Impulse Radio Ultra-Wideband: Requirements and Implementation

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ABSTRACT

Ultra-wideband (UWB) technology has been proposed as an alternative air interface for Wireless Personal Area Networks because of its low power spectral density, high data rate, and robustness to multipath fading. The Federal Communications Commission (FCC) has defined an intentional UWB device as one that has a bandwidth equal to or greater than 20% of the center frequency or that has a bandwidth equal to or greater than 500 MHz. The FCC has also permitted UWB devices to operate using spectrum occupied by existing radio services as long as emission restrictions, in the form of a spectral mask, are met.

Impulse radio is one of the popular choices for UWB transmission because of its ability to resolve multipath, as well as the relatively low implementation complexity associated with carrierless (baseband) pulses. Impulse radio does not use a sinusoidal carrier to shift the signal to a higher frequency, but instead communicates with a baseband signal composed of subnanosecond pulses. Because of the short duration of the pulses, the spectrum of the UWB signal can be several gigahertz wide. Impulse radio systems employ a pulse train with pulse amplitude modulation (PAM) or pulse-position modulation (PPM). Previously, UWB systems using PAM and PPM have been analyzed, especially the distance as a function of throughput. However, the standard monocycles do not satisfy the FCC spectral rules. Here, we analyze the transmission range as a function of data rate using a new pulse shape that meets the FCC regulations. This fifth derivative of the Gaussian pulse can be implemented by a 4^{th} order Chebychev highpass filter. Using this pulse, the link budget is calculated to quantify the relationship between data rate and distance. It is shown that UWB can be a good candidate for high rate transmission over short ranges, with the capability for reliably transmitting 100 Mbps over distances at about 10 meters.