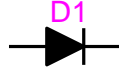


# Diode (ideal)



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Jean Mahseredjian, 6/22/2021 5:37 PM

## 1 Description

This device represents an ideal diode, zero resistance and zero voltage drop when conducting and infinite resistance when off. It is a 1-phase device.

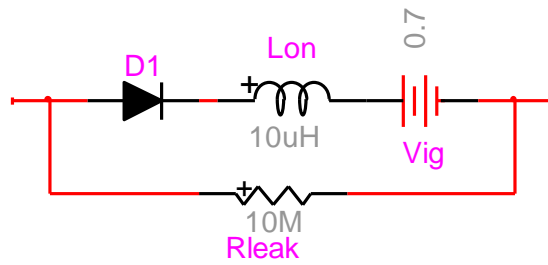
## 2 Parameters and rules

The parameters from the data tab are:

- $V_{ig}$  is the ignition voltage, the minimum voltage required for turning the diode on. This voltage should be greater than 0.
- $I_{hold}$  is the holding current. The diode stops conducting when its current falls below this value or crosses 0 when  $I_{hold} = 0$ .
- Closed at  $t=0$   
This option is used for initializing the simulated network in steady-state solution. When this option is checked the diode shows a green color for indicating its steady-state conduction.

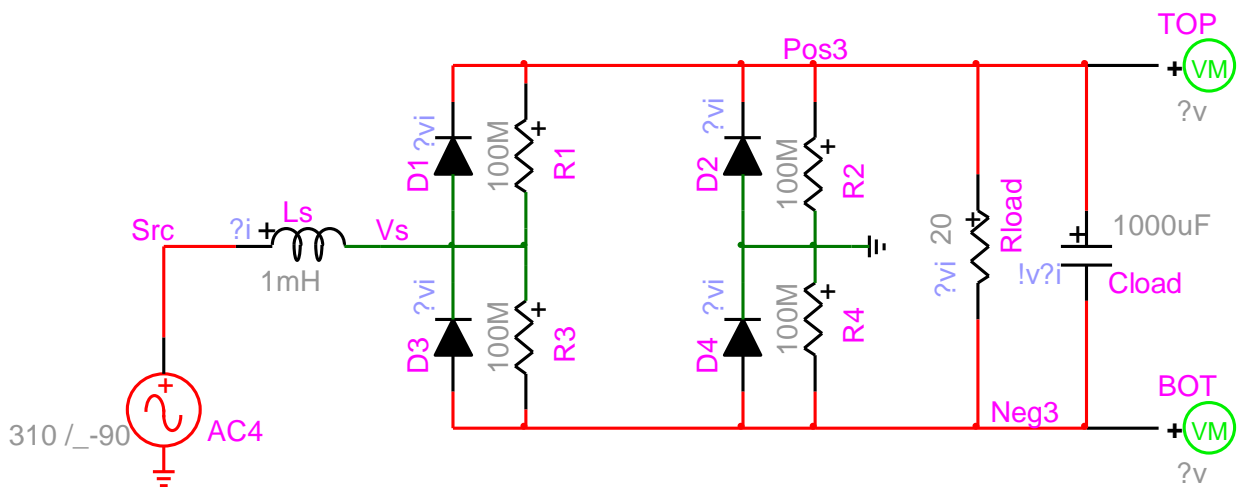
This is a 1-phase device and it is not allowed to change its pin attributes. It is not allowed to delete any pins. Since this is an ideal device, placing diodes in parallel will not work, although EMTP will try to solve such cases by inserting dummy resistances.

This device can be used as a building block for creating a more detailed model. The circuit in Figure 1 shows the inclusion of a dc voltage drop acting when the diode is closed and some extra devices such as a reverse-bias resistance and a turn-on inductance. Such a circuit can be encapsulated and masked to become transparent to the user.



**Figure 1 Turn-on model of the diode based on the ideal diode device**

The example of Figure 2 (see [diode\\_bridge.ecf](#)) shows a bridge rectifier based on ideal diodes. The large 100M resistances are required to create full connectivity when the diodes are not conducting and to create a symmetrical behavior on the load side. If the resistances are not used and the load side circuit is floating, EMTP inserts a resistance to ground on the load side at an arbitrary node, which makes the circuit unsymmetrical. A diode model, such as the one in Figure 1 could have been also used.



**Figure 2 Bridge rectifier with ideal diodes**

More sophistication can be achieved by replacing the diode by an actual nonlinear function. The design of Figure 2 is using four such nonlinear diode models. The diode subcircuit is shown in Figure 4. The 100M is not mandatory, but used to model the leakage resistance of the diode. The nonlinear function is rendered using the "R nonlinear" device from the "nonlinear" library. It is a piecewise linear representation of the nonlinear diode equation:

$$i_d = I_s (e^{v_d/V_T} - 1)$$

where  $i_d$  is the diode current,  $v_d$  ( $v_d \geq 0$ ) is the diode voltage. In this example  $I_s = 1e-13$  A and  $V_T = 0.026$  V. Two slopes are used to model the reverse bias condition when  $v_d < 0$ . This type of model is more appropriate for low voltages. The actual output voltage is very close to the voltage for the circuit of Figure 2. The differences are more important in the actual diode currents. The nonlinear model provides smoother current transition.

Another advantage of the nonlinear model is its ability to provide simultaneous switching. This is demonstrated in the design buck\_boost\_dis.ecf found in Examples\buck\_boost\_converter.

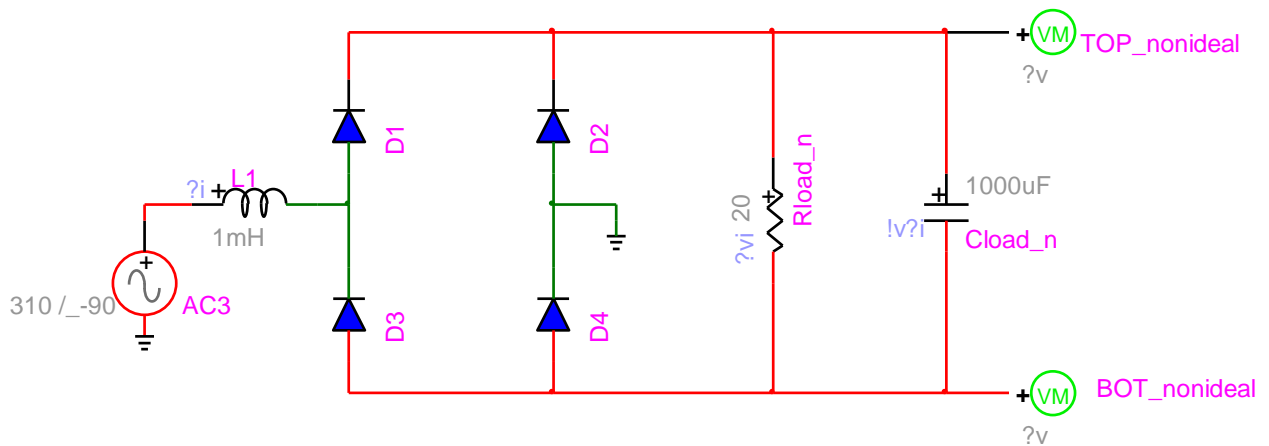


Figure 3 Bridge rectifier with nonideal diodes

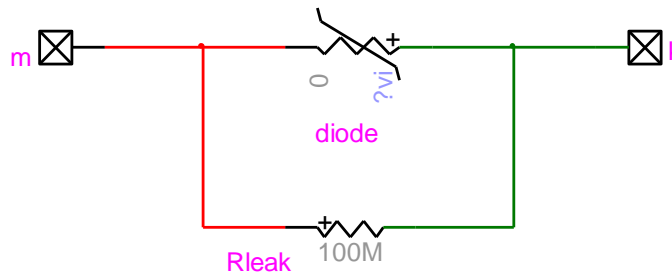


Figure 4 The nonideal diode subcircuit

### 3 Netlist format

```
_D0;D1;2;2;s6,s12,
0.7,0,0,?v,?i,?p,>v,>i,>p,>S,
```

Field	Description
<code>_D0</code>	Part name
<code>D1</code>	Instance name, any name.
<code>2</code>	Total number of pins
<code>2</code>	Number of pins given in this data section
<code>s6</code>	Signal name connected to k-pin, any name
<code>s12</code>	Signal name connected to m-pin, any name
<code>Vig</code>	Voltage $V_{ig}$ described above
<code>Ihold</code>	Current $I_{hold}$ described above
<code>Closed at t=0</code>	1 means closed in steady-state, 0 means open in steady-state
<code>?v, ?i, ?p</code>	Optional scope requests
<code>&gt;v, &gt;i, &gt;p, &gt;S</code>	Optional observe requests

Device data fields are saved into the ParamsA device attribute.

## **4 Steady-state model and initial conditions**

If the diode is closed at  $t=0$ , it is modeled as an ideal closed switch. It is an open-circuit otherwise.

## **5 Frequency Scan model**

Similar to the steady-state.

## **6 Time-domain model**

The diode is modeled by an ideal closed (zero resistance) switch when conducting and by an ideal infinite resistance open switch when turned off.