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A Novel Circuit for Digital Tuning of Bandpass Filters and its Analysis Using MCU

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Abstract: **In this paper we try to design and implement an MCU based Tunable Band pass filters. The design of these filters is presented along with the simulations. In Tunable filters the general 2nd order op amp filter is tuned via a variable resistor/capacitor components using a pre-programmed MC U through a PC serial port .The design of the filters is done in TI filter Pro, the complete circuit is designed using done using Proteus 8 professional, the MCU/LCD code is written in Kiel U vision 4, simulations are obtained in Proteus 8 and MCU is burned using ISP prog.**

Keywords: **Tunable, filters, frequency, resistor array, centre frequency, band pass, serial port, MCU, Hyper Terminal, filtering.**

I. INTRODUCTION

A filter is a device that passes electric signals at certain frequencies or Frequency ranges while preventing the passage of others. Filter circuits are used in a wide variety of applications. In the field of telecommunication, band-pass filters are used in the audio frequency range (0 kHz to 20 kHz) for modems and speech processing. High-frequency band-pass filters (several hundred MHz) are used for channel selection in telephone central offices. Tunable digital filters are widely employed in telecommunications, medical electronics, digital audio equipment and control systems. These filters are also known as variable digital filters. Tunable digital filters are used in telecommunication system in the front end of a receiver to select a particular band of frequencies. In medical electronics, tunable notch filters are used to suppress the power line interference. The bases for the design of the tunable digital filters are the spectral transformation. It is basically used to modify the characteristics of a filter to meet new specifications “without repeating the filter design procedure”.

II. TUNABLE FILTERS

Due to the occurrence of multi-frequency bands in different regions and diverse applications, requirement of tunable filters exists. It is significant for receivers and transceivers operating in wide frequency spectrum to have maximal tuning range and save filtering characteristics, while frequency is tuned. One possibility is a switch with an array of individual filters (filter bank) which have different frequency bands. This is quite simple approach, but needs a lot of components and large space to have enough quantity of filters with fixed frequency in an array. So, filter bank should consist of not less than 10 filters with 50 MHz bandwidth for smooth tuning in whole frequency range from 500 MHz to 1000 MHz However, the quality factor of filters realized with fixed value inductors and capacitors is better than Q of tunable elements. It allows filter banks to have good performance

III. THE DESIGN

We employed the Filter Pro V8.0 for the design of the filters using multiple feedback design technique. We designed and analyzed various this filter for different output frequency responses. A number of results were obtained using the real passive element simulations.

A. Sample 1:

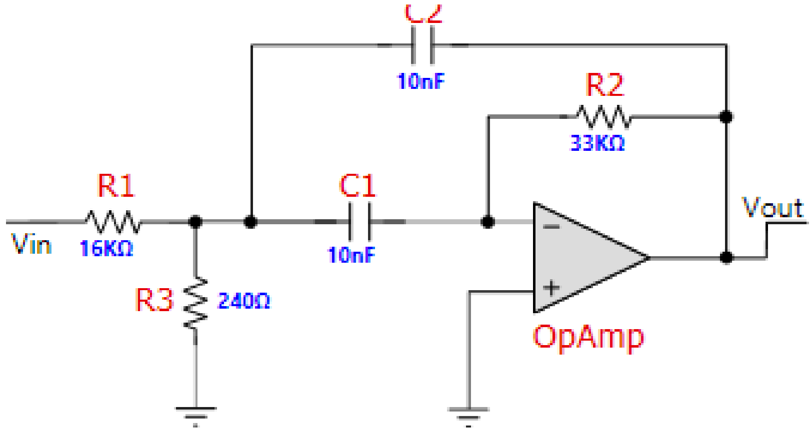

Fig 1: Multi feedback filter for 6 KHz Center frequency and 1 KHz pass band

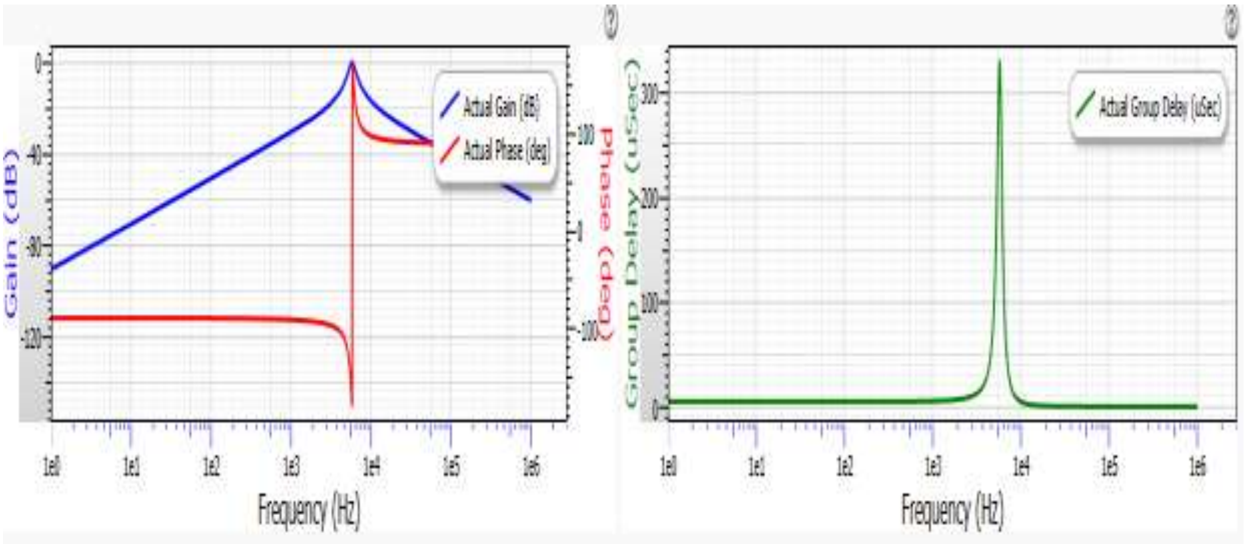

Fig 2 : Response of the above design.

B. Sample 2:

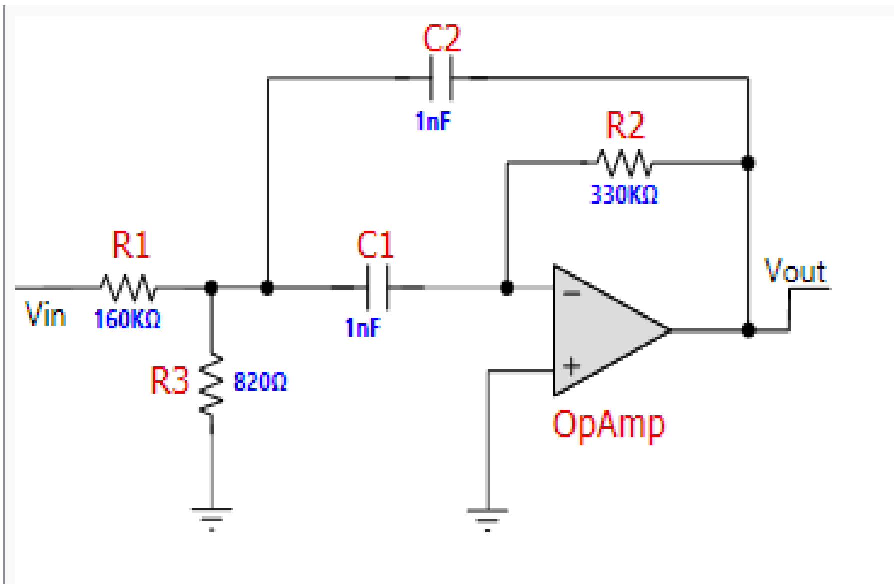

Fig 3 : 2 khz center frequency and 1khz pass band.

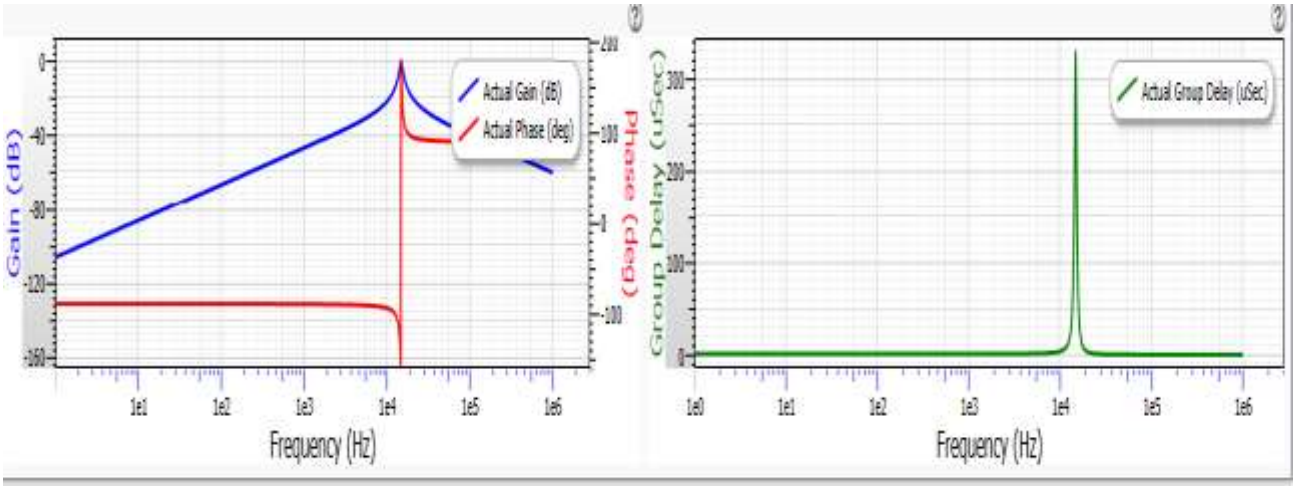

Fig 4 : Response of the above circuit.

C. Sample 3:

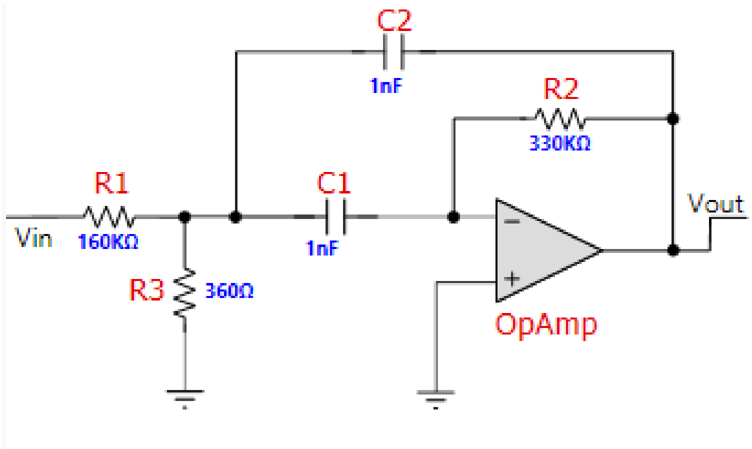

Fig 5 :15 Khz BP Filter with 1 Khz pass band.

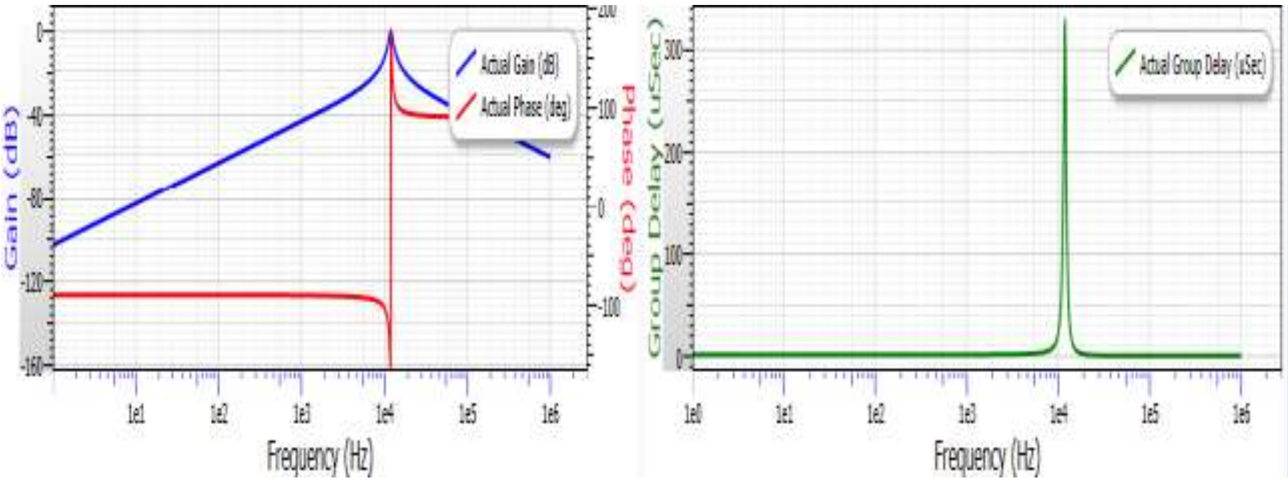

Fig 6 : Response of the filter.

We combined all the analysis to form a single circuit.

IV. DESIGN OF TUNABLE FILTER

We developed a set of filters in the butter worth response and analysed all the responses at different frequencies so that we could easily combine all the sets into a single bandpass using different techniques developed.

V. WORKING

The simulation has been designed in the Proteus Design Suite. The basic circuit has been given in fig. .It is known that the resistor R3 is used to basically tune the filter we have combined all the designed individual filters by combining the resistors as a resistor ladder of binary weights. The resistors need to be grounded for it to operate. For digital tuning we need to connect separate resistor every time, we employ :

- An 8051 microcontroller to the grounding of resistor's to obtain a separate center frequency as shown in Fig.In this circuit we use AT89S52 is used in to tune the circuit by programming the 8051 either by using hyper terminal software or by internal programming.

To design a tunable band pass filter we employ :

- 2 stage high bandwidth op amp CD-3140 of order 2(each Stage).
- Two groups of 8 weighted ressistors.
- Two groups of BC-547 npn transistors.
- AT89S52.
- Serial port.

We employ Kiel U vision 4 to write the program for identifying the data from the Hyper Terminal .Kiel The µVision IDE from Keil combines project management, make facilities, source code editing, program debugging, and complete simulation in one powerful environment. The µVision development platform is easy-to-use and helping you quickly create embedded programs that work. The µVision editor and debugger are integrated in a single application that provides a seamless embedded project development environment.

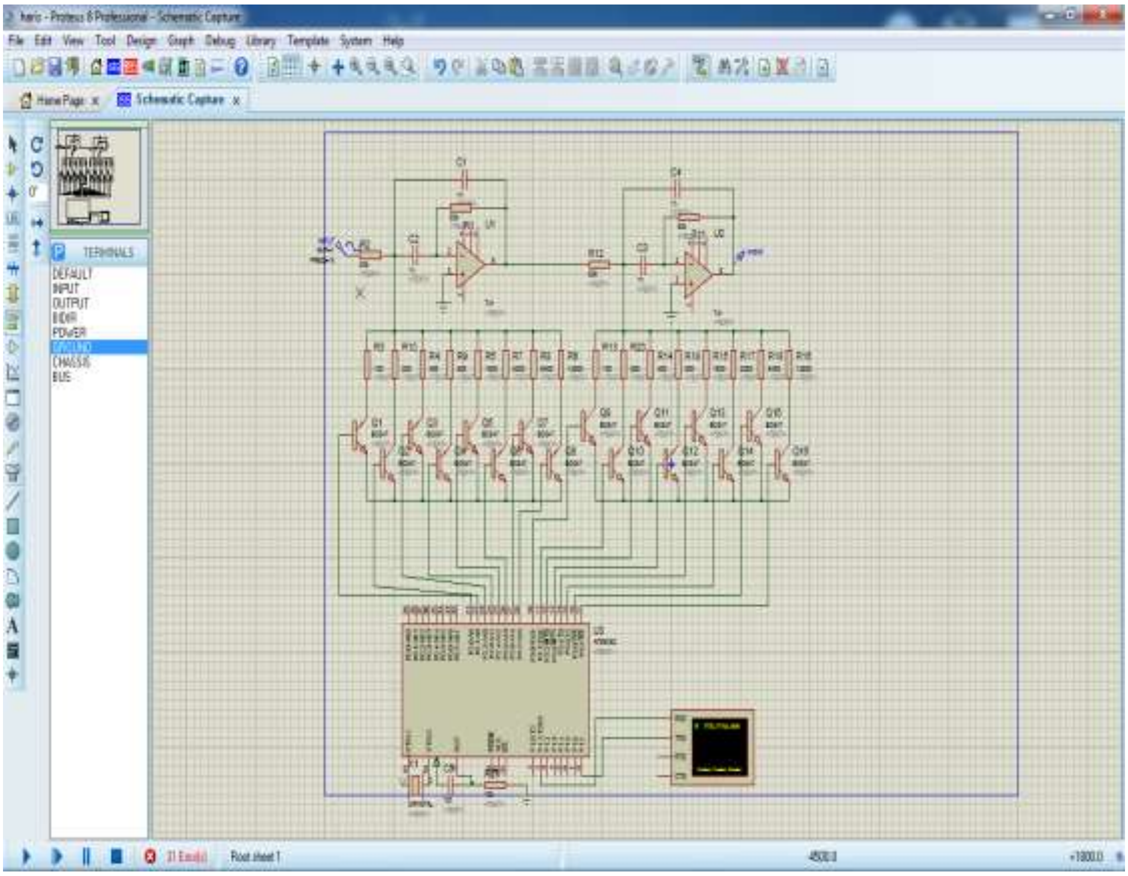

Fig 7: Circuit Diagram Of the tunable Band pass filter.

We programmed the MCU with a serial port program to receive a value from the PC via the serial port that will determine the filter characteristics .A table has been formulated for the values and the filter center frequency.

Table 1: Input values and the center frequency

Value Of Resistor R3	Digital Code	Center Frequency
100 ohm	01H	44 kHz
66 ohm	02H	42kHz
200 ohm	03H	37.6kHz
100 ohm	04H	35 kHz
480 ohm	18H	27.6 kHz
800 ohm	08H	23.7kHz
1200 ohm	40H	10.9 kHz
..	..	..
12800 ohm	80H	8.4 kHz

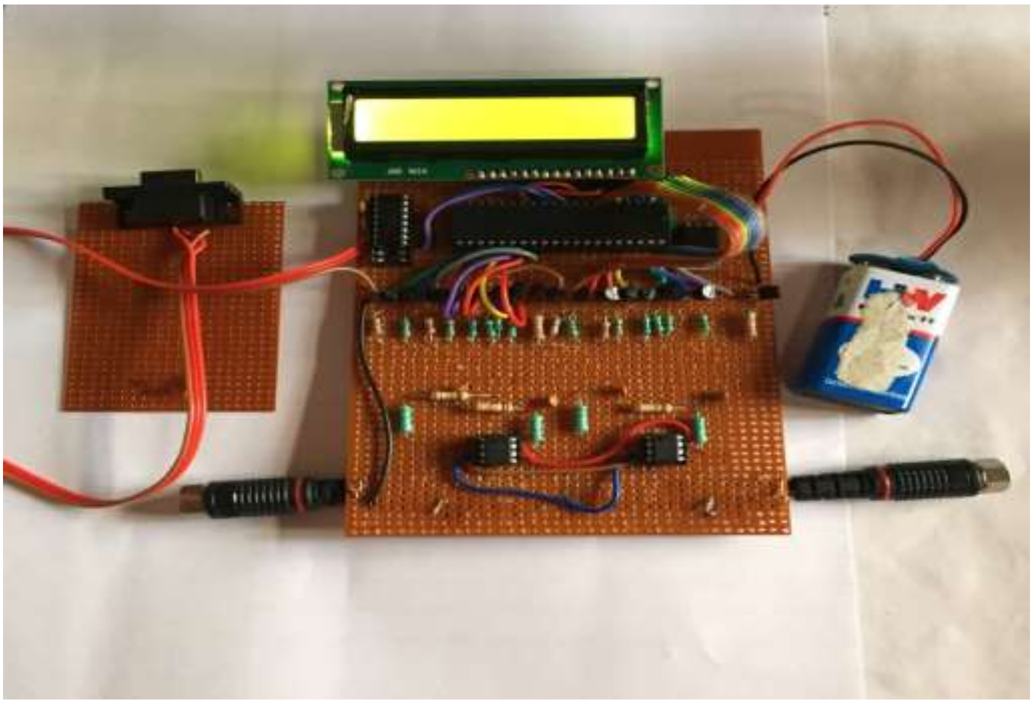

Fig 8: Hardware

VI. CONCLUSION

In this work a design of tunable band pass filters at band of 0-100Khz band was under research. One promising application of such devices is in frontends and sensors for the Cognitive Radio, Software defined radio and all. The main goal was to development sufficiently compact, low cost tunable filters with a quite narrow bandwidth using currently available lumped-element components. Filter design, different topologies and methods to tune band pass filters were explored to choose the best suitable variant to comply with the required purpose.

It appeared, that the 2nd and the 4th order resistive string filters showed promising results of high Q and stability. They were simulated with taking into account the influence of losses in real components. Resistors are used to adjust a central frequency at spectrum. Measurements revealed that the presented schematics have proper output response and filters are successfully tuned by resistors and selection components

Measured values of insertion losses have good agreement with simulated ones. Difference between them is less than 1 db. The increase of losses in real filters can be caused by parasitic resistance at element interconnects and wiring because the soldering is imperfect. In comparison with designs of filters presented in scientific papers, tunable filters of this work have several benefits. The first is a constant and relatively small bandwidth during tuning. Second advantage is that the range of insertion losses is 3.6 - 4.8 db. It is less than 7.9 dB, which other filter that also used Peregrine digitally tunable capacitors has filters [18]. Moreover, if bandwidth is wider than 5 kHz, losses in proposed filters can be smaller than 3 db. To summarize, considering the acceptable level of losses, the constant bandwidth during tuning, small dimensions and cost of realized filters, all topologies are suit for audio processing and filtering. The digital tuning type perfectly corresponds with the CR agenda of the spectrum-defined radio.

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REFERENCES

[1] Anatech Electronics Inc.,"Guidelines for choosing RF and Microwave products" Dedham, Massachusetts: Artech House Inc., 1980

[2] G.L. Matthaei, L. Young, E.M.T. Jones, "Microwave Filters, Impedance-Matching Networks, and Coupling Structures". Dedham, Massachusetts: Artech House Inc., 1980.

[3] J. Uher and W. J. R. Hoefer, "Tunable microwave and millimeter-wave band-pass filters", Microwave Theory and Techniques, IEEE Transactions on, vol. 39, pp. 643-653, 1991

[4] A. I. Zverev, Handbook of Filter Synthesis. New York: John Wiley and Sons, 1967

[5] G. D. Vendelin, A. M. Pavio, Rohde and Ulrich L., Eds.,"Microwave Circuit Design using Linear and Nonlinear Techniques". John Wiley & Sons, pp.273-289, 2005.

[6] Sedra, A.S., Brackett, and P.O.: "Filter Theory and Design: Active and Passive", Matrix, Beaverton, Champaign, 1978

[7] Moschytz, G.S.: "Linear Integrated Networks: Fundamentals". Van Nostrand-Reinhold, New York, 1974

[8] Moschytz, G.S.: "Linear Integrated Networks: Design. Van Nostrand-Reinhold", New York,1975

[9] Deliyannis, T., Sun, Y., Fidler, J.K.:"Continuous-Time Active Filter Design." CRC Press,Boca Raton,1999

[10] Tsividis, Y.P.,Voorman, J.O. (eds.):"Integrated Continuous-Time Filters".IEEE Press,Piscataway,1993.

[11] Schaumann, R., Ghausi, M.S., Laker, K.R.: Design of Analog Filters: Passive, Active RCand Switched Capacitor. Prentice Hall, Englewood Cliffs ,1990.

[12] Ghausi, M.S., Laker, K.R.: Modern Filter Design. Prentice-Hall, Englewood Cliffs ,1981

[13] Temes, G.C., Mitra, S.K. (eds.): Modern Filter Theory and Design. Wiley, New York,1973

[14]] Daryanani, G.: Principles of Active Network Synthesis and Design. Wiley, New York,1976

[15] Huelsman, L.P., Allen, P.E.: Introduction to the Theory and Design of Active Filters.McGraw-Hill, New York ,1980

[16] Bruton, L.T.: Active RC Circuits. Prentice-Hall, Englewood Cliffs,1980

[17] Unbehauen, R., Cichocki, A.: MOS Switched-Capacitor and Continuous-time IntegratedCircuits and Systems. Springer, Berlin ,1989

[18] Budak, A.: Passive and Active Network Analysis and Synthesis. Waveland Press, Prospect Heights ,1991

[19] Ghausi, M.S.: Analog active filters. IEEE Trans. Circuits Syst. CAS-31, 13–31,1984