

NGSPICE

```
.param temp=27
.options savecurrents reltol=1e-3 abstol=1e-12 gmin=1e-15
.control
save all
```

* Operating Point Analysis

```
op
remzerovec
write mosfet_diode_loopgain.raw
set appendwrite
```

* AC Analysis

```
ac dec 1001 10k 100G
remzerovec
write mosfet_diode_loopgain.raw
set appendwrite
```

* Middlebrook's Method

```
let tv=-v(vr1)/v(vf1)
let ti=-i(vr1)/i(vif1)
let tmb=(tv*ti - 1)/(tv + ti + 2)
```

```
plot db(tmb) ylabel 'Magnitude - Middlebrook'
plot 180/pi*cphase(tmb) ylabel 'Phase - Middlebrook'
```

* Tian's Method

```
* vtest=0, itest=1:
let A=i(Vimeas2)
let C=v(Vimeas2)
```

* vtest=1, itest=0:

```
let B=i(Vimeas1)
let D=v(Vimeas1)
let ttian=(A*D-B*C-A)/(2*(B*C-A*D)+A-D+1)
```

```
plot db(ttian) ylabel 'Magnitude - Tian'
plot 180/pi*cphase(ttian) ylabel 'Phase - Tian'
```

* Middlebrook vs. Tian

```
plot db(tmb) db(ttian) ylabel 'Magnitude'
plot 180/pi*cphase(tmb) 180/pi*cphase(ttian) ylabel 'Phase'
```

```
write mosfet_diode_loopgain.raw
```

```
*quit
.endc
```

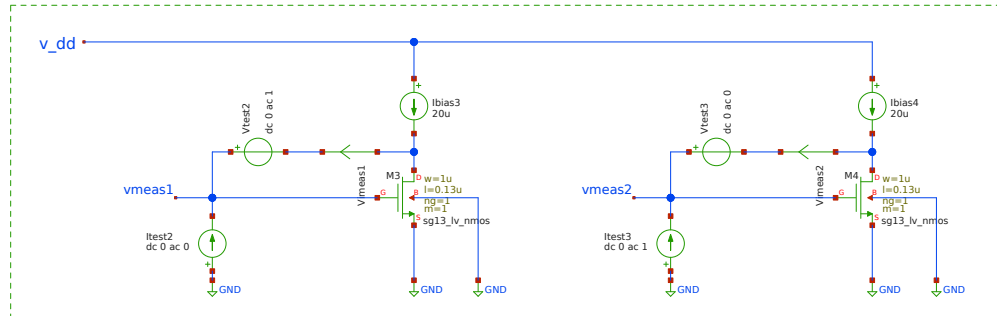
MODEL

```
.lib cornerM05lv.lib mos_tt
```

→ Simulate

→ Annotate OP

Tian's Method



Middlebrook's Method

