International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-2, December 2019

Implementation of Low, High and Band Pass Filters using Verilog HDL

Navin Kumar H G, Pruthviraj N, Surya N, Aruna Rao B P

Abstract: ***Filters are some of the highly essential components used for operating in most electronic based circuits. Filters are most important and widely used to block some portion of signals according to frequency. Having a detailed knowledge of various filters. A designer will be able to design an efficient communication networks, by varying the cut off frequencies. Filters are required in computer, mechanical and some other fields too. As days passed by the usage of active and passive filters has gradually increased in the market. There are various types of Filters available, in which we are going to perform the simulation of Low pass, High Pass and Band pass Filter using Verilog Hardware Descriptive Language and Xilinx ISE 13.1 as a simulation tool. This paper provides a detailed explanation, circuit diagram, advantages, disadvantages, applications, working of Verilog code and simulation result of Low pass, High pass and Band pass filter. Using Verilog Hardware Descriptive language its simpler to understand and execute the functionality of filters then using other tools like MATLAB, Microcontroller, Microprocessor.***

I. INTRODUCTION

A filter is device or process which is used to remove the little unwanted elements or a signal. Filtering is a class of signal processing, which means removing some frequencies or frequency bands. They are divided into two types. Active filters are those which are used by amplifiers, transistor etc which is used for improving the predictability, cost and performance of a filter. Where as in passive filter consists of four basic linear elements such as resistor, capacitor, transformer and inductor. Filters are used for mainly used in electronics, telecommunication, radio, T.V, audio systems, radar, computer graphic design and image processing.

II. FOUR MAJOR TYPES OF FILTERS

i. Low-Pass Filter –only low frequencies are pass, high frequency will get rejected or blocked.

ii. High-Pass Filter–only high frequencies are pass, low frequency will get rejected or blocked.

iii. Band-Pass Filter – only frequency range between low pass and high pass band are passed.

iv. Notch Filter –it rejects or blocks only a one particular frequency.

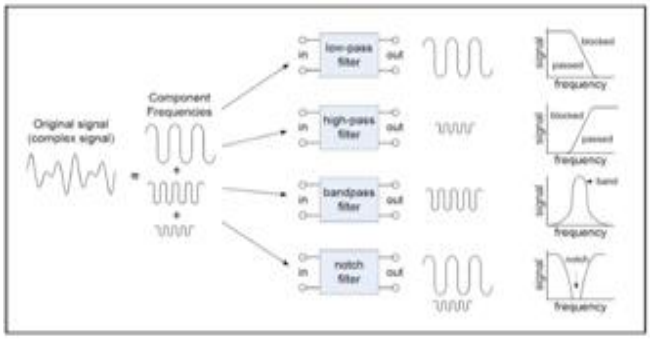


Fig 1.1 basic types of filters

A. Low Pass Filter:

The circuit of low pass can be designed by using a resistor and a capacitor in series combination which will get an output. Once the input is given to a low pass circuit then the resistance will block the signal and allows the capacitor to effect on the output signal. When the higher frequency is given to a low pass design which will offers an more value form a resistance it will gives a standard resistance. It's because of the resistance given from the capacitor into the high frequency will be equal to zero. Were the low frequency signal will be more or greater than zero.

i. Circuit diagram:

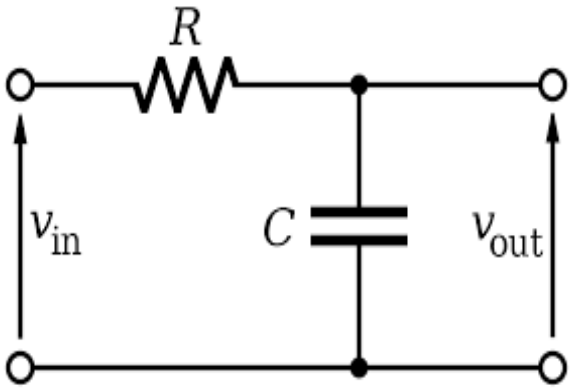
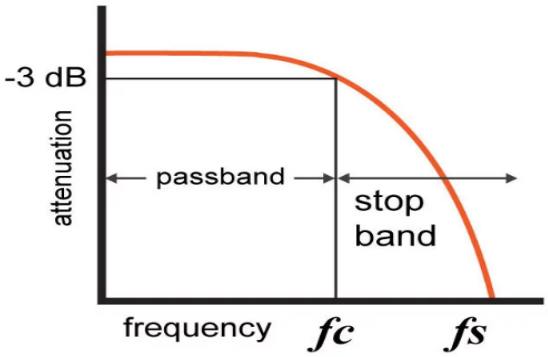


Fig 1.2 Low pass filter

ii. Working**:** From the above fig 1.2 we know that when the low pass filter gets an input of high frequencies then it allows that frequency to flow in capacitor and it will pass to the ground. In this region the obtained output voltage will be equals to zero because of the total voltage is supplied to ground. Later when the lower frequency is passed to low pass filter circuit then the output will be generated. Where the resistance will block the higher frequency then the capacitor will also get infinite resistance.

Revised Manuscript Received on December 30, 2019.
***** Correspondence Author
Navin Kumar H G*, Student, Electronics and Communication, K.S. Institute of Technology, Bengaluru, India. Email- navinkumarhg1905@gmail.com
Pruthviraj N, Student, Electronics and Communication, K.S. Institute of Technology, Bengaluru, India. Email- 281999pruthviraj@gmail.com
Surya N, Student, Electronics and Communication, K.S. Institute of Technology, Bengaluru, India. Email- surya.nagaraj206@gmai.com
Aruna Rao B P, Assistant professor, Electronics and Communication, K.S. Institute of Technology, Bengaluru, India. Email- arunarao87@gmail.com

iii. Graph:



iv. Advantage and Disadvantage:

a. The main advantage from this circuit is the operational amplifier of high input impedance will avoid the more loading on filters. Where as in low output impedance it avoids the filter cut off frequency point which will be get affected by changing an input impedance of the load.

b. Low pass will don't have a voltage gain which is greater than one because the obtained voltage gain is equal to one and its power gain is very high. In this the input impedance is higher than the output impedance. This is major disadvantage faced in the low pass filter.

v. Application:

a. They are mainly used in audio speakers to decrease the higher frequency in the system and they also used for inputs of sub woofers.

b. It also used in audio systems like equalizers, audio amplifiers and as well as in radio.

c. The digital filters are mainly used for image blurring and smoothing on data signals.

vi. RTL View:

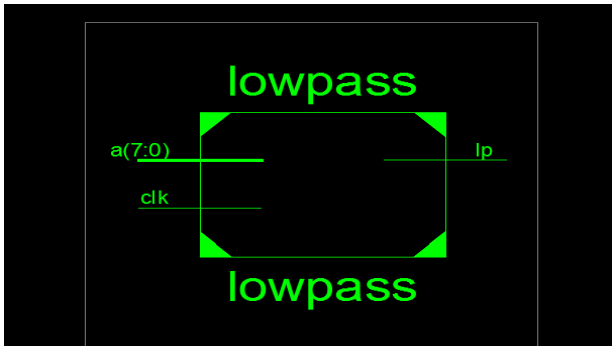


Fig 2.1 RTL view of low pass filter

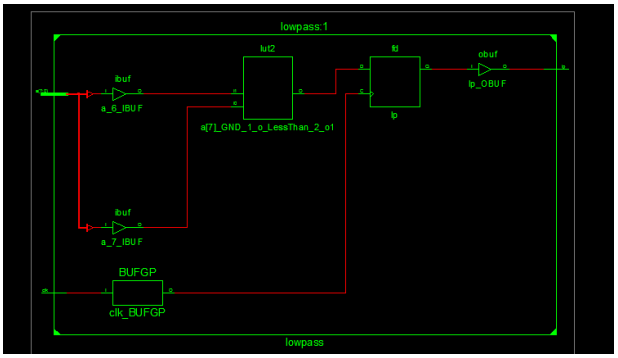


Fig 2.2 RTL schematic view of low pass filter

vii. Simulation output:

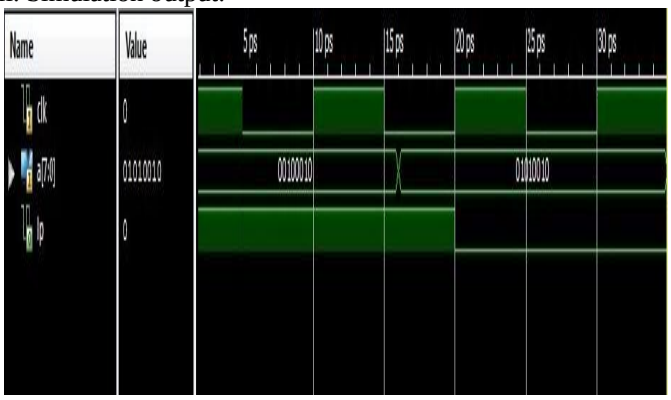


Fig 3.1 simulation result of low pass filter

With respective to the above simulation graph. We have initialized "clk" and "a" as inputs "lp" as the output. The clock is assigned with the standard values of 1 and 0 for the raising and trailing edge of the clock respectively. We have summed up 10 units into 1 complete cycle for the analysing of the graph (were the output changes only during raising edge). Provided with the data of cut off frequency as 40hz. If the input frequency is greater than cut off frequency range then the output variable will be set to '0' if not it will be set to '1'. This is shown as above in fig 3.1

B. High Pass Filter:

High pass filter is defined as which blocks or rejects the lower frequencies and allows the higher frequency signal to flow through that circuit. Even though it allows the all high frequency there will be some little reduction which can be ignored.

This circuit is designed by using a capacitor and a resistor in parallel. The combination components of resistance and as well as capacitor or inductor is known as reactance.

i. Circuit diagram:

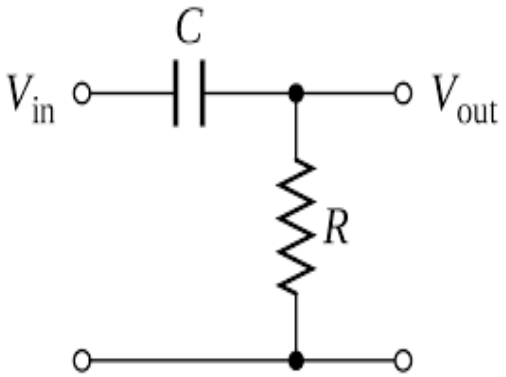
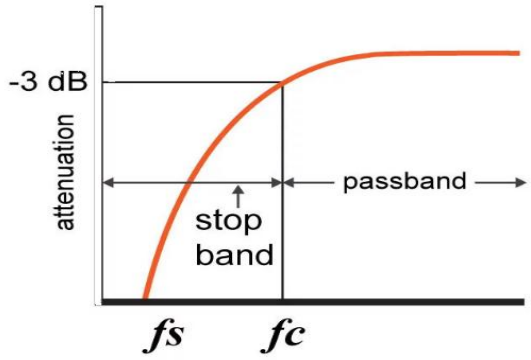


Fig 1.3 High Pass Filter

ii. Working: From the fig 1.3 we know that when the low frequency signal is given to a circuit then the output voltage will not be obtained because its block the lower frequency and value of the reactance will be high. If high frequency signal is given to the circuit which passes through a capacitor then the output voltage will be obtained across the resistor. But in this reactance value will be low.

iii. Graph:



iv. Advantages and Disadvantages:

a. They are having a simple transfer function which makes easier to calculate the coefficients of polynomial.

b. The major drawback of high pass filter is we should be careful about components while designing an circuit which we are going to use in it otherwise we will get an unwanted signals in stop band or pass band.

v. Applications:

a. They are mainly used in speakers for amplification.

b. The high pass digital filters are used in image processing.

c. It is used to avoid an amplification of dc current which can makes amplifier to not work properly.

d. They are also used in rc phase shift and given input for the ac coupling

vi. RTL View:

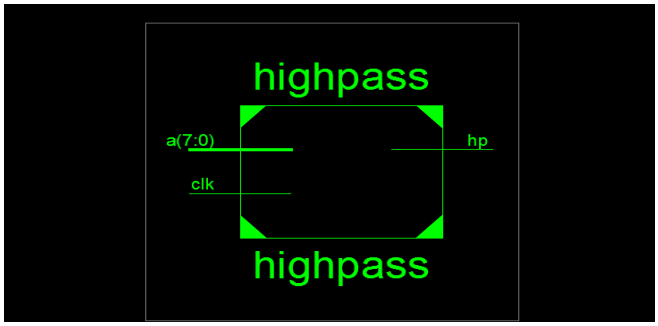


Fig 2.3 RTL view of high pass filter

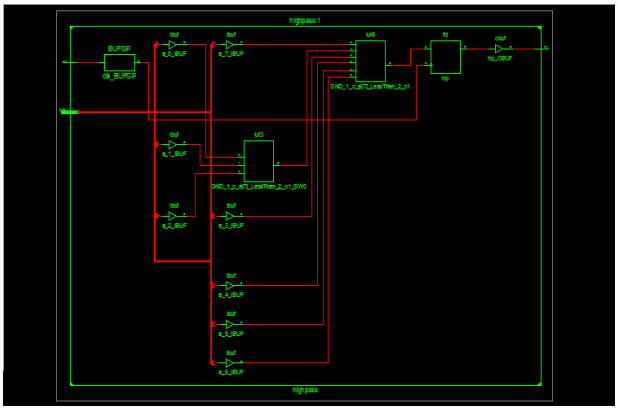


Fig 2.4 RTL schematic view of high pass filter

vii. Simulation output:

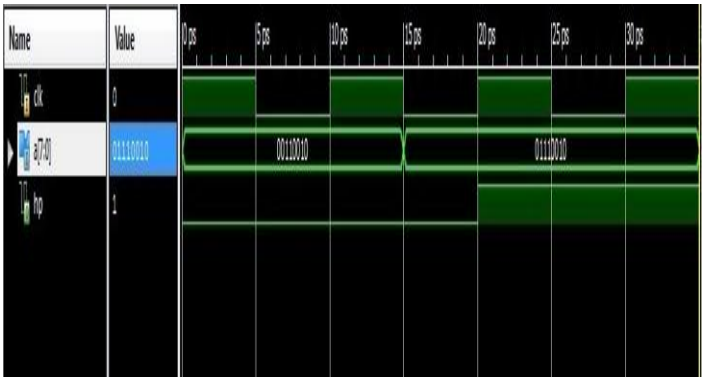


Fig 3.2 simulation result for high pass filter

With respective to the above simulation graph. We have initialized "clk" and "a" as inputs "hp" as the output. The clock is assigned with the standard values of 1 and 0 for the raising and trailing edge of the clock respectively. We have summed up 10 units into 1 complete cycle for the analysing of the graph (were the output changes only during raising edge). Provided with the data of cut off frequency as 60hz. If the input frequency is greater than cut off frequency range then the output variable will be set to '1' if not it will be set to '0'. This is shown as above in fig3.2

C. Band Pass Filter:

Band pass filter is defined as which allows only certain frequency through the circuit. In one word we can tell that it is combination of low pass and high pass filter. The output range lies between low pass cut off frequency and high pass cut off frequency. It is designed by using two resistor and capacitors which are connected in parallel.

i. Circuit diagram:

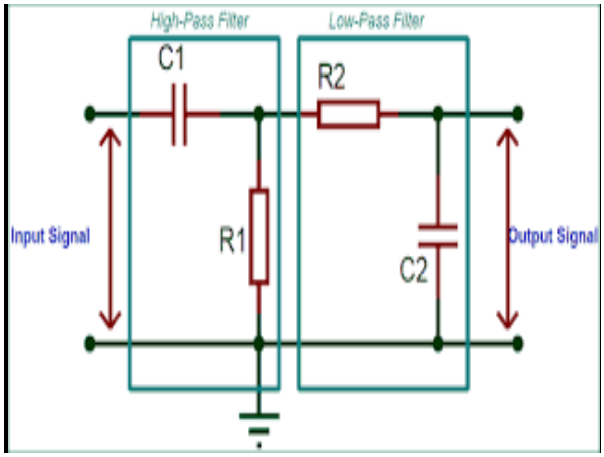
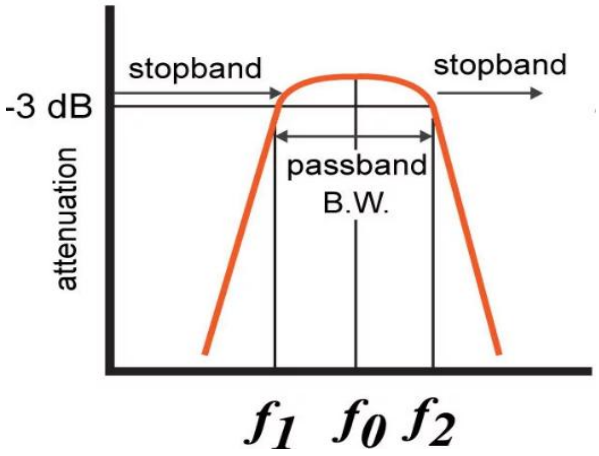


Fig 1.4 Band Pass Filter

ii. Working**:** From the above fig 1.4 we know that when the input frequency signal is passed though the circuit then the first half of the circuit is a high pass filter which rejects the low frequency and passes only high frequency then obtained output will be higher cut off frequency. Later, it passes to a second half of circuit which allows a low frequency and rejects a high frequency then we will obtain a lower cut off frequency. Band pass output is obtained by the sum of both cut off frequency is divided by two.

iii. Graph:



iv. Advantages and disadvantages:

a. We get excellent electrical performance, mechanical reliability and environmental stability.

b. It passes all the frequencies with more or less attenuations.

v. Applications:

a. They are majorly used in wireless transmitter and receivers.

b. They are also used in audio systems like audio amplifiers, wireless circuits.

vi. RTL View:

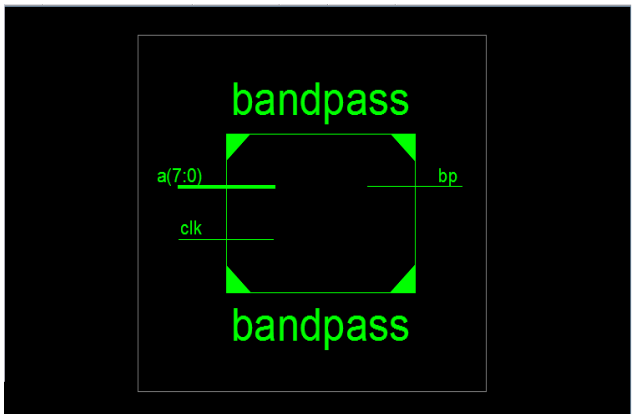


Fig 2.5 RTL view of band pass filter

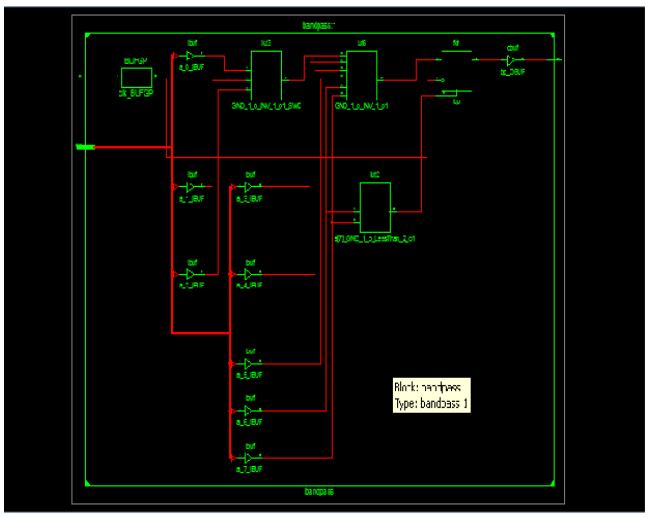


Fig 2.6 RTL Schematic view of band pass filter

vii. Simulation output:

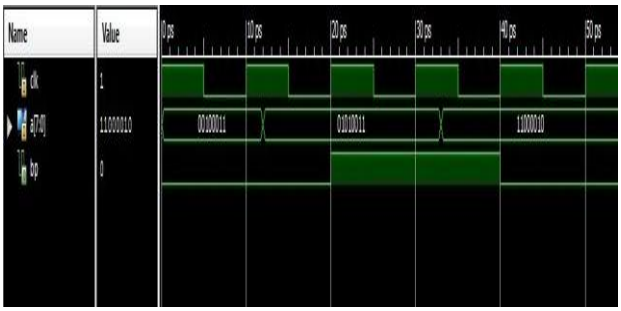


Fig 3.3 simulation result of band pass filter

With respective to the above simulation graph. We have initialized "clk" and "a" as inputs "bp" as the output. The clock is assigned with the standard values of 1 and 0 for the raising and trailing edge of the clock respectively. We have summed up 10 units into 1 complete cycle for the analysing of the graph (were the output changes only during raising edge). Provided with the data of cut off frequency as 40hz-60hz. If the input frequency is between the greater and lesser cut off frequency then output variable will be set to '1' if not it will be set to '0'. This is shown as above in fig3.3

III. RESULT

Table-I: Result of Low, High and Band pass filter

Cut off Frequency	Low Pass Filter	High Pass Filter	Band Pass Filter
40 hz	1	0	0
60 hz	0	1	0
50 hz	0	0	1

1 - indicates High 0 - indicates Low

From the above table I we know that when the cut off frequency is below 40 hz it acts as Low pass filter. When the cut off frequency is above 60 hz it acts as High pass filter. When the cut off frequency is between 40 to 60 hz it will behave as Band pass filter.

IV. CONCLUSION

As Filters plays a major role in many applications. The Verilog code is written and simulated for the same using XILINX ISE 13.1 as a simulation tool. In the above section, three types of filters are discussed based on working, graph, circuit diagram etc. From the above observation, we can conclude that the filters which passes the range of frequencies which are below than that of mentioned cut off frequency are consider to be as Low Pass Filters. Similarly, High-Pass Filter are those which passes the frequency above the mentioned cut off frequency range. The cut off frequency range between High pass and Low pass filter are consider to be as Band Pass Filter.

REFERENCE

1. G. J. Martin, "Low Pass Analog Filter Design", Nat. Telem. Conf., pp. 181-185, 1958.
2. F. Benriad, "A Novel Microstrip Low Pass Filter Based on Ring Topology," International Journal of Microwave and Optical Technology, vol. 12, Jan. 2017.

3. Roy, Kaushik, Yeo, and Kiat-Seng, “Low voltage Low-power VLSI Subsystems”, McGraw-Hill, pp.124- 141.
4. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis,” 2nd Edition, Pearson, 2003.
5. J. R. Macdonald, "Active adjustable audio band-pass filter", J. Acoust. Soc. Am., vol. 29, pp. 1348.
6. H. Yoo, and D. Anderson, “Hardware-Efficient Distributed Arithmetic Architecture for High-Order Digital Filters”, in Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing, 2005.
7. K. Xu, Y. Zhang, D. Li, Y. Fan, J. L.-W. Li,W. T. Joines, and Q. H. Liu, “Novel Design of a Compact Triple-Band Bandpass Filter Using Short Stub-Loaded Sirs and Embedded Sirs Structure,” Progress In Electromagnetics Research, vol. 142, pp. 309–320, 2013.
8. J. Chen, Z.-B.Weng, Y.-C.Jiao, and F.-S. Zhang, “Lowpass Filter Design of Hilbert”
9. J.R. Ashley, "Butterworth filters as loudspeaker frequency-dividing networks", Proceedings of the IEEE, vol. 58, no. 6, pp. 959-960, 1970.
10. Hany Selim, G. A. Girgis, "Microprocessor-Based Digital Accelerometer and its Application in an Instrument for Motor Torque-Speed Characteristic Display During the Transient Interval", Industrial Electronics IEEE Transactions on, vol. IE-33, no. 1, pp. 44-48, 1986.
11. Luis Bica Oliveira, Nuno Paulino, João P. Oliveira, Rui Santos-Tavares, Nuno Pereira, João Goes, "Undergraduate Electronics Projects Based on the Design of an Optical Wireless Audio Transmission System", Education IEEE Transactions on, vol. 60, no. 2, pp. 105-111, 2017.

AUTHORS PROFILE

Navin Kumar H G pursuing Bachelor of engineering (Electronics and communication) from K.S. Institute of Technology, Visvesvaraya technological university, India. Research interests includes the areas of network security, Analog electronics and ethical hacking.

Pruthviraj N pursuing Bachelor of engineering (Electronics and communication) from K.S. Institute of Technology, Visvesvaraya technological university, India. Research interests includes the areas of image processing, wireless communication and robotics.

Surya N pursuing Bachelor of engineering (Electronics and communication) from K.S. Institute of Technology, Visvesvaraya technological university, India. Research interests includes the areas of power electronics, Robotics and IOT.

Aruna Rao B P working as Assistant professor of Electronics and communication in K S Institute of technology, pursuing PhD in the field of high speed VLSI under Visvesvaraya technological university. Research interests includes the areas of VLSI and embedded systems.