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(54) Title: AN ULTRA WIDEBAND PULSE SHAPER FOR IN BAND INTERFERENCE MITIGATION

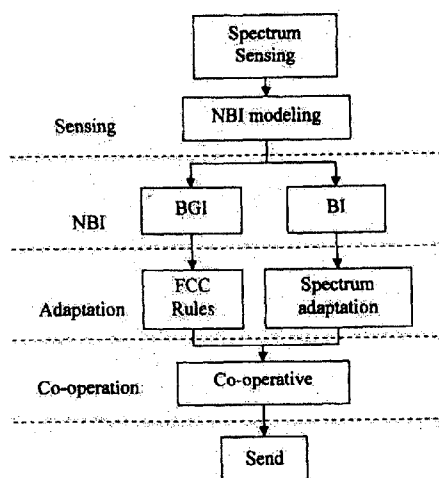


FIGURE 5

(57) Abstract: The present invention relates in general to an ultra wideband pulse shaper for in band interference mitigation characterized in that wherein a flat frequency spectrum of the transmitted signal over the bandwidth of the pulse is obtained by avoiding a DC component and wherein a desired frequency spectrum of the monocycle waveform is designed to be flat over a target bandwidth and wherein Gaussian waveform pulses are used due to the flexibility and low computation process in the pulse generation in a receiver.

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AN ULTRA WIDEBAND PULSE SHAPER FOR IN BAND INTERFERENCE**MITIGATION****FIELD OF THE INVENTION**

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The present invention relates to an ultra wideband pulse shaper for in band interference mitigation. More particularly the present invention relates to an ultra wideband pulse shaper approach to avoid the conventional narrowband carrier and most particularly to reduce the narrowband interference in a receiver using doublet Gaussian

10 Pulse to produce adapted spectral notch in the generated pulse.

BACKGROUND OF THE INVENTION

The unlicensed usage of a very wide spectrum that overlaps with the spectra of

15 narrowband technologies raised some concerns. Therefore, significant interference can affect ultra wideband (hereinafter referred as UWB throughout this specification including the claims) signals from existing narrowband systems.

In particular, high UWB system throughput requires that it must coexist and

20 contend with a variety of interfacing signals. UWB systems are able to co-exist with narrowband technologies such as GPS, PCS, ISM, IEEE 802.11b/g and FWA, UNI-ISM band IEEE 802.11a due to regulation by Federal Commission Committee (FCC), Figure 1.

However, the influence of the narrowband signals on the UWB system can still be significant and in an extreme case these signals may jam the UWB receiver completely. Even though narrowband signals interfere with only a small fraction of the UWB spectrum (particularly around the carrier frequency) due to their relatively high power with respect to the UWB signal, the performance and capacity of the UWB systems can be affected considerably.

Pulse shaping approach is a useful means to control the signal spectrum and to avoid interference legacy narrowband to UWB signals. In the present invention the Gaussian doublet is used which is a pair of separated narrow second derivative Gaussian pulse. This offers to degree of freedom, time separation between the two pulses in the doublet and time separation between doublets.

SUMMARY OF THE INVENTION

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The present invention generally relates to an ultra wideband pulse shaper for in band interference mitigation. A flat frequency spectrum of the transmitted signal over the bandwidth of the pulse is obtained by avoiding a DC component and wherein a desired frequency spectrum of the monocycle waveform is designed to be flat over a target bandwidth. Gaussian waveform pulses are used due to the flexibility and low computation process in the pulse generation in a receiver.

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The Gaussian doublet is used which consists of a pair of separated narrow second derivative Gaussian pulse wherein a positive pulse followed by a negative pulse. The amount of interference at an UWB receiver due to a narrowband emitter is highly dependent on the carrier frequency for the respective systems as well as their place on UWB bandwidth. Two degrees of freedom is provided wherein time separation between the two pulses in the doublet and time separation between doublets.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows a graph showing spectrum crossover of a narrowband interferers in UWB system

Figure 2 shows a diagrammatic view of a possible coexistence scenario with UWB and NB systems

Figure 3 shows a graph showing time domain representation a second derivatives Gaussian pulse

Figure 4 shows graph showing time domain representation doublet Gaussian pulse

Figure 5 shows a flow chart of a UWB interference mitigation using UWB pulse shaping.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Reference is made to Figure 2 wherein a typical coexistence scenario with an interference problem is depicted. In particular, this Figure 2 shows a realistic scenario where a UWB system contends with a radio spectrum which is already populated by narrowband (hereinafter also referred as NB throughout the specification including the claims) communications, which cause undesirable system throughput degradation.

The presence of narrowband interference with UWB systems reduces the signal – to – interference – and – noise ratio (hereinafter also referred as SINR in this description including the claims) at the receiver, and hence the bit error rate, therefore affects the quality of the radio link, including more packet losses, which results in an overall reduction of the system throughput and increase of energy consumption. In the present invention it provided therein an in band interference mitigation approach in which a notched band is contributed in the pulse spectrum using the flexibility of the doublet Gaussian pulse generation.

Systems with a fixed link capacity must be designed in order to sustain the worst possible condition, which is called maximum sustainable interference (hereinafter also referred as MSI throughout this specification, including the claims). This in turn imposes a low overall performance. Systems with an adaptive link capacity can take advantage of good channel conditions to transmit with a higher signal – to – interference

– noise ration and in case of channel degradation, their adaptability prevents complete communication outages.

5 In one scenario as shown in Figure 2, UWB node first should determined the impact of narrowband interferences on the UWB system performance, which depend on many factors such as pulse shape, modulation type, distance between interferer and the victim receiver and etc, and then adapt the UWB transmission signal such as power spectral density to guarantee interference mitigation and cancellation.

10 Pulse shaping approach is a useful means to control the signal spectrum and to avoid interference legacy narrowband to UWB signals. In the present invention the Gaussian doublet is used which is a pair of separated narrow second derivative Gaussian pulse. This offers to degree of freedom, time separation between the two pulses in the doublet and time separation between doublets.

15 Several approaches have been used to generate UWB short pulses. Historically, UWB signals are generated using the Max – generator, shock excitation of wideband antenna, time gated oscillator, a combination of conventional heterodyning and gated power amplifier, pulse modulation and Fourier techniques. Various waveforms types
20 have been proposed for Ultra wideband including Gaussian, rectangular, Hermite, prolate spheroidal and wavelets.

In general, the goal is to obtain a flat frequency spectrum of the transmitted signal over the bandwidth of the pulse and to avoid a Direct Current (hereinafter also referred as DC throughout this specification and including the claims) component. A monocycle should have zero DC components to allow it to radiate effectively. In fact, to satisfy the UWB emission constraint specified in FCC regulation, the desired frequency spectrum of the monocycle waveform should be flat over a target bandwidth not including the zero frequency. In the present invention, Gaussian waveform pulses are used due to the flexibility and low computation process in the pulse generation in the receiver.

In the present invention, Gaussian doublet is used which is a pair of separated narrow second derivative Gaussian pulse, Figure 3. A positive pulse followed by a negative pulse. This offers two degrees of freedom, time separation between the two pulses in the doublet and time separation between doublets. The Gaussian doublets can be designed by regulating the position of the second Gaussian pulse (the first pulse $P_0(t)$ begins at $t=0$, the second one $P_1(t)$ begins at $t=T_n$) as shown in Figure 4.

Since the power of UWB system's signal may be spread over a very wide bandwidth containing existing frequencies allocated to multiple existing narrowband systems, it is certain that the UWB system is subjected to interference from those narrowband systems. The amount of interference at an UWB receiver due to a narrowband emitter is highly dependent on the carrier frequency (interferer frequency) for the respective systems as well as their place on UWB bandwidth. The main

interference source to UWB is the in – band – interference (hereinafter also referred as IBI throughout this specification and including the claims) viz. the Unlicensed National Information Infrastructure (UNII) spectrum of Wireless Local Area Network (WLAN) (5.8Ghz) and Fixed Wireless Access (FWA) (3.9 Ghz), which affects with deep
5 interference in the corresponding bands.

Reference is now made to Figure 5 wherein is shown therein an interaction involves active negotiation and communication with other spectrum, decision making (spectrum adaption) within the radio, and share these information within the network
10 members (co-operation). The system starts with the discovery of the wireless channel so as to sense the available spectrum resources. Here it is considered that two types of interference to UWB receiver; coexistence systems interference (NBI) and UWB to UWB interference. There are two types of co-existence interference, background interference (hereinafter also referred as BGI throughout this specification and including
15 the claims) and burst interference (hereinafter also referred as BI throughout this specification and including the claims). The signals from a GSM based stations and WLAN access points are considered as background interference since they are transmitting almost continuously, which can be mitigated by using a high – pass or antennas, whose frequency transfer functions shows a strong out – of – band attenuation
20 according to FCC rules. The term, BI is used for narrowband interferences (NBIs) that transmits their data burst-wise, such as WLAN and FWA nodes.

This technique is called partial cognitive radio (hereinafter also referred as CR throughout this specification and including the claims) due to only in - band - narrowband interference has been tackled, in which the fully cognitive radio should be adaptive for all types of interference and the radio can change its transmitter parameters based on interaction with the environment in which it operates, Figure 6.

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CLAIMS

1. An ultra wideband pulse shaper for in band interference mitigation characterized in that wherein a flat frequency spectrum of the transmitted signal over the bandwidth
5 of the pulse is obtained by avoiding a DC component and wherein a desired frequency spectrum of the monocycle waveform is designed to be flat over a target bandwidth and wherein Gaussian waveform pulses are used due to the flexibility and low computation process in the pulse generation in a receiver.
- 10 2. An ultra wideband pulse shaper for in band interference mitigation as claimed in Claim 1 wherein the Gaussian doublet is used which consists of a pair of separated narrow second derivative Gaussian pulse wherein a positive pulse followed by a negative pulse.
- 15 3. An ultra wideband pulse shaper for in band interference mitigation as claimed in Claim 2 wherein the amount of interference at an UWB receiver due to a narrowband emitter is highly dependent on the carrier frequency for the respective systems as well as their place on UWB bandwidth.
- 20 4. An ultra wideband pulse shaper for in band interference mitigation as claimed in Claim 2 wherein two degrees of freedom is provided wherein time separation between the two pulses in the doublet and time separation between doublets.

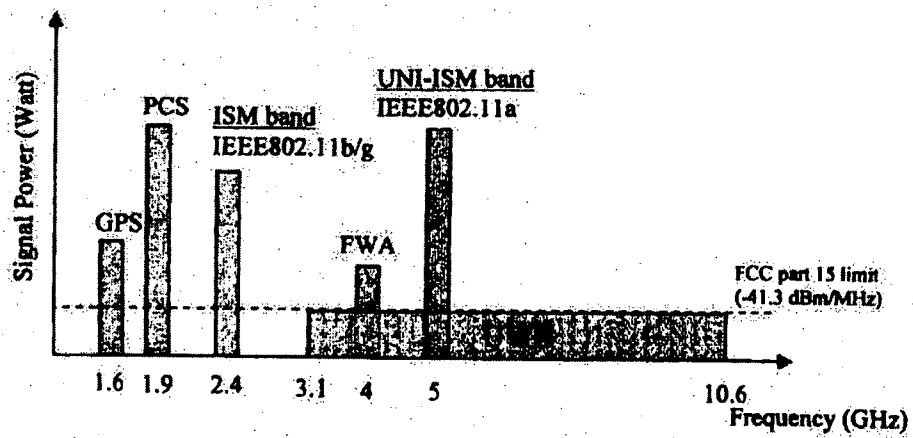


FIGURE 1

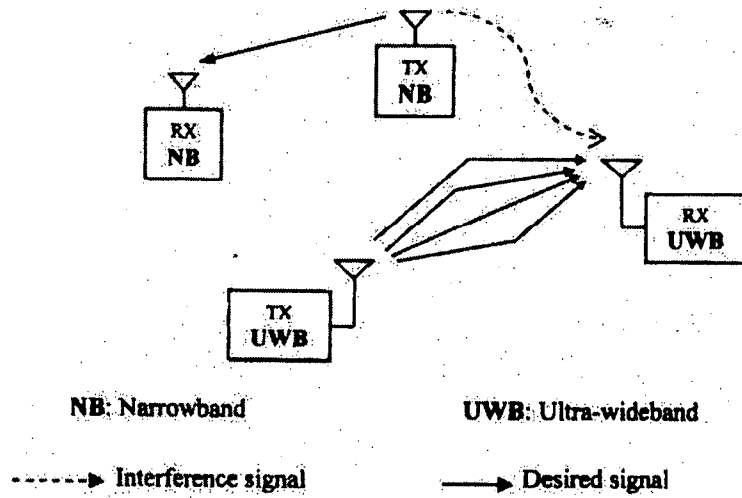


FIGURE 2

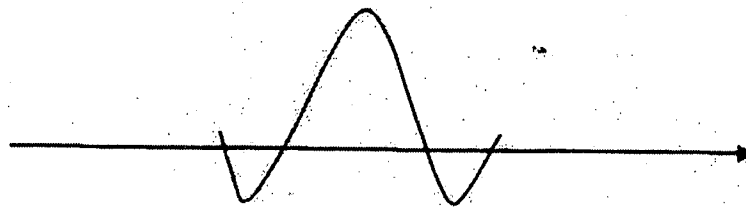


FIGURE 3

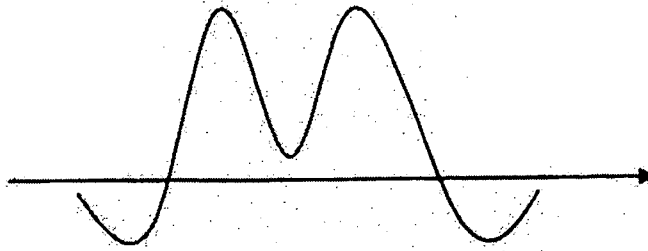


FIGURE 4

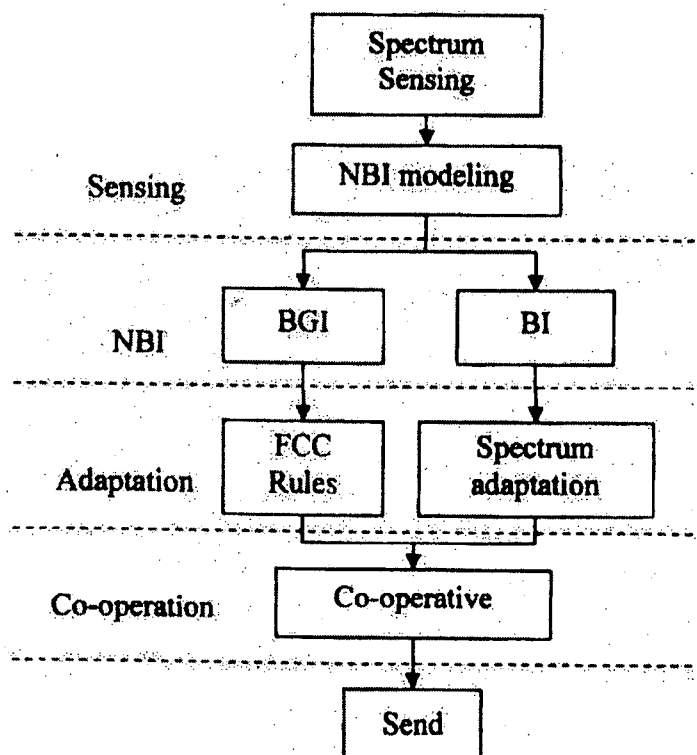
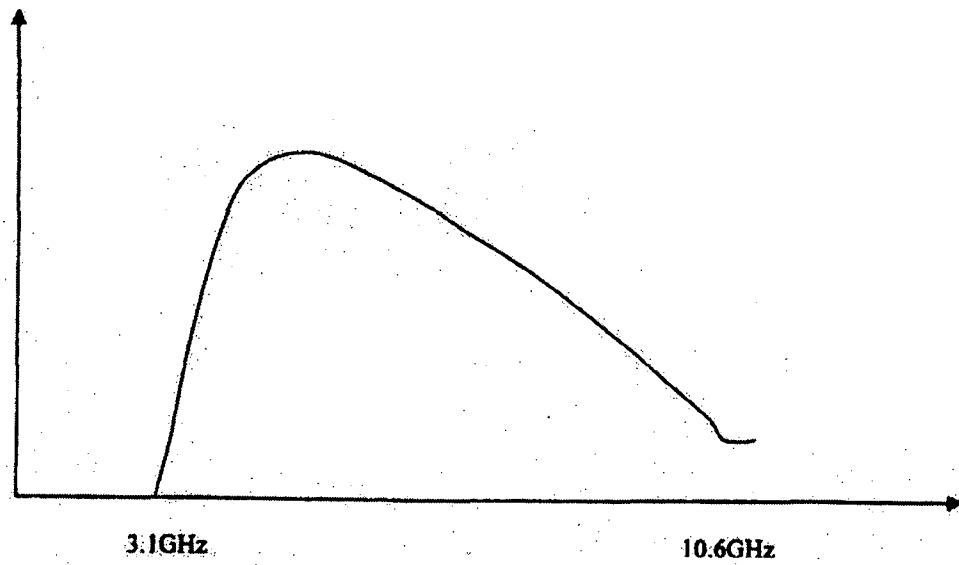
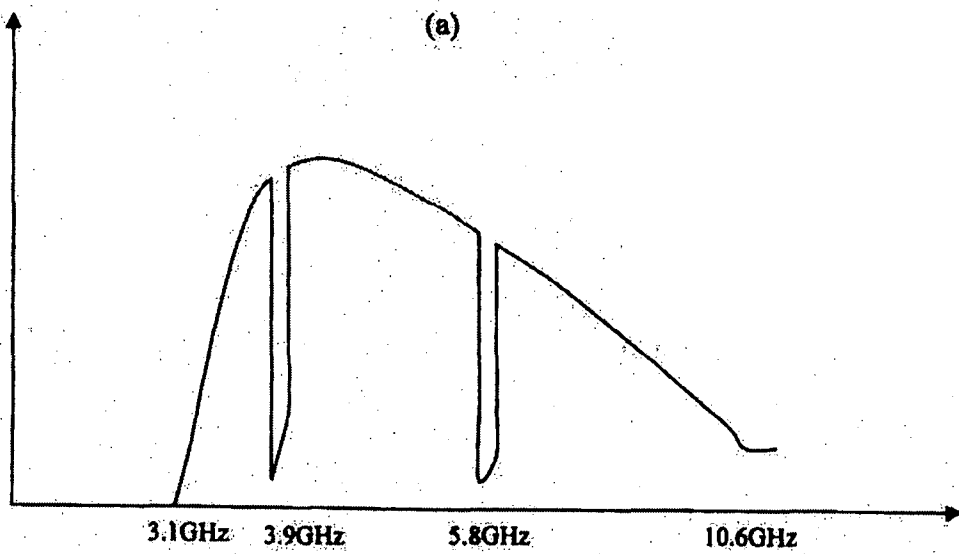


FIGURE 5



(a)



(b)

FIGURE 6