ASEAN Journal of Science and Engineering

Journal homepage: http://ejournal.upi.edu/index.php/AJSE/

QZSS L5 Bandwidth Frequency Filter Design for QZSS Receiver

Julongkorn Pattameak, Narumon Onanong, Teerachet Makpradab, Surachet Chinnapark, Prasert Kenpankho*

Department of Engineering Education, Faculty of Industrial Education and Technology
King Mongkut's Institute of Technology Ladkrabang, Thailand
Correspondence: E-mail: 63603071@kmitl.ac.th

ABSTRACT

The purpose of this study was to design QZSS L5 Bandwidth Frequency Filter for QZSS Receiver. We presented the configuration of the Butterworth bandpass filter by using PSpice as the tool for the simulation. Bandpass filter frequency of the QZSS L5 with bandwidth is designed in 25 MHz using the Butterworth filter which is presented in this article. These designed circuits are composed of the 3rd order. Moreover, the combination between low pass filter and high pass filter is performed as a bandpass filter. In conclusion, this designed filter on the frequency of QZSS L5 is to be useful by using the Butterworth bandpass filter

ARTICLE INFO

Article History:
Submitted/Received 30 Apr 2021
First revised 11 May 2021
Accepted 17 Aug 2021
First available online 19 Aug 2021
Publication date 01 Mar 2022

Keyword:
Bandwidth,
QZSS L5,
Satellite.

1. INTRODUCTION

QZSS was authorized by the Japanese government in 2002. In the beginning, the system was developed by the Advanced Space Business Corporation (ASBC) team, including Mitsubishi Electric Corp., Hitachi Ltd., and GNSS Technologies Inc. When in 2007 ASBC collapsed, the work was taken over by JAXA together with established in February 2007 and approved by the Ministers associated with QZSS research and development (Asari *et al*., 2021).

The multi-constellation GNSS interoperable signals, L1 C/A, L2C, L5, and L1C, are to be provided based on no direct user fee. Compatibility is a mandatory requirement for the QZSS system, working in the same frequency bands among the multi-GNSS systems without harmful interference. For the GPS performance enhancement signals, L1-SAIF and LEX, a charging policy is under examination. SPAC leads the investigation for L1-SAIF (sub-meter class) and LEX (centimeter class) user terminals.

For bandwidth frequency design on QZSS satellite, it is expected performances are three times better than the specified ones in nominal conditions. Based on our previous studies (Phansori *et al*., 2021; Chinnapark *et al*., 2021; Onanong *et al*., 2021), we presented the QZSS Butterworth bandpass filter for bandwidth frequency design on QZSS satellite to be supported on QZSS applications which are: Mobile mapping, IT aided precise farming, IT aided construction, fleet management, marine and transportation applications, among others. Finally, the QZSS Butterworth bandpass filter is for bandwidth frequency design on a QZSS satellite as a service based on position (see **Figure 1**).

Figure 1. QZSS satellites ground track.

DOI: http://dx.doi.org/10. 17509/xxxxt.vxix
p- ISSN 2776-6098 e- ISSN 2776-5938

2. METHOD

This section of the article has presented the configuration of the Butterworth bandpass filter by using PSpice as the tool for the simulation. **Figure 2** shows the design of the circuit used.

From the QZSS L5 signal frequency;

$f_l = 1164MHz$

$f_h = 1189MHz$

$f_0 = 1176.45MHz$

$Z = 50\Omega$,

$Bandwidth(BW) = 25\ MHz.$

$$f_0 = \sqrt{f_l \times f_h}$$

and

$$C'_1 = C'_3 = \frac{C}{FSF \times Z}$$

and

$$L'_2 = \frac{L \times Z}{FSF}$$

Calculate

$$L'_1 = \frac{1}{\omega_0 C'_1}$$

$$C'_2 = \frac{1}{{\omega_0}^2 L'_2}$$

when

$$\omega_0 = 2\pi f_0$$
$$FSF = 2\pi(BW_{3dB})$$
$$Z = R_s = R_L$$

where f_0 is the center of frequency, f_1 is the lower cut-off frequency, *fh* is the higher cut-off frequency, ω_0 is the center of angular frequency, *L* is the inductor, *C* is the capacitor, *R* is the resistor, *FSF* is the frequency-scaling factor, and Z is the desired impedance level.

The designed circuit is as follows in **Figure 3**. The figure shows the Butterworth bandpass filters.

DOI: http://dx.doi.org/10.17509/ijost.v6ix
p- ISSN 2528-1410 e- ISSN 2527-8045

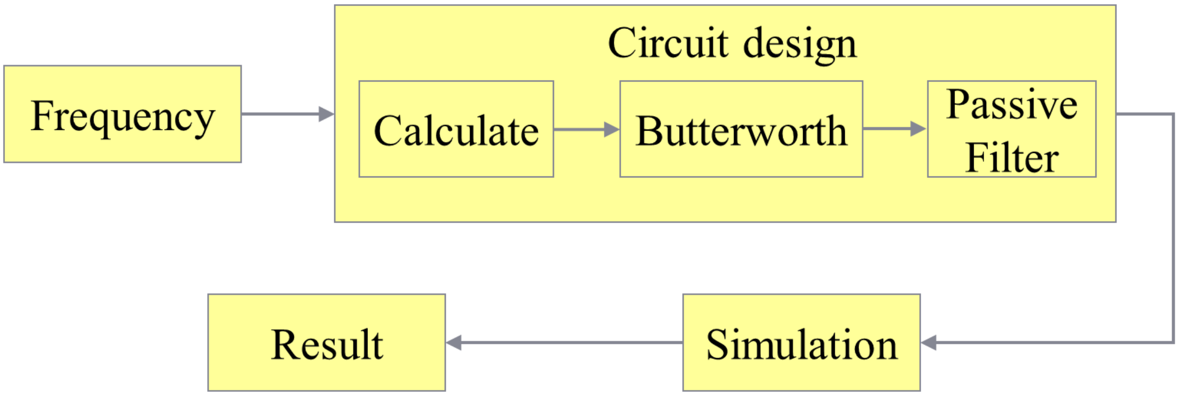

Figure 2. Circuit design method.

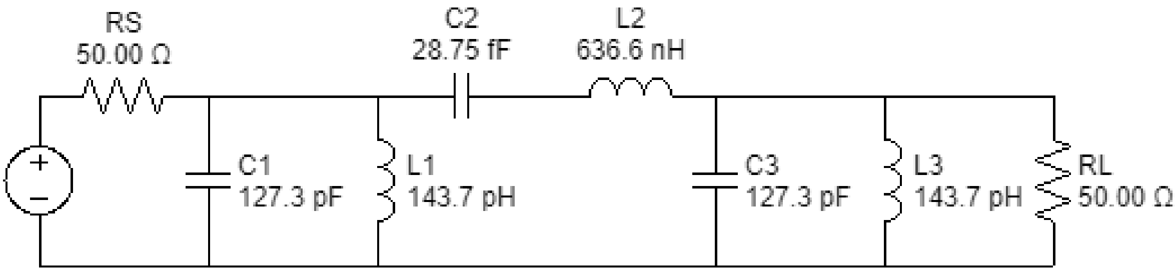

Figure 3. Butterworth bandpass filters.

3. RESULT AND DISCUSSION

3.1. Result

In this section, the results of the Butterworth bandpass filter circuit for design were presented using PSpice (**Figure 4**). The output of the band pass filter at -3 dB was between 1,164 and 1,189 MHz.We also showed phase response of bandpass filter, as shown in **Figure 5**.

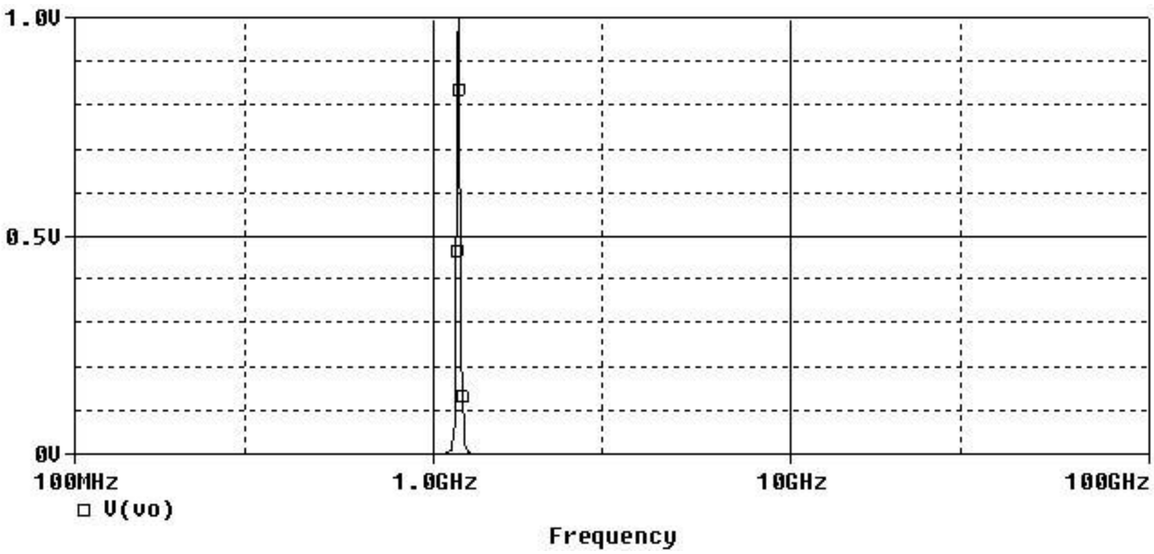

Figure 4. Amplitude-frequency response of bandpass filter.

DOI: http://dx.doi.org/10. 17509/xxxxt.vxix
p- ISSN 2776-6098 e- ISSN 2776-5938

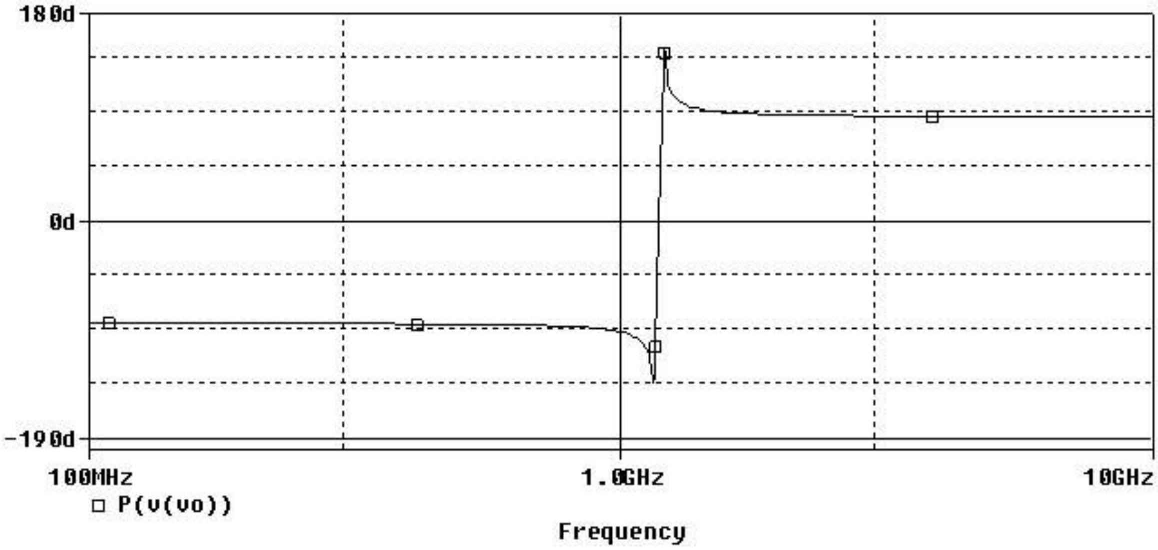

Figure 5. Phase response of bandpass filter.

3.2. Discussion

In this article, the combination of the low pass filter and high pass filter is to perform as the bandpass filter. Therefore, there are two combinations also in designing a bandpass filter. This combination aims to influence the performance of QZSS bandwidth frequency using the Butterworth bandpass filter.

4. CONCLUSION

Bandpass filter frequency of the QZSS L5 with bandwidth is designed in 25 MHz by using a Butterworth filter which is presented in this poster. These designed circuits are composed of the 3rd order. Moreover, the combination between low pass filter and high pass filter is performed as a bandpass filter. In conclusion, this designed filter on the frequency of QZSS L5 is to be useful using the Butterworth bandpass filter.

5. ACKNOWLEDGMENTS

We would like to thank class members, the professor in the radio frequency, mixed design subject in Department of Engineering Education, School of Industrial Education and Technology at King Mongkut's Institute of Technology Ladkrabang.

6. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. The authors confirmed that the data and the paper are free of plagiarism.

7. REFERENCES

Asari, K., Saito, M., Mikami, I., Kubo, Y., and Sugimoto, S. (2021). Detection algorithms on gnss millimeter displacement using orthogonal functions. *Transactions of the Institute of Systems, Control and Information Engineers*, *34*(5), 129-138.

Chinnapark, S., Onanong, N., Pattameak, J., Mekpradab, T., and Kenpankho, P. (2021). Galileo-E6 bandwidth frequency filter design for galileo receiver. *ASEAN Journal of Science and Engineering*, *1*(2), 57-62.

Onanong, N., Pattameak, J., Mekpradab, T., and Kenpankho, P. (2021). QZSS L1 bandwidth frequency filter design for QZSS receiver. *ASEAN Journal of Science and Engineering*, *1*(1), 27-32.

Phansori, N., Boatong, P., Phukrongta, S., Kriamthaisong, O., and Kenpankho, P. (2021). Analysis of the relationship between earthquake events and the disturbance of ionosphere by using IGS TEC. *ASEAN Journal of Science and Engineering Education*, *1*(1), 69-72.

DOI: http://dx.doi.org/10. 17509/xxxxt.vxix
p- ISSN 2776-6098 e- ISSN 2776-5938