Resistive Thermal Interconnect interconnectrt

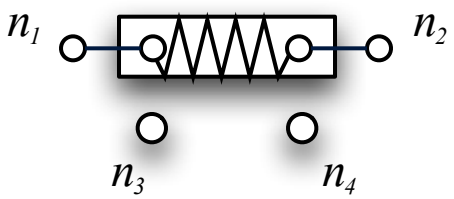

Figure 1: interconnectrt — Resistive electro-thermal interconnect element.

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Description:
This element implements an interconnect line as an electro-thermal resistor effects. The freeda command .locate can be used in the netlist to specify the X,Y coordinates of the ends of the interconnect. Electrical and thermal parameters are automatically calculated. This is useful for simulating netlists parsed from layout databases.

Form: `interconnectrt:`⟨`instance name`⟩ n_1 n_2 n_3 n_4 ⟨`parameter list`⟩
instance name is the model name,
n_1, n_2, n_3 and n_4 are the element terminals,
n_1 and n_2 are element electrical terminals,
n_3 and n_4 are element thermal terminals,
n_2 is the element local reference node,
n_4 is the element thermal reference node.

Parameters:

Parameter	Type	Default value	Required?
l: Length of interconnect line (m)	DOUBLE	n/a	no*
w: Width of interconnect line (m)	DOUBLE	1 μm	no
tm: Thickness of interconnect line (m)	DOUBLE	0.3 μm	no
rho: Resistivity of metal ($\Omega - m$)	DOUBLE	n/a	no
metal: Metal (Silver, Copper, Gold, Aluminum)	STRING	copper	no
t: System temperature (^0C)	DOUBLE	20	no
tnom: Initial system temperature (^0C)	DOUBLE	20	no
tc: Temperature coefficient ($1/^0C$)	DOUBLE	0	no
pdr: Thermal element flag	BOOLEAN	false	no

*if l, the length is not given, X,Y coordinates must be given in the netlist with the .locate command.

Example:

```
interconnectrt: irt1 2 0 3 "tref"  l = 20u  metal = "copper"
```

Example2 using .locate:

```
interconnectrt: irt1 2 0 3 "tref"   metal = "copper"
.locate 2 1.6e-6 2.0e-6
.locate 3 1.8e-6 2.0e-6
```

Details:

The resistive thermal interconnect is modeled as resistive only, the metal line is made by a kind of metal, which includes silver, copper, gold, and aluminum that are predefined in the model.

This is an electro-thermal element is modeled differently depending on the setting of the Parameter `pdr`.

`pdr` = false/true.

When `pdr` is false (the default) the interconnect line is calculated as a resistor by giving length and resistivity or metal selection.
When `pdr` is true, the interconnect line is modeled as electro-thermal resistor by giving length, resistivity or metal selection, and system temperature. Resistance calculation is based on the electrical parameters and system temperature. The power dissipation and heat flux are modeled with thermal terminals.

Resistance of the interconnect line:

$$R = \frac{\rho \cdot l}{A}$$

Electro-thermal resistance of the interconnect with temperature coefficient:

$$R = \frac{\rho \cdot l}{A} \cdot [1 + \beta \cdot (t - t_0)]$$

```
interconnectrt: irt1 2 0 3 "tref" l = 20u  metal = "copper"
```

Here terminals '0' and 'tref' are the local reference terminals of the element. Terminal '0' is the global ground. Terminal 'tref' is a thermal local reference terminal of the element. An example netlist is:

```
.ref "tref"
.ref 0

vsource 1 0 vac = 1 f = 5GHz
res:r1 1 2 r=50
interconnectrt:irt1 2 0 1000 "tref" l = 1m metal = "copper" pdr=1
```

References:

1. Houssam S.Kanj. fREEDA element ResistorT, "*elements\r\ResistorT*".
2. Tony Mulder, Travis Lentz. fREEDA element CmosInvT, "*elements\c\CmosInvT*"

Example of Transient Analysis (.TRAN2) Fixed times steps, time-stepping nonlinear analysis.
netlist file: interconnectrt.net: The output log file is

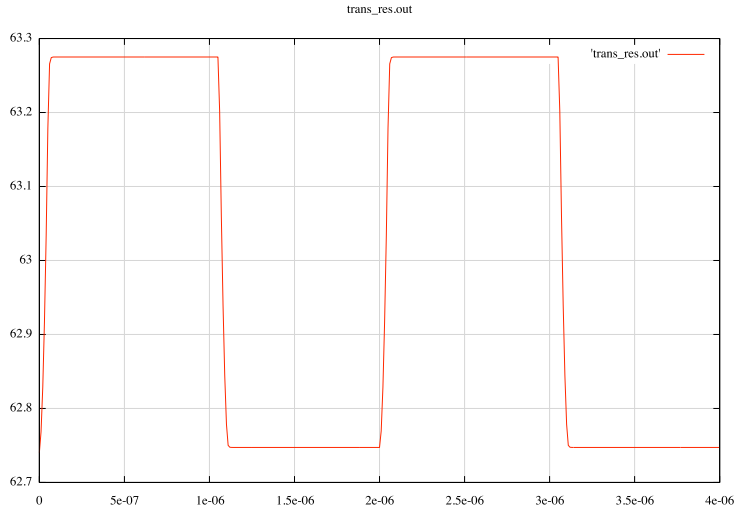

Figure 2: Transient Analysis - Resistance variation of thermal interconnect

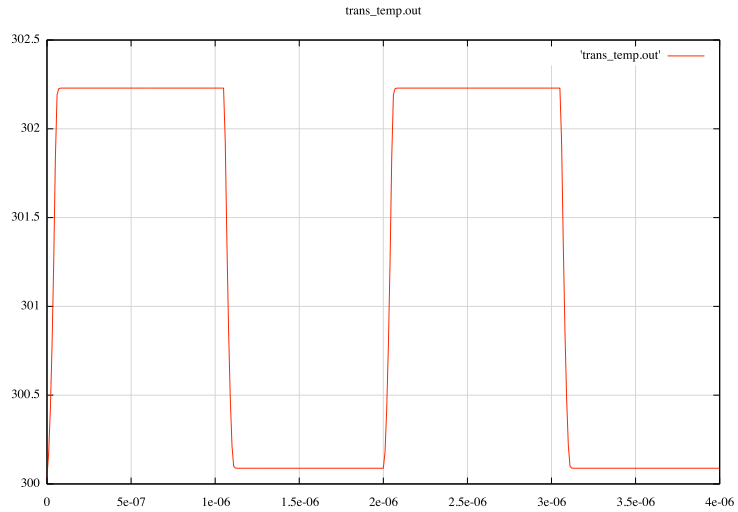

Figure 3: Transient Analysis - Temperature variation of interconnect line

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Credits:

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