0.0.1 Current Controlled Switch W

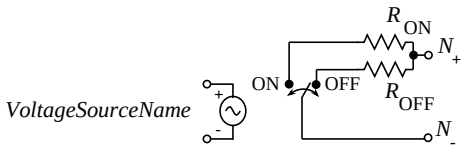

Figure 1: W — current controlled switch.

`SPICE` *Form:*
`W`name N_1 N_2 *VoltageSourceName ModelName* [ON] [OFF]

N_+	is the positive node of the switch.
N_-	is the negative node of the switch.
VoltageSourceName	is the name of the voltage source the current through which is the controlling current. The voltage source must be a `V` element.
`ON`	is the optional initial condition. It is intended for use with the `UIC` option on the `.TRAN` line, when a transient analysis is desired starting from other than the quiescent operating point. It is also the initial condition on the device for `DC` analysis.
`OFF`	is the optional initial condition. 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 the 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.

Description:
Model Type

`ISWITCH`

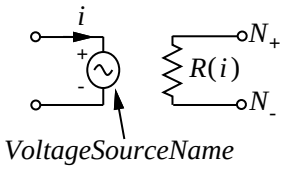

Figure 2: ISWITCH — current controlled switch model.

The current-controlled switch model is supported by both SPICE3 and PSPICE. However the model keywords differ slightly.

Name	Description	Units	Default
IT	threshold current ($I_{\rm ON}$)	A	0.0
IH	hysteresis current ($I_{\rm OFF}$)	A	0.0
RON	on resistance ($R_{\rm ON}$)	Ω	1.0
ROFF	off resistance ($R_{\rm OFF}$)	Ω	1/GMIN

Care must be exercised in using the switch. An instantaneous switch is highly nonlinear and will very likely lead to convergence problems. This problem is alleviated in the ISWITCH model by ramping the resistance of the switch from its off value to its on value. For this ramping action to be effective the difference between $I_{\rm ON}$ and $I_{\rm OFF}$ must not be too small. Also the values of $R_{\rm ON}$ and $R_{\rm OFF}$ should not be extreme. The ration $R_{\rm ON}/R_{\rm OFF}$ should be be as small as possible.

If $R_{\rm ON}/R_{\rm OFF}$ is large, e.g. $R_{\rm ON}/R_{\rm OFF} > 10^{12}$, then the default error tolerances TRTOL and CHGTOL, specified in a .OPTIONS statement (see page **??**) may need to be changed.

TRTOL Change to 1.0 from 7.0 idf there are convergence problems during transient analysis.

CHGTOL If a switch is across a capacitor then CHGTOL should be reduced to 10^{-16} if there are convergence problems during transient analysis.

Switch Model

W

The switch is modeled by a current variable resistor R, see figure 2.

Standard Calculations

$$R_{\mathrm{MEAN}} = \sqrt{R_{\mathrm{ON}} + R_{\mathrm{OFF}}} \quad (1)$$

$$R_{\mathrm{RATIO}} = R_{\mathrm{ON}}/R_{\mathrm{OFF}} \quad (2)$$

$$I_{\mathrm{MEAN}} = \sqrt{I_{\mathrm{ON}} + I_{\mathrm{OFF}}} \quad (3)$$

$$I_{\Delta} = \left(\frac{i - I_{\mathrm{MEAN}}}{I_{\mathrm{ON}} - I_{\mathrm{OFF}}}\right) \quad (4)$$

If $I_{\mathrm{ON}} > I_{\mathrm{OFF}}$ the switch resistance

$$R = \begin{cases} R_{\mathrm{ON}} & i \geq I_{\mathrm{ON}} \\ R_{\mathrm{OFF}} & i \leq I_{\mathrm{OFF}} \\ R_{\mathrm{MEAN}}\, R_{\mathrm{RATIO}}^{1.5 I_{\Delta}}\, R_{\mathrm{RATIO}}^{1.5 I_{\Delta}^3} & I_{\mathrm{OFF}} < i < I_{\mathrm{ON}} \end{cases} \quad (5)$$

If $I_{\mathrm{ON}} < I_{\mathrm{OFF}}$ the switch resistance

$$R = \begin{cases} R_{\mathrm{ON}} & i \leq I_{\mathrm{ON}} \\ R_{\mathrm{OFF}} & i \geq I_{\mathrm{OFF}} \\ R_{\mathrm{MEAN}}\, R_{\mathrm{RATIO}}^{1.5 I_{\Delta}}\, R_{\mathrm{RATIO}}^{1.5 I_{\Delta}^3} & I_{\mathrm{OFF}} < i < I_{\mathrm{ON}} \end{cases} \quad (6)$$

Noise Analysis

Noise Analysis

The current controlled switch noise model accounts for thermal noise generated in the switch resistance. The rms (root-mean-square) values of thermal noise current generators shunting the switch resistance is

Noise Model

$$I_n = \sqrt{4kT/R}\ \mathrm{A}/\sqrt{\mathrm{Hz}} \quad (7)$$

where T is the analysis temperature in kelvin (K), and k ($= 1.3806226\,10^{-23}$ J/K) is Boltzmanns constant.

Notes:
There is no equivalent element in *f*REEDA™.

Credits:

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