From Figures 16-27, the unintentional peak emissions that exceeded or were within 5 dB of the limit are reported in Table 3

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)
18	349.6	51.35			8.53	42.82	46	3.18
18	961.6	42.7			-1.89	44.59	54	9.41
19	959.2	43			-1.85	44.85	46	1.15
20	1880	53.2		31	1.58	29.42	54	24.58
22	2344	50.7		40.8	-7.16	47.96	54	6.04
22	2520	50.3		40.44	-6.44	46.88	54	7.12
22	2612	51.05		41.25	-6.91	48.16	54	5.84
23	2348	53.4		44.55	-7.18	51.73	54	2.27
23	2522	50.75		40.88	-6.45	47.33	54	6.67
23	2670	52.3		40.41	-7.21	47.62	54	6.38
24	3844	46.7		26.65	-12.13	38.78	54	15.22
25	3844	50.1		30.1	-12.13	42.23	54	11.77

Table 3: 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 3 that the unintentional radiated emissions are below limit. Hence the unit is in compliance.

Channel 11 – Radiated Emissions Data

Figures 28 –39 show data for the WiFi Module set to channel 11, corresponding to the center frequency of 2.46 GHz.

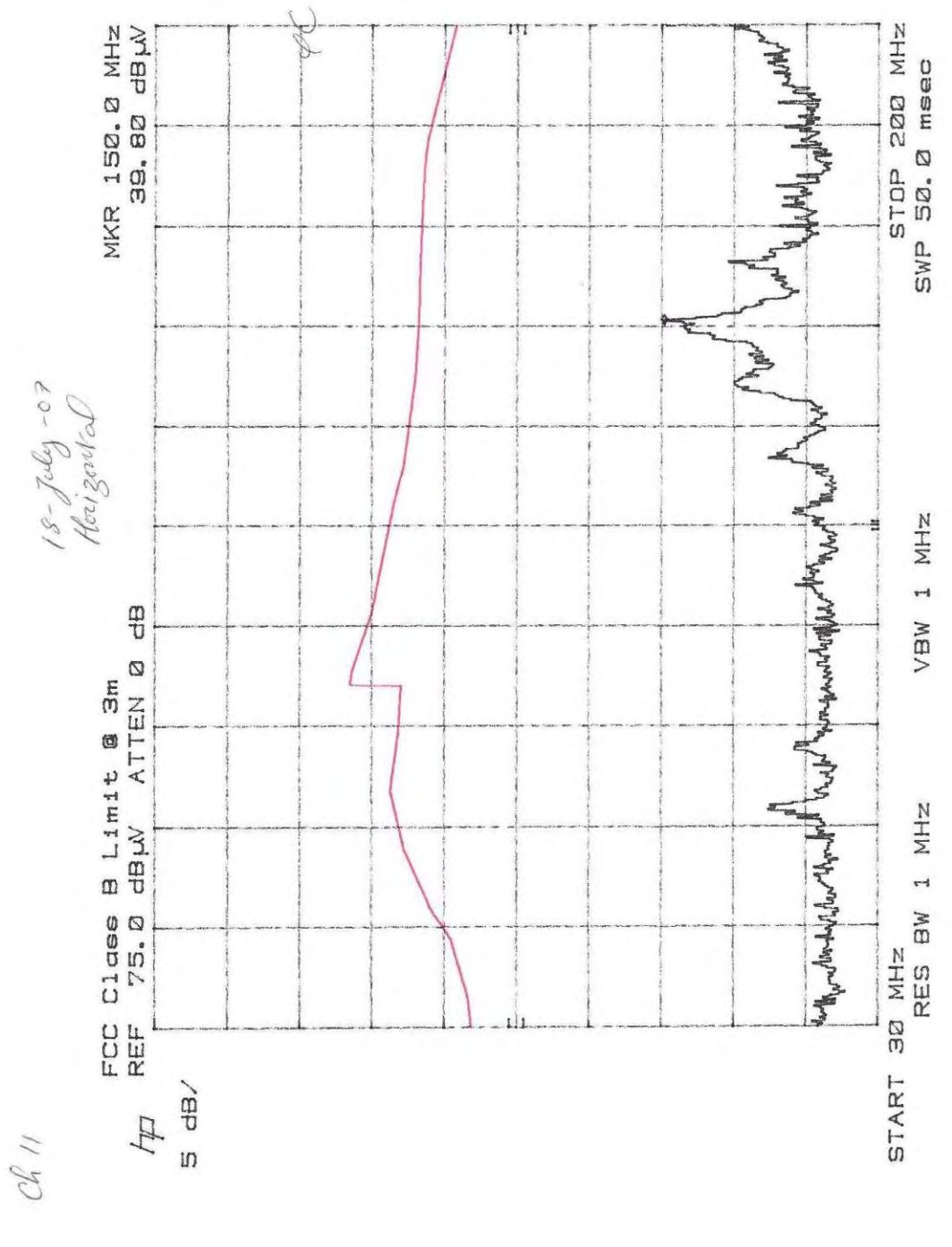


FIGURE 28: Radiated Emission 30 – 200 MHz Horizontal Polarization

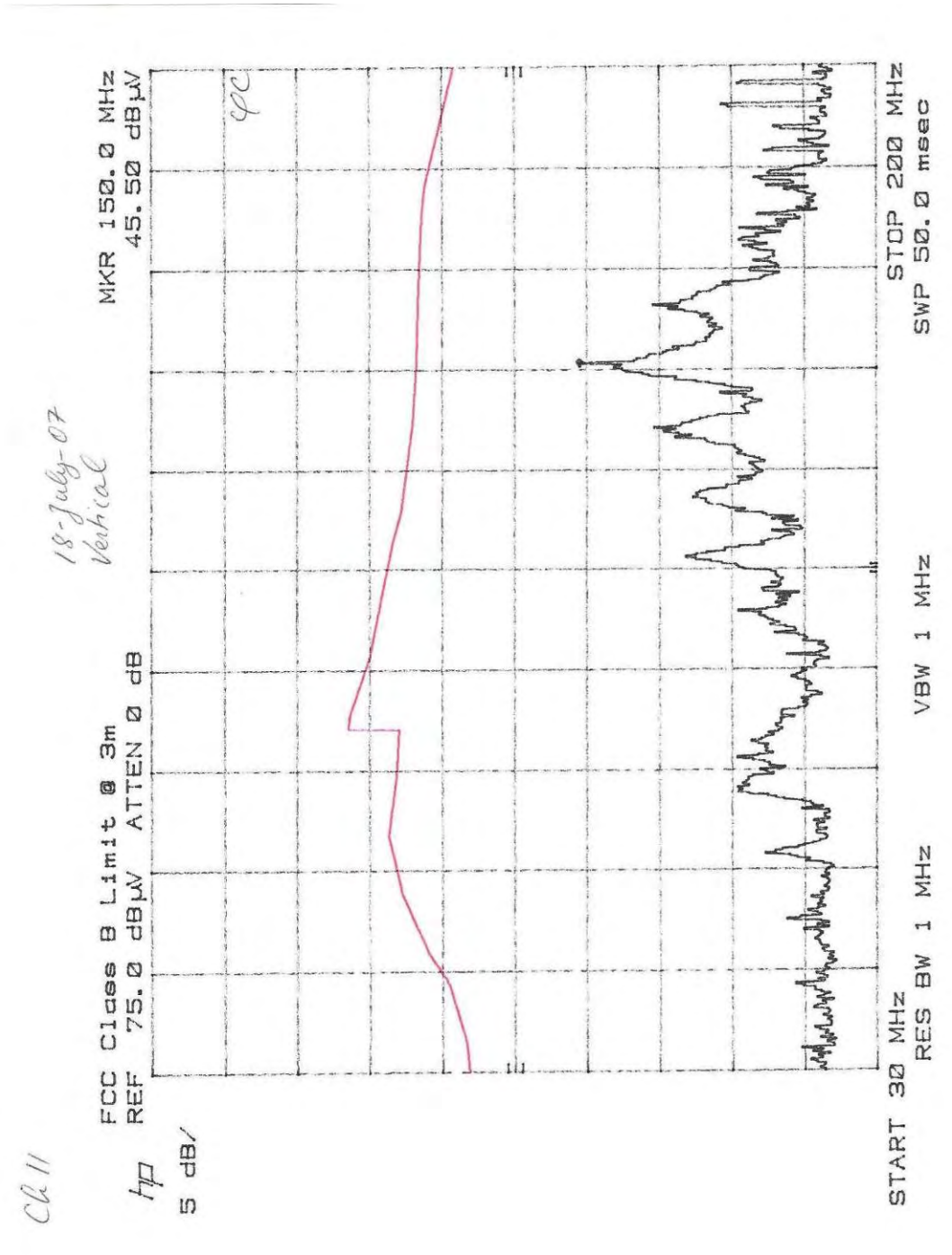


FIGURE 29: Radiated Emission 30 – 200 MHz Vertical Polarization

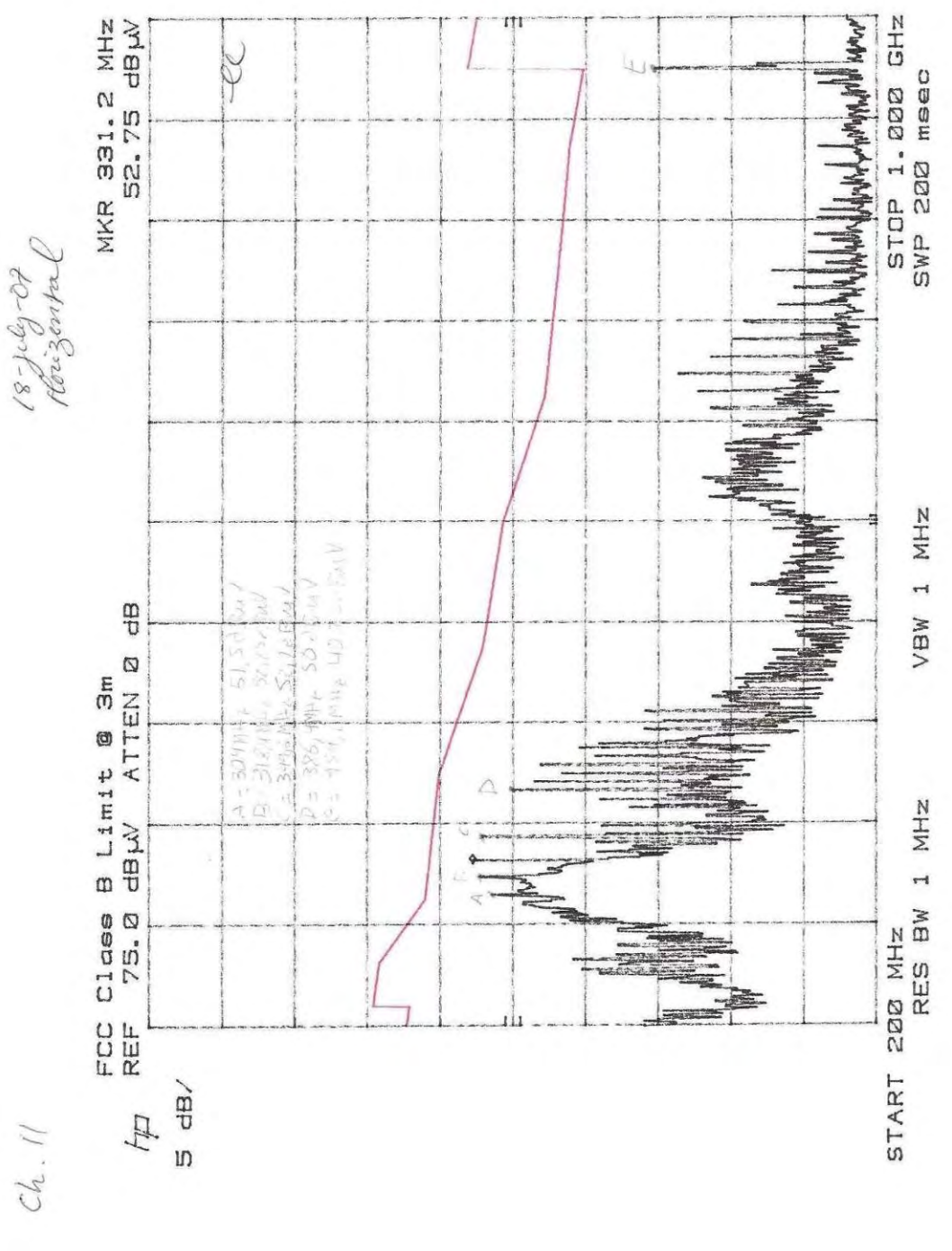


FIGURE 30: Radiated Emission 200 MHz – 1 GHz Horizontal Polarization

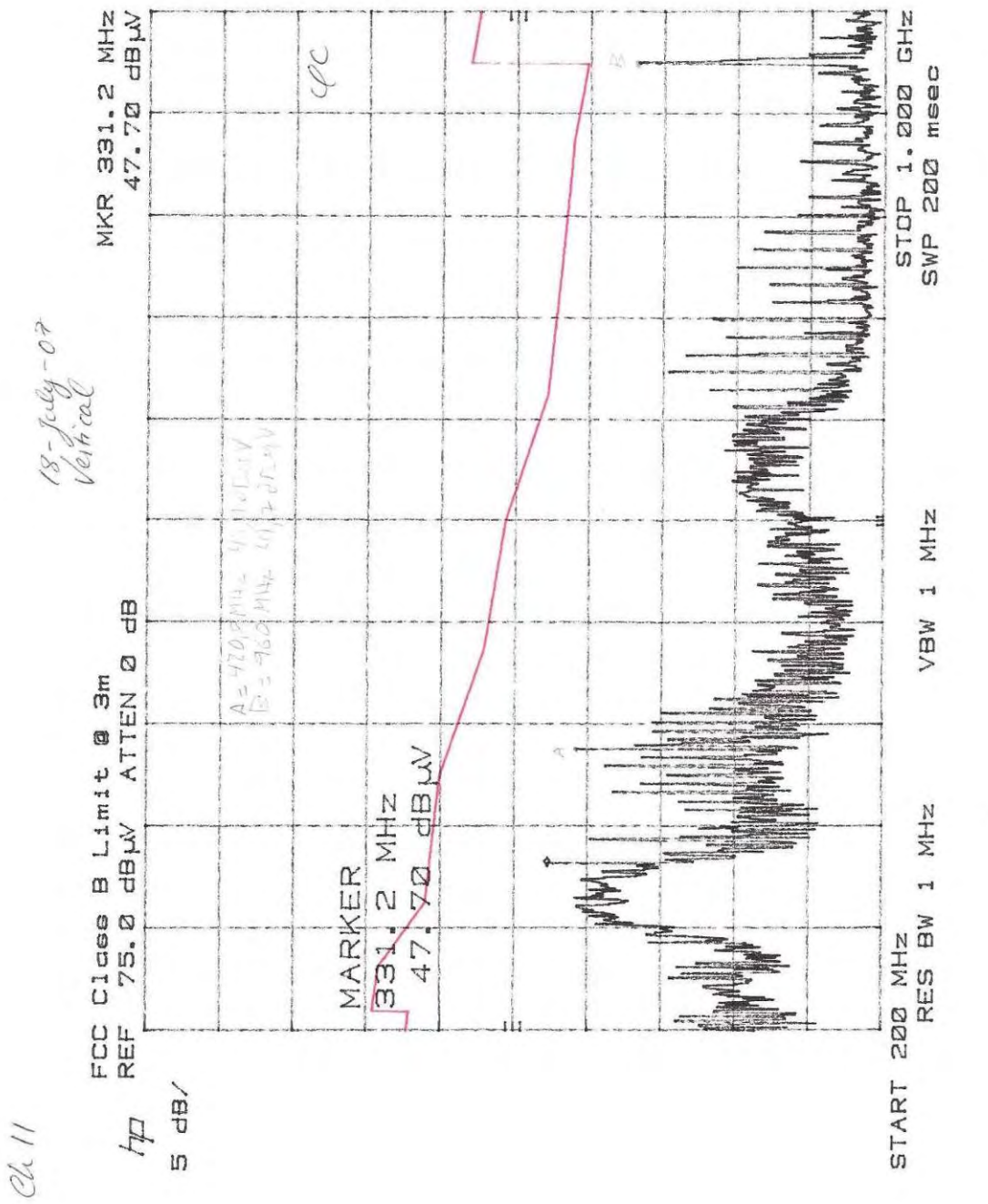


FIGURE 31: Radiated Emission 200 MHz – 1 GHz Vertical Polarization

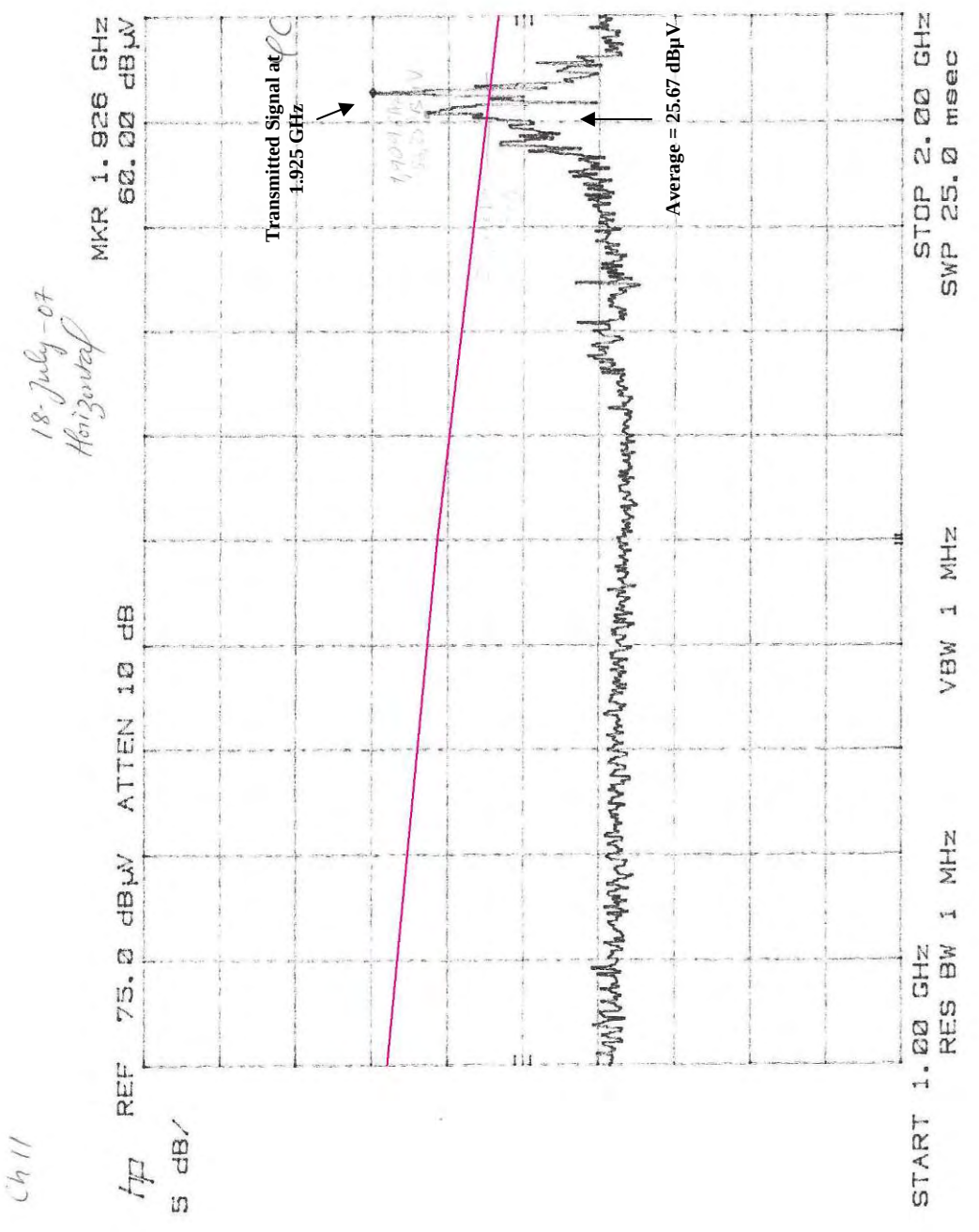


FIGURE 32: Radiated Emission 1 GHz – 2 GHz Horizontal Polarization

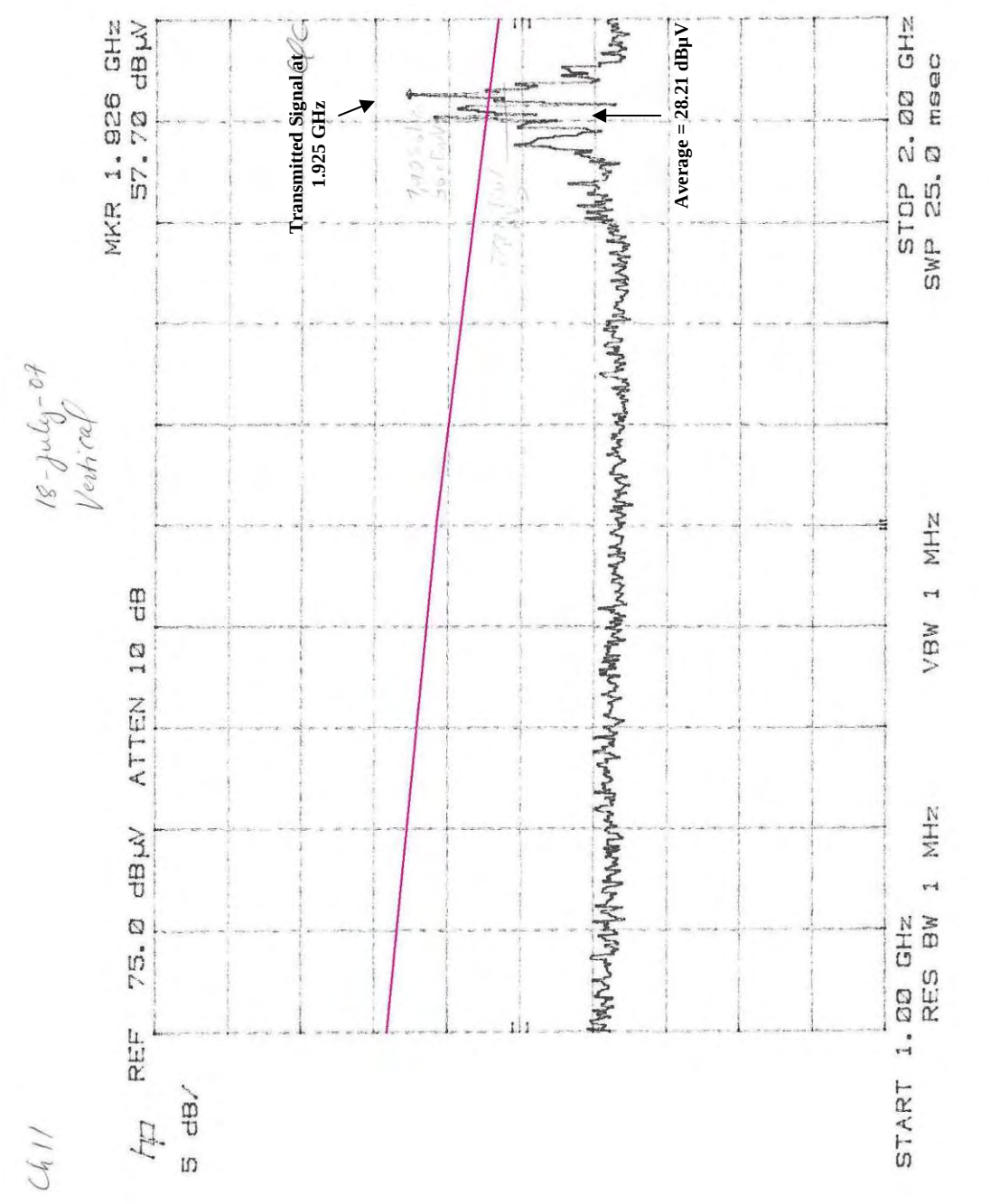


FIGURE 33: Radiated Emission 1 GHz – 2 GHz Vertical Polarization

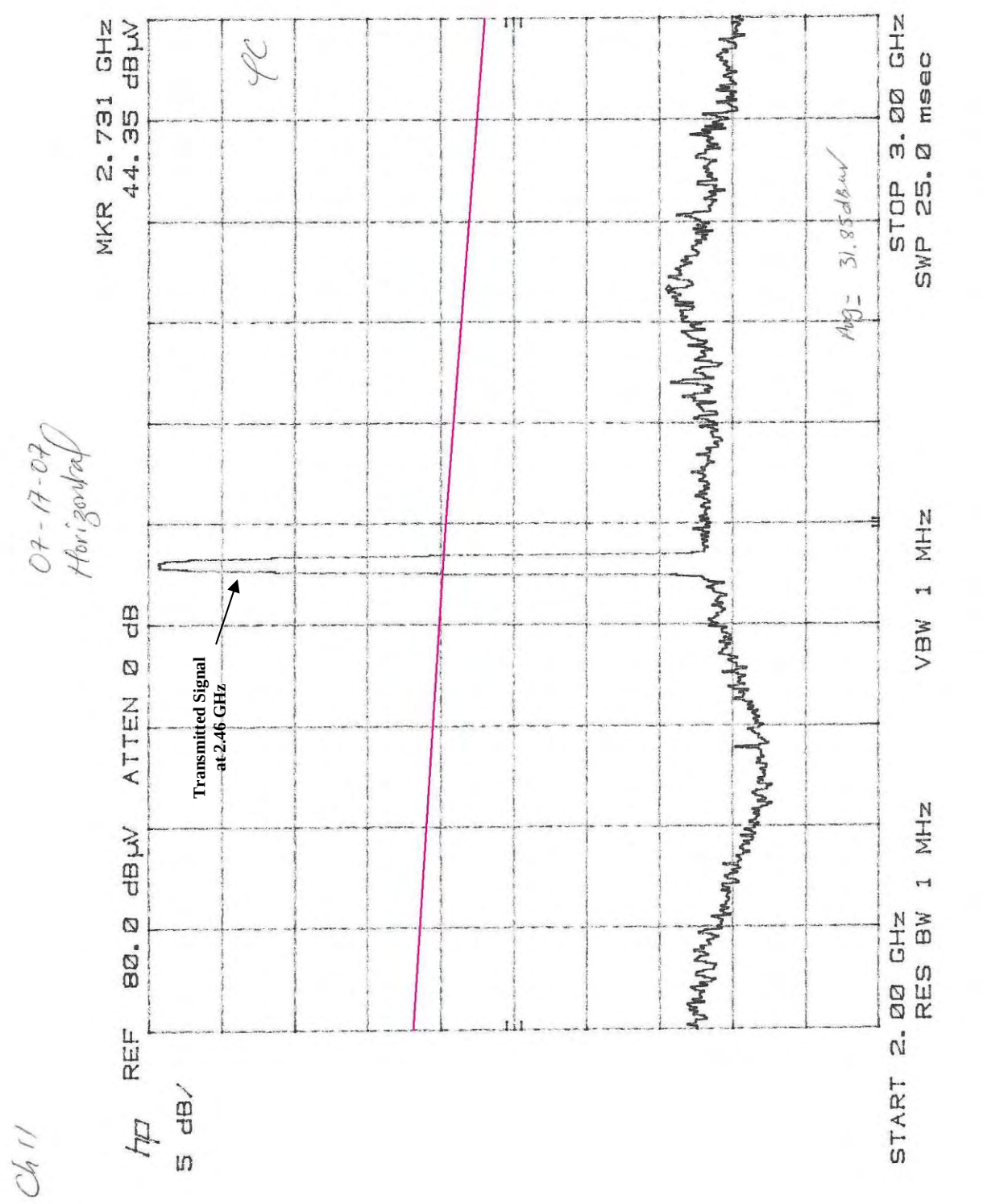


FIGURE 34: Radiated Emission 2 GHz – 3 GHz Horizontal Polarization

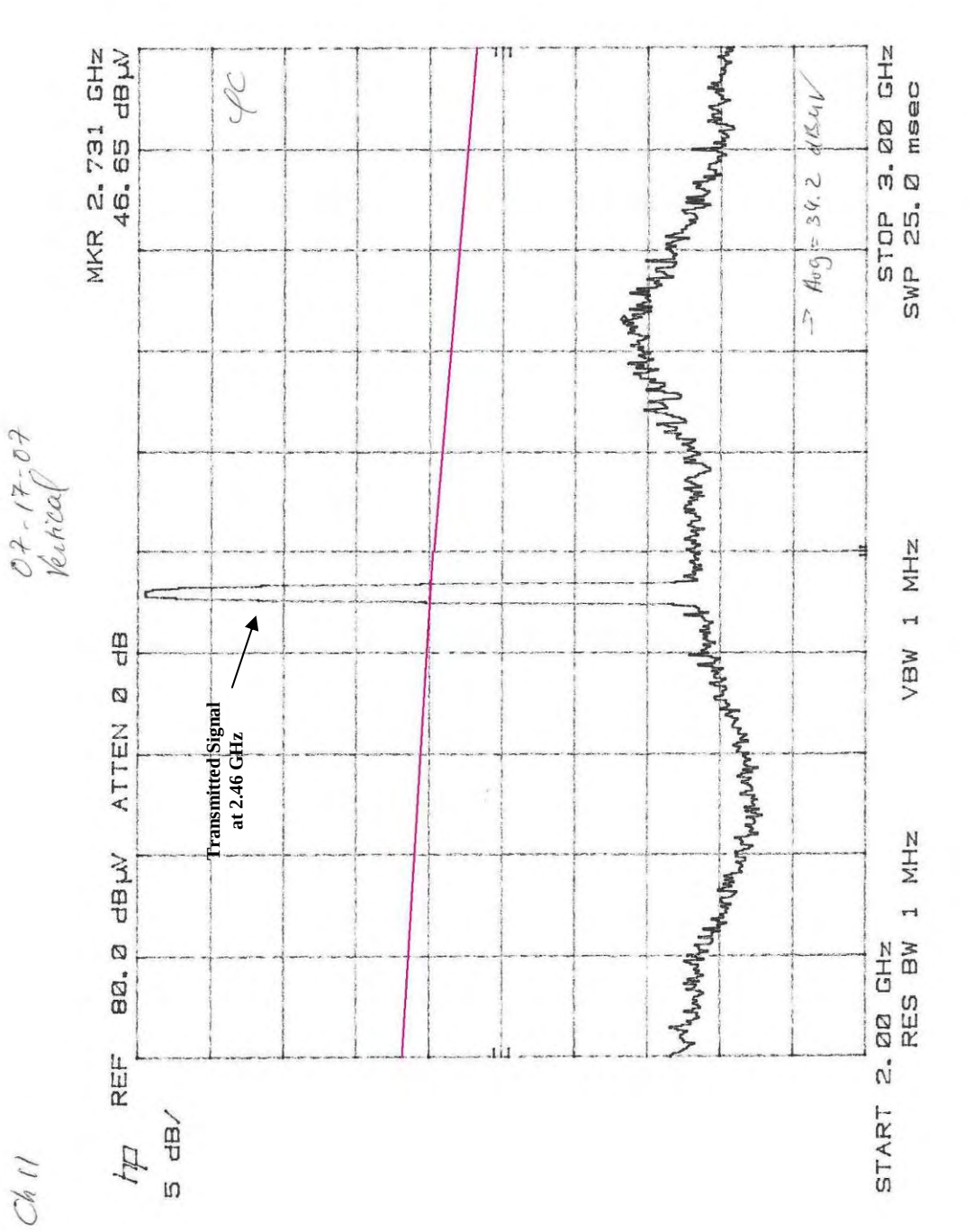


FIGURE 35: Radiated Emission 2 GHz – 3 GHz Vertical Polarization

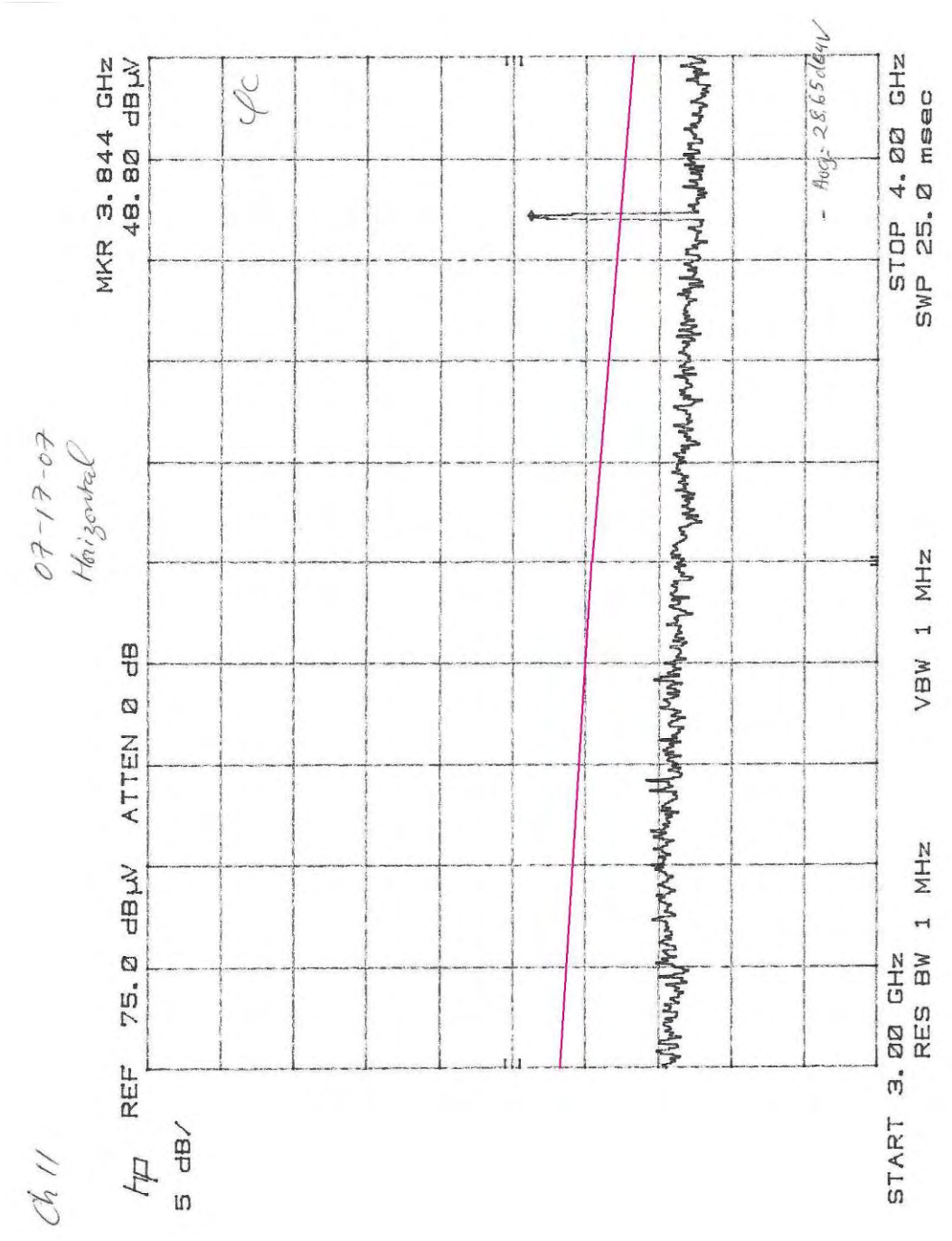


FIGURE 36: Radiated Emission 3 GHz – 4 GHz Horizontal Polarization

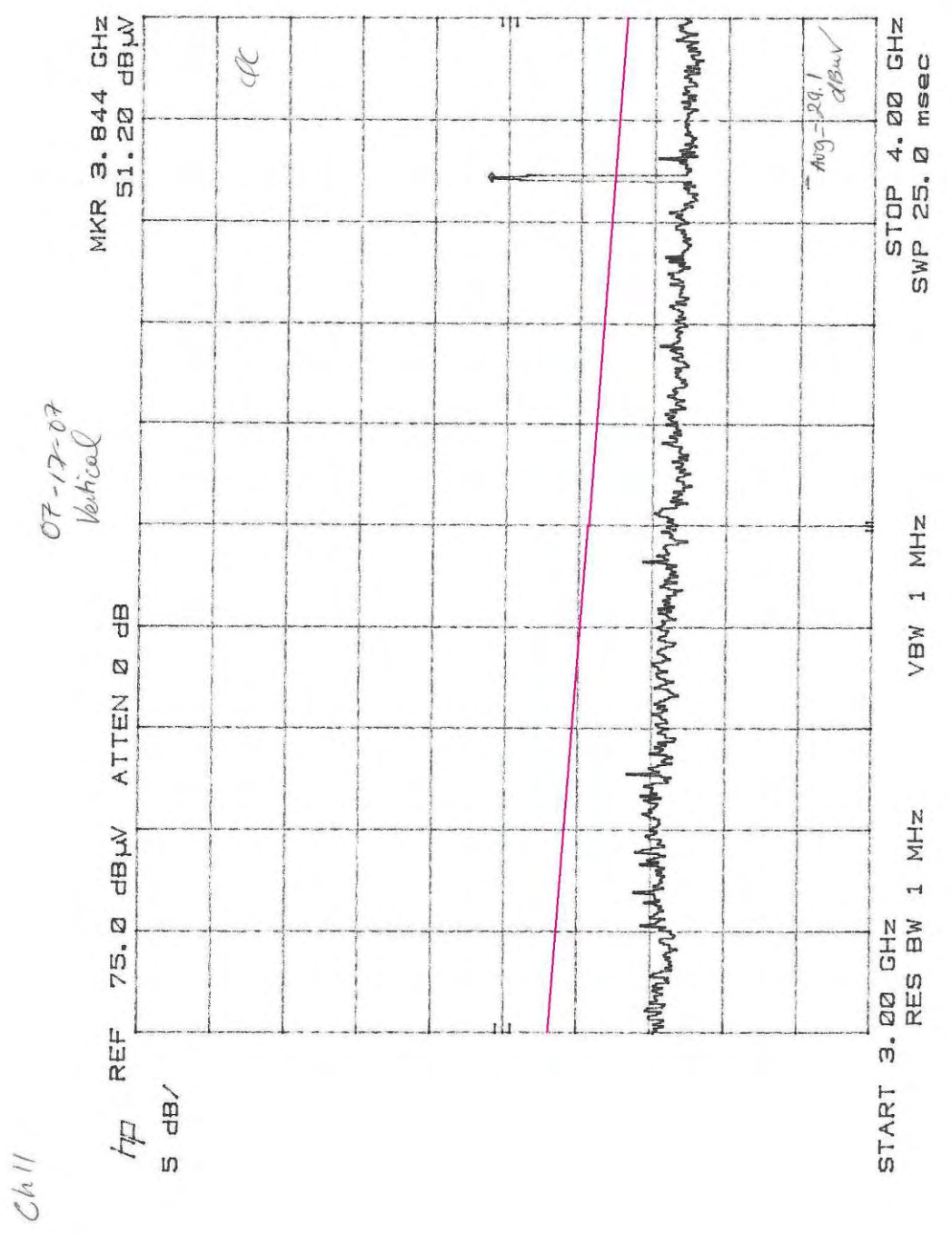


FIGURE 37: Radiated Emission 3 GHz – 4 GHz Vertical Polarization

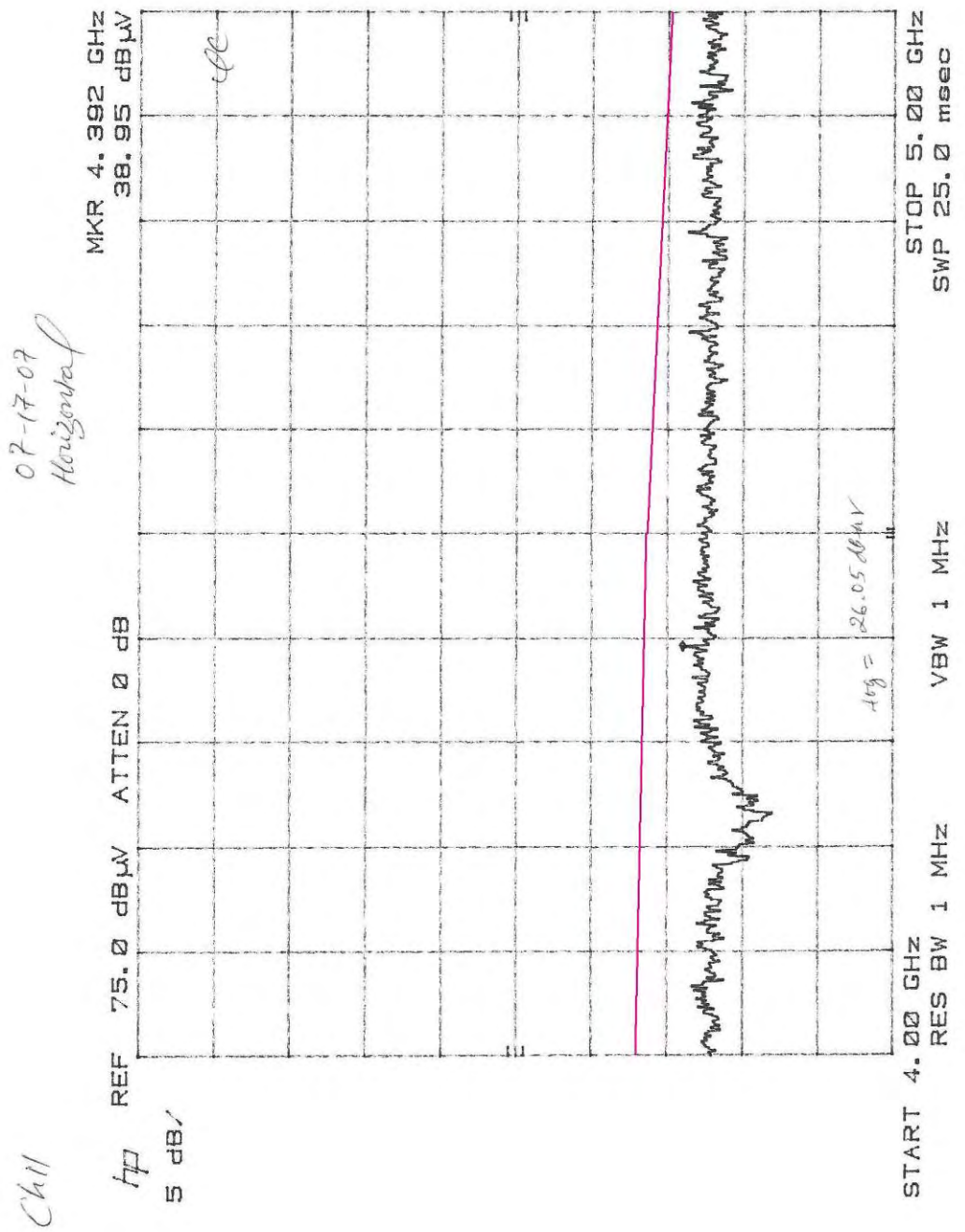


FIGURE 38: Radiated Emission 4 GHz – 5 GHz Horizontal Polarization

Note that Figure 38 reports the data for VBW set to 1 MHz. Video averaging with VBW set to 10 Hz reduces the maximum peak emission to 26.05 dBµV.

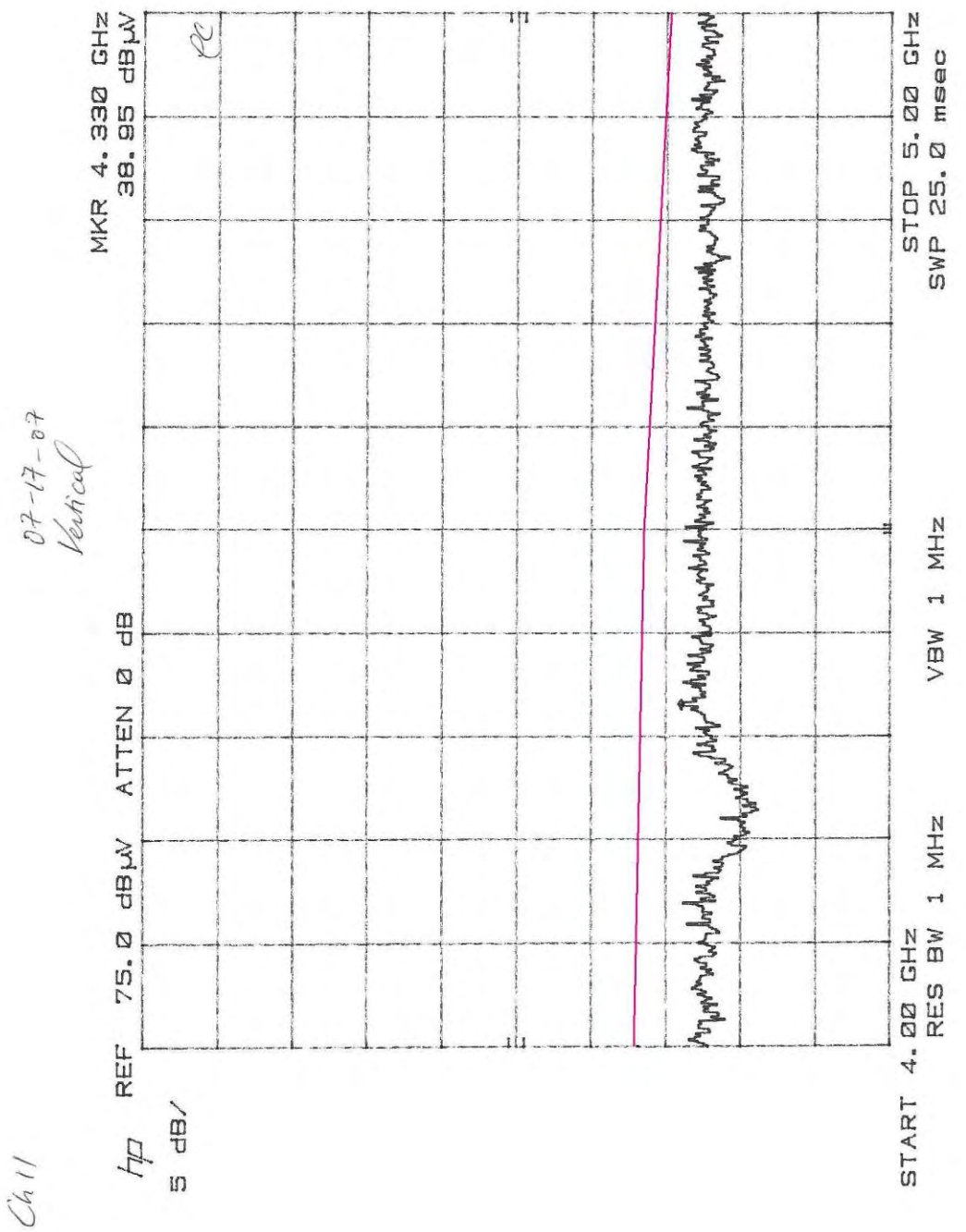


FIGURE 39: Radiated Emission 4 GHz – 5 GHz Vertical Polarization

Note that Figure 39 reports the data for VBW set to 1 MHz. Video averaging with VBW set to 10 Hz reduces the maximum peak emission to 26.1 dBµV.

From Figures 28-39, the unintentional peak emissions that exceeded or were within 5 dB of the limit are reported in Table 4. Note that the average measurements were obtained by reducing the video bandwidth of the HP 8566B spectrum analyzer to 10 Hz and increasing the sweep time to 20 sec.

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)
30	304	51.5			8.84	42.66	46	3.34
30	318.4	52.25			8.53	43.72	46	2.28
30	331.2	52.75			8.11	44.64	46	1.36
30	349.6	52.1			8.53	43.57	46	2.43
30	386.4	50			8.18	41.82	46	4.18
30	959.2	40.15			-1.85	42	46	4
31	960	41.7			-1.86	43.56	46	2.44
32	1909	56.35		25.67	-2.48	28.15	54	25.85
33	1905	56		28.21	-2.48	30.69	54	23.31
34	2731	44.35		31.85	-6.51	38.36	54	15.64
35	2731	46.65		34.2	-6.51	40.71	54	13.29
36	3844	48.8		28.65	-12.13	40.78	54	13.22
37	3844	51.2		29.1	-12.13	41.23	54	12.77
38	4392	38.95		26.05	-13.21	39.26	54	14.74
39	4330	38.95		26.1	-13.18	39.28	54	14.72

Table 4: 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 4 that the unintentional radiated emissions are below limit. Hence the unit is in compliance.

4.3.2 OCCUPIED BANDWIDTH TEST RESULTS

The Open Peak, VZ1 module was programmed to transmit a simultaneously within the 1920 to 1930 MHz and 2400 to 2483.5 MHz bands. For the evaluation, a double rigged horn antenna was used at the receiver and the filters were removed from the input of the microwave amplifier. An HP 8495B variable attenuator was set to 40 dB and connected to the input of the spectrum analyzer. The measurement configuration and procedures were undertaken as per the guidelines presented in the FCC procedures for the measurement of digital transmission systems operating under 15.247.

The receiving antenna set to vertical polarization. The bypass instrument function of the quasi peak adapter was enabled and the resolution bandwidth of the spectrum analyzer was reduced to 100 kHz. Figures 40 to 42 show the occupied bandwidth using 6 dB criteria for the VZ1 WiFi module set respectively to channels 1, 6 and 11, respectively corresponding to the carrier frequencies of 2.414, 2.436 and 2.46 GHz.

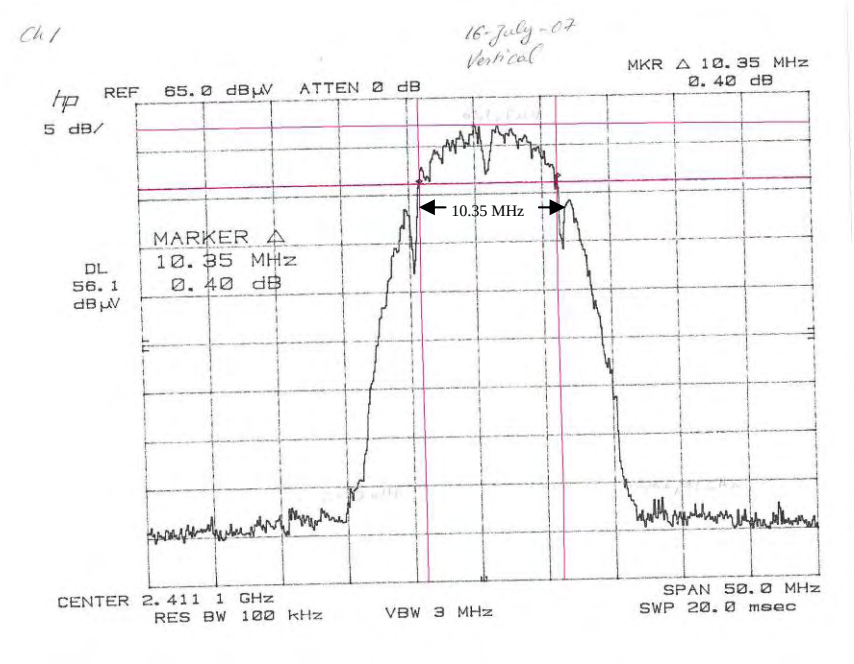


Figure 40: Occupied Bandwidth
WiFi Carrier Set to 2.411 GHz

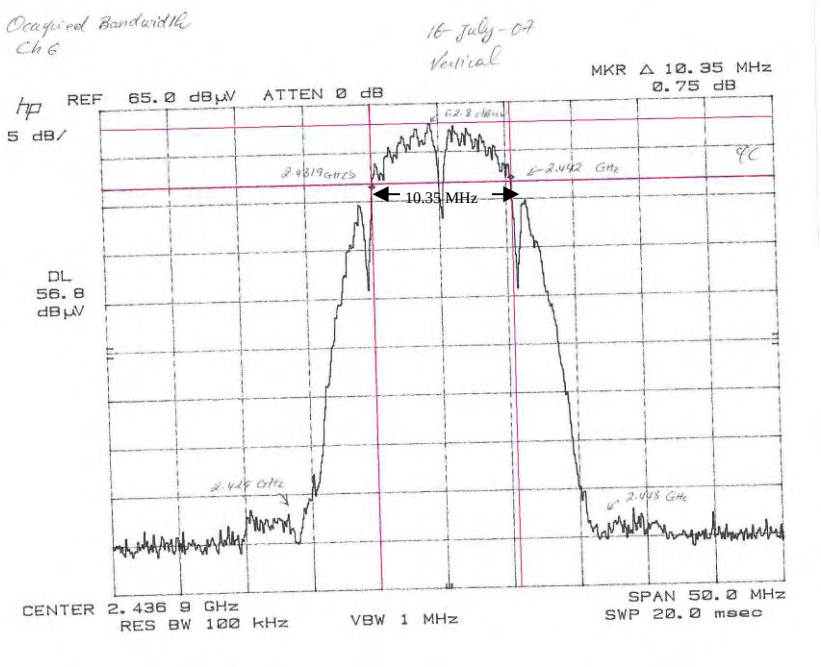


Figure 41: Occupied Bandwidth
WiFi Module Set to 2.436 GHz

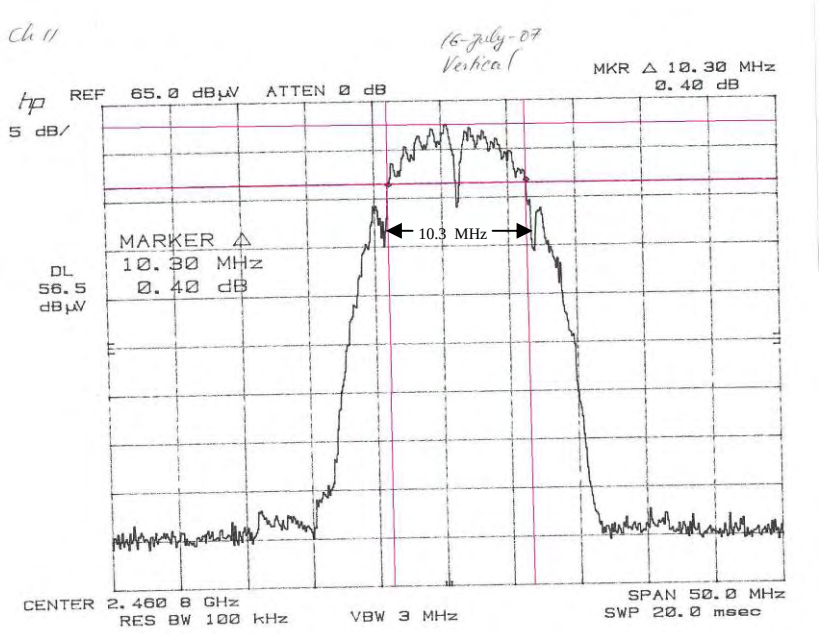


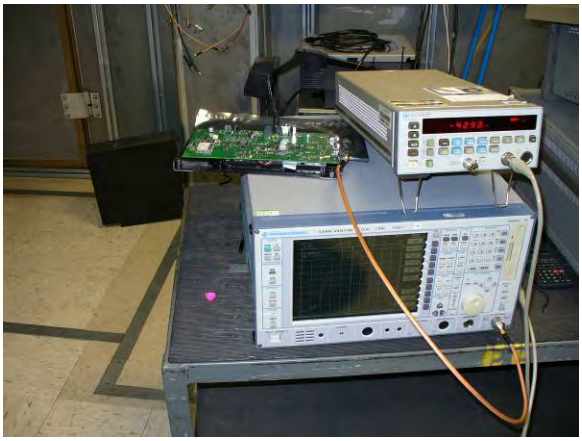
Figure 42: Occupied Bandwidth
WiFi Module Set to 2.46 GHz

Figures 40 to 42 show the module meets the 6 dB bandwidth requirements.

4.3.3 POWER OUTPUT

The conducted output power of the VZ1 WiFi module was measured on a Rohde & Schwarz, FSIQ 7 spectrum analyzer since the measurements require resolution and video bandwidths greater or equal to 10 MHz. The spectrum analyzer was set to the peak detector mode, VBW and RBW of 10 MHz, automatic sweep time and span of 50 MHz.

For the measurements, the –4 dBi patch antenna of the Open Peak VZ1 WiFi module was disconnected and an SMA cable was soldered at the feed point. The other end of the cable was connected to the input of the spectrum analyzer (Photographs 5 & 6).



Photographs 5 & 6: Conducted Power Setup

The measurements were undertaken for Channels 1, 6 and 11, corresponding respectively to frequencies near the bottom, middle and top of the range of 2400 to 2438.5 MHz. Figures 43 to 45 show the conducted output power.

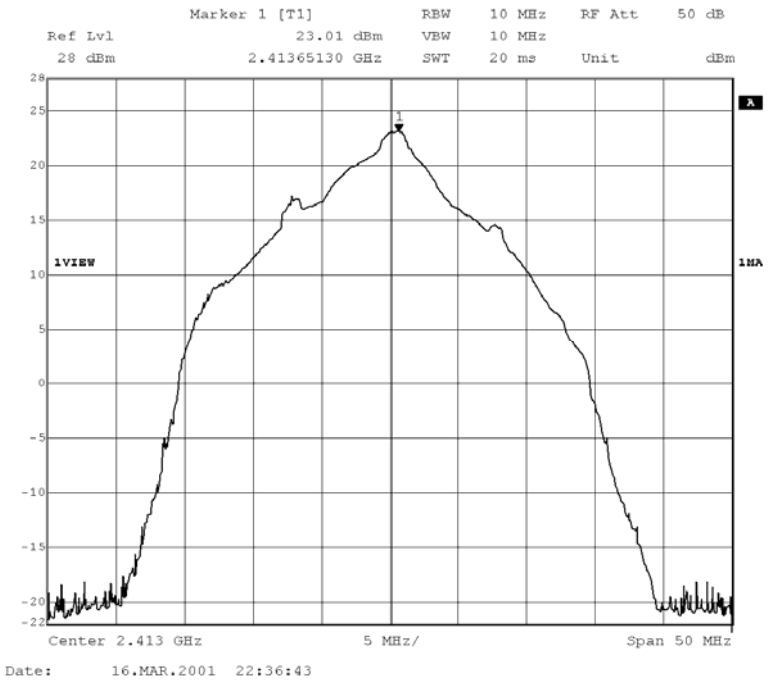


Figure 43: conducted Power
WiFi Module Set to 2.41 GHz

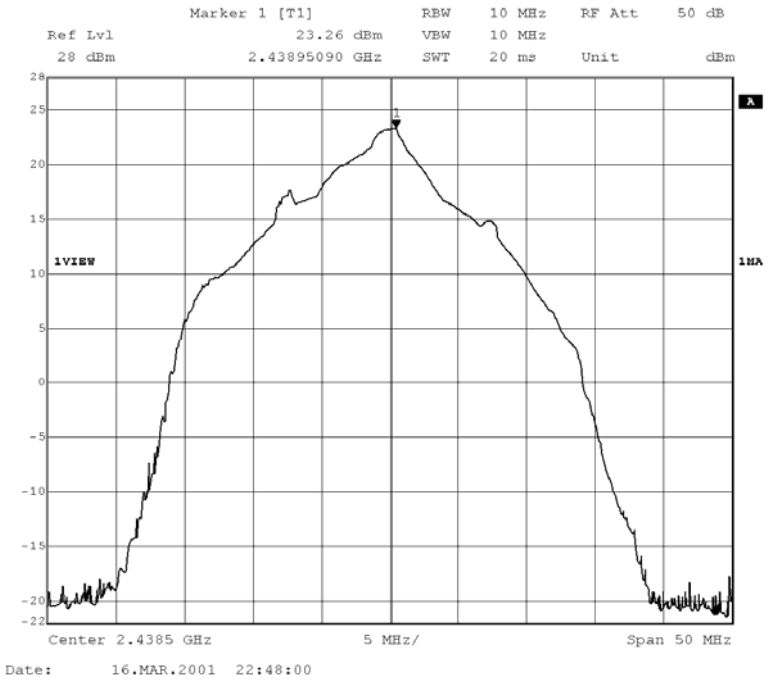


Figure 44: Conducted Power
WiFi Module Set to 2.438 GHz

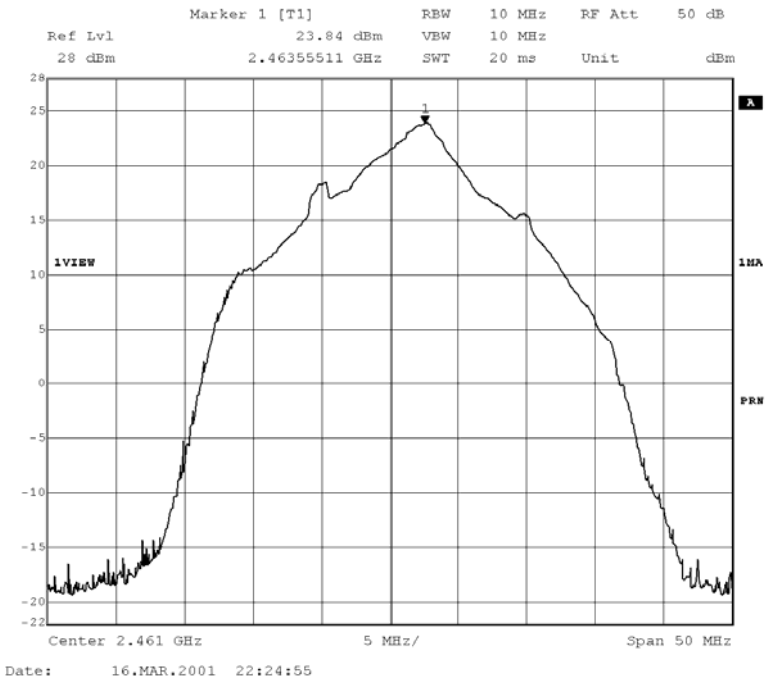


Figure 45: Conducted Power
WiFi Module Set to 2.46 GHz

From Figures 43 to 45, the peak power measurements are reported in Table 5.

Figure No.	Frequency (GHz)	Measured Peak (dBm)	Cable Loss (dB)	Peak Power (dBm)	Peak Power (Watt)
43	2.411	23.01	0.78	23.79	0.24
44	2.436	23.26	0.66	23.92	0.25
45	2.46	23.84	0.64	24.48	0.28

Table 5: Peak Measurement Results

It can be seen from Table 5 that the output power did not exceed the 1 watt limit. Hence the system is in compliance.

4.3.4 BAND EDGE MEASUREMENTS

Compliance of the Open Peak VZ1 WiFi module was investigated at the lower and upper edges of the frequency band of 2400 to 2483.5 MHz. The 40 dB attenuator was removed from the receiving system described in Section 4.3.2 of this document. The resolution bandwidth of the spectrum analyzer was set to 1 MHz. The emissions were maximized using the procedure described in the previous sections. The resolution bandwidth was then reduced to 1 % of the span. Where applicable, the delta-marker method was used to verify the compliance of the system to Section 15.209 of FCC Part 15. Figures 46 and 47 show the worst case of the band edge peak emission measurements using the Delta-Marker Method.

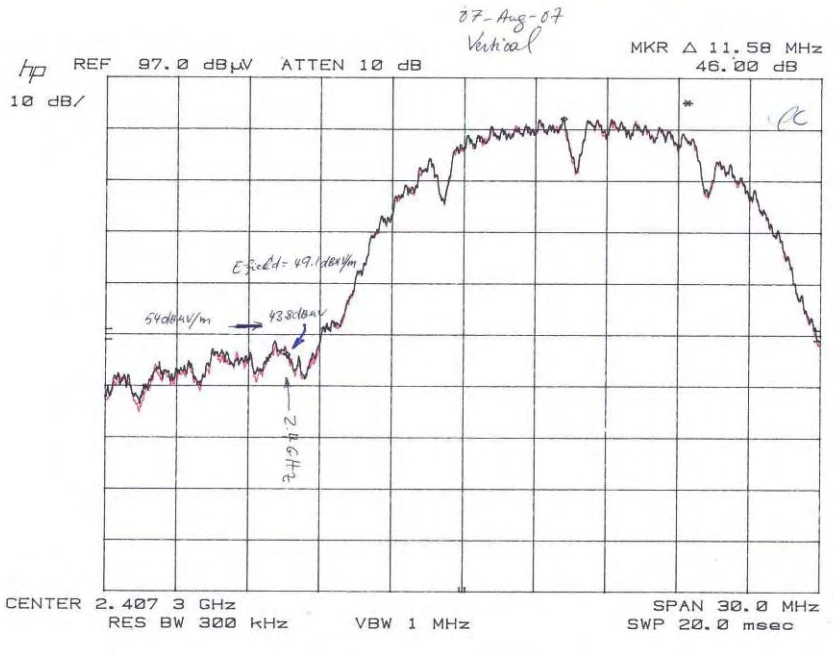


Figure 46: Delta-Marker Measurement
for the VZ1 WiFi Module Set to Channel 1

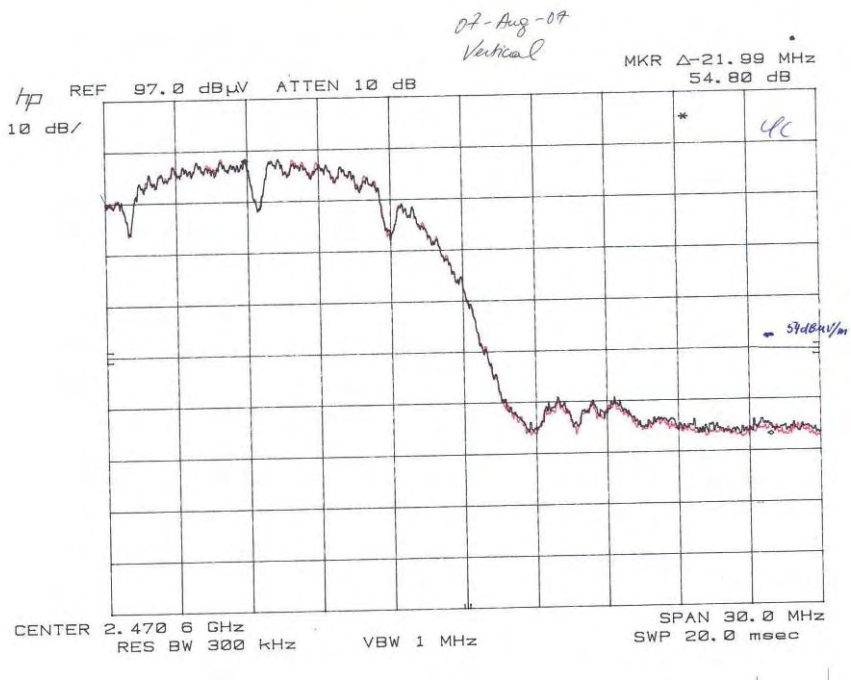


Figure 47: Delta-Marker Measurement
for the VZ1 WiFi Module Set to Channel 1

The field strengths of the emissions at the edges of the band of 2400 to 2483.5 MHz are computed using the delta recorded in the above figures.

Channel No.	Frequency (MHz)	E-field at Fundamental (dBµV/m)	Delta (dB)	*E-field at Edge (dBµV/m)	FCC Limit (dBµV/m)	Margin to Limit (dB)
1	2400	95.02	46	49.02	54	4.98
11	2483.5	95.71	54.8	40.91	54	13.09

Table 6: Band Edge Emission Measurement

*E-field at Edge (dBµV/m) = E-field at Fundamental (dBµV/m) - Delta (dB)

From the previous figures and Table 6, it can be seen that the emissions meet the requirements the FCC limit of Section 15.209. Hence, the unit does not operate outside of the band of 2400 to 2483.5 GHz.

4.3.5 SPURIOUS EMISSION MEASUREMENTS

Spurious emissions up to the 9th harmonic frequencies of the VZ1 WiFi module were measured on the HP 8566B spectrum analyzer (instrument limitation) with the bypass instrument function of the quasi peak adapter enabled. The 10th harmonic frequencies were evaluated with a Rhode & Schwarz (Model No.: FSEM 30, S/N: 835533/014) spectrum analyzer set on the peak detector mode. The double rigged horn antenna (EMCO 3115) was replaced by a Com-Power Corporation horn antenna (Model No.: AH-826) for measurements above 18 GHz. The data was recorded with RBW and VBW set to 1 MHz for peak measurements. The VBW was then reduced to 10 Hz for average measurements. A Trilithic high pass filter (6HC3000/19500-3-KK) was connected to the input of the microwave amplifier (see Filter Table in the Appendix).

To improve the sensibility of the system, the measurement distance was reduced to 1m and the corresponding antenna factors were used in the computation of the conversion factor. Then the readings were extrapolated back to 3m using the distance factor relation of 20*log(1/3). The emissions were maximized by rotating the turn-table, and moving the antenna up and down as previously described. The harmonic frequencies falling within the restricted bands reported in Section 15.205 were evaluated according to the limits listed in Section 15.209. It was also verified that the harmonic frequencies falling outside of the restricted band were at least 20 dB below the fundamental carrier, or met the requirements of section 15.209.

Table 7 reports the worst case of horizontal or vertical polarizations leading to the highest spurious emissions of the VZ1 WiFi module for Channels 1, 6 and 11, up to 10th harmonic.

channel No.	Freq (GHz)	Reading @ 3m dBµV	Transducer dB/m	E-field dBµV/m	Limit dBµV/m	Margin to limit dB
1	4.822	37.81	-3.99	41.80	54	12.20
1	7.233	26.36	-7.33	33.69	54	20.31
1*	9.644	27.56	-10.68	38.24	95.02	56.78
1	12.055	36.46	-11.77	48.23	54	5.77
1	14.466	28.71	-14.43	43.14	54	10.86
1*	16.877	29.66	-15.03	44.68	95.02	50.34
1	19.288	32.86	-5.35	38.21	54	15.79
1	21.699	35.11	-7.72	42.82	54	11.18
1*	24.11	23.06	-9.51	32.57	95.02	62.45
6	4.872	38.96	-4.11	43.07	54	10.93
6	7.308	27.21	-7.42	34.63	54	19.37
6*	9.744	30.11	-10.70	40.81	95.15	54.34
6	12.18	39.66	-11.82	51.48	54	2.52
6*	14.616	29.46	-14.03	43.49	95.15	51.66
6*	17.052	29.66	-15.76	45.42	95.15	49.73
6	19.488	33.21	-5.35	38.56	54	15.44
6	21.924	35.41	-7.72	43.12	54	10.88
6*	24.36	22.25	-9.51	31.76	95.15	63.39
11	4.92	37.96	-4.22	42.18	54	11.82
11	7.38	26.81	-7.51	34.32	54	19.68
11*	9.85	30.21	-10.72	40.93	95.71	54.78
11	12.31	35.26	-11.87	47.13	54	6.87
11*	14.77	29.61	-13.52	43.13	95.71	52.58
11*	17.23	29.91	-17.02	46.93	95.71	48.78
11	19.69	34.41	-5.35	39.76	54	14.24
11	22.16	36.06	-7.72	43.77	54	10.23
11*	24.62	22.93	-9.51	32.44	95.71	63.27

Table 7: Average Measurement Results

Where * noted, the spurious harmonic frequencies fall outside of the restricted bands. It should also be noted that, with the exception of the second and fifth harmonic frequencies, the spurious emissions are at the noise floor level.

The harmonic frequencies did not exceed the limit. Hence, the system is compliant.

4.3.6 POWER SPECTRAL DENSITY

The power spectral density of the Open Peak, VZ1, WiFi Module was measured on the HP 8566B Spectrum analyzer at channels 1, 6 and 11, respectively corresponding to the carrier frequencies of 2.414, 2.436 and 2.46 GHz. An HP 8495B variable attenuator was set to 40 dB and connected to the input of the spectrum analyzer while the filters were removed from the input of the microwave amplifier.

For the measurements, the carrier frequency was maximized by rotating the turn table and moving the antenna up and down as described previously. When the maximum peak emission was located, the resolution bandwidth of the spectrum analyzer was reduced to 3 kHz and the span to 300 KHz. The sweep time was set to 100 seconds. The power spectral density was measured for both horizontal and vertical polarizations of the double ridged horn antenna. The results are presented in figures 48 to 53.

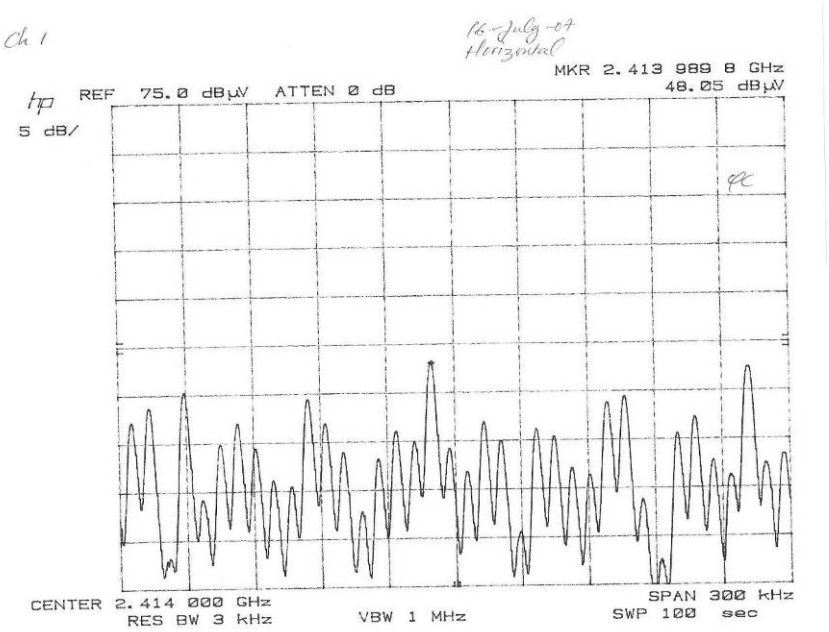


Figure 48: Power Spectral Density (Horizontal Polarization)
WiFi Module Set to 2.411 GHz

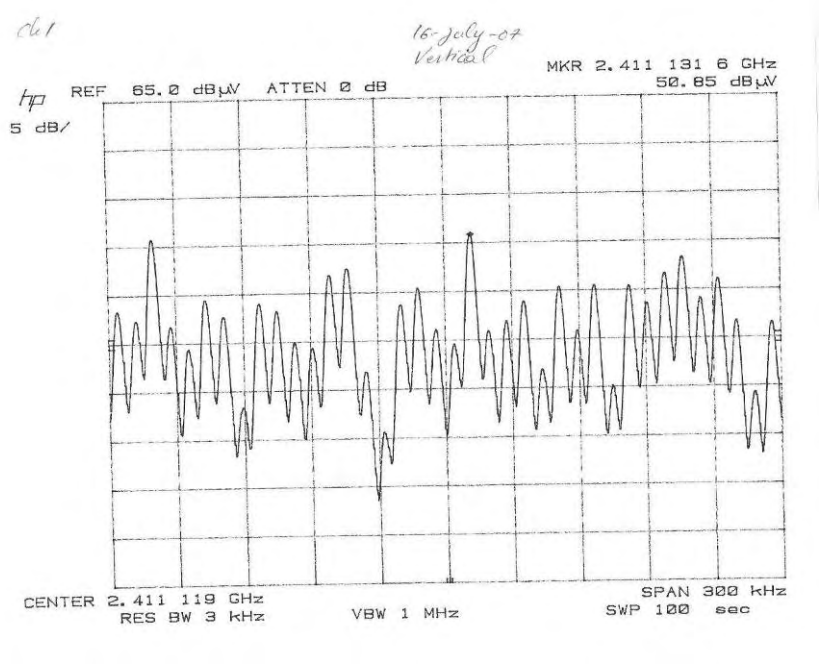


Figure 49: Power Spectral Density (Vertical Polarization)
WiFi Module Set to 2.411 GHz

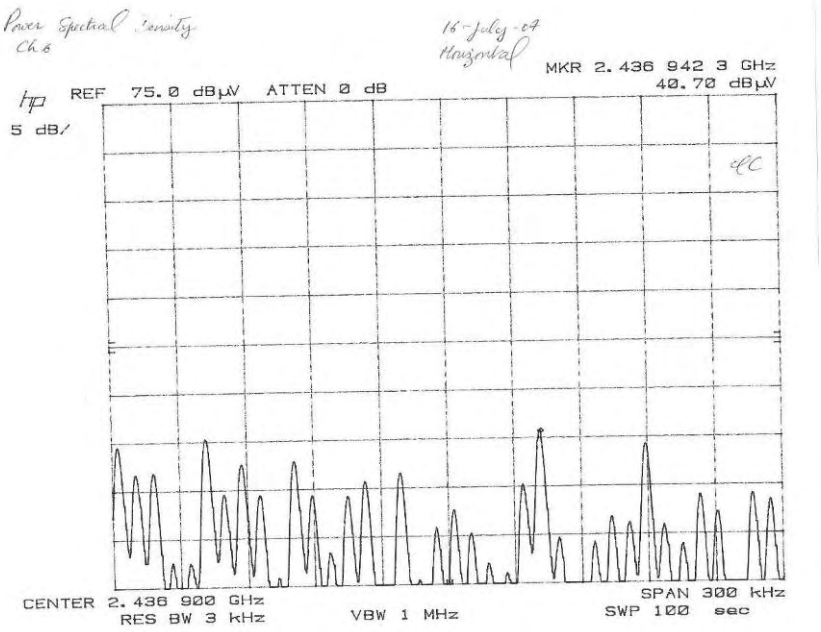


Figure 50: Power Spectral Density (Horizontal Polarization)
WiFi Module Set to 2.436 GHz

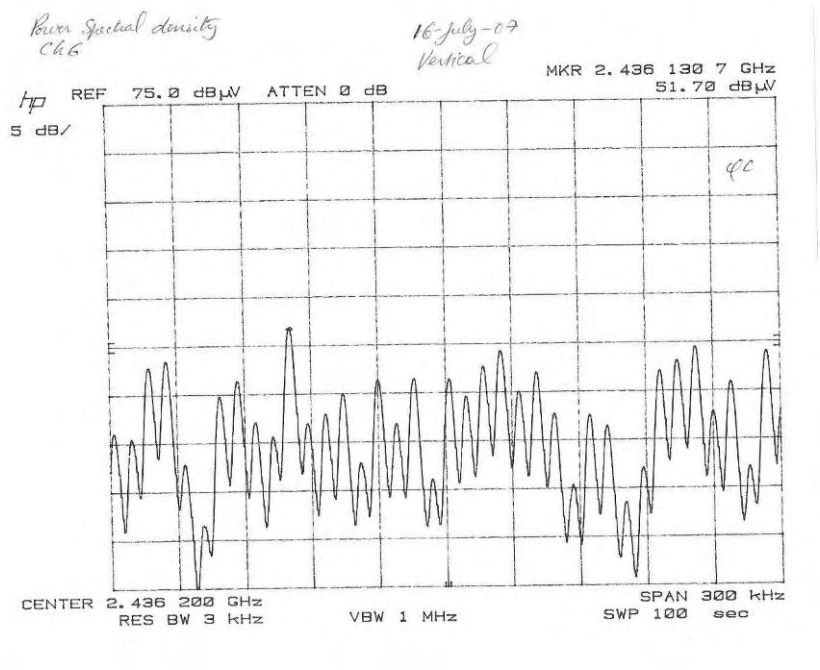


Figure 51: Power Spectral Density (Vertical Polarization)
WiFi Module Set to 2.436 GHz

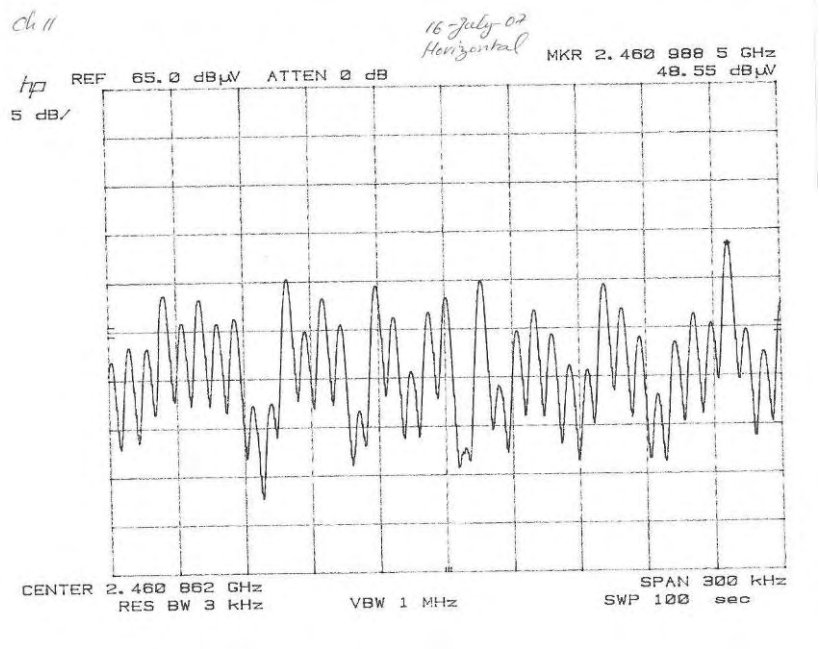


Figure 52: Power Spectral Density (Horizontal Polarization)
WiFi Module Set to 2.46 GHz

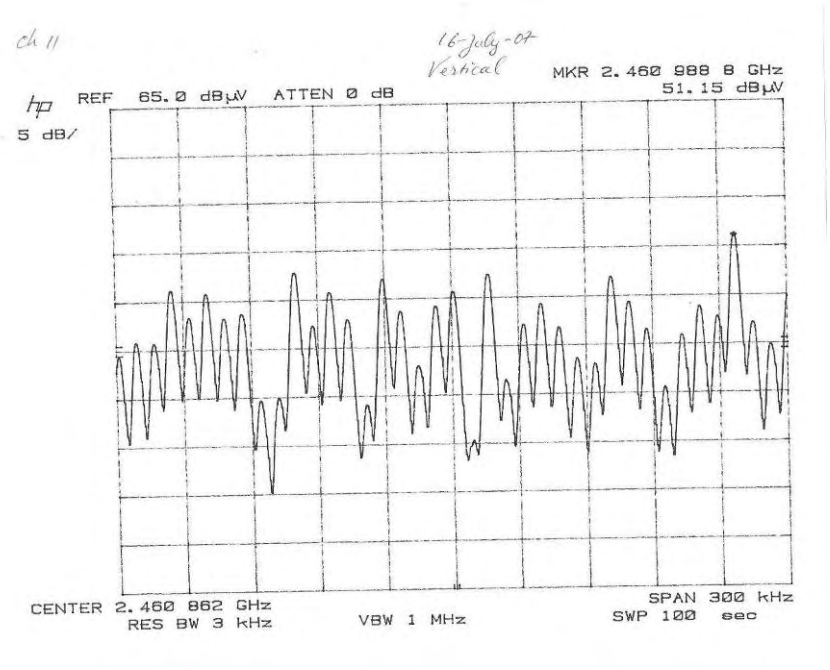


Figure 53: Power Spectral Density (Vertical Polarization)
WiFi Module Set to 2.46 GHz

Table 8 shows the peak power spectral density measurements for both horizontal and vertical polarizations of the receiving antenna.

Figure No.	Frequency (GHz)	Measured Peak (dBµV)	Correction Factor (dB/m)	Peak Field* (dBµV/m)	Peak Field* (V/m)	Antenna Gain (dBi)	Numerical Antenna Gain	Distance (m)	Peak Power (Watt)	Peak Power (dBm)
48	2.414	48.05	-43.94	91.99	0.04	-4	0.40	3	0.001	0.76
49	2.414	50.85	-43.94	94.79	0.05	-4	0.40	3	0.002	3.56
50	2.436	40.7	-44.03	84.73	0.02	-4	0.40	3	0.000	-6.50
51	2.436	51.7	-44.03	95.73	0.06	-4	0.40	3	0.003	4.50
52	2.46	48.55	-44.13	92.68	0.04	-4	0.40	3	0.001	1.45
53	2.46	51.15	-44.13	95.28	0.06	-4	0.40	3	0.003	4.05

Table 8: Peak Measurement Results

The level of the power spectral density is computed using the relation provided in the FCC procedures for measurement of digital equipment systems operating under 15.247:

$$P = \frac{(E \times d)^2}{30 \times G} \quad (1)$$

Where P is the power in watts, E is the measured field strength in V/m, d is the distance in meter from which the field is measured, and G is the numeric gain of the transmitting antenna over an isotropic radiator

It can be seen from Table 8 the power spectral density at the three different channels did not exceed the 8 dBm limit. Hence the unit is in compliance.

Appendix

Filters' Insertion Loss from 1 GHz to 3 GHz

Figures A.1 and A.2 show the insertion loss of the Trilithic 2.4 GHz notch filter (8CN2440/150-3-KK), connected in series with the Lorch Microwave 1.9 GHz notch filter (3NF-1000/2000-N) from 1 GHz to 3 GHz.

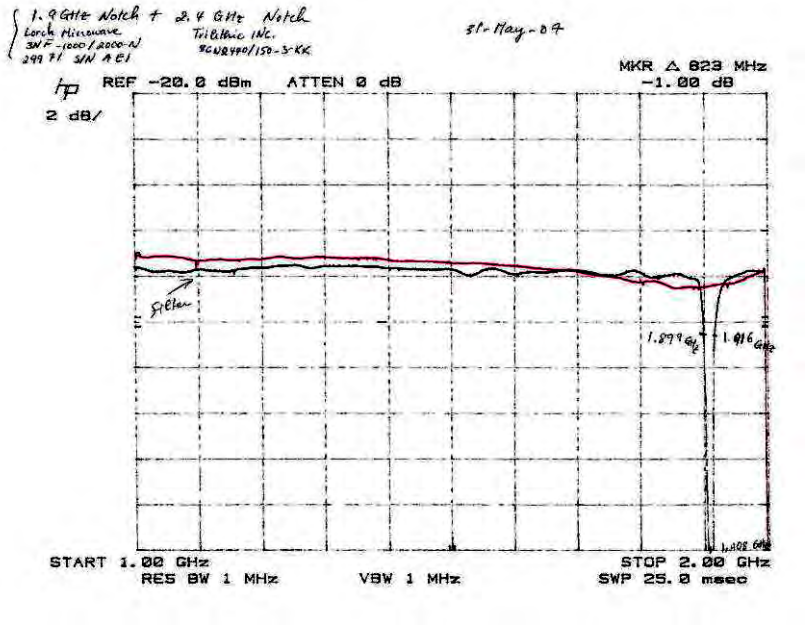


Figure A.1: Filters Insertion Loss from 1 GHz to 2 GHz

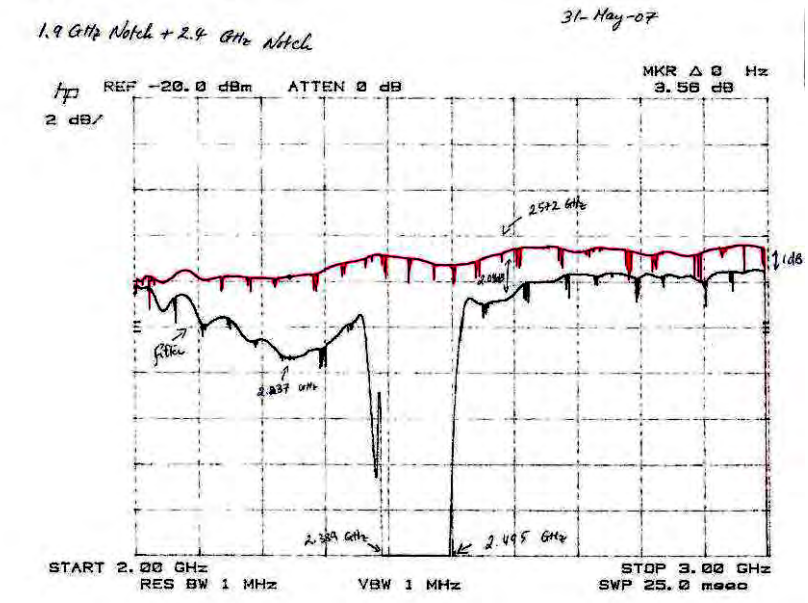


Figure A.2: Filters Insertion Loss from 2 GHz to 3 GHz

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
Spectrum Analyzer	Rohde & Schwarz	Spectrum Analyzer	FSIQ 7	DE 35471	Apr-27-07	1
Spectrum Analyzer	Rohde & Schwarz	Spectrum Analyzer	FSEM 30	835533/014	May-01-07	1

FILTER TABLE			
Model	**Manufacturer**	**Description**	**Application**
3NF-1000/2000-N	Lorch Microwave	Variable Notch	1 - 2 GHz
8CN2440/150-3-KK	Trilithic	Notch	2.4 GHz
6HC3000/19500-3-KK	Trilithic	High Pass	2.75 GHz

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