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Technical Report No. 08-070

EMI Evaluation of the OpenFrame to FCC Part 15, Class B, Sections 15.107(a) and 15.109(a), Conducted and Radiated Emissions Requirements

Performed:	December 5, 2008
Customer:	OpenPeak 5355 Town Center Road #301 Boca Raton, FL 33486
Company Official Responsible for Product(s) tested:	Yuval Shohet, Engineer (561) 281-8698
Test Performed and Reported By:	Thierry Jean-Charles, MSEE FAU EMI R&D Laboratory
Approved by:	Vichate Ungvichian, Ph.D., P.E. Director, FAU EMI R&D Laboratory

1. INTRODUCTION

The OpenFrame is a multimedia touch screen phone consisting of a base station and a handset operating at the frequency band of 1920 to 1930 MHz. The equipment under test (EUT) was tested with an internal WiFi module operating in the ISM band of 2400 to 2483.5 MHz. The system, with maximum operating clock frequency of 1.1 GHz, was evaluated for compliance to the FCC Part 15 Class B, unintentional conducted and radiated emission requirements, up to 6 GHz. The results apply only to the specific items of equipment, configurations and procedures supplied to the Florida Atlantic University EMI R&D Laboratory by the company as reported in this document.

2. OBJECTIVE

This evaluation was performed to verify conformance of the OpenFrame 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(a) and 15.109(a) conducted and radiated emission requirements.

3. CONCLUSION

The OpenFrame met the FCC, Part 15 Subpart B, Sections 15.107(a) and 15.109(a), unintentional conducted and radiated emission requirements, as described in the following pages.

4. TEST PROCEDURES AND RESULTS

4.1TEST 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.

4.2CONDUCTED EMISSIONS TEST RESULTS

4.2.1 CONDUCTED POWER LINE EMISSIONS - SECTION 15.107(a)

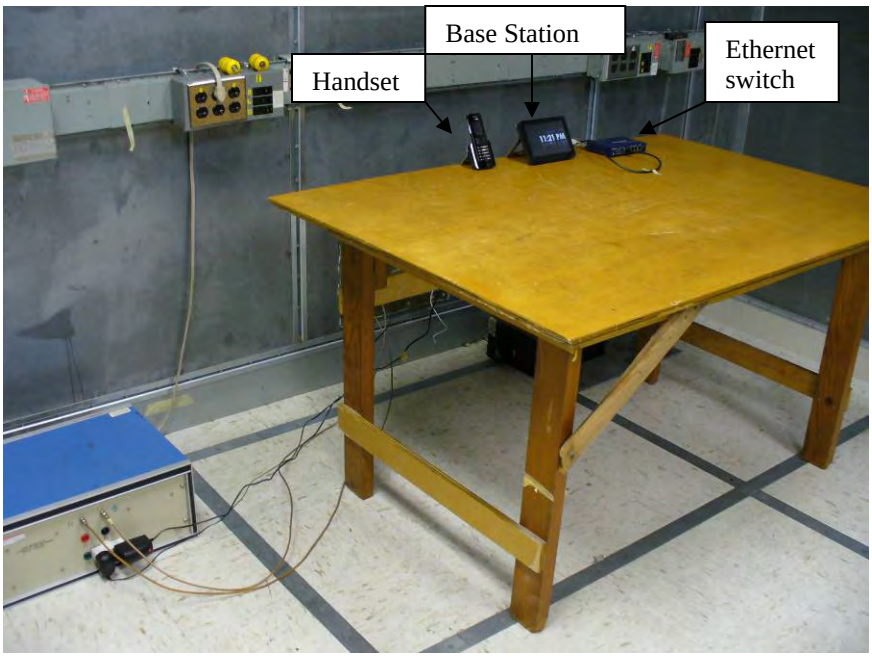
The OpenFrame was evaluated for conducted emission requirements. The base station and handset were powered by an LFS054000D-A8S and a GPE032-050050-1 switching power supply, respectively. The data port of the base station was connected to an FS105 Netgear Ethernet Switch. The Audio and USB ports of the base station were terminated with the appropriate cables. Excess cables were bundled for the measurements. The system was set to transmit simultaneously in the 1920-1930 and 2400-2483.5 MHz bands. The data was transmitted and received correctly as confirmed by the OpenPeak 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 to 3 show the conducted emissions on both the phase and neutral lines measured in the receiver peak detection mode for three configurations of EUT:

1. OpenFrame base station only,
2. OpenFrame handset only,
3. OpenFrame base station and handset operating together.



Photographs 1 & 2: Conducted Emission Setup

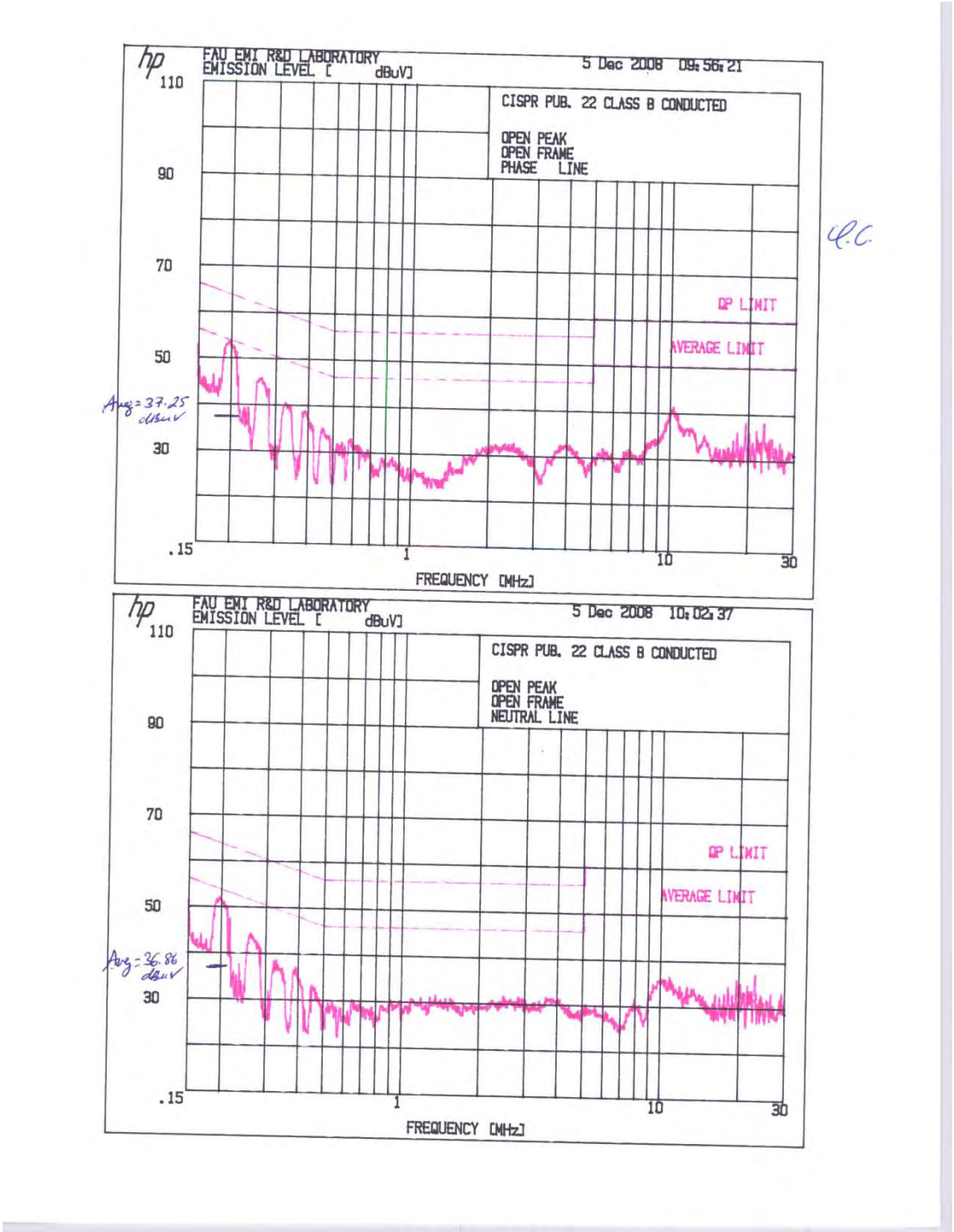


Figure 1: Phase and Neutral Conducted Emissions

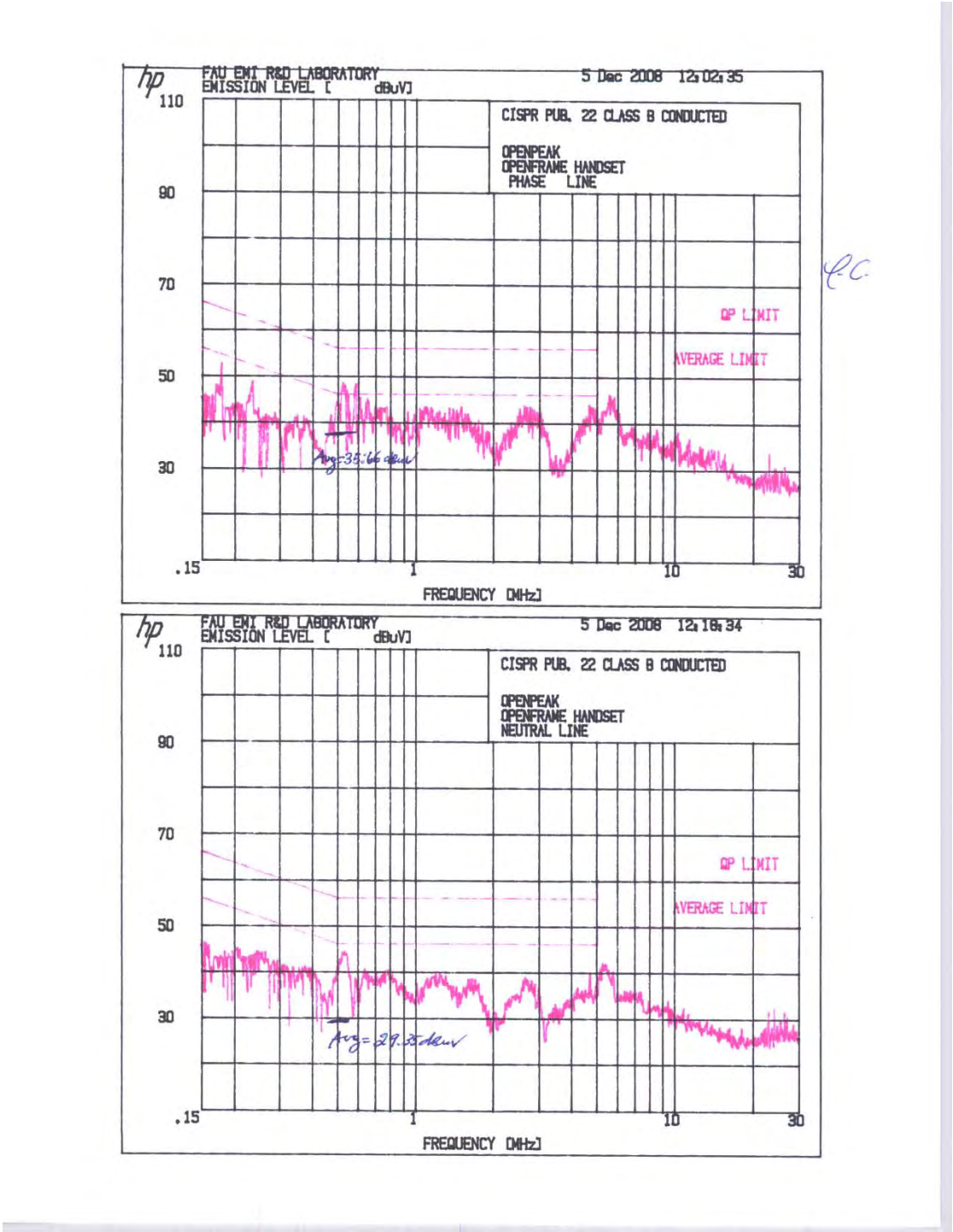
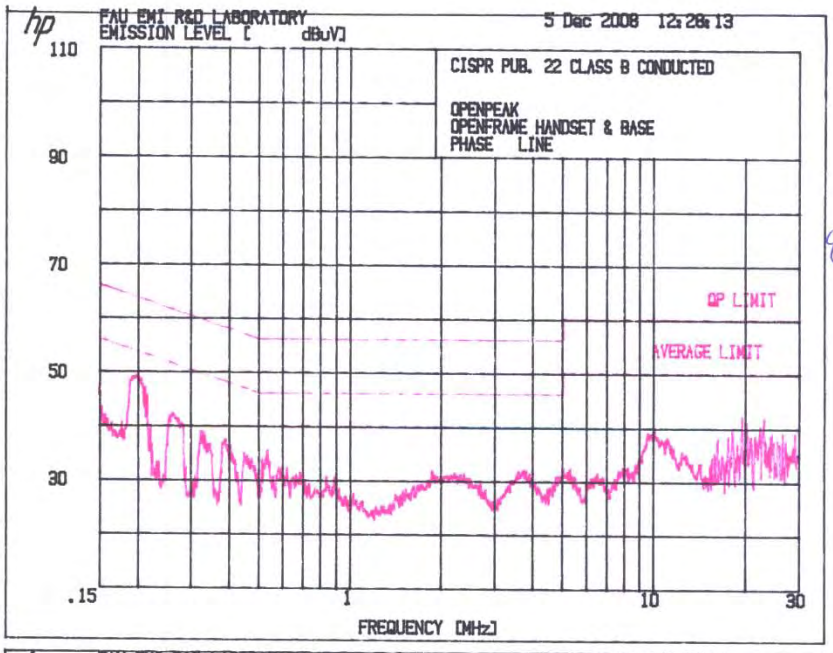


Figure 2: Phase and Neutral Conducted Emissions



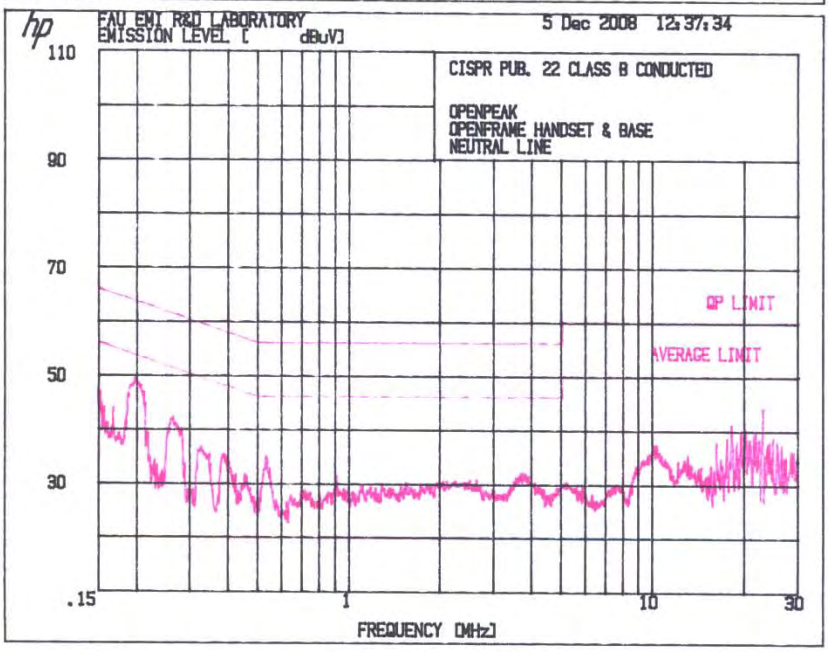


Figure 3: Phase and Neutral Conducted Emissions

From the above figures, the emissions that exceeded or were within 5 dB of the limit are reported in Table 1.

Figure No.	Line Tested	Frequency (kHz)	Peak Value (dBµV)	QP Value (dBµV)	Average Value (dBµV)	Avg. Limit (dBµV)	Margin to Avg. Limit (dB)*
1	Phase	198	55		37.25	55.14	17.89
	Neutral	198	52.5		36.86	55.14	18.28
2	Phase	150.65	53.9		43.82	55.99	12.17
	Neutral						
	Phase	527.3	48.59		35.66	46.00	10.34
	Neutral	527.3	45.04		29.35	46.00	16.65
	Phase	610.5	45.79		31.86	46.00	14.14
	Neutral						
	Phase	656.6	45.9		31.81	46.00	14.19

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 the emissions are below the limit. Hence, the system is in compliance.

4.3RADIATED EMISSIONS TEST RESULTS – SECTION 15.109(a)

This section reports the digital noises other than the harmonic frequencies of the fundamental carrier radiated from the OpenFrame Base Station and Handset Operating Together.

The OpenFrame was set up on a wooden table 80 centimeters above the ground plane turntable of the Semi-Anechoic test site, as shown in Photographs 3 & 4. The base station and handset were powered by an LFS054000D-A8S and a GPE032-050050-1 switching power supply, respectively. The data port of the base station was connected to an FS105 Netgear Ethernet Switch. The Audio and USB ports of the base station were terminated with the appropriate cables. Excess cables were bundled for the measurements. The system was set to transmit simultaneously in the 1920-1930 and 2400-2483.5 MHz bands. The data was transmitted and received correctly as confirmed by the OpenPeak Engineer. Photographs 3 and 4 show the setup used during the evaluations.

An EMCO, Model 3104, S/N 299988A, 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 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 meter 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 rotated 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. For the measurement above 1 GHz, the Log Periodic antenna and the RF amplifier were respectively replaced by a double rigged horn antenna (EMCO 3115) and an HP83017A microwave amplifier. The bypass instrument function of the quasi-peak adapter was activated, and the resolution and video bandwidths of the spectrum analyzer were set to 1 MHz. The emissions were maximized and collected using the procedure previously described.

To limit intermodulation at the receiver, a 3NF-1000/2000-N notch filter was used for the measurements below 3 GHz. This filter was replaced by a VHF^{+} 3100 high pass filters above 3 GHz. Figures 4-17 show the worse case radiated emissions, independent of azimuth or antenna height. Note that the transmitted signals mentioned above can still be observed (in some cases above the unintentional limit) despite the inclusion of the filters in the receiving system.

The E-field is calculated based on the following equation:

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

Photographs 3 & 4: Radiated Emission Setup

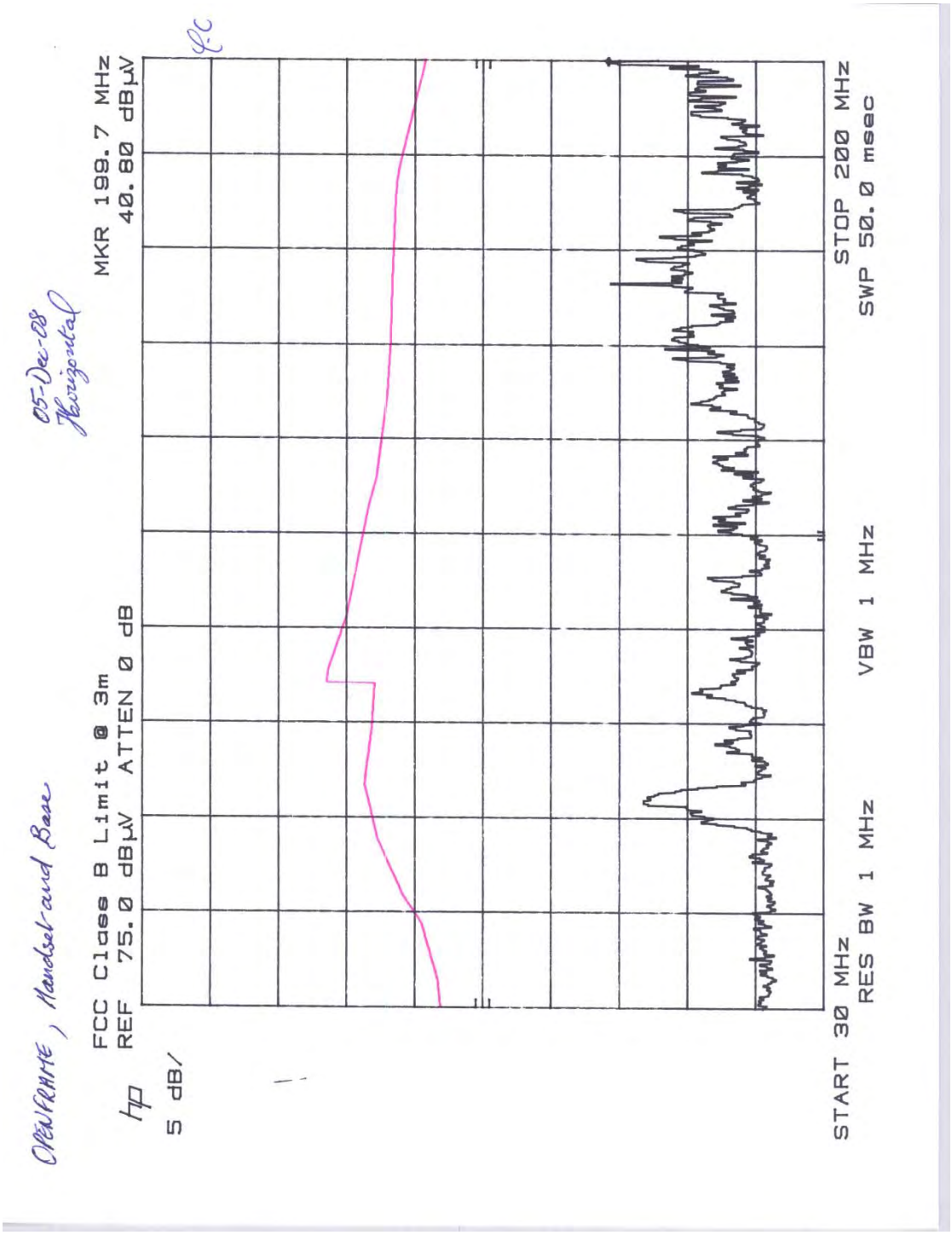


FIGURE 4: Radiated Emission 30 – 200 MHz Horizontal Polarization

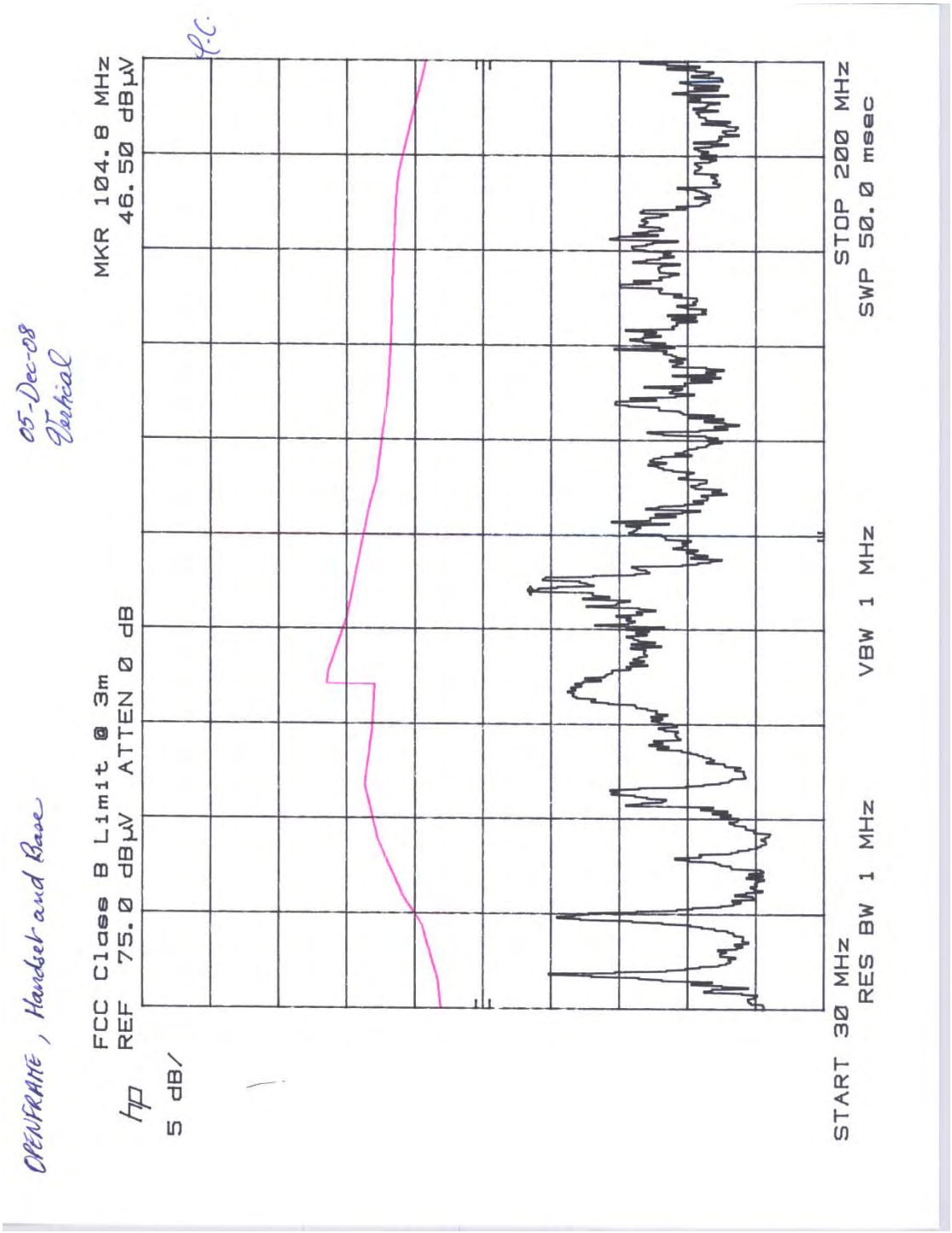


FIGURE 5: Radiated Emission 30 – 200 MHz Vertical Polarization

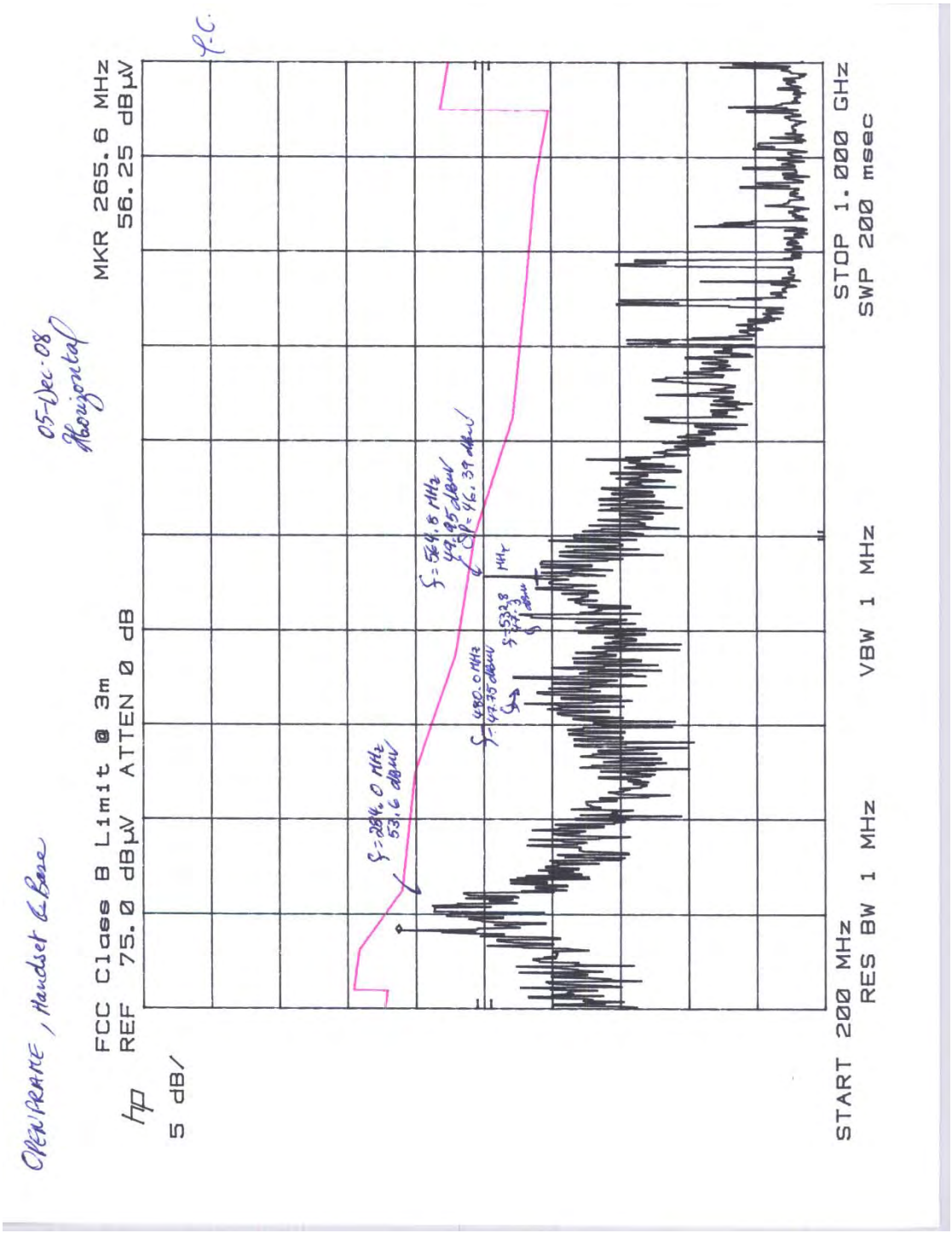


FIGURE 6: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

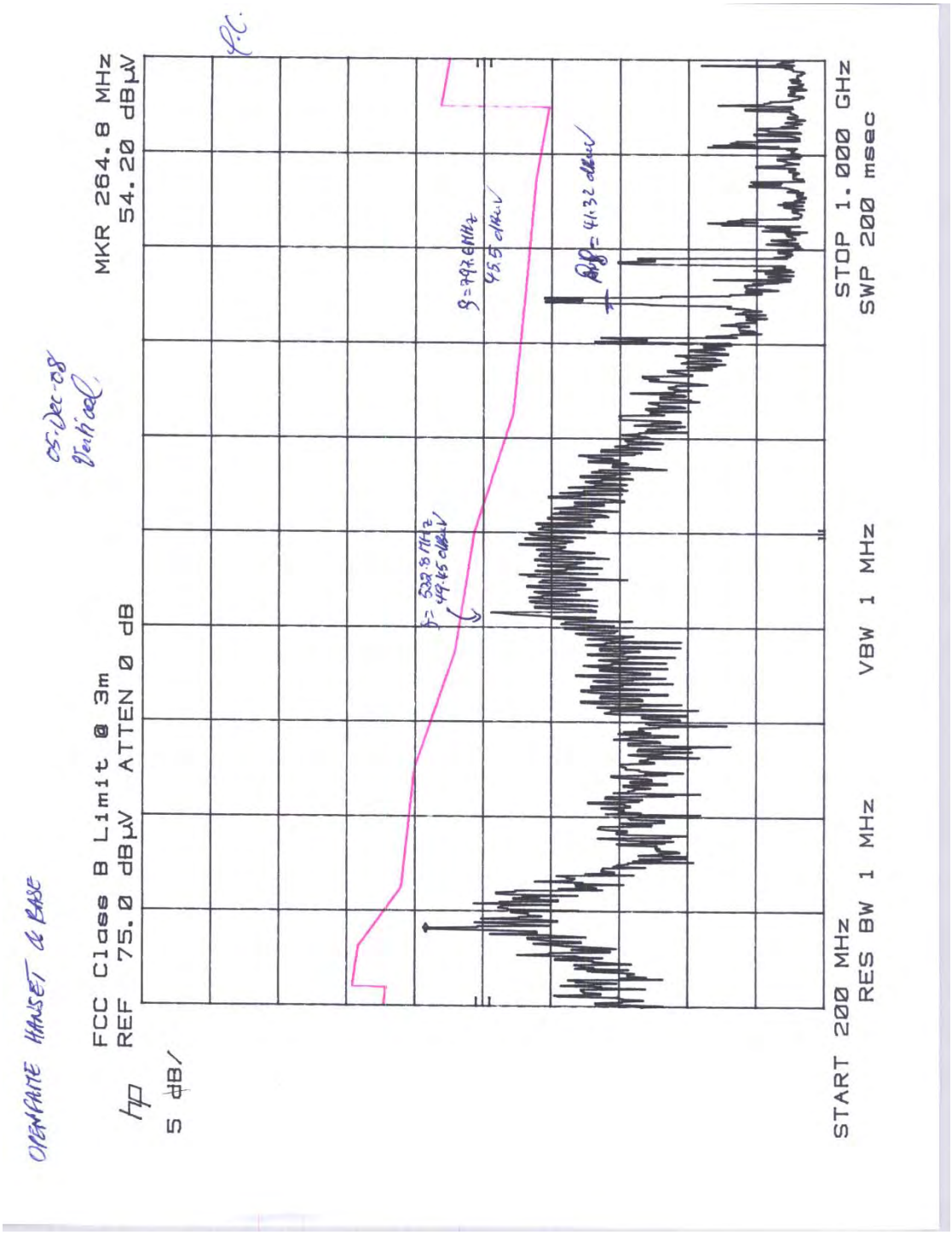


FIGURE 7: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

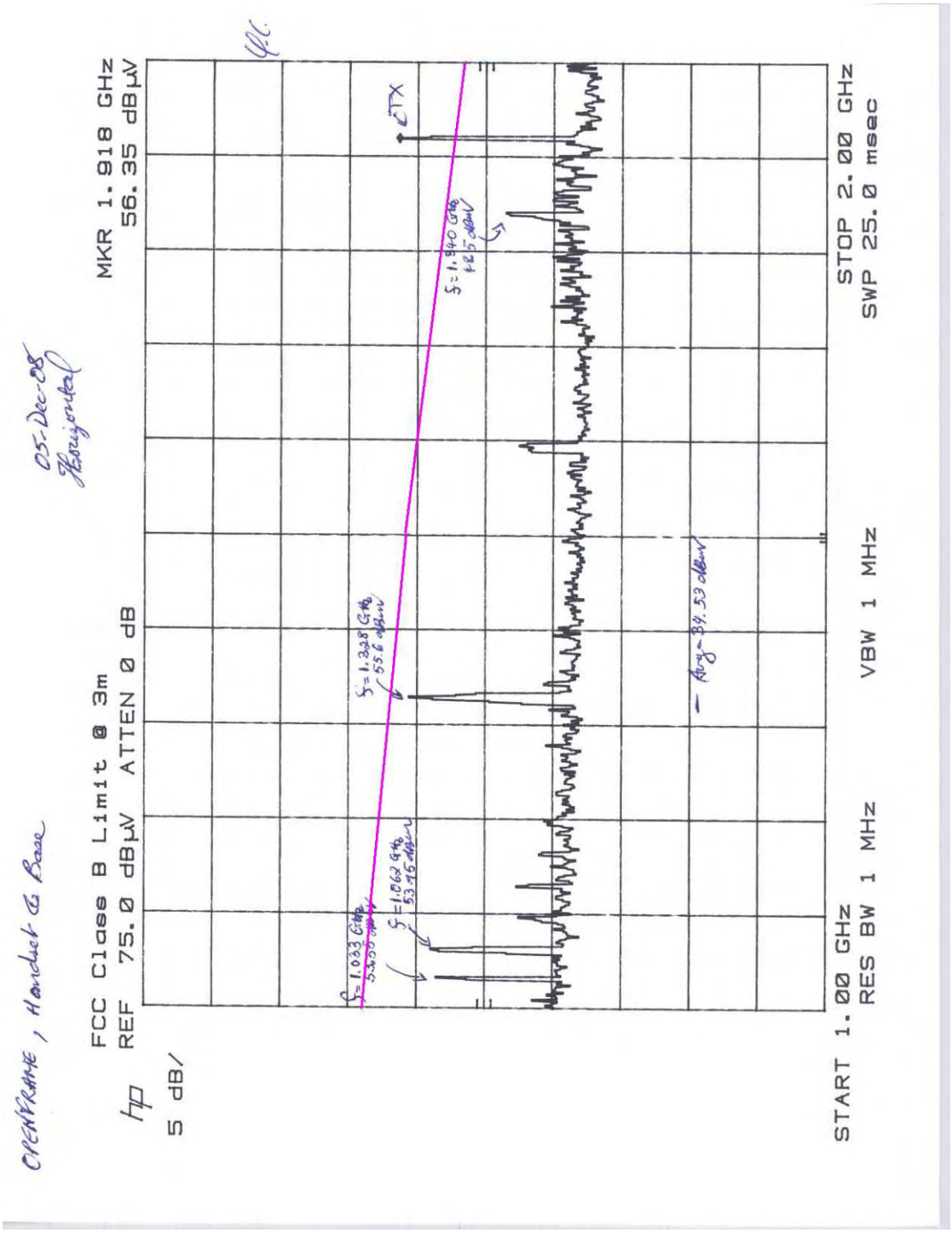


FIGURE 8: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

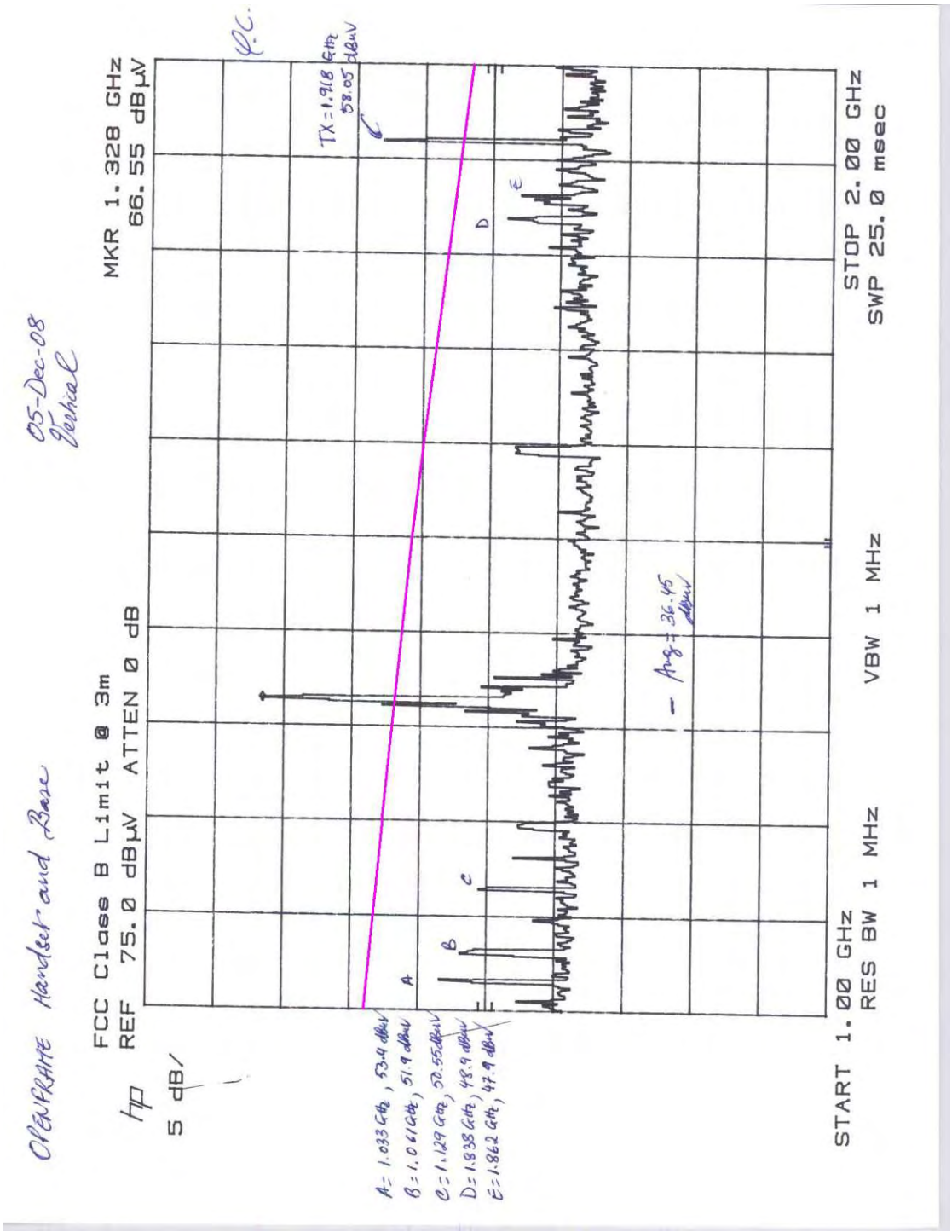


FIGURE 9: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

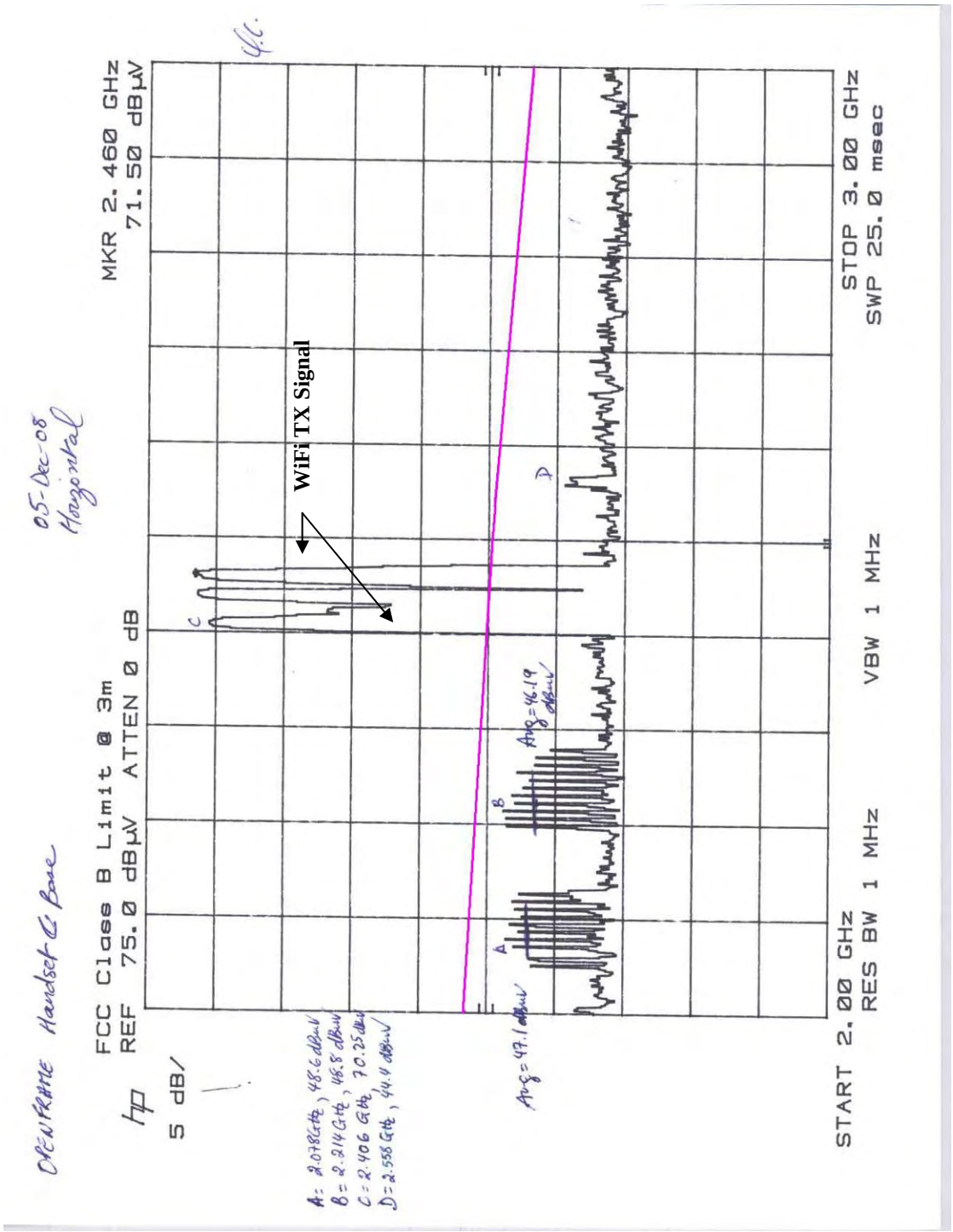


FIGURE 10: Radiated Emission 2 GHz – 3 GHz Horizontal Polarization

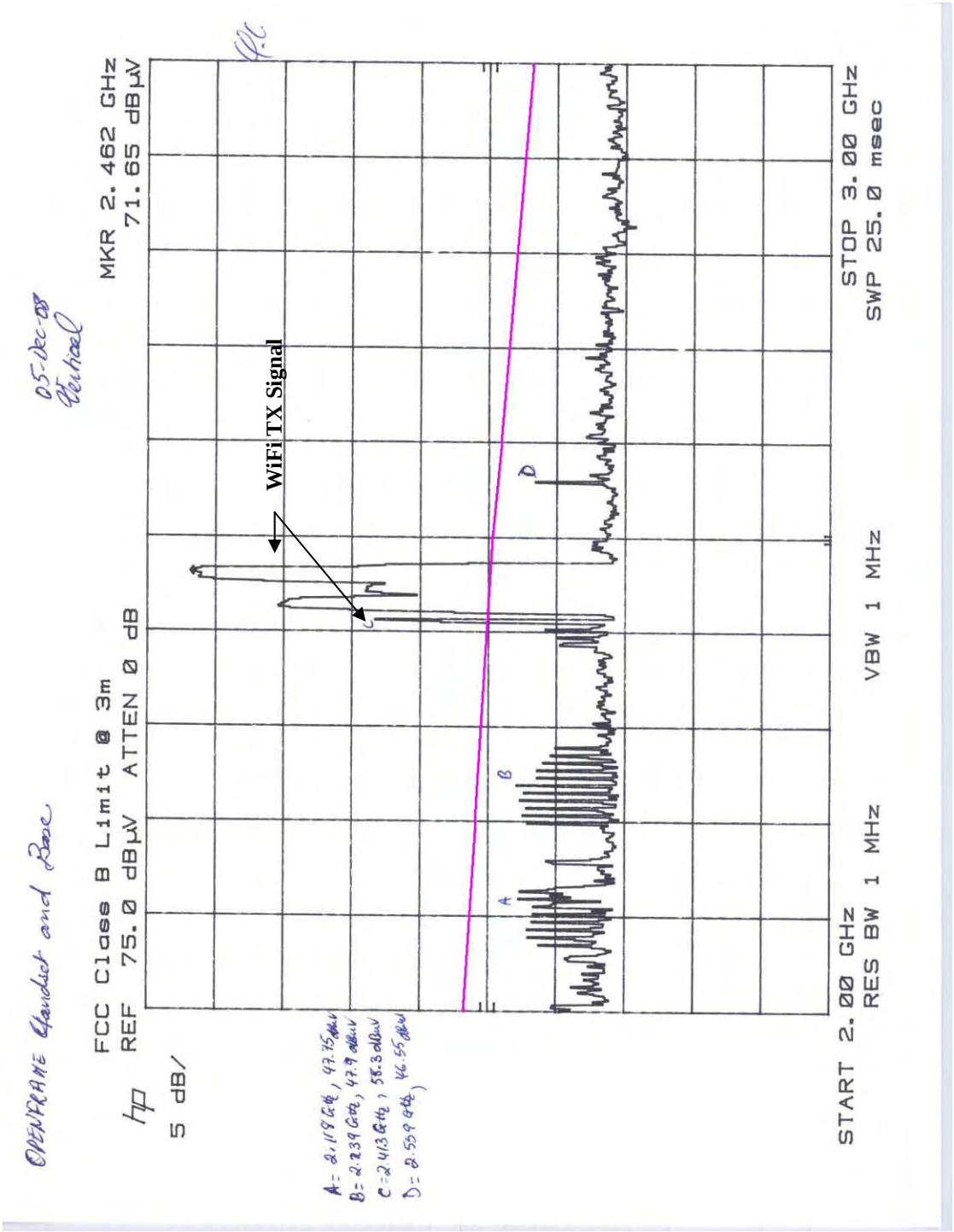


FIGURE 11: Radiated Emission 2 GHz – 3 GHz Vertical Polarization

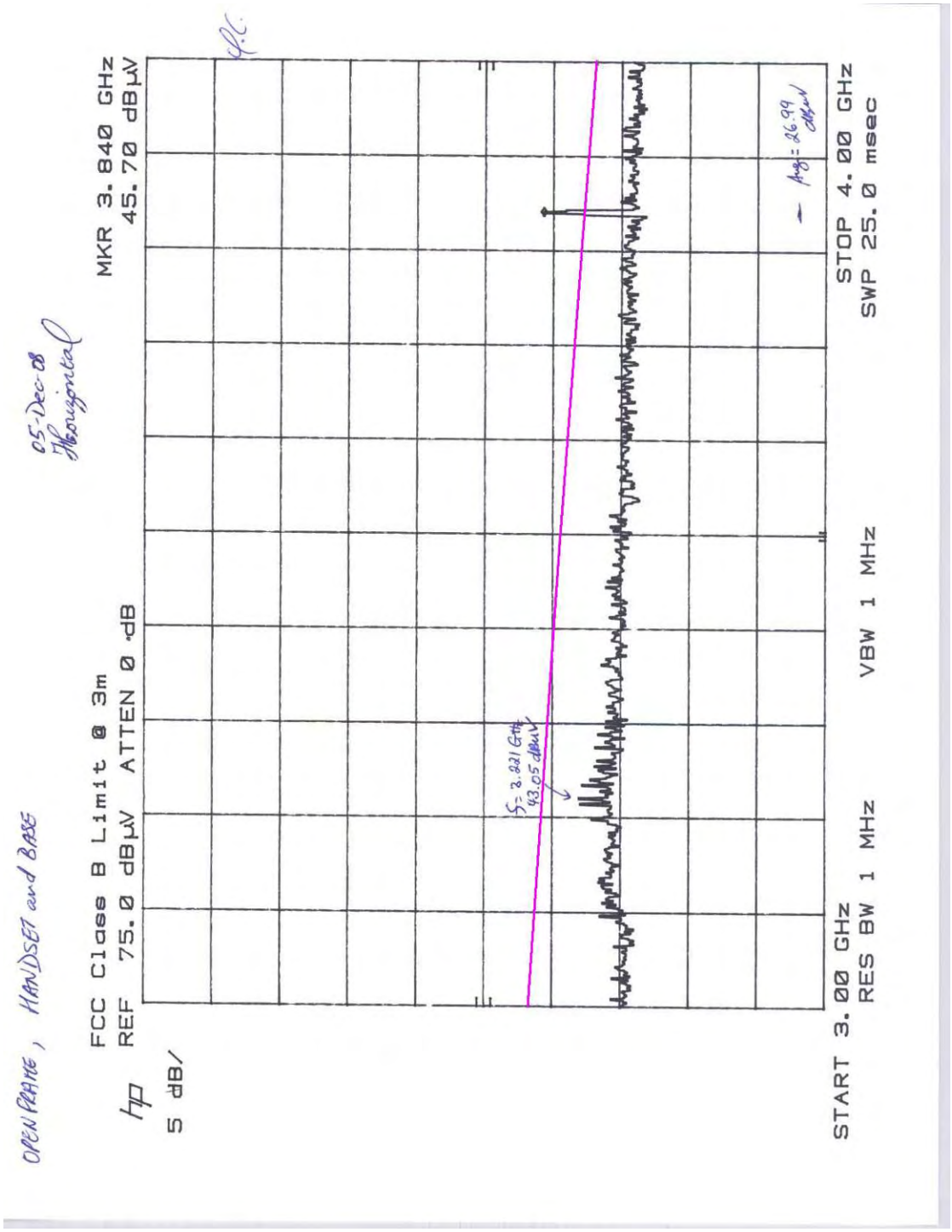


FIGURE 12: Radiated Emission 3 GHz – 4 GHz Horizontal Polarization

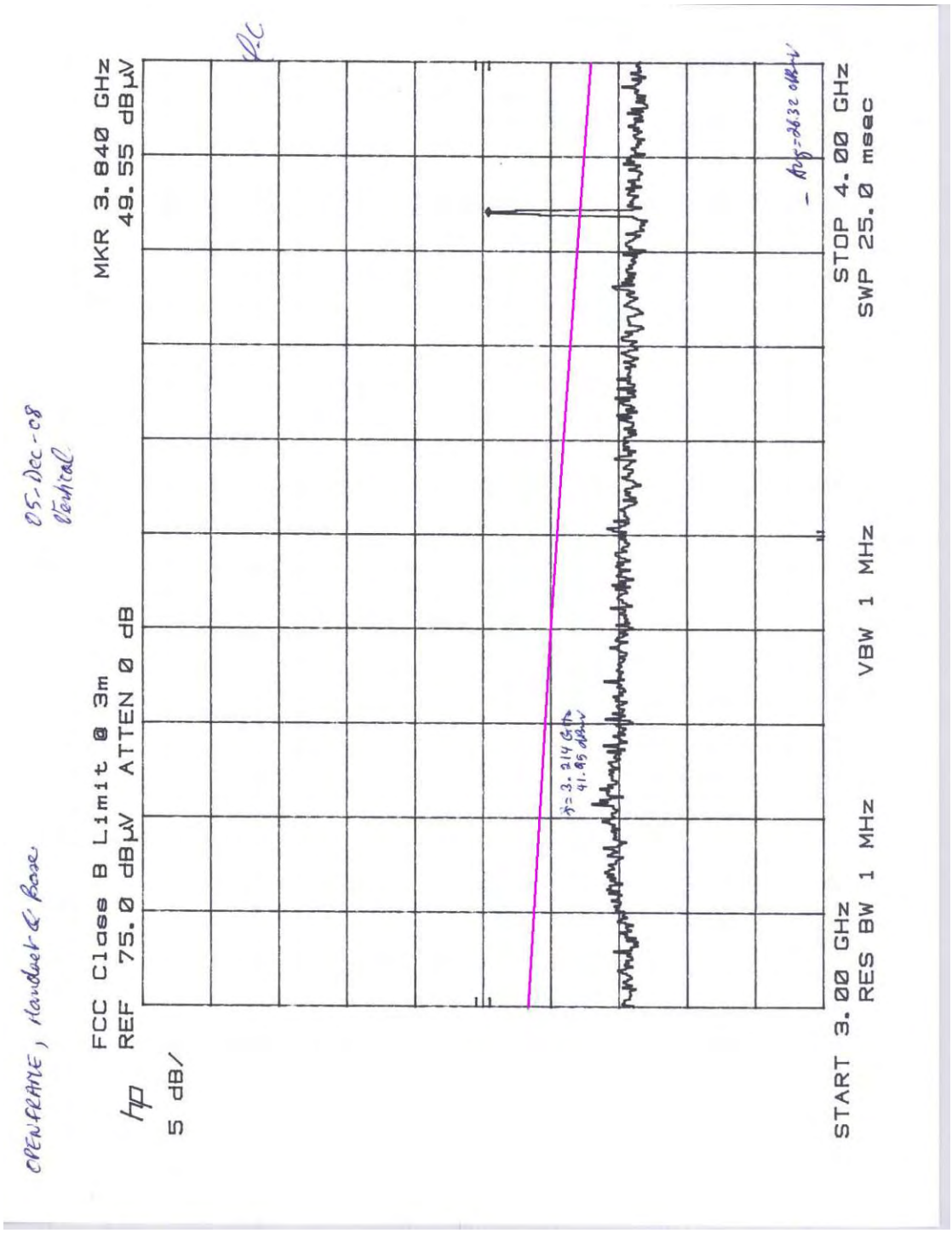


FIGURE 13: Radiated Emission 3 GHz – 4 GHz Vertical Polarization

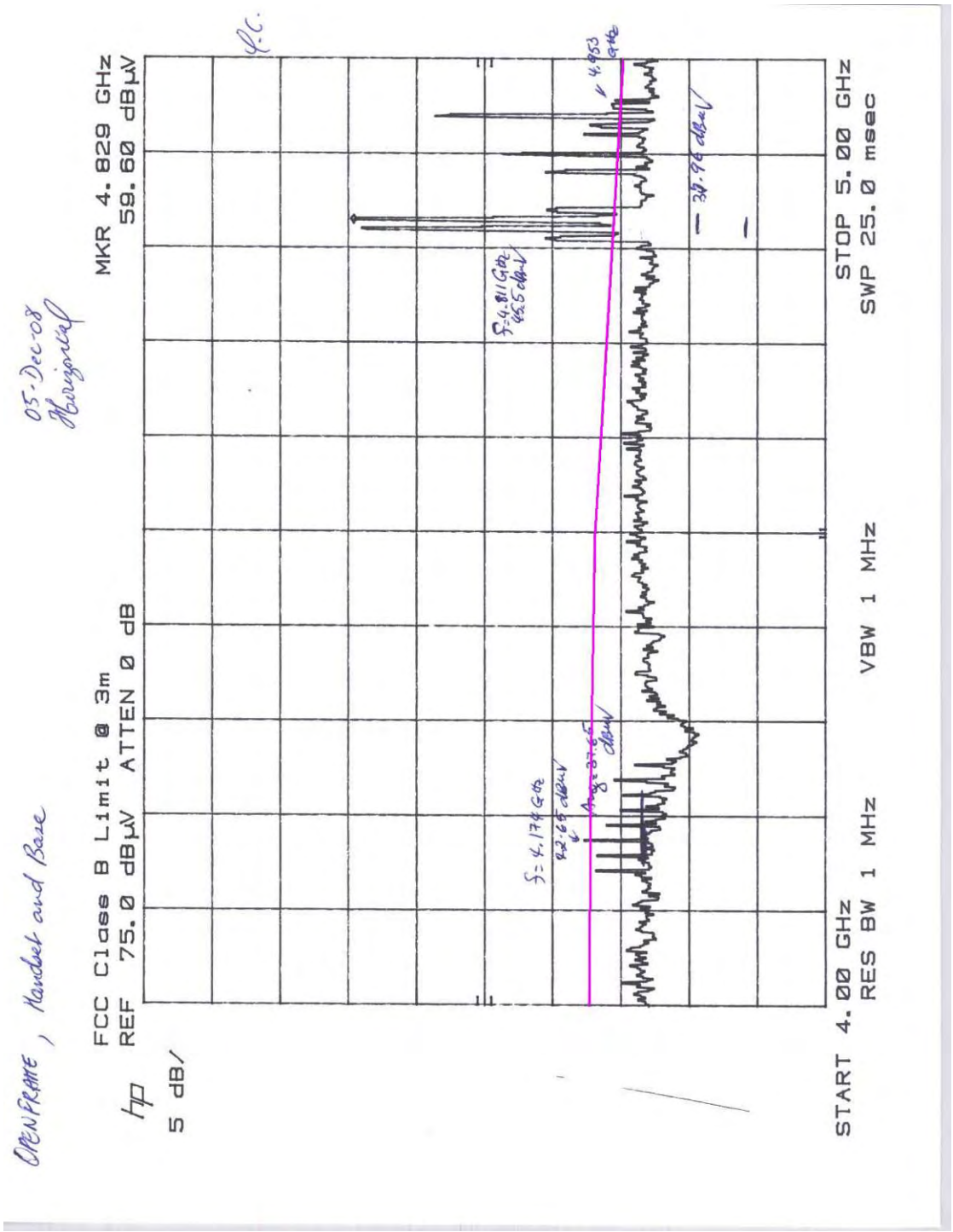


FIGURE 14: Radiated Emission 4 GHz – 5 GHz Horizontal Polarization

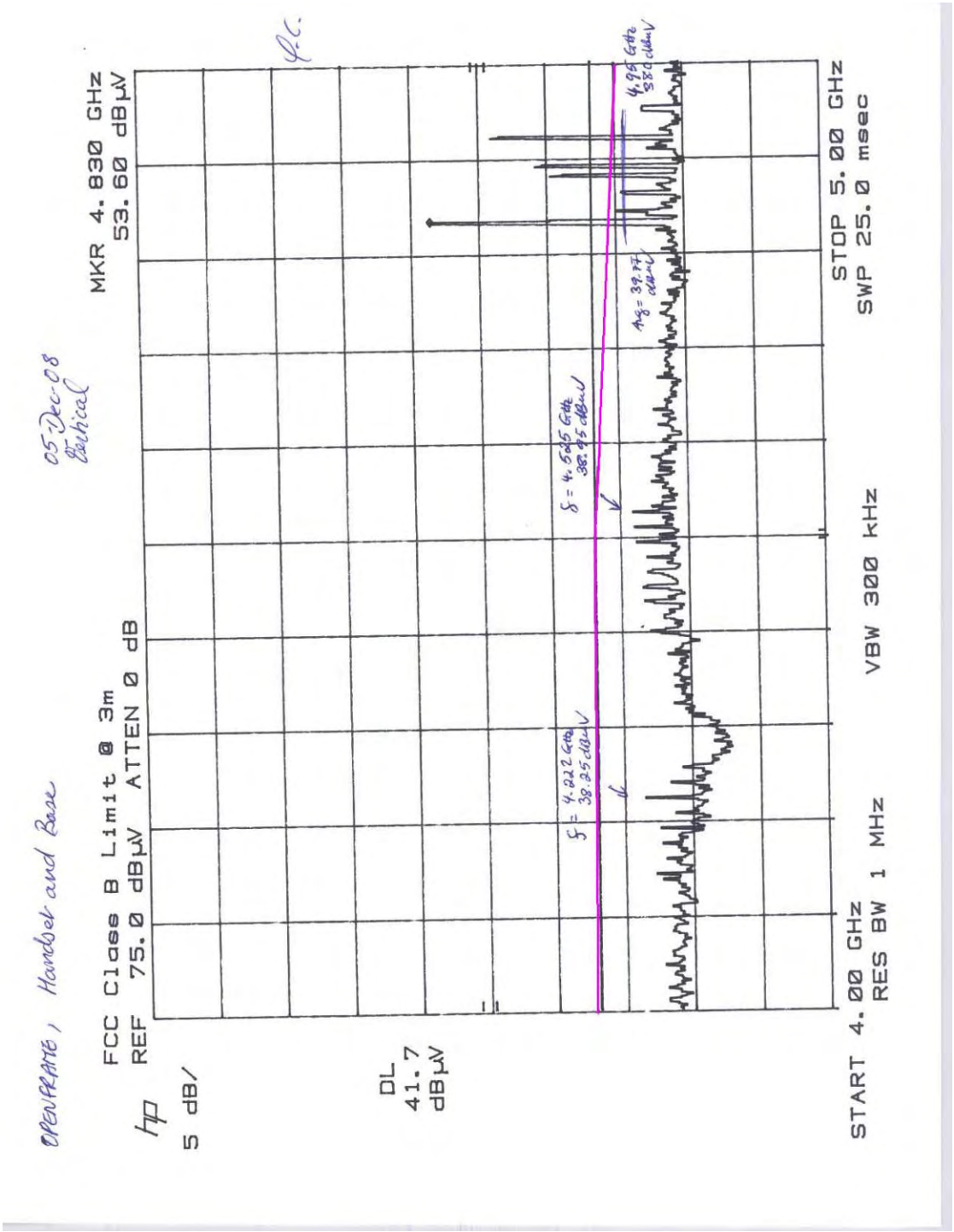


FIGURE 15: Radiated Emission 4 GHz – 5 GHz Vertical Polarization

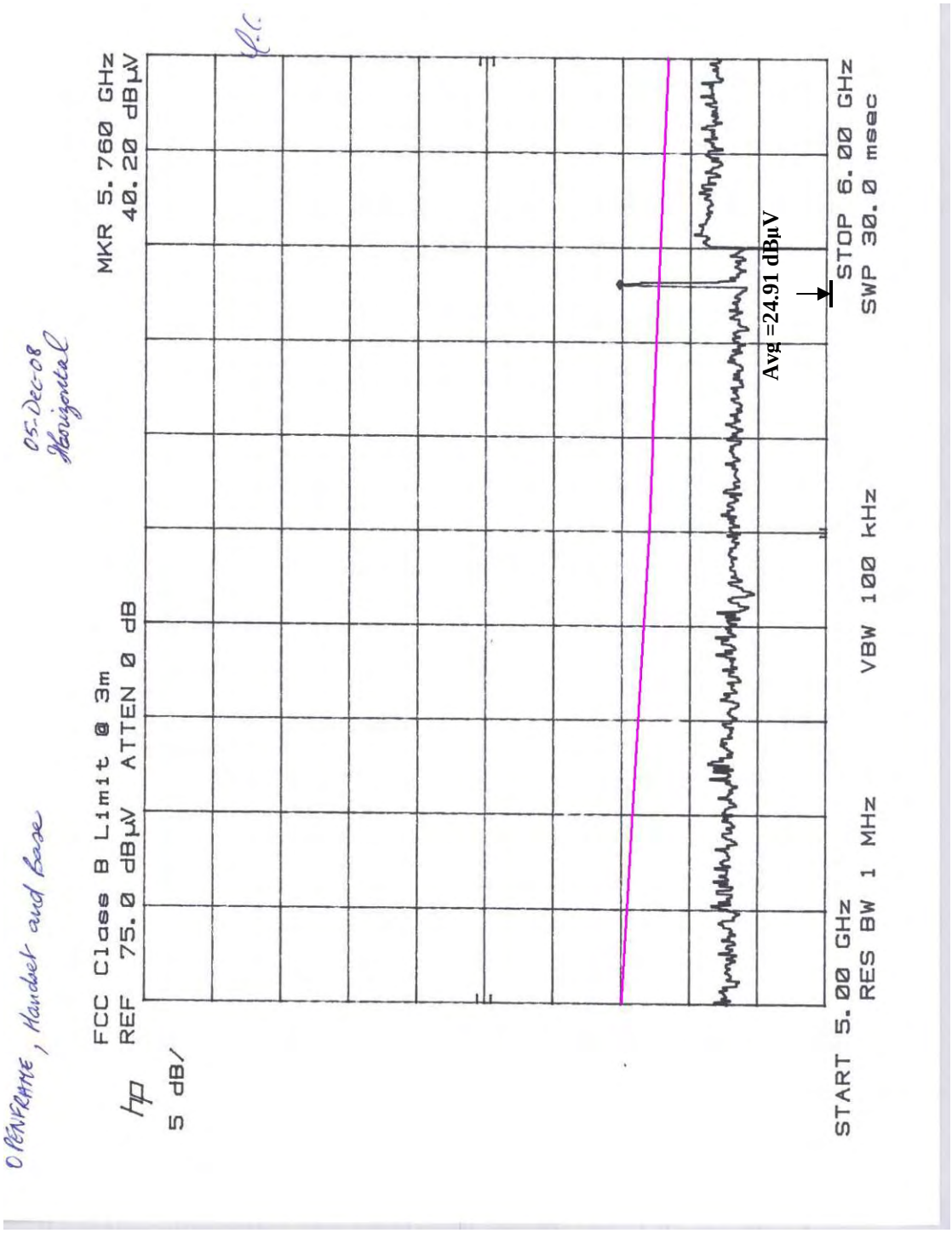


FIGURE 16: Radiated Emission 5 – 6 GHz Horizontal Polarization

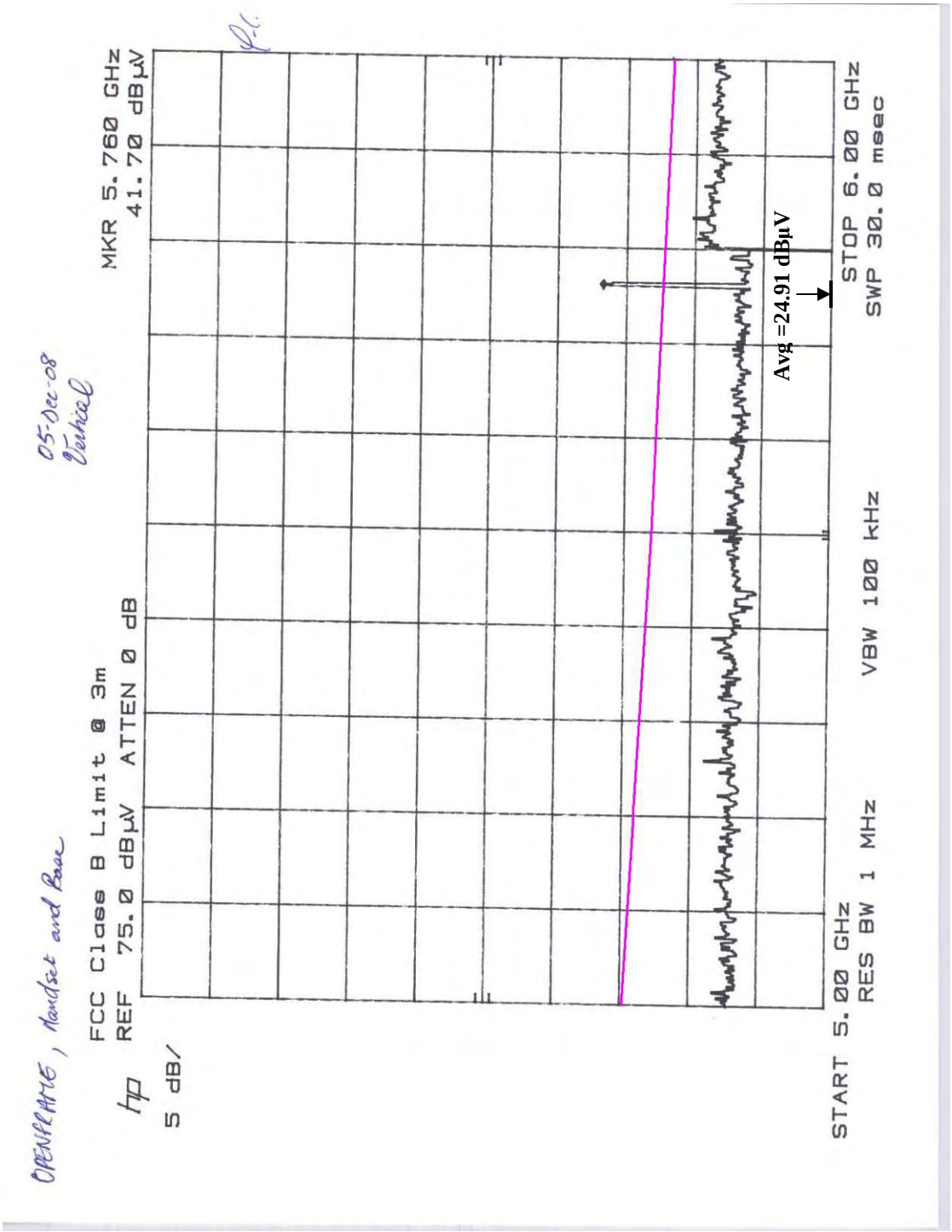


FIGURE 17: Radiated Emission 5 – 6 GHz Vertical Polarization

From Figures 4-17, the unintentional peak emissions that exceeded or were within 5 dB of the limit are reported in Table 2.

Figure No.	Frequency (MHz)	Measured Peak (dBµV)	Quasi Peak or Average (dBµV)	Correction Factor (dB/m)	Peak Field* (dBµV/m)	FCC Limit (dBµV/m)	Margin to limit (dB)
6	265.6	56.25		12.17	44.08	46.00	1.92
	284	53.6		11.01	42.59	46.00	3.41
	480	47.75		6.65	41.10	46.00	4.90
	532.8	47.3		5.59	41.71	46.00	4.29
	564.8	49.95	46.36	5.14	41.22	46.00	4.78
7	264.8	54.2		12.22	41.98	46.00	4.02
	532.8	49.45		5.59	43.86	46.00	2.14
	797.6	45.5	41.32	0.92	40.40	46.00	5.60
8	1033	53.55		4.75	48.80	54.00	5.20
	1062	53.95		4.59	49.36	54.00	4.64
	1328	55.60	34.53	2.94	31.59	54.00	22.41
	1840	48.50		-0.88	49.38	54.00	4.62
9	1033	53.40		4.75	48.65	54.00	5.35
	1328	66.55	36.45	2.94	33.51	54.00	20.49
	1838	48.90		-0.86	49.76	54.00	4.24
	1862	47.90		-1.07	48.97	54.00	5.03
10	2078	48.60	47.10	-2.67	49.77	54.00	4.23
	2214	48.8	46.19	-3.16	49.35	54.00	4.65
	2558	44.4		-4.59	48.99	54.00	5.01
11	2118	47.75		-2.81	50.56	54.00	3.44
	2239	47.9		-3.26	51.16	54.00	2.84
	2559	46.55		-4.59	51.14	54.00	2.86
12	3221	43.05		-8.13	51.18	54.00	2.82
	3840	45.7	26.99	-11.11	38.10	54.00	15.90
13	3214	41.95		-8.10	50.05	54.00	3.95
	3840	49.55	26.32	-11.11	37.43	54.00	16.57
14	4174	42.65	37.65	-12.08	49.73	54.00	4.27
	4829	59.60	35.96	-13.40	49.36	54.00	4.64
15	4222	38.25		-12.11	50.36	54.00	3.64
	4525	38.95		-12.36	51.31	54.00	2.69
	4830	53.60	39.77	-13.41	53.18	54.00	0.82
16	5760	44.75	24.91	-14.04	38.95	54.00	15.05
17	5760	43.97	24.91	-14.04	38.95	54.00	15.05

Table 2: Peak Measurement Results

Note that the filters' insertion losses are included in the correction factor data.

* E-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 and Table 2 that the unintentional radiated emissions are below limit. Hence the unit is in compliance.

MAJOR TEST EQUIPMENT

FAU EMI R&D LABORATORY TEST EQUIPMENT						
Equipment Type	**Manufacturer**	**Description**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Interval (Years)**
Spectrum Analyzer	Hewlett Packard	RF Section	8566B	2403A06381	Aug-07-08	2
Spectrum Analyzer	Hewlett Packard	Display	85662A	2407A06381	Aug-07-08	2
Spectrum Analyzer	Hewlett Packard	Quasi Peak Adapter	85650A	2430A00559	Aug-07-08	2
RF Preselector	Hewlett Packard	Preselector	85685A	2510A00151	Mar-4-08	2
LISN	EMCO	Line Impedance Stabilization Network	3825/2R	1095	June-28-07	2
Antenna	EMCO	Biconical	3108	2147	May-5-08	2
Antenna	EMCO	Log Periodic	3146	1385	May-5-08	2
Amplifier	Hewlett Packard	Amplifier	8447D	2443A03952	02-Jan-09	2
Amplifier	Hewlett Packard	Microwave Amplifier	83017A	3123A00324	02-Jan-09	2

FILTER TABLE			
Model	**Manufacturer**	**Description**	**Application**
3NF-1000/2000-N	Lorch Microwave	Variable Notch 1 - 2 GHz	1.925 GHz
VHF$^+$ 3100	Mini-Circuit	High Pass 3 – 11.85 GHz	41.2 dB attenuation at 2.49 GHz

TEST FACILITY

EMI Research and Development Laboratory
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Florida Atlantic University
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(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