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EMC Test Report

Company:	Research Technologies Inc. 115 Second Ave N, Suite 300 Edmonds, WA 98020
Contact:	Claire Rasmussen
Product:	Eclipse Laser Scanner
FCC ID Number:	TUR000220
Test Report No:	111105-01-01A
APPROVED BY:	Doug Kramer Senior Test Engineer
DATE:	9 January 2005
Total Pages:	30

ACCREDITED
Certificate Number 1953-01

1.0 Summary of test results

1.1 Test Results

Based on the data collected with the unit as configured.

Test	Test Specification	Results
CFR 47, FCC Part 15.203	Part 15.203	Complies
CFR 47, FCC Part 15.207	Part 15.207, Class A	Complies
CFR 47, FCC Part 15.209	Part 15.209, Class A	Complies
CFR 47, FCC Part 15.249	Part 15.249	Complies

1.2 Test Methods

1.2.1 Conducted Emissions

Measurements of conducted emissions to the limits set in CFR 47 Part 15.207 were conducted using the methods shown in ANSI/IEEE C63.4, 2001. The conducted emissions test range was from 150kHz to 30MHz. The EUT was supplied with 120VAC/60Hz from the mains supply network.

1.2.2 Radiated Emissions

Compliance to CFR 47 Parts 15.209 and 15.249 was tested in accordance with the methods of ANSI/IEEE C63.4, 2003. Several configurations were examined and the results presented represent a worst-case scenario. The EUT was placed on a wooden table approximately 80cm high and centered on a 4m diameter turntable. The table was rotated to find the angles of maximum emissions and the antenna was moved from 1m to 4m in both vertical and horizontal positions. All measurements were taken at a distance of 10m from the EUT for Part 15.109 unintentional radiator measurements, and 3m for 15.249 measurements of the fundamental frequency in the 902MHz to 928MHz band.

2.0 Description

2.1 Equipment under test

The Equipment under test (EUT) was a Research Technologies Eclipse Laser Scanner for use with a laser alignment system. The laser unit included a spinning laser and infrared sync pulse with a transceiver to communicate with target units and a control PC. The firmware was set to 915MHz transmission frequency with a BAUD rate of 115,200. There was a ferrite placed on the AC input of the unit. The ferrite was from Fair-Rite, part number 2631480002.

2.1.1 Identification: Eclipse Laser Scanner

2.1.2 EUT received date: 14 Nov. 2005

2.1.3 EUT tested dates: Nov 22, Dec 2, 4, 5, 6, of 2005

2.1.4 Manufacturer: Research Technologies, Inc.

2.1.5 Serial number: #5

2.2 Laboratory description

All testing was performed at the NCEE Lincoln facility, which is a FCC registered lab. This site has been fully described in a report submitted to your office, and accepted in a letter dated May 4, 2001. Laboratory environmental conditions varied slightly throughout the tests:

Relative humidity of 46 ± 4%
Temperature of 20 ± 3° Celsius

2.3 Special equipment or setup

The EUT was power by 120VAC/60Hz from the mains supply network. A second transmitter was used to send commands to the laser transceiver in order to produce continuous transmission for testing purposes. The laser was continuously transmitting its calibration file to another transceiver, which was placed as far from the emissions receiving antenna as possible. In normal applications, the transmitter would not be continuously active.

3.0 Test equipment used

Serial #	*Manufacturer*	*Model*	*Description*	*Last cal.*
1647	EMCO	3142B	Biconilog antenna	10-Mar-05
6416	EMCO	3115	DRG Horn	12-Oct-05
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	10-Aug-05
082001/003	Rohde & Schwarz	TS-PR18	Preamplifier	N/A
2575	Rohde & Schwarz	ES-K1	Software v1.60	N/A

4.0 Detailed Results

Radiated emissions measurements were made by first using a spectrum analyzer getting a rough signal spectrum, any points were then measured using a CISPR 16 compliant receiver with the following bandwidth setting:

30MHz - 1GHz: 120kHz IF bandwidth, 60kHz steps
1GHz - 10GHz: 1MHz IF bandwidth, 500kHz steps

4.1 FCC Part 15.203 unique connector for antenna

The antenna is inside of the EUT and is permanently attached to the EUT. Therefore the EUT complies with 47 CFR Part 15.203.

4.2 FCC Part 15.207 Conducted Emissions

The EUT was found to comply with the published limits. See figure 6 for a plot of the data, and see figures 3 and 4 for EUT setup.

4.3 FCC Part 15.109/209 Radiated Emissions

The EUT was found to comply with the published limits. The EUT was tested at 10m and 3m with the limits scaled to reflect those for Class A digital devices. The EUT was also tested at 10m, while the transmitter was not operating. See figures 5 and 8 for a plot of the data, and see figures 1 and 2 for EUT setup. Tabular Data can be found in table 1 through 4.

4.4 FCC Part 15.249 Operation within the 902-928 MHz Band

The EUT was tested while transmitting at 915MHz. This is the only possible frequency of operation as set in the EUT firmware. The EUT was found to comply with the published limits for the 902-928MHz band. All measurements were taken at a 3m distance. Below are the measurements of the fundamental frequency and the first two harmonics, which were the two harmonics with the highest emission levels. . A second transmitter was used to send commands to the laser transceiver in order to produce continuous transmission for testing purposes. Care was taken to ensure that the emissions measured were coming from the EUT not the auxiliary equipment. The laser was continuously transmitting its calibration file to another transceiver which was placed as far from the emissions receiving antenna as possible. In normal applications, the transmitter would not be continuously active. Average measurements were significantly lower than the peak measurements because the transmit time of the calibration file is less than the average measurement time. See figure 7 and 8 for a plot of the data, and see figures 1 and 2 for EUT setup. Tabular Data can be found in tables 2 through 4. A plot of the EUT not transmitting, but ready to receive commands can be seen in figure 5, and the tabular data can be seen in table 1.

Frequency	Level	Limit	Margin	Height	Angle	Pol.	Detector
MHz	dBµV/m	dBµV/m	dB	cm	deg		
915.240000	91.51	93.00	1.49	103.0	61	VERT	Quasi-Peak
1830.500000	26.26	53.9	27.6	100.0	34	VERT	Average
1830.500000	63.15	73.9	10.75	100.0	34	VERT	Peak
2743.500000	25.44	53.9	28.5	99.0	111	VERT	Average
2743.500000	52.67	73.9	21.2	99.0	111	VERT	Peak

Appendix A: Test Photos

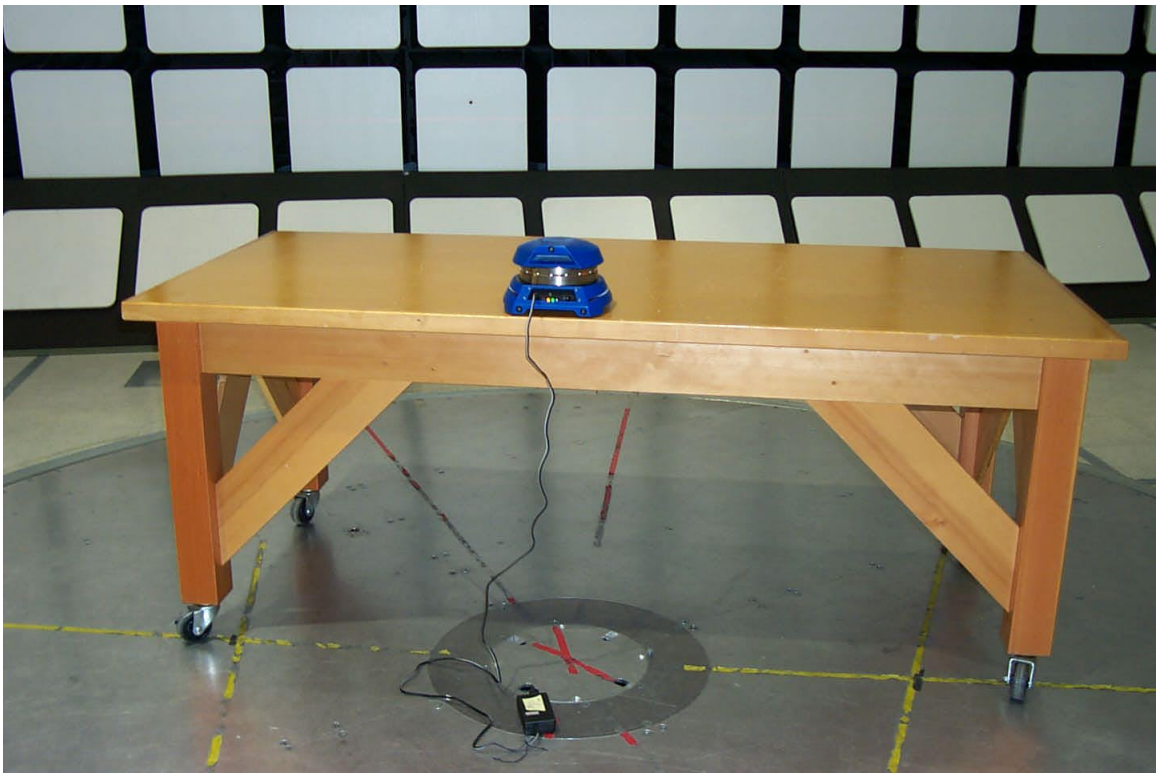

Figure 1 - Radiated Emissions Test Setup

Figure 2 - Radiated Emissions Test Setup

Figure 3 - Conducted Emissions Test Setup

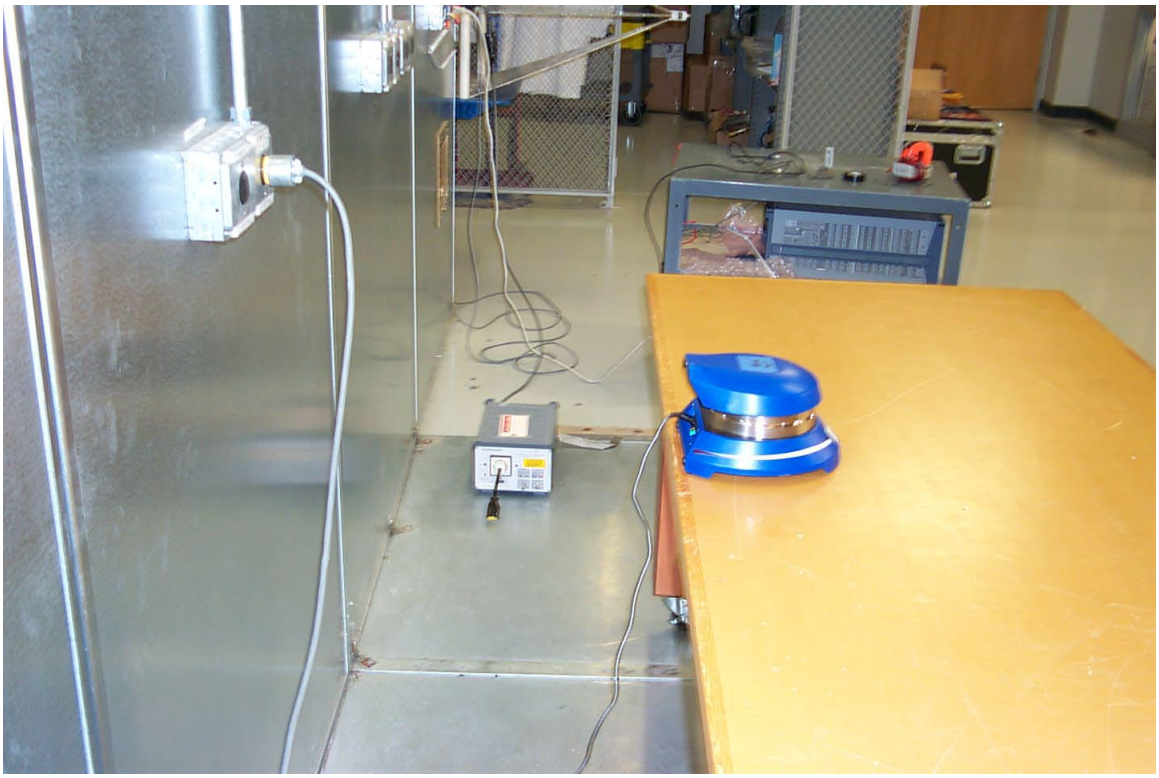

Figure 4 - Conducted Emissions Test Setup

Appendix B: Emissions Plots

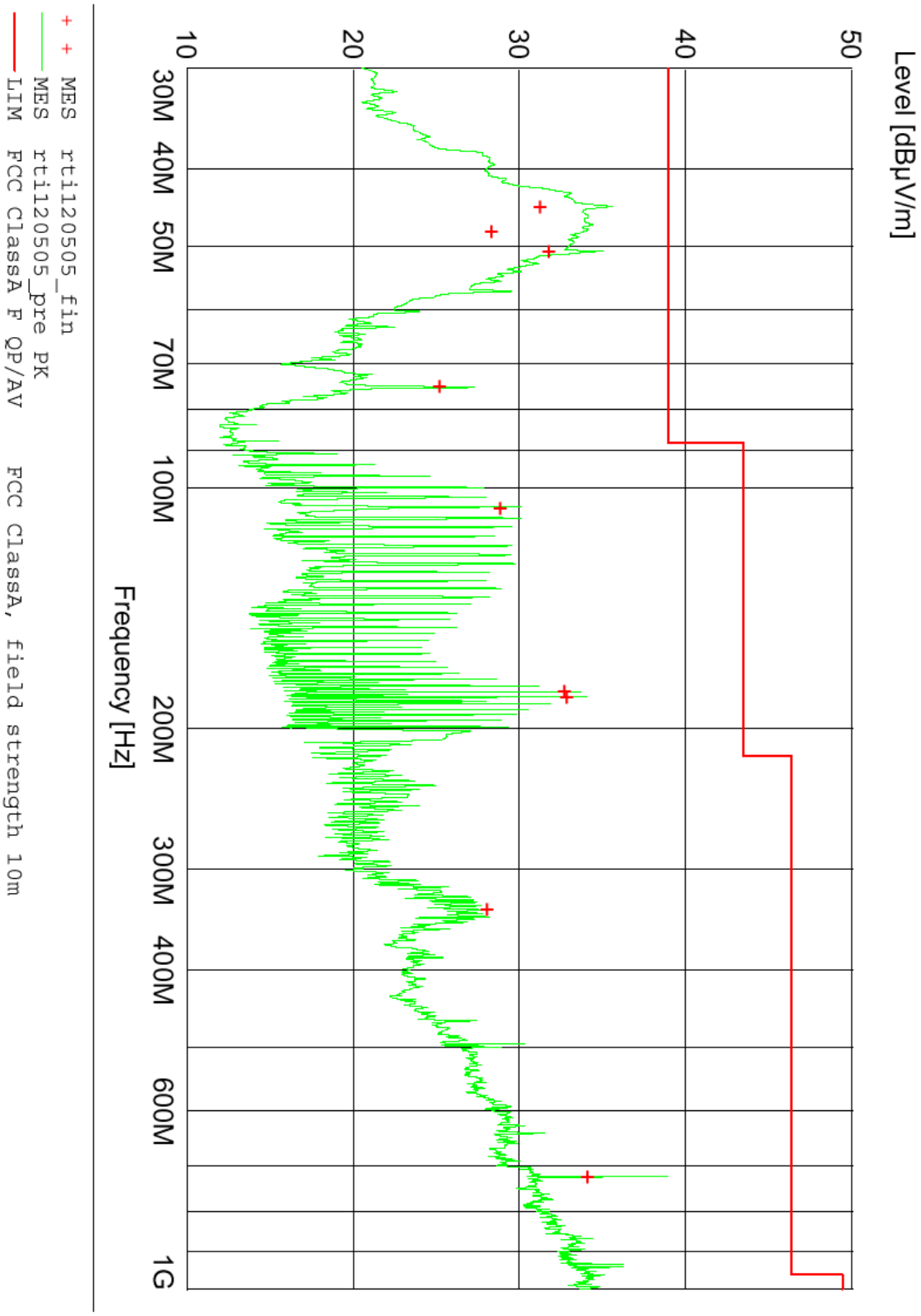

Figure 5 - Radiated Emission Plot, EUT not transmitting, 10m distance, Class A Limits

Table 1 – Radiated Emissions Quasi-Peak Data, EUT not transmitting

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
44.580000	31.26	39.0	7.7	104.0	230	VERT
47.880000	28.33	39.0	10.7	99.0	258	VERT
50.700000	31.81	39.0	7.2	135.0	140	VERT
75.000000	25.25	39.0	13.8	349.0	263	VERT
106.020000	28.88	43.5	14.6	101.0	92	VERT
179.760000	32.69	43.5	10.8	99.0	122	VERT
182.820000	32.87	43.5	10.6	100.0	110	VERT
336.480000	28.07	46.4	18.3	288.0	71	HORI
723.240000	34.08	46.4	12.3	298.0	315	HORI

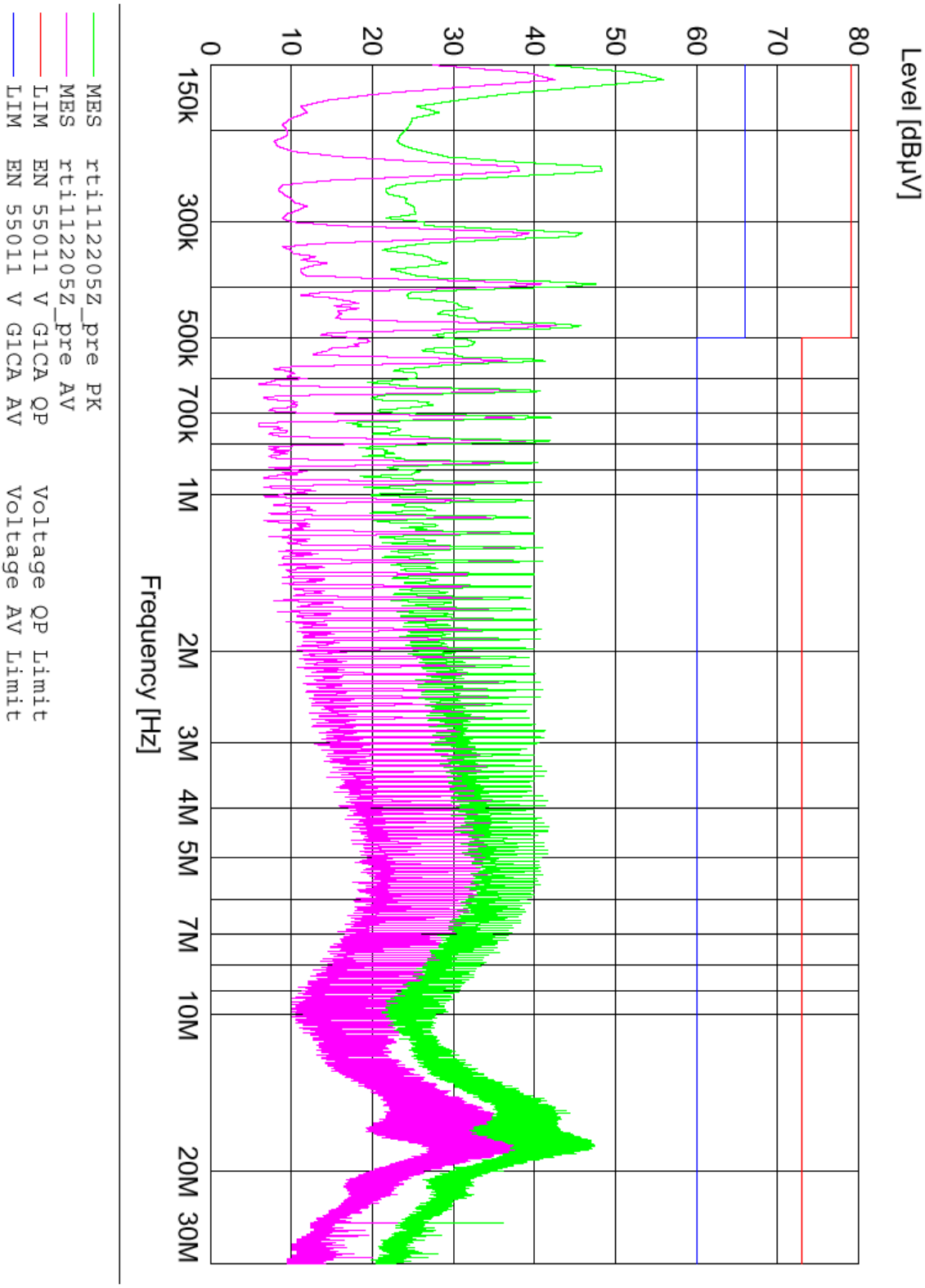

Figure 6 - Conducted Emissions Plot, EUT not transmitting

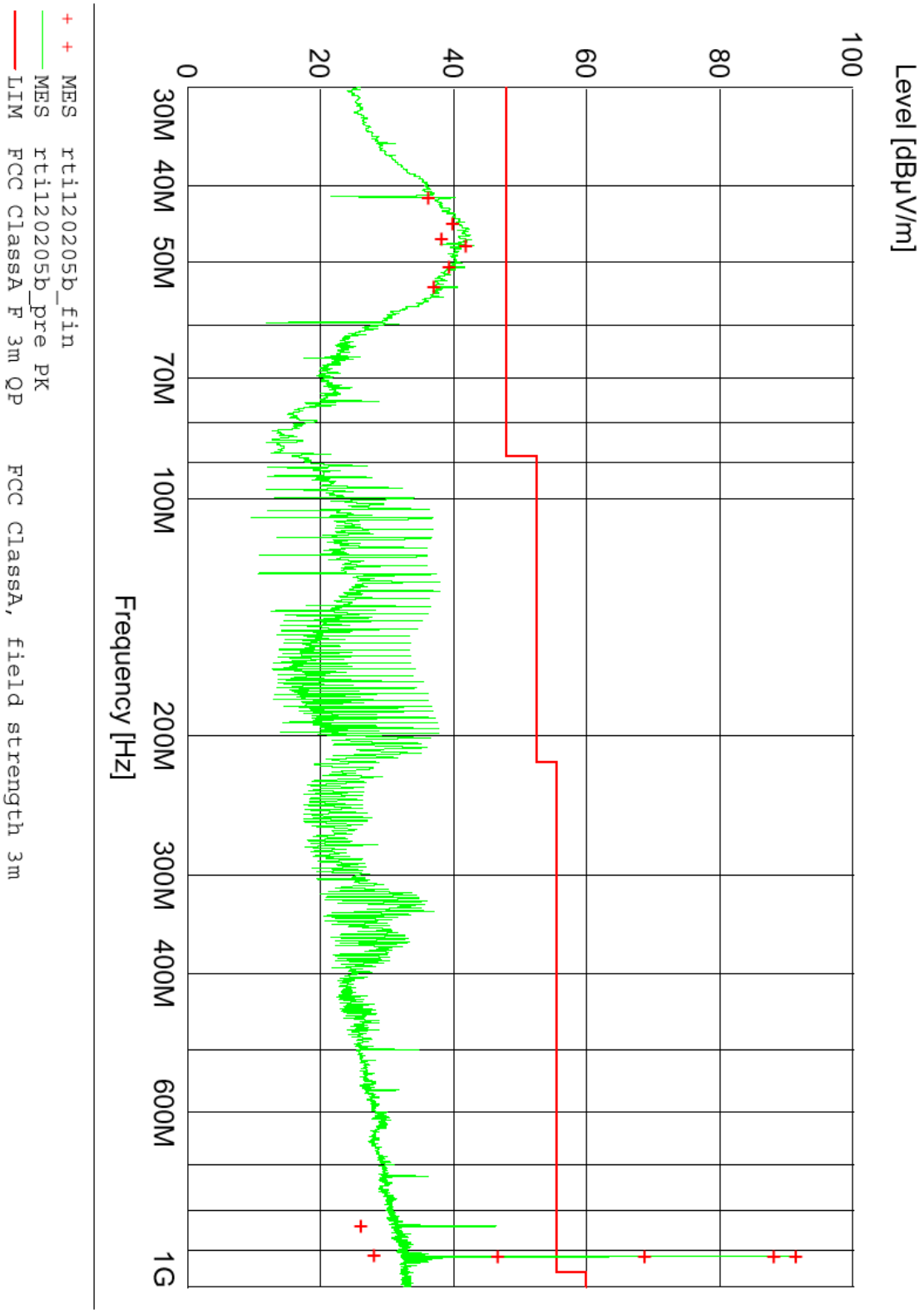

Figure 7 - Radiated Emission Plot, EUT transmitting, 3m distance, Class A Limits scaled for 3m measurement distance

Table 2 – Radiated Emissions Quasi-Peak Data, EUT transmitting at 915MHz

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
41.460000	36.28	48.0	11.7	99.0	127	VERT
44.580000	39.90	48.0	8.1	98.0	280	VERT
46.620000	38.19	48.0	9.8	100.0	90	VERT
47.640000	41.82	48.0	7.8	101.0	264	VERT
50.700000	39.34	48.0	8.7	102.0	119	VERT
53.760000	37.01	48.0	11.0	99.0	240	VERT
838.200000	26.14	55.4	29.3	98.0	111	HORI
838.620000	26.10	55.4	29.3	135.0	67	HORI
912.240000	27.99	93.0	65.0	99.0	297	HORI
914.580000	68.79	93.0	24.2	250.0	94	VERT
914.760000	88.22	93.0	4.8	198.0	0	VERT
915.240000	91.51	93.0	1.5	103.0	61	VERT
915.780000	46.78	93.0	46.2	217.0	243	VERT

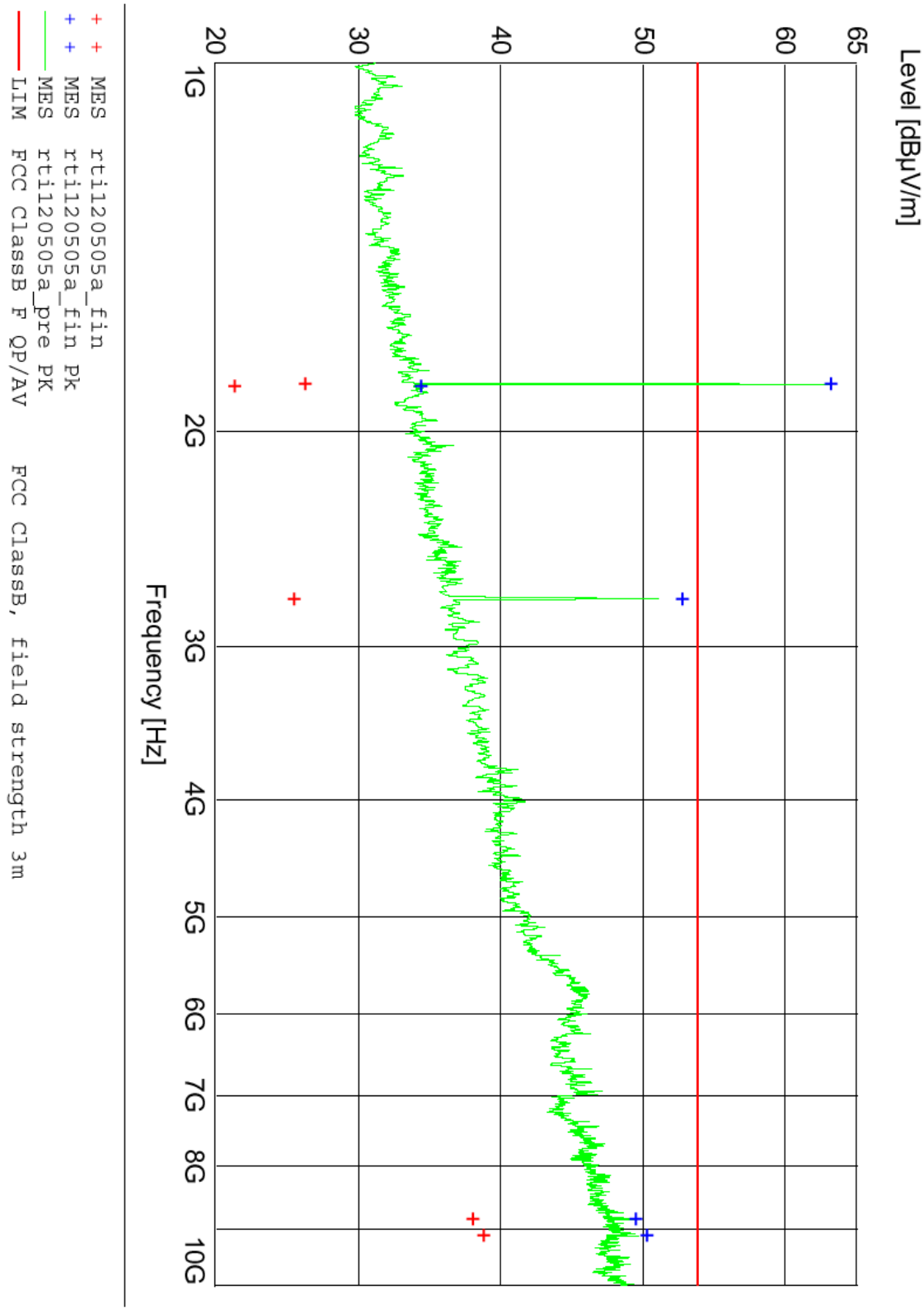

Figure 8 - Radiated Emissions Plot, 1-10GHz

Table 3 – Radiated Emissions Average Data

Above 1 GHz, EUT transmitting at 915MHz

Frequency	Level	Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1830.500000	26.26	53.9	27.6	100.0	34	VERT
1835.500000	21.26	53.9	32.6	100.0	164	VERT
2743.500000	25.44	53.9	28.5	99.0	111	VERT
8834.000000	38.01	53.9	15.9	300.0	211	VERT
9087.000000	38.80	53.9	15.1	294.0	359	VERT

Table 4 – Radiated Emissions Peak Data

Above 1 GHz, EUT transmitting at 915MHz

Frequency	Level	*Limit	Margin	Height	Angle	Pol.
MHz	dBµV/m	dBµV/m	dB	cm	deg	
1830.500000	63.15	53.9	-9.3	100.0	34	VERT
1835.500000	34.38	53.9	19.5	100.0	164	VERT
2743.500000	52.67	53.9	1.2	99.0	111	VERT
8834.000000	49.42	53.9	4.5	300.0	211	VERT
9087.000000	50.21	53.9	3.7	294.0	359	VERT

*Limit Shown is Average limit

Appendix C: Bandwidth Data

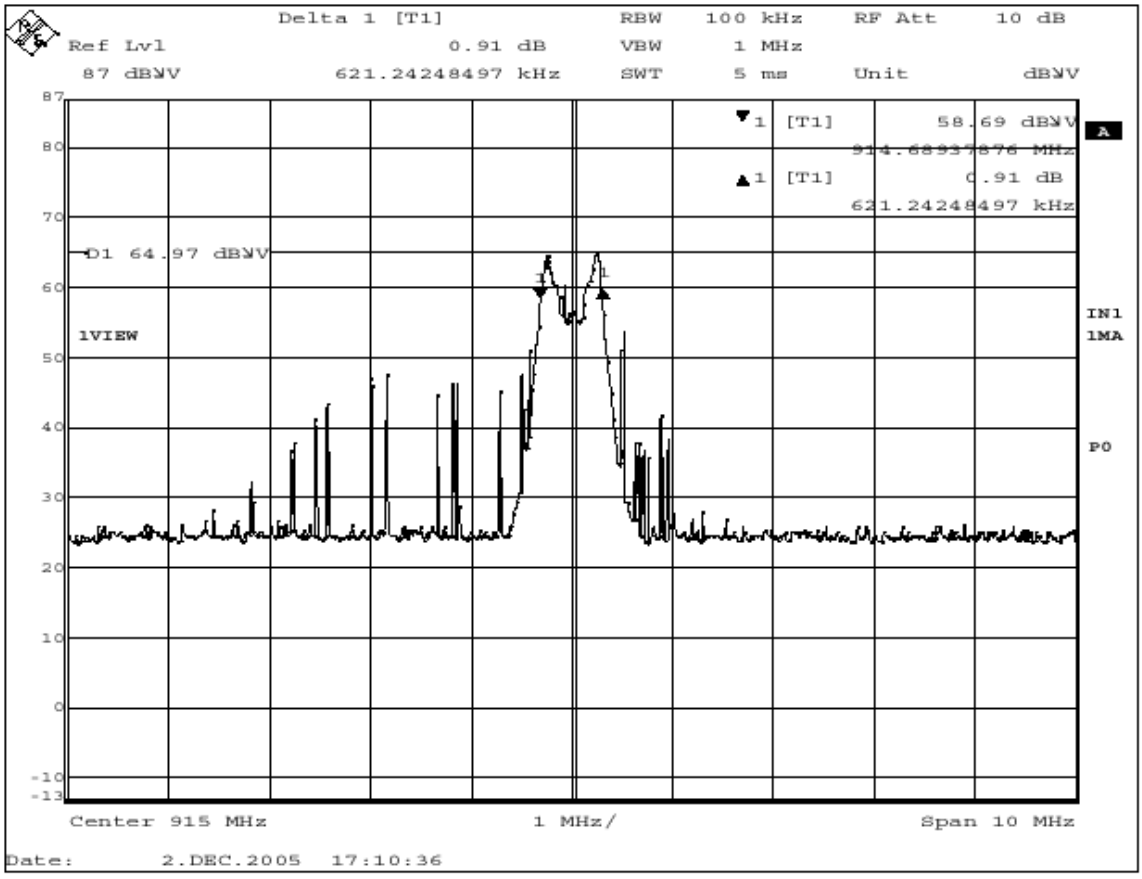

Figure 9 - 6dB Bandwidth at 915MHz, 621.24kHz

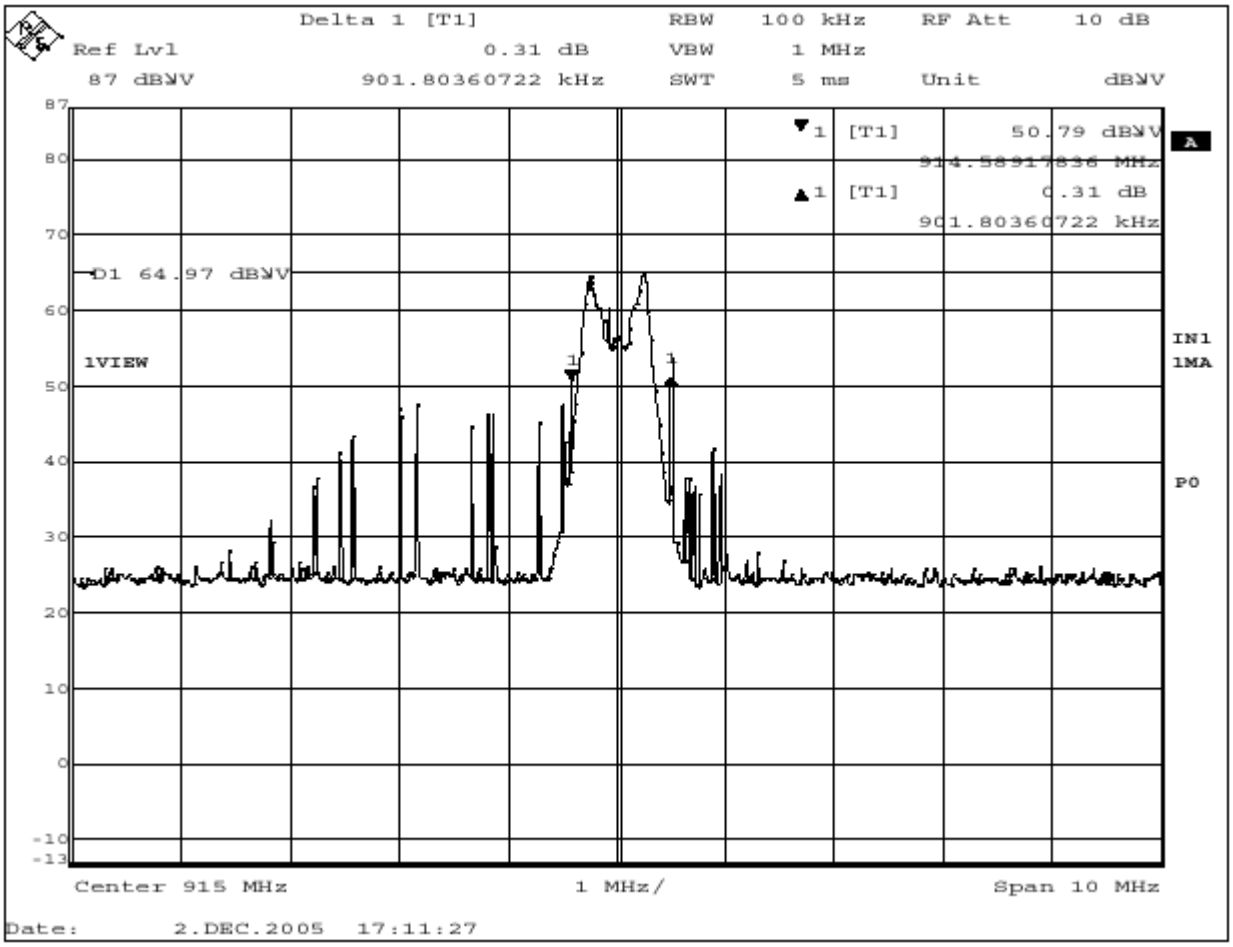

Figure 10 -20dB Bandwidth at 915MHz, 901.80kHz

Appendix D: Sample Calculation

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 reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBµV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBµV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBµV/m

The 48.1 dBµV/m value can be mathematically converted to its corresponding level in µV/m.

Level in µV/m = Common Antilogarithm [(48.1 dBµV/m)/20]= 254.1 µV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

Is this case, T_{on} is less than 50mSec for a 100mSec window. An average correction factor of 6dB was applied where noted.

Appendix E: EUT Photos

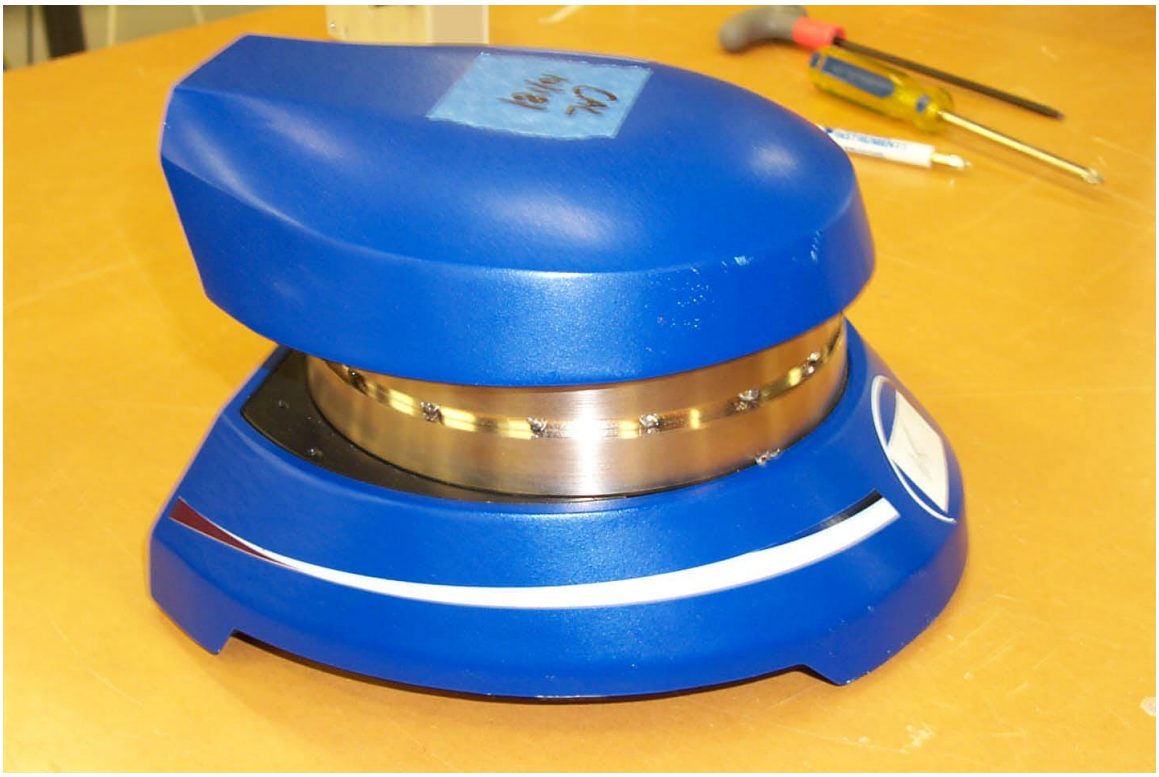

Figure 11 - EUT external view

Figure 12 - EUT external view

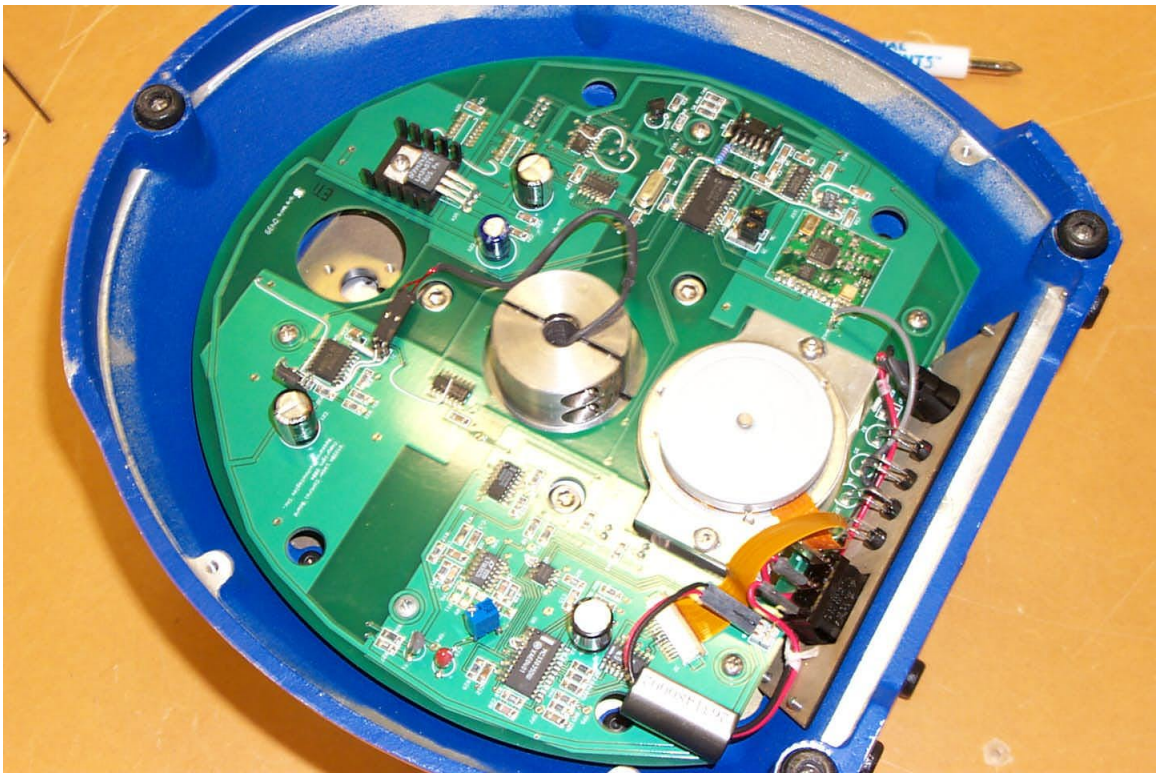

Figure 13- EUT, internal view

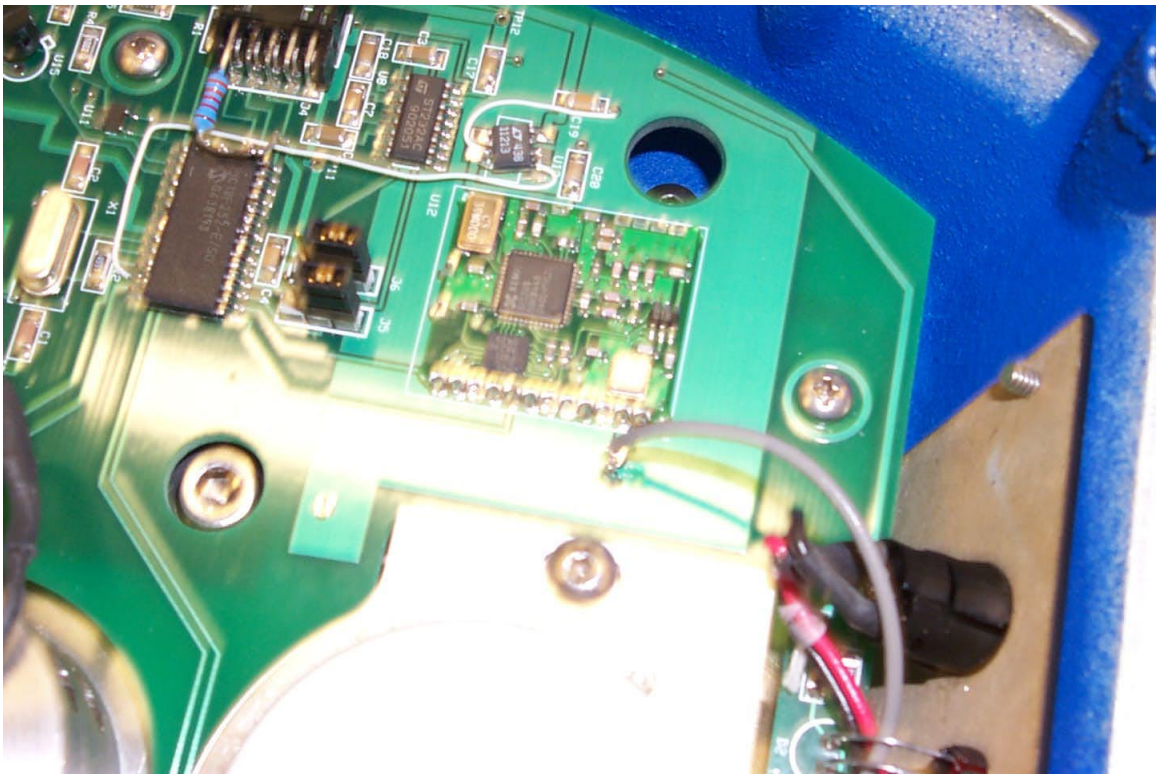

Figure 14 - EUT, internal view, wireless transceiver board

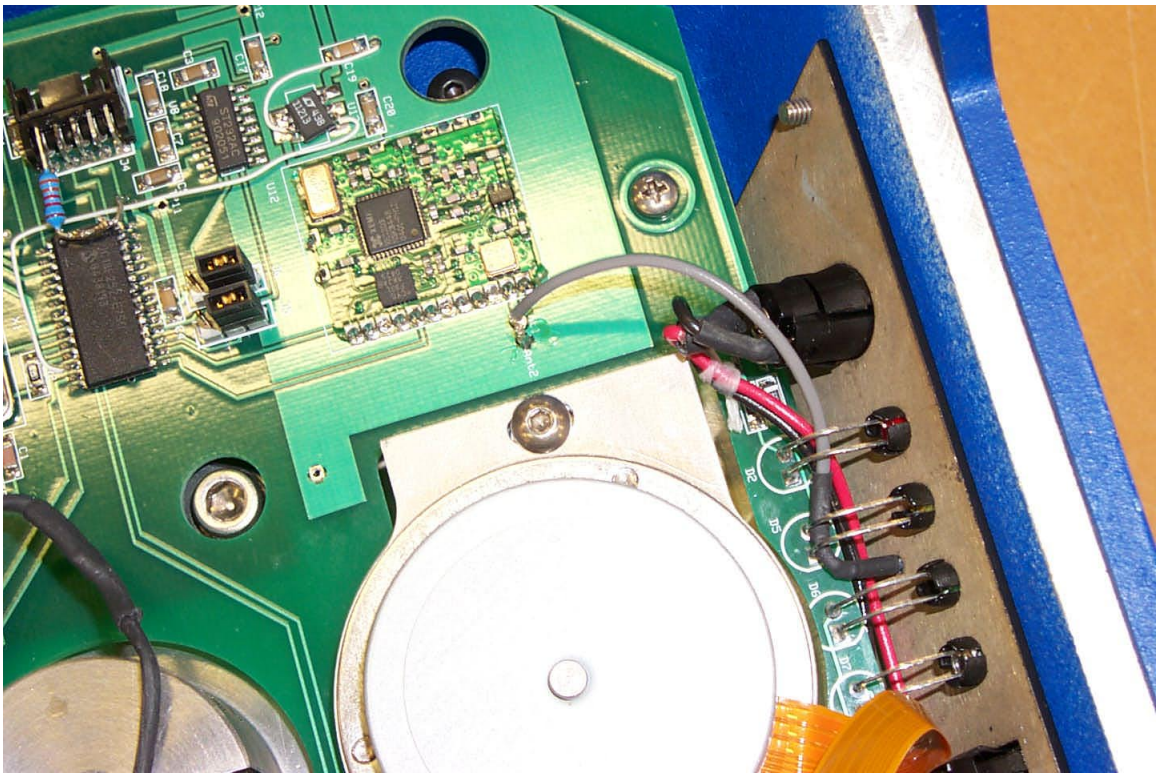

Figure 15 - EUT, internal view, wireless transceiver board

Appendix F: RF Block Diagram

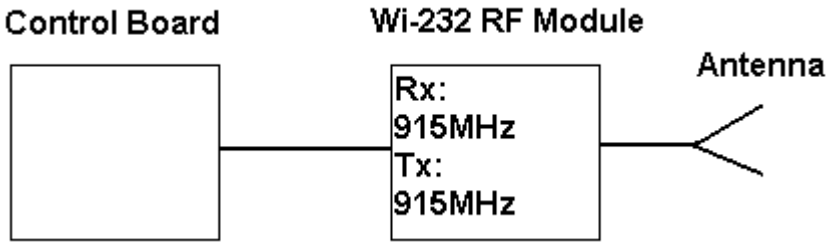

Figure 16 - RF Block Diagram

Appendix G: List of Figures

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