IEEE 802.11
Wireless Access Method and Physical Layer Specification

Title: **Definition of the Infrared Baseband Transmit Spectrum Mask**

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Summary

The spectrum of a PPM signal is presented and a mask for the transmit spectrum shape is proposed.

A system implementing the proposed specification is being developed by the University of Aveiro as part of the ESPRIT.6892 POWER (Portable Workstation for Education in Europe) project commissioned by the European Community.

1.0. Background

A. In the March [4] meeting it was decided to split the IR medium (electric spectrum) into three distinct bands. The bandwidth allocation was defined as:

"Baseband":	0 to 5 MHz
"Co-existence band":	5 to 15 MHz
"Carrier modulated band":	15 to 30 MHz

While the limit frequencies for each band were defined, there is still a lot of other parameters to specify before this bandwidth allocation is complete.

B. For baseband [3], PPM modulation was chosen for its high power efficiency, making possible a low cost implementation of a 1 and 2 Mbps PHY within a reasonable optical power budget and providing a minimum coverage area. This power efficiency is achieved by exchanging power budget for bandwidth.

PPM Transmit Spectrum Shape

The Power Spectral Density (PSD) of a 16-PPM at 1 Mbps signal is narrower than that of a 4-PPM signal at 2 Mbps. For this reason we will consider only the 4-PPM signal at 2 Mbps.

The PSD of a 4-PPM signal (random data) at 2 Mbps [1, 2] is shown in figure 1. This is a spectrum where ideal rectangular pulses were considered to be transmitted into the optical

medium. In practice, the pulses rise and fall times are limited by the physical properties of the used LEDs, resulting in a narrower spectrum with higher decay.

Superimposed on the signal spectrum there is a mask that all conformant implementations should respect. This is because arbitrary pulse shapes may produce signal spectra with arbitrary energy distributions. This mask should be respected while transmitting any symbol pattern.

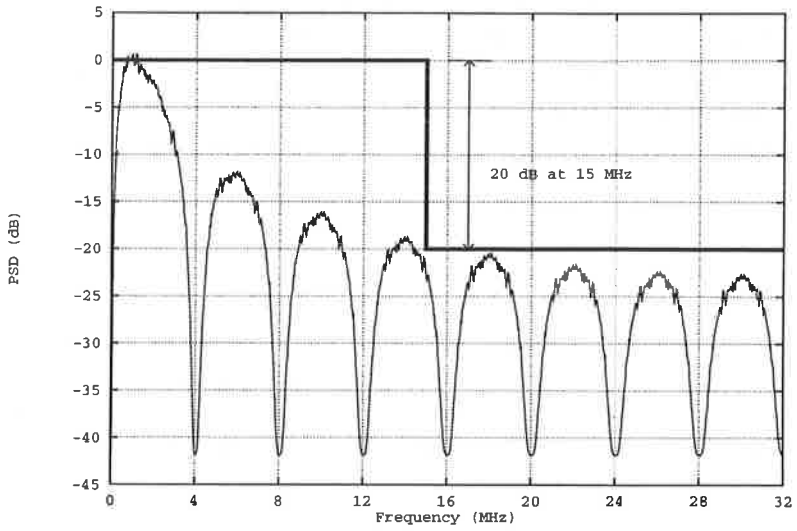

Figure 1. Worst case Power Spectral Density of a 4-PPM signal.

Taking into account the above results, we propose the extension of the bandwidth allocated for baseband operation to be in agreement with the mask defined in figure 1.

References

[1] Adriano J. C. Moreira and A. M. de Oliveira Duarte, "The use of PPM in wireless infrared transmission systems", Internal report, March 1994.

[2] Chien-Chung Chen and Chester S. Gardner, "Performance of PLL Synchronized PPM Communication Systems", IEEE Trans. Comm., Vol. COM-34, No.10, Oct. 1986

[3] Doc. P802.11-94/136, "Tentative Minutes of the IR-PHY Sub committee Meeting", Oshawa, Ontario

[4] Doc. P802.11-94/86, "Tentative Minutes if IR PHY Ad Hoc Group Meeting", Vancouver, BC, Canada