Chapter 11: Layout-Dependent Parasitics Model

BSIM4 provides a comprehensive and versatile geometry/layout-dependent parasitcs model [15]. It supports modeling of series (such as isolated, shared, or merged source/ drain) and multi-finger device layout, or a combination of these two configurations. This model have impact on every BSIM4 sub-models except the substrate resistance network model. Note that the narrow-width effect in the per-finger device with multi-finger configuration is accounted for by this model. A complete list of model parameters and selectors can be found in Appendix A.

11.1 Geometry Definition

Figure 11-1 schematically shows the geometry definition for various source/drain connections and source/drain/gate contacts. The layout parameters shown in this figure will be used to calculate resistances and source/drain perimeters and areas.

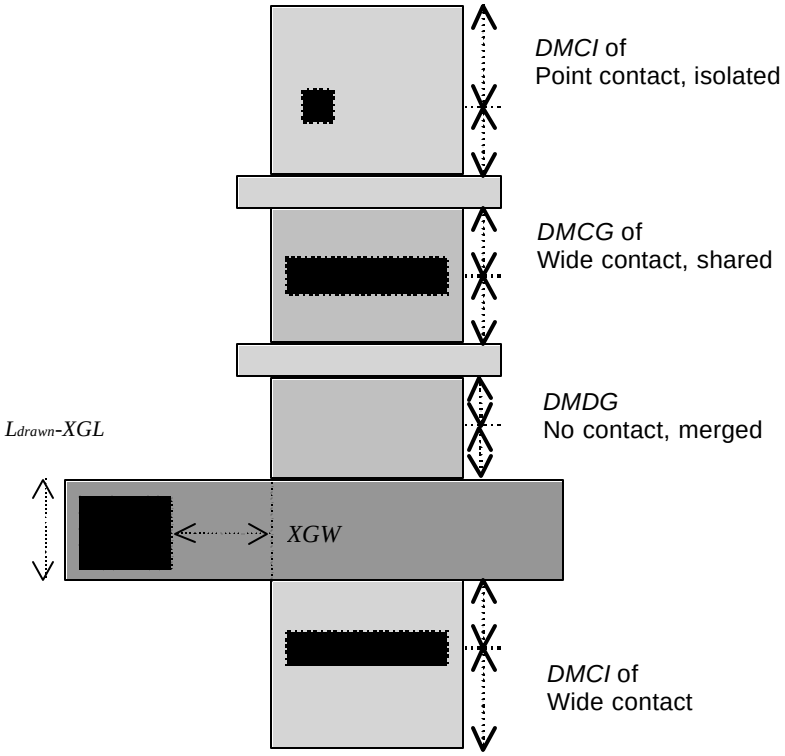

Figure 11-1. Definition for layout parameters.

11.2 Model Formulation and Options

11.2.1 Effective Junction Perimeter and Area

In the following, only the source-side case is illustrated. The same approach is used for the drain side. The effective junction perimeter on the source side is calculated by

If (*PS* is given)
  if (***perMod*** == 0)
    $P_{seff} = PS$
  else
    $P_{seff} = PS - W_{effcj} \cdot NF$
Else
  P_{seff} computed from *NF*, *DWJ*, ***geoMod***, *DMCG*, *DMCI*, *DMDG*, *DMCGT*, and *MIN*.

The effective junction area on the source side is calculated by

If (*AS* is given)
  $A_{seff} = AS$
Else
  A_{seff} computed from *NF*, *DWJ*, ***geoMod***, *DMCG*, *DMCI*, *DMDG*, *DMCGT*, and *MIN*.

In the above, P_{seff} and A_{seff} will be used to calculate junction diode IV and CV. P_{seff} does not include the gate-edge perimeter.

11.2.2 Source/Drain Diffusion Resistance

The source diffusion resistance is calculated by

If (***rgeoMod*** == 0)
  Source diffusion resistance R_{sdiff} is not generated.
Else if (number of source squares *NRS* is given)
  $R_{sdiff} = NRS \cdot RSH$
Else
  R_{sdiff} computed from *NF*, *DWJ*, ***geoMod***, *DMCG*, *DMCI*, *DMDG*, *DMCGT*, *RSH*, and *MIN*.

where the number of source squares *NRS* is an instance parameter. Similarly, the drain diffusion resistance is calculated by

If (***rgeoMod*** == 0)
  Drain diffusion resistance R_{ddiff} is not generated.
Else if (number of source squares *NRD* is given)
  $R_{ddiff} = NRD \cdot RSH$
Else
  R_{ddiff} computed from *NF*, *DWJ*, ***geoMod***, *DMCG*, *DMCI*, *DMDG*, *DMCGT*, *RSH*, and *MIN*.

11.2.3 Gate Electrode Resistance

The gate electrode resistance with multi-finger configuration is modeled by

(11.2.1)

$$Rgeltd = \frac{RSHG \cdot \left(XGW + \frac{W_{effcj}}{3 \cdot NGCON}\right)}{NGCON \cdot \left(L_{drawn} - XGL\right) \cdot NF}$$

11.2.4 Option for Source/Drain Connections

Table 11-1 lists the options for source/drain connections through the model selector ***geoMod***.

geoMod	**End source**	**End drain**	**Note**
0	isolated	isolated	*NF=Odd*
1	isolated	shared	*NF=Odd, Even*
2	shared	isolated	*NF=Odd, Even*
3	shared	shared	*NF=Odd, Even*
4	isolated	merged	*NF=Odd*
5	shared	merged	*NF=Odd, Even*
6	merged	isolated	*NF=Odd*
7	merged	shared	*NF=Odd, Even*
8	merged	merged	*NF=Odd*
9	sha/iso	shared	*NF=Even*
10	shared	sha/iso	*NF=Even*

Table 11-1. *geoMod* options.
For multi-finger devices, all inside S/D diffusions are assumed shared.

11.2.5 Option for Source/Drain Contacts

Talbe 11-2 lists the options for source/drain contacts through the model selector ***rgeoMod***.

rgeoMod	End-source contact	End-drain contact
0	No R_{sdiff}	No R_{ddiff}
1	wide	wide
2	wide	point
3	point	wide
4	point	point
5	wide	merged
6	point	merged
7	merged	wide
8	merged	point

Table 11-2. *rgeoMod* options.