



Certification Report for M/A-COM MASTRIII UHF Base Station FCC Part 90 & RSS-119

Document Number: KP000882-CR-RAD-01-01
Release Date: May 19, 2004

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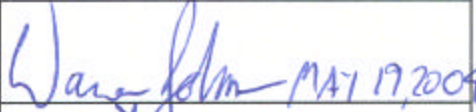


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Release Control Record

This document is based on CEI document template KG000347-TR-EMC-03.

Release no.	Reason for change	Date released
01	Original Release	May 19, 2004

Approvals

Function	Name	Job title	Signature
Document Release Approval	Warren Johnsen	Project Manager	 May 17, 2004
Author	Denis Lalonde	Radio Compliance Discipline Leader	 May 17, 2004
Technical Reviewer	Jacques Rollin	EMC Advisor	 May 18, 04

Accreditations

C-MAC Engineering test facilities are accredited by the Standards Council of Canada (SCC) in accordance with the scope of accreditation outlined at the following web site <http://www.scc.ca/scopes/reg126-eng-s.pdf>. [1]



Through a Mutual Recognition Agreement (MRA) between the National Voluntary Laboratory Accreditation Program (NVLAP) and SCC, the accreditation status of this facility is valid for the U.S.

C-MAC Engineering is ISO 9001:2000 and ISO-IEC 17025 certified and its processes are documented in the C-MAC Engineering Quality Manual [2] and Lab Operations Manual [3].

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1. Executive Summary

This test report documents the measurements performed on the M/A-COM MASTRIII UHF Base Station as part of an Original Equipment Certification for the FCC Part 90, and Industry Canada RSS-119 certifications.

On the basis of measurements performed between March and May 2004, the M/A-COM MASTRIII UHF Base Station is verified to be compliant with FCC Part 90, and Industry Canada RSS-119 requirements. The test data included in this report apply to the product titled above manufactured by M/A-COM, Inc.

The frequency of the band of operation is 403 to 450 MHz.

The FCCID of the new equipment is OWDTR-0033-E.

The Industry Canada certification number is 3636B-0033.

A detailed summary of compliance results is found in Table 2-1: Compliance Results Summary on page 10.

2. Compliance Summary

This section summarizes all the measurements performed on M/A-COM MASTRIII UHF Base Station and its compliance to FCC Part 90, and Industry Canada RSS-119.

Table 2-1: Compliance Results Summary

Product Summary					
Product Name:		M/A-COM MASTRIII UHF Base Station	Project Manager:		Warren Johnsen
Product Code:		TR-0033	Measurements by :		Denis Lalonde
Product Status:			Date:		May 18 2004
Test Cases					
Performed	Description	Specification	Test Results		Notes
			Pass	Fail	
■	RF Power	FCC Part 90.205 and 2.1046 RSS-119 sect. 5.4	■	□	
■	Conducted Spurious Emissions	FCC Part 90.210 & 2.1051 RSS-119 sect. 6.3	■	□	
■	Emission Mask	FCC Part 90.210 & 2.1049 RSS-119 sect. 6.4	■	□	
■	Field Strength of Spurious Emissions	FCC Part 90.210 & 2.1053	■	□	
■	Frequency Stability	FCC Part 90.213 and 2.1055 RSS-119 sect. 7	■	□	
■	Audio Frequency Response	FCC 2.1047	■	□	
■	Audio Low Pass Filter	FCC 2.1047 RSS-119 sect. 6.6	■	□	
■	Modulation Limiting	FCC 2.1047	■	□	
■	Occupied Bandwidth	FCC 2.202 RSP 100 sect. 7.2	■	□	
■	Transient Frequency Behavior	FCC 90.214 RSS-119 sect. 6.5	■	□	
□	RF Exposure	FCC 1.1310 RSS-119 sect. 9.0	□	□	To be evaluated during licensing of equipment

3. Equipment Under Test (EUT)

3.1 Product Functional Description

The product trade name of the unit tested is “M/A-COM MASTRIII UHF Base Station”.

Figure 3-1 provides a brief description of the tested product.

Figure 3-1 Product Description



The MASTR III P25 digital Base Station, built on the tradition of the popular MASTR series of repeaters, is an industry leader in interoperability, performance, and reliability. The MASTR III P25 provides secure digital communications for mission critical applications. The station is capable of both conventional Project 25 digital communications and conventional analog communications for maximum flexibility. The addition of a SitePro Controller provides the capability of delivering Internet Protocol (IP) data and voice to a M/A-COM P25^{IP} network.



3.2 Manufacturer Information

Company Name	M/A-COM, Inc.
Mailing Address	221 Jefferson Ridge Parkway, Lynchburg, Virginia, U.S.A., 24501
Product Name	M/A-COM MASTRIII UHF Base Station

3.3 Transmitter Specifications

Table 3-1 lists the specifications of the transmitter under test. Operation over the full frequency band of operation is achieved through the use of 2 different sets of transmitter/receiver synthesizers and receive front end modules. The only differences between modules of different frequency bands are the values of passive tuning components (R, L, C, and a helical filter).

Table 3-1: Transmitter Specifications

Circuit Pack	Fundamental Characteristics
Tx power	10 to 100 W
Tx frequency	Configuration 1: 403 to 430 MHz Configuration 2: 425 to 450 MHz
Channel spacing	12.5 or 25 kHz

3.4 System Components

The system tested consists of the units shown in Table 3-2. The capability to operate over all the frequency bands identified in Table 3-1 was achieved by selecting a Tx Synthesizer, Rx Synthesizer, Rx Front End, and Power Amplifier modules which are dedicated for their respective frequency band.

Table 3-2: MASTRIII UHF BTS Components

Component	Model	Serial Number
MASTRIII shelf	SXGPNX	9861756
Tx Synthesizer module	(conf. 1) 19D902780G6	CKA 0131 4543
	(conf. 2) 19D902780G7	06CEC5
Rx Synthesizer module	(conf. 1) 19D902781G3	CKA 0134 8034
	(conf. 2) 19D902781G7	0651UI
Rx Front End module	(conf. 1) 19D902782G11	06BD5P
	(conf. 2) 19D902782G7	06B6A2
IF module	EA101401V1	SLR 03150255
System module	19D902590G6	SLR 0251 2492
DSP module	EA101800V1	SLR 03084077
Power module	19D902589G2	CKA 01390368
Power supply	19A149979P1	31725690
SitePro shelf	EA101209V1	SLR 02190892
RF Power Amplifier	EA101292V21 R. P1A	10325279

3.5 Support Equipment

The support equipment used for operation and monitoring of the EUT is described in Table 3-3.

Table 3-3: Support equipment

Description	Model Number
IBM Thinkpad PC	600E

3.6 System Set-up and Test Configurations

The system configuration used for all test cases is presented in Figure 3-2 and Figure 3-3.

Figure 3-2: Module configuration

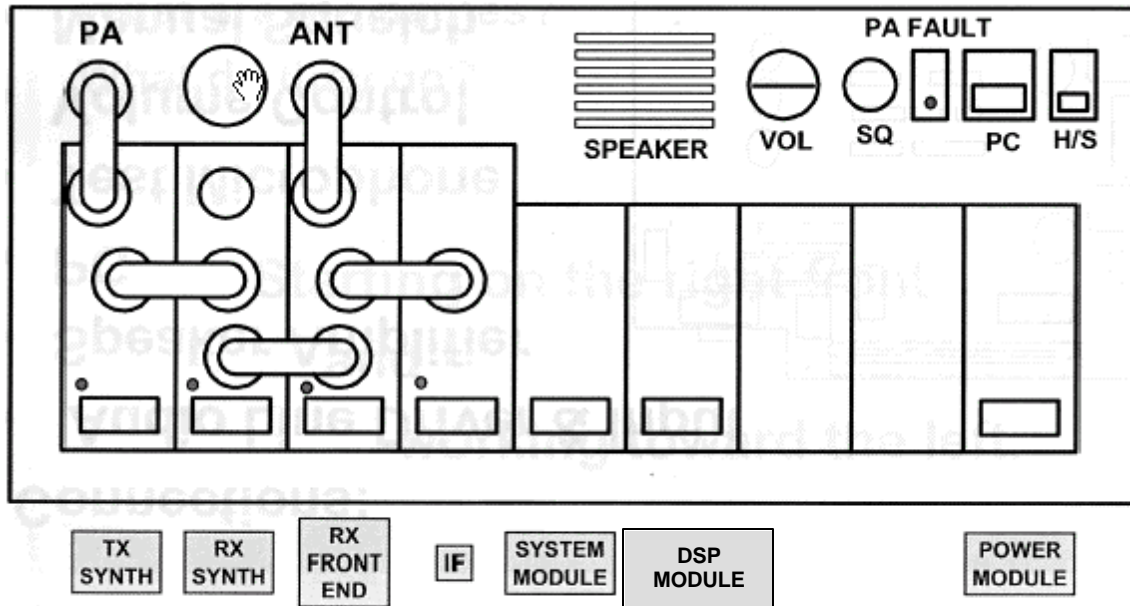
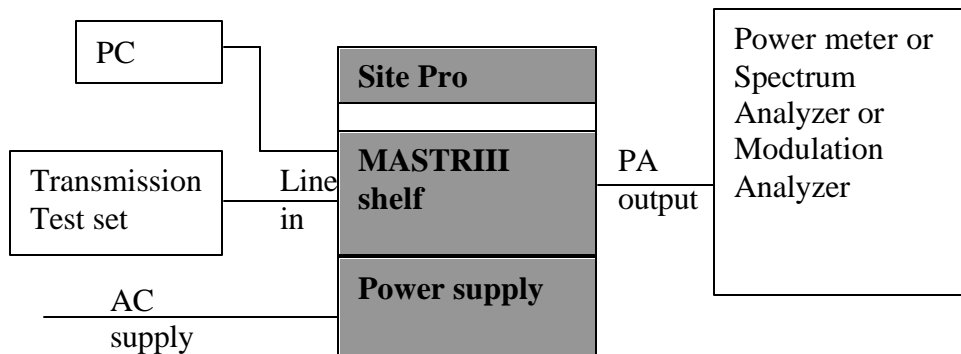


Figure 3-3: System Configuration



A photograph of the test setup used in this test report is presented in Appendix B: Test Set-up Photographs, on page 41.

3.7 System Modifications

No modifications were required to pass the requirements.

4. General Test Conditions

4.1 Test Facility

Radiated emissions testing was performed in a 10-meter Ambient Free Chamber (AFC) located at 21 Richardson Side road, Kanata, Ontario, Canada. The AFC consists of a shielded room lined with ferrite tiles and anechoic material.

These test facilities are accredited by the Standards Council of Canada (SCC) [1]. Through a Mutual Recognition Agreement (MRA) between the National Voluntary Laboratory Accreditation Program (NVLAP) and SCC, the accreditation status of the AFC facility is valid for the U.S.

4.2 Measurement Instrumentation

The measurement instrumentation conforms to ANSI C63.2 [5] and CISPR 16 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5. Detailed Test Results

5.1 RF Power

5.1.1 Test Specification

The system was tested to the requirements listed in Table 5-1:

Table 5-1: RF Power Requirements

Requirement	Part / Section
FCC	90.205, 2.1046
RSS-119	5.4

5.1.1.1 Limits

The system was tested to the rated power of the EUT, listed in Table 5-2.

Table 5-2: RF Power limit

Configuration	Frequency	Rated power
1	403 to 430 MHz	10 to 100 W (40 to 50 dBm)
2	425 to 450 MHz	10 to 100 W (40 to 50 dBm)

5.1.2 Test Facility Information

Location: Soletron Technical Centre Lab 13
Date tested: May 6, 2004
Tested by: Denis Lalonde

5.1.3 Test Procedure

The output of the power amplifier was connected to a power meter using a calibrated RF attenuator and cable.

The unmodulated RF signal was set at the bottom, middle, and top of the frequency band. The lowest and highest possible power levels were evaluated. Each of the 2 Tx/Rx Synthesizers were tested.

5.1.4 Test Results

Test results are shown in Table 5-3.

Table 5-3: RF power levels

Channel (MHz)	Low Power (dBm)	Hi Power (dBm)
403.025	40.1	50.0
420	40.1	50.0
440	40.0	50.0
449.975	40.2	50.0

5.1.5 Test Conclusion

The test results met the requirement.

5.1.6 Test Equipment List

Table 5-4: Test Equipment used for RF Power

Category	Manufacture	Model Number	Description	Serial Number	Cal. Due
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Power meter	Anritsu	2438A		971397	27/04/2005
Power sensor	Anritsu	M2424A		2652A15075	27/04/2005

The measurement instrumentation conforms to ANSI C63.2[5] and CISPR 16 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.2 Conducted Spurious Emissions

5.2.1 Test Specification

The system was tested to the limits of the requirements listed in Table 5-5:

Table 5-5: Conducted Spurious Emissions Requirement

Requirement	Part / Section
FCC	90.210, 2.1053
RSS-119	6.3

5.2.1.1 Limits

The following specification levels are applicable to this test:

Table 5-6: Conducted Spurious Emission Limit

Frequency Range (MHz)	Limit (dBm)
30 to 4500	-20 dBm (for all other power levels)

The limit is calculated in section 5.4.

5.2.2 Test Facility Information

Location: Soletron Technical Centre Lab 13
Date tested: May 7, 2004
Tested by: Denis Lalonde

5.2.3 Test Procedure

Conducted spurious emissions were measured at the bottom and top of the frequency band. Two sets of synthesizers were tested at their maximum (100 W) and minimum power levels (10 W). The transmitter was modulated with a 2 level digital signal with +/- 1.9 kHz deviation.

The measurement was separated in 5 frequency bands;

1. 30 MHz to 800 MHz: the power amplifier output is connected to the spectrum analyzer through a 10 dB and a 20 dB attenuator.
2. 800 MHz to 1.0 GHz: the power amplifier output is connected to the spectrum analyzer through a 10 dB and a 20 dB attenuator.
3. 1 GHz to 2.0 GHz the power amplifier output is connected to the spectrum analyzer through a 10 dB attenuator, a 20 dB attenuator, and a 1 GHz to 2 GHz band-pass filter.
4. 2 GHz to 2.75 GHz the power amplifier output is connected to the spectrum analyzer through a 10 dB attenuator, a 20 dB attenuator, and a 2 GHz to 4 GHz band-pass filter.
5. 2.75 GHz to 6.0 GHz the power amplifier output is connected to the spectrum analyzer through a 10 dB attenuator, a 20 dB attenuator, and a 2.5 GHz high-pass filter.

5.2.4 Test Results

The test result are shown in Table 5-7.

Table 5-7: Conducted Spurious Emissions

Configuration	Channel (MHz)	Maximum level of spurious emission (dBm)		Reference
		Hi Power	Low Power	
1	403.025	-25.5 dBm	-25.7 dBm	Figure 7-2 to Figure 7-11
2	449.975	-23.7 dBm	-26.5 dBm	Figure 7-12 to Figure 7-21

5.2.5 Test Conclusion

The test results met the requirement.

5.2.6 Test Equipment List

Table 5-8: Test Equipment used for Conducted Spurious Emissions

Category	Manufacture	Model Number	Description	Serial Number	Cal. Due
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Spectrum analyzer	HP	8564A	40 GHz	SSG012069	28/04/2005
Band Pass filter	HP	8430A	1–2 GHz band pass	00354	NA
Band Pass filter	HP	8431A	2-4 GHz band pass	00600	NA
High Pass filter	FSY Microwave	HR2380-11XNXN	2.5 GHz high pass	002	NA
Signal generator	HP	83732A	20 GHz	SSG012125	4/11/2004

The measurement instrumentation conforms to ANSI C63.2[5] and CISPR 16 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.3 Emission Mask

5.3.1 Test Specification

The system was tested to the limits of the requirements listed in Table 5-9:

Table 5-9: Emission Mask Requirement

Requirement	Part / Section
FCC	90.210, 2.1053
RSS-119	6.4

5.3.1.1 Limits

The specification levels in Table 5-10 were used.

Table 5-10: Emission Mask Limits

Channel spacing (kHz)	2 level/9600 baud modulation WB
25	Part 90 Mask C

5.3.2 Test Facility Information

Location: Soletron Technical Centre Lab 13
Date tested: May 7 , 2004
Tested by: Denis Lalonde

5.3.3 Test Procedure

The emission mask measurements were performed at 420 MHz. The system was tested at its maximum (100 W) and minimum power levels (10 W). The five modulation types of the transmitted signal were setup as follows:

1. Wibeand Analog signal: the power amplifier output was modulated with a 2500 Hz signal which had a level 16 dB higher than what was required to produce a deviation of 50% of rated system deviation (+/- 5kHz) at 1 kHz.
2. Narrowband Analog signal: the power amplifier output was modulated with a 2500 Hz signal which had a level 16 dB higher than what was required to produce a deviation of 50% of rated system deviation (+/- 2.5kHz) at 1 kHz.
3. Wideband 2 level/9600 baud modulation: the power amplifier output was modulated with a 2 level 9600 baud pseudo-random signal which had the level required for +/- 3 kHz deviation.
4. Narrowband 2 level/9600 baud modulation: the power amplifier output was modulated with a 2 level 9600 baud pseudo-random signal which had the level required for +/- 1.9 kHz deviation.
5. C4FM modulation: the power amplifier output was modulated with a C4FM pseudo-random signal which had the level required for a maximum of +/- 2826 Hz deviation.

For all of these measurements, the power amplifier output was connected to the spectrum analyzer through a 10 dB and a 20 dB attenuator.

5.3.4 Test Results

Table 5-11 lists the highest emissions measured:

Table 5-11: Emission Mask Results

Frequency (MHz)	Type of signal	Test result	Reference
420 MHz	2500 Hz analog (WB)	Pass	Figure 7-22
420 MHz	2500 Hz analog (NB)	Pass	Figure 7-23
420 MHz	2 level 9600 baud / +/- 3 KHz deviation	Pass	Figure 7-24
420 MHz	2 level 9600 baud / +/- 1.9 KHz deviation	Pass	Figure 7-25
420 MHz	C4FM	Pass	Figure 7-26

5.3.5 Test Conclusion

The test results met the requirement.

5.3.6 Test Equipment List

Table 5-12: Test Equipment used for Emission Mask

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Spectrum analyzer	HP	8562B	22 GHz	2913A00400	25/10/2004

The measurement instrumentation conforms to ANSI C63.2[5]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.4 Field Strength of Spurious Emissions

5.4.1 Test Specification

The system was tested to the limits of the following requirements:

Table 5-13: Field Strength of Spurious Emissions Requirement

Requirement	Part / Section
FCC	90.210, 2.1053

5.4.1.1 Limits

The following specification levels are worst-case limits taken from all test specifications.

Table 5-14: Field Strength of Spurious Emissions Limit

Frequency Range (MHz)	ERP Limit (dBm)
30 to 4500	-20

The ERP limit was calculated using the minimum attenuation requirement of FCC 90.210 d)3).

Attenuation = minimum of $50 + 10 \log (P)$ dB or 70 dB (when 12.5 kHz channels are used)
= minimum of $50 + 10 \log (100)$ or 70 dB
= minimum of 70 dB or 70 dB
= 70 dB

ERP limit = $10 \log (100 \text{ W}) - 70 \text{ dB}$
= -20 dBm

When operating at 10 W, the ERP limit for spurious emissions is – 20 dBm.

5.4.2 Test Facility Information

Location: Soletron Technical Centre 10m Ambient Free Chamber
Date tested: March 10 to 12, May 13 to 14, 2004
Tested by: A. Lavoie, R. Poirier, K. Sivaratram, and D. Lalonde

5.4.3 Test Procedure

Verifications of the test equipment and AFC were performed prior to the installation of the EUT in accordance with the quality assurance procedures in KP000270-LP-EMC-01-01 [7].

The system was tested in the following manner:

- The EUT was placed on a turntable inside the AFC and it was configured as in normal operation. The system and its cables were separated from the ground plane by an insulating support 10 mm in height. The system was grounded in accordance with its normal installation specifications. No additional grounding connections are allowed.
- For tests between 30 MHz and 1 GHz a broadband bilog antenna was placed at a 10 m distance; a horn antenna, placed also at 10 m distance from the EUT, was used for measurements between 1 GHz and 6 GHz.
- A pre-scan was performed to find emissions (frequencies) requiring detail measurement. The pre-scan (using a peak detector) was performed by rotating the system 360 degrees while recording all emissions (frequency and amplitude). This procedure was repeated for antenna heights of 1 to 4 meters, in steps of 1 meter, and for horizontal and vertical polarizations of the receiving antenna (for measurements above 30 MHz).
- Prescan optimization was performed based on the pre-scan data. All frequencies, having emission levels within 10 dB of the specification(s) limits, were optimized. For each such frequency, the EUT was rotated in azimuth over 360 degrees and the direction of

maximum emission was noted. Antenna height was then varied from 1 to 4 meters at this azimuth to obtain maximum emissions. The procedure was repeated for both horizontal and vertical polarizations of the search antenna. Then the maximum level measured was recorded.

- The frequency range investigated was 30 MHz to 6 GHz.
- Between 30 MHz and 1 GHz, a resolution bandwidth of 120 kHz was used.
- Above 1 GHz, a 1 MHz resolution bandwidth and 1 MHz video bandwidth were used.
- The highest emissions were evaluated using the substitution method. This is accomplished by replacing the EUT by a calibrated antenna, cable and signal generator. This equipment is used to transmit a signal that will generate a RF meter reading level identical to the one recorded when the EUT was present. The signal generator power level, the calibration data of the cable and antenna is then used to evaluate the Effective Radiated Power (ERP) of the EUT. The following formula is used:

$$\text{ERP} = \text{Signal generator level} - \text{Cable losses} + \text{Antenna gain (dBi)} - \text{Gain of tuned dipole (dBi)}$$

$$\text{Margin} = \text{Limit} - \text{ERP}$$

The measurement was performed while the power amplifier was operating at minimum power output (10 W) and its maximum power output (100 W). A 2 level 9600 baud narrowband signal tuned at 420 MHz and 440 MHz was used for this test. A 50 ohm load was connected to the power amplifier output.

5.4.4 Test Results

Table 5-15 lists the highest emissions measured, all other emissions had more than 20 dB margin:

Table 5-15: Field Strength of Spurious Emissions

Tx Channel	Freq. of Emission (MHz)	Signal Generator Level Hi Power (dBm)	Antenna Gain (dBi)	Cable losses (dB)	ERP Low Power (dBm)	ERP Hi Power (dBm)	Margin (dB)	Reference
420 MHz	2100 (5Tx)	-52.6	9.2	1.4	<-65.5	-47.0	27.0	Figure 7-27 to Figure 7-30
	2520 (6Tx)	-41.3	9.9	1.7	<-47.7	-35.3	15.3	
	2940 (7Tx)	-45.3	9.7	1.9	<-33.9	-39.7	19.7	
440 MHz	2200 (5Tx)	-39.1	9.4	1.4	<-46.8	-33.3	13.3	Figure 7-31 to Figure 7-34
	2640 (6Tx)	-44.2	9.8	1.9	<-41.8	-38.5	18.5	

5.4.5 Test Conclusion

The test results met the requirement.

5.4.6 Test Equipment List

Table 5-16: Test Equipment used for Field Strength of Spurious Emissions

Manufacture	Model	Description	Serial Number	Cal. Due
HP	8447D	Pre Amplifier #1	2944A1026	25-Oct-04
BNR	LNA-A5	LNA 1-18GHz	A5	11-Feb-05
HP	6216A	DC Power Supply	1141A15240	18-Feb-05
EMCO	3115	Double Ridge Guide Horn Antenna	9711-5314	29-Dec-04
A R	2420/A	Bilog - 30MHz- 1000MHz	1113	2-Mar-05
HUBER & SUHNER	106/A	AFC Bulkhead #2	SSG012453	12-Feb-05
HUBER & SUHNER	106/A	AFC Bulkhead #1	SSG012454	12-Feb-05
UL	EMI Software	EMI Software	V 3.02	n/a
HP	8566B	Spectrum Analyzer	SSG012521	29-Apr-05
HP	8566B	Display Unit	SSG012433	n/a
HP	85685A	RF Preselector	SSG012010	29-Apr-05
HP	85650A	QPA	2043A00313	25-Nov-04
Sunol Sciences	SC99V	Dual mast & turntable ctrl'r	120498-1	n/a

The measurement instrumentation conforms to ANSI C63.2[5] and CISPR 16 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.5 Frequency Stability

5.5.1 Test Specification

The system was tested to the limits of the following requirements:

Table 5-17: Frequency Stability Requirement

Requirement	Part / Section
FCC	90.213, 2.1055
RSS-119	7.0

5.5.1.1 Limits

The specification levels are listed in Table 5-18.

Table 5-18: Frequency Stability Limits

Frequency Range (MHz)	Minimum Frequency Stability (ppm)
421 to 512	1.5 (for operation in a 12.5 kHz band)

5.5.2 Test Facility Information

Location: Soletron Technical Centre Lab 9

Date tested: May 11 & 12, 2004

Tested by: Denis Lalonde

5.5.3 Test Procedure

The unmodulated output of the power amplifier was connected through attenuators into a spectrum analyzer with frequency counting capability. A 10 MHz rubidium frequency reference was used to provide improved frequency accuracy to the spectrum analyzer.

The base station was installed in an environmental chamber. The temperature was changed from – 30 degree Celsius up to 50 degree Celsius in 10 degree increments while the EUT was powered off. The temperature was allowed to stabilize for 1 hour after changing the temperature. The measurement of frequency was done 5 minutes after the base station was powered on.

Frequency accuracy measurement were also performed at 20 degree Celsius while modifying the voltage of the AC mains from 85% (102 VAC) to 115% (138 VAC) of the nominal value (120 VAC).

5.5.4 Test Results

The table below lists the frequency stability measurement results:

Table 5-19: Frequency Stability Results (420 MHz)

Temperature (degree. Celsius)	AC Voltage (V)	Frequency (MHz)	Frequency Error (ppm)
-30	120	420.000070	0.17
-20	120	420.000180	0.43
-10	120	420.000100	0.24
0	120	420.000020	0.05
10	120	419.999950	-0.12
20	102	419.999930	-0.17
20	120	419.999930	-0.17
20	138	419.999930	-0.17
30	120	419.999950	-0.12
40	120	420.000140	0.33
50	120	420.000020	0.05

5.5.5 Test Conclusion

The test results met the requirement.

5.5.6 Test Equipment List

Table 5-20: Test Equipment used for Frequency Stability

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Frequency Reference	UCT	2008	Rubidium 10 MHz	A1010	27/04/2005
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Spectrum analyzer	HP	8562B	22 GHz	2913A00400	25/10/2004

The measurement instrumentation conforms to ANSI C63.2[5] and CISPR 16 [6]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.6 Transient Frequency Behavior

5.6.1 Test Specification

The system was tested to the limits of the following requirements:

Table 5-21: Transient Frequency Behavior Requirement

Requirement	Part / Section
FCC	90.214
RSS-119	6.5

5.6.1.1 Limits

The specification levels are listed in Table 5-22.

Table 5-22: Transient Frequency Behavior Limit

Channel Spacing (kHz)	Time interval (ms)	Maximum Frequency Difference (kHz)
25	T1 = 5	+/- 25
	T2= 20	+/- 12.5
	T3= 5	+/- 25
12.5	T1 = 5	+/- 12.5
	T2= 20	+/- 6.25
	T3= 5	+/- 12.5

Note:

t1 is the time period immediately following Txon

t2 is the time period immediately following t1.

t3 is the time period from the instant when the transmitter is turned off until Txoff.

5.6.2 Test Facility Information

Location: Soletron Technical Centre Lab 13

Date tested: March 16, 23, 24 & May 7 , 2004

Tested by: Denis Lalonde

5.6.3 Test Procedure

The test procedure of EIA/TIA-603B-2002 section 2.2.19 (modulation domain analyzer method) was used.

5.6.4 Test Results

Table 5-23 shows the transient frequency behavior measurement results. Each graph shows the transmitted signal at the center of the +/- 25 kHz frequency scale over more than 25 msec.

Table 5-23: Transient Frequency Behavior Test Results

Channel	Channel Spacing (kHz)	Time interval (ms)	Maximum Frequency Difference (kHz)	Measured Frequency Difference (kHz)	Measurement reference
420 MHz	25	T1 = 5	+/- 25	< 2.5	Figure 7-35
		T2= 20	+/-12.5	< 2.5	Figure 7-35 & Figure 7-36
		T3= 5	+/- 25	< 1	Figure 7-36
420 MHz	12.5	T1 = 5	+/- 12.5	< 3	Figure 7-37
		T2= 20	+/-6.25	< 3	Figure 7-37 & Figure 7-38
		T3= 5	+/- 12.5	< 1	Figure 7-38

5.6.5 Test Conclusion

The test results met the requirement.

5.6.6 Test Equipment List

Table 5-24: Test Equipment used for Transient Frequency Behavior Measurement

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Modulation Domain analyzer	HP	53310A		3121A01217	14/08/2004

Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.7 Audio Frequency Response

5.7.1 Test Specification

The system was tested to the limits of the following requirement:

Table 5-25: Frequency Response Requirement

Requirement	Part / Section
FCC	2.1047

5.7.1.1 Limits

The specification levels are listed in Table 5-26.

Table 5-26: Frequency Response Limit

Frequency Range (kHz)	TIA 603-b [11] Recommended Response (dB)
0.3 to 2.5	+1 dB or -3 dB from a true 6 dB per octave pre-emphasis characteristic as referenced to the 1000 Hz level. The exception is from 500 Hz to 300 Hz, where an additional 6 dB per octave rolloff is allowed.
2.5 to 3	An additional 6 dB per octave attenuation is allowed

5.7.2 Test Facility Information

Location: Soletron Technical Centre Lab 13

Date tested: May 10 & 13, 2004

Tested by: Denis Lalonde

5.7.3 Test Procedure

The frequency deviation of the transmitter output was initially set to 20% of the rated system deviation at 1 kHz by varying the level in the audio input signal to the base station. The frequency of the input signal was then swept from 100 Hz to 5 kHz while keeping the input level constant. The frequency deviation was recorded as the input frequency was changed.

The frequency response was determined by the following formula.

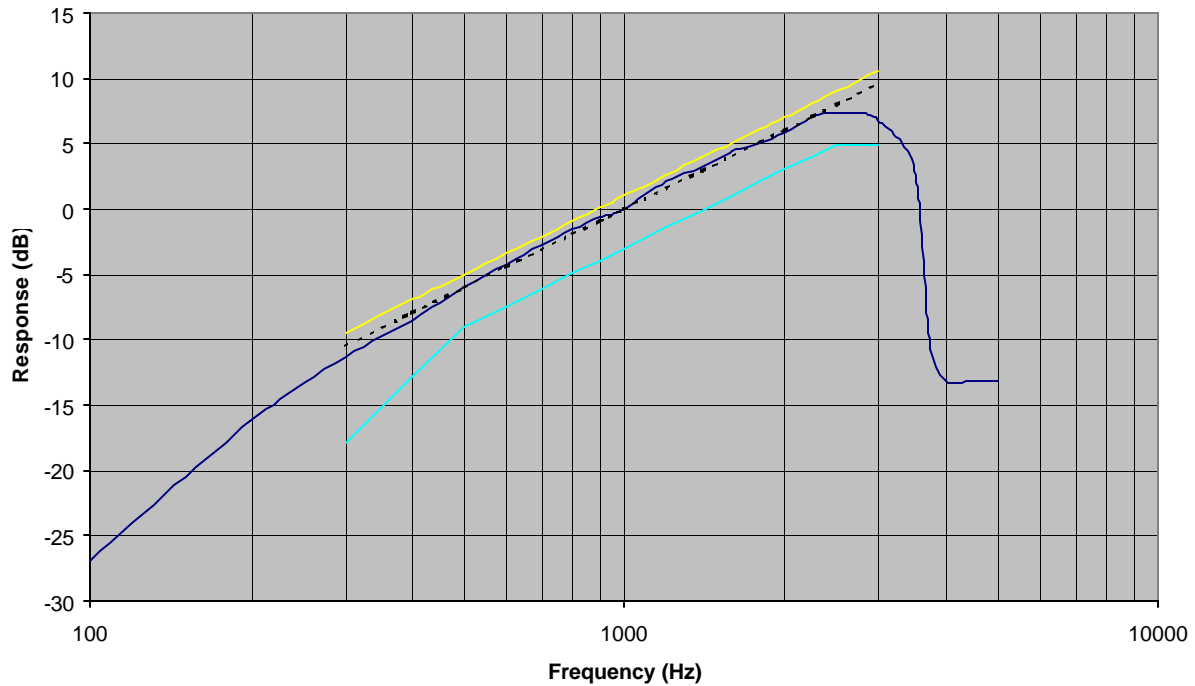
Response (dB) = 20 log (measured frequency deviation/frequency deviation at 1 kHz)

The transmitter was set for narrowband analog signal for this test at 420 MHz.

5.7.4 Test Results

Figure 5-1 illustrates the frequency response of the system:

Figure 5-1: Audio Frequency Response results



5.7.5 Test Conclusion

The test results met the requirement.

5.7.6 Test Equipment List

Table 5-27: Test Equipment used for Frequency Response Measurement

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Modulation Domain analyzer	HP	53310A		3121A01217	27/04/2005
Transmission Test Set	HP	3552A		1806U01296	7/10/2004
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004

Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.8 Audio Low Pass Filter Response

5.8.1 Test Specification

The system was tested to the limits of the following requirements:

Table 5-28: Audio Low Pass Filter Response Requirement

Requirement	Part / Section
FCC	2.1047
RSS-119	6.6

5.8.1.1 Limits

The specification levels are listed in Table 5-29.

Table 5-29: Audio Low Pass Filter Response Limit

Frequency Range (kHz)	RSS-119 Recommended Attenuation (dB)
3 to 20	$60 \log (\text{freq. (Hz)}/3000)$
20 to 30	50

5.8.2 Test Facility Information

Location: Soletron Technical Centre Lab 13

Date tested: May 10 & 13, 2004

Tested by: Denis Lalonde

5.8.3 Test Procedure

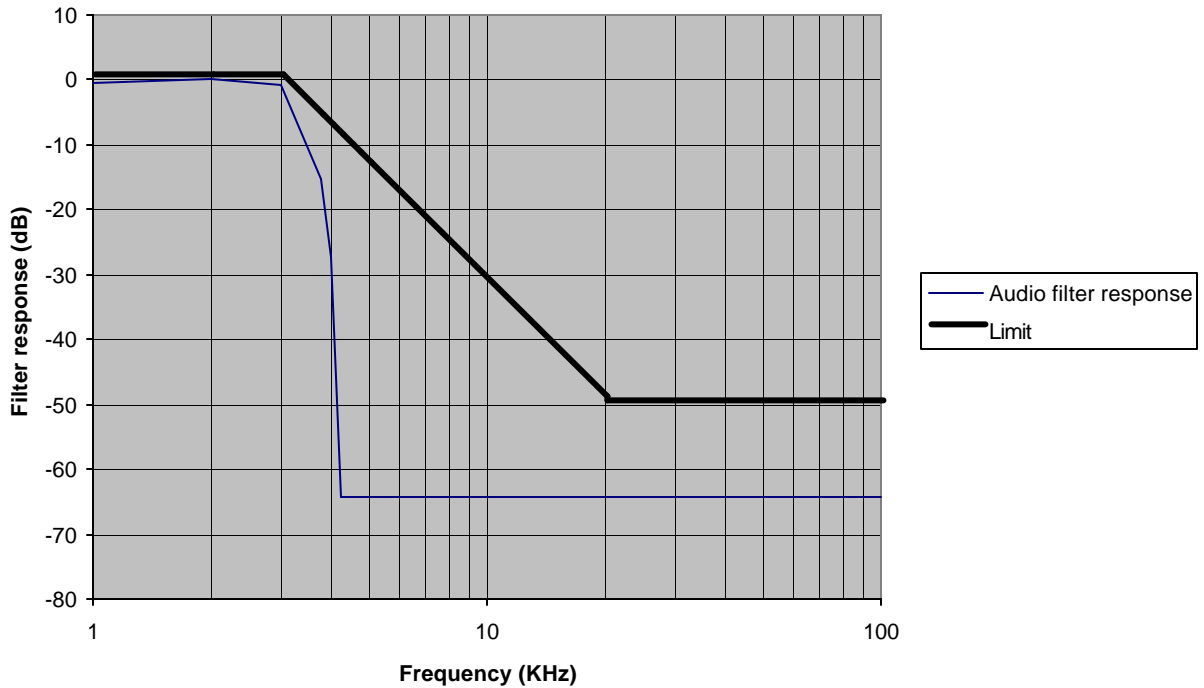
The system was initially set to transmit a signal with a deviation of 60% of the system rated deviation at 1 kHz. The output of the power amplifier was connected to a FM demodulator. The demodulated output was then fed into an audio signal analyzer. The audio signal analyzer measured the amplitude of the demodulated audio signal while the frequency of the transmitter audio signal was increased from 1 kHz to 30 kHz. The measured amplitude of the audio signal amplitude was recorded for each frequency measurement.

The test was conducted with the transmitter set to 420 MHz.

5.8.4 Test Results

Figure 5-2 shows the low pass filter response measurement results.

Figure 5-2 Audio Low Pass Filter Response



5.8.5 Test Conclusion

The test results met the requirement.

5.8.6 Test Equipment List

Table 5-30: Test Equipment used for Audio Low Pass Filter Response Measurement

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Spectrum analyzer	HP	3585A	40 MHz, 1 Mohm IN	1750A03502	25/10/2004
Modulation Domain analyzer	HP	53310A		3121A01217	27/04/2005
Transmission Test Set	HP	3552A		1806U01296	7/10/2004
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004

Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.9 Modulation Limiting

5.9.1 Test Specification

The system was tested to the limits of the following requirements:

Table 5-31: Modulation Limiting Requirement

Requirement	Part / Section
FCC	2.1047

5.9.1.1 Limits

The specification levels are listed in Table 5-32.

Table 5-32: Modulation Limiting Limit

Relative input signal level (dB)	12.5 kHz Channel spacing (kHz)	25 kHz Channel spacing (kHz)
-20 to 20	< rated deviation (2.5 kHz)	< rated deviation (5 kHz)

5.9.2 Test Facility Information

Location: Soletron Technical Centre Lab 13

Date tested: May 10 & 13, 2004

Tested by: Denis Lalonde

5.9.3 Test Procedure

The system was initially set to transmit a signal with a deviation of 60% of the system rated deviation at 1 kHz. The input level required for this deviation was then recorded as the reference level. The positive peak and negative peak frequency deviation was then recorded while the input signal was changed from -20 dB to 20 dB relative to the reference level. This was repeated for an input signal of 300 Hz and 2500 Hz.

The measurements were performed while the transmitter transmitted a wideband and narrowband analog signal at 420 MHz.

5.9.4 Test Results

Figure 5-3 to Figure 5-6 shows the modulation limiting measurement results:

Figure 5-3 Modulation Limiting, Positive Peak (25 kHz channel)

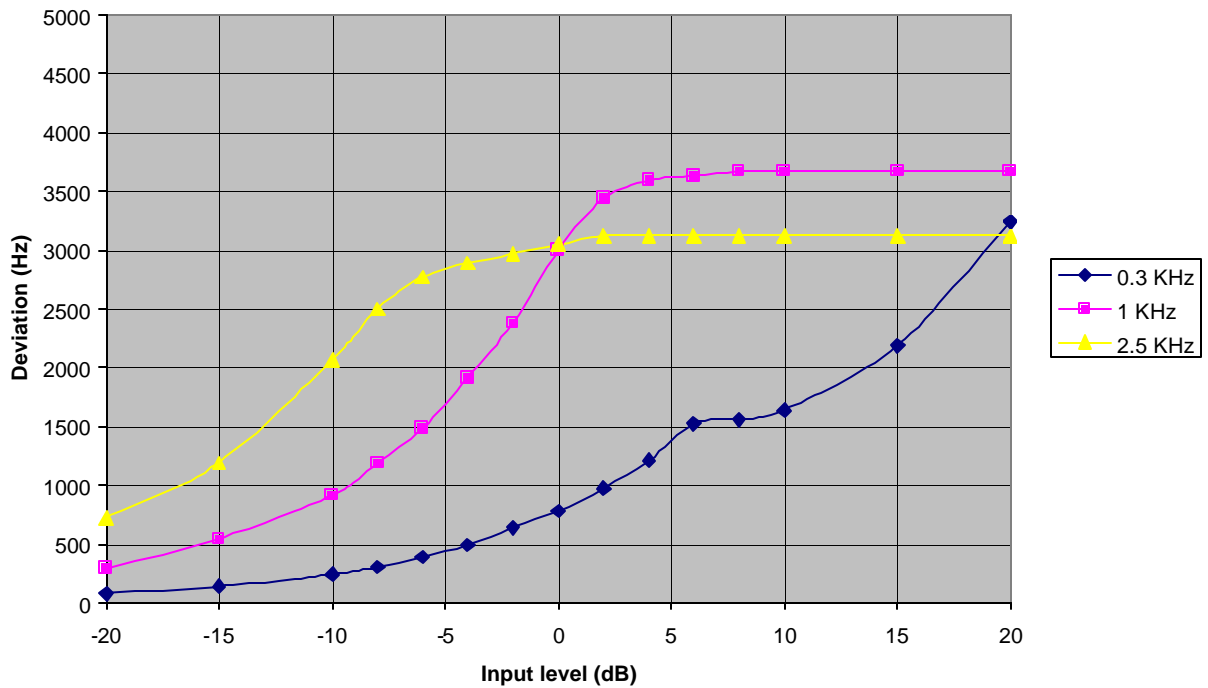


Figure 5-4 Modulation Limiting, Negative Peak (25 kHz channel)

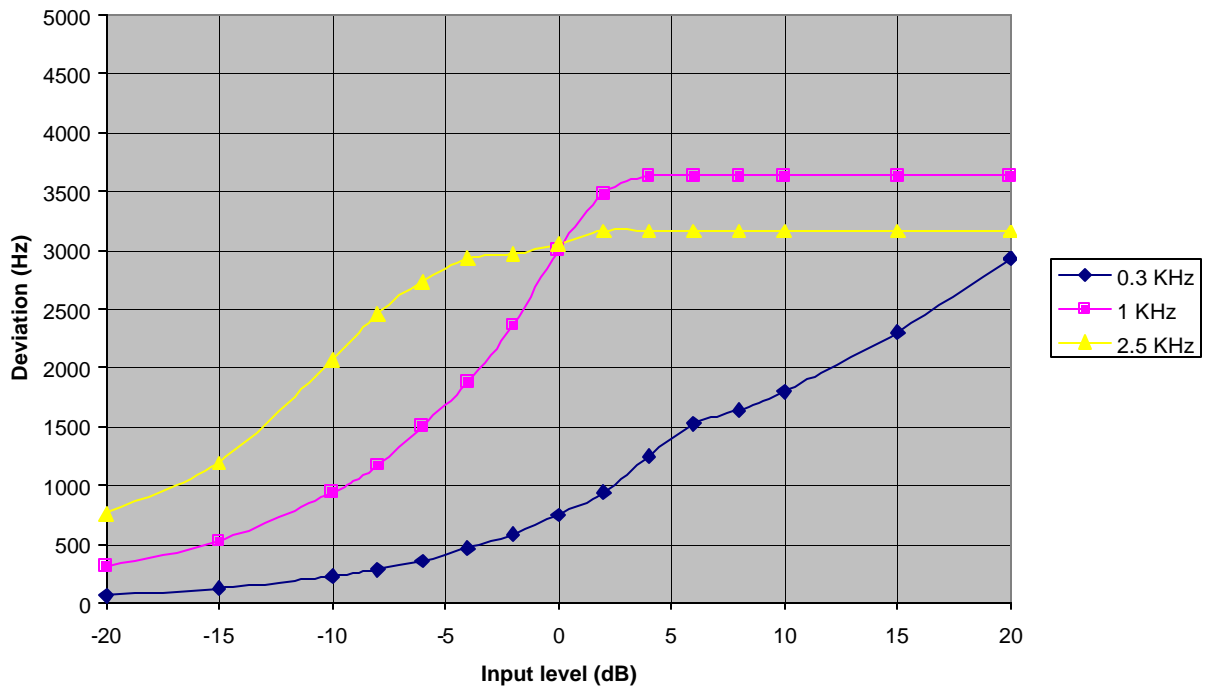


Figure 5-5 Modulation Limiting, Positive Peak (12.5 kHz channel)

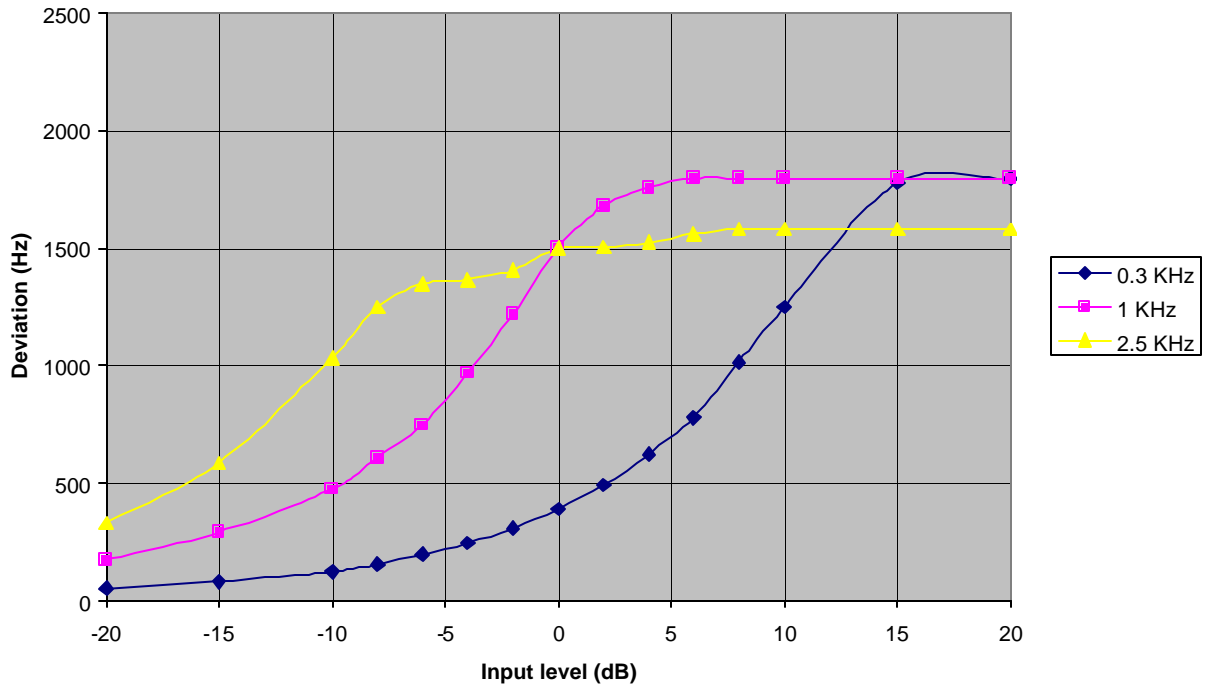
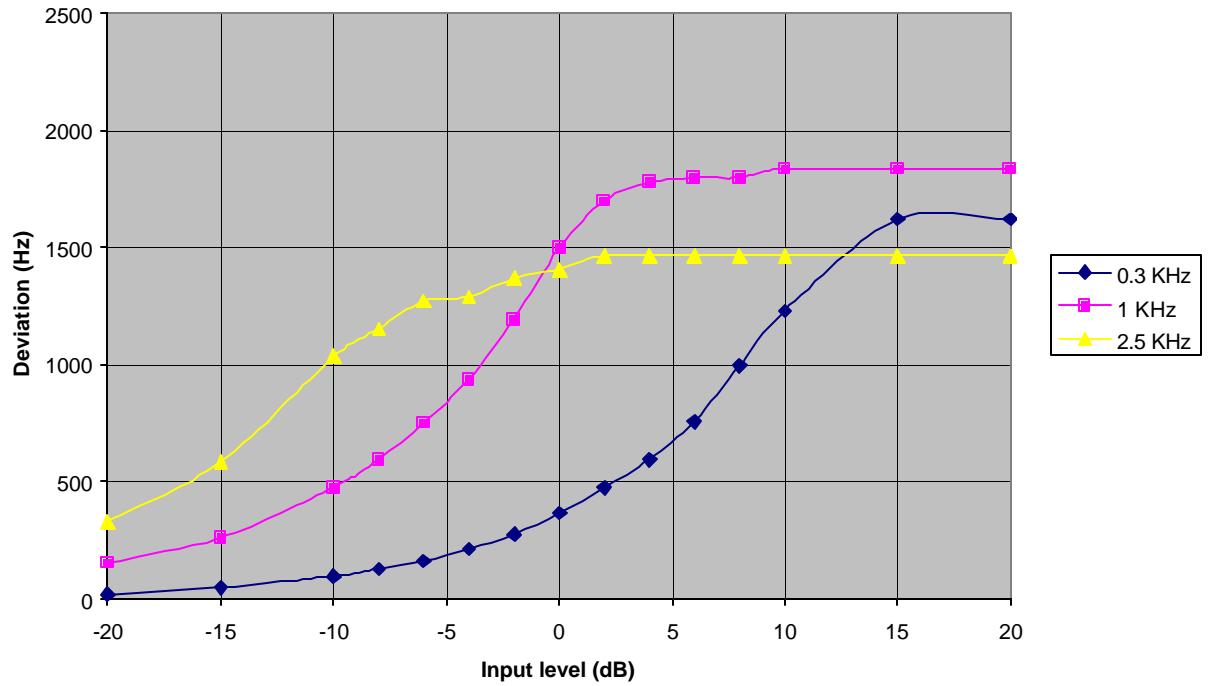


Figure 5-6 Modulation Limiting, Negative Peak (12.5 kHz channel)



5.9.5 Test Conclusion

The test results met the requirement.

5.9.6 Test Equipment List

Table 5-33: Test Equipment used for Audio Low Pass Filter Response Measurement

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Modulation Domain analyzer	HP	53310A		3121A01217	27/04/2005
Transmission Test Set	HP	3552A		1806U01296	7/10/2004
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004

Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

5.10 Occupied Bandwidth

5.10.1 Test Specification

The system occupied bandwidth was evaluated according to the specifications listed in Table 5-34:

Table 5-34: Occupied Bandwidth

Requirement	Part / Section
FCC	2.202
RSP-100	7.2

5.10.2 Test Facility Information

Location: Soletron Technical Centre Lab 13

Date tested: May 7, 2004

Tested by: Denis Lalonde

5.10.3 Test Procedure

Five occupied bandwidth measurements were performed at 420 MHz.

1. Wideband Analog signal: the power amplifier output was modulated with a 2500 Hz signal which had a level 16 dB higher than what was required to produce a deviation of 50% of rated system deviation (5 kHz) at 1 kHz.
2. Narrowband Analog signal: the power amplifier output was modulated with a 2500 Hz signal which had a level 16 dB higher than what was required to produce a deviation of 50% of rated system deviation (2.5 kHz) at 1 kHz.
3. Wideband two level/9600 baud modulation: the power amplifier output was modulated with a 2 level 9600 baud pseudo-random signal which had the level required for +/- 3 kHz deviation.
4. Narrowband two level/9600 baud modulation: the power amplifier output was modulated with a 2 level 9600 baud pseudo-random signal which had the level required for +/- 1.9 kHz deviation.
5. C4FM modulation: the power amplifier output was modulated with a C4FM pseudo-random signal which had the level required for a maximum of +/- 2826 Hz deviation.

For all of these measurements, the power amplifier output was connected to the spectrum analyzer through a 10 dB and a 20 dB attenuator.

The occupied bandwidth was measured using the 99% bandwidth measuring feature of the spectrum analyzer.

5.10.4 Test Results

The table below lists the calculated and measured occupied bandwidth.

Table 5-35: Occupied bandwidth values (420 MHz)

Type of signal	Calculation	Measurement (kHz)	Emission designator
Audio (wideband)	Max. modulation (M) = 3 kHz Max. deviation (D) = 5 kHz K = 1 $B_n = 2M + 2DK$ Bn = 16 kHz	10.1 kHz Figure 7-39 (measured with 2.5 kHz tone)	16K0F3E
Audio (narrowband)	Max. modulation (M) = 3 kHz Max. deviation (D) = 2.5 kHz K = 1 $B_n = 2M + 2DK$ Bn = 11 kHz	5.2 kHz Figure 7-40 (measured with 2.5 kHz tone)	11K0F3E
2 level 9600 baud / 3 KHz deviation	Max. modulation (B) = 9.6 kHz Max. deviation (D) = 3 kHz K = 1 $B_n = B + 2DK$ Bn = 15.6 kHz	11.0 kHz Figure 7-41	11K0F1D 11K0F1E
2 level 9600 baud / 1.9 KHz deviation	Max. modulation (B) = 9.6 kHz Max. deviation (D) = 1.9 kHz K = 1 $B_n = B + 2DK$ Bn = 13.4 kHz	8.4 kHz Figure 7-42	8K40F1D 8K40F1E
C4FM	Max. modulation (B) = 4.8 kHz Max. deviation (D) = 2.826 kHz K = 1 $B_n = B + 2DK$ Bn = 10.452 kHz	7.8 kHz Figure 7-43	7K80F1D 7K80F1E

5.10.5 Test Equipment List

Table 5-36: Test Equipment used for Occupied bandwidth

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	22/04/2005
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Spectrum analyzer	HP	8562B	22 GHz	2913A00400	25/10/2004

The measurement instrumentation conforms to ANSI C63.2[5]. Calibration of the measurement instrumentation is maintained in accordance with the supplier's recommendations, or as necessary to ensure its accuracy.

6. References

1. Standards Council of Canada Scope of Accreditation Letter SCC 1003-15/163 dated 2002-12-16 (Scope of accreditation is effective until 2005-10-05 and includes FCC Part 15 and ICES-003). This scope of accreditation is outlined at the following web site <http://www.scc.ca/scopes/reg126-eng-s.pdf>.
2. C-MAC Engineering Inc. Quality Manual, K0000608-QD-QM-01-05, March 2003.
3. C-MAC Engineering Inc. Lab Operations Manual KG000347-QD-LAB-01-03, January 2003.
4. ANSI C63.4-2001, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz, 17 June 2001.
5. ANSI C63.2-1996, American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz – Specifications.
6. CISPR 16-1, Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods - Part 1: Radio Disturbance and Immunity Measuring Apparatus, Edition 2.0, 1999-10.
7. C-MAC Engineering Inc., EMC General Lab Test Procedure, KP000270-LP-EMC-01-01, February 2004.
8. FCC Rules for Radio Frequency Devices, Title 47 of the Code of Federal Regulations), Part 2, U.S. Federal Communications Commission.
9. FCC Rules for Radio Frequency Devices, Title 47 of the Code of Federal Regulations), Part 90, U.S. Federal Communications Commission.
10. RSS-119, Issue 6, “Land Mobile and Fixed Radio, Transmitters and Receivers, 27.41 to 960 MHz” March 25, 2000.
11. ANSI/TIA-603-B-2002, “Land Mobile FM or PM Communications Equipment Measurement and Performance Standards”, November 7, 2002

7. Appendices

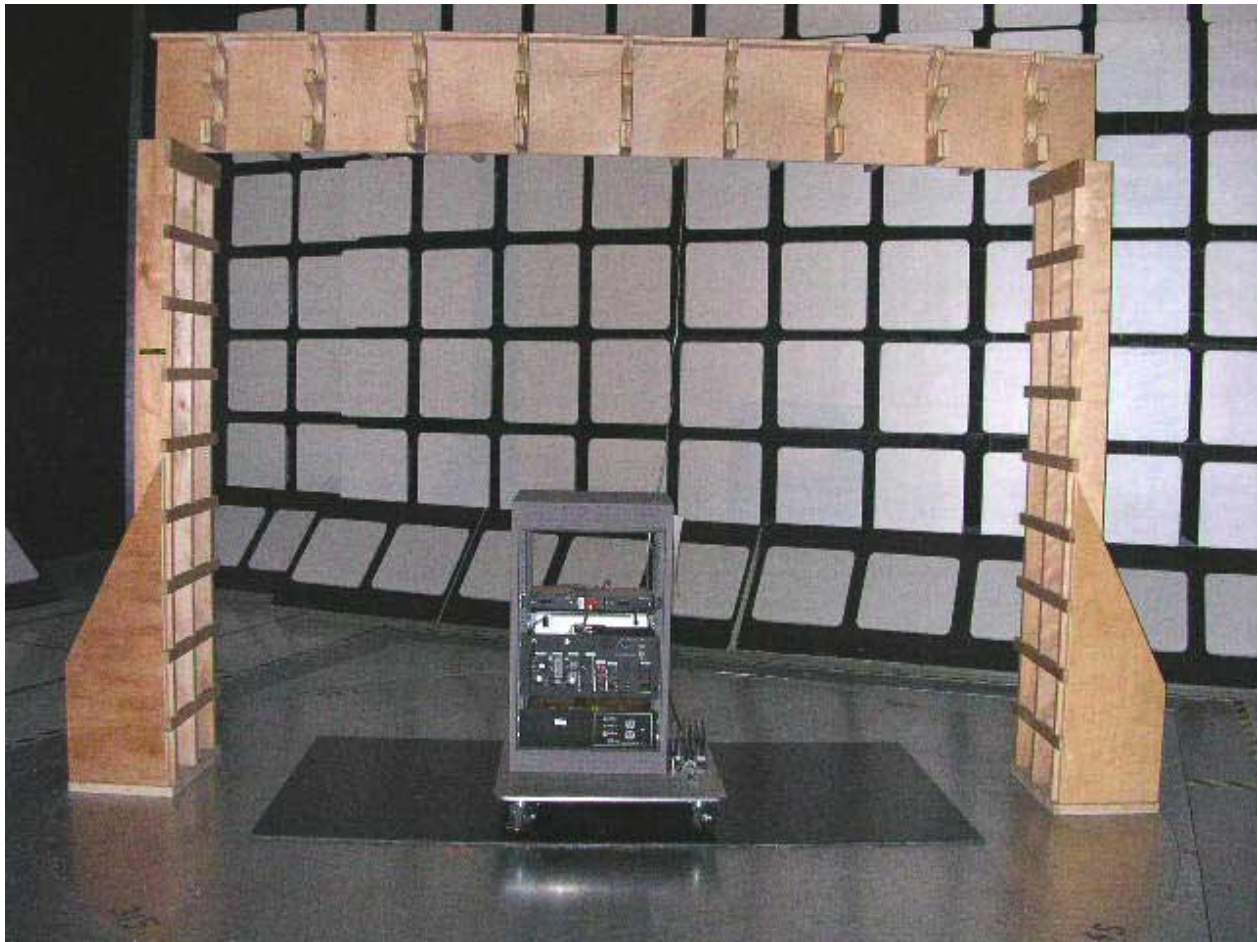
7.1 Appendix A: Glossary

Included below are definitions and abbreviations of terms used in this document.

Term	Definition
AC	Alternating Current
AFC	Ambient Free Chamber
AM	Amplitude modulation
ANSI	American National Standards Institute
AVG	Average detector
CISPR	Comité International Spécial Perturbation Radioélectrique (International Special Committee on Radio Interference)
Class A	Class A Limits for typical commercial establishments
Class B	Class B Limits for typical domestic and residential establishments
dB	Decibel
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	European Normative
EUT	Equipment Under Test
FCC	Federal Communications Commission, USA
GND	Ground
IC	Industry Canada
PA	Broadband Power Amplifier
RBW	Resolution Bandwidth
RF	Radio-Frequency
RFI	Radio-Frequency Interference
SCC	Standards Council of Canada

7.2 Appendix B: Test Set-up Photographs

Figure 7-1: M/A-COM MASTRIII UHF Base Station radiated emissions set-up



7.3 Appendix C: Conducted Spurious Emissions Plots

Figure 7-2: Tx at 403.025 MHz, 100 W power, 30 MHz to 800 MHz

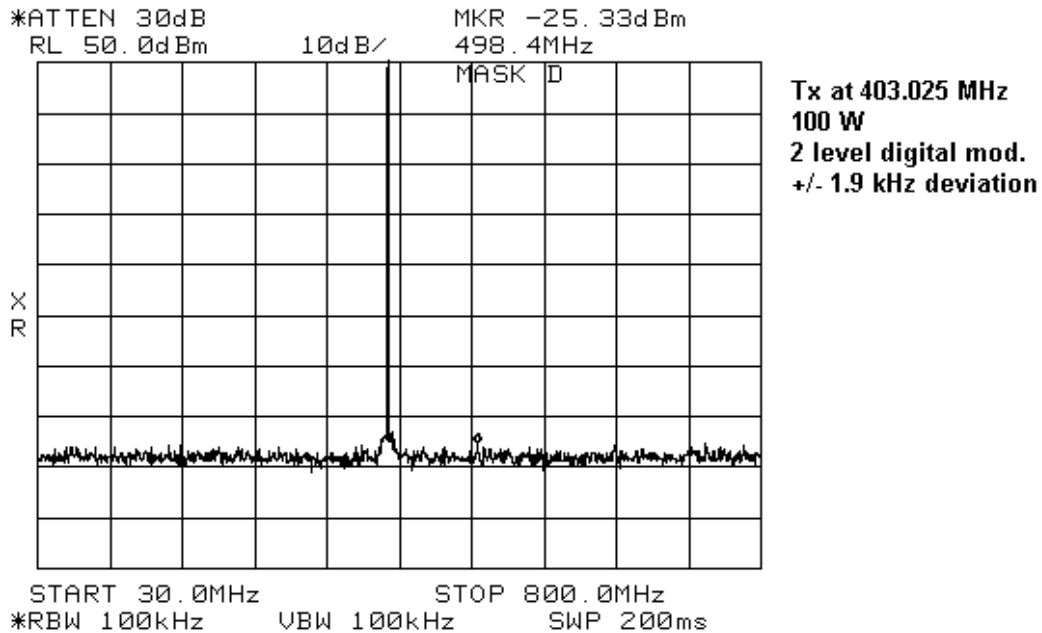


Figure 7-3: Tx at 403.025 MHz, 100 W power, 800 MHz to 1 GHz

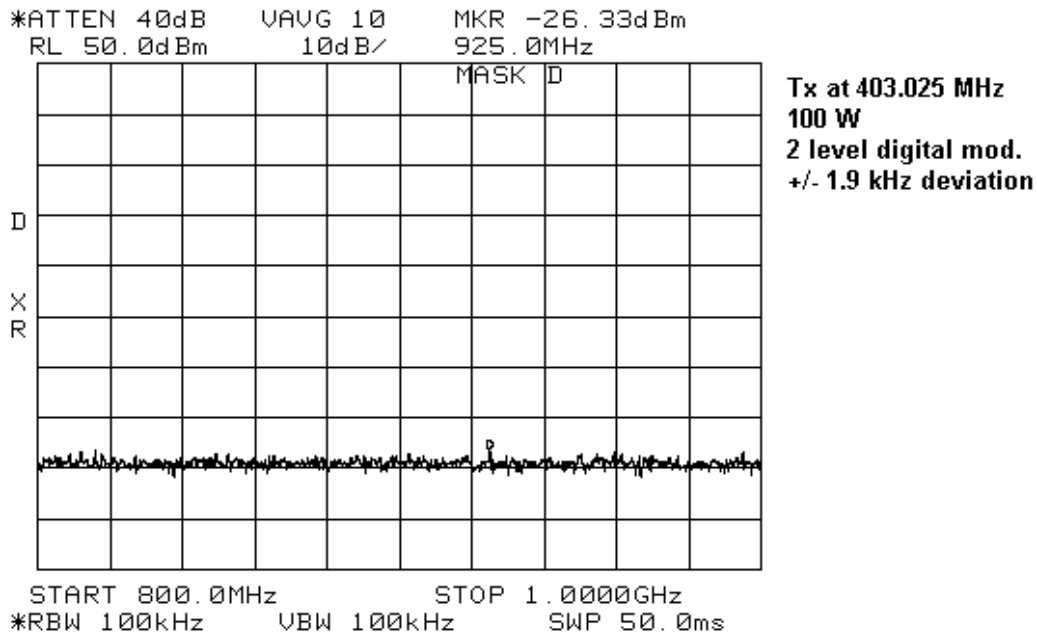
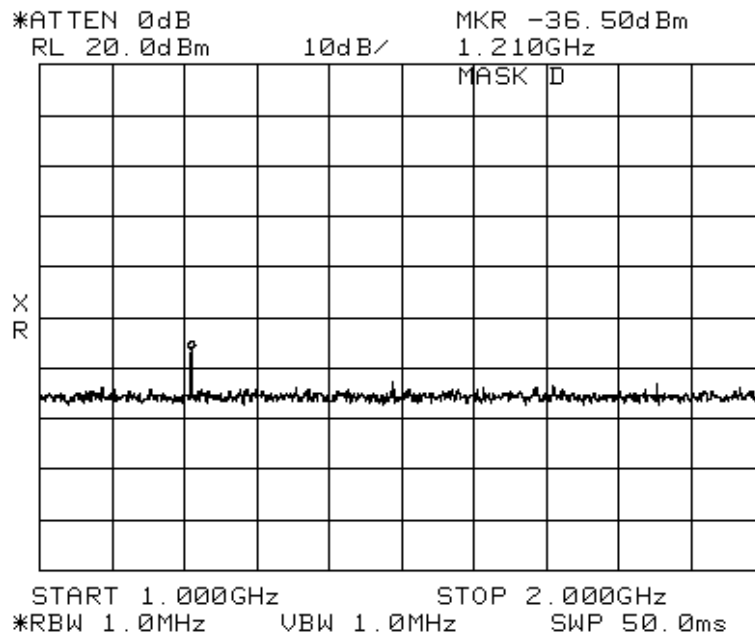
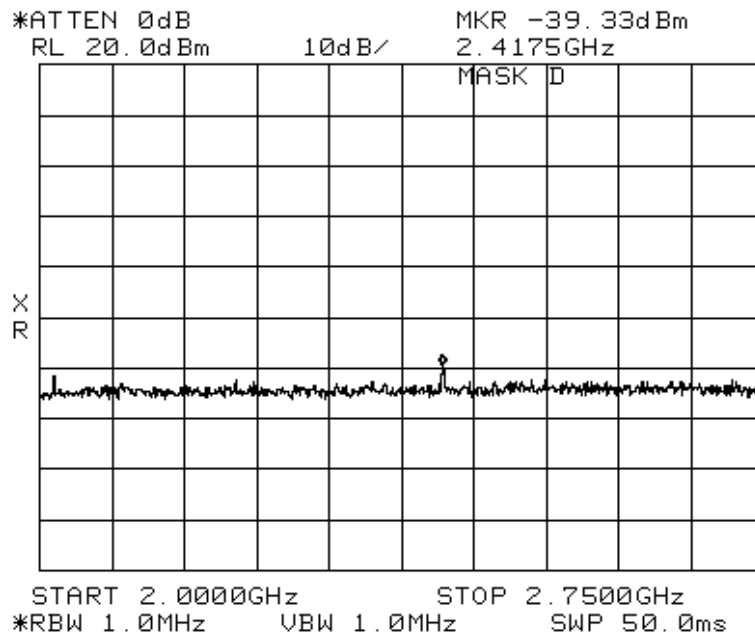


Figure 7-4: Tx at 403.025 MHz , 100 W power, 1 GHz to 2 GHz



**Tx at 403.025 MHz
100 W
2 level digital mod.
+/- 1.9 kHz deviation**

Figure 7-5: Tx at 403.025 MHz , 100 W power, 2 GHz to 2.75 GHz



**Tx at 403.025 MHz
100 W
2 level digital mod.
+/- 1.9 kHz**

Figure 7-6: Tx at 403.025 MHz , 100 W power, 2.75 GHz to 6 GHz

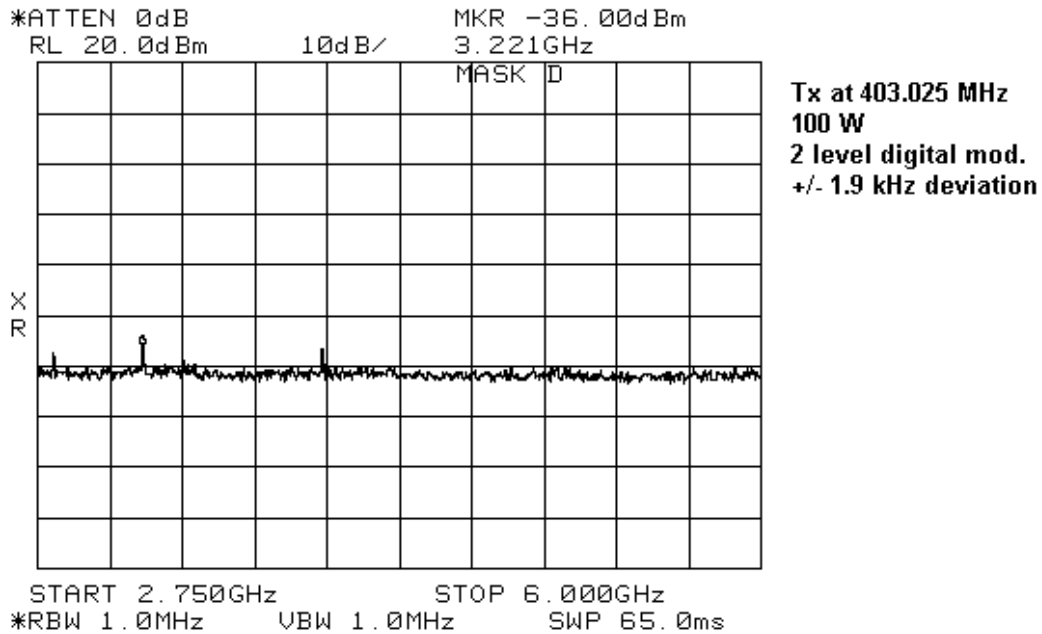


Figure 7-7: Tx at 403.025 MHz , 10 W power, 30 MHz to 800 MHz

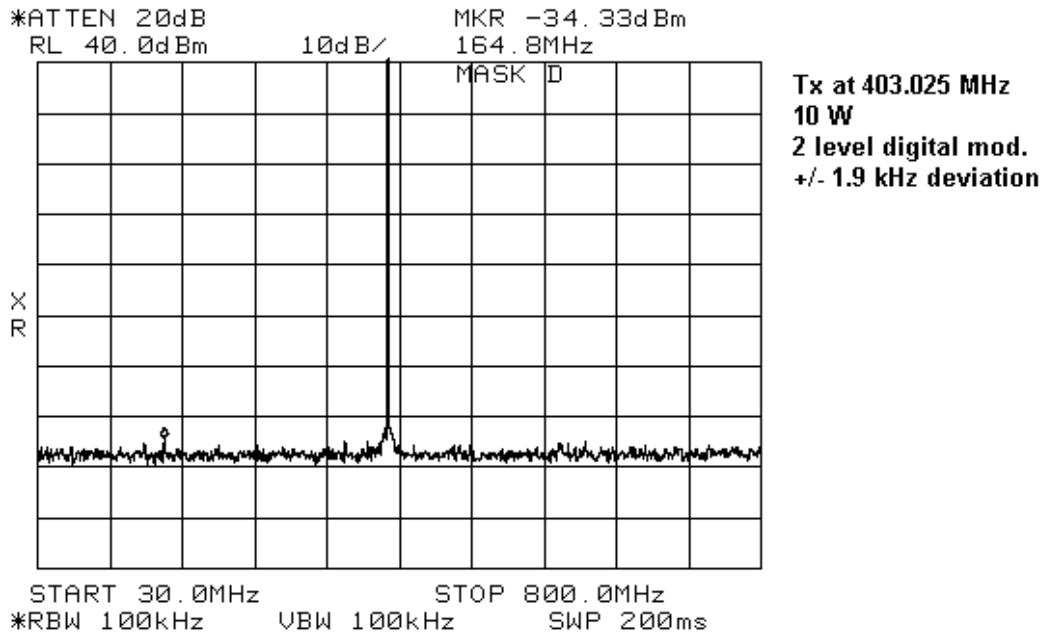


Figure 7-8: Tx at 403.025 MHz , 10 W power, 800 MHz to 1 GHz

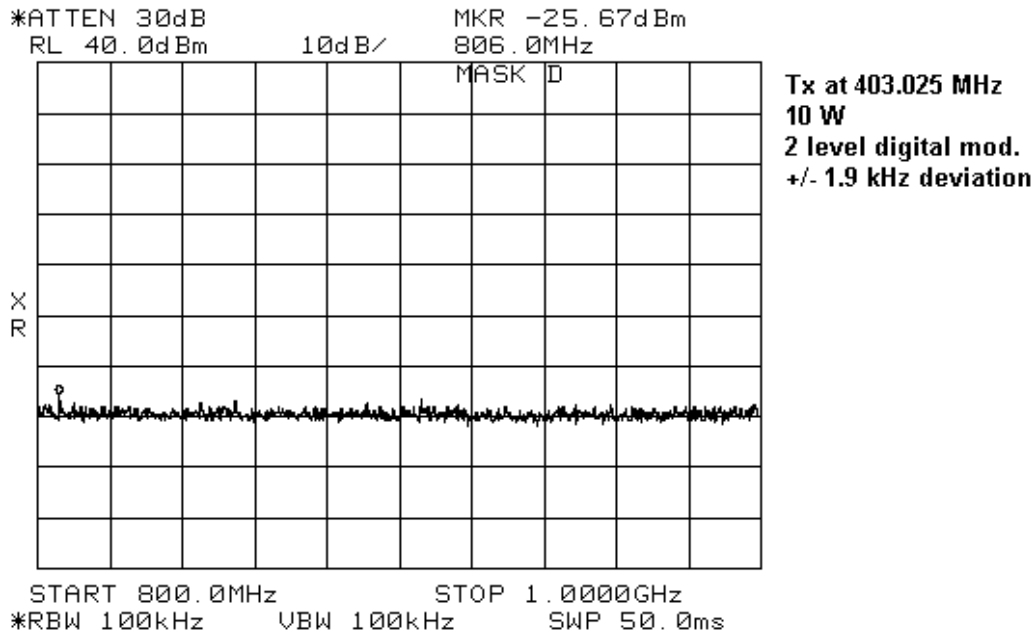


Figure 7-9: Tx at 403.025 MHz , 10 W power, 1 GHz to 2 GHz

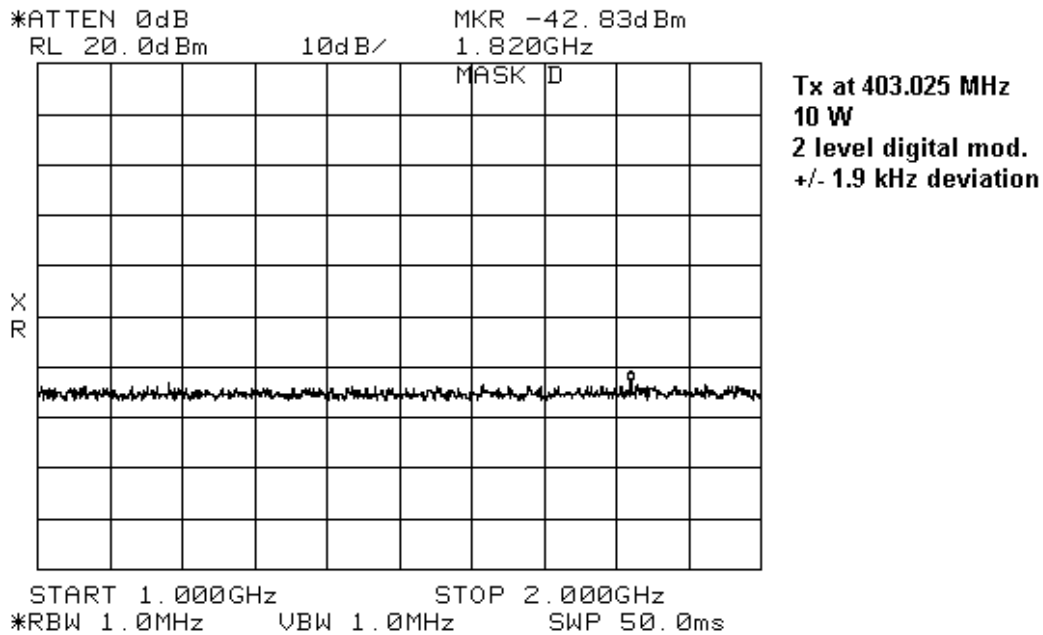


Figure 7-10: Tx at 403.025 MHz , 10 W power, 2 GHz to 2.75 GHz

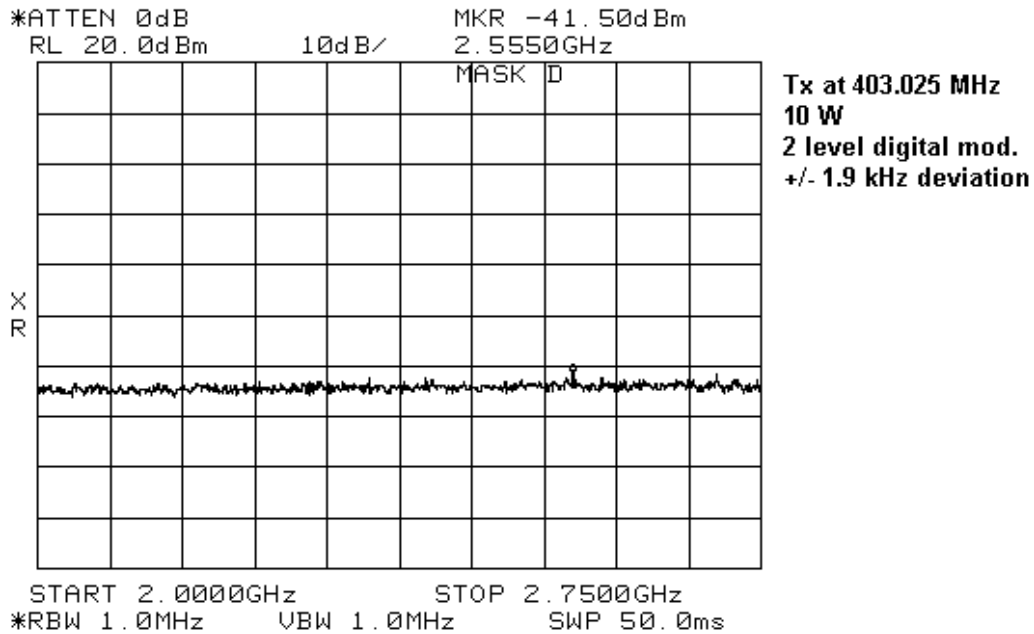


Figure 7-11: Tx at 403.025 MHz , 10 W power, 2.75 GHz to 6 GHz

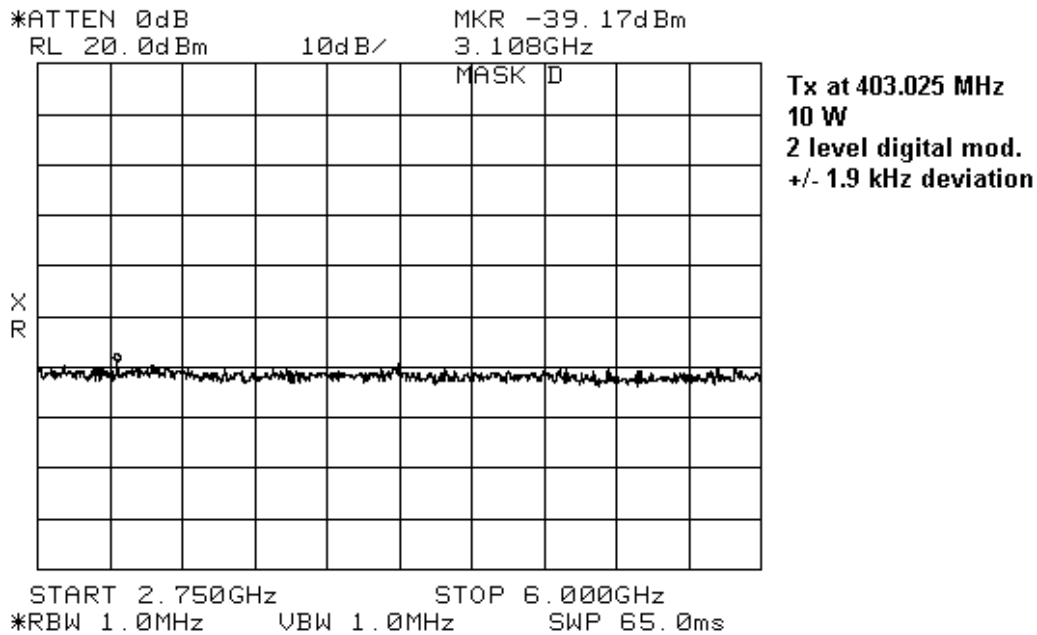


Figure 7-12: Tx at 449.975 MHz, 100 W power, 30 MHz to 800 MHz

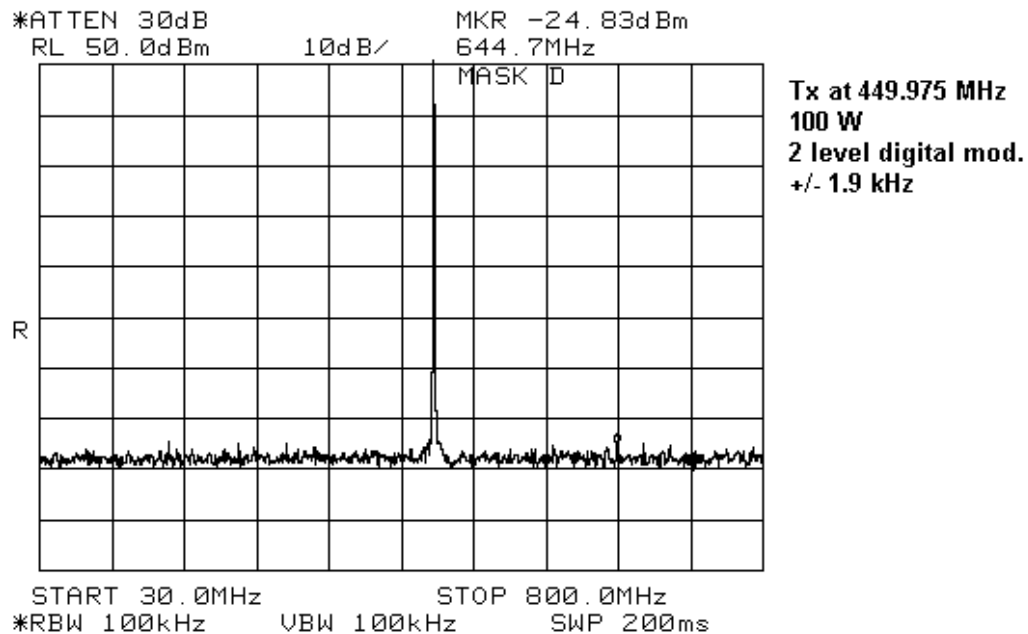


Figure 7-13: Tx at 449.975 MHz, 100 W power, 800 MHz to 1 GHz

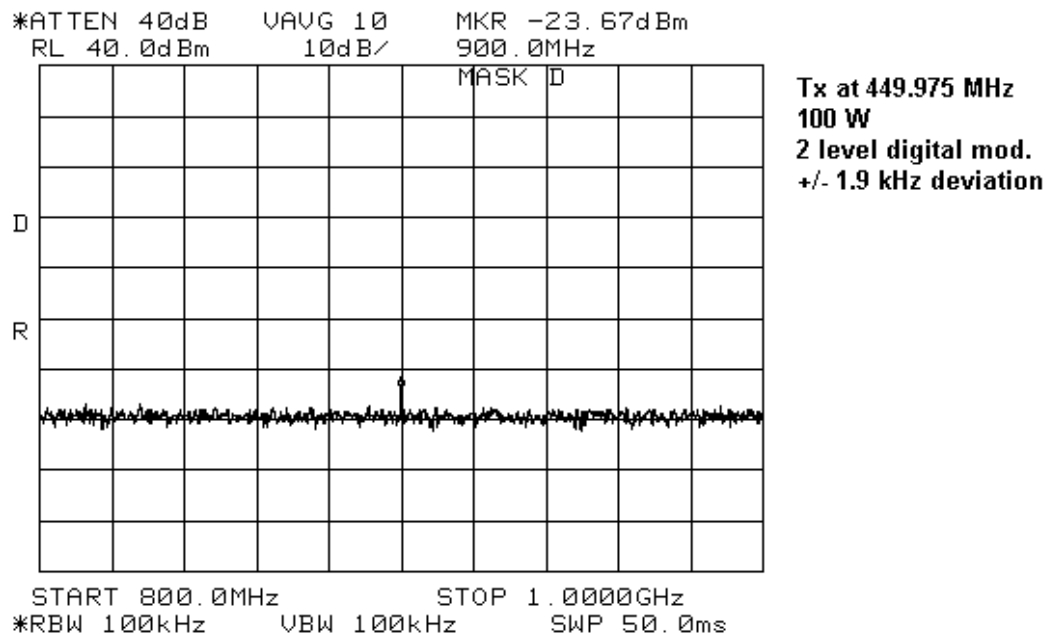
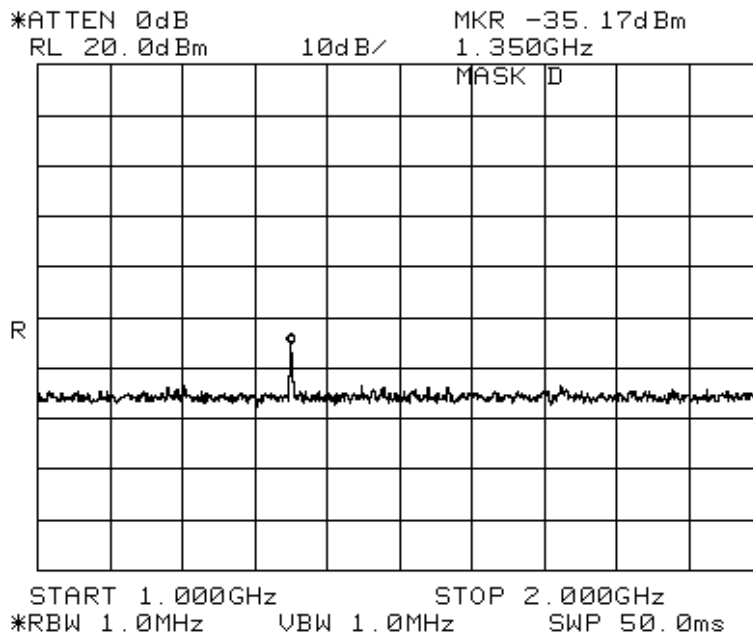
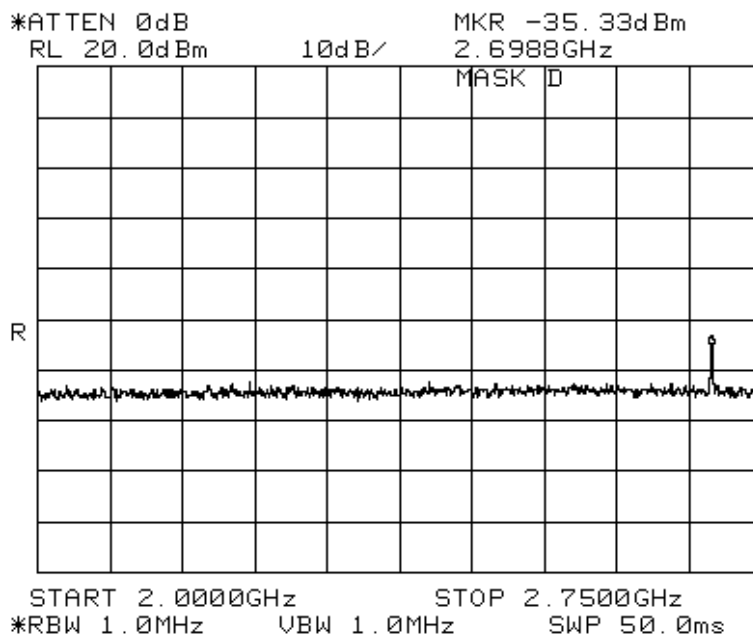


Figure 7-14: Tx at 449.975 MHz , 100 W power, 1 GHz to 2 GHz



**Tx at 449.975 MHz
100 W
2 level digital mod.
+/- 1.9 kHz deviation**

Figure 7-15: Tx at 449.975 MHz , 100 W power, 2 GHz to 2.75 GHz



**Tx at 449.975 MHz
100 W
2 level digital mod.
+/- 1.9 kHz deviation**

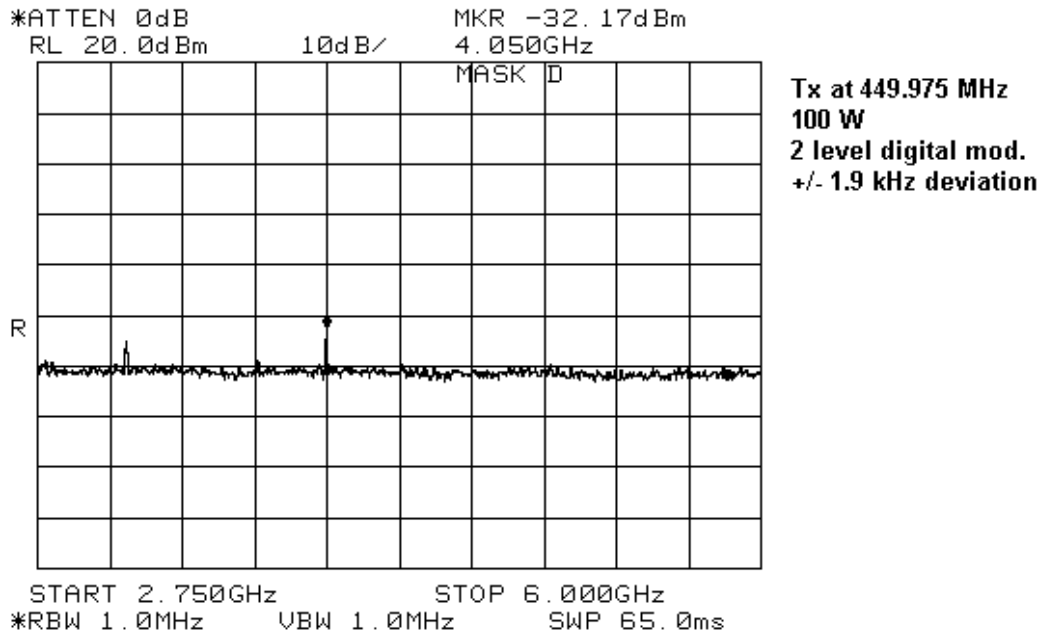
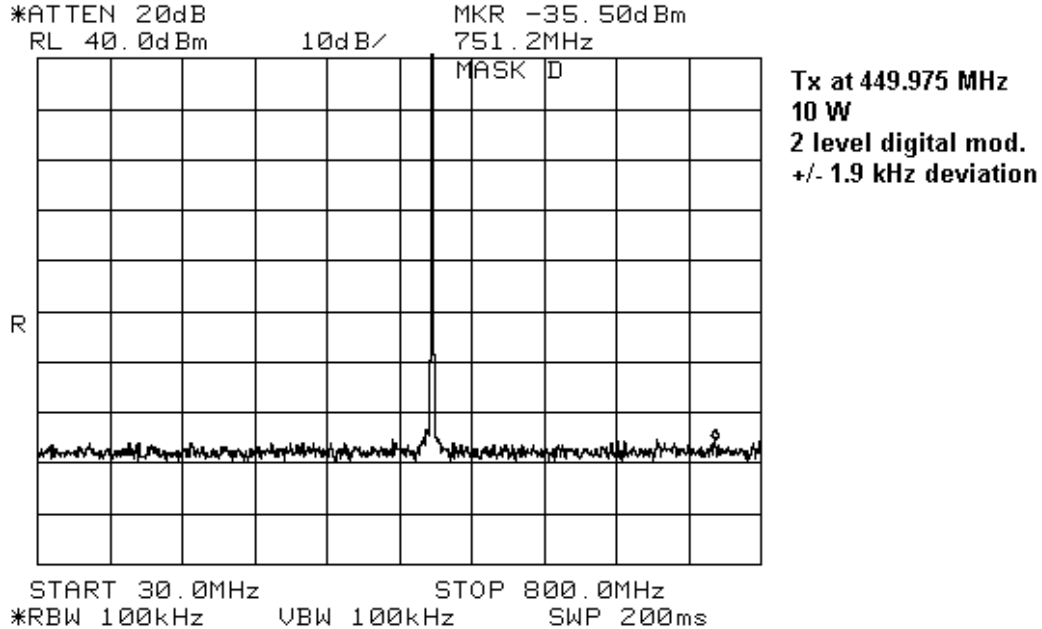
Figure 7-16: Tx at 449.975 MHz , 100 W power, 2.75 GHz to 6 GHz**Figure 7-17: Tx at 449.975 MHz , 10 W power, 30 MHz to 800 MHz**

Figure 7-18: Tx at 449.975 MHz , 10 W power, 800 MHz to 1 GHz

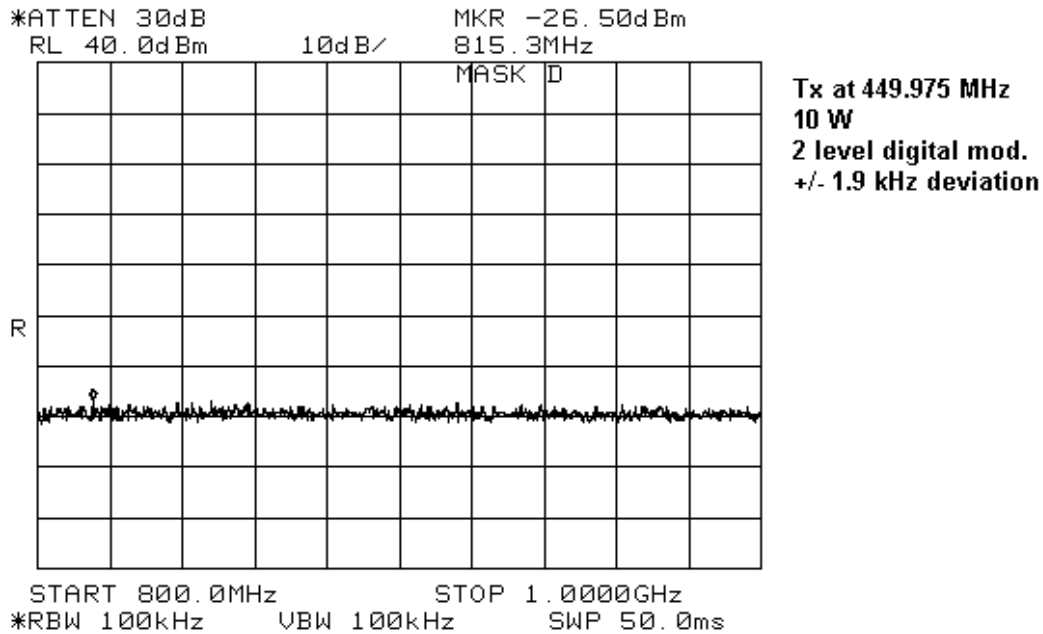


Figure 7-19: Tx at 449.975 MHz , 10 W power, 1 GHz to 2 GHz

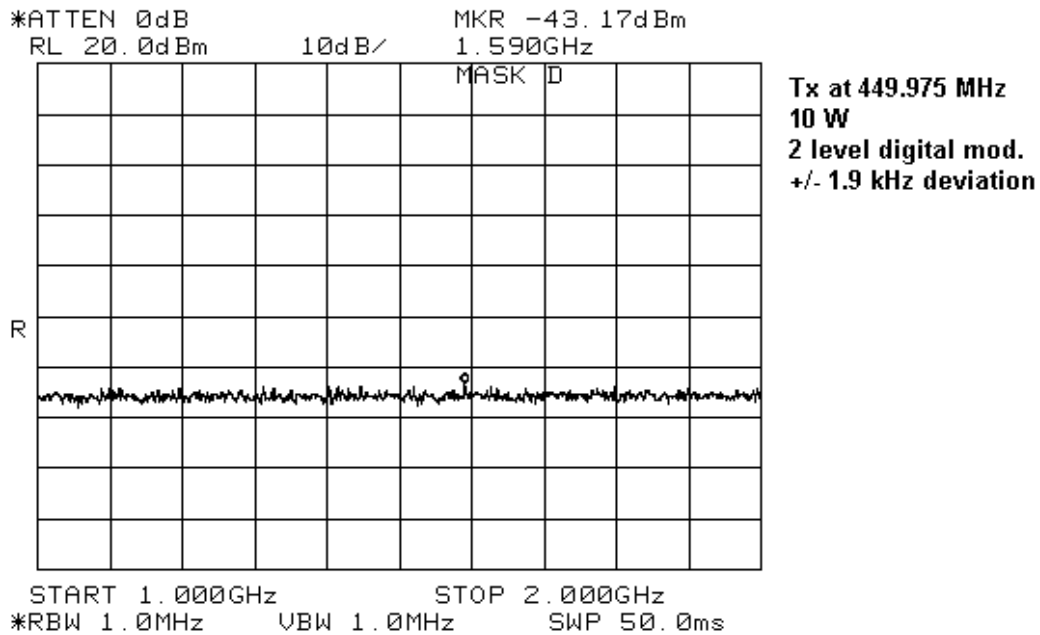
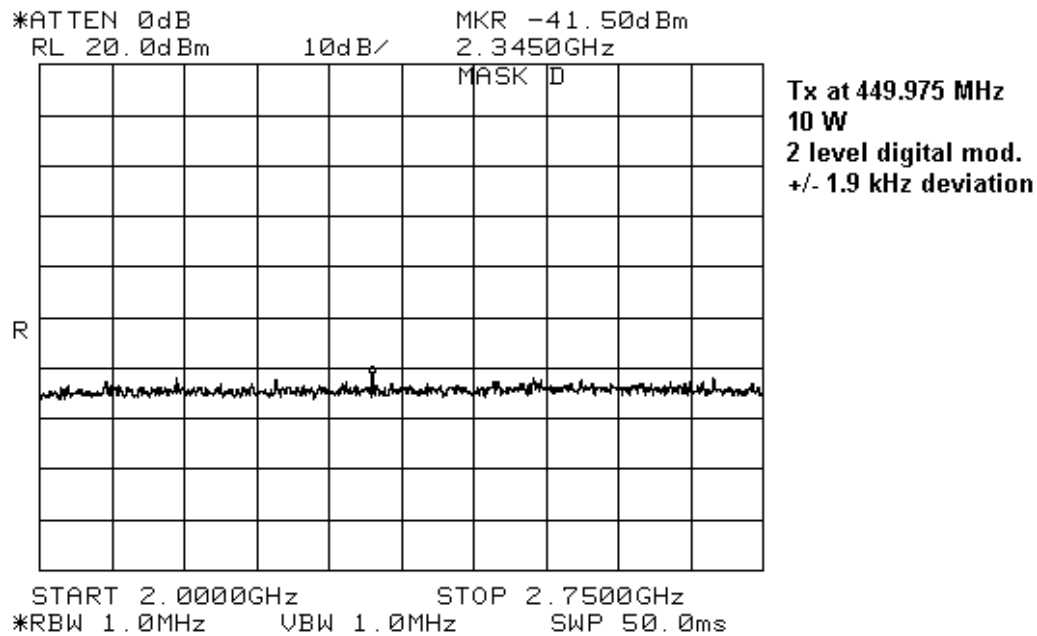
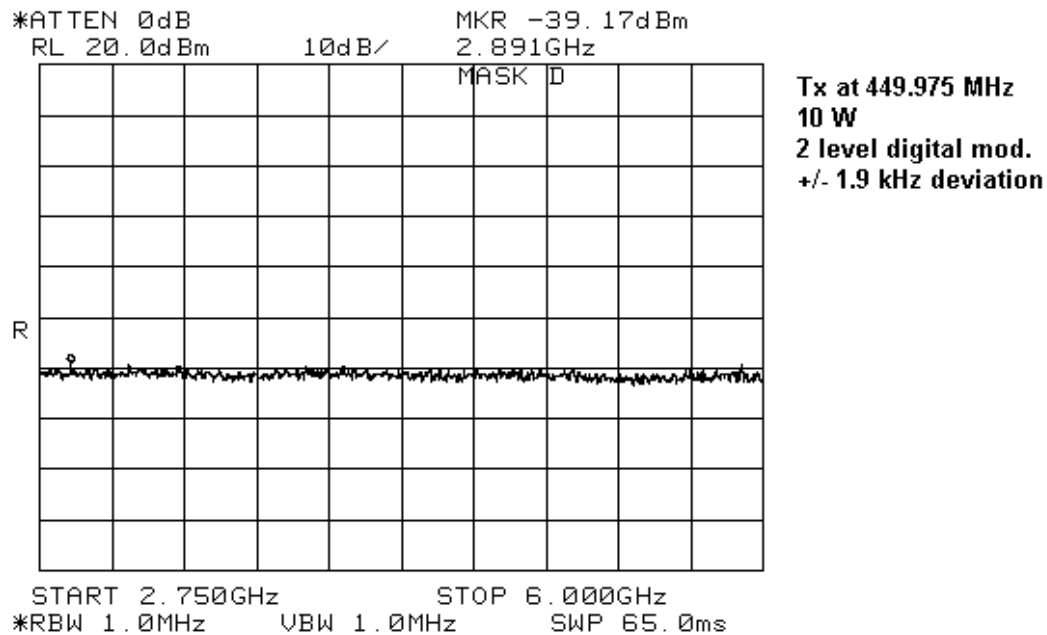


Figure 7-20: Tx at 449.975 MHz , 10 W power, 2 GHz to 2.75 GHz**Figure 7-21: Tx at 449.975 MHz , 10 W power, 2.75 GHz to 6 GHz**

7.4 Appendix D: Emission Mask Plots

This appendix presents all emission mask plots for the test cases measured.

Figure 7-22: 2500 Hz audio signal Wideband, 420 MHz

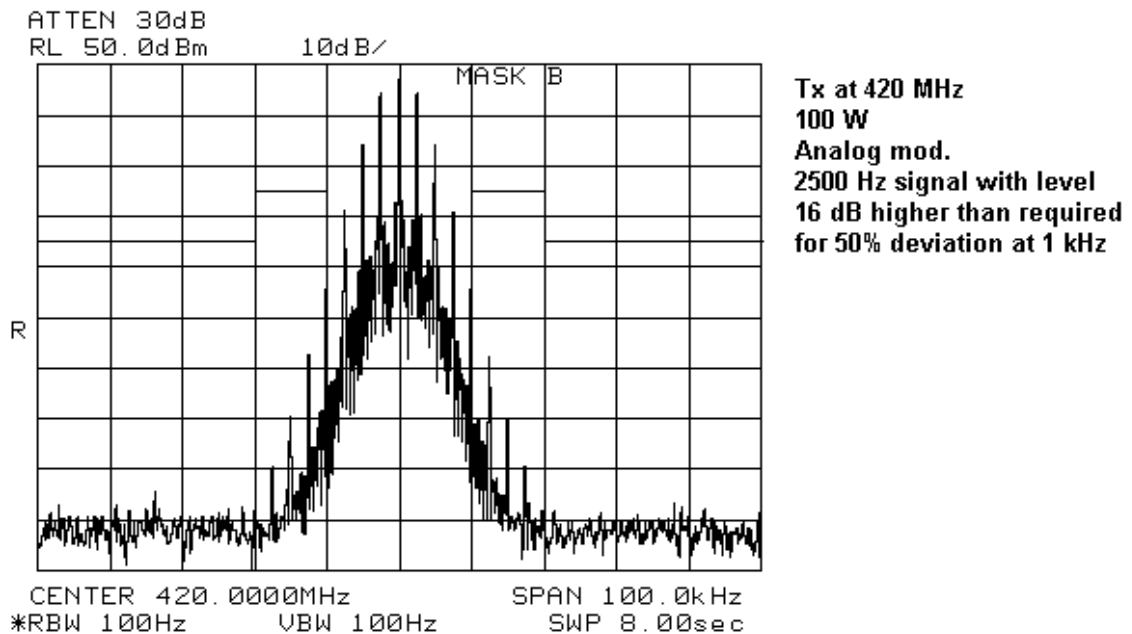


Figure 7-23: 2500 Hz audio signal Narrowband, 420 MHz

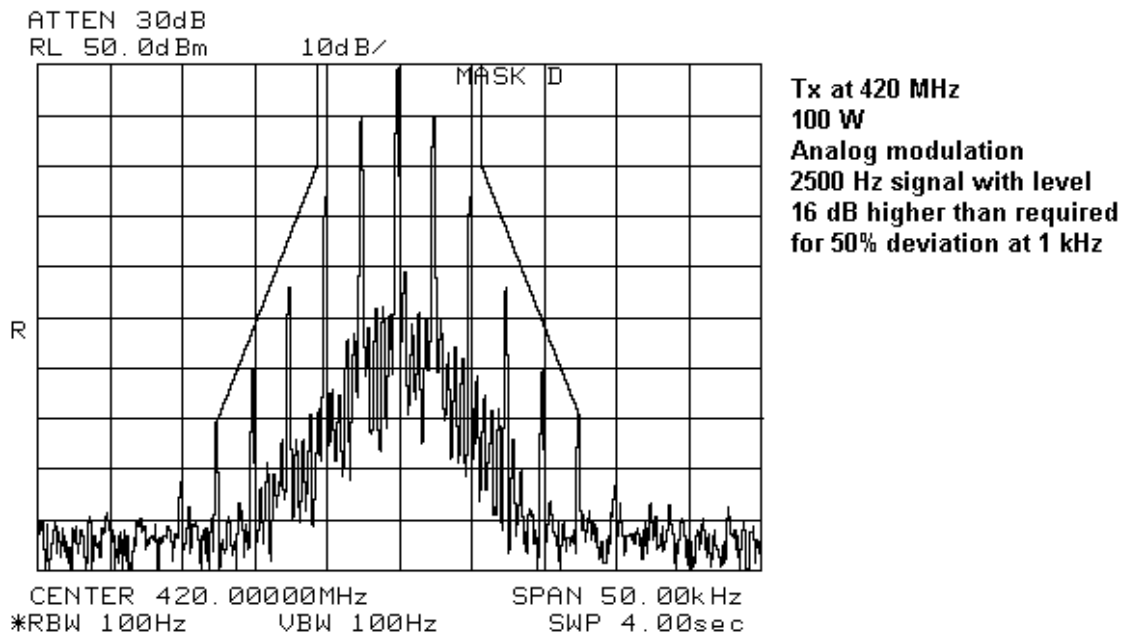
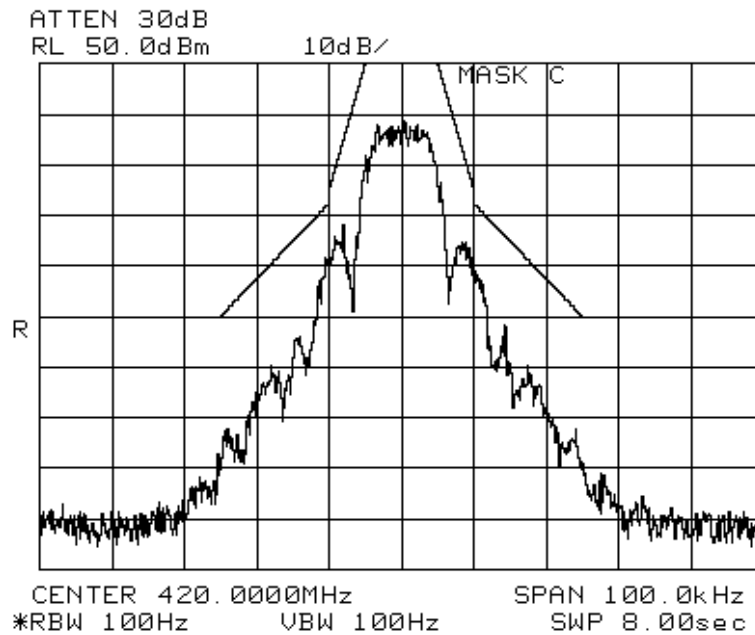
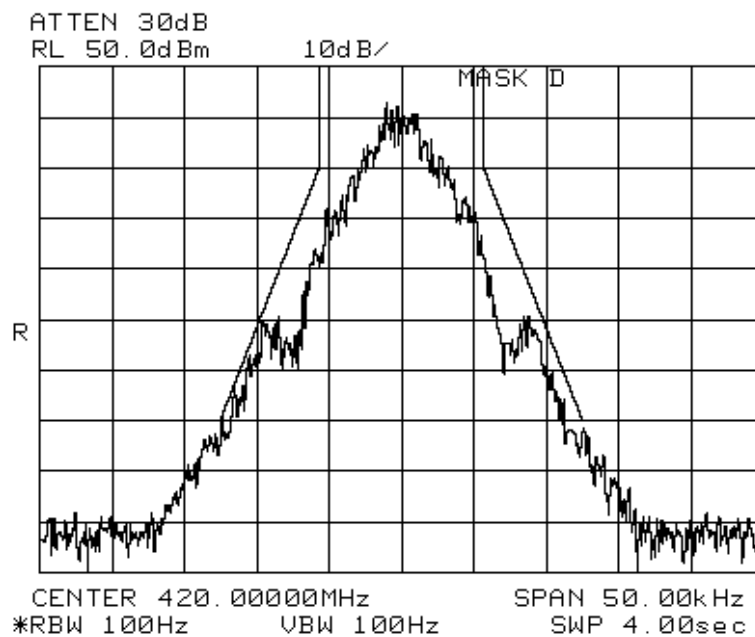


Figure 7-24: 2 level 9600 baud signal with +/- 3 kHz deviation, 420 MHz



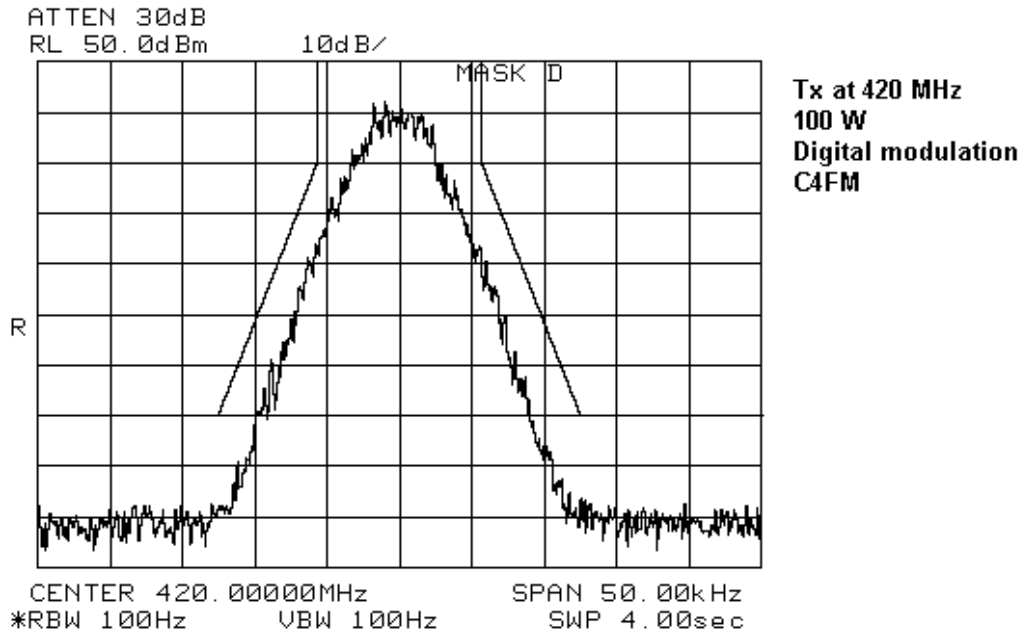
**Tx at 420 MHz
100 W
2 level digital mod.
+/- 3 kHz deviation**

Figure 7-25: 2 level 9600 baud signal with +/- 1.9 kHz deviation, 420 MHz



**Tx at 420 MHz
100 W
2 level digital modulation
+/- 1.9 kHz deviation**

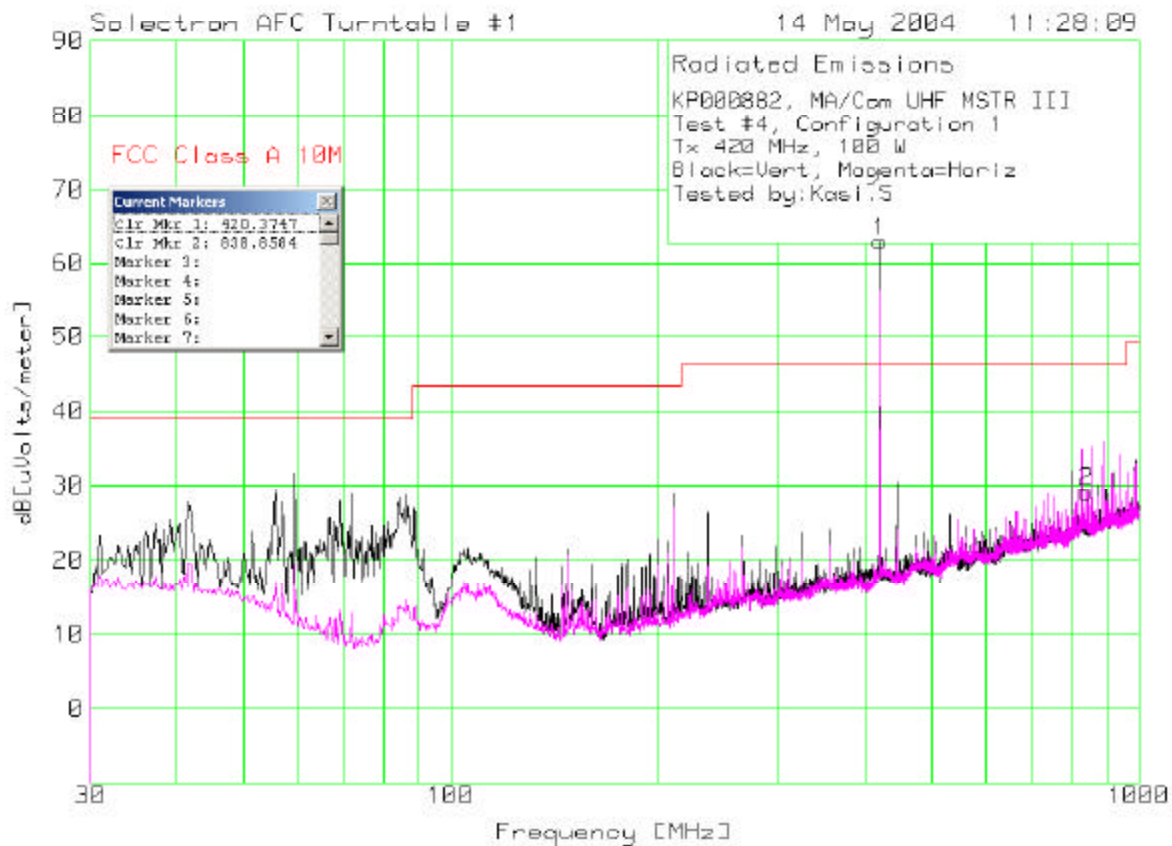
Figure 7-26: C4FM signal, 420 MHz



7.5 Appendix E: Field Strength of Spurious Emissions Plots

This appendix presents all field strength plots for the test cases measured.

Figure 7-27: Field strength with 100 W Tx, 30 MHz to 1 GHz (Tx at 420 MHz)



Note: the emissions at 420 MHz is leakage of the transmitted signal.

Figure 7-28: Field strength with 100 W Tx, 1 GHz to 6 GHz, low frequency split (Tx at 420 MHz)

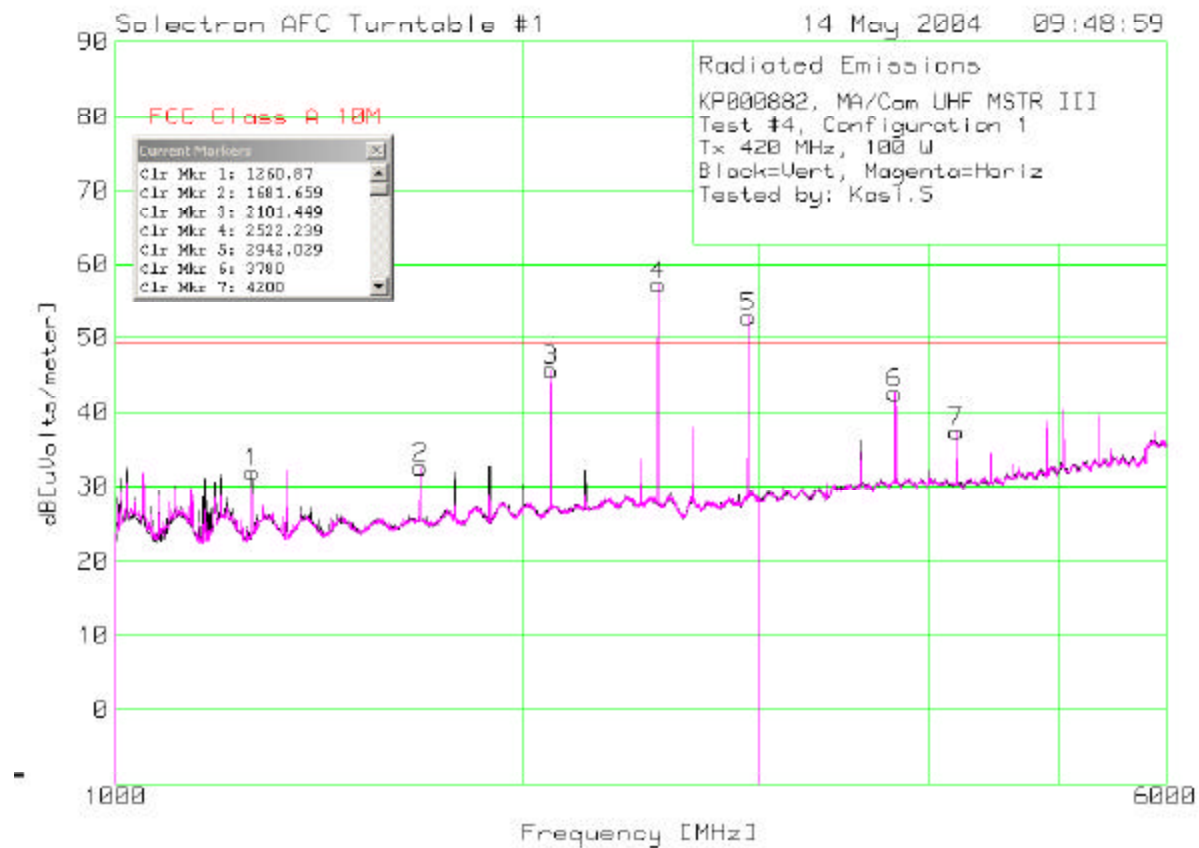
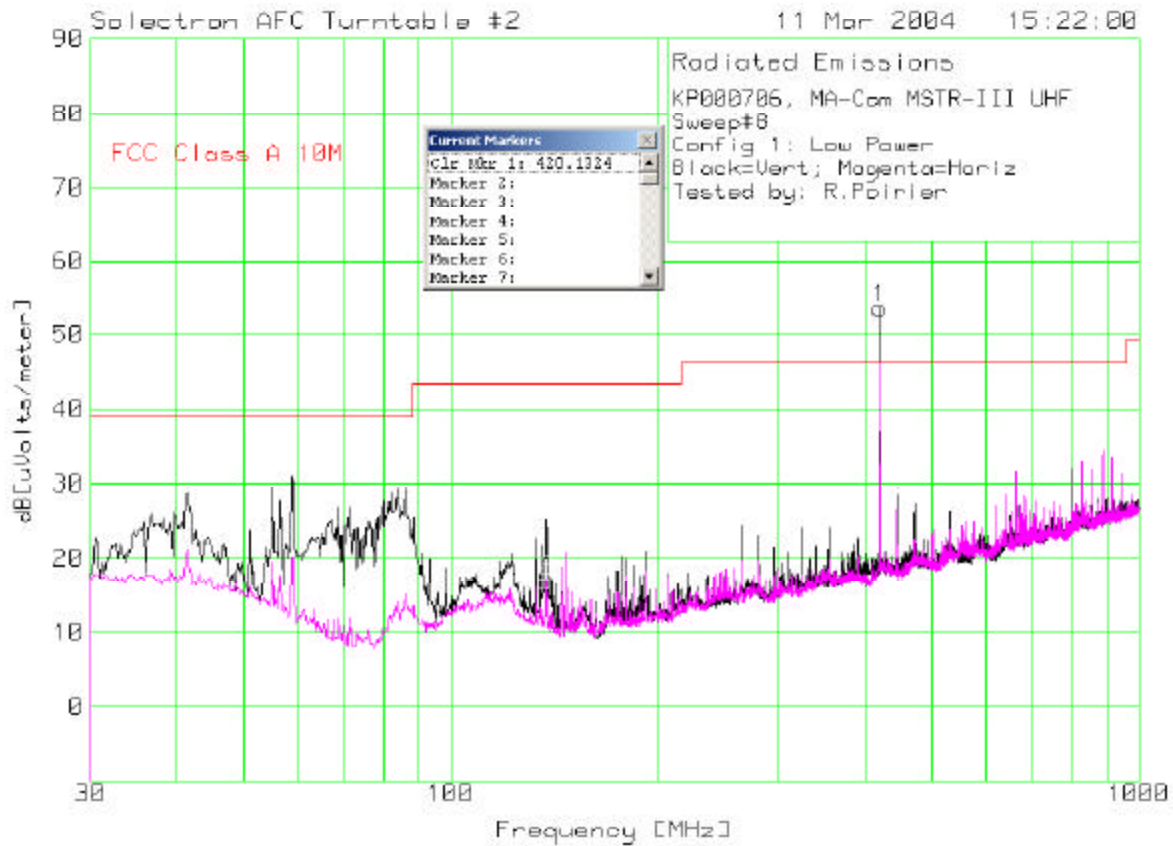


Figure 7-29: Field strength with 10 W Tx, 30 MHz to 1 GHz (Tx at 420 MHz)

Note: the emissions at 420 MHz is leakage of the transmitted signal.

Figure 7-30: Field strength with 10 W Tx, 1 GHz to 6 GHz, (Tx at 420 MHz)

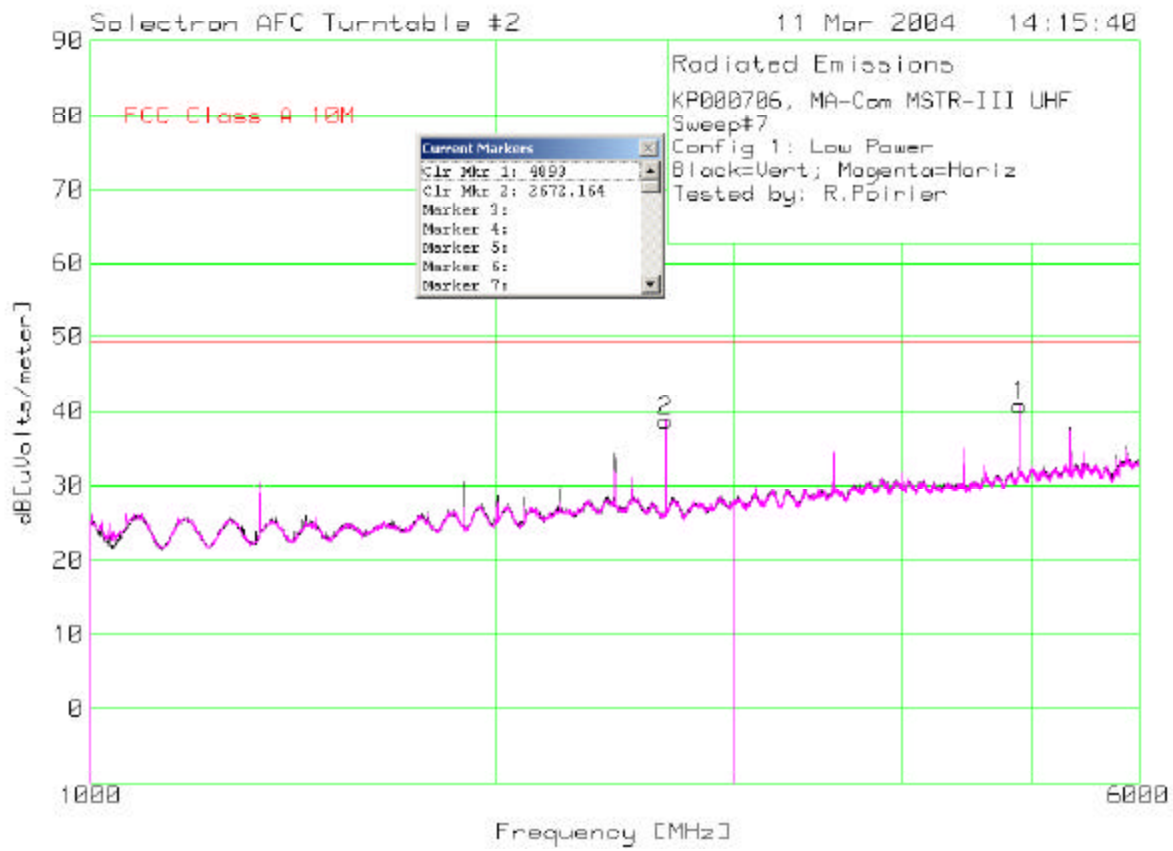
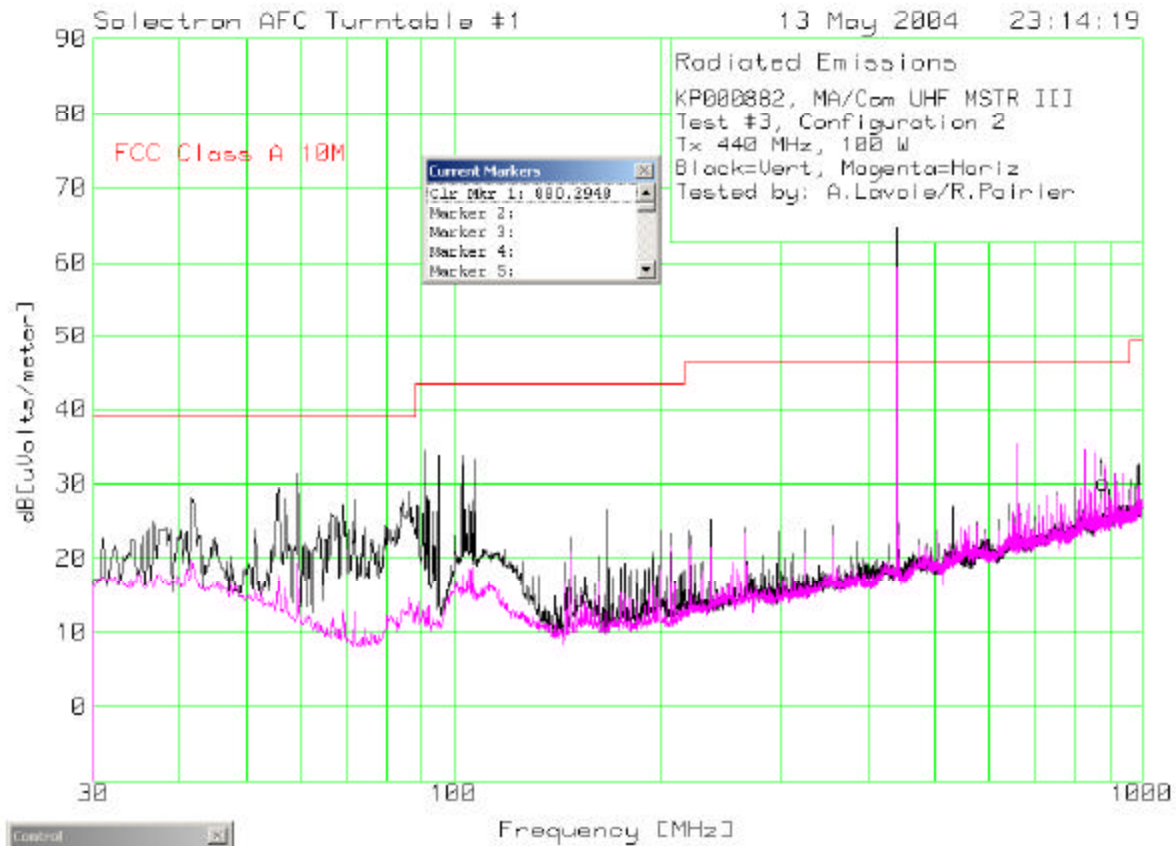


Figure 7-31: Field strength with 100 W Tx, 30 MHz to 1 GHz (Tx at 440 MHz)



Note: the emissions at 440 MHz is leakage of the transmitted signal.

Figure 7-32: Field strength with 100 W Tx, 1 GHz to 6 GHz, (Tx at 440 MHz)

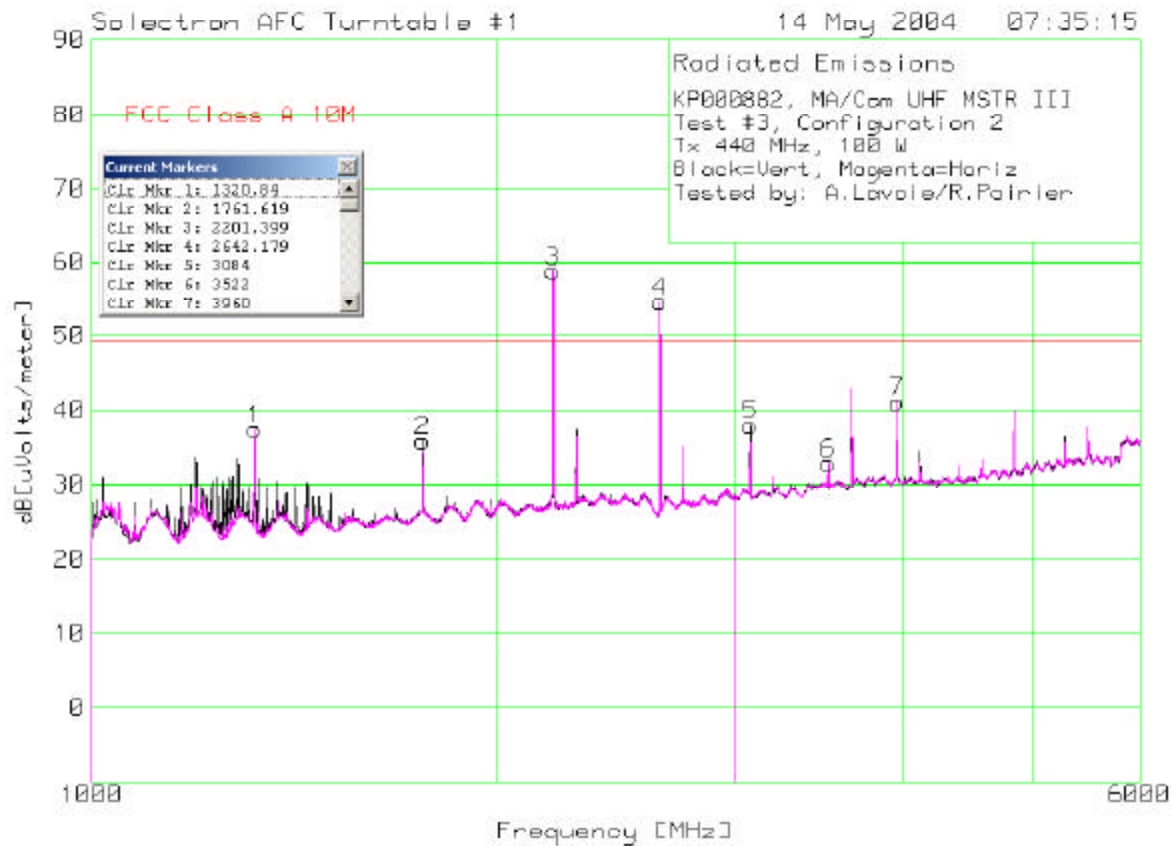
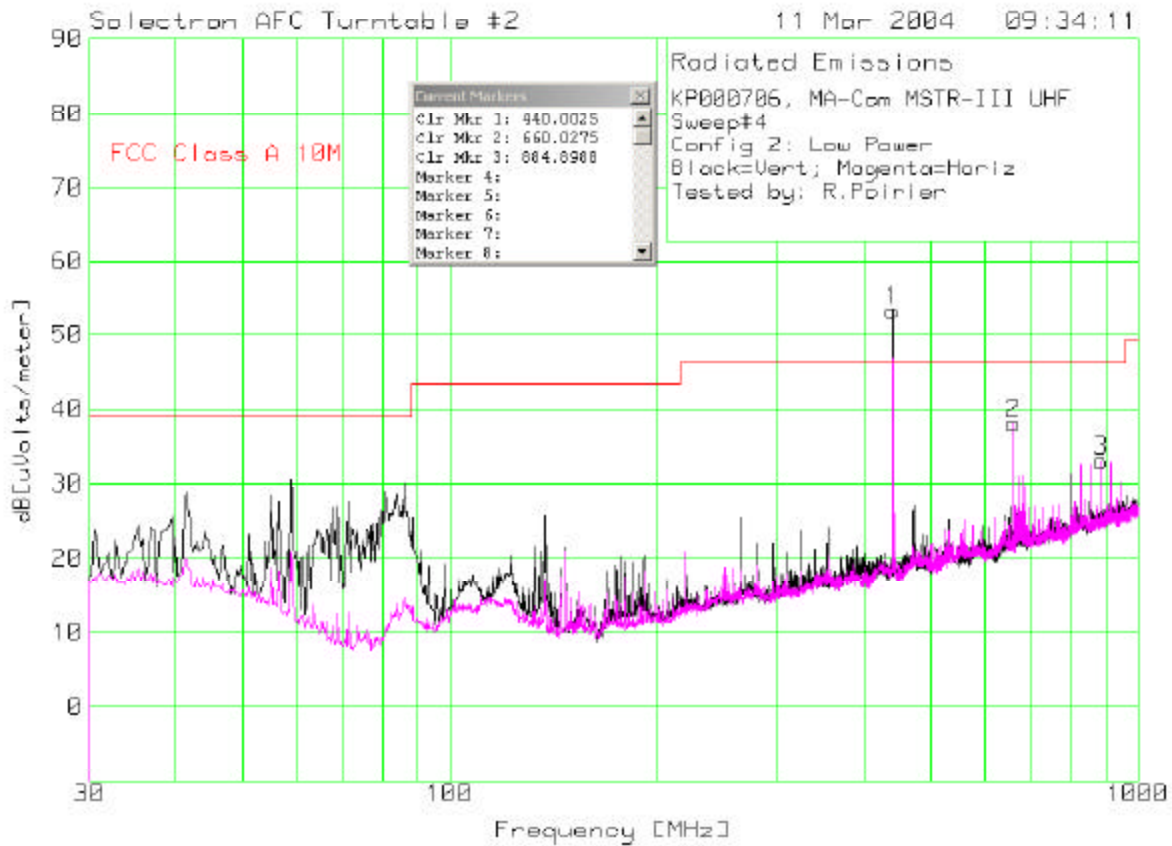
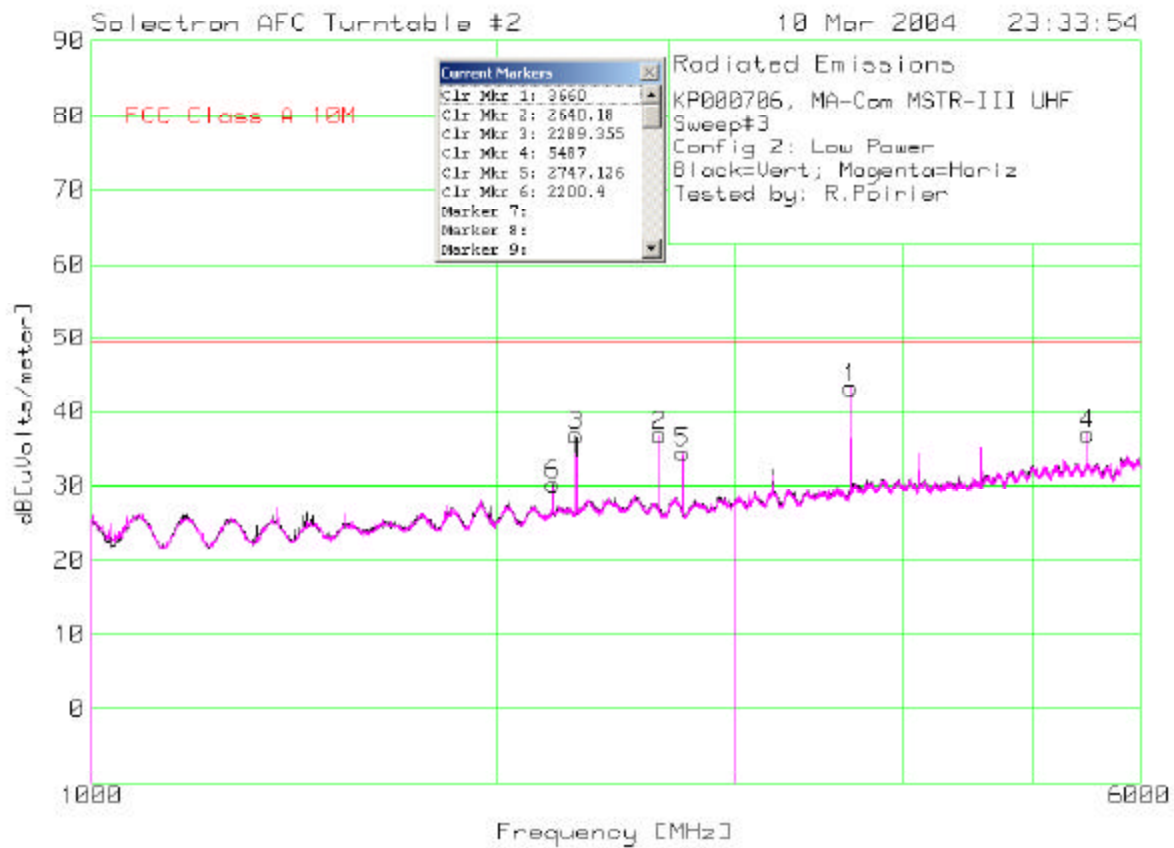


Figure 7-33: Field strength with 10 W Tx, 30 MHz to 1 GHz (Tx at 440 MHz)

Note: the emissions at 440 MHz is leakage of the transmitted signal.

Figure 7-34: Field strength with 10 W Tx, 1 GHz to 6 GHz, (Tx at 440 MHz)



7.6 Appendix F: Transient Frequency Behavior Plots

This appendix presents all the transient frequency behavior plots for the test cases measured

Figure 7-35 Transient Frequency Behavior, Tx at 420 MHz, Wideband, Transmitter on

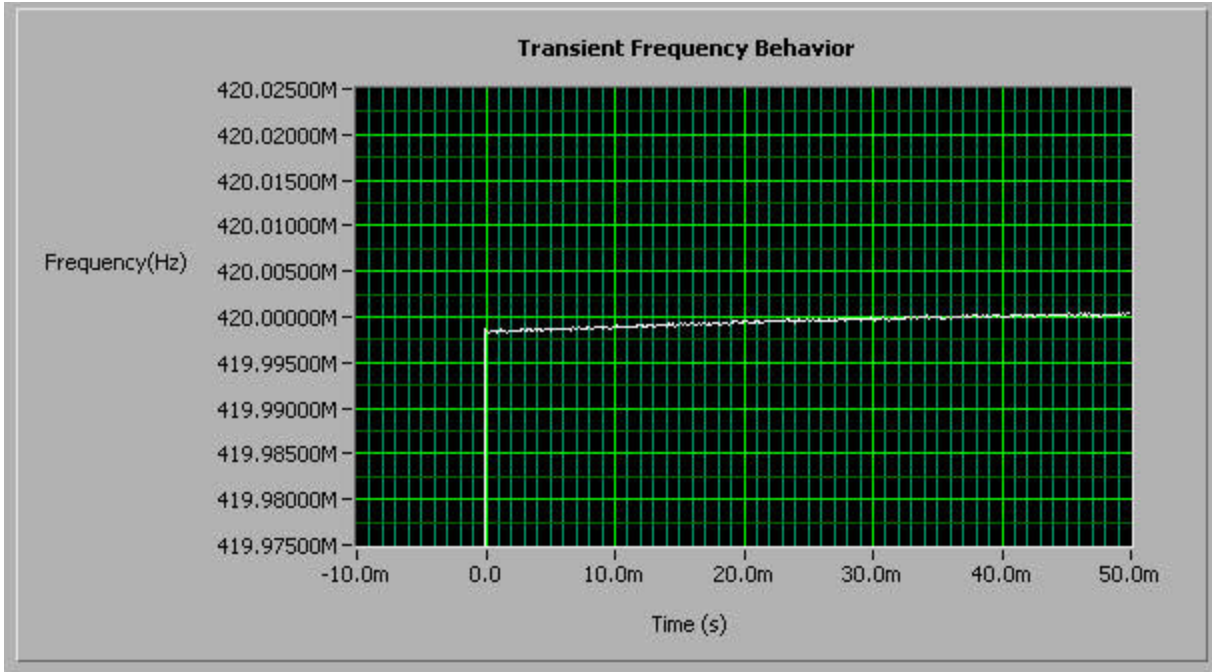


Figure 7-36 Transient Frequency Behavior, Tx at 420 MHz, Wideband, Transmitter off

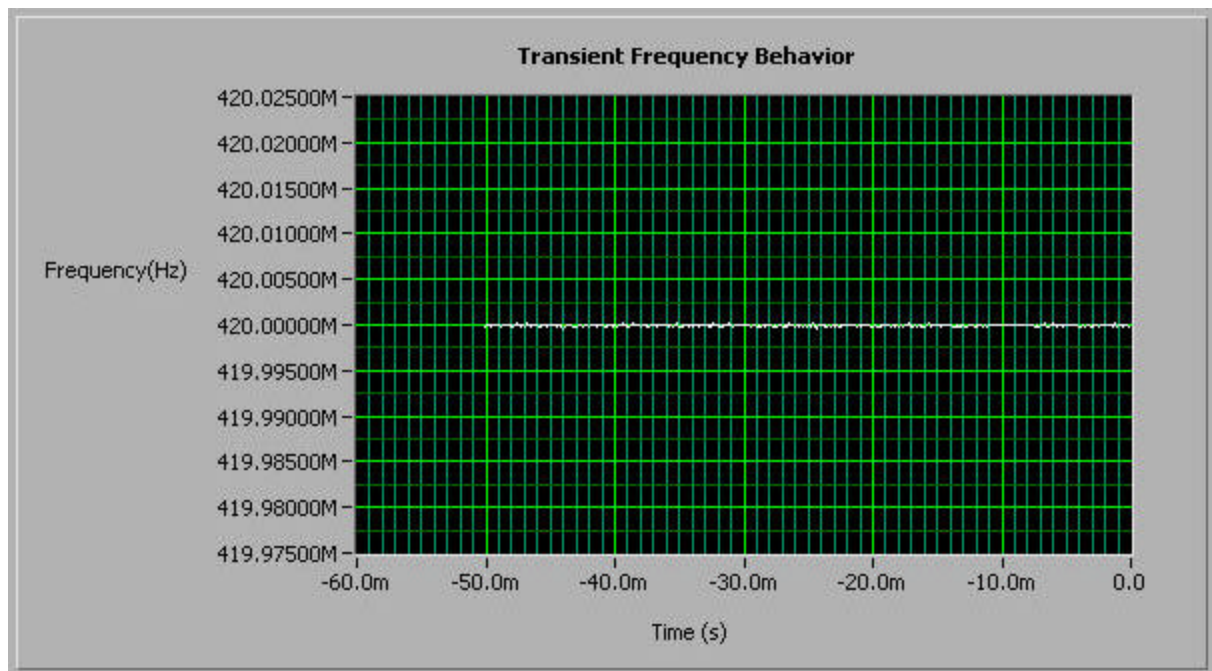


Figure 7-37 Transient Frequency Behavior, Tx at 420 MHz, Narrowband, Transmitter on

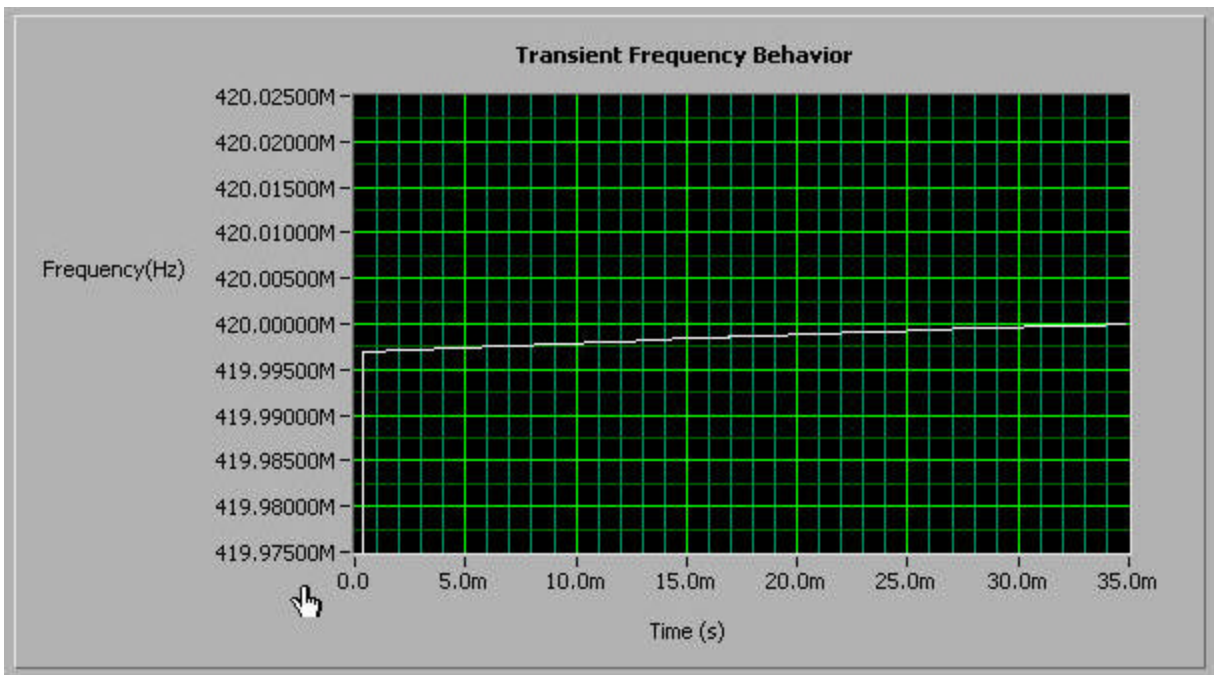
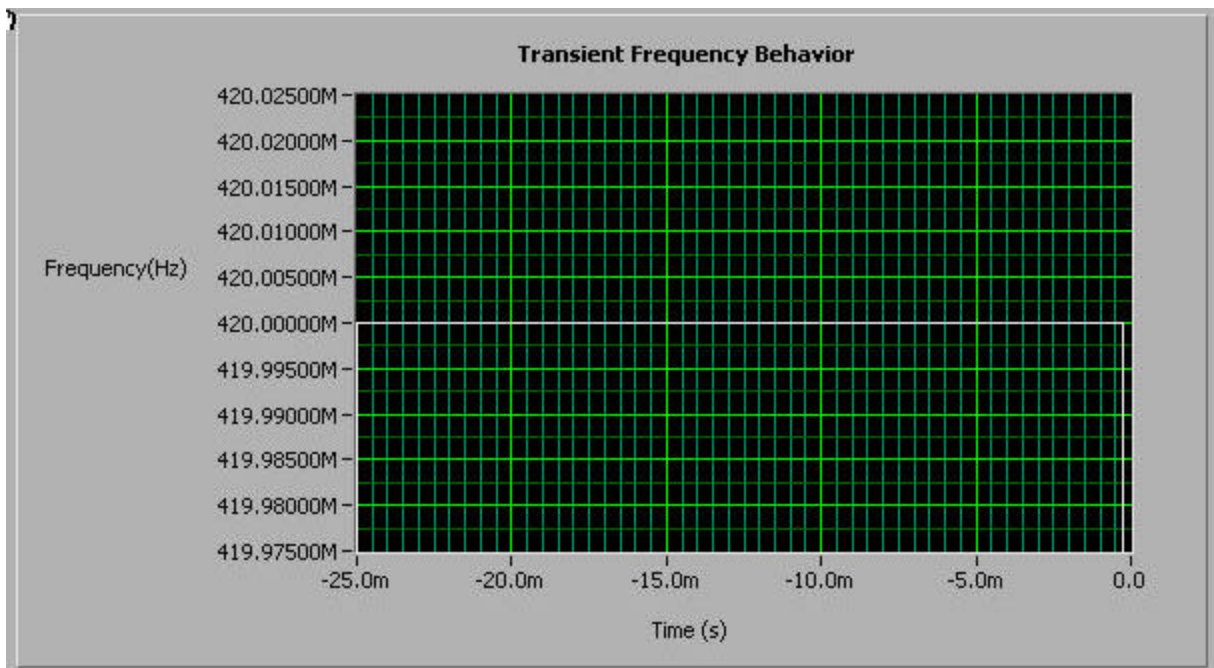


Figure 7-38 Transient Frequency Behavior, Tx at 420 MHz, Narrowband, Transmitter off



7.7 Appendix G: Occupied Bandwidth Plots

This appendix presents all the occupied bandwidth plots for the test cases measured.

Figure 7-39: 2500 Hz audio signal Wideband, 420 MHz

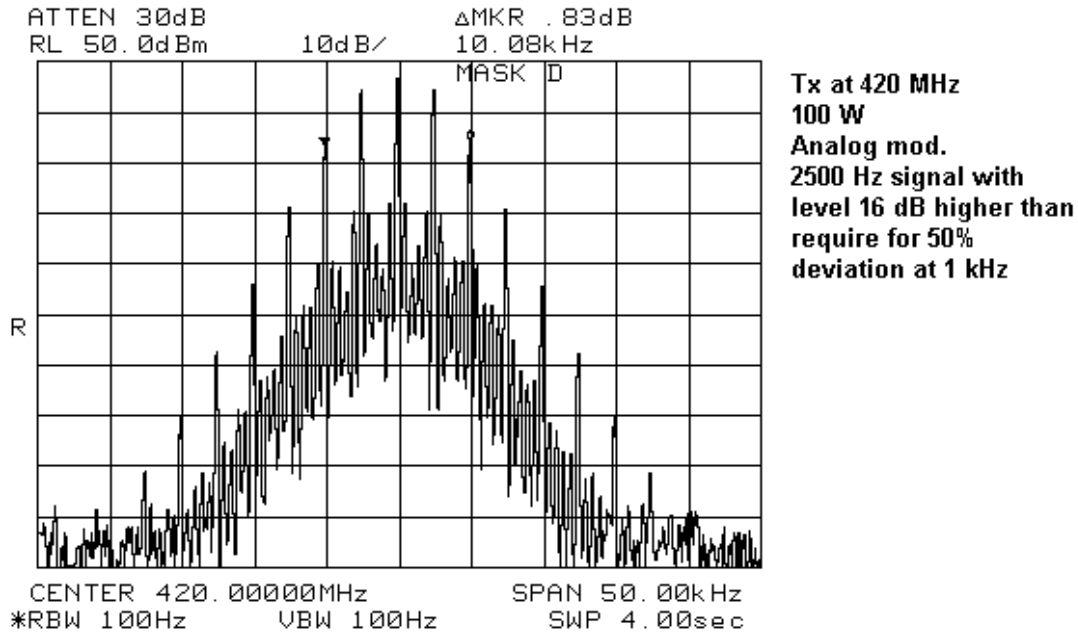


Figure 7-40: 2500 Hz audio signal Narrowband, 420 MHz

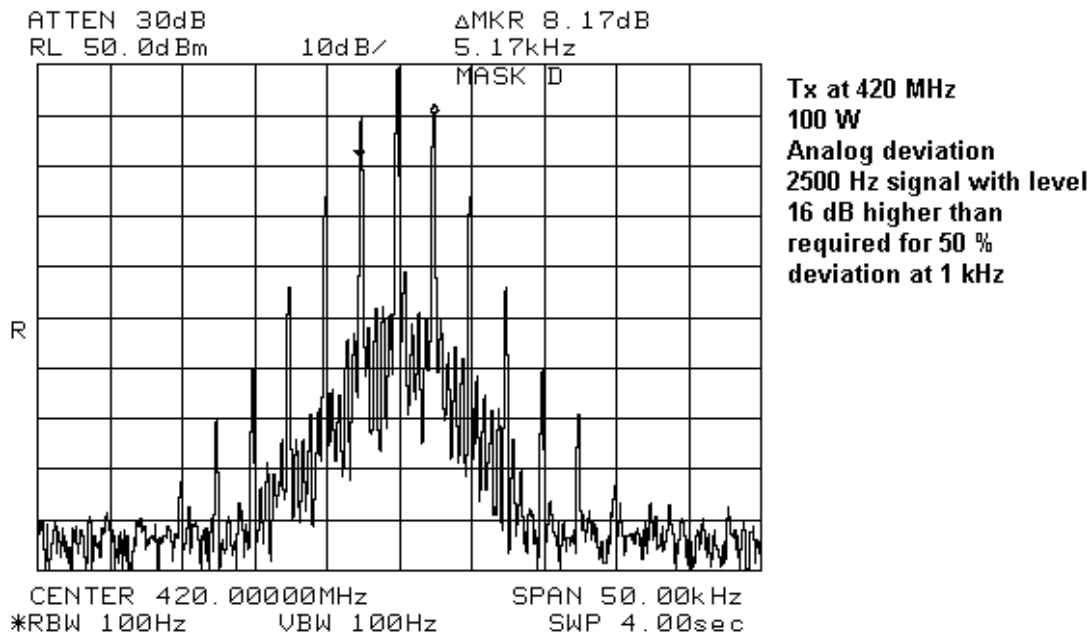
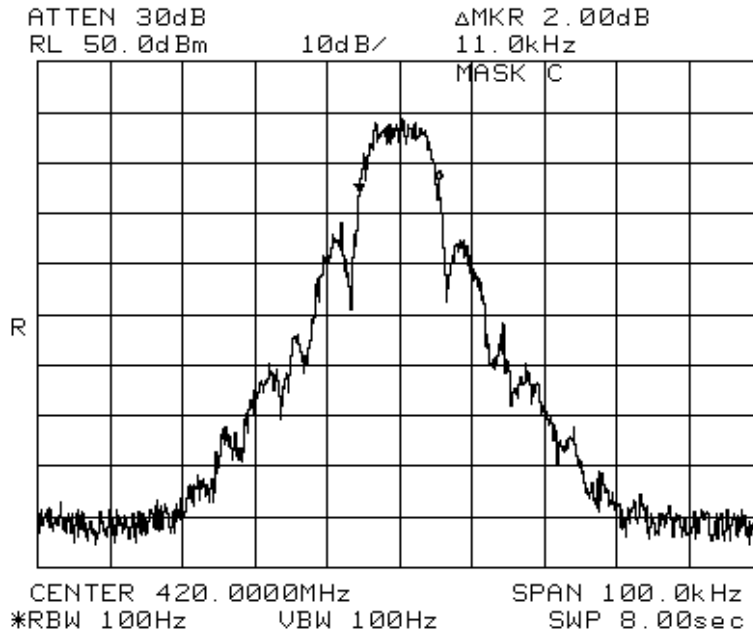
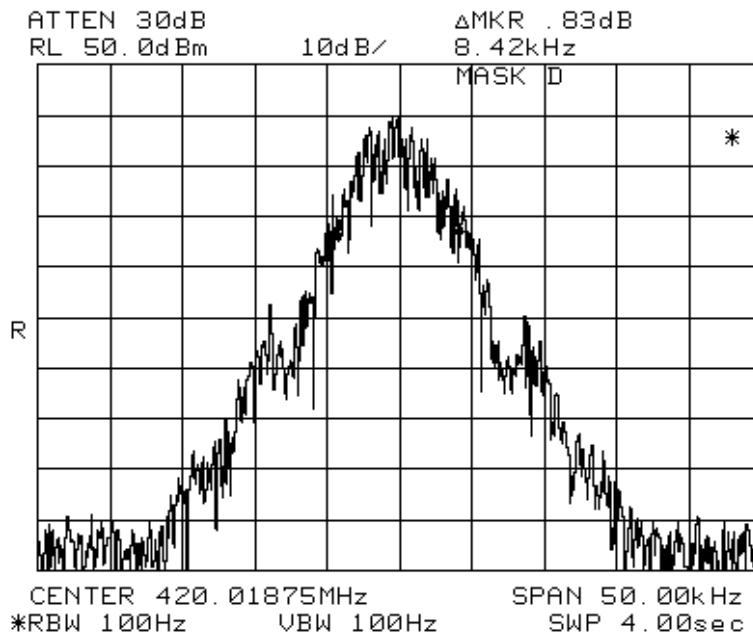


Figure 7-41: 2 level 9600 baud signal with +/- 3 kHz deviation, 420 MHz



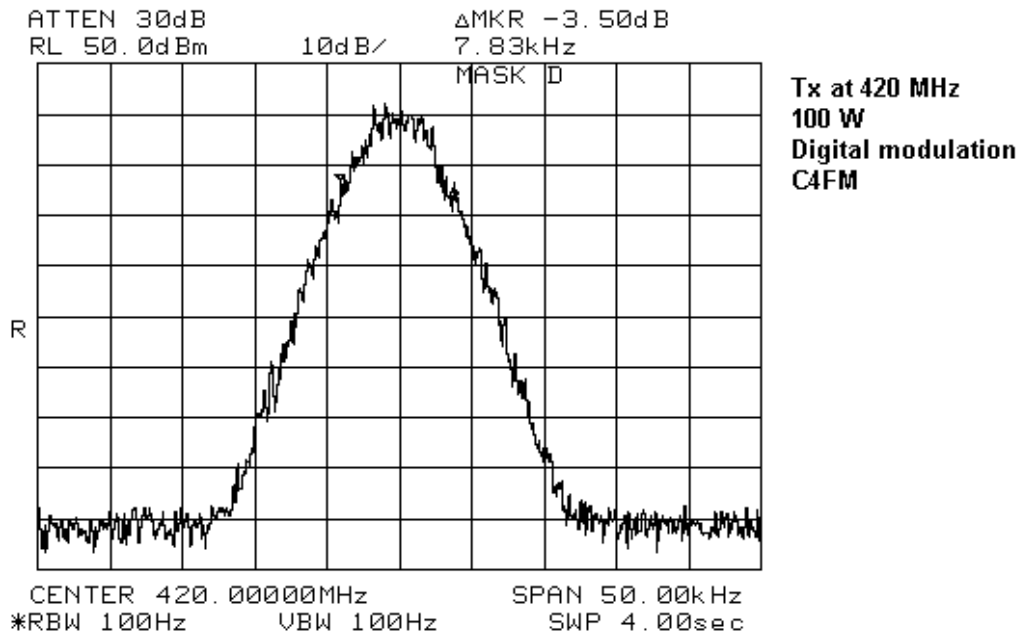
**Tx at 420 MHz
100 W
2 level digital mod.
+/- 3 kHz deviation**

Figure 7-42: 2 level 9600 baud signal with +/- 1.9 kHz deviation, 420 MHz



**Tx at 420 MHz
100 W
2 level digital mod.
+/- 1.9 kHz deviation**

Figure 7-43: C4FM signal, 420 MHz



C-MAC ENGINEERING INC. A Soletron Company

Certification Report for M/A-COM MASTRIII UHF Base Station FCC Part 90 & RSS-119



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