IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 10, Issue 3, March 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.122

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering (IJAREEIE)

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 10, Issue 3, March 2021||

DOI:10.15662/IJAREEIE.2021.1003003

A Bandstop Filter Based on an Optimum Bandstop Filter

S. Yang[1], K. Nyarko[2]

Assistant Professor, Dept. of EE and CS, Alabama A & M University, Huntsville, AL 35810, USA [1]

Associate Professor, Dept. of ECE, Morgan State University, Baltimore, MD 21251, USA [2]

ABSTRACT:A microstrip bandstop filter (BSF) based on an optimum BSF is presented. The original BSF has three open stubs. One narrow stub is attached onto the left open stub, and the length of the right open stub is reduced to form the new BSF. The filter is simulated on Sonnet Lite software. Simulation results show the new filter generates a wider stopband without increasing the circuit size.

KEYWORDS: Optimum Bandstop Filter, Open Stub, Attenuation Pole, Stopband Profile.

I.INTRODUCTION

Microstrip bandstop filters are very important microwave components. They are widely used in local oscillators, mixers, switches, diplexers, and etc. Some fundamental techniques to synthesize and design BSFs were summarized by Hong [1]. In general, at least three ways are used to design BSFs [2]. The first way is to place resonators very close to the main transmission line. The resonators may take energy from the main transmission line through coupling. The second routine way is to tap resonators to the main transmission line. The resonators will definitely take energy from the main transmission line. The third way is to use defected ground structures (DGS), and the DGS will form resonations. But in this way, the cost to fabricate the filter circuit may increase. In this paper, a new BSF is formed based on an optimum BSF. The proposed method is very simple and very effective. The proposed BSFs are simulated on Sonnet Lite software. Simulation results show a wider stopband can be generated without increasing the circuit size.

II.RELATED WORK

To change the stopband profiles of conventional microstrip BSFs has been a hot research topic for many years [3-5]. In [3], a spur line was embedded onto the connecting line between the open stubs of a conventional open-stub BSF to get a wider and deeper stopband. In [4], a meander spurline was embedded between the open-stubs of a conventional open-stub BSF. In [5], an asymmetrical double spurlines were inserted between the two open stubs of a conventional open-stub BSF. In [6], two very narrow stubs are attached onto the two open stubs in an optimum BSF. In [7], the middle open stub of an optimum BSF was replaced by a half –wavelength, two-section, shunt open stub. The resultant filter generates a much wider stopband. Optimum BSFs should have better passband and stopband performances than conventional open-stub BSFs [1]. In this research, the stopband profile of an optimum BSF is changed by attaching only one very arrow stub on the left open stub in this optimum BSF, and decreasing the length of the right open stub. The proposed method is very simple and very straight forward, and also very effective.

III.FILTER LAYOUT AND SIMULATION RESULTS

An optimum BSFs can have very low insertion loss and very low reflection in the passbands, and keep very deep rejection level in the stopband. Such an optimum BSF with three open stubs was designed. It has a fractional bandwidth of 0.8 and a midband frequency of 4.9 GHz. The left and the right stub are 6.10 mm long. The wide middle stub is 5.75 mm long. Detailed filter structure and simulation results can be found in [6]. The proposed BSF is based on this optimum BSF.

First, a very narrow stub is attached onto the left open stub. This method is very similar to that in [6]. The new filter is shown in Fig. 1, and length unit is mm. This narrow stub is 0.2 mm wide and 2.0 mm long. The narrow stub should be as narrow as possible so that it will have less influence on passband insertion loss. The narrow stub and the original

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 10, Issue 3, March 2021||

DOI:10.15662/IJAREEIE.2021.1003003

left open stub will form a new longer stub and generate a new attenuation pole. In this way, the stopband profile will change.

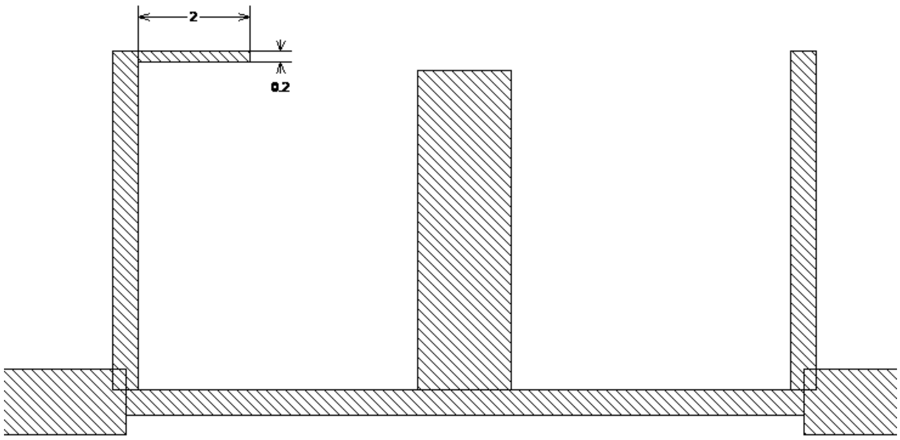


Fig. 1. The filter with a narrow open stub attached to the left open stub of an optimum BSF.

This filer is simulated on Sonnet Lite and the simulation results are shown in Fig. 2. The new stopband is much wider at rejection levels less than about -30 dB. The narrow stub and the left original stub form an extended open stub, which generates an additional attenuation pole at 4.16 GHz. This new attenuation pole is the source for the stopband profile change.

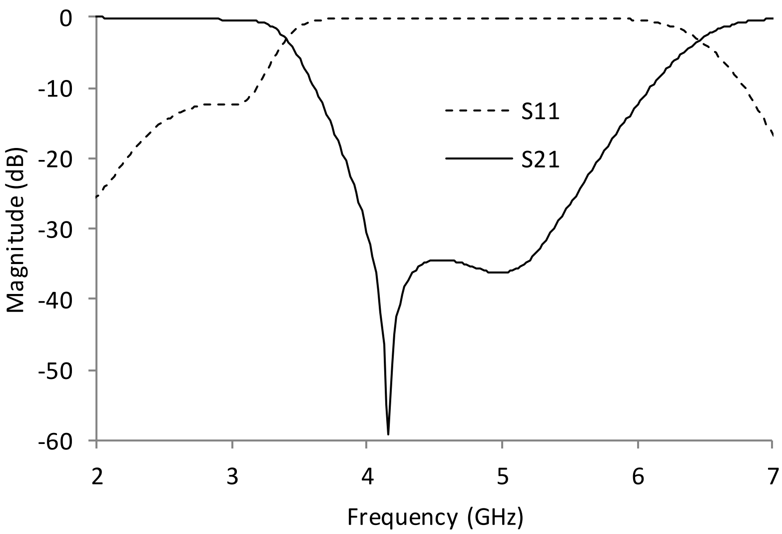


Fig. 2. The simulation results of the BSF filter with the narrow stub.

If the length of the attached narrow stub is reduced to 1.5 mm. The new attenuation pole is moved to 4.34 G. This situation is shown in Fig. 3. It is apparent the new attenuation pole will go to a higher frequency when the new narrow stub length decreases. At the same time, the bottom of the stopband will become a little bit narrower, but a little bit deeper.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 10, Issue 3, March 2021||

DOI:10.15662/IJAREEIE.2021.1003003

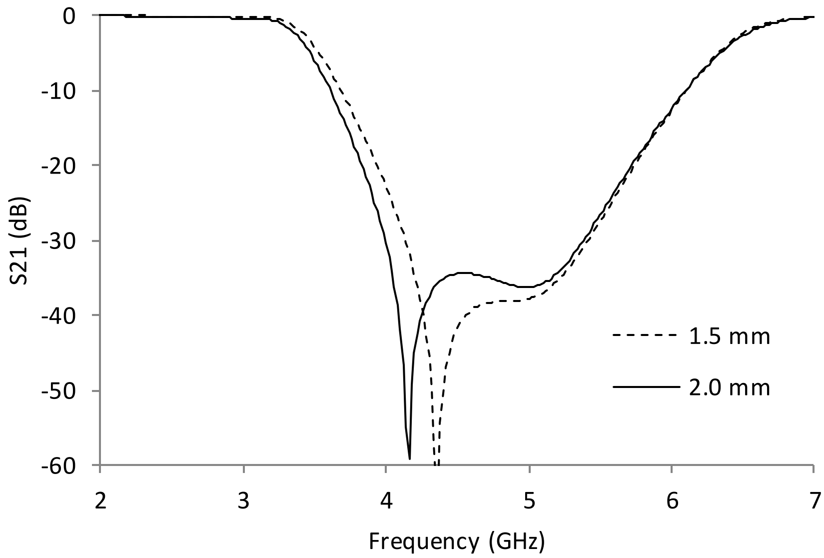


Fig. 3. The insertion losses for two selected narrow stub lengths.

For better comparison, the insertion losses of the original optimum BSF and the proposed filter are shown together in Fig. 4. The narrow stub length is 2.0 mm in this new filter. The new filter's stopband has a wider bottom. The new stopband center frequency is shifted to the left. The side effect of this method is that right side of the stopband also shifts to the left. This effect is also similar to that in [6]. This side effect can be overcome next.

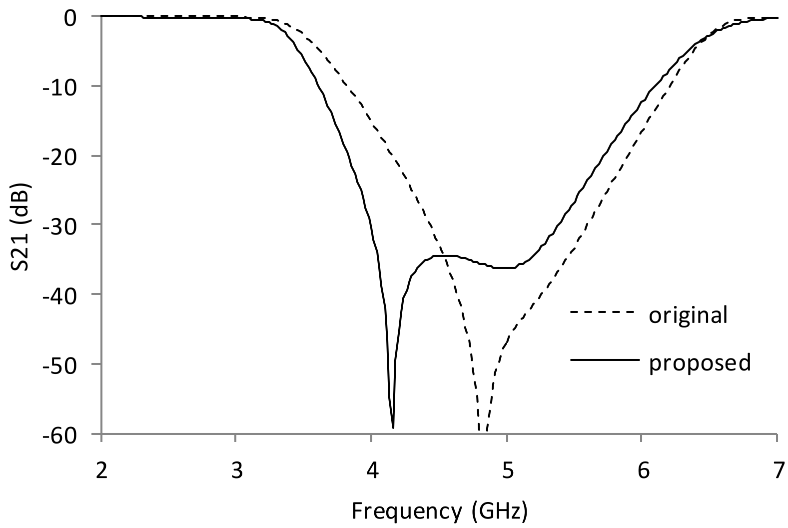


Fig. 4. The insertion losses of the original filter and the new filter with a narrow stub attached.

The second change on the original optimum BSF is to reduce its right stub length. The purpose is improve the stopband profile on the high frequency side. The length of the right open stub was 6.1 mm. This length is reduced to 5.8 mm, and the new filter is simulated again. The simulated insertion loss is included in Fig. 5. The stopband right side is shifted to the right with a little bit sacrifice on the stopband bottom depth. In this way, the new filter stopband profile can be improved.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 10, Issue 3, March 2021||

DOI:10.15662/IJAREEIE.2021.1003003

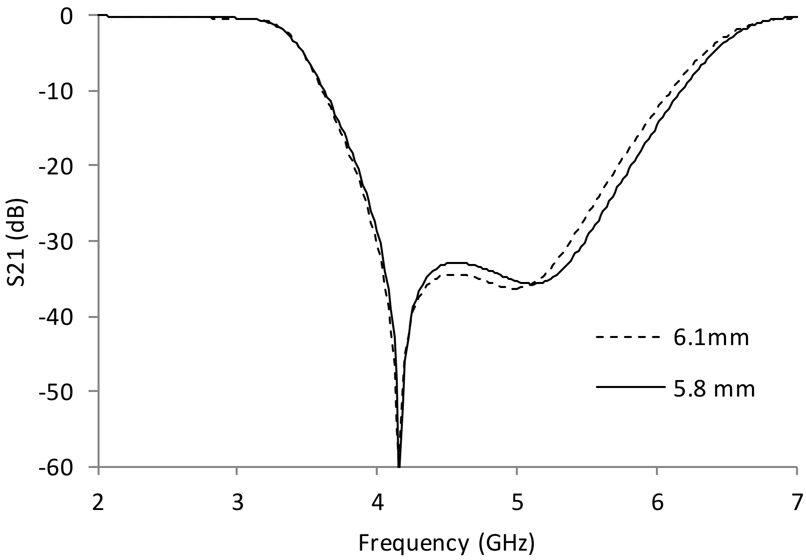


Fig. 5. Insertion losses for two selected right open stub lengths.

The right open stub is carefully tuned to 5.2 mm. The final filter is simulated again on Sonnet Lite, and the simulations results are shown in Fig. 6. The right side of the new stopband is moved to right, and the center of the stopband is around 4.9 GHz. The bottom of the stopband is wider. This bottom is also deeper than -30 dB.

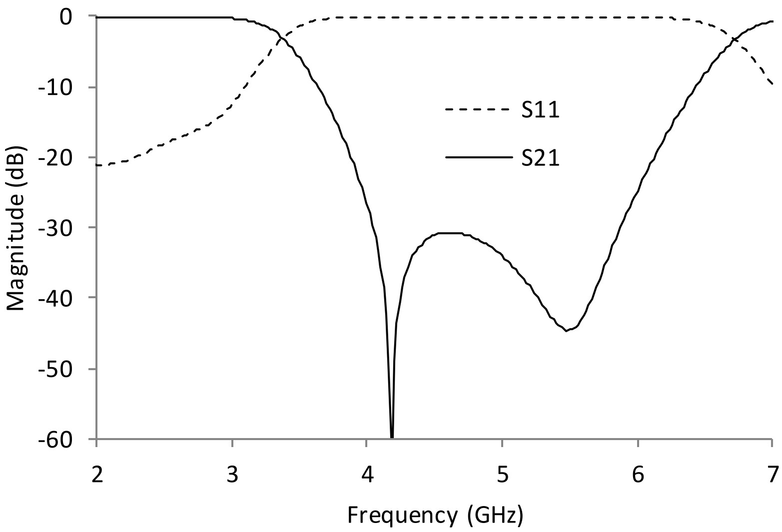


Fig. 6. The simulation results of the final filter.

Also for better comparison, the insertion losses of the original optimum BSF and final filter are shown together in Fig. 7. The attached narrow stub is 2.0 mm long and 0.20 mm wide. The right open stub is 5.20 mm long. The final filter's stopband has a wider bottom. The -30 dB stopband bandwidth is about 1.8 GHz for the final filter. This value is only about 1.1 GHz for the original optimum BSF.

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 7.122|

||Volume 10, Issue 3, March 2021||

DOI:10.15662/IJAREEIE.2021.1003003

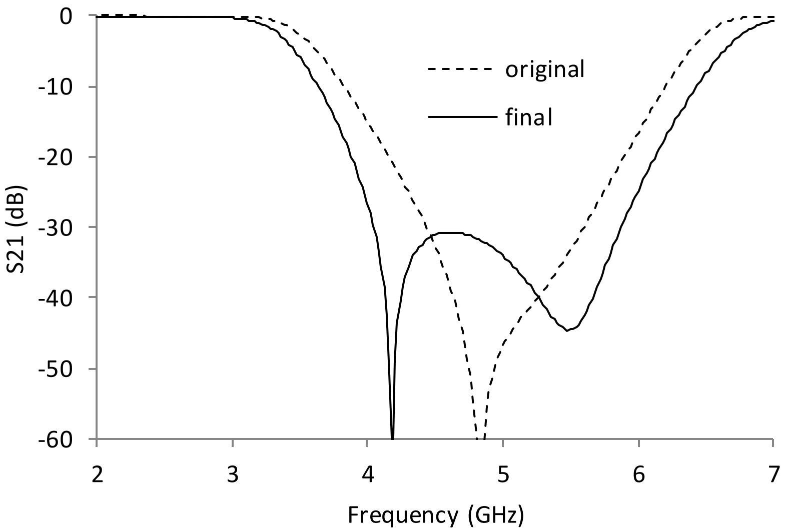


Fig. 7. The insertion losses of the original filter and final filter.

IV.CONCLUSION

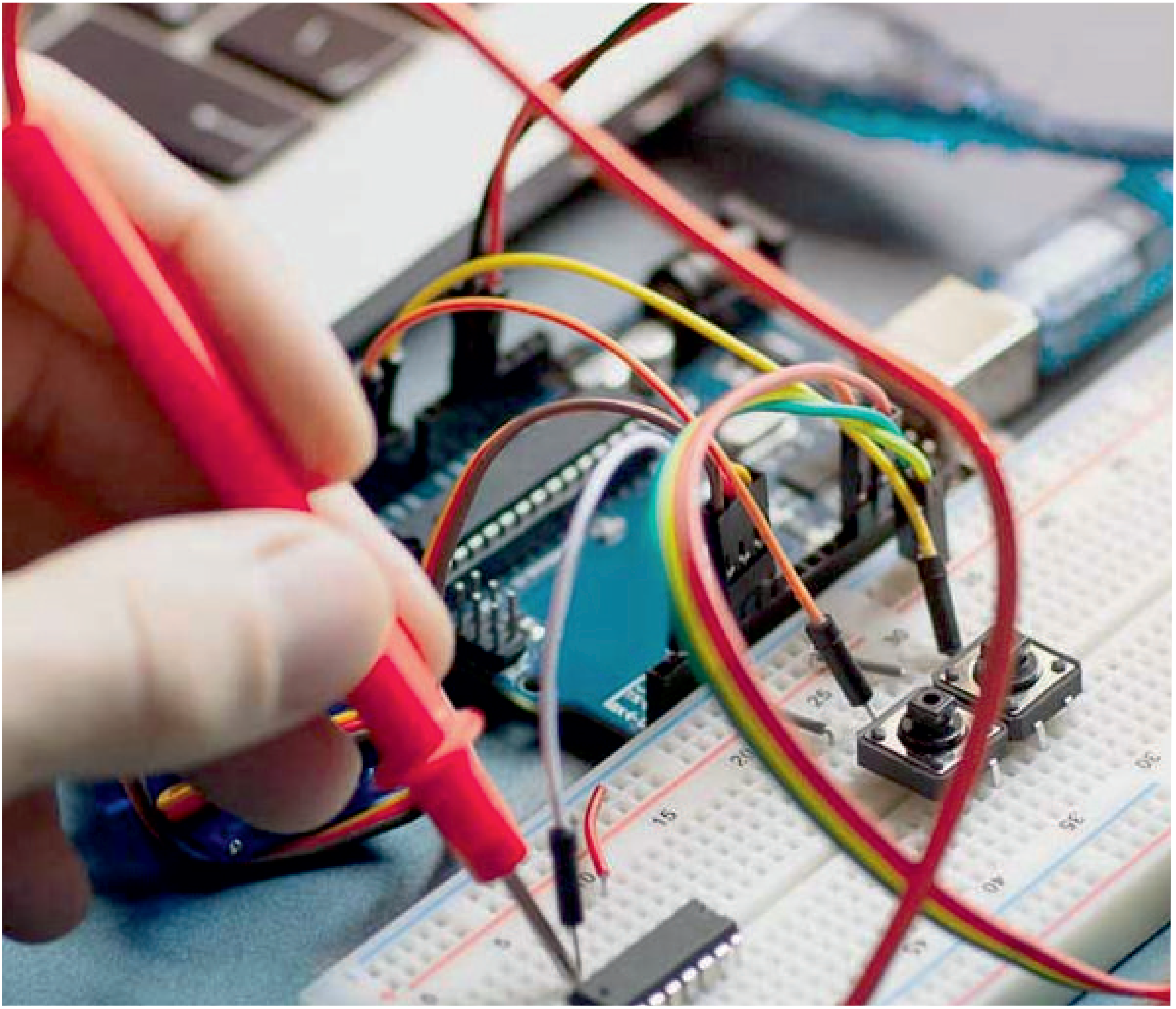
A new BSF filter is formed from an optimum BSF having three open stubs. First, a narrow stub is attached onto the left open stub of the original filter to generate an attenuation pole in the stopband. This attenuation pole expands the stopband profile to the lower frequency direction. Secondly, the length of the third open stub is reduced to expand the stopband profile in the higher frequency direction. The proposed filter has a wider stopband at -30 dB attenuation depth.

ACKNOWLEDGMENT

The authors would like to thank Dr. Montgomery, Dr. Scott,and Dr. Heidaryfor their assistances. This research was mainly supported by NSF, and the grant number is 1849454.

REFERENCES

[1] J. S. Hong, Microstrip Filters for RF/Microwave Applications, John Wiley and Sons Inc., 2011.
[2] Y. Luo, and Q. X. Chu, "A compact high selectivity dual-band bandstop filter using bent L-resonators", proceeding of the 43rd European microwave conference, Nuremberg, Oct., 2013, pp. 25-28.
[3] W. Tu, and K. Chang, "Compact microstrip bandstop filter using open stub and spurline", IEEE Microwave and Wireless Components Letters vol.15, no. 4, pp. 268-270, 2005.
[4] Y. Liu, H. Zheng, and C. Sun, "A tunable compact bandstop filter using meander spurline and folding open stubs", IEEE 2nd International Conference on Consumer Electronics, Communications and Networks (CECNet)", April, 2012.
[5] S. Yang, "Simulation of a bandstop filter with two open stubs and asymmetrical double spurlines", IJAREEIE, vol. 3, no. 9, 2014.
[6] S. Yang, "Simulation of a bandstop filter derived from an optimum bandstop filter", IJAREEIE, vol. 4, no. 7, 2015.
[7] V. K. Velidi, A. B. Guntupalli, and S. Sanyal, "Sharp-rejection ultra-wide bandstop filters", IEEE Microwave and Wireless Components Letters vol.19, no. 8, pp. 503-505, 2009.



INTERNATIONAL STANDARD SERIAL NUMBER INDIA

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering