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Galileo-E5a Bandwidth Frequency Filter Design for Galileo-E5a Receiver

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ABSTRACT

This study focused on the design of the band-reject filter on the frequency of the Galileo satellite by providing bandwidth at the cut-off frequency equal to the bandwidth of the Galileo-E5a. The selecting of response characteristic is Butterworth's maximally flat, amplitude-frequency response of the band-reject filter. This poster shows the combination of the LPF and HPF to perform a band-reject filter. Therefore, there are two combinations also in designing for the band-reject filter. This combination aims to influence the performance of the band-reject filter. Band rejects filter design using the frequency of the Galileo-E5a with bandwidth is 25 MHz.using a Butterworth filter which is presented in this poster. The circuit is composed 3rd.order.Moreover, the combination between LPF and HPF is designed to act as a band-reject filter. As a result, we can filter the frequency of Galileo-E5a by using the band-reject filter.

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1. INTRODUCTION

Galileo is the global navigation satellite system (GNSS), which is currently being created by the European Union (EU) and the European Space Agency (ESA) (Lechner & Baumann, 2000). It is name after the ltalian astronomer Galileo Galilei. Galileo is Europe’s own global navigation satellite system. It is interoperable with GPS and GLONASS. Galileo-E5a signal frequency is the as same frequency in GPS and GLONASS as (1176.45MHz) with a bandwidth of 25 MHz (Kovar *et al*., 2011)

Band rejects filter for bandwidth design is used for Galileo-E5a bandwidth frequency filter design and included in the allocated spectrum for Aeronautical Radio Navigation Services (ARNS). Galileo provides several navigation signals in right-hand circular polarization (RHCP) at the frequency ranges of 1164–1215 MHz (E5a and E5b). The carrier frequency of E5a for center frequency is 1176.45 MHz. There is rarely studied about Galileo-E5a bandwidth frequency filter design for Galileo-E5a Receiver (see **Figure 1**).

Based on our previous studies (Phansori *et al*., 2021; Chinnapark *et al*., 2021; Onanong *et al*., 2021), this research studied the design of the band-reject filter on the frequency of the Galileo satellite by providing bandwidth at the cut-off frequency equal to the bandwidth of the Galileo-E5a. The selecting of response characteristic is Butterworth's maximally flat, amplitude-frequency response of the band-reject filter.

Figure 1. Galileo-E5a Figure was adopted from https://earth.esa.int/web/eoportal/satellite-missions/Galileo, retrieved on Dec 2020.

2. METHOD

This study presents the configuration of the circuit in the Butterworth band-reject filter by using PSpice as the tool for the simulation (see **Figure 2**).

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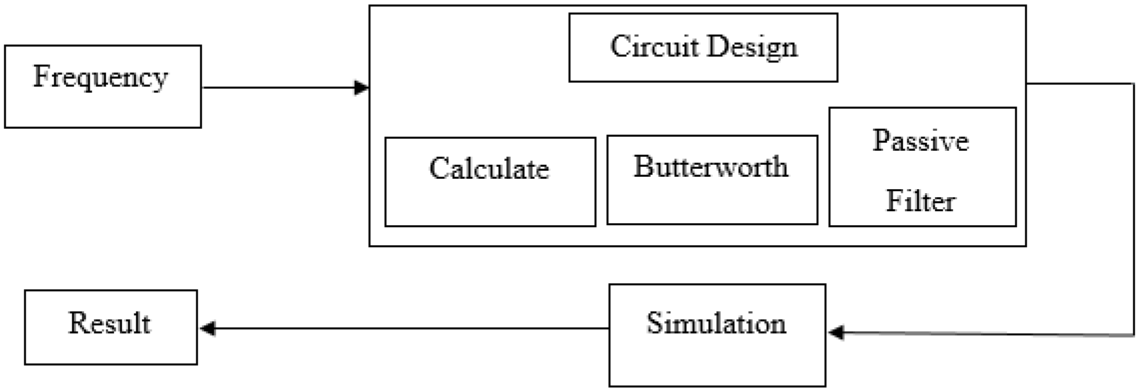

Figure 2. Circuit design method.

From the Galileo-E5a signal frequency;

$f_l = 1164$ MHz

$f_h = 1189$ MHz

$f_0 = 1176.45$ MHz

$Z = 50\Omega$,

$Bandwidth(BW) = 25\ MHz.$

Calculate by Equation [1].

$$f_0 = \sqrt{f_l \times f_h} \tag{1}$$

and

$$C'_1 = C'_3 = Z \times FSF$$

and

$$L'_1 = \frac{Z}{FSF}$$

$$L'_2 = \frac{1}{\omega_0{}^2 C'_1}$$

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

when

$$\omega_0 = 2\pi f_0$$

$$FSF = 2\pi(BW_{3dB})$$

$$Z = R_S = R_L$$

when

f_0 = center frequency

f_l = lower cut-off frequency

$$L'_2 = \frac{1}{\omega_0{}^2 C'_1}$$

f_h = higher cut-off frequency

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

ω_0 = center angular frequency

R = *Resistor*

C = Capacitor

Z = desired impedance level

L = Inductor

FSF=frequency-scaling factor

The designed circuit is as follows in **Figure 3**.

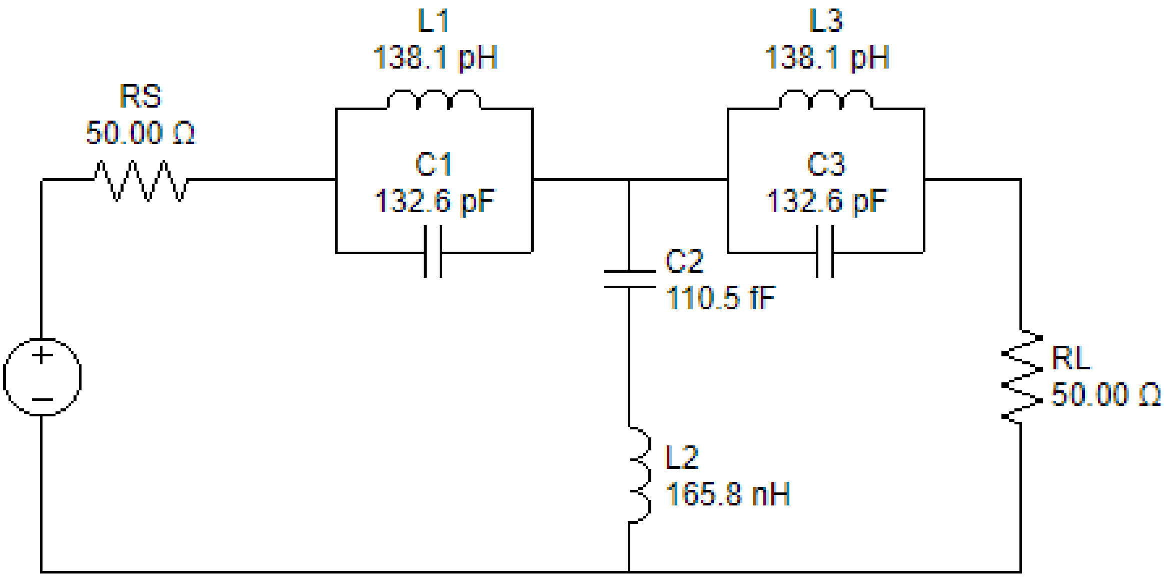

Figure 3. Band reject filters.

3. RESULT AND DISCUSSION

This result of the band-reject filter circuit for design was presented using PSpice. The output of the band-reject filter at -3dB was between 1164 MHz and 1189 MHz (see **Figure 4** and **5**).

This study shows the combination of the LPF and HPF to perform a band-reject filter. Therefore, there are two combinations also in designing for the band-reject filter. This combination aims to influence the performance of the band-reject filter.

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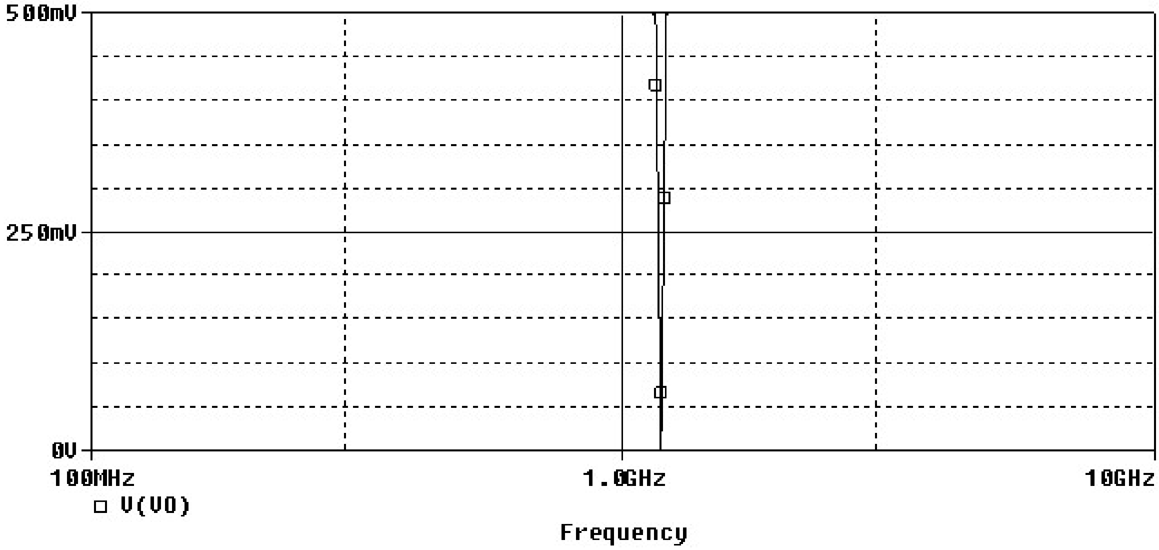

Figure 4. Amplitude-frequency response of the band-reject filter.

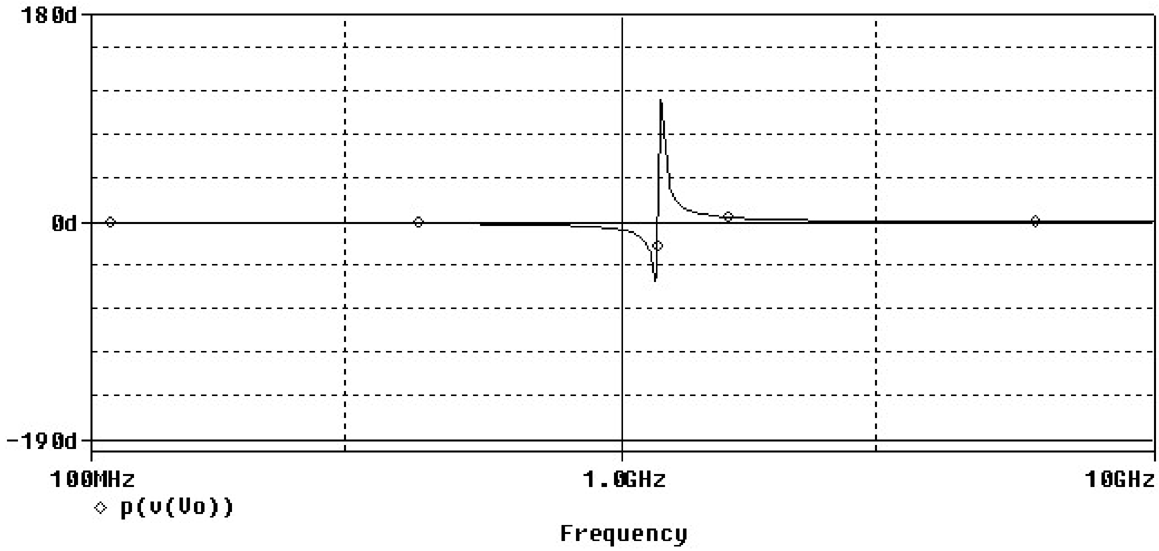

Figure 5. Phase response of the band-reject filter.

4. CONCLUSION

Band-reject filter design using the frequency of the Galileo-E5a with bandwidth is 25 MHz.using a Butterworth filter which is presented in this poster. The circuit is composed 3rd.order. Moreover, the combination between LPF and HPF is designed to act as a band-reject filter. As a result, we can filter the frequency of Galileo-E5a by using the band-reject filter.

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6. AUTHORS' NOTE

This study is under the research study for the radio frequency and mixed design subject, Department of Engineering Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang.

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