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Selection of modulation method for city uses of data transfer system through power lines



Peyman Karami

mpkarami@gmail.com

Islamic Azad university of Hidaj

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Name of the Presenter: Peyman Karami

Abstract

Technology of data transfer system through power lines is a system for data transferring through a conductor that is used for electric energy transferring too. For connect the communication system to power system coupling capacitors and line matching unites should be used. For giving way to data current should be used line traps. Modulation and coding are actions those are done for availability to trust worthy and effective connection. Amplitude modulator because of need to less band width, use of simple detector system , having simple circuit and ability of separating carrier signal from external signal without need to filter is suitable for the use in PLC system.

Key words: Modulator, PLC, Amplitude, multiplex,

1. Introduction

Modulation and coding are actions those are done for availability to trust worthy and effective connection in transmitter the major object of modulation in a communication system is production of modulated signal that agree with communication channel specifications. Transfer of Signal to far distances accompany with electromagnetic waves movement always whether is a conductible environment or not. Efficiency of any transfer way transfer way depends on a transferred signal frequency.

This paper introduces data transmission system through power line and survey and contrast of most usable CW modulation methods and other data transmission methods. In continue we'll select and suggest most suitable method for the city uses of PLC.

2. PLC system

Today however high speed interest with optical fiber is easy and available but PLC system is used in a wide level yet. PLC is a system for data transmission through a conductor line that is used for electric energy transmission too and uses broad band over power line (BPL) with send or receive radio signals through electric transmission line for connect to internet. PLC

system at most of the time is a most economic and trust worthy private channel with possible high speed for possible protective relaying. Power line carrier system has three major parts: transmission line that supply a channel for transmission of carrier signal, tuning, blocking and coupling equipments those supply possibility of connection to high voltage transmission line, and transmitters receivers and relays. A simple design of power line carrier system is shown in figure 1.[5]

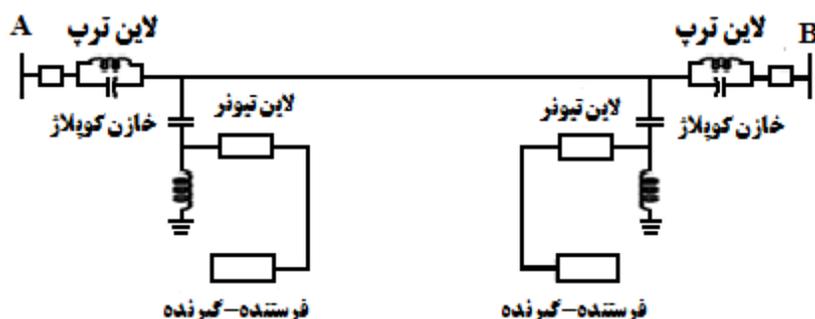


Fig 1: Schematic of PLC system.

2.1. Points about PLC

PLC communication systems from frequency point of view are divided to three groups:

- 1) High frequency communication
- 2) Intermediate frequency communication
- 3) Low frequency communication

Common city uses of PLC communication network consist of:

- 1) Domestic networking
- 2) Connect to internet
- 3) Domestic control
- 4) Radio programs transmission

From said cases domestic networking and connect to internet are group of high frequency and domestic control and radio programs transmission are in group of Intermediate frequency communication.

Transmission lines have much noise. Whenever an electrical set is turned on or off, it imports a sudden beat or click to line. Most of the time energy saving equipments import noise harmonic to transmission line. PLC system should be designed to come to terms with this natural signal disturbance and operate with them.

Transmission lines are without cover and act as antennas for signals that they carry and there is possibility of interference with radio communication short waves .plc modern systems profit from OFDM modulation that keep least interference with radio services through delete of special frequencies.[1]

3. Comparison between CW modulation systems

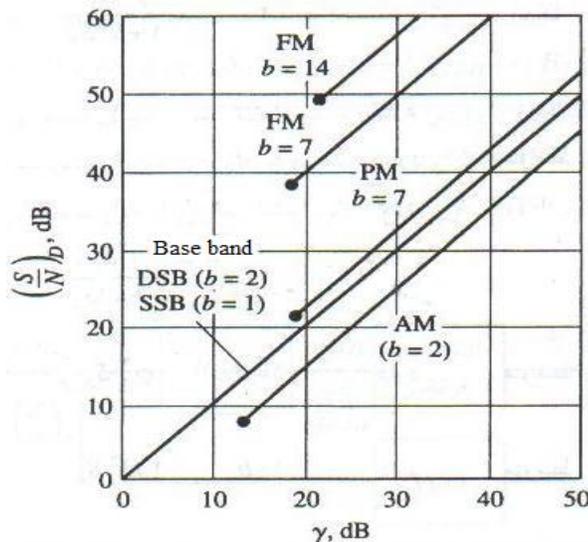
Finally we can contrast correctly between different kinds of modulation methods. Points should be contrasted is summarized in table 1: transmission band width normalized to Y ($b = B_T/W$), signal to noise ratio ($(S/N)_D$) normalized to Y , in destination threshold point if possible, DC response (or low frequency response) and hardware complication. In this table transmission in base band is written as a reference. We have selected $Y = S_R N_O$ that S_R is recieved power, W is message band width and N_O is referenced noise density to receiver entrance. We have used $S_x = X^2 \leq x(t)$ that $x(t)$ is message. We have considered systems almost ideal so $(S/N)_D$ shows high level.

Between different kinds of linear modulation deleted carrier methods are superior than AM at least two regarding: signal to noise ratio and lack of threshold effect. In case that saving in bandwidth is important single side band and rejection single side band have much grace, but nothing earn without cost and cost of more efficiency linear modulation is increase of hardware complication chiefly in receiver. Simultaneous detector is down in any form needs more complicated circuit than the Sheath detector. For point to point communication (a transmitter and a receiver) can be pay this cost but for commercial distribution (a transmitter and several receivers) for economic considerations easiest receiver or in other words push detector is suitable. From the view of hardware AM is simplest method for linear modulation and deleted carrier VSB with special side band filter and necessity of simultaneous is the most complex method. Between DSB and SSB (in suitable uses) the second one has less problem of construction because its simultaneous is not critical. Also with Improvement of filter construction technology, necessary side band filters are available more and more now. In the same way VSB+C is average in complication. Because Notwithstanding Necessity of rejection filter, Sheath detector can be used in it.

Type	compiexity	DC	Y_{th}	$(S/N)_D \div Y$	$b=B_T/W$	Explanations
Base band	Low	No	...	1	1	Without modulation
AM	Low	No	20	$(\mu^4 S_x)/(1+\mu^2 S_x)$	2	Sheath detector $\mu \leq 1$
DSB	High	Yes	...	1	2	Simultaneous detection
SSB	Medium	No	...	1	1	Simultaneous detection
VSB	High	Yes	...	1	1 ⁺	Simultaneous detection
VSB+C	Medium	Yes	20	$(\mu^4 S_x)/(1+\mu^2 S_x)$	1 ⁺	Sheath detector $\mu < 1$
PM	Medium	Yes	10b	$\phi_{\Delta}^2 S_x$	$2M(\phi_{\Delta})$	Phase detector .fixed amplitude , $\phi_{\Delta} \leq \pi$
FM	Medium	Yes	10b	$3D^2 S_x$	$2M(D)$	Frequency detector , Fixed amplitude

Table 1. Comparison between CW modulation systems.[3]

FM and PM modulations in contrast with baseband and linear modulation can improve $(S/N)_D$ considerably and this matter doesn't cause hardware complication. Figure 2 shows this matter for $S_x = 1/2$. All of curves are specified in according to band width. It's clear that in lieu of same b FM is superior that PM regarding performance.

**Fig 2:** Operation of CW modulation system.[3]

Also until when action is done above threshold can be with increase of b improved position, while because of $\phi \leq \pi$ PM is limited to $b \leq 10$. The cost that is pay for improvements of FM is increase of transmission band width. So at times that vivid output signal is in first degree of importance at and economy in band width is at next degrees, wide band exponential modulation (frequency and phase modulations) is more suitable. In microwave frequencies both effect of noise decrease and stability of amplitude are desirable. Regarding economy in power, FM with average b is better than linear modulation if threshold effect doesn't appear. Regarding send of signals that have much low frequency content, we have discussed superiority of DSB and VSB beforehand. For fax and video, electronic DC convertor circuits possible Sheath detector and has converted it to a desirable method. (We can use AM too but band with increases. We never discuss deleted carrier single side band.)

Also we noticed that Dominant Separator has well low frequency response so low frequency performance of FM can be like DSB or VSB without simultaneity causes any problem. In similar reasons, magnetic recorders with high quality have FM mode. It means that entrance is recorded as frequency modulated wave. In relative performance table of systems regarding time change of transmission channel, fade with choice of frequency, multipath distribution and etc is not showed. Unstable transmission channel has multiplier effect that usually causes disaster for Sheath detector (persons who listen to far AM stations at night late, are familiar with this destructive effect.). In similar way instability of transmission channel commonly destroy wide modulation. Brief summation is not possible. There is no general solution for solve of all communication problems. So communication engineer should deal with new matter with open mind and consider all available information.

Therefore, in AM: asynchronous modulation and demodulation systems in comparison with synchronous systems have some advantages and disadvantages. Synchronous need a complex demodulator system. because its oscillation maker must be synchronous with modulator in frequency and phase. In other hand, asynchronous modulator for transmitting needs more power, because for making Sheath detector, Sheath must be positive. In another word, there should be compiled carrier in transmitting signal. In cases like radio, this method is often preferred. Since receivers (modulator) are numerous therefore the construction cost would be less. Extra costs which are caused by additional power, compensated by thrift, but in some cases when the transmitting power is the most important, like satellite transmitting so the building cost of complex synchronous receivers becomes viable. In modulated signal with sinusoidal carrier there are extra information, it is possible to cancel this information by the use of a method, known as single side band modulation. Single side band synchronous demodulation systems are the same as double side band synchronous demodulation. The cost of this increase in single side band systems efficiency is the complexity of the modulator. regarding the power , DSB is more economical but requires complex modulation , therefore, AM by transmitting more power has the capability to prepare a simple method of detecting. SSB , for sending pulse , digital data or similar functions is not suitable and more suitable modulator signals should also be filtered before modulation to slowdown their fast variations and prevent disappearance.[2],[3]

in FM: In another important modulation method known as frequency modulation, a modulating signal is used to control the sinusoidal carrier frequency. This type of modulation in comparison with amplitude modulation has some advantages: in sinus range modulation, career range has direct relation with the size of modulator signal and the frequency of this signal can vary in a wide range. In frequency modulation Sheath of career is always fixed, therefore, FM transmitter can always work with maximum power. Besides, in FM systems it is possible to cancel the existence disappearances in receivers for this reason, in public sector and other function, the quality of receiving FM is better than the AM. The necessary band wide for frequency modulation is generally greater than the amplitude modulation. Angle modulation systems are highly nonlinear. As a result their analyses are not the same as analyzing the amplitude modulation systems as discussed previously. The amplitude of modulated wave is a fixed facing. Passing through the exponential modulated wave zeroes is not frequent, But in linear modulation, it is always frequent because of fixed amplitude in FM and PM we can say: message is always hidden in passing through zeroes, if the carrier frequency becomes great. Up to this point it appears that using the systems are based on the amplitude modulation (AM) for application of PLC within the cities for its technical and economical reasons is more suitable than the other modulation methods (C.W.). But, in comparison with FSK and wide range is it the same? Before going on toward FSK systems let's talk about multiplex systems.[2],[3]

3.1. Multiplex systems.[3]

When we need some communication channels between two points, by sending all the messages on a transmitting area, a huge saving is obtained. This process is called multiplex. Multiplex applications are expanded from telephone networks (in which multiplex is vital) to FM stereo networks and far measurement space systems. There are three major methods for multiplex:

- 1) Frequency division multiplex (FDM)

- 2) Time division multiplex (TDM)
- 3) Code division (C.D.M)

The goal of these methods is to prepare shared usage of a channel by a user. For this reason these methods are called: multi access with frequency division (FDMA), multi access with time division and multi access with code division (CDMA). Figure 3 shows the block diagram of a FDM multiplex system.

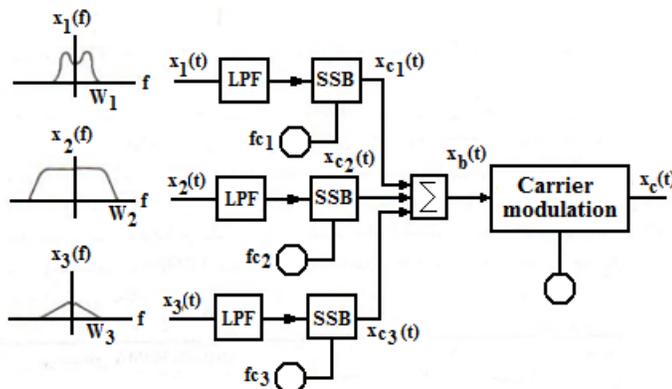


Fig 3: Input spectrum and block diagram of a typical FDM multiplex system.

4. Conclusion

Plc systems use current carrier cables for spreading waves. And as a result the band width in these systems in comparison with other communication methods and facilities are limited. So, using the multiplex systems causes to solve this problem. Regarding the previous discussions, multiplex systems benefit from CW modulation methods. But, because the necessary band width for FM is greater than the AM, and angle modulation systems are also very nonlinear, therefore, the analysis of them is not as direct as the amplitude modulation systems. Since the FSK modulation method is a digital modulation method, which only acts as sending digital data, and doesn't cover the application of PLC inside the cities, so as a result , application of amplitude modulation systems like : balanced amplitude modulator which is designed by the use of differential category with respect to some specifications like high power output, linearity [4] in plc applications within cities are economical and would cover up about all our requirements .

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