

Report No.:

31453994.001

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Electromagnetic Compatibility Test Report

Prepared in accordance with

FCC Part 15C, RSS-210 Issue 8 and ANSI C63.10

Tested to FCC Part 15C & RSS-210

On

Ironman Classic 50 Move+ Watch

Model: M049

**Timex Group USA Inc.
555 Christian Rd.
Middlebury CT 06787 USA**

Prepared by:

TUV Rheinland of North America, Inc.

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Manufacturer's statement - attestation

The manufacturer; Timex Group USA Inc., as the responsible party for the equipment tested, hereby affirms:

- a) That he has reviewed and concurs that the test shown in this report are reflective of the operational characteristics of the device for which certification is sought;
- b) That the device in this test report will be representative of production units;
- c) That all changes (in hardware and software/firmware) to the subject device will be reviewed.
- d) That any changes impacting the attributes, functionality or operational characteristics documented in this report will be communicated to the body responsible for approving (certifying) the subject equipment.

Sam Everett

Printed name of official

Timex Group USA Inc.
555 Christian Road
Middlebury CT 06787 USA

Address

203-346-5603

Telephone number



Signature of official

26 January 2015

Date


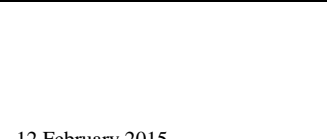


severett@timexgroup.com

Email address of official

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Client:	TIMEX GROUP	Timex Group USA Inc. 555 Christian Rd. Middlebury CT 06787 USA	Sam Everett Ph: 203-346-5603 Fax: 203-346-7163 severett@timexgroup.com
Identification:	Ironman Classic 50 Move+ Watch	Serial No.:	PRODUCTION PROTOTYPE
Test item:	Model: M049	Date tested:	23 January 2015
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 8: FCC Parts 15.207(a) and RSS-GEN 7.2.4, FCC Parts 15.249(d), 15.209, 15.215(c) and RSS-210 A2.9, RSS-GEN 7.2.1 FCC Part 15.249 and RSS-210 Annex 2.9, FCC Parts 15.249(a), 15.249(c), RSS-210 A2.9(a), FCC Part 15.109(a) and RSS-210 2.2 and 2.3, FCC Part 15.107(a) and RSS-210 2.2 and 2.3 FCC Part 2.1093 and RSS-102, Issue 4,		
Test Result	The above product was found to be Compliant to the above test standard(s)		
tested by: Mark Ryan		reviewed by: Michael Moranha	
 12 February 2015 <i>Signature</i>		 12 February 2015 <i>Signature</i>	
Other Aspects:	None		
Abbreviations: OK, Pass, Compliant, Complies = passed Fail, Not Compliant, Does Not Comply = failed N/A = not applicable			
			
		Industry Canada	
90552 and 100881		Testing Cert #3331.05	
		2932H-1 and 2932H-2	

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1 General Information

1.1 Scope

This report is intended to document the status of conformance with the requirements of the FCC Part 15C, RSS-210 Issue 8 and ANSI C63.10 based on the results of testing performed on 23 January 2015 on the Ironman Classic 50 Move+ Watch, Model No. M049, manufactured by Timex Group USA 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. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

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 Revision History

Revision	Date	Description of Revision
- -	29January2014	Initial Release
B	12February2015	Updated testing procedures

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1.1 Summary of Test Results

Applicant	Timex Group USA Inc. 555 Christian Rd Middlebury CT 06787 USA	Tel	203-346-5603	Contact	Sam Everett
		Fax	203-346-7163	e-mail	severett@timexgroup.com
Description	DIGITAL INDICATOR	Model	M049		
Serial Number	Production Prototype	Test Voltage/Freq.	3 V DC Lithium battery		
Test Date Completed:	23 January 2015	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 8 Standard	Low-Power Licence-exempt Radiocommunication Devices Category I Equipment	See called out parts below		See Below	Complies
FCC Part 15.249 and RSS-210 Annex 2.9	Operation within the band 2400 to 2483.5 MHz	See called out parts below		See Below	Complies
FCC Parts 15.249(a), 15.249(c), RSS-210 A2.9(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, (unrestricted bands)		40.46 mV/m 314.1 µV/m -	Complies
FCC Parts 15.249(d), 15.209, 15.215(c) and RSS-210 A2.9, RSS-GEN 7.2.1	Out-of-Band Spurious Emissions and Band Edges (EUT in Transmit Mode)	Below the applicable limits		14.50 dBµV	Complies
FCC Parts 15.207(a) and RSS-GEN 7.2.4	Conducted Emissions on AC Mains	NA, The EUT is battery operated only		NA	NA
RSS-210 A1.1.3	Occupied Bandwidth	99% BW ≤ 0.5% of center freq.		1.07 MHz	Complies
FCC Part 15.109(a) and RSS-210 2.2 and 2.3	Receive Mode - Radiated Emissions	Below limit of the restricted bands listed in RSS-GEN section 6		25.50 dBµV	Complies
FCC Part 15.107(a) and RSS-210 2.2 and 2.3	Receive Mode - Conducted Emissions on AC Mains	NA, The EUT is battery operated only		NA	NA
FCC Part 2.1093 and RSS-102, Issue 4	RF Exposure and Antenna Gain Calculation	SAR or MPE Requirements		0.865 mW	Complies

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2 Laboratory Information

2.1 Accreditations

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 Industry Canada

Registration No.: 2932H-1 The OATS has been accepted by Industry Canada to perform testing to 3 and to 10 meters, based on the test procedures described in ANSI C63.4-2009.

Registration No.: 2932H-2 The 5 meter chamber has been accepted by Industry Canada to perform testing to 3 meters, based on the test procedures described in ANSI C63.4-2009.

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).

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2.1.5 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:

$$\text{Field Strength (dB}\mu\text{V/m)} = \text{RAW} - \text{AMP} + \text{CBL} + \text{ACF}$$

Where: RAW = Measured level before correction (dB μ V)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

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

Sample radiated emissions calculation @ 30 MHz

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

$$25 \text{ dB}\mu\text{V/m} + 17.5 \text{ dB} - 20 \text{ dB} + 1.0 \text{ dB} = 23.5 \text{ dB}\mu\text{V/m}$$

2.2 Measurement Uncertainty Emissions

	U_{lab}	U_{cispr}
Radiated Disturbance @ 10m		
30 MHz – 1,000 MHz	3.3 dB	5.2 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	1.18 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	3.88 dB	4.5 dB

2.3 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.

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2.4 Measurement Equipment Used

Equipment	Manufacturer	Model #	Serial/Inst #	Last Cal dd/mm/yy	Next Cal dd/mm/yy
Radiated Emissions (5 Meter Chamber)					
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	19-Aug-14	19-Aug-15
Spectrum Analyzer	Agilent Tec.	E7405A	US39440161	20-Aug-14	20-Aug-15
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	14-Aug-13	14-Aug-15
Ant. BiconiLog	Chase	CBL6140A	1108	16-Sep-13	16-Sep-15
Antenna Horn 1-18 GHz	EMCO	3115	3115	30-Dec-14	30-Dec-15
Antenna Horn 18-26.5 GHz	ATM	42-442-6/cal	G181104-01	31-Dec-14	31-Dec-15
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	22-Aug-14	22-Aug-15
Cable, Coax	MicroCaox	MKR300C-0-1968-500310	005	22-Aug-14	22-Aug-15
Cable, Coax	MicroCaox	UFB29C-1-5905-50U-50U	009	22-Aug-14	22-Aug-15
Cable, Coax	Andrew	FSJ1-50A	045	22-Aug-14	22-Aug-15
3.0 GHz High Pass Filter	Bonn Elektronik	BHF 3000	025155	14-Aug-13	14-Aug-15
Notch Filter	Micro-tronics	BRM50702	049	14-Aug-13	14-Aug-15
General Laboratory Equipment					
Meter, Multi & Thermocouple	Fluke	179	90580752	19-Aug-14	19-Aug-15
Meter, Temp/Humid/Barom	ExTech	SD700	Q677933	06-May-13	06-May-15
Meter, Temp/Humid/Barom	ExTech	SD700	Q677942	06-May-13	06-May-15

3 Product Information

3.1 Product Description

The EUT is a family of Sport watches with a Bluetooth Low-Energy (BLE) and a Near-field Passive tag. The models in the family are M049 and M053.

Two sets of each EUT were provided for testing. One is normal a configuration for unintentional cabinet radiation. The second was modified with test firmware to allow the low, medium and high hopping channels to continuously transmit with modulation. External batteries were included on the modified devices to allow long-term transmissions.

There is enough difference in size and layout of the circuit boards to require separate testing and certification. The Model M049 was the device provided for testing in this report.

Refer to TUV test report Number 31453995.001 for the report for the Model M053.

3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

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4 Radiated Emissions in Transmit mode

4.1 Radiated emissions - FCC Parts 15.249, RSS-210 A2.9(a)

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 μ V/m) at 3m.

Harmonic Frequencies: 500 μ V/m (54 dB μ V/m) at 3m.

Spurious Emissions: To the limits of FCC Part 15.209 and RSS-GEN 7.2.1.

4.1.1 Over View of Test

Results	Complies (as tested per this report)				Date	20-23 January 2015	
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	M049		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	70° F	Humidity	28%	Pressure	1008 mbar
Perf. Criteria	(Below Limit)		Perf. Verification		Readings Under Limit		
Mod. to EUT	None		Test Performed By		Mark Ryan		

4.1.2 Test Procedure

Testing was performed in accordance with 47 CFR Part 15, ANSI C63.10:2009, 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.

4.1.3 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 A8.5, and RSS-GEN 7.2.1.

4.1.4 Final Test

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

The worst –case emissions are shown below. All other emissions are on file at TUV Rheinland.

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4.1.4.1 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)	Equivelent EiRP level (mV/m)	Spec Limit (mV/m)
Orientation A:										
2402.00	H	2.1	349	54.32	0.00	8.29	28.65	91.26		
2402.00	V	1.1	5	57.66	0.00	8.29	28.65	94.60	53.70	500.00
2402.00	H	2.1	275	50.74	0.00	8.20	28.51	87.45		
2402.00	V	1.1	5	55.20	0.00	8.29	28.65	92.14	40.46	50.00
2440.00	H	2.1	349	54.32	0.00	8.29	28.65	91.26		
2440.00										
2440.00	H	2.1	349	52.61	0.00	8.29	28.65	89.55		
2440.00	V	1.2	0	54.96	0.00	8.20	28.51	91.67		
2402.00	H	2.1	275	52.74	0.00	8.20	28.51	89.45		
2402.00	V	1.2	0	54.96	0.00	8.20	28.51	91.67		
2480.00	H	2	323	52.68	0.00	8.32	28.76	89.76		
2480.00	V	1.8	171	53.68	0.00	8.32	28.76	90.76		
Orientation B:										
2402.00	H	2.1	43	53.14	0.00	5.89	28.51	87.54		
2402.00	V	1.2	0	53.40	0.00	5.89	28.51	87.80		
2402.00	H	2.1	43	51.03	0.00	5.89	28.51	85.43		
2402.00	V	1.2	0	51.45	0.00	5.89	28.51	85.85		
Orientation C:										
2402.00	H	2.1	5	53.14	0.00	5.89	28.51	87.54		
2402.00	V	1.2	289	54.31	0.00	5.89	28.51	88.71		
2402.00	H	2.1	5	51.11	0.00	5.89	28.51	85.51		
2402.00	V	1.2	289	52.31	0.00	5.89	28.51	86.71		

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

 Notes: **Red = Peak Detector**, **Blue = Average Detector**

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 worst case (2402 MHz, Orientation A).

4.1.4.2 Maximum Time-weighted Emission:

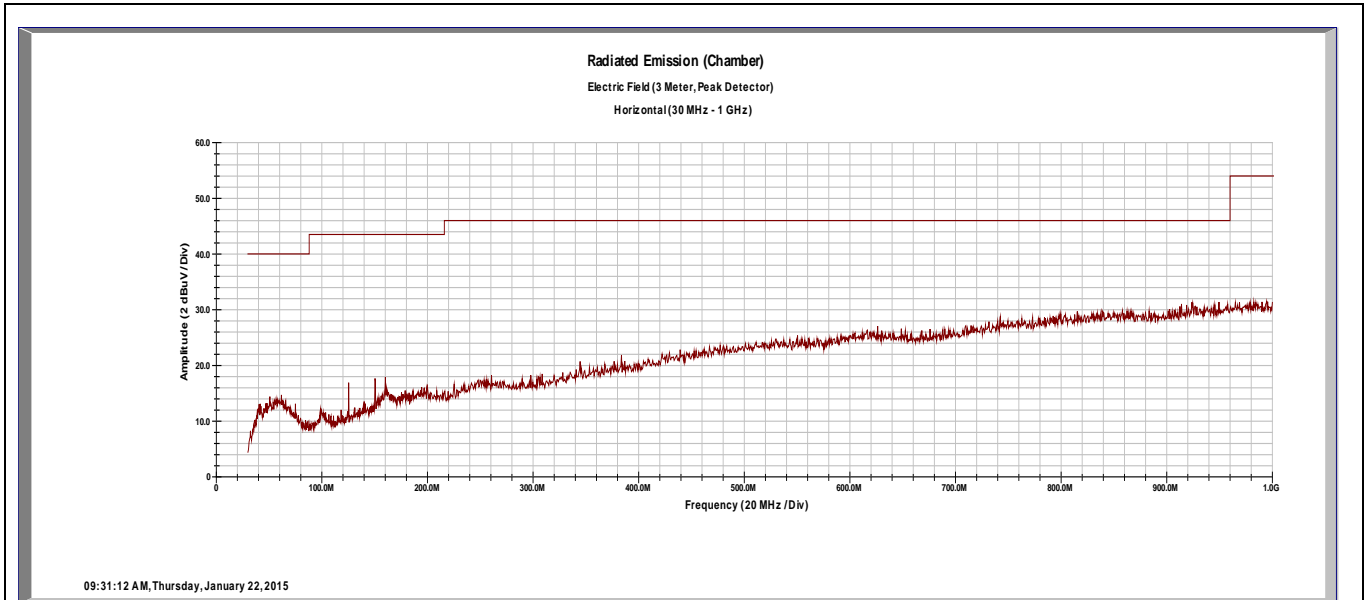
The EUT was modified to transmit continuously at 100% Duty cycle.

Even at 100% Duty Cycle the EUT is compliant to the rules.

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4.1.4.3 Emissions Outside the Frequency Band:

Radiated Emissions – 30 MHz to 1000 MHz
Horizontal



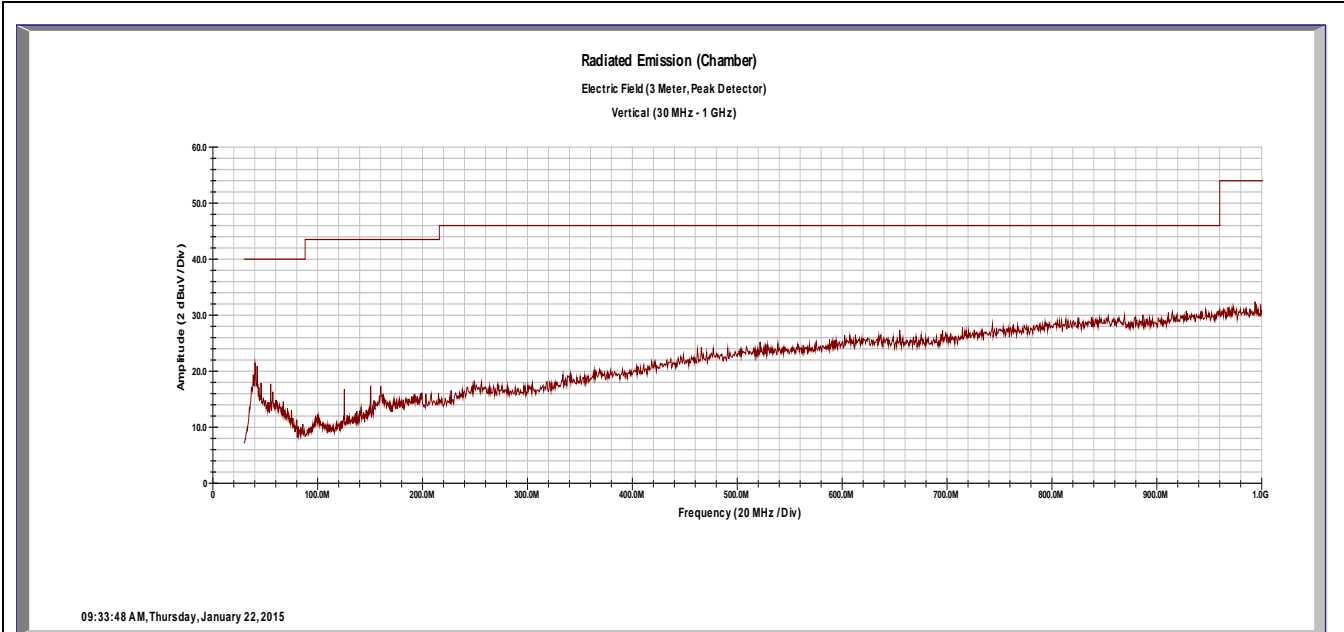
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: All emissions were below the noise floor of the instrumentation.
The remaining two channels gave very similar results.
The signals shown below 200 MHz are anomalies in the preamp of the measuring instrument.
A notch filter at the transmitter fundamental frequency was used.

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Radiated Emissions Ch 2 – 30 MHz to 1000 MHz
Vertical



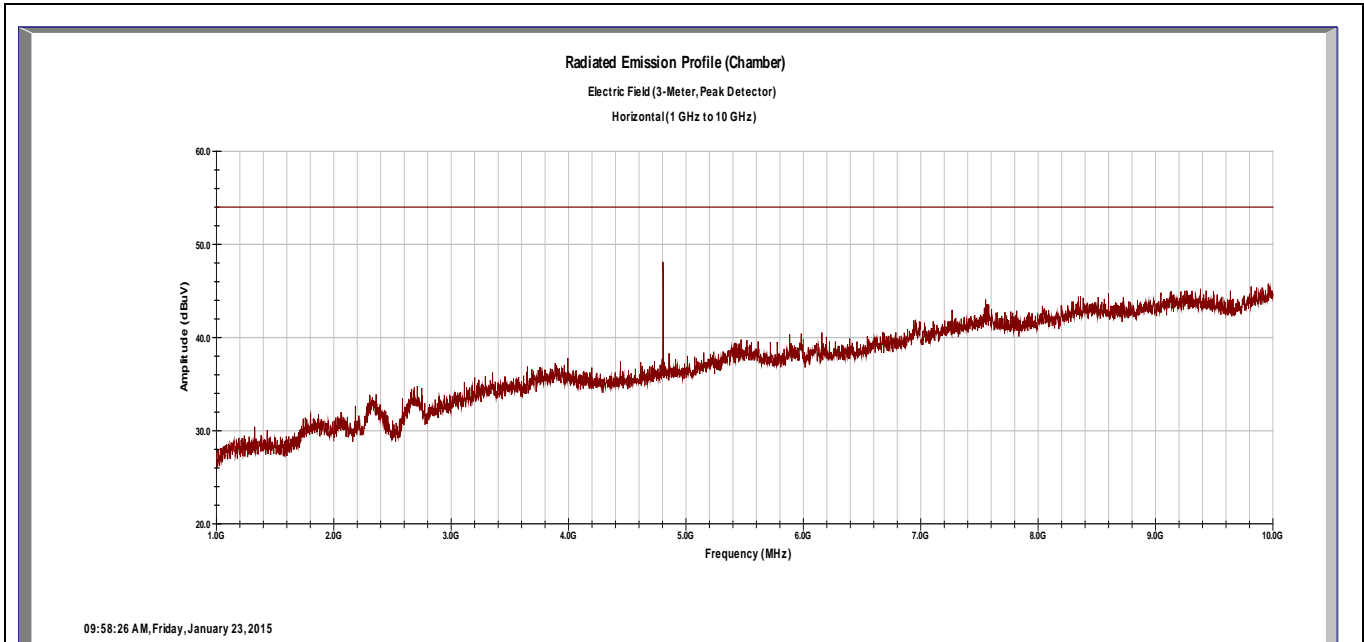
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
36.88	V	1	0	4.46	0.00	0.71	8.16	13.33	40.00	-26.67

Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor
Notes: This is the worst-case emissions on low channel (2402 MHz).
Other channel data is on file at TUV Rheinland.

All other emissions were below the noise floor of the instrumentation.
The remaining two channels gave very similar results.
The signals shown below 200 MHz are anomalies in the preamp of the measuring instrument.
A notch filter at the transmitter fundamental frequency was used.

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Worst Case Radiated Emissions – 1 to 10 GHz
Horizontal



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)	Spec Limit (dBuV/m)	Spec Margin (dB)
Low:										
4804.00	H	1.9	353	37.85	33.84	11.60	32.92	48.53	54.00	-5.47
4804.00	H	1.9	353	46.52	33.84	11.60	32.92	57.20	74.00	-16.80
Mid:										
4880.00	H	1.8	355	35.42	33.77	11.71	33.00	46.36	54.00	-7.64
4880.00	H	1.8	355	45.22	33.77	11.71	33.00	56.16	74.00	-17.84
Hi:										
4960.00	H	1.1	303	38.62	33.66	11.81	33.17	49.94	54.00	-4.06
4960.00	H	1.1	303	45.22	33.66	11.81	33.17	56.54	74.00	-17.46

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

Notes

The worst case emission was a harmonic at **49.94 dBµV/m** at 3m, (avg) which is equivalent to **314.05 µV/m**. This channel and orientation provided the worst case Harmonic and Spurs radiation. A Band- Notch filter was used to attenuate the fundamental frequency

The **Blue** emissions are using the Average detector

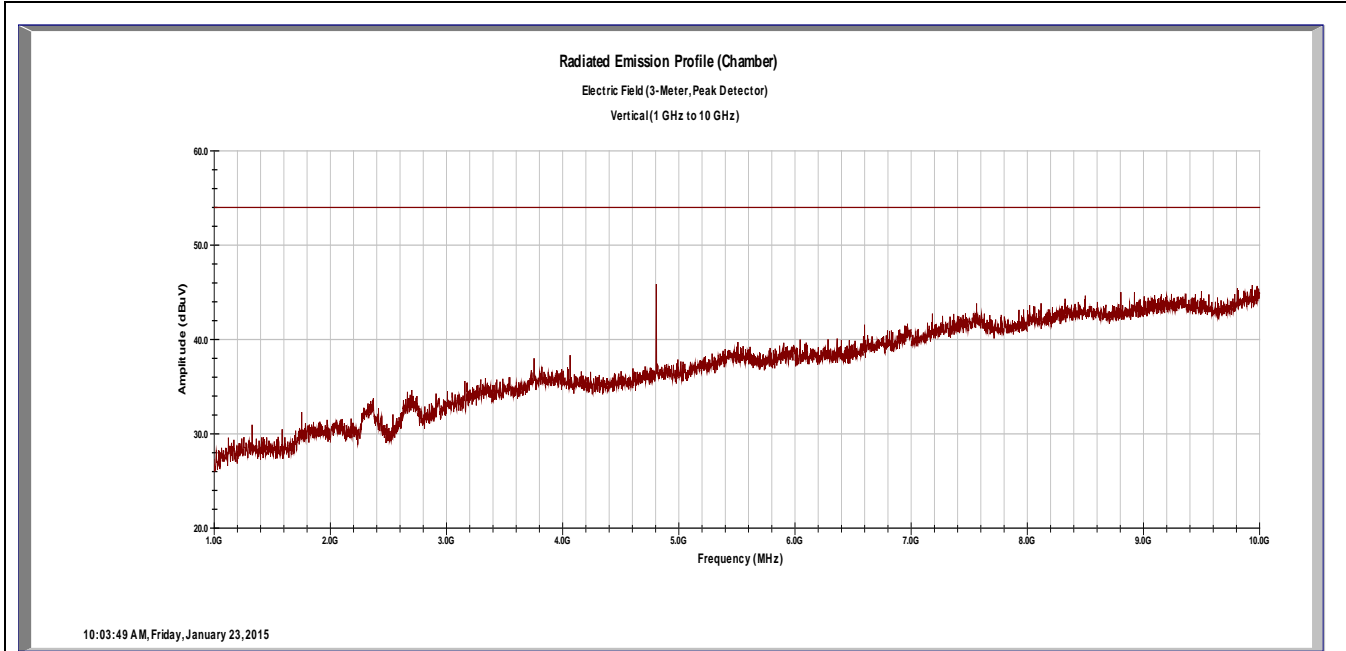
The **RED** emissions are using the Peak detector

Worst-Case Plot shown. Plots for other channels are on file at TUV Rheinland.

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Worst Case Radiated Emissions - 1 to 10 GHz

Vertical



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)	Spec Limit (dBuV/m)	Spec Margin (dB)
Low:										
4804.00	V	1.2	103	33.47	33.84	11.60	32.92	44.15	54.00	-9.85
4804.00	V	1.2	103	43.38	33.84	11.60	32.92	54.06	74.00	-19.94
Mid:										
4880.00	V	1.3	351	31.39	33.77	11.71	33.00	42.33	54.00	-11.67
4880.00	V	1.3	351	42.70	33.77	11.71	33.00	53.64	74.00	-20.36
Hi:										
4960.00	V	1.3	356	37.93	33.66	11.81	33.17	49.25	54.00	-4.75
4960.00	V	1.3	356	44.80	33.66	11.81	33.17	56.12	74.00	-17.88

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

Notes:

Worst case emission is in the Horizontal Polarity (see previous page)

The **Blue** emissions are using the Average detector

The **Red** emissions are using the Peak detector

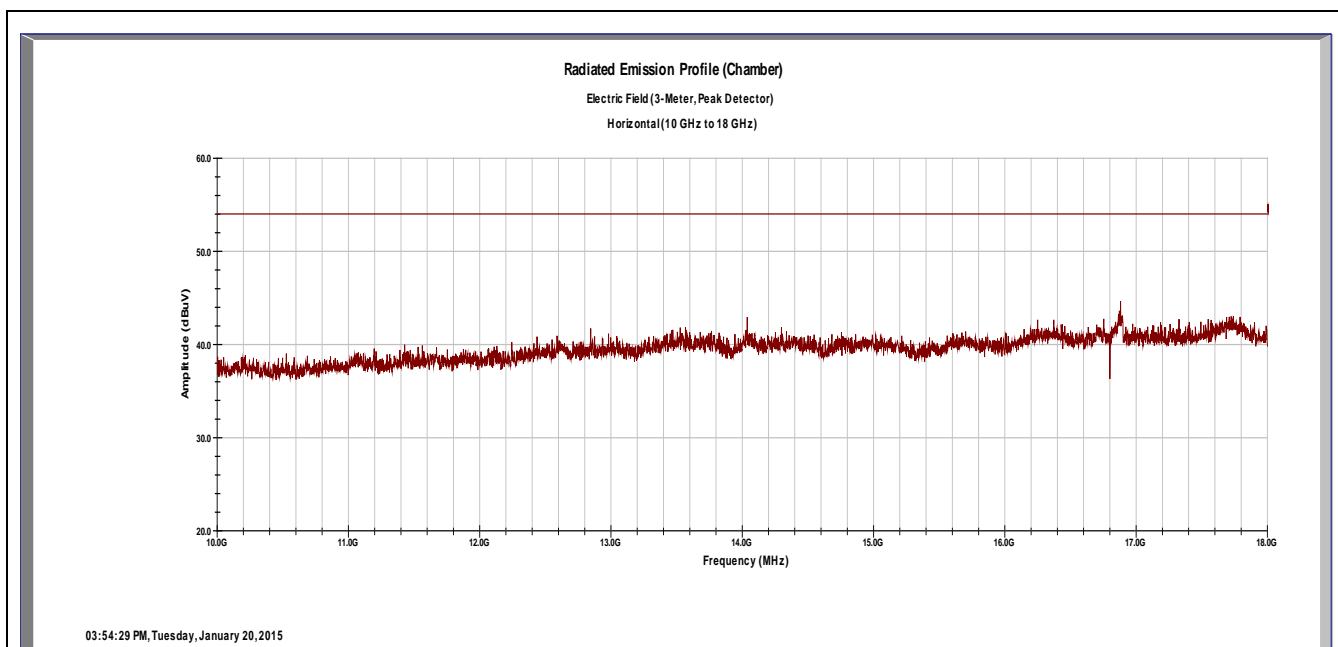
All spurious and harmonic emissions are below the level of Part 15.209, including those not in restricted bands.

A Band- Notch filter was used to attenuate the fundamental frequency.

Worst-Case Plot shown. Plots for other channels are on file at TUV Rheinland.

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Radiated Emissions Ch 2 – 10 to 18 GHz
Horizontal

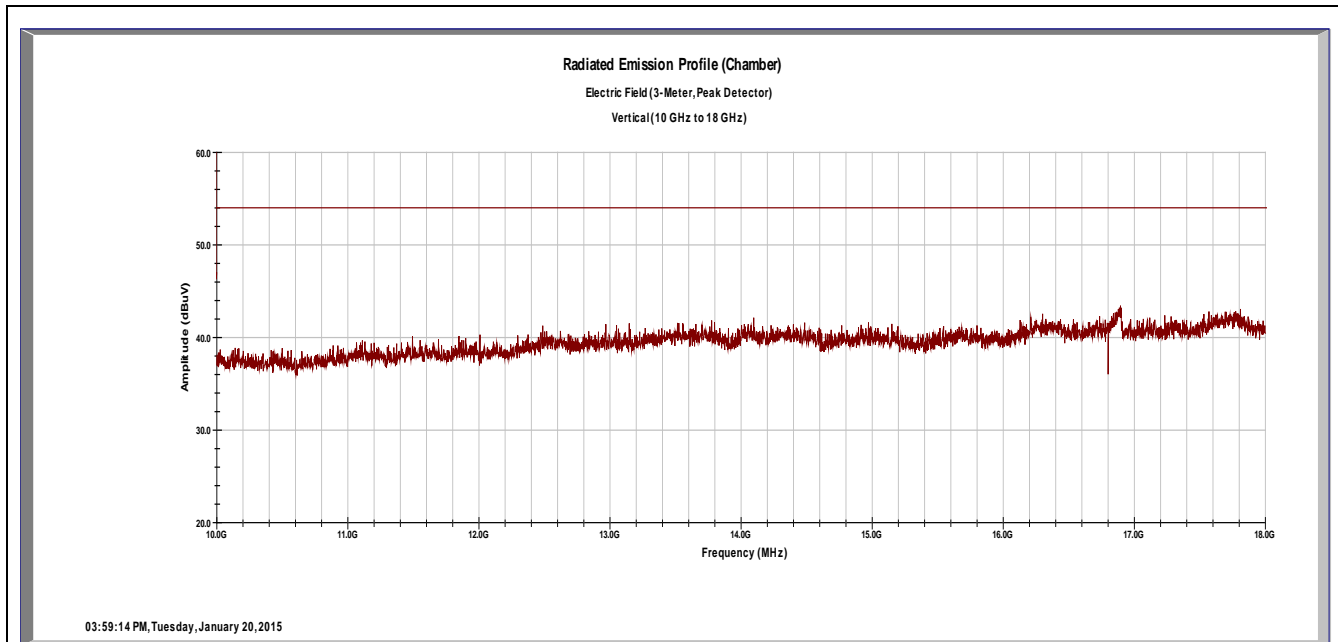


Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: No measureable emissions were noted.
 A High-Pass filter was used to attenuate the fundamental frequency.
 No emissions were seen above the noise floor of the instrumentation.
 The other two channels presented very similar results. Plots for other the channels are on file at TUV Rheinland.

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Radiated Emissions Ch 2 – 10 to 18 GHz
Vertical


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)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Combined Standard Uncertainty $u_c(y) = \pm 1.6\text{dB}$ Expanded Uncertainty $U = k u_c(y)$ $k = 2$ for 95% confidence

Notes: No measureable emissions were noted.
 A High-Pass filter was used to attenuate the fundamental frequency.
 No emissions were seen above the noise floor of the instrumentation.
 The other two channels presented very similar results. Plots for other the channels are on file at TUV Rheinland.

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Radiated Emissions Ch 2 – 18 to 25 GHz
Horizontal

Agilent 13:52:40 Jan 23, 2015

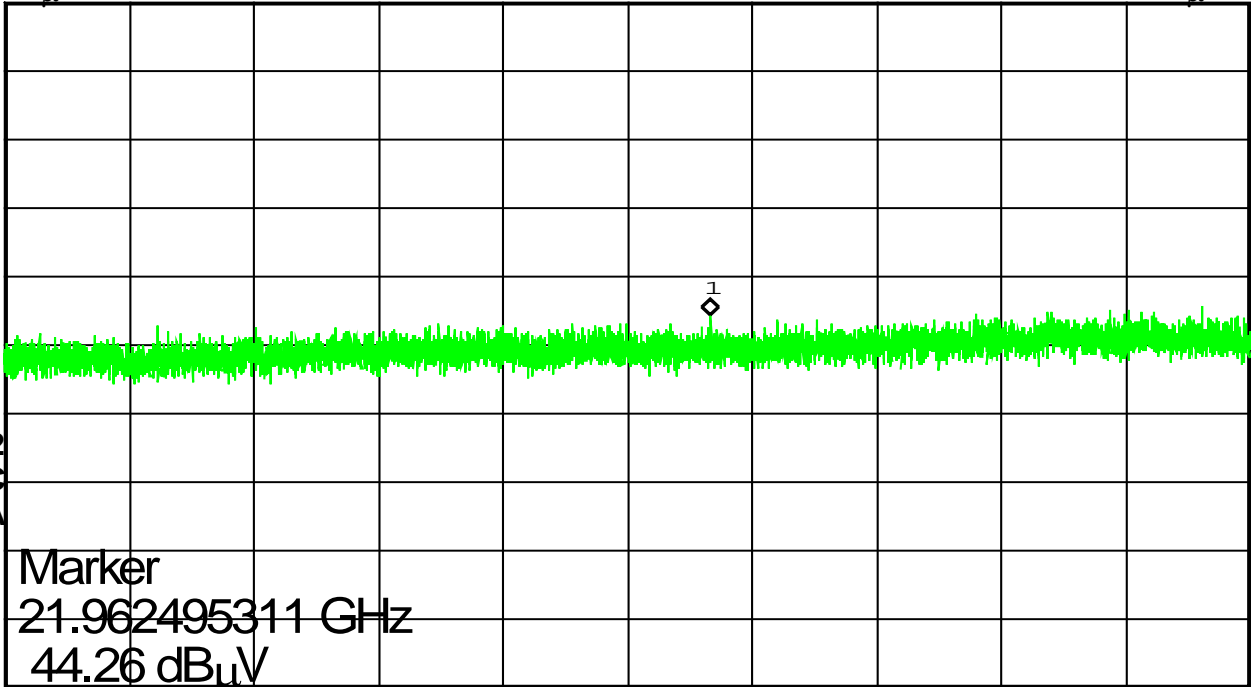
Mkr1 21.9625 GHz
44.26 dB μ V

Ref 90 dB μ V

#Atten 0 dB

Peak
Log
10
dB/

V1 S2
S3 FC
AA



Marker
21.962495311 GHz
44.26 dB μ V

Start 18 GHz **Res BW 1 MHz** **VBW 3 MHz** **Stop 25 GHz** **#Sweep 200 ms (8000 pts)**

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dB μ V)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dB μ V/m)	Spec Limit (dB μ V/m)	Spec Margin (dB)

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

Notes: No measureable emissions were noted.
No correction factors were used for the above graph. The number of Sweep Points was increased to 8000.
The Measuring distance was decreased to 1 meter.
No notch filter was used for this frequency range.
The other two channels presented very similar results. Plots for other the channels are on file at TUV Rheinland.

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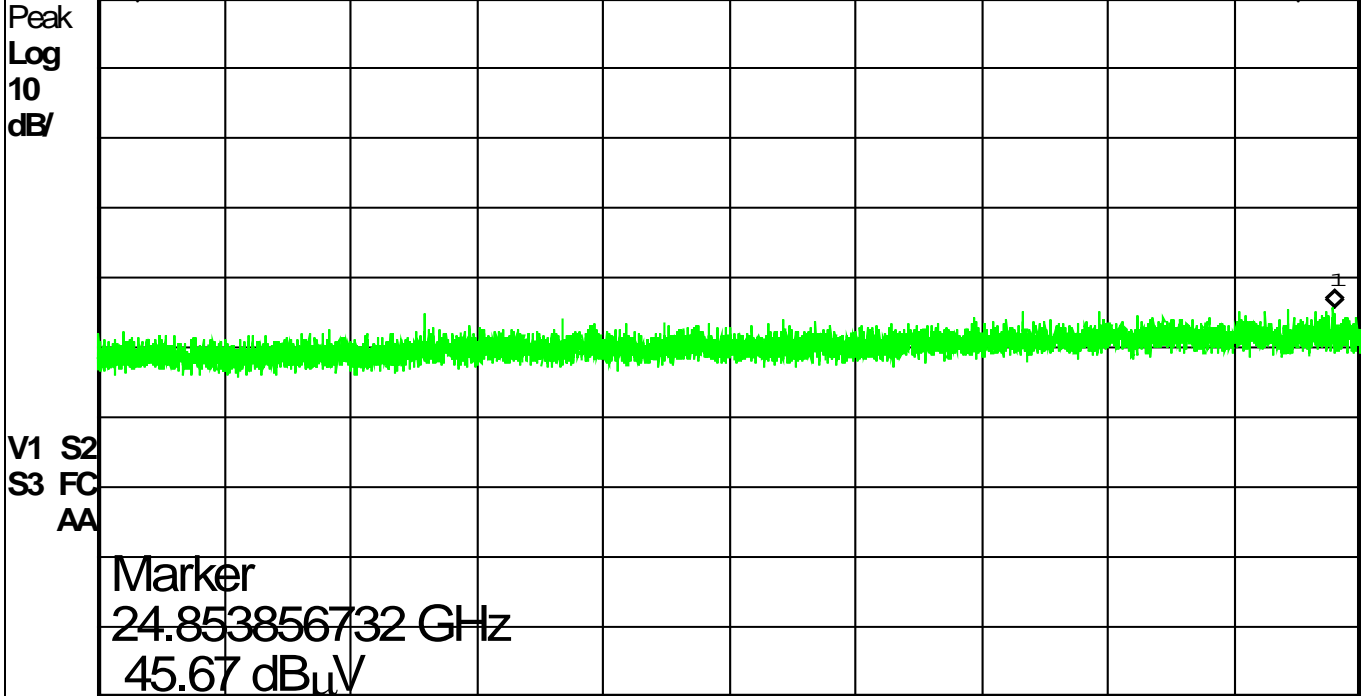
Radiated Emissions Ch 2 – 18 to 25 GHz
Vertical

Agilent 13:49:10 Jan 23, 2015

Mkr1 24.8539 GHz
45.67 dB_μV

Ref 90 dB_μV

#Atten 0 dB



Start 18 GHz **Stop 25 GHz**
Res BW 1 MHz **VBW 3 MHz** **#Sweep 200 ms (8000 pts)**

Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dB _μ V)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dB _μ V/m)	Spec Limit (dB _μ V/m)	Spec Margin (dB)

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

Notes: No measureable emissions were noted.
No correction factors were used for the above graph. The number of Sweep Points was increased to 8000.
The Measuring distance was decreased to 1 meter.
No notch filter was used for this frequency range.
The other two channels presented very similar results. Plots for other the channels are on file at TUV Rheinland.

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4.2 Band Edge requirements - FCC Part 15.249(d), RSS-210 2.2

4.2.1 Test Over View

Results	Complies (as tested per this report)				Date	21 January 2015	
Standard	FCC Part 15.249(d), RSS 210 2.2						
Product Model	M049			Serial#	Production Prototype		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3.0 V DC Lithium battery	Temp	72° F	Humidity	30%	Pressure	1002 mbar
Perf. Criteria	(Below Limit)		Perf. Verification		Readings Under Limit		
Mod. to EUT	None		Test Performed By		Mark Ryan		

4.2.2 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.

4.2.3 Deviations

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

4.2.4 Final Test

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

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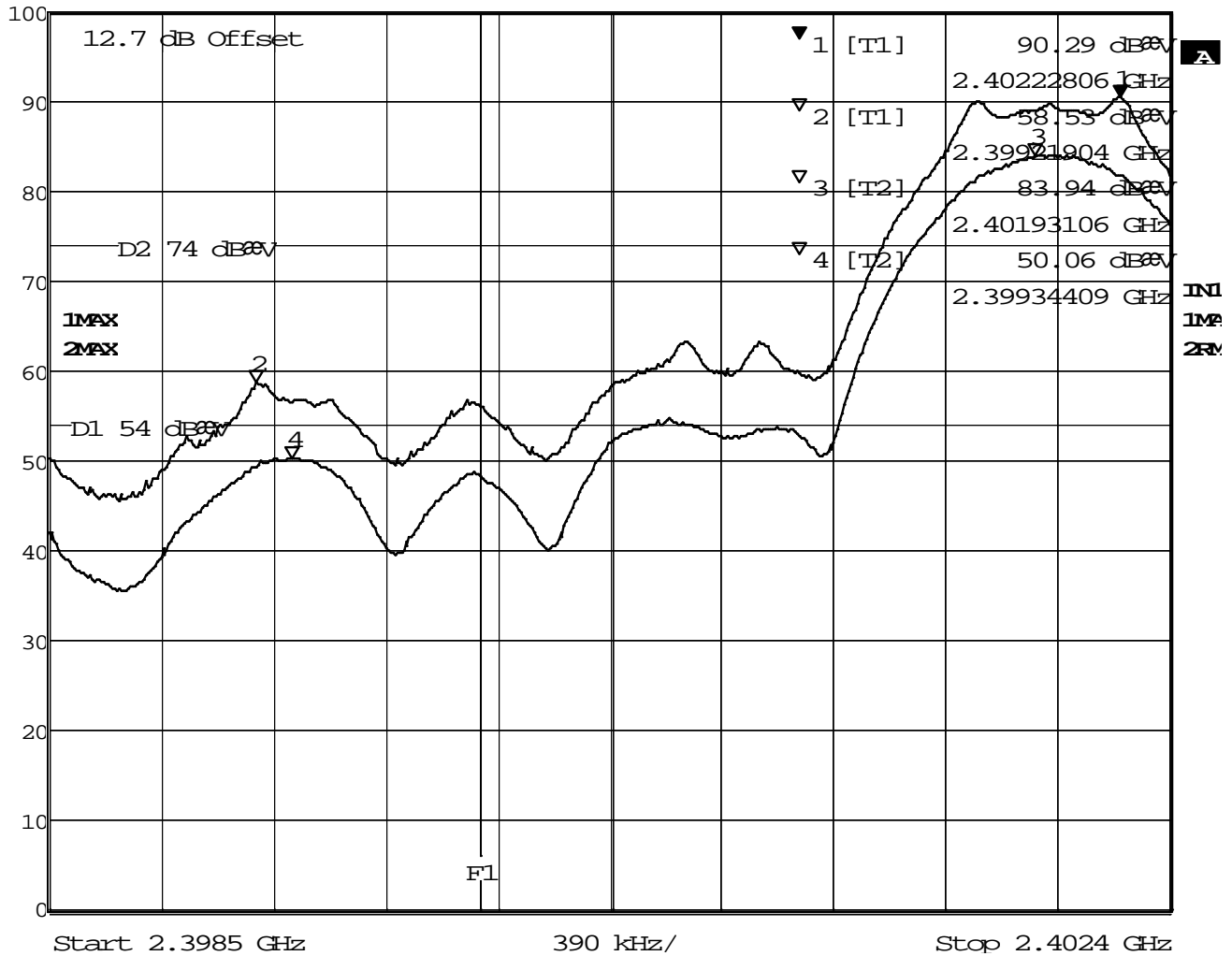
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31453994.001

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Marker 1 [T1] RBW 100 kHz RF Att 0 dB
Ref Lvl 90.29 dB μ V VBW 300 kHz
100 dB μ V 2.40222806 GHz SWF 500 ms Unit dB μ V



Date: 21.JAN.2015 11:03:14

Notes: Measured using the Peak (top trace) and Average detectors (lower trace).
Band Edge is at 2.4 GHz (Line F1).

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

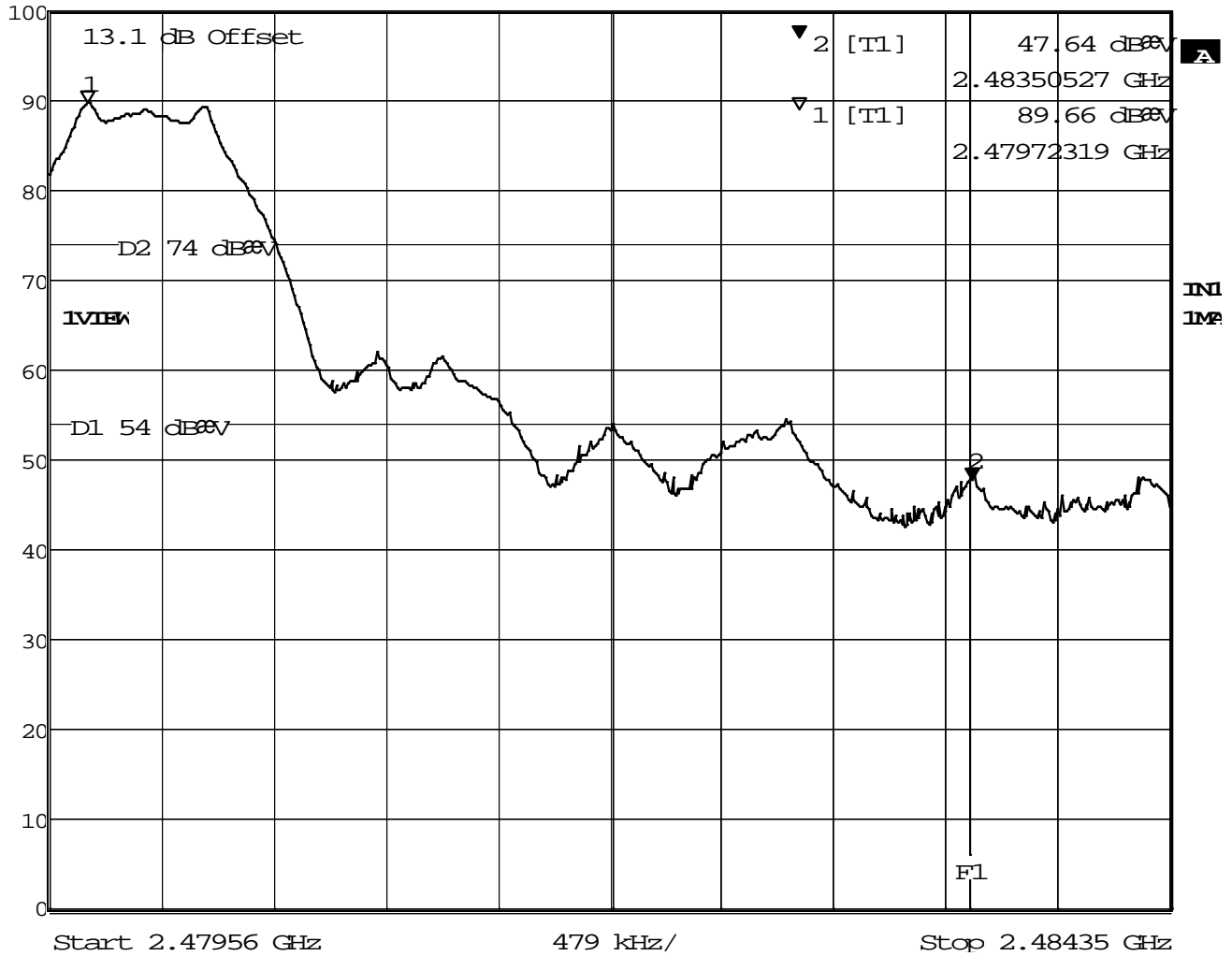
The Highest frequency outside the band is at 50.06 dB μ V (using the Average Detector) which is below the Average restricted-band limits)

Figure 1: Lower Band Edge Measurement (Radiated Emission)

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Marker 2 [T1] RBW 100 kHz RF Att 0 dB
 Ref Lvl 47.64 dB μ V VBW 300 kHz
 100 dB μ V 2.48350527 GHz SWF 500 ms Unit dB μ V



Date: 21.JAN.2015 11:12:15

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

Band edge at 2483.5 MHz is also the start of a restricted band, so the restricted band rules apply.

The Highest frequency outside the band is at 47.46 dB μ V (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.

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4.1 Conducted Emissions on AC Mains – FCC 207(a) and RSS-GEN 7.2.4

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.

4.1.1 Over View of Test

Results	NA EUT is battery operated only			Date	NA		
Standard	FCC Parts 15.207(a) and RSS-GEN 7.2.4						
Product Model	M049			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			

4.1.2 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.

4.1.3 Deviations

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

4.1.4 Final Test

This test is not applicable for the device submitted for testing

The test results contained in this report refer exclusively to the product(s) presented for testing. No liability may be assumed for models or products not referred to herein. This test report may not be published or duplicated in part without permission of the testing body. This test report by itself does not constitute authorization for the use of any TUV Rheinland test mark. The report must not be used by the client to claim product certification, approval, or endorsement by A2LA.

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4.1 99% Power Bandwidth

For the purpose of Section A1.1, the 99% bandwidth shall be no wider than .25% of the center frequency for devices operating between 70-900MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. This device operates above 900 MHz.

4.1.1 Test Over View

Results	Complies (as tested per this report)				Date	21 January 2015	
Standard	RSS-210 Section A1.1.3						
Product Model	DIGITAL INDICATOR			Serial#	Production Prototype		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3 V DC Lithium battery	Temp	72° F	Humidity	30%	Pressure	1002 mbar
Perf. Criteria	(Below Limit)		Perf. Verification		Readings Under Limit		
Mod. to EUT	None		Test Performed By		Mark Ryan		

4.1.2 Test Procedure

Using the procedures of RSS-GEN section 4.6.1, the 3 kHz resolution bandwidth is 1% of the 300 kHz span. The 10 kHz video bandwidth is over 3 times that of the resolution bandwidth.

The limit of the bandwidth would be 0.5% of 2.4 GHz or 12 MHz.

4.1.3 Deviations

There were no deviations from the test methodology listed in the test plan for the Electrical Fast transients (EFT) Immunity test.

4.1.4 Final Results

The measured 99% bandwidth is 146.69 kHz, which is well below the 12 MHz limit.

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

Frequency (MHz)	99% BW (MHz)	Limit (MHz)	Margin (MHz)
2402	1.070	12.0	-10.918
2440	1.070	12.0	-10.924
2480	1.070	12.0	-10.912

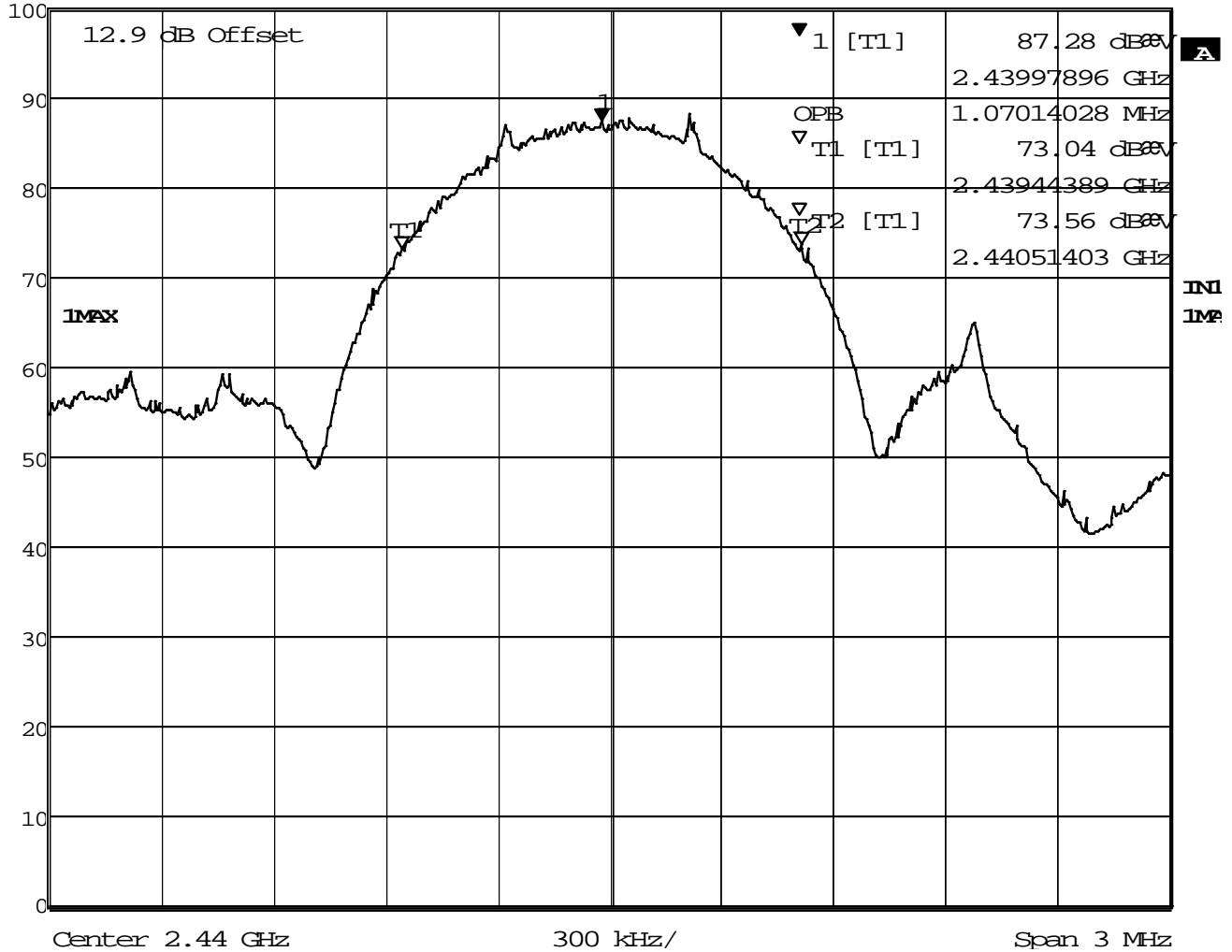
99% Power Band Width.

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4.1.5 Final Data



Marker 1 [T1]	REW	30 kHz	RF Att	0 dB
Ref Lvl	87.28 dB μ V	VBW	100 kHz	
100 dB μ V	2.43997896 GHz	SWT	500 ms	Unit dB μ V



Date: 21.JAN.2015 11:27:00

Figure 3 – 99% Power Bandwidth = 1.07 MHz. The Worst-Case shown.

Span = 3MHz, RBW = 30 kHz (1% of Span), VBW = 100 kHz ($\geq 3x$ RBW)

The EUT is compliant to the requirements of RSS-210 A1.1.3

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5 Emissions in Receive Mode.

5.1 Radiated Emissions in Receive mode – FCC 15.109(a) and ICES-003

This test measures the electromagnetic levels of spurious signals generated by the EUT that radiated from the EUT and may affect the performance of other nearby electronic equipment.

5.1.1 Over View of Test

Results	Complies (as tested per this report)			Date	21&22 January 2015		
Standard	FCC Part 15.109(a) and RSS-210 2.2 and 2.3						
Product Model	M049		Serial#	Production Prototype			
Configuration	See test plan for details						
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	73° F	Humidity	28%	Pressure	1010 mbar
Frequency Range	30 MHz to 13 GHz @ 3m						
Perf. Criteria	(Below Limit)		Perf. Verification	Readings Under Limit			
Mod. to EUT	None		Test Performed By	Mark Ryan			

5.1.2 Test Procedure

Radiated emissions tests were performed using the procedures of ANSI C63.4:2009 including methods for signal maximizations and EUT configuration. The photos included with the report show the EUT in its maximized configuration. The EUT was tested on a foam table 80cm above the ground plane.

The frequency range from 30 MHz to 13 GHz was investigated for radiated emissions.

Radiated emission testing was performed at a distance of 3 meters in a 5 meter semi-anechoic chamber.

The EUT was unmodified.

5.1.3 Deviations

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

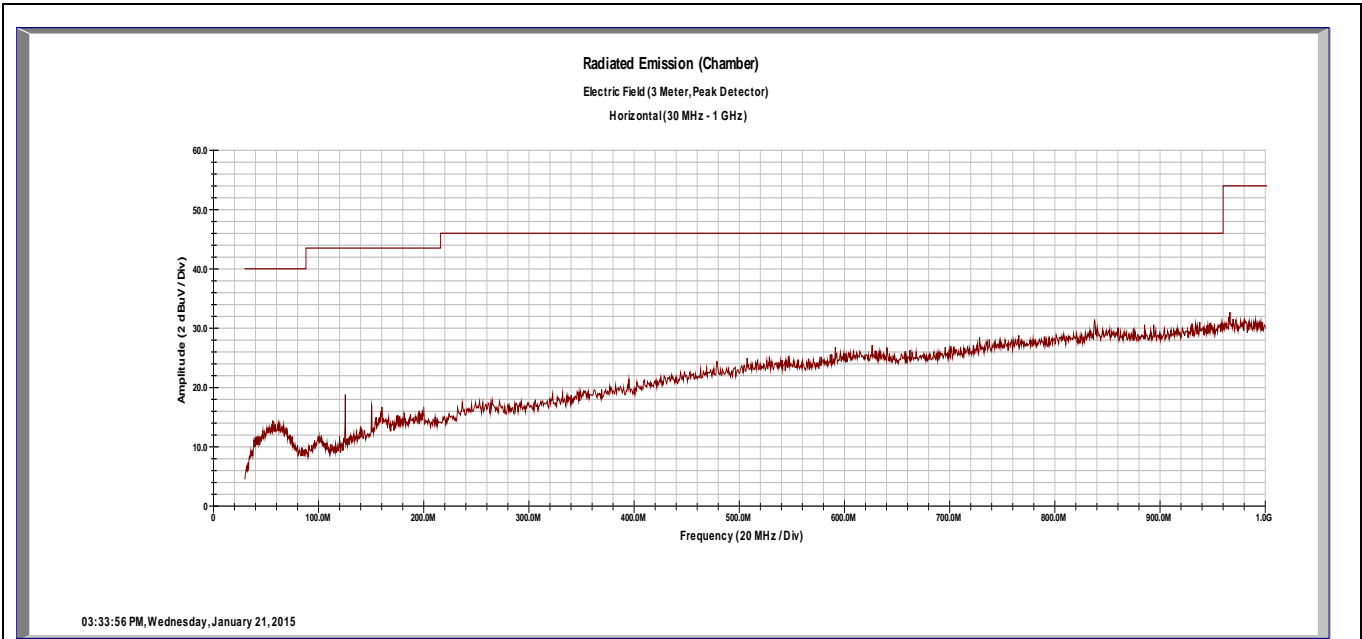
5.1.4 Final Test

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

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5.1.5 Final Graphs and Tabulated Data

Radiated Emissions in Receive Mode – 30MHz to 1 GHz
Horizontal



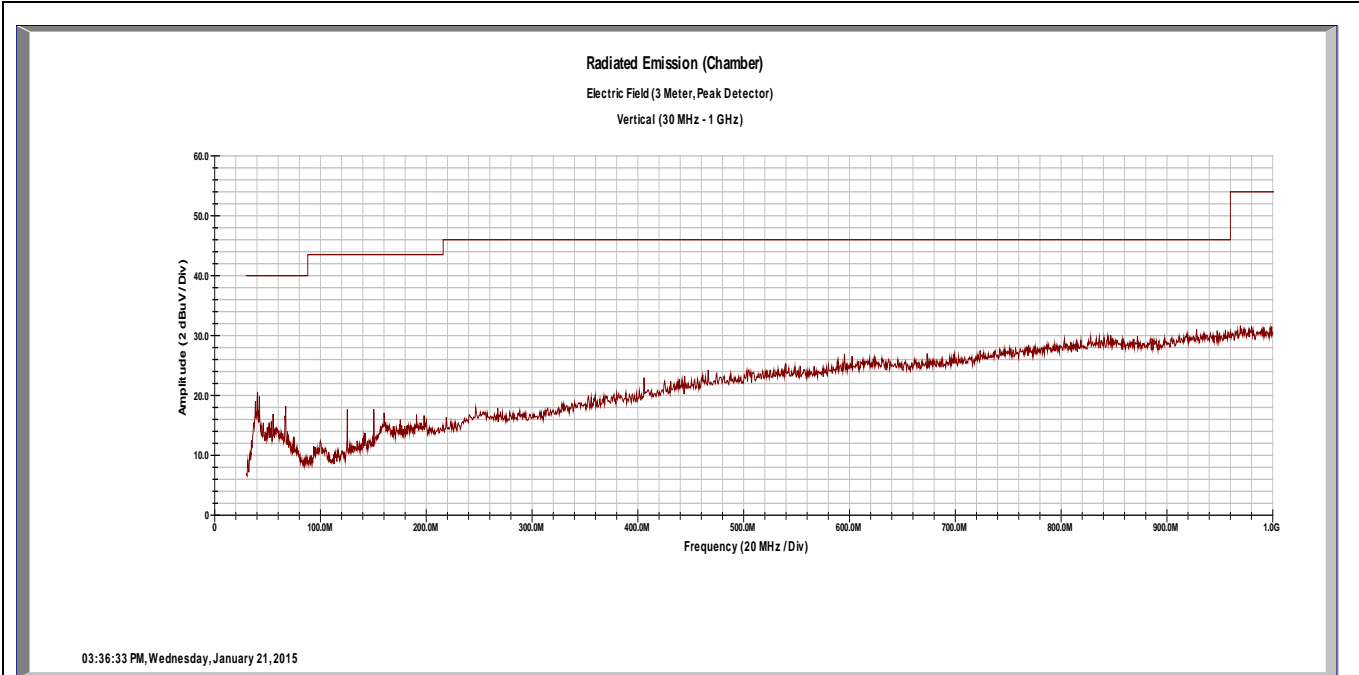
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: All emissions were below the noise floor of the instrumentation.
The signals shown below 200 MHz are anomalies in the preamp of the measuring spectrum analyzer.
A filter was not used for these scans.
The worst-case emissions were noted in the Vertical measurements, see below.

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Radiated Emissions in Receive Mode – 30MHz to 1 GHz
Vertical



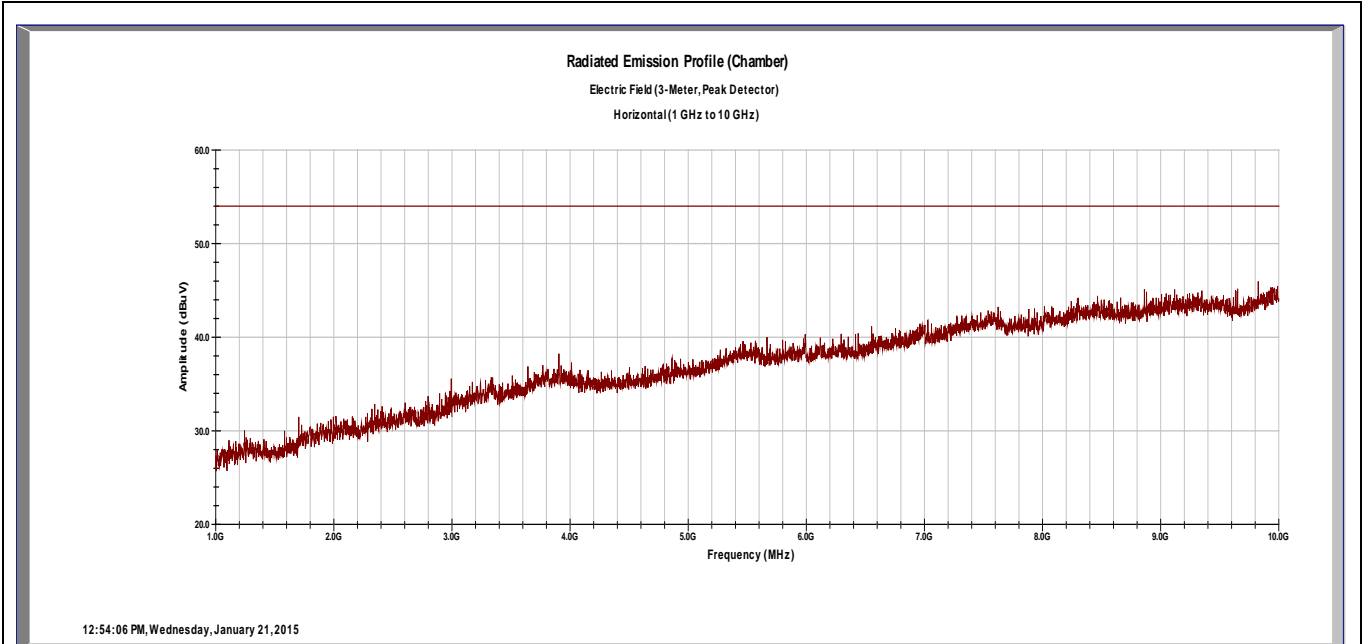
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)
36.88	V	1	0	5.63	0.00	0.71	8.16	14.50	40.00	-25.50

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

Notes: All other emissions were below the noise floor of the instrumentation.
The signals shown below 200 MHz are anomalies in the preamp of the measuring spectrum analyzer.
A filter was not used for these scans.

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Radiated Emissions in Receive Mode – 1 GHz to 10 GHz
Horizontal



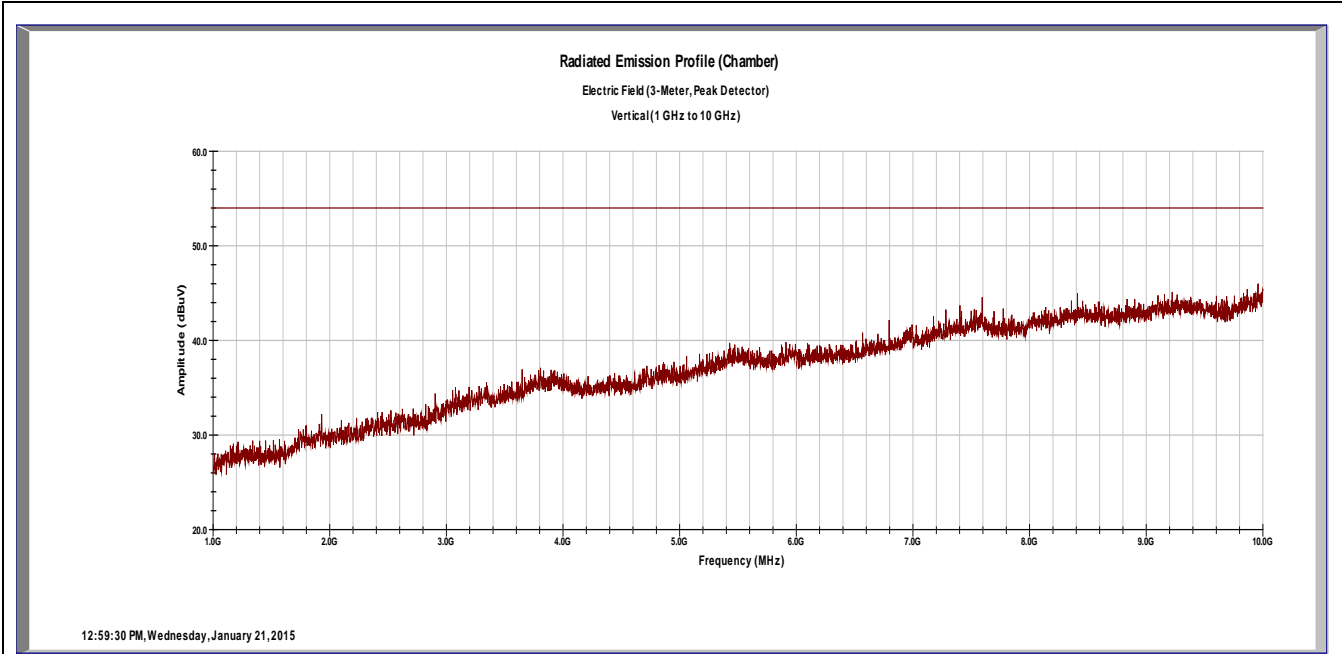
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: All emissions are below the noise floor of the receiver.
The remaining two channels gave very similar results.
A filter was not used for these scans.

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Radiated Emissions in Receive Mode – 1 GHz to 10 GHz
Vertical



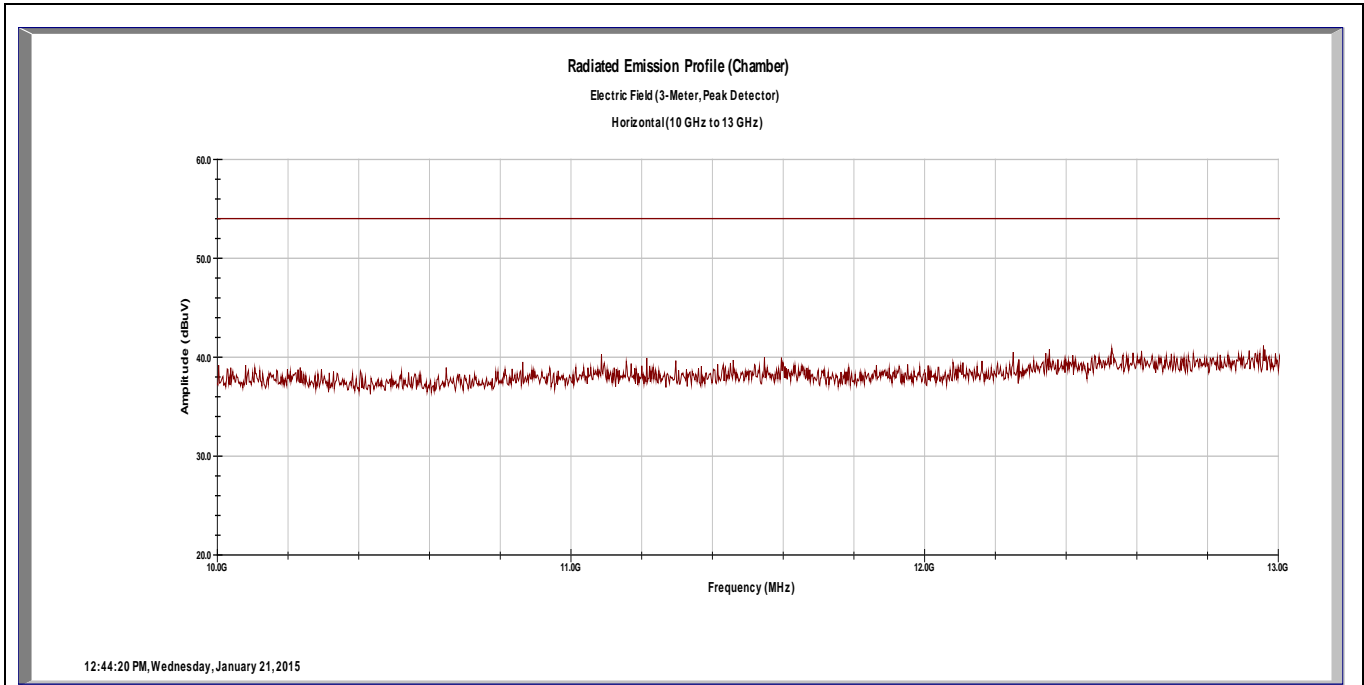
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBUV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBUV/m)	Spec Limit (dBUV/m)	Spec Margin (dB)

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

Notes: All emissions are below the noise floor of the receiver.
The remaining two channels gave very similar results.
A filter was not used for these scans.

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Radiated Emissions in Receive Mode – 10 GHz to 13 GHz
Horizontal



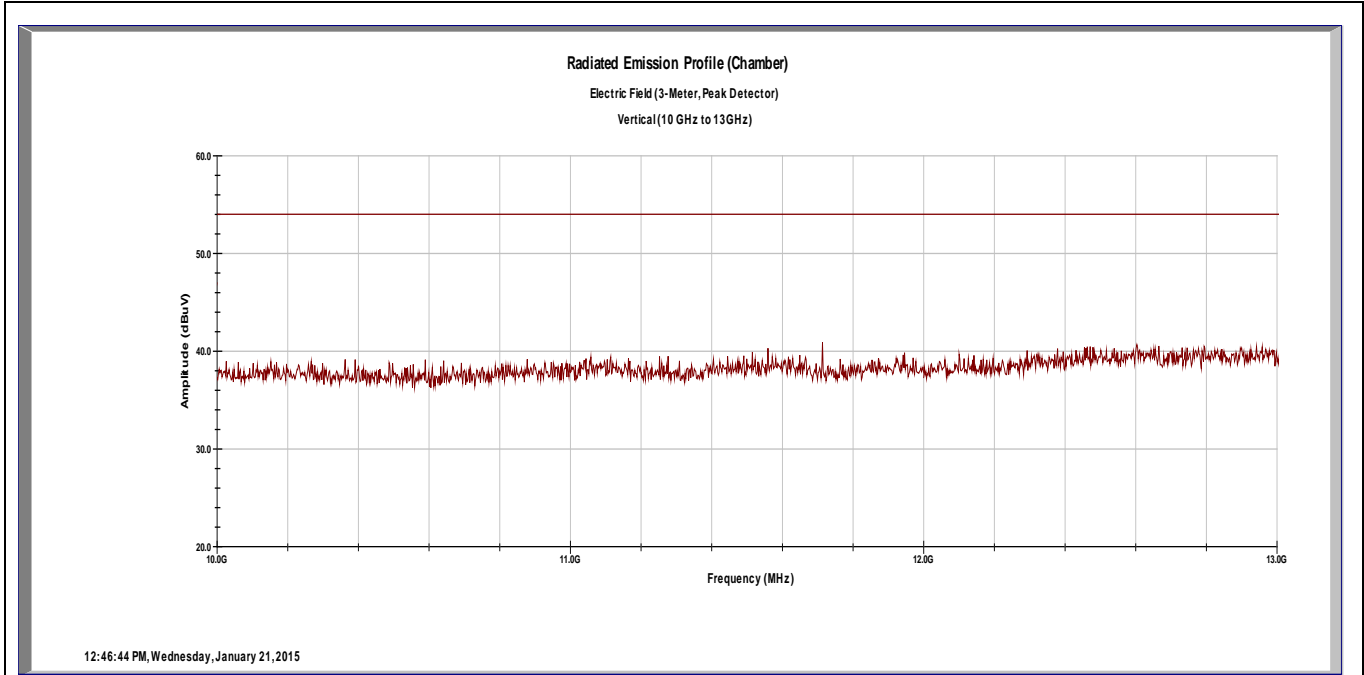
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: All emissions are below the noise floor of the receiver.
The remaining two channels gave very similar results.
A filter was not used for these scans.

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Radiated Emissions in Receive Mode – 10 GHz to 13 GHz
Vertical



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)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Notes: All emissions are below the noise floor of the receiver.
The remaining two channels gave very similar results.
A filter was not used for these scans.

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5.2 Conducted Emissions in Receive mode – FCC 15.107(a) and RSS-210

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.

5.2.1 Over View of Test

Results	NA (as tested per this report)			Date	NA		
Standard	FCC 15.107(a) and RSS-210						
Product Model	M049			Serial#	Production Prototype		
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			

5.2.2 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.

5.2.3 Deviations

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

5.2.4 Final Test

This this is not applicable for the device submitted for testing

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6 RF Exposure

6.1 Exposure Requirements – FCC KDB # 447498 DO1 and RSS-102 Issue 4

FCC KDB # 447498 DO1 V05r02 - Mobile and Portable Device RF Exposure and Procedures and Equipment, Appendix A shows that the SAR Text Exclusion Threshold for a device with a separation distance of 5 mm at 2450 MHz is 10 mW

RSS-102 section 2.5.1 states that a device is exempt from SAR evaluation if the frequency is “above 2.2 GHz and up to 3 GHz inclusively, and with output power (i.e. the higher of the conducted or radiated (EiRP.) source-based, time-averaged output power) that is less than or equal to 20 mW for general public use...”.

6.1.1 Test Procedure

If the antenna is located > 20cm from the user, then an MPE calculation is acceptable.

If the antenna is located < 20cm (portable / mobile / hand-held device) from the user, then SAR evaluation is required.

6.1.2 Evaluation

The EUT will be used as a portable device where the antenna will be located less than 20cm from the user, therefore SAR evaluation is required.

6.1.2.1 Evaluation for FCC

FCC 447498 DO1 Mobile Portable RF Exposure V05r02, Appendix A shows that the SAR Text Exclusion Threshold for a device with a separation distance of 5mm at 2450 MHz is 10 mW.

The minimum power that requires SAR testing with a separation distance of 5mm at 2.445 GHz is 10 mW.

The maximum EiRP peak power output of the EUT is: 0.865 mW (See calculation next page).

The EUT is well below the 25mW power level.

6.1.2.2 Evaluation for Industry Canada

The maximum EiRP peak power output of the EUT is: 0.865 mW (See calculation next page).

The EUT is well below the 20mW power level.

6.1.3 Conclusion

SAR data is not required for either FCC or Industry Canada.

Note: The 0.865 mW power level has not been time-averaged. (100% Duty Cycle).
This is considered to be the absolute worst case.

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6.1.4 Calculated EiRP Level

Notes: The EUT does not have a means to make direct measurements.

This EiRP calculation was made using the maximum peak value in section 4.1.4.1 of this report (Page 10) which is 94.60 dB μ V/m at 3m.

Per the equation in section 1.3.1 of FCC Document # 412172 D01 Determining ERP and EiRP v01;

$$\mathbf{EiRP = p_t \times g_t = (E \times d)^2 / 30,}$$

where:

p_t = transmitter output power in watts,

g_t = Numeric gain of transmitting antenna (unitless),

E = electric field strength in V/m; $E = 10^{(94.6/20)} / 10^6 = 0.0537$ V/m,

d = measurement distance in meters; $d = 3$ m,

$$\mathbf{EiRP = (0.0537 \times 3)^2 / 30 = 0.000865 \text{ Watts or } \underline{\underline{0.865 \text{ mW}}}}$$

6.1.5 Antenna Gain Calculation:

The antenna used in the EUT is a metallic “Inverted-L” that is soldered to the circuit board and is formed around an edge of the display.

The stated Maximum output power by the Manufacturer is 1 mW or 0 dBm.

The Maximum EiRP output is 0.865 mW or -0.63 dBm.

The Gain of the antenna would be 0 dBm + (-0.63 dBm) = **-0.63 dBi** or a numeric gain of: **0.86**.

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