CARRIER LESS AMPLITUDE AND PHASE (CAP) ODULATION TECHNIQUE FOR OFDM SYSTEM

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Abstract: Nowadays, Carrier less Amplitude and Phase (CAP) Modulation has been used in various industrial applications because of its simplicity and bandwidth efficiency. In this paper, a novel CAP modulation technique has been used for OFDM in wireless communication system. To reduce the spectrum efficiency losses and improving the speed of the data transmission are the main requirements of the wireless communication systems. In conventional technologies transmitter takes long time to modulate and encode the signal, the time delay occurred during the conversion is suffers the total Li-Fi networks. In order to overcome this problem, novel modulation techniques have been proposed such as Carrier less amplitude and phase modulation (CAP) and Quadrature Phase Shift Keying (QPSK) Modulation. The design simulation is carried out in ModelSim XE III 6.3C and Synthesized in Xilinx ISE 10.1 by using Verilog HDL Language.

Key words: Carrier less amplitude and phase modulation (CAP), Bit Error rate (BER), Verilog Hardware description language (HDL), Area-Delay-Product (ADP), Modelsim, Xilinx

I. DATA TRANSMISSION IN WIRELESS SYSTEMS:

In Wireless Communication Systems, the data transmission from one area into another area is one of the efficient task to achieve high data rates. Fixed bandwidth is allocated for multiple users in wireless networks. The present wireless networks generate the slow internet activity for multi user environment. Light based Wi-Fi can be known as LiFi. Wi-Fi performs the wireless internet access and bandwidth limitation is 50-100 Mbps at 2.4 -5 GHz RF . Li-Fi can be used in applications which are interfered with radio waves and undersea where Wi-Fi cannot reach by using light intensity. Li-Fi used in various applications such as Military, Aircrafts, Hospitals. Li-Fi provides better authentication, mobility, efficiency than Wi-Fi.

Visible light communication (VLC) technology is used for Li-Fi for transfer the data through illumination of light intensity through LED bulb. These LED changes in the light intensity faster than a human eye. For data transmission and illumination, the VLC technology uses visible light between 400 THz and 800 THz. LED bulbs have capable to ON or OFF. Digital data 1 and 0 is transmitted based on light LED light conditions.

II. LITERATURE SURVEY

[Walid Abdallah, Noureddine Boudriga, 2016] presented OFDM based Li-Fi technology for 5G wireless access. To exaggerate the data rates and reduces the transmission delay, the OFDM based Li-Fi system is used. Li-Fi is used to improve the transmission capacity in indoor . VLC based OFDM reached the highest data rate that is 3 Gbits/s. For multiuser environment, the Light Fidelity is not applicable.

To provide the highest transmission capacity , the encoding technique is used.[Abdelmoujoud Assabir et al, 2016] presented Li-Fi data transmission based Pulse Width Modulation(PWM) signal. To modulate the signal, the PWM is used. That light signal is transmitted via Light Emitting Diode (LED). For transform the light signal into electrical signal, the Photo Diode is used. [M. Samuel Lazar, T. Ravi, 2015] described high speed data transmission based Light Fidelity (Li-Fi). Li-Fi is performs with transceiver section.

For transmission and reception, the Light Emitting Diode (LED) and Photo diode is used. The light intensity of light is changed faster than the human eye by using LED devices. [Harald Haas, 2015] explained the difference between the visible light communication (VLC) and Light Fidelity (Li-Fi). VLC technologies are suitable for the high frequency systems. For modulations purpose, there are various modulation techniques are used. Lifi provides the connectivity to realize the IoT. [Yichen Li et al, 2013] described optical spatial modulation based orthogonal frequency division multiplexing (OFDM). For optical Wireless Communication (OWC) Systems, the positive and negative values are determined by using various modulation techniques.

III. VISIBLE LIGHT COMMUNICATION (VLC) TECHNOLOGY:

In Indoor applications, the Li-Fi systems are used to improve the data transmission range. Visible Light Communication (VLC) system is entirely used for Li-Fi systems. Transceiver is used to perform the data transmission in Li-Fi systems. Light intensity is used to communicate the data information from transmitter and receiver.

Transmitter section contains Digital Modulation, Encoding and Decoding Mechanism and Photo diode. Data from sender is transformed to the Modulation Block. After completing the modulation process, the data is forward to the encoder block. If the data contains any type of errors, the encoder is used to detect and correct the error.

That electrical data is converted into the light signal by using photo diode. The data transmission through LED is necessary to modulate into a carrier signal. To receive the original signal, the photo diode is used in receiver section. Demodulation is used to retrieve the original signal in final section.

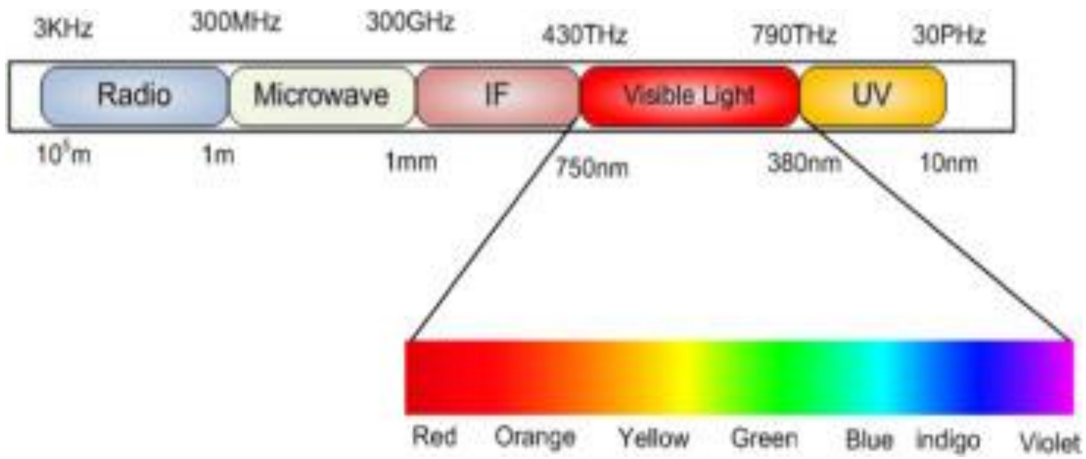

Figure 1: Visible Light Communication Spectrum

IV. VARIOUS MODULATION TECHNIQUES FOR DATA TRANSMISSION:

Binary phase shift keying (BPSK) is the method of digital modulation under the category of phase shift keying (PSK). In this method of digital modulation, one of two phases of the carrier signal is transmitted during every bit duration, denoted by T . These carrier signal phases are 180 degree apart so that wave forms are antipodal. In general, antipodal waveforms give the minimum error probability over any other group of binary signals. There are two signals separated by 180 degree is utilized by BPSK and it also can be termed as 2-PSK.

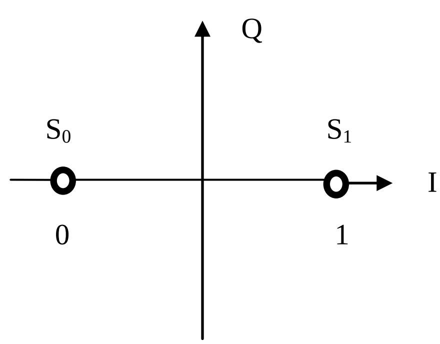

Fig 2: Constellation diagram for BPSK Modulation

In above constellation diagram, the 0^0 and 180^0 real axis are shown. That diagram clearly demonstrates the points are only on the x-axis. There is no projection on the y-axis. BPSK technique is single basis function because that modulated signal have only in-phase component (I) not quadrature component (Q). Every T_b seconds, the modulator transmits the one of two carrier phases that related to the input bit 0 or 1.

Input bit 1: $s1(t) = Ac\cos(2\pi fct)$

Input bit 0: $s2(t) = Ac\cos(2\pi fct + \pi) = -Ac(\cos(2\pi fct))$

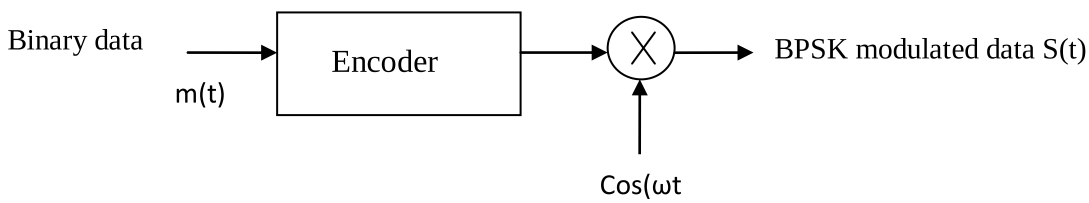

Fig 3: BPSK Modulator

Binary phase shift keying (BPSK) Modulator is implemented by using NRZ encoding to represent the binary input 1 by negative voltage and binary bit 0 by positive voltage. Then the data is given to the multiplier to multiply the data by a reference oscillator at carrier frequency ω.

In BPSK Demodulator, the report of the carrier frequency and angle must be known to the receiver by using phase locked loop (PLL). Phase locked loop (PLL) at the receiver is practically to close the input carrier frequency and find the changes in frequency and phase. Reference frequency (cosωt) is used to multiply the received signal then that signal is combined over one bit period by using integrator. Both positive and negative direction, NRZ signaling is used with same amplitudes. That signaling method the threshold would be zero.

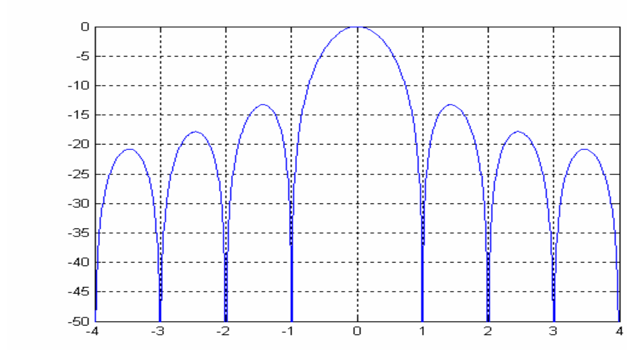

Fig 4: Power Spectrum response for BPSK

Quadrature phase shift keying (QPSK) is most general form of phase shift keying and widely used in cellular and MODEM applications. In QPSK technique, two bits of carrier pulse is transmitted by using 45, 135,225,or 315 degrees phase shifts. NRZ Symbol sequence is used to modulate the each orthogonal carrier signal. The input binary data is received at data rate $R_{b.}$ By using serial to parallel converter, the R_b is divided to two data streams, one including even bits(b_{2n}) and another including even bits(b_{2n+1}). That odd and even bits are encoded into polar transmission symbols a_{2n} and a_{2n+1} by QPSK Modulator.

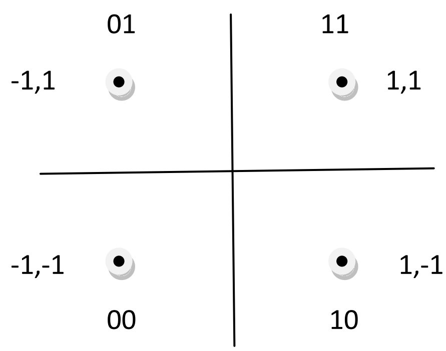

Fig 5: Constellation diagram for BPSK Modulation

In QPSK modulation, the phase shift of the carrier signal is not related to the reference signal but related to the previous signals phase shifts. For reconstruction, the two signals is only compared, it doesn't require reference signals. The angle of the signal is always related to the reference signal. Inter channel interference (ISI) is one of the main issue in this modulation scheme. The amplitude and phase of QPSK is varied to reduce the ISI. QPSK technique is more sensitive for phase variations.

(C) Quadrature amplitude modulation (QAM):

Quadrature amplitude modulation (QAM) is replacement digital amplitude modulation for the digital phase modulation. In QAM technique, both amplitude and phase of the carrier signal is changed based on input bits. In general, the two bits of data are considered but in QAM the four bits if data is considered to perform modulation. This technique also has phase and quadrature signal.

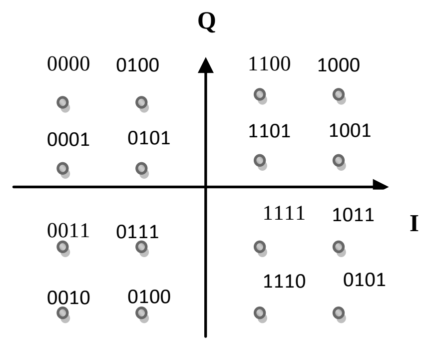

Fig 6: Constellation Diagram for QAM

Digital input is modulated by using 16 combinations of input bits as shown in figure. So the hardware utilization is not highly achieved in this type of modulation. Speed and accuracy is achieved highly than other modulation techniques In Radio communication systems, the transmission efficiency is increased by using both amplitude and phase changes in QAM. In general, the constellation points are closer together with the number of points equal to the power of 2. So there is the possibility of noise occurrence. Linearity is one of the main issue in this modulation technique because of linear amplifiers.

V. EXPERIMENTAL RESULTS:

VERILOG HDL is a hardware description language (HDL). A hardware description language is a language used to describe a digital system, for example, a computer or a component of a computer. An even high level describes the register and the transfer of vector of information between the registers. This is called as Register Transfer Level (RTL). VERILOG supports at all these levels. However, this hand-out focuses on only the portion of VERILOG support the RTL level.

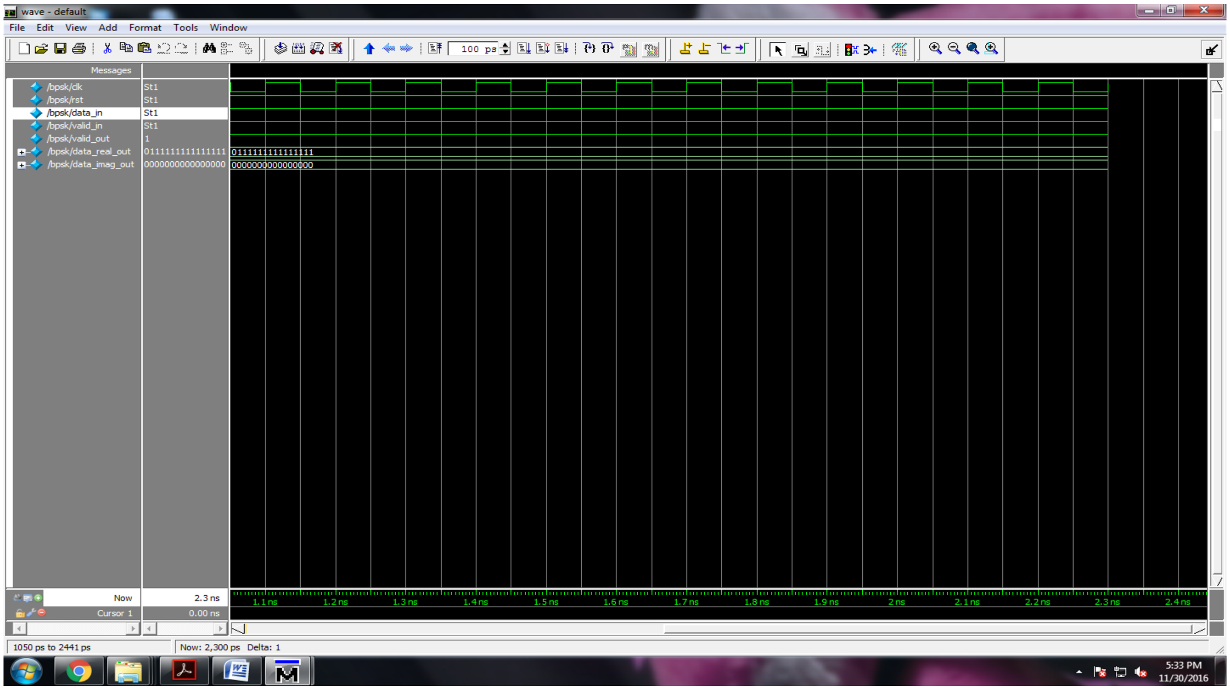

Figure 2: BPSK Modulation Scheme

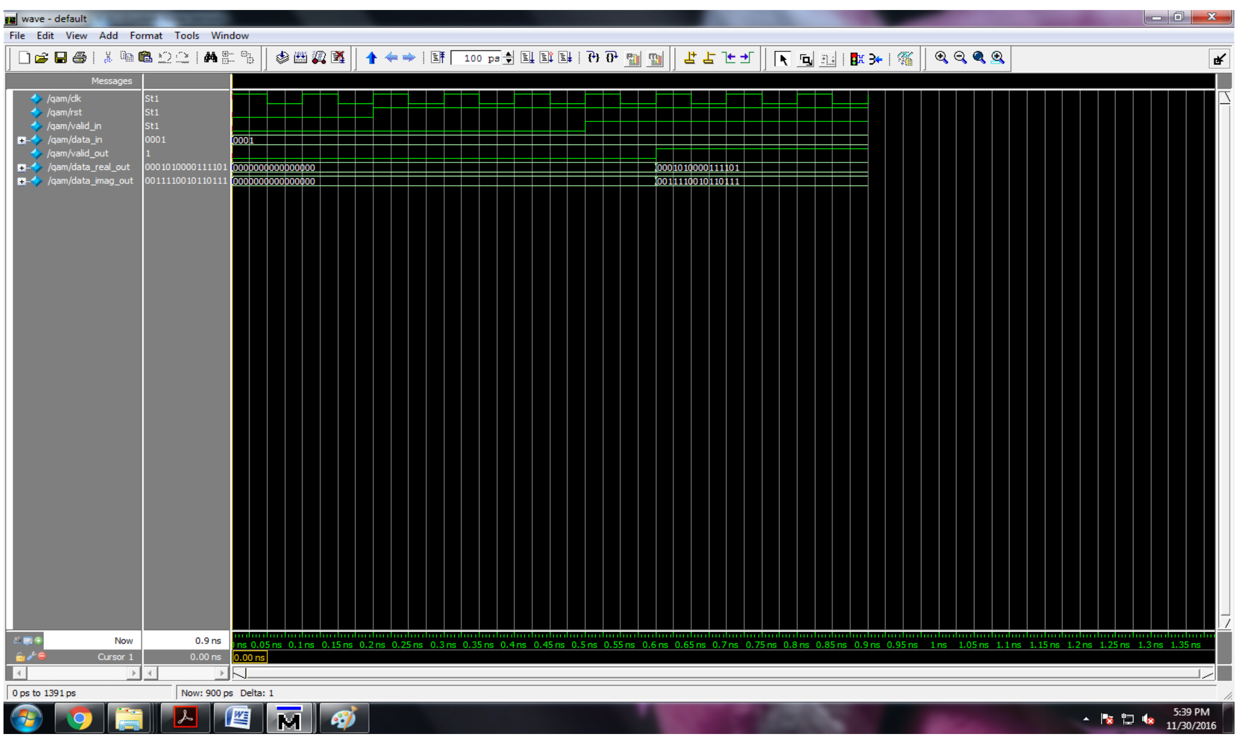

Figure 3: QAM Modulation scheme

Table 1: Comparison tabulation for various modulation techniques

Modulation Model						
QAM Modulation	**4**	**8**	**2.637**	**379.218**	**255**	**~**
QPSK Modulation	**2**	**4**	**2.571**	**388.953**	**255**	**Low Area and High Speed**
Demodulation Model						
QAM Demodulation	**19**	**35**	**6.141**	**162.839**	**242**	**High Speed**
QPSK Demodulation	**12**	**22**	**6.216**	**160.875**	**197**	**Low Area and Low Power**

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