OptiSPICE

Device Library

Opto-Electronic Circuit Design Software

Version 5.1

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Resistor

Generates voltage drop between its terminals in proportion to the current flow.

Pins

Number	Signal Type	Description
1	Electrical	-
2	Electrical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Resistance Resistance value at room temperature	R	1 k	Ohm	[0, INF]

Optional

Name and description	Symbol name	Default value	Units	Value range
First-order temperature coefficient First-order temperature coefficient for the resistance	TC1	0.0	Ohm/C	]-INF, +INF[
Second-order temperature coefficient Second-order temperature coefficient for the resistance	TC2	0.0	Ohm/C^2	]-INF, +INF[
Temperature difference Temperature difference between the resistor and the circuit	DTEMP	0.0	C	]-INF, +INF[
Resistance for AC analysis	AC	0.0	Ohm	[0, +INF[

Name and description	Symbol name	Default value	Units	Value range
Multiplier Multiplier to simulate parallel resistors	M	1	-	[1,+ INF]
Scaling factor Scaling factor for resistance value	SCALE	1.0	-	[0, +INF[
Resistor length Used if resistor model is given	L	1e-4	m	[0, +INF[
Resistor width Used if resistor model is given	W	1e-4	m	[0, +INF[
Capacitance Capacitance from second node to bulk node	C	0.0	F	[0, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]

Model

Model is optional for a resistor. A physical wire model can be given using a resistor model statement. For the details, see Resistor Model in the Element and Model Library book. If such a model is given, the resistance value `R` is optional.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the resistor is given by

```
RXXX SIGI SIGJ <MODEL_NAME> R=val <TC1=val> <TC2=val> <DTEMP=val>
+ <AC=val> <M=val> <SCALE=val> <L=val> <W=val> <C=val> <NoNoise=0/1>
```

Note: The optional parameters are enclosed by angle brackets.

Example

For a resistor with device name R1 connected between signals SIG1 and SIG2 with 10 kilo-ohms, and temperature coefficients (TC1 and TC2) of 0.01 and 0.001, the netlist statement to be generated as follows:

```
R1 SIG1 SIG2 R=10k TC1=0.01 TC2=0.001
```

Capacitor

A two terminal device storing electric charge in proportion to its capacitance and applied voltage.

Pins

Number	Signal Type	Description
1	Electrical	-
2	Electrical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Capacitance Capacitance value at room temperature	C	1 n	F	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Initial voltage Initial voltage across capacitor terminals	IC	0.0	V	]-INF, +INF[
First-order temperature coefficient First-order temperature coefficient for the capacitance	TC1	0.0	F/C	]-INF, +INF[
Second-order temperature coefficient Second-order temperature coefficient for the capacitance	TC2	0.0	F/C^2	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the capacitor and the circuit	DTEMP	0.0	C	]-INF, +INF[
Multiplier Multiplier to simulate parallel capacitors	M	1	-	[1, +INF[
Scaling factor Scaling factor for capacitance value	SCALE	1.0	-	[0, +INF[
Capacitor length Used if capacitor model is given	L	1e-4	m	[0, +INF[
Capacitor width Used if capacitor model is given	W	1e-4	m	[0, +INF[

Model

Model is optional for a capacitor. A physical capacitor model can be given using a capacitor model statement. For the details, see Capacitor Model in the Element and Model Library book. If such a model is given, the capacitance value `C` is optional.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the capacitor is given by:

```
CXXX SIGI SIGJ <MODEL_NAME> C=val <IC=val> <TC1=val> <TC2=val>
+ <DTEMP=val> <M=val> <SCALE=val> <L=val> <W=val>
```

Note: The optional parameters are enclosed by angle brackets.

Example

For a capacitor with device name C1 connected between signals SIG1 and SIG2 with 2 pF, and initial voltage of 0.05 V, the netlist statement to be generated as follows:

```
C1 SIG1 SIG2 C=2p IC=0.05
```

Inductor

A two terminal device storing energy in magnetic field in proportion to its inductance and current flowing through its terminals.

Pins

Number	Signal Type	Description
1	Electrical	-
2	Electrical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Inductance Inductance value at room temperature	L	10 u	H	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Initial current Initial current through the inductor	IC	0.0	A	]-INF, +INF[
First-order temperature coefficient First-order temperature coefficient for the inductance	TC1	0.0	H/C	]-INF, +INF[
Second-order temperature coefficient Second-order temperature coefficient for the inductance	TC2	0.0	H/C^2	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the inductor and the circuit	DTEMP	0.0	C	]-INF, +INF[
Multiplier Multiplier to simulate parallel inductors	M	1	-	[1, +INF[
Scaling factor Scaling factor for inductance value	SCALE	1.0	-	[0, +INF[
Resistance Resistance of the inductor	R	0.0	Ohm	[0, +INF[

Model

A model is optional for the Inductor. A physical inductor model can be given using an Inductor model statement. For further details, see the Inductor Model in the Element and Model Libraries. If such a model is given, the inductance value `L` is optional.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
LXXX SIGI SIGJ L=val <IC=val> <TC1=val> <TC2=val> <DTEMP=val> <M=val>
+ <SCALE=val> <R=val>
```

Example

For an inductor with device name L1 connected between signals SIG1 and SIG2 with 10 nH, initial current = 0.01 mA, and a total of four replications in parallel, the netlist to be generated as follows:

```
L1 SIG1 SIG2 L=10n IC=0.01m M=4
```

Mutual Inductor

A device generates coupling between to two given inductors.

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Name of first inductor Name of the first coupling inductor	L1	-	-	-
Name of second inductor Inductance value at room temperature	L2	-	-	-
Coupling coefficient Coefficient that determines the coupling between two inductors	K	1.0	-	[0, 1]

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
KXXX LXXX LYYY K=val
```

Example

For a mutual inductor K1 forming coupling between two inductors L1 and L2 with coupling coefficient = 0.86, netlist to be generated as follows:

```
K1 L1 L2 K=0.86
```

Notes:

Diode

A two terminal device with semiconductor junction, known as junction diode.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal (anode)
2	Electrical	Negative terminal (cathode)

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Area Area factor (for non-geometric diode model) or area in m^2 (for geometric diode model)	AREA	1.0	- or m^2	[0, +INF[
Periphery of junction Junction perimeter factor (for non-geometric diode model) or junction perimeter in m (for geometric diode model)	PJ	0.0	- or m	[0, +INF[
Set initial condition Set initial condition on the diode for dc analysis	ON/OFF	ON	-	[ON, OFF]
Initial voltage Initial voltage across diode	IC	0.0	V	]-INF, +INF[
Width of the diode For geometric diode model only	W	0.0	m	[0, +INF[
Length of the diode For geometric diode model only	L	0.0	m	[0, +INF[

Name and description	Symbol name	Default value	Units	Value range
Multiplier Multiplier to simulate parallel diodes	M	1	-	[1, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the diode and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given. For details see Diode Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
DXXX SIGI SIGJ MNAME <AREA=val> <PJ=val> <ON/OFF> <IC=val> <W=val>
+ <L=val> <WP=val> <LP=val> <WM=val> <LM=val> <M=val> <DTEMP=val>
+ <ExtTnode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a diode with device name Dclamp connected between signals SIG1 and SIG2 with a model name DMOD and initial voltage = 0.23V, the netlist to be generated as follows:

```
Dclamp SIG1 SIG2 DMOD IC=0.23
```

NPN

NPN is a Bipolar Junction Transistor (BJT) having P-doped semiconductor base between two N-doped semiconductors, collector and emitter.

Pins

Number	Signal Type	Description
1	Electrical	Collector
2	Electrical	Base
3	Electrical	Emitter

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Emitter area factor Emitter area multiplying factor	AREA	1.0	- or m^2	[0, +INF[
Base area factor Base area multiplying factor. If not entered, it is equal to emitter area factor	AREAB	1.0	-	[0, +INF[
Collector area factor Collector area multiplying factor. If not entered, it is equal to emitter area factor	AREAC	1.0	-	[0, +INF[
Set initial condition Set initial condition on the transistor for dc analysis	ON/OFF	ON	-	[ON, OFF]
Initial base-emitter voltage Initial base-emitter voltage	VbeIC	0.0	V	]-INF, +INF[
Initial collector-emitter voltage Initial collector-emitter voltage	VceIC	0.0	V	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Multiplier Multiplier to simulate parallel NPN transistors	M	1	-	[1, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the transistor and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a NPN transistor. The model type must be of type `NPN`. For details see BJT Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
QXXX C B E MNAME <AREA=val> <AREAB=val> <AREAC=val> <ON/OFF>
+ <VbeIC=val> <VceIC=val> <M=val> <NoNoise=0/1> <DTEMP=val>
+ <ExtTNode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a NPN transistor with device name Q5 connected to signals C, B, and E with model name NPNMOD, area factors of 1.2, 2.1, and 2.8 (for emitter, base, and collector respectively), and initial voltages V_{BE} = 0.4 V, and V_{CE} = 5 V, the netlist to be generated as follows:

```
Q5 C B E NPNMOD AREA=1.2 AREAB=2.1 AREAC=2.8 VbeIC=0.4 VceIC=5
```

Example 2 (Mextram)

For an NPN transistor with device name Q1 connected to signals C, B, and E with model name mextram

```
Q1 C B E 0 mextram
.model mextram NPN level = 504 no_cap_i = 0 RE=50 RBC=0 RCC=0
RCBLX=0 RCBLI=0
```

PNP

PNP is a Bipolar Junction Transistor (BJT) having N-doped semiconductor base between two P-doped semiconductors, collector and emitter.

Pins

Number	Signal Type	Description
1	Electrical	Collector
2	Electrical	Base
3	Electrical	Emitter

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Emitter area factor Emitter area multiplying factor	AREA	1.0	- or m^2	[0, +INF[
Base area factor Base area multiplying factor. If not entered, it is equal to emitter area factor	AREAB	-	-	[0, +INF[
Collector area factor Collector area multiplying factor. If not entered, it is equal to emitter area factor	AREAC	-	-	[0, +INF[
Set initial condition Set initial condition on the transistor for dc analysis	ON/OFF	ON	-	[ON, OFF]
Initial base-emitter voltage Initial base-emitter voltage	VbeIC	0.0	V	]-INF, +INF[
Initial collector-emitter voltage Initial collector-emitter voltage	VceIC	0.0	V	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Multiplier Multiplier to simulate parallel NPN transistors	M	1	-	[1, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the transistor and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a PNP transistor. The model type must be of type `PNP`. For details see BJT Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
QXXX C B E MNAME <AREA=val> <AREAB=val> <AREAC=val> <ON/OFF>
+ <VbeIC=val> <VceIC=val> <M=val> <NoNoise=0/1> <DTEMP=val>
+ <ExtTNode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a PNP transistor with device name Qp connected to signals SIG_C, SIG_B, and SIG_E, with model name PNPMOD, the netlist to be generated as follows:

```
Q5 SIG_C SIG_B SIG_E PNPMOD
```

N-channel MOSFET

This device is a n-channel Metal Oxide Semiconductor Field Effect Transistor (NMOSFET).

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source
4	Electrical	Body

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Channel width MOSFET channel width	W	1e-4	m	[0, +INF[
Channel length MOSFET channel length	L	1e-4	m	[0, +INF[
Drain diffusion area MOSFET drain diffusion area	AD	0.0	m^2	[ON, OFF]
Source diffusion area MOSFET source diffusion area	AS	0.0	m^2	[ON, OFF]
Perimeter of drain junction MOSFET perimeter of the drain junction	PD	0.0	m	]-INF, +INF[
Perimeter of source junction MOSFET perimeter of the source junction	PS	0.0	m	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Drain diffusion resistance squares Number of squares of drain diffusion for resistance calculation	NRD	0	-	[0, +INF[
Source diffusion resistance squares Number of squares of source diffusion for resistance calculation	NRS	0	-	[0, +INF[
Drain contact resistance Resistance of the contact metal for the drain	RDC	0.0	Ohm	[0, +INF[
Source contact resistance Resistance of the contact metal for the source	RSC	0.0	Ohm	[0, +INF[
Set initial condition Set initial condition on the transistor for dc analysis	ON/OFF	ON	-	[ON, OFF]
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Initial bulk-source voltage Initial V_{BS}	VbsIC	0.0	V	]-INF, +INF[
Multiplier Multiplier to simulate parallel n-channel MOSFETS	M	1	-	[1, +INF[
Zero-bias threshold voltage shift MOSFET Zero-bias threshold voltage shift	DELVTO	0.0	V	[0, +INF[
Source/Drain sharing selector Source/Drain sharing selector when MOSFET model parameter ACM =3	GEO	0.0		]-INF, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the n-channel MOSFET and the circuit	DTEMP	0.0	C	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a n-channel MOSFET. Several MOSFET models are supported. For details see Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
MXXX D G S B MNAME <W=val> <L=val> <AD=val> <AS=val> <PD=val> <PS=val>
+ <NRD=val> <NRS=val> <RDC=val> <RSC=val> <ON/OFF>
+ <VdsIC=val> <VgsIC=val> <VbsIC=val> <M=val> <DELVTO=val> <GEO=val>
+ <NoNoise=0/1> <DTEMP=val> <ExtTnode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a n-channel MOSFET with a device name Mamp connected to signals VDD, VI, VSS, and GND, with model name MNMOS, channel width = 2 µm, and channel length = 0.13 µm, the netlist to be generated as follows:

```
Mamp VDD VI VSS GND MNMOS W=2u L=0.13u
```

Notes:

P-channel MOSFET

This device is a p-channel Metal Oxide Semiconductor Field Effect Transistor (PMOSFET).

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source
4	Electrical	Body

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Channel width MOSFET channel width	W	1e-4	m	[0, +INF[
Channel length MOSFET channel length	L	1e-4	m	[0, +INF[
Drain diffusion area MOSFET drain diffusion area	AD	0.0	m^2	[ON, OFF]
Source diffusion area MOSFET source diffusion area	AS	0.0	m^2	[ON, OFF]
Perimeter of drain junction MOSFET perimeter of the drain junction	PD	0.0	m	]-INF, +INF[
Perimeter of source junction MOSFET perimeter of the source junction	PS	0.0	m	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Drain diffusion resistance squares Number of squares of drain diffusion for resistance calculation	NRD	0	-	[0, +INF[
Source diffusion resistance squares Number of squares of source diffusion for resistance calculation	NRS	0	-	[0, +INF[
Drain contact resistance Resistance of the contact metal for the drain	RDC	0.0	Ohm	[0, +INF[
Source contact resistance Resistance of the contact metal for the source	RSC	0.0	Ohm	[0, +INF[
Set initial condition Set initial condition on the transistor for dc analysis	ON/OFF	ON	-	[ON, OFF]
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Initial bulk-source voltage Initial V_{BS}	VbsIC	0.0	V	]-INF, +INF[
Multiplier Multiplier to simulate parallel n-channel MOSFETS	M	1	-	[1, +INF[
Zero-bias threshold voltage shift MOSFET Zero-bias threshold voltage shift	DELVTO	0.0	V	[0, +INF[
Source/Drain sharing selector Source/Drain sharing selector when MOSFET model parameter ACM =3	GEO	0.0		]-INF, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the n-channel MOSFET and the circuit	DTEMP	0.0	C	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a p-channel MOSFET. Several MOSFET models are supported. For details see Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
MXXX D G S B MNAME <W=val> <L=val> <AD=val> <AS=val> <PD=val> <PS=val>
+ <NRD=val> <NRS=val> <RDC=val> <RSC=val> <ON/OFF>
+ <VdsIC=val> <VgsIC=val> <VbsIC=val> <M=val> <DELVTO=val> <GEO=val>
+ <NoNoise=0/1> <DTEMP=val> <ExtTnode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a p-channel MOSFET with a device name Mp connected to signals SIG1, SIG2, SIG3, and SIG4, model name PmosBsim3, channel width = 40. nm, channel length = 65 nm, drain diffusion area= 1.3e-15 m^2, drain junction perimeter = 180 nm, source junction perimeter = 170 nm, the netlist to be generated as follows:

```
Mp SIG1 SIG2 SIG3 SIG4 PmosBsim3 W=40n L=65n AS=1.3e-15 PD=180n PS=170n
```

Notes:

Vsource

This device is a general voltage source applicable for any type of analysis (AC,DC,or transient). However for transient analysis users are recommended to use dedicated transient sources.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
DC voltage DC voltage of the source	DC	0.0	V	]-INF, +INF[
AC magnitude For AC analysis only	AC	0.0	V	]-INF, +INF[
AC phase For AC analysis only	ACPHASE	ON	Deg	[-180, 180]
Transient function Enter transient function such as SIN, PULSE, PWL, etc. with necessary details	TRAN		-	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ DC=dcval AC=acmag acphase Transientfunction
```

Example

For a voltage source with device name Vsrc1 connected between signals IN and GND, with DC voltage = 1 V, with AC magnitude = 1 V and AC phase = 90°, and with sinusoidal transient function with amplitude = 1 V and frequency = 1 GHz, the netlist to be generated as follows:

```
Vsrc1 IN GND DC=1 AC=1 90 SIN 0 1 1G 0
```

Vsin

Vsin is a sinusoidal voltage source used in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Voltage offset Offset DC voltage to be added for the sinusoidal signal	VO	0.0	V	]-INF, +INF[
Voltage amplitude Amplitude of the sinusoidal signal	VA	0.0	V	]-INF, +INF[
Frequency Sinusoidal signal frequency	FREQ	0.0	Hz	[0, +INF[
Time delay Delay time until the sinusoidal signal starts	TD	0.0	s	]-INF, +INF[
Damping factor Sinusoidal signal damping factor	Q	0.0	1/s	]-INF, +INF[
Phase delay Sinusoidal phase delay	J	0.0	Deg	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ SIN VO VA FREQ TD <Q> <J>
```

Example

For a sinusoidal voltage source with device name Vsin1 connected between signals SIG1 and GND, with voltage offset = 0.2 V, amplitude = 1.5 V, frequency = 200 MHz, time delay = 0.5 µs, damping factor = 1000, the netlist to be generated as follows:

```
Vsin1 SIG1 GND SIN 0.2 1.5 200Meg 0.5u 1000
```

Vpulse

Vpulse is a voltage source that generates trapezoidal pulse waveform in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Initial voltage Initial voltage of the pulse source	V1	0.0	V	]-INF, +INF[
Pulsed voltage The peak or pulsed voltage of the pulse	V2	0.0	V	]-INF, +INF[
Time delay Time delay before pulse signal starts	TD	0.0	s	[0, +INF[
Rise time Time required for the voltage levels to rise from V1 to V2	TR	0.0	s	[0, +INF[
Fall time Time required for the voltage levels to fall from V2 to V1	TF	0.0	s	[0, +INF[
Pulse width Time the pulse stays at voltage V2	PW	0.0	s	[0, +INF[
Period Period of the pulse	PER	0.0	s	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ PULSE V1 V2 TD TR TF PW PER
```

Example

For a pulse voltage source with device name Vpulse2 connected between signals IN2 and GND, with initial voltage = 0.1 V, pulsed voltage = 2 V, time delay = 2 ns, rise/fall time = 0.5 ns, pulse width = 1.2 ns, and period = 3 ns, the netlist to be generated as follows:

```
Vpulse2 IN2 GND PULSE 0.1 2 2n 0.5n 0.5n 1.2n 3n
```

Vpwl

Vpwl is a voltage source that generates piece-wise linear waveform in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Time-voltage pairs Enter piece-wise linear waveform as a series of time-voltage pair (Ti,Vi) separated by space	PWL	0.0 0.0	s,V	[0, +INF[,]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ PWL t1 v1 t2 v2 t3 v3 ..........
```

Example

For a PWL voltage source with device name Vpwl1 connected between signals SIG1 and SIG2, with time voltage pair {0s, 0V}, {0.1ns, 1V}, {0.3ns, 2.5V}, {0.6ns, 2.5V}, {0.7ns, 1.8V}, and {1.0 ns, 0V}, the netlist to be generated as follows:

```
Vpwl1 SIG1 SIG2 PWL 0.0 0.0 0.1n 1 0.3n 2.5 0.6n 2.5 0.7n 1.8 1n 0.0
```

Notes:

Vdc

Vdc is a DC voltage source.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
DC voltage DC voltage value of the source	DC	0.0	V	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ DCVAL
```

Example

For a DC voltage source with device name Vdd connected between signals VIN and GND, with 5 V, the netlist to be generated as follows:

```
Vdd VIN GND 5
```

Vac

Vac is an AC voltage source.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
AC magnitude AC magnitude voltage of the source	AC	0.0	V	]-INF, +INF[
AC phase Phase of the source in degrees	ACPHASE	0.0	Deg	[-180, 180[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
VXXX SIGI SIGJ AC ACMAG ACPHASE
```

Example

For a DC voltage source with device name Vac connected between signals IN and GND, with 1.5V magnitude and 90° phase delay, the netlist to be generated as follows:

```
Vac IN GND AC 1.5 90
```

Isource

This device is a general current source applicable for any type of analysis (AC,DC,or transient). However for transient analysis users are recommended to use dedicated transient sources.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
DC current DC current value of the source	DC	0.0	A	[0, +INF[
AC magnitude For AC analysis only	AC	0.0	A	[0, +INF[
AC phase For AC analysis only	ACPHASE	0.0	Deg	]-INF, +INF[
Transient function Enter transient function such as SIN, PULSE, PWL, etc. with necessary details	TRAN	0.0	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ DC=dcval AC=acmag acphase Transientfunction
```

Example

For a current source with device name Isrc1 that generates a current flow from GND to IN with DC current = 1 mA, with AC magnitude = 1 mA and AC phase = 90°, and with sinusoidal transient function with amplitude = 1.5 mA and frequency = 1 GHz, the netlist to be generated as follows:

```
Isrc1 GND IN DC=1m AC=1m 90 SIN 0 1.5 1G 0
```

Isin

Isin is a sinusoidal current source used in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Current offset Offset DC current to be added for the sinusoidal signal	IO	0.0	A	]-INF, +INF[
Amplitude of current Amplitude of the sinusoidal signal	IA	0.0	A	]-INF, +INF[
Frequency Amplitude of the sinusoidal signal	FREQ	0.0	Hz	[0, +INF[
Time delay Delay time until the sinusoidal signal starts	TD	0.0	s	]-INF, +INF[
Damping factor Sinusoidal signal damping factor	Q	0.0	1/s	]-INF, +INF[
Phase delay Sinusoidal phase delay	J	0.0	Deg	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ SIN IO IA FREQ TD <Q> <J>
```

Example

For a sinusoidal current source with device name Isin1 that generates a current flow from SIG1 to GND, with current offset = 0.2 mA, amplitude = 1.5 ma, frequency = 200 MHz, time delay = 0.5 µs, damping factor = 1000 the netlist to be generated as follows:

```
Isin1 SIG1 GND SIN 0.2m 1.5m 200Meg 0.5u 1000
```

Ipulse

Ipulse is a current source that generates trapezoidal pulse waveform in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Initial current Initial current of the pulse source	I1	0.0	A	]-INF, +INF[
Pulsed current The peak or pulsed current	I2	0.0	A	]-INF, +INF[
Time delay Time delay before pulse signal starts	TD	0.0	s	[0, +INF[
Rise time Time required for the current levels to rise from I1 to I2	TR	0.0	s	[0, +INF[
Fall time Time required for the current levels to fall from I2 to I1	TF	0.0	s	[0, +INF[
Pulse width Time the pulse stays at current I2	PW	0.0	s	[0, +INF[
Period Period of the pulse	PER	0.0	s	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ PULSE I1 I2 TD TR TF PW PER
```

Example

For a pulse current source with device name Ipulse2 that generates a current flow from IN2 to IN3, with initial current = 0.1 mA, pulsed current = 2 mA, time delay = 2 ns, rise/fall time = 0.5 ns, pulse width = 1.2 ns, and period = 3 ns, the netlist to be generated as follows:

```
Ipulse2 IN2 IN3 PULSE 0.1m 2m 2n 0.5n 0.5n 1.2n 3n
```

Ipwl

Ipwl is a current source that generates piece-wise linear waveform in transient analysis.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Time-current pairs Enter piece-wise linear waveform as a series of time-current pair (Ti,Ii) separated by space	PWL	0.0 0.0	s,A	[0, +INF[,]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ PWL t1 i1 t2 i2 t3 i3 ...........
```

Example

For a PWL current source with device name Ipwl1 that generates a current flow from SIG1 to SIG2, with time current pair {0s, 0mA}, {0.1ns, 1mA}, {0.3ns, 2.5mA}, {0.6ns, 2.5mA}, {0.7ns, 1.8mA}, and {1.0 ns, 0mA}, the netlist to be generated as follows:

```
Ipwl1 SIG1 SIG2 PWL 0.0 0.0 0.1n 1m 0.3n 2.5m 0.6n 2.5m 0.7n 1.8m 1n 0.0
```

Notes:

Idc

Idc is a DC current source.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
DC current DC current value of the source	DC	0.0	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ DCVAL
```

Example

For a DC current source with device name IDC that generates a current flow from IN to GND, with a DC current of 10 mA, the netlist to be generated as follows:

```
IDC IN GND 10m
```

Iac

Iac is an AC current source.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
AC magnitude AC magnitude current of the source	AC	0.0	A	]-INF, +INF[
AC phase Phase of the AC current source in degrees	ACPHASE	0.0	Deg	[-180, 180[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
IXXX SIGI SIGJ AC ACMAG ACPHASE
```

Example

For an AC current source with device name Iac that generates a current flow from IN to GND, with 5 mA magnitude and 45° phase delay, the netlist to be generated as follows:

```
Iac IN GND AC 5m 45
```


VCVS

VCVS is a voltage controlled voltage source with linear gain.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal
3	Electrical	Positive terminal of controlling voltage
4	Electrical	Negative terminal of controlling voltage

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Voltage gain Output voltage linear gain factor	GAIN	0.0	-	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum voltage Maximum limit of the output voltage	MAX	1e12	V	]-INF, +INF[
Minimum voltage Minimum limit of the output voltage	MIN	-1e12	V	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
EXXX SIGI SIGJ SIGIN+ SIGIN- GAIN <MAX=val> <MIN=val>
```


Example

For a voltage controlled voltage source with device name E1 connected between signals SIG1 and SIG2, controlled by voltage difference between IN1 and IN2 with a gain of 2.5 and maximum limit of 10 V, the netlist to be generated as follows:

```
E1 SIG1 SIG2 IN1 IN2 2.5 MAX=10
```

VCVS Poly

VCVS Poly is a voltage controlled voltage source, output of which is polynomial function of controlling voltages.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Polynomial dimension Polynomial dimension equal to number of controlling voltages	NDIM	1	-	[0, +INF[
Positive and negative controlling nodes Positive and negative signal names for all controlling voltages	CNODES		-	
Polynomial coefficients List of polynomial coefficients for the polynomial function in the order of zero-th to higher order	PCOEFF		-	

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum voltage Maximum limit of the output voltage	MAX	1e12	V	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Minimum voltage Minimum limit of the output voltage	MIN	-1e12	V	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
EXXX SIGI SIGJ POLY(NDIM) SIGIN1+ SIGIN1- .... p0 p1 p2 ... <MAX=val>
+ <MIN=val>
```

Example

For a voltage controlled voltage source with device name Epoly1 connected between signals SIG1 and SIG2, and controlled by voltage differences between signals {IN1, IN1-} and {IN2,IN2-} with polynomial coefficients p0 = 2, p1 = 0.5, p2 = 0.25, the netlist to be generated as follows:

```
Epoly1 SIG1 SIG2 POLY(2) IN1+ IN1- IN2+ IN2- 2 0.5 0.25
```

CCCS

CCCS is a current controlled current source with linear gain.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Voltage source name Name of the voltage source, current through which is the control input	VSRC	0.0	-	[0, +INF[
Current gain	GAIN	0.0	-	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum current Maximum limit of the output current	MAX	1e12	A	]-INF, +INF[
Minimum current Minimum limit of the output current	MIN	-1e12	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
FXXX SIGI SIGJ VSRC GAIN <MAX=val> <MIN=val>
```


Example

For a current controlled current source with device name F1 connected between signals SIG1 and SIG2, controlled by current through voltage source Vx with a gain of 3, the netlist to be generated as follows:

```
F1 SIG1 SIG2 Vx 3
```

CCCS Poly

CCCS Poly is a current controlled current source, output of which is polynomial function of controlling currents.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Polynomial dimension Polynomial dimension equal to number of controlling currents	NDIM	1	-	[0, +INF[
Voltage source names Names of voltage sources, corresponding current through them are the control inputs	VSRC		-	
Polynomial coefficients List of polynomial coefficients for the polynomial function in the order of zero-th to higher order	PCOEFF		-	

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum current Maximum limit of the output current	MAX	1e12	A	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Minimum current Minimum limit of the output current	MIN	-1e12	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
FXXX SIGI SIGJ POLY(NDIM) Vsrc1 Vsrc2 .... p0 p1 p2 ... <MAX=val>
+ <MIN=val>
```

Example

For a current controlled current source with device name F4 connected between signals SIG1 and SIG2, controlled by currents flowing through Vsrc1, Vsrc2, with polynomial coefficients p0 = 1.2, p1 = 0.4, p2 = 0.5 the netlist to be generated as follows:

```
F4 SIG1 SIG2 POLY(2) Vsrc1 Vsrc2 1.2 0.4 0.5
```

VCCS

VCCS is a voltage controlled current source with linear transconductance.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal
3	Electrical	Positive terminal of controlling voltage
4	Electrical	Negative terminal of controlling voltage

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Transconductance Voltage-to-current conversion factor	Transconductance	0.0	Mho	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum current Maximum limit of the output current	MAX	1e12	A	]-INF, +INF[
Minimum current Minimum limit of the output current	MIN	-1e12	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
GXXX SIGI SIGJ SIGIN+ SIGIN- Transconductance <MAX=val> <MIN=val>
```


```
+ <IC=val>
```

Example

For a voltage controlled current source with device name G1 connected between signals SIG1 and SIG2, controlled by voltage difference between IN1 and IN2 with a transconductance of 1.5 and maximum limit of 10 mA, the netlist to be generated as follows:

```
G1 SIG1 SIG2 IN1 IN2 1.5 MAX=10m
```

VCCS Poly

VCCS Poly is a voltage controlled current source, output of which is polynomial function of controlling voltages.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Polynomial dimension Polynomial dimension equal to number of controlling voltages	NDIM	1	-	[0, +INF[
Positive and negative controlling nodes Positive and negative signal names for all controlling voltages	CNODES		-	
Polynomial coefficients List of polynomial coefficients for the polynomial function in the order of zero-th to higher order	PCOEFF		-	

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum current Maximum limit of the output current	MAX	1e12	A	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Minimum current Minimum limit of the output current	MIN	-1e12	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
GXXX SIGI SIGJ POLY(NDIM) SIGIN1+ SIGIN1- .... p0 p1 p2 ... <MAX=val>
+ <MIN=val>
```

Example

For a voltage controlled current source with device name G2 connected between signals SIG1 and SIG2, controlled by voltage differences between signals {IN1, IN1-} and {IN2,IN2-}, with polynomial coefficients p0 = 1, p1 = 1.5, p2 = 0.6, p3 = -0.2, p4 = 0.1, and p5 = -0.1, the netlist to be generated as follows:

```
G2 SIG1 SIG2 POLY(2) IN1+ IN1- IN2+ IN2- 1 1.5 0.6 -0.2 0.1 -0.1
```

CCVS

CCCS is a current controlled voltage source with linear transresistance.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Voltage source name Name of the voltage source, current through which is the control input	VSRC		-	[0, +INF[
Transresistance	Transresistance	0.0	Ohm	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum voltage Maximum limit of the output voltage	MAX	1e12	V	]-INF, +INF[
Minimum voltage Minimum limit of the output voltage	MIN	-1e12	V	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
HXXX SIGI SIGJ VSRC GAIN <MAX=val> <MIN=val>
```


Example

For a current controlled voltage source with device name H1 connected between signals SIG1 and SIG2, controlled by current through voltage source Vx with a gain of 10, the netlist to be generated as follows:

```
H1 SIG1 SIG2 Vx 10
```

CCVS Poly

CCCS Poly is a current controlled voltage source, output of which is polynomial function of controlling currents.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Polynomial dimension Polynomial dimension equal to number of controlling currents	NDIM	1	-	[0, +INF[
Voltage source names Names of voltage sources, corresponding current through them are the control inputs	VSRC		-	
Polynomial coefficients List of polynomial coefficients for the polynomial function in the order of zero-th to higher order	PCOEFF		-	

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum voltage Maximum limit of the output voltage	MAX	1e12	A	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Minimum voltage Minimum limit of the output voltage	MIN	-1e12	A	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
HXXX SIGI SIGJ POLY(NDIM) Vsrc1 Vsrc2 .... p0 p1 p2 ... <MAX=val>
+ <MIN=val>
```

Example

For a current controlled voltage source with device name Hpoly1 connected between signals SIG1 and SIG2, controlled by currents flowing through Vsrc1 with polynomial coefficients p0 = 10, p1 = 5, p2 = 3, the netlist to be generated as follows:

```
H4 SIG1 SIG2 POLY(1) Vsrc1 10 5 3
```

VCR

VCR is a voltage controlled resistor source with linear voltage-to-resistance ratio.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal
3	Electrical	Positive terminal of controlling voltage
4	Electrical	Negative terminal of controlling voltage

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Voltage-to-resistance ratio	TRANSFACTOR	0.0	Ohm/V	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum resistance Maximum limit of the output resistance	MAX	1e12	Ohm	]-INF, +INF[
Minimum resistance Minimum limit of the output resistance	MIN	-1e12	Ohm	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
GXXX SIGI SIGJ VCR SIGIN+ SIGIN- TFRATIO <MAX=val> <MIN=val>
```


Example

For a voltage controlled resister with device name Gres1 connected between signals SIG1 and SIG2, controlled by voltage difference between IN1 and IN2 with a voltage-to resistance ratio of 50, the netlist to be generated as follows:

```
Gres1 SIG1 SIG2 IN1 IN2 50
```

VCR Poly

VCR Poly is a voltage controlled resistor, output of which is polynomial function of controlling voltages.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Polynomial dimension Polynomial dimension equal to number of controlling voltages	NDIM	1	-	[0, +INF[
Positive and negative controlling nodes Positive and negative signal names for all controlling voltages	CNODES		-	
Polynomial coefficients List of polynomial coefficients for the polynomial function in the order of zero-th to higher order	PCOEFF		-	

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum resistance Maximum limit of the output resistance	MAX	1e12	Ohm	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Minimum resistance Minimum limit of the output resistance	MIN	-1e12	Ohm	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
GXXX SIGI SIGJ VCR POLY(NDIM) SIGIN1+ SIGIN1- .... p0 p1 p2 ...
+ <MAX=val> <MIN=val>
```

Example

For a voltage controlled resistor with device name Gr5 connected between signals SIG1 and SIG2, controlled by voltage differences between signals IN1 and IN2 with polynomial coefficients p0 = 100, p1 = 10, and p2 = 5, the netlist to be generated as follows:

```
Gr5 SIG1 SIG2 VCR POLY(1) IN1 IN2 100 10 5
```

Transmission Line - Ideal

Ideal transmission line is a single conductor transmission line without loss and it is characterized by propagation delay and characteristic impedance.

Pins

Number	Signal Type	Description
1	Electrical	Input
2	Electrical	Input reference
3	Electrical	Output
4	Electrical	Output reference

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Characteristic impedance Characteristic impedance of the line	Z0	50.0	Ohm	[0, +INF[
Time delay Propagation delay of the line	TD	0.0	s	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
TXXX IN INREF OUT OUTREF Z0 TD
```

Example

For an ideal transmission line with device name T1, connected to signals In1, GND, Out1, and GND with characteristic impedance = 50 Ohms and line delay = 2 ns, the netlist to be generated as follows:

```
T1 In1 GND Out1 GND 50 2n
```

Notes:

Transmission Line 1 - Lumped

This device represents a single transmission line with lumped resistance, capacitance, inductance and conductance values

Pins

Number	Signal Type	Description
1	Electrical	Input
2	Electrical	Output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Length of the transmission line	L	0.1	m	[0, +INF[
Number of lumped sections Number of lumped sections to represent the transmission line	LUMPS	20	-	[0, +INF[

Model

Model name and model statement are required for lumped transmission line. Model statement must provide the per-unit-length (PUL) resistance, inductance, capacitance, and conductance values. For details see Lumped Transmission Line (U) Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
UXXX IN 0 OUT 0 Modelname <L=val> <LUMPS=val>
```

Example

For a single conductor lumped transmission line represented by lumped transmission line model TR1MOD with device name U1 connected to signals IN and OUT with a length of 5 cm and 100 lumped segments, the netlist to be generated as follows:

```
U1 IN 0 OUT 0 TR1MOD L=0.05 LUMPS=100
```

Transmission Lines 2 - Lumped

This device represents two conductor transmission lines with lumped resistance, capacitance, inductance and conductance values

Pins

Number	Signal Type	Description
1	Electrical	Input line 1
2	Electrical	Input line 2
3	Electrical	Output line 1
4	Electrical	Output line 2

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Length of the transmission line	L	0.1	m	[0, +INF[
Number of lumped sections Number of lumped sections to represent the transmission line	LUMPS	20	-	[0, +INF[

Model

Model name and model statement are required for lumped transmission line. Model statement must provide the per-unit-length (PUL) resistance, inductance, capacitance, and conductance values. For details see Lumped Transmission Line (U) Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
UXXX IN1 IN2 0 OUT1 OUT2 0 Modelname <L=val> <LUMPS=val>
```

Example

For two conductor lumped transmission lines represented by lumped transmission line model TR2MOD with device name U2 connected to signals I1, I2, O1, and O2 with a length of 12 cm and 60 lumped segments, the netlist to be generated as follows:

```
U2 I1 I2 0 O1 O2 0 TR2MOD L=0.12 LUMPS=60
```

Transmission Lines 3 - Lumped

This device represents three conductor transmission lines with lumped resistance, capacitance, inductance and conductance values

Pins

Number	Signal Type	Description
1	Electrical	Input line 1
2	Electrical	Input line 2
3	Electrical	Input line 3
4	Electrical	Output line 1
5	Electrical	Output line 2
6	Electrical	Output line 3

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Length of the transmission line	L	0.1	m	[0, +INF[
Number of lumped sections Number of lumped sections to represent the transmission line	LUMPS	20	-	[0, +INF[

Model

Model name and model statement are required for lumped transmission line. Model statement must provide the per-unit-length (PUL) resistance, inductance, capacitance, and conductance values. For details see Lumped Transmission Line (U) Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
UXXX IN1 IN2 IN3 0 OUT1 OUT2 OUT3 0 Modelname <L=val> <LUMPS=val>
```

Example

For three conductor lumped transmission lines represented by lumped transmission line model TR3MOD with device name U3 connected to signals I1, I2, I3, O1, O2, and O3 with a length of 12 cm and 60 lumped segments, the netlist to be generated as follows:

```
U3 I1 I2 I3 0 O1 O2 O3 0 TR3MOD L=0.12 LUMPS=60
```

Transmission Lines 4 - Lumped

This device represents four conductor transmission lines with lumped resistance, capacitance, inductance and conductance values

Pins

Number	Signal Type	Description
1	Electrical	Input line 1
2	Electrical	Input line 2
3	Electrical	Input line 3
4	Electrical	Input line 4
5	Electrical	Output line 1
6	Electrical	Output line 2
7	Electrical	Output line 3
8	Electrical	Output line 4

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Length of the transmission line	L	0.1	m	[0, +INF[
Number of lumped sections Number of lumped sections to represent the transmission line	LUMPS	20	-	[0, +INF[

Model

Model name and model statement are required for lumped transmission line. Model statement must provide the per-unit-length (PUL) resistance, inductance,

capacitance, and conductance values. For details see Lumped Transmission Line (U) Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
UXXX IN1 IN2 IN3 IN4 0 OUT1 OUT2 OUT3 OUT4 0 Modelname <L=val>
+ <LUMPS=val>
```

Example

For four conductor lumped transmission lines represented by lumped transmission line model TR4MOD with device name U4 connected to signals I1, I2, I3, I4, O1, O2, O3, and O4 with a length of 7.5 cm and 200 lumped segments, the netlist to be generated as follows:

```
U4 I1 I2 I3 I4 0 O1 O2 O3 O4 0 TR4MOD L=0.075 LUMPS=200
```

Transmission Lines 5 - Lumped

This device represents five conductor transmission lines with lumped resistance, capacitance, inductance and conductance values

Pins

Number	Signal Type	Description
1	Electrical	Input line 1
2	Electrical	Input line 2
3	Electrical	Input line 3
4	Electrical	Input line 4
5	Electrical	Input line 5
6	Electrical	Output line 1
7	Electrical	Output line 2
8	Electrical	Output line 3
9	Electrical	Output line 4
10	Electrical	Output line 5

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Length of the transmission line	L	0.1	m	[0, +INF[
Number of lumped sections Number of lumped sections to represent the transmission line	LUMPS	20	-	[0, +INF[

Model

Model name and model statement are required for lumped transmission line. Model statement must provide the per-unit-length (PUL) resistance, inductance, capacitance, and conductance values. For details see Lumped Transmission Line (U) Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
UXXX IN1 IN2 IN3 IN4 IN5 0 OUT1 OUT2 OUT3 OUT4 OUT5 0
+ Modelname <L=val> <LUMPS=val>
```

Example

For five conductor lumped transmission lines represented by lumped transmission line model TR5MOD with device name U5 connected to signals I1, I2, I3, I4, I5, O1, O2, O3, O4, and O5 with a length of 15 cm and 70 lumped segments, the netlist to be generated as follows:

```
U5 I1 I2 I3 I4 I5 0 O1 O2 O3 O4 O5 0 TR5MOD L=0.15 LUMPS=70
```

S-Parameter

This device represents two port scattering parameter.

Pins

Number	Signal Type	Description
1	Electrical	Port 1
2	Electrical	Port 2
3	Electrical	Reference

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Pole-residue file File containing the poles and residues that describes the filter	rfmfile	-	-	-

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp SPARAM Name=XXX Nodes=[ SIGI SIGJ ] Vref=SIGK rfmfile="filpath"
```

Example

For a two port S-parameter with device name S1 connected to signals in, out, and GND, and represented by pole-residue file having a file path C:\Filter\Bessel.prf, the netlist to be generated as follows:

```
Osp SPARAM Name=S1 Nodes=[ in out ] Vref=GND
+ rfmfile="C:\Filter\Bessel.prf"
```


Notes:

Delay Element

This device produce output voltage with a pure delay for a given input voltage.

Pins

Number	Signal Type	Description
1	Electrical	input
2	Electrical	output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Delay Output voltage delay in seconds	DEL	1e-9s	s	[0, +INF[
Voltage gain Voltage gain of the delay element	A	1.0		]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp DELAY Name=XXX Nodes=[ SIGI SIGJ ] Del=val <A=val>
```

Example

For a delay element, VD1, connected to signals SIG1 and SIG2 with 5 ns delay, the netlist statement is as follows:

```
Osp DELAY Name=VD1 Nodes=[ SIG1 SIG2 ] Del=10n A=1.0
```

Notes:

Bit Generator

Bit generator is a voltage source that generates voltage waveform for internally generated pseudorandom bits or a user given bit sequence.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Line code Binary code used to represent the voltage waveform	LineCode	NRZ	-	NRZ, RZ
Rectangle shape Determines the shape for the edges of the pulse: EXP - exponential; LIN - linear	PuseShape	EXP	-	EXP, LIN
Bit amplitude Peak-to-peak amplitude of the pulse	BitMag	1	V	]-INF, +INF[
Bias DC offset of the pulse	DCOffSet	0	V	]-INF, +INF[
Bit length Length of time that constitutes a bit	Length	1e-10	s	[0, +INF[
Rise time Defined as the time from when the rising edge reaches 10% of the amplitude to the time it reaches 90% of the amplitude	RiseTime	1e-11	s	[0, +INF[

Name and description	Symbol name	Default value	Units	Value range
Fall time Defined as the time from when the falling edge reaches 90% of the amplitude to the time it reaches 10% of the amplitude	FallTime	1e-11	s	[0, +INF[
Duty cycle for RZ pulse Ratio (in percentage) of the pulse duration with respect to bit length. The pulse duration defined to be the time interval between 50% of the peak amplitude points.	DutyCycle	50	%	[0, 100]

Optional

Name and description	Symbol name	Default value	Units	Value range
Bit stream User defined bit sequence. If not given, random bits will be generated	BitStream	-	-	-
Number of bits in one period Number of bits to be repeated as a cycle when bit stream is given. If Period is -1 (default) then only one cycle of bits in the Bitstream are generated. If number of bits in period are greater than the number of bits in Bitstream, then rest of the bits are filled with 0s, otherwise, number of bits in Bitstream are capped by number of bits in Period.	Period	-1	-	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp BitGen Name=XXX Nodes=[ SIGI SIGJ ] LineCode=NRZ/RZ
+ PulseShape=EXP/LIN BitMag=val DCOffSet=val Length=val RiseTime=val
+ FallTime=val <BitStream=bitsequence> <Period=val>
```

Example

For a bit generator with name B1 connected between signals In1 and ground generating NRZ coded random bits with exponential pulse shape, magnitude of 1 V, bit length of 0.1 ns, and rise and fall time of 0.01 ns, the statement can be generated as follows:

```
Osp BITGEN Name=B1 Nodes=[In 0] LineCode=NRZ PulseShape=EXP
+ BigMag=1 DCOffSet=0 Length=0.1n RiseTime=0.01n FallTime=0.01n
```

For a bit generator with the name B2 connected between signals In2 and ground generating RZ coded random bits with linear pulse shape, magnitude of 5 V, bit length of 0.25 ns, rise time of 0.05 ns, fall time of 0.07 ns, and 40% duty cycle, the statement can be generated as follows:

```
Osp BITGEN Name=B2 Nodes=[In2 0] LineCode=RZ PulseShape=LIN
+ BigMag=5 DCOffSet=0 Length=0.25n RiseTime=0.05ns
+ FallTime=0.07ns DutyCycle=40
```

For a bit generator with the name B3 connected between signals In3 and ground generating NRZ coded user given bit sequence of 010110 with exponential pulse shape, a bit magnitude of 2.5 V, bit length 10ns, rise and fall time of 2 ns, and with the sequence length of six bits to be repeated as a cycle, the statement can be generated as follows:

```
Osp BITGEN Name=B3 Nodes=[In3 0] LineCode=NRZ PulseShape=EXP
+ BigMag=2.5 DCOffSet=0 Length=10n RiseTime=2n FallTime=2n
+ BitStream=010110 Period=6
```


Noise Source

Noise source generates transient noise in the form of voltage or current.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Noise source type Type of noise source (voltage or current)	Type	I		I, V
Noise source mode Frequency dependence mode of the noise source	Mode	Res		Res, White, Pink
Noise distribution Probability distribution functions to generate noise based on a Monte-Carlo method	Dist	Gaussian		Gaussian, Poisson, WMC
Resistance Resistance of the noise source if noise mode is Res	R	0	ohm	[0, +INF[
Temperature Noise source temperature	Temp	0	K	]-INF, +INF[
Noise spectral density Magnitude of noise spectral density if the noise mode is White	Magnitude	0	(A or V)^2/Hz	[0, +INF[

Name and description	Symbol name	Default value	Units	Value range
Pink noise calculation method Method used to compute noise for frequency dependent Pink noise	Method	Default	-	Default, Sequence,
Flicker noise exponent Flicker noise exponent used to compute a frequency dependent Pink noise	AF	1.0	-	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp NOISESOURCE Name=XXX Nodes=[ SIGI SIGJ ] Type=V/I
+ Mode=Res/Pink/White Dist=Gaussian/Poisson/WMC <R=val> <Temp=val>
+ <Magnitude=val> <Method=Default/Sequence> <AF=val>
```

Example

For a white noise source (current source) with the name WhiteNoiseSrc connected between NIN and ground with the noise density 1.5e-11 A^2/Hz, the statement can be generated as follows:

```
Osp NOISESOURCE Name = WhiteNoiseSrc Type = I Nodes = [NIN 0]
+ Mode=White Magnitude = 1.5e-11
```

Nonlinear Resistor

The non-linear resistor is used to express resistance as a non-linear function of nodal voltages, branch currents, and time.

Pins

Number	Signal Type	Description
1	Electrical	
2	Electrical	

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Element type Element's current-voltage relationship expression type: RES - resistance, COND - conductance, CURR - current	Type	RES	-	RES, COND, CURR
Function mode Non-linear function mode: POLY - polynomial function of voltage; EQ - resistance function as a mathematical expression	Mode	POLY	-	POLY, EQ
Polynomial coefficients List of coefficients representing polynomial function from zeroth order to higher order	coeff	[0.0]	-	]-INF, +INF[
Equation Equation expression	Eq	-	-	-

Optional

Name and description	Symbol name	Default value	Units	Value range
Maximum voltage Maximum voltage across the terminals for resistance calculation	Vmax	1e50	V	]-INF, +INF[
Minimum voltage Minimum voltage across the terminals for resistance calculation	Vmin	1e-50	V	]-INF, +INF[
Temperature polynomial coefficients Temperature polynomial coefficients for the dependency of current on temperature	Tcoeff	[0.0]	-	]-INF, +INF[
Offset temperature Offset value from the device temperature	Toff	0	K	[0, 1]
Temperature difference Temperature difference between the n-channel MOSFET and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp NResistor Name=XXX Nodes=[ SIGI SIGJ ] <Type=RES/COND/CURR>
+ <Mode=POLY/EQ> <coeff=[val1 val2 ...]> <Eq='expr'> <Vmax=val>
+ <Vmin=val> <Tcoeff=[ val1 val2 ... ]> <Toff=val> <DTEM=val>
+ <ExtTNode=val> <Rth=val> <Cth=val>
```

Examples

For a polynomial non-linear resistor with the name NR1 connected between nodes 1 and ground with a polynomial coefficients p0 = 1000, p1 = -500, p2 = 3000, and p3 = 500, the statement can be written as follows:

```
Osp NResistor Name=NR1 Nodes=[1 0] coeff=[ 1000 -500 3000 500 ]
```

For a non-linear resistor with name R1 connected between signals 1 and 2, and its value expressed mathematically as $R = 50 + 10 \cdot (v_{in1} - v_{in2}) \cdot e^{-kt}$ where $k = 1.5 \times 10^9$, the statement can be expressed as:

```
Osp NResistor Name=R1 Nodes=[1 2] Mode = EQ
+ Eq = '50 + 10 * V(in1,in2) * exp(1.5e9*TIME)'
```

Nonlinear Capacitor

The nonlinear capacitor is used to express capacitance as a polynomial function of voltage across its terminals.

Pins

Number	Signal Type	Description
1	Electrical	
2	Electrical	

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Capacitor type To define capacitor as a charge function (QDEF) or capacitance function (CDEF)	Type	QDEF		QDEF, CDEF
Zeroth order polynomial coefficient Zeroth order polynomial coefficient value for the capacitance function represented as a polynomial function of voltage	D	0	-	]-INF, +INF[
First order polynomial coefficient First order polynomial coefficient value for the capacitance function represented as a polynomial function of voltage	C	0	-	]-INF, +INF[
Second order polynomial coefficient Second order polynomial coefficient value for the capacitance function represented as a polynomial function of voltage	B	0	-	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Third order polynomial coefficient Third order polynomial coefficient value for the capacitance function represented as a polynomial function of voltage	A	0	-	]-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp NCapacitor Name=XXX Nodes=[ SIGI SIGJ ] Mode=CONST/POLY <D=val>
+ <C=val> <B=val> <A=val>
```

Examples

For a non-linear capacitor to be expressed as a nonlinear charge with the name NC1, connected between signals 1 and ground with polynomial coefficients D = 1e-7, C=2e-7, B = 1.5e-8, and A = 1e-9 the netlist statement can be generated as:

```
Osp NCapacitor Name=NC1 Nodes[1 0] Type=QDEF D=1e-7 C=2e-7 B=1.5e-8
+ A=1e-9
```

For a non-linear capacitor to be expressed as a nonlinear capacitance with the name NC2, connected between signals 2 and ground with polynomial coefficients (for charge) D = 1e-12, C=2.5e-10, and B = 3e-11, the netlist statement can be generated as:

```
Osp NCapacitor Name=NC2 Nodes[2 0] Type=CDEF D=1e-12 C=2.5e-10 B=3e-11
```

Switch - Voltage Controlled

This device is a voltage controlled resistor having two different resistance values RON and ROFF controlled by an external voltage. Typically ROFF is very high and RON is very low.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal
3	Electrical	Positive terminal of the control voltage
4	Electrical	Negative terminal of the control voltage

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
ON control voltage Control voltage to be applied in order to change the resistance value to RON	VON	1.0	V	]-INF, +INF[
OFF control voltage Control voltage to be applied in order to change the resistance value to ROFF	VOFF	0.0	V	]-INF, +INF[
ON resistance Resistance value when the switch is ON	RON	1.0	Ohm	[0+, +INF[
OFF resistance Resistance value when the switch is OFF	ROFF	1e6	Ohm	[0+, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp Switch Nodes=[SIGI SIGJ] CNodes=[SIGIN+ SIGIN-] <VON=val>
+ <VOFF=val> <RON=val> <ROFF=val>
```

Example

For a voltage controlled switch connected to SIG1 and SIG2, controlled by voltage difference between SIG4 and SIG5, and having VON=2V, VOFF=1.5V, RON=0.1 Ohm, ROFF=5 Mega Ohm, the netlist to be generated as follows:

```
Osp Switch Nodes=[SIG4 SIG5] CNodes=[SIG4 SIG5] VON=2 VOFF=1.5 RON=0.1
+ ROFF=5MEG
```

Switch - Current Controlled

This device is a current controlled resistor having two different resistance values RON and ROFF controlled by an external current through a voltage source.

Pins

Number	Signal Type	Description
1	Electrical	Positive terminal
2	Electrical	Negative terminal

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Controlling voltage source name Name of the voltage source through which the control current flows	VSRC	1.0	-	-
ON control current Control current to be applied in order to change the resistance value to RON	ION	1e-3	A	]-INF, +INF[
OFF control current Control voltage to be applied in order to change the resistance value to ROFF	IOFF	0.0	A	]-INF, +INF[
ON resistance Resistance value when the switch is ON	RON	1.0	Ohm	[0+, +INF[
OFF resistance Resistance value when the switch is OFF	ROFF	1e6	Ohm	[0+, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp Switch SWTYPE=CCSW Nodes=[SIGI SIGJ] VSRC=VsrcName <ION=val>
+ <IOFF=val> <RON=val> <ROFF=val>
```

Example

For a current controlled switch connected to SIG1 and SIG2, controlled by a current through a voltage source name V1, and having ION=10mA, IOFF=2mA, RON=0.5 Ohm, ROFF=2 Mega Ohm, the netlist to be generated as follows:

```
Osp Switch SWTYPE=CCSW Nodes=[SIG1 SIG2] VSRC=V1 ION=10m IOFF=2m
+ RON=0.5 ROFF=2MEG
```

N-channel JFET

This device is a n-channel junction gate field effect transistor.

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Gate width JFET channel width	W	1e-4	m	[0, +INF[
Gate length JFET channel length	L	1e-4	m	[0, +INF[
Area factor Area multiplying factor	AREA	1	-	[0, +INF[
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Set initial condition Set initial condition to set the initial DC values	ON/OFF	ON	-	[ON, OFF]
Multiplier Multiplier to simulate parallel n-channel JFETS	M	1	-	[1, +INF[

Name and description	Symbol name	Default value	Units	Value range
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the element and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a n-channel JFET. For details see JFET Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
JXXX D G S MNAME <W=val> <L=val> <AREA=val> <VdsIC=val> <VgsIC=val>
+ <ON/OFF> <M=val> <NoNoise=0/1> <DTEMP=val> <ExtTnode=NODENAME>
+ <Rth=val> <Cth=val>
```

Example

For a n-channel JFET with a device name J1 connected to signals VDD, VI, and VSS, with model name JMOD, gate width = 2 µm, and gate length = 0.13 µm, the netlist to be generated as follows:

```
J1 VDD VI VSS JMOD W=2u L=0.13u
```

P-channel JFET

This device is a p-channel junction gate field effect transistor.

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Gate width JFET channel width	W	1e-4	m	[0, +INF[
Gate length JFET channel length	L	1e-4	m	[0, +INF[
Area factor Area multiplying factor	AREA	1	-	[0, +INF[
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Set initial condition Set initial condition to set the initial DC values	ON/OFF	ON	-	[ON, OFF]
Multiplier Multiplier to simulate parallel p-channel JFETS	M	1	-	[1, +INF[

Name and description	Symbol name	Default value	Units	Value range
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]
Temperature difference Temperature difference between the element and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a p-channel JFET. For details see JFET Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
JXXX D G S MNAME <W=val> <L=val> <AREA=val> <VdsIC=val> <VgsIC=val>
+ <ON/OFF> <M=val> <NoNoise=0/1> <DTEMP=val> <ExtTnode=NODENAME>
+ <Rth=val> <Cth=val>
```

Example

For a p-channel JFET with a device name J1 connected to signals VDD, VI, and VSS, with model name PJFMOD, gate width = 3 µm, and gate length = 0.5 µm, the netlist to be generated as follows:

```
J1 VDD VI VSS PJFMOD W=3u L=0.5u
```

N-channel MESFET

This device is a n-channel metal semiconductor field effect transistor.

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Area factor Area multiplying factor	AREA	1	-	[0, +INF[
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Set initial condition Set initial condition to set the initial DC values	ON/OFF	ON	-	[ON, OFF]
Multiplier Multiplier to simulate parallel devices	M	1	-	[1, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the element and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a n-channel MESFET. For details see MESFET Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
ZXXX D G S MNAME <AREA=val> <VdsIC=val> <VgsIC=val> <ON/OFF> <M=val>
+ <NoNoize=0/1> <DTEMP=val> <ExtTnode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a n-channel MESFET with a device name Zn connected to signals VDD, VI, and VSS, with model name NMFMOD, the netlist statement can be generated as follows:

```
Zn VDD VI VSS NMFMOD
```

P-channel MESFET

This device is a p-channel metal semiconductor field effect transistor.

Pins

Number	Signal Type	Description
1	Electrical	Drain
2	Electrical	Gate
3	Electrical	Source

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Area factor Area multiplying factor	AREA	1	-	[0, +INF[
Initial drain-source voltage Initial V_{DS}	VdsIC	0.0	V	]-INF, +INF[
Initial gate-source voltage Initial V_{GS}	VgsIC	0.0	V	]-INF, +INF[
Set initial condition Set initial condition to set the initial DC values	ON/OFF	ON	-	[ON, OFF]
Multiplier Multiplier to simulate parallel devices	M	1	-	[1, +INF[
Exclude noise Option to exclude noise for this device if noise simulation is performed	NoNoise	0	-	[0, 1]

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the element and the circuit	DTEMP	0.0	C	]-INF, +INF[
Temperature node The name of the external temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	W sec/K	[0, +INF[

Model

Model name and model statement must be given for a p-channel MESFET. For details see MESFET Model in the Element and Model Library.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
ZXXX D G S MNAME <AREA=val> <VdsIC=val> <VgsIC=val> <ON/OFF> <M=val>
+ <NoNoise=0/1> <DTEMP=val> <ExtTnode=NODENAME> <Rth=val> <Cth=val>
```

Example

For a p-channel MESFET with a device name Zp connected to signals VDD, VI, and VSS, with model name PMFMOD:

```
Zp VDD VI VSS PMFMOD
```

Optical Devices Library

This section contains information on the following components

Notes:

X Coupler

An optical cross-coupler is a device that physically couples two input signals and produces two output signals.

Pins

Number	Signal Type	Description
1	Optical	Input 1
2	Optical	Input 2
3	Optical	Output 1
4	Optical	Output 2

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Coupling coefficient Coupling ratio from input 1 to output 2	C	0.5	-	[0, 1]
Conjugate Defines whether the device uses the complex conjugate definition or not	Conjugate	1	-	[0, 1]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see XCOUPLER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp XCOUPLER Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK SIGL]
+ MoName=MODEL_NAME <C=val> <Conjugate=0/1> <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a cross coupler with device name XC1, model XCModel, connected to signals SIG1, SIG2, SIG3 and SIG4, with 0.5 coupling coefficient and conjugate mode enable, the netlist statement to be generated as follows:

```
Osp XCOUPLER Name=XC1 Nodes=[SIG1 SIG2 SIG3 SIG4]
+ MoName=XCModel C=0.5 Conjugate=1
```

SM Fiber

The SM Fiber device simulates the propagation of an optical field in a single-mode fiber with the dispersive and nonlinear effects taken into account by a direct numerical integration of the modified nonlinear Schrödinger (NLS) equation.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Fiber length	Length	0.1	km	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see SMFIBER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp SMFIBER Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ Length=val <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a fiber with device name SM1, model SMFModel, connected to signals SIG1 and SIG2, with 1 km, the netlist statement to be generated as follows:

```
Osp SMFIBER Name=SM1 Nodes=[SIG1 SIG2] MoName=SMFModel Length=1
```

MM Fiber

This device is a multimode fiber. It is a spatially dependent device that models the transverse field profiles and propagation constants for each mode supported by the fiber.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Length Fiber length	Length	0.1	km	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see MMFIBER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp MMFIBER Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ Length=val <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a fiber with device name MMF1, model MMFModel, connected to signals SIG1 and SIG2, with 1 km, the netlist statement to be generated as follows:

```
Osp MMFFIBER Name=MMF1 Nodes=[SIG1 SIG2] MoName=MMFModel Length=1
```

FSO Channel

This device is a free space optical channel.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Distance Propagation distance	D	0	m	[0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see FREESPACE Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp FREESPACE Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <D=val> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a free space propagation with device name FSO1, model FSOModel, connected to signals SIG1 and SIG2, with a distance of 10 um, the netlist statement to be generated as follows:

```
Osp FREESPACE Name=FSO1 Nodes=[SIG1 SIG2] MoName=FSOModel D=10
```

Optical Gain

This device amplifies the optical signal power.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Gain Power gain (port 1 to port 2)	GaindB	20	dB	]-INF, +INF[
Noise figure Determines the amplifier noise figure (port 1 to port 2)	NoiseFigure	4	dB	]-INF, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTGAIN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTGAIN Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <GaindB=val> <NoiseFigure=val> <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a gain device with name OA1, model OGModel, connected to signals SIG1 and SIG2, with 3 dB of forward gain and 5 dB of noise figure, the netlist statement to be generated as follows:

```
Osp OPTGAIN Name=OA1 Nodes=[SIG1 SIG2] MoName=OGModel GaindB=3
+ NoiseFigure=5
```

Optical Loss

This device attenuates the optical signal power.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Attenuation Power attenuation (port 1 to port 2)	AttendB	0	dB	]-INF, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTGAIN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTGAIN Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <AttendB=val> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an attenuator with name OA1, model OAModel, connected to signals SIG1 and SIG2, with 3 dB attenuation, the netlist statement to be generated as follows:

```
Osp OPTGAIN Name=OA1 Nodes=[SIG1 SIG2] MoName=OAModel AttendB=3
```

Ideal Optical Isolator

This device is an ideal isolator, without attenuation or return losses.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Direction Defines whether the device direction is forward (Port 1 to Port 2) or reverse (Port 2 to Port 1)	IsoMode	FWD	-	[REV, FWD]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OCONN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTISO Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <IsoMode=FWD/REV> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an ideal isolator with name OI1, model OIModel, connected to signals SIG1 and SIG2, working with forward direction, the netlist statement to be generated as follows:

```
Osp OPTISO Name=OI1 Nodes=[SIG1 SIG2] MoName=OIModel IsoMode=FWD
```

Ideal Optical Circulator

This device is an ideal circulator, without attenuation or return losses, and infinite isolation.

Pins

Number	Signal Type	Description
1	Optical	Port 1
2	Optical	Port 2
3	Optical	Port 3

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Direction Defines whether the device direction is clockwise (FWD) or counterclockwise (REV)	IsoMode	FWD	-	[REV, FWD]

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTCIRC Name=DEVICE_NAME Nodes=[SIGI SIGJ] <IsoMode=FWD/REV>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an ideal circulator with name OC1, connected to signals SIG1, SIG2 and SIG3, working with clockwise direction, the netlist statement to be generated as follows:

```
Osp OPTCIRC Name=OC1 Nodes=[SIG1 SIG2 SIG3]
```


Notes:

Optical Connector

This device connects two optical ports.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Insertion loss Power loss (port 1 to port 2)	AttendB	0	dB	]-INF, +INF[
Reverse insertion loss Power loss (port 2 to port 1)	RevAttendB	0	dB	]-INF, +INF[
Return loss Power return loss (port 1 to port 1)	RefdB	100	dB	]-INF, +INF[
Reverse return loss Power return loss (port 2 to port 2)	RevRefdB	100	dB	]-INF, +INF[
Phase shift Phase shift (port 1 to port 2)	PhaseShift	0	rad	]-INF, +INF[
Reverse phase shift Phase shift (port 2 to port 1)	RevPhaseShift	0	rad	]-INF, +INF[
Return phase shift Phase shift (port 1 to port 1)	RefPhaseShift	pi/2	rad	]-INF, +INF[
Reverse return phase shift Phase shift (port 2 to port 2)	RevRefPhaseShift	pi/2	rad	]-INF, +INF[

Spatial Effects

Name and description	Symbol name	Default value	Units	Value range
X shift Defines the amount of translation of the mode shape in the X-direction	XOff	0	um	]-INF, +INF[
Y shift Defines the amount of translation of the mode profile in the Y-direction	YOff	0	um	]-INF, +INF[
X tilt Defines the amount of rotation of the mode profile around the X-axis	XTilt	0	rad	]-INF, +INF[
Y tilt Defines the amount of rotation of the mode profile around the Y-axis	YTilt	0	rad	]-INF, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OCONN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OCONN Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <AttendB=val> <RevAttendB=val> <RefdB=val> <RevRefdB=val>
+ <PhaseShift=val> <RevPhaseShift=val> <RefPhaseShift=val>
```

```
+ <RevRefPhaseShift=val> <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a connector with name OC1, model OCModel, connected to signals SIG1 and SIG2, with 0.5 dB of insertion loss, the netlist statement to be generated as follows:

```
Osp OCONN Name=OC1 Nodes=[SIG1 SIG2] MoName=OCModel AttendB=0.5
```


Notes:

Optical Isolator

This device is an isolator, it includes insertion loss, isolation and return losses.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Insertion loss Power loss (port 1 to port 2)	AttendB	0	dB	]-INF, +INF[
Isolation Power loss (port 2 to port 1)	RevAttendB	0	dB	]-INF, +INF[
Return loss Power return loss (port 1 to port 1, and port 2 to port 2)	RefdB	100	dB	]-INF, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OCONN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OCONN Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <AttendB=val> <RevAttendB=val> <RefdB=val> <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an isolator with name OI1, model OIModel, connected to signals SIG1 and SIG2, with 0.5 dB of insertion loss, 60 dB isolation and 60 dB return loss, the netlist statement to be generated as follows:

```
Osp OCONN Name=OI1 Nodes=[SIG1 SIG2] MoName=OIModel AttendB=0.5
+ RevAttendB=60 RefdB=60
```

Optical Mirror

This device is an optical mirror.

Pins

Number	Signal Type	Description
1	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Reflection Reflection	Ref	0	-	[0, 1]
Phase shift Phase shift	PhaseShift	0	rad	]-INF, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see MIRROR Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp MIRROR Name=DEVICE_NAME Nodes=[SIGI] MoName=MODEL_NAME <Ref=val>
+ <PhaseShift=val> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an mirror with name OM1, model OMModel, connected to signal SIG1, with 50% reflection, the netlist statement to be generated as follows:

```
Osp MIRROR Name=OM1 Nodes=[SIG1] MoName=OMModel Ref=0.5
```

Optical Power Splitter

Component for combining or splitting optical signals.

Pins

Number	Signal Type	Description
1	Optical	Input 1
2	Optical	Output 1
3	Optical	Output 2

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Splitting ratio Splitting ratio from input 1 to output 1	SplitRatio	0.5	-	[0, 1]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OMNIOCONN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp SPLITTER Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <SplitRatio=val> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Examples

For a splitter/combiner with device name SPT1, model SPTModel, connected to signals SIG1, SIG2 and SIG3, with 50% splitting ratio, the netlist statement to be generated as follows:

```
Osp SPLITTER Name=SPT1 Nodes=[SIG1 SIG2 SIG3] MoName=SPTModel
+ SplitRatio=0.5
```

Optical Fork

Component for duplicating or adding optical signals.

Pins

Number	Signal Type	Description
1	Optical	Input 1
2	Optical	Output 1
3	Optical	Output 2

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OMNIOCONN Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp SPLITTER Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ LossType=IDEAL <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Examples

For a duplicator/adder with device name F1, model FModel, connected to signals SIG1, SIG2 and SIG3, the netlist statement to be generated as follows:

```
Osp SPLITTER Name=F1 Nodes=[SIG1 SIG2 SIG3] MoName=FModel
+ LossType=UNITY
```

Optical Termination

This device is an optical termination represented by a mirror with zero reflection.

Pins

Number	Signal Type	Description
1	Optical	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see MIRROR Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp MIRROR Name=DEVICE_NAME Nodes=[SIGI] MoName=MODEL_NAME
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an termination with name OT1, model OTModel, connected to signal SIG1, the netlist statement to be generated as follows:

```
Osp MIRROR Name=OT1 Nodes=[SIG1] MoName=OTModel
```


Notes:

Optical Channel Filter

Component for selecting optical channels.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency list List of channel frequencies	PassBands	[193.1]		]0, +INF[
Frequency unit Channel frequency unit	FrequencyUnit	THz		[Hz, THz, nm]
Bandwidth Channel frequency bandwidth	Bandwidth	50		]0, +INF[
Bandwidth unit Channel bandwidth unit	BandwidthUnit	GHz		[Hz, GHz, nm]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTCHANNELFILTER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTCHANNELFILTER Name=DEVICE_NAME Nodes=[SIGI SIGJ]
+ MoName=MODEL_NAME PassBandMode=CenterFreqAndConstBW <PassBands=val>
+ <FrequencyUnit=Hz/THz/nm> <Bandwidth=val> <BandwidthUnit=Hz/GHz/nm>
+ <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Examples

For a channel filter with device name OF1, model OFModel, connected to signals SIG1 and SIG2, filtering 193.1 THz and 193.2THz, bandwidth of 50 GHz, the netlist statement to be generated as follows:

```
Osp OPTCHANNELFILTER Name=OF1 Nodes=[SIG1 SIG2] MoName=OFModel
+ PassBandMode=CenterFreqAndConstBW PassBands=[193.1 193.2]
+ FrequencyUnit=THz Bandwidth=50 BandwidthUnit=GHz
```

Optical Filter

Optical filter with a user defined frequency transfer function such as Bessel or Butterworth.

Pins

Number	Signal Type	Description
1	Optical	Filter input
2	Optical	Filter output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency of the filter	Frequency	193.1	-	[0, +INF[
Frequency unit Frequency unit for Frequency and FilterFreqShift parameters	FrequencyUnit	THz	-	Hz, THz, nm
Filter type Filter transfer characteristics type	FilterType	BESSEL	-	BESSEL, BUTTERWORTH
Bandwidth 3 dB filter bandwidth	FilterBW	10	GHz	]0,+INF[
Insertion loss Insertion loss of the filter	FilterIL	0	dB	[0,+INF[
Order Order of the function	FilterOrder	1	-	1,2,3, ...

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTFFT Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTFFT Name=DEVICE_NAME Nodes=[ SIGI SIGJ ] MoName=MODEL_NAME
+ <Frequency=val> <FrequencyUnit=Hz/THz/nm>
+ <FilterType=BESSEL/BUTTERWORTH> <FilterBW=val> <FilterIL=val>
+ <FilterOrder=val> <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Examples

For an optical filter with device name OF1, model OFModel, connected to signals SIG1 and SIG2, with center frequency of 193.4 THz, and having bessel type of transfer function with a 3-dB bandwidth of 7 GHz, insertion loss of 0.5 dB, and order of 4, the netlist statement to be generated as follows:

```
Osp OPTFFT Name=OF1 Nodes=[ SIG1 SIG2 ] MoName=OFModel
+ Frequency=193.4 FrequencyUnit=THz FilterType=BESSEL FilterBW=7
+ FilterIL=0.5 FilterOrder=4
```

Optical Filter - Measured

Optical filter based on measurements. Measured data is provided by text file.

Pins

Number	Signal Type	Description
1	Optical	-
2	Optical	-

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency of the filter	Frequency	193.1	-	[0, +INF[
Frequency unit Frequency unit for Frequency and FilterFreqShift parameters	FrequencyUnit	THz	-	Hz, THz, nm
Filter file Filename with the measured data	FilterFile	-	-	-
File frequency unit Determines the frequency unit of the file with the measurements	FileFreqUnit	Hz	-	Hz, GHz, THz, m, nm
File format Determines the format of the file with the measurements	FileFormat	POWERPHASE	-	POWERPHASE, REALIMAG
File power scale Determines whether the measured data is in linear scale or in dB	FilePowScale	LINEAR	-	LINEAR, DB

Name and description	Symbol name	Default value	Units	Value range
Touchstone file Touchstone file name containing two port S-parameters for the optical filter	Tstonefile	-	-	-

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTFFT Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTFFT Name=DEVICE_NAME Nodes=[ SIGI SIGJ ] MoName=MODEL_NAME
+ <Frequency=val> <FrequencyUnit=Hz/THz/nm>
+ <FilterFile=”filename”> <FileFreqUnit=Hz/GHz/THz/m/nm>
+ <FileFormat=POWERPHASE/REALIMAG> <FilePowScale=LINEAR/DB>
+ <Tstonefile=”filename”> <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Examples

For a measured optical filter with device name OF2, model OFModel, connected to signals SIG3 and SIG4, with center frequency of 193.2 THz, and having measured filter response given by ‘filter.dat’ where frequency is provided in GHz, response is in real imaginary form, the netlist statement to be generated as follows:

```
Osp OPTFFT Name=OF2 Nodes=[ SIG3 SIG4 ] MoName=OFModel
+ Frequency=193.2 FrequencyUnit=THz FilterFile="filter.dat"
+ FileFreqUnit=GHz FileFormat=REALIMAG
```

Multi-layer Filter - Implicit

Multi-layer filter consists of layers of material of differing optical index to produce a complex series of interfering waves formed by the reflection and transmission through each interface. For an implicit filter, index of refraction for each layer is static. It models the effect of the entire stack with a single optical scattering element and the multi-layer nature of the element is captured implicitly.

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Output

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Defined wavelength Unless channel wavelength is known from the source (laser, cw), this wavelength value is used to calculate the filter characteristics.	DefLambda	1550	nm	]0, +INF[
Expected rise in initial temperature Initial expected temperature at t=0; used for robust DC convergence.	InitialT	0.0	C	]-INF, +INF[
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Name and description	Symbol name	Default value	Units	Value range
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model type of MULTILAYERFILTER is required for this device. All the main parameters characterizing this device are given by the model statement. For more details see MULTILAYERFILTER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp MULTILAYERFILTER Name=DEVICE_NAME Nodes=[SIGI SIGJ]
+ MoName=MODEL_NAME <DefLambda=val> <DTemp=val> <InitialT=val>
+ <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For an implicit multi-layer filter with device name Filter, model FilterModel, connected to signals IN and OUT, the netlist statement to be generated as follows:

```
Osp MULTILAYERFILTER Name=Filter Nodes=[IN OUT] MoName=FilterModel
```

Multi-layer Filter - Explicit

An active explicit filter comprised of a set of layers (interfaces with waveguides between them). Index of refraction of each layer is time varying and dependent on voltage and temperature.

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
List of connected voltage pairs to layers List containing node names (in pairs) that are connected as controlling voltage for each layer	FilterCNodes	-	-	-
Initial values for connected voltages List containing initial voltage difference for the node pairs given by LayerCnodes	InitialVs	-	V	]-INF, +INF[
List of temperature nodes for layers List containing temperature node names that set the temperate for each layer	FilterTNodes	-	-	-

Optional

Name and description	Symbol name	Default value	Units	Value range
Defined wavelength Unless channel wavelength is known from the source (laser,cw), this wavelength value is used to calculate the filter characteristics.	DefLambda	1550	nm	]0, +INF[
Expected rise in initial temperature Initial expected temperature at t=0; used for robust DC convergence.	InitialT	0.0	C	]-INF, +INF[
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Temperature node The name of the external signal or temperature node. Only used if FilterTnodes are not given.	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model type of MULTILAYERFILTER is required for this device. Most parameters characterizing this device are given by the model statement. For more details see MULTILAYERFILTER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp MULTILAYERFILTER Name=DEVICE_NAME Nodes=[SIGI SIGJ]
+ MoName=MODEL_NAME <FilterCnodes=[{N1+ N1-} {N2+ N2-} ... {NL+ NL-}]>
+ <InitialVs=[vi1 vi2 ...viL]> <FilterTnodes=[TN1 TN2 ... TNL]>
+ <DefLambda=val> <InitialT=val> <DTemp=val> <ExtTNode=NODE_NAME>
+ <Rth=val> <Cth=val>
```

Note: L is the number of layers. Optional parameters are enclosed by angle brackets.

Example

For an explicit multi-layer filter with three layers and device name FilterExp connected to signals IN and OUT, represented by model FilterExpModel, and controlled by the voltage differences between nodes {V1, V2}, {V3, V4}, and {V5, V6} with the initial voltage differences of 0.1 V, 0.2 V, and 0.1 V respectively, the netlist statement to be generated as follows:

```
Osp MULTILAYERFILTER Name=FilterExp Nodes=[IN OUT]
+ MoName=FilterExpModel FilterCnodes=[{V1 V2} {V3 V4} {V5 V6}]
+ InitialVs = [0.1 0.2 0.1]
```

Waveguide

A multi-mode waveguide element is similar to the multimode fiber element. However, index can be made to be temperature dependent.

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
List of mode effective indexes List containing effective index for each mode of the waveguide	Neff	-	-	]0, +INF[
Waveguide length Length of the waveguide	Length	1.0	um	]0, +INF[
List of mode attenuations List containing attenuation for each mode	Atten	-	-	]0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Expected rise in initial temperature Initial expected temperature at t=0; used for robust DC convergence.	InitialT	0.0	C	]-INF, +INF[

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A WAVEGUIDE model type is required for the device to model the characteristics of this device. For more details see MULTILAYERFLITER (WAVEGUIDE) Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp WAVEGUIDE Name=DEVICE_NAME Nodes=[SIGI SIGJ]
+ MoName=MODEL_NAME <Neff=[n1 n2 ...nL]> <Length=val>
+ <Atten=[a1 a2 ... aL]> <InitialT=val> <DTemp=val>
+ <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a waveguide with device name WG, model WgModel, connected to signals IN and OUT, with the mode effective index of 1.47, length of 20 um, and attenuation of 0.95, the netlist statement to be generated as follows:

```
Osp WAVEGUIDE Name=WG Nodes=[IN OUT] MoName=WgModel
+ Neff=[1.47] Length=20 Atten = [0.95]
```

Waveguide Crossing

The ***Waveguide Crossing*** device simulates the transmission and reflection effects that occur when two waveguides cross

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Right
3	Optical	Through
4	Optical	Left

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Through port The fraction of the field which propagates straight through the waveguide crossing	Through	0.8	-	[0, 1]
Right port The fraction of the field which propagates to the right-most exit port relative to the signal input port	Right	0.4	-	[0, 1]
Left port The fraction of the field which propagates to the left-most exit port relative to the signal input port	Left	0.4	-	[0, 1]
Reflection The fraction of the field which is reflected back from the signal input port	Ref	0.1	-	[0, 1]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	0, 1
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

The XCOUPLER model type is required for the device to model the characteristics of this device. The ElemType must be set to WGUIDECROSS to enable the model for this type of application.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp XCOUPLER Name=DEVICE_NAME Nodes=[SIG1 SIG2 SIG3 SIG4]
+ MoName=MODEL_NAME <Through=val> <Right=val> <Left=val>
+ <Ref=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a waveguide with device name WC1 connected to signals SIG1, SIG2, SIG3 and SIG4 and with a Through = 0.7, Right = 0.1, Left = 0.1 and Ref = 0.1 the netlist statement to be generated as follows:

```
Osp XCOUPLER Name=WC1 Nodes=[ SIG1 SIG2 SIG3 SIG4] MoName=WC_MODEL
+ Through=0.7 Right=0.1 Left=0.1 Ref=0.1
Osp Model Name = WC_MODEL  type = XCOUPLER ElemType=WGUIDECROSS
```

Optical Ring

Optical ring is a two port ring resonator comprised of a cross-coupler and a waveguide which can be represented by an explicit multi-layer filter.

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Radius Radius of ring resonator	Radius	10	um	]0, +INF[
Coupling coefficient for XCoupler Coupling ratio for the cross coupler	C	0.5	-	[0, 1]
List of connected voltage pairs to layers List containing node names (in pairs) that are connected as controlling voltage for each layer	LayerCnodes	-	-	-
Initial values for connected voltages List containing initial voltage difference for the node pairs given by LayerCnodes	InitialVs	-	V	]-INF, +INF[
List of temperature nodes for layers List containing temperature node names that set the temperate for each layer	LayerTNodes	-	-	-

Optional

Name and description	Symbol name	Default value	Units	Value range
Conjugate Complex conjugate option for the cross coupler	Conjugate	1	-	[0, 1]
Defined wavelength Unless channel wavelength is known from the source (laser,cw), this wavelength value is used to calculate the filter characteristics.	DefLambda	1550	nm	]0, +INF[
Expected rise in initial temperature Initial expected temperature at t=0; used for robust DC convergence.	InitialT	0.0	C	]-INF, +INF[
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model of type OPTRING is required to model the characteristics of this device. For more details see OPTRING Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTRING Name=DEVICE_NAME Nodes=[SIGI SIGJ] MoName=MODEL_NAME
+ <Radius=val> <C=val>
+ <LayerCnodes=[{N1+ N1-} {N2+ N2-} ... {NL+ NL-}]>
+ <InitialVs=[vi1 vi2 ...viL]> <LayerTnodes=[TN1 TN2 ... TNL]>
+ <Conjugate=0/1> <DefLambda=val> <InitialT=val> <DTemp=val>
+ <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a two port optical ring with device name R1, model RingModel, and a radius of 15 um connected to signals IN and OUT, with coupling coefficient for the cross-coupler with 0.35, controlled by the voltage difference between nodes V1 and V2 and connected by the temperature node TN at its single layer, and the netlist statement to be generated as follows:

```
Osp OPTRING Name=R1 Nodes=[IN OUT] MoName=RingModel Radius=15
+ C=0.35 LayerCnodes=[{V1 V2}] LayerTnodes=[TN]
```

Optical Ring- 4 ports

This is a four port ring resonator comprised of two cross-coupler and two waveguides which are represented by two explicit multi-layer filters.

Pins

Number	Signal Type	Description
1	Optical	Port 1
2	Optical	Port 2
3	Optical	Port 3
4	Optical	Port 4

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Radius Radius of ring resonator	Radius	10	um	]0, +INF[
Coupling coefficient for XCoupler 1 Coupling ratio for the cross coupler	C1	0.5	-	[0, 1]
Coupling coefficient for XCoupler 2 Coupling ratio for the cross coupler	C2	0.5	-	[0, 1]
List of connected voltage pairs to layers List containing node names (in pairs) that are connected as controlling voltage for each layer	LayerCnodes	-	-	-

Name and description	Symbol name	Default value	Units	Value range
Initial values for connected voltages List containing initial voltage differences for the node pairs given by LayerCnodes	InitialVs	-	V	]-INF, +INF[
List of temperature nodes for layers List containing temperature node names that set the temperate for each layer	LayerTNodes	-	-	-

Optional

Name and description	Symbol name	Default value	Units	Value range
Conjugate 1 Complex conjugate option for the cross coupler 1	Conjugate1	1	-	[0, 1]
Conjugate 2 Complex conjugate option for the cross coupler 2	Conjugate2	1	-	[0, 1]
Defined wavelength Unless channel wavelength is known from the source (laser,cw), this wavelength value is used to calculate the filter characteristics.	DefLambda	1550	nm	]0, +INF[
Expected rise in initial temperature Initial expected temperature at t=0; used for robust DC convergence.	InitialT	0.0	C	]-INF, +INF[
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTRING Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by

```
Osp OPTRING Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK SIGL]
+ MoName=MODEL_NAME <Radius=val> <C1=val> <C2=val>
+ <LayerCnodes=[{N1+ N1-} {N2+ N2-} ... {NL+ NL-}]>
+ <InitialVs=[vi1 vi2 ...viL]> <LayerTnodes=[TN1 TN2 ... TNL]>
+ <Conjugate1=0/1> <Conjugate2=0/1><DefLambda=val> <InitialT=val>
+ <DTemp=val> <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a four port optical ring with device name Ring4, model RingMod, connected to signals IN, D, T, and X, with radius of 12 um and coupling coefficient for the first and second cross-coupler with 0.3 and 0.4 respectively, and with the third layer controlled by the voltage from node Vcnt, the netlist statement to be generated as follows:

```
Osp OPTRING Name=Ring4 Nodes=[IN D T X] MoName=RingMod Radius=12 C1=0.3
+ C2=0.4 LayerCnodes=[{0 0} {0 0} {Vcnt} {0 0} {0 0}]
```


Opto-Electronic Devices Library

This section contains information on the following components

- CW Source
- Laser
- Laser - Thermal
- MZ Modulator
- EA Modulator
- Optical Phase Delay
- Photodiode
- LED

Notes:

CW Source

An optical device that behaves like a continuous output wave source (similar to laser's continuous wave mode of operation) or as a voltage controlled optical source.

Pins

Number	Signal Type	Description
1	Electrical	Input voltage node controlling magnitude
2	Electrical	Input voltage node controlling phase
3	Optical	Optical output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency	Frequency	193.1		]0, +INF[
Frequency unit Channel frequency unit	FrequencyUnit	THz		[Hz, THz, nm]
Frequency shift Shift from center frequency	FreqShift	0		[Hz, THz, nm]

Optional

Name and description	Symbol name	Default value	Units	Value range
Carrier frequency node External node to input varying carrier frequency value. This node can be connected to an independent voltage source so that the source value will be the carrier frequency value at any given time point.	CarrierFreqNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see CWSOURCE Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp CWSOURCE Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <Frequency=val> <FrequencyUnit=Hz/THz/nm> <FreqShift=val>
+ <CarrierFreqNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a CW source with device name CW1, model CWModel, connected to signals SIG1, SIG2 and SIG3, with center frequency of 193.1 THz the netlist statement to be generated as follows:

```
Osp CWSOURCE Name=CW1 Nodes=[SIG1 SIG2 SIG3] MoName=CWModel
+ Frequency=193.1 FrequencyUnit=THz
```

Laser

An optical device that uses stimulated emission of radiation to generate EM waves, based on laser rate-equations.

Pins

Number	Signal Type	Description
1	Electrical	Laser diode positive node
2	Electrical	Laser diode negative node
3	Optical	Optical output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency	Frequency	193.1		]0, +INF[
Frequency unit Channel frequency unit	FrequencyUnit	THz		[Hz, THz, nm]
Frequency shift Shift from center frequency	FreqShift	0		[Hz, THz, nm]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see LASER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp LASER Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <Frequency=val> <FrequencyUnit=Hz/THz/nm> <FreqShift=val>
+ <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a Laser with device name LS1, model LSModel, connected to signals SIG1, SIG2 and SIG3, with center frequency of 193.1 THz the netlist statement to be generated as follows:

```
Osp LASER Name=LS1 Nodes=[SIG1 SIG2 SIG3] MoName=LSModel
+ Frequency=193.1 FrequencyUnit=THz
```

Laser - Thermal

An optical device that uses stimulated emission of radiation to generate EM waves, based on laser rate-equations and thermal interaction. This device is same as Laser, except external temperature node is explicitly connected by the user.

Pins

Number	Signal Type	Description
1	Electrical	Laser diode positive node
2	Electrical	Laser diode negative node
3	Optical	Optical output
4	Thermal	External temperature node

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency	Frequency	193.1		]0, +INF[
Frequency unit Channel frequency unit	FrequencyUnit	THz		[Hz, THz, nm]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]

Name and description	Symbol name	Default value	Units	Value range
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see LASER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp LASER Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <Frequency=val> <FrequencyUnit=Hz/THz/nm>
+ <DTemp=val> <NoNoise=0/1> ExtTnode=SIGL <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a Laser with device name LS1, model LSModel, connected to signals SIG1, SIG2 SIG3, and thermal node SIG4, with center frequency of 193.1 THz the netlist statement to be generated as follows:

```
Osp LASER Name=LS1 Nodes=[SIG1 SIG2 SIG3] MoName=LSModel
+ Frequency=193.1 FrequencyUnit=THz ExtTnode=SIG4
```

MZ Modulator

This device is a Mach-Zehnder modulator.

Pins

Number	Signal Type	Description
1	Optical	Optical input
2	Optical	Optical output
3	Electrical	RF 1
4	Electrical	RF 2
5	Electrical	Bias 1
6	Electrical	Bias 2

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Extinction ratio Extinction ratio of the modulator in dB	ExtinctionRatio	20	dB	]0, +INF[
Switching bias voltage DC voltage required to turn the modulator from the OFF state to the ON state, or vice versa	SwitchBiasVoltage	4	V	]0, +INF[
Switching RF voltage RF voltage required to turn the modulator from the OFF state to the ON state, or vice versa	SwitchRFVoltage	4	V	]0, +INF[
Insertion loss The insertion loss of the Machzehdner interferometer	InsertionLoss	5	dB	]0, +INF[

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see MACHZEHNDER Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp MACHZEHNDER Name=DEVICE_NAME Nodes=[SIGI SIGJ] CNodes=[SIGK SIGL]
+ BNodes = [SIGM SINGN] MoName=MODEL_NAME <DTemp=val> <NoNoise=0/1>
+ <ExtTNode=NODE_NAME> <ExtinctionRatio=val> <SwitchBiasVoltage=val>
+ <SwitchRFVoltage=val> <InsertionLoss=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a modulator with device name MZ1, model MZModel, connected to signals SIG1, SIG2, SIG3, SIG4, SIG5 and SIG6 with extinction ratio of 20 dB, switching bias voltage 4.5V, switching RF voltage of 4.5V, and insertion loss of 3dB, the netlist statement to be generated as follows:

```
Osp MACHZEHNDER Name=MZ1 Nodes=[SIG1 SIG2] CNodes=[SIG3 SIG4]
+ BNodes=[SIG5 SIG6] MoName=MZModel ExtinctionRatio=20
+ SwitchBiasVoltage=4.5 SwitchRFVoltage=4.5 InsertionLoss=3
```

EA Modulator

This device is a electroabsorption modulator.

Pins

Number	Signal Type	Description
1	Optical	Input
2	Optical	Output
3	Electrical	Control voltage positive terminal
4	Electrical	Control voltage negative terminal

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTELECABS Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp Name=OPTELECABS Nodes=[SIGI SIGJ] CNodes=[SIGK SIGL]
+ MoName=MODEL_NAME <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a modulator with device name EA1, model EAModel, connected to signals SIG1, SIG2, SIG3 and SIG4, the netlist statement to be generated as follows:

```
Osp OPTELECABS Name=EA1 Nodes=[SIG1 SIG2] CNodes=[SIG3 SIG4]
+ MoName=EAModel
```

Optical Phase Delay

A optical device that delays the incoming optical signal.

Pins

Number	Signal Type	Description
1	Electrical	Optical input
2	Electrical	Optical output
3	Optical	Phase delay controlling voltage positive node
4	Optical	Phase delay controlling voltage negative node

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see OPTPHASEDELAY Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp Name=OPTPHASEDELAY Nodes=[SIGI SIGJ] CNodes=[SIGK SIGL]
+ MoName=MODEL_NAME <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a phase delay with device name OP1, model OPModel, connected to signals SIG1, SIG2, SIG3 and SIG4, the netlist statement to be generated as follows:

```
Osp OPTPHASEDELAY Name=OP1 Nodes=[SIG1 SIG2] CNodes=[SIG3 SIG4]
+ MoName=OPModel
```

Photodiode

Photodiode is a device that converts light into an electrical signal.

Pins

Number	Signal Type	Description
1	Optical	Optical input
2	Electrical	Diode positive node
3	Electrical	Diode negative node

Parameters

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see PHOTODIODE Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp Name=PHOTODIODE Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a phase delay with device name PD1, model PDModel, connected to signals SIG1, SIG2 and SIG3, the netlist statement to be generated as follows:

```
Osp PHOTODIODE Name=PD1 Nodes=[SIG1 SIG2 SIG3] MoName=PDModel
```

LED

An optical device that simulates Light Emitting Diode (LED). Simulation of this device is only available for transient analysis with noise simulation enabled.

Pins

Number	Signal Type	Description
1	Electrical	Diode positive node
2	Electrical	Diode negative node
3	Optical	Optical output

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Frequency Center frequency	Frequency	193.1		]0, +INF[
Bandwidth 3-dB bandwidth	Bandwidth	6	-	[0, +INF[
Frequency unit Channel frequency unit	FrequencyUnit	THz		[Hz, THz, nm]

Optional

Name and description	Symbol name	Default value	Units	Value range
Temperature difference Temperature difference between the device and the circuit	DTemp	0.0	C	]-INF, +INF[
Noise flag Defines whether the device generates noise or not	NoNoise	0	-	[0, 1]

Name and description	Symbol name	Default value	Units	Value range
Temperature node The name of the external signal or temperature node	ExtTNode	-	-	-
Thermal resistance Thermal resistance of the element	Rth	0	K/W	[0, +INF[
Thermal capacitance Thermal capacitance of the element	Cth	0	J/K	[0, +INF[

Model

A model is required for the device. A physical model can be described using the model statement. For the details, see LED Model in the Element and Model Library book.

Statement

Using parameters entered in the dialog box, netlist statement for the device is generated as follows:

```
Osp LED Name=DEVICE_NAME Nodes=[SIGI SIGJ SIGK] MoName=MODEL_NAME
+ <Frequency=val> <Bandwidth=val> <FrequencyUnit=Hz/THz/nm>
+ <DTemp=val> <NoNoise=0/1> <ExtTNode=NODE_NAME> <Rth=val> <Cth=val>
```

Note: Optional parameters are enclosed by angle brackets.

Example

For a LED with device name led1, model LEDModel, connected to nodes Vp, Vm and Lout, with center wavelength of 650 nm and a 3-dB bandwidth of 30 nm, the netlist statement is generated as follows:

```
Osp LED Name=LS1 Nodes=[Vp Vm Lout] MoName=LEDModel
+ Frequency=650 Bandwidth=30 FrequencyUnit=nm
```

Thermal Devices Library

This section contains information on the following components

- Thermal Resistor
- Thermal Capacitor
- Thermal Source

Notes:

Thermal Resistor

Thermal resistor provides thermal resistance which creates a temperature difference across a material when a unit of heat energy flows through it in unit time. The thermal resistance can be temperature dependent or independent. When thermal resistance becomes temperature dependent it exhibits non-linear heat flow with temperature variance. For more details see THERMALRESISTOR in Element and Model Library book.

Pins

Number	Signal Type	Description
1	Thermal	Thermal node 1
2	Thermal	Thermal node 2

Parameters

Main

Name and description	Symbol	Default value	Units	Value range
Thermal resistance Nominal thermal resistance that is independent of temperature	Rth	0.0	K/W	[0, +INF[
Mode Mode option that defines whether the thermal resistance is temperature dependent (TempDep) or not (Const)	Mode	TempDep		Const, TempDep
Material Material that conducts the thermal power between the two thermal nodes. DEF is the user defined material where user has to define the following parameters. For GaAs it used predefined values.	Material	DEF		DEF, GaAs

Name and description	Symbol	Default value	Units	Value range
Nominal operational temperature Nominal temperature of the user defined material (Material = DEF)	Tnom	300.0	K	[0, +INF[
Maximum operational temperature Nominal temperature of the user defined material (Material = DEF)	Tmax	600.0	K	[0, +INF[
Third order polynomial coefficient Third order polynomial coefficient for modeling temperature dependent thermal resistance for the user defined material (Material = DEF)	A	0.0	W/K^3	[-INF, +INF]
Second order polynomial coefficient Second order polynomial coefficient for modeling temperature dependent thermal resistance for the user defined material (Material = DEF)	B	0.0	W/K^2	[-INF, +INF]
First order polynomial coefficient First order polynomial coefficient for modeling temperature dependent thermal resistance for the user defined material (Material = DEF)	C	0.0	W/K	[-INF, +INF]
Zeroth order polynomial coefficient Zeroth order polynomial coefficient for modeling temperature dependent thermal resistance for the user defined material (Material = DEF)	D	0.0	W	[-INF, +INF]

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by:

```
Osp THERMALRESISTOR Name=DEVNAME Nodes=[ SIGI SIGJ ] <Rth=val>
+ <Mode=Const/TempDep> <Material=DEF/GaAs> <Tnom=val>
+ <Tmax=val> <A=val> <B=val> <C=val> <D=val>
```

Examples

For a thermal resistor with a device name THRES connected between signals T1 and T2 with a thermal resistance of 50 K/W independent of temperature, the netlist statement can be generated as follows:

```
Osp THERMALRESISTOR Name=THRES Nodes=[ T1 T2 ] Mode=Const Rth=50
```

For a thermal resistor with a device name THRES2 connected between signals T3 and T4 with a nominal thermal resistance of 500 K/W and made of the material GaAs, the netlist statement can be generated as follows:

```
Osp THERMALRESISTOR Name=THRES2 Nodes=[ T3 T4 ] Rth=500 Material=GaAs
```

For a thermal resistor with a device name THRES3 connected between signals T5 and T6 with a with nominal thermal resistance of 300 K/W and with user defined material with temperature dependent polynomial coefficients of 1.02e-5, 4.3e-6, 0.015, and -0.02 (from third to zeroth order respectively), the netlist statement can be generated as follows:

```
Osp THERMALRESISTOR Name=THRES3 Nodes=[ T5 T6 ] Rth=300 Material=DEF
+ A = 1.02e-5 B = 4.3e-6 C = 0.015 D = -0.02
```


Thermal Capacitor

Thermal capacitor provides thermal capacitance to a material in the thermal network. Thermal capacitance is the amount of heat required to raise the temperature of the material by a unit value. For more details see THERMALCAPACITOR in Element and Model Library book.

Pins

Number	Signal Type	Description
1	Thermal	Thermal node of the thermal capacitor

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
Thermal Capacitance Thermal capacitance of the material	Cth	0.0	J/K	[0, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by:

```
Osp THERMALCAPACITOR Name=DEVNAME Node=TNODE <Cth=val>
```

Example

For a thermal capacitor with the device name ThCap connected to the thermal signal T1 with thermal capacitance 0.001 J/K, the netlist statement can be generated as follows:

```
Osp THERMALCAPACITOR Name=ThCap Node=T1 Cth = 0.001
```

Thermal Source

Thermal Source allows one to set a temperature difference to a thermal node from the global circuit temperature. To set a constant temperature difference provide the “DC temperature” only. To set time varying temperature difference provide the “Time-temperature points”. Using the provided time temperature points, a piecewise linear temperature difference will be set to the thermal node. If you enabled “Time-temperature points”, then DC value will be ignored in the transient analysis.

Pins

Number	Signal Type	Description
1	Thermal	Thermal node where a temperature difference from circuit temperature to be set

Parameters

Main

Name and description	Symbol name	Default value	Units	Value range
DC value DC temperature value	dcValue	0.0	°C	[-INF, +INF[
Time-temperature points List of source values at specific time points (used for piece-wise linear function)	Tpoints	{0 25} {1e-6 25}	s, °C	[0, +INF[, [-INF, +INF[

Statement

Using parameters entered in the dialog box, syntax for the netlist statement for the device is given by:

```
Osp THERMSOURCE Name=DEVNAME Nodes=[SIGX 0] dcMode dcValue=val
+ tranMode=PWL Tpoints=[{t1 T1} {t2 T2} {t3 T3} ... ]
```

Examples

To set a a time varying temperature difference given by piecewise linear (PWL) function to the TNode from the global circuit temperature using a thermal source name THSRC, the netlist statement can be written as

```
Osp THERMSOURCE Name=THSRC Nodes=[ TNode 0 ] tranMode=PWL
+ Tpoints = [ {0 0} {1u 10} {5u 15} {10u 5} {30u 0}]
```

OptiSystem Co-simulation Library

This section contains information on the following components

- Electrical Input - Isource
- Electrical Input - Vsource
- Optical Input

Notes:

Electrical Input - Isource

This device is used to receive electrical input signal from OptiSystem to function as a current source in the OptiSPICE design during OptiSystem - OptiSPICE Co-simulation. Once the co-simulation configuration is performed in OptiSPICE, the electrical signal output generated from OptiSystem is fed through a corresponding electrical input port in the OptiSPICE Netlist component in OptiSystem.

Pins

Number	Signal Type	Description
1	Electrical	Positive node
2	Electrical	Negative node

Statement

```
Osp OPTISYSINELEC Name=DEVNAME Nodes=[ SIGI SIGJ ]
+ SignalFile="DEVNAME_DESIGNNAME.OSSig" tranMode=FILE EL_Type=I_SOU
```

> ***Note:*** The parameter values in the statement are auto generated. Therefore user does not need to provide values for any of these parameters.

The parameter SignalFile is a text file that contains electrical signal data for this device generated by OptiSystem.

Example

For an OptiSystem input current source Eleclin1 connected to SIG1 and SIG2 in the design file “SysSpiceCosim.osch”, the statement will be generated as follows

```
Osp OPTISYSINELEC Name=ElecIin1 Nodes=[ SIG1 SIG2 ]
+ SignalFile="ElecIin1_SysSpiceCosim.OSSig" tranMode=FILE
+ EL_Type=I_SOU
```


Notes:

Electrical Input - Vsource

This device is used to receive electrical input signal from OptiSystem to function as a voltage source in the OptiSPICE design during OptiSystem - OptiSPICE Co-simulation.

Pins

Number	Signal Type	Description
1	Electrical	Positive node
2	Electrical	Negative node

Statement

Netlist statement syntax is given by:

```
Osp OPTISYSINELEC Name=DEVNAME Nodes=[ SIGI SIGJ ]
+ SignalFile="DEVNAME_DESIGNNAME.OSSig" tranMode=FILE EL_Type=V_SOU
```

> ***Note:*** The parameter values in the statement are auto generated. Therefore user does not need to provide values for any of these parameters.

The parameter SignalFile is a text file that contains electrical signal data for this device generated by OptiSystem.

Example

For an OptiSystem input voltage source ElecVin1 connected to SIG3 and 0 in the design file “SysSpiceCosim.osch”, the statement will be generated as follows

```
Osp OPTISYSINELEC Name=ElecVin1 Nodes=[ SIG3 0 ]
+ SignalFile="ElecIin1_SysSpiceCosim.OSSig" tranMode=FILE
+ EL_Type=V_SOU
```


Notes:

Optical Input

This device is used to receive optical input signal from OptiSystem to function as an optical source in the OptiSPICE design during OptiSystem - OptiSPICE Co-simulation. The optical signal output generated from OptiSystem is fed through a corresponding optical input port in the OptiSPICE Netlist component in OptiSystem.

Pins

Number	Signal Type	Description
1	Optical	Optical input from OptiSystem

Model

A model statement is automatically generated by OptiSystem for this device. For more details, see OPTISYSINOPT Model in the Element and Model Library book.

Statement

Netlist statement syntax is given by:

```
Osp OPTISYSINOPT Name=DEVNAME Nodes=[ SIGI ] MoName=DEVNAME_Model
+ SignalFile="DEVNAME_DESIGNNAME.OSSig"
```

> ***Note:*** The parameter values in the statement are auto generated. Therefore user does not need to provide values for any of these parameters.

The parameter SignalFile is a text file that contains optical signal data for this device generated by OptiSystem.

Example

For an optical source from OptiSystem with the name Oin1 connected to SIG4 in the design “SysSpiceCosim.osch”, the statement will be generated as follows

```
Osp OPTISYSINOPT Name=Oin1 Nodes=[ SIG4 ] MoName=Oin1_Model
+ SignalFile="Oin1_SysSpiceCosim.OSSig"
```


Notes:

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