OTA_HangOn_Delay

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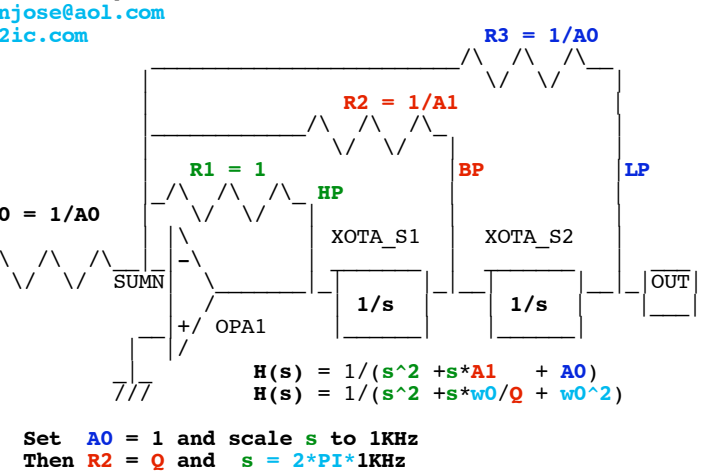
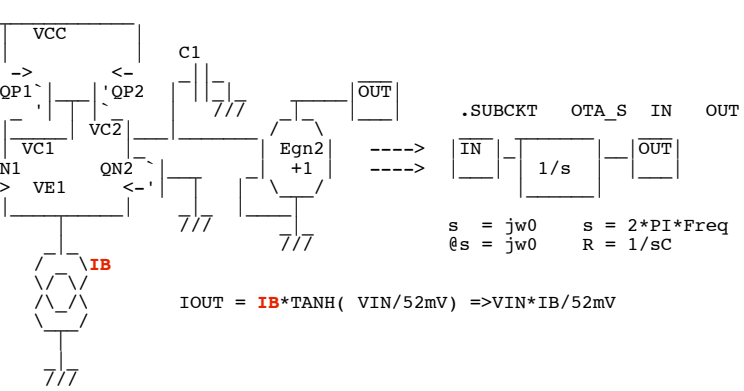


* Set A0 = 1 and scale s to 1KHz
* Then R2 = Q and s = 2*PI*1KHz

```
.OPTIONS  GMIN=1p     METHOD=euler  ABSTOL=1n  TEMP=27 srcsteps = 100  gminsteps = 10 ITL1=400
.OPTIONS RELTOL=.001  ABSTOL=1p     VNTOL=1p      ITL4=500
*======== ====== ====== ====== ====== ====== ====== ====== ======
VT        Vtime  0      PWL   ( 0 0 1 1 )
*VF       VF     0      PWL   ( 0 500 .5 1200 )
VF        VF     0      PWL   ( 0 1500 .5 800 )
BIN       BIN    0      v =    0.0001*(1-exp(-600*v(Vtime)))*(sin(6.28319*v(VF)*v(Vtime)))
R0        BIN    SUMN   10k
R1        SUMN   HP     10k
R2        SUMN   BP     900k
R3        SUMN   LP     10k
XOPA1     SUMN   0      HP    OPA
XOTAS1    HP     BP           OTA_S
XOTAS2    BP     LP           OTA_S

.control
tran    .1m     .5      0
plot   bp  vf/1000000 title  StateVariable_Q_90
.endc

.SUBCKT OTA_S IN      OUT
QN1         VC1     IN      VE1     NPNP
QN2         VC2     0       VE1     NPNP
QP1         VC1     VC1     VCC     PNPP
QP2         VC2     VC1     VCC     PNPP
IB          VE1     0               5.2u
VCC         VCC     0               DC      2
EGN2        OUT     0       VC2     0       +1
C1          VC2     0               .01592u
.ends
```




```
.SUBCKT OPA   INP     INN     OUT
EGN1        O1      0       INP     INN     -1
EGN2        OUT     0       IP      0       -1000000
R1          O1      IP      10k
C1          OUT     IP      3p
.ends
```

* http://www.idea2ic.com/PlayWithJavascript/R_C_Freq.html

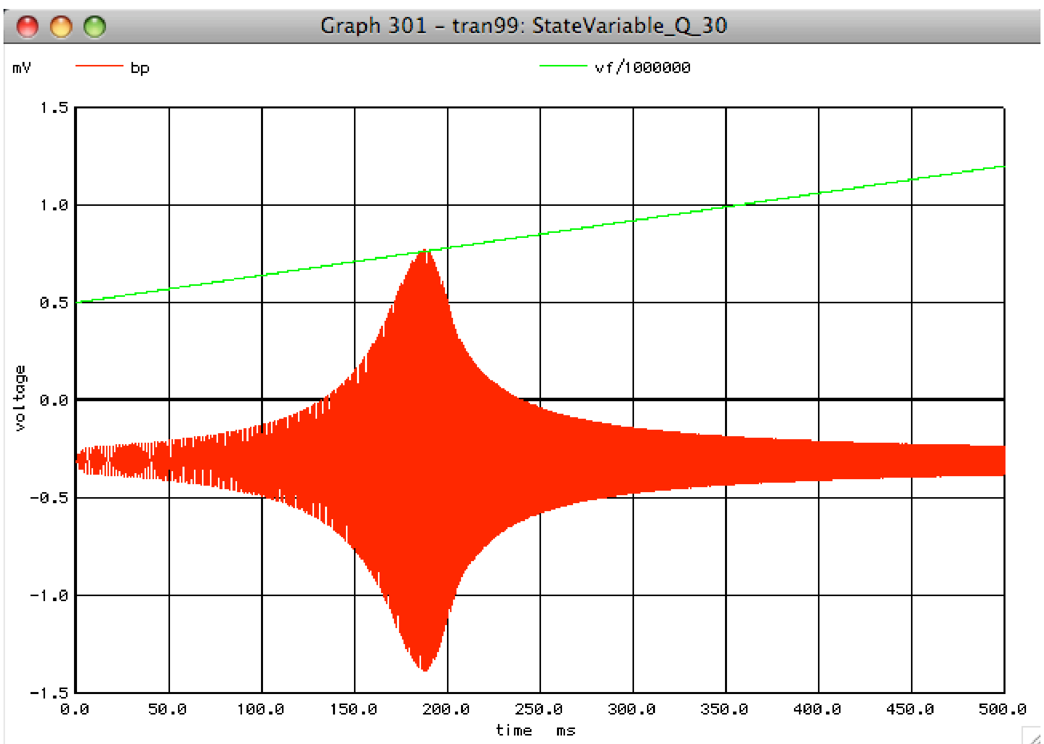
```
*
*                 O1          C1  10pF              .SUBCKT  OPA INP INN OUT
*    |INP|_       _____      _||_______|OUT|
*    |___| |     |     |R1  | ||       |___|         |\
*          |_  /-|-\   |_/\_|  /-|-\                |INP|__|-\
*             |EGN1 |  10K\/  IP| EGN2 |   ---->     |___|  |  \__|OUT|
*    |INN|____| -1  |          _| 90dB |   ---->            |  /  |___|
*    |___|     \_|_/      IP  |  \_|_/              |INN|__|+/
*                |            |____|                |___|  |/ OPA
*                |                 |
*               ///               ///
```

.model **NPNP** NPN(**BF=2100 VAF=216**)
.model **PNPP** PNP(**BF=2100 VAF=210**)

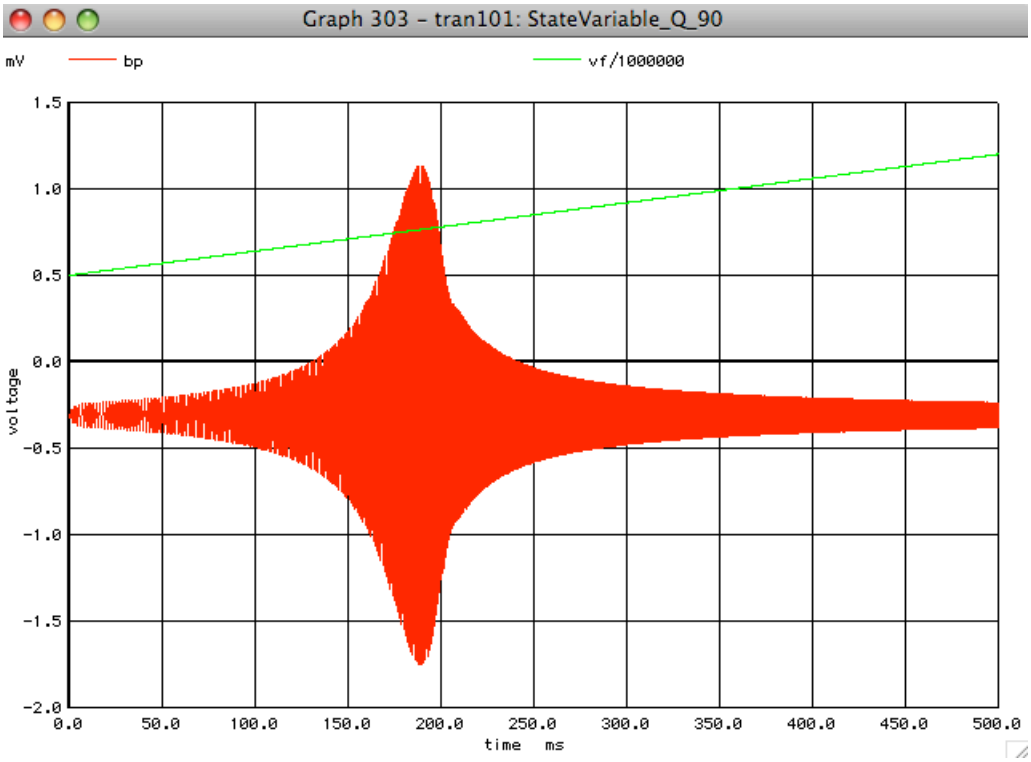
.end

=====================END_OF_SPICE======================

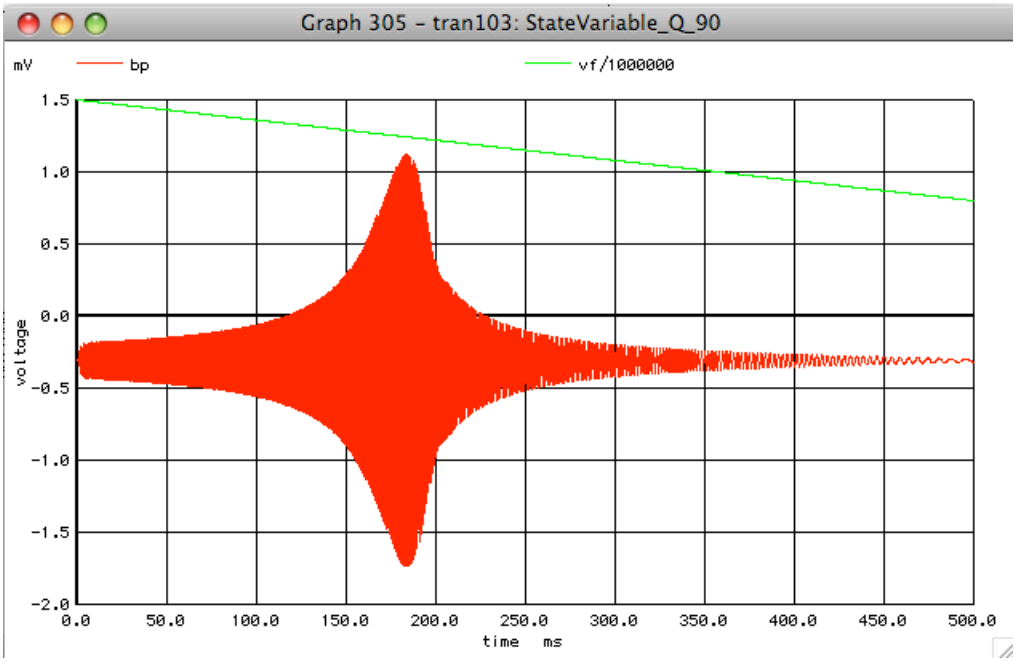
When a active filter is set a high Q value, the nolinearity in the filter can sometimes be observed to have sort of a hang on response. The curve below is the Bandpass output as the input's frequency is rising from 500Hz to 1200Hz. The green line shows the input signal frequency moving from .5 to 1.2.



The Q of the bandpass is 30 and its center frequency is 1000Hz. Two things to notice. The peaking appears to be happening at 800Hz and the peaking wave form is a little unsymetrical. The reason for the delays is the fact that a Q of 30 means there will be at least a 30 cycle delay in the bandpass output peaking.



The curve above is when the Q has been increased to 90. Notice how the curve seems to want to lean to the right. It is like once the filter gets into resonance, it wants to stay in resonance. This effect has been called "Hang On". Once the input frequency gets high enough, the filter will snap out of this state into a more linear state.



This can be proven by sweeping the frequency from the other direction. Again the filter tends to want to hang on to the input signal. Notice that a Q of 90 should be a delay of at least 90 cycles of 1000Hz which is at least 100msec.