Test Report No. 7191139322-EEC16/01
dated 03 Jun 2016

PSB Singapore

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FORMAL REPORT ON TESTING IN ACCORDANCE WITH
47 CFR FCC Parts 15B & C
OF A
BLUETOOTH LOW ENERGY BUTTON
[Model : Flic]
[FCC ID : 2ACR9-FLIC]

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	Shortcut Labs AB Drottning Kristinas Vag 41 Stockholm 11428 Sweden Tel : +46 7 3506 0393 Fax : Nil
QUOTATION NUMBER	2191015831 & 2191041395
JOB NUMBER	7191112070 & 7191139322
TEST PERIOD	31 Mar 2015 – 20 Apr 2015

PREPARED BY

Quek Keng Huat
Higher Associate Engineer

APPROVED BY

Lim Cher Hwee
Assistant Vice President

TÜV SÜD PSB

ilac-MRA

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

Laboratory:
TÜV SÜD PSB Pte. Ltd.
No.1 Science Park Drive
Singapore 118221

Phone : +65-6885 1333
Fax : +65-6776 8670
E-mail: enquiries@tuv-sud-psb.sg
www.tuv-sud-psb.sg
Co. Reg : 199002667R

Regional Head Office:
TÜV SÜD Asia Pacific Pte. Ltd.
1 Science Park Drive, #02-01
Singapore 118221

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TEST SUMMARY

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

Test Results Summary

Test Standard	Description	Pass / Fail
47 CFR FCC Part 15		
15.107(a), 15.207	Conducted Emissions	Not Applicable *See Note 5
15.109(a), 15.205, 15.209	Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement)	Pass
15.247(a)(2)	Spectrum Bandwidth (6dB Bandwidth Measurement)	Pass
15.247(b)(3)	Maximum Peak Power	Pass
15.247(d)	RF Conducted Spurious Emissions (Non-Restricted Bands)	Pass
15.247(d)	RF Conducted Spurious Emissions (Restricted Bands)	Pass
15.247(d)	Band Edge Compliance (Conducted)	Pass
15.247(d)	Band Edge Compliance (Radiated)	Pass
15.247(e)	Peak Power Spectral Density	Pass

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 (Lower Channel)	2.402
Channel 19 (Middle Channel)	2.440
Channel 39 (Upper Channel)	2.480

2. The EUT is a Class B device when in non-transmitting state and meets the 47 CFR FCC Part15B Class B requirements.

3. All test measurement procedures are according to ANSI C63.4: 2003 and KDB 558074 D01 DTS Measurement Guidance V03R01.

4. The maximum measured RF power of the Equipment Under Test is -3.0dBm.

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

6. The EUT was tested using fully charged batteries with DC voltage of 3.0VDC.

Notes (continued)

7. This report 7191139322-EEC16/01 was reproduced from TÜV SÜD PSB's issued test report, 7191112070-EEC15/01 dated 27 Apr 2015 as per Shortcut Labs AB's request for changes and declaration as shown:
   i. Include declared model "Powered by Flic"
   ii. Update of address
   iii. New label – Refer to ANNEX C
   iv. New product photo for "Powered by Flic"
   v. Manufacturer change to Shortcut Labs AB while SMT details (factory details)

SHORTCUT labs

Shortcut Labs AB
Drottning Kristinas Vag 41
11428, Stockholm, Sweden

Shortcut Labs makes the following declaration:

The **Product: Bluetooth low energy button** models: Flic and Powered by Flic(Poic) are the same in term of components, circuitry designs, PCB layouts and mechanical structures. The differences among the declared models are:

a. Both *Flic* and *Powered by Flic* have plastic housing, but *Flic* has an extra layer of Silicone covering the exterior for a premium feeling for the end customer. *Powered by Flic* is the lower cost version which does not have the premium silicone covering the exterior and is meant for B2B customers that want to print their logo on the button.
b. *Powered by Flic* product contains a larger battery, CR2032, to give longer battery life as compared to *Flic* which is using CR2016.
c. *Powered by Flic* product does not have replaceable battery as compared to *Flic*.

The similarities are:

a) Similar size, *Powered by Flic* is 1mm wider and 0.12mm higher, see separate attached document "PbF vs Flic Dimensions.PDF"
b) Same schematics
c) Same PCB
d) Same electrical BoM
e) Same firmware
f) Same battery contacts
g) In fact, the production line for *Flic* and *Powered by Flic* is the same, it is only after the battery contacts have been assembled to the PCBA that the units are separately assembled as *Flic* or *Powered by Flic*.

Shall the model *Flic* pass all the tests, the declared model *Powered by Flic(Poic)* is deemed to meet the same requirements.

SHORTCUT LABS

Signature/Date

Company Stamp

Name: Amir Sharifat
Designation : 2016-06-03

Modifications

No modifications were made.

PRODUCT DESCRIPTION

Description	:	The Equipment Under Test (EUT) is a **BLUETOOTH LOW ENERGY BUTTON.** It is a simple and stylish button that lets users create a shortcut to their favourite actions so that they don't have to touch their phones.
Applicant	:	Shortcut Labs AB Drottning Kristinas Vag 41 Stockholm 11428 Sweden
Manufacturer	:	Shortcut Labs AB Drottning Kristinas Vag 41 Stockholm 11428 Sweden
Factory (ies)	:	SMT Technologies Sdn Bhd Plot 102, Jalan Empat Bakar Arang Industrial Estate, 08000 Sungai Petani, Kedah, Malaysia
Model Number	:	Flic (Tested) Powered by Flic (Declared)
FCC ID	:	2ACR9-FLIC
Serial Number	:	Nil
Microprocessor	:	DA14580
Operating / Transmitting Frequency	:	2.402GHz (lower channel) to 2.480GHz (upper channel) 40 channels in total
Clock / Oscillator Frequency	:	16MHz
Modulation	:	Gaussian Frequency Shift Keying (GFSK) (Bluetooth Low Energy)
Antenna Gain	:	-3.5dBi
Port / Connectors	:	Nil
Rated Input Power	:	3VDC (coin battery)
Accessories	:	Nil

SUPPORTING EQUIPMENT DESCRIPTION

Equipment Description (Including Brand Name)	Model, Serial & FCC ID Number	Cable Description (List Length, Type & Purpose)
HP Laptop	M/N: LV440PA#AB4 S/N: CNU1254451 FCC ID: DoC	Nil
HP AC Adapter	M/N: PA-165032HT S/N: 1430360702 FCC ID: Verification	2.0m unshielded DC power cable 2.0m unshielded AC power cable

EUT OPERATING CONDITIONS

47 CFR FCC Part 15
1. Radiated Emissions (Spurious Emissions inclusive Restricted Bands Requirement) **2. Spectrum Bandwidth (6dB Bandwidth Measurement)** **3. Maximum Peak Power** **4. RF Conducted Spurious Emissions (Non-Restricted Bands)** **5. RF Conducted Spurious Emissions (Restricted Bands)** **6. Band Edge Compliance (Conducted)** **7. Band Edge Compliance (Radiated)** **8. Peak Power Spectral Density**
The EUT was exercised by operating in maximum continuous transmission in test mode, i.e transmitting at lower, middle and upper channels respectively at one time.

47 CFR FCC Part 15.205 Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

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

Frequency Range (MHz)	Quasi-Peak Limit Values (dBµV/m)
0.009 - 0.490	20 log [2400 / F (kHz)] @ 300m
0.490 - 1.705	20 log [24000 / F (kHz)] @ 30m
1.705 - 30.0	30.0 @ 30m
30 - 88	40.0 @ 3m
88 - 216	43.5 @ 3m
216 - 960	46.0 @ 3m
Above 960	54.0* @ 3m
* For frequency bands 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, average detector was used. A peak limit of 20dB above the average limit does apply.	

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

Instrument	Model	S/No	Cal Due Date
EMCO Loop Antenna	6502	134413	01 Oct 2015
R&S Test Receiver – ESI1	ESI40	100010	23 Jul 2015
Schaffner Bilog Antenna –(30MHz-2GHz)	CBL6112D	2549	29 Jan 2016
TDK-RF Horn Antenna	HRN-0118	130256	10 Jul 2015
Com-Power Preamplifier (1MHz-1GHz)	PAM-103	441096	13 Oct 2015
R&S Preamplifier (1GHz -18GHz)	SCU18	102191	13 Mar 2016
Toyo Preamplifier (26.5GHz-40GHz)	HAP26-40W	00000005	02 Oct 2015
ETS Horn Antenna(18GHz-40GHz)	3116	0004-2474	02 Oct 2015
Micro-Tronics Bandstop Filter (2.4-2.5 GHz)	BRM50701	017	13 Aug 2015

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

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m X 1.0m X 0.8m high, non-metallic table.
2. The filtered power supply for the EUT and supporting equipment were tapped from the appropriate power sockets located on the turntable.
3. The relevant broadband antenna was set at the required test distance away from the EUT and supporting equipment boundary.

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

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. A prescan was carried out to pick the worst emission frequencies from the EUT. For EUT which is a portable device, the prescan was carried out by rotating the EUT through three orthogonal axes to determine which altitude and equipment arrangement produces such emissions.
3. The test was carried out at the selected frequency points obtained from the prescan in step 2. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
   a. Vertical or horizontal polarisation (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
   b. The EUT was then rotated to the direction that gave the maximum emission.
   c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
4. A Quasi-peak measurement was made for that frequency point if it was less than or equal to 1GHz. For frequency point in the range of 9kHz – 90kHz, 110kHz – 490kHz and above 1GHz, both Peak and Average measurements were carried out.
5. Steps 3 and 4 were repeated for the next frequency point, until all selected frequency points were measured.
6. The frequency range covered was from the lowest radio frequency signal generated from the EUT, without going below 9kHz to 10th harmonics of the EUT fundamental frequency, using the loop antenna for frequency below 30MHz, Bi-log antenna for frequencies from 30MHz up to 1GHz, and the Horn antenna above 1GHz.

Sample Calculation Example

At 300 MHz	Q-P limit = 46.0 dBμV/m
Log-periodic antenna factor & cable loss at 300 MHz = 18.5 dB	
Q-P reading obtained directly from EMI Receiver = 40.0 dBμV/m (Calibrated level including antenna factors & cable losses)	
Therefore, Q-P margin = 46.0 - 40.0 = 6.0	i.e. 6.0 dB below Q-P limit

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

Test Input Power	3VDC	Temperature	21°C
Test Distance	3m (<30MHz) 3m (≥30MHz – 25GHz)	Relative Humidity	50 %
		Atmospheric Pressure	1030mbar
		Tested By	Zaw Paing Win

Spurious Emissions ranging from 9kHz – 30MHz (for 9kHz – 90kHz, 110kHz – 490kHz) *See Notes 2 and 3

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
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Spurious Emissions ranging from 9kHz – 30MHz *See Notes 2 and 3

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

Frequency (MHz)	Q-P Value (dBµV/m)	Q-P Limit (dBµV/m)	Q-P Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Channel
95.7900	14.0	43.5	29.5	111	81	V	CH 39
181.2620	3.5	43.5	40.0	123	151	V	CH 39
193.5390	7.5	43.5	36.0	98	144	V	CH 39
229.9930	2.9	46.0	43.1	100	177	V	CH 39
239.9900	7.3	46.0	38.7	99	148	V	CH 39
287.4750	3.4	46.0	42.6	98	100	H	CH 39

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

Spurious Emissions above 1GHz – 25GHz

Freq (GHz)	Peak Value (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	AV Value (dBµV/m)	AV Limit (dBµV/m)	AV Margin (dB)	Height (cm)	Azimuth (Degrees)	Pol (H/V)	Ch
7.1901	39.0	74.0	35.0	-- *See Note 4	54.0	-- *See Note 4	200	352	V	0
7.2630	39.6	74.0	34.4	-- *See Note 4	54.0	-- *See Note 4	300	353	H	11
7.4330	39.3	74.0	34.7	-- *See Note 4	54.0	-- *See Note 4	100	327	V	39
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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. "--" indicates no emissions were found and shows compliance to the limits.
3. The measurement was done at 10m. The measured results were extrapolated to the specified test limits as specified in § 15.209 (a) based on 40dB/decade.
4. As the measured peak shows compliance to the average limit, as such no average measurement was required.
5. 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.
6. 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.
7. EMI receiver Resolution Bandwidth (RBW) and Video Bandwidth (VBW) settings:
   30MHz - 1GHz
   RBW: 120kHz VBW: 1MHz
   >1GHz
   RBW: 1MHz VBW: 1MHz
8. 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.
9. The channel in the table refers to the transmit channel of the EUT.
10. 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.

SPECTRUM BANDWIDTH (6dB BANDWIDTH MEASUREMENT) TEST

47 CFR FCC Part 15.247(a)(2) Spectrum Bandwidth (6dB Bandwidth Measurement) Limits

The EUT shows compliance to the requirements of this section, which states that the minimum bandwidth of the EUT employing digital modulation techniques shall be at least 500kHz.

47 CFR FCC Part 15.247(a)(2) Spectrum Bandwidth (6dB Bandwidth Measurement) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	24 Jul 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

47 CFR FCC Part 15.247(a)(2) Spectrum Bandwidth (6dB 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 the following:
   RBW = 100kHz
   VBW = 3 times RBW
5. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Part 15.247(a)(2) Spectrum Bandwidth (6dB 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 at lower channel.
2. The center frequency of the spectrum analyser was set to the transmitting frequency with the frequency span wide enough to capture the 6dB bandwidth of the transmitting frequency.
3. The spectrum analyser was set to max hold to capture the transmitting frequency. The signal capturing was continuous until no further changes were observed.
4. The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser. The frequencies below the 6dB peak frequency at lower (f_L) and upper (f_H) sides of the transmitting frequency were marked and measured by using the marker-delta function of the spectrum analyser.
5. The 6dB bandwidth of the transmitting frequency is the frequency difference between the marked lower and upper frequencies, $| f_H - f_L |$.
6. The steps 2 to 5 were repeated with the transmitting frequency was set to middle and upper channel respectively.

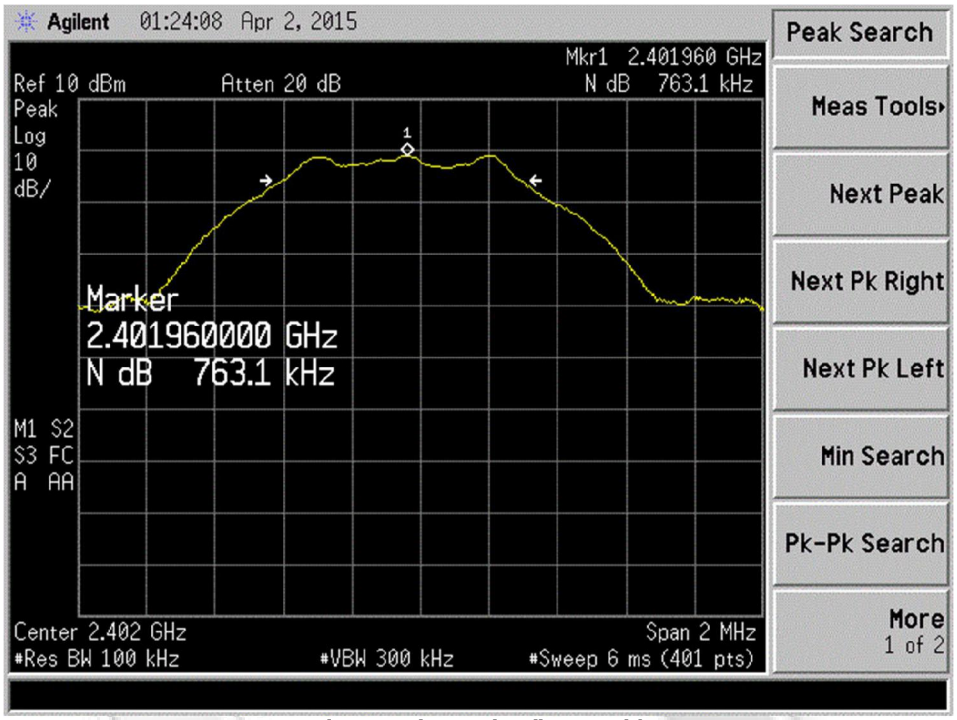
SPECTRUM BANDWIDTH (6dB BANDWIDTH MEASUREMENT) TEST

47 CFR FCC Part 15.247(a)(2) Spectrum Bandwidth (6dB Bandwidth Measurement) Results

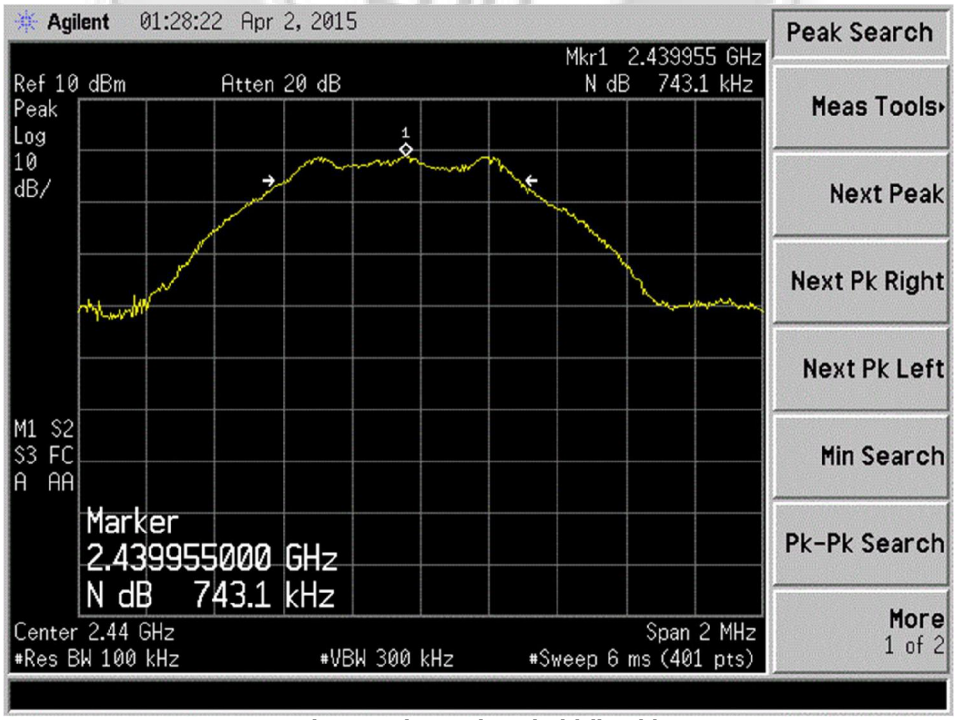
Test Input Power	3VDC	Temperature	22°C
Attached Plots	1 - 3	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

Channel	Channel Frequency (GHz)	6dB Bandwidth (MHz)
0 *(lower ch)*	2.402	0.7631
19 *(mid ch)*	2.440	0.7431
39 *(upper ch)*	2.480	0.7581

Spectrum Bandwidth (6dB Bandwidth Measurement) Plots

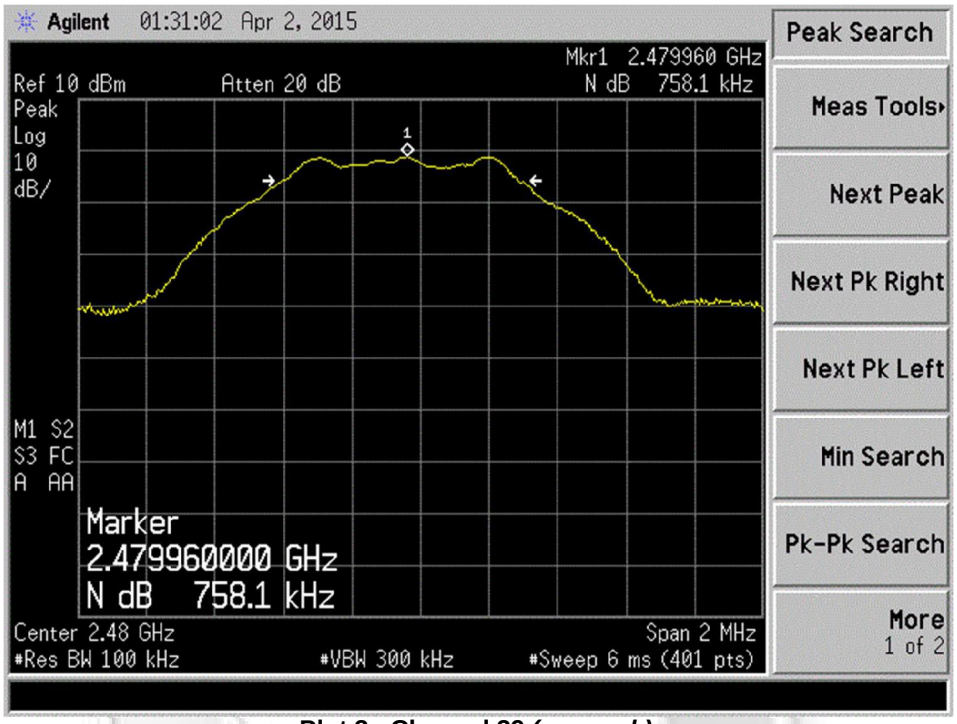


Plot 1 - Channel 0 *(lower ch)*



Plot 2 - Channel 19 *(middle ch)*

Spectrum Bandwidth (6dB Bandwidth Measurement) Plots



Plot 3 - Channel 39 *(upper ch)*

47 CFR FCC Part 15.247(b)(3) Maximum Peak Power Limits

The EUT shows compliance to the requirements of this section, which states the maximum peak power of the EUT employing digital modulation shall not exceed 1W (30dBm).

47 CFR FCC Part 15.247(b)(3) Maximum Peak Power Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent EPM-P Series Power Meter	E4416A	GB41290618	18 Aug 2015
Agilent Power Sensor	8482A	MY41090429	27 Aug 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

47 CFR FCC Part 15.247(b)(3) Maximum Peak Power Test Setup

1. The EUT and supporting equipment were set up as shown in the setup photo.
2. The power supply for the EUT was connected to a filtered mains.
3. The RF antenna connector was connected to the power meter.
4. All other supporting equipment were powered separately from another filtered mains.

47 CFR FCC Part 15.247(b)(3) 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 at lower channel.
2. The maximum peak power of the transmitting frequency was detected and recorded.
3. The step 2 was repeated with the transmitting frequency was set to middle and upper channel respectively.

47 CFR FCC Part 15.247(b)(3) Maximum Peak Power Results

Test Input Power	3VDC	Temperature	22°C
Antenna Gain	-3.5dBi	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

Channel	Channel Frequency (GHz)	Maximum Peak Power (W)	Limit (W)
0 *(lower ch)*	2.402	0.0005	1.0
19 *(mid ch)*	2.440	0.0005	1.0
39 *(upper ch)*	2.480	0.0005	1.0

Notes

1. Nil.

RF CONDUCTED SPURIOUS EMISSIONS (NON-RESTRICTED BANDS) TEST

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Non-Restricted Bands) Limits

The EUT shows compliance to the requirements of this section, which states in any 100kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator (EUT) is operating, the radio frequency power that is produced by the EUT shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of desired power.

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Non-Restricted Bands) Test Instrumentation

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	24 Jul 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Non-Restricted Bands) 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 (Non-Restricted Bands) 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 the transmitting frequency was set to lower channel.
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 middle and upper channel respectively.

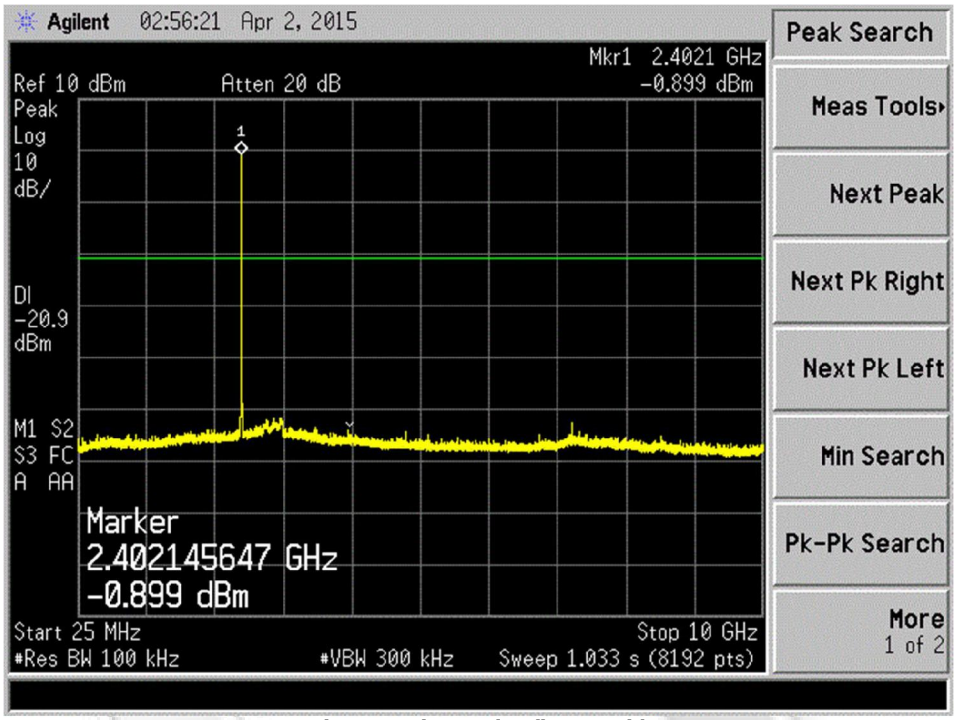
RF CONDUCTED SPURIOUS EMISSIONS (NON-RESTRICTED BANDS) TEST

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Non-Restricted Bands) Results

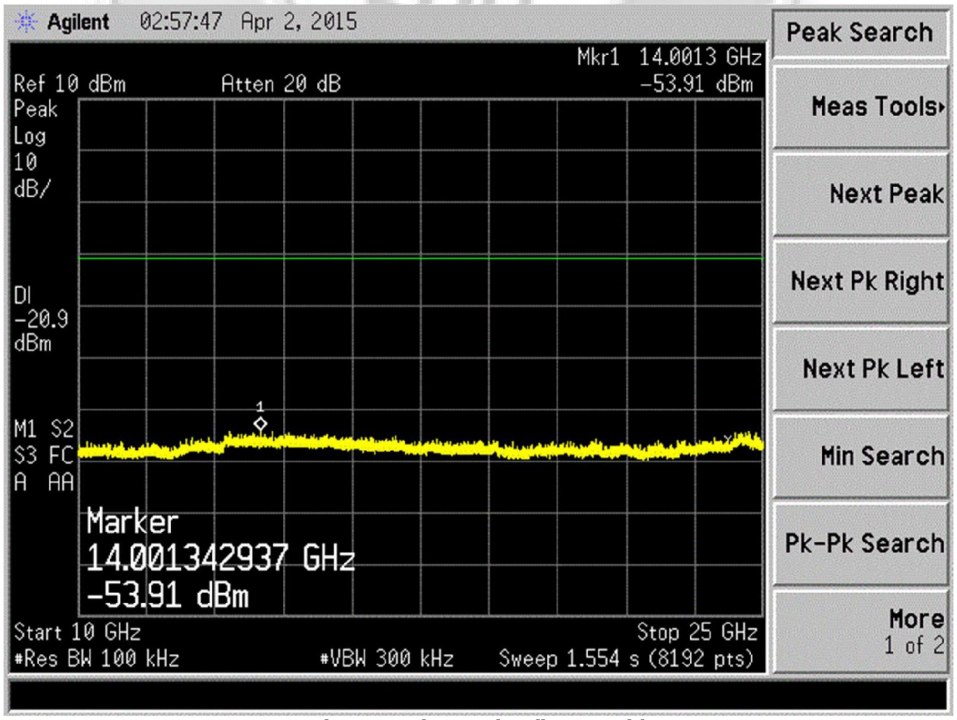
Test Input Power	3VDC	Temperature	22°C
Attached Plots	4 - 9	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

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

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots

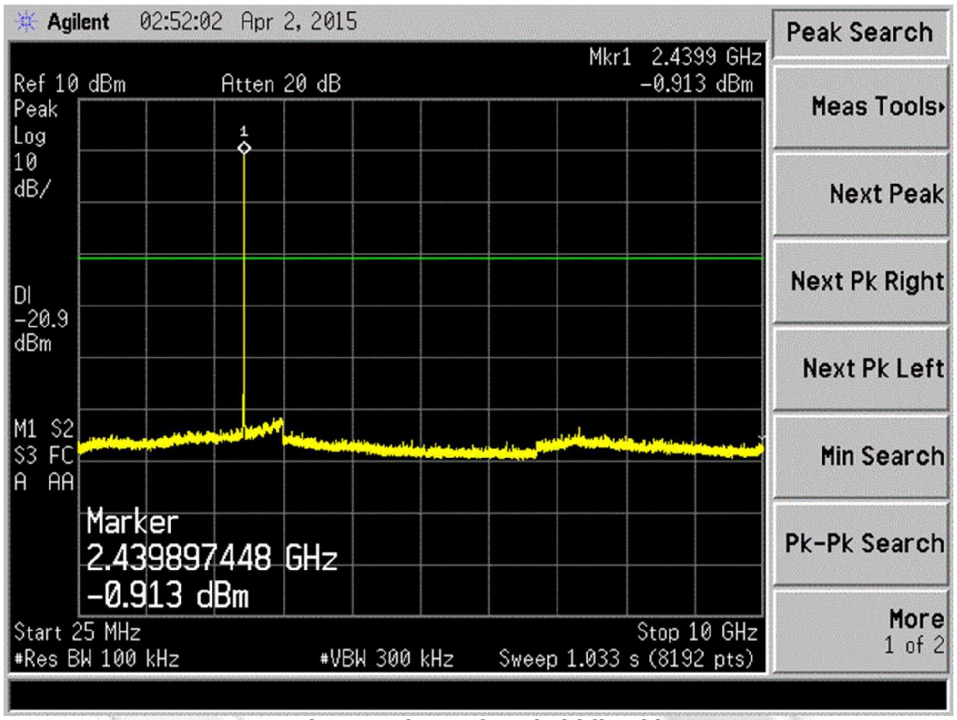


Plot 4 – Channel 0 *(lower ch)*

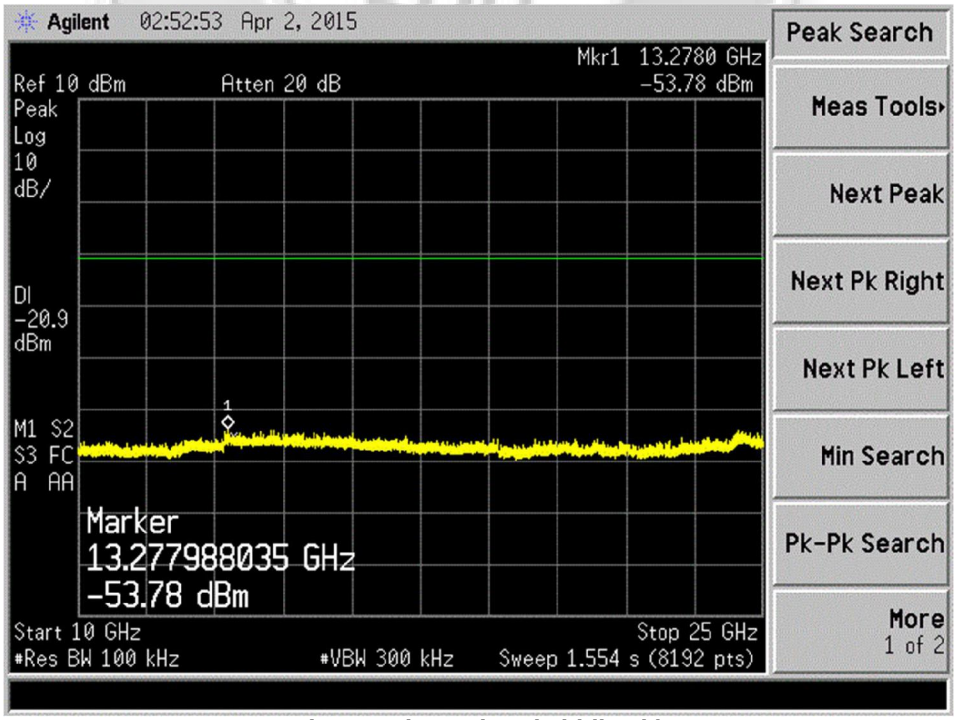


Plot 5 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots

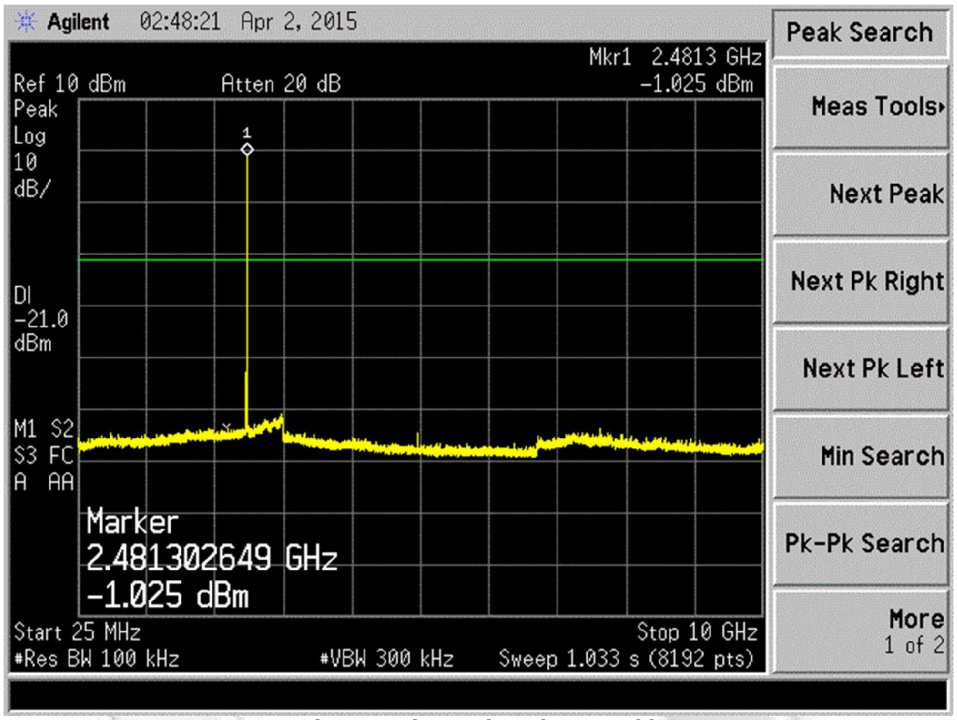


Plot 6 – Channel 19 *(middle ch)*

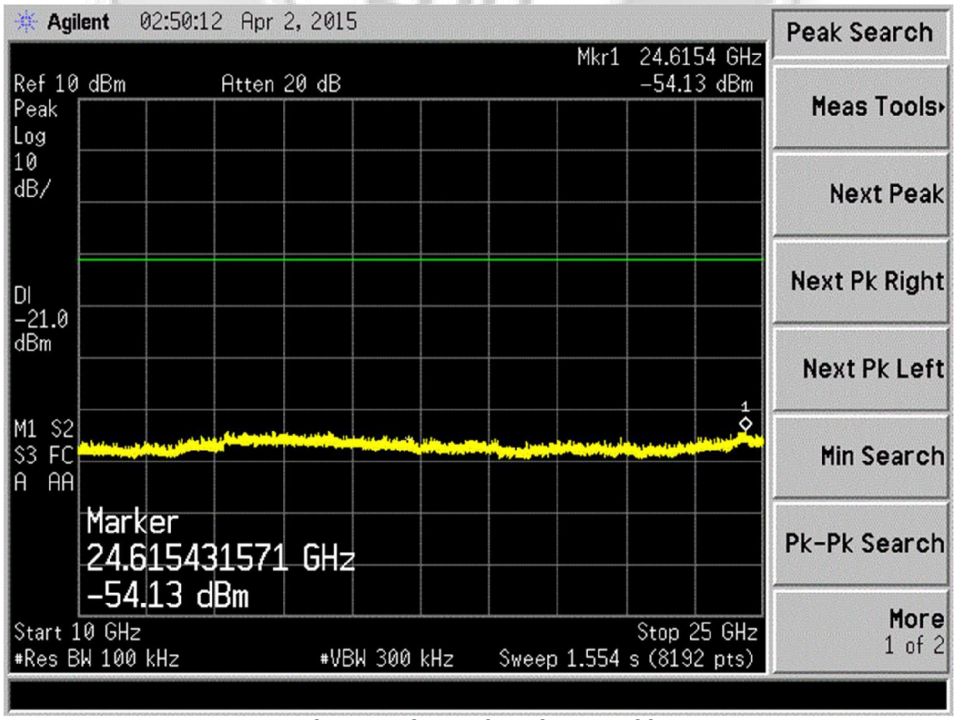


Plot 7 – Channel 19 *(middle ch)*

RF Conducted Spurious Emissions (Non-Restricted Bands) Plots



Plot 8 – Channel 39 *(upper ch)*



Plot 9 – Channel 39 *(upper ch)*

RF CONDUCTED SPURIOUS EMISSIONS (RESTRICTED BANDS) TEST

47 CFR FCC Part 15.205 Restricted Bands

MHz			MHz			MHz			GHz		
0.090	-	0.110	16.42	-	16.423	399.9	-	410	4.5	-	5.15
0.495	-	0.505	16.69475	-	16.69525	608	-	614	5.35	-	5.46
2.1735	-	2.1905	16.80425	-	16.80475	960	-	1240	7.25	-	7.75
4.125	-	4.128	25.5	-	25.67	1300	-	1427	8.025	-	8.5
4.17725	-	4.17775	37.5	-	38.25	1435	-	1626.5	9.0	-	9.2
4.20725	-	4.20775	73	-	74.6	1645.5	-	1646.5	9.3	-	9.5
6.215	-	6.218	74.8	-	75.2	1660	-	1710	10.6	-	12.7
6.26775	-	6.26825	108	-	121.94	1718.8	-	1722.2	13.25	-	13.4
6.31175	-	6.31225	123	-	138	2200	-	2300	14.47	-	14.5
8.291	-	8.294	149.9	-	150.05	2310	-	2390	15.35	-	16.2
8.362	-	8.366	156.52475	-	156.52525	2483.5	-	2500	17.7	-	21.4
8.37625	-	8.38675	156.7	-	156.9	2690	-	2900	22.01	-	23.12
8.41425	-	8.41475	162.0125	-	167.17	3260	-	3267	23.6	-	24.0
12.29	-	12.293	167.72	-	173.2	3332	-	3339	31.2	-	31.8
12.51975	-	12.52025	240	-	285	3345.8	-	3358	36.43	-	36.5
12.57675	-	12.57725	322	-	335.4	3600	-	4400	Above 38.6		
13.36	-	13.41									

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Restricted Bands) Limits

The EUT shows compliance to the requirements of this section, which states that emissions which fall in the restricted bands must comply with the radiated emission limits specified in the table below:

Frequency Range (MHz)	EIRP (dBm)	Radiated Emissions (dBµV/m)
0.009 – 0.490	-6.7 – (-41.4) **	67.6 – 20logF* @ 300m **
0.490 – 1.705	-41.4 – (-52.3) **	87.6 – 20logF* @ 30m **
1.705 – 30	-45.7	29.5 @ 30m
30 - 88	-55.2	40.0 @ 3m
88 - 216	-51.7	43.5 @ 3m
216 - 960	-49.2	46.0 @ 3m
>960	-41.2 ***	54.0 @ 3m ***
* F is frequency in kHz.		
** Decreasing linearly with the logarithm of the frequency.		
*** Above 1GHz, a peak limit of 20dB above the average limit does apply.		

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

Instrument	Model	S/No	Cal Due Date
Agilent Spectrum Analyzer	E7405A	MY45106084	24 Jul 2015
Agilent DC Power Supply	E3620A	MY40000448	Output Monitor

47 CFR FCC Part 15.247(d) RF Conducted Spurious Emissions (Restricted Bands) 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) of the spectrum analyser was set to the following settings. The video bandwidth (VBW) was set to at least three times of the RBW.

Frequency (MHz)	RBW (kHz)
0.009 – 0.150	0.2
0.150 – 30.0	9.0
30.0 - 1000	100.0
> 1000	1000.0

5. The detector of the spectrum analyser was set to peak detection mode.
6. All other supporting equipment were powered separately from another filtered mains.

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

1. Measurement in the range 9kHz – 1000MHz

1.1 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 the transmitting frequency was set to lower channel.
1.2 The start and stop frequencies of the spectrum analyser were set according to the supported RBW.
1.3 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.
1.4 No further measurement was required if all the captured emissions complied to the limits. Else, the spectrum analyser was set to zoom to the captured emission with the detector of the spectrum analyser was set to quasi-peak. The emission level of the captured frequency was measured.
1.5 The step 1.4 was repeated until all the captured emissions which exceeding the limits were measured.
1.6 The steps 1.2 to 1.5 were repeated with the transmitting frequency was set to middle and upper channel respectively.

2. Measurement above 1000MHz

2.1 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 the transmitting frequency was set to lower channel.
2.2 The start and stop frequencies of the spectrum analyser were set according to the supported frequency band of the set RBW with the number of points in a sweep was set to equal or greater than 2 times of the ratio of span over RBW.
2.3 The detector of the spectrum analyser was set to power average (RMS) mode with the sweep time was set to equal or greater than 10 times of the product of number of measurement points in a sweep and transmission symbol time.
2.4 The spectrum analyser was then allowed to capture any spurious emissions within a single sweep. The peak marker function of the spectrum analyser was used to locate the highest power level.
2.5 The steps 2.2 to 2.4 were repeated until all the required frequency bands were measured.
2.6 The steps 2.2 to 2.5 were repeated with the transmitting frequency was set to middle and upper channel respectively.
2.7 The measurements were repeated with the detector of the spectrum analyser was set to peak detecting mode. The sweep time was set to auto coupler.

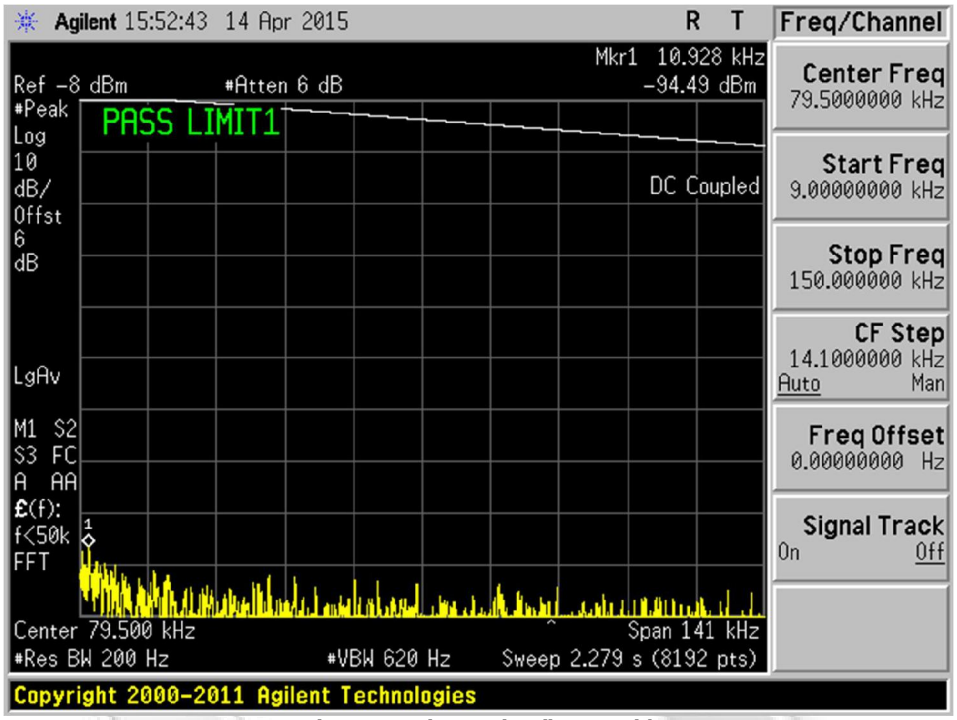
RF CONDUCTED SPURIOUS EMISSIONS (RESTRICTED BANDS) TEST

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

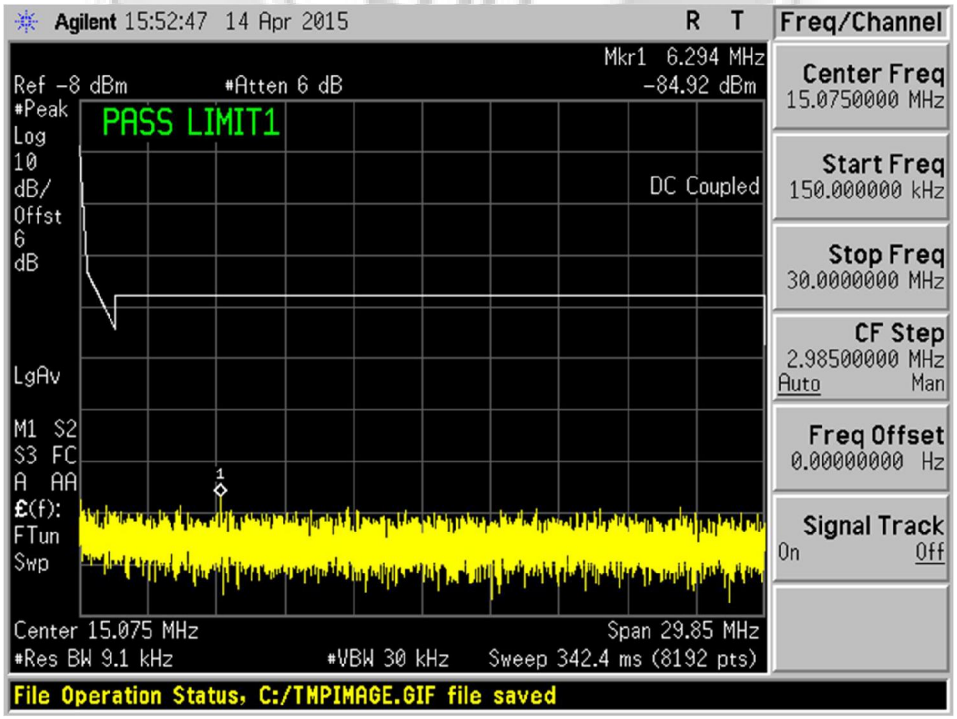
Test Input Power	3VDC	Temperature	22°C
Attached Plots	10 - 35	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

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

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

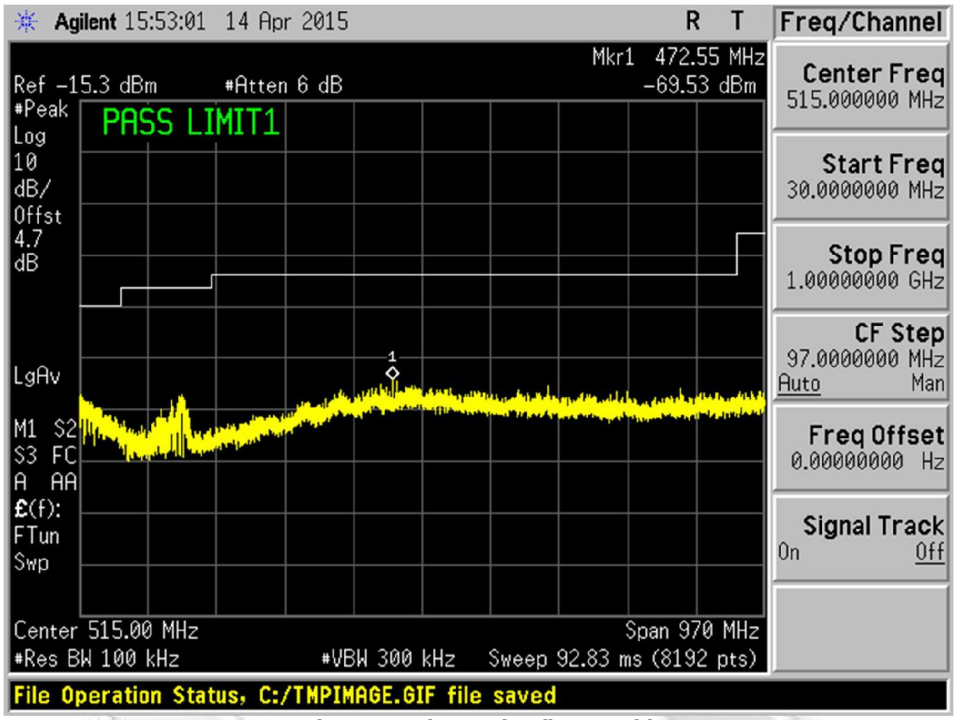


Plot 10 – Channel 0 *(lower ch)*

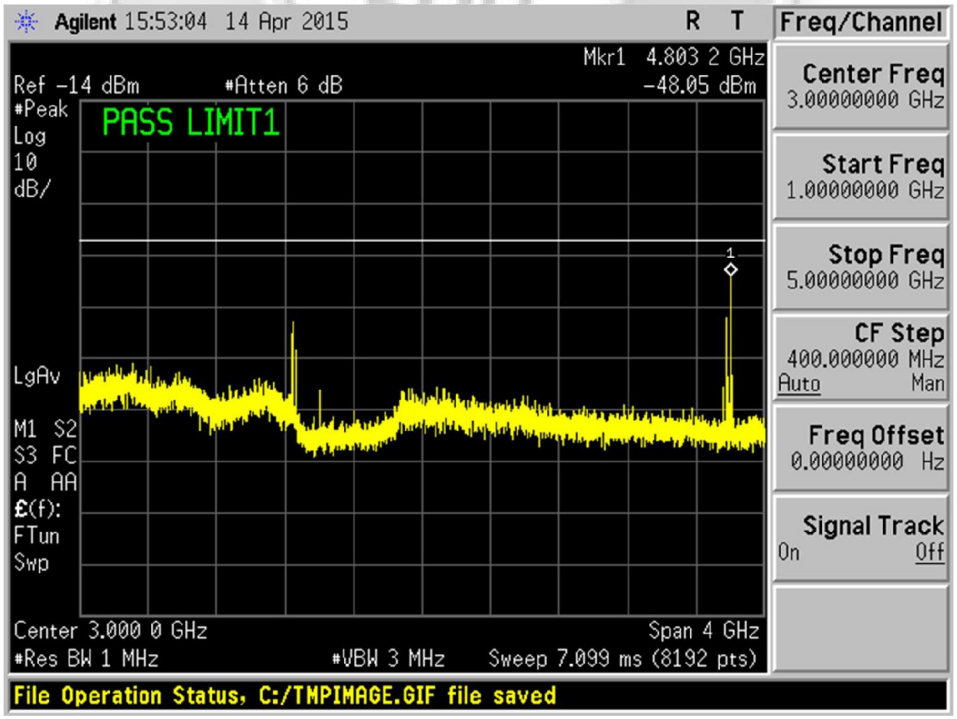


Plot 11 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

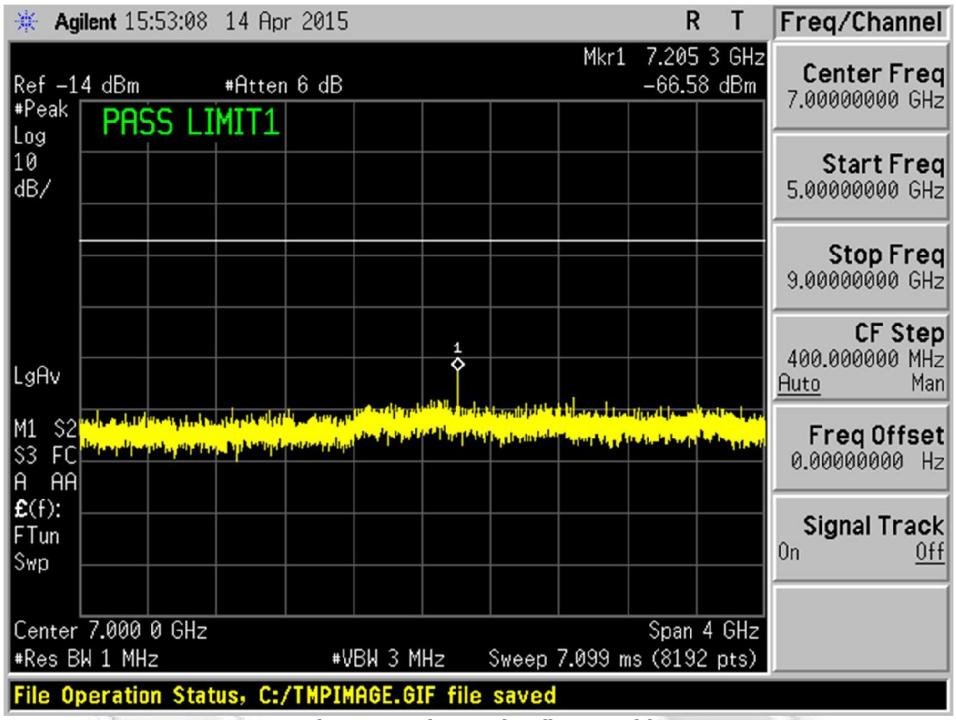


Plot 12 – Channel 0 *(lower ch)*

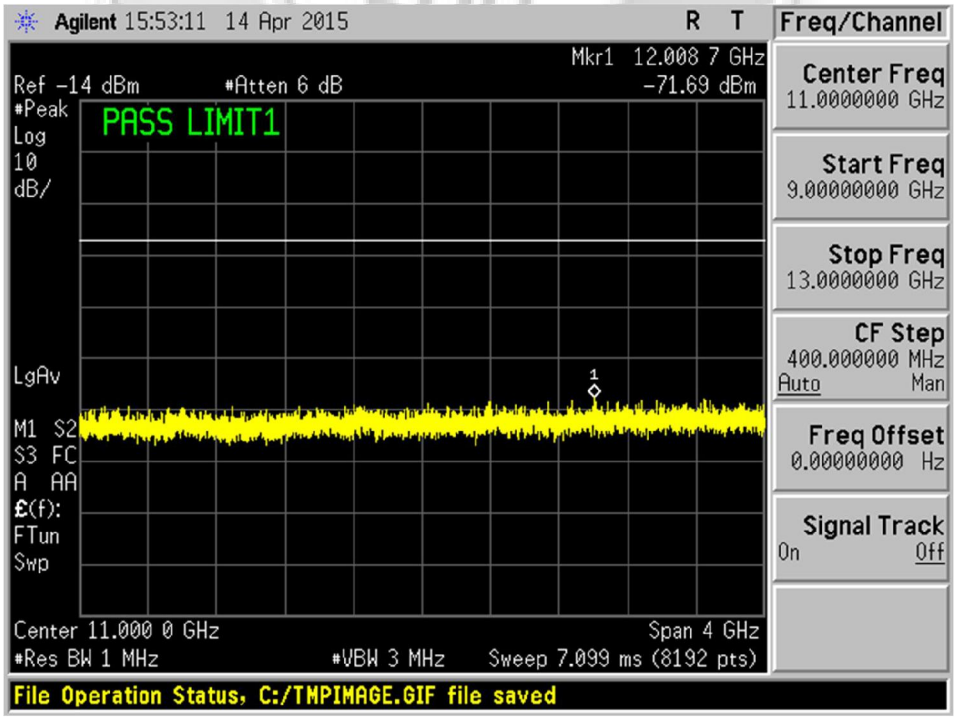


Plot 13 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

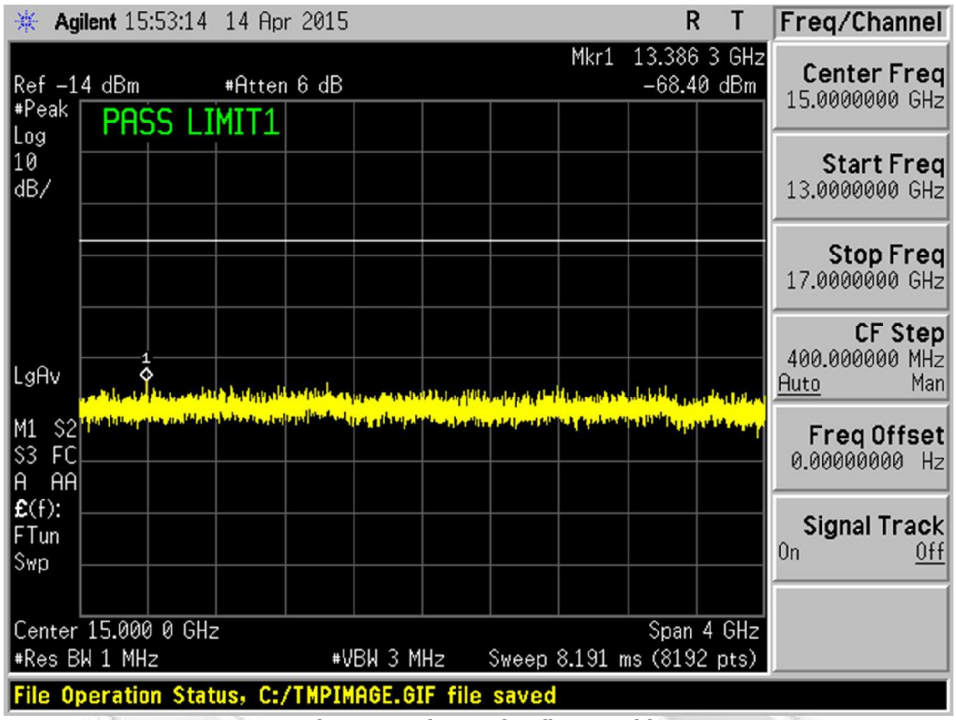


Plot 14 – Channel 0 *(lower ch)*

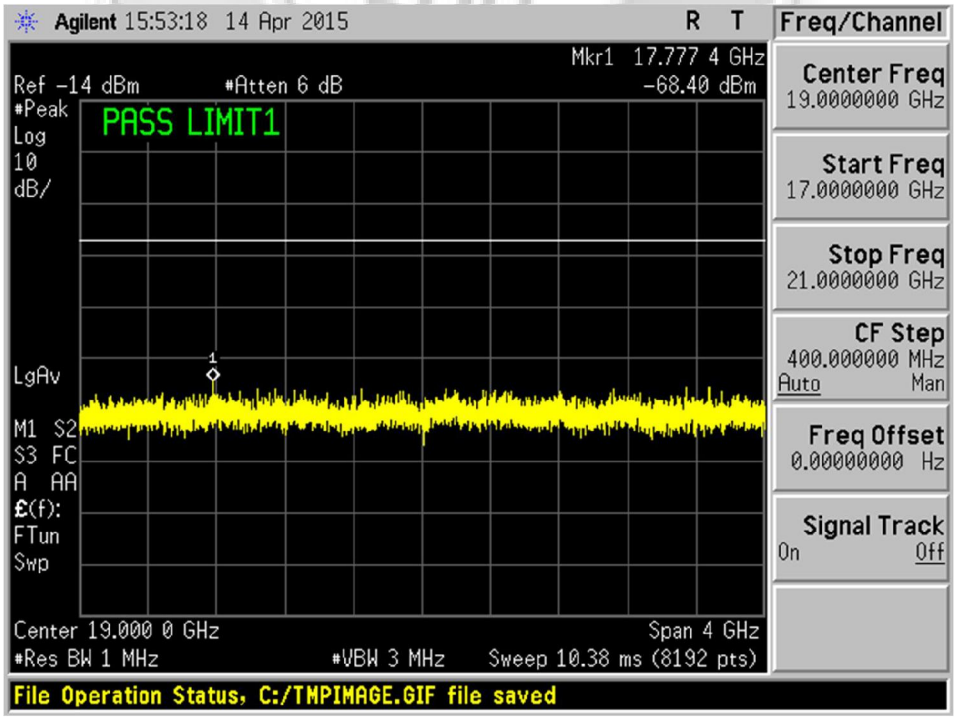


Plot 15 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

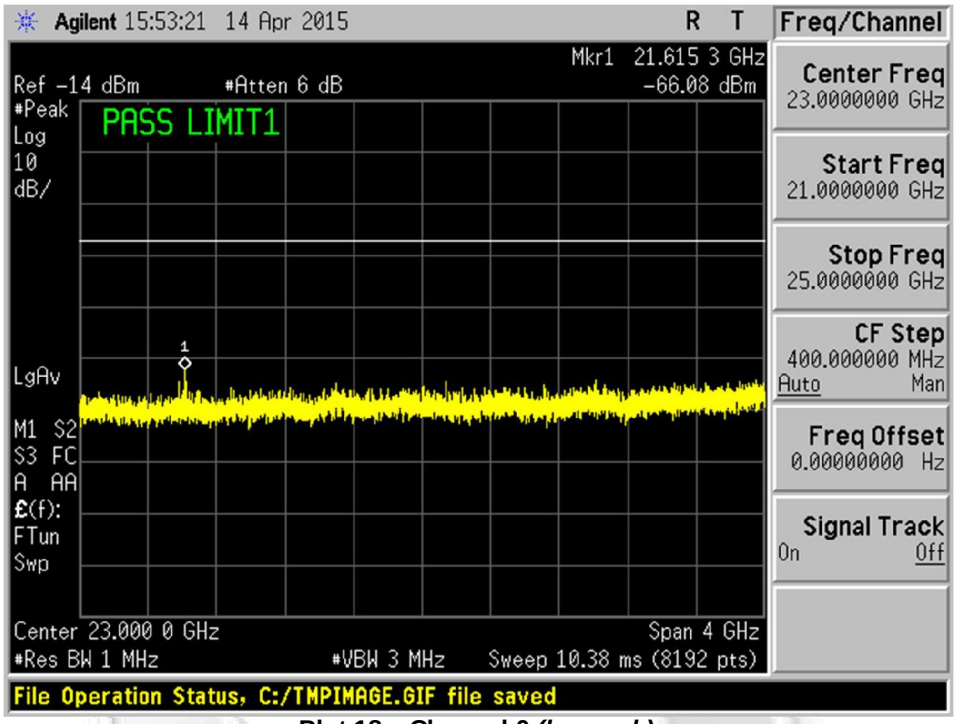


Plot 16 – Channel 0 *(lower ch)*



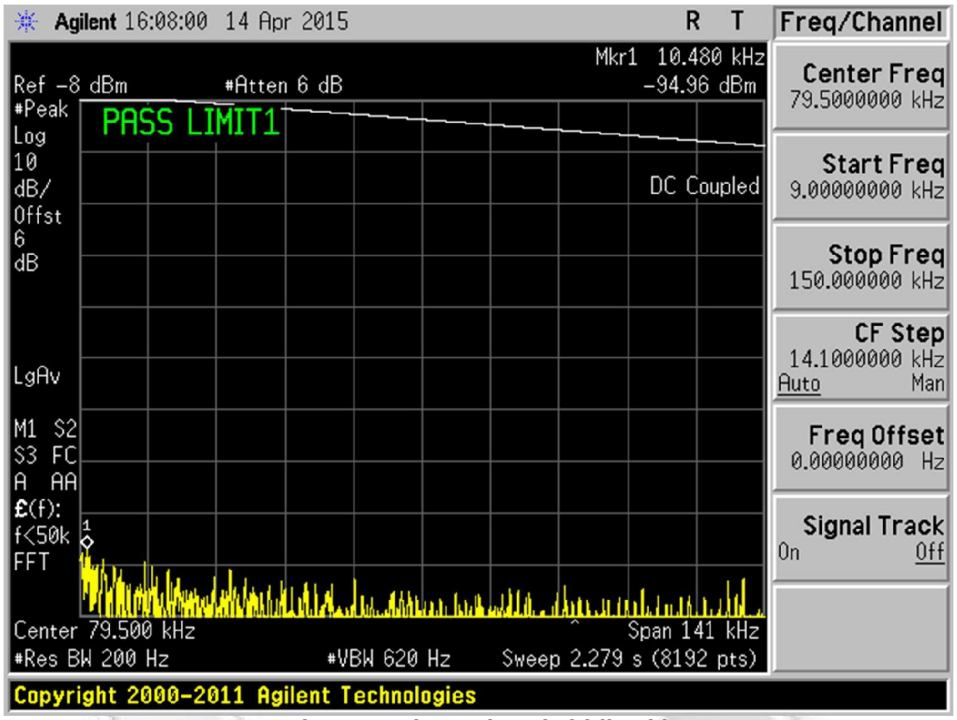
Plot 17 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

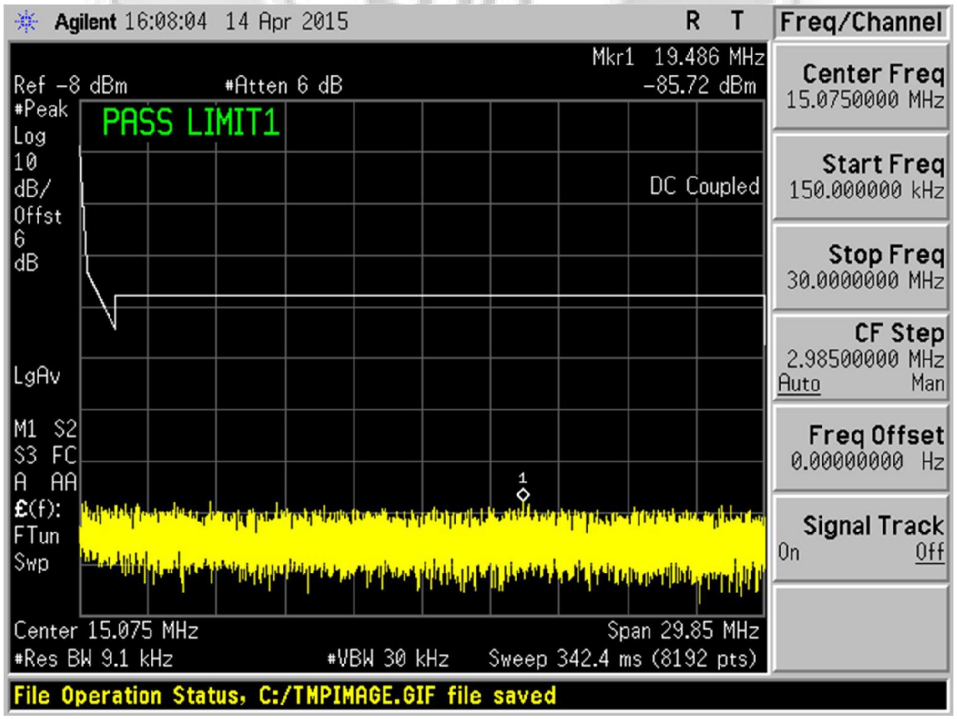


Plot 18 – Channel 0 *(lower ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

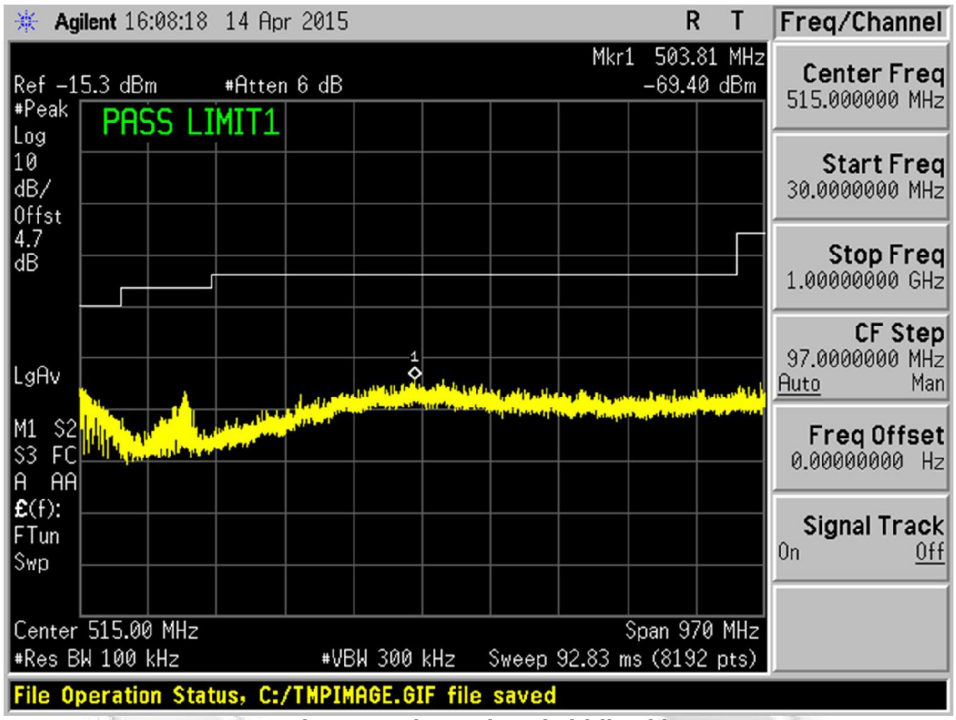


Plot 19 – Channel 19 *(middle ch)*

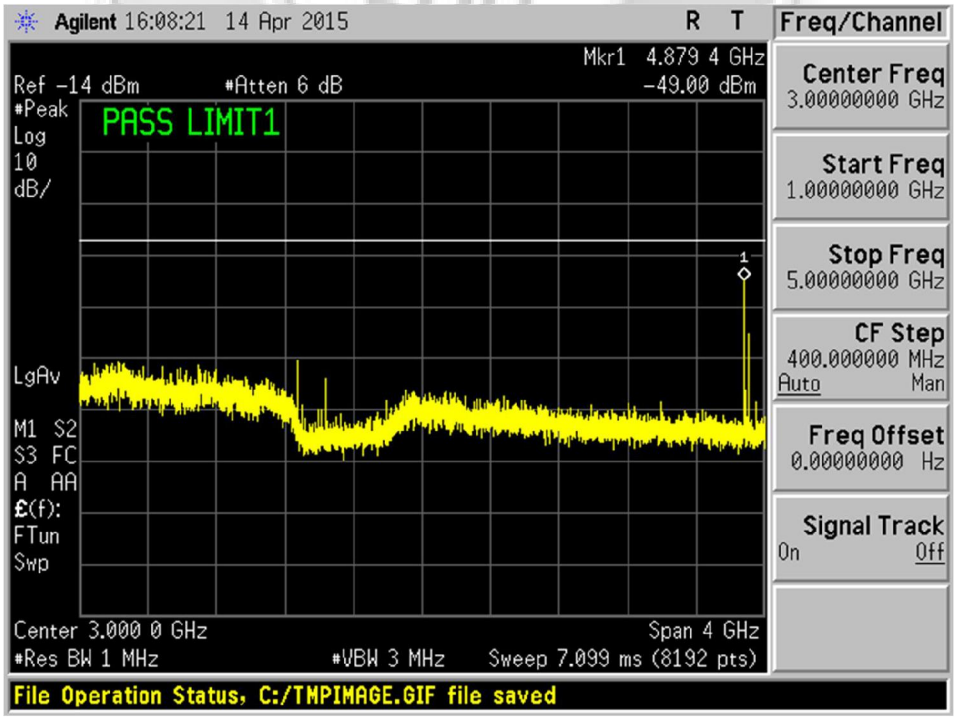


Plot 20 – Channel 19 *(middle ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

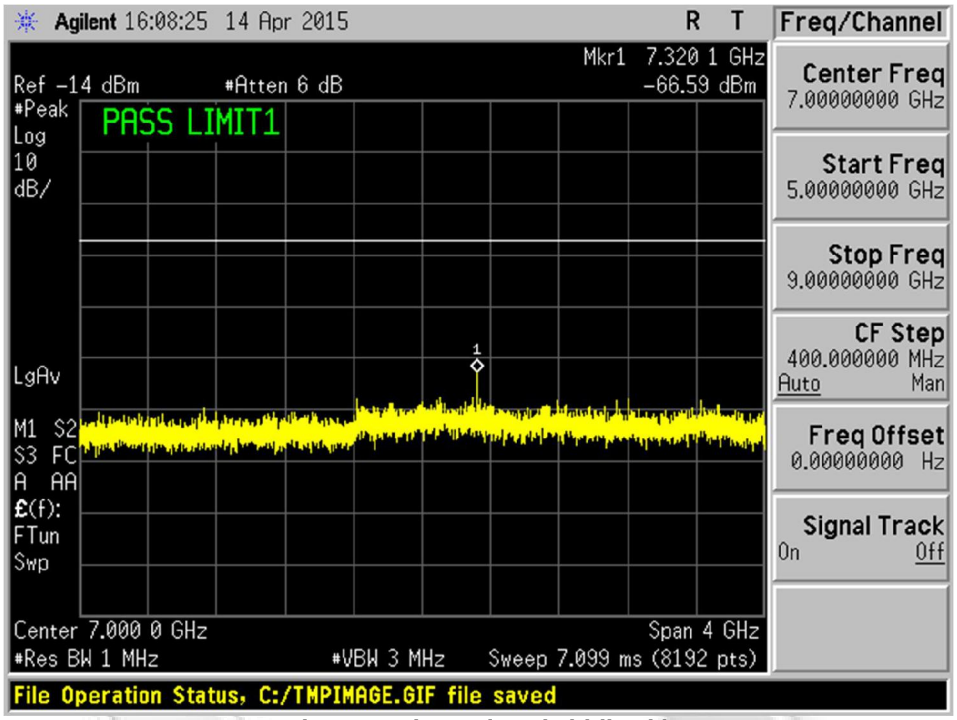


Plot 21 – Channel 19 *(middle ch)*

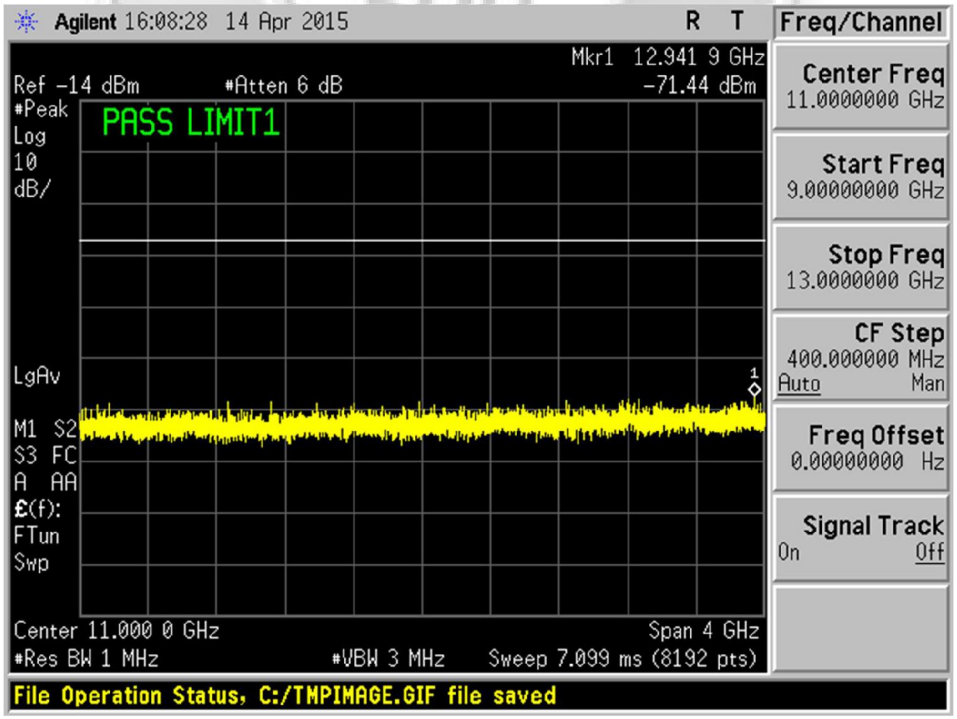


Plot 22 – Channel 19 *(middle ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

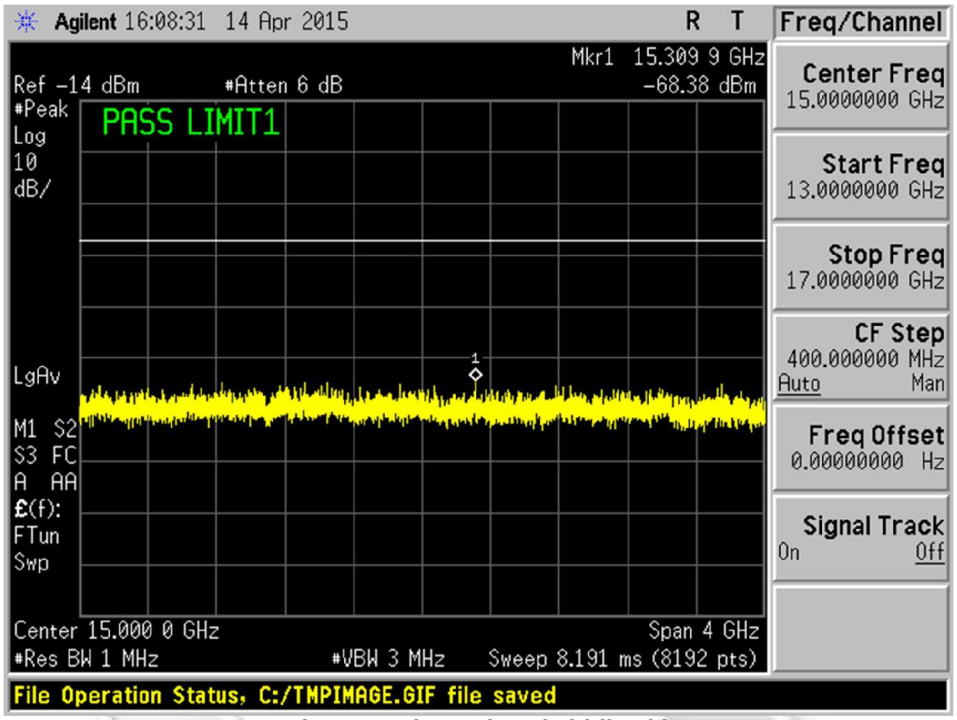


Plot 23 – Channel 19 *(middle ch)*

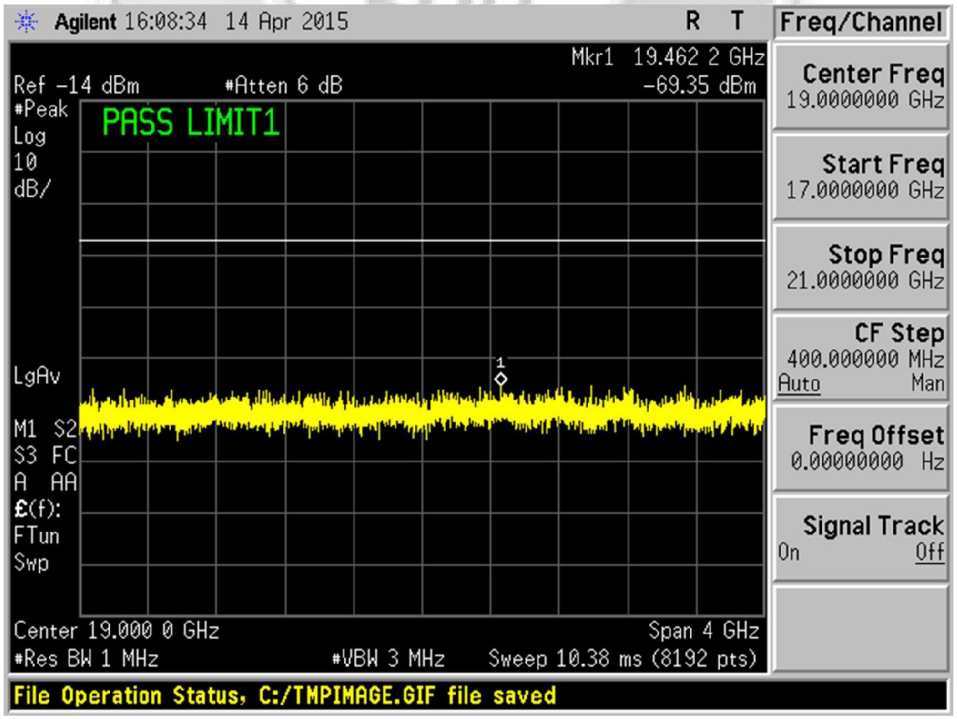


Plot 24 – Channel 19 *(middle ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

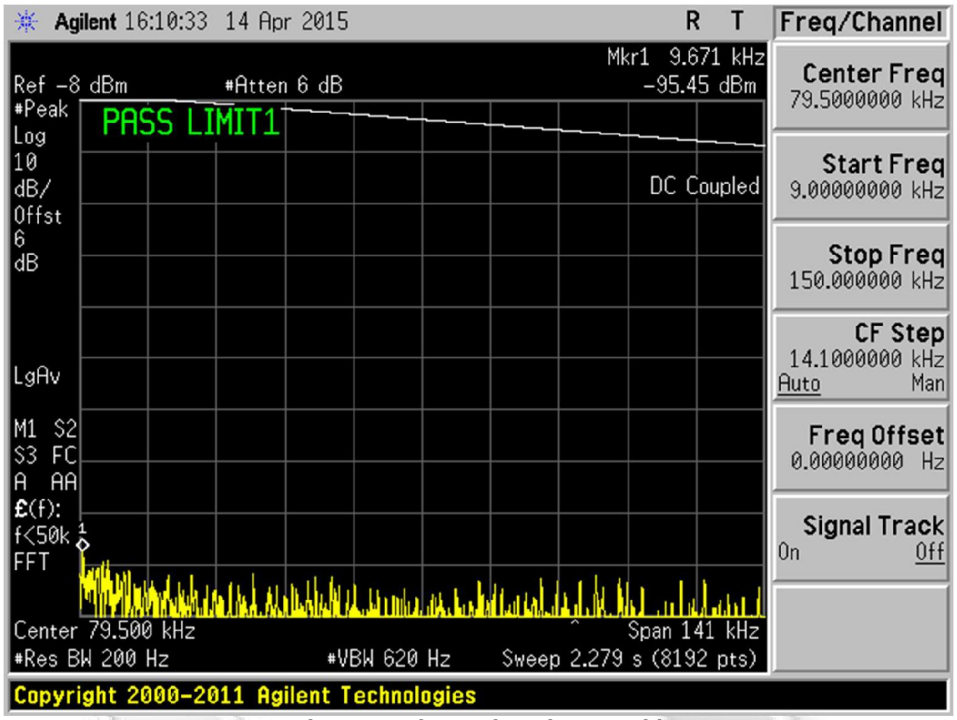


Plot 25 – Channel 19 *(middle ch)*

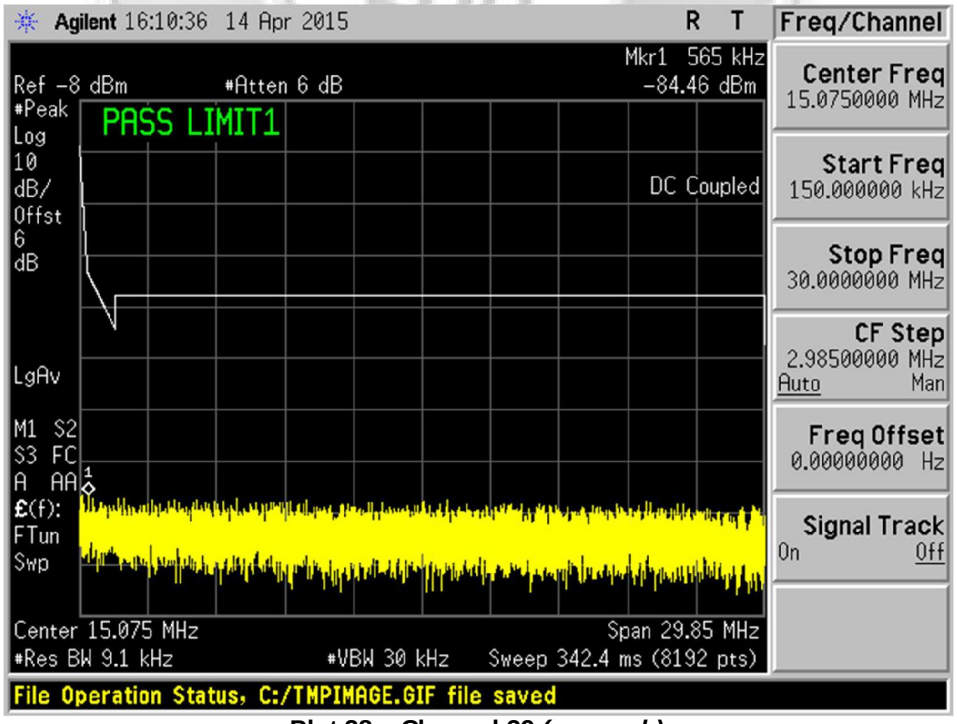


Plot 26 – Channel 19 *(middle ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

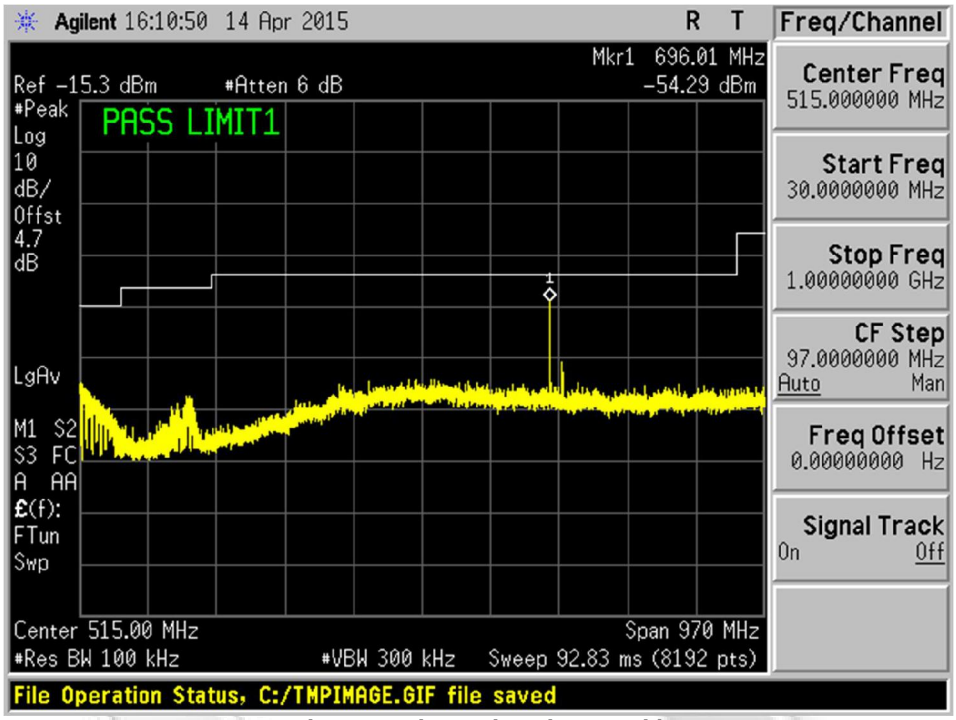


Plot 27 – Channel 39 *(upper ch)*

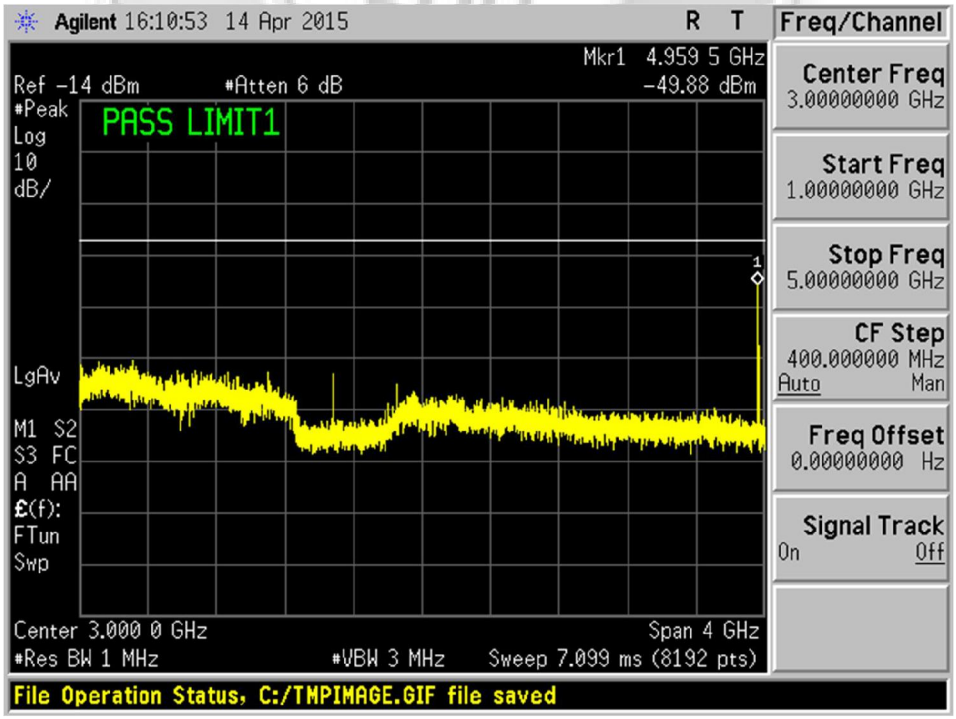


Plot 28 – Channel 39 *(upper ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

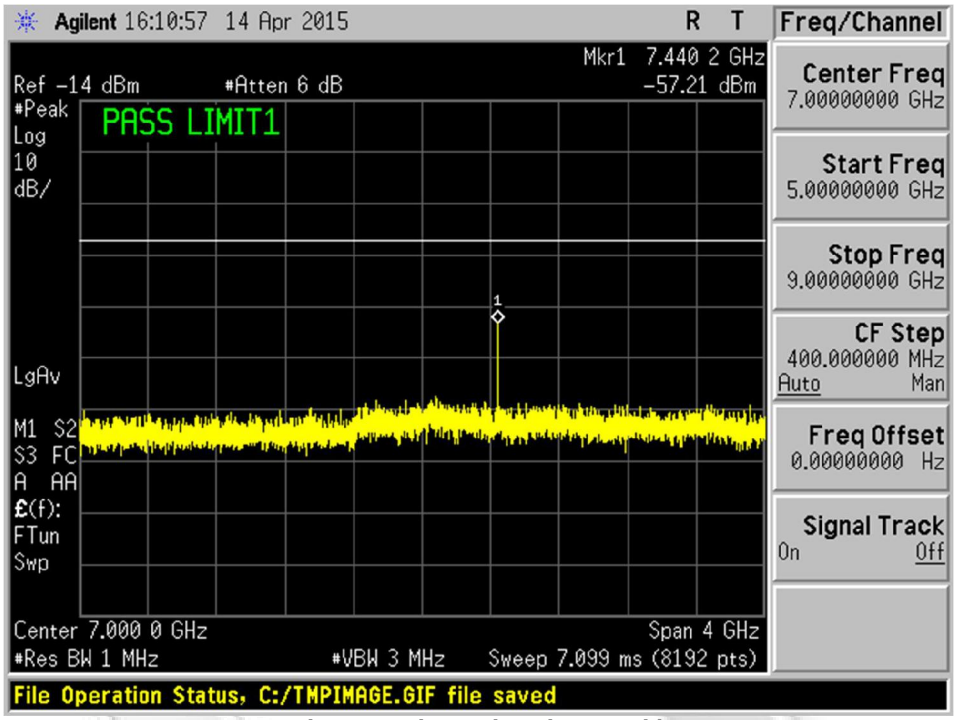


Plot 29 – Channel 39 *(upper ch)*

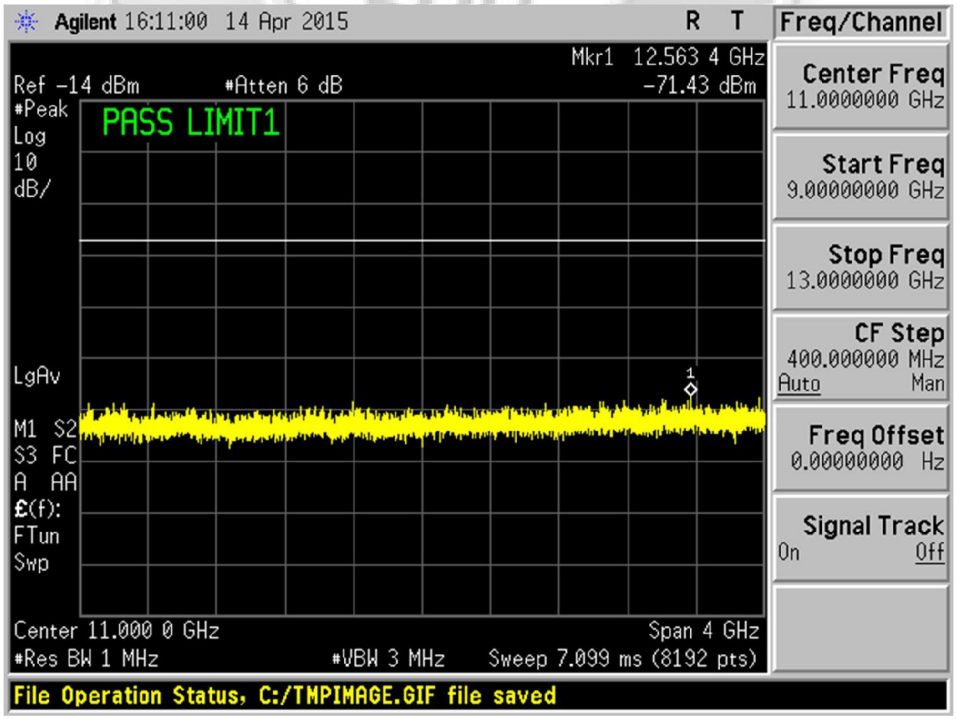


Plot 30 – Channel 39 *(upper ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

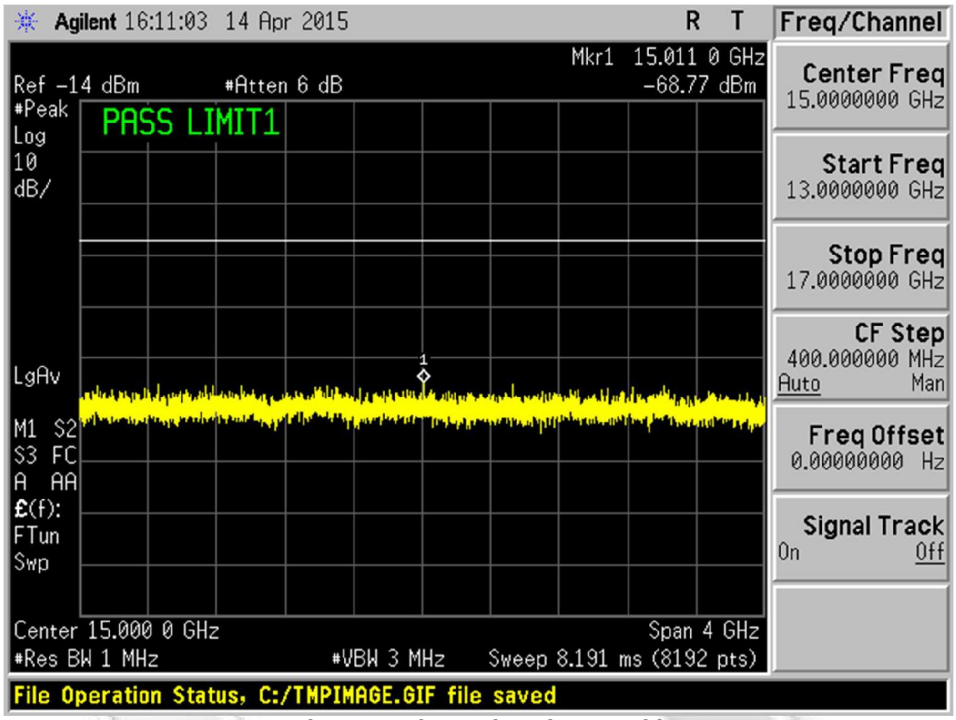


Plot 31 – Channel 39 *(upper ch)*

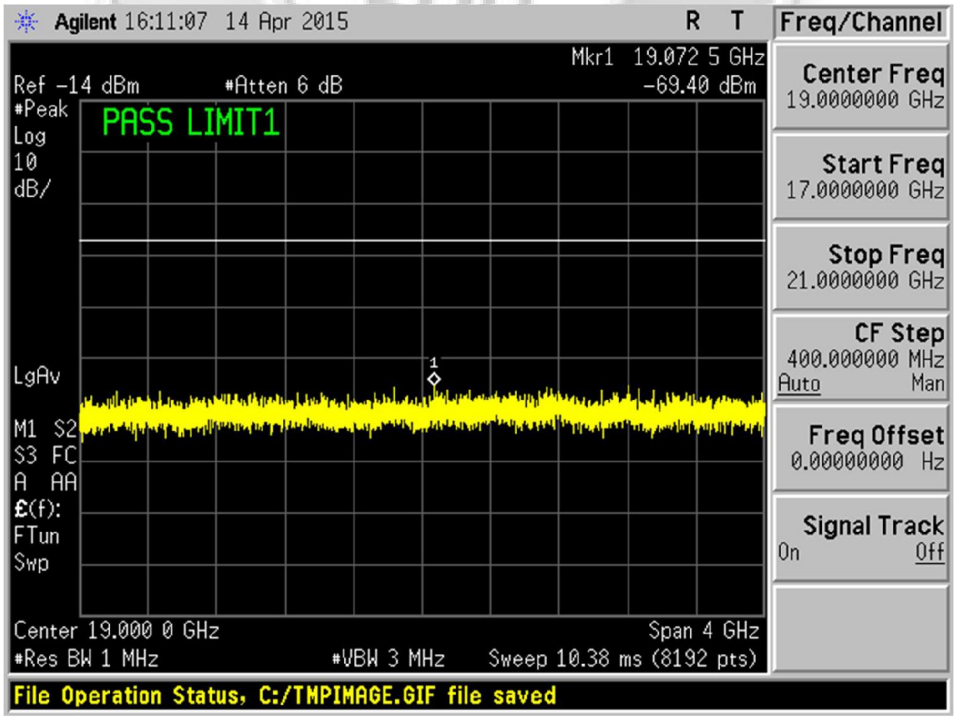


Plot 32 – Channel 39 *(upper ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak

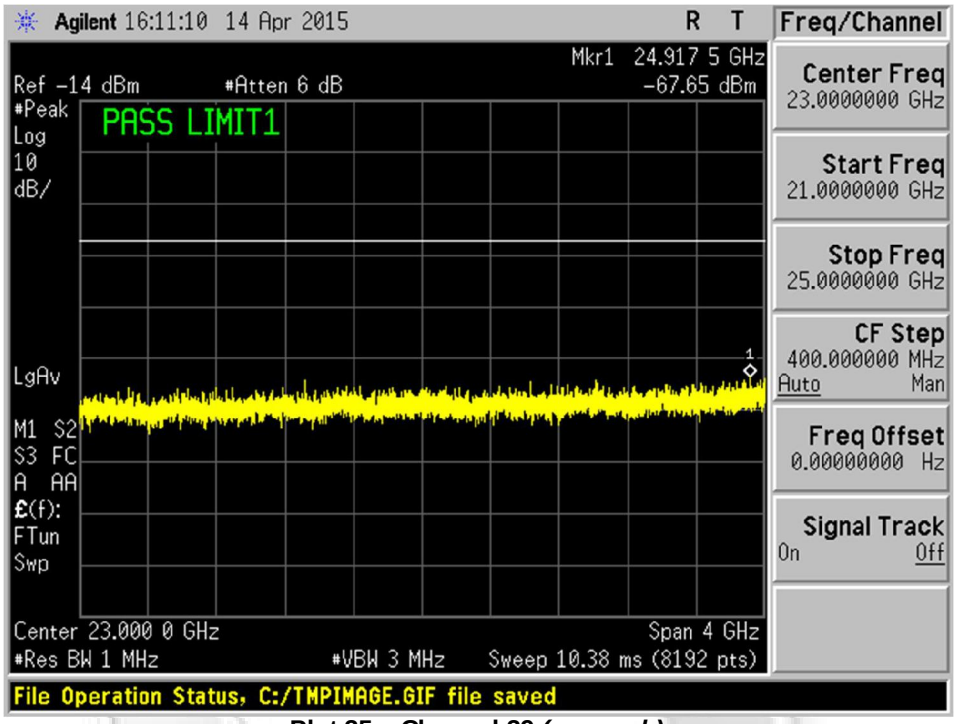


Plot 33 – Channel 39 *(upper ch)*



Plot 34 – Channel 39 *(upper ch)*

RF Conducted Spurious Emissions (Restricted Bands) Plots – Peak



Plot 35 – Channel 39 *(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	E7405A	MY45106084	24 Jul 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

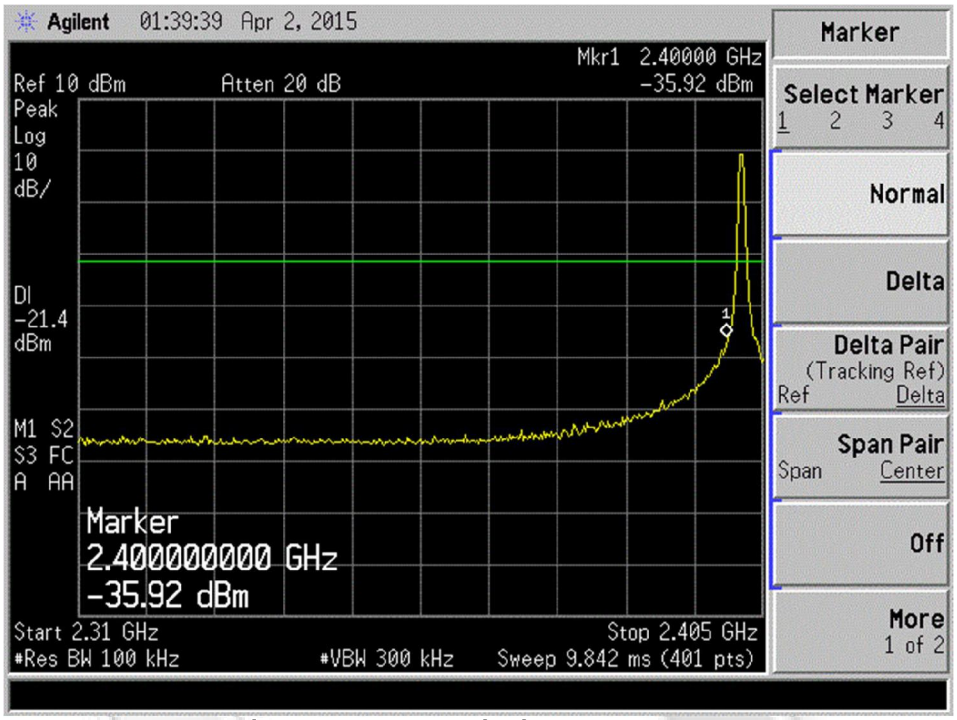
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions 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

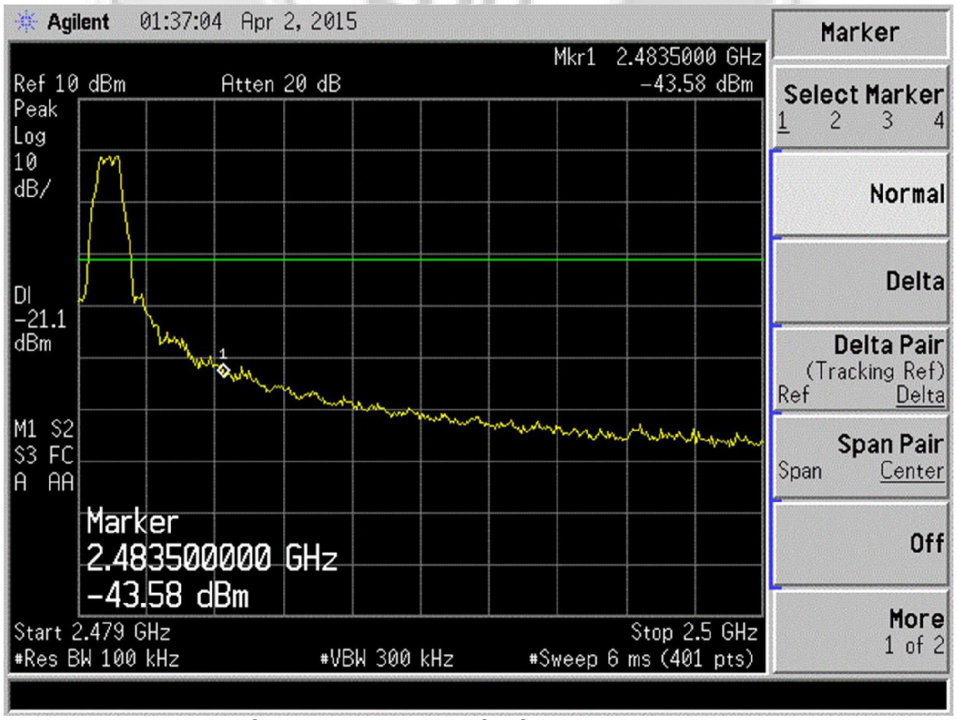
Test Input Power	3VDC	Temperature	22°C
Attached Plots	36 - 37	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

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

Band Edge Compliance (Conducted) Plots



Plot 36 – Lower Band Edge at 2.4000GHz



Plot 37 – 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
TDK-RF Horn Antenna	HRN-0118	130256	10 Jul 2015
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

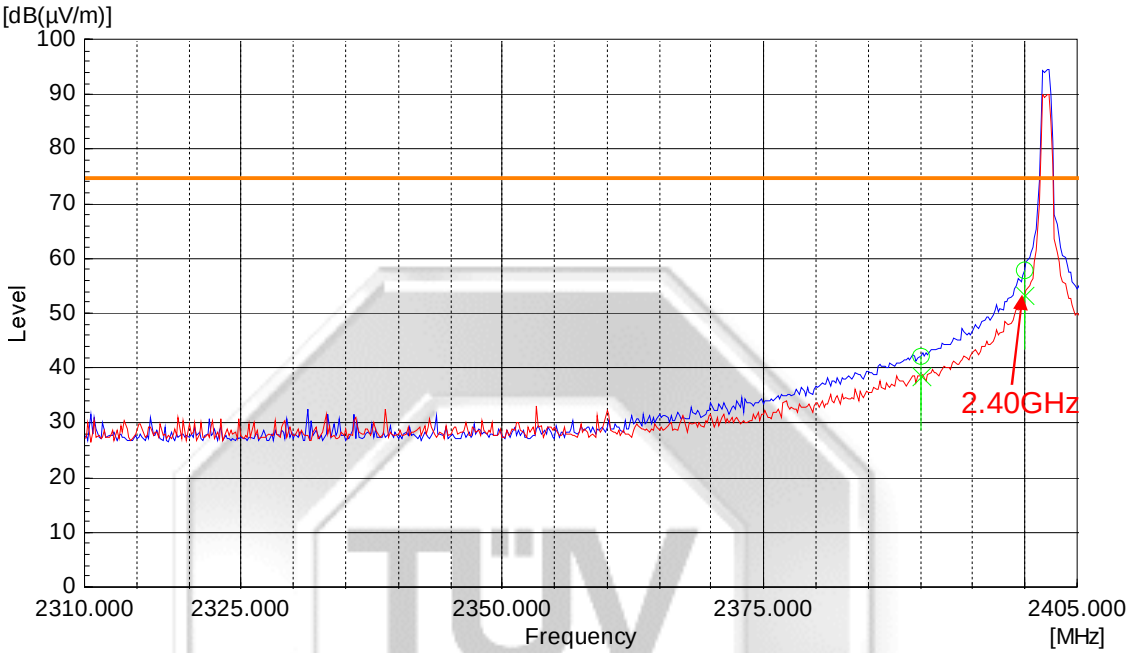
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode.
2. The frequency span of the spectrum analyser was set to wide enough to capture the lower band edge of the transmission band, 2.400GHz and any spurious emissions 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

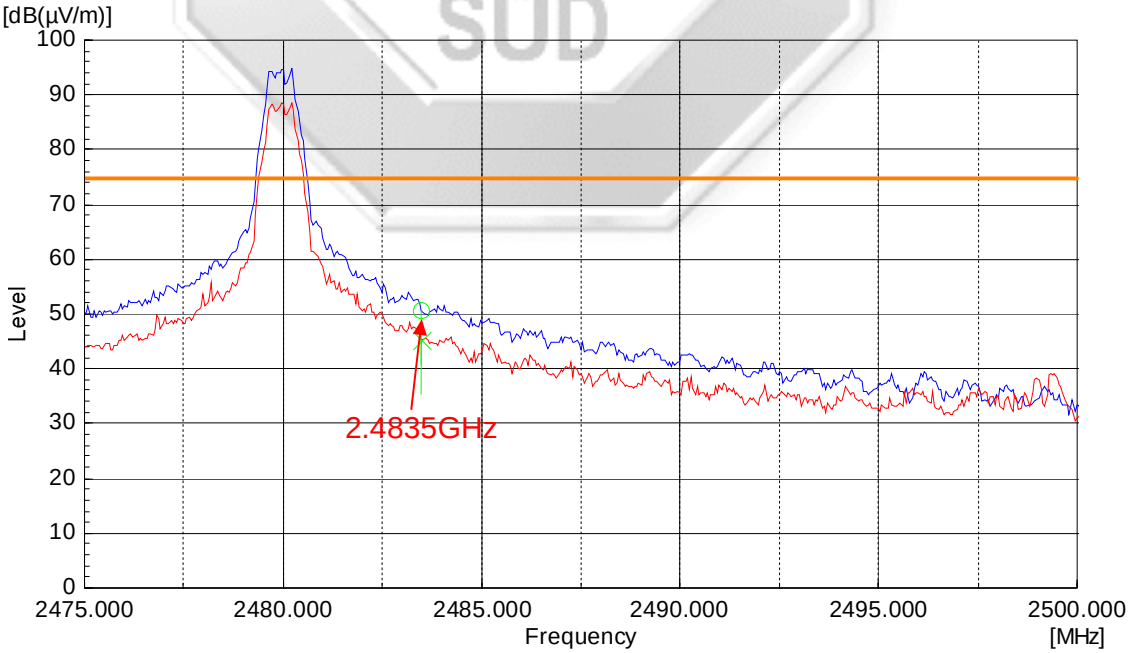
Test Input Power	3VDC	Temperature	28°C
Attached Plots	38 - 43	Relative Humidity	59%
		Atmospheric Pressure	1030mbar
		Tested By	Lim Kay Tak

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

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

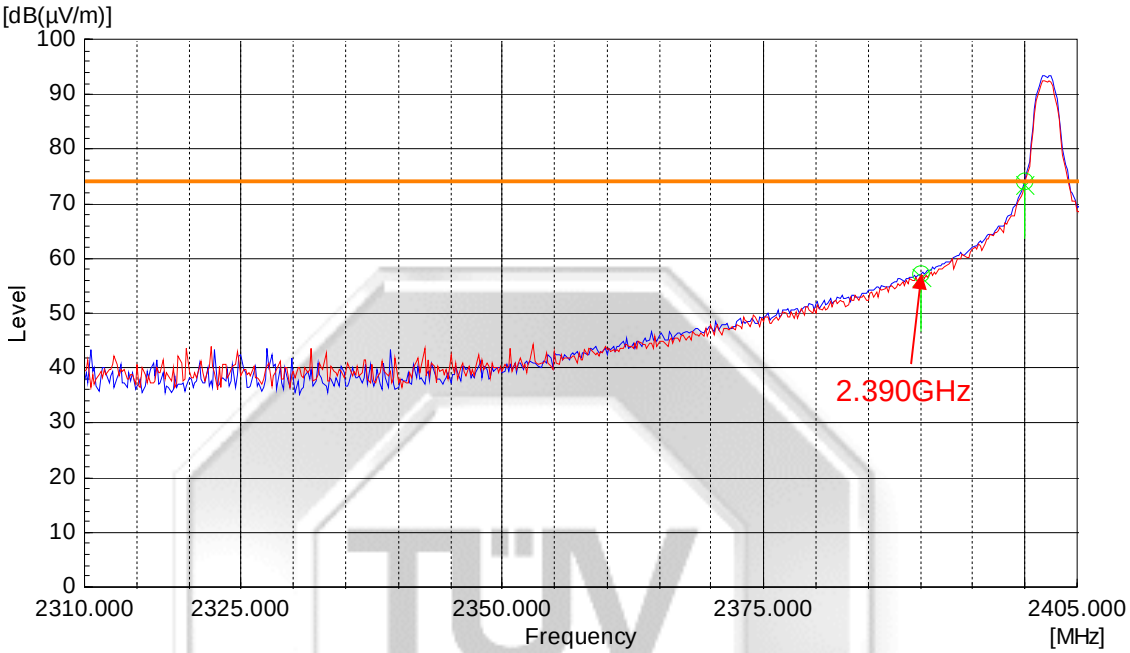


Plot 38 – Lower Band Edge at 2.4000GHz

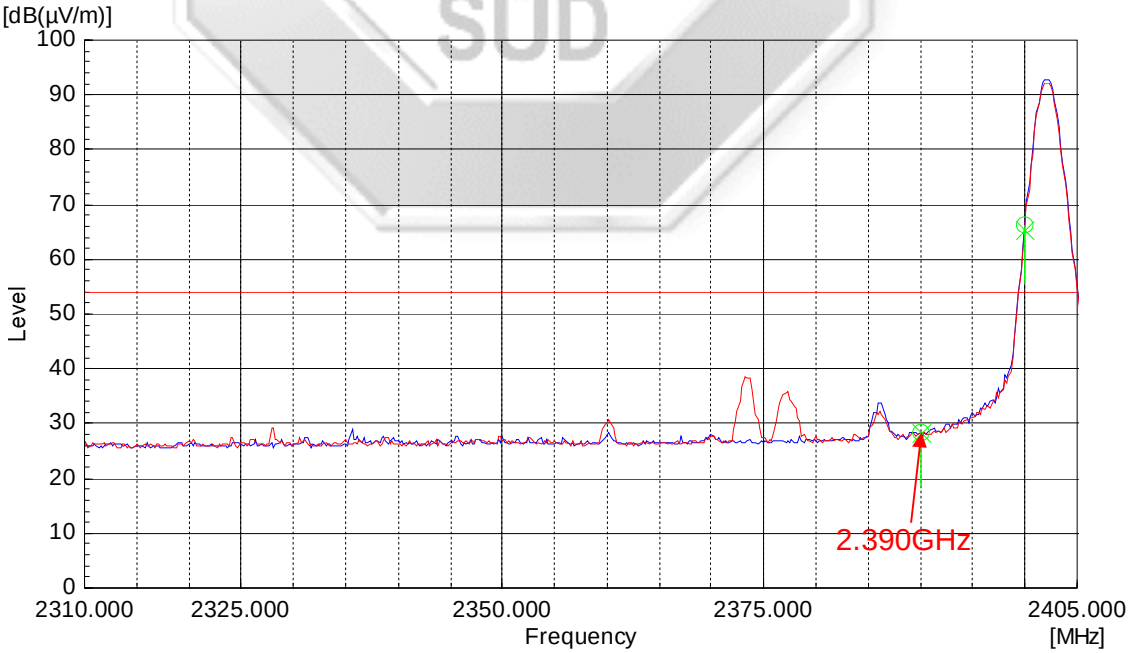


Plot 39 – Upper Band Edge at 2.4835GHz

Band Edge Compliance (Radiated) Plots (Restricted Band)

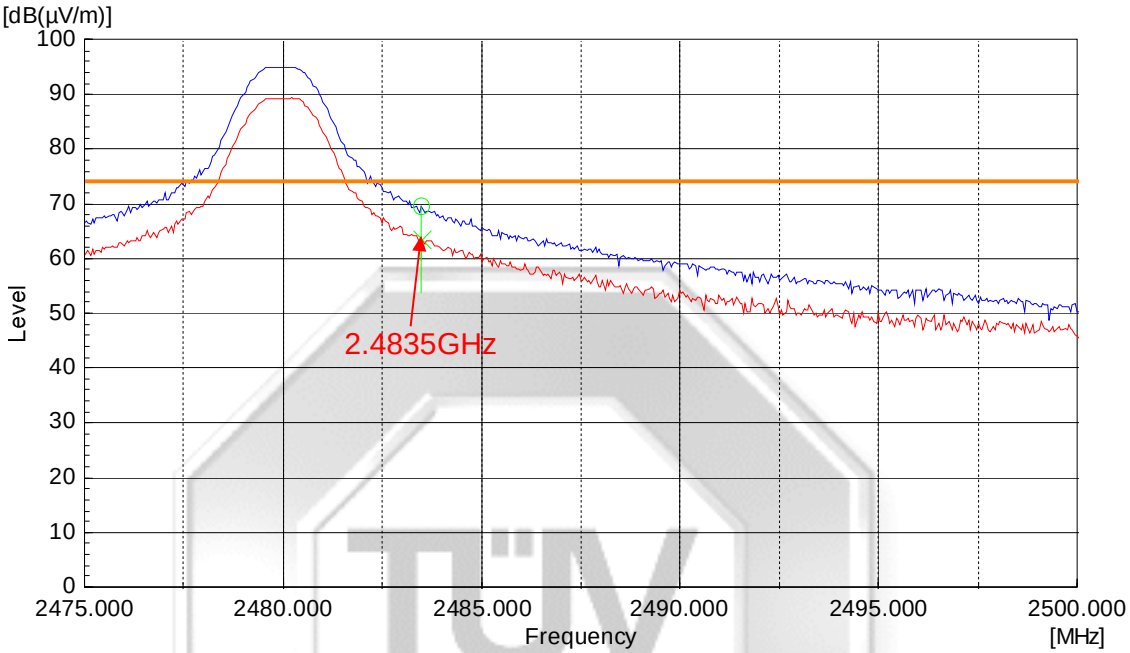


Plot 40 – Peak Plot at Lower Band Edge at 2.4000GHz

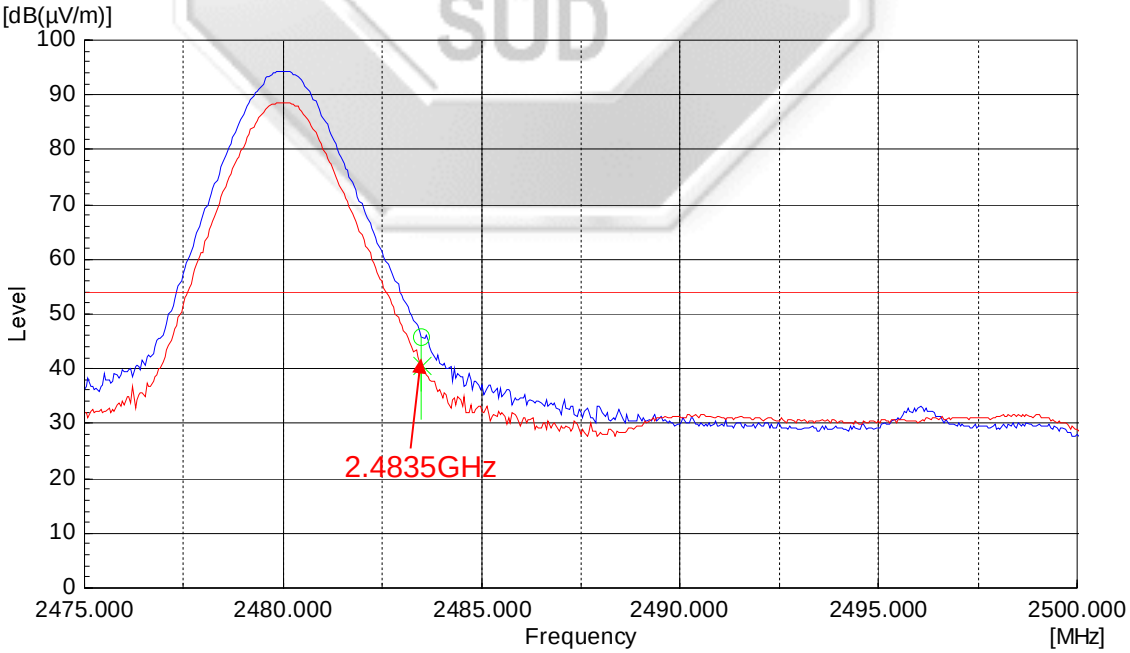


Plot 41 – Average Plot at Lower Band Edge at 2.4000GHz

Band Edge Compliance (Radiated) Plots (Restricted Band)



Plot 42 – Peak Plot at Upper Band Edge at 2.4835GHz



Plot 43 – 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	E7405A	MY45106084	24 Jul 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), video bandwidth (VBW) and span of the spectrum analyser were set to the following:
   RBW = 3kHz
   VBW = 9kHz
   Span = 1.5 times the channel bandwidth
   Sweep time = auto couple
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

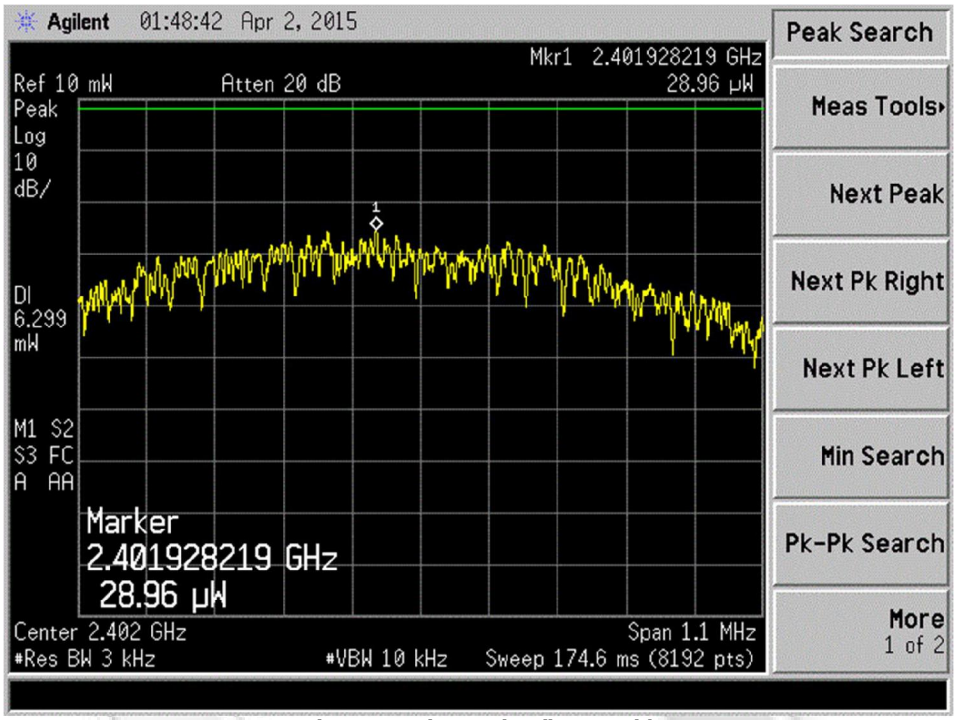
1. The EUT was switched on and allowed to warm up to its normal operating condition. The EUT was then configured to operate in the test mode at lower channel.
2. The peak of the transmitting frequency was detected with the marker peak function of the spectrum analyser.
3. The peak power density of the transmitting frequency was plotted and recorded.
4. The steps 2 to 3 were repeated with the transmitting frequency was set to middle and upper channel respectively.

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

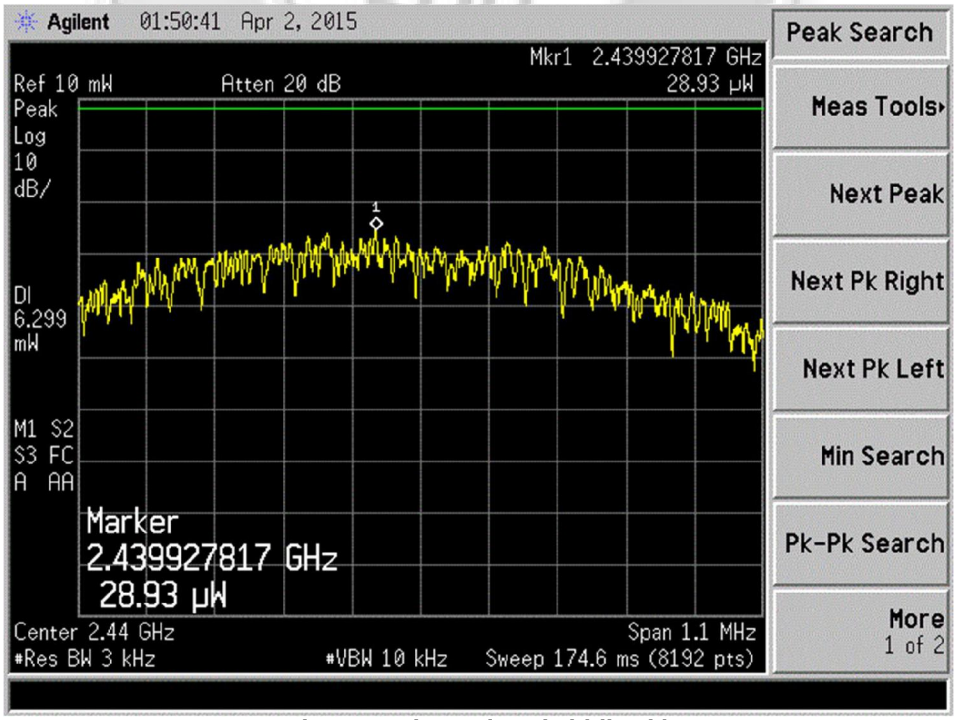
Test Input Power	3VDC	Temperature	22°C
Attached Plots	44 - 46	Relative Humidity	52%
		Atmospheric Pressure	1029mbar
		Tested By	Liau Lee Yin

Channel	Channel Frequency (GHz)	Peak Power Spectral Density (mW)	Limit (mW)
0 *(lower ch)*	2.402	0.0289	6.3
19 *(mid ch)*	2.440	0.0289	6.3
39 *(upper ch)*	2.480	0.0287	6.3

Peak Power Spectral Density Plots

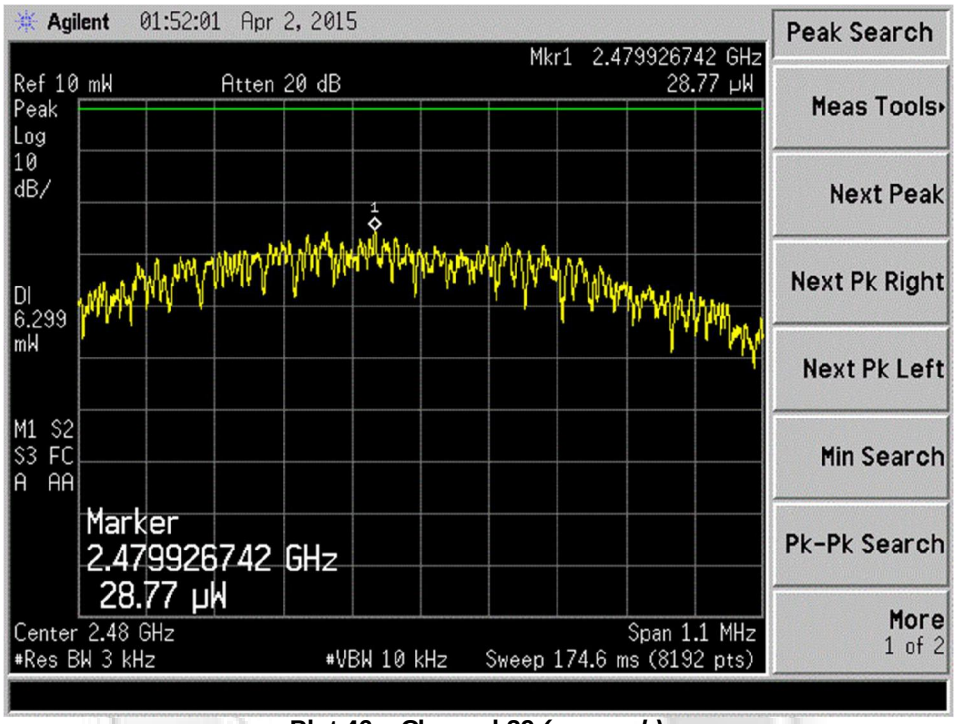


Plot 44 – Channel 0 *(lower ch)*



Plot 45 – Channel 19 *(middle ch)*

Peak Power Spectral Density Plots



Plot 46 – Channel 39 *(upper ch)*