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Technical Report No. 07-112

EMI Evaluation of the XG Technology, XG-VOIP-BTS to FCC Part 15, Class A Conducted and Radiated Emission Requirements, and Section 15.247, "Operation within the band of 902 – 928 MHz."

Performed: 11 October 2007

Customer: XG Technology, Inc.
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Approved by:
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Director, FAU EMI R&D Laboratory

1. INTRODUCTION

This document reports the FCC compliance results for the XG Technology, Inc.'s XG-VOIP-BTS, with updated software revision FVXGBTS101107-A. The unit is a base station for transmission and reception of voice over IP. The device transmits at a fixed frequency (914.3 MHz) within the ISM band of 902 to 928 MHz using an XG proprietary modulation scheme. The unit, with maximum operating clock frequency of 210 MHz, was evaluated for compliance to the FCC CFR-47, Part 15, Class A requirements as well as Section 15.247. The device was evaluated for both transmitting mode and receiving mode. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI R&D Laboratory as reported in this document.

2. OBJECTIVE

This evaluation was performed to verify conformance of the XG Technology, XG-VOIP-BTS module to the U.S. Federal Communications Commission (FCC), Code of Federal Regulations (CFR), Title 47 - Telecommunication, FCC Part 15 Subpart B- Unintentional Radiators, Sections 15.107(b) and 15.109 (b), FCC Class A conducted and radiated emission requirements, and Subpart C- Intentional Radiators, Section 15.247, "Operation within the bands 902-928 MHz".

3. CONCLUSION

The XG Technology, XG-VOIP-BTS unit met the FCC, Part 15 Subpart B, Class A conducted and radiated emission requirements, as well as the requirements for Section 15.247, operation within the band of 902-928 MHz, as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1 TEST PROCEDURES

The measurement techniques identified in the measurement procedure of ANSI C63.4-2003 *"American National Standard of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"* were followed as close as practical during this evaluation. Complete details and specific procedures used are discussed in the respective test result sections.

4.2 CONDUCTED EMISSIONS TEST RESULTS

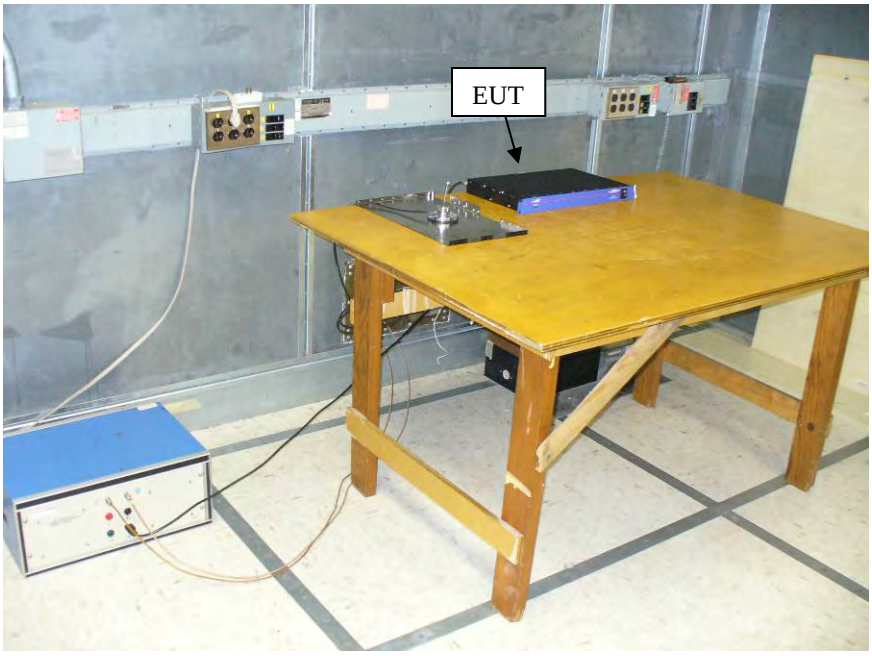
4.2.1 CONDUCTED POWERLINE EMISSIONS

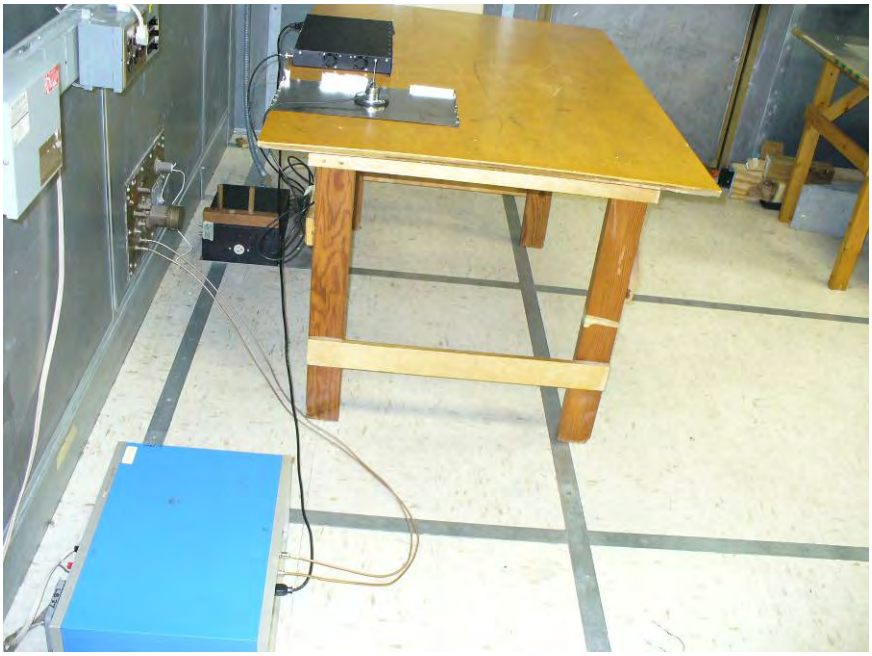
The XG Technology, XG-VOIP-BTS unit was evaluated for conducted emission requirements for both transmitting and receiving modes of operation. The module, powered by an internal switching power supply, was assessed with an antenna attached on a thin metal-sheet counterpoise and was placed set on top of the wooden test table. The data was transmitted and received correctly as confirmed by the XG Technology Engineer. Photographs 1 and 2 show the setup used during the evaluations.

The system was installed in the FAU EMI Research facilities conducted emissions shielded enclosure, on a wooden test table 80 centimeters above the ground plane floor and 40 centimeters from the rear wall. The device was then plugged into a Line Impedance Stabilization Network (LISN) EMCO Model No.3825/2R Serial No. 1095.

Conducted power line emissions were measured on both the phase and neutral lines with reference to earth ground, over the specified 150 kHz to 30 MHz range on a Hewlett Packard HP 8566B Spectrum Analyzer operated in the peak detection mode, in conjunction with HP 85685A Preselector, with a bandwidth of 9 kHz obtained through the HP 85650A Quasi Peak Adapter.

Figures 1 and 2 show the conducted emissions on both the phase and neutral lines measured in the receiver peak detection mode.





Photographs 1 & 2: Conducted Emission Setup

4.2.2 RECEIVING MODE

Figure 1 presents the results for the system evaluated in the receiving mode.

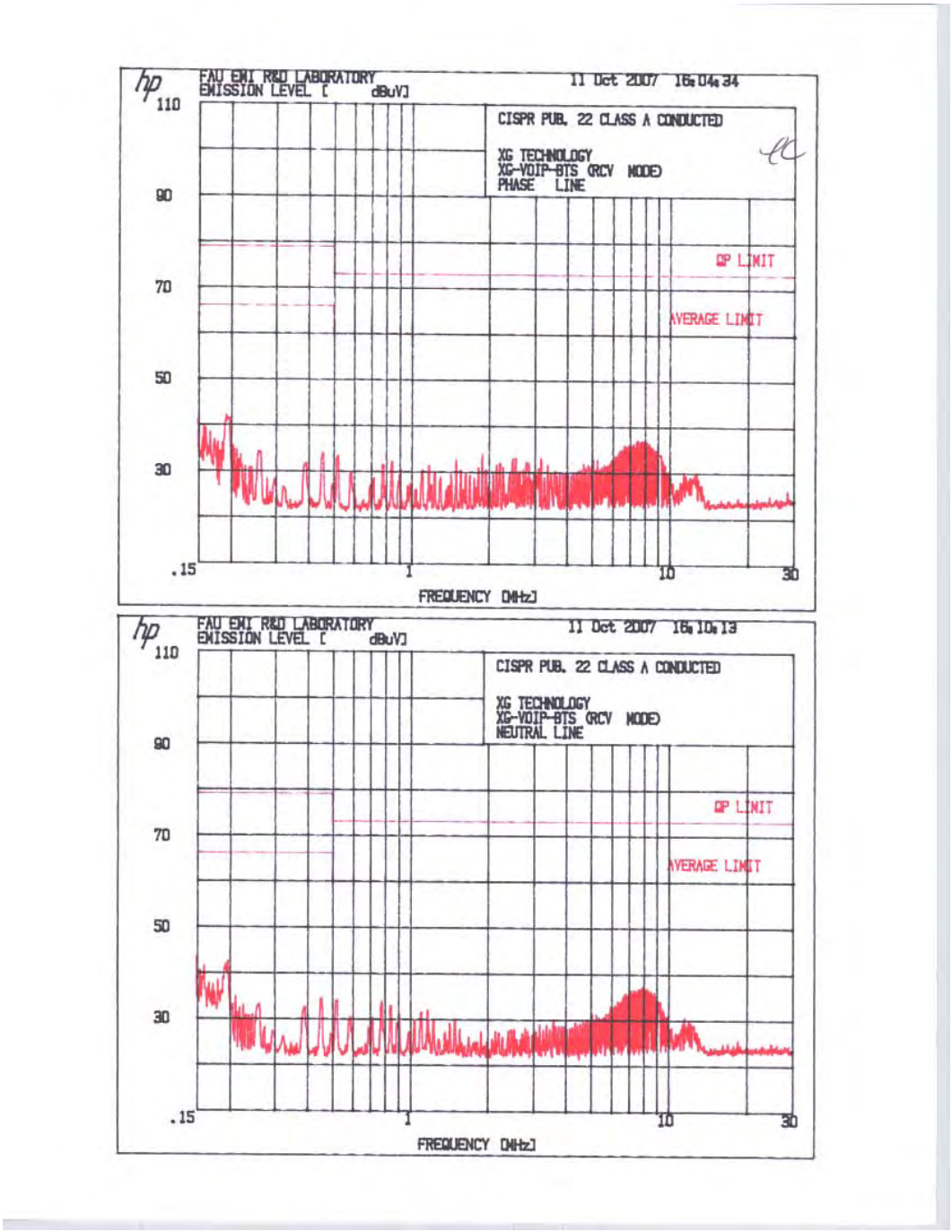


Figure 1: Phase and Neutral Conducted Emissions

4.2.3 TRANSMITTING MODE

Figure 2 presents the results for the unit evaluated in the transmitting mode. The unit was set to transmit voice packets of 30 ms duration using an XG proprietary modulation scheme within the ISM band of 902 to 928 MHz.

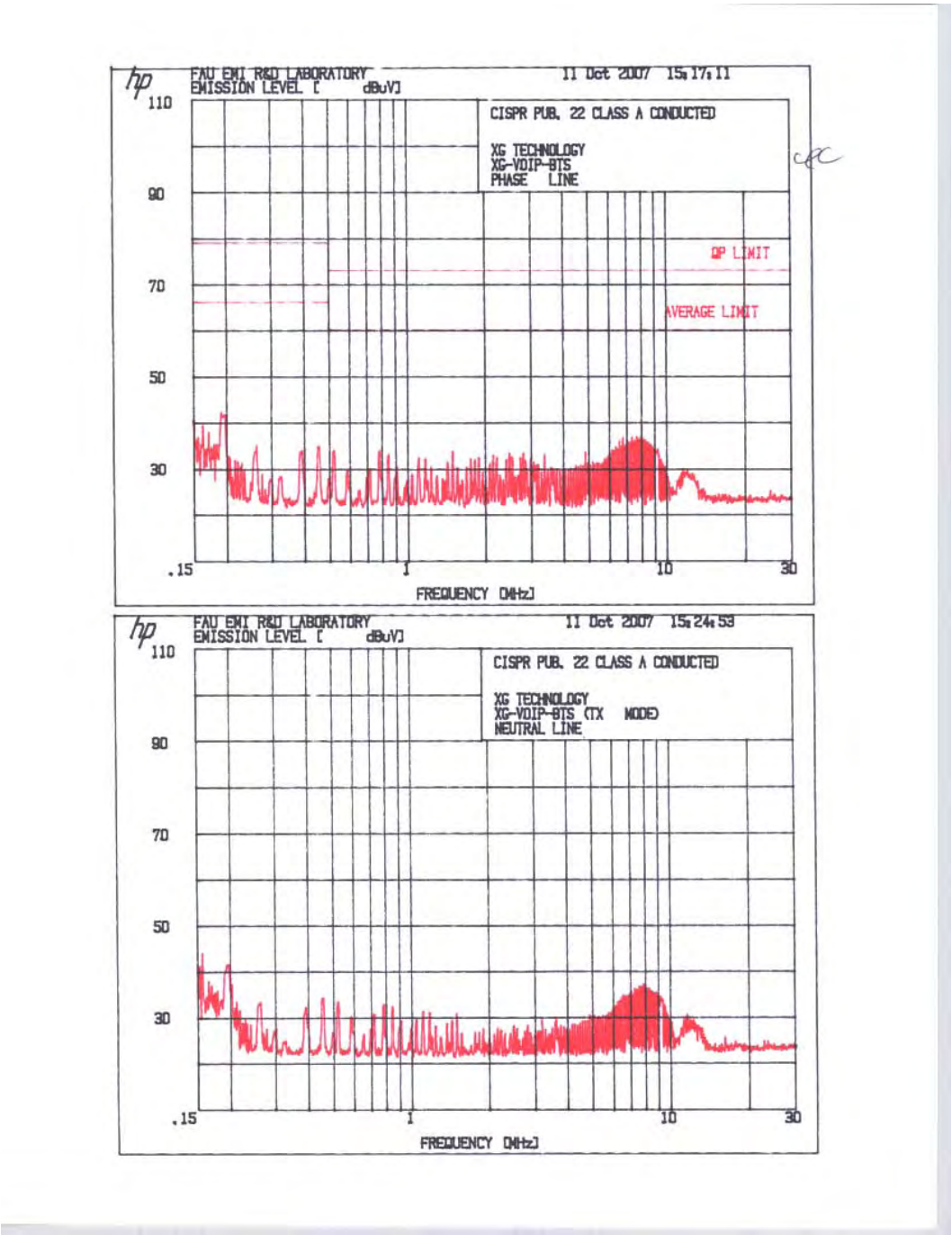


Figure 2: Phase and Neutral Conducted Emissions

From the above figures, the emissions that exceeded or were within 5 dB of the limit are reported in Table 1. Since the peak emissions are more than 5 dB below the average limit, there are no values to report on Table 1.

Line Tested	Frequency (kHz)	Peak Value (dBµV)	QP Value (dBµV)	Average Value (dBµV)	Avg. Limit (dBµV)	Margin to Avg. Limit (dB)*
Phase						
Neutral						

Table 1: Conducted Emission Peak Measurement

*****Margin to Avg. Limit (dB) = Avg. Limit (dBµV) – the measured value (either Peak, Quasi-Peak or Average Value) in dBµV

It can be seen that on both the phase and neutral lines, the emissions did not exceed the limits. Hence, the system is in compliance.

4.3 RADIATED EMISSIONS TEST RESULTS

4.3.1 UNINTENTIONAL RADIATED EMISSIONS

The XG Technology, XG-VOIP-BTS unit was setup on a wooden table 80 centimeters above the ground plane turntable of the Semi-Anechoic test site, as shown in Photographs 3 & 4. An antenna, set on a metal sheet (ground plane), was connected to the antenna jack of EUT. The XG-VOIP-BTS unit was connected to 110V/ 60 Hz power outlet located at the center of the turntable. The unit was evaluated for both transmitting and receiving mode.

An EMCO, Model 3104, S/N 299988A, the Broadband Biconical antenna was installed on an EMCO pneumatically controlled antenna mast at a distance of 3 meters from the system. The 30 MHz to 200 MHz frequency range was automatically scanned on the HP 8566B Spectrum analyzer (SA) that was operated in the peak detector mode with a bandwidth of 120 kHz obtained through the HP 85650A Quasi Peak Adapter. It should be noted that the RES BW and VBW of the spectrum analyzer must be set to 1 MHz for the Quasi Peak Adaptor to provide a 120 kHz bandwidth correctly. Hence, in the figures, RES BW and VBW are still indicated as 1 MHz.

After setting the SA to operate between 30-200 MHz, the max hold switch on the SA was pressed. The Biconical antenna was set to horizontal polarization and at 1-m above the floor. The turntable was then rotated 360 degrees. After a full revolution, the turntable was rotated back to the previously noted azimuth angles where the higher E-fields occurred, and the antenna was then scanned from 1 to 4 meters high at those angles in order to determine the height that will provide to highest amplitude. The antenna was moved back to the location where the highest amplitude was observed and the turn table was rotated again 360º. The maximum value was plotted and presented herein. The antenna was then turned to measure the vertical polarized E-field and the above procedure was repeated.

For the 200-1000 MHz band, a Log Periodic antenna (EMCO 3146) was installed and the SA was set to operate between 200-1000 MHz. To collect data, the above procedure was then repeated.

For the 1 GHz to the 2 GHz band, a double rigged horn antenna as well as a microwave pre-amplifier were installed and the SA was set to operate between 1 GHz to 2 GHz. The RBW and VBW were left at the 1 MHz setting and the bypass instrument function of the HP 85650A Quasi Peak Adapter was enabled. To collect the data, the procedure previously described was repeated again.

Figures 3-14 show the worse case radiated emissions of both configurations, for this evaluation, independent of azimuth or antenna height. The E-field is calculated using antenna factor, cable loss, distance factor and amplifier gain based on the following equation:

E (dBμV/m) = SA reading (dBμV) + Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB) - Distance Factor (dB)

Note that for the transmitting mode assessment, a Trilithic notch filter 7NM867/122-X1-AA was used at the receiver to notch the RF signal transmitted by the XG-VOIP-BTS module within the frequency band of 902 to 928 MHz.

Photographs 3 & 4: Radiated Emission Setup

4.3.1.1 RECEIVING MODE

Figures 3-8 present the results for the XG-VOIP-BTS module set to the receiving mode.

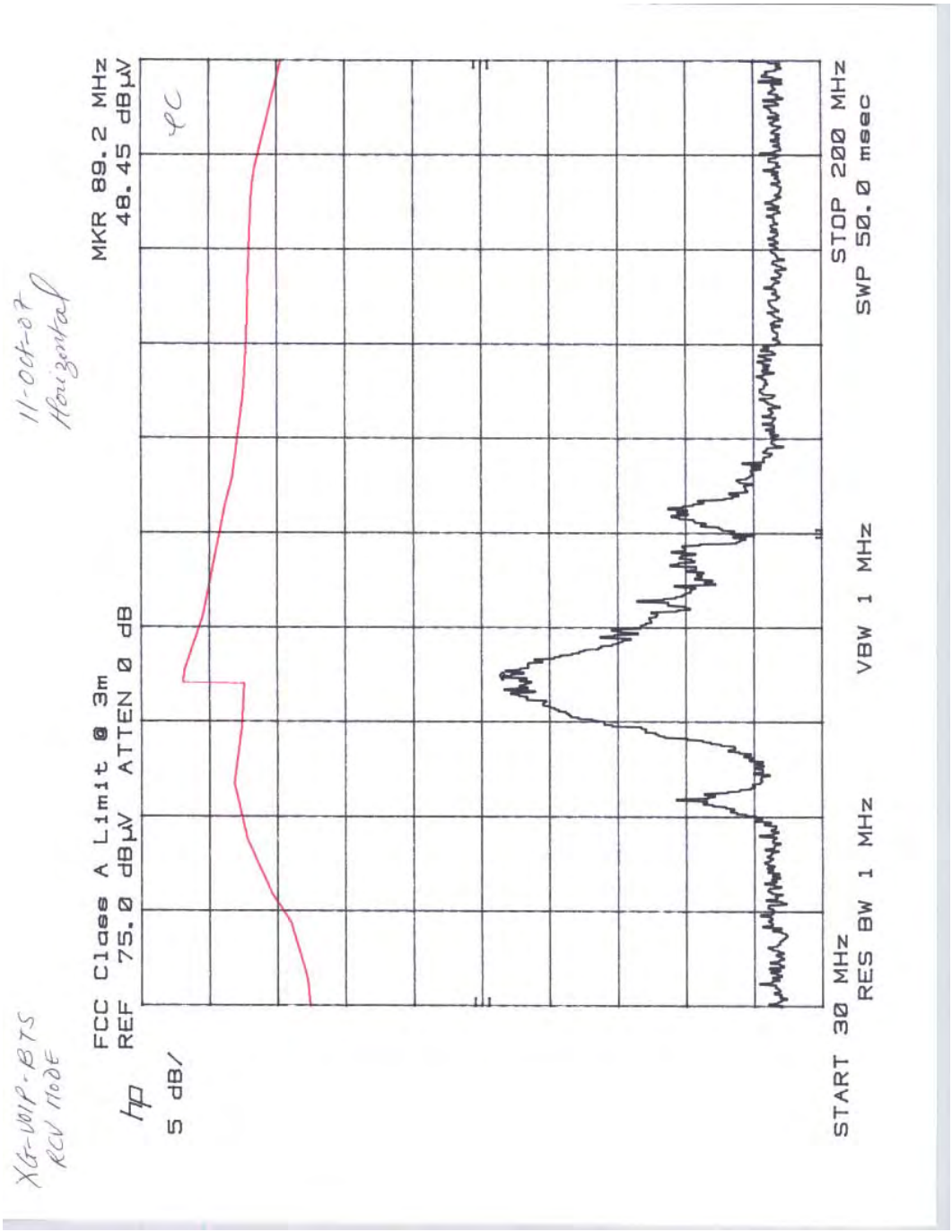


FIGURE 3: Radiated Emission 30 – 200 MHz Horizontal Polarization

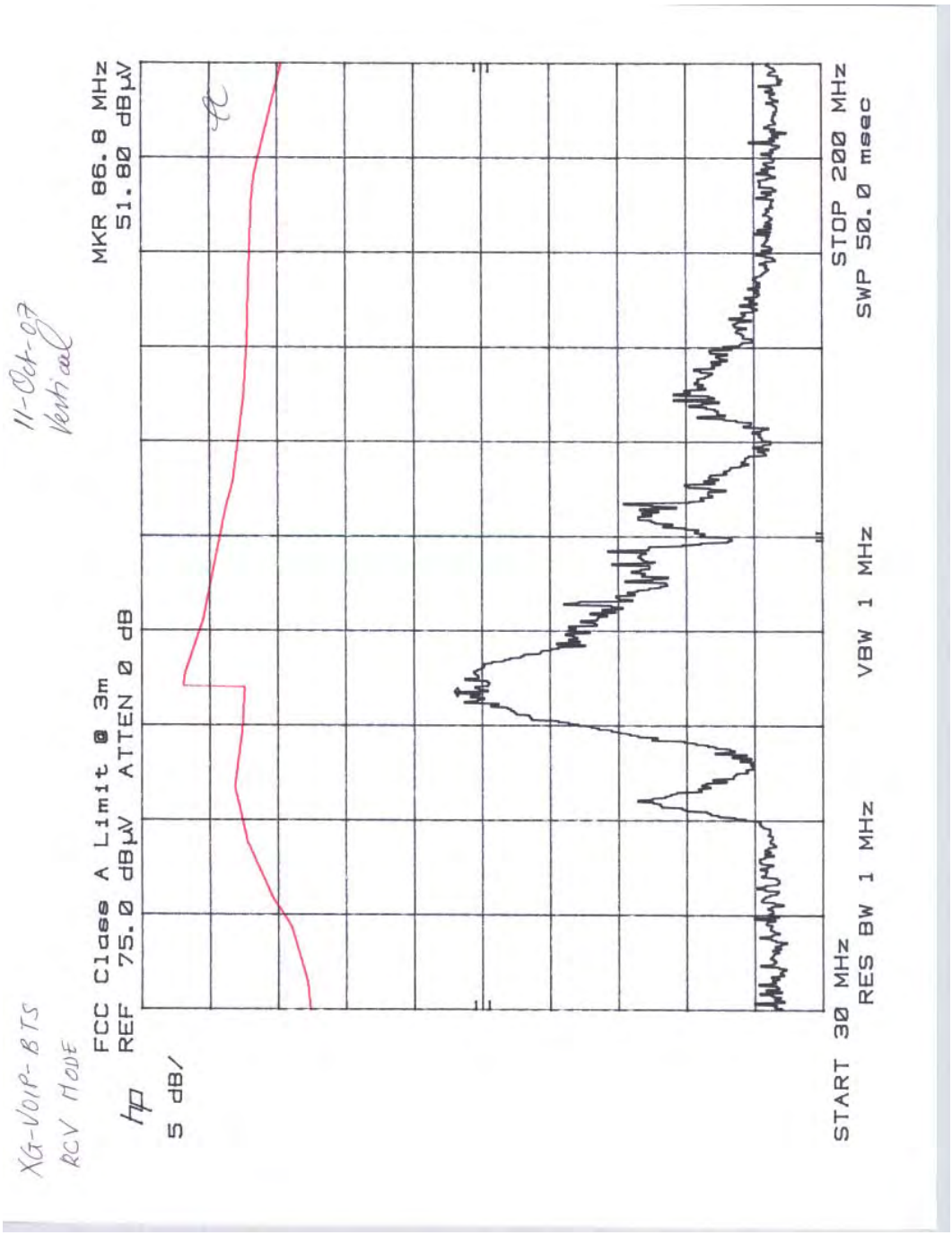


FIGURE 4: Radiated Emission 30 – 200 MHz Vertical Polarization

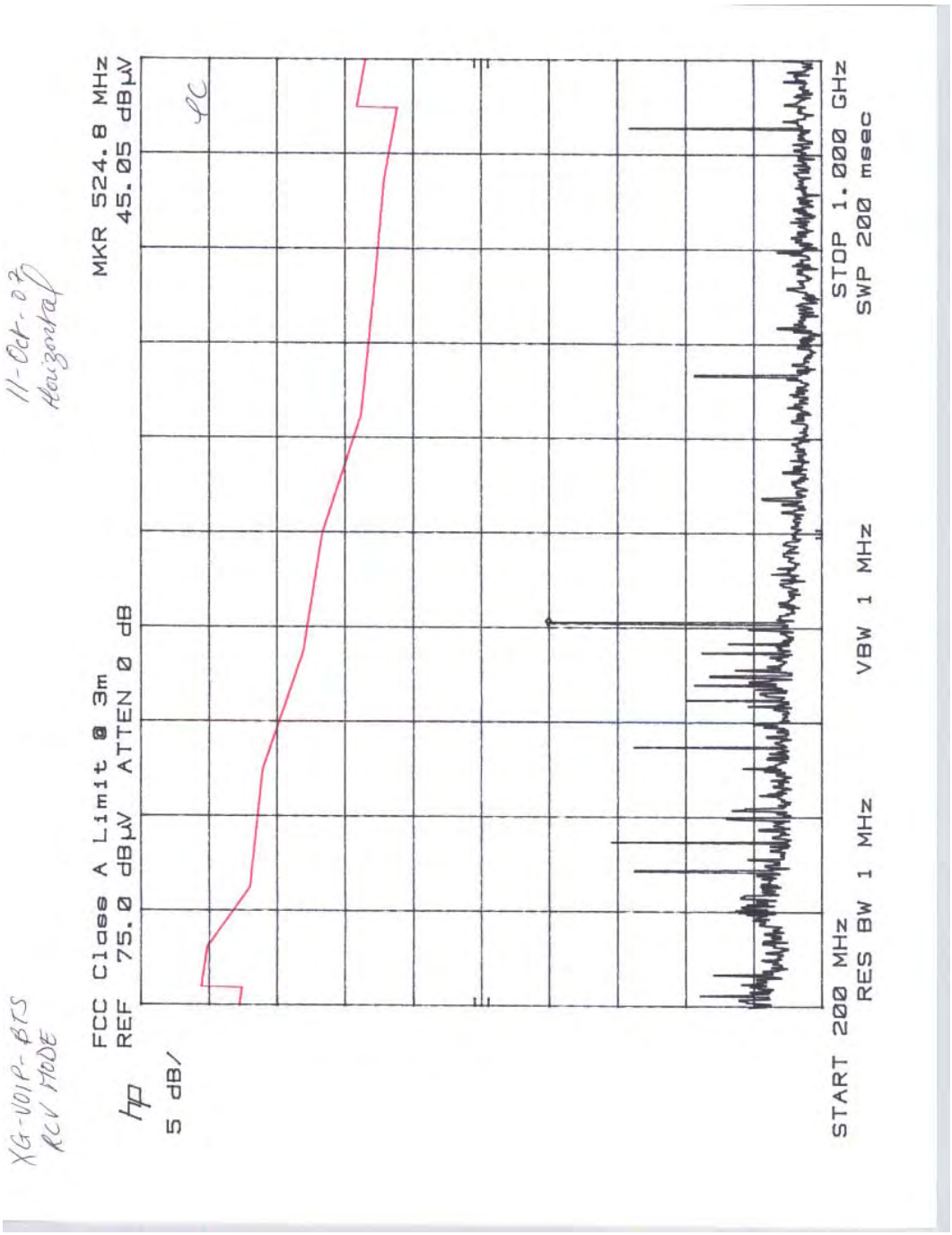


FIGURE 5: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

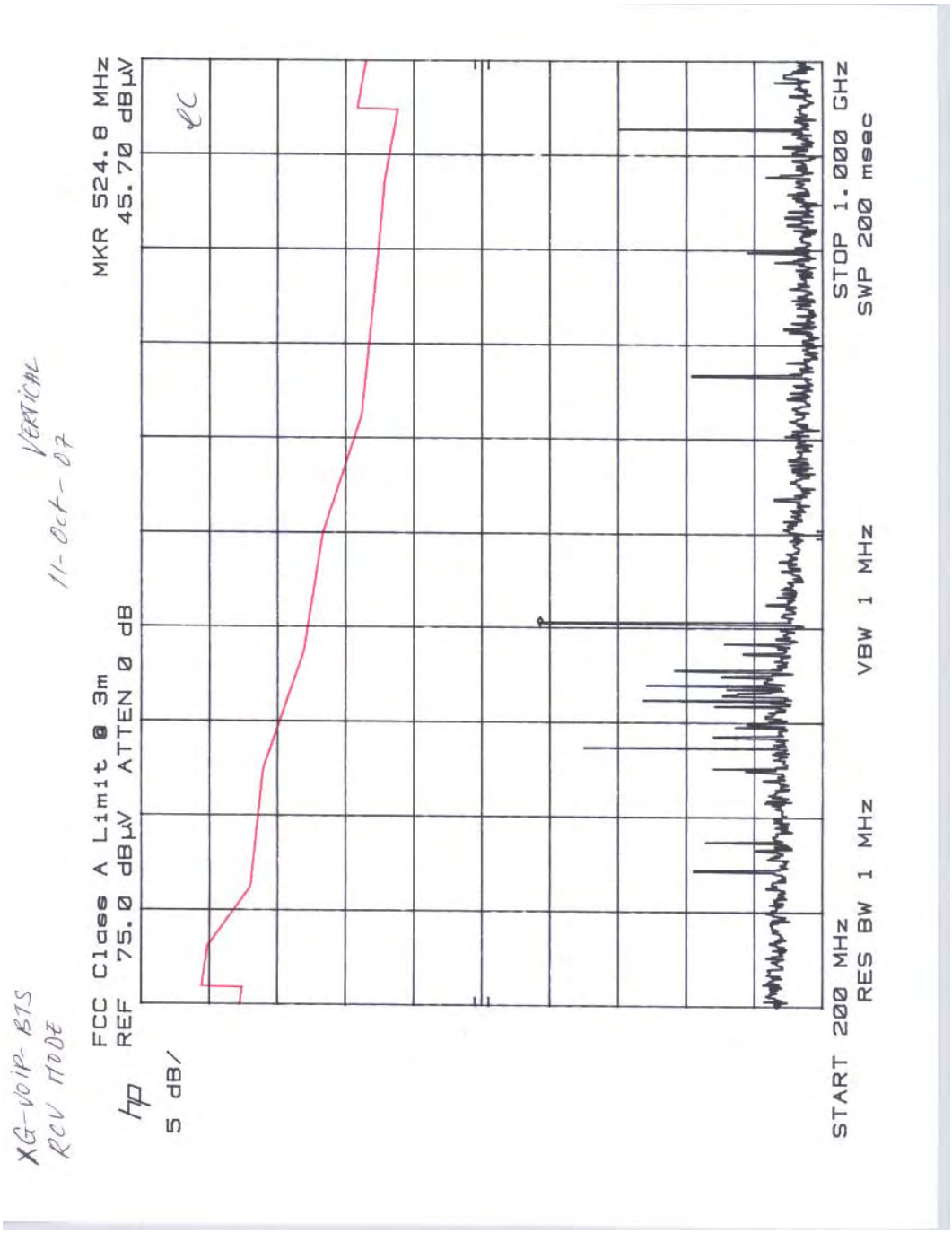


FIGURE 6: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

Since the maximum operating clock frequency is 210 MHz, the unit was evaluated up to 2 GHz.

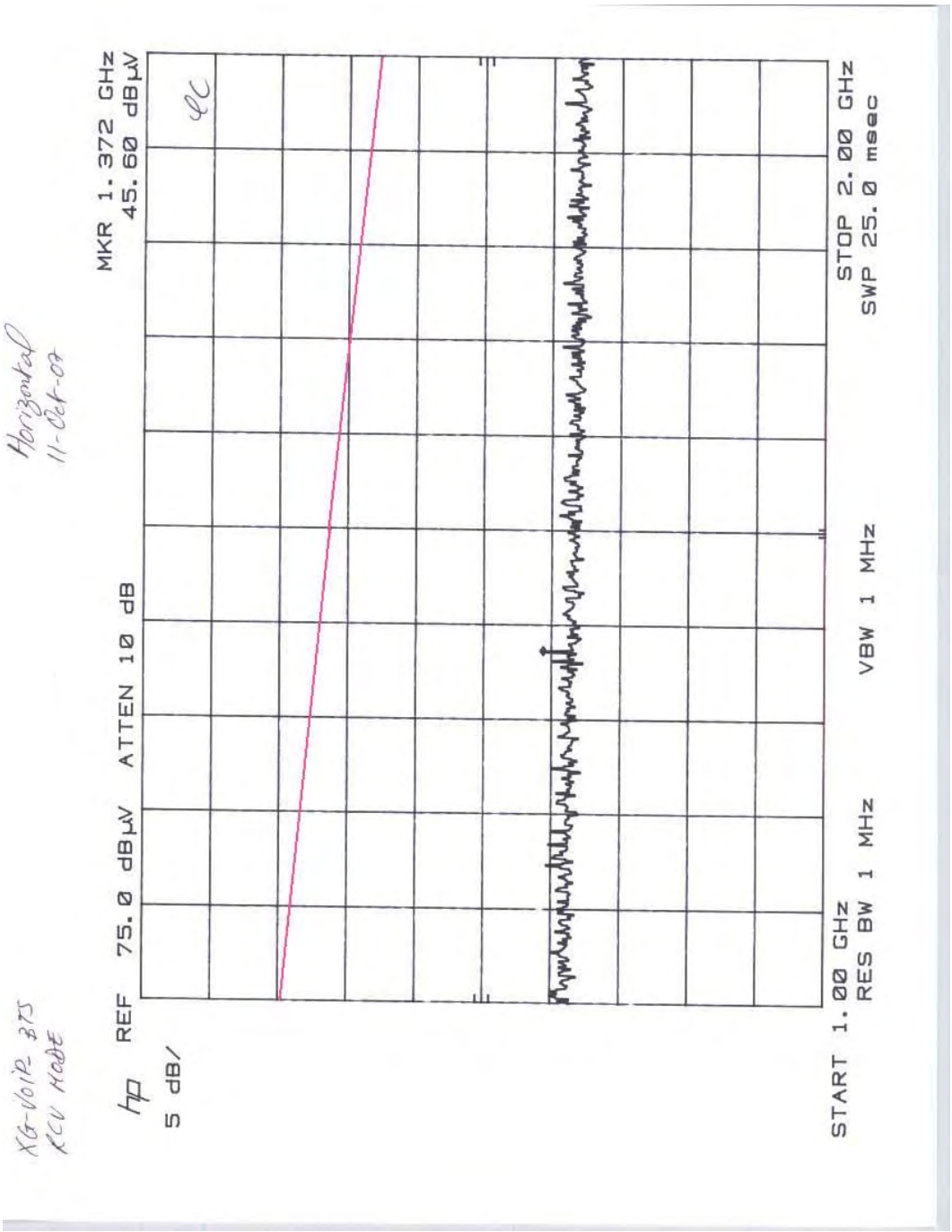


FIGURE 7: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

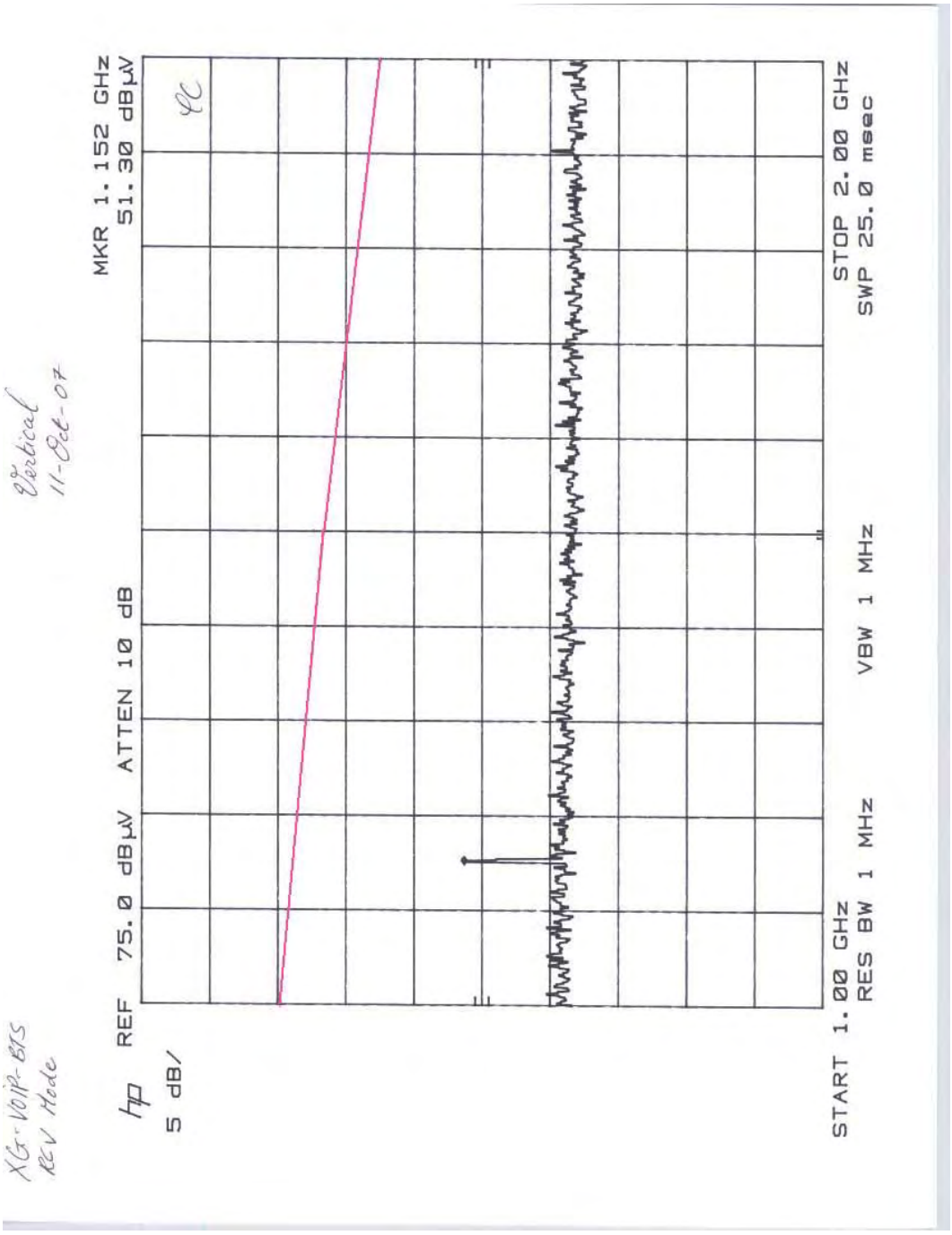


FIGURE 8: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

4.3.1.2 TRANSMITTING MODE

Figures 9 to 14 present the results for the XG-VOIP-BTS unit evaluated in the transmitting mode. The module was set to transmit voice packets of 30 ms duration, using an XG proprietary modulation technique. A Trilithic filter 7NM867/122-X1-AA was used at the receiver to notch the RF signal transmitted by the XG-VOIP-BTS module within the frequency band of 902 to 928 MHz. It should be noted from Figures 11-12 that even with the notch filter the receiving system is still able to measure the intentional TX signal.

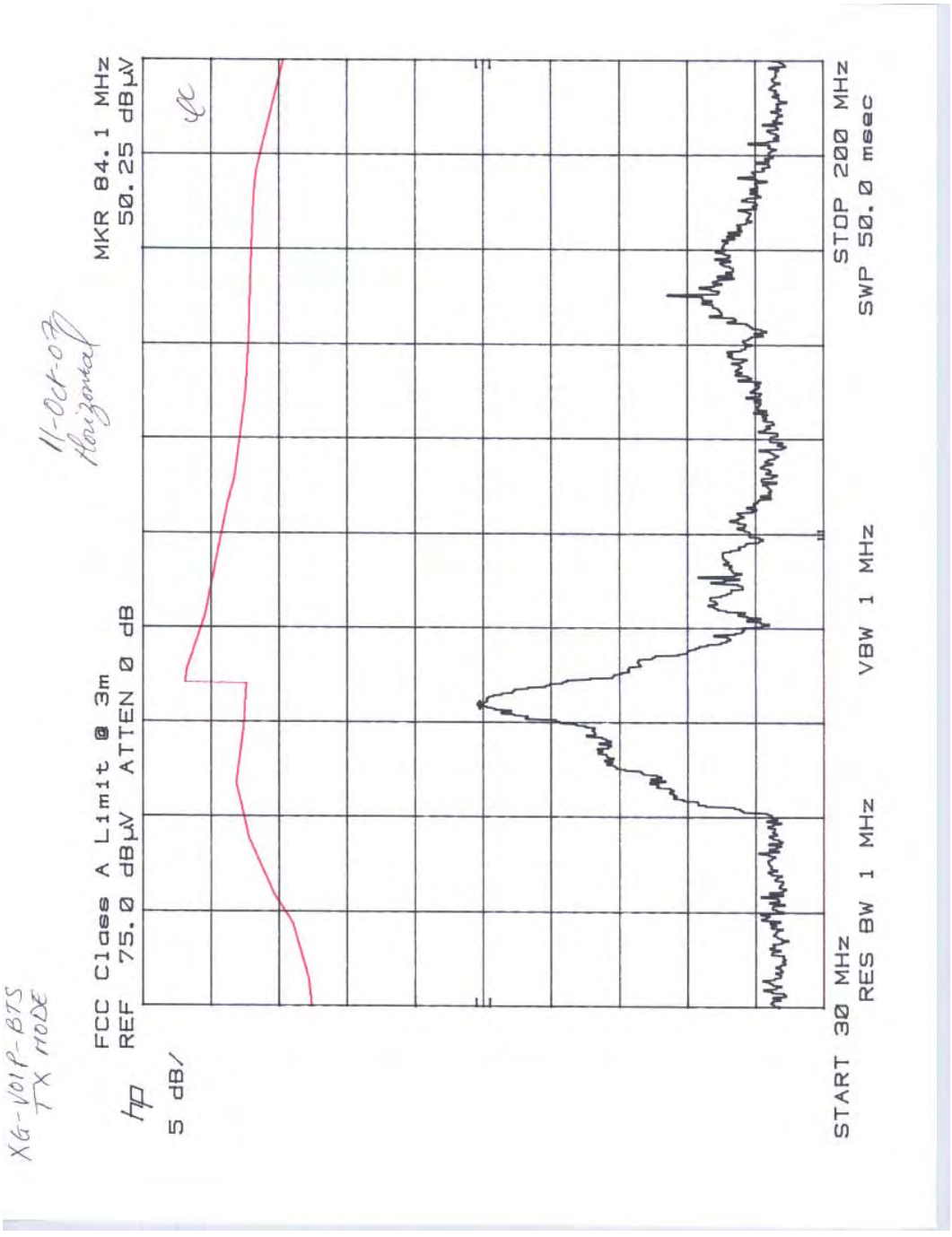


FIGURE 9: Radiated Emission 30 – 200 MHz Horizontal Polarization

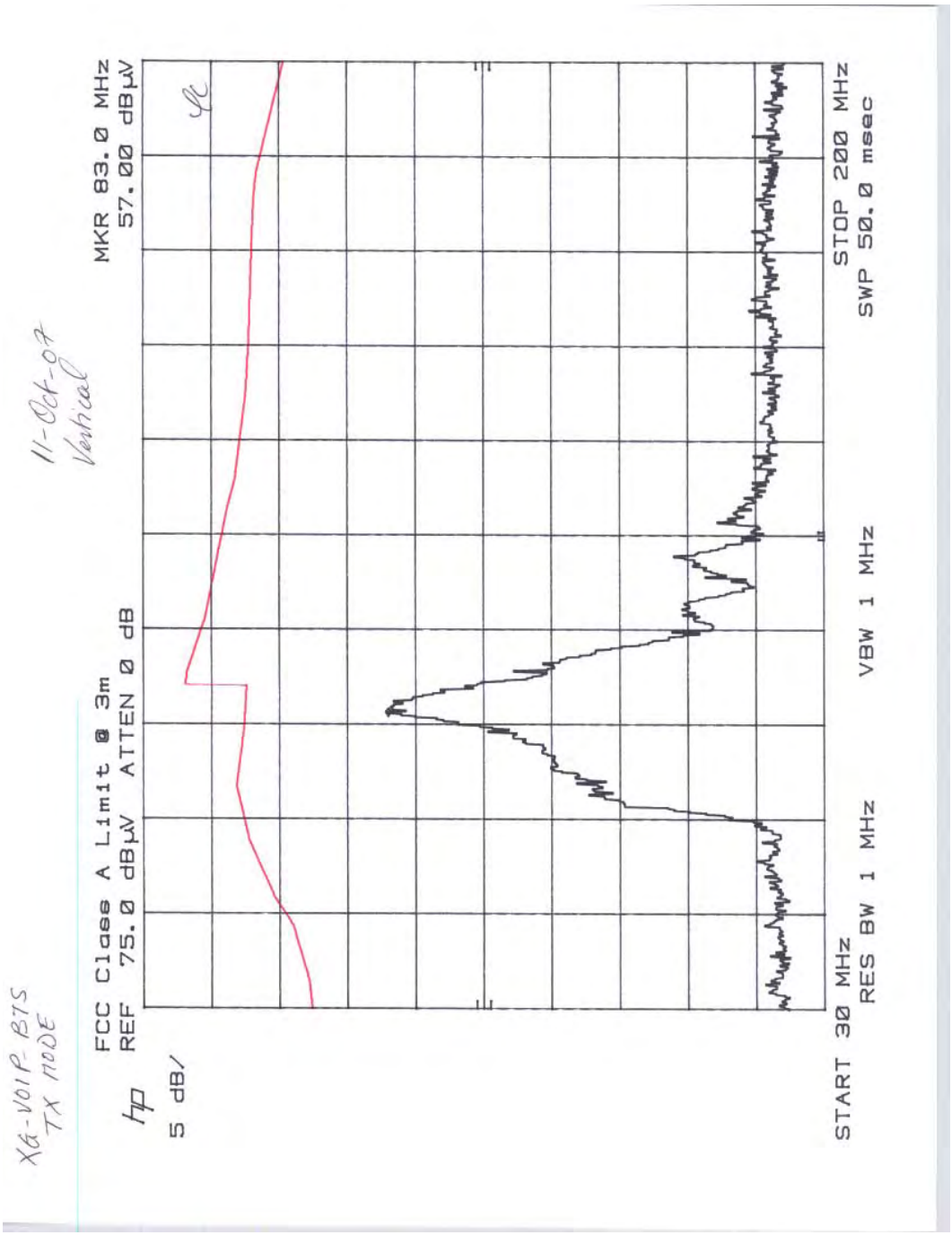


FIGURE 10: Radiated Emission 30 – 200 MHz Vertical Polarization

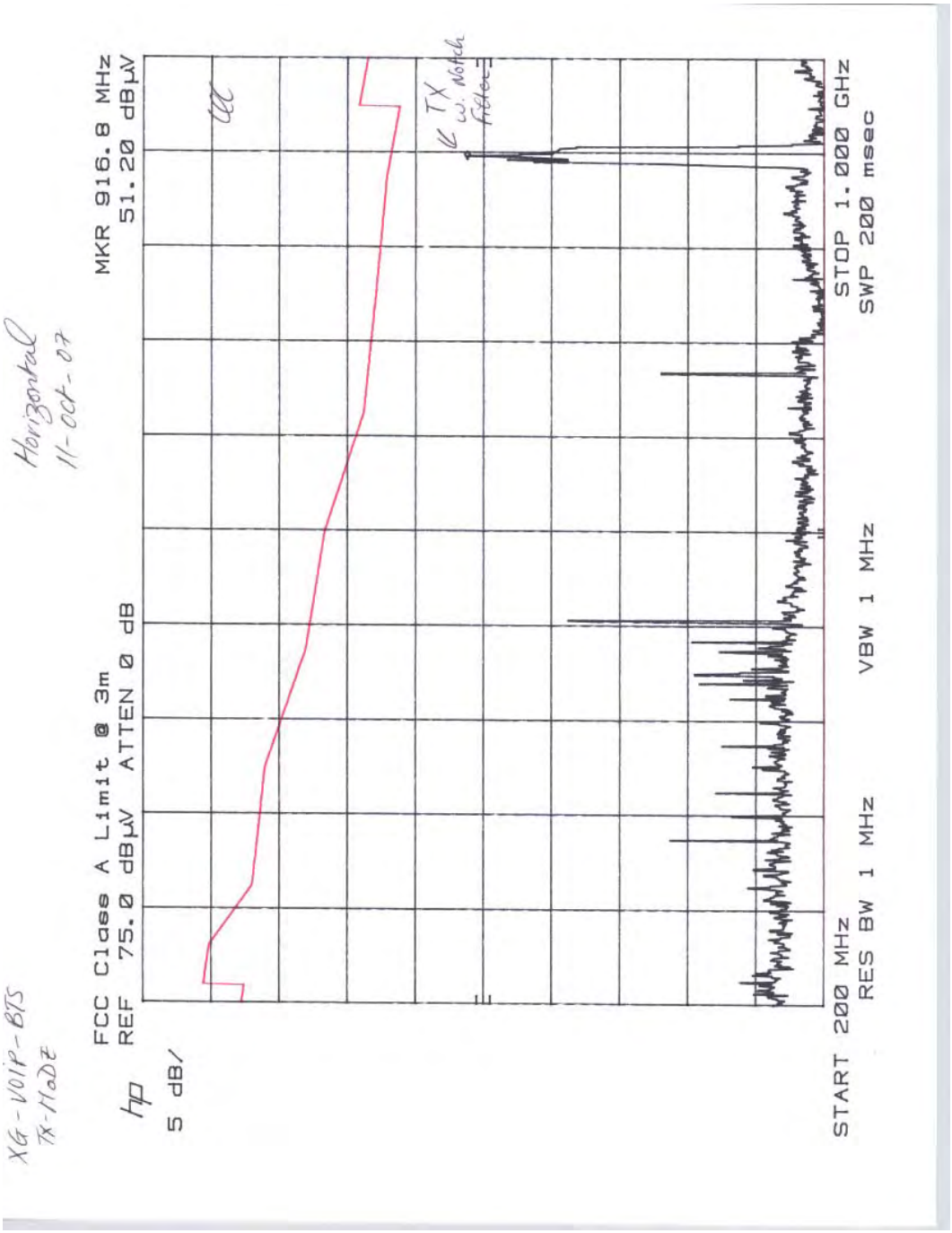


FIGURE 11: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

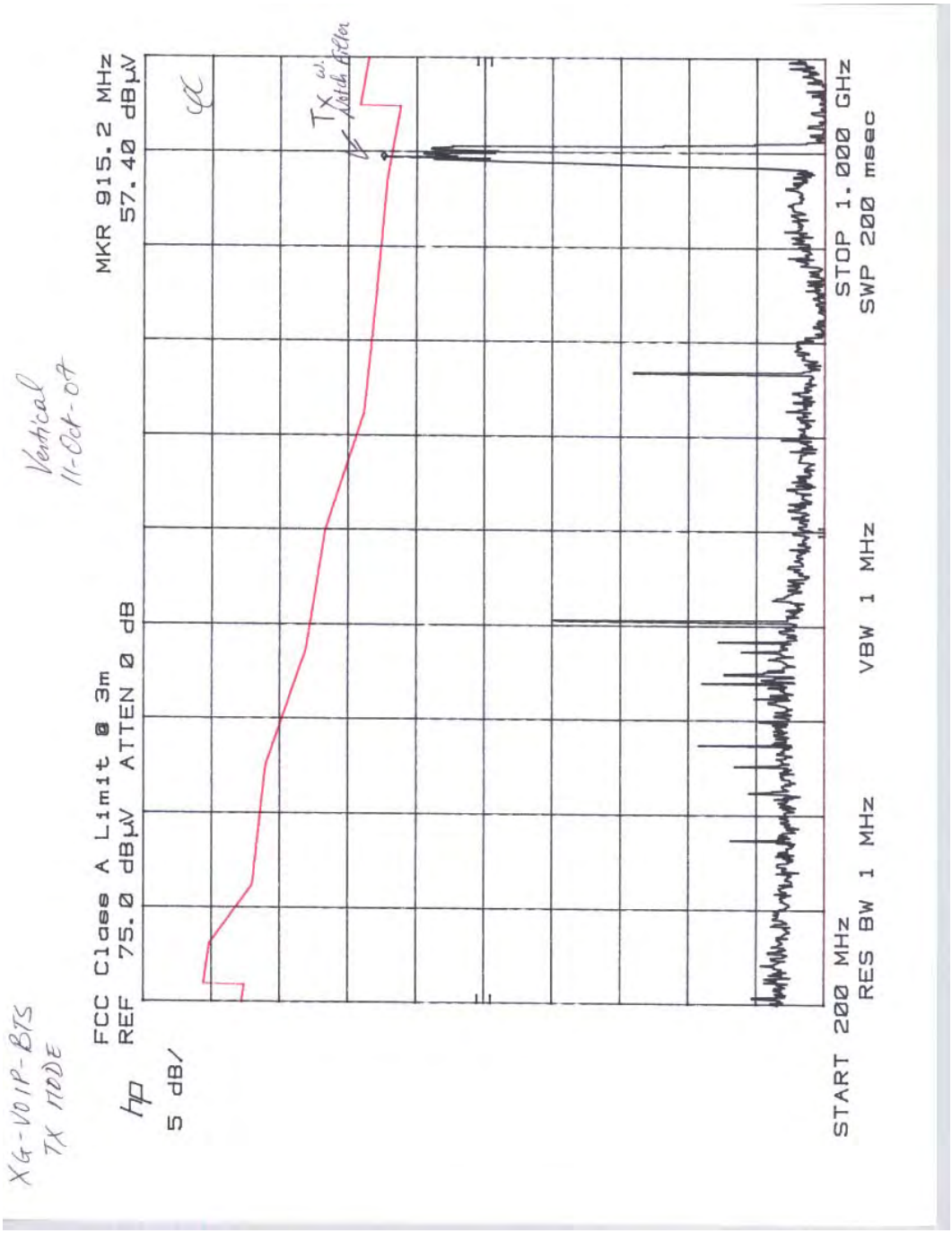


FIGURE 12: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

Since the maximum operating clock frequency is 210 MHz, the unit was evaluated up to 2 GHz.

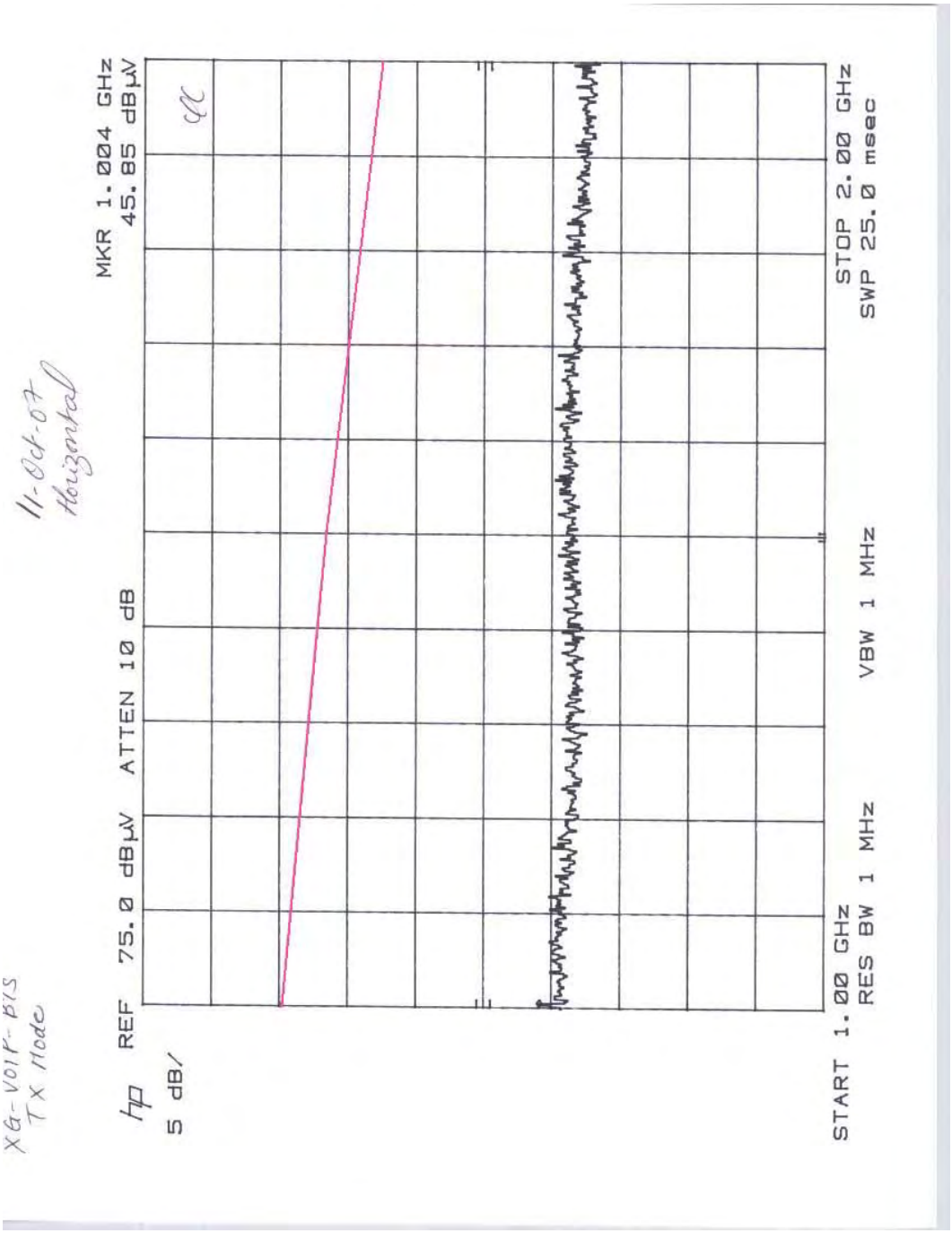


FIGURE 13: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

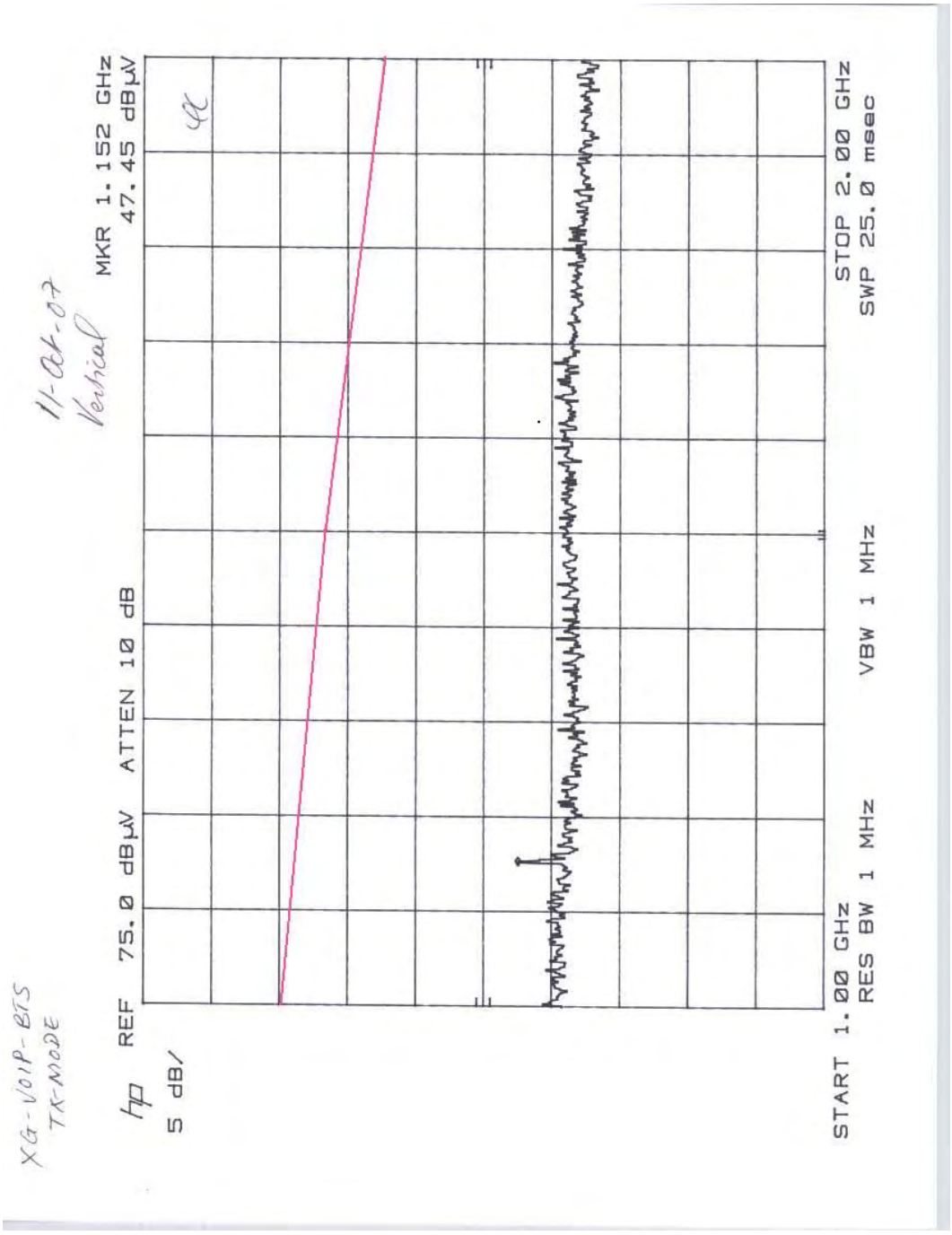


FIGURE 14: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

From Figures 3-14, no unintentional peak emissions exceeded or were within 5 dB of the limit. Note that the peak emissions at 916 MHz from Figures 11 and 12 represent the intentional RF signal transmitted by the module, attenuated by the band reject Trilithic filter 7NM867/122-X1-AA. Therefore, these values are not reported in Table 2. The characteristics of the transmitted signal are evaluated in the next sections.

Figure No.	Frequency (MHz)	Measured Peak (dBµV)	Quasi Peak (dBµV)	Average (dBµV)	Correction Factor (dB/m)	Peak Field* (dBµV/m)	FCC Limit (dBµV/m)	Margin to limit (dB)

Table 2: Peak Measurement Results

* Peak field (dBµV/m) = the measured value (either Peak, Quasi Peak or Average) in dBµV - Correction Factor (dB/m)

It can be seen from the previous figures that the unintentional radiated emissions are below limit. Hence the unit is in compliance.

4.3.2 INTENTIONAL RADIATED EMISSIONS

4.3.2.1 OCCUPIED BANDWIDTH (BW) TEST RESULTS And BAND EDGE EMISSION MEASUREMENTS

The XG Technology, XG-VOIP-BTS, programmed to transmit a digitally modulated signal within the ISM band of 902 to 928 MHz using an XG proprietary modulation technique, was evaluated for occupied bandwidth. A Log Periodic antenna was used to capture the signal. The measurements were recorded with the RF preamp in the receiving system but the notch filter was removed. The signal was measured on an HP 8566B Spectrum analyzer on the peak detector mode. A resolution bandwidth of 120 kHz was achieved through the HP 85650A Quasi Peak adapter. The measurement configuration and procedures followed the guidelines of the FCC procedures for the measurement of digital transmissions systems operating under Section 15.247.

Figure 15 shows the occupied bandwidth using 6 dB criterion for the receiving antenna polarization leading to the highest emissions.

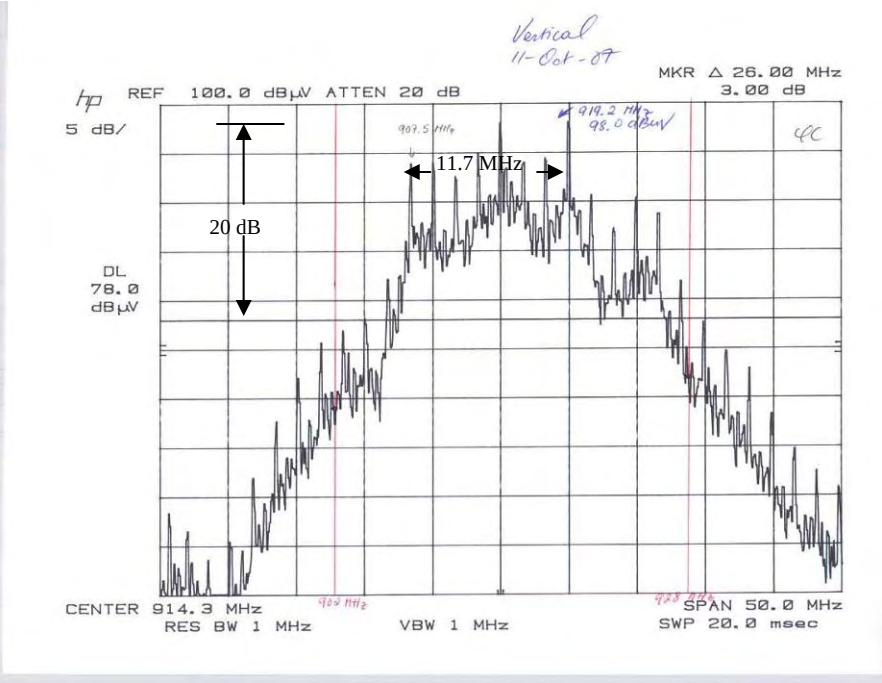


Figure 15: Occupied Bandwidth Results

The 6 dB bandwidth of the XG Technology XG-VOIP-BTS unit was measured to be 11.7 MHz (907.5-919.2 MHz), hence meeting the minimum bandwidth requirement of 500 kHz. Additionally, the emissions outside of the band of 902 – 928 MHz are at least 20 dB below the maximum peak of the fundamental. Hence, the unit is operating within the band and meets the band edge requirements.

4.3.2.2 MAXIMUM OUTPUT POWER MEASUREMENTS

The measurement of the maximum output power at the frequency of 914.3 MHz was undertaken using a Rohde & Schwarz NRP-Z55 thermal power sensor. The thermal power sensor was connected to the antenna feed without any external attenuation. The duty cycle of the transmitted signal was measured and determined the duty cycle, and the appropriate correction was used to obtain the peak output power.

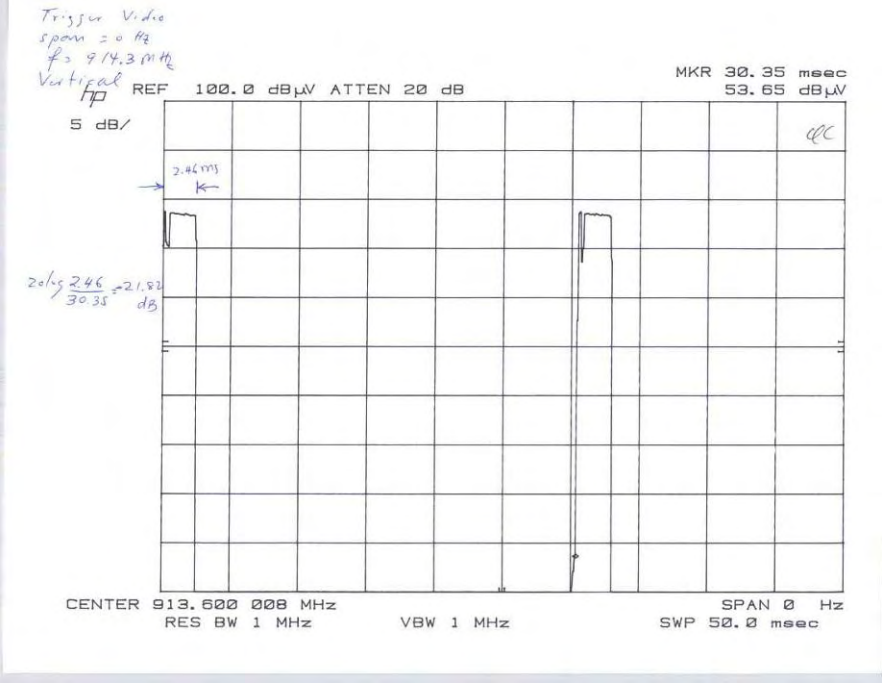


Figure 16: Fundamental Carrier Duty Cycle

Power Sensor Reading (dBm)	Duty Cycle (%)	Peak Power (dBm)	Peak Power (mW)
-0.742	8.11	10.17	10.40

Table 3: Conducted Power Measurement

It can be seen from the data above that the maximum peak output power is 10.17 dBm, corresponding to 10.40 milliwatts, which is lower than the 1 watt limit. Hence, the device meets the maximum output power requirements as per Section 15.247.

4.3.2.3 POWER SPECTRAL DENSITY

The power spectral density of the XG Technology, XG-VOIP-BTS, was measured on the HP 8566B spectrum analyzer on the peak detector mode while the "bypass" instrument function of the HP 85650A Quasi-Peak Adapter was activated. The coaxial feed for the XG-VOIP-BTS antenna was connected to SA in conjunction with an HP 8495B variable attenuator set to 40 dB. The spectrum analyzer was centered on the peak of the fundamental carrier frequency. The resolution bandwidth was reduced to 3 kHz and the span to 300 KHz. The sweep time was set to 100 seconds. The measurement configuration and procedures followed the guidelines of the FCC procedures for the measurement of digital transmissions systems operating under Section 15.247.

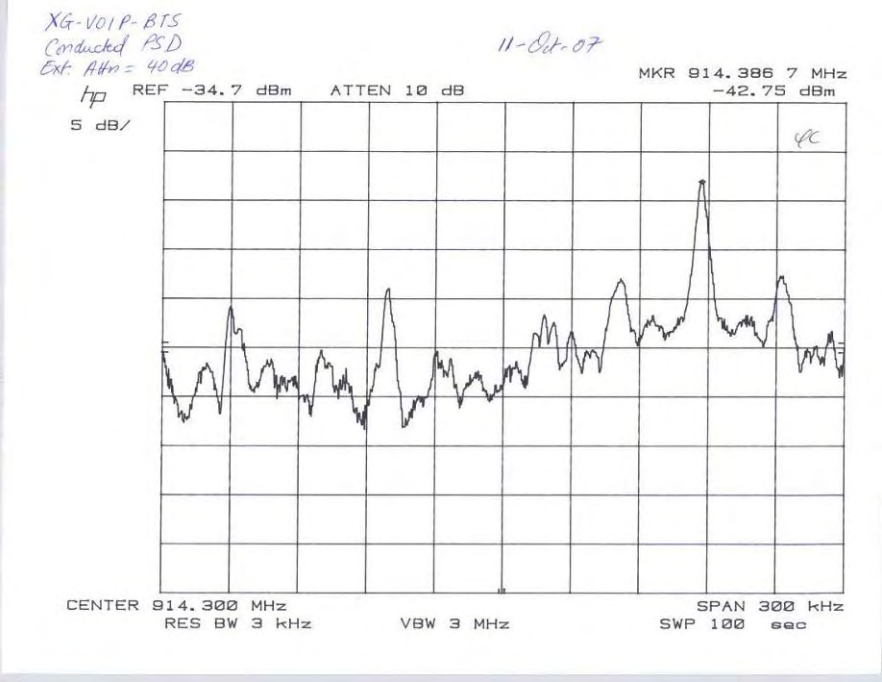


Figure 17: Power Spectral Density

SA Reading (dBm)	External Attenuation (dB)	Cable Loss (dB)	Corrected Power (dBm)	FCC Limit (dBm)	Margin to Limit (dB)
-42.75	40	0.61	-2.14	8	10.14

Table 4: Peak Measurement Results

It can be seen from Figure 17 and Table 4 that the power spectral density did not exceed the 8 dBm limit. Hence the unit meets the power spectral density requirements as per Section 15.247.

4.3.2.4 SPURIOUS EMISSION MEASUREMENTS

For the measurement of the spurious emissions of the XG Technology XG-VOIP-BTS transmitting at 913.4 MHz, a Trilithic, Inc. 4HC1400-1-KK high-pass filter was connected to the input of the preamp. The peak spurious emissions from the harmonic frequencies of the 914.3 MHz were recorded on the HP 8566B Spectrum analyzer with the max hold key. The resolution and video bandwidths of the spectrum analyzer were both set to 1 MHz and the bypass instrument function of the quasi peak adapter was activated. The data was recorded with a frequency span of 50 MHz.

An EMCO, Model 3115, double rigged horn antenna, set to horizontal polarization, was installed on the EMCO pneumatically controlled antenna mast at a distance of 3 meters from the system and 1 meter above the ground floor. The turntable was then rotated 360 degrees. After a full revolution, the turntable was rotated back to the previously noted azimuth angles where the higher E-field occurred, and the antenna was then scanned from 1 to 4 meters high, in order to determine the highest E-field amplitude. The antenna was moved back to the location where the highest amplitude was observed and the turn table was rotated 360º again. The maximum value was recorded and presented herein. The antenna was then rotated to measure the vertical polarized E-field and the above procedure was repeated.

For the average measurements, the video bandwidth of the spectrum analyzer was reduced to 10 Hz, the spectrum analyzer was set to linear scale with sweep-time in auto mode. The emissions were maximized using the procedure described above.

Tables 5 and 6 present the worse case emissions leading to the worst case emissions for horizontal and vertical polarizations of the receiving antenna respectively.

Frequency (GHz)	Peak Reading (dBµV)	Average Reading (dBµV)	CF (dB)	Peak E-Field (dBµV/m)	FCC Peak Limit (dBµV/m)	Margin to Peak Limit (dB)	Average E-Field (dBµV/m)	FCC Average Limit (dBµV/m)	Margin to Average Limit (dB)
1.828	44.55		-0.77	45.32	98.13	52.81		98.13	52.81
2.743	43.8		-3.27	47.07	74	26.93		54	6.93
3.657	42.45	30.06	-5.58	48.03	74	25.97	35.64	54	18.36
4.571	42.7	30.2	-12.51	55.21	74	18.79	42.71	54	11.29
5.485	42.25	29.19	-15.86	58.11	98.13	40.02	45.05	98.13	53.08
6.4	40.4	28.01	-18.79	59.19	98.13	38.94	46.80	98.13	51.33
7.314	40.85	27.87	-21.02	61.87	74	12.13	48.89	54	5.11
8.228	40.25	27.91	-21.97	62.22	74	11.78	49.88	54	4.12
9.142	39.5	26.99	-23.69	63.19	74	10.81	50.68	54	3.32

Table 5: Peak Spurious Emission Measurement Results (Horizontal Polarization)

Frequency (GHz)	Peak Reading (dBµV)	Average Reading (dBµV)	CF (dB)	Peak E-Field (dBµV/m)	FCC Peak Limit (dBµV/m)	Margin to Peak Limit (dB)	Average E-Field (dBµV/m)	FCC Average Limit (dBµV/m)	Margin to Average Limit (dB)
1.828	45		-0.77	45.77	98.13	52.36		98.13	52.36
2.743	43.9		-3.27	47.17	74	26.83		54	6.83
3.657	42.25	30.06	-5.58	47.83	74	26.17	35.64	54	18.36
4.571	42.6	30.25	-12.51	55.11	74	18.89	42.76	54	11.24
5.485	42.05	29.19	-15.86	57.91	98.13	40.22	45.05	98.13	53.08
6.4	40.92	28.12	-18.79	59.71	98.13	38.42	46.91	98.13	51.22
7.314	40.3	27.87	-21.02	61.32	74	12.68	48.89	54	5.11
8.228	39.75	27.91	-21.97	61.72	74	12.28	49.88	54	4.12
9.142	39.25	26.98	-23.69	62.94	74	11.06	50.67	54	3.33

Table 6: Peak Spurious Emission Measurement Results (Vertical Polarization)

Note that for the emissions falling outside of the restricted band, the FCC limit is 20 dB below the highest level of the fundamental carrier; hence the limit of 98.13 dBµV/m. Emissions falling within the restricted bands, as defined in Section 15.205, must comply with the limit of Section 15.209 of 54 dBµV/m for emissions above 1 GHz.

From Tables 5 and 6, it can be seen that the peak spurious emissions did not exceed the limit. Hence the unit is in compliance.

MAJOR TEST EQUIPMENT

FAU EMI R&D LABORATORY TEST EQUIPMENT						
Equipment Type	**Manufacturer**	**Description**	**Model**	**Serial No.**	**Calibration Date**	**Calibration Interval (Years)**
Spectrum Analyzer	Hewlett Packard	RF Section	8566B	2403A06381	Aug-22-06	2
Spectrum Analyzer	Hewlett Packard	Display	85662A	2407A06381	Aug-22-06	2
Spectrum Analyzer	Hewlett Packard	Quasi Peak Adapter	85650A	2430A00559	Aug-22-06	2
RF Preselector	Hewlett Packard	Preselector	85685A	2510A00151	Feb-8-06	2
LISN	EMCO	LISN	3825/2R	1095	March-10-06	2
Antenna	EMCO	Biconical	3108	2147	Feb-24-06	2
Antenna	EMCO	Log Periodic	3146	1385	Feb-24-06	2
Amplifier	Hewlett Packard	Amplifier	8447D	2443A03952	Dec-01-06	2
Amplifier	Hewlett Packard	Microwave Amplifier	83017A	3123A00324	Nov-27-06	2
Power Meter	Rohde & Schwarz	Thermal Power Sensor	NRP-Z55	10028	July-18-07	2

TEST FACILITY

EMI Research and Development Laboratory
Department of Electrical Engineering
Florida Atlantic University
Boca Raton, Florida 33431
(561) 361-4390

A2LA Certification No. 2129.01
FCC Registration: 90599
Industry of Canada: IC46405-4076

Description	The 3m semi-anechoic chamber and Power Line Conducted Spurious Voltage test setup are constructed and calibrated to meet the FCC requirements of Section 2.948, as well as Industry Canada RSS 212 Issue 1.
Site Filing	A site description is on file with the Federal Communications Commission, 7435 Oakland Mills Road, Columbia, MD 21046, and with the Industry Canada, Certification and Engineering Bureau, 3701 Carling Ave., Building 94, P.O. Box 11490, Station "H", Ottawa Ontario, K2H 8S2.
Instrument	All measuring equipment is in accord with ANSI C63.4 and CISPR 22 requirements.

End of Report