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A NOVEL TRANSCEIVER FORENHANCED BLUETOOTH COVERAGE

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***Abstract*— In recent days people frequently use Bluetooth for data sharing. They suffer the lack of speed and preferred to use some mobile applications. Bluetooth is inbuilt in the personal communication devices has the data rate of 25Mbs. Also it is well know that the Bluetooth has the coverage of 10 to 33 meters. The coverage distance is limited by the transmitted power and the data rate is by low spectral modulation. This issue is taken as a challenge and tackled by changing the air interface for communication.**

Though there is a trade of between spectral efficiency and power efficiency there are advanced modulation and coding techniques to enhance these two considerably Amplitude Shift Keying Modulation is found to have appreciable power and spectral efficiency and recommended for wireless application requiring extended distance coverage. In this work a Novel Transceiver system for Bluetooth is proposed and designed with the above said modulation. The work is carried out as a Simulink work using Matlab and the range extension are observed.

I. INTRODUCTION

In order to increasing number of users in short distance data sharing applications Bluetooth is implemented. Bluetooth is a global wireless communication standard that connects devices together over a certain distance. Bluetooth is mostly preferred as Personal Area Network (PAN) such as headset and phone, speaker and PC, basketball to smart phone and more. It is built into billions of products on the market today and connects the Internet of Things (IoT).There are several kinds of different versions of the core specifications in Bluetooth. The most common today are Bluetooth BR/EDR (basic rate/enhanced data rate) and Bluetooth with low energy functionality. The Enhanced Bluetooth coverage Transceiver provides coverage of 10 to 33 meters with increased data rate of 25 Mbps. It can be achieved by using Amplitude Phase Shift Keying modulation technique.

Keywords
Bluetooth, PAN, Amplitude Phase Shift Keying, IoT

II. BLUETOOTH AS PAN

Bluetooth is a wireless technology standard for exchanging data from fixed and mobile devices, and building PANs using short-wavelength UHF radio bands in the ISM band from 2.4 to 2.485 GHz. PAN describes how two or more Bluetooth enabled devices can form an ad-hoc network and how the same mechanism can be used to access a remote network through a network access point. The PAN defines three roles, that of a Network Access Point (NAP), Group Ad-hoc Network (GN) and PAN User (PANU). Network Access point is a Bluetooth device that supports the NAP service that provides some of the features of an Ethernet bridge to support network services. A Bluetooth device that supports the GN service is able to forward Ethernet packets to each of the connected Bluetooth devices, the PAN users, as needed. PANU is the Bluetooth device that uses either the NAP or the GN service. Generally The Baseband, LMP and L2CAP are the part of the Bluetooth protocols that reside in the OSI layers 1 and 2.

Bluetooth versions

There are number of Bluetooth versions which all are being developed to meet the particular requirements of the time. They come with different specifications to offer different options to the users.

Table 1. Comparison of Bluetooth versions

Versions	Data rate	Maximum ApplicationThroughput
1.2	1Mbits/s	>80 Kbits/s
2.0+EDR	3 Mbits/s	>80 Kbits/s
3.0+HS	24Mbits/s	>1 Mbits/s
4.0	24Mbits/s	>1 Mbits/s

The comparison table for Bluetooth versions is shown in the Table 1.

III. ENHANCEMENT IN BLUETOOTH

IoT(Internet of Things)

The "Internet of Things" is not a second Internet rather it is a network of devices that are connected to the Internet that is used every day to search Google, upload images and connect with friends. It is a network of products that are connected to the Internet, thus they have their own IP address and can connect to each other to automate simple tasks. The power-efficiency of Bluetooth with low energy functionality makes it perfect for devices that run for long periods on power sources such as coin cell batteries or energy-harvesting devices. The smart part is the native support for Bluetooth technology on every major operating system, for easy mobile application development and connectivity for cloud

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computing and the social economy. *Bluetooth* makes it easy for developers and OEMs to create innovative new products that communicate with the billions of Bluetooth enabled devices already in the market. Bluetooth with low energy is inexpensive and developer-friendly, with flexible development architecture. And as a Bluetooth SIG member, we can tap into a network of tens of thousands of application developers, device makers and service providers.

Modulation in Bluetooth

Gaussian frequency shift keying: When GFSK is used for the chosen form of Bluetooth modulation, the frequency of the carrier is shifted to carry the modulation. A binary one is represented and by a positive frequency deviation and a binary zero is represented by a negative frequency deviation. The modulated signal is then filtered using a filter with a Gaussian response curve to ensure the sidebands do not extend too far either side of the main carrier. By doing this the Bluetooth modulation achieves a bandwidth of 1 MHz with stringent filter requirements to prevent interference on other channels. For correct operation the level of BT is set to 0.5 and the modulation index must be between 0.28 and 0.35.

Demodulation in Bluetooth :

An efficient mixed-mode Gaussian frequency-shift keying (GFSK) demodulator with a frequency offset cancellation circuit is presented. The structure is suitable for a low-IF Bluetooth receiver and can also be applied to other receivers involving continuous phase shift keying (CPSK) signals. The demodulator implementation is robust to tolerate process variations without requiring calibration. It can also track and cancel the time-varying local oscillator frequency offset between transmitter and receiver during the entire reception period. The chip was fabricated in CMOS 0.35-μm digital process; it consumes 3 mA from a 3-V power supply and occupies 0.7 mm^2 of silicon area. A 16.2-dB input signal-to-noise ratio is obtained to achieve 0.1% bit-error rate as specified in Bluetooth specs. The co-channel interference rejection ratio is about 11 dB.

IV. CONSTRUCTION OF TRANSMITTER

a. Transmitter block:

The implementation was built on Matlab/Simulink using fundamental components in Simulink to demonstrate how reliably complex modulation schemes can be built, cost effectively and efficiency [2]. The design of Enhanced Bluetooth Transmitter using APSK modulation is shown in fig.1. Here the input baseband signal is given as binary data to bit to symbol mapping block. Here we map input data bits to 8-chip PN sequences to be transmitted and results in a chip rate of two mega chips per second. The resulted chip sequence is given to the modulation block. In the modulation block we use APSK modulation technique. It is a digital modulation scheme that uses both the amplitude and the phase changes of on the carrier signal to provide the data transport mechanism for the information. Many existing wireless systems use various forms of quadrature amplitude modulation. This form of modulation provides excellent performance in terms of spectral efficiency, noise immunity and ease of use.

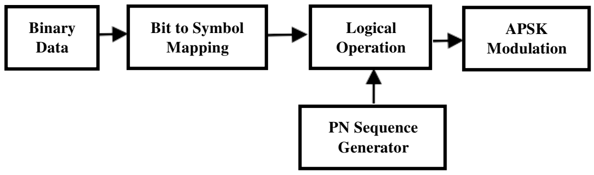

Figure 1. Bluetooth Transmitter

So it is considered as a super class of Quadrature Amplitude modulation. Here the APSK modulation block deals with PN sequence and that produce DSSS signal

V. Experiment RESULTS

After the design phase of Bluetooth transmitter (Figure 1) the following results have been obtained. Based on the constellation diagram of APSK we get 4 different amplitude and phase shifted Inphase and Quadrature signals. They are shown in following figures 2, 3, 4, 5. The equation for 16 point APSK derived using constellation diagram

$$X=\begin{cases} r_1 e^{j((2\pi/n1)i+\theta_1)} & i=0\ldots n_1-1 \\ r_2 e^{j((2\pi/n)ki+\theta_{nR})} & i=0\ldots n_2-1 \\ \vdots & \\ r_n Re^{\,j((2\pi i/nk)+\theta_{nR})} & i=0\ldots nR-1 \end{cases}$$

where,

θ is the phase angle of a symbol
rn is number of circles and
R is the radius of the circle

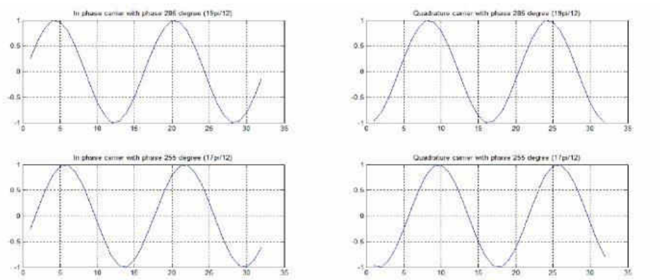

Figure 2. Inphase and Quadrature phase carriers with 75^0 and 105^0

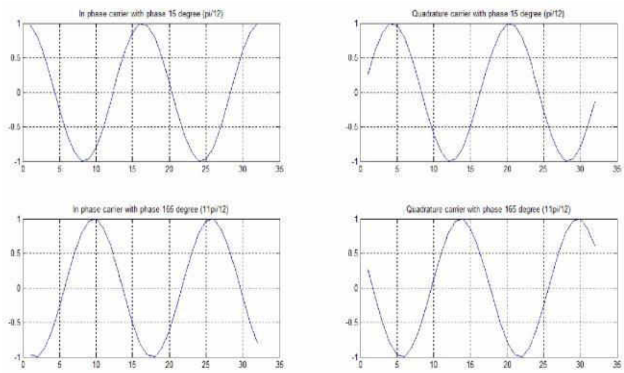

Fig 4 285^0 and 255^0 of Inphase and Quadrature phase.

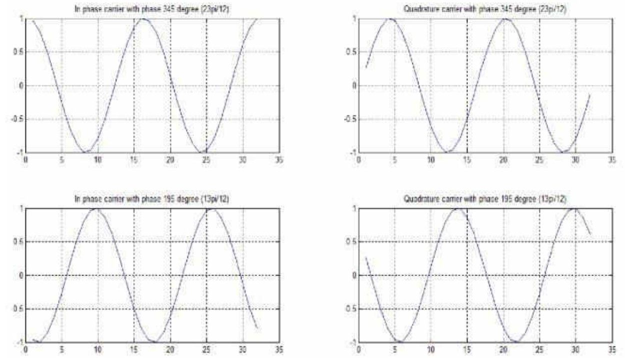

Fig 4 15^0 and 165^0 of Inphase and Quadrature phase.

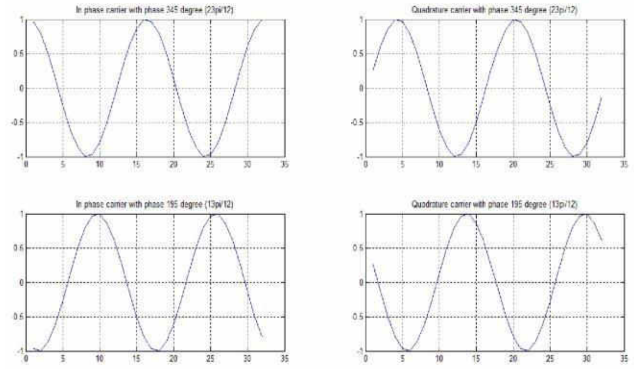

Fig.5.345^0 and 195^o of Inphase and Quadrature phase.

Resulted Apsk modulated signal from the modulation block is shown in the figure.7

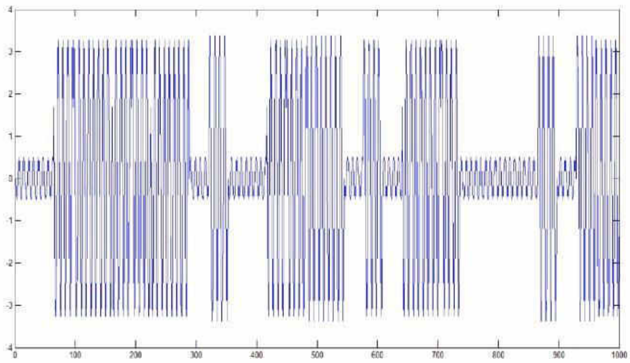

Fig 7Output Waveform of APSK Modulation.

Here we can get better power spectral density for APSK modulation that shown in figure 8.

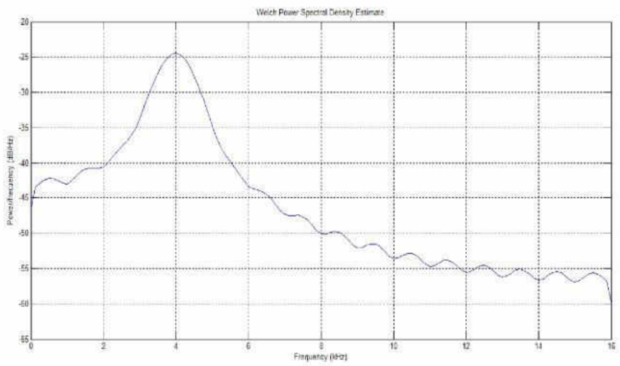

Fig 8.Output Waveform of Welch Power Spectral density estimate.

VI. Conclusion:

Bluetooth with enhanced data rate is designed and simulated using Matlab. This paper contains the APSK modulation and its descriptions. The simulation results show the APSK waveforms and its power spectral density. This will be implemented in the DSSS for enhanced Bluetooth. The use of APSK will improve the coverage along with the data rate at an acceptable range. As a future work it can be deployed in hardware for implementation.

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