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

The EUT shows compliance to the requirements of this section, which states the EUT employing at least 75 non-overlapping hopping channels shall not exceed 1W (30dBm). For the EUT employs other frequency hopping systems, the peak power shall not greater than 0.125W (21dBm).

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

Instrument	Model	S/No	Cal Due Date
Agilent Power Meter	E4416A	GB41290618	14 Aug 2015
Agilent Power Sensor	E9304A	MY41496637	28 May 2015

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

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the Universal Radio Communication Tester, which set into power analyser mode via a low-loss coaxial cable.
4. All other supporting equipment were powered separately from another filtered mains.

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

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

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

Test Input Power	5Vdc	Temperature	23°C
Antenna Gain	2.0 dBi	Relative Humidity	60%
		Atmospheric Pressure	1030mbar
		Tested By	Stephen Chng

GFSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0018	0.0029	1.0
39 *(mid ch)*	2.441	0.0018	0.0029	1.0
78 (upper ch)	2.480	0.0018	0.0028	1.0

(π/4) DQPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0012	0.0019	1.0
39 *(mid ch)*	2.441	0.0012	0.0019	1.0
78 (upper ch)	2.480	0.0012	0.0018	1.0

8DPSK

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Maximum EIRP (W)	Limit (W)
0 *(lower ch)*	2.402	0.0012	0.0019	1.0
39 *(mid ch)*	2.441	0.0012	0.0019	1.0
78 (upper ch)	2.480	0.0012	0.0018	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 the desired power.

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

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

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

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

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

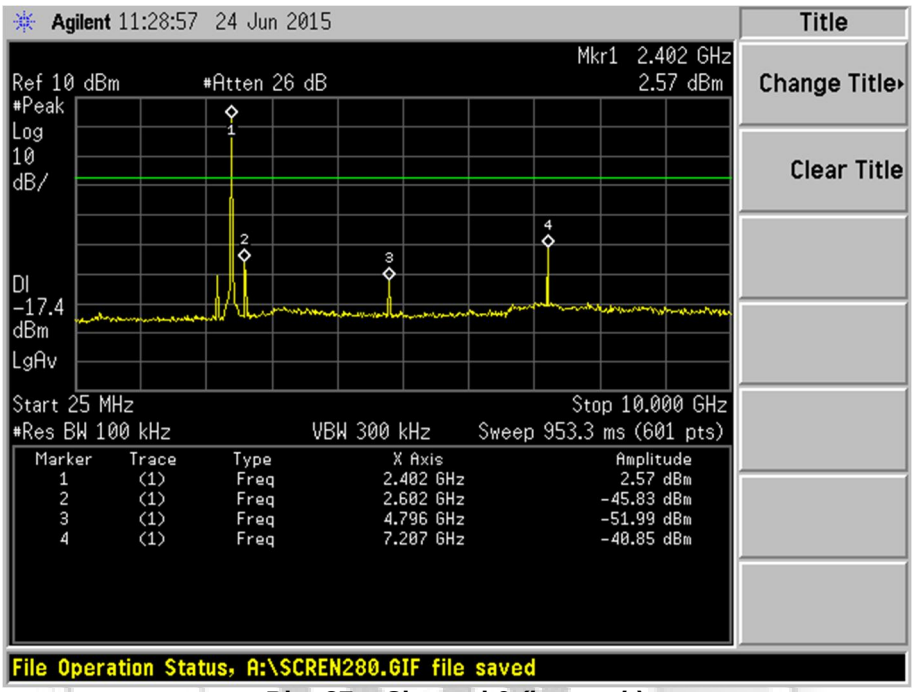
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The start and stop frequencies of the spectrum analyser were set to 30MHz and 10GHz.
3. The spectrum analyser was set to max hold to capture any spurious emissions within the span. The signal capturing was continuous until no further spurious emissions were detected.
4. The steps 2 to 3 were repeated with frequency span was set from 10GHz to 25GHz.
5. The steps 2 to 4 were repeated with the transmitting frequency was set to Channel 39 (2.441GHz) *(mid ch)* and Channel 78 (2.480GHz) *(upper ch)* respectively.

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

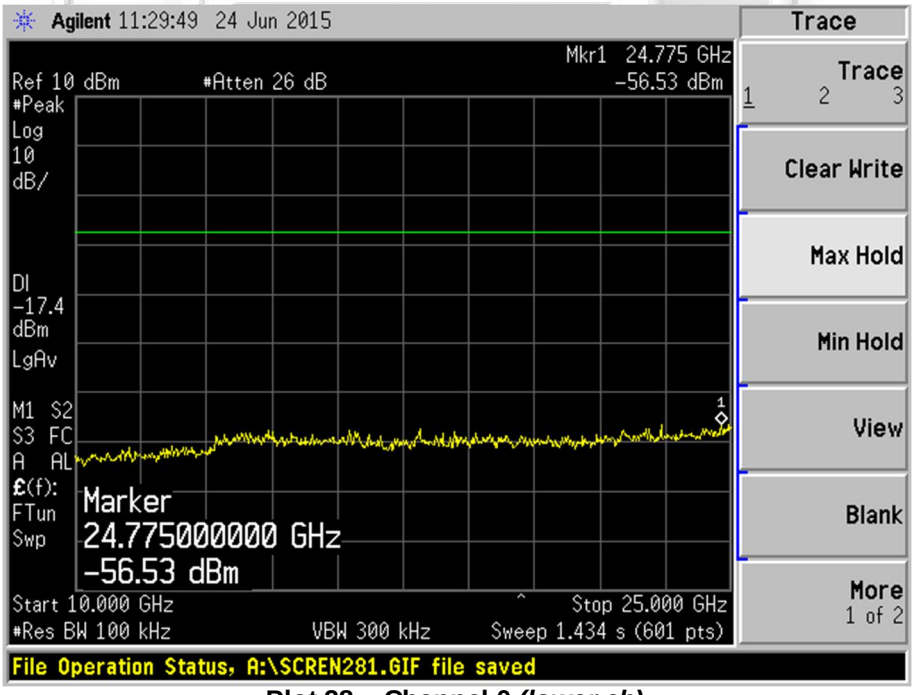
Test Input Power	5Vdc	Temperature	23°C
Attached Plots	27 – 32 (GFSK)	Relative Humidity	60%
	33 – 38 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	39 – 44 (8DPSK)	Tested By	Stephen Chng

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

RF Conducted Spurious Emissions Plots – GFSK

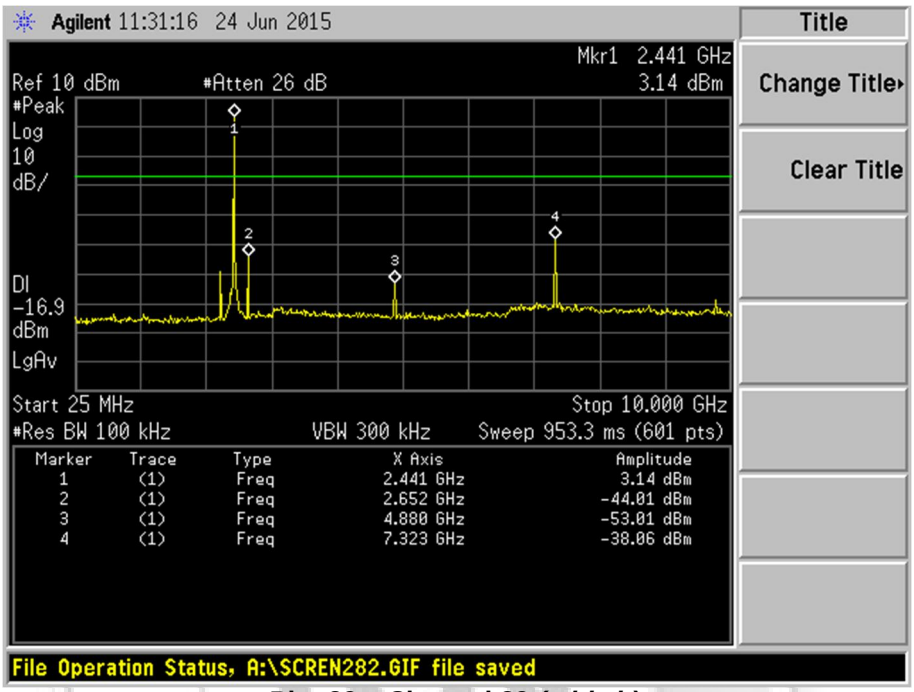


Plot 27 – Channel 0 *(lower ch)*

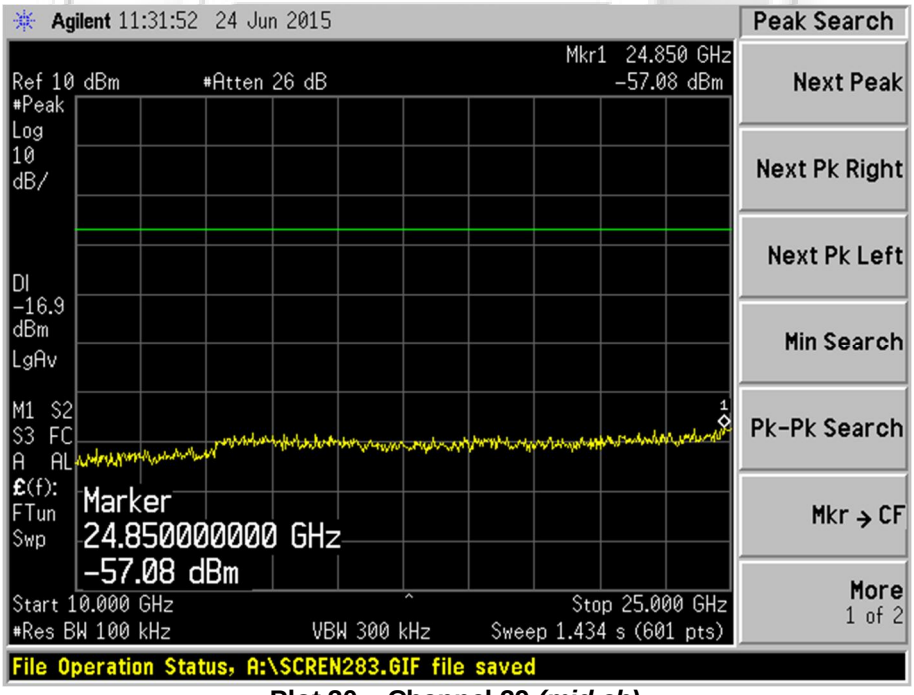


Plot 28 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – GFSK

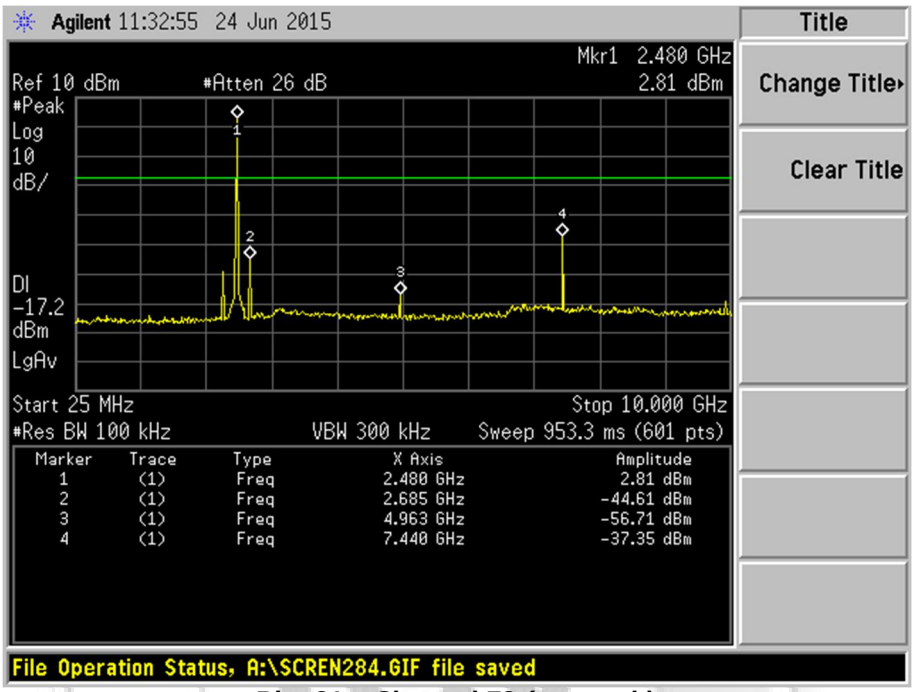


Plot 29 – Channel 39 *(mid ch)*

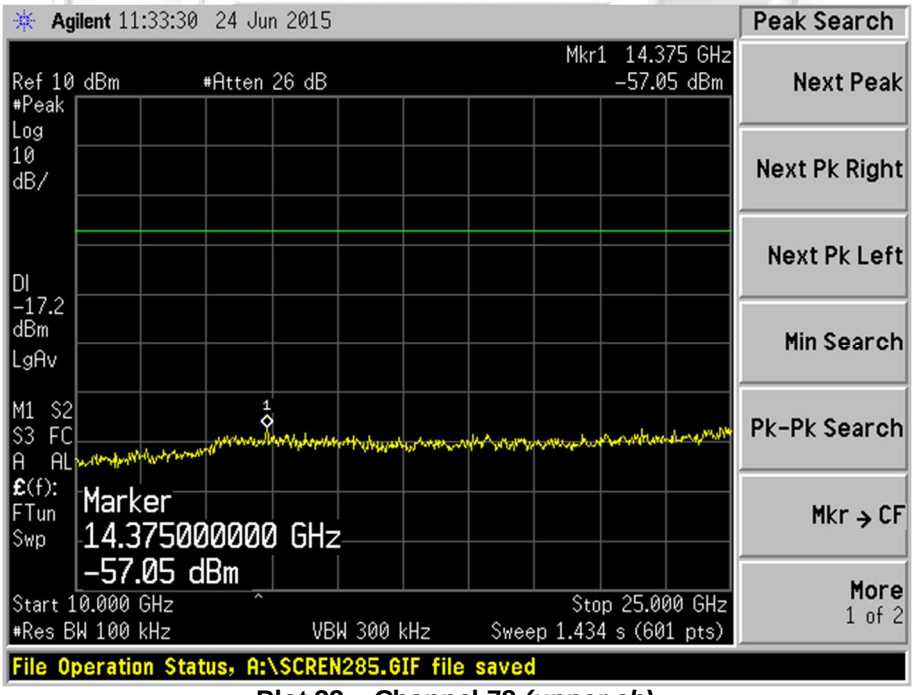


Plot 30 – Channel 39 *(mid ch)*

RF Conducted Spurious Emissions Plots – GFSK

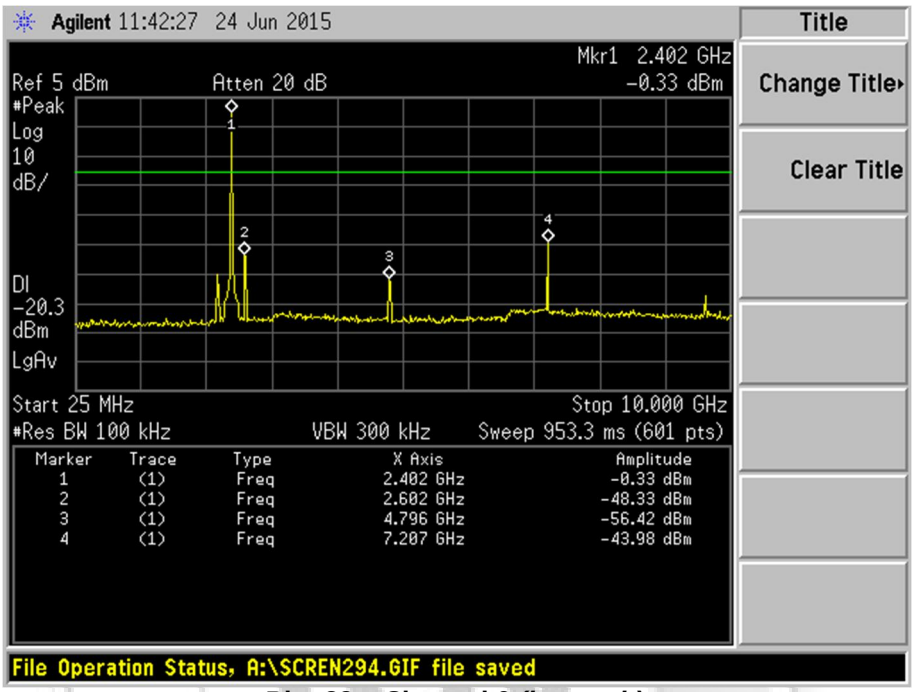


Plot 31 – Channel 78 *(upper ch)*

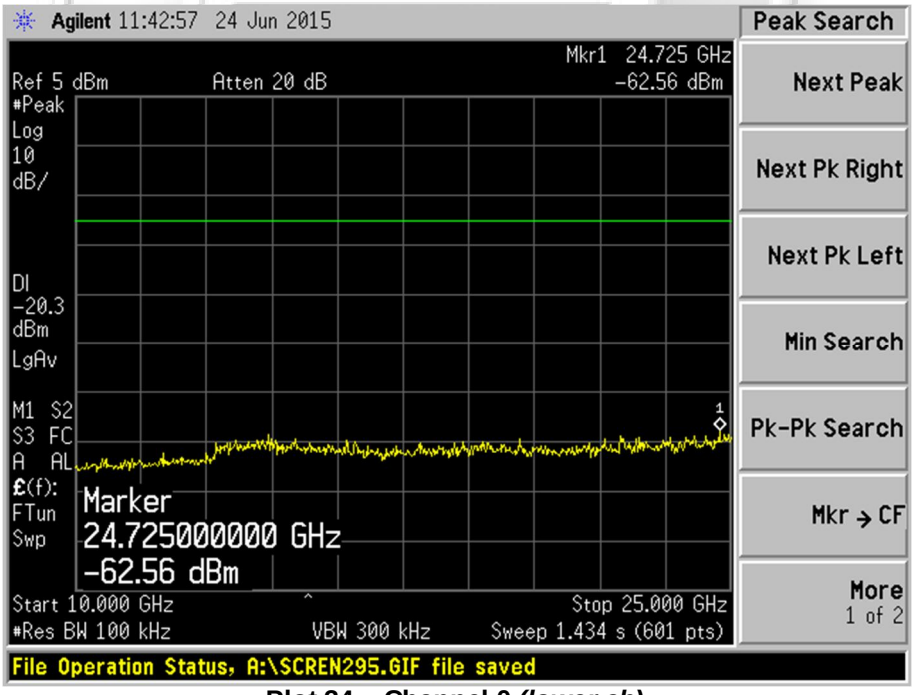


Plot 32 – Channel 78 *(upper ch)*

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

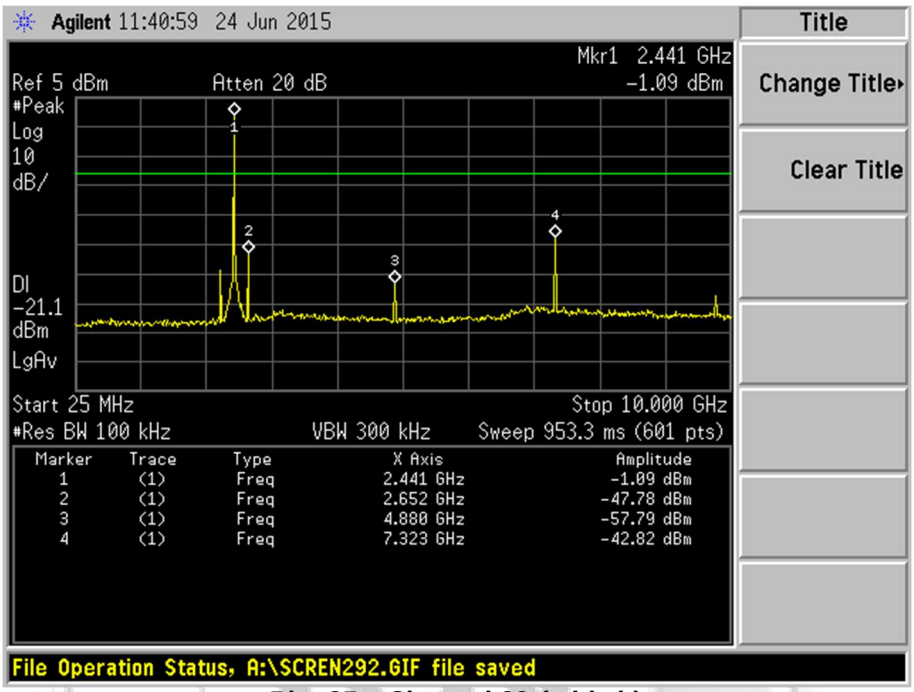


Plot 33 – Channel 0 *(lower ch)*

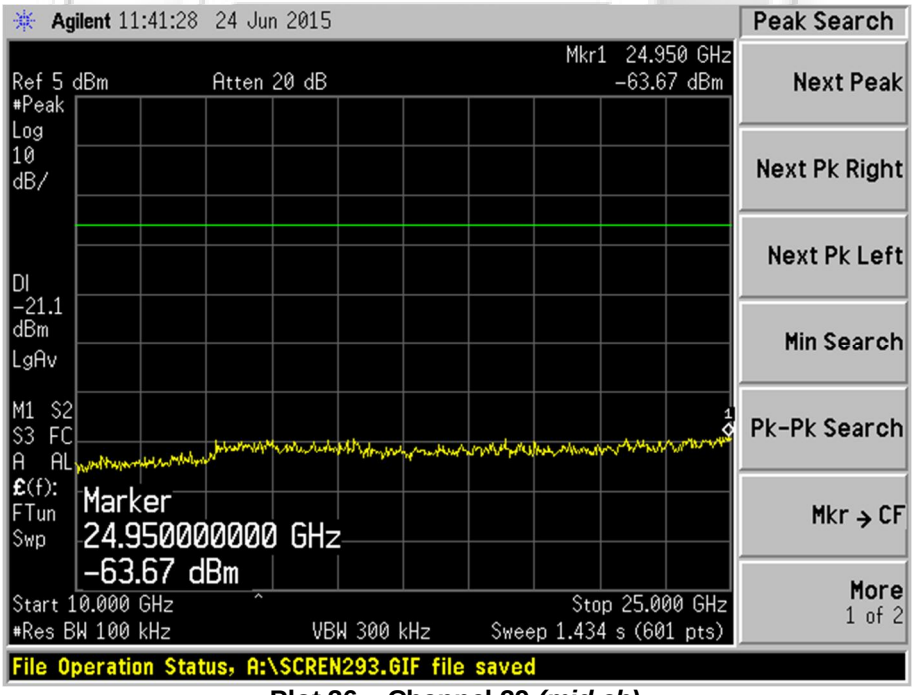


Plot 34 – Channel 0 *(lower ch)*

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

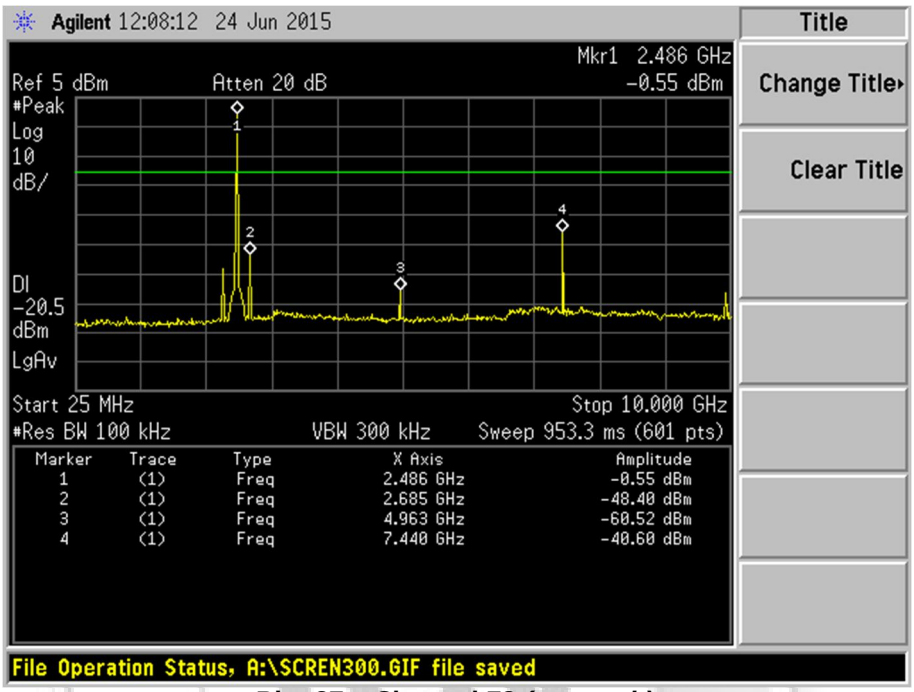


Plot 35 – Channel 39 *(mid ch)*

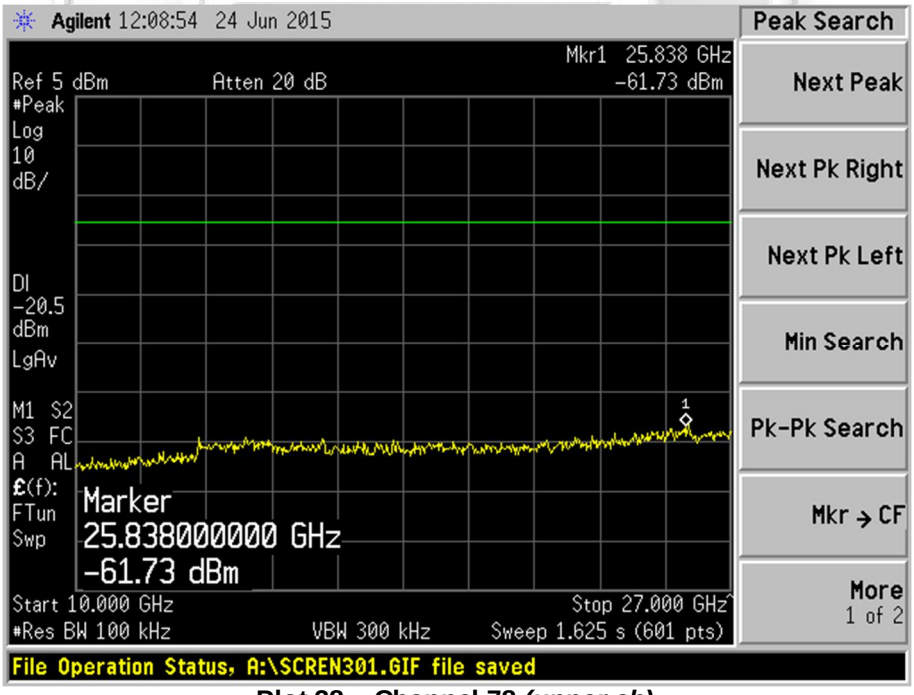


Plot 36 – Channel 39 *(mid ch)*

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

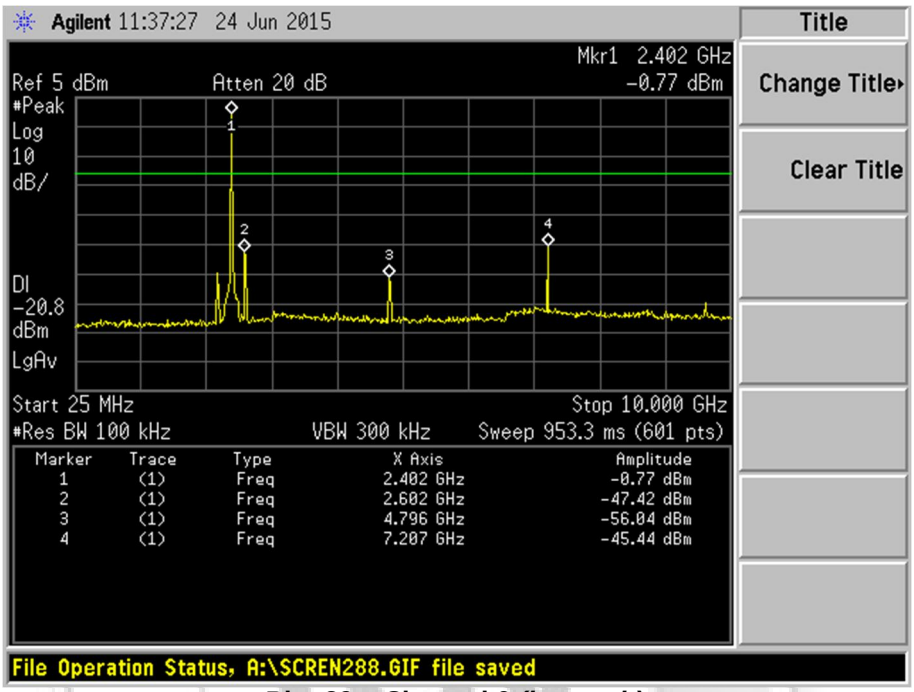


Plot 37 – Channel 78 *(upper ch)*

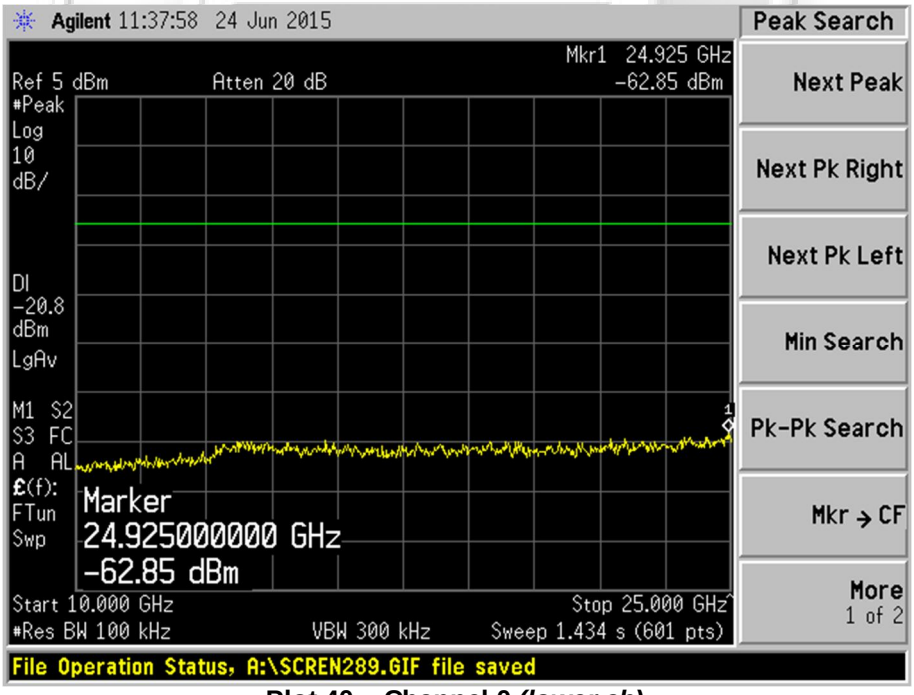


Plot 38 – Channel 78 *(upper ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

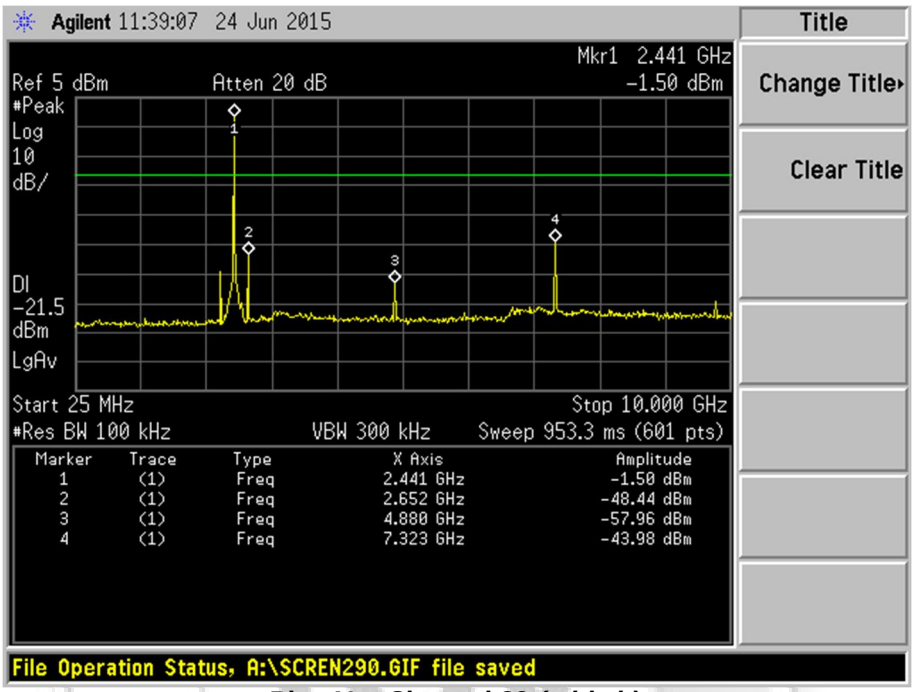


Plot 39 – Channel 0 *(lower ch)*

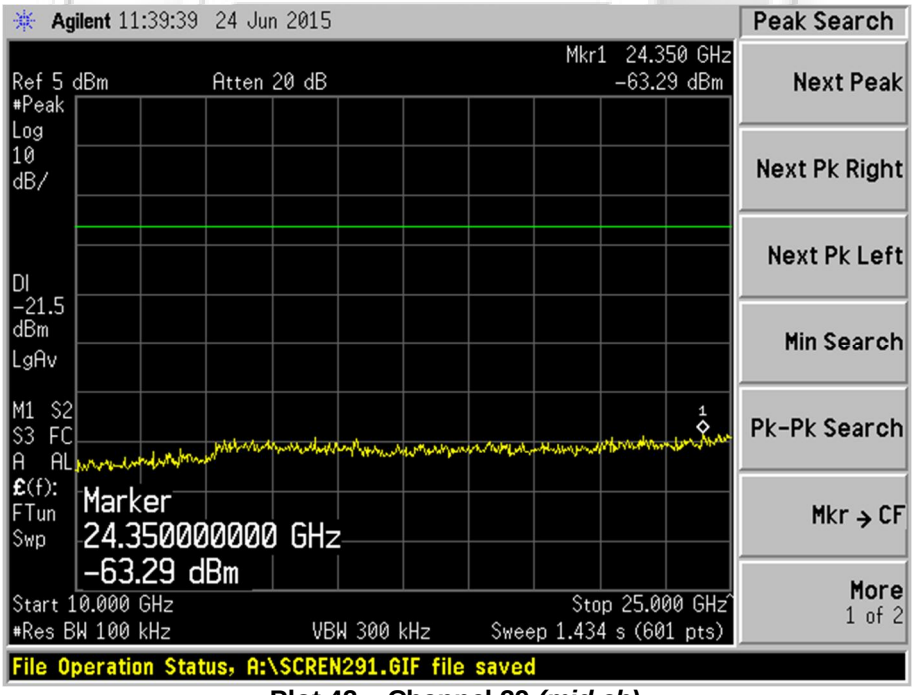


Plot 40 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions Plots – 8DPSK

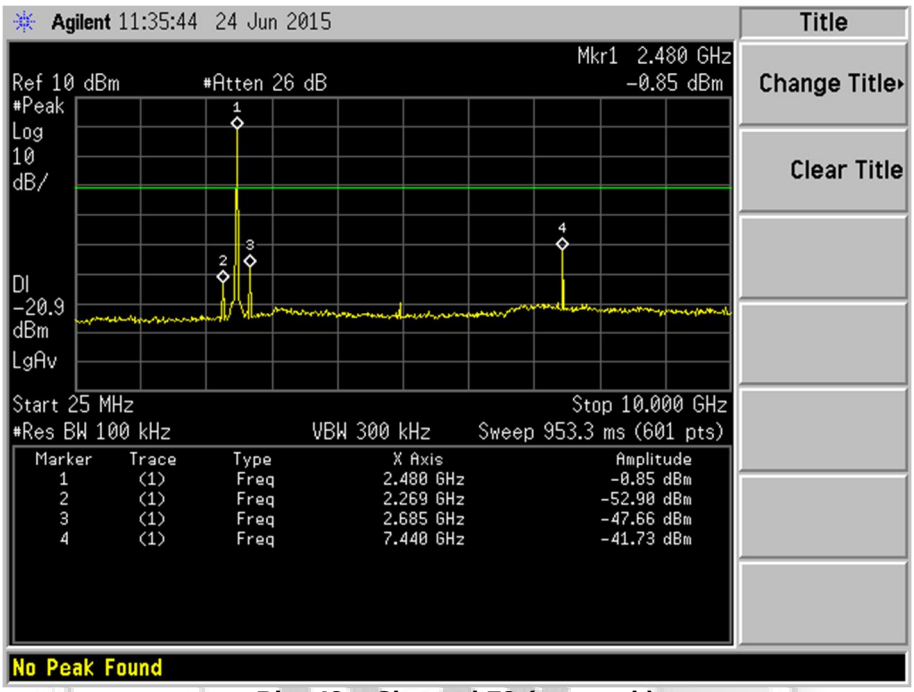


Plot 41 – Channel 39 *(mid ch)*

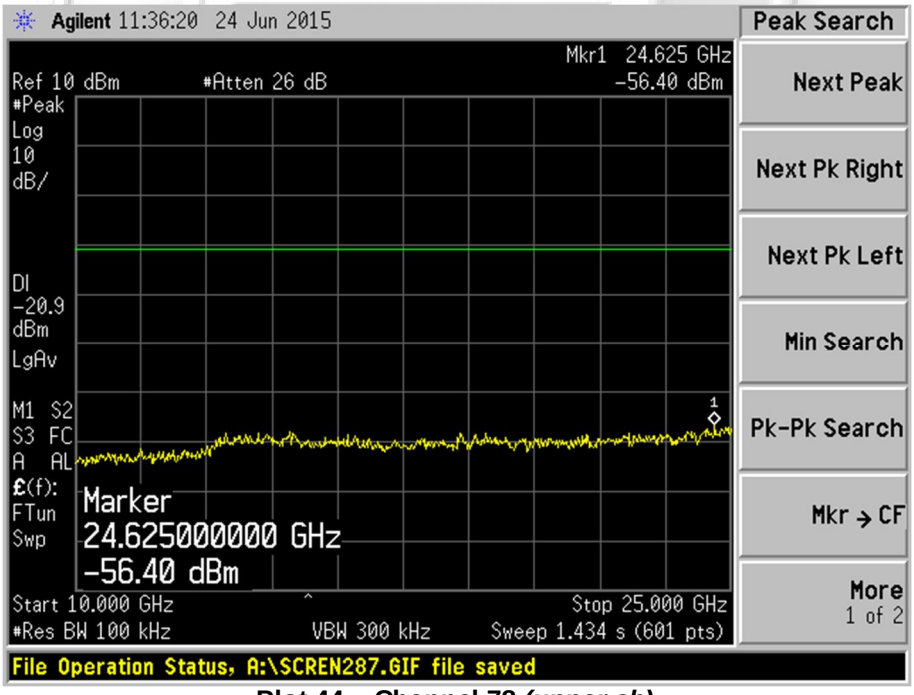


Plot 42 – Channel 39 *(mid ch)*

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 desired power.

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

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

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

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

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

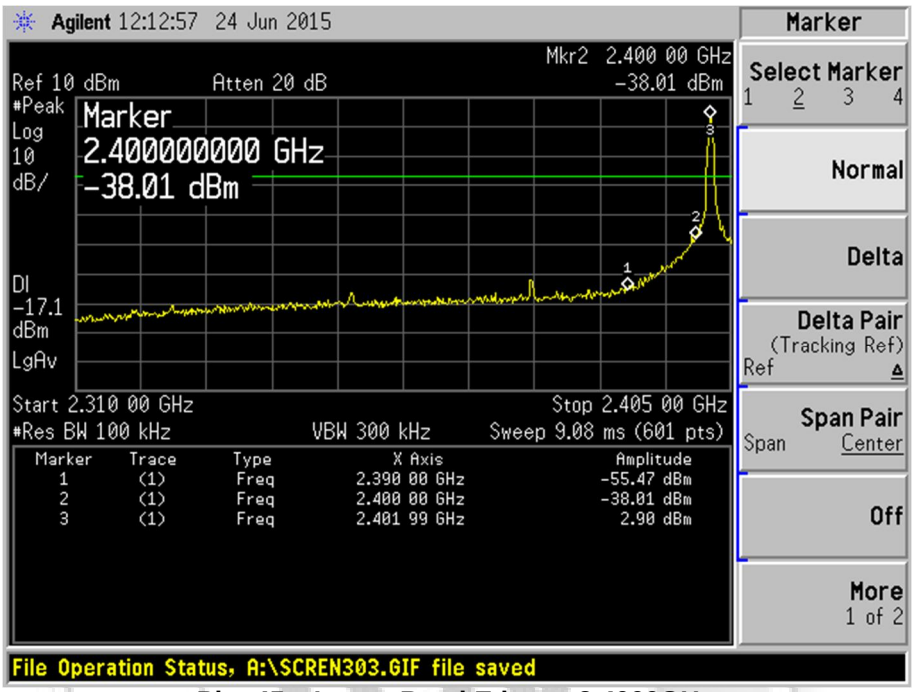
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band,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

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

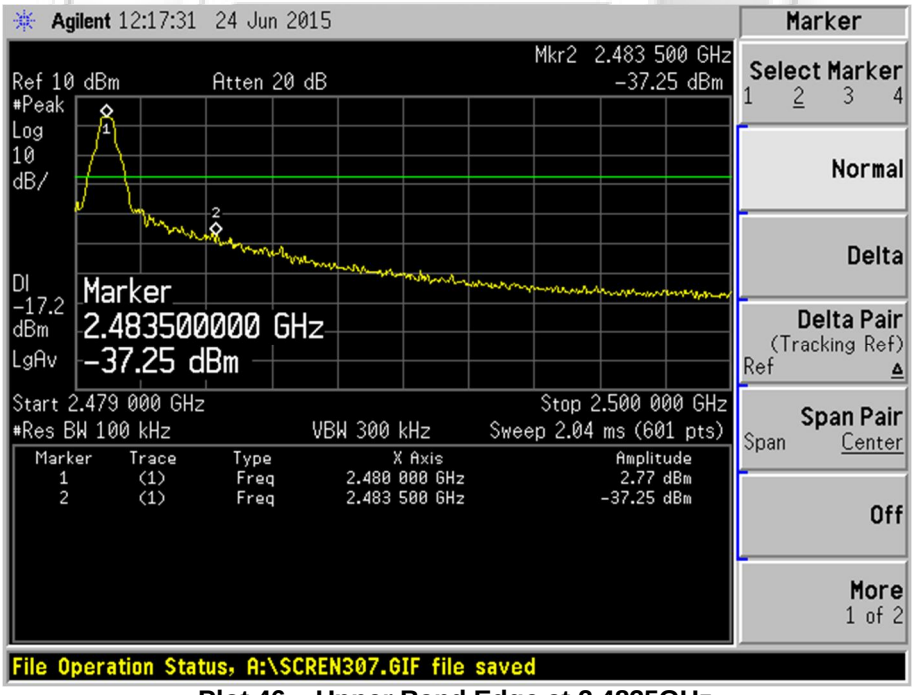
Test Input Power	5Vdc	Temperature	23°C
Attached Plots	45 – 46 (GFSK)	Relative Humidity	60%
	47 – 48 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	49 – 50 (8DPSK)	Tested By	Stephen Chng

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

Band Edge Compliance (Conducted) Plots – GFSK

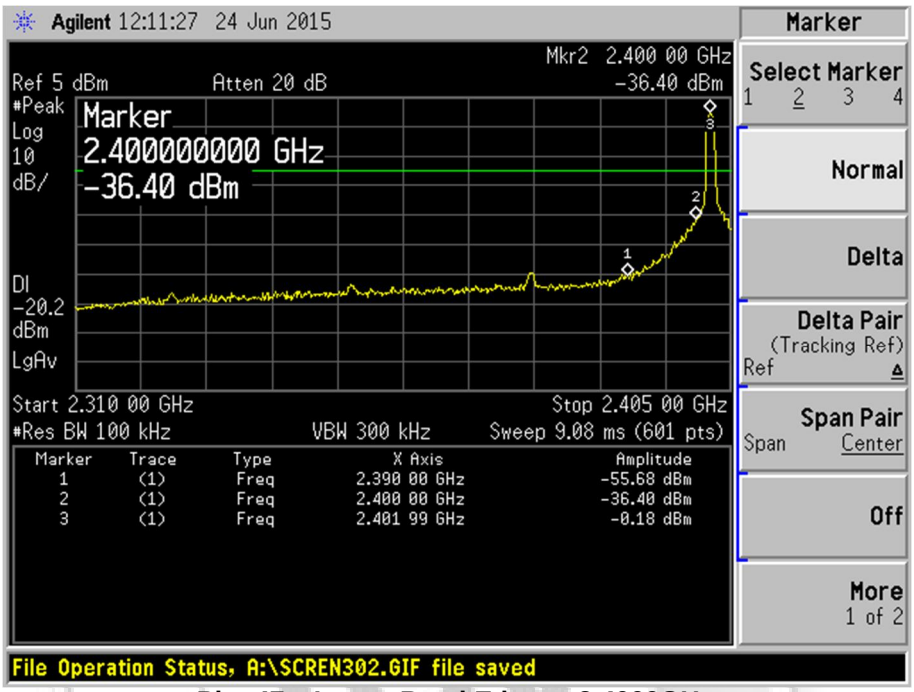


Plot 45 – Lower Band Edge at 2.4000GHz

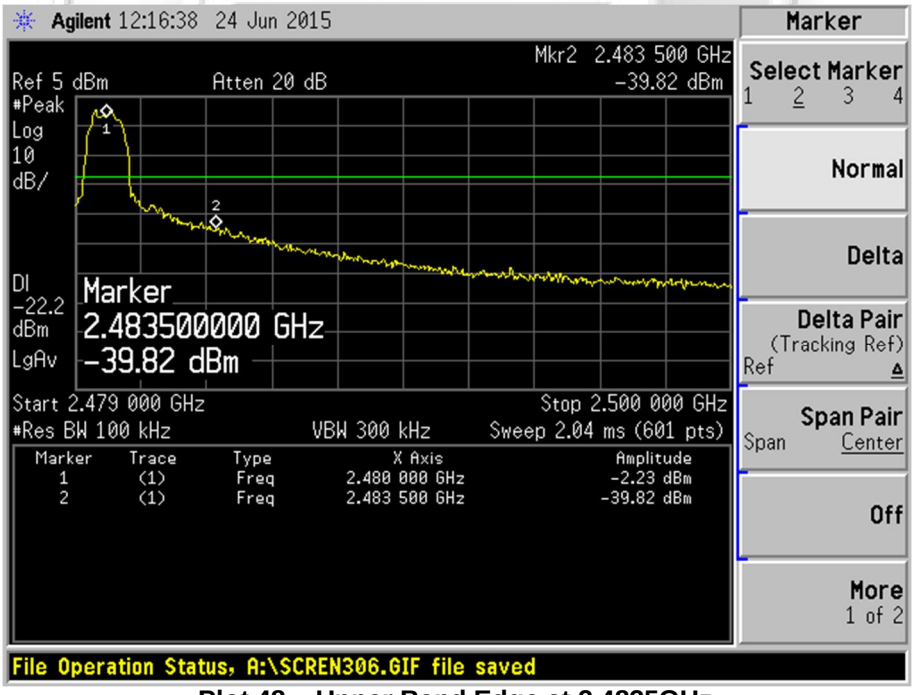


Plot 46 – Upper Band Edge at 2.4835GHz

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

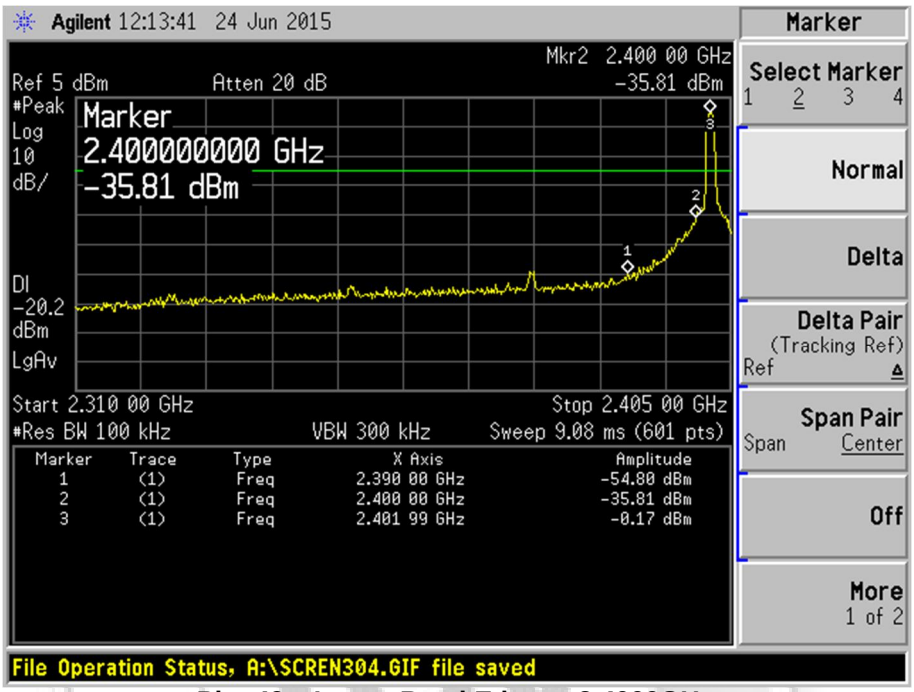


Plot 47 – Lower Band Edge at 2.4000GHz

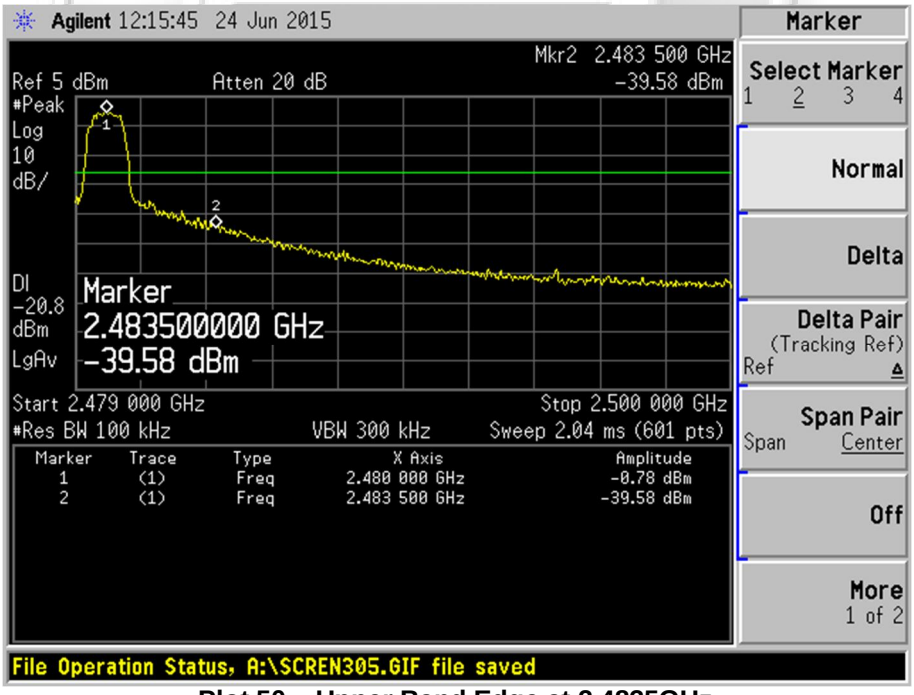


Plot 48 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Conducted) Plots – 8DPSK



Plot 49 – Lower Band Edge at 2.4000GHz



Plot 50 – Upper Band Edge at 2.4835GHz

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

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power. In addition, radiated emissions which fall in the restricted bands shall comply to the radiated emission limits specified in 15.209.

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

Instrument	Model	S/No	Cal Due Date
R&S Test Receiver – ESI1	ESI40	100010	23 Jul 2015
EMCO Horn Antenna(1GHz-18GHz)	3115	0003-6088	20 Apr 2016
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016

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

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

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

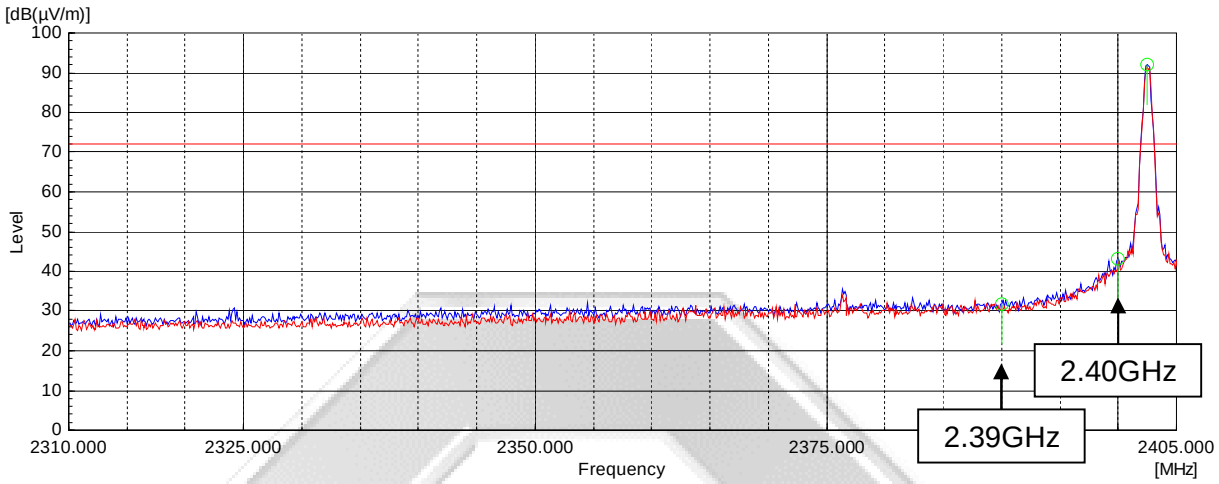
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode with frequency hopping sequence on.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band,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

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

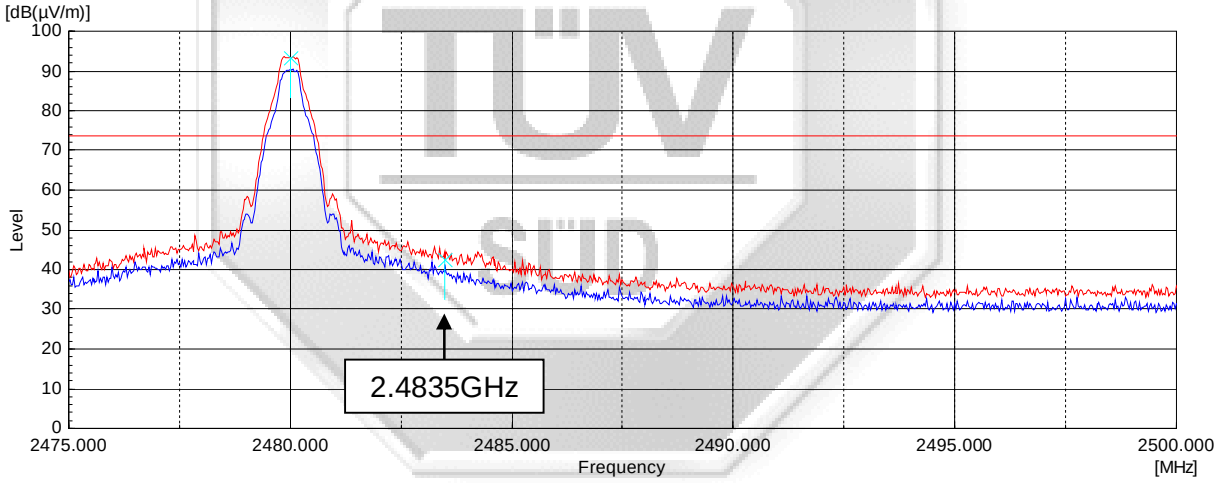
Test Input Power	120V 60Hz	Temperature	23°C
Attached Plots	51 – 56 (GFSK)	Relative Humidity	60%
	57 – 62 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	63 – 68 (8DPSK)	Tested By	Stephen Chng

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

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

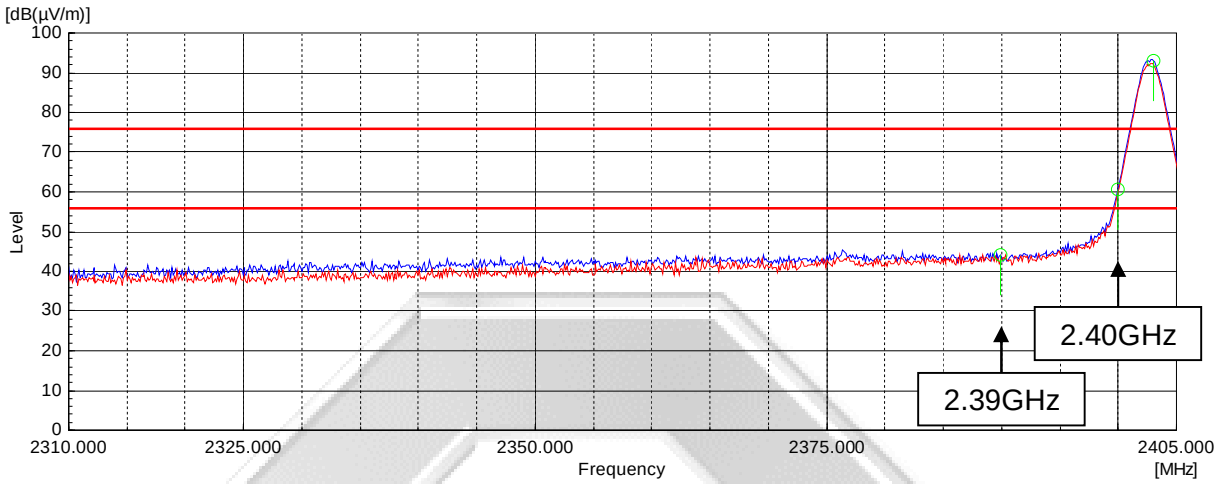


Plot 51 – Lower Band Edge at 2.4000GHz

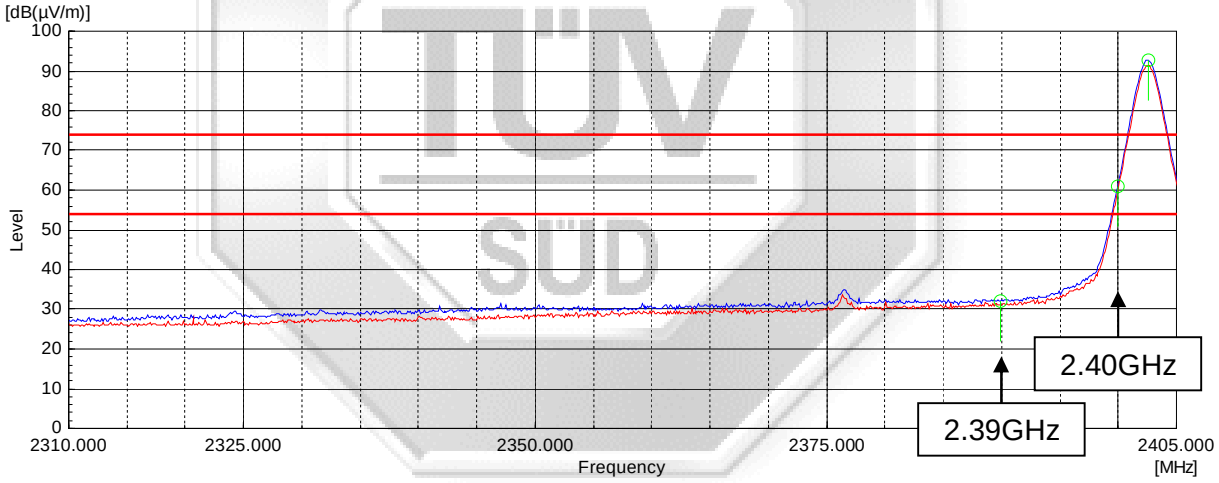


Plot 52 – Upper Band Edge at 2.4835GHz

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

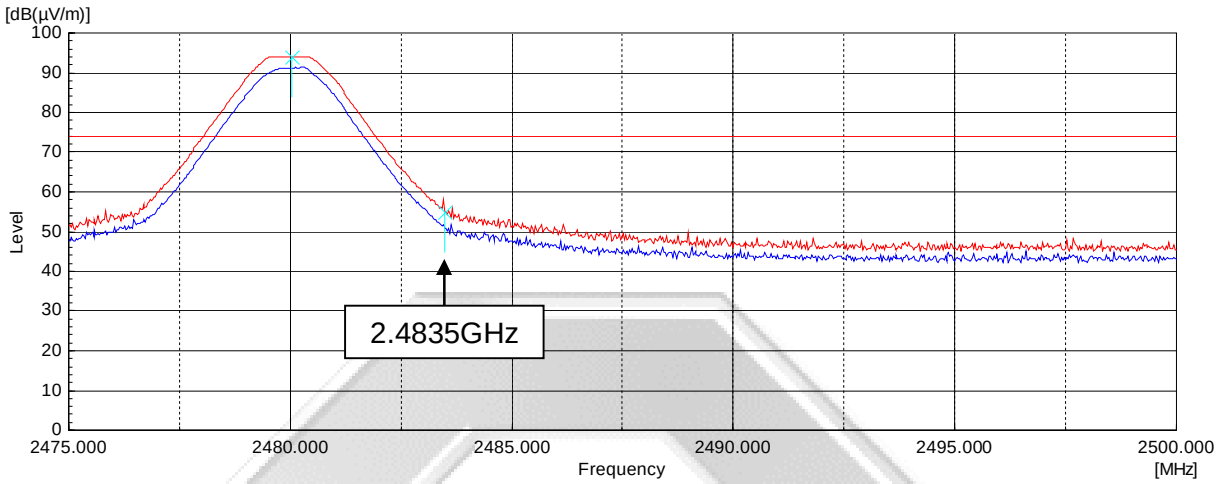


Plot 53 – Peak Plot at Lower Band Edge at 2.4000GHz

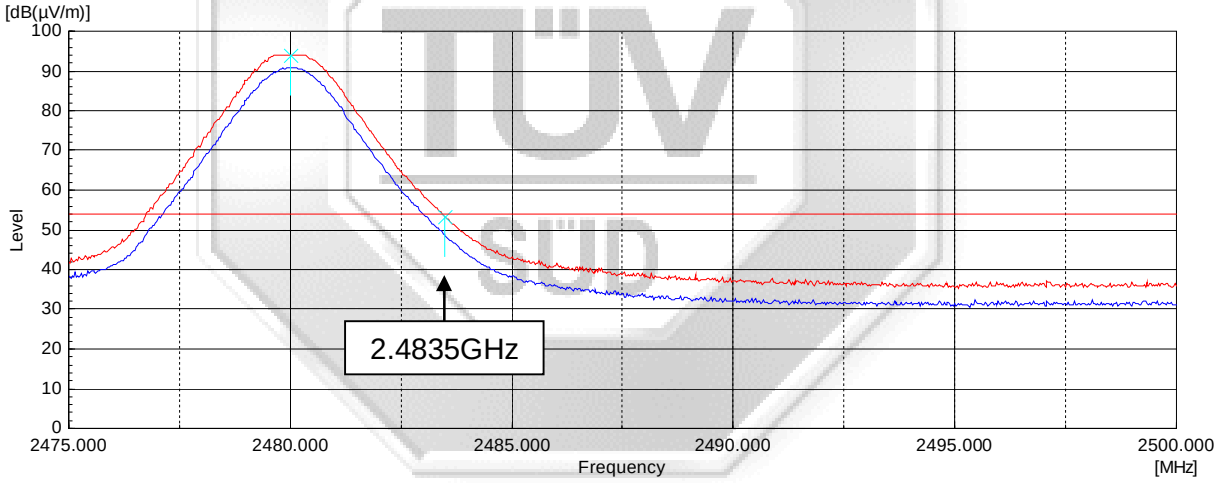


Plot 54 – Average Plot at Lower Band Edge at 2.4000GHz

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

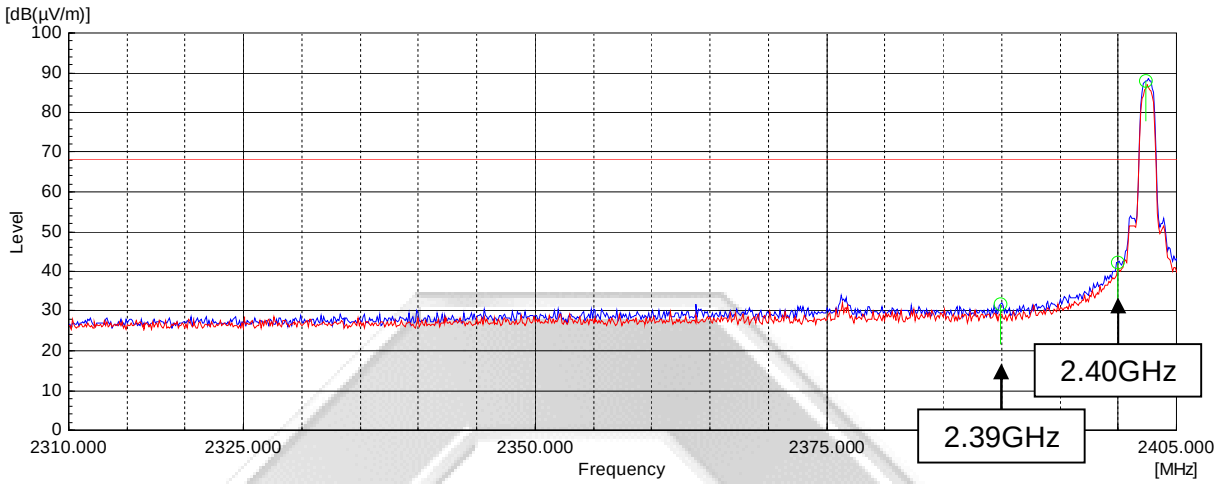


Plot 55 – Peak Plot at Upper Band Edge at 2.4835GHz

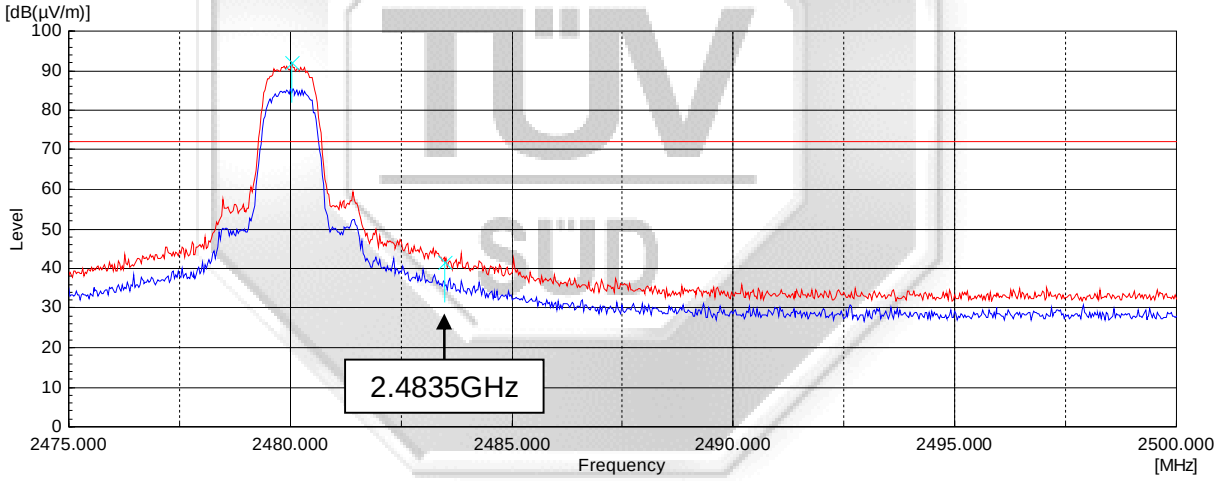


Plot 56 – Average Plot at Upper Band Edge at 2.4835GHz

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

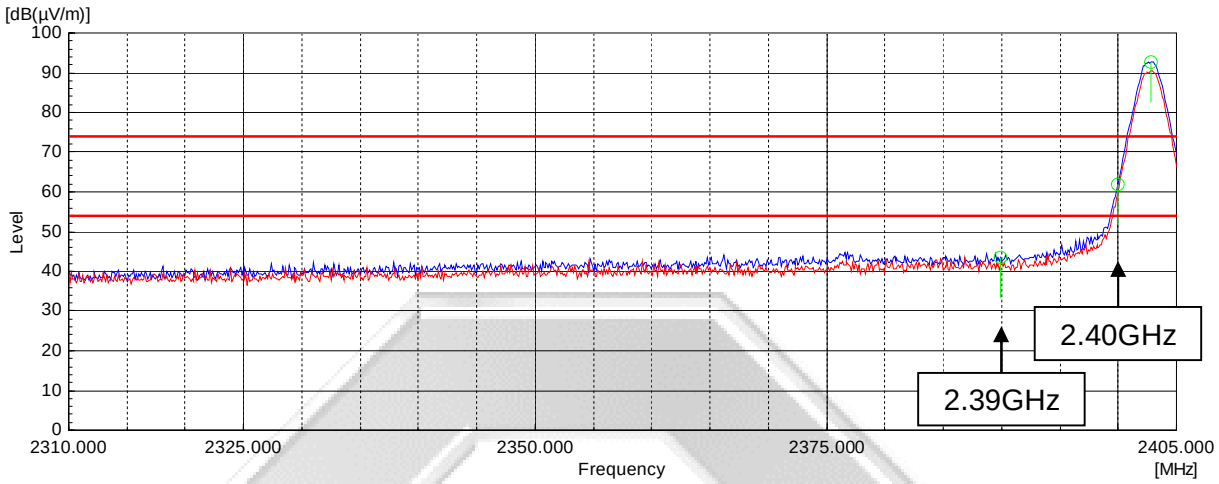


Plot 57 – Lower Band Edge at 2.4000GHz

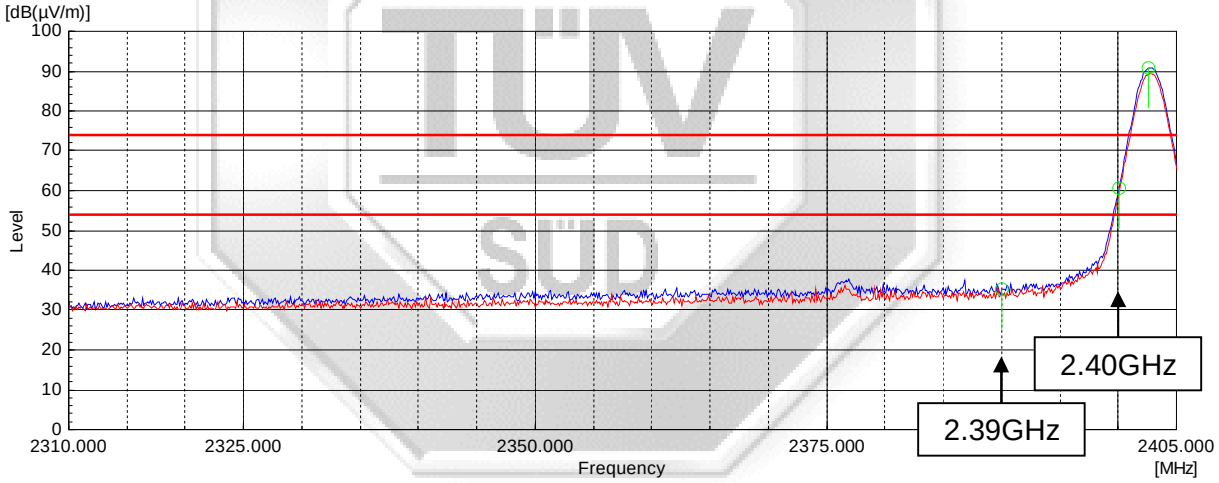


Plot 58 – Upper Band Edge at 2.4835GHz

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

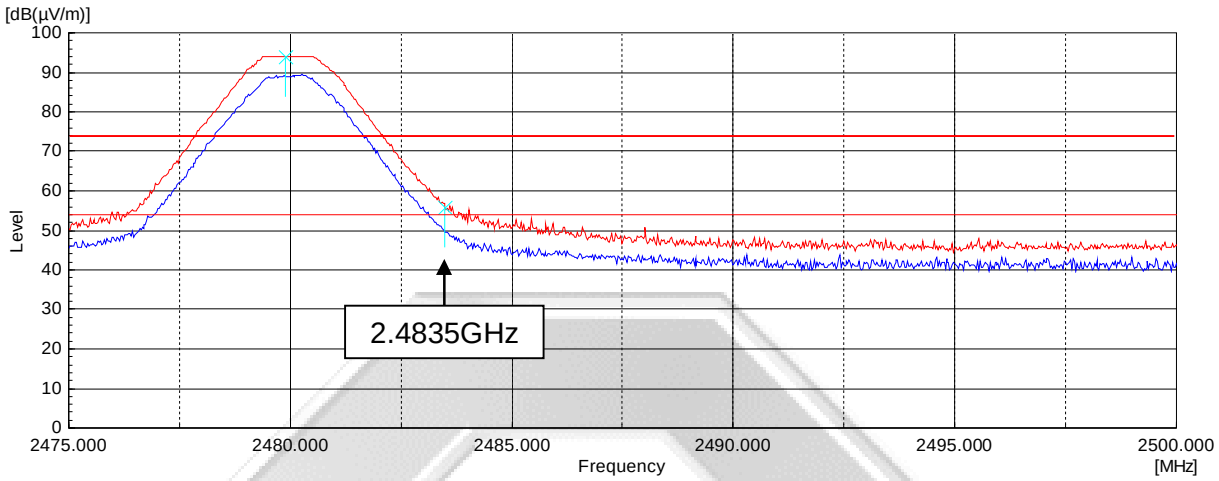


Plot 59 – Peak Plot at Lower Band Edge at 2.4000GHz

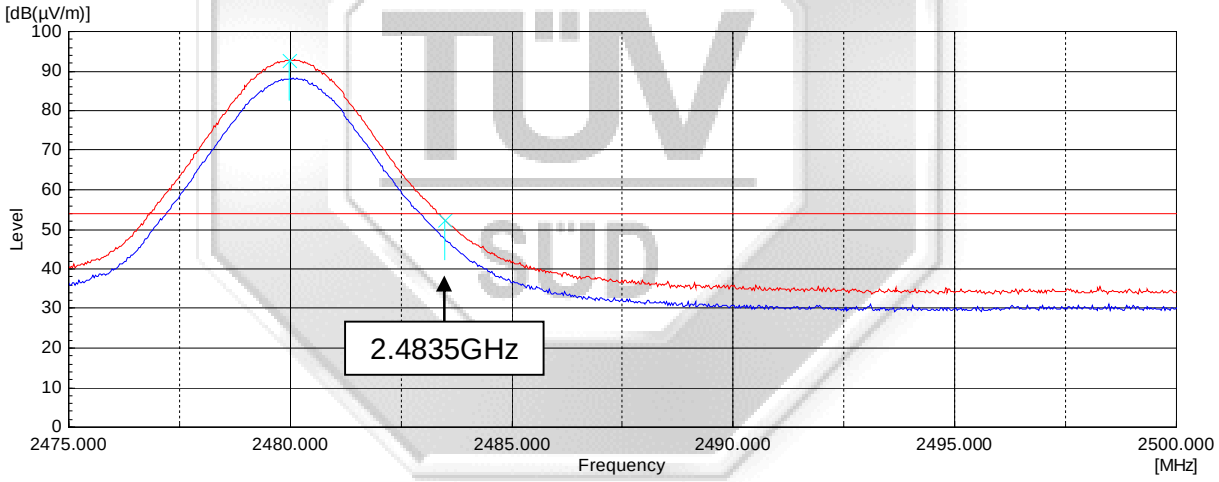


Plot 60 – Average Plot at Lower Band Edge at 2.4000GHz

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

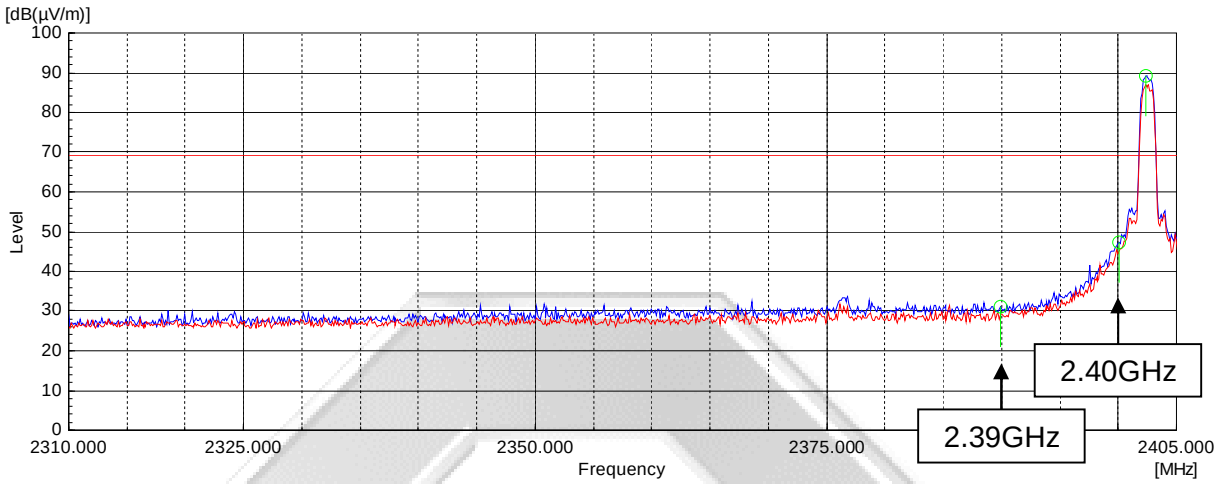


Plot 61 – Peak Plot at Upper Band Edge at 2.4835GHz

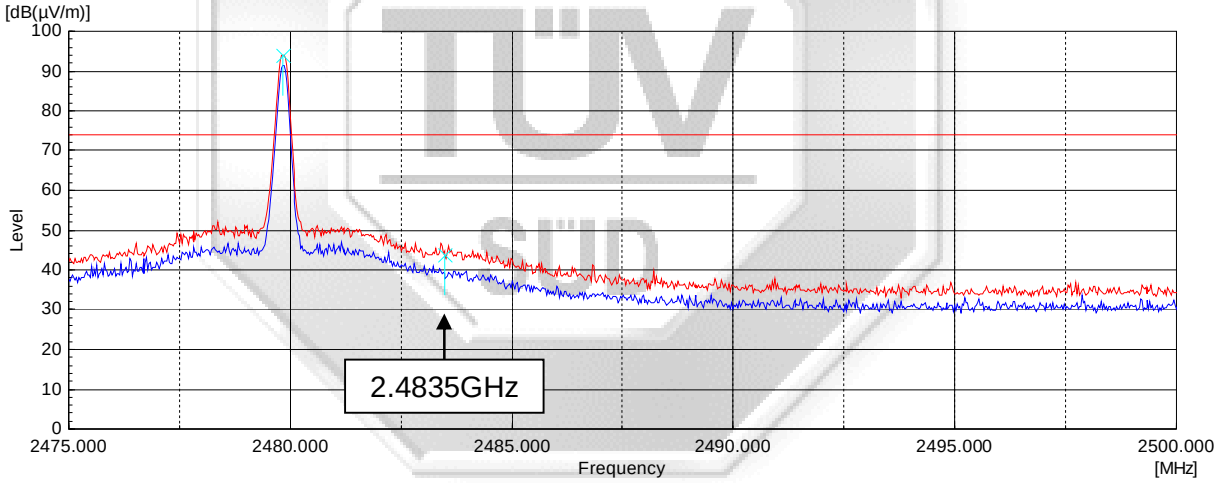


Plot 62 – Average Plot at Upper Band Edge at 2.4835GHz

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

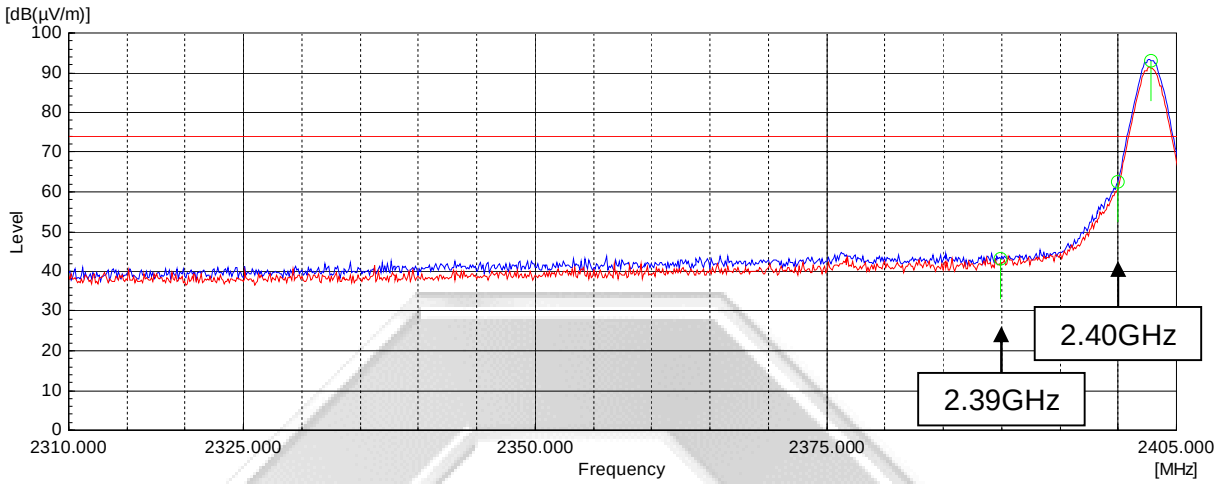


Plot 63 – Lower Band Edge at 2.4000GHz

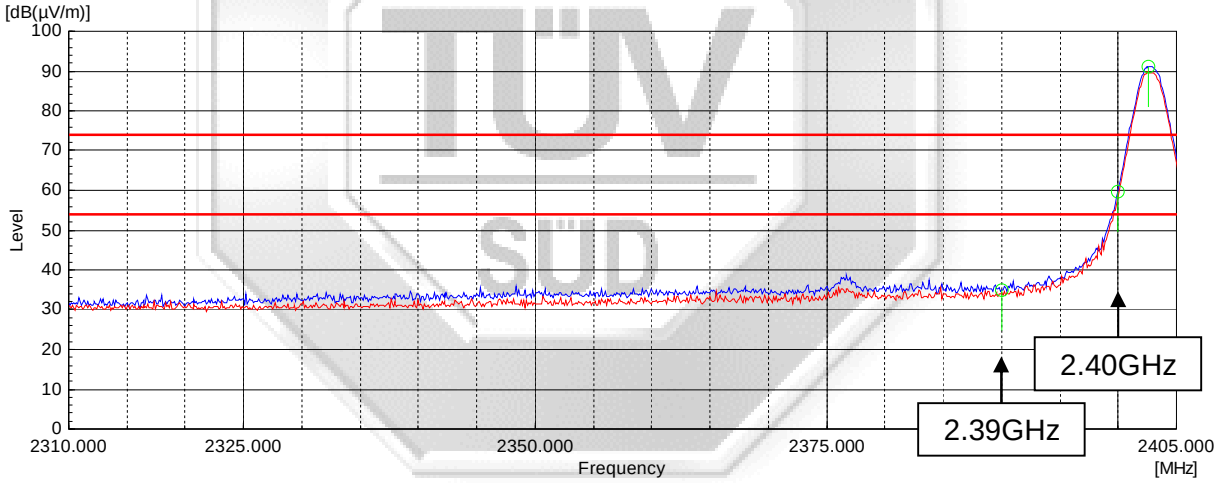


Plot 64 – Upper Band Edge at 2.4835GHz

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

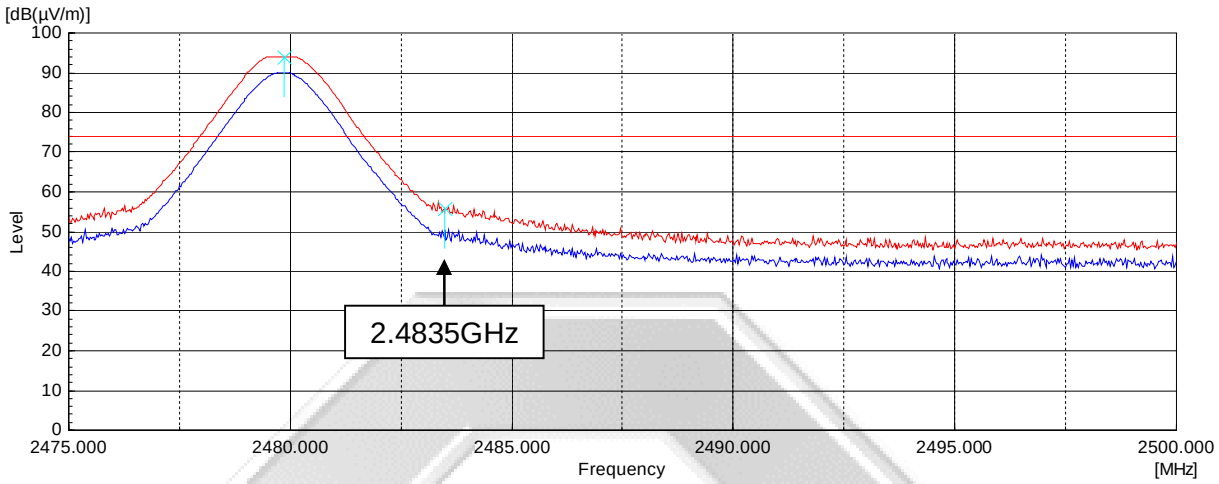


Plot 65 – Peak Plot at Lower Band Edge at 2.4000GHz

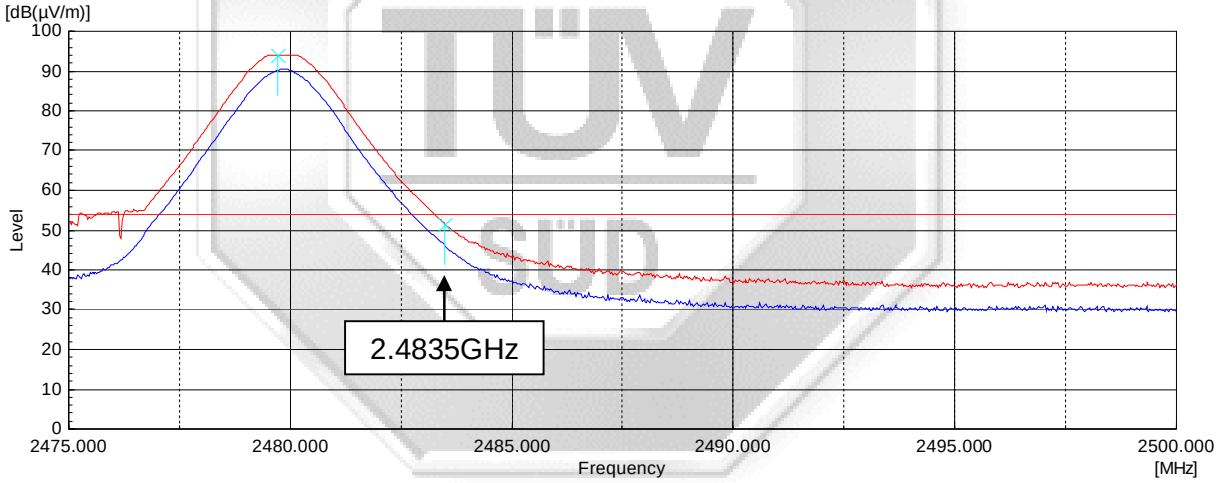


Plot 66 – Average Plot at Lower Band Edge at 2.4000GHz

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



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



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

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

The EUT shows compliance to the requirements of this section, which states the peak power spectral density conducted from the intentional radiator (EUT) to the antenna shall not be greater than 8dBm (6.3mW) in any 3kHz band during any time interval of continuous transmission.

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

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E4440A	MY45304764	12 Dec 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

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

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

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

1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode, non-hopping with transmitting frequency at Channel 0 (2.402GHz) *(lower ch)*.
2. The sweep time of the spectrum analyser was set to the value of the ratio of the frequency span divided by the RBW.
3. The peak power density of the transmitting frequency was detected and recorded.
4. The step 3 was repeated with the transmitting frequency was set to Channel 39 (2.441GHz) *(mid ch)* and Channel 78 (2.480GHz) *(upper ch)* respectively.

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

Test Input Power	5Vdc	Temperature	23ºC
Attached Plots	69 – 71 (GFSK)	Relative Humidity	60%
	72 – 74 ((π/4) DQPSK)	Atmospheric Pressure	1030mbar
	75 – 77 (8DPSK)	Tested By	Stephen Chng

GFSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.143	6.3
39 *(mid ch)*	2.441	0.141	6.3
78 *(upper ch)*	2.480	0.135	6.3

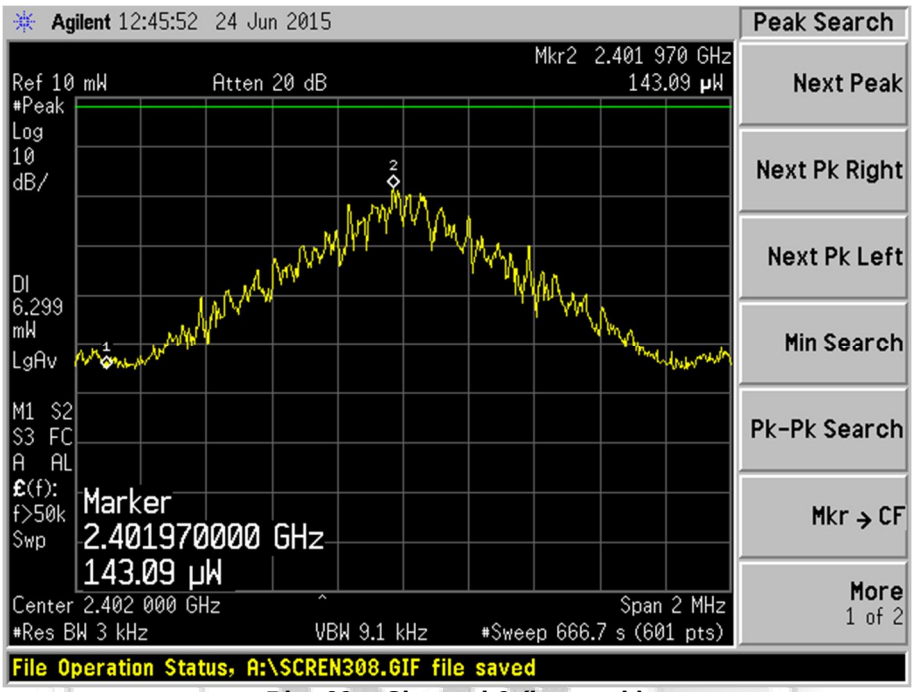
(π/4) DQPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.035	6.3
39 *(mid ch)*	2.441	0.033	6.3
78 *(upper ch)*	2.480	0.034	6.3

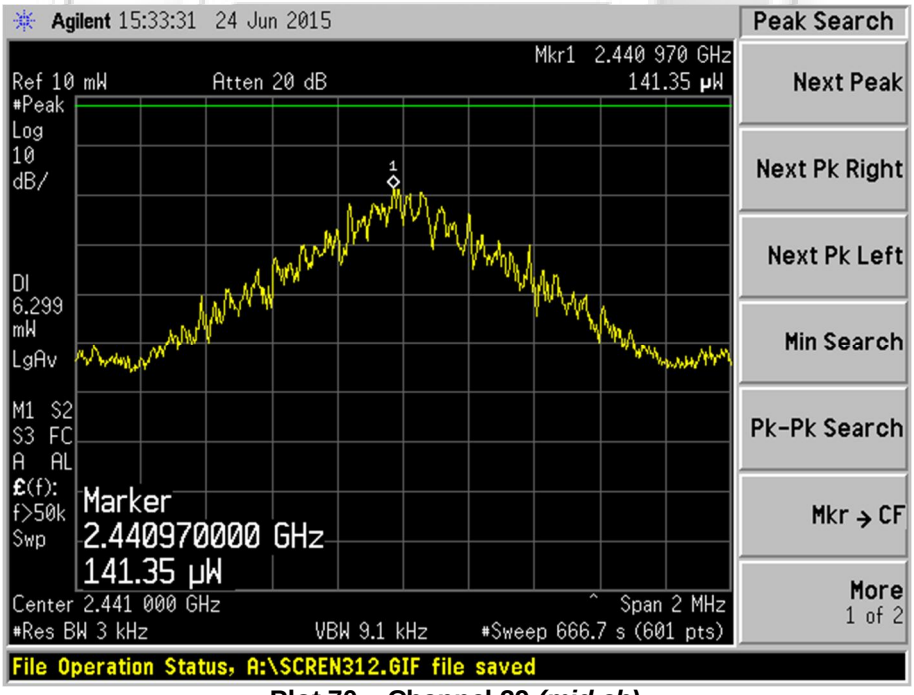
8DPSK

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.035	6.3
39 *(mid ch)*	2.441	0.035	6.3
78 *(upper ch)*	2.480	0.034	6.3

Peak Power Spectral Density Plots – GFSK

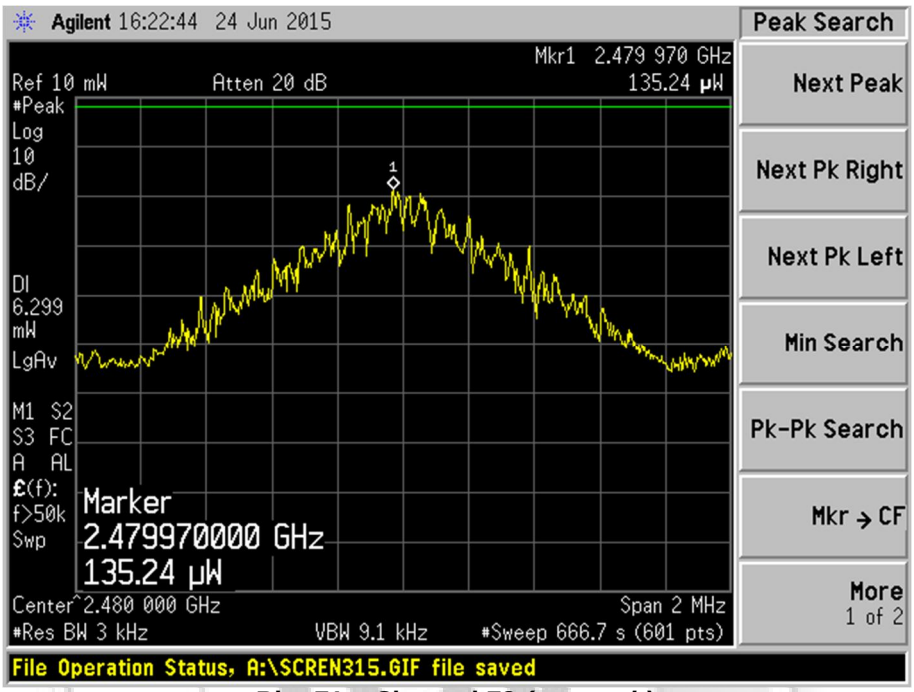


Plot 69 – Channel 0 *(lower ch)*



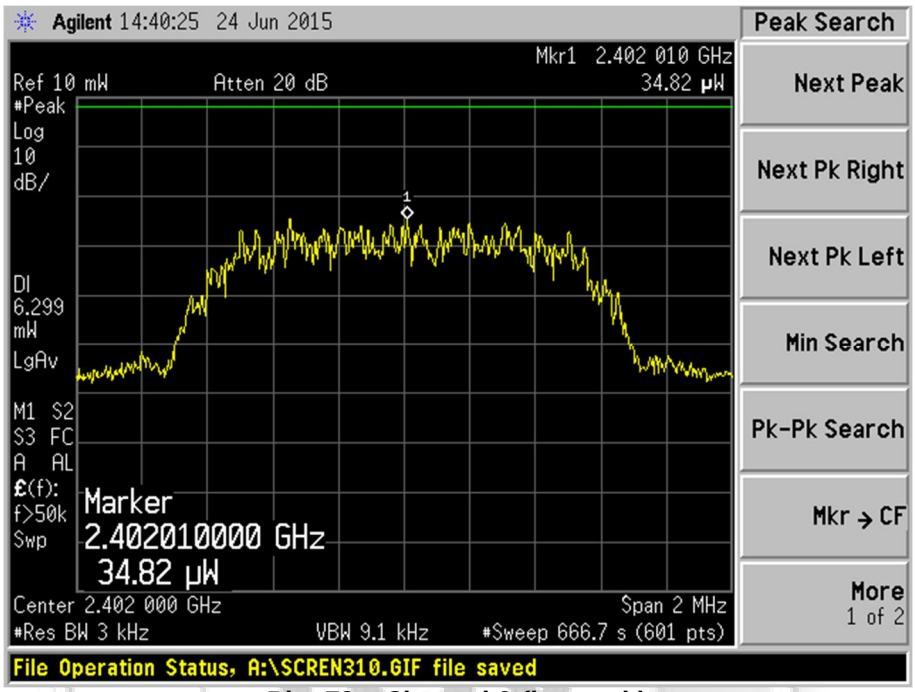
Plot 70 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – GFSK

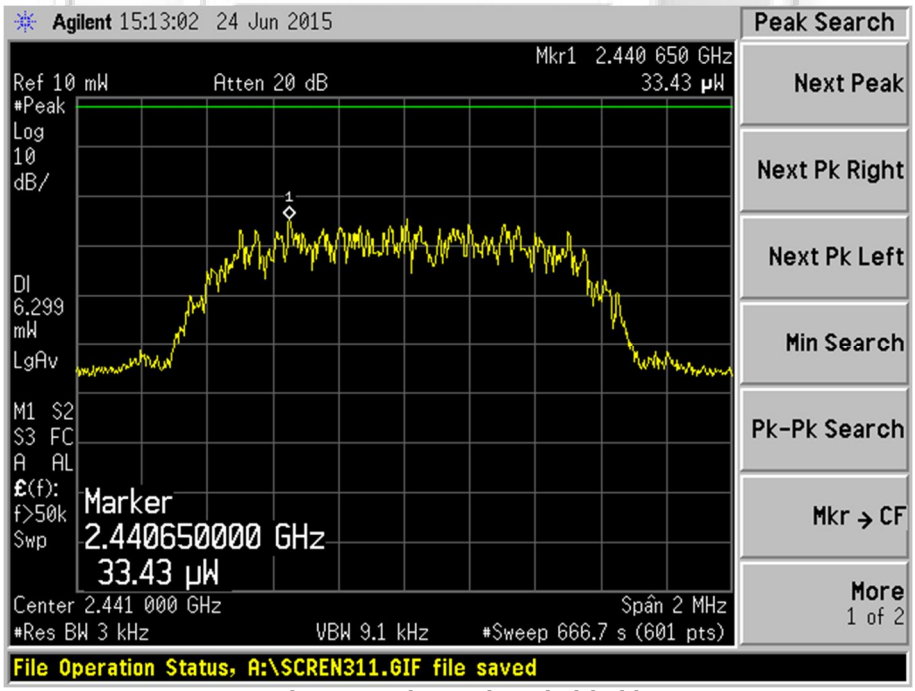


Plot 71 – Channel 78 *(upper ch)*

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

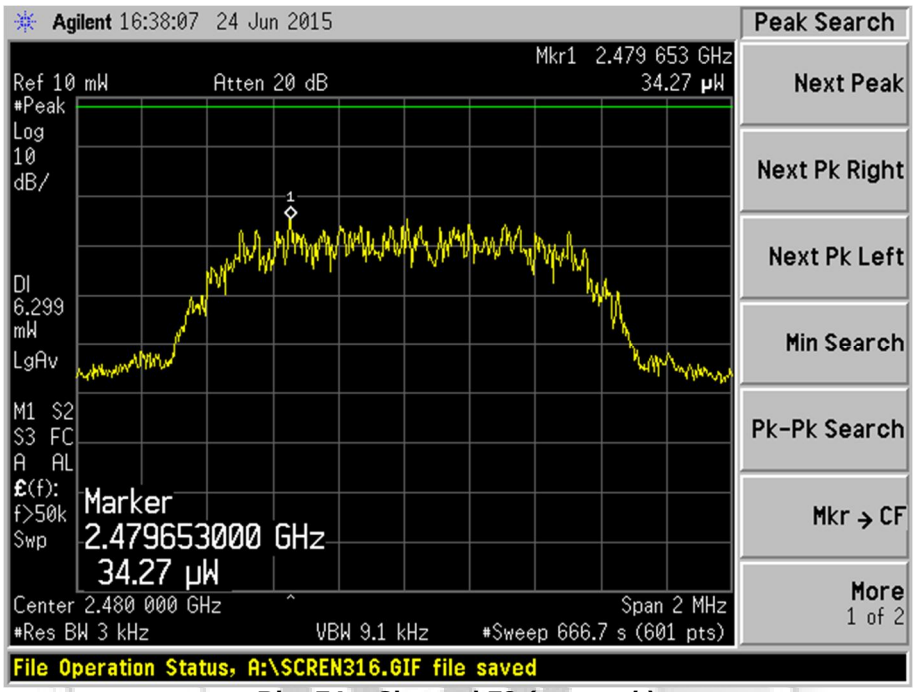


Plot 72 – Channel 0 *(lower ch)*



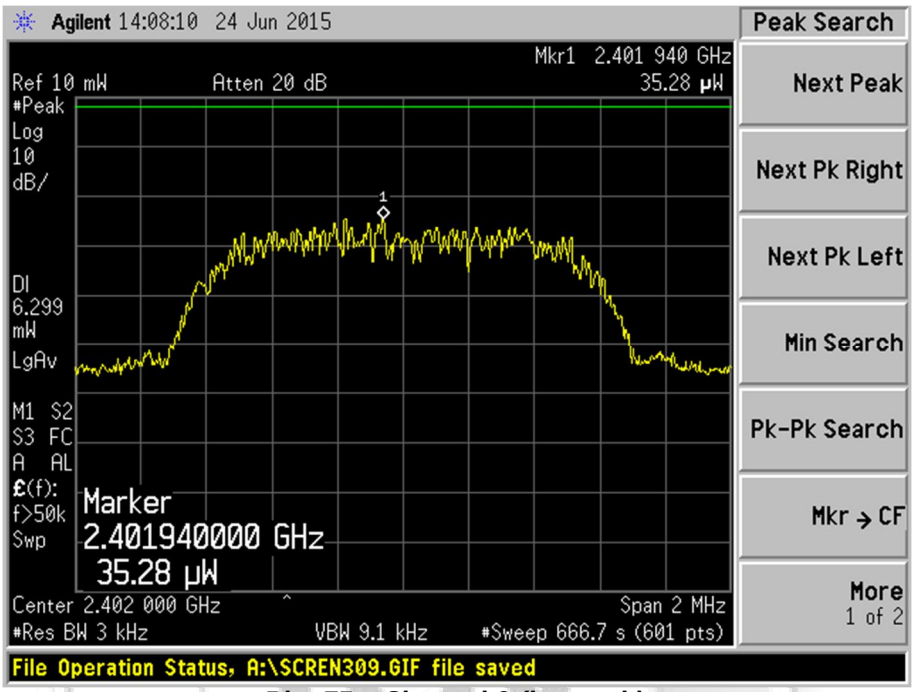
Plot 73 – Channel 39 *(mid ch)*

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

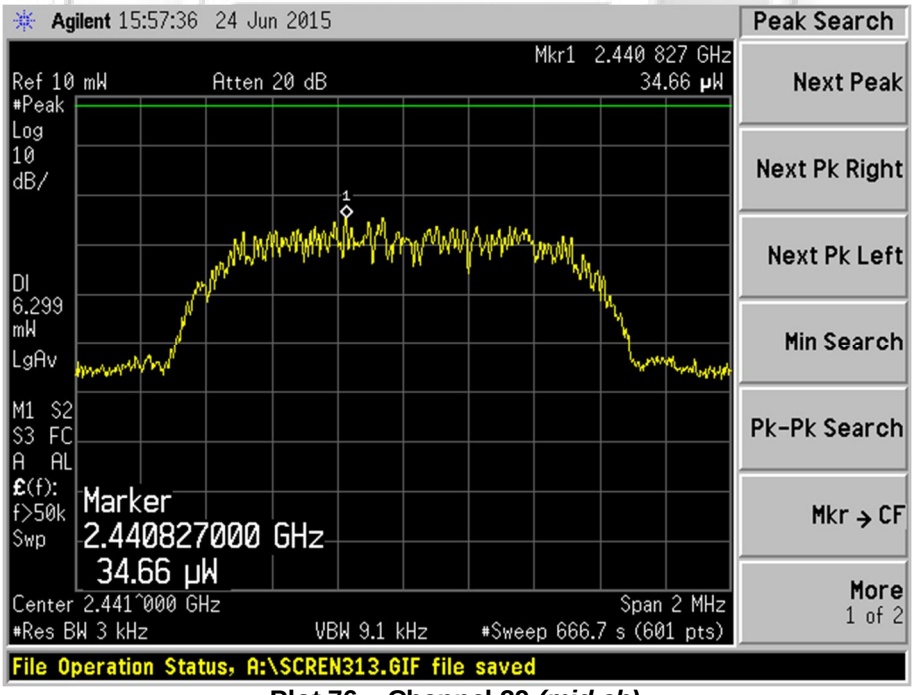


Plot 74 – Channel 78 *(upper ch)*

Peak Power Spectral Density Plots – 8DPSK

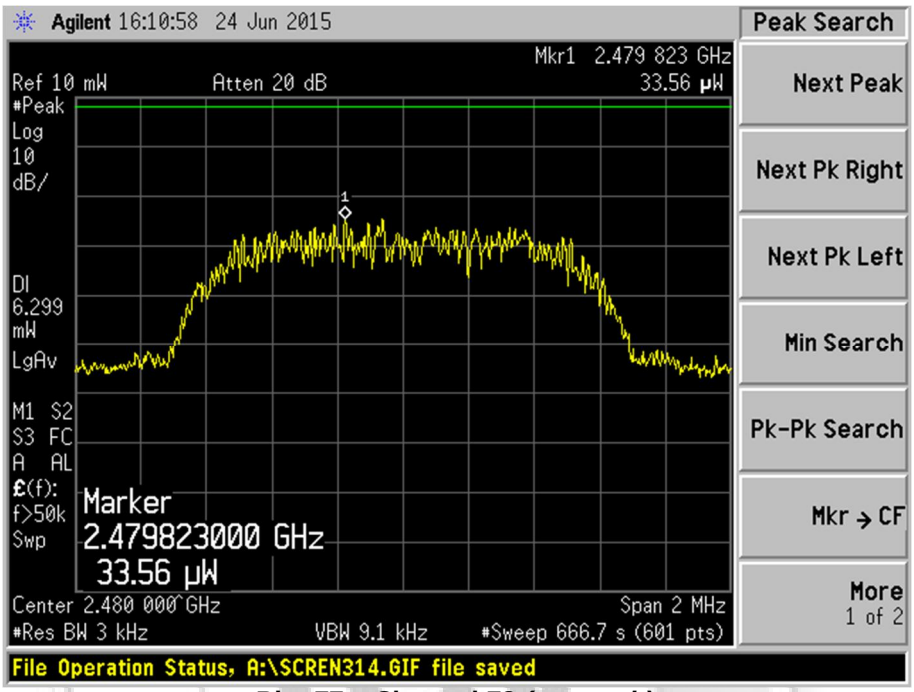


Plot 75 – Channel 0 *(lower ch)*



Plot 76 – Channel 39 *(mid ch)*

Peak Power Spectral Density Plots – 8DPSK



Plot 77 – Channel 78 *(upper ch)*

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

The EUT shows compliance to the requirements of this section, which states the MPE limits for general population / uncontrolled exposure are as shown below:

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (min)
0.3 - 1.34	614	1.63	100 Note 2	30
1.34 - 30	824 / f	2.19 / f	$180 / f^2$ Note 2	30
30 - 300	27.5	0.073	0.2	30
300 - 1500	-	-	f / 1500	30
1500 - 100000	-	-	1.0	30
Notes				
1. f = frequency in MHz				
2. Plane wave equivalent power density				

47 CFR FCC Part 1.1310 Maximum Permissible Exposure Computation

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

$S = (30GP) / (377d^2)$

where S = Power density in W/m^2
P = 0.0018W
d = Test distance at 0.2m
G = Numerical isotropic gain, 1.58 (2.0dBi)

Substituting the relevant parameters into the formula:

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

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

PSB Singapore

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July 2011