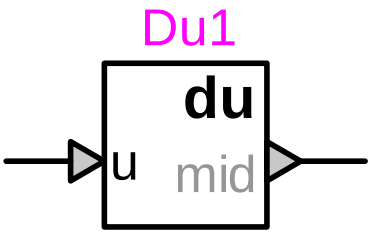
Control device : derivative

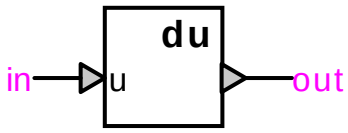


1 Description

This device calculates one of four types of time derivatives of the input signal:

no derivative
mid-step du/dt
end-step du/dt
mid-step d2u/dt2

1.1 Pins



This device has two signal pins:

pin	*description*	*value when unconnected*
in	input	0
out	output	as calculated

1.2 Parameters

Selection options for the type of derivative:

derivative type	*output value*
no derivative	0
mid-step du/dt	mid-interval first-order time derivative
end-step du/dt	end-of-interval first-order time derivative
mid-step d2u/dt2	mid-interval second-order time derivative

1.3 History

Selection options for the history value of the output signal:

option	*value*	*rules*
zero	history(t) = zero	
constant value	history(t) = user-defined value	any value
function value	history(t) = user-defined function	constant or f(t)

1.4 Scopes

Setting the scope flag enables monitoring of the output signal during the simulation.

1.5 Output signal interpolation

During the simulation, the output value of this device is calculated at successive instants *t* at intervals Δt. Between these simulation instants, the output value can be set to vary in one of two modes, ramped or stepped:

mode	*output value between* $t - \Delta t$ *and* t^-	*value at* t^-	*value at* t
ramped	interpolated linearly between values out($t - \Delta t$) and out(t^-)	calculated at t^-	calculated at t
stepped	remains at out($t - \Delta t$)	remains at out($t - \Delta t$)	calculated at t

2 Time-domain representation

In the time-domain calculation at t>0, the output value is calculated as follows:

- mid-step first-order time derivative:

$$\text{out}(t) = \frac{\Delta \text{in}}{\Delta t}(t) = \frac{\text{in}(t^-) - \text{in}(t^+ - \Delta t)}{\Delta t} \qquad (1)$$

- end-step first-order time derivative:

$$\begin{aligned}\text{out}(t) &= \frac{\Delta \text{in}}{\Delta t}(t) + \frac{\Delta^2 \text{in}}{\Delta t^2}(t) \cdot \frac{\Delta t}{2} \\ &= \frac{1.5 \cdot \text{in}(t^-) - 1.5 \cdot \text{in}(t^+ - \Delta t) - 0.5 \cdot \text{in}(t^- - \Delta t) + 0.5 \cdot \text{in}(t^+ - 2\Delta t)}{\Delta t}\end{aligned} \qquad (2)$$

- mid-step second-order time derivative:

$$\text{out}(t) = \frac{\frac{\Delta \text{in}}{\Delta t}(t) - \frac{\Delta \text{in}}{\Delta t}(t - \Delta t)}{\Delta t} = \frac{\text{in}(t^-) - \text{in}(t^+ - \Delta t) - \text{in}(t^- - \Delta t) + \text{in}(t^+ - 2\Delta t)}{\Delta t^2} \quad (3)$$

3 Steady-state representation

In the steady-state calculation at t=0, the output value is calculated as follows:

if history is defined, out(0) = history(0)
else out(0) = derivative of input calculated as above (4)

4 Netlist

4.1 Netlist format for no derivative

Netlist format:

```
_c_cst;name;2;2;out,in,
0,step/ramp,scope,
```

field	*description*	*value*
c_cst name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
0	output value	
step/ramp	output interpolation	"S1" for stepped "S0" for ramped
scope	monitoring, optional	"?s" for enabled

The comma separated data is saved into the ParamsA attribute of this device.

4.2 Netlist format for mid-step first-order time derivative

Netlist format:

```
_c_dm;name;2;2;out,in,
history,step/ramp,scope,
history function expression
```

field	*description*	*value*
c_dm name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
history	history	constant value or "H" for function
step/ramp	calculation mode	"S1" for stepped "S0" for ramped
scope	monitoring, optional	"?s" for enabled
history function expression	optional, required when history field is "H"	

The comma separated data is saved into the ParamsA attribute of this device. The history function expression is saved into the ModelData attribute.

4.3 Netlist format for end-step first-order time derivative

Netlist format:

```
_c_de;name;2;2;out,in,
history,step/ramp,scope,
history function expression
```

field	*description*	*value*
c_de name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
history	history	constant value or "H" for function
step/ramp	calculation mode	"S1" for stepped "S0" for ramped
scope	monitoring, optional	"?s" for enabled
history function expression	optional, required when history field is "H"	

The comma separated data is saved into the ParamsA attribute of this device. The history function expression is saved into the ModelData attribute.

4.4 Netlist format for mid-step second-order time derivative

Netlist format:

```
_c_d2;name;2;2;out,in,
history,step/ramp,scope,
history function expression
```

field	*description*	*value*
c_d2 name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
history	history	constant value or "H" for function
step/ramp	calculation mode	"S1" for stepped "S0" for ramped
scope	monitoring, optional	"?s" for enabled
history function expression	optional, required when history field is "H"	

The comma separated data is saved into the ParamsA attribute of this device. The history function expression is saved into the ModelData attribute.