Hints, Tips and Solutions

Q: How can I get a CV curve of a MOSFET? And how can I get the current on all terminals?

A: There are two methods to get the CV curve of MOSFET, Small Signal analysis and Large Signal analysis.

From the charge conservation, the sum of charge in the device must meet the charge neutrality relationship given by:

$$Qg + Qd + Qs + Qsub = 0$$

so the Capacitance should be

$$Cij = dQi/dVij \quad i \neq j, i\ j = G,D,S,SUB$$

$$Cij = -dQi/dVij \quad i = j$$

The small signal analysis method applies AC sinusoidal bias to a DC condition.

For example, if the small signal is only applied to gate electrode, then

```
solve vgate=-2.0 vstep=0.1 vfinal=2.0 ac freq=1e6 aname=gate
```

The results can be seen in Figure 1.

The large signal analysis method consists of a Transient simulation with DC offset condition.

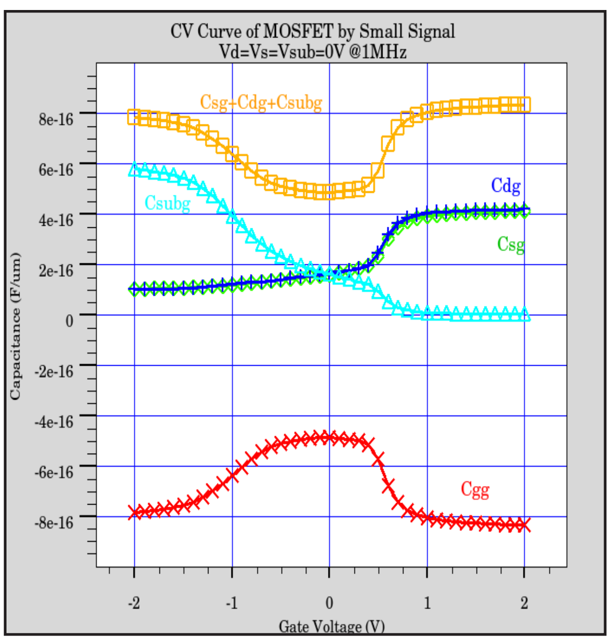

Figure 1. CV Curve of MOSFET by Small Signal Analysis.

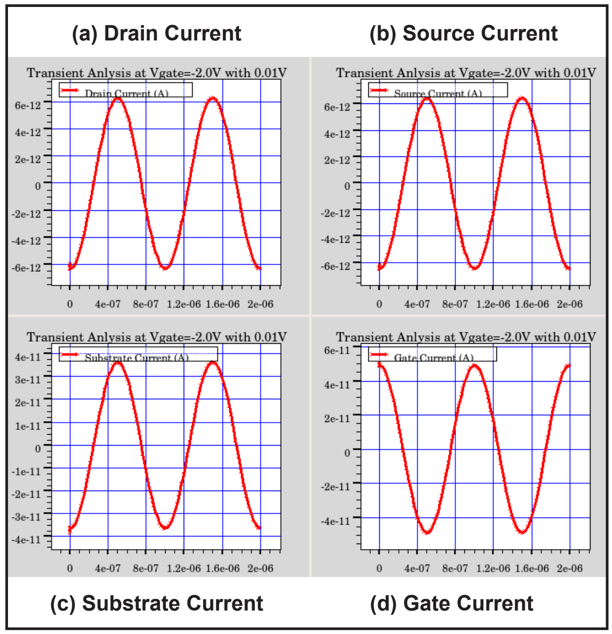

Figure 2. Current of MOSFET by Transient anlaysis at gate bias -2.0V.

To define a sinusoidal bias offset of 0.01V to the gate bias the following syntax should be used:

```
set vg=-2.0
solve vgate=$vg local
log outf=vg$"vg"-ac.log
solve trans.analysis freq=1e6 vgate=$vg+0.01 tstop=2e-6 tstep=1e-8 cycle=2
log off
```

the resulting currents are shown in Figure 2.

To convert current to capacitance (i=C*dv/dt), the extract statement was used as follows:

```
extract name="Cdg" y.val from curve(time, i."drain"/(2*3.14*1e4)) where x.val=5e-7
extract name="Csg" y.val from curve(time, i."source"/(2*3.14*1e4)) where x.val=5e-7
extract name="Cdg" y.val from curve(time, i."gate"/(2*3.14*1e4)) where x.val=5e-7
extract name="Csubg" y.val from curve(time, i."substrate"/(2*3.14*1e4)) where x.val=5e-7
```

The capacitance is then extracted at t=5e-7s using the following formula:

Cdg=idrain*1/(2*pi*freq)*(vss)=idrain/(2*3.14*1e6*0.01)

To get the CV curve as in Figure 1., the internal simulator was used as follows:

```
go internal

load infile=Large-Cap.in (1)

sweep param=vg type=linear range="-2.0, 2.0, 41" (2)

save outfile="largesig-cap.dat"

quit
```

(1) Large-Cap.in is a file that contains the transient simulation described before.

(2) The sweep command will vary vg from -2.0V to 2V with 41 points.

The results are shown in Figure 3.

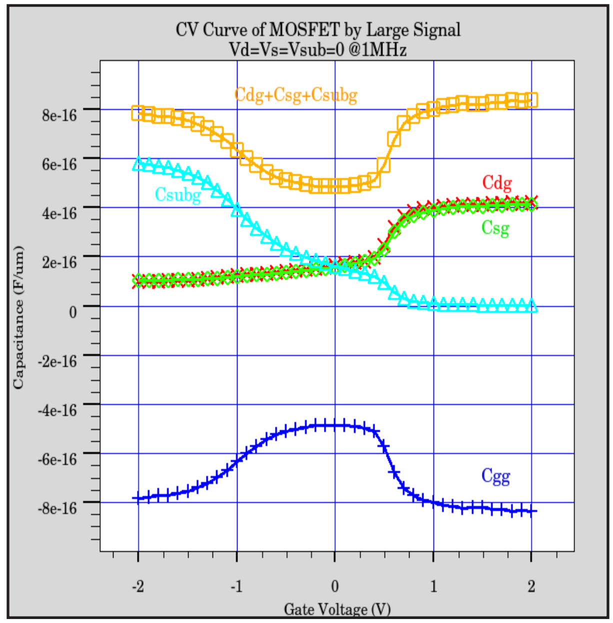

Figure 3. CV Curve of MOSFET by Large Signal Analysis.

Call for Questions

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