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Electromagnetic Compatibility Test Report

Prepared in accordance with

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

On

DIGITAL INDICATOR

MarCator 1086 R

Mahr Federal Inc.
1144 Eddy Street
Providence, RI 02905, USA

Prepared by:

TUV Rheinland of North America, Inc.

Manufacturer's statement - attestation

The manufacturer; Mahr Federal 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.

Peter Jette Printed name of official	 Signature of official
1144 Eddy Street **Providence, RI 02905, USA** Address	6/12/12 Date
401-784-3443 Telephone number	**Peter.Jette@Mahr.com** Email address of official

Client:	Mahr Federal Inc. 1144 Eddy Street Providence, RI 02905, USA	Peter Jette 401-784-3443 Peter.Jette@Mahr.com	
Identification:	DIGITAL INDICATOR	***Serial No.:***	11081514
Test item:	MarCator 1086 R	***Date tested:***	18 April 2012
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 Part 15.31(e) 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:*** Robert Richards	
18 April 2012 ***Signature***		19 June 2012 ***Signature***	
Other Aspects:	**None**		

Abbreviations: OK, Pass, Compliant, Complies = passed
Fail, Not Compliant, Does Not Comply = failed
N/A = not applicable

FC	NVLAP®	**Industry Canada**
90552 and 100881	**NVLAP Lab Code (200094-0)**	**IC-2932H**

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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 18 April 2012 on the DIGITAL INDICATOR, Model No. MarCator 1086 R, manufactured by Mahr Federal 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
--	19 June 2012	Initial Release

1.4 *Summary of Test Results*

Applicant	Mahr Federal Inc. 1144 Eddy Street Providence, RI 02905, USA	**Tel**	401-784-3443	**Contact**	Peter Jette
		Fax	401-784-3344	**e-mail**	Peter.Jette@Mahr.com

Description	DIGITAL INDICATOR	**Model**	MarCator 1086 R
Serial Number	11081514	**Test Voltage/Freq.**	3 V DC Lithium battery
Test Date Completed:	18 April 2012	**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 50mV/m at 3m Harmonics: Shall not exceed 500µV/m (0.5 mV/m) at 3m, (unresticted bands)	0.806 mV/m 221 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 (EUT in Transmit Mode)	Below the applicable limits	31.37 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
FCC Part 15.31(e)	Frequency Stability	The EUT is battery operated only. A fresh battery was used for testing	NA	Complies
RSS-210 A1.1.3	Occupied Bandwidth	99% BW ≤ 0.5% of center freq.	136 kHz	Complies
FCC Part 15.109(a) and RSS-210 2.2 and 2.3	Receive Mode - Radiated Emissions	Below limit of the resticted bands lised in RSS-GEN section 6	Noise Floor	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	SAR or MPE Requirements	2.87 mW	Complies

2 Laboratory Information

2.1 Accreditations and 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 NIST / NVLAP

Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Standard 17025:2005 (Lab code: 200094-0). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Industry Canada

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

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. (Registration No. R-1174, R-1679, C-1790 and C-1791).

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:

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

2.2 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
Temperature measurement	**Humidity measurements**	**DC Voltage measurements**
± 4. 0 %	± 4. 0 %	± 0.5 %

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.

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 and Bench top)					
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	01-Feb-11	01-Feb-12
Antenna Horn 1-18GHz	EMCO	3115	2236	13-Dec10	13-Dec-12
Antenna Horn 1-18GHz	EMCO	3115	5770	18-Aug-10	18-Aug-12
Ant. BiconiLog	Chase	CBL6140A	1108	24-Aug-11	24-Aug-12
Receiver, EMI	Rohde & Schwarz	ESIB40	100043	01-Aug-11	01-Aug-12
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	06-Dec-10	06-Dec-11
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	003	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	030	16-Dec-10	16-Dec-11
Cable, Coax	Andrew	FSJ1-50A	045	16-Dec-10	16-Dec-11
High Pass Filter	Micro-tronics	BRM50702	049	20-Jan-11	20-Jan-12
Conducted Emissions (AC/DC and Signal I/O)					
LISN 15-18 (NSLK 8126)	Schwarzbeck Mess-Electronik	NSLK 8126	003885	21-Jan-11	21-Jan-12
Transient Limiter	Schaffner	CFL-9206	1649	01-Aug-11	01-Aug-12
Receiver, EMI	Rohde & Schwarz	ESH 3	860905/005	15-Dec-10	15-Dec-11
Spectrum Analyzer	Agilent Tec.	E7405A	US39440157	06-Dec-10	06-Dec-11
Cable, Coax	Pasternack	RG-223	051	16-Dec-10	16-Dec-11
General Laboratory Equipment					
Generator, Noise	York University	CNE III	Ser/98/66	CNR II	CNR II
Meter, Multi	Fluke	179	90580752	06-Dec-10	06-Dec-11
Power Supply, AC	California Instruments	3001ix	53354	07-Dec-10	07-Dec-11
Meter, Temp/Humid/Barom	Davis Instruments	7400	PB00205A13	1-Jan-11	1-Jan-12

3 Product Information

3.1 Product Description

See Description in the test plan in Appendix A of this report

3.2 Equipment Modifications

No modifications were needed to bring product into compliance.

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 µV/m) at 3m.
Harmonic Frequencies – 500 µV/m (54 dB µV/m) at 3m.

4.1.1 Over View of Test

Results	**Complies** (as tested per this report)				**Date**	5 - 6 April 2012	
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 7.2.1						
Product Model	MarCator 1086 R			**Serial#**	11081514		
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 Re-chargeable battery	**Temp**	72º F	**Humidity**	40%	**Pressure**	997 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 2. These test methods are listed under the laboratory's NVLAP 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.

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 (dBm)	Spec Limit (dBm)
Orientation 1										
Ch 1:										
2405.00	H	1	29	58.69	0.00	5.36	28.47	92.52		
2405.00	V	1	346	62.48	0.00	5.36	28.47	96.31		
CH 2:										
2440.00	H	1.1	1	61.05	0.00	5.42	28.42	94.89		
2440.00	V	1	3	62.45	0.00	5.42	28.42	96.29		
CH 3:										
2478.00	H	1	16	61.18	0.00	5.45	28.50	95.13		
2478.00	V	1	344	62.14	0.00	5.45	28.50	96.09		
Orientation 2										
Ch 1:										
2405.00	H	1	0	60.76	0.00	5.36	28.47	94.59		
2405.00	V	1	36	56.71	0.00	5.36	28.47	90.54		
CH 2:										
2440.00	H	1.7	355	64.29	0.00	5.42	28.42	98.13	2.87	30.00
2440.00	V	1.3	357	58.55	0.00	5.42	28.42	92.39		
CH 3:										
2478.00	H	1.3	355	63.10	0.00	5.45	28.50	97.05		
2478.00	V	1.3	15	59.52	0.00	5.45	28.50	93.47		
Orientation 3										
Ch 1:										
2405.00	H	1.6	220	56.45	0.00	5.36	28.47	90.28		
2405.00	V	1.6	313	52.56	0.00	5.36	28.47	86.39		
CH 2:										
2440.00	H	1.6	320	56.97	0.00	5.42	28.42	90.81		
2440.00	V	1.5	312	51.19	0.00	5.42	28.42	85.03		
CH 3:										
2478.00	H	1.5	317	56.45	0.00	5.45	28.50	90.40		
2478.00	V	1	275	52.78	0.00	5.45	28.50	86.73		

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

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: EUT is Orientation 2 (Facing up)

This highlighted frequency and orientation was worst case (2440 MHz).

4.1.4.2 Maximum Time-weighted Emission:

The manufacturer specifies that the Duty Cycle of the device will be up to 1%, depending on the length of the transferred information.

The Highest measured emission in on the second channel (2440 MHz) at 98.3 dBµV.

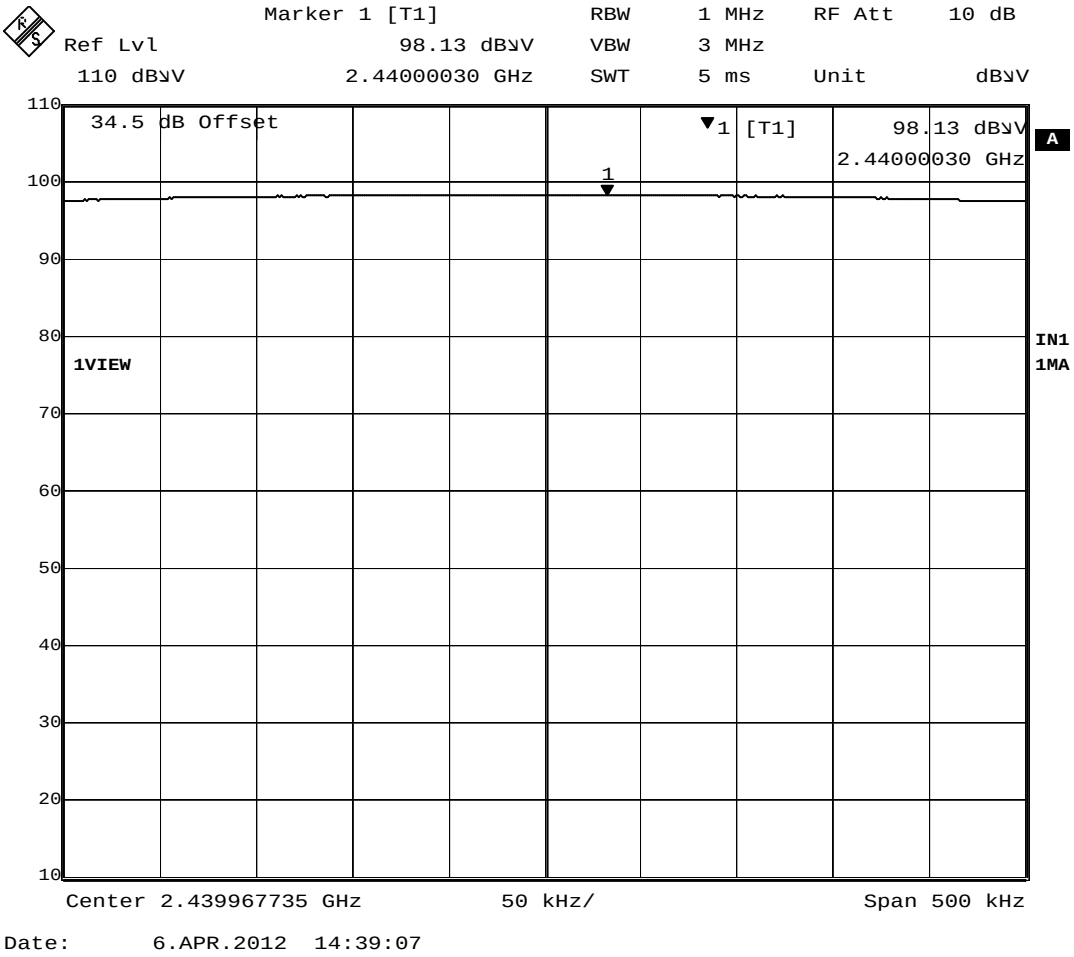


Figure 1 – Highest Emission.

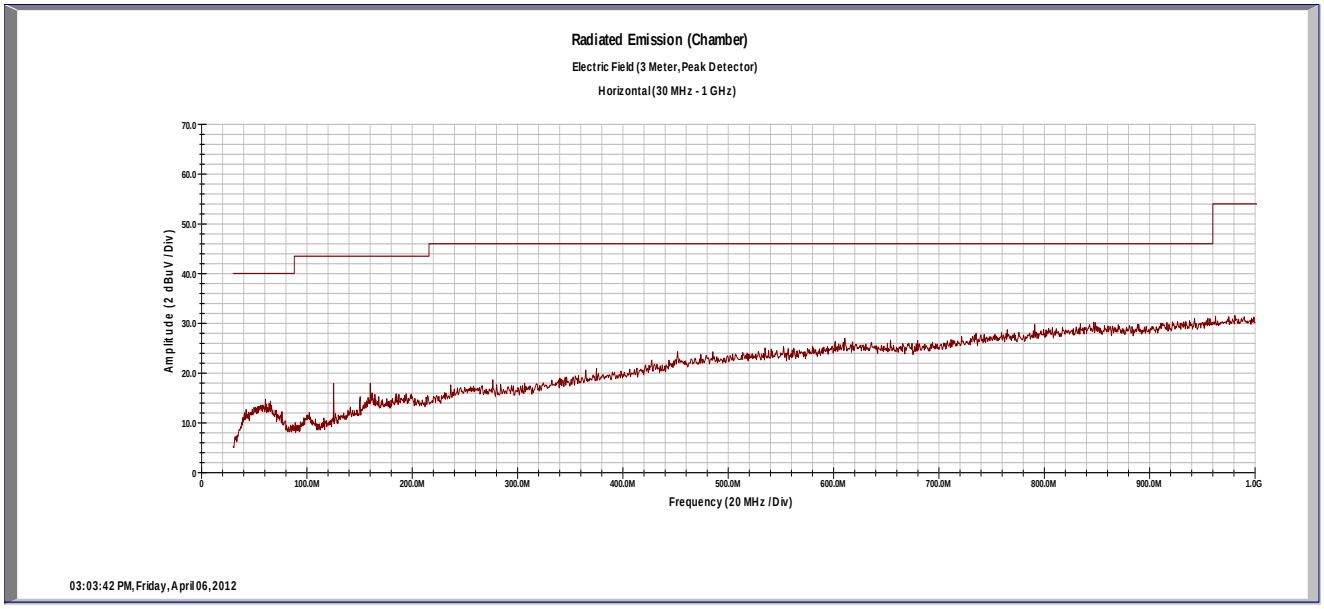
Note: Correction factors were included in the Spectrum Analyzer trace for this frequency.

Frequency (MHz)	Maximum emission (dB µV/m @ 3m)	Duty Cycle (%)	Time averaged (dBµV/m)	Time averaged (µV/m)	Limit (dBµV/m)	Margin to limit (dB)
2440	98.13	1	**58.13**	806	94	**35.87**

(58.13 dBµV/m is equivalent to 0.806 mV/m which is well below the 50 mV/m limit.)

4.1.4.3 Emissions Outside the Frequency Band:

Radiated Emissions Ch 2 – 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)

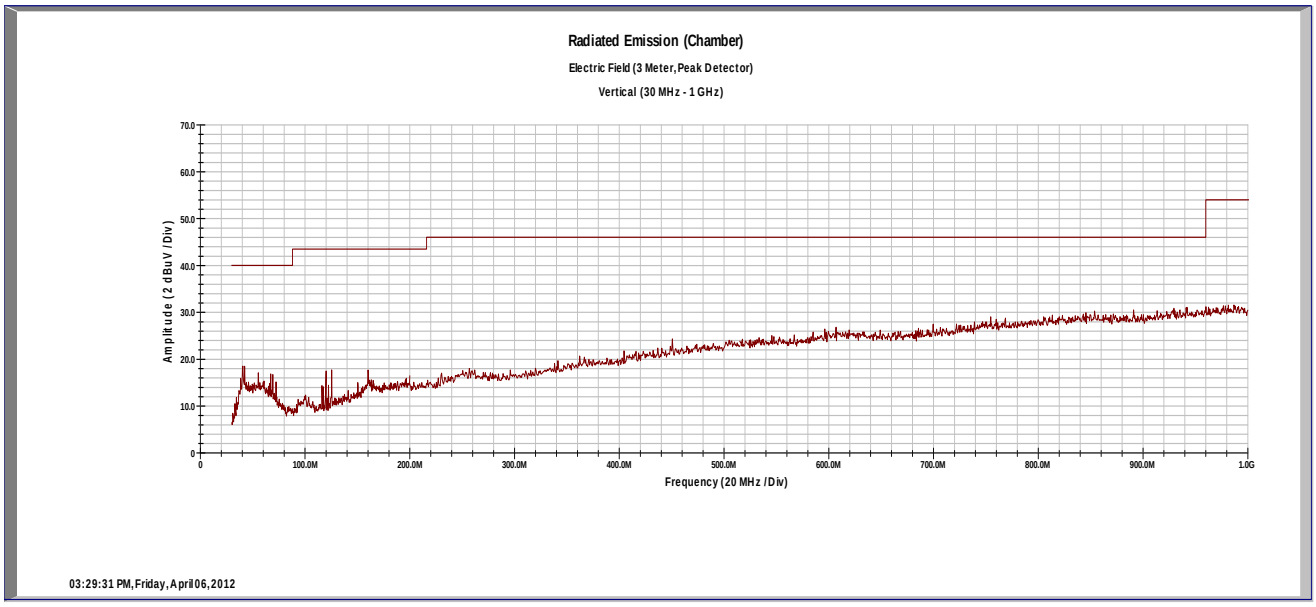
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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 spectrum analyzer.
A notch filter at the transmitter fundamental frequency was used.

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)

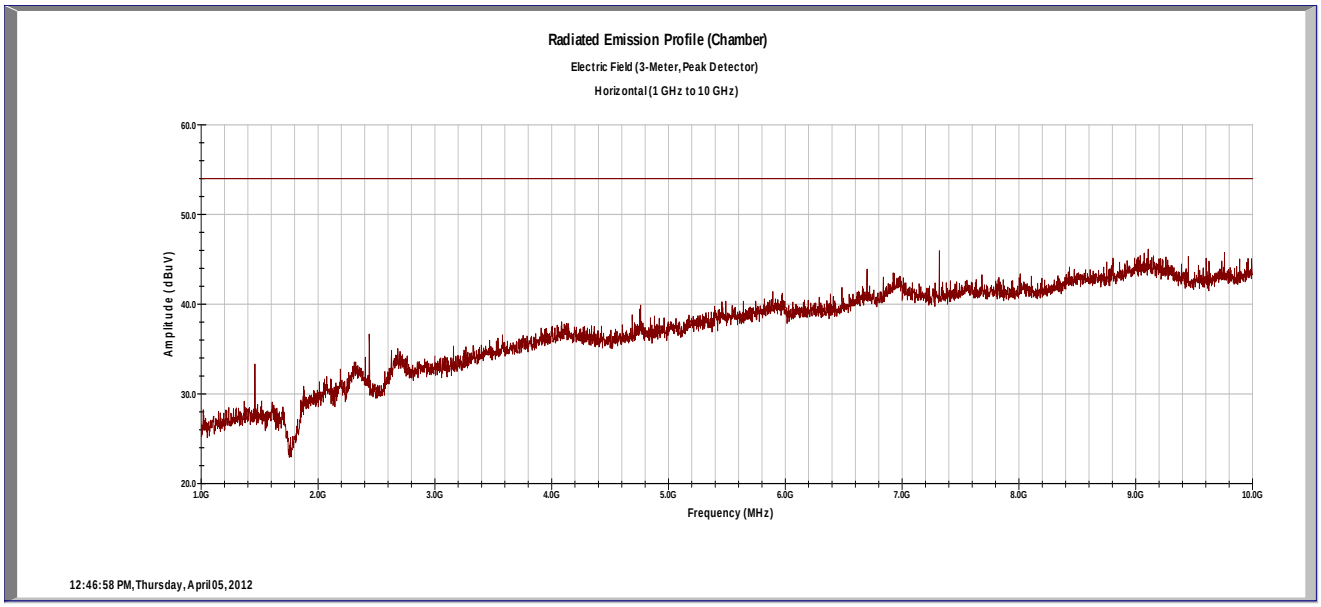
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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 spectrum analyzer.
A notch filter at the transmitter fundamental frequency was used.

Worst Case Radiated Emissions: Ch 2 – 1 to 10 GHz

Horizontal



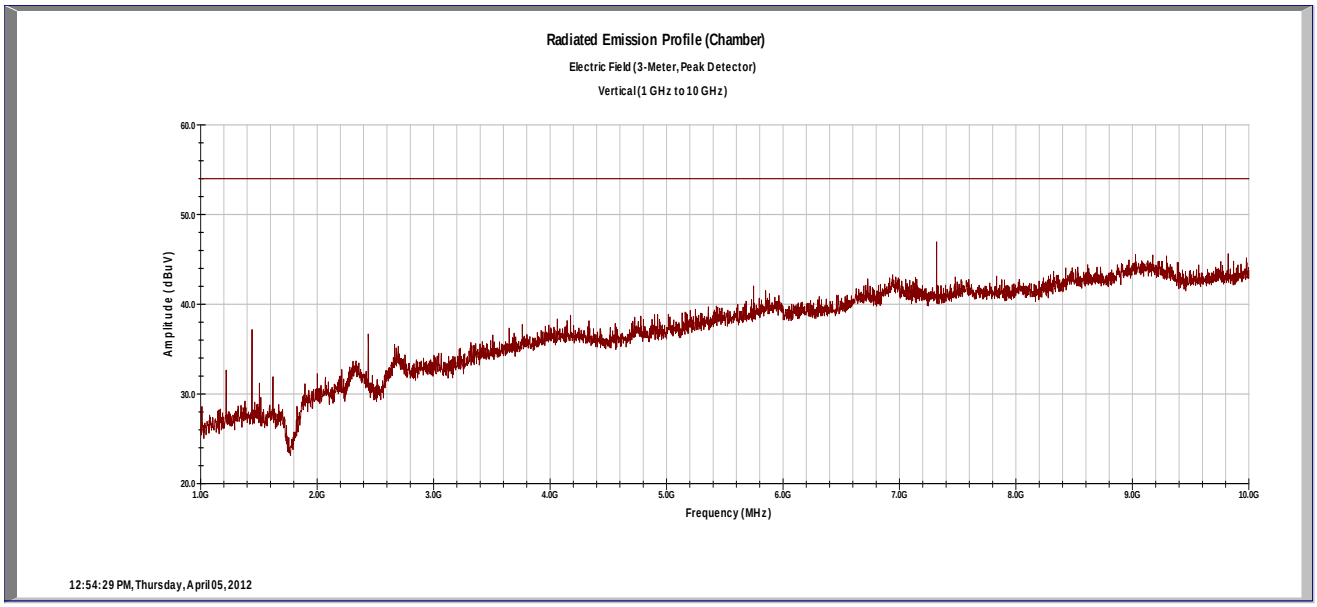
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: a Notch filter was used for the fundamental
Worst case emissions are in the Vertical Polarity (see next page)
The **Green** emissions are using the Average detector
The **Blue** emissions are using the Peak detector
Vertical showed the worst-case emissions (see below)

Worst Case Radiated Emissions: Ch 2 – 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)
1220.00	V	1	110	36.60	35.46	5.34	25.22	31.71	54.00	-22.29
1220.00	V	1	110	45.80	35.46	5.34	25.22	40.91	74.00	-33.09
7320.00	V	1.1	96	30.23	33.79	13.47	36.60	46.51	54.00	-7.49
7320.00	V	1.1	96	38.24	33.79	13.47	36.60	54.52	74.00	-19.48

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

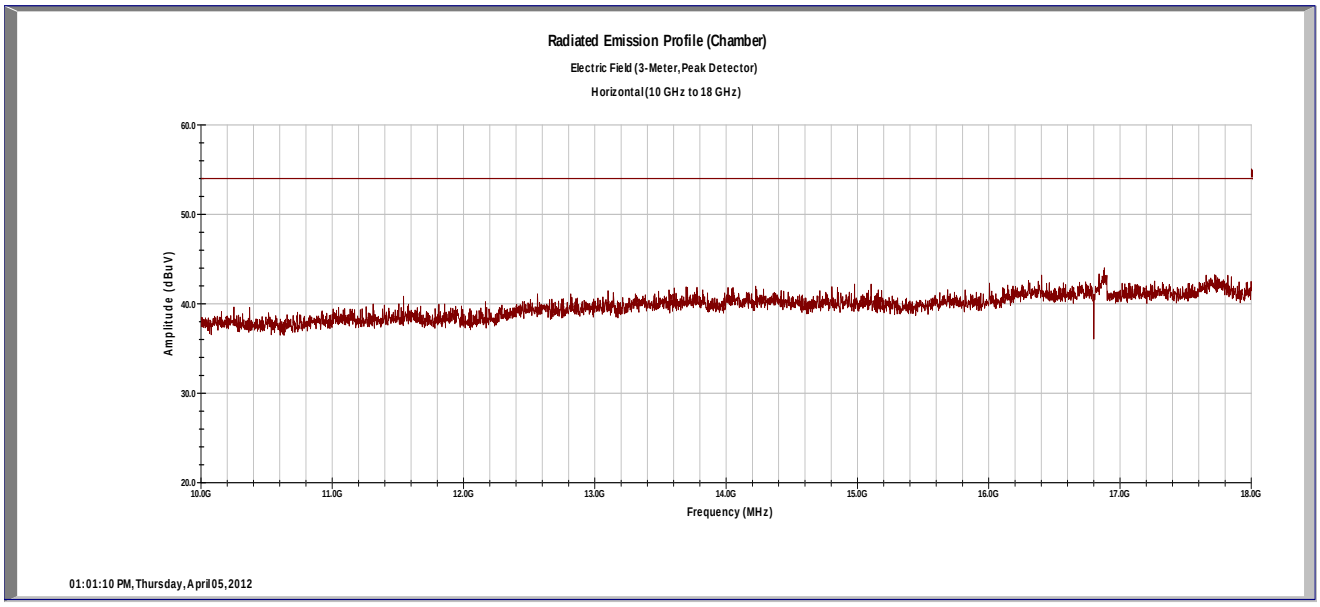
Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes:
The worst case emissions was a harmonic at **46.514 dBµV /m** (avg) which is equivalent to **211 µV/m** (at 3m)

The **RED** emissions are using the Average detector
The **Blue** 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.
This channel and orientation provided the worst case Harmonic and Spurs radiation
The signals shown below 200 MHz are anomalies in the preamp of the measuring spectrum analyzer.
A notch filter at the transmitter fundamental frequency was used.

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)

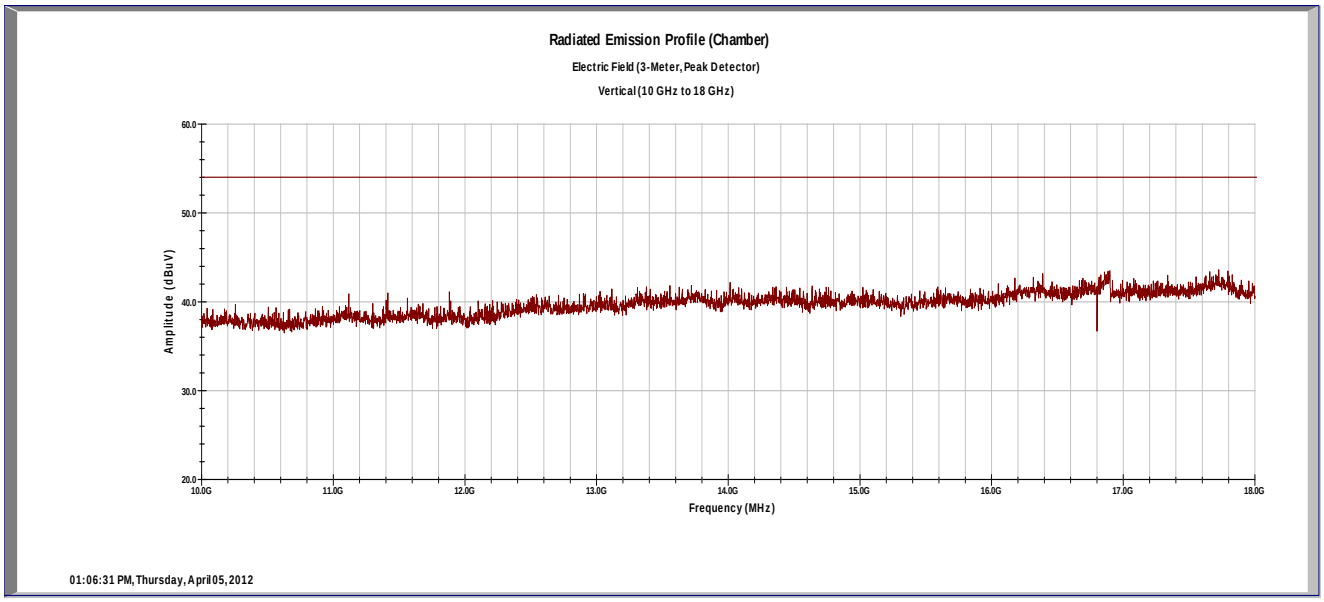
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: No measureable emissions were noted.
A Notch filter was used on the fundamental frequency
No emissions were seen above the noise floor of the instrumentation.
The other two channels presented very similar results

Radiated Emissions Ch 2 – 10 to 18 GHz

Vertical



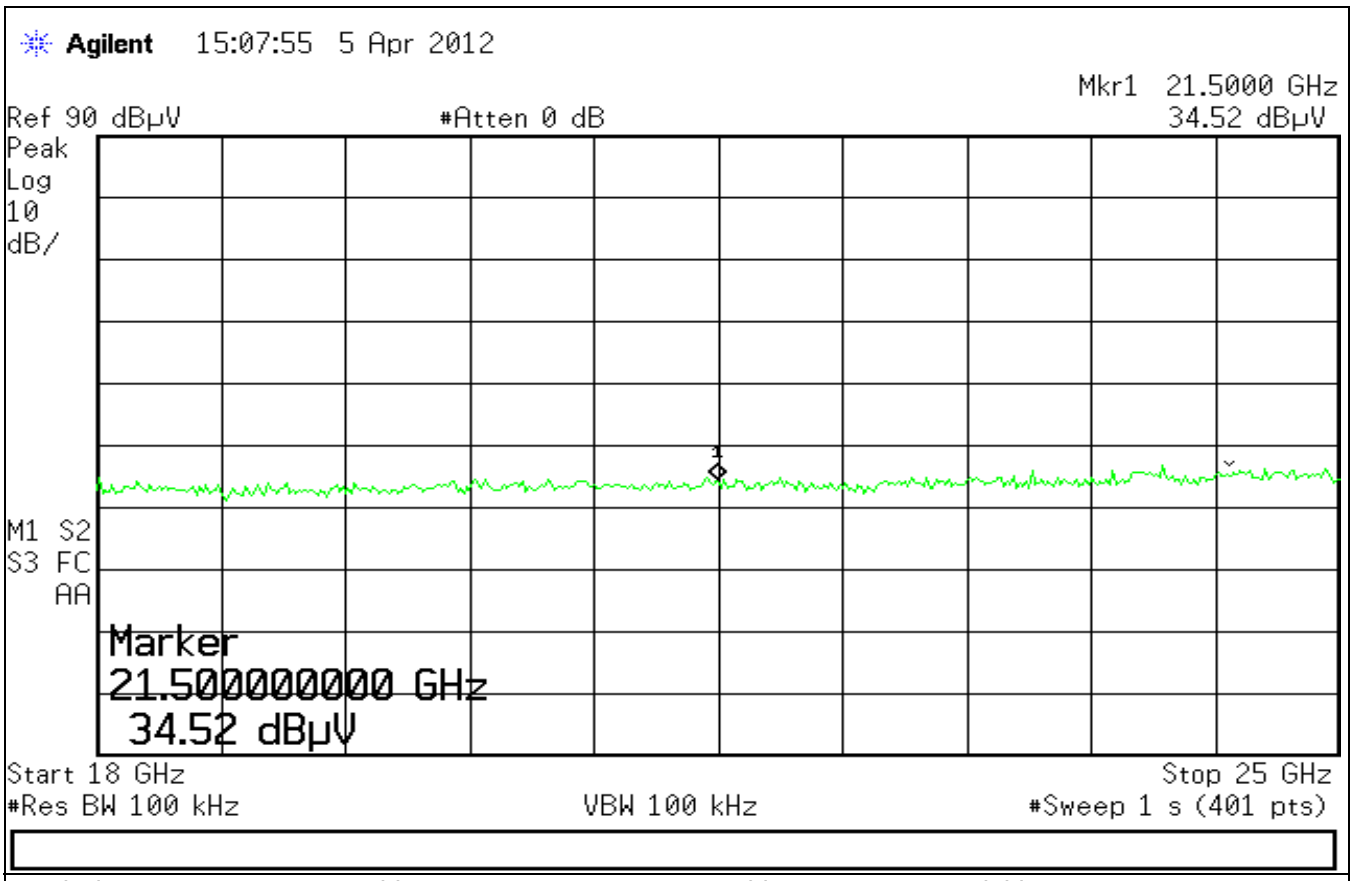
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: No measureable emissions were noted.
A Notch filter was used on the fundamental frequency
No emissions were seen above the noise floor of the instrumentation.
The other two channels presented very similar results

Radiated Emissions Ch 2 – 18 to 25 GHz
Horizontal



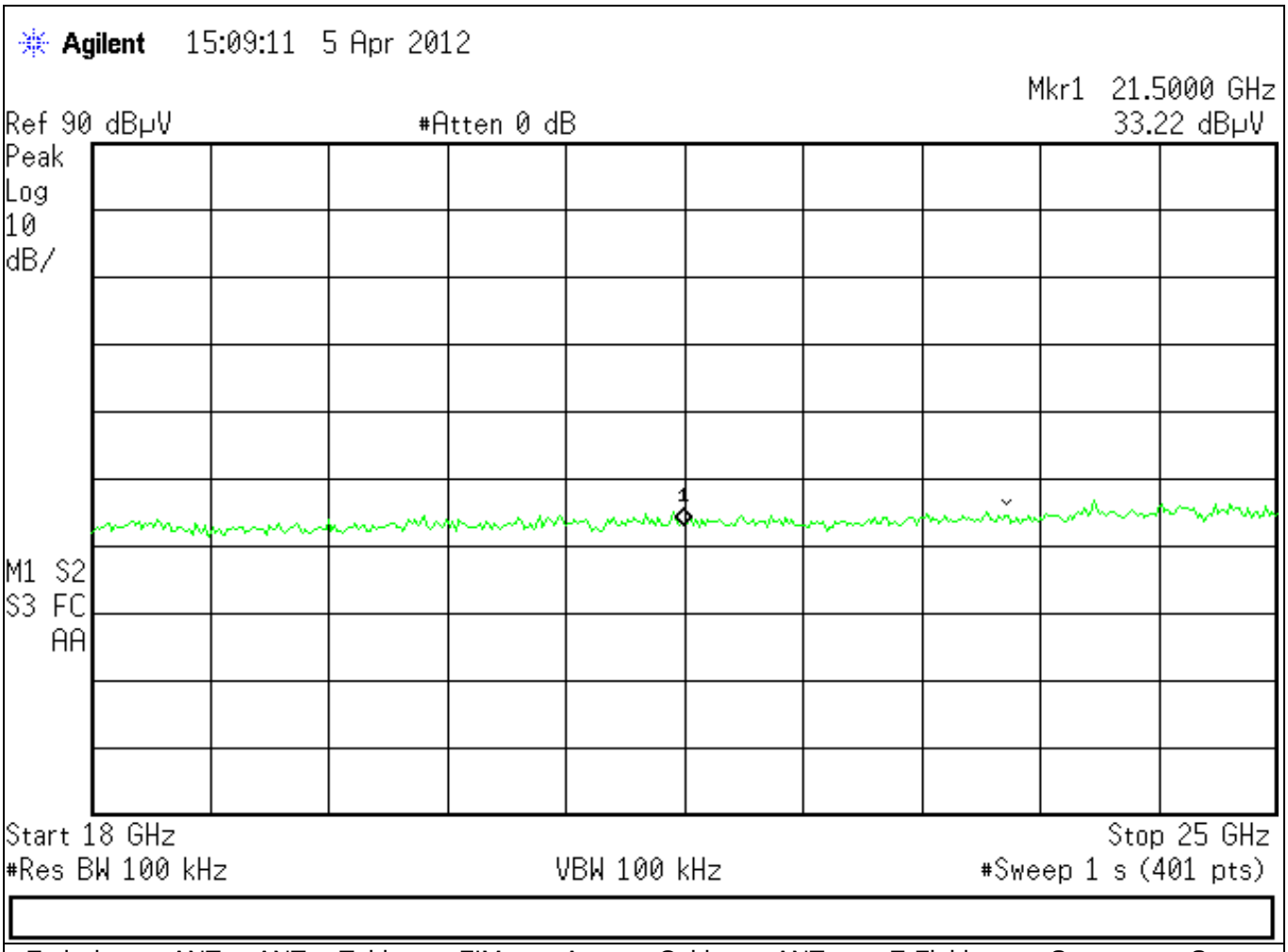
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: No measureable emissions were noted.
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

Radiated Emissions Ch 2 –18 to 25 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 ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: No measureable emissions were noted.
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

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**	3 April 2012
Standard	FCC Part 15.249(d), RSS 210 2.2						
Product Model	MarCator 1086 R			**Serial#**	11081514		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3.0 V DC Lithium battery	**Temp**	76º F	**Humidity**	45%	**Pressure**	999 mbar
Perf. Criteria	(Below Limit)		**Perf. Verification**		Readings Under Limit		
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

4.2.2 Test Procedure

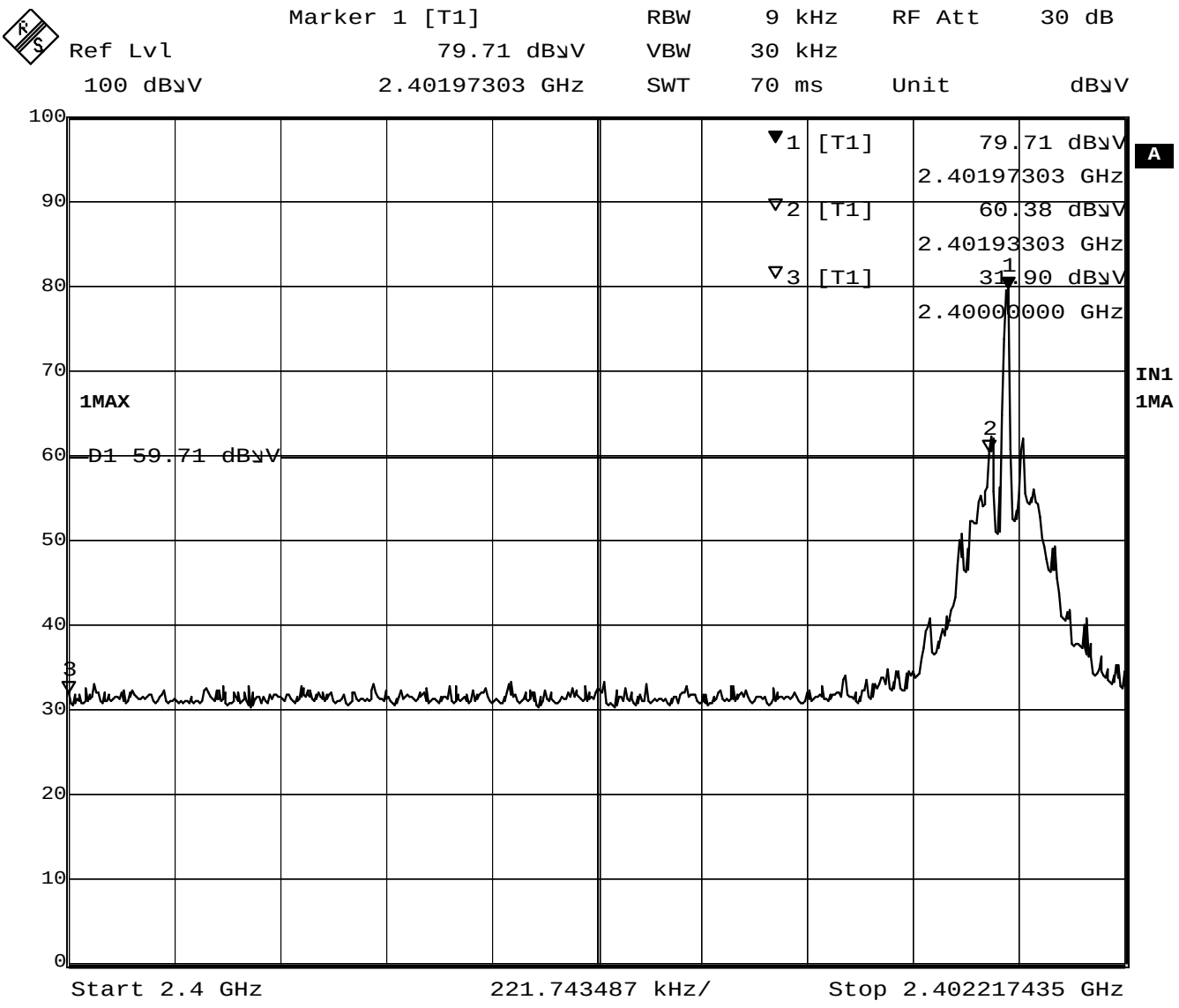
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Sec. 15.209, whichever is the lesser attenuation.

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.



Date: 3.APR.2012 12:40:21

Notes: Measured using the Peak detector. Band Edge is at 2.4 GHz (Marker 3).

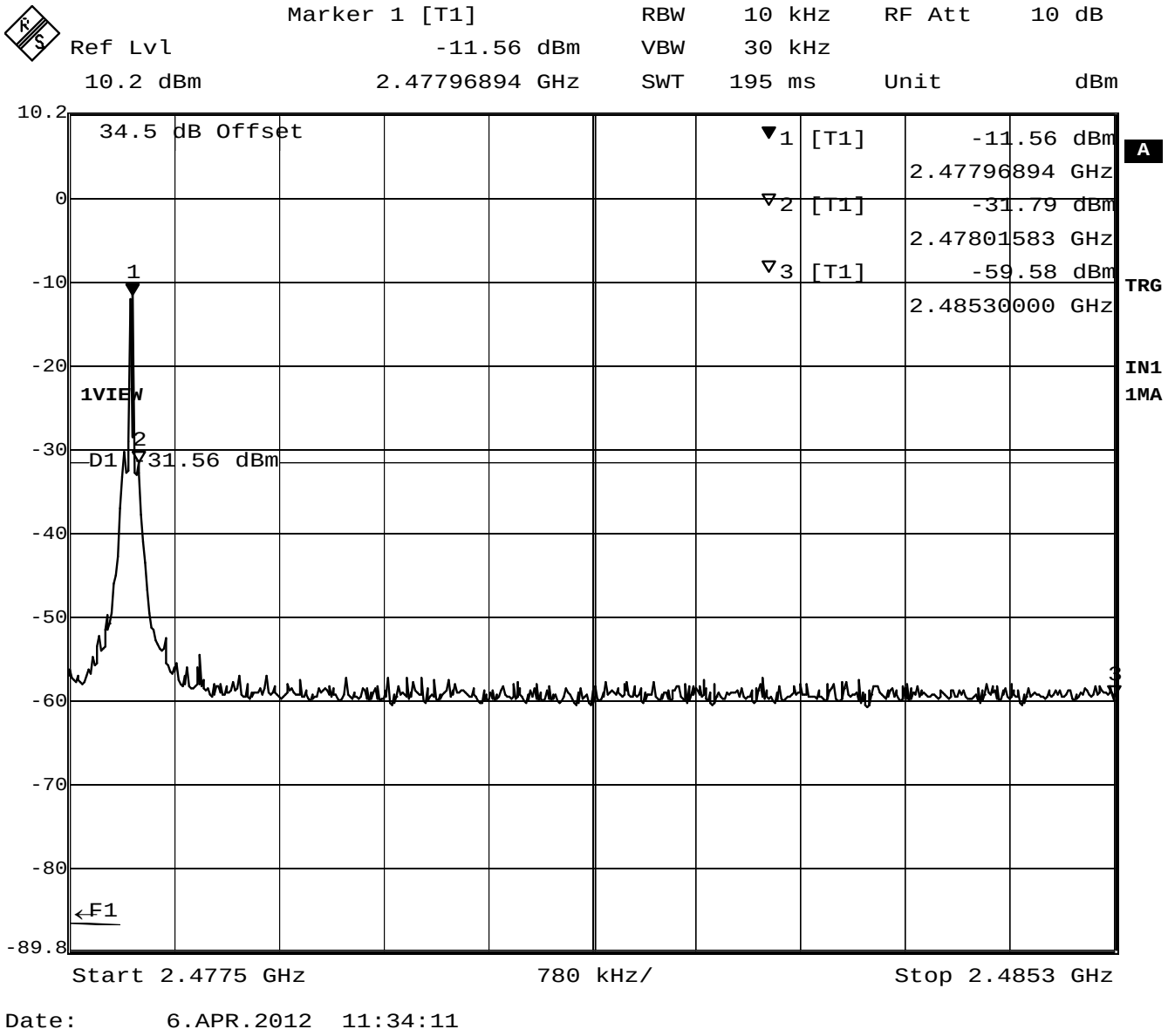
The nearest restricted band (2390MHz) is 10 MHz below the band edge

At the lowest channel, the 20dB down point is at 2401.93 MHz.

The band edge is at 2400 MHz

Figure 2: Lower Band Edge Measurement (Radiated Emission)

The EUT is compliant with the rules.



Note: Measured using the Peak and Average detectors.

Band edge at 2483.5 MHz is also the start of a restricted band, so the rules of 15.205 apply.

The 20dB down point is inside the band at 2478.02 MHz.
The highest peak above the band edge is at 2.483.95 MHz:

Figure 3: Upper Band Edge Measurement (Radiated Emission)

The EUT is compliant with the rules.

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 near by 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	MarCator 1086 R			**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 this is not applicable for the device submitted for testing

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**	18 April 2012
Standard	RSS-210 Section A1.1.3						
Product Model	DIGITAL INDICATOR			**Serial#**	11081514		
Test Set-up	Direct Measurement from antenna port						
EUT Powered By	3 V DC Lithium battery	**Temp**	71º F	**Humidity**	36%	**Pressure**	1009 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.

4.1.5 Final Data

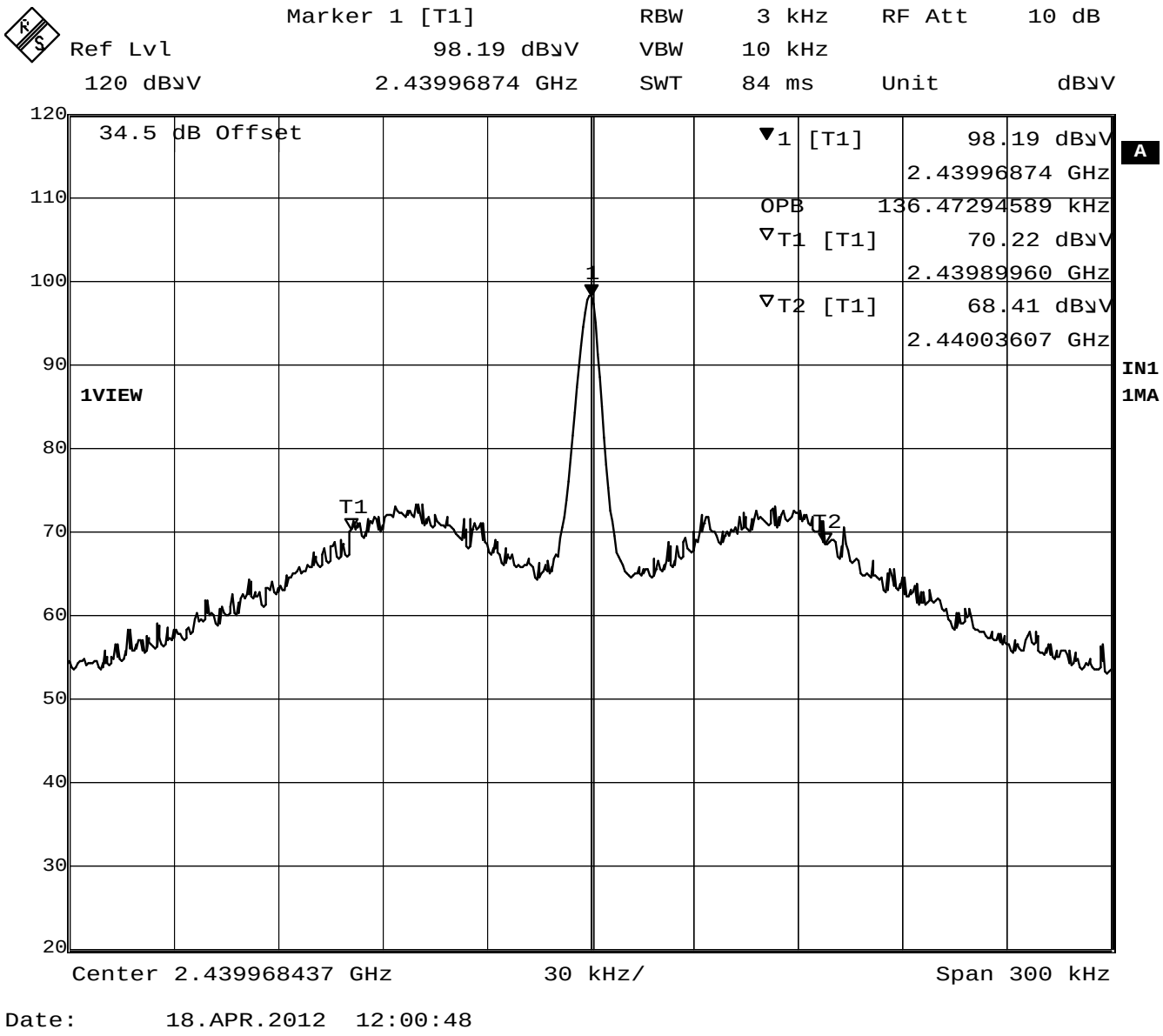


Figure 4 – 99% Power Bandwidth = 136 kHz

Span = 300 kHz, RBW = 3 kHz, VBW = 10 KHz

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

4.2 Extreme Voltage Requirements - FCC Part 15.31(e)

FCC Part 15.31 states that for intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

4.2.1 Over View of Test

Results	**Complies** (as tested per this report)	**Date**	6 April 2012
Standard	FCC Part 15.31(e)		
Product Model	MarCator 1086 R	**Serial#**	11081514
Test Set-up	Tested in shielded room. EUT placed on table, see test plans for details		
Mod. to EUT	None	**Test Performed By**	Mark Ryan

4.2.1 Test Procedure

This device is battery operated: Per FCC Part 15.3(e), a new battery was installed for the tests.

4.2.2 Final Test

As tested, the EUT was found to be compliant to the requirements of the test standard.

5 Emissions in Receive Mode.

5.1 Radiated Emissions in Receive mode – FCC 15.109(a) and RSS-210

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**	6 April 2012	
Standard	FCC Part 15.109(a) and RSS-210 2.2 and 2.3						
Product Model	MarCator 1086 R			**Serial#**	11081514		
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**	74º F	**Humidity**	45%	**Pressure**	999 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 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.

5.1.3 Deviations

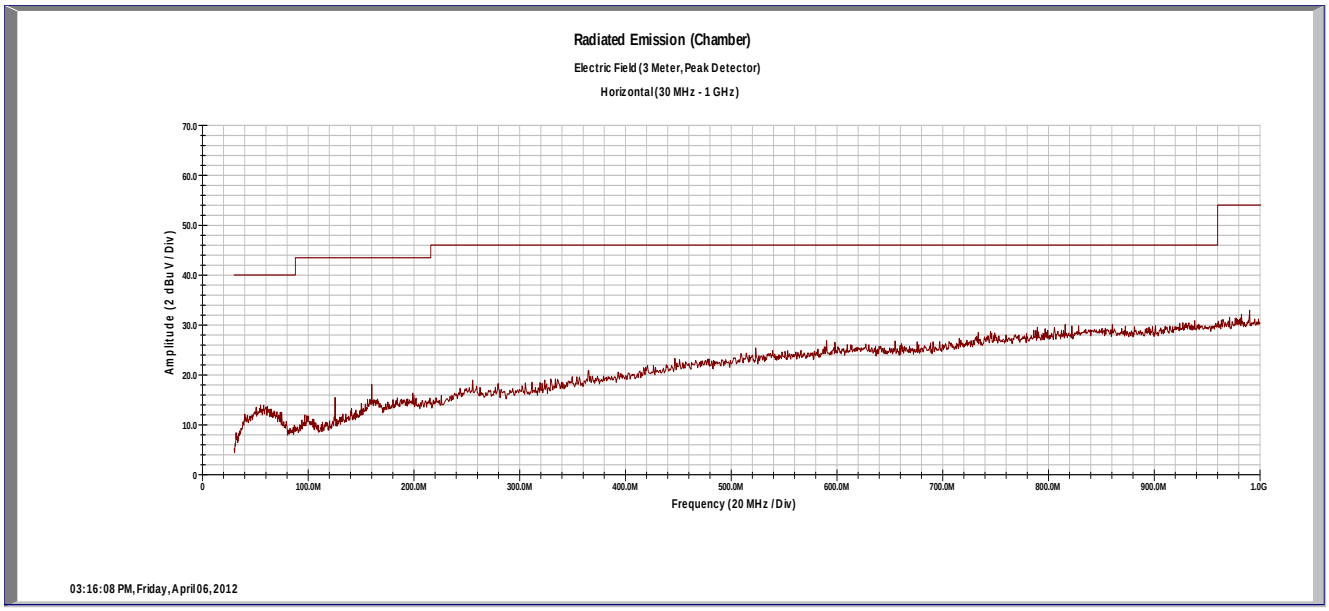
There were no deviations from the test methodology listed in the test plan for the radiated emission test.

5.1.4 Final Test

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

5.1.5 Final Graphs and Tabulated Data

Radiated Emissions Receive Mode Ch 2 – 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)

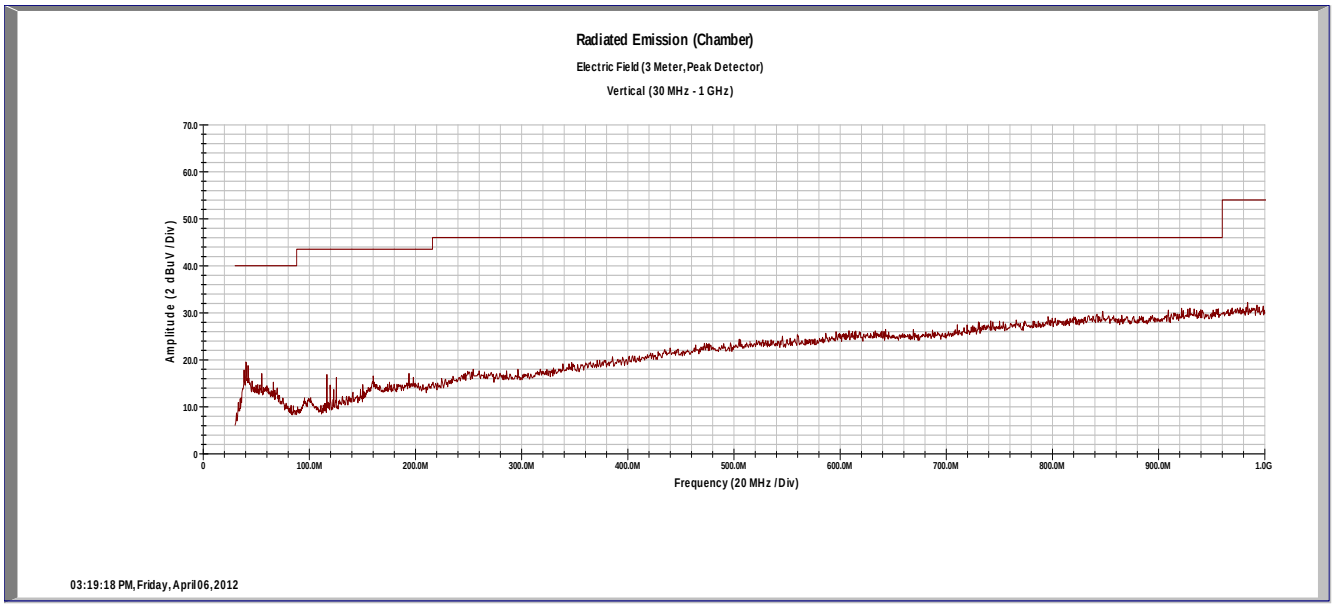
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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.
The transmitter notch filter was not used for these scans.
The remaining two channels gave very similar results.

Radiated Emissions Receive Mode Ch 2 – 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)

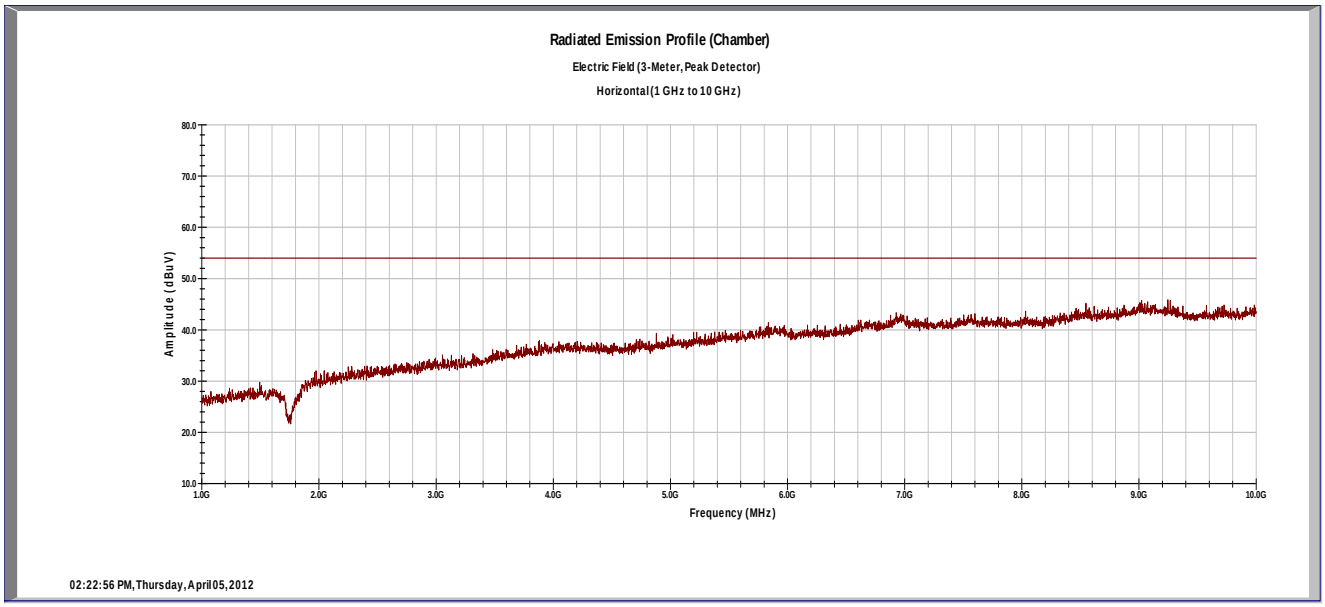
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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.
The transmitter notch filter was not used for these scans.
The remaining two channels gave very similar results.

Radiated Emissions Receive Mode Ch 2 – 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)

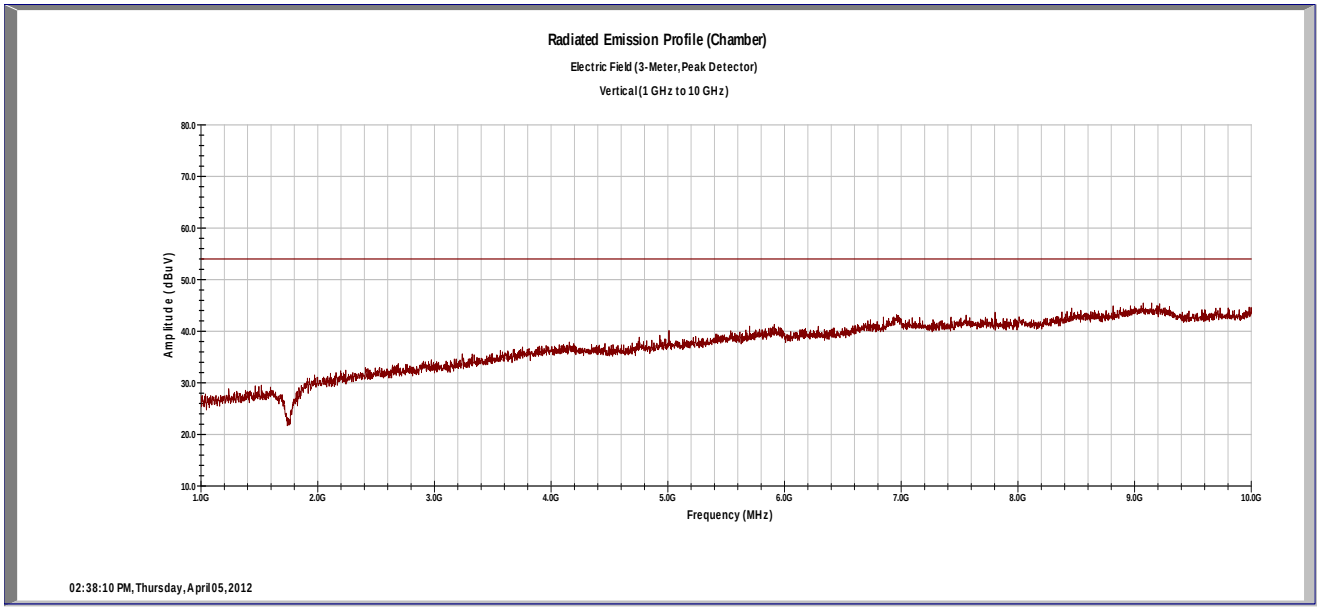
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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

Radiated Emissions Receive Mode Ch 2 – 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)

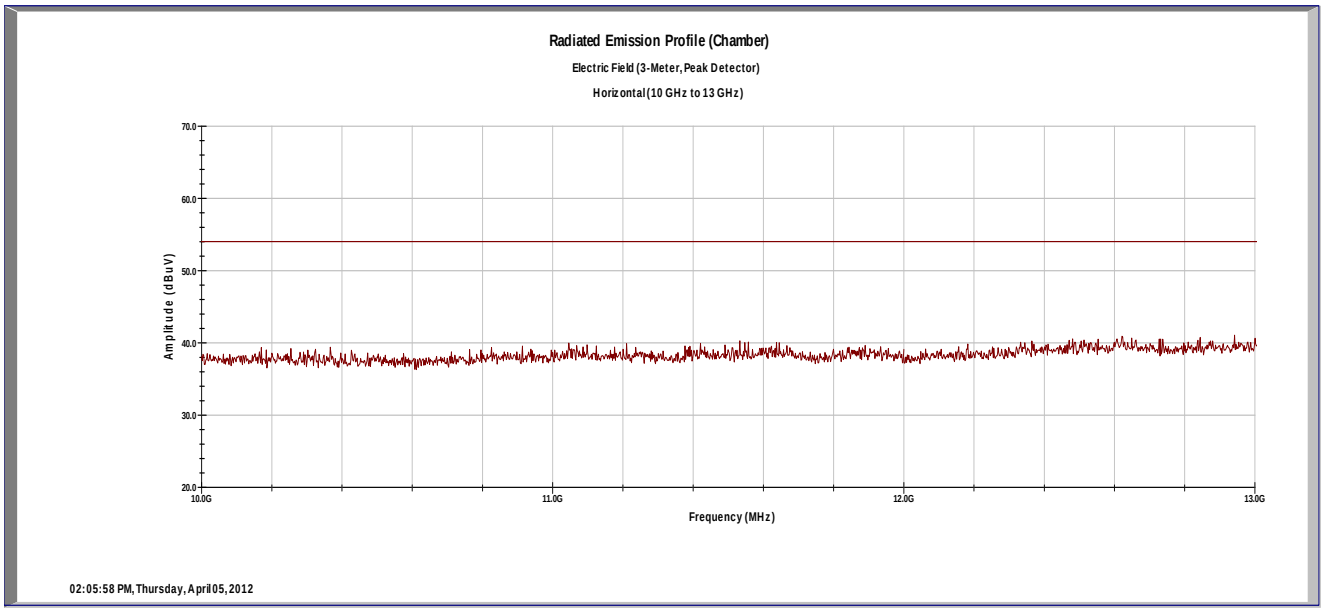
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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

Radiated Emissions Receive Mode Ch 2 – 10 GHz to 13 GHz

Horizontal



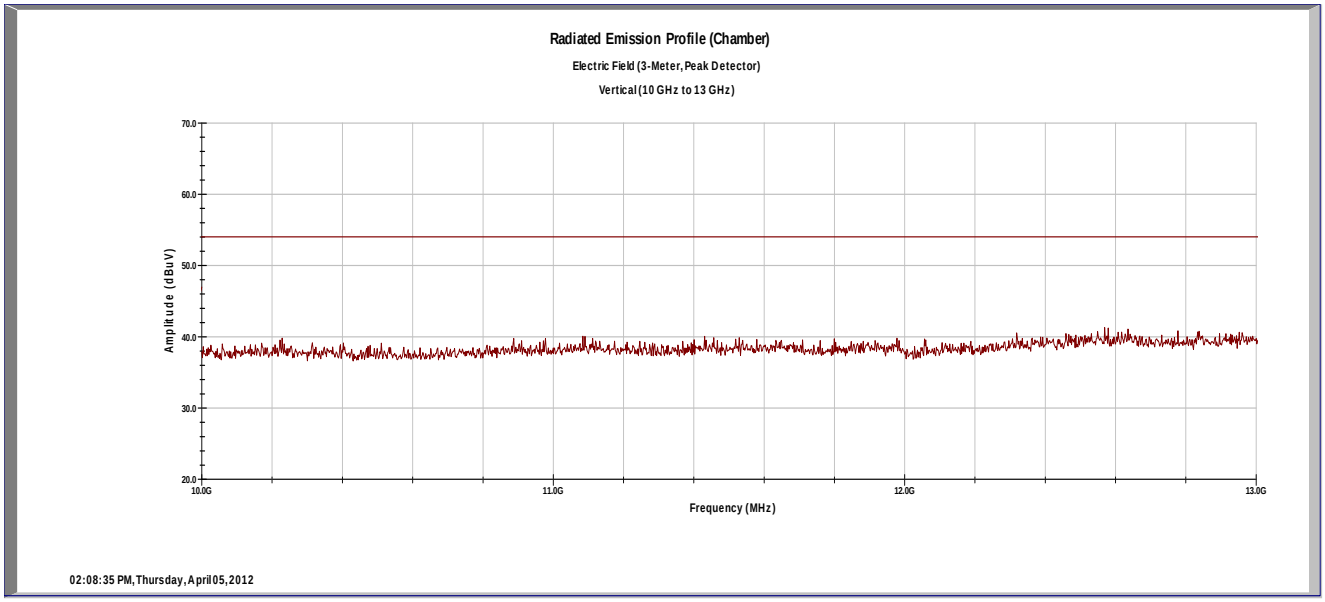
Emission Freq (MHz)	ANT Polar (H/V)	ANT Pos (m)	Table Pos (deg)	FIM Value (dBuV)	Amp Gain (dB)	Cable Loss (dB)	ANT Factor (dB/m)	E-Field Value (dBuV/m)	Spec Limit (dBuV/m)	Spec Margin (dB)

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

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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

Radiated Emissions Receive Mode Ch 2 – 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 ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 1.6dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

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

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 near by 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	MarCator 1086 R			**Serial#**	11081514		
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

6 RF Exposure

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

FCC KDB # 447498 DO1 - Mobile and Portable Device RF Exposure and Procedures and Equipment Authorization Policies section 1) c) states that unless excluded by *specific FCC test procedures*, portable devices with output power > $60/f_{(GHz)}$ mW shall include SAR data for equipment approval.

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 may be used as a hand-held portable device where the antenna can be located less than 20cm from the user, therefore SAR evaluation is required.

6.1.2.1 Evaluation for FCC

FCC 447498 D01 Mobile Portable RF Exposure v04, Paragraph 2) section a) i) states:
"A device may be used in portable exposure conditions with no restrictions on host platforms when either the source-based time-averaged output power is ≤ $60/f_{(GHz)}$ mW or all measured 1-g SAR are < 0.4 W/kg."

The minimum power that requires SAR testing is 60 / 2.4 GHz or 25 mW.

The maximum EIRP peak power output of the EUT is: 2.87 dBm which is equivalent to 1.94 mW.

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: 2.87 dBm which is equivalent to 1.94 mW.

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 2.87 dBm power level has not been time-averaged and it is considered the absolute worst case.

6.1.4 Calculated EIRP Level

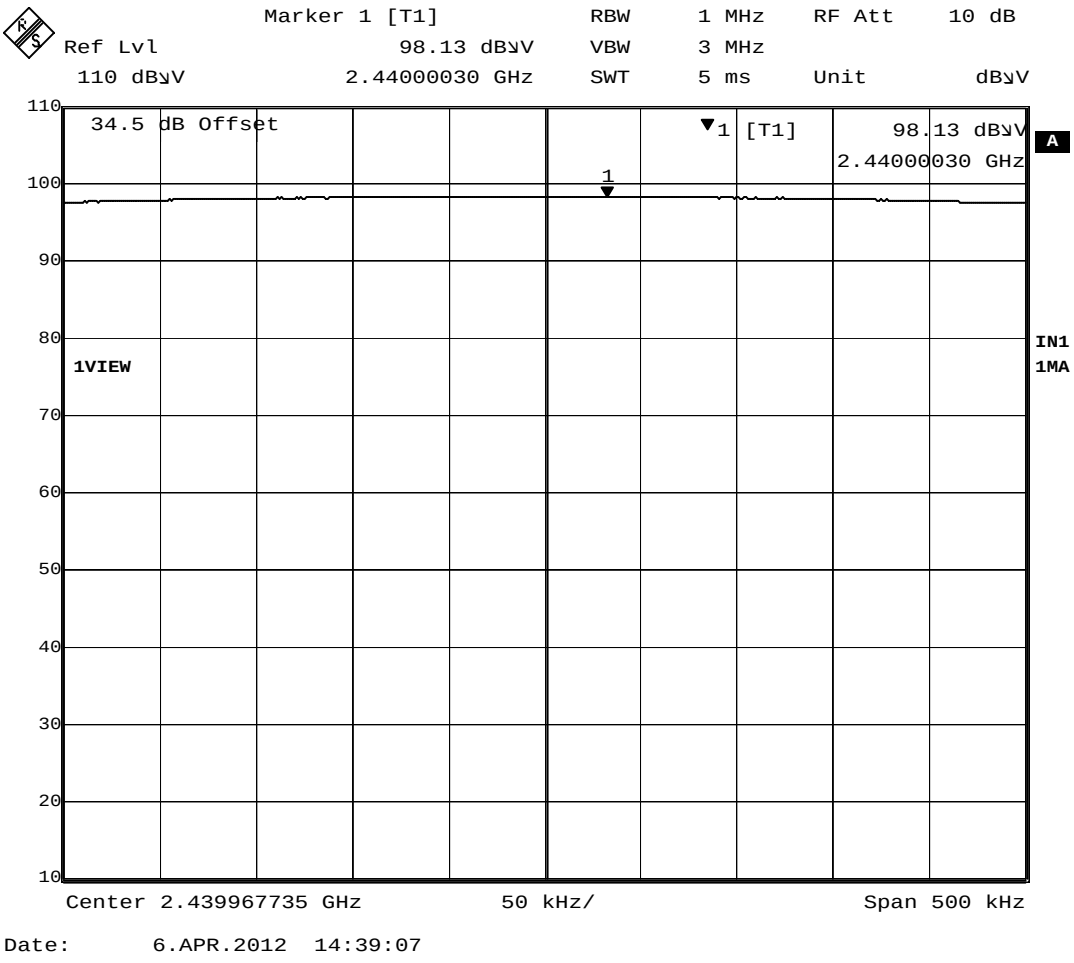


Figure 5 – Maximum Peak Power = 98.13 dBµV/m at 3m

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

Per the equation in section 5.4.2 of FCC Document # 558074 D01 Meas Guidance v01;

EIRP = E + 20Log(d)-104.8, where:

EIRP = the equivalent isotropic radiated power in dBm,

E = electric field strength in dBµV /m; E = 98.12,

d = measurement distance in meters; d = 3,

EIRP = 98.13 + 20Log(3) – 104.8 = 98.12 + 9.54 - 104.8 = **2.87 dBm** which is equivalent to: 1.94 mW