



# Galileo-E6 Bandwidth Frequency Filter Design for Galileo Receiver

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## ABSTRACT

This research discusses about the combination of the LPF and HPF to perform band reject filter. Therefore, there are two combination also in designing band reject filter. The aim of this combination to get know is there have an influence on the performance of band reject filter was designed by using the frequency of the GalileoE6 with bandwidth 40 MHz. This filter is used a Butterworth filter which is presented in this study. These filter circuit is composed 4rd order. In addition to, the combination between LPF and HPF forming to a band reject filter is designed. As a result, the filter design on the frequency of Galileo-E6 is successfully used in band reject filter.

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## 1. INTRODUCTION

Galileo is an autonomous navigation and positioning service under civilian control compatible and interoperable with GPS (Hegarty & Chatre, 2008; Hadas et al., 2019). The signal frequency on Galileo-E6 is the same frequency as on GPS and GLONASS (1278.75MHz) with bandwidth at 40MHz (Ortega et al., 2020). Band reject filter is designed for studying Galileo-E6 bandwidth frequency filter on Galileo-E6 receiver frequency between 1260MHz and 1300MHz with bandwidth 40 MHz which includes in the allocated spectrum for Aeronautical Radio Navigation Services (ARNS) (Aragon et al., 2021; Susi & Borio, 2020; Das et al., 2020). The carrier frequencies of Galileo-E6 at center frequency is 1278.75 MHz (Stansell, 2020). The Butterworth band reject filter is one type of signal processing filter design (Sagath et al., 2019). There is seldom studied about Galileo-E6 bandwidth filter design. In this study, we studied and designed the band reject pass filter on the frequency of the Galileo-E6 satellite by providing its bandwidth at the cut-off frequency. The selecting of response characteristic is Butterworth maximally flat, amplitude-frequency response of band reject filter.

## 2. METHODS

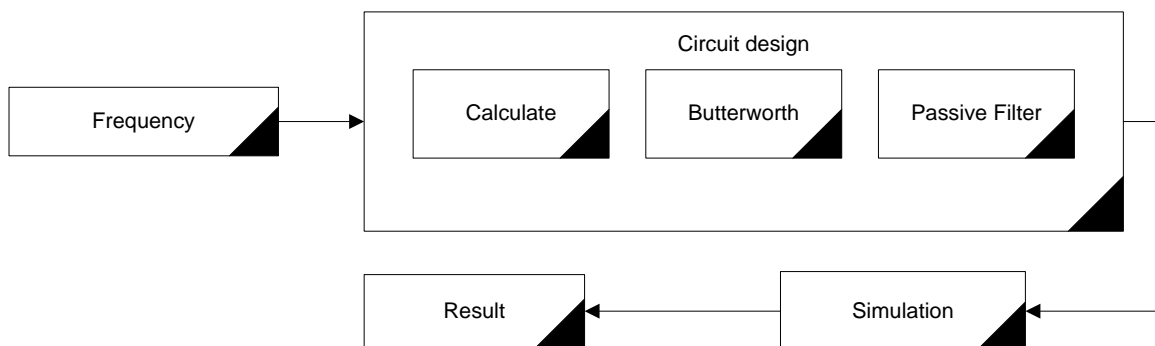
This study is presented about configuration of circuit on Butterworth band reject filter by using PSpice as the tools for the simulation that shows in **Figure 1**.

From the Galileo-E6 signal frequency

$$f_l = 1260 \text{ MHz} \quad (1)$$

$$f_h = 1300 \text{ MHz} \quad (2)$$

$$f_0 = 1278.75 \text{ MHz} \quad (3)$$



**Figure 1.** Circuit design method.

Bandwidth (BW) = 40 MHz

Calculate

$$f_0 = \sqrt{f_l \times f_h} \quad (4)$$

And

$$C'_1 = C'_3 = C'_4 = Z \times FSF \quad (5)$$

And

$$L'_1 = \frac{Z}{FSF} \quad (6)$$

$$L'_2 = \frac{1}{\omega_0^2 C'_1} \quad (7)$$

$$L'_3 = \frac{1}{\omega_0^2 C'_2} \quad (8)$$

$$L'_4 = \frac{1}{\omega_0^2 C'_3} \quad (9)$$

$$C'_2 = \frac{1}{\omega_0^2 L'_2} \quad (10)$$

When

$f_0$  = Center frequency

$f_l$  = Lower cut – off frequency

$f_h$  = Higher cut – off frequency

$\omega_0$  = Center angular frequency

$R$  = Resistor

$L$  = Inductor

$C$  = Capacitor

$Z$  = Desired impedance level

$FSF$  = Frequency – scaling factor

When

$$\omega_0 = 2\pi f_0 \quad (11)$$

$$FSF = 2\pi(BW_{3dB}) \quad (12)$$

$$Z = R_S = R_L \quad (13)$$

Then, get the circuit as follows **Figure 2**.

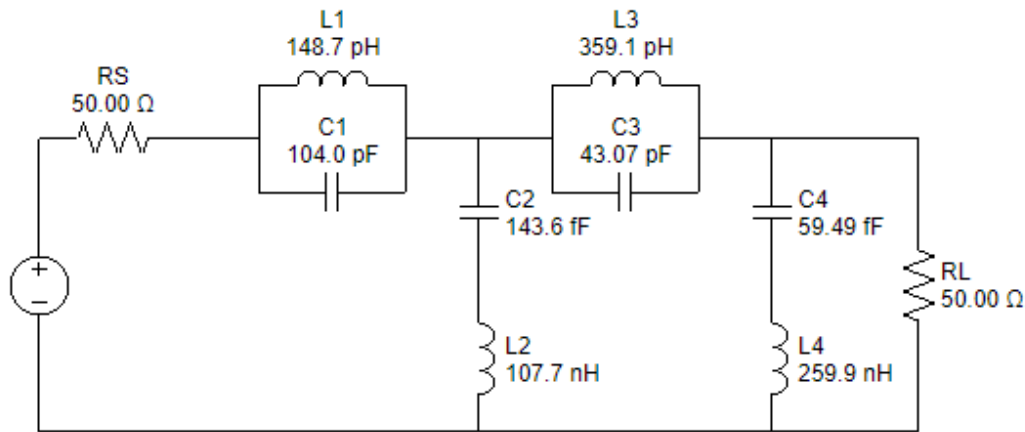


Figure 2. Band reject filter

### 3. RESULTS AND DISCUSSION

The result of band reject filter circuit for design was represented by using Pspice. The output of band-reject filter was at -3dB at 1260 MHz and 1300 MHz. This study discusses about the combination of the LPF and HPF to perform band reject filter. Therefore, there are two combination also in designing band reject filter. The aim of this combination to get know is there have an influence on the performance of band reject filter.

### 4. CONCLUSION

Band reject filter was designed by using the frequency of the GalileoE6 with bandwidth 40 MHz. This filter is used a Butterworth filter which is presented in this study. These filter circuit is composed 4rd order. In addition to, the combination between LPF and HPF forming to a band reject filter is designed. As a result, the filter design on the frequency of Galileo-E6 is successfully used in band reject filter.

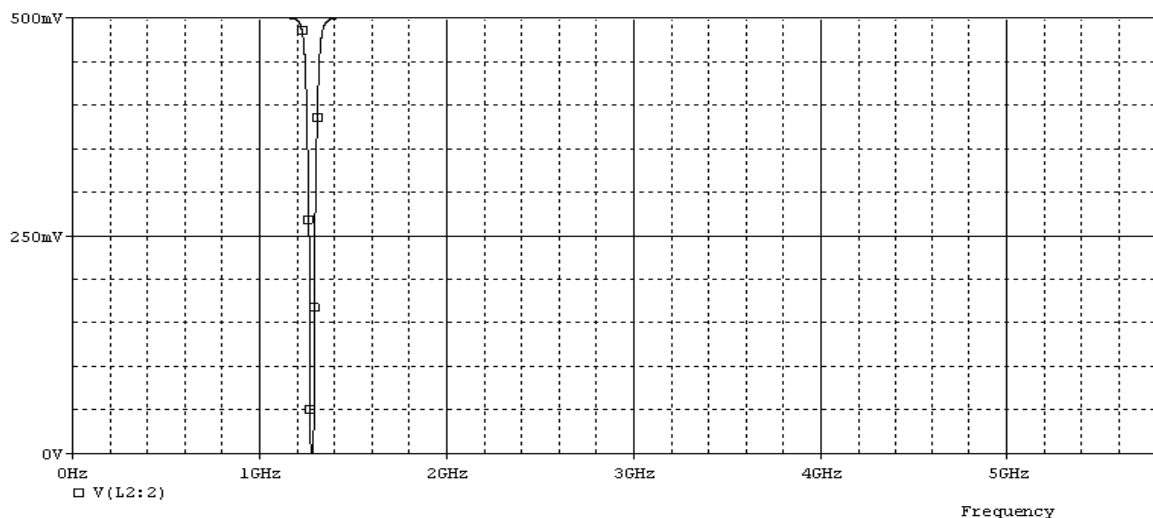
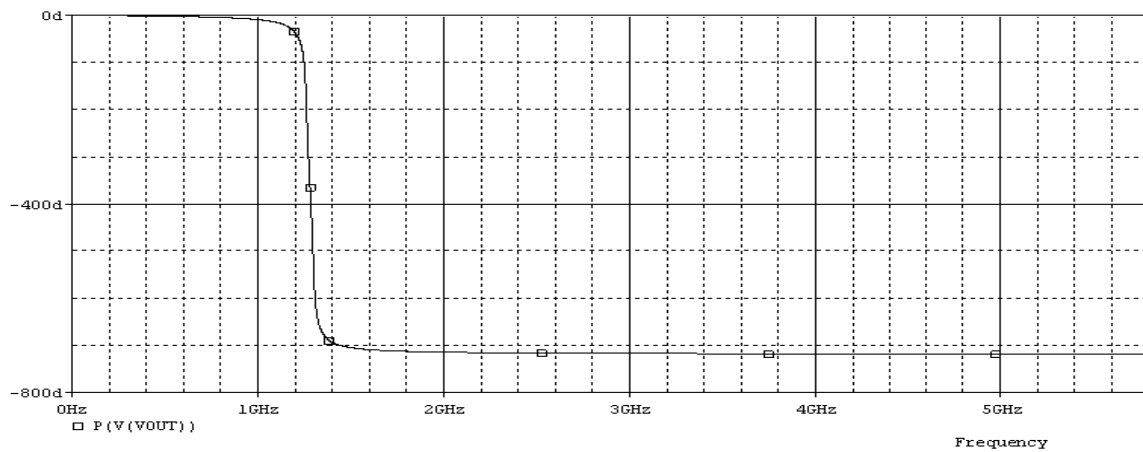


Figure 3. Amplitude-frequency response of band-reject filter



**Figure 4.** Phase response of band-reject filter

## 5. ACKNOWLEDGEMENTS

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## 6. AUTHORS' NOTE

The author states that there is no conflict of interest regarding the publication of this article. The author confirms that the paper is free from plagiarism. There are still many shortcomings and need further research from this article so that the resulting battery is used like a conventional battery.

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