State_Variable_OTA_100Hz

```
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*   4/15/08
*                                                   R3 = 1/A0
*                                                  /\  /\  /\
*                                                   \/  \/
*                                        R2 = 1/A1
*                                       /\  /\  /\
*                                        \/  \/
*                                 R1 = 1                BP            LP
*                                /\  /\  /\  HP
*          R0 = 1/A0              \/  \/
*                                          XOTA_S1       XOTA_S2
*    IN  /\  /\  /\   SUMN                 -\
*        \/  \/                            \
*                                           /
*    VIN                                   +/ OPA1                    OUT
*                                          /
*                                 H(s) = 1/(s^2 +s*A1   + A0)
*                                 H(s) = 1/(s^2 +s*w0/Q + w0^2)
*
*            Set  A0 = 1 and scale s to 1KHz
*            Then R2 = Q and  s = 2*PI*1KHz
```
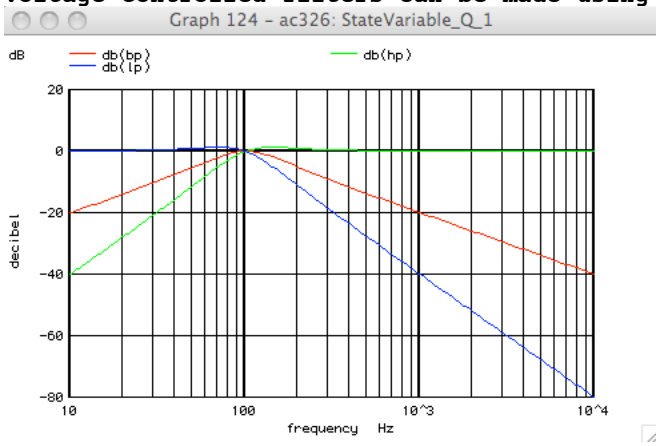

```
.OPTIONS  GMIN=1e-12    METHOD=trap   srcsteps = 1  gminsteps = 1
*======== ====== ====== ====== ====== ====== ====== ====== ======
V_IN      VIN    0      AC     1      DC     0
R0        VIN    SUMN   10k
R1        SUMN   HP     10k
R2        SUMN   BP     100k
R3        SUMN   LP     10k
XOPA1     SUMN   0      HP     OPA
XOTAS1    HP     BP            OTA_S
XOTAS2    BP     LP            OTA_S
.ac       dec    50     10     10k
```

```
*==OTAs_Make_It_Possible_To_Voltage_Control_Frequency====

.control
run
plot  db(bp)  db(hp) db(lp)  title  StateVariable_Q_10
alter  R2     resistance =   10k
run
plot  db(bp)  db(hp) db(lp)  title  StateVariable_Q_1
.endc
```

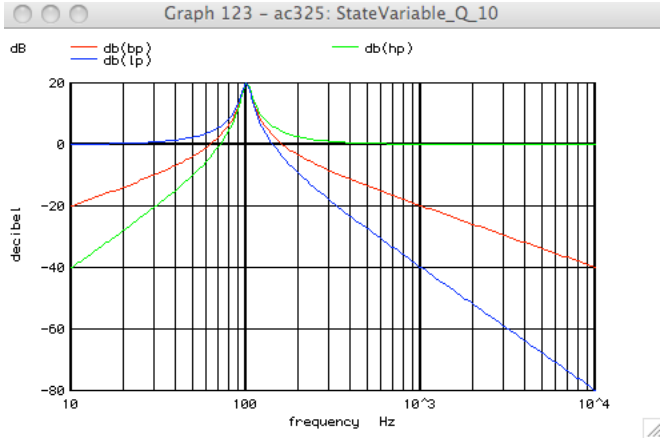
```
*
*          VCC
*    VCC                      C1
*                  ->    <-
*    QP1     QP2                                  OUT
*                                                       .SUBCKT   OTA_S  IN   OUT
*    VC1     VC2
*    VC1                                  Egn2   ---->  IN                  OUT
*    IN  QN1       QN2                    +1     ---->
*                  VE1     <-
*                                                       1/s
*                                                       s  = jw0    s = 2*PI*Freq
*                                                       @s = jw0    R = 1/sC
*                  IB
*
*                  IOUT = IB*TANH( VIN/52mV) =>VIN*IB/52mV
*
*
*
*
*   http://www.idea2ic.com/PlayWithJavascript/R_C_Freq.html
*
*                O1          C1 10pF                 .SUBCKT  OPA INP INN OUT
*   INP                                   OUT
*                      R1
*                 EGN1   10K\/  IP  EGN2   ---->   INP
*   INN            -1            90dB    ---->                  OUT
*                                                   INN
*                                                   +/
*                                                   / OPA
*
*
```

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

.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             .52u
VCC           VCC    0             DC     2
EGN2          OUT    0      VC2    0      +1
C1            VC2    0             .01592u
.ends

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


.end

=====================END_OF_SPICE=====================
```

The effective resistance of OTAs is controllable.
Voltage Controlled filters can be made using OTAs.



Since Q is independently controlled by R1-R3
The Voltage Controlled filter can be have
a 6 pole bessel filter responce over a wide
frequency range.


Graph 123 - ac325: StateVariable_Q_10
dB
db(bp)
db(lp)
db(hp)
20
0
-20
-40
-60
-80
decibel
10
100
10^3
10^4
frequency Hz