Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In The Matter Of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems	)	ET Docket No. 98-153

COMMENTS OF QUALCOMM INCORPORATED ON REPORT OF THE STAFF OF THE OFFICE OF ENGINEERING AND TECHNOLOGY

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Summary

QUALCOMM submits these comments in response to the October 22, 2002 report issued by the Staff of the FCC's Office of Engineering and Technology ("OET")[1]. QUALCOMM would like to express concerns regarding the manner in which the emission measurements were conducted. QUALCOMM also conducted its own ambient noise measurements, and the results of QUALCOMM's tests differ markedly from the results of the tests conducted by the OET Staff. The next few sections of these comments will list in detail these concerns and then we present the results of the ambient noise study conducted by QUALCOMM.

1. Discrepancies in OET Staff Measurements

1.1 Issue 1: Path Gain Calibration Inconsistent With Block Diagram

In their report, the OET Staff calibrated the measurement setup and obtained certain numbers as shown in Table 4-2 and Table 4-3 of that report[2]. These numbers do not correspond to the gain obtained by using the typical component gains shown in the block diagram of the report. The block diagram and the System A calibration table is provided in here to explain this discrepancy. For example, consider the calculation at 1575.4 MHz. Using the typical numbers provided in the block diagram, the external gain K is:

$$K = -1dB + 45dB - 10dB + 25dB = 59\ dB.$$

The equivalent measured value shown in the Table 4-2 in the report is 64.8 dB, which is a deviation of 5.8 dB from the typical value. Also, there are probably some interconnect cables between the antenna and the bandpass filter (BPF) and LNA2 and the spectrum analyzer. The attenuation from these cables would further reduce the measured gain. QUALCOMM has no knowledge of the type of cables used by the FCC but assuming a cumulative cable loss of 0.8 dB would yield a typical path gain of 58.2 dB. This value is 6.6 dB lower than what the FCC measured.

QUALCOMM would like to know what type of cables were used and their attenuation factors and also, we would like to better understand the variation between the theoretically calculated gain and that obtained by measurements. The report itself does not provide any explanation for this significant discrepancy.

[1] FCC OET Staff Report, DA 02-2786 released October 22, 2002
[2] FCC OET Staff Report, DA 02-2786 released October 22, 2002, page 13.

Table 1-1: Measurement System External Gain (System A)

Center Frequency (MHz)	Measurement System External Gain (dB)
1575.4	64.8
1227.6	66.7
1176.0	66.4
985.0	68.0
1035.0	67.7
1085.0	67.3
1135.0	67.0

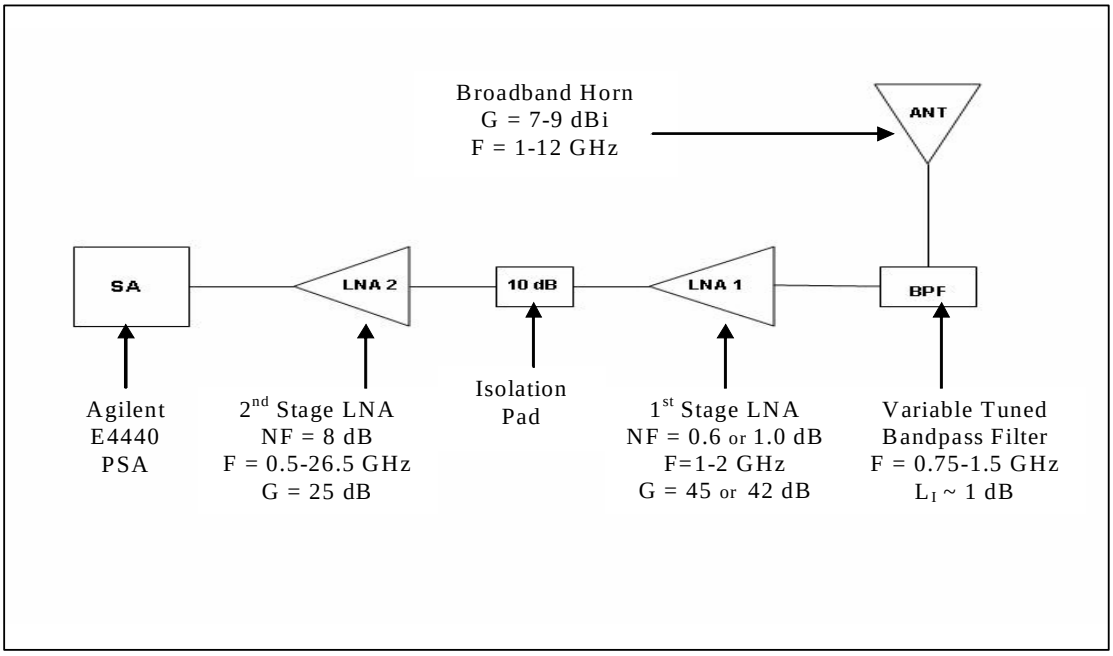


Figure 1-1: Measurement system block diagram

1.2 Issue 2: Bandpass Filter Out of Measurement Range

In the block diagram of the FCC OET Staff setup, the bandpass filter is shown to operate only up to 1500 MHz, whereas, the measurements were performed in the GPS L1 band (1565 MHz-1585 MHz). At these frequencies, one would expect the insertion loss of the filter to be higher than the typical 1 dB value reported on the block diagram. As explained in Issue 1 above, this should further reduce the overall system gain rather than increase it as measured by the FCC OET Staff. Once again, the report does not provide any explanation for this significant discrepancy.

1.3 Issue 3: Measurement System Noise Floor Not Shown

In the FCC OET Staff Report, there was no mention of the measurement system noise floor. Knowing the noise floor of a test setup is paramount in any measurement campaign since it tells us the sensitivity of the measuring equipment and how much margin we have from the true emissions that we are trying to measure. The report merely indicates the GPS pass limit of -117.5 dBm on all the plots, but makes no mention of the noise floor. QUALCOMM tried to calculate the noise floor using 2 methods (1) theoretically using typical values on the block diagram and (2) inferring the noise floor in the GPS L1 band using the calibration plot shown in Figure A-1 of Appendix A in the OET Staff Report and shown here for reference.

Theoretical Noise Floor

Noise Floor in 1 MHz = Thermal Noise density + Noise Figure - Antenna Gain + bandwidth
= -174 dBm / Hz + 1.6 dB -8.6 dB + 60
= -121 dBm / MHz

This calculation is a best case and could easily be higher depending on the characteristics of the two cables between the antenna and the bandpass filter and LNA2 and the spectrum analyzer.

Noise Floor from Calibration Plot

From the calibration plot shown in Figure 1-2, which is a reproduction of Figure A-1 of Appendix A of the Report, at frequency 1475.4 MHz, the amplitude is approximately -45dBm / MHz. If we assume this is the noise floor of the system, and it remains the same even at the GPS L1 frequency of 1575.42 MHz, we can infer the noise floor by simply correcting for the overall system gain including the antenna.

Noise Floor = -45 dBm / MHz - 64.8 dB - 8.6 dB
= -118.4 dBm / MHz

Again, this is a best case calculation because if we were to use the –43 dBm / MHz value at 1675.4 MHz, it would result in 2 dB higher noise floor.

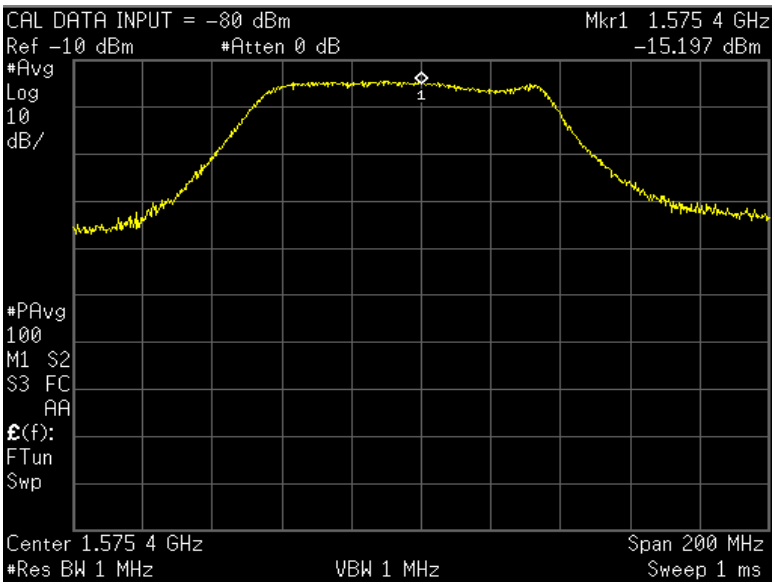


Figure 1-2: OET Staff System A calibration plot for GPS L1 Band

The previous calculations show that there is some ambiguity as to the true noise floor of the FCC OET Staff measurement setup. In addition, several of the FCC measurements show values as low as -122 dBm / MHz[3], which is lower than the theoretically calculated value. These discrepancies are highly significant.

1.4 Issue 4: Questionable Spurious Emissions Plots of Part 15 Devices

QUALCOMM has some concerns about the plots of the radiated spurious emissions obtained from some of the Part 15 devices[4], specifically, the Electric Drill # 1 and Electric Hair Dryer # 1 measurements. For reference, the plots related to the GPS L1 band are shown here in Figures 1-3 and 1-4. The drill and the hairdryer are known to generate broadband impulsive noise. For a single sweep, it is expected that a given frequency component may exhibit large power spikes. However, when averaging 100 sweeps, these spikes should average out to produce smoother curve.

As can be seen from the FCC plots, the maximum value is about 10 dB higher than the other spectral components and does not resemble an average but looks more like a peak trace capture. QUALCOMM has concerns how such a plot was obtained. Could it be that the spectrum analyzer trace was set to 'Max Hold'? The Agilent 4440 analyzer does not annotate the trace settings on the display so there is no way of knowing if the plot obtained is 'Max Hold' or the desired average plot. The annotations of '#Avg' and 'PAvg' on the left side of the grid indicate the analyzer detector is set to RMS Average. The analyzer detector could have been set to RMS Average and the trace display could have been set to 'Max Hold' thus, measuring much higher emissions. In fact, this combination is a valid one, according to Agilent's engineers.

[3] FCC OET Staff Report, DA 02-2786 released October 22, 2002, tables in Section 6
[4] FCC OET Staff Report, DA 02-2786 released October 22, 2002, plots in Appendix E

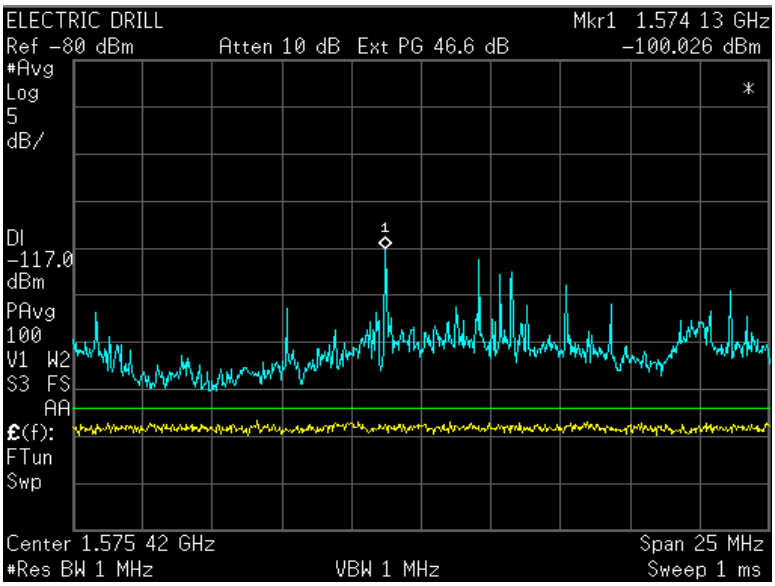


Figure 1-3: FCC OET Staff Data, Electric Drill #1 Radiated Emissions in GPS L1 Frequency Band

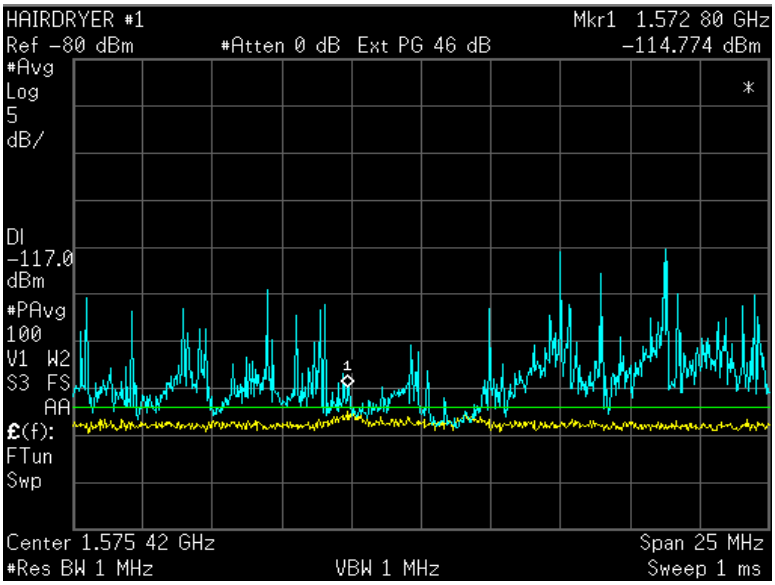


Figure 1-4: FCC OET Staff Data, Electric Hairdryer #1 Radiated Emissions in the GPS L1 Frequency Band

1.5 Issue 5: Spectrum Analyzer Error Indicator On Screen Capture

All the spectrum analyzer plots in the FCC OET Staff report have a '*' annotated on the top right corner of the screen capture. According to the Agilent 4440 manuals, and upon consultation with Agilent engineers, QUALCOMM understands that this is indicative of an error condition and that the trace may not be valid, in light of the error indicator on all of the spectrum analyzer plots. QUALCOMM would like to know what caused this error condition and whether all the data collected is indeed valid.

1.6 Issue 6: Indoor Ambient Noise Plots

In the FCC OET Staff Report, all the indoor test locations showed the ambient noise significantly in excess of the GPS limit of -117.5 dBm. QUALCOMM undertook a similar study to characterize the ambient noise in indoor office locations and found all sites to have emissions less than or equal to -117.5 dBm. The results of this study are provided in the next section. The sites chosen by QUALCOMM were similar to those where wireless devices equipped with GPS would most likely operate to originate E-911 calls, such as an offices, lobbies, break rooms and conference rooms. From its data, QUALCOMM believes that there are indeed many indoor locations that are much 'quieter' than those chosen by the FCC in its study.

1.7 Summary of Discrepancies In Measurements

In these Comments, QUALCOMM has identified a number of significant discrepancies in the FCC OET Staff Report. Unless and until these discrepancies are satisfactorily explained, QUALCOMM believes that the OET Staff Report should not be relied upon.

2. QUALCOMM Ambient Noise Data

QUALCOMM conducted tests similar to those conducted by the FCC OET Staff, to characterize the ambient noise in the GPS L1 band from 1565 to 1585 MHz. Although measurements were made across the entire 20 MHz band, QUALCOMM's primary concern was the emissions present in a 1 MHz resolution bandwidth centered at 1575.42 MHz since that is the frequency used by QUALCOMM's **gpsOne** technology to fulfill the FCC E-911 mandate. The next few sections go over the measurement setup and the test data.

The site survey measurements were performed at various locations within the Qualcomm headquarters in San Diego, California, during business hours. These locations were chosen to represent a typical office environment.

Summary Of Measurement Locations	
Site Location	
5775 Morehouse Dr. (Bldg. L)	
San Diego, CA 92121-1714	
GPS coordinates:	32.8952144
	-117.1953958
Measurement Location	***Comments***
Radiated Ambient Noise Floor	Antenna Range: Lab L513 This is the display line reference on all of the plots
Office-Laptop Computer	Office number L633N
Office-Desktop Computer	Office number L633N
Conference Room- 802.11 access point	Room Number L634B
Conference Room- window	Room Number L634B
Break Room- Vending Machines	6th floor break room near elevators
Break Room-Television & Window	6th floor break room near elevators
Main Lobby	1st floor

2.1 Test Setup and Calibration

A block diagram of the measurement setup is shown in Figure 2-1. There are short interconnect cables between the various components. The system noise floor was measured by pointing the antenna at a quiet location like the anechoic chamber as shown in Figure 2–2. The plot has already been corrected for the total system gain of 49.3 dB. A summary of the link budget at the GPS L1 center frequency is shown below.

Link Budget Summary @ 1575.4 MHz
Measured Path Gain = 35.2 dB
Antenna Gain = 14.1dB
Total System Gain = 49.3 dB
Measured System Noise Floor with Antenna = -122.5 dBm / MHz

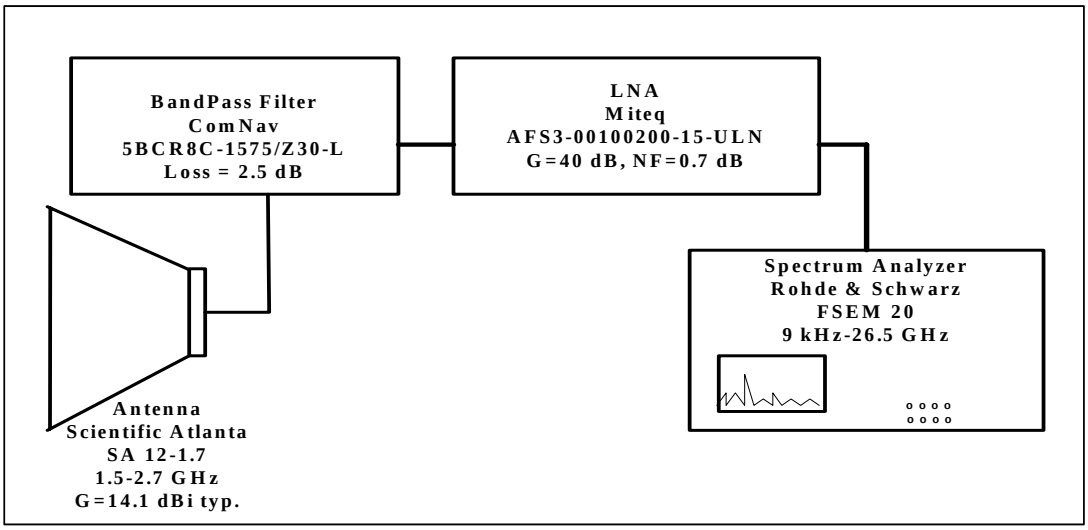


Figure 2-1: QUALCOMM measurement setup block diagram

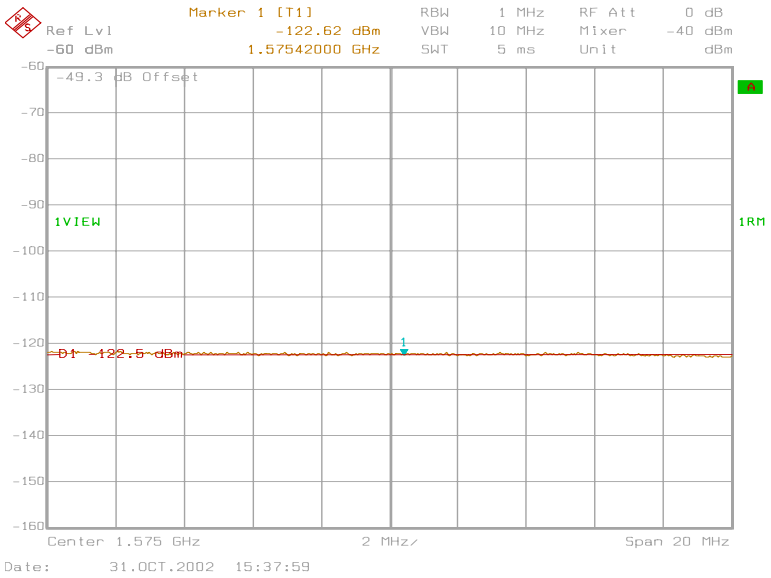


Figure 2-2: Radiated Noise Floor

2.2 Measured Data

This section covers the ambient noise data measured at different locations. In all the plots, there are 3 traces shown. The trace in red is the display line and it indicates the noise floor of the system, which was found to be -122.5 dBm / MHz. The upper trace in blue-green is a Max Hold reading and shows the maximum emissions at the given location. This trace is merely provided for informational purpose. The middle trace in orange is the RMS Average emissions taken over 20 sweeps of 5ms each. This is the trace that is compared to the GPS limit of -117.5 dBm.

Display Definitions
Red = System Noise Floor = -122.5 dBm / MHz
Blue-Green = Max Hold (provided for informational purpose)
Orange = RMS Average (this is used for comparing to GPS limit)

2.2.1 Office-Antenna Pointing Towards Laptop

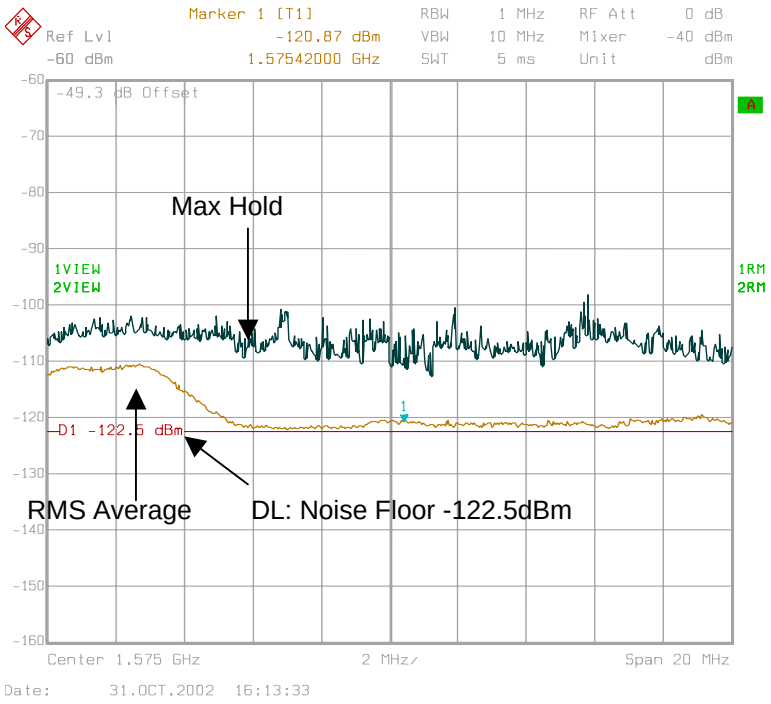
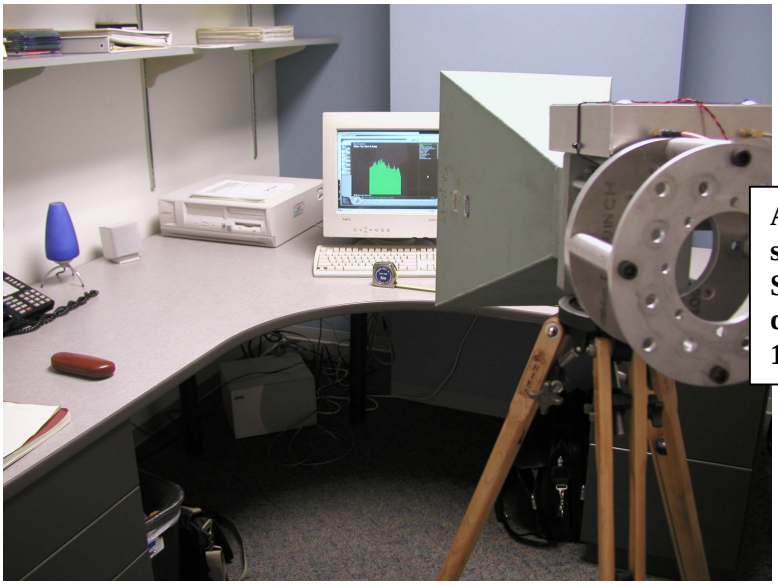


Figure 2-3: Office-Antenna pointing toward laptop

2.2.2 Office Antenna Pointing Towards Desktop Computer



Antenna-source Separation distance: 1m

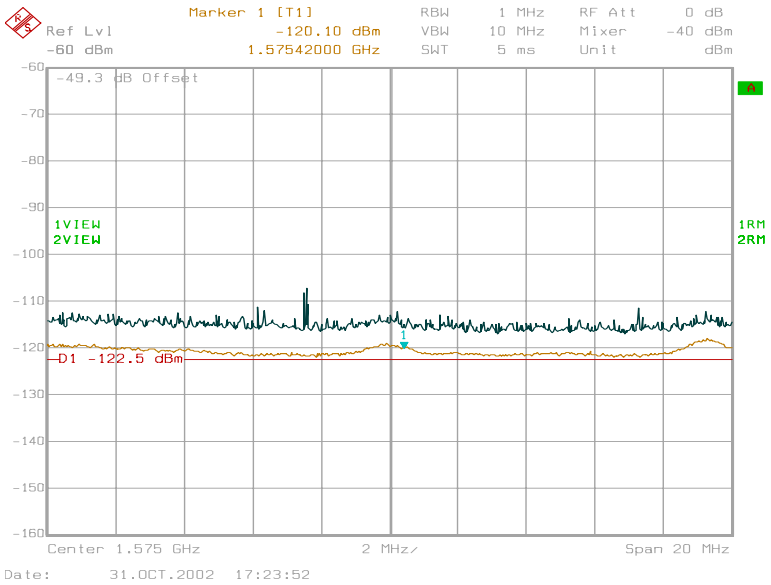


Figure 2-4: Office-Antenna pointing toward desktop computer

2.2.3 Conference Room-Antenna Pointing Towards 802.11b Access Point

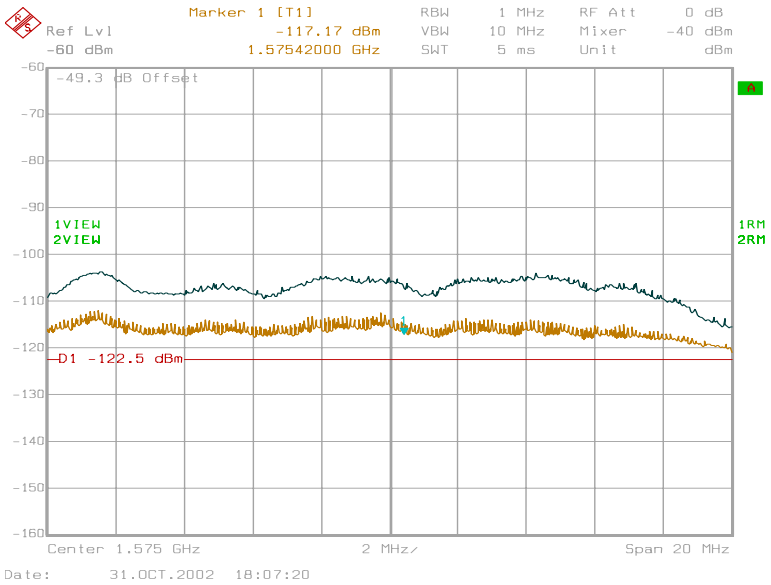


Figure 2-5: Conference Room- Antenna pointing toward 802.11 Access Point

2.2.4 Conference Room-Antenna Pointing Towards Window

Antenna Location: 4m to window

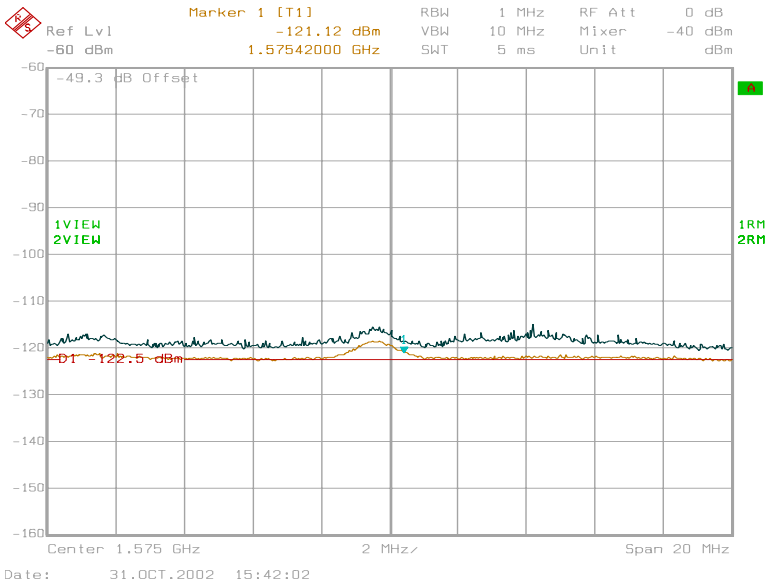


Figure 2-6: Conference Room- Antenna pointing toward window

2.2.5 Break Room- Antenna Pointing Towards Vending Machine

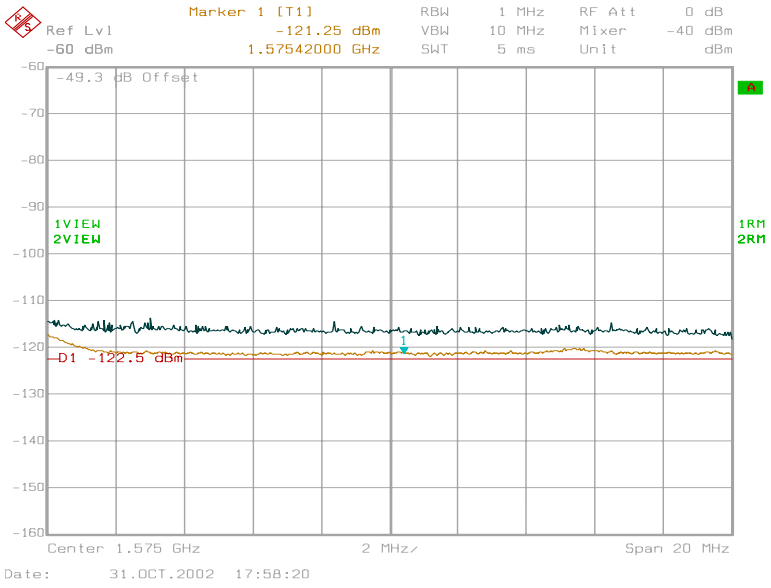


Figure 2-7: Break room- antenna pointing toward vending machine

2.2.6 Break Room- Antenna Pointing Towards Television

Antenna-source Separation distance: 3.3m

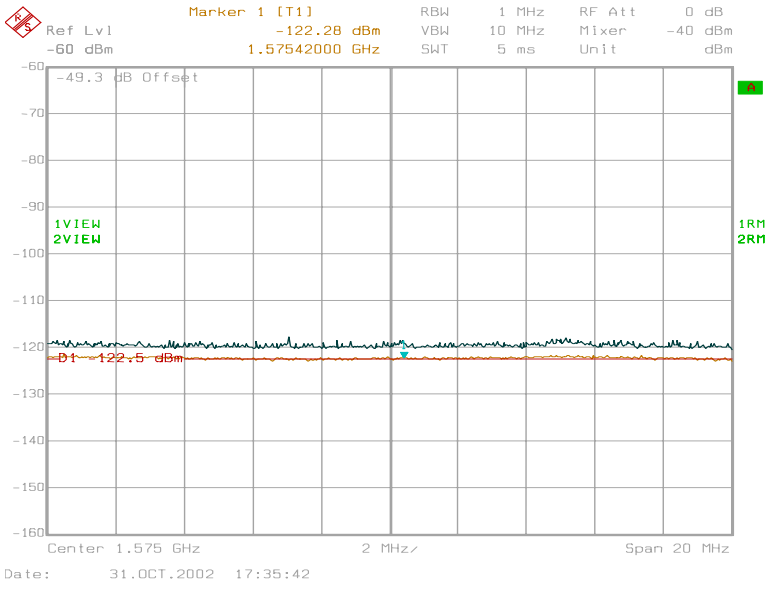


Figure 2-8: Break room- antenna pointing toward television

2.2.7 Lobby- Antenna Pointing Towards Receptionist Station (Halloween)

Antenna-source Separation distance: 1.5-2.5m

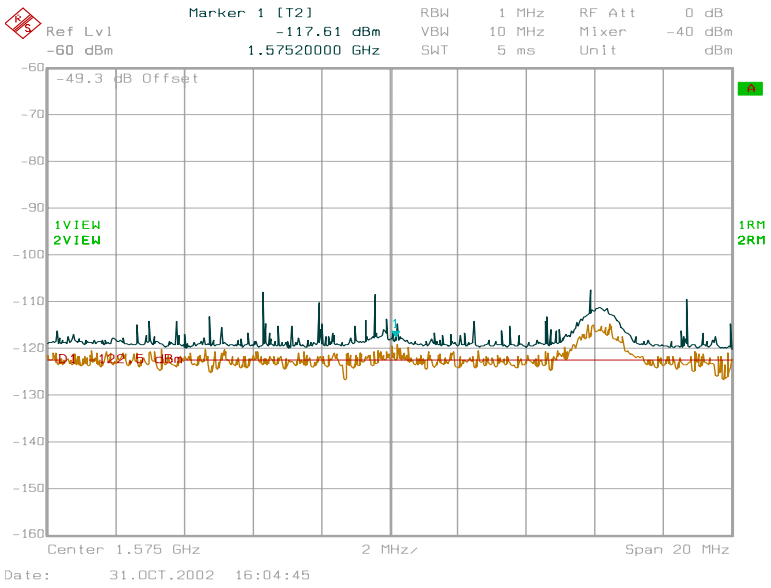


Figure 2-9: Lobby- Antenna pointing toward receptionist station

2.2.8 Measured Data Summary

A summary of the plots obtained in the previous section is shown in Table 2-1. The 3rd column shows the maximum amplitude emission across the entire 20 MHz band using the RMS Average trace (orange trace). The 4th column shows the emission at the GPS L1 center frequency of 1575.42 MHz using the RMS Average trace. The last column shows the difference between the values in the 4th column and the GPS limit of -117.5 dBm. This represents the available margin for E-911 service. Clearly, we can see that in almost all cases the emission at the center frequency is well below the GPS limit. Only in the case with the antenna pointing towards the 802.11b Access Point and at 2 meters distance, does the emission just exceed the limit. These results are contrary to the FCC indoor data, wherein, almost all locations exhibited emissions significantly higher than -117.5 dBm limit.

Table 2-1: Ambient Noise Summary in GPS L1 Band

No.	Location	Max. P_{rx} across band (dBm/MHz)	P_{rx} @ 1575.42 MHz (dBm/MHz)	E-911 Margin from -117.5 dBm (dB)
1	Office towards laptop (one meter distance)	-111	-120.9	3.4
2	Office toward desktop (one meter distance)	-118	-120.1	2.6
3	Conference room towards 802.11b access point (2 meters distance)	-112.5	-117.2	-0.3
4	Conference room towards window (4 meters from window)	-118	-121.1	3.6
5	Break Room towards vending machine (2.5 meters distance)	-117.5	-121.3	3.8
6	Break Room towards TV (3.3 meters distance)	-122.3	-122.3	4.8
7	Lobby towards reception (1.5-2.5 meters distance)	-115	-120	2.5

2.3 Conclusion

QUALCOMM has identified a number of significant discrepancies in the FCC OET Staff Report. Consequently, this report does not represent the rigorous testing required for fact-based rulemaking. QUALCOMM believes that these test measurements are inconclusive and recommends that no changes in the FCC's rules should be adopted based on the data in the OET Staff Report.

Moreover, QUALCOMM has conducted its own testing and the data shows, contrary to the FCC OET Staff Report, that the existing levels of ambient noise in indoor environments are not well above the UWB emission limits. Thus, the existing levels of ambient noise indoors provide no basis for the Commission to modify the UWB emission limits to allow greater UWB emissions. To the contrary, all of QUALCOMM's testing has shown that for reliable, highly accurate E-911 service, the PCS, cellular, and GPS bands need greater protection from UWB emissions than the FCC's current rules provide, especially when taking aggregation into consideration.