Intertek ETL SEMKO

TEST REPORT

Report Number: 3067474.011 Rev. 2
Project Number: 3067474
January 21, 2005

Evaluation of the Opt Transmitter

FCC ID: DGF-OPTICOMGPS1

To
FCC 15, Subpart C, Section 247

For
3M Traffic Safety Systems

Test Performed by:
Intertek
7250 Hudson Blvd. Suite 100
Oakdale, MN 55128

Test Authorized by:
3M Traffic Safety Systems
3M Center, 235-3W-52
Saint Paul, MN 55144

Prepared by: _____ Date: January 21, 2005
Uri Spector

Approved by: _____ Date: January 21, 2005
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1.0 GENERAL DESCRIPTION

1.1 Related Submittals Grants

This is single application of the *OPTICOM GPS Transmitter Model: 1011A, s/n: 10110101* for Certification under FCC Part 15, Subpart C. There are no other simultaneous applications. The Receiver portion will be verified under Declaration of Conformity.

1.2 Product Description

The *OPTICOM GPS Transmitter* is a part of the Traffic Light Control System. The *OPTICOM GPS Transmitter* is a Frequency Hopping System Transmitter operating within 2400-2483.5 MHz frequency band under Section 15.247. The intended use of the *OPTICOM GPS Transmitter* unit is to generate a RF signal, deliver the signal to the antenna in order to communicate with the *OPTICOM GPS Receiver*. During testing the *OPTICOM GPS Transmitter* is connected to the support DC power supply. During normal operation the OPTICOM GPS is powered by a vehicle or intersection power supply.

RF Power Output:

1 Watt maximum (30dBm)

Antenna Description:

Omni-directional antenna
Gain: 2.2 dBi
Impedance: 50Ω
Connector: SMA

Sample Submitted: October 26, 2004
Test Work Started: October 26, 2004
Test Work Completed: January 21, 2005

1.3 Test Methodology

Emission measurements were performed according to the procedures in ANSI C63.4-2001. All field strength radiated emissions measurements were performed in the semi-anechoic chamber, and for each scan, the procedure for maximizing emissions in Appendices D and E were followed. All field strength radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "**Justification Section**" of this Application.

1.4 Test Facility

The test site facility used to collect the radiated and conducted measurement data is located at 7250 Hudson Blvd., Suite 100, Oakdale, Minnesota. This test facility has been fully described in a report dated on March 2003 submitted to FCC. Please reference the site registration number: 90706, dated April 18, 2003.

2.0 SYSTEM TEST CONFIGURATION

2.1 Justification

N/A

2.2 EUT Setup

For simplicity of testing, the transmitter was wired to transmit continuously

2.3 EUT Exercising Software

The *OPTICOM GPS Transmitter* was operated in continuous frequency hopping transmission mode and in continuous single channel transmission mode for testing purposes. The support DC power supply was used to control these modes of operation by cycling the power.

2.4 Special Accessories

There are no special accessories necessary for compliance of these products.

2.5 Equipment Modification

No modifications were installed on the EUT during testing.

2.6 Support Equipment List and Description

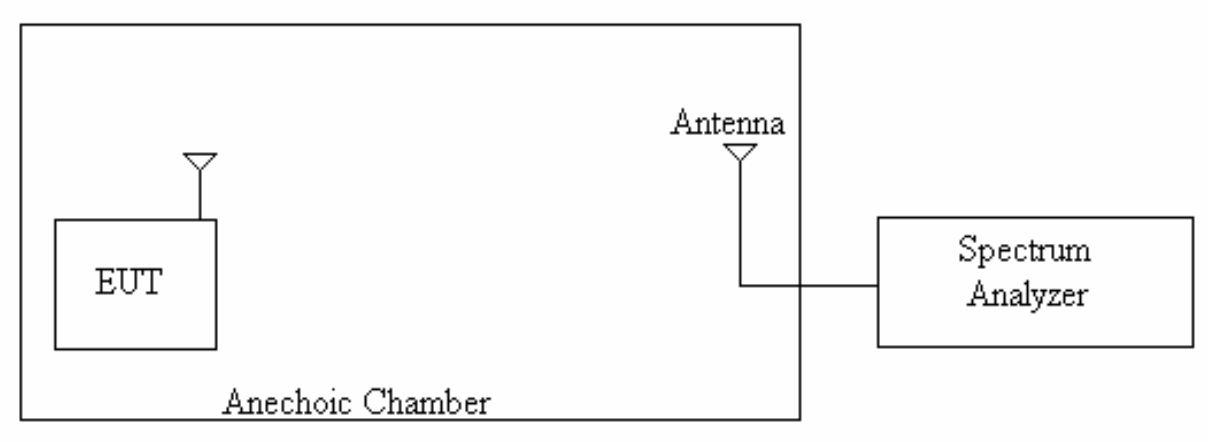
Opticom GPS Priority Control System-intersection power supply (used during Line Conducted Emissions test only).

TENMA Laboratory DC power supply, model: 72-2010 (used during the rest of the tests).

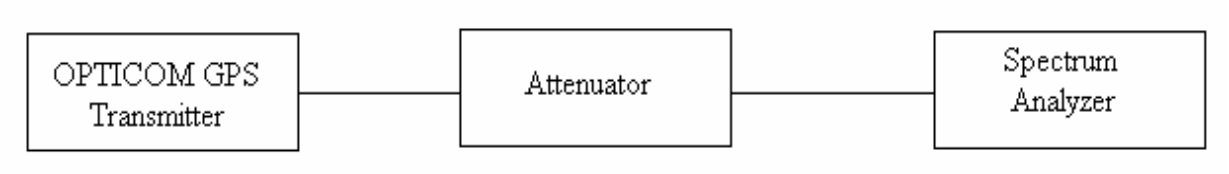
2.7 Test Configuration Block Diagrams

The EUT was setup as tabletop equipment.
The EUT was powered at 8VDC from TENMA Laboratory DC power supply, model: 72-2010. During normal operation the *OPTICOM GPS is powered via car battery*.

Field Strength Measurements



Measurements at Antenna Terminal



Note: Attenuator was not used during measurements at Antenna Terminal.

3.0 TEST RESULTS

Data is included for the worst case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs, data tables and graphical representations of the emissions are included.

The EUT is intended for operation under the requirements of Part 15 Subpart C. Specific test requirements include the following:

47 CFR 15.247(a)(1)	Hopping Channel Frequency Separation
47 CFR 15.247(a)(1)(iii)	Number of Hopping Frequencies
47 CFR 15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)
47 CFR 15.247(b)(1)	Peak Output Power
47 CFR 15.247(c)	Band Edge Compliance
47 CFR 15.247(c)	Spurious RF Conducted Emissions
47 CFR 15.247(c)	Radiated Spurious Emissions
47 CFR 15.109, Class A	Radiated Emissions

3.1 Hopping Channel Frequency Separation

The Hopping Channel Frequency Separation measurements were made on two adjacent channels.

Test Procedure

The Hopping Channel Frequency Separation was measured in max hold analyzer mode with span wide enough to capture the peaks of two adjacent channels.

Table 3-1-1 and Graphs 3-1-1 & 3-1-2 show the Hopping Channel Frequency Separation and separation at –20dB level.

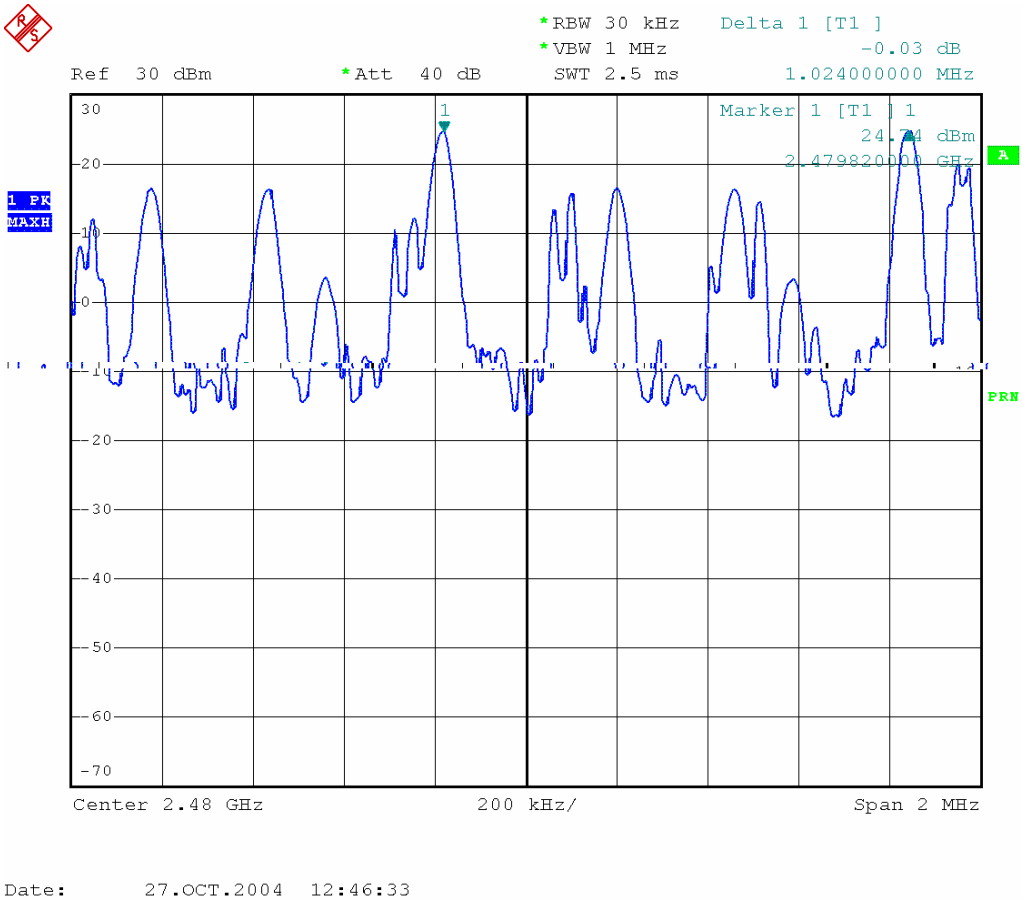
Hopping Channel Frequency Separation

Date: 10-26-2004
Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Special Config. Info:
Standard: FCC 15.247(a)(1)

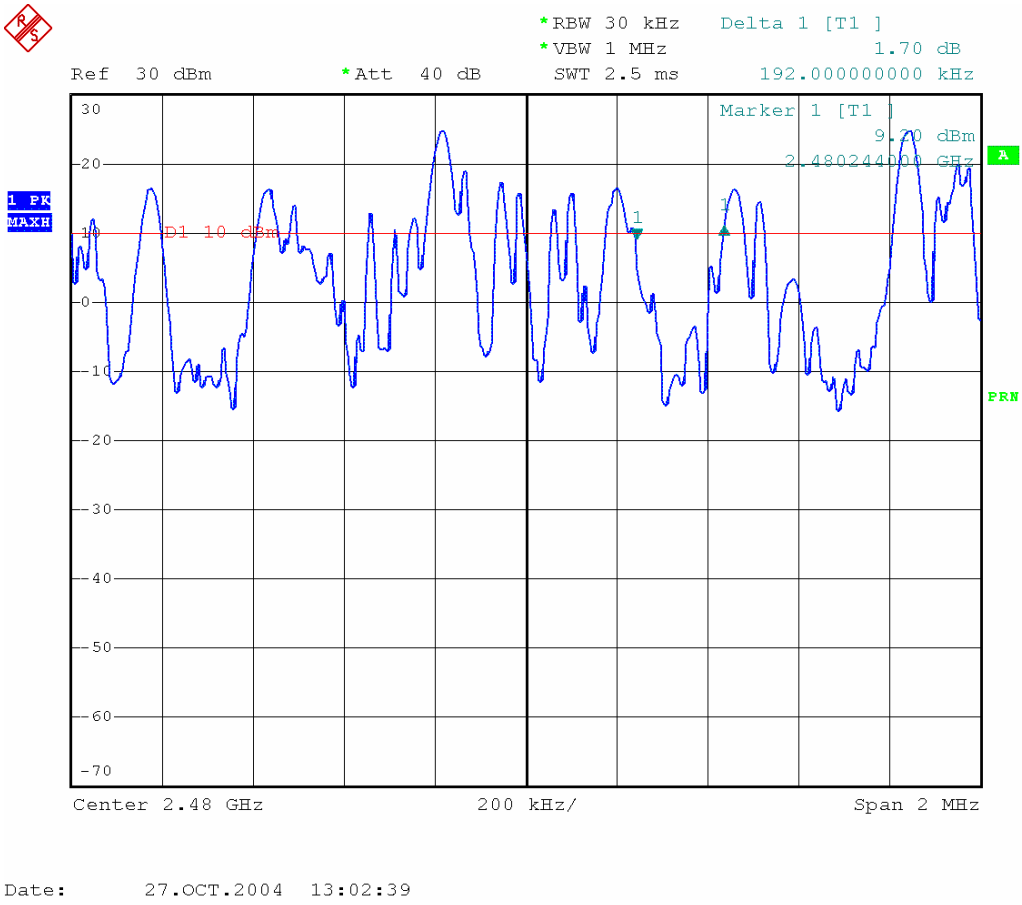
Table # 3-1-1

	Measured Separation kHz	Minimum Requirements kHz	Test result
Peak Separation	1024.0	25.0	Pass
Separation at -20dB level	192.0	25.0	Pass

Graph 3-1-1


*RBW 30 kHz
*VBW 1 MHz
Ref 30 dBm
*Att 40 dB
SWT 2.5 ms
Delta 1 [T1]
-0.03 dB
1.024000000 MHz
Marker 1 [T1] 1
24.74 dBm
2.479820000 GHz
1 PK
MAXH
A
PRN
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 2.48 GHz
200 kHz/
Span 2 MHz
Date: 27.OCT.2004 12:46:33

Graph 3-1-2


*RBW 30 kHz
*VBW 1 MHz
Ref 30 dBm
*Att 40 dB
SWT 2.5 ms
Delta 1 [T1]
1.70 dB
192.000000000 kHz
Marker 1 [T1]
9.20 dBm
2.480244000 GHz
1 PK
MAXH
D1 10 dBm
A
PRN
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
Center 2.48 GHz
200 kHz/
Span 2 MHz
Date: 27.OCT.2004 13:02:39

3.2 Number of Hopping Frequencies, FCC 15.247(a)(1)(iii)

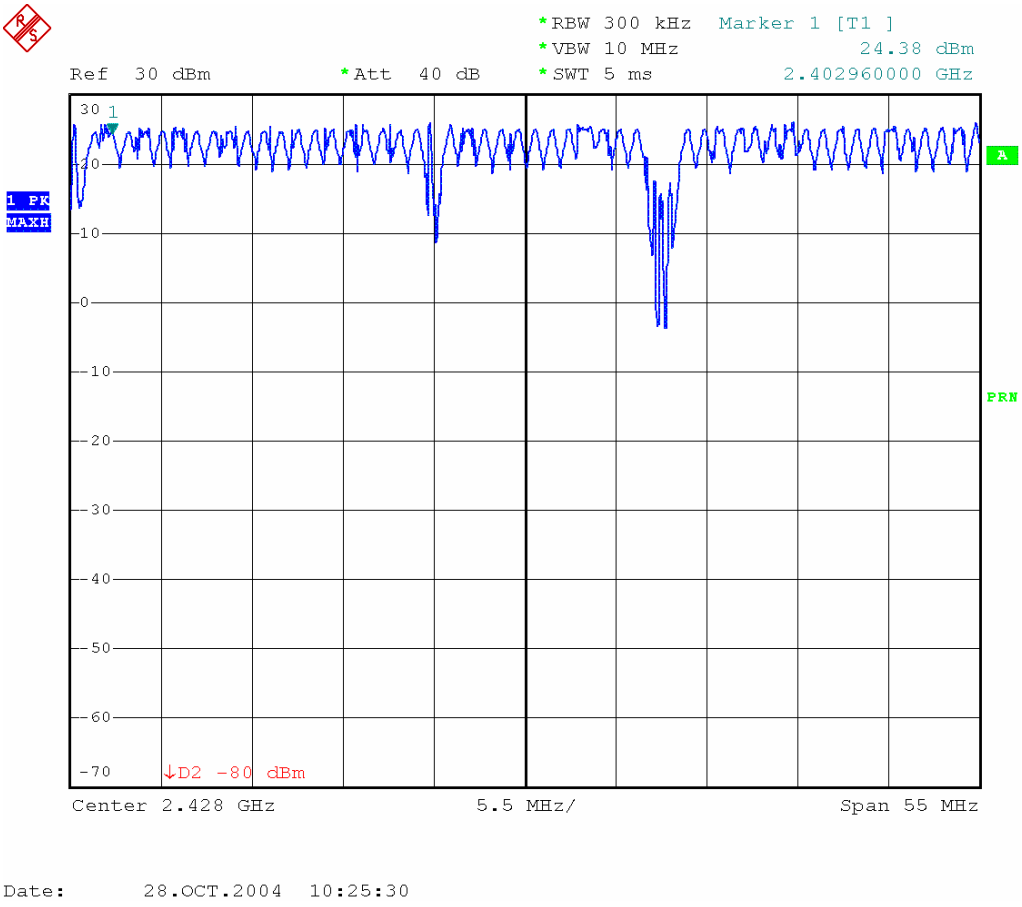
Frequency hopping system in 2400-2483.5MHz frequency band shall use at least 15 non-overlapping channels. Hopping Channels requirement is 75 hopping channels. Transmitter complies with the requirements.

Test Procedure

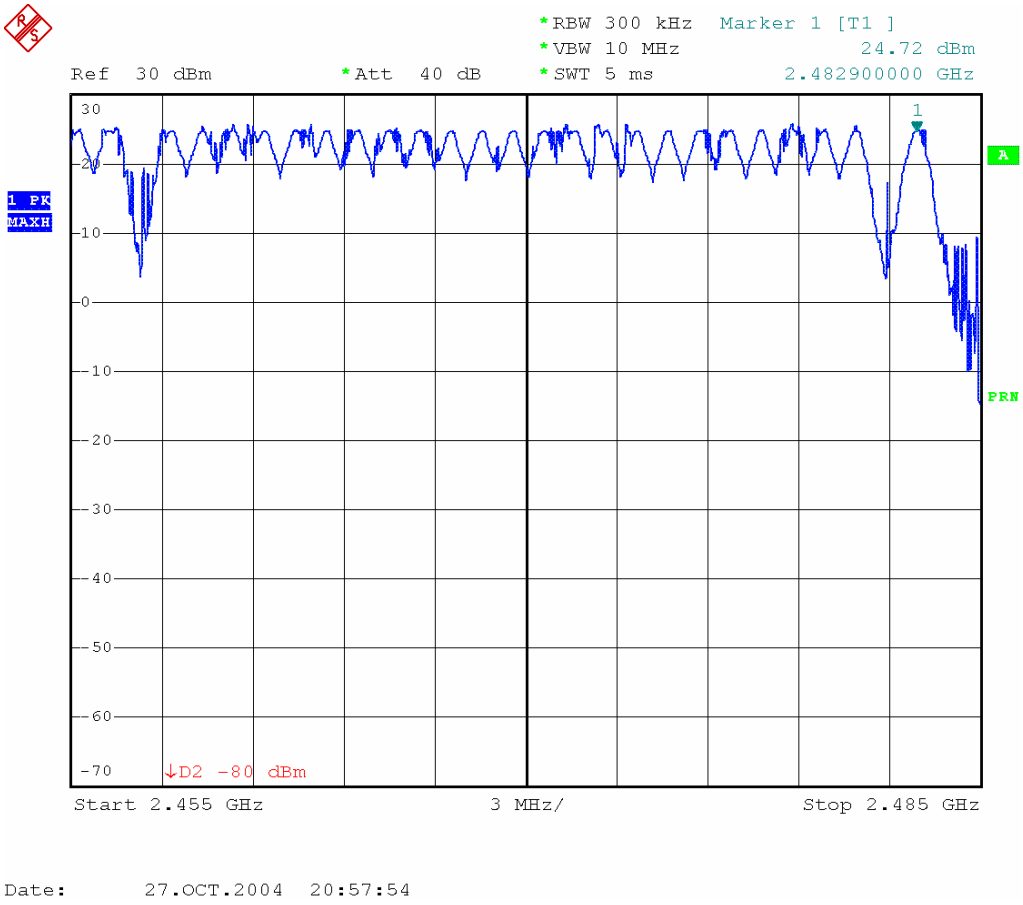
The Number of Hopping Channels was measured in "max hold" analyzer mode. The frequency range was divided in four sub-ranges to clearly show all hopping frequencies.

Graphs 3-2-1, 3-2-2 show the Number of Hopping Frequencies.

Graph 3-2-1


*RBW 300 kHz
Marker 1 [T1]
*VBW 10 MHz
24.38 dBm
Ref 30 dBm
*Att 40 dB
*SWT 5 ms
2.402960000 GHz
1 PK
MAXH
A
PRN
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
D2 -80 dBm
Center 2.428 GHz
5.5 MHz/
Span 55 MHz
Date: 28.OCT.2004 10:25:30

Graph 3-2-2


*RBW 300 kHz
*VBW 10 MHz
*SWT 5 ms
Marker 1 [T1]
24.72 dBm
2.482900000 GHz
Ref 30 dBm
*Att 40 dB
1 PK
MAXH
A
PRN
↓D2 -80 dBm
Start 2.455 GHz
3 MHz/
Stop 2.485 GHz
Date: 27.OCT.2004 20:57:54

3.3 Time of Occupancy (Dwell Time), FCC 15.247(a)(1)(iii)

Time of Occupancy was measured at the antenna terminal of the EUT.

The average time of occupancy on any channel shall not be greater than 0.4 seconds multiplied by the number of hopping channels employed: 0.4s*75=30 seconds.

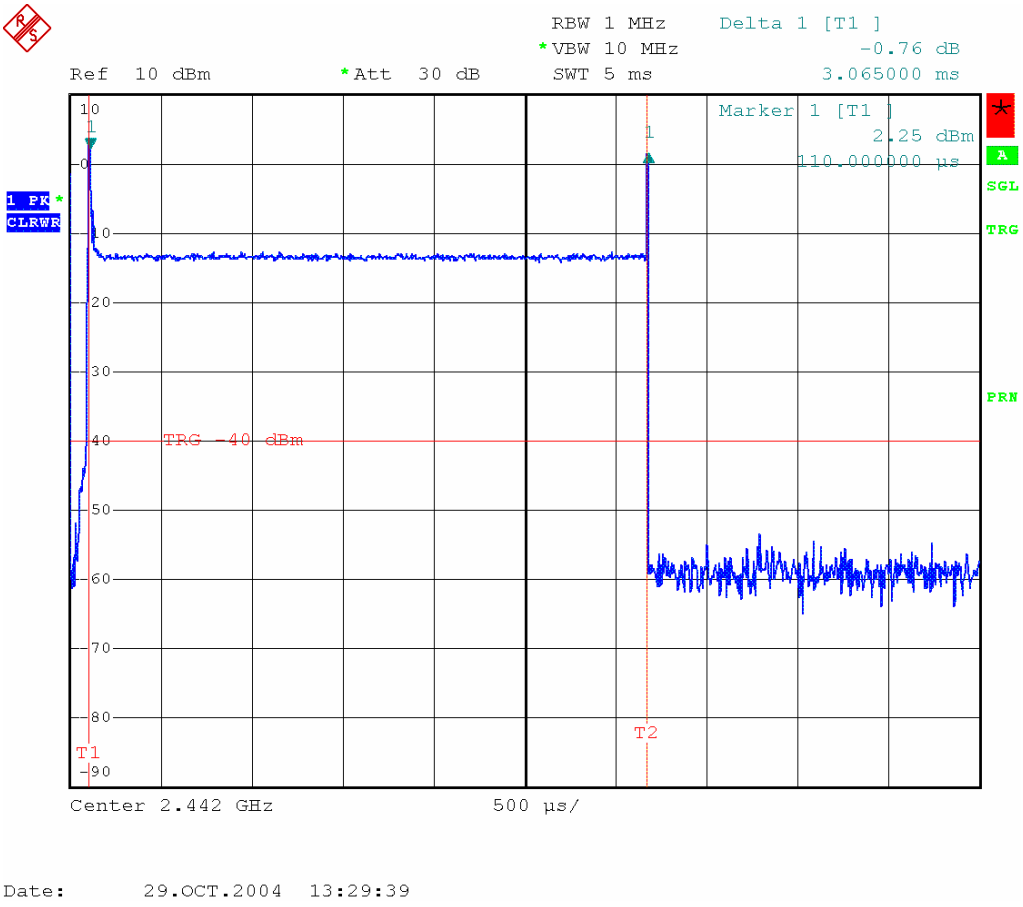
Measured average time of occupancy: 3ms* 90=270ms or 0.27s within a 30 seconds period.

Test Procedure

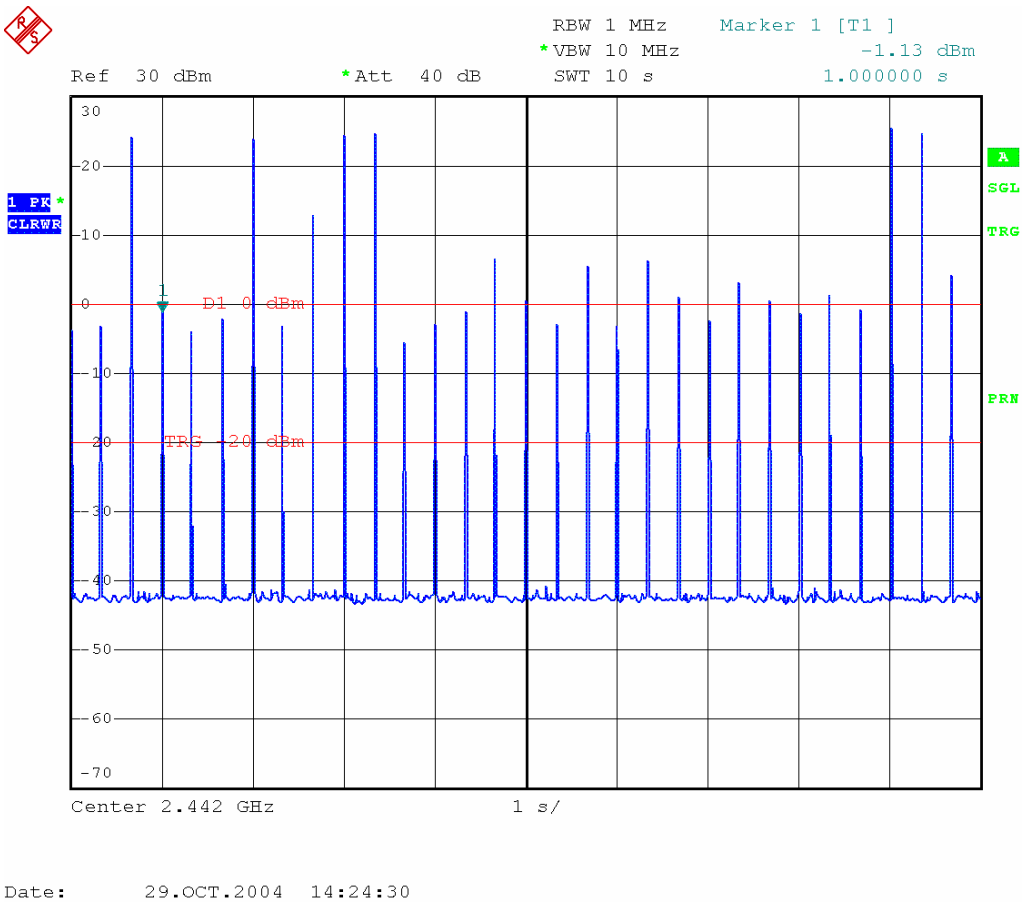
The Time of Occupancy was measured in “max hold” analyzer mode with zero span.

Graphs 3-3-1, 3-3-2 show the Time of Occupancy test results.

Graph 3-3-1


RBW 1 MHz
*VBW 10 MHz
SWT 5 ms
Delta 1 [T1]
-0.76 dB
3.065000 ms
Ref 10 dBm
*Att 30 dB
Marker 1 [T1]
2.25 dBm
110.000000 µs
1 PK *
CLRWR
SGL
TRG
PRN
TRG -40 dBm
T1
T2
Center 2.442 GHz
500 µs/
Date: 29.OCT.2004 13:29:39

Graph 3-3-2


RBW 1 MHz
*VBW 10 MHz
SWT 10 s
Marker 1 [T1]
-1.13 dBm
1.000000 s
Ref 30 dBm
*Att 40 dB
1 PK*
CLRWR
A
SGL
TRG
PRN
D1 0 dBm
TRG -20 dBm
Center 2.442 GHz
1 s/
Date: 29.OCT.2004 14:24:30

3.4 Peak Output Power, FCC 15.247(b)(1)

For frequency hopping system in 2400-2483.5MHz frequency band employing 75 hopping channels, maximum peak output power shall not exceed 1 watt. Transmitter complies with the requirements (see Graphs 3-2-1, 3-2-2).

Peak Output measurements were made at the low, center, and high frequency channels (channels 1, 40, and 81).

Test Procedure

The Peak Power Output for the device was measured at the maximum power transmission condition. The transmitter antenna port was connected to the Spectrum analyzer.

Total Power was calculated from Measured Power adding 1.2dB cable factor.

Table 3-4-1 and Graphs 3-4-1, 3-4-2, and 3-4-3 show the Peak Output Power at the antenna terminal.
Note: Emission level shown in the Graphs does not include 1.2dB attenuation cable factor.

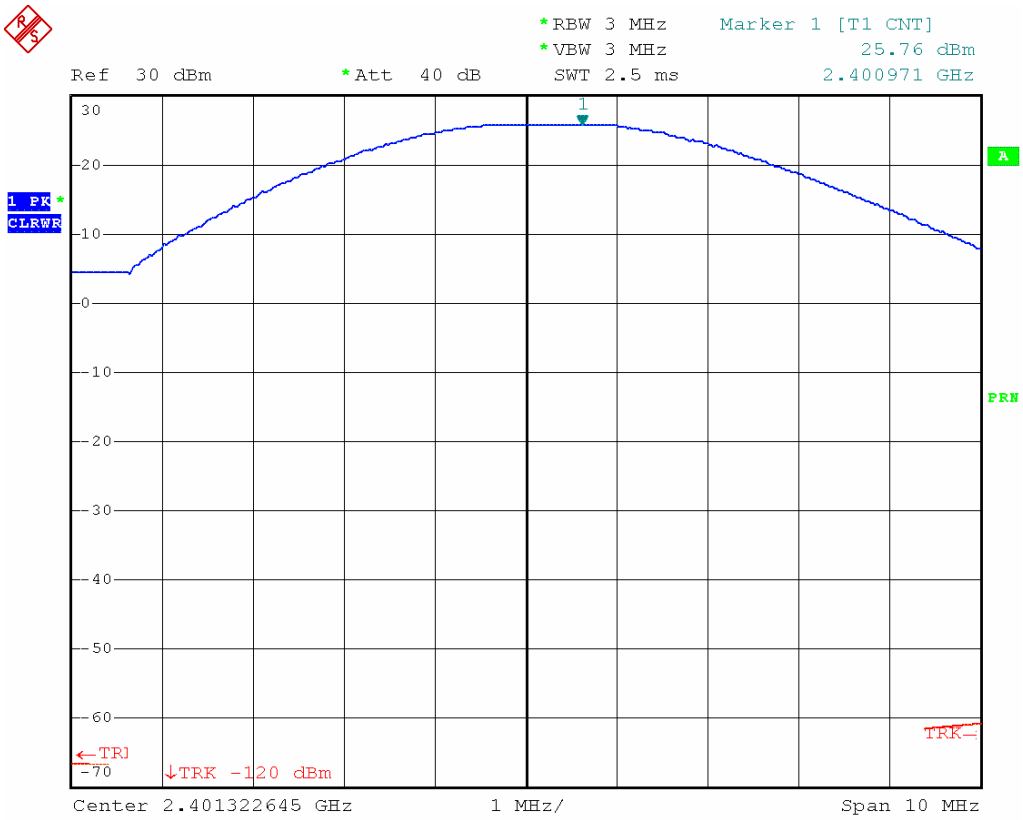
RF Power Output **Date:** 10-26-2004
Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Special Config. Info: The EUT antenna terminal was connected to the Spectrum

Standard: FCC Part 15.247(b)(1)

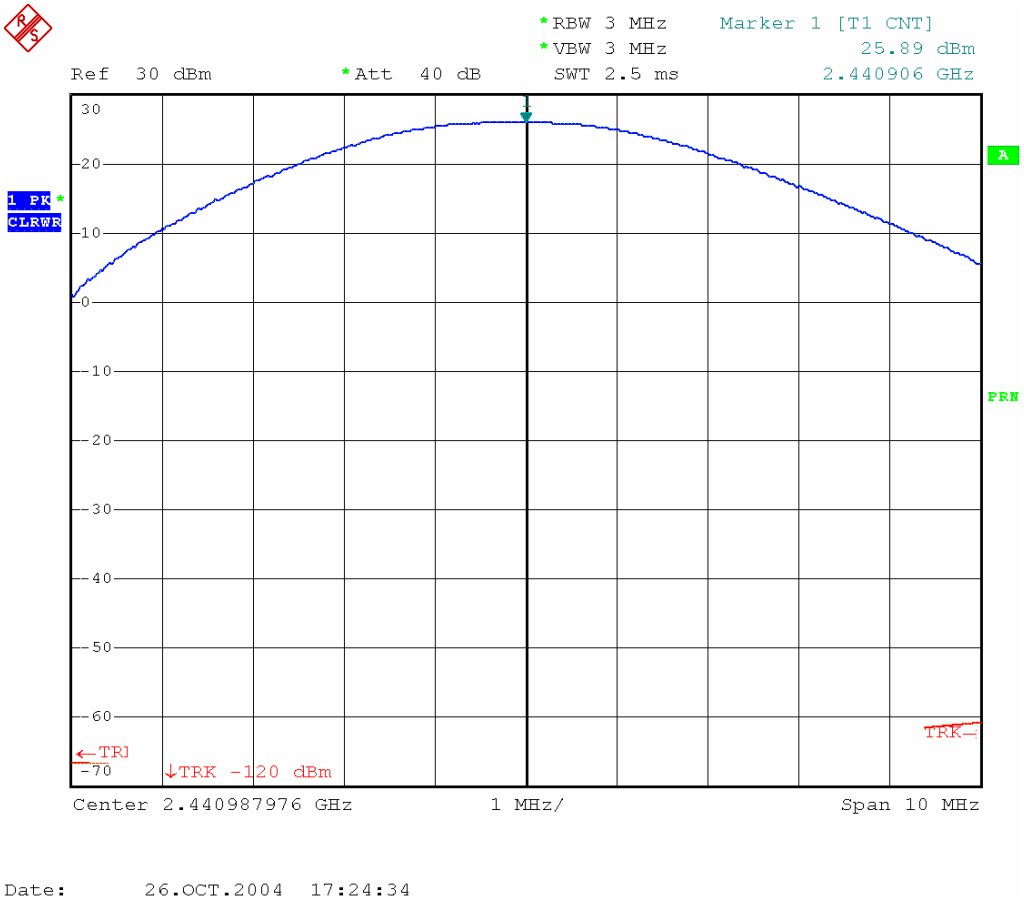
Table # 3-4-1

Output Freq. MHz	Measured Power dBm	Attenuator and Cable factor dB	Total Power dBm	Maximum Power dBm	Margin dB	Comments
Channel 1	25.76	1.2	26.96	30.0	-3.04	
Channel 40	25.89	1.2	27.09	30.0	-2.91	
Channel 81	25.68	1.2	26.88	30.0	-3.12	

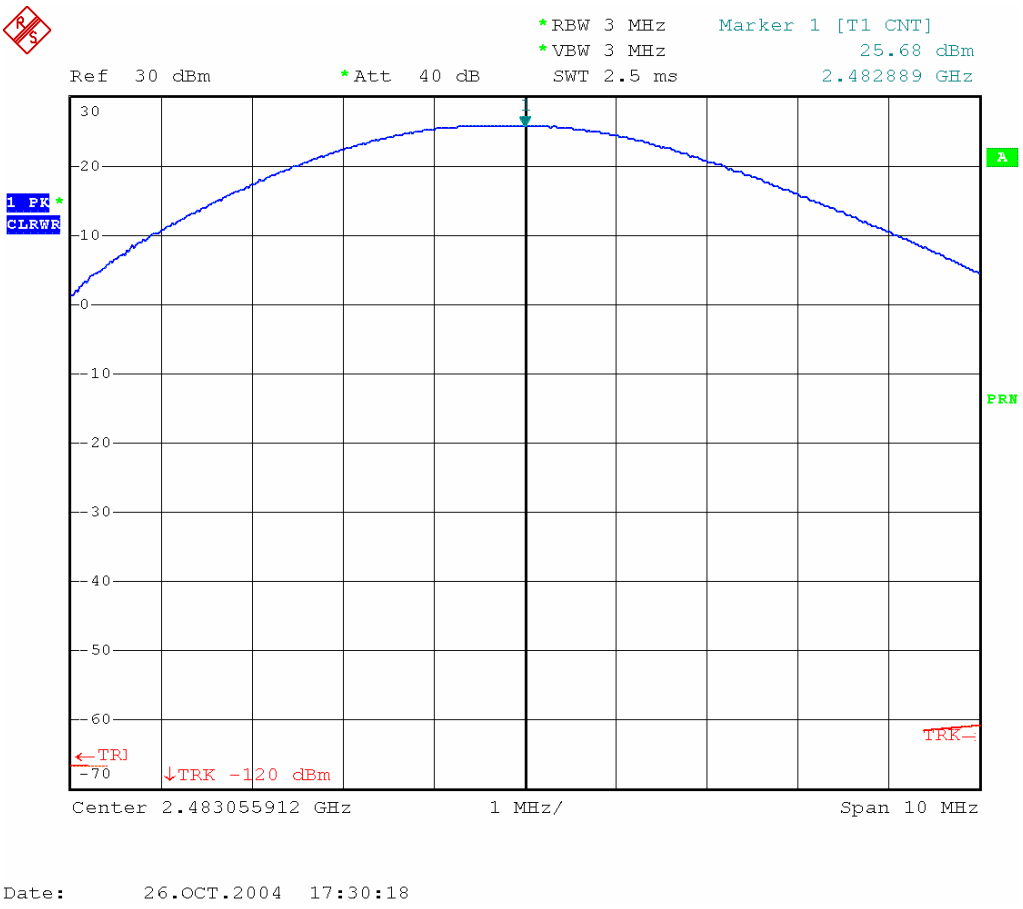
Graph 3-4-1


*RBW 3 MHz
*VBW 3 MHz
Marker 1 [T1 CNT]
25.76 dBm
2.400971 GHz
Ref 30 dBm
*Att 40 dB
SWT 2.5 ms
1 PK*
CLRWR
A
PRN
TRK
←TRJ
-70
↓TRK -120 dBm
Center 2.401322645 GHz
1 MHz/
Span 10 MHz
Date: 26.OCT.2004 17:21:42

Graph 3-4-2


*RBW 3 MHz
*VBW 3 MHz
Marker 1 [T1 CNT]
25.89 dBm
2.440906 GHz
Ref 30 dBm
*Att 40 dB
SWT 2.5 ms
1 PK*
CLRWR
A
PRN
TRK
←TRJ
-70
↓TRK -120 dBm
Center 2.440987976 GHz
1 MHz/
Span 10 MHz
Date: 26.OCT.2004 17:24:34

Graph 3-4-3


*RBW 3 MHz
*VBW 3 MHz
Marker 1 [T1 CNT]
25.68 dBm
2.482889 GHz
Ref 30 dBm
*Att 40 dB
SWT 2.5 ms
1 PK *
CLRWR
A
PRN
TRK
←TRJ
-70
↓TRK -120 dBm
Center 2.483055912 GHz
1 MHz/
Span 10 MHz
Date: 26.OCT.2004 17:30:18

3.5 Band Edge Compliance, FCC 15.247(c)

Left and right band-edge compliance measurements were made at Channel 1 and Channel 81 for band-edge frequencies of 2400.0 and 2483.5MHz respectively.

Test Procedure

The Spurious Emissions at the Antenna Terminal of the EUT were measured at the maximum power. The transmitter antenna port was connected to the Spectrum analyzer.

The Band-Edge Emissions Attenuation calculation
The Band-Edge Emissions Attenuation was calculated using the output power P at Channel 1 or Channel 81 and spurious emissions E at band-edges of 2400.0 and 2483.5MHz respectively

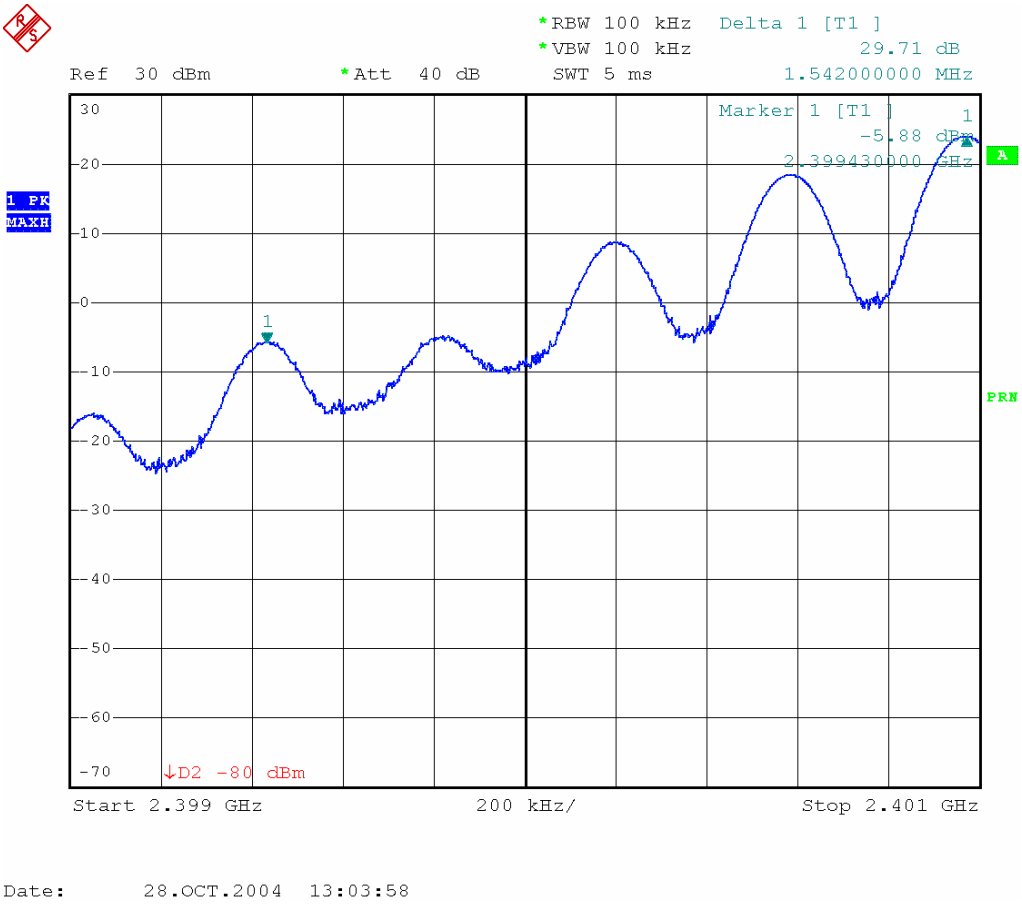
The Band-Edge Emissions Attenuation = $P - E$

Table 3-5-1 below and Graphs 3-5-1 and 3-5-2 show the band-edge emissions attenuation at the antenna terminal.

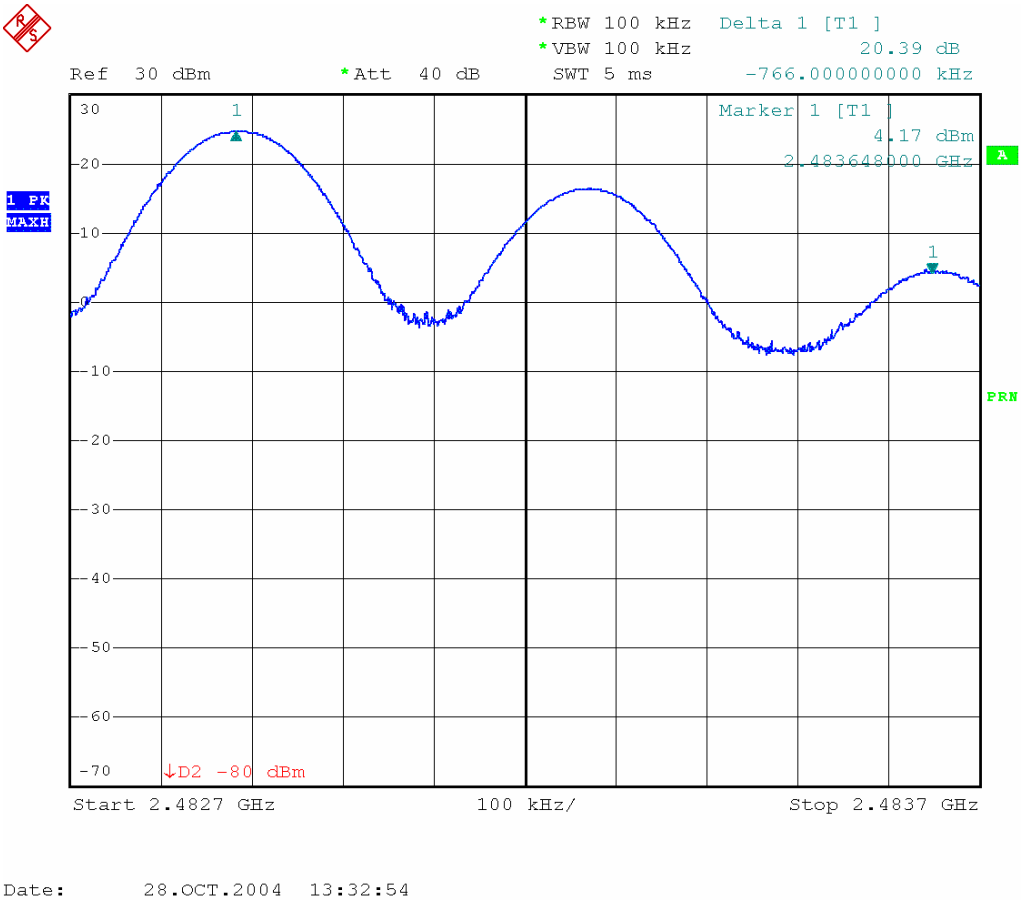
Table # 3-5-1

Center of Output Emissions MHz	Edge Freq. MHz	Power at center of emissions dBm	Power at band-edge dBm	Measured Atten. dB	Minimum Atten. dB	Margin
2401.00	2400.00	23.83	-5.88	29.71	20.00	-9.71
2482.90	2483.50	24.56	4.17	20.39	20.00	-0.39

Graph 3-5-1


*RBW 100 kHz
*VBW 100 kHz
SWT 5 ms
Delta 1 [T1]
29.71 dB
1.542000000 MHz
Ref 30 dBm
*Att 40 dB
Marker 1 [T1]
-5.88 dBm
2.399430000 GHz
1 PK
MAXH
A
PRN
D2 -80 dBm
Start 2.399 GHz
200 kHz/
Stop 2.401 GHz
Date: 28.OCT.2004 13:03:58

Graph 3-5-2


*RBW 100 kHz
*VBW 100 kHz
SWT 5 ms
Delta 1 [T1]
20.39 dB
-766.000000000 kHz
Ref 30 dBm
*Att 40 dB
Marker 1 [T1]
4.17 dBm
2.483648000 GHz
1 PK
MAXH
A
PRN
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
↓D2 -80 dBm
Start 2.4827 GHz
100 kHz/
Stop 2.4837 GHz
Date: 28.OCT.2004 13:32:54

3.6 Spurious RF Conducted Emissions, FCC 15.247(c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement.

Test Procedure

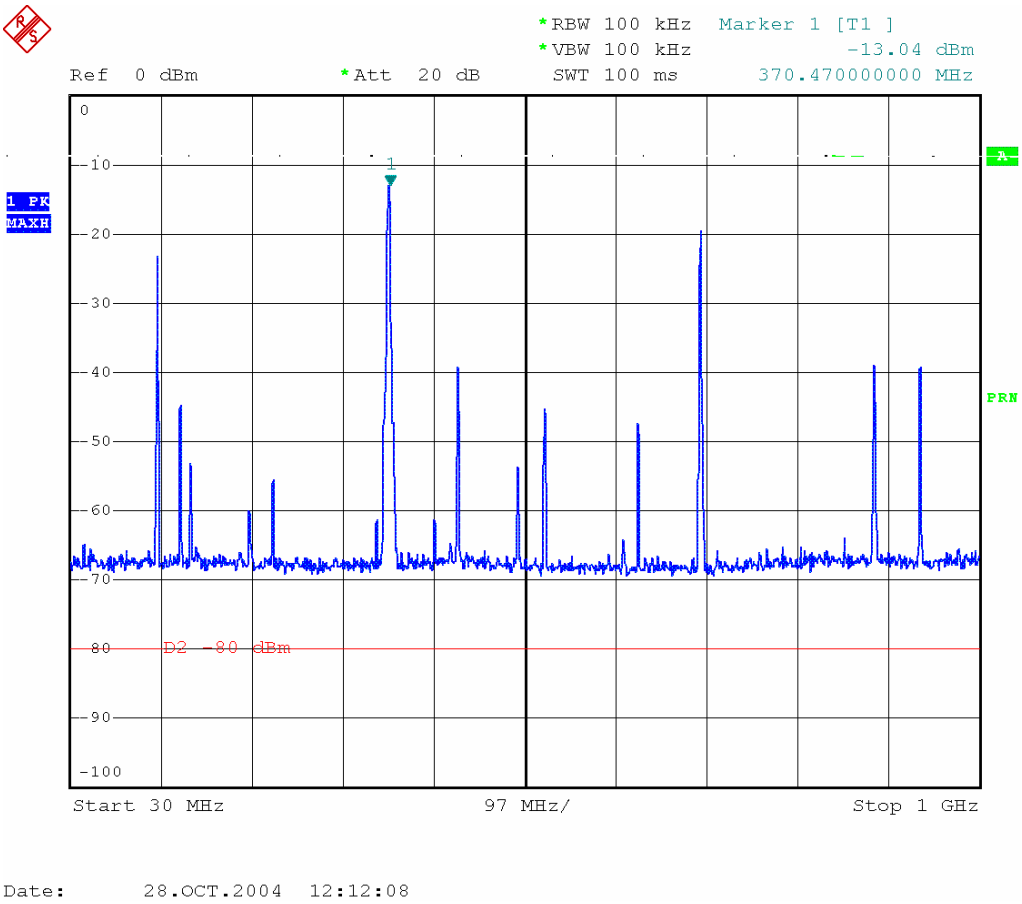
The Spurious RF Conducted Emissions was measured at the EUT antenna terminal at the maximum power in frequency range from 30MHz to 25GHz. The transmitter antenna port was connected to the Spectrum analyzer.

Limits Calculation

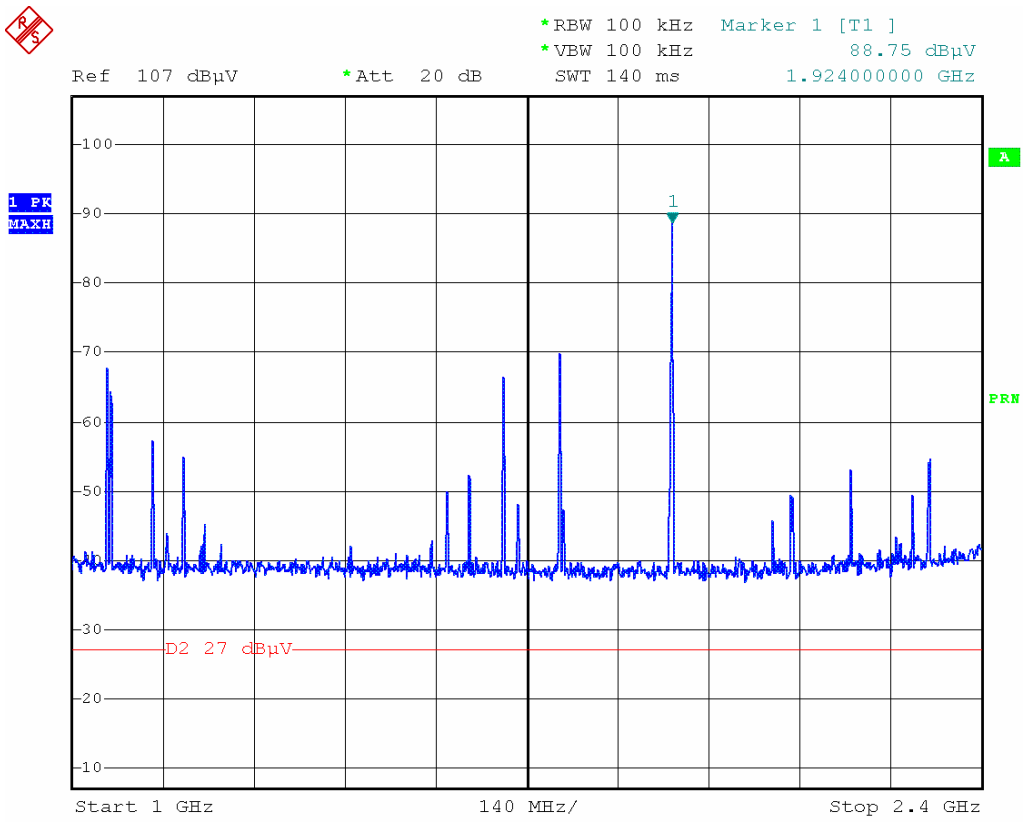
Spurious Emissions limits should be 20dB below of the levels are shown in the Table 3-4-1.
Spurious Emissions Limits for configuration with no Amplifier = 26.88dBm – 20dB = 6.88dBm or 133.88dBµV-20dB=113.88dBµV.

Graphs from 3-6-1 to 3-6-4 show the Spurious RF Conducted Emissions.

Graph 3-6-1
Spurious Emissions at Antenna Terminal from 30 MHz to 1 GHz
Limits: 6.88dBm or 113.88dBµV

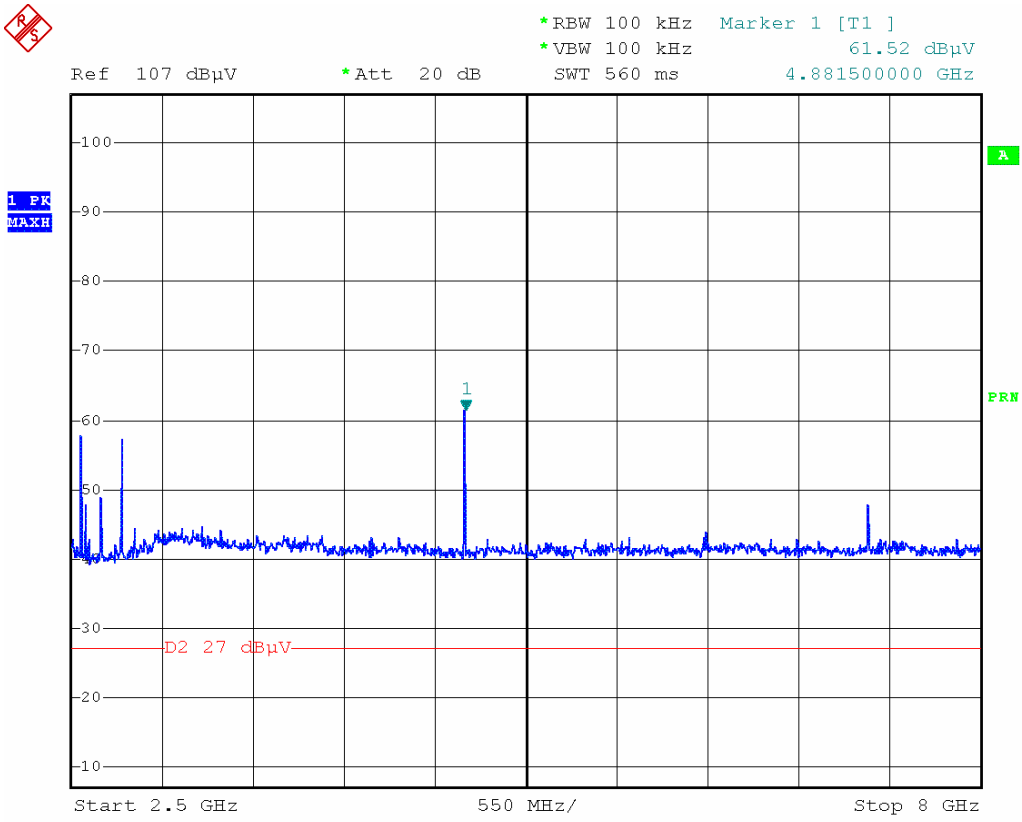


Graph 3-6-2
Spurious Emissions at Antenna Terminal from 1 GHz to 2.4 GHz
Limits: 6.88dBm or 113.88dBµV

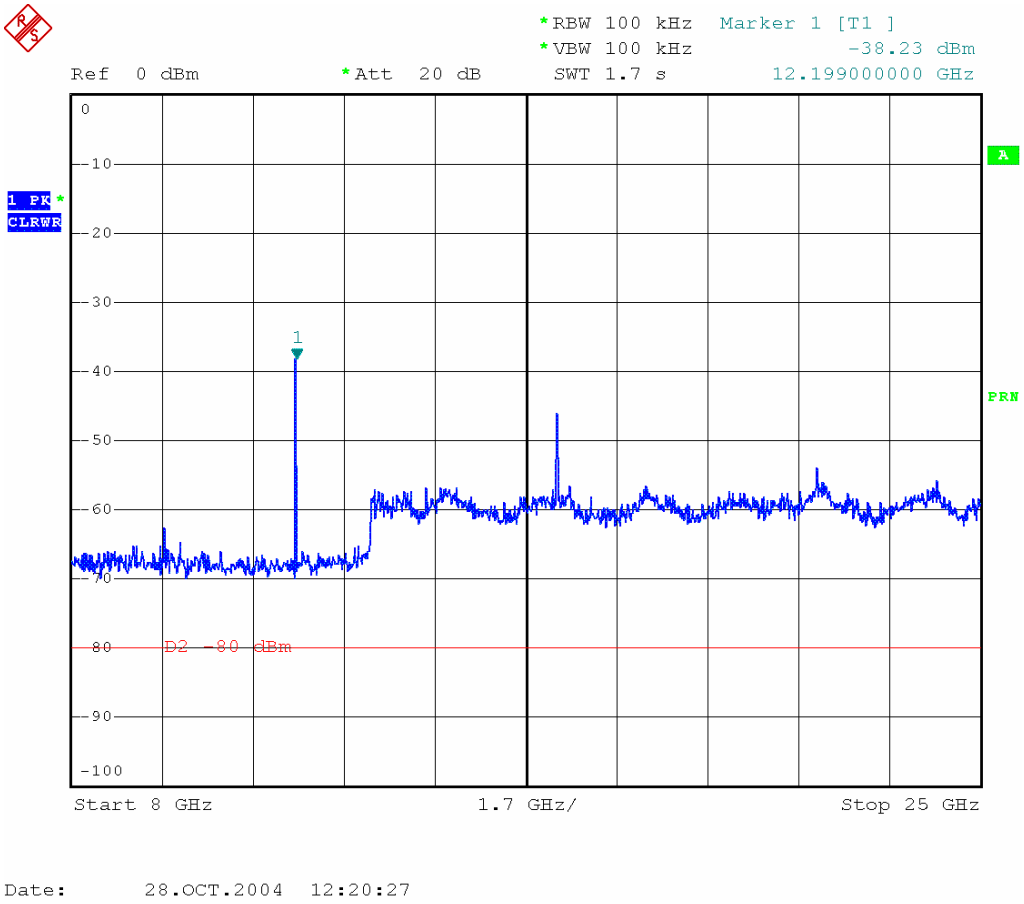


Date: 28.OCT.2004 12:09:26

Graph 3-6-3
Spurious Emissions at Antenna Terminal from 2.5 GHz to 8 GHz
Limits: 6.88dBm or 113.88dBµV



Graph 3-6-4
Spurious Emissions at Antenna Terminal from 8 GHz to 25 GHz
Limits: 6.88dBm or 113.88dBµV



3.7 Radiated Spurious Emissions, FCC 15.247(c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or radiated measurement. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emissions limits specified in section 15.209(a).

Field Strength Measurements

The EUT was placed on a non-conductive table 0.8m above the ground plane inside the Anechoic Chamber. The table was centered on a motorized turntable, which allows 360-degree rotation. The measurement antenna was positioned at 3m distance. The Bicono-Log antenna was used in frequency range from 30MHz to 1GHz, and the Horn antenna was used in frequency range above 1GHz. The radiated emissions were maximized by configuring the EUT through its placement in three orthogonal axes, by rotating the EUT, by changing antenna polarization, and by changing antenna height from 1 to 4m. Method of the direct Field Strength Calculation is shown in Section 3.8.

Tables from 3-7-1 to 3-7-3 show Radiated Spurious Emissions in restricted band in frequency range from 2.4 GHz to 25 GHz. No Radiated Spurious Emissions were detected in frequency range from 1 GHz to 2.4 GHz.

Tables from 3-7-4 to 3-7-6 show Radiated Spurious Emissions in restricted band in frequency range from 30 MHz to 1 GHz.

Note: "Duty cycle correction factor" was used during measurement above 1 GHz. If the dwell time per channel of the hopping signal is less than 100 ms, then the reading obtained with 10 Hz VBW may be adjusted by a "Duty cycle correction factor", derived from 20log(dwell time/100 ms), in an effort to demonstrate compliance with the 15.209 limit.

Calculation of "Duty cycle correction factor": The dwell time per channel of the hopping signal is 3 ms. (See Graph 3-3-1), therefore "Duty cycle correction factor"= 20log(3 ms/100 ms)=-30.45dB, maximum allowed is 20dB.

Spurious Radiated Emissions **Date:** 10-26-2004

Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Limits: FCC Part 15.209
Test Site: 3 meters Anechoic chamber, 3 meters measurement distance
Note: All readings were taken with RBW 1MHz and VBW l0Hz
Table shows harmonics spurious emissions for Ch. 1 in the Restricted Bands of Operation per FCC 15.205

Table # 3-7-1

Frequency	Antenna			Reading	Duty Cycle	Total Emissions	Limit	Margin
MHz	Polarity	Hts(cm)	Factor (dB1/m)	dBµV	Factor (dB)	dBµV/m	dBµV/m	dB
4801.92	V	155	8.1	53.8	20.0	41.9	54.0	-12.1
4801.92	H	132	8.1	49.2	20.0	37.3	54.0	-16.7
12004.75	V	100	19.3	36.2	20.0	35.5	54.0	-18.5
12004.75	H	114	19.3	34.8	20.0	34.1	54.0	-19.9

Comments: No spurious emissions in restricted band were detected detected above 5th harmonic

Spurious Radiated Emissions **Date:** 10-26-2004

Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Limits: FCC Part 15.209
Test Site: 3 meters Anechoic chamber, 3 meters measurement distance
Note: All readings were taken with RBW 1MHz and VBW l0Hz
Table shows harmonics spurious emissions for Ch. 40 in the Restricted Bands of Operation per FCC 15.205

Table # 3-7-2

Frequency	Antenna			Reading	Duty Cycle	Total Emissions	Limit	Margin
MHz	Polarity	Hts(cm)	Factor (dB1/m)	dBµV	Factor (dB)	dBµV/m	dBµV/m	dB
4882.29	V	135	8.4	52.7	20.0	41.1	54.0	-12.9
4882.29	H	107	8.4	46.4	20.0	34.8	54.0	-19.2
7322.00	V	128	12.3	42.7	20.0	35.0	54.0	-19.0
7322.00	H	125	12.3	40.4	20.0	32.7	54.0	-21.3
12205.86	V	100	19.1	35.4	20.0	34.5	54.0	-19.5
12205.86	H	154	19.1	31.4	20.0	30.5	54.0	-23.5

Comments: No spurious emissions in restricted band were detected detected above 5th harmonic

Spurious Radiated Emissions **Date:** 10-26-2004

Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Limits: FCC Part 15.209
Test Site: 3 meters Anechoic chamber, 3 meters measurement distance
Note: All readings were taken with RBW 1MHz and VBW l0Hz
Table shows harmonics spurious emissions for Ch. 81 in the Restricted Bands of Operation per FCC 15.205

Table # 3-7-3

Frequency MHz	Antenna			Reading dBµV	Duty Cycle Factor (dB)	Total Emissions dBµV/m	Limit dBµV/m	Margin dB
	Polarity	Hts(cm)	Factor (dB1/m)					
4965.82	V	148	8.7	50.2	20.0	38.9	54.0	-15.1
4965.82	H	150	8.7	45.3	20.0	34.0	54.0	-20.0
7448.66	V	121	12.6	42.0	20.0	34.6	54.0	-19.4
7448.66	H	135	12.6	39.2	20.0	31.8	54.0	-22.2
12414.36	V	153	18.9	33.3	20.0	32.2	54.0	-21.8
12414.36	H	100	18.9	29.5	20.0	28.4	54.0	-25.6

Comments: No spurious emissions in restricted band were detected detected above 5th harmonic

Spurious Radiated Emissions **Date:** 10/26/2004

Company: 3M Traffic Safety Systems

Model: Opticom GPS Transmitter

Test Engineer: Uri Spector

Standard: FCC Part 15.209

Test Site: 3 meters Anechoic Chamber, 3 meters measurement distance

Note: Table shows harmonics spurious emissions for Ch. 1 in the Restricted Bands of Operation per FCC 15.205
All measurements were taken using a CISPR Quasi-peak detector using RBW 100k & VBW 300kHz

Table # 3-7-4

Frequency	Antenna			Total QP	QP Limit	Margin	Comments
MHz	Polarity	Hts(cm)	Factor(dB1/m)	dBµV/m	dBµV/m	dB	
245.75	H	114	14.1	39.9	46.0	-6.1	
270.33	H	100	14.9	40.5	46.0	-5.5	
983.02	H	100	26.0	41.7	54.0	-12.3	

Spurious Radiated Emissions **Date:** 10/26/2004

Company: 3M Traffic Safety Systems

Model: Opticom GPS Transmitter

Test Engineer: Uri Spector

Standard: FCC Part 15.209

Test Site: 3 meters Anechoic Chamber, 3 meters measurement distance

Note: Table shows harmonics spurious emissions for Ch. 40 in the Restricted Bands of Operation per FCC 15.205
All measurements were taken using a CISPR Quasi-peak detector using RBW 100k & VBW 300kHz

Table # 3-7-5

Frequency	Antenna			Total QP	QP Limit	Margin	Comments
MHz	Polarity	Hts(cm)	Factor(dB1/m)	dBµV/m	dBµV/m	dB	
245.75	H	111	14.1	39.8	46.0	-6.2	
270.33	H	100	14.9	40.5	46.0	-5.5	
983.02	H	100	26.0	43.8	54.0	-10.2	

Spurious Radiated Emissions **Date:** 10/26/2004

Company: 3M Traffic Safety Systems
Model: Opticom GPS Transmitter
Test Engineer: Uri Spector
Standard: FCC Part 15.209
Test Site: 3 meters Anechoic Chamber, 3 meters measurement distance
Note: Table shows harmonics spurious emissions for Ch. 81 in the Restricted Bands of Operation per FCC 15.205
All measurements were taken using a CISPR Quasi-peak detector using RBW 100k & VBW 300kHz

Table # 3-7-6

Frequency	Antenna			Total QP	QP Limit	Margin	Comments
MHz	Polarity	Hts(cm)	Factor(dB1/m)	dBμV/m	dBμV/m	dB	
245.75	H	113	14.1	39.6	46.0	-6.4	
270.33	H	100	14.9	40.6	46.0	-5.4	
983.02	H	100	26.0	41.8	54.0	-12.2	

3.8 Radiated Emissions, FCC 15.109, Class A

The EUT was tested as a digital device according to FCC Part 15.109, Class A in frequency range from 30MHz to 12.5GHz. Radiated Emissions testing was performed in Anechoic Chamber with 3m-measurement distance. Signal generator was used in close proximity to activate the EUT in receiving mode. Transmitting frequency of the signal generator was excluded from the readings.
Table 3-8-1 shows radiated emissions data in frequency 30 MHz-1 GHz. Graphs 3-8-1 & 3-8-2 show compliance of the EUT in frequency range 1 GHz- 12.5 GHz in vertical and horizontal antenna polarity.

Radiated Emissions **Date:** 12-23-2004

Company: 3M Corp.

Model: Opticom GPS Transmitter

Test Engineer: Norman Shpilsher

Special Info: Frequency range from 30 MHz to 1 GHz

Standard: FCC Part 15.109, Class A

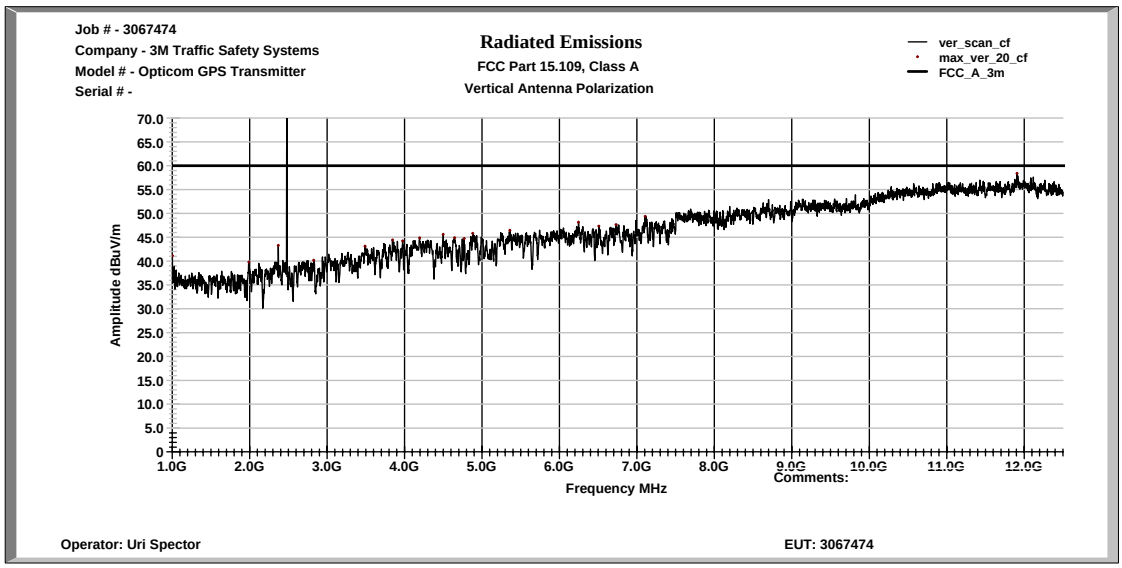
Test Site: 3 meters Anechoic Chamber, 3 meters measurement distance

Note: The table shows the worst case radiated emissions
All measurements were taken using a Peak detector

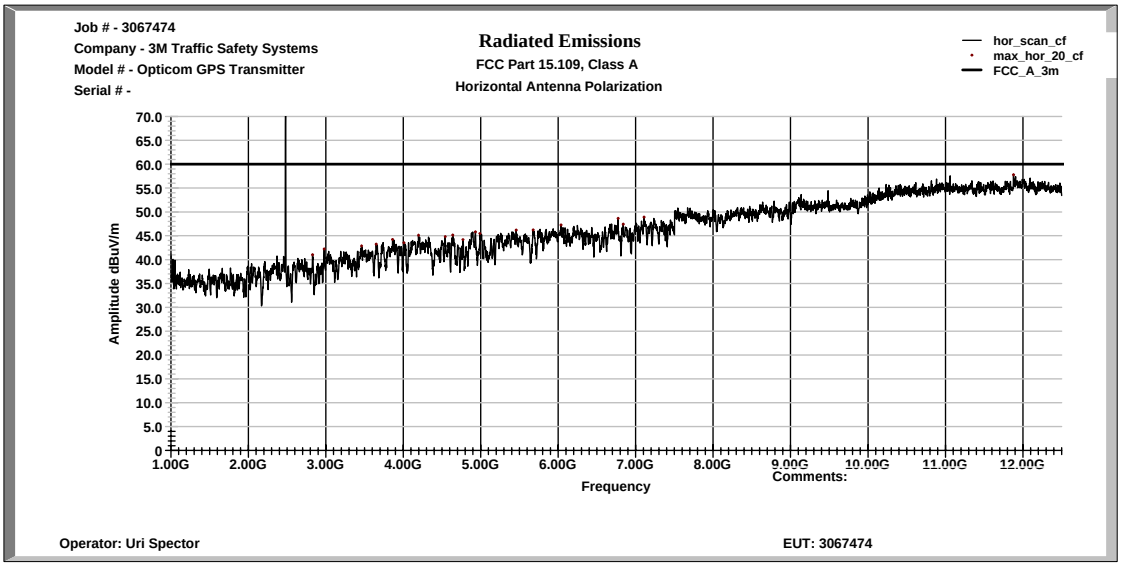
Table # 3-8-1

Frequency	Ant. Polarity	Peak Reading dBµV	Total CF dB1/m	Total at 3m dBµV/m	QP Limit dBµV/m	Margin dB
30.606 MHz	V	19.8	20.2	40.1	49.5	-9.5
32.078 MHz	V	16.9	19.4	36.3	49.5	-13.3
32.857 MHz	V	16.4	18.9	35.3	49.5	-14.2
123.21 MHz	V	27.1	13.6	40.7	54.0	-13.3
147.69 MHz	V	30.2	12.4	42.6	54.0	-11.3
172.6 MHz	V	37.1	11.0	48.2	54.0	-5.8
197.12 MHz	V	38.8	10.9	49.7	54.0	-4.2
222.04 MHz	V	31.3	11.7	43.0	56.9	-13.9
246.15 MHz	V	33.8	13.9	47.7	56.9	-9.3
270.66 MHz	V	25.8	15.3	41.0	56.9	-15.9
295.58 MHz	V	27.7	15.3	43.0	56.9	-13.9
345.02 MHz	V	27.2	16.8	44.0	56.9	-12.9
443.73 MHz	V	21.0	19.4	40.4	56.9	-16.5
30.606 MHz	H	17.0	20.2	37.3	49.5	-12.3
123.21 MHz	H	28.2	13.6	41.8	54.0	-12.2
147.69 MHz	H	30.0	12.4	42.4	54.0	-11.6
172.6 MHz	H	39.2	11.0	50.2	54.0	-3.8
197.12 MHz	H	35.8	10.9	46.7	54.0	-7.3
221.63 MHz	H	30.2	11.7	41.9	56.9	-15.0
246.55 MHz	H	35.7	13.9	49.6	56.9	-7.3
295.18 MHz	H	32.1	15.3	47.4	56.9	-9.5
320.78 MHz	H	22.9	16.0	38.9	56.9	-18.0
345.02 MHz	H	29.3	16.8	46.1	56.9	-10.8
836.43 MHz	H	17.6	24.4	42.0	56.9	-14.9
860.3 MHz	H	18.4	24.3	42.7	56.9	-14.2
885.06 MHz	H	18.4	24.7	43.1	56.9	-13.8
909.81 MHz	H	18.4	24.8	43.2	56.9	-13.7

Graph 3-8-1



Graph 3-8-2



3.9 Line Conducted Emissions, FCC 15.207

The EUT was tested according to FCC Part 15.207, Line Conducted Emissions. For test results see Table 3-9-1 and Graphs 3-9-1& 3-9-2.

TILE Instrument Control System EMI Measurement Software

Conducted Emissions	**Date:** 1/21/2005
Company:	3M Corp.
Model:	Opticom GPS Transmitter
Test Engineer:	Uri Spector
Standard:	FCC Part 15.207
Note:	The table shows the worst case conducted emissions
	All measurements were taken using a CISPR Quasi-peak detector

Table # 3-9-1

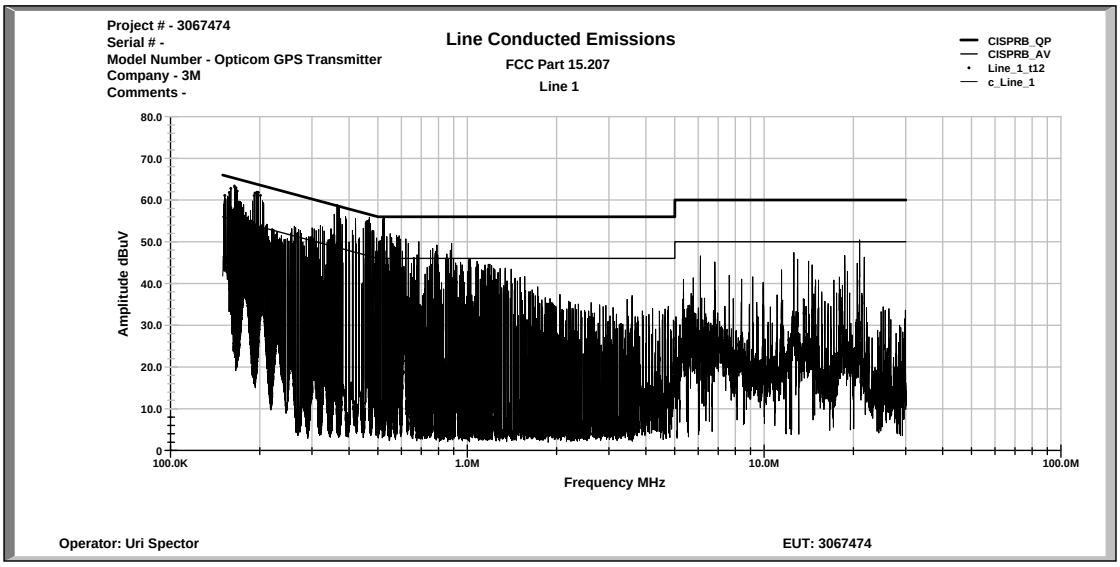
Line 1

Frequency	QP dBµV	AVG dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
156.63 KHz	56.19	39.39	65.81	55.81	-9.62	-16.42
158.75 KHz	56.72	34.45	65.75	55.75	-9.03	-21.30
159.19 KHz	56.92	33.62	65.74	55.74	-8.82	-22.12
159.85 KHz	57.00	32.88	65.72	55.72	-8.72	-22.84
160.11 KHz	57.05	31.97	65.71	55.71	-8.66	-23.74
161.7 KHz	57.02	27.95	65.67	55.67	-8.65	-27.72
163.13 KHz	56.67	25.59	65.62	55.62	-8.95	-30.03
186.15 KHz	54.03	23.91	64.97	54.97	-10.94	-31.06
189.72 KHz	52.16	21.68	64.87	54.87	-12.70	-33.19
191.99 KHz	50.72	20.87	64.80	54.80	-14.08	-33.93
195.81 KHz	46.98	19.03	64.69	54.69	-17.71	-35.66
202.35 KHz	46.84	31.82	64.50	54.50	-17.66	-22.68

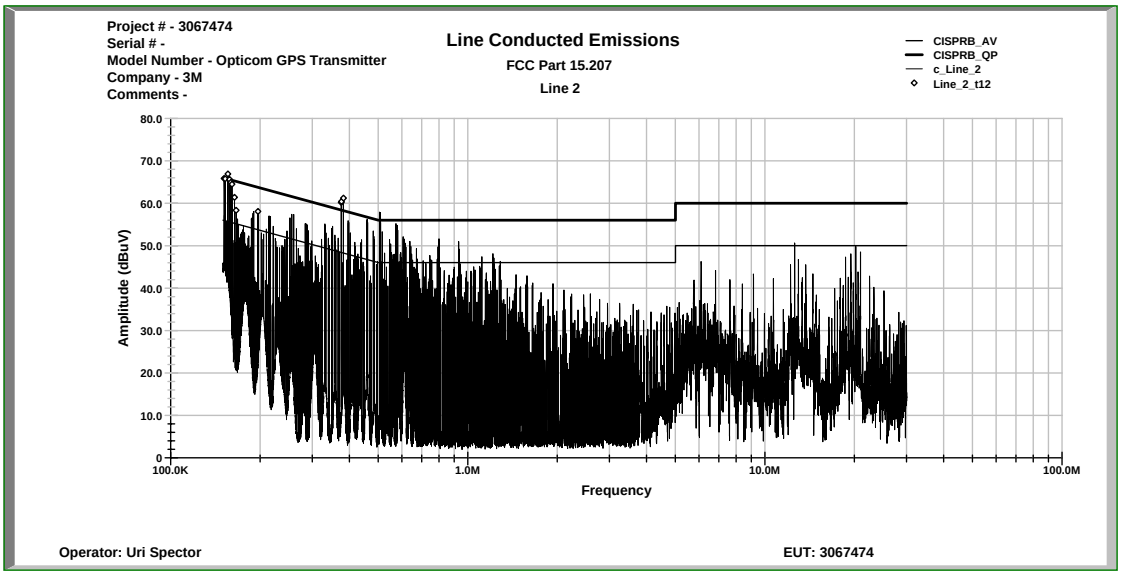
Line 2

Frequency	QP dBµV	AVG dBµV	QP Limit dBµV	AVG Limit dBµV	QP Margin dB	AVG Margin dB
152.73 KHz	59.39	42.10	65.92	55.92	-6.53	-13.83
153.29 KHz	59.38	41.86	65.91	55.91	-6.53	-14.05
154.26 KHz	59.56	41.50	65.88	55.88	-6.32	-14.38
154.52 KHz	59.28	41.12	65.87	55.87	-6.59	-14.75
155.42 KHz	59.35	40.30	65.85	55.85	-6.49	-15.54
156.46 KHz	59.06	38.41	65.82	55.82	-6.76	-17.41
159.67 KHz	57.04	30.13	65.72	55.72	-8.68	-25.59
161.65 KHz	55.21	26.15	65.67	55.67	-10.46	-29.52
191.08 KHz	52.21	19.52	64.83	54.83	-12.62	-35.31
374.49 KHz	53.88	20.99	59.59	49.59	-5.71	-28.60
374.59 KHz	53.93	21.08	59.58	49.58	-5.66	-28.50
376.44 KHz	53.90	20.68	59.53	49.53	-5.63	-28.85

Graph 3-9-1



Graph 3-9-2



4.0 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured emissions reading on the EMI Receiver.
The basic equation with a sample calculation is as follows:
FS = RA + AF + CF - AG

Where: FS = Field Strength in dB(µV/m)
RA = Receiver Amplitude in dB(µV)
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB(m^{-1})
AG = Amplifier Gain in dB

Assume a receiver reading of 48.1 dB(µV) is obtained. The antenna factor of 7.4 dB(m^{-1}) and cable factor of 1.6 dB is added and amplifier gain of 16.0 dB is subtracted giving field strength of 41.1 dB(µV/m).

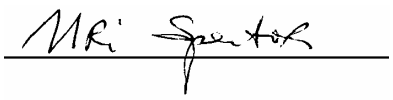
RA = 48.1 dB(µV)
AF = 7.4 dB(m^{-1})
CF = 1.6 dB
AG = 16.0 dB
FS = RA + AF + CF - AG
FS = 48.1 + 7.4 + 1.6 – 16.0
FS = 41.1 dB(µV/m)

In the tables the Cable correction factors are included to the Antenna Factors.

Tested by:

Uri Spector
EMC Project Engineer
Intertek ETL SEMKO

Signature



Date: December 23, 2004

5.0 TEST EQUIPMENT

Receivers/Spectrum Analyzers

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
HP85462A Receiver RF Section	3549A00306	01/04	01/05	X
HP85460A RF Filter Section	3448A00276	01/04	01/05	X
HP85462A Receiver RF Section	3325A00106	08/04	08/05	X
HP85460A RF Filter Section	3330A00109	08/04	08/05	X
Rohde & Schwarz FSP Spectrum Analyzer	100024	03/04	03/05	X

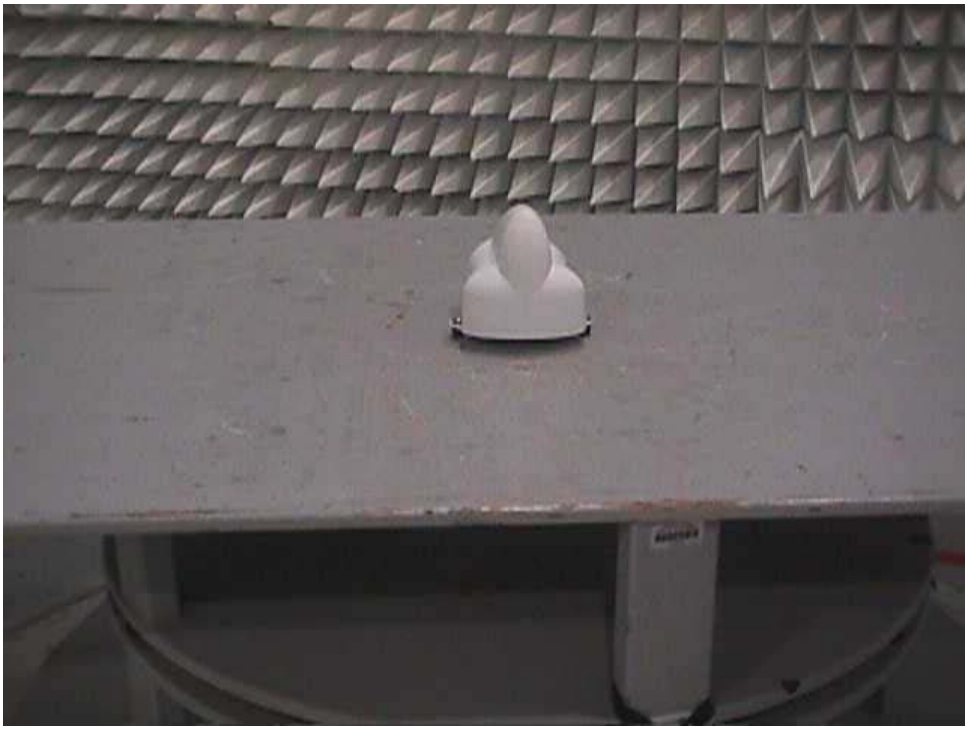
Antennas/Pre-Amplifiers/Signal Generator/Filters

DESCRIPTION	SERIAL NO.	LAST CAL	CAL DUE	USED
Schaffner-Chase Bicono-Log Antenna	2468	01/04	01/05	X
EMCO Horn Antenna 3115	9507-4513	12/03	12/04	X
EMCO Horn Antenna 3116	9904-2423	06/04	06/05	X
HP 83017A Pre-Amplifier	3123A00475	05/04	05/05	X
Rohde & Schwarz SMT 03 Signal Generator	DE12157	08/04	08/05	X
Reactel 7HS-4G-S12 Filter	0223	01/04	01/05	X

Artificial Mains Networks/Absorbing Clamps

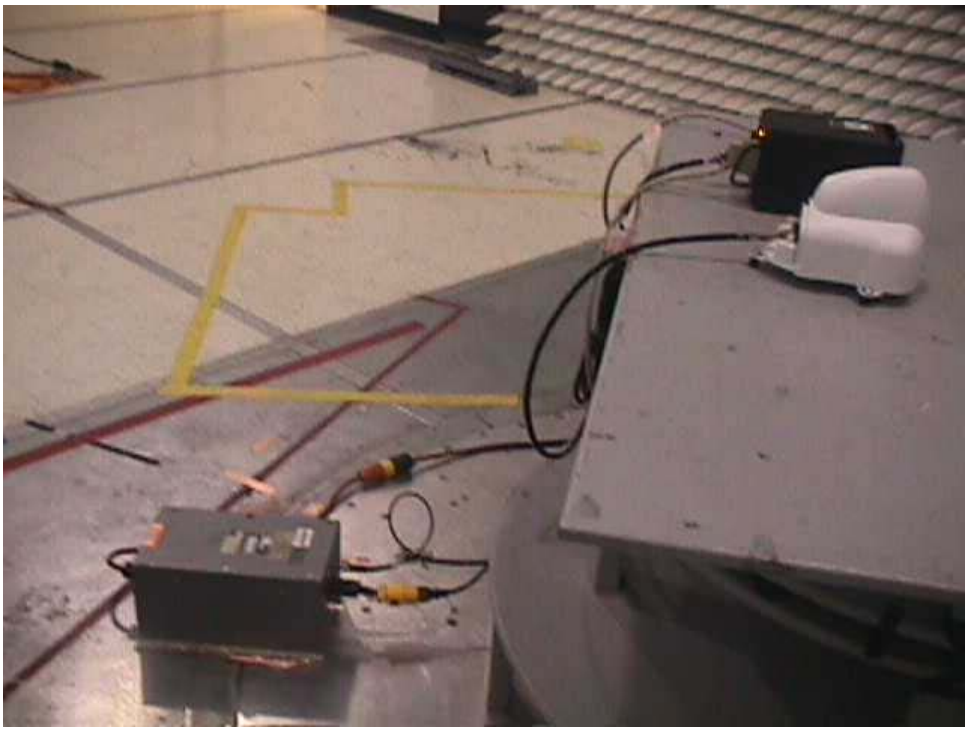
DESCRIPTION	SERIAL #	LAST CAL	CAL DUE	USED
FCC LISN-2	316	05/04	05/05	X

EXHIBIT
CONFIGURATION PHOTOS

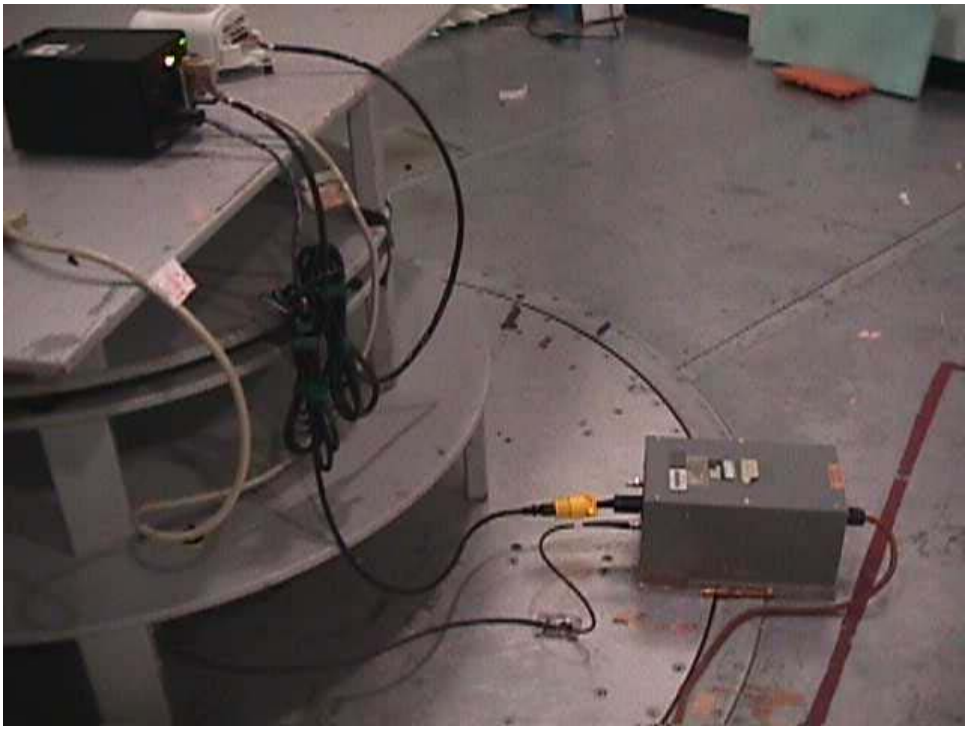


Radiated Emissions Test Configuration

Radiated Emissions Test Configuration



Line Conducted Emissions Test Configuration



Line Conducted Emissions Test Configuration