

## 1 Variables

### 2 root

	var	symbol	documentation	type	units	eqs
10	$F_{N,A}$	<b>F</b>	basic directed graph incidence matrix	network		
4	$t$	<b>t</b>	time	frame	$s$	
5	$t^o$	<b>to</b>	time zero	frame	$s$	<b>3</b>
6	$t^e$	<b>te</b>	time end	frame	$s$	<b>4</b>
7	$\Delta t$	<b>t_interval</b>	time interval	frame	$s$	<b>5</b>
9	$\Delta$	<b>pulse</b>	pulse of length time interval	frame		<b>7</b>
1	$\#$	<b>value</b>	numerical value	constant		
2	1	<b>one</b>	numerical one	constant		<b>1</b>
3	0	<b>zero</b>	numerical value zero	constant		<b>2</b>
8	0.5	<b>onehalf</b>	numerical one half	constant		<b>6</b>

### 3 physical

	var	symbol	documentation	type	units	eqs
11	$l_N$	<b>l</b>	length	frame	$m$	
12	$r_{xN}$	<b>r_x</b>	x-direction	frame	$m$	8
13	$r_{yN}$	<b>r_y</b>	y-direction	frame	$m$	9
14	$r_{zN}$	<b>r_z</b>	z-direction	frame	$m$	10
15	$V_N$	<b>V</b>	fundamental state - volume	state	$m^3$	11
16	$U_N$	<b>U</b>	fundamental state - internal energy	state	$kg\,m^2\,s^{-2}$	
17	$S_N$	<b>S</b>	fundamental state - entropy	state	$kg\,m^2\,K^{-1}\,s^{-2}$	
18	$n_{N,S}$	<b>n</b>	fundamental state - molar mass	state	$mol$	
22	$H_N$	<b>H</b>	Enthalpy	state	$kg\,m^2\,s^{-2}$	15
23	$A_N$	<b>A</b>	Helmholts energy	state	$kg\,m^2\,s^{-2}$	17
24	$G_N$	<b>G</b>	Gibbs free energy	state	$kg\,m^2\,s^{-2}$	18
25	$C_N$	<b>C</b>	fundamental state - charge	state	$A\,s$	
19	$T_N$	<b>T</b>	temperature	effort	$K$	16
20	$p_N$	<b>p</b>	pressure	effort	$kg\,m^{-1}\,s^{-2}$	13
21	$\mu_{N,S}$	<b>chemPot</b>	chemical potential	effort	$kg\,m^2\,mol^{-1}\,s^{-2}$	14

## 4 control

	var	symbol	documentation	type	units	eqs
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## 5 reactions

	var	symbol	documentation	type	units	eqs
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## 6 material

	var	symbol	documentation	type	units	eqs
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## 7 macroscopic

	var	symbol	documentation	type	units	eqs
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## 8 solid

	var	symbol	documentation	type	units	eqs
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## 9 fluid

	var	symbol	documentation	type	units	eqs
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## 10 energy

	var	symbol	documentation	type	units	eqs
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## 11 liquid

	var	symbol	documentation	type	units	eqs
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## 12 gas

	var	symbol	documentation	type	units	eqs
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## 13 control-control

	var	symbol	documentation	type	units	eqs
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## 14 energy–gas

	var	symbol	documentation	type	units	eqs
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## 15 energy–energy

	var	symbol	documentation	type	units	eqs
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## 16 gas–gas

	var	symbol	documentation	type	units	eqs
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## 17 energy-liquid

	var	symbol	documentation	type	units	eqs
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## 18 liquid–liquid

	var	symbol	documentation	type	units	eqs
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## 19 energy–solid

	var	symbol	documentation	type	units	eqs
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## 20    solid–solid

	var	symbol	documentation	type	units	eqs
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## 21 gas–liquid

	var	symbol	documentation	type	units	eqs
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## 22 gas-solid

	var	symbol	documentation	type	units	eqs
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## 23 liquid–solid

	var	symbol	documentation	type	units	eqs
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## 24 material–material

	var	symbol	documentation	type	units	eqs
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## 25 reactions-reactions

	var	symbol	documentation	type	units	eqs
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## 26 control-reactions

	var	symbol	documentation	type	units	eqs
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## 27 reactions-control

	var	symbol	documentation	type	units	eqs
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## 28 control-material

	var	symbol	documentation	type	units	eqs
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## 29 material-control

	var	symbol	documentation	type	units	eqs
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## 30 control-macroscopic

	var	symbol	documentation	type	units	eqs
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## 31 macroscopic-control

	var	symbol	documentation	type	units	eqs
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## 32 reactions-material

	var	symbol	documentation	type	units	eqs
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### 33 material-reactions

	var	symbol	documentation	type	units	eqs
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## 34 reactions-macroscopic

	var	symbol	documentation	type	units	eqs
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## 35 macroscopic-reactions

	var	symbol	documentation	type	units	eqs
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## 36 material-macroscopic

	var	symbol	documentation	type	units	eqs
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## 37    macroscopic-material

	var	symbol	documentation	type	units	eqs
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## 38 Equations

## 39 Generic

no	equation	documentation	layer
1	$1 := \text{Instantiate}(\#, \#)$	numerical one	root
2	$0 := \text{Instantiate}(\#, \#)$	numerical value zero	root
3	$t^o := \text{Instantiate}(t, 0)$	time zero	root
4	$t^e := \text{Instantiate}(t, \#)$	time end	root
5	$\Delta t := \text{Instantiate}(t, \#)$	time interval	root
6	$0.5 := \text{Instantiate}(\#, \#)$	numerical one half	root
7	$\Delta := \text{sign}(t - t^o) - \text{sign}(t - (t^o - \Delta t))$	pulse of length time interval	root
8	$r_{xN} := \text{Instantiate}(l_N, \#)$	x-direction	physical
9	$r_{yN} := \text{Instantiate}(l_N, \#)$	y-direction	physical
10	$r_{zN} := \text{Instantiate}(l_N, \#)$	z-direction	physical
11	$V_N := r_{xN} \cdot r_{yN} \cdot r_{zN}$	volume	physical
13	$p_N := \frac{\partial U_N}{\partial V_N}$	pressure	physical
14	$\mu_{N,S} := \frac{\partial U_N}{\partial n_{N,S}}$		physical
15	$H_N := U_N - p_N \cdot V_N$	Enthalpy	physical
16	$T_N := \frac{\partial U_N}{\partial S_N}$	temperature	physical
17	$A_N := U_N - T_N \cdot S_N$	Helmholts energy	physical

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no	equation	documentation	layer
18	$G_N := U_N + p_N \cdot V_N - T_N \cdot S_N$	Gibbs free energy	physical