



Electromagnetic Compatibility Test Report

Tests Performed on a Recognition Source, LLC

902-928 MHz Transceiver, Model MIRL

Radiometrics Document RP-5053



Product Detail:

FCC ID: PM7-IRL2001

Equipment type: 902 to 928 MHz Low Power Transceiver

Test Standards:

US CFR Title 47, Chapter I, FCC Part 15 Subpart C

FCC Part 15 CFR Title 47: 2002

Industry Canada RSS-210, Issue 5 as required for Category I Equipment

This report concerns: Class II permissive change.

FCC Part 15.247

Tests Performed For:

Recognition Source, LLC

3820 Stern Avenue

St. Charles, IL 60174

Test Facility:

Radiometrics Midwest Corporation

12 East Devonwood

Romeoville, IL 60446

Phone: (815) 293-0772

Test Date(s): (Month-Day-Year)

July 18 and August 15, 2003

Document RP-5053 Revisions:

Rev.	Issue Date	Affected Pages	Revised By	Authorized Signature for Revision
0	September 11, 2003			

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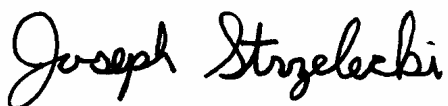
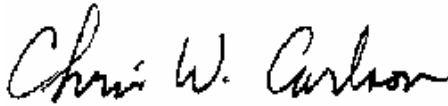
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1 ADMINISTRATIVE DATA

<i>Equipment Under Test:</i> A Recognition Source, LLC, 902-928 MHz Transceiver Model: MIRL Serial Number: None This will be referred to as the EUT in this Report	
<i>Date EUT Received at Radiometrics: (Month-Day-Year)</i> 7/18/03	<i>Test Date(s): (Month-Day-Year)</i> July 18 and August 15, 2003
<i>Test Report Written By:</i> Joseph Strzelecki Senior EMC Engineer	<i>Test Witnessed By:</i> Dennis Johanson James F. Wiemeyer Recognition Source
<i>Radiometrics' Personnel Responsible for Test:</i> 	<i>Test Report Approved By</i> 
Joseph Strzelecki Senior EMC Engineer NARTE EMC-000877-NE	Chris W. Carlson Director of Engineering NARTE EMC-000921-NE

2 TEST SUMMARY AND RESULTS

The EUT (Equipment Under Test) is a 902-928 MHz Transceiver, Model MIRL, manufactured by Recognition Source, LLC. The detailed test results are presented in a separate section. The following is a summary of the test results.

Emissions Tests Results

Environmental Phenomena	Frequency Range	Basic Standard	Test Result
RF Radiated Emissions	30-9300 MHz	RSS-210 & FCC Part 15	Pass
Occupied Bandwidth Test	Fundamental Freq.	RSS-210 & FCC Part 15	Pass

Spread Spectrum Transmitter Requirements

Environmental Phenomena	Frequency Range	FCC Section	RSS-210 Section	Test Result
20 dB Bandwidth Test	902-928 MHz	15.247 a	6.2.2 (o) (a)	Pass
Peak Output Power	902-928 MHz	15.247 b	6.2.2 (o) (a)	Pass
Band-edge Compliance of RF Conducted Emissions	902-928 MHz	15.247 c	6.2.2 (o) (e)	Pass
Spurious RF Conducted Emissions	30-9300 MHz	15.247 c	6.2.2 (o) (e1)	Pass
Spurious Radiated Emissions	30-9300 MHz	15.247 c	6.2.2 (o) (a)	Pass
Power Spectral Density	902-928 MHz	15.247 d	6.2.2 (o) (b)	Pass

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3 EQUIPMENT UNDER TEST (EUT) DETAILS

3.1 EUT Description

The EUT is a 902-928 MHz Transceiver, Model MIRL, manufactured by Recognition Source, LLC. The EUT was in good working condition during the tests, with no known defects.

3.1.1 FCC Section 15.203 & RSS-210 Section 5.5 Antenna Requirements

The EUT is professionally installed, so the antenna does not need unique antenna adaptors. The EUT will be marketed to businesses only.

3.2 Related Submittals

Recognition Source, LLC is also submitting a permissive change on a related product. Its FCC ID is PM7-DCMI2001.

4 TESTED SYSTEM DETAILS

4.1 Tested System Configuration

The system was configured for testing in a typical fashion. The EUT was placed on an 80-cm high, nonconductive test stand. The testing was performed in conditions as close as possible to installed conditions. Wiring was consistent with manufacturer's recommendations.

The EUT was tested as a stand-alone device. Power was supplied with a new battery.

4.2 Special Accessories

No special accessories were used during the tests in order to achieve compliance.

4.3 Equipment Modifications

No modifications were made to the EUT at Radiometrics' test facility in order to comply with the standards listed in this report.

5 TEST SPECIFICATIONS AND RELATED DOCUMENTS

Document	Date	Title
FCC CFR Title 47	2002	Code of Federal Regulations Title 47, Chapter 1, Federal Communications Commission, Part 15 - Radio Frequency Devices
ANSI C63.4-1992	1992	Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
IC RSS-210 Issue 5	2001	Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)
IC RSS-212 Issue 1	1998	Test Methods For Radio Equipment
FCC DA 00-705	2000	Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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The test procedures used are in accordance with the FCC DA 00-75, Industry Canada RSS-212 and ANSI document C63.4-1992, (July 17, 1992) "Methods of Measurement of Radio Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz". The specific procedures are described herein. Radiated testing was performed at an antenna to EUT distance of 3 meters. The antenna was raised and lowered from 1 to 4 meters.

6 RADIOMETRICS' TEST FACILITIES

The results of these tests were obtained at Radiometrics Midwest Corp. in Romeoville, Illinois, USA. Radiometrics has been accredited by A2LA (American Association for Laboratory Accreditation) to conform to ISO/IEC 17025: 1999 "General Requirements for the Competence of Calibration and Testing Laboratories". Radiometrics' Lab Code is 121191 and Certification Number is 1495.01. Radiometrics' scope of accreditation includes all of the "basic standards" listed herein. A copy of the accreditation can be accessed on our web site (www.radiomet.com). Radiometrics accreditation status can be verified at A2LA's web site (www.a2la.org).

The following is a list of shielded enclosures located in Romeoville, Illinois:

Chamber A: Is an anechoic chamber that measures 24' L X 12' W X 12' H. The walls and ceiling are fully lined with ferrite absorber tiles. The floor has a 10' x 10' section of ferrite absorber tiles in the located in the center. Panashield of Rowayton, Connecticut manufactured the chamber. The enclosure is NAMAS certified.

Chamber B: Is a shielded enclosure that measures 24' L X 12' W X 8' H. Erik A. Lindgren & Associates of Chicago, Illinois manufactured the enclosure.

Chamber C: Is a shielded enclosure that measures 20' L X 10' W X 8' H. Lindgren RF Enclosures Inc. of Addison, Illinois manufactured the enclosure.

Chamber D: Is a fully anechoic chamber that measures 22' L X 10' W X 10' H. The walls, ceiling and floor are fully lined with ferrite absorber tiles. Braden Shielding Systems of Tulsa, Oklahoma manufactured the chamber.

A separate ten-foot long, brass plated, steel ground rod attached via a 6 inch copper braid grounds each of the above chambers. Each enclosure is also equipped with low-pass power line filters.

Open Area Test Site (OATS): Is located on 8625 Helmar Road in Newark, Illinois, USA and measures 56' L X 24' W X 17' H. The entire open field test site has a metal ground screen. The FCC has accepted these sites as test site number 31040/SIT 1300F2. The FCC test site Registration Number is 90897. Details of the site characteristics are on file with the Industry Canada as file number IC3124.

A complete list of the test equipment is provided herein. The calibration due dates are indicated on the equipment list. The equipment is calibrated in accordance to ANSI/NCSL Z540-1 with traceability to the National Institute of Standards and Technology (NIST).

7 DEVIATIONS AND EXCLUSIONS FROM THE TEST SPECIFICATIONS

There were no deviations or exclusions from the test specifications.

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8 CERTIFICATION

Radiometrics Midwest Corporation certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specification. The results relate only to the EUT listed herein. Any modifications made to the EUT subsequent to the indicated test date will invalidate the data and void this certification.

9 TEST EQUIPMENT TABLE

RMC ID	Manufacturer	Description	Model No.	Serial No.	Frequency Range	Cal Period	Cal Date
AMP-05	RMC/Celeritek	Pre-amplifier	MW110G	1001	1.0-12GHz	12 Mo.	11/29/02
AMP-12	MITEQ	Pre-amplifier	AM-1431	530935	0.01-1000MHz	12 Mo.	12/28/02
AMP-22	Anritsu	Pre-amplifier	MH648A	M23969	0.1-1200MHz	12 Mo.	11/25/02
ANT-03	Tensor	Biconical Antenna	4104	2231	20-200MHz	12 Mo.	08/07/03
ANT-06	EMCO	Log-Periodic Ant.	3146	1248	200-1000MHz	12 Mo.	08/07/03
ANT-13	EMCO	Horn Antenna	3115	2502	1.0-18GHz	12 Mo.	09/30/02
ANT-28	Empire	Loop Antenna	LG-105	102	10-150kHz	12 Mo.	05/01/03
ANT-29	Empire	Loop Antenna	LP-105	656	0.15-30MHz	12 Mo.	05/01/03
ATT-02	KDI	Attenuator	A710N	RMC1	DC-10GHz	12 Mo.	12/31/02
HPF-01	Solar	High Pass Filter	7930-100	HPF-1	0.15-30MHz	12 Mo.	01/02/03
HPF-02	Microwave Cir.	High Pass Filter	H2G09G02	HPF-2	1.5-11 GHz	12 Mo.	05/01/03
LSN-01	Electrometrics	LISN	FCC/VDE 50/2	1001	0.01-30MHz	12 Mo.	1/10/03
REC-01	Hewlett Packard	Spectrum Analyzer	8566A	2106A02115, 2209A01349	30Hz-22GHz	12 Mo.	06/07/03
REC-07	Anritsu	Spectrum Analyzer	MS2601A	MT53067	0.01-2200MHz	12 Mo.	12/23/02
REC-10	Hewlett Packard	Spectrum Analyzer	8594E	3441A01426	9kHz-2.9GHz	12 Mo.	12/23/02
THM-01	Extech Inst.	Temp/Humid Meter	4465CF	001106557	N/A	12 Mo.	12/31/02

Note: All calibrated equipment is subject to periodic checks.

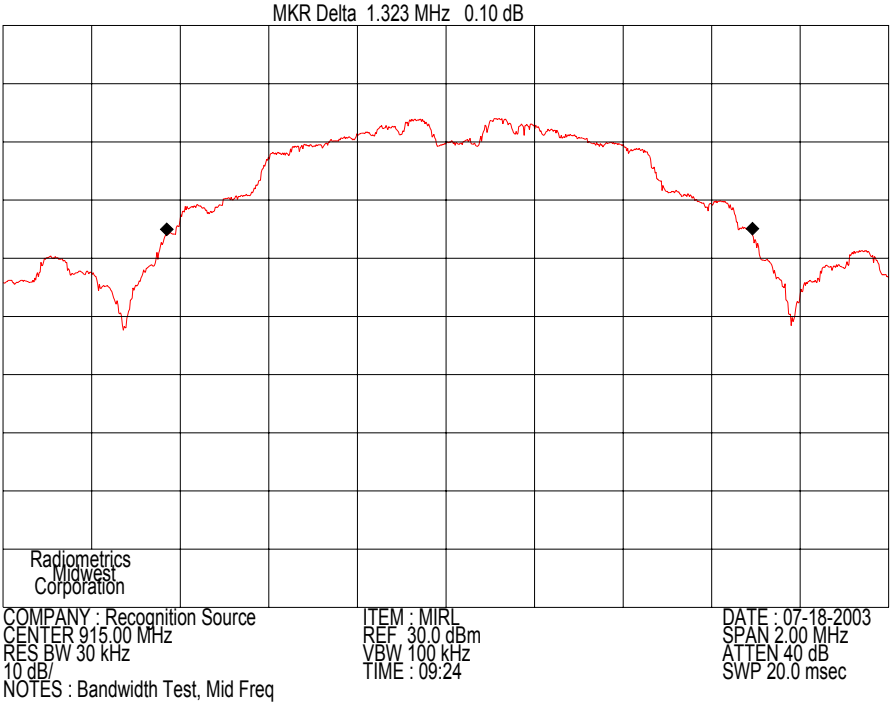
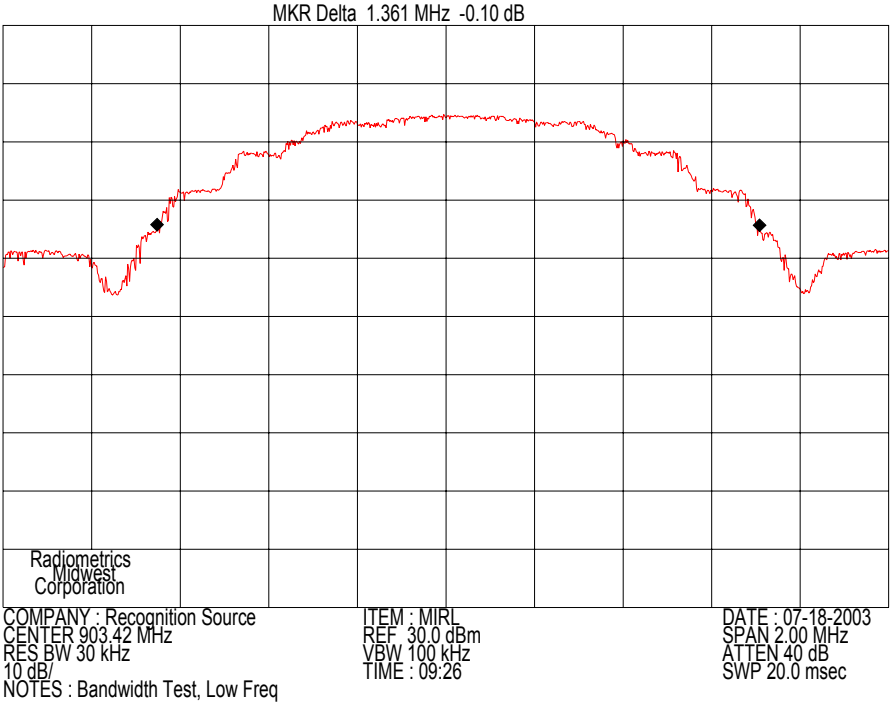
NCR – No Calibration Required. Device monitored by calibrated equipment. N/A: Not Applicable.

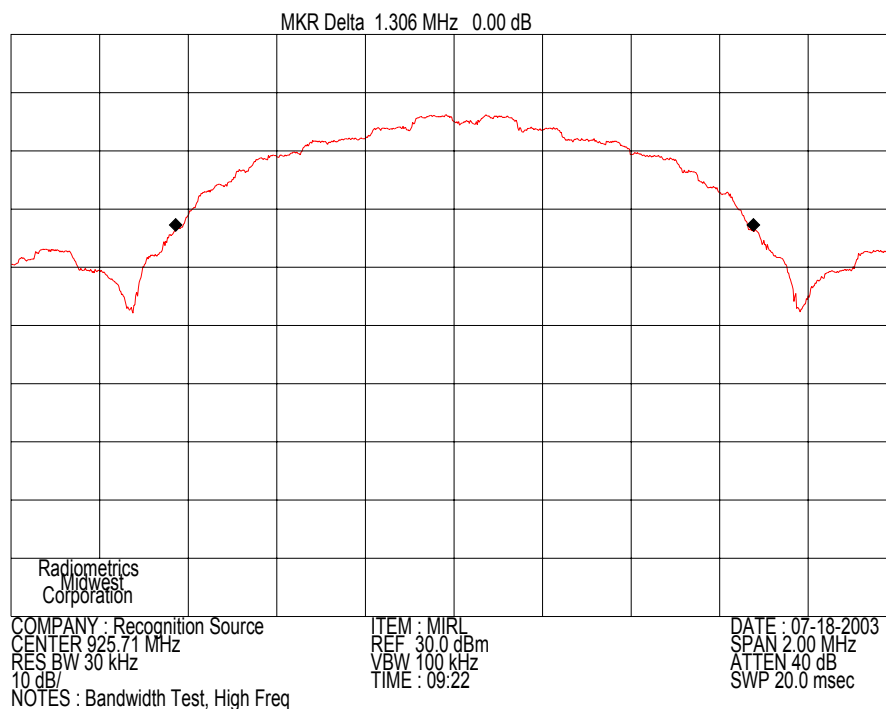
10 TEST SECTIONS

10.1 Occupied Bandwidth (20 dB)

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation. The EUT was transmitting at its maximum data rate. The trace was allowed to stabilize.

The marker-to-peak function was set to the peak of the emission. Then the marker-delta function was used to measure 20 dB down one side of the emission. The marker-delta function was reset and then moved to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20 dB bandwidth of the emission.





10.2 Peak Output Power

The spectrum analyzer was set to the following settings:

Span = 50 kHz (approximately 5 times the 20 dB bandwidth, centered on a hopping channel)

RBW = 100 kHz (> the 20 dB bandwidth of the emission being measured)

VBW = 300 kHz

Sweep = auto

Detector function = peak

Trace = max hold

The trace was allowed to stabilize. The marker-to-peak function was used to measure the peak of the emission. The indicated level is the peak output power. Note 30 dBm = 1 watt. Since the gain of the antenna is always less than 6dB, the limit is not reduced.

Frequency (MHz)	Reading (dBm)	Cable Loss (dB)	Total Power		Limit (dBm)
			dBm	Watts	
903.5	22.3	0.1	22.4	0.174	30
915.0	22.5	0.1	22.6	0.182	30
925.7	22.7	0.1	22.8	0.191	30

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10.3 Power Spectral Density

The spectrum analyzer was set to the following settings:

Span = 6 kHz (Stepped Center frequency within channel to obtain Maximum Reading)

Channel Bandwidth = 3 kHz

RBW = 1 kHz

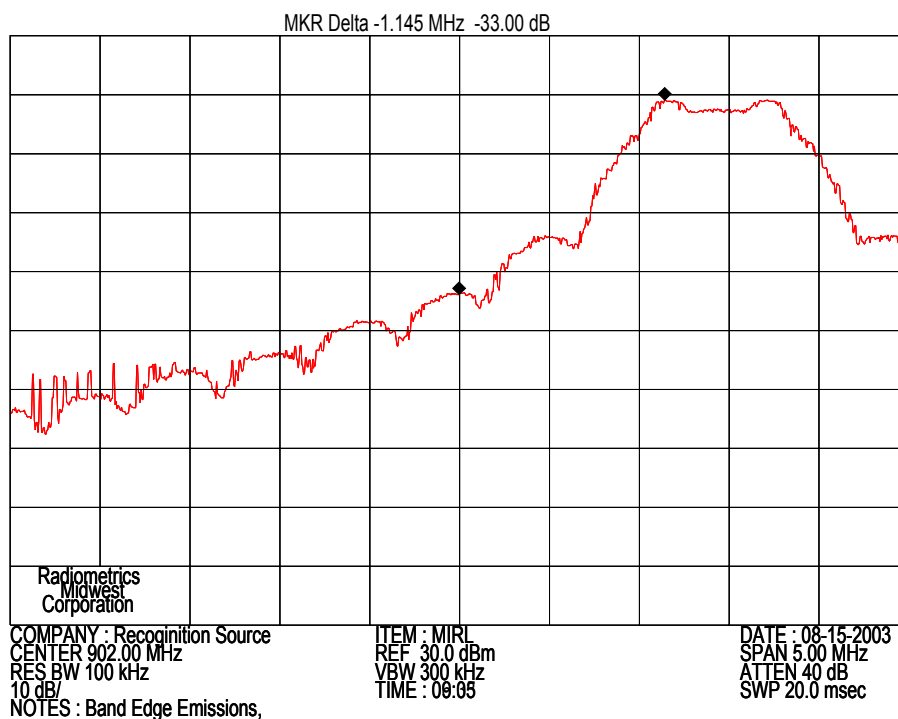
VBW = 10 kHz

Sweep = auto

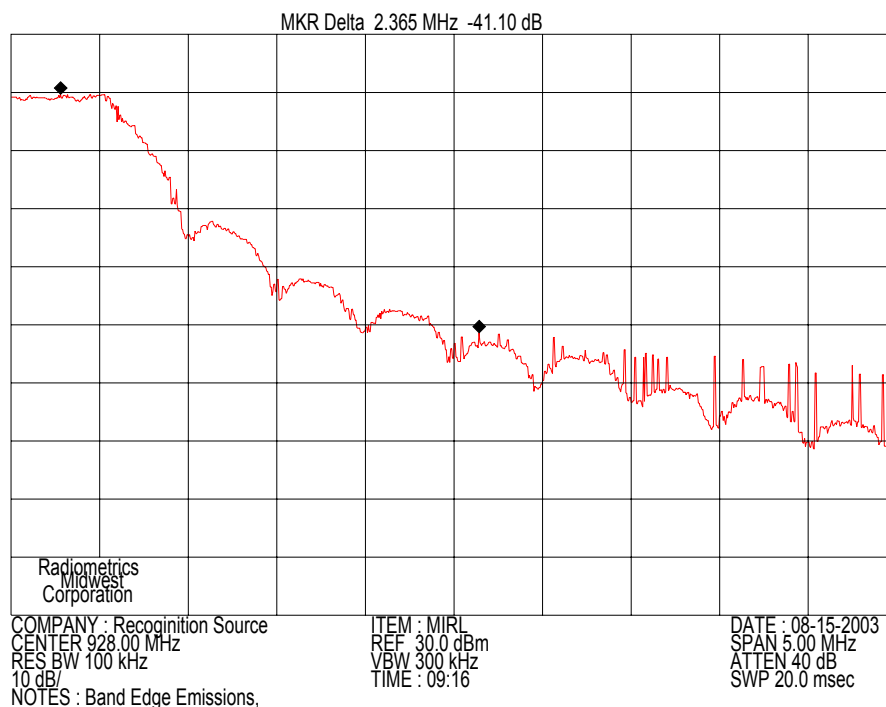
Frequency (MHz)	Reading (dBm)	Cable Loss (dB)	3 kHz Spectral Density (dBm)	Limit (dBm)
903.5	-1.4	0.1	-1.3	8
915.0	0.2	0.1	0.3	8
925.7	0.1	0.1	0.1	8

10.4 Band-edge Compliance of RF Conducted Emissions

The spectrum analyzer was set to the MAX HOLD mode to record the worst case of the modulation at the band-edge, with the EUT set to the lowest frequency. The trace was allowed to stabilize.

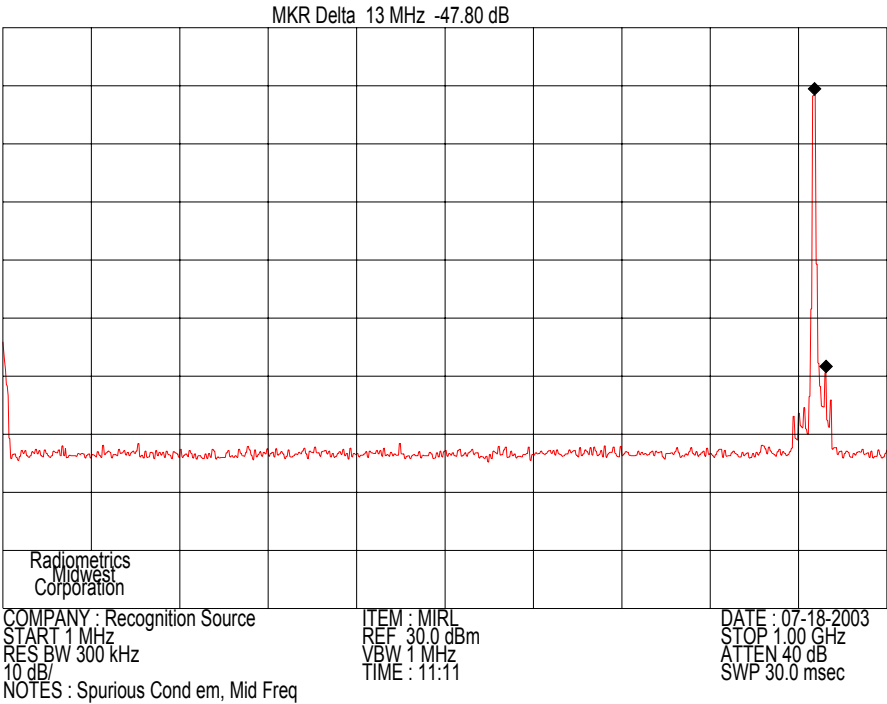
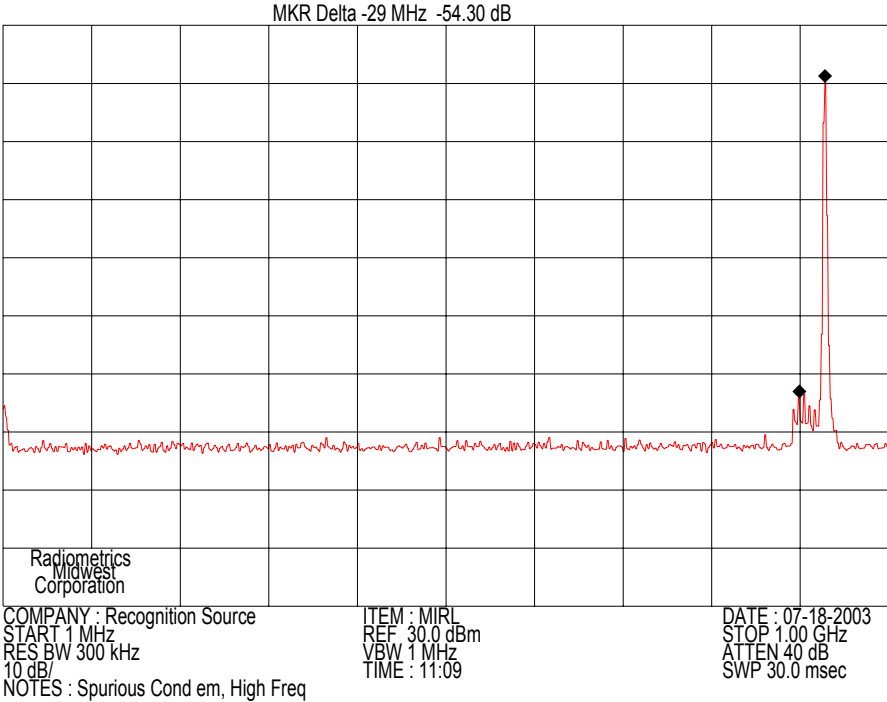


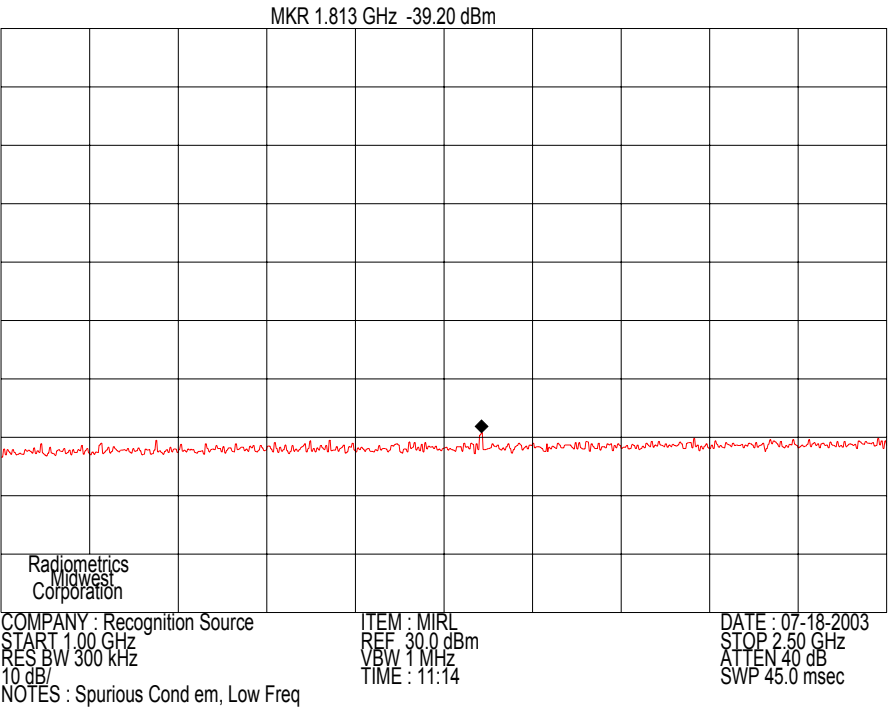
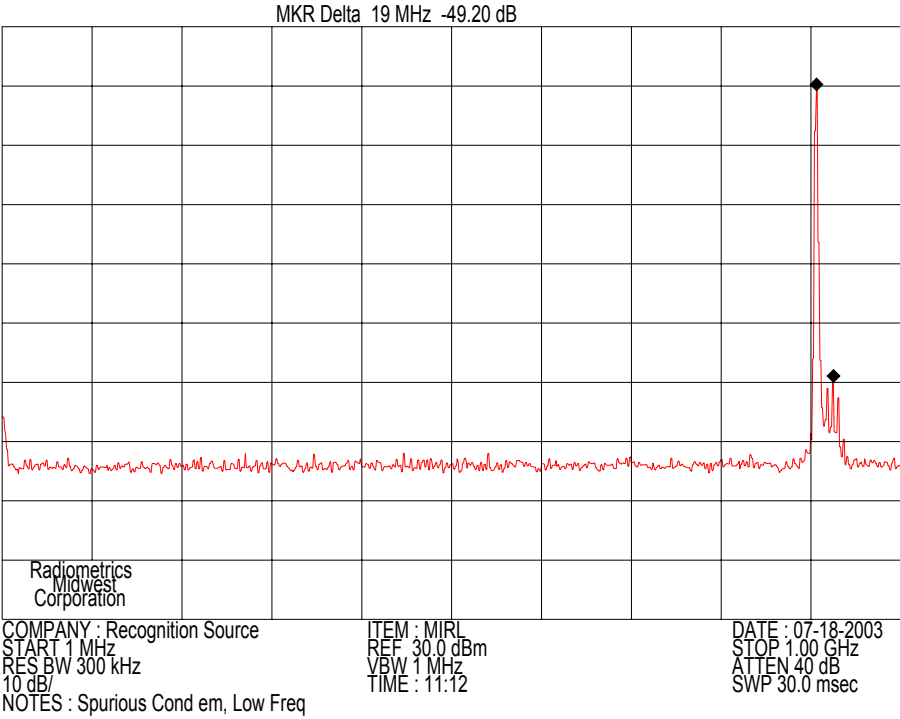
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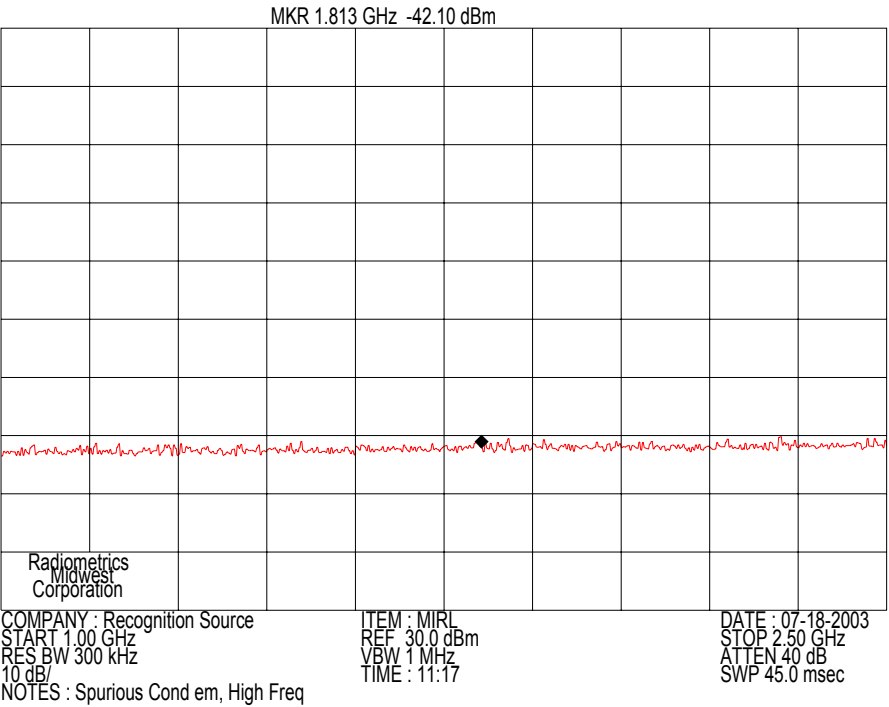
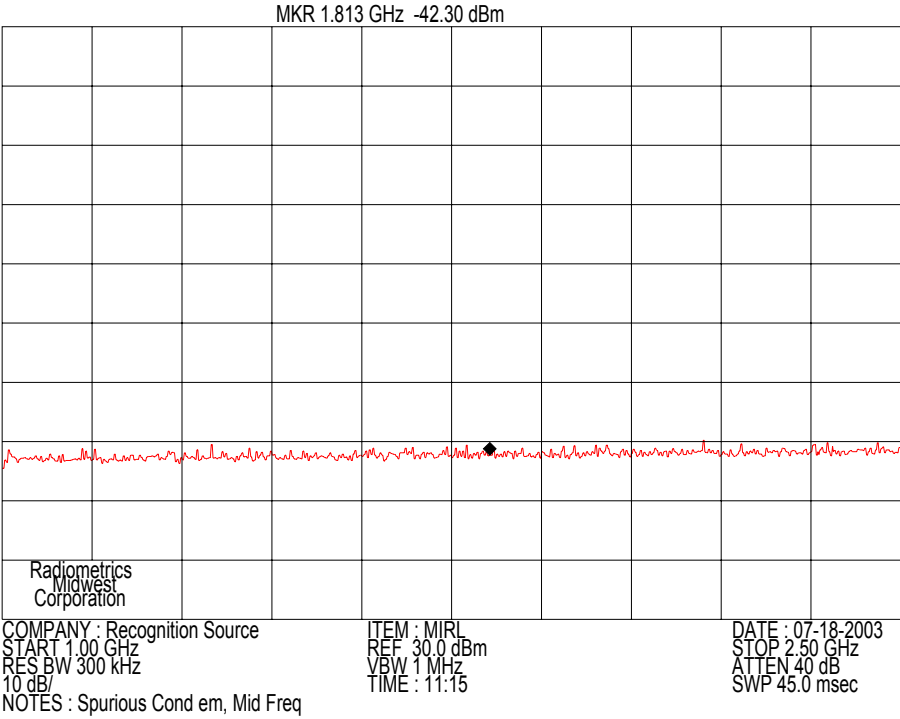


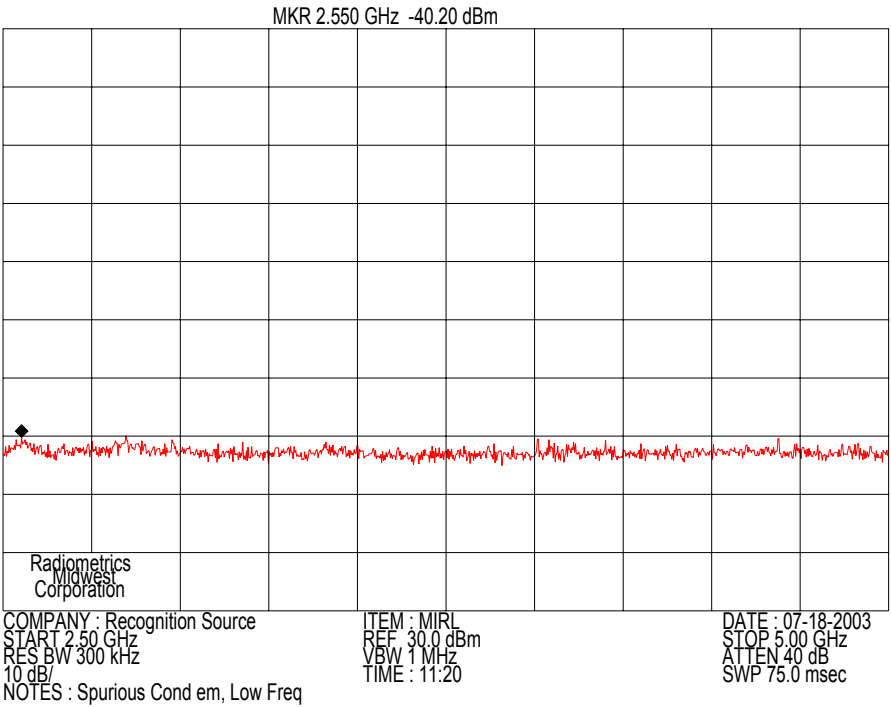
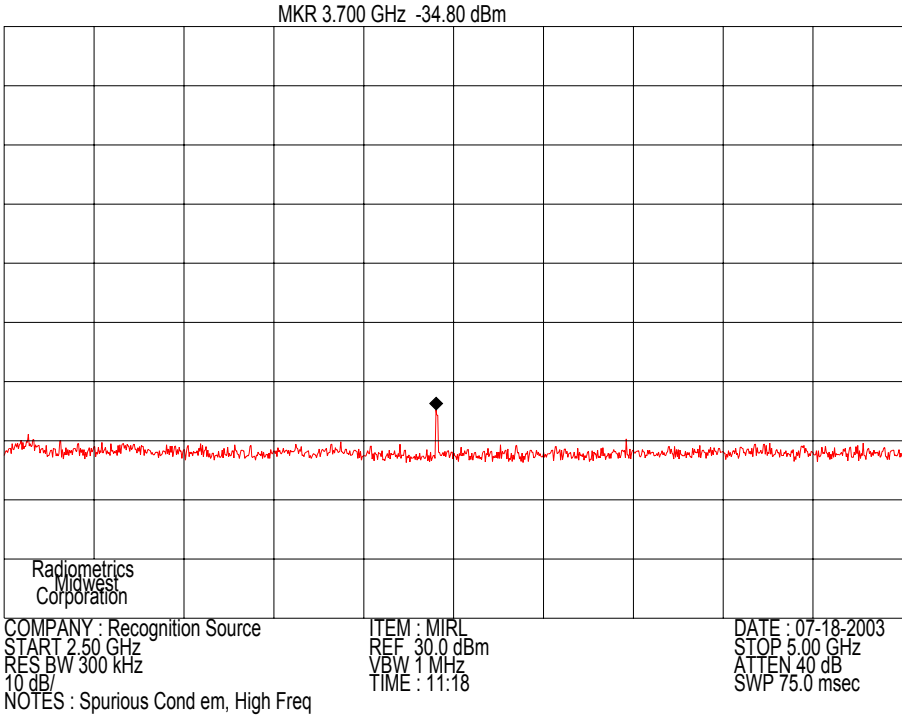
10.5 Spurious RF Conducted Emissions

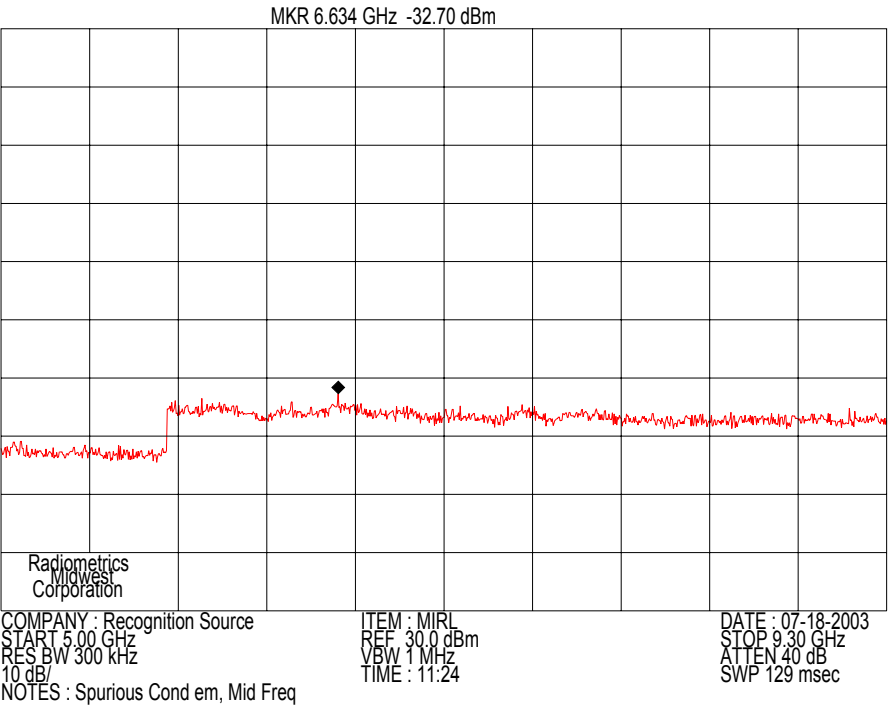
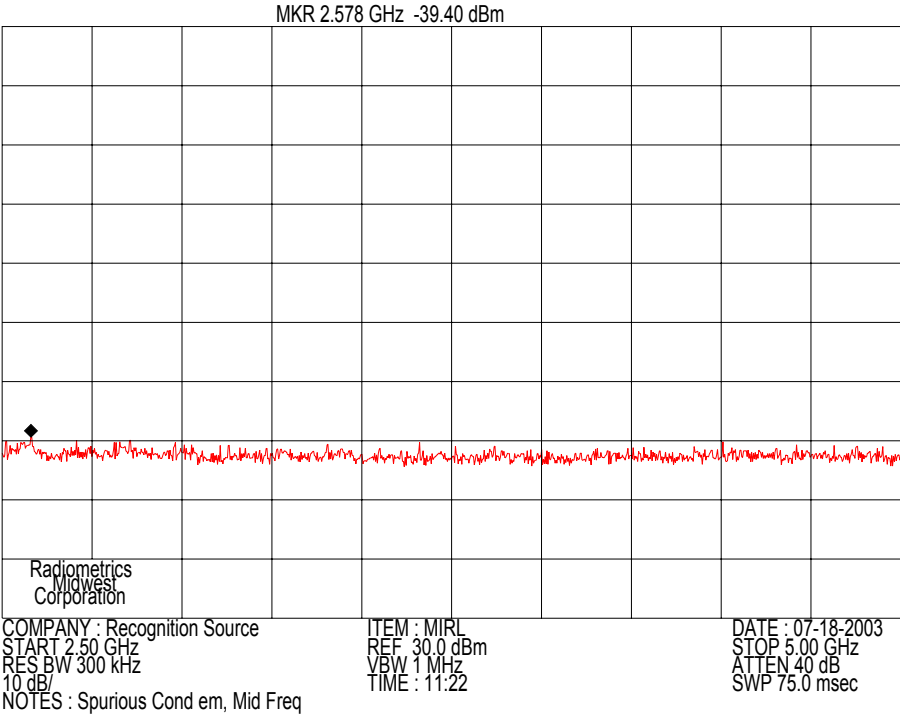
The spectrum analyzer was set to the MAX HOLD mode to record all spurious emissions from the lowest frequency generated in the EUT up through the 10th harmonic. The trace was allowed to stabilize. The first two plots were made while stepping through three frequencies (Low middle and high). Each frequency was on for 30 seconds. The last two plots were made with hopping enabled.

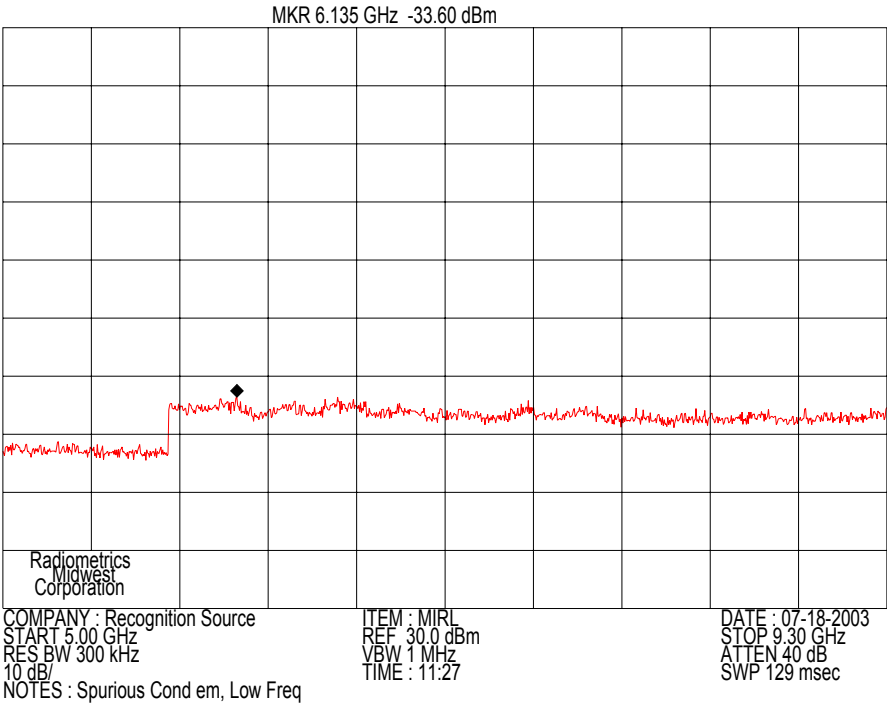
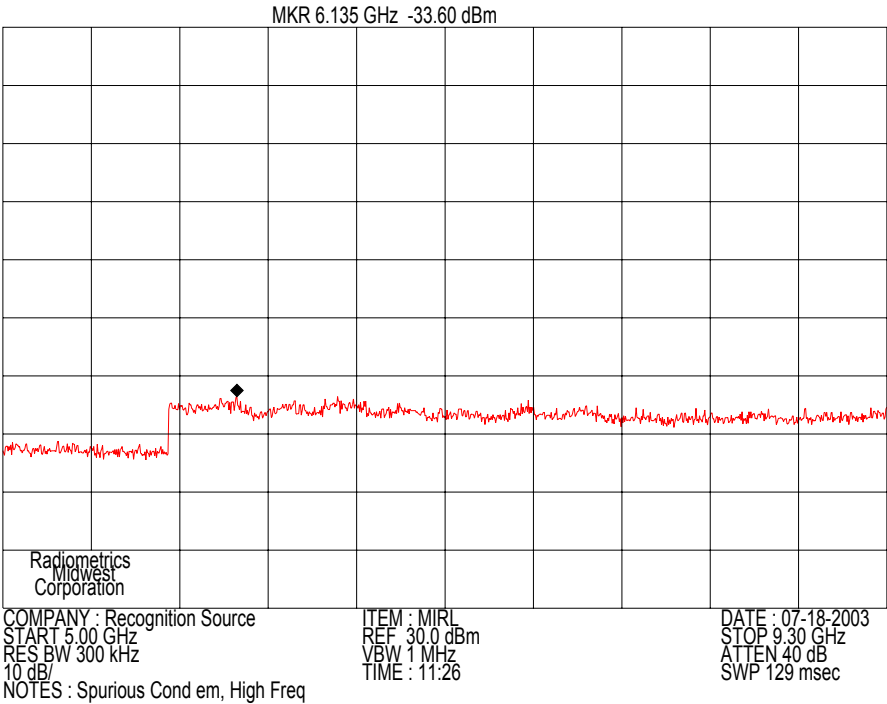












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10.6 Spurious Radiated Emissions

Radiated emission measurements in the Restricted bands were performed with linearly polarized broadband antennas. The results obtained with these antennas can be correlated with results obtained with a tuned dipole antenna. Below 1 GHz, when a radiated emission is detected approaching the specification limit, the measurement of the emission is repeated using a tuned dipole antenna with a Roberts Balun. A 10 dB linearity check is performed prior to start of testing in order to determine if an overload condition exists.

From 30 to 1000 MHz, an Anritsu Spectrum analyzer and a MITEQ AM-1431 amplifier with a 10 dB attenuator connected to the input were used. The out of band emissions and the ambient emissions were below the level of input overload (80 dBuV).

For tests from 1 to 9.3 GHz, an HP8566A spectrum analyzer was used with a Celeritek uWave amplifier. The out of band emissions and the ambient emissions were below the level of input overload (72 dBuV). In addition, a high pass filter was used to reduce the fundamental emission.

Radiated emission measurements are performed with linearly polarized broadband antennas. Measurements were performed using two antenna polarizations, (vertical and horizontal). The worst case emissions were recorded.

Final radiated emissions measurements were performed in the open area test site at a test distance of 3 meters. The entire frequency range from 30 to 9300 MHz was slowly scanned and the emissions in the restricted frequency bands were recorded. Measurements were performed using the peak detector function. The detected emission levels were maximized by rotating the EUT, adjusting the positions of all cables, and by scanning the measurement antenna from 1 to 4 meters above the ground. The open area test site used to collect the radiated data is located on 8625 Helmar Road in Newark, Illinois. The open field test site has a metal ground screen. All other tests are performed at 12 East Devonwood Ave. Romeoville, Illinois EMI test lab.

10.6.1 Radiated Emissions Field Strength Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Loss, and by subtracting the Amplifier Gain from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG + PKA$$

Where: FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

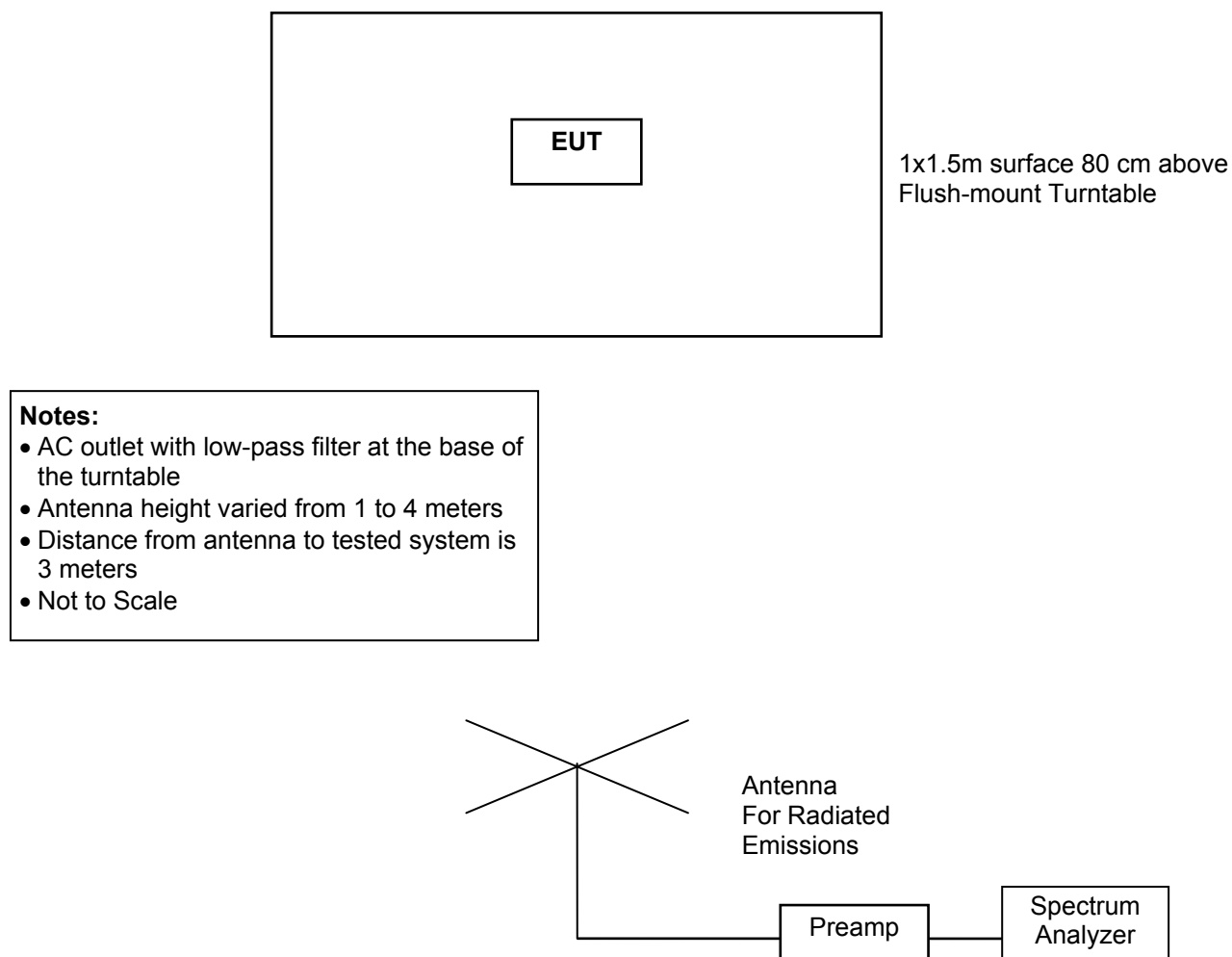
AG = Amplifier Gain

PKA = Peak to Average Factor (This is zero for non average measurements)

The Peak to average factor is used when average measurements are required. It is calculated by the highest duty cycle in percent over any 100mS transmission. The factor in dB is $20 * \text{Log}(\text{Duty cycle}/100)$.

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Figure 1. Drawing of Radiated Emissions Setup



10.6.2 Spurious Radiated Emissions Test Results (Restricted Band)

The following spectrum analyzer settings were used.

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold

The duty cycle factor is $20 * \log(31/100) = -10.2$ dB; The plot for this is in section 10.3. The peak emissions did not exceed the average by more than 20 dB.

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Test Distance	3 Meters	Test Date	8-15-03
Specification	FCC Part 15 Subpart C & RSS-210		
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical (ANT-3); LP = Log-Periodic (ANT-6); HN = Horn (ANT-13) P = peak; Q = QP		
Notes	Corr. Factors = Cable Loss – Preamp Gain + High Pass Filter Loss		
Antennas Used	30 to 200 MHz Biconical (ANT-3); 200 to 1000 MHz Log-Periodic (ANT-6) 1 to 18 GHz Double Ridged Guide Horn (ANT-13)		

Transmitting at 903.6 MHz

Freq (MHz)	Meter Reading (dBUV)	Ant Factor (dB/m)	Ant Polarity	Corr. Factors (dB)	Peak to Ave Factor (dB)	EUT Field Strength (dBUV/m)	Limit (dBUV/m)	Margin under Limit (dB)
2709.4	47.4	31.2	H	-20.4	-10.2	48.0	54.0	6.0
3612.6	43.9	33.4	H	-20.3	-10.2	46.8	54.0	7.2
4519.0	40.3	34.9	H	-21.8	-10.2	43.2	54.0	10.8
5418.8	44.6	36.2	H	-21.4	-10.2	49.2	54.0	4.8
7225.7	40.8	37.7	H	-20.3	-10.2	48.0	54.0	6.0
8128.5	40.2	38.0	H	-20.7	-10.2	47.3	54.0	6.7
9032.8	39.5	40.1	H	-19.6	-10.2	49.8	54.0	4.2
2709.4	47.8	31.2	V	-20.4	-10.2	48.4	54.0	5.6
3612.7	43.2	33.4	V	-20.3	-10.2	46.1	54.0	7.9
4518.8	40.1	34.9	V	-21.8	-10.2	43.0	54.0	11.0
5422.5	44.3	36.2	V	-21.4	-10.2	48.9	54.0	5.1
7231.9	40.1	37.7	V	-20.3	-10.2	47.3	54.0	6.7
8128.6	40.7	38.0	V	-20.7	-10.2	47.8	54.0	6.2
9036.4	40.0	40.1	V	-19.6	-10.2	50.3	54.0	3.7

Transmitting at 915 MHz

2746.0	44.0	31.3	H	-20.3	-10.2	44.8	54.0	9.2
3661.4	45.3	33.6	H	-20.3	-10.2	48.4	54.0	5.6
4575.3	39.5	35.0	H	-21.8	-10.2	42.5	54.0	11.5
7316.0	40.2	37.8	H	-20.4	-10.2	47.4	54.0	6.6
8238.4	41.2	38.1	H	-20.9	-10.2	48.2	54.0	5.8
9148.8	39.7	39.8	H	-19.8	-10.2	49.5	54.0	4.5
2744.2	46.2	31.3	V	-20.3	-10.2	47.0	54.0	7.0
3661.2	44.3	33.6	V	-20.3	-10.2	47.4	54.0	6.6
4577.9	39.8	35.0	V	-21.8	-10.2	42.8	54.0	11.2
7319.9	39.9	37.8	V	-20.4	-10.2	47.1	54.0	6.9
8236.8	40.7	38.1	V	-20.8	-10.2	47.8	54.0	6.2
9147.2	39.8	39.8	V	-19.8	-10.2	49.6	54.0	4.4

Transmitting at 925 MHz

2777.9	48.3	31.3	H	-20.3	-10.2	49.1	54.0	4.9
3701.6	48.7	33.8	H	-20.3	-10.2	52.0	54.0	2.0
4624.6	39.7	35.0	H	-21.7	-10.2	42.8	54.0	11.2
7407.1	38.9	37.9	H	-20.7	-10.2	45.9	54.0	8.1

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Transmitting at 925 MHz

Freq (MHz)	Meter Reading (dBUV)	Ant Factor (dB/m)	Ant Polarity	Corr. Factors (dB)	Peak to Ave Factor (dB)	EUT Field Strength (dBUV/m)	Limit (dBUV/m)	Margin under Limit (dB)
8332.9	41.0	38.2	H	-20.8	-10.2	48.2	54.0	5.8
9252.9	39.0	39.5	H	-20.1	-10.2	48.2	54.0	5.8
2777.9	49.0	31.3	V	-20.3	-10.2	49.8	54.0	4.2
3704.1	45.2	33.8	V	-20.3	-10.2	48.5	54.0	5.5
4628.5	39.6	35.0	V	-21.7	-10.2	42.7	54.0	11.3
7405.4	39.3	37.9	V	-20.7	-10.2	46.3	54.0	7.7
8329.6	41.0	38.2	V	-20.8	-10.2	48.2	54.0	5.8
9252.4	38.5	39.5	V	-20.0	-10.2	47.8	54.0	6.2

Radiated Emissions Tests Below 1 GHz

Notes	Corr. Factors = cable loss - preamp gain
Abbreviations	Pol = Antenna Polarization; V = Vertical; H = Horizontal; BC = Biconical; LP = Log-Periodic; BL = Bilog; P = peak; Q = QP

Freq. MHz	Meter Reading dBUV	Antenna		Corr. Factors dB	Field Strength dBUV/m		Margin Under Limit dB
		Factor dB	Pol/ Type		EUT	Limit	
126.6	31.0 P	11.8	H/BC	-16.5	26.2	43.5	17.3
130.8	31.9 P	11.7	H/BC	-16.5	27.1	43.5	16.4
156.8	32.9 P	14.1	H/BC	-16.2	30.8	43.5	12.7
170.6	30.9 P	15.8	H/BC	-16.2	30.5	43.5	13.0
243.8	38.3 P	12.3	H/LP	-15.7	34.9	46.0	11.1
251.8	39.0 P	12.8	H/LP	-15.6	36.3	46.0	9.7
252.1	38.8 P	12.8	H/LP	-15.6	36.0	46.0	10.0
262.2	37.3 P	13.1	H/LP	-15.4	35.0	46.0	11.0
279.6	38.3 P	13.9	H/LP	-15.3	37.0	46.0	9.0
279.6	37.7 Q	13.9	H/LP	-15.3	36.3	46.0	9.7
280.8	39.3 P	13.9	H/LP	-15.3	37.9	46.0	8.1
282.9	39.9 P	14.0	H/LP	-15.3	38.6	46.0	7.4
284.0	37.7 Q	14.1	H/LP	-15.2	36.6	46.0	9.4
123.7	29.9 P	12.9	V/BC	-16.6	26.3	43.5	17.2
156.8	37.4 P	15.5	V/BC	-16.2	36.7	43.5	6.8
162.1	37.9 P	15.8	V/BC	-16.2	37.5	43.5	6.0
162.8	36.5 P	15.9	V/BC	-16.2	36.2	43.5	7.3
173.2	34.2 P	17.2	V/BC	-16.2	35.3	43.5	8.2
240.4	39.3 P	12.1	V/LP	-15.7	35.6	46.0	10.4
241.7	39.0 P	12.2	V/LP	-15.7	35.4	46.0	10.6
273.9	33.6 P	13.6	V/LP	-15.3	31.9	46.0	14.1
274.0	33.2 P	13.6	V/LP	-15.3	31.5	46.0	14.5
406.2	24.9 P	16.4	V/LP	-14.6	26.7	46.0	19.3

Judgment: Passed by 2.0 dB

No other emissions were detected in the restricted bands.

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10.7 Peak to Average Calculations

As required by FCC section 15.35 and RSS-210 section 6.5, the Peak to Average correction factor was calculated with the data supplied by the EUT designer.

The device will transmit RF-borne messages of 31.0ms duration or less. Its duty cycle averaged over 100ms will not exceed 31%. The PIM-OTD will transmit a maximum 31.0ms duration message, at a rate of not more than 1 message per 100ms.

$20 \cdot \text{Log} (.31) = -10.2 \text{ dB}$ Peak to average correction factor.