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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

August 7, 2000

The Honorable Susan Ness
Commissioner
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Re: Amendment of Part 15 of the Commission's Rules Regarding Spread Spectrum Devices, ET Docket No. 99-231
Ex Parte Filing

Dear Commissioner Ness,

The arguments put forward by CUBE in support of Wide Band Frequency Hopping (WBFH) have been shown to contain many serious errors. It is absolutely essential that the Commission understand the scope of these errors before reaching a final decision in this matter. Most of the more serious technical errors made by CUBE have been documented in this proceeding.[1] During the debate on this matter before you on Thursday, August 3, 2000, proponents of WBFH repeated one of their more serious technical mistakes. The issue related to the effect of WBFH interference on conventional Frequency Hopping Spread Spectrum (FHSS) systems such as Bluetooth. This submission seeks to clarify this one important issue among the many grave concerns relating to CUBE's analysis.

As shown below, contrary to CUBE's position, WBFH will cause far more interference to FHSS radios operating in accordance with current FCC rules than do other authorized narrowband FHSS radios. This interference, together with the inherent inefficiency of the WBFH signaling scheme, will cause disruption to Bluetooth voice links *at distances which far exceed the useful range of WBFH systems*. The Commission must fully appreciate this fact before reaching a final ruling in this matter.

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List A B C D E

[1] Reply Comments of WECA, Submission in ET Docket 99-231, January 18, 2000.

I. Effect of WBFH on Bluetooth

During the debate, representatives of CUBE asserted that WBFH radios would have no adverse impact on conventional FHSS radios such as Bluetooth. According to CUBE, although WBFH signals will overlap up to five conventional FHSS channels (see Figure 1 below), only one narrowband FHSS channel, the centermost or co-channel, would encounter any significant interference. Further, CUBE asserted that the level of Co-Channel Interference (CCI) encountered from WBFH emissions would be lower than the level of interference resulting from a same-strength conventional narrowband FHSS signal.

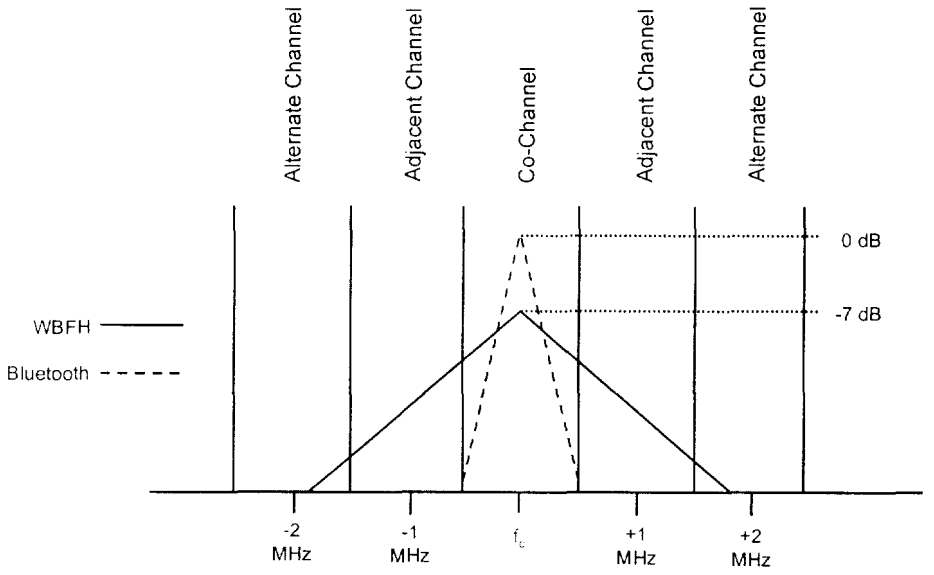

Figure 1 WBFH Emissions Will Overlap up to Five Bluetooth Channels

CUBE's assertions are false. Although the WBFH power is spread out over five channels, testing shows that the degree of interference encountered by the centermost narrowband FHSS channel is actually WORSE from WBFH than would be encountered from another narrowband FHSS radio. *Further, both adjacent narrowband channels suffer virtually the same degree of interference from WBFH as the centermost channel.* Not only has this effect been clearly demonstrated by independent test results and analysis submitted within this proceeding, but it has also been demonstrated by CUBE's own test results.

Table 1 on page 35 of CUBE's Reply Comments of November 19, 1999, shows the effects of both narrowband FHSS and WBFH interference on a conventional FHSS receiver (Open Air radio). These results are shown in Table 1 below:

Channel Offset	Conventional FHSS vs Open Air (SIR dB)*	WBFH vs Open Air (SIR dB)
+2 MHz (Alternate Channel Interference)	-18	5
+1 MHz (Adjacent Channel Interference)	15	18
0 MHz (Co-Channel Interference)	14	18
-1 MHz (Adjacent Channel Interference)	15	18
-2 MHz (Alternate Channel Interference)	-11	5

Table 1 CUBE Test Results Demonstrate WBFH Increases Interference to Conventional FHSS Radios

* SIR dB stands for "signal to interference ratio" expressed in decibels (dB). This number represents the ratio of the device's desired signal (S) to the interference signal (I).

Contrary to the claims of WBFH proponents, it is quite clear from Table 1 that three channels (the co-channel and two adjacent channels) experience a significant degree of interference. Further, the degree of interference is worse in absolute terms from WBFH even though the power from the WBFH system is spread over a much wider bandwidth.

The relative effect on Bluetooth is even worse. Unlike Open Air radios, Bluetooth receivers have very robust channel filtering requirements. They are designed specifically to suppress interference from other narrowband FHSS radios authorized under current FCC Rules. However, Bluetooth radios cannot suppress WBFH interference to the same degree. Results of simulations for Bluetooth receivers in the presence of both narrowband FHSS and WBFH interference are shown below in Table 2:

Channel Offset	Narrowband vs Bluetooth (SIR dB)	WBFH vs Bluetooth (SIR dB)	Increased Susceptibility to Interference Due to WBFH (dB)
+2 MHz (Alternate Channel Interference)	- 35	-0.3	35.3
+1 MHz (Adjacent Channel Interference)	- 0.8	9.2	10
0 MHz (Co-Channel Interference)	7.0	11.7	4.7
-1 MHz (Adjacent Channel Interference)	- 0.8	9.2	10
-2 MHz (Alternate Channel Interference)	- 35	-0.3	35.3

Table 2 WBFH Impact on Bluetooth (Simulation Results)[2]

[2] *See* Zyren and Gandolfo, "*Effect of WBFH Interference on Bluetooth Receiver Reliability*," Submission in ET Docket 99-231, September 24, 1999, (hereinafter *WBFH Interference on Bluetooth*).

Note that the Bluetooth receiver can combat narrowband FHSS interference quite well. However, as shown in Table 2, the effect of WBFH interference is quite pronounced. These results have been independently confirmed by another commenter in this proceeding.[3] Also, like the Open Air receiver shown in Table 1, the Bluetooth receiver is more susceptible to co-channel interference from a WBFH source even though the energy is spread across a much wider bandwidth. For the cases of Adjacent Channel Interference (+/- 1 MHz) and Alternate Channel Interference (+/- 2 MHz) the difference is even more dramatic.

II. *Why* is CUBE in Error?

As stated above, CUBE has asserted that only one of the five instantaneously overlapped Bluetooth channels (the centermost, or co-channel) will suffer any serious degradation. Further, CUBE asserts, this level of degradation will actually be less than would be experienced as a result of co-channel interference from another conventional FHSS system. This argument at first appears to be compelling. The energy from a WBFH system is spread across five Bluetooth channels, as shown in Figure 1 above, and is actually lower in the center channel relative to a "same strength" signal from a conventional narrowband FHSS interfering signal.

However, test data clearly shows that CUBE is wrong on this key point. As described in detail in this proceeding,[4] FHSS receivers are more susceptible to interference at the edge of their receiver channel than to interference concentrated in the middle of the receiver channel. The analysis supporting this conclusion has been independently and authoritatively confirmed.[5]

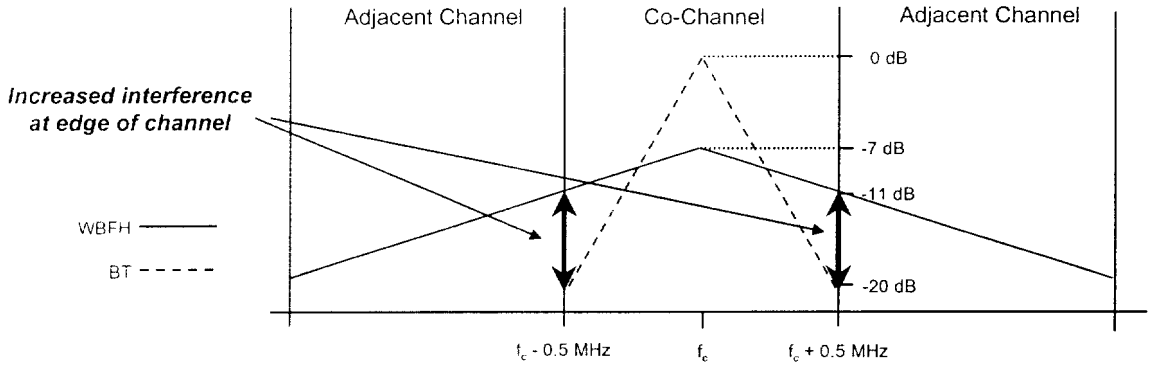

Figure 2 WBFH Increases Interference at Edge of Co-Channel and Adjacent Channels by 9 dB

[3] Comments of Silicon Wave, Submission ET Docket 99-231, December 23, 1999.
[4] *See WBFH Interference on Bluetooth.*
[5] Comments of Dr. William H. Tranter, submission in ET Docket 99-231, April 28, 2000

From Figure 2 above, it becomes obvious that the WBFH signal places more interference at the channel edge than does the same level of interference from a conventional narrowband FHSS signal. Further, since the two adjacent channels share a common boundary with the center channel, they should experience nearly the same degree of interference as the center channel. As shown previously in Table 1, CUBE's own test data clearly demonstrates precisely this effect.

Again, the interference mechanism described above, in combination with the inherent inefficiency of the WBFH signaling scheme, will cause disruption to Bluetooth voice links *at distances which far exceed the useful range of WBFH systems.* The Commission must completely understand this fact before reaching a final ruling in this matter.

III. Conclusion

WBFH will result in harmful interference to other Part 15 radios including both direct sequence spread spectrum devices and conventional FHSS devices such as Bluetooth. CUBE's statements during the debate indicating that only one of five conventional FHSS channels would be affected by WBFH interference are false. As explained in this submission, CUBE's own data disproves its position. Again, this submission highlights only one of a variety of serious errors in CUBE's technical analysis.

Intersil urges the Commission to adopt the WECA Compromise in this matter. The Compromise provides the flexibility required to enable FHSS radios to achieve data rates necessary to service consumer oriented multimedia applications while still providing meaningful protection for existing services.

If you have any questions regarding this filing, please contact James Zyren at (407) 729-4177.

Very truly yours,

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