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

5 reactions

	var	symbol	documentation	type	units	eqs

6 material

	var	symbol	documentation	type	units	eqs

7 macroscopic

	var	symbol	documentation	type	units	eqs

8   atomic

	var	symbol	documentation	type	units	eqs

9 chemical

	var	symbol	documentation	type	units	eqs

10   electrical

	var	symbol	documentation	type	units	eqs

11 magnetic

	var	symbol	documentation	type	units	eqs

12   mechanical

	var	symbol	documentation	type	units	eqs

13 optical

	var	symbol	documentation	type	units	eqs

14 radiological

	var	symbol	documentation	type	units	eqs

15 thermal

	var	symbol	documentation	type	units	eqs

16 solid

	var	symbol	documentation	type	units	eqs

17 fluid

	var	symbol	documentation	type	units	eqs

18   energy

	var	symbol	documentation	type	units	eqs

19 liquid

	var	symbol	documentation	type	units	eqs

20 gas

	var	symbol	documentation	type	units	eqs

21 atomic–chemical

	var	symbol	documentation	type	units	eqs

22 atomic–atomic

	var	symbol	documentation	type	units	eqs

23 chemical–chemical

	var	symbol	documentation	type	units	eqs

24 atomic–electrical

	var	symbol	documentation	type	units	eqs

25 electrical–electrical

	var	symbol	documentation	type	units	eqs

26 atomic–energy

	var	symbol	documentation	type	units	eqs

27 energy–energy

	var	symbol	documentation	type	units	eqs

28 atomic–gas

	var	symbol	documentation	type	units	eqs

29 gas–gas

	var	symbol	documentation	type	units	eqs

30   atomic–liquid

	var	symbol	documentation	type	units	eqs

31 liquid–liquid

	var	symbol	documentation	type	units	eqs

32 atomic–magnetic

	var	symbol	documentation	type	units	eqs

33   magnetic–magnetic

	var	symbol	documentation	type	units	eqs

34 atomic–mechanical

	var	symbol	documentation	type	units	eqs

35 mechanical–mechanical

	var	symbol	documentation	type	units	eqs

36   atomic–optical

	var	symbol	documentation	type	units	eqs

37   optical–optical

	var	symbol	documentation	type	units	eqs

38 atomic–radiological

	var	symbol	documentation	type	units	eqs

39   radiological–radiological

	var	symbol	documentation	type	units	eqs

40   atomic–solid

	var	symbol	documentation	type	units	eqs

41 solid–solid

	var	symbol	documentation	type	units	eqs

42   atomic–thermal

	var	symbol	documentation	type	units	eqs

43   thermal–thermal

	var	symbol	documentation	type	units	eqs

44   chemical–electrical

	var	symbol	documentation	type	units	eqs

45 chemical–energy

	var	symbol	documentation	type	units	eqs

46 chemical–gas

	var	symbol	documentation	type	units	eqs

47   chemical–liquid

	var	symbol	documentation	type	units	eqs

48   chemical–magnetic

	var	symbol	documentation	type	units	eqs

49 chemical–mechanical

	var	symbol	documentation	type	units	eqs

50 chemical–optical

	var	symbol	documentation	type	units	eqs

51 chemical–radiological

	var	symbol	documentation	type	units	eqs

52 chemical–solid

	var	symbol	documentation	type	units	eqs

53 chemical–thermal

	var	symbol	documentation	type	units	eqs

54 control–control

	var	symbol	documentation	type	units	eqs

55 electrical–energy

	var	symbol	documentation	type	units	eqs

56   electrical–gas

	var	symbol	documentation	type	units	eqs

57 electrical–liquid

	var	symbol	documentation	type	units	eqs

58   electrical–magnetic

	var	symbol	documentation	type	units	eqs

59   electrical–mechanical

	var	symbol	documentation	type	units	eqs

60   electrical–optical

	var	symbol	documentation	type	units	eqs

61 electrical–radiological

	var	symbol	documentation	type	units	eqs

62 electrical–solid

	var	symbol	documentation	type	units	eqs

63 electrical–thermal

	var	symbol	documentation	type	units	eqs

64 energy–gas

	var	symbol	documentation	type	units	eqs

65　energy–liquid

	var	symbol	documentation	type	units	eqs

66 energy–magnetic

	var	symbol	documentation	type	units	eqs

67 energy–mechanical

	var	symbol	documentation	type	units	eqs

68 energy–optical

	var	symbol	documentation	type	units	eqs

69 energy–radiological

	var	symbol	documentation	type	units	eqs

70   energy–solid

	var	symbol	documentation	type	units	eqs

71 energy–thermal

	var	symbol	documentation	type	units	eqs

72 gas–liquid

	var	symbol	documentation	type	units	eqs

73 gas–magnetic

	var	symbol	documentation	type	units	eqs

74 gas–mechanical

	var	symbol	documentation	type	units	eqs

75 gas–optical

	var	symbol	documentation	type	units	eqs

76   gas–radiological

	var	symbol	documentation	type	units	eqs

77 gas–solid

	var	symbol	documentation	type	units	eqs

78 gas–thermal

	var	symbol	documentation	type	units	eqs

79 liquid–magnetic

	var	symbol	documentation	type	units	eqs

80 liquid–mechanical

	var	symbol	documentation	type	units	eqs

81 liquid–optical

	var	symbol	documentation	type	units	eqs

82 liquid–radiological

	var	symbol	documentation	type	units	eqs

83 liquid–solid

	var	symbol	documentation	type	units	eqs

84 liquid–thermal

	var	symbol	documentation	type	units	eqs

85   magnetic–mechanical

	var	symbol	documentation	type	units	eqs

86 magnetic–optical

	var	symbol	documentation	type	units	eqs

87 magnetic–radiological

	var	symbol	documentation	type	units	eqs

88   magnetic–solid

	var	symbol	documentation	type	units	eqs

89   magnetic–thermal

	var	symbol	documentation	type	units	eqs

90   mechanical–optical

	var	symbol	documentation	type	units	eqs

91 mechanical–radiological

	var	symbol	documentation	type	units	eqs

92 mechanical–solid

	var	symbol	documentation	type	units	eqs

93 mechanical–thermal

	var	symbol	documentation	type	units	eqs

94 optical–radiological

	var	symbol	documentation	type	units	eqs

95   optical–solid

	var	symbol	documentation	type	units	eqs

96   optical–thermal

	var	symbol	documentation	type	units	eqs

97 radiological–solid

	var	symbol	documentation	type	units	eqs

98 radiological–thermal

	var	symbol	documentation	type	units	eqs

99   reactions–reactions

	var	symbol	documentation	type	units	eqs

100 solid–thermal

	var	symbol	documentation	type	units	eqs

101 control–reactions

	var	symbol	documentation	type	units	eqs

102 reactions–control

	var	symbol	documentation	type	units	eqs

103 control–macroscopic

	var	symbol	documentation	type	units	eqs

104   macroscopic–control

	var	symbol	documentation	type	units	eqs

105   reactions–macroscopic

	var	symbol	documentation	type	units	eqs

106 macroscopic−reactions

	var	symbol	documentation	type	units	eqs

107 Equations

108 Generic

no	equation	documentation	layer
1	$1 := \mathrm{Instantiate}(\#, \#)$	numerical one	root
2	$0 := \mathrm{Instantiate}(\#, \#)$	numerical value zero	root
3	$t^o := \mathrm{Instantiate}(t, 0)$	time zero	root
4	$t^e := \mathrm{Instantiate}(t, \#)$	time end	root
5	$\Delta t := \mathrm{Instantiate}(t, \#)$	time interval	root
6	$0.5 := \mathrm{Instantiate}(\#, \#)$	numerical one half	root
7	$\Delta := \mathrm{sign}\,(t - t^o) - \mathrm{sign}\,(t - (t^o - \Delta t))$	pulse of length time interval	root
8	$r_{xN} := \mathrm{Instantiate}(l_N, \#)$	x-direction	physical
9	$r_{yN} := \mathrm{Instantiate}(l_N, \#)$	y-direction	physical
10	$r_{zN} := \mathrm{Instantiate}(l_N, \#)$	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

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