Blaise Pascal University

Polytech Clermont Ferrand

Electric engineering Department

Application Note

INTERFACING OF THE VOCAL SIGNALS WITH A MICROCONTROLEUR

Prepared by the engineering student:

Mohamad ZARZOUR

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1. Introduction

A signal is a message coded so as to be able to be remotely communicated. Thus it is the physical representation which transports information from a source towards an addressee. This term indicates a big variety of met physical signals, as the signals of words or music, the signals radars either the images and the videos.

The principle of the development lives in the gain of power for a signal. That is when a signal is amplified, he will win in power. The sound emitted by the voice is amplified by an audio amplifier conceived to amplify the audio signals who will be the type of signal to amplify in this project.

Let be a sinusoidal signal x(t) according to time. This signal is amplified by a device of amplification. In exit of this device, we find a signal y(t) which is identical to the signal x (t) which was amplified (Figure 1).

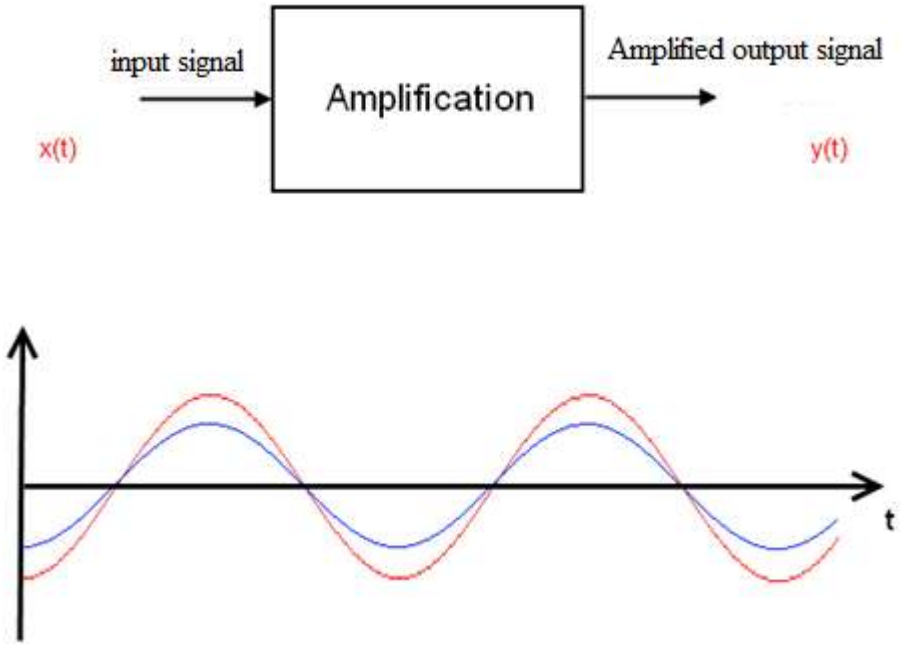


Figure 1 : amplification principle

The signal of input x(t), in blue, is amplified and becomes then the output signal y(t), in red. From a mathematical point of view, the signal has sudden the following operation:

$y(t) = G.x(t)$ (With G is the factor of amplification)

In this application note, we explain the development of two cards. A card of acquisition and a card of restitution of the sound. The need is a acquire an audio signal resulting from the voice and treat this signal amplified, to restore the same signal with an audio output with the other card.

2. Card of the audio acquisition

In this part we detail the procedure to realize the card of acquisition of the system. The purpose of this map is to acquire an audio signal and amplify it so that it is applied to the input of a system to be processed.

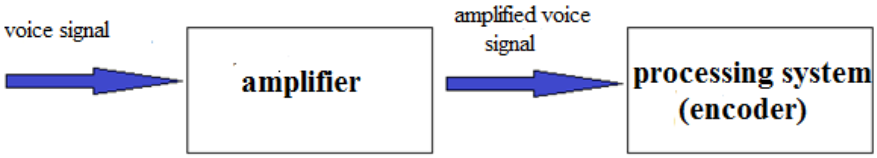


Figure 2 : block diagram of the acquisition

The amplifier block represents the card of acquisition. The vocal signal comes from two sources to apply one between them.

- Audio source coming from a PC and applied to the entrance of the card via a grip jack female. This source having the same characteristics of the human voice.
- Audio Source coming from a microphone. This microphone is a component welded on the card.

Thus the purpose of this card is to amplify the signal so that it is applied to a system (encoder) to undergo the necessary treatment.

2.1 Electronic plan

The card of acquisition is a set of the components which fall over together to realize the necessary development of the signal to be treated (Figure 3).

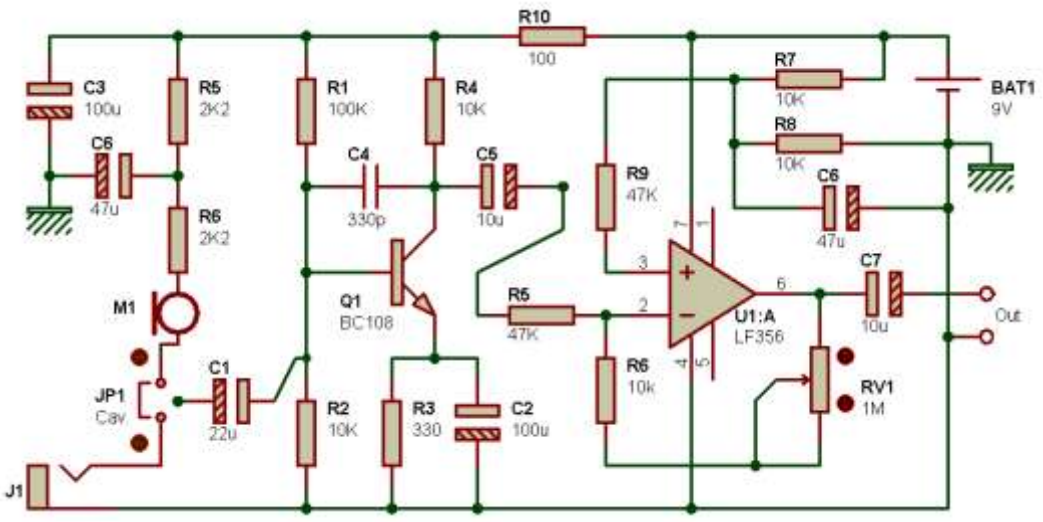


Figure 3 : electronic plan of the acquisition card

This card contains the following components:

- RV1 : Potentiometer.
  The power of resistances is 1 / 4W.
- C1 : 35V Electrolytic.
- C2, C3, C6: 25V Electrolytic.
- C4 : 50V Ceramic.
- C5, C7 : 40V Electrolytic.
- M1 : Electrostatic microphone (50 à 200Ω).
- JP1 : Jumper => Place 3 brooches.
- J1: Taken Jack female of 3mm, mono.
- BAT and Out: Place 2 brooches for each.

The principle of functioning is based on the development of the audio signal human resulting from the entrance by the grip jack (J1) or by the electrostatic microphone. This signal will be treating by various components, to obtain at the exit out an identical signal but with amplitude higher so that is treated by the encoder.

The components which appear on the card of the face 3 have specific functioning which allows securing the amplification of the signal. This circuit is formed by two floors. For that purpose, we can explain these functioning by dividing them into several series:

- The first floor realizes a development of the power of the signal by using a transistor in common transmitter. The base constitutes the entrance and the collector frees the output signal of the first floor. This signal will be applied to the entrance of the amplifier which represents the second floor where the signal undergoes the amplification.
- The second floor is represented by an amplifier which amplifies the power of the signal following a good gain to specify.
- The resistance R3 contributes to the stability in temperature of the assembly and which decreases the gain, for this it is in parallel with C2 who short-circuits R3 when a signal alternative appears at the entrance of the card.
- The capacity C4 allows limiting the bandwidth to a reasonable value, and limiting the parasites.
- The supply of the microphone is assured by the resistances R6 and R5 and capacity C6.
- The jumper jp1 allows cutting the supply towards the microphone if it is of the dynamic type.
- The decoupling of the entrance supply is assured with R10 and C3. They assure also allows to isolate both floors at the level of supply.

The operational amplifier which is marked on the Figure 3 is the LF356 having the characteristics to amplify an audio signal. This ampli is fed by a tension+15v -15v. Yet the

card needs of 9v so that it works, what returned to us to find an equivalent amplifier which is the LF357N. This ampli will be fed by 0v-9v which corresponds to the food of the card.

The signal of the exit must be adapted in terms of tension with the analog entrance of the encoder. Yet, the AOP is fed with a tension of 9v. But it is not a model "rail to rail ", And his excursion of exit is limited in approximately 6v for a supply of 9v. What can guarantee that the analog entrances of the encoder receive a signal which suits in a tension to adapt with the encoder, what prevents from burning out it.

2.2 Electronic study of the card

The study of the card consists in finding the gain at the level of every floor of amplification. For this, we are interested to present both floors each has part.

- The first floor is represented by the transistor NPN in common transmitter. He allows a amplification by current. For it we need to find the gain in tension any access which allows knowing the gain by current. Where from the power of the signal will be amplified.

  To present the equivalent plan for the alternative vocal signal, Capacities will be short-circuited.

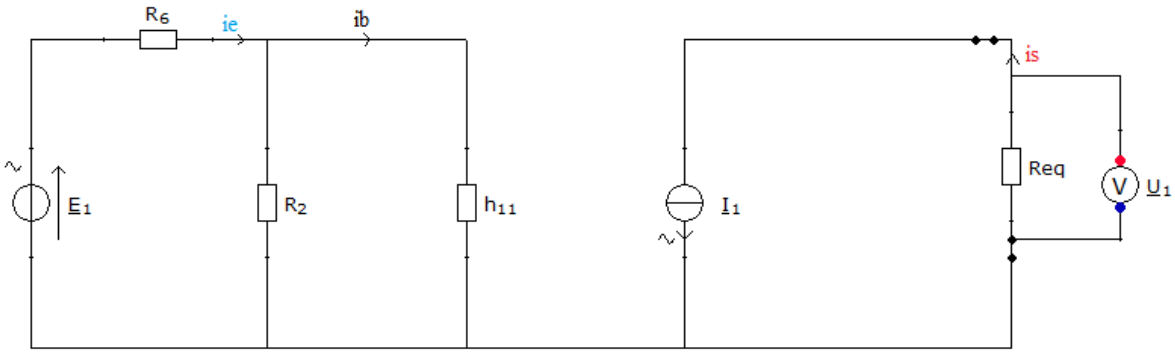


Figure 4 : equivalent plan of the first floor

With :

- H11 is the dynamic junction of the junction BE.
- I1 =β*Ib / β=120 According to the builder.
- E1 is a voice signal.
- U1 is the signal amplified on the first floor.
- Req corresponds to the equivalent resistance for mass R10 with R1, R4 in parallel.

Any access we shall have the gain Ae in voltage. Whence :

$$Ae = \frac{U1}{E1}$$

$$E1 = h11 * ib \qquad Et \quad U1 = -Req * I1$$

Then we deduct that : $Ae = -\frac{Req}{h11} * \beta$

So the voltage of entrance and exit are in apposition of phase: It is an inverting amplifier.

On the other hand and from the gain in voltage we can establish the expression of the factor of amplification by current :

$$E1 = \frac{R2*h11}{R2+h11} * ie = Req1 * ie \quad ET \quad U1 = -Req * is$$

We shall thus have in final the gain by current given by the following one:

$$Ai = \frac{is}{ie} * ie = -\frac{Req1}{Req} * Ae$$

- The second floor is represented by the ampli AOP. In this floor we shall have the amplified and ready signal to be processed by the encoder.

2.3 Bandwidth and gain

The bandwidth is an interval of frequencies on which a system can be to consider as reliable. The signal in the card is an audio signal which represents the human voice. This voice is capable of producing a very big variety of frequency. Where from the use of a microphone electret which puts us in a bandwidth of 20 HZ to 20 KHZ.

The gain is mainly determined by the values of the resistances R3 and R4. Where from the value of R3 is rather high, that is why there is a condenser C2 which short circuit the resistance as soon as we have a signal in the entrance.

We shall have the earnings is of the order 40dB, that is a development a report of 100.

3. Card of the audio restitution

This part consists in developing the card of restitution of the audio signal at the exit of the system after he undergoes the decoding. The restored signal is the same which has been to generate has the entrance of the card of acquisition.

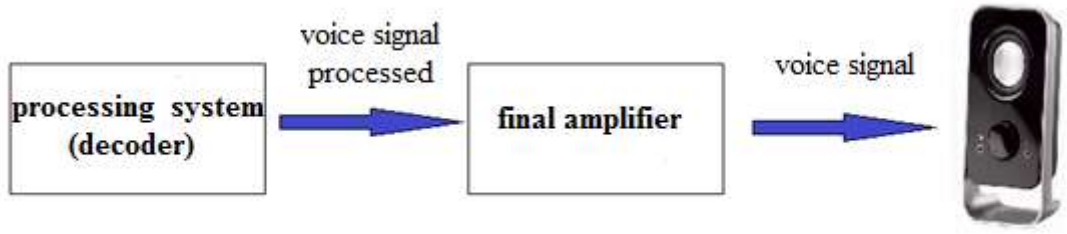


Figure 5 : block diagram of the restitution

The final amplifier block of the Figure 4 represents the card of restitution. In this card the signal of the entrance results from a single source which is the exit of the card of the decoder. The audio sound will be heard by high speakers connected with the exit of the card.

3.1 Electronic plan

This card is trained by the same principle as that of the card of acquisition but with components which are varied. (Figure 5)

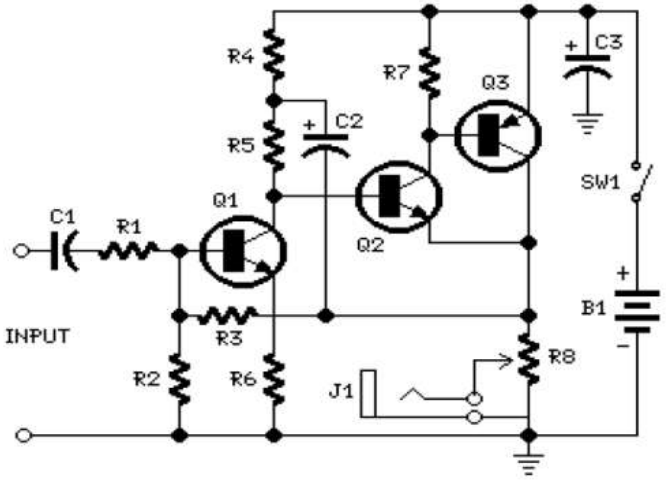


Figure 6 : electronic plan of the restitution card

This card contains the following components:

- R1 : 10 kΩ.
- R2 : 100 kΩ.
- R3 : 68 kΩ.
- R4 : 1,5 kΩ.
- R5 : 3,3 kΩ.
- R6 : 330 Ω.
- R7 : 4,7 kΩ.
- R8 : 2,2 Ω.
- The power of resistances is 1 / 4W.
- C1 : 1µF 63V Polyester.
- C2 : 100µF 25V Electrolytic.
- C2 : 470µF 25V Electrolytic.
- Q1 : BC239C 25V 100mA NPN
- Q2 : BC337 45V 800mA NPN
- Q3 : BC307 45V 800mA NPN

This card is an amplifier of class D. An amplifier of class D is an amplifier having the components of power is used as switches. This type of amplification presents the highest yield on all the amplifiers shelf space. But he presents a rate of distortion slightly upper to the other type of amplifiers.

This audio amplifier receives in its entrance a signal of low amplitude and low power and has to free in his exit a signal of strong power in a load. Yet here the load is a loudspeaker to hear the voice.

The assembly is formed by 3 floors:

- A floor of entrance allows realizing a buckle of return by combining the signal of feedback with the input signal of the card. Here it is the transistor Q1.
- The second floor which frees the full tension of the output signal. He is represented by the transistor Q2.
- The floor of exit has to produce a signal the tension of which has high amplitudes.

3.2 Bandwidth and gain

Because the signal applied to the entrance of the card results initially from the card of acquisition, the bandwidth always remains the same of 30 HZ to 100 KHZ.

The signal treated by the sudden system of the losses. Where from we shall have to amplify it with an order of 10dB which corresponds to a report of 3.

In principle, the gain of the floor of exit is independent from the impedance of loudspeakers, what allows her to adapt himself to loudspeakers of various impedances without modifying the amplitude of the output signal.

4. Conception of the cards

There is numerous software of CAD which allows us to realize cards.

4.1 Realisation of the cards

In this step, we do not take into account components but we establish the various functions of the circuit according to the exercise book of load.

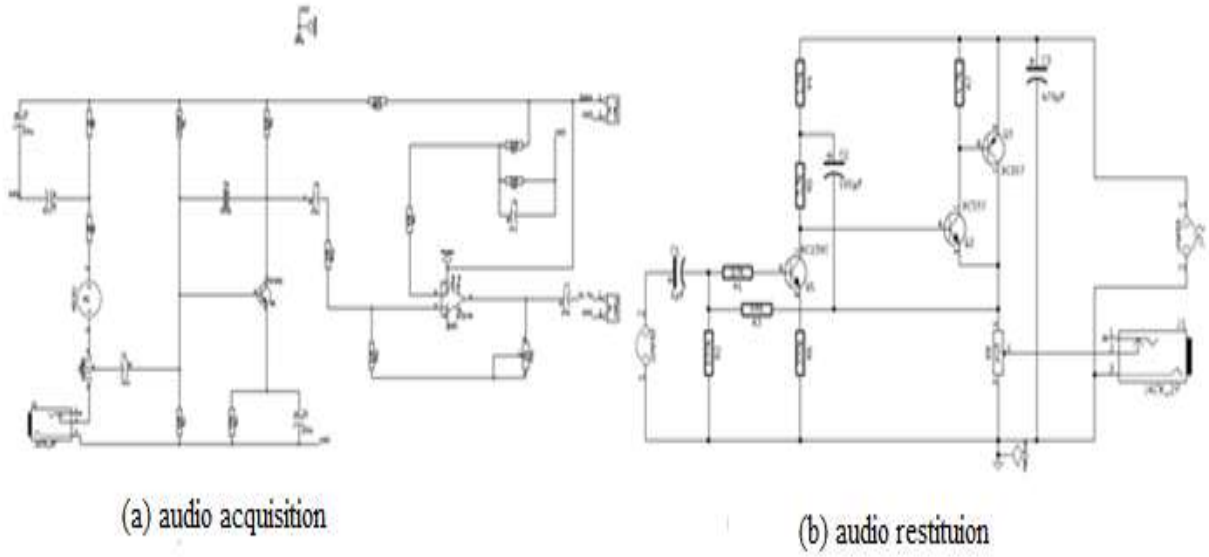


Figure 7 : the electric plans

As we can see it in the Figure 6, we draw with the software KiCad the plans of acquisition and restitution audio by using the libraries of components included in KiCad. Then we can test the behavior of the circuit thanks to the modes of simulation proposed by these various tools of CAD.

4.2 Routing of the electric cards

Once the tests were made, we study how components are going to be placed physically on the future electronic board. We choose components and we establish the connections between them.

Bitter, the place of the various components is known. It is enough to know the tracks which connect them between them. The objective thus is to obtain the plan of these tracks thanks to the functions of routing of the software. What returns us to obtain clearly the path borrowed by tracks on the plate. Bitter that the circuit is prepared with KiCad, we pass in the realization of the circuit.

4.3 Manufaturing of the printed circuit

The electronic support of cards is a printed circuit. This one is a plate in epoxy on the surface of which the copper tracks are engraved.

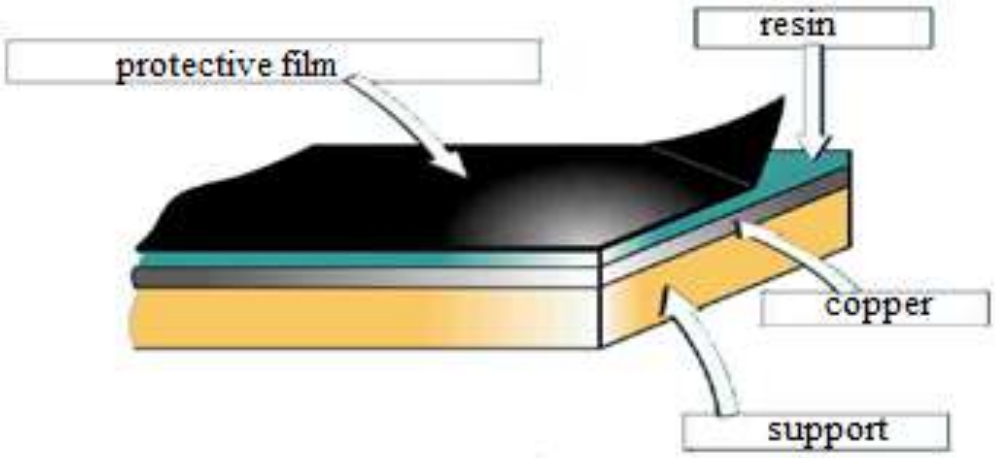
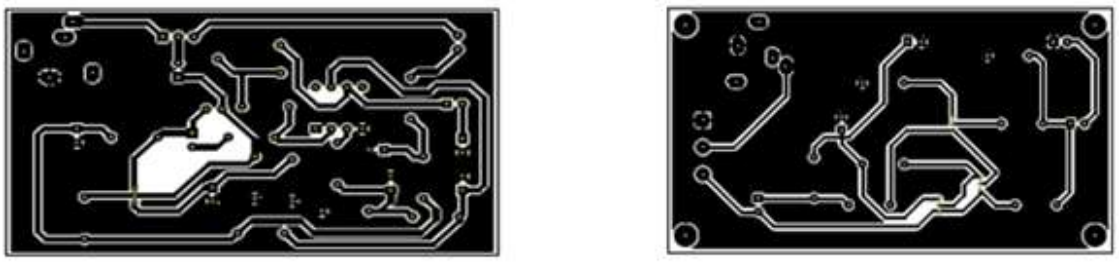


Figure 8 : constitution of the plate

All the phase of preparation of the plate aims at removing the resin then a part of the brass coat so that the staying copper trains tracks. Bitter we pass has the impression of the typon. It is drawing of the printed circuit on a transparent film.



(a) audio acquisition (b) audio restitution

Figure 9 : final printed circuit

Finally the circuit is engraved, and it remains to remove the tracks of resin which remain on the protected tracks. It thus remains to weld components to train the electronic circuit.