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EMC testing of the M1

In accordance with FCC Part 15.247, ANSI C63.4: 2014 and ANSI C63.10: 2013 as referenced by FCC OET KDB 558074 D01 DTS Measurement Guidance v03r03

FCC ID: 2AGS9M1

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Prepared for: **MRF Geosystems Corporation**

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REVISION RECORD

ISSUE	DATE	AUTHOR	REVISIONS
DRAFT 1	2015-11-09	I. Akram	Initial draft submitted for review.
DRAFT 2	2015-12-15	M. Rousseau	Add FCC ID, customer information and correct miscellaneous errors
Release 1	2015-12-21	M. Rousseau	Sign off
Release 2	2015-12-29	M. Rousseau	Correct customer company name
Release 3	2016-01-05	M. Rousseau	Correct model number and FCC ID

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1.0 INTRODUCTION

1.1 Scope

The purpose of this report is to present the results of compliance testing performed in accordance with FCC Part 15.247 as specified in MRF Geosystems Corporation Test Plan. All test procedures, limits, criteria, and results described in this report apply only to the MRF Geosystems Corporation M1 test sample, referred to herein as the EUT (Equipment Under Test).

This report does not imply product endorsement by the Electronics Test Centre, SCC, NAVLP, A2LA, nor any Canadian Government agency.

1.2 Applicant

This test report has been prepared for MRF Geosystems Corporation, located in Calgary, Alberta, Canada.

1.3 Test Sample Description

As provided to ETC (Airdrie) by MRF Geosystems Corporation:

Product Name:	M1
Model #	M1
Serial #	n/a
Power:	Internal battery

The device is a wireless (Bluetooth Low Energy) device. It incorporates an integral antenna, with characteristics as found in Texas Instrument application note AN043 (document number: SWRA117D).

The device has an internal non-rechargeable battery. There are no cables or connectors.

1.4 General Test Conditions and Assumptions

The EUT was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. All inputs and outputs to and from other equipment associated with the EUT were adequately simulated.

Where relevant, the EUT was only tested using the monitoring methods and test criteria defined in this report.

The environmental conditions are recorded during each test, and are reported in the relevant sections of this document.

1.5 Scope of Testing

Tests were performed in accordance with FCC Part 15.247, ANSI C63.4-2014, and ANSI C63.10-2013 as referenced in FCC KDB 558074 v03r03.

1.5.1 Test Methodology

Test methods are documented in the part of Section 2 of this report associated with each particular Test Case.

1.5.2 Variations in Test Methodology

Any variance in methodology or deviation from the reference Standard is documented in the part of Section 2 of this report associated with each particular Test Case.

1.5.3 Test Sample Verification, Configuration & Modifications

EUT setup, configuration, protocols for operation and monitoring of EUT functions, and any modifications performed in order to meet the requirements, are detailed in each Test Case of Section 2 of this report.

2.0 TEST CONCLUSION

STATEMENT OF COMPLIANCE

The customer equipment referred to in this report was found to comply with the requirements, as summarized below.

The EUT was subjected to the following tests. Compliance status is reported as **Compliant** or **Non-compliant**. **N/A** indicates the test was Not Applicable to the EUT.

> **Note:** Maintenance of compliance is the responsibility of the Manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the EUT with respect to the standards detailed in this test report.

The following table summarizes the tests performed in terms of the specification, class or performance criterion applied, and the EUT modification state.

Test Case	Test Type	Specification	Test Sample	Modifications	Config.	Result
2.1	AC Conducted Emissions (Tx)	15.207	M1	none	see § 2.1	**N/A**
2.2	Peak Output Power	15.247(b)(3)	M1	none	see § 2.2	**Compliant**
2.3	Power Spectral Density	15.247(e)	M1	none	see § 2.3	**Compliant**
2.4	Occupied Bandwidth	15.247(a)(2)	M1	none	see § 2.4	**Compliant**
2.5	Band Edge Attenuation	15.247(d)	M1	none	see § 2.5	**Compliant**
2.6	Conducted Spurious	15.247(d)	M1	none	see § 2.6	**Compliant**
2.7	EUT Position	ANSI C63.4	M1	none	see § 2.7	**see § 2.7**
2.8	Transmitter Radiated Spurious	15.205, 15.209 15.247(d)	M1	none	see § 2.8	**Compliant**
2.9	Receive Radiated Spurious	15.205, 15.109	M1	none	see § 2.9	**Compliant**
2.10	RF Exposure	15.247(i)	M1	none	see § 2.9	**Compliant**

Refer to the test data for applicable test conditions.

2.1 AC Power Line Conducted Emissions: Transmit Mode

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: N/A	**Standard: FCC Part 15.207**
Test Method: TM-EMC 11	**Basic Standard: ANSI C63.4: 2014**
Date:	

EUT status: Not Applicable

Comments: The device is only powered by an internal, non-rechargeable battery. There is no connection to the AC mains

2.2 Peak Output Power

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.10: 2013**
Date: 2015-11-09 (18.9° C,26.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(b)(3)

Criteria: (3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

2.2.1 Test Methodology: ANSI C63.10-2013, Clause 11.9.1.1

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation.

The spectrum analyzer is set for a frequency span ≥ (3*RBW) centered on a channel. The RBW is set ≥ (6dB BW) and VBW is set ≥ (3*RBW). The Peak detector is used, with the trace set to Max Hold. After the trace has stabilized, the peak amplitude is found with the marker Peak Search function.

2.2.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.2.3 Test Equipment

Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMI receiver	Agilent	N9038A	6130	2016-06-23

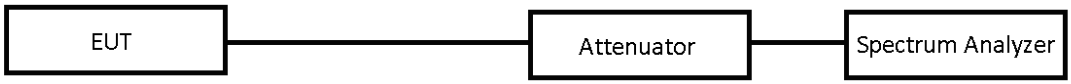
2.2.4 Test Sample Verification, Configuration & Modifications

The EUT was modified to permit direct connection of the RF output to the spectrum analyzer.

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

Test setup diagram for Peak Power testing:

Conducted:



2.2.5 Measurement Parameters

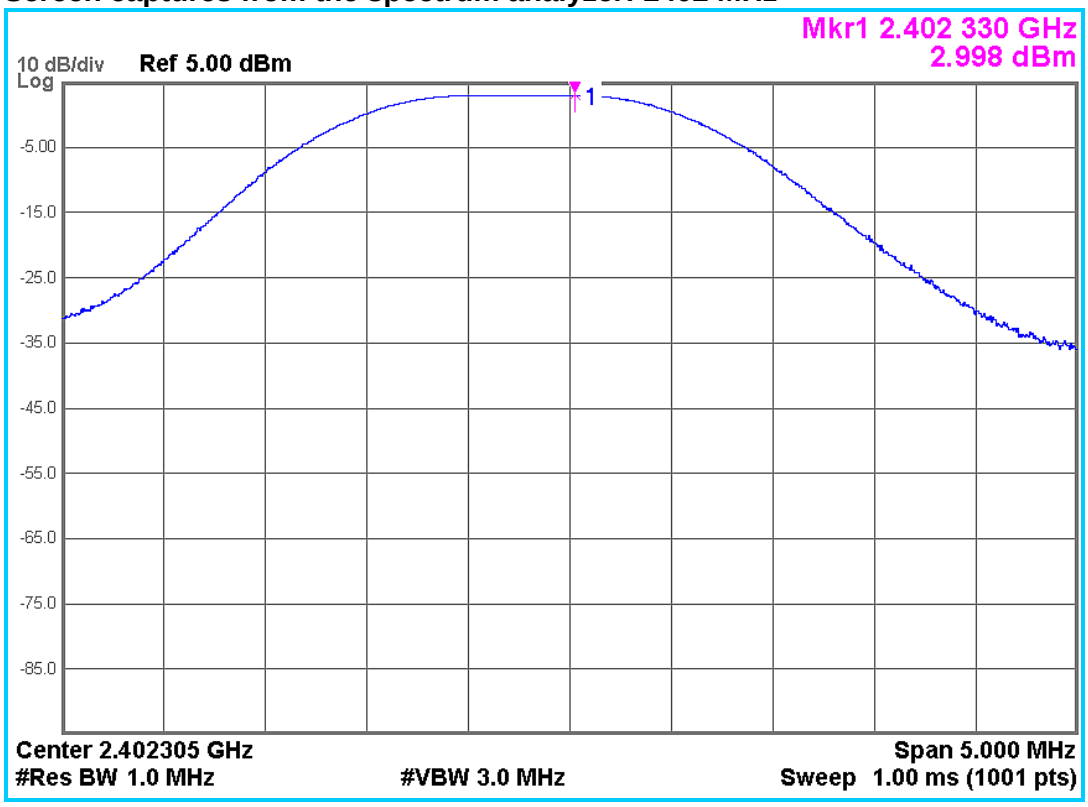
Detector	Peak
Resolution Bandwidth	1 MHz
Video Bandwidth	3 MHz
Span	5 MHz
Sweep Time	Auto
Trace-Mode	Max Hold

2.2.6 Peak Output Power Data

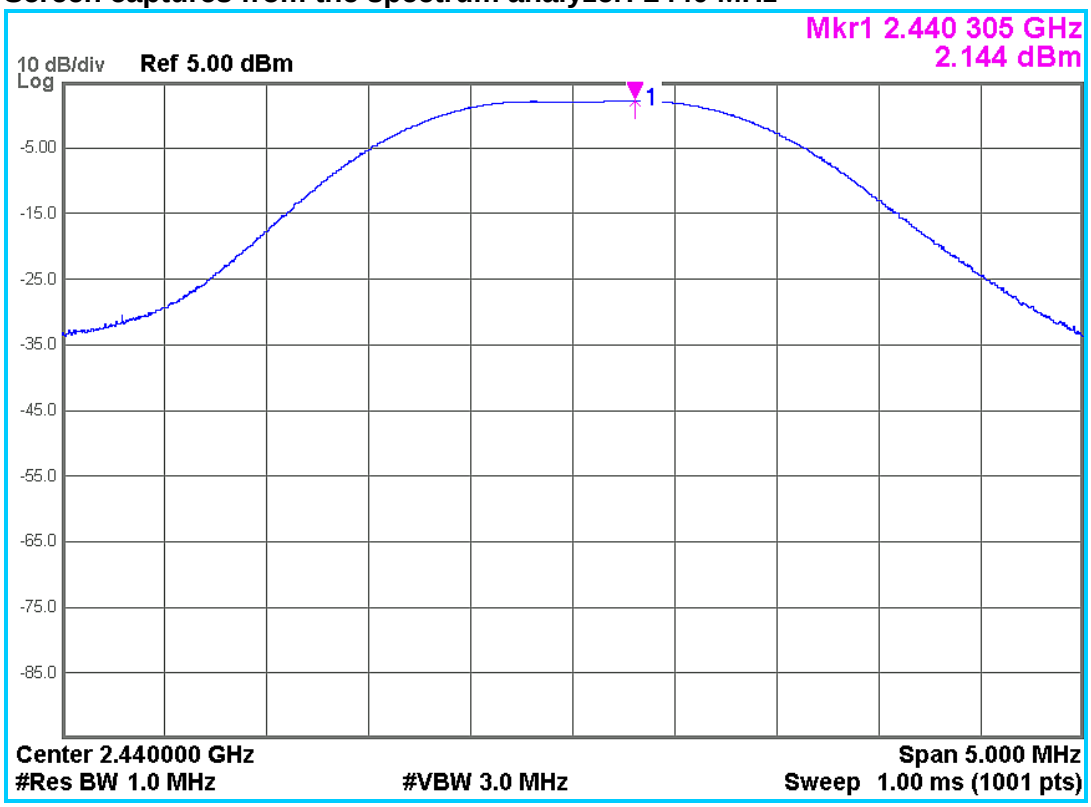
Carrier Frequency (MHz)	Peak RF Output (dBm)	Peak RF Output (Watts)	Limit (Watts)	Limit (dBm)	Margin (Watts) (Pk O/P – Limit)	Margin (dBm) (Pk O/P – Limit)
2402	2.998	0.0019943	**1.000**	**30**	**0.99801**	**-27.002**
2440	2.144	0.0016383	**1.000**	**30**	**0.9983617**	**-27.856**
2480	0.9	0.0012303	**1.000**	**30**	**0.9987697**	**-29.1**

***No External Attenuation used**

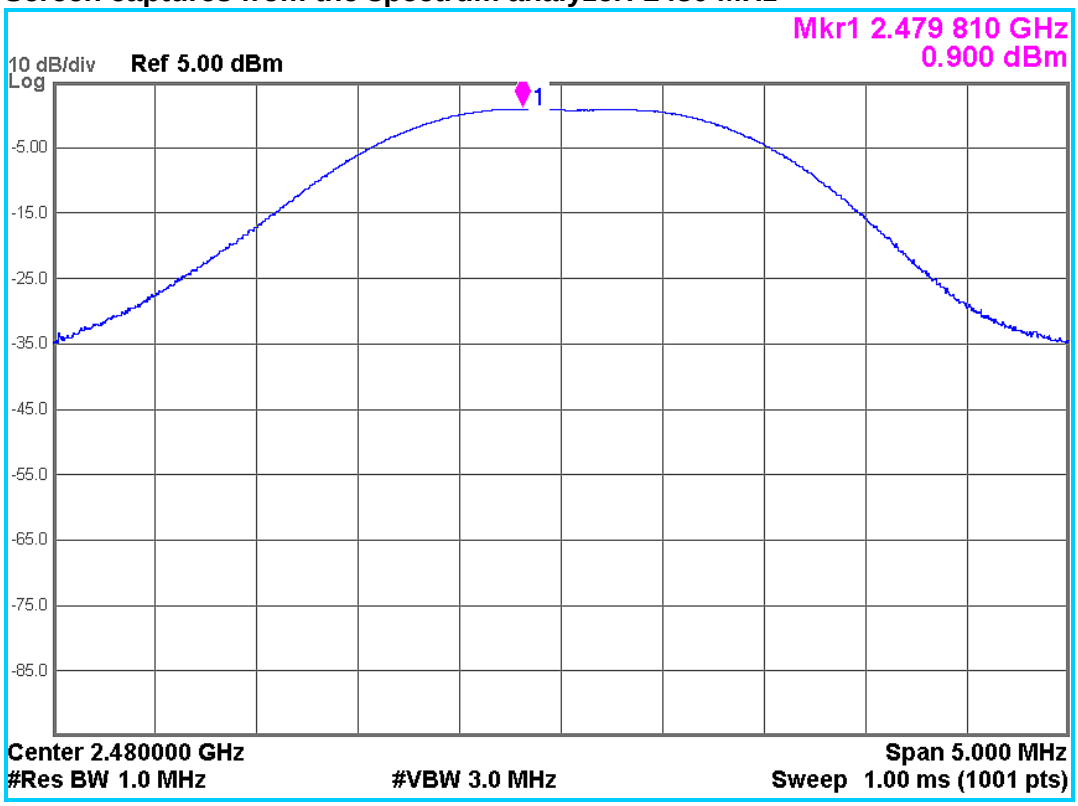
Screen captures from the spectrum analyzer: 2402 MHz



Screen captures from the spectrum analyzer: 2440 MHz



Screen captures from the spectrum analyzer: 2480 MHz



2.3 Power Spectral Density

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.10: 2013**
Date: 2015-11-09 (18.9° C,26.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(e)

Criteria: For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

2.3.1 Test Methodology: ANSI C63.10-2013, Clause 11.10.2

This measurement is performed at low, mid and high frequencies, in continuous transmission, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation.

The spectrum analyzer is set for a frequency span of (1.5*(6dB BW)) centered on a channel. The RBW is set to 3 kHz and VBW is set ≥ (3*RBW). The Peak detector is used, with the trace set to Max Hold. The marker is placed on the highest peak of the resulting trace.

2.3.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.3.3 Test Equipment

Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMI receiver	Agilent	N9038A	6130	2016-06-23

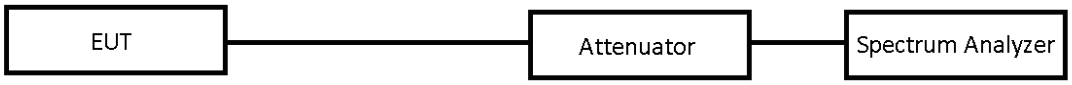
2.3.4 Test Sample Verification, Configuration & Modifications

The EUT was modified to permit direct connection of the RF output to the spectrum analyzer.

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation.

Test setup diagrams for Peak Power Spectral Density testing:

Conducted:



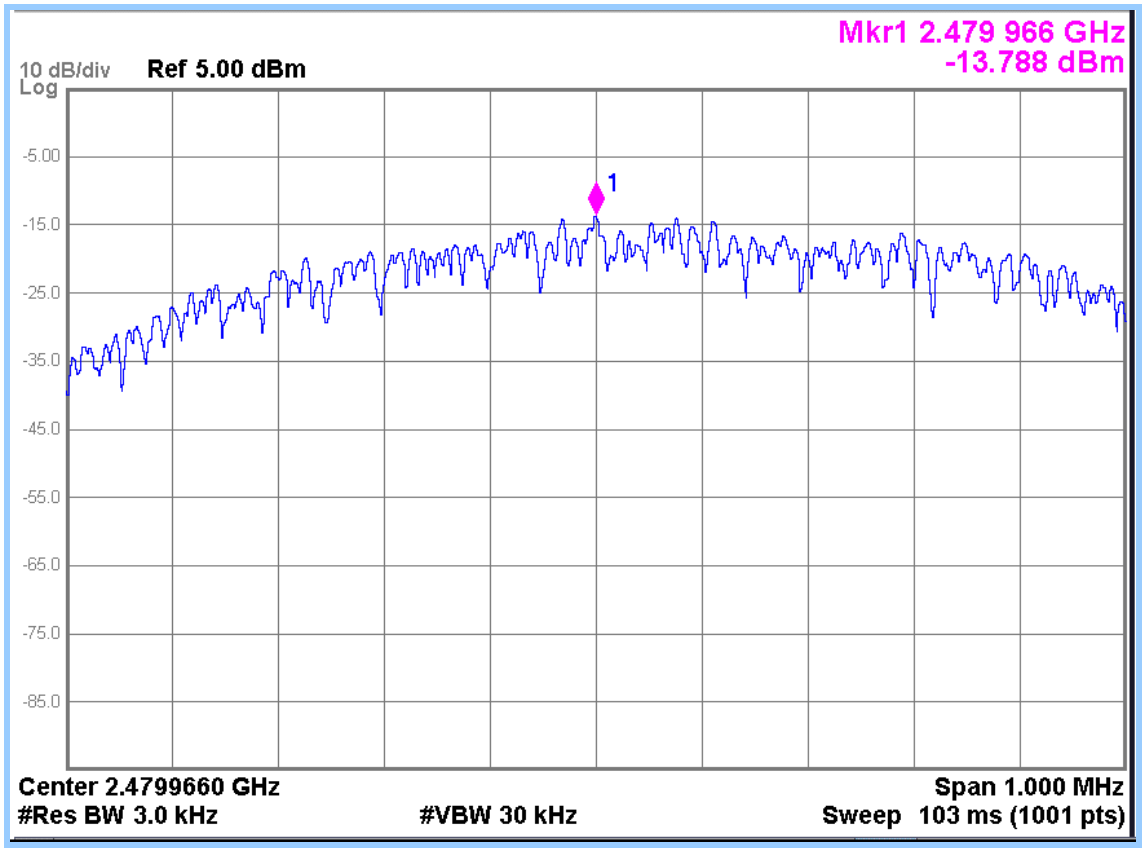
2.3.5 Measurement Parameters

Detector	Peak
Resolution Bandwidth	3 KHz
Video Bandwidth	30 KHz
Span	1 MHz
Sweep Time	Auto
Trace-Mode	Max Hold

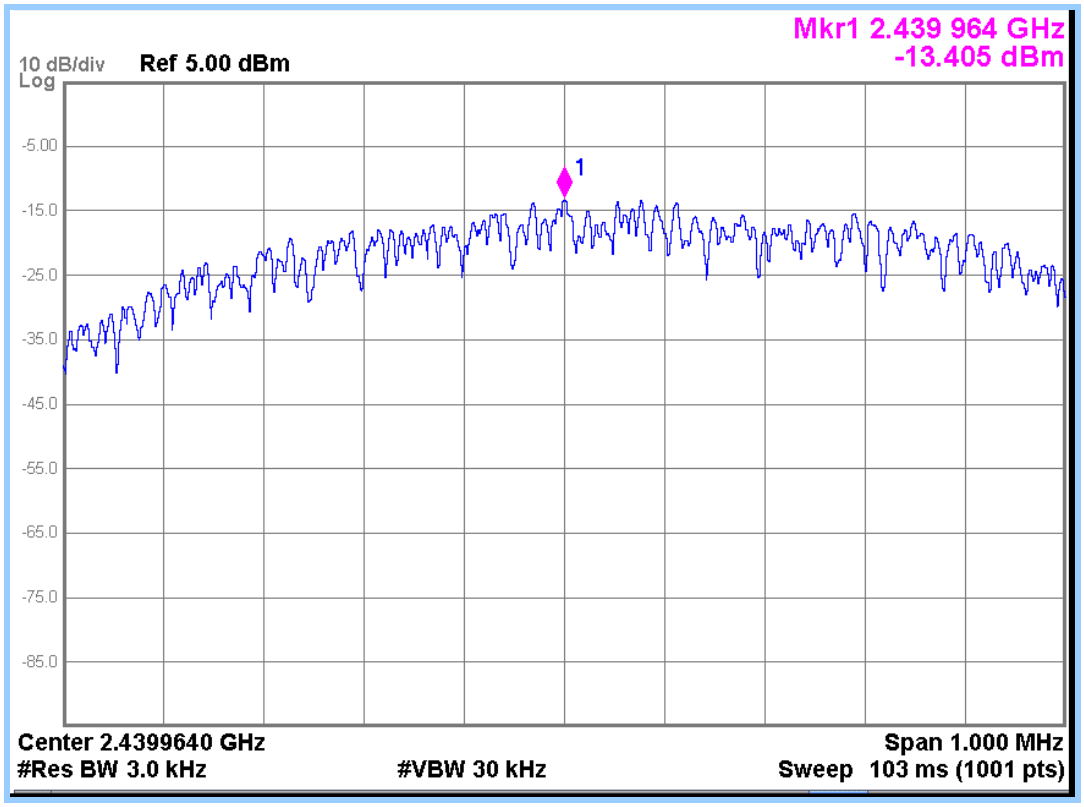
2.3.6 Peak PSD Data

Frequency (MHz)	Peak PSD (dBm)	Limit (dBm)	Margin (dB) (PSD – Limit)
2402	-13.788	8	**-21.788**
2440	-13.405	8	**-21.405**
2480	-12.100	8	**-20.100**

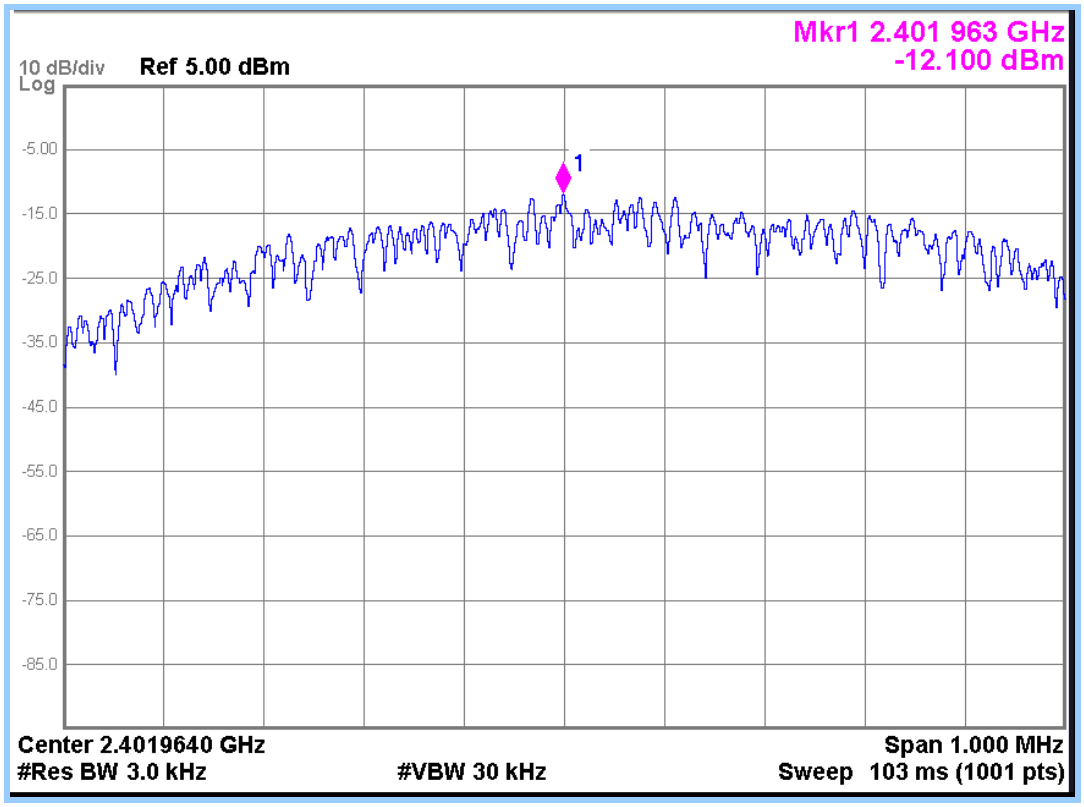
Screen Captures from the spectrum analyzer: 2402 MHz:



Screen Captures from the spectrum analyzer: 2440 MHz



Screen Captures from the spectrum analyzer: 2480 MHz:



2.4 Channel Occupied Bandwidth

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.10-2013**
Date: 2015-11-09 (18.9° C, 26.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(a)(2)

Criteria: Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

2.4.1 Test Methodology: ANSI C63.10-2013, Clause 6.9.1

This measurement is performed at low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, an antenna is placed to capture the transmitted signals.

The spectrum analyzer is set for a frequency span ≥ (2 * OBW), ≤ (5 * OBW), selected to clearly display the channel. The RBW is set to 100 kHz. The VBW is set to ≥ (3 * RBW). The Peak detector is used, with the trace set to Max Hold.

The automated 99% BW function of the spectrum analyzer is engaged, and the 6 dB OBW and/or 20 dB OBW is measured with the x dB function.

2.4.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.4.3 Test Equipment

Testing was performed with this equipment:

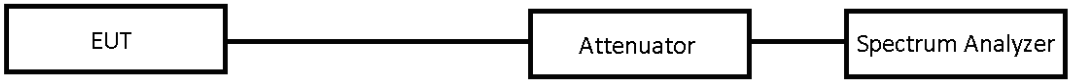
Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMI receiver	Agilent	N9038A	6130	2016-06-23

2.4.4 Test Sample Verification, Configuration & Modifications

The EUT was set to transmit continuously on a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagrams for Occupied Bandwidth testing:

Conducted:



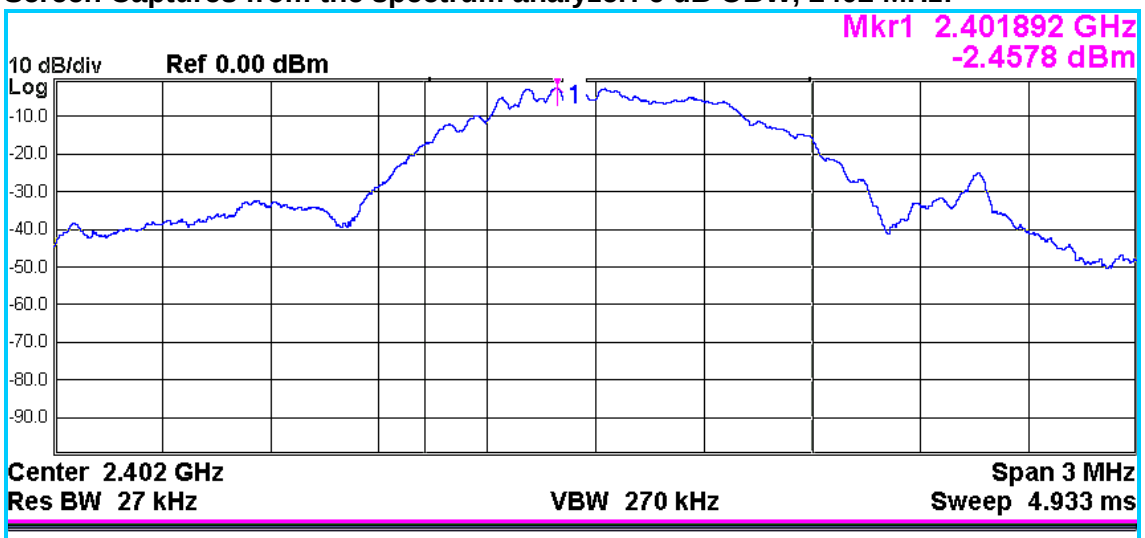
2.4.5 Measurement Parameters

Detector	Peak
Resolution Bandwidth	27 KHz
Video Bandwidth	270 KHz
Span	3 MHz
Sweep Time	Auto
Trace-Mode	Max Hold

2.4.6 Channel Occupied Bandwidth Data:

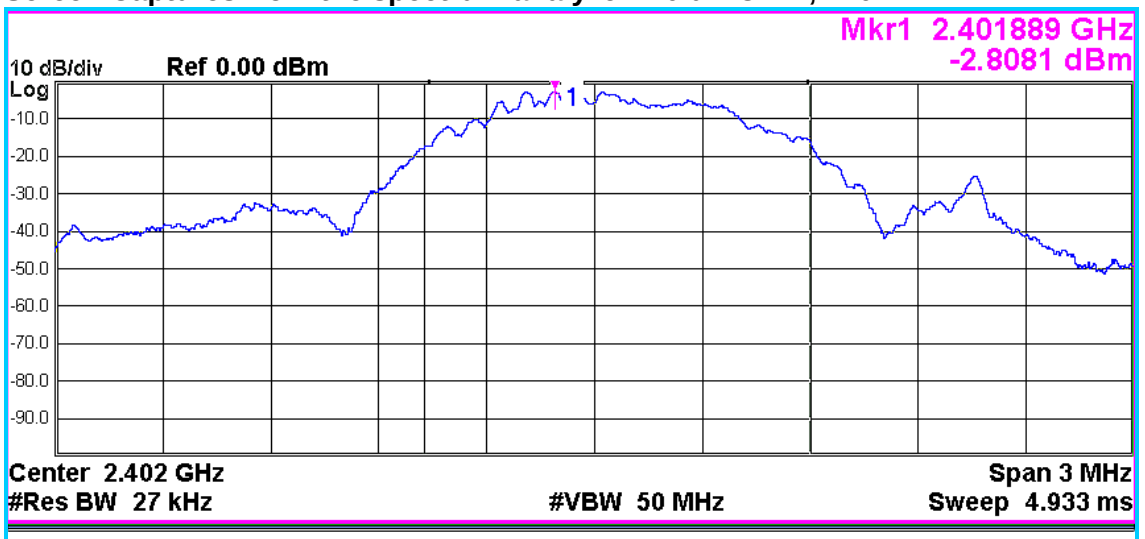
Freq. [MHz]	6 dB OBW [kHz]	20 dB OBW [MHz]	99% OBW [MHz]	6 dB OBW Limit
2402	672.8	1.203	1.0713	≥ 500 KHz
2440	672.4	1.209	1.0712	
2480	669.9	1.206	1.0713	

Screen Captures from the spectrum analyzer: 6 dB OBW, 2402 MHz:



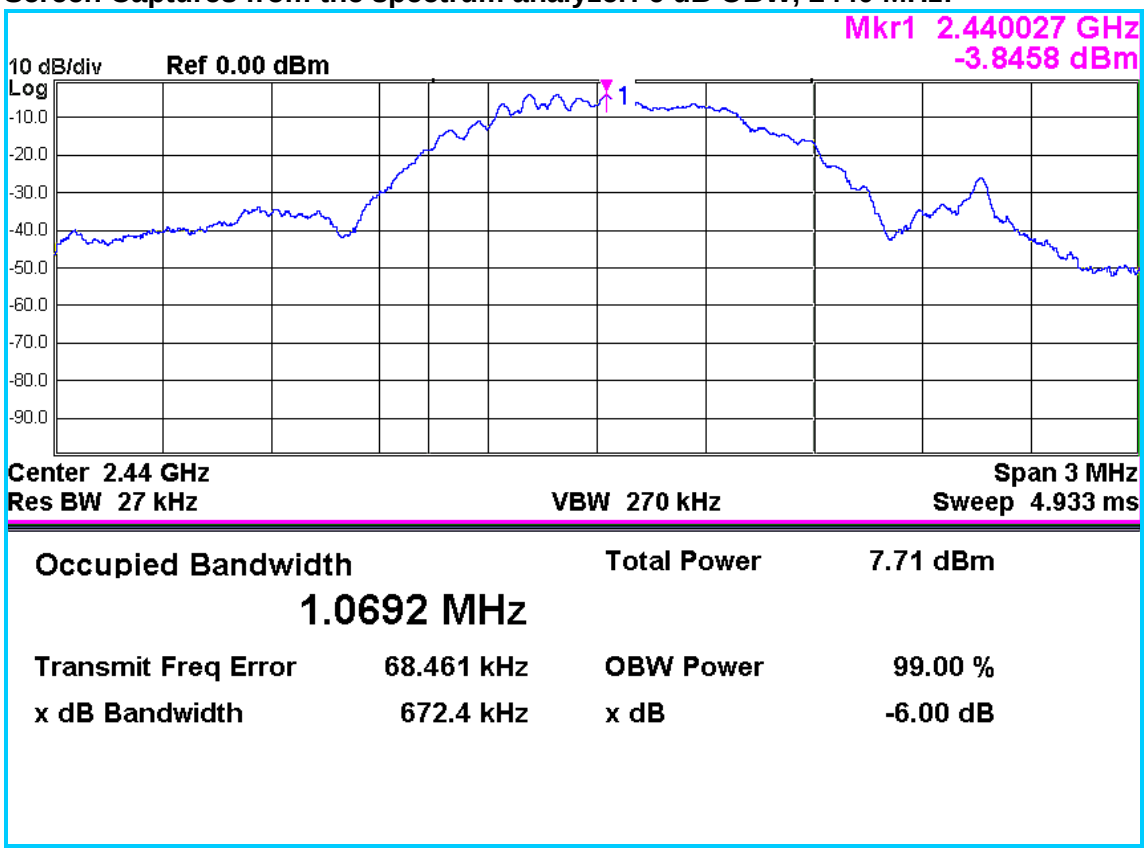
Occupied Bandwidth		Total Power	9.09 dBm
1.0713 MHz			
Transmit Freq Error	66.820 kHz	OBW Power	99.00 %
x dB Bandwidth	672.8 kHz	x dB	-6.00 dB

Screen Captures from the spectrum analyzer: 20 dB OBW, 2402 MHz:

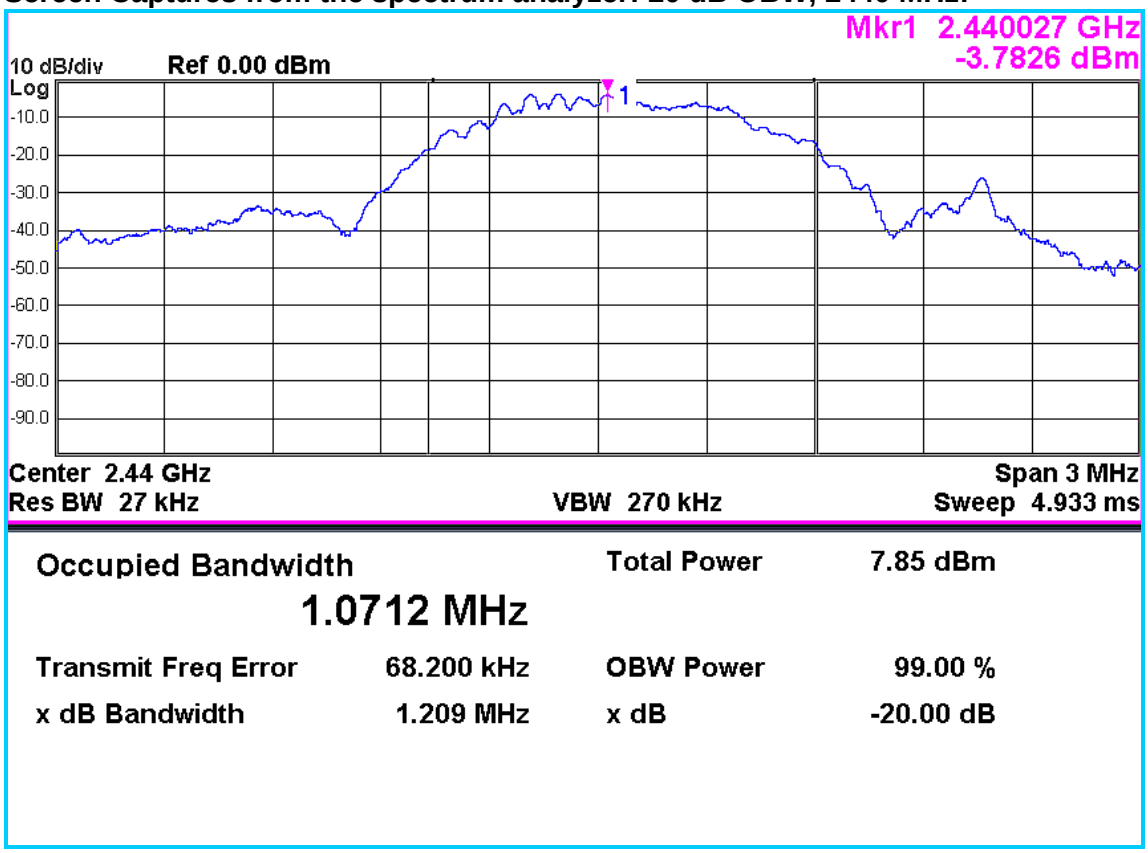


Occupied Bandwidth		Total Power	8.81 dBm
1.0693 MHz			
Transmit Freq Error	66.292 kHz	OBW Power	99.00 %
x dB Bandwidth	1.203 MHz	x dB	-20.00 dB

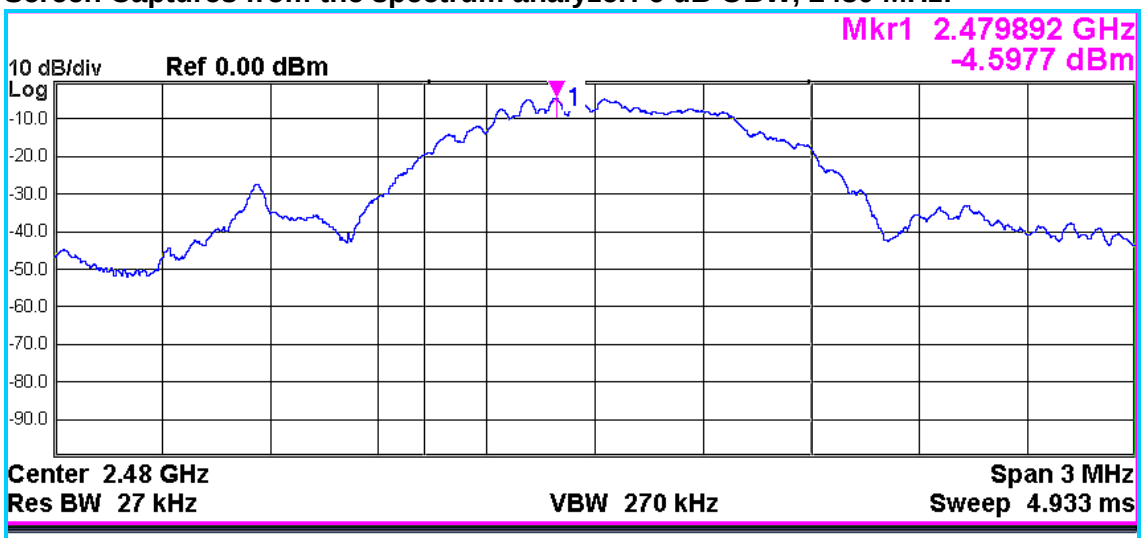
Screen Captures from the spectrum analyzer: 6 dB OBW, 2440 MHz:



Screen Captures from the spectrum analyzer: 20 dB OBW, 2440 MHz:

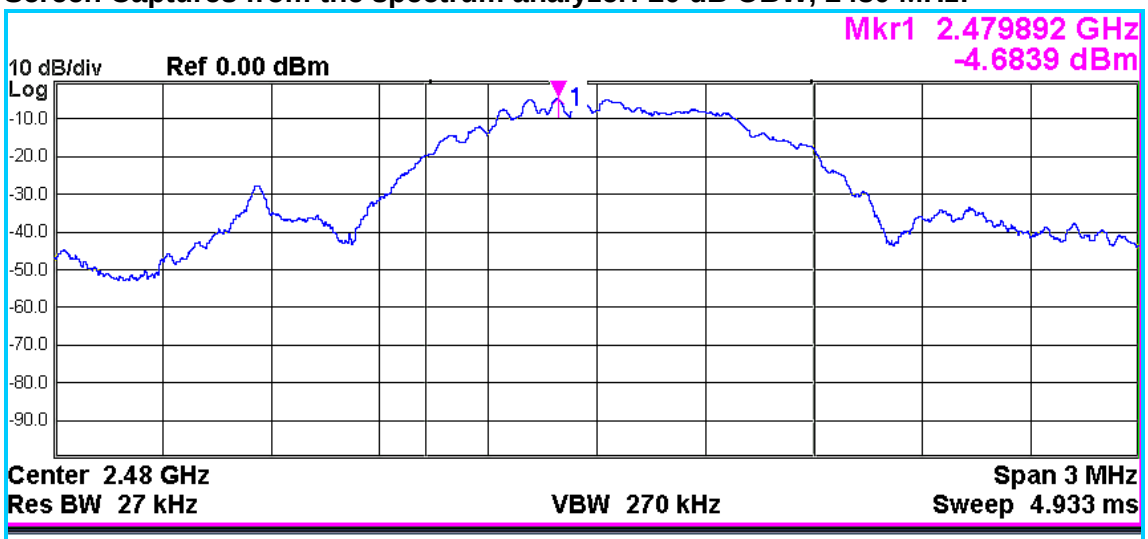


Screen Captures from the spectrum analyzer: 6 dB OBW, 2480 MHz:



Occupied Bandwidth		Total Power	6.92 dBm
1.0713 MHz			
Transmit Freq Error	65.826 kHz	OBW Power	99.00 %
x dB Bandwidth	669.9 kHz	x dB	-6.00 dB

Screen Captures from the spectrum analyzer: 20 dB OBW, 2480 MHz:



Occupied Bandwidth		Total Power	6.78 dBm
1.0693 MHz			
Transmit Freq Error	66.098 kHz	OBW Power	99.00 %
x dB Bandwidth	1.206 MHz	x dB	-20.00 dB

2.5 Band Edge Attenuation

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.10: 2013**
Date: 2015-11-09 (18.9° C, 26.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(d)

Criteria: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

2.5.1 Test Methodology: ANSI C63.10-2013 Clause 11.13.2

This measurement is performed at the low and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation. If the EUT antenna is integral to the device, the radiated output is measured.

The spectrum analyzer is set for a frequency span to show the band edge and the nearest channel. The RBW is set to ≥ 100 kHz. The VBW is set to ≥ (RBW * 3). The Peak detector is used, with the trace set to Max Hold.

The attenuation is measured with the Marker Delta function.

2.5.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.5.3 Test Equipment

Testing was performed with this equipment:

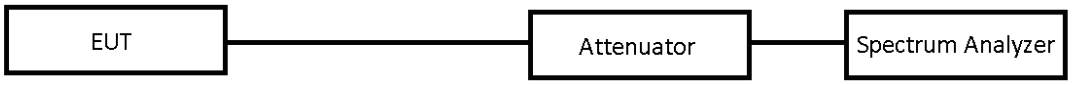
Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMI receiver	Agilent	N9038A	6130	2016-06-23

2.5.4 Test Sample Verification, Configuration & Modifications

The EUT was operating normally, in communication with an iPod. The EUT met the requirements without modification.

Test setup diagrams for Band Edge Attenuation testing:

Conducted:



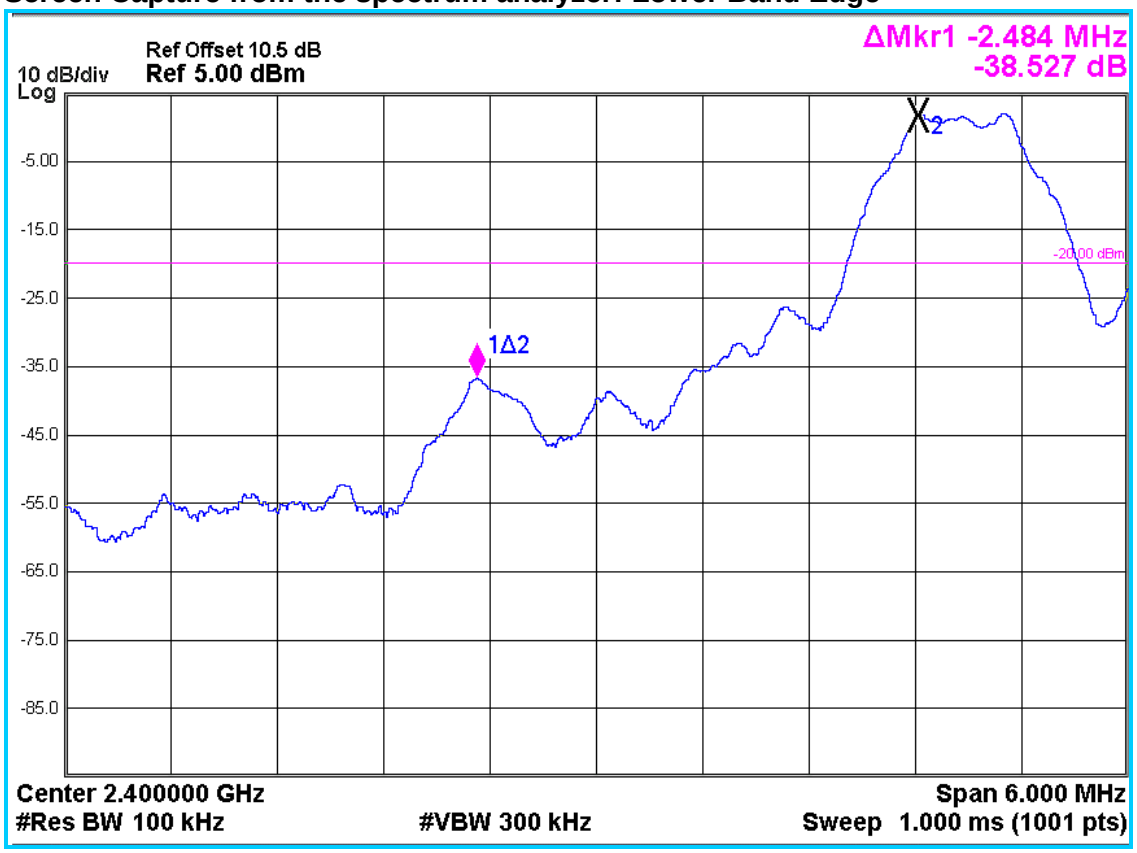
2.5.5 Measurement Parameters

Detector	Peak
Resolution Bandwidth	100 KHz
Video Bandwidth	300 KHz
Span	Lower Band Edge: 2397.8 – 2402.8 MHz Upper Band Edge: 2479.2 – 2485.0 MHz
Sweep Time	Auto
Trace-Mode	Max Hold

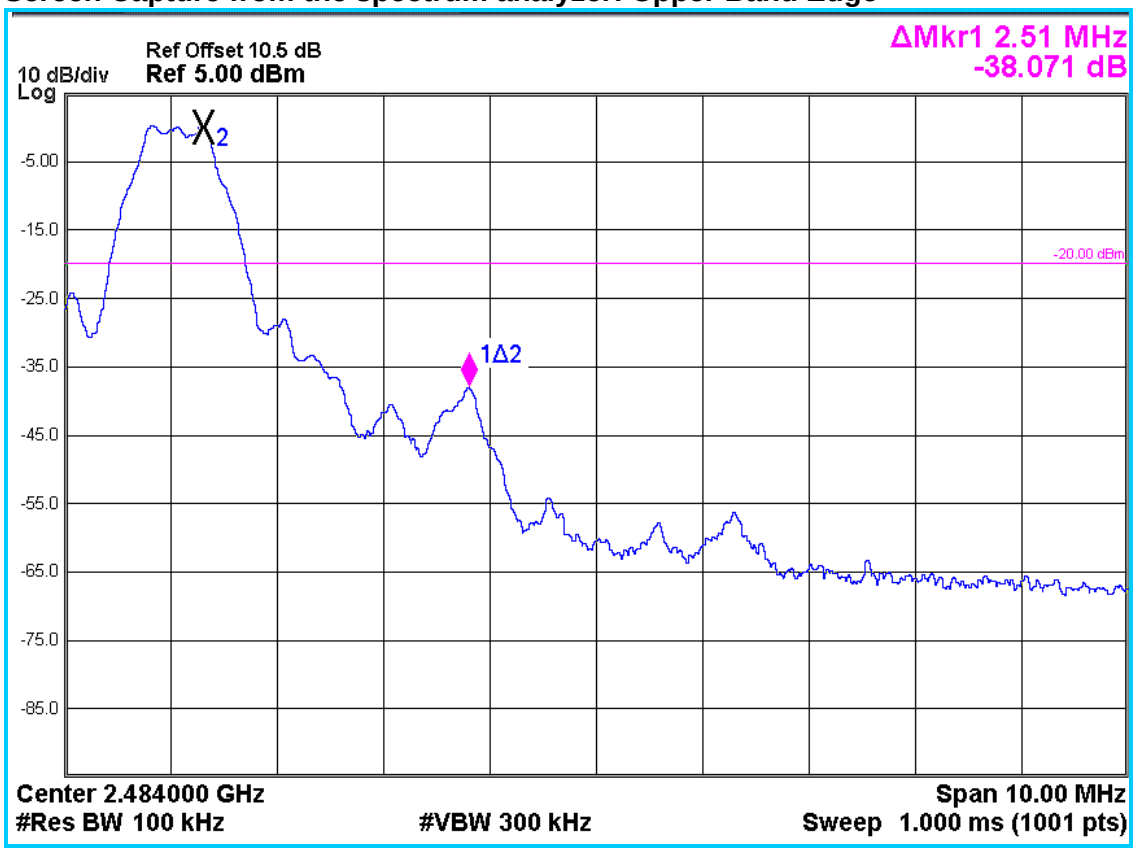
2.5.6 Band Edge Data

Channel	Edge	Attenuation at Band Edge [dBc]	Limit [dBc]
2402 MHz	Lower Band	-38.527	≥ -20
2480 MHz	Upper Band	-38.071	≥ -20

Screen Capture from the spectrum analyzer: Lower Band Edge



Screen Capture from the spectrum analyzer: Upper Band Edge



2.6 Conducted Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.4-2014**
Date: 2015-11-09 (18.9° C, 26.5% RH)	

EUT status: Compliant

Specification: FCC Part 15.247(d)

Criteria: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

2.6.1 Test Methodology: ANSI C63.10-2013, Clause 6.7

This measurement is performed at the low, mid and high frequencies, with modulation.

The RF output of EUT with an antenna connector is fed to the input of the spectrum analyzer through appropriate attenuation and/or band-block filter.

The spectrum analyzer is stepped through the spectrum. The RBW is set to ≥ 100 kHz. The VBW is set to ≥ 300 kHz. The Peak detector is used, with the trace set to Max Hold.

2.6.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.6.3 Test Equipment

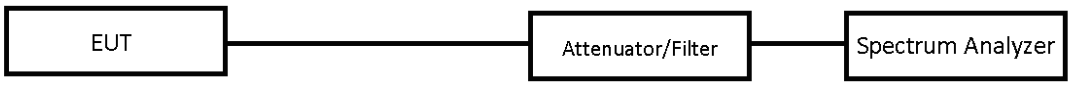
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMI receiver	Agilent	N9038A	6130	2016-06-23

2.6.4 Test Sample Verification, Configuration & Modifications

The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagram for Conducted Spurious Emissions testing:



2.6.5 Measurement Parameters

Detector	Peak
Resolution Bandwidth	F<30 MHz: 9 KHz F>30 MHz: 100 KHz
Video Bandwidth	F<30 MHz: 30 KHz F>30 MHz: 300 KHz
Span	25 KHz - 26500 MHz
Sweep Time	Auto
Trace-Mode	Max Hold

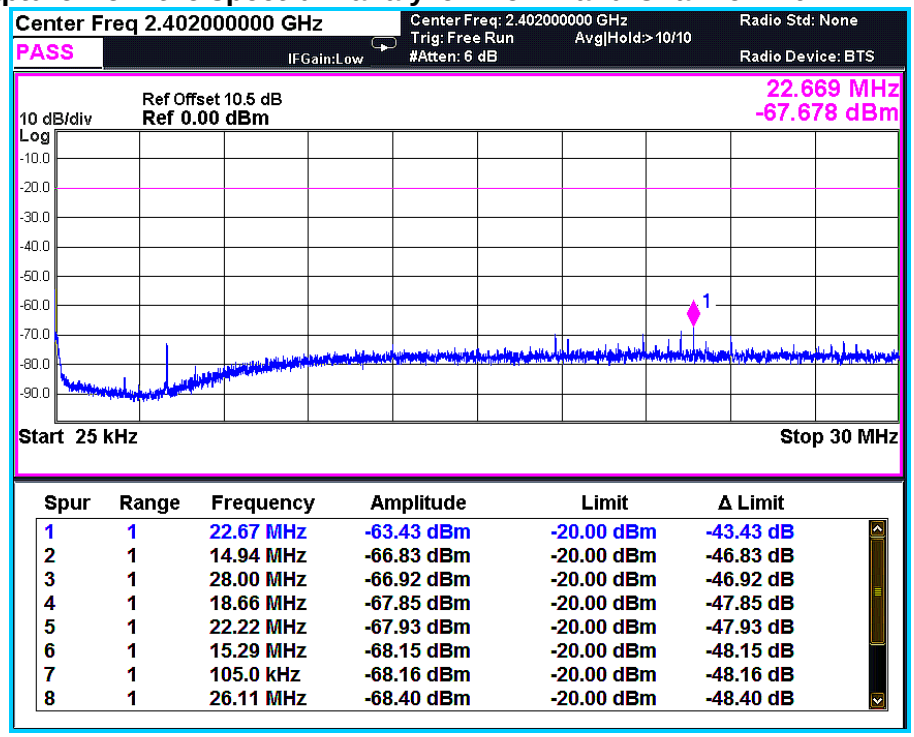
2.6.6 Conducted Emissions Data:

Delta = Measured Value - Limit

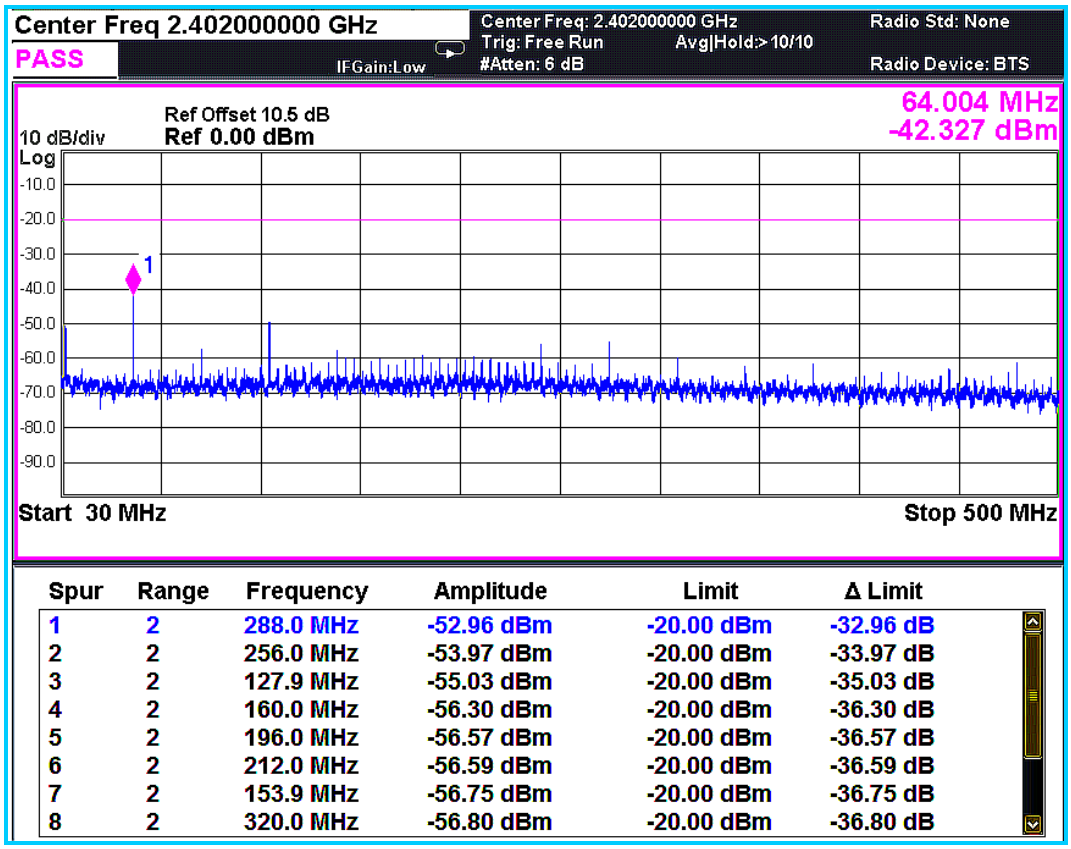
Negative values for Delta indicate compliance.

Attenuation = 10.5 dB

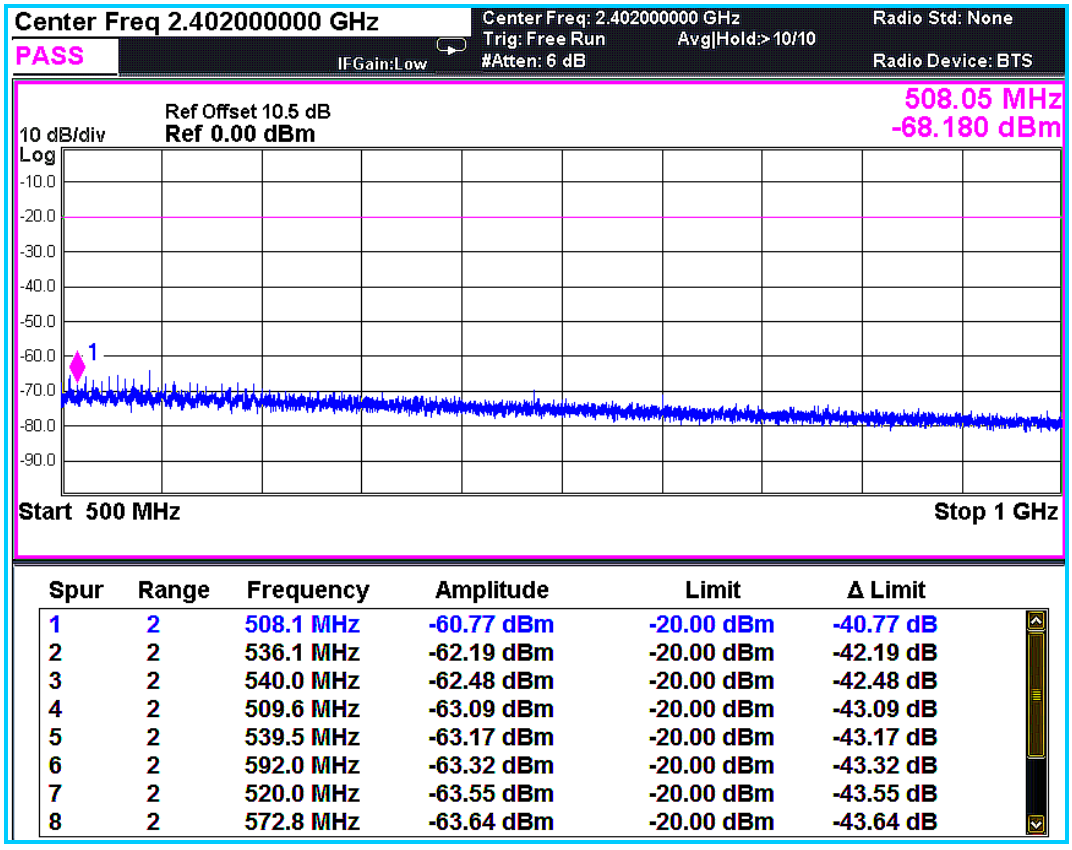
Screen Capture from the spectrum analyzer: Low Band Channel 2402 MHz



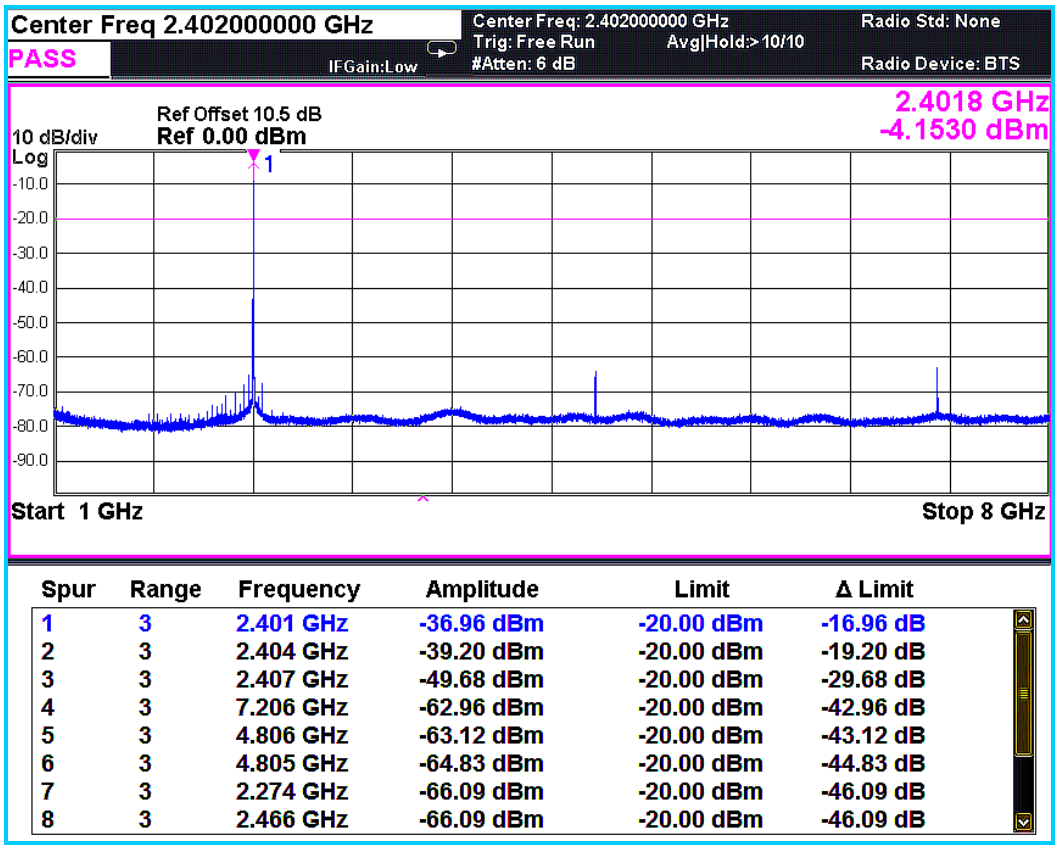
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	22.67 MHz	-63.43 dBm	-20.00 dBm	-43.43 dB
2	1	14.94 MHz	-66.83 dBm	-20.00 dBm	-46.83 dB
3	1	28.00 MHz	-66.92 dBm	-20.00 dBm	-46.92 dB
4	1	18.66 MHz	-67.85 dBm	-20.00 dBm	-47.85 dB
5	1	22.22 MHz	-67.93 dBm	-20.00 dBm	-47.93 dB
6	1	15.29 MHz	-68.15 dBm	-20.00 dBm	-48.15 dB
7	1	105.0 kHz	-68.16 dBm	-20.00 dBm	-48.16 dB
8	1	26.11 MHz	-68.40 dBm	-20.00 dBm	-48.40 dB



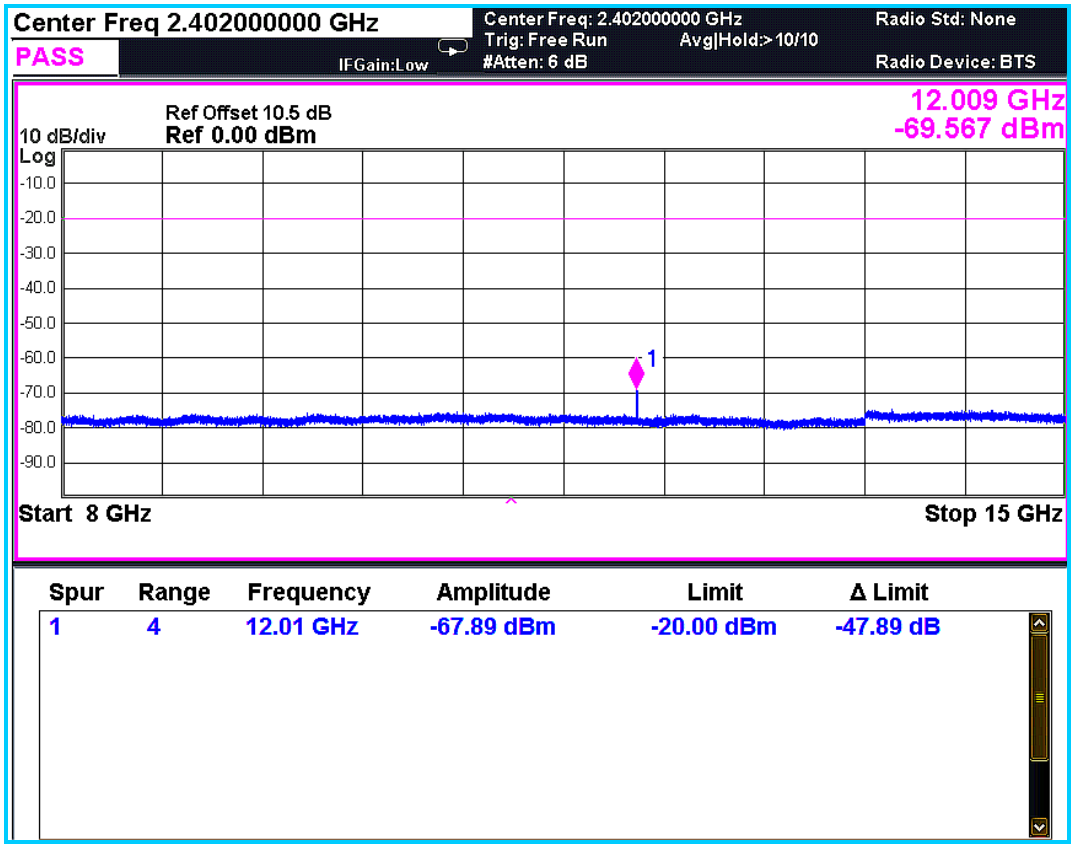
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	288.0 MHz	-52.96 dBm	-20.00 dBm	-32.96 dB
2	2	256.0 MHz	-53.97 dBm	-20.00 dBm	-33.97 dB
3	2	127.9 MHz	-55.03 dBm	-20.00 dBm	-35.03 dB
4	2	160.0 MHz	-56.30 dBm	-20.00 dBm	-36.30 dB
5	2	196.0 MHz	-56.57 dBm	-20.00 dBm	-36.57 dB
6	2	212.0 MHz	-56.59 dBm	-20.00 dBm	-36.59 dB
7	2	153.9 MHz	-56.75 dBm	-20.00 dBm	-36.75 dB
8	2	320.0 MHz	-56.80 dBm	-20.00 dBm	-36.80 dB



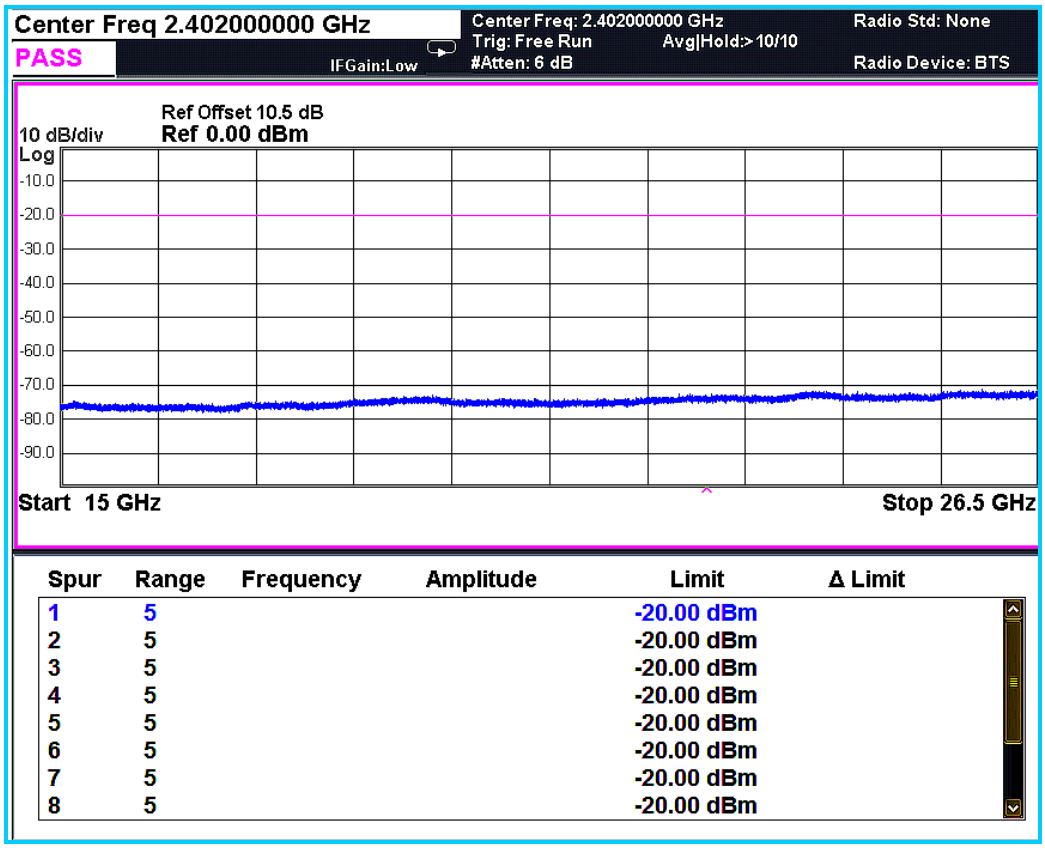
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	508.1 MHz	-60.77 dBm	-20.00 dBm	-40.77 dB
2	2	536.1 MHz	-62.19 dBm	-20.00 dBm	-42.19 dB
3	2	540.0 MHz	-62.48 dBm	-20.00 dBm	-42.48 dB
4	2	509.6 MHz	-63.09 dBm	-20.00 dBm	-43.09 dB
5	2	539.5 MHz	-63.17 dBm	-20.00 dBm	-43.17 dB
6	2	592.0 MHz	-63.32 dBm	-20.00 dBm	-43.32 dB
7	2	520.0 MHz	-63.55 dBm	-20.00 dBm	-43.55 dB
8	2	572.8 MHz	-63.64 dBm	-20.00 dBm	-43.64 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	3	2.401 GHz	-36.96 dBm	-20.00 dBm	-16.96 dB
2	3	2.404 GHz	-39.20 dBm	-20.00 dBm	-19.20 dB
3	3	2.407 GHz	-49.68 dBm	-20.00 dBm	-29.68 dB
4	3	7.206 GHz	-62.96 dBm	-20.00 dBm	-42.96 dB
5	3	4.806 GHz	-63.12 dBm	-20.00 dBm	-43.12 dB
6	3	4.805 GHz	-64.83 dBm	-20.00 dBm	-44.83 dB
7	3	2.274 GHz	-66.09 dBm	-20.00 dBm	-46.09 dB
8	3	2.466 GHz	-66.09 dBm	-20.00 dBm	-46.09 dB

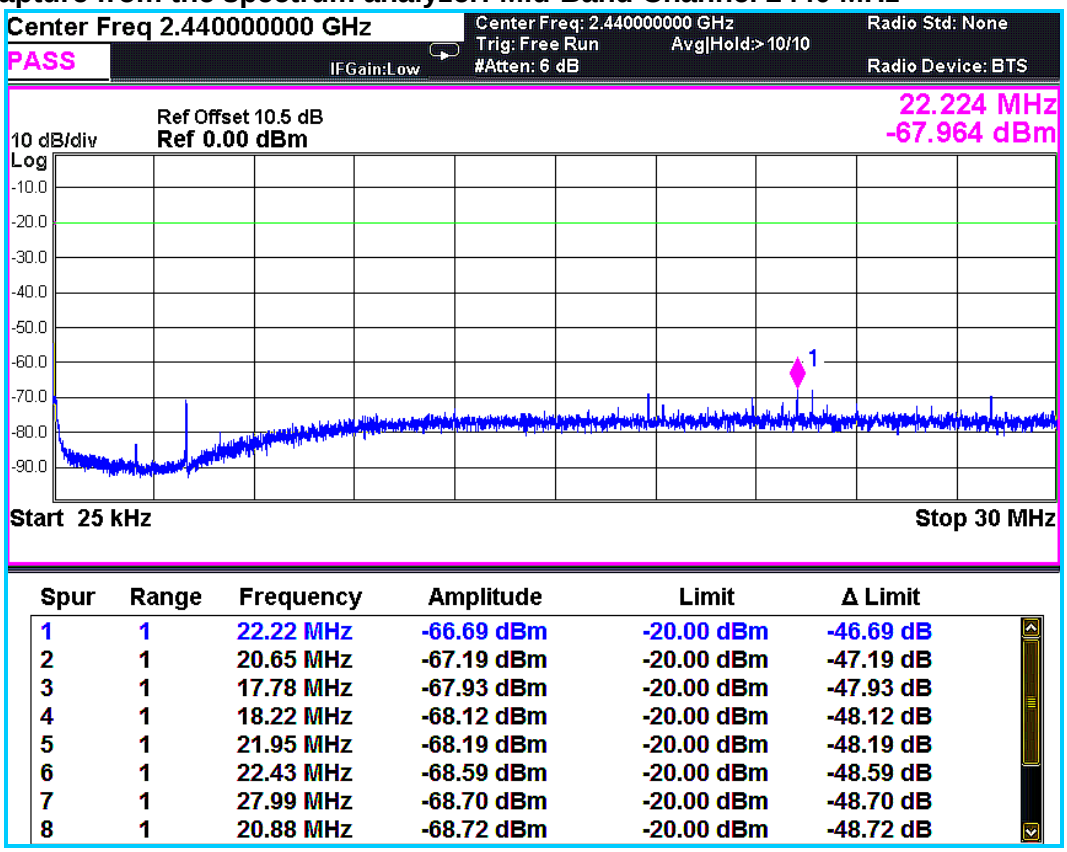


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	4	12.01 GHz	-67.89 dBm	-20.00 dBm	-47.89 dB

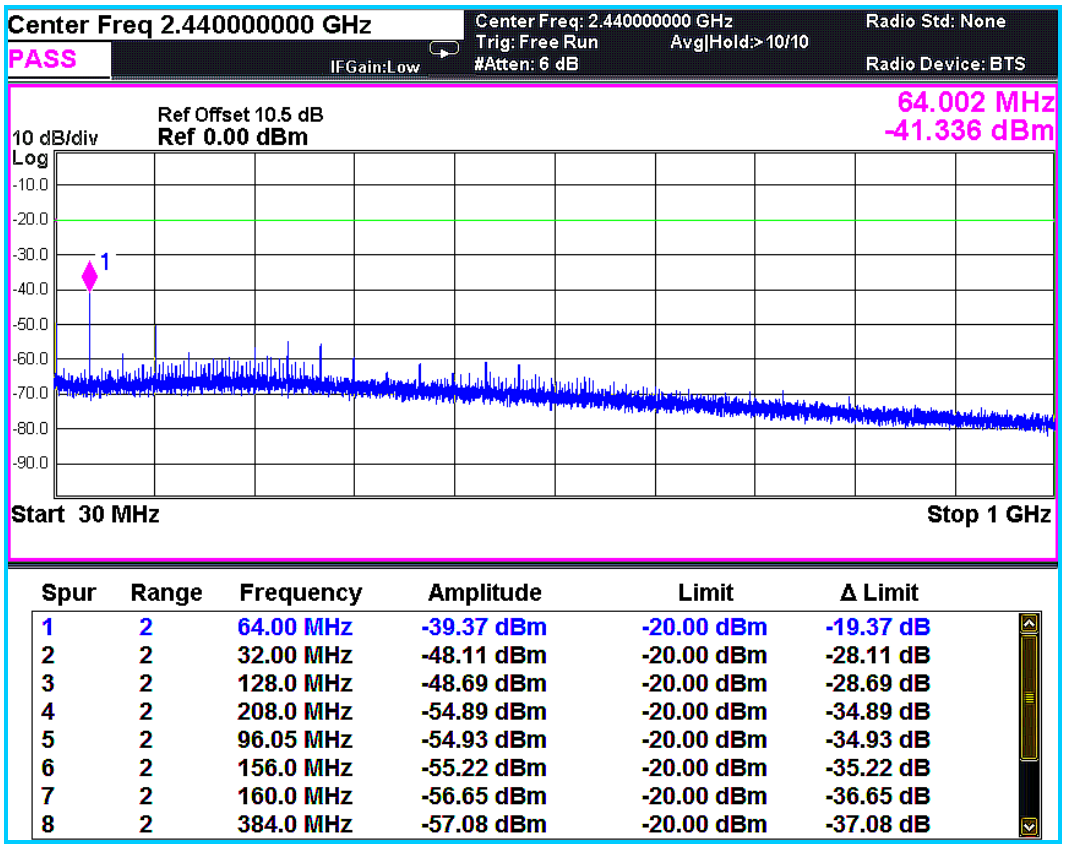


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	5			-20.00 dBm	
2	5			-20.00 dBm	
3	5			-20.00 dBm	
4	5			-20.00 dBm	
5	5			-20.00 dBm	
6	5			-20.00 dBm	
7	5			-20.00 dBm	
8	5			-20.00 dBm	

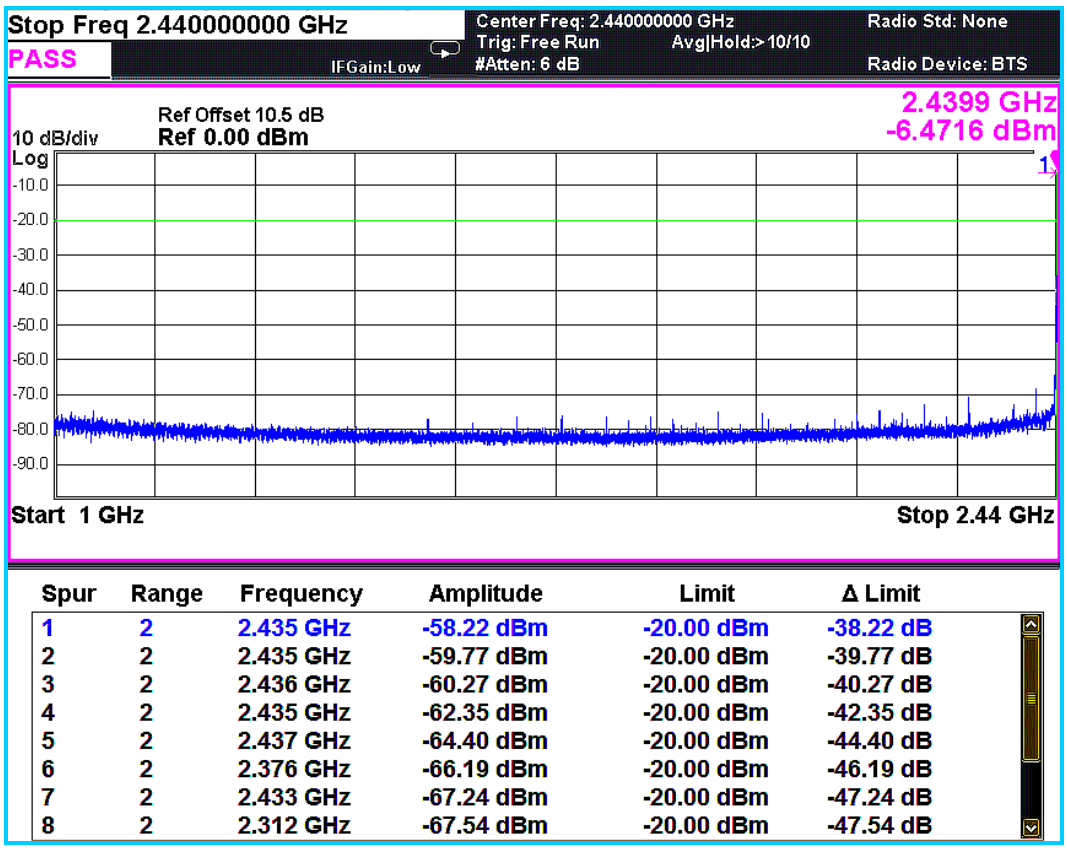
Screen Capture from the spectrum analyzer: Mid-Band Channel 2440 MHz



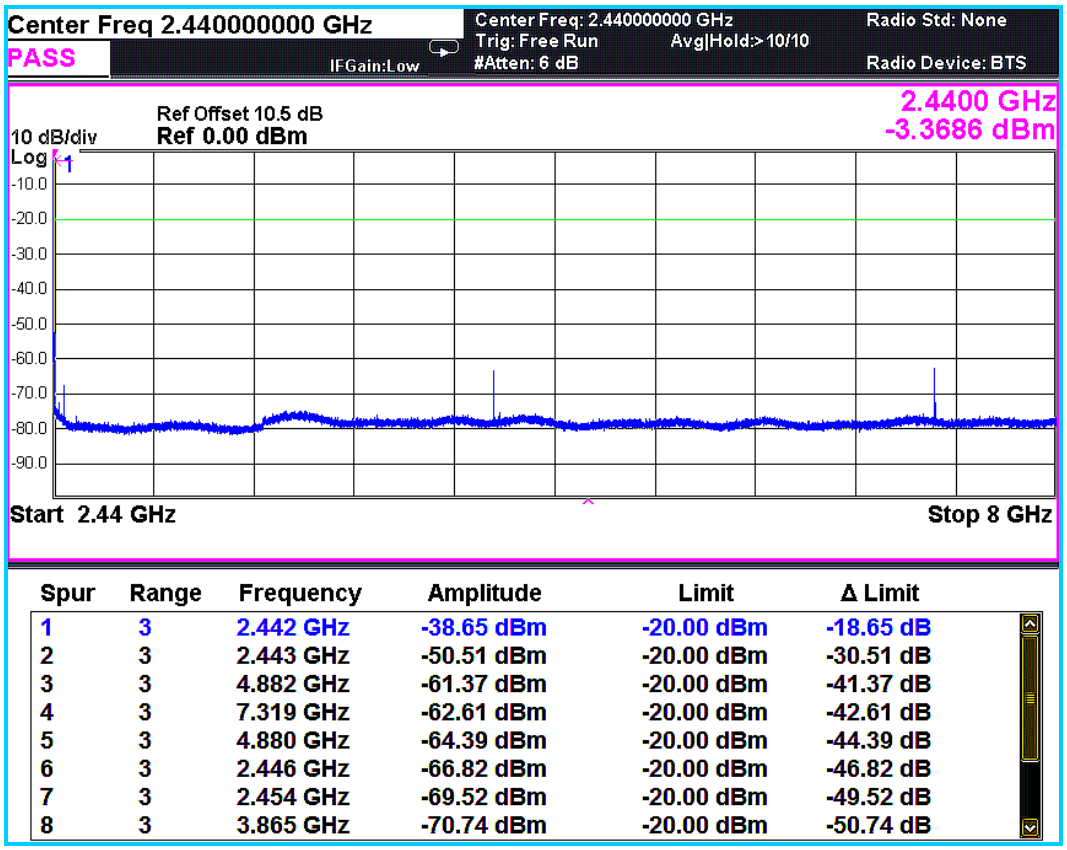
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	22.22 MHz	-66.69 dBm	-20.00 dBm	-46.69 dB
2	1	20.65 MHz	-67.19 dBm	-20.00 dBm	-47.19 dB
3	1	17.78 MHz	-67.93 dBm	-20.00 dBm	-47.93 dB
4	1	18.22 MHz	-68.12 dBm	-20.00 dBm	-48.12 dB
5	1	21.95 MHz	-68.19 dBm	-20.00 dBm	-48.19 dB
6	1	22.43 MHz	-68.59 dBm	-20.00 dBm	-48.59 dB
7	1	27.99 MHz	-68.70 dBm	-20.00 dBm	-48.70 dB
8	1	20.88 MHz	-68.72 dBm	-20.00 dBm	-48.72 dB



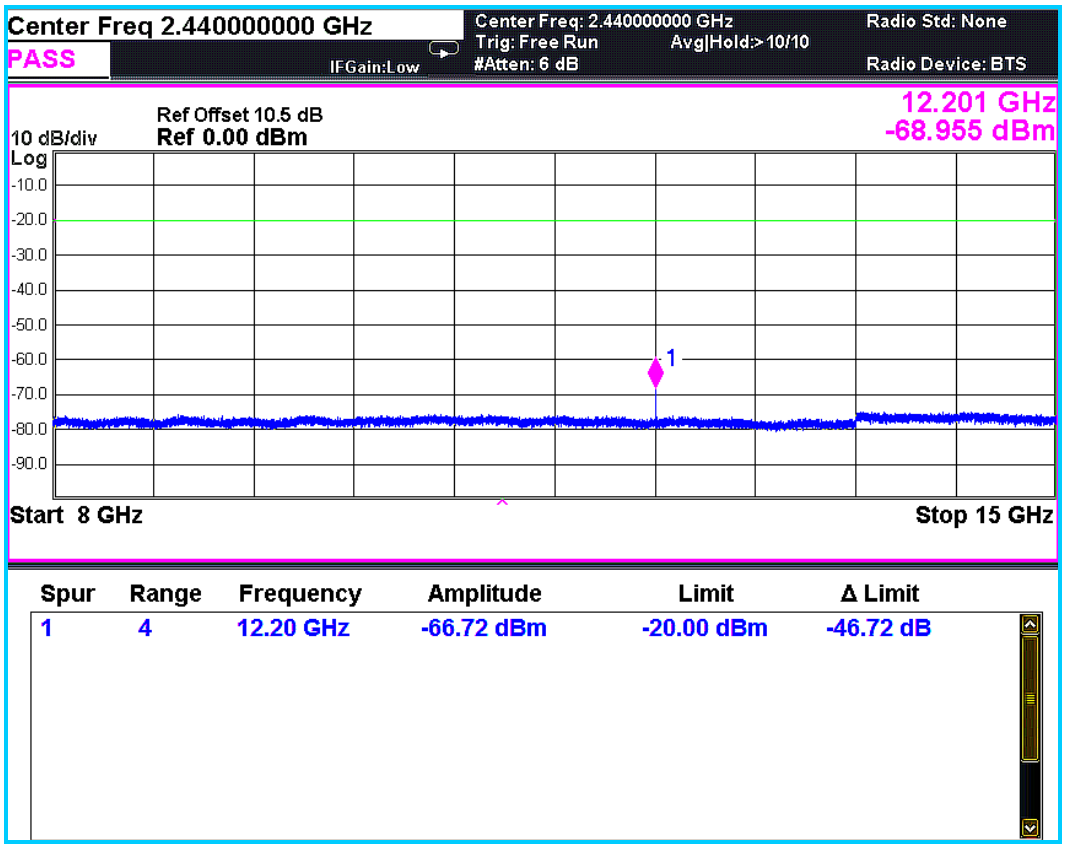
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	64.00 MHz	-39.37 dBm	-20.00 dBm	-19.37 dB
2	2	32.00 MHz	-48.11 dBm	-20.00 dBm	-28.11 dB
3	2	128.0 MHz	-48.69 dBm	-20.00 dBm	-28.69 dB
4	2	208.0 MHz	-54.89 dBm	-20.00 dBm	-34.89 dB
5	2	96.05 MHz	-54.93 dBm	-20.00 dBm	-34.93 dB
6	2	156.0 MHz	-55.22 dBm	-20.00 dBm	-35.22 dB
7	2	160.0 MHz	-56.65 dBm	-20.00 dBm	-36.65 dB
8	2	384.0 MHz	-57.08 dBm	-20.00 dBm	-37.08 dB



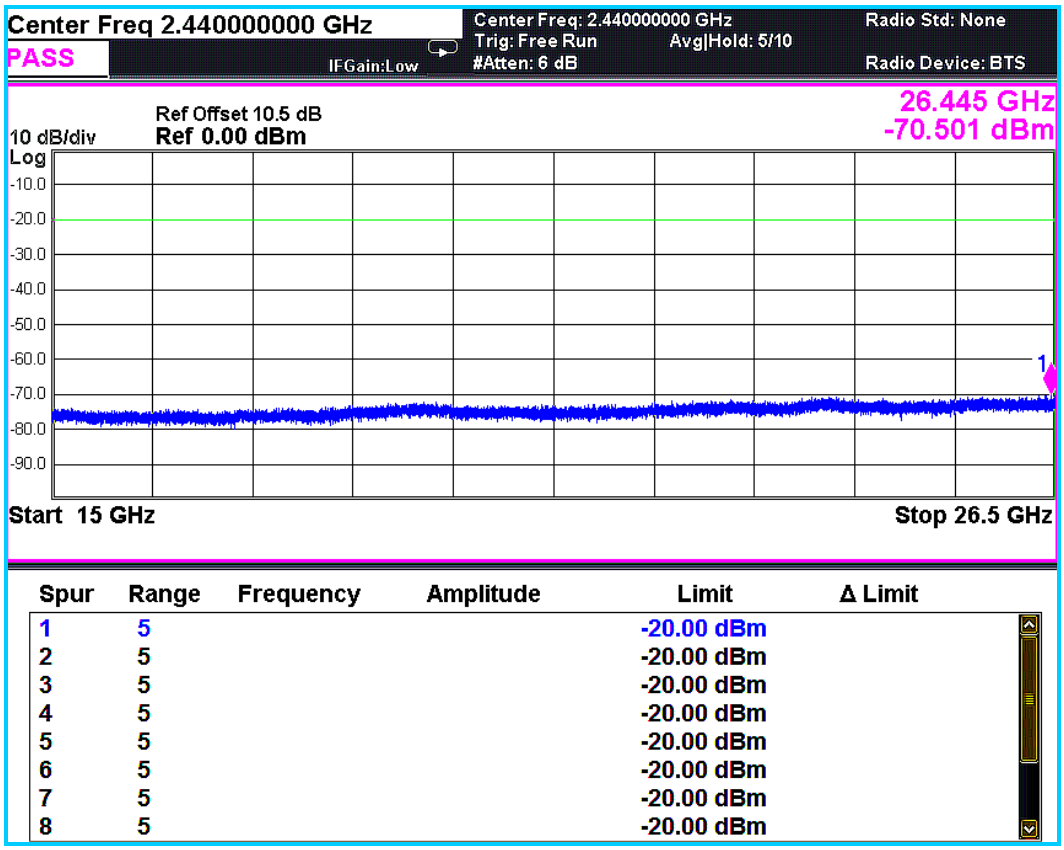
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	2.435 GHz	-58.22 dBm	-20.00 dBm	-38.22 dB
2	2	2.435 GHz	-59.77 dBm	-20.00 dBm	-39.77 dB
3	2	2.436 GHz	-60.27 dBm	-20.00 dBm	-40.27 dB
4	2	2.435 GHz	-62.35 dBm	-20.00 dBm	-42.35 dB
5	2	2.437 GHz	-64.40 dBm	-20.00 dBm	-44.40 dB
6	2	2.376 GHz	-66.19 dBm	-20.00 dBm	-46.19 dB
7	2	2.433 GHz	-67.24 dBm	-20.00 dBm	-47.24 dB
8	2	2.312 GHz	-67.54 dBm	-20.00 dBm	-47.54 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	3	2.442 GHz	-38.65 dBm	-20.00 dBm	-18.65 dB
2	3	2.443 GHz	-50.51 dBm	-20.00 dBm	-30.51 dB
3	3	4.882 GHz	-61.37 dBm	-20.00 dBm	-41.37 dB
4	3	7.319 GHz	-62.61 dBm	-20.00 dBm	-42.61 dB
5	3	4.880 GHz	-64.39 dBm	-20.00 dBm	-44.39 dB
6	3	2.446 GHz	-66.82 dBm	-20.00 dBm	-46.82 dB
7	3	2.454 GHz	-69.52 dBm	-20.00 dBm	-49.52 dB
8	3	3.865 GHz	-70.74 dBm	-20.00 dBm	-50.74 dB

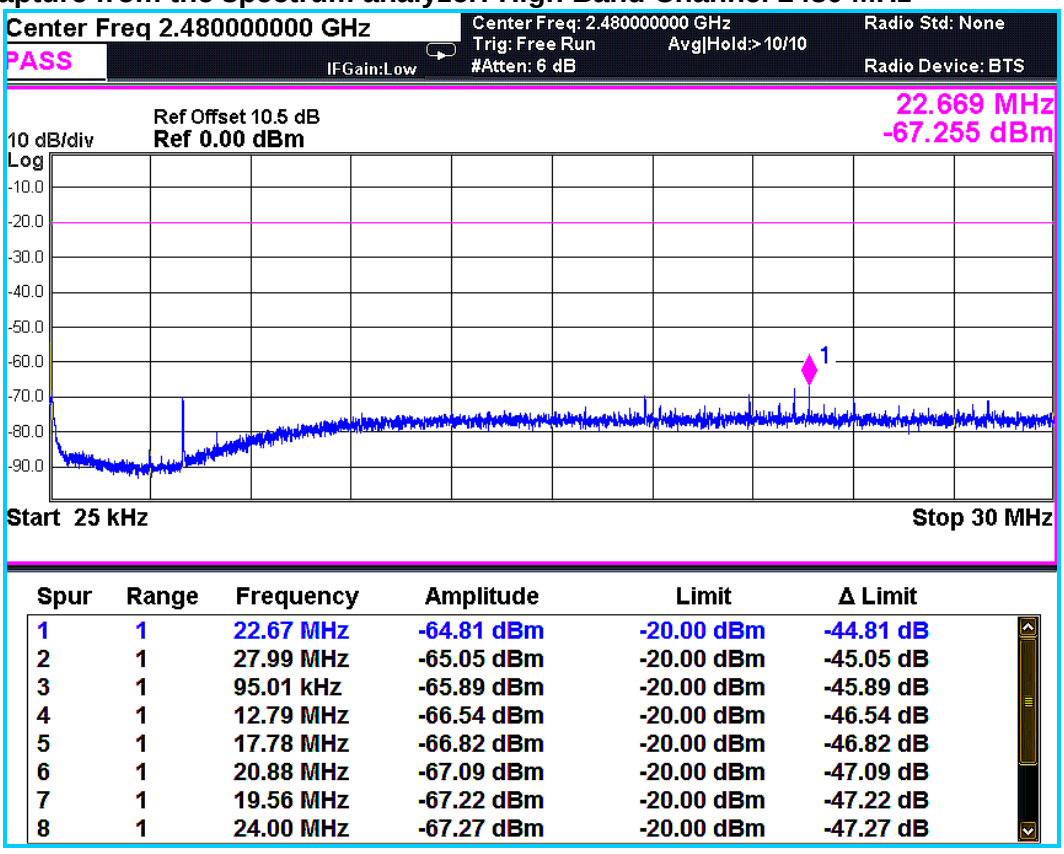


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	4	12.20 GHz	-66.72 dBm	-20.00 dBm	-46.72 dB

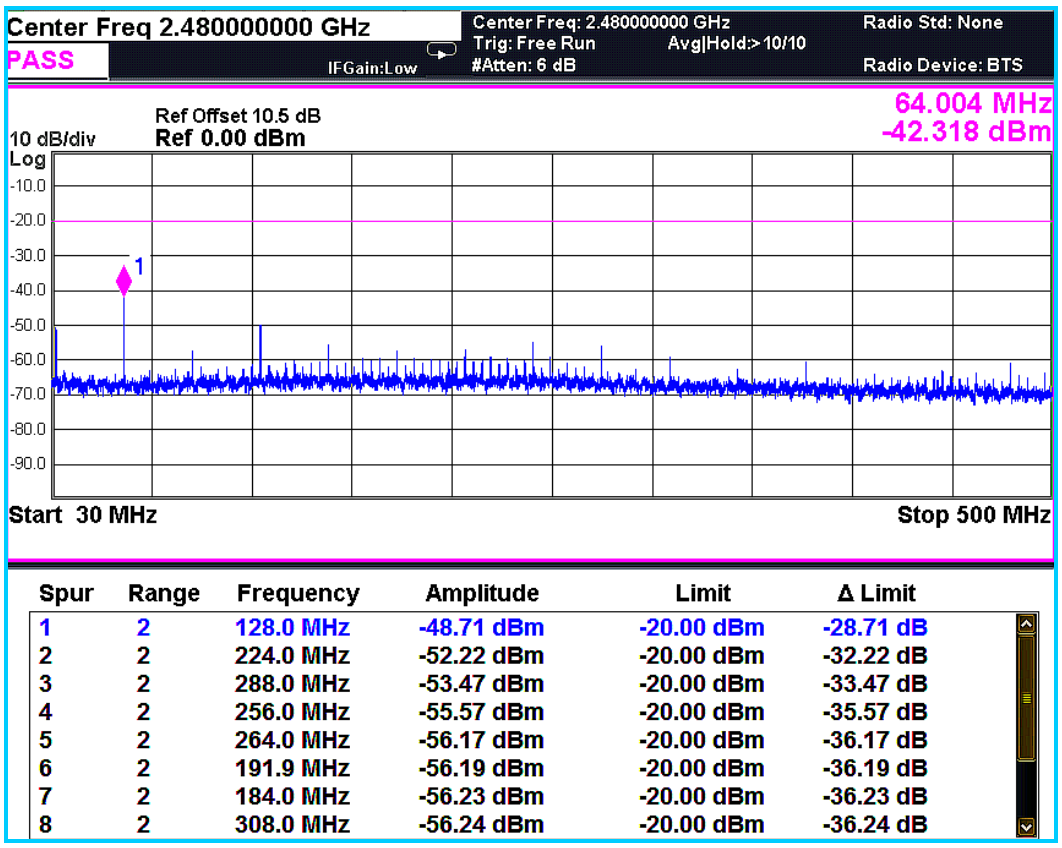


Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	5			-20.00 dBm	
2	5			-20.00 dBm	
3	5			-20.00 dBm	
4	5			-20.00 dBm	
5	5			-20.00 dBm	
6	5			-20.00 dBm	
7	5			-20.00 dBm	
8	5			-20.00 dBm	

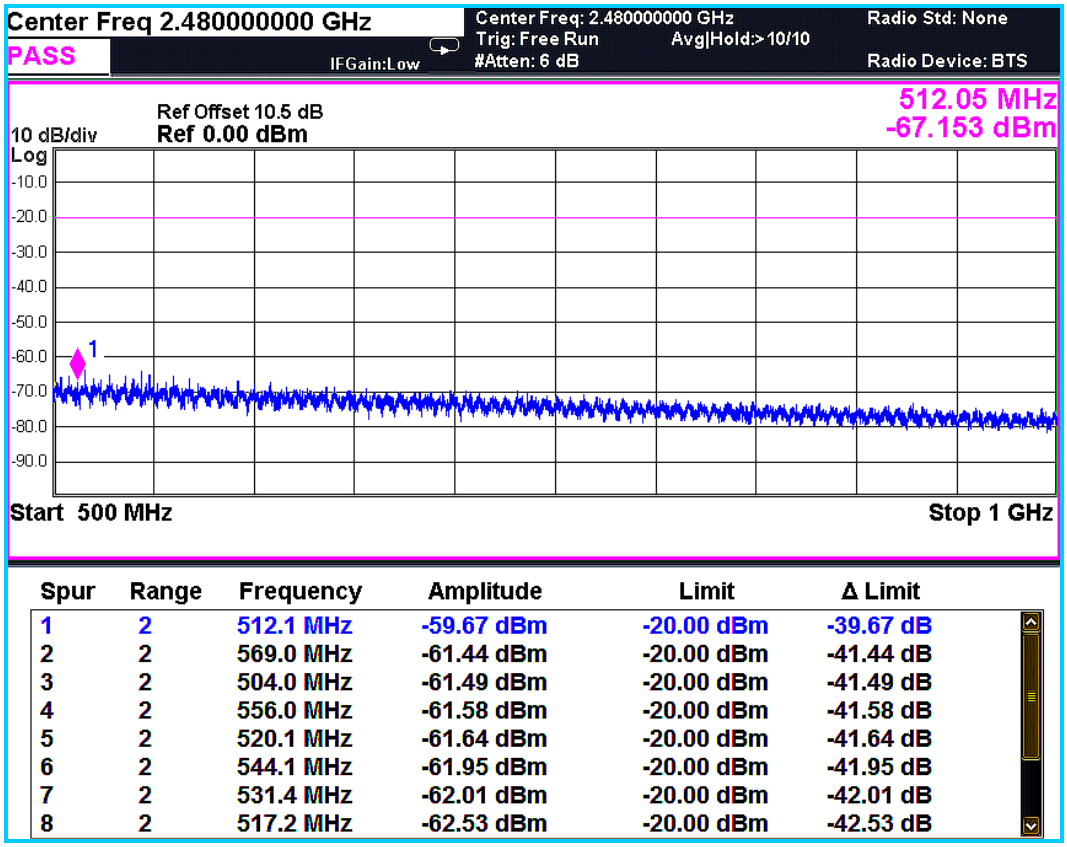
Screen Capture from the spectrum analyzer: High Band Channel 2480 MHz



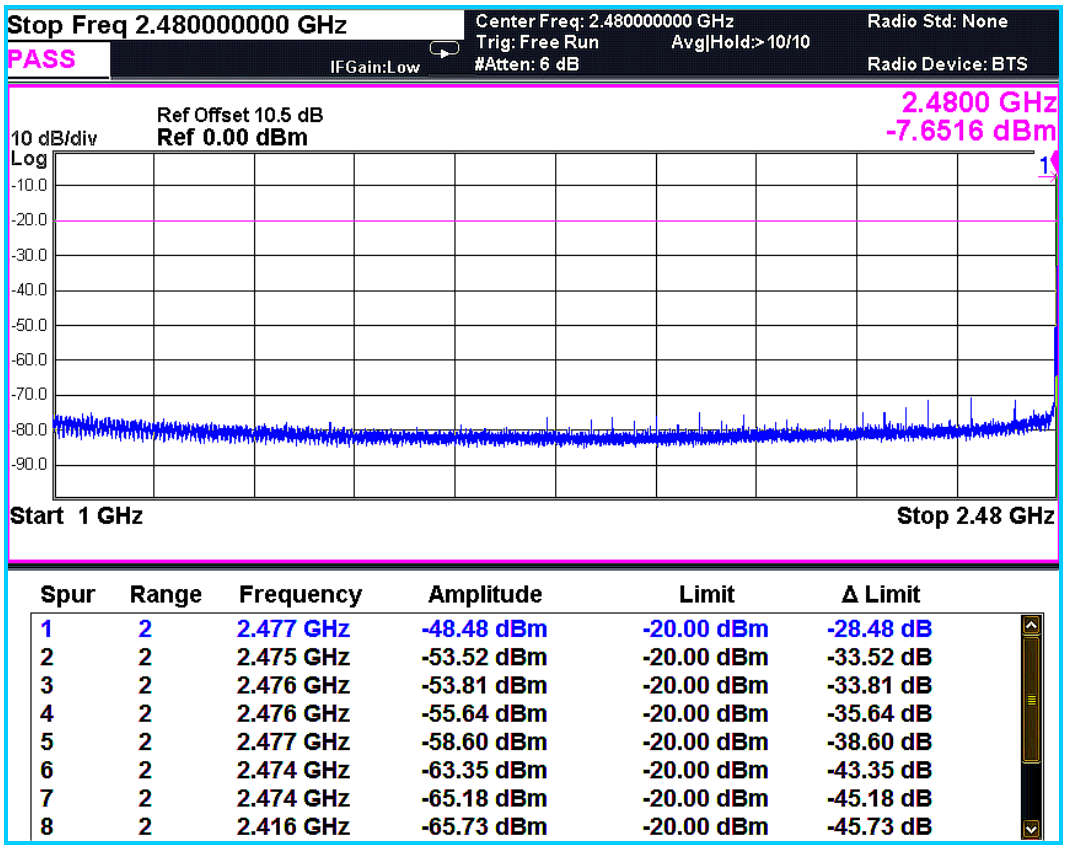
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	1	22.67 MHz	-64.81 dBm	-20.00 dBm	-44.81 dB
2	1	27.99 MHz	-65.05 dBm	-20.00 dBm	-45.05 dB
3	1	95.01 kHz	-65.89 dBm	-20.00 dBm	-45.89 dB
4	1	12.79 MHz	-66.54 dBm	-20.00 dBm	-46.54 dB
5	1	17.78 MHz	-66.82 dBm	-20.00 dBm	-46.82 dB
6	1	20.88 MHz	-67.09 dBm	-20.00 dBm	-47.09 dB
7	1	19.56 MHz	-67.22 dBm	-20.00 dBm	-47.22 dB
8	1	24.00 MHz	-67.27 dBm	-20.00 dBm	-47.27 dB



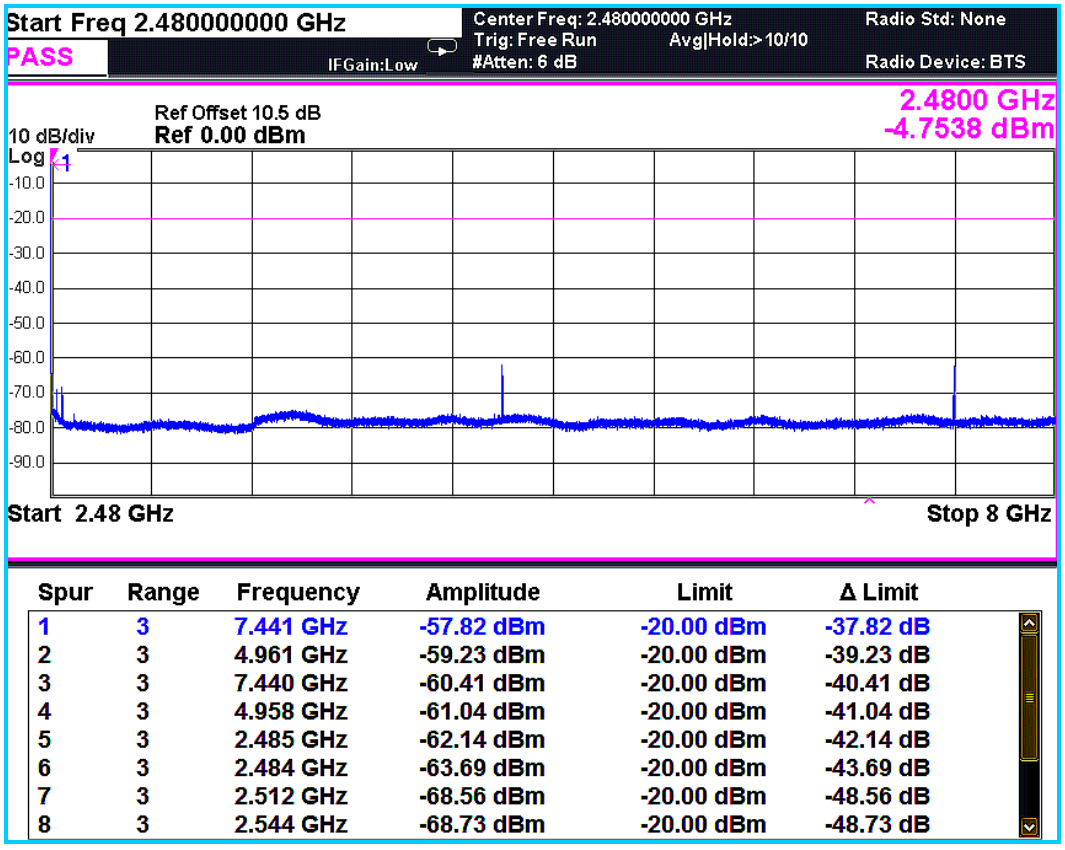
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	128.0 MHz	-48.71 dBm	-20.00 dBm	-28.71 dB
2	2	224.0 MHz	-52.22 dBm	-20.00 dBm	-32.22 dB
3	2	288.0 MHz	-53.47 dBm	-20.00 dBm	-33.47 dB
4	2	256.0 MHz	-55.57 dBm	-20.00 dBm	-35.57 dB
5	2	264.0 MHz	-56.17 dBm	-20.00 dBm	-36.17 dB
6	2	191.9 MHz	-56.19 dBm	-20.00 dBm	-36.19 dB
7	2	184.0 MHz	-56.23 dBm	-20.00 dBm	-36.23 dB
8	2	308.0 MHz	-56.24 dBm	-20.00 dBm	-36.24 dB



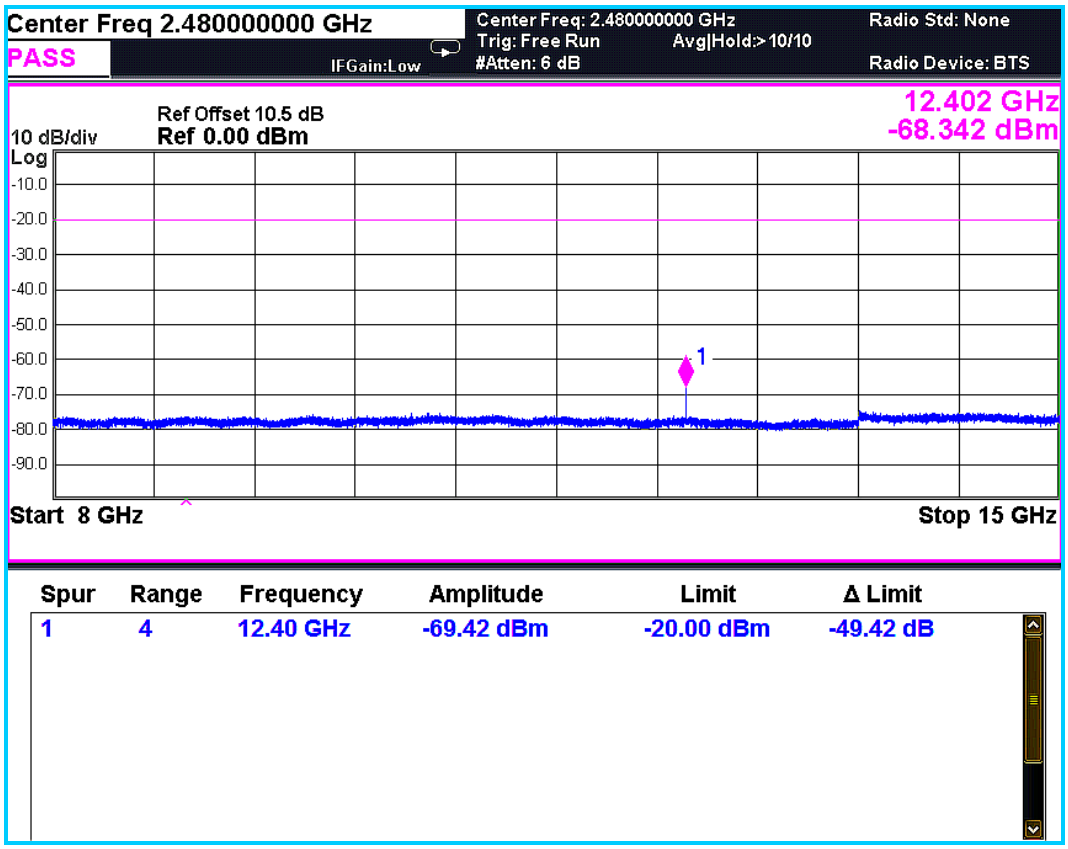
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	512.1 MHz	-59.67 dBm	-20.00 dBm	-39.67 dB
2	2	569.0 MHz	-61.44 dBm	-20.00 dBm	-41.44 dB
3	2	504.0 MHz	-61.49 dBm	-20.00 dBm	-41.49 dB
4	2	556.0 MHz	-61.58 dBm	-20.00 dBm	-41.58 dB
5	2	520.1 MHz	-61.64 dBm	-20.00 dBm	-41.64 dB
6	2	544.1 MHz	-61.95 dBm	-20.00 dBm	-41.95 dB
7	2	531.4 MHz	-62.01 dBm	-20.00 dBm	-42.01 dB
8	2	517.2 MHz	-62.53 dBm	-20.00 dBm	-42.53 dB



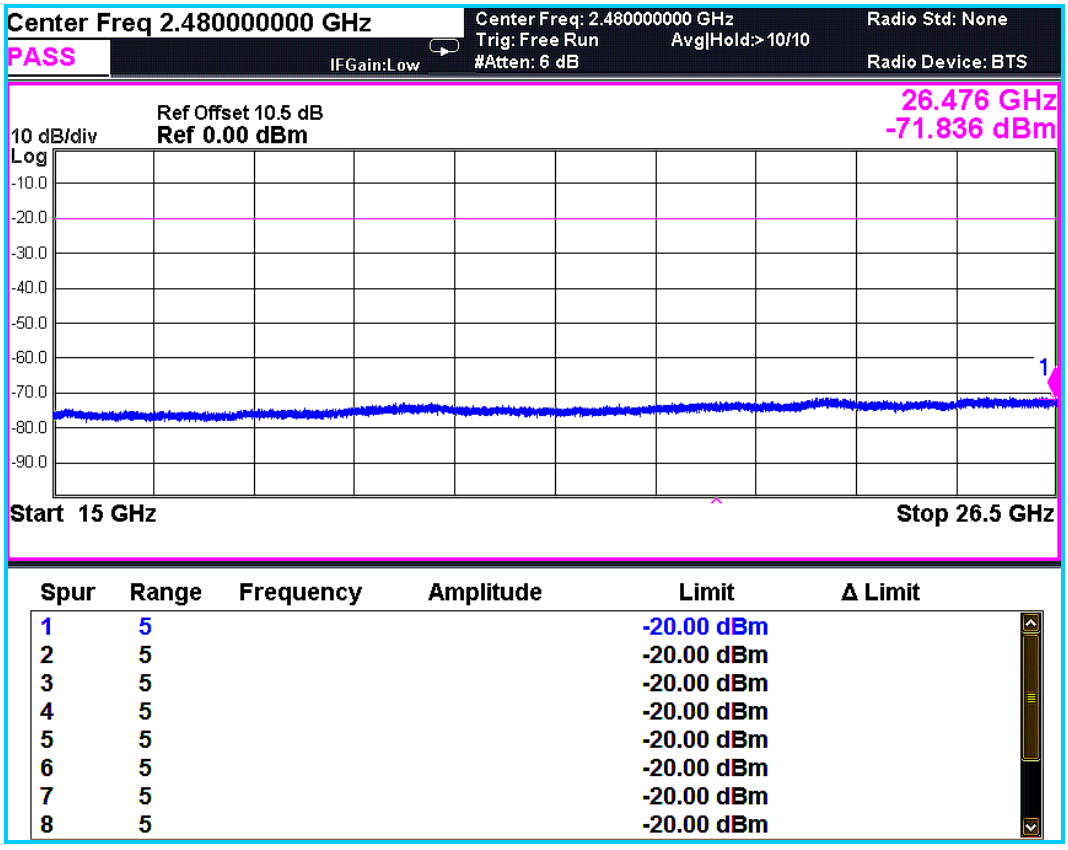
Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	2	2.477 GHz	-48.48 dBm	-20.00 dBm	-28.48 dB
2	2	2.475 GHz	-53.52 dBm	-20.00 dBm	-33.52 dB
3	2	2.476 GHz	-53.81 dBm	-20.00 dBm	-33.81 dB
4	2	2.476 GHz	-55.64 dBm	-20.00 dBm	-35.64 dB
5	2	2.477 GHz	-58.60 dBm	-20.00 dBm	-38.60 dB
6	2	2.474 GHz	-63.35 dBm	-20.00 dBm	-43.35 dB
7	2	2.474 GHz	-65.18 dBm	-20.00 dBm	-45.18 dB
8	2	2.416 GHz	-65.73 dBm	-20.00 dBm	-45.73 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	3	7.441 GHz	-57.82 dBm	-20.00 dBm	-37.82 dB
2	3	4.961 GHz	-59.23 dBm	-20.00 dBm	-39.23 dB
3	3	7.440 GHz	-60.41 dBm	-20.00 dBm	-40.41 dB
4	3	4.958 GHz	-61.04 dBm	-20.00 dBm	-41.04 dB
5	3	2.485 GHz	-62.14 dBm	-20.00 dBm	-42.14 dB
6	3	2.484 GHz	-63.69 dBm	-20.00 dBm	-43.69 dB
7	3	2.512 GHz	-68.56 dBm	-20.00 dBm	-48.56 dB
8	3	2.544 GHz	-68.73 dBm	-20.00 dBm	-48.73 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	4	12.40 GHz	-69.42 dBm	-20.00 dBm	-49.42 dB



Spur	Range	Frequency	Amplitude	Limit	Δ Limit
1	5			-20.00 dBm	
2	5			-20.00 dBm	
3	5			-20.00 dBm	
4	5			-20.00 dBm	
5	5			-20.00 dBm	
6	5			-20.00 dBm	
7	5			-20.00 dBm	
8	5			-20.00 dBm	

2.7 EUT Positioning Assessment

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.4-2014**
Date: 2015-11-09 (20.1° C, 31.7% RH)	

EUT status: On Edge position selected

Specification: ANSI C63.4-2014, Clause 6.3.2.1

Portable, small, lightweight, or modular devices that may be handheld, worn on the body, or placed on a table during operation shall be positioned on a non-conducting platform, the top of which is 80 cm above the reference ground plane. The preferred area occupied by the EUT arrangement is 1 m by 1.5 m, but it may be larger or smaller to accommodate various sized EUTs (see Figure 6, Figure 7, and Figure 9). For testing purposes, ceiling- and wall-mounted devices also shall be positioned on a tabletop (see also 6.3.4 and 6.3.5). In making any tests involving handheld, body-worn, or ceiling-mounted equipment, it is essential to recognize that the measured levels may be dependent on the orientation (attitude) of the three orthogonal axes of the EUT. Thus, exploratory tests as specified in 8.3.1 shall be carried out for various axes orientations to determine the attitude having maximum or near-maximum emission level.

2.7.1 Test Methodology: ANSI C63.4-2014, Clause 6.3.2.1

The EUT is set to a selected channel with test-specific software. The output is modulated as in normal operation.

Assessment measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz. The EUT is placed 80 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The EUT is rotated in azimuth over 360 degrees to find the direction of maximum emission. Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the Peak detector and recorded.

This process is repeated for all three orthogonal axes of the EUT, in both polarizations.

2.7.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.7.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Frequency	Uncertainty
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.7.4 Test Equipment

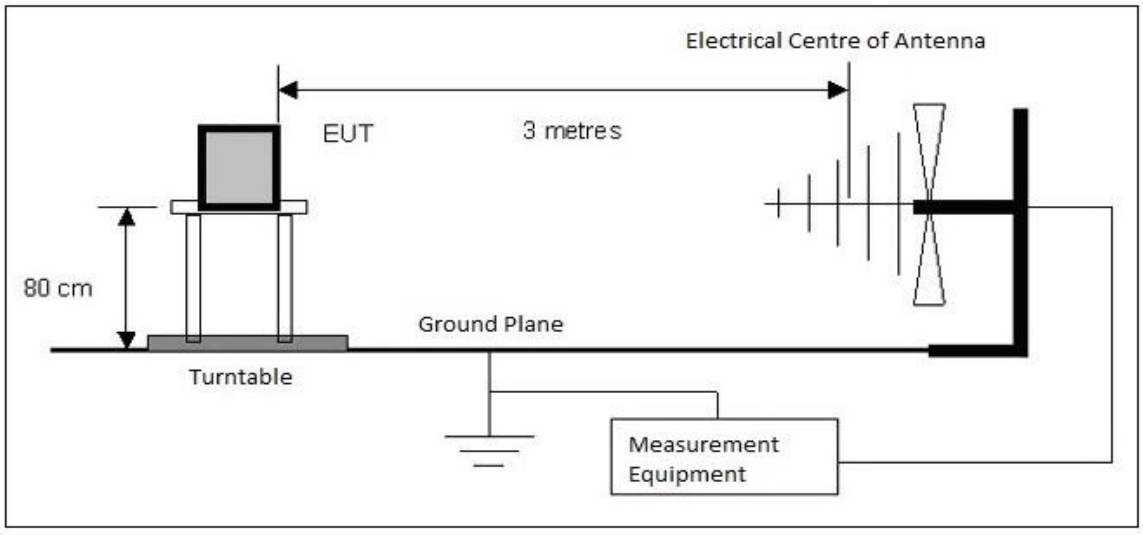
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A
EMI receiver	Agilent	N9038A	6130	2016-06-23
DRG Horn	EMCO	3115	19357	2016-09-17

2.7.5 Test Sample Verification, Configuration & Modifications

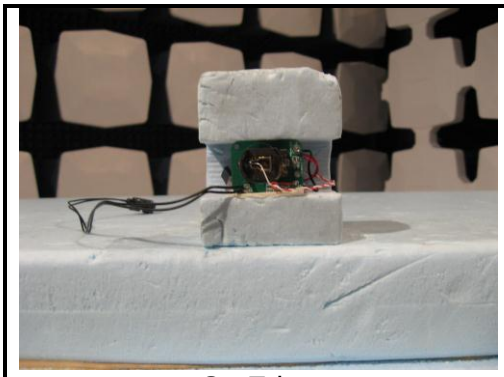
The EUT was set to a selected channel with test-specific software. The output was modulated as in normal operation. The EUT was not modified.

Test setup diagram for EUT Positioning Assessment:

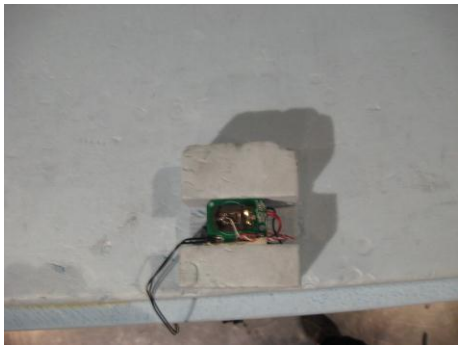


2.7.6 Peak Radiated Emissions Data:

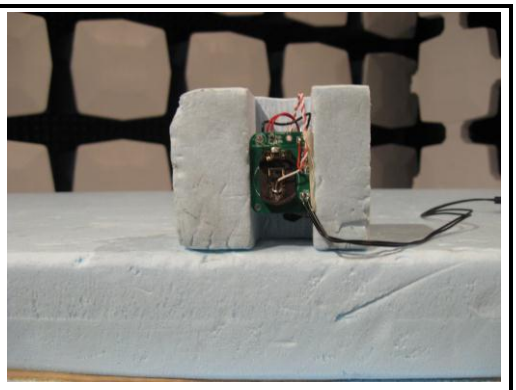
The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, and the uncorrected spectrum analyzer reading.



On Edge



Flat (top view)



Upright

EUT Position	Frequency [MHz]	SA Reading [dBuV]	Azimuth [deg]	Antenna Height [cm]	Polarization
Upright	2402	47.91	360	150	Horizontal
Upright	2402	51.08	352	150	Vertical
Upright	2440	45.27	179	150	Horizontal
Upright	2440	49.08	351	150	Vertical
Upright	2480	49.29	358	150	Horizontal
Upright	2480	48.84	358	150	Vertical
Flat	2402	52.93	360	150	Horizontal
Flat	2402	42.55	180	150	Vertical
Flat	2440	53.32	269	150	Horizontal
Flat	2440	46.04	179	150	Vertical
Flat	2480	49.65	351	150	Horizontal
Flat	2480	45.87	90	150	Vertical
On Edge	2402	45.82	179	150	Horizontal
On Edge	2402	48.82	351	150	Vertical
On Edge	2440	49.35	352	150	Horizontal
On Edge	2440	48.5	180	150	Vertical
On Edge	2480	47.54	179	150	Horizontal
On Edge	2480	48.35	269	150	Vertical

2.8 Transmitter Radiated Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie

EUT: M1

Test Personnel: Imran Akram, Vassan Kohli

Standard: FCC PART 15.247

Test Method: TM-EMC 13

Basic Standard: ANSI C63.10-2013

Date:2015-11-(09/12/16)(18.9/18.6/18.8°C)
(26.5/21.4/23.6% RH)

EUT status: Compliant

Criteria: The radiated emissions produced by a device, measured at a distance of 3 meters, shall not exceed the limits as specified. EUT emissions were scanned up to 26.5 GHz. No reportable emissions were observed above 18.0 GHz.

Specification: FCC PART 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

Restricted Bands of Operation:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.0900000 – 0.1100000	8.2910000 - 8.2940000	16.804250 - 16.804750	162.01250 - 167.17000 *	1660.0000 – 1710.0000	3.6000000 – 4.4000000	14.470000 – 14.500000
0.4950000 - 0.5050000 *	8.3620000 - 8.3660000	25.500000 - 25.670000	167.72000 - 173.20000 *	1718.8000 – 1722.2000	4.5000000 – 5.1500000	15.350000 – 16.200000
2.1735000 - 2.1905000	8.3762500 - 8.3867500	37.500000 - 38.250000	240.00000 – 285.00000	2200.0000 – 2300.0000	5.3500000 – 5.4600000	17.700000 – 21.400000
4.1250000 - 4.1280000	8.4142500 - 8.4147500	73.000000 - 74.600000	322.00000 - 335.40000	2310.0000 – 2390.0000	7.2500000 – 7.7500000	22.010000 – 23.120000
4.1772500 - 4.1777500	12.290000 - 12.293000	74.800000 - 75.200000	399.90000 – 410.00000	2483.5000 – 2500.0000 *	8.0250000 – 8.5000000	23.600000 – 24.000000
4.2072500 - 4.2077500	12.519750 - 12.520250	108.00000 - 121.94000 **	608.00000 – 614.00000	2655.0000 – 2900.0000	9.0000000 – 9.2000000	31.200000 – 31.800000
5.6770000 - 5.6830000	12.576750 - 12.577250	123.00000 - 138.00000 **	960.00000 – 1240.0000 ***	3260..0000 – 3267.0000	9.3000000 – 9.5000000	36.430000 – 36.500000
6.2150000 - 6.2180000	13.360000 - 13.410000	149.90000 - 150.05000 *	1300.0000 – 1427.0000 ***	3332.0000 – 3339.0000	10.600000 – 12.700000	Above 38.600000
6.2677500 - 6.2682500	16.420000 - 16.423000	156.52475- 156.52525	1435.0000 – 1626.5000	3345.8000 – 3358.0000	13.250000 – 13.400000	
6.3117500 - 6.3122500	16.694750 - 16.695250	156.70000 - 156.90000	1645.5000 – 1646.5000	3500.0000 – 3600.0000 ****		

* US only ** Canada 108 – 138 MHz *** Canada 960 – 1427 MHz **** Canada only

2.8.1 Test Methodology: ANSI C63.10-2013, Clause 13.4.2

From 9kHz to 150 kHz (resolution bandwidth of 200 Hz) and from 150 kHz to 30 MHz (resolution bandwidth 9 kHz) measurements are performed with a loop antenna (as per KDB 460108).

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz. The EUT is raised to 150 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The scan is performed at discreet increments of turntable azimuth and antenna height, which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

Frequencies having peak emissions within 10dB of the limits are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

Note: The EUT was assessed for worst-case orientation. All radiated testing was performed with this orientation, as shown in the test setup photos.

2.8.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.8.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.8.4 Test Equipment

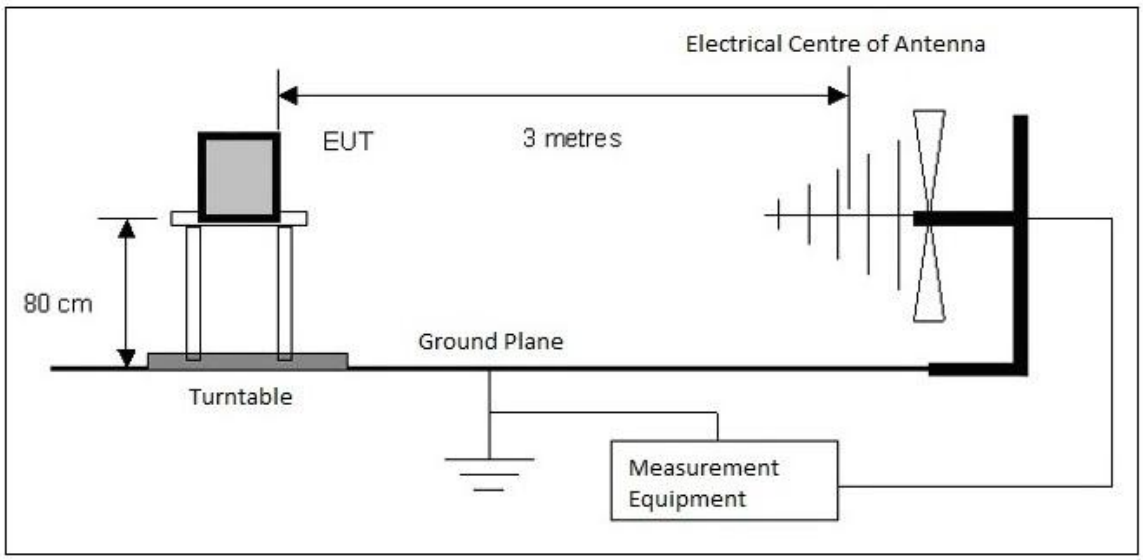
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A
EMI receiver	Agilent	N9038A	6130	2016-06-23
Loop Antenna	EMCO	6502	10868	2017-04-10
Biconilog Antenna	ARA	LPB-2520/A	4318	2017-02-20
DRG Horn	EMCO	3115	19357	2016-09-17
Standard Gain Horn 18 – 26.5 GHz	QuinStar	QWH-KPRS-00	6163	2016-08-27
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	Monitored
Low Noise Amplifier (18 – 26.5GHz)	MITEQ			Monitored

2.8.5 Test Sample Verification, Configuration & Modifications

The EUT was set to Low, Mid and High channels with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagram for Radiated Spurious Emissions testing:



2.8.6 Radiated Emissions Data:

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

Meter Reading in dBμV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dbμV/m.

Delta = Field Strength - Limit

Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Peak, Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- In Transmit mode, the EUT was assessed up to 26.5 GHz. To prevent LNA saturation, a band-reject filter was used to block frequencies between 2.4 GHz and 2.5 GHz. Above 10 GHz, in Transmit mode, preliminary scanning of the EUT was performed at a distance of 50 cm with the RBW set at 300 kHz. There were no emissions.
- Pursuant to Part 15.31(o), emissions that are more than 20 dB below the applicable limit are not reported.

Negative values for Delta indicate compliance.

Transmit Mode, Low Channel 2402 MHz:

Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre-Amp Gain [dB	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
	191.9538	30.25	PK	9.6	-23.3	16.55	43.5	-26.95	160	100	Horizontal
	223.9354	33.64	PK	11.7	-23.1	22.24	46.02	-23.78	200	100	Horizontal
	256.0246	29.1	PK	12.2	-22.9	18.4	46.02	-27.62	240	100	Horizontal
1	4806.2*	56.6	Av	34	-45.4	45.2	54	-8.8	205	100	Horizontal
1	**4806.0***	**60.3**	**PK**	**34**	**-45.4**	**48.9**	**73.9**	**-25.0**	**340**	**100**	**Horizontal**
2	7207*	42.16	Av	37.8	-39.9	40.66	54	-13.34	167	108	Horizontal
2	**7205.7***	**51.42**	**PK**	**37.8**	**-39.9**	**49.92**	**73.9**	**-23.98**	**100**	**100**	**Horizontal**
3	9609*	35.83	Av	39	-36.4	38.43	54	-15.57	180	105	Horizontal
3	**9610***	**46.74**	**PK**	**39**	**-36.4**	**49.34**	**73.9**	**-24.56**	**300**	**100**	**Horizontal**
4	4806.2*	54.51	Av	34	-45.5	43.11	54	-10.89	23	193	Vertical
4	**4805.3***	**59.27**	**PK**	**34**	**-45.5**	**47.87**	**73.9**	**-26.03**	**40**	**249**	**Vertical**
5	7205.5*	45.03	Av	37.8	-39.9	43.53	54	-10.47	13	104	Vertical
5	**7205.7***	**55.73**	**PK**	**37.8**	**-39.9**	**54.23**	**73.9**	**-19.67**	**140**	**100**	**Vertical**
6	9609.1*	36.57	Av	39	-36.4	39.17	54	-14.83	332	113	Vertical
6	**9607.4***	**47.37**	**PK**	**39**	**-36.4**	**49.97**	**73.9**	**-23.93**	**60**	**100**	**Vertical**
7	12011.4*	65.17	Av	40.2	-65.7	39.67	54	-14.33	218	100	Horizontal
7	**12008.6***	**69.74**	**PK**	**40.2**	**-65.7**	**44.24**	**73.9**	**-29.66**	**20**	**100**	**Horizontal**
8	12009.3*	66.55	Av	40.2	-65.7	41.05	54	-12.95	277	211	Vertical
8	**12008.6***	**69.07**	**PK**	**40.2**	**-65.7**	**43.57**	**73.9**	**-30.33**	**60**	**250**	**Vertical**
54dBµv/m = Average Limit						74dBµv/m = Peak Limit					

*** Restricted Band**

PK - Peak detector

Av – Linear average detection

Transmit Mode, Mid Channel 2440 MHz:

Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre-Amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	191.9538	29.93	PK	9.6	-23.3	16.23	43.5	-27.7	120	100	Horizontal
2	223.9354	32.06	PK	11.7	-23.1	20.66	46.02	-25.36	200	100	Horizontal
2	256.0246	28.02	PK	12.2	-22.9	17.32	46.02	-28.27	20	100	Horizontal
4	157.2802	30.64	PK	8.9	-23.5	16.04	43.5	-27.46	40	249	Vertical
1	4882.1*	57.25	Av	34	-45.3	45.95	54	-8.05	150	11	Horizontal
1	**4882.0***	**58.52**	**PK**	**34**	**-45.3**	**47.22**	**73.9**	**-26.68**	**360**	**100**	**Horizontal**
2	7319.3*	38.57	Av	37.8	-38.9	37.47	54	-16.53	162	193	Horizontal
2	**7318.9***	**48.71**	**PK**	**37.8**	**-38.9**	**47.61**	**73.9**	**-26.29**	**180**	**250**	**Horizontal**
3	4882.1*	54.14	Av	34	-45.3	42.84	54	-11.16	199	214	Vertical
3	**4882.0***	**59.2**	**PK**	**34**	**-45.3**	**47.9**	**73.9**	**-26.0**	**200**	**249**	**Vertical**
4	7320.9*	40.77	Av	37.8	-38.9	39.67	54	-14.33	336	260	Vertical
4	**7318.9***	**52.69**	**PK**	**37.8**	**-38.9**	**51.59**	**73.9**	**-22.31**	**180**	**249**	**Vertical**
54dBµv/m = Average Limit						74dBµv/m = Peak Limit					

*** Restricted Band**

PK - Peak detector

Av – Linear average detection

Transmit Mode, High Channel 2480 MHz:

Freq. Marker	Freq. [MHz]	Raw reading [dBµv]	Det	Antenna Factor [dB/m]	Pre- Amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	95.9014	38.56	PK	8.7	-24.2	23.06	43.5	-20.44	140	100	Horizontal
2	191.9538	31.54	PK	9.6	-23.3	17.84	43.5	-25.66	360	100	Horizontal
3	223.9354	30.74	PK	11.7	-23.1	19.34	46.02	-26.68	20	100	Horizontal
4	235.8881	31.5	PK	12	-23.1	20.4	46.02	-25.62	100	100	Horizontal
5	256.0246	31.16	PK	12.2	-22.9	20.46	46.02	-25.56	240	100	Horizontal
6	608.0373	29.80	PK	18.6	-21.1	27.29	46.02	-18.73	100	250	Horizontal
1	4958.2*	54.97	Av	34	-45.5	43.47	54	-10.53	150	104	Horizontal
1	**4958.1**	**57.8**	**PK**	**34**	**-45.5**	**46.3**	**73.9**	**-27.6**	**260**	**100**	**Horizontal**
2	7440.9*	38.83	Av	37.6	-38.5	37.93	54	-16.07	159	225	Horizontal
2	**7441.0**	**50.16**	**PK**	**37.6**	**-38.5**	**49.26**	**73.9**	**-24.64**	**180**	**250**	**Horizontal**
3	4958.2*	56.19	Av	34	-45.5	44.69	54	-9.31	201	208	Vertical
3	**4958.1**	**60.15**	**PK**	**34**	**-45.5**	**48.65**	**73.9**	**-25.25**	**359**	**250**	**Vertical**
4	7441.0*	41.06	Av	37.6	-38.5	40.16	54	-13.84	352	224	Vertical
4	**7439.1**	**52.21**	**PK**	**37.6**	**-38.5**	**51.31**	**73.9**	**-22.59**	**340**	**250**	**Vertical**
54dBµv/m = Average Limit						73.9dBµv/m = Peak Limit					

*** Restricted Band**

PK - Peak detector

Av – Linear average detection

Receive Mode, Mid Channel 2440 MHz:

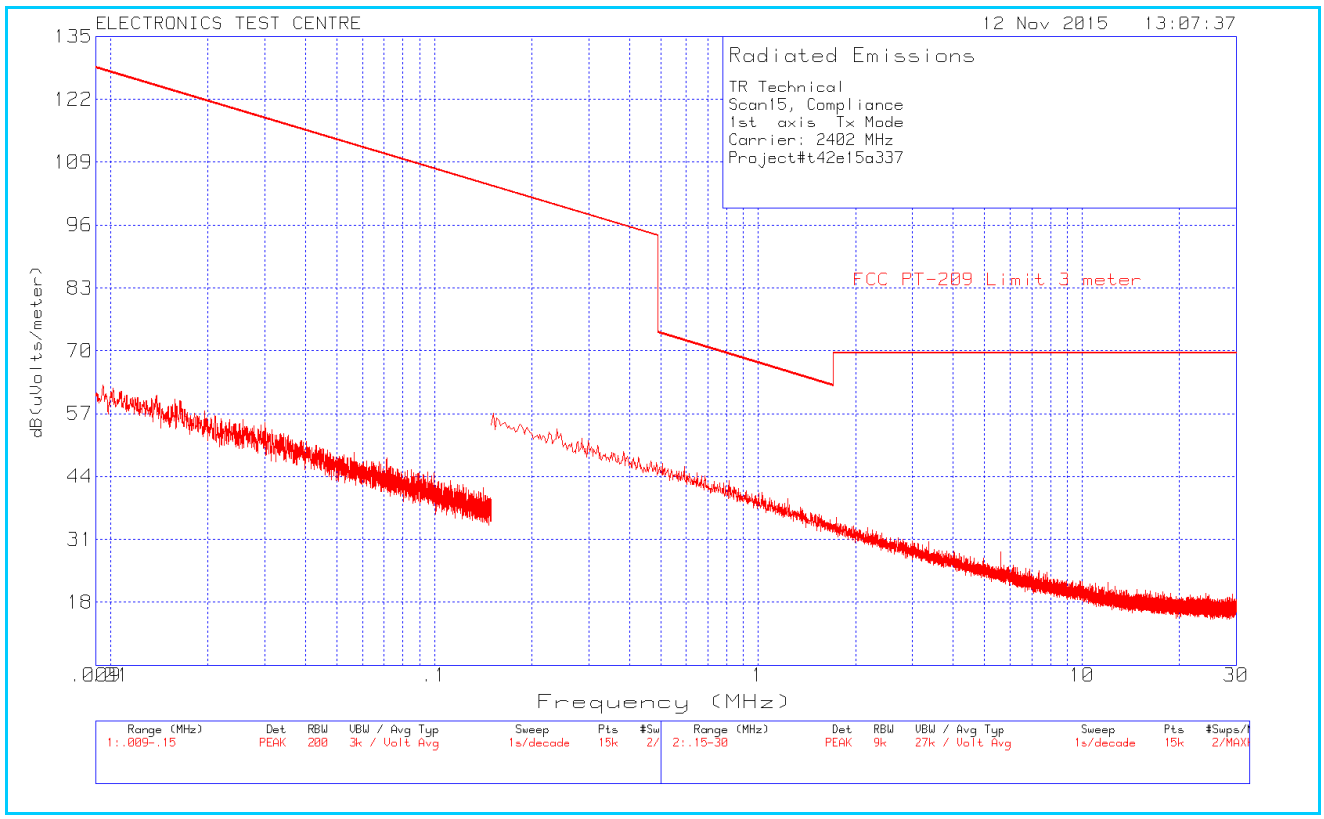
Freq. Marker	Freq. [MHz]	Raw reading[dBµv]	Det	Antenna Factor [dB/m]	Pre- Amp Gain [dB]	Corrected Reading [dBµv/m]	FCC 15.209 Limit [dBµv/m]	Delta [dB]	Azimuth [Deg]	Height [cm]	Polarization
1	4882.0*	58.81	PK	34	-45.3	47.51	74	-29.39	180	100	Horizontal
2	4882.0*	58.13	PK	34	-45.3	46.83	74	-2707	60	100	Vertical
1	4882.0*	58.81	PK	34	-45.3	47.51	54	-6.49	180	100	Horizontal
2	4882.0*	58.13	PK	34	-45.3	46.83	54	-7.17	60	100	Vertical
54dBµv/m = Average Limit							73.9dBµv/m = Peak Limit				

*** Restricted Band**

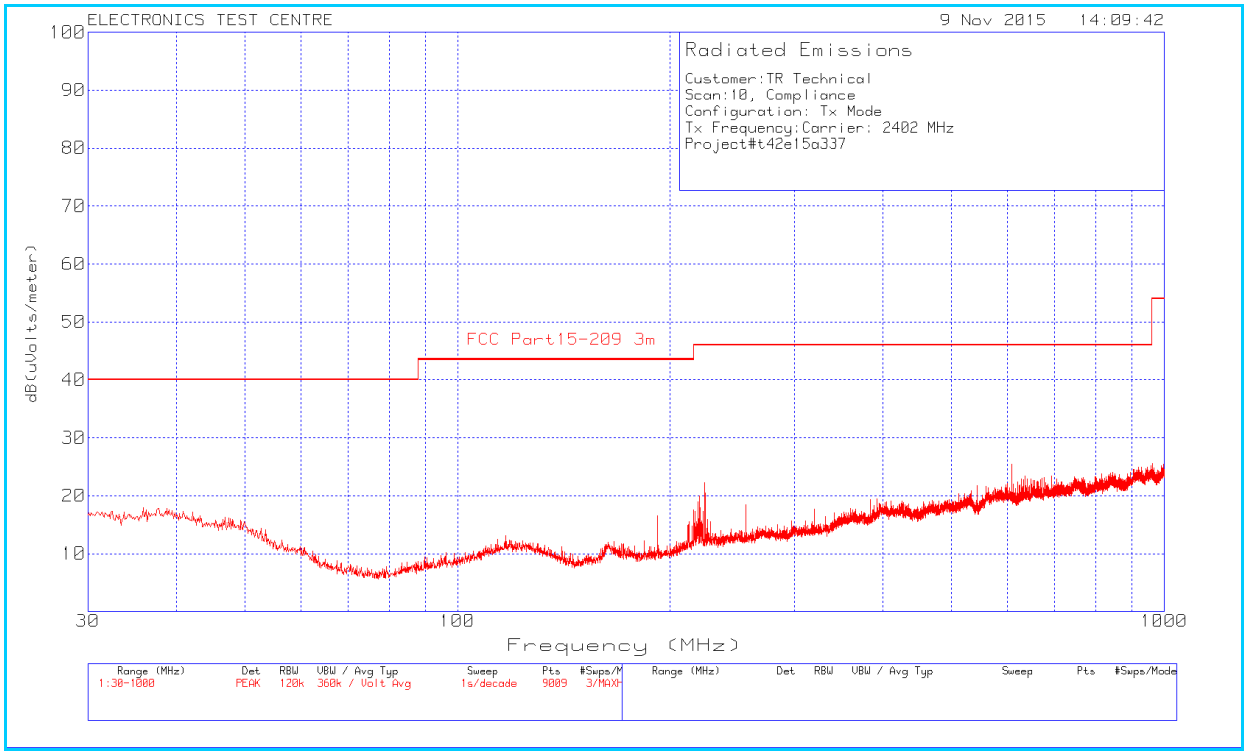
PK - Peak detector

Av – Linear average detection

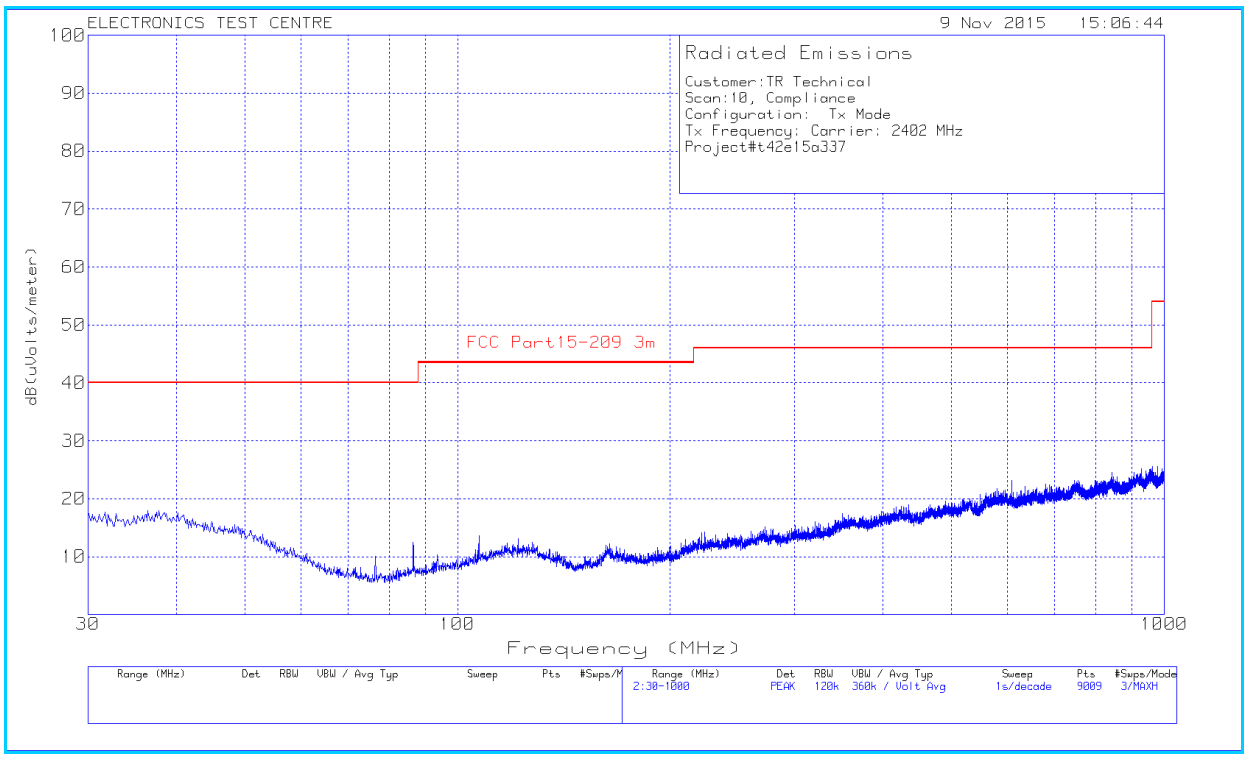
Low Channel 2402 MHz



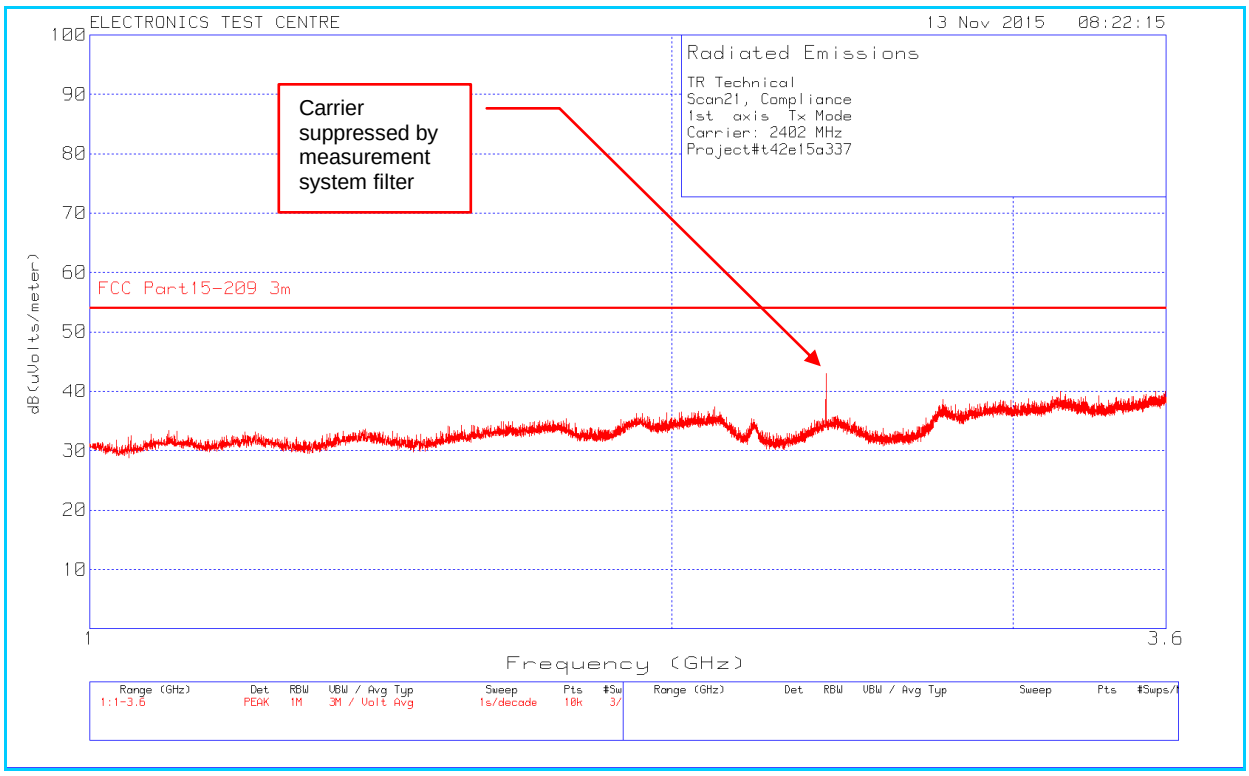
Plot of Radiated Emissions: [Horizontal-Polarization]



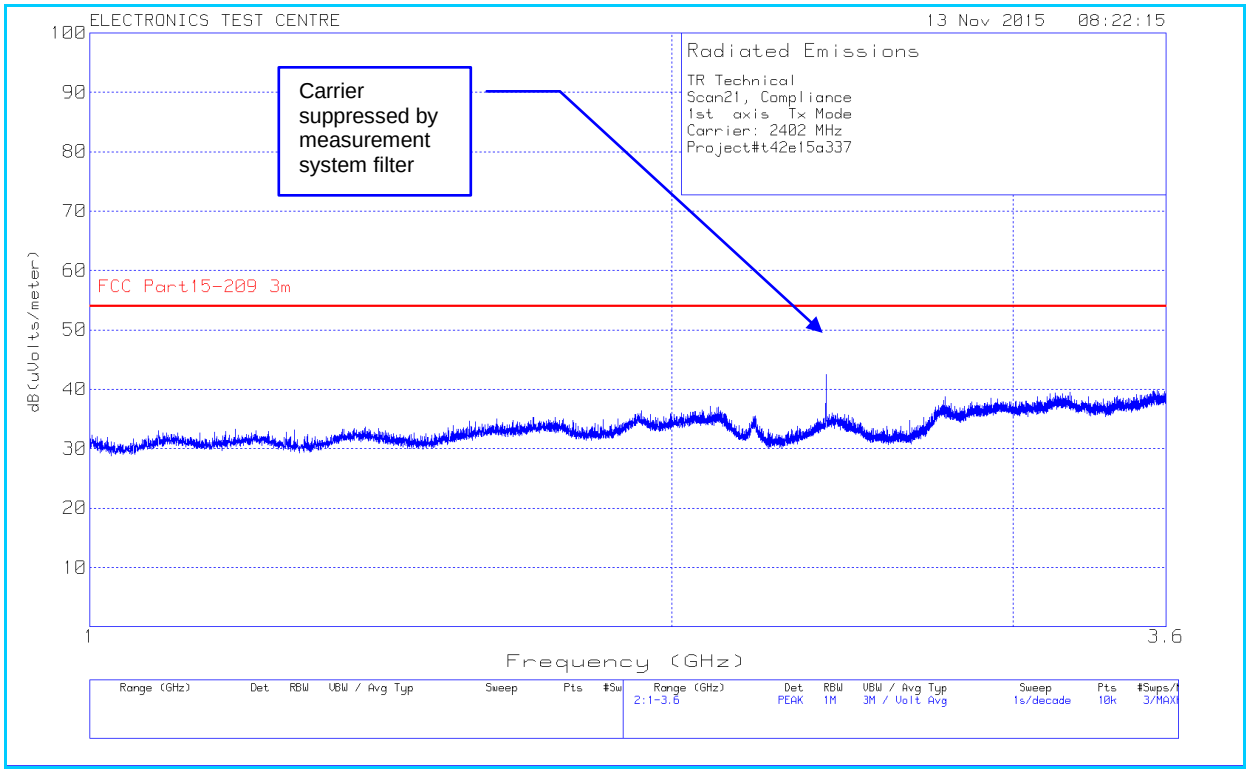
Plot of Radiated Emissions: [Vertical-Polarization]



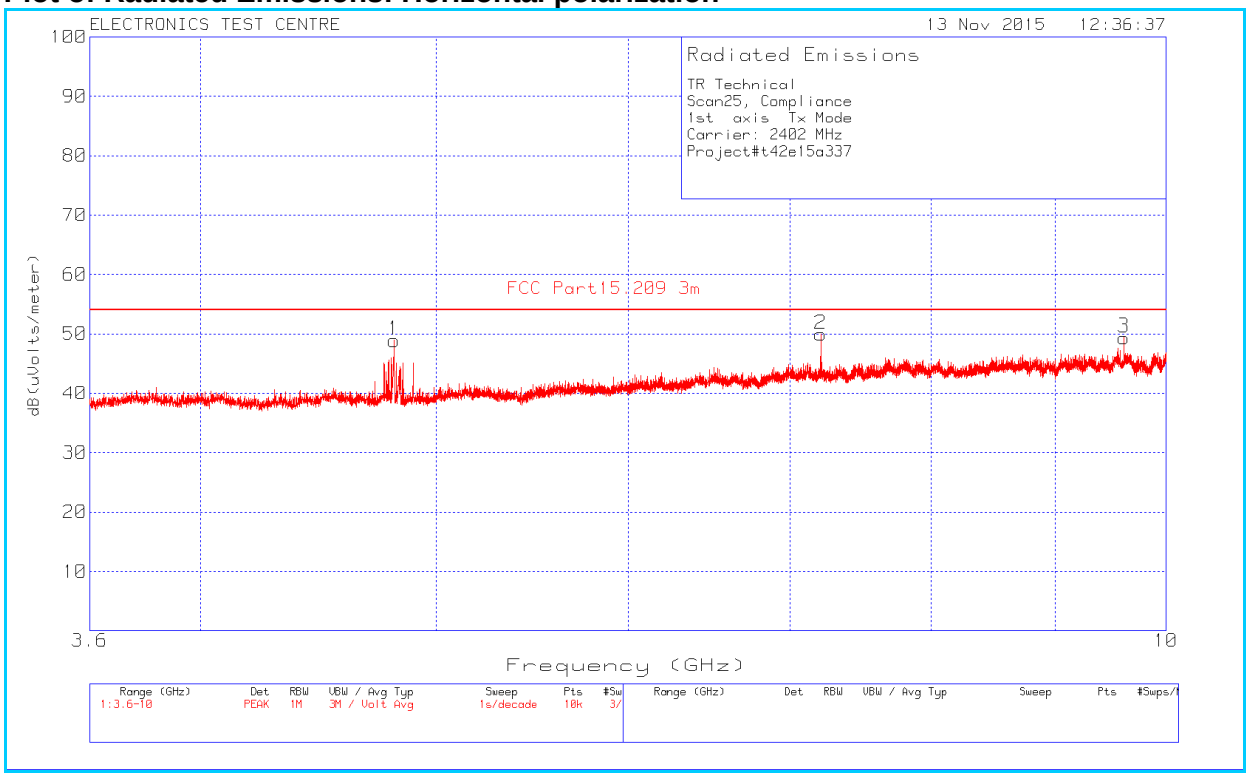
Plot of Radiated Emissions: [Horizontal polarization]



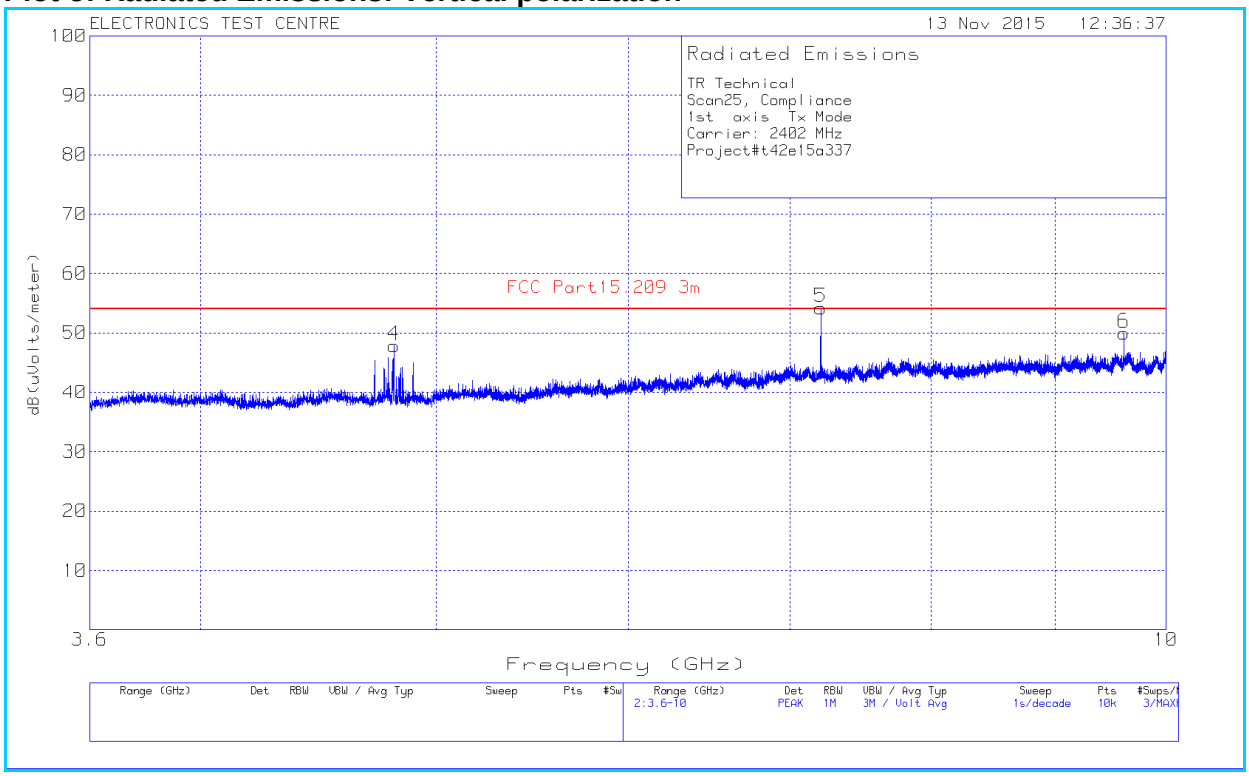
Plot of Radiated Emissions: [Vertical polarization]



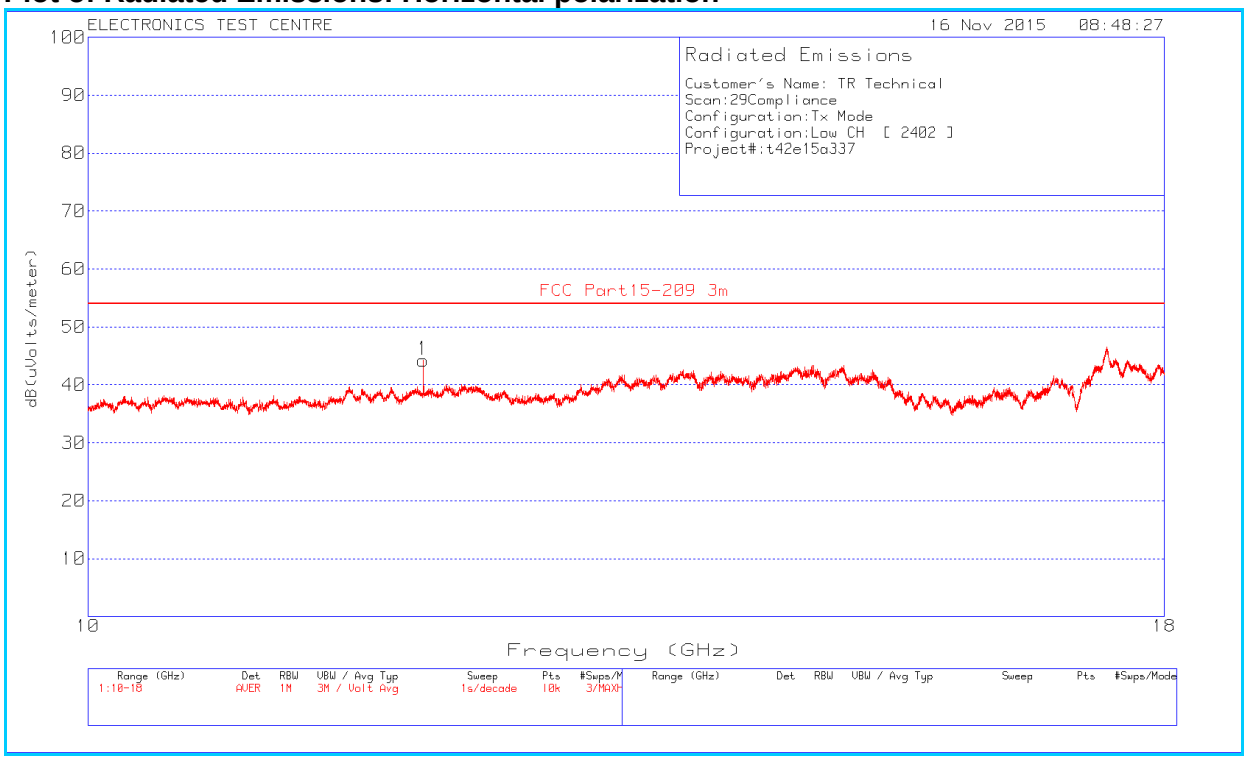
Plot of Radiated Emissions: Horizontal polarization



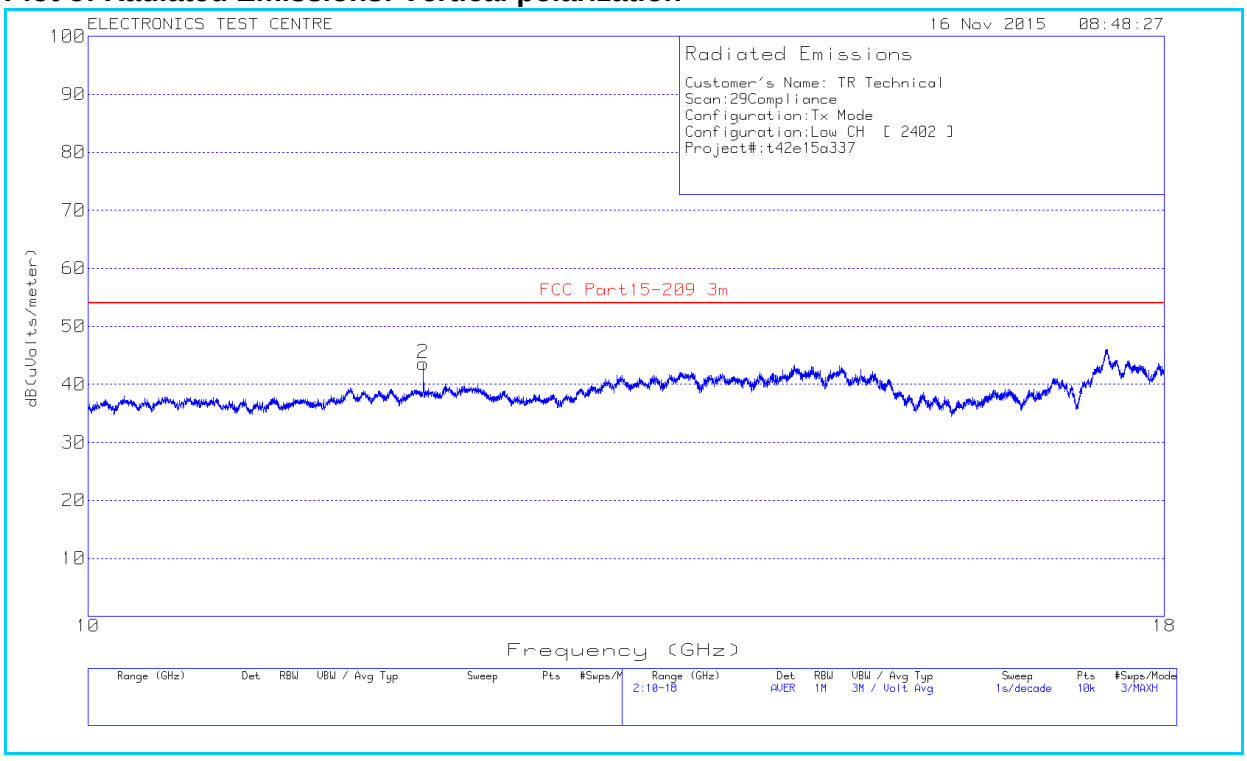
Plot of Radiated Emissions: Vertical polarization



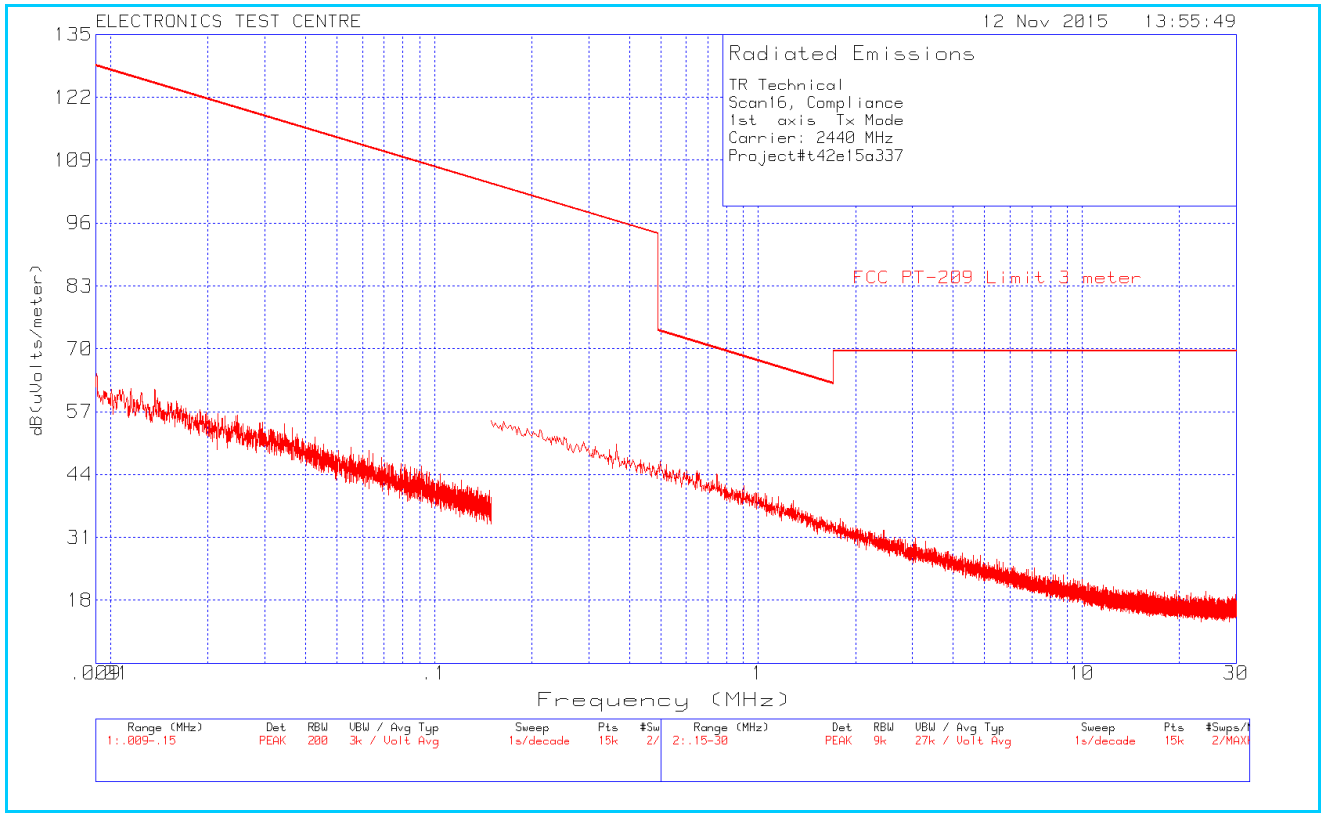
Plot of Radiated Emissions: Horizontal polarization



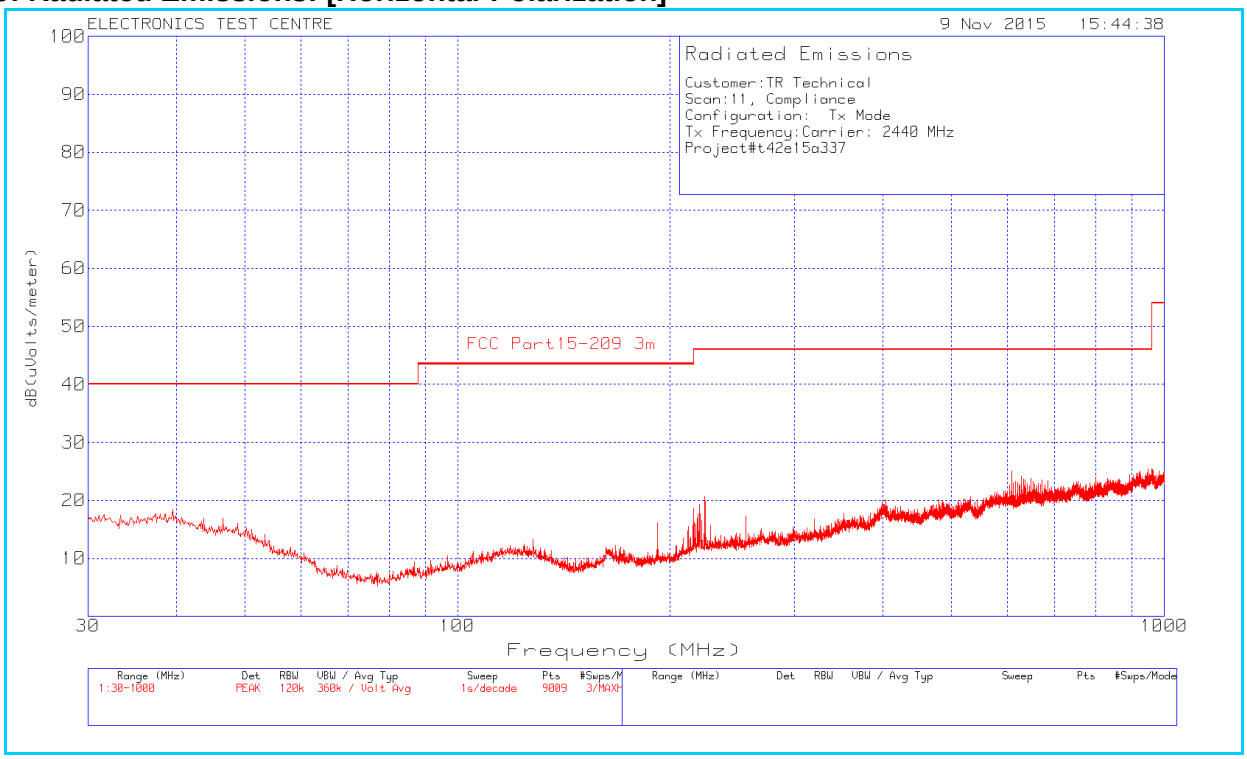
Plot of Radiated Emissions: Vertical polarization



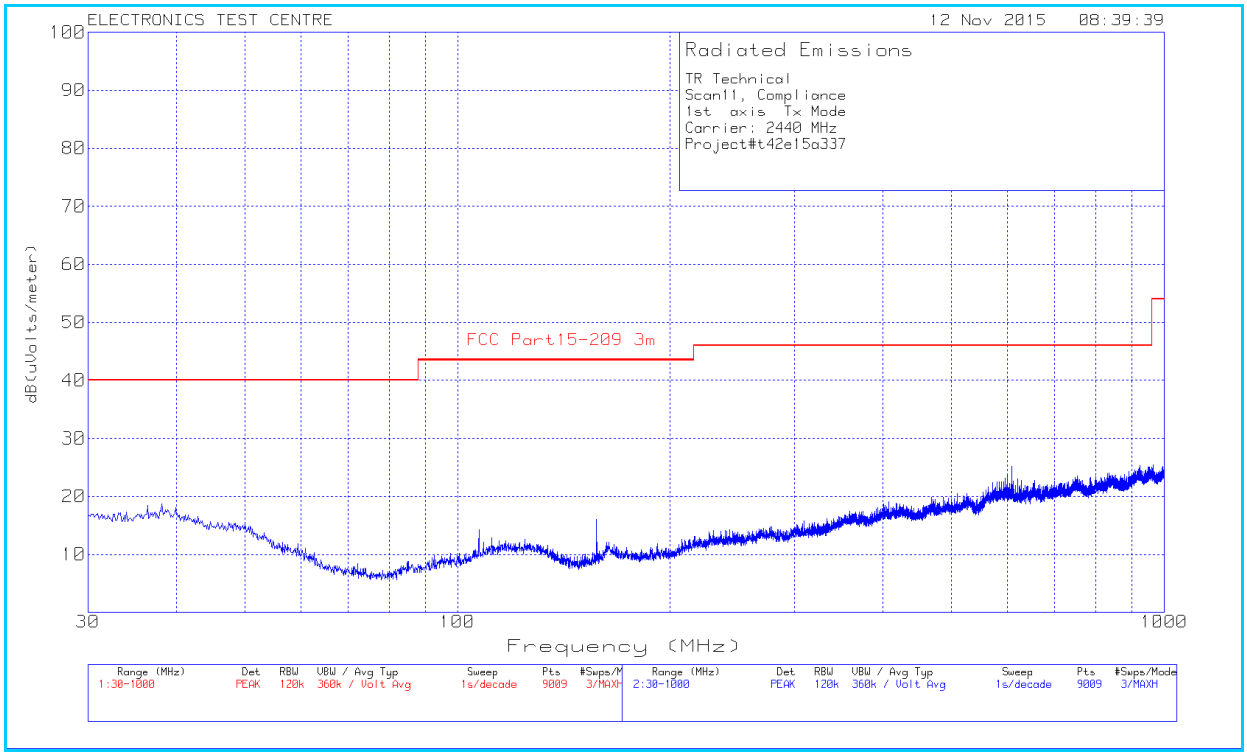
Mid Channel 2440 MHz



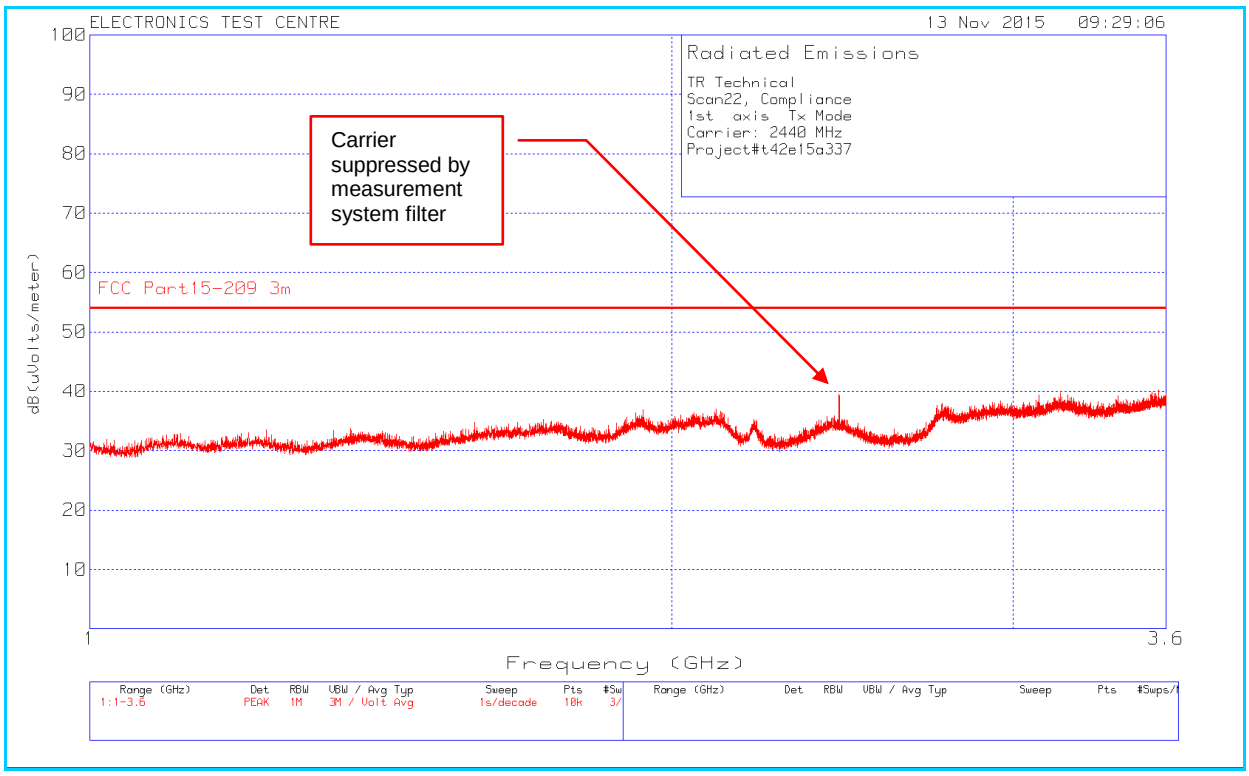
Plot of Radiated Emissions: [Horizontal-Polarization]



Plot of Radiated Emissions: [Vertical-Polarization]

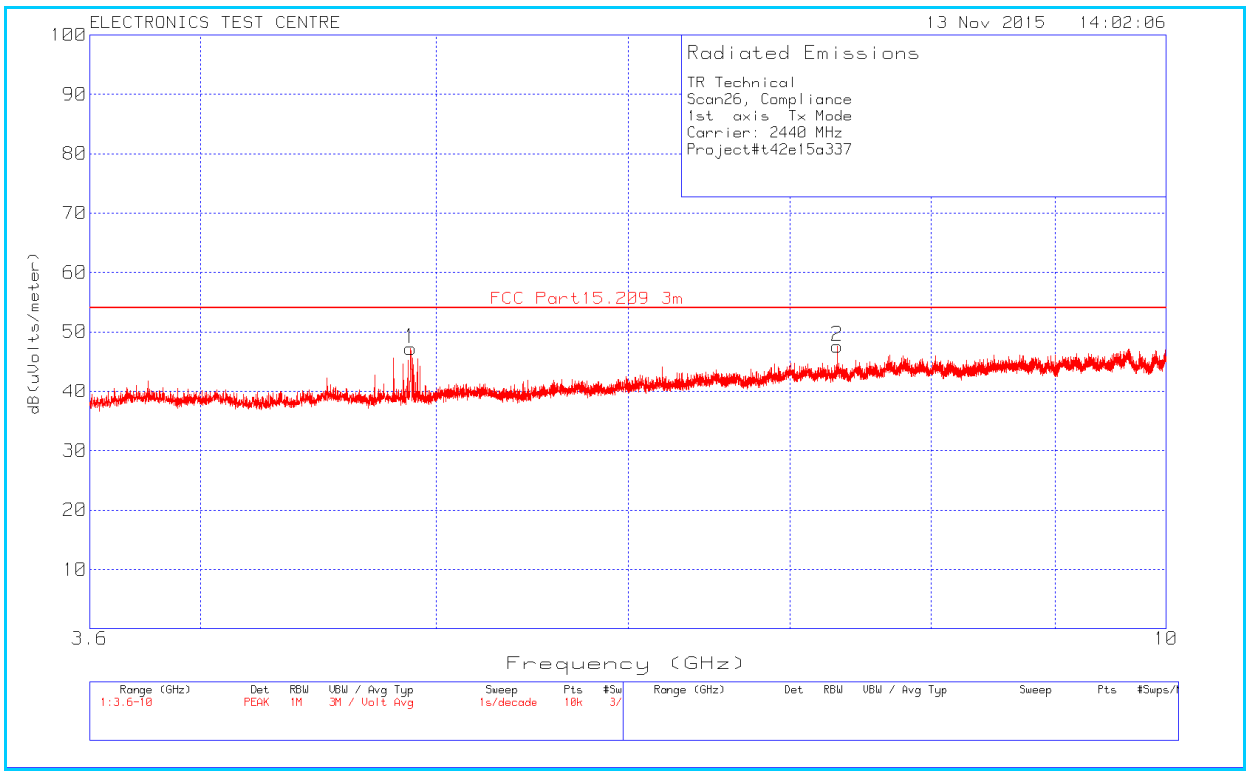


Plot of Radiated Emissions: [Horizontal polarization]

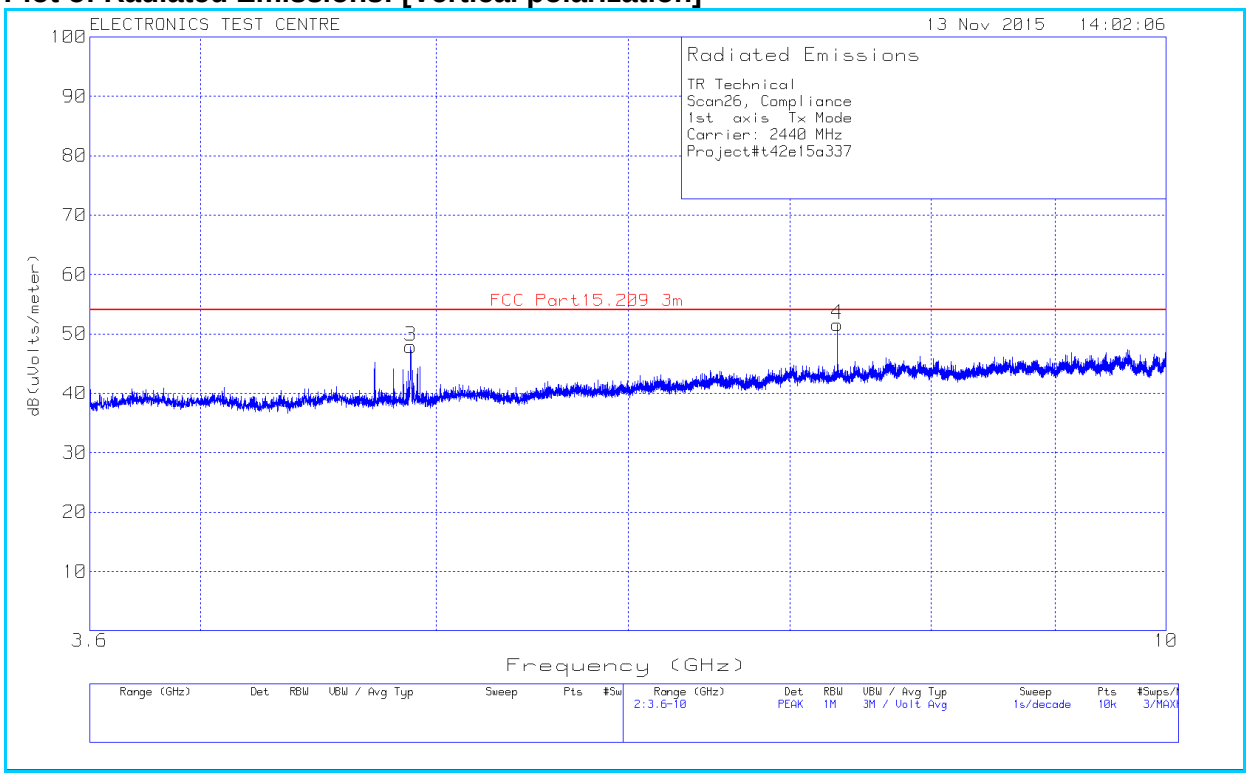


Plot of Radiated Emissions: [Vertical polarization]

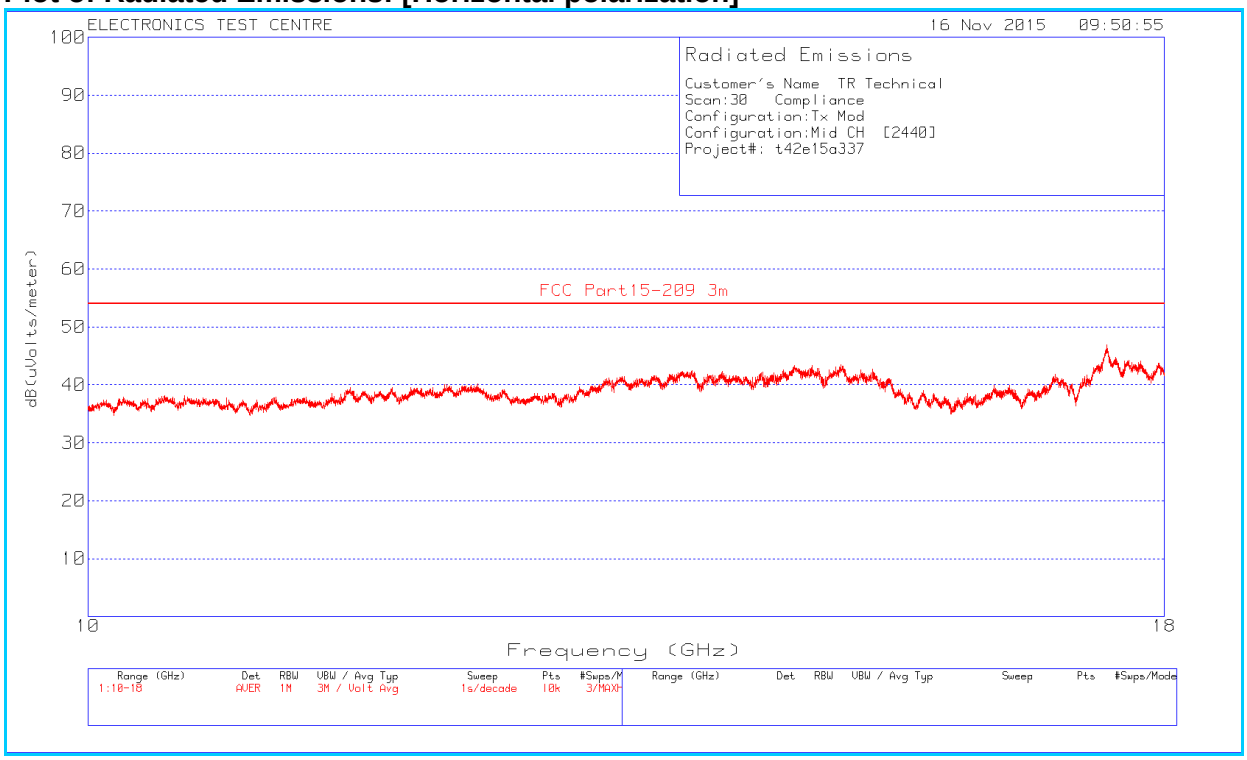
Plot of Radiated Emissions: [Horizontal polarization]



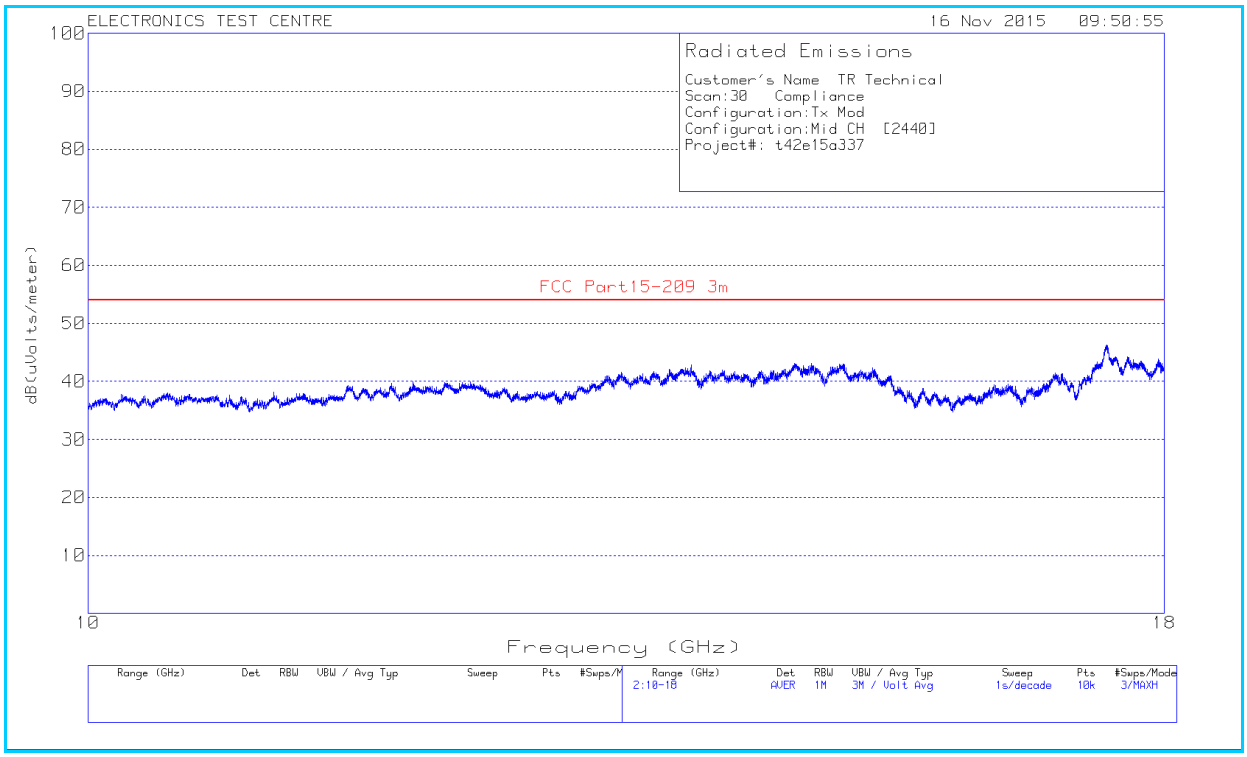
Plot of Radiated Emissions: [Vertical polarization]



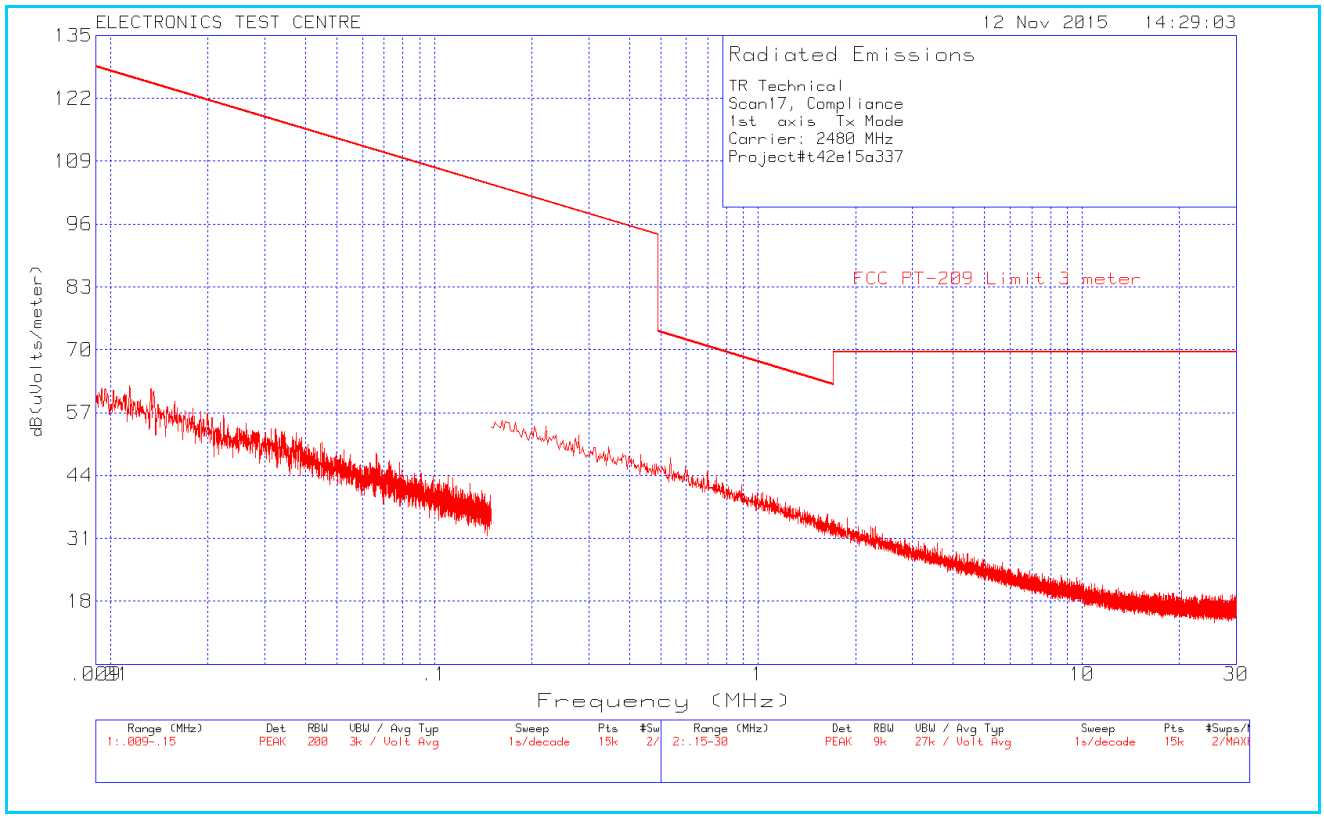
Plot of Radiated Emissions: [Horizontal polarization]



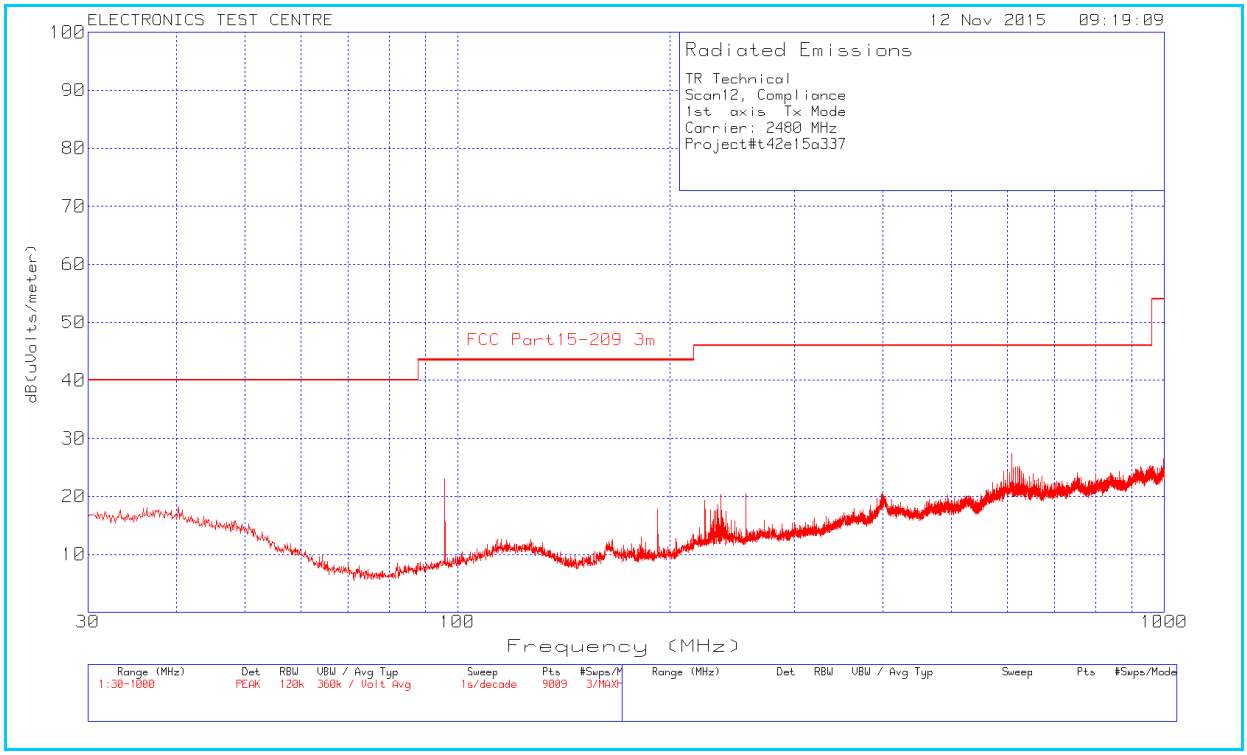
Plot of Radiated Emissions: [Vertical polarization]



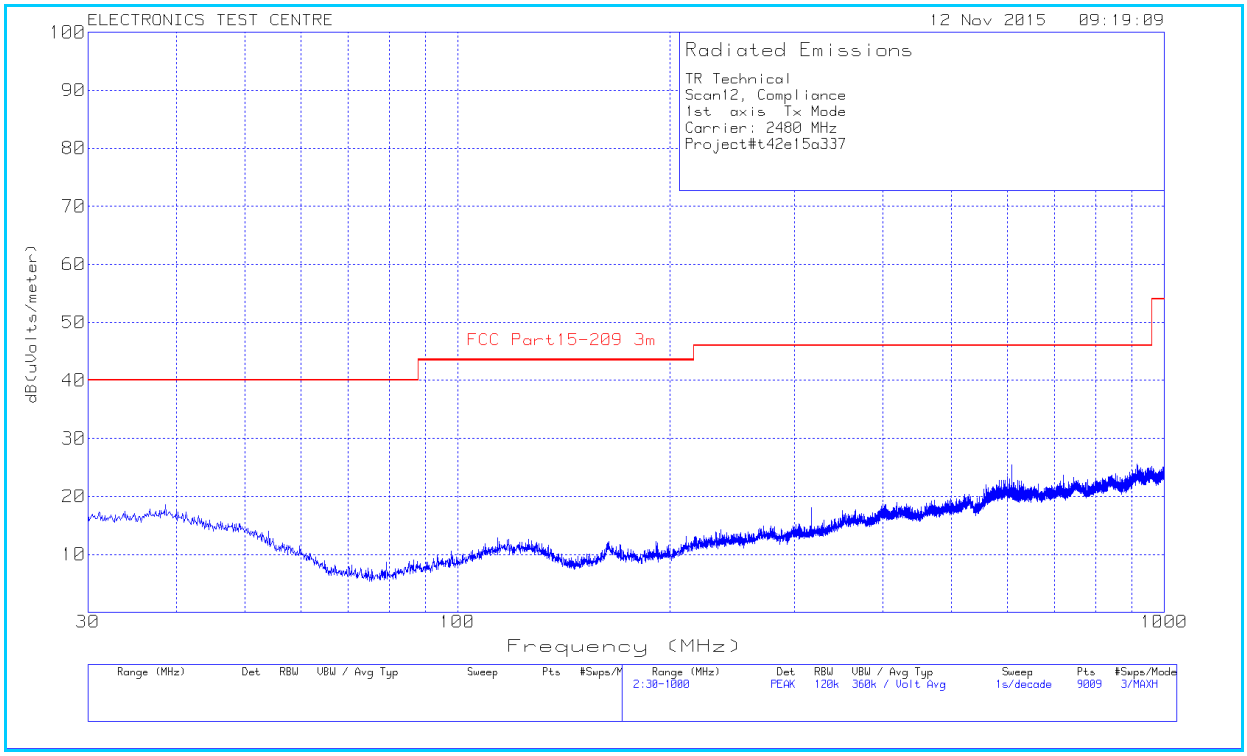
High Channel 2480 MHz



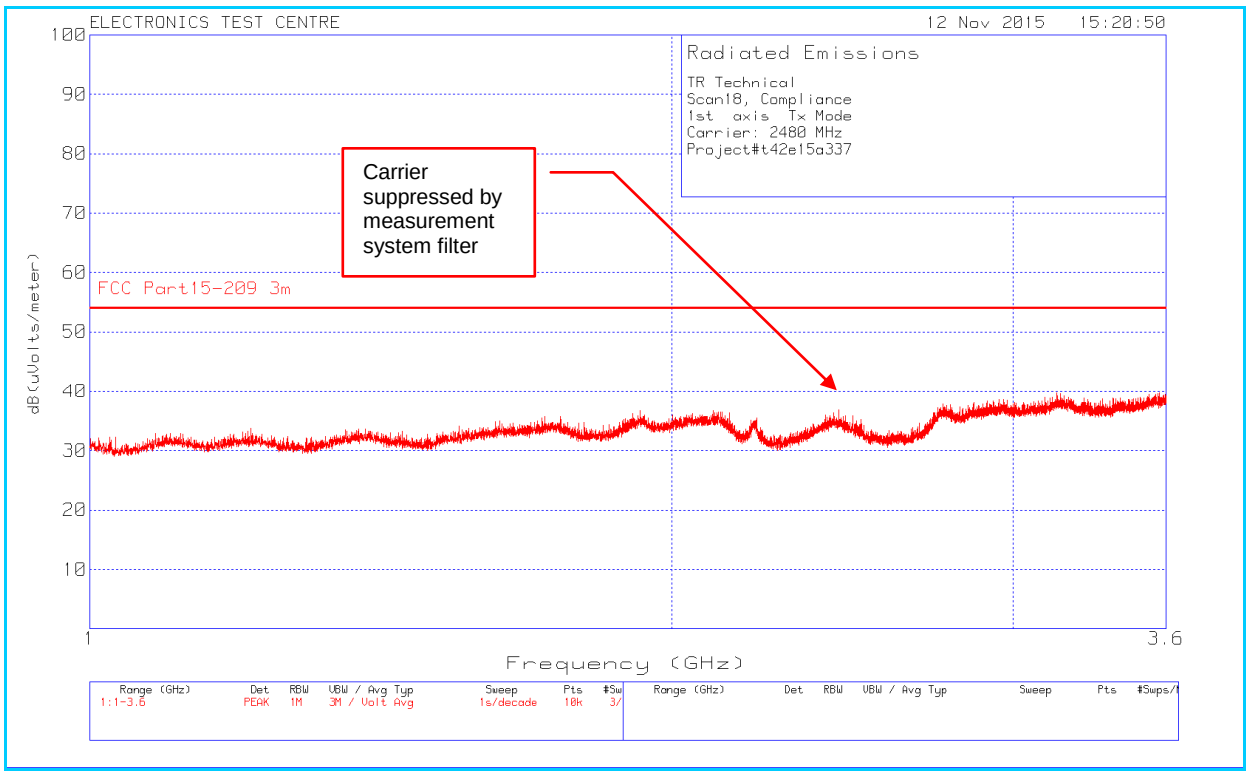
Plot of Radiated Emissions: [Horizontal-Polarization]



Plot of Radiated Emissions: [Vertical-Polarization]

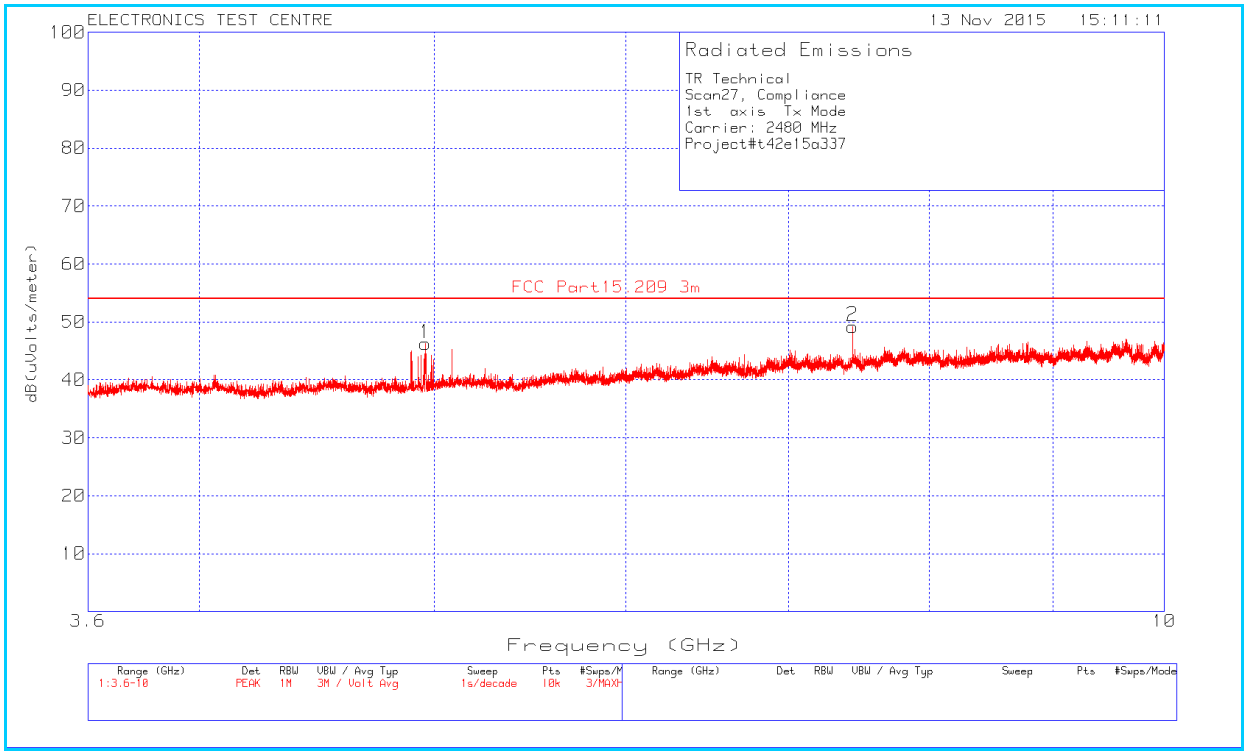


Plot of Radiated Emissions: [Horizontal polarization]

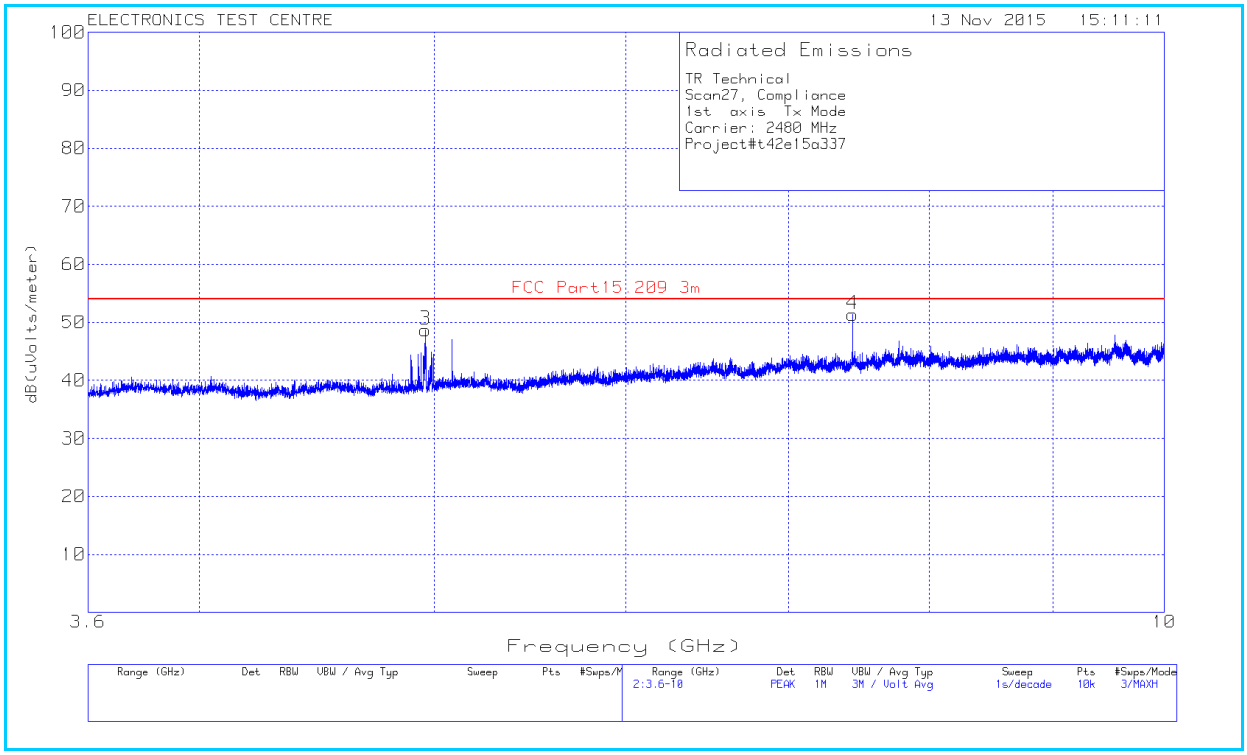


Plot of Radiated Emissions: [Vertical polarization]

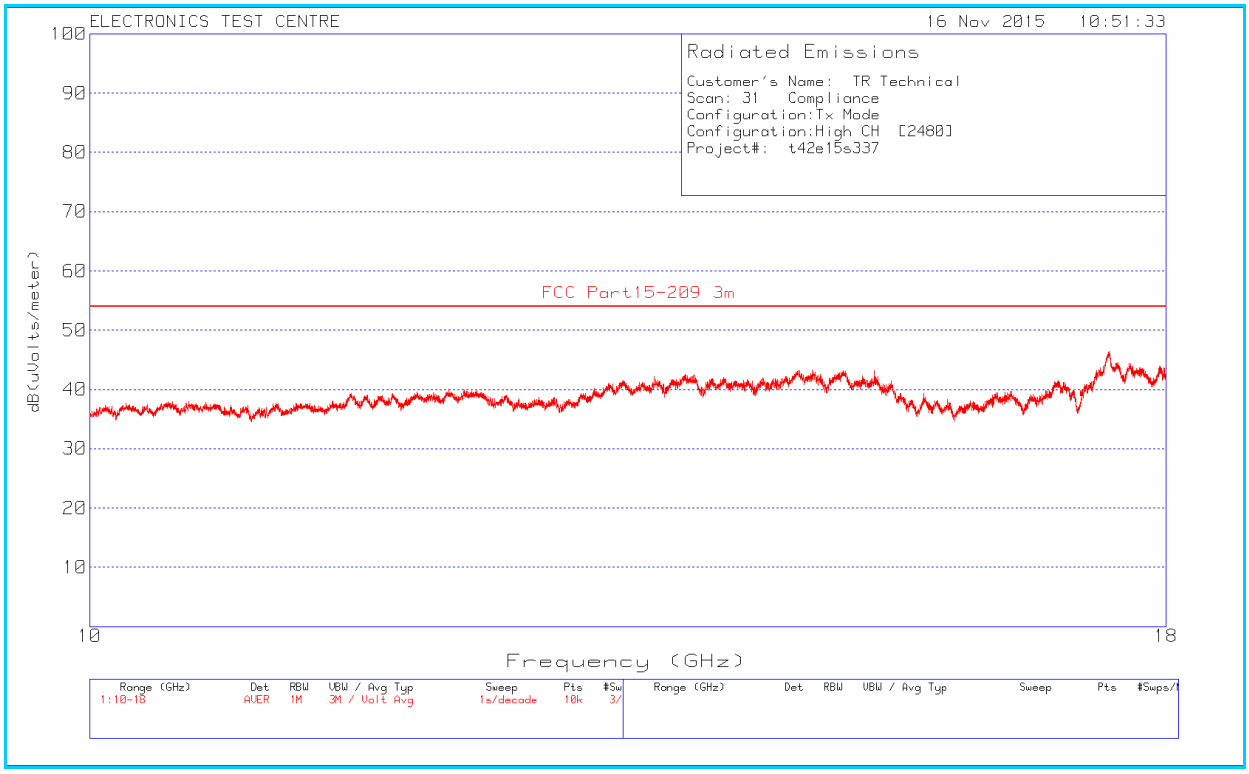
Plot of Radiated Emissions: Horizontal polarization



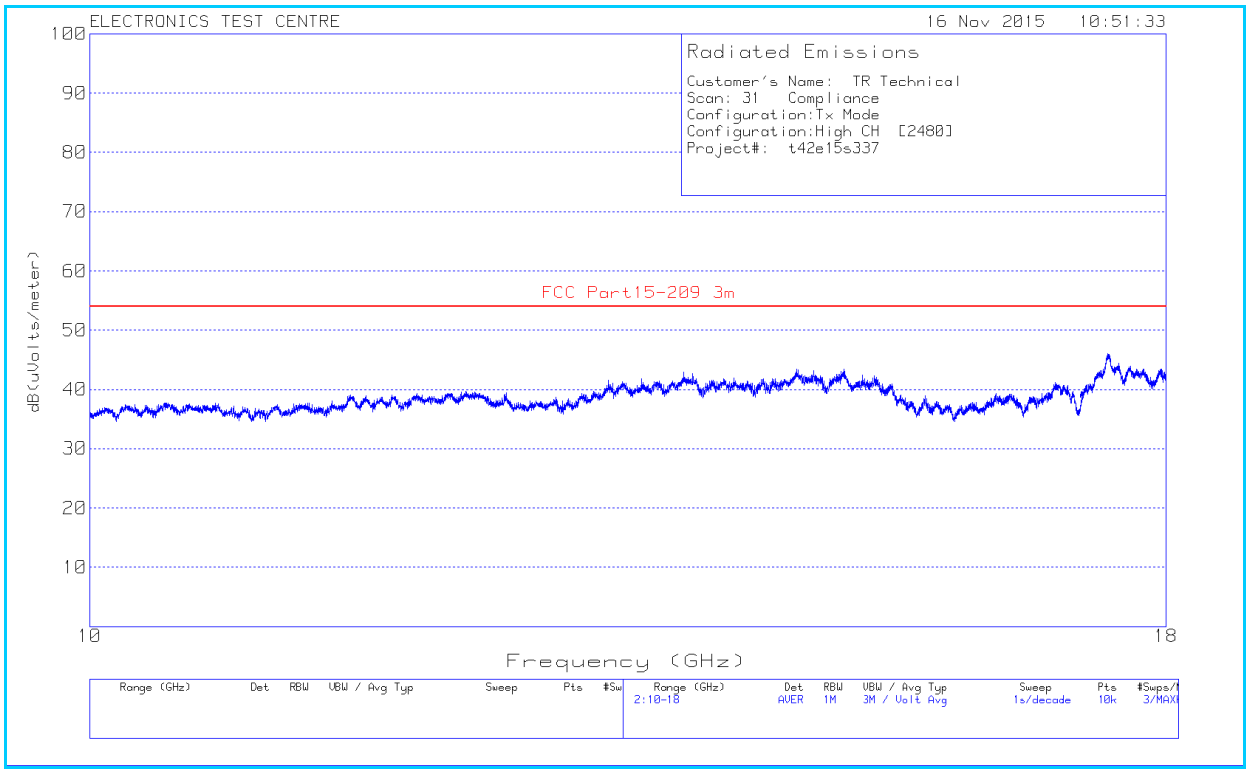
Plot of Radiated Emissions: Vertical polarization



Plot of Radiated Emissions: Horizontal polarization



Plot of Radiated Emissions: Vertical polarization



2.9 Receiver Radiated Spurious Emissions

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel: Imran Akram, Vassan Kohli	**Standard: FCC PART 15.247**
Test Method: TM-EMC 13	**Basic Standard: ANSI C63.10-2013**
Date: 2015-11-12/13 (18.6° C,21.4 % RH)	

EUT status: Compliant

Specification: FCC PART 15.109

The EUT was in receiving mode and measurement performed on middle channel only.

Frequency	FCC Class B Limit (3 m)	FCC Class B Limit (3 m)
30 – 88 MHz	100 µV/m (QP)	40 dBµV/m (QP)
88 – 216 MHz	150 BµV/m (QP)	43.52 dBµV/m (QP)
216 – 960 MHz	200 BµV/m (QP)	46.02 dBµV/m (QP)
960 – 1000 MHz	500 BµV/m (QP)	53.98 dBµV/m (QP)
Above 1000 MHz	500 µV/m (Avg.)	53.98 dBµV/m (Avg.)
Criteria: The radiated emissions produced by a device, measured at a distance of 3 meters, shall not exceed the limits as specified. EUT emissions were scanned up to 12.4 GHz.		

2.9.1 Test Methodology: ANSI C63.10-2013, Clause 13.4.2

From 30 MHz to 1000 MHz, measurements are performed with a broadband biconilog antenna and a resolution bandwidth of 120 kHz.

Above 1000 MHz, measurements are performed with a DRG Horn antenna or a Standard Gain horn, and a resolution bandwidth of 1 MHz. The EUT is raised to 150 cm above the ground plane, and the area between the EUT and the antenna mast is covered with RF absorbent material.

The scan is performed at discreet increments of turntable azimuth and antenna height, which are selected in accordance with the applicable standard in order to assure capture of frequencies of interest. Optimization is performed based on the scan data.

Frequencies having peak emissions within 10dB of the limits are optimized. The EUT is rotated in azimuth over 360 degrees and the direction of maximum emission is noted.

Antenna height is varied from 1 – 4 meters at this azimuth to obtain the maximum emission. Then the maximum level is measured with the appropriate detector and recorded. Up to 1 GHz, measurements are performed with a Quasi-Peak detector. Above 1 GHz, measurements are recorded with Peak and/or Average detectors, as applicable.

Note: The EUT was assessed for worst-case orientation. All radiated testing was performed with this orientation, as shown in the test setup photos.

2.9.2 Deviations From The Standard:

There were no deviations from the EUT setup or methodology specified in the standard.

2.9.3 Uncertainty of Measurement:

The factors contributing to uncertainty of measurement are identified and calculated in accordance with UKAS (United Kingdom Accreditation Service) document “Lab 34, The Expression of Uncertainty in EMC Testing, Aug 2002.” as based on the “ISO Guide to the Expression of Uncertainty in Measurement, 1995.”

This uncertainty estimate represents an expended uncertainty expressed at approximately 95% confidence using a coverage factor of k = 2.

Test Method	Frequency	Uncertainty
Radiated Emissions Level	30 MHz – 1 GHz	±4.6 dB
Radiated Emissions Level	1 GHz – 26.5 GHz	±5.31 dB

2.9.4 Test Equipment

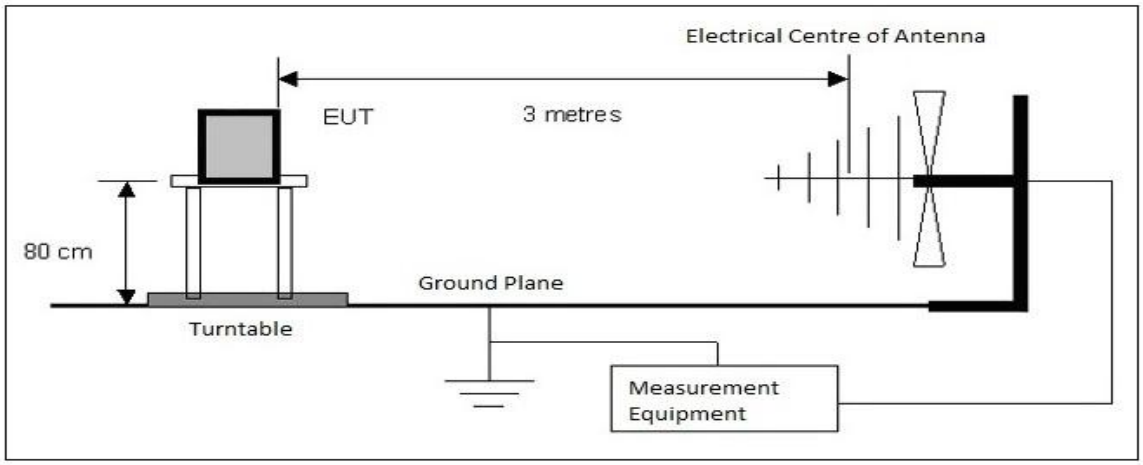
Testing was performed with this equipment:

Equipment	Manufacturer	Model #	Asset #	Calibration Due-Date
EMC Software	UL	Ver. 9.5	ETC-SW-EMC 2.1	N/A
EMI receiver	Agilent	N9038A	6130	2015-06-17
Loop Antenna	EMCO	6502	10868	2017-04-10
Biconilog Antenna	ARA	LPB-2520/A	4318	2017-02-20
DRG Horn	EMCO	3115	19357	2016-09-17
Low Noise Amplifier (1 – 18 GHz)	MITEQ	JS43-01001800-21-5P	4354	Monitored

2.9.5 Test Sample Verification, Configuration & Modifications

The EUT was set to Low, Mid and High channels with test-specific software. The output was modulated as in normal operation. The EUT met the requirements without modification.

Test setup diagram for Radiated Spurious Emissions testing:



2.9.6 Radiated Emissions Data:

The emissions data are presented in tabular form, showing turntable azimuth, antenna height and polarization, the uncorrected spectrum analyzer reading, the correction factors applied, the net result, the value of the limit at the frequency investigated, and the Delta between the result and the limit.

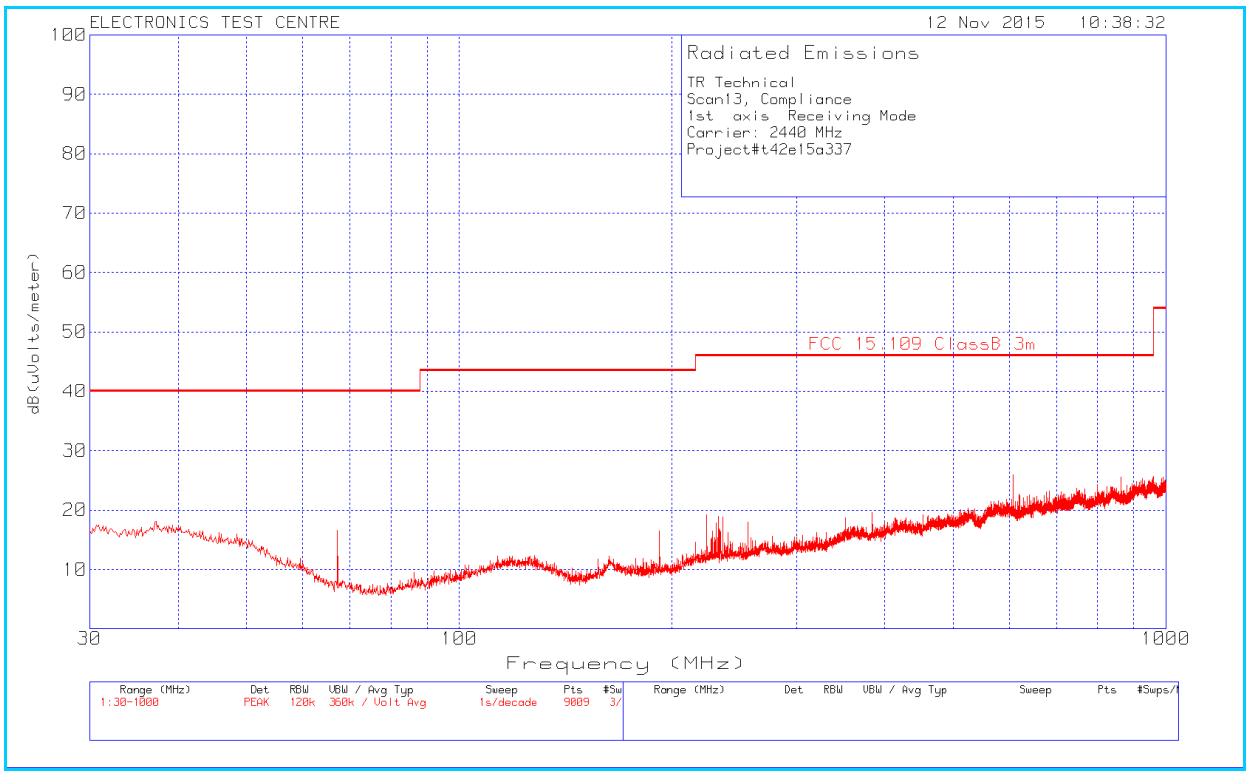
Meter Reading in dBμV + Antenna Factor in dB/m + Gain/Loss Factor in dB = Corrected Field Strength in dbμV/m.

Delta = Field Strength - Limit

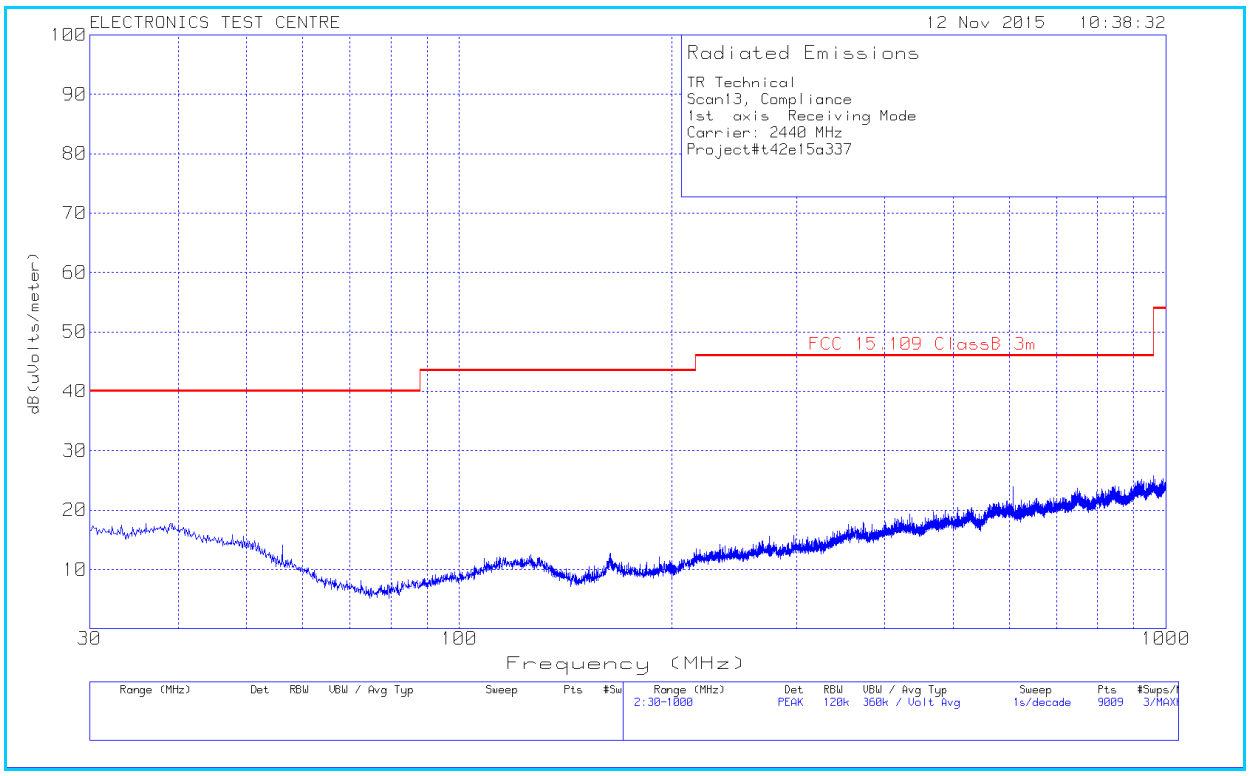
Notes:

- When a preamp is used, the resulting gain is compensated, producing a negative value for the Cable Loss.
- Measurements reported are the result of adjusting the turntable azimuth and antenna height to obtain the maximum EUT emission. This may produce a different reading than the plot trace. The plot is a Peak Hold function obtained at discreet increments of height and azimuth, while the reported measurement is obtained with the appropriate Quasi Peak or Average detector after the height and azimuth have been adjusted for maximum emission.
- In receive mode, the EUT was assessed up to 12.5 GHz. Above 10 GHz, preliminary scanning of the EUT was performed at a distance of 50 cm with the RBW set at 300 kHz. There were no emissions.
- Pursuant to Part 15.31(o), emissions that are more than 20 dB below the applicable limit are not reported.

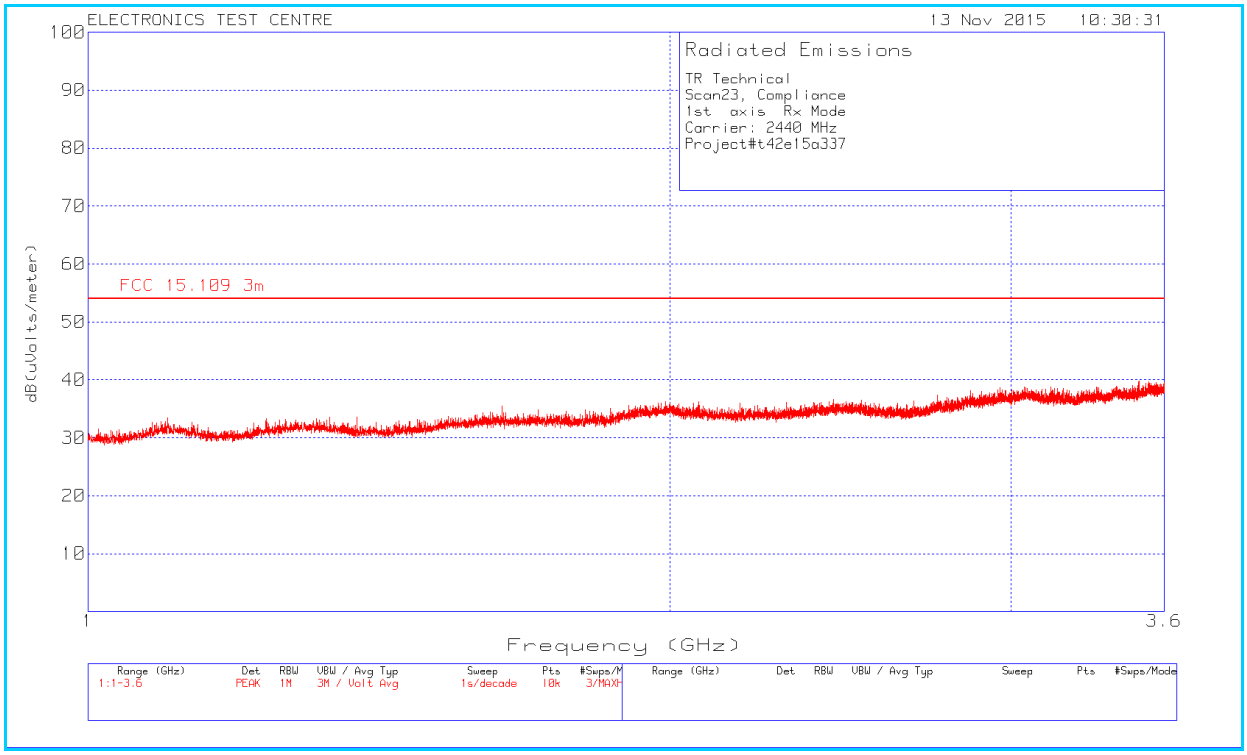
Plot of Radiated Emissions: [Horizontal polarization]



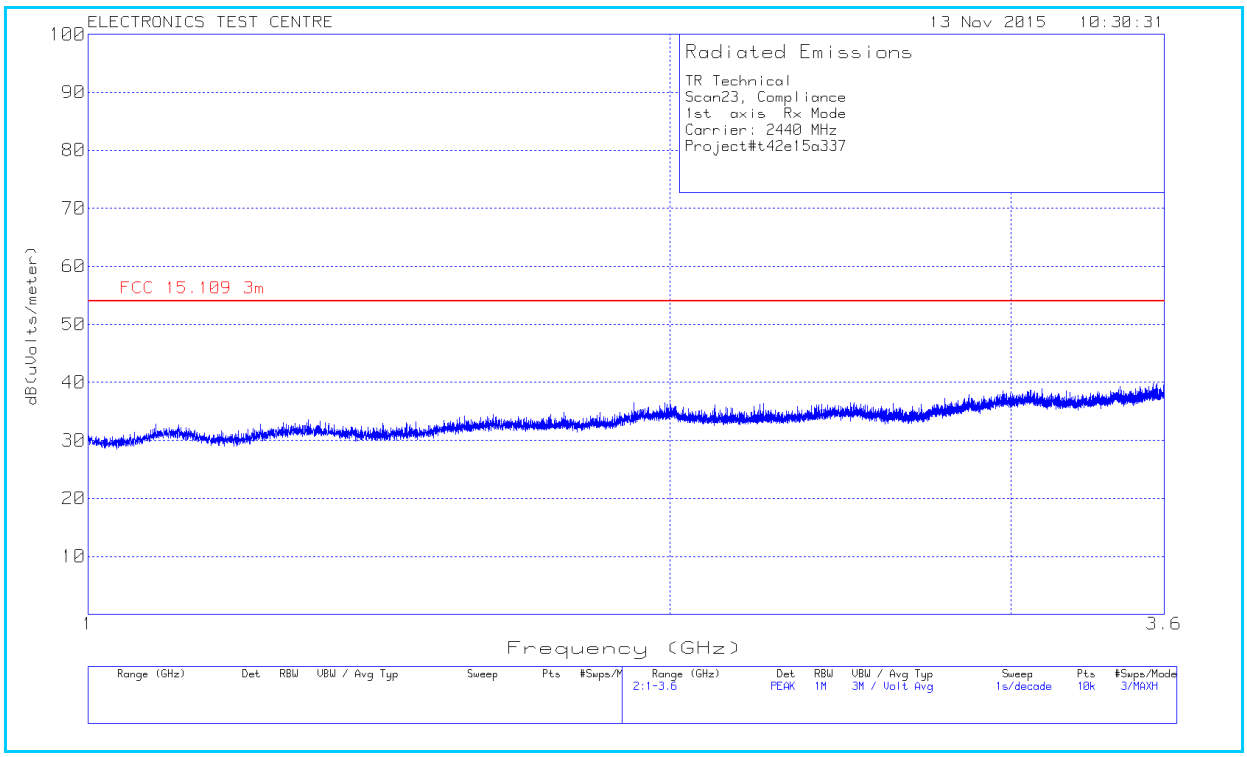
Plot of Radiated Emissions: [Vertical polarization]



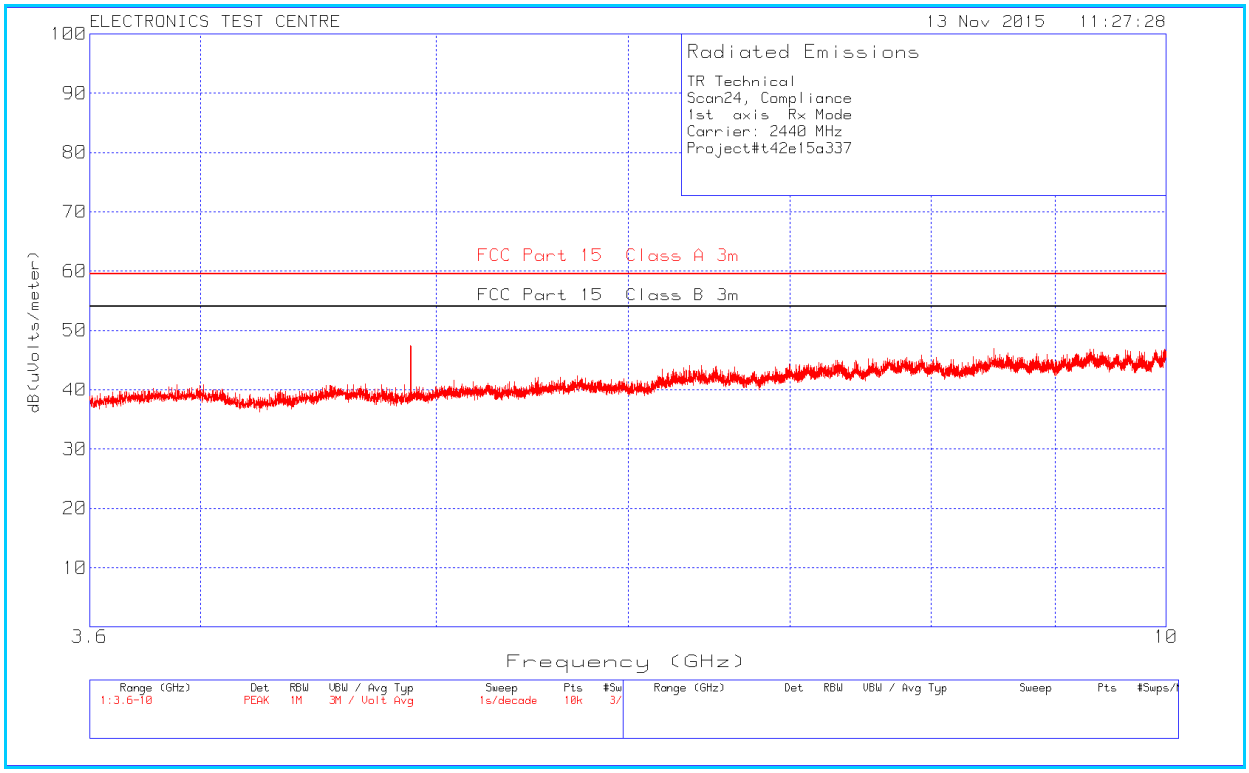
Plot of Radiated Emissions: [Horizontal polarization]



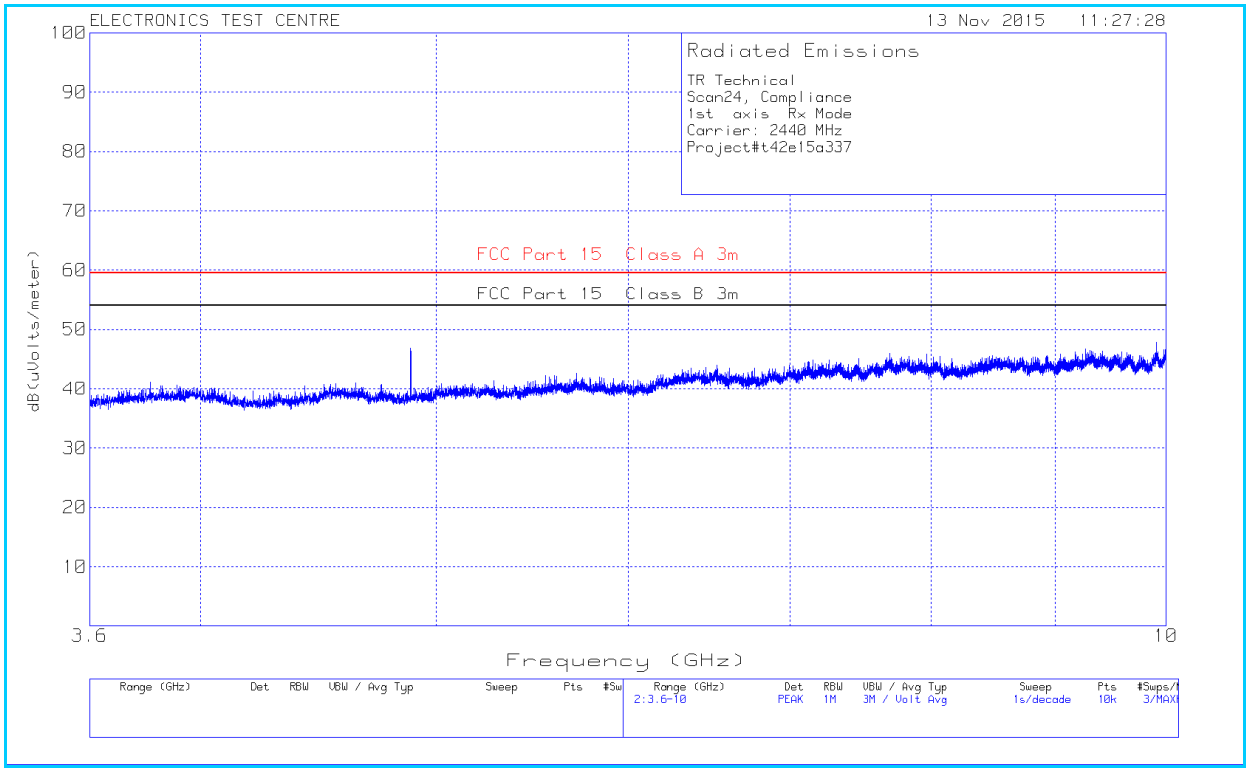
Plot of Radiated Emissions: [Vertical polarization]



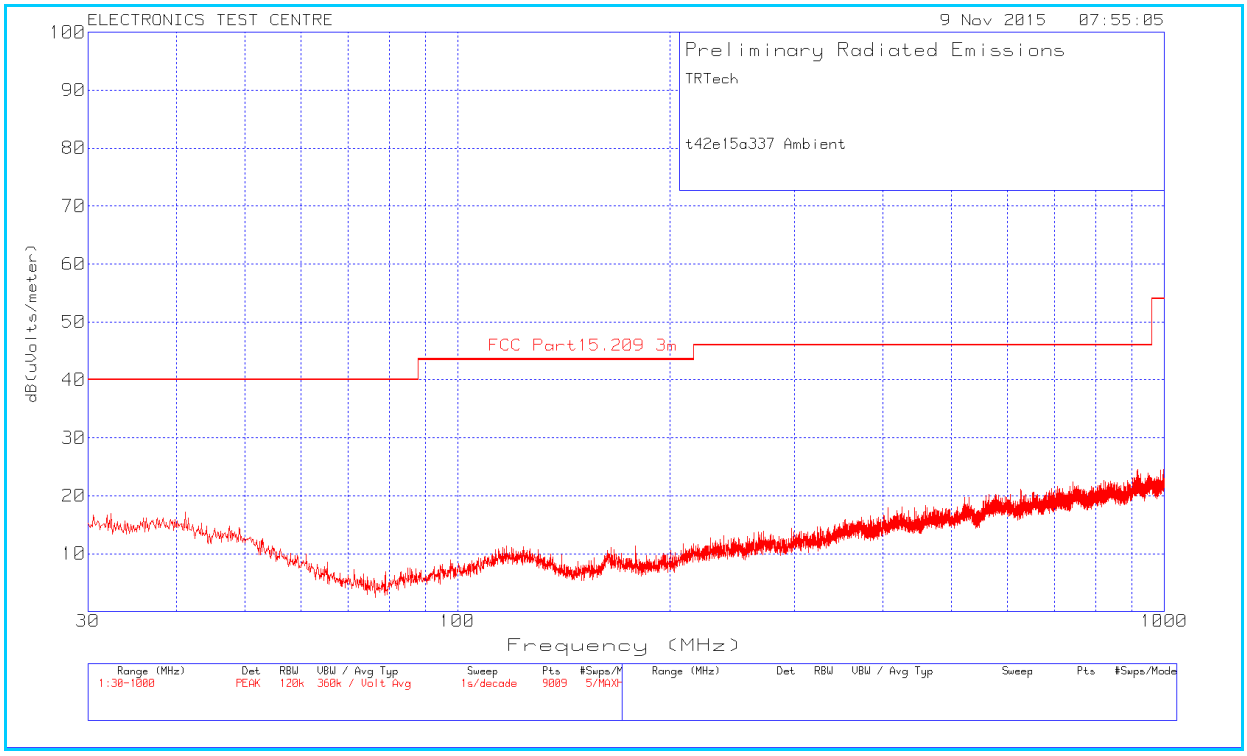
Plot of Radiated Emissions: [Horizontal polarization]



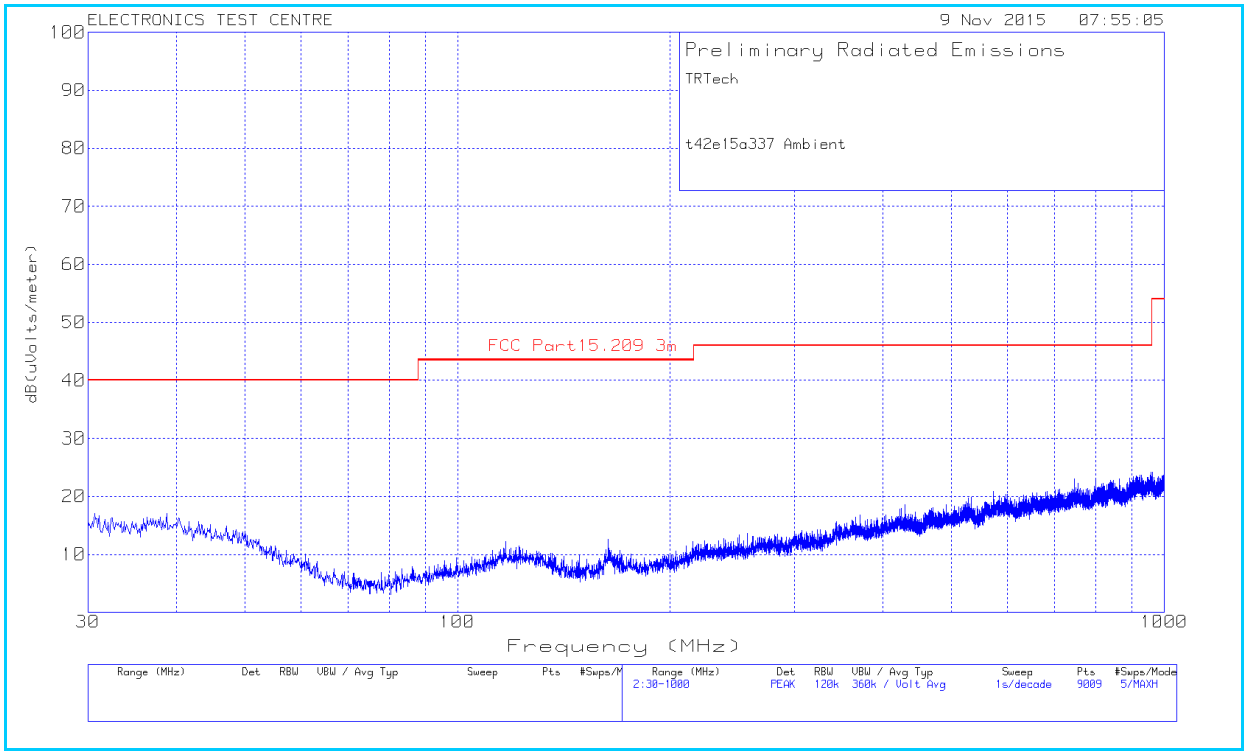
Plot of Radiated Emissions: [Vertical polarization]



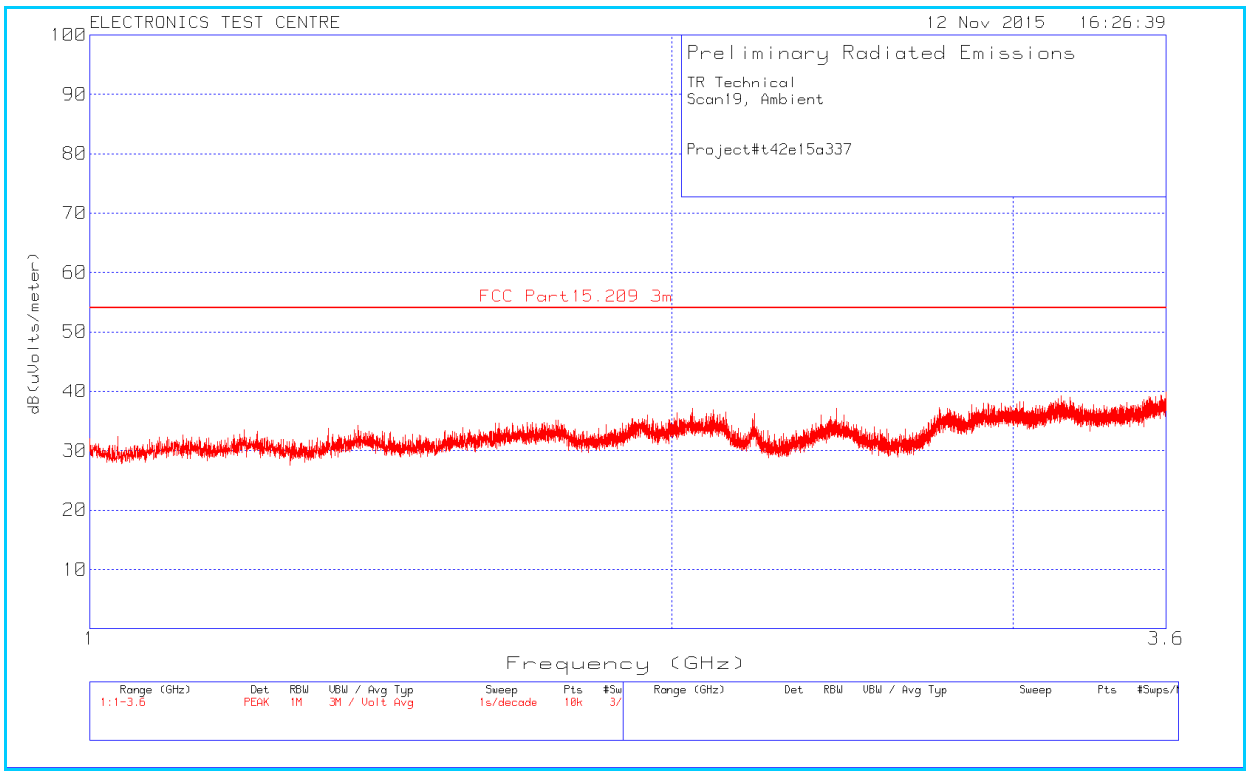
Plot of Test Chamber Ambient: (measurement noise floor):



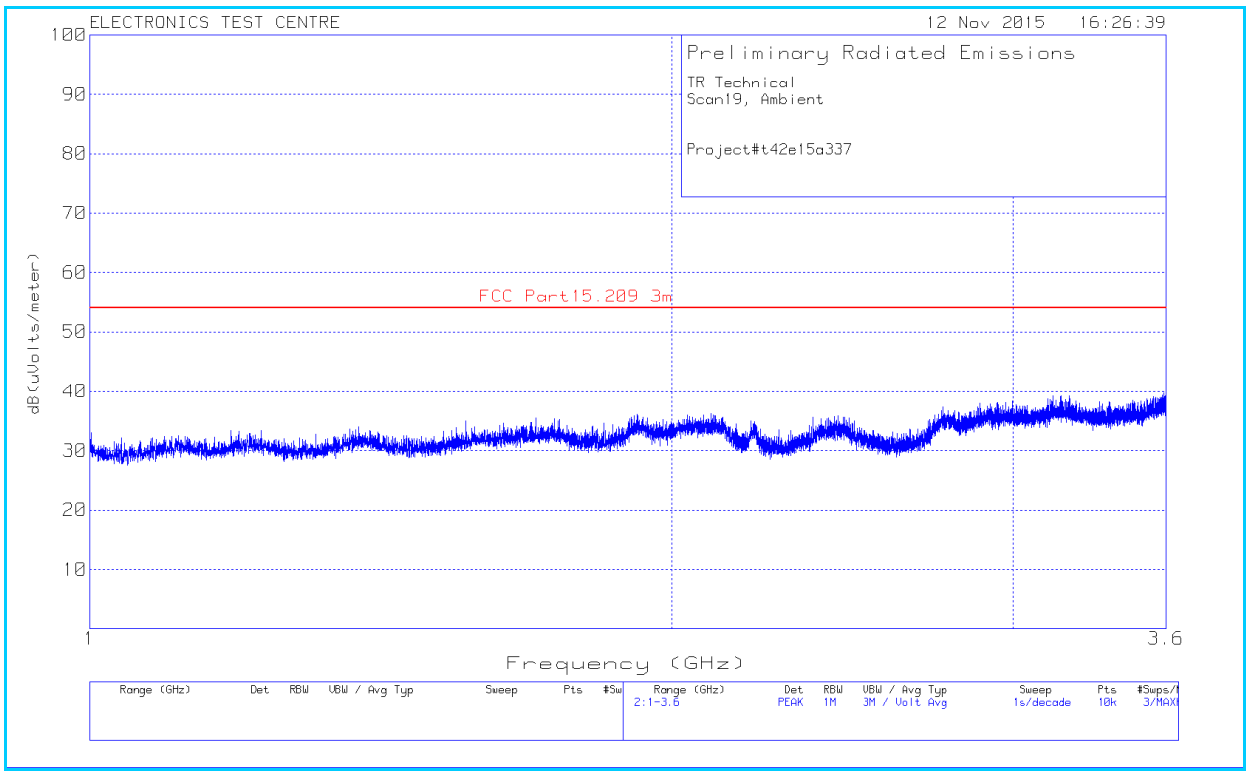
Plot of Test Chamber Ambient: (measurement noise floor):



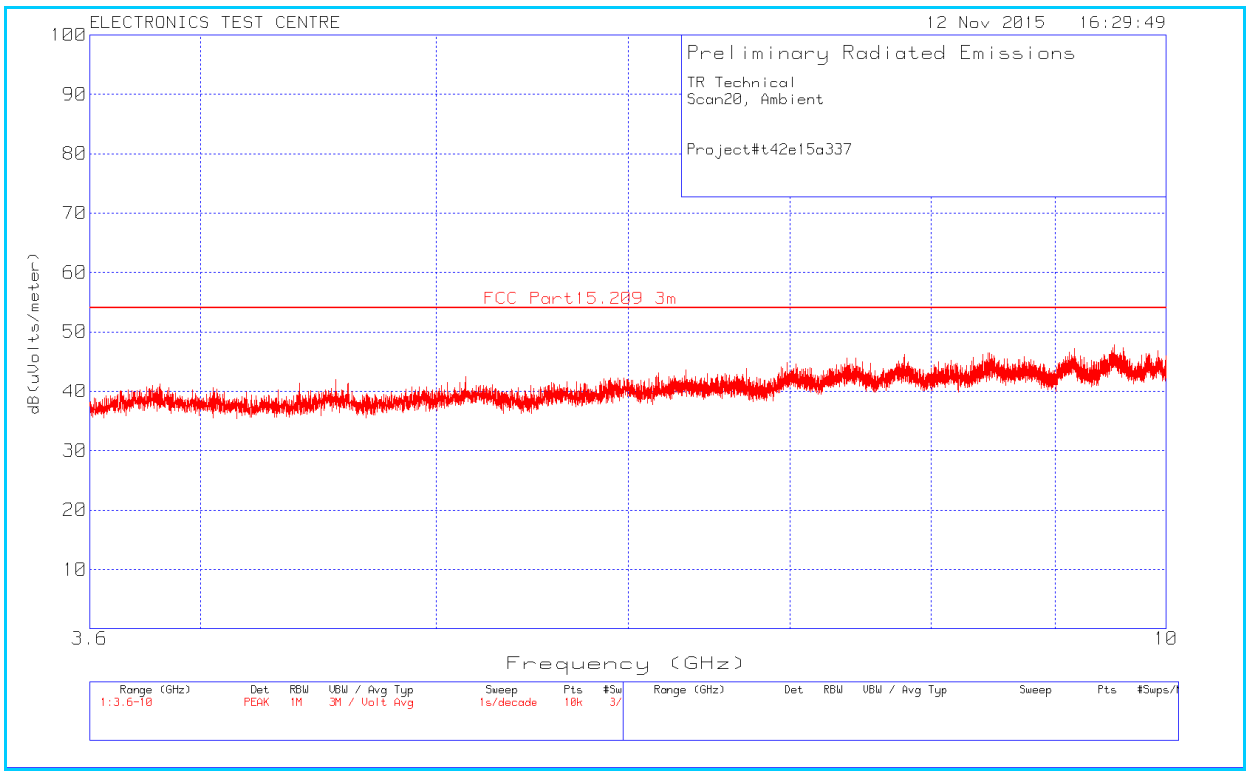
Plot of Test Chamber Ambient: (measurement noise floor):



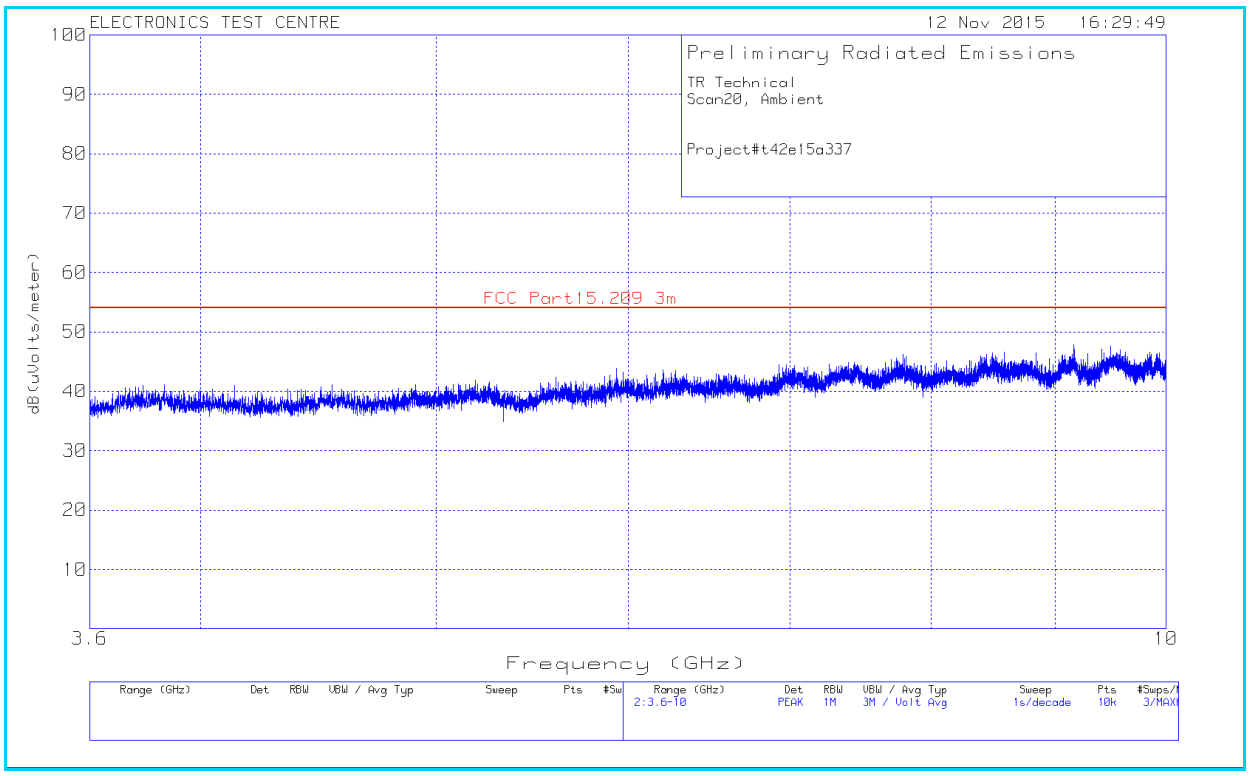
Plot of Test Chamber Ambient: (measurement noise floor):



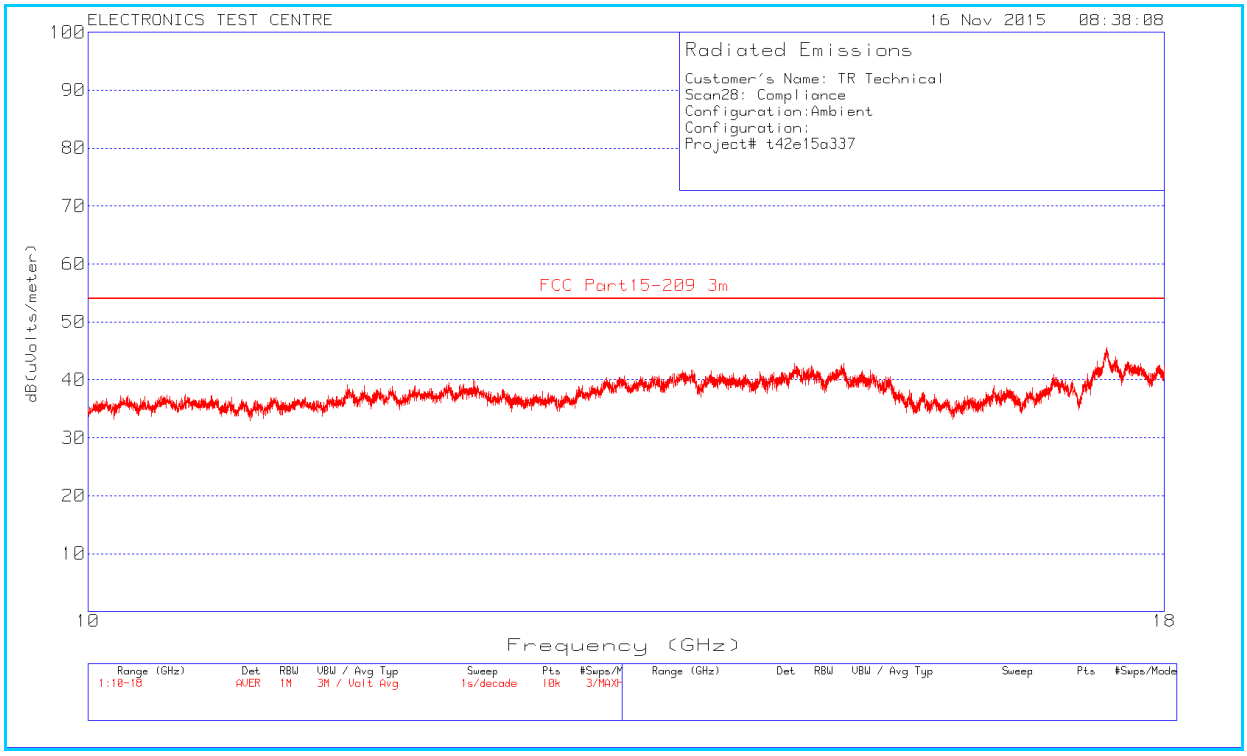
Plot of Test Chamber Ambient: (measurement noise floor):



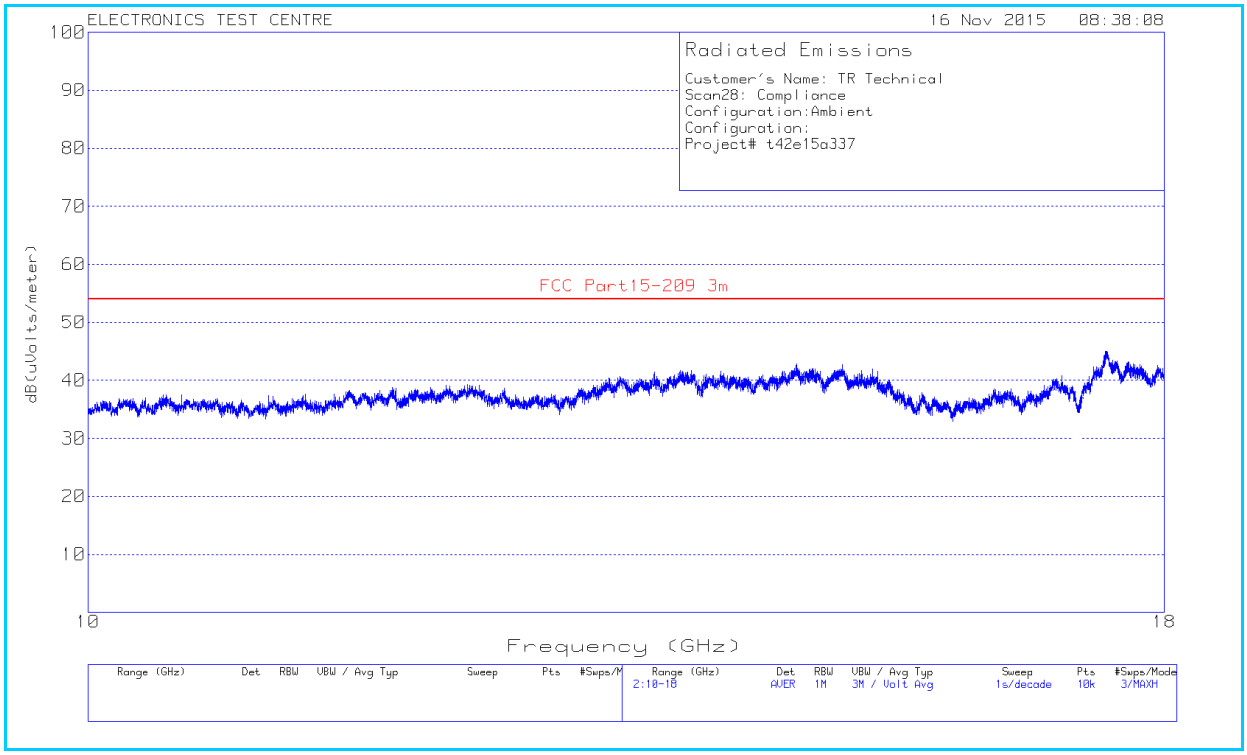
Plot of Test Chamber Ambient: (measurement noise floor):



Plot of Test Chamber Ambient: (measurement noise floor):



Plot of Test Chamber Ambient: (measurement noise floor):



2.10 RF Exposure

Test Lab: Electronics Test Centre, Airdrie	**EUT: M1**
Test Personnel:	**Standard: FCC PART 15.247**
Date: YYYY-MM-DD	

EUT status: Compliant

Compliant: See the Environmental Assessment provided in a separate Exhibit.

3.0 TEST FACILITY

3.1 Location

The M1 was tested for emissions at the Electronics Test Centre laboratory located in Airdrie, Alberta, Canada. The Radio Frequency Semi Anechoic Chamber (RFSAC), identified as Chamber 1, has a usable working space measuring 10.6 m long x 7.3 m wide x 6.5 m high.

Measurements taken at this site are accepted by Industry Canada as evidence of conformity per registration file # 2046A. This site is also listed with the FCC under Designation Number CA2046.

The floor, walls and ceiling consist of annealed steel panels. The walls and ceiling are covered with ferrite tile, augmented by RF absorbant foam material on the end wall nearest the turntable, and on the adjacent walls and the ceiling. The chamber floor supports a 15 cm high internal floor, constructed of annealed steel panels, that forms the ground plane, and is bonded to the chamber walls.

The 3-m diameter turntable is flush-mounted with the floor. A sub-floor cable-way is provided to route cables between the turntable pit and EUT support equipment located in the Control Room. Cables reach the EUT through an opening in the centre of the turntable.

Test instrumentation and EUT support equipment is located in the Control Room, consisting of two shielded vestibules joined together at the side of the main room. Cables are routed through bulkhead panels between the rooms and the test chamber as required. Power feeds are routed into the main room and vestibules through line filters providing at least 100 dB of attenuation between 10 kHz and 10 GHz.

Either floor mounted or table-top equipment can be tested at this facility.

3.2 Grounding Plan

The M1 was placed at the centre of the test chamber turntable on top of a polystyrene foam table. The EUT was not grounded, in accordance with MRF Geosystems Corporation specifications.

3.3 Power Supply

All EUT power was supplied by an internal non-rechargeable battery.

3.4 Emissions Profile

Ambient emission profiles were generated throughout the tests and are included in the test data.

End of Document