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FCC PART 90 EMI MEASUREMENT AND TEST REPORT

Company: Union Pacific Corp.
1400 Douglas St.
Omaha, NE 68179

Contact: Jeff Massman

Product: Union Pacific MCA8030 Booster Amp
FCC ID: TPBMCA8030

Test Report No: R101306-01C

APPROVED BY: Nic Johnson
Test Engineer

A handwritten signature in black ink, appearing to read "Nic Johnson", written over a horizontal line.

DATE: 15 September 2008

Total Pages: 29

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1.0 Summary of test results

The equipment under test (EUT) was tested for compliance to FCC Part 90 and Part 2. Below is a summary of the test results. Complete results can be found in Section 3.

Rule	Description	Result
§ 2.1046 § 90.205	RF Output Power	Compliant
§ 2.1049 § 90.209 § 90.210	Occupied Bandwidth	Compliant
§ 2.1051 § 90.210	Spurious Emissions at Antenna Terminals	Compliant
§ 2.1053 § 90.210	Radiated Spurious Emission	Compliant
§ 90.210	Two-Tone Test	N/A
§ 1.1310 § 2.1091	RF Exposure	Compliant
TIA-603-C 2.2.16	Intermodulation Attenuation	Compliant

1.1 Reason for amendment**Amendment B:**

Table 2 on page 7 was updated to present data on the transmitting antenna and cable correction factors used in the substitution method. More data was taken using previous measurements taken during using a spectrum analyzer and receiving antenna only. The measurements were then matching using a substitution antenna and signal generator and then recorded. The equipment list on page 10 has been modified to show equipment used for testing done on a later date.

Amendment C:

Corrected margin calculations were made to replace previous. Second data table was deleted because of redundancy. Harmonics data was added to the uplink section of the table.

2.0 EUT Description

The Equipment Under Test (EUT) was a Union Pacific MCA8030 Booster Amplifier. The MCA8030 is a 40% duty amplifier operating in the 896-938 MHz frequency band with 30W of output power and is intended for boosting the output power from a mobile transceiver.

2.1 Equipment under test

- 2.1.1 Identification: Union Pacific MCA8030 Booster Amp
- 2.1.2 EUT received date: 13 Apr 07
- 2.1.3 EUT tested dates: 13, 16 and 17 April 2007 and 7 May 2007
*12 September 2008 (see section 1.1 for details)
- 2.1.4 Manufacturer: Union Pacific Corp.
- 2.1.5 Serial number: NCEE Test 1 (assigned)

2.2 Testing location

All testing was performed at the NCEE Labs Lincoln, NE facility, which is an A2LA accredited EMC test laboratory and is registered with the FCC.

2.3 EUT Setup

The EUT was powered by an Astron RS-35A power supply (S/N: 200100162). The RF In was connected to the Nexterna G02078-001 radio (S/N: SGF010). The Nexterna Radio was controlled with an external laptop and set to run with maximum transmission.

2.4 Objective

This type of report is prepared on behalf of Union Pacific Corporation in accordance with Part 2 and Part 90 of the Federal Communication Commissions rules. The objective of the manufacturer is to determine compliance with FCC rules for output power, occupied bandwidth, spurious emission at antenna terminal, radiated spurious emission, two-tone test and RF exposure.

3.0 Test Results

3.1 RF Output Power

Test: FCC §2.1046 and §90.205

Test Result: *Complies*

Date: 16 Apr 07

Test Description

Per FCC §2.1046 and §90.205 The Maximum ERP is dependent upon the station's antenna HAAT and required service area. The maximum output power of the transmitter for mobile station is 100 watts (20dBW).

Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $40 \pm 5\%$

Temperature of $20 \pm 2^\circ$ Celsius

Test Setup

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuators. The spectrum analyzer was used to make power measurements using bandwidth filter large enough to capture the entire bandwidth of the signal. The test setup can be seen in Figures 2 through 4 in appendix A.

Test Equipment Used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last Cal.</i>
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	8/15/06
N/A	JFW	50FH-006-300	6dB Attenuator	CNR
9949	BIRD	25-A-MFN-30	30B Attenuator	CNR

Test Results

The power measurements were found to comply with FCC §2.1046 and §90.205. The recorded data can be seen in Table 1 in Appendix B.

3.2 Occupied Bandwidth

Test: FCC §2.1049, §90.209, §90.210

Test Result: *Complies*

Date: 13 Apr & 7 May 2007

Test Description

For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:

- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 5 kHz, but no more than 10 kHz: at least $83 \log(f_d/5)$ dB.
- On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 10 kHz, but no more than 250 percent of the authorized bandwidth: at least $116 \log(f_d/6.1)$, or $50 + 10 \log(P)$ dB, or 70 dB, whichever is the lesser attenuation.
- On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: at least $43 + 10 \log(P)$ dB.

Test Setup

The RF output of the transmitter was connected to the input of the receiver in spectrum analyzer mode through sufficient attenuation. The resolution bandwidth was set at 1 kHz and the spectrum was recorded in the frequency band ± 50 kHz from the carrier frequency. Figures 2 through 4 in appendix A show the test setup.

Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $40 \pm 5\%$

Temperature of $20 \pm 2^\circ$ Celsius

Test Equipment Used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last Cal.</i>
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	8/15/06
N/A	JFW	50FH-006-300	6dB Attenuator	CNR
9949	BIRD	25-A-MFN-30	30B Attenuator	CNR

Test Results

The occupied bandwidth was found to comply with FCC §2.1049, §90.209, §90.210. Figures 5 through 11 in appendix C shows the plots recorded from this test.

3.3 Spurious Emissions at Antenna Terminals

Test: FCC §2.1051 and §90.210

Result: *Complies*

Date: 13 Apr 07

Test Description

On any frequency removed from the center of the assigned channel by more than 250 percent at least: $43 + 10 \log (P)$ dB

Test Environment

Testing was performed at the NCEE Labs Lincoln facility. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $40 \pm 5\%$

Temperature of $20 \pm 2^\circ$ Celsius

Test Setup

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to the 10th harmonic. The test setup can be seen in Figures 2 through 4 of appendix A.

Test Equipment Used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last Cal.</i>
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	8/15/06
N/A	JFW	50FH-006-300	6dB Attenuator	CNR
9949	BIRD	25-A-MFN-30	30B Attenuator	CNR

Test Results

The spurious emissions at the antenna terminals were found to comply with FCC §2.1051 and §90.210. Figures 12 through 17 in appendix D show the plots recorded from this test.

3.4 Radiated Spurious Emission

Test: FCC §2.1053 and §90.210

Result: *Complies*

Date: 13 Apr 07
12 Sept 08*

Test Description

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis. The frequency range up to tenth harmonic of the fundamental frequency was investigated.

The EUT was then removed and the replaced with a substitution antenna of the same model as the receiving antenna.. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution. Spurious emissions in dB = 10 log (TXpwr in Watts/0.001) which is the absolute level.

*Note: These measurements were made on 12 Sept 2008 in order to verify previous results.

Test Environment

Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $40 \pm 5\%$

Temperature of $20 \pm 2^\circ$ Celsius

Test Setup

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable. The test setup can be seen in Figure 1 of appendix A.

Test Results

The radiated spurious emissions were found to comply with FCC §2.1053 and §90.210. Table 2 of appendix E shows a table of these results. Pre-scan level measurements were taken on 13 April 2007, all receiver output power measurements were taken on 12 Sept 2008.

Test Equipment Used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last Cal</i>
100477	Rohde & Schwarz	SML03	Signal Generator 3.3GH	11/7/06
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	8/15/06 ¹
100007	Rohde & Schwarz	ESIB7	EMI Test Receiver	6/9/08 ²
1647	EMCO	3141B	Bicon Antenna	2/8/08 ³
1654	EMCO	3141B	Bicon Antenna	2/8/08
6415	EMCO	3115	DRG Horn	2/5/08 ⁴
6416	EMCO	3115	DRG Horn	2/5/08
300416	Amplifier Research	150W1000MS	Amplifier	N/A
405	Rohde & Schwarz	EMS0K1	Software v.1.20	N/A
837333/057	Rohde & Schwarz	NRVD	Dual Channel Power Me	10/26/06

Notes:

1. Used for preview measurements on 13 April 2008
2. Used for substation measurements on 12 September 2008
3. Calibrated on 1/29/07 for measurements made on 13 April 2008
4. Calibrated on 1/31/07 for measurements made on 13 April 2008

3.5 Intermodulation Attenuation

Test: TIA-603-C, Section 2.2.16

Result: *Complies*

Date: 13 June 08

Test Description

Intermodulation attenuation is the ratio in dB of the power level of a third order intermodulation product to the carrier power level. The test frequencies 896MHz and 936MHz were chosen to represent each of the EUT operating ranges. Interfering signals were set to 895.9MHz and 935.9MHz respectively, to be off from the carrier by 100kHz.

Test Environment

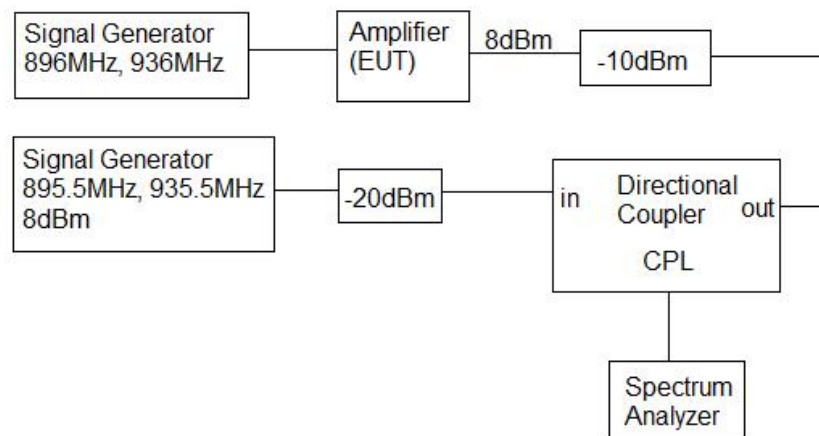
Testing was performed at the NCEE Labs Lincoln facility in the 10m semi-anechoic chamber. Laboratory environmental conditions varied slightly throughout the test:

Relative humidity of $40 \pm 5\%$

Temperature of $20 \pm 2^\circ$ Celsius

Test Setup

The test setup was derived from section 2.2.16.2 in TIA-603-C. The reverse power terminal of the directional coupler was internal terminated by a 50ohm load.



The third order intermodulation products are represented by the following equations:

$$2A - B = 896.1\text{MHz}, 936.1\text{MHz}$$

$$A + 2B = 2687.8\text{MHz}, 2807.8\text{MHz}$$

$$2B - A = 895.8\text{MHz}, 935.8\text{MHz}$$

with A being the carrier signal and B being the interfering signal.

The three frequencies above were measured for each of the two carrier frequencies. The results can be found below in Test Results.

Test Equipment Used

<i>Serial #</i>	<i>Manufacturer</i>	<i>Model</i>	<i>Description</i>	<i>Last Cal</i>
100477	Rohde & Schwarz	SML03	Signal Generator 3.3GH	11/7/06
834674/013	Rohde & Schwarz	SMR20	Signal Generator 20GHz	8/16/06
100037	Rohde & Schwarz	ESIB26	EMI Test Receiver	8/15/06
15542	Mini-circuits	ZFDC-15-5	Directional coupler	N/A

Test Results

Carrier Frequency (MHZ)	Intermodulation Product (MHZ)	Intermodulation Attenuation (dB)
896	896.1	32.5
896	2687.8	29.8
896	895.8	35.6
936	936.1	36.9
936	2807.8	28.1
936	935.8	33.3

Appendix A: Test Photos



Figure 1 – Radiated Spurious Emissions Test Setup

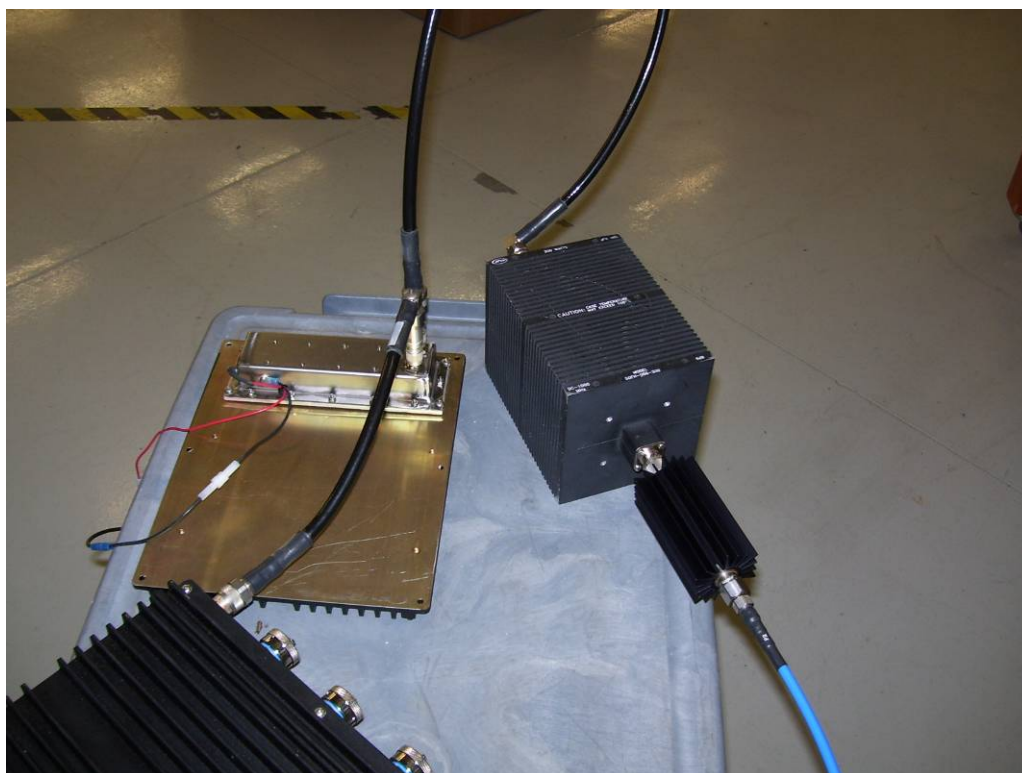


Figure 2 - Power, Bandwidth, Spurious Emissions at Antenna Port

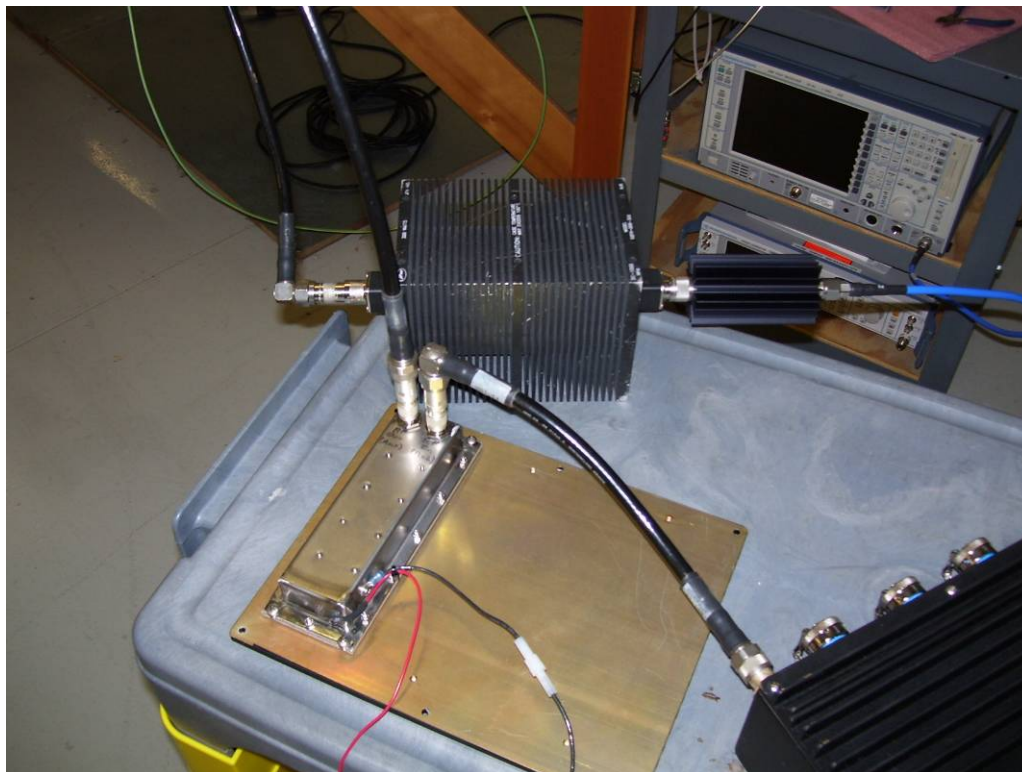


Figure 3 - Power, Bandwidth, Spurious Emissions at Antenna Port

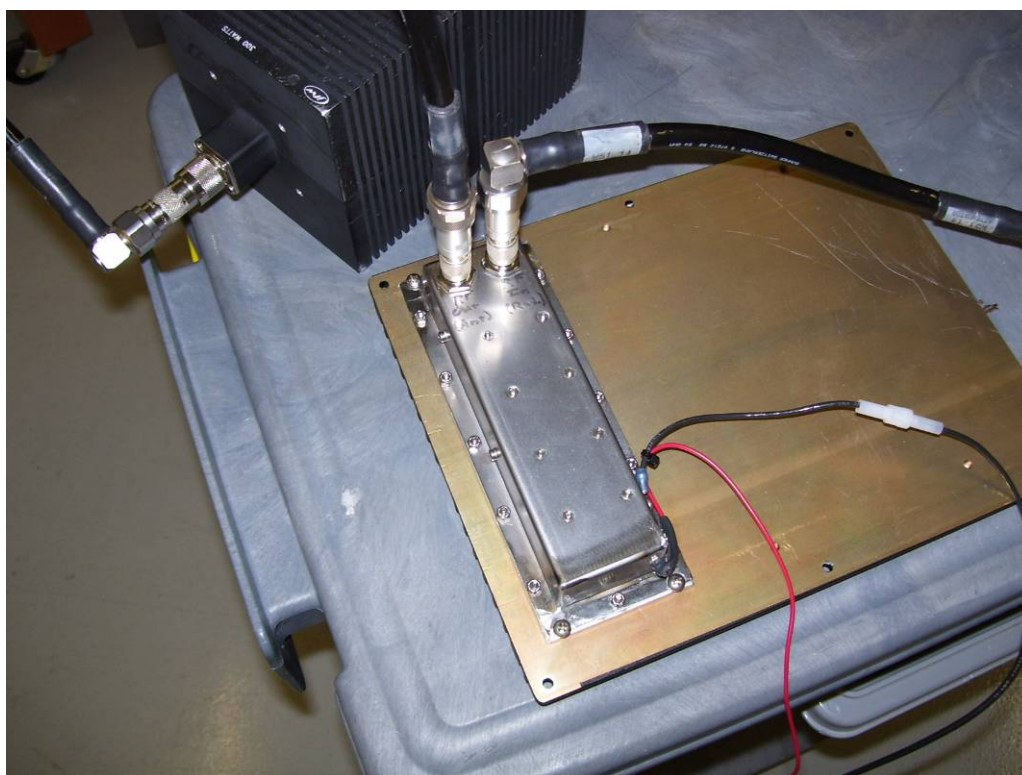


Figure 4 - Power, Bandwidth, Spurious Emissions at Antenna Port

Appendix B: Output Power Results

Table 1

Output Power Results FCC §2.1046 and §90.205

Frequency	Correction Factor	Power Uncorrected	Power Corrected
MHz	dB	dBm	watts
896.8875	37.0	7.89	30.8318795
896.9375	37.0	7.89	30.8318795
896.9875	37.0	7.89	30.8318795
897.8875	37.0	8.02	31.76874071
897.9375	37.0	8.02	31.76874071
897.9875	37.0	8.02	31.76874071
935.8875	37.3	7.6	28.57590543
935.9375	37.3	7.26	28.57590543
935.9875	37.3	7.26	28.57590543
936.8875	37.3	7.26	28.57590543
936.9375	37.3	7.26	28.57590543
936.9875	37.3	7.26	28.57590543

Correction Factor = Attenuator loss + cable loss**Power Uncorrected = Reading on spectrum analyzer****Power Corrected = Power Uncorrected + Correction Factor**

The Test setup included one 30dB attenuator and one 6dB attenuator. See the description in section 3.1 for details.

Appendix C: Occupied Bandwidth Plots

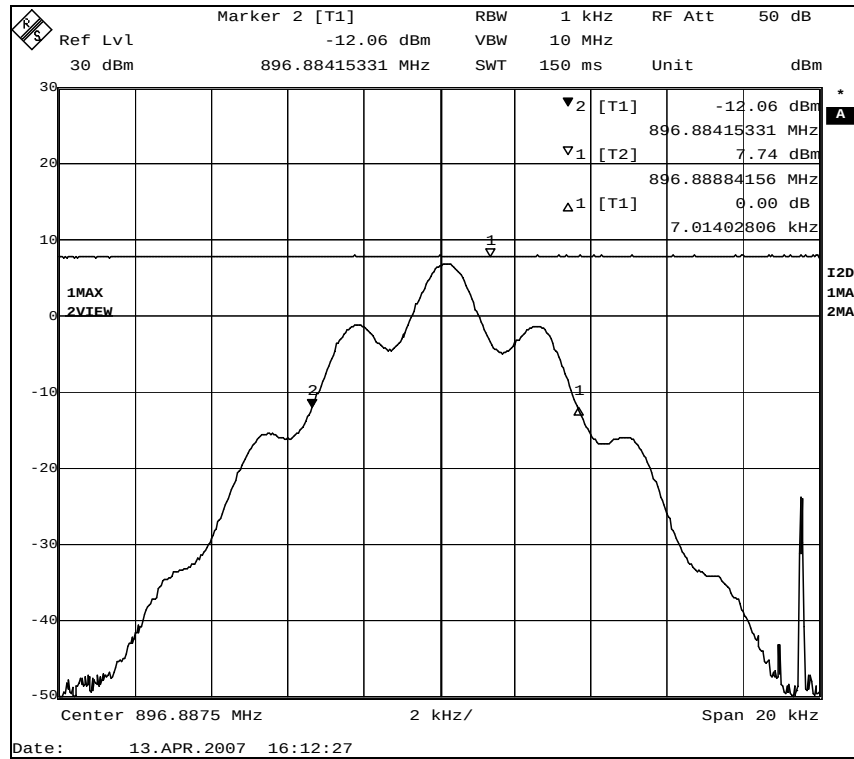


Figure 5 - Occupied Bandwidth Center 896.887MHz, 7.014 kHz

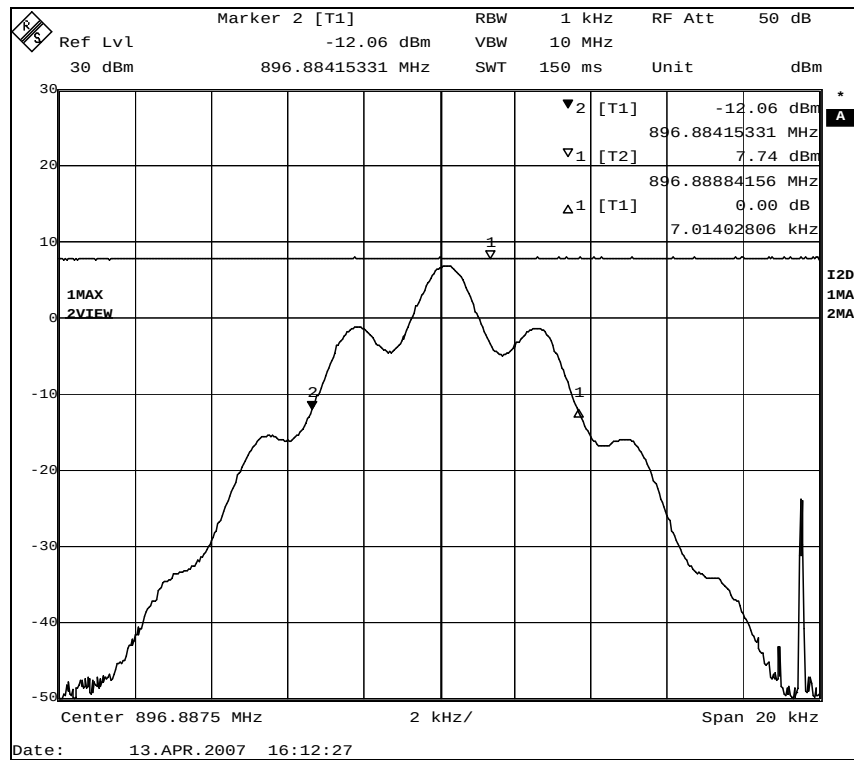
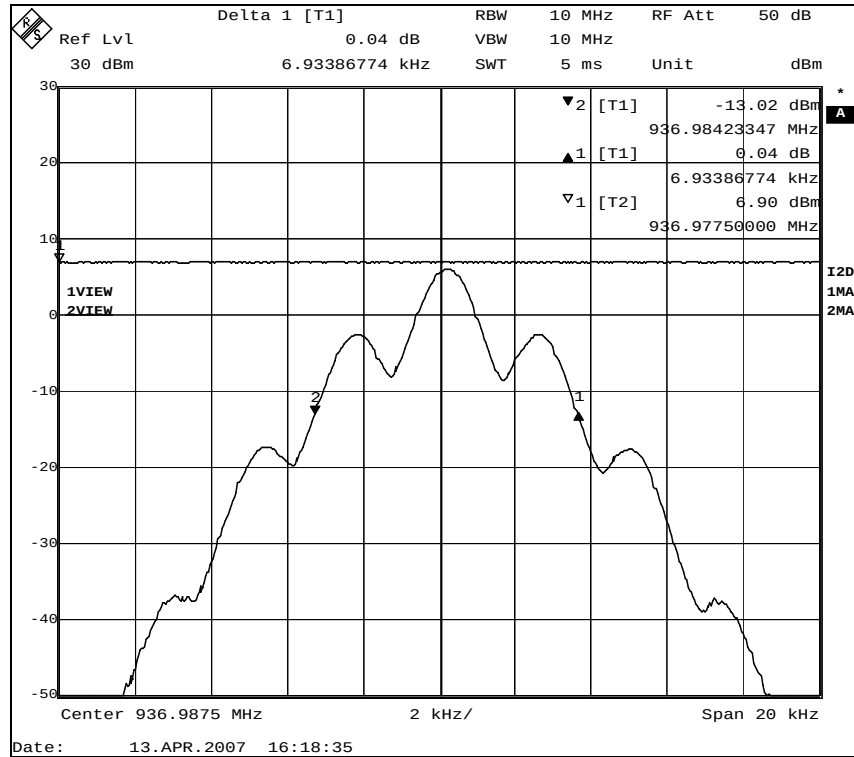
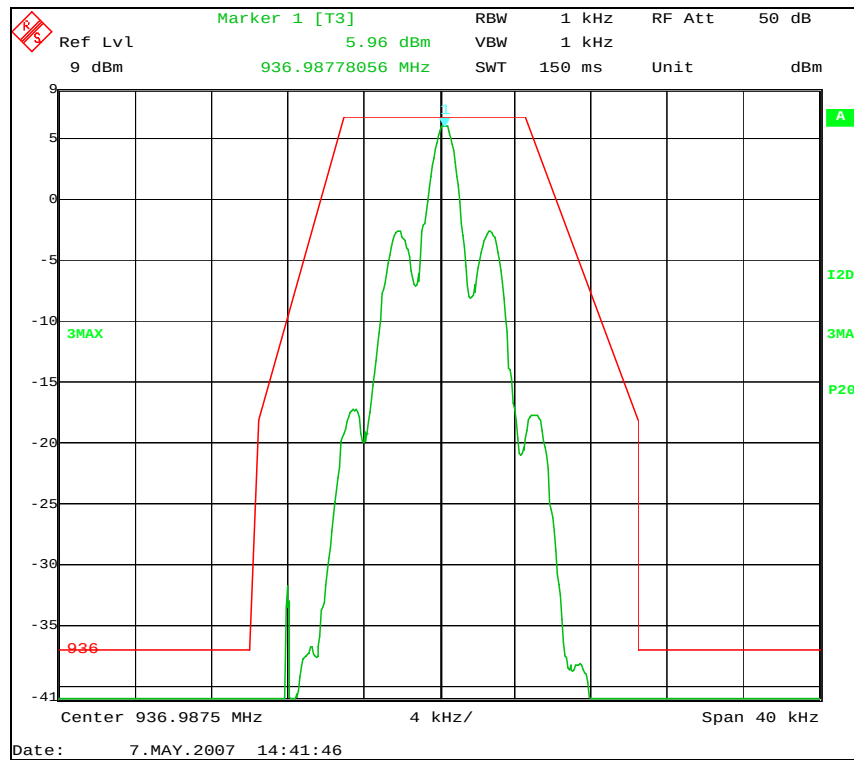


Figure 6 - Occupied Bandwidth Center 896.887MHz, 7.014 kHz

**Figure 7 - Occupied Bandwidth Center 936.987MHz, 6.9338 kHz****Figure 8 - Occupied Bandwidth Center 936.987MHz, High Mask**

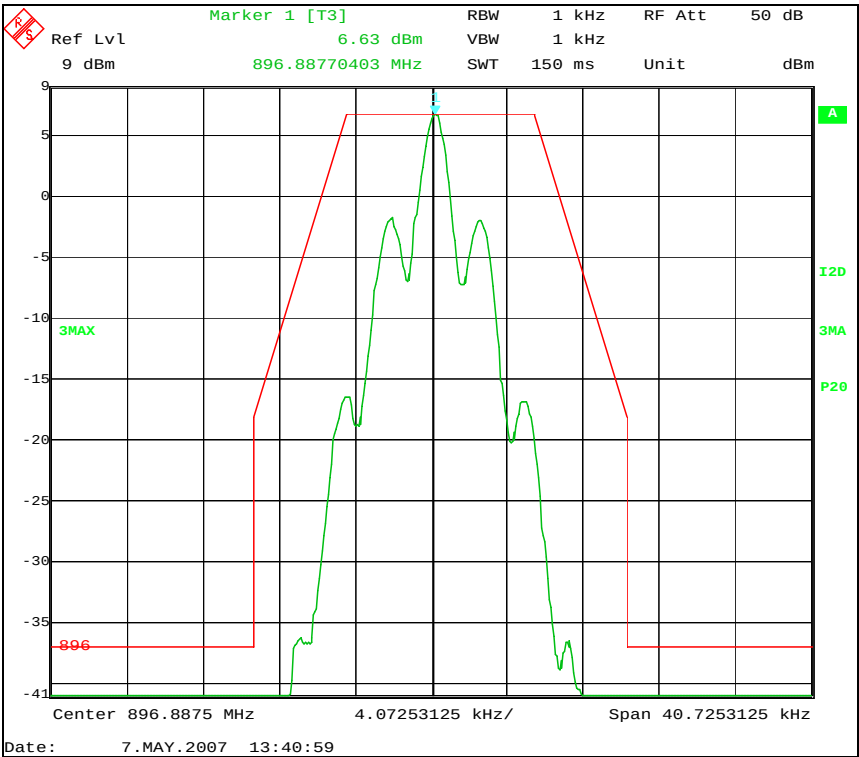


Figure 9 - Occupied Bandwidth Center 896.887MHz, Low Mask

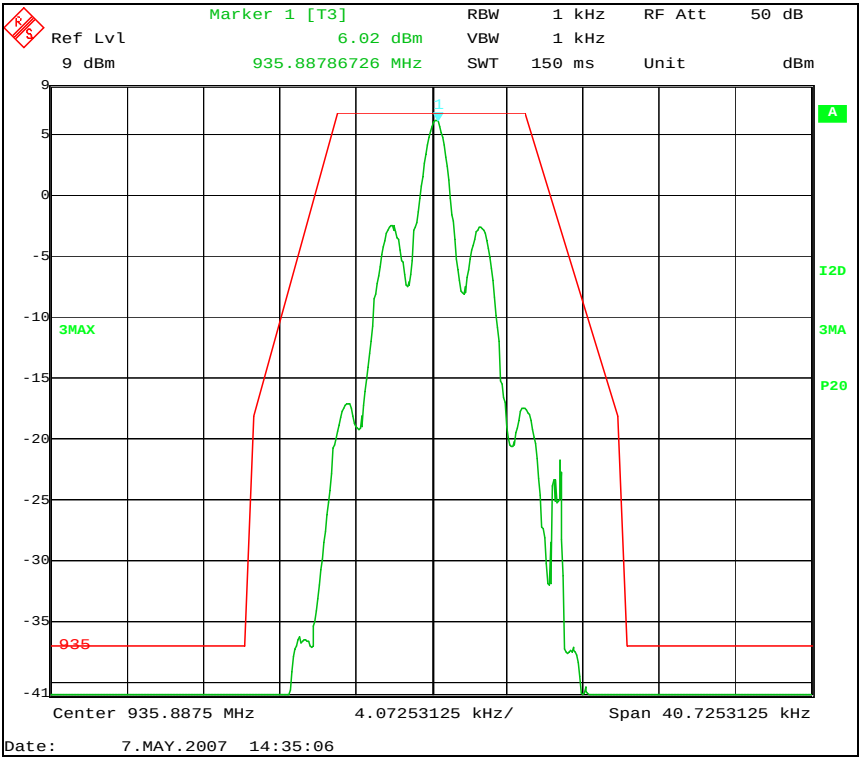


Figure 10 - Occupied Bandwidth Center 935.887MHz, Mid Mask

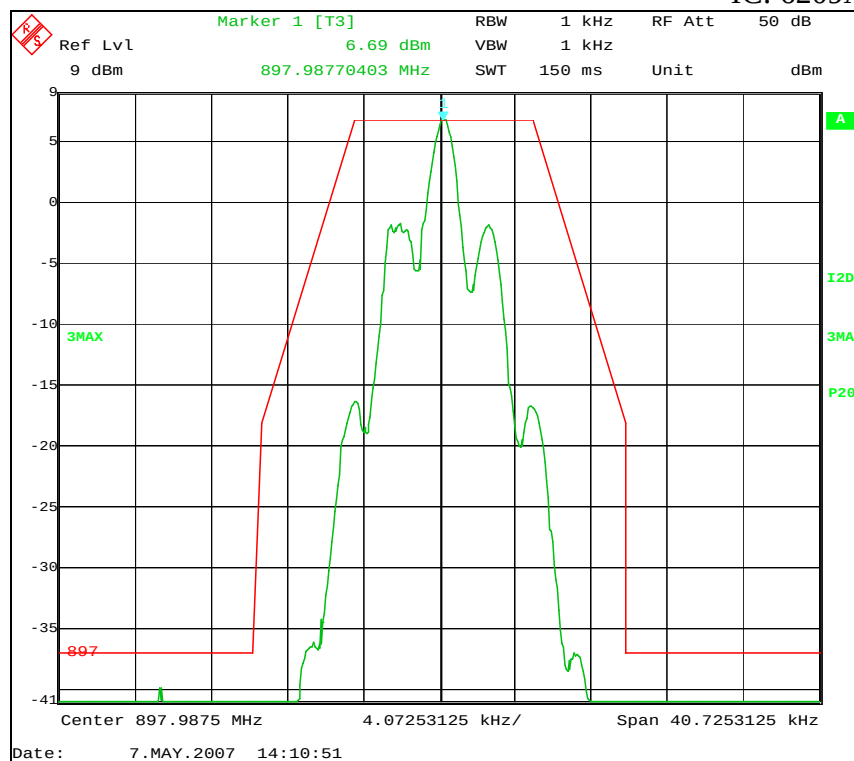


Figure 11 - Occupied Bandwidth Center 897.987MHz, Mid Mask

Appendix D: Spurious Emissions at Antenna Terminals Plots

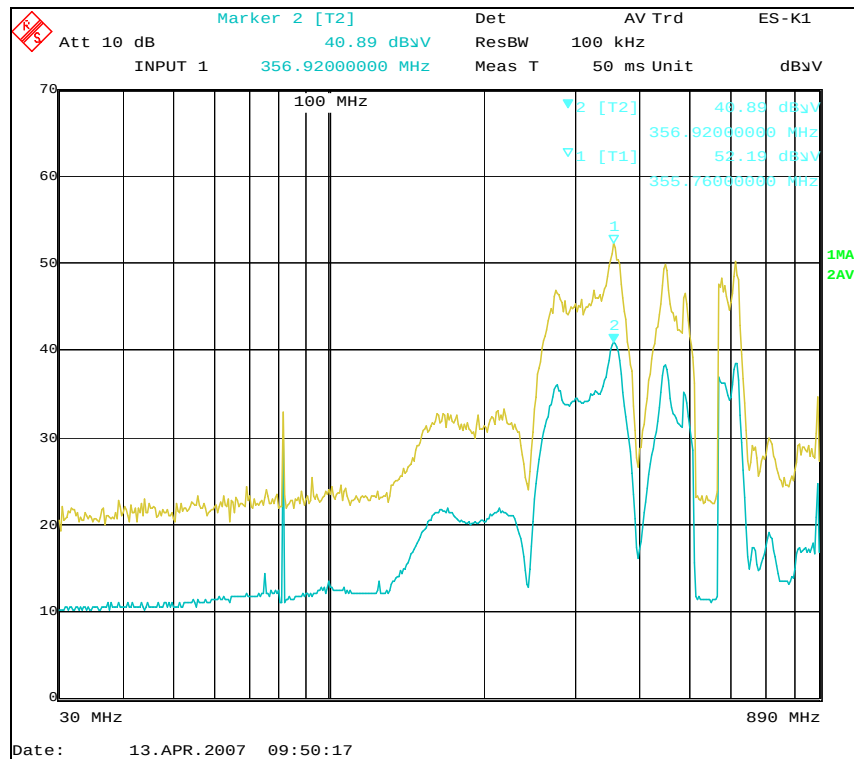


Figure 12 – Antenna Port Spurious Emissions 30MHz - 900MHz

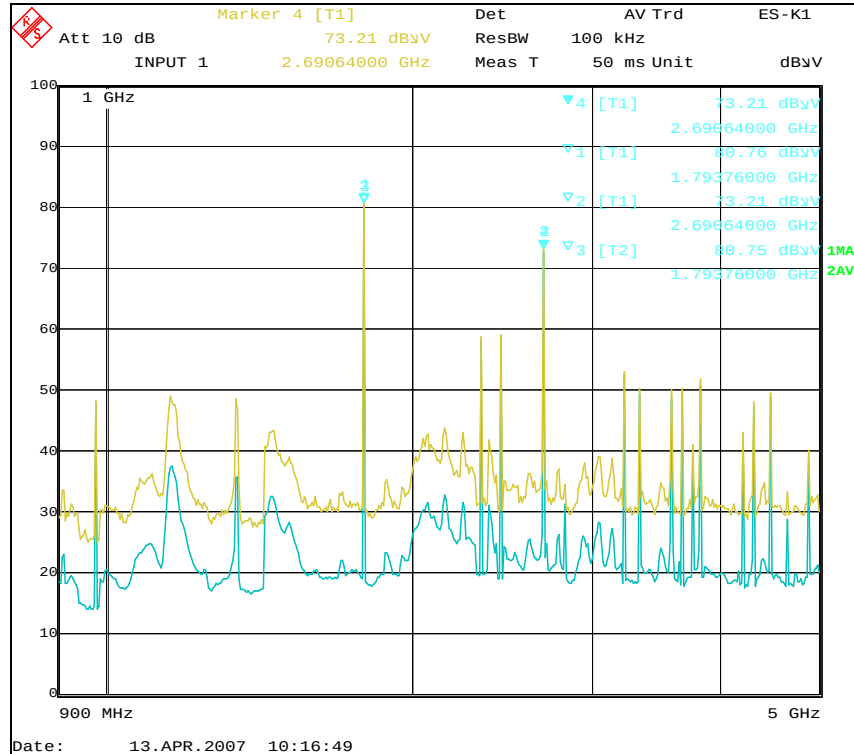


Figure 13 - Antenna Port Spurious Emissions 900MHz - 5GHz

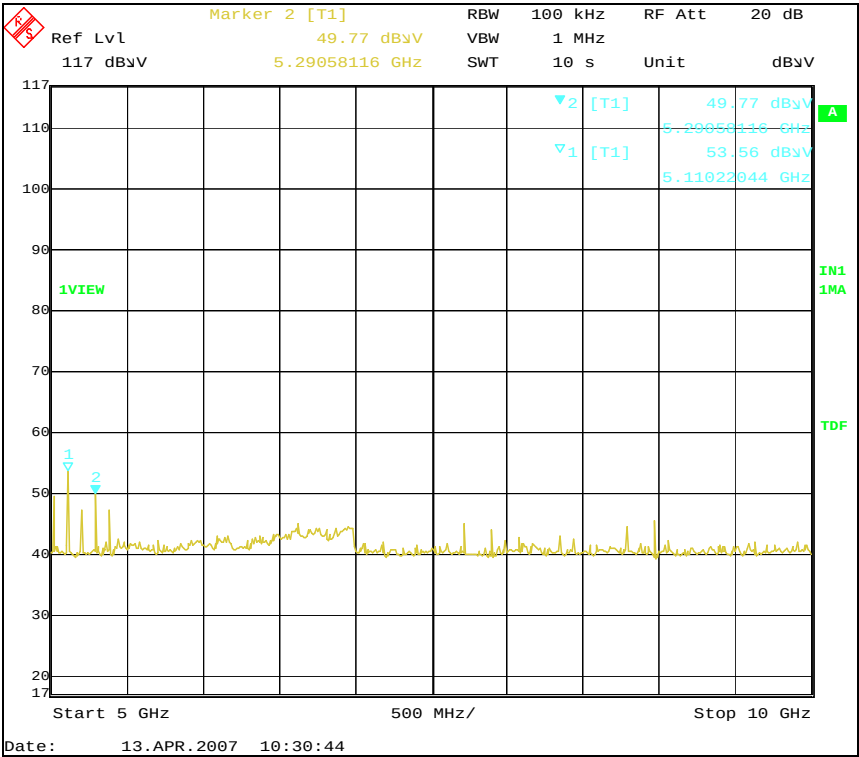


Figure 14 - Antenna Port Spurious Emissions 5GHz - 10GHz

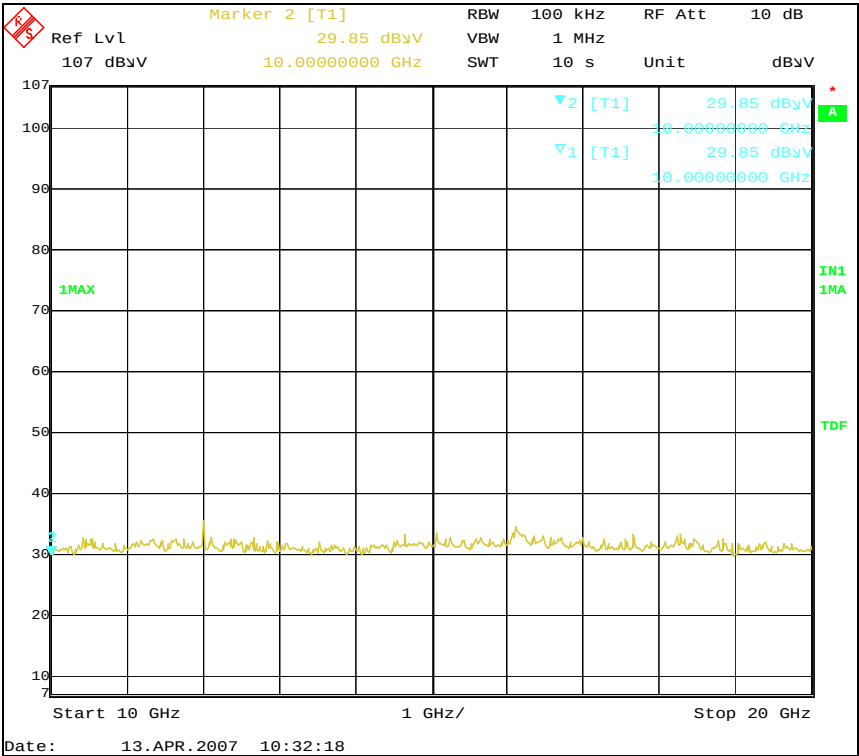


Figure 15 - Antenna Port Spurious Emissions 10GHz - 20GHz

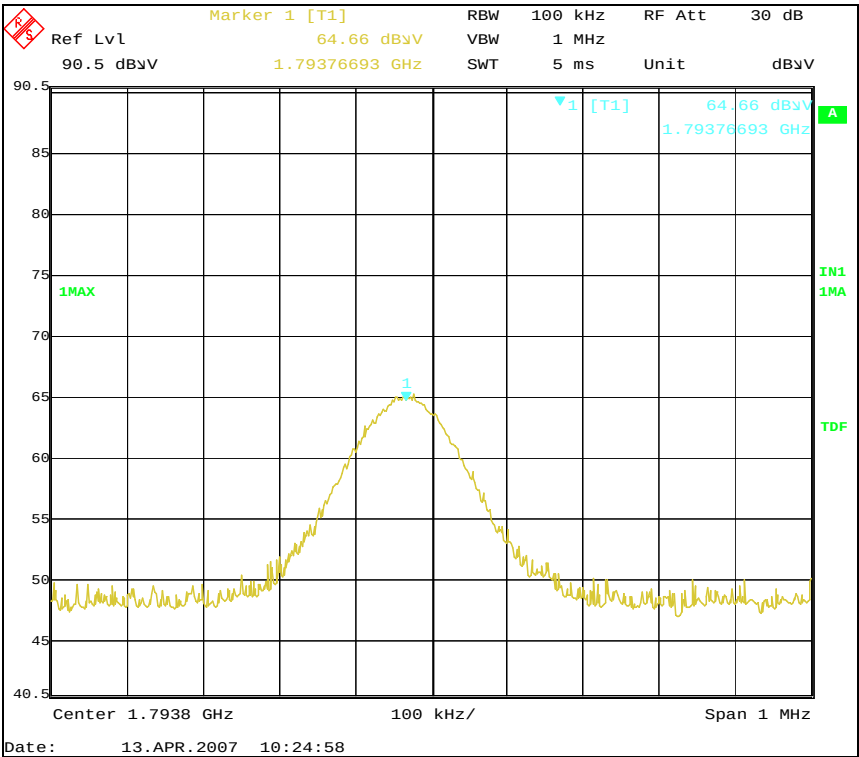


Figure 16 - Antenna Port Spurious Emissions 2nd Harmonic Detail

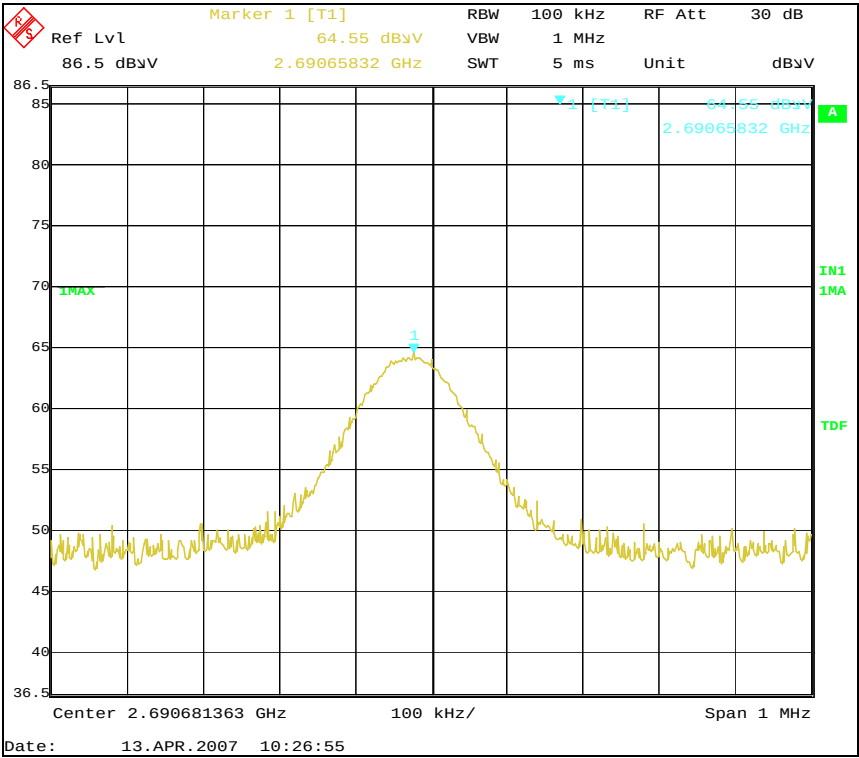


Figure 17 - Antenna Port Spurious Emissions 3rd Harmonic Detail

Appendix E: Radiated Spurious Emission Results

Table 2
Radiated Spurious Emission Measurements

Frequency	Pre-scan Level	Antenna Height	Angle	Pol.	Signal Generator Level	Transmit Antenna Factor	Transmit Cable loss	Level	Limit	Margin
MHz	dBμV/m	cm	deg.		dBm	dB	dB	dBm	dBm	
Up Link, Channel 4, 897.8875MHz										
175.410	43.44	101	274	VER	-46.67	9.8	1.7	-36.17	-13	23.17
199.780	43.54	99	252	VER	-46.5	10.0	1.8	-34.7	-13	21.70
628.140	47.23	100	198	HOR	-38.12	20.2	3.2	-14.72	-13	1.72
1795.78	42.11	100	288	VER	-21.20	-2.6*	5.5	-18.30	-13	5.30
2693.66	46.85	100	288	VER	-22.50	-0.5*	6.9	-16.10	-13	3.10
Down Link, Channel 4, 936.8875										
199.98	41.25	99	261	VER	-47.60	10.6	1.8	-35.20	-13	22.20
649.92	28.76	194	150	VER	-46.40	20.7	3.3	-22.40	-13	9.40
864.18	25.61	150	255	HOR	-52.10	22.9	3.9	-25.30	-13	12.30
1873.78	41.32	100	288	VER	-22.01	-2.6*	5.5	-19.11	-13	6.11
2810.66	45.29	100	288	VER	-21.11	-0.5*	6.9	-14.71	-13	1.71

*Note: Measurements made with antenna and preamp combination

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