Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20544

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

Comments on SIA Interference Study

Pulse~LINK Inc.

John Santhoff
Chief Technology Officer
9001 Brown Deer Rd. Ste. 8
San Diego, Ca. 92121
jsanthoff@pulselink.net
Website: www.pulselink.net

Table of Contents

I. Introduction:

On January 10, 2003 the Satellite Industry Association (SIA) filed an ex parte communication entitled "The Expected Signal Level Received at a Typical Earth Station Due to Emission from An Ultra-Wideband Transmitter Operating in the 3700 – 4200 MHz Band". The study appears inherently flawed in that it doesn't address well-known techniques used within the UWB community for ensuring coexistence with narrowband systems. Additionally, if the SIA report were to be taken at face value, numerous existing part 15 devices would currently render earth stations inoperable.

II. Satellite Industry Association Report appears Inherently Flawed.

The report filed by SIA is inherently flawed in that it is internally inconsistent as discussed below. Additionally it derives wide conclusions on Ultra Wideband (UWB) technology from assumptions not based on or consistent with real world FCC compliant UWB systems.

A. SIA Report did not Consider Realistic UWB Systems.

The UWB system considered in this report has the following characteristics: Fixed PRF at 1KHz, 1MHz, 10MHz, and 50MHz; Unmodulated and "dithered" or PPM modulated systems. From comments filed under ET Docket 98-153, it should be apparent to SIA that the models used are not representative of UWB systems currently under development or sanctioned under current FCC regulations covering UWB emmisions.

The SIA study is predicated on the assumption that all UWB systems will be employing relatively low fixed PRFs with Pulse Position Modulation. Known techniques in UWB communications can be employed to whiten the spectrum and render this analysis moot. In 1969 Dr. Henning Harmuth described the use of Walsh functions in communications.[1] Since Walsh functions are inherently bi-phasic, any modulation scheme based on these functions will eliminate spectral lines and reduce the peak–to-average power ratio. Additionally, Aether Wire and Location as early as 1995 has been working with bi-phase "doublet" signals in UWB communications.[2] In XtremeSpectrum's September 12, 2000 they disclose the use of Bi-Phase and Quad-Phase modulated "wavelets" that will inherently eliminate spectral lines. Other techniques for whitening the UWB spectrum include pseudo-random time hopping as described by Withington and Fullerton[3], Scholtz[4], and Ramirez-Mireles[5] just to name a few.

---

[1] "Applications of Walsh Functions in Communications", Henning F. Harmuth, IEEE Spectrum November 1969.

[2] "Low-Power, Miniature, distributed Position Location and Communication Devices Using Ultra-Wideband Non-Sinusoidal Communication Technology," Semi-Annual Technical Report Contract J-FBI-94-058, Aether Wire and Location, Inc. July 1995

[3] "An Impulse Radio Communications System", in *Ultra-Wideband Short Pulse Electromagnetics,* Plenum Press 1993.

[4] "Multiple Access with Time Hopping Modulation", PROC IEEE MILCOM December 1993.

Improperly designed fixed PRF UWB systems can pose a risk to narrowband systems if the PRF is selected so that the spectral line created by the PRF or one of its harmonics falls within the band of the victim receiver. This can be avoided by proper selection of PRF, whitening the spectrum, or eliminating spectral lines through modulation. None of these techniques were considered by SIA in their report. These techniques additionally reduce the peak power to average power of the UWB signal. Only the most potentially interfering system was considered. Alternatively, if UWB device manufacturers wanted to disrupt narrowband systems one might suggest generation of a carrier in band instead of an impulse train that results in a spectral line. Since this is not the intention of UWB developers, those wishing to study the impact of UWB on narrowband systems would be better advised to take the well known techniques into consideration when modeling and testing UWB systems.

B. SIA Study is Internally Inconsistent and Produces Inaccurate Results

The SIA report concludes that for a UWB device operating within the limits imposed by the FCC there would potentially be harmful interference if the device were operated, under certain parameters, within 4.4 Km of a ground earth station. In the frequency band of interest, 3700 – 4200 MHz, other part 15 devices operate at the same power levels, as will UWB devices. If this analysis is to be believed, ground earth stations can not currently function within 4.4 Km of any part 15 device radiating in this frequency band.

The SIA study raises concerns of additive multi-path reflections making the analysis more harmful than discussed in their paper. The study is in error in its analysis of the regulated limits. The –41.3 dBm/MHz limit imposed by the FCC includes all emitted power regardless of its propagation path to the receiver. Additionally, portions of the transmission that propagate through a longer distance will suffer additional degradation due to reflections with objects and a longer path to the receiver. The multi-path argument is without merit.

The SIA model is predicated on both dithered and non-dithered UWB signals with high peak-to-average power levels. As discussed above this is not an appropriate model for all UWB devices. Additionally, it is assumed that the PRF will be within the 50MHz bandwidth of the ground receiver. No consideration is given for UWB systems utilizing PRFs significantly higher than 50MHz. Pulse~LINK agrees with the FCC's conclusion that "[P]eak power limit provides the restriction at lower PRFs while the average power limit provides the restriction at higher PRFs."[6]

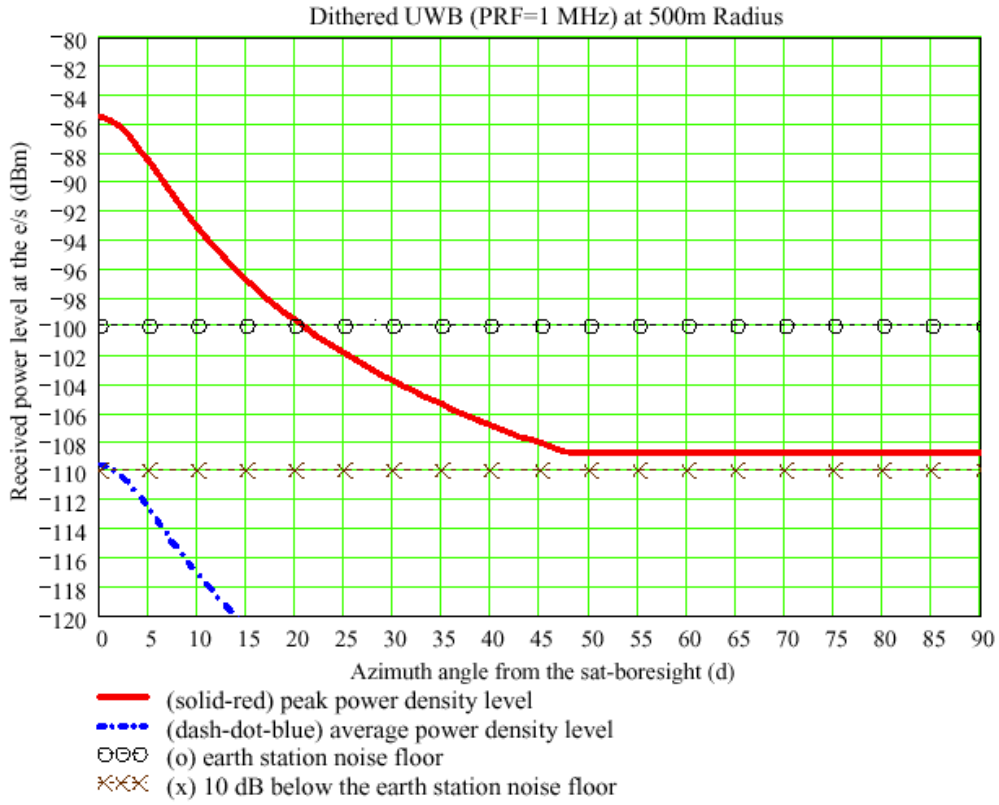
---

[5] "Performance of Ultra Wideband SSMA Using Time Hopping and M-Airy PPM", IEEE JSAC Wireless Communications Series, 1999

[6] In the matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, ET Docket 98-153, 14 February 2002, Federal Communications Commission, USA

Figure 2 is inaccurate for UWB systems using techniques to reduce the peak-to-average power ratio. Additionally, for higher PRF systems the limiting factor is average power not peak power as discussed above.

Since high PRF systems are limited by average power, Figure 3 clearly demonstrates coexistence with earth ground stations for average power. SIA Figure3 is provided for reference, clearly showing the blue dashed line remaining below the noise floor of –100 dBm. The peak power density shown in the figure is indicative of a very low PRF without using any of the techniques previously discussed to reduce the peak-to-average power ratio.



SIA report Figure 3 provided for reference

The study in internally inconsistent in that using the provided formulas it derives results inconsistent with the stated conclusions.

Using the Average signal level density formula provided by SIA.

$$SLD = EIRPave + BWCF - LP + Gr(\theta)$$

Where:

EIRPave	= -41.3 dB/MHz.	FCC limit
BWCF	= 10log(50MHz/1MHz)	to correct power in 50MHz versus 1 MHz
LP	= 20Log(freq) + 20Log(distance) + 32.45	SIA report
Gr(θ)	= 32 – 25 Log(θ)	θ In degrees for 1 to 48 degrees
Gr(θ)	= -10	for 48 – 180 degrees

One assumption of the SIA report is that the transmitting UWB device will be within the main lobe of the ground station directional antenna. For the following analysis it is assumed that the satellite downlink antenna is directed skyward, and the UWB device is not being operated in a hot air balloon.

Gr(θ) in this case = -10
Using the center frequency of SIA's interest at 3.95 GHz.

Lp = 20Log(3.95) + 32.45 + 20Log(4400)
Lp = 44.38 + 20Log(Distance) (1)
Lp = 117.25

Gr(θ) = 32-25*Log(5)
Gr(θ) = 14.5 (2)

EIRPave = -41.3 (3)

BWCF = 10*Log(50) = 17 (4)

From Figure 1, the noise floor of the ground station is –100 dBm/50MHz. Coexistence, would require that SDL not exceed –100 dBm/50 MHz.

Substituting (1) through (4) and solving for distance

$$SLD = EIRPave + BWCF - LP + Gr(\theta)$$

SLD = -41.3 + 17 – 117.25 -10
SLD = -151.6 dBm/50MHz

This analysis would lead to the conclusion that a UWB device coexists with 51dB to spare. SIA's Figure 3 further supports this conclusion.

Using the SIA's formulas does not support the stated conclusion.

III. Conclusion

SIA's report entitled "The Expected Signal Level Received at a Typical Earth Station Due to Emission from An Ultra-Wideband Transmitter Operating in the 3700 – 4200 MHz Band" is inherently flawed. The study did not involve simulations from realistic UWB systems deductively under development by any company. Previous filings in ET Docket 98-153 make clear some of the intentions of commercial UWB companies. The UWB industry is fully aware of potential interference to narrowband systems. Since using the data and formulas provided in SIA's report, may not replicate the claimed results, the study internally inconsistent.

We conclude that in order to achieve the claimed result of potentially harmful interference at 4.4 Km, would require the use of a relatively low fixed PRF with PPM modulation, (which UWB companies repeatedly assert is not anticipated), with radiating power 125,800 times greater than the FCC approved limit. Any signal, narrowband or UWB radiated at 125,800 times greater than FCC limits poses predictable undesirable results. In light of this Pulse~LINK feels the study is without merit and that the current FCC guidelines are adequate protection for the 3700 – 4200 MHz band.