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**UNIVERSITAS PENDIDIKAN INDONESIA**
**FAKULTAS PENDIDIKAN TEKNOLOGI DAN KEJURUAN**
**JURUSAN PENDIDIKAN TEKNIK ELEKTRO**
**(ELEKTRONIKA TELEKOMUNIKASI)**

**PRAKTIKUM TELEKOMUNIKASI II FILTER: JOBSHEET. 2**

# CHEBYCHEVdan BUTTERWORTH FILTER

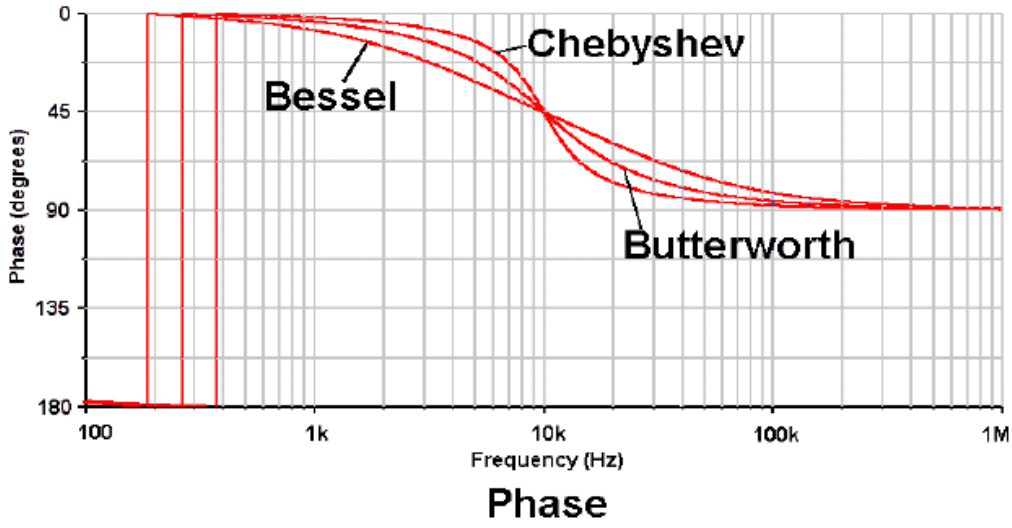
**TUJUAN:**

Dengan praktikum ini diharapkan mahasiswa dapat mengenal lebih jauh tentang filter jenis lain, antara lain di sini adalah Chebychev Filter. Mahasiswa juga mengenal dan dapat merancang serta mengaplikasikan filter ini pada aplikasi dilapangan.

**MATERI:**

The goal of this lab was to build a 600 KHz Chebyshev high pass RF filter of 7th order (3dB). Chebyshev filters feature superior attenuation in the stop band at the expense of ripple in the pass band. The Chebyshev response has the fastest rate of phase change compared to the Bessel and Butterworth filters. The trade off for this is that the Chebyshev filter has the longest group delay in the same comparison.

Gambaran:




**A graph of the phase change of a Chebyshev filter compared to the a Bessel and Butterworth Filters**[1]

**Gambaran lain adalah:**

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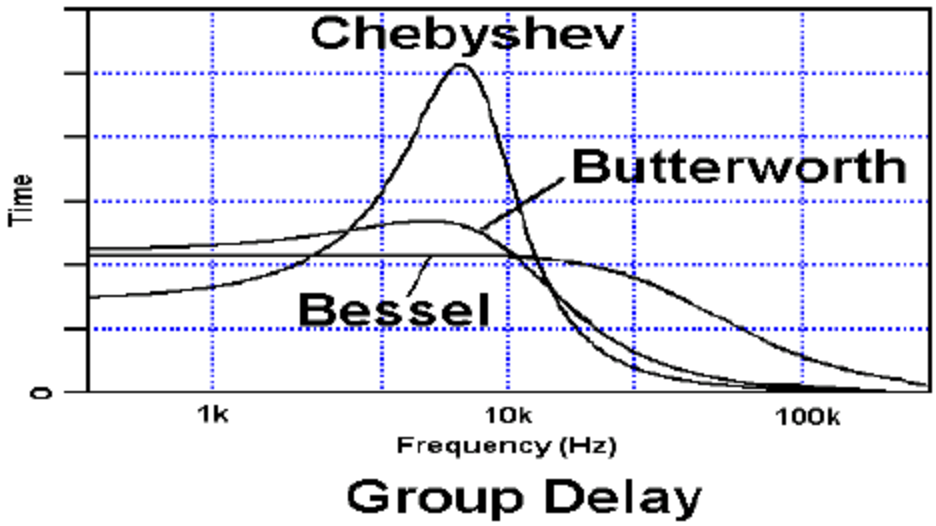



· This graph shows the group delay of the Chebyshev filter vs. the Butterworth and Bessel filters[1]

Implementasi sederhana bisa sbb:

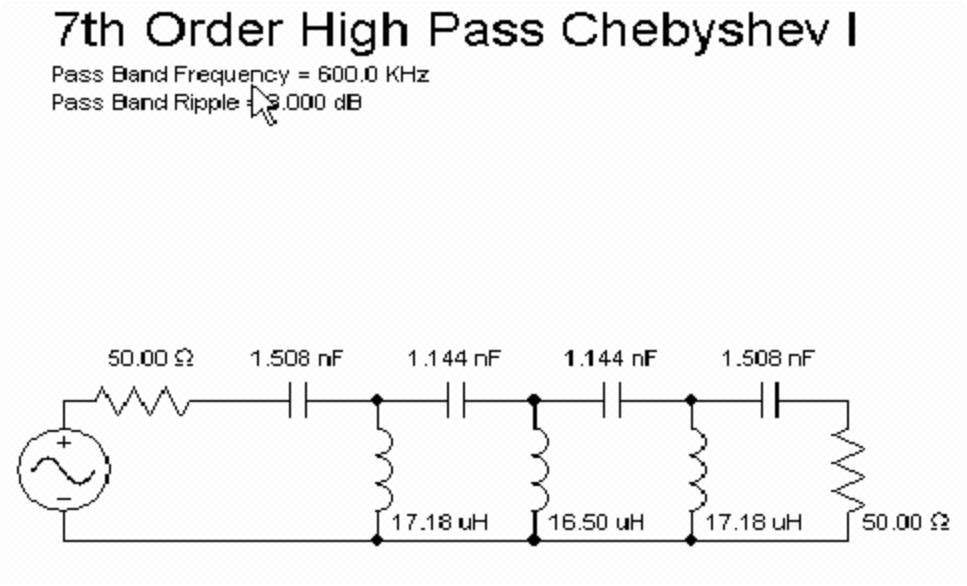



**Figure 3 – Initial schematic**

7th Order High Pass Chebyshev I
Pass Band Frequency = 600.0 KHz
Pass Band Ripple = 3.000 dB
50.00 Ω
1.508 nF
1.144 nF
1.144 nF
1.508 nF
17.18 uH
16.50 uH
17.18 uH
50.00 Ω

**Figure 3 – Initial schematic**

Atau dengan modifikasi:

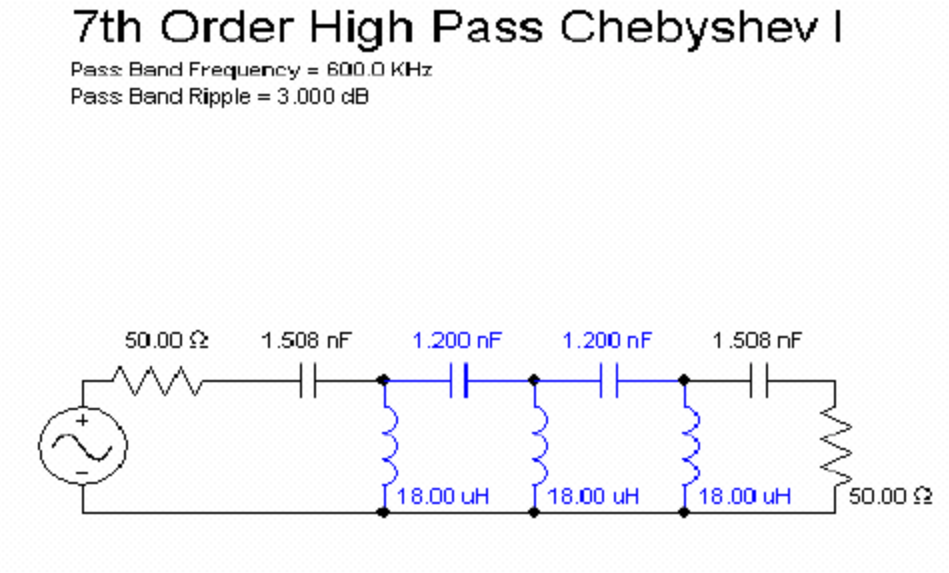


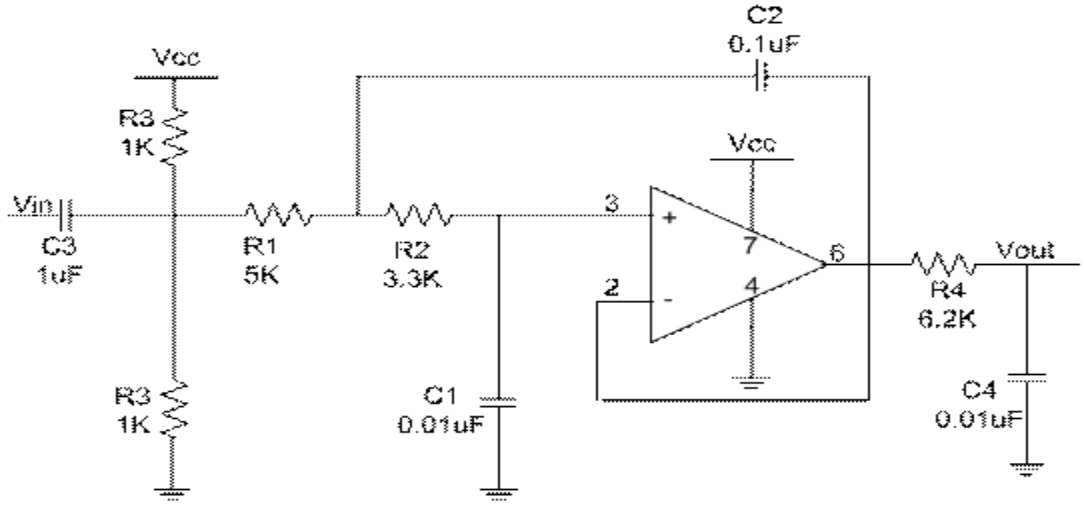

**Figure 4 – Modified schematic**

Spesifikasinya misanya sebagai berikut:

| **Chebyshev I High Pass Filter** | |
|---|---|
| Pass band frequency | 600 kHz |
| Pass band ripple | 3.0 dB |
| Impedance | 50O |

**Table 1- Filter specifications**

Gambaran Chebyshev yang dibangun dengan IC OpAmp :




2 pole Chebyshev Filter followed by a single pole Butterworth Low pass filter

The filter consists of an Active Device (opamp) LMC7111 along with a combination of resistors and capacitors to provide the performance which is equivalent to LRC circuit at low frequency.

The transfer function of the low pass filter is equal to

A(s) = 1/ (1+ wc*C1*(R1+R2)*s + wc^2*R1*R2*C1*C2*s^2)

Comparing this with standard transfer function we get A0= 1, a1= wc*C1*(R1+R2)*s, b1= wc^2*R1*R2*C1*C2.

So we pick the value of C1= 0.01uF. C2>=C1*4*b1/a1^2. So we get C2>=.07uF. So we decided C2= 0.1uF. Calculating R1 and R2 we get R1= 620 ohms and R2= 3.3K ohms.But now R1 in parallel with 2 R3's becomes very small. So a higher value than calculated was put for R1 to get less ringing.

The component values of R4 and C4 were selected using the 2*Π*fc= 1/(R4*C4). We picked an available value of C which was 0.01 uf and R4 was found out to be 6.2k for a cutoff frequency of 2.6 kHz.

Untuk filter lolos rendah Butterworth dapat kita reviu dan buat sebagai berikut:
Tentang IC pendukungnya (LMF 100):

**General Description**

The LMF100 consists of two independent general purpose high performance switched capacitor filters. With an external clock and 2 to 4 resistors, various second-order and first-order filtering functions can be realized by each filter block. Each block has 3 outputs. One output can be configured to perform either an allpass, highpass, or notch function. The other two outputs perform bandpass and lowpass functions. The center frequency of each filter stage is tuned by using an external clock or a combination of a clock and resistor ratio. Up to a 4th-order biquadratic function can be realized with a single LMF100. Higher order filters are implemented by simply cascading additional packages, and all the classical filters (such as Butterworth, Bessel, Elliptic, and Chebyshev) can be realized. The LMF100 is fabricated on National Semiconductor's high performance analog silicon gate CMOS process, LMCMOS™. This allows for the production of a very low offset, high frequency filter building block. The LMF100 is pin-compatible with the industry standard MF10, but provides greatly improved performance.

**Features**

- Wide 4V to 15V power supply range
- Operation up to 100 kHz
- Low offset voltage: typically (50:1 or 100:1 mode): Vos1 = ±5 mV, Vos2 = ±15 mV
- Vos3 = ±15 mV
- Low crosstalk -60 dB

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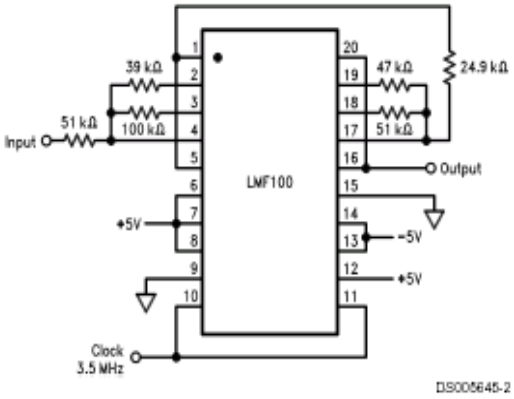
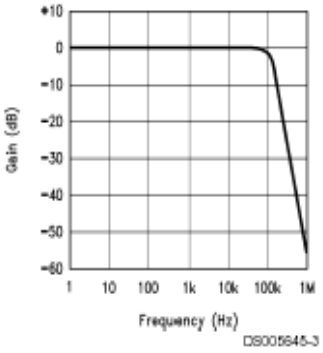
- Clock to center frequency ratio accuracy ±0.2% typical
- f0 x Q range up to 1.8 MHz
- Pin-compatible with MF10

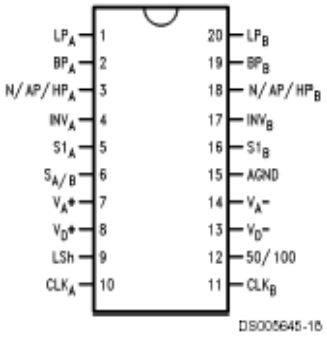
## 4th Order 100 kHz Butterworth Lowpass Filter




## Connection Diagram

**Surface Mount and Dual-In-Line Package**




Top View
Order Number
LMF100CCN or LMF100CIWM
See NS Package Number N20A or M20B

**PERALATAN DAN KOMPONEN YANG DIPERLUKAN**

Siapkanlah peralatan :

1. Oscilloscope yang sesuai
2. Signal Generator yang sesuai
3. AVO/ Multimeter
4. Breadboard 1 atau 2 buah
5. Kabel-kabel/kawat-lawat seperlunya
6. Solder dengan timah dan perlengkapannya
7. Tang/ pinzet

Komponen-komponen yang diperlukan:

1. IC Op Amp seperti dapat dibaca pada gambar-gambar dibawah ini.
2. Beberapa kapasitor (sda)
3. Beberapa resistor (sda)
4. Beberapa induktor(sda)
5. Lain-lain jika diperlukan atau menghendaki variasi.

**JALANNYA PERCOBAAN:**

Bangunlah rangkaian-rangkaian percobaan sebagai berikut:

1. Percobaan 1:

a. Berilah pada Vin tegangan dibawah 5 Volt dengan frekuensi bervariasi, dari yang terendah hingga tertinggi yang dimungkinkan.
b. Ukurlah diterminal Vout dengan Oscilloscope yang bersesuaian juga
c. Amati dan catat hasil-hasil percobaannya dengan mengisi tabel berikut:

| No | Input: Signal Generator | | Output: Oscilloscope | | Keterangan |
|---|---|---|---|---|---|
| | Tegangan | Frekuensi | Tegangan | Frekuensi | |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

d. Coba gambarkan hasil percobaan diatas. Jelaskan tafsiran anda.

2. Percobaan 2:

a. Susunlah percobaan sesuai gambar percobaan berikut:

b. Lengkapi percobaan seperti langkah-langkah a dan c diatas.
c. Isilah tabel hasil percobaan seperti pada c di atas.
d. Gambarkanlah hasil-hasil percobaan itu.

3. Percobaan 3

a. Susunlah percobaan sesuai gambar percobaan berikut:

b. Ikuti langkah-langkah seperti percobaan di atas.

**TUGAS**

1. Bereskan kembali dan kembalikan alat serta komponen yang anda gunakan pada percobaan ini kepada petugas.
2. Bersihkan bekas percobaan dengan baik

3. Buatlah Laporan Sementara untuk dikumulkan kepada Dosen ybs, dan segeralah buat Laporan Akhirnya di rumah paling lama 2 hari setelah percobaan ini.