Portable function generator

Puneet Chugh, Soumya Jain and Varun Jindal Electronics Club, IIT Kanpur

***Abstract* –The problem of obtaining a portable, cost effective student friendly *device for working as a function generator thus for* testing the circuits for any competition as in the technical fests. This report describes our *device* - which is an easy way to achieve this by the combination of microcontroller and a waveform generator IC.**

INTRODUCTION

The objective of this project was to design something for practical use, which would also give us exposure to new frontiers. As a result we zeroed on making a Function generator. The basic concept is very straight forward – with the help of the interface take necessary inputs from the user and thus make necessary selections for the waveform generator ic, the details of the project are as follows:

DEVICE COMPONENTS

Atmega 16

We used Atmega16 – an Atmel AVR series microcontroller. Atmega16 has been used because of availability of compatible C compiler with automatic code generator tool (Code Wizard AVR). The processor clock was set to 8MHz internal oscillator. This Atmega was used basically for acting as an interface and thus controlling the waveform generator IC.

ICL 8038

This is the waveform generator used for making the function generator. It has the following specification:

Low Frequency Drift with Temperature 250ppm/oC
• Low Distortion . . . . . 1% (Sine Wave Output)
• High Linearity . . . . . .0.1% (Triangle Wave Output)
• Wide Frequency Range . . . . . .0.001Hz to 300kHz
• Variable Duty Cycle . . . . . 2% to 98%
• High Level Outputs. . . . . TTL to 28V
• Simultaneous Sine, Square, and Triangle Wave
Outputs
• Easy to Use - Just a Handful of External Components
Required

The pin and functionality diagram

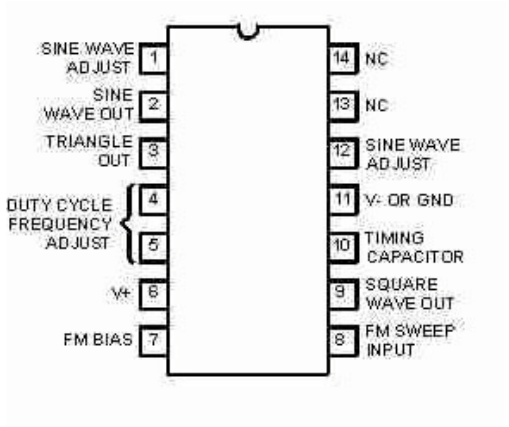

Figure 1: Pin diagram

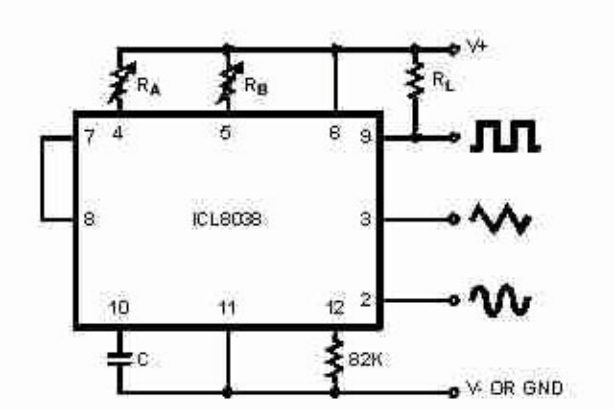

Figure 2: Functionality diagram

The IC works as follows one selects different resistances and different capacitance combination for selecting different frequencies and different duty cycle. The high time and the low time of a frequency can be selected as follows

$$t1=\frac{C \text{ X } V}{I}=\frac{C \text{ X } {}^{1}/_{3} \text{ X } V(\text{SUPPLY }) \text{ X } R(A)}{0.22 \text{ X } V(\text{SUPPLY })} = \frac{R(A) \text{X } C}{.66}$$

Similarly

$$t2=\frac{C \text{ X } V}{I}=\frac{C \text{ X } {}^{1}/_{3} \text{ X } V(\text{SUPPLY })}{\frac{2 \text{ X } .22 \text{ X } V(\text{SUPPLY })}{R(B)} - \frac{.22 \text{ X } V(\text{SUPPLY })}{R(A)}} = \frac{R(A) \text{X} R(B) \text{X } C}{.66(2 \text{ X } R(A) - R(B)}$$

Thus

$$\text{Frequency} = \frac{1}{\frac{R(A) \text{X } C}{.66}\left(1+\frac{R(B)}{2 \text{ X } R(A)-R(B)}\right)}$$

THE RESISTIVE AND CAPACITIVE ARRAY

It was made through the help of shift register and multiplexer and was required to select the R (a), R (b) and C.

Detailed implementation

User friendly interface

The LCD interface helps in communication and interaction with the user. It asks for the wave types the user wants 1-square, 2-sin and 3-triangle. There is a calculator kind of keypad with enter and clear also inbuilt. Then it asks for the frequency with has a digit of characteristic and a mantissa. If it is a square wave it also asks for duty cycle and then the microcontroller selects and sends pulses to the four shift register to select the resistances and selects a capacitor using multiplexer. Now in total 90 different frequency values can be generated with 5 different duty cycles making a total of 450 cases and for each case one needs to select capacitance and two resistances. However all these could be achieved with the help of just 28 pins of shift registers and 4 pins of the multiplexer. This is how it was done: First of all the capacitances acted as the mantissa of the frequencies so reducing cases down to 45 in which one had to select 90 resistances. Now it was noticed a few resistances could be made as parallel combinations of other resistances which had been earlier used. Also in some cases R (a) of one acted as R (B) of other thus reducing the number down to 23. The waveform generator IC produces all three waves simultaneously the multiplexer then selects one of those and gives the output.

Challenges faced and solutions brought out:

1) With too many combinations to implement reducing the number of I/O pins of microcontroller down to a total of 32 was a bring problem in the initial stages.
Solution: Strong logic implementations lead to reduction in pins.
2) Another problem was 8038 requires at least ten volts to run and resistances should be connected through v+ but shift registers could only give a maximum output of 5 volts similarly capacitance needs to be connected through v-
Solution: we came with a solution of applying -5 at ground and +5 at vcc of 8038 which worked beautifully

Scope for improvement:

1) Implementing all levels of frequencies i.e. with a step size of 1 Hz.
2) Due to low current output of the ic

- We can only work with it on the oscilloscope reducing its practical application
- Different levels of voltages as desired could not be implemented using opamp and potentiometer.

Conclusion

The project was complete though it could not fulfil all the objectives with which it was undertaken. No doubt the generator cost bout Rs 1000 only way less than the usual cost of 40000-45000 and it is also portable but its low current output remains a big hurdle once that is overcome it can very well become a household thing with every student doing basic experiments with it just like a multimeter. It was never meant for a researcher but for beginners and intermediates.

Acknowledgments

We are very thankful to our mentor Ankit Gupta and the other club coordinators Siddharth Garg and Anubhav Singhla for all the support and the suggestions for overcoming difficulties and motivating us in times of disappointment.

We would also like to thank Prof A.R Harish for allowing using his lab for seeing output on as a DSO.