



MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

June 3, 2005

Navigational Sciences Inc.
Corporate Square 1, Suite 100
2420 Mall Drive
North Charleston, SC 29406

Dear Jeffrey Scott Blair,

Enclosed is the EMC test report for compliance testing of the Navigational Sciences Inc., WARP 1.0. The Navigational Sciences Inc., WARP 1.0 was tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 24 Subpart E for Broadband PCS Devices.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,

MET LABORATORIES, INC.

Marie Confroy
Documentation Department

Reference: (\Navigational Sciences Inc.\ EMC16990-FCC_24)

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc. While use of the National Voluntary Laboratory Accreditation Program (NVLAP) letters or the NVLAP Logo, the Standards Council of Canada Logo, or the Nationally Recognized Testing Laboratory (NRTL) Letters in this report reflects MET Accreditation under these programs, these letters, logo, or statements do not claim product endorsement by NVLAP or any Agency of the U.S. Government.



The Nation's First Licensed Nationally Recognized Testing Laboratory





MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*
914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230-3432 • PHONE (410) 354-3300 • FAX (410) 354-3313

Electromagnetic Compatibility Criteria Test Report

For the

**Navigational Sciences Inc.
WARP 1.0**

Tested under

**FCC Certification Rules
Title 47 of the CFR, Part 24 Subpart E for Broadband PCS Devices**

MET Report: EMC16726-FCC

June 3, 2005

Prepared For:

**Navigational Sciences Inc.
Corporate Square 1, Suite 100
2420 Mall Drive
North Charleston, SC 29406**

Prepared By:
MET Laboratories, Inc.
914 W. Patapsco Ave
Baltimore, MD 21230



Navigational Sciences, Inc.
WARP 1.0
FCC ID: S46-WP0100NS

CFR Title 47 Part 24 Subpart E

Electromagnetic Compatibility Criteria Test Report

For the

Navigational Sciences Inc.
WARP 1.0

Tested Under

FCC Certification Rules
Title 47 of the CFR, Part 24 Subpart E for Broadband PCS Devices

Kevin Mehaffey
Electromagnetic Compatibility Lab

Marie Confroy
Documentation Department

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 24 Subpart E and Part 15 Subpart B of the FCC Rules under normal use and maintenance.

Liming Xu
Electromagnetic Compatibility Lab



Navigational Sciences, Inc.
WARP 1.0
FCC ID: S46-WP0100NS

CFR Title 47 Part 24 Subpart E

Report Status Sheet

Revision	Report Date	Reason for Revision
Ø	June 3, 2005	Initial Issue.



Table of Contents

1. Requirements Summary	1
2. Equipment Configuration.....	2
2.1. Overview	2
2.2. Test Site	3
2.3. Description of Test Sample.....	3
2.4. Equipment Configuration.....	4
2.5. Support Equipment	4
2.6. Ports and Cabling Information	5
2.7. Mode of Operation	6
2.8. Method of Monitoring EUT Operation	6
2.9. Modifications	7
2.9.1. Modifications to EUT	7
2.9.2. Modifications to Test Standard	7
2.10. Disposition of EUT	7
3. Electromagnetic Compatibility Criteria.....	8
3.1. Conducted Limits	8
3.2. Radiated Emission Limits	9
4. Electromagnetic Compatibility Criteria for Broadband PCS Devices	13
4.1. RF Power Output	13
4.2. Modulation Characteristics	19
4.3. Occupied Bandwidth.....	21
4.4. Spurious Emissions	23
4.4.1. Spurious Emissions at Antenna Terminals.....	23
4.4.2. Spurious Emissions at Antenna Terminal Frequency Block Edges	28
4.4.3. Radiated Spurious Emissions	31
4.4.4. MPE Calculation	35
4.5. Frequency Stability over Temperature Variations	36
4.6. Frequency Stability over Voltage Variations	37
5. Test Equipment	38
6. Compliance Information.....	39
6.1. Certification Information	39
6.2. Label and User's Manual Information	43



List of Tables

Table 1. Requirements Summary of EMC Part 24 Compliance Testing	1
Table 2. Equipment Configuration	4
Table 3. Support Equipment	4
Table 4. Ports and Cabling Information	5
Table 5. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)	8
Table 6. Radiated Emissions Limits calculated from FCC Part 15 Subpart B, 15.109 (a) (b)	9
Table 7. Carrier Frequency Deviations Due To Temperature Instability	36
Table 8. Carrier Frequency Deviations Due to Voltage Variations	37

List of Photographs

Photograph 1. Radiated Emission Limits, Test Setup	12
Photograph 2. EUT Test Setup for Part 24	18
Photograph 3. Radiated Spurious Emissions, Test Setup	33
Photograph 4. Radiated Spurious Emissions, Test Setup	34

List of Plots

Plot 1. RF Power Output Test Results	15
Plot 2. RF Power Output Test Results	16
Plot 3. RF Power Output Test Results	17
Plot 4. Modulation Characteristics Test Results	20
Plot 5. Occupied Bandwidth Test Results	22
Plot 6. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results	24
Plot 7. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results	25
Plot 8. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results	26
Plot 9. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results	27
Plot 10. Conducted Spurious Emissions- Block Edges Test Results	29
Plot 11. Conducted Spurious Emissions- Block Edges Test Results	30



List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
d	Measurement Distance
dB	Deci Bels
dBμV	Deci-Bels above one micro Volt
dBμV/m	Deci-Bels above one micro Volt per meter
DC	Direct Current
DCF	Distance Correction Factor
E	Electric Field
EUT	Equipment Under Test
e.i.r.p	equivalent isotropically radiated power
f	Frequency
FCC	Federal Communications Commission
GHz	Giga Hertz
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kV	kilo Volt
LISN	Line Impedance Stabilization Network
MHz	MegaHertz
RF	Radio Frequency
RMS	Root-Mean-Square
V/m	Volts per meter



2.0 Requirements Summary

Reference	Description	Compliance
Part 15 Subpart B §15.109(a)	Conducted Emissions	Not Applicable
Part 15 Subpart B §15.107(a)	Radiated Emissions	Compliant
2.1046; Part 24 Subpart E §24.232 (a), (c)	RF Power Output	Compliant
2.1047 (a)	Modulation Characteristics	Compliant
2.1049	Occupied Bandwidth	Compliant
2.1051; 24.238 (a)	Spurious Emissions at Antenna Terminals	Compliant
2.1051; 24.238 (b)	Spurious Emissions at Antenna Terminals Frequency Block Edges	Compliant
2.1053; 24.238 (a)	Radiated Spurious Emissions	Compliant
2.1055 (a) (1)	Frequency Stability Over Temperature Variations	Compliant
2.1055 (d) (1)	Frequency Stability Over DC Power	Compliant

Table 1. Requirements Summary of EMC Part 24 Compliance Testing



2.0 Equipment Configuration

2.1 Overview

An EMC evaluation to determine compliance of the Navigational Sciences Inc. WARP 1.0 with the requirements of Part 24 Subpart E and Part 15 Subpart B, was performed. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Navigational Sciences Inc. WARP 1.0. Navigational Sciences Inc. should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the WARP 1.0 has been **permanently** discontinued.

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 24 Subpart E, and Part 15 Subpart B, in accordance with Navigational Sciences Inc., purchase order number 3000. All tests were conducted using measurement procedure *ANSI C63.4-1992*.

Type of Submission/Rule:	Part 24 Original Filing
Model(s) Tested:	WARP 1.0
Model(s) Covered:	WARP 1.0
EUT Specifications:	Primary Power: 6-30 Vdc
	FCC ID S46-WP0100NS
	Type of Emissions: 235 KGXW
	RF Power Output: 0.7 Watts
	Equipment Frequency Range: (MHz) 1850.2-1909.8
	Frequency Stability: 50 Hz
Analysis:	The results obtained relate only to the item(s) tested.
Evaluated by:	Liming Xu
Date(s):	June 3, 2005



2.2 Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave, Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed semi-anechoic chamber. In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories. In accordance with §2.948(d), MET Laboratories has been accredited by the National Voluntary Laboratory Accreditation Program (Lab Code: 100273-0).

2.3 Description of Test Sample

The WARP 1.0, Equipment Under Test (EUT) is powered from a 6-30 Vdc supply.

The WARP 1.0 is a compact asset-tracking device, which utilizes the GPS satellite system to determine location and the GSM/GPRS mobile telephony system for communication. User parameters are configured using a PC ASCII terminal or remotely by SMS or GPRS.

Various reported modes are supported, as below:

- a) Real- time reporting via GPRS (TCP)
- b) SMS text mode (either plain text or MPTP format)
- c) SMS PDU mode- 8 positions per SMS (to reduce running costs)
- d) Data logging only for download on demand

In full power mode, typical current consumption is only 22 mA at 13.8 Vdc. Faster GPS and reduced processor consumption allow even greater power savings in low power modes of operation. Autonomous battery powered applications (e.g. cargo tracking), will benefit from extended operation durations or smaller, lower cost battery solutions.

The WP010NS incorporates the latest GPS technology from FAstraX. In addition to the size and power efficiency benefits, many applicants will benefit from tracking into marginal areas, which were previously beyond GPS coverage.

When GSM communications are unavailable, data is logged to non-volatile flash memory for sending when communications resume (or download over GPRS upon request). The WP010NS has sufficient on-board flash memory for storage of 10, 000 individual position/date/status reports.

The GSM modem is a Wavecom dual band device (900/1800 or 850/1900), and is capable of fully automatic international roaming.



2.4 Equipment Configuration

The EUT was set up as outlined in Figure 1. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

Name / Description	Model Number
Tracking Device	GSM/GPRS

Table 2. Equipment Configuration

2.5 Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number
1	IBM Think Pad	IBM	2629
2	WARP Module	VASoTrack	WP010NS
3	GSM/ GPRS /GPS Antenna	San Jose	AU-3S-GSM
4	AC Adapter	IBM	AA21131
5	Programming Cable	VascoTrack	64219-01 CP
6	WARP Module Power Lead	N/A	N/A
14	GSM V 3.0 SunCom Sim Card	SunCom	89014 90110 12617 2118

Table 3. Support Equipment



2.6 Ports and Cabling Information

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded (Y/N)	Termination Box ID & Port ID
7	GPS	SSMB Jack	1	N/A		
8	GSM	MCX Jack	1	N/A		
9	Power	103653-1, 104505-1	1	N/A		
10	Data	TX20A	1	N/A		
11	None Listed	Programming Cable	1	0.4	Yes	Data Pot/JAE TX20A-26PH1-D2P1-D1
12	GSM/GPRS/GPS Antenna	Combo GSM/GPS Antenna	1	3	Yes	GPS (SSMB)/ GSM (MCX)
13	Power	WARP Module Lead Power	1	2	No	Power

Table 4. Ports and Cabling Information



2.7 Mode of Operation

Communication with device can be done through the serial connection (programming cable) or via SMS / GPRS by using NEMA Commands. A list of all commands that can be issued to the unit via these two methods are listed in the System Integration Reference and in the NEMA Command Reference.

The unit operates in GSM / GPRS modes and can utilize SMS when available.

GSM- Global Standards for Mobile
GPRS- General Packet Radio Services
SMS- Short Messaging Service

2.8 Method of Monitoring EUT Operation

There are Green and Blue lights on the front of the unit. These lights indicate what operation the unit is undertaking and what the status is.

GPS Status (Green):	Constant ON	Searching for internal fix
	Flash (1 Hz)	GPS 3D navigation
	Constant OFF	Lost GPS signal
GSM Status (Blue):	Constant ON	GSM ON, searching for network
	Slow Flash (0.5 Hz)	GSM registered on network
	Quick Flash (1 Hz)	GSM communication in progress
	Constant OFF	GSM Modem OFF



2.9 Modifications

2.9.1 Modifications to EUT

No modifications were made to the EUT.

2.9.2 Modifications to Test Standard

No modifications were made to the test standard.

2.10 Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Navigational Sciences Inc. upon completion of testing.



3.0 Electromagnetic Compatibility Criteria

3.1 Conducted limits

Test Requirement(s): **15.107 (a)** Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 5. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

15.107 (b) For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 5. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

15.207(a), Except as shown in paragraphs (b) and (c) of this section*, charging, AC adapters or battery eliminators the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the Table 5, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Frequency range (MHz)	Class A Conducted Limits (dB μ V)		*Class B Conducted Limits (dB μ V)	
	Quasi-Peak	Average	Quasi-Peak	Average
* 0.15- 0.45	79	66	66 - 56	56 - 46
0.45 - 0.5	79	66	56	46
0.5 - 30	73	60	60	50
Note 1 — The lower limit shall apply at the transition frequencies.				
Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz.				
* -- Limits per Subsection 15.207(a).				

Table 5. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)

Results: The EUT was not applicable with the requirements of this section. The EUT is DC powered only.



3.2 Radiated Emission Limits

Test Requirement(s): **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 6.

15.109 (b) The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 6.

Frequency (MHz)	Field Strength (dB μ V/m)	
	§ 15.109 (b), Class A Limit (dB μ V) @ 10m	§ 15.109 (a), Class B Limit (dB μ V) @ 3m
30 - 88	39.00	40.00
88 - 216	43.50	43.50
216 - 960	46.40	46.00
Above 960	49.50	54.00

Table 6. Radiated Emissions Limits calculated from FCC Part 15 Subpart B, 15.109 (a) (b)



Test Procedure:

- a) The EUT was placed on a 0.8 m high wooden table (See Photograph 1).
- b) Various antennas were placed near the EUT and measurements were taken of the field strengths and frequencies. For final radiated measurements, the EUT was placed in semi-anechoic chamber, and located 1 m and 3 m from an adjustable antenna mast.
- c) For pre-scanning, the spectrum analyzer scanned the frequency range from 30 MHz to 1 GHz to obtain an emission profile of the EUT. For each point of measurement, the turntable was rotated, and the antenna height was varied between 1 m and 4 m, in order to find the maximum radiated emissions.
- d) Measurements above 30 MHz were taken using the above procedures with the antenna in two polarizations: horizontal and vertical. Unless otherwise specified, measurements between 30 MHz and 1 GHz were made using a quasi-peak detector with a 120 kHz bandwidth.
- e) For measurements above 1 GHz, a 1 MHz detector was used with either a "peak" detector or an "average" detector. In general, all radiated emissions above 1 GHz measurements were made with the average detector unless otherwise noted.

Test Results: The EUT complies with the requirements of this section.

Test Engineer(s): Liming Xu

Test Date(s): 4/19/2005



Electromagnetic Compatibility Criteria

Radiated Emission Limits Test Results

Radiated Emissions Limits Test Results, 15.109 (30 MHz to 1 GHz) Class B

Frequency (MHz)	EUT Azimuth (Degrees)	Antenna Polarity (H/V)	Antenna Height (m)	Uncorrected Amplitude (dBuv)	ACF (dB) (+)	Cable Loss (dB) (+)	DCF (dB) (-)	Corrected Amplitude (dBuv)	Limit (dBuv)	Margin (dB)
98.000	0	H	1.00	9.11	7.60	2.27	0.00	18.98	43.50	-24.52
98.000	0	V	1.00	9.15	7.40	2.27	0.00	18.82	43.50	-24.68
120.500	140	H	1.97	9.10	7.31	2.44	0.00	18.85	43.50	-24.65
120.500	275	V	1.39	13.28	7.83	2.44	0.00	23.55	43.50	-19.95
134.050	78	H	2.99	16.45	7.66	2.53	0.00	26.64	43.50	-16.86
134.050	105	V	1.03	20.50	7.78	2.53	0.00	30.81	43.50	-12.69
144.375	236	H	1.84	12.76	8.07	2.61	0.00	23.44	43.50	-20.06
144.375	64	V	1.03	26.26	8.35	2.61	0.00	37.22	43.50	-6.28
148.750	233	H	1.92	13.26	8.10	2.64	0.00	24.00	43.50	-19.50
148.750	62	V	1.03	26.18	8.25	2.64	0.00	37.07	43.50	-6.43
464.975	95	H	2.11	12.01	16.90	4.34	0.00	33.25	46.00	-12.75
464.975	202	V	1.03	10.96	17.10	4.34	0.00	32.40	46.00	-13.60

Note: There are no detectable emissions from 464 MHz to 20 GHz.



Radiated Emission Limits Test Setup



Photograph 1. Radiated Emission Limits, Test Setup



4.0 Electromagnetic Compatibility Criteria for Broadband PCS Devices

4.1 RF Power Output

Test Requirement(s): § 2.1046 Measurements required: RF power output:

§ 2.1046 (a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

§ 2.1046 (b) For single sideband, independent sideband, and single channel, controlled carrier radiotelephone transmitters, the procedure specified in paragraph (a) of this section shall be employed and, in addition, the transmitter shall be modulated during the test as specified and as applicable in § 2.1046 (b) (1-5). In all tests, the input level of the modulating signal shall be such as to develop rated peak envelope power or carrier power, as appropriate, for the transmitter.

§ 2.1046 (c) For measurements conducted pursuant to paragraphs (a) and (b) of this section, all calculations and methods used by the applicant for determining carrier power or peak envelope power, as appropriate, on the basis of measured power in the radio frequency load attached to the transmitter output terminals shall be shown. Under the test conditions specified, no components of the emission spectrum shall exceed the limits specified in the applicable rule parts as necessary for meeting occupied bandwidth or emission limitations.

§ 24.232 Power and antenna height limits.

§ 24.232 (b): Mobile/portable stations are limited to 2 watts e.i.r.p. peak power and the equipment must employ means to limit the power to the minimum necessary for successful communications.



Test Procedures:

- a) The EUT was placed on a 0.8 m high wooden table (See Photograph 2).
- b) As required by 47 CFR 2.1046, RF power output measurements were made at the RF output terminals using an attenuator and spectrum analyzer. This test was performed with carrier modulated by a PCS GSM, modulated signal.

Test Results:

The EUT complies with the requirements of this section. The EUT conducted power does not exceed limit at the carrier frequency.

Test Engineer(s):

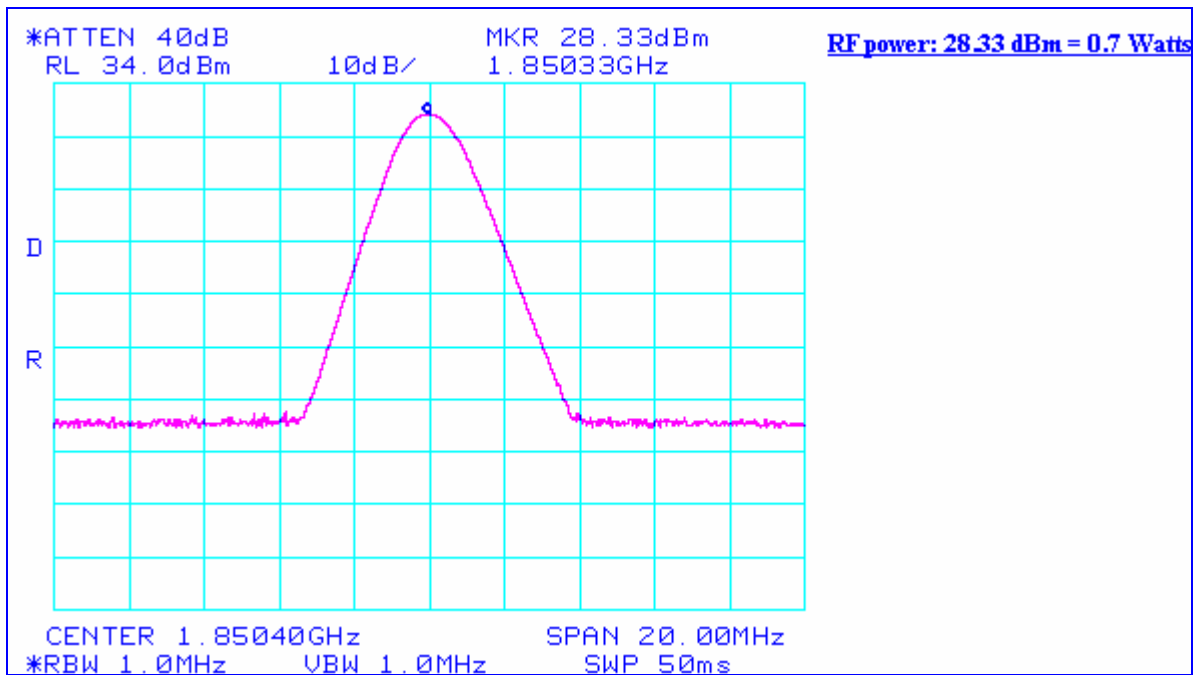
Liming Xu

Test Date(s):

2/21/2005



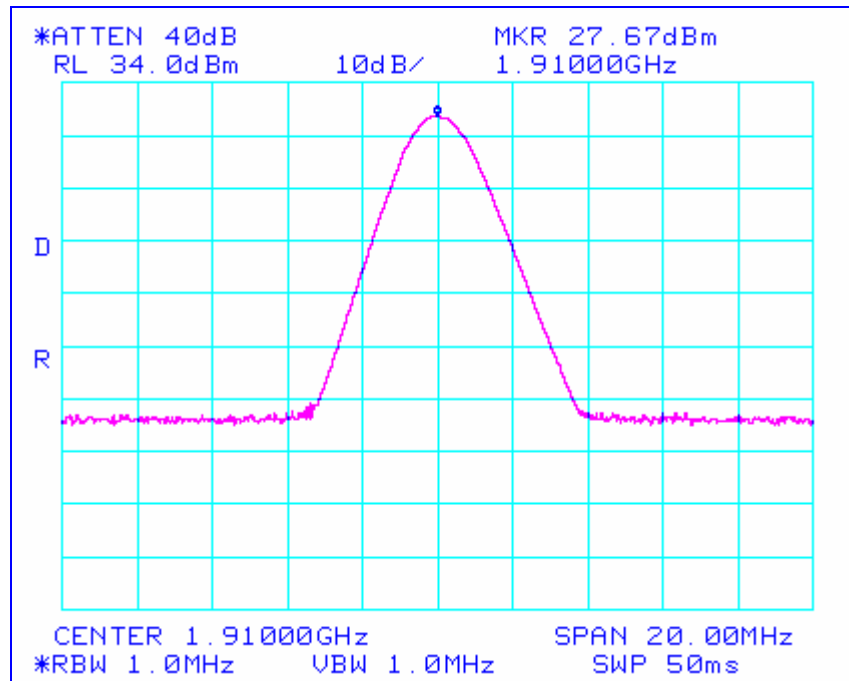
RF Power Output Test Results



Plot 1. RF Power Output Test Results



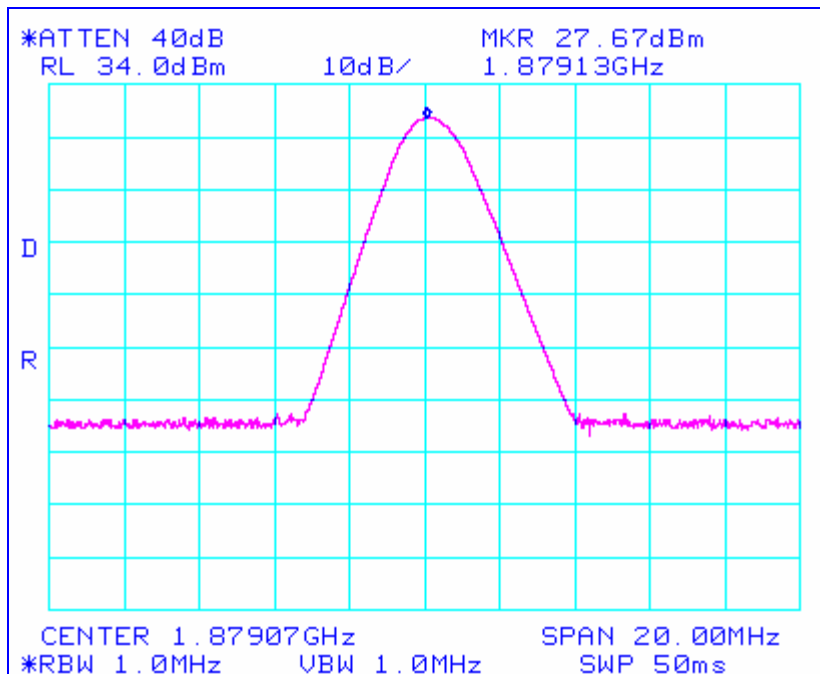
RF Power Output Test Results



Plot 2. RF Power Output Test Results



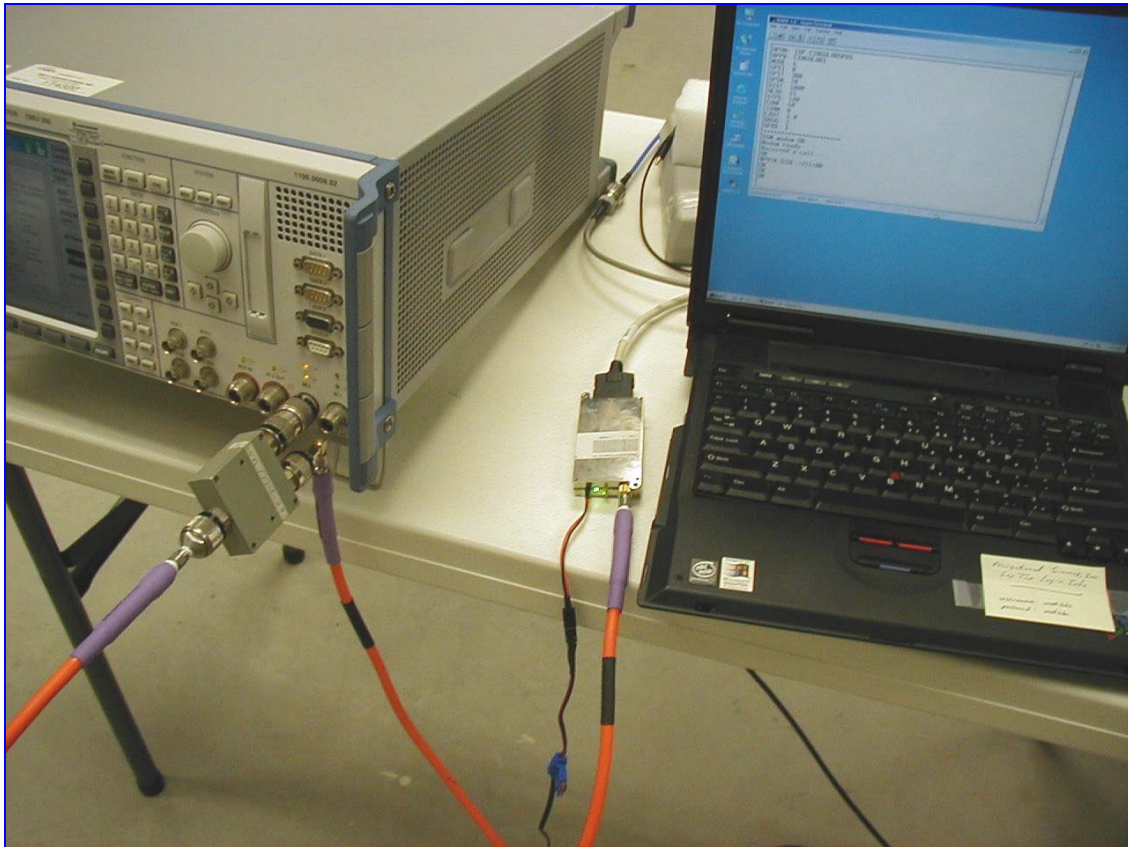
RF Power Output Test Results



Plot 3. RF Power Output Test Results



WARP 1.0 Part 24 Test Setup



Photograph 2. EUT Test Setup for Part 24



4.2 Modulation Characteristics

Test Requirement(s): § 2.1047 Measurements required: Modulation characteristics

§ 2.1047 (a): Voice modulated communication equipment. A curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage shall be submitted.

Test Procedures:

- a) The EUT uses GMSK modulation. In GMSK modulation, voice or data information is digitized and coded into a bit stream.
- b) Modulation plots were taken in order to give a detailed explanation of the modulation scheme used in the EUT of the PCS system.

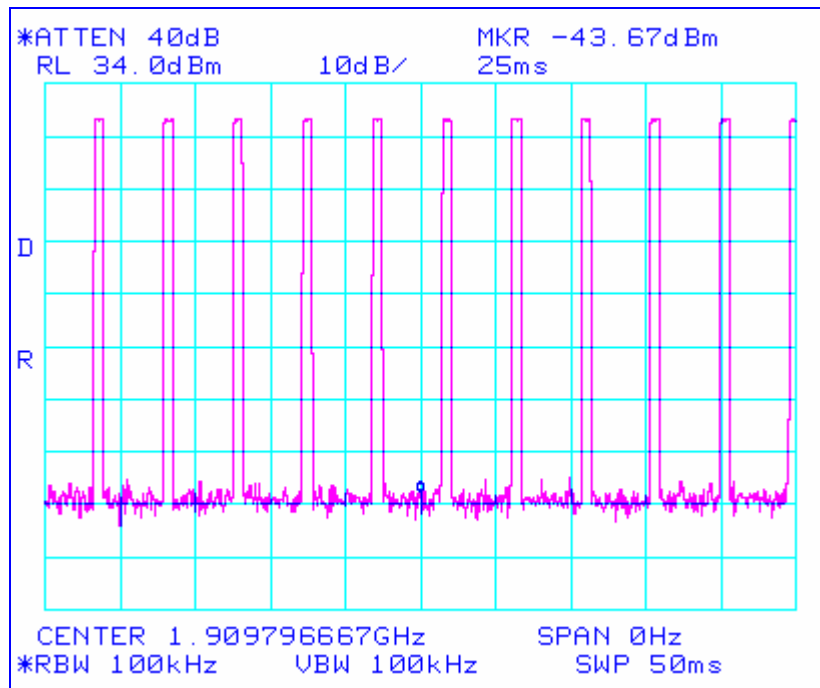
Test Results: The EUT complies with the requirements of this section. The following plot illustrates a detailed explanation of the modulation scheme used in the EUT of the PCS system.

Test Engineer(s): Liming Xu

Test Date(s): 4/13/2005



Modulation Characteristics Test Results



Plot 4. Modulation Characteristics Test Results



4.3 Occupied Bandwidth

Test Requirement(s): **§ 2.1049 Measurements required: Occupied bandwidth:** The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the specified conditions of § 2.1049 (a) through (i) as applicable.

Test Procedures:

- a) As required by §2.1049 of CFR 47, occupied bandwidth measurements were made on the EUT.
- b) The EUT was configured to transmit a PCS GMSK modulated carrier signal.
- c) Using an IF bandwidth of 10 kHz, the test engineer determined the occupied bandwidth of the emission at the center of the selectable channel range and recorded the detailed measurements as plotted data.

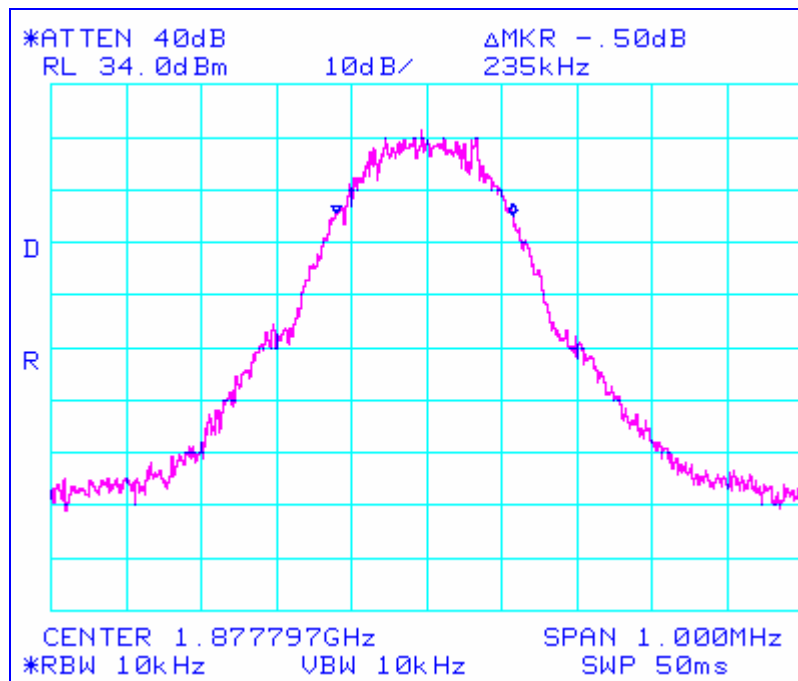
Test Results: The EUT complies with the requirements of this section.

Test Engineer(s): Liming Xu

Test Date(s): 4/13/2005



Occupied Bandwidth Test Results



Plot 5. Occupied Bandwidth Test Results



4.4 Spurious Emissions

4.4.1 Spurious Emissions at Antenna Terminals

Test Requirement(s): § 2.1051 **Measurements required: Spurious emissions at antenna terminals:** The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

24.238 Emission limitations for Broadband PCS equipment: The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

§ 24.238 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.

Test Procedures:

- As required by 47 CFR 2.1051, spurious emissions at antenna terminal measurements were made at the RF output terminals using a 50 Ω attenuation and spectrum analyzer set for a 100 kHz bandwidth.
- The RBW of 100 kHz was used to investigate and search for spurious emissions; any spurious emissions found with this technique were re-measured with the appropriate 1 MHz RBW.
- This test was performed with digitally modulated carrier signals, and the EUT was adjusted for continuous transmission on frequencies across the operating band.
- The frequency spectrum was investigated from 9.0 KHz to 20.0 GHz. For measuring emissions above 2 GHz, a high-pass filter was used to eliminate the fundamental transmit frequency to prevent possible saturation effects on the front end of the spectrum analyzer.

Test Results: The EUT complies with the requirements of this section. There were no detectable spurious emissions for this EUT.

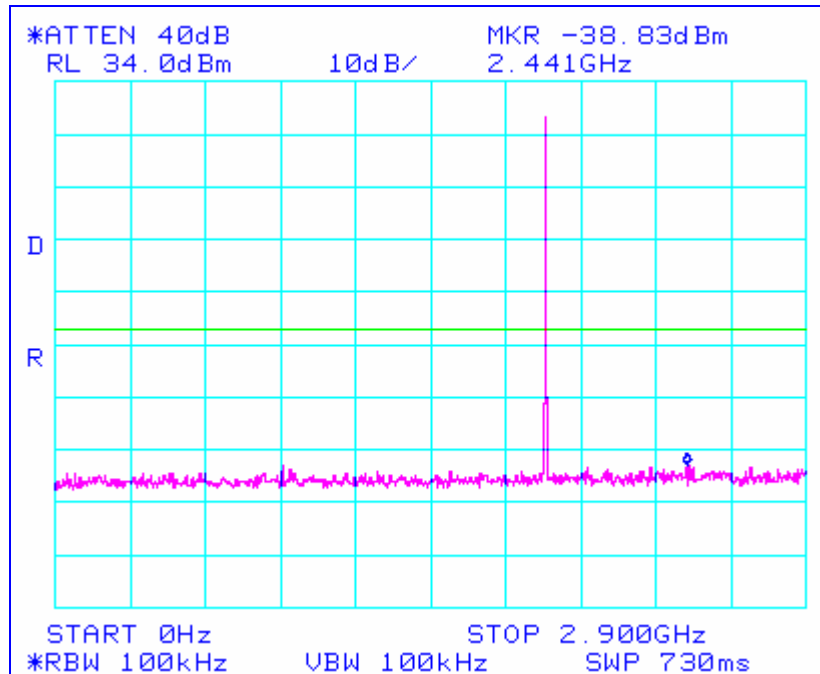
Test Engineer(s): Liming Xu

Test Date(s): 4/14/2005



Spurious Emissions at Antenna Terminals Test Results

Conducted Spurious Emissions Measurements at Antenna Terminals, Test Data Plots

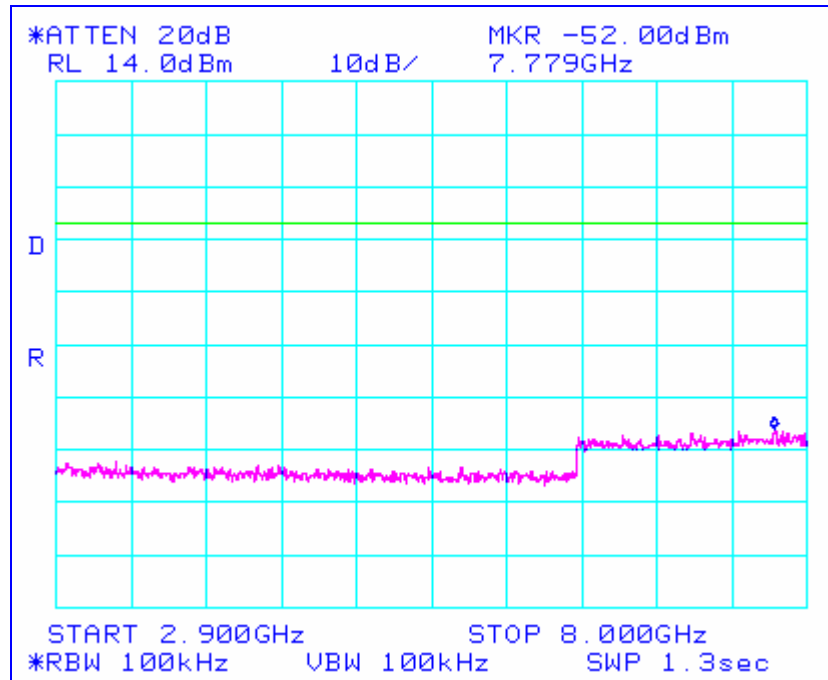


Plot 6. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results



Spurious Emissions at Antenna Terminals Test Results

Conducted Spurious Emissions Measurements at Antenna Terminals, Test Data Plots

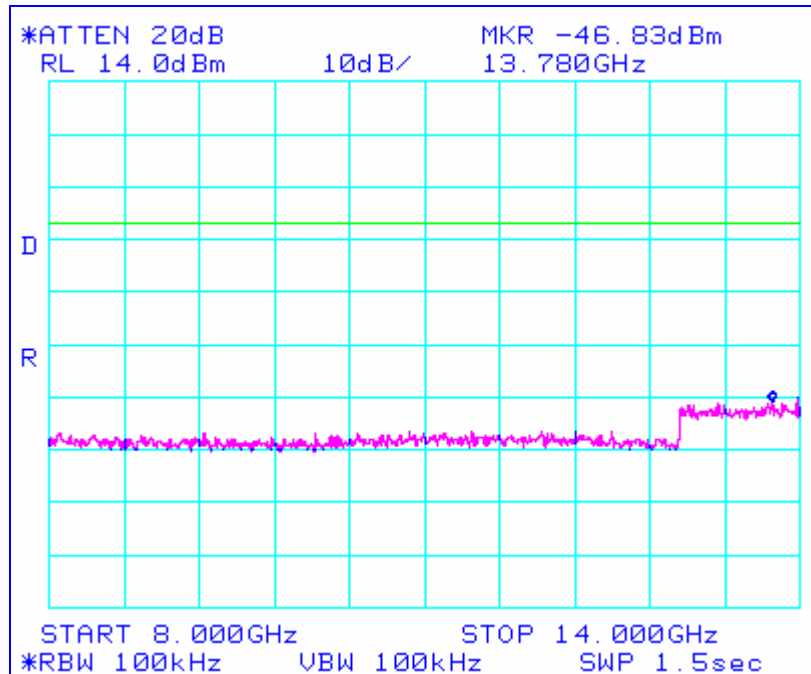


Plot 7. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results



Spurious Emissions at Antenna Terminals Test Results

Conducted Spurious Emissions Measurements at Antenna Terminals, Test Data Plots

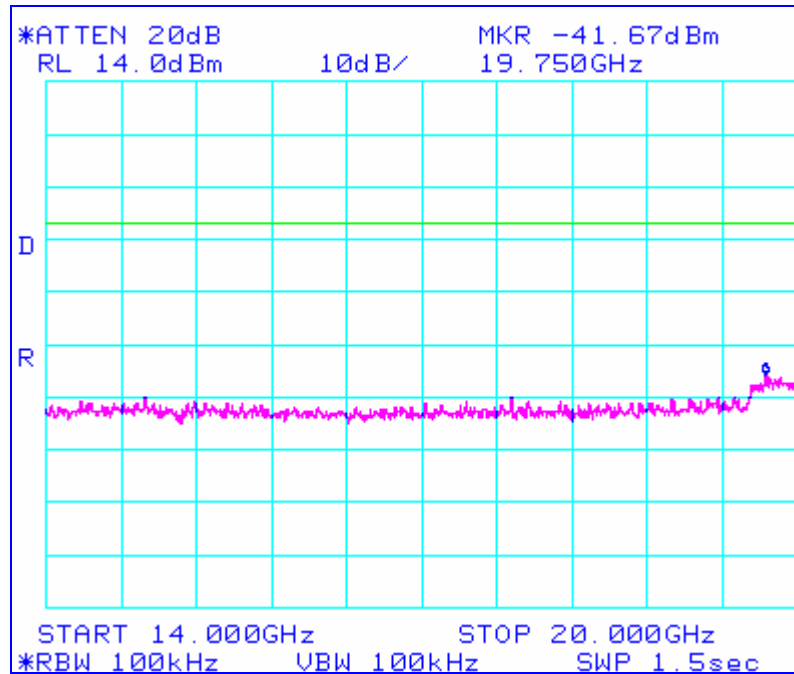


Plot 8. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results



Spurious Emissions at Antenna Terminals Test Results

Conducted Spurious Emissions Measurements at Antenna Terminals, Test Data Plots



Plot 9. Conducted Spurious Emissions Measurements at Antenna Terminals Test Results



4.4.2 Spurious Emissions at Antenna Terminal Frequency Block Edges

Test Requirement(s): § 2.1051 **Measurements required: Spurious emissions at antenna terminals:** The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

24.238 Emission limitations for Broadband PCS equipment: The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

§ 24.238 (b): Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

Test Procedures:

- a) As recommended in FCC Part 24, greater than or equal to 1% of emission spectrum bandwidth was chosen to measure the peak of any emission inside the 1.0 MHz frequency band adjacent to each frequency block edge. All other frequencies were measured using a 3 KHz RBW.
- b) The unit was exercised using signal types required by §2.1049.

Test Results: The EUT complies with the requirements of this section. Modulation products outside of this band are attenuated at least $43 + 10 \log(P)$ below the level of the modulated carrier.

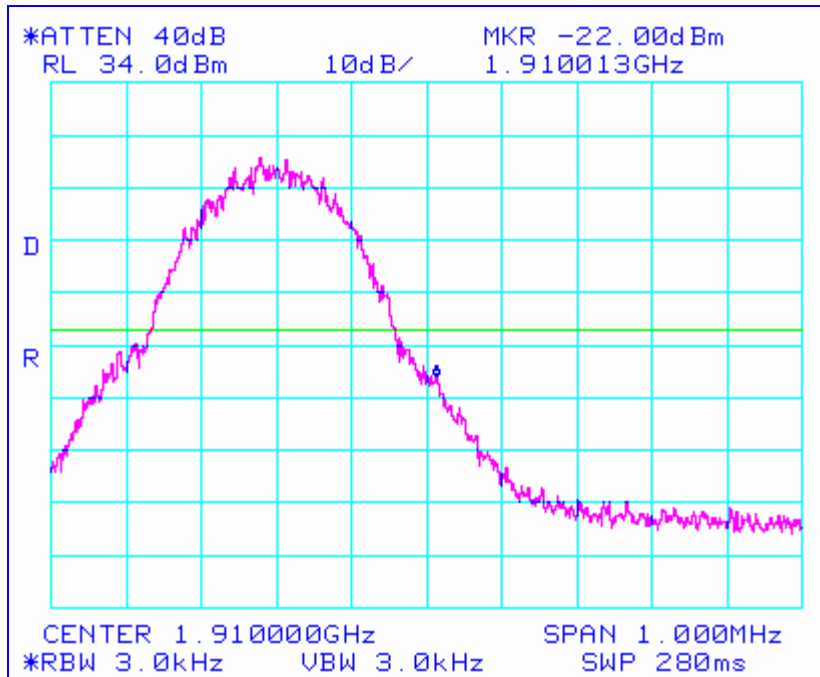
Test Engineer: Liming Xu

Test Date(s): 4/22/2005



Spurious Emissions at Antenna Terminal Frequency Block Edges Test Results

Spurious Emissions (Block Edges) Test Data Plots

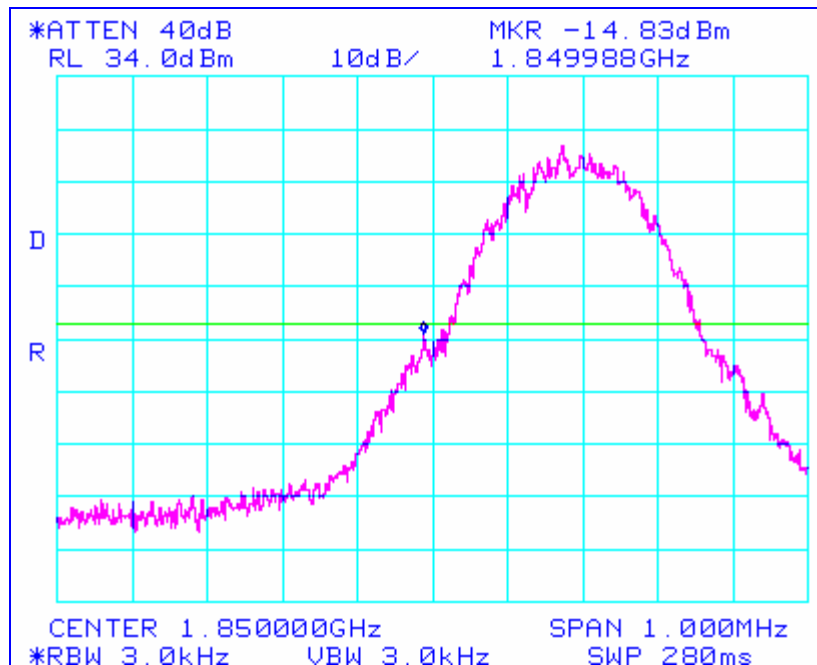


Plot 10. Conducted Spurious Emissions- Block Edges Test Results



Spurious Emissions at Antenna Terminal Frequency Block Edges Test Results

Spurious Emissions (Block Edges) Test Data Plots



Plot 11. Conducted Spurious Emissions- Block Edges Test Results



4.4.3 Radiated Spurious Emissions

Test Requirement(s): § 2.1053 Measurements required: Field strength of spurious radiation.

§ 2.1053 (a) Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of § 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from half-wave dipole antennas.

§ 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

- (1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
- (2) All equipment operating on frequencies higher than 25 MHz.
- (3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
- (4) Other types of equipment as required, when deemed necessary by the Commission.

§ 24.238 Emission limitations for Broadband PCS equipment: The rules in this section govern the spectral characteristics of emissions in the Broadband Personal Communications Service.

§ 24.238 (a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least $43 + 10 \log(P)$ dB.



Test Procedures:

- a) As required by §2.1053, field strength of spurious radiation measurements were made in accordance with the general procedures of the EIA/TIA Substitution Method.
- b) Preliminary radiated emission measurements were performed inside a shielded chamber with all digital signal generators on and terminated. The frequency list from the preliminary measurements was used as a guide for making final measurements in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site).
- c) The unit was scanned over the frequency range of the lowest system oscillator value to 20 GHz.
- d) The Radiated Spurious Emissions Limit is obtained by the following:
- e) Based on an output power (as measured at the output of the Antenna port) of 0.7 watts:

$$P_o = 0.7 \text{ W}$$

the radiated power level of all spurious emissions must be attenuated by at least $43 + 10\log(P_o)$ below P_o , yielding:

$$P_o - [43 + 10\log(P_o)] = -13\text{dBm}$$

Test Results: The EUT complies with the requirements of this section.

Test Engineer: Liming Xu

Test Date(s): 4/22/2005



Radiated Spurious Emissions



Photograph 3. Radiated Spurious Emissions, Test Setup



Radiated Spurious Emissions



Photograph 4. Radiated Spurious Emissions, Test Setup



4.4.4 MPE Calculation

The MPE calculation for Navigational science PCS module (700mW conducted power) and @ 20cm; the maximum antenna gain 5.0 dBi (Antenna numeric gain $G = 3.2$) (33dBm limit)

$$\begin{aligned} P_d &= PG / 4\pi R^2 \\ &= (700 \times 3.2) / 12.566 \times (20)^2 \\ &= (2240) / 12.566 \times 400 \\ &= (2240) / 5026.4 \\ &= 0.45 \text{ mW/cm}^2 \end{aligned}$$

* P_d = power density in mW/cm^2

* G = Antenna numeric gain (3.2); $\text{Log } G = g/10$ ($g = 5.0$).

* P = Conducted RF power to antenna (700 mW).

* R = Minimum allowable distance.(20 cm)

*The power density $P_d = 0.45 \text{ mW/cm}^2$ is less than 1 mW/cm^2 (listed MPE limit for General Population)

*The EUT/antenna should be 20cm away from the general population with the maximum antenna gain 5.0 dBi. (Based on the 2 Watts limit)

** Antenna gain (g) must be equal or less then 1 dBi for compliance with band edge emissions on low side.



4.5 Frequency Stability over Temperature Variations

Technical Specifications: §2.1055(a)(1)

Measurement Procedures: As required by §2.1055(a)(1) of CFR 47, *frequency tolerance measurements* were made over the temperature range of -30°C to +50°C. The frequency measurements were made using direct input to a spectrum analyzer. Climatic control was accomplished using an environmental simulation chamber. The temperature was first lowered to -30°C and then raised hourly in 10° increments. The unit remained in the chamber during temperature transitions and during the measurement process.

Temperature (°C)	Carrier Frequency (CH 600) (MHz)	Frequency Deviation (Hz)	Deviation Limit (KHz)
-30	1867.80000	50 *	± 1.86
-20	1867.80000	50 *	± 1.86
-10	1867.80000	50 *	± 1.86
0	1867.80000	50 *	± 1.86
+10	1867.80000	50 *	± 1.86
+20	1867.80000	50 *	± 1.86
+30	1867.80000	50 *	± 1.86
+40	1867.80000	50 *	± 1.86
+50	1867.80000	50 *	± 1.86

Table 7. Carrier Frequency Deviations Due To Temperature Instability

* The frequency deviation is less than 50 Hz,

* There is no detectable frequency variation when the frequency counter was set to 10Hz resolution.

*The unit meets the requirements of 2.1055 (a)(1)

Test Results: The EUT complies with the requirements of this section. Frequency tolerance of carrier signal: +/- 0.0001% (+/- 1ppm) for a temperature variation from -30°C to +50°C at normal supply voltage.

Test Engineer: Liming Xu

Test Date: 04/19/2005



4.6 Frequency Stability over Voltage Variations

Technical Specifications: §2.1055(d)(1)

Measurement Procedures: As required by §2.1055(d)(1) of CFR 47, *frequency tolerance measurements* were made over changes in the supply voltage to the EUT from 85% to 115% of the nominal supply voltage using a variable transformer to vary the AC supply. The frequency measurements were made using direct input to a spectrum analyzer.

Test Results: Frequency tolerance of carrier signal: $\pm 0.0001\%$ for a variation in primary voltage from 85% to 115% of the rated supply.

Percentage of Rated Supply	DC Voltage (V)	Carrier Frequency (MHz)	Frequency Deviation (Hz)	Deviation Limit (kHz)
85%	10.2	1867.80000	50 *	± 1.87
100%	12.0	1867.80000	50 *	± 1.87
115%	13.8	1867.80000	50 *	± 1.87

Table 8. Carrier Frequency Deviations Due to Voltage Variations

* The frequency deviation is less than 50 Hz,

* There is no detectable frequency variation when the frequency counter was set to 10Hz resolution.

Test Results: The EUT complies with the requirements of this section. The unit meets the requirements of 2.1055 (d)(1).

Test Engineer: Liming Xu

Test Date: 04/18/2005



5.0 Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of *ANSI/NCSL Z540-1-1994* and *ANSI/ISO/IEC 17025:2000*.

Test Equipment					
MET Asset #	Nomenclature	Manufacturer	Model	Last Cal Date	Cal Due Date
1T4300	Semi-Anechoic Chamber # 1	EMC Test Systems	NONE	5/3/2003	4/3/2006
1T4303	Antenna; BILOG	Schafner-Chase EMC	CBL6140A	8/22/2004	4/22/2005
1T2665	Antenna; Horn	EMCO	3115	3/28/2005	3/28/2006
1T2511	Antenna; Horn	EMCO	3115	4/14/2004	7/14/2005
1T4351	Spectrum Analyzer	Agilent	E7405A	9/28/2004	9/28/2005
1T4302	EMI Receiver	HP	85462A	10/18/2004	10/18/2005
1T4320	Universal Radio Communication Tester	Rhode & Schwarz	CMU200	8/9/2004	8/9/2007
1T4453	Vector Signal Generator	Rhode & Schwarz	SMIQ03	2/23/2005	2/23/2006



6.0 Compliance Information

6.1 Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

§ 2.801 Radio-frequency device defined.

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

- (a) The various types of radio communication transmitting devices described throughout this chapter.
- (b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*
- (c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.
- (d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

§ 2.803 Marketing of radio frequency devices prior to equipment authorization.

- (a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:
 - (1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or
 - (2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.
- (d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the



equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

- (e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:
 - (i) *Compliance testing;*
 - (ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;
 - (iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or
 - (v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.
- (e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.
- (f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.



**The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J —
Equipment Authorization Procedures:**

§ 2.901 Basis and Purpose

- (a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.¹ *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.
- (b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

§ 2.907 Certification.

- (a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.
- (b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

¹ In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.



§ 2.948 Description of measurement facilities.

- (a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.
 - (1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.
 - (i) *If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*
 - (ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.
 - (2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.



6.2 Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

§ 15.19 Labeling requirements.

(a) *In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

- (1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

- (2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

- (3) All other devices shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

- (4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

- (5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

§ 15.21 Information to user.

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.



The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

§ 15.105 Information to the user.

- (a) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.