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Technical Report No. 07-070
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"EMI Evaluation of the Open Peak, VZ1 to FCC Part 15, Section 15.209 and Section 15.247, Operation within the band of 2400 to 2483.5 MHz."

Performed: 14 June to 17 July 2007

Customer: Open Peak
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1. INTRODUCTION

The Open Peak, VZ1 (Model No.: OP2207015) is a cordless phone base station operating in the band of 1920 to 1930 MHz with WiFi interface operating in the ISM band of 2400 to 2483.5 MHz. The unit falls within the category of digital transmission systems (DTS) and has a maximum operating clock frequency of 500 MHz.

The unit was evaluated for compliance to the FCC CFR-47, Part 15, Section 207, conducted emissions, as well as Section 209, intentional radiators, and Section 15.247, operation within the band of 2400 to 2483.5 MHz requirements. For the evaluation, the device was programmed to three different channels, channels 1, 6 and 11, located respectively near the top, near the middle and near the bottom of the band of 2400 to 2483.5 MHz, in accordance to Section 15.31 (m).

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 Open Peak, VZ1 module to the U.S. Federal Communications Commission (FCC), Code of Federal Regulations (CFR), Title 47 - Telecommunication, FCC Part 15 Subpart C- Intentional Radiators, Section 15.247, Operation within the bands 2400-2483.5 MHz, including Sections 15.207 and 15.209 conducted and radiated emission requirements.

3. CONCLUSION

The Open Peak, VZ1 unit met the FCC, Part 15 Subpart C, Section 15.247, operation within the band of 2400-2483.5 MHz requirements, as well as the requirements for Sections 15.207 and 15.209, 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"* and the procedures required by the FCC *"Measurement of Digital Transmission Systems Operating under 15.24"7*, 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

The Open Peak, VZ1 unit was evaluated for conducted emission requirements for 3 different channels, channels 1, 6 and 11, corresponding respectively to the center frequencies of 2411, 2436 and 2462 MHz.

The module was powered by an external switching power supply (Model: KTEC, Serial No.: KSAH0500500TIM3). The data port, phone jack and one of two USB ports of the base station were terminated with the appropriate cables for the measurements. Excess cables were bundled for the measurements. The unit was evaluated running an embedded LINUX OS code and charging a handset phone (Model: OP2207010). The unit 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 Open Peak 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.

Photographs 1 & 2: Conducted Emission Setup

Channel 1 – Conducted Emissions Data

For this evaluation, the device was set to transmit simultaneously at 1925 and 2411 MHz.

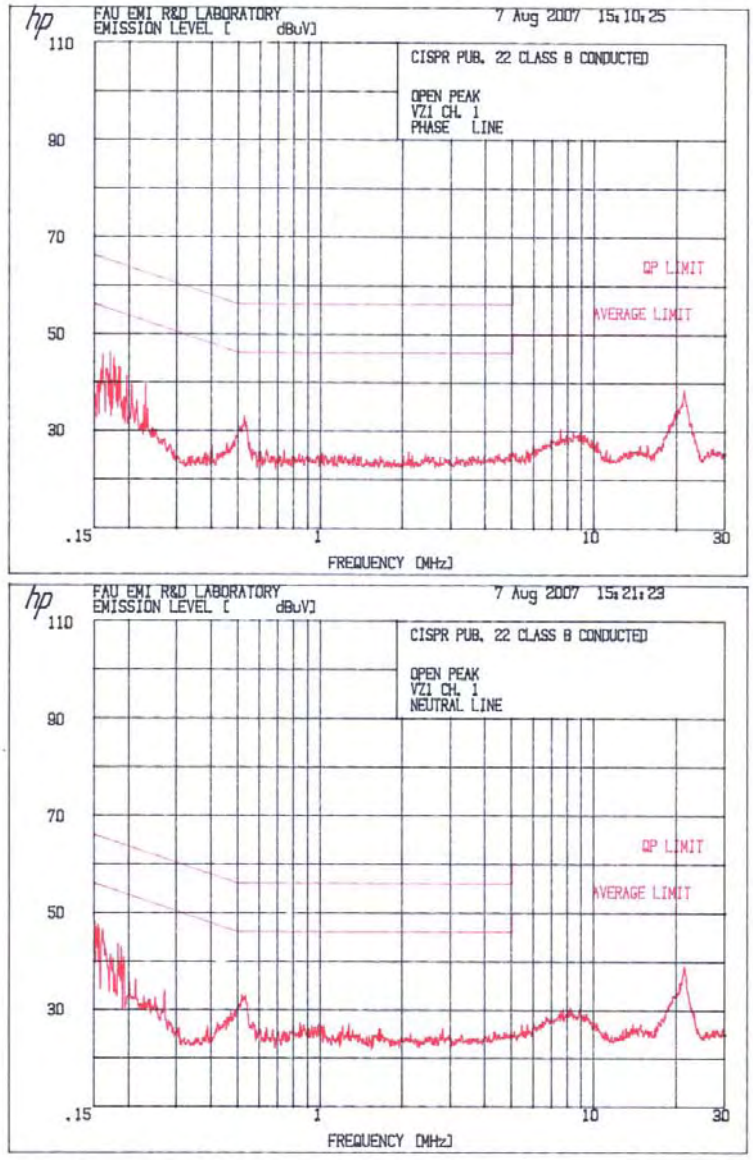

Figure 1: Phase and Neutral Conducted Emissions

Channel 6 – Conducted Emissions Data

For this evaluation, the device was set to transmit simultaneously at 1925 and 2436 MHz.

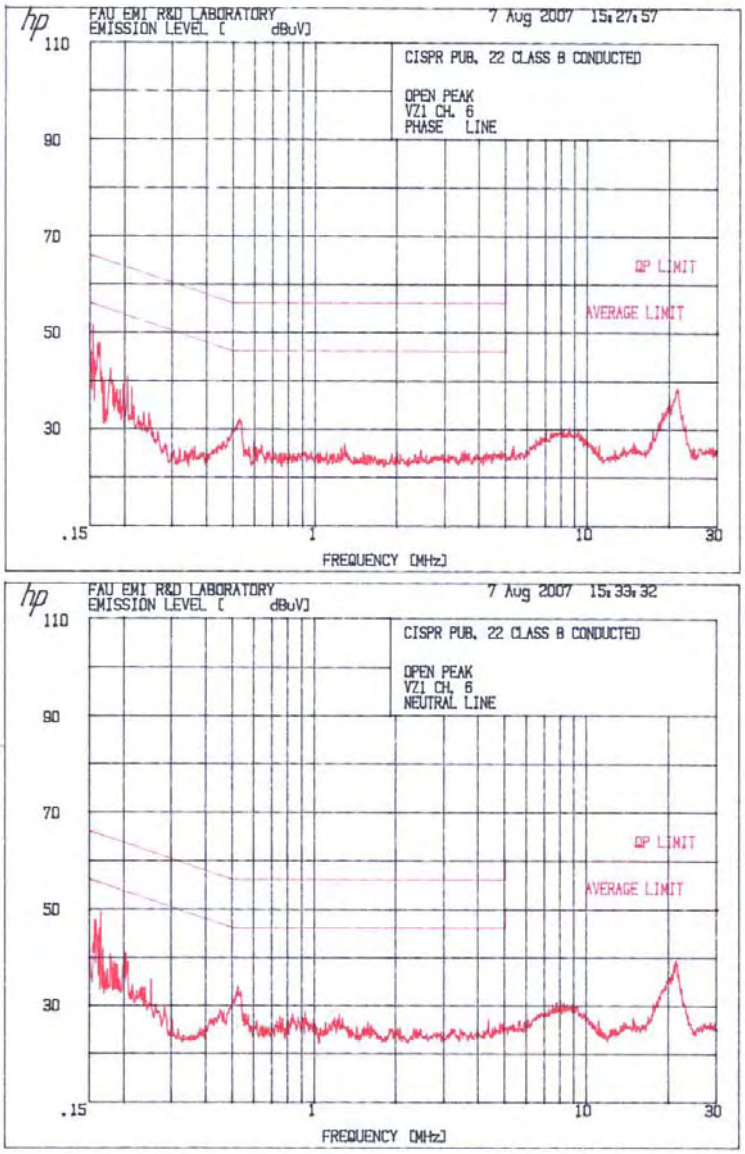

Figure 2: Phase and Neutral Conducted Emissions

Channel 11 – Conducted Emission Data

For this evaluation, the device was set to transmit simultaneously at 1925 and 2462 MHz.

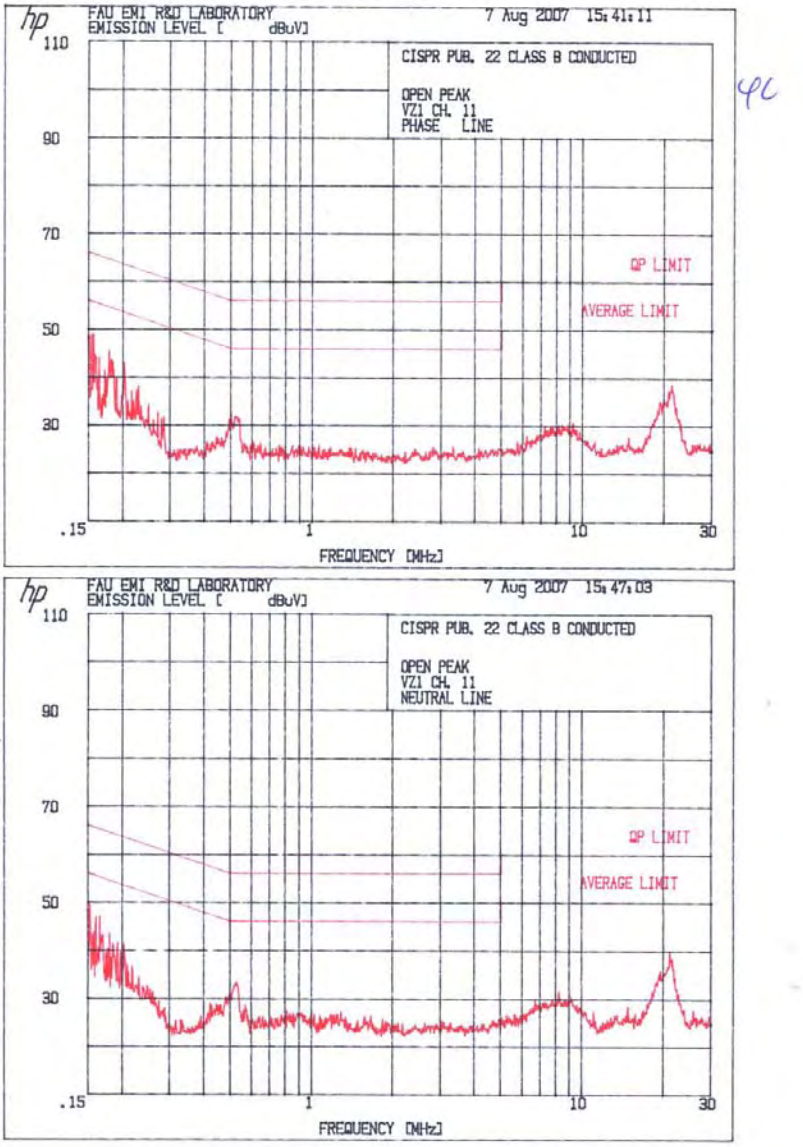

Figure 3: Phase and Neutral Conducted Emissions

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)*
2	Phase	151.5	51.5			55.97	4.47
	Neutral	151.5	50			55.97	5.97
	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 the emissions are below the limit. Hence, the system is in compliance.

4.3RADIATED EMISSIONS TEST RESULTS

4.3.1 UNINTENTIONAL RADIATED EMISSIONS

This section reports the digital noises other than the harmonic frequencies of the fundamental carrier radiated from the device.

The Open Peak, VZ1 unit 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 module was powered by an external switching power supply (Model: KTEC, Serial No.: KSAH0500500TIM3). The data port, phone jack and one of two USB ports of the base station were terminated with the appropriate cables for the measurements. The unit was evaluated running an embedded LINUX OS code and charging a handset phone (Model: OP2207010). The unit 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 Open Peak Engineer. Photographs 3 and 4 show the setup used during the evaluations.

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. For the measurement of the radiated emissions from 30 MHz to 1000 MHz, a Lorch Microwave variable notch filter (3NF-1000/2000-N) set to 1925 MHz was used to limit artifacts generated by nonlinearity of the receiver.

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 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 the data, the above procedure was then repeated.

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 HP 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. Combinations of notch and high pass filters (see Filter Table in the Appendix) were installed at the input of the microwave amplifier to limit intermodulation at the receiver. The emissions were maximized and collected using the procedure previously described.

The E-field is calculated using antenna factor, cable loss, and amplifier gain based on the following equation:

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

Figures 4-39 show the worse case radiated emissions for this evaluation, independent of azimuth or antenna height. Note that the transmitted signals can still be measured (in some cases above the unintentional limit) despite the inclusion of the filters in the receiving system.

Photographs 3 & 4: Radiated Emission Setup

-Channel 1 - Radiated Emission Data

Figures 4 – 15 show data for the WiFi Module set to channel 1.

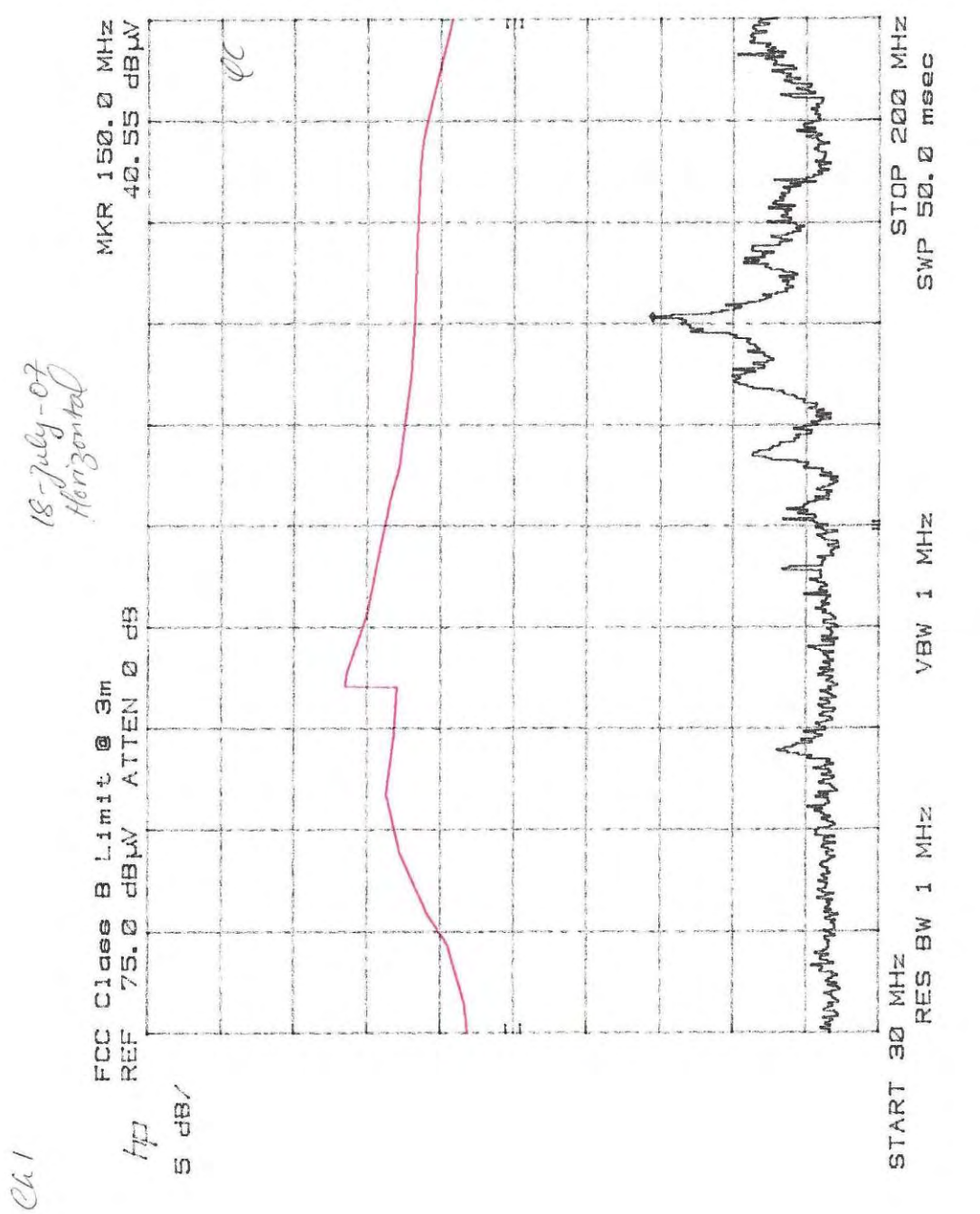

FIGURE 4: Radiated Emission 30 – 200 MHz Horizontal Polarization

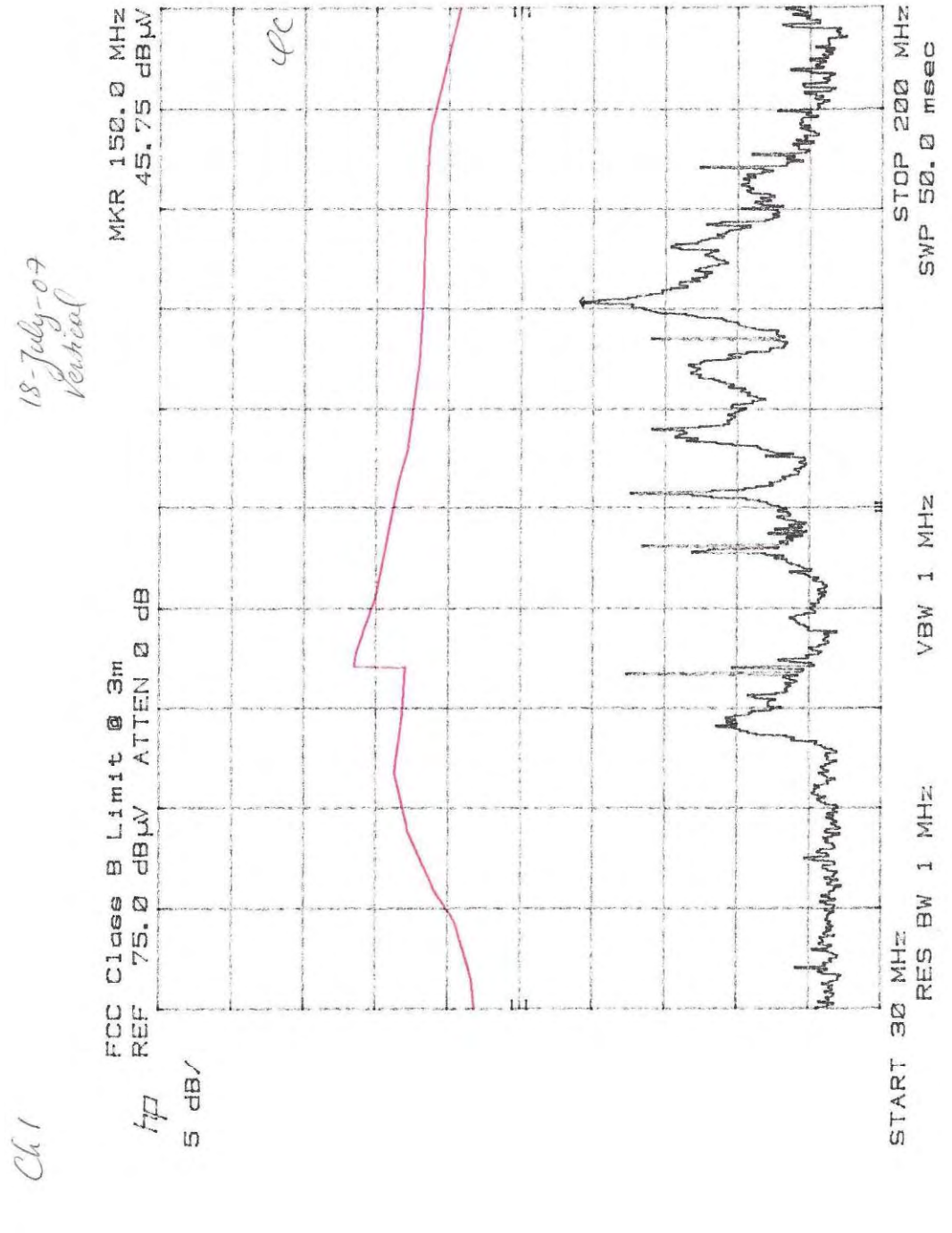

FIGURE 5: Radiated Emission 30 – 200 MHz Vertical Polarization

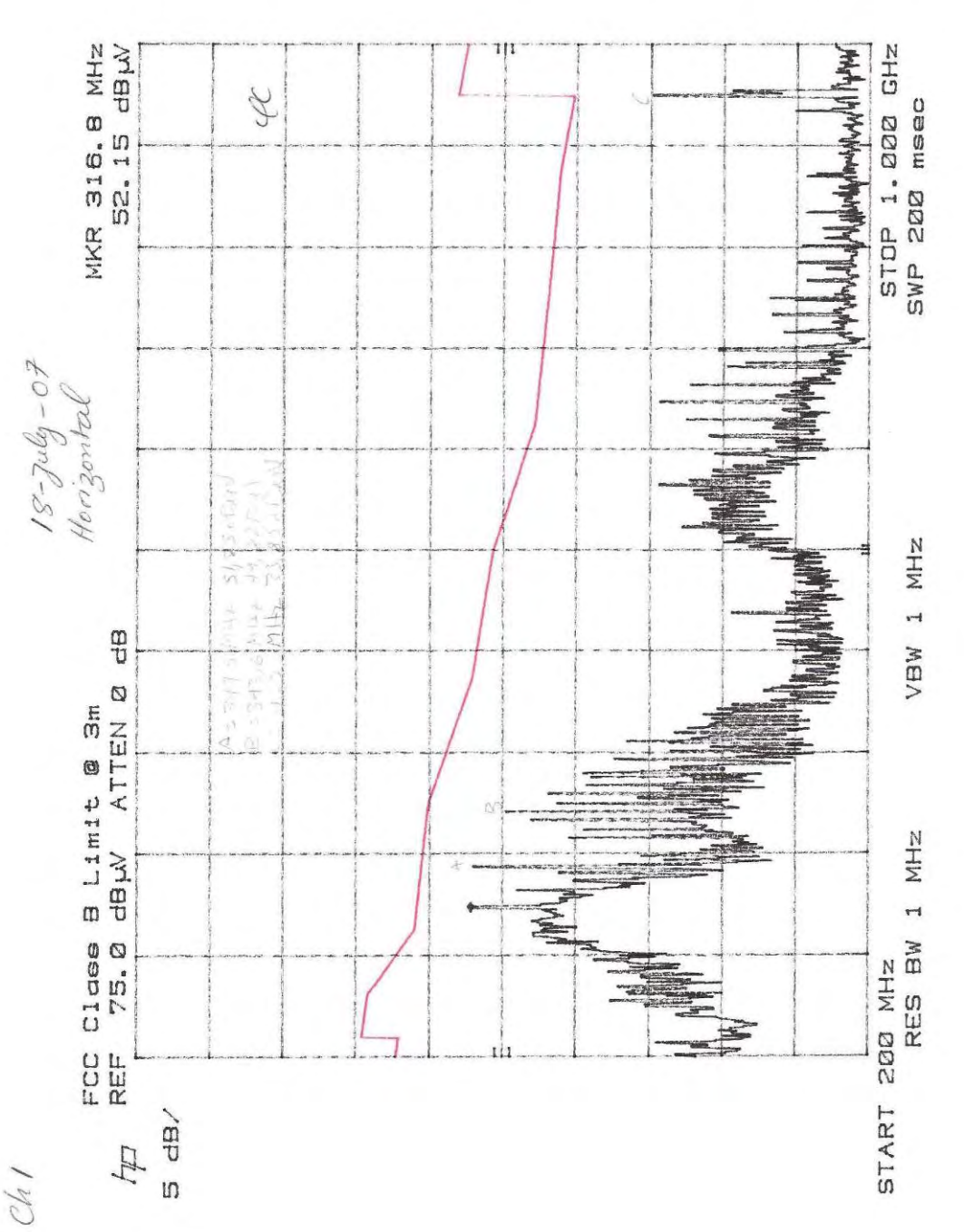

FIGURE 6: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

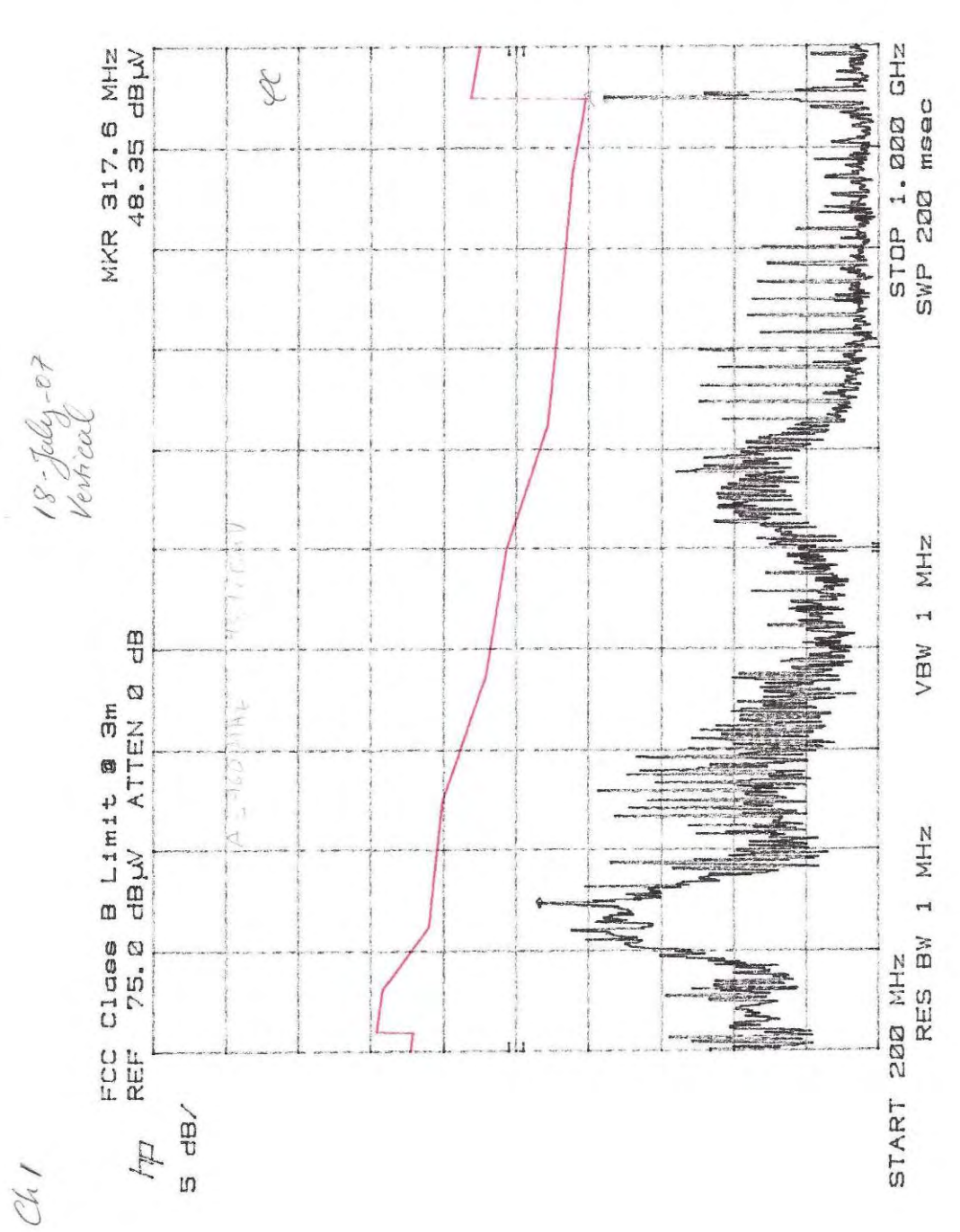

FIGURE 7: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

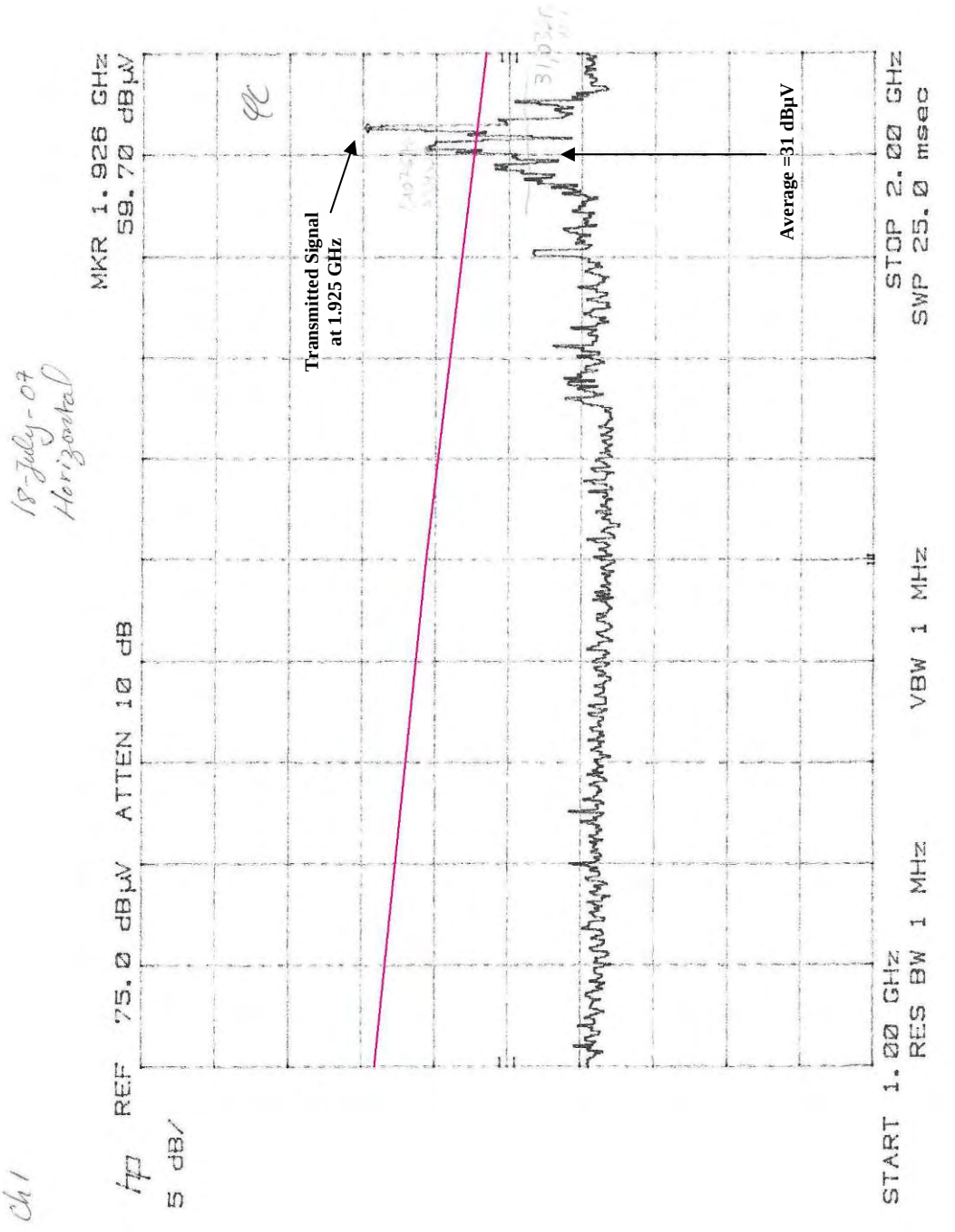

FIGURE 8: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

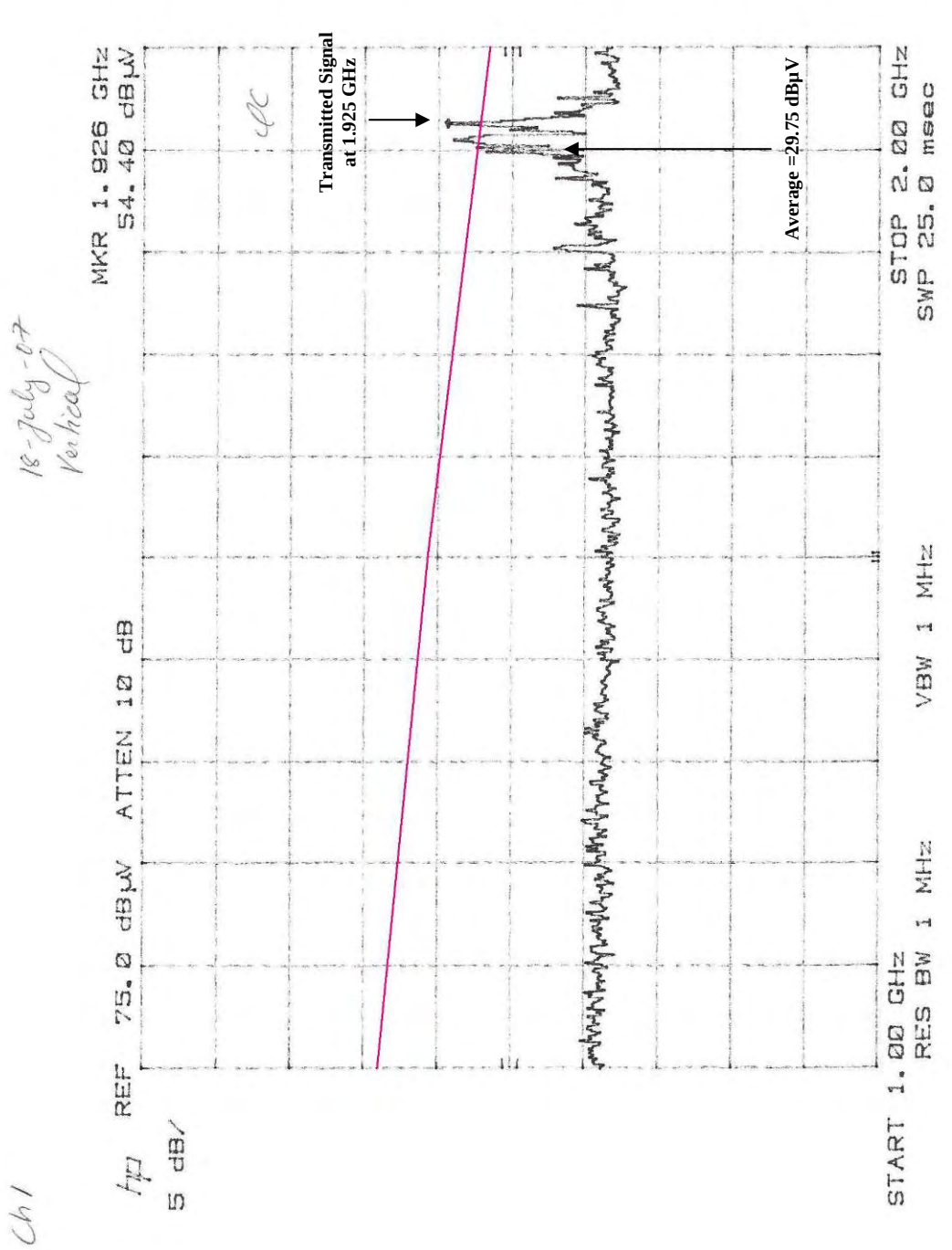

FIGURE 9: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

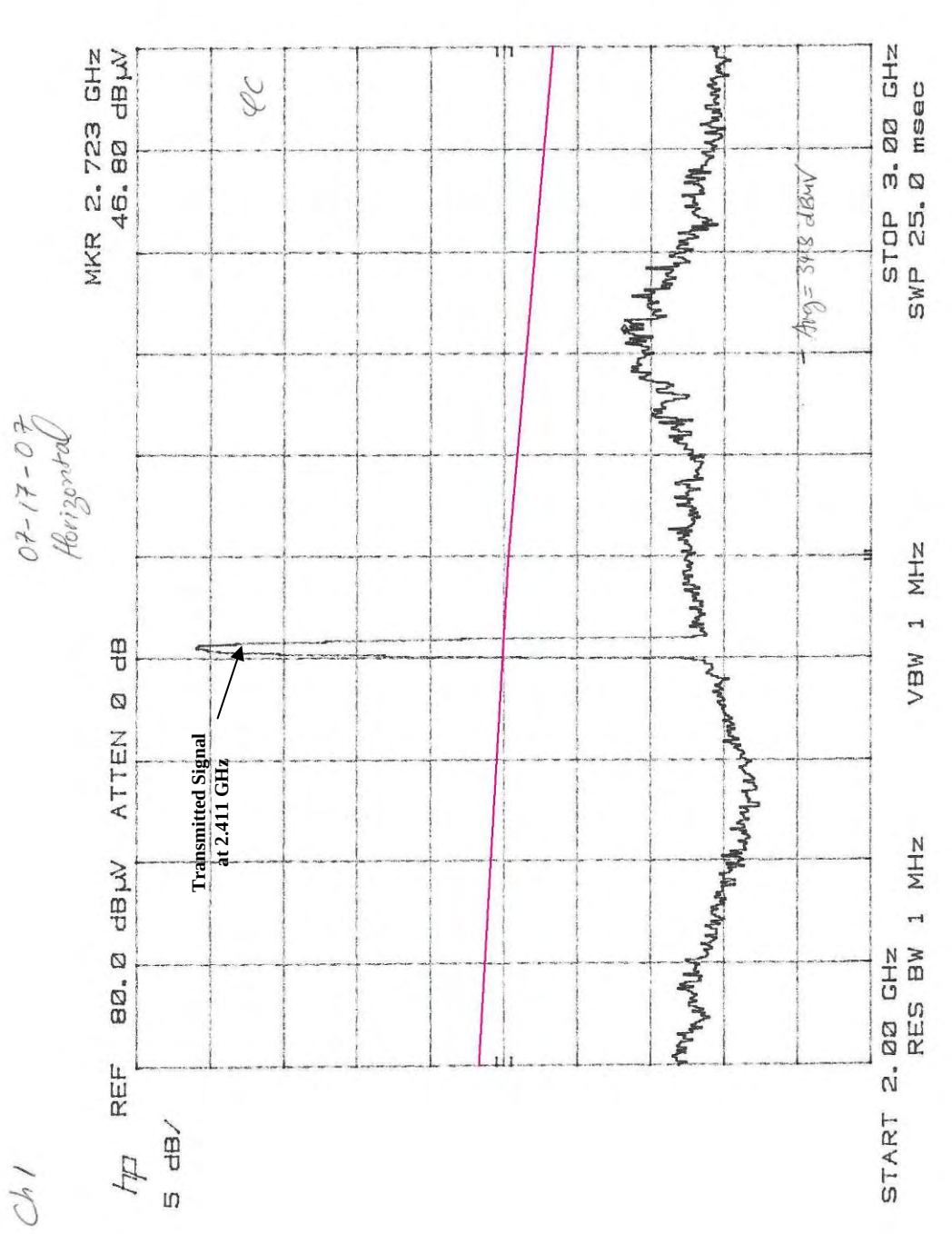

FIGURE 10: Radiated Emission 2 GHz – 3 GHz Horizontal Polarization

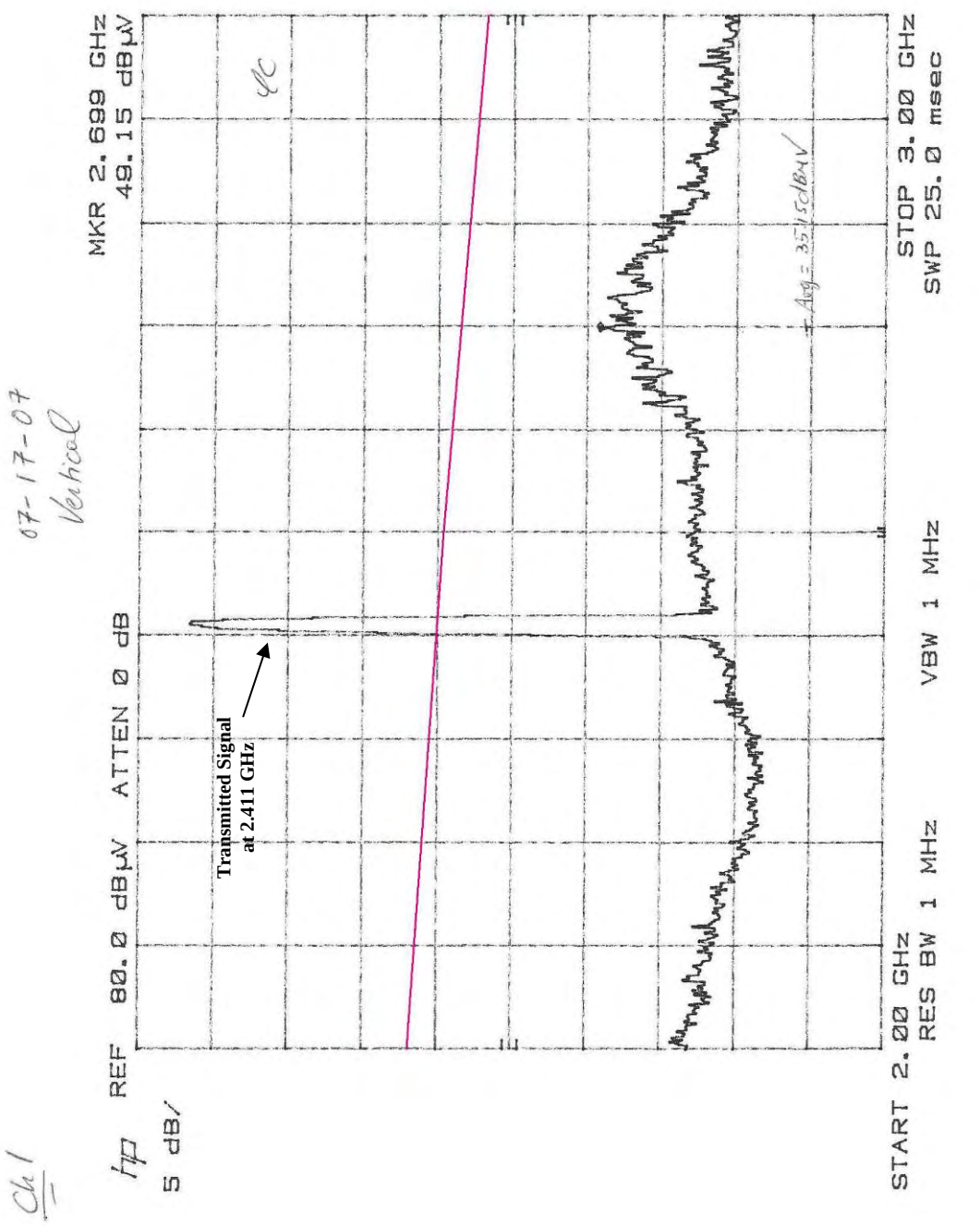

FIGURE 11: Radiated Emission 2 GHz – 3 GHz Vertical Polarization

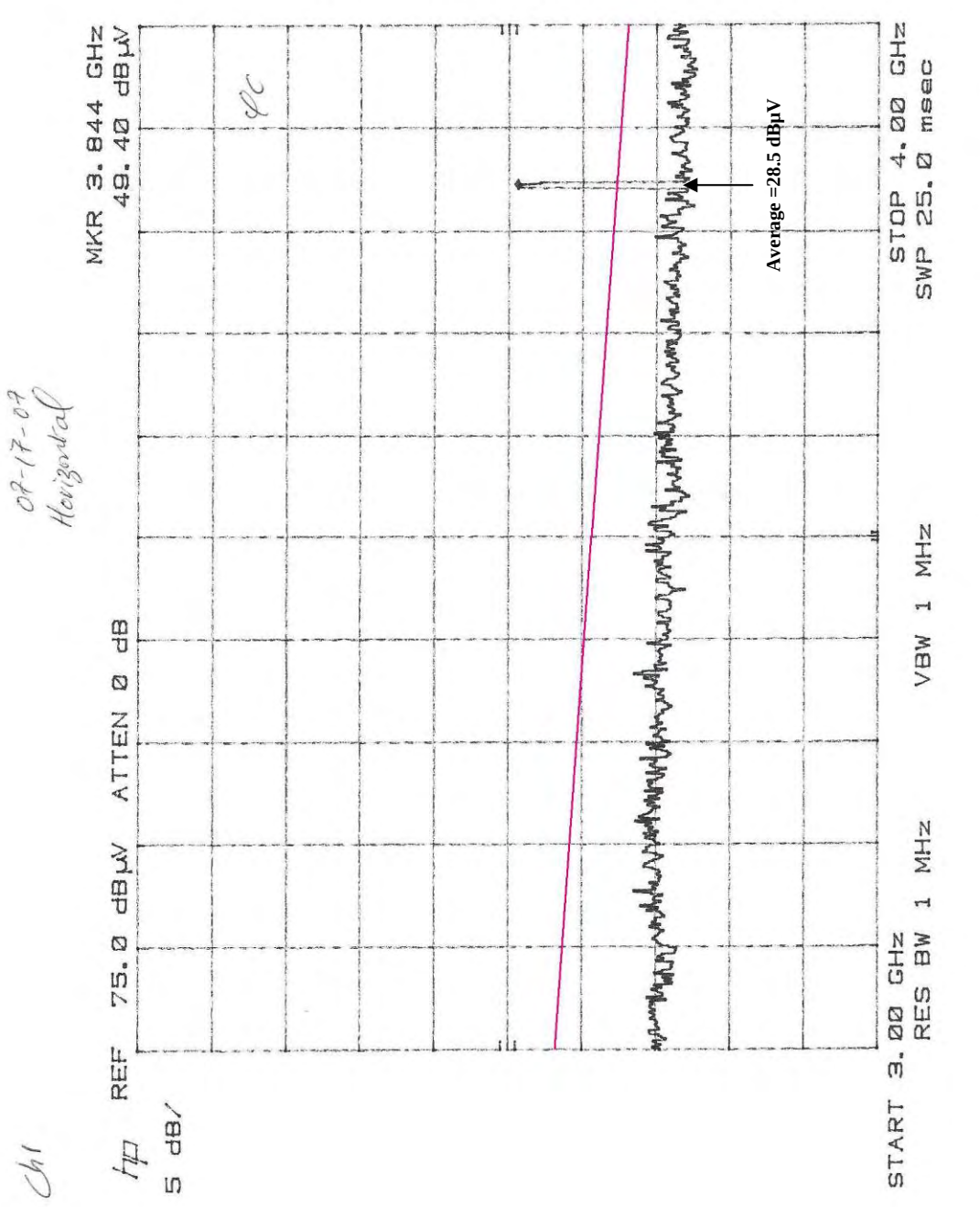

FIGURE 12: Radiated Emission 3 GHz – 4 GHz Horizontal Polarization

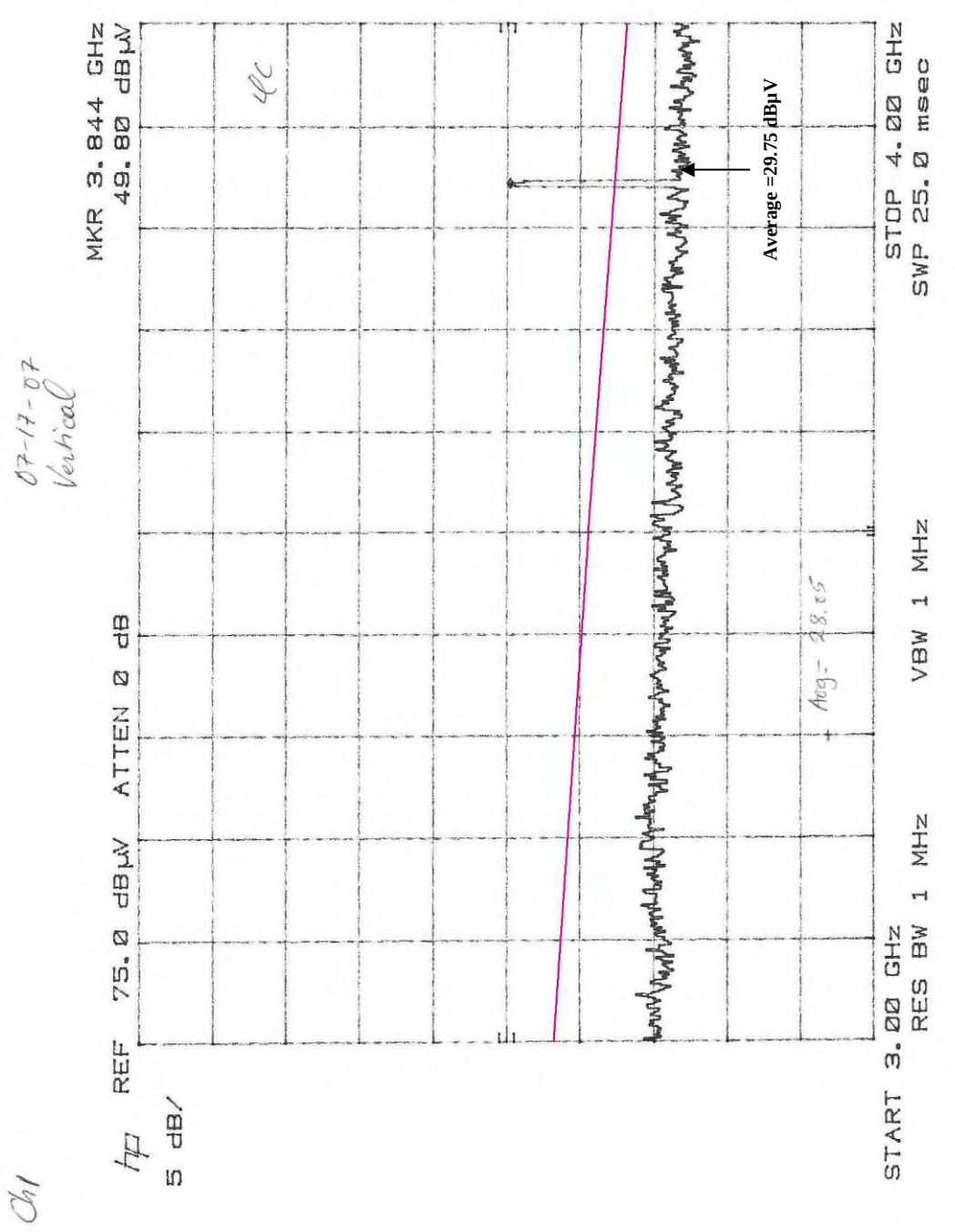

FIGURE 13: Radiated Emission 3 GHz – 4 GHz Vertical Polarization

Note that video averaging reduces the noise floor to 28.05 dBµV.

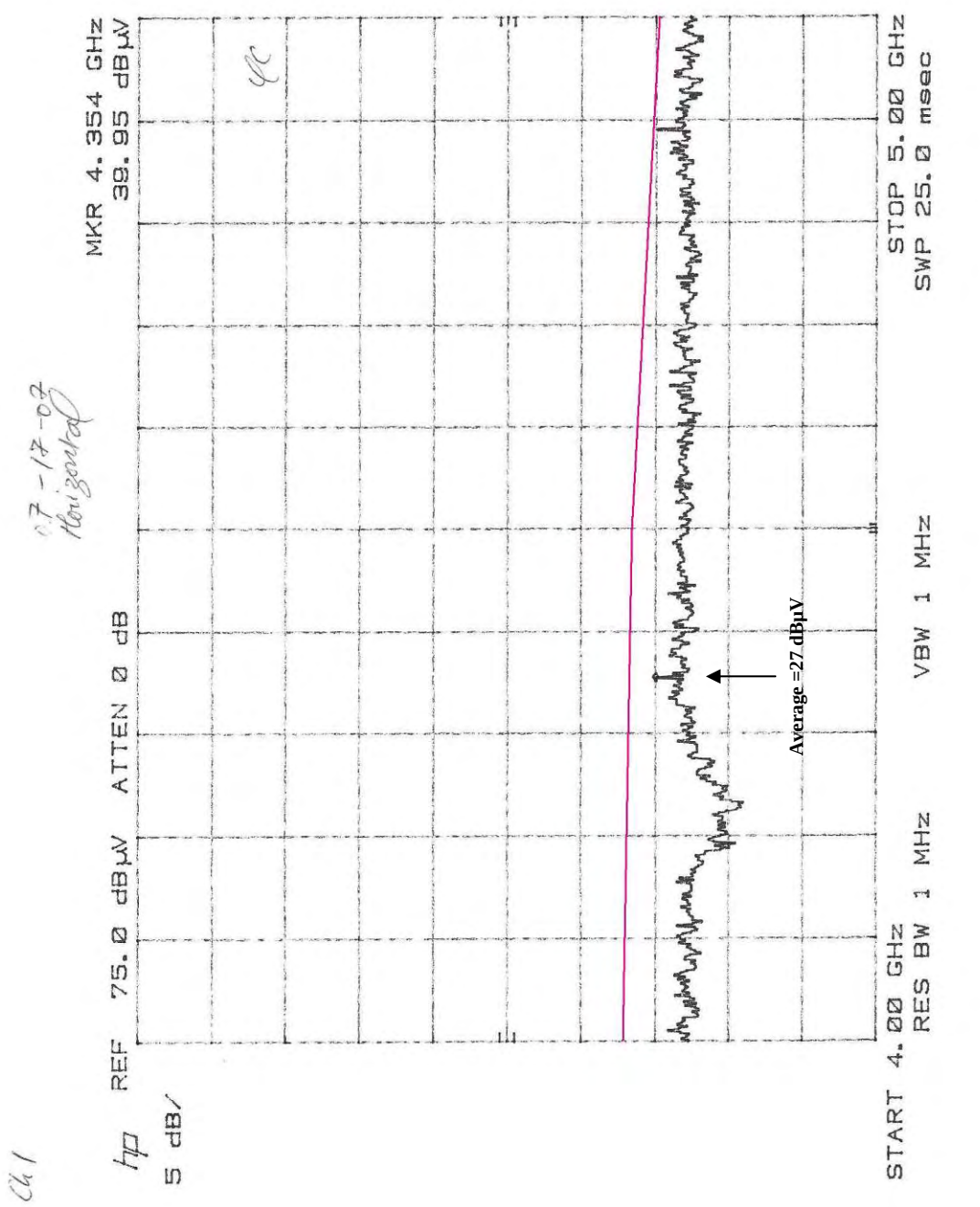

FIGURE 14: Radiated Emission 4 GHz – 5 GHz Horizontal Polarization

Note that Figure 14 reports data taken with VBW = 1 MHz. Video averaging using VBW = 10 Hz reduces the emissions to a maximum of 27 dBµV.

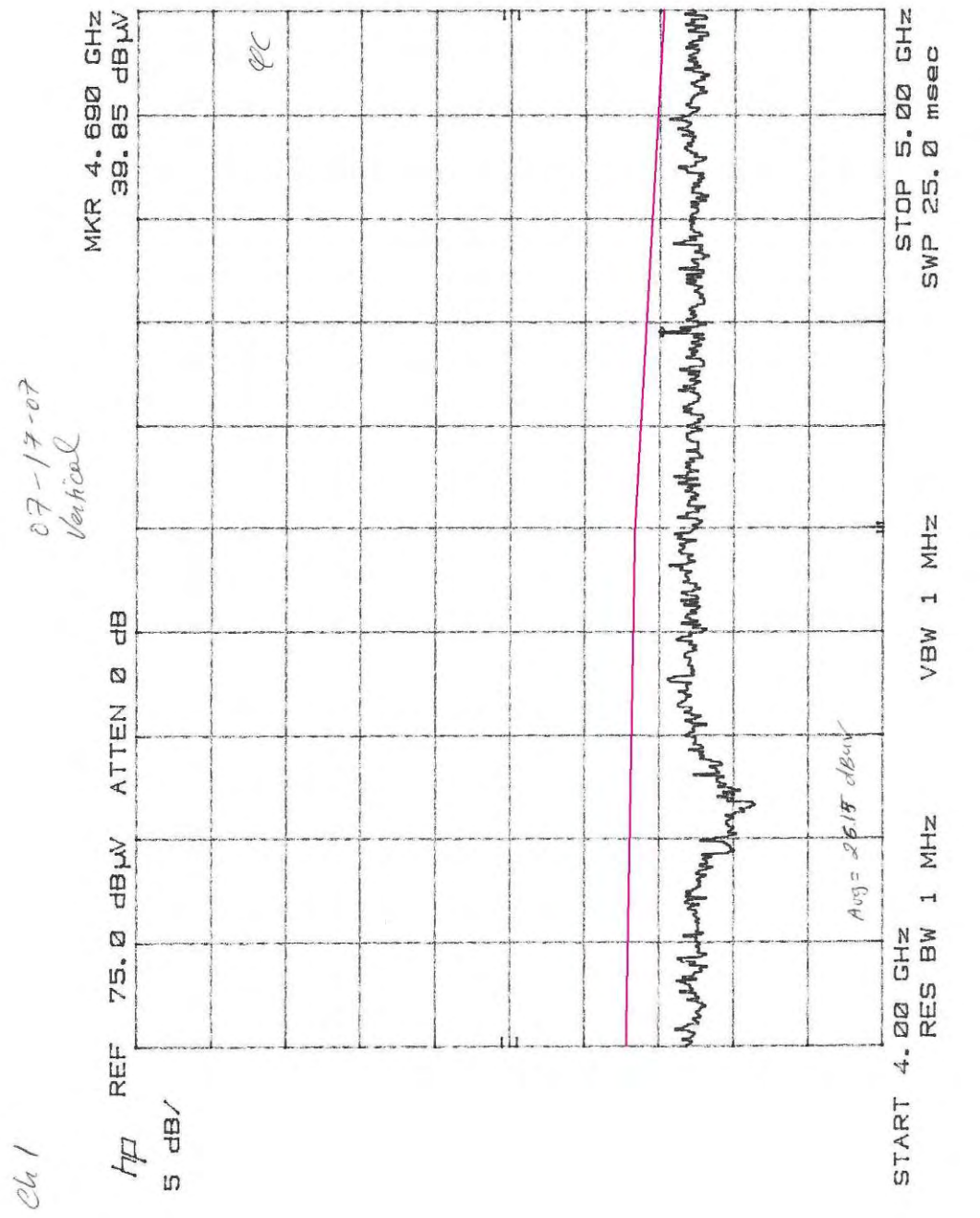

FIGURE 15: Radiated Emission 4 GHz – 5 GHz Vertical Polarization

Note that Figure 14 reports data taken with VBW = 1 MHz. Video averaging using VBW = 10 Hz reduces the emissions to a maximum of 26.15 dBµV.

From Figures 4-15, 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 (dBµV)	Average (dBµV)	Correction Factor (dB/m)	E- Field* (dBµV/m)	FCC Limit (dBµV/m)	Margin to limit (dB)
6	316.8	52.15			8.84	43.31	46	2.69
6	349.6	51.85			8.53	43.32	46	2.68
6	393.6	49.8			8.11	41.69	46	4.31
7	960	43.9			-1.86	45.76	46	0.24
8	1907	55.45		31	-2.48	33.48	54	20.52
9	1907	54		29.75	-2.48	32.23	54	21.77
10	2723	46.8		34.8	-6.46	41.26	54	12.74
11	2669	49.15		35.15	-6.17	41.32	54	12.68
12	3844	49.4		28.5	-12.13	40.63	54	13.37
13	3844	49.8		29.75	-12.13	41.88	54	12.12
14	4354	39.95		27	-13.19	40.19	54	13.81
15	4394	39.85		26.15	-13.21	39.36	54	14.64

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.

Channel 6 – Radiated Emission Data

Figures 16 –27 show data for the WiFi Module set to channel 6, corresponding to the center frequency of 2.436 GHz.

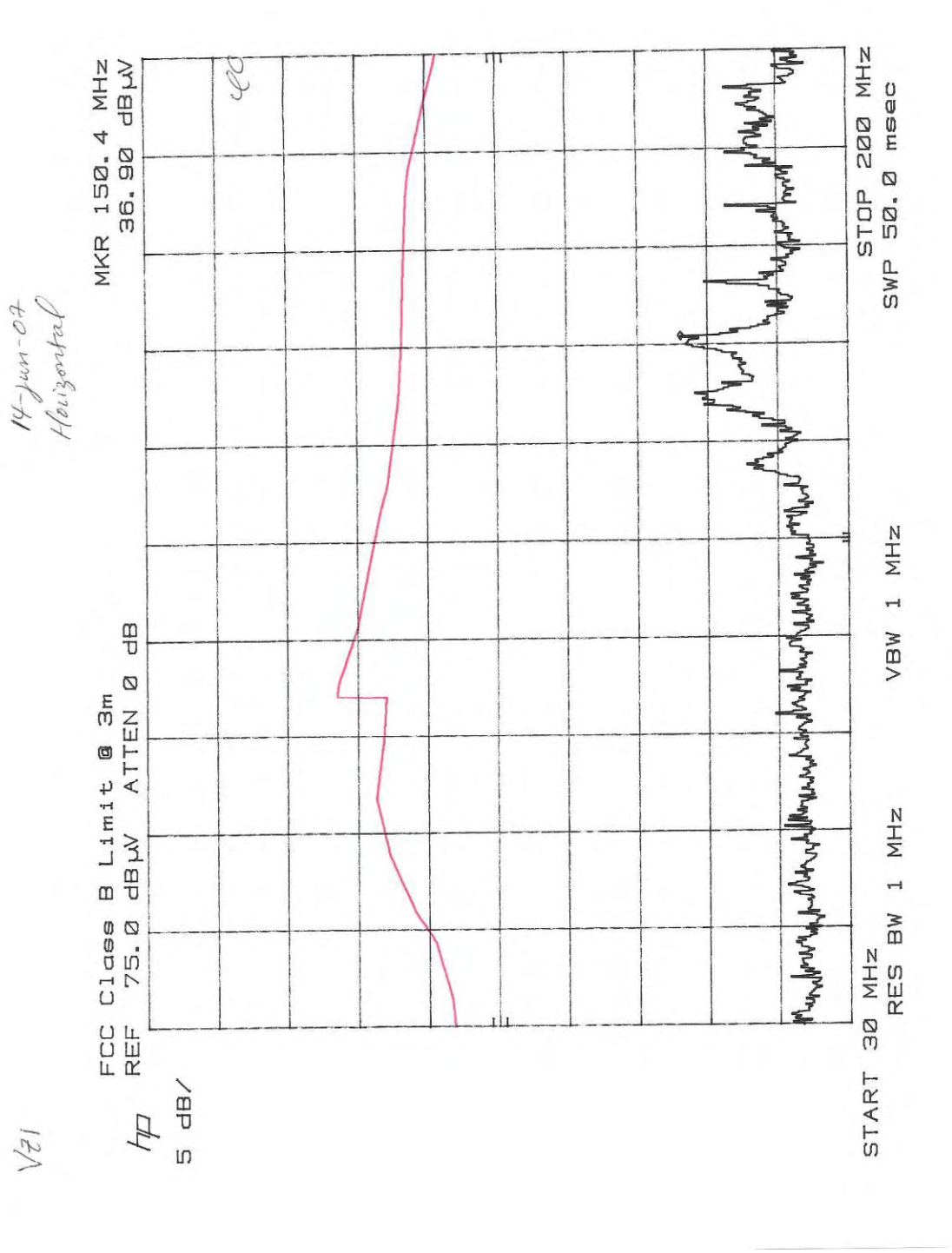

FIGURE 16: Radiated Emission 30 – 200 MHz Horizontal Polarization

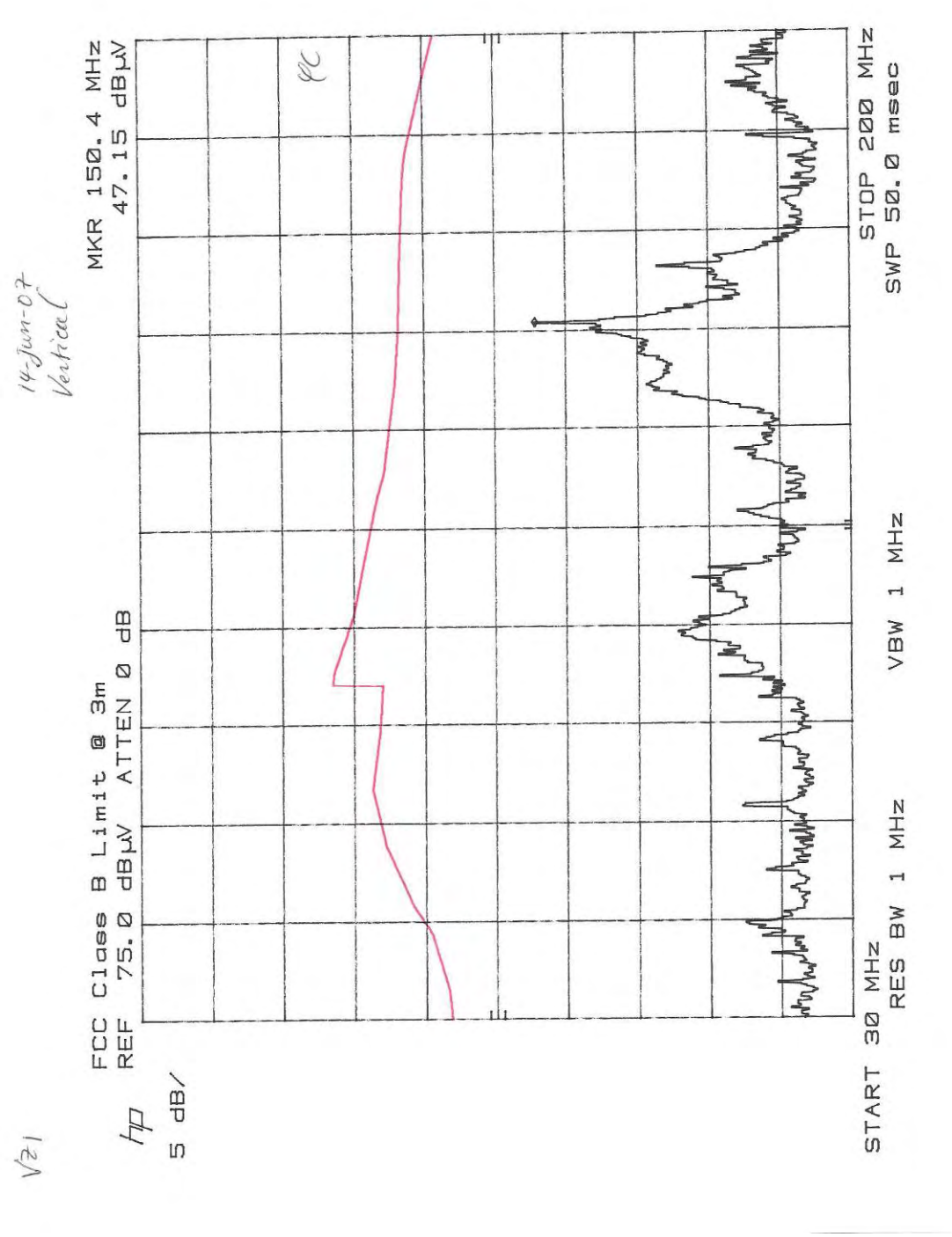

FIGURE 17: Radiated Emission 30 – 200 MHz Vertical Polarization

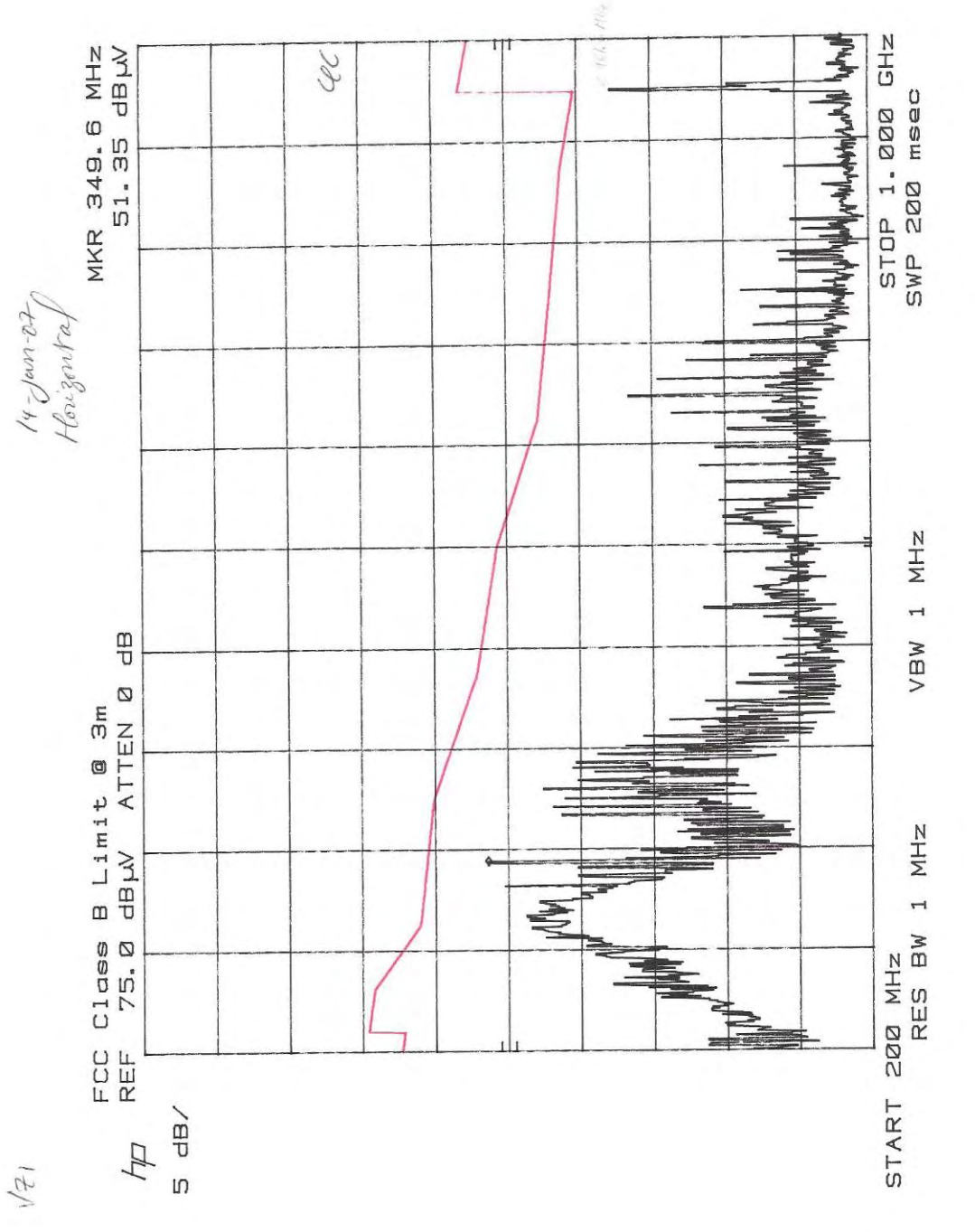

FIGURE 18: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

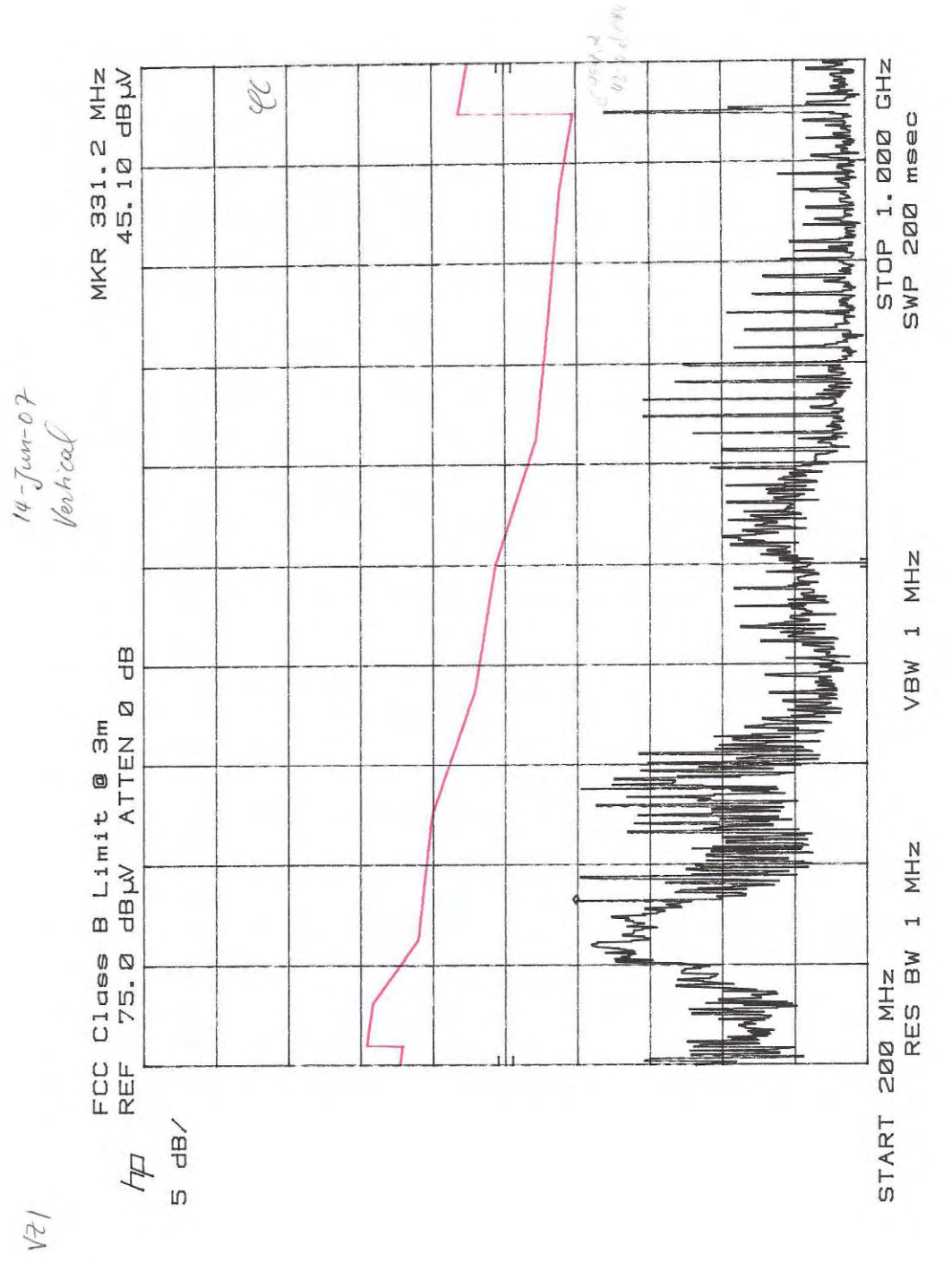

FIGURE 19: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

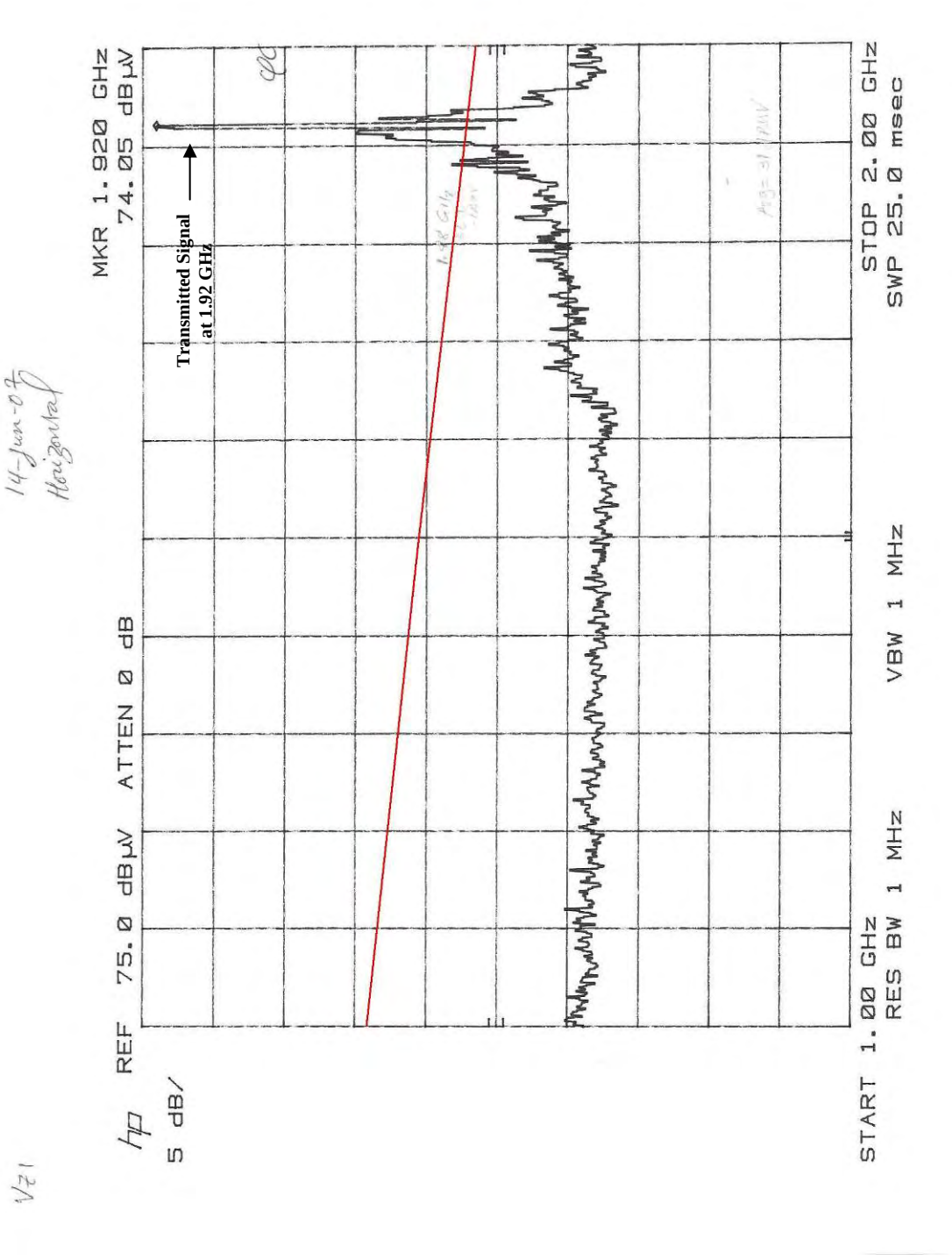

FIGURE 20: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

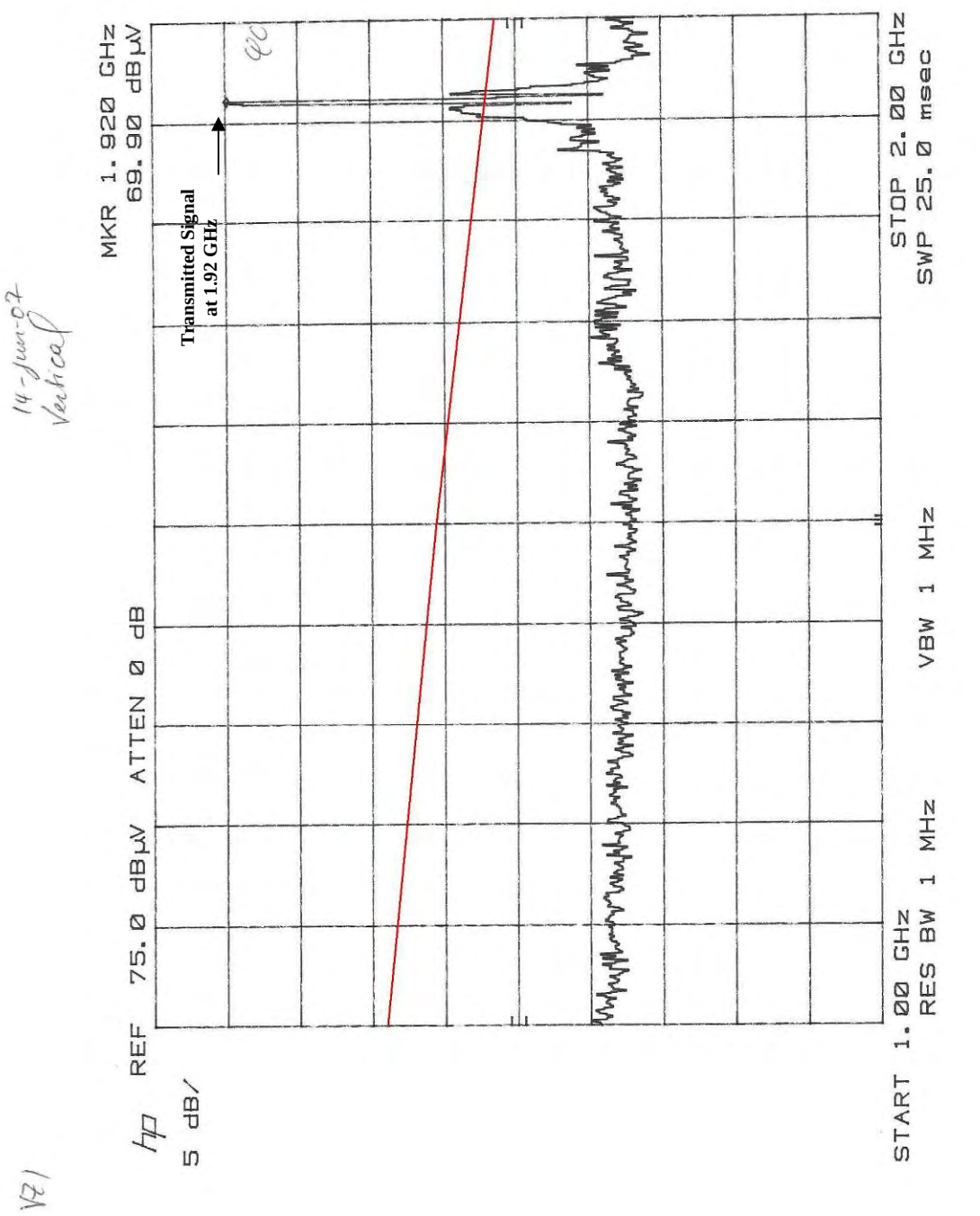

FIGURE 21: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

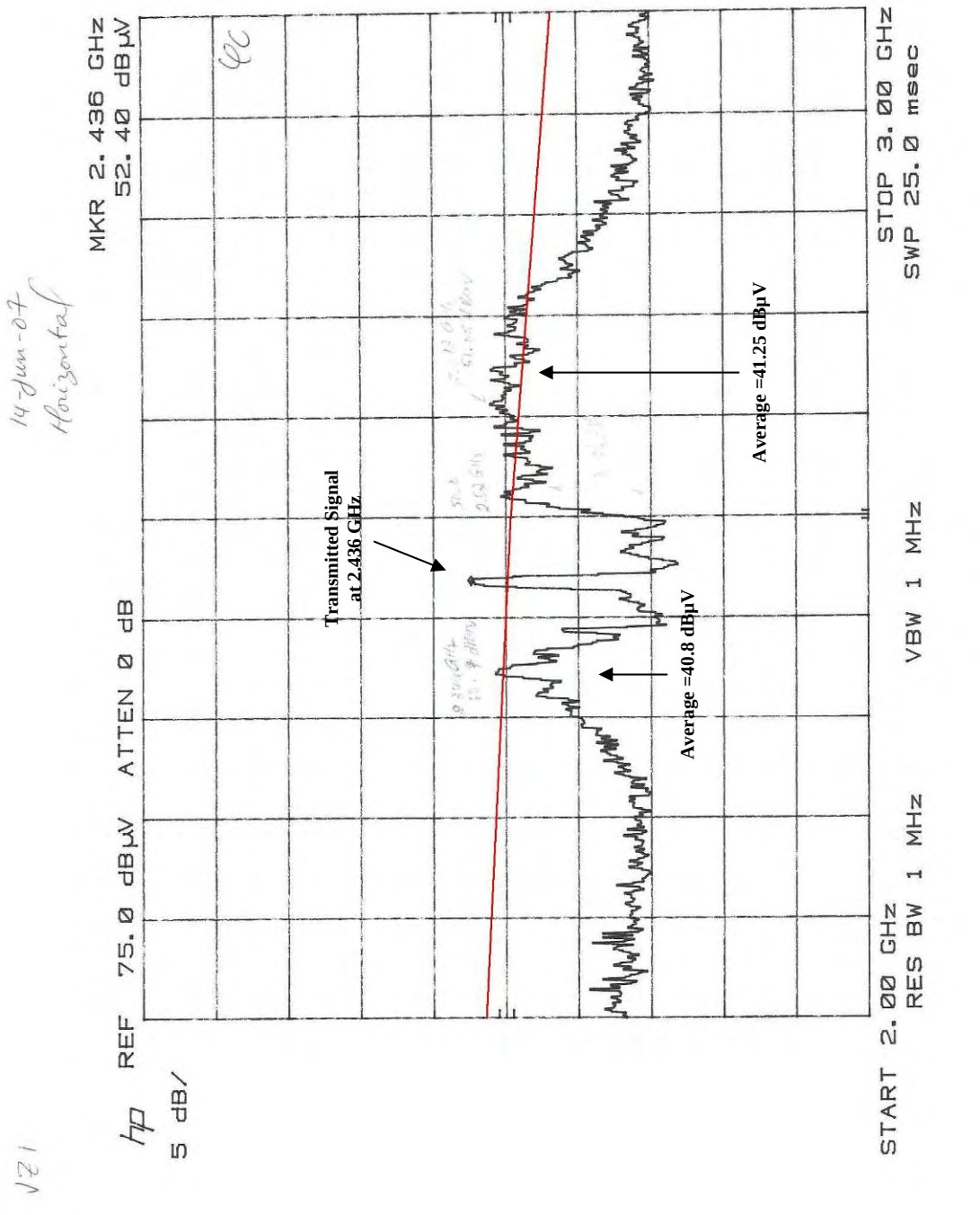

FIGURE 22: Radiated Emission 2 GHz – 3 GHz Horizontal Polarization

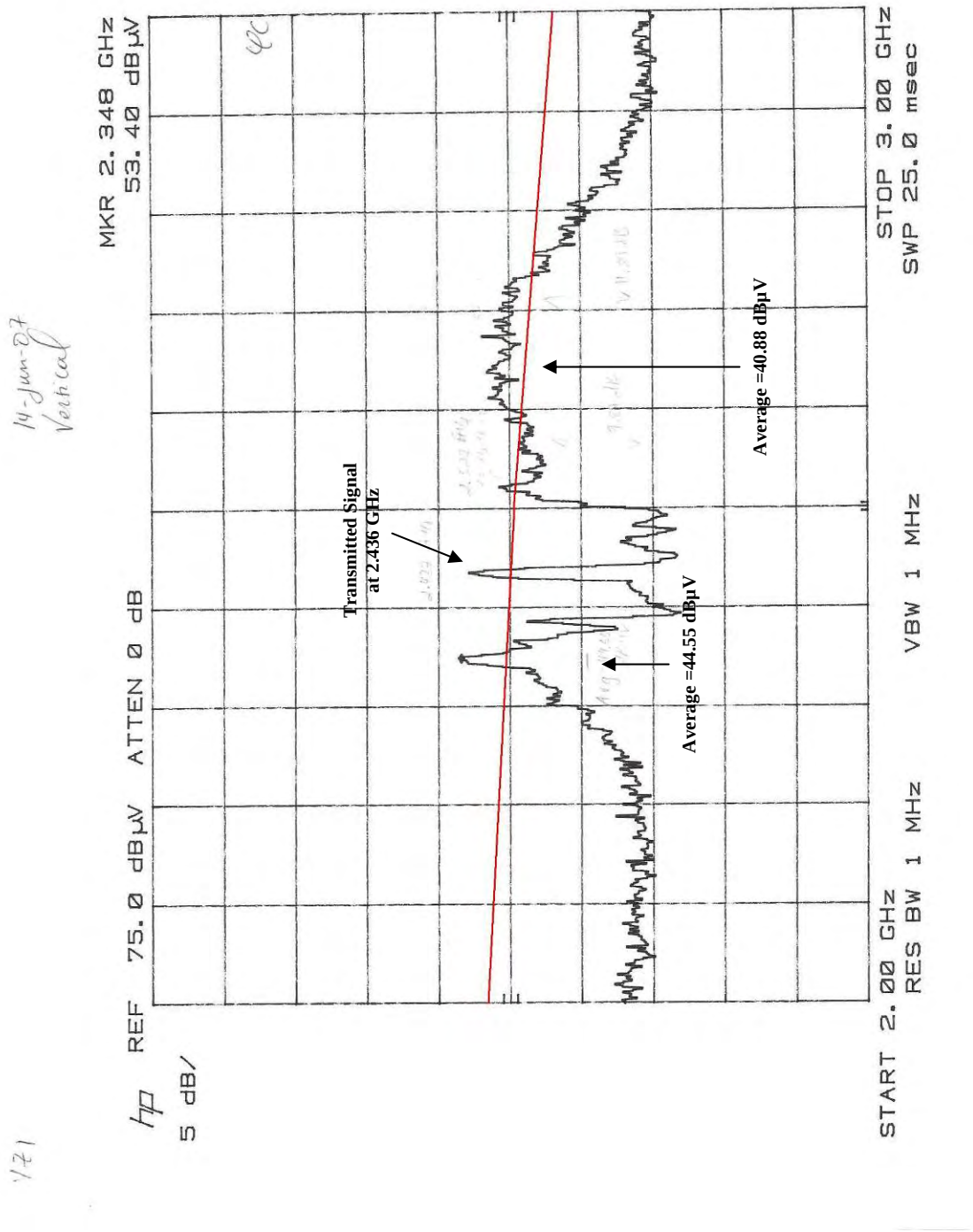

FIGURE 23: Radiated Emission 2 GHz – 3 GHz Vertical Polarization

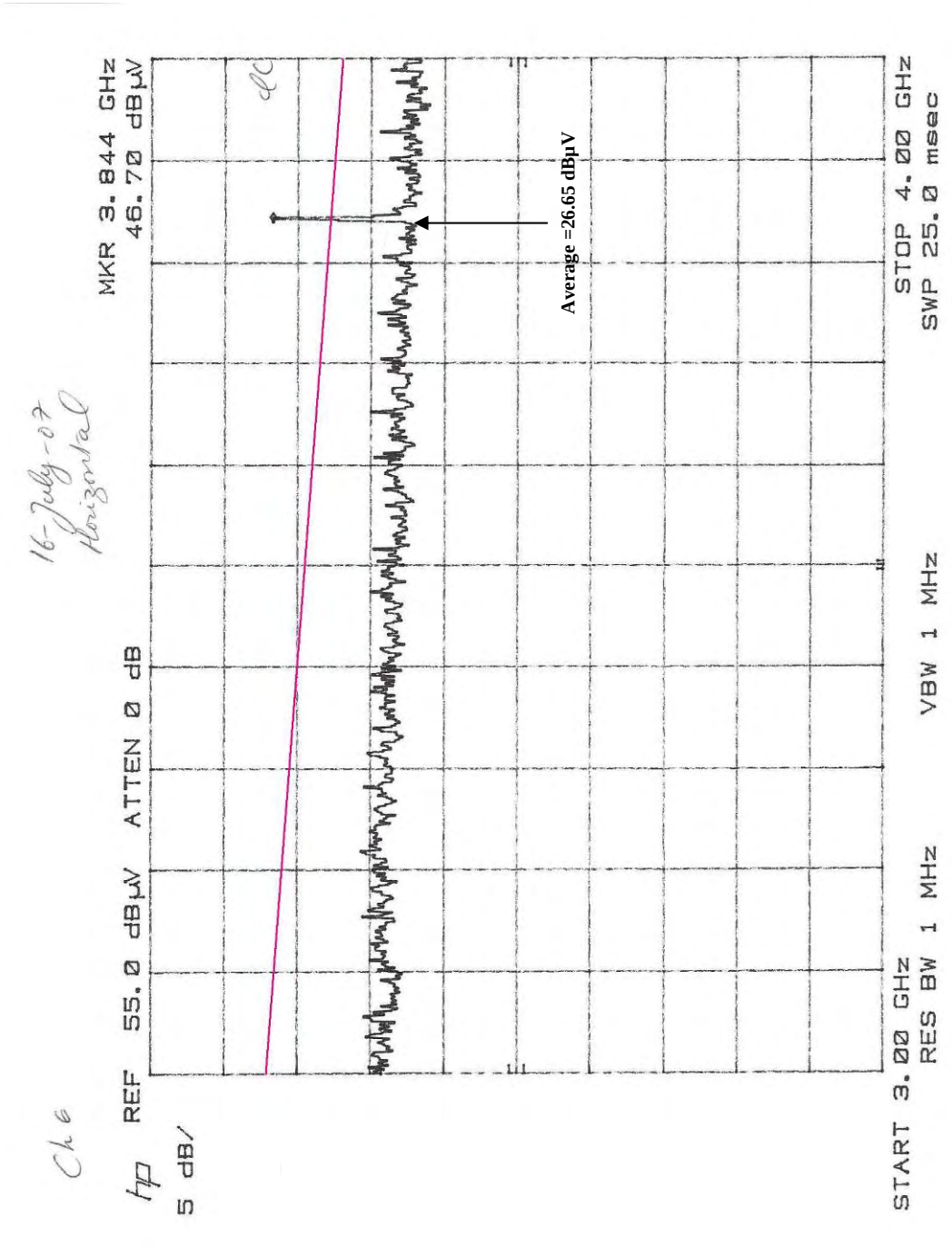

FIGURE 24: Radiated Emission 3 GHz – 4 GHz Horizontal Polarization

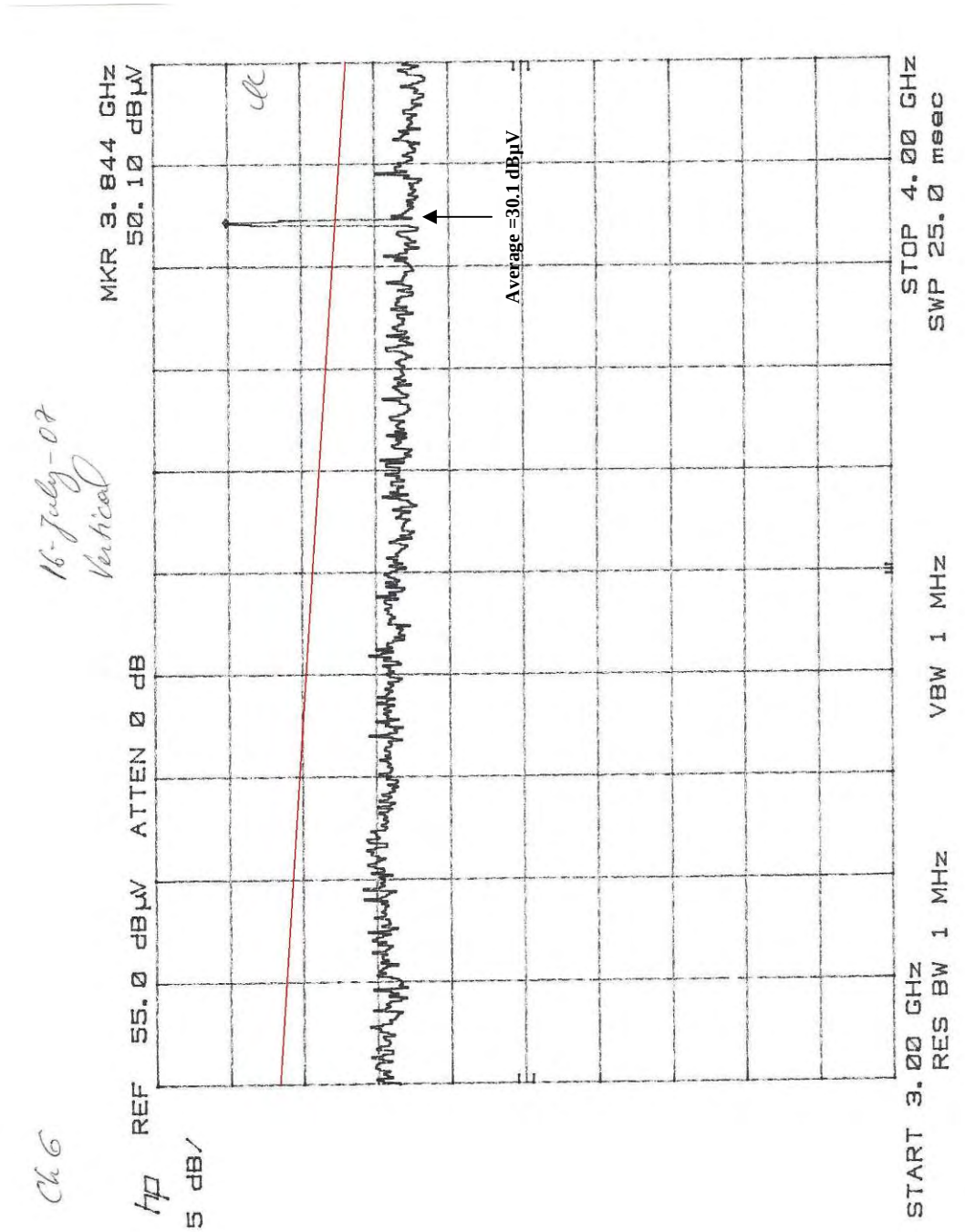

FIGURE 25: Radiated Emission 3 GHz – 4 GHz Vertical Polarization

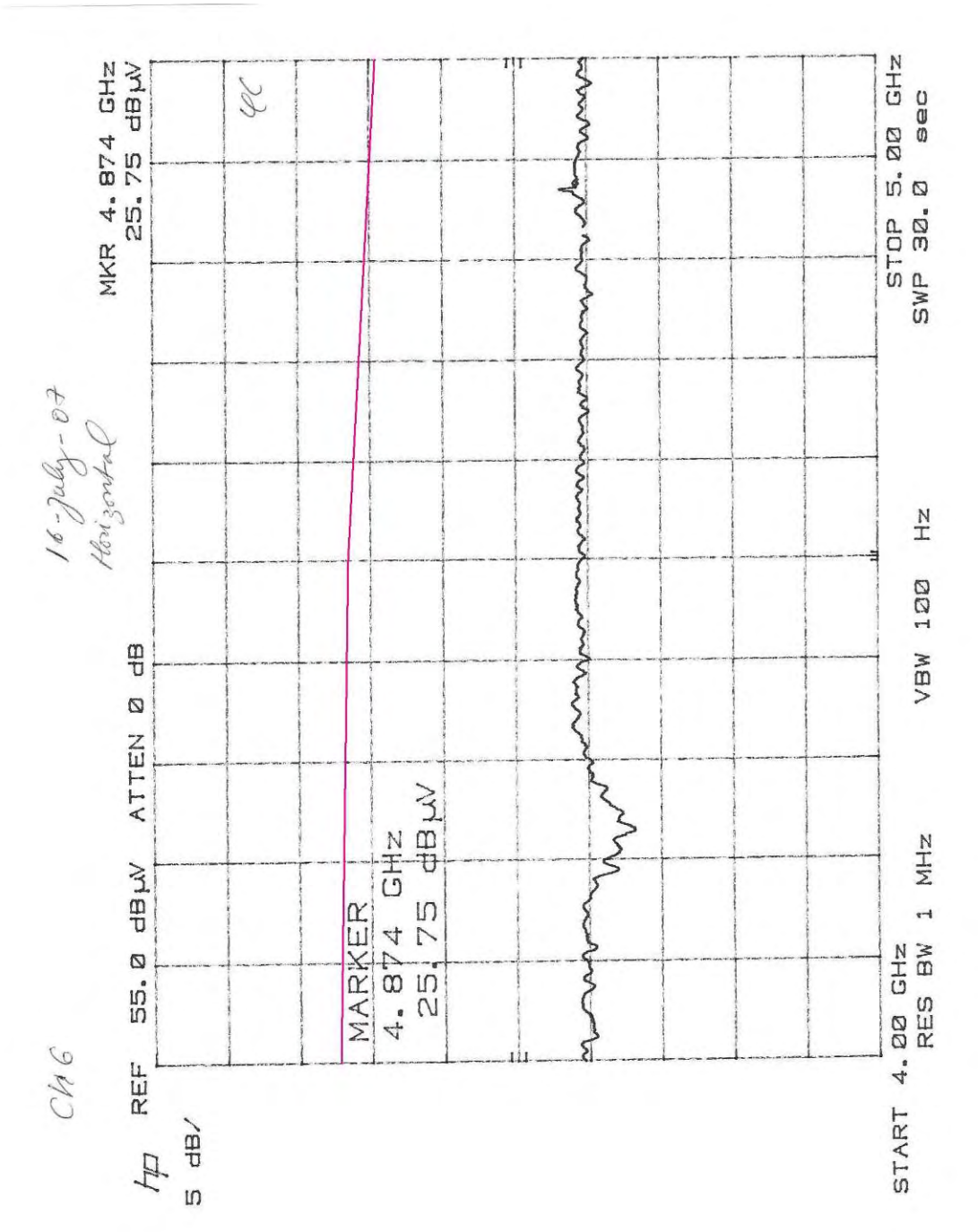

FIGURE 26: Radiated Emission 4 GHz – 5 GHz Horizontal Polarization

Note that Figure 26 shows the averaged measurements with VBW reduced to 10 Hz.

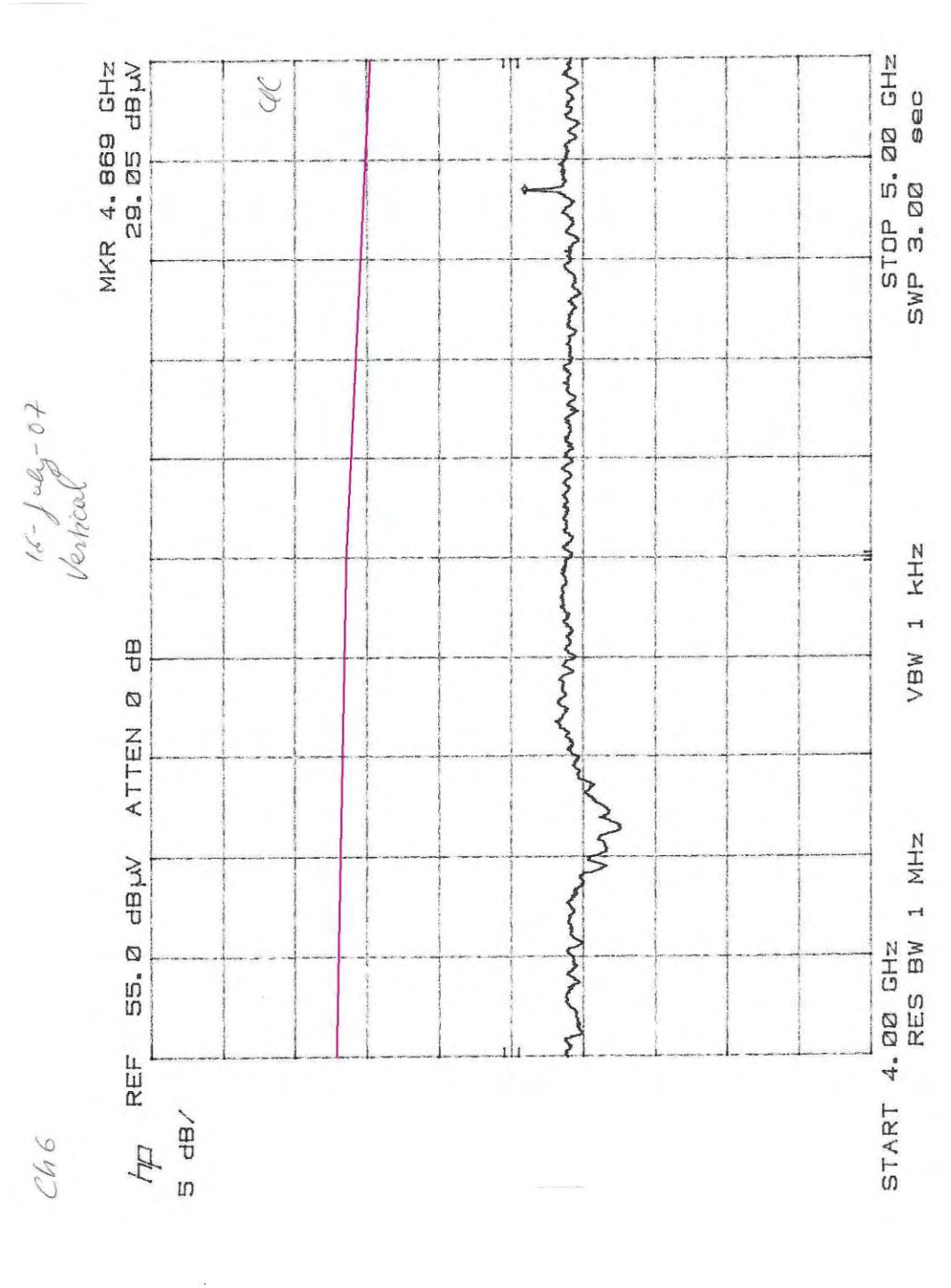

FIGURE 27: Radiated Emission 4 GHz – 5 GHz Vertical Polarization

Note that Figure 27 shows the averaged measurements with VBW reduced to 1 kHz.