Techniques of Modulation: Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation

Diouba Sacko, Alpha Amadou Kéïta

Abstract: ***The modulation technique aims at adapting the frequency band of the informative signal to that of the transmission channel. This avoids a great attenuation of certain frequencies on the transmission channel and also reduces the effects of the noise. In addition, the modulation technique, which requires a transposition of the low frequencies towards the high frequencies, is used during the transmission of the informative signal (or useful signal) on long distances: the narrow band transmission. There are several types of modulation according to the nature of the informative signal (analogical or digital) and that of carrier signal (analogical or digital). In fact, the type of modulation to choose depends of practical application. In the transmission in baseband, i.e. on short distances, any frequency transposition is needed. This type of transmission utilizes copper wire, coaxial cable, the twisted pair or optical fiber as physical support; to transport pulse trains. In this article, we consider the narrow band transmission. We choose an informative signal of low frequency analogical nature (for example the human voice) and a carrier signal of high frequency digital nature (for example the clock signal). For frequency transposition, we use modulator with adapted sensitivity. Indeed, we simulate signals modulated in amplitude (PAM, Pulse Amplitude Modulation), in width (PWM, Pulse Width Modulation) and in position (PPM, Pulse Position Modulation). On an illustrative basis, we simulated the case of an audio informative signal. We analyze obtained results from simulation and recall advantages, disadvantages and applicability of each type of modulation. The modulation software used is ISIS from proteus. Let us mention that obtained results from simulation are little different from those of the real world and that because of the performance of the utilized software and other environmental parameters. PAM, PWM and PPM modulations are particularly employed for the analogical transmissions of the signals on optical fibers, in remote control IRE or telemetry.***

Keywords: Modulation, PAM, PWM, PPM, Simulation

I. INTRODUCTION

The modulation technique aims at adapting the frequency band of the useful signal to that of the transmission channel. This avoids a great attenuation of certain frequencies on the transmission channel and also reduces the effects of the noise.

Manuscript published on 30 December 2017.
***** Correspondence Author (s)
Dr. Diouba Sacko*, Département de Génie Informatique et de Télécommunications, Ecole Nationale d'Ingénieurs- Abderhamane Baba Touré, Bamako, République du Mali.
Dr. Alpha Amadou Keïta, Département des Sciences Fondamentales, Ecole Nationale d'Ingénieurs- Abderhamane Baba Touré, Bamako, République du Mali.

The technique of modulation, which requires a transposition of the low frequencies towards the high frequencies, is employed during the transmission on long distances: It is the narrow band transmission. To transmit a useful signal which is generally low frequency on long distances we use another signal called carrier signal to transpose its frequency towards high frequencies. It is the case of broadcasting, television, and the satellite communication. According to the nature of the useful signal (analogical or numerical) and that of the carrier signal (analogical or numerical), we distinguish the following types of modulation: AM, FM, PM, ASK, FSK, PSK, PAM, PWM and PPM. In base band transmission, i.e. on short distances, no need for transposition of frequency. This type of transmission utilizes the copper wire, the coaxial cable, the twisted pair or optical fiber as transmission channel. In this article, we will study PAM, PWM and PPM modulations. In these types of modulation, the useful signal is of analogical form while the carrier signal is a pulse resulting from a clock. These two signals (useful and carrier) arrive in a modulator who will give at its output the modulated signal (PAM, PWM or PPM). The analysis of the simulation results allows us to determine the advantages, the disadvantages and the applicability of the various types of modulation. Let us mention that obtained results from simulation are little different from those of the real world because of the performance of the used software and other environmental parameters. PAM, PWM and PPM modulations are used for the analogical transmissions of the signals over optical fibers, in the remote control IRE or telemetry.

II. STRUCTURE OF PAPER

The work is subdivided in seven chapters. The first chapter gives us the general information on the analogical modulation. In the chapters two, three, and four, we study theoretically PAM, PWM and PPM modulations; respectively. In the fifth chapter, we use ISIS software of proteus to simulate these modulations. The sixth chapter simulates the case of an audio useful signal by using the same software. The last chapter discusses about the advantages, disadvantages and applicability of PAM, PWM and PPM modulations.

III. GENERAL INFORMATION ON THE ANALOGICAL MODULATION

With the development of the telecommunication devices, it was necessary to code information to be transmitted in order to adapt it to the transmission channel such as optical fiber, coaxial cable, radio-transmit by relay of the systems.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Coding is also necessary when we must simultaneously transmit several signals on a single channel. Nowadays coding is subject of research and calibration. The frequency transposition (modulation) is an example of coding information. We distinguish two types of analogical modulations:

- Continuous analogical modulations

Amplitude modulation (AM);
Frequency modulation (FM);
Phase modulation (P.M)

- Analogical modulations by pulses

Pulse Amplitude Modulation (PAM);
Pulse Width Modulation (PWM);
Pulse Position Modulation (PPM).

According to the useful signal (low frequency), the modulation consists at the variation of one of the characteristics (amplitude, frequency, phase, width or position) of the carrier signal (high frequency). A modulator generally has two inputs and one output. By applying the useful and carrier signals at the inputs, it gives to its output the modulated signal which will be propagated in the transmission channel.

3.1. Principle of the Modulation

The transmission of a telecommunications signal (radio, T.V…) is done in the form of electromagnetic wave. It is propagated with the celerity of the light (C = 3.10^8 m/s). The useful signal x (t) is low frequency and can be produced by a microphone, a walkman or CD reader. The carrier signal p (t) is high frequency, and is produced by a local oscillator.

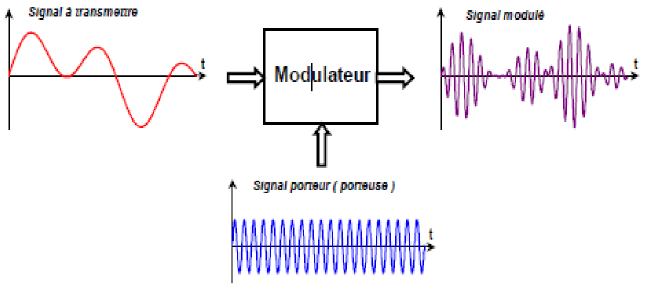

Fig 1: Modulator Block

3.2. Characteristics of the Signals

We consider
$x(t) = A_m\cos((2\pi f_m)\,t)$ and
$p(t) = A_p\cos((2\pi f_P)\,t)$
the expressions of useful and carrier signals; respectively.
A_m , A_p _ amplitudes of the useful and carrier signals;
f_m , f_P _ frequencies of the useful and carrier signals.
The modulated signal in amplitude is written:
$S(t) = (1 + K\,x(t)) * p(t)$;
With: $K*A_m$ the modulation coefficient and K the index of multiplier (modulator)
In a traditional modulation: $k \le 100\%$
There is overmodulation when k = m > 100 %

It is shown that: $k = \dfrac{Amax - Amin}{Amax + Amin} = m$

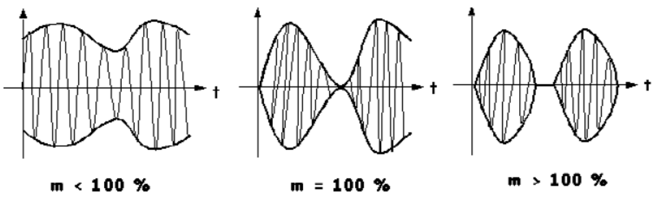

Fig -2: Modulation rate

We consider:
s (t) = A(t)cos $((2\pi f_0)t + \varphi(t))$, the expression of the signal to be transmitted
In FM, the instantaneous phase is written:
$\theta i(t) = ((2\pi fo)\,t + \varphi(t))$ and the instantaneous frequency:

$$Fi(t) = \frac{1}{2\pi}\frac{d\theta i(t)}{dt} = f_o + \frac{1}{2\pi}\frac{d\varphi(t)}{dt}$$
$$= f_0 + K_f * x(t)$$

The modulated signal s (t)) can be written in the form:
$S(t) = A(t)\cos((2\pi fo)\,t + \varphi(t)) = A(t)\cos(\theta i(t))$
The maximum excursion in frequency: $\Delta f = K_f * A_m$
We consider:
S (t) = A (t) cos $((2\pi f_0)\ t + \varphi\ (t))$, the expression of the signal to be transmitted
In PM:
$\varphi(t) = Kp*x(t)$
$Kp = 2\pi K_f$; with Kp-index multiplier (in PM) and K_f- index of frequency multiplier (in FM)
Modulations FM and PM are called angular modulations.

3.3. Modulation of a Linear Tension

Table below gives us a comparison between AM, FM and AM (image) signals in terms of bandwidth and power. In addition, it gives us the corresponding frequency bands for carrier signals.

Table 1: Comparison of the Continuous Analogical Modulations

	Type of modulation	Band-width	Carrier	Power
Radio long waves (amplitude)	AM	4,5 KHz	[150 KHz; 285 kHz]	[1 MW ; 2 MW]
Local radio (frequency)	FM	15 kHz	[88 KHz ; 108 kHz]	[1 MW ; 2 MW]
Television (phase)	AM (image)	6 MHz	[470 MHz ; 860 MHz]	[10 W; 50W]

IV. PULSE AMPLITUDE MODULATION: PAM

In modulated signal (PAM), the width and position of pulses are constant while the amplitude of pulses varies proportionally with the amplitude of analogical useful signal. Carrier signal is from a clock.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

4.1. Principle

The modulator transforms the analogical useful signal into a succession of rectangles. These rectangles are formed following the action of the sampler-blocker. Indeed, the taken samples, with regular intervals of time, on the useful signal are maintained for certain duration.

The rectangle amplitudes vary proportionally with those of the useful signal.

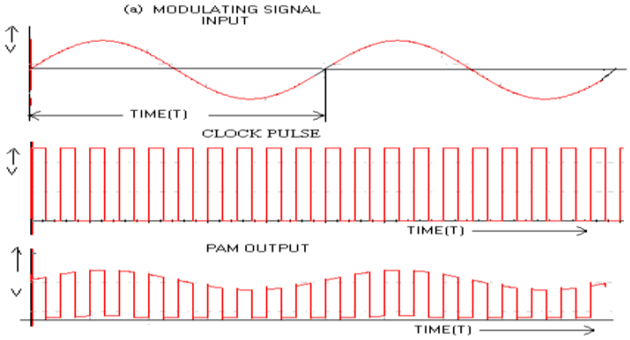

Fig -3: a) Modulating signal, b) Carrier signal, c) Modulated signal

4.2. Demodulation

To recover the initial useful signal e (t), it is necessary to remove the replications of spectrum generated by sampling. The demodulator is composed of a low-pass filter, whose cut-off frequency is slightly higher than f_m; with f_m the frequency of useful signal.

V. PULSE WIDTH MODULATION: PWM

In modulated signal (PWM), the amplitude and position of pulses are constant while the width (or duration) of pulses varies proportionally with the amplitude of analogical useful signal. Carrier signal is from a clock.

5.1. Principle

To transform the input signal e (t) into a succession of rectangles which duration varies proportionally according to the amplitude of the analogical signal, we use the following figure:

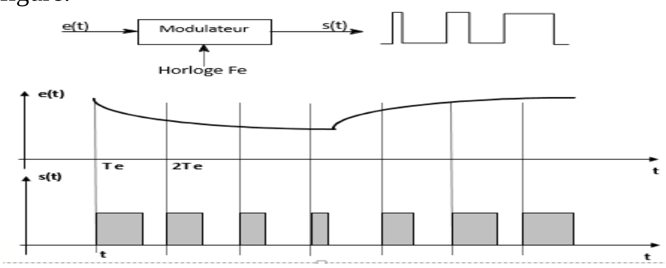

Fig -4: a) Structure of Modulator, b) Modulating Signal, c) Modulated Signal

The analogical initial signal e (t) is sampled and blocked at the sampling rate Fe. e (k) is the value of the sample at the time (kTe). The pulse duration q_K at the output of the modulator is closely connected to e(k) by the equation: $q_K = A + B.e(k)$, where A and B are constants. The modulated signal in width is carried out by the comparison between a rectangular signal $e_2(t)$ and the initial signal (before sampling and blocking) $e_1(t)$. PWM modulator delivers an signal whose width is function of the value (nTe) of the sample, taken at the time (nTe) on the signal e(t). The other characteristics (amplitude and position) of the pulse are constants.

5.2. Demodulation

The average value of modulated signal (s (t)) is proportional to useful signal (e (t)). The demodulator uses a low-pass filter, whose cut-off frequency will be judiciously chosen, in order to extract at the output the average value representing demodulated signal (or useful signal).

VI. PULSE POSITION MODULATION: PPM

In modulated signal (PPM), the amplitude and width of pulses are constant while the position of pulses varies proportionally with the amplitude of analogical useful signal. Carrier signal is from a clock.

6.1. Principle

The analogical signal e(t) is converted into a succession of rectangular signals. The decalage of these rectangular pulses compared to the period of sampling varies proportionally with the amplitude of the useful signal (see figure 5 below).

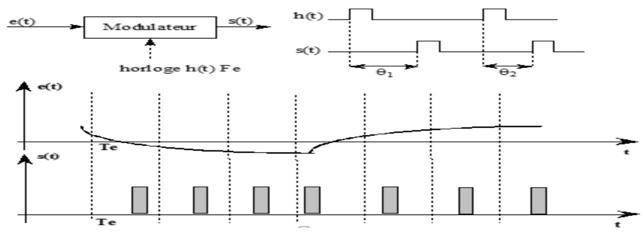

Fig -5: a) Structure of Modulator PPM, b) Modulating Signal, c) Modulated signal

The initial analogical signal (e (t)) is sampled and blocked at the sampling rate Fe. e (k) is the value of the sample at the instant (kTe). Modulated signal s (t) is a pulses series of duration t and whose qK position presents a decalage compared to each rise time of clock (kTe). This decalage, given by the equation below, is closely related to e (k): qk=A+B.e (k); A and B are constants.

6.2. Demodulation

The useful signal is applied to the entry R of the RS flip-flop while clock is connected at the entry S of the same flip-flop. We recover modulated signal (PPM) at the output Q of the flip-flop. When applying this modulated signal (PPM) at the input of a low-pass filter; we recover original signal at the output of the filter. In fact, original signal represents the average value of the modulated signal.

VII. SIMULATION

7.1. Presentation of Software

An electronic simulator is software modeling the operation of electronic circuits in order to be able to envisage and analyze their behavior. There are various levels of simulation, according to the degree of smoothness and the scale of simulation.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

For the simulation of our electronic circuits, we used ISIS, used generally for the design of electronic circuits. We explained the operation of the generator, and then have simulated some electronic circuits in order to obtain modulated signals in amplitude, in duration, and in position (PAM, PWM and PPM). The useful signal has an analogical form and the carrier is an pulse train from clock.

- **Isis**

Software ISIS of Proteus is mainly used to draw electric diagrams. In addition, it simulates diagrams in order to detect certain design errors. In fact, it can be used in documentations because it controls the majority of the graphic aspect of the circuits.

- **Ares**

The software ARES is a tool of edition and routing which completely perfects ISIS. An electric diagram carried out on ISIS can then be imported easily on ARES to carry out the printed circuit although this one is more efficient when it is carried out manually. The software places the components automatically and carries out also the routing automatically.

7.2. Environment of Work of Isis

We did our simulation under the environment of work of ISIS Professional version 7. Figure below shows its interface.

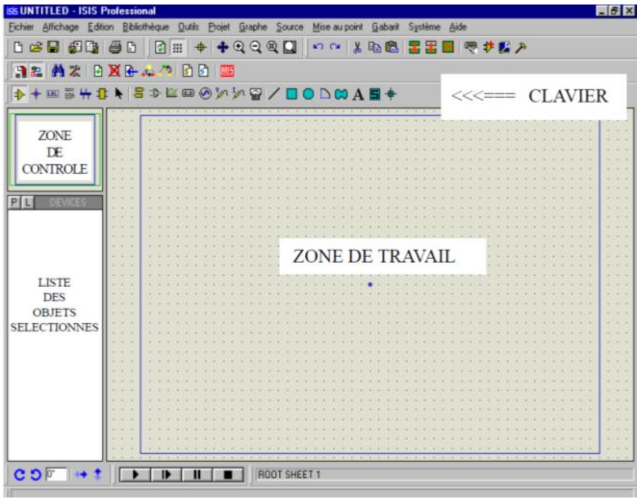

Fig -6: The Environment of Work of ISIS Professional version 7.

7.3. Generator CI555 Used for Simulation

CI555 is an integrated circuit used for temporization or in multivibrator mode. It was created in 1970 by Hans R. Camenzind and was marketed in 1971 by Signetics. It's used nowadays because of its dextirity, its low cost and its stability.

It contains 23 transistors, 2 diodes and 16 resistances which form 4 elements:

Two operational amplifiers of comparator type;

One logical gate of reverser type; One RS flip-flop.

It can function according to three modes: monostable, astable or flip-flop.

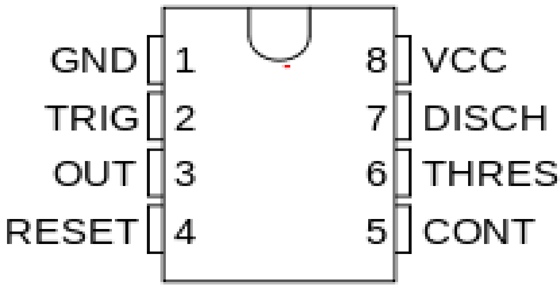

Fig -7: Roles of the pins of the integrated circuit 555

Table -2: Integrated Circuit 555

1	GND	Mass
2	TRIG	Trigger, starts temporization - Detects when the tension is lower than 1/3 of VCC
3	OUT	Output signal
4	RESET	Restoring, interruption of temporization
5	CONT	Access to the internal reference (2/3 of VCC)
6	THRES	Announce the end of temporization when the tension exceeds 2/3 of VCC
7	DISCH	Limit being used to discharge the condenser from temporization
8	VCC	Supply voltage, generally between 5 and 15V

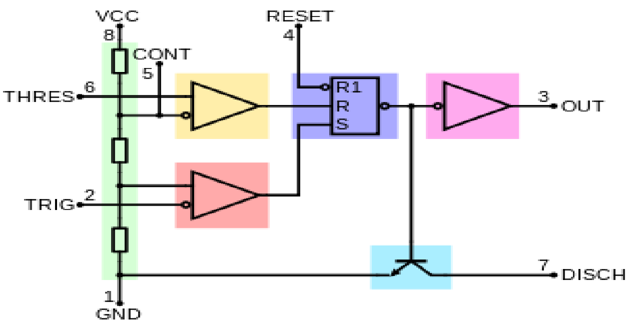

Fig -8: Diagram block simplified of the CI555

According to the Fig-8, CI555 is composed by the following components:

2 comparators (yellow and pale pink);

3 resistances configured out of the tension divider. The two tensions (1/3) Vcc and (2/3) Vcc are used as references to the comparators (green);

1 RS flip-flop controlled by the comparators (indigo);

1 reverser (fuchsia);

1 transistor to discharge the temporization condenser (cyan).

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

The CI555 operation follows the logic of the operation of the presented diagram block and can take 4 different states.

- The RESET signal is on a lower level: the flip-flop is reset to zero and the transistor of the discharge is activated; the output remainders imperatively on a low level. No more operation is possible.
- The TRIG signal is lower than (1/3) V_{CC}: the flip-flop is activated (SET) and the output is on a high level, the transistor of the discharge is deactivated.
- The THRES signal is higher than (2/3) V_{CC}: the flip-flop is reset to zero (RESET) and the output is on a low level, the transistor of the discharge is activated.
- The THRES and TRIG signals are respectively higher than (2/3) V_{CC} and lower than (1/3) V_{CC}: The flip-flop preserves its previous level as well as the output; the transistor is just a transistor of the discharge.

VIII. ELECTRONIC CIRCUIT FOR GENERATION OF MODULATED SIGNAL (PAM)

Generation of PAM signal using the integrated circuit CI555. This technique of modulation consists to the variation of the amplitude of each pulse according to the instantaneous amplitude of the analogical modulating signal.

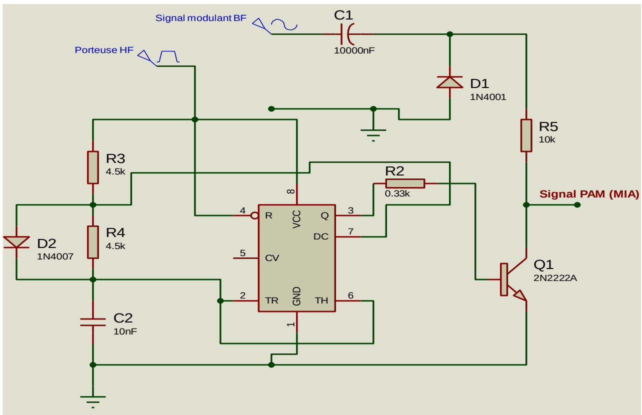

Fig -9: Electronic circuit for generation of signal PAM

8.1. Components

This electronic circuit consists of a timer integrated circuit 555 to which are connected:
Transistor NPN of the Q1 2N2222A type;
D1 diode of the 1N4001 type;
D2 diode of the 1N4007 type;
Four resistances: R2 = 0.33 KΩ, R3 = 4.5 KΩ, R4= 4.5 KΩ, R5 = 10KΩ;
Two capacitances: C1 = 10000 nF and C2 =10 nF.
In this system, continuous waves are sampled with regular intervals of time. Information and synchronization signal are transmitted only to the sampling periods. At the end of reception, the original forms of information and synchronization signal can be reconstituted from information concerning samples. PAM is the simplest form of the pulse modulations.

8.2. Operation of the Circuit

The CI555 is used as oscillator. Two resistances and one condenser modify the frequency of oscillation as well as the cyclic ratio. In this configuration, the flip-flop is re-initialized automatically with each cycle generating a train of perpetual pulse. A complete oscillation is carried out when the condenser is charged to (2/3) Vcc and discharged to (1/3) Vcc. During the charge , resistances R3 and R4 are in series with the condenser C2 and the discharge is carried out only through R4. The oscillations frequency (f) follows the relation:

$$f = \frac{144}{(R3+2*R4)*C}$$

According to the Fig-9; the integrated circuit CI555 is configured to generate PAM signal with a transistor NPN connected to its output; through R2 resistance. Carrier varies between 100 KHz and 500 KHz in order to obtain samples from modulating signal (probably an audio signal). The collector of the transistor is coupled with a low frequency of modulating signal (700Hz), via positive tightening composed by the condenser C1 and of a D1 diode. The positive tighten passes the level of the audio signal higher than 0 V. We obtain on the collector of the transistor a PAM signal.

8.3. Result of Simulation

The pulse amplitude modulation (PAM) is of a simple principle. It consists to use a sampler-blocker to obtain the modulated signal (PAM) from the modulating informative signal, samples sampled with regular intervals of time (Fig-10 below):

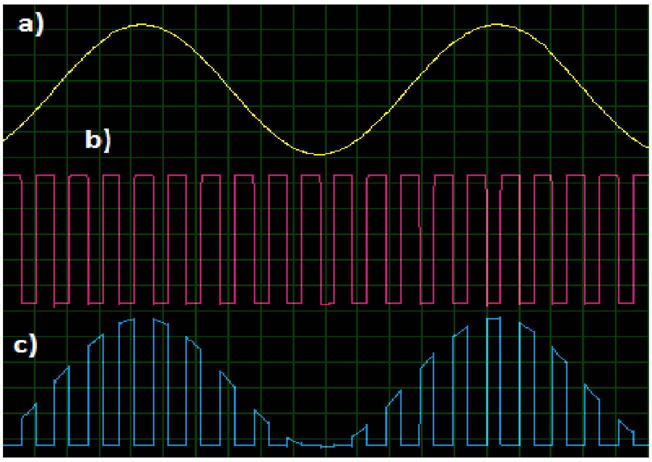

Fig -10: a) Useful (modulating) signal, b) Carrier, c) Modulated Signal (PAM)

8.4. Interpretation of the Results

The useful signal to be transmitted is analogical; it is sampled in accordance with the theorem of Shannon. According to this theorem, the sampling period must be higher or equal of two times the period of the (useful) signal. Carrier signal is digital and is from a clock. When applying both signals (useful and carrier) at the inputs of the modulator, we obtain at its output the modulated signal (PAM). The width and the position of this signal are constant while its amplitude is directly proportional to the instantaneous amplitude of the useful signal.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Table -3: Modulating (or useful) Signal, Carrier, and Modulated Signal

Modulating Signal

Amplitude (V)	Period (μs)	Frequency (Hz)
10	667	1500

Carrier

Amplitude (V)	Period (μs)	Frequency(MHz)
10	0.333	3

Modulated Signal

Amplitude (V)	Period (μs)	Frequency (KHz)
10	94	10,667

IX. ELECTRONIC CIRCUIT FOR GENERATION OF MODULATED SIGNAL PWM

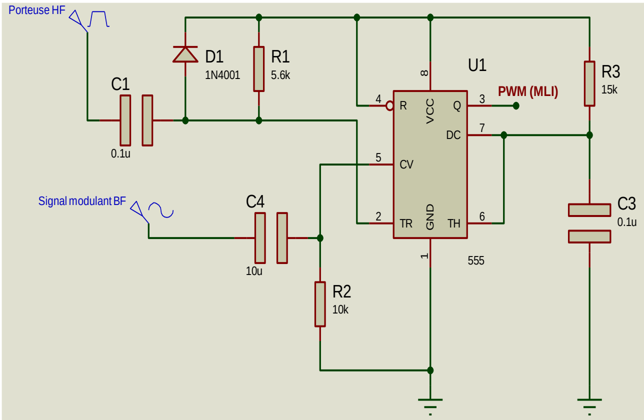

Fig -11: Electronic circuit for generation of signal PWM

The PWM consists at the variation of the pulses width according to the instantaneous amplitude of the analogical modulating signal.

9.1. Components

The electronic circuit is composed of:

An integrated circuit CI555 functioning in monostable mode of multivibrator;

A D1 diode, type 1N4001;

Three resistances R1=5.6KΩ, R2=10KΩ, R3=15KΩ;

Three capacities C1= 0.1µF, C3 = 0.1µF, C4 = 10µF.

In PWM modulation, the pulses amplitude is fixed, but the pulses width is proportional to the amplitude of the modulating signal. That process converts the informative signal, of variable amplitude, in a rectangular wave of fixed amplitude, but whose cyclic ratio is variable to correspond to the power of the modulating signal.

9.2. Operation of the Circuit

We use the integrated circuit CI555 in monostable configuration in order to generate a pulse train whose duration is defined by the resistance R3 and the condenser C3 (see Fig-11 above). A pulse is generated after application of a fall time to the input of circuit (TRIG). Immediately after the application of the fall time, the internal flip-flop is activated as well as the output. At the same time, the transistor of discharge is deactivated, the condenser C3 is charged through resistance R3. The wave form of condenser is exponential increasing. When this exponential reaches a value equal to two thirds of the supply voltage Vcc (2/3 Vcc), the internal flip-flop is deactivated bringing back the output and the condenser to zero. The duration of the pulse Tw is given by:

$$Tw = 1.1*R3*C3$$

In this circuit, a negative pulse applied to pin 2, trigger an internal flip-flop which fall down; pin 7 discharges the transistor, then condenser C1 charges through R1 and in the same time, the flip-flop brings the output pin 3 at the high level.

When the C1 condenser is charged until approximately (2/3)Vcc, the flip-flop is switched once more, this time the output of pin 3 is low level and while turning on the transistor, pin 7 discharges C1 (puts C1 at the ground). This circuit, in fact, produces a pulse train at the pin 3 whose width T is right the product of R1 and C1, i.e. T = R1*C1. We observe that T is different of Tw that implies a variation of width.

9.3. Result of Simulation

According to the electronic circuit (Fig-11 above), the integrated circuit CI555 is cabled as a monostable flip-flop, which varies the period of output of the oscillations according to the instantaneous amplitude of the modulating signal. The PWM signal consists at the sampling of the modulating signal. With each rise time of the clock, the modulated signal is a square signal whose cyclic ratio t varies by modifying the pulses duration *T* (see Fig-12 below):

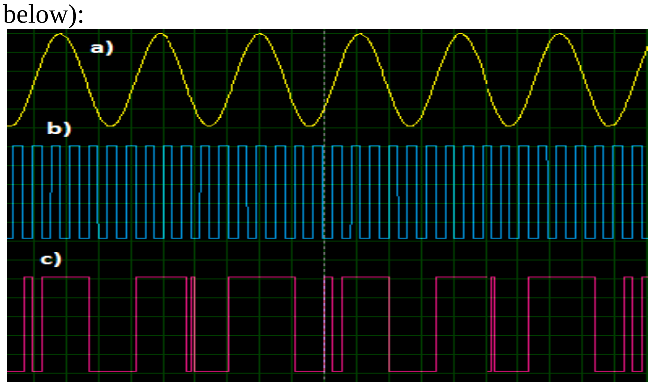

Fig -12: a) Modulating signal, b) Carrier, c) Modulated Signal (PWM)

9.4. Interpretation of the Results

According to the Fig-12 above, we note that the width of each pulse varies according to the instantaneous value of the amplitude of the modulating signal. The modulated signal (PWM) is carried out by the comparison between the instantaneous amplitude of modulating signal, beforehand sampled and blocked, and a rectangular signal (carrier signal). When the instantaneous amplitude of modulating signal is lower than that of the carrier, signal PWM is in a high level "1"; which fixes the maximum value. In the contrary case, it is in a low level "0"; which fixes the minimum value of the width of pulse. The index of modulator controls the amplitude of the output voltage. The pulse duration follows the variation of the analogical signal, the pulses width varies and thus the contents of the power.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

Table -4: Modulating Signal, Carrier, Modulated Signal

Modulating signal

Amplitude (V)	Period (μs)	Frequency(Hz)
10	667	1500

Carrier

Amplitude (V)	Period (μs)	Frequency (kHz)
10	125	8

Modulated Signal

Amplitude (V)	Period(μs)	Frequency (Hz)
10	1650	606

X. ELECTRONIC CIRCUIT FORGENERATION OF MODULATED SIGNAL PPM

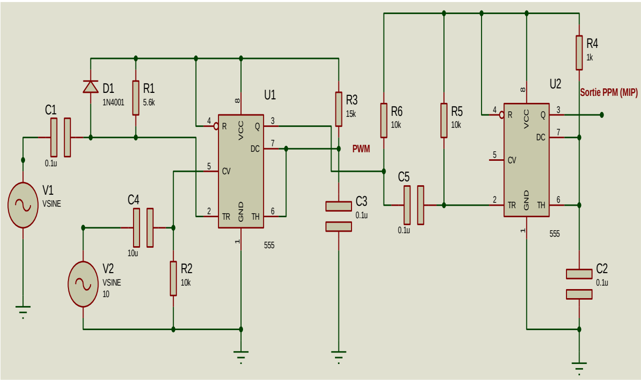

Fig -13: Electronic circuit for generation of signal PPM

The PPM modulation consists at the variation of intervals of time between identical pulses according to the instantaneous amplitude of analogical information. We can generate a modulated signal in position (PPM) from a modulated signal in width (PWM) using a monostable multivibrator

10.1. Components

This circuit consists of:

An integrated circuit CI555 in astable mode;

PWM is used as input signal of an integrated circuit 555;

Three resistances R4=1KΩ, R5=10KΩ, R6=10KΩ;

Two capacitances C2=0.1µF, C5=0.1µF.

The PPM modulation utilizes pulses with amplitude and width uniforms but shifted in the time of a certain position of the base; according to the amplitude of the signal at the sampling instant. The position of each pulse, compared to the position of a reference periodic pulse, is modified by each instantaneous sampled value of the wave of modulation.

10.2. Operation of the Circuit

We realize the PPM modulated signal using a PWM modulated signal and an integrated circuit CI555 used in monostable mode. By applying the PWM modulated signal at the input of an integrated circuit CI555, used in monostable mode, we obtain at its output a PPM signal. PWM signal is thus utilized for triggering monostable circuit.

10.3. Result of simulation

The PPM modulation consists in sampling of modulating signal, with each rise time of the clock, the modulated signal is a pulses train. Each pulse is delayed, compared to the clock, according to the amplitude of the modulating signal.

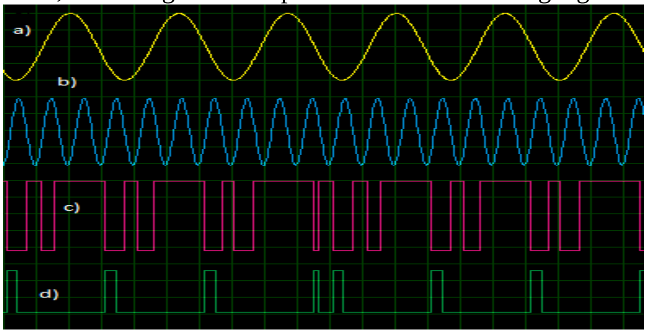

Fig -14: a) Modulating signal, b) Carrier, c) Modulated Signal (PWM), d) Modulated signal PPM

10.4. Interpretation of the Results

The pulses duration is constant and is fixed by the monostable one. The pulses amplitude and width are hold constant in this system, whereas the position of each pulse, compared to the position of a reference pulse, is modified by the instantaneous sampled value. The PPM modulated signal can be obtained by differentiating PWM modulated signal to produce narrow pulses (PPM).

Table -5: a) Modulating signal, b) Carrier, c) Modulated signal

Modulating signal

Amplitude (V)	Period(μs)	Frequency(Hz)
15	667	1500

Carrier

Amplitude (V)	Period (μs)	Frequency(Hz)
15	125	8

Modulated signal

Amplitude (V)	Period (μs)	Frequency (Hz)
15	2083	480

XI. CASE OF AN AUDIO INFORMATIVE SIGNAL

- **Signal PAM**

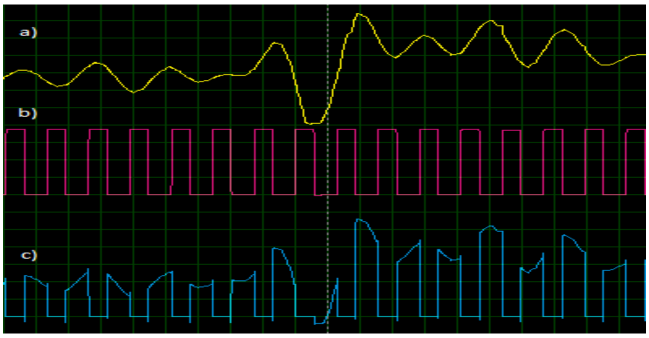

Fig -15: a) Modulating signal; b) Carrier; c) modulated Signal

We observe that simulation starts late and that the exit is not in conformity with PAM signal. The pulses are broad, the amplitude of the modulated signal changes with that of the informative signal.

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

- **Signal PWM**

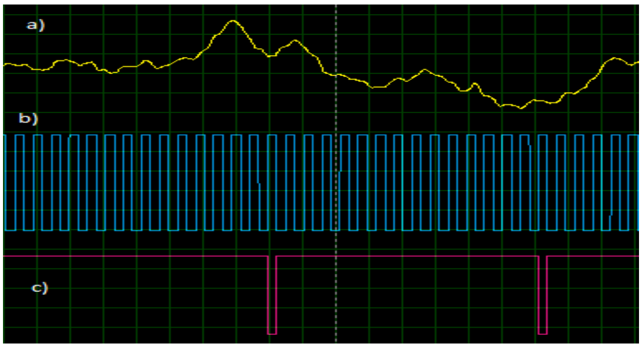

Fig -16: a) Modulating signal; b) Carrier; c) modulated Signal

We note that simulation starts late; the width of PWM signal is very broad. The output signal deviates from the shape of a PWM signal. Pulses are identical because they do not vary. For a random pseudo signal, the width of the pulses is not conforming to the PWM signal.

- **Signal PPM**

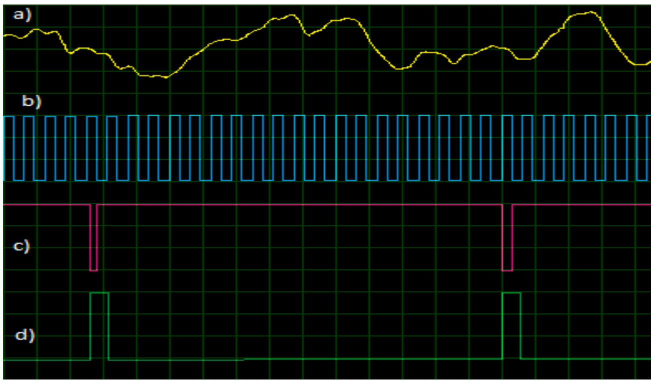

Fig -17: a) Modulating signal; b) Carrier; c) Signal PWM; d) Signal PPM

We note that simulation starts late, it is thus slower, and we observe that a dephasing appears, the PPM pulses are not narrow compared to signal PWM.

Table -6: Comparative Table of PAM, PWM, PPM Modulations

N°	Parameters	PAM	PWM	PPM
1	Carriers	Pulse Train	Pulse Train	Pulse Train
2	Variable Parameter of the Pulsated Carrier	Amplitude	Width	Position
3	Requirement of the Band-width	Low	High	High
4	Immunity of Noise	Low	High	High
5	Contents of Information	Amplitude Variation	Width Variation	Position Variation
6	Transmitted Power	Pulses Vary According to the Amplitude	Pulses Vary Accor ding to the Width	Remain Constant
7	Synchronization of Pulse to be Transmitted	Not Necessary	Not Necessary	Necessary
8	Complexity of Detection Generation	Complex	Easy	Complex
9	Similar to other Modulation Systems	Similar to AM	Similar to FM	Similar to PM
10	Wave Forms of Output Signals	Rectangular	Rectangular	Rectangular

According to the comparative table above, from their characteristics, the modulations PWM and especially PPM are especially used for the analogical transmissions of signals on optical fibers, in remote control IR or telemetry.

XII. DISCUSSION

- **PAM**

It is at the base of the PWM and PPM techniques. The emitter and receiver circuits are simple and easy to implement. This type of modulation requires a relatively large bandwidth. The transmit necessary power as well as the peak power required are significant. The drawback is that the attenuation, the deformation and the noise are significant. The applicability is multiple: In data processing, it is used at the time of the communication by Ethernet; in telecommunications for the radio transmission (radio AM) and analogical television; in electronic for the conduction of light by LED and for the transmission of the control signals by microcontrollers.

- **PWM**

The interference of the noise is weak due to constant amplitude;
Signal and Noise can be separated easily during the demodulation;
Synchronization between transmitter and receiver is not necessary;
This type of modulation (PWM) is not sensitive to non-linearities, fluctuations of the attenuation;
The signal can be directly treated by the logical circuits;
The power is variable because of variation of pulse width;
While the transmitted signal is an analogical form, the value of the pulse duration is discredited;
The pulse duration remains sensitive to the deformations of the phase and the transmission noise;
The pulse width is variable, therefore the transmitter must be enough powerful to handle the width of the maximum pulse;
PWM requires a great bandwidth.
It is used in the telecommunication systems: for analogical transmission of the signals over optical fibers, in the remote control IRE or telemetry.
PWM signals are used to order the speed of the robot by ordering the engines;
Binary support of the recording (magnetic tapes);
Variable transmission speed for the engine with D.C. current;
Gradator of light under the continuous tension

Published By:
Blue Eyes Intelligence Engineering
and Sciences Publication (BEIESP)

- **PPM**

The interference of noise is weak compared with (PAM) because the amplitude and the width of the pulses are constant;
The consumption of energy is very weak compared with other types of modulation;
Modulation (PPM) is sensitive neither to the linearities nor to the fluctuations of the attenuation;
Transmission (PPM) detects and corrects the transmission errors;
Installation cost is higher;
The electronics of design, which utilizes the PLL principle, is complex because it is necessary to reconstitute the position of the reference;
A great bandwidth is required;
Synchronization between transmitter and receiver is required.
This type of modulation is used in the following fields: Analogical transmission of the signals over optical fibers, in the remote control IRE or telemetry, incoherent detection (where a receiver does not need the loop PLL), the radio communication.
Moreover, (PPM) is used in the smart chart without contact, RFID, infra-red digital transmission (IrDA).

XIII. CONCLUSIONS

The practical realization of integrated circuits with reconfigurable and command circuits is very complex, because we need an adapted technology for that. In this paper, we simulated PAM, PWM, and PPM modulations using ISIS software from proteus which contains in its library, the CI555 integrated circuits and other components such as transistors, diodes, condensers and resistances. This allows us optimization of our results. We use modulation technique in order to adapt the frequency band of the signal to be transmitted to the transmission canal and to propagate the signal on long distances: Narrow band transmission.

At the emission, the frequency of the modulating signal (Low frequency, BF) will be transposed in high frequency by carrier signal. In our case, the clock plays the role of carrier signal. When the signal spectrum is adapted to the transmission channel, then we avoid a great attenuation of certain frequencies on the transmission channel and we reduce the effects of the noise. At the reception, we use a demodulator, a low-pass filter and probably a preamplifier for the extraction, amplification and restitution of the modulating (useful) signal. According to the discussion chapter, we deduct the advantages, disadvantages and application domains of PAM, PWM and PPM modulations.
From simulation results, we observe that the quality of an audio informative signal modulated in amplitude, width and position is not the best one.

In addition, the software enables us to carry out and to optimize electronic circuits in various scientific fields. It is always necessary to take into account that the results obtained of simulation are little different from those of the real world, this depends on the precision of SPICE models, of the components and the complication of the assemblies.

REFERENCES

1. Anas HANAF « Etude et conception d'un Emetteur / Récepteur UWB-IR » Ingénieur Réseaux et Télécommunications, 2008.
2. MAURY J. « Étude et caractérisation d'une fibre optique amplificatrice et compensatrice de dispersion chromatique » (Thèse), Université de Limoges, 2003.
3. Ch BISSIERES « Optoélectronique industrielle: Conception et applications Electronique », Paris, Dunod 2010.
4. F. De DIEULEVEULT « Electronique appliquée aux hautes fréquences » Ed Dunod, Paris, 1999.
5. G. COUTURIER « Cours d'IUT GEII Bordeaux I » 2007.
6. J. TAQUIN « Cours de Transmission Numérique du module SRM (Signaux Rapides et Micro-ondes) de la Maîtrise EEA d'Orsay » 2008.
7. P. G. FONTOLLIET: « Systèmes de télécommunication », Cours de l'Ecole Polytechnique Fédérale de Lausanne, édition Presses Polytechniques et Universitaires Romandes 2009.
8. Paul H. YOUNG « Electronic Communication Techniques » 4th Edition, Prentice Hall, 1999.
9. Wayne TOMASI « Electronic Communications
10. Systems, Fundamentals Through Advanced » 4th Edition, Prentice Hall, 2001
11. Robert DUBOIS : Structure et applications des émetteurs et des récepteurs, Presses polytechniques et universitaires romandes
12. http://genelaix.free.fr/telech/APPROCHE CONCRETEDES TELECOMMUNICATIONS.pdf Mars 2014
13. http://www.electronicshub.org/modulation-and-different-types-of-modulation/; Mars 2014
14. http://www.Pulse Modulation and Sampling (PAM/PWM/PPM) - Lab Volt. Juin 2014
15. http://www.techno-science.net/ Mai 2014
16. http://www.syscope.net/elec/ : G. Pinson - Physique Appliquée ; Juin 2014 http://www.sportnat.com/acil/histoire.html; Avril 2014

(Biographies)

Dr. Sacko Diouba is graduated from Huazhong University of Sciences and Technologies, Wuhan, People's Republic of China. Currently, he is Teacher-Researcher at the National School of Engineers at Bamako, Republic of Mali (West Africa). In addition, he is head of Laboratory at the Department of Computer Sciences and Telecommunications.

Dr. Keïta Amadou Alpha is graduated from Huazhong University of Sciences and Technologies, Wuhan, People's Republic of China. Currently, he is Teacher-Researcher at the National School of Engineers at Bamako, Republic of Mali (West Africa). In addition, he is head of the Department of Fundamental Sciences.

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)