Spice Circuit Elements and Models

Note: In order to finish the Computer Project 2 (CP2): Matlab Simulator, you need to understand the description of the circuit elements and models in Spice. This information sheet intends to give you a basic understanding of this. This is not a full list of all the elements description and you should be able to figure out by yourself for some other elements. A detailed description of the Spice circuit elements and models can be referred in the following link:

http://www.seas.upenn.edu/~jan/spice/spice.overview.html

Note: One example is given at the end of this document for better understanding.

Capacitors
General form:
   CXXXXXXX N+ N- VALUE <IC=INCOND>
Examples:
   CBYP 13 0 1UF
   COSC 17 23 10U IC=3V

N+ and N- are the positive and negative element nodes, respectively. VALUE is the capacitance in Farads.

The (optional) initial condition is the initial (time-zero) value of capacitor voltage (in Volts). Note that the initial conditions (if any) apply 'only' if the UIC option is specified on the .TRAN control line.

Linear Voltage-Controlled Voltage Sources
General form:
   EXXXXXXX N+ N- NC+ NC- VALUE

   Examples:
   E1 2 3 14 1 2.0

N+ is the positive node, and N- is the negative node. NC+ and NC- are the positive and negative controlling nodes, respectively. VALUE is the voltage gain.

Linear Current-Controlled Current Sources
General form:
   FXXXXXXX N+ N- VNAM VALUE

   Examples:
   F1 13 5 VSENS 5

N+ and N- are the positive and negative nodes, respectively. Current flow is from the positive node, through the source, to the negative node. VNAM is the name of a voltage source through which the
controlling current flows. The direction of positive controlling current flow is from the positive node, through the source, to the negative node of VNAM. VALUE is the current gain.

**Linear Voltage-Controlled Current Sources**

*General form:*

\[ \text{GXXXXXXX N+ N- NC+ NC- VALUE} \]

*Examples:*

\[ \text{G1 2 0 5 0 0.1MMHO} \]

N+ and N- are the positive and negative nodes, respectively. Current flow is from the positive node, through the source, to the negative node. NC+ and NC- are the positive and negative controlling nodes, respectively. VALUE is the transconductance (in mhos).

**Linear Current-Controlled Voltage Sources**

*General form:*

\[ \text{HXXXXXXX N+ N- VNAM VALUE} \]

*Examples:*

\[ \text{HX 5 17 VZ 0.5K} \]

N+ and N- are the positive and negative nodes, respectively. VNAM is the name of a voltage source through which the controlling current flows. The direction of positive controlling current flow is from the positive node, through the source, to the negative node of VNAM. VALUE is the transresistance (in ohms).

**Independent Sources (voltage and current source)**

*General form:*

\[ \text{VXXXXXXX N+ N- <DC<> DC/TRAN VALUE> <AC <ACMAG <ACPHASE>>>} \\
+ <DISTOF1 <F1MAG <F1PHASE>>> <DISTOF2 <F2MAG <F2PHASE>>> \\
\text{IYYYYYYY N+ N- <<DC> DC/TRAN VALUE> <AC <ACMAG <ACPHASE>>>} \\
+ <DISTOF1 <F1MAG <F1PHASE>>> <DISTOF2 <F2MAG <F2PHASE>>> \\
\]

*Examples:*

\[ \text{VCC 10 0 DC 6} \\
\text{VIN 13 2 0.001 AC 1 SIN(0 1 1MEG)} \\
\text{ISRC 23 21 AC 0.333 45.0 SFFM(0 1 10K 5 1K)} \\
\text{VMEAS 12 9} \\
\text{VCARRIER 1 0 DISTOF1 0.1 -90.0} \\
\text{VMODULATOR 2 0 DISTOF2 0.01} \\
\text{IIN1 1 5 AC 1 DISTOF1 DISTOF2 0.001} \]

N+ and N- are the positive and negative nodes, respectively. Note that voltage sources need not be grounded. Positive current is assumed to flow from the positive node, through the source, to the negative node. A current source of positive value forces current to flow out of the N+ node, through the source, and into the N- node. Voltage sources, in addition to being used for circuit excitation, are the 'ammeters' for SPICE, that is, zero valued voltage sources may be inserted into the circuit for the purpose of measuring current. They of course have no effect on circuit operation since they represent short-circuits.
DC/TRAN is the dc and transient analysis value of the source. If the source value is zero both for dc and transient analyses, this value may be omitted. If the source value is time-invariant (e.g., a power supply), then the value may optionally be preceded by the letters DC.

ACMAG is the ac magnitude and ACPHASE is the ac phase. The source is set to this value in the ac analysis. If ACMAG is omitted following the keyword AC, a value of unity is assumed. If ACPHASE is omitted, a value of zero is assumed. If the source is not an ac small-signal input, the keyword AC and the ac values are omitted.

DISTOF1 and DISTOF2 are the keywords that specify that the independent source has distortion inputs at the frequencies F1 and F2 respectively (see the description of the .DISTO control line). The keywords may be followed by an optional magnitude and phase. The default values of the magnitude and phase are 1.0 and 0.0 respectively.

Any independent source can be assigned a time-dependent value for transient analysis. If a source is assigned a time-dependent value, the time-zero value is used for dc analysis. There are five independent source functions: pulse, exponential, sinusoidal, piece-wise linear, and single-frequency FM. If parameters other than source values are omitted or set to zero, the default values shown are assumed. (TSTEP is the printing increment and TSTOP is the final time (see the .TRAN control line for explanation)).

**Inductors**

*General form:*

```
LYYYYYYY N+ N- VALUE <IC=INCOND>
```

*Examples:*

```
LLINK 42 69 1UH
LSHUNT 23 51 10U IC=15.7MA
```

N+ and N- are the positive and negative element nodes, respectively. VALUE is the inductance in Henries.

The (optional) initial condition is the initial (time-zero) value of inductor current (in Amps) that flows from N+, through the inductor, to N-. Note that the initial conditions (if any) apply only if the UIC option is specified on the .TRAN analysis line.

**Resistors**

*General form:*

```
RXXXXXXXX N1 N2 VALUE
```

*Examples:*

```
R1 1 2 100
RC1 12 17 1K
```

N1 and N2 are the two element nodes. VALUE is the resistance (in ohms) and may be positive or negative but not zero.

**Switches**

*General form:*

```
SXXXXXXXX N+ N- NC+ NC- MODEL <ON><OFF>
```
Examples:

s1 1 2 3 4 switch1 ONs2 5 6 3 0 sm2 off
Switch1 1 2 10 0 smodel1
w1 1 2 vclock switchmod1
W2 3 0 vramp sm1 ON
wreset 5 6 vclck lossyswitch OFF

Nodes 1 and 2 are the nodes between which the switch terminals are connected. The model name is mandatory while the initial conditions are optional. For the voltage controlled switch, nodes 3 and 4 are the positive and negative controlling nodes respectively. For the current controlled switch, the controlling current is that through the specified voltage source. The direction of positive controlling current flow is from the positive node, through the source, to the negative node.

Example:

We have the following Spice input file:

I 0 1 1
R1 1 0 1
L 1 2 2
C 2 0 1
F 2 0 1 2 2
R2 2 0 3

The corresponding circuit is: