SOLECTRON

Certification Report for M/A-COM MASTRIII VHF Base Station

FCC Part 90

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Prepared for:	**M/A-COM, Inc.** **221 Jefferson Ridge Parkway** **Lynchburg, Virginia** **U.S.A., 24501**
Author:	**Denis Lalonde** Radio Compliance Discipline Leader

C-MAC Engineering Inc.
A Solectron Company
21 Richardson Side Road,
Kanata, Ontario, K2K 2C1
http://www.solectrontechnicalctr.com/

Release Control Record

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Approvals

Function	Name	Job title	Signature
Document Release Approval	Warren Johnsen	Program Manager	March 9, 2004
Author	Denis Lalonde	Radio Compliance Discipline Leader	March 9, 2004
Technical Reviewer	Jacques Rollin	EMC Advisor	March 9, 2004

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 VHF Base Station as part of a original application for the FCC Part 90 certification.

Reference: - FCCID: OWDTR-0032-E

On the basis of measurements performed in August and December 2003 to March 2004, the M/A-COM MASTRIII VHF 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. 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 VHF 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 VHF Base Station	Project Manager:	Warren Johnsen
Product Code:		Measurements by :	Denis Lalonde
Product Status:		Date:	Dec. 2003 to March 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 and 2.1051 RSS-119 sect. 6.3	■	□	
■	Emission Mask	FCC Part 90.210 and 2.1049 RSS-119 sect. 6.4	■	□	
■	Field Strength of Spurious Emissions	FCC Part 90.210 and 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 was "M/A-COM MASTRIII VHF Base Station".

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

Figure 3-1 Product Description

3.1.1 Description of Equipment Changes

The rationale for this Class 2 Permissive Change application is the introduction of modified modules in the M/A-COM MASTRIII VHF Base Station as follows:

1. Modified Transmit Synthesizer
2. Modified Receive Synthesizer
3. Modified Power Amplifier

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 VHF Base Station

3.3 Transmitter Specifications

Table 3-1 lists the specifications of the transmitter under test.

Table 3-1: Transmitter Specifications

Circuit Pack	Fundamental Frequencies (MHz)
Tx power	10 to 110 W
Tx frequency	136 to 174 MHz
Channel spacing	12.5 or 25 kHz

3.4 System Components

The system tested consists of the following units, as shown in Table 3-2.

Table 3-2: MASTRIII VHF BTS Components

Component	Model	Serial Number
MASTRIII shelf	SXGPNX	9861756
Tx Synthesizer module (low freq. split)	EA101685V1	SLR 0330 1352
Tx Synthesizer module (low freq. split)	EA101685V1	SLR 0330 1348
Tx Synthesizer module (high freq. Split)	EA101685V2	SLR 0330 1362
Tx Synthesizer module (high freq. Split)	EA101685V2	SLR 0330 1366
Rx Synthesizer module	EA101684V1	SLR 0330 1730
Rx Front End module	19D902782G1	CKA 01346979
IF module	EA101401V1	SLR 03150255
System module	19D902590G6	SLR 03040661
DSP module	EA101800V1	SLR 03084077
Power module	19D902589G2	CKA 01390368
Power supply	19A149979P1	31725690
SitePro shelf	EA101209V1	SLR 02190892
RF Power Amplifier	EA101292V10	08324897

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

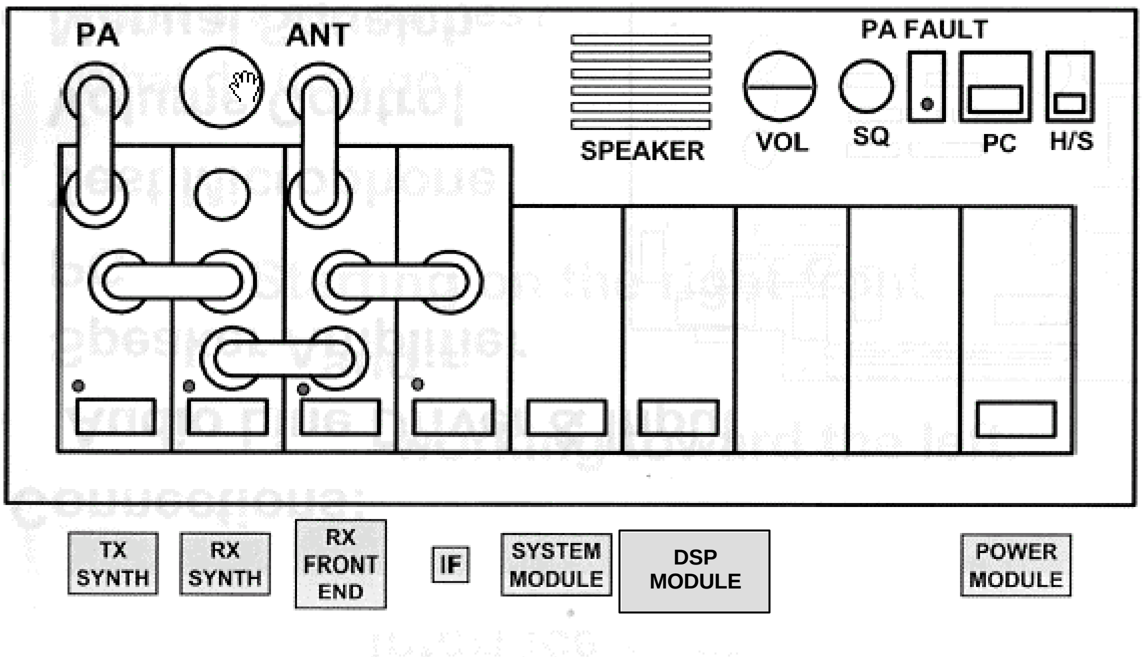
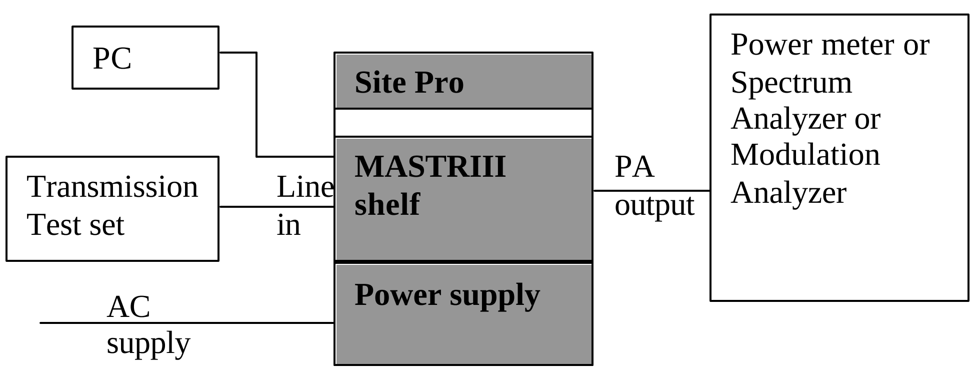


Figure 3-3: System Configuration



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

Rated power
10 to 110 W (40 to 50.4 dBm)

5.1.2 Test Facility Information

Location:	Solectron Technical Centre Lab 13
Date tested:	December 11, 2003
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 both extremities and in the middle of the frequency band. The lowest and highest possible power levels were evaluated. The lowest frequency signal was measured with a low frequency split Tx Synthesizer, the highest frequency signal was measured with a high frequency split Tx Synthesizer. The mid-frequency signal was measured with Tx Synthesizers of both frequency splits.

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)
136.025	40.2	50.5
153.975 (low freq. split)	40.0	50.5
153.975 (high freq. split)	40.1	50.4
173.975	40.1	50.4

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	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
Power meter	Anritsu	2438A		971397	14/04/2004
Power sensor	Anritsu	M2424A		2652A15075	14/04/2004

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.

5.2 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, 2.1051
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 1740	-19.6

The limit is calculated in section 5.4.

5.2.2 Test Facility Information

Location: Solectron Technical Centre Lab 13

Date tested: January 16, 2004

Tested by: Denis Lalonde

5.2.3 Test Procedure

Conducted spurious emissions were measured at the bottom, middle, and top of the 136 to 174 MHz frequency band. The lowest frequency signal was measured with a low frequency split Tx Synthesizer, the highest frequency signal was measured with a high frequency split Tx Synthesizer. The mid-frequency signal was measured with Tx Synthesizers of both frequency splits.

The 153.975 MHz (mid-frequency) measurements were repeated while the power amplifier was operating at 10 W and 110 W.

The signal modulation used for measurements was a 2 level 9600 baud digital wide band signal (+/-3000 Hz deviation).

The measurement was separated in 2 frequency bands;

1. 30 MHz to 250 MHz: the power amplifier output is connected to the spectrum analyzer through a 10 dB and a 20 dB attenuator.
2. 250 MHz 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 200 MHz high pass filter.

5.2.4 Test Results

The test result are shown in Table 5-7.

Table 5-7: Conducted Spurious Emissions

Channel (MHz)	Low Power (dBm)	Hi Power (dBm)	Reference
136.025	Not done	<-25 dBm	Figure 7-2 to Figure 7-3
153.975 (low freq. split)	<-33.5 dBm	<-24.9 dBm	Figure 7-4 to Figure 7-7
153.975 (high freq. split)	<-33.7 dBm	<-25.2 dBm	Figure 7-8 to Figure 7-11
173.975	Not done	<-25 dBm	Figure 7-12 to Figure 7-13

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	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
Spectrum analyzer	HP	8562B	22 GHz	2913A00400	25/10/2004
High Pass filter	Mini Circuits	NHP-200	200 MHz high pass	19950	NA
Signal generator	HP	8648C	3 GHz	3537A01539	05/11/2004

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, 2.1049
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)	Audio modulation	2 level/9600 baud modulation WB/NB, C4FM modulation
25	Mask B	Mask C
12.5	Mask D	Mask D

5.3.2 Test Facility Information

Location: Solectron Technical Centre Lab 13

Date tested: January 22 to 28, 2004

Tested by: Denis Lalonde

5.3.3 Test Procedure

Five emission mask measurements were performed at 153.975 MHz, 110 W. The five different modulated signals were evaluated as follows:

1. Wibeband 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 +/- 1.5 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

Type of signal	Test result	Reference
2500 Hz Audio WB	Pass	Figure 7-14
2500 Hz Audio NB	Pass	Figure 7-15
2 level 9600 baud / +/- 3 KHz deviation	Pass	Figure 7-16
2 level 9600 baud / +/- 1.5 KHz deviation	Pass	Figure 7-17
C4FM	Pass	Figure 7-18

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	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
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 1740	-19.6

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
= minimum of 50 + 10 log (110) or 70 dB
= minimum of 70.4 dB or 70 dB
= 70 dB

ERP limit = 10 log (110 W) – 70 dB
= -19.6 dBm

5.4.2 Test Facility Information

Location: Solectron Technical Centre 10m Ambient Free Chamber

Date tested: December 17 to 19, 2003

Tested by: Ryan Wallace, Kasi Sivaratram, Alain Lavoie and Denis 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-DF [7]. The test was performed as per the relevant Test procedures: ANSI C63.4 [4].

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 2 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 2 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:

ERP = Signal generator level – Cable losses + Antenna gain (dBi) – Gain of tuned dipole (dBi)

Margin = Limit – ERP

The measurement was performed while the power amplifier was operating at 10 W and 110 W. A 2 level 9600 baud wideband signal at 153.975 MHz was used for this test. The test was done while using a low frequency split Tx Synthesizer (Tx1) and then repeated with a high frequency split Tx Synthesizer (Tx2). A 50 ohm load was connected to the power amplifier output.

5.4.4 Test Results

Table 5-15 lists the highest emissions measured between the low frequency split configuration (Tx1) and the high frequency split configuration (Tx2), all other emission had more than 30 dB margin:

Table 5-15: Field Strength of Spurious Emissions

Channel (MHz)	Signal Generator Level Hi Power (dBm)	Antenna Gain (dBi)	Cable losses (dB)	ERP Low Power (dBm)	ERP Hi Power (dBm)	Margin (dB)	Reference
461.925 (3 x Tx)	-61.8	5.8	0.6	<-60	-58.8	39.2	Figure 7-19 to Figure 7-26
1077.825 (7 x Tx)	-55.7	6.5	1.3	-54.7	-52.7	33.1	Figure 7-19 to Figure 7-26
1539.75 (10 x Tx)	-61.1	8.3	1.5	<-60	-56.5	36.9	Figure 7-19 to Figure 7-26
1847.7 (12 x Tx)	-66.6	8.5	1.6	<-65	-61.9	42.3	Figure 7-19 to Figure 7-26

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

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Antenna	Chase	CBL6111	Bi-log	10111	3/06/2004
Antenna	EMCO	3115	Horn antenna	9603-4690	29/12/2004
Substitution signal generator	Wiltron	69369A	40 GHz	670022	25/10/2004
Amplifier	HP	8447D	Pre Amplifier #2	2944A06919	4-Mar-04
Amplifier	BNR	LNA-A5	LNA 1-18GHz	A5	6-Feb-04
Antenna	A R	2420/A	Bilog - 30MHz-1000MHz	1174	19-Dec-03
Antenna	EMCO	3115	Double Ridge Guide Horn	9711-5314	19-Dec-03
Cable-RF	SUCOFLEX	106/A	AFC Bulkhead #2	1060	18-Feb-04
Cable-RF	SUCOFLEX	106/A	AFC Bulkhead #1	1061	18-Feb-04
Software	UL	EMI Software	EMI Software	V 3.02	n/a
S A	HP	8566B	(AFC#1) SA	3014A07256	25-Jul-04
S A	HP	8566B	(AFC#1) Display Unit	3026A20026	25-Jul-04
S A	HP	85685A	(AFC#1) RF Preselector	3010A01085	25-Jul-04
S A	HP	85650A	(AFC#1) QPA	3107A01549	25-Jul-04
Mast & Turntable	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)
136 to 174	2.5 (for operation in a 12.5 kHz band)

5.5.2 Test Facility Information

Location: Solectron Technical Centre Lab 9

Date tested: December 22, 2003

Tested by: Denis Lalonde

5.5.3 Test Procedure

The unmodulated output of the power amplifier was connected trough 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

Table 5-19 lists the frequency stability measurement results:

Table 5-19: Frequency Stability Results

Temperature (degree. Celsius)	AC Voltage (V)	Frequency (MHz)	Frequency Error (ppm)
-30	120	153.975122	0.792
-20	120	153.975142	0.922
-10	120	153.975294	1.909
0	120	153.975178	1.156
10	120	153.975124	0.805
20	102	153.975071	0.461
20	120	153.975070	0.455
20	138	153.975070	0.455
30	120	153.975078	0.507
40	120	153.975073	0.474
50	120	153.975045	0.292

5.5.5 Test Conclusion

The test results met the requirement.

5.5.6 Test Equipment List

Table 5-20: Test Equipment used for Signal Leads Conducted Emissions

Category	Manufacture	Model	Description	Serial Number	Cal. Due
Frequency Reference	UCT	2008	Rubidium 10 MHz	A1010	14/04/2004
Attenuator	Weinschel	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
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:

t 1 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: Solectron Technical Centre Lab 13

Date tested: January 28, 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 +/- 4 kHz frequency scale over the first and last 5 msec of transmission. The signal was observed over 25 msec for both the start and stop of transmission but only the first and last 5 msec is shown on the graphs in order to properly view the frequency shift in the first and last 500 usec. No signal frequency shift was observed in the un-graphed part of the 25 msec measurement.

Table 5-23: Transient Frequency Behavior Test Results

Channel Spacing (kHz)	Time interval (ms)	Maximum Frequency Difference (kHz)	Measured Frequency Difference (kHz)	Measurement reference
25	T1 = 5	+/- 25	<1 and >-1	Figure 7-27
	T2= 20	+/-12.5	<1 and >-1	Figure 7-27 and Figure 7-29
	T3= 5	+/- 25	<1 and >-1	Figure 7-29
12.5	T1 = 5	+/-12.5	<1 and >-1	Figure 7-28
	T2= 20	+/-6.25	<1 and >-1	Figure 7-28 and Figure 7-30
	T3= 5	+/-12.5	<2 and >-1	Figure 7-30

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	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
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: Solectron Technical Centre Lab 13

Date tested: March 5, 2005

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.

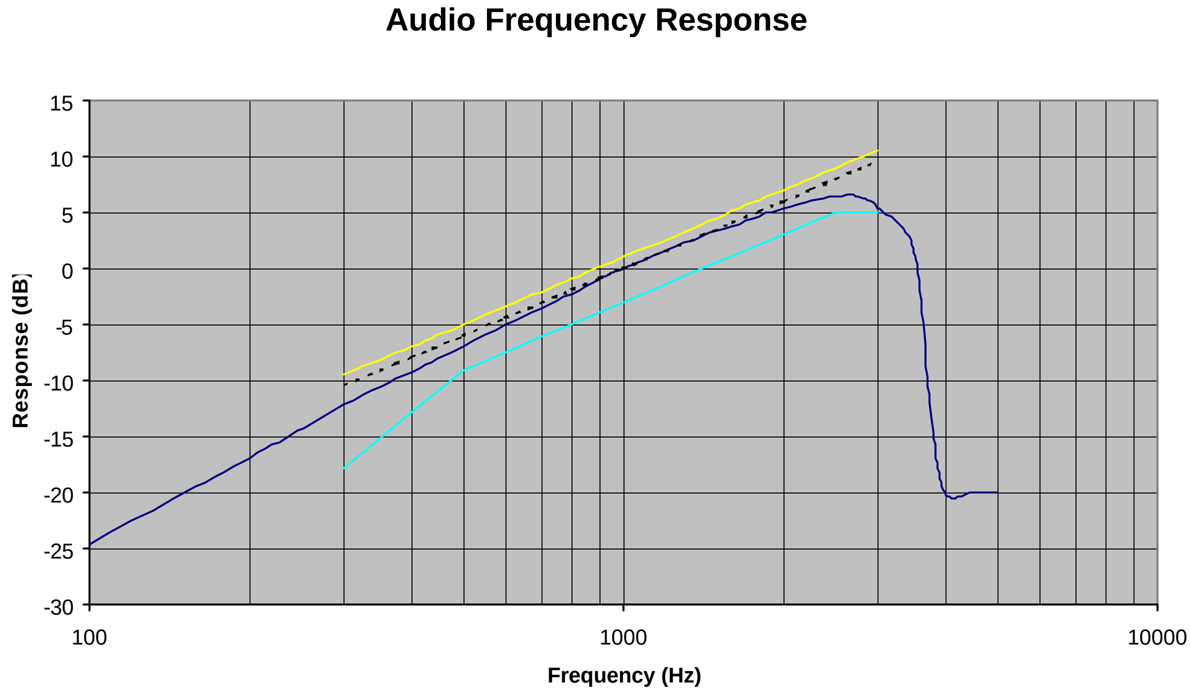
The frequency response was determined by the following formula.

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

5.7.4 Test Results

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

Figure 5-1: 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	14/08/2004
Transmission Test Set	HP	3552A		1806U01296	7/10/2004
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	15/04/2004
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	40 log (freq.(Hz)/3000)
15 to 30	28

5.8.2 Test Facility Information

Location: Solectron Technical Centre Lab 13

Date tested: March 5, 2004

Tested by: Denis Lalonde

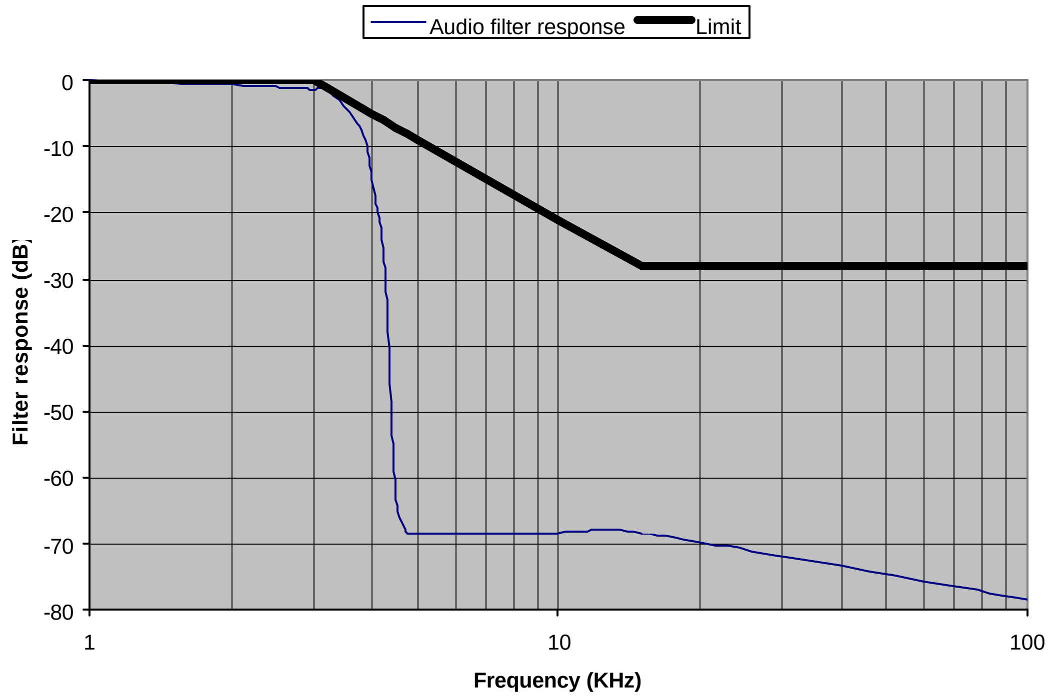
5.8.3 Test Procedure

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.

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
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	15/04/2004
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Modulation Domain analyzer	HP	53310A		3121A01217	14/08/2004
Transmission Test Set	HP	3552A		1806U01296	7/10/2004

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: Solectron Technical Centre Lab 13

Date tested: March 5, 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.

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)

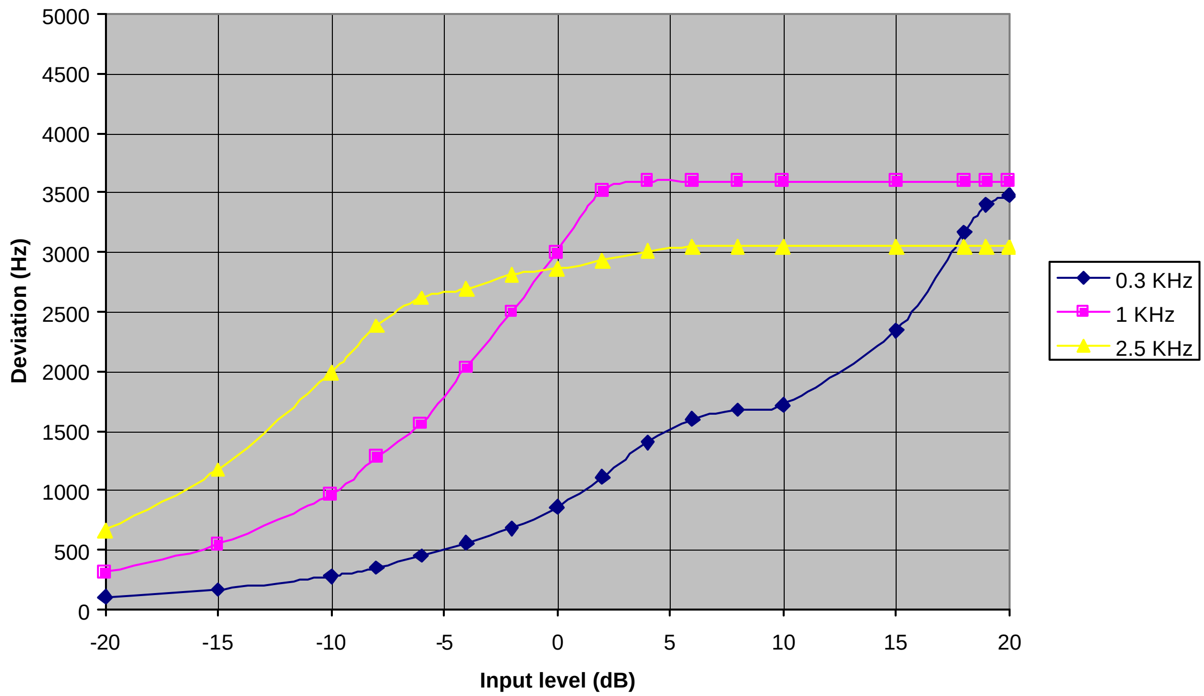


Figure 5-4 Modulation Limiting, Negative Peak (25 kHz channel)

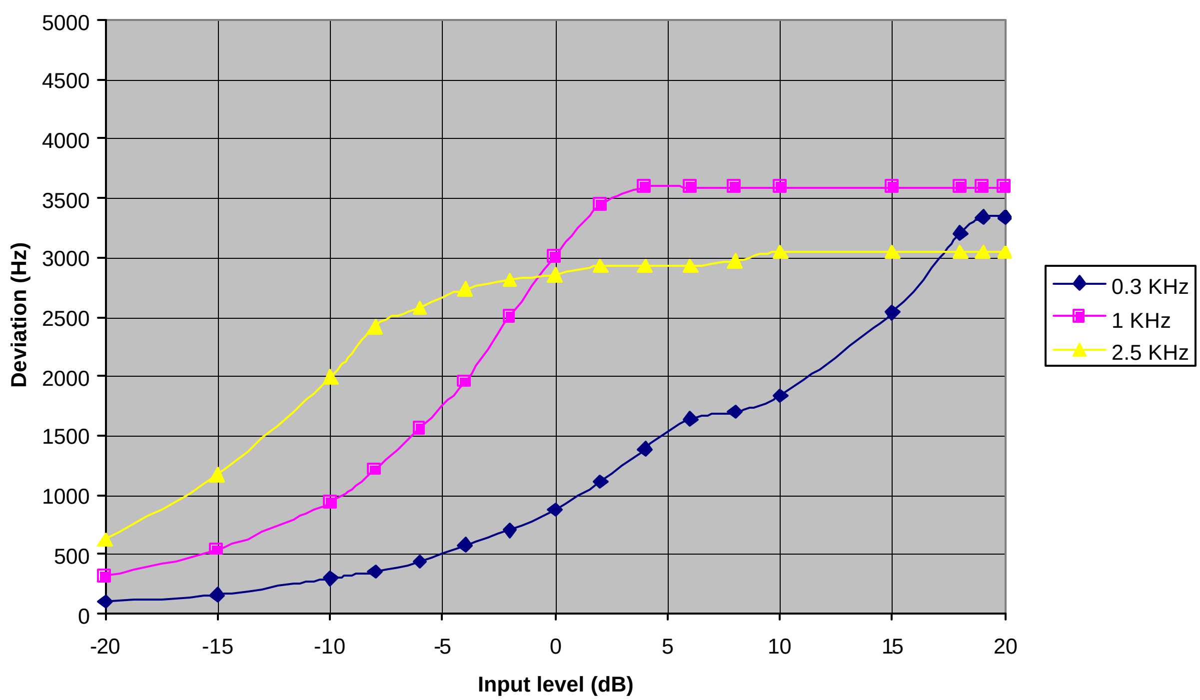


Figure 5-5 Modulation Limiting, Positive Peak (12.5 kHz channel)

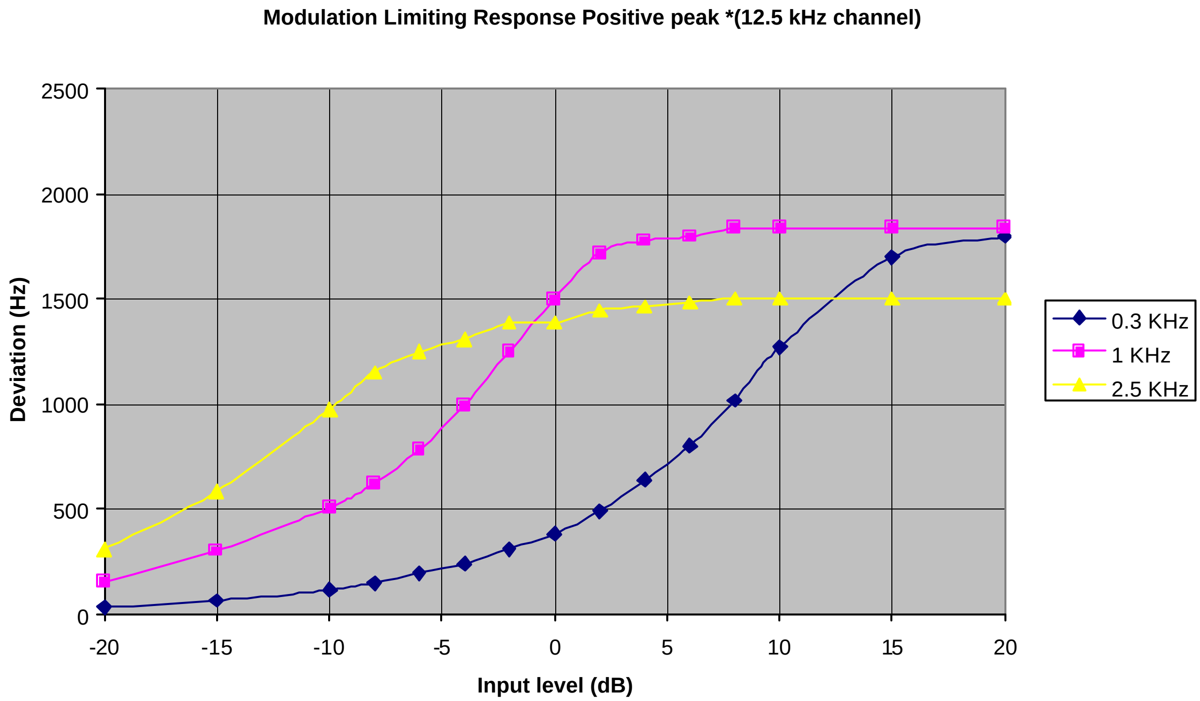
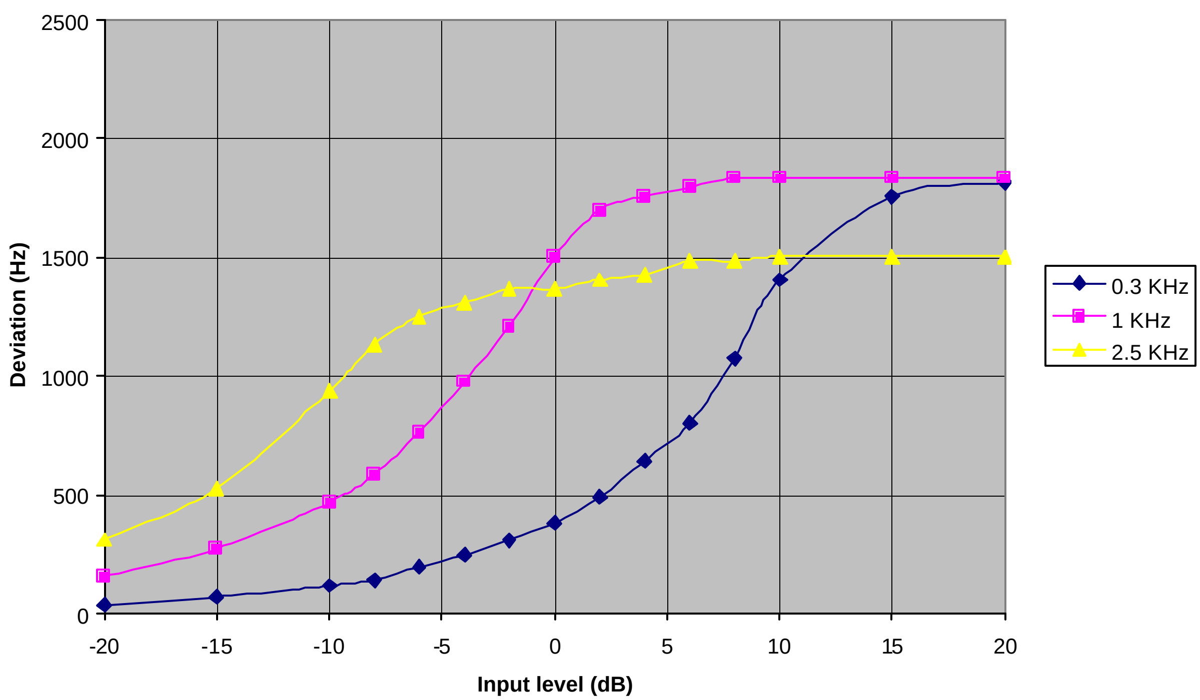


Figure 5-6 Modulation Limiting, Negative Peak (12.5 kHz channel)



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
Attenuator	Weinschel	53-20-33	20 dB, 500 W	KW975	15/04/2004
Attenuator	Weinschel	6070-10	10 dB, 25 W	BE0846	25/10/2004
Modulation Domain analyzer	HP	53310A		3121A01217	14/08/2004
Transmission Test Set	HP	3552A		1806U01296	7/10/2004

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: Solectron Technical Centre Lab 13

Date tested: January 22 to 28, 2004

Tested by: Denis Lalonde

5.10.3 Test Procedure

Five occupied bandwidth measurements were performed at 153.975 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 +/- 1.5 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

Table 5-35 lists the occupied bandwidth calculated and measured:

Table 5-35: Occupied bandwidth values

Type of signal	Calculation	Measurement (kHz)	Emission designator
Audio (wideband)	Max. modulation (M) = 3 kHz Max. deviation (D) = 5 kHz K = 1 Bn = 2M + 2DK Bn = 16 kHz	10.5 kHz Figure 7-31 (measured with 2.5 kHz tone)	16K0F3E
Audio (narrowband)	Max. modulation (M) = 3 kHz Max. deviation (D) = 2.5 kHz K = 1 Bn = 2M + 2DK Bn = 11 kHz	5.25 kHz Figure 7-32 (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 Bn = B + 2DK Bn = 15.6 kHz	11.2 kHz Figure 7-33	11K2F1D 11K2F1E
2 level 9600 baud / 1.5 KHz deviation	Max. modulation (B) = 9.6 kHz Max. deviation (D) = 1.5 kHz K = 1 Bn = B + 2DK Bn = 12.6 kHz	7.5 kHz Figure 7-34	7K50F1D 7K50F1E
C4FM	Max. modulation (B) = 4.8 kHz Max. deviation (D) = 2.826 kHz K = 1 Bn = B + 2DK Bn = 10.452 kHz	8.25 kHz Figure 7-35	8K25F1D 8K25F1E

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	53-10-33	10 dB, 500 W	KT039	6/02/2004
Attenuator	Weinschel	6070-20	20 dB, 25 W	BE0847	15/04/2004
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-DF Feb 2002.
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

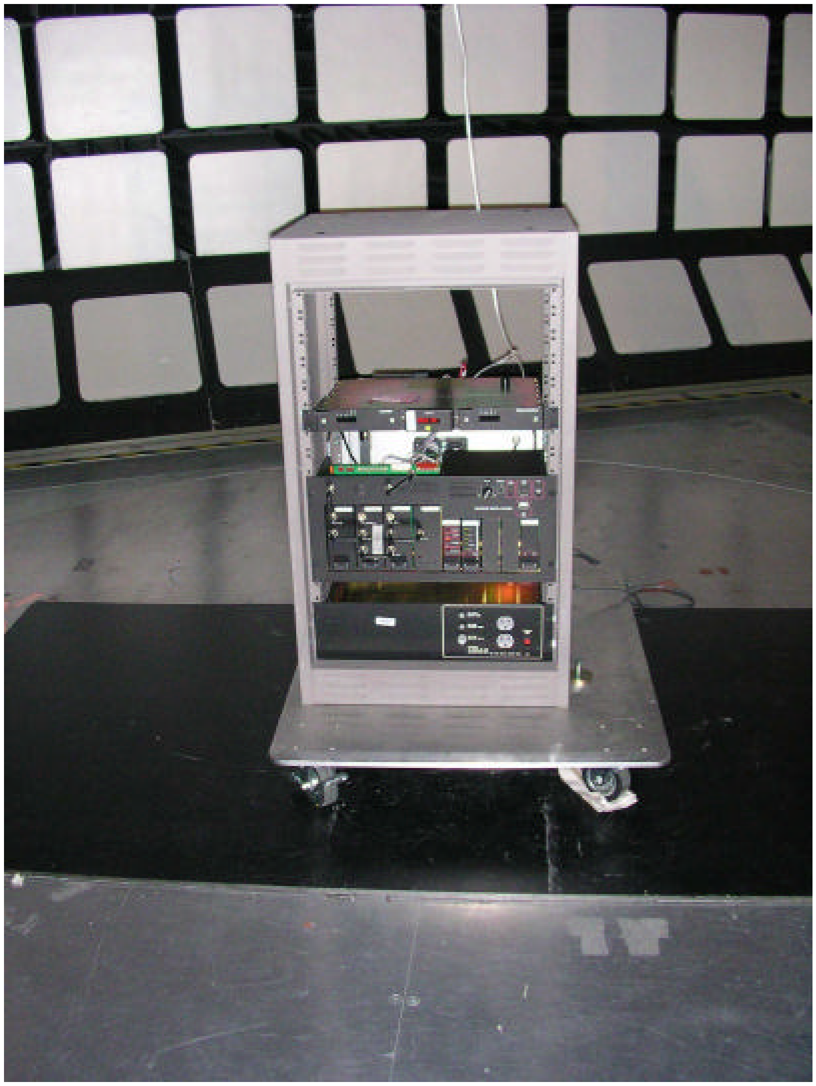
7.1 Appendix A: Glossary

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 VHF Base Station radiated emissions set-up



7.3 Appendix C: Conducted Spurious Emissions Plots

Figure 7-2: Tx at 136.025 MHz, 110 W power, 30 MHz to 250 MHz

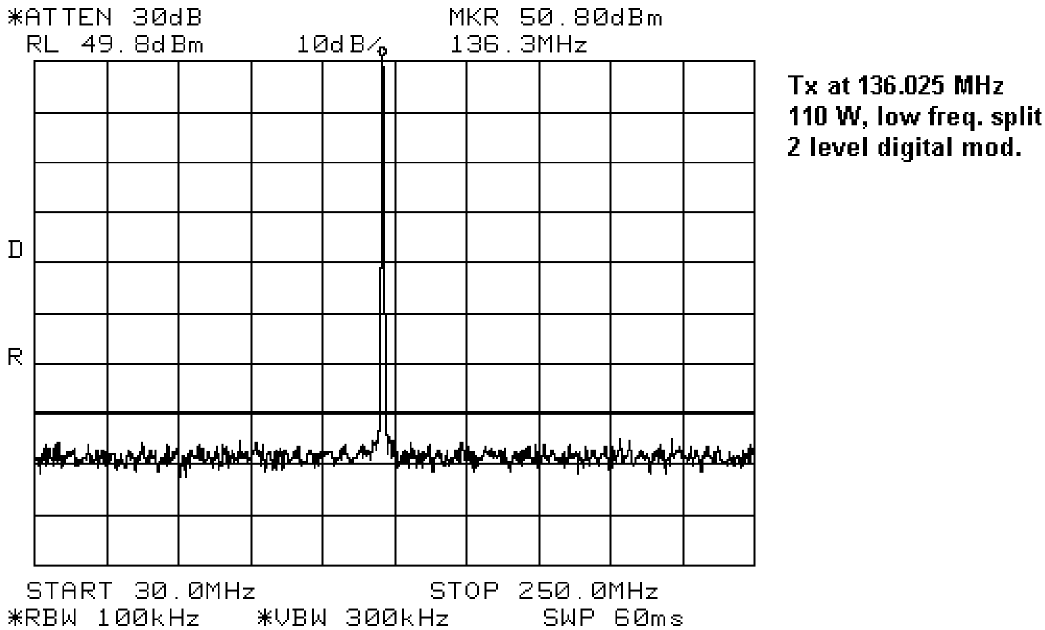


Figure 7-3: Tx at 136.025 MHz, 110 W power, 250 MHz to 2 GHz

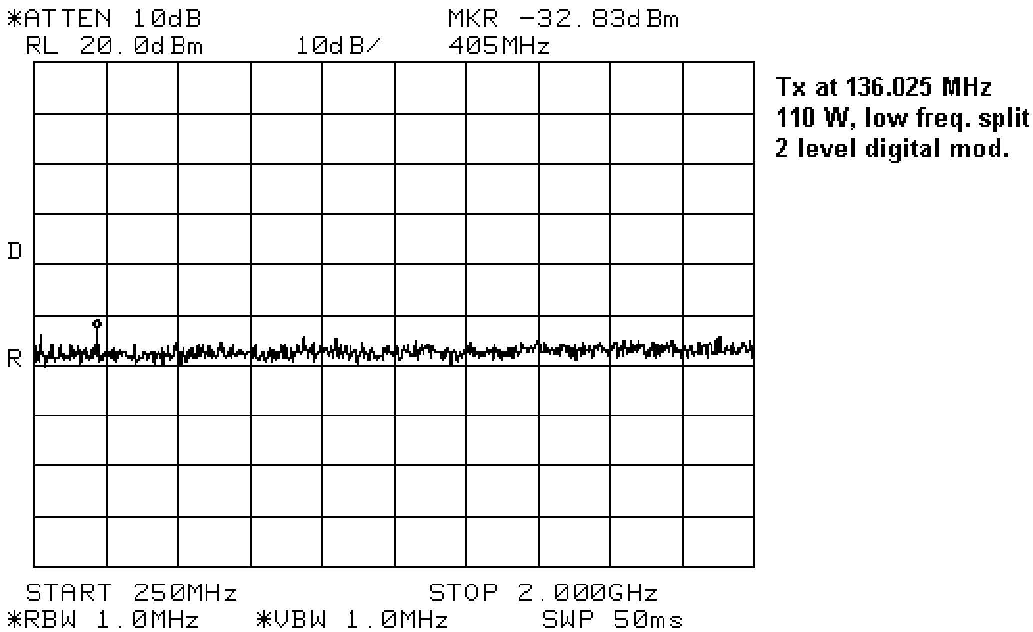


Figure 7-4: Tx at 153.975 MHz (low split) , 10 W power, 30 MHz to 250 MHz

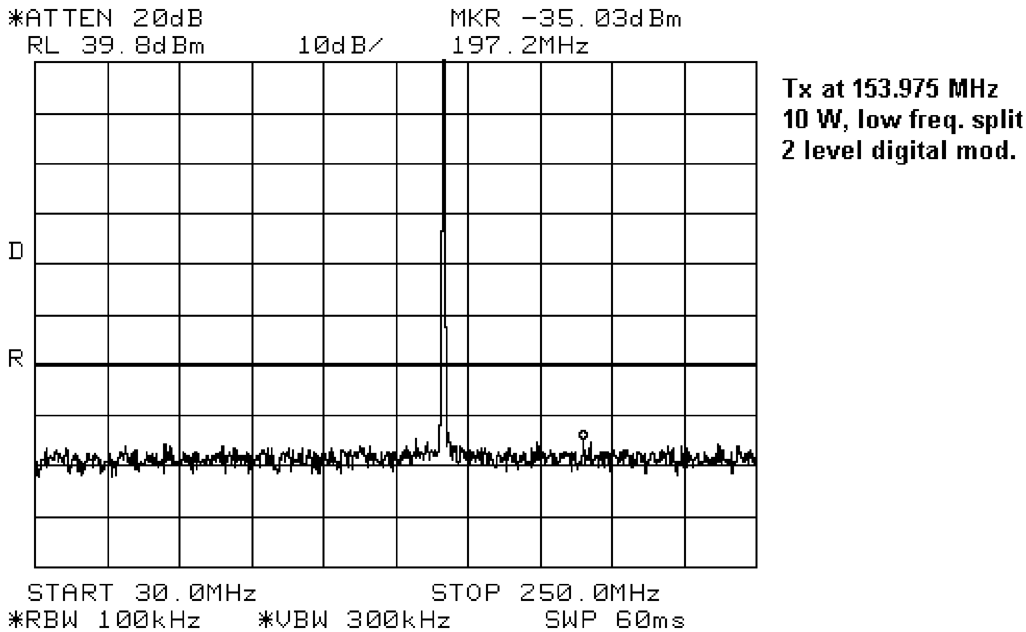


Figure 7-5: Tx at 153.975 MHz (low split), 10 W power, 250 MHz to 2 GHz

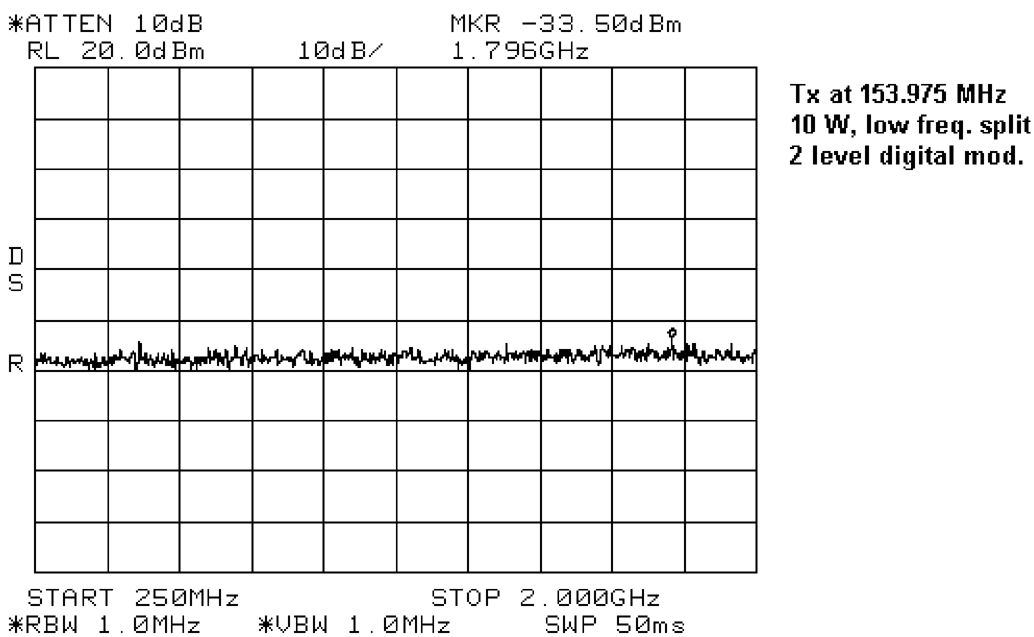


Figure 7-6: Tx at 153.975 MHz (low split), 110 W power, 30 MHz to 250 MHz

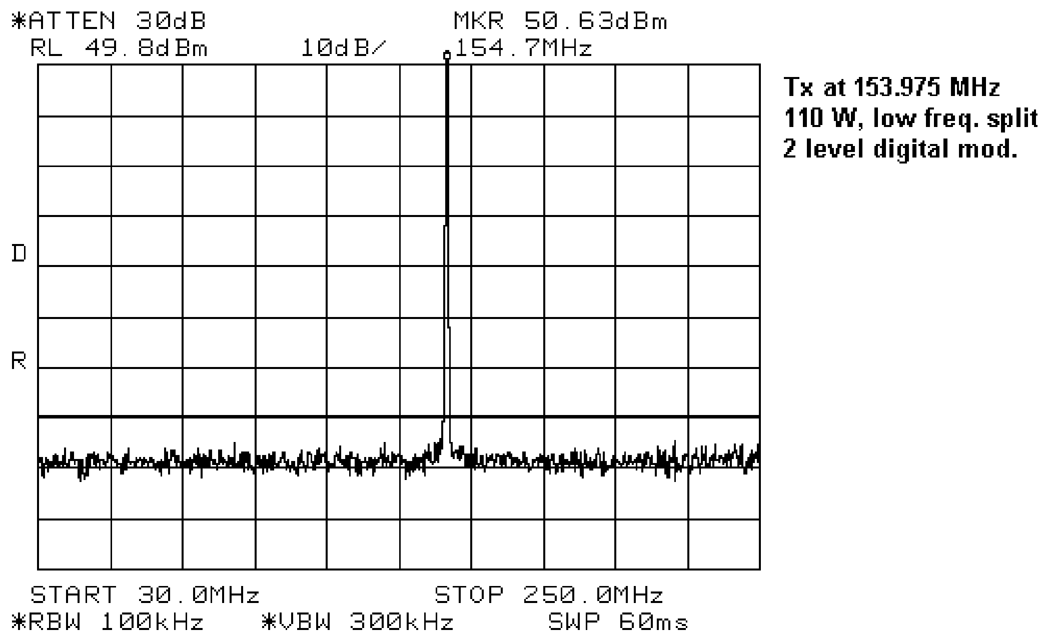


Figure 7-7: Tx at 153.975 MHz (low split), 110 W power, 250 MHz to 2 GHz

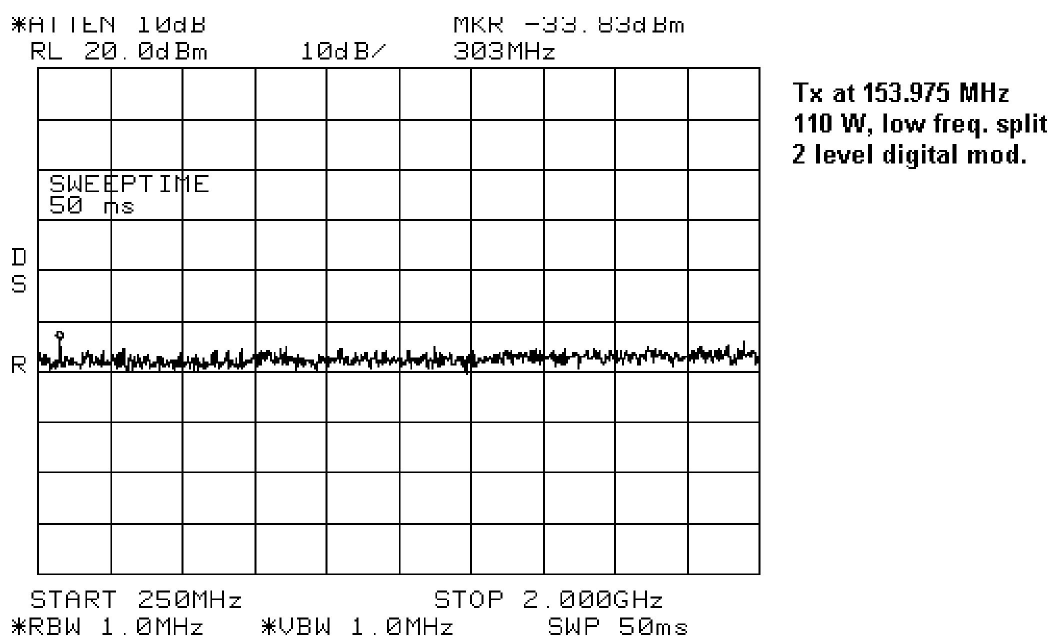


Figure 7-8: Tx at 153.975 MHz (high split), 10 W power, 30 MHz to 250 MHz

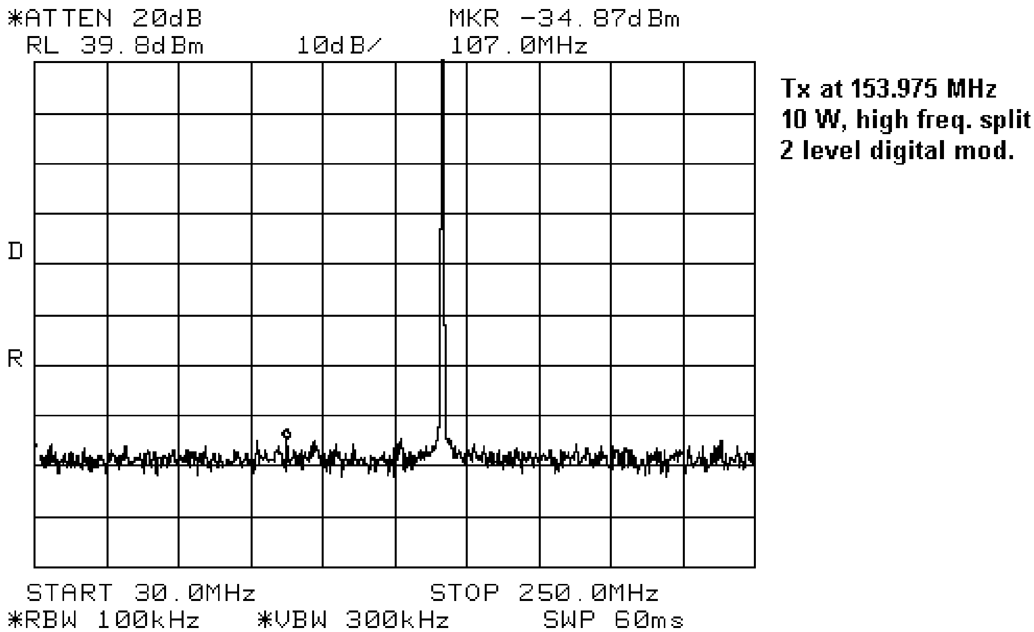


Figure 7-9: Tx at 153.975 MHz (high split), 10 W power, 250 MHz to 2 GHz

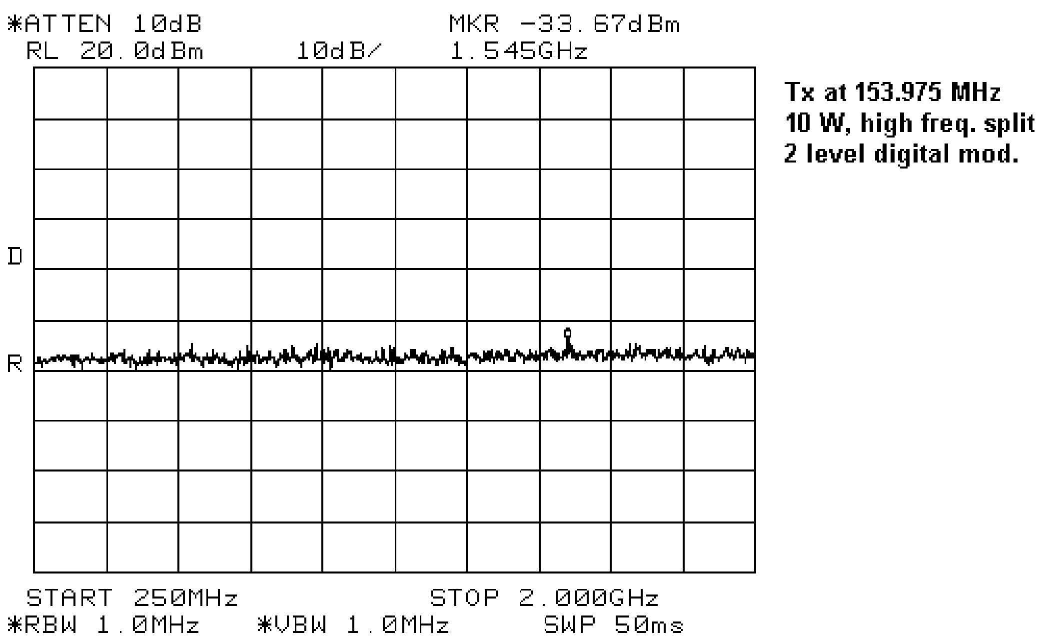


Figure 7-10: Tx at 153.975 MHz (high split), 110 W power, 30 MHz to 250 MHz

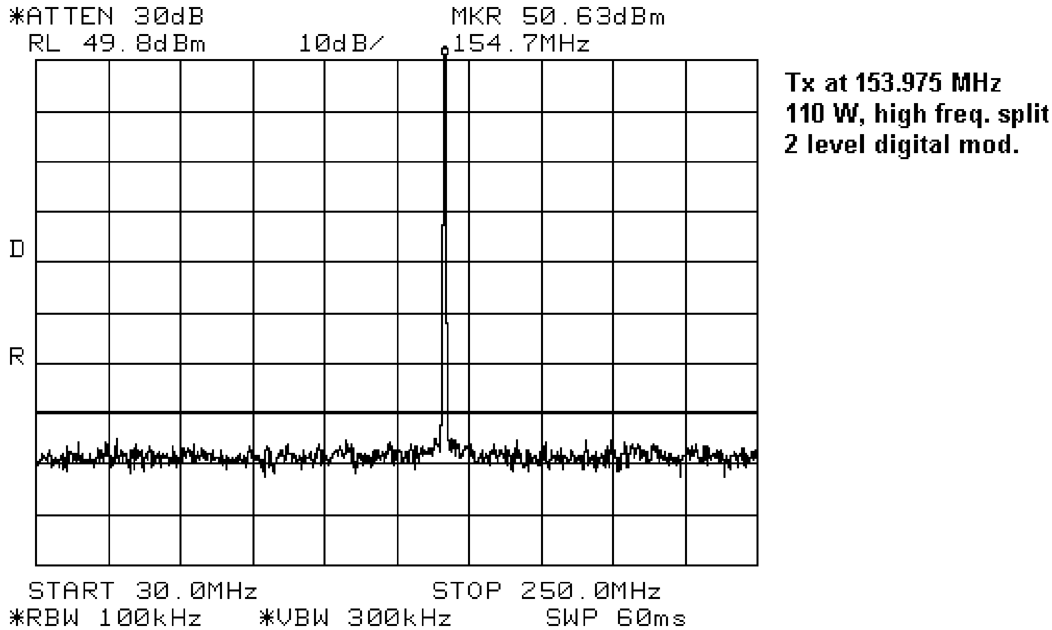


Figure 7-11: Tx at 153.975 MHz (high split), 110 W power, 250 MHz to 2 GHz

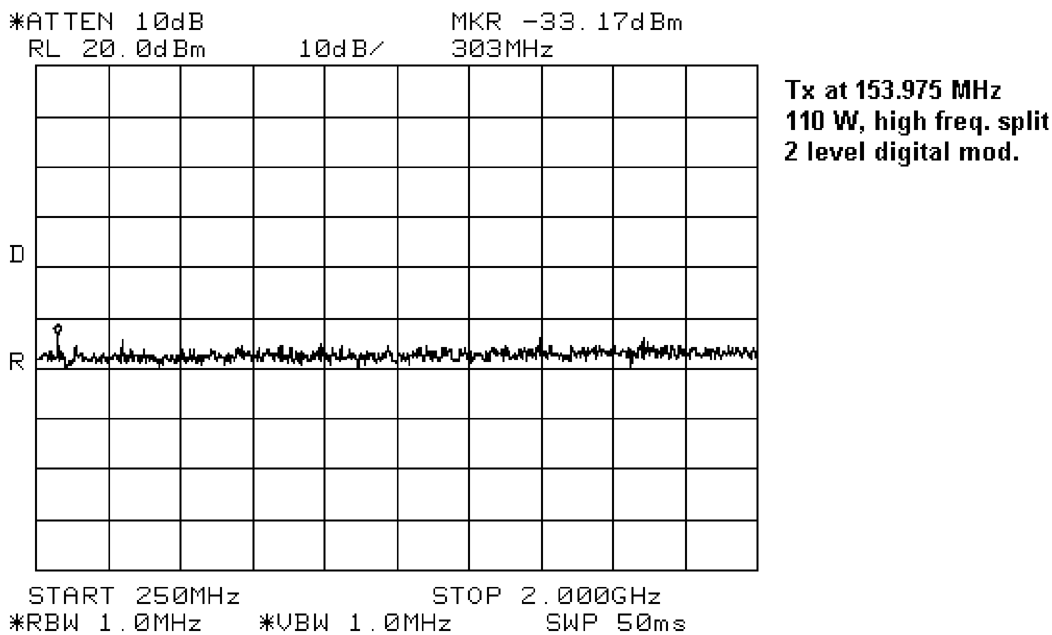


Figure 7-12: Tx at 173.975 MHz (high split), 110 W power, 30 MHz to 250 MHz

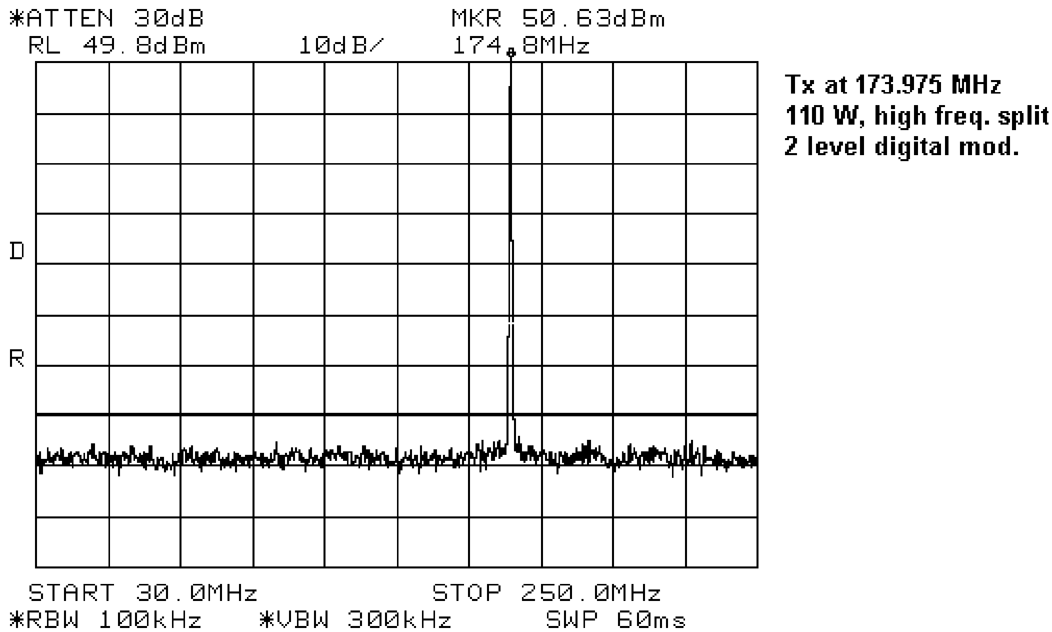
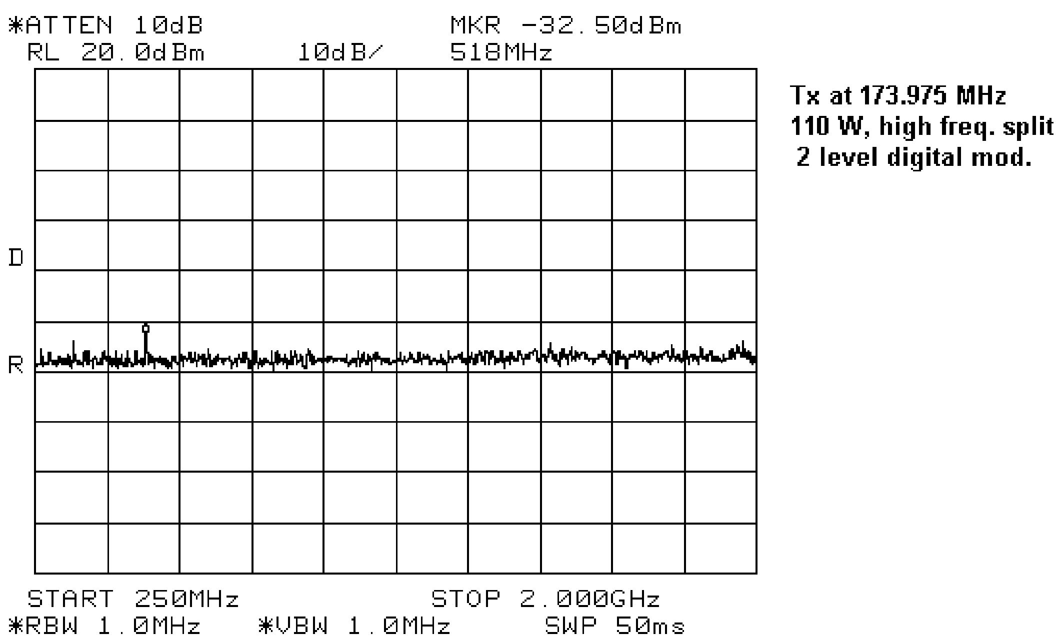


Figure 7-13: Tx at 173.975 MHz (high split), 110 W power, 250 MHz to 2 GHz



7.4 Appendix D: Emission Mask Plots

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

Figure 7-14: 2500 Hz audio signal Wideband

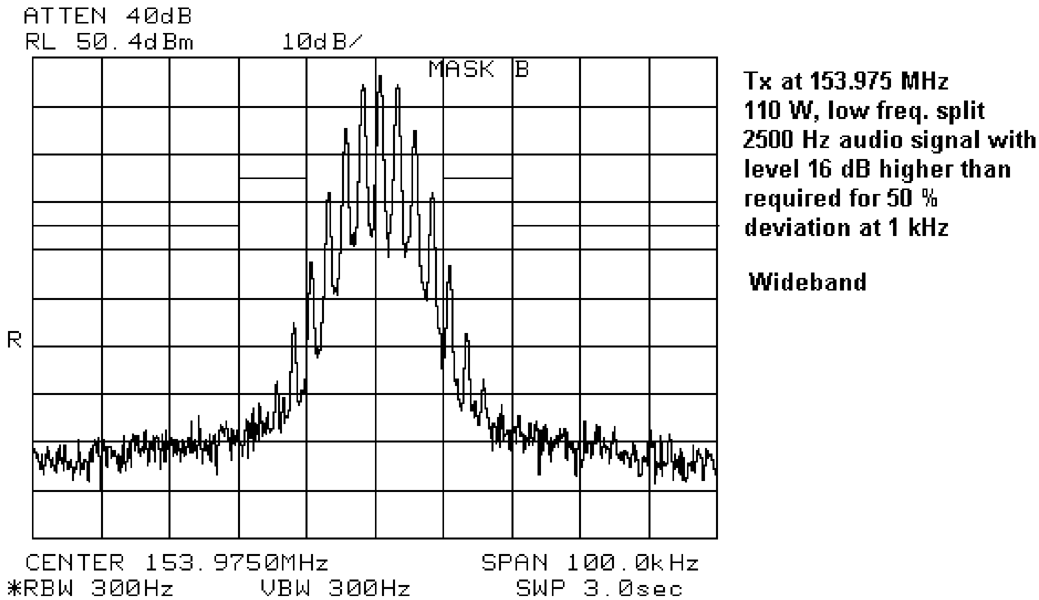


Figure 7-15: 2500 Hz audio signal Narrowband

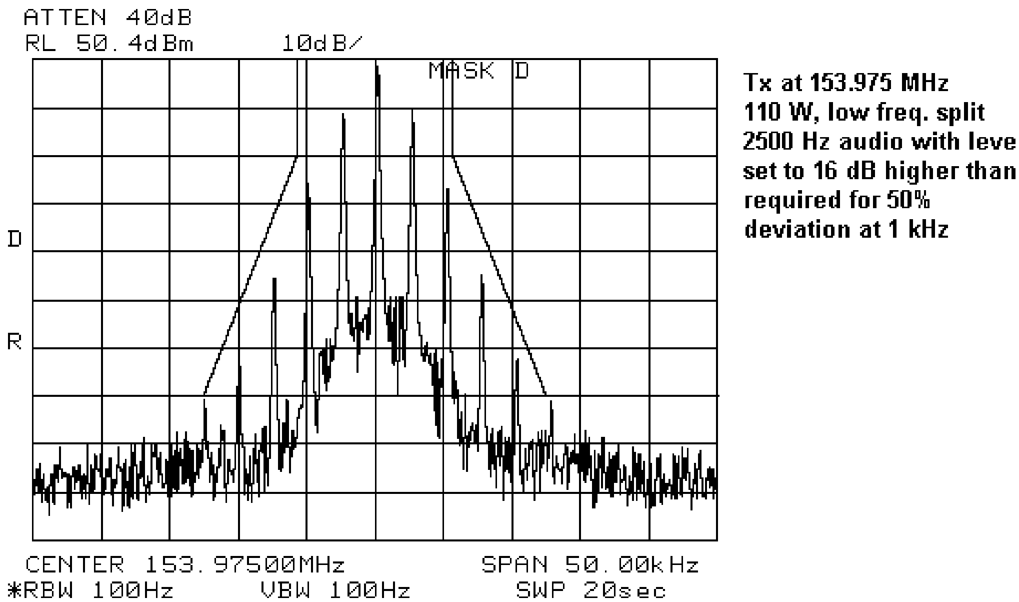


Figure 7-16: 2 level 9600 baud signal with +/- 3 kHz deviation

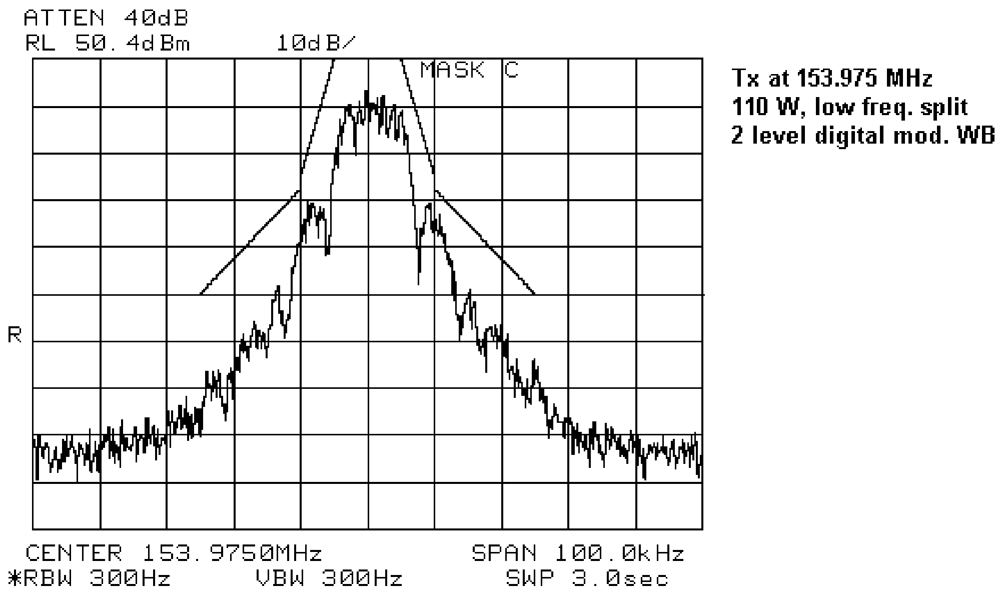


Figure 7-17: 2 level 9600 baud signal with +/- 1.5 kHz deviation

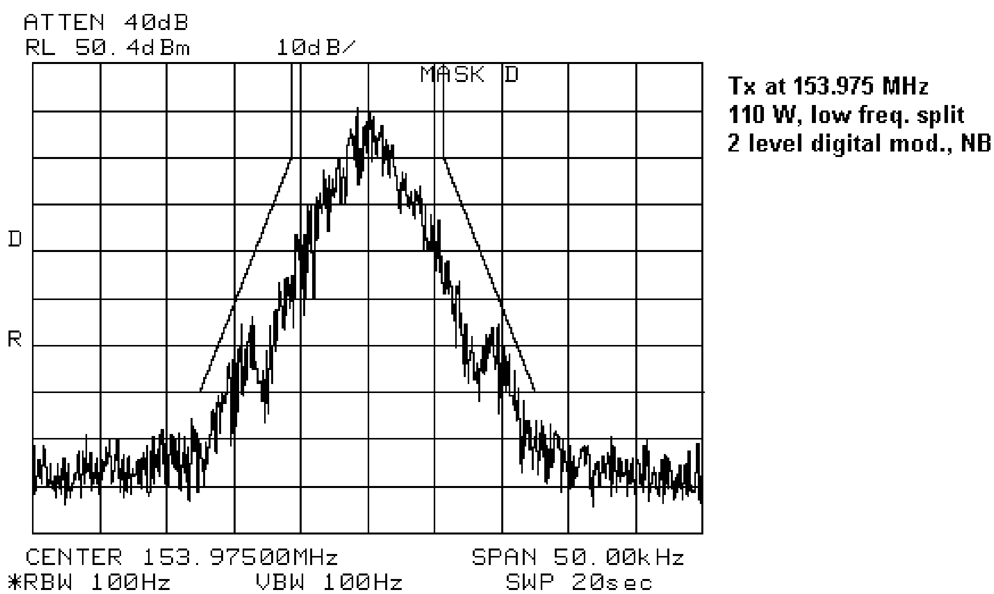
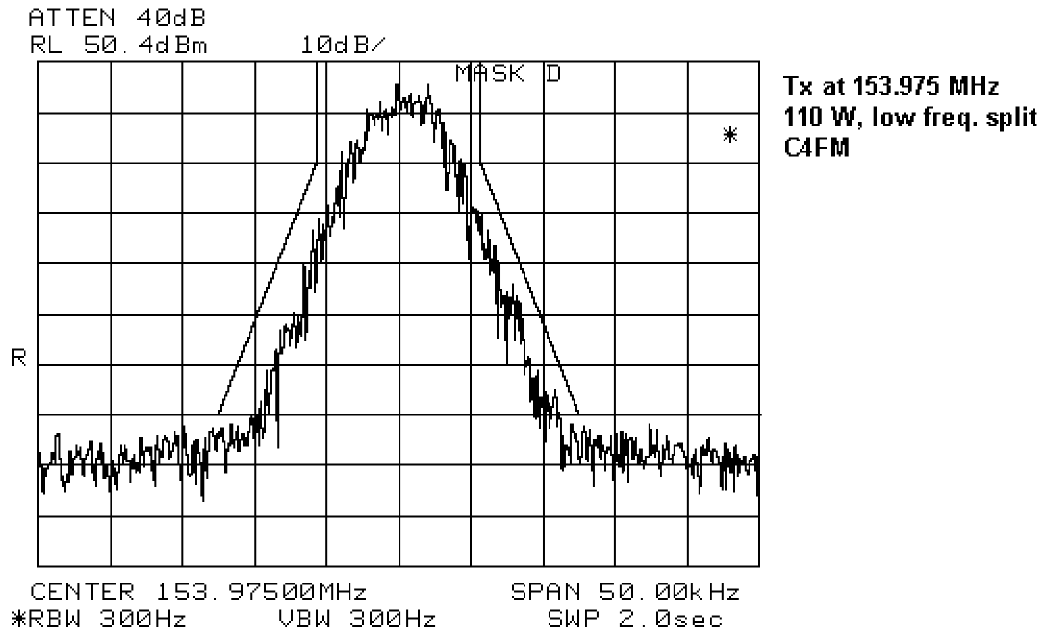


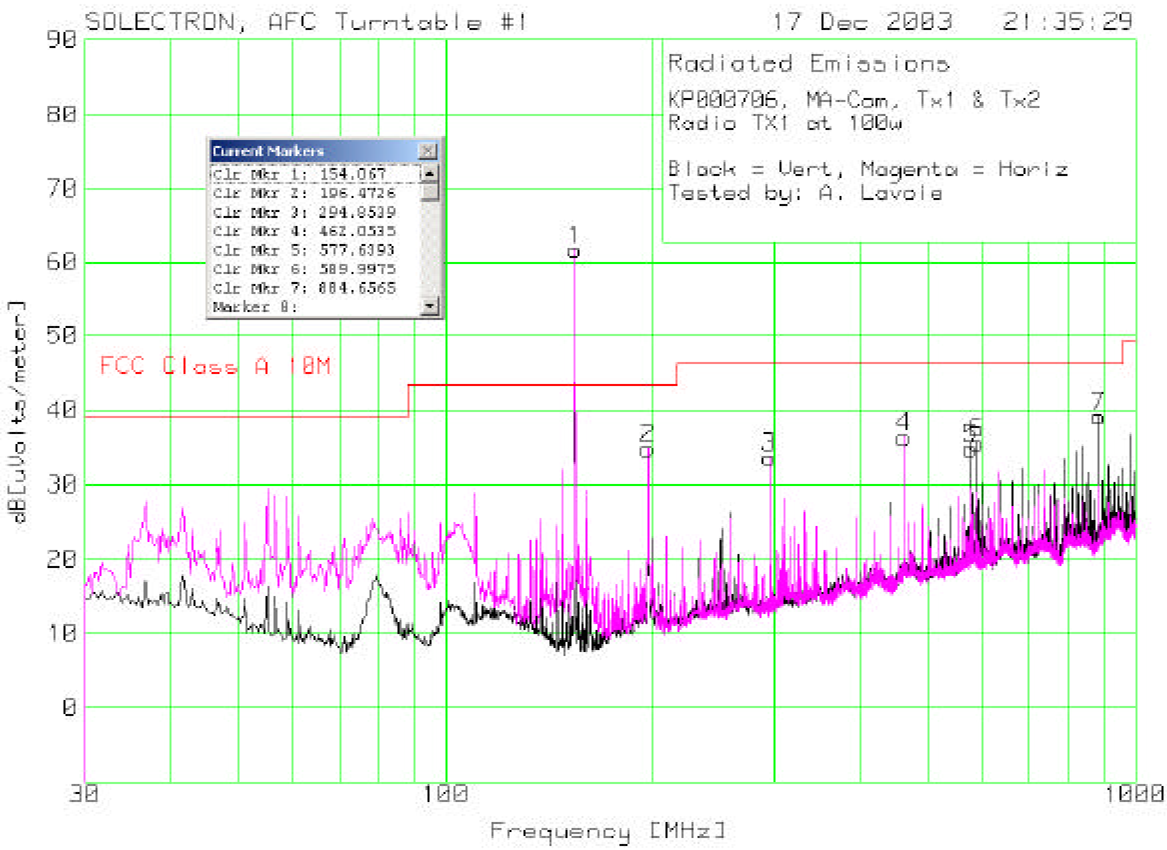
Figure 7-18: C4FM signal



7.5 Appendix E: Field Strength of Spurious Emissions Plots

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

Figure 7-19: Field strength with 110 W Tx, 30 MHz to 1 GHz, low frequency split



Note: the emissions at 154 MHz is leakage of the transmitted signal. The power rating on the plot should be 110 W.

Figure 7-20: Field strength with 110 W Tx, 1 GHz to 2 GHz, low frequency split

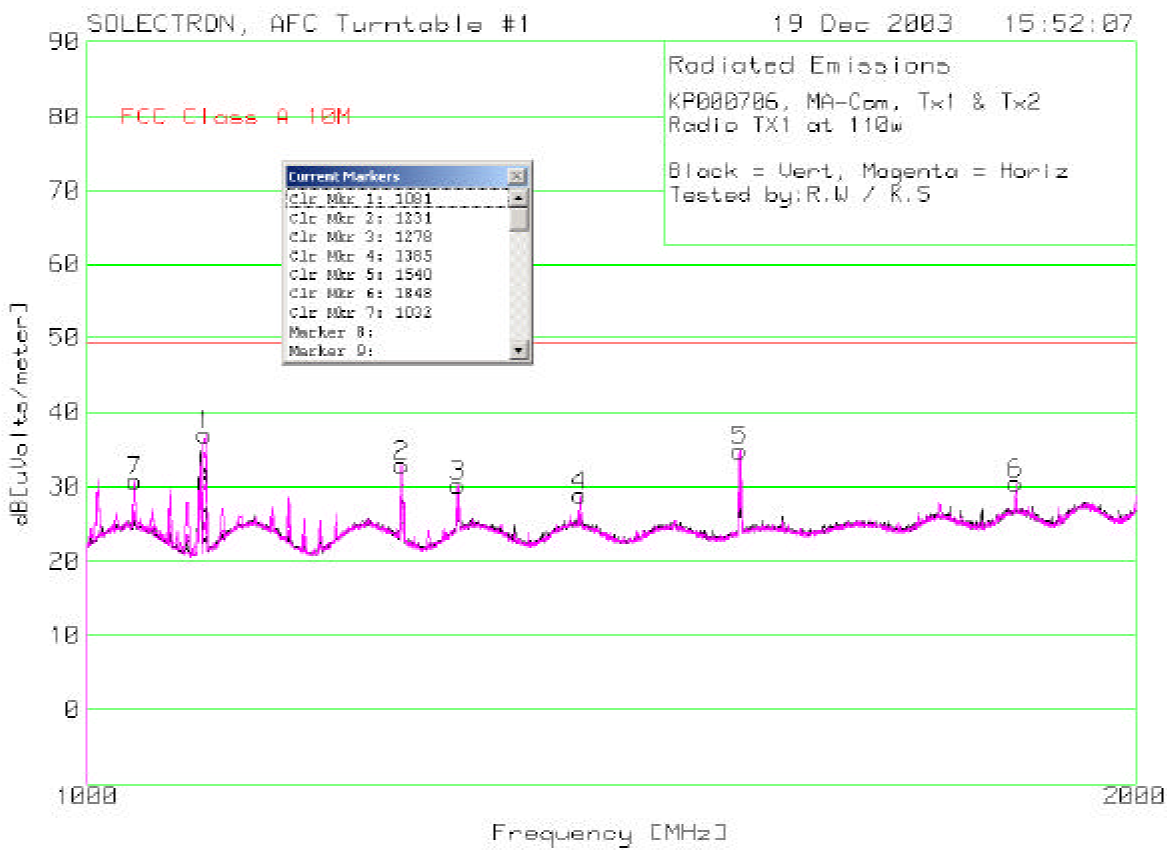
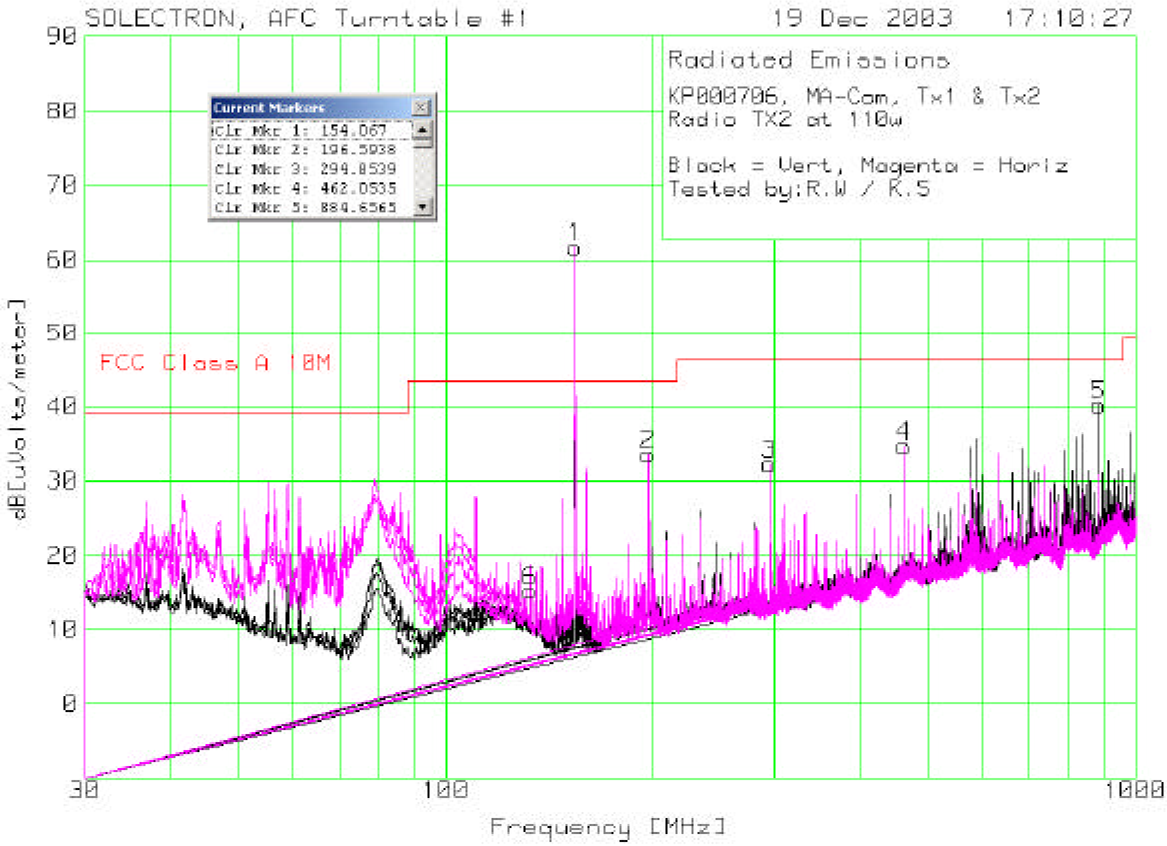


Figure 7-21: Field strength with 110 W Tx, 30 MHz to 1 GHz, high frequency split



Note: the emissions at 154 MHz is leakage of the transmitted signal.

Figure 7-22: Field strength with 110 W Tx, 1 GHz to 2 GHz, high frequency split

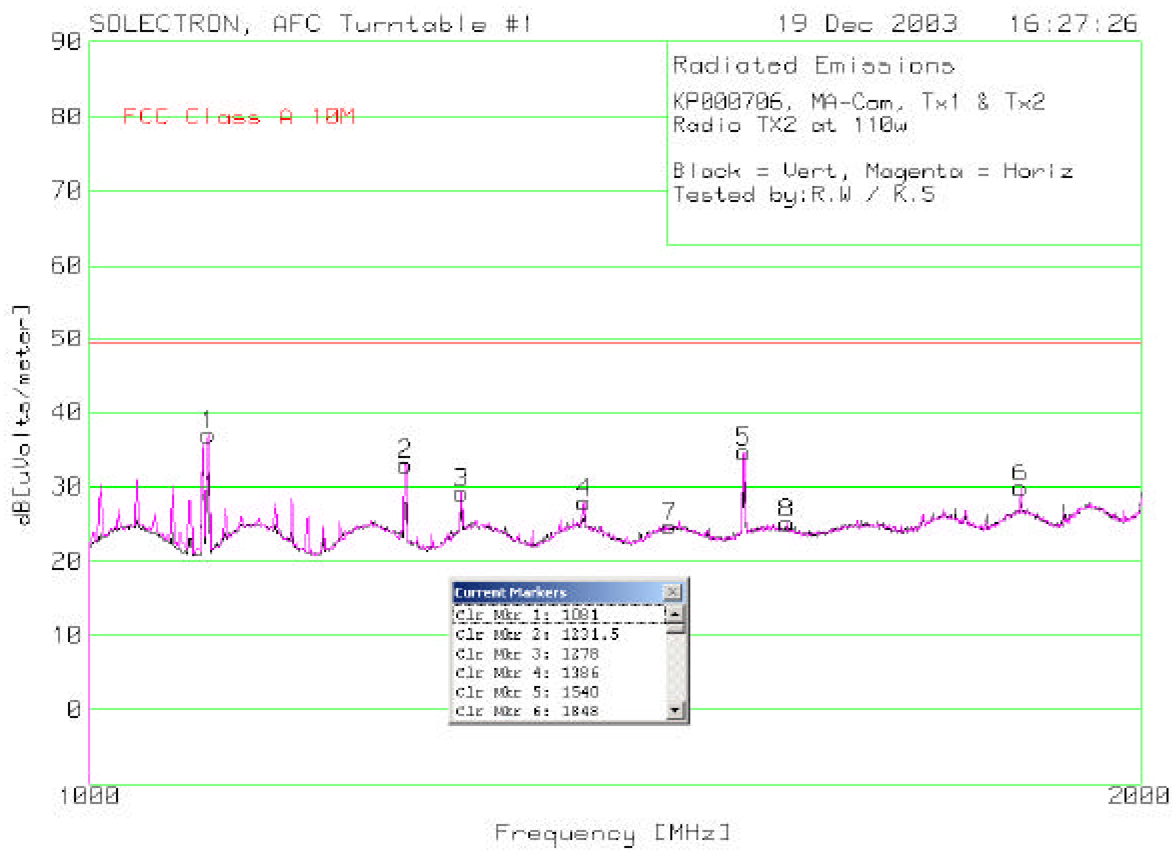
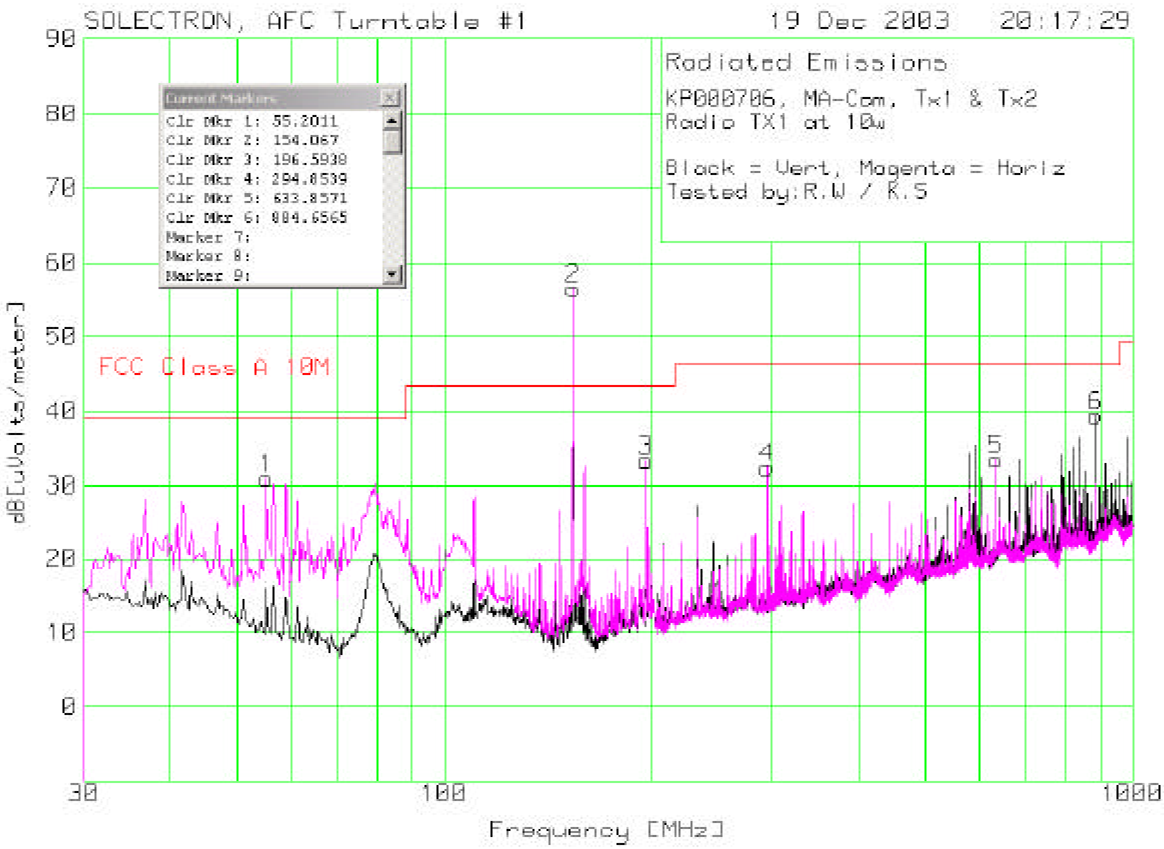


Figure 7-23: Field strength with 10 W Tx, 30 MHz to 1 GHz, low frequency split



Note: the emissions at 154 MHz is leakage of the transmitted signal

Figure 7-24: Field strength with 10 W Tx, 1 GHz to 2 GHz, low frequency split

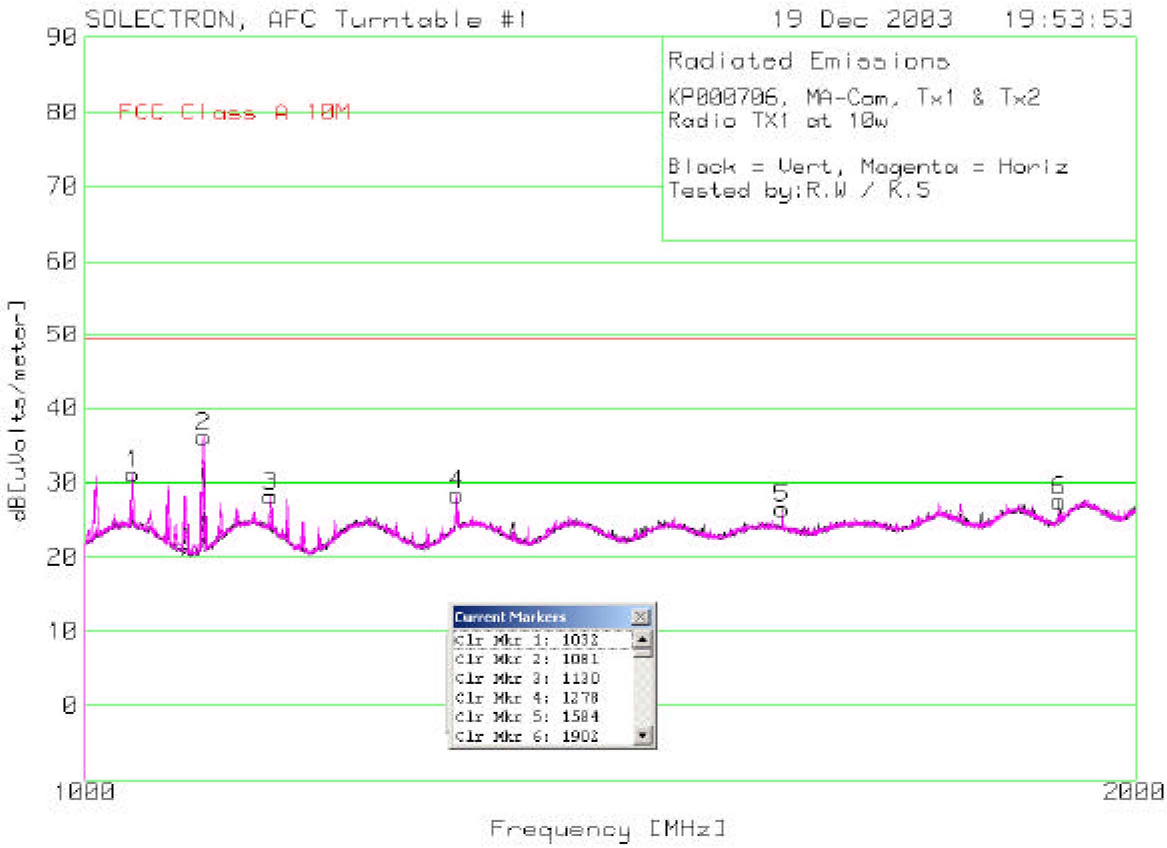
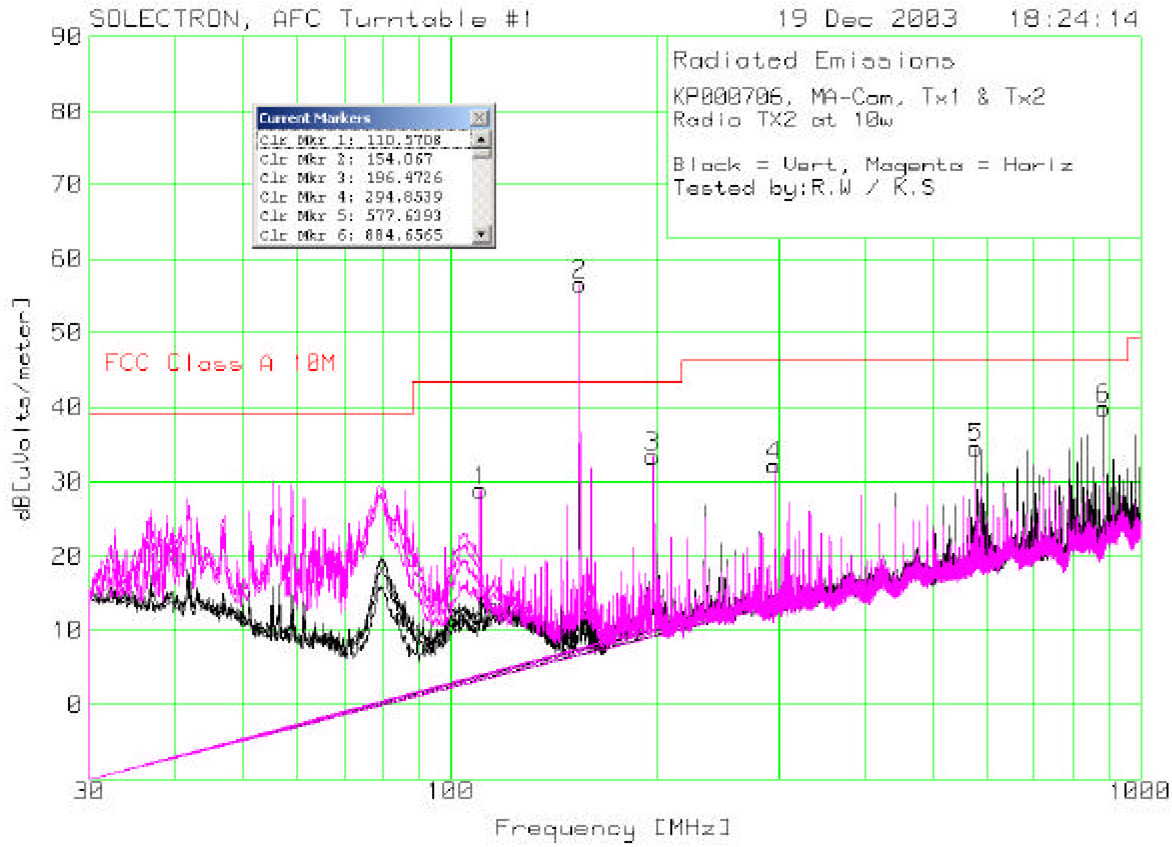
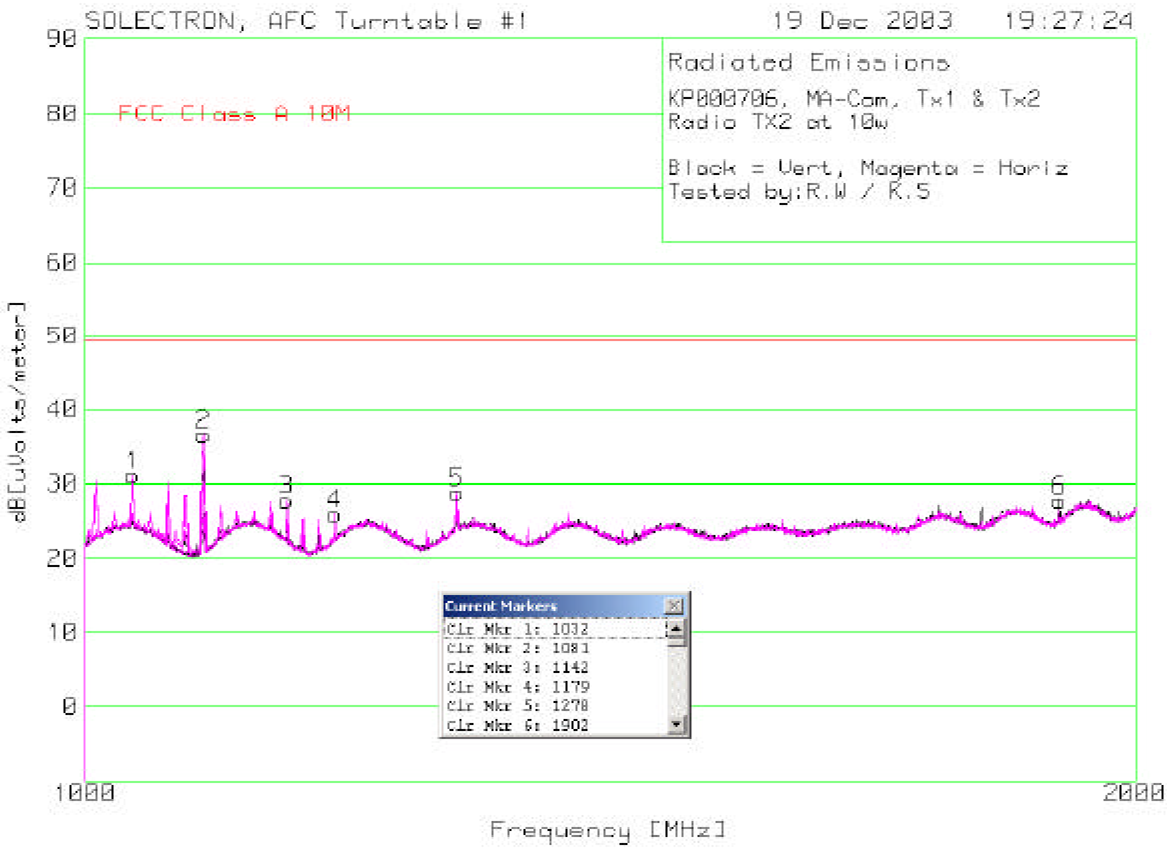


Figure 7-25: Field strength with 10 W Tx, 30 MHz to 1 GHz, high frequency split



Note: the emissions at 154 MHz is leakage of the transmitted signal

Figure 7-26: Field strength with 10 W Tx, 1 GHz to 2 GHz, high frequency split



7.6 Appendix F: Transient Frequency Behavior Plots

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

Figure 7-27 Transient Frequency Behavior, Wideband, Transmitter on

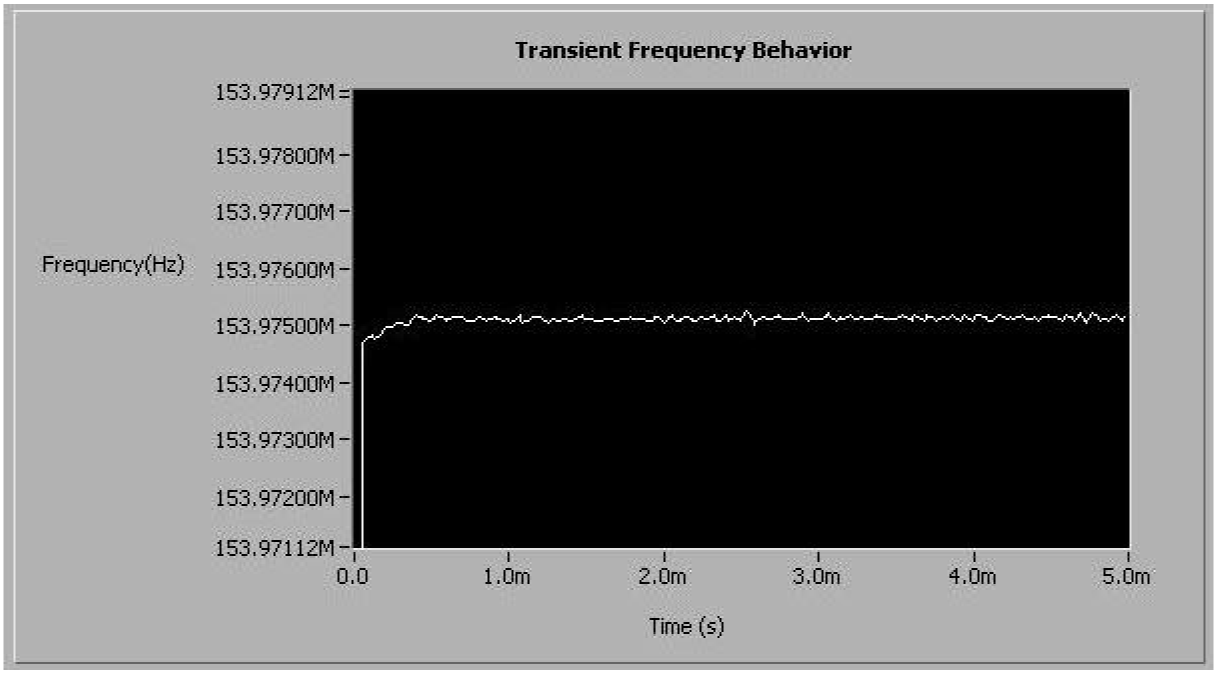


Figure 7-28 Transient Frequency Behavior, Narrowband, Transmitter on

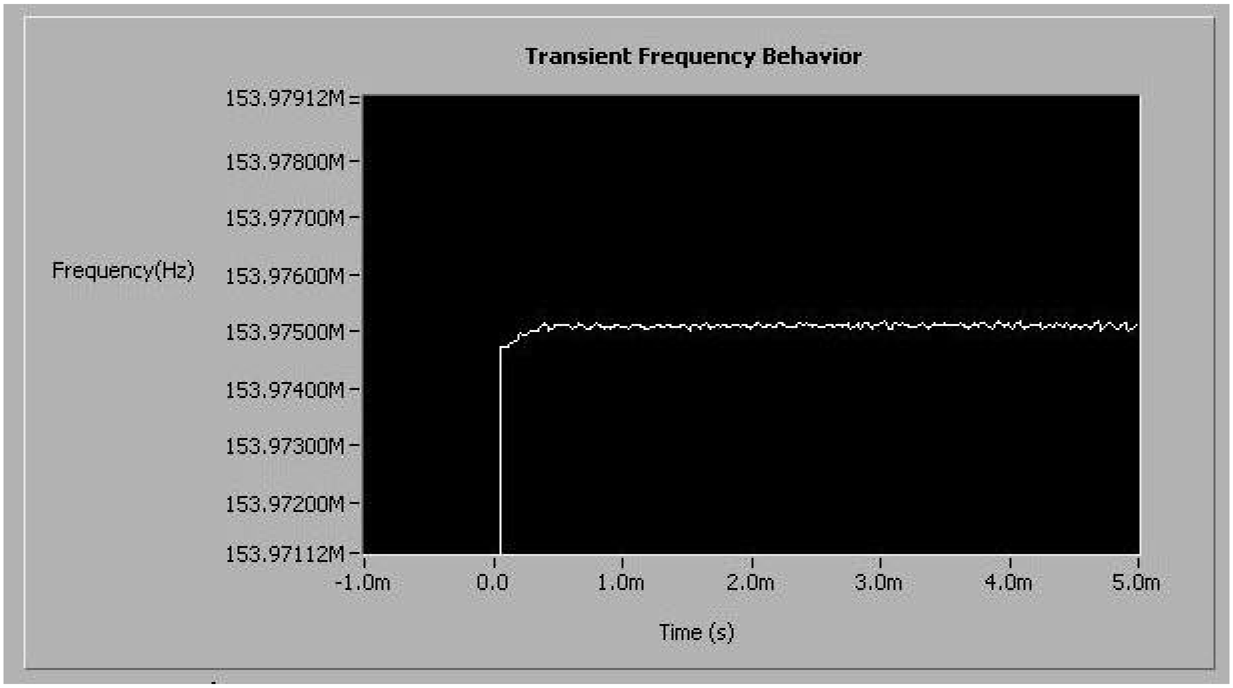


Figure 7-29 Transient Frequency Behavior, Wideband, Transmitter off

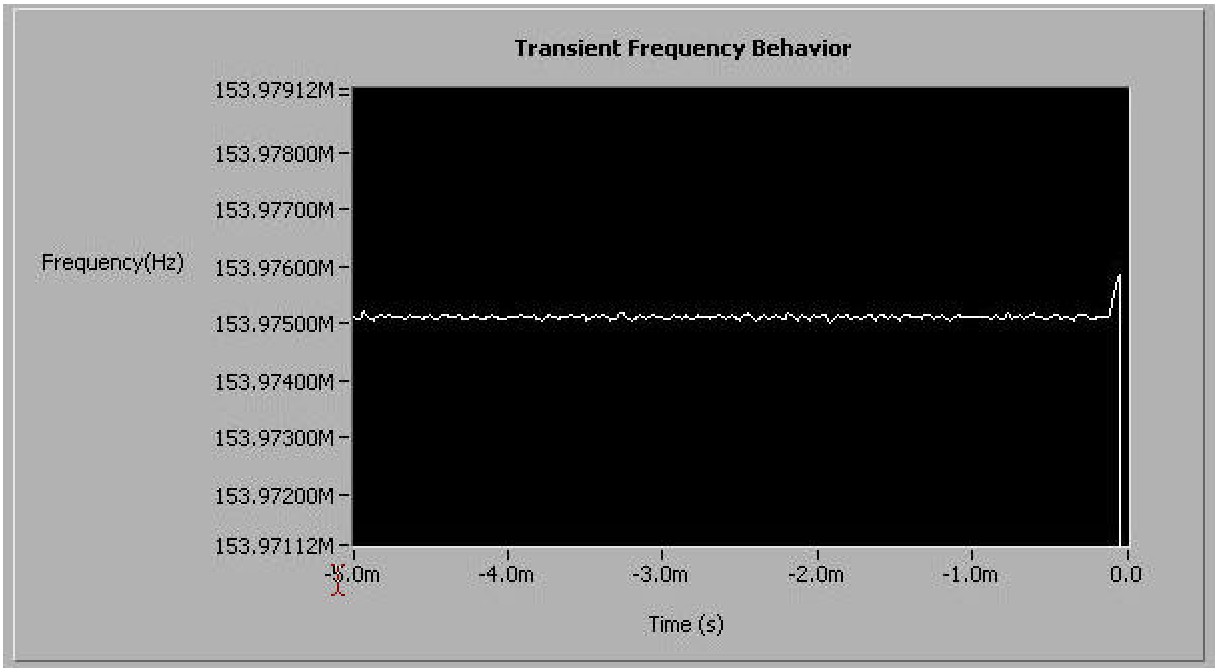
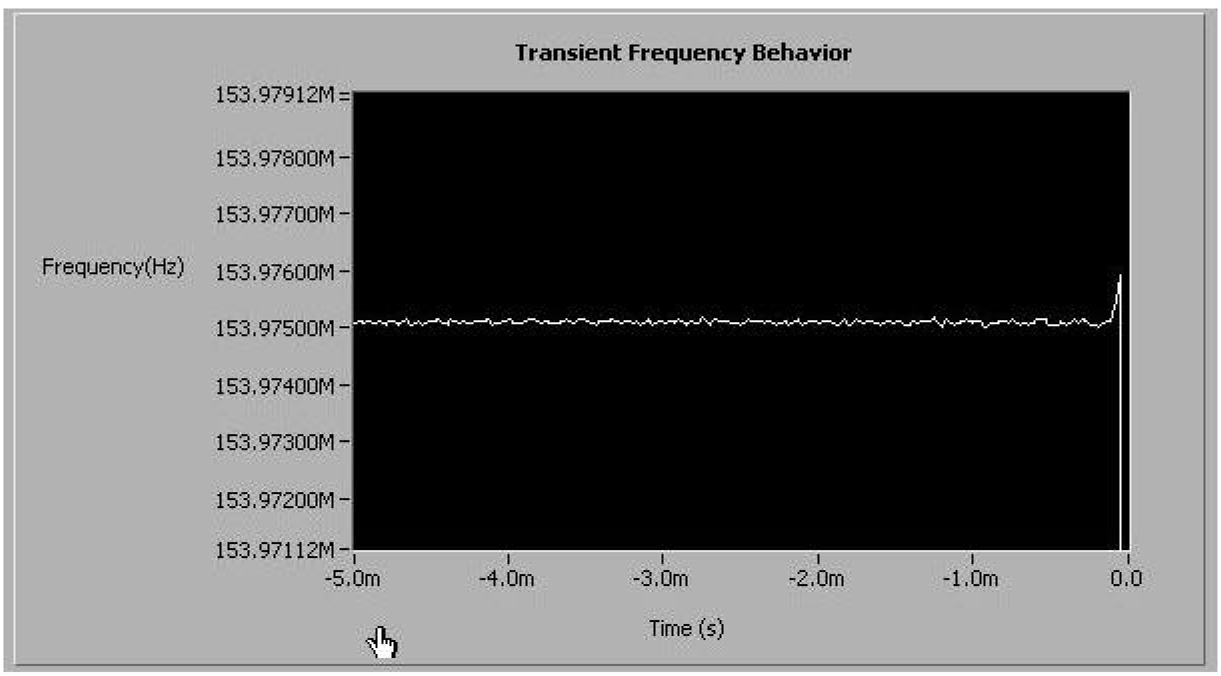


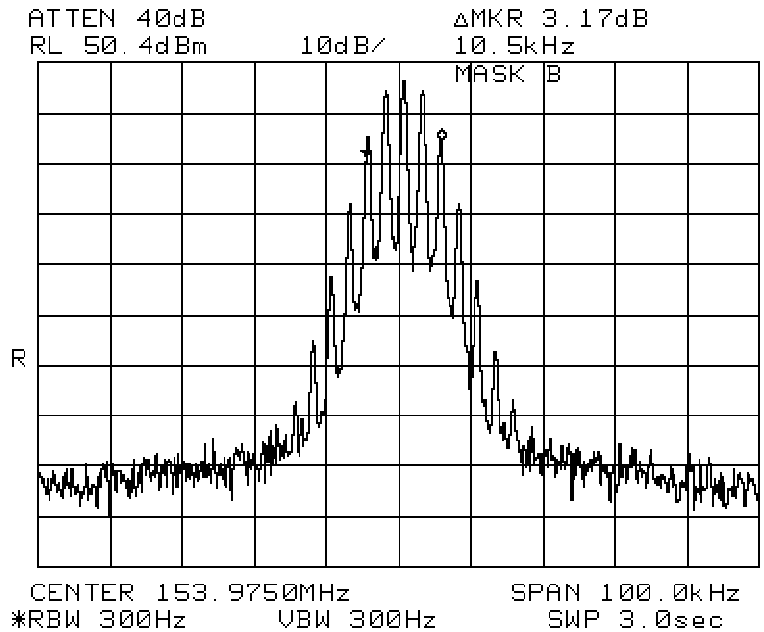
Figure 7-30 Transient Frequency Behavior, Narrowband, Transmitter off



7.7 Appendix G: Occupied Bandwidth Plots

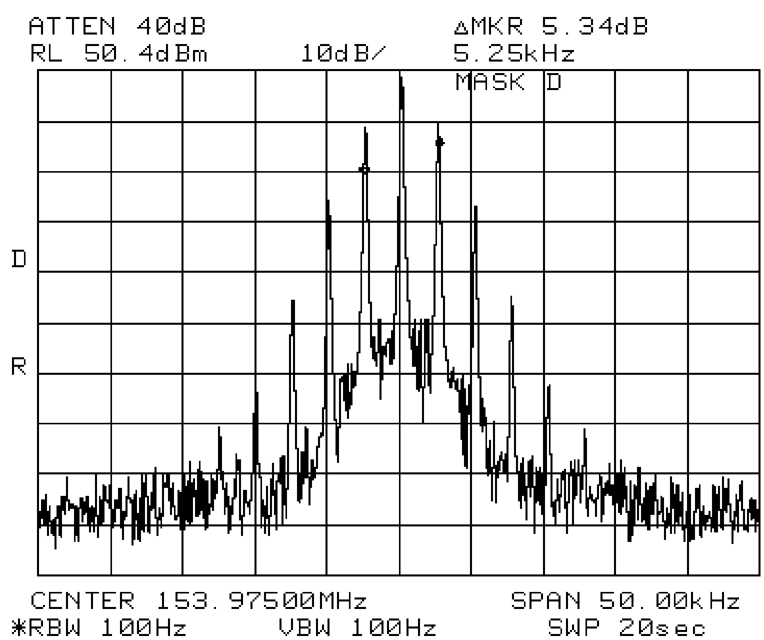
This appendix presents all occupied bandwidth plots for the test cases measured.

Figure 7-31: Wideband 2500 Hz audio signal



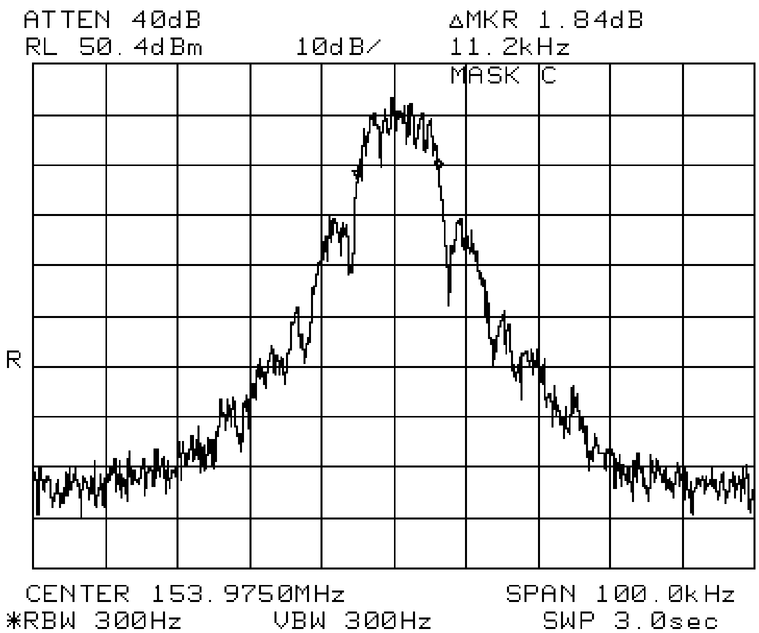
Tx at 153.975 MHz
110 W, low freq. split
2500 Hz audio with level 16 dB higher than required for 50 % deviation at 1 kHz
Wideband

Figure 7-32: Narrowband 2500 Hz audio signal



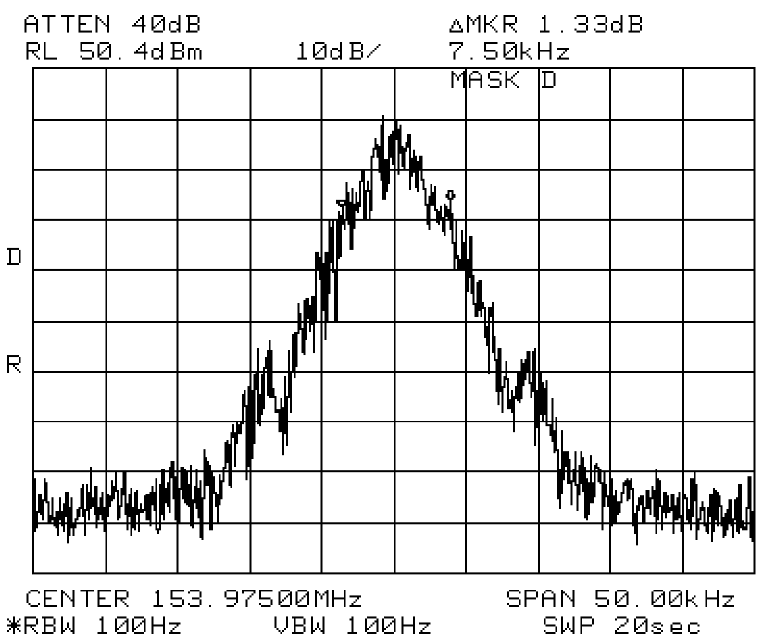
Tx at 153.975 MHz
110 W, low freq. split
2500 Hz audio with level set at 16 dB higher than required for 50% deviation at 1 kHz

Figure 7-33: 2 level 9600 baud signal with 3 kHz deviation



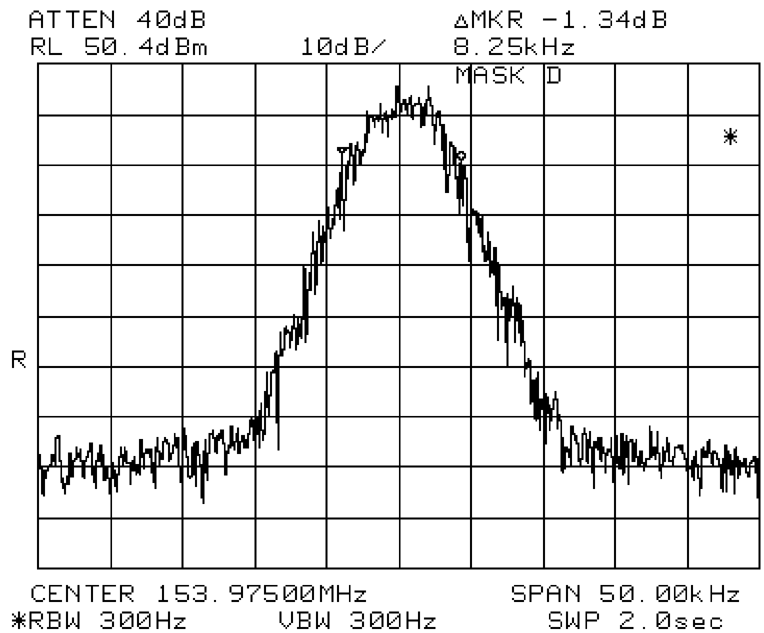
Tx at 153.975 MHz
110 W, low freq. split
2 level digital mod. WB

Figure 7-34: 2 level 9600 baud signal with 1.5 kHz deviation



Tx at 153.975 MHz
110 W, low freq. split
2 level digital mod., NB

Figure 7-35: C4FM signal



Tx at 153.975 MHz
110 W, low freq. split
C4FM

C-MAC ENGINEERING INC.

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Certification Report for M/A-COM MASTRIII VHF Base Station

FCC Part 90