PROJECT
ON
FUNCTION GENERATOR

DHARMSINH DESAI UNIVERSITY
FACULTY OF TECHNOLOGY
DEPARTMENT OF ELECTRONICS & COMMUNICATION

PREPARED BY:
Prit Varmora (EC 96),
Sem. V

GUIDED BY:
Prof. Keyur M. Patel

CERTIFICATE

This is to certify that the project on **FUNCTION GENERATOR** and term work carried out in the subject of Term Project is bonafide work of **PRIT VARMORA** (Roll no.: EC 96) and of B. Tech. semester V in the branch of Electronics & Communication, during the academic year 2019-20.

Prof. Keyur M. Patel	Dr. Nikhil Khothari
Project Guide, EC Dept.	HOD, EC Dept.

ACKNOWLEDGEMENT

I would like to express our special thanks to the Dharmsinh Desai University for giving me such an amazing platform where I can express my knowledge as well as ideas and fulfil them successfully. A special thanks to my term project faculty Prof. Keyur M. Patel to guide and support us in implementation and documentation. I am overwhelmed in all humbleness and gratefulness to acknowledge our depth to all those who have helped us to put this idea. Apart from this I am kindly thankful to the whole staff who allowed me to perform my term project work after college schedule and allow me to use any instruments I needed. Any attempt at any level can't be satisfactorily completed without the support of these faculties. Thank You.

ABSTRACT

While working on circuits or testing circuits in laboratories, to test each block of the circuit there is need of a device that can give different simulated waveforms in form of voltage to individual block to test their characteristics. This kind of device called Function Generator. Of course the Function Generator available in market are more powerful but they are bulkier also and not easy to carry everywhere. In order to solved the problem, function generator is designed which is small enough to carry in pocket, powerful enough to drive up to 50 ohms of load by the 20V peak-peak signal with different waveforms like Sine wave, Square wave, TTL wave, Triangular wave, PWM wave with adjustable DC offset, frequency and amplitude. The reason behind using Analog circuit here is to provide accurate waveforms and to learn circuit designing.

INDEX

INTRODUCTION

The function generator design introduced here is fully Analog approach to generate pure waveforms. Though the size of the function generator is small enough to carry in the pocket, Output power capacity and features are not compromised even. It can generate all basic waveforms (sine wave, square wave, triangular wave, TTL wave, PWM wave) at the output side. Other main feature like DC offset controller (-7v to +7v), PWM conversion of External signals, Amplitude control are also added to make it more reliable. It can drive up to 50-ohm load at the o/p side with the amplitude of 20V peak to peak signal. The main feature here is provided different ranges of frequencies like 1-10 Hz, 10-100Hz, and 100Hz-10 kHz to linearize frequency control and variation block.

BLOCK DIAGRAM

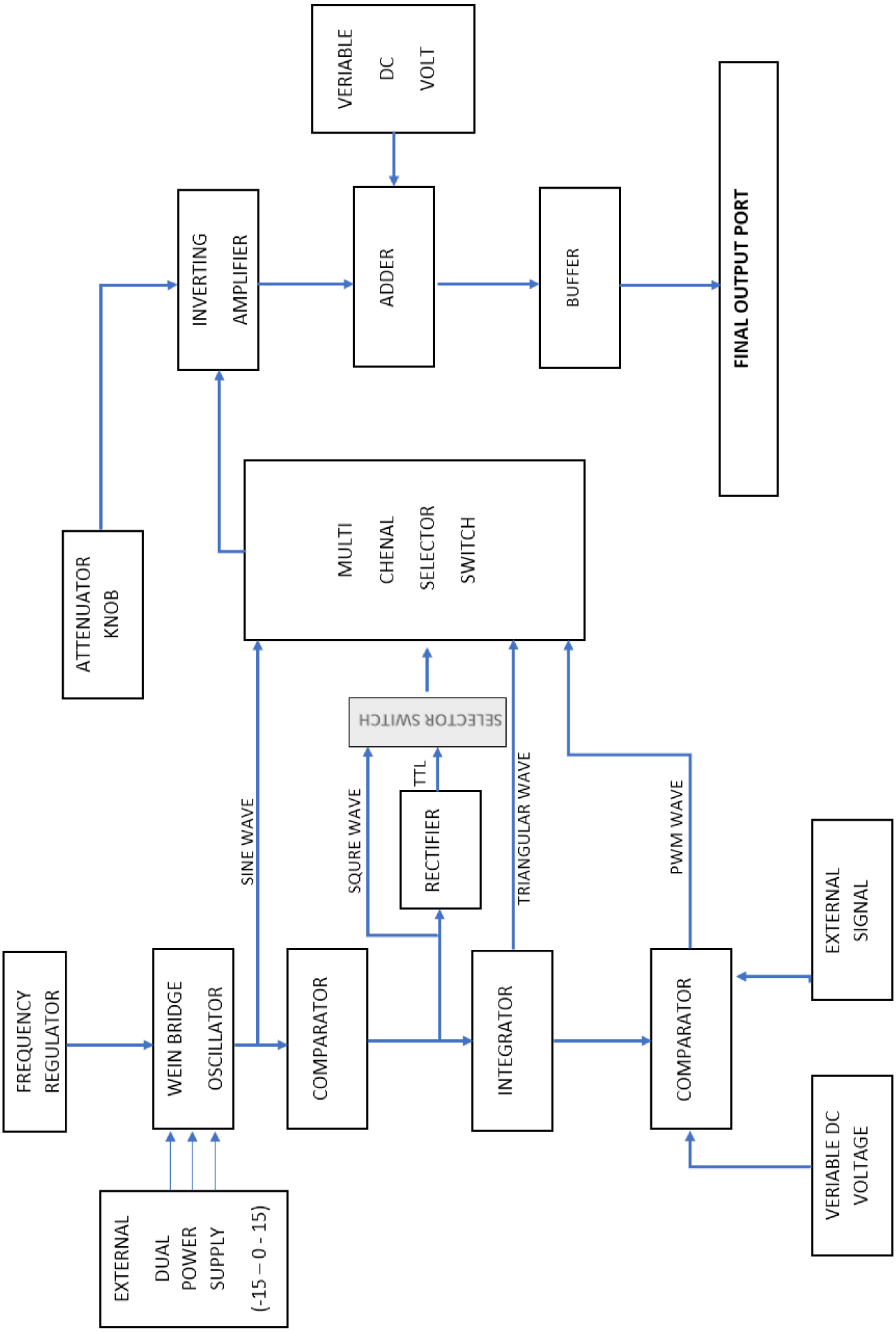

Fig.1.1 Block Diagram

CIRCUIT DIAGRAM

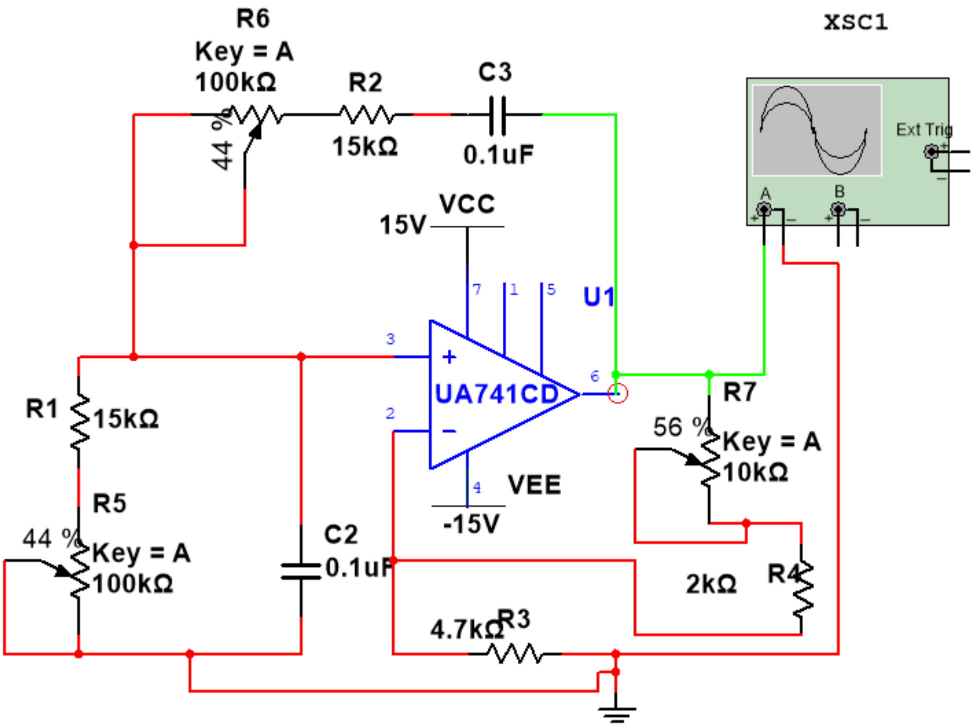

Fig. 1.2 Wein bridge oscillator

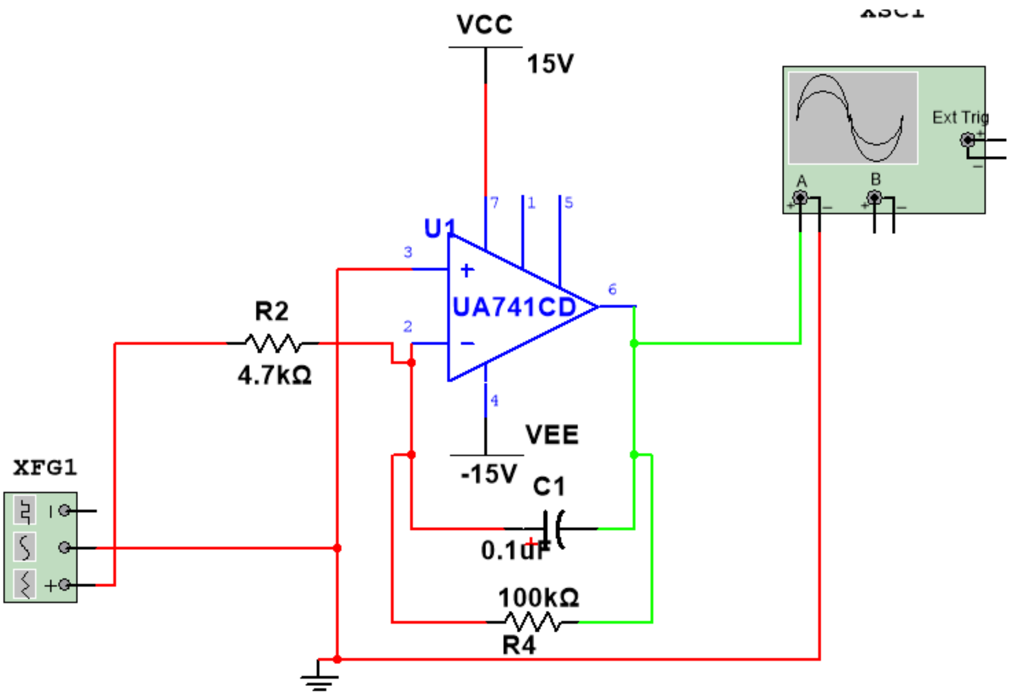

Fig.1.3 Integrator circuit

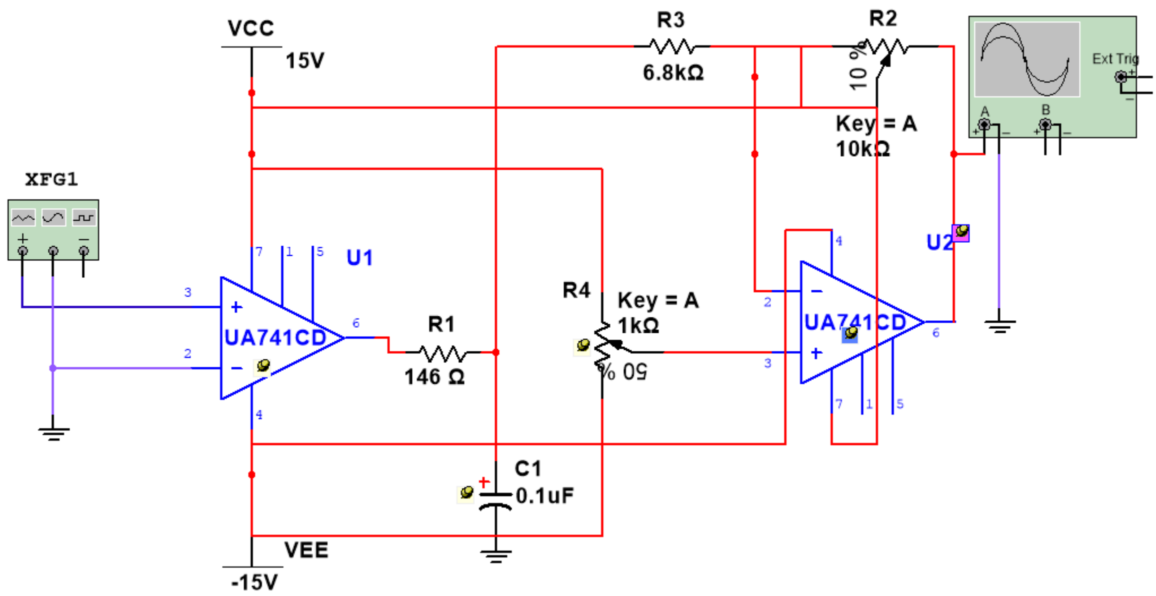

Fig.1.4 Comparator and Attenuator

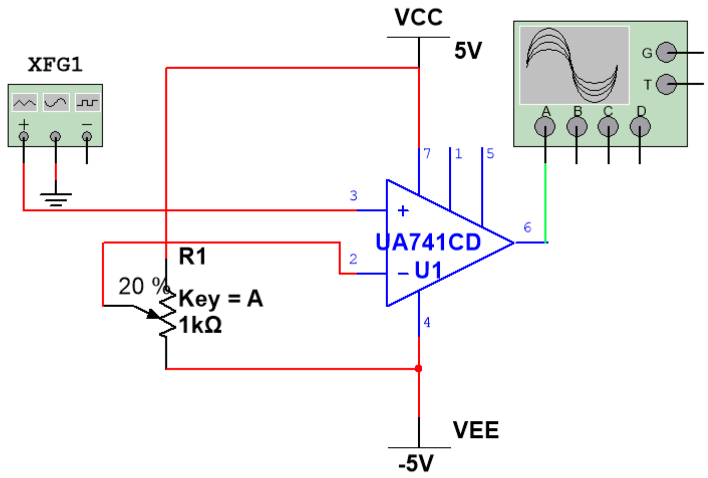

Fig.1.5 PWM convertor

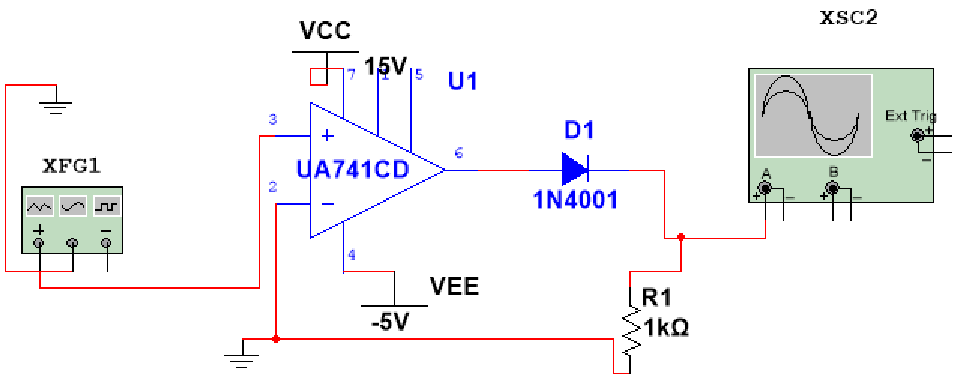

Fig. 1.6 TTL convertor

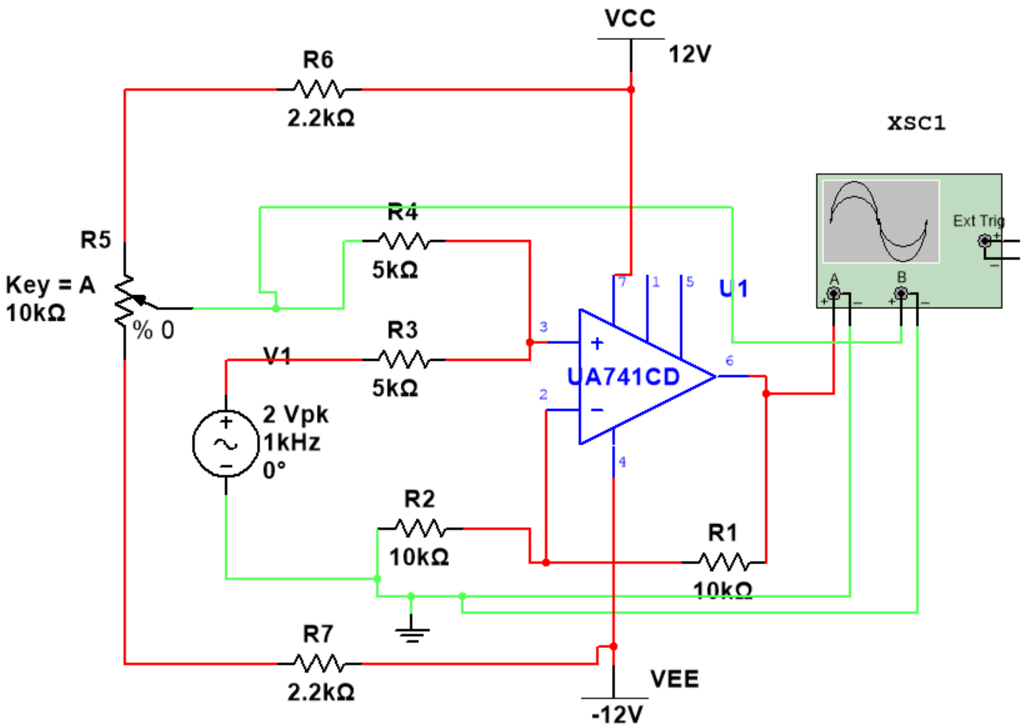

Fig.1.7 DC offset controller circuit

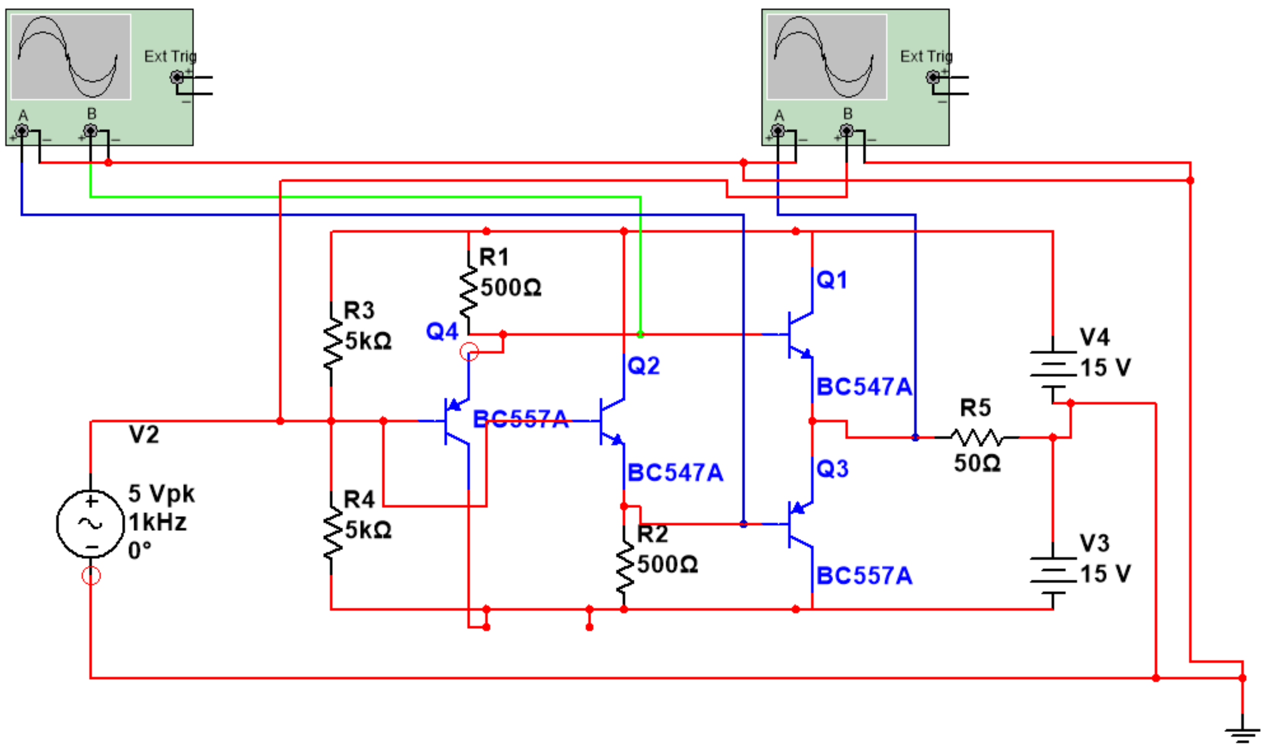

Fig.1.8 Buffer circuit

Component Description

1) IC UA741:

The µA741 device is a general-purpose operational amplifier featuring offset-voltage null capability. The high common-mode input voltage range and the absence of latch-up make the amplifier ideal for voltage-follower applications. The device is short circuit protected and the internal frequency compensation ensures stability without external components.

2) **Transistor BC 547:**

BC547 is an NPN Bipolar Junction Transistor. Similar to the other transistors BC547 is also used for the amplification of current. The smaller amount of current at the base is used to control the larger amount of currents at collector and emitter as well. Its basic applications are switching and amplification.

3) **Transistor BC 557:**

BC557 is a widely used PNP bipolar junction transistor manufactured in a small TO-92 package. It is a general-purpose PNP transistor that can be used as a switch or amplifier in electronic circuits. The max collector dissipation is 500 mill watt which is also another good point to use it in amplification stages.

4) Rotary switch:

A rotary switch is a switch operated by rotation as shown in fig 1.9. These are often chosen when more than 2 positions are needed, such as a three-speed fan or a CB radio with multiple frequencies of reception or "channels".

A rotary switch consists of a spindle or "rotor" that has a contact arm or "spoke" which projects from its surface like a cam. It has an array of terminals, arranged in a circle around the rotor, each of which serves as a contact for the "spoke" through which any one of a number of different electrical circuits can be connected to the rotor. Rotary switches were used as channel selectors on television receivers until the early 1970s, as range selectors on electrical metering equipment, as band selectors on multi-band radios, etc.

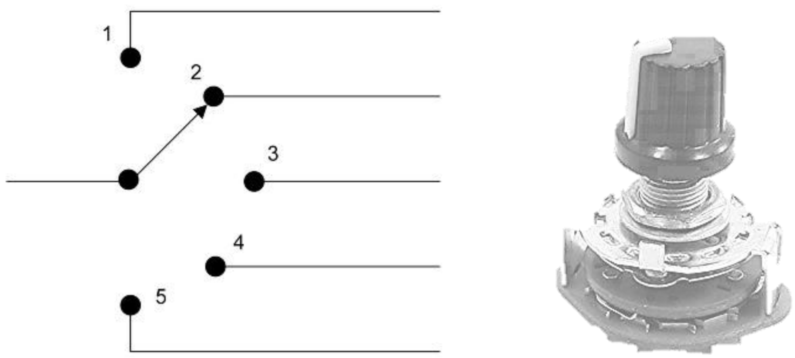

Fig.1.9. Rotary Switch

Working of Circuit

To understand the working of function generator we can divide the whole circuit into different blocks as shown in the block diagram in fig.1.1. These different blocks have their own circuit to function.

As shown in fig 1.1 first of all the Wein Bridge oscillator will generate SINE wave with varying frequency by regulator block as shown in fig.1.2. Then this sine wave gets converted into square wave using a simple comparator circuit shown in fig.1.4. We can generate TTL wave by just rectifying this square wave. Then the square wave further gets converted into a triangular wave by simply using the integrator circuit shown in fig. 1.3. Using this triangular wave we can convert external signals to PWM signals with use of comparator circuit shown in fig.1.5.

The Wein bridge oscillator is used here to generate sine wave as a primary wave. The o/p frequency of the sine wave can be varied by changing the value of R and C in the circuit. Varying R with a dual ganged potentiometer varies frequency almost linearly as per design. And to change frequency ranges we change here connected capacitor C with the use of a rotary switch. The frequency of Wein bridge oscillator can be given by equation [1].

$$f = \frac{1}{2\pi RC}$$

Where $R_5 = R_6 = R$

$C_2 = C_3 = C$

Then the comparator compares this sine wave with 0V and converts it into the square wave. The half-wave Rectifier stage simply removes the lower half portion of the square wave to convert it into TTL square wave as shown in fig 1.6. The square wave further gets converted to into triangular wave using integrator circuit. Now when we compare any DC voltage with triangular wave using simple comparator it converts it into PWM And if we compare any wave signal with this it converts it to its equivalent PWM wave waves as shown in fig 1.10.

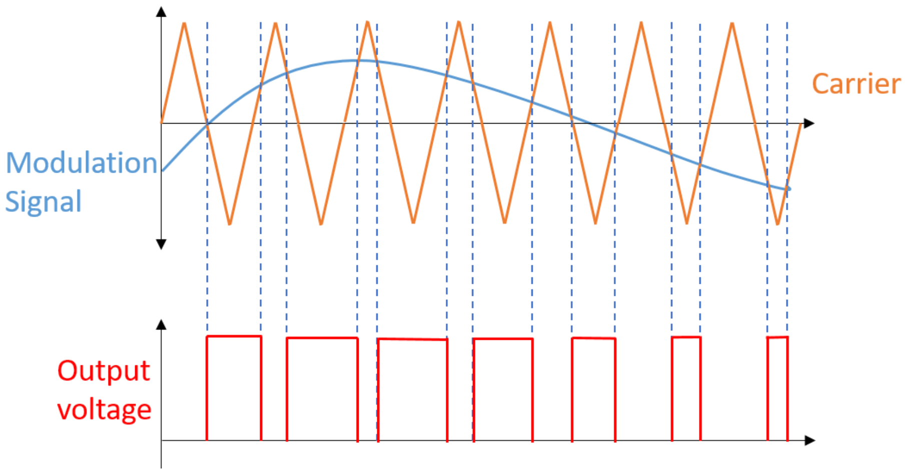

Fig 1.10 generation of PWM waves using triangular wave

All the waveforms generated here are connected to further stages using a rotary switch to select any one of the waveforms at o/p side. All stages described here gives us o/p wave of fix amplitude. Now to attenuate it we just simply pass it through inverting amplifier using op-amp circuit as shown in fig 1.4. By changing the gain of this amplifier stage we can simply adjust the amplitude of o/p waveform. Now we add simply variable DC voltage into it using Adder circuit as shown in fig.1.7 to adjust its dc offset. At last, we pass it through A followed by AB-type buffer circuit as shown in fig 1.8 to reduce o/p impedance of all over function generator. Thus the load driving capacity of the function generator increases up to 50 **Ω**. The final look of function generator is shown in fig.1.11 and fig.1.12.

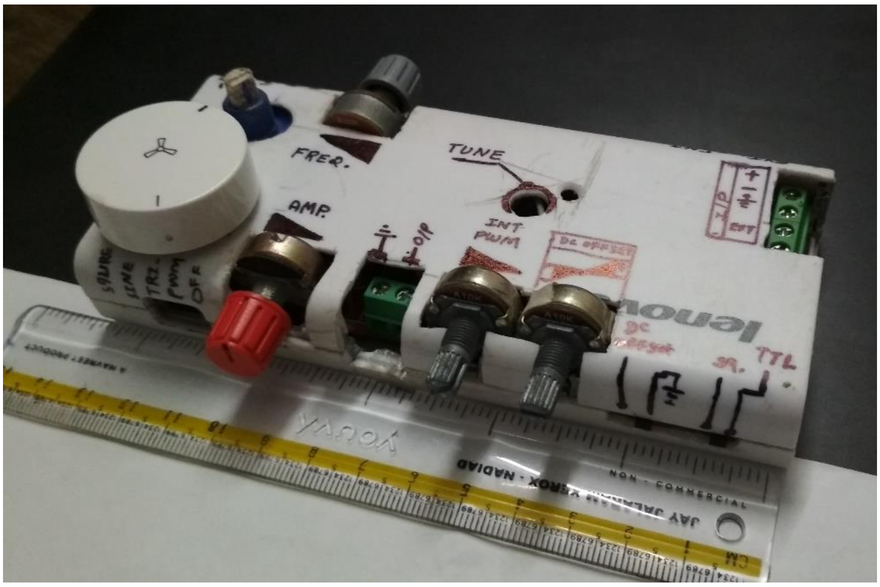

Fig. 1.11 outer look and size of function generator

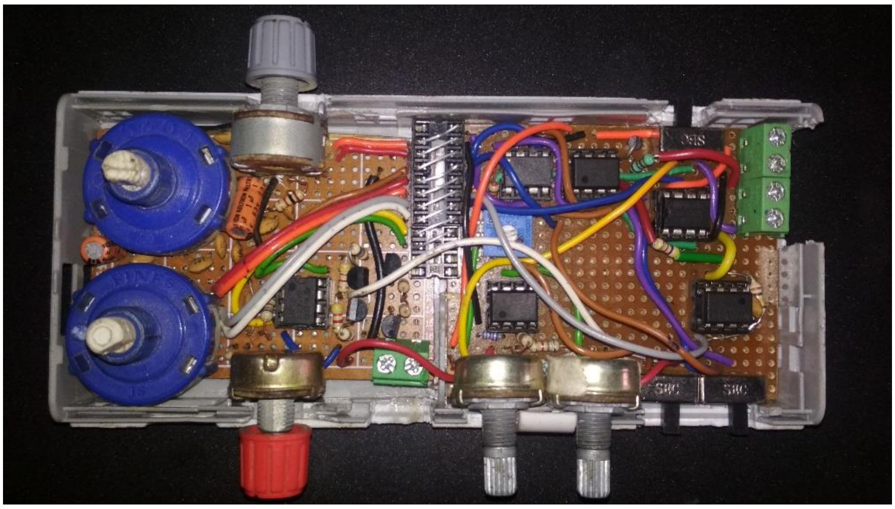

Fig 1.12 Inner look and circuit arrangement of function generator

Practical Steps and Trouble Shooting

Here the practical steps to implement whole this function generator were to test each stage separately and then combine them to gather on a single board. Though here we are trying to make a circuit that should be stable with frequency, it is preferable to test every stage on the general-purpose circuit board to avoid problem caused by loose contacts on a breadboard.

The main portion that was trouble full here was to choose appropriate values of the capacitor to adjust different ranges of frequency. When we calculate it mathematically and then apply it on circuit, the expected o/p and real o/p were not same that tends to loss of executable frequency between two ranges like expected frequency of the first stage is 1-10 Hz and practically we get 1.39Hz to 10.4 Hz and second range we get 13.58 Hz to 113.8 Hz instead of 10 Hz to 100 Hz so we lost frequency range of 10.4 Hz to 13.58 Hz. So to fill this cavity of frequency furthermore, we have to go for trial and error method.

The second main challenge was to drive a big load at the o/p side with small power losses and temperature stable system. To overcome this problem we have used an A followed by A-B type buffer circuit that reduces the power losses and o/p impedance of function generator that makes it to capable of driving big loads.

One unsolved problem here is the unstable amplitude of triangular wave o/p of integrator over frequency. That bounds us to use triangular wave and PWM wave over a small range of frequency (600 Hz to 900 Hz).

Conclusion

The experiment proves that we can design a more compact function generator to fulfil all basic requirements of laboratory experiment and testings with wide verity of features. The circuit described here can be a big approach at a glance for beginners but not that much hard to understand. The whole circuit is designed using fundamentals of linear electronics and also for calculations I have used graphical approach instead of working with a huge mathematical equation. Though here the approach was limited to test the design of the circuit, the maximum range of frequency is only 1 kHz to reduce implementation cost.

Application and Future work

As a first prototype, the design was aimed to provide all features with the almost linear ranges of frequency, we have used here op-amp IC UA741 which has a limitation of lower slew rate that bounds us up to 1 kHz of maximum frequency. In future to make it more reliable we are going to use other instrumentation op-amp ICs with higher slew rate. In future, we can remove the frequency limitation of triangular wave by just modifying integrator block. The digital display also can be added to the design to display frequency and amplitude.

References

https://www.allaboutcircuits.com

http://www.circuitstoday.com/triangular-wave-generator

Integrated electronics by millmen jecob & chritos halkias

https://www.electronics-tutorials.ws/amplifier/class-ab-amplifier.html

https://www.alldatasheet.com