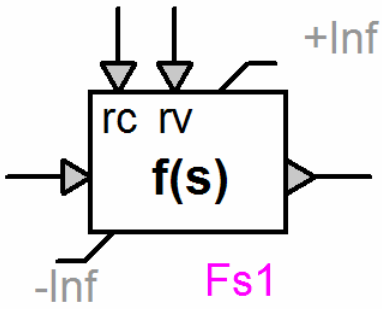
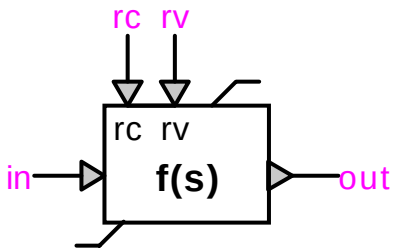
Control device : f(s) with limits



1 Description

This device applies a Laplace transfer function to the input signal, and applies low and high limits to the resulting output signal. The limits are user-defined and can have constant or variable values. The limits are dynamic.

1.1 Pins



This device has four signal pins:

pin	*description*	*value when unconnected*
in	input	0
rc	reset control	0
rv	reset value	0
out	output	as calculated

1.2 Gain

The function gain is a user-defined constant value.

1.3 Function parameters

The parameters of the function can be specified in three ways:

coefficients of the numerator and denominator polynomials in increasing order of s
coefficients of the numerator and denominator polynomials in decreasing order of s
zeros and poles of the function

In either case, the parameters are provided as a space-separated list of values for each the numerator and the denominator.

1.4 Limits

The low and high limits are user-defined constant or variable values.

The selection options for the low limit values are:

option	*value*
no limit	low limit = -infinity
constant value	low limit = user-defined value
function value	low limit = user-defined function

The selection options for the high limit values are:

option	*value*
no limit	low limit = +infinity
constant value	low limit = user-defined value
function value	low limit = user-defined function

1.5 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)

1.6 Scopes

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

1.7 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:

- when rc(t) >0

  $$out(t) = rv(t) \quad (1)$$

- else the output value is calculated as a sequence of three operations:
  - the device approximates the incremental value of the filtered input over the interval Δt by linearizing and averaging the value of the input over the interval; the polynomials in *s* are interpreted as a ratio of polynomials of the derivatives of the input and output signals, and are transformed into a ratio of polynomials in 1/z by using successive applications of the trapezoidal rule at the actual value of Δt; it responds correctly to discontinuities encountered in the value of the input between t^- and t

    $$out1(t) = f(z^{-1}) \cdot in(t) \quad (2)$$

  - then, the calculated value is checked against the value of the low limit

    $$out2(t) = \max(low(t), out1(t)) \quad (3)$$

  - then, the calculated value is checked against the value of the high limit

    $$out(t) = \min(high(t), out2(t)) \quad (4)$$

  - note: when the value of the low limit exceeds the value of the high limit, the output is given the value of the high limit without warning

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 if rc(0) > 0,	out(0) = rv(0)	(5)
else	out(0) = 0	

4 Netlist

4.1 Format

Netlist format:

```
_c_fslim;name;4;4;out,in,rc,rv,
history,high,low,kind,numcount,dencount,gain,step/ramp,scope,
history function expression
;
high limit function expression
;
low limit function expression
;
numerator parameters
;
denominator parameters
```

field	*description*	*value*
c_fslim name 4 4	part name instance name pin count pin count	
out in rc rv	signal name of the output signal name of the input signal name of the reset control signal name of the reset value	
history	history	constant value or "H" for function
high	high limit	constant value or "H" for function
low	low limit	constant value or "L" for function
kind	kind of parameters	"1" for increasing order of s "2" for decreasing order of s "3" for polynomial roots
numcount	count of numerator coefficients	>0
dencount	count of denominator coefficients	>0
gain	function gain	
step/ramp	output interpolation	"S1" for stepped "S0" for ramped
scope	monitoring, optional	"?s" for enabled
history function expression	optional, required when history field is "H"	
;	optional, required when the above line is present	
high limit function expression	optional, required when high limit field is "H"	
;	optional, required when the above line	
low limit function expression	optional, required when low limit field is "L"	
;	optional, required when the above line is present	
numerator parameters	space-separated list of numerator parameters	
;	required separator	
denominator parameters	space-separated list of denominator parameters	