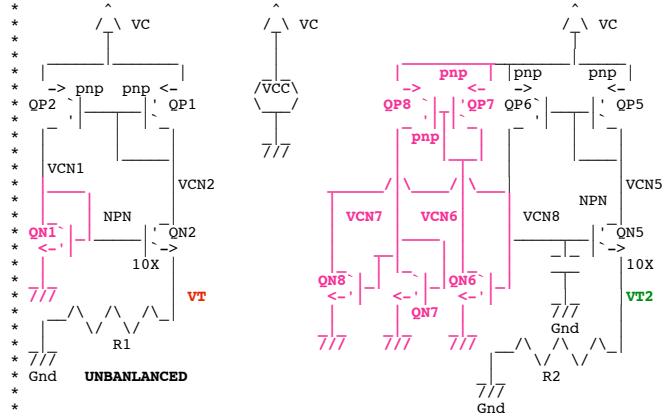


**Balanced\_BandGap.cir**

\* dsauersanjose@aol.com 4/22/08  
\* www.idea2ic.com



\* Patent No.: US 6,614,293 B1

```

.OPTIONS gminsteps = 1
=====
VCC      VC      0      DC      5
*Q_NUMB COL  BASE  EMIT  SUB  MODEL  AREA
QN1      VCN1  VCN1  0      NPN1  1
QN2      VCN2  VCN1  VT     NPN1  10
QP1      VCN2  VCN2  VC     PNP1  1
QP2      VCN1  VCN2  VC     PNP1  1
R1       VT     0      60K
QN5      VCN5  VCN8  VT2    NPN1  10
QN6      VCN6  VCN8  0      NPN1  1
QN7      VCN7  VCN7  0      NPN1  1
QN8      VCN8  VCN7  0      NPN1  1
QP5      VCN5  VCN5  VC     PNP1  1
QP6      VCN8  VCN5  VC     PNP1  1
QP7      VCN6  VCN6  VC     PNP1  1
QP8      VCN7  VCN6  VC     PNP1  1
R2       VT2   0      60K
C2       VCN8  0      1P
.dc      VCC      1.5      5      1

```

\*#0====The\_Balanced\_BandGap\_Balances\_Out\_Beta\_And\_VAF====

**.control**

\*#1====Start\_Off\_With\_Normal\_Levels\_Of\_Beta\_And\_VAF====

```

run
plot vt vt2 title BF_110_50_VAF_60_30

```

\*#2====Test\_The\_Effects\_Of\_Cutting\_NPN\_Beta\_BY\_50%====

```

altermod npn1 bf=50
run
plot vt vt2 title BF_50_50_VAF_60_30

```

\*#3====Test\_The\_Effects\_Of\_Cutting\_PNP\_Beta\_BY\_50%====

```

altermod npn1 bf=110
altermod pnp1 bf=25
run
plot vt vt2 title BF_110_25_VAF_60_30

```

\*#4====Test\_The\_Effects\_Of\_Cutting\_NPN\_VAF\_BY\_50%====

```

altermod npn1 bf=50
altermod npn1 vaf=30
run
plot vt vt2 title BF_110_50_VAF_30_30

```

\*#5====Test\_The\_Effects\_Of\_Cutting\_PNP\_VAF\_BY\_50%====

```

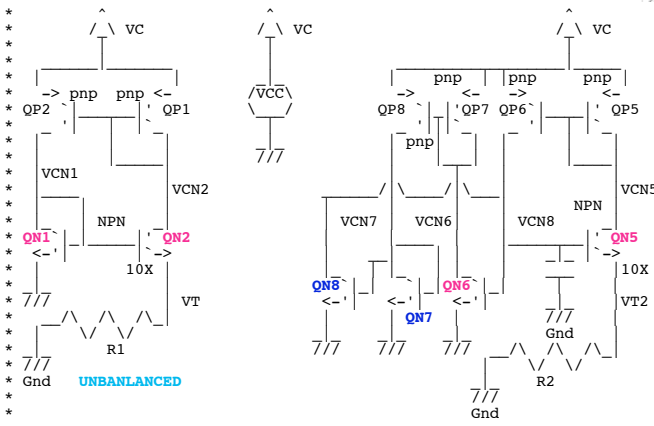
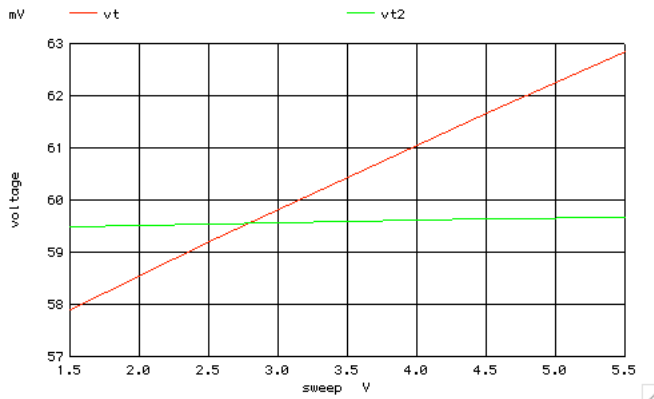
altermod npn1 vaf=60
altermod pnp1 vaf=15

```

```
run
plot      vt          vt2 title  BF_110_50_VAF_60_15
.endc
-----
.model  NPN1  NPN(  BF=110 VAF=60 )
.model  PNP1  PNP(  BF=50  VAF=30 )
.END
```



Graph 17 - dc27: BF\_50\_50\_VAF\_60\_30



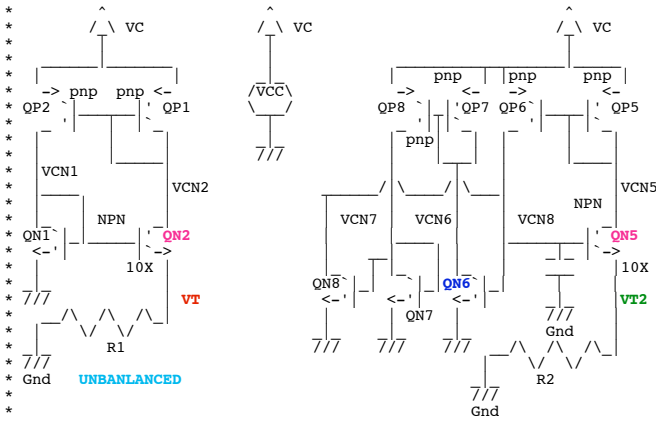
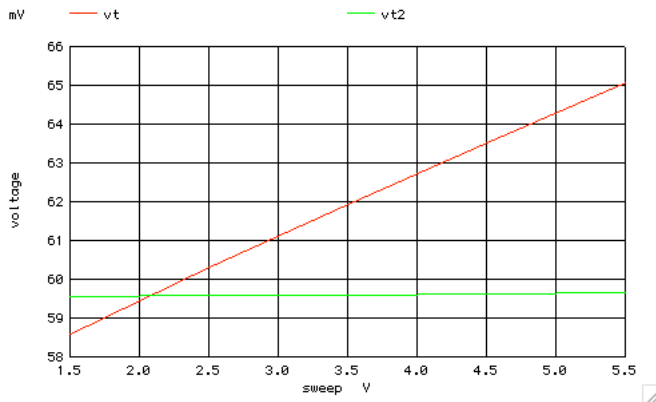
Transistors QN7 and QN8 balance out QN5 and QN6

```

*#3====Test_The_Effects_Of_Cutting_PNP_Beta_BY_50%====
altermod npn1      bf=110
altermod pnp1      bf=25
run
plot vt vt2 title BF_110_25_VAF_60_30
    
```



Graph 19 - dc29: BF\_110\_50\_VAF\_30\_30

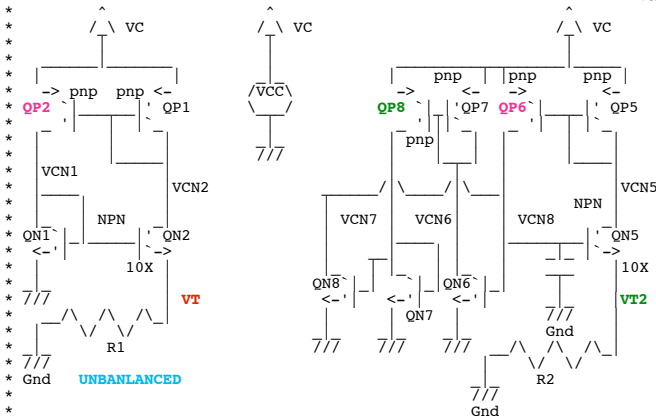
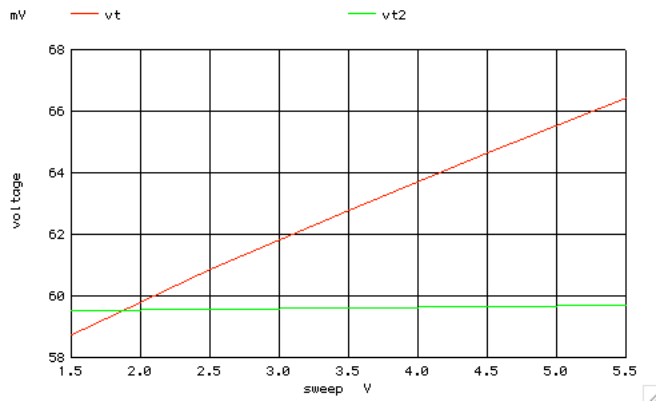


Transistors QN6 balances out QN5

```

*#5====Test_The_Effects_Of_Cutting_PNP_VAF_BY_50%====
altermod npn1 vaf=60
altermod pnp1 vaf=15
run
plot vt vt2 title BF_110_50_VAF_60_15
    
```

Graph 20 - dc30: BF\_110\_50\_VAF\_60\_15



Transistors QP8 balances out QP6

When the supply voltage is too low to add cascodes, the "old" balancing technique appears to work.