


```

*
.SUBCKT      ONE_S      IN      OUT
R1          IN      ISUM      1
C1          ISUM      OUT1      .1
BOp1       OUT1      0      V =      5*tanh(tanh((-v(ISUM))*100)*100)
BINV1      OUT      0      V =      -v(OUT1)
.ends

```

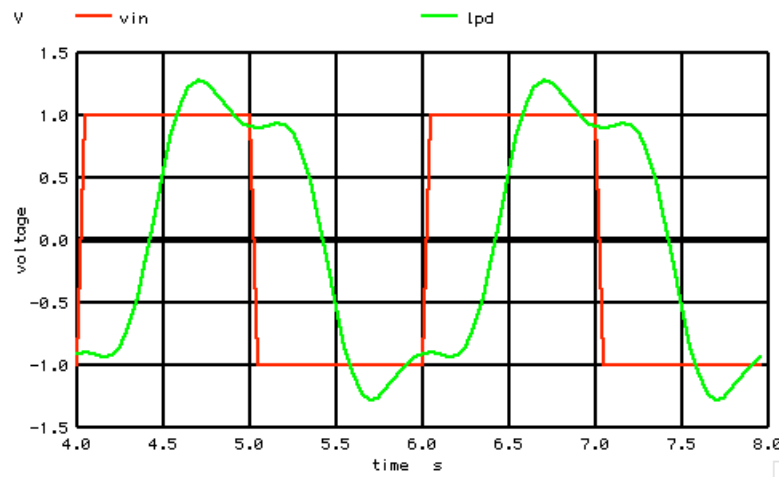
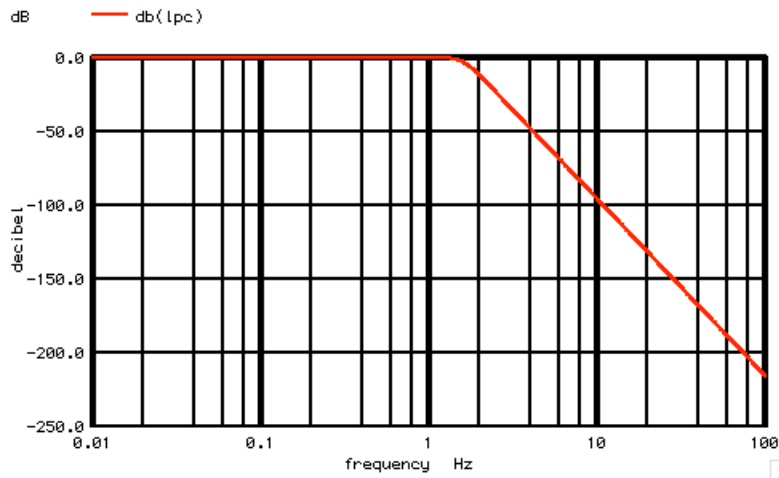
=====Simple_Simulations=====

It is not hard to do AC and Transient tests.

```

=====
.control
ac          dec      500      .01      100
plot       db(lpc)
*TRAN      TSTEP    TSTOP    TSTART  TMAX
tran       50m      7.95     4       50m

```



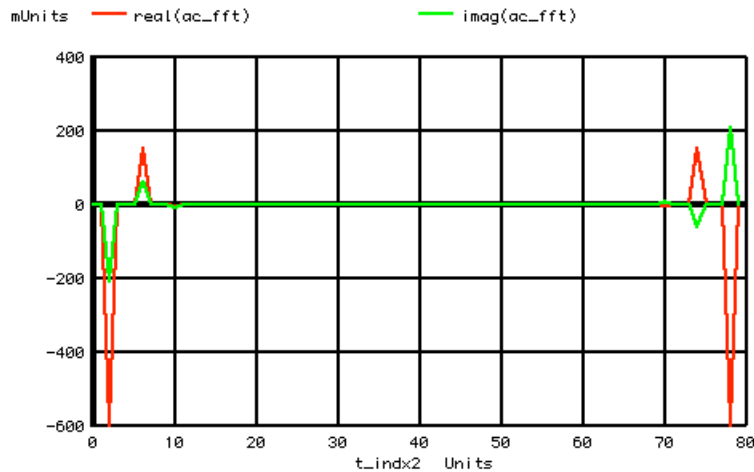
The AC test shows that the frequency roll off is pretty sharp.

But look at how the output of the low pass filter rings. Looking at what happened to all the harmonics to the input square wave can show what happened.

=====Look_at_the_Output_Spectrum=====

The FFT reveals that only the fundamental and third harmonic got through the lowpass filter.

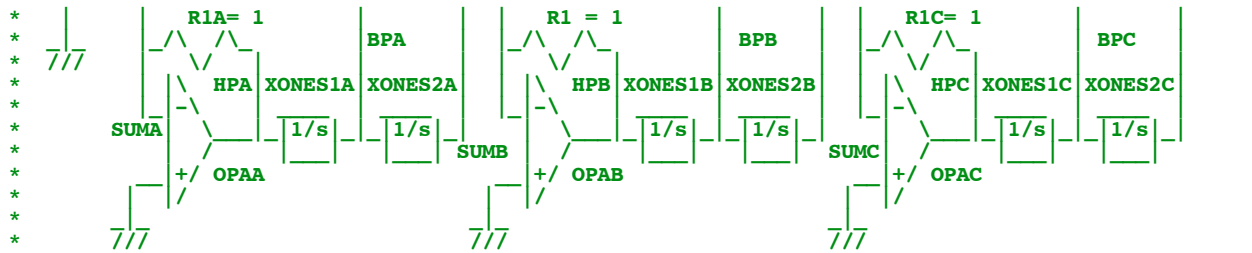
```
=====
linearize
plot      vin      lpd
let      numb2    = length(vin)
print    numb2
let      t_indx2  = vector($&numb2)
let      ac       = lpd +j(0)
let      ac_fft   = fft(ac)
plot     real(ac_fft) imag(ac_fft) vs t_indx2
```



*=====The_Harmonics_Can_Be_Dissected=====

The dissection of the harmonics show the results

```
=====
let      funbin   = 2
let      unvect   = unitvec($&numb2)
let      fundspec = unvect*0 +j(0)
let      fundspec[2] = real(ac_fft[2]) +j(imag(ac_fft[2] ))
let      fundspec[numb2-2] = real(ac_fft[numb2-2]) +j(imag(ac_fft[numb2-2] ))
let      fund     = ifft(fundspec)
let      thirdspect = unvect*0 +j(0)
let      thirdspect[6] = real(ac_fft[6]) +j(imag(ac_fft[6] ))
let      thirdspect[numb2-6] = real(ac_fft[numb2-6]) +j(imag(ac_fft[numb2-6] ))
let      third    = ifft(thirdspect)
let      fiftspect = unvect*0 +j(0)
let      fiftspect[10] = real(ac_fft[10]) +j(imag(ac_fft[10] ))
let      fiftspect[numb2-10] = real(ac_fft[numb2-10]) +j(imag(ac_fft[numb2-10] ))
let      fifth    = ifft(fiftspect)
let      seventhspect = unvect*0 +j(0)
let      seventhspect[14] = real(ac_fft[14]) +j(imag(ac_fft[14] ))
let      seventhspect[numb2-14] = real(ac_fft[numb2-14]) +j(imag(ac_fft[numb2-14] ))
let      seventh  = ifft(seventhspect)
let      sum      = fund + third + fifth + seventh
set      scale    time
plot     fund third fifth seventh sum
plot     fund third fifth seventh sum xlimit 5.2 5.7
.endc
```

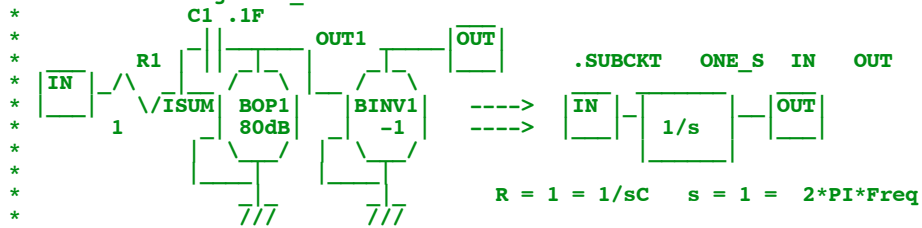
Butterworth terms

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

.OPTIONS GMIN=1e-18 METHOD=euler srcsteps = 1 gminsteps = 1

*V_PULSE#	NODE_P	NODE_N	DC	VALUE	PULSE(VINIT	VPULSE	TDELAY	TRISE	TFALL	PWIDTH	PERIOD)
V_IN	VIN	0	DC	0	PULSE(-1	1	100u	100u	100u	1	2) AC = 1
R0A	VIN	SUMA	1									
R1A	SUMA	HPA	1									
R2A	SUMA	BPA	1.9319									
R3A	SUMA	LPA	1									
BOPA1A	HPA	0	V =	5*tanh(tanh((-v(SUMA))*100)*100)								
XONES1A	HPA	BPA	ONE_S									
XONES2A	BPA	LPA	ONE_S									
R0B	LPA	SUMB	1									
R1B	SUMB	HPB	1									
R2B	SUMB	BPB	.707									
R3B	SUMB	LPB	1									
BOPA1B	HPB	0	V =	5*tanh(tanh((-v(SUMB))*100)*100)								
XONES1B	HPB	BPB	ONE_S									
XONES2B	BPB	LPB	ONE_S									
R0C	LPB	SUMC	1									
R1C	SUMC	HPC	1									
R2C	SUMC	BPC	.5176									
R3C	SUMC	LPC	1									
BOPA1C	HPC	0	V =	5*tanh(tanh((-v(SUMC))*100)*100)								
XONES1C	HPC	BPC	ONE_S									
XONES2C	BPC	LPC	ONE_S									
Binv	LPD	0	V =	-V(LPC)								

-----Integrator_Cell-----



.SUBCKT	ONE_S	IN	OUT
R1	IN	ISUM	1
C1	ISUM	OUT1	.1
BOP1	OUT1	0	V = 5*tanh(tanh((-v(ISUM))*100)*100)
BINV1	OUT	0	V = -v(OUT1)

=====A_Bessel_is_Best_for_Low_Phase_Distortion=====

```
.control
ac dec 500 .01 100
plot db(lpc)
*TRAN TSTEP TSTOP TSTART TMAX
tran 50m 7.95 4 50m
```

```
linearize
plot vin lpd
let numb2 = length(vin)
print numb2
let t_indx2 = vector($&numb2)
let ac = lpd + j(0)
let ac_fft = fft(ac)
plot real(ac_fft) imag(ac_fft) vs t_indx2

let funbin = 2
let unvect = unitvec($&numb2)
let fundspec = unvect*0 + j(0)
let fundspec[2] = real(ac_fft[2]) + j(imag(ac_fft[2] ))
let fundspec[numb2-2] = real(ac_fft[numb2-2]) + j(imag(ac_fft[numb2-2] ))
let fund = ifft(fundspec)
```

```

let      thirdspec          = unvect*0 +j(0)
let      thirdspec[6]      = real(ac_fft[6])      +j(imag(ac_fft[6] ))
let      thirdspec[numb2-6] = real(ac_fft[numb2-6]) +j(imag(ac_fft[numb2-6] ))
let      third             = ifft(thirdspec)
let      fifthspec        = unvect*0 +j(0)
let      fifthspec[10]    = real(ac_fft[10])      +j(imag(ac_fft[10] ))
let      fifthspec[numb2-10] = real(ac_fft[numb2-10]) +j(imag(ac_fft[numb2-10] ))
let      fifth            = ifft(fifthspec)
let      seventhspec      = unvect*0 +j(0)
let      seventhspec[14]  = real(ac_fft[14])      +j(imag(ac_fft[14] ))
let      seventhspec[numb2-14] = real(ac_fft[numb2-14]) +j(imag(ac_fft[numb2-14] ))
let      seventh          = ifft(seventhspec)
let      sum = fund + third + fifth + seventh
set      scale time
plot     fund third fifth seventh sum

plot     fund third fifth seventh sum xlabel 5.2 5.7
.endc

.end

```