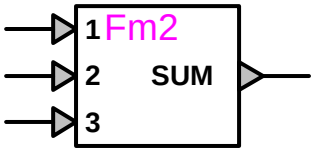
Control device : f(u)



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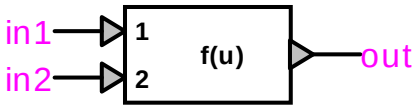
1 Description

This device applies the specified function to its inputs. The number of inputs is arbitrary, and can be zero. The function may be defined arbitrarily by the user, or selected from a list of pre-defined functions. User-defined functions may refer to simulation variables such as the value of time or time-step, and to the value of the applied input signals.

1.1 Pins



This device has one or more signal pins:

pin	*description*	*value when unconnected*
in1	input 1	0
...	more inputs	0
out	output	as calculated

1.2 Pre-defined functions

When selecting a pre-defined function, the function is considered to be applied to all inputs of the function. Some of the pre-defined functions require a specific number of inputs, while others work with a list of any number of inputs. When selecting a pre-defined function, the drawing of the function is automatically modified according to the selection. The following pre-defined functions are available:

- logical functions

function	*description*	*output value*
NOT	not	out = NOT(in > 0)
AND	and	out = (in1 > 0) AND (in2 > 0) AND ...
OR	or	out = (in1 > 0) OR (in2 > 0) OR ...
XOR	exclusive or	out = (in1 > 0) XOR (in2 > 0) XOR ...
NAND	not and	out = (in1 > 0) NAND (in2 > 0) NAND ...
NOR	not or	out = (in1 > 0) NOR (in2 > 0) NOR ...

- numerical functions

function	*description*	*output value*
RECIP	multiplicative inverse	when in(t) = 0 then out = inf inity else out = 1/in
ABS	absolute value	$out = \lvert in \rvert$
SQRT	square root	$out = \sqrt{in}$
EXP	exponential	$out = e^{in}$
LOG	base-e logarithm	$out = \log_e(in)$
LOG10	base-10 logarithm	$out = \log_{10}(in)$
DEG	radians to degrees	$out = in \cdot 180/\pi$
RAD	degrees to radians	$out = in \cdot \pi/180$
SUM	sum	$out = in1 + in2 + ...$
PROD	product	$out = in1 \cdot in2 \cdot ...$
MIN	minimum	out = min(in1, in2, ...)
MAX	maximum	out = max(in1, in2, ...)
NORM	Euclidian norm	$out = \sqrt{(in1^2 + in2^2 + ...)}$

- trigonometric functions

function	*output value*
SIN	out = sin(in)
COS	out = cos(in)
TAN	out = tan(in)
COTAN	out = cot an(in)
ASIN	$out = \sin^{-1}(in)$
ACOS	$out = \cos^{-1}(in)$
ATAN	$out = \tan^{-1}(in)$
SINH	out = sinh(in)
COSH	out = cosh(in)
TANH	out = tanh(in)

1.3 User-defined functions

User-defined functions are arbitrary expressions written according to the expression syntax rules.

1.4 History

Selection options for the history value of the output signal:

option	*value*	*rules*
zero	Inherit from inputs	
constant value	history(t) = user-defined value	any value, 0 means inherit, use 0.0 to get 0
function value	history(t) = user-defined function	constant or f(t)

1.5 Scopes

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

1.6 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:

$$out(t) = f(t, in1(t), in2(t), ...) \quad (1)$$

3 Steady-state representation

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

$$\begin{aligned} &\text{if history is defined,} && out(0) = history(0) \\ &\text{else} && out(0) = f(t, in1(0), in2(0), ...) \end{aligned} \quad (2)$$

4 Netlist

4.1 Format

Netlist format:

```
_c_fu;name;npins;npins;out,list(inputs),
history,step/ramp,scope,
history function expression
;
output function expression
```

field	*description*	*value*
c_fu name npins npins	part name instance name pin count pin count	 1+count(inputs) 1+count(inputs)
out list(inputs)	signal name of the output signal names of the inputs	
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"	
;	optional, required when the above line is present	
output function expression	provides selected output function	

4.2 Examples

Netlist example with 2 inputs, math function choice, history expression, step mode, scope:

```
_c_fu;f1;3;3;s1,s2,s3,
H,S1,?s,
5*COS(10*pi/180)
;
u[1]*t-3*ABS(u[2])
```

Netlist example with 3 inputs, selected math function “PROD”, zero initial value, ramp mode, no scope:

```
_c_fu;f2;4;4;s4,s5,s6,s7,
0,S0,
[PROD]
```