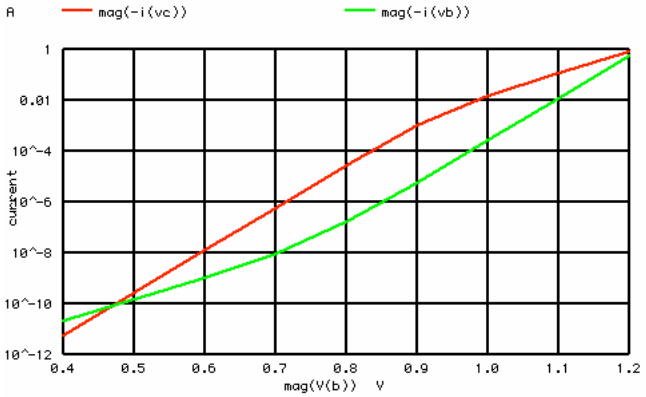
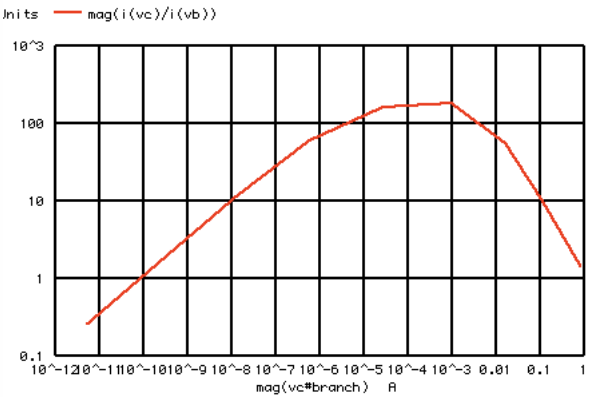
==========NPN_GUMMEL==========

HOW TO DO MODEL VERIFICATION FOR CURRENT,VOLTAGE,AND BETA.





NPN_GUMMEL

```
* MEASURE IS,ISE,NF,NE,RE,IKF,BETA
*
*
*                    ┌────────┐ VC
*                    │C       │
*          B      _  │       _│_
*          ┌──────|'  npnv   /2v \
*          │      |`->       \___/
*     VB  _│_     │    0       │
*       /.7v\      └────────────┘
*       \___/       _│_
*         │         ///
*        _│_
*        ///
```

```
.OPTIONS  GMIN=1e-15    METHOD=gear   ABSTOL=1e-15
*======== ====== ====== ====== ====== ====== ====== ====== ======
VC        C       0       DC      5V
VB        B       0       0V
Q1        C       B       0       NPNV

.MODEL    NPNV    NPN(
*=========================================================
+IS=1.1E-18       NF=1.005    BF=220          VAF=130       IKF=5e-03
+ISE=9.15E-15     NE=2
*=========================================================
+CJE=2E-12 CJC=2E-13 CJS=3E-12 TF=.6E-9 )

.control
*DC       SOURC1 VSTART VSTOP  VSTEP  SOURC2 START2 STOP2  STEP2
dc        vb      .4     1.2    .1
set       pensize = 2
plot      mag(-i(vc)) mag(-i(vb)) vs mag(V(b))      ylog   title Gummel
plot      mag(i(vc)/i(vb))        vs mag(vc#branch) loglog title Beta_vs_IC
.endc
.end
```

```
**
**                                  ┌─┐
**                                  │C│    NPN
**     SPICE MODEL                  └┬┘
**    <actual_behavior>              │
**    <varies from spice model !>   / RC 110ohms    VAF=215
**                                  \
**                                  /                    4fF
**        ┌─────────┬─────────┬─────┴─┬─────────┬─────────┬─┴─┬─┐
**        │         │         │       │         │Irn /‾_‾\  ‾‾ │
**        │         │12fF     │       │Ir/BR    │   \_/ \_/  gnd!
**        │_|_Cjcx  │_|_Cjc   │_|_Cdc \    _|_    _|_    /\_/\  _|_
**        ‾‾‾       ‾‾‾       ‾‾‾     /   /_\    /_\   \___/ \sub/
**        │   Rbb'  │         │gmin   \     │       │Ic       \ /
**   ┌─┐  │   /\    ├─────────┼─────────┼─────┼───────┼─────────┤  V
**   │B│  │_|_/  \__│         │         │     │       │         │V (hidden)
**   └─┘  │   \/    │         │         │     │       │         │
**        │ 600ohms │_|_Cje   │_|_Cde   \     \ /     \ /       │
**        │  BF=116 │         │         /     v       v       │
**        │         ├─────────┼─────────┼─────┼───────┼─────────┤
**        │         │20fF     │gmin     \     │If/Bf  │Ifn      │
**        │         │         │         │     │       │         │
**        └─────────┴─────────┴─────────┴─────┴───────┴─────────┘
**                                  │
**                    TF=8ps       / RE 45ohms
**                                 \
**                                 /
**                                 ‾‾‾
**                                 ┌─┐
**                                 │E│
**                                 └─┘
**
**
```