Diode **D**

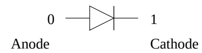

Figure 1: D — Diode Element.

`SPICE` *Form:*

`D`*name* n_1 n_2 *ModelName* [*Area*] [`OFF`] [`IC`=V_D]

n_1	is the positive element node
n_2	is the negative element node
ModelName	is the optional model name
Area	is an optional relative area factor. (Units: none; Optional; Default: 1, Symbol: *Area*)
`OFF`	Indicates an optional starting condition on the device for DC operating point analysis. If specified, the DC operating point is calculated with the terminal voltages set to zero. Once convergence is obtained, the program continues to iterate to obtain the exact value of terminal voltages. The OFF option, is used to enforce the solution to correspond to a desired state if the circuit has more than one stable state.
`IC`	is the optional initial condition specification. Using `IC`=V_D is used with the *UIC* option on the *.TRAN* line when a transient analysis is desired with initial current V_D across the diode rather than the quiescent operating point. Specification of the transient initial condition using the `.IC` is preferred and is more convenient.

Diode Model:

Form:

.MODEL *ModelName* `D`([[*keyword* = *value*]...])

Example:

```
DCLMP  3  7 DMOD  3.0 IC=0.2
.MODEL DMOD D(IS=100pA  N=1.68  BV=10V  IBV=1nA)
```

Model Parameters:

Name	Description	Units	Default
`AF`	Flicker noise exponent (AF)		1
`AFAC`	Temperature related coefficient ($AFAC$)		1
`ALFA`	Slope factor of conduction current ($ALFA$)	/volt	38.696
`AR0`	R0 Linear temperature coefficient (AR_0)	K	0
`AREA`	Area multiplier ($AREA$)		1.0
`BR0`	R0 Quadratic temperature coefficient (BR_0)	K^2	0
`BV`	Magnitude of current at breakdown voltage (V_B)		10^-14
`CD0`	Zero bias diffusion capacitance (C_{D0})	/volt	0.0
`CJ0`	Zero bias depletion capacitance (C_{J0})	farad	0
`E`	Power law parameters of breakdown current (E)		10.0
`EG`	Barrier height at 0K (E_G)	eV	0.8
`IS`	Saturation current (I_S)	amps	0
`KF`	Flicker noise coefficient (K_F)		1.0
`M`	Grading coefficient (M)		0.5
`N`	Emission coefficient (n)		1.0
`R0`	Bias dependent part of series resistance in the forward bias (R_0)	ohms	0
`TT`	Intrinsic time constant of depletion layer for abrupt junction (τ_t)	secs	0
`VB`	Breakdown voltage (V_B)	volts	∞
`VJ`	Junction potential (ϕ)	volts	1.0
`XTI`	IS temperature coefficient (XTI)		1

Example:

```
DCLMP  3  7 DMOD  3.0 IC=0.2
.MODEL DMOD D(IS=100pA  N=1.68  BV=10V  IBV=1nA)
```

Description:
DIODE MODEL:

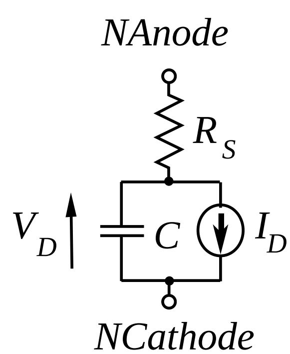

Figure 2: Schematic of the Diode Element Model

The physical constants used in the model evaluation are:

k	Boltzmann's constant	$1.3806226\ 10^{-23} J/K$
q	electron charge	$1.6021918\ 10^{-19} C$

DEVICE EQUATIONS:

Current Characteristics

$$I_D = I_S(e^{ALFA\,V_D} - 1) - I_B \tag{1}$$

$$I_B = \begin{cases} 0 & V_D \geq (1 + V_B) \\ I_{BV}(1 + V_B + V_D)^E & V_D < (1 + V_B) \end{cases} \tag{2}$$

where $ALFA = 1/(n\ V_{TH})$
V_{TH}=kT/q

Capacitance

$$C_J = \begin{cases} C_{J0}(1 - V_D/\phi)^{-M} + C_D & V_D \leq 0.8\phi \\ C_{J0}0.2^{-M} + C_D & V_D > 0.8\phi \end{cases} \tag{3}$$

where C_D is the diffusion capacitance.
$C_D = C_{D0}e^{AFACV_D}$

Parasitic Resistance

$$R_S = \begin{cases} R_0 - \tau/C_J & R_0 > \tau/C_J \\ 0 & R_0 \leq \tau/C_J \end{cases} \tag{4}$$

Temperature Dependence

T is the analysis temperature
T_NOM is the reference temperature (298 K)
$V_TH = kT/q$

$$\begin{aligned}
& I_S(T) = I_S[e^{(T/T_{NOM-1})E_G/V_{TH}}](T/T_{NOM})^{XTI} \\
& \phi(T) = \phi(T/T_NOM) - 3V_{TH}\ln(T/T_{NOM}) - E_G(T_{NOM})(T/T_{NOM}) + E_G(T) \\
& E_G(T) = E_G - 0.000702(T^2/T + 1108) \\
& C_{J0}(T) = C_{J0}(1 + M(0.0004(T - T_{NOM}) + (1 - \phi(T)/\phi))) \\
& R_0(T) = R_0(1 + AR_0(T - T_{NOM}) + BR_0(T - T_{NOM})^2) \\
& V_B(T) = V_B(1 + AV_B(T - T_{NOM}) + BV_B(T - T_{NOM})^2)
\end{aligned} \tag{5}$$

Notes:

The actual element in TRANSIM is the `diode` element. See TRANSIM element diode for full documentation.

Credits:

Name	Affiliation	Date	Logo
Carlos E. Christofferson	NC State University	Sept 2000	NC STATE UNIVERSITY