Ultra Wideband (UWB) communications are poised to enable short-range applications, such as remote health monitoring (e-health) and home or office automation.

Body Area Networks (BANs)\(^1\) are potential candidates for UWB since the low radiated power of the UWB transmitter enables low DC power consumption yielding long battery life and the possibility to use energy scavenging. Size and cost constraints require a low-complexity approach that allows multiple users sharing the same RF bandwidth, and offers robustness to interference and frequency-selective multipath propagation conditions.

Constant-envelope FM-UWB uses double FM: binary FSK followed by high modulation index analog FM implementing analog spreading. The FM-UWB signal is characterized by a flat spectrum and steep spectral roll-off.

Due to the instantaneous despreading in the receiver, synchronization time is limited only by the bit synchronizer in the FSK demodulator. Figure 1 shows measurement results taken in a 62.5 kbps FM-UWB system operating at 4 GHz. Transmission starts at the rising edge of the TX_ENABLE signal. On the receiver side, the raw data RXD is available almost instantaneously, whereas the bit synchronizer circuit determines the overall receiver synchronization time. From a synchronization point of view, the FM-UWB system behaves like a narrowband FSK system.

Interference from in-band UWB users benefits from the receiver processing gain which is equal to the ratio of RF and subcarrier bandwidth

\[
G_{\text{PSN}} = 10 \log_{10} \left( \frac{B_{\text{RF}}}{B_{\text{SUB}}} \right) = 10 \log_{10} \left( \frac{2 \Delta f_{\text{SF}}}{(B_{\text{SUB}} + 1)R} \right)
\]

In a 100 kbit/s LDR system with a RF bandwidth of 500 MHz a processing gain of 34 dB is obtained. As a result a 100 kbps FM-UWB radio can tolerate a 21 dB stronger FM-UWB interferer. Simulations have confirmed these values and also show that Impulse Radio and MBOFDM interference up to 15 dB stronger than the FM-UWB signal can be dealt with.

FM-UWB signals are robust to frequency-selective multipath\(^2\), Figure 2 shows MATLAB simulation results of the RF sensitivity improvement for 1000 realizations of the IEEE CM4 (strong non line-of-sight) channel. The graph in the upper part of the figure shows the RF sensitivity improvement for each channel realization. The histogram in the lower part of the figure shows the distribution of the receiver sensitivity improvement. The average and median value both equal 0 dB meaning that 50% of the strong non line-of-sight channels yield a performance improvement. The worst-case sensitivity degradation is only 2.5 dB.

Straightforward by its principles, FM-UWB constitutes a LDR UWB communication system highly robust to interferences and multipath.