Telemics Inc.
111 W. Washington Street
Suite 300
Louisville, KY 40202

FCC Part 15 Certification Application

Industrie Canada RSS210 Certification

EMI Test Report
and
Technical Documentation
On the
"Telemics Verics™ Module"

FCC ID: QC5-09-MSS1
IC: 4435A-09-MSS1

Prepared by:
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General Information

Unit Under Test: Telemics Verics™ Module

FCC ID: QC5-09-MSS1

Industrie Canada ID: 4435A-09-MSS1

Tested For: Telemics, Inc.
111 W. Washington Street
Suite 300
Louisville, KY 40202

Tested At: Elliott Laboratories
684 West Maude Ave
Sunnyvale, CA 94086

Tested By: David Waitt, (Independent Consultant)
Chris Byleckie, Test Engineer, Elliott Laboratories
Juan Matinez, Test Engineer, Elliott Laboratories

Test Specifications: FCC CFR 47, Part 15.247, 900MHz Spread Spectrum Intentional Radiator Industrie Canada RSS 210 - 6.2.2(O)

Test Date: Oct 2002

Requested Certification: 900MHz frequency hopping module approval.

Company Background Telemics is a provider of low cost, wireless networks for streetlight monitoring. We have developed a wireless network called Verics™, which is used for the monitoring and control of outdoor devices such as streetlights. More info on our network exists at http://www.telemics.com/

The “building blocks” that presently make up this infrastructure consist of small radios that will be mounted on streetlights. The radios consist of a plastic housing that connects directly to, and is powered from, the streetlight that incorporates a power supply board and a 900MHz frequency-hopping module. There are presently two products using the Verics™ Module tested as part of this report. The "CheckPoint” uses an internal omni directional antenna described as "Antenna 1" in this report. The "AccessPoint" utilizes one external omni antennas described as "Antenna 2" in this report.

Detailed Product Information

Telemics wishes to certify the frequency-hopping module only. Telemics is pursuing a module approval in order to allow the rapid development of a radio aimed at a limited number of customer specific needs. A module certification allows Telemics to meets its customers' requirements by providing a FCC certified radio in a short amount of time.

Currently, however, the only projected use for the Verics™ Module is within the products that make up the Streetlight control infrastructure, however the module may be used elsewhere in the future either by Telemics or another company.

RF Module:
The module is a 900 MHz frequency hopping module that transmits 100 mW peak output power and uses 101, 250 kHz wide channels.

Antennas:
1) internal solder attach helical wire omni-directional antenna (Telemics Helical)
2) external coaxial dipole omni-directional antenna (Astron Coaxial Dipole)

Data for each of these antennas has been uploaded with this application.

Multiple Antennae
In the event Telemics sells the Verics™ Module to outside companies wishing to incorporate the module into their product, Telemics will ensure that each customer of the module clearly understands that the module is ONLY certified for use with the antennas specified in the application or antennae of the same type and gain as those specified in this application. If a different type of antenna of higher gain antenna is to be used with the module, a permissive change application against this certification will be filed with the commission.

Additionally Telemics will ensure that the customer of the Verics™ Module is aware of the fact that the module must be professionally installed in order to comply with 15.203

Modular Certification Requirements:
The Verics™ Module satisfies all of the requirements of the FCC for modular approval. These criteria and the manner in which they are satisfied are outlined in the "Modular Approval Request Letter" uploaded with this application

Results Summary

The following test were performed to demonstrate compliance with FCC Part 15.247 and RSS-210 6.2.2.(o). Compliance with the following Part 15 / RSS-210 regulations was verified:

Part 15 Paragraph	RSS-210 Paragraph	Test	Results
15.247(b)	6.2.2(o)(a) 3	Maximum Power Output at Antenna Terminal	20.58 dBm Max
15.247(a)(1)	6.2.2(o)(a)	Channel Frequency Separation (20dB BW)	165 kHz Max
15.247(a)(1)(I)	6.2.2.(O)(a)-1	Minimum Number of Hopping Channels	100 Demonstrated (101 Actual)
15.247(a)(1)	6.2.2.(O)(a)-1	Average Channel Occupancy Time	9.28 ms / 20 Sec Avg.
15.247(c)	6.2.2(o)(a) 4	Out of Band Conducted Emissions	-53.68 dBc at band edge
15.205	6.3(c)	Radiated Emissions in Restricted bands	.4.6 dB in spec min

Test Facilities

Radiated emissions tests in accordance with FCC Part 15.205 and IC RSS210 6.2.2(O)(a)(5)

Were conducted at:

Elliott Labs
684 West Maude Ave
Sunnyvale, CA 94086

General:

Elliott Laboratories is located at 684 West Maude Ave in Sunnyvale, California. Elliott maintains several Open Air Test Sites (OATS) at this location for Radiated Emissions testing. Pursuant to section 2.948 of the Rules, Construction, calibration and equipment data has been filed with the FCC and Industrie Canada.

OATS:

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated emissions are performed in an open field environment. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 Guidelines.

Antenna, Antenna Mast and Turntable

The Horn antennas that are use to measure radiated emissions above 1000MHz are amounted on a non-conductive antenna mast equipped with a motor drive to vary the antenna height.

ANSI C63.4 specifies that the test height above the ground plane shall be 80cm unless the equipment is intended to be floor mounted. During the radiated emissions tests the equipment is positioned on a motorized turntable in conformance with the ANSI requirement.

All remaining “Conducted RF” tests (20 dB BW, Channel spacing, number of hopping channels, etc...) were performed by David Waitt utilizing the Agilent spectrum analyzer below

Item	Desc.	Manufacturer	Model	S/N	Cal due date
1.	Spectrum Analyzer	Agilent	4404B	US39440486	25 Feb 03

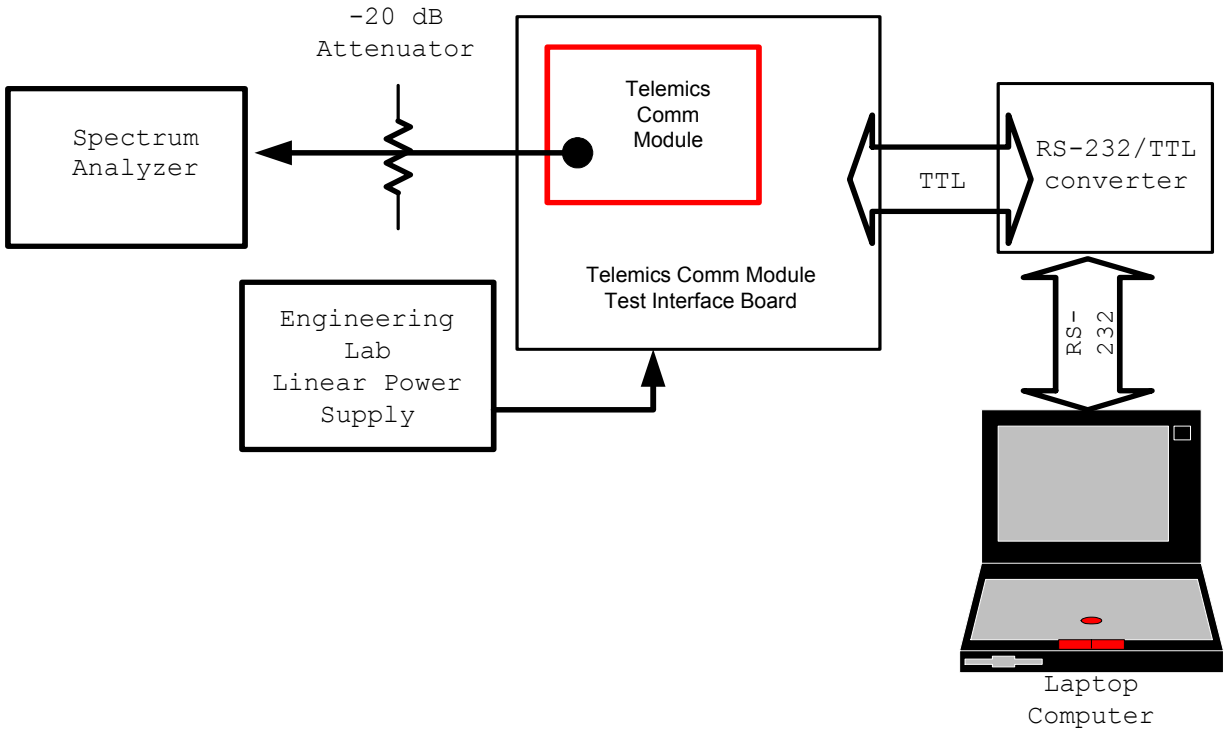
Test Methods

Many of the tests are performed at the low, middle and the high portion of the 902 - 928 MHz band. These tests are typically performed on the following channels / frequencies:

Channel	Frequency (MHz)
0	902.25
51	915.0
100	927.25

The tests below are performed using the basic test setup shown below. In several cases it is required that the EUT have the hopping function disabled in order to make the required measurement, because of this necessity, the EUT was running special diagnostic firmware to allow this functionality. The test interface board is NOT part of the UUT, its purpose it to provide power to the module and provide serial communications to / from the Verics™ Module.

Part 15	RSS210	Test
15.247(a)(1)	6.2.2(O)(a)	Channel Frequency Separation
15.247(c)	6.2.2(O)(a) 4	Out of Band Conducted Emissions
15.247(a)(1)(I)	6.2.2(O)(a)-1	Minimum Number of Hopping Channels
15.247(a)(1)	6.2.2(O)(a)(1)	Maximum time on Channel
15.247(a)(2)	6.2.2(o)	Transmit Power



Conducted RF Bench Test Setup
Figure 1

Test Results

Detailed test procedures and test results are contained in the following sections. In cases where the test setup differs from the Conducted RF test setup shown earlier, the test setup is also presented.

Unless otherwise noted, the support equipment and the test conditions for the following tests are given in the tables below.

Support Equipment				
Description	**Model number**	**FCC ID or SN**	**Manufacturer**	**Power Cable**
Laptop	390E	SN AF19B6R	IBM	Unshielded AC Adapter
Communications / power interface card	Engineering test fixture	*na*	Telemics	Generic AC adapter
RS-232 / TTL converter	Engineering test fixture	*na*	Telemics	NA

Test Conditions			
Temperature	16 C	**Humidity:**	52%
ATM pressure	1017 mBar	**Grounding:**	None
Tested By	David Waitt	**Date of Test:**	12 Oct 2002
Test Reference	Refer to individual test results		
Tested Range	Test Dependent		
Test Voltage	5 VDC to the module		
Modifications	No modifications were made to the unit during the tests		

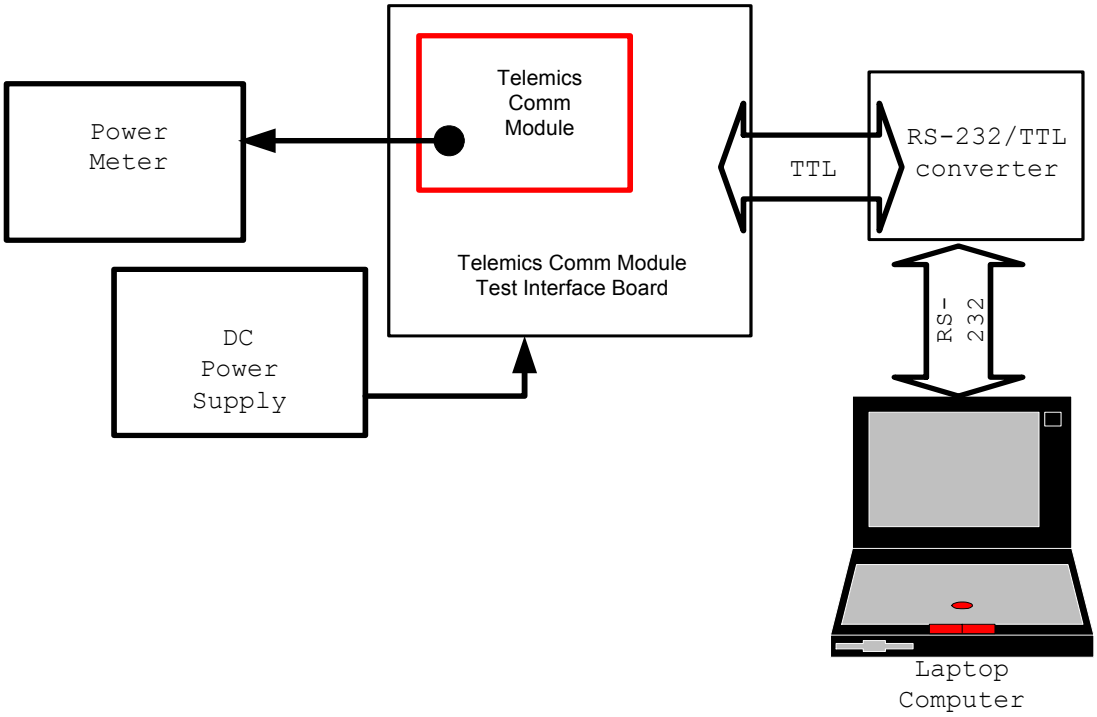
Maximum RF Power Output at Antenna Terminals

Specifications:

FCC Specification: Paragraph: 15.247(b)
Industrie Canada Specification: Paragraph RSS210, 6.2.2(o)(a) 3

Procedure:

The EUT was running on the diagnostic firmware the hopping function was disabled. The test was configured as shown below. The unit was then set to the individual channels shown below and the power read directly from the power meter on the low, mid and high channels.



Transmit Power test Setup
Figure 2

Result:

The following power levels were measured on low, mid and high channels

Freq. (MHz)	Level (dBm)	Level (mW)
902.25	+20.58	114.28
915.00	+20.02	100.46
927.25	+19.17	82.60

20 dB bandwidth

Specifications

FCC Specification: Paragraph 15.247(a)(1)
Industrie Canada Specification: Paragraph RSS210, 6.2.2(o)(a) 3

Procedure:

The channels that the Telemics module operates on are evenly spaced within the 902.25 to 927.25 MHz band, and there are 101 channels. By design, the channel bandwidth is 250kHz.

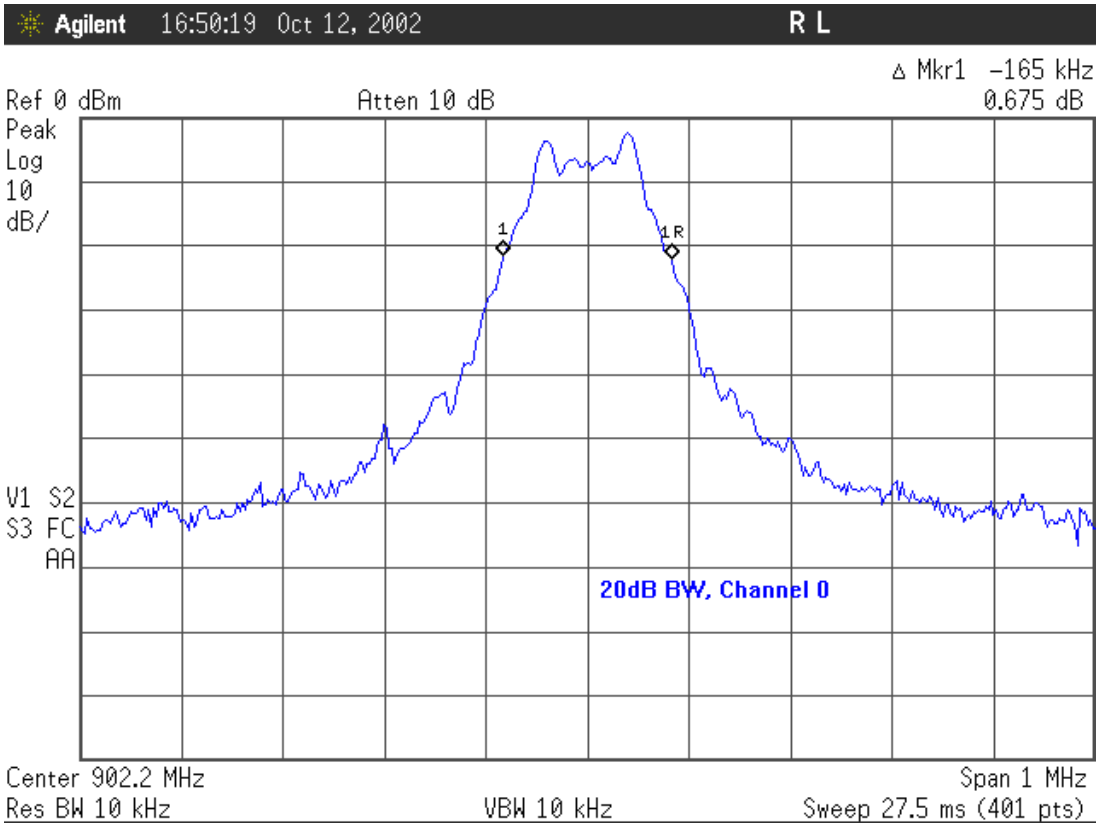
The spectrum analyzer was set to a span of 1 MHz kHz. The RBW = VBW = 10 kHz. The trace was set to MAX HOLD. The trace was allowed to stabilize and a "Marker Peak Search" was performed. The marker delta function was then used to determine the –20 dBc point. This point was then established as the reference for another delta measurement. The marker was then moved to the other side of the emission and adjusted to be equal to the reference level established previously. The delta between these two markers is the 20 dB bandwidth. This procedure was repeated for the three test channels. The test setup used in figure 1 was used

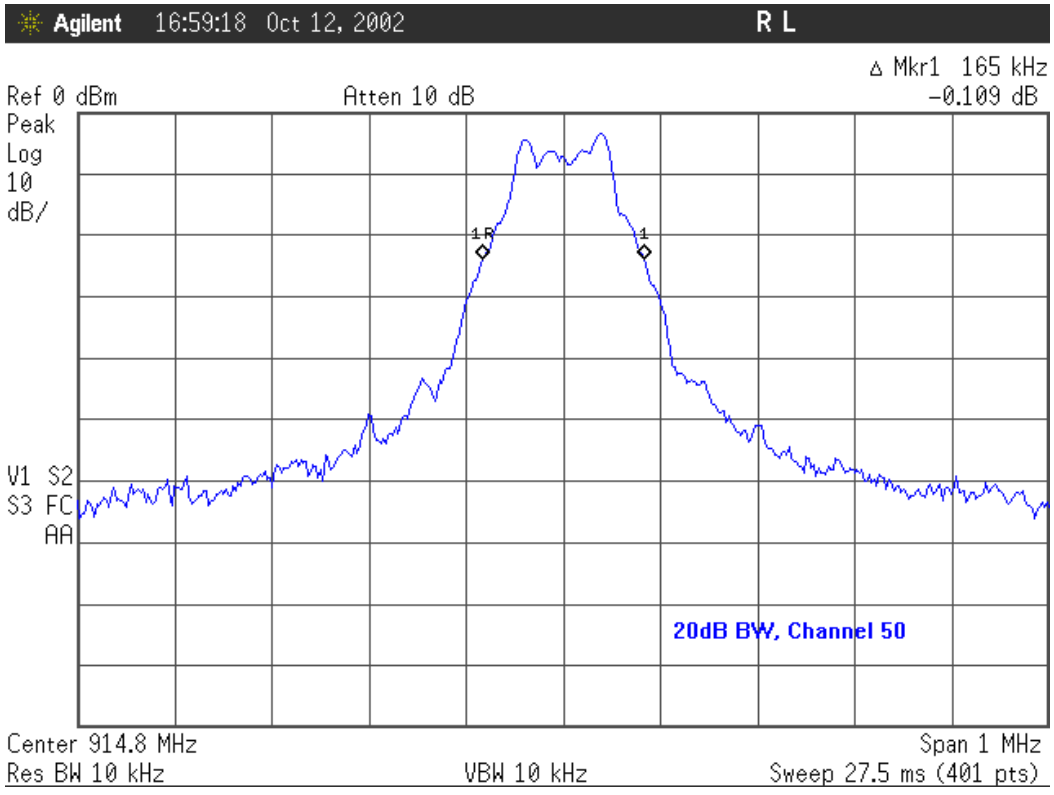
Results:

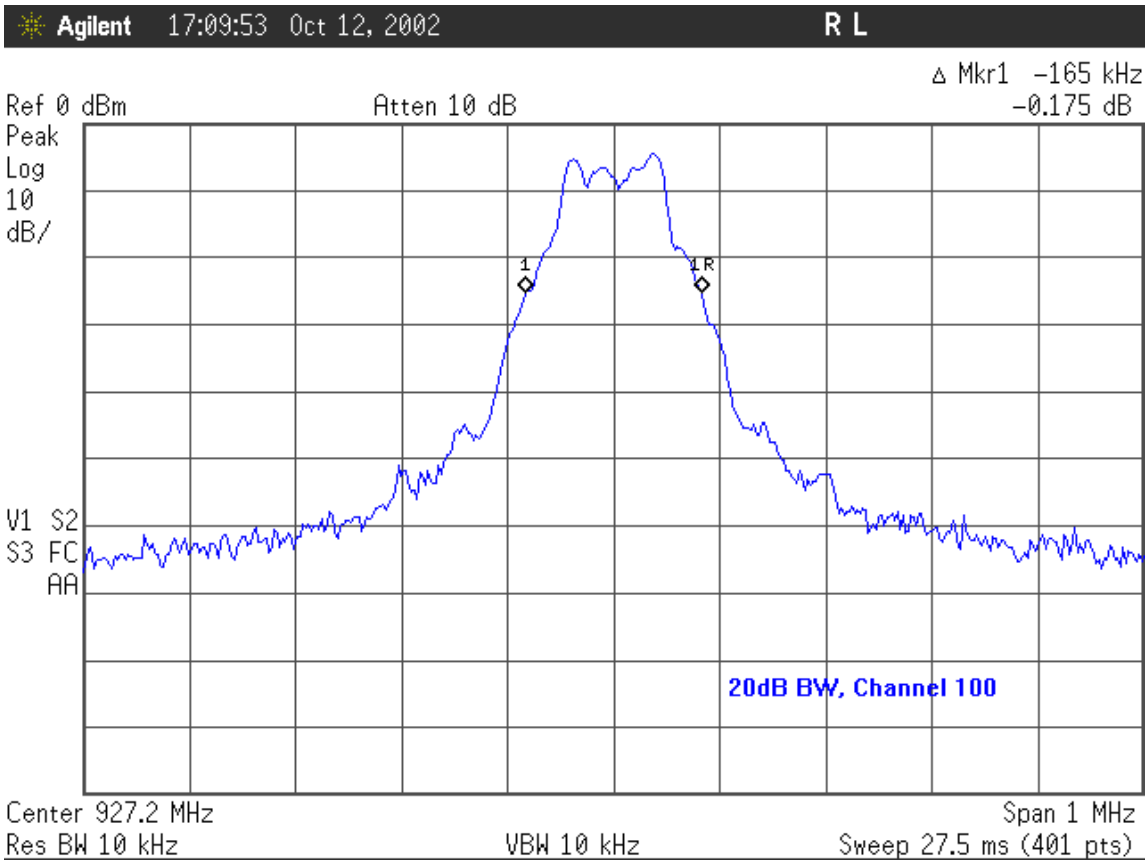
The occupied bandwidth of the EUT was measured as shown below.

Channel	Bandwidth(kHz)
0	165
50	165
100	165

Plots showing the bandwidths for the low mid and high channels are below.







Channel Frequency Separation

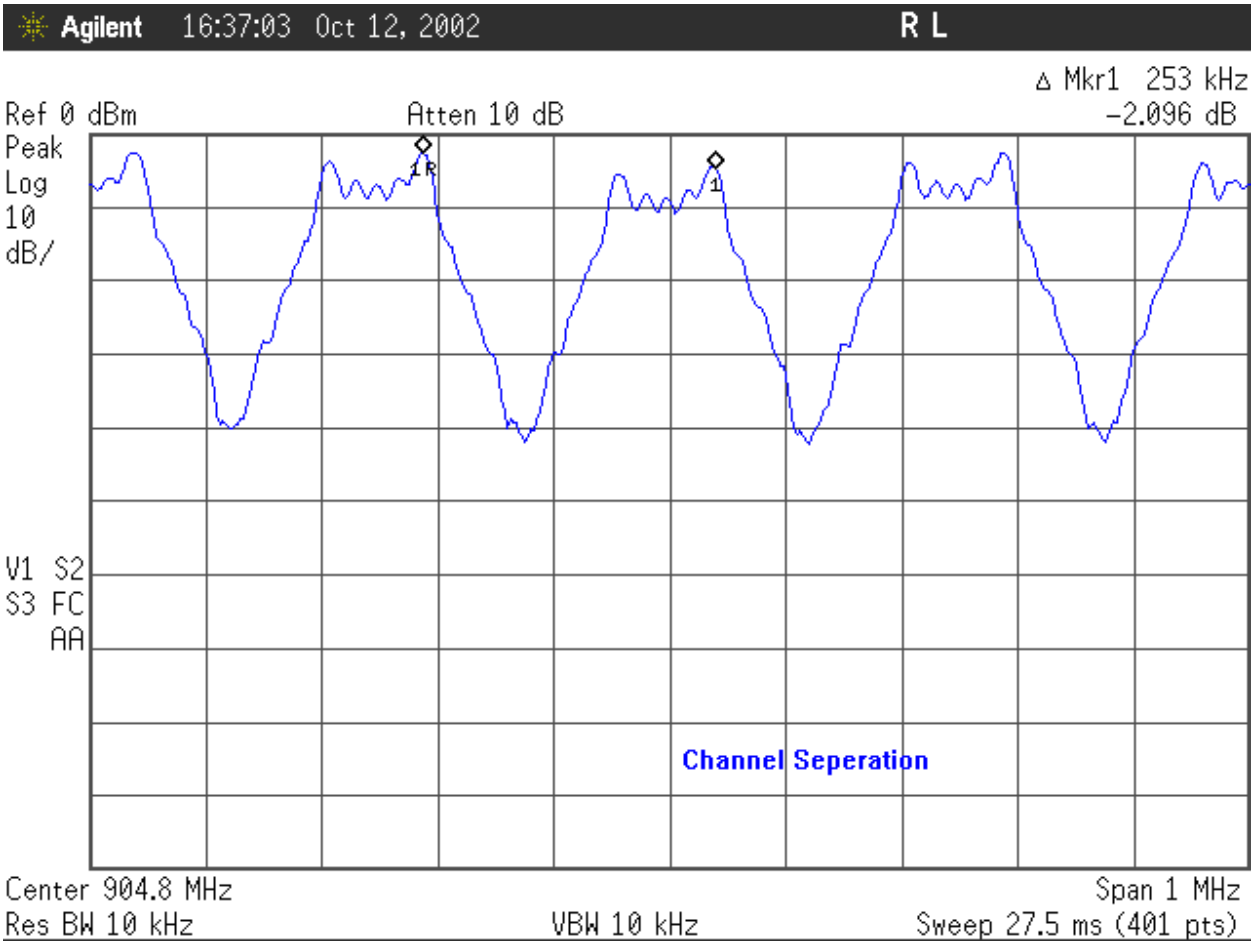
FCC Specification: Paragraph: 15.247(a)(1)(i)
Industrie Canada Specification: Paragraph 6.2.2.(o)(a)(1)

Procedure:

Using “test software” the UUT was commended to step sequentially through its hopping channels. The basic test setup shown in Figure 1 was used. The analyzer was set to a span of 1 MHz to encompass several adjacent channels. The RBW = VBW = 10kHz. The trace was set to MAX HOLD. The marker delta function used to determine the separation between peaks of the adjacent channels. Given that the 20 dB BW was measured at 165 kHz the separation between the two adjacent channels must be at least 165 kHz

Results:

The plot below demonstrates the channel separation of approximately 250 kHz



Minimum Number of Hopping Channels

Specifications:

FCC Specification: Paragraph: 15.247(a)(1)(i)
Industrie Canada Specification: Paragraph 6.2.2.(o)(a)(1)

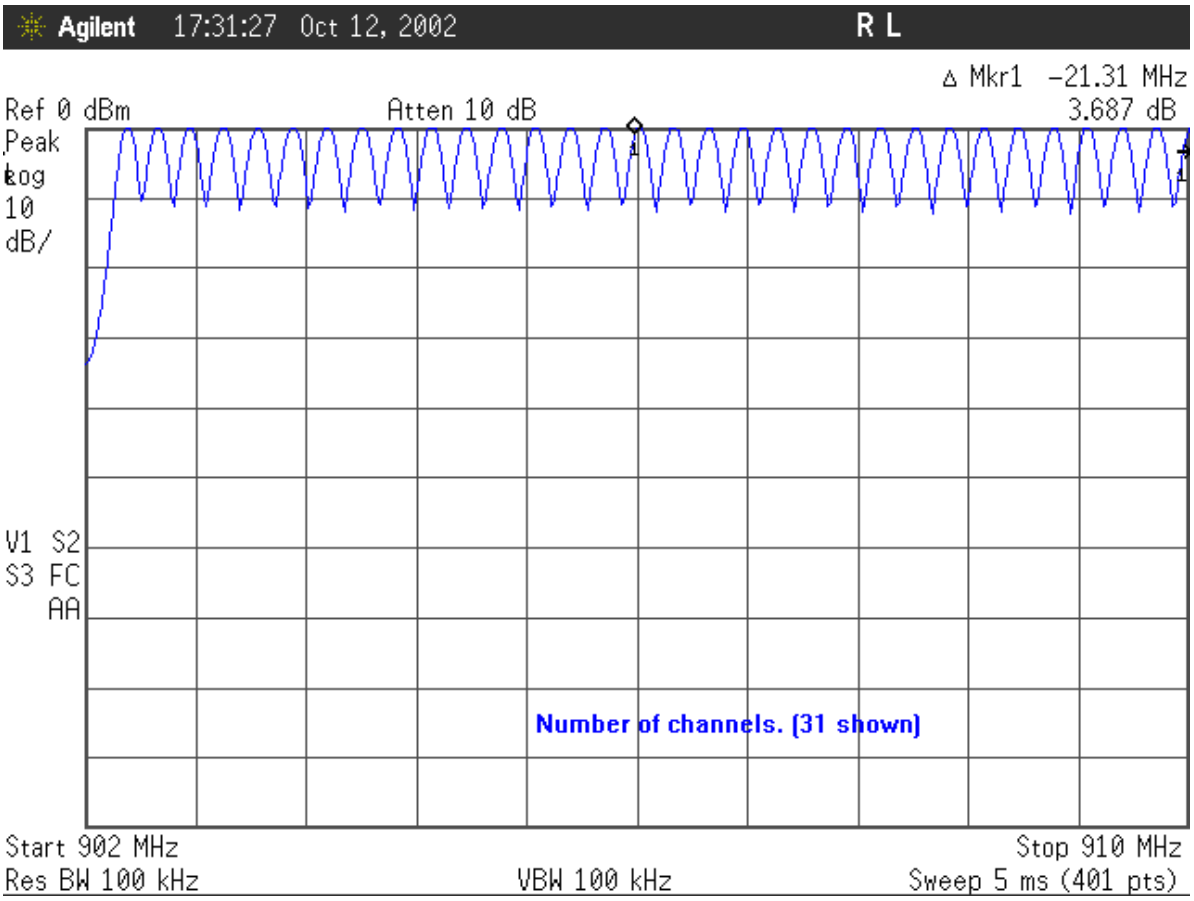
Procedure:

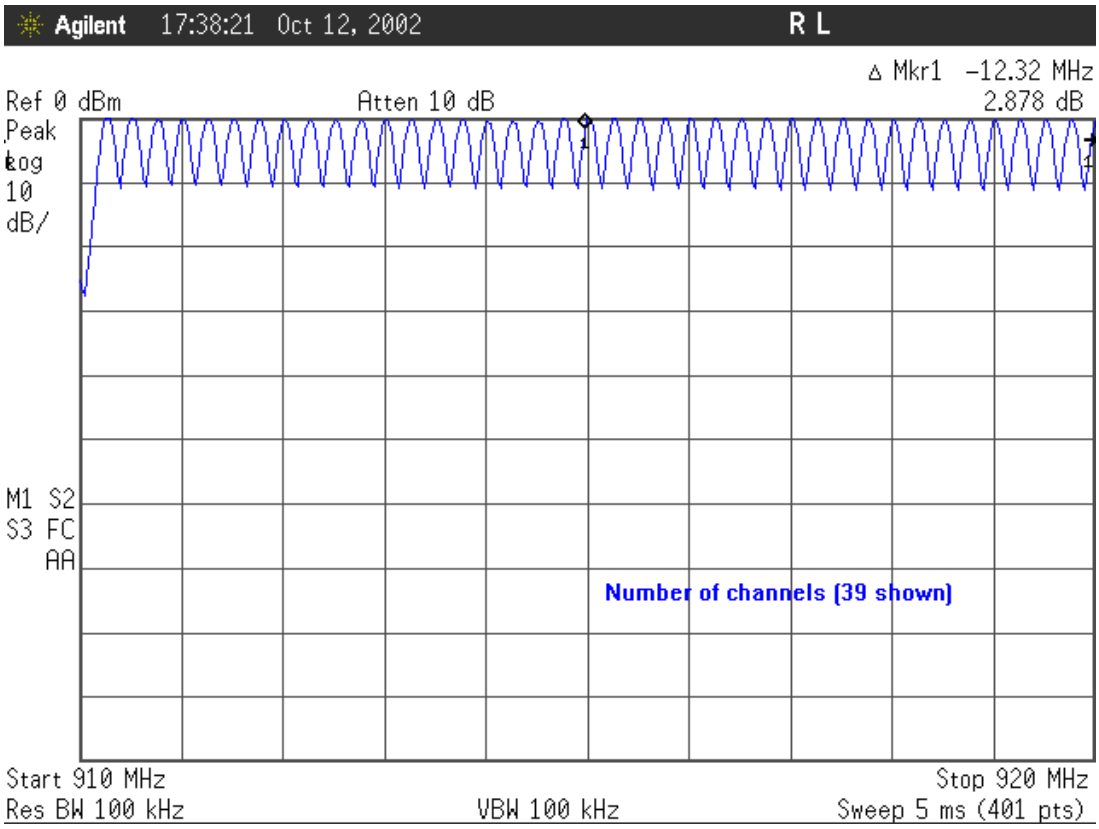
The basic test setup shown in figure 1 was used. The analyzer was set to sweep over a small portion of the 902 - 928 MHz band, (i.e.: 902 - 910 MHz), and wide resolution bandwidth was chosen to allow a fast sweep. The analyzer is set to MAX HOLD.

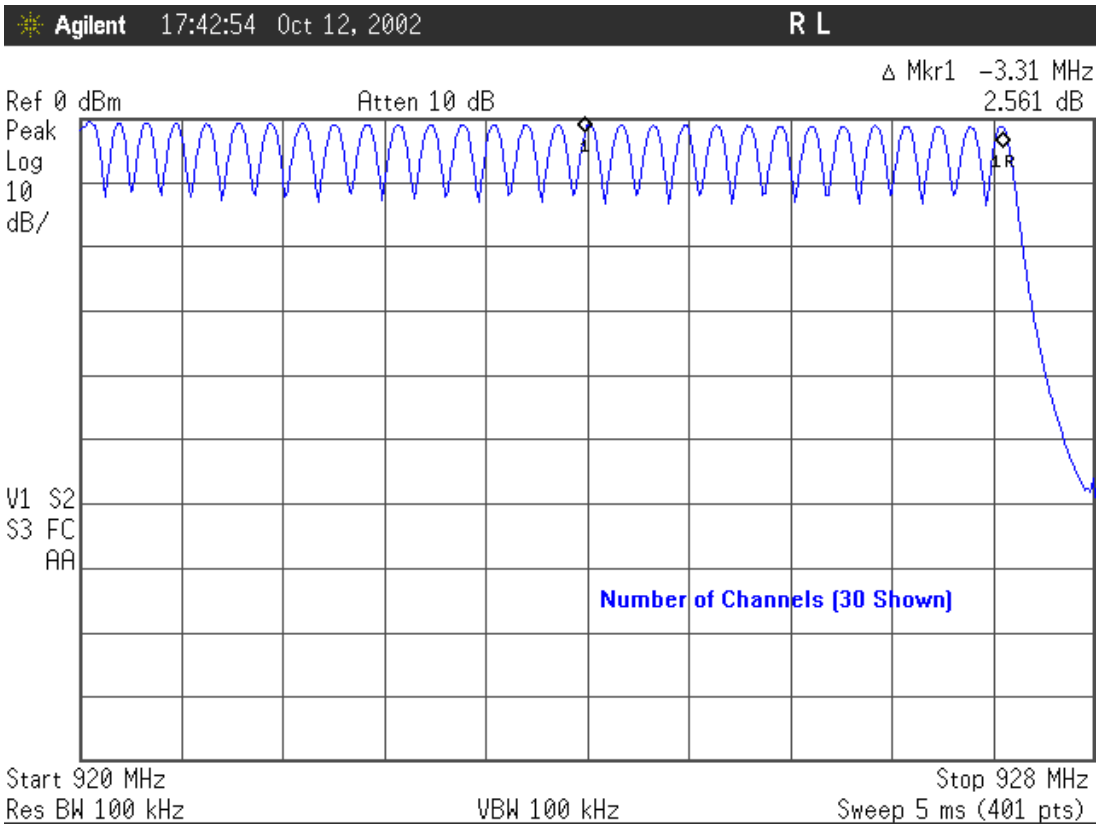
Using special test commands, it is possible to tell the unit to transmit a CW signal on each channel for a short time. With the spectrum analyzer set to MAX HOLD, each of the individual channels can be "captured" as the unit steps through all of the channels. Because the channels are close together, the 902 - 928 MHz band was examined in segments.

Results:

The individual channels are clearly visible in the plots. 100 channels were demonstrated Plots showing the results of the test are below.







Average Channel Occupancy Time

Specifications

FCC Specification: Paragraph 15.247(a)(1)
Industrie Canada Specification: Paragraph 6.2.2.(o)(a)(1)

Procedure:

The test was configured as shown below and was performed on a randomly chosen test channel. The analyzer was set to the selected test channel center frequency with a span of 0 Hz, a sweep time of 20 seconds and set for a single sweep. The test setup shown in figure 1 was used. The EUT was then powered on and allowed to transmit packets in search of another radio. The spectrum analyzer was used as to monitor "hits" on that particular channel.

Once the number of "hits" on the selected test channel within the 20 second window have been recorded the sweep time is reduced until there is just a few "hits" recorded. This is to allow the actual time of a single data packet transmission to be accurately measured. The total time on channel is obtained by multiplying the number of hits on a channel by the time for one transmission.

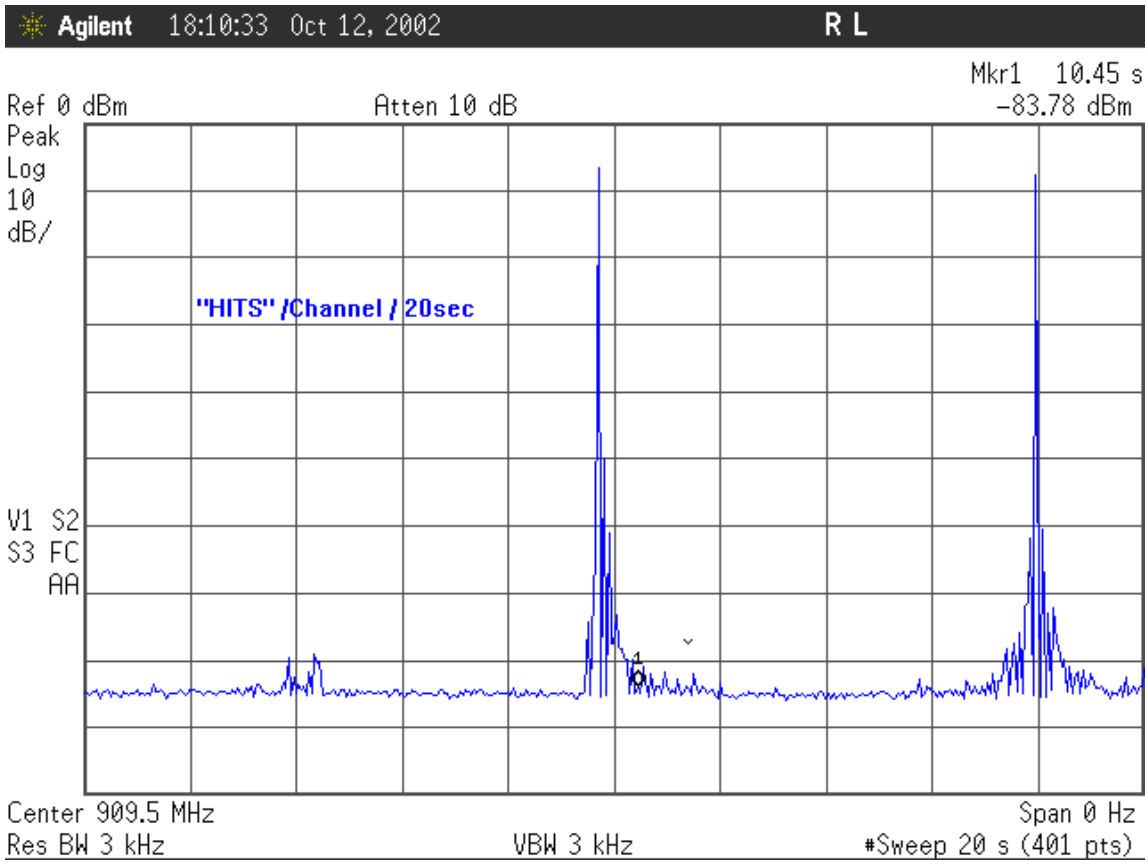
Total time on channel = (# of "hits") x (Duration of 1 "hit")

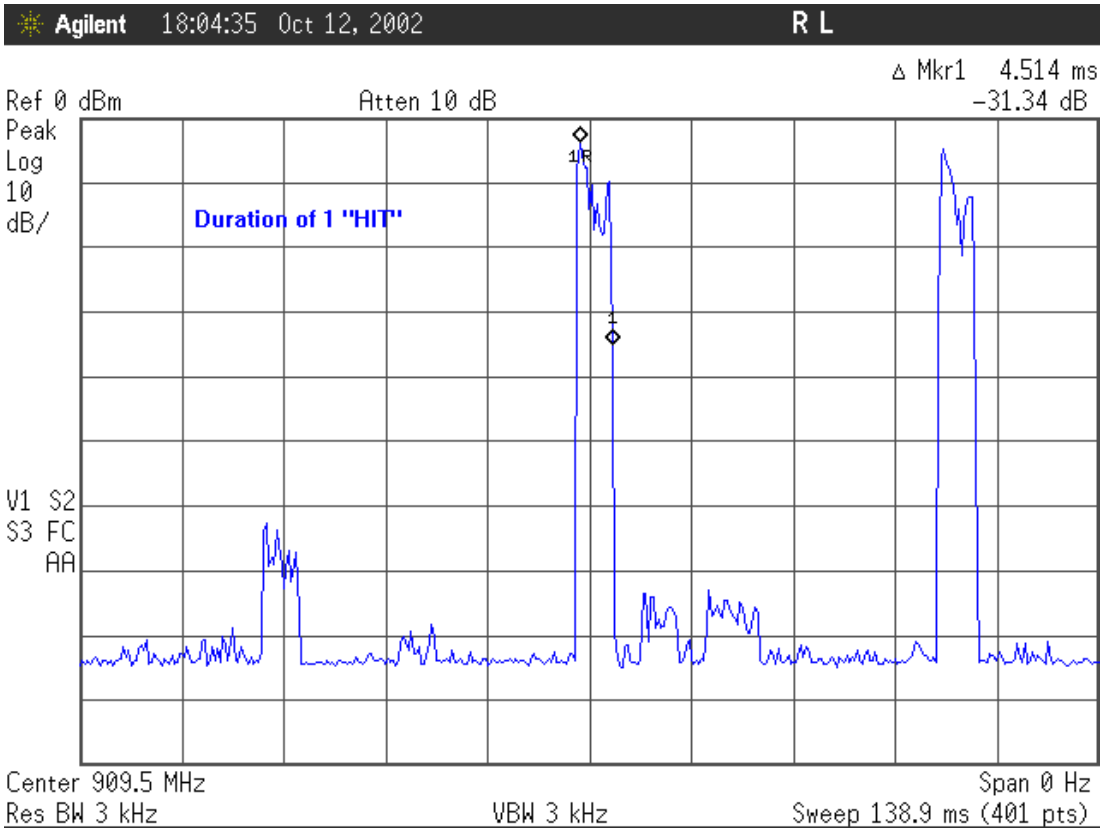
Results:

The time recorded for one "hit" was 4.514 ms. In a 20 Sec time period, there was a total of2 hits. Therefore the total time on channel is:

(2 hits/20 sec) x (4.514 ms/hit) = 9.28 ms/20 seconds

Plots showing the results of the test are on the following page





Radiated Emissions in Restricted bands

Specification:

FCC Specification: Paragraph 15.205
Industrie Canada Specification: Paragraph RSS210, 6.2.3 (c)

Procedure:

This test was conducted on a 3-meter open air test site at Elliott Laboratories The unit was placed on a rotating wooden table 80cm above the ground plane. A 1 - 18 GHz Horn antenna was secured to a mast 3 meters away. The unit was tested at each of the Low, Mid and High channels. The EUT was running in the diagnostic mode and set to transmit CW at maximum power on each of the channels. The test equipment was configured as shown below.

The harmonics of the fundamental that fell within restricted bands (up to the tenth) were measured (See table 1 below). A high pass filter prior to the pre-amplifier was required to prevent the large signal level of the fundamental frequency from overloading the front end of the spectrum analyzer and creating harmonics within the analyzer.

The EUT was rotated 360 degrees and the height of the antenna adjusted from 1 to 4 meters above the ground plane to determine the maximum level of the emission. The level of the harmonic emission was measured in two modes, “Peak” and “Average” .

The spectrum analyzer reading was entered into a spread sheet where correction factors (antenna factor, cable loss, pre-amplifier gain, HPF loss...) were then applied by Elliott Lab’s Software to obtain a final corrected measurement..

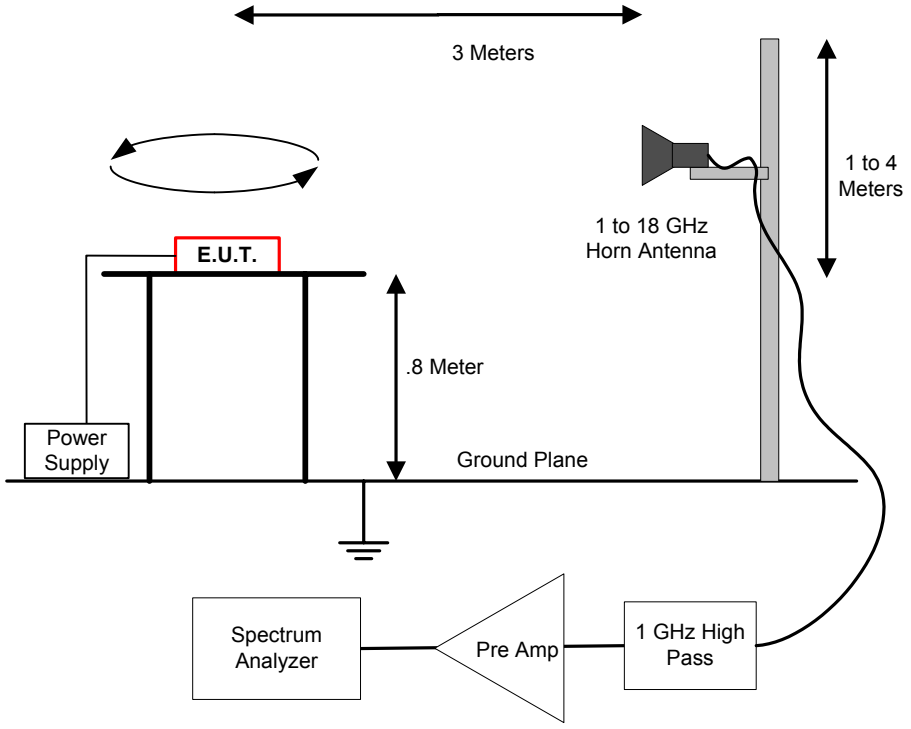
This procedure was repeated for the low mid and high channels within the 902 – 928 MHz band

Fund	2	3	4	5	6	7	8	9	10
902.25	1804.32	**2706.48**	**3608.64**	**4510.8**	5412.96	6315.12	7217.28	**8119.44**	**9021.6**
915.00	1829.88	**2744.82**	**3659.76**	**4574.7**	**5489.64**	6404.58	**7319.52**	**8234.46**	**9149.4**
927.25	1855.44	**2783.16**	**3710.88**	**4638.6**	**5566.32**	6494.04	**7421.76**	**8349.48**	9277.2

15.205 Harmonic test table

*Harmonics in **RED** fall within a restricted band specoified in FCC Part 15.205*

Test Setup



Radiated Emissions in Restricted Bands Test Setup

Results:

There were some harmonic emissions detected during the test. In many cases the resolution bandwidth and the video bandwidth were reduced well below what is required of the specifications in an attempt to find the actual level of the emission. In the case of the “PEAK” measurement the RBW and VBW were always set to 1 MHz. The “AVG” test was conducted with the RBW = 1MHz and VBW =10 Hz. If there was no emission detected, this is noted in the comments column of the data sheet.

The highest level measured for each of the three antennas is shown below.

	Harmonic	Level (dBuv)	Margin (dB)
(Dipole) Antenna 1	3	47.6	-6.4
(Antenna 2 deleted)			
(Helical) Antenna 3	3	49.4	-4.6

The complete set of data sheets showing the emission levels that were measured for each of the antennas that were tested and additional test parameters is contained on the following pages.

Elliott

EMC Test Data

Client:	Telemics	Job Number:	J47405
Model:	900 MHz FHSS Transceiver	T-Log Number:	T47560
		Proj Eng:	Chris Byleckie
Contact:	David Waitt		
Emissions Spec:	FCC 15.247	Class:	
Immunity Spec:		Environment:	

EMC Test Data

For The

Telemics

Model

900 MHz FHSS Transceiver

Elliott

EMC Test Data

Client:	Telemics	Job Number:	J47405
Model:	900 MHz FHSS Transceiver	T-Log Number:	T47560
		Proj Eng:	Chris Byleckie
Contact:	David Waitt		
Emissions Spec:	FCC 15.247	Class:	
Immunity Spec:	Enter immunity spec on cover	Environment:	

EUT INFORMATION

General Description

The EUT is a wireless spread spectrum transciever utilizing frequency hopping in the 900 MHz ISM band. Normally, the EUT would be placed on a table top during operation. The EUT was, therefore, treated as table-top equipment during testing to simulate the end user environment. The electrical rating of the EUT is 120 V, 60 Hz

Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Telemics	Verics Comm module	FHss Transciever	pre_prod	QC5-09-MSS1
Astron	AXH9RAMMPTL6I	Dipole Antenna	none	N/A
Telemics	910-0002	Helical Antenna	none	N/A

Other EUT Details

EUT Enclosure

The EUT was connected to a serial communications interface board that provided DC power and data communications o the module. It was not placed inside of any other enclosure and no shielding other than shielding intergral to the module was used.

Modification History

Mod. #	Test	Date	Modification
1			
2			
3			

Elliott

EMC Test Data

Client:	Telemics	Job Number:	J47405
Model:	900 MHz FHSS Transceiver	T-Log Number:	T47560
		Proj Eng:	Chris Byleckie
Contact:	David Waitt		
Emissions Spec:	FCC 15.247	Class:	
Immunity Spec:	Enter immunity spec on cover	Environment:	

Test Configuration #1

Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
IBM	Thinkpad	laptop	AF19B5R	NA
Generic		AC adapter		

Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None				

Interface Ports

		Cable(s)		
Port	Connected To	Description	Shielded or Unshielded	Length(m)
Serial*	Laptop	4 wire	Unshielded	2
Antenna	Antenna	coax	Shielded	see test data
Power in	AC adapter	2 wire	Unshielded	1

* Used only for changing the transmit channel

EUT Operation During Emissions

The EUT was transmitting on continuously on either the low, middle or high channel

Elliott

EMC Test Data

Client:	Telemics	Job Number:	J47405
Model:	900 MHz FHSS Transceiver	T-Log Number:	T47560
		Proj Eng:	Chris Byleckie
Contact:	David Waitt		
Spec:	FCC 15.247	Class:	N/A

Radiated Emissions

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 10/10/2002
Test Engineer: Chris Byleckie
Test Location: SVOATS #4

Config. Used: 1
Config Change:
EUT Voltage: 120V/60Hz

General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing. All remote support equipment was located approximately 30 meters from the EUT with all I/O connections running on top of the groundplane or routed in overhead in the GR-1089 test configuration.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT.

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

Unless stated otherwise the EUT was operating such that it constantly hopped on either the low, center or high channels.

Ambient Conditions:

Temperature: 14°C
Rel. Humidity: 75%

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 10000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	
2	RE, 30 - 10000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	
3	RE, 30 - 10000 MHz - Spurious Emissions In Restricted Bands	FCC Part 15.209 / 15.247(c)	Pass	
4	Output Power	15.247(b)	Pass	

Modifications Made During Testing:

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Dipole Antenna

Run #1a: Radiated Spurious Emissions, 30-10000 MHz. Low Channel @ 902.16 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2706.712	47.6	v	54.0	-6.4	Pk	58	1.2	Peak reading, average limit
3609.018	51.6	v	74.0	-22.4	Pk	276	1.4	
3608.950	47.5	v	54.0	-6.5	Avg	276	1.4	
4511.233	45.3	V	54.0	-8.7	Pk	0	1.0	Peak reading, average limit
3609.098	50.5	H	74.0	-23.5	Pk	0	1.5	
3609.001	46.0	H	54.0	-8.0	Avg	0	1.5	
4511.467	45.0	H	54.0	-9.0	Pk	0	1.3	Peak reading, average limit
5413.729	48.4	H	74.0	-25.6	Pk	0	1.5	
5413.391	35.2	H	54.0	-18.8	Avg	0	1.5	
8118.944	58.3	H	74.0	-15.7	Pk	0	1.5	
8118.708	45.3	H	54.0	-8.7	Avg	0	1.5	
9021.649	59.9	H	74.0	-14.1	Pk	0	1.5	
9022.399	47.2	H	54.0	-6.8	Avg	0	1.5	
2706.847	47.1	H	54.0	-6.9	Pk	267	1.9	Peak reading, average limit
5413.229	48.5	V	74.0	-25.5	Pk	0	1.0	
5412.388	35.1	V	54.0	-18.9	Avg	0	1.0	
8120.279	59.0	V	74.0	-15.0	Pk	0	1.0	
8119.898	45.4	V	54.0	-8.6	Avg	0	1.0	
9021.074	60.3	V	74.0	-13.7	Pk	0	0.0	
9020.889	47.2	V	54.0	-6.8	Avg	0	0.0	

Note 1:	For emissions in restricted bands, the limit of 15.209 was used.

Run #1b: Radiated Spurious Emissions, 30-10000 MHz. Center Channel @ 914.7 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2744.904	62.0	H	74.0	-12.0	Pk	56	1.8	
2744.261	40.9	H	54.0	-13.1	Avg	0	0.0	
3659.049	49.9	H	74.0	-24.1	Pk	165	2.0	
3659.022	44.0	H	54.0	-10.0	Avg	165	2.0	
4573.662	45.8	H	54.0	-8.2	Pk	302	1.4	Peak reading, average limit
7317.829	57.3	H	74.0	-16.7	Pk	0	1.5	
7318.039	44.7	H	54.0	-9.3	Avg	0	1.5	
8232.054	58.4	H	74.0	-15.6	Pk	0	1.5	
8231.720	45.2	H	54.0	-8.8	Avg	0	1.5	
9146.382	59.5	H	74.0	-14.5	Pk	0	1.5	
9146.604	47.0	H	54.0	-7.0	Avg	0	1.5	
2744.774	50.1	V	74.0	-23.9	Pk	91	1.0	
2744.235	41.9	V	54.0	-12.1	Avg	91	1.0	
3659.056	50.4	V	74.0	-23.6	Pk	345	1.3	
3659.002	45.4	V	54.0	-8.6	Avg	345	1.3	
4573.966	44.7	V	54.0	-9.3	Pk	0	1.0	Peak reading, average limit
7318.406	58.5	V	74.0	-15.5	Pk	0	1.0	
7317.239	44.6	V	54.0	-9.4	Avg	0	1.0	
8232.009	57.8	V	74.0	-16.2	Pk	0	1.0	
8232.064	45.2	V	54.0	-8.8	Avg	0	1.0	
9147.493	60.0	V	74.0	-14.0	Pk	0	0.0	
9147.468	47.0	V	54.0	-7.0	Avg	0	0.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #1c: Radiated Spurious Emissions, 30-10000 MHz. High Channel @ 927.57 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2782.417	50.4	H	74.0	-23.6	Pk	79	1.6	
2782.462	43.3	H	54.0	-10.7	Avg	0	0.0	
3710.181	46.1	H	54.0	-7.9	Pk	85	1.3	Peak reading, average limit
2782.545	49.9	V	74.0	-24.1	Pk	176	1.3	
2782.458	43.6	V	54.0	-10.4	Avg	0	0.0	
3709.749	49.8	V	74.0	-24.2	Pk	154	1.5	
3709.979	43.5	V	54.0	-10.5	Avg	0	0.0	
4637.152	45.8	V	54.0	-8.2	Pk	199	1.0	Peak reading, average limit
7419.889	57.7	V	74.0	-16.3	Pk	0	1.0	
7420.166	45.2	V	54.0	-8.8	Avg	0	1.0	
8348.339	58.8	V	74.0	-15.2	Pk	0	1.0	
8347.454	44.8	V	54.0	-9.2	Avg	0	1.0	
4637.584	44.8	H	54.0	-9.2	Pk	0	1.4	Peak reading, average limit
7420.782	58.0	H	74.0	-16.0	Pk	0	1.5	
7420.319	45.0	H	54.0	-9.0	Avg	0	1.5	
8347.649	57.8	H	74.0	-16.2	Pk	0	0.0	
8347.400	44.8	H	54.0	-9.2	Avg	0	0.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Helical Antenna

Run #3a: Radiated Spurious Emissions, 30-10000 MHz. Low Channel @ 902.16 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2706.978	50.2	V	74.0	-23.8	Pk	305	1.0	
2706.690	44.0	V	54.0	-10.0	Avg	305	1.0	
3609.134	48.8	V	74.0	-25.2	Pk	344	1.3	
3609.005	43.0	V	54.0	-11.0	Avg	344	1.3	
4511.233	45.5	V	54.0	-8.5	Pk	78	0.0	Peak reading, average limit
5414.236	48.4	V	74.0	-25.6	Pk	0	1.0	
5413.598	35.6	V	54.0	-18.4	Avg	0	1.0	
8120.226	59.0	V	74.0	-15.0	Pk	0	1.0	
8120.086	45.5	V	54.0	-8.5	Avg	0	1.0	
9022.346	59.9	V	74.0	-14.1	Pk	0	1.0	
9021.752	47.2	V	54.0	-6.8	Avg	0	1.0	
2706.847	50.3	H	74.0	-23.7	Pk	248	1.6	
2706.725	44.7	H	54.0	-9.3	Avg	248	1.6	
3608.715	48.9	H	74.0	-25.1	Pk	92	2.0	
3608.991	43.0	H	54.0	-11.0	Avg	92	2.0	
4510.910	44.9	H	54.0	-9.1	Pk	273	1.5	Peak reading, average limit
5413.208	48.6	H	74.0	-25.4	Pk	0	1.5	
5413.475	35.8	H	54.0	-18.2	Avg	0	1.5	
8119.840	58.1	H	74.0	-15.9	Pk	0	1.5	
8120.249	45.6	H	54.0	-8.4	Avg	0	1.5	
9022.407	59.9	H	74.0	-14.1	Pk	0	1.5	
9022.312	47.2	H	54.0	-6.8	Avg	0	1.5	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #3b: Radiated Spurious Emissions, 30-10000 MHz. Center Channel @ 917.7 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2745.145	51.2	H	74.0	-22.8	Pk	254	1.6	
2744.238	43.2	H	54.0	-10.8	Avg	254	1.6	
3658.978	48.7	H	74.0	-25.3	Pk	73	2.0	
3658.974	42.7	H	54.0	-11.3	Avg	73	2.0	
4574.263	44.9	H	54.0	-9.1	Pk	0	1.6	Peak reading, average limit
7317.743	57.4	H	74.0	-16.6	Pk	0	1.5	
7317.935	44.8	H	54.0	-9.2	Avg	0	1.5	
8233.197	58.2	H	74.0	-15.8	Pk	0	1.5	
8232.516	45.2	H	54.0	-8.8	Avg	0	1.5	
9147.223	59.9	H	74.0	-14.1	Pk	0	1.5	
9147.283	47.0	H	54.0	-7.0	Avg	0	1.5	
2744.910	50.5	V	74.0	-23.5	Pk	25	1.0	
2744.185	45.5	V	54.0	-8.5	Avg	25	1.0	
3659.045	50.6	V	74.0	-23.4	Pk	12	1.6	
3659.065	46.2	V	54.0	-7.8	Avg	12	1.6	
4573.152	44.9	V	54.0	-9.1	Pk	0	1.0	Peak reading, average limit
7318.600	57.8	V	74.0	-16.2	Pk	0	1.0	
7317.934	44.9	V	54.0	-9.1	Avg	0	1.0	
8233.737	58.0	V	74.0	-16.0	Pk	0	1.0	
8232.644	45.1	V	54.0	-8.9	Avg	0	1.0	
9147.607	59.9	V	74.0	-14.1	Pk	0	1.0	
9147.170	47.0	V	54.0	-7.0	Avg	0	1.0	

Note 1: For emissions in restricted bands, the limit of 15.209 was used.

Run #3c: Radiated Spurious Emissions, 30-10000 MHz. High Channel @ 927.5 MHz								
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2782.538	53.1	V	74.0	-20.9	Pk	169	1.2	
2782.470	49.4	V	54.0	-4.6	Avg	169	1.2	
3710.192	47.5	V	54.0	-6.5	Pk	254	1.0	Peak reading, average limit
4638.440	44.9	V	54.0	-9.1	Pk	0	1.0	Peak reading, average limit
7420.825	57.6	V	74.0	-16.4	Pk	0	1.0	
7420.019	45.1	V	54.0	-8.9	Avg	0	1.0	
8348.237	58.1	V	74.0	-15.9	Pk	0	1.0	
8348.416	44.9	V	54.0	-9.1	Avg	0	1.0	
2782.381	50.8	H	74.0	-23.2	Pk	237	1.9	
2782.498	44.5	H	54.0	-9.5	Avg	237	1.9	
3710.066	46.4	H	54.0	-7.6	Pk	166	1.8	Peak reading, average limit
4637.491	45.2	H	54.0	-8.8	Pk	0	1.5	Peak reading, average limit
7420.786	58.1	H	74.0	-15.9	Pk	0	1.5	
7420.158	45.0	H	54.0	-9.0	Avg	0	1.5	
8349.386	58.0	H	74.0	-16.0	Pk	0	1.5	
8347.999	44.9	H	54.0	-9.1	Avg	0	1.5	
Note 1:	For emissions in restricted bands, the limit of 15.209 was used.							

Radiated Emissions Equipment List

Radiated Emissions, .9 - 10GHz, 10-Oct-02						
Engineer: Chris						
Manufacturer	**Description**	**Model #**	**Assett #**	**Cal interval**	**Last Calibrated**	**Cal Due**
EMCO	Horn Antenna, D. Ridge 1-18GHz	3115	487	12	4/22/2002	4/22/2003
EMCO	Log Periodic Antenna, 0.2-2 GHz	3148	1321	12	4/23/2002	4/23/2003
Hewlett Packard	Spectrum Analyzer 9KHz - 26GHz	8563E	284	12	3/21/2002	3/21/2003
Miteq	Pre-amp, 1-18GHz	AFS44	1346	12	1/7/2002	1/7/2003
Rohde & Schwarz	Test Receiver, 20-1300 MHz	ESVP	1317	12	5/3/2002	5/3/2003
Hewlett Packard	High Pass filter, 1.5GHz	P/N 84300-80037	1158	12	3/4/2002	3/4/2003
Rohde & Schwarz	Power Meter	NRVS	1422	12	9/6/2002	9/6/2003
Rohde & Schwarz	Power Sensor 100uW - 10 Watts	NRV-Z53	1236	12	8/15/2002	8/15/2003

Radiated Emissions Sample Calculations

Receiver readings are compared directly to the specification limit. The receiver internally corrects for cable loss, preamp gain and antenna factor. The calculations are in reverse from the signal flow, meaning that cable loss is actually added to the reading and amplification is subtracted. Antenna factor is a measure of the conversion of the voltage at the coaxial connector to the field strength at the antenna elements. A distance factor, for the electric field is calculated using the following formula

$$F_d = 20 \text{ Log}_{10} (D_m/D_s)$$

Where:
F_d = Distance Factor
D_m = Measurement distance in meters
D_s = specification distance in meters

Measurement distance is the distance at which the measurements were taken and the specification distance is the distance at which the specification limit is based.

The margin of a given emissions peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

Where :
R_r = Relative reading in dBuV/m
F_d = Distance Factor
R_c = Corrected reading in dBuV/m
L_s = specification Limit in dBuV/m
M = Margin in dB relative to the spec.

Out of band Spurious Emissions

Specifications:
FCC Part 15 Paragraph 15.247(c)
Industrie Canada: Paragraph RSS210, 6.2.2.(o)(b)4

Two tests were performed to demonstrate compliance with the specifications

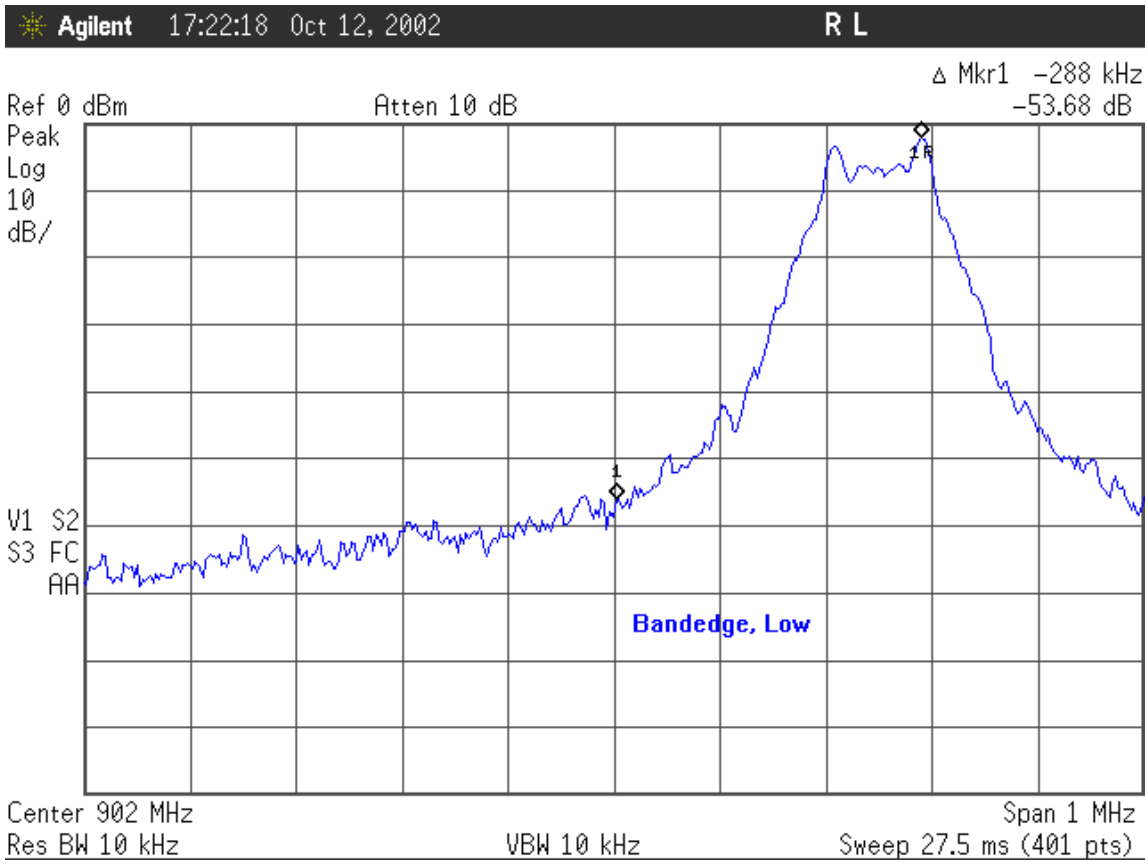
Band edge:
The first test was performed as a conducted test using the Basic Conducted RF Test Setup. Only the "edges" of the 902 to 928 MHz band are examined since these are expected to be the worst-case frequencies for out of band emissions. (The two points where the in-band EUT signal is most likely to "spill" out of the 902 to 928 MHz band

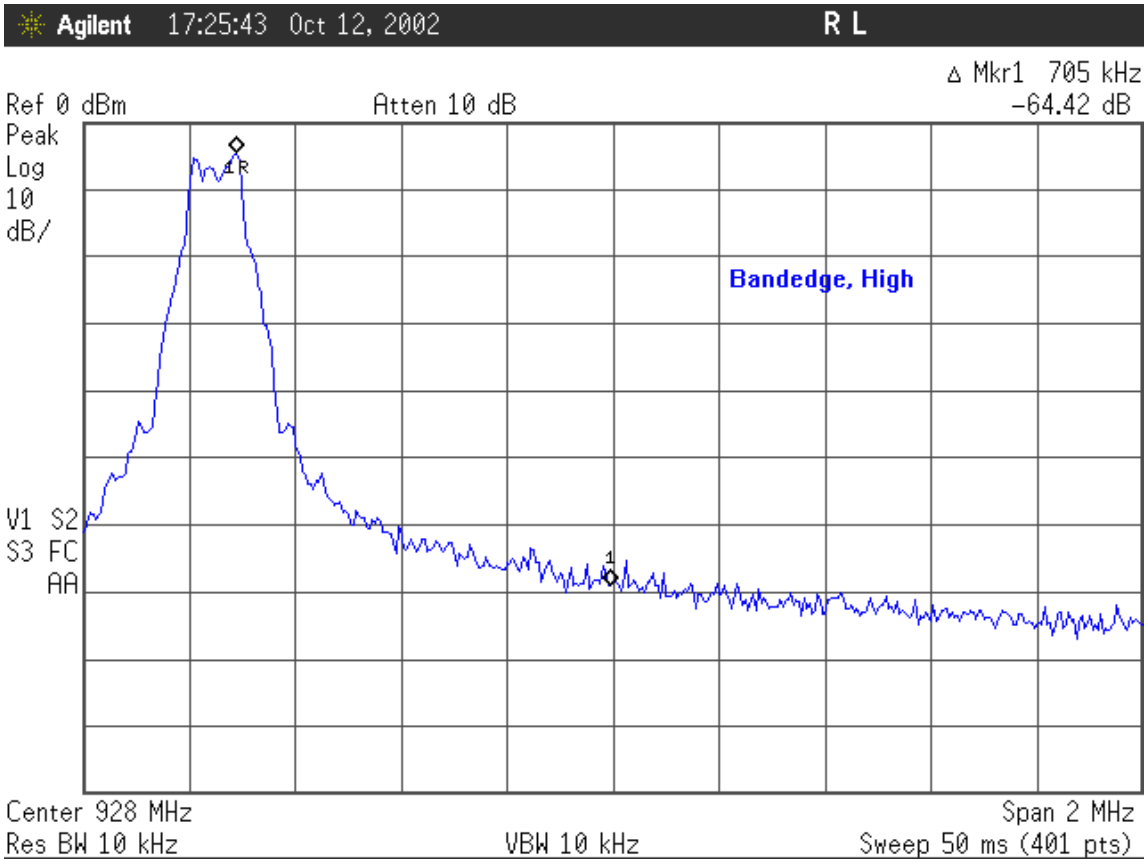
Out of Band Emissions
The second test is performed as a conducted test using the conducted RF test setup. This test examines a much wider band for out of band emissions (1 to 10 GHz).

NOTE:
In the case of the Telemics Module, the limits set forth in 15.209 and RSS-210 Table 3 are not relevant to the test (for spurs produced from modulation products of the spreading sequence, the information sequence and the carrier frequency, NOT falling in a restricted band) since the transmit power of the radio is about 100 mw, the -20 dBc rule will be the governing limit.

Band Edge Procedure:
The Conducted RF test setup was used for this test. The spectrum analyzer was set to a 10 kHz RBW and a VBW of 10 kHz. The low edge of the band (902MHz) was centered with a 1MHz span. The EUT was running the diagnostic mode and was set to transmit random data on channel 0 (902.25 MHz). The analyzer was set to MAX HOLD. Then a marker-delta measurement was made to insure that the signal level was at least -20 dBc at 902.0 MHz.
The test was then repeated with the sweep set to center of 928 MHz with a 1 MHz span and the EUT set to transmit on the highest channel (Ch #100 @ 927.25 MHz).

Result:
At the high end of the band the level was at –53.68 dBc at 902 MHz and –64.42 dBc at 928 MHz. Plots showing the band edges are on the following page.





Out of Band Emissions Procedure:

The UUT was configured to transmit on Channel 0. The band from 30 MHz to 10 GHz was examined for out of band emissions. The band was examined in small "bands" to get a clear picture of the entire 30MHz to 10 GHz band. This test was repeated for for channel 50 and then again for channel 100

Results:

In each case the out of band emissions were well below the –20dBc limit. The plots showing the levels of the detected emissions are contained on the following pages.

Elliott

EMC Test Data

Client:	Telemics	Job Number:	J47405
Model:	900 MHz FHSS Transceiver	T-Log Number:	T47560
		Proj Eng:	Chris Byleckie
Contact:	David Waitt		
Spec:	FCC 15.247	Class:	N/A

Conducted Emissions Antenna Port

Test Specifics

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 10/10/2002
Test Engineer: Chris Byleckie
Test Location: SVOATS #4

Config. Used: 1
Config Change:
EUT Voltage: 120V/60Hz

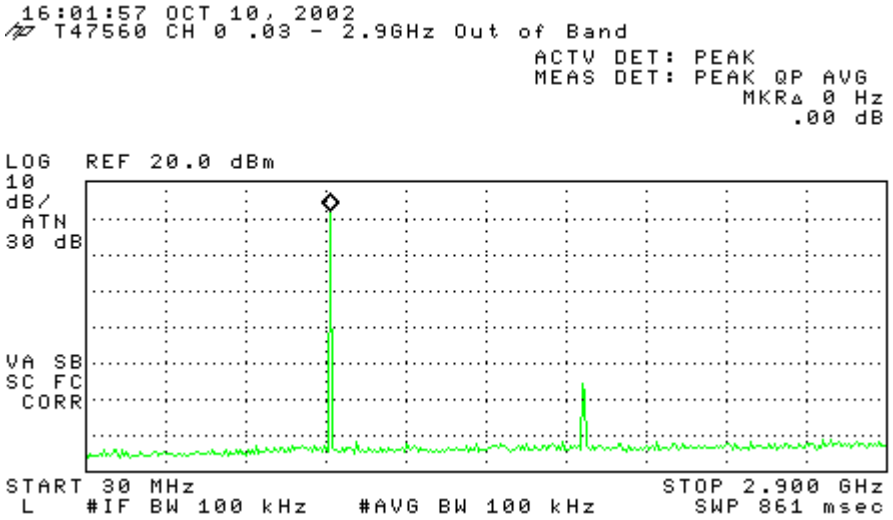
General Test Configuration

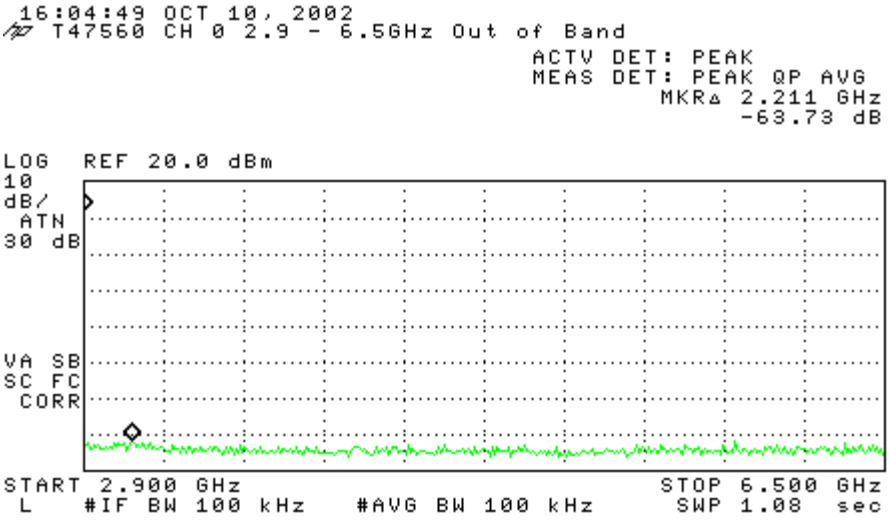
When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.

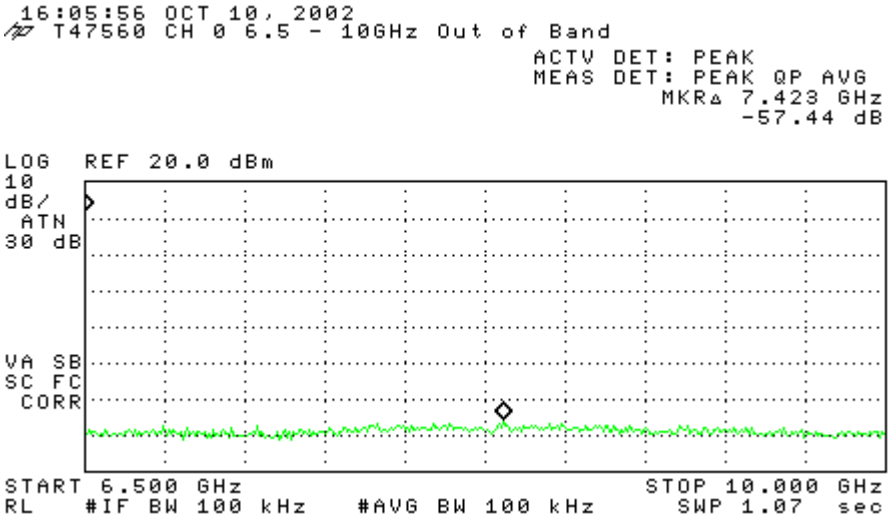
Ambient Conditions:

Temperature: 14°C
Rel. Humidity: 75%

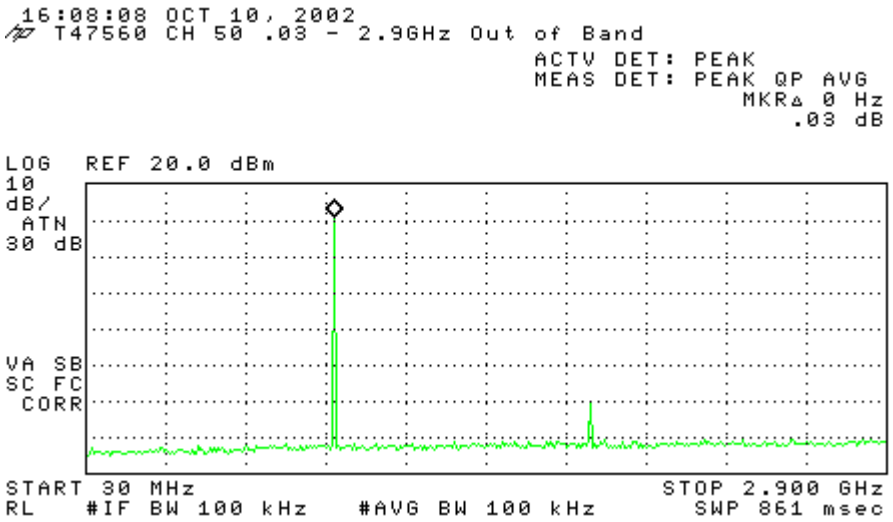
Out of band emissions, 30MHz to 10GHz
UUT Transmitting on Channel 0

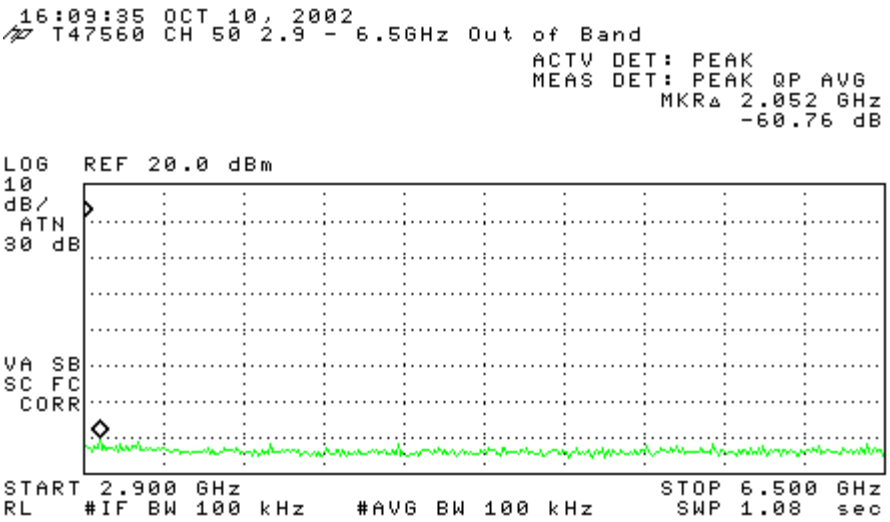


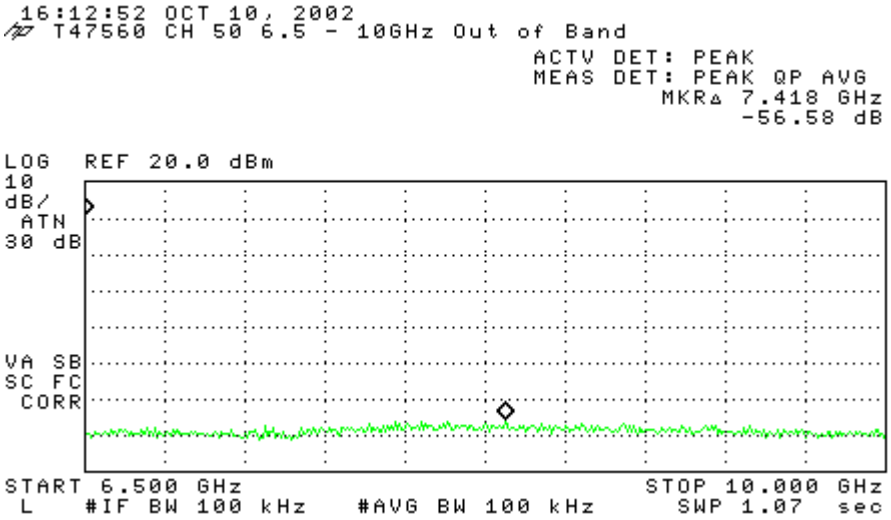




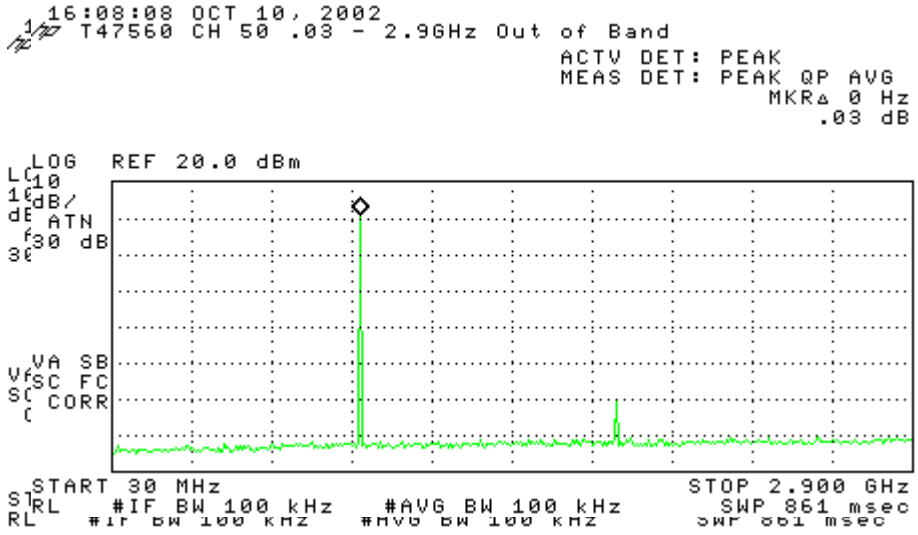
Out of band emissions, 30MHz to 10GHz
UUT Transmitting on Channel 50

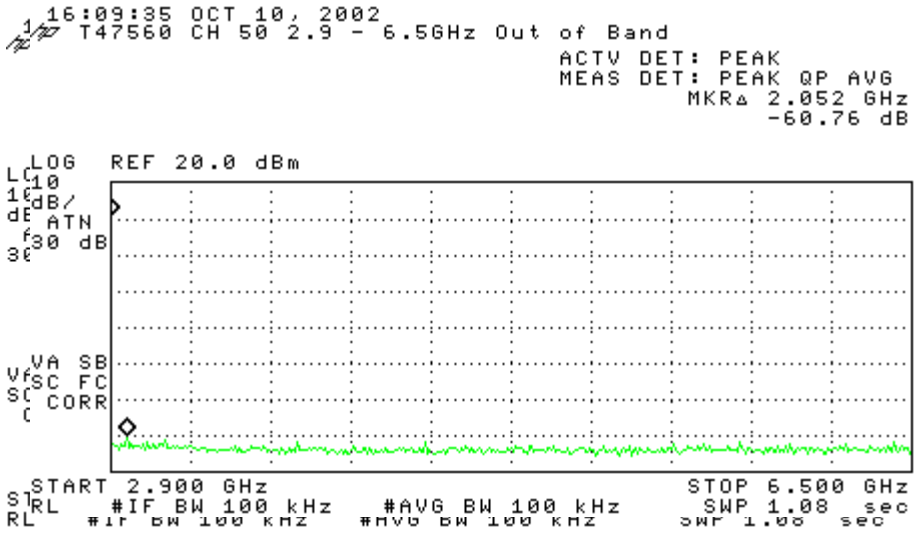


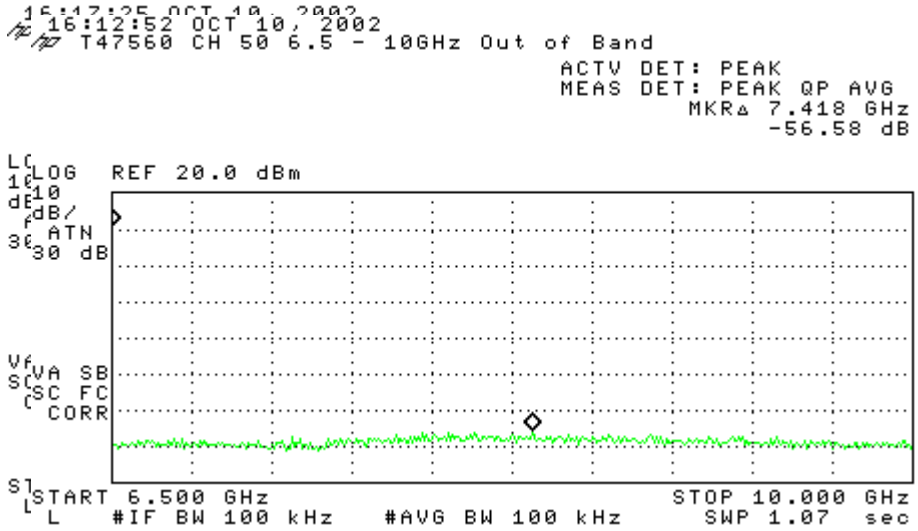




Out of band emissions, 30MHz to 10GHz
UUT Transmitting on Channel 100







Receiver Spurious Emissions

Specifications:
FCC Part 15 Paragraph 15.247(c)
Industrie Canada: Paragraph RSS210, 6.2.2.(o)(b)4

Procedure:
Since this is a test of the spurious emissions of the receiver, the Verics module was powered on but not transmitting. The module was connected to the 2dBi antenna and positioned on the OATS site. The module was powered by a small DC power supply, however this supply was shielded during the measurement to prevent emissions from the power supply being misinterpreted as emissions from the receiver. The relevant harmonics of the receiver 1st LO, 1st IF, 2d LO and the 2IF were calculated and the applicable harmonics were examined on the OATS relative to the limit.

Results:
In some cases, ambient signals interfered with obtaining an accurate reading on the OATS, these are marked with “AMB” in the results table. Because of this, in at least one instance, (the fundamental of the first LO) the measurement was made in a 3-meter anechoic chamber and determined to be 20 dB below the limit. In other cases an emission could not be detected. These are marked with “NF” signifying “nothing found” for that particular harmonic. The results for vertical and horizontal polarization are on the following pages.

Receiver Spurious Emissions (Vertical)

Rcvr Harmonics (Sorted by Frequency)					
Frequency (MHz)	Msrd Lvl dBuv (Vert)	Delta (dB in spec)	Frequency (MHz)	Msrd Lvl dBuv (Vert)	Delta (dB in spec)
32.10	NF		245.10	NF	
42.80	NF		284.00	NF	
53.50	NF		326.80	NF	
64.20	NF		355.00	25.6	20.4
71.00	27.7	12.3	408.50	NF	
74.90	23.6	16.4	426.00	NF	
81.70	AMB		490.20	NF	
85.60	NF		497.00	NF	
96.30	AMB		568.00	NF	
107.00	AMB		571.90	NF	
117.70	NF		639.00	NF	
128.40	NF		653.60	NF	
139.10	NF		710.00	NF	
142.00	23.1	20.4	735.30	27.1	18.9
149.80	26.3	17.2	781.00	NF	
160.50	21	22.5	817.00	NF	
163.40	32.7	10.8	852.00	NF	
171.20	24.3	19.2	898.70	NF	
181.90	18.8	24.7	923.00	NF	
192.60	NF		973.25	NF	
203.30	AMB		980.40	NF	
213.00	NF		994.00	NF	
214.00	17.5	26	998.25	NF	

Receiver Spurious Emissions (Horizontal)

Rcvr Harmonics (Sorted by Frequency)					
Frequency (MHz)	Msrd Lvl dBuv (Horz)	Delta (dB in spec)	Frequency (MHz)	Msrd Lvl dBuv (Horz)	Delta (dB in spec)
32.10	NF		245.10	NF	
42.80	NF		284.00	NF	
53.50	NF		326.80	NF	
64.20	NF		355.00	NF	
71.00	28.8	11.2	408.50	NF	
74.90	NF		426.00	NF	
81.70	AMB		490.20	NF	
85.60	NF		497.00	NF	
96.30	AMB		568.00	NF	
107.00	AMB		571.90	NF	
117.70	NF		639.00	NF	
128.40	23.8	19.7	653.60	NF	
139.10	15.7	27.98	710.00	NF	
142.00	17.6	25.9	735.30	NF	
149.80	18.9	24.6	781.00	NF	
160.50	16.2	27.3	817.00	NF	
163.40	18.9	24.6	852.00	NF	
171.20	21.2	22.3	898.70	NF	
181.90	21.9	21.6	923.00	NF	
192.60	22.1	21.4	973.25	NF	
203.30	AMB		980.40	NF	
213.00	NF		994.00	NF	
214.00	NF		998.25	NF	

The device into which the Verics RF module will be initially integrated into (by Telemics Inc.) is a FCC Part 15 Class A device. The module and the host system were tested and found to comply with the Class A radiated and conducted emission limits. The test data for the host system are provided on the following pages for reference only.

No frequencies exceeding the Class B limits in the following conducted emissions data are used within the receiver or the transmitter.

Signal Number	Frequency (MHz)	Peak (dBuV)	QP (dBuV)	QP Delta L 1 (dB)	Corr (dB)
1	100.881450	45.4	38.7	-1.3	12.2
2	162.498450	38.9	37.9	-2.1	11.2
3	32.500615	38.5	35.6	-4.4	17.7
4	139.749288	33.2	30.3	-9.7	11.9
5	227.499000	29.4	28.4	-11.6	13.1
6	214.492238	29.9	26.9	-13.1	12.1

(1.)

EMC COMPLIANCE MANAGEMENT GROUP

Client:: Telemics		Project #: 3465	Frequency Range:
EUT: Checkpoint, series w/ dipole		Test Reference: FCC A	
Model:	S/N:	Test Run # 1	
Antenna Polarization:	Vertical (X)	Horizontal ( )	
Test Distance:	3 Meter ( )	10 meter (X)	
Scan Type:	Eng. ( )	Final (X)	
Temperature:	Degree C	Humidity: %	
Tested By: Jack Plotner.		Date: 10-23-02	

(2.)

Signal Number	Frequency (MHz)	Peak (dBuV)	QP (dBuV)	QP Delta L 1 (dB)	Corr (dB)
1	104.128300	49.0	42.6	-0.9	12.4
2	108.068000	46.4	39.9	-3.6	12.6
3	391.844075	41.8	34.4	-12.1	19.3
4	213.567750	38.9	31.3	-12.2	12.1
5	215.598338	38.0	29.4	-14.1	12.2
6	236.898338	26.8	18.5	-28.0	13.7

EMC COMPLIANCE MANAGEMENT GROUP

Client:: Telemics		Frequency Range: Project #: 3465	
EUT: Checkpoint, verics w/ dipole		Test Reference: FCC A	
Model:	S/N:	Test Run # 2	
Antenna Polarization:	Vertical ( )	Horizontal (X)	
Test Distance:	3 Meter ( )	10 meter (X)	
Scan Type:	Eng. ( )	Final (X)	
Temperature: 17	Degree C	Humidity: 54 %	
Tested By: Jack Plotner		Date: 10-23-02	

EMC Compliance Management Group
120VAC/60Hz, Line 1
1. Conducted Emission for FCC15 Class A

ct.... ACCESSPOINT
C:\TileData\3465c120vac.til
Wed Oct 16 21:06:54 2002

EMC Engineer

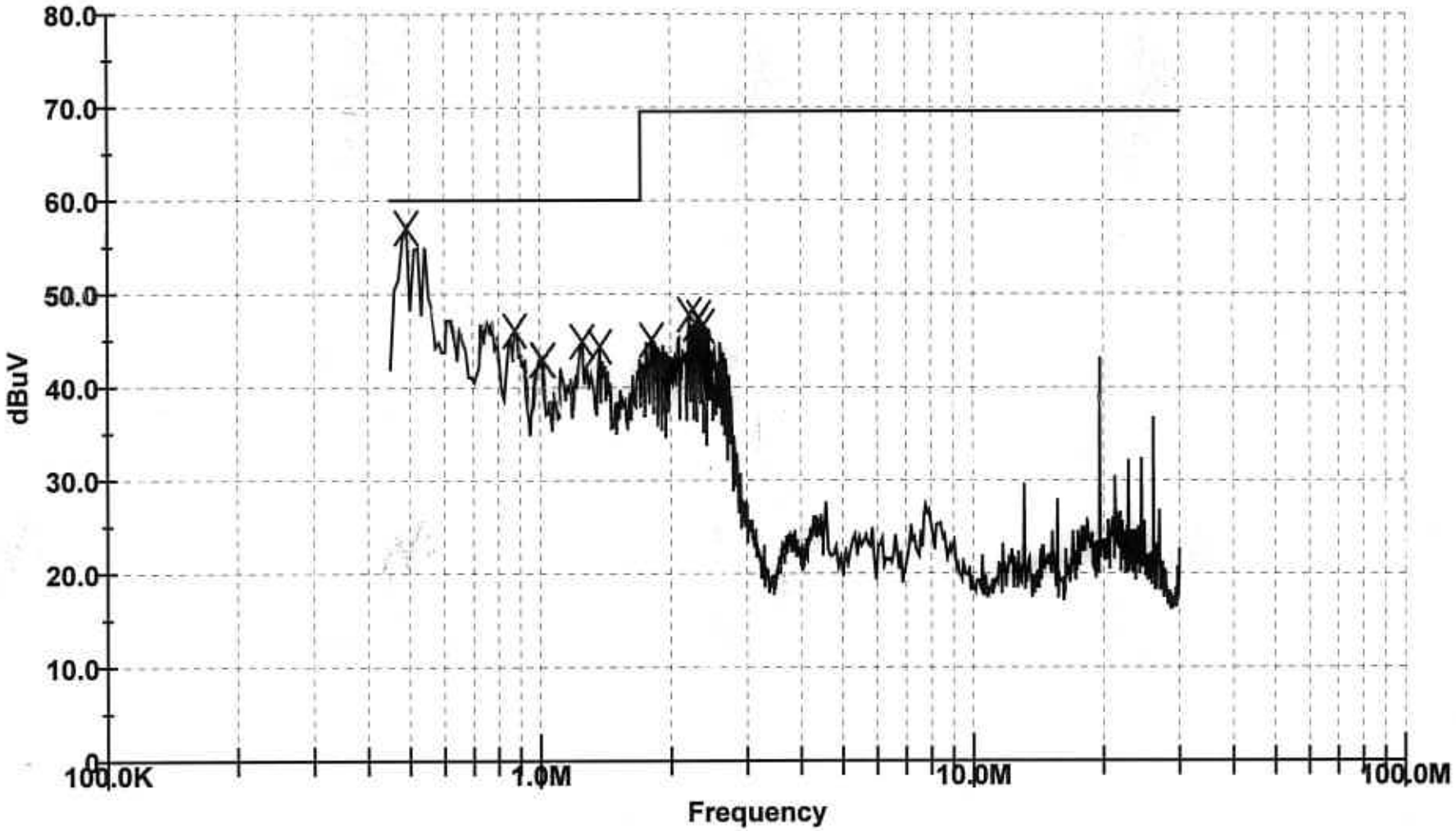
	1	2
Frequency MHz	QP_L1	EUT_L1_QP
498.2KHz	53.76	-6.24
884.88KHz	41.69	-18.31
1.0098MHz	39.85	-20.15
1.2528MHz	38.65	-21.35
1.3729MHz	38.28	-21.72
1.8028MHz	40.65	-28.85
2.2038MHz	42.23	-27.27
2.2821MHz	42.35	-27.15
2.3208MHz	42.01	-27.49
2.379MHz	39.75	-29.75

ACCESS POINT

EMC Compliance Management Group

120VAC/60Hz, Line 1

1. Conducted Emission for FCC15 Class A



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Telemics Corporate

EMC Engineer

EMC Compliance Management Group
120VAC/60Hz, Line 2
2. Conducted Emission for FCC15 Class A

ACCESSPOINT
ct....
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EMC Engineer

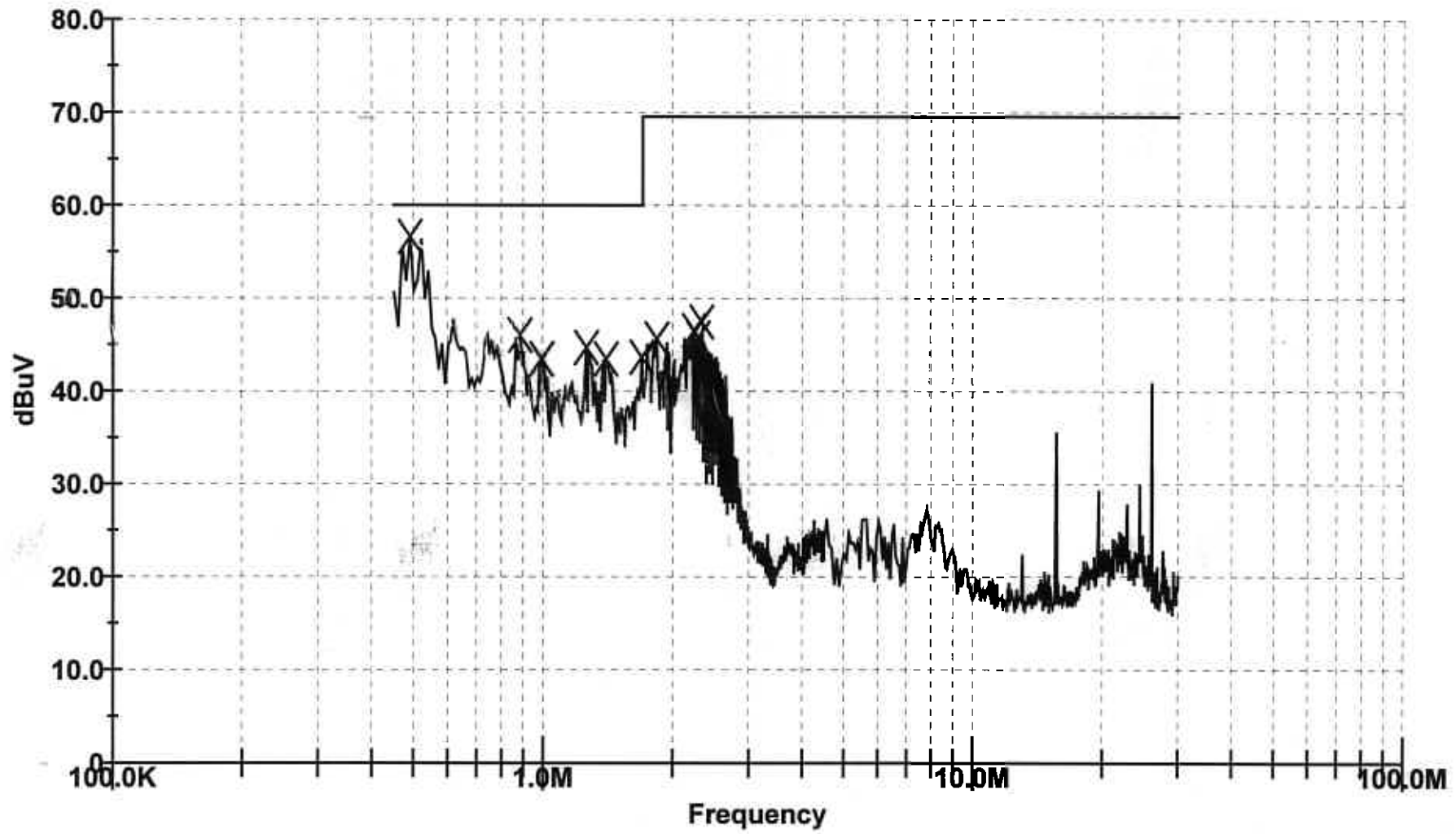
	1	2
Frequency MHz	QP_L2	EUT_L2_QP
496.8KHz	53.1	-6.9
884.13KHz	41.63	-18.37
997.82KHz	40.12	-19.88
1.2571MHz	38.44	-21.56
1.3988MHz	37.89	-22.11
1.691MHz	36.86	-23.14
1.8343MHz	38.28	-31.22
2.2473MHz	40.64	-28.86
2.3012MHz	41.27	-28.23
2.3328MHz	40.71	-28.79

ACCESSPOINT

EMC Compliance Management Group

120VAC/60Hz, Line 2

2. Conducted Emission for FCC15 Class A



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Telemics Corporate

Wed Oct 16 21:05:35 2002

EMC Engineer

Telemics Inc.
111 W. Washington Street
Suite 300
Louisville, KY 40202

FCC Part 15 Certification Application
Industrie Canada RSS210 Certification

Additional Technical Information for the Telemics Verics™ Module

FCC ID : QC5-09-MSS1
IC: 4435A-09-MSS1

Section 15.247(a) System Receiver Input Bandwidth:

Requirement: Describe how the associated receiver(s) complies with the requirement that its input bandwidth (either RF or IF) matches the bandwidth of the transmitted signal.

Response: The receiver input bandwidth is set by the composite rejection characteristics of the first IF filter, an Epcos SAW filter, p/n B4570 and the second IF filter, a Murata ceramic filters p/n SFELA10M7HA00-BO. The nominal receive bandwidth 3 dB bandwidth is 250 kHz. This composite of bandpass filters was picked to match our modulation transmission bandwidth over conditions of temperature drift and production tolerance specifications for the filters and transmitter reference oscillator.

Section 15.247(a) FH-SS System Requirements

Requirement: Describe how the EUT meets the definition of a frequency hopping spread spectrum system, found in Section 2.1, based on the technical description.

Response: The Verics™ Module complies with Telemics' Verics™ Mesh Network Protocol which requires the following:

- 101 non-overlapping channels
- 20 dB transmitter bandwidth no greater than 250 kHz
- The transmitter hops through a pseudorandomly ordered list of hopping frequencies revisiting each frequency equally on average and does not occupy any one frequency with an average time of occupancy greater than 0.4 seconds within a 20 second period.
- The receiver bandwidth matches the transmitter FSK modulation output bandwidth and the receiver shifts frequency in synchronization with the transmitter.

Section 15.247(g) FH-SS System Requirements

Requirement: Describe how the EUT complies with the requirement that it be designed to be capable of operating as a true frequency hopping system.

Response: Telemics' Verics™ Mesh Network Protocol can allow application layer information to be long continuous data streams or short bursts.
If the transmitter is presented with a continuous data (or information) stream it will comply with all of the regulations of Part 15.247. It will continue to follow the protocol defined in the previous question on ‘how the EUT meets the definition of a frequency hopping spread spectrum system'.

If the transmitter is presented with a short burst of data, it will continue to follow the protocol defined in the previous question on 'how the EUT meets the definition of a frequency hopping spread spectrum system'.
The transmitter still follows the receiver oriented hopping pattern of its target as defined in the previous question on "Section 15.247(a) Pseudorandom Frequency Hopping Sequence" and will continue to start transmission at a random phase of the chosen hopping sequence. Over time, all of the channels are visited equally.

Section 15.247(h) Hopping Synchronization

Requirement: Describe how the EUT complies with the requirement that it not have the ability to be coordinated with other FHSS systems in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters.

Response: The Verics™ Module possesses no carrier sense mechanism nor any computer controlled algorithms to detect presence of foreign or other Verics™ Mesh Network transmitters which could be used to coordinate efforts to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitters. The Verics™ Module only potentially knows the receive channel of a potential target module.