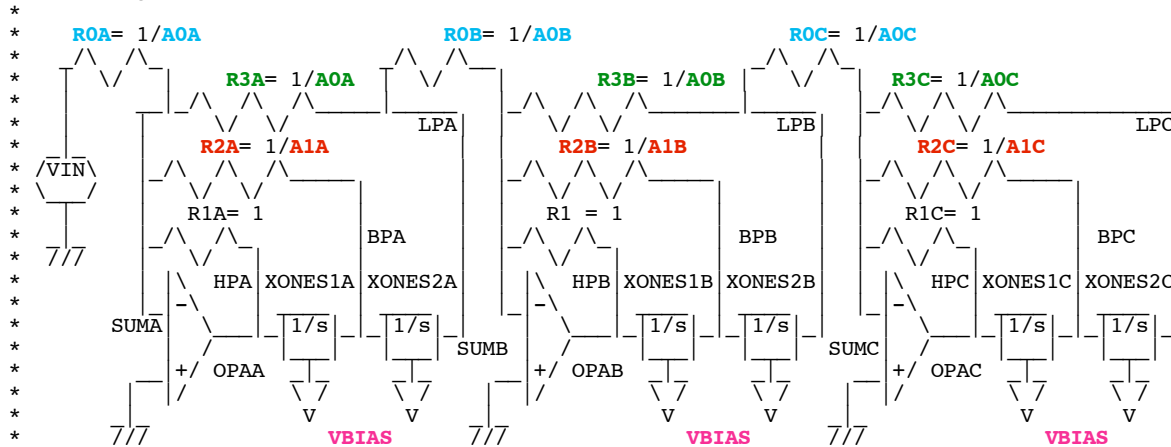


Butterworth_6P_VCF_FINE

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Butterworth terms

$$(s^2 + 0.5176s + 1)(s^2 + 1.4142s + 1)(s^2 + 1.9319s + 1)$$

```
.OPTIONS GMIN=1e-18 METHOD=gear srcsteps = 1 gminsteps = 1
=====
```

```
V_IN VIN 0 PULSE( -.5 .5 1u 1u 1u 10m 20m ) AC = 1
```

```
ROA VIN SUMA 1
R1A SUMA HPA 1
R2A SUMA BPA 1.9319
R3A SUMA LPA 1
XOPA1A SUMA HPA OPA
XONES1A HPA BPA VBIAS ONE_S
XONES2A BPA LPA VBIAS ONE_S
ROB LPA SUMB 1
R1B SUMB HPB 1
R2B SUMB BPB .707
R3B SUMB LPB 1
XOPA1B SUMB HPB OPA
XONES1B HPB BPB VBIAS ONE_S
XONES2B BPB LPB VBIAS ONE_S
ROC LPB SUMC 1
R1C SUMC HPC 1
R2C SUMC BPC .5176
R3C SUMC LPC 1
XOPA1C SUMC HPC OPA
XONES1C HPC BPC VBIAS ONE_S
XONES2C BPC LPC VBIAS ONE_S
```

```
E_INVERT OUT0 0 LPC 0 -1
VBIAS VBIAS 0 DC .4
```

```
*#0 =====A Bessel is Best for Low Phase Distortion=====
```

```
.control
```

```
set pensize = 2
```

```
*#1 =====SET VCF VBIAS TO 400m=====
```

```
set outfile0 = "Butterworth_6P_VCF_400m.txt"
```

```
tran 1m 40m 0 10m
```

```
run
```

```
plot vin out0 title Vbias_600m
```

```
let saveData = 1
```

```
if (saveData>0)
```

```
echo "Vpw1A OUTA 0 PWL(" >$outfile0
```

```
let NoOfTime = length(time)
```

```
echo "Number of points is $NoOfTime "
```

```
let n = 0
```

```
repeat $NoOfTime
```

```
let timestep = time[n] - time[n-1]
```

```
let timme = time[n]
```

```
let vout = out0[n]
```

```
if (timestep > 1u)
```

```
echo "+ $timme $vout " >> $outfile0
```

```
endif
```

```
let n = n+1
```

```
echo "+ )" >>$outfile0
```

```
endif
```

```
ac dec 50 1 10000
```

```
plot db(out0) ylimit -20 0 title Vbias_400m
```

```

*#2 =====SET_VCF_VBIAS_TO_200m=====
alter      vbias dc = .2
set        outfile1 = "Butterworth_6P_VCF_200m.txt"
tran       1m      40m      0      10m
run
plot       vin out0 title Vbias_200m

let        saveData = 1
if         (saveData>0)
echo       "VpwlB OUTB 0 PWL(" >$outfile1
let        NoOfTime = length(time)
echo       "Number of points is $&NoOfTime "
let        n = 1
repeat    $&NoOfTime
let        timestep = time[n] - time[n-1]
let        timme = time[n]
let        vout = out0[n]
if         (timestep > 1u)
echo       "+ $&timme $&vout " >> $outfile1
endif
let        n = n+1
end
echo      "+ )" >>$outfile1
endif
ac         dec 50 1 10000
run
plot       db(out0) ylimit -20 0 title Vbias_200m

*#3 =====SET_VCF_VBIAS_TO_100m=====
alter      vbias dc = .1
set        outfile2 = "Butterworth_6P_VCF_100m.txt"
tran       1m      40m      0      10m
run
plot       vin out0 title Vbias_100m

let        saveData = 1
if         (saveData>0)
echo       "VpwlC OUTC 0 PWL(" >$outfile2
let        NoOfTime = length(time)
echo       "Number of points is $&NoOfTime "
let        n = 0
repeat    $&NoOfTime
let        timestep = time[n] - time[n-1]
let        timme = time[n]
let        vout = out0[n]
if         (timestep > 1u)
echo       "+ $&timme $&vout " >> $outfile2
endif
let        n = n+1
end
echo      "+ )" >>$outfile2
endif
ac         dec 50 1 10000
run
plot       db(out0) ylimit -20 0 title Vbias_100m

.endc

```

```

=====OP_AMP=====
.SUBCKT OPA IN OUT 0 -10k
EGN1 OUT 0 IN 0
.ends
*
*
*
*
*
*
*
*
*
*
*

```

```

=====GM_C=====
.SUBCKT ONE_S IN OUT VB
BGM 1 0 i = -10*v(IN)*v(VB)
C1 1 0 1m
EBUF OUT 0 1
.ends
*
* i = -10*v(IN)*v(VBIAS)
*
*
*
*
*
*
*
*
*
*

```

.end

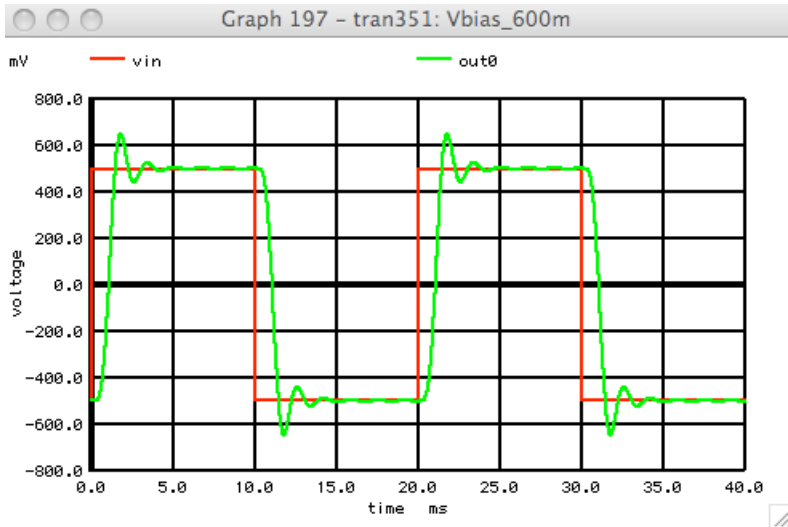
=====**END_OF_SPICE**=====

The Phase Distortion of the Butterworth needs to be looked at with more resolution.

```

*#1 =====SET_VCF_VBIAS_TO_400m=====
set outfile0 = "Bessel_6P_VCF_1.txt"
VBIAS VBIAS 0 DC .4

```

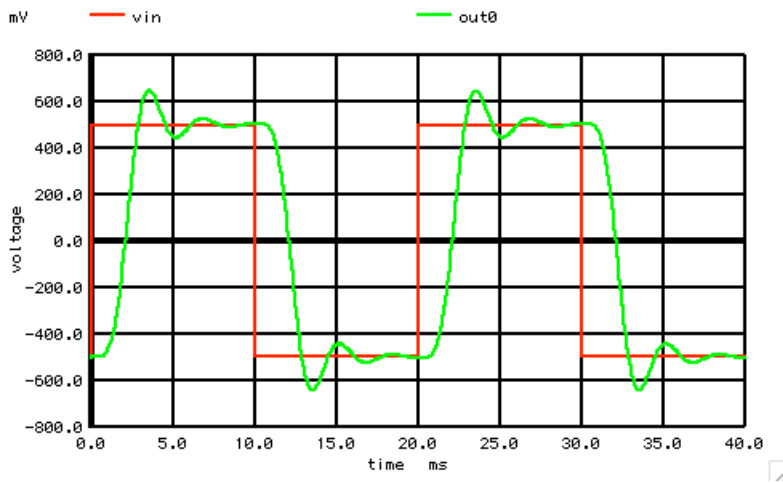


```

*#2 =====SET_VCF_VBIAS_TO_200m=====
alter vbias dc = .2
set outfile1 = "Bessel_6P_VCF_200m.txt"

```

Graph 199 - tran353: Vbias_200m



```
*#3 =====SET VCF_VBIAS_TO_100m=====  
alter      vbias dc = .1  
set        outfile2 =          "Bessel_6P_VCF_100m.txt"
```

Graph 201 - tran355: Vbias_100m

