1 Variables

2 root

	var	symbol	documentation	type	units	tokens	eqs
8	$F_{N,A}$	`F`	directed graph indicence matrix	network		[]	
1	t	`t`	time	frame	s	[]	
6	t_o	`to`	starting time	frame	s	[]	3
7	t_e	`te`	end time	frame	s	[]	4
3	#	`value`	numerical value	constant		[]	
4	1	`one`	numerical value 1	constant		[]	1
5	0	`null`	numerical value 0	constant		[]	2

3 Properties

	var	symbol	documentation	type	units	tokens	eqs
57	${M^{A,\alpha}}_N$	`M_A_alpha`	norming factor token A mechanism alpha	constant		[]	51
58	${M^{A,\beta}}_N$	`M_A_beta`	norming factor token A mechanism beta	constant		[]	52
59	${M^{B,\gamma}}_N$	`M_B_gamma`	norming factor token B mechanism gamma	constant		[]	53
60	${M^{B,\delta}}_N$	`M_B_delta`	norming factor token B mechanism delta	constant		[]	54
69	${M^{A}}_N$	`M_A`	stack of M matrices token A	propertyOut		[]	55
70	${M^{B}}_N$	`M_B`	stack of M matrices token B	propertyOut		[]	56
71	M_N	`M`	stack of M matrices token A and B	propertyOut		[]	57

4 Control

	var	symbol	documentation	type	units	tokens	eqs
67	y_A	`y`	controller output	controlOut		[]	49 50
61	m_A	`m`	measurement	measureIn		[]	61 62
65	$I_{N,D}$	`I_N_D`	Identity to shift from differential space to integral space	network		[]	
66	$I_{A,D}$	`I_A_D`	identity to shift from differential space to arc	network		[]	
55	x_N	`x`	controller state	state		[]	48
56	${x^o}_N$	`xo`	controller state initial condition	state		[]	44
50	$A_{N,D}$	`A`	dynamic matrix A	constant	s^{-1}	[]	
51	$B_{A,D}$	`B`	input matrix C	constant	s^{-1}	[]	
52	$C_{N,A}$	`C`	output matrix C	constant		[]	
53	$D_{N,A}$	`D`	event matrix D	constant		[]	
62	y_{sA}	`setpoint`	set point	constant		[]	45
63	e_A	`e`	control error	constant		[]	46
68	D_A	`D_A`	event diagonal matrix D	constant		[]	
64	$\dot{x}_D$	`dx`	differential state	differentialState	s^{-1}	[]	47

5 System

	var	symbol	documentation	type	units	tokens	eqs
76	u_A	u	[0-1]-normed control signal	controlIn		[]	63 70
74	z_N	measure	normed measurement of pi A alpha	measureOut		[]	59
75	$\underline{\mathbf{z}}_A$	measure_set_A	measurement vector for A	measureOut		[]	60
25	${\hat{x}^{A,\alpha}}_N$	fx_A_alpha	netflow of token A due to mechanism alpha	transport	ms^{-1}	[]	11
26	${\hat{x}^{A,\beta}}_N$	fx_A_beta	net flow of token A due to mechanism beta	transport	ms^{-1}	[]	12
27	${\hat{y}^{B,\gamma}}_N$	fy_B_gamma	netflow of token B due to mechanism gamma	transport	s^{-1}	[]	14
28	${\hat{y}^{B,\delta}}_N$	fy_B_delta	netflow of token B due to mechansim beta	transport	s^{-1}	[]	15
80	$fx_{Aa}lpha_{mA}$	fx_A_alpha_m	flow of token A due to mechanism alpha	transport	ms^{-1}	[]	75
73	$I_{zN,A}$	I_measure	unidirectional graph for interface connection	network		[]	
36	$D_{N,A}$	D	difference operator	differenceOperator		[]	
9	x_N	x	state token A	state	m	[]	20
10	y_N	y	state token B	state		[]	21
11	${x^o}_N$	xo	initial condition for state x	state	m	[]	5
12	${y^o}_N$	yo	initial condition for state y	state		[]	6
34	s	s	mixed state	state		[]	31
13	${K^{A,\alpha}}_A$	K_A_alpha	conductivity token A mechanism alpha	constant	s^{-1}	[]	
14	${K^{A,\beta}}_A$	K_A_beta	conductivity token A mechanism beta	constant	s^{-1}	[]	
15	${K^{B,\gamma}}_A$	K_B_gamma	conductivity token B mechanism gamma	constant	s^{-1}	[]	
16	${K^{B,\delta}}_A$	K_B_delta	conductivity token B mechanism delta	constant	s^{-1}	[]	
17	${M^{A,\alpha}}_N$	M_A_alpha	norming factor token A mechanism alpha	constant		[]	
18	${M^{A,\beta}}_N$	M_A_beta	norming factor token A mechanism beta	constant		[]	
19	${M^{B,\gamma}}_N$	M_B_gamma	norming factor token B mechanism gamma	constant		[]	
20	${M^{B,\delta}}_N$	M_B_delta	norming factor token B mechanism delta	constant		[]	

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	var	symbol	documentation	type	units	tokens	eqs
72	$\pi^{A,\alpha,o}{}_N$	`pi_A_alpha_norm`	norming factor for pi A alpha	constant	m	[]	58
29	$\dot{x}_N$	`dx`	diferential balance for token A	differentialState	ms^{-1}	[]	16 32
30	$\dot{y}_N$	`dy`	differential balance for token B	differentialState	s^{-1}	[]	17 33
35	$\dot{xy}$	`dxy`	mixed stack of the two accumulation terms	differentialState		[]	34
21	$\pi^{A,\alpha}{}_N$	`pi_A_alpha`	effort for A mechanism alpha	secondaryState	m	[]	7 27
22	$\pi^{A,\beta}{}_N$	`pi_A_beta`	effort for A mechanism beta	secondaryState	m	[]	8 28
23	$\pi^{B,\gamma}{}_N$	`pi_B_gamma`	effort for B mechanism gamma	secondaryState		[]	9 29
24	$\pi^{B,\delta}{}_N$	`pi_B_delta`	effort for B mechanism delta	secondaryState		[]	10 30
31	$\underline{\pi}^{A}{}_N$	`pi_A_stack`	effort for token A stack	secondaryState	m	[]	24
32	$\underline{\pi}^{B}{}_N$	`pi_B_stack`	effort for token B stack	secondaryState		[]	25
33	$\underline{\pi}^{A,B}$	`pi_stack`	effort for token A, B stack	secondaryState		[]	26
77	$M^{A}{}_N$	`M_A`	stack of M matrices for token A	propertyIn		[]	64 67
78	$M^{B}{}_N$	`M_B`	stack of M matrices for token B	propertyIn		[]	65 68
79	M_N	`M`	stack of all M matrices	propertyIn		[]	66 69

6 Equations

7 Generic

no	equation	documentation	layer
1	$1 := \text{Instantiate}(\#, \#)$	numerical value 1	root
2	$0 := \text{Instantiate}(\#, \#)$	numerical value 0	root
3	$t_o := \text{Instantiate}(t, \#)$	starting time	root
4	$t_e := \text{Instantiate}(t, \#)$	end time	root
5	${x^o}_N := \text{Instantiate}(x_N, \#)$	initial condition for state x	System
6	${y^o}_N := \text{Instantiate}(y_N, \#)$	initial condition for state y	System
7	${\pi^{A,\alpha}}_N := {M^{A,\alpha}}_N \,.\, x_N$	effort for B mechanism alpha	System
8	${\pi^{A,\beta}}_N := {M^{A,\beta}}_N \,.\, x_N$	effort for A mechanism beta	System
9	${\pi^{B,\gamma}}_N := {M^{B,\gamma}}_N \,.\, y_N$	effort for B mechanism gamma	System
10	${\pi^{B,\delta}}_N := {M^{B,\delta}}_N \,.\, y_N$	effort for B mechanism delta	System
11	${\hat{x}^{A,\alpha}}_N := {F_{N,A}}^{A} \star \left({u_A} \,.\, {K^{A,\alpha}}_A \,.\, {D_{N,A}}^{N} \star {\pi^{A,\alpha}}_N \right)$	netflow of token A due to mechanism alpha	System
12	${\hat{x}^{A,\beta}}_N := {F_{N,A}}^{A} \star \left({K^{A,\beta}}_A \,.\, {D_{N,A}}^{N} \star {\pi^{A,\beta}}_N \right)$	net flow of token A due to mechanism beta	System
14	${\hat{y}^{B,\gamma}}_N := {F_{N,A}}^{A} \star \left({K^{B,\gamma}}_A \,.\, {D_{N,A}}^{N} \star {\pi^{B,\gamma}}_N \right)$	netflow of token B due to mechanism gamma	System
15	${\hat{y}^{B,\delta}}_N := {F_{N,A}}^{A} \star \left({K^{B,\delta}}_A \,.\, {D_{N,A}}^{N} \star {\pi^{B,\delta}}_N \right)$	netflow of token B due to mechansim beta	System

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no	equation	documentation	layer
16	$\dot{x}_N := \hat{x}^{A,\alpha}{}_N + \hat{x}^{A,\beta}{}_N$	diferential balance for token A	System
17	$\dot{y}_N := \hat{y}^{B,\gamma}{}_N + \hat{y}^{B,\delta}{}_N$	differential balance for token B	System
20	$x_N := \int_{t_o}^{t_e} \dot{x}_N \ dt + x^o{}_N$	state token A	System
21	$y_N := \int_{t_o}^{t_e} \dot{y}_N \ dt + y^o{}_N$	state token B	System
24	$\underline{\pi}^A{}_N := \text{Stack}\left(\pi^{A,\alpha}{}_N, \pi^{A,\beta}{}_N\right)$	effort for token A stack	System
25	$\underline{\pi}^B{}_N := \text{Stack}\left(\pi^{B,\gamma}{}_N, \pi^{B,\delta}{}_N\right)$	effort for token B stack	System
26	$\underline{\pi}^{A,B} := \text{MixedStack}\left(\underline{\pi}^A{}_N, \underline{\pi}^B{}_N\right)$	effort for token A, B stack	System
27	$\pi^{A,\alpha}{}_N := \text{Instantiate}(\pi^{A,\alpha}{}_N, \#)$	effort for B mechanism alpha	System
28	$\pi^{A,\beta}{}_N := \text{Instantiate}(\pi^{A,\beta}{}_N, \#)$	effort for A mechanism beta	System
29	$\pi^{B,\gamma}{}_N := \text{Instantiate}(\pi^{B,\gamma}{}_N, \#)$	effort for B mechanism gamma	System
30	$\pi^{B,\delta}{}_N := \text{Instantiate}(\pi^{B,\delta}{}_N, \#)$	effort for B mechanism delta	System
31	$s := \text{MixedStack}\left(x_N, y_N\right)$	mixed state	System
32	$\dot{x}_N := \text{Instantiate}(\dot{x}_N, 0)$	diferential balance for token A	System
33	$\dot{y}_N := \text{Instantiate}(\dot{y}_N, 0)$	differential balance for token B	System
34	$\dot{xy} := \text{MixedStack}\left(\dot{x}_N, \dot{y}_N\right)$	mixed stack of the two accumulation terms	System
44	$x^o{}_N := \text{Instantiate}(x_N, \#)$	controller state initial condition	Control
45	$y_{sA} := \text{Instantiate}(m_A, \#)$	set point	Control
46	$e_A := m_A - y_{sA}$	control error	Control

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no	equation	documentation	layer
47	$\dot{x}_D := A_{N,D} \overset{N}{\star} x_N + B_{A,D} \overset{A}{\star} e_A$	differential state	Control
48	$x_N := \int_{t_o}^{t_e} I_{N,D} \overset{D}{\star} \dot{x}_D \; dt$	controller state	Control
49	$y_A := C_{N,A} \overset{N}{\star} x_N + I_{A,D} \overset{D}{\star} \left(I_{N,D} \overset{N}{\star} D_{N,A} \overset{A}{\star} e_A \right)$	controller output	Control
50	$y_A := C_{N,A} \overset{N}{\star} x_N + D_A \cdot e_A$	controller output	Control
51	$M^{A,\alpha}{}_N := \text{Instantiate}(M^{A,\alpha}{}_N, \#)$	norming factor token A mechanism alpha	Properties
52	$M^{A,\beta}{}_N := \text{Instantiate}(M^{A,\beta}{}_N, \#)$	norming factor token A mechanism beta	Properties
53	$M^{B,\gamma}{}_N := \text{Instantiate}(M^{B,\gamma}{}_N, \#)$	norming factor token B mechanism gamma	Properties
54	$M^{B,\delta}{}_N := \text{Instantiate}(M^{B,\delta}{}_N, \#)$	norming factor token B mechanism delta	Properties
55	$M^{A}{}_N := \text{Stack}\left(M^{A,\alpha}{}_N, M^{A,\beta}{}_N\right)$	stack of M matrices token A	Properties
56	$M^{B}{}_N := \text{Stack}\left(M^{B,\gamma}{}_N, M^{B,\delta}{}_N\right)$	stack of M matrices token B	Properties
57	$M_N := \text{Stack}\left(M^{A}{}_N, M^{B}{}_N\right)$	stack of M matrices token A and B	Properties
58	$\pi^{A,\alpha,o}{}_N := \text{Instantiate}(\pi^{A,\alpha}{}_N, \#)$	norming factor for pi A alpha	System
59	$z_N := \left(\pi^{A,\alpha,o}{}_N\right)^{-1} \cdot \pi^{A,\alpha}{}_N$	normed measurement of pi A alpha	System
60	$\underline{\mathbf{z}}_A := I_{zN,A} \overset{N}{\star} z_N$	measurement vector for A	System
61	$m_A := \text{Instantiate}(m_A, \#)$	measurement	Control
63	$u_A := \text{Instantiate}(u_A, \#)$	[0-1]-normed control signal	System

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no	equation	documentation	layer
64	$M^A{}_N := \text{Stack}\left(M^{A,\alpha}{}_N, M^{A,\beta}{}_N\right)$	stack of M matrices for token A	System
65	$M^B{}_N := \text{Stack}\left(M^{B,\gamma}{}_N, M^{B,\delta}{}_N\right)$	stack of M matrices for token B	System
66	$M_N := \text{Stack}\left(M^A{}_N, M^B{}_N\right)$	stack of all M matrices	System
75	$fx_{Aa}lpha_{mA} := \left(u_A \,.\, K^{A,\alpha}{}_A \,.\, D_{N,A} \overset{N}{\star} \pi^{A,\alpha}{}_N\right)$	flow of token A due to mechanism alpha	System

8 Interface Link Equation

no	equation	documentation	layer
62	$m_A := \underline{\mathbf{z}}_A$	interface equation	System –> Control
67	$M^A{}_N := M^A{}_N$	interface equation	Properties –> System
68	$M^B{}_N := M^B{}_N$	interface equation	Properties –> System
69	$M_N := M_N$	interface equation	Properties –> System
70	$u_A := y_N$	interface equation	Control –> System