



FCC Part 15.247 Certification Application

**Industrie Canada RSS210 Certification
Application**

**EMI Test Report
on
SilverSpring Relay Radio
Model: 210-040102**

FCC ID: OWS-NIC505

IC ID: 5975A-NIC505

Report #:SSN_05

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General Information

Unit(s) Under Test: 900MHz Relay Radio, Version B
Model(s): 210-040102

Product Description: Relay Radio, Version B

FCC ID: OWS-NIC505
IC ID: 5975A-NIC505

Tested For: Silver Spring Networks
2755 Campus Drive
Suite 205
San Mateo, CA 94403

Tested At: (Radiated Emissions)
Elliott Laboratories
41039 Boyce Road
Fremont, CA

(RF Conducted tests)
Elliott Laboratories
41039 Boyce Road
Fremont, CA 94538

Tested By: Mehran Birgani, Test Engineer, Elliott Labs
David Waitt, (Independent Consultant)

Tested To: FCC CFR 47, Part 15.247, 900MHz FHSS
IC RSS-210 / Issue 7

Tested On: 12 - 15 Sept 2007

**Requested
Certifications:** FCC Part 15 Subpart C certification
IC RSS-210 / Issue 7 Certification

Detailed Product Information

The Relay Radio is a 900MHz FHSS radio that is used to relay information from SilverSpring wireless electric meters to the SilverSpring wireless network infrastructure.

Number of hopping channels:	83
Operating Frequency Range:	902.3 MHz to 926.9 MHz
Channel spacing:	300kHz
RF Power Output:	26.85 dBm
Antenna Gain:	Approx 2.5 dBi Avg, 3.08dBi Max Peak
Antenna Type:	Single, external, Omni
Operating Voltage:	120 VAC @ 60 Hz
DUT:	Engineering prototype, equivalent to mass produced items.
Modifications:	No modifications were made to the unit during testing

Test Results Summary

This report presents the results of the tests that verify compliance with FCC Part 15.247 and RSS210

A brief results summary of all the in this report is below.

Part 15 Paragraph	RSS-210, Issue 7 Paragraph	Test	Results
15.247(b)(2)	A8.4(1)	Maximum Power	dBm Max .96383 W
15.247(a)(1)(i)	A8.1(c)	20dB Bandwidth	220 kHz Max
15.247(d) 15.205	A8.5 2.2	Out of Band Spurious Emissions Radiated Emissions in Restricted bands	6.5dB in spec min @ 6400.0MHz (Restricted Band)
15.247(a)(1)(i)	A8.1(c)	Number of hopping channels	83
15.247(a)(1)(i)	A8.1(b)	Channel Spacing	300kHz

Test Facilities

All radiated emissions testing for 15.247 (15.205) were performed at:

Elliott Laboratories
41039 Boyce Road
Fremont, CA 94538

Testing was conducted in accordance with ANSI C63.4 (2003)

General:

Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data for chamber 1 has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Within the chamber, ambient levels are well below this requirement. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

Antenna, Antenna Mast and Turntable

The Horn antennas that are used to measure radiated emissions above 1000MHz are mounted 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 most recent ANSI requirements.

Equipment Lists

Instrument Calibration

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles.

The following test equipment was used to perform the testing

Elliott Test Equipment

Radiated Emissions, 30 - 10,000 MHz, 12-Sep-07				
Engineer: Mehran Birgani				
<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	263	16-Mar-08
EMCO	Antenna, Horn, 1-18 GHz	3115	786	28-Nov-07
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	11-Jan-08
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	03-May-08
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037 (84125C)	1769	08-Nov-07
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	1771	11-Nov-07

Conducted Emissions - AC Power Ports, 13-Sep-07				
Engineer: Mehran Birgani				
<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
Elliott Laboratories	LISN, FCC / CISPR	LISN-3, OATS	304	18-Jul-08
Solar Electronics	LISN	8028-50-TS-24-BNC support	904	19-Jan-08
Rohde & Schwarz	Test Receiver, 0.009-2750 MHz	ESN	1332	21-Nov-07
Rohde& Schwarz	Pulse Limiter	ESH3 Z2	1398	05-Feb-08

Test Methods

Unless otherwise noted in the specific test procedure, tests are performed at a low, middle and high channel band used by the device. Unless otherwise noted, all testing was performed on these channels / frequencies.

902 - 928 MHz Band	
Channel	Freq(MHz)
Low	902.3
Mid	915.4
High	926.9

The device was running special diagnostic software to allow it to transmit random data on a particular channel indefinitely. This diagnostic software allowed the frequency hopping function to be disabled or enabled as tested required.

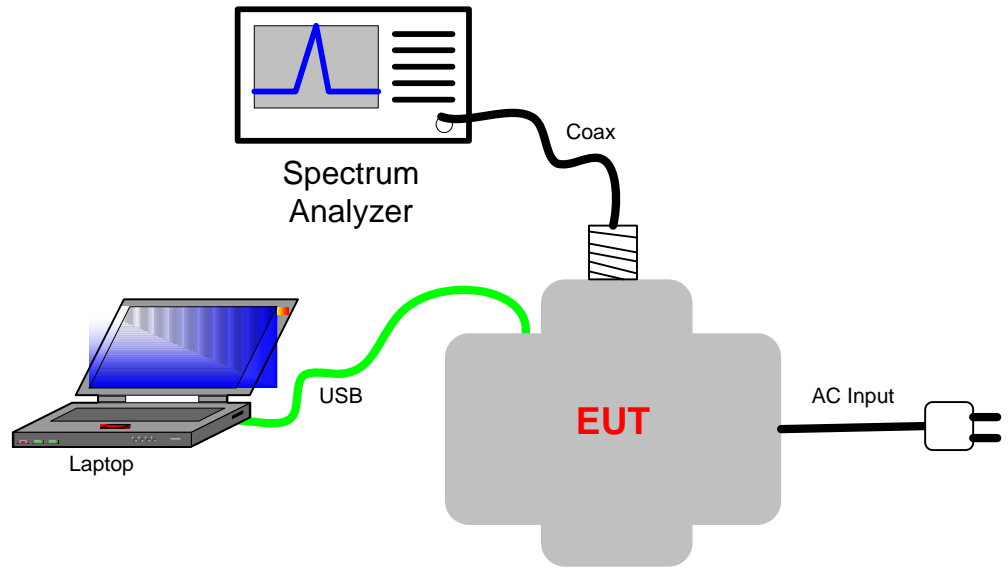
The diagnostic software also allowed variation of the RF transmit power. The maximum power setting that allowed compliance with the radiated emissions requirements (determined during testing) will be programmed into the configuration firmware of the relay radio. This will ensure compliance with the FCC / IC radiated emissions requirements.

The tests listed below are performed using the basic “conducted” test setup shown below unless otherwise noted

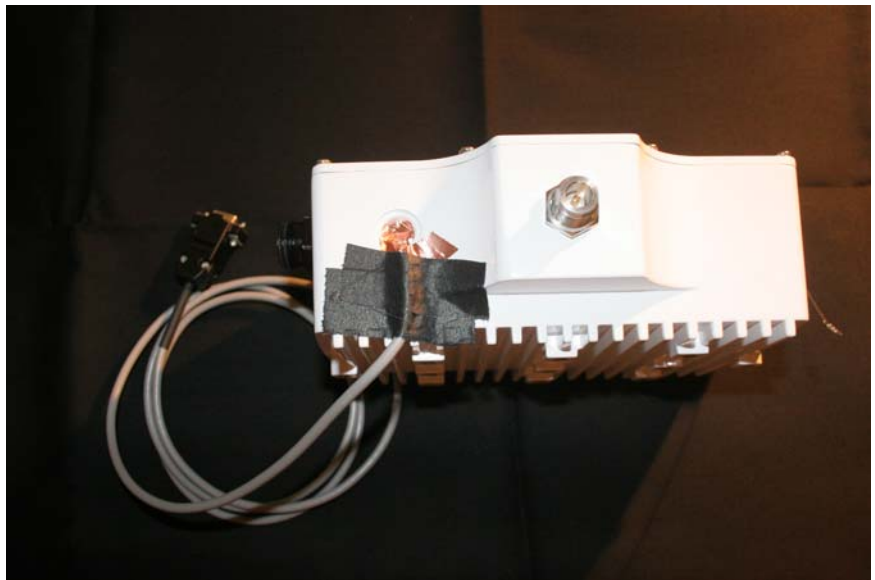
Part 15	Test
15.247(b)(2)	RF Transmit power
15.247(a)(1)(i)	Bandwidth
15.247(a)(1)(i)	Number of hopping channels
15.247(a)(1)	Channel Spacing
15.247(a)(1)(i)	Time on channel

Basic Conducted RF Bench Test Setup

The bench top RF test setup is shown to the right. Unless otherwise noted, the support equipment for the bench tests is listed below.



It should be noted that the hole drilled through the housing of the EUT to accommodate the serial cable is for test purposes ONLY and is NOT present in the production units.



Support Equipment				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	Satellite	DOC	Toshiba	Laptop PS, unshielded

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 Bench Top” test setup shown earlier, the test setup is also presented within that section of the test report.

Test Conditions			
Temperature	57.2 F	Humidity:	80%
ATM pressure	29.88 in	Grounding:	None
Tested By	David Waitt	Date of Test:	16 Sept 2007
Test Reference	Refer to individual test results		
Tested Freq Range	Test dependent		
Test Voltage	120 VAC		
Modifications	No internal modifications were made to the unit during he conducted testing. Some modification were made during the radiated emissions testing.		

Maximum RF Power Output at Antenna Terminals

Specifications:

FCC Specification: Paragraph: 15.247(b)(2)

IC Specification: RSS-210/7, A8.4(1)

Procedure:

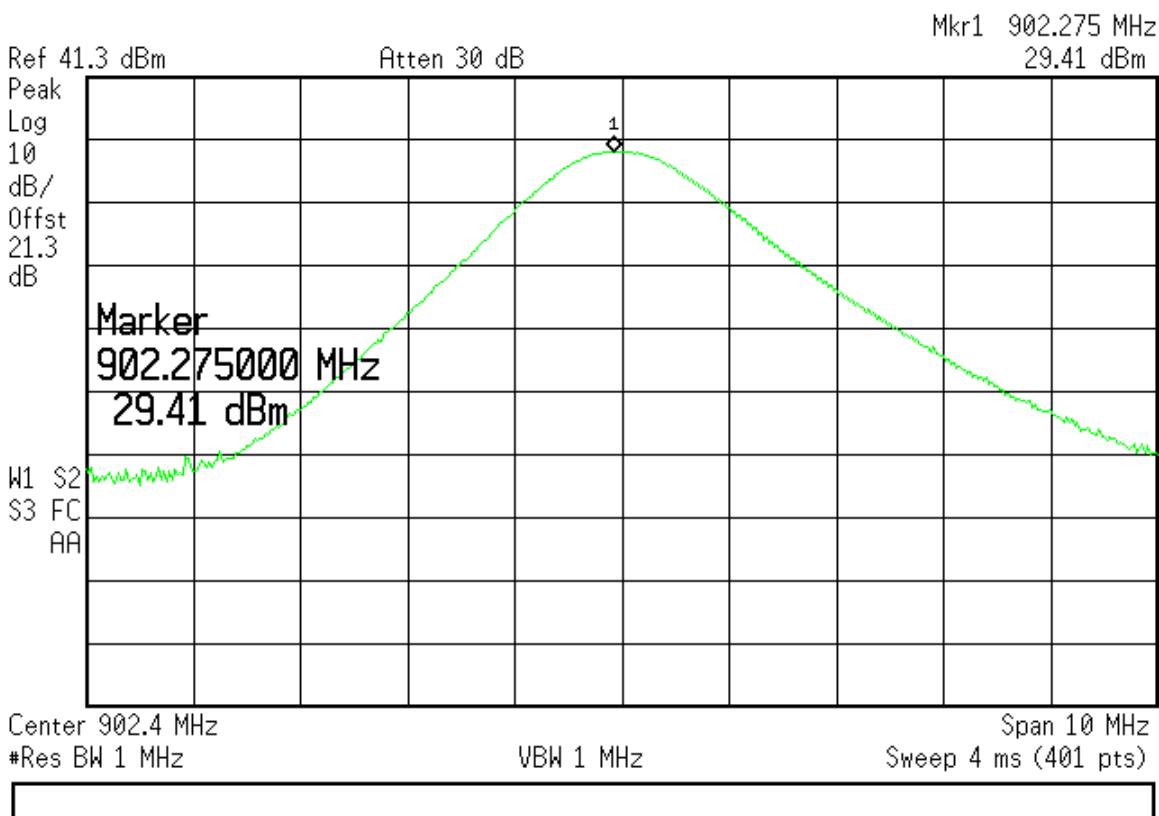
The test was configured as shown in the RF conducted bench top test setup. The unit was sequentially tuned to the test channels (Low, Mid and High) and configured to transmit random data (100% duty cycle). The RF transmit integrated channel power was then measured on the spectrum analyzer. RBW=1MHz, VBW = 1MHz. These settings ensure that the entire channel power is within the RBW of the measurement given that the 20dB BW is approximately 220kHz

Results:

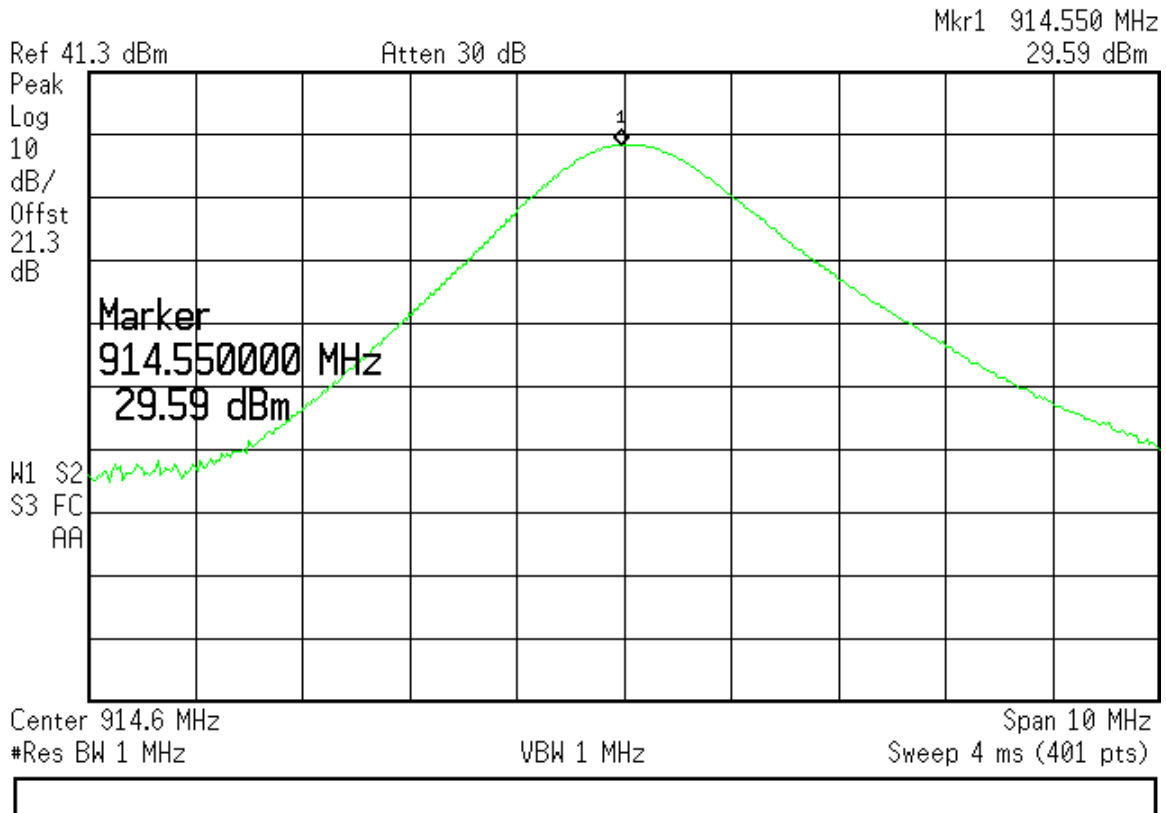
Measured RF power levels are below. Spectrum analyzer photos showing the data are contained in the appendix

	Power (dBm)	Power (mW)	(Max EIRP) Peak antenna gain (3.08 dBi)
LOW	26.54	450.817	29.62
MID	26.79	477.529	29.87
HIGH	26.85	484.172	29.93

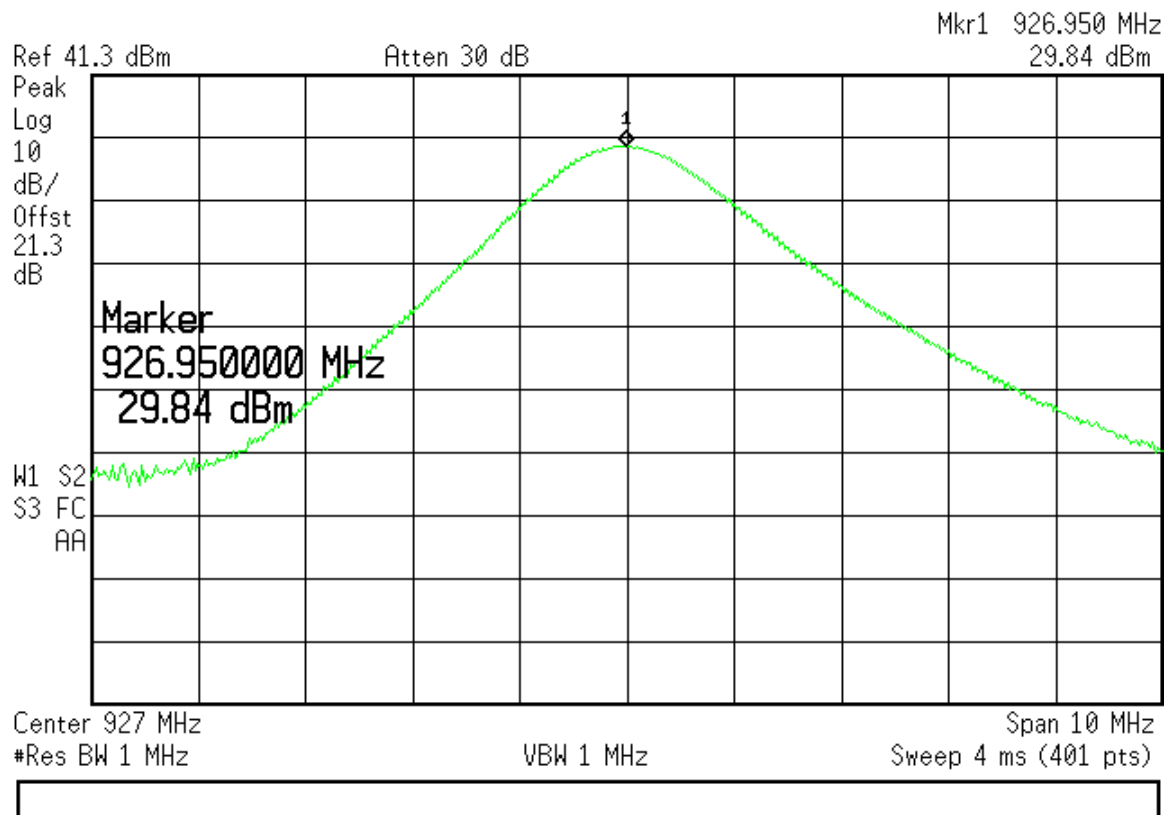
Agilent 06:30:14 Oct 5, 2007



Agilent 06:31:13 Oct 5, 2007



Agilent 06:31:41 Oct 5, 2007



20 dB Bandwidth

Specifications

FCC Specification: Paragraph 15.247(a)(1)(i)

IC Specification: RSS-210 / 7 A8.1(c)

Procedure:

The 20 dB bandwidth was measured on the low middle and high channels of the 900 MHz band using the conducted RF test setup. The spectrum analyzer was configured for MAX HOLD and the trace allowed to stabilize. A peak search was performed and the then “Delta-Marker” used to locate the points at –20dB below the peak.

Results:

Measured 20 dB bandwidths for the low, middle and high channels are below. Spectrum analyzer photos showing the data are contained in the appendix

	20 dB BW (kHz)	BW Spec (min, kHz)	Delta from spec (kHz)
LOW	220	500	280
MID	215	500	285
HIGH	213	500	287

Number of Hopping Channels

Specifications:

FCC Specification: Paragraph 15.247(a)(1)(i)

IC Specification: RSS-210 / 7 A8.1(c)

Procedure:

The test setup is as shown in the Conducted RF bench setup. The EUT was configured to hop sequentially through all of its channels. (This is not possible with the normal operating code). The spectrum analyzer was set to MAX HOLD to capture the number of hopping channels. The entire 902 - 928 MHz band was examined in three sub-bands. 902 - 910 MHz, 910 - 920MHz and 920 - 928 MHz. The results are below.

Results:

All 83 hopping channels were recorded.

Spectrum analyzer photos showing the data are contained in the appendix

From (MHz)	to (MHz)	Num of Channels
902	910	26
910	920	34
920	928	23
TOTAL		83

Channel Spacing

Specifications:

FCC Specification: Paragraph 15.247(a)(1)

IC Specification: RSS-210 / 7 A8.1(b)

Procedure:

The test setup is as shown in the Conducted RF bench setup. The EUT was configured to hop sequentially through all of its channels. (This is not possible with the normal operating code). The spectrum analyzer was set to MAX HOLD to capture a few of the sequential channel frequencies. The spectrum analyzer markers were used to determine the channel spacing. The results are below.

Results:

Channel spacing was measured at **300kHz**. The specification requires that the channel spacing be greater than the measured 20 dB BW. The 20 dB BW was measured at a maximum of 220 kHz.

Spectrum analyzer photo showing the data are contained in the appendix

900MHz Band Edge

Specifications:

FCC Specification: Paragraph 15.247(d)

IC Specification: RSS-210/7 A8.5

Procedure:

The test setup was configured as shown in the conducted test setup. The UUT was configured to continuously transmit random data on the low, and then the high test channel. The span of the analyzer was centered on the 902 and 928 MHz band edge respectively.

The RBW was set to 100 kHz, VBW = 1 MHz. The trace was allowed to stabilize then a Peak-search and a marker delta measurement to the band edge was performed to verify that the RF power at the band edge was at least 20 dB below the peak of the fundamental level.

Results:

Level at 902 MHz: -27.86dBc Spec -20 dBc Min

Level at 928 MHz: -58.00dBc Spec -20 dBc Min

Spectrum analyzer photos showing the data are contained in the appendix

Radiated Emissions in Restricted Bands & Out of Band Radiated Emissions

Tx and Rx

Specifications:

FCC Specification: Paragraph 15.247(d)

IC Specification: RSS-210 / 7 Sec 2.2

Procedure:

This test was conducted inside a semi-anechoic chamber at BACL. The unit was placed on a rotating wooden table 80cm above the ground plane. A Horn antenna was secured to a mast 3 meter away. The unit was tested at each of the Low, Mid and High channels. The UUT was running in the diagnostic mode and set to transmit at maximum on each of the channels in turn. The test equipment was configured as shown below.

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 made by the test software and the appropriate correction factors (antenna factor, cable loss,...) were then applied by the test lab software to obtain a final corrected measurement.

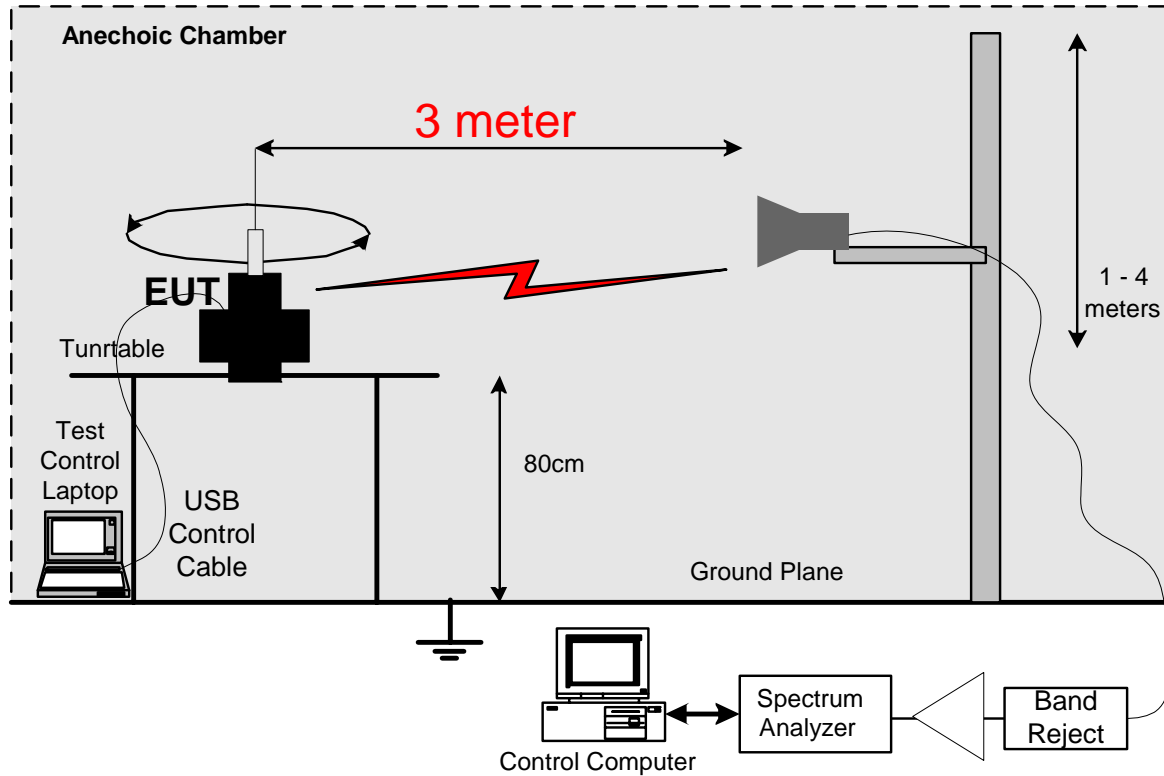
Preliminary emission scans were performed on the EUT in three orthogonal planes. It was determined that the horizontal plane was the worst case. The final radiated emissions data was recorded with the EUT being horizontal. This procedure was performed for all of the channels outlined in the Test Methods section of this report.

The band up to 10 GHz was examined. The table below indicates the harmonics that fall within restricted bands.

CHAN	FUND	2	3	4	5	6	7	8	9	10
LOW	902.3	1804.6	2706.9	3609.2	4511.5	5413.8	6316.1	7218.4	8120.7	9023.0
MID	915.4	1830.8	2746.2	3661.6	4577.0	5492.4	6407.8	7323.2	8238.6	9154.0
HIGH	926.7	1853.4	2780.1	3706.8	4633.5	5560.2	6486.9	7413.6	8340.3	9267.0

15.205 Harmonic test tables

NOTE: RED indicates a harmonic that falls within a restricted band and is subject to 15.205. The harmonics in Green are NOT in restricted bands and are subject to 15.209



Radiated Emissions in Restricted Bands Test Setup

Support Equipment				
Description	Model number	FCC ID or SN	Manufacturer	Power Cable
Laptop	A20	DOC	IBM	Laptop PS, unshielded

Test Conditions			
Temperature	24 C	Humidity:	73%
ATM pressure	29.72 in	Grounding:	None
Tested By	Mehran Birgani , Elliott	Date of Test:	12 Sept 2007
Test Reference	FCC Part 15.205 IC Paragraph RSS210, 6.2.3 (c)		
Setup Method	ANSI C63.4		
Tested Range	1 GHz to 10GHz		
Test Voltage	120 VAC		
Modifications	No modifications were made to the unit		

NOTES: For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental.

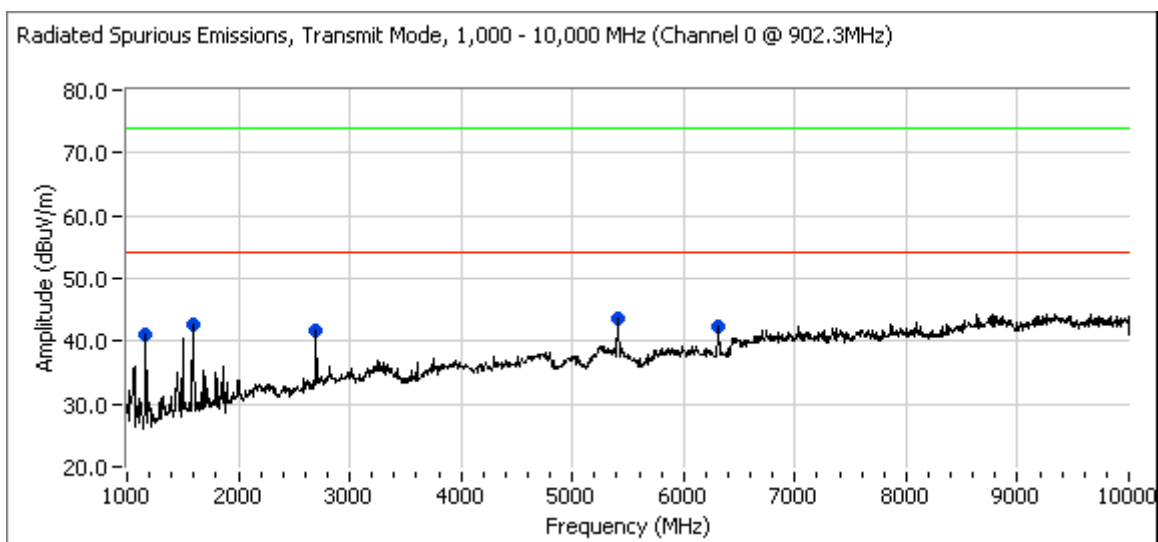
Restricted Band Peak Measurements: RBW = VBW = 1 MHz

Restricted Band Average Measurements: RBW = 1MHz and VBW = 10 Hz.

All other measurements, RBW = 1MHz and VBW = 3MHz, video averaging on (100 samples).

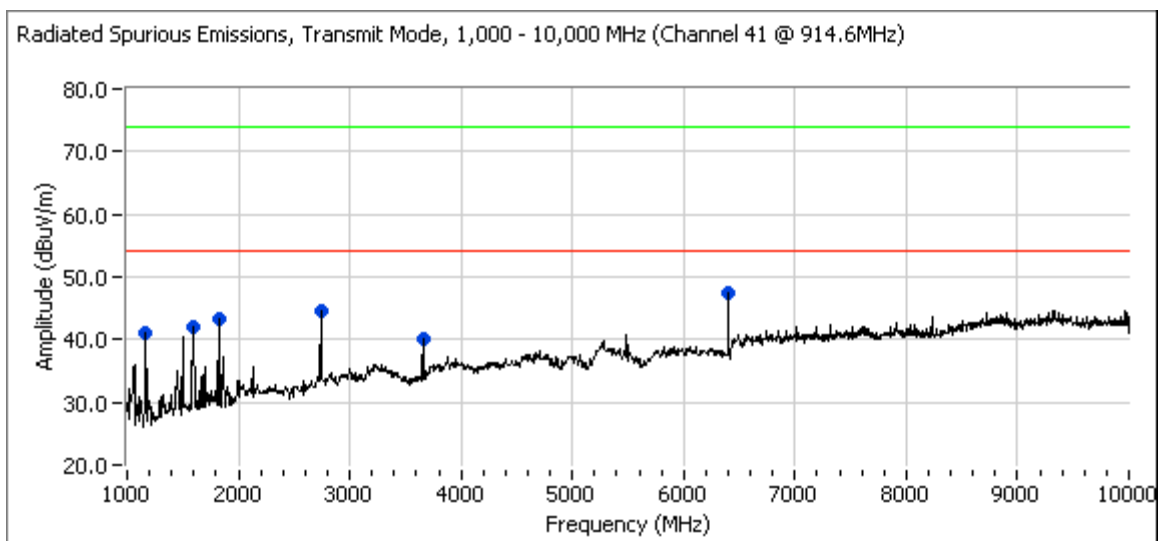
Results:

EUT Transmitting on LOW channel, 902.3 MHz



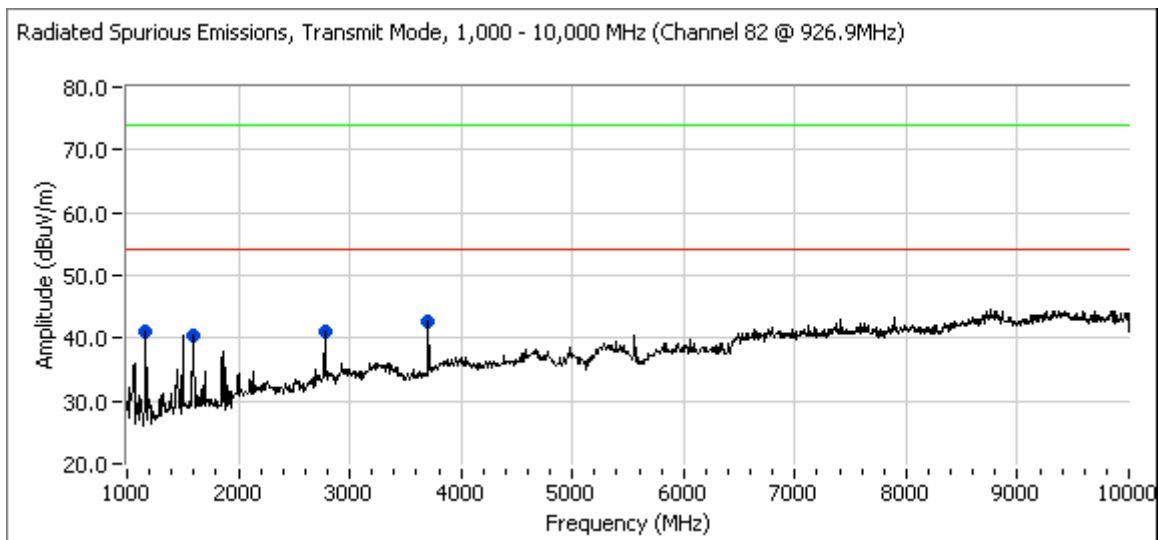
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
5408.330	43.5	V	54.0	-10.5	Peak	174	1.3	Peak reading with average limit
1591.670	42.6	V	54.0	-11.4	Peak	220	1.0	Peak reading with average limit
6316.670	42.5	V	54.0	-11.5	Peak	167	1.3	Note 1, PK reading with AVG limit
2700.000	41.6	V	54.0	-12.4	Peak	144	1.6	Peak reading with average limit

EUT Transmitting on MID channel, 914.6 MHz



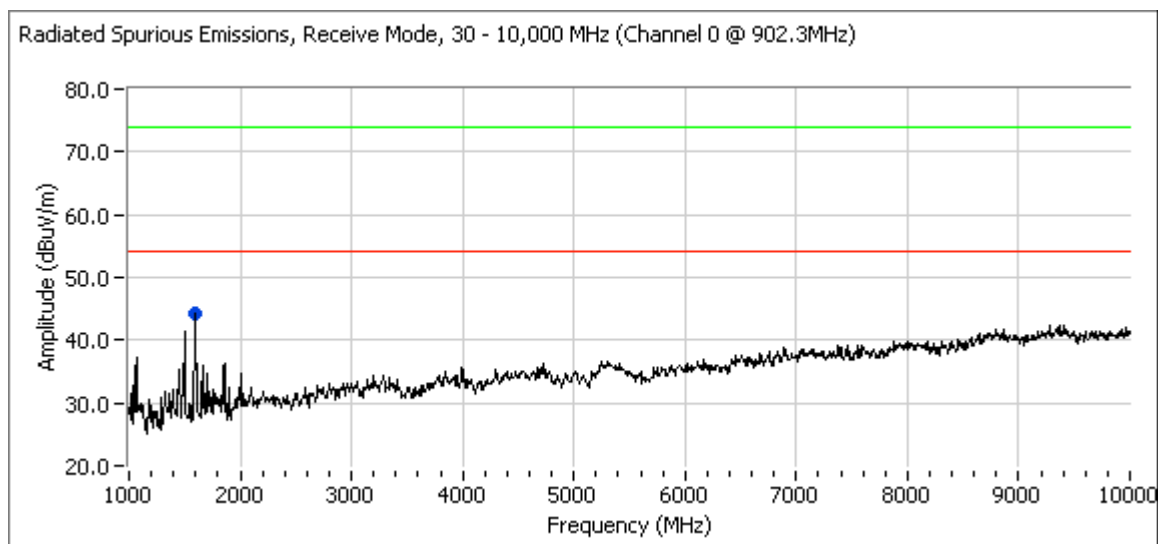
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
6400.000	47.5	V	54.0	-6.5	Peak	201	1.9	Note 1, PK reading with AVG limit
2741.670	44.6	V	54.0	-9.4	Peak	266	1.6	Peak reading with average limit
1825.000	43.3	V	54.0	-10.7	Peak	188	1.0	Note 1, PK reading with AVG limit
1591.670	42.1	V	54.0	-11.9	Peak	200	1.0	Peak reading with average limit
3658.330	40.0	V	54.0	-14.0	Peak	228	1.3	Peak reading with average limit

EUT Transmitting on HIGH channel, 926.9 MHz



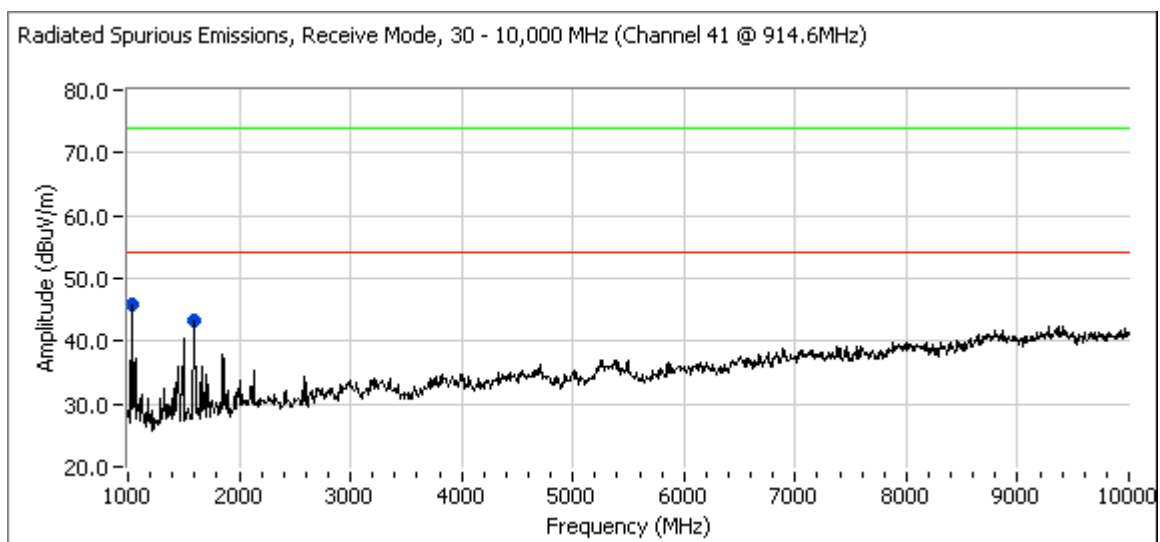
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
3708.330	42.7	V	54.0	-11.3	Peak	235	1.3	Note 1, PK reading with AVG reading
2775.000	41.1	V	54.0	-12.9	Peak	158	1.0	Peak reading with average limit
1591.670	40.3	V	54.0	-13.7	Peak	230	1.0	Peak reading with average limit

EUT RECEIVING on LOW channel, 902.3 MHz



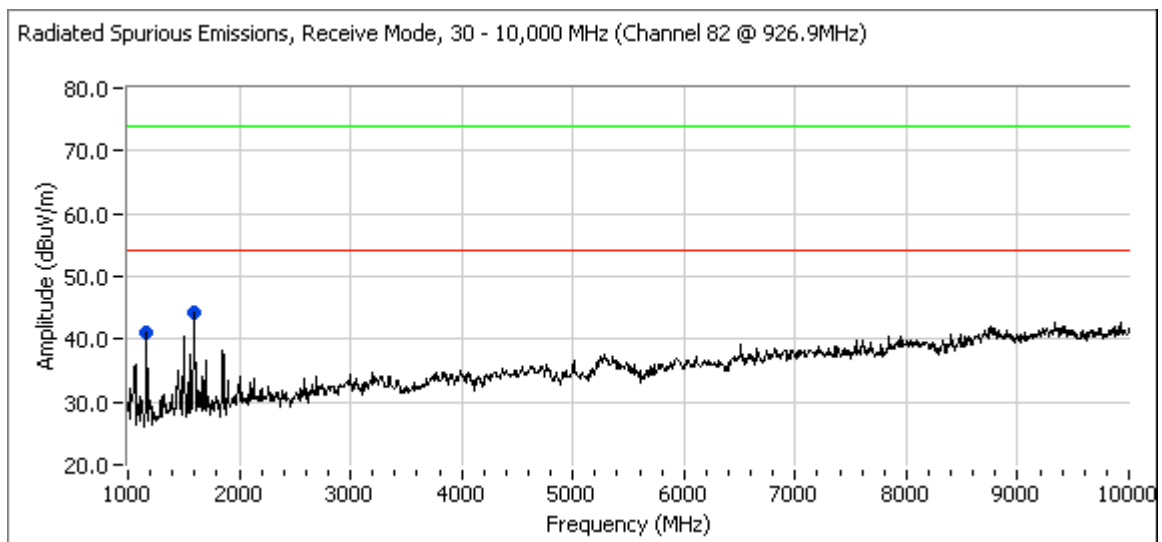
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
1595.830	44.1	V	54.0	-9.9	Peak	192	1.0	

EUT RECEIVING on MID channel, 914.6 MHz



Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	V/H	Limit	Margin	Pk/QP/Avg	degrees	meters	
1027.500	45.8	V	54.0	-8.2	Peak	330	1.3	
1595.830	43.4	V	54.0	-10.6	Peak	227	1.0	

EUT RECEIVING on HIGH channel, 926.9 MHz



Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1595.830	44.4	V	54.0	-9.6	Peak	196	1.0	
1165.000	41.1	V	54.0	-12.9	Peak	350	2.2	

30MHz - 1 GHz Spurious Radiated Emissions

Specification:

FCC Specification: 15.109(f)

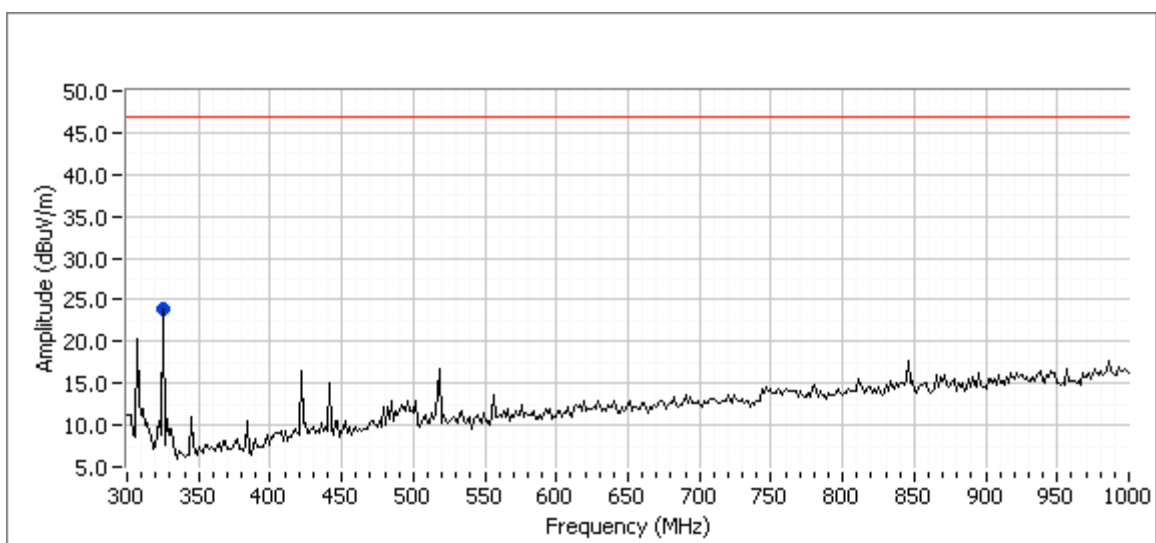
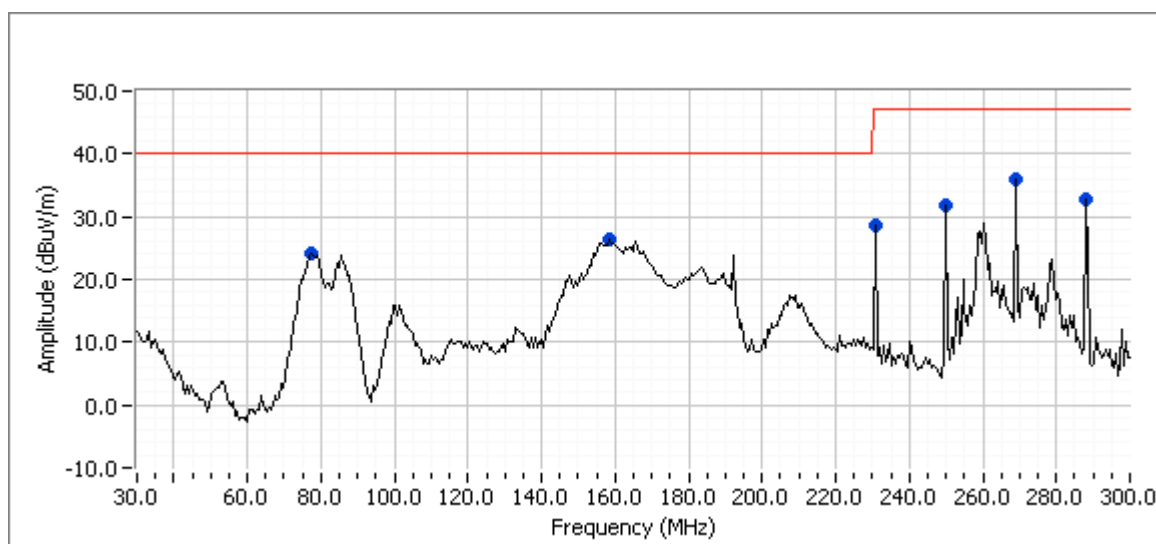
IC Specification: RSS210 / 7 A8.5

Procedure:

The test was configured as a standard ANSI C63.4 Class A radiated emissions test setup. The EUT was tested in XMIT mode on the middle channel. The frequency range of 30 to 1000 MHz was scanned.

Results: (XMIT mode)

Preliminary emissions were checked in all three orthogonal planes, the worst case results are presented below and on the following page.



Maximized quasi-peak readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	EN55022 Class A		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
268.806	39.7	H	47.0	-7.3	QP	224	1.5	Class A Limits
288.001	35.3	H	47.0	-11.7	QP	46	1.5	
249.607	33.1	V	47.0	-13.9	QP	35	1.0	
230.404	30.9	V	47.0	-16.1	QP	39	1.0	
158.861	19.5	H	40.0	-20.5	QP	99	3.5	
78.490	18.0	H	40.0	-22.0	QP	76	3.0	

AC Line Conducted Emissions

Specification:

CISPR 22

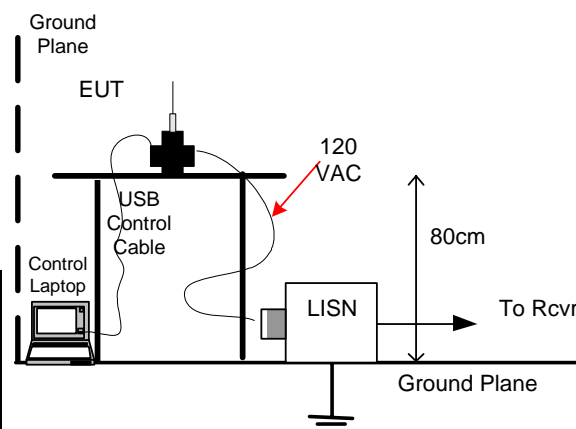
Procedure:

The test was set up according to the guidelines set forth in EN55022:1998 and FCC Part 2 for AC Line Conducted Emissions. The measurement used a LISN line on each AC line and an EMI receiver. A peak scan was made over the measurement frequency range (150 kHz to 30 MHz). The highest peaks were then marked and re-measured and quasi-peaked and averaged.

The test was configured as shown below. The product was tested with a generic power supply running on 120 VAC @ 60 Hz. The power supply provides 3.6 VDC to the EUT. The EUT was configured to transmit in order to draw the maximum current from the power supply. This results in the worst case conducted emissions.

Results:

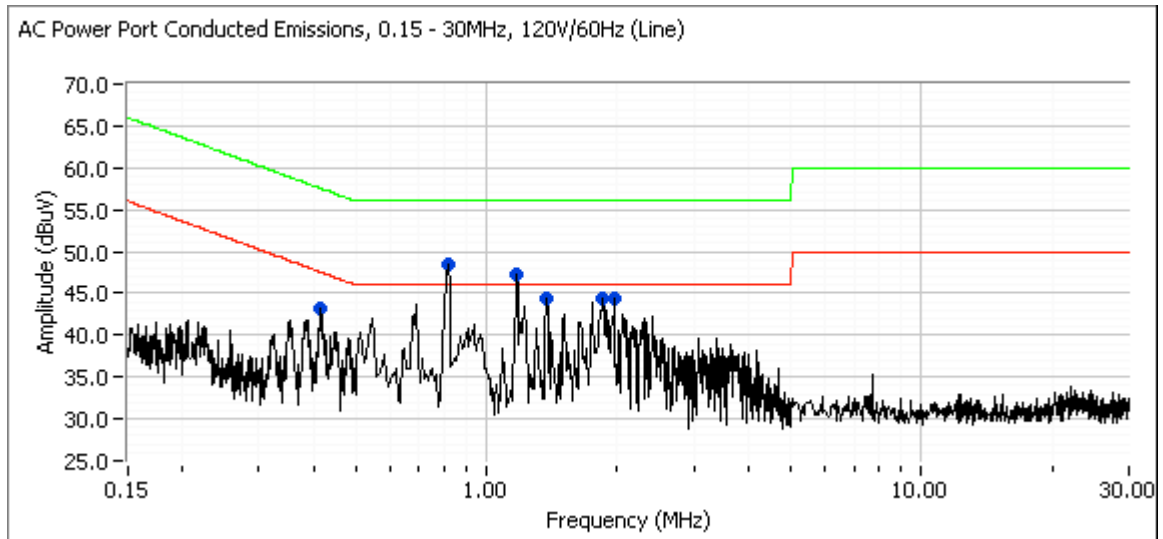
AC line Conducted Emissions, QP and AVG Results



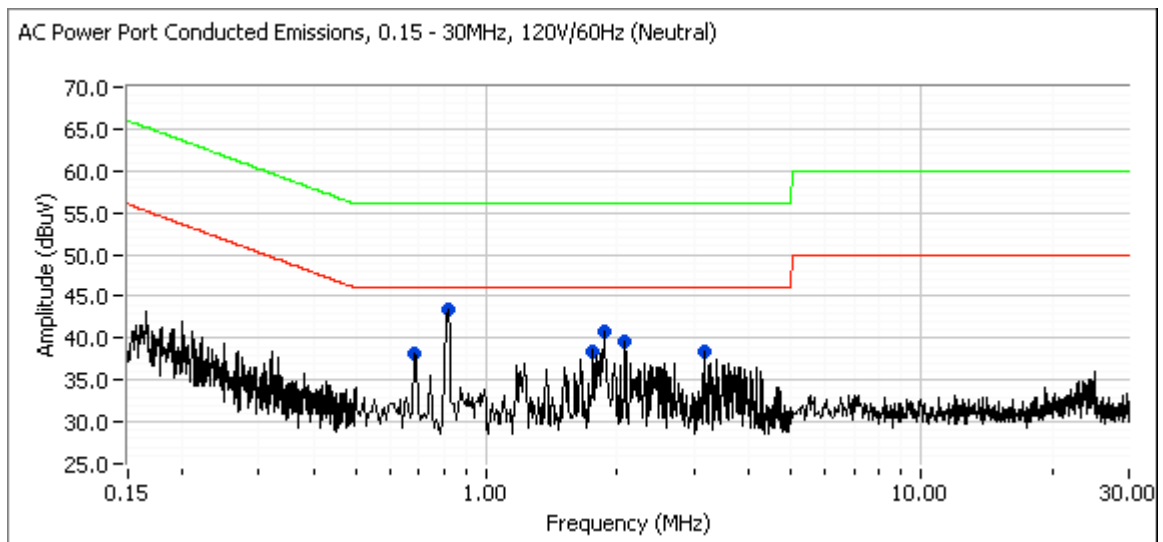
Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

Frequency MHz	Level dBμV	AC Line	EN 55022 Class B		Detector QP/Ave	Comments
			Limit	Margin		
1.854	36.0	Line	46.0	-10.0	AVG	
0.420	36.2	Line	47.4	-11.2	AVG	
1.962	32.2	Line	46.0	-13.8	AVG	
1.854	41.9	Line	56.0	-14.1	QP	
1.371	31.0	Line	46.0	-15.0	AVG	
1.962	40.3	Line	56.0	-15.7	QP	
1.749	28.7	Neutral	46.0	-17.3	AVG	
1.860	28.1	Neutral	46.0	-17.9	AVG	
2.076	27.2	Neutral	46.0	-18.8	AVG	
1.749	35.8	Neutral	56.0	-20.2	QP	
0.420	37.1	Line	57.4	-20.3	QP	
2.076	35.2	Neutral	56.0	-20.8	QP	
1.860	34.6	Neutral	56.0	-21.4	QP	
1.371	33.9	Line	56.0	-22.1	QP	
3.169	22.1	Neutral	46.0	-23.9	AVG	
3.169	30.8	Neutral	56.0	-25.2	QP	
0.815	48.5	Line	46.0	2.5	Peak	Ambient
1.170	47.2	Line	46.0	1.2	Peak	Ambient
0.815	43.5	Neutral	46.0	-2.5	Peak	Ambient
0.680	38.1	Neutral	46.0	-7.9	Peak	Ambient

AC Line conducted emissions, LINE



AC Line conducted emissions, NEUTRAL



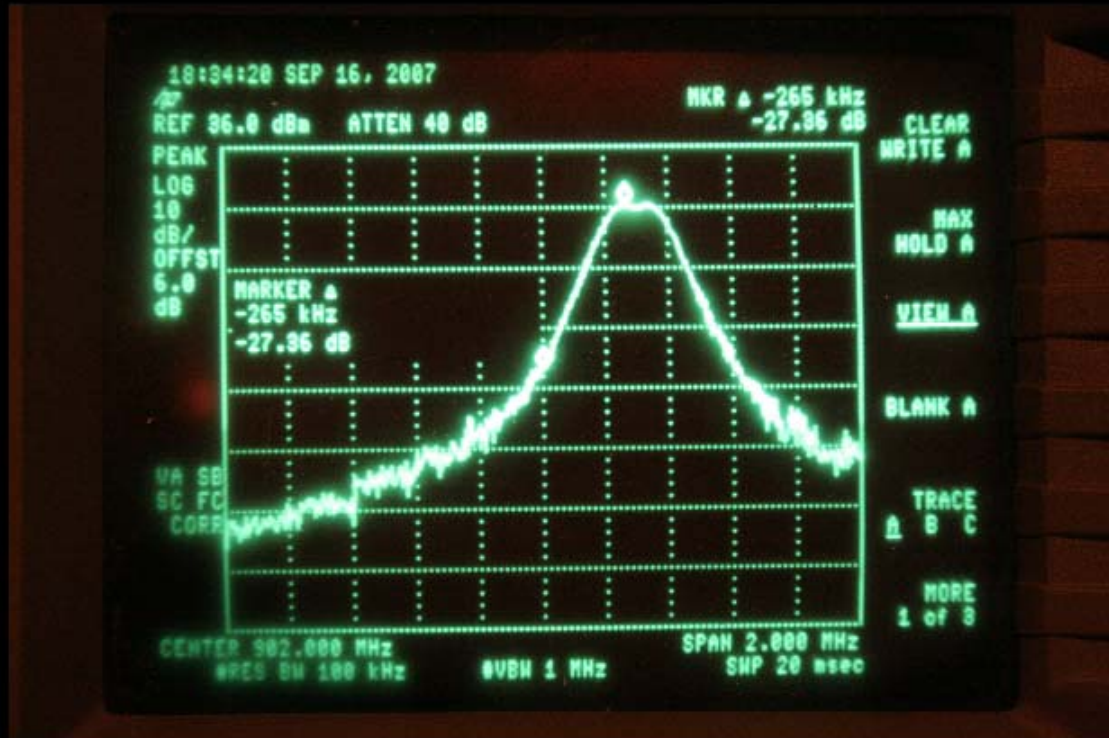
EMI Test Report APPENDIX

EMI Test Report
APPENDIX
on
SilverSpring Relay Radio

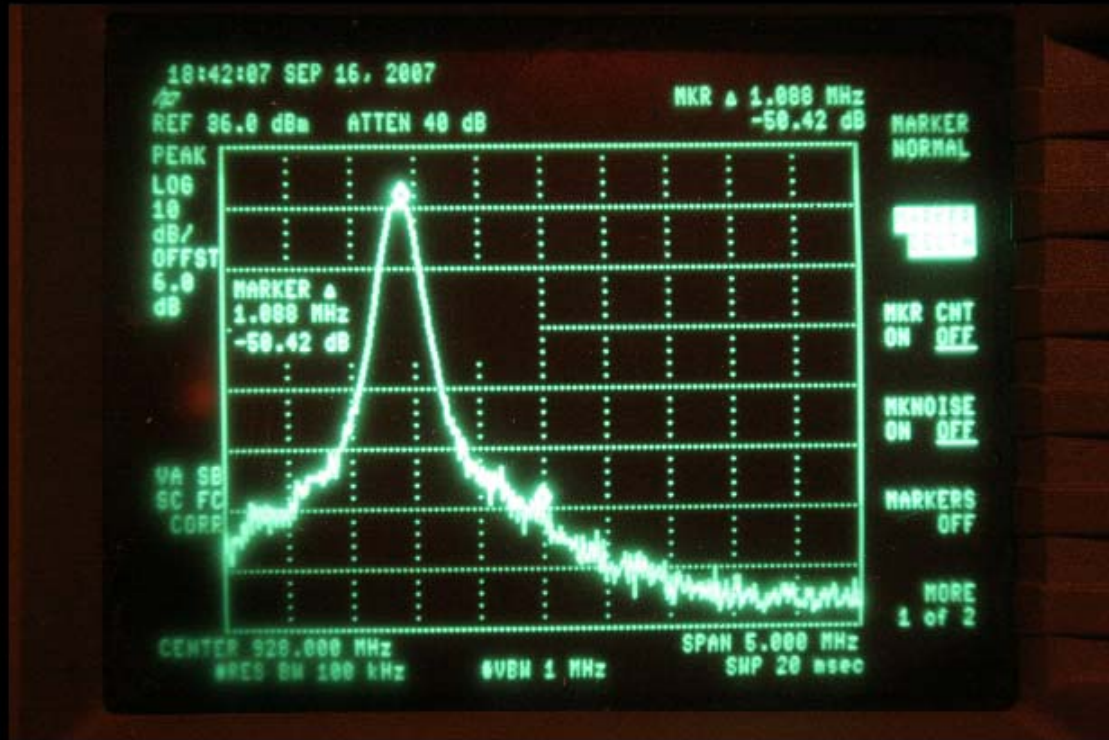
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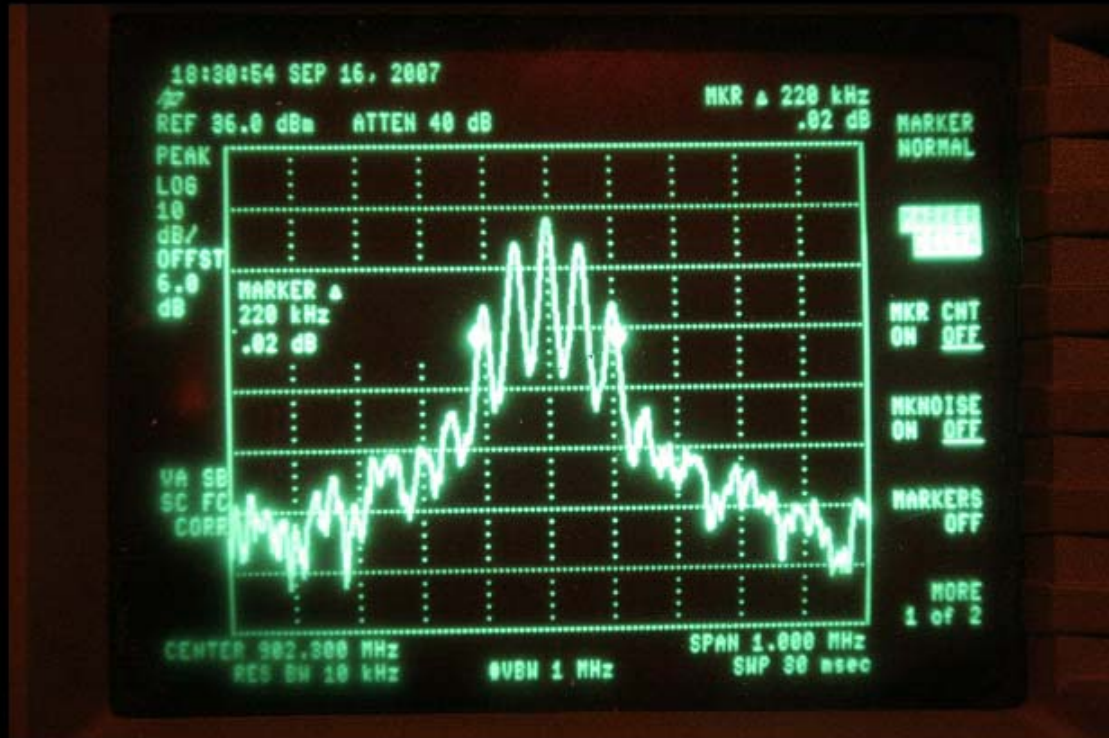
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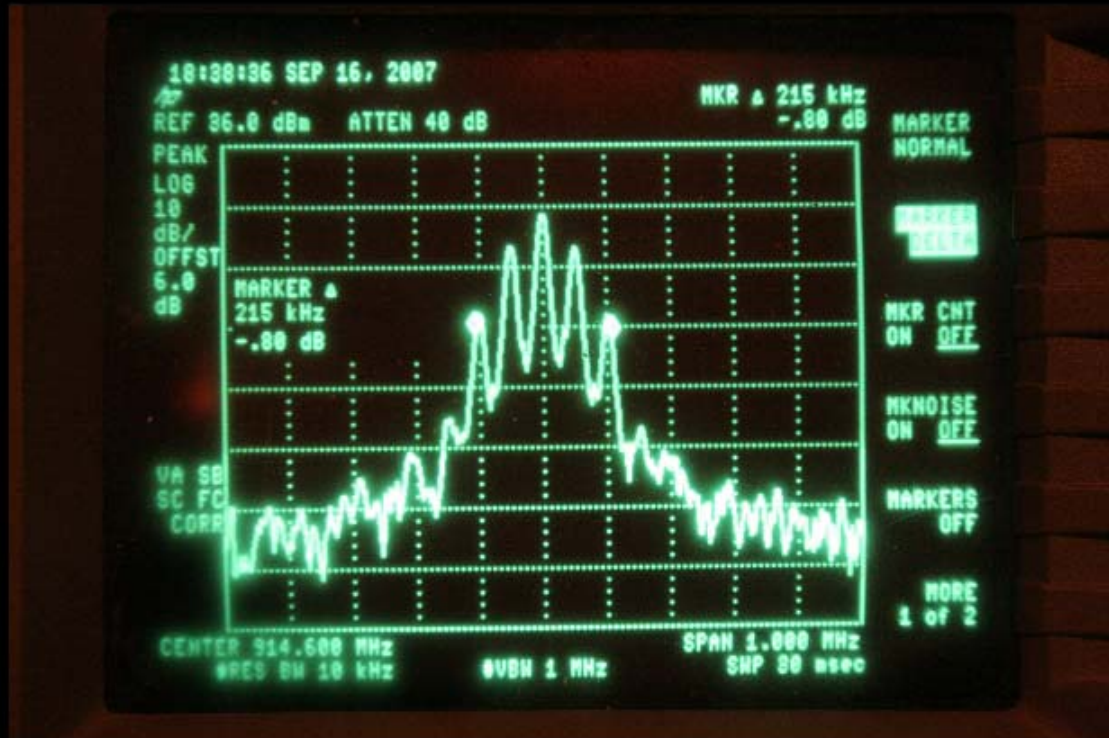
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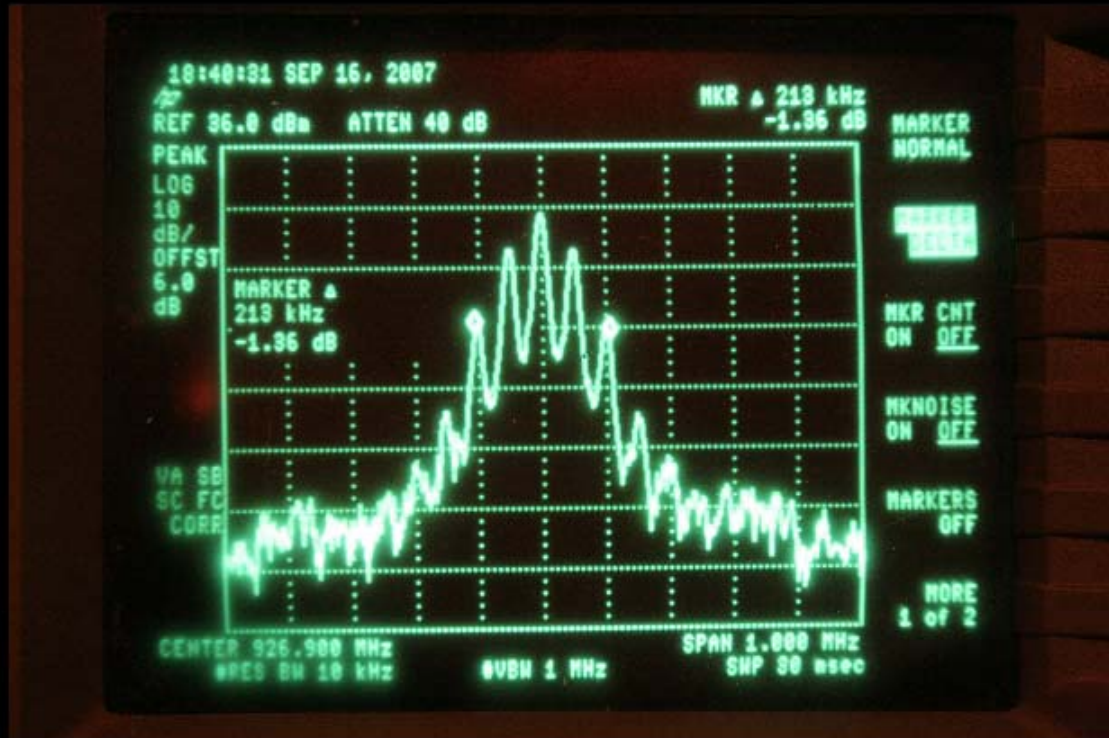
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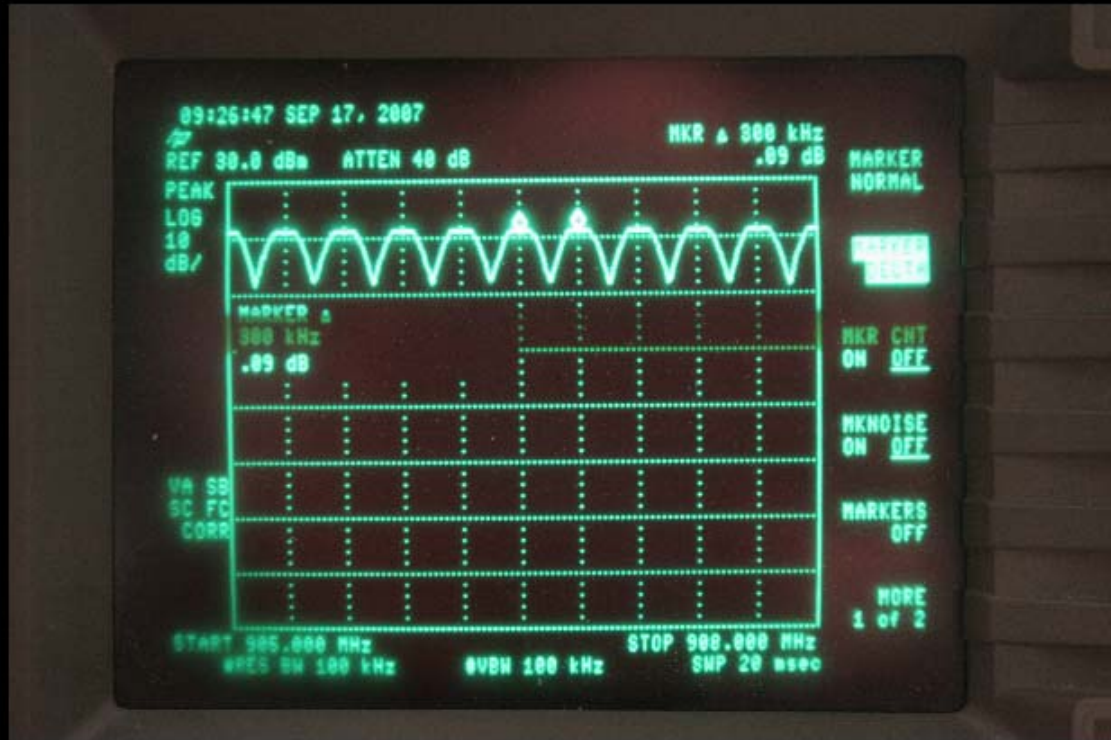
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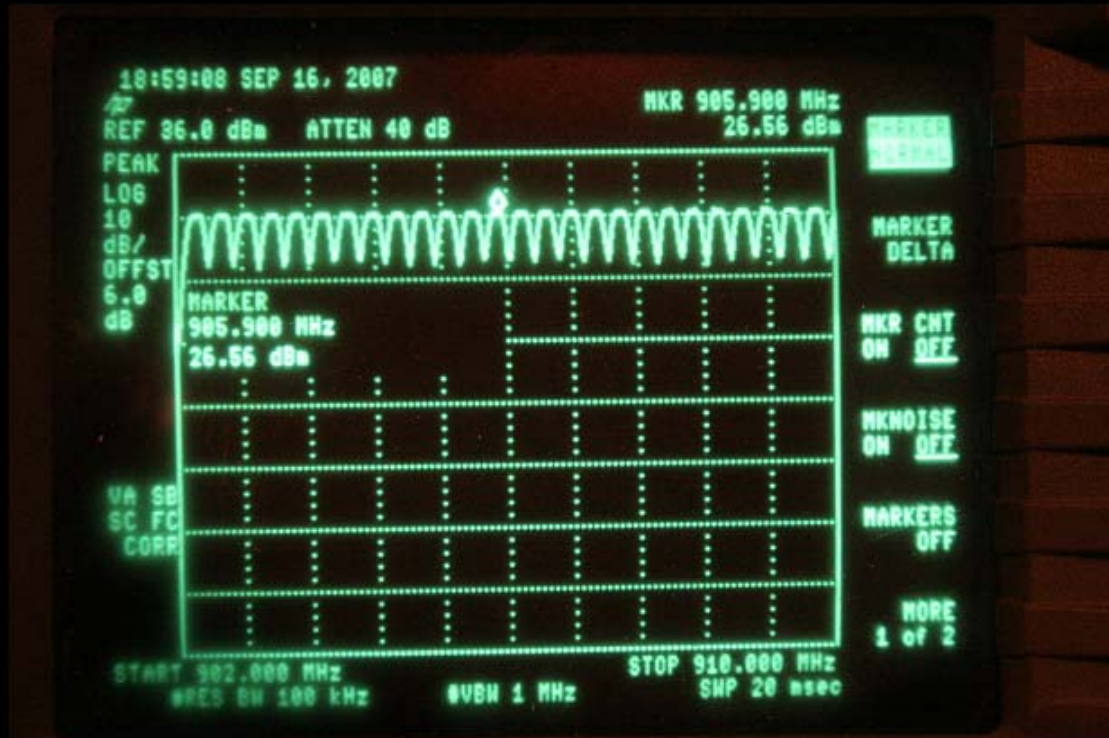
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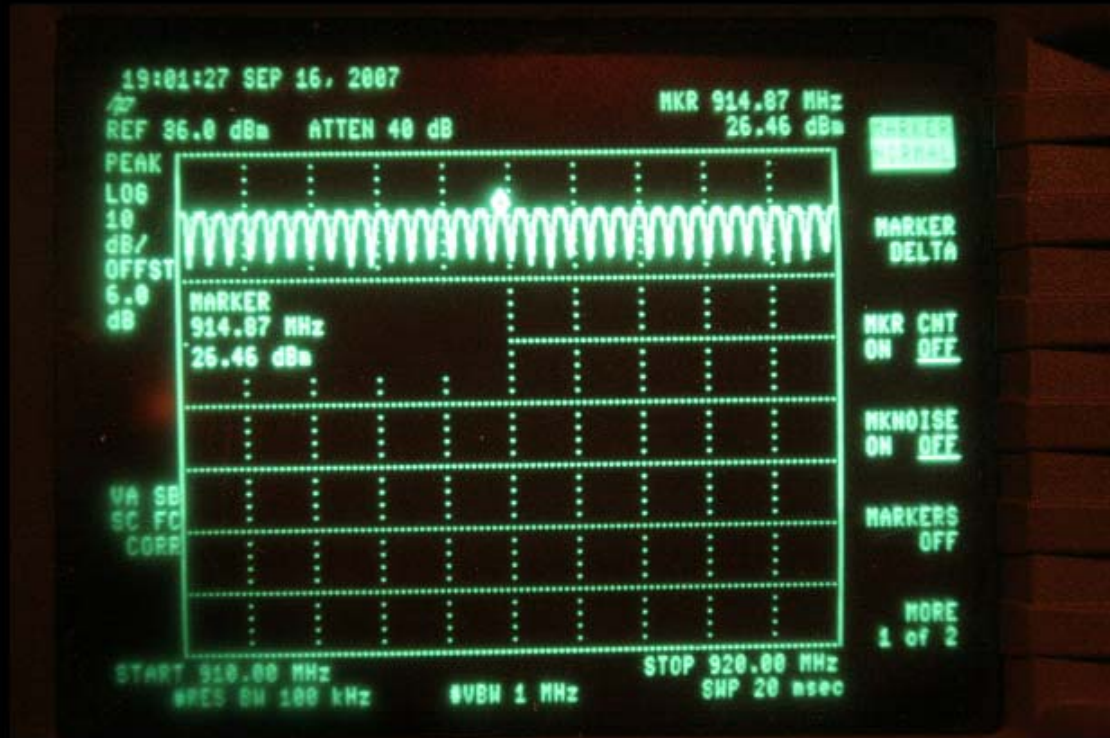
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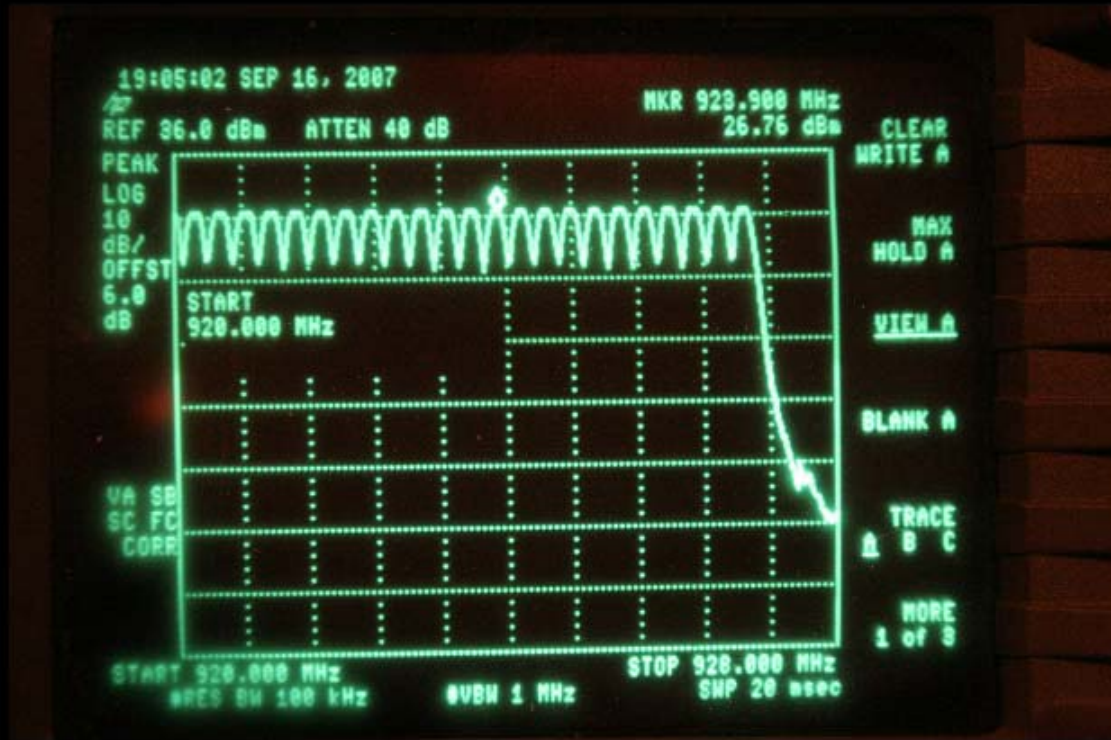
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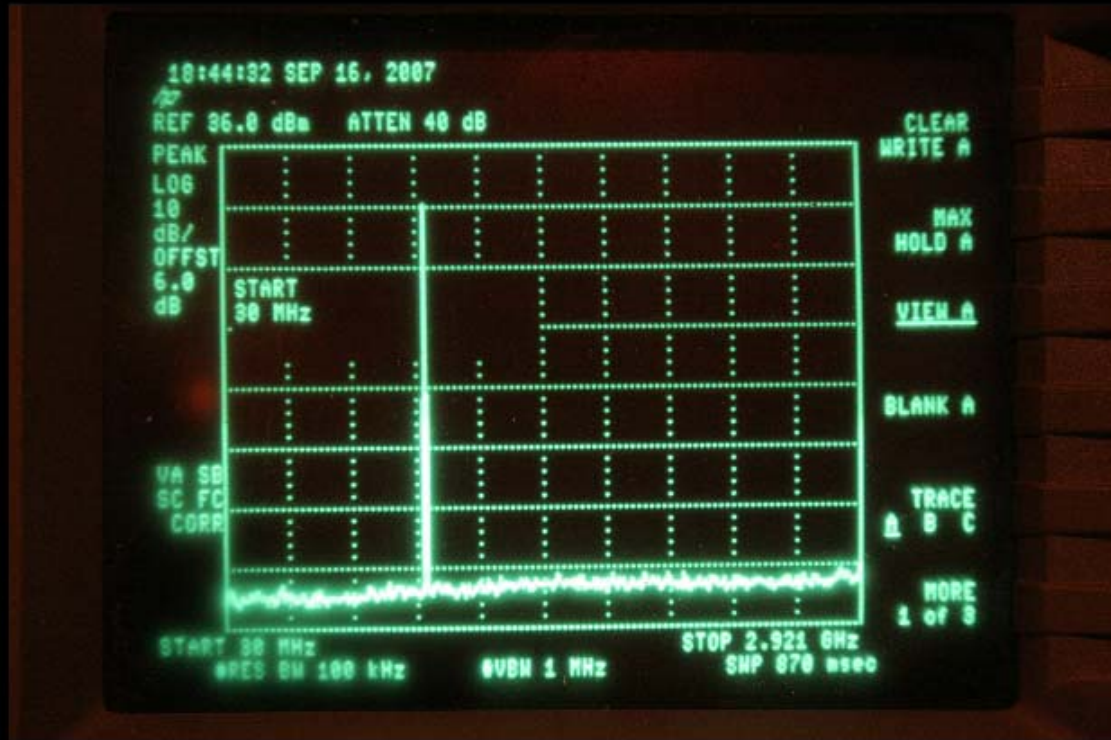
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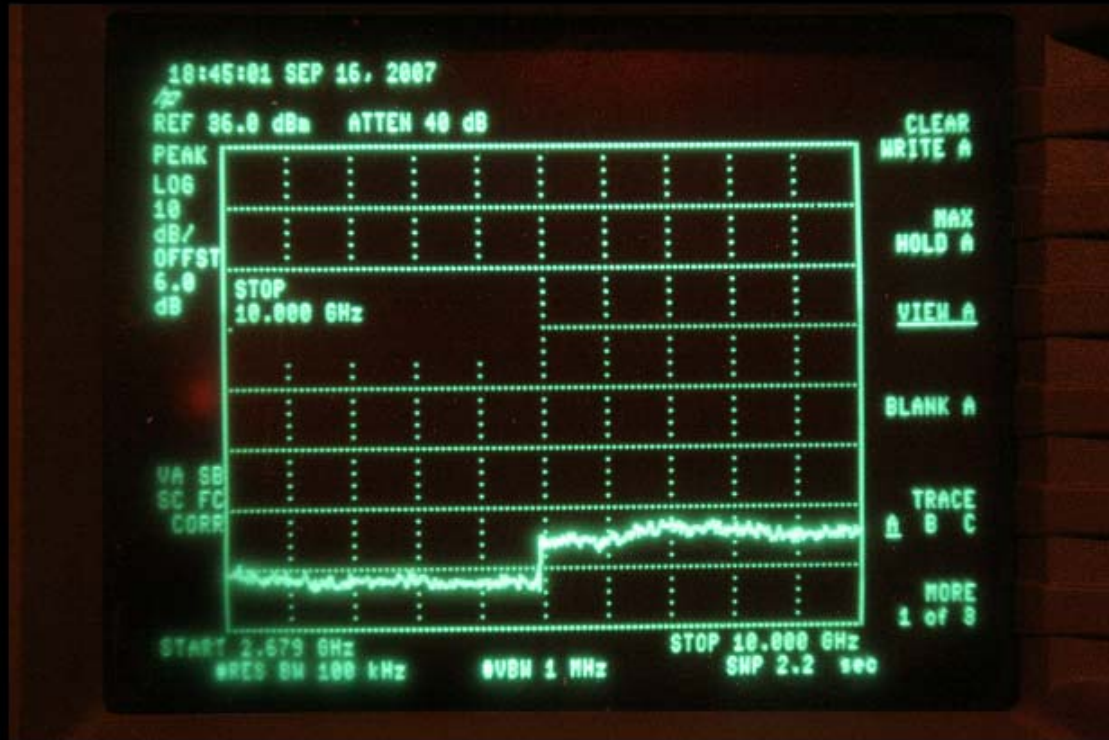
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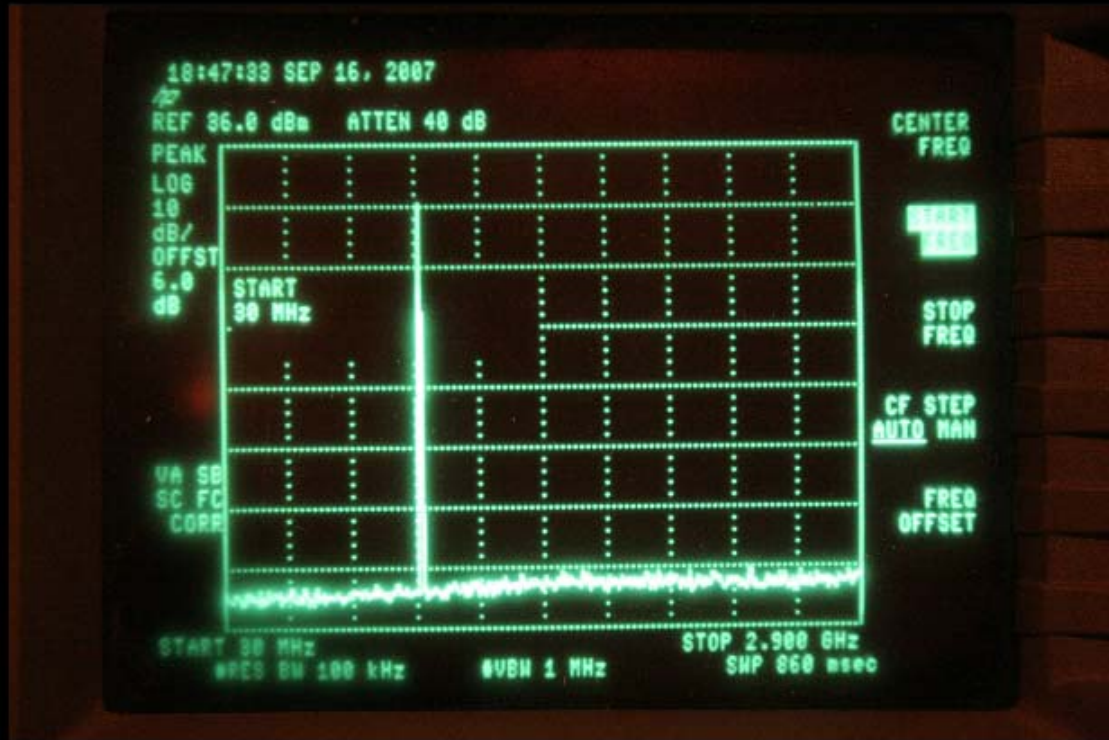
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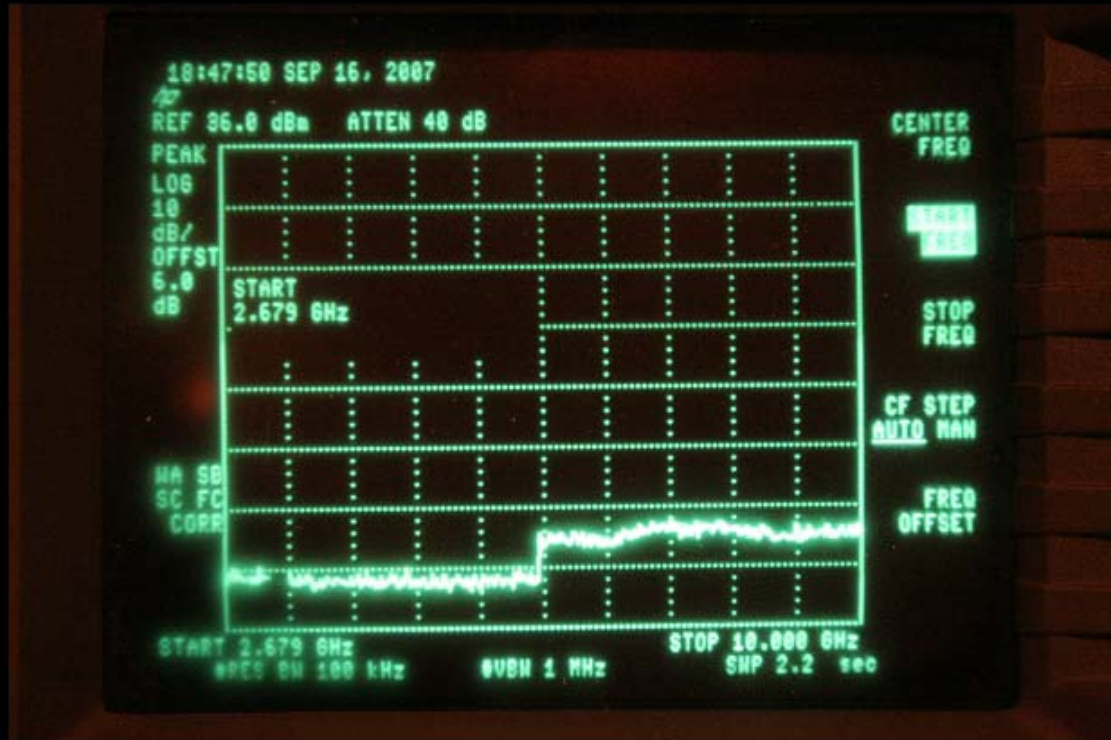
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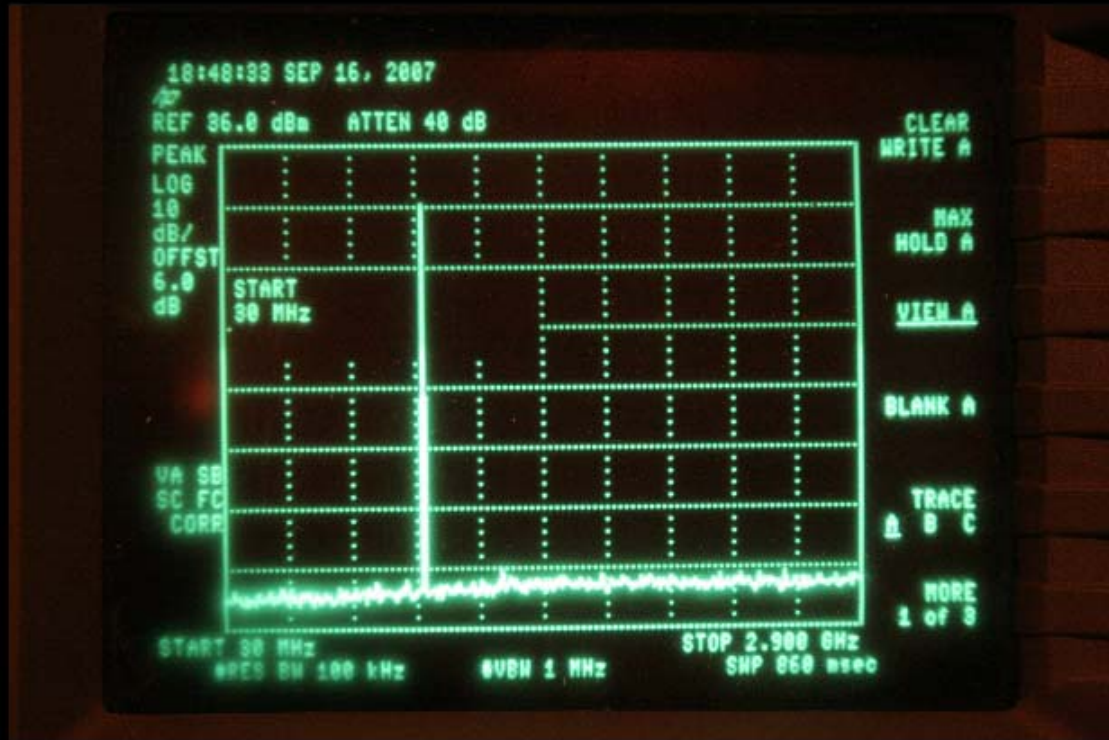
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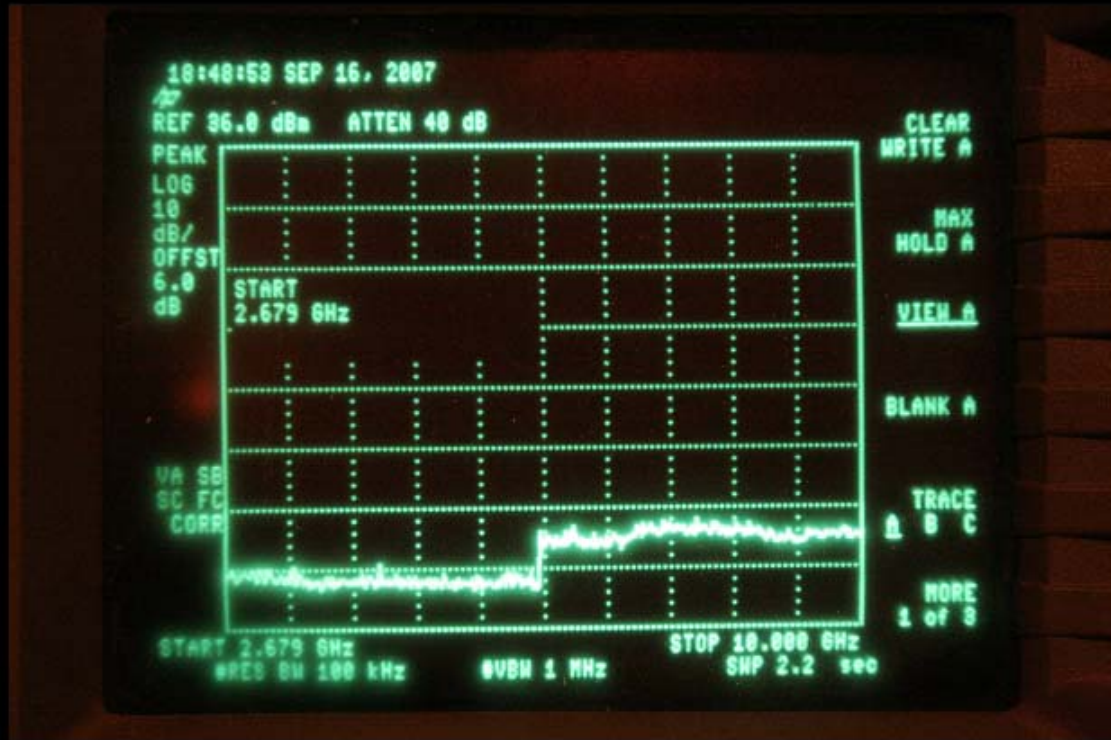
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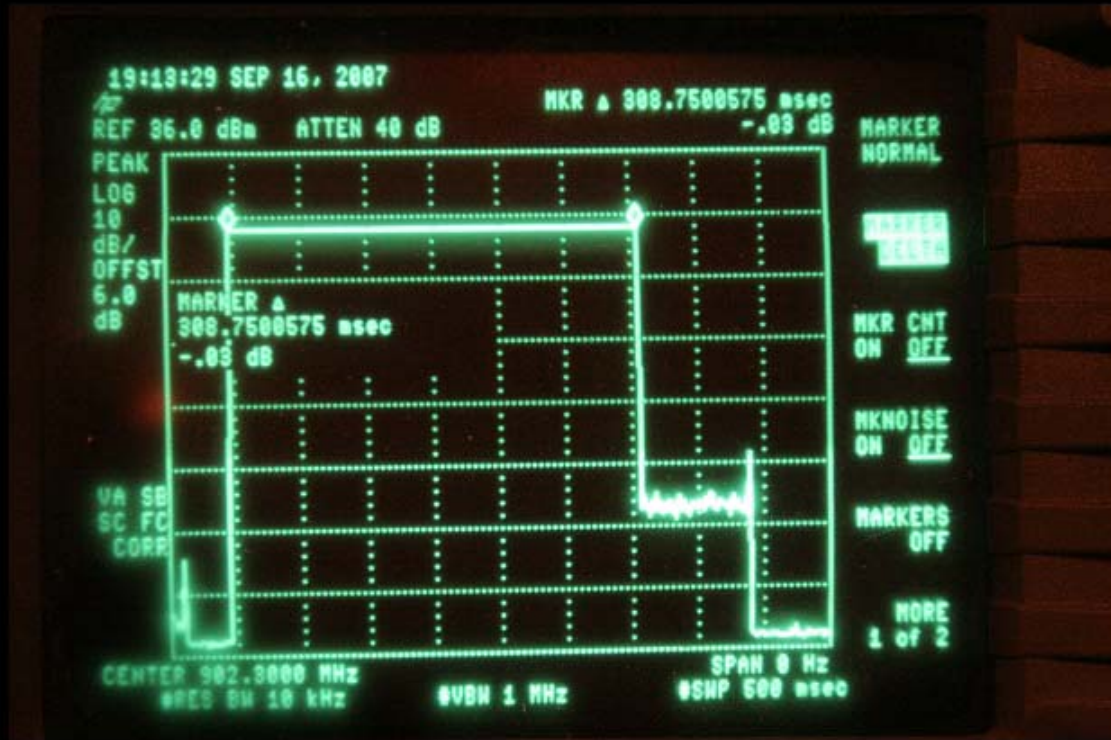
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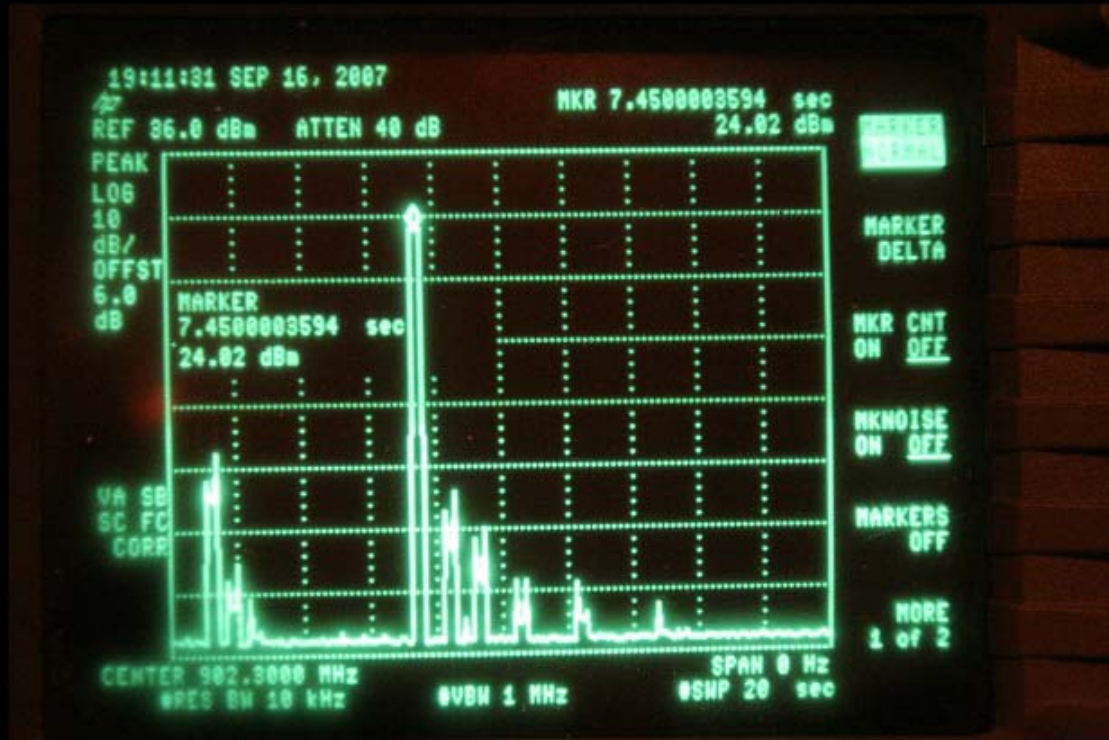
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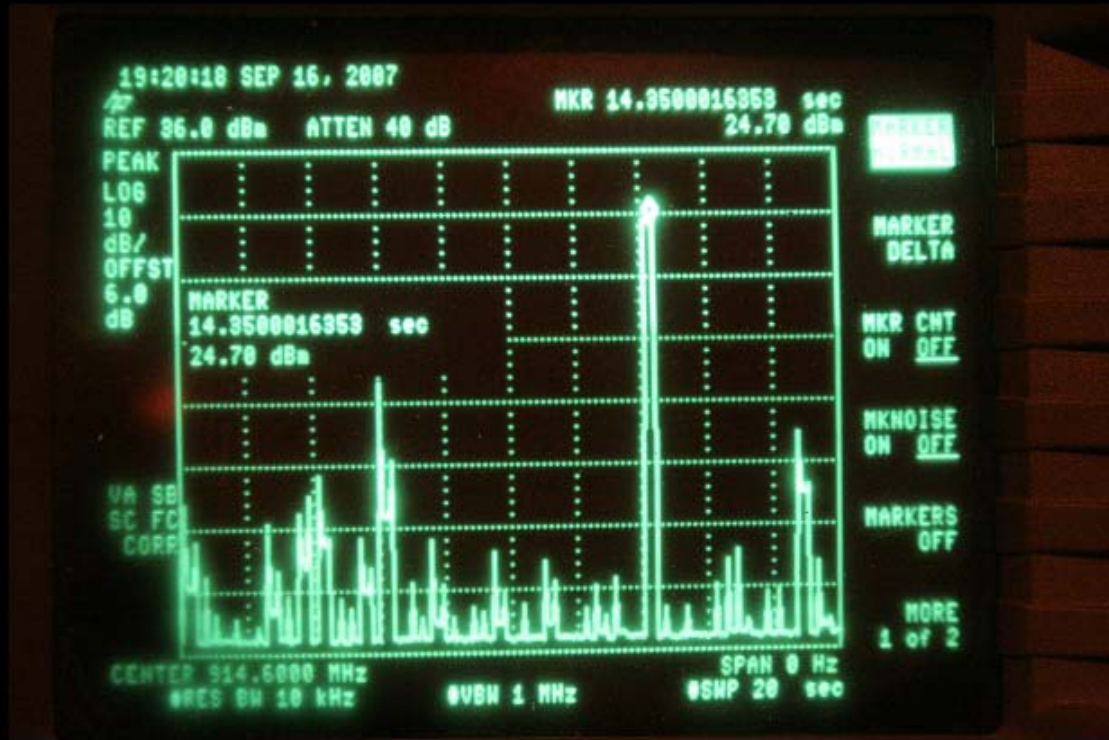
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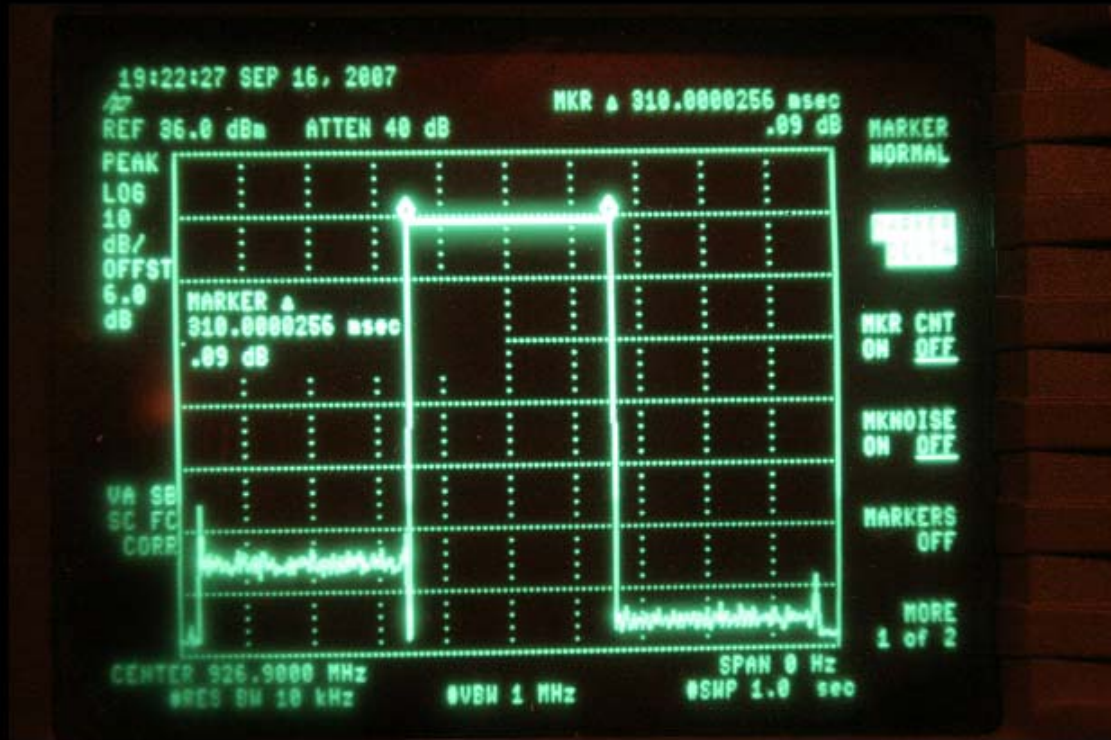
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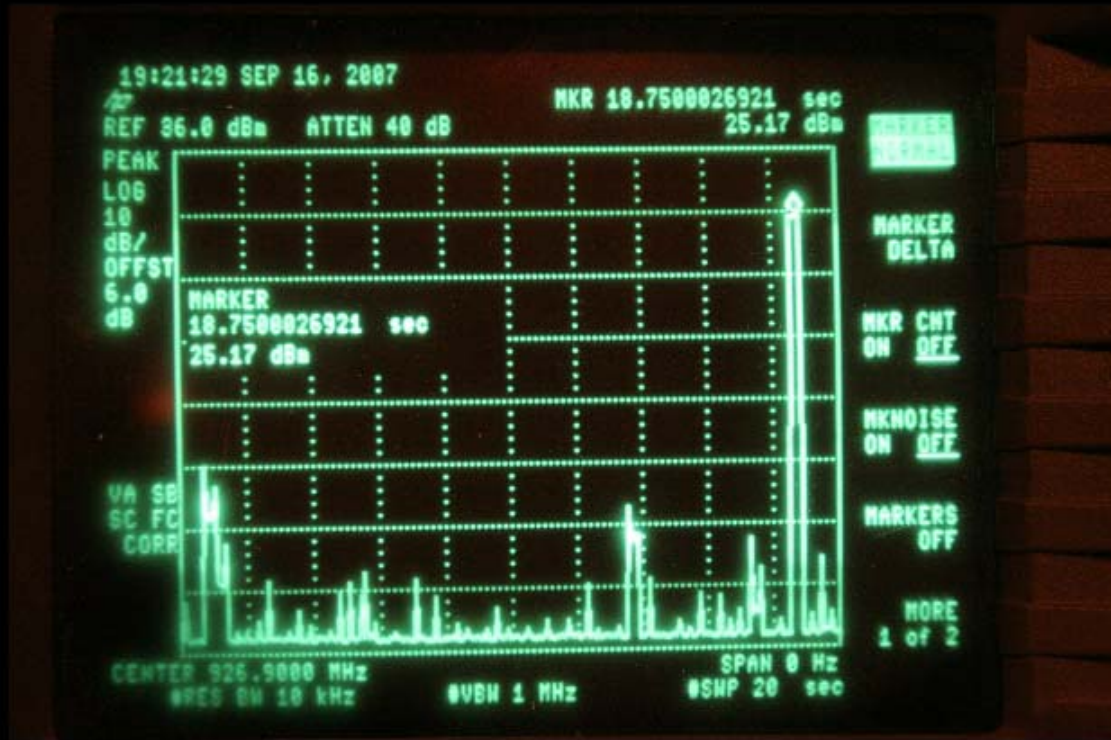
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Name: TOC_chan82_20_sec.jpg