Test Report No. 7191124055-EEC15/03
dated 11 Dec 2015

PSB Singapore

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Note: This report is issued subject to the Testing and Certification Regulations of the TÜV SÜD Group and the General Terms and Conditions of Business of TÜV SÜD PSB Pte Ltd. In addition, this report is governed by the terms set out within this report.

TEST REPORT COVER PAGE

Product Information			
Product Name / Description:	MOBILE TWO-WAY RADIO	Applicant Company Number:	109U
Model Number(s):	AAM28UMN9RA1AN	UPN Number:	92FT7083
All Used IC Test Site(s) Reg. #:	2932I-1	SAR Test Lab Company Number:	--

Emissions Information								
	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	Band 7	Band 8
RSS # & Issue #	RSS-247 & Issue 1							
Frequency Min (MHz)	2402							
Frequency Max (MHz)	2480							
RF Power Min (W) Conducted / EIRP / ERP	--							
RF Power Max (W) Conducted	0.0083							
Field Strength Units @ distance	108.4 dBµV/m @ 3m							
Measured BW (kHz) (99%, 26dB, 6dB, etc.)	1194 (99%)							
Calculated BW (kHz) As per TRC-43	1200							
Emission Classification (FID, GID, DID, etc.)	1M20G1D							
Transmitter Spurious Units @ distance	3.6GHz 48.3 dBµV/m @ 3m							
	B	B	B	B	B	B	B	B
RSS # & Issue #								
Frequency Min (MHz)								
Frequency Max (MHz)								
RF Power Min (W) Conducted / EIRP / ERP								
RF Power Max (W) Conducted / EIRP / ERP								
Field Strength Units @ distance								
Measured BW (kHz) (99%, 26dB, 6dB, etc.)								
Calculated BW (kHz) As per TRC-43								
Emission Classification (FID, GID, DID, etc.)								
Transmitter Spurious Units @ distance								

Agreement Signature

ATTESTATION: The test measurements were made in accordance with the above-mentioned departmental standard(s), and that the radio equipment identified in this application has been subject to all the applicable test conditions specified in the departmental standards and all of the requirements of the standards have been met.

Applicant / Agent Name:	Lim Cher Hwee	Applicant / Agent Title:	Assistant Vice President
Applicant / Agent Signature:		Signature Date:	11 Dec 2015

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
RSS-GEN Issue 4: 2014
RSS-247 Issue 1: 2015
OF A
MOBILE TWO-WAY RADIO (BLUETOOTH CLASSIC)
[Model : AAM28UMN9RA1AN]
[FCC ID : AZ492FT7083 & IC : 109U-92FT7083]

TEST FACILITY	TÜV SÜD PSB Pte Ltd Electrical & Electronics Centre (EEC), Product Services, No. 1 Science Park Drive, Singapore 118221
FCC REG. NO.	99142 (3m and 10m Semi-Anechoic Chamber, Science Park)
IND. CANADA REG. NO.	2932I-1 (3m and 10m Semi-Anechoic Chamber, Science Park)
PREPARED FOR	Motorola Solutions Malaysia Sdn Bhd Plot 2, Technoplex Industrial Park Mukim 12 Swd, Medan Bayan Lepas, Bayan Lepas Industrial Park, 11900 Bayan Lepas, Pulau Penang, Malaysia Tel : +604 2528543 Fax : +604 8503099
QUOTATION NUMBER	2191027954
JOB NUMBER	7191124055
TEST PERIOD	02 Sep 2015 – 18 Nov 2015

PREPARED BY

Quek Keng Huat
Higher Associate Engineer

APPROVED BY

Lim Cher Hwee
Assistant Vice President

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

Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Part 15 & RSS-GEN Issue 4: 2014 and RSS-247 Issue 1: 2015		
15.207 RSS-GEN 8.8	Conducted Emissions	Pass
15.205, 15.209 RSS-GEN 8.9, 8.10	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(1) RSS-247 5.1(2)	Carrier Frequency Separation	Pass
	Spectrum Bandwidth (20dB and 99% Bandwidth Measurement)	Pass
15.247(a)(1)(iii) RSS-247 5.1(4)	Number of Hopping Frequencies	Pass
	Average Frequency Dwell Time	Pass
15.247(b)(1) RSS-247 5.4(2)	Maximum Peak Power	Pass
15.247(d) RSS-247 5.5	RF Conducted Spurious Emissions	Pass
15.247(d) RSS-247 5.5	Band Edge Compliance (Conducted)	Pass
15.247(d) RSS-247 5.5	Band Edge Compliance (Radiated)	Pass
15.247(e) RSS-102 4.0, RSS-GEN 3.2	Peak Power Spectral Density	Pass
1.1310 RSS-102 4.0, RSS-GEN 3.2	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. 99% Bandwidth Measurement is applicable to RSS-247 only.

6. RSS-102 is RSS-102 Issue 4: 2015.

7. The unit was also investigated for inter-modulation products between the co-located Bluetooth and the land mobile radios. All inter-modulation products between the co-located radios were found to be compliant to the FCC limits of 15.209 and Industry Canada RSS-GEN.

8. The EUT uses a 4dBi internal PIFA which connects to the RF port via a spring contact. The EUT meets the requirement of FCC 15.203.

9. The maximum measured RF power of the Equipment Under Test is 9.19dBm.

10. All tests except Maximum Peak Power and Band Edge Compliance (Radiated) were tested at the maximum power of the RF module which is higher than the supported maximum EUT RF power. The Maximum Peak Power and Band Edge Compliance (Radiated) tests were tested at the maximum RF power of the EUT.

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **Mobile Two-Way Radio.**
Manufacturer	:	Motorola Solutions Malaysia Sdn Bhd Plot 2, Technoplex Industrial Park Mukim 12 Swd, Medan Bayan Lepas, Bayan Lepas Industrial Park, 11900 Bayan Lepas, Pulau Penang, Malaysia
Model Number	:	AAM28UMN9RA1AN
FCC ID	:	AZ492FT7083
IC	:	109U-92FT7083
Serial Number	:	203TRP2540
Microprocessor	:	Ti OMAPL138BZWTA3R
Operating / Transmitting Frequency	:	Bluetooth / Bluetooth LE 2.402GHz (lower channel) to 2.480GHz (upper channel) 79 channels (Bluetooth), 40 channels (Bluetooth LE) WiFi 2.412GHz (lower channel) to 2.462GHz (upper channel) 11 channels Land Mobile 806MHz to 870MHz /Channel Spacing 12.5kHz/25kHz 896MHz to 941MHz /Channel Spacing 12.5kHz/25kHz
Clock / Oscillator Frequency	:	Reference Clock: 19.2MHz, LO 1: 924.35MHz - 943.35MHz LO 2: 861.65MHz - 867.65MHz
Modulation	:	Bluetooth Gaussian Frequency Shift Keying (GFSK) (π/4) DQPSK 8DPSK WiFi Differential Binary Phase Shift Keying (DBPSK) Differential Quadrature Phase Shift Keying (DQPSK) Complementary Code Keying (CCK) Binary Phase Shift Keying (BPSK) Quadrature Phase Shift Keying (QPSK) 16-Quadrature Amplitude Modulation (16QAM) 64-Quadrature Amplitude Modulation (64QAM) Land Mobile Frequency Modulation (FM)
Antenna Gain	:	4.0 dBi (PIFA Antenna)

(Continued)

Port / Connectors	:	Refer to manufacturer's user manual / operating manual
Rated Input Power	:	120V 60Hz
Accessories	:	Refer to manufacturer's user manual / operating manual

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
Fujitsu Laptop	M/N: S6310 S/N: R7100269 FCC ID: DoC	Nil
Fujitsu AC Adapter	M/N: CP293662-01 S/N: O6X00399B FCC ID: DoC	1.80m unshielded power cable
Microsoft Wheel Mouse	M/N: X08-71118 S/N: Nil FCC ID: DoC	Nil
Alfatronix Limited Desktop Power Supply	M/N: AD MT 3100/DM S/N: Nil FCC ID: DoC	Nil
Motorola IMPRES Keypad Microphone	M/N: RMN5127C S/N: Nil FCC ID: DoC	Nil

EUT OPERATING CONDITIONS

47 CFR FCC Part 15, RSS-GEN Issue 4: 2014 and RSS-247 Issue 1: 2015
1. Conducted Emissions **2. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)** **3. Spectrum Bandwidth (20dB and 99% Bandwidth Measurement)** **4. Maximum Peak Power** **5. RF Conducted Spurious Emissions** **6. Band Edge Compliance (Conducted)** **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.
47 CFR FCC Part 15, RSS-GEN Issue 4: 2014 and RSS-247 Issue 1: 2015
1. Carrier Frequency Separation **2. Number of Hopping Frequencies** **3. Average Frequency Dwell Time** **4. Band Edge Compliance (Conducted)** **5. Band Edge Compliance (Radiated)**
The EUT was exercised by operating in maximum continuous transmission with frequency hopping on.

47 CFR FCC Part 15.207 and RSS-GEN 8.8 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 Part 15.207 and RSS-GEN 8.8 Conducted Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Schaffner EMI Receiver	SMR4503	040	11 Feb 2016	1 year
Agilent EMC Analyzer-SA7	E7403A	US41160167	28 May 2016	1 year
Schaffner LISN –LISN10 (EUT)	NNB42	04/10055	31 Oct 2016	1 year
EMCO LISN (for supporting) – LISN6	3825/2	9309-2127	31 Oct 2016	1 year

47 CFR FCC Part 15.207 and RSS-GEN 8.8 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 Part 15.207 and RSS-GEN 8.8 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 Part 15.207 and RSS-GEN 8.8 Conducted Emission Results

Test Input Power	120V 60Hz	Temperature	22°C
Line Under Test	AC Mains	Relative Humidity	55%
Modulation	GFSK (Worst)	Atmospheric Pressure	1030mbar
		Tested By	Derrick Ng

Frequency (MHz)	Peak Value (dBµV)	Q-P Limit (dBµV)	Q-P Margin (dB)	AV Value (dBµV)	AV Limit (dBµV)	AV Margin (dB)	Line	Channel
0.6521	42.7	56.0	13.3	-- *See Note 3	46.0	3.3	Live	78
1.0685	40.3	56.0	15.7	-- *See Note 3	46.0	5.7	Neutral	78
1.6685	41.7	56.0	14.3	-- *See Note 3	46.0	4.3	Neutral	78
3.8729	39.4	56.0	16.6	-- *See Note 3	46.0	6.6	Neutral	78
6.3635	39.4	60.0	20.6	-- *See Note 3	50.0	10.6	Neutral	78
13.0805	36.6	60.0	23.4	-- *See Note 3	50.0	13.4	Neutral	78

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. As the measured peak shows compliance to the Q-P & Average limits, as such no Q-P & Average measurements was carried out. The EUT is deemed to meet both requirements.
4. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   9kHz - 30MHz
   RBW: 9kHz VBW: 30kHz
5. 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 and & RSS-GEN 8.10 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 Part 15.209 and & RSS-GEN 8.9 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 Part 15.209, RSS-GEN 8.9 and 8.10 Radiated Emission Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016	1 year
Schaffner Bilog Antenna –(30MHz-2GHz) BL3 (Ref)	CBL6112D	2549	29 Jan 2016	1 year
ETS Horn Antenna(18GHz-40GHz)(Ref)	3116	0004-2474	02 Oct 2016	1 year
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016	1 year
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016	1 year
Agilent Preamplifier(1GHz-26.5GHz) (PA18)	8449D	3008A02305	06 Oct 2016	1 year
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	09 Oct 2016	1 year
Micro-Tronics Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2016	1 year

47 CFR FCC Part 15.209, RSS-GEN 8.9 and 8.10 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 >1GHz measurements, the EUT is raised further to a height of 1.5m with a non-metallic foam block.
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 Part 15.209, RSS-GEN 8.9 and 8.10 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 Part 15.205, 15.209 and RSS-GEN 8.9 and 8.10 Radiated Emission Results

Test Input Power	120V 60Hz	Temperature	22°C
Test Distance	3m (30MHz – 1GHz)	Relative Humidity	55%
Modulation	GFSK (Worst)	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

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
48.5050	33.9	40.0	6.1	100	212	V	78
192.1950	36.1	43.5	7.4	200	234	H	78
260.7740	40.4	46.0	5.6	100	278	H	78
396.8430	40.2	46.0	5.8	100	316	H	78
449.0940	40.8	46.0	5.2	200	247	H	78
784.3690	39.0	46.0	7.0	100	266	H	78

Test Input Power	120V 60Hz	Temperature	22°C
Test Distance	3m (1GHz – 25GHz)	Relative Humidity	55%
Modulation	GFSK (Worst Mode)	Atmospheric Pressure	1030mbar
		Tested By	Chang Wai Kit

Spurious Emissions above 1GHz - 25GHz

Frequency (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.6578	43.6	74.0	30.4	28.5	54.0	25.5	100	35	H	0
1.8602	44.1	74.0	29.9	31.1	54.0	22.9	100	350	V	0
1.9918	41.5	74.0	32.5	29.3	54.0	24.7	100	40	H	0
2.1335	44.3	74.0	29.7	31.9	54.0	22.1	100	356	V	0
3.6009	48.0	74.0	26.0	39.9	54.0	14.1	100	175	V	0
4.8052	46.0	74.0	28.0	39.9	54.0	14.1	100	280	H	0

Spurious Emissions above 1GHz - 25GHz

Frequency (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.1012	43.1	74.0	30.9	26.1	54.0	27.9	100	54	H	39
1.3238	42.3	74.0	31.7	26.0	54.0	28.0	100	287	V	39
1.6578	44.1	74.0	29.9	29.0	54.0	25.0	100	60	H	39
1.9918	41.8	74.0	32.2	29.6	54.0	24.4	100	235	V	39
3.6009	48.3	74.0	25.7	40.2	54.0	13.8	100	281	V	39
4.8052	43.6	74.0	30.4	37.5	54.0	16.5	100	214	H	39

47 CFR FCC Part 15.205, 15.209 and RSS-GEN 8.9 and 8.10 Radiated Emission Results

Spurious Emissions above 1GHz - 25GHz

Frequency (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
1.6781	42.1	74.0	31.9	27.2	54.0	26.8	100	341	V	78
1.8602	41.3	74.0	32.7	28.3	54.0	25.7	100	195	V	78
1.9918	43.2	74.0	30.8	31.0	54.0	23.0	100	307	V	78
2.1335	40.7	74.0	33.3	28.3	54.0	25.7	100	217	V	78
3.6009	48.2	74.0	25.8	40.1	54.0	13.9	100	206	V	78
4.8052	42.9	74.0	31.1	36.8	54.0	17.2	100	277	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. Quasi-peak measurement was used for frequency measurement up to 1GHz. Average and peak measurements were used for emissions above 1GHz. The average measurement was done by averaging over a complete cycle of the pulse train, including the blanking interval as the pulse train duration does not exceed 0.1 second.
3. A "positive" margin indicates a PASS as it refers to the margin present below the limit line at the particular frequency. Conversely, a “negative” margin indicates a FAIL.
4. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 100kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 3MHz
5. The upper frequency of radiated emission investigations was according to requirements stated in Section 15.33(a) for intentional radiators & Section 15.33(b) for unintentional radiators.
6. The upper frequency of radiated emission investigations was according to requirements stated in RSS-GEN 6.13.
7. The channel in the table refers to the transmit channel of the EUT.
8. 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) and RSS-247 5.1(2) 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) and RSS-247 5.1(2) Carrier Frequency Separation Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015	1 year

47 CFR FCC Part 15.247(a)(1) and RSS-247 5.1(2) 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) and RSS-247 5.1(2) Carrier Frequency Separation Test Method

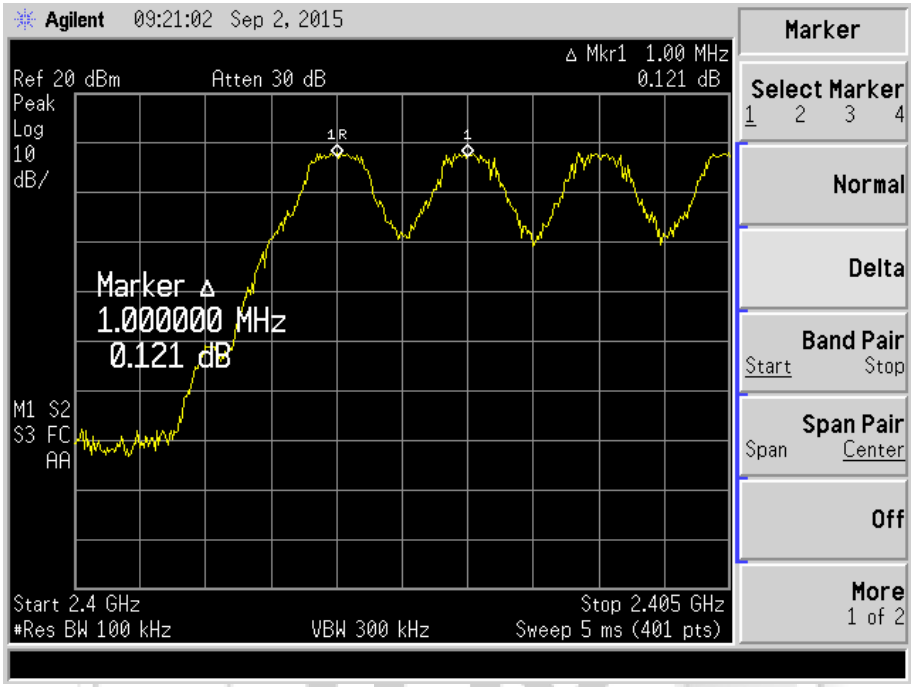
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.400GHz and 2.405GHz.
3. The spectrum analyser was set 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 2.481GHz

47 CFR FCC Part 15.247(a)(1) and RSS-247 5.1(2) Carrier Frequency Separation Results

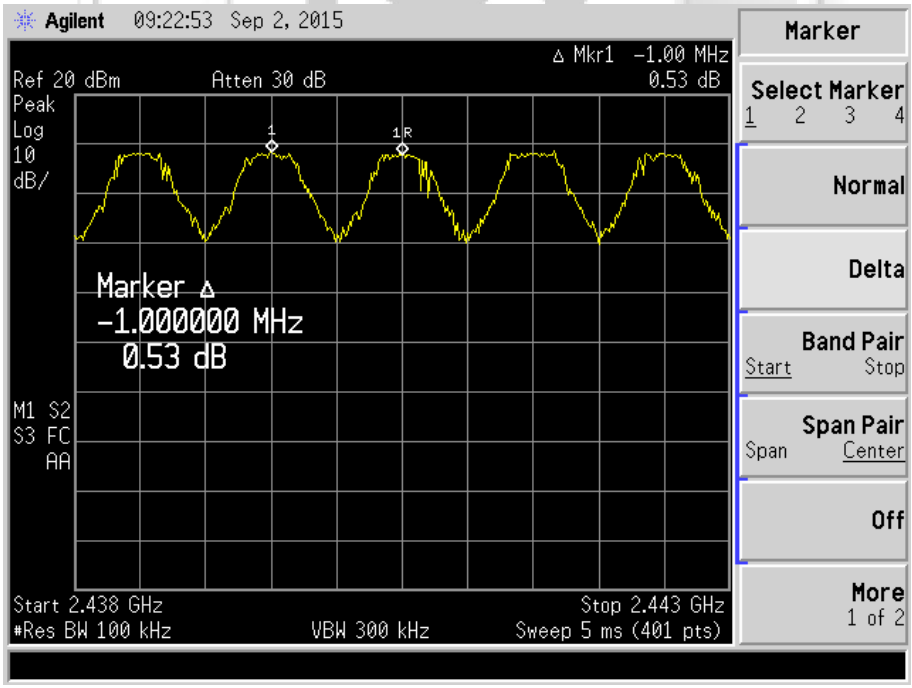
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	1 – 4	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

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

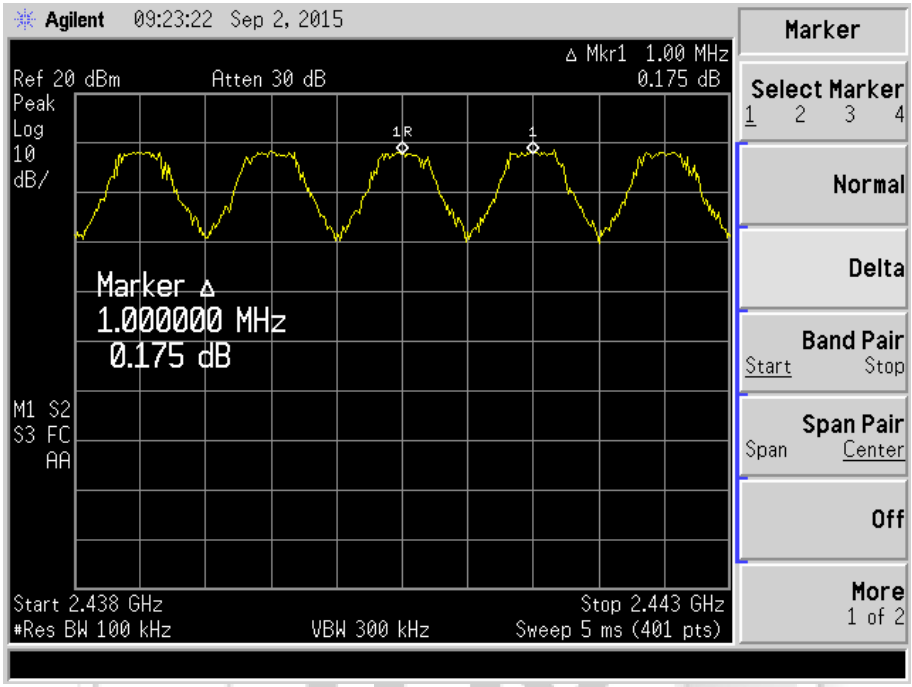


Plot 1 - Channels 0 *(lower ch)* and 1 *(ch after lower ch)* Separation

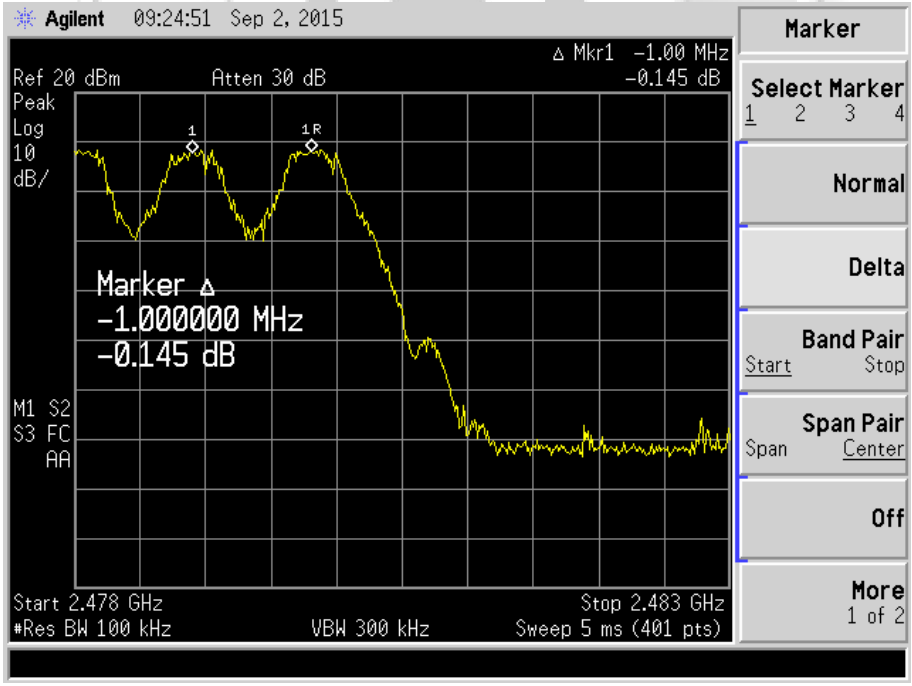


Plot 2 – Channels 38 *(preceding mid ch)* and 39 *(mid ch)* Separation

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

SPECTRUM BANDWIDTH (20dB and 99% BANDWIDTH MEASUREMENT) TEST

47 CFR FCC Part 15.247(a)(1) and RSS-247 5.1(2) Spectrum Bandwidth (20dB and 99% 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) and RSS-247 5.1(2) Spectrum Bandwidth (20dB and 99% Bandwidth Measurement) Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4404B	US39440632	02 Apr 2016	1 year

47 CFR FCC Part 15.247(a)(1) and RSS-247 5.1(2) Spectrum Bandwidth (20dB and 99% 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) and RSS-247 5.1(2) Spectrum Bandwidth (20dB and 99% Bandwidth Measurement) Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 20dB and 99% 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. For 6dB bandwidth measurement, the frequencies below the 20dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser. For 99% bandwidth measurement, the spectrum analyser power measurement was activated with bandwidth measurement as 99%.
5. For 6dB bandwidth measurement, the 20dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$. For 99% bandwidth measurement, the measured 99% bandwidth shown on the spectrum analyser was recorded.
6. The steps 2 to 5 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) *(mid ch)* and Channel 79 (2.480GHz) *(upper ch)* respectively.

SPECTRUM BANDWIDTH (20dB and 99% BANDWIDTH MEASUREMENT) TEST

47 CFR FCC Part 15.247(a)(1) and RSS-247 5.1(2) Spectrum Bandwidth (20dB and 99% Bandwidth Measurement) Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots (20dB)	5 – 7 (GFSK) 8 – 10 ((π/4) DQPSK) 11 – 13 (8DPSK)	Relative Humidity	60%
Attached Plots (99%)	14 – 16 (GFSK) 17 – 19 ((π/4) DQPSK) 20 – 22 (8DPSK)	Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

GFSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	0.930	0.864
39 *(mid ch)*	2.441	0.930	0.886
78 *(upper ch)*	2.480	0.935	0.867

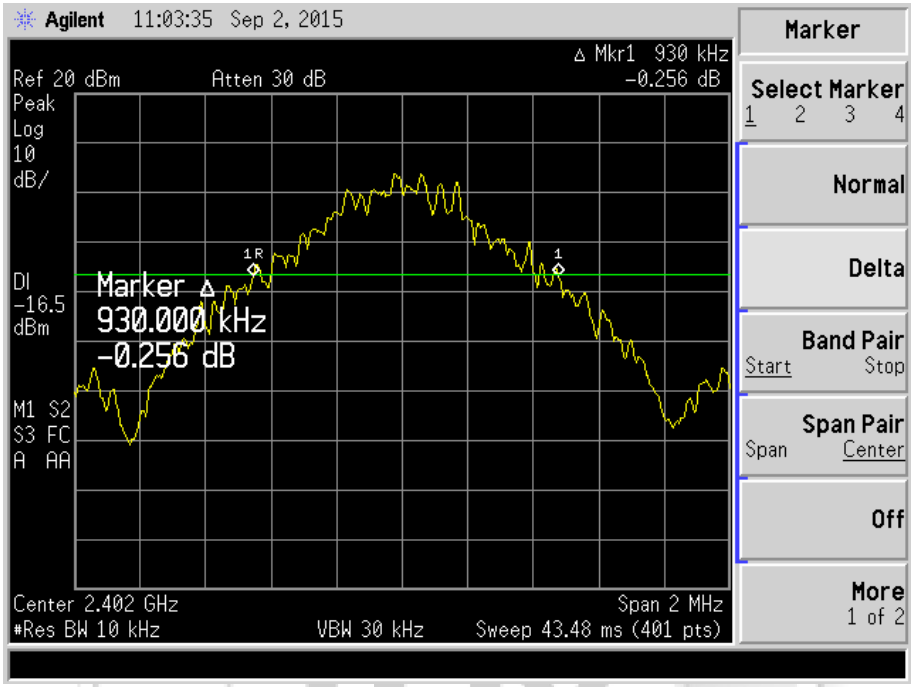
(π/4)DQPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	1.347	1.162
39 *(mid ch)*	2.441	1.339	1.193
78 *(upper ch)*	2.480	1.354	1.194

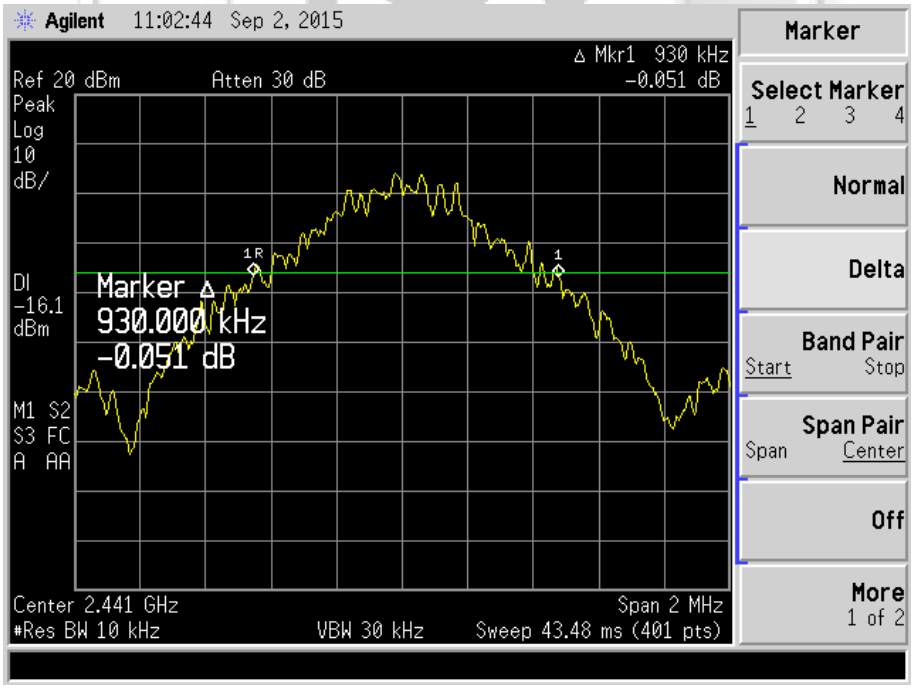
8DPSK

Channel	Channel Frequency (GHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
0 *(lower ch)*	2.402	1.309	1.168
39 *(mid ch)*	2.441	1.324	1.185
78 *(upper ch)*	2.480	1.317	1.165

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

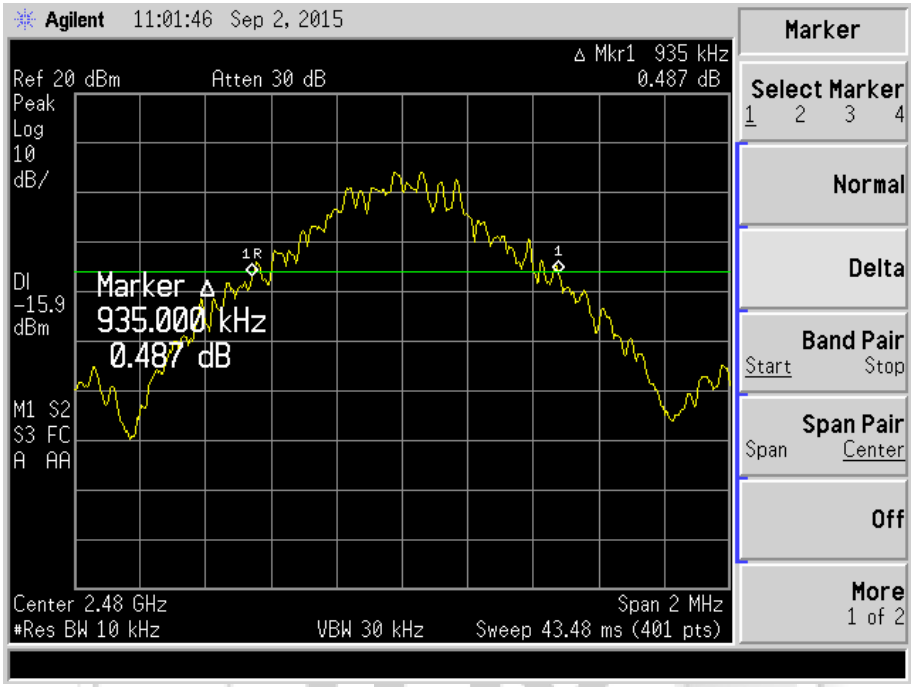


Plot 5 – Channel 0 *(lower ch)*



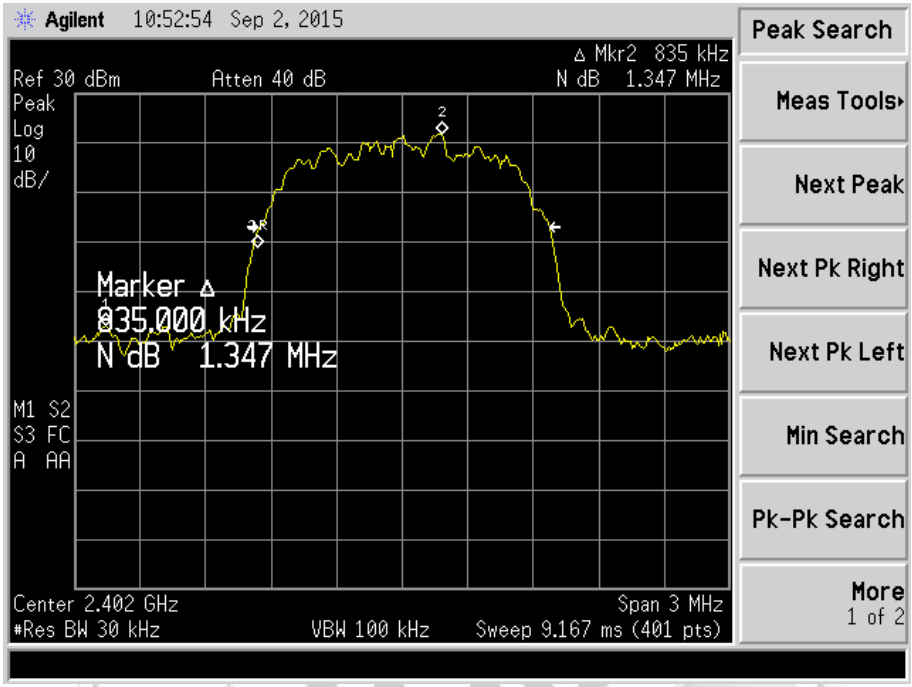
Plot 6 – Channel 39 *(mid ch)*

Spectrum Bandwidth (20dB Bandwidth Measurement) Plots – GFSK

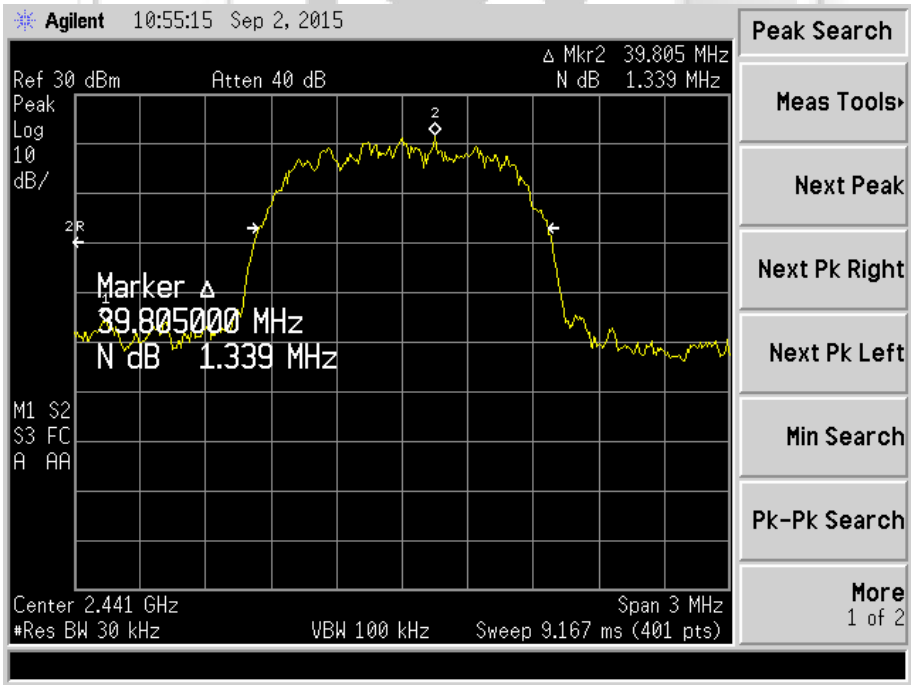


Plot 7 – Channel 78 *(upper ch)*

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

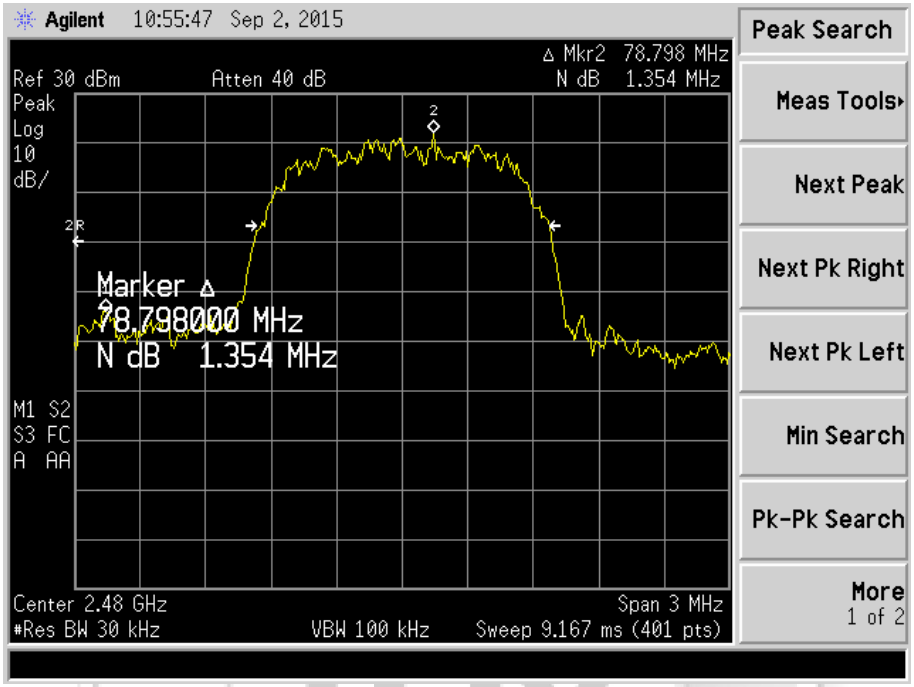


Plot 8 – Channel 0 *(lower ch)*



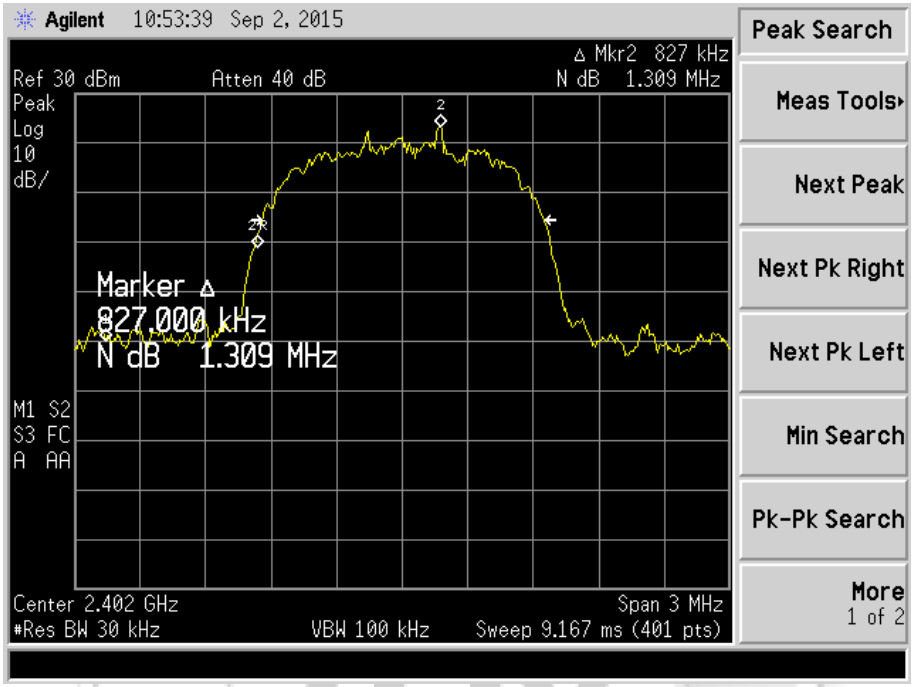
Plot 9 – Channel 39 *(mid ch)*

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

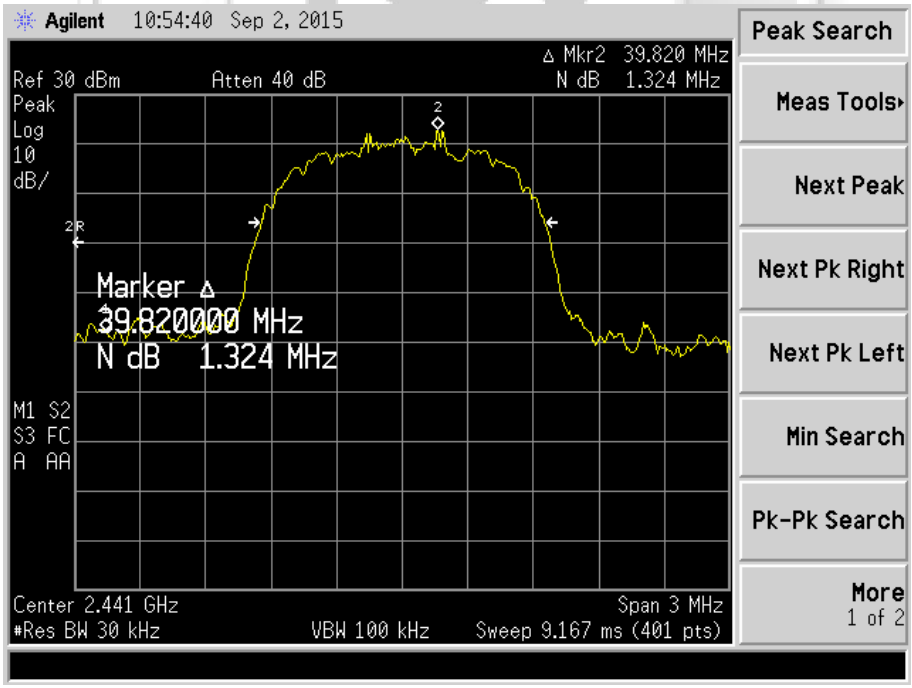


Plot 10 – Channel 78 *(upper ch)*

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

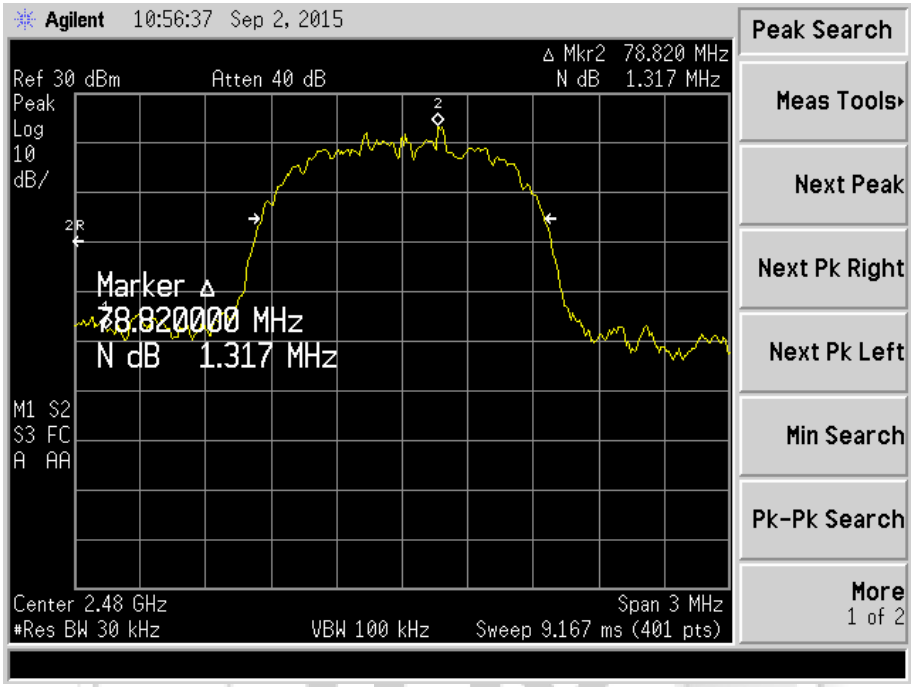


Plot 11 – Channel 0 *(lower ch)*



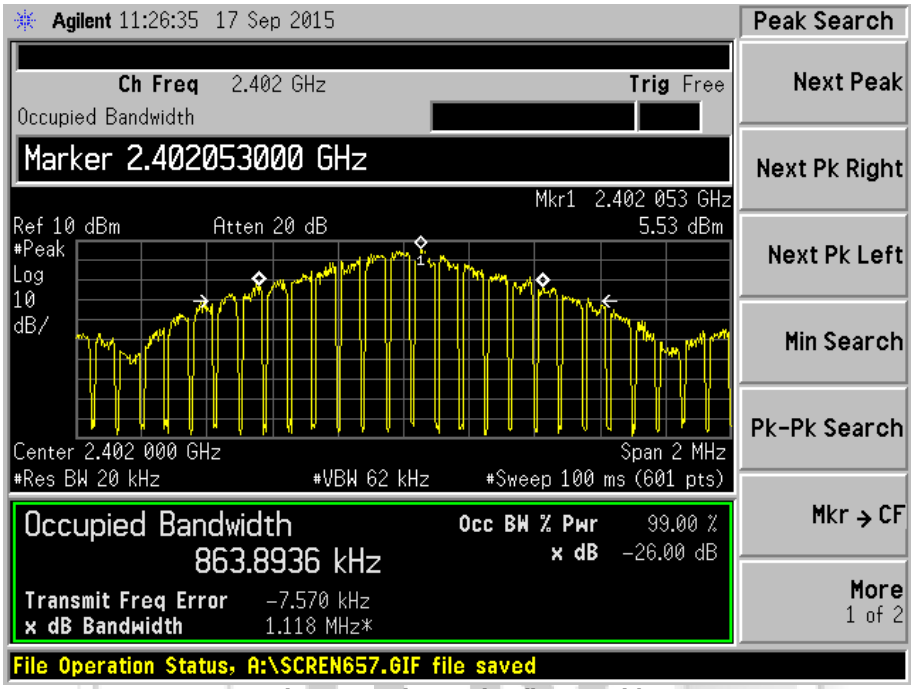
Plot 12 – Channel 39 *(mid ch)*

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

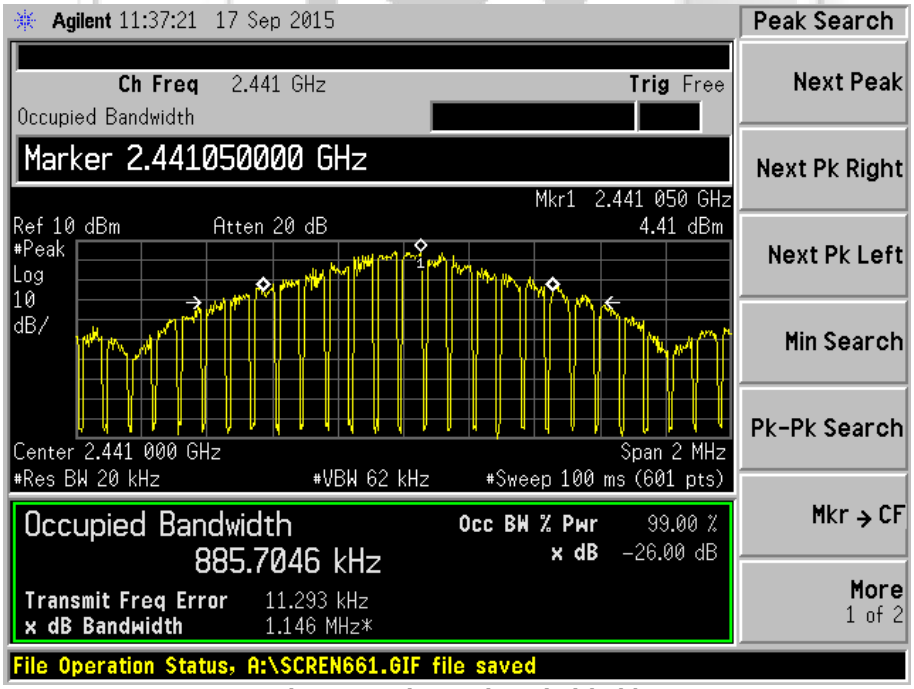


Plot 13 – Channel 78 *(upper ch)*

Spectrum Bandwidth (99%dB Bandwidth Measurement) Plots – GFSK

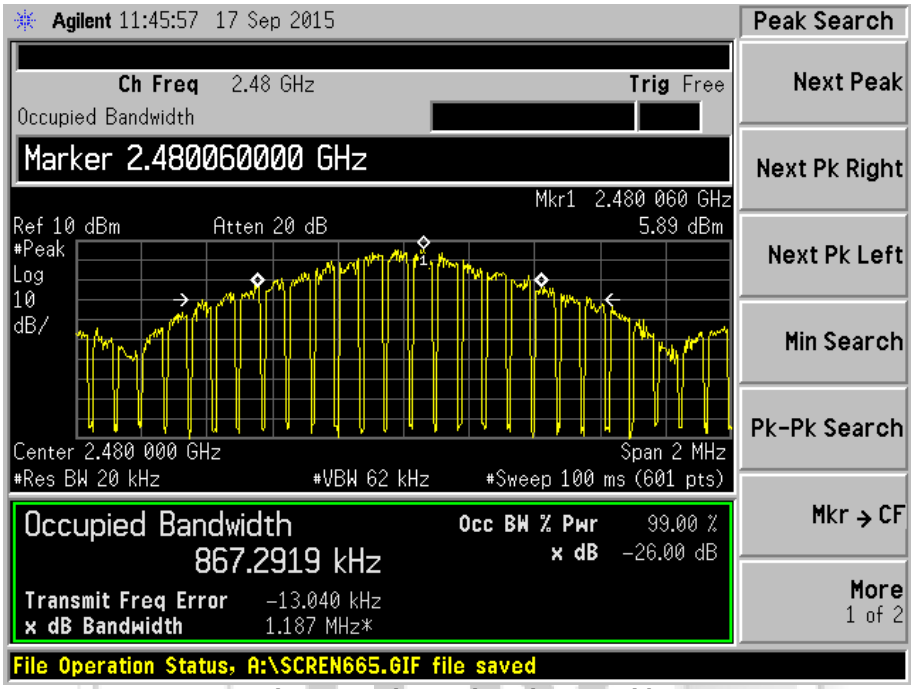


Plot 14 – Channel 0 *(lower ch)*



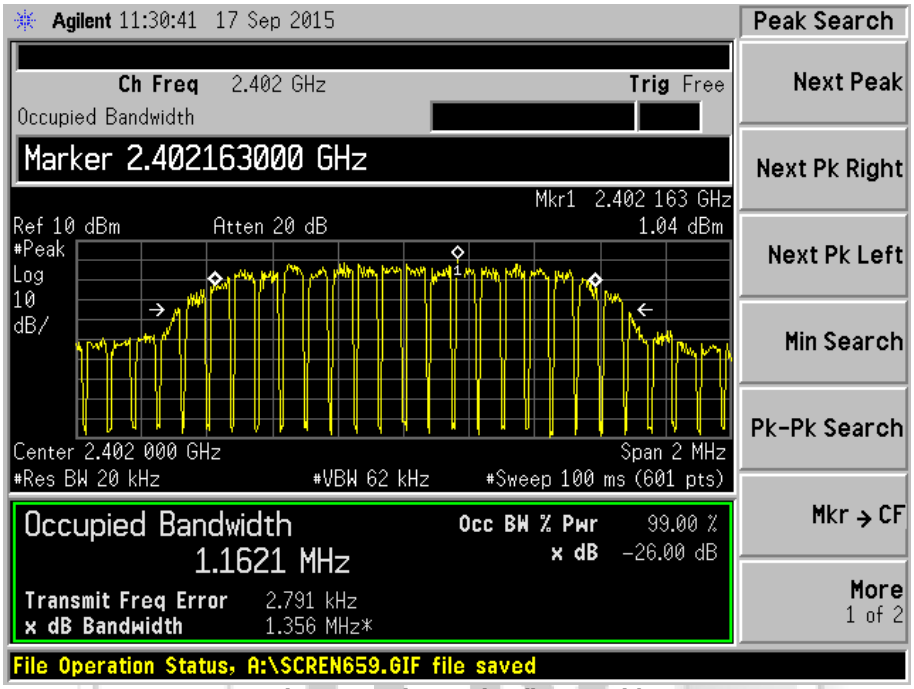
Plot 15 – Channel 39 *(mid ch)*

Spectrum Bandwidth (99% Bandwidth Measurement) Plots – GFSK

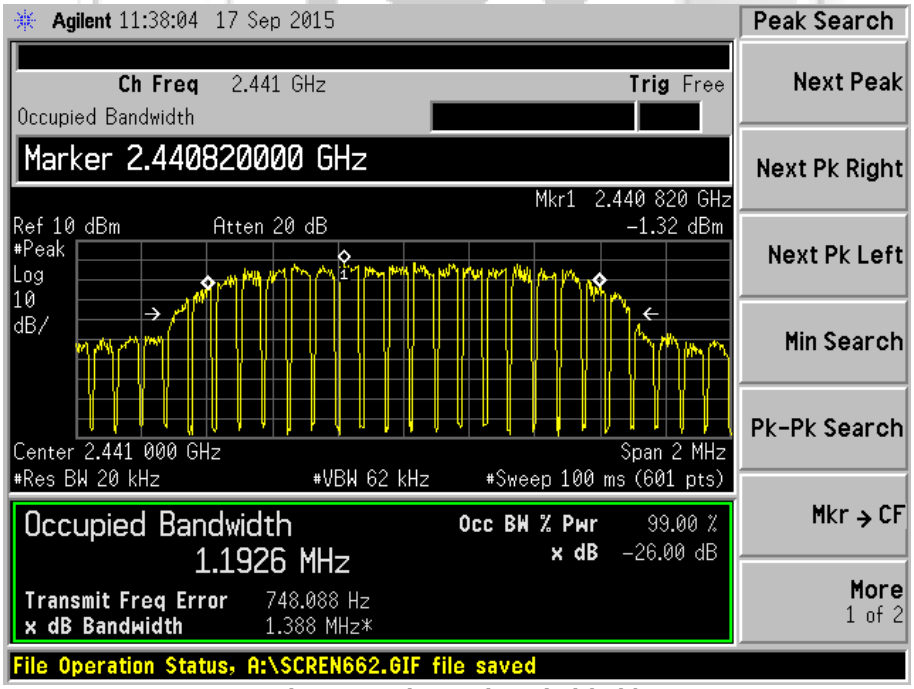


Plot 16 – Channel 78 *(upper ch)*

Spectrum Bandwidth (99% Bandwidth Measurement) Plots – (π/4)DQPSK

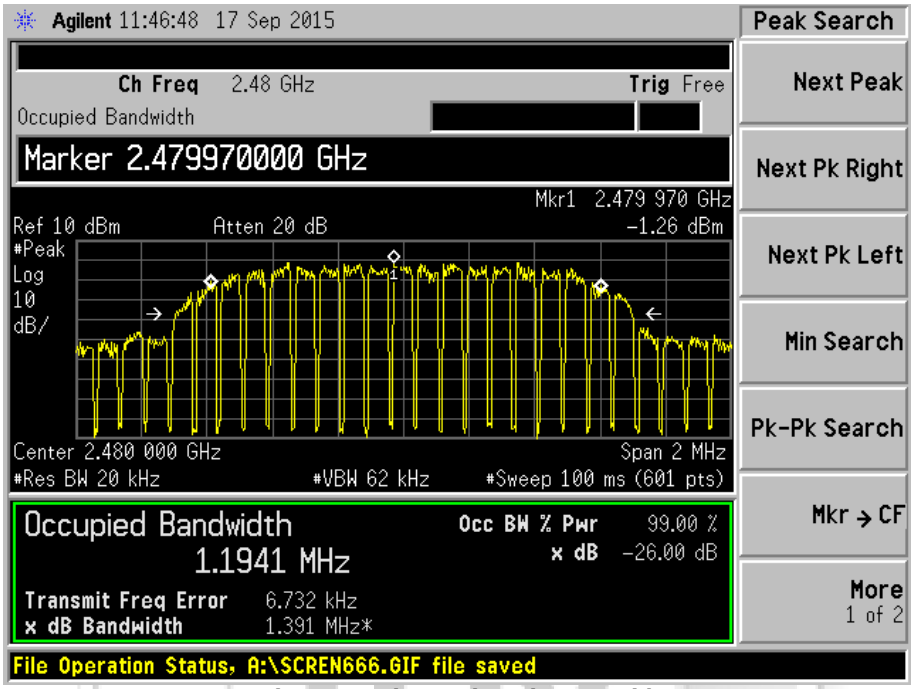


Plot 17 – Channel 0 *(lower ch)*



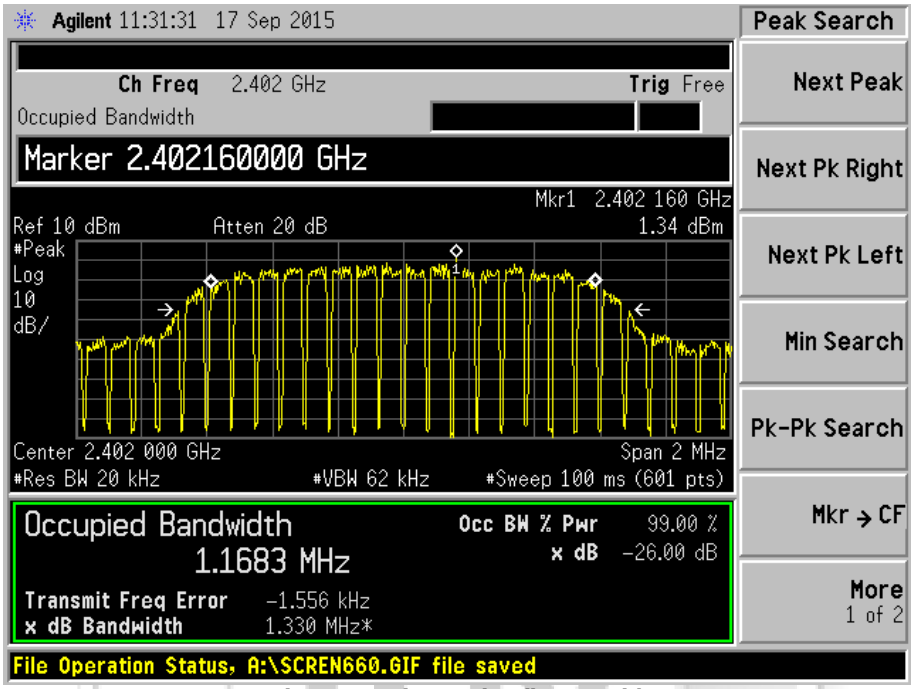
Plot 18 – Channel 39 *(mid ch)*

Spectrum Bandwidth (99% Bandwidth Measurement) Plots – (π/4)DQPSK

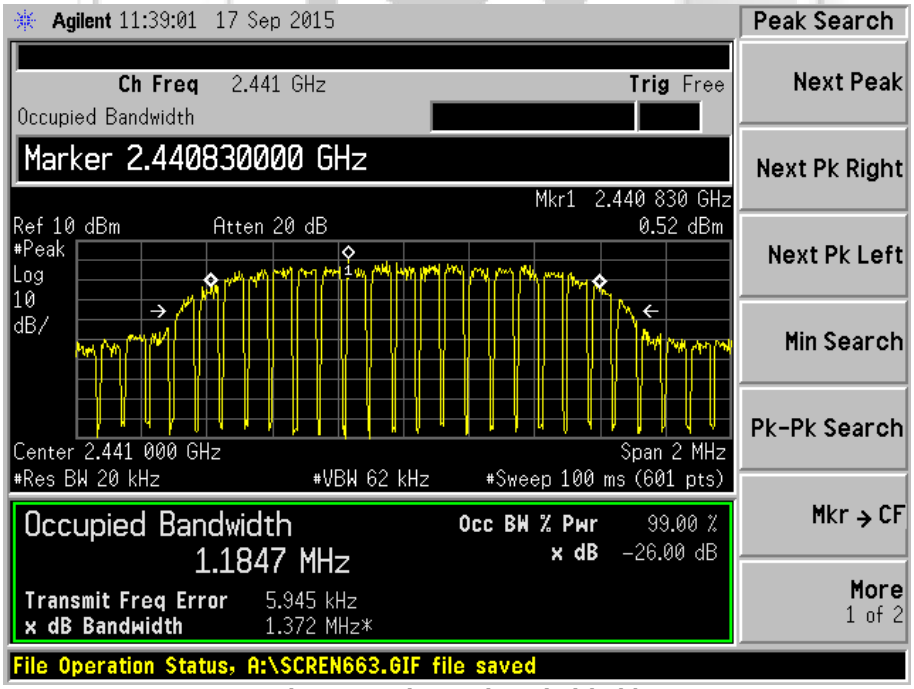


Plot 19 – Channel 78 *(upper ch)*

Spectrum Bandwidth (99% Bandwidth Measurement) Plots – 8DPSK

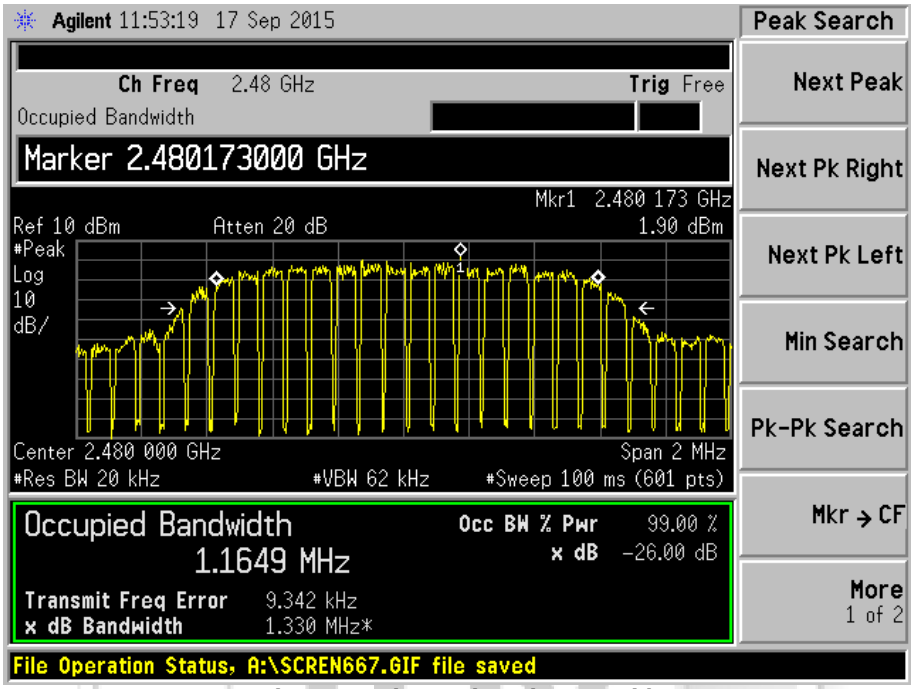


Plot 20 – Channel 0 *(lower ch)*



Plot 21 – Channel 39 *(mid ch)*

Spectrum Bandwidth (99% Bandwidth Measurement) Plots – 8DPSK



Plot 22 – Channel 78 *(upper ch)*

47 CFR FCC Part 15.247(a)(1)(iii) and RSS-247 5.1(4) 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) and RSS-247 5.1(4) Number of Hopping Frequencies Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4404B	US39440632	02 Apr 2016	1 year

47 CFR FCC Part 15.247(a)(1)(iii) and RSS-247 5.1(4) 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) and RSS-247 5.1(4) Number of Hopping Frequencies Test Method

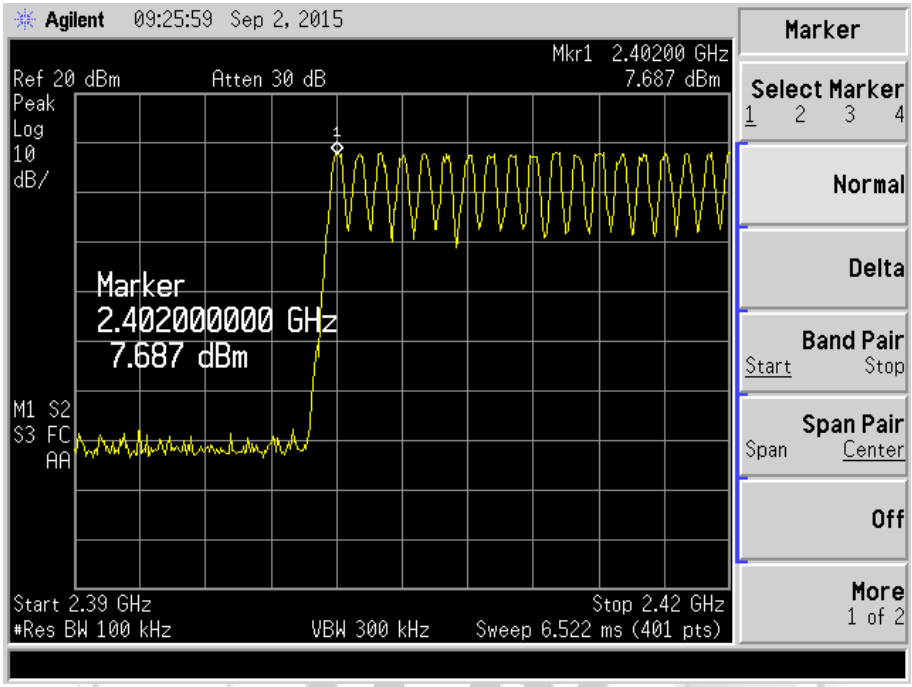
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The start and stop frequencies of the spectrum analyser were set to 2.390GHz and 2.420GHz.
3. The spectrum analyser was set to max hold to capture all the transmitting frequencies within the span. The signal capturing was continuous until all the transmitting frequencies were captured and no further signals were detected.
4. The numbers of transmitting frequencies were counted and recorded.
5. The steps 2 to 4 were repeated with the following start and stop frequencies settings:
   a. 2.420GHz to 2.441GHz
   b. 2.441GHz to 2.461GHz
   c. 2.461GHz to 2.483GHz
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) and RSS-247 5.1(4) Number of Hopping Frequencies Results

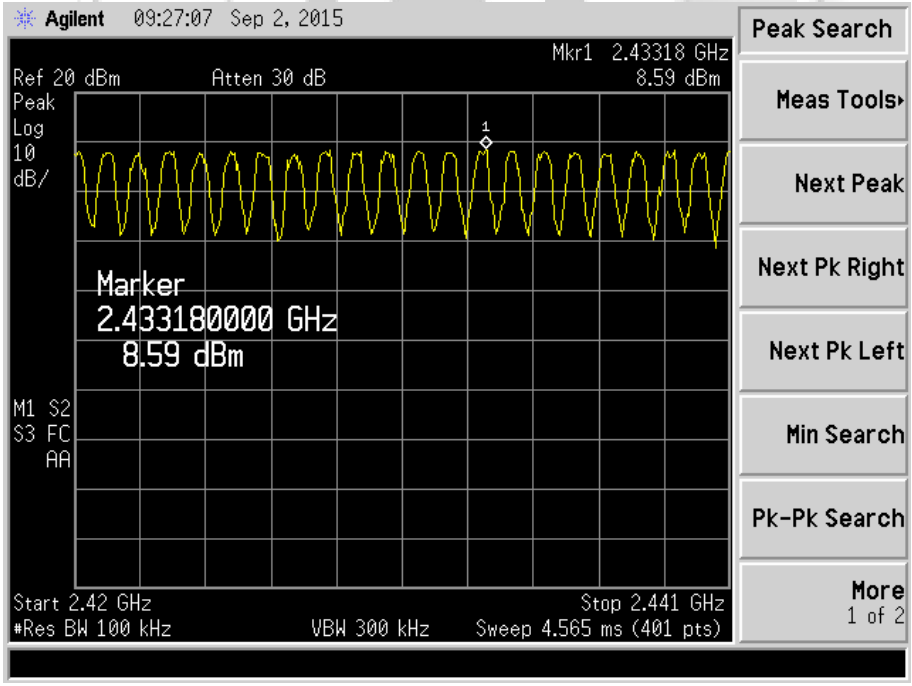
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	23 – 26	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

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

Number Of Hopping Frequencies Plots

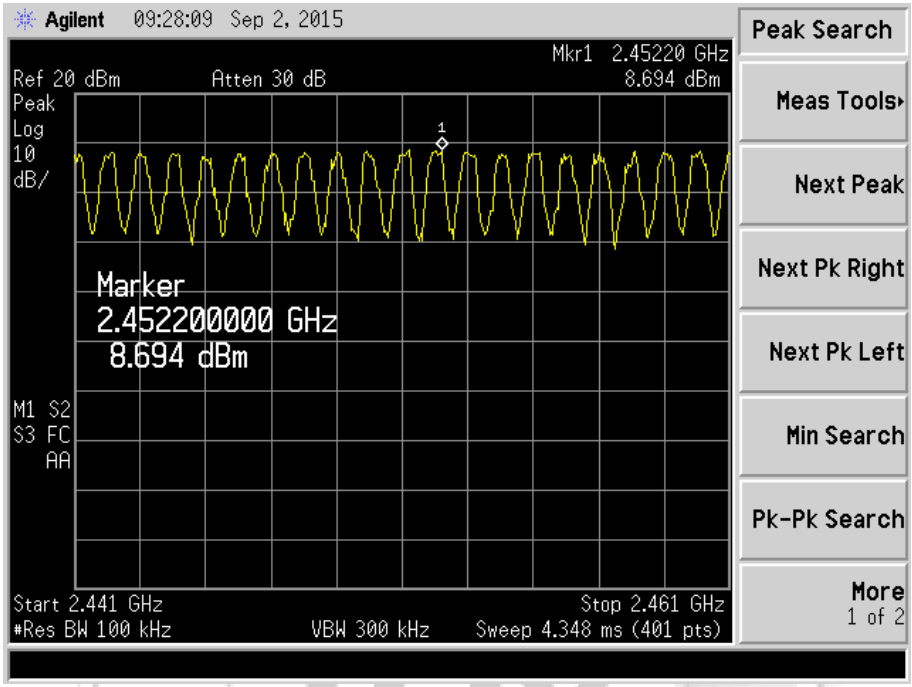


Plot 23 - Channels 0 to 18

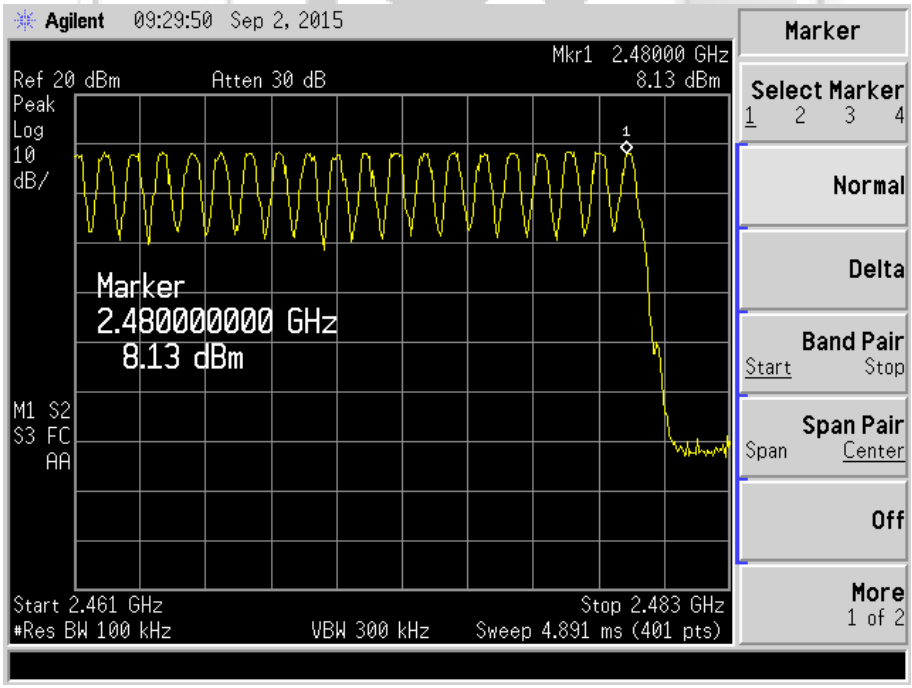


Plot 24 - Channels 18 to 39

Number Of Hopping Frequencies Plots



Plot 25 - Channels 39 to 59



Plot 26 - Channels 59 to 78

47 CFR FCC Part 15.247(a)(1)(iii) and RSS-247 5.1(4) 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) and RSS-247 5.1(4) Average Frequency Dwell Time Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015	1 year

47 CFR FCC Part 15.247(a)(1)(iii) and RSS-247 5.1(4) 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.

CFR FCC Part 15.247(a)(1)(iii) and RSS-247 5.1(4) 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 was measured using the marker-delta function of the spectrum analyser. The average dwell time of the transmitting frequency was computed as below:
   Average Frequency Dwell Time = [measured pulse time x hopping rate / number of hopping channels] x [0.4 x number of hopping channels]
5. The steps 2 to 4 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) and RSS-247 5.1(4) Average Frequency Dwell Time Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	27 – 29 (DH1) 30 – 32 (DH3) 33 – 35 (DH5)	Relative Humidity	60%
Hopping Rate	1600 hops / s	Atmospheric Pressure	1030mbar
Number of Hopping Channels	79 channels	Tested By	Liau Lee Yin

DH1

Channel	Channel Frequency (GHz)	Measured Time Slot Length (ms)	Average Frequency Dwell Time (s)	Average Occupancy Limit (s)
0 *(lower ch)*	2.402	0.3750	0.1200	0.4
39 *(mid ch)*	2.441	0.3750	0.1200	0.4
78 *(upper ch)*	2.480	0.3750	0.1200	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	1.6300	0.2608	0.4
39 *(mid ch)*	2.441	1.6300	0.2608	0.4
78 *(upper ch)*	2.480	1.6300	0.2608	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	2.8750	0.3067	0.4
39 *(mid ch)*	2.441	2.8750	0.3067	0.4
78 *(upper ch)*	2.480	2.8667	0.3058	0.4

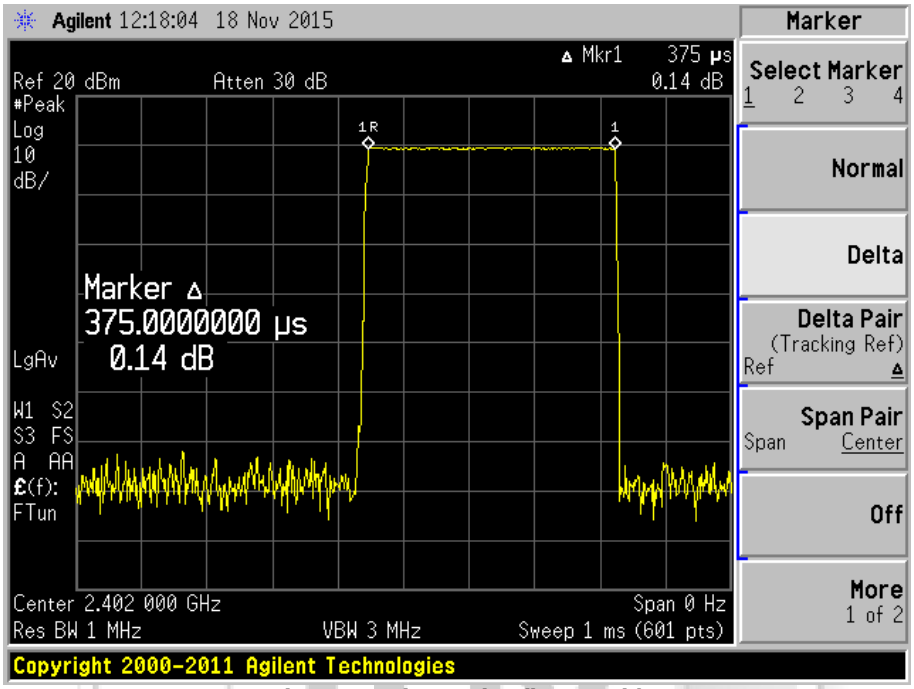
Notes

1. Average Frequency Dwell time = Pulse Time*(Hop Rate/2/Number of Channels)*31.6 (DH1)
   Pulse Time*(Hop Rate/4/Number of Channels)*31.6 (DH3)
   Pulse Time*(Hop Rate/6/Number of Channels)*31.6 (DH5)

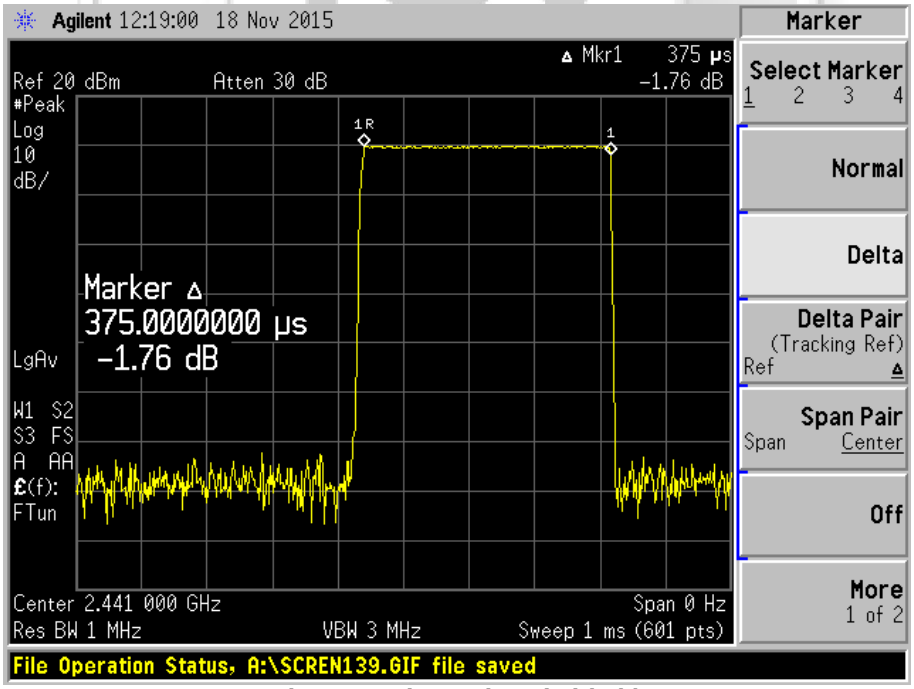
   where:

   • Hop Rate = 1600
   • Number of Channels = 79

Average Frequency Dwell Time Plots – DH1

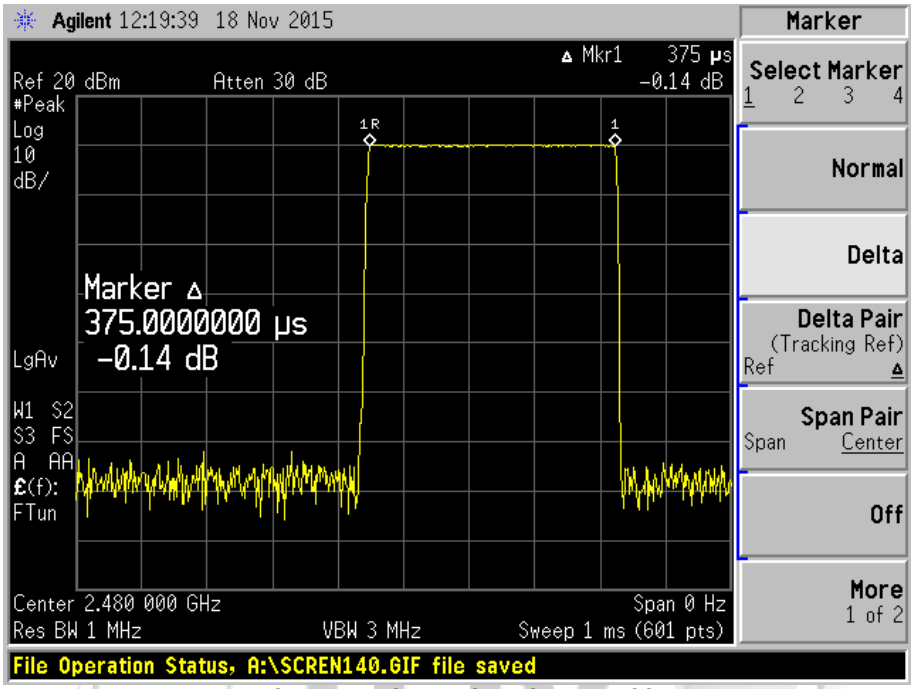


Plot 27 – Channel 0 *(lower ch)*



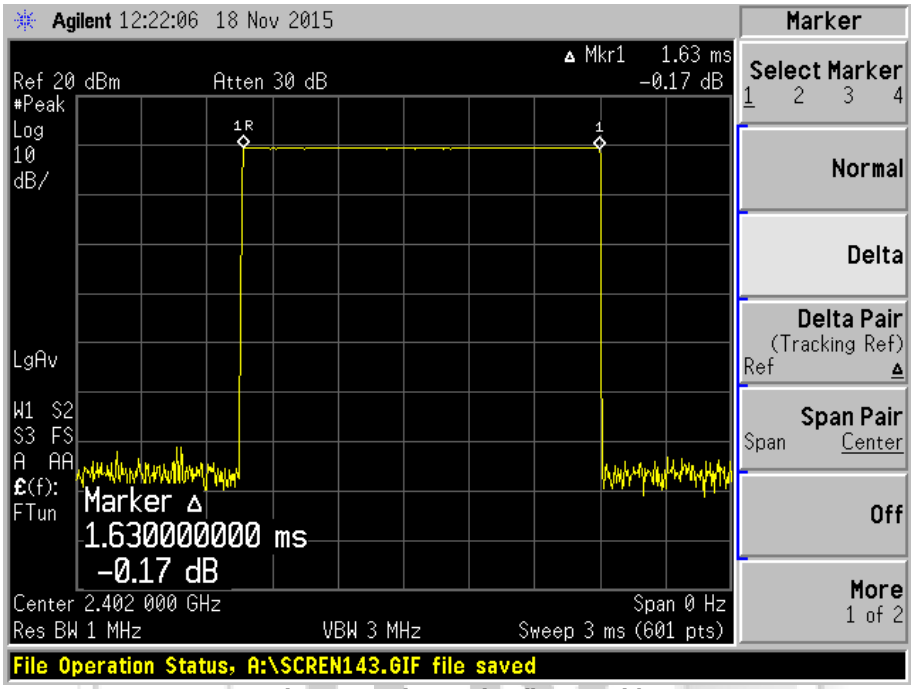
Plot 28 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH1

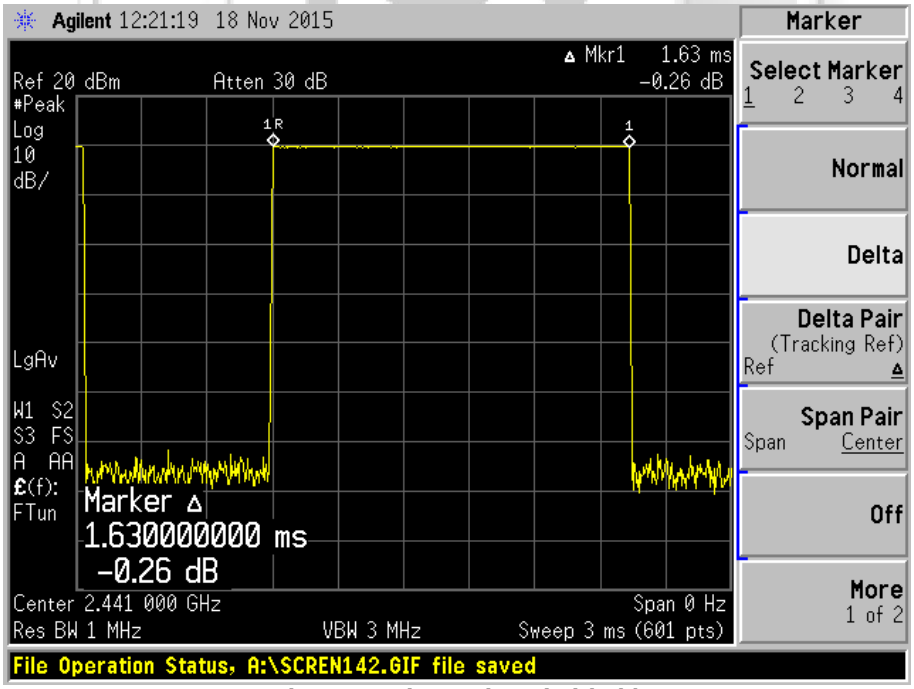


Plot 29 – Channel 78 *(upper ch)*

Average Frequency Dwell Time Plots – DH3

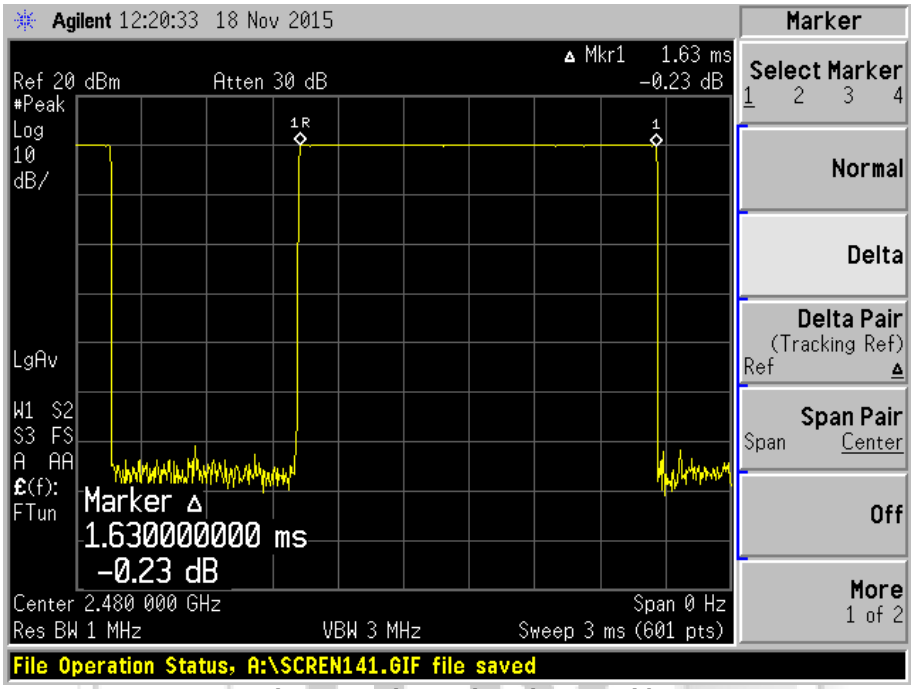


Plot 30 – Channel 0 *(lower ch)*



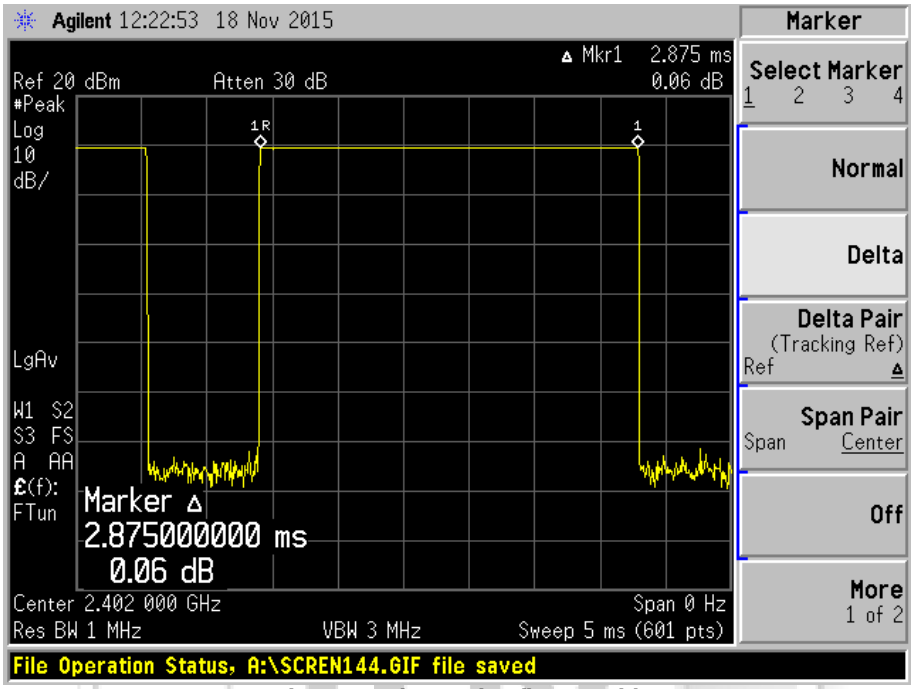
Plot 31 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH3

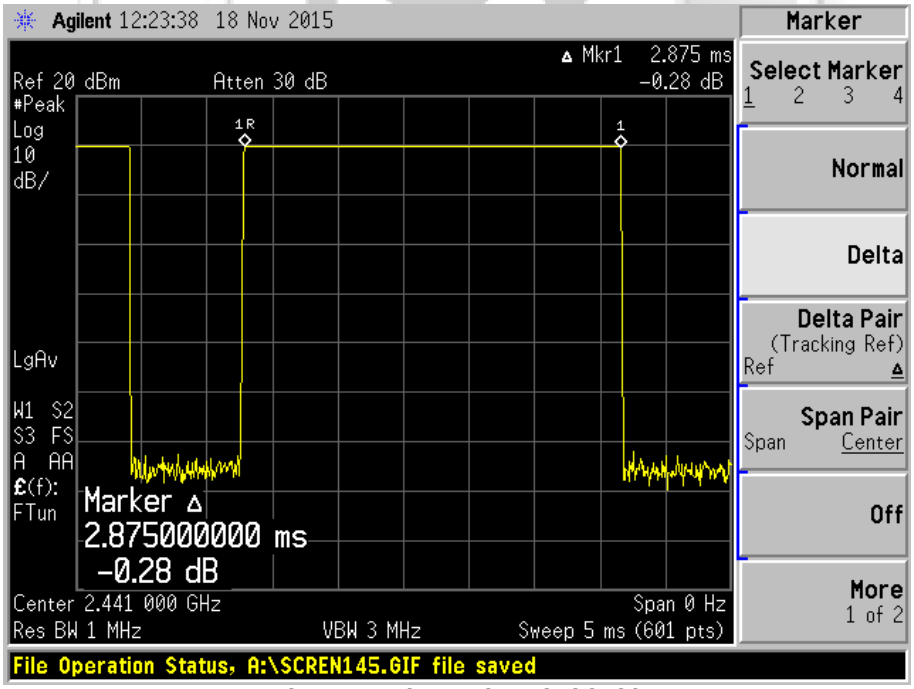


Plot 32 – Channel 78 *(upper ch)*

Average Frequency Dwell Time Plots – DH5

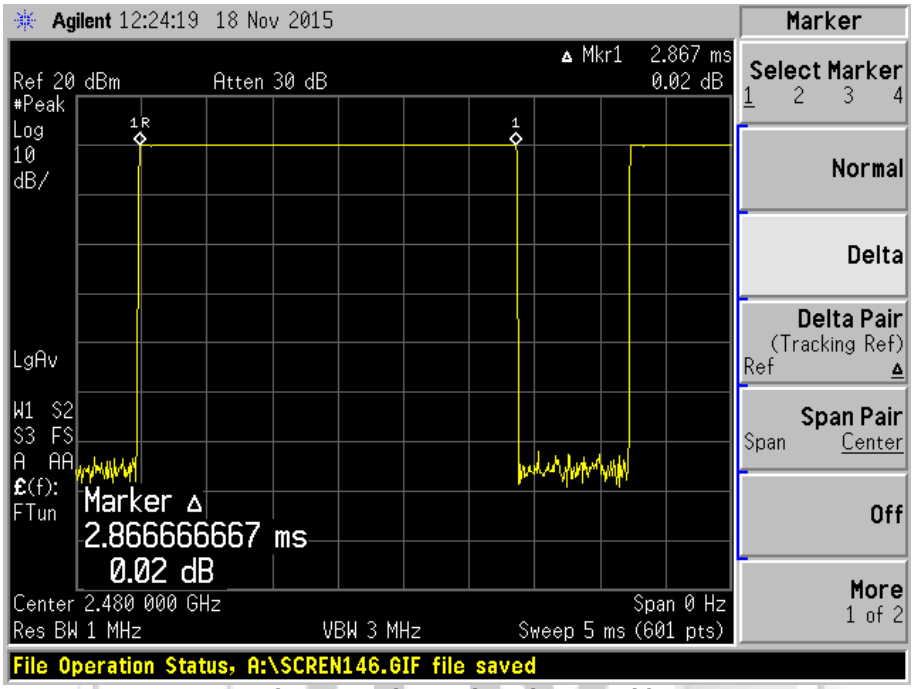


Plot 33– Channel 0 *(lower ch)*



Plot 34 – Channel 39 *(mid ch)*

Average Frequency Dwell Time Plots – DH5



Plot 35 – Channel 78 *(upper ch)*

47 CFR FCC Part 15.247(b)(1) and RSS-247 5.4(2) 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) and RSS-247 5.4 (2) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Boonton Electronics RF Power Meter	4532	72901	27 Aug 2016	1 year
Boonton Electronics Peak Power Sensor	56218-S/1	1417	27 Aug 2016	1 year

47 CFR FCC Part 15.247(b)(1) and RSS-247 5.4(2) 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) and RSS-247 5.4(2) Maximum Peak Power Test Method

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The Equivalent Isotropic Radiated Power (EIRP) of the EUT was computed by adding its antenna gain to the measured maximum peak power.
4. The steps 2 to 3 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) *(mid ch)* and Channel 78 (2.480GHz) *(upper ch)* respectively.

47 CFR FCC Part 15.247(b)(1) and RSS-247 5.4(2) Maximum Peak Power Results

Test Input Power	120V 60Hz	Temperature	24°C
Antenna Gain	4.0 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

GFSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0068	0.0171	1.0
39 *(mid ch)*	2.441	0.0080	0.0201	1.0
78 (upper ch)	2.480	0.0083	0.0208	1.0

(π/4) DQPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0037	0.0093	1.0
39 *(mid ch)*	2.441	0.0042	0.0105	1.0
78 *(upper ch)*	2.480	0.0045	0.0113	1.0

8DPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0036	0.0090	1.0
39 *(mid ch)*	2.441	0.0042	0.0105	1.0
78 *(upper ch)*	2.480	0.0045	0.0113	1.0

Notes

1. Nil.

47 CFR FCC Part 15.247(d) and RSS-247 5.5 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) and RSS-247 5.5 RF Conducted Spurious Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015	1 year

47 CFR FCC Part 15.247(d) and RSS-247 5.5 RF Conducted Spurious Emissions Test Setup

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

47 CFR FCC Part 15.247(d) and RSS-247 5.5 RF Conducted Spurious Emissions Test Method

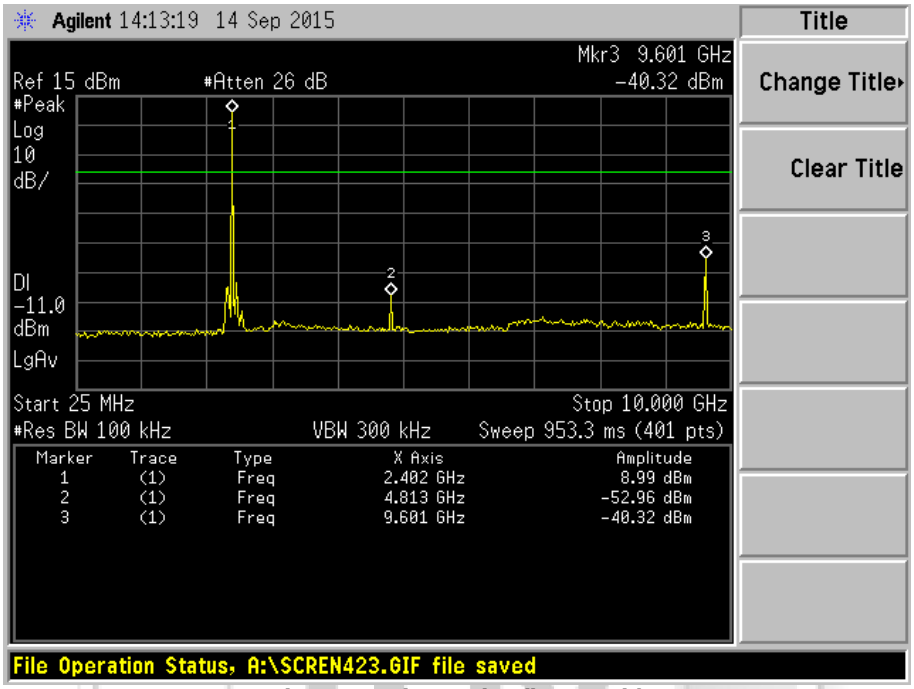
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 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) and RSS-247 5.5 RF Conducted Spurious Emissions Results

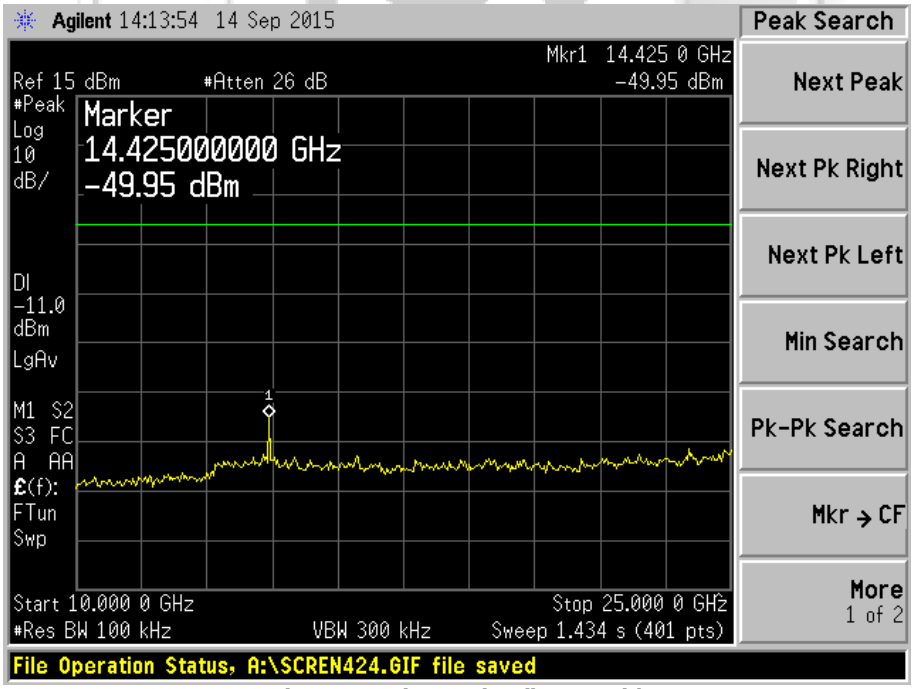
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	36 – 41 (GFSK) 42 – 47 ((π/4) DQPSK) 48 – 53 (8DPSK)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

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

RF Conducted Spurious Emissions Plots – GFSK

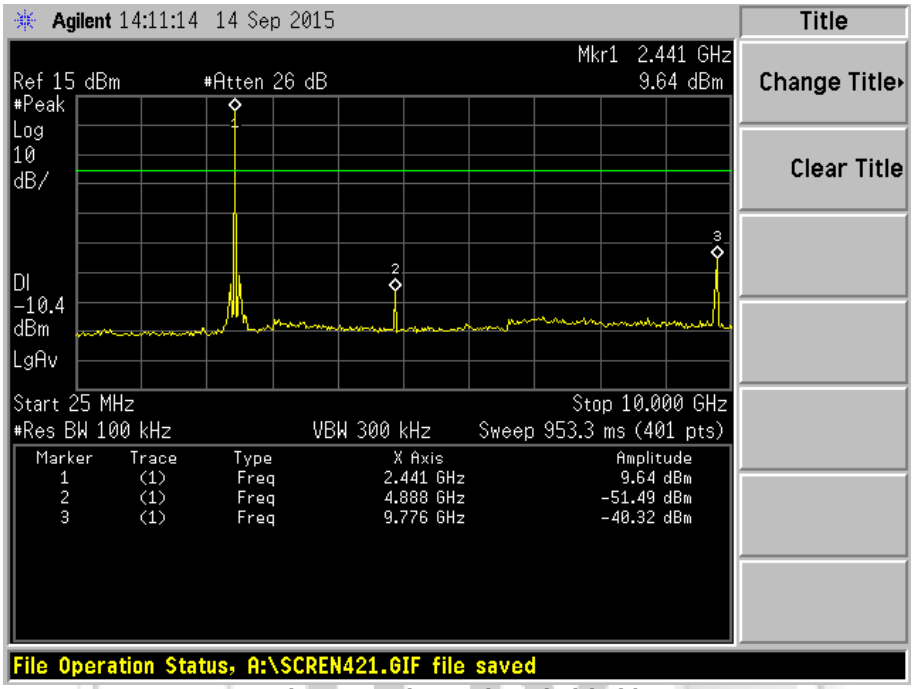


Plot 36 – Channel 0 *(lower ch)*

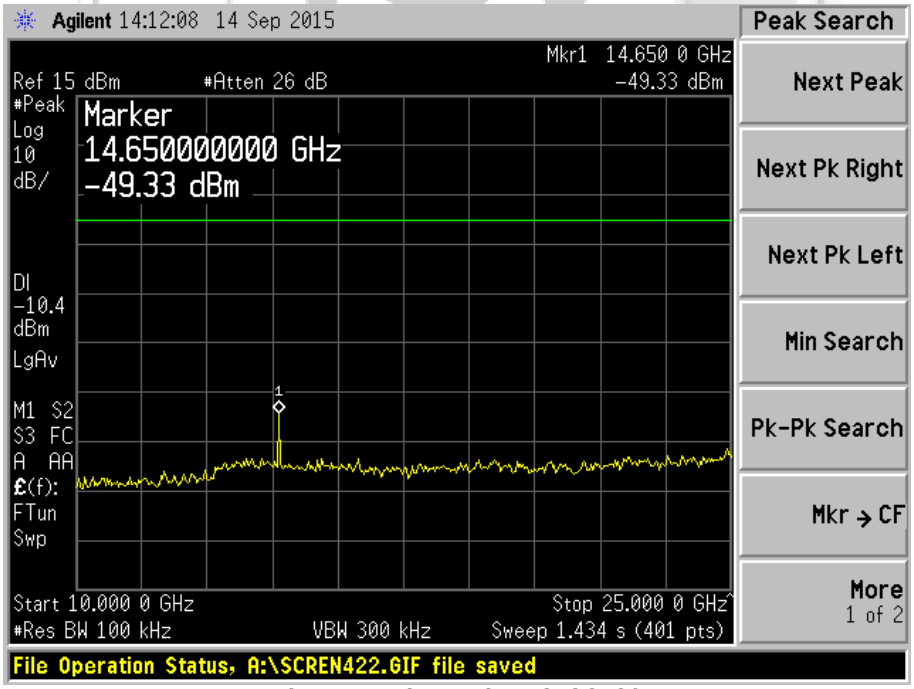


Plot 37 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – GFSK

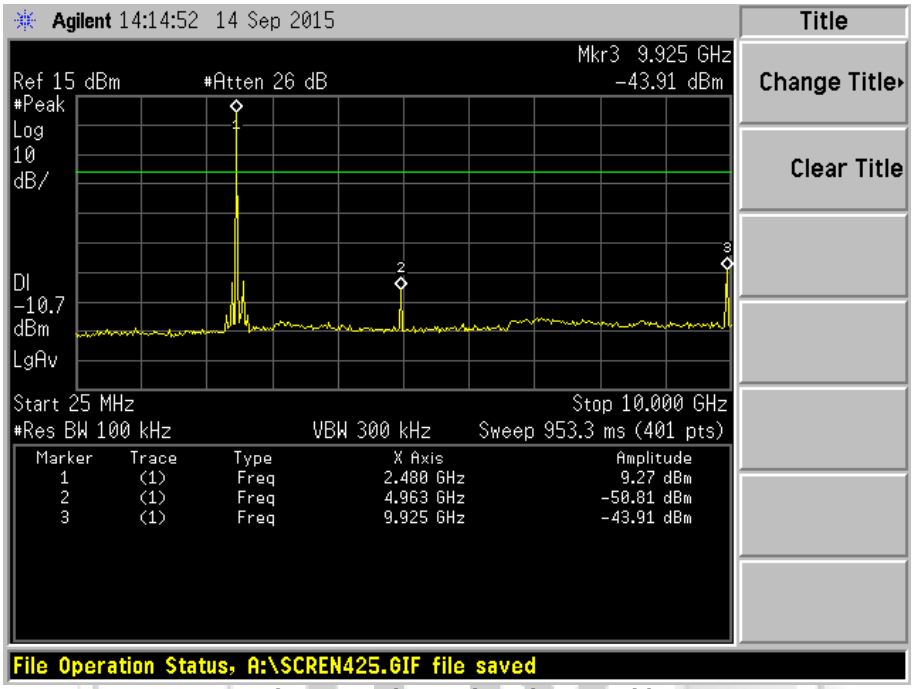


Plot 38 – Channel 39 *(mid ch)*

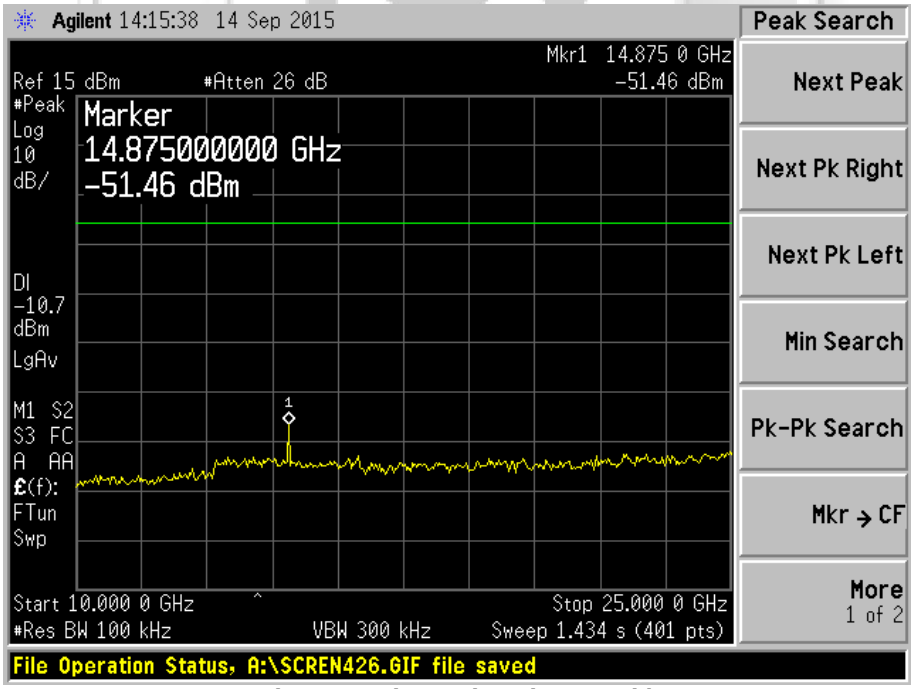


Plot 39 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – GFSK

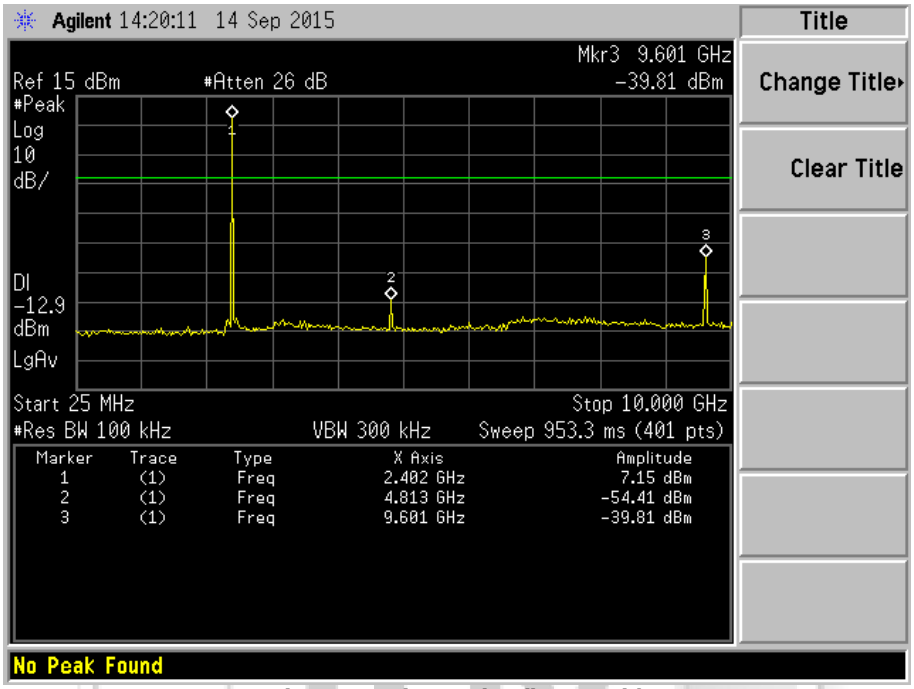


Plot 40 – Channel 78 *(upper ch)*

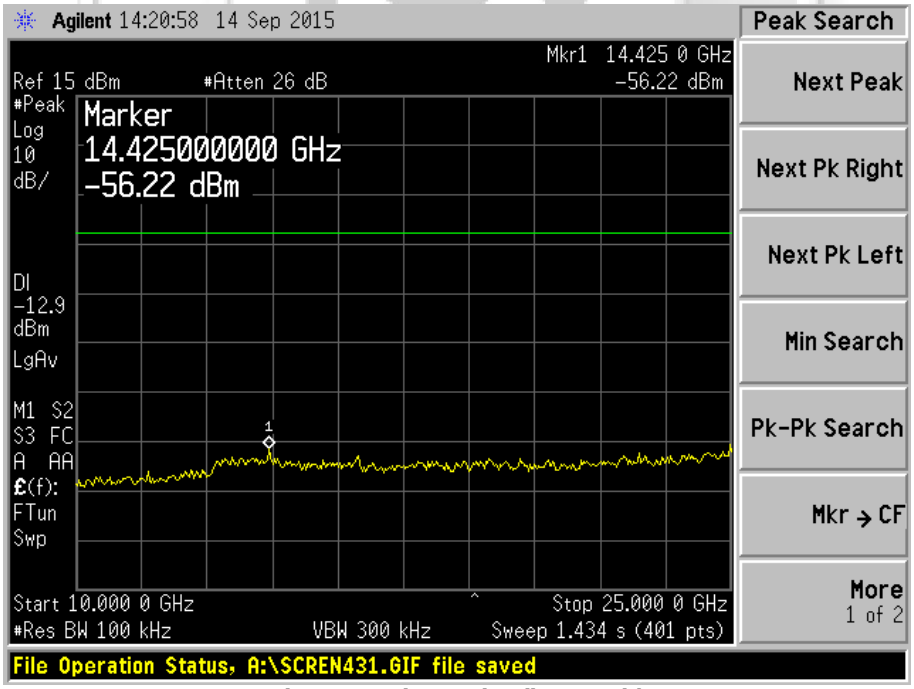


Plot 41 – Channel 78 *(upper ch)*

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

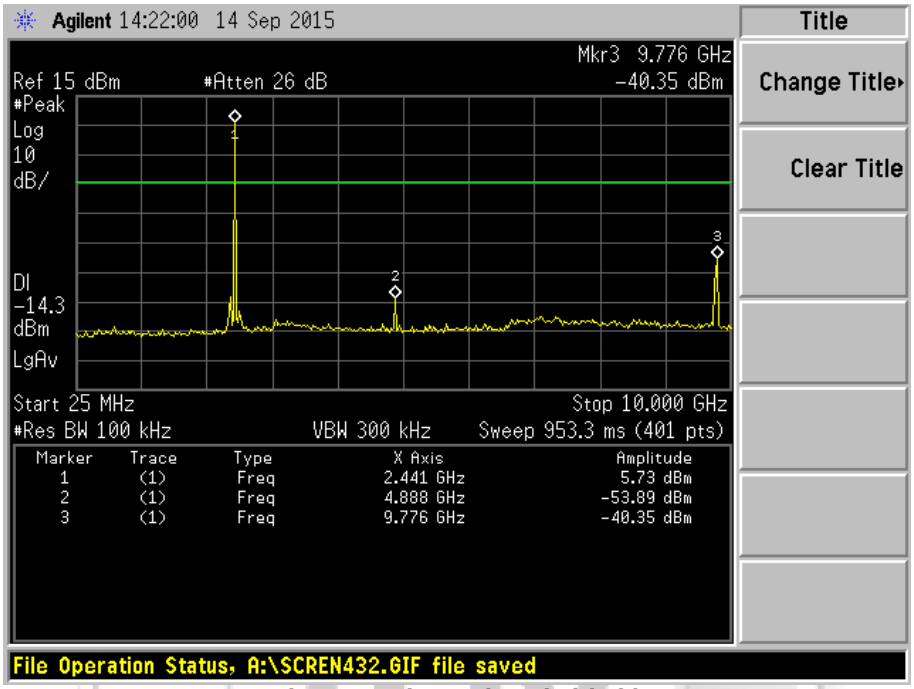


Plot 42 – Channel 0 *(lower ch)*

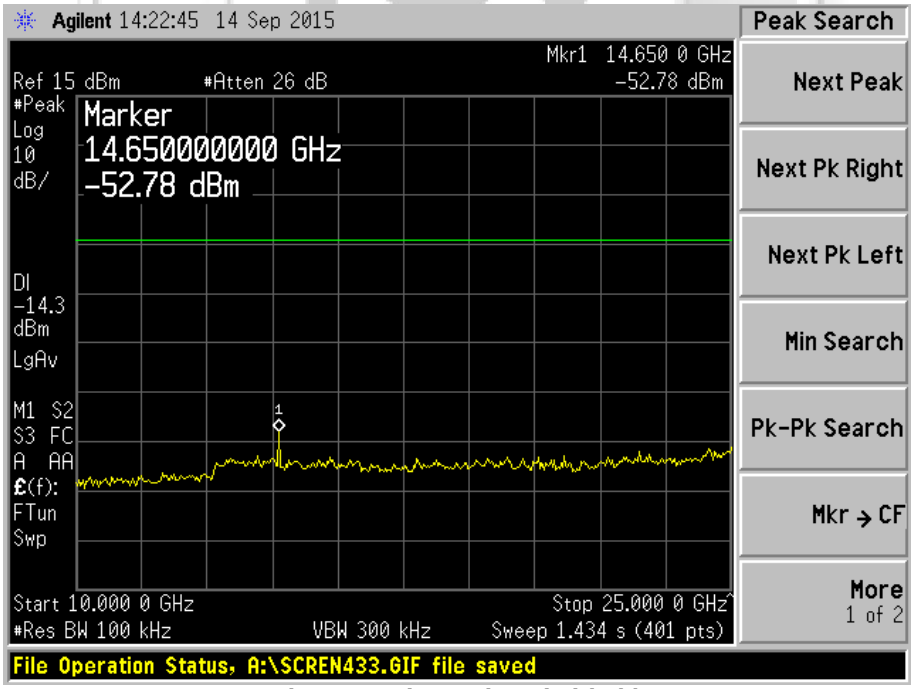


Plot 43 – Channel 0 *(lower ch)*

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

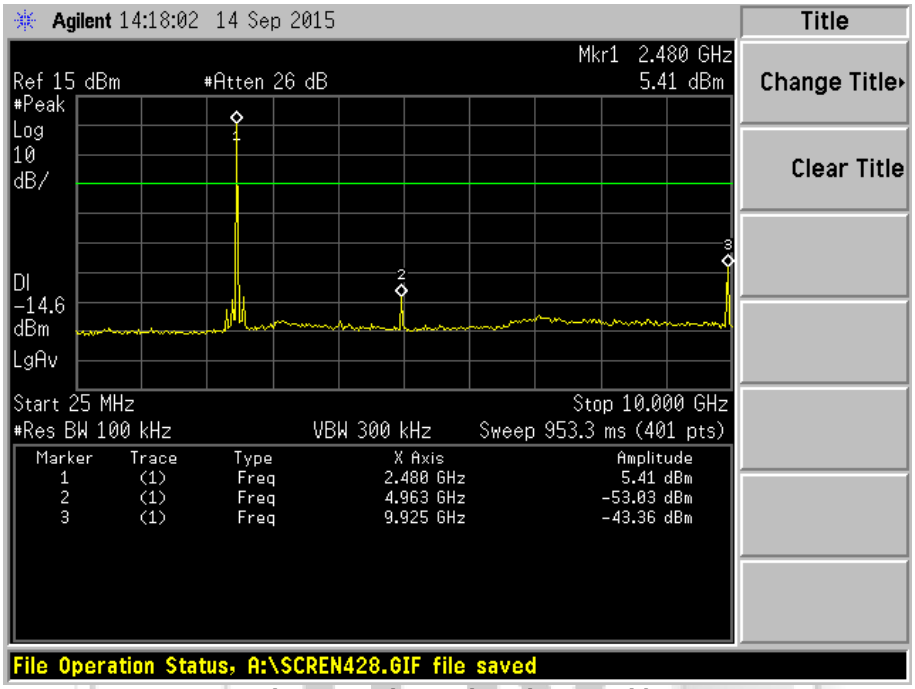


Plot 44 – Channel 39 *(mid ch)*

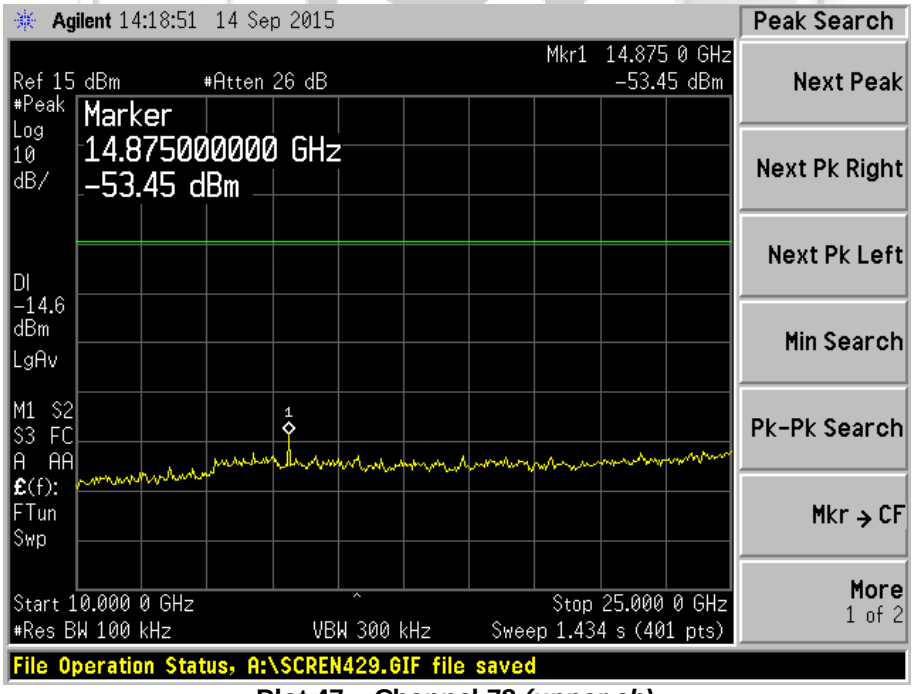


Plot 45 – Channel 39 *(mid ch)*

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

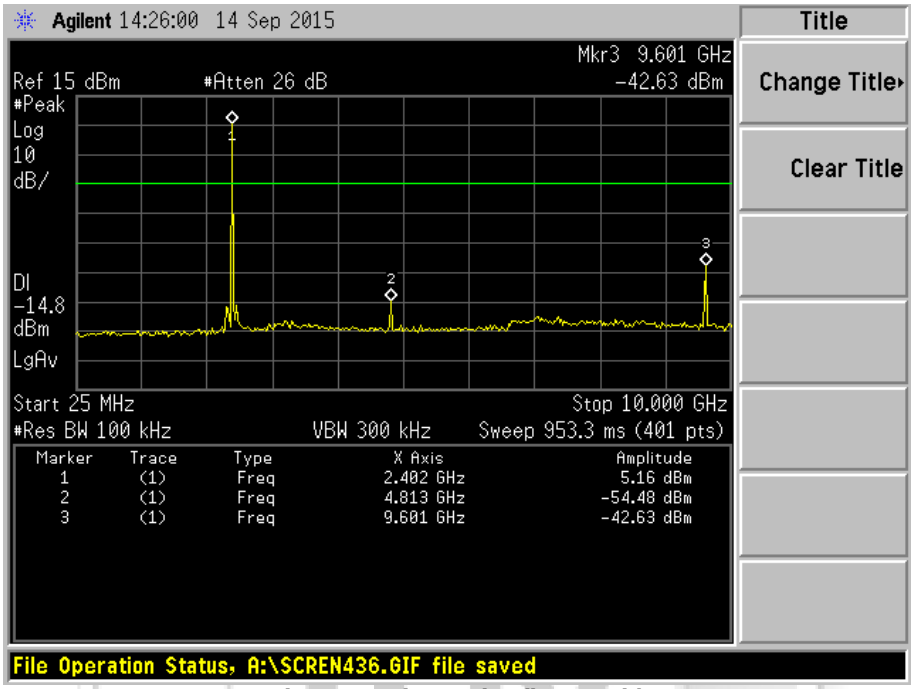


Plot 46 – Channel 78 *(upper ch)*

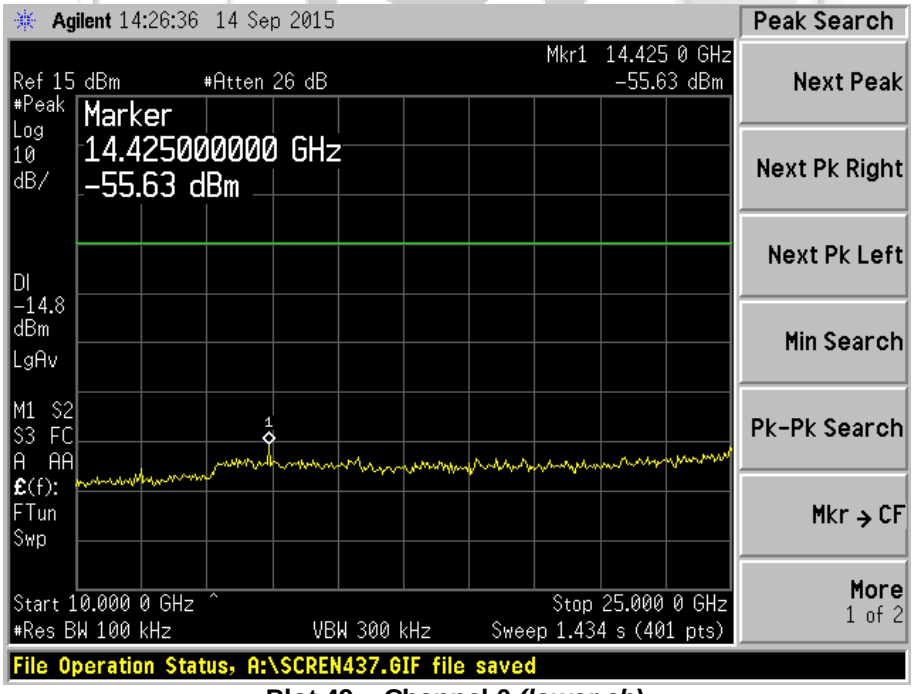


Plot 47 – Channel 78 *(upper ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

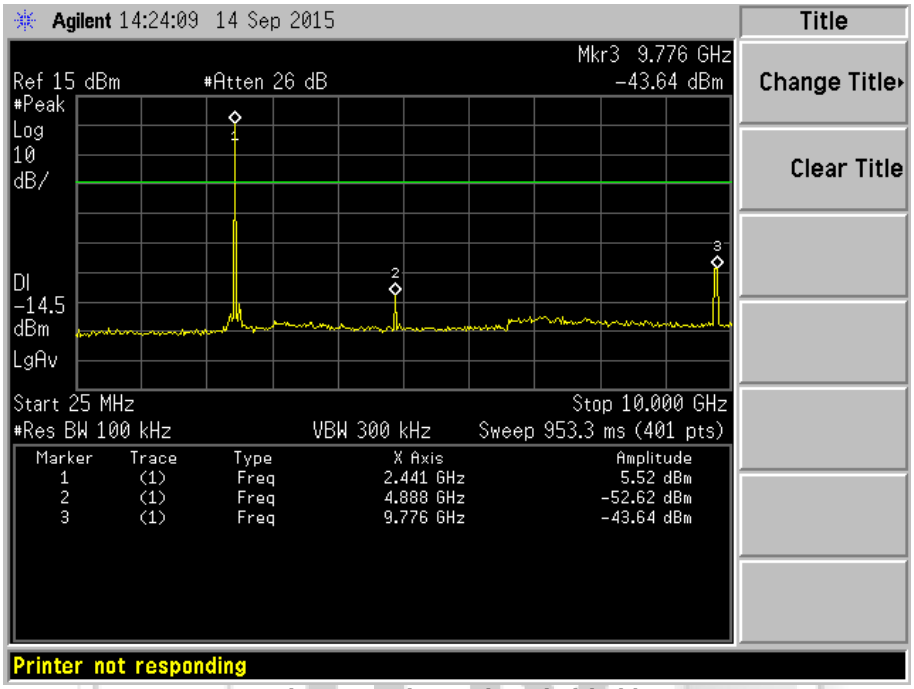


Plot 48 – Channel 0 *(lower ch)*

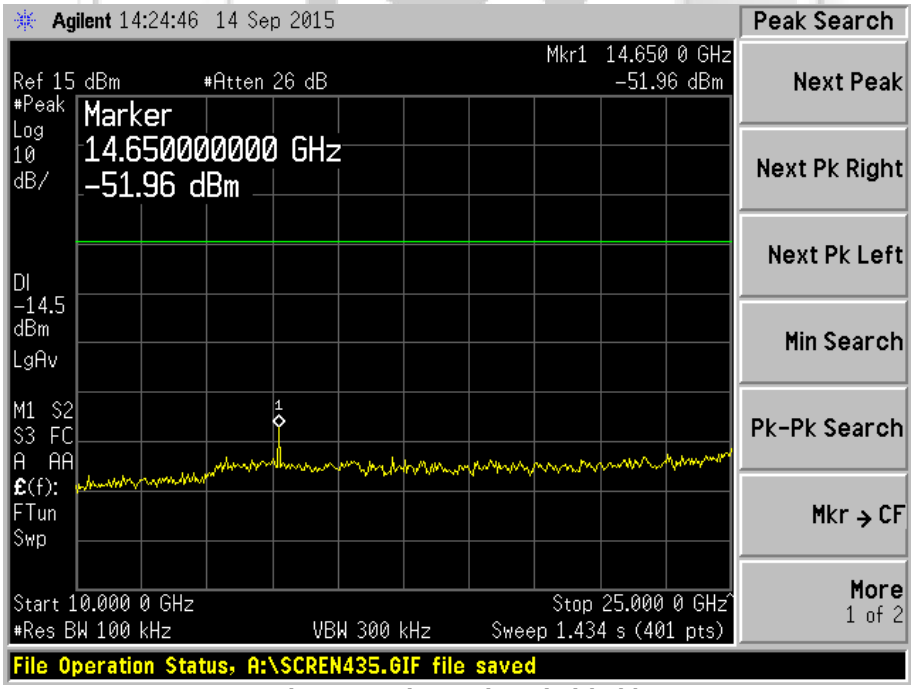


Plot 49 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

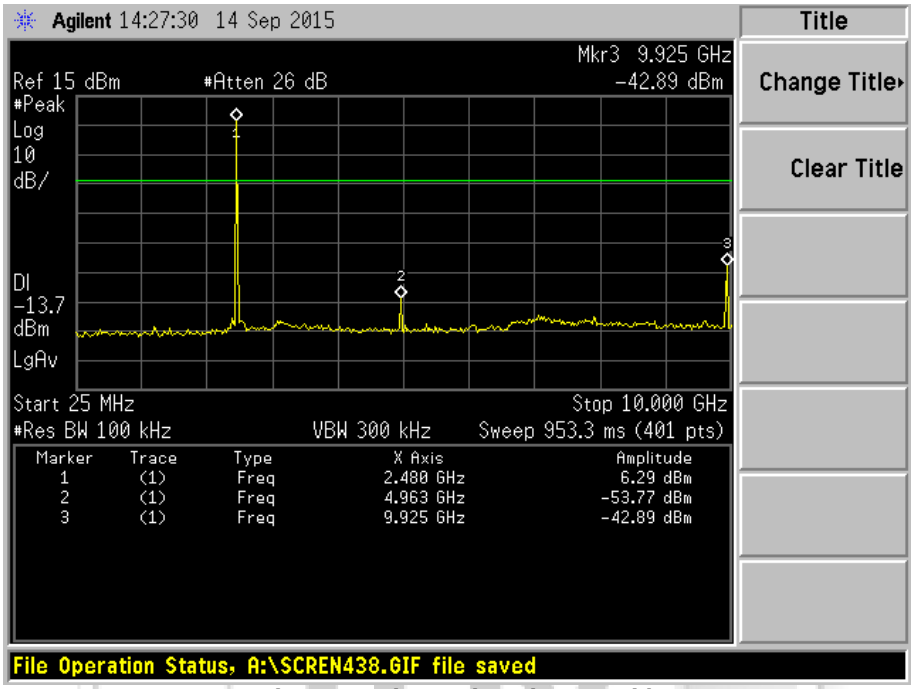


Plot 50 – Channel 39 *(mid ch)*

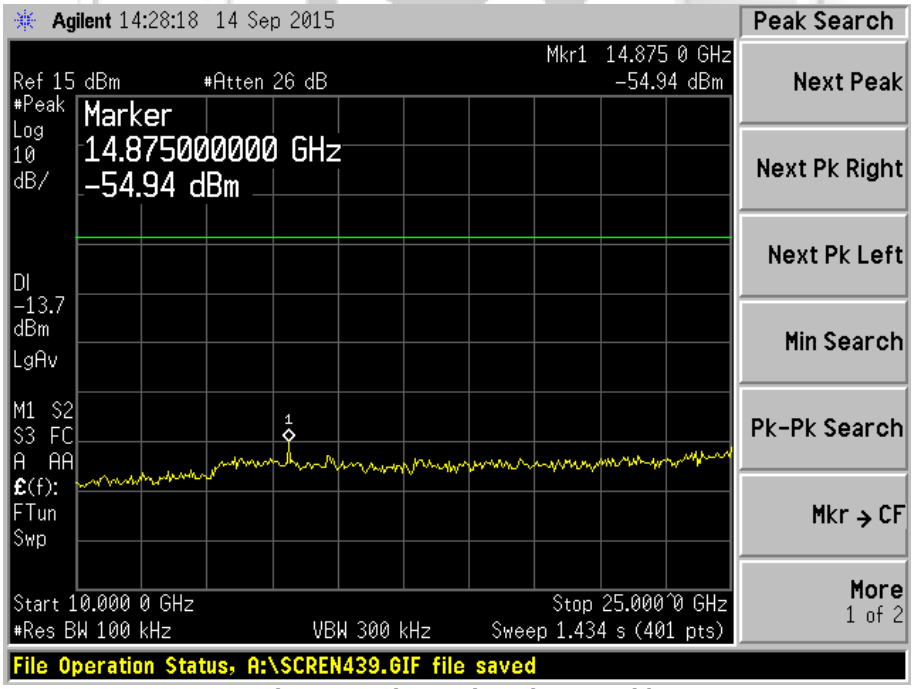


Plot 51 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – 8DPSK



Plot 52 – Channel 78 *(upper ch)*



Plot 53 – Channel 78 *(upper ch)*

BAND EDGE COMPLIANCE (CONDUCTED) TEST

47 CFR FCC Part 15.247(d) and RSS-247 5.5 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 desired power.

CFR FCC Part 15.247(d) and RSS-247 5.5 Band Edge Compliance (Conducted) Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4404B	US39440632	02 Apr 2016	1 year

47 CFR FCC Part 15.247(d) and RSS-247 5.5 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) and RSS-247 5.5 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 off.
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 steps 2 to 4 were repeated with the EUT configured to operate in the test mode with frequency hopping on.

47 CFR FCC Part 15.247(d) and RSS-247 5.5 Band Edge Compliance (Conducted) Results

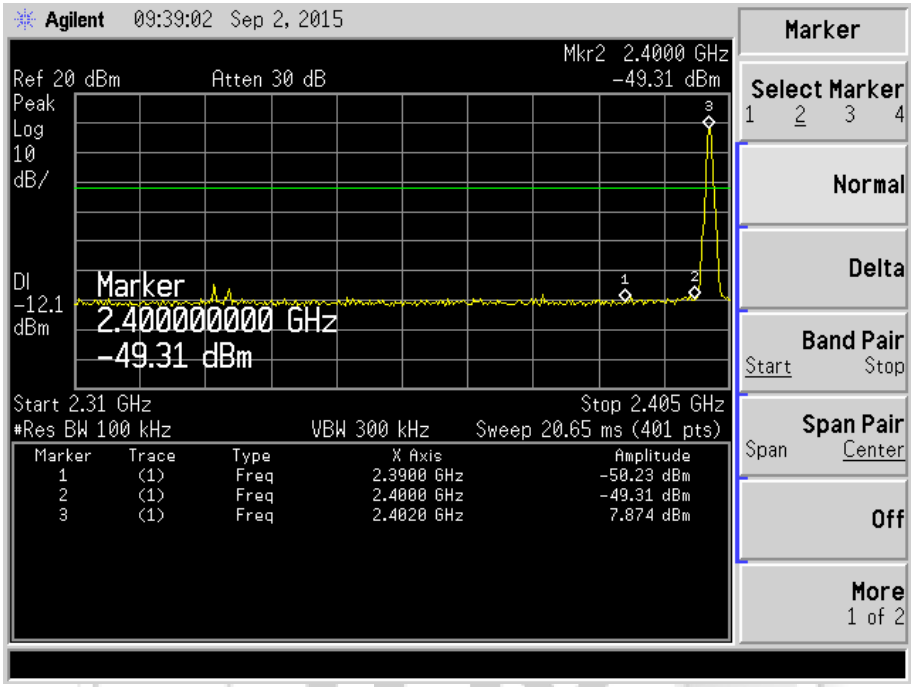
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	54 – 55 (GFSK) 56 – 57 ((π/4) DQPSK) 58 – 59 (8DPSK)	Relative Humidity	60%
Remark	Non-Hopping	Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

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

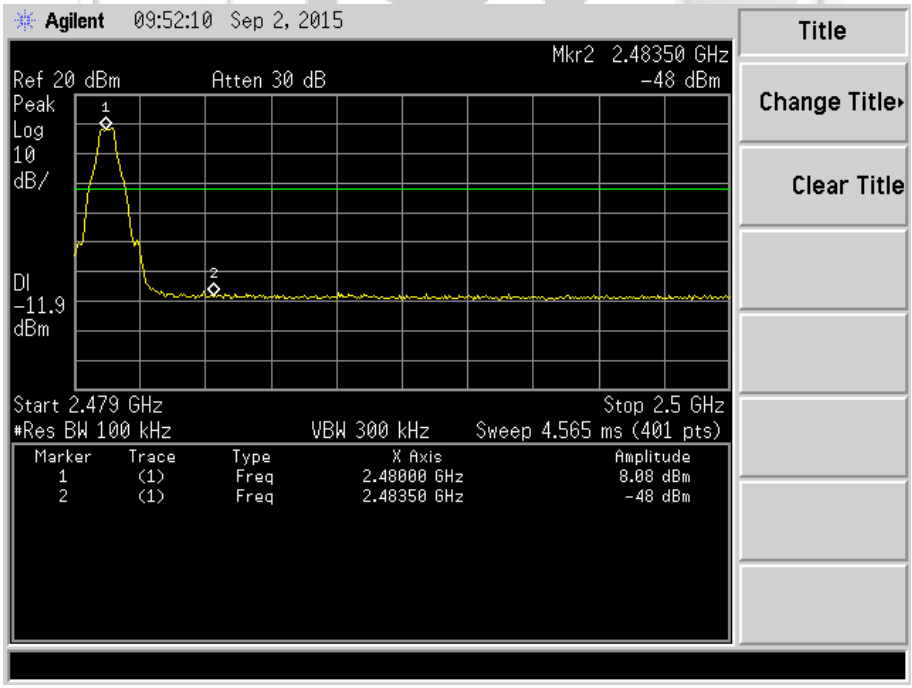
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	60 – 61 (GFSK) 62 – 63 ((π/4) DQPSK) 64 – 65 (8DPSK)	Relative Humidity	60%
Remark	Hopping	Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

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

Band Edge Compliance (Conducted) Plots – GFSK (Non-Hopping)

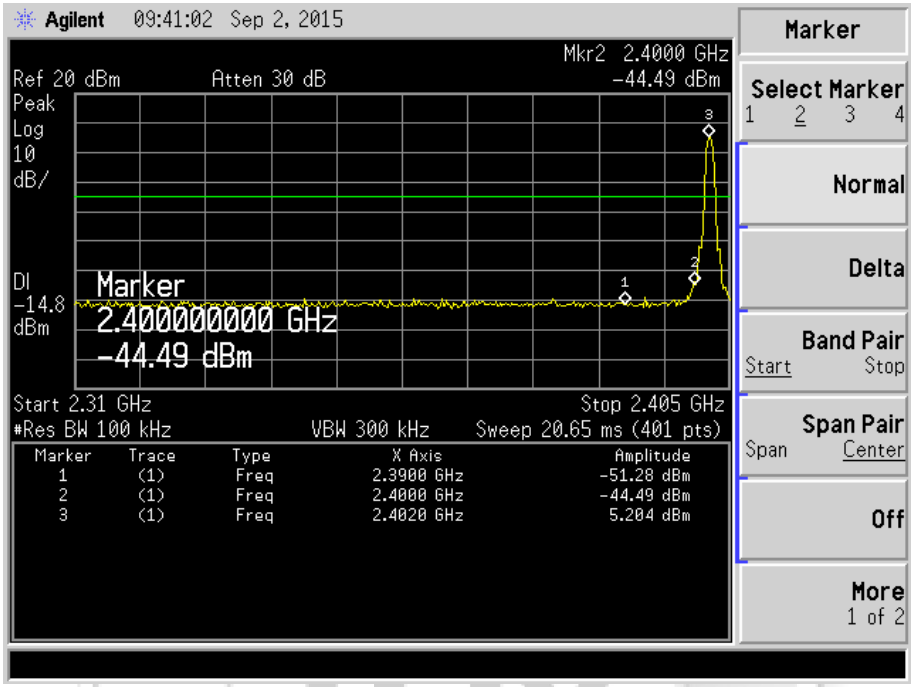


Plot 54 – Lower Band Edge at 2.4000GHz

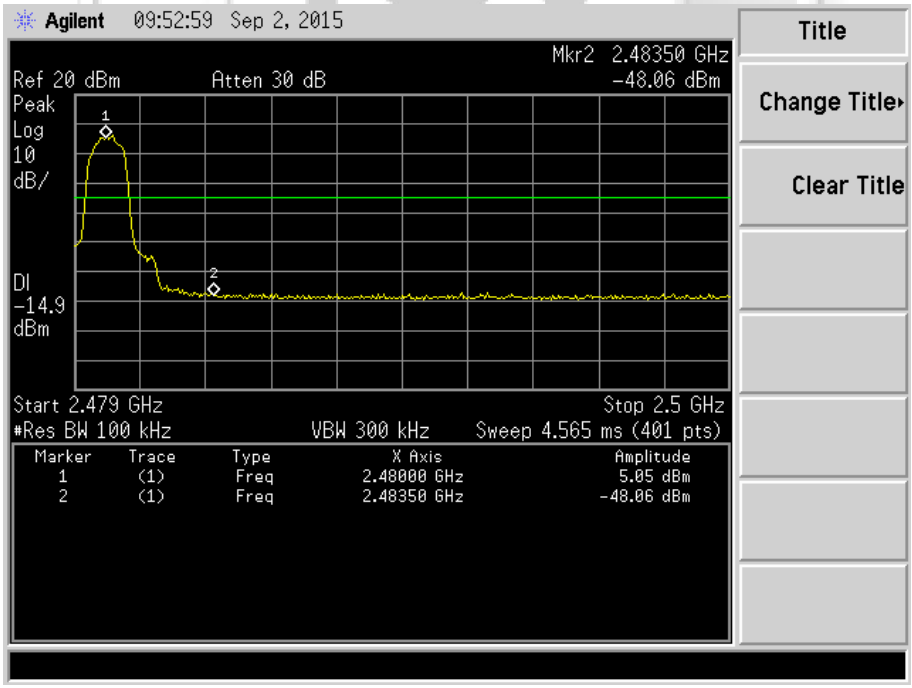


Plot 55 – Upper Band Edge at 2.4835GHz

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

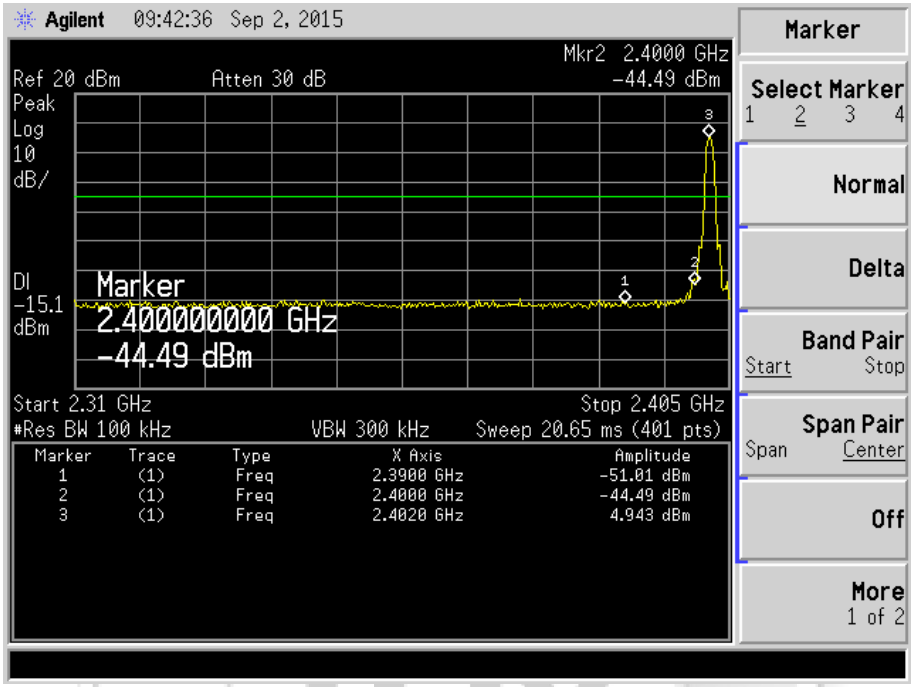


Plot 56 – Lower Band Edge at 2.4000GHz

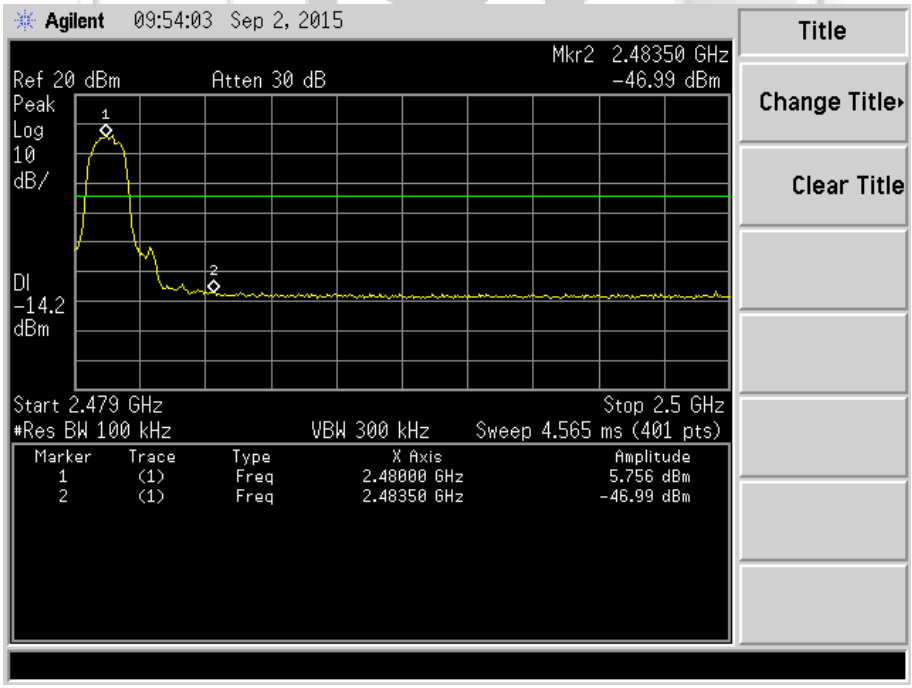


Plot 57 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – 8DPSK (Non-Hopping)

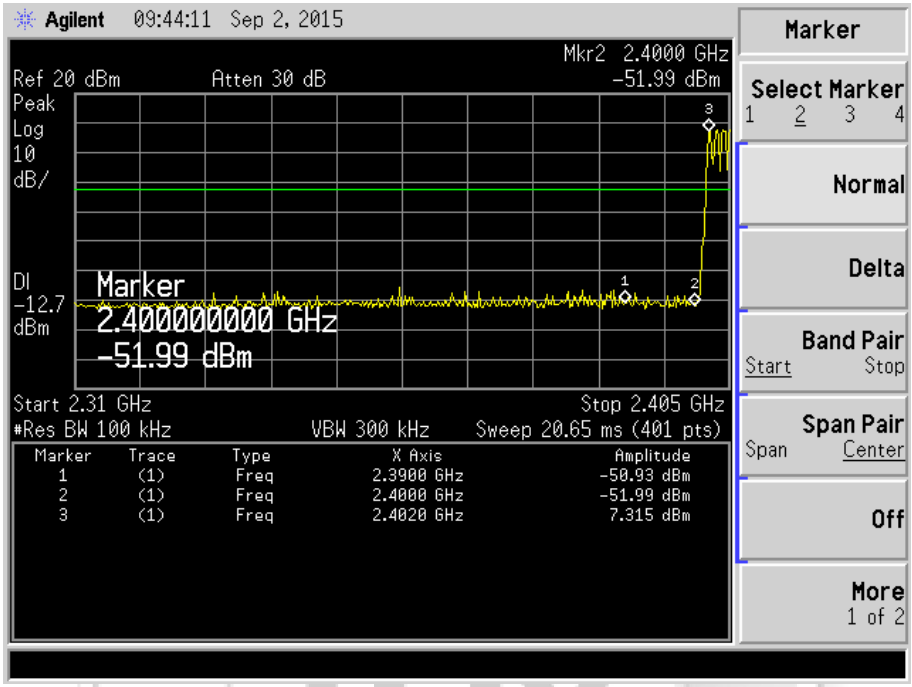


Plot 58 – Lower Band Edge at 2.4000GHz

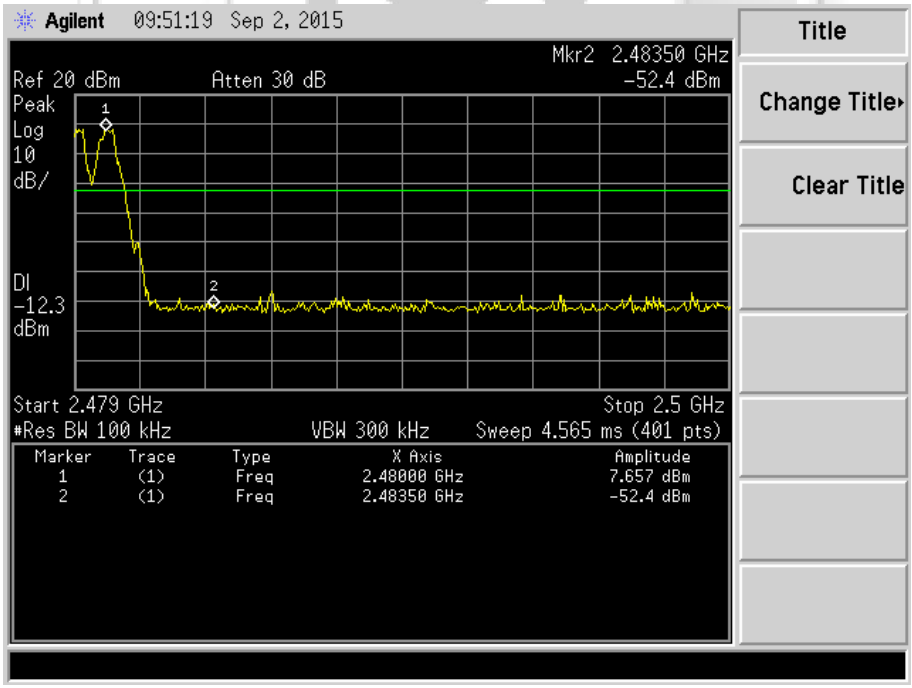


Plot 59 – Upper Band Edge at 2.4835GHz

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

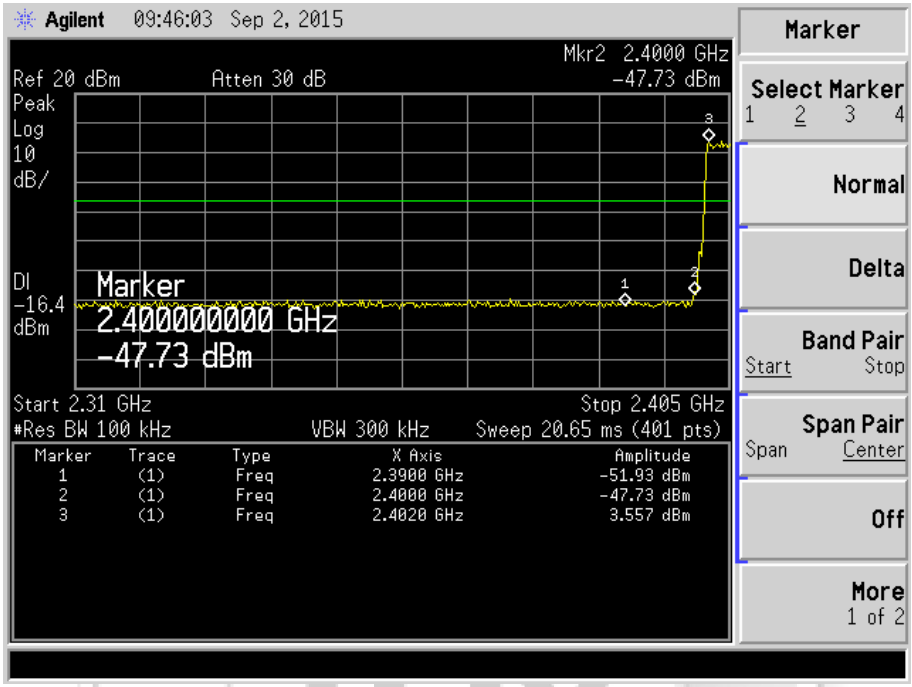


Plot 60 – Lower Band Edge at 2.4000GHz

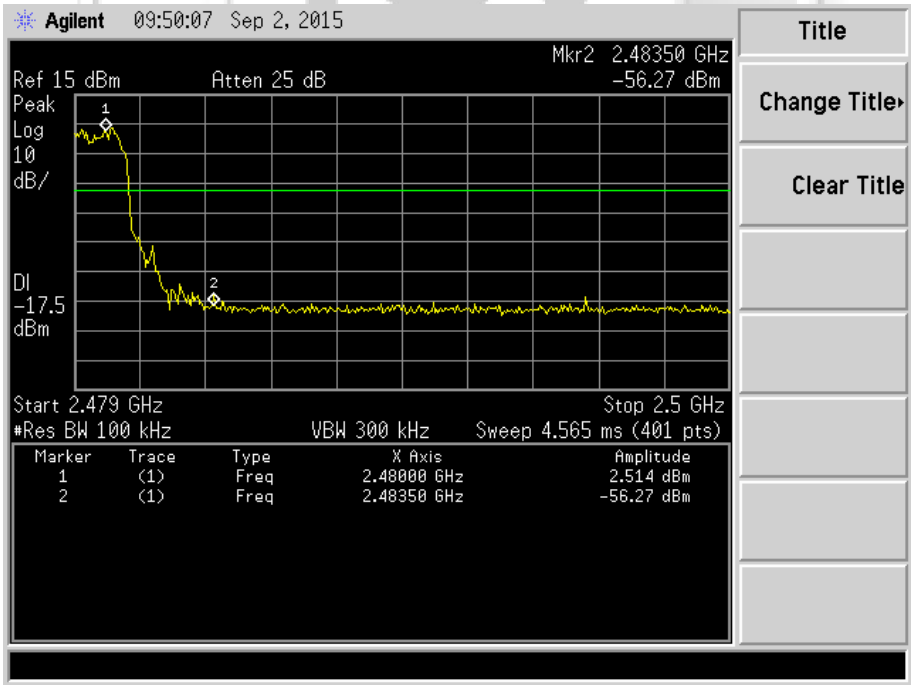


Plot 61 – Upper Band Edge at 2.4835GHz

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

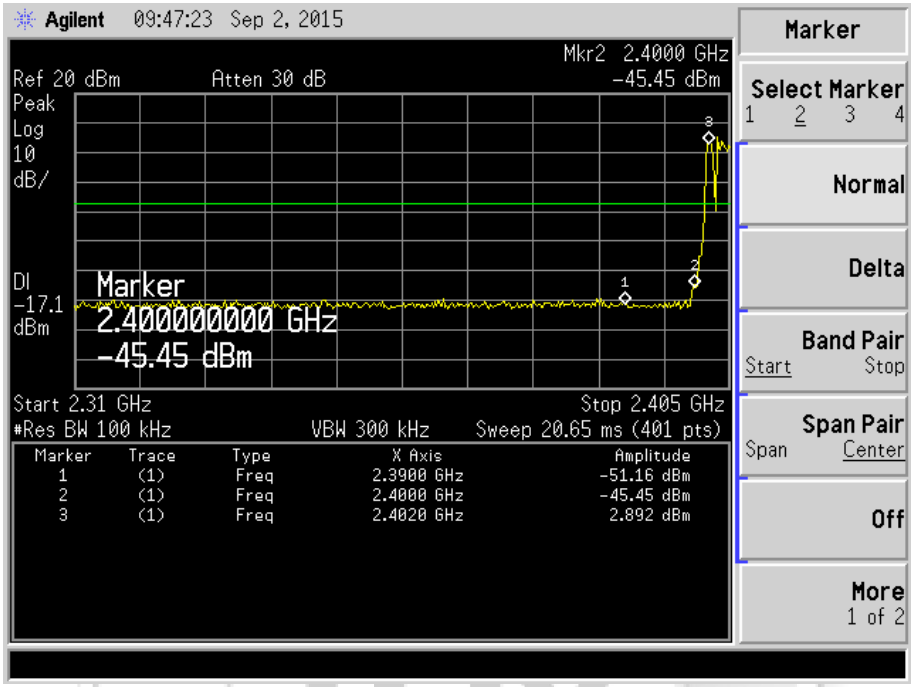


Plot 62 – Lower Band Edge at 2.4000GHz

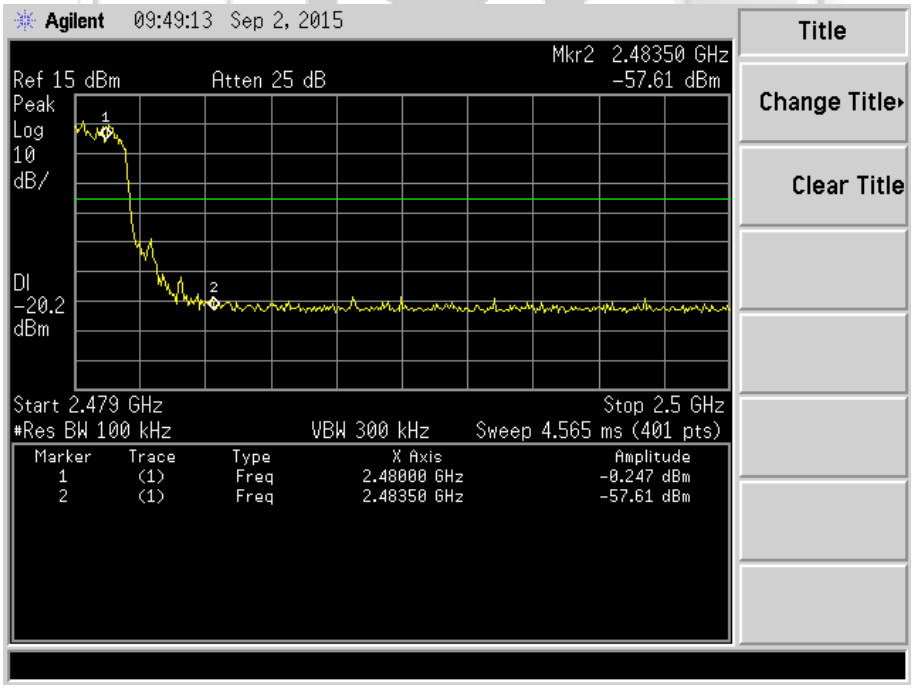


Plot 63 – Upper Band Edge at 2.4835GHz

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



Plot 64 – Lower Band Edge at 2.4000GHz



Plot 65 – Upper Band Edge at 2.4835GHz

47 CFR FCC Part 15.247(d) and RSS-247 5.5 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 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) and RSS-247 5.5 Band Edge Compliance (Radiated) Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
R&S Test Receiver – ESI1	ESI40	100010	14 Jul 2016	1 year
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016	1 year
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016	1 year

47 CFR FCC Part 15.247(d) and RSS-247 5.5 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 = 3MHz
   b. Average Plot
      RBW = 1MHz, VBW = 30Hz
4. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Part 15.247(d) and RSS-247 5.5 Band Edge Compliance (Radiated) Test Method

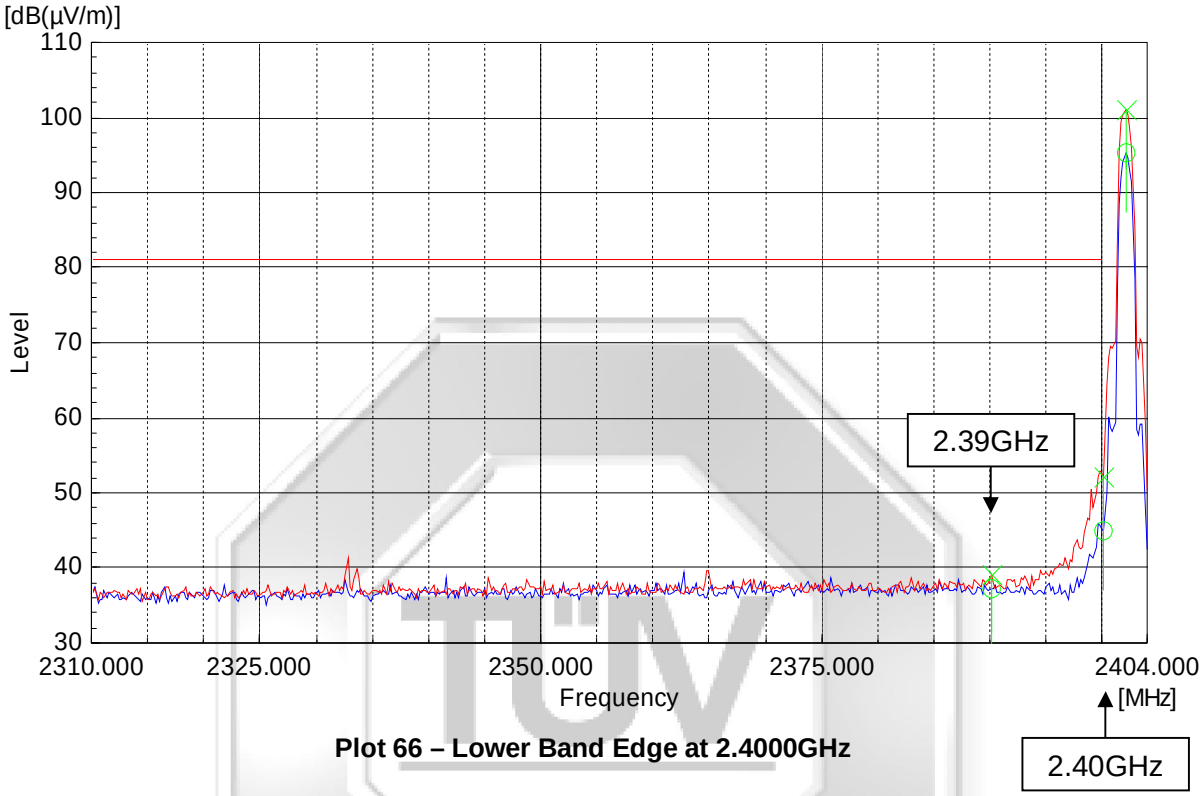
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 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. For the average measurement, it was done via a video average mode with a reduced VBW.
4. Repeat steps 1 to 3 with all possible modulations and data rates.
5. The steps 2 to 4 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) and RSS-247 5.5 Band Edge Compliance (Radiated) Results

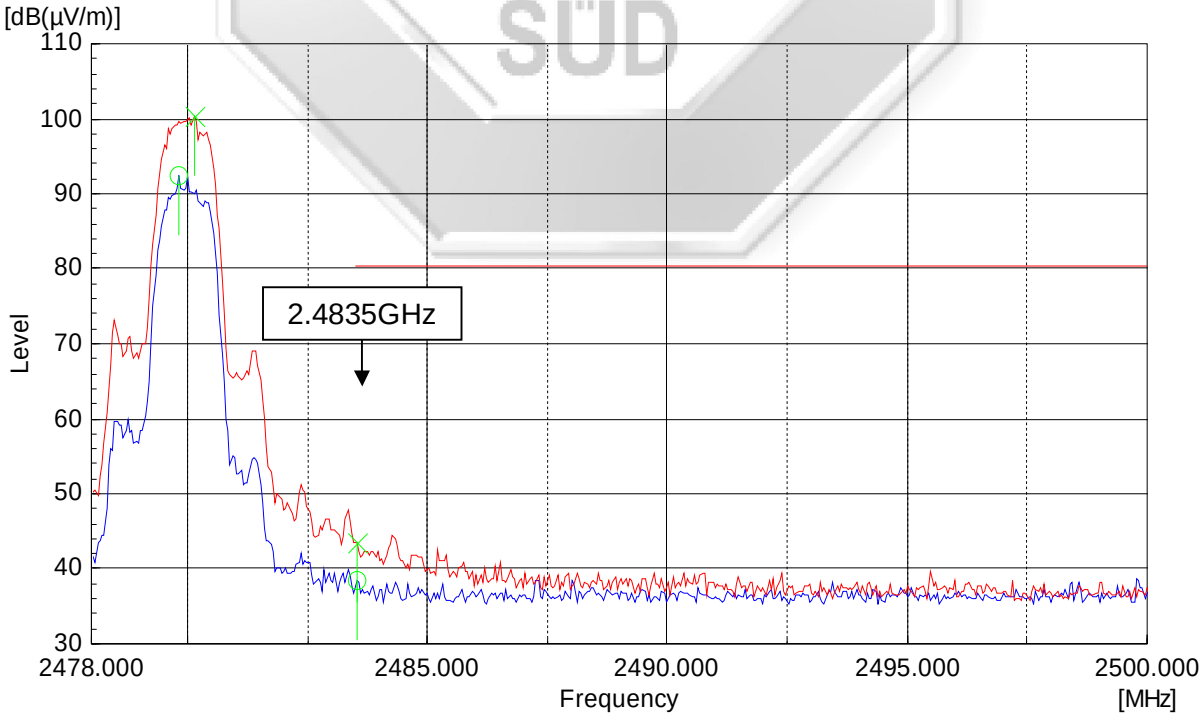
Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	66 – 71	Relative Humidity	60%
Modulation	8DPSK (Worst)	Atmospheric Pressure	1030mbar
		Tested By	Lim Kay Tak Li Chaoming

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

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

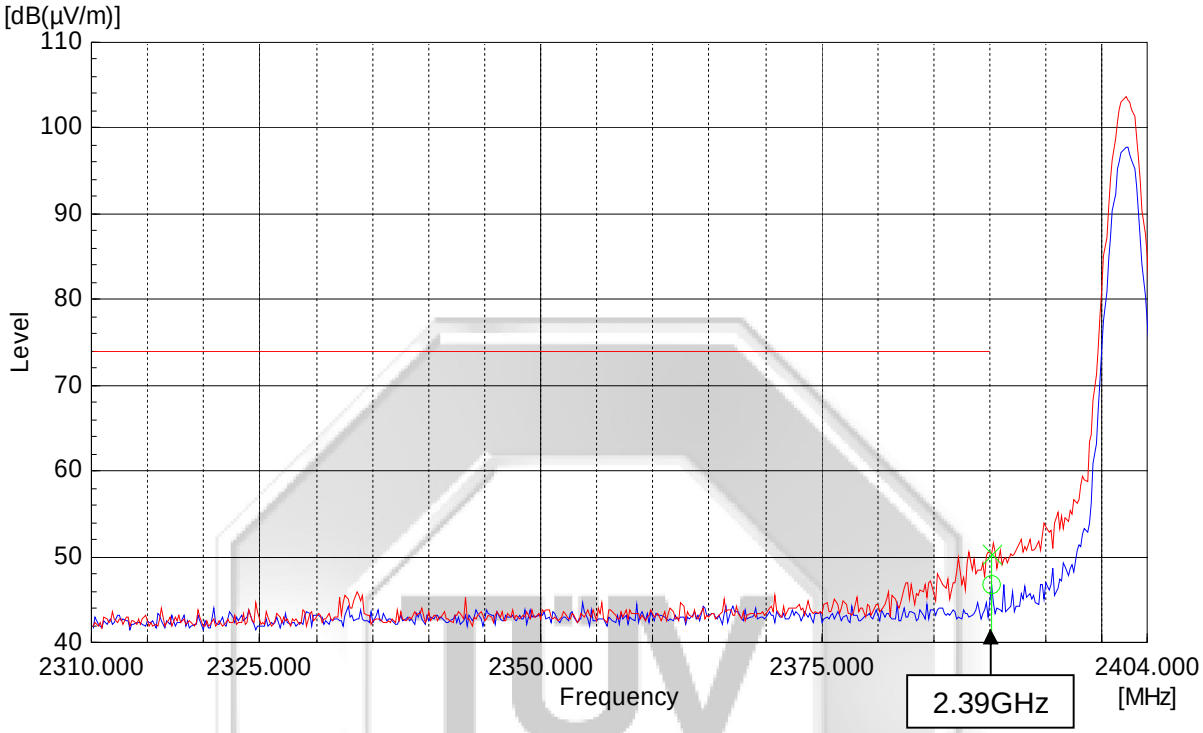


Plot 66 – Lower Band Edge at 2.4000GHz

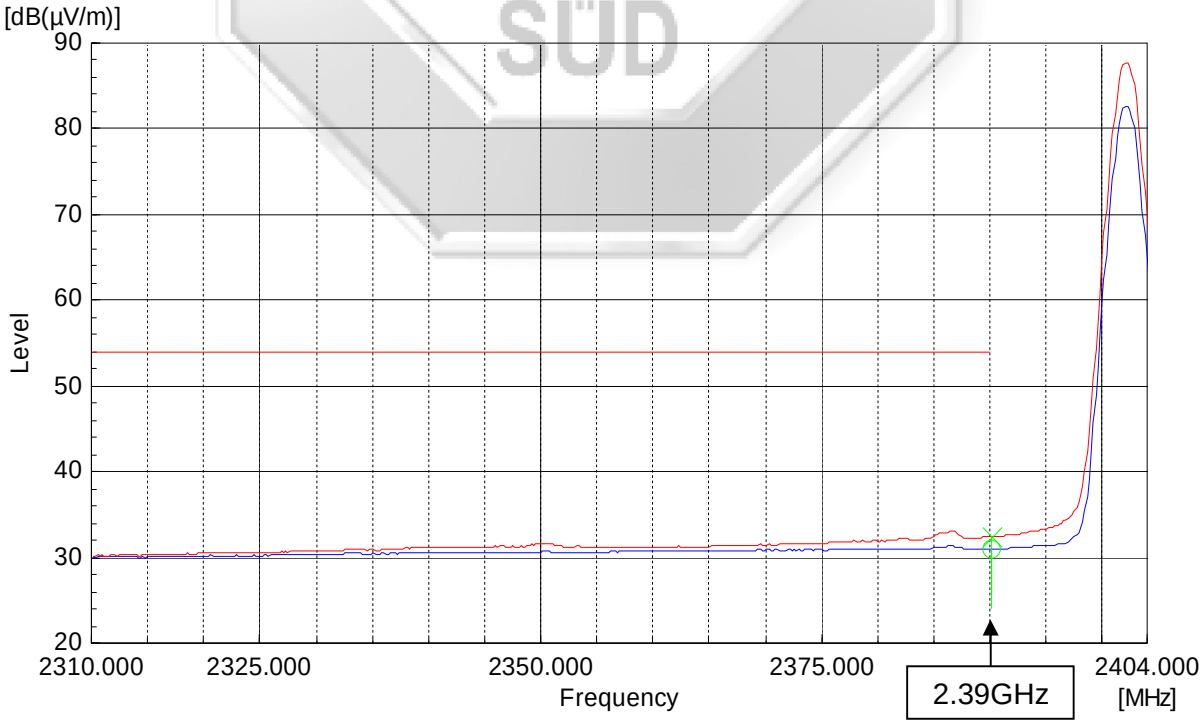


Plot 67 – Upper Band Edge at 2.4835GHz

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

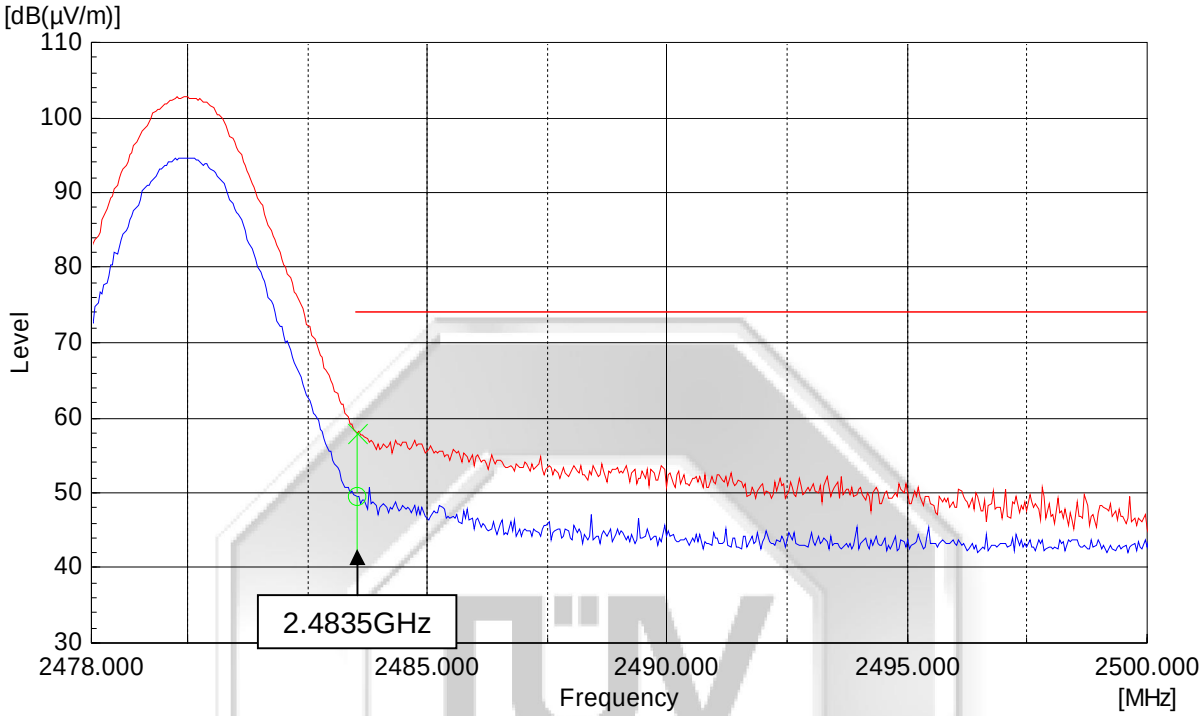


Plot 68 – Peak Plot at Lower Band Edge at 2.4000GHz

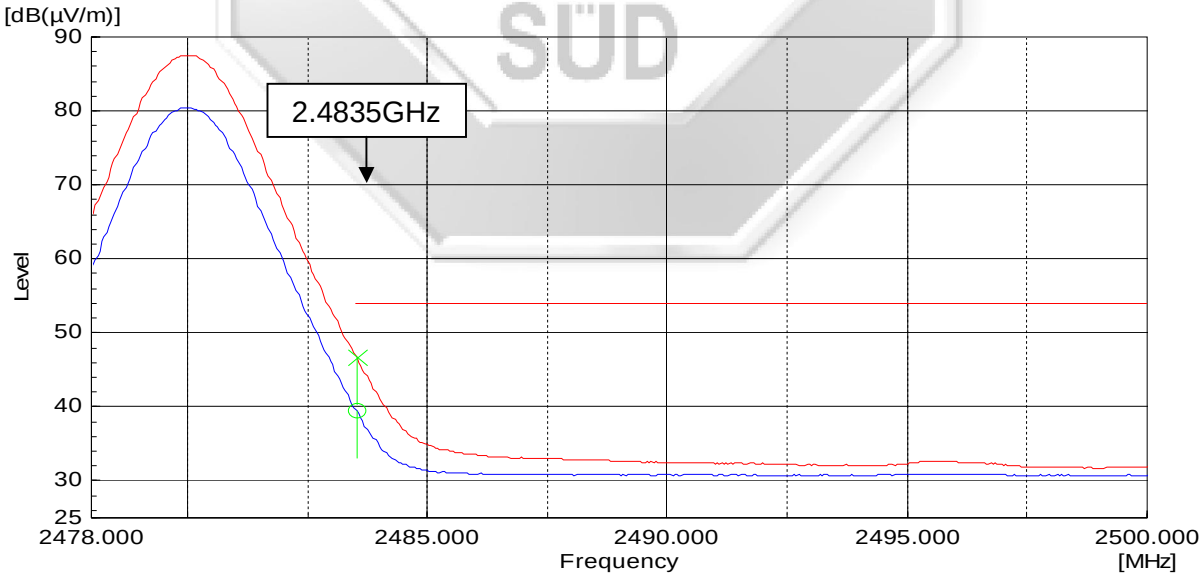


Plot 69 – Average Plot at Lower Band Edge at 2.4000GHz

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



Plot 70 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 71 – Average Plot at Upper Band Edge at 2.4835GHz

PEAK POWER SPECTRAL DENSITY TEST

47 CFR FCC Part 15.247(e) and RSS-247 5.3(2) 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) and RSS-247 5.3(2) Peak Power Spectral Density Test Instrumentation

Instrument	Model	S/No	Cal Due Date	Cal Interval
Agilent Spectrum Analyzer	E4404B	US39440632	02 Apr 2016	1 year

47 CFR FCC Part 15.247(e) and RSS-247 5.3(2) 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) and RSS-247 5.3(2) 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) and RSS-247 5.3(2) Peak Power Spectral Density Results

Test Input Power	120V 60Hz	Temperature	24°C
Attached Plots	72 – 74 (GFSK) 75 – 77 ((π/4) DQPSK) 78 – 80 (8DPSK)	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Liau Lee Yin

GFSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.6775	6.3
39 *(mid ch)*	2.441	0.7166	6.3
78 *(upper ch)*	2.480	0.7130	6.3

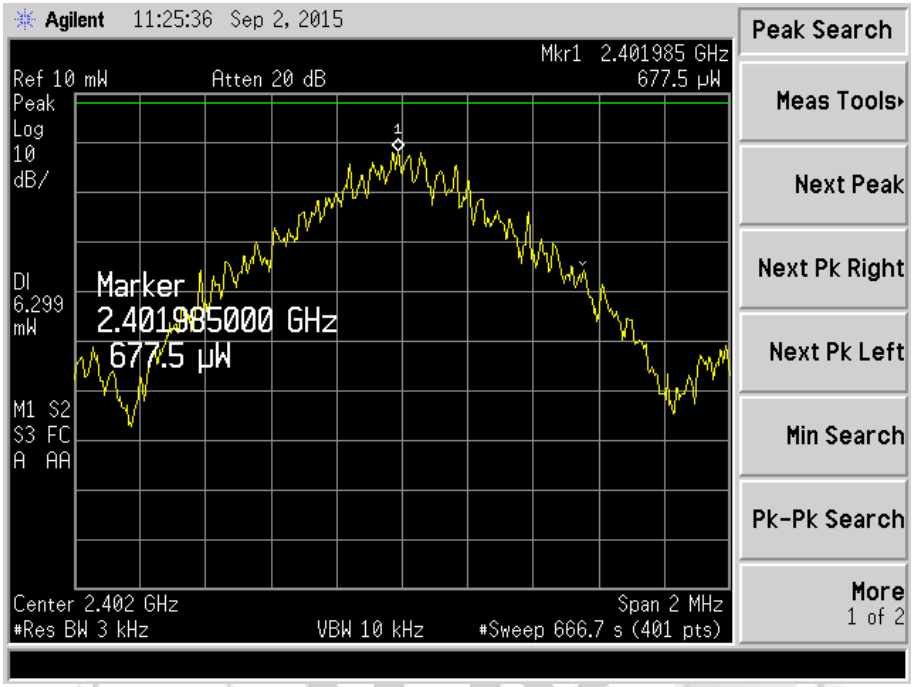
(π/4)DQPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.1637	6.3
39 *(mid ch)*	2.441	0.1695	6.3
78 *(upper ch)*	2.480	0.1833	6.3

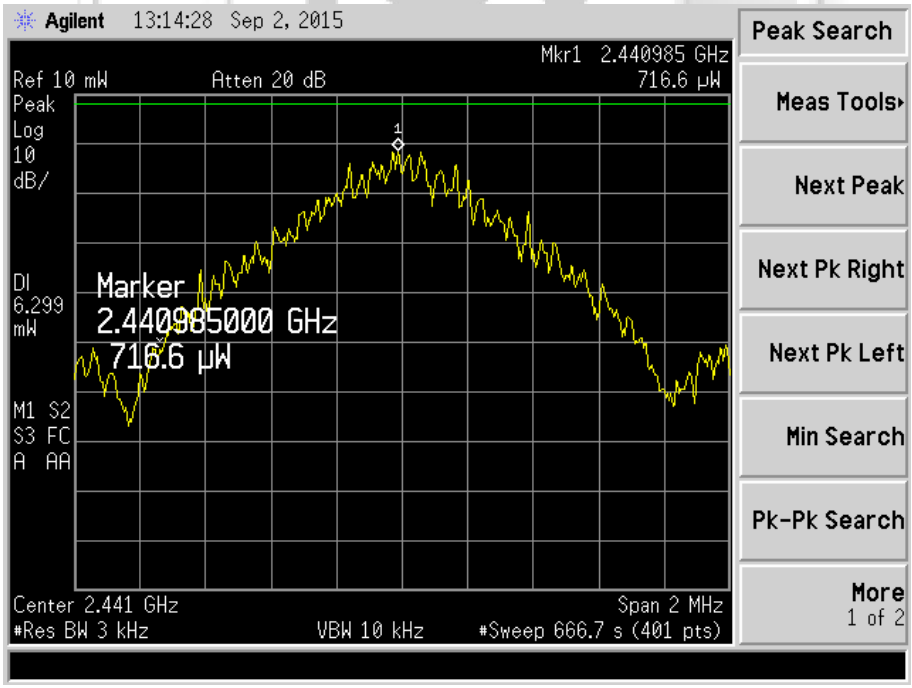
8DPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.1884	6.3
39 *(mid ch)*	2.441	0.2039	6.3
78 *(upper ch)*	2.480	0.2158	6.3

Peak Power Spectral Density Plots – GFSK

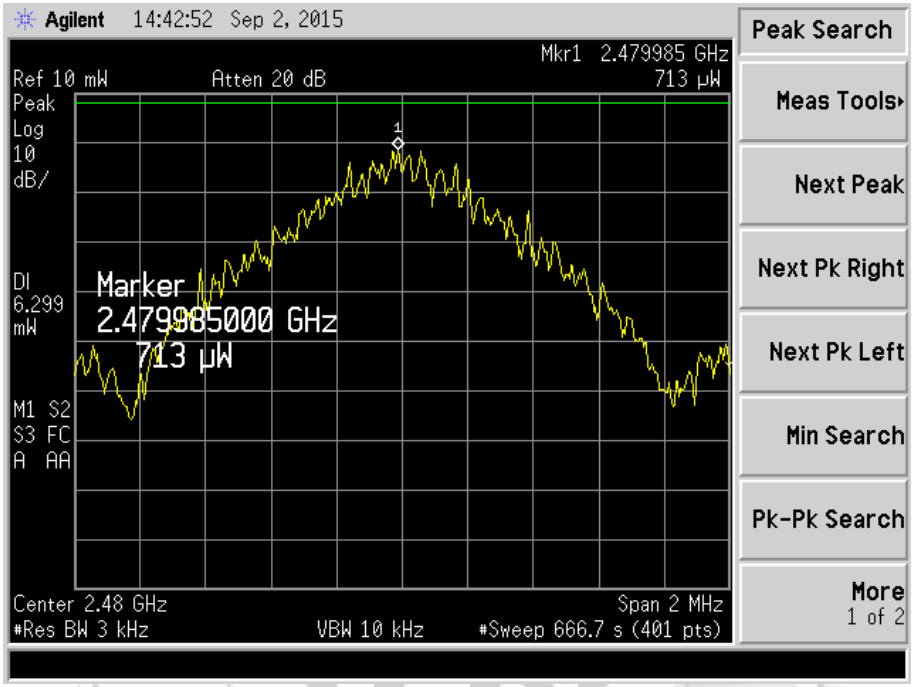


Plot 72 – Channel 0 *(lower ch)*



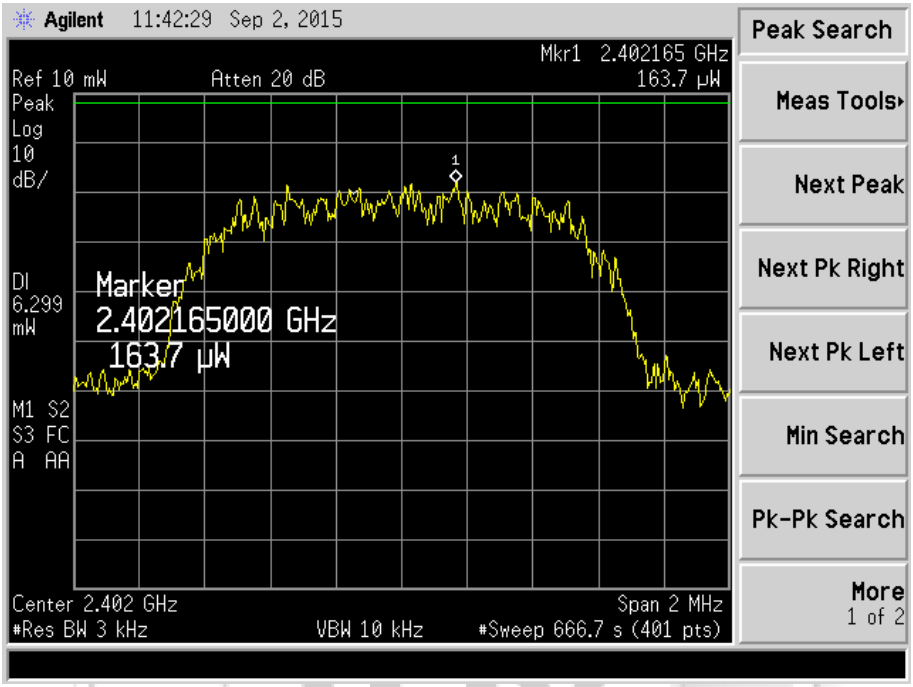
Plot 73 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – GFSK

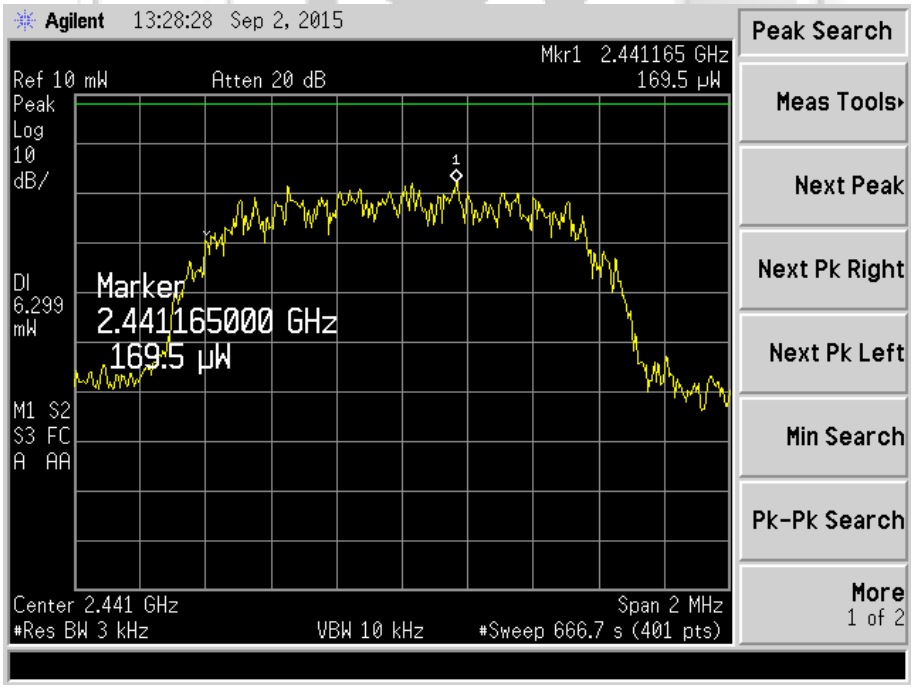


Plot 74 – Channel 78 *(upper ch)*

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

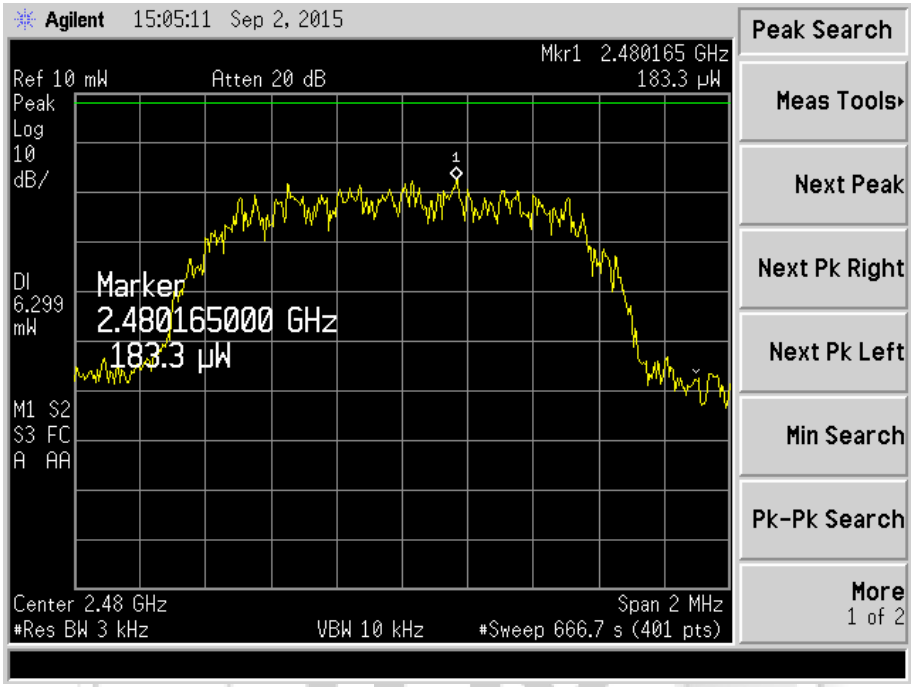


Plot 75 – Channel 0 *(lower ch)*



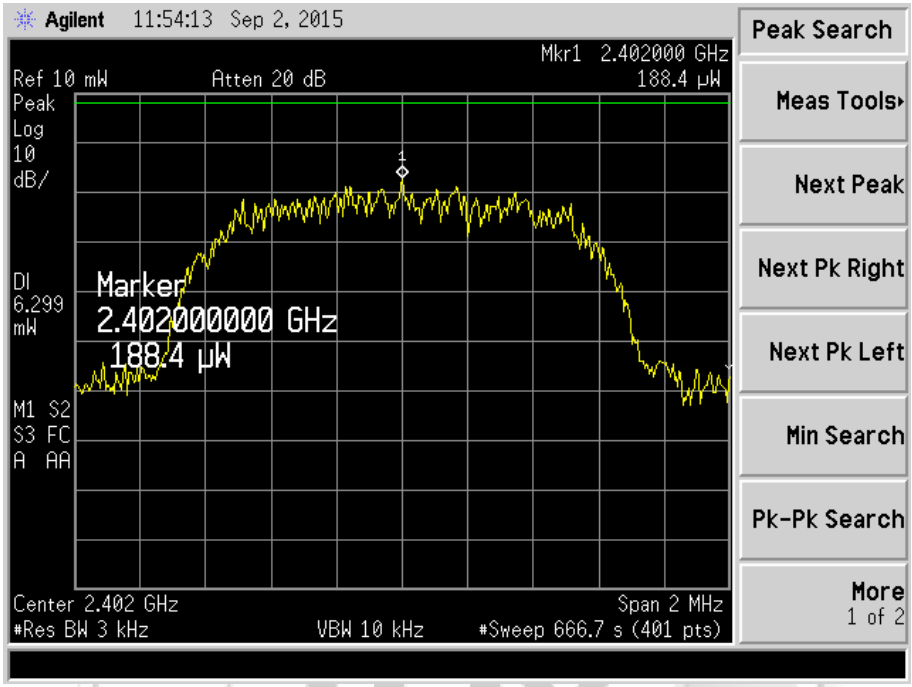
Plot 76 – Channel 39 *(mid ch)*

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

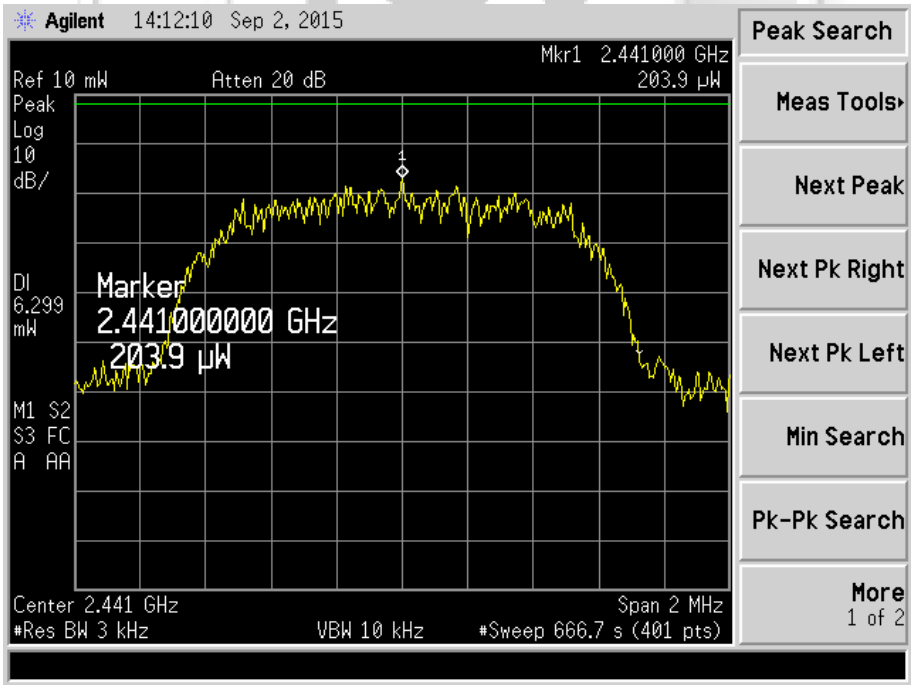


Plot 77 – Channel 78 *(upper ch)*

Peak Power Spectral Density Plots – 8DPSK

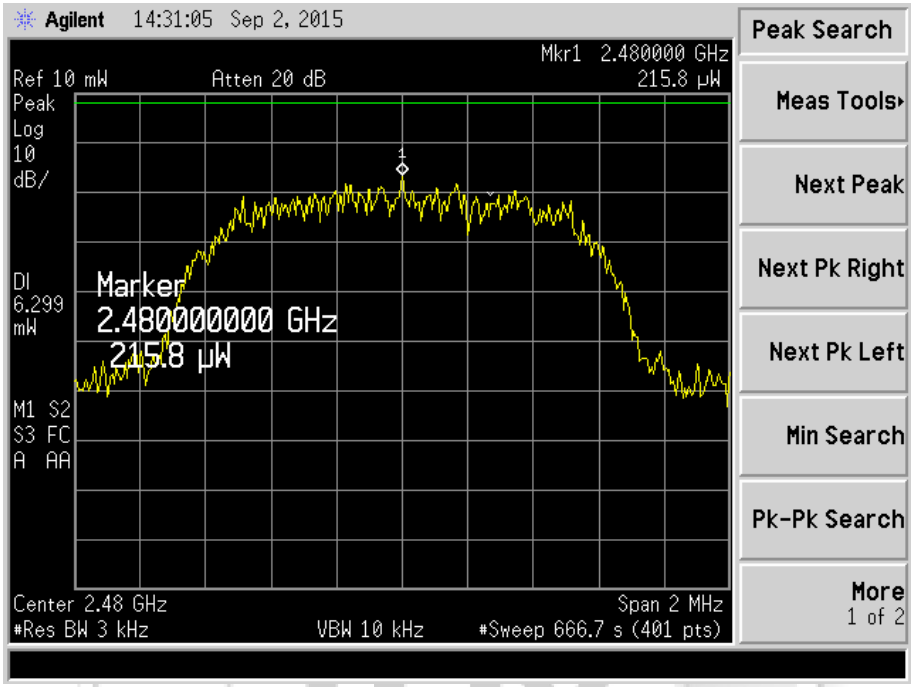


Plot 78 – Channel 0 *(lower ch)*



Plot 79 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – 8DPSK



Plot 80 – Channel 78 *(upper ch)*

47 CFR FCC Part 1.1310, RSS-102 4.0 and RSS-GEN 3.2 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, RSS-102 4.0 and RSS-GEN 3.2 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 = 0.0083W
d = Test distance at 0.2m
G = Numerical isotropic gain, 2.51 (4.0dBi)

Substituting the relevant parameters into the formula:

$S = [(30GP) / 377d^2]$
$= 0.0414\ W/m^2$
$= 0.0041\ mW/cm^2$

∴ The power density of the EUT at 20cm distance is $0.0041 mW/cm^2$ based on the above computation and found to be lower than the power density limit of $1.0mW/cm^2$.

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

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

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

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

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

July 2011

ANNEX A

TEST SETUP / EUT PHOTOGRAPHS / DIAGRAMS

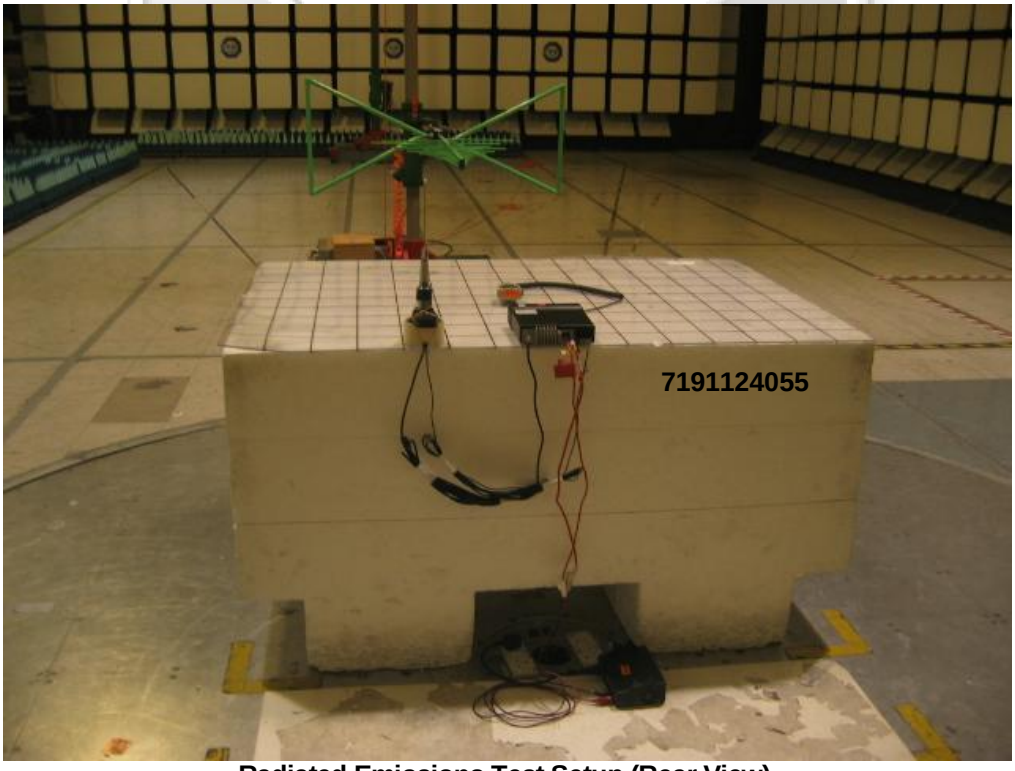
TEST SETUP

Conducted Emissions Test Setup (Front View)

Conducted Emissions Test Setup (Rear View)

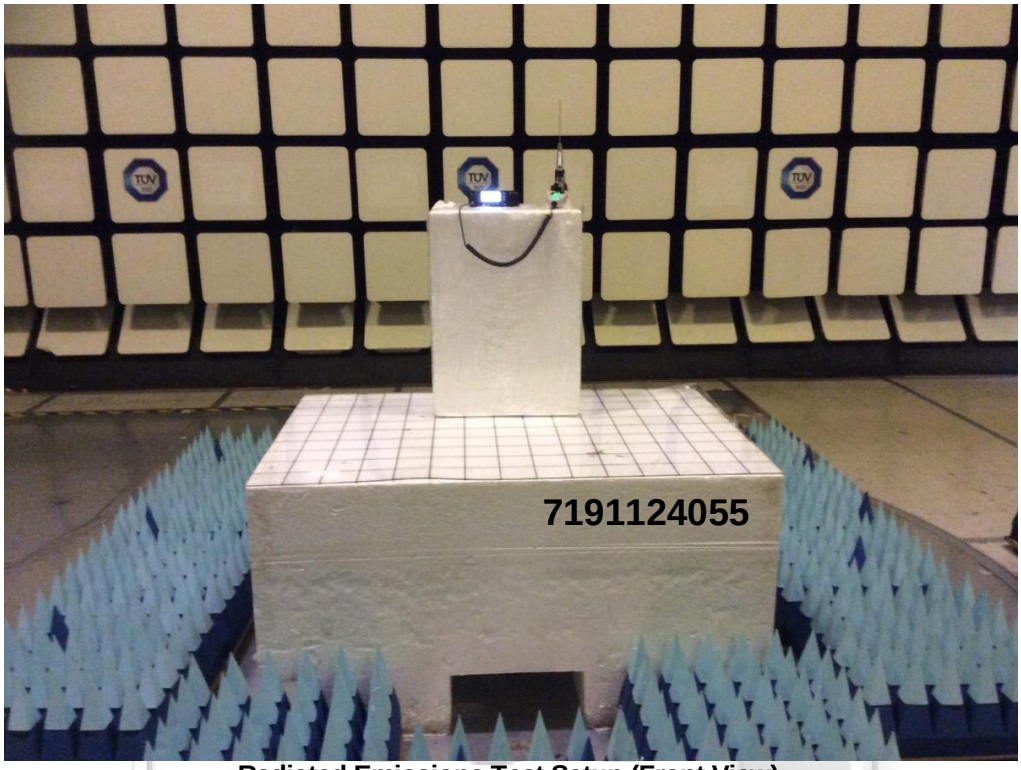
TEST SETUP (30MHz to 1GHz)

Radiated Emissions Test Setup (Front View)

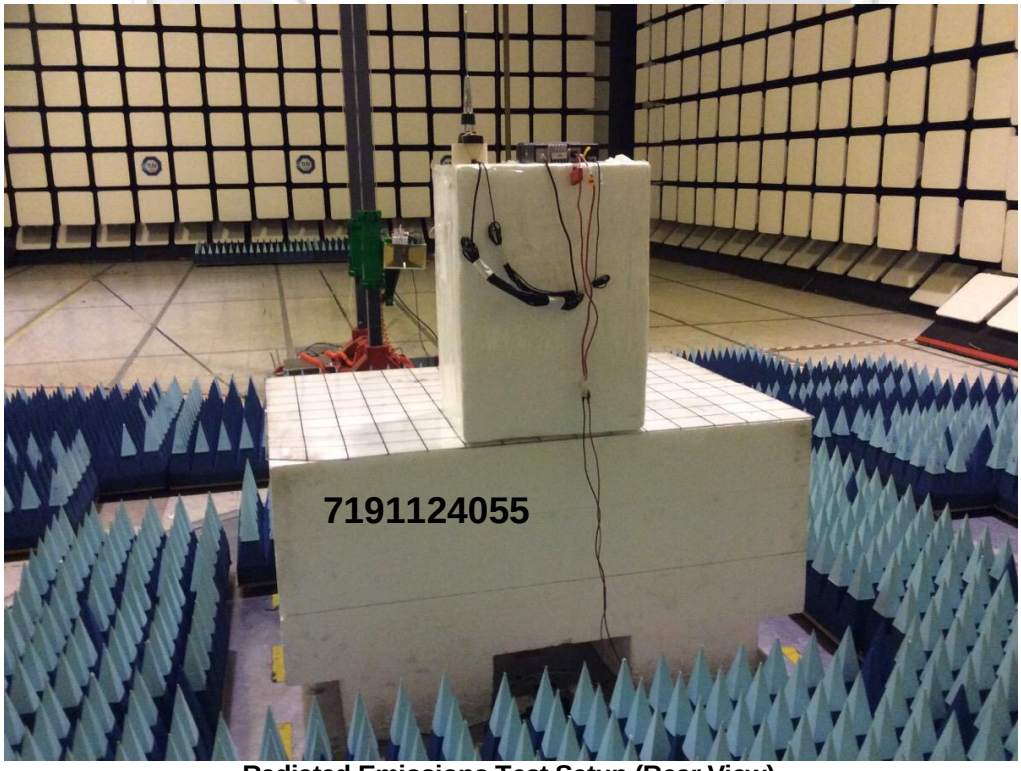


Radiated Emissions Test Setup (Rear View)

TEST SETUP (Above 1GHz)



Radiated Emissions Test Setup (Front View)



Radiated Emissions Test Setup (Rear View)

TEST SETUP

Carrier Frequency Separation Test Setup

Spectrum Bandwidth (20dB Bandwidth Measurement) Test Setup

TEST SETUP

Number of Hopping Frequencies Test Setup

Average Frequency Dwell Time Test Setup

TEST SETUP

Maximum Peak Power Test Setup

RF Conducted Spurious Emissions Test Setup

TEST SETUP

Band Edge Compliance (Conducted) Test Setup

Band Edge Compliance (Radiated) Test Setup

ANNEX A TEST SETUP / EUT PHOTOGRAPHS / DIAGRAMS

TEST SETUP

Peak Power Spectral Density Test Setup

EUT PHOTOGRAPHS

Front View

Rear View

ANNEX B

USER MANUAL
TECHNICAL DESCRIPTION
BLOCK & CIRCUIT DIAGRAMS

ANNEX C

FCC, IC LABEL & POSITION

ANNEX C FCC, IC LABEL & POSITION

Labelling requirements per Section 2.925, 15.19 & per Section 8.0

The label shown will be permanently affixed at a conspicuous location on the device and be readily visible to the user at the time of purchase.

Sample Label

Physical Location of FCC & IC Label on EUT

ANNEX D

TEST SITE DESCRIPTION

ANNEX D TEST SITE DESCRIPTION

Radiated Emission Test Site Description

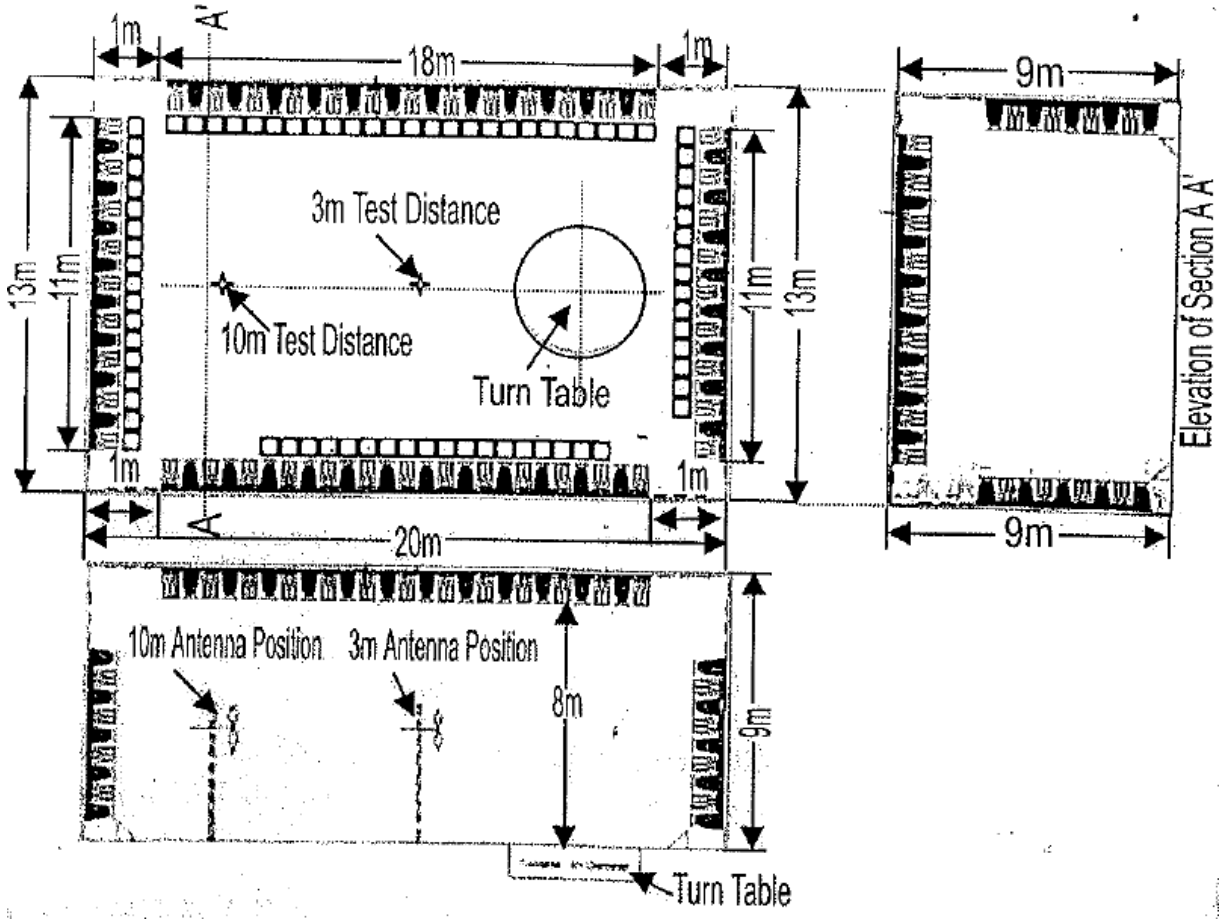
The Radiated Emission test facility consists of a RF-shielded enclosure (Model: 04" x 07") manufactured by Lindgren whose dimensions are shown below. The exterior of the chamber is made of rigid steel panels while the interior is covered with RF absorbing panels on the 4 walls and ceiling. The steel-clad ground place is covered with vinyl flooring.

The turntable is mounted flushed with the chamber floor and is driven by a pneumatic motor, which is capable of supporting 4,000 kg.

The boresight antenna mast is driven by a pneumatic motor with heights variation from 1m- 4m for both vertical and horizontal polarity and with tilt capability.

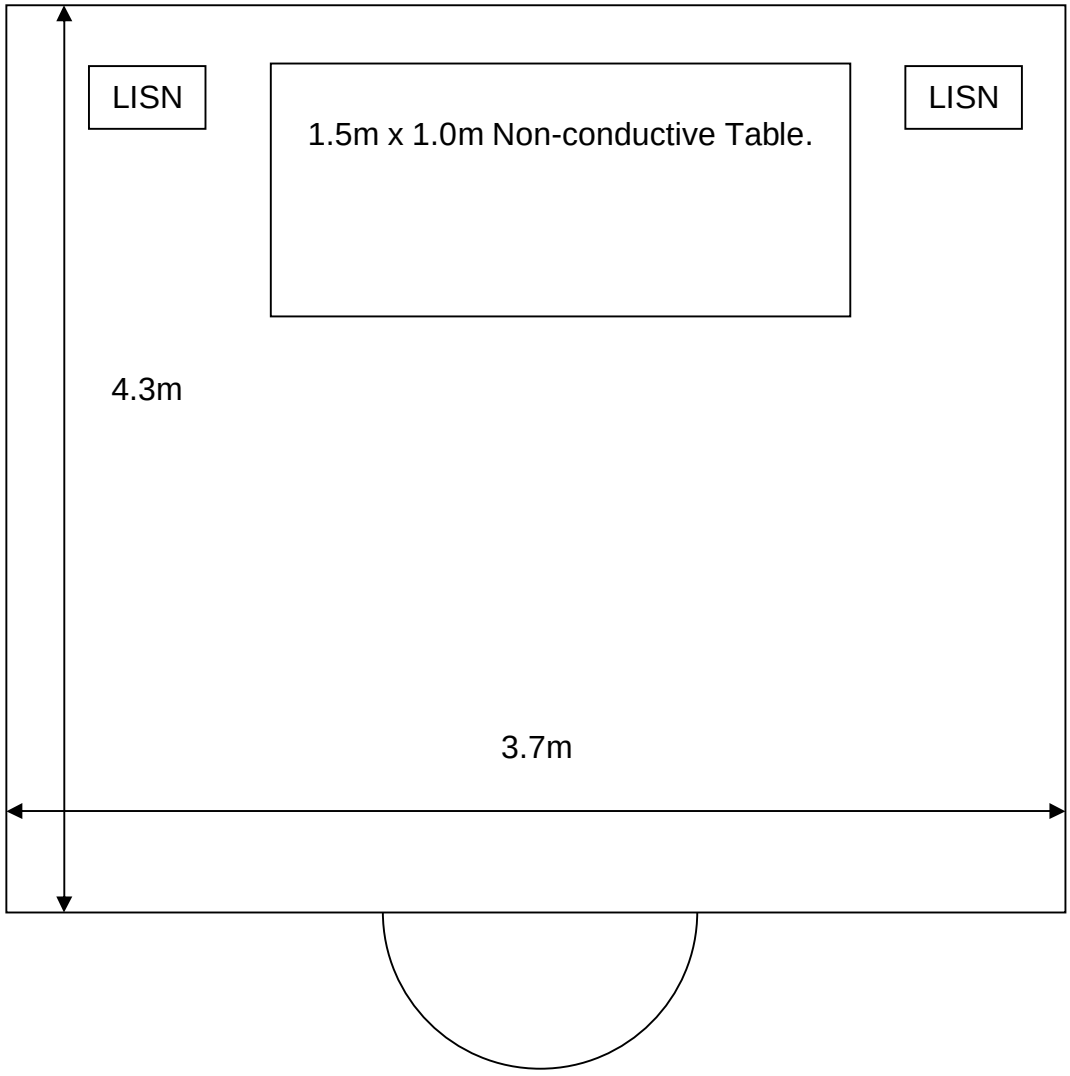
Both turntable and antenna mast in the chamber are controlled by system controller stationed outside the chamber.

The physical layout of the chamber is show below:



ANNEX D TEST SITE DESCRIPTION

Conducted Emission Test Site Description

The Conducted Emission facility consists of an RF-shielded enclosure measuring 4.3m x 3.7m x 2.45m manufactured by Universal Shielding Corporation. The Conducted Emission data were taken using two LISNs.

The physical layout of the test site is show below: