Design of a Low-cost Computer-aided Function Generator for Laboratory

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Abstract— Function generator is widely used in laboratory especially in electrical and electronics related laboratory. It is use to generate different types of signal wave according to a given function. This paper will discuss about the design of a very low-cost computer-aided function generator. In this system we have to write a function or draw a wave in the computer screen and then the computer software will convert it into a coded signal. After that the computer send this coded signal to the function generator device through USB-port wire as input. Then the function generator device will generate the wave signal according to the input signal sent by the computer and the required wave signal will appear as output of the function generator.

Keywords- Adder, DAC (digital to analog converter), Digitally-coded signal, Function generator, USB-port etc.

I. INTRODUCTION

Function generator is widely used in laboratory especially in electrical and electronics related laboratory to generate different kinds of signal wave. But with the conventional function generators we are able to generate only limited type of standard wave functions and the cost of those function generators are also very high. This paper will discuss about the design of a very low-cost computer-aided function generator which is not only able to generate standard wave functions but also able to generate manually design any type of signal wave. Here the main work is done by computer software which is converted a given signal into a digitally-coded signal. Then this coded signal is transmitted to the function generator device through USB-port cable. After receiving the signal the function generator device converts digitally-coded signal into an analog signal and this analog signal will then appear as output of the function generator device. The block diagram is shown in Fig.1 below.

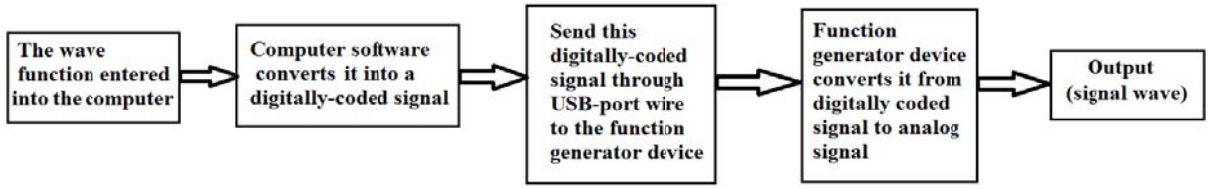

Fig.1 Block diagram of the working procedure of the computer-aided function generator

II. WHAT IS FUNCTION GENERATOR?

A function generator is used to generate different types of electrical waveforms over a wide range of frequencies. Some of the most common waveforms produced by the function generator are the sine, square, triangular and saw-tooth shapes. These waveforms can be either repetitive or single-shot (which requires an internal or external trigger source). Integrated circuits used to generate waveforms may also be described as function generator ICs. Although function generators cover both audio and radio frequencies, they are usually not suitable for applications that need low distortion or stable frequency signals. When those traits are required, other signal generators would be more appropriate. Some function generators can be phase-locked to an external signal source (which may be a frequency reference) or another function generator. Function generators are used in the development, test and repair of electronic equipment. For example, they may be used as a signal source to test amplifiers or to introduce an error signal into a control loop. Some standard signals which conventional function generators able to generate shown in Fig.1 as follows.

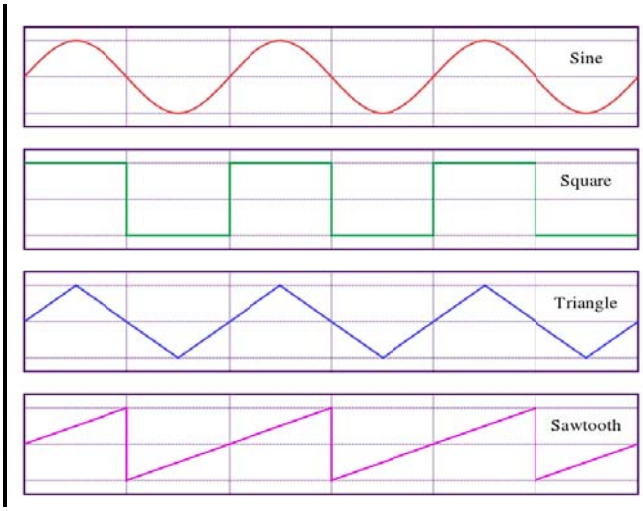

Fig.2 Some standard signals which conventional function generators able to generate

III. HOW THE COMPUTER-AIDED FUNCTION GENERATOR WORKS?

Here we designed the system which is able to accept dual type of input one is standard type of input waves like sine, square, triangular and saw-tooth shapes etc. and other type of input is to draw the shape of wave and system will repeat that wave-shape periodically. We can also set the frequency of the signal wave as per our requirement. So, first of all we have to develop a software which can analyze the entered function or designed wave-shape what we want to generate. After analyzing the entered wave-function the software will generate a digitally-coded signal. Let see a preview of the software shown on the computer screen.

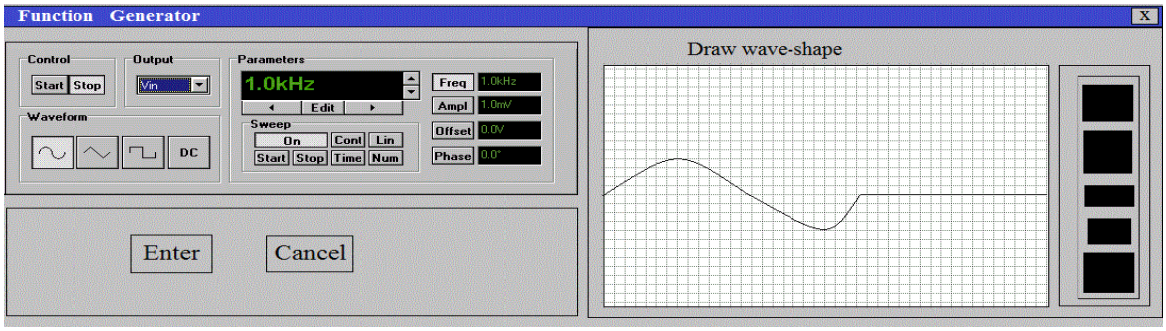

Fig.3 A preview of the software shown on the computer screen

Now we will see the conversion process. Here the software first converts the given continuous-time signal into a discrete-time signal and then this discrete-time signal into a digitally-coded signal. Now suppose we enter a standard wave-signal or draw a wave-shape then software converts the continuous-time signal into a discrete-time signal shown in the figure (Fig.4) below.

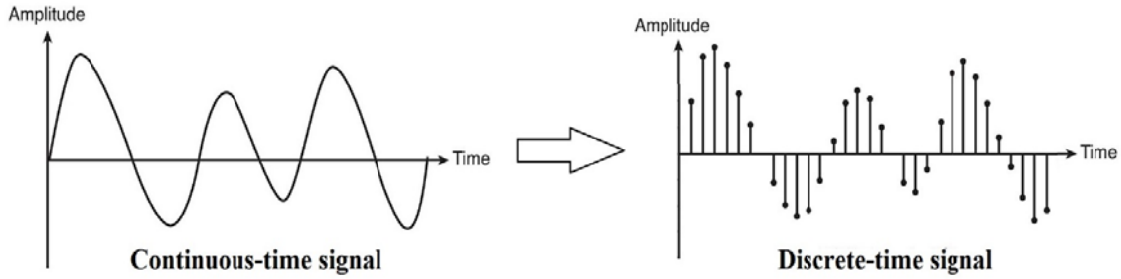

Fig.4 Conversion of a continuous-time signal into a discrete-time signal

Here we can also set the sampling frequency which must be greater than twice of the highest frequency component present in the signal (according to Sampling Theorem). Now the computer software converts the discrete-time signal into a digitally-coded signal (shown in Fig.5) and then send it to the function generator device through USB-port cable.

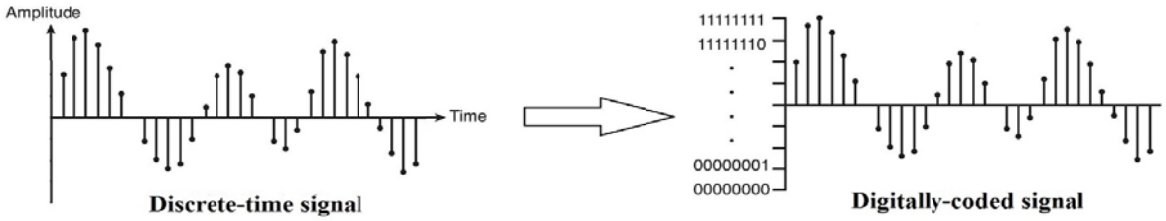

Fig.5 conversion of the discrete-time signal into a digitally-coded signal

A. What is USB-port?

Here we are considering only type-A USB-port as our function generator is connected with the computer through type-A USB-port. A schematic diagram of the type-A USB-port and its pin functions are shown in the figure (Fig.6) below.

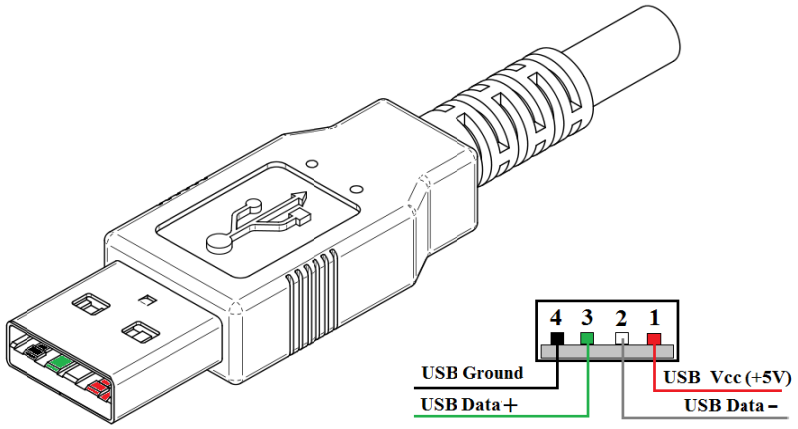

Fig.6 Pin functions of a type-A USB-port

From the above figure (Fig.6) it is clear that pin number 2 and 3 are used for data transmission. Here the computer software converts the discrete-time signal into a digitally-coded signal but the conversion and transmission of the coded signal are done in two different way. Here positive side of the wave-signal converts into a digitally-coded signal and transmit it through pin no.3 which is used for positive data transmission. And the negative side of the wave-signal also converts into a digitally-coded signal and transmit it through pin no.2 which is used for negative data transmission. The function generator device receives these two different types of data and by using them it generates the required wave signal as output of the function generator. Now we will see how function generator converts a digitally-coded signal into an analog signal.

IV. WORKING PROCEDURE OF THE FUNCTION GENERATOR DEVICE

Here the function generator's input part or receiver is mainly divided into two parts. One part receives the positive data from pin no.3 of the USB-port and other part receives negative data from pin no.2 of the USB-port shown in the Fig.7 below.

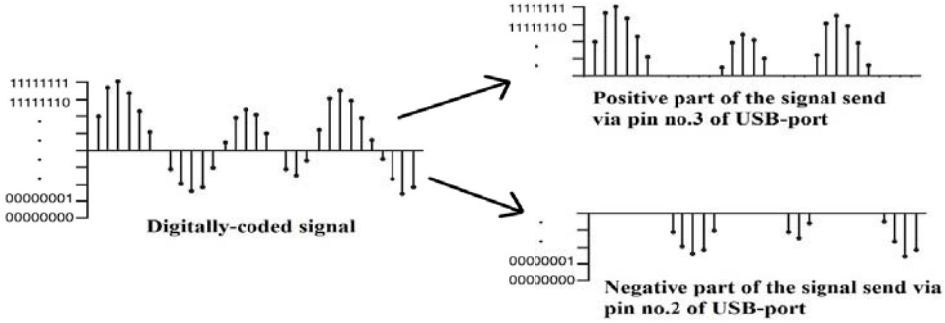

Fig.7 Positive and negative part of digitally-coded signal

After receiving the digitally-coded signal, it is converted into analog signal by using DAC (digital to analog converter). But here the conversion is done in two steps. In first step the positive part's data is used for constructing positive side of the wave and the negative part's data is used for constructing negative side of the wave shown in the Fig.8 below.

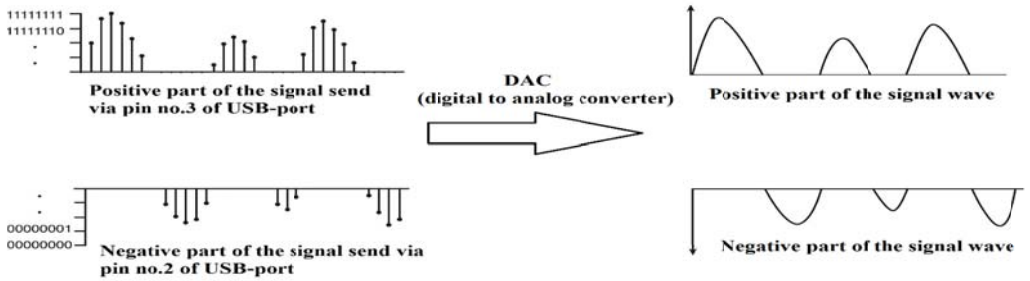

Fig.8 Conversion process of digitally-coded positive and negative signal into analog wave signal separately

And in second step an internal device of the function generator called adder, added these positive and negative parts of the signal wave shown in Fig.9 below.

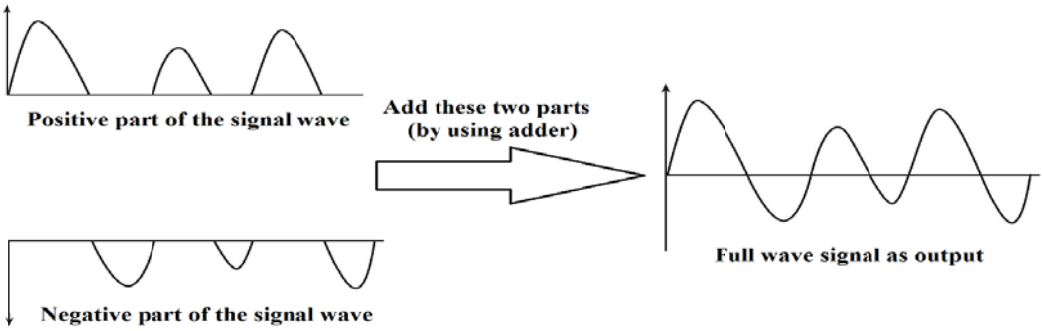

Fig.9 Addition of the positive and negative part to get the whole analog signal

As a result, we receive the required wave as output of the function generator. Here in this method we are able to generate any type of wave signal and the generation process is not depends upon the shape of the wave. Here, we can also explain the whole working procedure of this function generator through the following flow-chart (Fig.10).

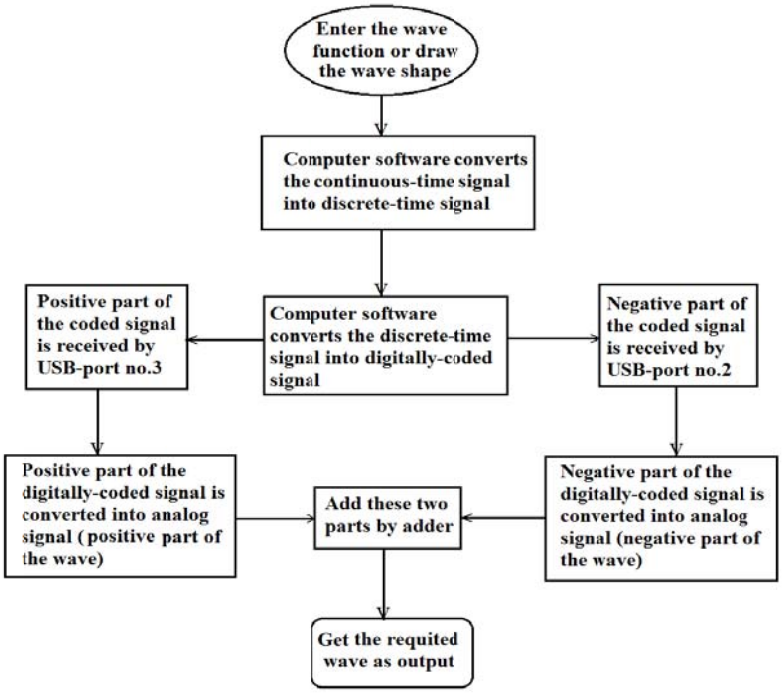

Fig.10 Flow-chart for the whole working procedure of the computer-aided function generator

V. CONCLUSION

So, here we develop a design of the computer-aided function generator. The cost is very low and the conversion process is very simple. In this function generator we do not need costly electronic devices for sampling purposes as the whole procedure of sampling and make the signal digitally coded is done by the computer software. The coded signal is then transmitted to the function generator via USB-port wire. The main two things which the function generator device contains are the DAC (digital to analog converter) and Adder. By using these two devices the function generator is able to generate the required wave signal from digitally-coded signal. This technique may be very useful for designing a low-cost computer aided function generator for the laboratory.

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