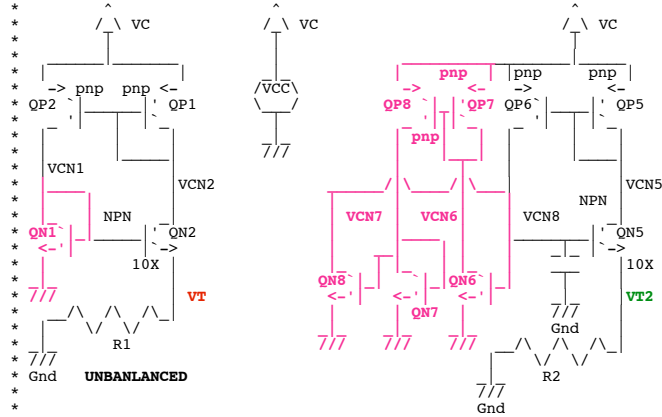


Balanced_BandGap.cir

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 * 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%====

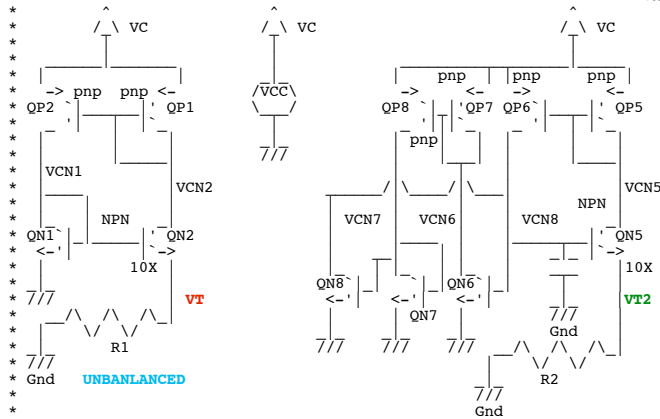
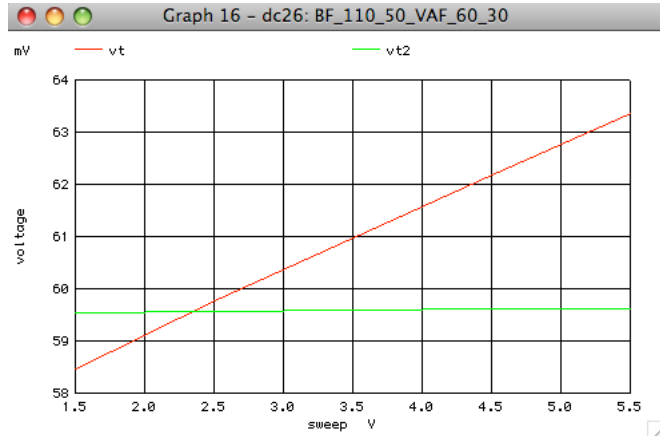
```

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
```

*#1====Start_Off_With_Normal_Levels_Of_Beta_And_VAF====

```
run
plot vt vt2 title BF_110_50_VAF_60_30
```

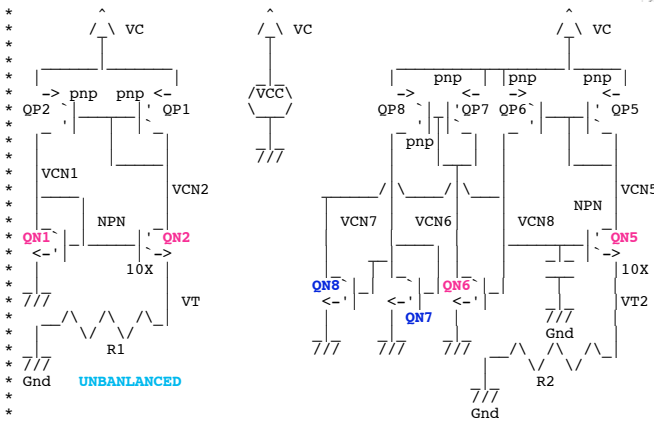
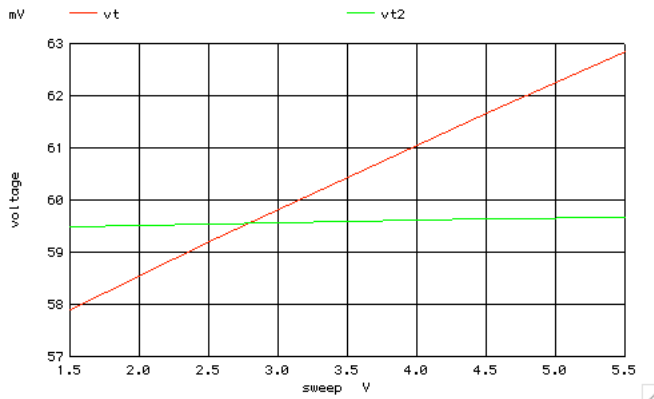


Compared to the normal low voltage bandgap, the balance bandgap is much more accurate.

*#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
```

Graph 17 - dc27: BF_50_50_VAF_60_30

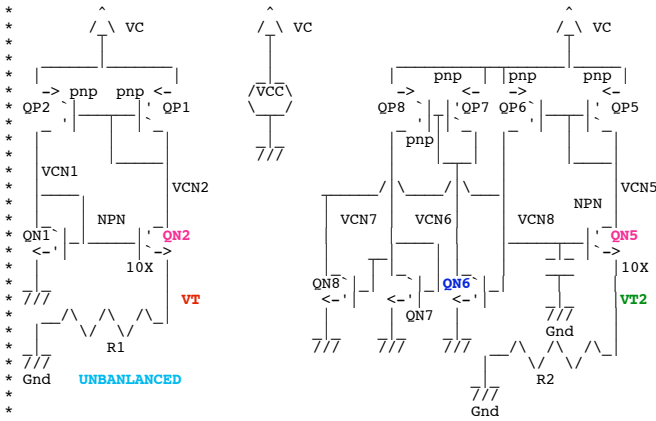
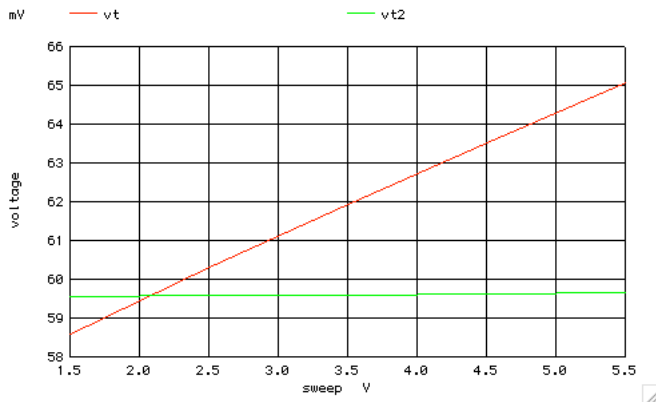


Transistors QN7 and QN8 balance out QN5 and QN6

```

*#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

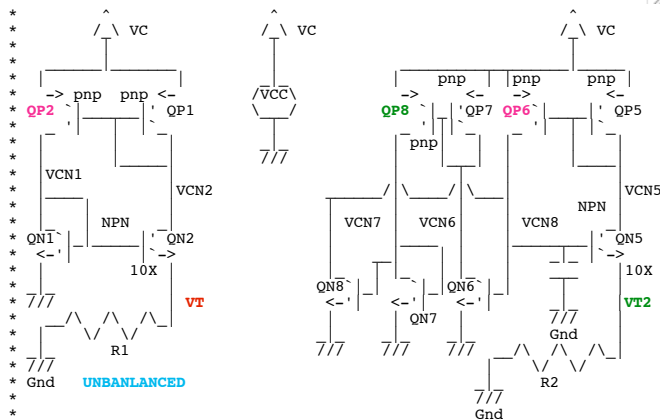
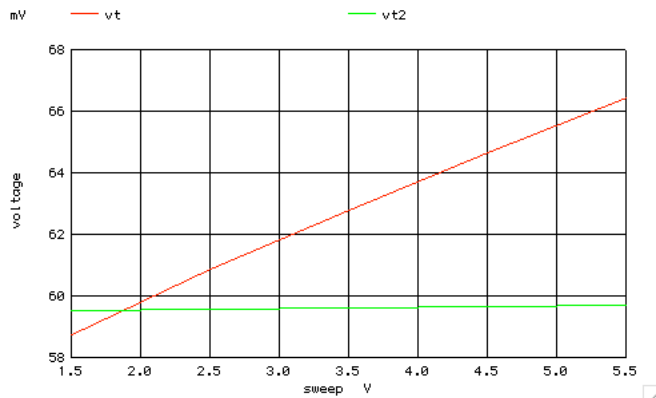


Transistors QN6 balances out QN5

```

*#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.