Electromagnetic Compatibility Test Report

Prepared in accordance with

ANSI C63.4:2009

On

Energy Axis Mobile Interrogator

EA_MOBILE w/ WAKEUP

Elster Solutions
208 South Rogers Lane
Raleigh, NC 27610

Prepared by:

TUV Rheinland of North America, Inc.

Manufacturer's statement - attestation

The manufacturer; Elster Solutions, LLC 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.

Steve Bragg	Steven B. Bragg
Printed name of official	Signature of official
208 South Rogers Lane Raleigh, NC 27610	20 December 2012
Address	Date
919-212-4899	Steve.Bragg@us.elster.com
Telephone number	Email address of official

Client:	Elster Solutions 208 South Rogers Lane Raleigh, NC 27610 USA	Steve Bragg 919-212-4899 / 919-250-5439 Steve.Bragg@us.elster.com

Identification:	Energy Axis Mobile Interrogator	***Serial No.:***	PRODUCTION PROTOTYPE
Test item:	EA_MOBILE W/ WAKEUP	***Date tested:***	22 October 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: CFR 47 FCC Part 90, FCC Part 90.203(j)(3), FCC Parts 90.205(h)(1), 2.985, FCC Part 90.207 FCC Part 90.209(a), FCC Part 90.209(b)(5), FCC Part 2.997(a)(1), FCC Parts 90.210(d), FCC Parts 90.35(a)(1) and (b)(3), FCC Parts 90.213, 2.1055, FCC Part 15B, FCC Part 2.1091	
Test Result	**The above product was found to be Compliant to the above test standard(s)**	

tested by: Mark Ryan	***reviewed by:*** Michael Moranha
20 December 2012 ***Signature***	22 December 2012 ***Signature***

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 ANSI C63.4:2009 based on the results of testing performed on 22 October 2012 on the Energy Axis Mobile Interrogator, Model No. EA_MOBILE W/ WAKEUP, manufactured by Elster Solutions. 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
--	22 Dec 2012	Initial Release
A	4 Jan 2013	Correct typos on Emission designators

1.4 *Summary of Test Results*

Applicant	Elster Solutions 208 South Rogers Lane Raleigh, NC 27610	**Tel**	919-212-4899	**Contact**	Steve Bragg
		Fax	919-250-5439	**e-mail**	Steve.Bragg@us.elster.com
Description	Energy Axis Mobile Interrogator	**Model Number**	EA_MOBILE W/ WAKEUP		
Serial Number	PRODUCTION PROTOTYPE	**Test Voltage/Freq.**	12 VDC		
Test Date Completed:	22 October 2012	**Test Engineer**	Mark Ryan		

Standards	Description	Severity Level or Limit	Criteria	Test Result
CFR 47 FCC Part 90	Private Land Mobile Radio Services. FCC Scope B2 and IC TYPE I Equipment	See called out basic standards below including references to FCC Part 2	See Below	**Complies**
FCC Part 90.203(j)(3)	Certification Required	Greater than 500 mW, 4800 bps per 6.25 kHz of channel BW.	Limit	Complies
FCC Parts 90.215(c), 2.987	Modulation Requirements and Charactertistics	Per the standards	Limit	Complies
FCC Parts 90.35(a)(1) and (b)(3)	Industrial/Business Pool Frequencies	Operating frequency listed in table	Limit	Complies
FCC Parts 90.205(h)(1), 2.985	RF Output power	Greater than 2 Watts	Limit	Complies
FCC Part 90.207	Type of Emissions – Emission Designator	Emissions Designator	A3D & F2D	Complies
FCC Part 90.209(a)	Bandwidth Limitations	Desgination of Bandwidth Limitation:	6K00	Complies
FCC Part 90.209(b)(5)	Standard Channel Spacing and Bandwidth	Channel Spacing - 12.5 kHz, Authorized Bandwidth: 11.25 kHz	NA	Complies
FCC Part 2.997(a)(1)	Frequency Spectrum to be Investigated	150 kHz to 5 GHz	Limit	Complies
FCC Parts 90.210(d)	Spurious Emissions	Emission Mask D (see below)	Limit	Complies
FCC Parts 90.213, 2.1055	Frequency Stability Function of the Temperature	For transmitters over 2 Watts	5 ppm	Complies
FCC Part 2.1055(d)(1)	Frequency Stability Function of Primary Supply Voltage	Battery Operated only (mobile)	Limit	Complies
FCC Part 90.214	Transient Frequency Behavior	Function of Time t_1 = t_2 = t_3 =	±25.0kHz ±12.5 kHz ±25.0 kHz	Complies
FCC Part 15B	Receiver / Cabinet emissions	Class A, 30 MHz - 5 GHz (battery operated only, no conducted emisions)	Limit	Complies
FCC Part 2.1091	RF Exposure	MPE Limits for controlled and uncontrolled areas	Limit	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 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).

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 Expanded Measurement Uncertainty Emissions

	U_{lab}	U_{cispr}
Radiated Disturbance @ 3m		
30 MHz – 1,000 MHz	4.52 dB	5.2 dB
Radiated Disturbance @ 10m		
30 MHz – 1,000 MHz	4.51 dB	5.2 dB
Conducted Disturbance @ Mains Terminals		
150 kHz – 30 MHz	3.33 dB	3.6 dB
Disturbance Power		
30 MHz – 300 MHz	4.00 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.

2.4 Software Used

Manufacturer	Name	Version
Quantum Change/EMC Systems LLC.	Tile	3.2U
TUV	Alt "R"	1
TUV	Alt "C"	1

2.5 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	04-Sep-12	04-Sep-13
Receiver, EMI	Rohde & Schwarz	ESCI 7	100917	05-Sep-12	05-Sep-13
Amplifier, preamp	Agilent Technologies	8449B	3008A01480	01-Sep-12	01-Sep-13
Antenna Horn 1-18GHz	EMCO	3115	2236	13-Dec10	13-Dec-12
Cable, Coax	MicroCaox	MKR300C-0-0-1200-500500	002	01-Sep-12	01-Sep-13
Cable, Coax	MicroCaox	MKR300C-0-1968-500310	005	01-Sep-12	01-Sep-13
Cable, Coax	MicroCaox	UFB29C-1-5905-50U-50U	009	01-Sep-12	01-Sep-13
Cable, Coax	Andrew	FSJ1-50A	045	01-Sep-12	01-Sep-13
Conducted Emissions (AC/DC and Signal I/O)					
Receiver, EMI	Rohde & Schwarz	ESCI 7	100917	05-Sep-12	05-Sep-13
Cable, Coax	Pasternack	RG-223	051	01-Sep-12	01-Sep-13
LISN 15-18 (NSLK 8126)	Schwarzbeck Mess-Electronik	NSLK 8126	003885	11-Jan-12	11-Jan-14
Transient Limiter	Schaffner	CFL-9206	1649	01-Aug-11	01-Aug-13
General Laboratory Equipment					
Generator, Noise	York University	CNE III	Ser/98/66	CNR	CNR
Meter, Multi	Fluke	179	90580752	06-Sep-12	06-Sep-13
Meter, Multi/ Clamp	Fluke	381	14250055	06-Sep-12	06-Sep-13
Power Supply, DC	Sorensen	DCS55-55	0103B1286	CNR	CNR
Meter, Temp/Humid/Barom	Davis	7400	PB00205A13	09-May-12	09-May-13
Meter, Temp/Humid/Barom	Davis	7400	PB00205A05	09-May-12	09-May-13

3 Product Information

3.1 Product Description

3.1.1 General Characteristics

Supply Voltage 13.8V ± 15% (11.56 – 15.6 VDC)
Modulation: A3D, AM (DSB) with frequency-shift-keyed sinusoidal subcarrier (1786 or 2777 Hz)
F2D, Frequency Shift Keying, no subcarrier (3.125 kBits/sec, 3.125 kHz deviation)
Operating Temperature –20 to +60°C
Weight ~ 33 lbs.
Antenna connector type RX: TNC; TX: N

3.1.2 Transmitter Characteristics

Frequency Range 451.35 ± 0.5 MHz
Channel Spacing 12.5 kHz
RF Output Power 12.5 W @ 13.8 VDC'
Frequency Stability 0.1 ppm worst case
XTAL frequencies: 100 MHz TCXO, divided by 10 and multiplied by 10
Data rates: 3125 bits/sec (F2D), 1786 or 2777 bits/sec (A3D)

Refer to appendix A of this test report for more details.

3.2 Equipment Modifications

A ferrite was added to the monitor power and data cables to be compliant.

3.3 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

4 Emissions

4.1 Certification Required - FCC Part 90.203(j)(3)

Applications for part 90 certification of transmitters designed to operate on frequencies in the 421–512 MHz band, received on or after February 14, 1997 must include a certification that the equipment meets a spectrum efficiency standard of one voice channel per 12.5 kHz of channel bandwidth. Additionally, if the equipment is capable of transmitting data, has transmitter output power greater than 500 mW, and has a channel bandwidth of more than 6.25 kHz, the equipment must be capable of supporting a minimum data rate of 4800 bits per second per 6.25 kHz of channel bandwidth.

4.1.1 Method of Measurement

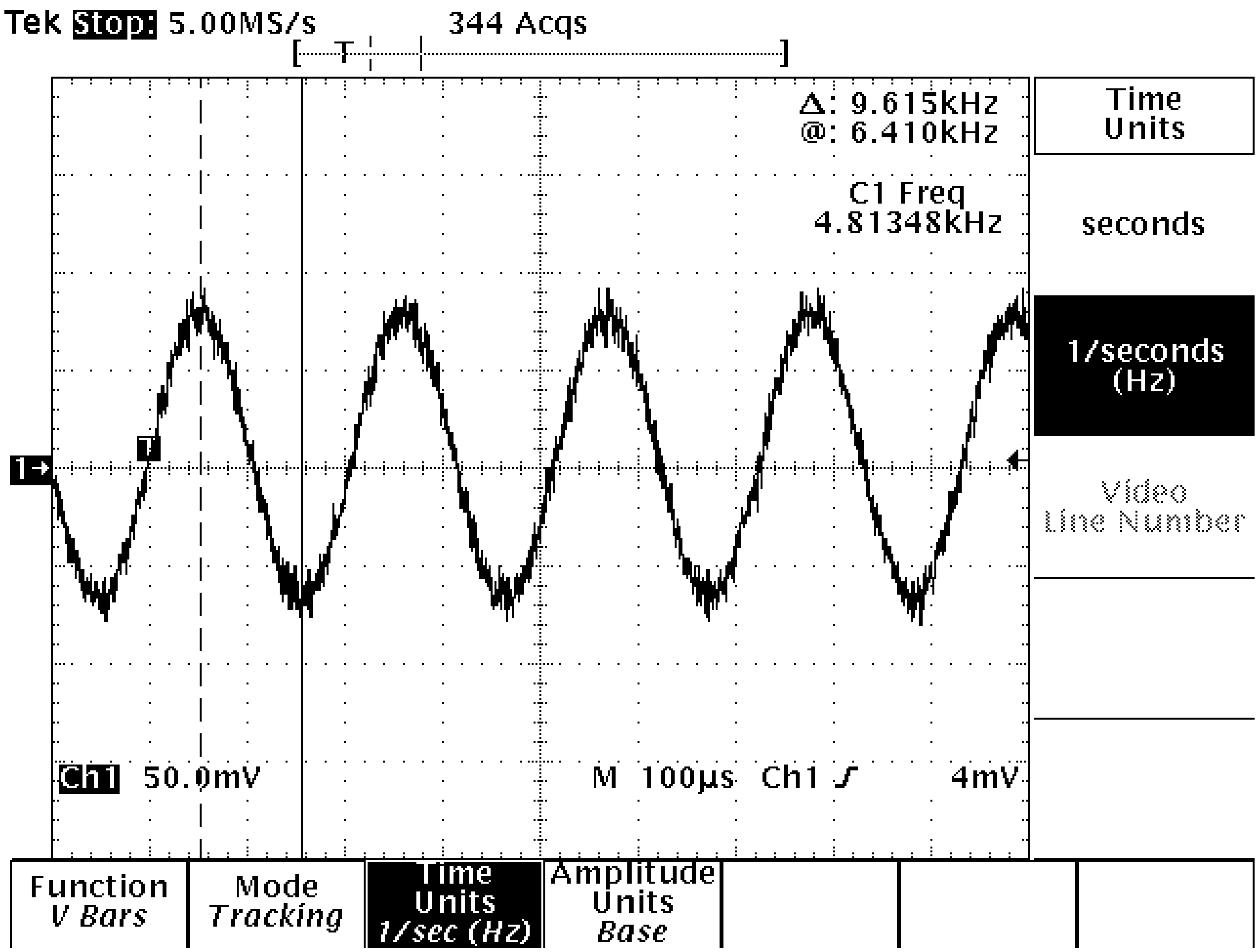
The transmitter antenna output port is connected to an EMI receiver/Spectrum analyzer featuring a demodulation output port. This port is then connected to a digital oscilloscope. The transmitter was set to the High Data Rate mode.

4.1.2 Test Results

The equipment, EA_Mobile from Elster Integrated, meets a spectrum efficiency standard of 12.5 kHz of channel bandwidth. The equipment was capable of supporting a minimum data rate of 4800 bits per second per 6.25kHz of bandwidth, that is 9600 bits/s. See measurement plots, below.

4.1.3 Test Data

MEASUREMENT PLOTS; FCC PART 90.203(j)(3)



data rate = 9600 Baud

4.2 Modulation Requirements and Characteristics

Per FCC Parts 90.215(c), 2.987

The EA_Mobile maximum output power is more than 2 watts.
The transmitter utilizes digital emissions without an audio-low pass filter. Therefore, it was tested using the modulating signal as specified by Part 2.

4.2.1 Test Procedure

The transmitter antenna output port is connected to a Rohde & Schwarz ESCI 7 EMI/ EMC receiver, incorporating a demodulation output port.

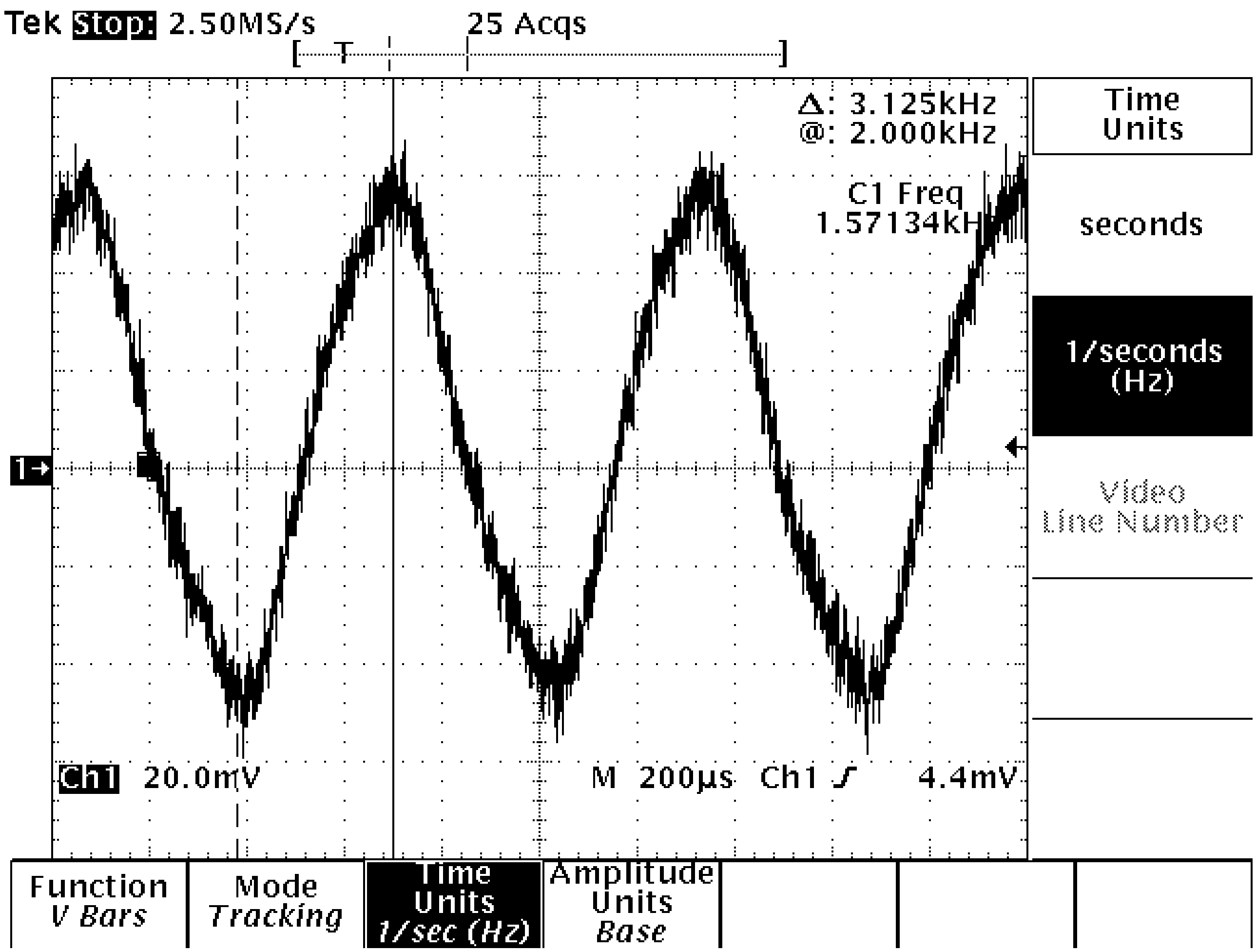
4.2.2 Test Results

The measurement plots show that the equipment meets the modulation requirements of the rules under which the equipment is to be licensed. The following transmission modes are representative of the transmitter intended use.

The two modes are called EA Wakeup Mode and TRACE Mode.

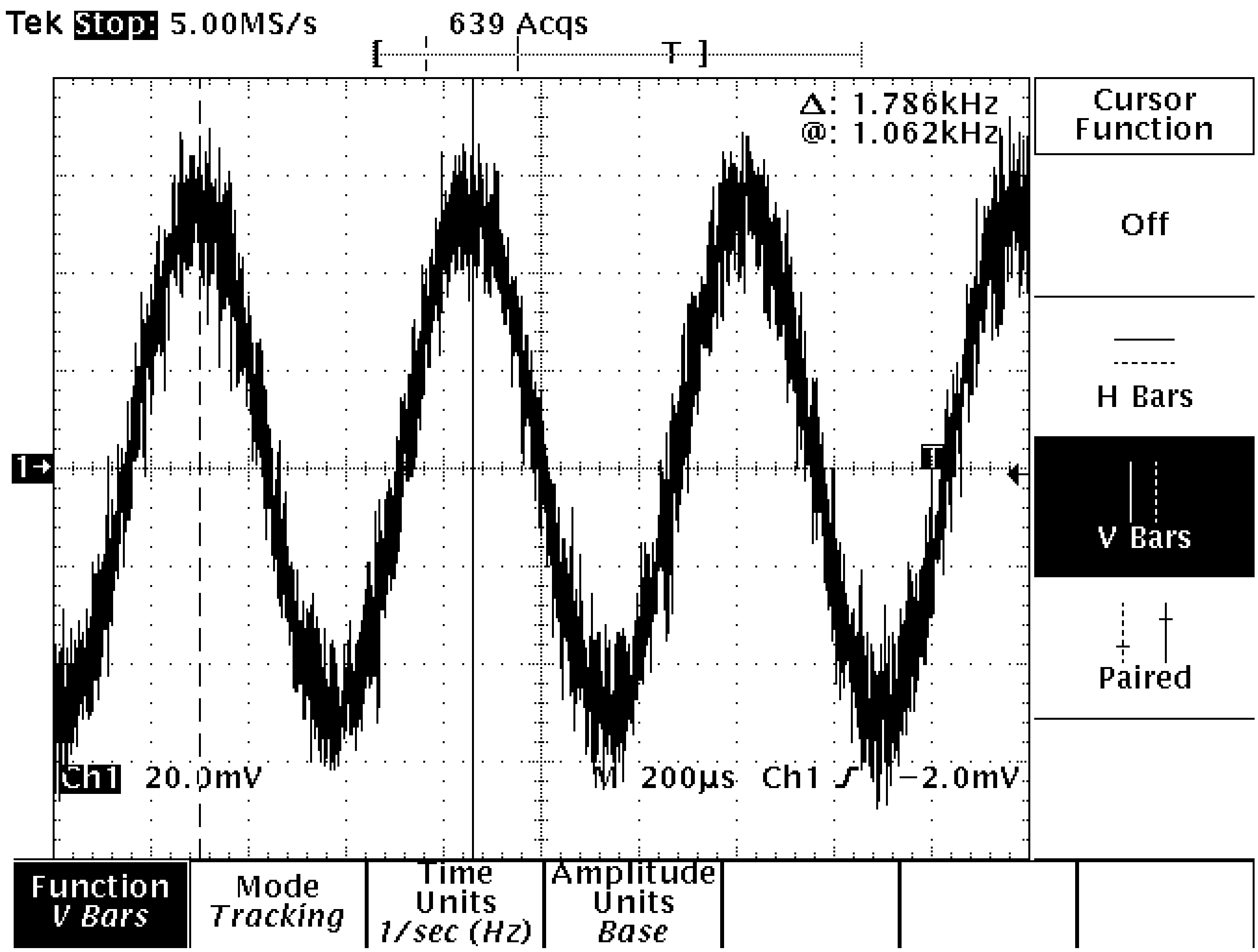
EA Wakeup Mode is emission designator F2D, and the modulation is Sunde's FSK with the deviation equal to the baud rate (3125 Hz). The plot for EA Wakeup Mode below shows a continuous stream of data, alternating between 0 and 1.

TRACE Mode is emission designator A3D. An FSK subcarrier is amplitude-modulated onto the carrier. The subcarrier is modulated with either a 1786 Hz (for logic 1) or 2778 Hz (for logic 0) sinusoidal tone. Both states are shown in separate plots below.



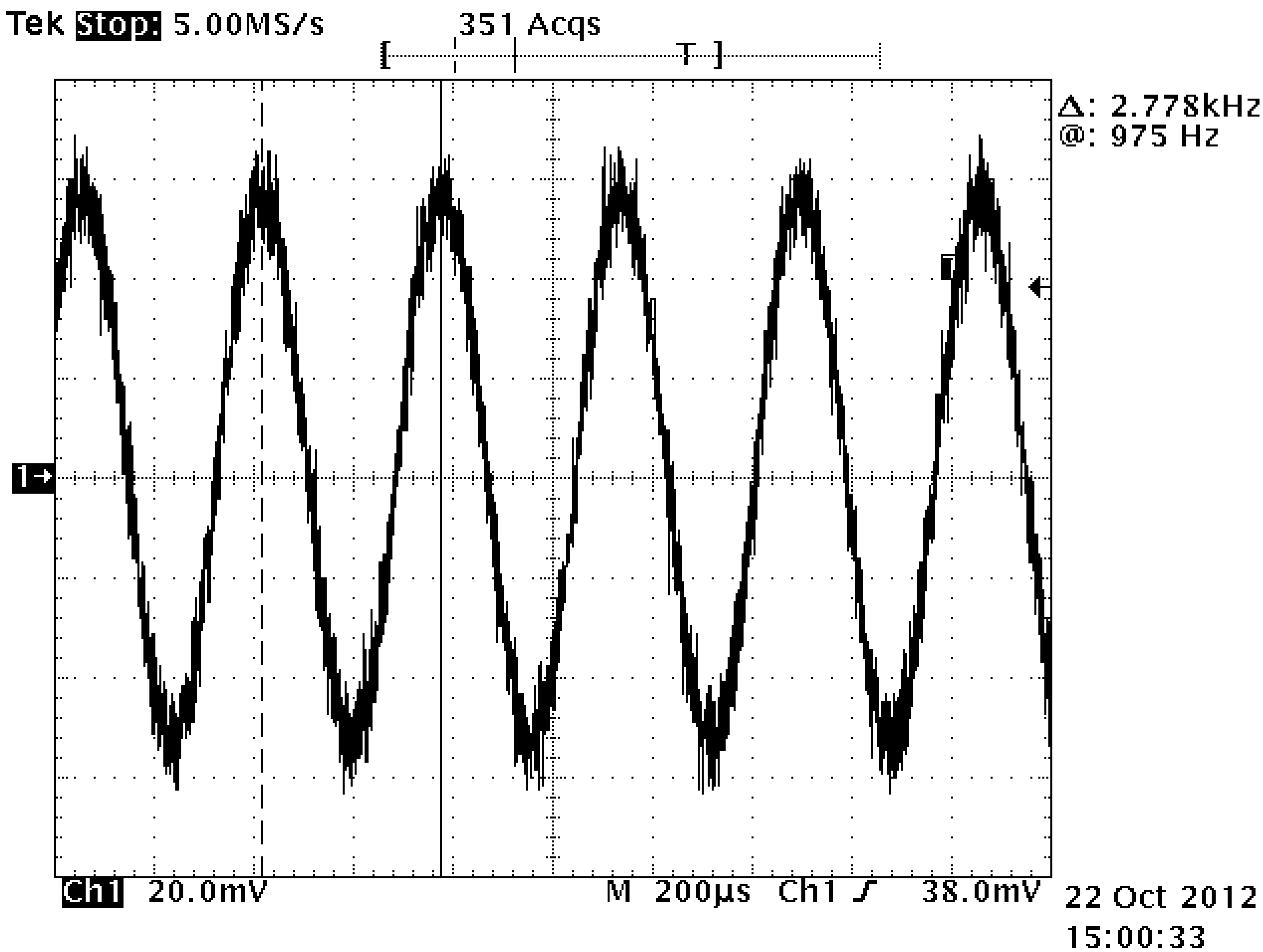
data rate = 3125 Baud

MEASUREMENT PLOTS for EA Wakeup Mode; FCC PART 90.215(c)



data rate = 1786 Baud

MEASUREMENT PLOTS for TRACE mode with subcarrier at logic 1; FCC PART 90.215(c)



data rate = 2778 Baud

MEASUREMENT PLOTS for TRACE mode with subcarrier at logic 0; FCC PART 90.215(c)

4.3 Frequencies of Operations (Industrial/Business Pool)

The operating frequency of 451.350 MHz is listed in the table of 90.35(b)(3).

4.4 RF Power Output

RF Power Output (ERP) and antenna height limits: 450-460 MHz band

4.4.1 Test Over View

<table>
<tr><td>Results</td><td colspan="4">Complies (as tested per this report)</td><td>Date</td><td colspan="2">27 September 2012</td></tr>
<tr><td>Standard</td><td colspan="7">FCC Parts 90.205(h)(1), 2.985</td></tr>
<tr><td>Product Model</td><td colspan="3">EA_MOBILE W/ WAKEUP</td><td>Serial#</td><td colspan="3">PRODUCTION PROTOTYPE</td></tr>
<tr><td>EUT Powered By</td><td>13.6 VDC</td><td>Temp</td><td>72º F</td><td>Humidity</td><td>32%</td><td>Pressure</td><td>1001 mbar</td></tr>
<tr><td>Mod to EUT</td><td colspan="2">None</td><td colspan="2">Test Performed By</td><td colspan="3">Mark Ryan</td></tr>
</table>

4.4.2 Test Procedure

The maximum allowable effective radiated power (ERP) is dependent upon the station's antenna HAAT and required service area and is authorized with the following table:

Service area radius (km)	8
Maximum ERP (w) (1)	100
Up to reference HAAT (m) (2)	15

(1) Maximum ERP indicated provides for a 39dBu signal strength at the edge of the service area per FCC Report R-6602, Fig. 29 (See 73.699, Fig. 10 b).
(2) When the actual antenna HAAT is greater than the reference HAAT, the allowable ERP will be reduced in accordance with the following equation: ERPallow=ERPmax x (HAATref/HAATactual)2.

4.4.3 Method of Measurement

The EUT was commanded to CW mode, therefore the peak measurements was made using a Boonton power meter and a Bird Thru-line watt meter was used to measure the rms power output.

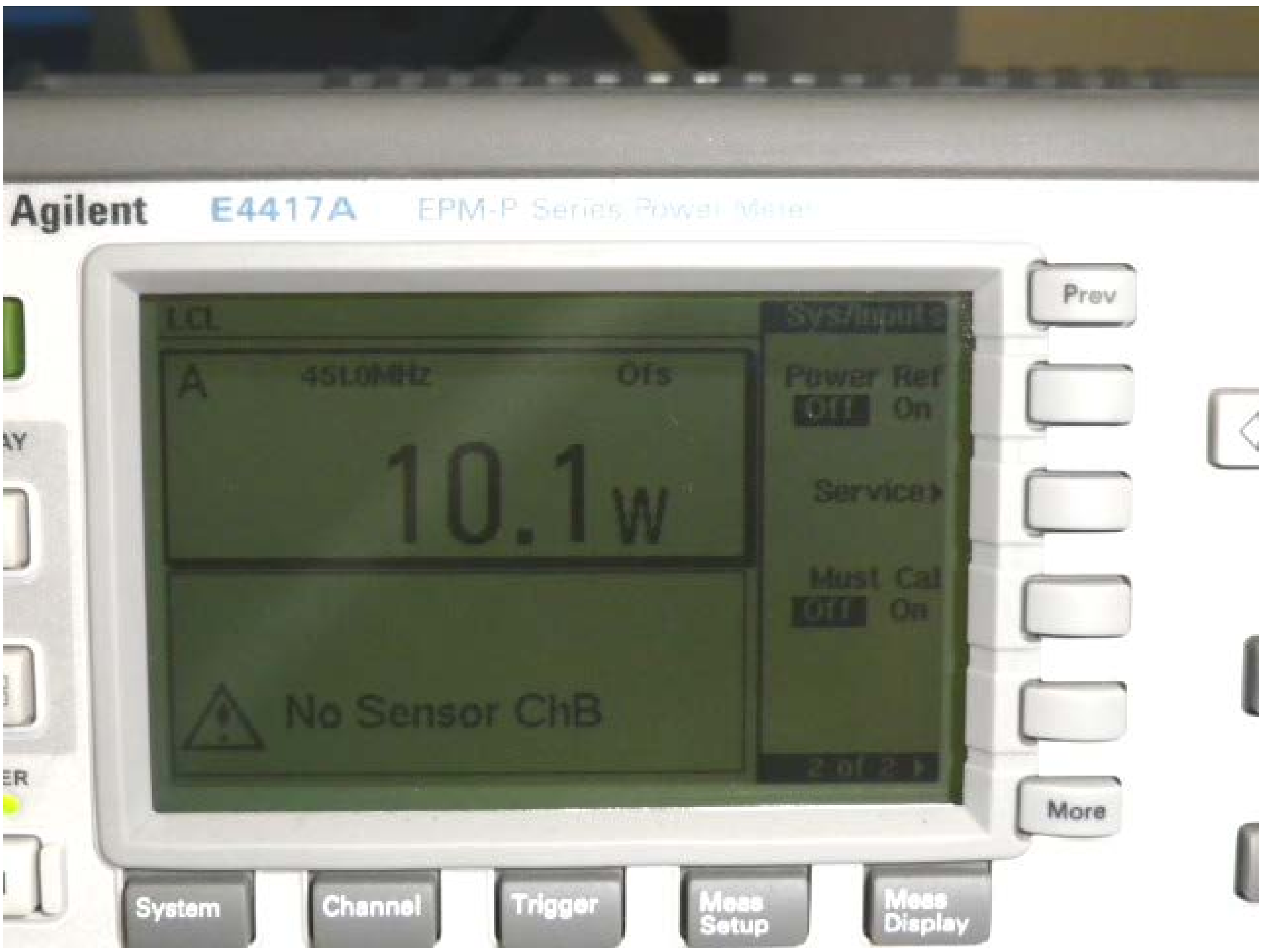
4.4.4 Test results

Termination	Level (dBuV)	Output Power (W) (modulated)
50 ohm	140.5	10.0 (rms)

Note: This Power level will allow an antenna with up to 10 dBi gain to be employed.

Max output power of 12.5 Watts will allow an antenna up to 9 dBi gain.

4.4.5 Test Data



Power (rms) reading on a Agilent Power Meter in CW mode.

4.5 Type of Emissions – Emission Designator

Per FCC Part 90.207

The first symbol indicates the type of modulation on the transmitter carrier. The second symbol indicates the type of signal modulating the transmitter carrier. The third symbol indicates the type of transmitted information.

Designator for the EA_Mobile: **A3D** for TRACE mode, and **F2D** for EA Wakeup mode.

4.6 Bandwidth Limitations

Per FCC Part 90.209(a): 12K5A3D and 12K5F2D.

4.7 Standard Channel Spacing and Bandwidth

Per FCC Part 90.209(b)(5) and 90.209(b)(6)(i):.

Frequency (MHz)	Channel spacing (kHz)	Authorized bandwidth (kHz)
451.350 (2)	12.5 (1)	11.25 (1) (3) (4) (5)

(1) Per part 90.209(b)(5); For stations authorized on or after August 18, 1995.
(2) Bandwidths for radiolocation stations in the 420-450MHz band and for stations operating in bands subject to this footnote will be reviewed and authorized on a case-by case basis.
(3) Operations using equipment designed to operate with a 25 kHz channel bandwidth will be authorized a 20 kHz bandwidth. Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25 kHz bandwidth. Operations using equipment designed to operate with a 6.25 kHz channel bandwidth will be authorized a 6 kHz bandwidth. All stations must operate on channels with a bandwidth of 12.5 kHz or less beginning January 1, 2013, unless the operations meet the efficiency standard of § 90.203(j)(3).
(4) Operations using equipment designed to operate with a 12.5 kHz channel bandwidth will be authorized a 11.25kHz bandwidth.
(5) Per part 90.209(b)(6)(i); Beginning January 1, 2011, no new applications for the 150–174 MHz and/or 421–512 MHz bands will be acceptable for filing if the applicant utilizes channels with an authorized bandwidth exceeding 11.25 kHz, unless specified elsewhere or the operations meet the efficiency standards of § 90.203(j)(3).

4.8 Frequency Spectrum to be investigated

Per FCC Part 2.997(a)(1)

(a) In all of the measurements set forth in 2.991 and 2.993, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:

(1) If the equipment operates below 10GHz: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

The device under test was investigated from 150 kHz to 5 GHz.

4.9 Spurious Radiation

Per FCC Parts 90.210(d)

Emission masks and spurious emissions at antenna terminal used to verify occupied bandwidth.

4.9.1 Test Procedure

The transmitter was properly loaded with a 50 Ohm termination and operated under normal condition in its intended use. That is the maximum rated conditions under which the equipment will be operated.

For measuring emissions up to and including 50kHz from the edge of the authorized bandwidth, the resolution bandwidth was adjusted to 100Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps was measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must no be less than the instrument resolution bandwidth. For frequencies more that 50kHz removed from the edge of the authorized bandwidth a resolution of at least 10 kHz was used for frequencies below 1000 MHz. Above 1000 MHz the resolution bandwidth of the instrumentation was at least 1 MHz.

Applicable emission mask for equipment designed to operate with a 12.5 kHz channel bandwidth:

Frequency (MHz)	Mask for equipment with 12.5 kHz bandwidth authorization
450.0 – 460.0	D

4.10 Emission Mask D:

Per FCC Parts 90.210(d)
Emission Mask D—12.5 kHz channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f_0 to 5.625 kHz removed from f_0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(f_d-2.88 kHz) dB. (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

(4) The reference level for showing compliance with the emission mask shall be established using a resolution bandwidth sufficiently wide (usually two to three times the channel bandwidth) to capture the true peak emission of the equipment under test. In order to show compliance with the emissions mask up to and including 50 kHz removed from the edge of the authorized bandwidth, adjust the resolution bandwidth to 100 Hz with the measuring instrument in a peak hold mode. A sufficient number of sweeps must be measured to insure that the emission profile is developed. If video filtering is used, its bandwidth must not be less than the instrument resolution bandwidth. For emissions beyond 50 kHz from the edge of the authorized bandwidth, see paragraph (m) of this section.

Frequency range (kHz) Displacement frequency	Attenuation (dB) from reference level	Formula
$0 < f_d < 5.625$	0	none
$5.625 < f_d < 12.5$	0 < Att. < 69.9	7.27*(f_d -2.88)
$62.5 > f_d > 12.5$	70	50 + 10 Log P or 70 whichever is greater
$f_d > 62.5$	50	55 + 10 Log P or 50 whichever is lesser

Notes:
Measurements of emission power are expressed with the same parameters used to specify the un-modulated transmitter carrier power.

f_d: Displacement frequency
P: Output Power in Watt (Un-modulated)

4.10.1 Test Over View

Results	**Complies** (as tested per this report)				**Date**	27 September 2012	
Standard	FCC Parts 90.210(d)						
Product Model	EA_MOBILE W/ WAKEUP			**Serial#**	PRODUCTION PROTOTYPE		
EUT Powered By	13.6 VDC	**Temp**	72º F	**Humidity**	32%	**Pressure**	1001 mbar

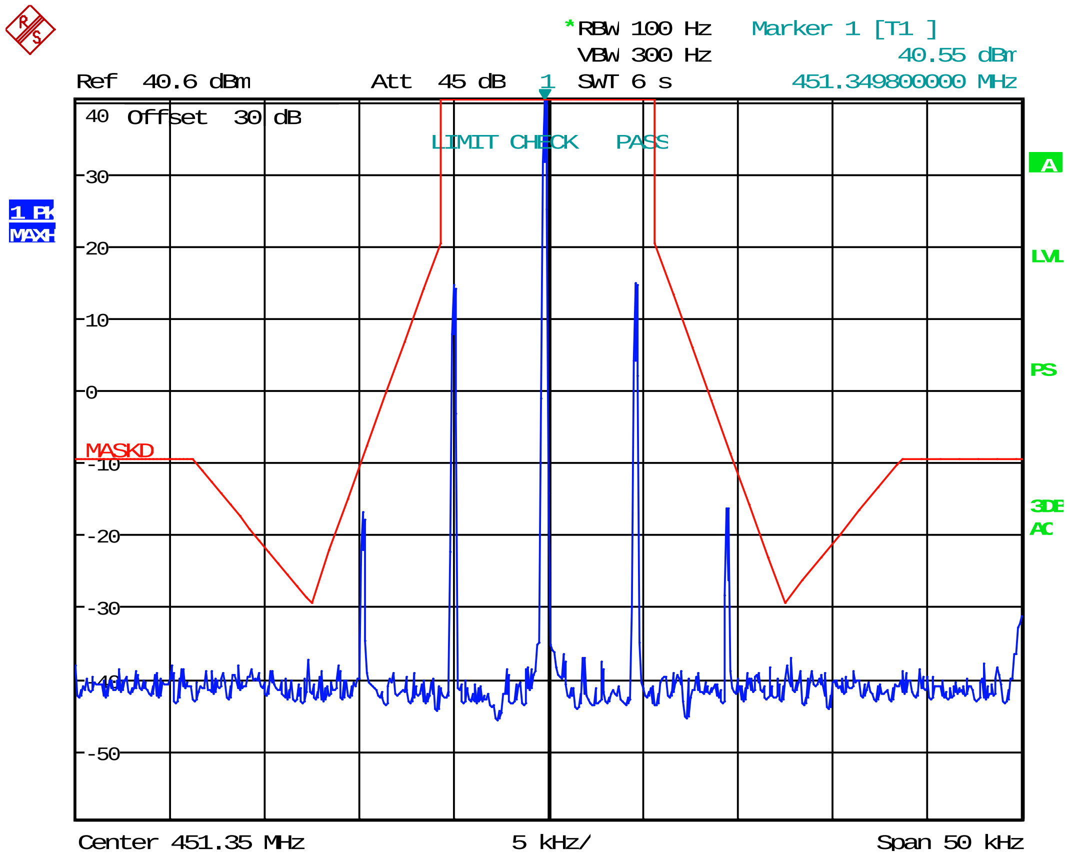
4.10.2 Test Procedure

A 50 Ohm dummy load is used to terminate the transmitter antenna output port.
A procedure can be found in the following document: ANSI/TIA/EIA-603: 1992 Land Mobile for PM Communications Equipment Measurement and Procedure Standards

4.10.3 Test Results

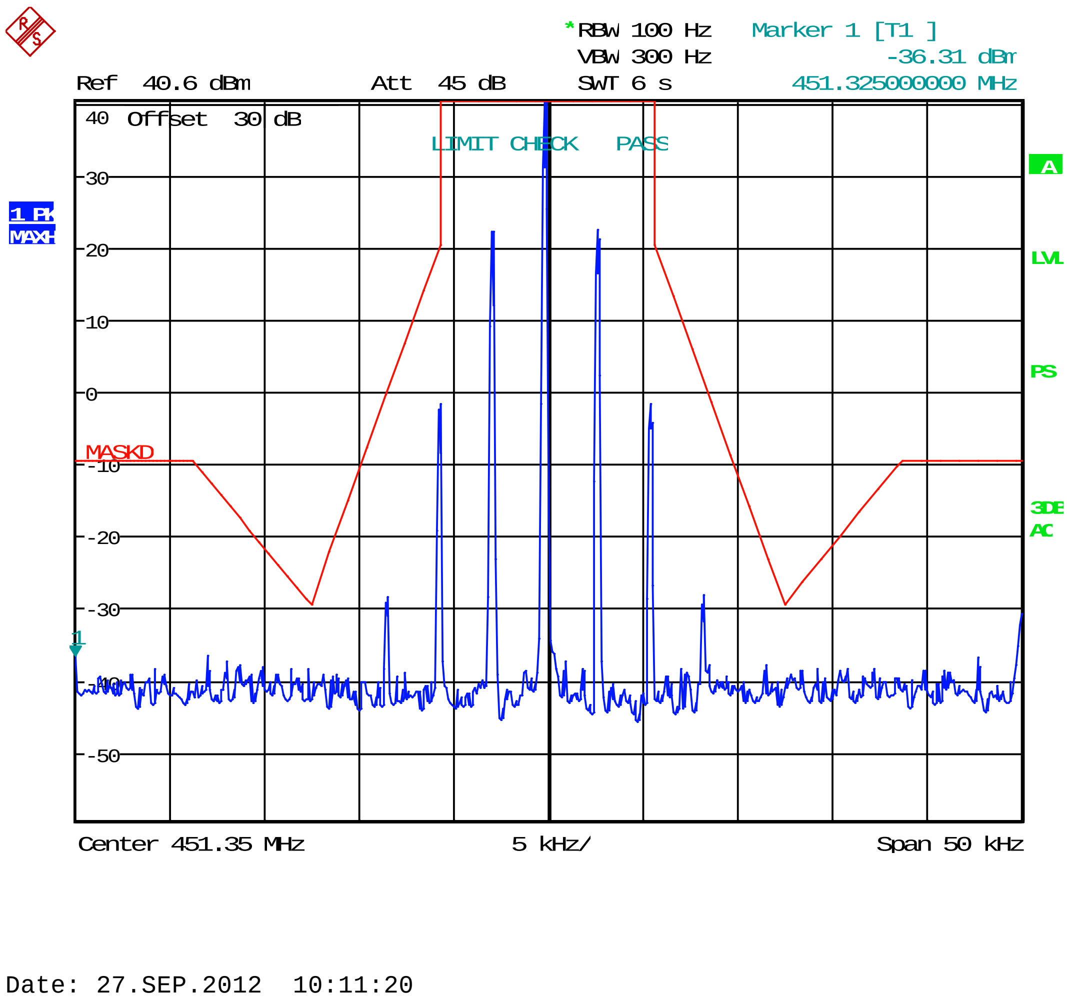
All emissions are below the limits ad defined by emission Mask D in

4.10.4 Test Data

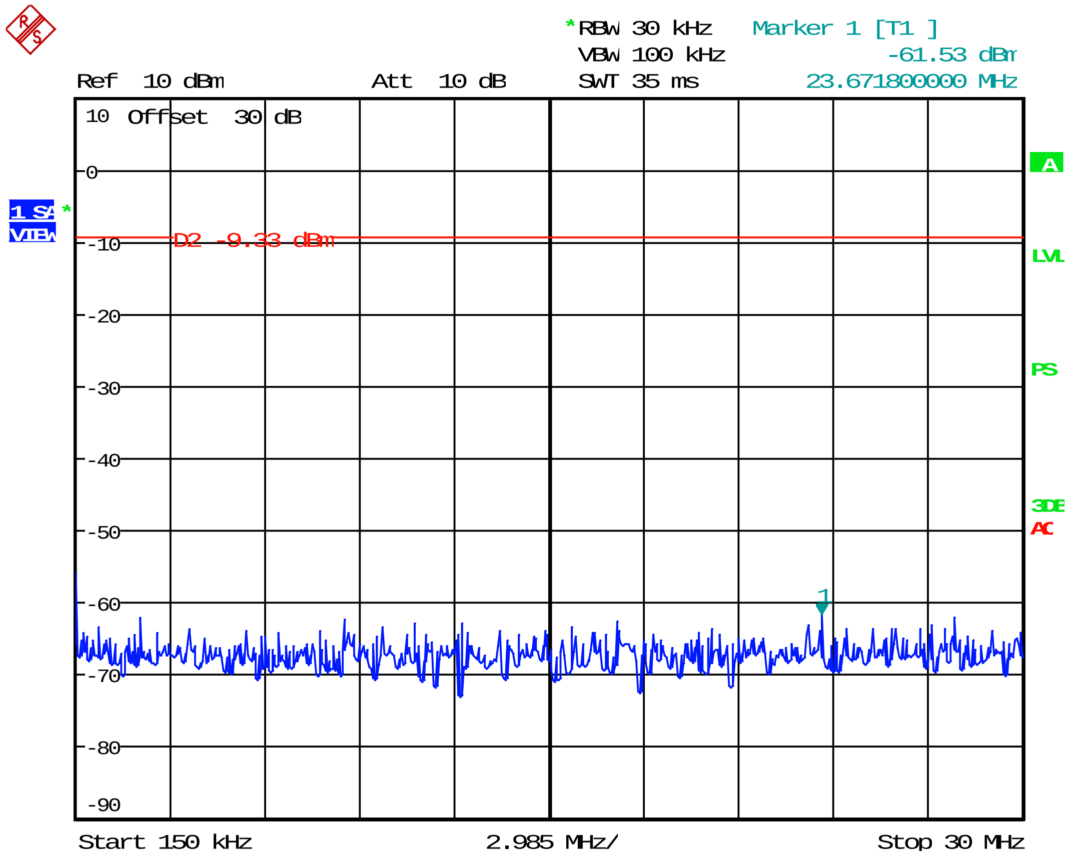


Date: 27.SEP.2012 09:51:51

Plot of in-band Emissions Mask for EA Wakeup mode - FCC 90.210(d)

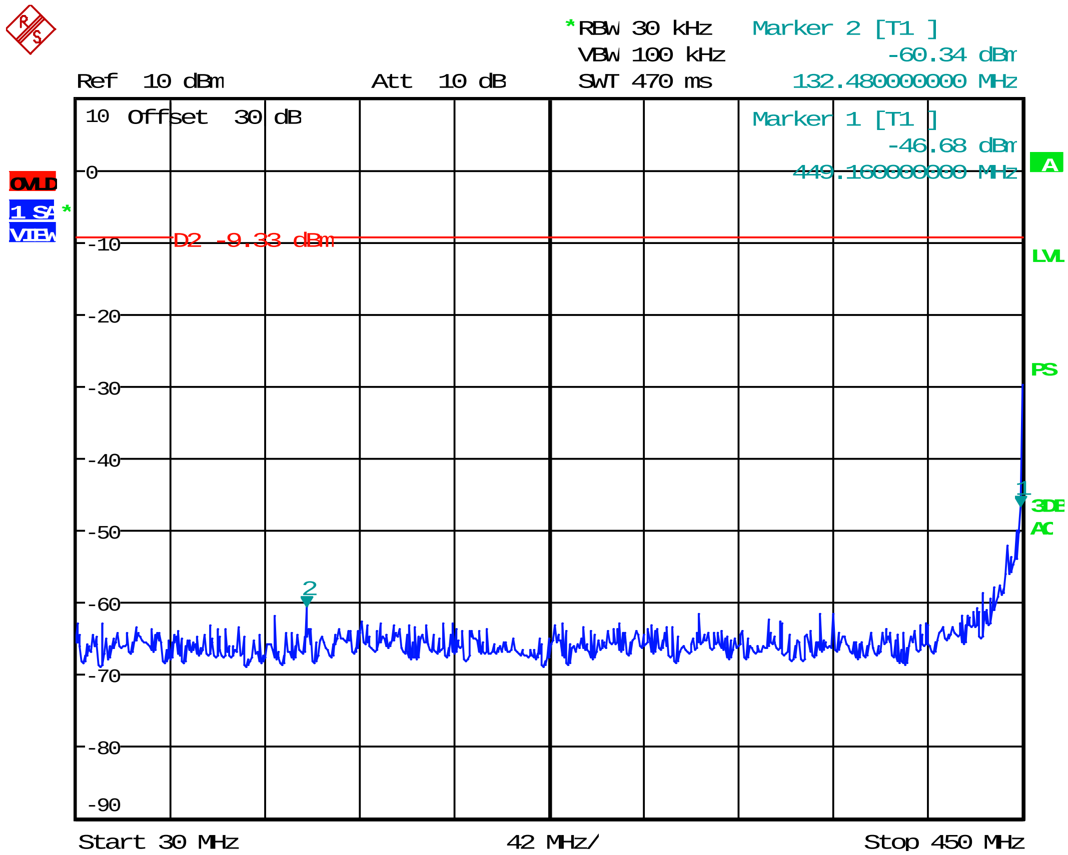


Plot of in-band Emissions Mask in TRACE mode - FCC 90.210(d)



Date: 18.SEP.2012 13:09:25

Plot of Emissions Mask - FCC 90.210(d) - 150 kHz to 30 MHz



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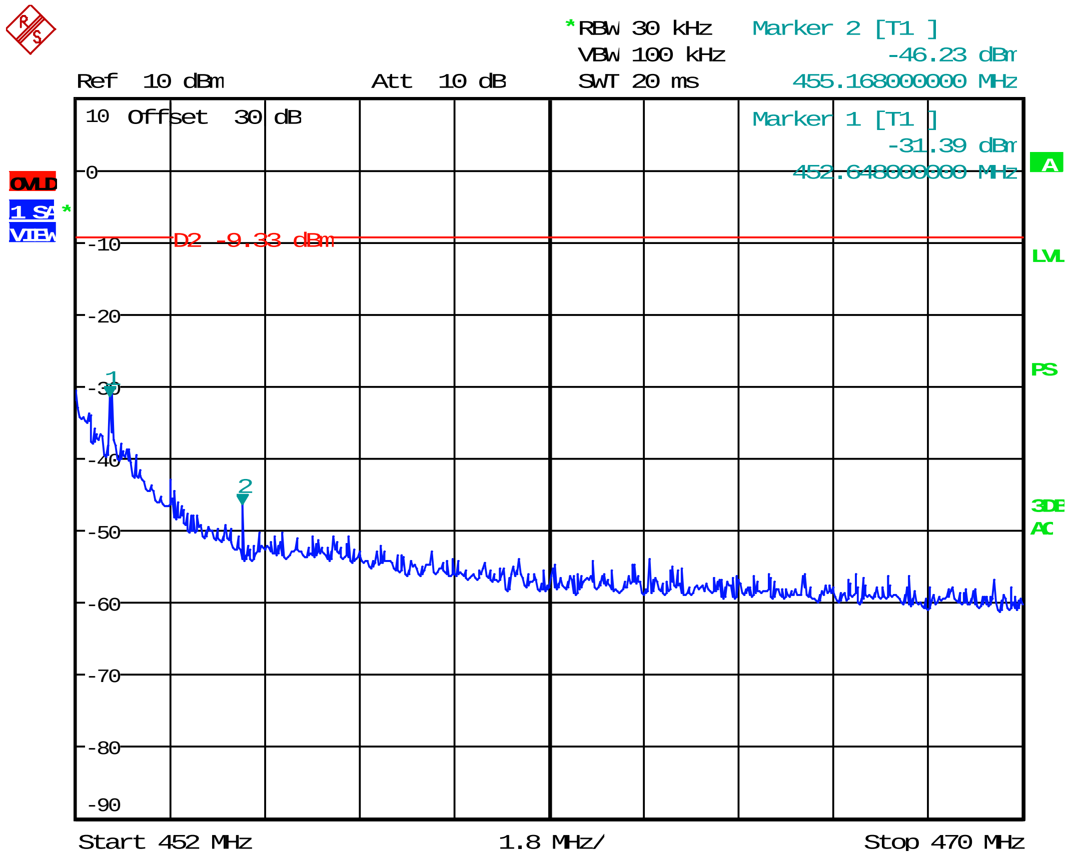
Plot of Emissions Mask - FCC 90.210(d) – 30 MHz to 450 MHz



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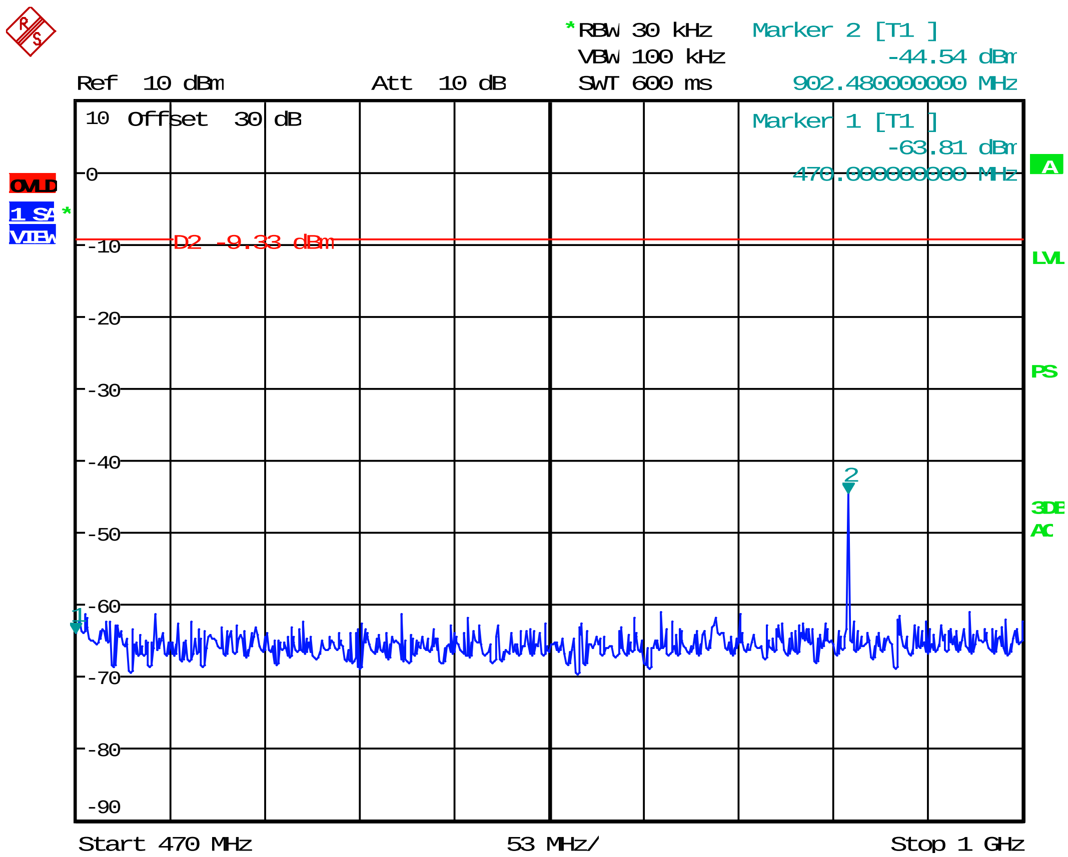
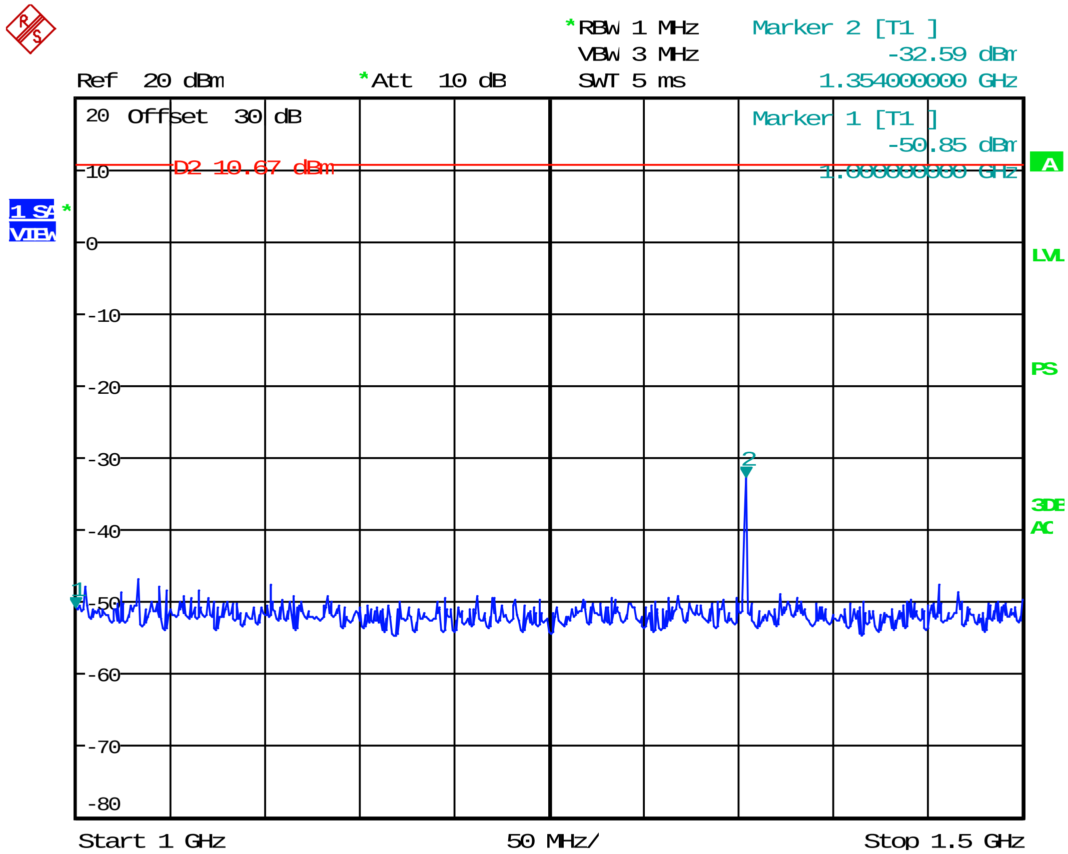
Plot of Emissions Mask - FCC 90.210(d) – 452 MHz to 470 MHz



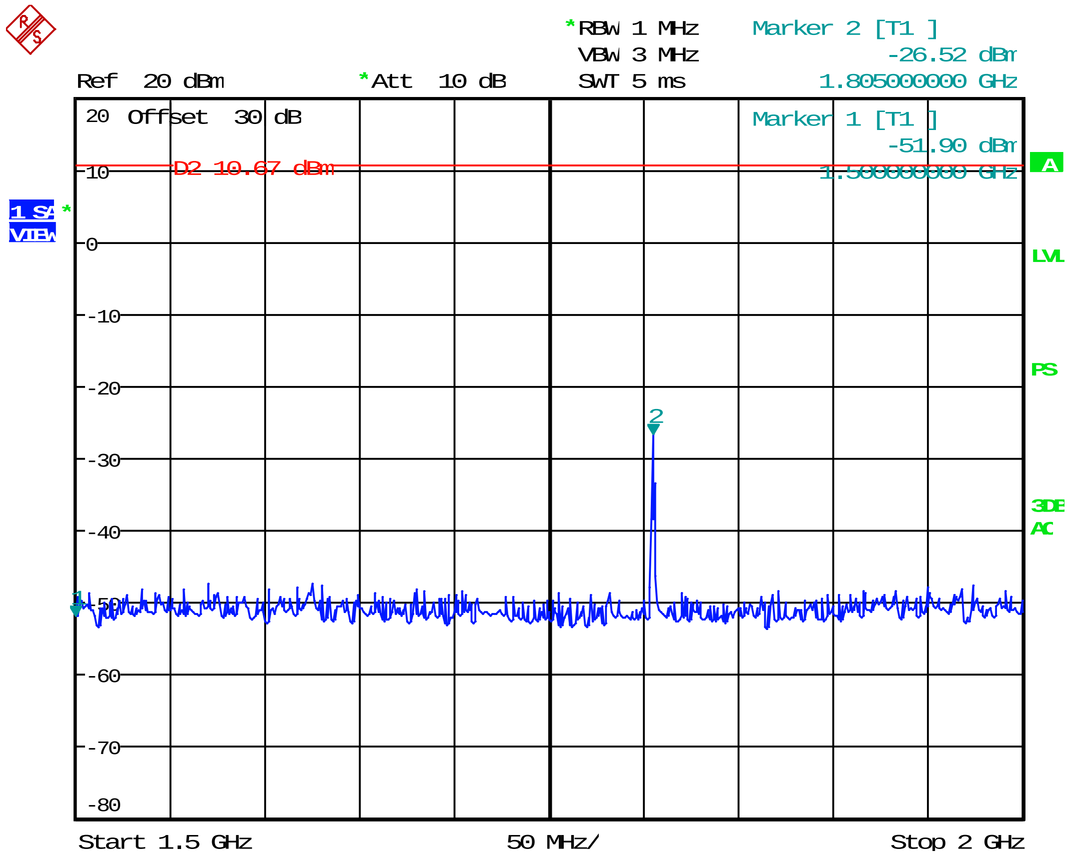
Date: 18.SEP.2012 13:13:53

Plot of Emissions Mask - FCC 90.210(d) – 470 MHz to 1 GHz (In-band)



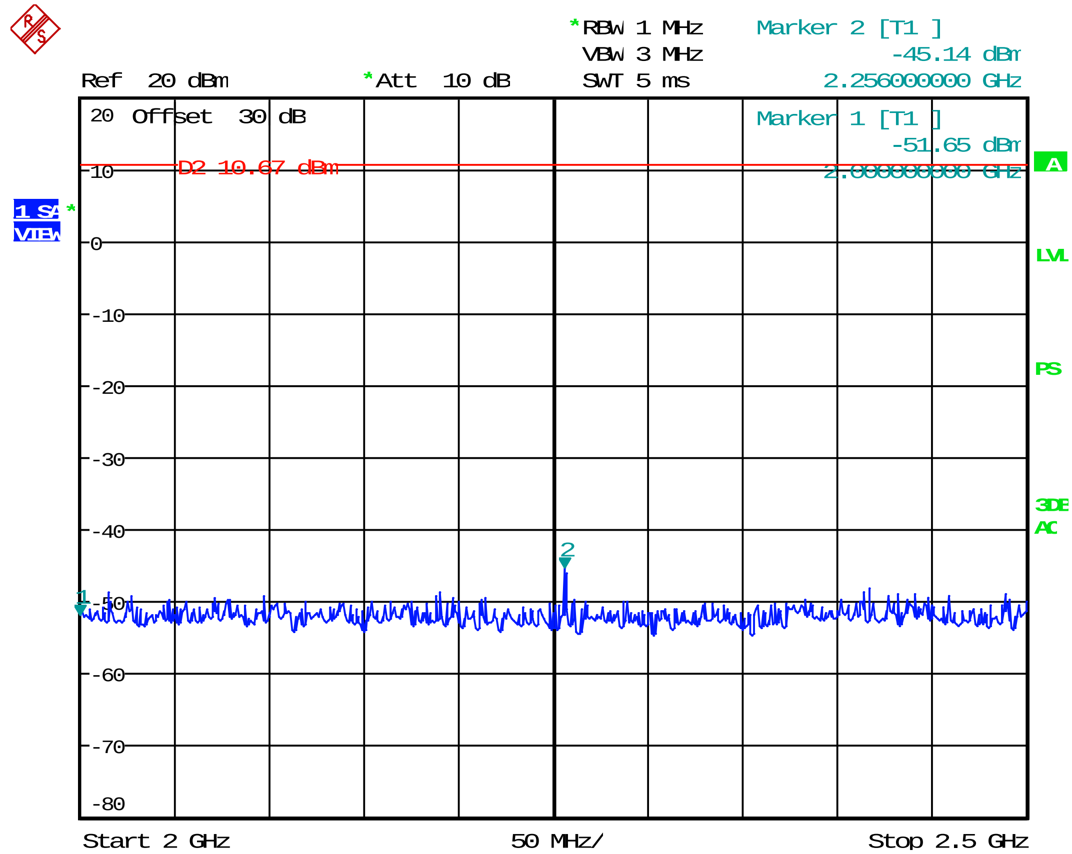
Date: 18.SEP.2012 13:18:18

Plot of Emissions Mask - FCC 90.210(d) – 1 GHz to 1.5 GHz



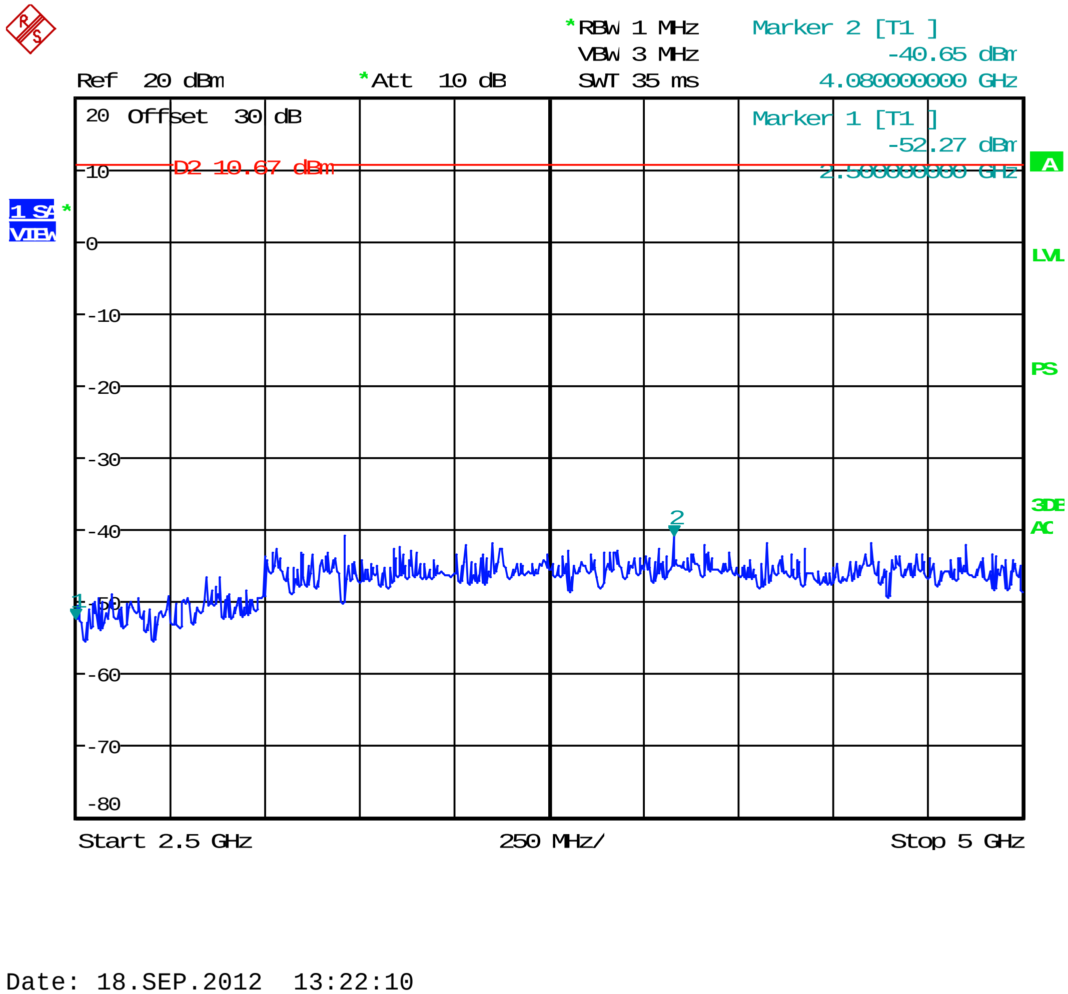
Date: 18.SEP.2012 13:19:32

Plot of Emissions Mask - FCC 90.210(d) – 1.5 GHz to 2 GHz



Date: 18.SEP.2012 13:20:21

Plot of Emissions Mask - FCC 90.210(d) – 2 GHz to 2.5 GHz



Plot of Emissions Mask - FCC 90.210(d) – 2.5 GHz to 5 GHz

4.10.5 Test Results

All emissions are below the limits as defined by emission Mask D.

4.11 Frequency Stability Function of the Temperature

Per FCC Parts 90.213, 2.1055(a) and (b)

Minimum frequency stability in the Frequency range of 421 – 512 MHz is 5 ppm, for Mobile stations with output power over 2 Watts. It was also demonstrated that the transmitter will not engage unless the crystal oscillator is at temperature.

4.11.1 Method of Measurement

The transmitter is set in operation with the maximum rated output power specified by the manufacturer. A Russells Model GD-16-3-3 temperature chamber was used to perform the test. The transmitter is exercised with a transmission mode providing a continuous stream of data.
The ambient temperature is varied from -30° to +50°C. The device under test is operated for 15 minutes prior to testing. A sufficient period of time before any measurements was observed to stabilize all the transmitter components for each temperature level.

4.11.2 Test Data

Frequency stability function of temperature		
Temperature (°C)	MCF(MHz)	PPM error [(MCF/ACF)-1]10^6
Reference:	451.35	0.0
-30	451.350017	0.037665
-20	451.3500168	0.037222
-10	451.350015	0.033234
0	451.3500126	0.027916
10	451.3500104	0.023042
20	451.3500058	0.027916
30	451.3500012	0.033234
40	451.349997	0.037222
50	451.3499932	0.037665

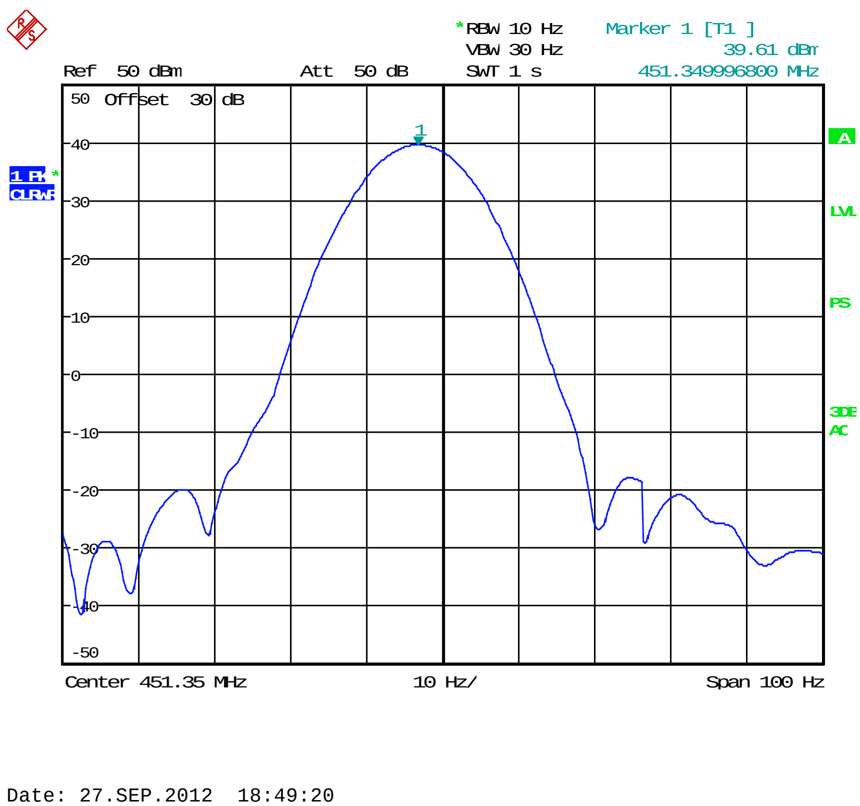
FCC PART 90.213 AND PART 2.1055(a) and (b): FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE

4.12 Frequency Stability Function of Primary Supply Voltage

Per FCC Part 2.1055(d)(1)

The device under test is powered up and set to a continuous transmission mode. The primary supply voltage was varied from 85% to 115% of the nominal 13.6 Volts.

Time	Chamber Indicated ºC	INPUT LINE (V)	Freq (MHz)	Delta Hz	ppm	Plot #
6:28 PM	26	11.56	451.34999940	-0.6	-0.001329	12
6:25 PM	26	13.6	451.35000000	0.0	0.000000	11
6:38 PM	26	15.64	451.3499968	-3.2	-0.007090	13



Worst case Voltage vs. frequency plot

4.13 *Transient Frequency Behavior*

Per FCC Part 90.214

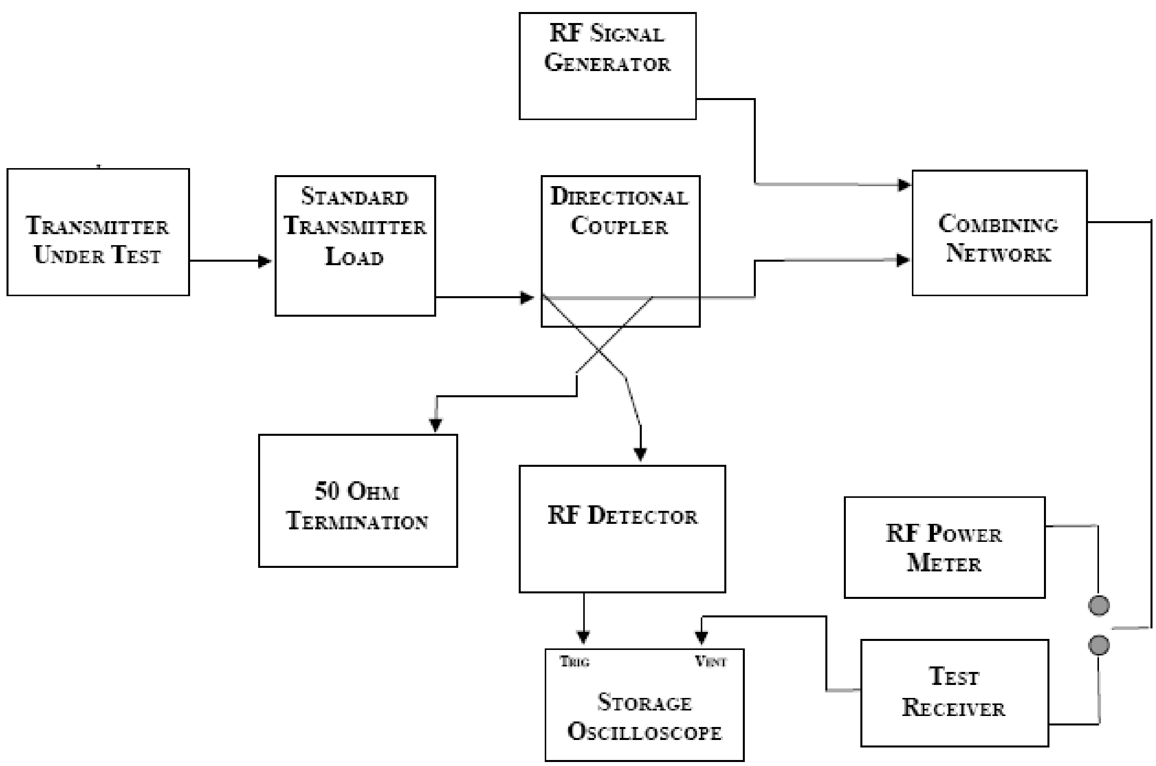
Transient frequency behavior is a measure of the difference, as a function in time, of the actual transmitter frequency to the assigned transmitter frequency when the transmitter RF output power is switch off or on.

4.13.1 Method of Measurement

Please refer to the following publication ANSI/TIA/EIA-603: 1992 Land Mobile for PM Communications Equipment Measurement and Procedure Standards

Note: It was determined that the modifications will not effect this measurement. Therefore, this test data was taken from the original test report submitted to the FCC.

TEST SET UP METHOD OF MEASUREMENT PART 90.214



a) The equipment is connected as illustrated in the above figure.

b) The test receiver's Demodulator Output Port (DOP) is connected to the vertical input channel of the storage oscilloscope. Connect the output of the RF peak detector is connected to the external trigger on the storage oscilloscope. The output of the RF combiner is connected to the RF power meter.

c) The test receiver is set to measure FM deviation with the audio bandwidth set at <50Hz to >15,000Hz and the RF frequency is tuned to the transmitter assigned frequency.

d) The signal generator is set to the assigned transmitter frequency and is modulated with a 1kHz tone at +12.5kHz deviation and its output level is set to -100dBm.

e) The transmitter is turned on.

f) Sufficient attenuation via the RF attenuator is supplied to provide an input level to the test receiver which is approximately 40dB below the test receiver's maximum allowed input power when the transmitter is operation at its rated power level. Note this power level on the RF power meter.

g) The transmitter is turned off.

h) The RF level of the signal generator is adjusted to provide RF power into the RF power meter 20dB below the level noted in step f). This signal generator RF level is maintained throughout the rest of the measurement.

i) The RF power meter is disconnected and connect the output of the RF combiner network is connected to the input of the test receiver.

j) The horizontal sweep rate on the storage oscilloscope is set to 10 milliseconds per division and the display is adjusted to continuously view the 1000Hz tone from the DOP. The vertical amplitude control of the oscilloscope is adjusted to display the 1000Hz at +4 divisions vertically centered on the display.

k) The oscilloscope is adjusted so it will trigger on an increasing magnitude from the RF peak detector at 1 division from the left side of the display when the transmitter is turned on. The controls are set to store the display.

l) The attenuation of the RF attenuator is reduced so the input to the RF peak detector and the RF combiner is increased by 30dB when the transmitter is turned on. The controls are set to store the display.

m) The transmitter is turned on and the stored display is observed. The output at the DOP, due to the change in ratio of power between the signal generator input power and the transmitter output power will, because of the capture effect of the test receiver, produce a change in display: For the first part of the sweep it shows the 1kHz test signal. Then once the receiver's demodulator has been captured by the transmitter power, the display shows the frequency difference from the assigned frequency to the actual transmitter frequency versus time. The instant when the 1kHz test signal is completely suppressed (including any capture time due to phasing) is considered to be t_{on}. The trace should be maintained within the allowed divisions during the period t_1 and t_2. During the time from the end of t_2 to the beginning of t_3 the frequency difference should not exceed the limit set by the FCC in Part 90.213. That is 2.257 kHz for the EA_MOBILE device.

o) To test the transient frequency behavior during the period t_3 the transmitter is switched on.

p) The oscilloscope is adjusted so it will trigger at 1 division from the right side of the display, when the TX is turned off. The moment when the 1kHz test signal stars to rise is considered to provide t off.

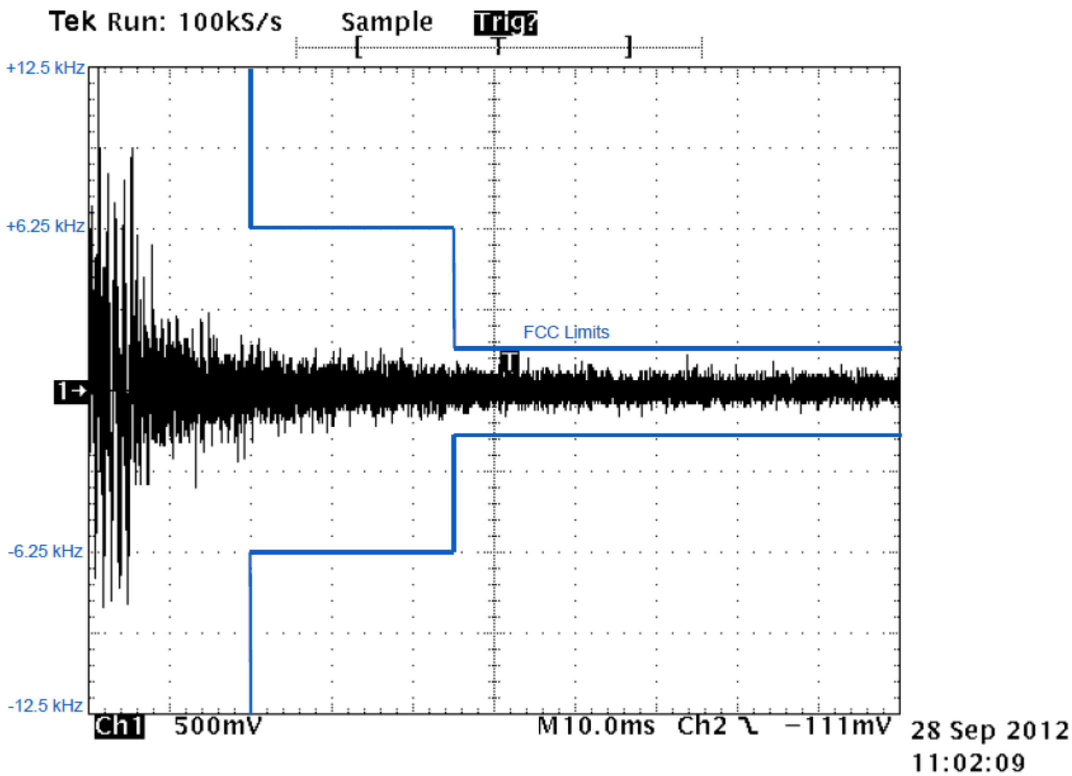
TRANSIENT FREQUENCY BEHAVIOR FOR EQUIPMENT DESIGNED TO OPERATE ON 12.5KHZ CHANNELS TABLE

Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels

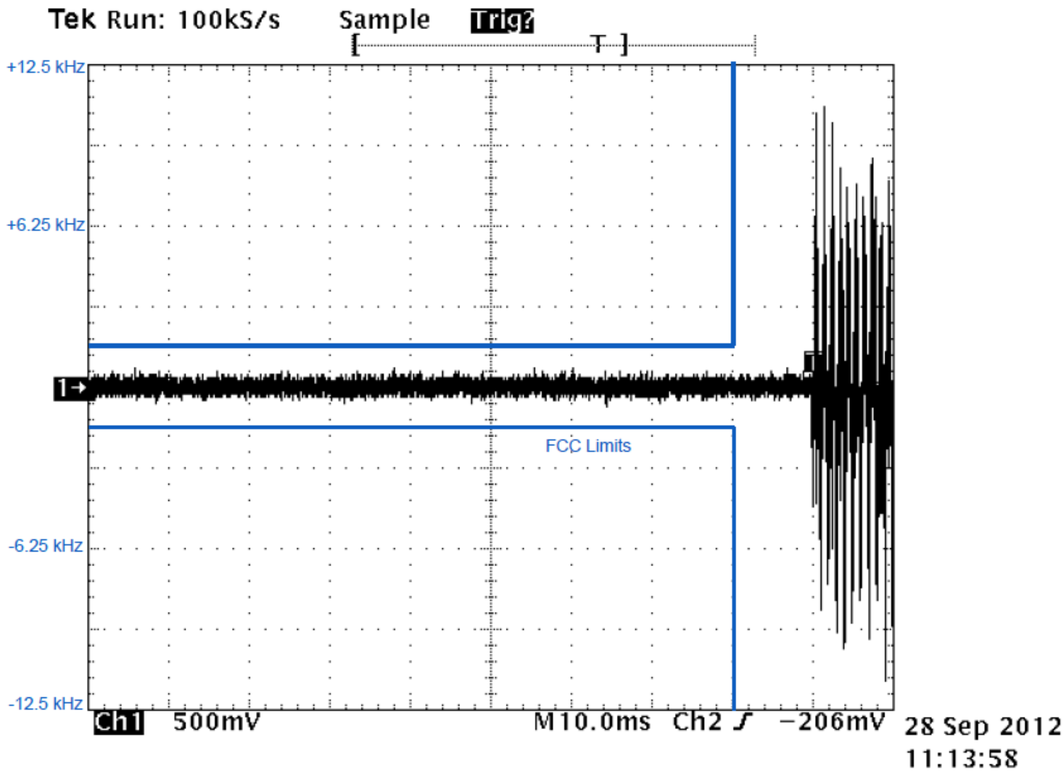
t_1 [4]	±12.5 kHz	5.0 ms	10.0 ms
t_2	±6.25 kHz	20.0 ms	25.0 ms
t_3 [4]	±12.5 kHz	5.0 ms	10.0 ms

1. ton is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until toff.
toff is the instant when the 1 kHz test signal starts to rise.
2. During the time from the end of t2 to the beginning of t3, the frequency difference must not exceed the limits specified in paragraph 90.213.
3. Difference between the actual transmitter frequency and the assigned transmitter frequency.
4. If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

4.13.2 Test Data:



PART 90.214, TRANSIENT FREQUENCY BEHAVIOR – T_1



PART 90.214, TRANSIENT FREQUENCY BEHAVIOR- T_3

4.14 Receiver / Cabinet Emissions

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.

4.14.1 Over View of Test

Results	Complies (as tested per this report)				**Date**	22 October 2012	
Standard	FCC Part 15B						
Product Model	EA_MOBILE W/ WAKEUP			**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. See test plans for details						
EUT Powered By	13.6 VDC	**Temp**	71° F	**Humidity**	37%	**Pressure**	1011 mbar
Frequency Range	30 MHz - 5 GHz @ 3m						
Mod. to EUT	None		**Test Performed By**		Mark Ryan		

4.14.2 Test Procedure

Radiated and FCC emissions tests were performed using the procedures of ANSI C63.4 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 - 5 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 comes with two configurations, one using a laptop and the other is using a touch-screen monitor. The worst case will be show in the data below.

4.14.3 Deviations

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

The EUT is intended to be a mobile device powered by a 12 VDC Battery, as such conducted emissions on the power line are not required per FCC Part 15.107(d).

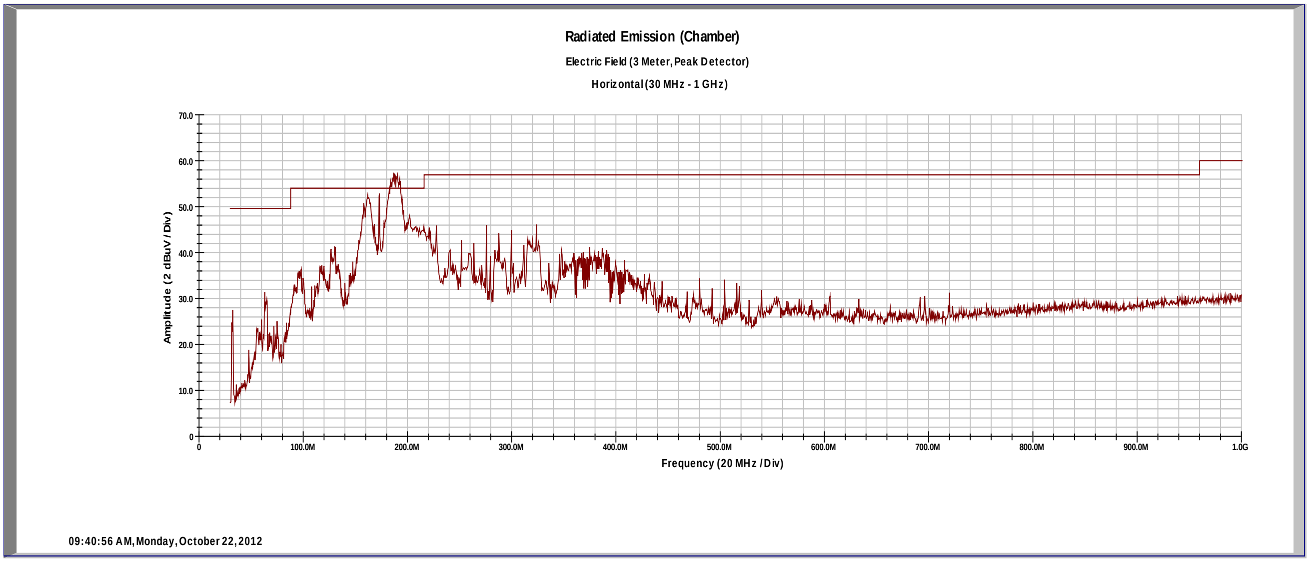
4.14.4 Final Test

The configuration using the touch-screen monitor was the worst case. In order to achieve compliance, a ferrite was added to the monitor power and data lines. After in installation of the two ferrites, all final radiated emissions measurements were below (in compliance) the limits.

4.14.5 Final Graphs and Tabulated Data

Radiated Emissions

Horizontal, w/ ferrite on monitor power and VGA cable



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)
162.36	H	1.6	134	39.30	0.00	1.39	8.51	49.20	54.00	-4.80
172.80	H	1.7	347	42.31	0.00	1.43	8.77	52.51	54.00	-1.49
185.16	H	1.5	168	42.20	0.00	1.49	9.81	53.50	54.00	-0.50
130.28	H	2.0	166	33.82	0.00	1.24	7.50	42.56	54.00	-11.44

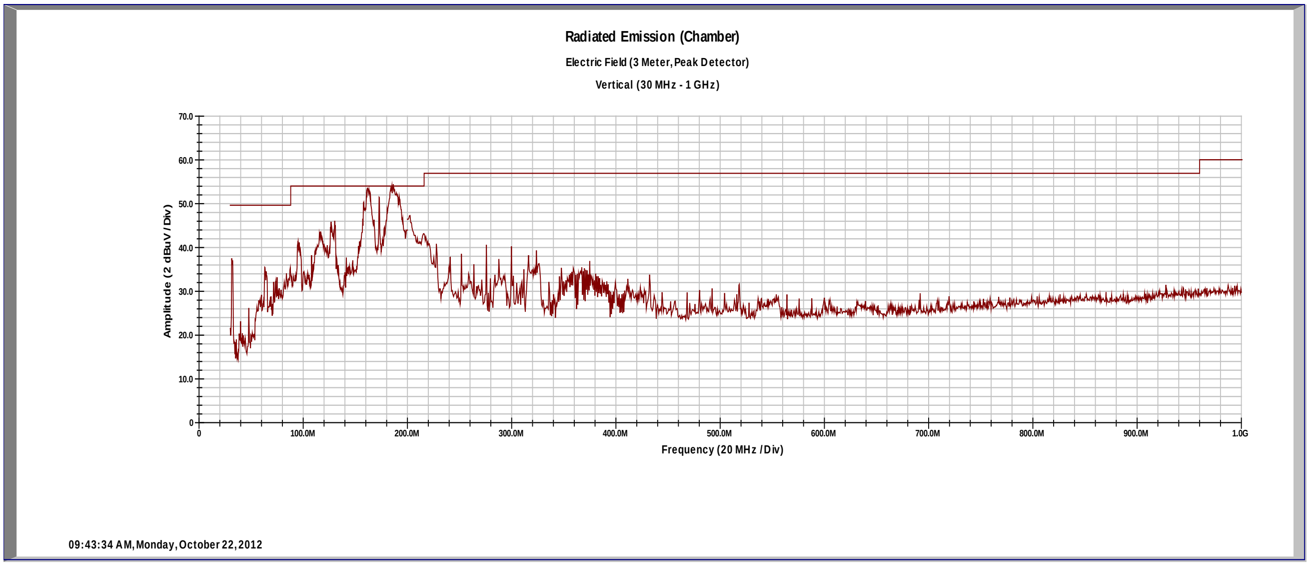
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 2.29dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: Scans performed with 120kHz RBW and peak detector. Measurements made with 120kHz RBW and Quasi-Peak detector. All are referenced to FCC Class A limit. Fair-Rite part number 0443167251 used in both location. VGA cable with one pass, power cable with 3 passes. (see photos)

Radiated Emissions

Vertical, w/ ferrite on monitor power and VGA cable



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)
161.64	V	1.0	101	37.39	0.00	1.39	8.57	47.35	54.00	-6.65
172.80	V	1.0	5	40.08	0.00	1.43	8.77	50.28	54.00	-3.72
186.32	V	1.0	127	39.58	0.00	1.50	9.91	50.98	54.00	-3.02
200.96	V	1.0	232	30.39	0.00	1.55	10.40	42.34	54.00	-11.66
130.30	V	1.0	54	34.77	0.00	1.24	7.50	43.51	54.00	-10.49

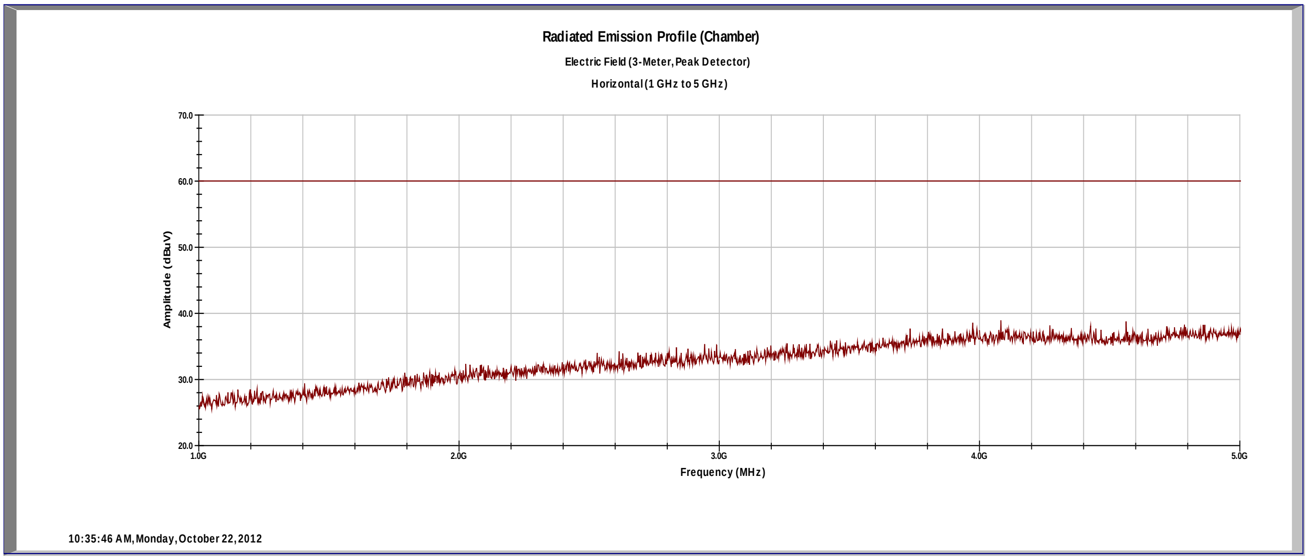
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 2.29dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: Scans performed with 120kHz RBW and peak detector. Measurements made with 120kHz RBW and Quasi-Peak detector. All are referenced to FCC Class A limit. Fair-Rite part number 0443167251 used in both location. VGA cable with one pass, power cable with 3 passes. (see photos)

Radiated Emissions

Horizontal, w/ ferrite on monitor power and VGA cable, 1 – 5 GHz



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)

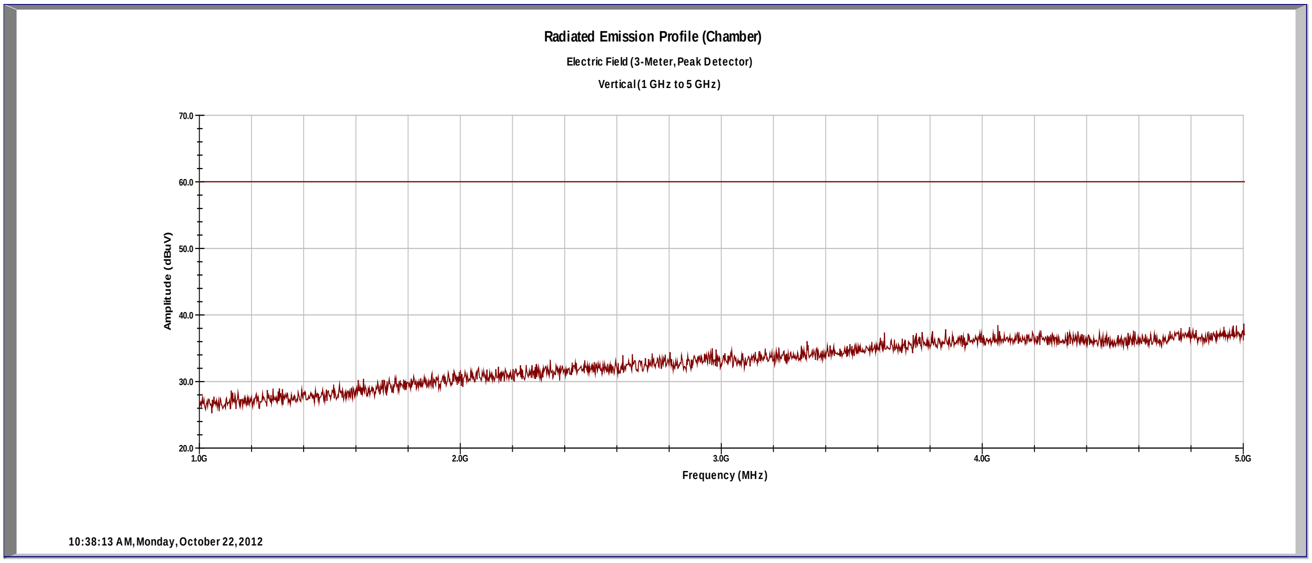
Spec Margin = E-Field Value - Limit, E-Field Value = FIM Value - Amp Gain + Cable Loss + ANT Factor ± Uncertainty

Combined Standard Uncertainty $u_c(y)$ = ± 2.29dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: Scan performed with 100kHz RBW, peak detector. Referenced to FCC Class A limit. Fair-Rite part number 0443167251 used in both location. VGA cable with one pass, power cable with 3 passes. (see photos)

Radiated Emissions

Vertical, w/ ferrite on monitor power and VGA cable, 1 – 5 GHz



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 $u_c(y)$ = ± 2.29dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence

Notes: Scan performed with 100kHz RBW, peak detector. Referenced to FCC Class A limit. Fair-Rite part number 0443167251 used in both location. VGA cable with one pass, power cable with 3 passes. (see photos)

5 RF Exposure

5.1 Exposure Requirements – FCC Part 2.1091

FCC publication states that SAR evaluation in not required if “Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. *See* §1.1307(b)(1) of CFR 47.”

5.1.1 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.

5.1.2 Evaluation

The EUT is a Mobile Radio Device and is intended to be separated from human contact by more than 20cm. Therefore the MPE calculation will be used.

5.2 MPE Calculation for FCC

In this document, we will prove the safety of radiation harmfulness to the human body for our product. The limit for Maximum Permissible Exposure (MPE) specified in FCC 1.1310 is followed. The Gain of the antenna used in this product is measured in a Semi-Anechoic Chamber, and also the maximum total power input to the antenna is measured. Through the Friis transmission formula (see section 5.2.4) and the maximum gain of the antenna, we can calculate the distance, away from the product, where the limit of MPE is reached.

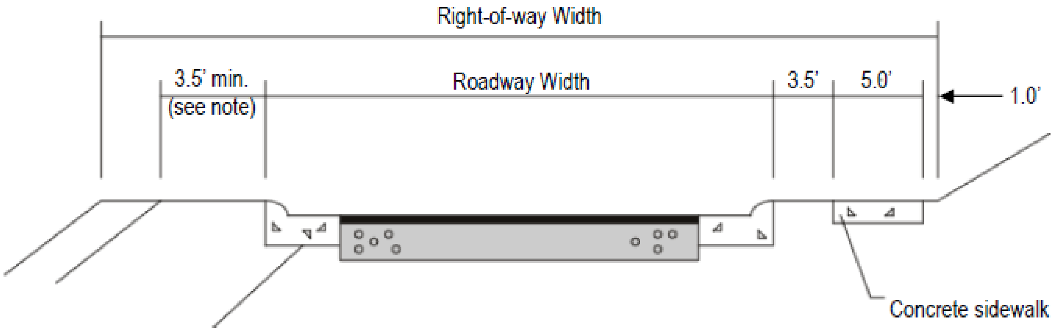
Although the Friis transmission formula is a far field assumption, the calculated result of that is an over-prediction for near field power density. We will take that as the worst case to specify the safety range.

As this is a mobile device with the antenna mounted on the roof of a motor vehicle, the distances from the antenna are based on the *City of Raleigh Streets, Sidewalks, and Driveway Access Handbook* (revised January 2009) which references the *Guidelines for Urban Major Street Design, A Recommended Practice* by the Institute of Transportation Engineers, Washington, D.C., 1984. The Distance from the antenna will be increased from 20cm to 2 feet (61 cm) for controlled exposure, and 5.5 feet (166 cm) for uncontrolled exposure. See Diagram below.

Also note that page 21 of the Operation manual shows locations of antennas. Note that the equipment is placed in the passenger seat; therefore the separation distances are from the driver of the vehicle. The calculations do not include the shielding provided by the Vehicle’s roof (antenna ground plane), thereby making these a worst case scenario.

The EUT is considered to be a PTT device; however a 100% duty cycle will be used for this calculation as it considered to be the worst-case exposure.

Figure 2. Local Access System Roadways



Roadway Classification	Right-of-way Width (feet)	Roadway Width (feet)
Residential Collector Street	55*	36**
Collector Street	60	41

*60 feet within 300' of a collector street or a thoroughfare system roadway intersection
**41 feet within 300' of a collector street or a thoroughfare system roadway intersection

Reference of the distances used for the MPE calculations

Photo of Antenna on mobile vehicle

5.2.1 RF Exposure Limit

According to FCC 1.1310 table 1: The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b)

LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm^2)	Average Time (minutes)
(A)Limits For Occupational / Control Exposures				
300-1500	…	…	F/300	6
1500-100,000	…	…	5	6
(B)Limits For General Population / Uncontrolled Exposure				
300-1500	…	…	f /1500	30
1500-100,000	…	…	1.0	30

f = Frequency in MHz

5.2.2 Classification

The antenna of the product, under normal use condition, is at least 20cm away from the body of the user. However this calculation will be using a distance of 61 cm for Controlled Exposures and 166 cm for Uncontrolled Exposures.

5.2.3 Test Results

5.2.3.1 Antenna Gain

The Manufacturer states that no more than a 6dBi gain antenna will be used..

5.2.3.2 RF Exposure value calulation:

Calculations for this report are based on highest power measurement and the highest gain of the antenna. Limit for MPE (from FCC part 1.1310 table 1) is **f / 300 = 451.85 / 300 = 1.51 mW/cm^2** for controlled exposure.

And **f / 1500 = 451.85 / 15000 = 0.3 mW/cm^2** for uncontrolled exposure

And Highest Pout is 12.5W = 12500 mW, highest antenna gain 6 dBi (numeric gain is 3.98),

R is 61cm for controlled exposure, and 166 cm for uncontrolled exposure.

f = 451.85 MHz

DC or the Time weighted duty will be worst-case 100%.

Pd = $((12500*3.98) / (61^2*4\pi))$ = **0.95 mW/cm^2**, which is **0.56 mW/cm^2 below to the controlled limit**. And

Pd = $((12500*3.98) / (166^2*4\pi))$ = **0.13 mW/cm^2**, which is **0.17 mW/cm^2 below to the uncontrolled limit**.

The Exposure time of 6 Minutes was included for this calculation.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

5.2.4 Sample Calculation

The Friis transmission formula: $Pd = (Pout*G) / (4*\pi*R^2)$

Where;

Pd = power density in mW/cm^2
Pout = output power to antenna in mW
G = gain of antenna in linear scale
$\pi \approx 3.1416$
R = distance between observation point and center of the radiator
DC = Time weighted Duty Cycle

Ref. : David K. Cheng, *Field and Wave Electromagnetics*, Second Edition, Page 640, Eq. (11-133).

Appendix A

6 Test Plan

This test report is intended to follow this test plan outlined below unless otherwise stated in this report or quote agreement. The following test plan will give details on product information, test set ups, and product configurations. The product information below came via client, product manual, product itself and or the internet.

6.1 General Information

Client	Elster Solutions
Address	208 South Rogers Lane
Address	Raleigh, NC 27610
Contact Person	Steve Bragg
Telephone	919-212-4899
Fax	919-250-5439
e-mail	Steve.Bragg@us.elster.com

Product Name

EA_MOBILE

Model(s) Name

5D26054G01

6.2 Equipment Under Test (EUT) Description

The EA_MOBILE is a portable data retrieval and storage system designed to provide remote meter reading of mechanical indexes via TRACE meter transponders.

The EA_MOBILE is designed for use in vehicles for fast, accurate automated meter reading at maximum range and at normal residential driving speeds.

The EA_MOBILE consists of several required components. Those components are:

- Interrogator unit
- GPS receiver
- Transmitting antenna
- Receiving antenna
- LCD VGA Touch Screen designed for in car computing
- Power supply cable

Interrogator unit: The interrogator unit is the heart of the EA_MOBILE, containing within its rugged case these core components:

- Wake-up Transmitter
- Transceiver
- Power supply (backup)
- Computer CPU (microprocessor)
- Connection receptacles, controls and indicators

Modifications

A ferrite was added to the monitor power and data cables to be compliant.

Countries

☒	**USA**	☐	**Europe**
☐	**Taiwan**	☐	**Other: Canada**
☐	**Japan**		

*Check all that apply

General Product Information

Size	H	18cm	W	46cm	L	32cm
Weight	~30kg		Fork-Lift Needed		No	
Notes						

6.2.1 EUT Electrical Powered Information

6.2.1.1 Electrical Power Type

☐	AC	☒	DC	☒	Batteries	☐	Host -

6.2.1.2 Electrical Power Information

Name	Type	Voltage		Frequency	Current	Notes
		min	max			
Power	DC	11	16.6	N/A	~6.5 ADC	TX Mode
Notes						

6.2.2 EUT Modes of Operation

The EUT (EA_MOBILE) will be powered with a 12 VDC deep cycle automotive battery to simulate actual use in a meter reading vehicle. TX/RX antennas as supplied will be attached to the transmit and receive ports respectively. The Xenarc VGA display will be connected and powered by the 12 VDC battery.

For the Radiated Emissions Limits, TX function will be disabled. Ref 1.16.2.

For Land Mobile Radio testing, TX can be enabled and a typical transponder data can be transmitted.

6.2.3 Technical information and Configuration

EUT Clock/Oscillator Frequencies

☐	**Less than 108MHz**	**FCC – scan up to 1GHz**
☐	**Less than 500MHz**	**FCC – scan up to 2GHz**
☒	**Less than 1000MHz**	**FCC – scan up to 5GHz**
☐	**Greater then 1000MHz**	**FCC – scan up to 5th Harmonic or 40GHz**

Electrical Support Equipment

Type	Manufacture	Model	Connected To
Battery	Optima	3478DT	Elster Power Cable
Power Cable	Elster	N/A	EUT Power
TX Antenna	MaxRad	MUF4505	EUT Transmitter
RX Antenna	MaxRad	MUF4065	EUT Receiver
VGA Monitor	Xenarc	705TSV	EUT VGA and USB
VGA Monitor Power	Xenarc	705TSV	Battery
GPS	Garmin	16x-HVS	EUT GPS

EUT Equipment / Cabling Information

EUT Port	Connected To	Location	Cable Type		
			Length	Shielded	Bead
EUT/Monitor Power	12 VDC Battery	Under Test Table	12 AWG 8 ft.	N	Y
GPS	GPS Receiver	On Test Table	28 AWG 16 ft.	Y	N
Transmitter, N Female	TX Antenna	On Test Table	12 ft. N Type, Male	Y	N
Receiver, BNC Female	RX Antenna	On Test Table	12 ft. BNC Type, Male	Y	N
VGA	Xenarc VGA Monitor	On Test Table	6 ft.	Y	Y
USB 1	Xenarc VGA Monitor	On Test Table	6 ft.	Y	Y

EUT Test Program(s)

For FCC and IC:

For Radiated Emissions, TX will be disabled for detection of unintentional radiation from the EUT.

For Land Mobile testing, the transmitter will be enabled for RF power and spurious emission testing. Typical transponder data will be transmitted.

Monitoring of EUT during Testing

The EUT will be installed, monitored, and evaluated by test agency personnel for compliance with requested FCC and IC standards.

EUT representatives will be present to operate and troubleshoot equipment as necessary.

6.2.4 EUT Configuration

6.2.4.1 Description

Configuration	Description
Reference Block Diagram 1.16.2	
Notes All configurations are the same except as noted above	

6.2.4.2 Block Diagram