Electromagnetic Compatibility Test Report

Description: SISU Sense

Model: EMG

Akervall Technologies, Inc.
1512 Woodland Drive
Saline, MI 48176 USA

Prepared by:

TUV Rheinland of North America, Inc.

Client:	Akervall Technologies, Inc. 1512 Woodland Drive Saline, MI 48176 USA	***Contact:*** ***Tel:*** ***Fax:*** ***e-mail:***	Adam Davis 734-255-9697 - email@address.com
Identification:	SISU Sense	***Serial No.:***	Not Serialized
Test item:	EMG	***Date Test Completed:***	09/05/2018
Testing location:	TUV Rheinland of North America 762 Park Avenue Youngsville, NC 27596-9470 U.S.A.	Tel: (919) 554-3668 Fax: (919) 554-3542	
Test specification:	**Emissions:** FCC Part 15, Subpart C, RSS-210 Issue 9: FCC Parts 15.207(a):2017 and RSS-GEN I4 clause 8.8, FCC Parts 15.249(d), 15.209, 15.215(c), RSS-210 I9 clause B.10, RSS-GEN I4 clauses 8.9 and 8.10, FCC Part 15.249:2017 and RSS-210 Annex B.10, FCC Parts 15.249(a):2017, 15.249(c):2017, RSS-210 B.10(a),		
Test Result and/or Conclusion:	The above product was found to be **Compliant** to the above test standard(s)		

Report written/updated by: Richard Decker	***reviewed by:*** David Spencer
27 February 2019 ***Date*** ***Signature***	27 February 2019 ***Date*** ***Signature***

		VCCI	**ISED Canada**
# 90552 and 100881	**3331.05**	**1097 (A-0034)**	**2932H-2**

Revisions

Date mm/dd/yy	Name	Page Number of Change	Describe Change
09/05/2018	**31851225.001**	All	Original release

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1 General Information

1.1 Scope

This report is intended to document the status of conformance based on the results of testing performed on the SISU Sense, Model Number: EMG, manufactured by Akervall Technologies, Inc.. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT (Equipment Under Test) in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report.

1.3 Summary of Test Results

Applicant:	Akervall Technologies, Inc. 1512 Woodland Drive Saline, MI 48176 USA	**Tel:**	734-255-9697	**Contact:**	Adam Davis
		Fax:	-	**e-mail:**	email@address.com
Description:	SISU Sense	**Model Number:**	EMG		
Serial Number:	Not Serialized	**Test Voltage/Freq.:**	3VDC Lithum Battery		
Test Date Completed:	09/05/2018	**Test Engineer:**	Mark Ryan		

Standards	Description	Severity Level or Limit	Worst-case Values	Test Result
FCC Part 15, Subpart C Standard	Radio Frequency Devices-Subpart C: Intentional Radiators	See called out parts below	See Below	**Complies**
RSS-210 Issue 9 Standard	Low-Power Licence-exempt Radiocommunication Devices Category I Equipment	See called out parts below	See Below	**Complies**
FCC Part 15.249:2017 and RSS-210 Annex B.10	Operation within the band 2400 to 2483.5 MHz	See called out parts below	See Below	Complies
FCC Parts 15.249(a):2017, 15.249(c):2017, RSS-210 B.10(a)	Radiated Output Power for Fundamental and Harmonic Frequencies	Fund: Shall not exceed 50 mV/m at 3m Harmonics: Shall not exceed 500µV/m (0.5 mV/m) at 3m, (unresticted bands)	3.64 mV/m 41.40 µV/m -	Complies
FCC Parts 15.249(d):2017, 15.209, 15.215(c):2017, RSS-210 I9 clause B.10, RSS-GEN I4 clauses 8.9 and 8.10	Out-of-Band Spurious Emissions and Band Edges (EUT in Transmit Mode)	Below the applicable limits	32.34 dBµV	Complies
FCC Parts 15.207(a):2017 and RSS-GEN I4 clause 8.8	Conducted Emissions on AC Mains	NA, The EUT is battery operated only	NA	NA
RSS-GEN I4 clause 6.6	Occupied Bandwidth	99% BW ≤ 0.5% of center freq.	1070 kHz	Complies

Note: The included test results are verified and confirmed as of 09/04/2018.

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

TUV Rheinland of North America located at 762 Park Avenue, Youngsville, NC 27596-9470, is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 90552 and 100881). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

2.1.2 ILAC / A2LA

The laboratory has been assessed and accredited by A2LA in accordance with ISO Standard 17025:2005 (Certificate Number: 3331.05, Master Code: 134288). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Innovation, Science and Economic Development Canada (ISED)

Registration No.: 2932H-2 The 5 meter chamber has been accepted by ISED to perform testing to 3 meters, based on the test procedures described in ANSI C63.4.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. TUV Rheinland at the 762 Park Ave. Youngsville, N.C 27596 address has been assessed and approved in accordance with the Regulations for Voluntary Control Measures. (Laboratory Registration No: A-0034).

2.1.5 Test Software

1) Tile Quantum Change/EMC Systems LLC. Version: 3.2U
2) RadCon RF Immunity TopRudder Version: 1.1.13
3) National Instruments 'Measurement & Automation Employer' Version 4.6.2f1
4) TUV Alt 'R' Version: 1
5) TUV Alt 'C' Version: 1
6) VolTech Instruments IEC61000-3 for PM6000 Version: 1.24.12
7) California Instruments AC Source GUI 32 Version 1.19
8) CTS 3.0 Version 3.2.0.32
9) Teseq Win 3000 Version 1.3.2
10) Rohde & Schwarz Click Rate Analyzer Version 1.7.0

2.2 Expanded Measurement Uncertainty

The accumulated measurement uncertainties of the test system in use for the parameters measured were expected not exceed the values given in the following tables.

Per CISPR 16-4-2:2011	U_{95}
Radiated Disturbance @ 3m, 10m	
30 MHz – 1,000 MHz (Horizontal Polarity)	3m = 4.52 dB,
1.0 GHz – 6.0 GHz	3m = 4.25 dB
> 6.0 GHz	3m = 4.93 dB

U_{95}= Expanded Uncertainty.

Note:
Expanded measurement uncertainty numbers are shown in the table above. Compliance criteria are not based on measurement uncertainty. The expanded uncertainty at a level of 95% confidence is obtained by multiplying the combined standard uncertainty by a coverage factor of 2 (U_{96}).

Per ETSI TR 100 028 and ETSI TR 100 273	U_{95}
Frequency Accuracy	
30 MHz – 1000 MHz (Band 1)	1.44 Hz
1.0 GHz – 6.0 GHz (Band 2)	1.78 Hz
> 6.0 GHz (Band 3)	3.13 Hz
Carrier Power Measurement	
Total	1.59 dB
Adjacent Channel Power Measurement	
Total	1.47 dB
Conducted Spurious Emissions Measurement	
Total	4.01 dB
Frequency Deviation Measurement	
Total	1.30 dB
Total Response Measurement	
Total	0.46 dB

U_{95}= Expanded Uncertainty.

Notes: Expanded measurement uncertainty numbers are shown in the table above. The given uncertainty figures are valid to a confidence level of 95 % (k=2), calculated according to the methods described in ETSI TR 100 028 and ETSI TR 100 273.

2.3 Measurement Uncertainty

Two types of measurement uncertainty are expressed in this report, per *ISO Guide To The Expression Of Uncertainty In Measurement*, 1st Edition, 1995.

The Combined Standard Uncertainty is the standard uncertainty of the result of a measurement when that result is obtained from the values of a number of other quantities, equal to the positive square root of a sum of terms, the terms being the variances or co-variances of these other quantities weighted according to how

the measurement result varies with changes in these quantities. The term standard uncertainty is the result of a measurement expressed as a standard deviation.

The Expanded Uncertainty defines an interval about the result of a measurement that may be expected to encompass a large fraction of the distribution of values that could reasonably be attributed to the measurand. The fraction may be viewed as the coverage probability or level of confidence of the interval.

2.3.1 Sample Calculation – radiated & conducted emissions

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = RAW - AMP + CBL + ACF

Where: RAW = Measured level before correction (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

Sample radiated emissions calculation @ 30 MHz

Measurement +Antenna Factor–Amplifier Gain+Cable loss=Radiated Emissions (dBuV/m)

25 dBuV/m + 17.5 dB – 20 dB + 1.0 dB = 23.5 dBuV/m

2.3.1 Measurement Uncertainty Emissions

TUV Rheinland of North America located at 762 Park Avenue, Youngsville, NC 27596-9470, is accredited by the commission for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No 90552 and 100881). The laboratory scope of accreditation includes: Title 47 CFR Part 15, and 18. The accreditation is updated every 3 years.

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2005. Equipment calibration records are kept on file at the test facility.

2.5 Measurement Equipment Identification

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Spectrum Analyzer	Rohde & Schwarz	FSU	200751	14-Aug-18	14-Aug-19
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	14-Aug-18	14-Aug-19
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	11-Aug-17	11-Sep-19
Antenna Loop 9kHz -30MHz	EMCO	6502	3336	24-Apr-18	24-Apr-19
Ant. BiconiLog 30-1000MHz	Chase	CBL6140A	1108	06-Oct-15	31-Sep-18
Antenna Horn 1-18GHz	EMCO	3115	5770	20-Jun-18	20-Jun-19
Antenna/Amp/Cable 26.5-40 GHz	ATM/Miteq/Microcoax	28-442-6/cal, JS42-26004000-28-5A, MKR300C-0-1968-500310	G047702-01	26-April-18	26-April-19
RF Power Head	ETS Lindgren	7002-006	00160220	16-Aug-18	16-Aug-19
RF Power Head	ETS Lindgren	7002-006	00160221	16-Aug-18	16-Aug-19
Notch Filter: 2.4-2.4835GHz	Micro-Tronics	BRM50702-01	G039	17-Nov-17	17-Nov-18
3.0 GHz High Pass Filter	Bonn Electronik	BHF 3000	025155	17-Nov-17	17-Nov-18
General Laboratory Equipment					
Meter, Multi	Fluke	179	90580752	14-Aug-18	14-Aug-19
Meter, Multi	Fluke	381	14250055	14-Aug-18	14-Aug-19
Meter, Temp/Humid/Barom	ExTech	SD700	Q677933	1-May-18	1-May-19
Meter, Temp/Humid/Barom	ExTech	SD700	Q677942	27-Jun-18	27-Jun-19

Note:

3 Product Information

3.1 Test Plan

The EUT product information, test configuration, mode of operation, test types, test procedures, test levels, pass/failure criteria, in this report were carried out per the product test plan located in appendix A of this report.

3.2 Operational Description

The SISU Sense uses Bluetooth Low Energy, operating in the 2.4GHz unlicensed ISM band. A frequency hopping transceiver provides many FHSS carriers. Basic operation uses a shaped, binary frequency modulation with a symbol rate of 1 million symbols per second.

3.2.1 Theory of Operation

Two multiple access systems are provided: FDMA, and TDMA. Forty channels support the FDMA scheme, with 3 serving as primary advertising and 37 as secondary advertising. Channels are divided into time units known as events, and transceivers position data in these events. Events are Advertising, Extended Advertising, Periodic Advertising, and Connection.
This device is an Advertiser that accepts Connections, and following the Bluetooth Low Energy specification communicates with mobile devices, supplying impact data with those devices.

The device is intended to operate at 3V and between 0-70°C.

4 Test Results and Measurement Data

4.1 Antenna Requirements

47 CFR Part 15C Parts 15.203 and 247(b)(4).

Part 15.203 requirement:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible part shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, by the use of a standard antenna jack or electrical connector is prohibited.

Result: The antenna used is integrated on the main PCB and has no consideration of replacement. The best case gain of the antenna is 0 dBi, as supplied by the manufacturer.

5 RF Radiated Emissions in Transmit mode

5.1 Radiated emissions - FCC Parts 15.249, RSS-210 B.10

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following limits:
Fundamental Frequency: 2400 to 2483.5 MHz – 50 mV/m (94 dB µV/m) at 3m.
Harmonic Frequencies: 500 µV/m (54 dB µV/m) at 3m.
Spurious Emissions: To the limits of FCC Part 15.209 and RSS-GEN 7.2.1.

5.1.1 Over View of Test

Results	**Complies** (as tested per this report)				**Date**	21 June 2017	
Standard	FCC Parts 15.205, 15.209, 15.215(c), 15.249(a), 15.249(c), 15.249(d) RSS-210 A2.9, and RSS-GEN						
Product Model	M329			**Serial#**	Production Prototype		
Test Set-up	Tested in a 5m Semi Anechoic chamber, placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane on a turn-table.						
EUT Powered By	3.0 V DC Lithium battery	**Temp**	75º F	**Humidity**	40%	**Pressure**	1000 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

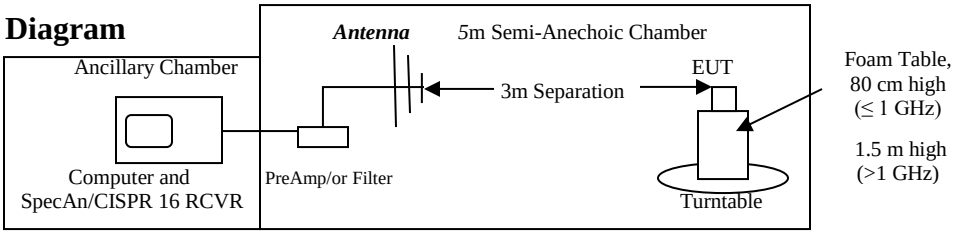
5.1.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2013, RSS-GEN Issue 4. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

5.1.3 Deviations

Since all emissions outside the band are within the limits of FCC Part 15.209 and RSS-GEN 7.2.1, the emissions shown below are also compliant with FCC Parts 15.205, 15.209, 15.215(c), 15.249(d), RSS-210 B.10, and RSS-GEN 7.2.1.

5.1.4 Test Setup Block Diagram



5.1.5 Final Test

All final radiated spurious emissions measurements were below (in compliance) the limits.

5.1.5.1 Worst Case Emissions inside the Frequency Band

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Equivalent EiRP level (mV/m)	Spec Limit (mV/m)
Orientation A:										
2402.00	H	1.9	272	65.31	34.11	8.52	28.43	68.16	2.559	50.00
2402.00	H	1.9	272	66.71	34.11	8.52	28.43	69.56	3.006	500.00
2402.00	V	2.0	187	58.69	34.11	8.52	28.43	61.54	1.194	50.00
2402.00	V	2.0	187	62.92	34.11	8.52	28.43	65.77	1.943	500.00
2440.00	H	1.7	268	66.01	34.13	8.59	28.31	68.78	2.748	50.00
2440.00	H	1.7	268	67.75	34.13	8.59	28.31	70.52	3.357	500.00
2440.00	V	1.9	202	63.00	34.13	8.59	28.31	65.77	1.943	50.00
2440.00	V	1.9	202	65.01	34.13	8.59	28.31	67.78	2.449	500.00
2480.00	H	1.7	275	67.55	34.15	8.66	28.35	70.41	3.315	50.00
2480.00	H	1.7	275	71.82	34.15	8.66	28.35	74.68	5.420	500.00
2480.00	V	1.9	207	62.89	34.15	8.66	28.35	65.75	1.939	50.00
2480.00	V	1.9	207	67.68	34.15	8.66	28.35	70.54	3.365	500.00
Orient2ation B:										
2402.00	H	1.9	280	50.96	34.11	8.52	28.43	53.81	0.490	50.00
2402.00	H	1.9	280	52.57	34.11	8.52	28.43	55.42	0.590	500.00
2402.00	V	1.8	213	66.79	34.11	8.52	28.43	69.64	3.034	50.00
2402.00	V	1.8	213	68.20	34.11	8.52	28.43	71.05	3.569	500.00
2440.00	H	2	275	59.32	34.13	8.59	28.31	62.09	1.272	50.00
2440.00	H	2	275	64.11	34.13	8.59	28.31	66.88	2.208	500.00
2440.00	V	1.9	215	67.62	34.13	8.59	28.31	70.39	3.308	50.00
2440.00	V	1.9	215	68.94	34.13	8.59	28.31	71.71	3.850	500.00
2480.00	H	2.2	278	62.18	34.15	8.66	28.35	65.04	1.786	50.00
2480.00	H	2.2	278	66.34	34.15	8.66	28.35	69.20	2.884	500.00
2480.00	V	2.2	213	68.36	34.15	8.66	28.35	71.22	3.639	50.00
2480.00	V	2.2	213	72.57	34.15	8.66	28.35	75.43	5.909	500.00
Orientation C:										
2402.00	H	1.6	0	63.73	34.11	8.52	28.43	66.58	2.133	50.00
2402.00	H	1.6	0	65.58	34.11	8.52	28.43	68.43	2.639	500.00
2402.00	V	1.4	82	50.95	34.11	8.52	28.43	53.80	0.490	50.00

2402.00	V	1.4	82	53.60	34.11	8.52	28.43	56.45	0.665	500.00
2440.00	H	1.8	0	63.91	34.13	8.59	28.31	66.68	2.158	50.00
2440.00	H	1.8	0	65.71	34.13	8.59	28.31	68.48	2.655	500.00
2440.00	V	1.8	95	50.20	34.13	8.59	28.31	52.97	0.445	50.00
2440.00	V	1.8	95	53.46	34.13	8.59	28.31	56.23	0.648	500.00
2480.00	H	2.0	101	65.18	34.15	8.66	28.35	68.04	2.523	50.00
2480.00	H	2.0	0	69.47	34.15	8.66	28.35	72.33	4.135	500.00
2480.00	V	1.3	87	50.70	34.15	8.66	28.35	53.56	0.476	50.00
2480.00	V	1.3	87	55.78	34.15	8.66	28.35	58.64	0.855	500.00

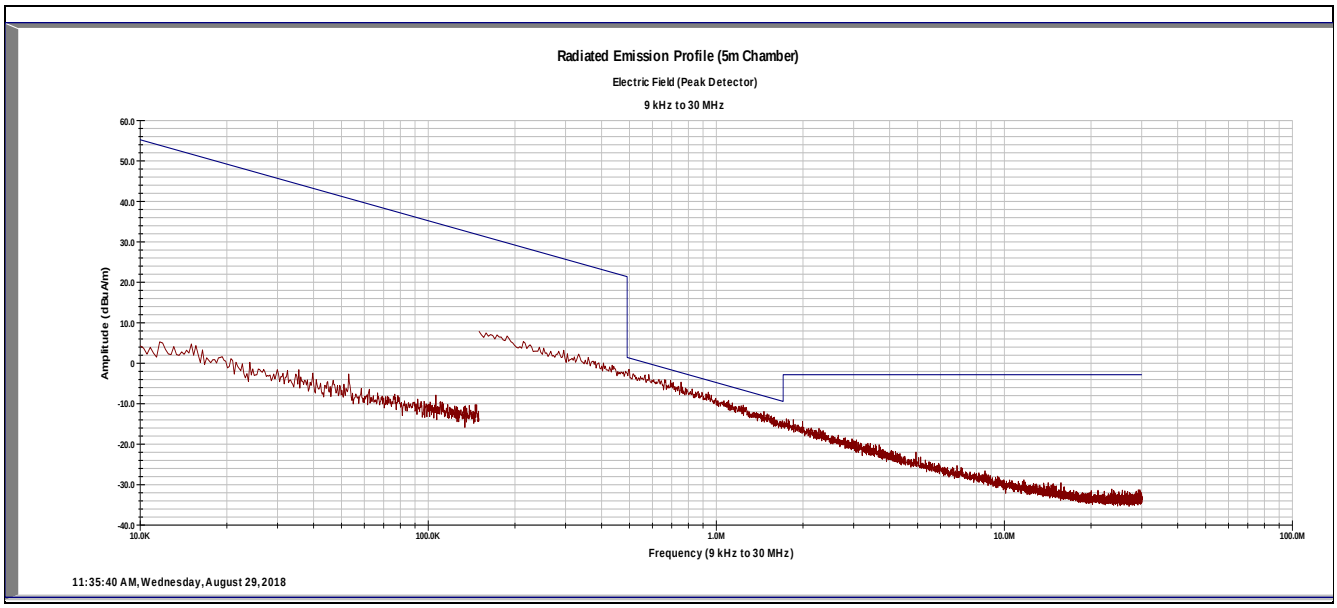
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor

Notes: **GREEN = Average Detector, Blue = Peak Detector**
All measurements made at 3m. The Limit using the Peak Detector is 20dB higher than the Average Detector limit.
EUT in Orientation A is worst case as shown. All other data is on file at TUV Rheinland.
This highlighted frequency and orientation was Highest Emission (2480 MHz, Orientation B).

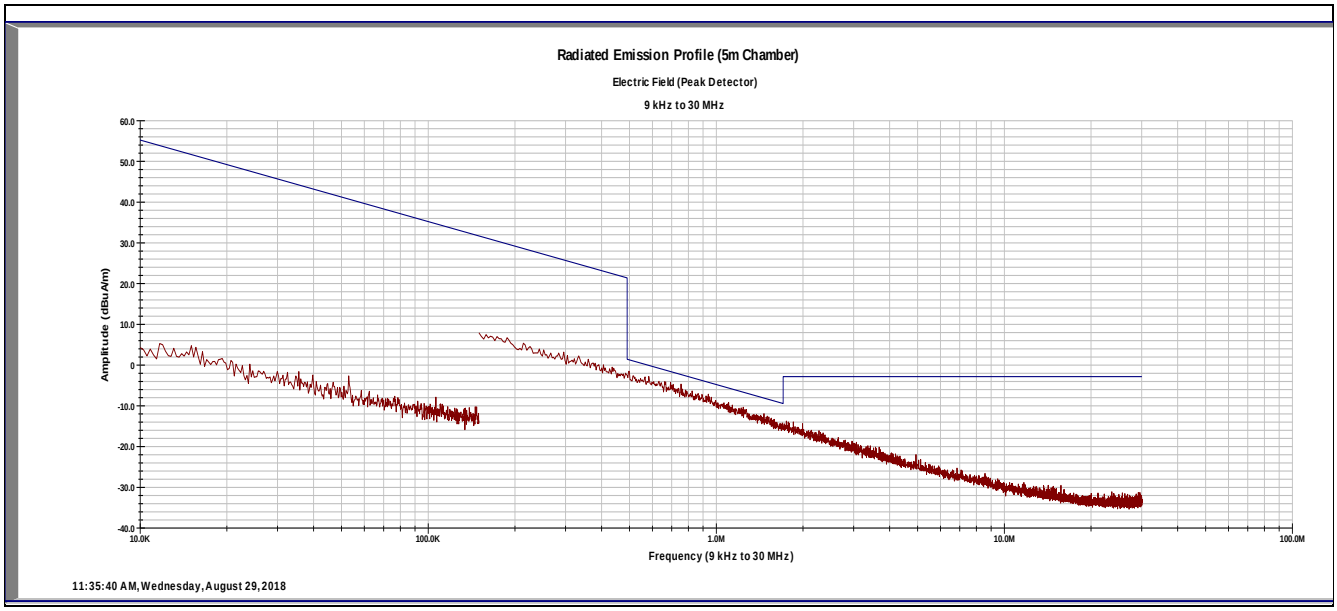
Notes: The signal strength was low enough that a notch filter was not needed.
Peak Power out (using the Friis Eqauation);
71.22 dBµV//m at 3m = 3.97 µW Average and 75.43 dBµV//m at 3m = 10.47 µW Peak

5.1.5.2 Emissions Outside the Frequency Band:

Radiated Emissions – 10 kHz to 30 MHz - Orientation A
Parallel

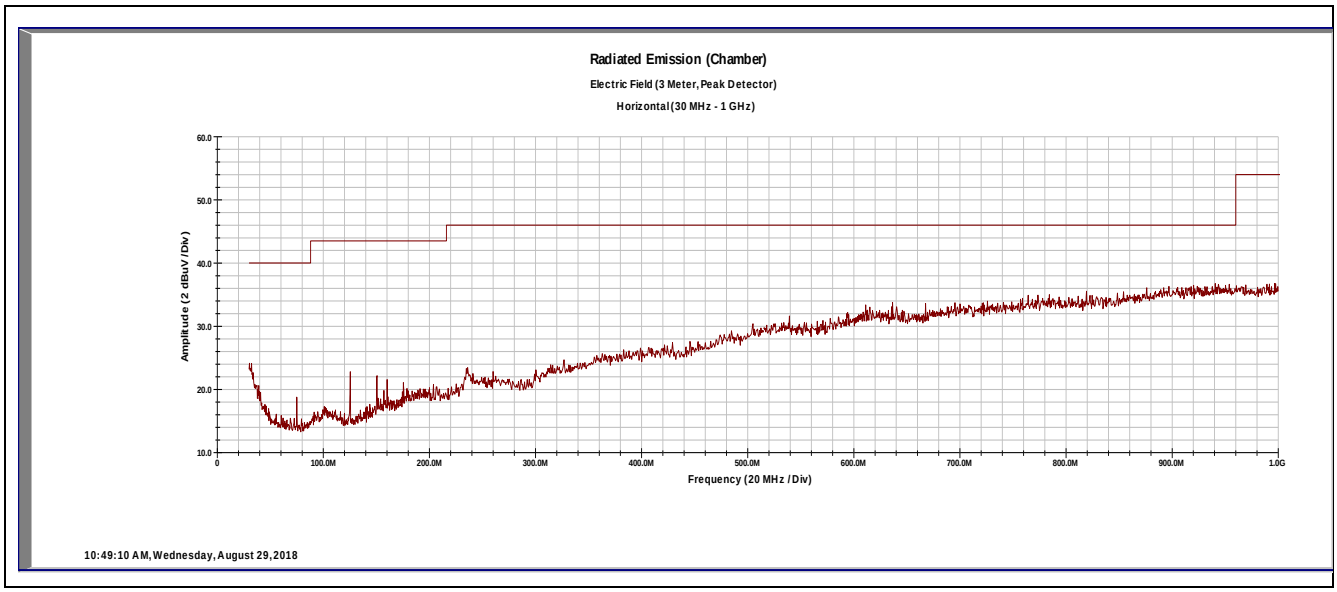


Radiated Emissions – 10 kHz to 30 MHz - Orientation A
Perpendicular

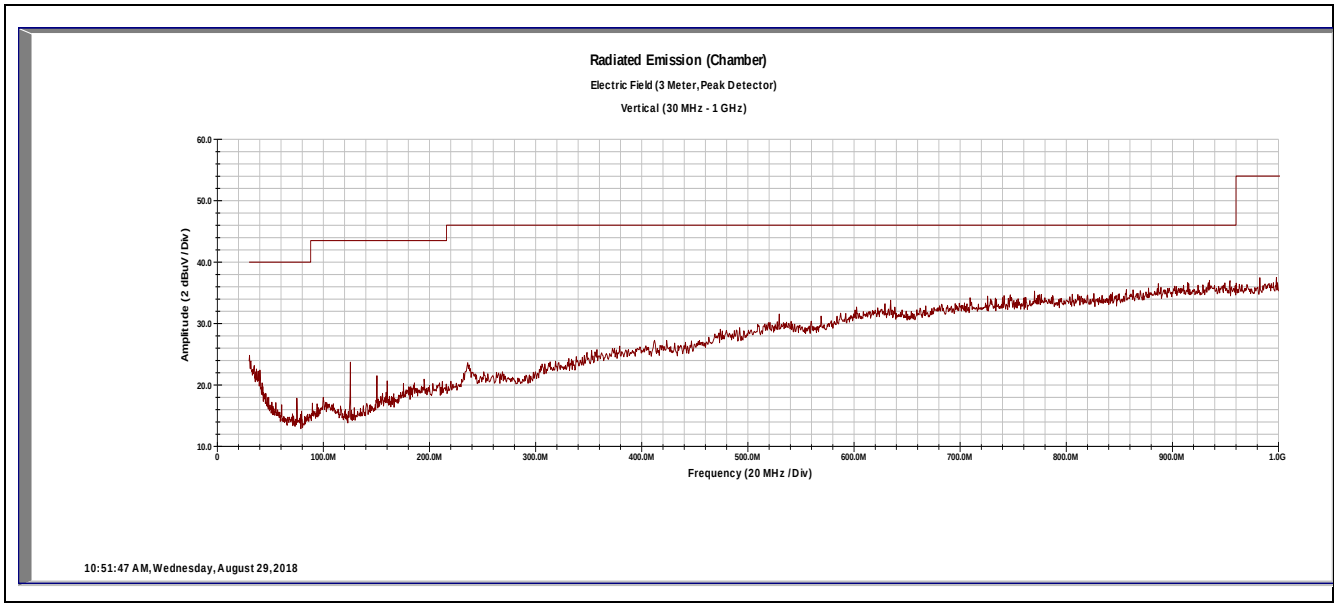


Notes: No measurable emissions noted.
All orientations and frequencies yielded very similar results. No notch filter was used.

Radiated Emissions – 30 MHz to 1000 MHz - Orientation B
Horizontal

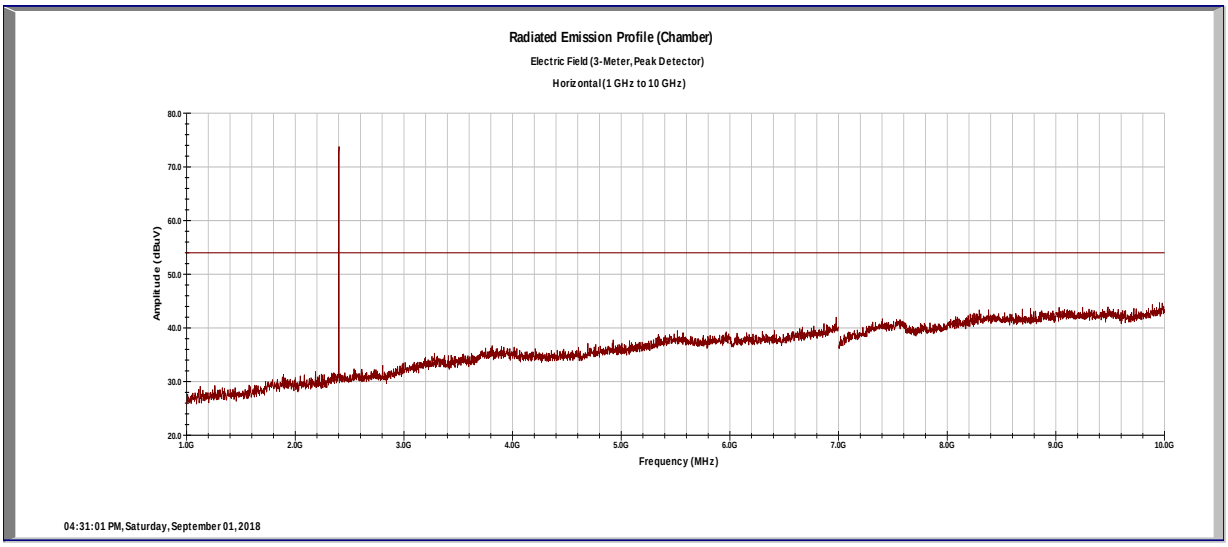


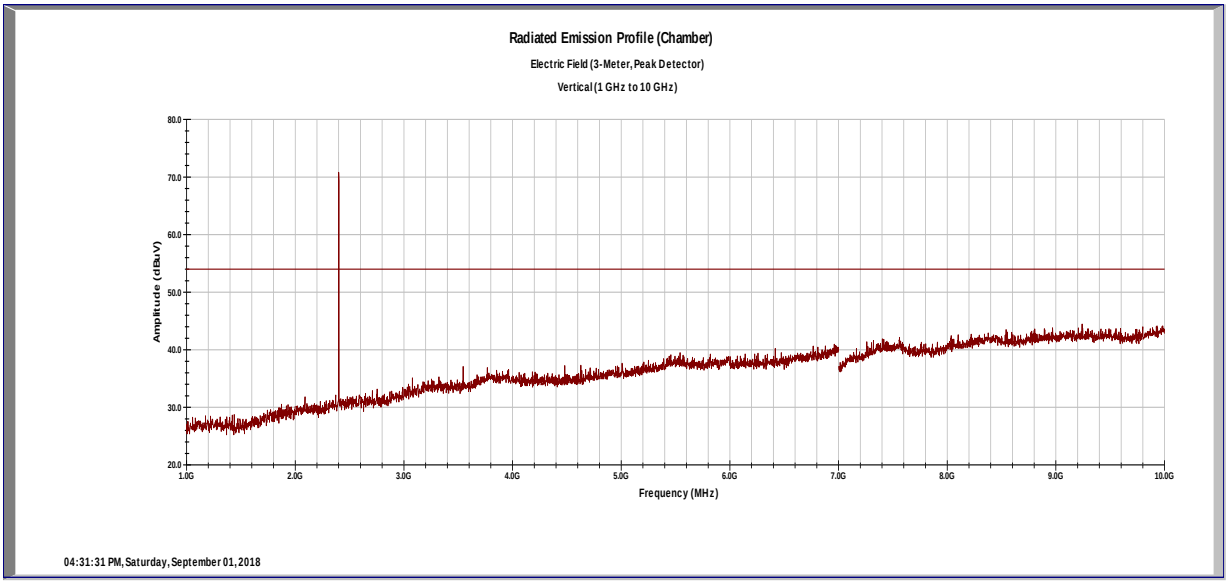
Radiated Emissions – 30 MHz to 1000 MHz - Orientation B
Horizontal



Notes: The spikes below 200 MHz are anomalies of the internal preamp of the spectrum.
Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

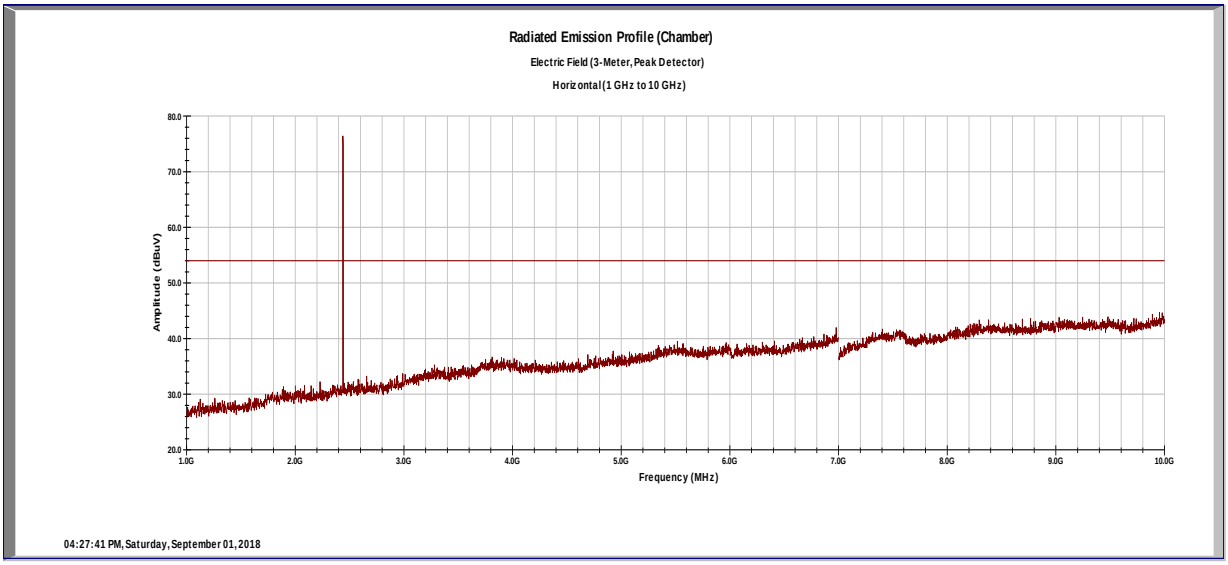
RFE_1-10G_TX-OrientationA-Low:

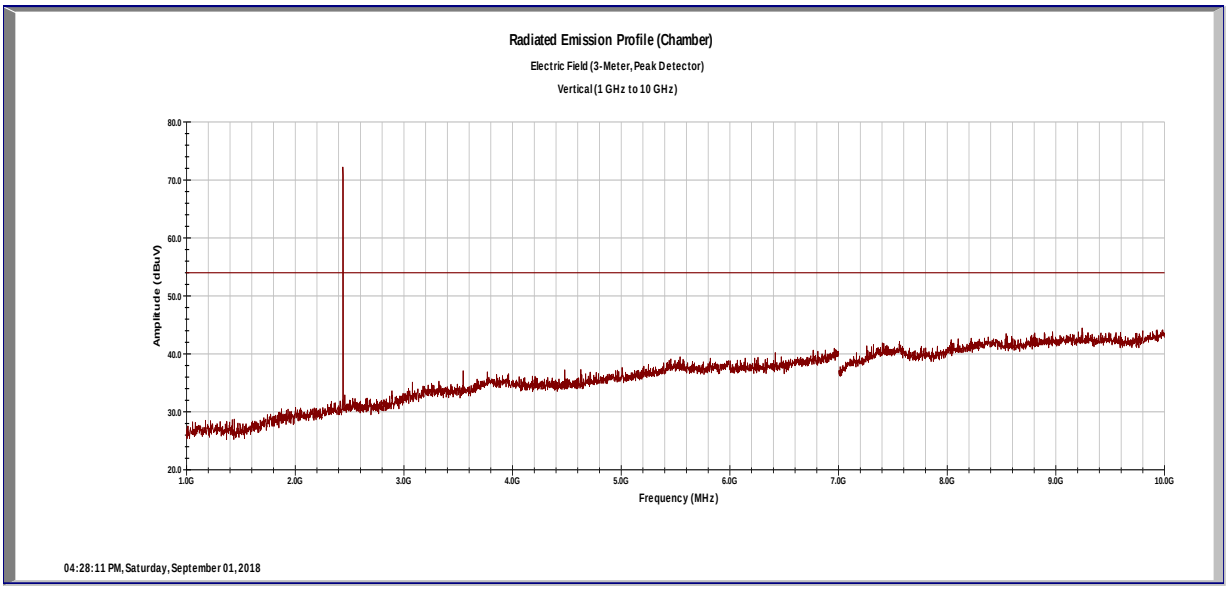




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

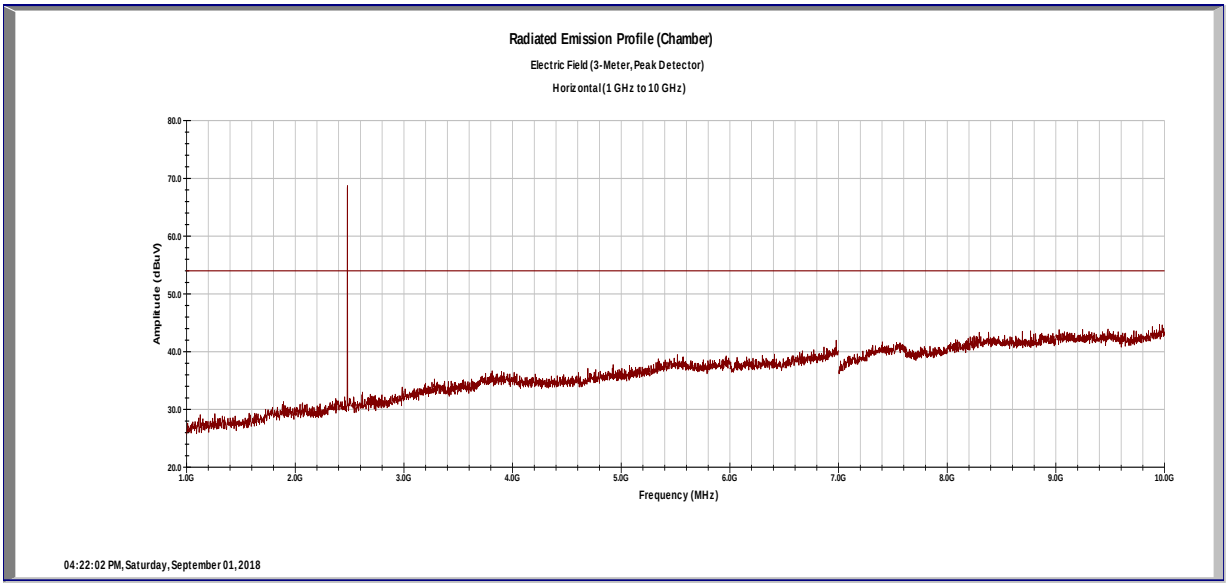
RFE_1-10G_TX-OrientationA-mid:

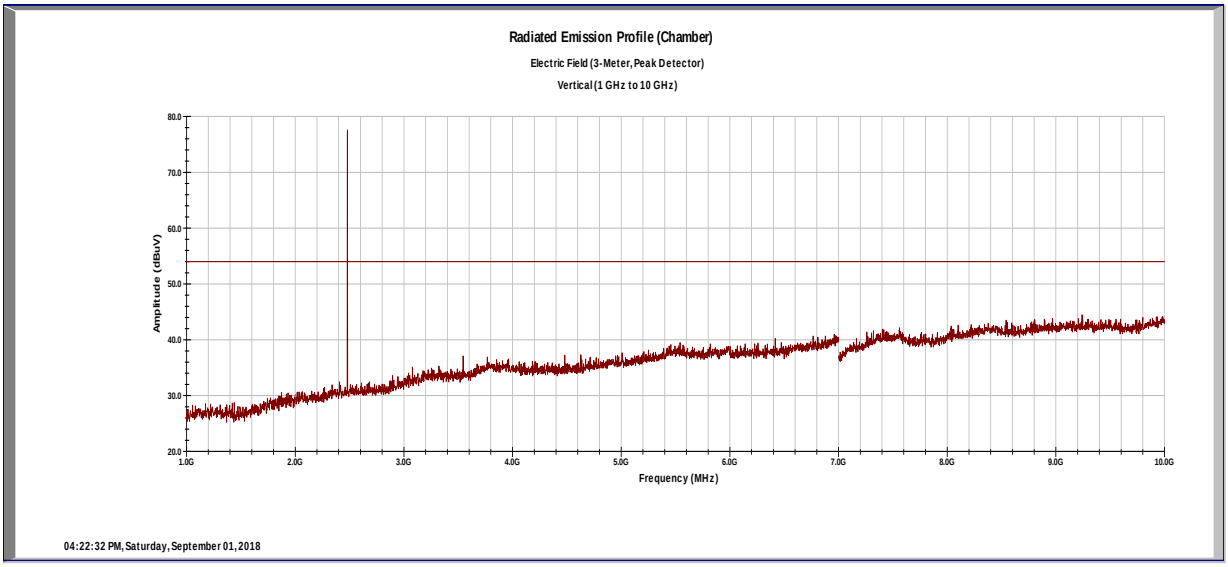




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

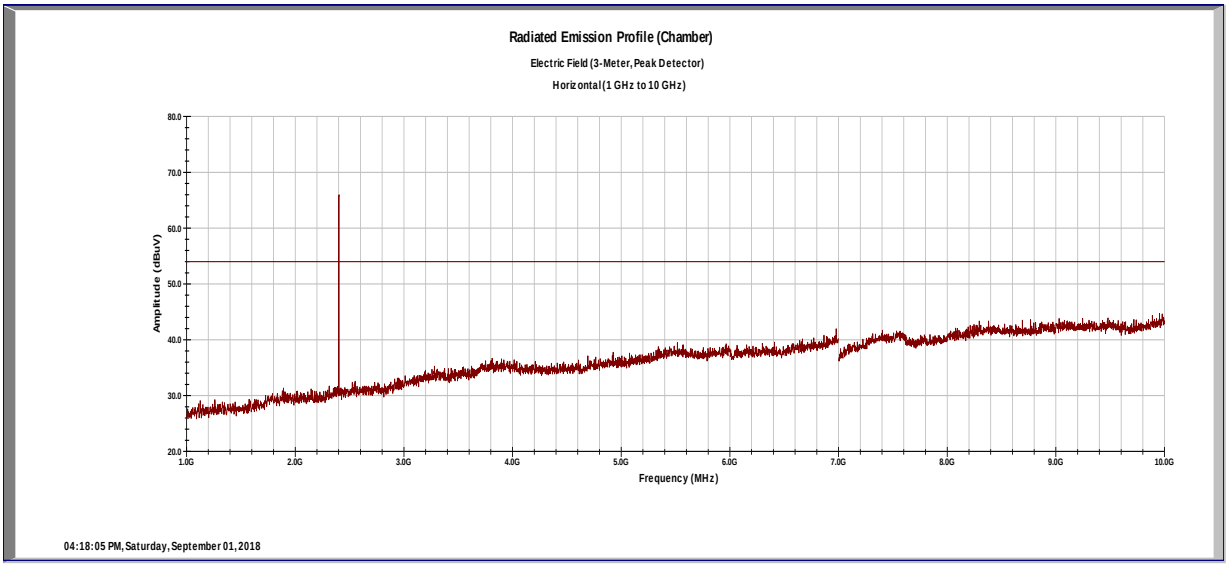
RFE_1-10G_TX-OrientationA-hi:

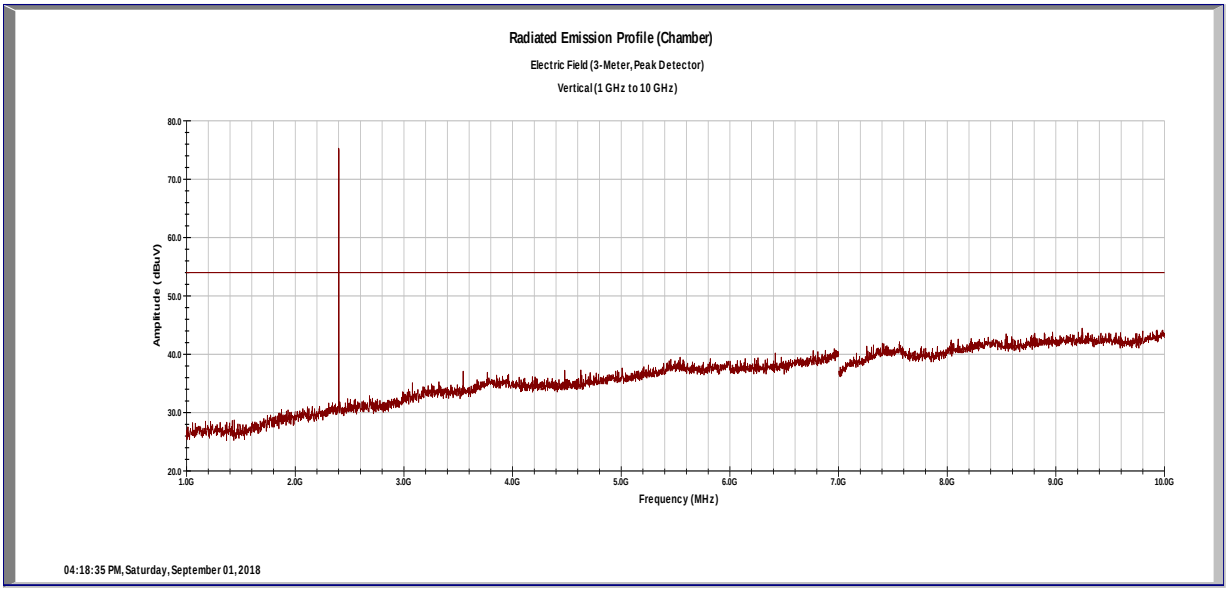




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

RFE_1-10G_TX-OrientationB-Low:





Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

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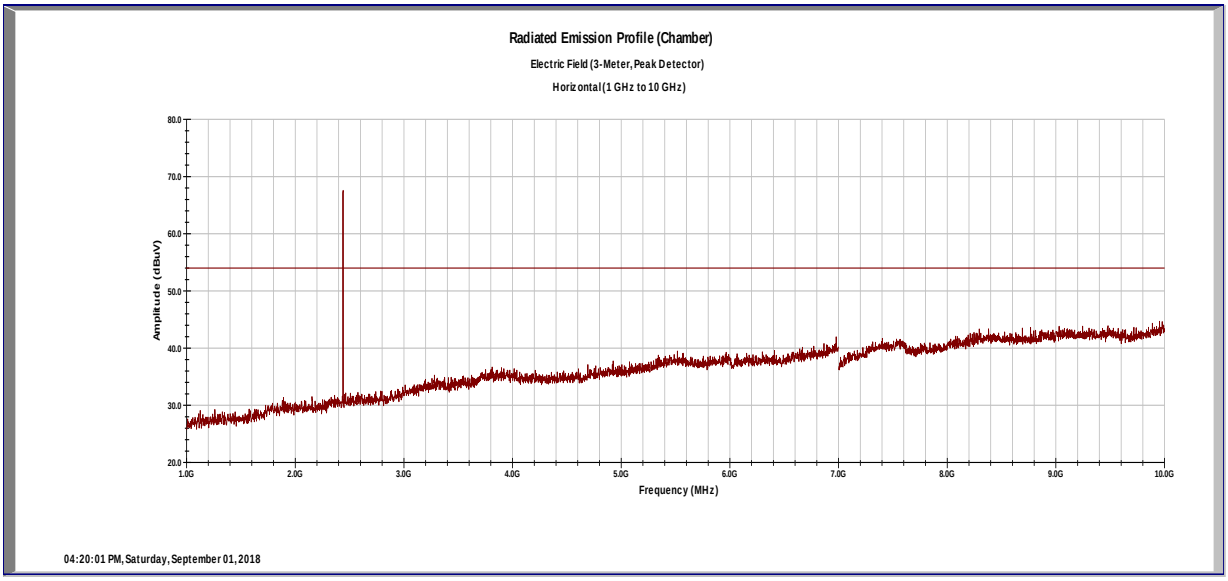
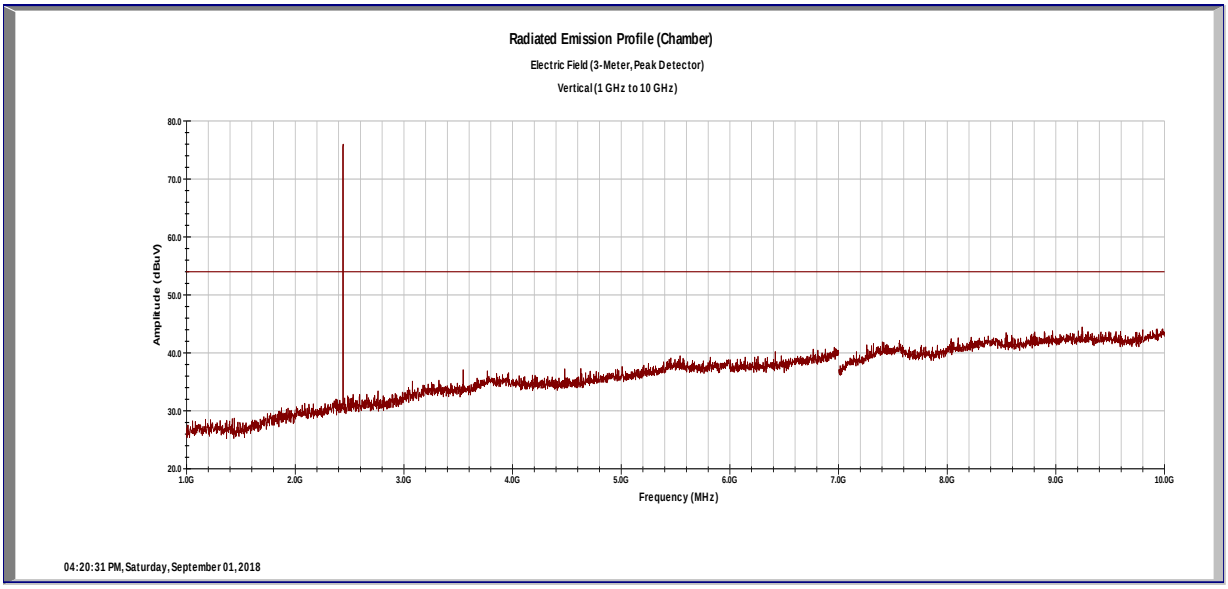
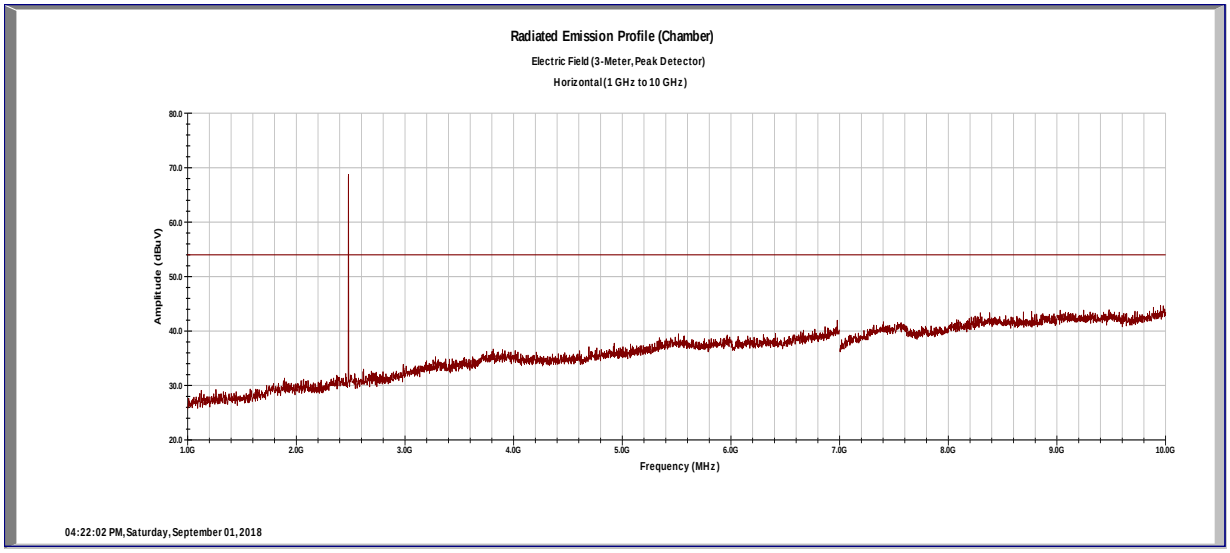
RFE_1-10G_TX-OrientationB-mid:





Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

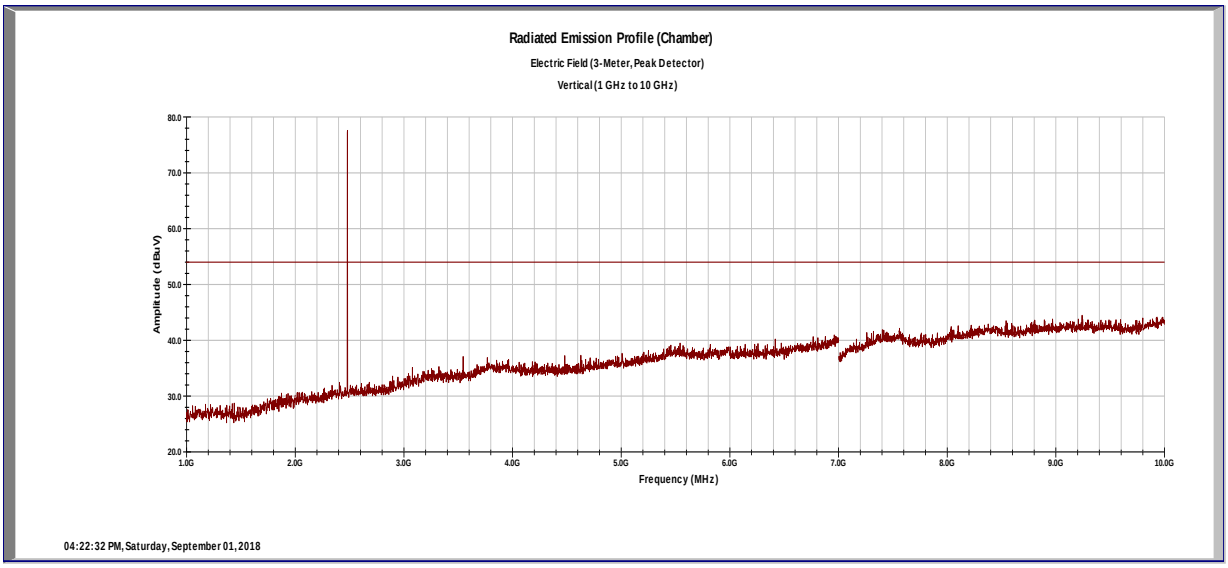
RFE_1-10G_TX-OrientationB-hi:



Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBµV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBµV/m)	Equivalent EiRP level (µV /m)	Spec Limit (µV /m)
2819.64	V	1.8	278	28.17	34.24	9.31	29.09	32.34	41.40	500.00
2819.64	V	1.8	278	40.22	34.24	9.31	29.09	44.39	165.77	5000.00

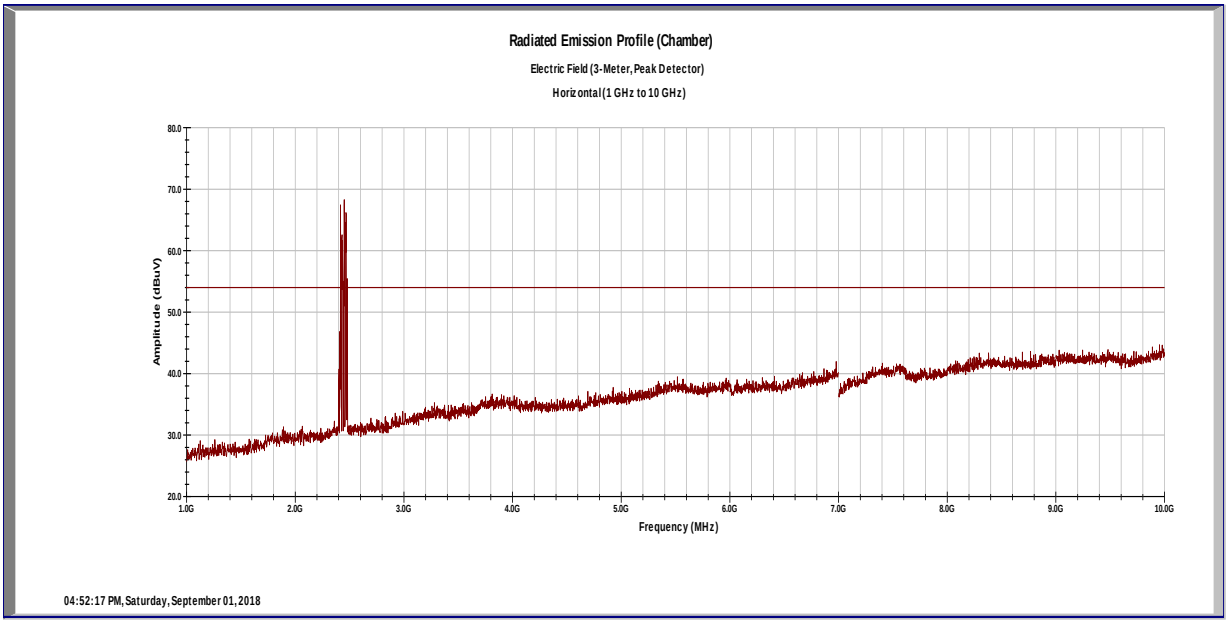
Notes: Worst case spurious emission and is located within a restricted band (limits applied).

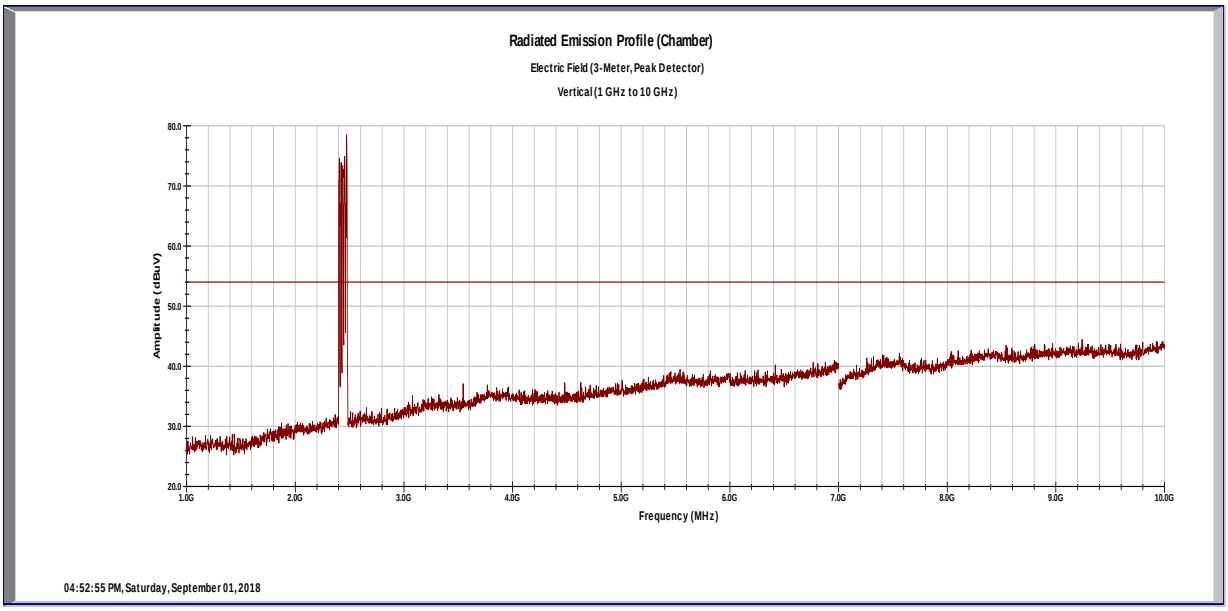
The Emissions shown in **GREEN** are measured using the Average Detector. The Emissions shown in **BLUE** were measured using the Peak Detector.



Notes: This orientation and channel produced the highest fundamental emissions
No other measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

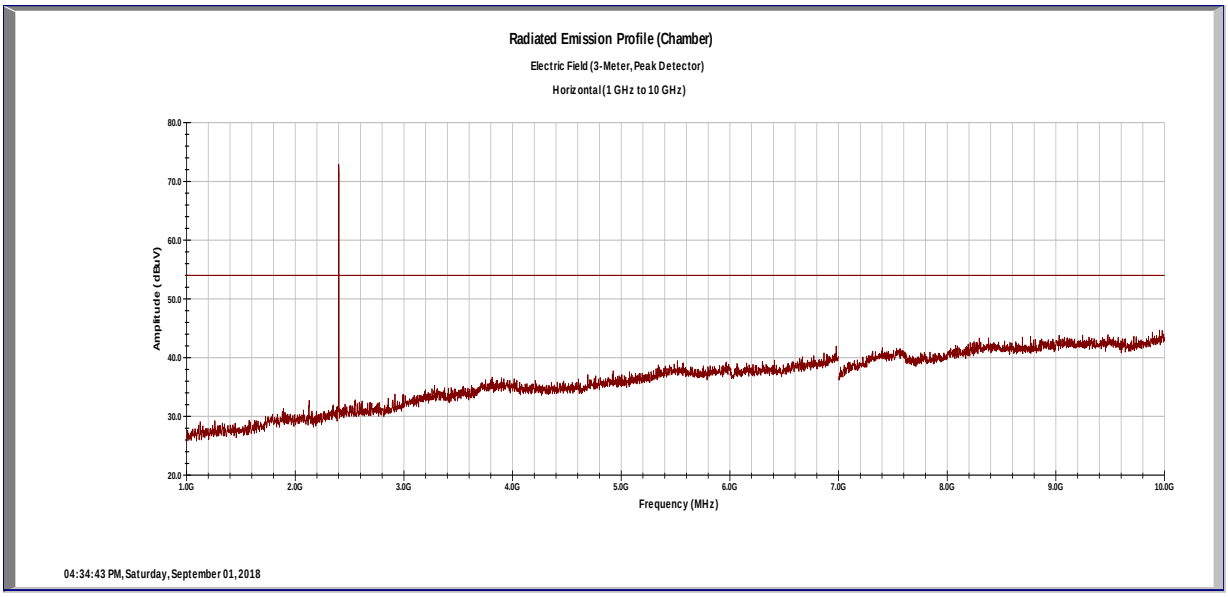
RFE_1-10G_TX-OrientationB-Hopping:

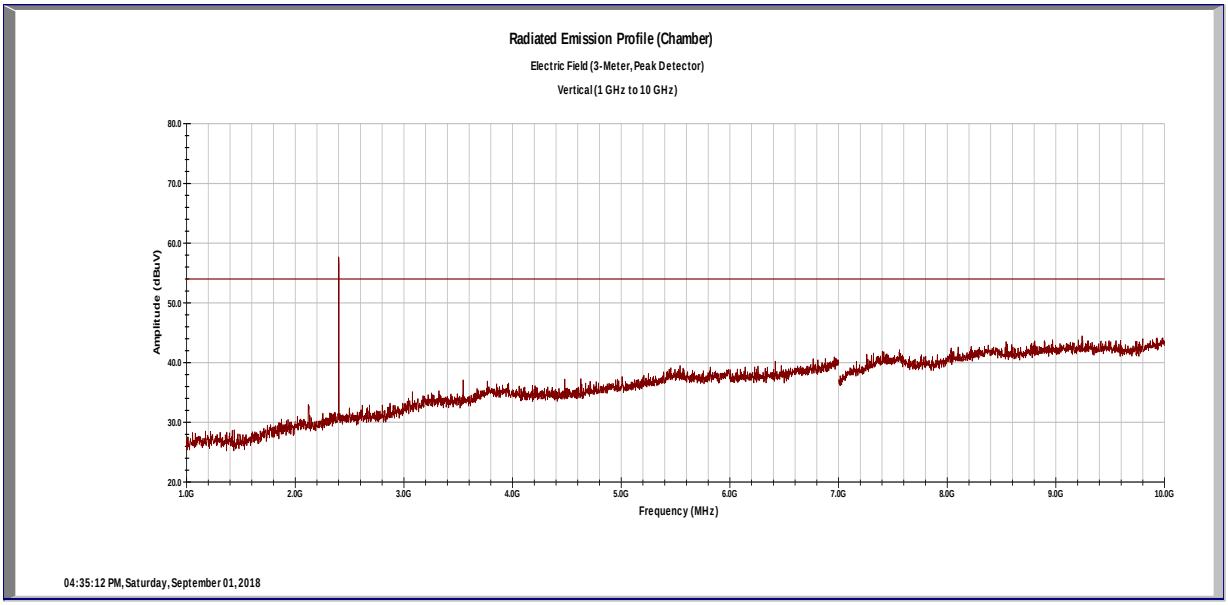




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

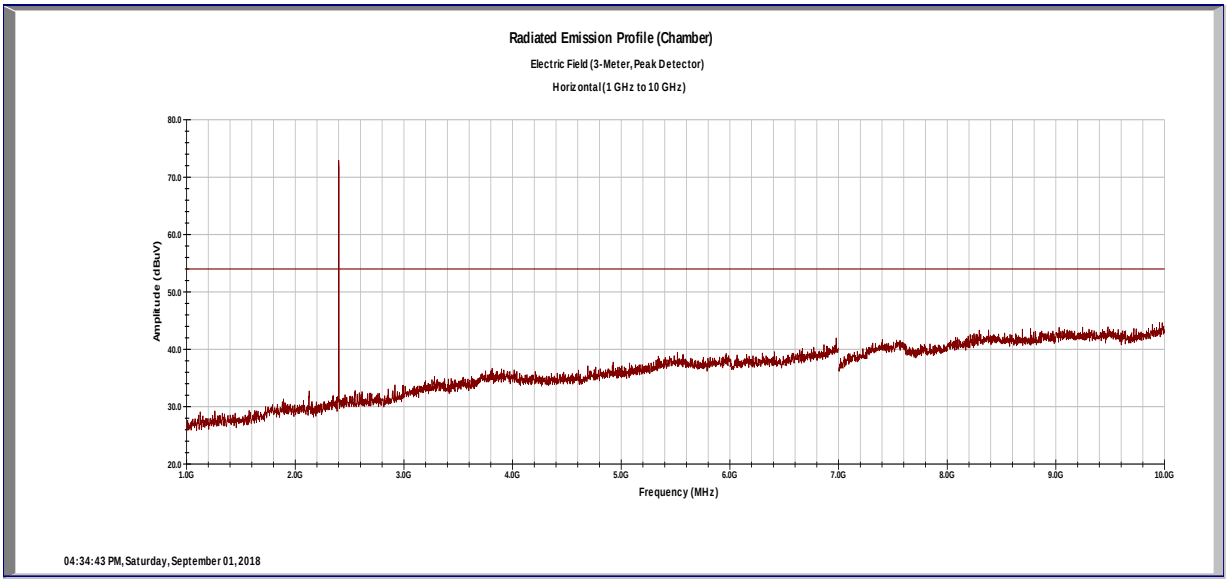
RFE_1-10G_TX-OrientationC-Low:

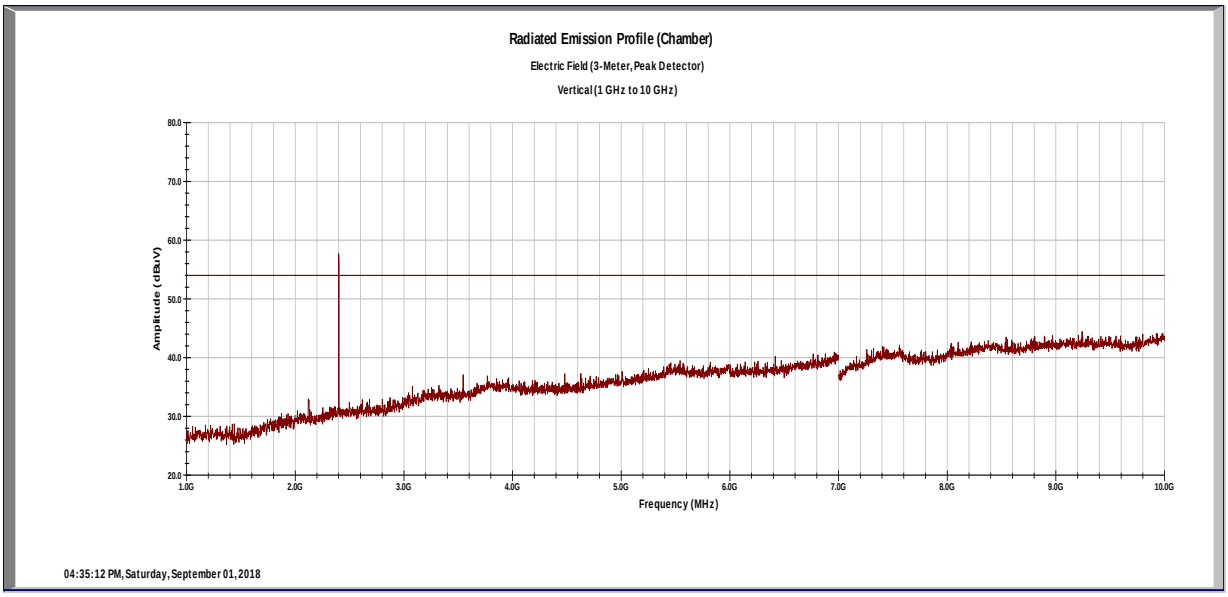




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

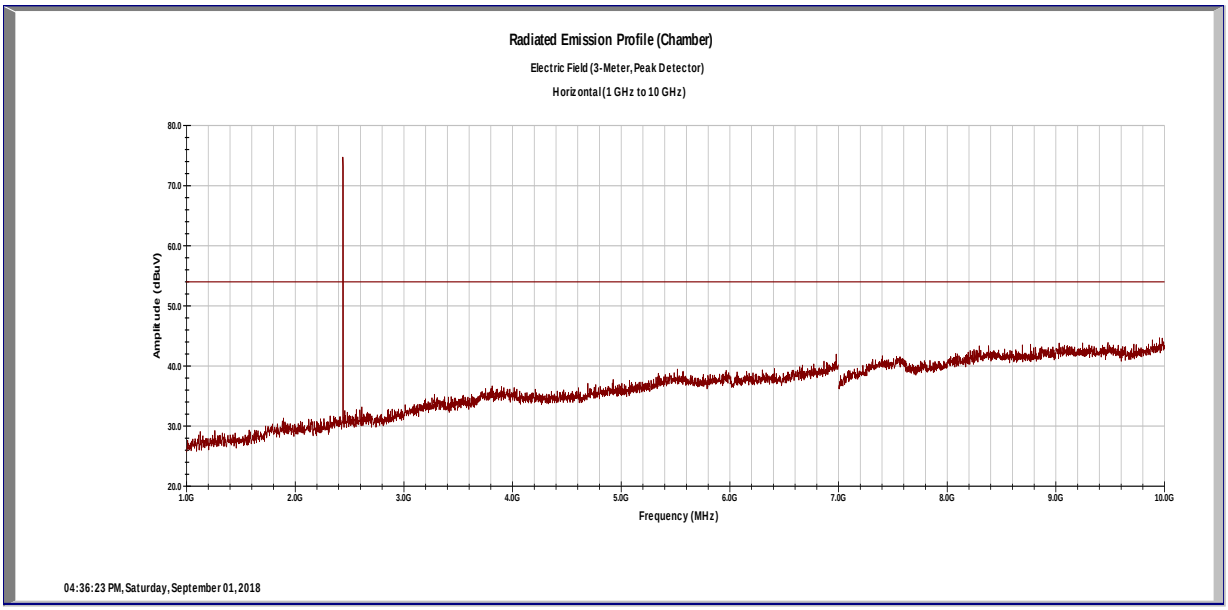
RFE_1-10G_TX-OrientationC-mid:

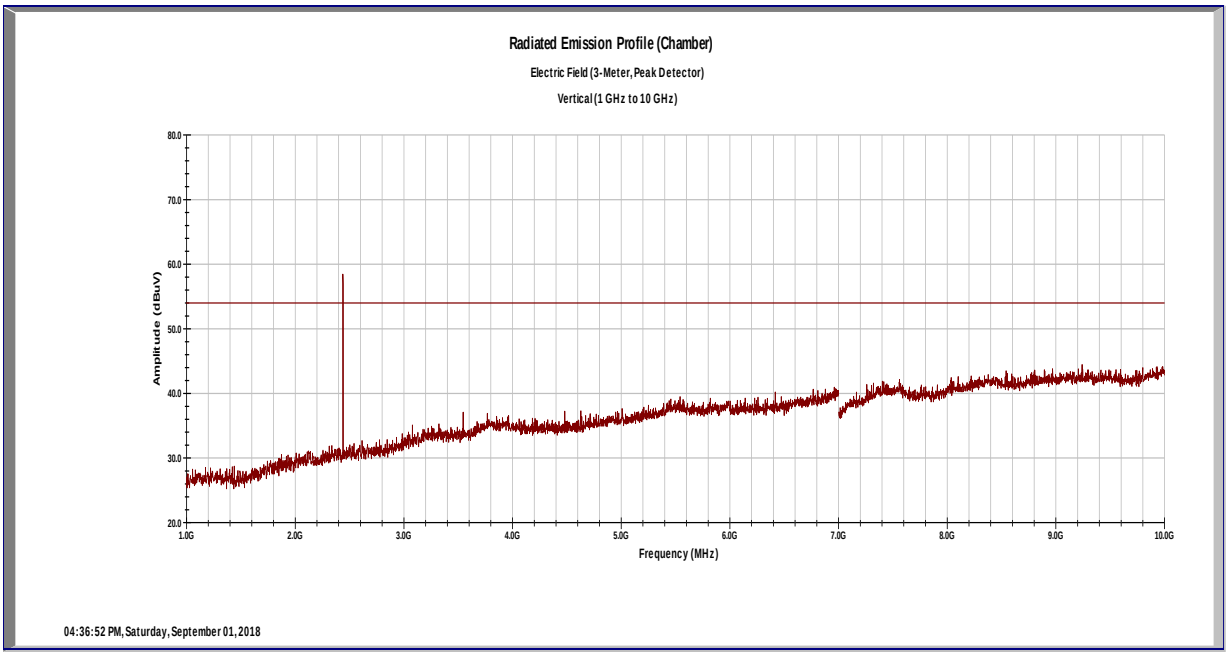




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

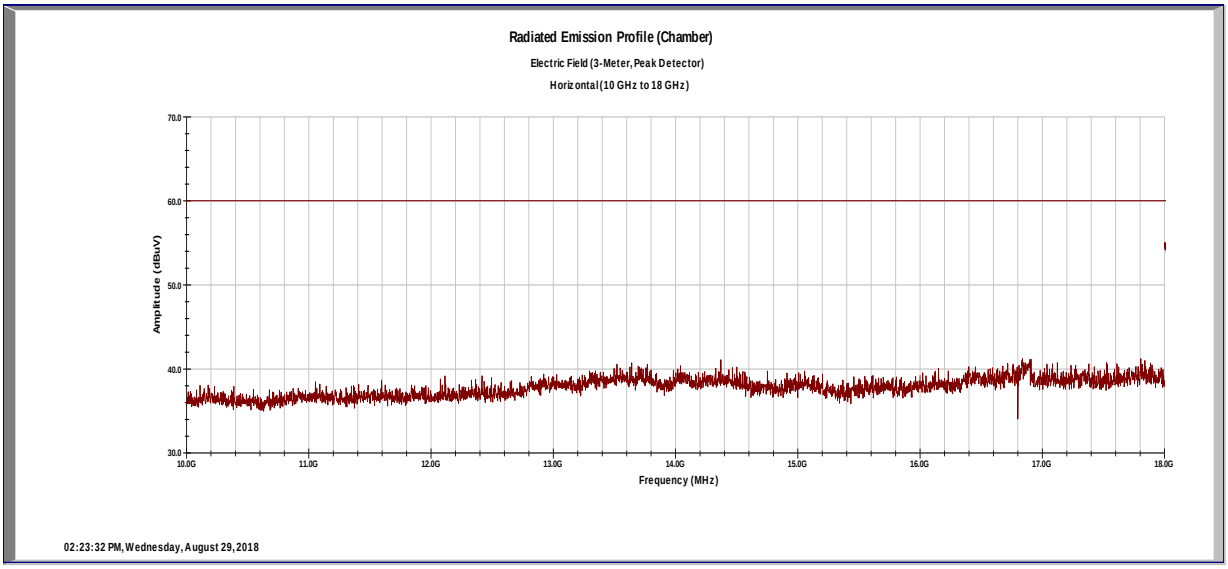
RFE_1-10G_TX-OrientationC-hi:

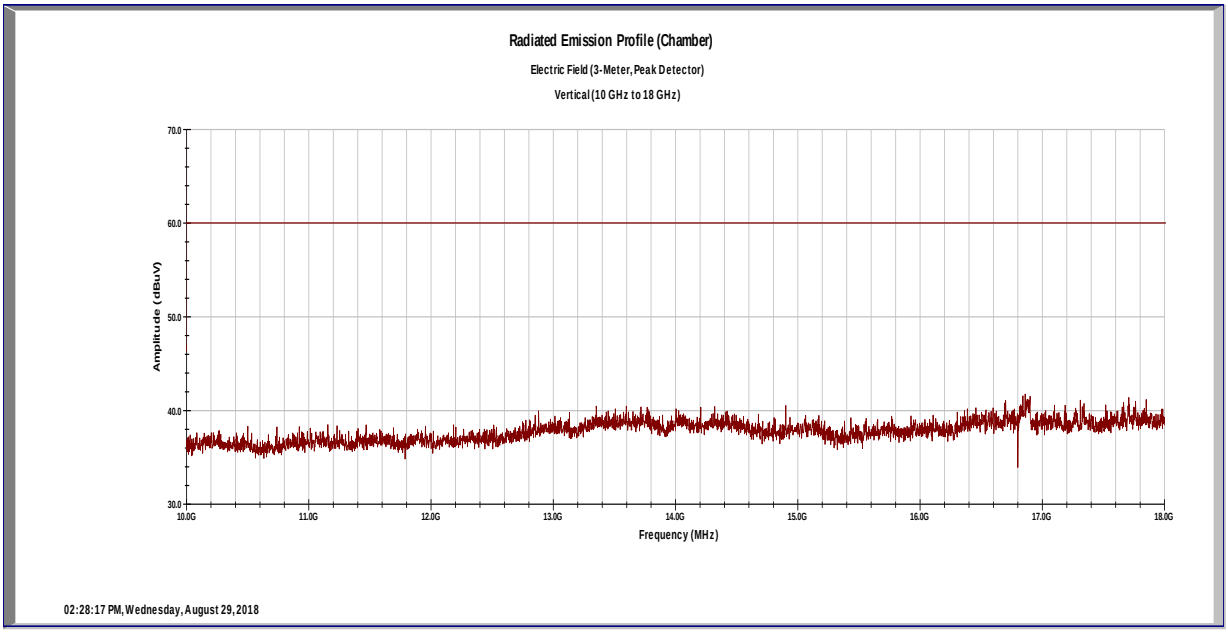




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

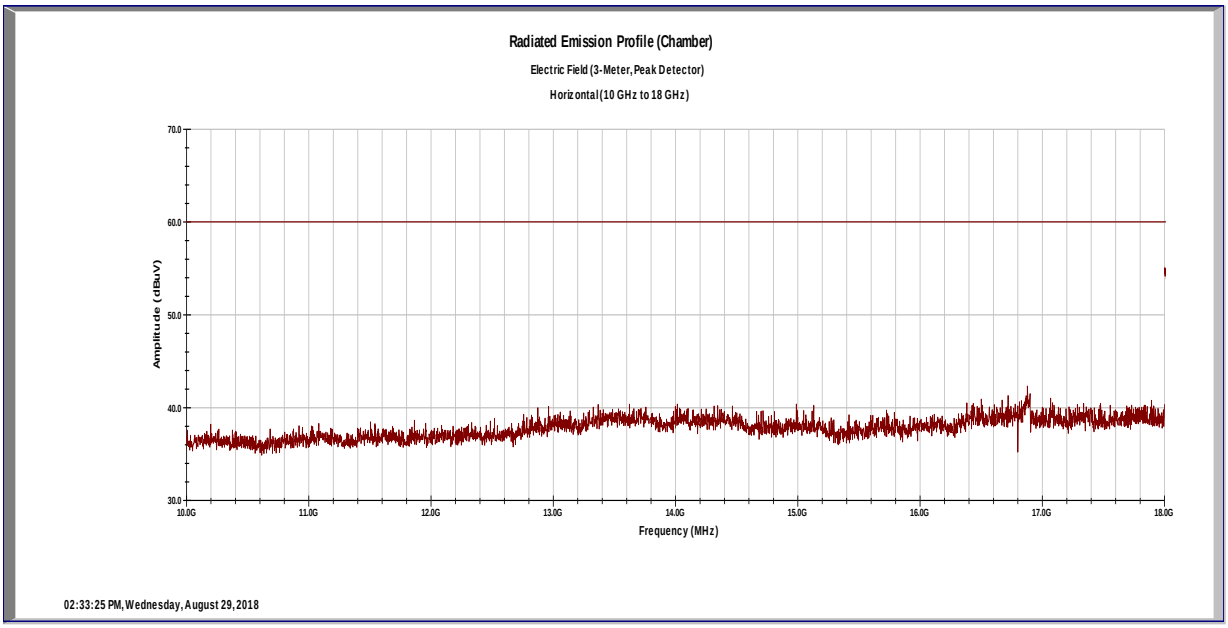
RFE_10-18G_Orientation A:

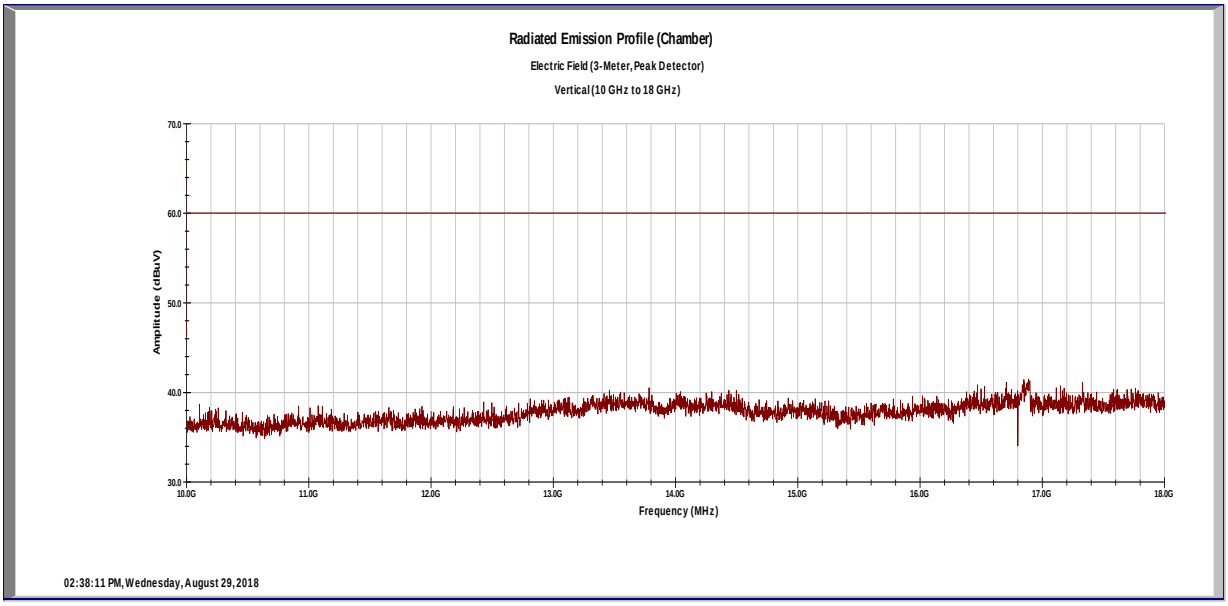




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

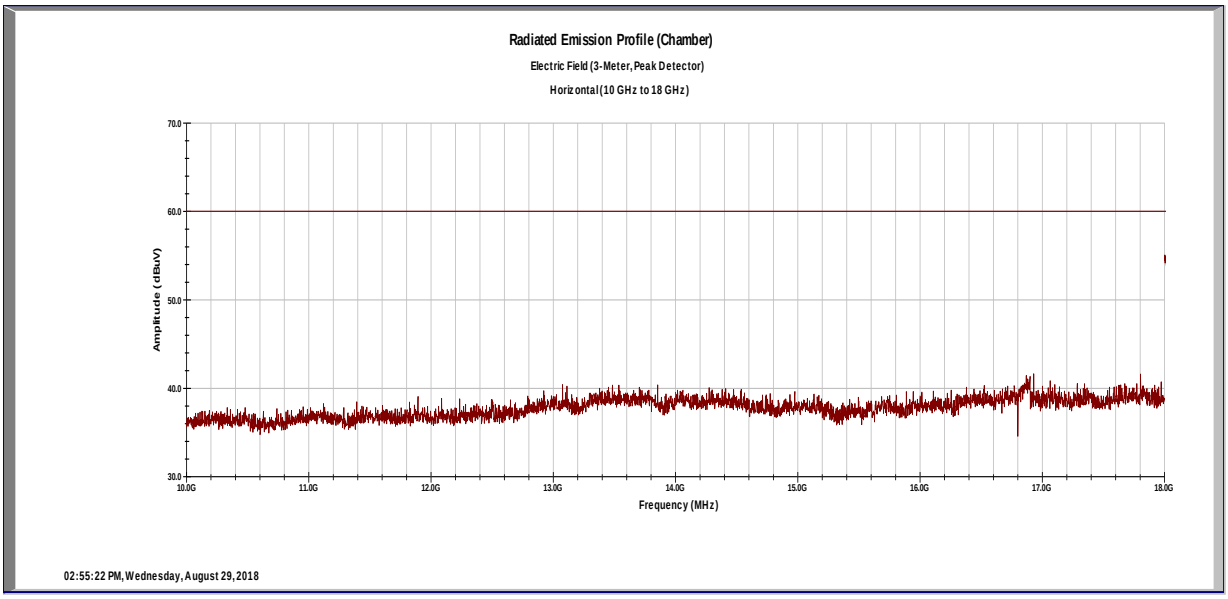
RFE_10-18G_Orientation B:

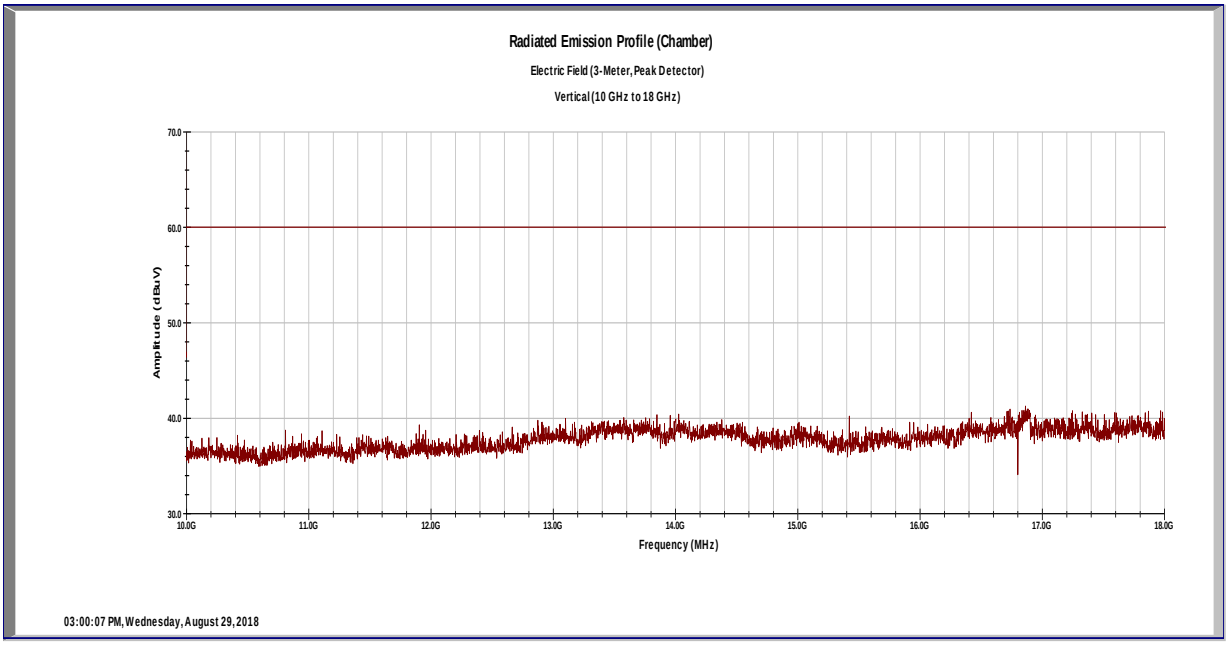




Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

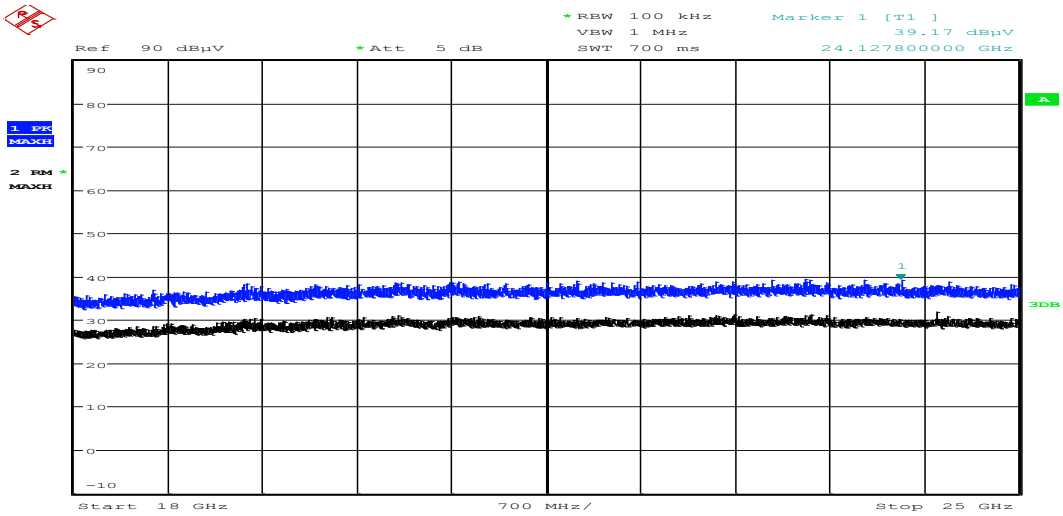
RFE_10-18G_Orientation C:



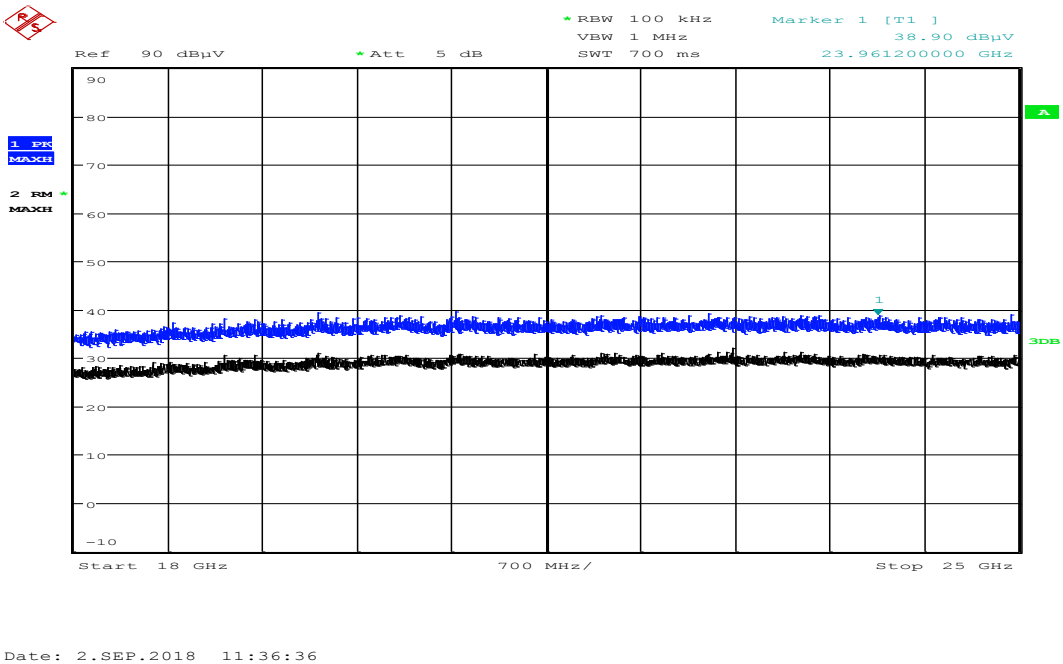


Notes: No measurable spurs or harmonic emissions noted. No notch filter was used.
All orientations and frequencies yielded very similar results.

RFE_18-24G_Orientation B, at 2480 MHz, Horizontal:



RFE_18-24G_Orientation B, at 2480 MHz, Vertical:



Notes: The measurement antenna was pushed in to 2 meters from the EUT.
No measureable emissions were noted.
No correction factors were used for the above graphs. The number of Sweep Points was increased to 4000.
No notch filter was used.

The other two channels presented very similar results. Plots for other the channels are on file at TUV Rheinland.

5.2 Band Edge requirements - FCC Part 15.249(d), RSS-GEN

5.2.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	1 September 2018	
Standard	FCC Part 15.249(d), RSS-GEN						
Product Model	M329			**Serial#**	Production Prototype		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3.0 V DC Lithium battery	**Temp**	82º F	**Humidity**	42%	**Pressure**	1006 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

5.2.2 Test Procedure

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Sec. 15.209, whichever is the lesser attenuation.

5.2.3 Deviations

There were no deviations from the test methodology listed in the test plan.

RBW of 100 kHz was chosen as it is within 1% to 5% of the total span. (4.8%)

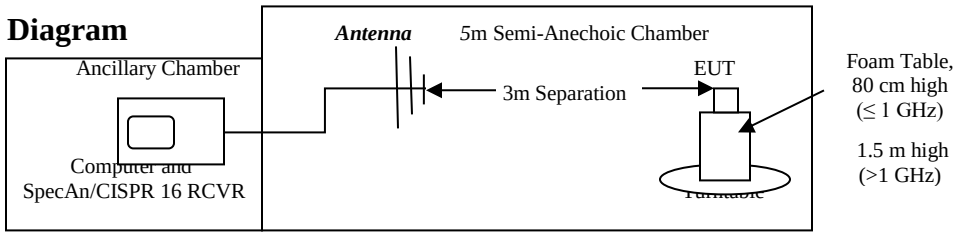
The VBW of 300 kHz was chosen as it is 3 times the 100 kHz RBW.

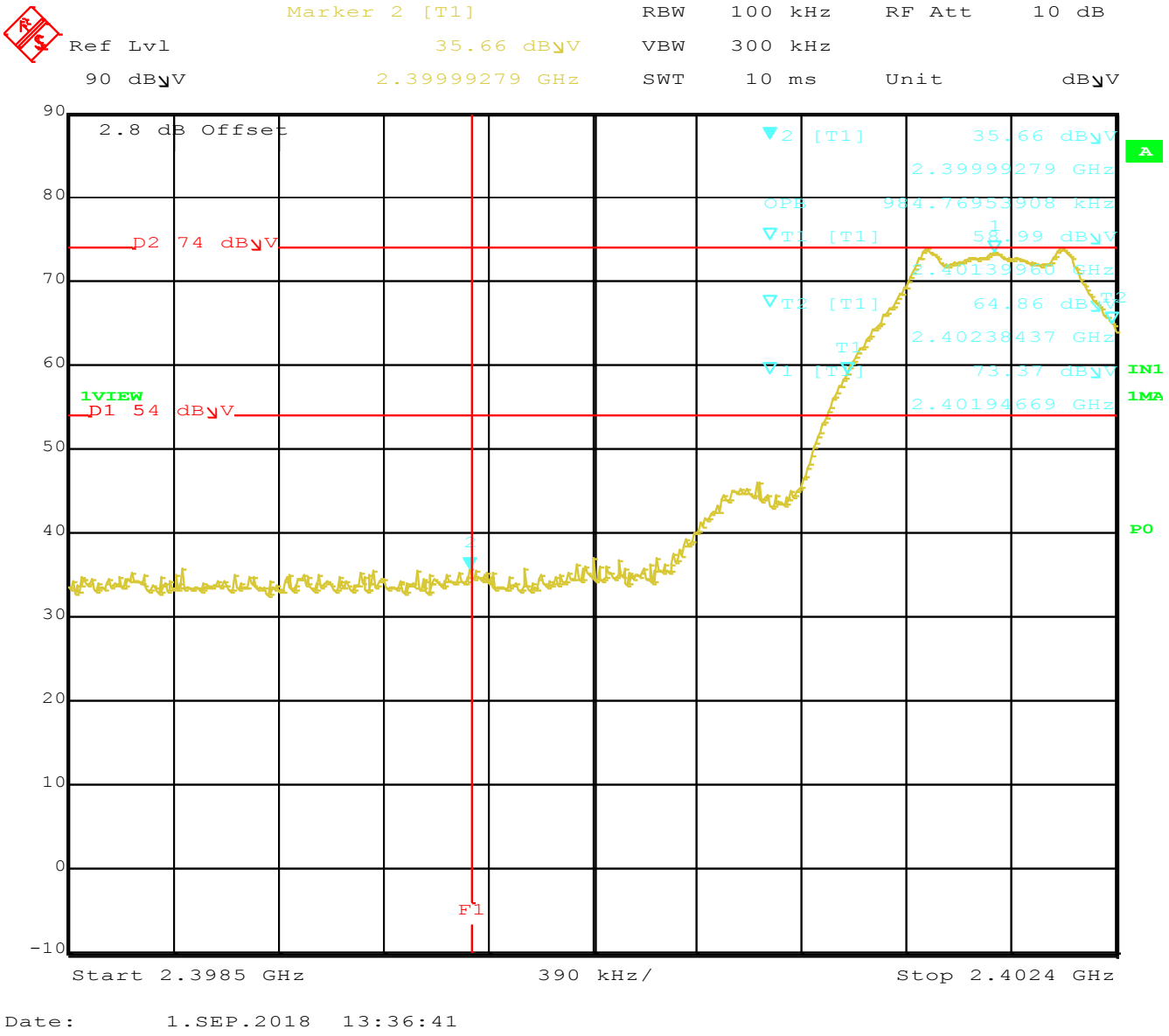
The Sweep time was set to Auto.

5.2.4 Final Test

The EUT met the performance criteria requirement as specified in the standards.

5.2.5 Test Setup Block Diagram



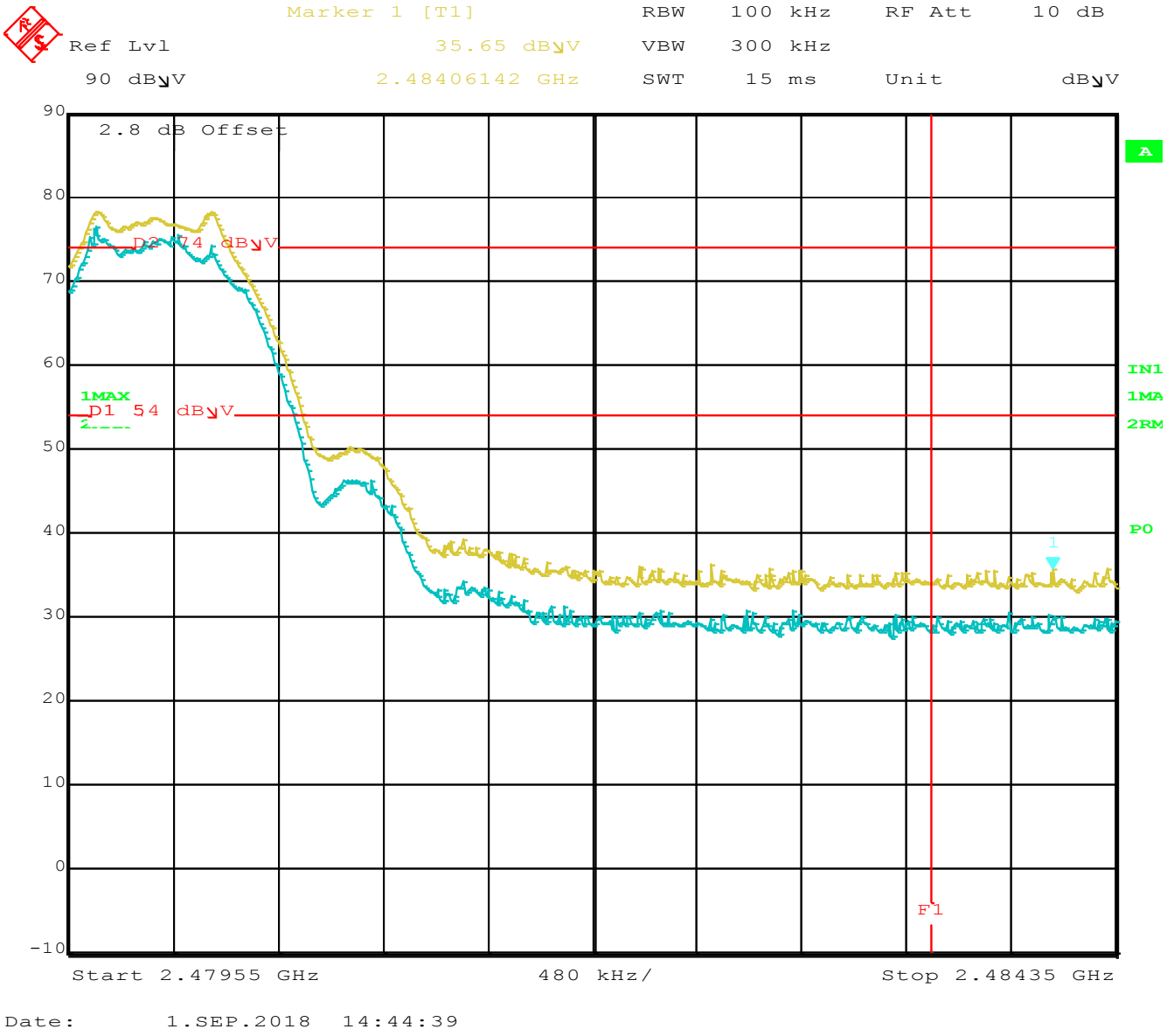


Notes: Measured using the Peak detector. The highest Peak level is below the Average Limit at the Band Edge; 2.4 GHz (Line F1).

The nearest restricted band (2390MHz) is 10 MHz below the band edge

The Highest frequency outside the band is at 38.07 dBµV/m (using the Peak Detector) which is below the Average restricted-band limits)

Figure 1: Lower Band Edge Measurement (Radiated Emission)



Note: Measured using the Peak and RMS detectors. Band Edge is at 2.483.5 MHz (Line F1).

Band edge at 2480.6 MHz is also the start of a restricted band, so the restricted band rules apply.

The Highest frequency outside the band is at 35.65 dBµV/m (using the Peak Detector) which is below the Average restricted-band limits)

Figure 2: Upper Band Edge Measurement (Radiated Emission)

The EUT is compliant with the rules.

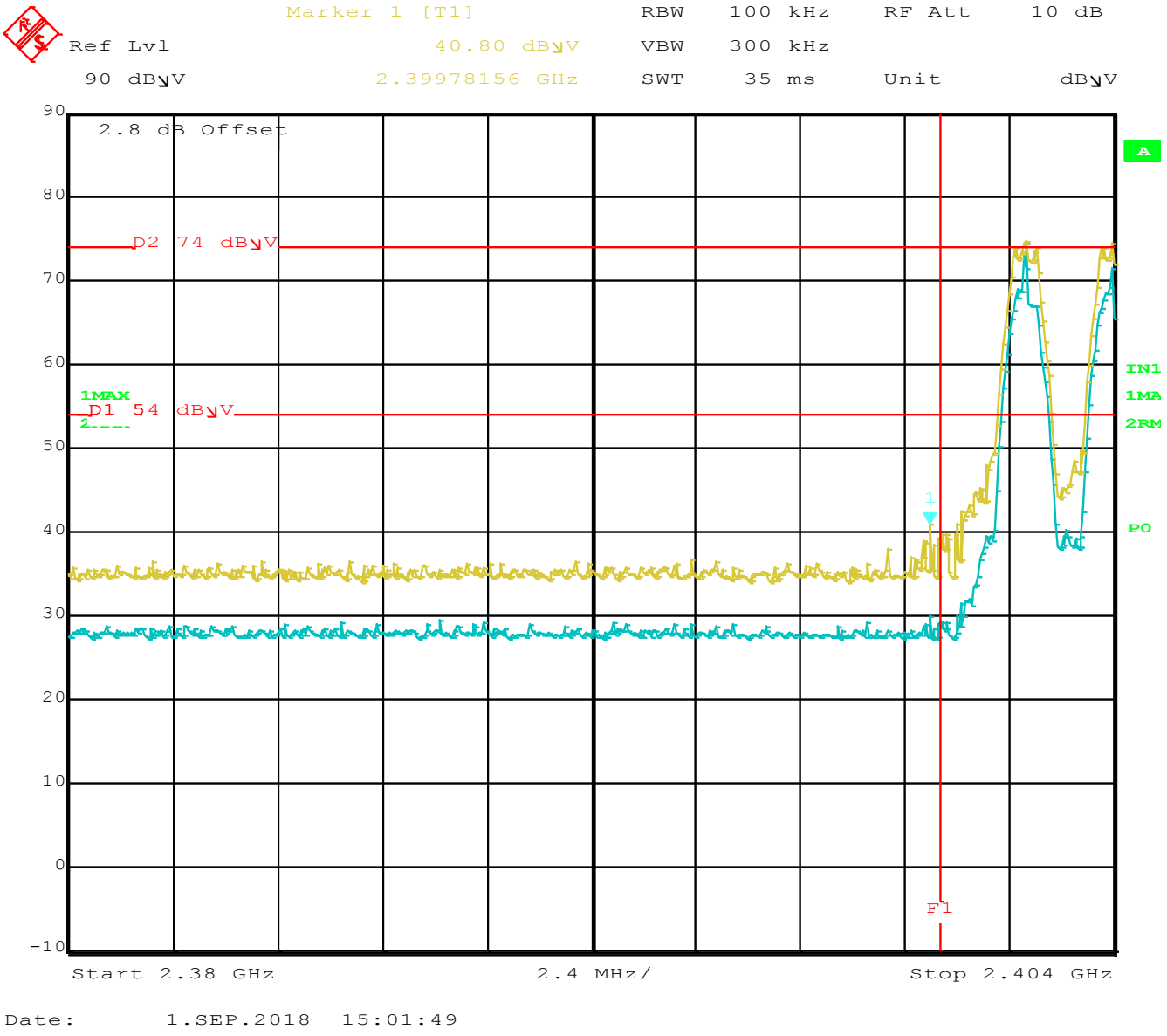


Figure 3: Verification of Lower Band Edge Measurement (Radiated Emission) in Hopping Mode

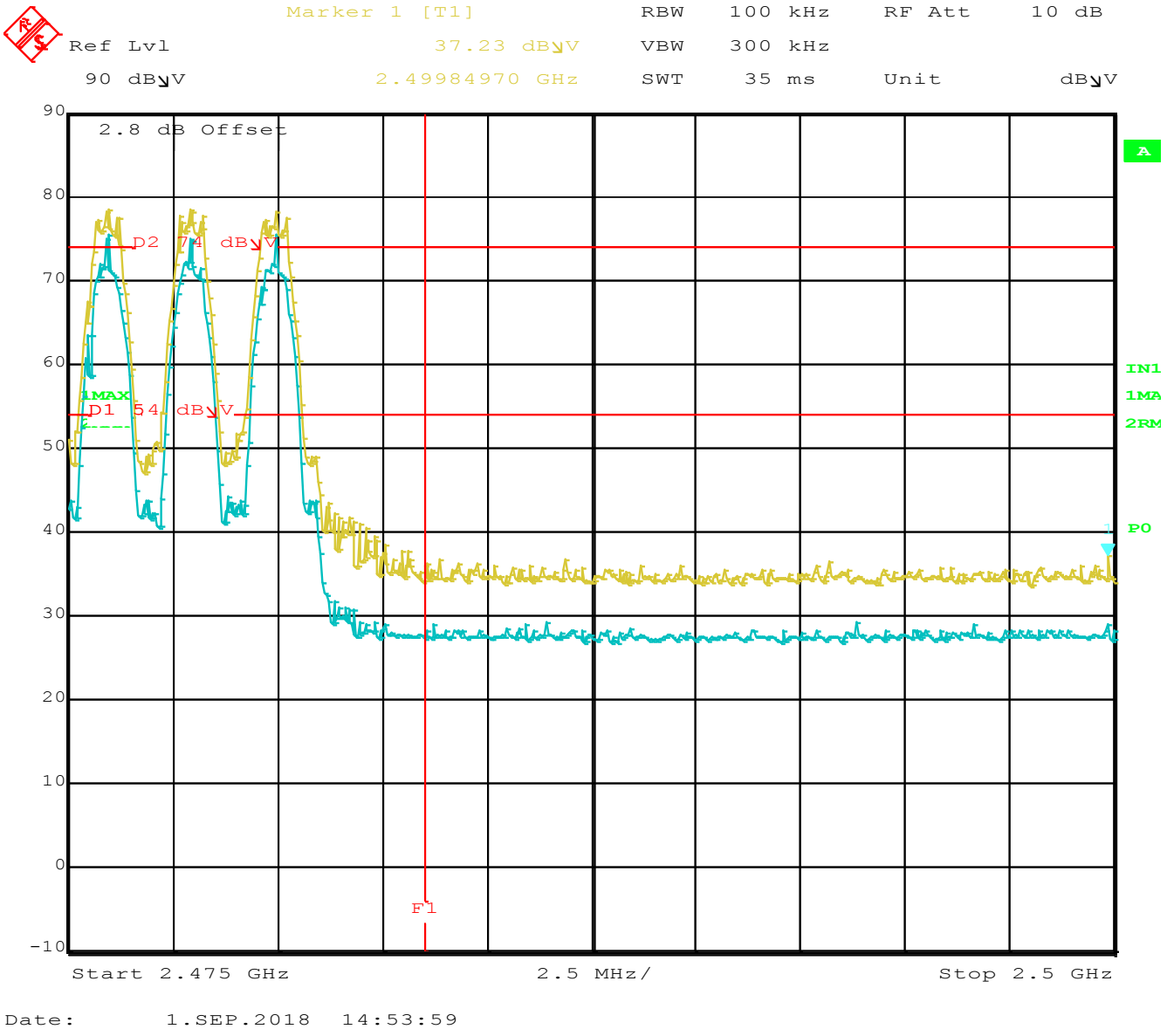


Figure 4: Verification of Upper Band Edge Measurement (Radiated Emission) in Hopping Mode

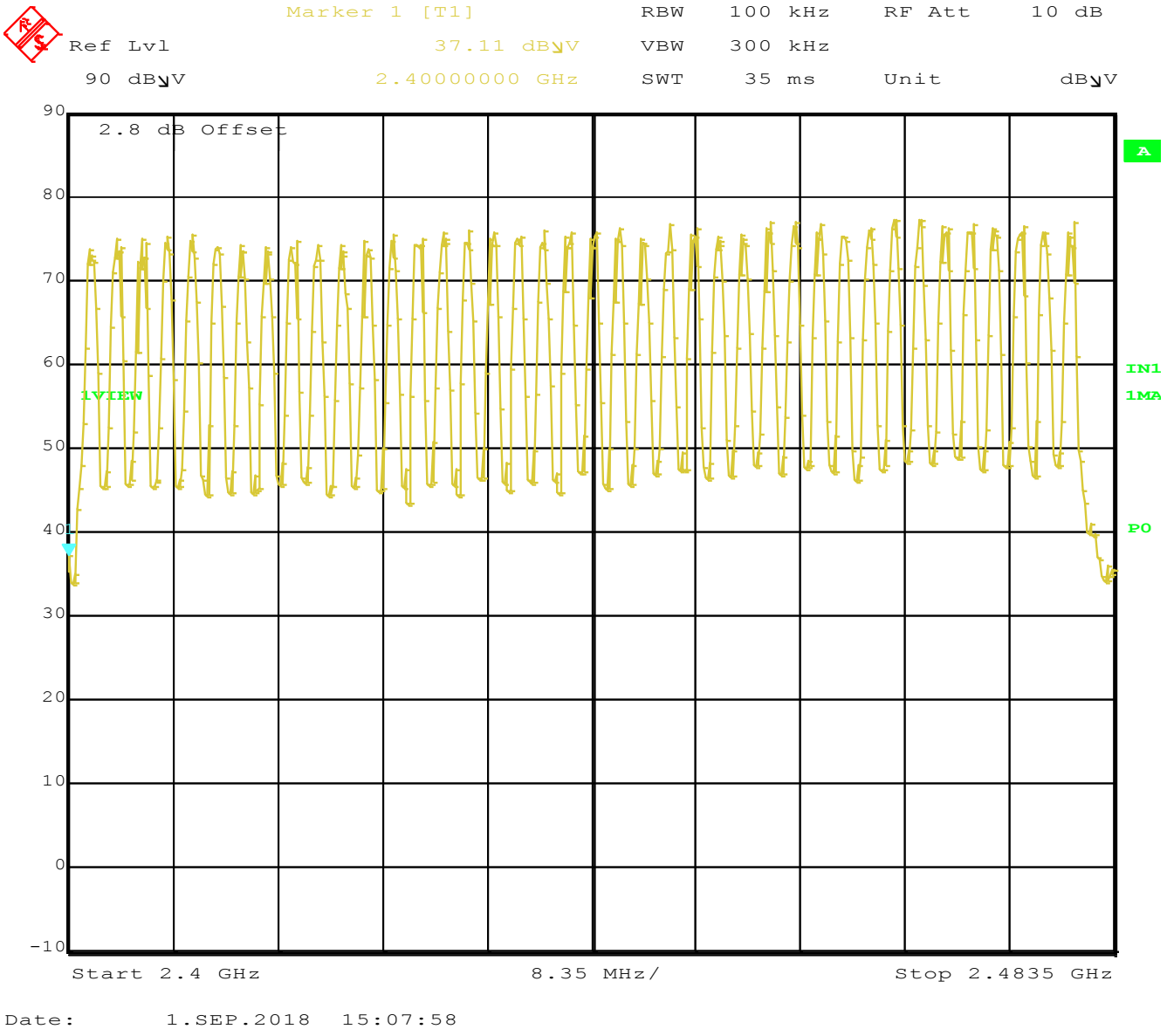


Figure 5: Verification of BLE transmissions (40 Hopping Channels)

5.1 Conducted Emissions on AC Mains – FCC 207(a) and RSS-GEN 8.8

This test measures the electromagnet levels of spurious signals generated by the EUT on the AC power line that may affect the performance of other nearby electronic equipment.

5.1.1 Over View of Test

Results	**NA** EUT is battery operated only					**Date**	NA
Standard	FCC Parts 15.207(a):2017 and RSS-GEN I4 clause 8.8						
Product Model	M329			**Serial#**	NA		
Test Set-up	Tested in shielded room. EUT placed on table, see test plans for details						
EUT Powered By	3.0 V DC Lithium battery	**Temp**	NA	**Humidity**	NA	**Pressure**	NA
Frequency Range	150 kHz – 30 MHz						
Perf. Criteria	(Below Limit)	**Perf. Verification**	Readings Under Limit for L1 & Neutral				
Mod. to EUT	None	**Test Performed By**	NA				

5.1.2 Test Procedure

Conducted emissions tests were performed using the procedures of ANSI C64.4: 2009, including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration.

5.1.3 Deviations

The Test sample is battery operated only. It does not have provision for external power of any kind.

5.1.4 Final Test

This test is not applicable for the device submitted for testing

5.2 99% Power Bandwidth

When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

5.2.1 Test Over View

Results	**Complies** (as tested per this report)					**Date**	1 September 2018
Standard	RSS-GEN Issue 5, Clause 6.7						
Product Model	M329			**Serial#**	Production Prototype		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3 V DC Lithium battery	**Temp**	82º F	**Humidity**	42%	**Pressure**	1006 mbar
Perf. Criteria	(Below Limit)			**Perf. Verification**	Readings Under Limit		
Mod. to EUT	None			**Test Performed By**	Mark Ryan		

5.2.2 Test Procedure

Using the procedures of RSS-GEN section 6.7;
• The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
• The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
• The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

5.2.3 Deviations

Measurement was made using the Peak detector, as this is considered to be the worst-case. Otherwise, there were no deviations from the test methodology.

5.2.4 Final Results

The highest measured 99% bandwidth is 1070.14 kHz.

The EUT met the performance criteria requirement as specified in the test plan of this report and in the standards.

Frequency (MHz)	99% BW (kHz)
2402	1046.09
2440	1062.12
2480	1070.14

99% Peak Power Band Width.

5.2.5 Final Data

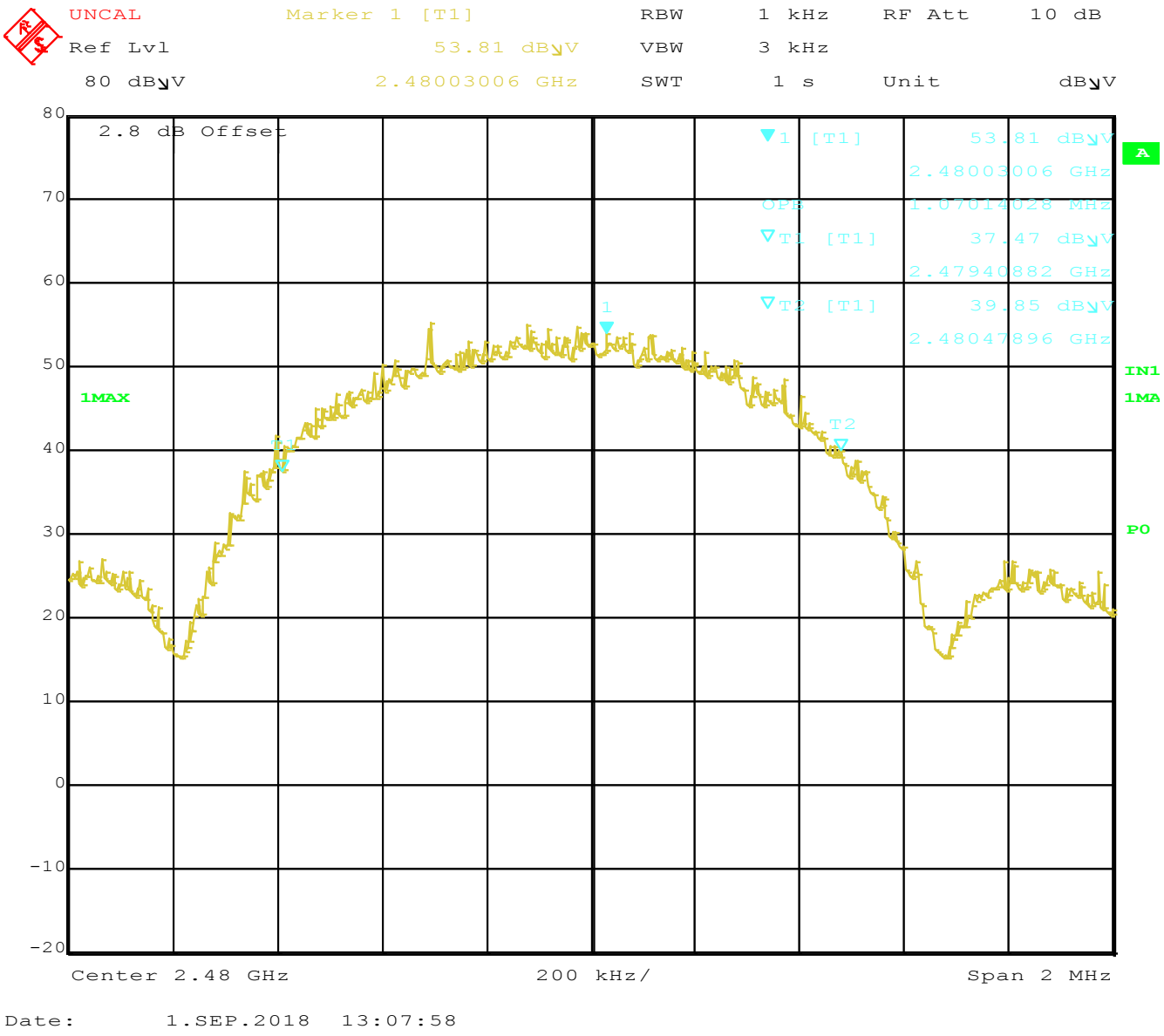


Figure 6 – 99% Power Bandwidth = 1070.14 kHz. The Worst-Case shown.

Span = 2MHz, RBW = 1 kHz (within 1% to 5% of Occupied Bandwidth), VBW = 3 kHz (≥ 3x RBW)

Measurement made using

The EUT is compliant to the requirements of RSS-GEN, clause 6.7

Appendix A

6 Test Plan

This test report is intended to follow the test plan outlined herein unless otherwise stated. The test plan provides product information, reference standards, and testing details. The product information below came via client, product manual, product itself and or the internet. Test procedure information will reference standards or internal TUV Rheinland NA procedures.

6.1 General Information

Client	Akervall Technologies, Inc.
Address 1	1512 Woodland Drive
Address 2	Saline, MI 48176 USA
Contact Person	Adam Davis
Telephone	734-255-9697
Fax	-
e-mail	email@address.com

6.2 Model(s) Name

EMG

Note: If multiple models are listed additional documentation is required.

6.3 Type of Product

SISU Sense