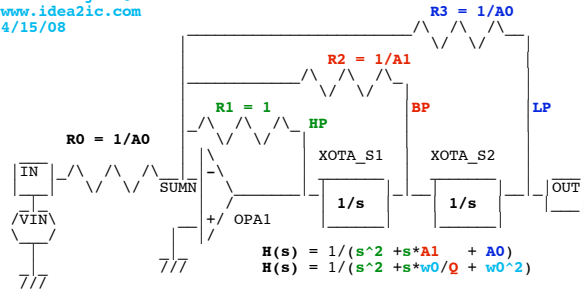


# State\_Variable\_OTA\_10PF

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 \* www.idea2ic.com  
 \* 4/15/08



$$H(s) = 1/(s^2 + s*A1 + A0)$$

$$H(s) = 1/(s^2 + s*w0/Q + w0^2)$$

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
```

\*==BiCMOS\_OTAs\_Can\_Use\_Internal\_Capacitors=====

.control

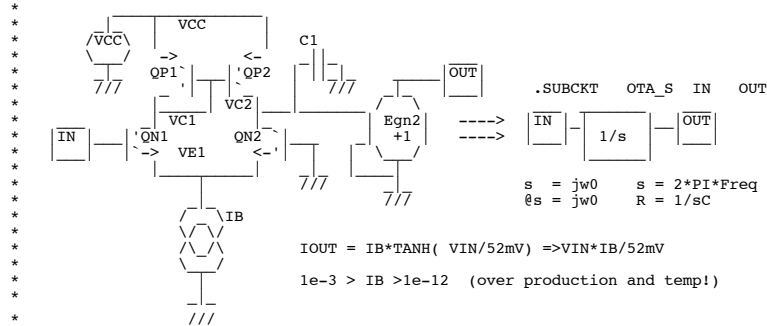
run

plot db(bp) db(hp) db(lp) title StateVariable\_Q\_10  
 alter R2 resistance = 10k

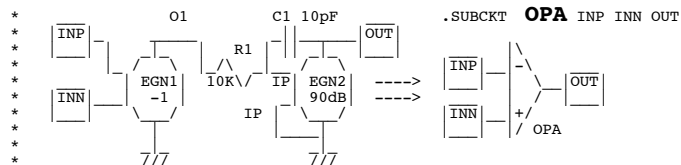
run

plot db(bp) db(hp) db(lp) title StateVariable\_Q\_1

.endc



[http://www.idea2ic.com/PlayWithJavascript/R\\_C\\_Freq.html](http://www.idea2ic.com/PlayWithJavascript/R_C_Freq.html)



.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
I1       VE1      0
VCC      VCC      0      DC       2
EGN2     OUT     0      VC2      0      +1
C1       VC2     0      16p
.ends

```

```

.model1   NPNP   NPN(   BF=2100 VAF=216 )
.model1   PNPP   PNP(   BF=2100 VAF=210 )

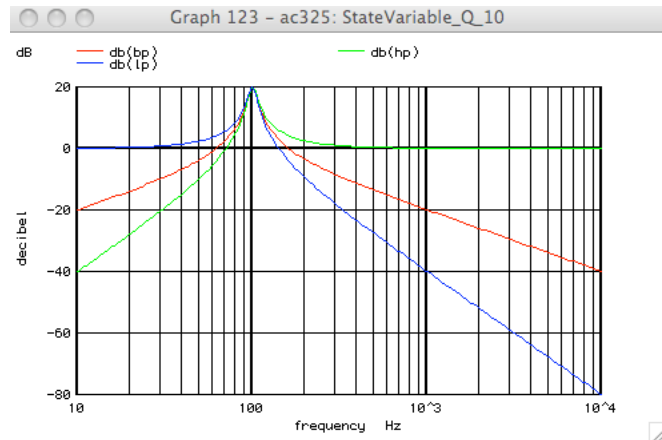
```

```

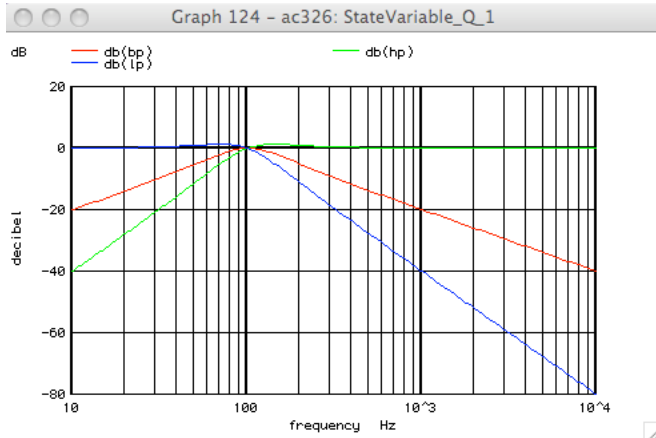
.end
=====END_OF_SPICE=====

```

Because Bipolar transistors can run at low currents, audio freq filters can be built completely on chip using internal capacitors.



Since the value of Q holds very well, a 6 pole voltage controlled filter with any desired response can be built completely on chip.



However OTA can be used to vary feedback.  
 So complete on-chip audio filters can be build.  
 These are in fact voltage controlled filters.  
 And because feedback is adjustable using OTAs,  
 a 6 pole butterworth can be electronically  
 reconfigured into a 6 pole bessel.