

1 Variables

2 root

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

3 physical

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

	var	symbol	documentation	type	units	eqs
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9 chemical

	var	symbol	documentation	type	units	eqs
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10 electrical

	var	symbol	documentation	type	units	eqs
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11 magnetic

	var	symbol	documentation	type	units	eqs
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12 mechanical

	var	symbol	documentation	type	units	eqs
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13 optical

	var	symbol	documentation	type	units	eqs
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14 radiological

	var	symbol	documentation	type	units	eqs
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15 thermal

	var	symbol	documentation	type	units	eqs
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16 solid

	var	symbol	documentation	type	units	eqs
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17 fluid

	var	symbol	documentation	type	units	eqs
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18 energy

	var	symbol	documentation	type	units	eqs
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19 liquid

	var	symbol	documentation	type	units	eqs
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20 gas

	var	symbol	documentation	type	units	eqs
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21 atomic-chemical

	var	symbol	documentation	type	units	eqs
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22 atomic–atomic

	var	symbol	documentation	type	units	eqs
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23 chemical-chemical

	var	symbol	documentation	type	units	eqs
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24 atomic–electrical

	var	symbol	documentation	type	units	eqs
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25 electrical–electrical

	var	symbol	documentation	type	units	eqs
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26 atomic-energy

	var	symbol	documentation	type	units	eqs
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27 energy–energy

	var	symbol	documentation	type	units	eqs
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28 atomic-gas

	var	symbol	documentation	type	units	eqs
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29 gas–gas

	var	symbol	documentation	type	units	eqs
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30 atomic-liquid

	var	symbol	documentation	type	units	eqs
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31 liquid–liquid

	var	symbol	documentation	type	units	eqs
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32 atomic-magnetic

	var	symbol	documentation	type	units	eqs
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33 magnetic–magnetic

	var	symbol	documentation	type	units	eqs
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34 atomic-mechanical

	var	symbol	documentation	type	units	eqs
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35 mechanical–mechanical

	var	symbol	documentation	type	units	eqs
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36 atomic-optical

	var	symbol	documentation	type	units	eqs
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37 optical–optical

	var	symbol	documentation	type	units	eqs
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38 atomic-radiological

	var	symbol	documentation	type	units	eqs
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39 radiological–radiological

	var	symbol	documentation	type	units	eqs
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40 atomic-solid

	var	symbol	documentation	type	units	eqs
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41 solid-solid

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42 atomic-thermal

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43 thermal-thermal

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44 chemical-electrical

	var	symbol	documentation	type	units	eqs
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45 chemical-energy

	var	symbol	documentation	type	units	eqs
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46 chemical-gas

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47 chemical-liquid

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48 chemical–magnetic

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49 chemical–mechanical

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50 chemical-optical

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51 chemical–radiological

	var	symbol	documentation	type	units	eqs
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52 chemical-solid

	var	symbol	documentation	type	units	eqs
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53 chemical-thermal

	var	symbol	documentation	type	units	eqs
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54 control-control

	var	symbol	documentation	type	units	eqs
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55 electrical-energy

	var	symbol	documentation	type	units	eqs
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56 electrical-gas

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57 electrical–liquid

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58 electrical–magnetic

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59 electrical–mechanical

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60 electrical–optical

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61 electrical–radiological

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62 electrical–solid

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63 electrical-thermal

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64 energy-gas

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65 energy-liquid

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66 energy–magnetic

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67 energy–mechanical

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68 energy-optical

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69 energy–radiological

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70 energy–solid

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71 energy-thermal

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72 gas–liquid

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73 gas-magnetic

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74 gas-mechanical

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75 gas-optical

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76 gas-radiological

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77 gas–solid

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78 gas-thermal

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79 liquid-magnetic

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80 liquid-mechanical

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81 liquid-optical

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82 liquid-radiological

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83 liquid–solid

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84 liquid-thermal

	var	symbol	documentation	type	units	eqs
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85 magnetic–mechanical

	var	symbol	documentation	type	units	eqs
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86 magnetic-optical

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87 magnetic–radiological

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88 magnetic-solid

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89 magnetic-thermal

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90 mechanical–optical

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91 mechanical–radiological

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92 mechanical–solid

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93 mechanical–thermal

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94 optical–radiological

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95 optical–solid

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96 optical–thermal

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97 radiological-solid

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98 radiological-thermal

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99 reactions-reactions

	var	symbol	documentation	type	units	eqs
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100 solid-thermal

	var	symbol	documentation	type	units	eqs
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101 control-reactions

	var	symbol	documentation	type	units	eqs
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102 reactions-control

	var	symbol	documentation	type	units	eqs
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103 control-macroscopic

	var	symbol	documentation	type	units	eqs
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104 macroscopic-control

	var	symbol	documentation	type	units	eqs
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105 reactions–macroscopic

	var	symbol	documentation	type	units	eqs
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106 macroscopic-reactions

	var	symbol	documentation	type	units	eqs
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107 Equations

108 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	$\mu_{N,S} := \frac{\partial U_N}{\partial n_{N,S}}$	chemical potential	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

Continued on next page

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