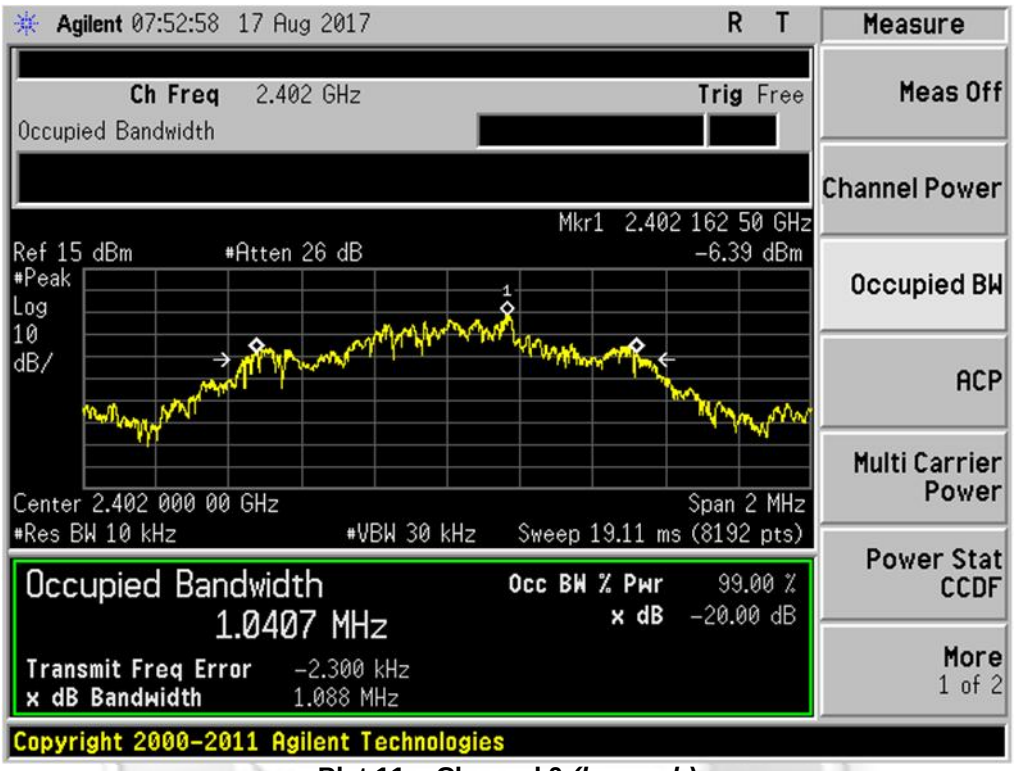
Plot 9 – Channel 39 *(mid ch)*

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



Plot 10 – Channel 78 *(upper ch)*

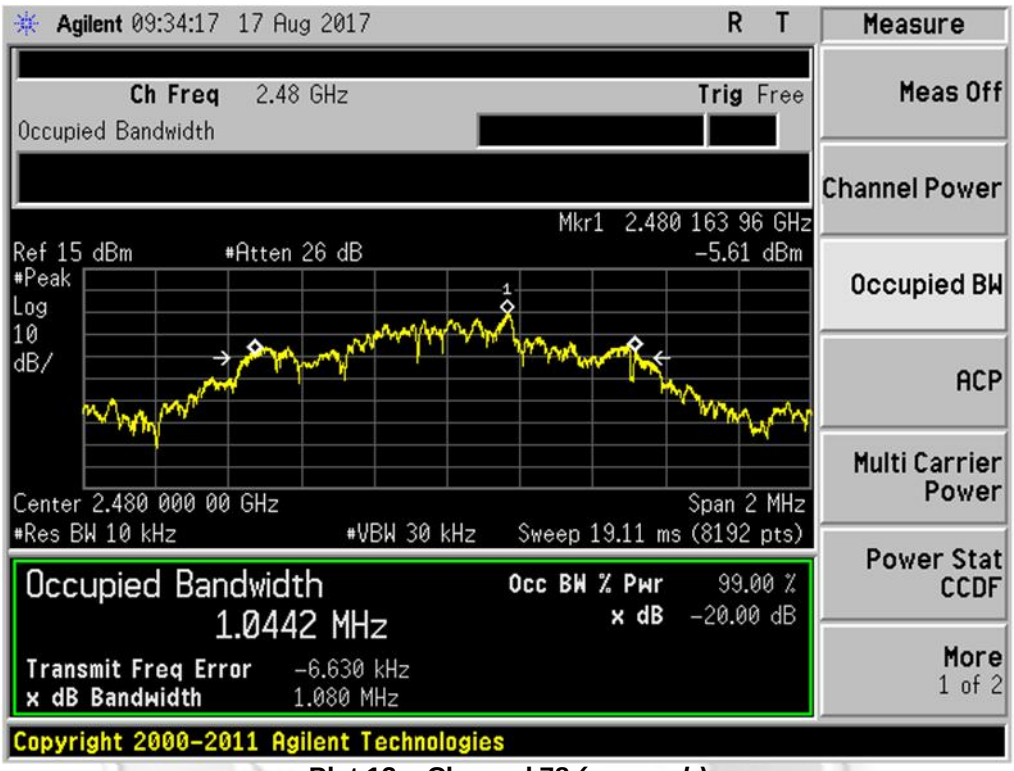
Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – 8DPSK



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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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

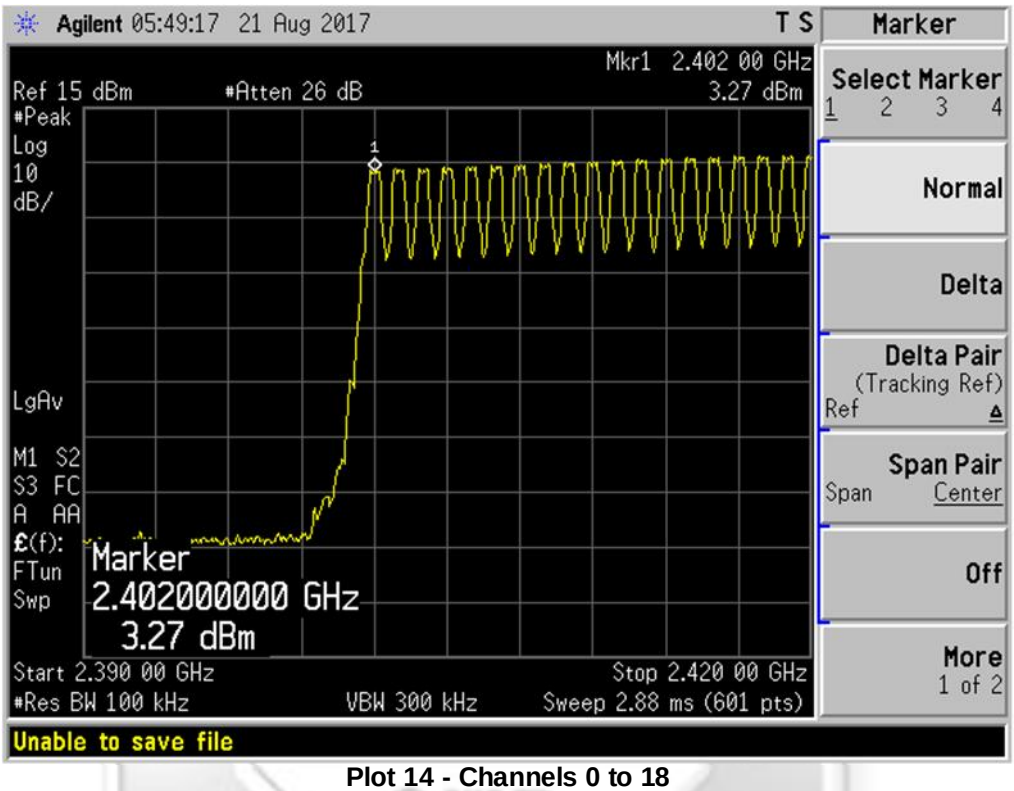
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.39GHz and 2.420GHz.
3. The spectrum analyser was set 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

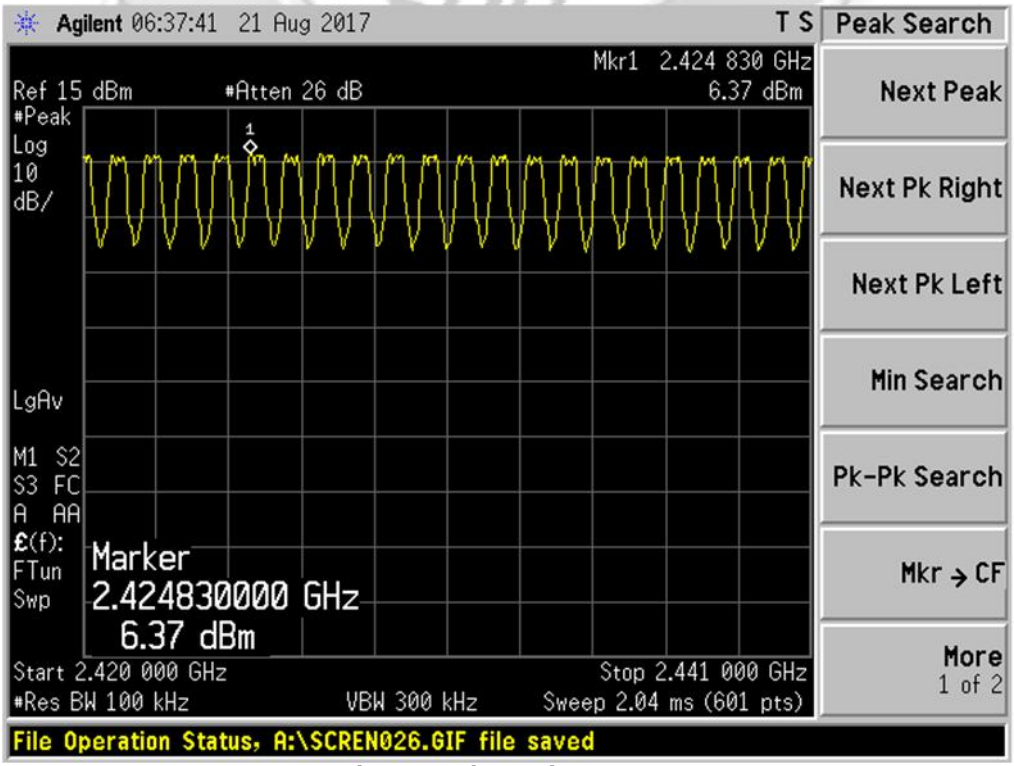
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	14 – 17	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

Number Of Hopping Frequencies Plots

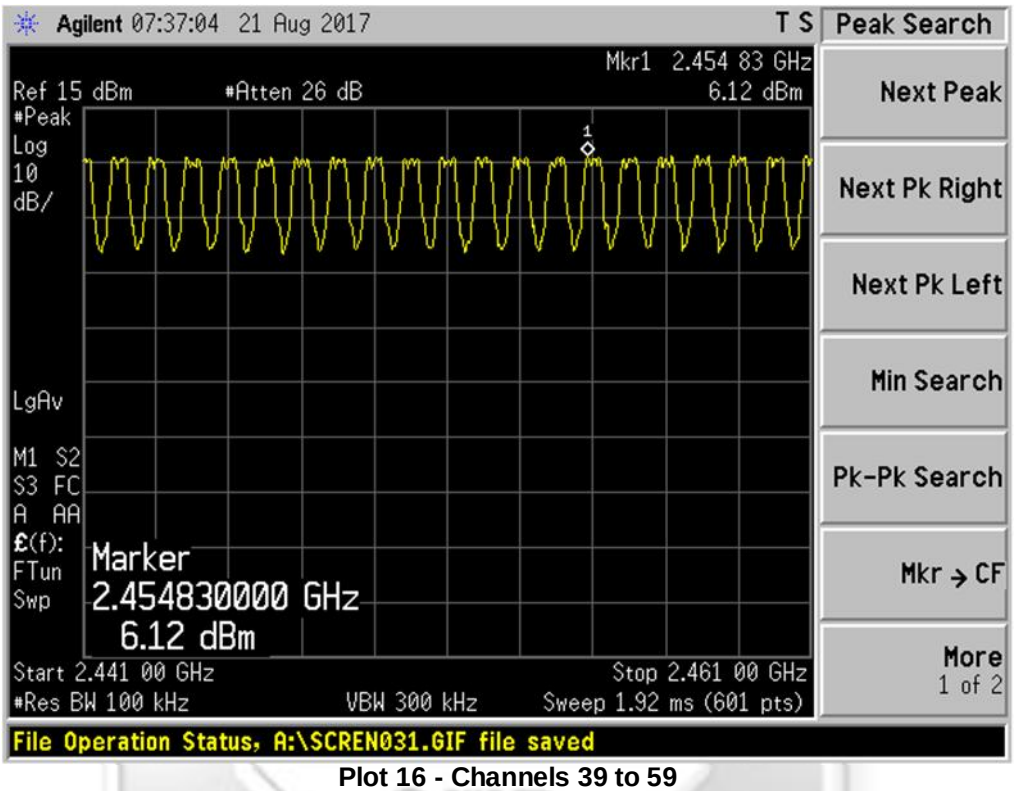


Plot 14 - Channels 0 to 18

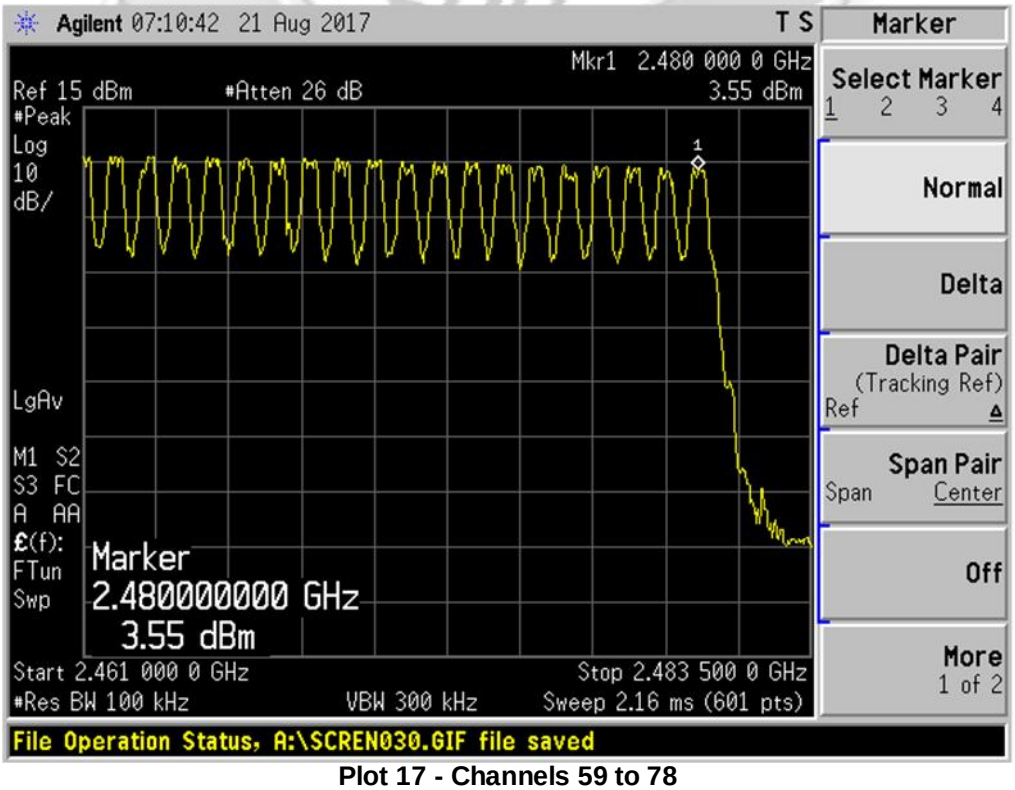


Plot 15 - Channels 18 to 39

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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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	12.5Vdc	Temperature	24ºC
Attached Plots	18 – 26	Relative Humidity	60%
Hopping Rate	1600 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Chang Wai Kit

DH1

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Number of Hops, N	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	0.1543	25280	3.9007	0.4
39 *(mid ch)*	2.441	0.1537	25280	3.8855	0.4
78 *(upper ch)*	2.480	0.1543	25280	3.9007	0.4

DH3

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Number of Hops, N	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	0.1544	12640	1.9516	0.4
39 *(mid ch)*	2.441	0.1554	12640	1.9643	0.4
78 *(upper ch)*	2.480	0.1544	12640	1.9516	0.4

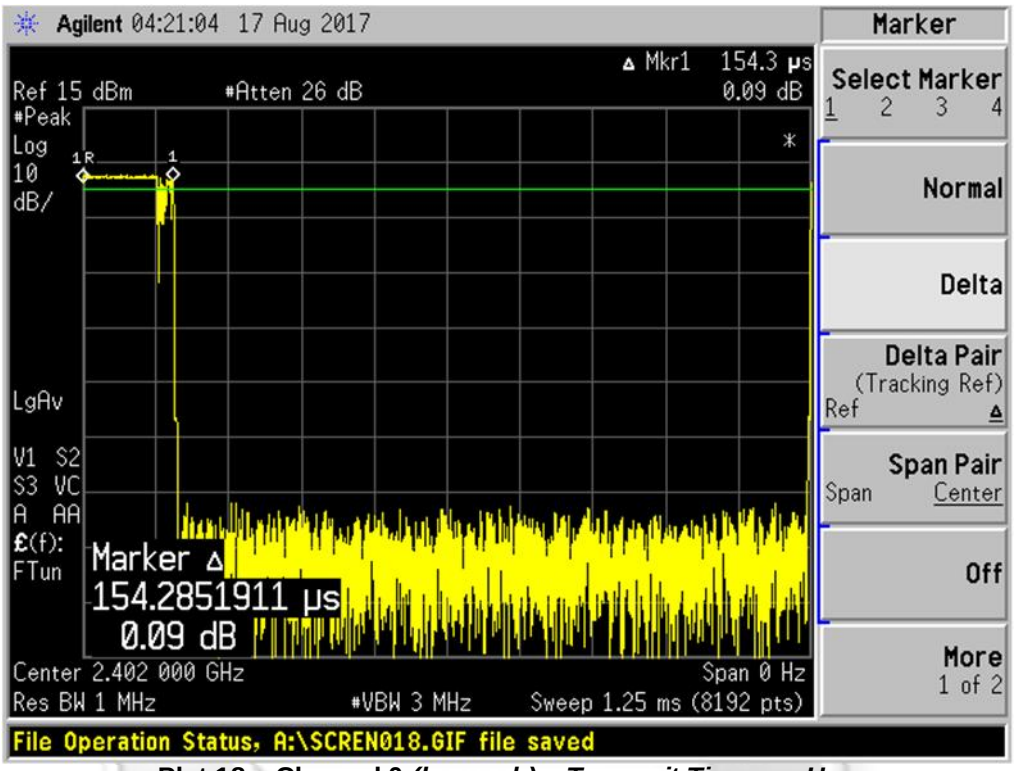
DH5

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Number of Hops, N	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	0.1579	8427	1.3306	0.4
39 *(mid ch)*	2.441	0.1602	8427	1.3500	0.4
78 *(upper ch)*	2.480	0.1602	8427	1.3500	0.4

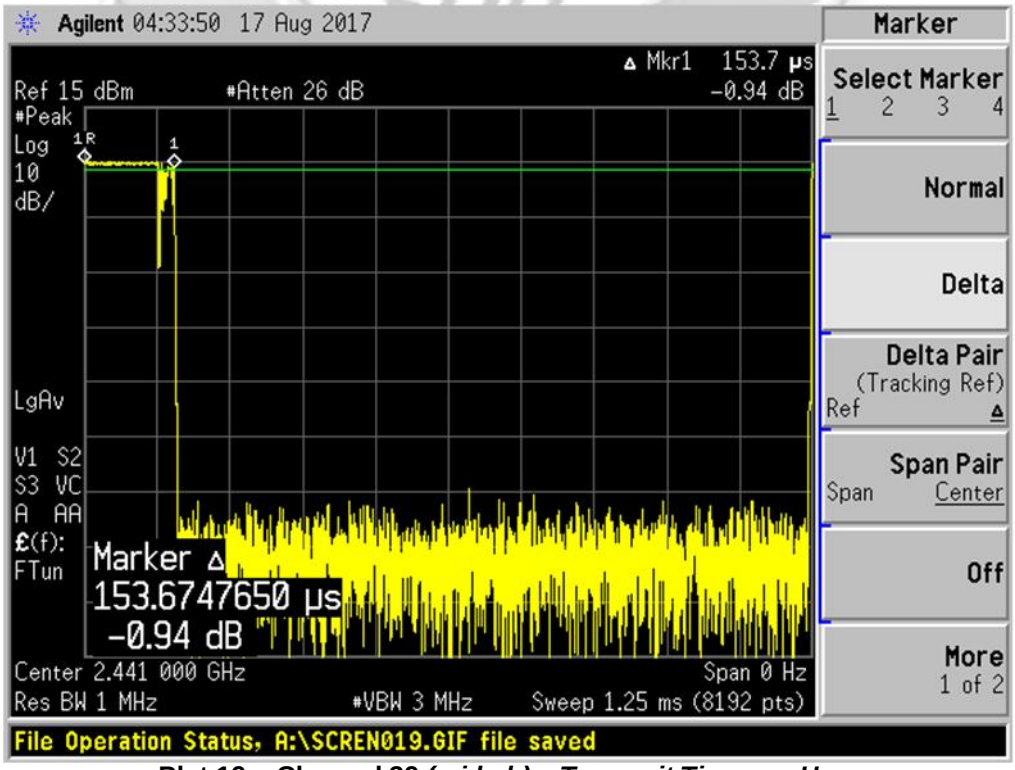
Notes

1. Period specified in the requirement = 31.6s

Average Frequency Dwell Time Plots – DH1

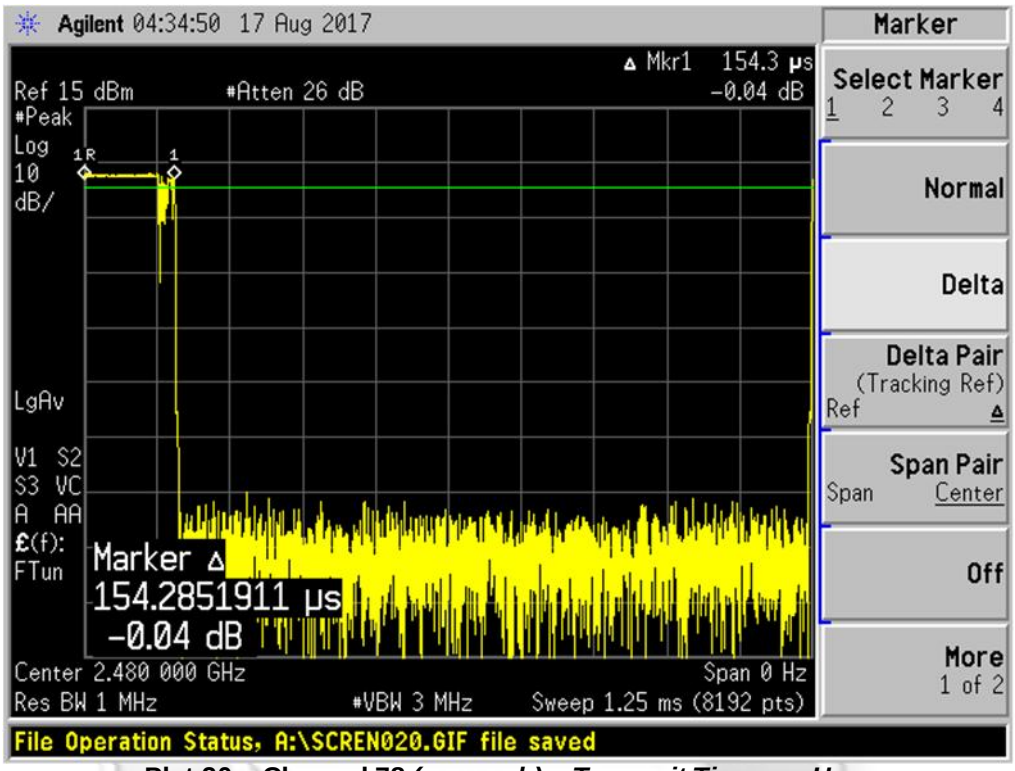


Plot 18 – Channel 0 *(lower ch) – Transmit Time per Hop*



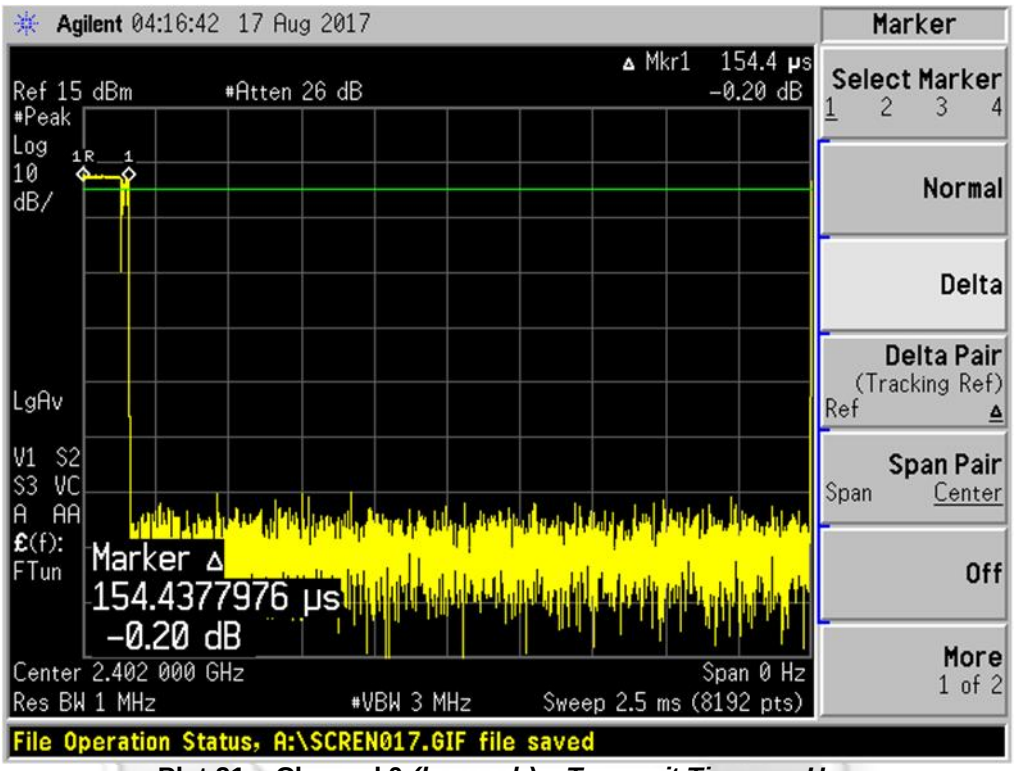
Plot 19 – Channel 39 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH1

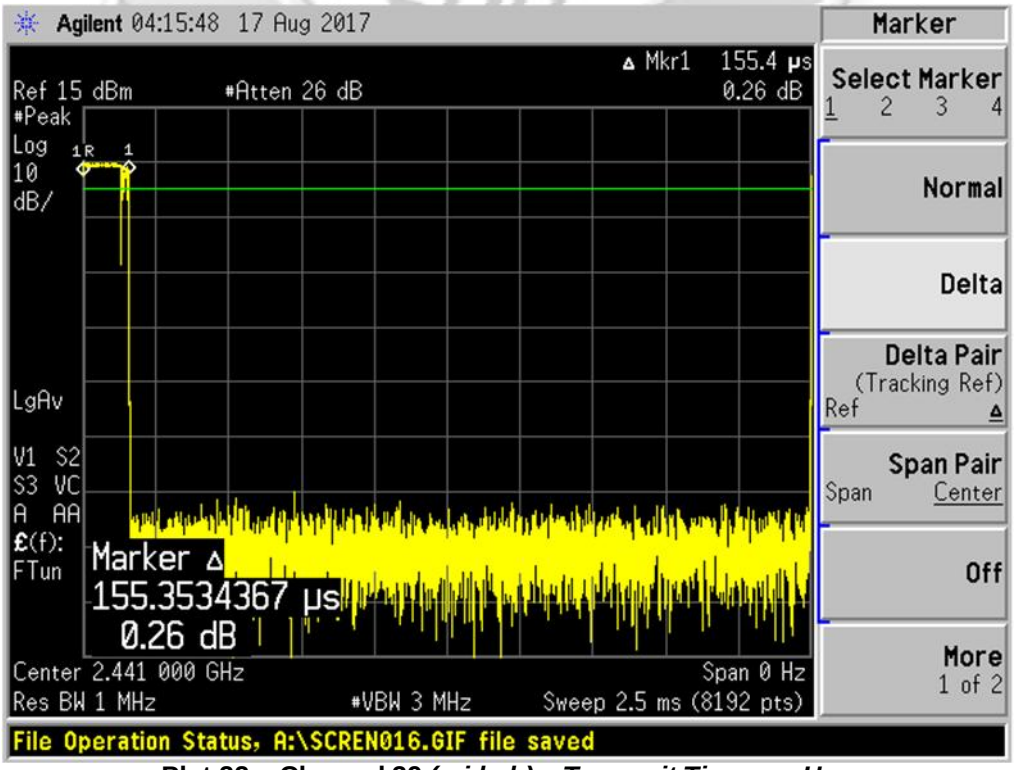


Plot 20 – Channel 78 *(upper ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH3

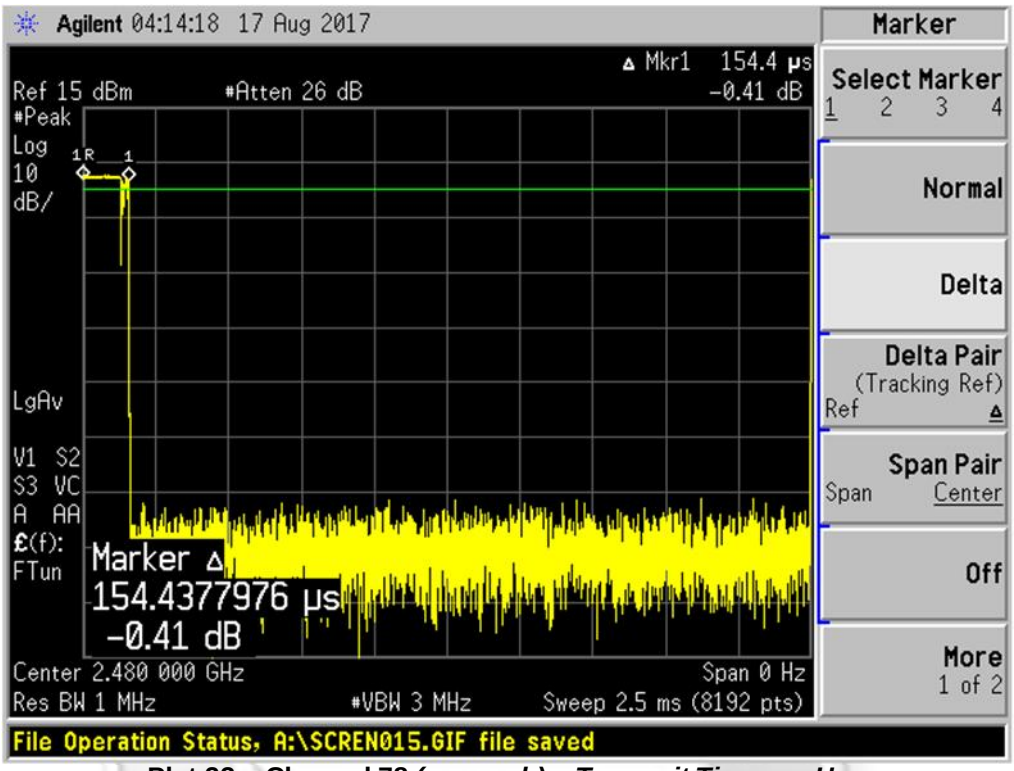


Plot 21 – Channel 0 *(lower ch) – Transmit Time per Hop*



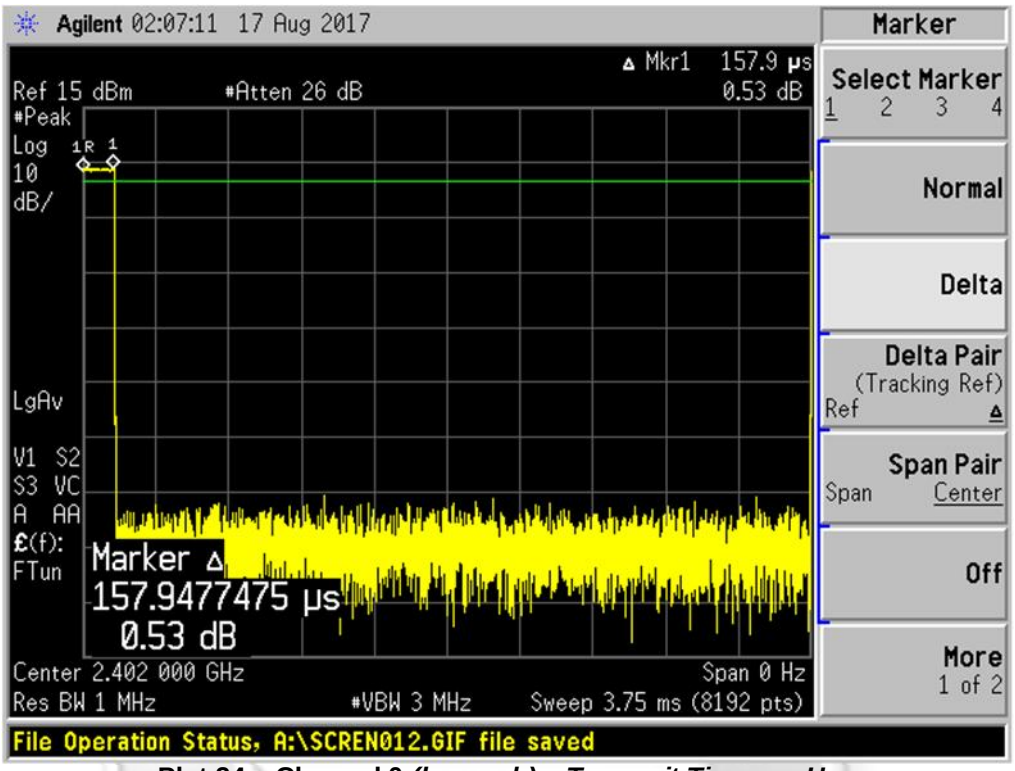
Plot 22 – Channel 39 *(mid ch) – Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH3

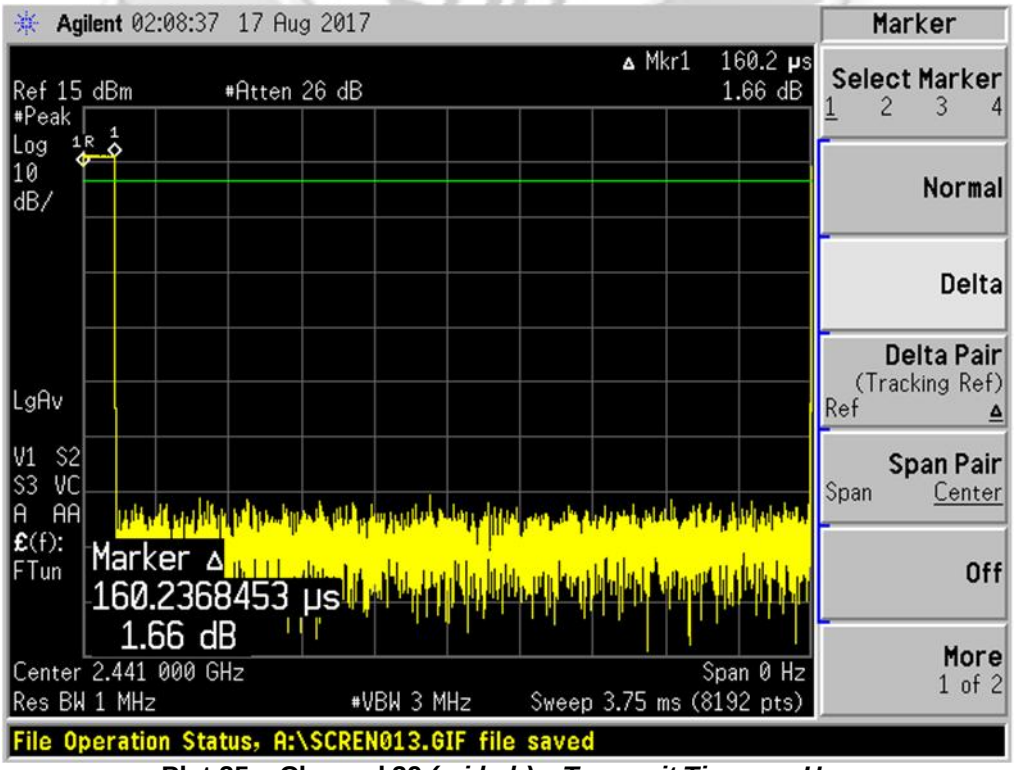


Plot 23 – Channel 78 *(upper ch)* – *Transmit Time per Hop*

Average Frequency Dwell Time Plots – DH5

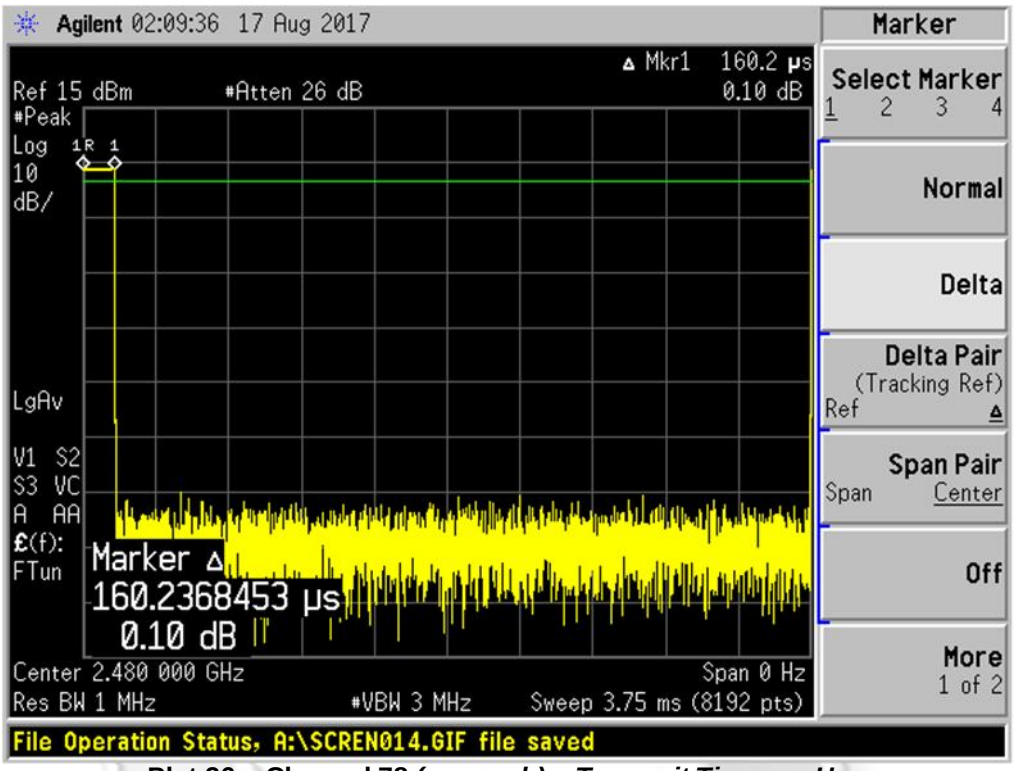


Plot 24 – Channel 0 *(lower ch) – Transmit Time per Hop*



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

Average Frequency Dwell Time Plots – DH5



Plot 26 – Channel 78 *(upper 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
Boonton Electronics RF Power Meter	4532	72901	26 Aug 2018
Boonton Electronics Peak Power Sensor	56218-S/1	1417	26 Aug 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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 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	12.5Vdc	Temperature	24ºC
Antenna Gain	2.75 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	Data Rate (Mbps)	Maximum Peak Power (W)	Limit (W)
0 *(lower ch)*	2.402	GFSK	0.0009	1.0
39 *(mid ch)*	2.441		0.0015	1.0
78 *(upper ch)*	2.480		0.0009	1.0
0 *(lower ch)*	2.402	(π/4) DQPSK	0.0005	1.0
39 *(mid ch)*	2.441		0.0008	1.0
78 *(upper ch)*	2.480		0.0005	1.0
0 *(lower ch)*	2.402	8DPSK	0.0005	1.0
39 *(mid ch)*	2.441		0.0008	1.0
78 *(upper ch)*	2.480		0.0005	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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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

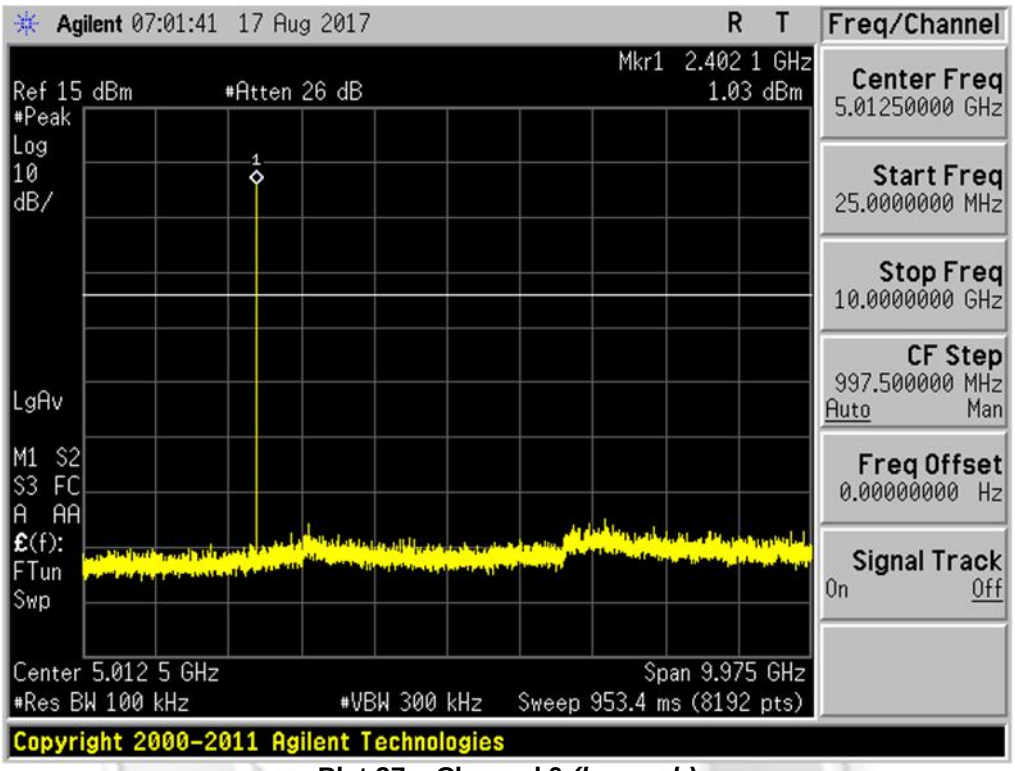
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and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

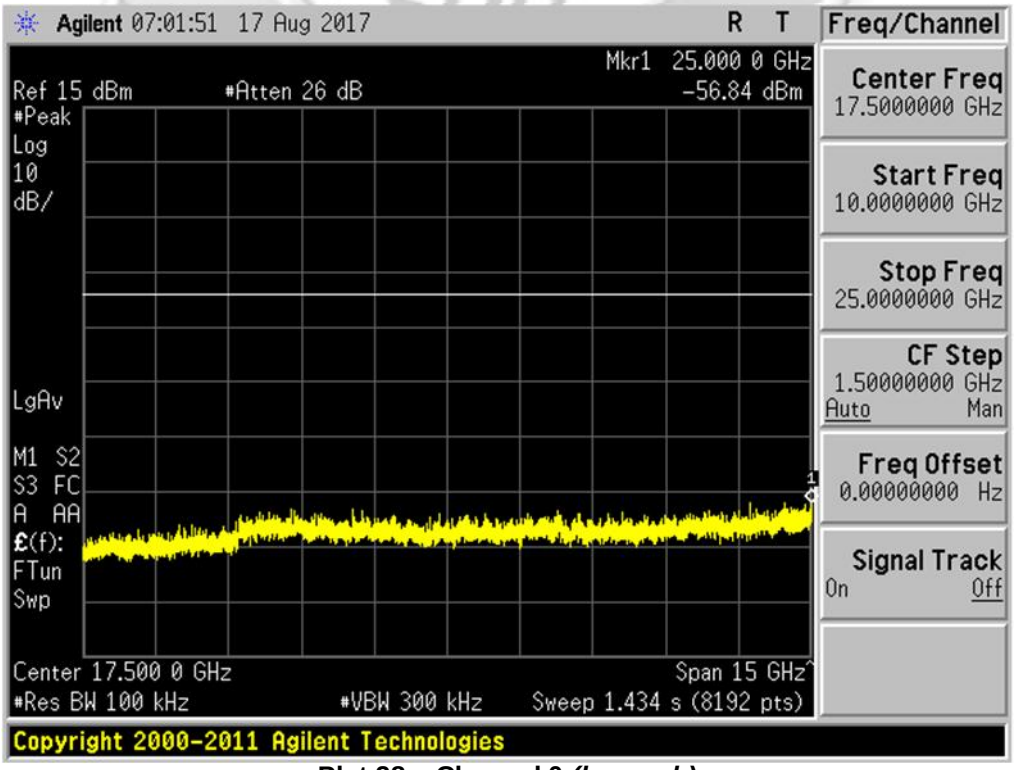
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	27 – 44	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

RF Conducted Spurious Emissions Plots – GFSK

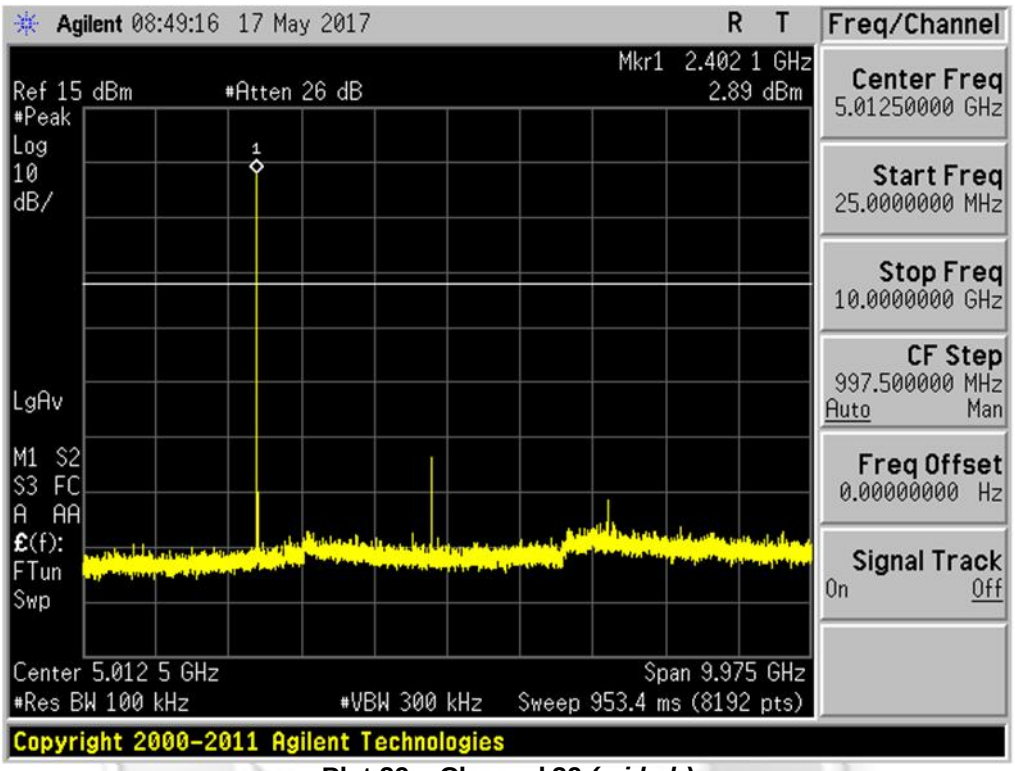


Plot 27 – Channel 0 *(lower ch)*

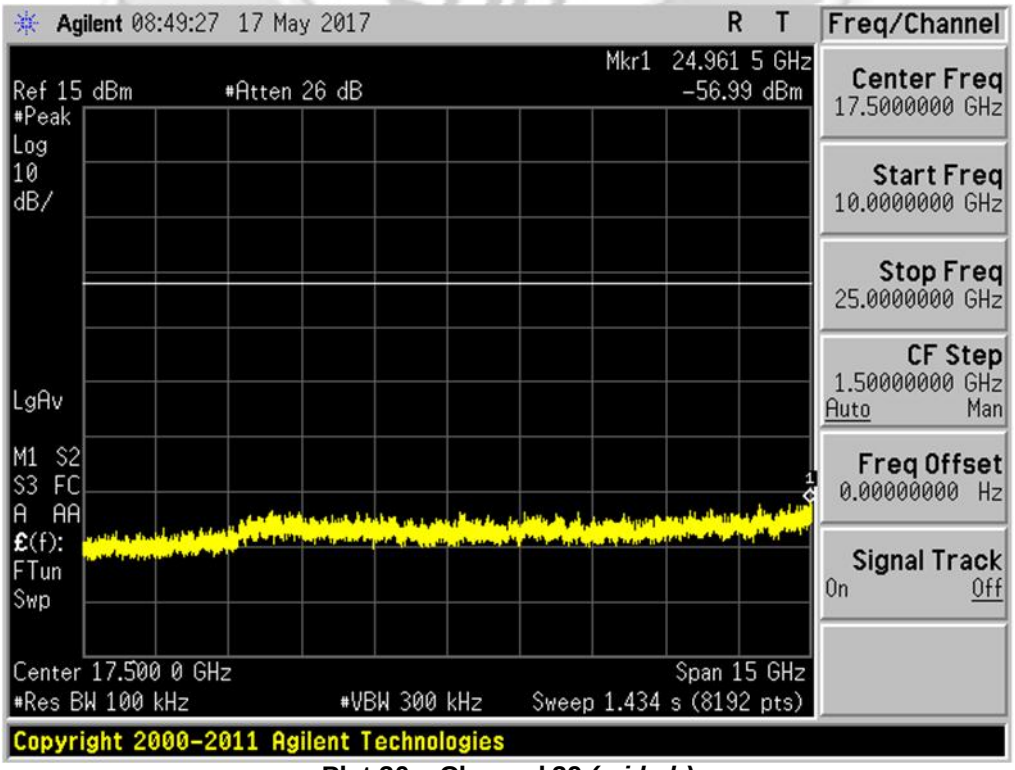


Plot 28 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – GFSK

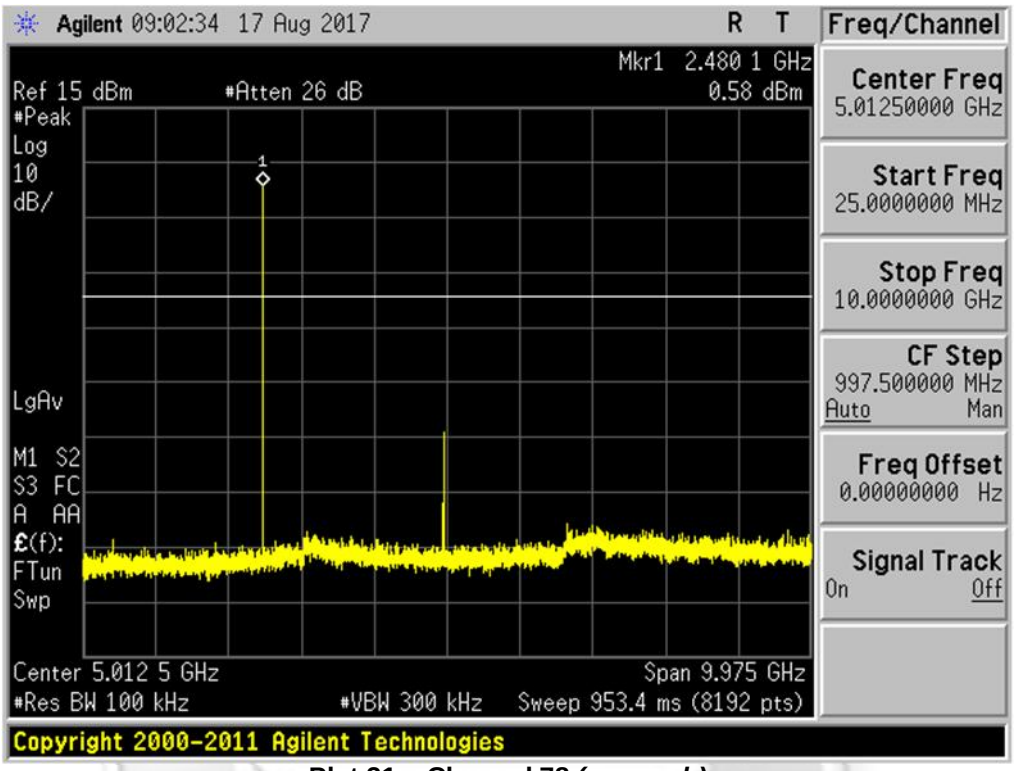


Plot 29 – Channel 39 *(mid ch)*

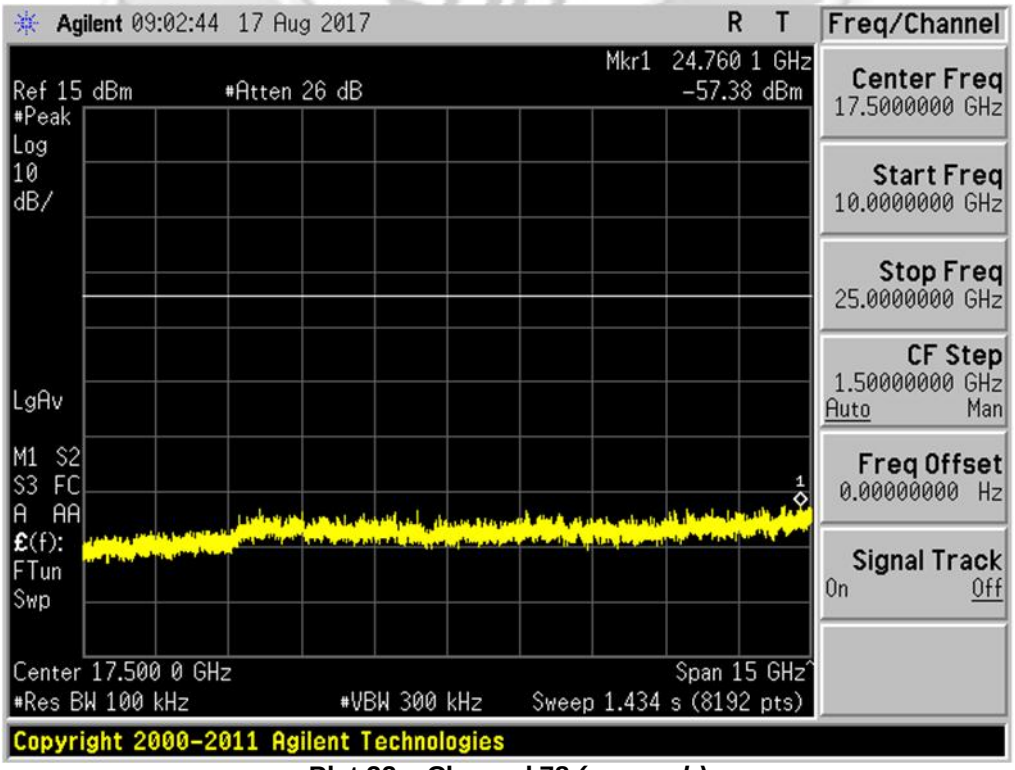


Plot 30 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – GFSK

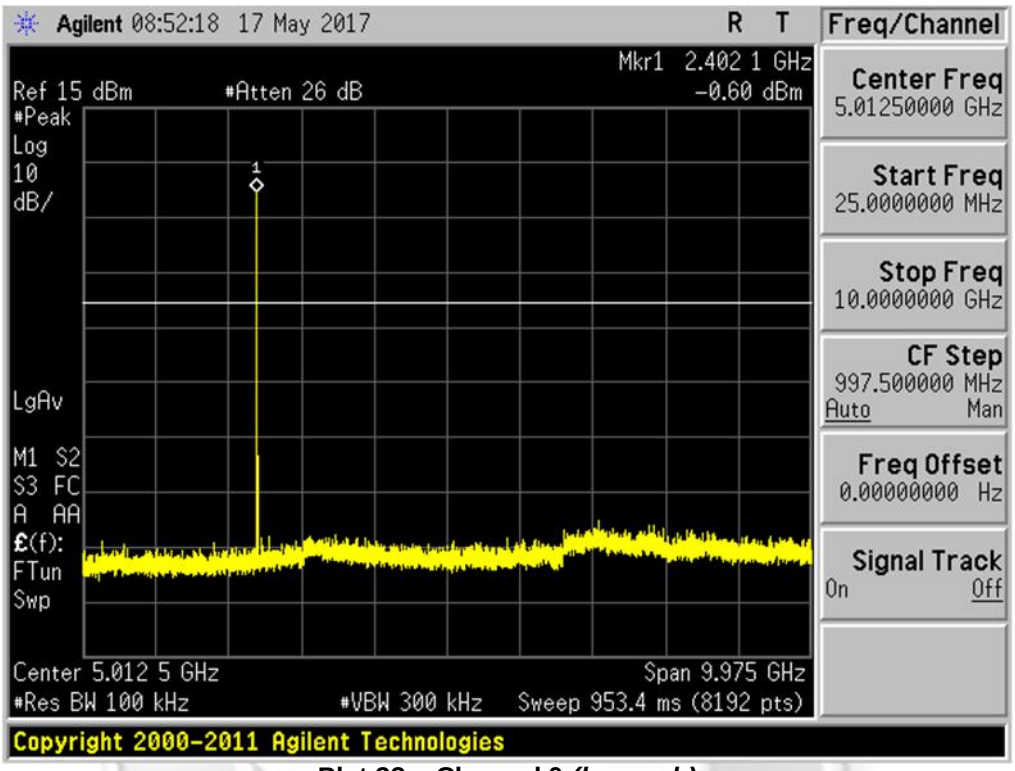


Plot 31 – Channel 78 *(upper ch)*

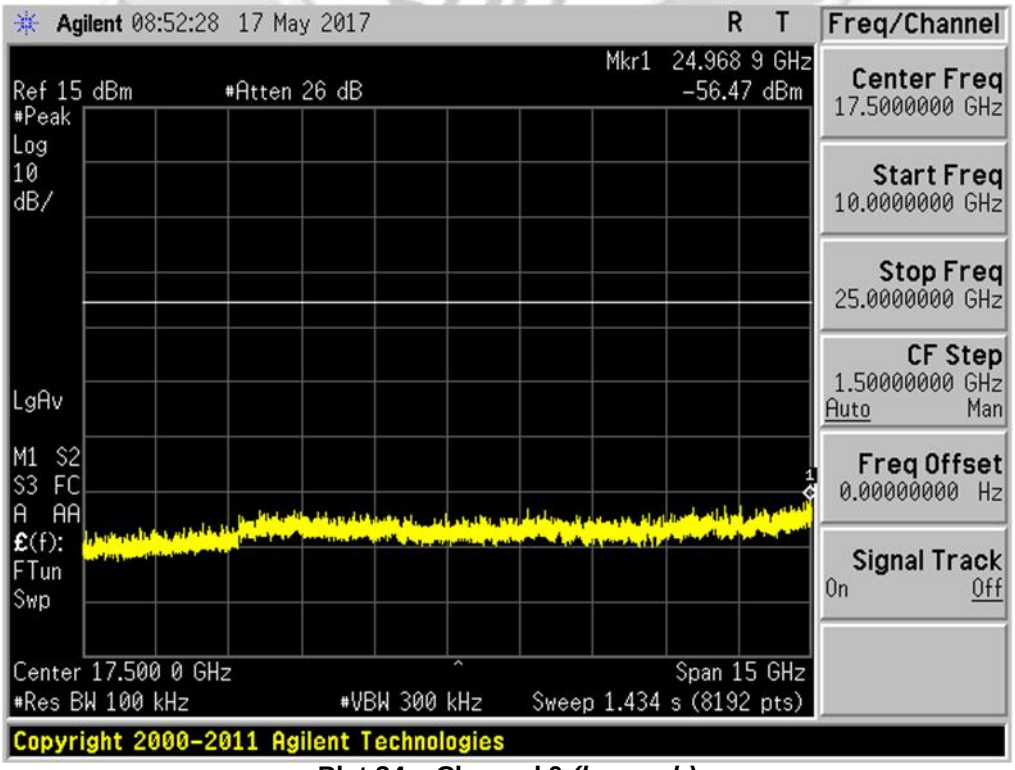


Plot 32 – Channel 78 *(upper ch)*

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

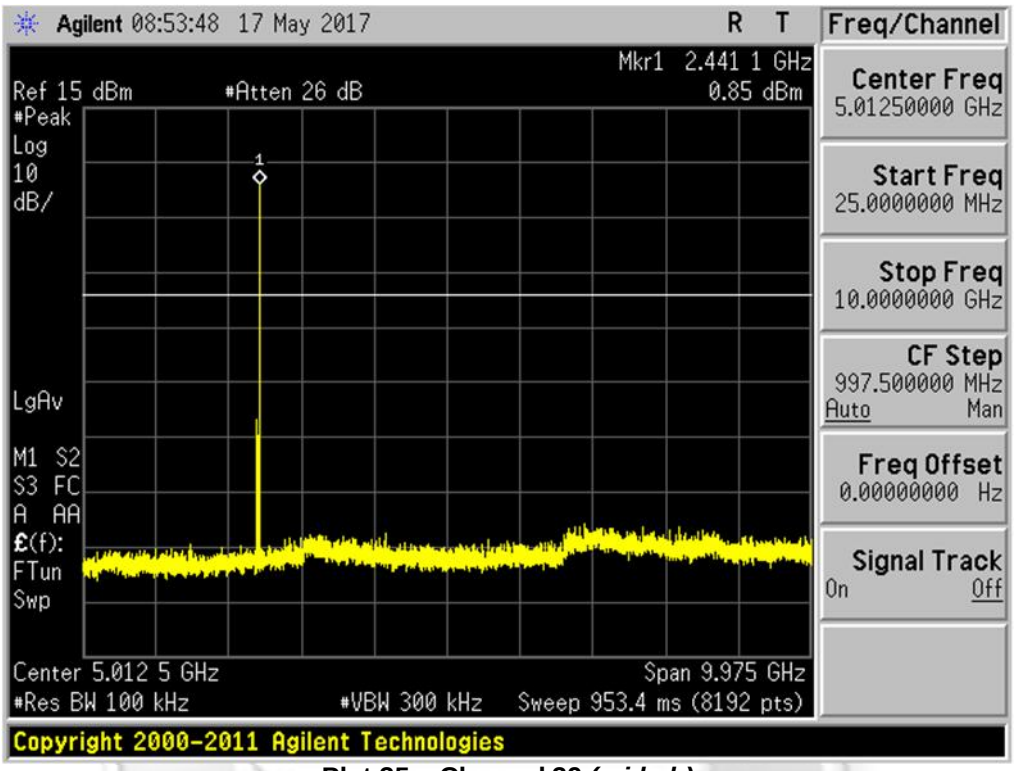


Plot 33 – Channel 0 ***(lower ch)***

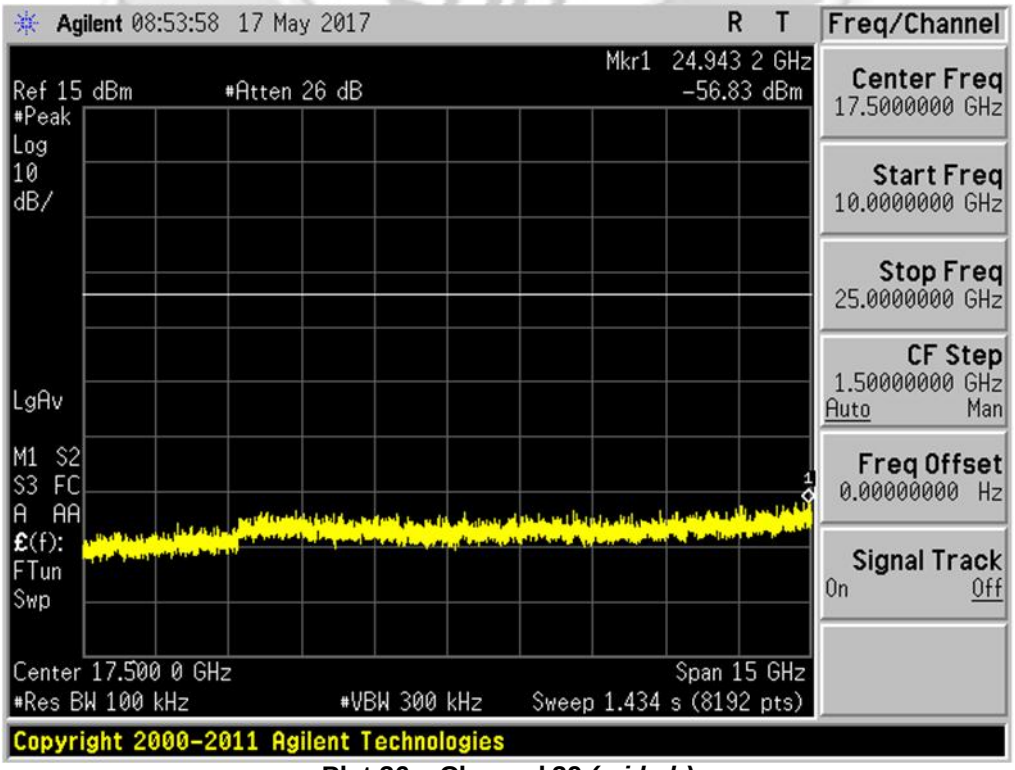


Plot 34 – Channel 0 ***(lower ch)***

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

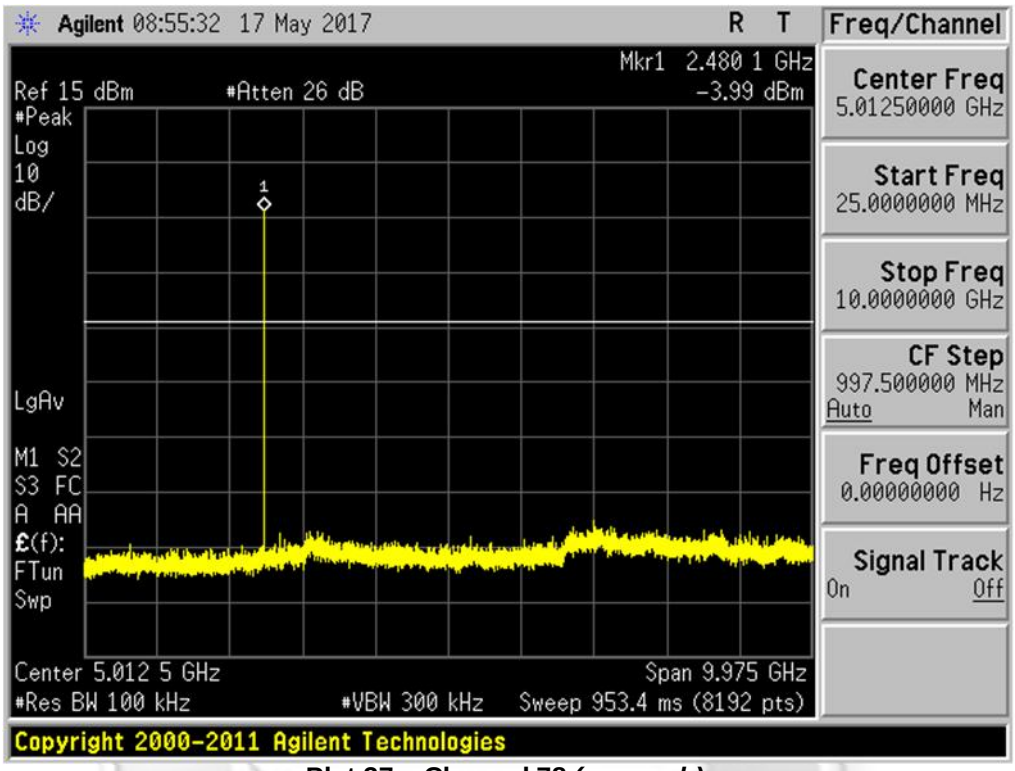


Plot 35 – Channel 39 *(mid ch)*

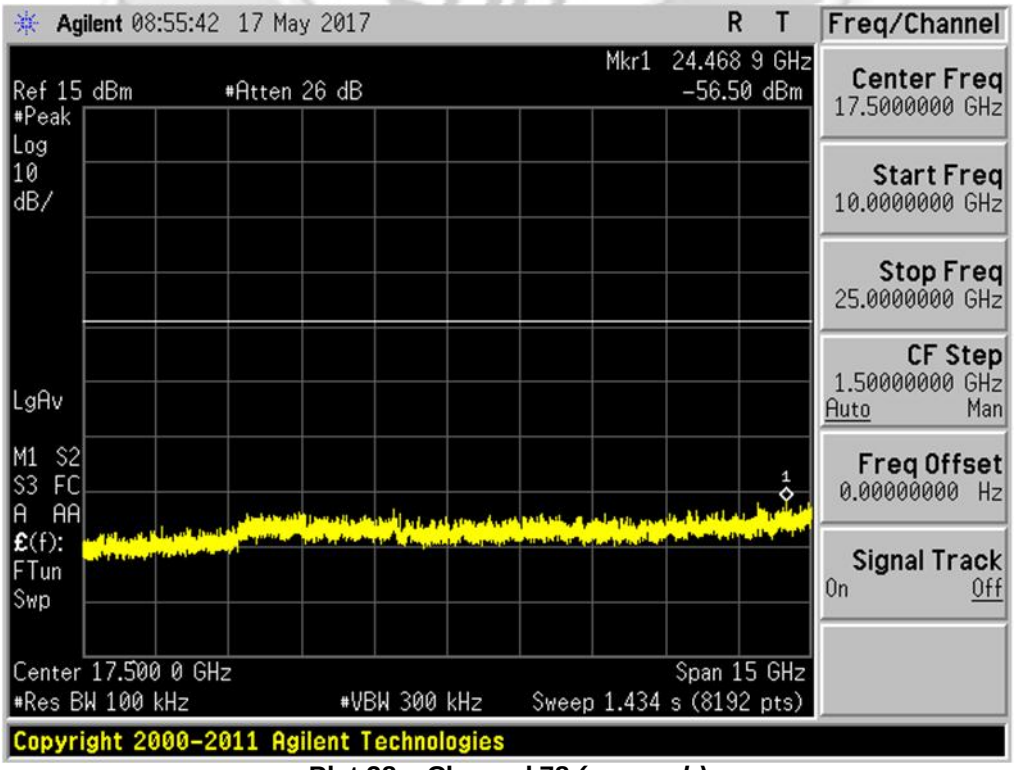


Plot 36 – Channel 39 *(mid ch)*

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

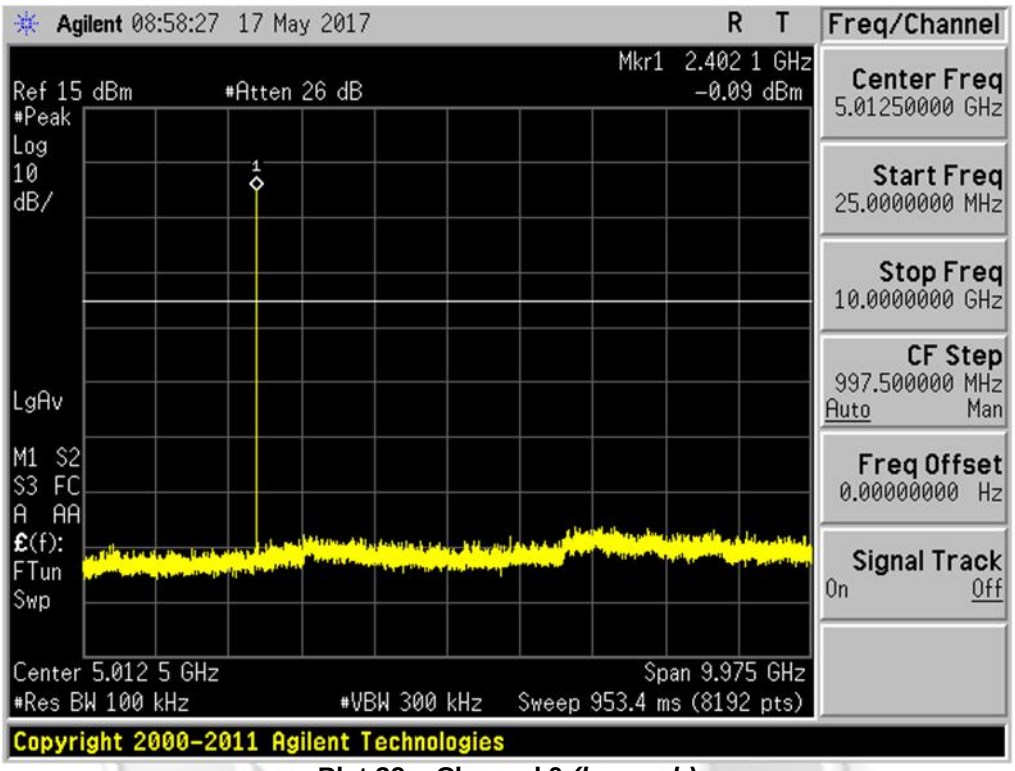


Plot 37 – Channel 78 *(upper ch)*

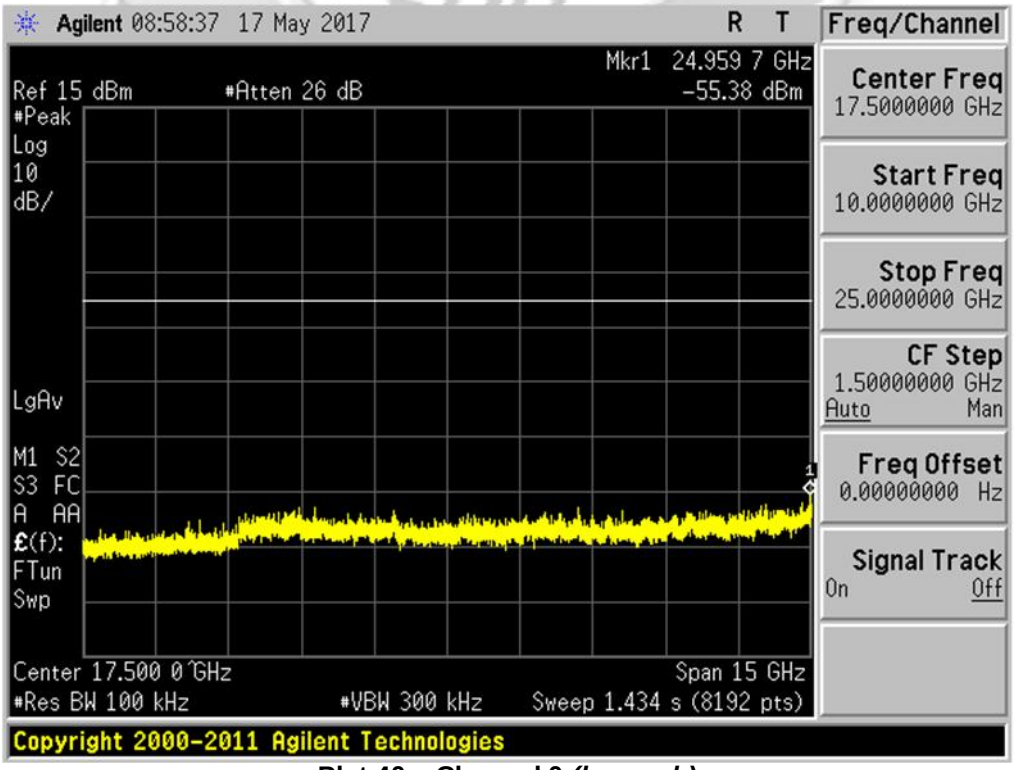


Plot 38 – Channel 78 *(upper ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

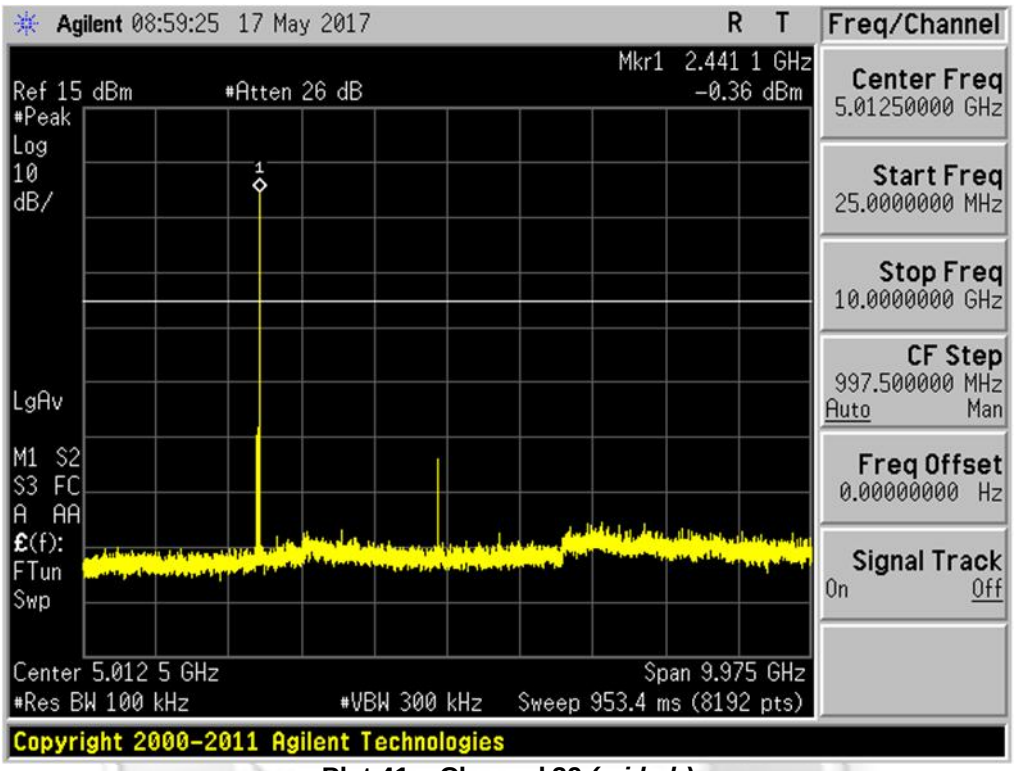


Plot 39 – Channel 0 *(lower ch)*

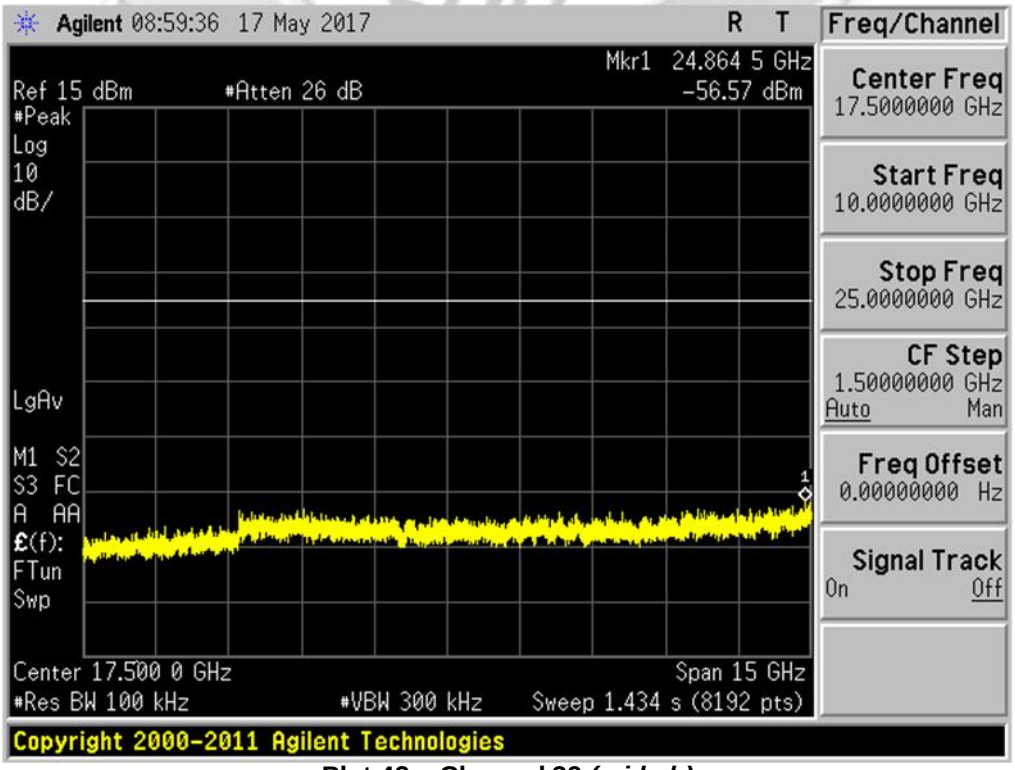


Plot 40 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

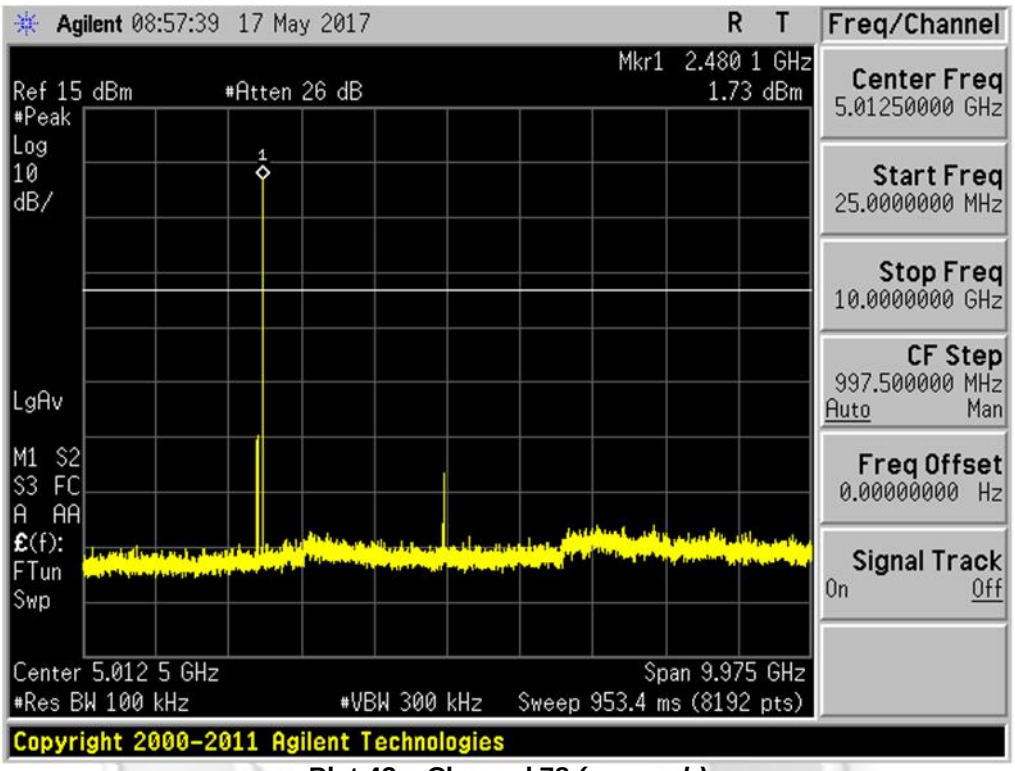


Plot 41 – Channel 39 *(mid ch)*

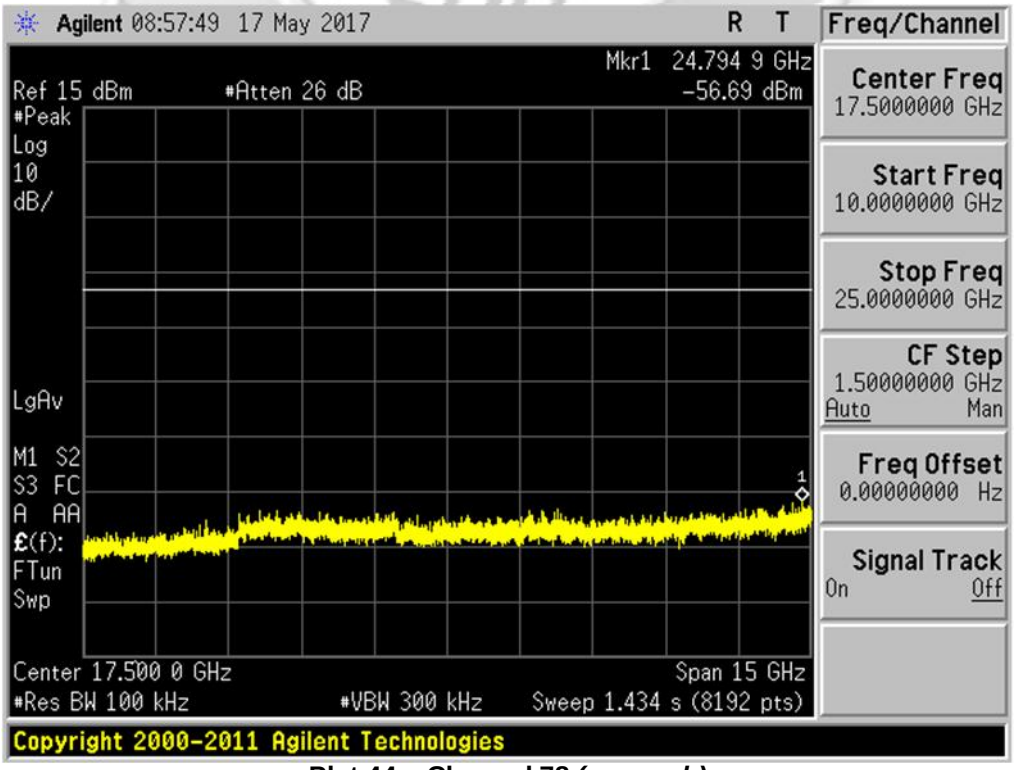


Plot 42 – Channel 39 *(mid ch)*

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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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 1MHz and 3MHz.
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

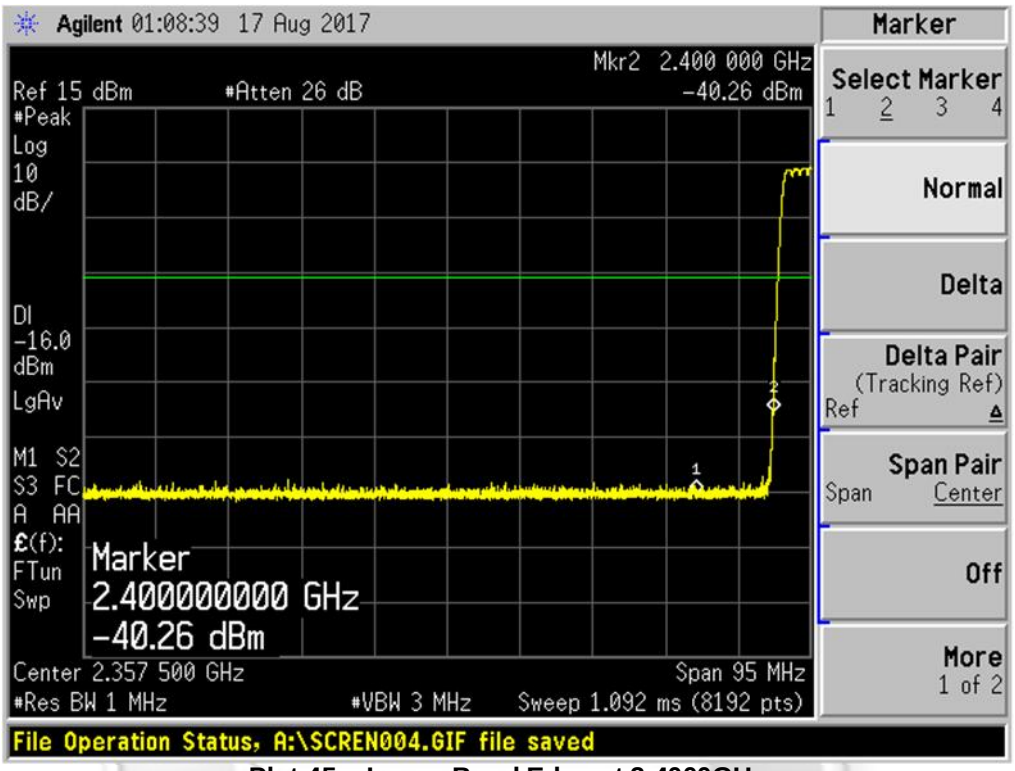
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band,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

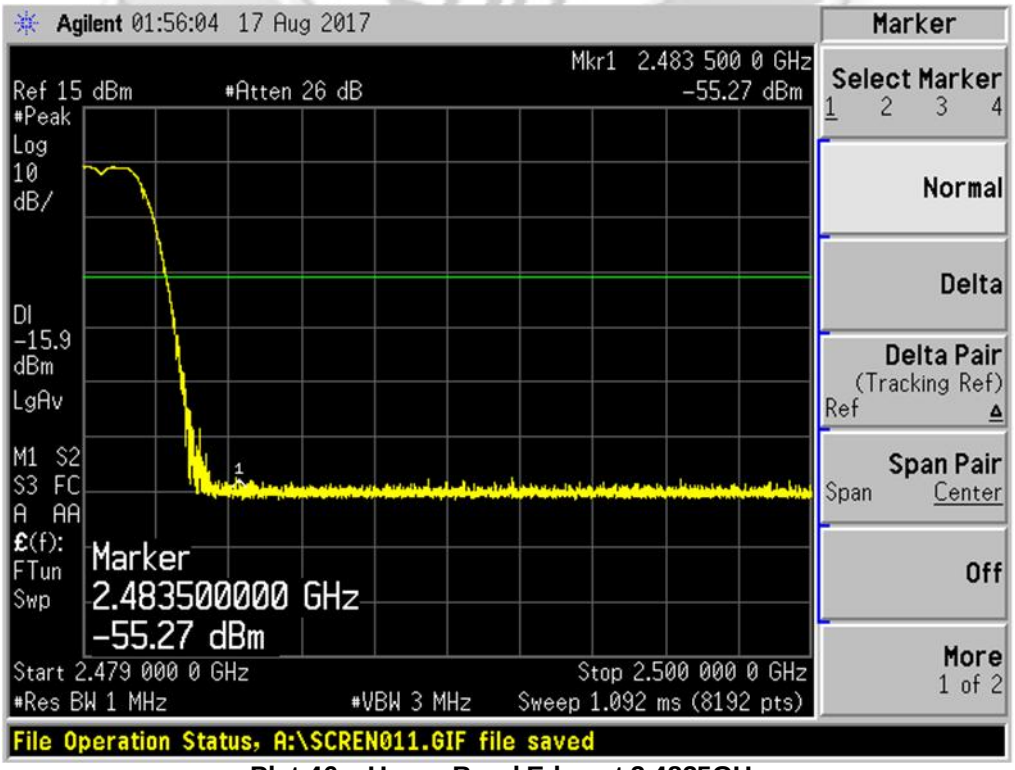
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	45 – 56	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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

Band Edge Compliance (Conducted) Plots – Frequency Hopping On (GFSK)

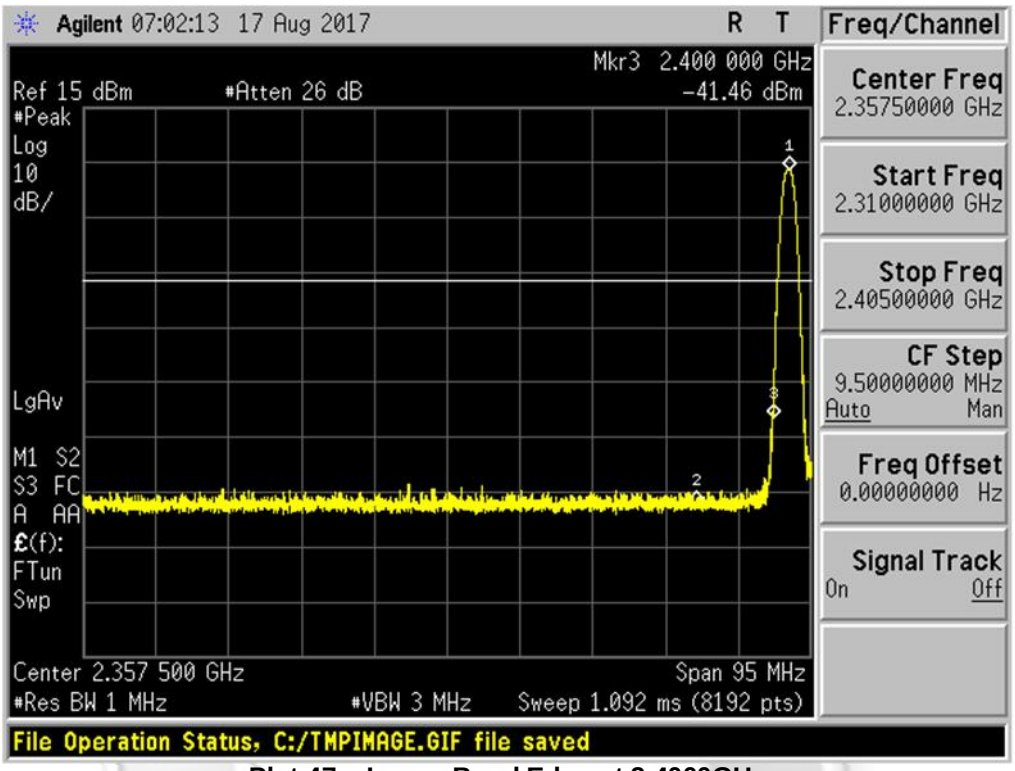


Plot 45 – Lower Band Edge at 2.4000GHz

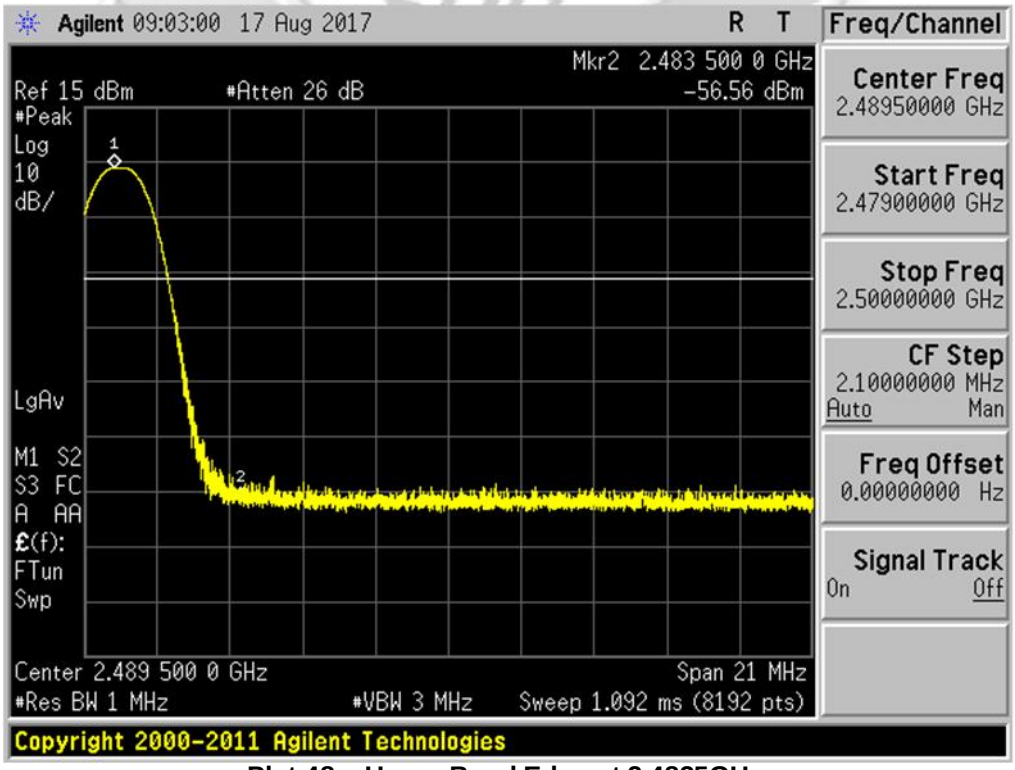


Plot 46 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – Frequency Hopping Off (GFSK)

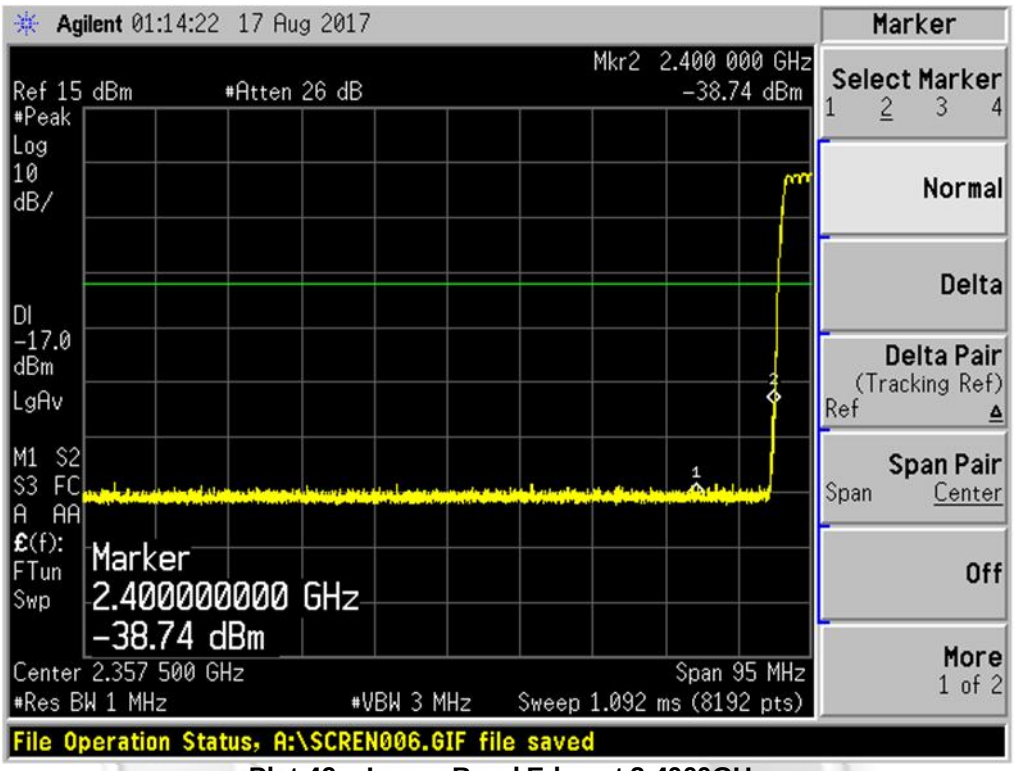


Plot 47 – Lower Band Edge at 2.4000GHz

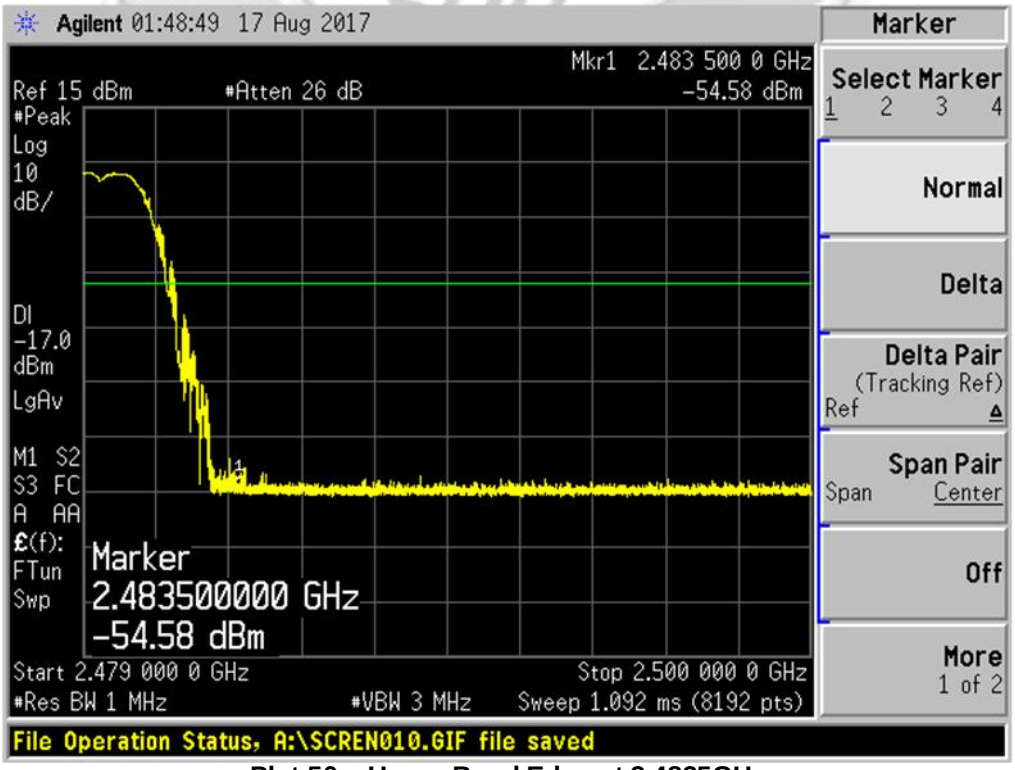


Plot 48 – Upper Band Edge at 2.4835GHz

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

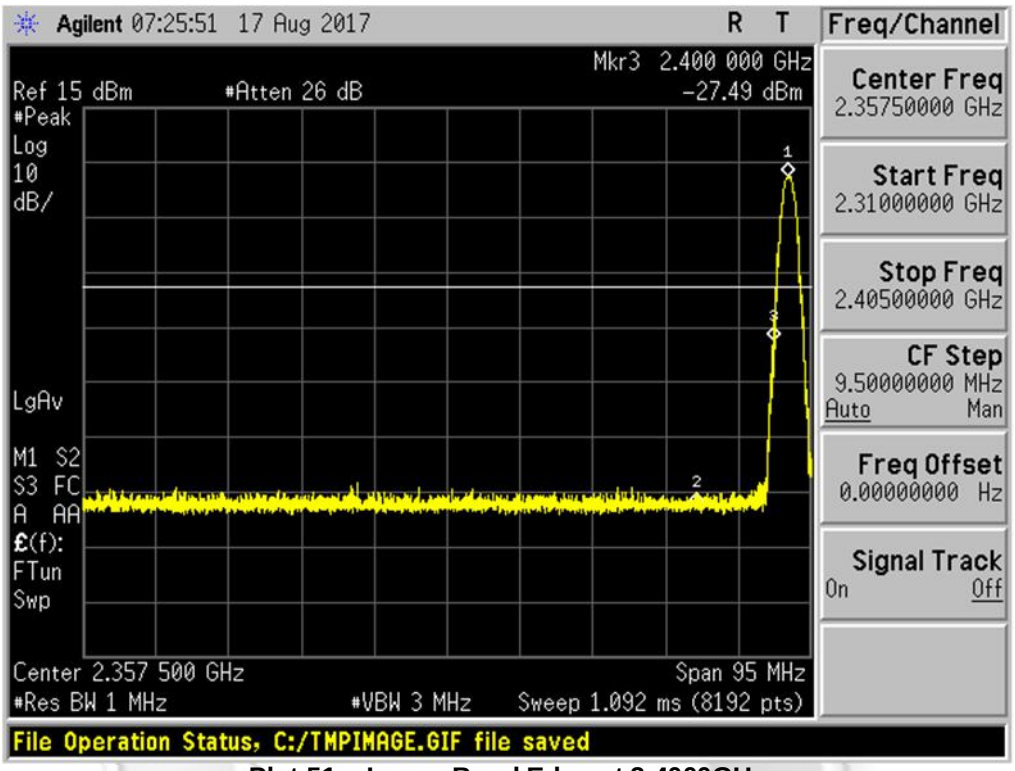


Plot 49 – Lower Band Edge at 2.4000GHz

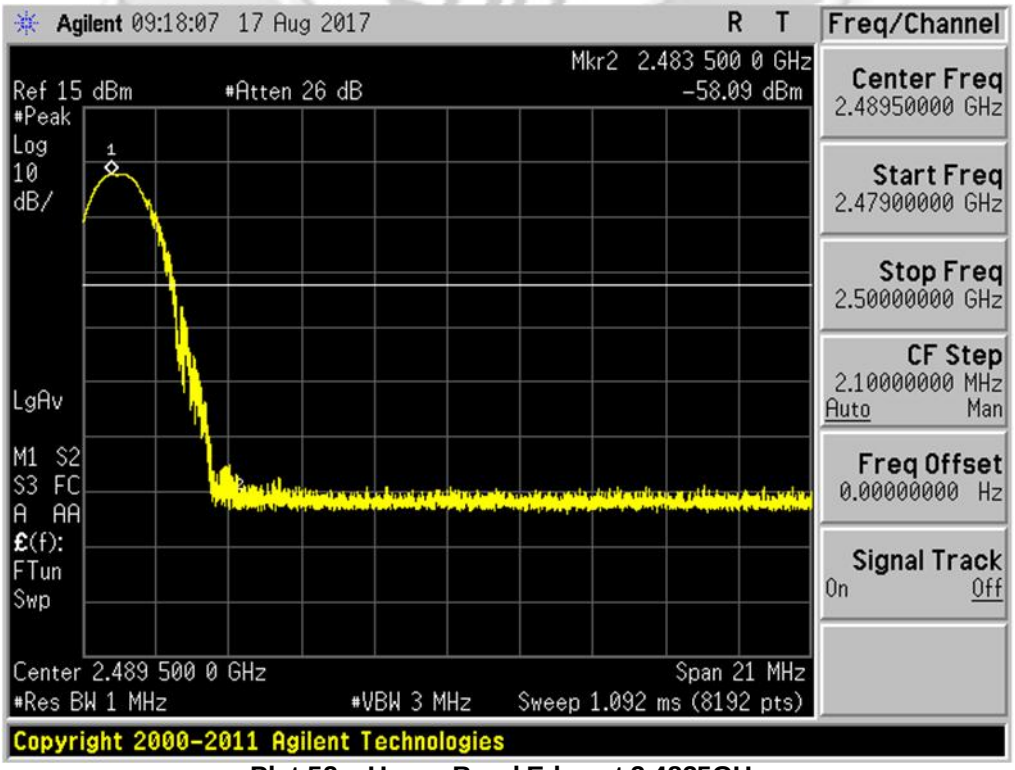


Plot 50 – Upper Band Edge at 2.4835GHz

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

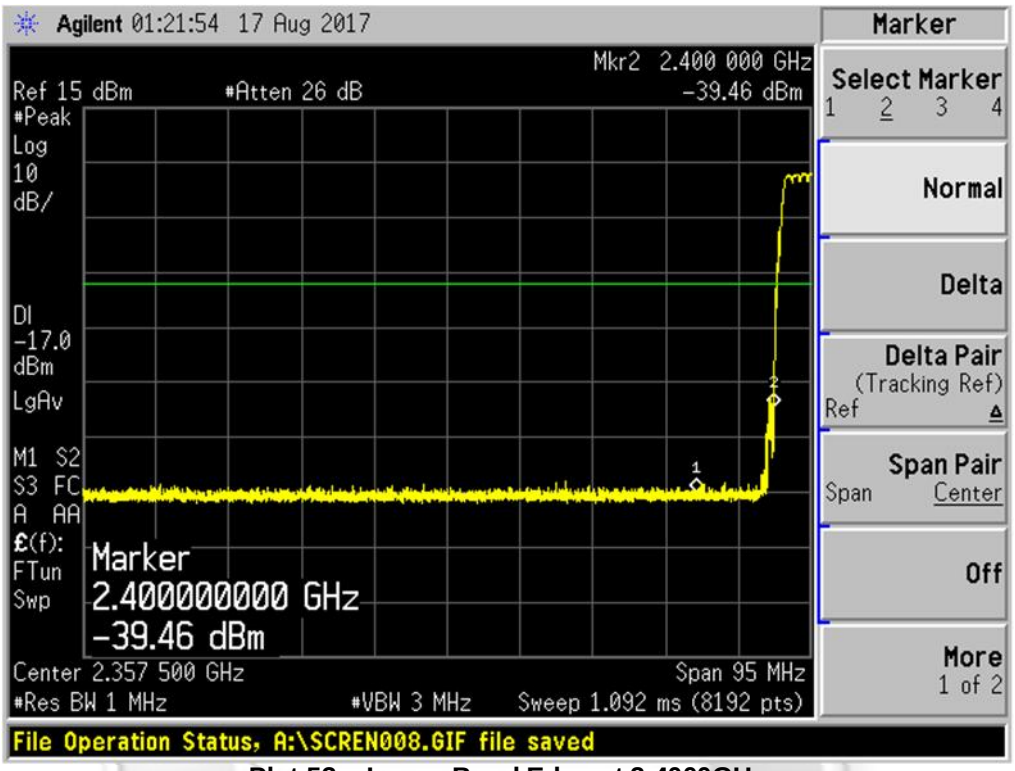


Plot 51 – Lower Band Edge at 2.4000GHz

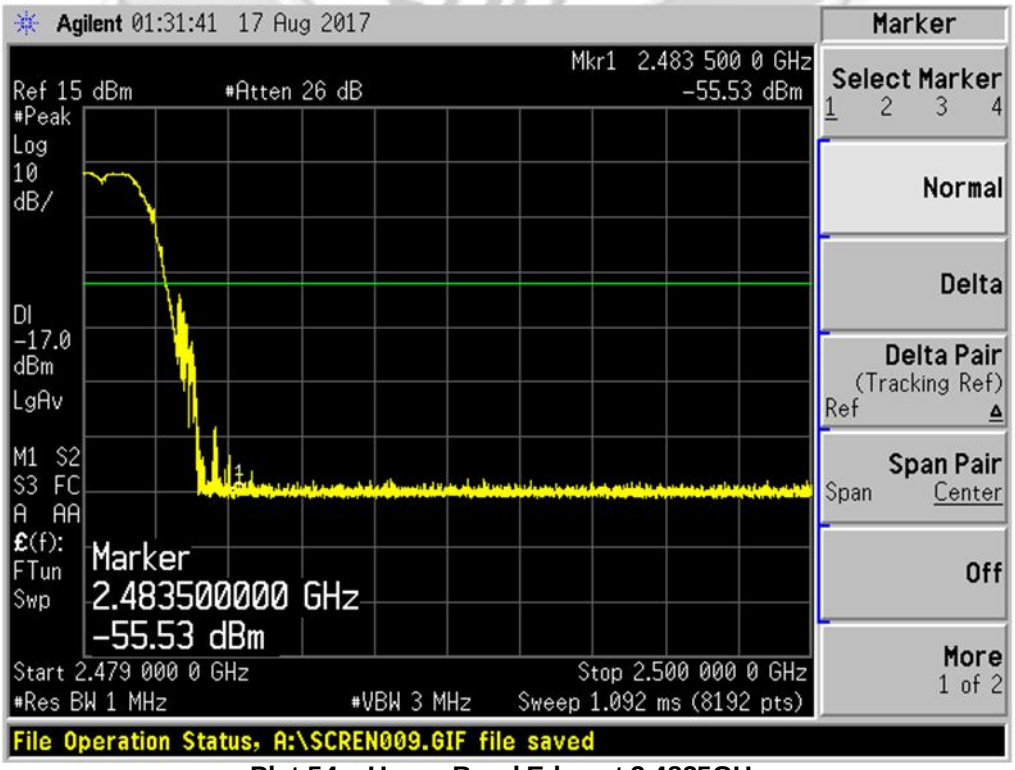


Plot 52 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – Frequency Hopping On (8DPSK)

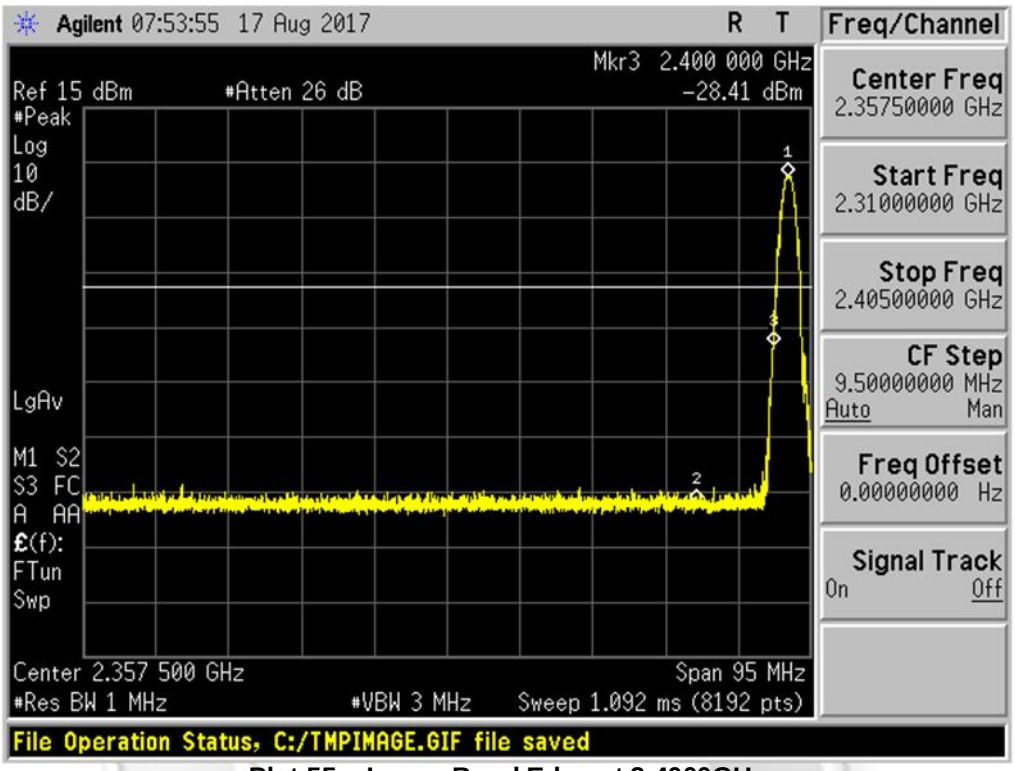


Plot 53 – Lower Band Edge at 2.4000GHz

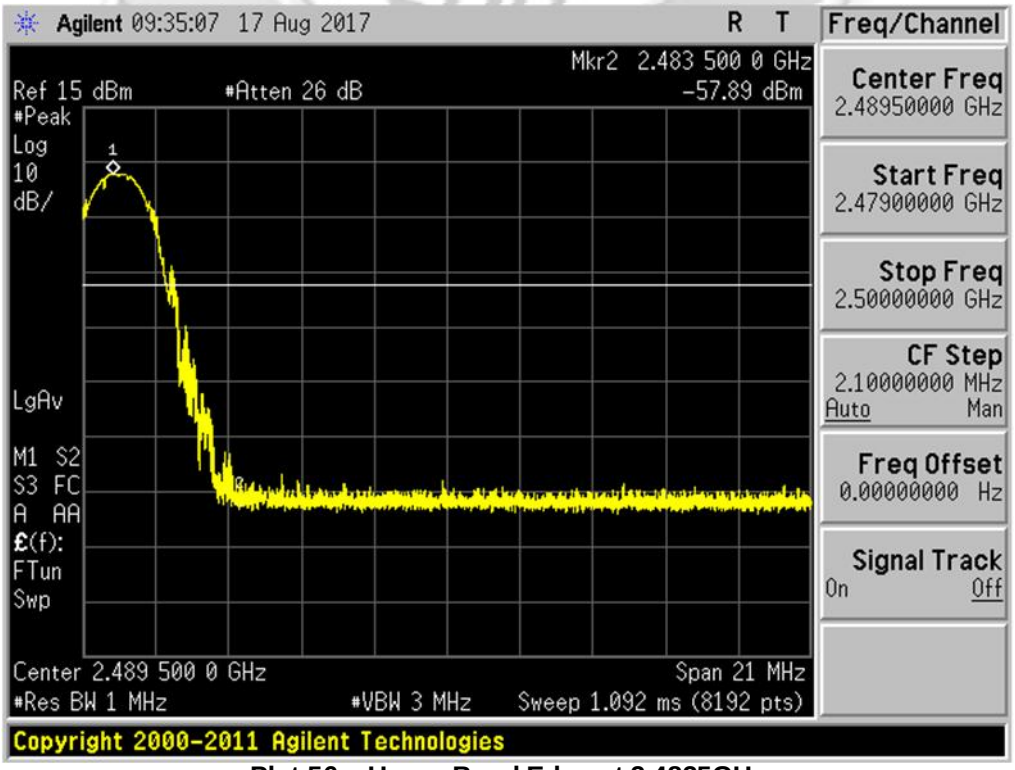


Plot 54 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – Frequency Hopping Off (8DPSK)



Plot 55 – Lower Band Edge at 2.4000GHz



Plot 56 – 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 EMI Test Receiver	ESU40	100355	14 Sep 2018
Eletro-Metrics Double Ridged Antenna (Horn) Antenna (1-18GHz)	EM-6961	6525	08 Apr 2018
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	10 Mar 2018

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

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The resolution bandwidth (RBW) and the video bandwidth (VBW) of the spectrum analyser were respectively set to 100kHz and 300kHz to show compliance of spurious at band edges are at least 20dB below the carriers. For restricted band spurious at band edges, peak and average measurement plots were taken using the following setting:
   a. Peak Plot:
      RBW = 1MHz, VBW = 3RBW
   b. Average Plot
      RBW = 1MHz, VBW = 10Hz
4. All other supporting equipment were powered separately from another filtered mains.

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

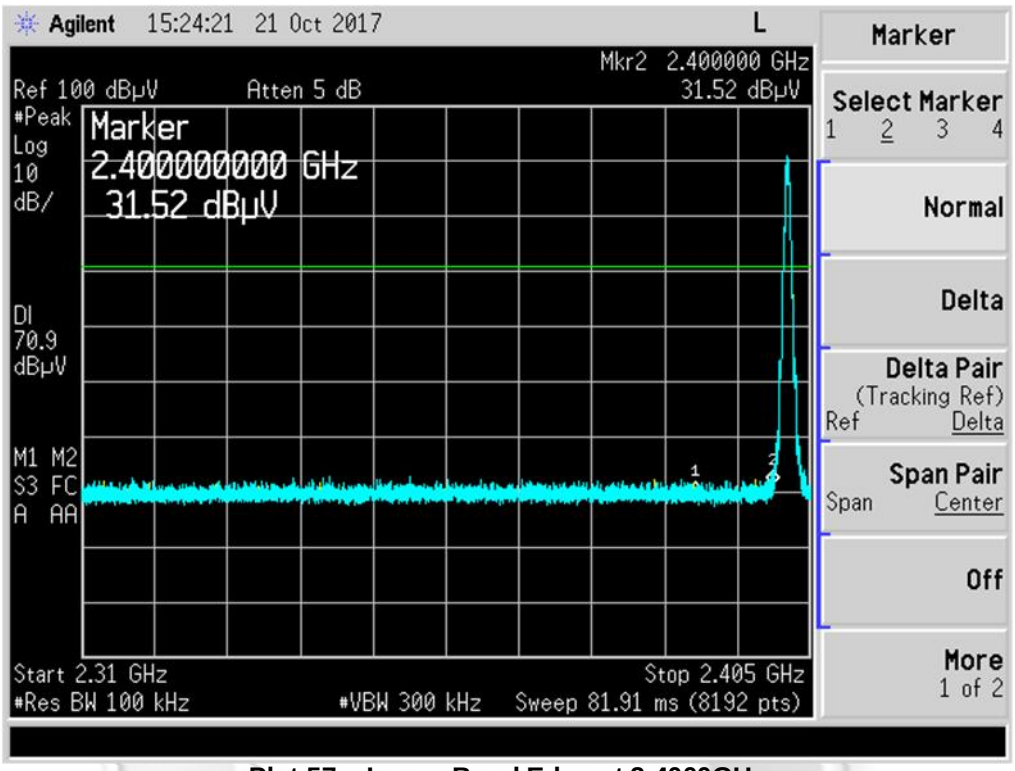
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions at the band edge.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.
4. The steps 2 to 3 were repeated with the frequency span of the spectrum analyser was set to wide enough to capture the upper band edge frequency of the transmission band, 2.4835GHz and the any spurious emissions at the band-edge.

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

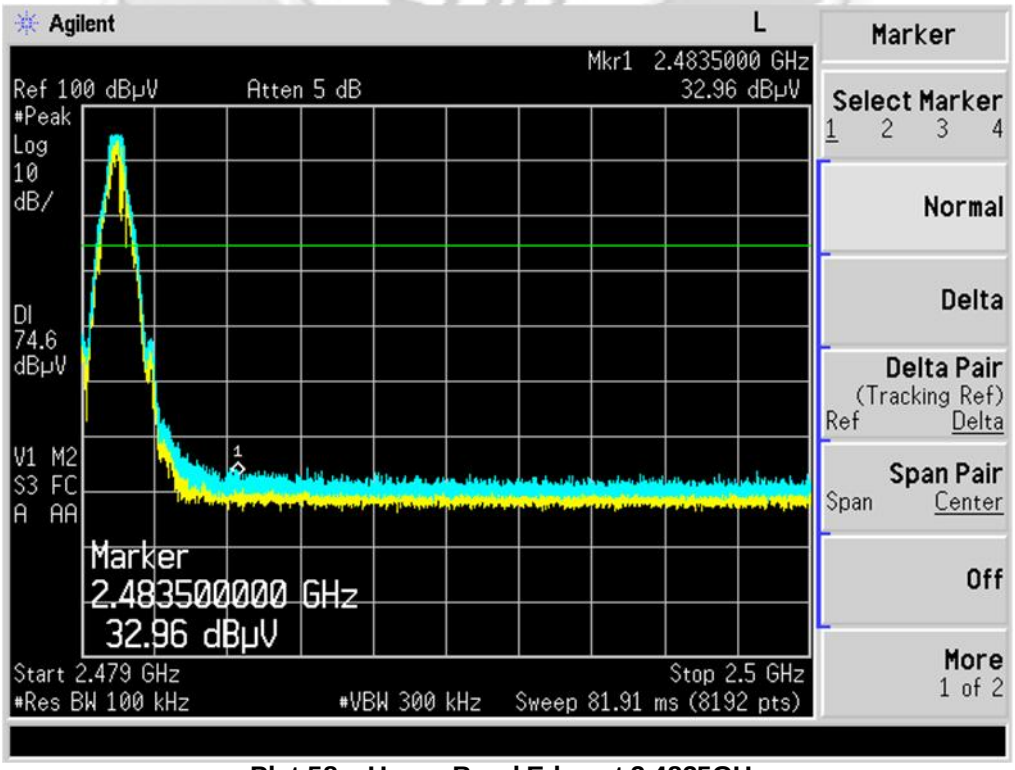
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	57 – 62	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Kelvin Cheng

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) (Worst)

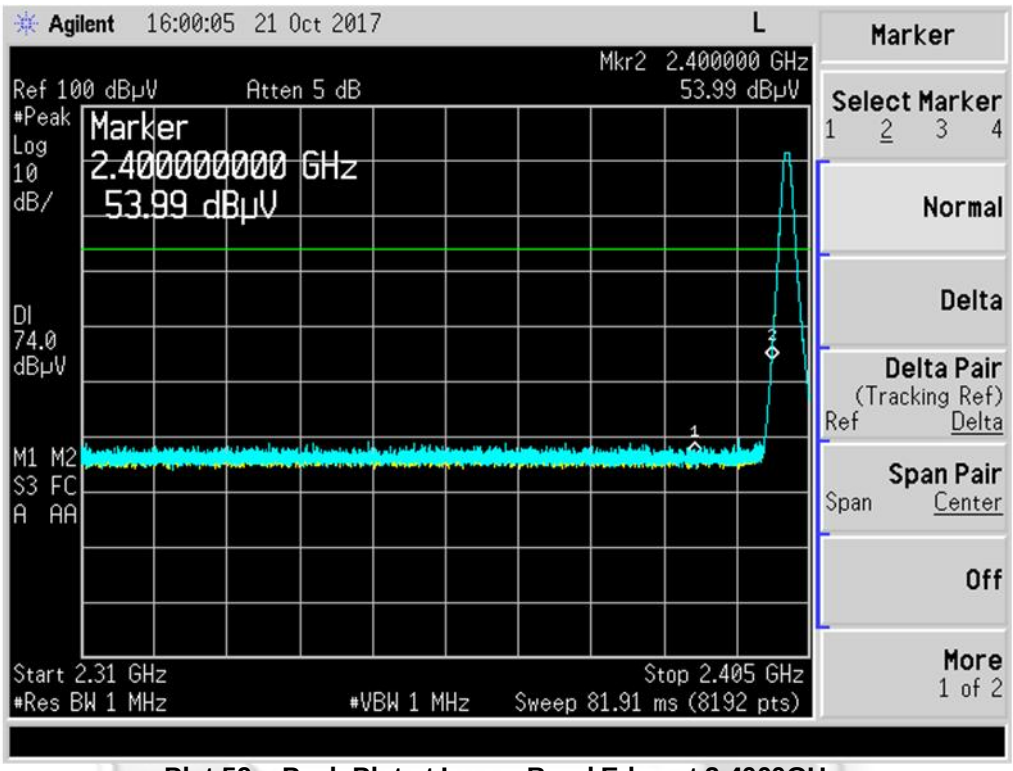


Plot 57 – Lower Band Edge at 2.4000GHz

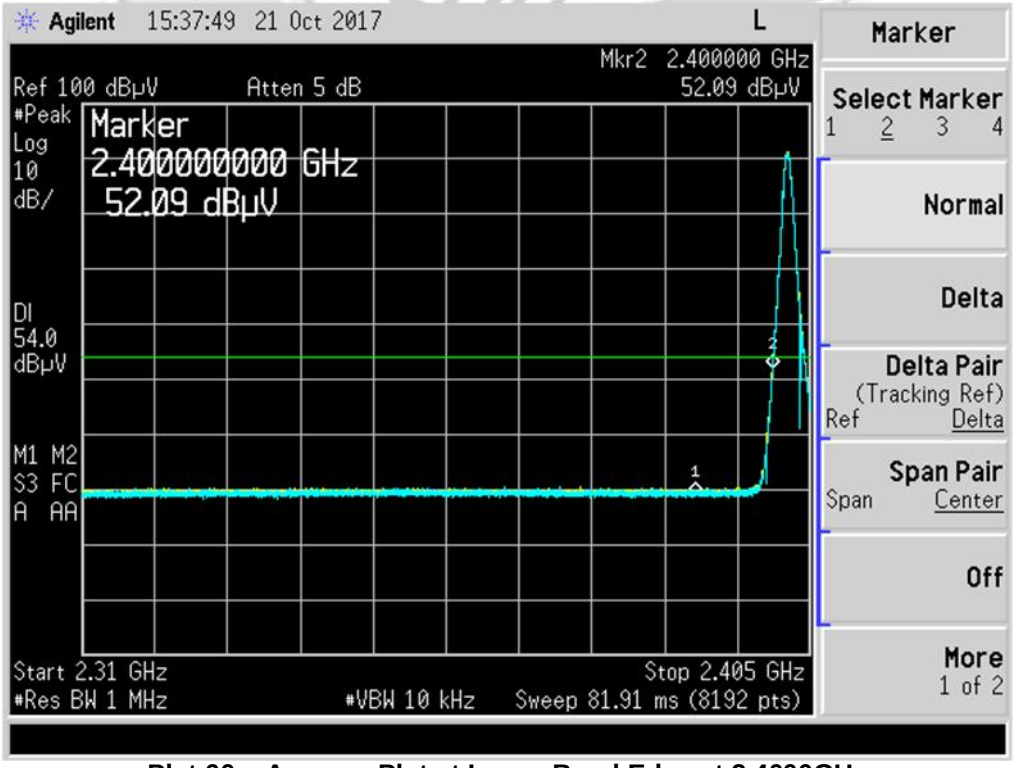


Plot 58 – Upper Band Edge at 2.4835GHz

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

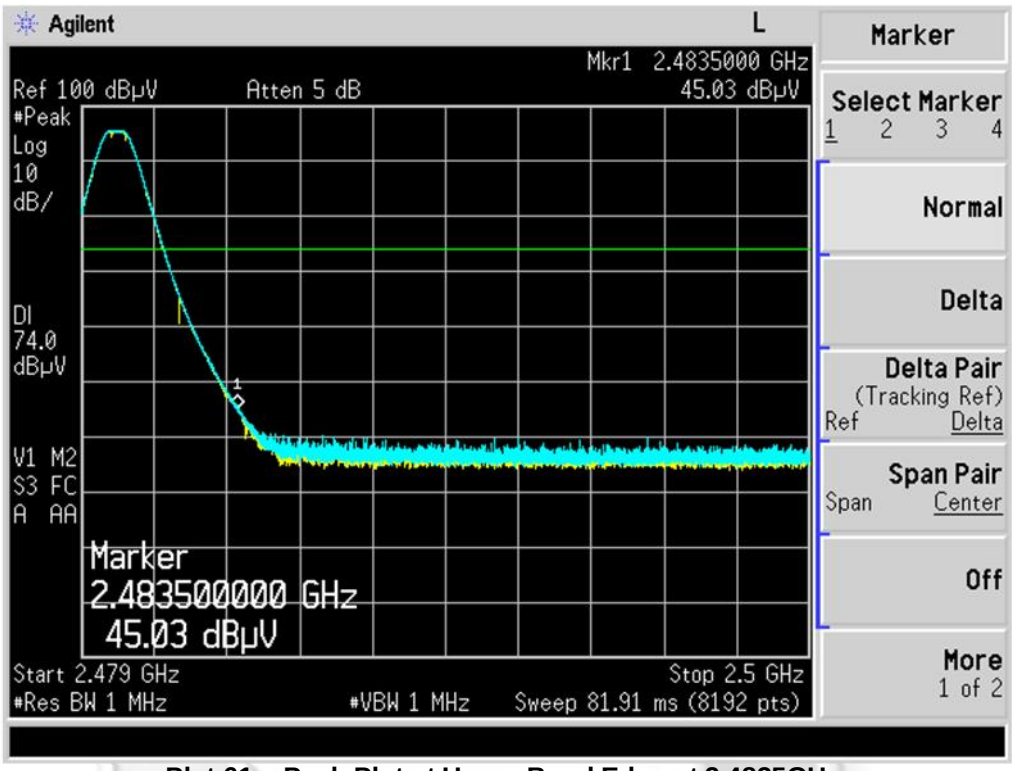


Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz

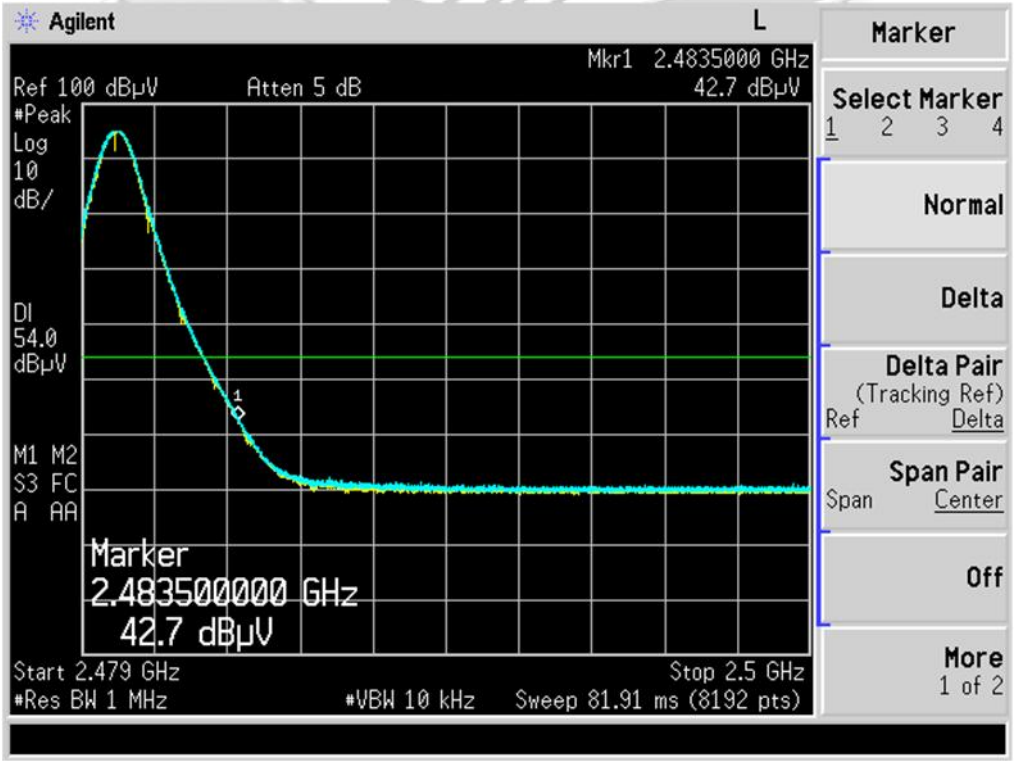


Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

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



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



Plot 62 – 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	04 Jan 2018
BK Precision Multi Range DC Power Supply	9111	459G14131	23 Nov 2017

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	12.5Vdc	Temperature	24ºC
Attached Plots	63 – 65	Relative Humidity	60%
Modulation	GFSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.073	6.3
39 *(mid ch)*	2.441	0.129	6.3
78 *(upper ch)*	2.480	0.082	6.3

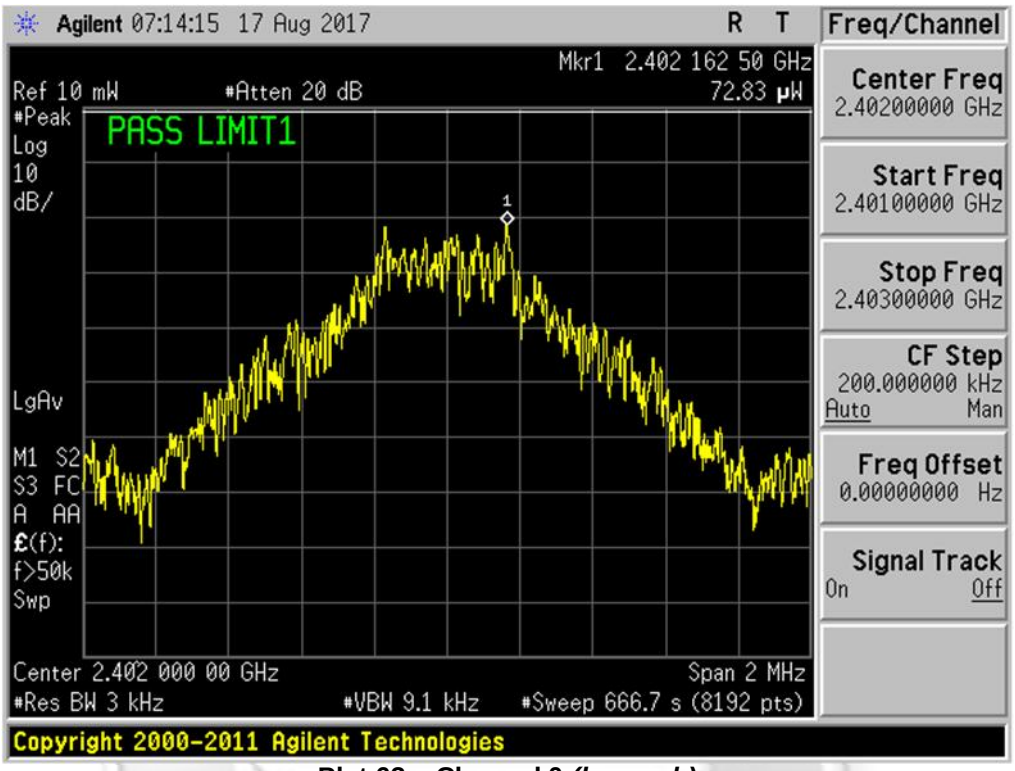
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	66 – 68	Relative Humidity	60%
Modulation	(π/4) DQPSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.063	6.3
39 *(mid ch)*	2.441	0.110	6.3
78 *(upper ch)*	2.480	0.070	6.3

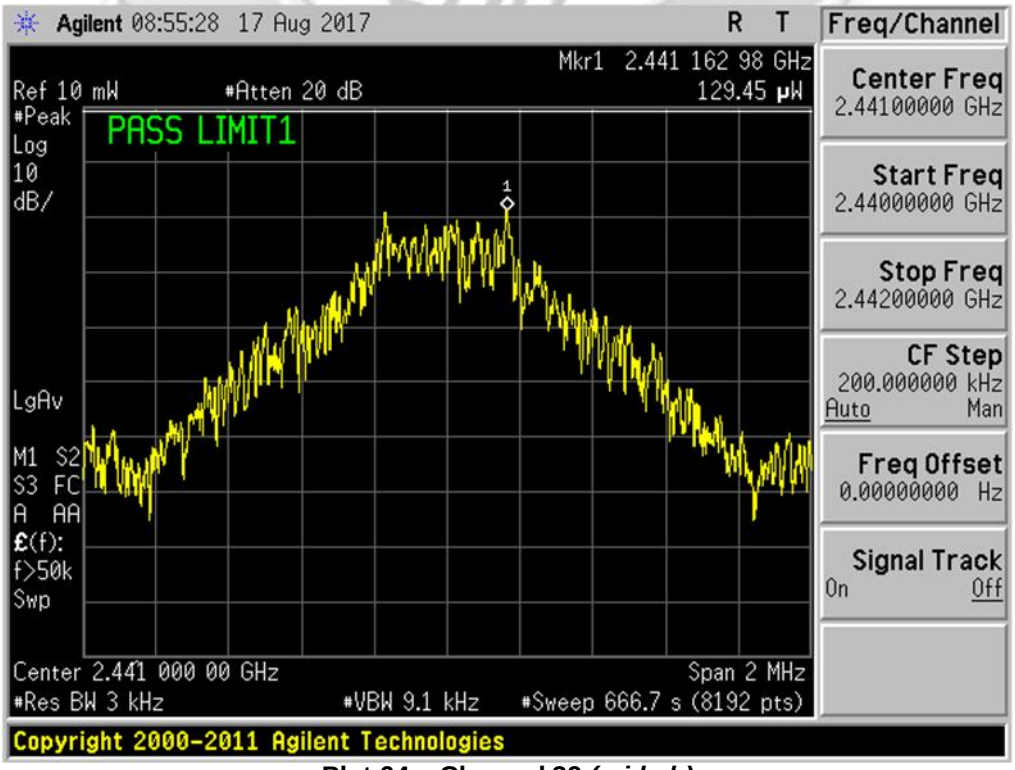
Test Input Power	12.5Vdc	Temperature	24ºC
Attached Plots	69 – 71	Relative Humidity	60%
Modulation	8DPSK	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.047	6.3
39 *(mid ch)*	2.441	0.081	6.3
78 *(upper ch)*	2.480	0.051	6.3

Peak Power Spectral Density Plots – GFSK

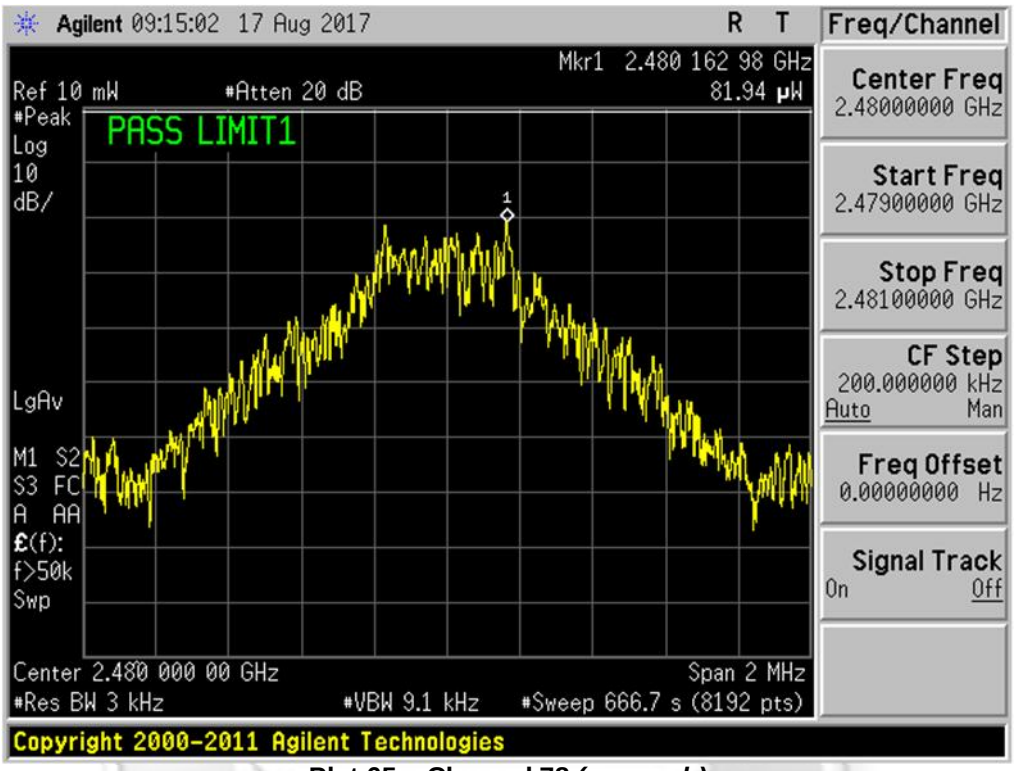


Plot 63 – Channel 0 ***(lower ch)***



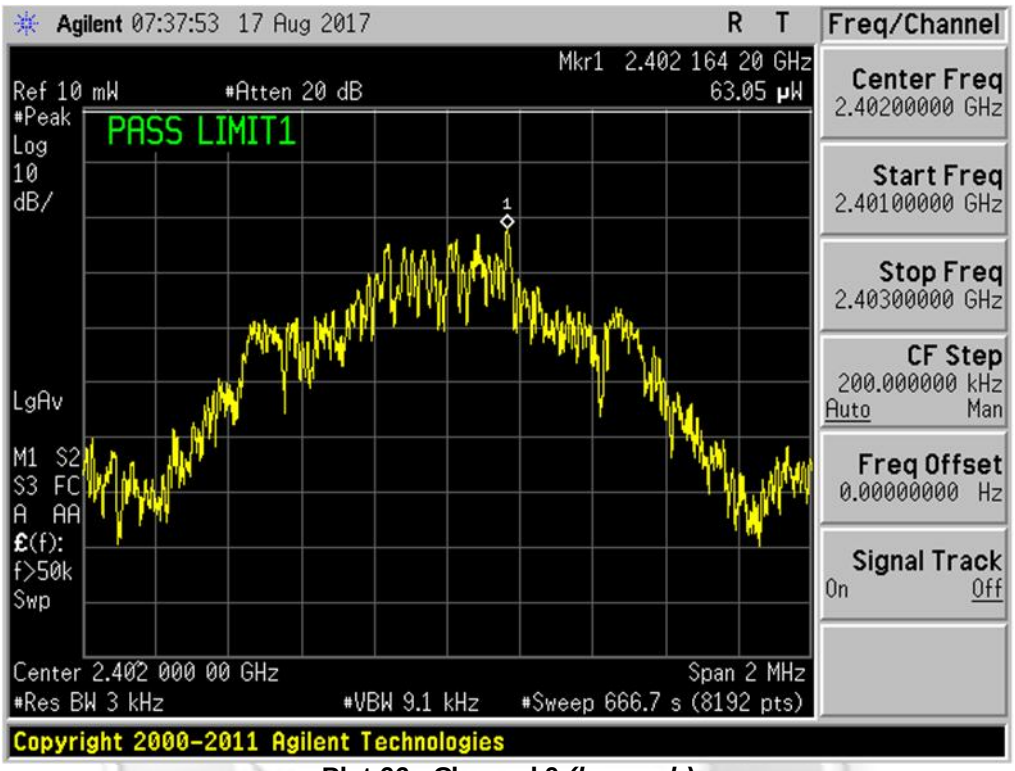
Plot 64 – Channel 39 ***(mid ch)***

Peak Power Spectral Density Plots – GFSK

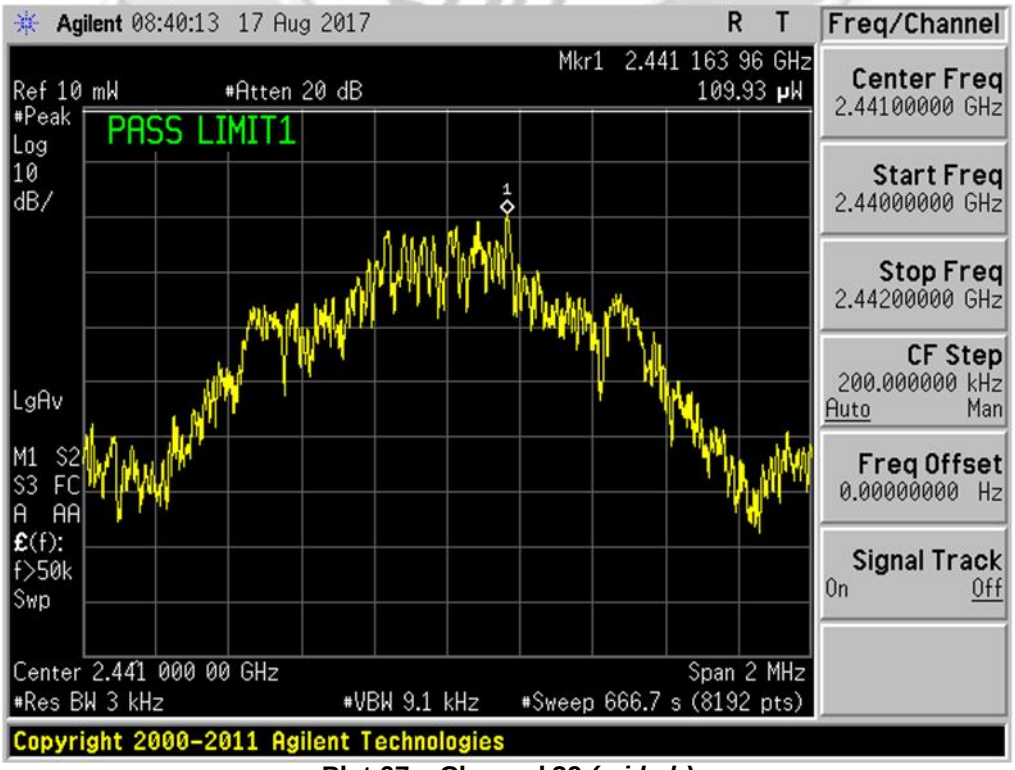


Plot 65 – Channel 78 *(upper ch)*

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

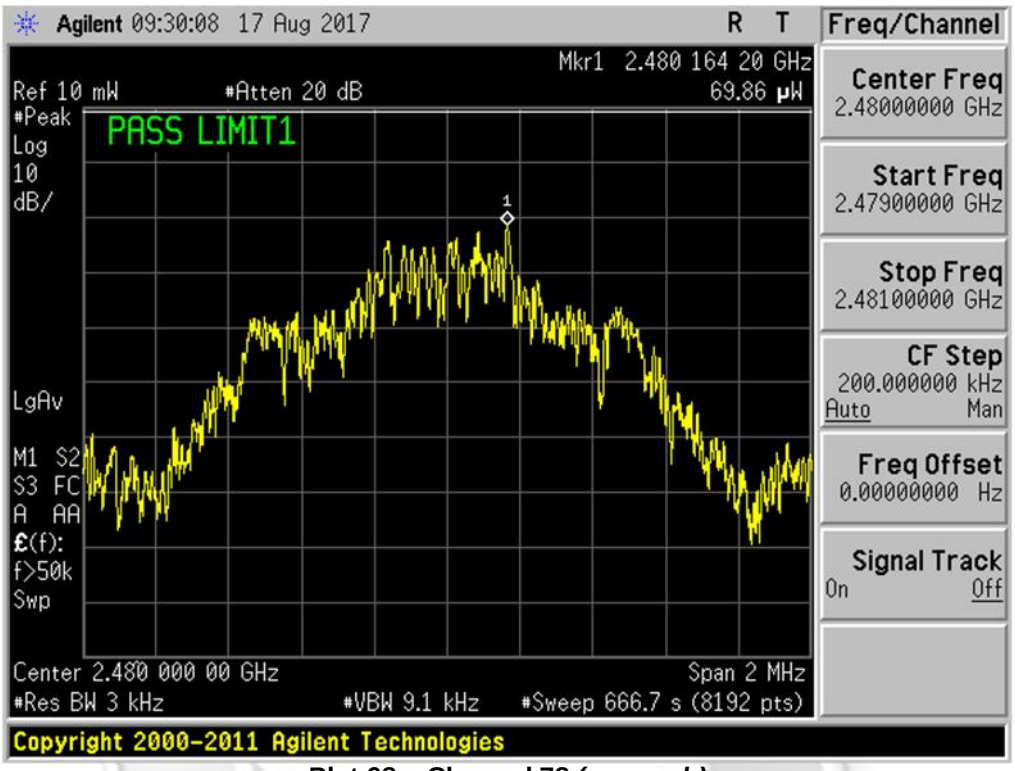


Plot 66– Channel 0 *(lower ch)*



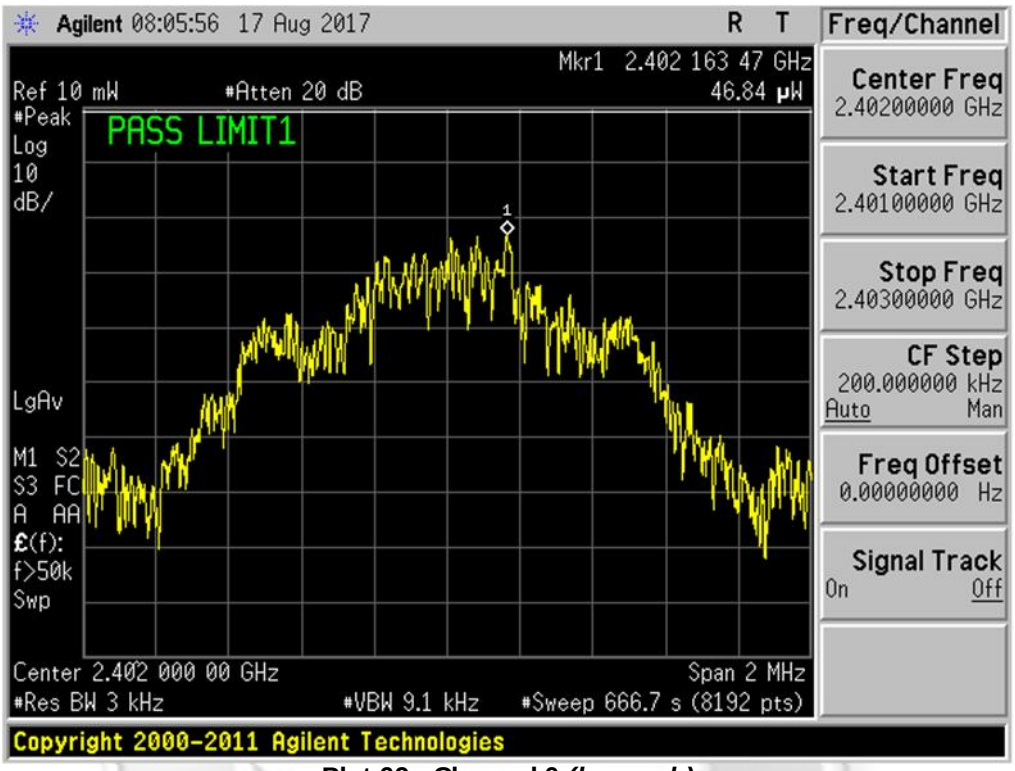
Plot 67 – Channel 39 *(mid ch)*

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



Plot 68 – Channel 78 ***(upper ch)***

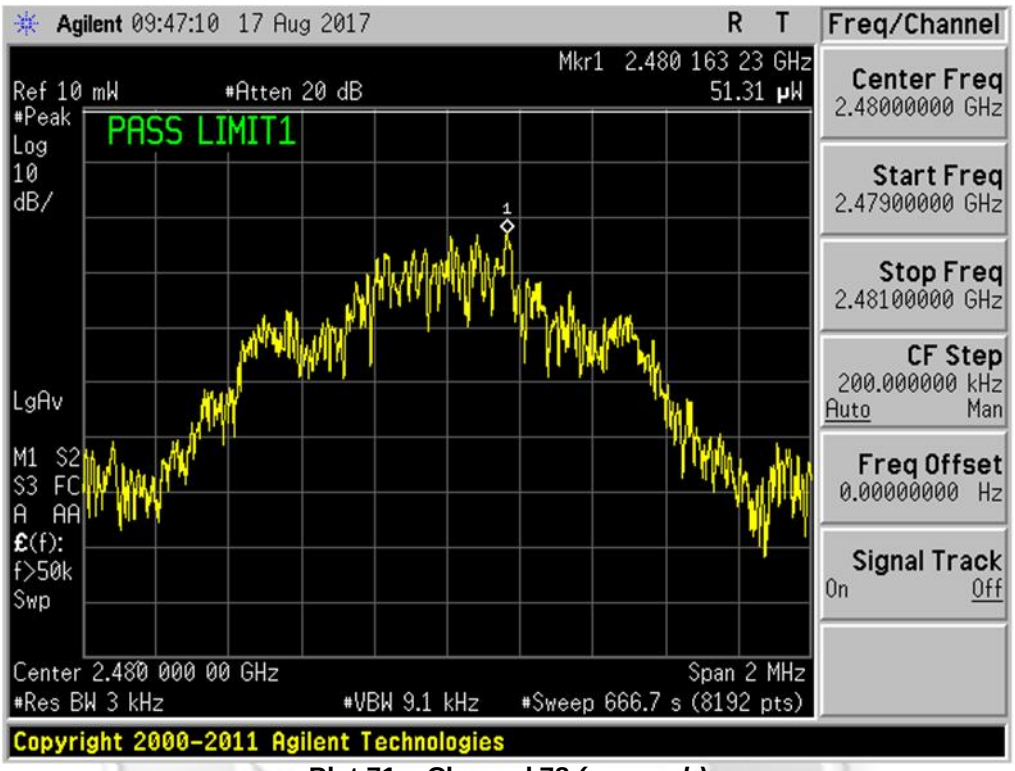
Peak Power Spectral Density Plots – 8DPSK



Plot 69– Channel 0 *(lower ch)*

Plot 70 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – 8DPSK



Plot 71 – 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 (MPE) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
PMM 8053 Portable Field Meter	8053	0220J10308	20 Jan 2019
PMM EP330 Electric Field Probe	EP330	1010J10301	20 Jan 2019
R&S Universal Radio Communication Tester	CMU 200	837587/068	24 Dec 2017

47 CFR FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Setup

1. The EUT and supporting equipment were set up as shown on the setup photo.
2. The relevant field probe was positioned at least 20cm away from the EUT and supporting equipment boundary.

47 CFR FCC Part 1.1310 Maximum Permissible Exposure (MPE) Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was first carried out at one of the positions / sides of the EUT.
3. Power density measurement (mW/cm^2) was made using the field meter set to the required averaging time.
4. Steps 2 and 3 were repeated for the next position and its associate EUT operating mode, until all possible positions and modes were measured.

Sample Calculation Example

At 2400 MHz, limit = 1.0 mW/cm^2

Power density reading obtained directly from field meter = 0.3 mW/cm^2 averaged over the required 30 minutes.

Therefore, margin = 0.3 – 1.0 = -0.7 mW/cm^2 i.e. 0.7 mW/cm^2 below limit

47 CFR FCC Part 1.1310 Maximum Permissible Exposure (MPE) Results

Test Input Power	12.5Vdc	Temperature	24°C
Test Distance	20cm	Relative Humidity	60%
	GSM 850 + Bluetooth @ GFSK (Worst)	Atmospheric Pressure	1030mbar
		Tested By	Chelmin Li

Channel	Channel Frequency (GHz)	Power Density Value (mW/cm^2)	Averaging Time (min)	Limit (mW/cm^2)
0 *(lower ch)*	2.402	0.0037	30	1.0
39 *(mid ch)*	2.441	0.0024	30	1.0
78 *(upper ch)*	2.480	0.0370	30	1.0

Notes

1. All possible modes of operation were investigated. Only the worst case highest radiation levels were measured. Measurements were taken at the required averaging time. All other radiation levels 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. Maximum Permissible Exposure 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 0.1MHz – 3GHz is ±15.0%.

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