

Control device : delay



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1 Description

This device applies a time delay to the input signal.
Several types of delay are available:

<i>delay type</i>	<i>output value</i>
no delay	$out(t) = in(t)$
constant discrete delay	$out(t) = in(t - n \cdot \Delta t)$
constant continuous delay	$out(t) = in(t - delay)$
variable continuous delay	$out(t) = in(t - delay(t))$
variable pulse delay	$out(t) = boolean(in)(t - delay(t))$

1.1 Pins



This device has two signal pins:

<i>pin</i>	<i>description</i>	<i>value when unconnected</i>
in	input	0
out	output	as calculated

1.2 Parameters

Selection options for the type of delay:

<i>option</i>	<i>delay value</i>	<i>rules</i>
no delay	0	
constant discrete delay	$n \cdot \Delta t$	n: integer, >0
constant continuous delay	given value	>0
variable continuous delay	given f(t)	>0
variable pulse delay	given f(t)	>0

When a continuous delay is selected, the interpolation method to be used on the input signal must also be specified:

<i>interpolation</i>	<i>rules</i>
linear fitting	linear interpolation between recorded input values
staircase fitting	input signal considered as stepped

When a variable delay is selected, a maximum delay value must also be specified:

<i>value</i>	<i>rules</i>
maximum delay	>0

1.3 History

Selection options for the history value of the output signal:

<i>option</i>	<i>value</i>	<i>rules</i>
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 the 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:

<i>mode</i>	<i>output value between $t - \Delta t$ and t^-</i>	<i>value at t^-</i>	<i>value at t</i>
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:

- in the case where the delay value is an exact multiple of the time step:

$$out(t) = in(t - delay) \quad (1)$$
- in the case where the delay value is not an exact multiple of the time step and linear fitting has been selected:

$$out(t) = in(t - delay)$$
interpolated linearly between $in(t - delay1)$ and $in(t - delay2)$
where $delay1 = \Delta t \cdot \text{integer part of } \frac{delay}{\Delta t}$ (2)
 $delay2 = delay1 + \Delta t$
- in the case where the delay value is not an exact multiple of the time step and staircase fitting has been selected:

$$out(t) = in(t - delay2)$$
where $delay1 = \Delta t \cdot \text{integer part of } \frac{delay}{\Delta t}$ (3)
 $delay2 = delay1 + \Delta t$
- in the case where the input is considered as a Boolean value:

$$out(t) = bool(in)(t - delay)$$
interpolated linearly between $bool(in)(t - delay1)$ and $bool(in)(t - delay2)$
where $delay1 = \Delta t \cdot \text{integer part of } \frac{delay}{\Delta t}$ (4)
 $delay2 = delay1 + \Delta t$

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 $out(0) = in(0 - delay)$ (5)
with delay calculated as above

4 Netlist

4.1 Netlist format for no delay

Netlist format:

```
_c_gain;name;2;2;out,in,
1,step/ramp,scope,
```

<i>field</i>	<i>description</i>	<i>value</i>
c_gain	part name	
name	instance name	
2	pin count	
2	pin count	
out	signal name of the output	
in	signal name of the input	
1	gain 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 constant discrete delay

Netlist format:

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

<i>field</i>	<i>description</i>	<i>value</i>
c_dlydis	part name	
name	instance name	
2	pin count	
2	pin count	
out	signal name of the output	
in	signal name of the input	
history	history	constant value or "H" for function
delay	number of steps	integer, >0
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 constant continuous delay

Netlist format:

```
_c_dly;name;2;2;out,in,
fitting,history,delay,step/ramp,scope,
history function expression
```

<i>field</i>	<i>description</i>	<i>value</i>
c_dly name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
fitting	input interpolation	"0" for staircase "1" for linear
history	history	constant value or "H" for function
delay	delay value	>0
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 variable continuous delay

Netlist format:

```
_c_dlyvar;name;2;2;out,in,
fitting,history,maxdelay,step/ramp,scope,
history function expression
;
delay function expression
```

<i>field</i>	<i>description</i>	<i>value</i>
c_dlyvar name 2 2	part name instance name pin count pin count	
out in	signal name of the output signal name of the input	
fitting	input interpolation	"0" for staircase "1" for linear
history	history	constant value or "H" for function
maxdelay	maximum delay value	>0
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", must be followed by ";" when present	
delay function expression	delay function expression	

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

4.5 Netlist format for variable pulse delay

Netlist format:

```

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

<i>field</i>	<i>description</i>	<i>value</i>
c_dlybin	part name	
name	instance name	
2	pin count	
2	pin count	
out	signal name of the output	
in	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", must be followed by ";" when present	
delay function expression	delay function expression	

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