ORIGINAL

CRISPIN & BRENNER, P.L.L.C.
1156 15TH STREET, N.W.
SUITE 1105
WASHINGTON, D.C. 20005
(202) 828-0152
(202) 828-0158 (FAX)

EX PARTE OR LATE FILED

WRITER'S DIRECT NO.
(202) 828-0155

January 24, 2002

RECEIVED

JAN 24 2002

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

BY HAND

Ms. Magalie R. Salas
Federal Communications Commission
236 Massachusetts Ave., N.E.
Suite 110
Washington, D.C. 20002

Re: Oral Ex Parte Presentation
ET Docket No. 98-153

Dear Ms. Salas:

This is to report that on January 23, 2002, representatives of QUALCOMM and Cingular Wireless (collectively referred to as the "Wireless Companies") met with Monica Desai, Legal Advisor to Commissioner Martin, to discuss the above-referenced proceeding, and specifically QUALCOMM's recent study demonstrating that QUALCOMM's E911 technology (so-called gpsOne) cannot meet the FCC's E911 mandate in the face of harmful interference from ultra wideband ("UWB") devices. Attending the meeting were Dr. Samir Soliman, Dr. Klein Gilhousen, Kevin Kelley, Jonas Neihardt, and myself on behalf of QUALCOMM, and Jim Bugel on behalf of Cingular Wireless. At the meeting, we gave Ms. Desai the attached documents.

During the meeting, Dr. Soliman, the author of QUALCOMM's study, summarized its results. He explained that because the major UWB proponents had declined to loan or sell QUALCOMM a UWB device for testing purposes, QUALCOMM's recent testing, like QUALCOMM's testing of last year, was conducted with off-the-shelf equipment which was put together to produce a waveform that has similar characteristics as those of UWB devices as described in UWB literature. He also explained that QUALCOMM used a commercial wireless phone containing the gpsOne technology in these tests. Finally, he stressed that the tests were conducted in a very benign indoor environment and with a relatively strong GPS signal to isolate the impact of UWB emissions, to eliminate other variables, and to generate reproducible results.

Dr. Soliman stated that QUALCOMM found that if a single UWB device is within 15 meters of a wireless phone containing QUALCOMM's gpsOne technology and the UWB device is operating at Part 15 Class B levels, the wireless phone cannot meet the FCC's E911

No. of Copies rec'd 0+5
List ABCDE

requirements. He also explained that the wireless phone begins to suffer substantial degradation if the wireless phone is within 75 meters of a UWB device. Dr. Soliman said that even if the UWB device were operating at 12 dB less than Part 15 Class B levels, the gpsOne receiver still would suffer harmful interference such that it could not meet the FCC's mandate.

Dr. Soliman stated that to mitigate the harmful interference to wireless phones from a single UWB device, he believed that UWB emissions should be limited across all bands to 35 dB below current Part 15 levels, which would protect gpsOne and wireless receivers to within six feet from such harmful interference. He also stated that he did not believe that such an emissions mask would provide adequate protection from the aggregate harmful interference caused by multiple UWB devices. Thus, he stated that there would have to be an additional margin to protect against such aggregate effect. QUALCOMM pointed out that no emissions mask has been tested and asked that such testing occur with actual UWB devices provided by the manufacturers before any mask is adopted.

The Wireless Companies also emphasized during the meeting that UWB devices do not operate like existing Part 15 devices, which do not intentionally radiate dense power into the PCS and cellular bands. Dr. Gilhousen explained that UWB devices intentionally emit dense power into the PCS and cellular bands, unlike Part 15 devices. It would be very difficult and costly to mitigate the harmful interference to wireless phones from the UWB devices, and to place such a burden upon wireless carriers would be inconsistent with Part 15 and would be fundamentally unfair to wireless carriers. Thus, the Wireless Companies again asked that, consistent with the positions of the Defense Department, the Department of Transportation, and the National Aeronautics and Space Administration, UWB devices not be authorized to operate below 6 GHz.

Sincerely yours,

Dean R. Brenner
Attorney for QUALCOMM Incorporated

cc: Monica Desai

Executive Summary

QUALCOMM recently conducted a series of laboratory tests to assess the impact of ultra-wideband (UWB) emission on GPS enabled PCS phones. QUALCOMM's tests have shown that close proximity of UWB devices to GPS enabled wireless phones will prevent the location of wireless callers to 911 from being determined in compliance with the Commission's E-911 mandate. The presence of UWB emissions within the GPS spectrum significantly raises the noise floor of the GPS sensor to the extent that it will render the GPS device useless in reporting position information to Public Safety Answering Points (PSAPs), and hence it will not be possible to meet the safety of life system requirements embodied in the Commission's E-911 rules in the face of UWB emissions.

Thus, QUALCOMM urges the Commission not to permit operation of UWB devices within the GPS band until suitable measures have been taken to limit sufficiently the UWB emissions within the band, and empirical testing conclusively proves that there will be no further system degradation once these measures have been implemented.

1. Introduction

In June 1996 the FCC adopted a Report and Order for enhanced 911 wireless service (E-911). The mandate requires that cellular and broadband PCS licensees relay a caller's telephone number to the appropriate PSAP, automatically route 911 calls to the PSAP and provide the location of the originating mobile station. For handset based solutions, the FCC specifies that wireless carriers locate wireless callers to E-911 67% of the time to within 50 meters and 95% of the time to within 150 meters.

QUALCOMM has developed an enhanced GPS technology called gpsOne™ , to support the FCC mandated handset based solution. This solution has been integrated into commercially available CDMA chipsets found in cellular and PCS handsets and other wireless devices. The gpsOne™ solution has several modes of operation. In one mode, the mobile station collects measurements from both the GPS constellation and the terrestrial infrastructure and sends the information to a location server in the network. The location server has GPS navigation information and is able to compute the phone's position and relay it back to the mobile station or to the requesting entity such as PSAP. The gpsOne™ receiver has enhanced sensitivity and is able to acquire GPS signals as low as -150 dBm. As a result, wireless devices enabled with this technology can work indoors and under severe shadowing conditions.

The presence of UWB interference will hinder the operation of the GPS receiver in environments with marginally strong GPS signals. Since UWB devices transmit very narrow pulses, they inherently occupy a vast spectrum including the GPS band. This in turn is likely to cause degradation in the gpsOne™ performance. The goal of QUALCOMM's study was to quantify the performance of the gpsOne™ receiver in the presence of UWB interference in the GPS band. Only a single UWB emitter was considered and a favorable indoor channel scenario was emulated.

Section 3 will go over the performance metrics used in this study. Section 4 will describe the measurement setup and data collection process. Section 5 will discuss the test results and finally, the conclusions will be summarized in Section 6.

2. Performance Metrics

The metrics used to characterize the gpsOne™ functionality are different from those used in traditional GPS receivers. The traditional receivers, upon power-up, utilize carrier/phase tracking to acquire, and stay in lock with the satellites. The two important parameters that are normally tested are (1) Break Lock power (BL) and (2) Re-acquisition time (RQT). The BL is defined as the interference power level that causes the receiver to re-enter the acquisition mode. The RQT is defined as the time it takes a receiver that has been forced from tracking (maybe due to shadowing of satellite signal), to re-enter tracking mode in the presence of interference.

When a position location session is initiated on the gpsOne™ enabled device, the GPS device obtains navigation assistance information from the location server. The initiating GPS device uses this information to search for satellites and reports pseudo range measurements to the location server. The location server in turn computes the device's position and relays it back to the requesting entity. Each GPS measurement is independent of the previous one, *i.e.*, the phone does not track the incoming GPS signal or have any sort of memory to help it re-acquire it if there is shadowing. Thus, we cannot use BL as a performance metric. RQT is also not important since each measurement is independent of the previous one. Essentially, each measurement is like a new (cold) acquisition.

More meaningful metrics for gpsOne™ are (a) Position Error, (b) Satellite Availability (Yield) and (c) Signal-to-noise (C/No) Degradation.

2.1 Position Error

The purpose of this metric is to determine the mobile station's capability to obtain precise location. The FCC mandated limit is: *The error in location shall be < 50 meters for 67% of calls and < 150 meters for 95% of calls.*

2.2 Satellite Availability

This metric measures how many satellites are detected by the mobile station in the presence of interference. Ideally, at least 4 satellites need to be visible to the mobile to obtain a 3-dimensional position fix. If the interference power is sufficiently large, it could degrade the C/No of the satellite signals resulting in fewer than four satellites being visible to the mobile. A reduction in satellite availability directly translates to a reduction in yield (position determination).

2.3 C/No Degradation

This metric is a fundamental metric that helps quantify the RF performance of the GPS receiver. It is identical to the degradation in the GPS receiver noise figure.

3. Laboratory Measurements

QUALCOMM recently conducted a series of laboratory tests to assess the impact of UWB emission on gpsOne™ enabled PCS phones. The focus of this investigation was to try to quantify the impact of UWB interference on gpsOne™ performance. The testing was performed using a live GPS constellation in a controlled conducted environment. Data was simultaneously collected on two phones- a Test phone with UWB injected and a Reference phone without UWB. The two phones were isolated from each other using shielded boxes. Due to the dynamic satellite geometry, the Reference phone was needed to compare the Test phone data with. This section goes over the measurement equipment, the test setup and preliminary lab measurements.

3.1 Test Equipment

This section goes over the equipment used during the testing. All instruments used were commercial off-the-shelf test equipment.

Table 1: Test Equipment

Equipment	*Manufacturer*	*Model*	*Purpose*
Arbitrary Waveform Generator	Tektronix	AWG2021	Trigger waveform for UWB
Spectrum Analyzer	Advantest	R3465	UWB power measurements
Power Meter/Sensor	Gigatronix	8541C(meter) 80601A(sensor)	Test setup path loss calibration
Signal Generator	Agilent	ESG-D3000A	Test setup path loss calibration
UWB Device	HyperLabs Inc	HL9200	Interference source

3.1.1 Base Station/Mobile Station

The base station signal was generated by a commercial Base Station compliant with the IS-95A Air Interface Standard. The base station was configured as a single sector. The phones used in the testing were commercial equivalent PCS phones enabled with the gpsOne™ technology. The phones were complaint with the IS-95A CDMA Air Interface Standard. The phones were programmed/tuned to receive and transmit on PCS channels 500 and the base station was also configured to transmit on PCS channel 500 for all tests. A position location session was initiated from the mobile using standardized service negotiation call (Service Option 36).

3.1.2 UWB Pulse Generator Module

QUALCOMM contacted several UWB companies in order to buy or borrow an UWB pulse generator module. All the companies contacted declined the request due to lack of resources. QUALCOMM subsequently decided to buy the HL9200 pulse generator module from HyperLabs Inc. The HL9200 has the following listed features:

Rise time: 35 pico seconds
Fall time: 50 pico seconds
Duration: 70 pico seconds
Output Amplitude: 2 V minimum
Trigger rate: DC to 20 MHz
Trigger input: 0 to +5, Schmitt Trigger at +2V

The time-domain structure of UWB signals are such that emission bandwidths are very large and could overlap many licensed wireless bands. The output of the pulse generator captured by a sampling oscilloscope is shown Figure 3-1.

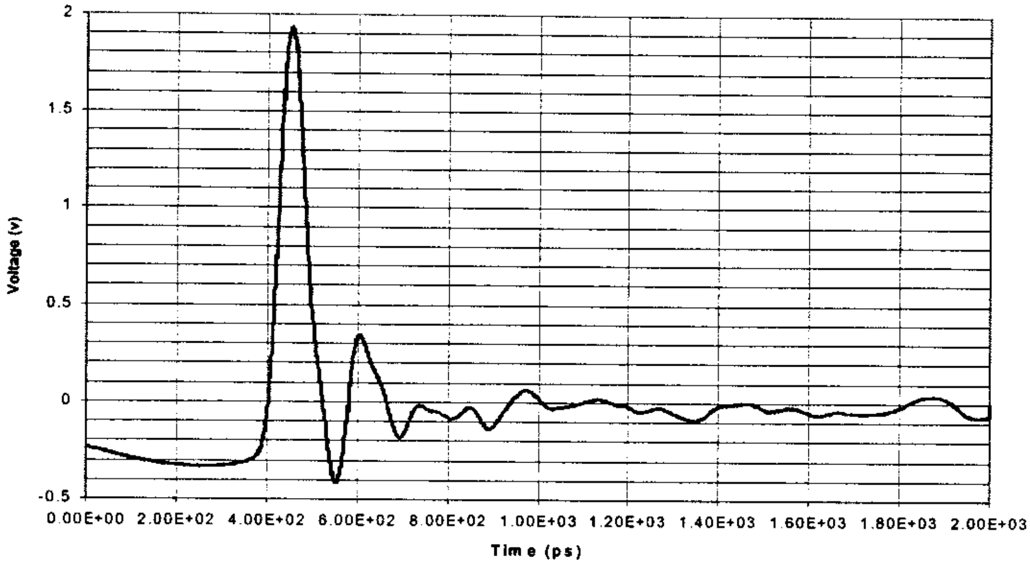

Figure 3-1: UWB Pulse Shape

3.2 Test Setup

The test setup consisted of a live GPS satellite feed injected into a test phone and a reference phone via an RF Matrix as shown in Figure 3-2. Since the satellite geometry was dynamic, the second phone was needed to act as a reference. Both phones were connected to the serial port of 2 separate PCs. The GPS messages were logged on the PCs using a Qualcomm developed tool QXDM (Qualcomm Extensible Diagnostic Monitor). Both PCs had automation software running on them to facilitate remote control of test equipment and synchronized data logging. The test phone data was compared to the reference phone data to quantify the performance in the presence of UWB interference. The tests were performed in a conducted environment with the phones placed in isolation boxes to prevent any unintentional interference from skewing the test results.

Each RF path was calibrated using a CW tone injected at one end of the path and the power measured at the other end using a power sensor. The calibration reference was defined at the output of the GPS feed, the output of the UWB module and the input to the phone antenna ports. This reference is labeled "CAL REF" in Figure 3-2. The measured calibration factors for paths used in the testing are summarized in Table 3. The programmable attenuator was set to 0 dB during the calibration. The entire lab setup is shown in Figure 3-3 and Figure 3-4.

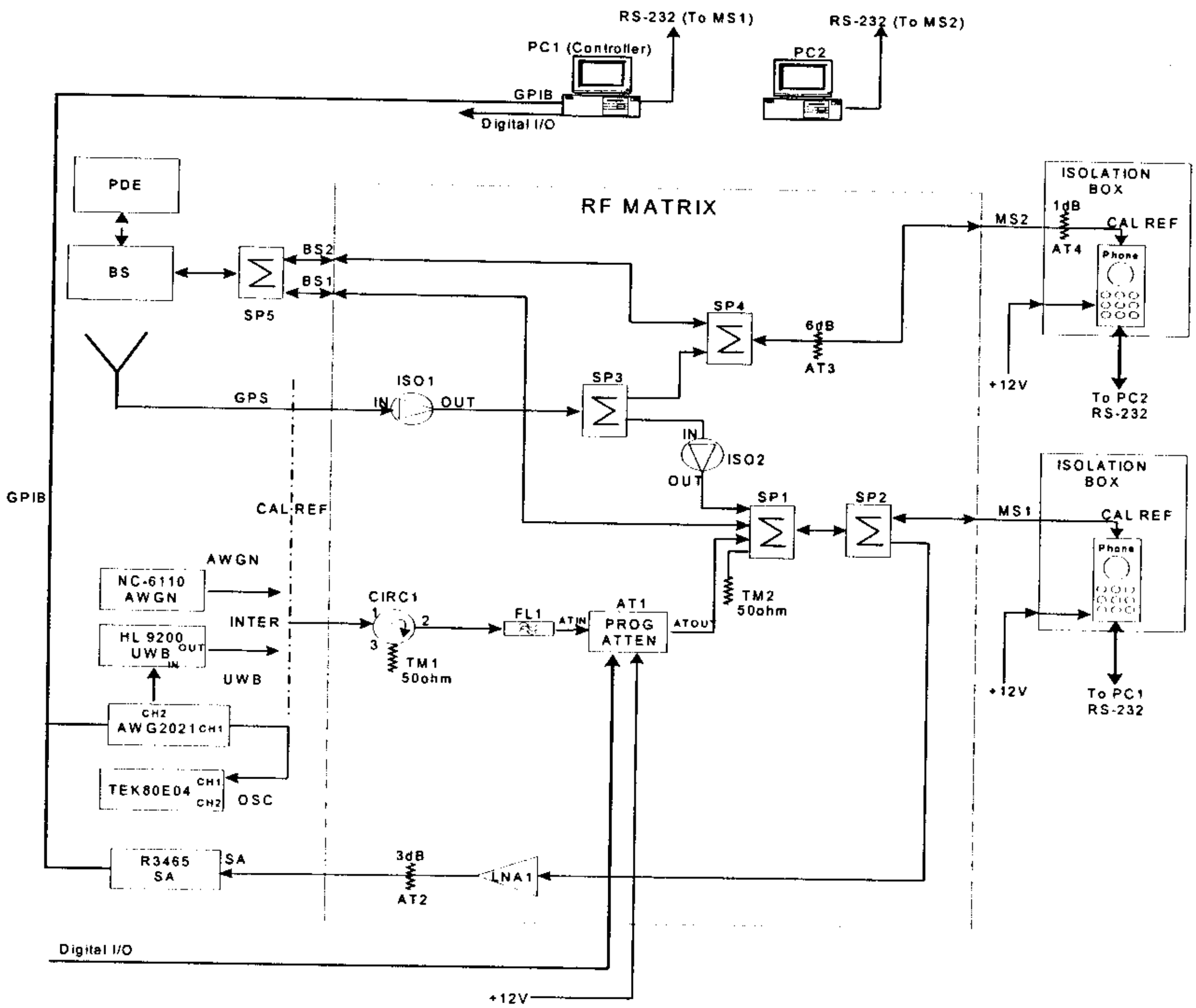

Figure 3-2: Test Setup

Table 2: RF Parts List

Ref	*Description*	*Manufacturer*	*Qty*
AT1	Programmable attenuator	Weinschel	1
AT2	3dB attenuator	n/a	1
AT3	6dB attenuator	n/a	1
At4	1dB attenuator	n/a	1
CIRC1	Circulator, 1.25-2.5GHz	UTE Microwave	1
ISO1,ISO2	Isolator, 1.25-2.5GHz	UTE Microwave	2
FL1	GPS 20 MHz bandpass filter,	ComNav Engineering Inc.	1
LNA1	LNA, 10Mhz-3000Mhz,G=18 NF=3dB, Po1dB=9.7dBm	Mini-Circuits	1
SP1	Splitter, 4 way, 0.5-2Ghz	KDI Triangle	1
SP2,SP3,SP4,SP 5	Splitter, 2 way, 0.5-2Ghz	KDI Triangle	3

Table 3: Measured Path Gain

Path		*Path Gain (dB)*	*Calibration Frequency(MHz)*
From	*To*		
GPS	MS1	-15.4	1575.42
GPS	MS2	-15.4	1575.42
INTER(UWB)	MS1	-19.3	1575.42
INTER(UWB)	MS2	< -80	1575.42

Figure 3-3: Lab Setup

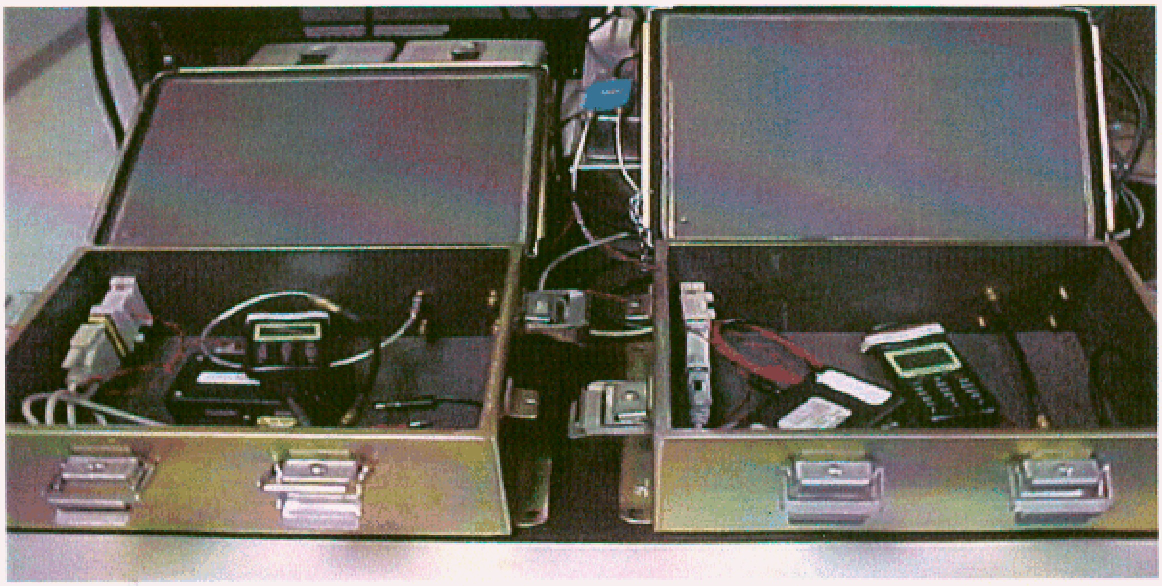

Figure 3-4: Phone in Isolation Box

3.3 Test Cases

The gpsOne™ receiver was characterized in the presence of UWB interference using the combinations specified in Table 4. The UWB power was swept for each combination of UWB parameters given in the table for a total of 8 tests. All tests were performed in a controlled conducted environment.

Table 4: Test Cases

Parameter	***Value***
PRF (MHz)	1, 5,15,17.5
Modulation	UPS (uniform pulse spacing), dither

3.4 UWB Power

The UWB power was swept from -112 dBm per 2 MHz to -92dBm per 2 MHz[1] as measured at the phone antenna port. The output of the UWB module was calibrated using the channel power option of the spectrum analyzer. The power was measured in 1 MHz and 2 MHz bandwidths for each UWB PRF and modulation scheme. These values were stored in a table for use by the automation software. The absolute interference power in a 2 MHz bandwidth was set at the input of the phone antenna port by using the pre-stored UWB power and applying the appropriate UWB to phone path loss factor and adjusting the programmable attenuator. The spectrum analyzer was pre-calibrated against a power meter in the frequency range 1570 MHz to 1580 MHz to ensure accurate absolute power levels.

Note that although the UWB power is set in a 2 MHz bandwidth, most of the data presented in the subsequent sections has been translated to 1 MHz bandwidth by using empirical correction factors. This facilitates comparison with FCC emissions limits.

3.5 UWB Waveform Generation

The UWB module was triggered using the Tektronix AWG2021 waveform generator. The trigger waveform for the UPS (uniform pulse spacing) and dithering cases was generated using the procedure described in a previous filing[2].

3.6 Live GPS Constellation

An amplified GPS signal from the output of an external GPS antenna having a clear view of the sky was fed into the test lab. The external antenna was located on the rooftop of one of the Qualcomm buildings and the coaxial feed was run into the test lab. The GPS signal was attenuated using a step

[1] 2 MHz is the proposed bandwidth for receivers utilizing the gpsOne™ technology as specified in the 3GPP2 *Recommended Minimum Performance Specification for IS801-1 Spread Spectrum Mobile Stations*

[2] Report on PCS phones by Qualcomm Incorporated (filed March 8, 2001)

attenuator to bring it down to levels emulating an indoor or in-vehicle environment having favorable channel conditions (i.e. with no multipath). This attenuated signal was then injected into the RF test setup.

Through extensive field testing, QUALCOMM was able to characterize the C/No within buildings to be around 34dB-Hz 95% of times. GPS measurements collected inside vehicles demonstrated similar behavior. The cumulative distribution function of in-vehicle C/No indicates that 82% of the time C/No will be less than 34 dB-Hz. The attenuator was adjusted until approximately the same C/No was observed in the lab setup.

3.7 Baseline Phone Measurements

To ensure that the Test and Reference phones had identical performance, GPS data was simultaneously collected on the two phones in the absence of any interference. The cumulative distribution function of position error and C/No for the two phones is shown in Figure 3-5 and Figure 3-6. From these plots we can clearly see that the two receivers perform almost identically.

3.8 Spectrum Analyzer Plots

The UWB emissions in the GPS L1 band (1575.42 MHz) for the dithered and UPS (uniform pulse spacing) UWB case are shown in Figure 3-7 and Figure 3-8, respectively. The spectrum analyzer resolution bandwidth was set to 10 kHz. The plots are shown for a PRF of 1 MHz. For the UPS case, two spectral lines separated by 1 MHz are clearly visible. The dithered spectrum exhibits no spectral lines indicating that the dithering used was sufficient to whiten the data within the GPS band.

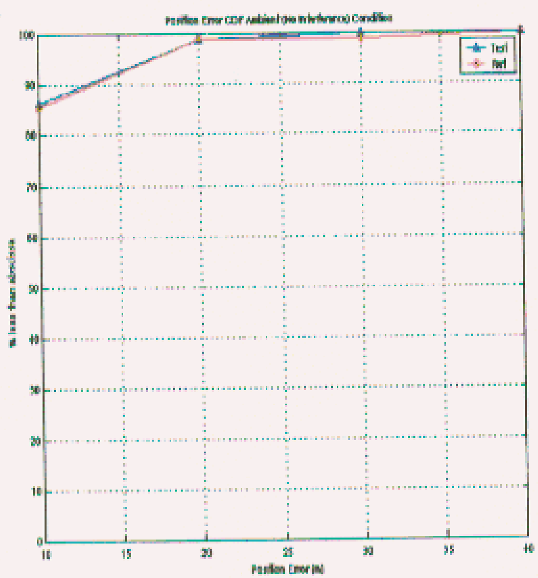

Figure 3-5: Baseline Position Error CDF

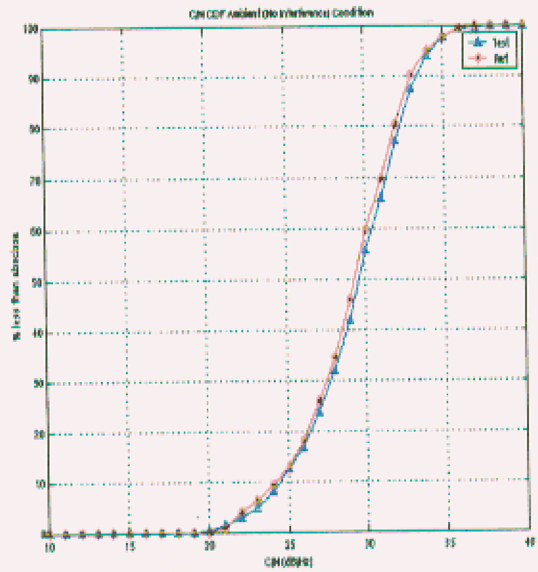

Figure 3-6: : Baseline C/No CDF

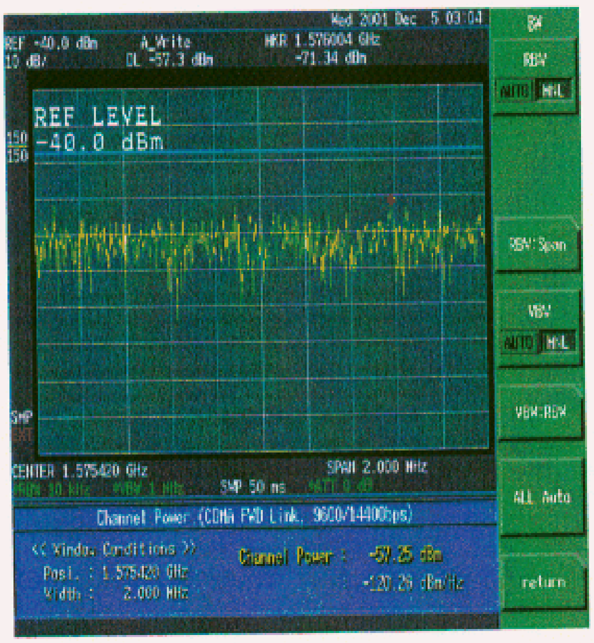

Figure 3-7: PRF 1MHz dithered in GPS Band

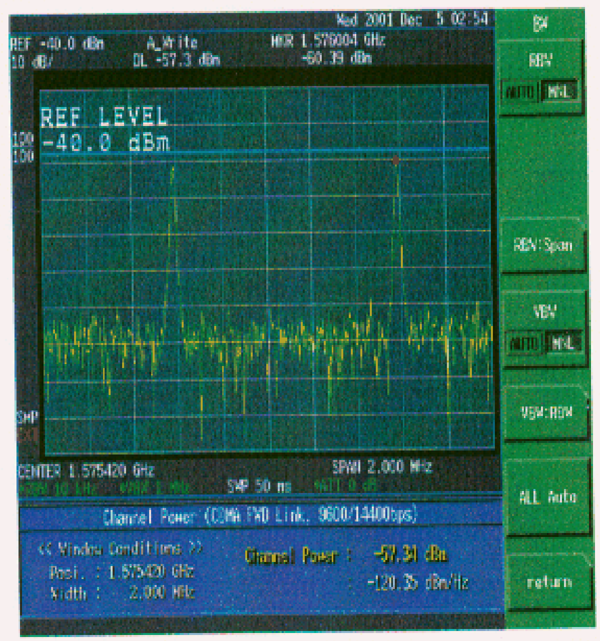

Figure 3-8: PRF 1MHz UPS in GPS Band

4. Impact on gpsOne™ Receivers

This section discusses the experimental data collected in the laboratory. In all the plots it should be noted that each curve is a separate test case taken at different time and hence, under different GPS satellite geometry. As a result, for the same average UWB power, the position errors can be slightly different for different test cases. No attempt should be made to infer the GPS performance as a function of UWB PRF or modulation. At times, the plots are separated into UPS and Dither cases for visual clarity only.

4.1 UWB Impact versus Time

Figure 4-1 shows the impact of UWB interference as a function of time. This plot uses PRF 1MHz UPS at -96dBm per 2 MHz. The x-axis depicts the call number (each call is an independent GPS fix). The left y-axis shows the position error for a given GPS fix and the right one shows the number of visible satellites for the given fix. The position error and the satellites visible are plotted as function of call number. The reference phone data is also shown for comparison. From the plot we see that the test phone has an extremely large spread in position errors (uppermost curve) and the number of visible satellites ranges from 1 to 4 (lowermost curve). In contrast, for the reference phone, the position error is close to 10 meters in most of the samples and the number of visible satellites ranges from 8 to 10. This plot clearly exhibits the adverse impact of the UWB device on the test phone.

Note that the ~800 meters position error is a default value that is returned by the location server when it does not have sufficient information to obtain a position measurement. Hence, this reported error means that there were no enough measurements to determine a position.

Number of Visible Satellites and Position Error. UWB Power = -96 dBm/2MHz. PRF = 1 MHz.

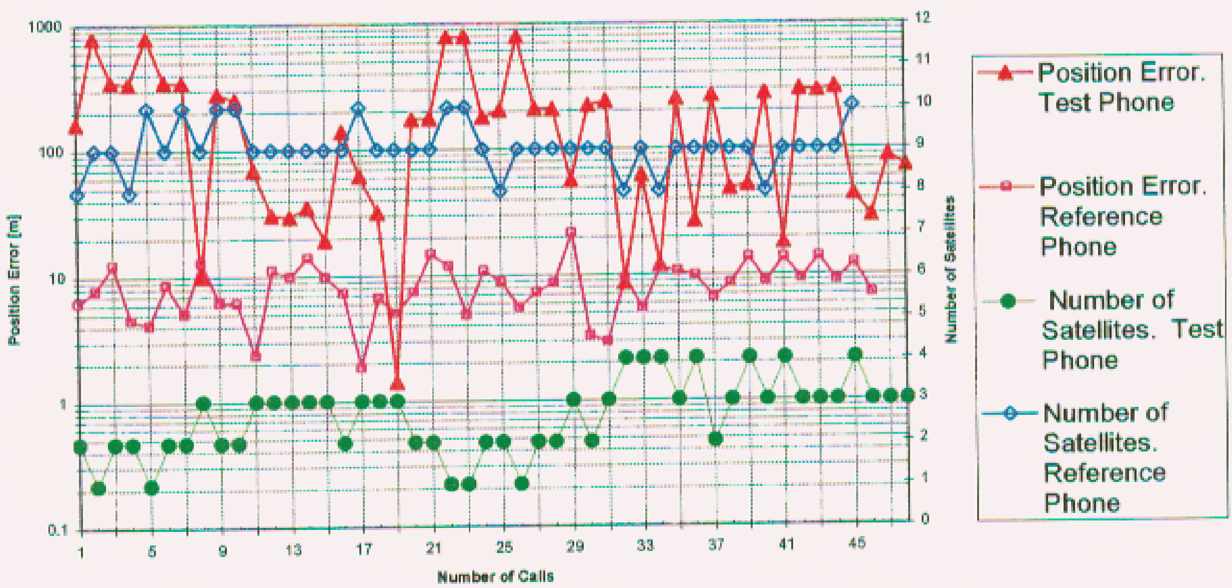

Figure 4-1: UWB Impact versus time

4.2 Position Error

The error in positioning as a function of UWB power is shown in Figure 4-2 and Figure 4-3 for the UPS and dithering cases, respectively. These plots are for the 50th percentile position error, *i.e.,* at a given UWB power level, 50% of the times the position error will exceed the measured error at that power as shown in the plots. For example, for 1 MHZ PRF at-96dBm per 2 MHz, the position error will exceed 175 meters in 50% of the calls. In contrast, the reference phone error is around 6 meters. Note that these plots show the UWB power expressed in dBm per 2 MHz.

Position error versus UWB power plots are converted to GPS-UWB separation distance using the free space model. The UWB power levels are converted from dBm per 2 MHz to dBm/MHz using empirical correction factors obtained from the spectrum analyzer. The UWB is assumed to be transmitting at the FCC Part 15 limit of -41.3dBm/MHz and both UWB and GPS antenna gains are assumed to be 0dBi. The resulting position error versus separation distance plots are shown in Figure 4-4 and Figure 4-5 for the UPS and dithering cases, respectively. An examination of these plots shows that as the UWB device gets within 75 meters from the victim receiver there will be a noticeable degradation in the noise figure. A sharp degradation in positioning performance, to the extent of not meeting the FCC mandated requirements, will start to happen when the UWB device is as far as 14.5 meters from the GPS receiver.

Figure 4-6 through Figure 4-9 show the power level and separation distance to achieve a position error of 50 meters or 150 meters in 50% of the calls. For 15MHz dithering case, and a UWB power of -100.9dBm/MHz at the GPS receiver, 50% of the calls will produce an error exceeding 50 meters. Alternatively stated, a UWB transmitter located 14.5 meters away from a GPS receiver can result in positioning errors greater than 50 meters in 50% of the calls. Similarly, at a UWB received power level of -100dBm/MHz (corresponding to 12.9 meters separation), the same UWB device can result in position errors greater than 150 meters in 50% of the calls. This clearly violates the FCC E-911 mandate. What this means is that one out of every two Safety of Life 911 calls is likely to fail the FCC mandate if a UWB device is located 12.9 meters away from the GPS receiver.

Although the functionality of E-911 complaint handset is impacted at distances of 12.9 meters, the actual RF degradation occurs much sooner as exhibited by Figure 4-10. If a maximum noise figure degradation of 1dB is allowed, a UWB device transmitting with an EIRP of -41.3dBm would need to be more than 75 were to consider the nearest emitters, the aggregation effect could significantly raise the noise floor of the GPS receiver, thus rendering it useless in making any emergency calls.

50th Percentile Position Error vs UWB Power. No Dithering

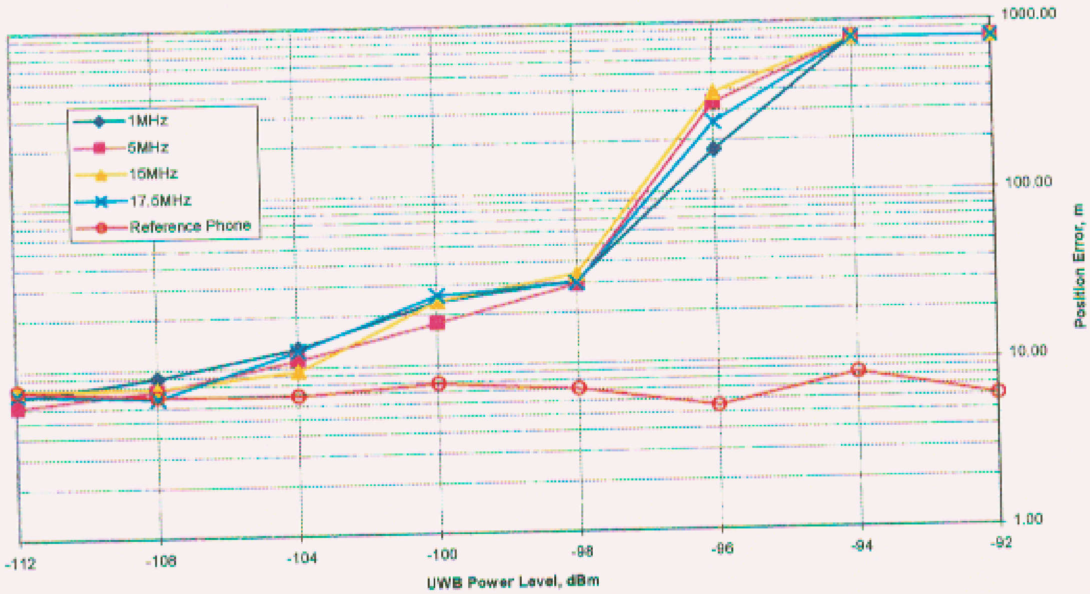

Figure 4-2: Percentile Position Error Vs UWB Power in dBm per 2MHz, UPS

50th Percentile Position Error vs UWB Power. Dithering

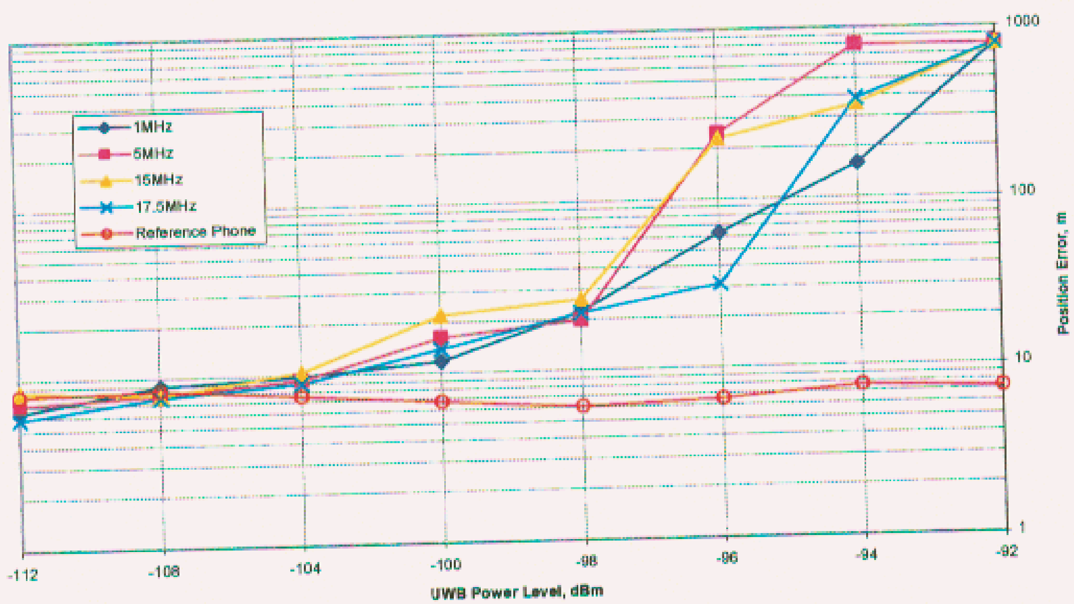

Figure 4-3: 50th Percentile Position Error Vs UWB Power in dBm per 2MHz, Dithering

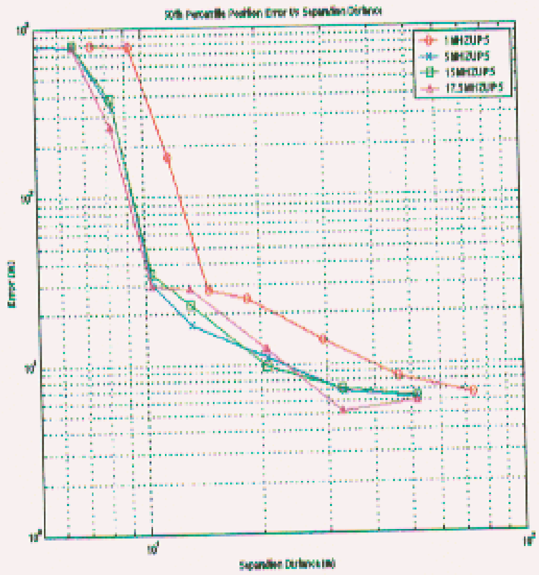

Figure 4-4: 50th Percentile Position Error Vs UWB-GPS separation distance, UPS

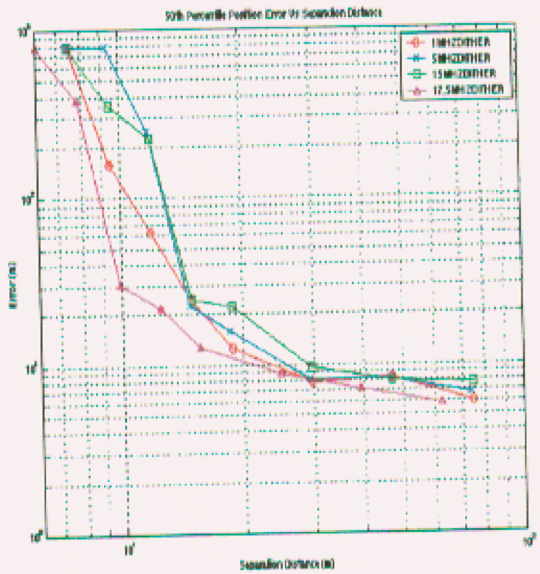

Figure 4-5: 50th Percentile Position Error Vs UWB-GPS separation distance, Dithering

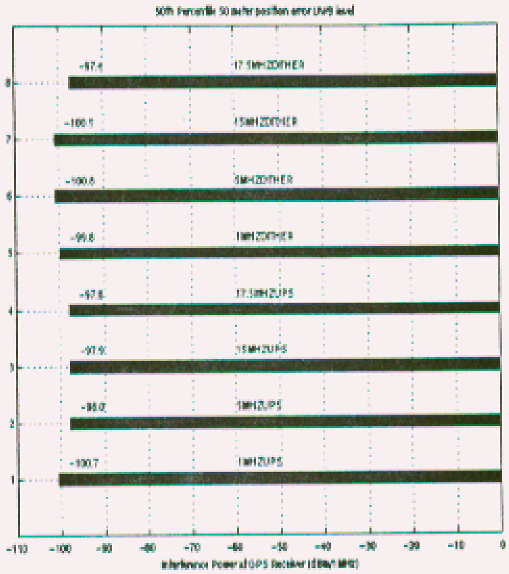

Figure 4-6: UWB power for 50m error 50% of times

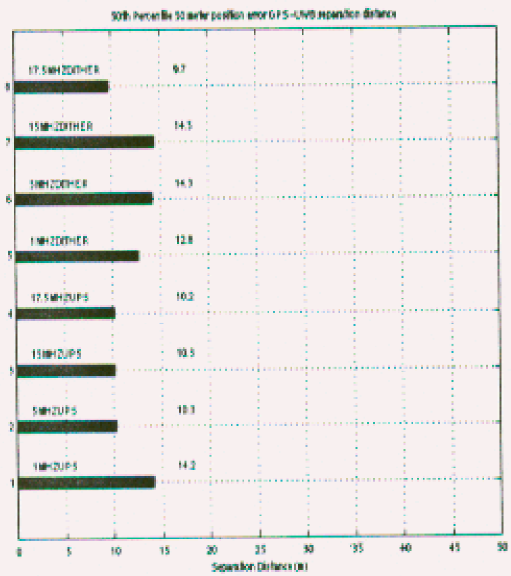

Figure 4-7: UWB-GPS separation distance for 50m error 50% of times

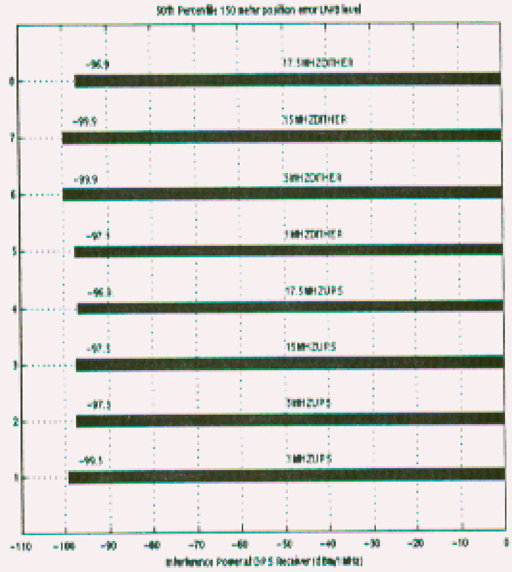

Figure 4-8: UWB power for 150m error 50% of times

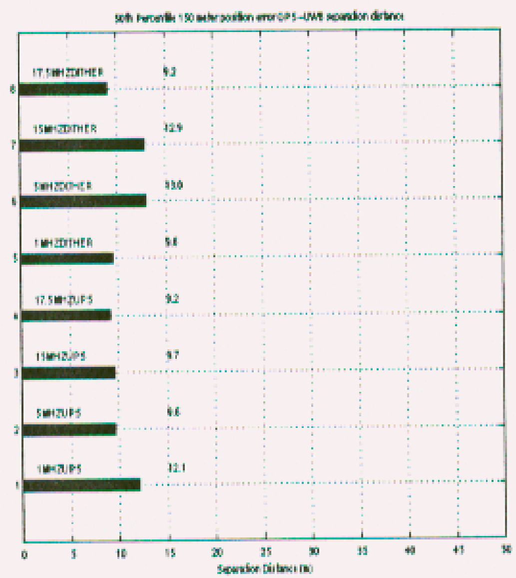

Figure 4-9: : UWB-GPS separation distance for 150m error 50% of times

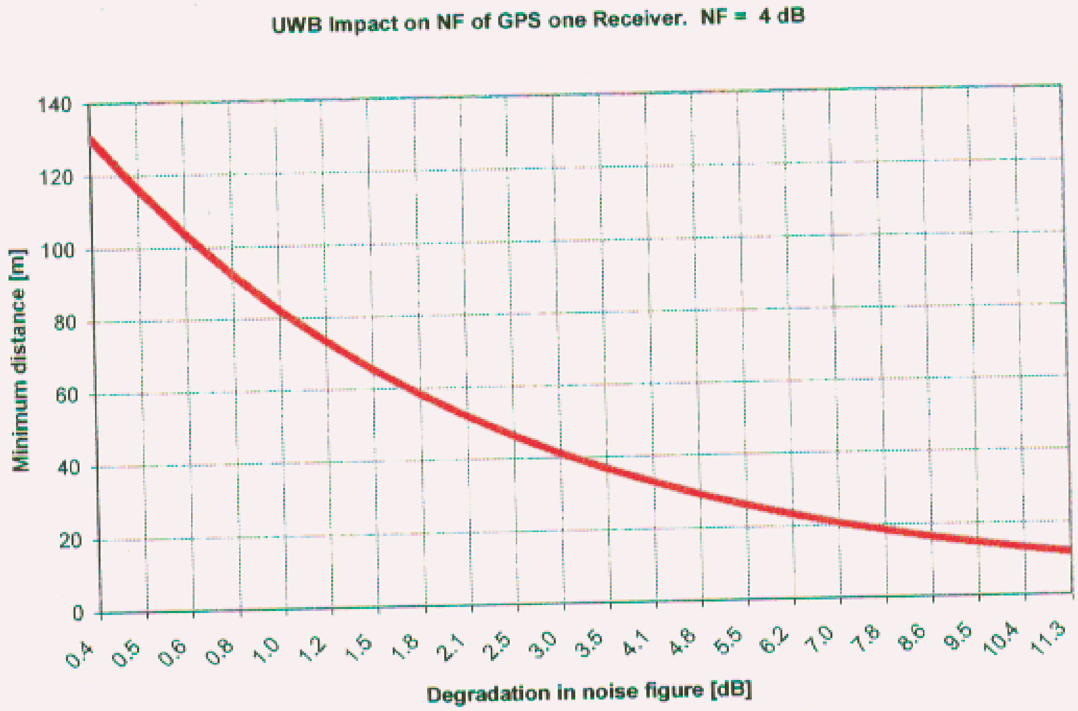

Figure 4-10: Theoretical noise figure degradation versus UWB-GPS separation

4.3 Satellite Availability (Yield)

Figure 4-11 through Figure 4-14 shows the satellite availability of the strongest 4 satellites as a function of UWB power. For each UWB power level, the strongest 4 satellites were first found in the test phone data. By strongest, we mean those satellites that were visible (detected) most often during the course of sample collection. The cumulative detection rate of the 4 satellites is referred to as Satellite Availability or % Availability. Next, the detection rates of the same 4 satellites are found in the reference phone data to obtain the reference satellite availability. A sample scatter plot of the detection rate for PRF 17.5 MHz dithering, -98dBm/2MHz is shown in Figure 4-15. The x-axis of this plot shows the satellite number (SVPRN) and the y-axis shows the detection rate. The strongest 4 test phone satellites numbers are [9,23,29,4] with corresponding detection rates of about [100,100,90,60]%. Thus, the satellite availability in this case is 87.5%. In contrast, the same 4 satellites are visible by the reference phone close to 100% of the times.

For the reference phone, the availability is almost 100% for most of the test cases. During the same period, the test phone exhibits a significant reduction in satellite availability due to the excess noise generated by UWB. This reduction directly translates to (a) Reduction in yield and (b) Degradation in location accuracy.

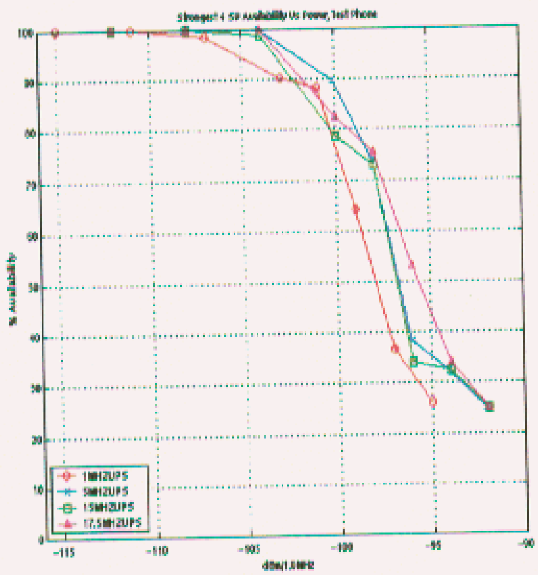

Figure 4-11: Test Phone SA, strongest 4 sats, UPS

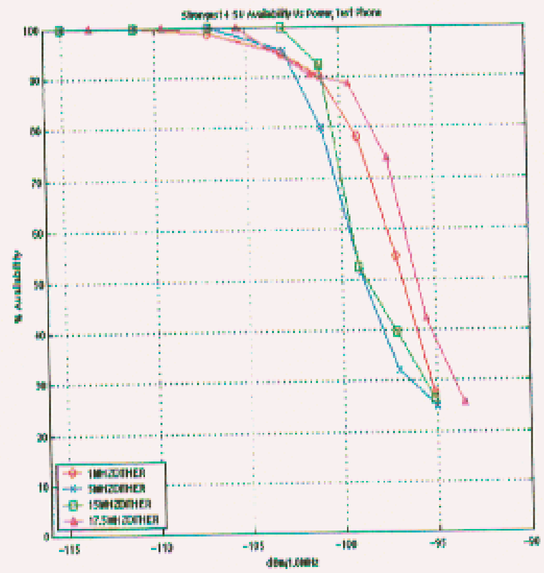

Figure 4-13: Test Phone SA, strongest 4 sats, Dither

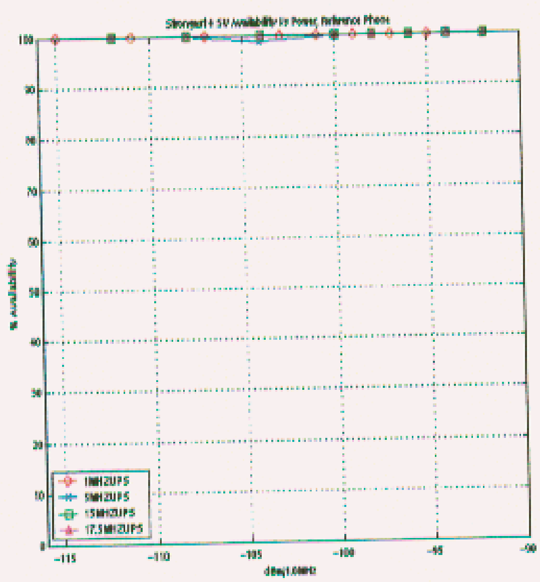

Figure 4-12: Ref Phone SA, strongest 4 sats, UPS

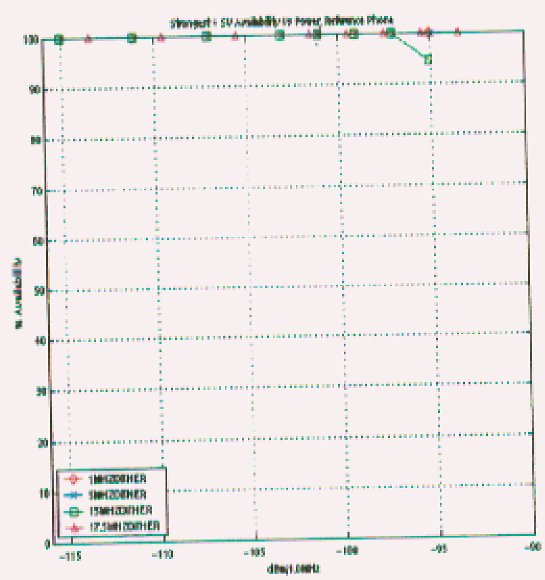

Figure 4-14:Ref Phone SA, strongest 4 sats, Dither

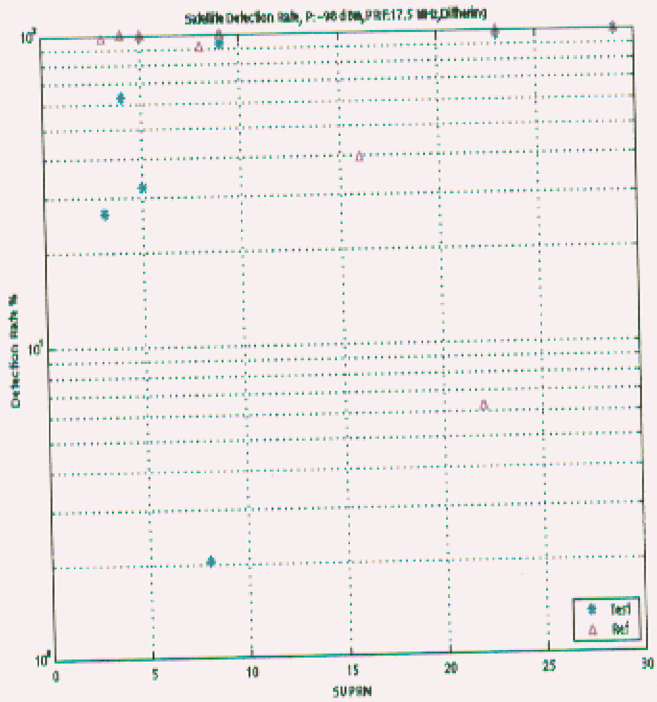

Figure 4-15: Satellite Detection Rate: PRF 17.5MHz Dither, Power = -98dBm/2MHz

4.4 C/No Degradation

The phone estimated C/No ratio at the antenna port is shown in Figure 4-16 and Figure 4-17 for the test and reference phones respectively. The reference phone C/No varies from around 31dB-Hz to 35dB-Hz at the antenna port. In the presence of UWB interference, the noise floor of the test phone is substantially raised causing a reduction in C/No ranging from less than 20dB-Hz to 33dB-Hz. The C/No degradation for the test phone is obtained by taking the difference of the test and reference phones C/No for each test case. This degradation as a function of UWB power is shown in Figure 4-18. This is equivalent to the degradation in noise figure of the GPS receiver. From the figure it is evident that even at power levels as low as -115dBm/1 MHz, there is about 1dB loss in C/No. A theoretical plot of the noise figure degradation in shown in Figure 4-19. The empirical degradation for PRF 1 MHz UPS is shown on the same plot for comparison.

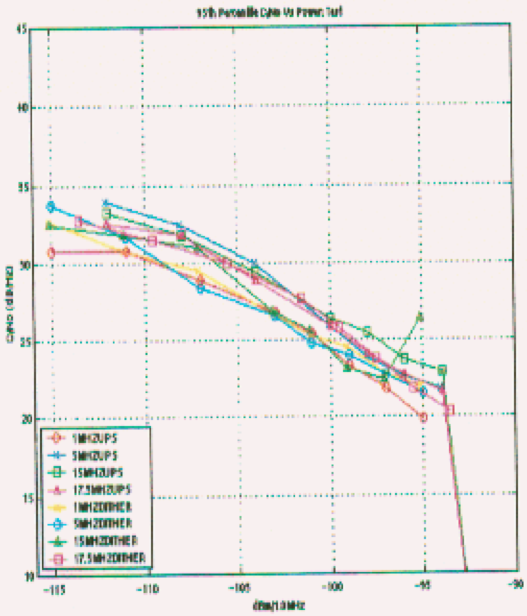

Figure 4-16: Test Phone C/No

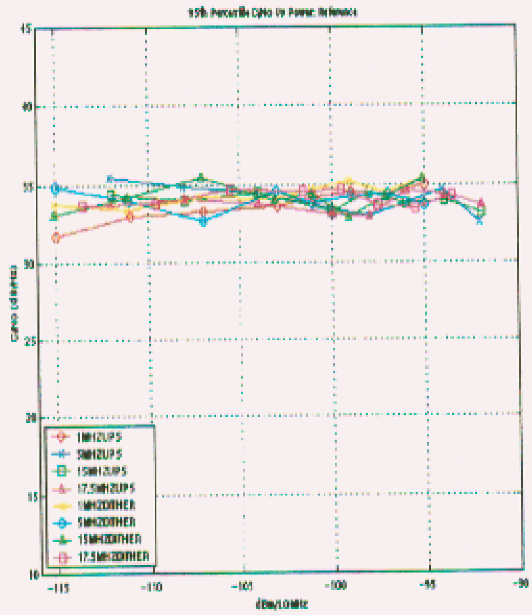

Figure 4-17: Reference Phone C/No

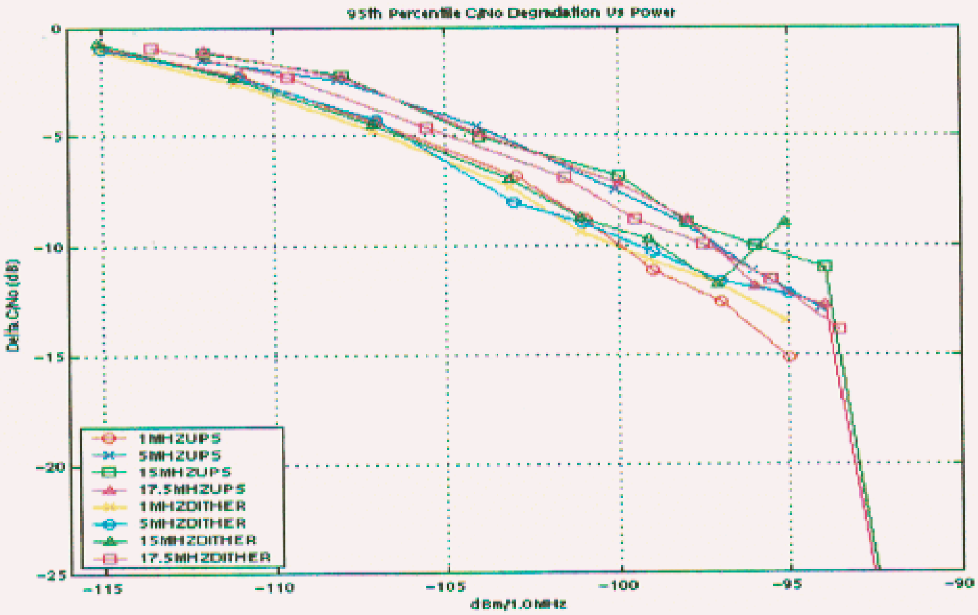

Figure 4-18: C/No degradation

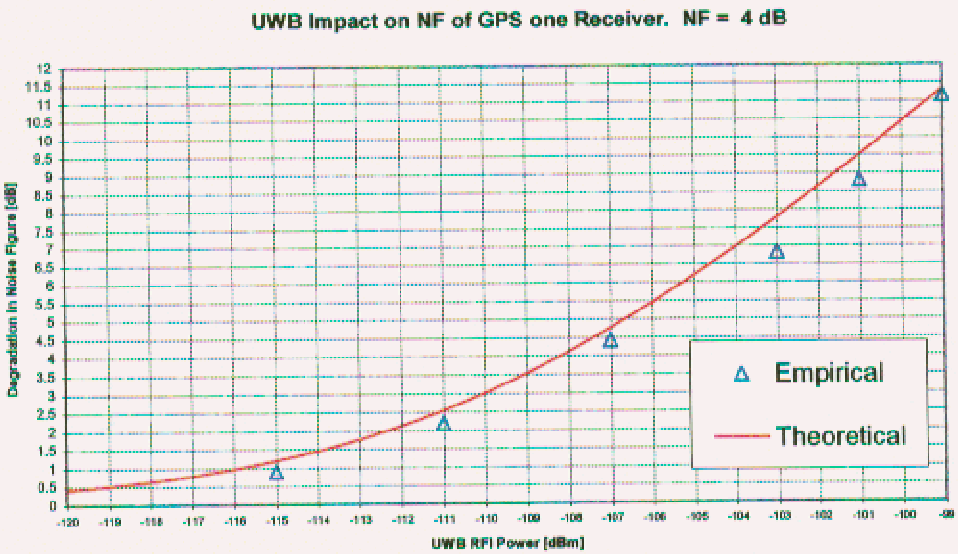

Figure 4-19: Theoretical noise figure degradation vs. UWB power

5. Conclusion

The FCC must not permit UWB operation within the GPS band until significant steps have been taken to limit the UWB emissions, and empirical testing conclusively proves that there will be no further system degradation.

The tests conducted by QUALCOMM clearly show that UWB emissions adversely impact the performance of the gpsOne™ system. Summarizing the results from the preceding sections, the interference from a single UWB device degrades performance in the following ways:

1. Raises the effective noise floor of the gpsOne™ receiver
2. Significantly reduces the satellite availability
3. Negatively impacts position accuracy
4. Degrades the C/No even at UWB receive power levels as low as -115dBm/MHz (corresponds to 75 meter away from Part 15 Class B device)

For Public Safety systems such as E-911, obtaining the GPS user's location is of utmost importance. The test data demonstrates that a UWB device located 12.9 meters away from a GPS receiver, can cause position errors greater than 150 meters in 50% of the calls. One out of every two Safety of Life 911 calls is likely to fail the FCC mandate if a UWB device is located 12.9 meters away from the GPS receiver. Since it is envisioned that the UWB devices will be used for short range communication in various handheld devices, a separation distance of 12.9 meters is very plausible. In addition to the positioning degradation, the RF performance of the GPS receiver degrades much sooner. A UWB device would need to be more than 75 meters away to cause a 1 dB degradation of the GPS receiver noise figure. QUALCOMM has invested huge engineering efforts and substantial sums of money to reduce the noise figure of it's enhanced GPS receiver to ensure optimal performance of E-911 in indoor and in-vehicle environments. It would be iniquitous to have unlicensed devices operating within the GPS band and taking away the design margin that was put in place to ensure a more sensitive and robust location determination system.

The QUALCOMM tests performed only considered a single UWB emitter. QUALCOMM is concerned that the aggregation of many of these devices will further degrade the performance of the gpsOne™ system by raising the noise floor even more. Permitting UWB devices to be commercially marketed on an unlicensed basis will result in a large proliferation of non-policed devices all having adverse effects on Safety of Life systems. If at a later date it is determined that these UWB devices degrade systems more than is currently presented in the proponent's studies, the task of recalling them would be extremely daunting if not entirely impossible. Once marketed to the general public, it is virtually impossible to police the operation of these devices.

QUALCOMM urges the Commission not to modify the Part 15 rules until all the questions regarding the impact of UWB devices on safety of life and other wireless services are fully and thoroughly answered.