Consejo Nacional de Operación

ANEXO 1

DATOS TÉCNICOS GENERALES DE LAS UNIDADES DE GENERACIÓN DE LA CENTRAL HIDROELÉCTRICA DE MIEL 1

Tabla 1. Parámetros del generador.

Libary >> Equipment Type Library >> Miel Generator		
PARÁMETRO GENERADOR	**UNIDAD**	**VALOR**
Fabricante	ALSTOM	
Tipo	Polos salientes	
Potencia aparente Nominal	Sn [MVA]	150
Tensión de estator Nominal	Un [kV]	13.8
Factor de potencia	Cos (phi)	0.9
Velocidad Nominal	fn [rpm]	300
Resistencia de Armadura del Estator	ra [pu]	0.0027
Reactancia de Fuga del Estator.	xl [pu]	0.1072
Reactancia sincrónica eje D (no saturado)	xd [pu]	1.35
Reactancia sincrónica eje Q (no saturado)	xq [pu]	0.75
Reactancia transiente sincrónica eje D (no saturado)	xd' [pu]	0.36
Reactancia sub-transiente sincrónica eje D (no saturado)	xd'' [pu]	0.18
Reactancia de sub-transiente sincrónica eje Q (no saturado)	xq'' [pu]	0.18
Constante de tiempo transiente (circuito abierto) sin carga eje D	Td'o [s]	6.2
Constante de tiempo sub-transiente (circuito abierto) sin carga eje D	Td''o [s]	0.08
Constante de tiempo sub-transiente (circuito abierto) sin carga eje Q	Tq''o [s]	0.08
Constante de inercia (todo el eje incluyendo la turbina)	H [MWs/MVA]	5.389
Impedancia de secuencia negativa	X-[pu]	0.0133
Impedancia de secuencia cero	X0[pu]	0.0059

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ANEXO 2

DIAGRAMAS DE BLOQUE Y TABLAS DE VALORES DE LOS PARÁMETROS DE CONTROL DE LA UNIDAD 1

Sistema de Excitación

Parámetros Regulador de tensión (AVR) y Limitadores

Tabla 2. Parámetros AVR y Limitadores

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U1_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Measurement Time Constant	Tr	[s]	0.001
Maximum thermal stator current limit	ITth	[p.u.]	2.55
Measurement time constant	TR_scl	[s]	0.001
ST5C not active selection	AVR_mode_disable_scl	[logic]	0
Release of IGnd limiter	ignd_onoff	[logic]	1
Release of IGCap limiter	igcap_onoff	[logic]	0
Measurement Time Constant	Tr_e	[s]	0.05
Measurement Time Constant	TR_uel	[s]	0.001
Direct axis synchronous reactance	Xd	[pu]	1.35
Quadrature axis synchronous reactance	Xq	[pu]	0.75
ST5C not active selection	AVR_mode_disable_uel	[pu]	0
OEL active/deactive selector	uel_onoff	[logic]	1

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Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U1_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Maximum thermal field current limit	IFth	[pu]	2
Maximum field current limit	IFmax	[pu]	2.1
Measurement Time Constant	TR_oel	[s]	0.001
ST5C not active selection	AVR_mode_disable_oel	[pu]	0
OEL active/deactive selector	oel_onoff	[logic]	1
Controller Gain	KR1	[pu]	500
Steady state gain	KR2	[p.u.]	500
Steady state gain adjustment	KR2i	[p.u.]	0.8
Fixed time integration constant	KToI	[1/s]	0
Cooling integration constant	KCI	[1/s]	0.01
Inverse time characteristic integration constant	KHI	[1/s]	0.0381
	MC_Sn		150
Steady state gain	KR4	[p.u.]	250
Steady state gain adjustment	KR4i	[p.u.]	0.5
Reactive Power Measurement Gain	KIR	[pu]	0
Steady State Gain	KR6	[pu]	500
Active Power Measurement Gain	KIA	[pu]	0
Lead-time constant	TC26	[s]	0.1
Lag-time constant	TB26	[s]	0.1
Lead-time constant	TC16	[s]	1.52
Lag-time constant	TB16	[s]	9.5
Steady State Gain Adjustment	KR6i	[pu]	0.4
Steady State Gain	KR3	[pu]	500

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Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U1_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Steady State Gain Adjustment	KR3i	[pu]	0.3
Fixed integration time	KToF	[s]	0.1
Cooling integration time	KCF	[s]	0
Inverse time characteristic integration time	KHF	[s]	0.0429
Exponent factor of inverse time characteristic	KexpIT	[-]	2
Controller first lag time constant	TB12	[s]	9.5
Controller first lead time constant	TC12	[s]	1.52
Controller second lag time constant	TB22	[s]	0.1
Controller second lead time constant	TC22	[s]	0.1
Controller first lag time constant	TB14	[s]	25
Controller first lead time constant	TC14	[s]	3
Controller second lag time constant	TB24	[s]	0.01
Controller second lead time constant	TC24	[s]	0.01
Lag-time constant	Tb21	[s]	21.56
Lead-time constant	Tc21	[s]	3.45
Lag-time constant	Tb11	[s]	0.1
Lead-time constant	Tc11	[s]	0.1
Exponent factor of inverse characteristic	KexpIF	[pu]	1
Lag-time constant	TB13	[s]	9.5
Lead-time constant	TC13	[s]	1.52
Lag-time constant	TB23	[s]	0.1
Lead-time constant	TC23	[s]	0.1
1st Lead Lag Minimum Limit	LL12minlim	[pu]	-0.2

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Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U1_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
2st Lead Lag Minimum Limit	LL22minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL14minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL24minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL21_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL11_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL13minlim	[pu]	-0.2
2st Lead Lag Minimum Limit	LL23minlim	[pu]	-1.25
Voltage Regulator Minimum Output	VA_min	[pu]	-100
2st Lead Lag Minimum Limit	LL26minlim	[pu]	-1.25
1st Lead Lag Minimum Limit	LL16minlim	[pu]	-0.2
1st Lead Lag Maximum Limit	LL12maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL22maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL14maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL24maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL21_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL11_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL13maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL23maxlim	[pu]	1.25
Voltage Regulator Maximum Output	VA_max	[pu]	100
2st Lead Lag Maximum Limit	LL26maxlim	[pu]	1.25
1st Lead Lag Maximum Limit	LL16maxlim	[pu]	0.2

Lookup Table_lin array_UEL	
UEL_x	UEL_y

0	-0,6
0,2	-0,6
0,4	-0,6
0,6	-0,55
0,8	-0,45
1	-0,3

Modelo Regulador de tensión (AVR)

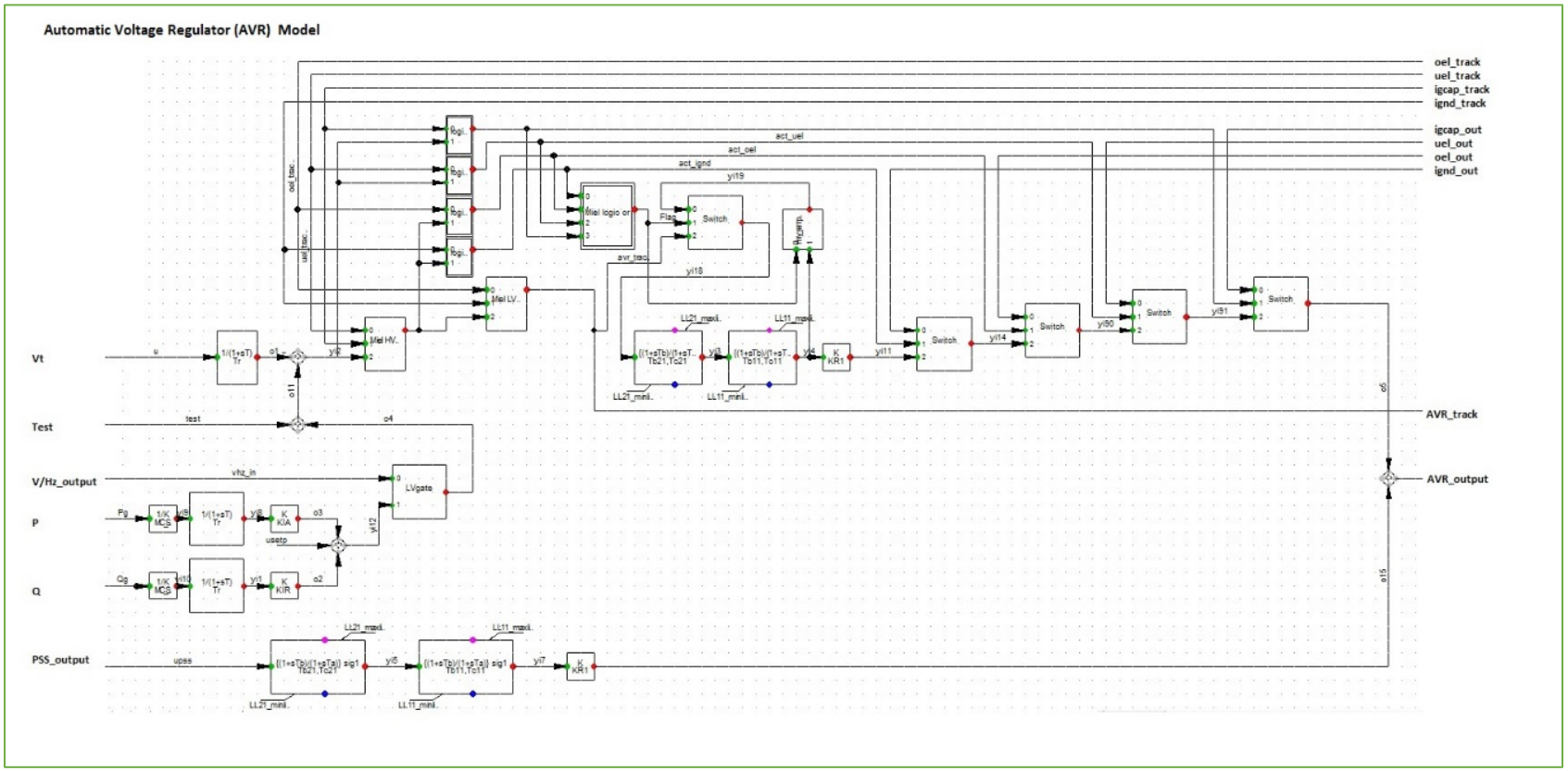
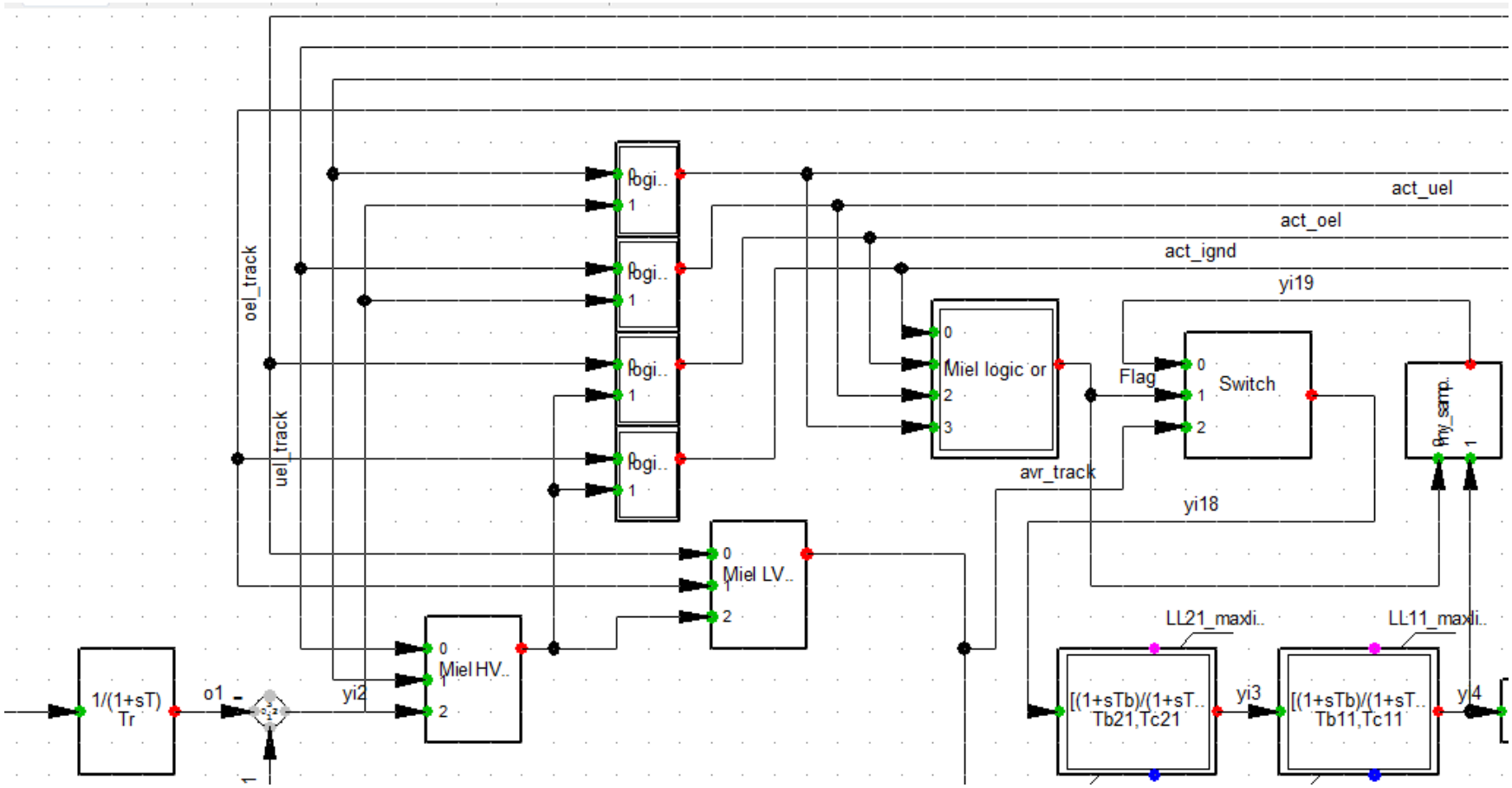


Figura 1. Modelo AVR.


oel_track
uel_track
Logi..
Logi..
Logi..
Logi..
act_uel
act_oel
act_ignd
yi19
Miel logic or
Flag
Switch
avr_track
yi18
Hy_samp..
Miel LV..
Miel HV..
1/(1+sT)
Tr
o1
yi2
LL21_maxli..
LL11_maxli..
[(1+sTb)/(1+sT..
Tb21,Tc21
yi3
[(1+sTb)/(1+sT..
Tb11,Tc11
yi4

cno
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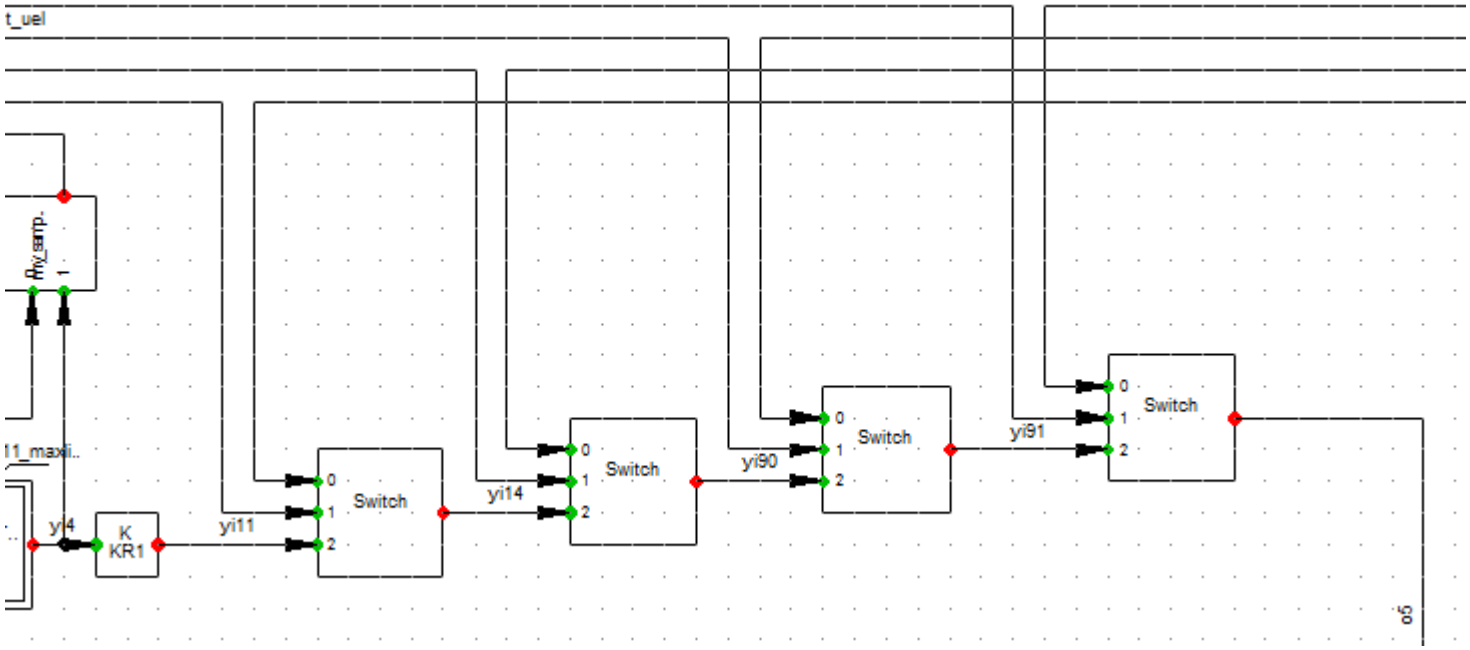
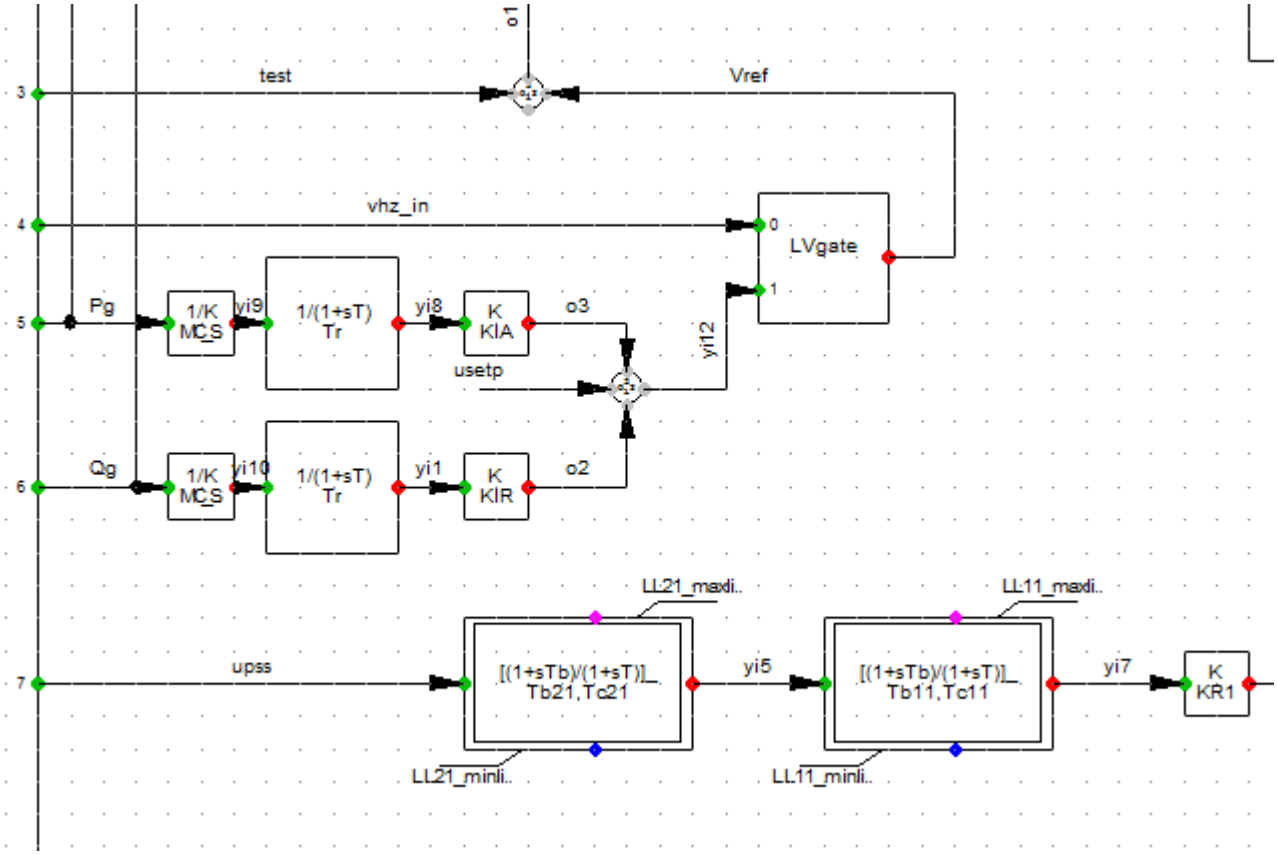
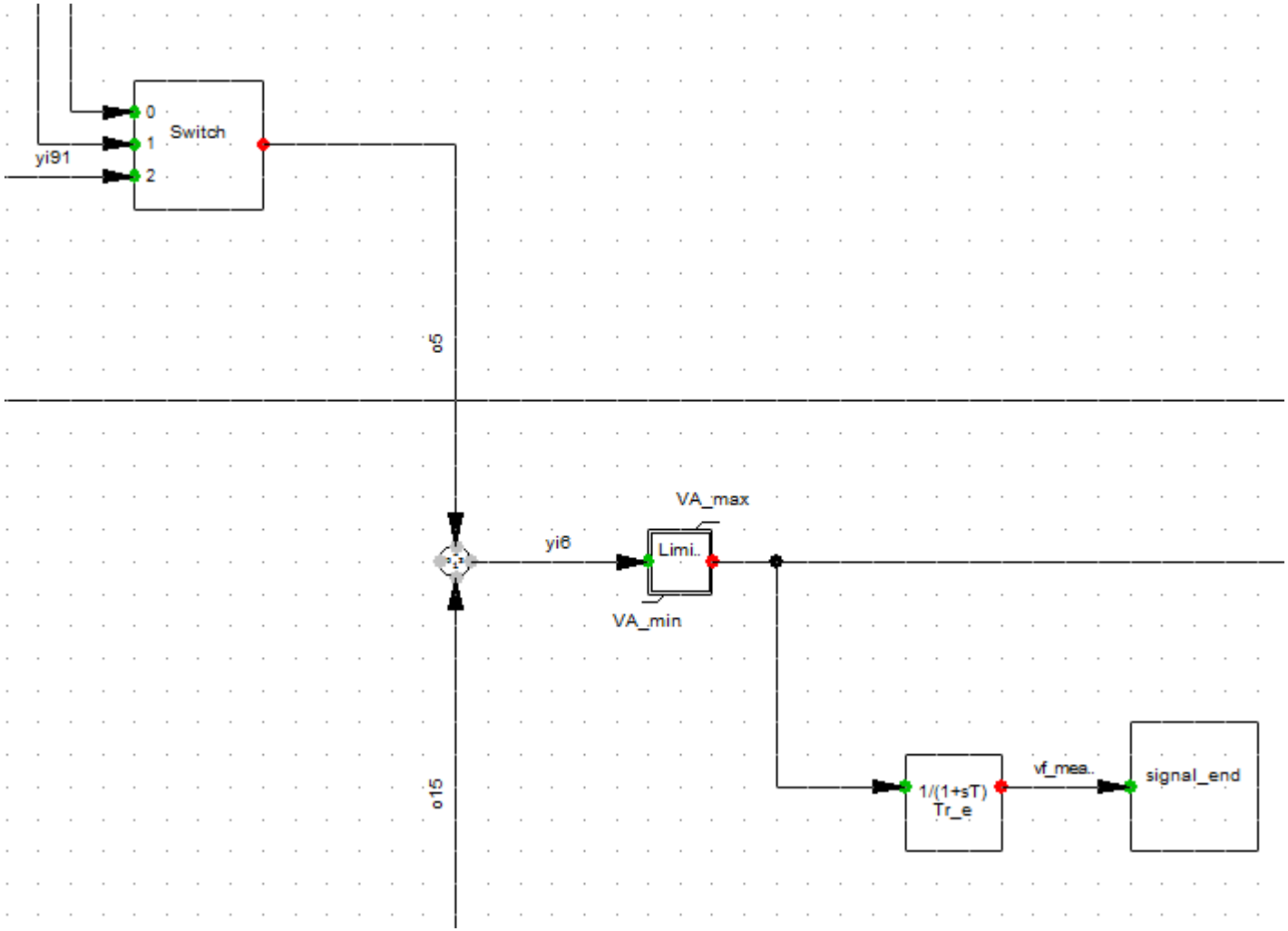



o1
test
Vref
3
vhz_in
4
0
LVgate
1
Pg
5
1/K
MCS
yi9
1/(1+sT)
Tr
yi8
K
KIA
o3
yi12
usetp
Qg
6
1/K
MCS
yi10
1/(1+sT)
Tr
yi1
K
KIR
o2
LL21_maxdi..
LL11_maxdi..
upss
7
[(1+sTb)/(1+sT)]_
Tb21,Tc21
yi5
[(1+sTb)/(1+sT)]_
Tb11,Tc11
yi7
K
KR1
LL21_minli..
LL11_minli..


0
1
2
Switch
yi91
o5
VA_max
yi6
Limi..
VA_min
o15
1/(1+sT)
Tr_e
vf_mea..
signal_end

Modelo Limitador de Limitador de subexcitación (UEL)

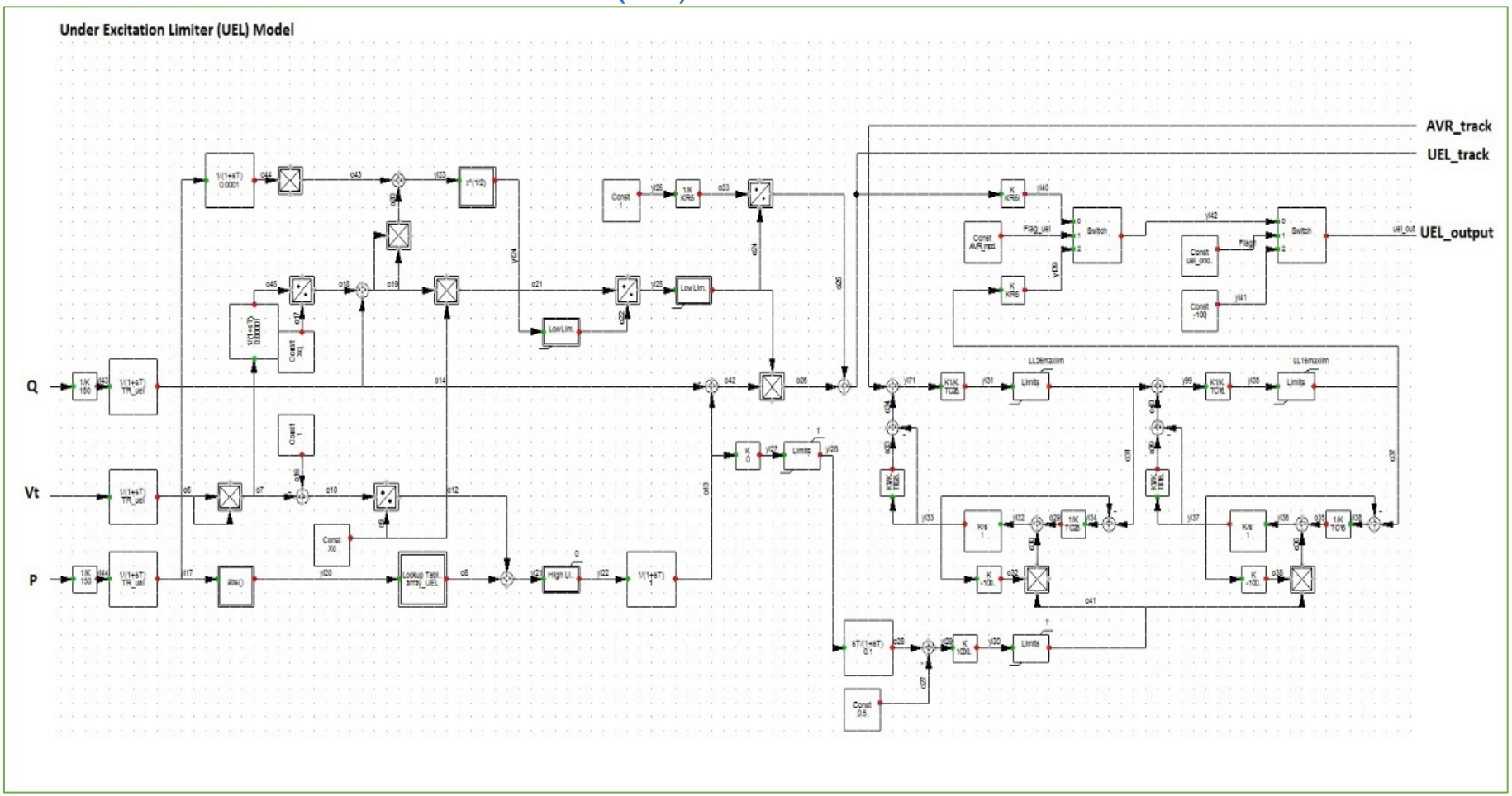
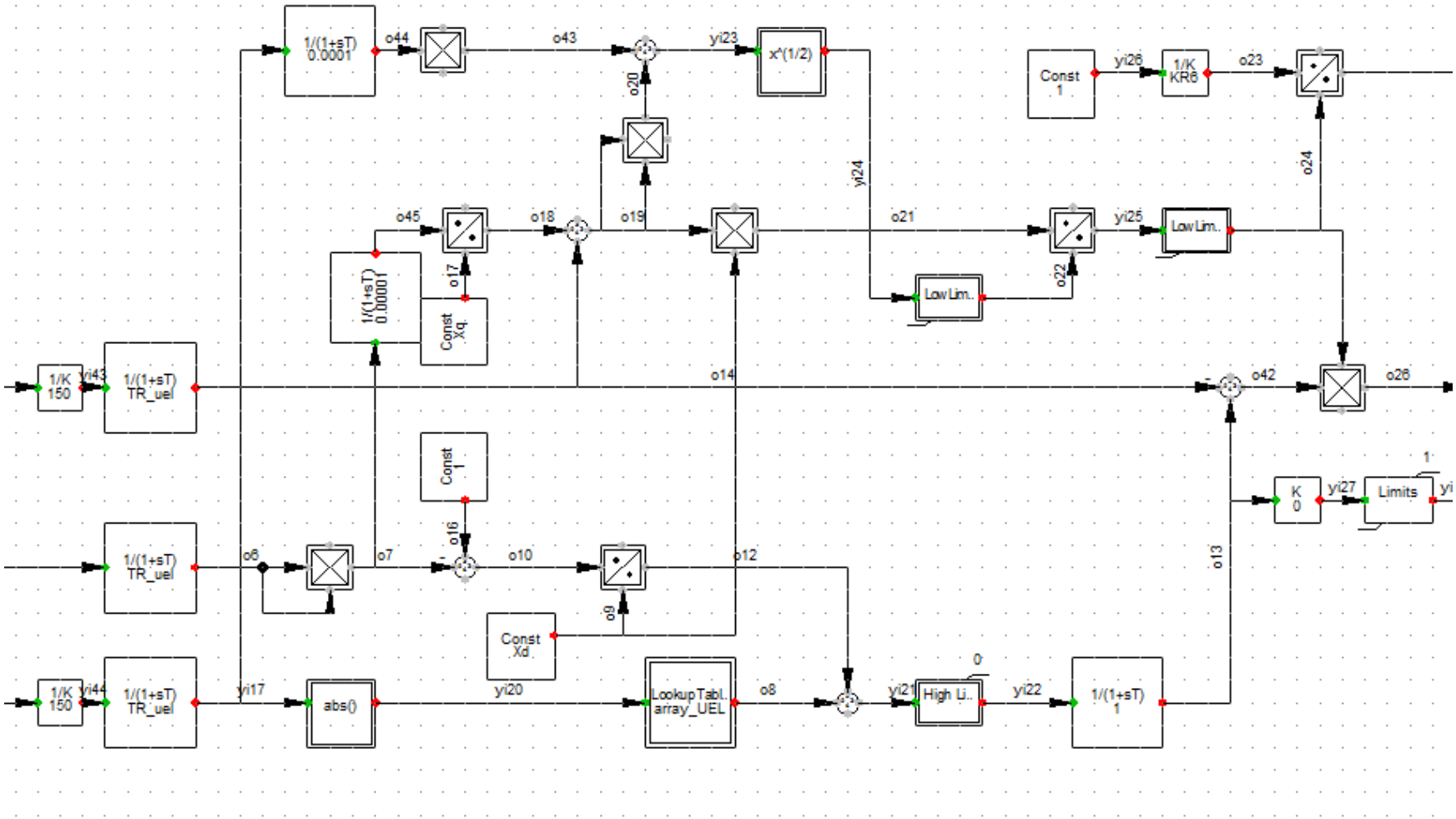
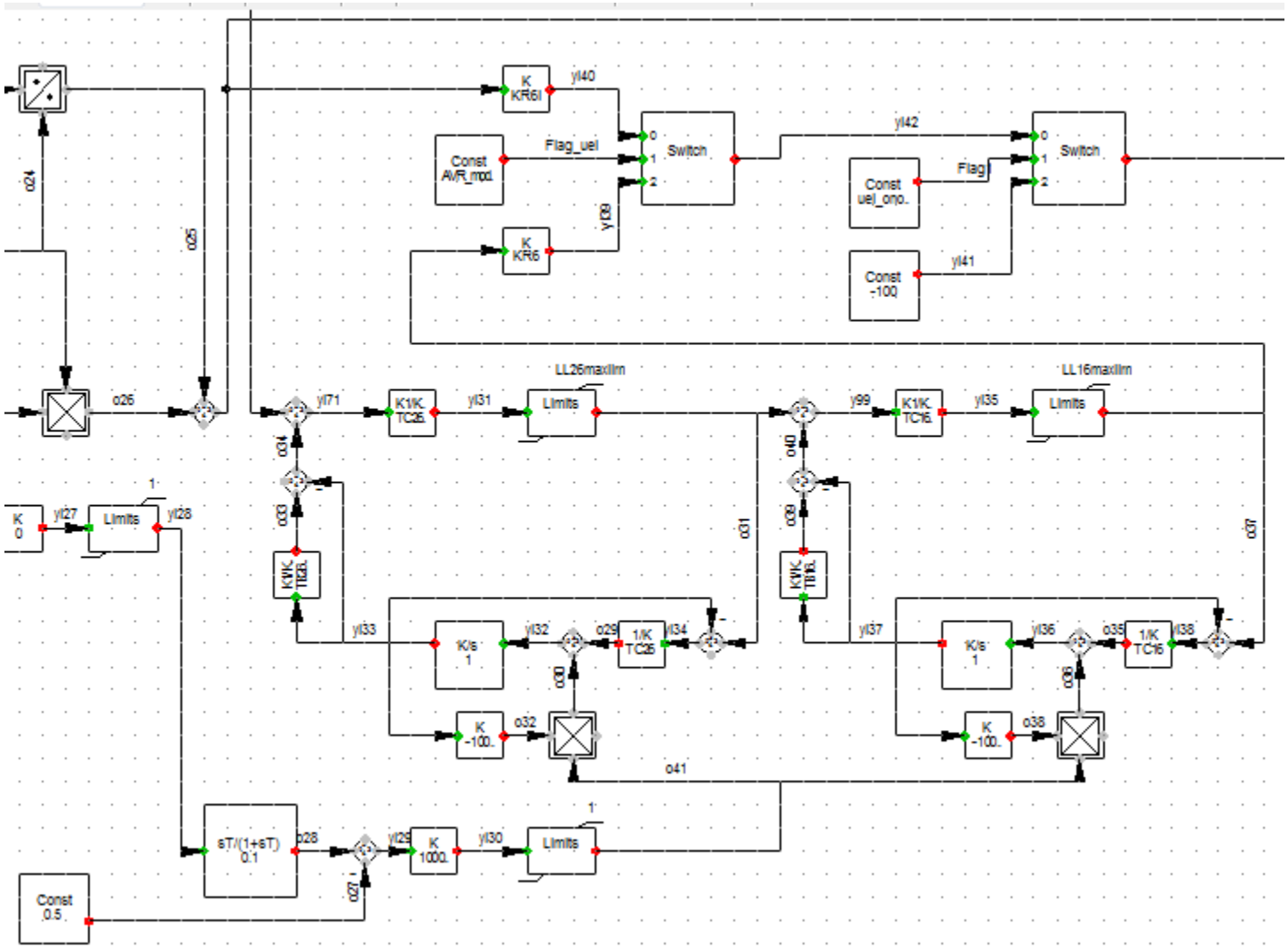


Figura 2. Modelo del limitador – UEL


1/(1+sT)
0.0001
o44
o43
yi23
x^(1/2)
o20
Const
1
yi26
1/K
KR6
o23
o24
yi24
o45
o18
o19
o21
yi25
LowLim..
o22
o17
Const
Xq
1/K
150
yi43
1/(1+sT)
TR_uel
o14
o42
o26
Const
1
K
0
yi27
Limits
1
o6
o7
o16
o10
o12
o9
o13
Const
Xd
yi17
abs()
yi20
LookupTabl
array_UEL
o8
yi21
High Li..
0
yi22
1/(1+sT)
1


K
KR6i
yl40
Const
AVR_mod.
Flag_uel
Switch
yl42
Const
uel_onp.
Flag
Switch
K
KR6
yl39
Const
-100
yl41
o24
o25
o26
yl71
K1/K.
TC26.
yl31
Limits
LL26maxIlm
y99
K1/K.
TC16.
yl35
Limits
LL16maxIlm
o34
o33
K/K.
TR6.
o40
o39
K/K.
TR6.
o31
o37
K
0
yl27
Limits
1
yl28
yl33
K/s
1
yl32
o29
1/K
TC26
yl34
yl37
K/s
1
yl36
o35
1/K
TC16
yl38
o30
o36
K
-100.
o32
K
-100.
o38
o41
sT/(1+sT)
0.1
o28
o27
yl29
K
1000.
yl30
Limits
1
Const
0.5

Modelo Limitador de Limitador de sobrexcitación (OEL)

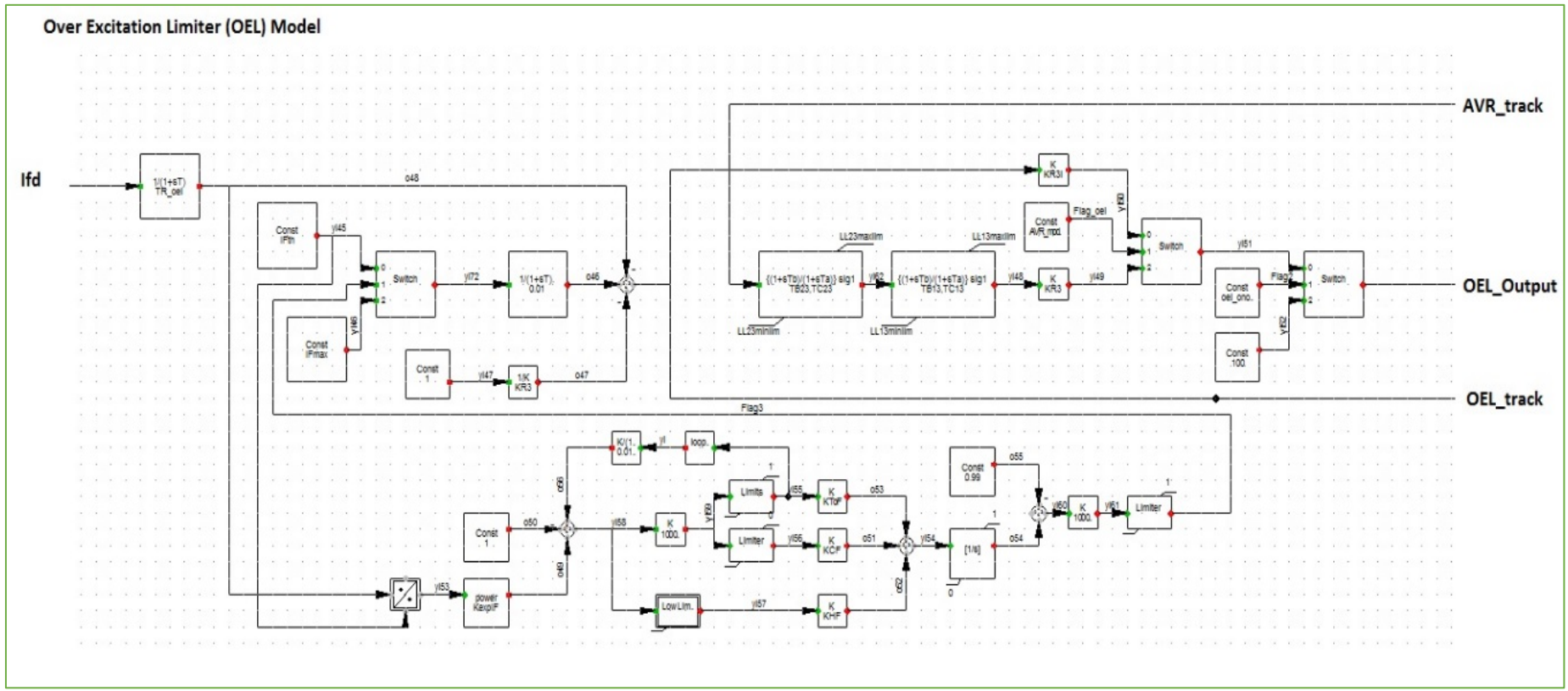


Figura 3. Modelo del limitador – OEL.

cno
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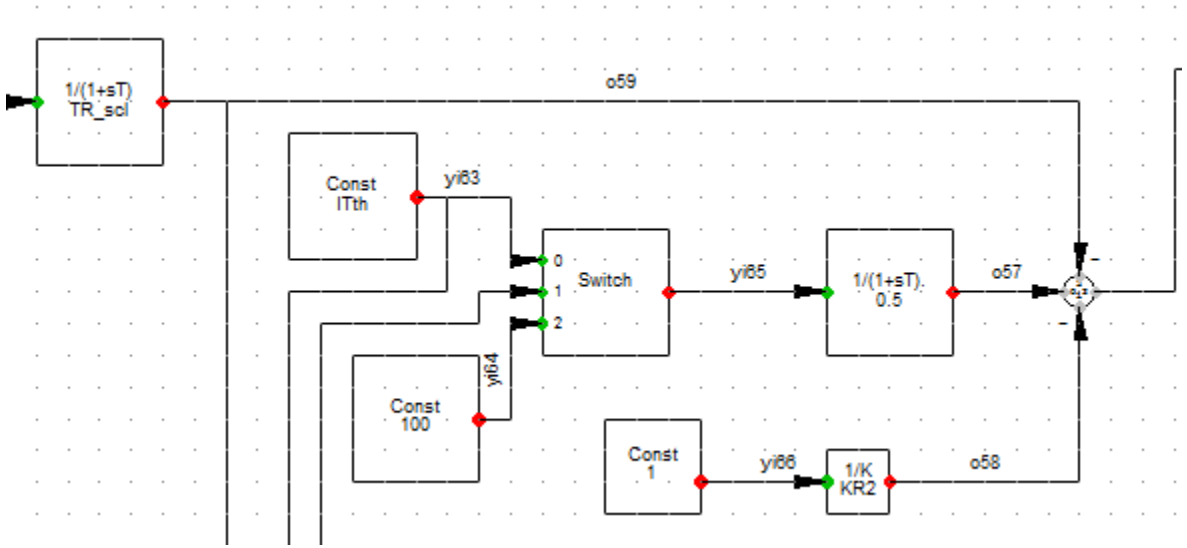
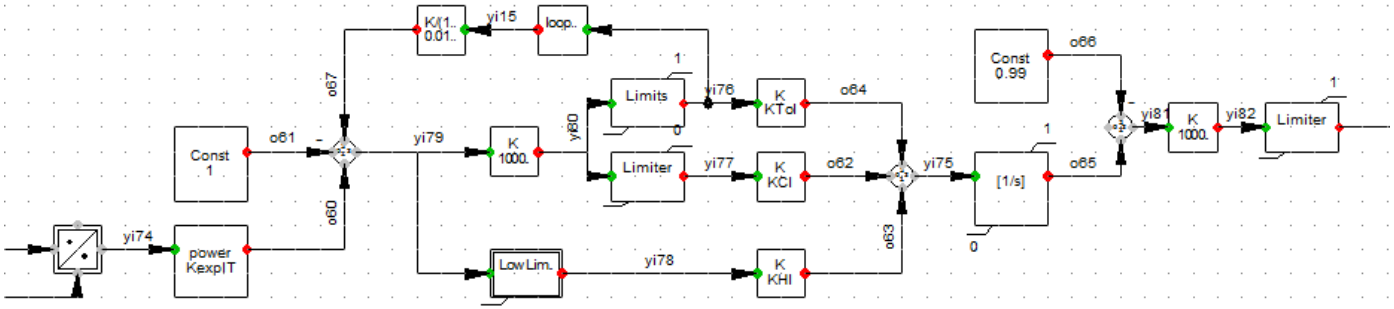
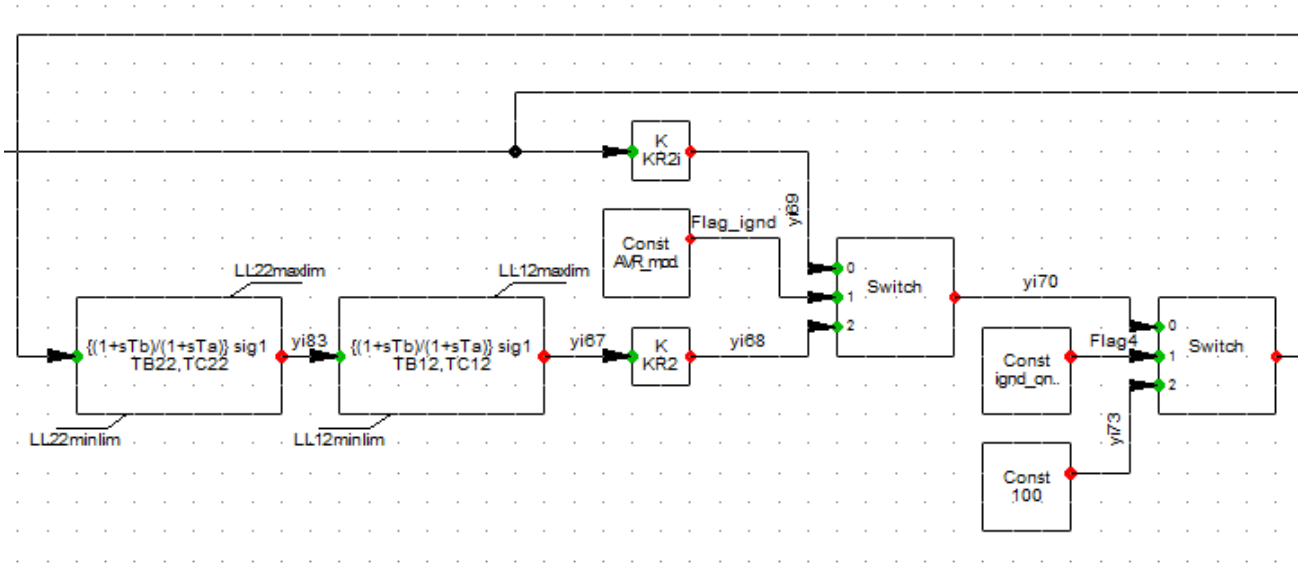





K
KR2i
Const
AVR_mod
Flag_ignd
yi69
LL22maxlim
LL12maxlim
{(1+sTb)/(1+sTa)} sig1
TB22,TC22
yi83
{(1+sTb)/(1+sTa)} sig1
TB12,TC12
yi67
K
KR2
yi68
0
1
2
Switch
yi70
Const
ignd_on..
Flag4
0
1
2
Switch
yi73
Const
100
LL22minlim
LL12minlim

Limitador de corriente estatórica (SCL)

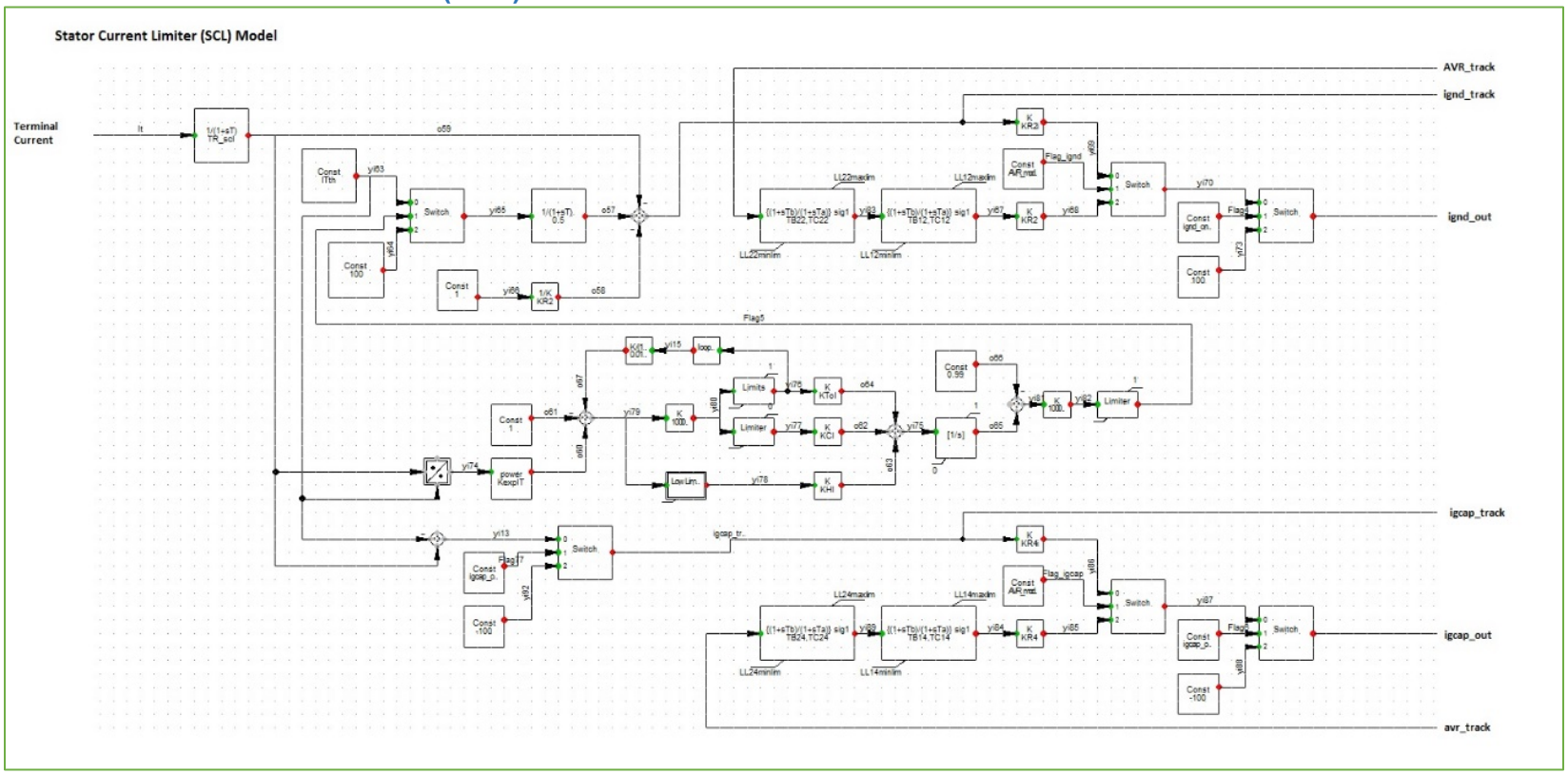
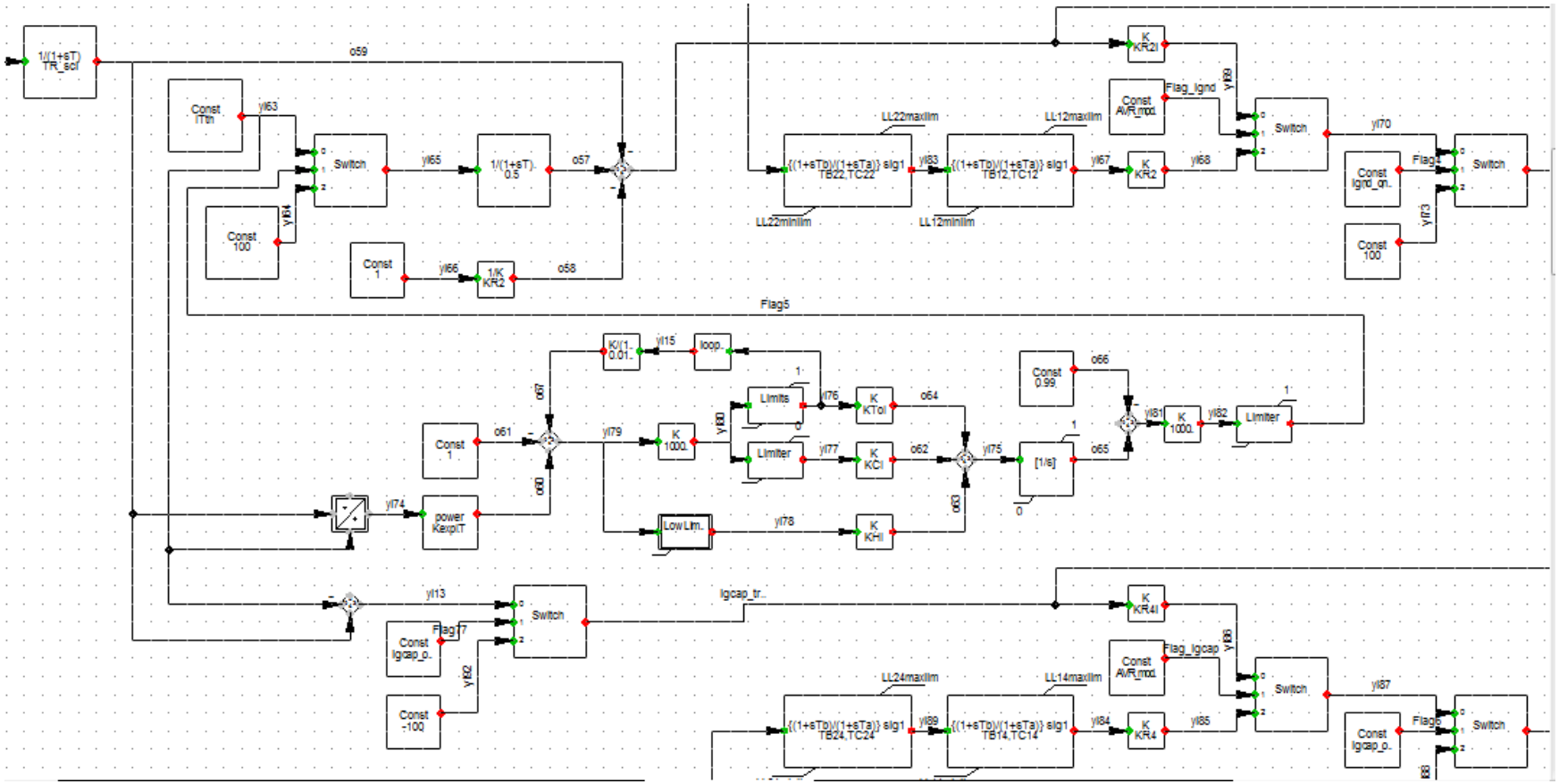


Figura 4. Modelo del limitador – SCL.


1/(1+sT)
TR_scl
o59
Const
ITth
yl63
Switch
yl65
1/(1+sT)
0.5
o57
Const
100
yl64
Const
1
yl66
1/K
KR2
o58
K
KR2i
Const
AVR_mod
Flag_Ignd
yl69
Switch
yl70
LL22maxlim
LL12maxlim
{(1+sTb)/(1+sTa)} slg1
TB22,TC22
yl83
{(1+sTb)/(1+sTa)} slg1
TB12,TC12
yl67
K
KR2
yl68
LL22minlim
LL12minlim
Const
Ignd_on
Flag1
Switch
yl73
Const
100
Flag5
KI/(1.
0.01.
yl15
loop
Limits
yl76
K
KTol
o64
Const
1
o61
yl79
K
1000.
yl80
Limiter
yl77
K
KCl
o62
o60
o63
Low Lim.
yl78
K
KHl
yl74
power
KexpIT
o67
Const
0.99
o66
yl81
K
1000.
yl82
Limiter
yl75
[1/s]
o65
yl13
Switch
Flag17
Const
Igcap_o.
yl62
Const
-100
Igcap_tr
K
KR4i
Const
AVR_mod
Flag_Igcap
yl86
Switch
yl87
LL24maxlim
LL14maxlim
{(1+sTb)/(1+sTa)} slg1
TB24,TC24
yl89
{(1+sTb)/(1+sTa)} slg1
TB14,TC14
yl84
K
KR4
yl85
Const
Igcap_o.
Flag8
Switch
yl88

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Limitador V/HZ

cno
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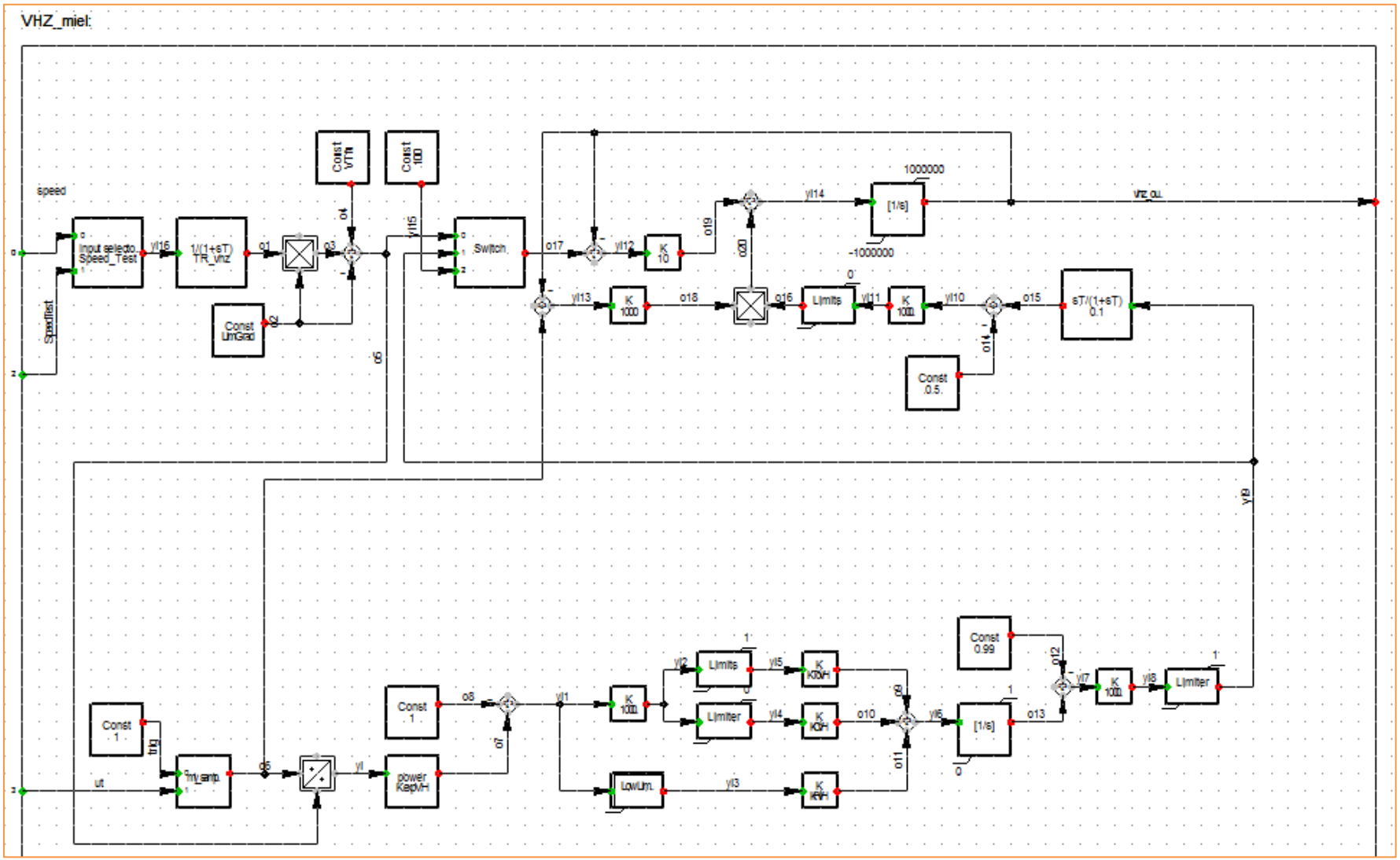

Figura 5. Modelo del limitador V/Hz. MIEL 1.

Tabla 3. Parámetros V/Hz.

PARÁMETROS V/Hz			
Network Model >> Network Data >> Grid >>U1_VHZ			
Descripción	**Parámetro**	**Unidad**	**Valor**
Maximum V/Hz Gradient	VTfn	[pu]	1.1
Maximum generator voltage	LimGrad	[pu]	1.5
Test enable (0 = normal mode, 1 = test mode)	Speed_Test	-	0
Measurement Time Constant	TR_vhz	[s]	0.001
Fixed integration time	KToVH	[s]	1000
Cooling integration time	KCVH	[s]	0.001
Inverse time characteristic integration time	KHVH	[s]	0
Exponent factor of inverse characteristic	KexpVH	[pu]	1

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Estabilizador del Sistema de Potencia

cno
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pss_PSS4B_miel: IEEE Type PSS4B - P-W Input Power System Stabilizer Model

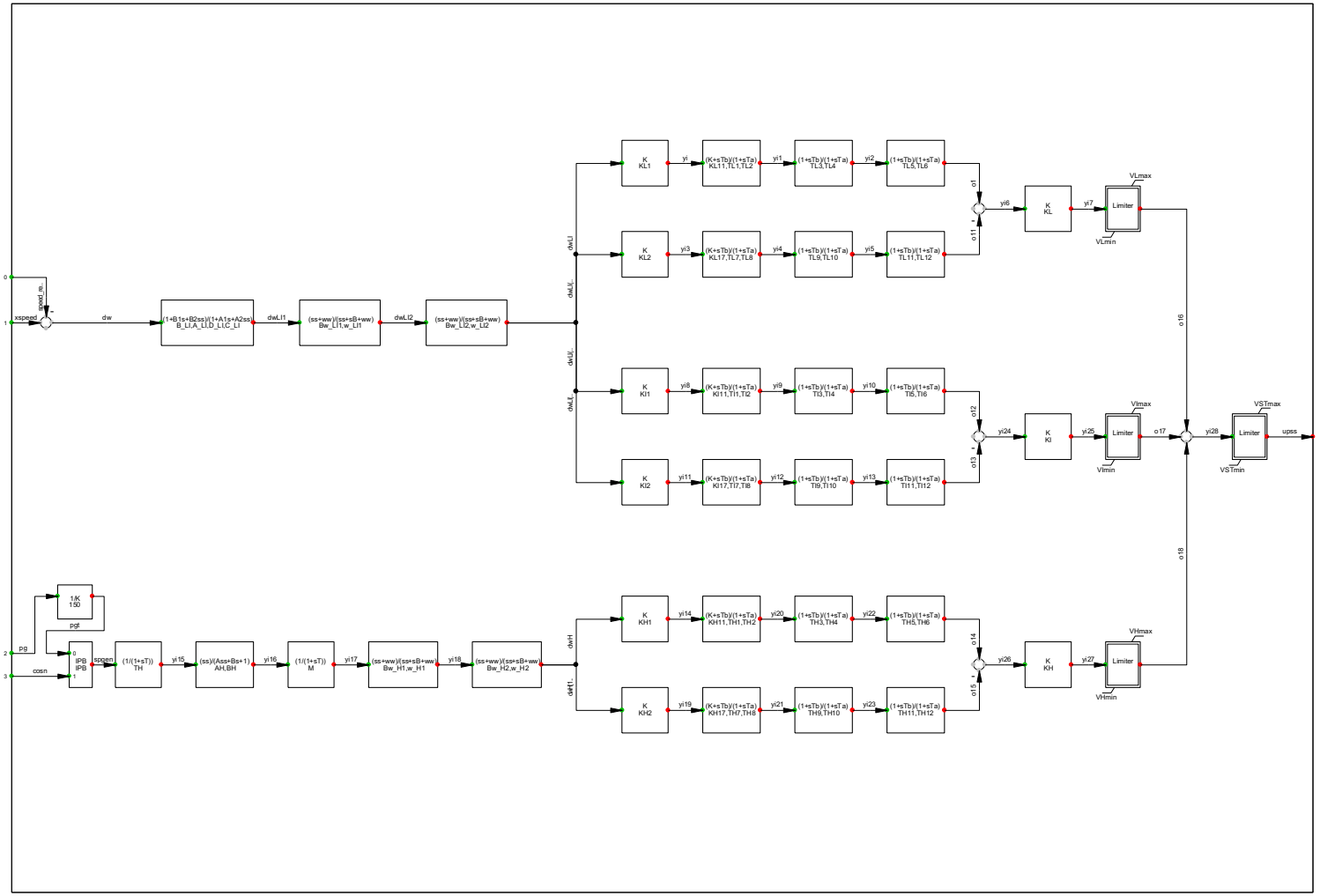
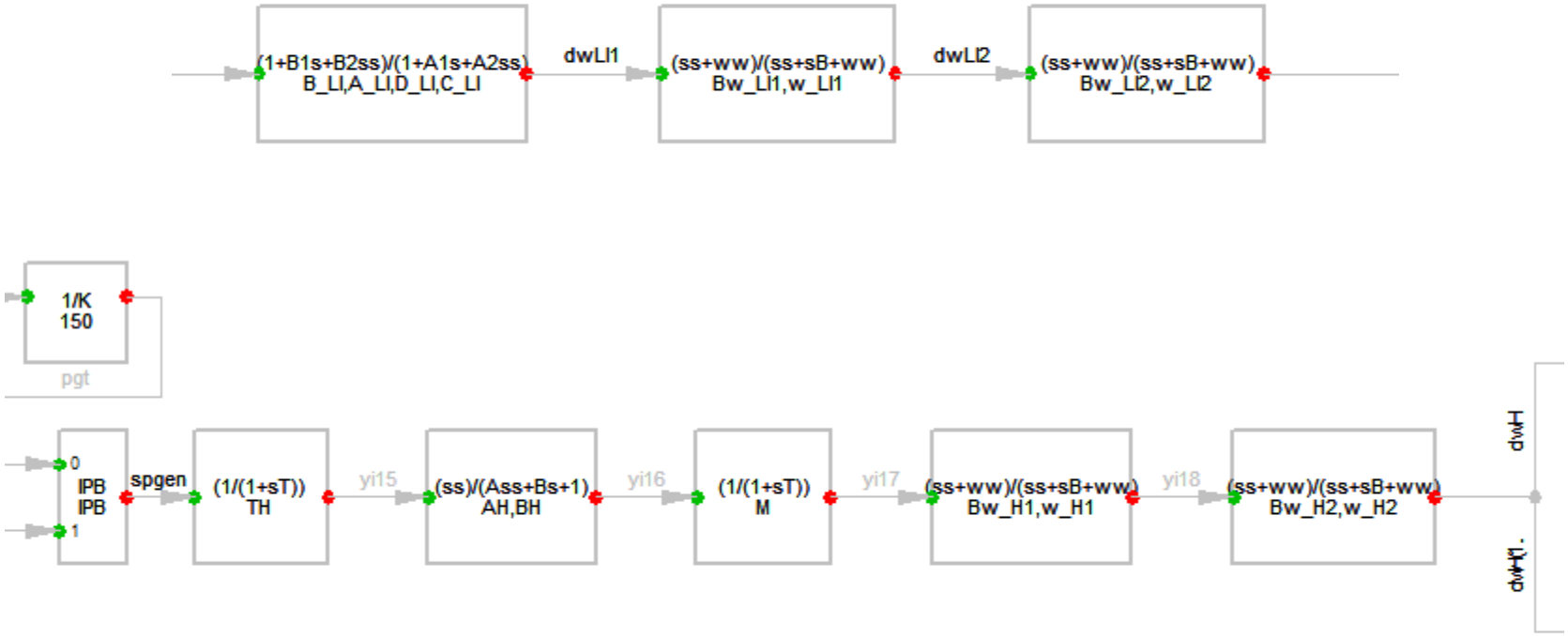
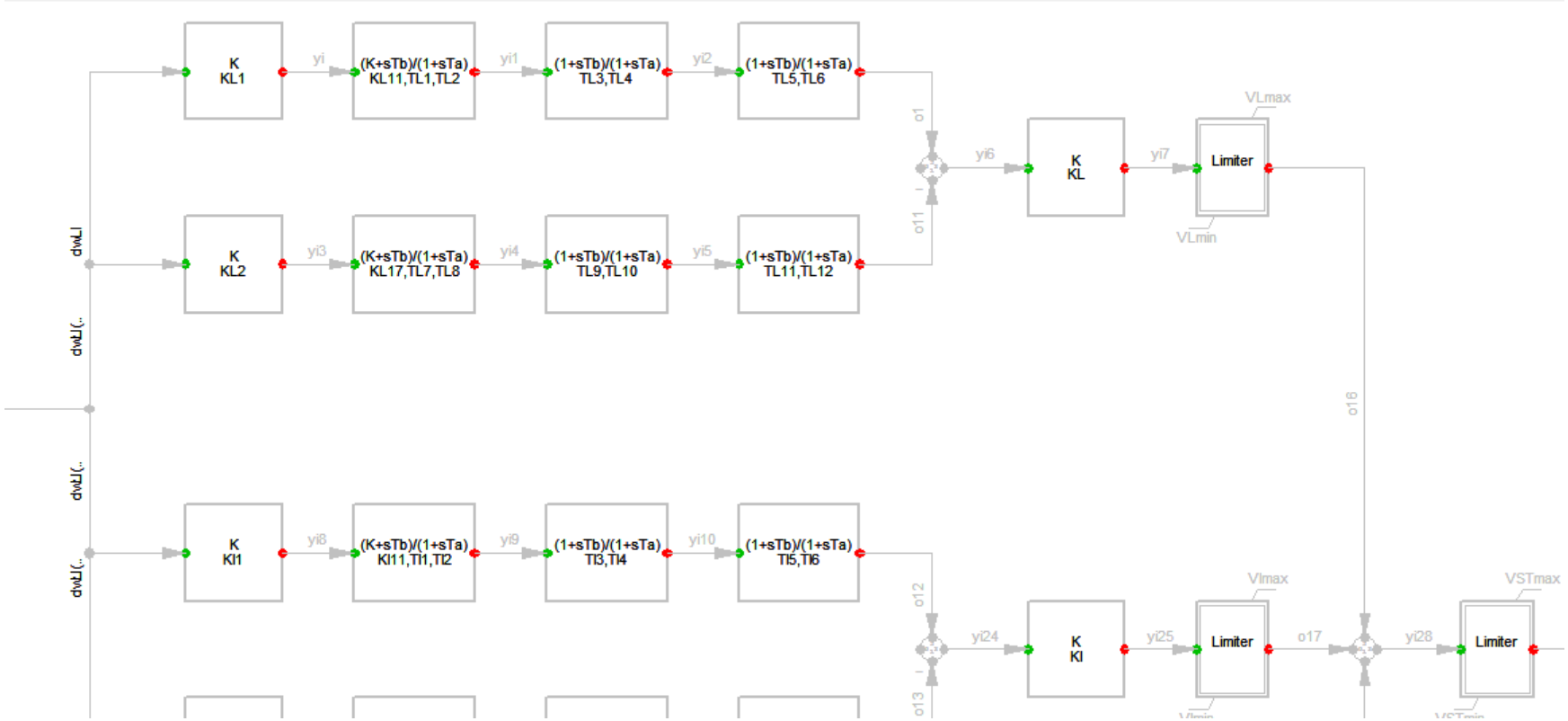


Figura 6. Modelo PSS4B.




K
KL1
yi
(K+sTb)/(1+sTa)
KL11,TL1,TL2
yi1
(1+sTb)/(1+sTa)
TL3,TL4
yi2
(1+sTb)/(1+sTa)
TL5,TL6
K
KL2
yi3
(K+sTb)/(1+sTa)
KL17,TL7,TL8
yi4
(1+sTb)/(1+sTa)
TL9,TL10
yi5
(1+sTb)/(1+sTa)
TL11,TL12
K
KI1
yi8
(K+sTb)/(1+sTa)
KI11,TI1,TI2
yi9
(1+sTb)/(1+sTa)
TI3,TI4
yi10
(1+sTb)/(1+sTa)
TI5,TI6
o1
o11
yi6
K
KL
yi7
VLmax
Limiter
VLmin
o16
o12
o13
yi24
K
KI
yi25
VImax
Limiter
o17
yi28
VSTmax
Limiter
dwLI
dwLI(..
dwLI(..
dwLI(..

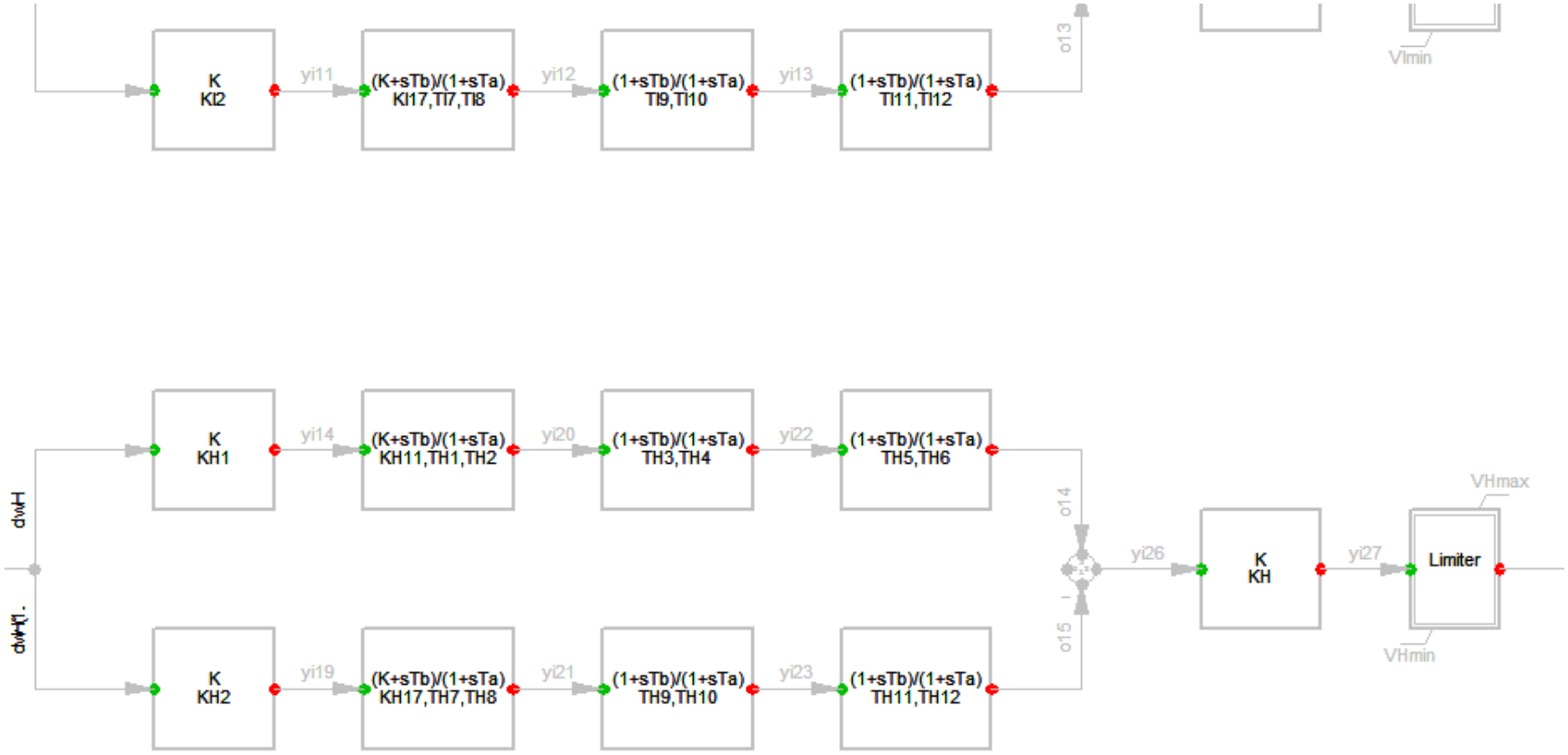

K
KI2
yi11
(K+sTb)/(1+sTa)
KI17,TI7,TI8
yi12
(1+sTb)/(1+sTa)
TI9,TI10
yi13
(1+sTb)/(1+sTa)
TI11,TI12
o13
Vlmin
K
KH1
yi14
(K+sTb)/(1+sTa)
KH11,TH1,TH2
yi20
(1+sTb)/(1+sTa)
TH3,TH4
yi22
(1+sTb)/(1+sTa)
TH5,TH6
o14
dwH
dwH1
K
KH2
yi19
(K+sTb)/(1+sTa)
KH17,TH7,TH8
yi21
(1+sTb)/(1+sTa)
TH9,TH10
yi23
(1+sTb)/(1+sTa)
TH11,TH12
o15
yi26
K
KH
yi27
Limiter
VHmax
VHmin

Tabla 4. Parámetros del PSS.

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PSS	
Network Model >> Network Data >> Grid >>U2_PSS	
Parámetro	Valor
B_LI	0.017823
A_LI	0.00012739
D_LI	0.001759
C_LI	0
Bw_LI1	0
w_LI1	1
Bw_LI2	0
w_LI2	1
KL1	0.375
KL2	0.375
KI1	0
KI2	0
KL11	1
TL1	35.58
TL2	7.11
TL3	25.94
TL4	6.406
TL5	4.84
TL6	3.66
KL17	1
TL7	7.11
TL8	1.42
TL9	25.94
TL10	6.4
TL11	4.84
TL12	3.66
KL	3.754
KI11	1
TI1	8.37
TI2	1.674
TI3	0.648
TI4	0.16
TI5	0.25
TI6	0.194
KI17	1
TI7	1.674
TI8	0.334
TI9	0.648
TI10	0.16
TI11	0.256

PSS	
Network Model >> Network Data >> Grid >>U2_PSS	
Parámetro	Valor
TI12	0.194
KI	5.139
IPB	-1
TH	0.0125
AH	1
BH	2
Bw_H1	0
w_H1	1
M	9.1
Bw_H2	0
w_H2	1
KH1	0
KH2	0.375
KH11	1
TH1	0.406
TH2	0.081
TH3	0.12
TH4	0.029
TH5	0.027
TH6	0.0204
KH17	1
TH7	0.081
TH8	0.016
TH9	0.012
TH10	0.0297
TH11	0.027
TH12	0.0204
KH	40.721
VLmin	-0.075
VImin	-0.1
VHmin	-0.1
VSTmin	-0.2
VLmax	0.075
VImax	0.1
VHmax	0.1
VSTmax	0.2

Regulador de Velocidad/Potencia y Turbina

Conducción y turbina hidráulica

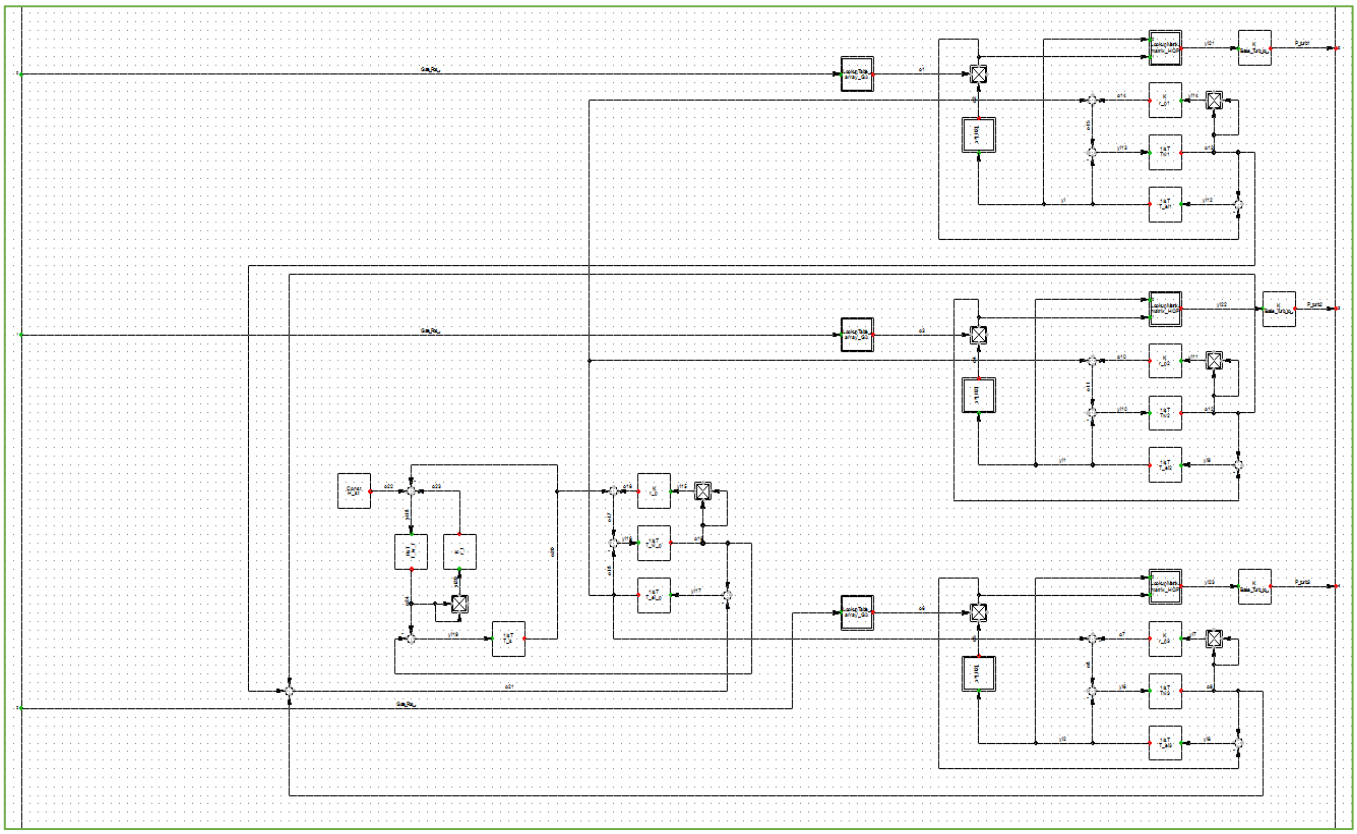


Figura 7. Modelo conjunto conducción y turbinas.

Modelo de la conducción

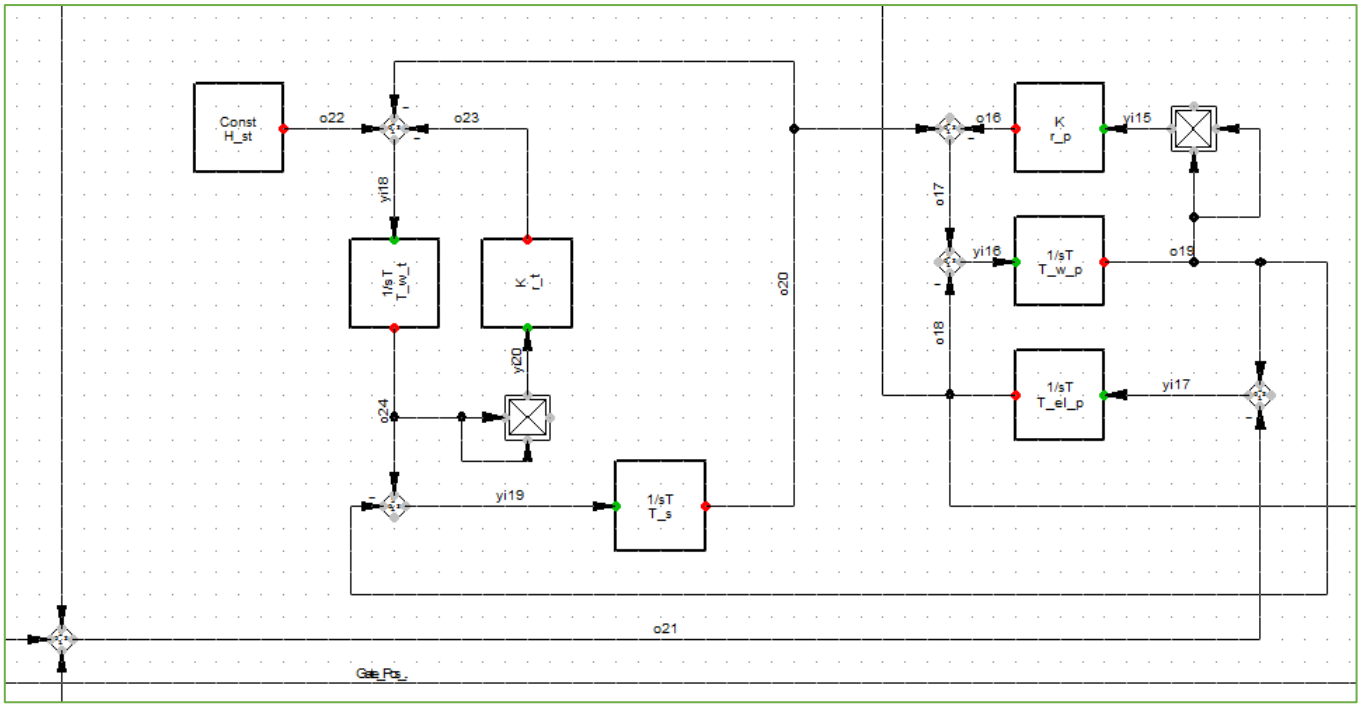


Figura 8. Modelo Túnel de energía y almenara

Modelo turbina Hidráulica

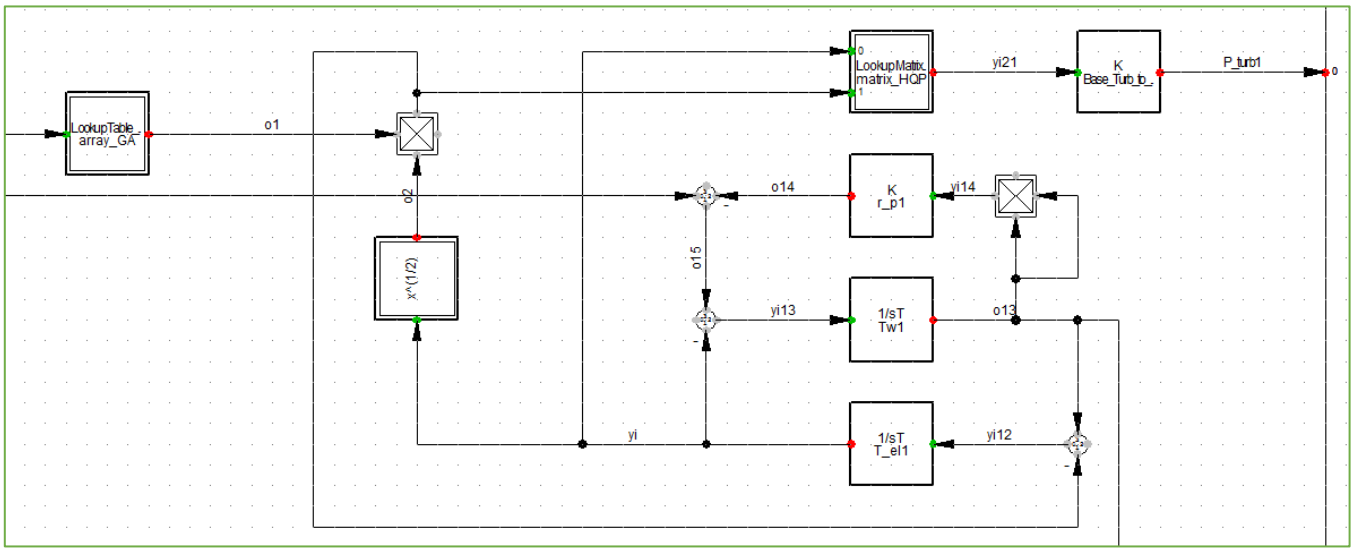


Figura 9. Modelo turbina Hidráulica

Tabla 5. Parámetros de conducción y turbina

Parámetros de conducción y turbina	
Network Model >> Network Data >> Grid >> Full_Turb_model	
Parámetro	Valor
Base_Turb_to_Gen	1.1111
H_st	0.984055
Tw3 (U3)	0.179
T_w_t	0.076
T_w_p	0.32
Tw1 (U1)	0.179
Tw2 (U2)	0.168
T_el2 (U2)	0.0014
T_el3 (U3)	0.0015
T_el1 (U1)	0.0015
r_p3 (U3)	0.01
r_p1 (U1)	0.01
r_t	0.002
r_p	0.002
T_el_p	0.0366
r_p2 (U2)	0.01
T_s	274.27
Pbase	135

Tabla 6. Características de posición – área de flujo del acctuador

Características de posición – área de flujo del acctuador	
Network Model >> Network Data >> Grid >>Full_Turb_model>>GA	
Apertura [p.u.]	Área de flujo [p.u.]
0	0
0.2617	0.3013768
0.3424	0.3420008
0.4131	0.3907275
0.4681	0.461077
0.5251	0.5239942
0.5772	0.6003013
0.6663	0.7621623
0.7121	0.8403952
0.7715	0.9381117
0.7829	0.9686905

	GA_x	GA_y
Size	11,	0,
1	0,	0,
2	0,2617	0,3013768
3	0,3424	0,3420008
4	0,4131	0,3907275
5	0,4681	0,461077
6	0,5251	0,5239942
7	0,5772	0,6003013
8	0,6663	0,7621623
9	0,7121	0,8403952
10	0,7715	0,9381117
11	0,7829	0,9686905

Hoja de cálculo de
Microsoft Excel 97-20

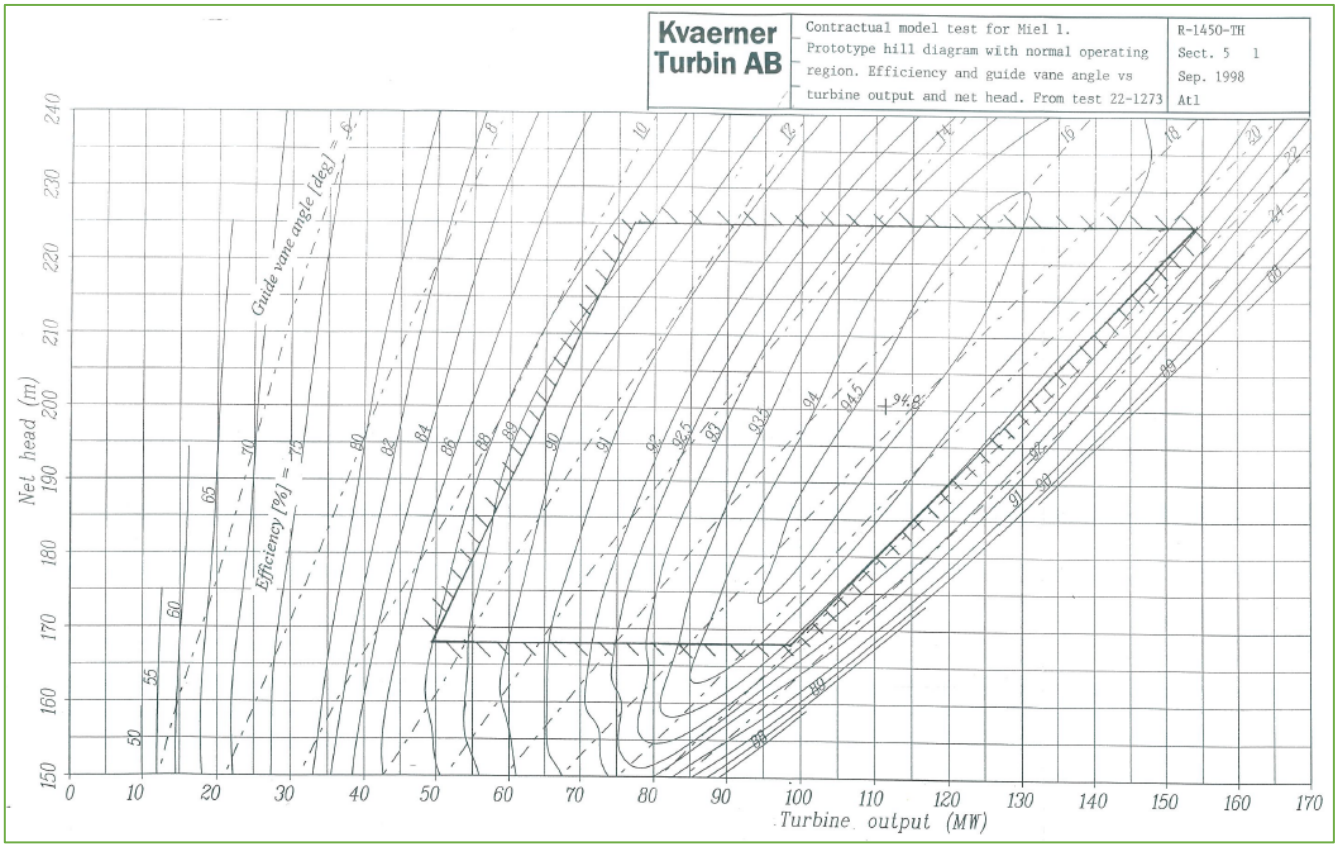


Figura 10. Superficie de eficiencia turbina.

Modelo del gobernador de la turbina

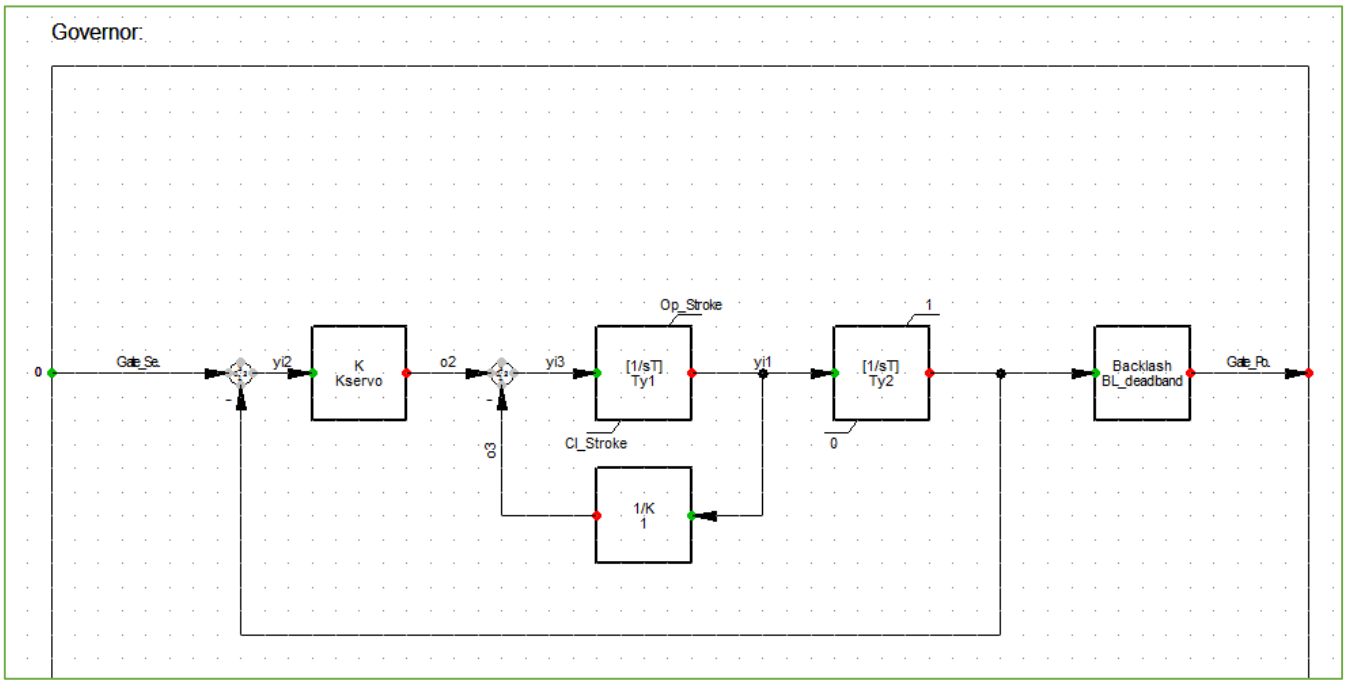


Figura 11. Modelo del gobernador de la turbina.

Tabla 7. Parámetros de gobernador.

PARÁMETROS DE GOBERNADOR	
Network Model >> Network Data >> Grid >>Governor_u1	
PARÁMETRO	**VALOR**
Kservo	10
Ty1	0.005
Ty2	0.02
BL_deadband	0.005
Cl_Stroke	-0.16
Op_Stroke	0.08

Modelo controlador de velocidad / potencia

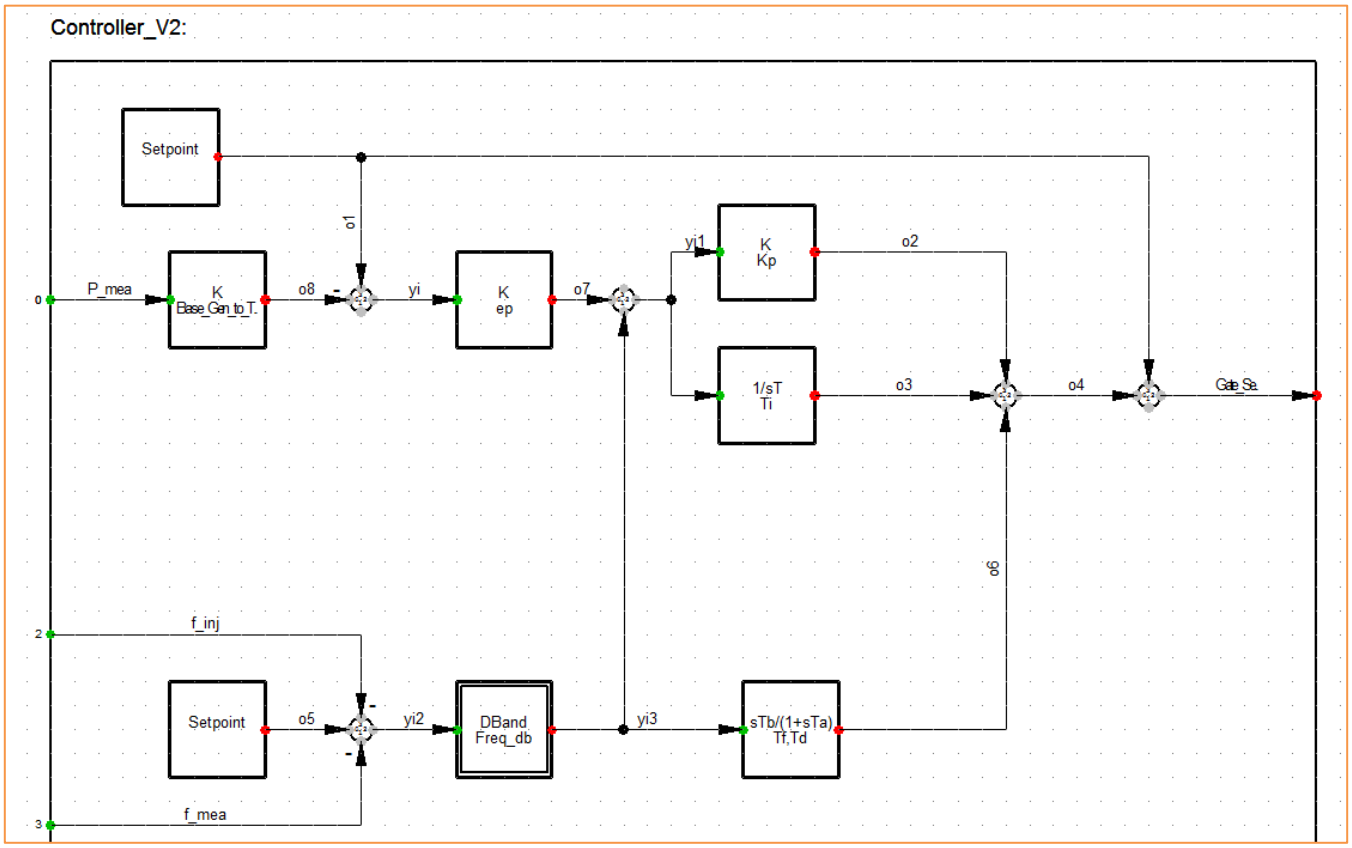


Figura 12. Modelo controlador de velocidad / potencia.

Tabla 8. Parámetros de control de velocidad / potencia.

PARÁMETROS DE CONTROL DE VELOCIDAD / POTENCIA	
Network Model >> Network Data >> Grid >> Controller_u1	
PARÁMETRO	**VALOR**
Freq_db	0.0005
Base_Gen_to_Turb	0.9267522
Ep	0.04
Kp	4
Ti	0.175
Tf	1.2
Td	0.4

ANEXO 3

DIAGRAMAS DE BLOQUE Y TABLAS DE VALORES DE LOS PARÁMETROS DE CONTROL DE LA UNIDAD 2

Sistema de Excitación

Parámetros Regulador de tensión (AVR) y Limitadores

Tabla 9. Parámetros AVR y Limitadores

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U2_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Measurement Time Constant	Tr	[s]	0.001
Maximum thermal stator current limit	ITth	[p.u.]	2.55
Measurement time constant	TR_scl	[s]	0.001
ST5C not active selection	AVR_mode_disable_scl	[logic]	0
Release of IGnd limiter	ignd_onoff	[logic]	1
Release of IGCap limiter	igcap_onoff	[logic]	0
Measurement Time Constant	Tr_e	[s]	0.05
Measurement Time Constant	TR_uel	[s]	0.001
Direct axis synchronous reactance	Xd	[pu]	1.35
Quadrature axis synchronous reactance	Xq	[pu]	0.75
ST5C not active selection	AVR_mode_disable_uel	[pu]	0
OEL active/deactive selector	uel_onoff	[logic]	1
Maximum thermal field current limit	IFth	[pu]	2
Maximum field current limit	IFmax	[pu]	2.1
Measurement Time Constant	TR_oel	[s]	0.001
ST5C not active selection	AVR_mode_disable_oel	[pu]	0
OEL active/deactive selector	oel_onoff	[logic]	1
Controller Gain	KR1	[pu]	500
Steady state gain	KR2	[p.u.]	500
Steady state gain adjustment	KR2i	[p.u.]	0.8
Fixed time integration constant	KToI	[1/s]	0
Cooling integration constant	KCI	[1/s]	0.01
Inverse time characteristic integration constant	KHI	[1/s]	0.0381
	MC_Sn		150
Steady state gain	KR4	[p.u.]	250
Steady state gain adjustment	KR4i	[p.u.]	0.5
Reactive Power Measurement Gain	KIR	[pu]	0
Steady State Gain	KR6	[pu]	500

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U2_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Active Power Measurement Gain	KIA	[pu]	0
Lead-time constant	TC26	[s]	0.1
Lag-time constant	TB26	[s]	0.1
Lead-time constant	TC16	[s]	1.52
Lag-time constant	TB16	[s]	9.5
Steady State Gain Adjustment	KR6i	[pu]	0.4
Steady State Gain	KR3	[pu]	500
Steady State Gain Adjustment	KR3i	[pu]	0.3
Fixed integration time	KToF	[s]	0.1
Cooling integration time	KCF	[s]	0
Inverse time characteristic integration time	KHF	[s]	0.0429
Exponent factor of inverse time characteristic	KexpIT	[-]	2
Controller first lag time constant	TB12	[s]	9.5
Controller first lead time constant	TC12	[s]	1.52
Controller second lag time constant	TB22	[s]	0.1
Controller second lead time constant	TC22	[s]	0.1
Controller first lag time constant	TB14	[s]	25
Controller first lead time constant	TC14	[s]	3
Controller second lag time constant	TB24	[s]	0.01
Controller second lead time constant	TC24	[s]	0.01
Lag-time constant	Tb21	[s]	21.56
Lead-time constant	Tc21	[s]	3.45
Lag-time constant	Tb11	[s]	0.1
Lead-time constant	Tc11	[s]	0.1
Exponent factor of inverse characteristic	KexpIF	[pu]	1
Lag-time constant	TB13	[s]	9.5
Lead-time constant	TC13	[s]	1.52
Lag-time constant	TB23	[s]	0.1
Lead-time constant	TC23	[s]	0.1
1st Lead Lag Minimum Limit	LL12minlim	[pu]	-0.2
2st Lead Lag Minimum Limit	LL22minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL14minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL24minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL21_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL11_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL13minlim	[pu]	-0.2
2st Lead Lag Minimum Limit	LL23minlim	[pu]	-1.25
Voltage Regulator Minimum Output	VA_min	[pu]	-100
2st Lead Lag Minimum Limit	LL26minlim	[pu]	-1.25

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U2_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
1st Lead Lag Minimum Limit	LL16minlim	[pu]	-0.2
1st Lead Lag Maximum Limit	LL12maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL22maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL14maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL24maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL21_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL11_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL13maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL23maxlim	[pu]	1.25
Voltage Regulator Maximum Output	VA_max	[pu]	100
2st Lead Lag Maximum Limit	LL26maxlim	[pu]	1.25
1st Lead Lag Maximum Limit	LL16maxlim	[pu]	0.2

Lookup Table_lin array_UEL	
UEL_x	UEL_y
0	-0,6
0,2	-0,6
0,4	-0,6
0,6	-0,55
0,8	-0,45
1	-0,3

Modelo Regulador de tensión (AVR)

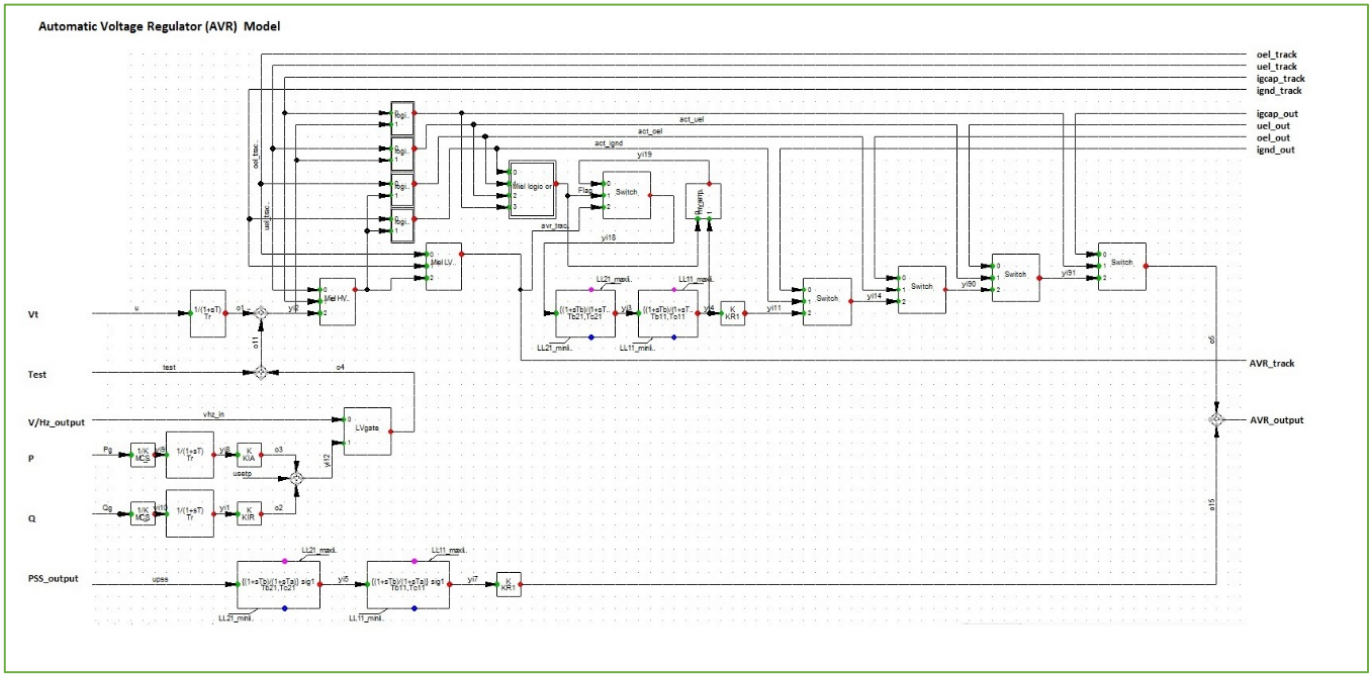
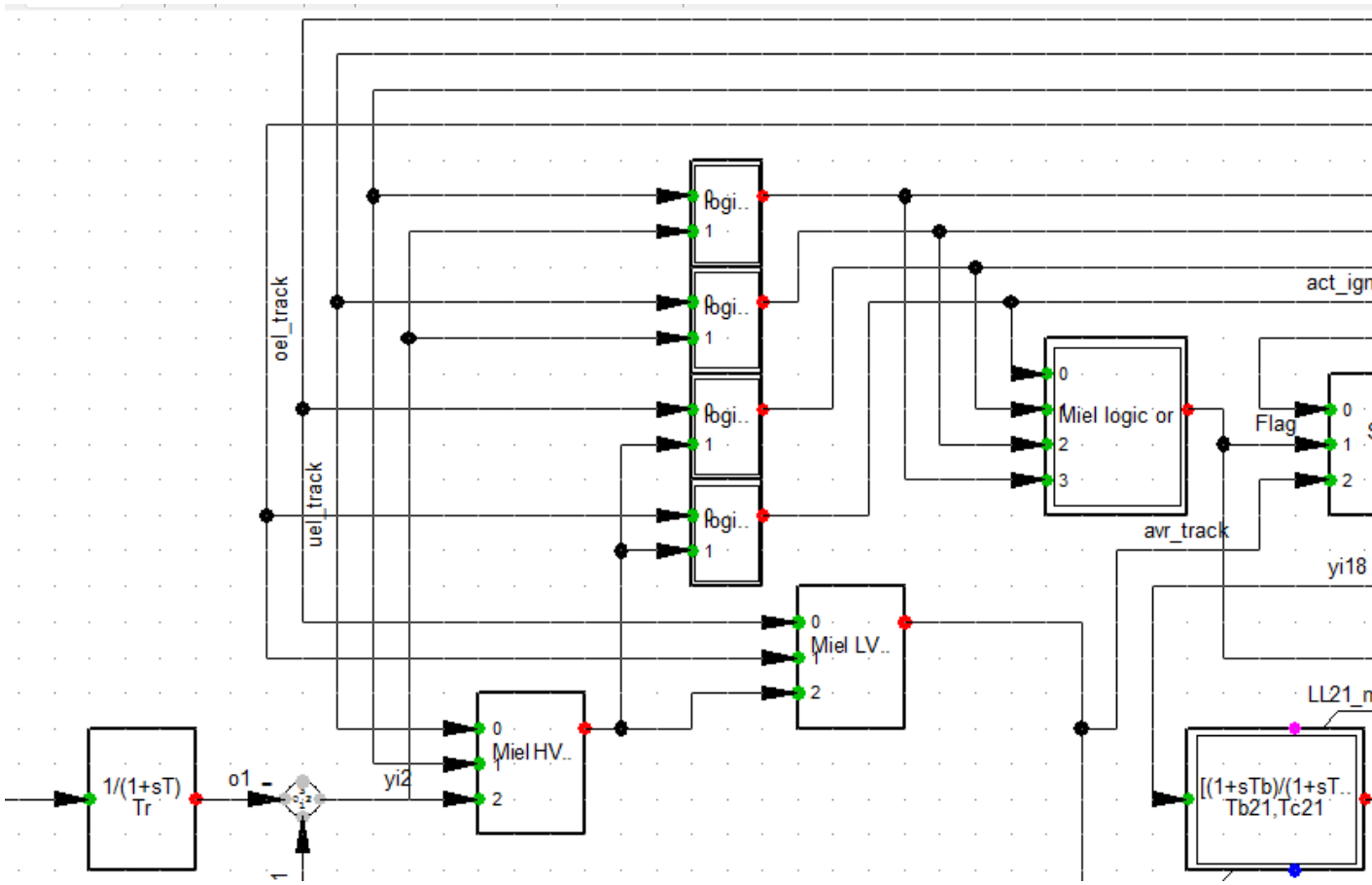
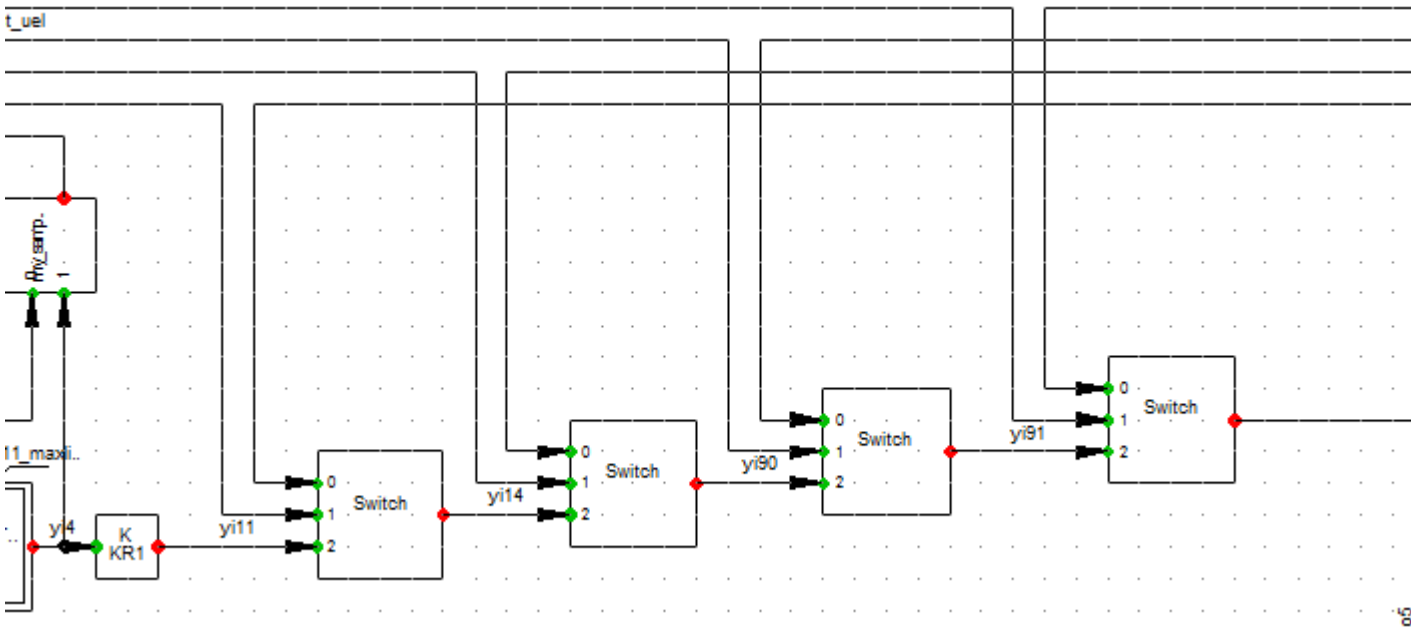
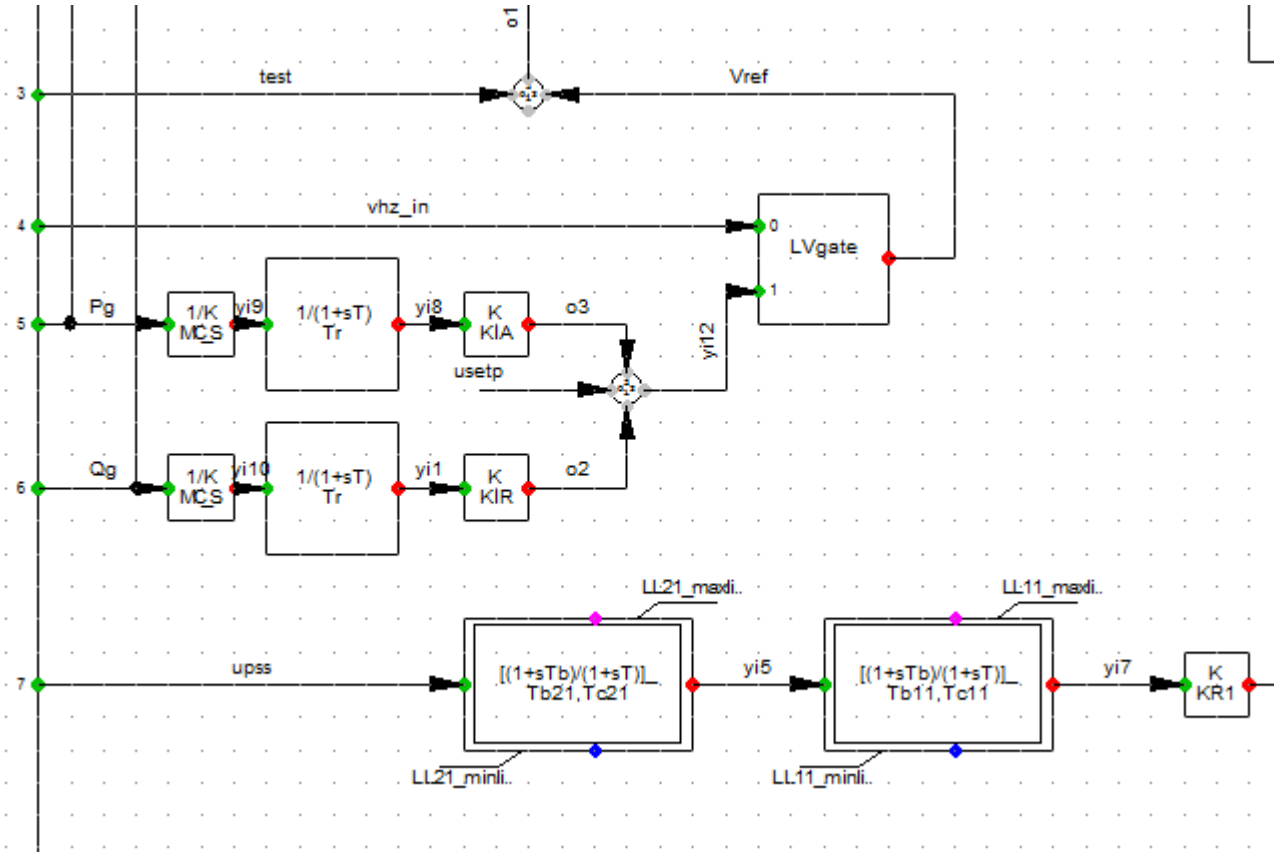
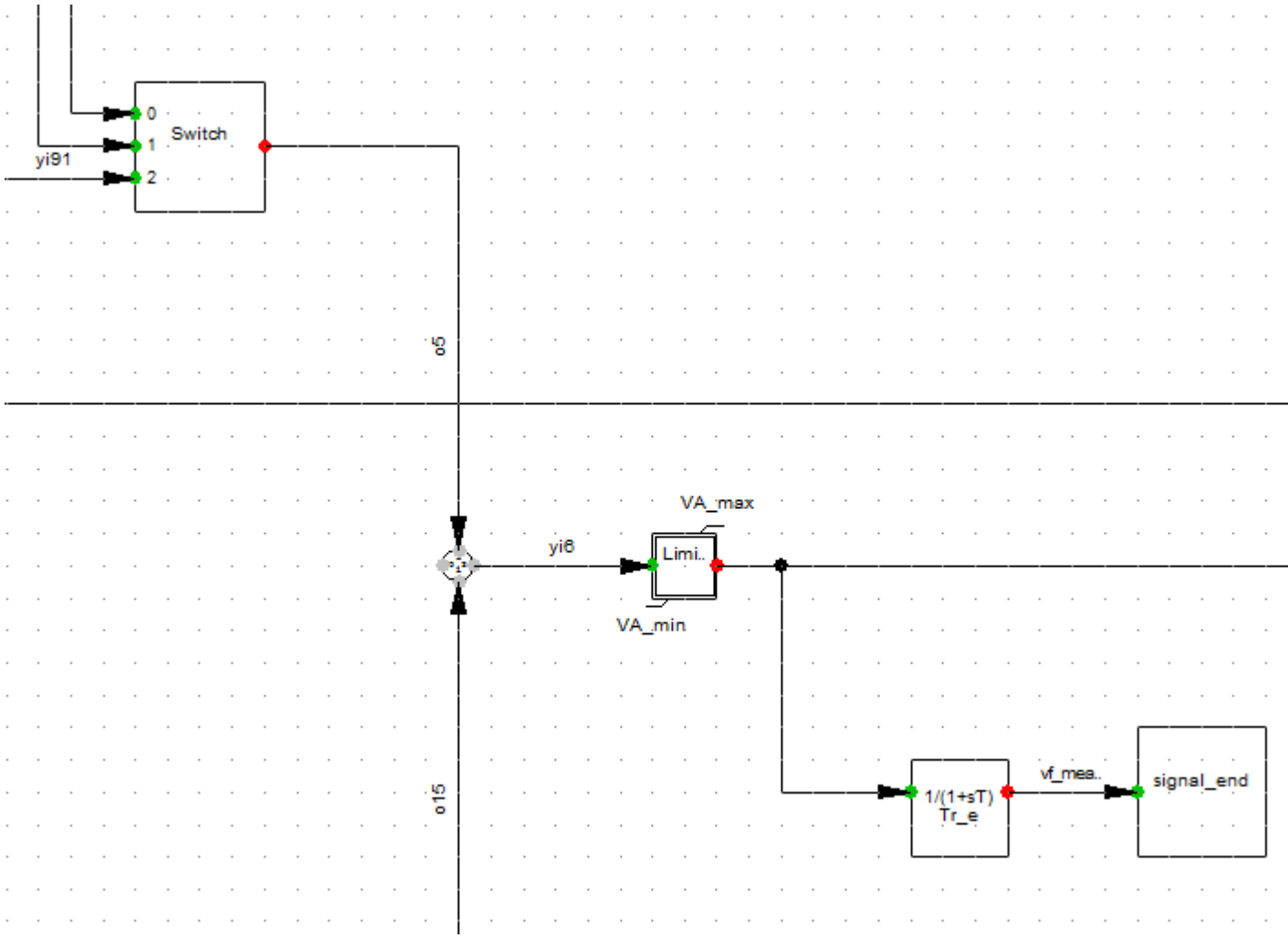


Figura 13. Modelo AVR.


oel_track
uel_track
Logi..
Logi..
Logi..
Logi..
Miel logic or
act_ign
Flag
avr_track
yi18
Miel LV..
Miel HV..
LL21_n
1/(1+sT)
Tr
o1
yi2
[(1+sTb)/(1+sT..
Tb21,Tc21


t_uel
Switch
Switch
Switch
Switch
yi4
K
KR1
yi11
yi14
yi90
yi91


o1
3
test
Vref
4
vhz_in
0
LVgate
1
5
Pg
1/K
MCS
yi9
1/(1+sT)
Tr
yi8
K
KIA
o3
usetp
yi12
6
Qg
1/K
MCS
yi10
1/(1+sT)
Tr
yi1
K
KIR
o2
LL21_maxdi..
LL11_maxdi..
7
upss
[(1+sTb)/(1+sT)]_
Tb21,Tc21
yi5
[(1+sTb)/(1+sT)]_
Tb11,Tc11
yi7
K
KR1
LL21_minli..
LL11_minli..


0
1
2
Switch
yi91
o5
VA_max
yi6
Limi..
VA_min
o15
1/(1+sT)
Tr_e
vf_mea..
signal_end

Modelo Limitador de Limitador de subexcitación (UEL)

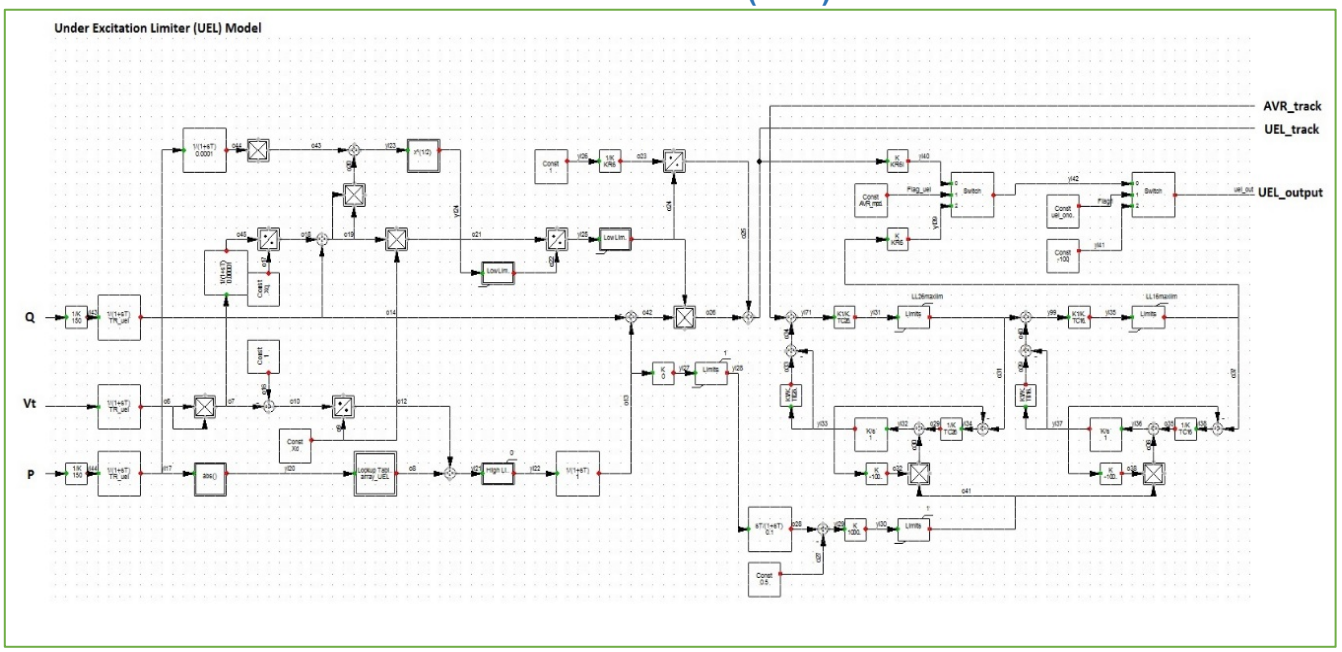
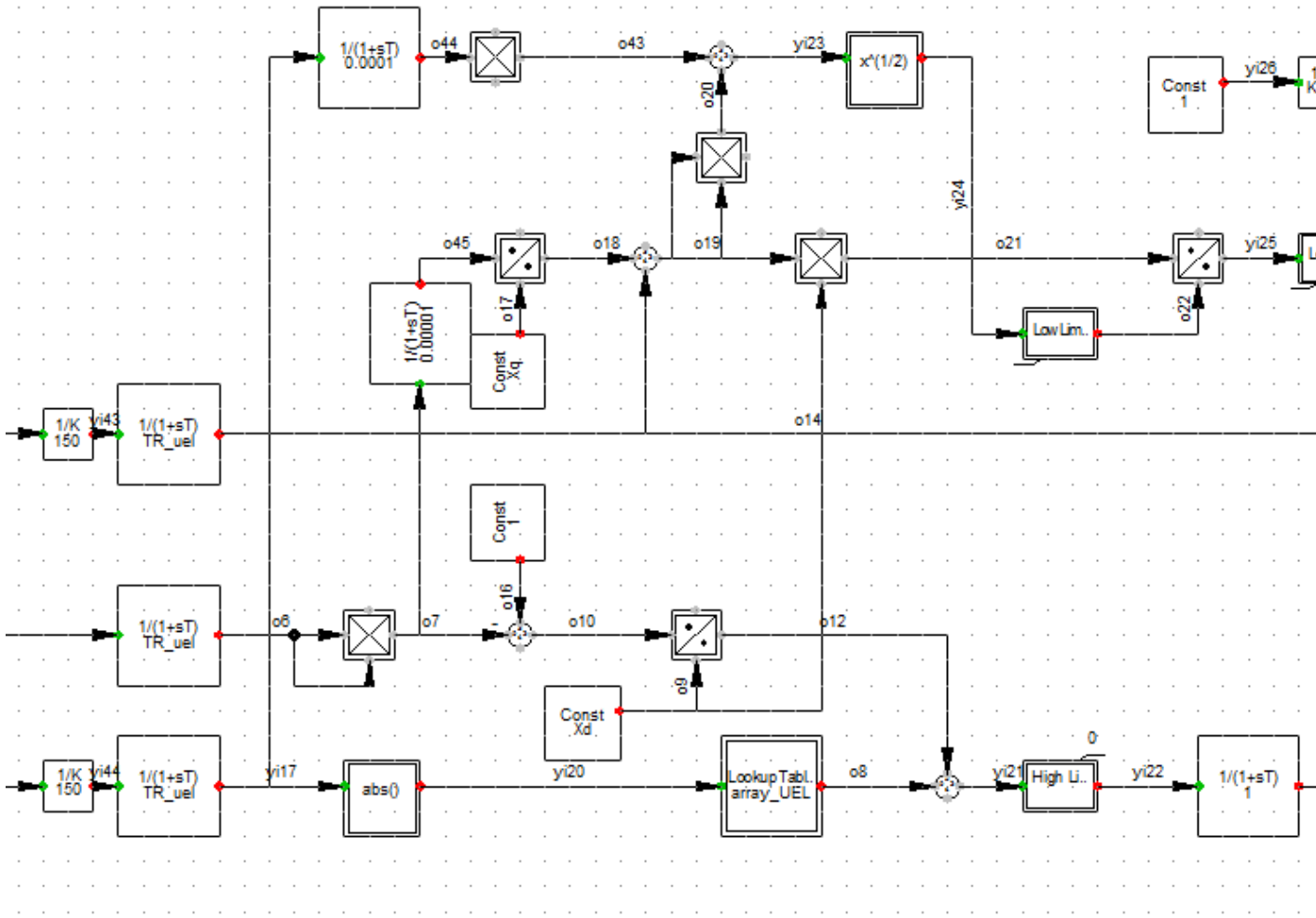
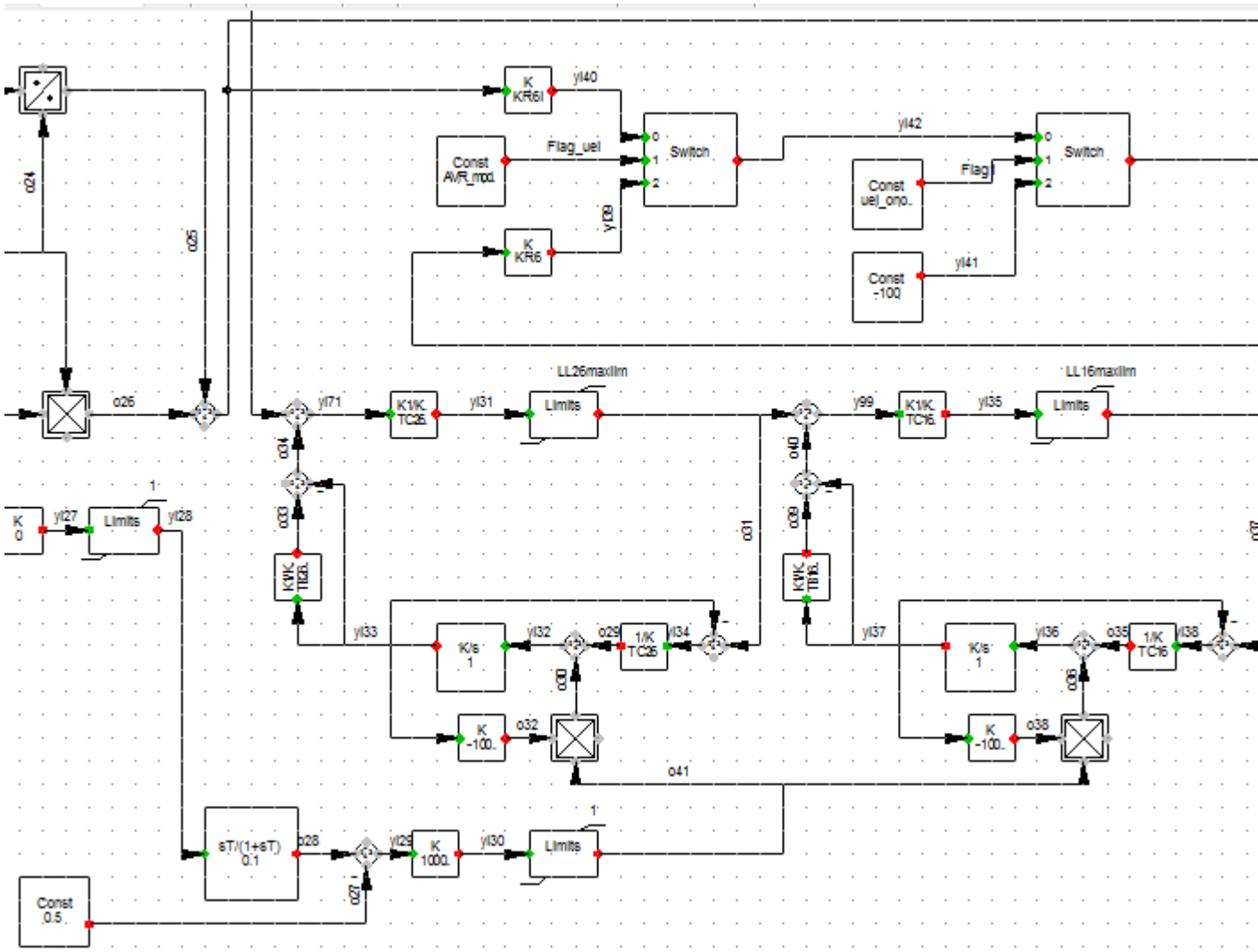


Figura 14. Modelo del limitador – UEL


1/(1+sT)
0.0001
o44
o43
yi23
x^(1/2)
Const
1
yi26
o20
yi24
o45
o18
o19
o21
yi25
1/(1+sT)
0.00001
o17
Const
Xq
Low Lim..
o22
1/K
150
yi43
1/(1+sT)
TR_uel
o14
Const
1
o16
1/(1+sT)
TR_uel
o6
o7
o10
o12
o9
Const
Xd
1/K
150
yi44
1/(1+sT)
TR_uel
yi17
abs()
yi20
Lookup Tabl.
array_UEL
o8
0
yi21
High Li..
yi22
1/(1+sT)
1


K
KR6I
yl40
Const
AVR_mod.
Flag_uel
Switch
yl42
Const
uel_ono.
Flag
Switch
K
KR6
yl39
Const
-100
yl41
o24
o25
o26
yl71
K1/K.
TC26.
yl31
Limits
LL26maxIlm
y99
K1/K.
TC16.
yl35
Limits
LL16maxIlm
o34
o40
o33
o39
o31
K3/K.
TI26.
K3/K.
TI16.
K
0
yl27
Limits
yl28
yl33
K/s
1
yl32
o29
1/K
TC26
yl34
yl37
K/s
1
yl36
o35
1/K
TC16
yl38
o30
o36
K
-100.
o32
K
-100.
o38
o41
sT/(1+sT)
0.1
o28
o27
yl29
K
1000.
yl30
Limits
Const
0.5

Modelo Limitador de Limitador de sobrexcitación (OEL)

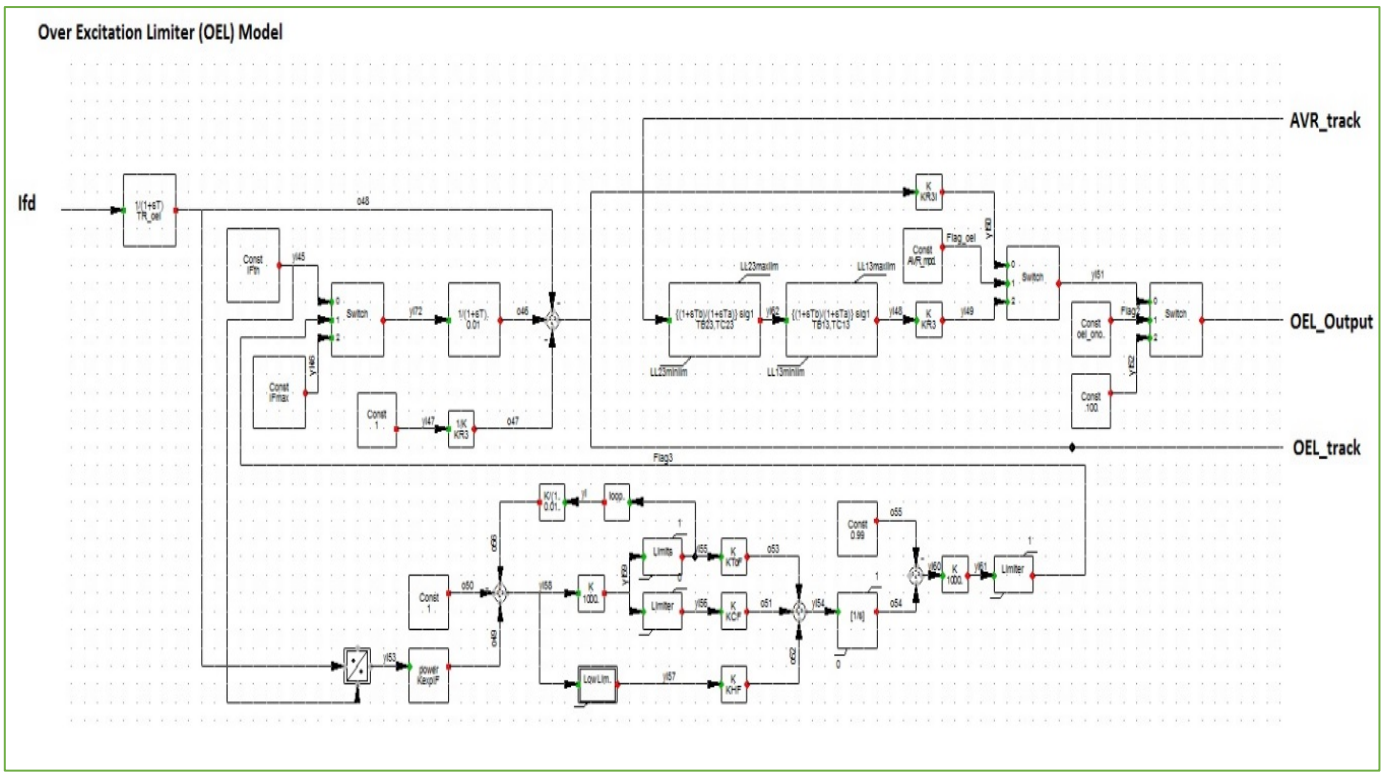
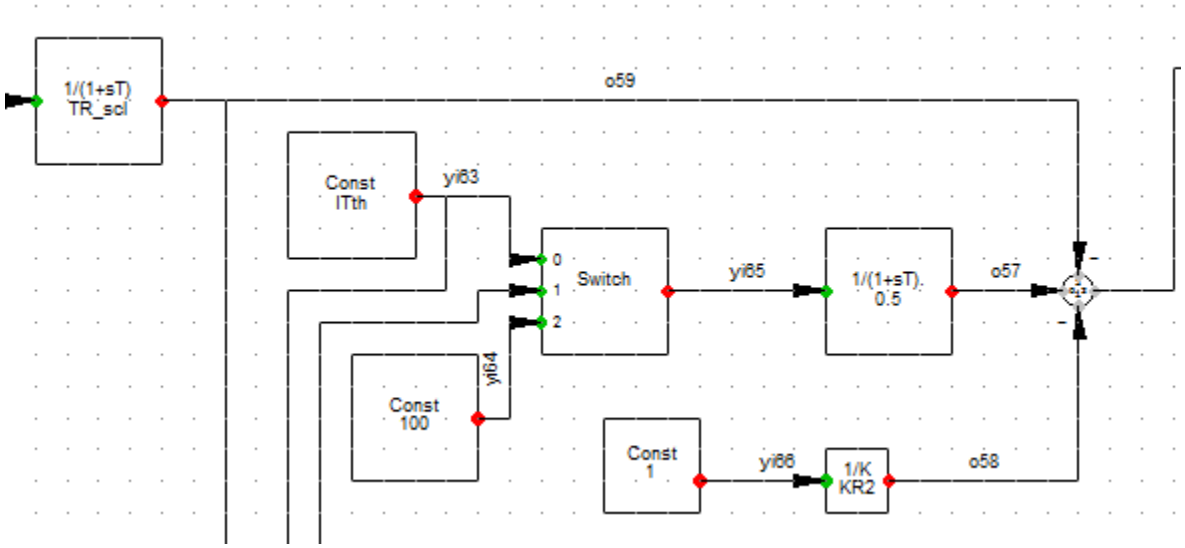
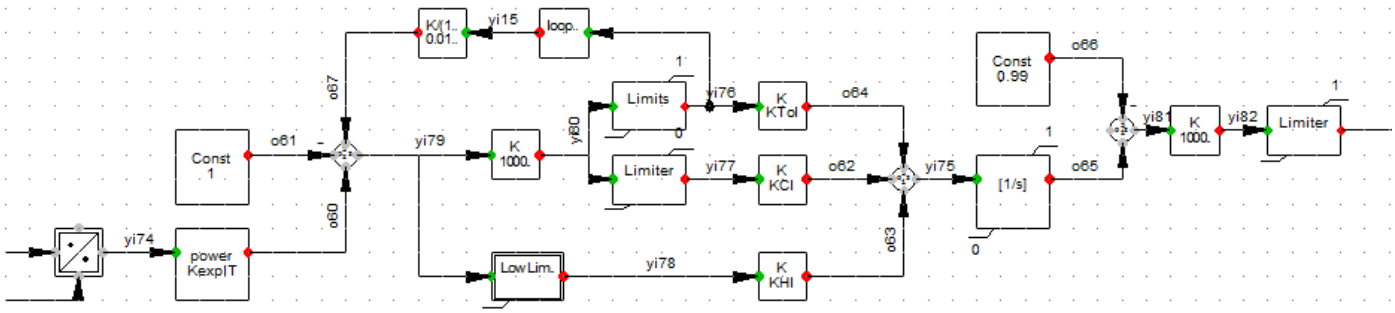
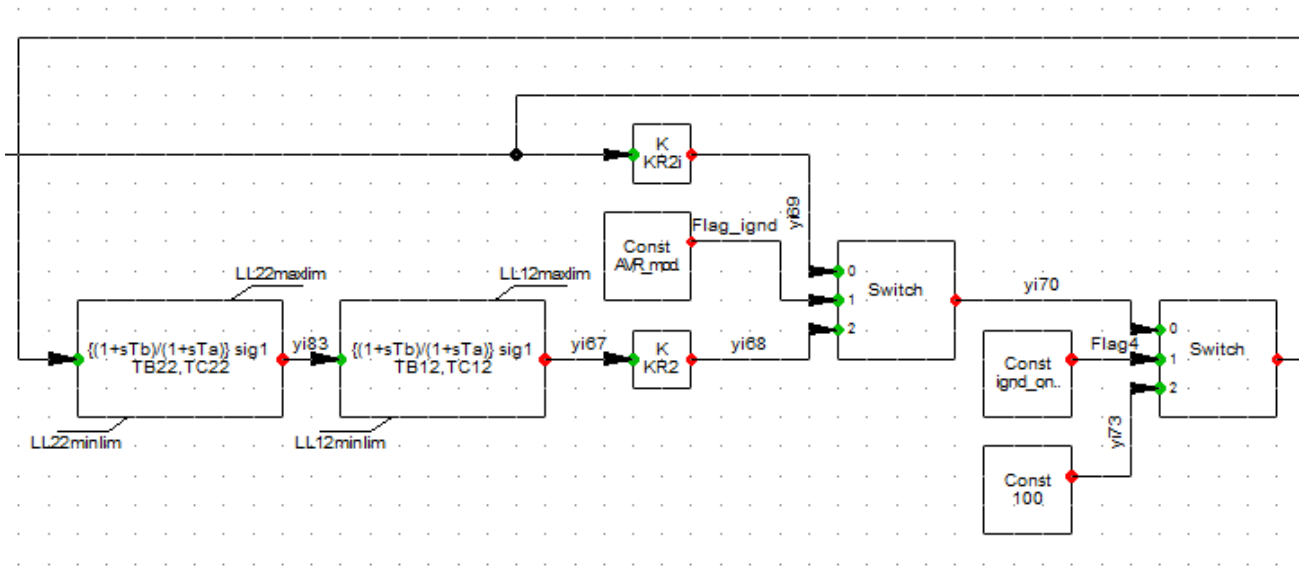


Figura 15. Modelo del limitador – OEL.




K/(1.
0.01..
yi15
loop..
o67
1
Limits
0
yi76
K
KTol
o64
Const
0.99
o66
yi80
Const
1
o61
yi79
K
1000.
Limiter
yi77
K
KCl
o62
yi75
1
[1/s]
0
o65
yi81
K
1000.
yi82
1
Limiter
yi74
power
KexpIT
o60
LowLim.
yi78
K
KHI
o63


K
KR2i
Const
AVR_mod
Flag_ignd
yi69
LL22maxlim
LL12maxlim
{(1+sTb)/(1+sTa)} sig1
TB22,TC22
yi83
{(1+sTb)/(1+sTa)} sig1
TB12,TC12
yi67
K
KR2
yi68
0
1
2
Switch
yi70
LL22minlim
LL12minlim
Const
ignd_on..
Flag4
0
1
2
Switch
yi73
Const
100

Limitador de corriente estatórica (SCL)

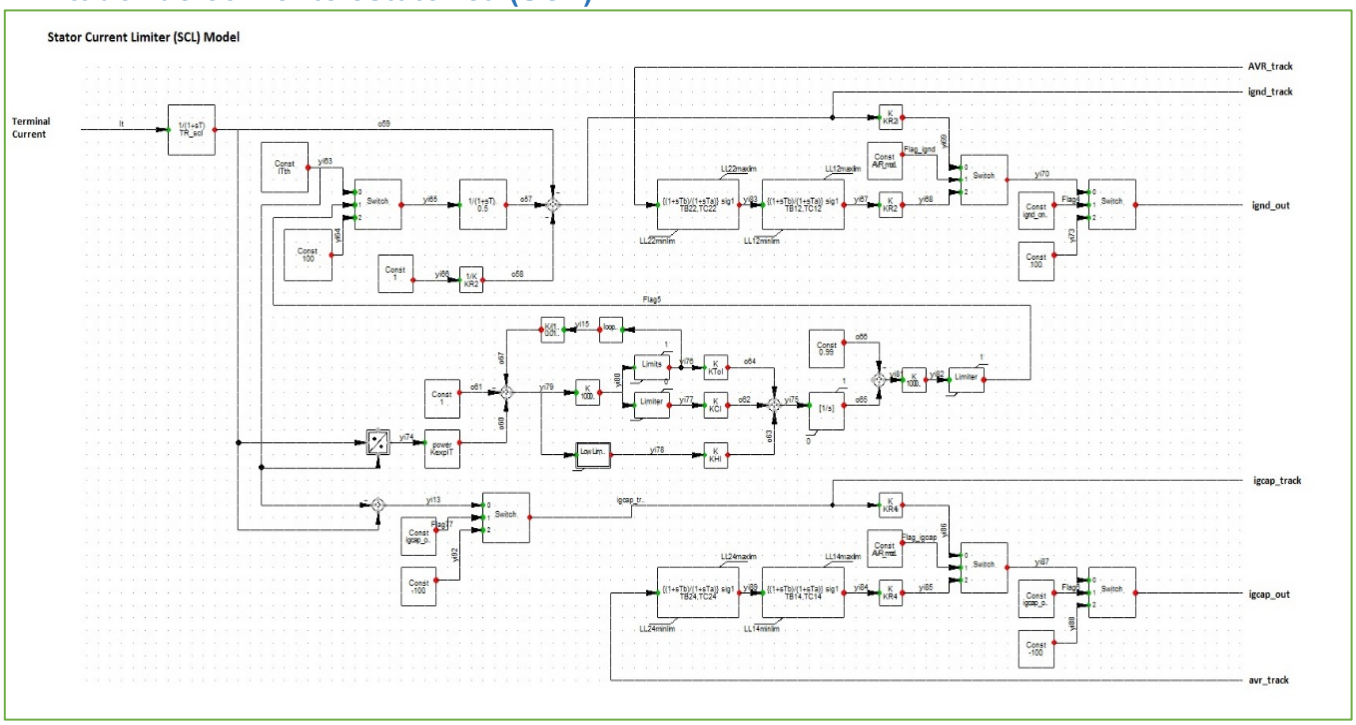
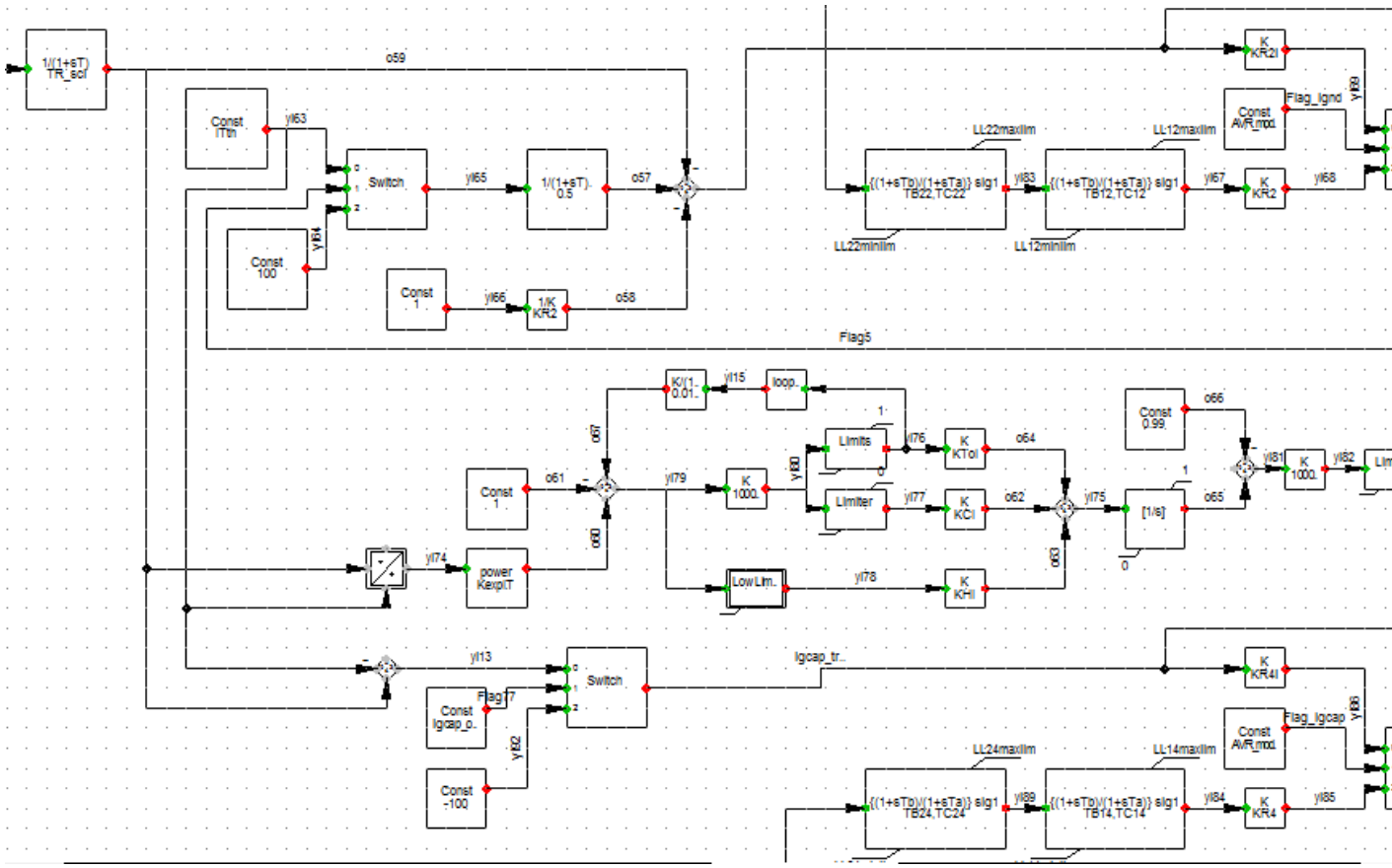


Figura 16. Modelo del limitador – SCL.


1/(1+sT)
TR_sol
o59
Const
ITth
yl63
Switch
yl65
1/(1+sT)
0.5
o57
Const
100
yl64
Const
1
yl66
1/K
KR2
o58
K
KR2i
Const
AVR_mod
Flag_Ignd
yl69
LL22maxlim
LL12maxlim
((1+sTo)/(1+sTa)) sig1
TB22,TC22
yl83
((1+sTo)/(1+sTa)) sig1
TB12,TC12
yl67
K
KR2
yl68
LL22minlim
LL12minlim
Flag5
K/(1.
0.01.
yl15
loop.
Const
1
o61
o67
o60
yl79
K
1000.
Limits
yl76
K
KTol
o64
Limiter
yl77
K
KCl
o62
yl75
Const
0.99
o66
[1/s]
o65
yl81
K
1000.
yl82
yl80
yl74
power
KexpLT
Low Lim.
yl78
K
KHl
o63
yl13
Switch
Igcap_tr..
Const
Igcap_o..
Flag17
yl92
Const
-100
K
KR4i
Const
AVR_mod
Flag_Igcap
yl93
LL24maxlim
LL14maxlim
((1+sTo)/(1+sTa)) sig1
TB24,TC24
yl89
((1+sTo)/(1+sTa)) sig1
TB14,TC14
yl84
K
KR4
yl85

Limitador V/HZ

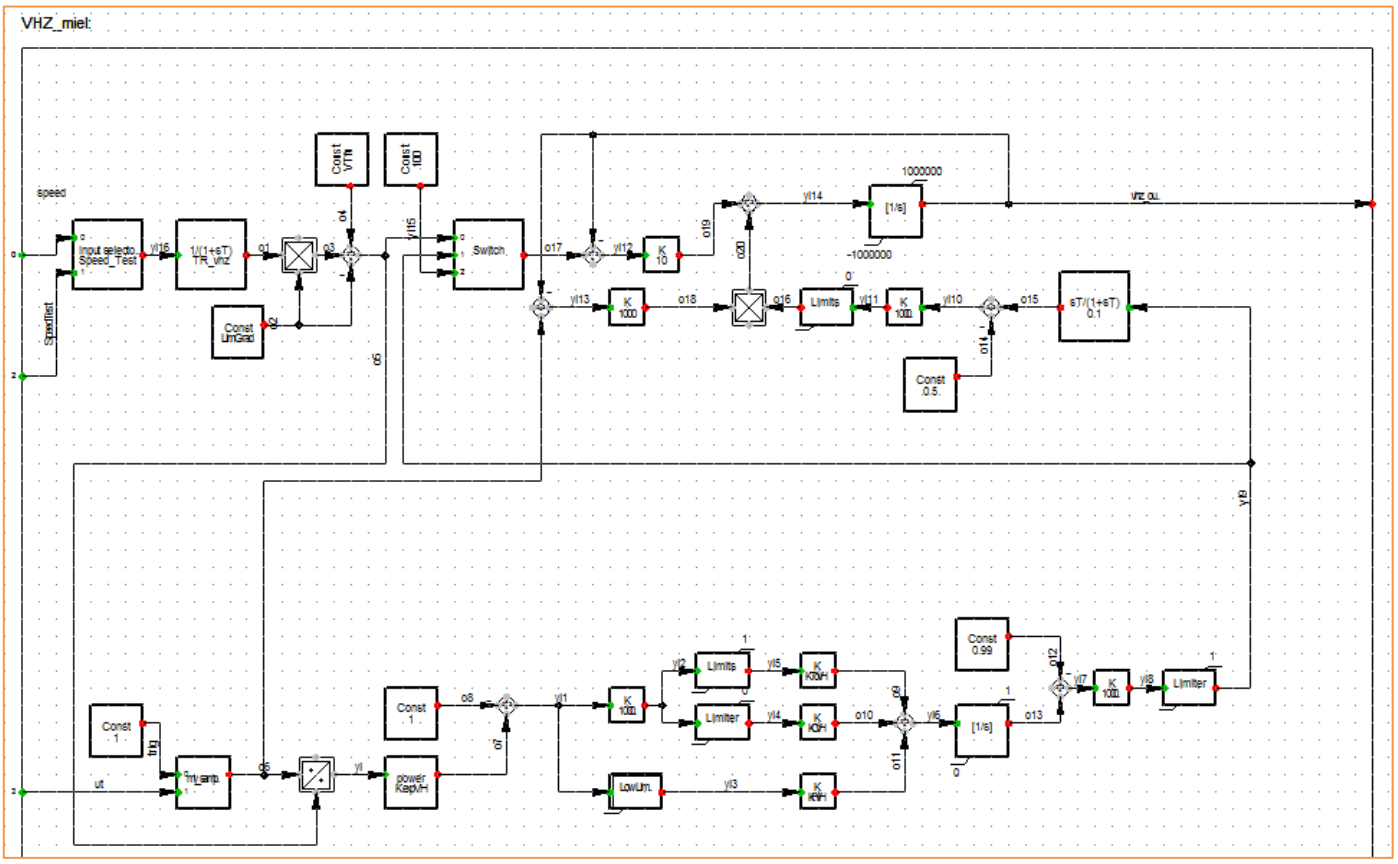


Figura 17. Modelo del limitador V/Hz. MIEL 1.

Tabla 10. Parámetros V/Hz.

PARÁMETROS V/Hz			
Network Model >> Network Data >> Grid >>U2_VHZ			
Descripción	**Parámetro**	**Unidad**	**Valor**
Maximum V/Hz Gradient	VTfn	[pu]	1.1
Maximum generator voltage	LimGrad	[pu]	1.5
Test enable (0 = normal mode, 1 = test mode)	Speed_Test	-	0
Measurement Time Constant	TR_vhz	[s]	0.001
Fixed integration time	KToVH	[s]	1000
Cooling integration time	KCVH	[s]	0.001
Inverse time characteristic integration time	KHVH	[s]	0
Exponent factor of inverse characteristic	KexpVH	[pu]	1

Estabilizador del Sistema de Potencia

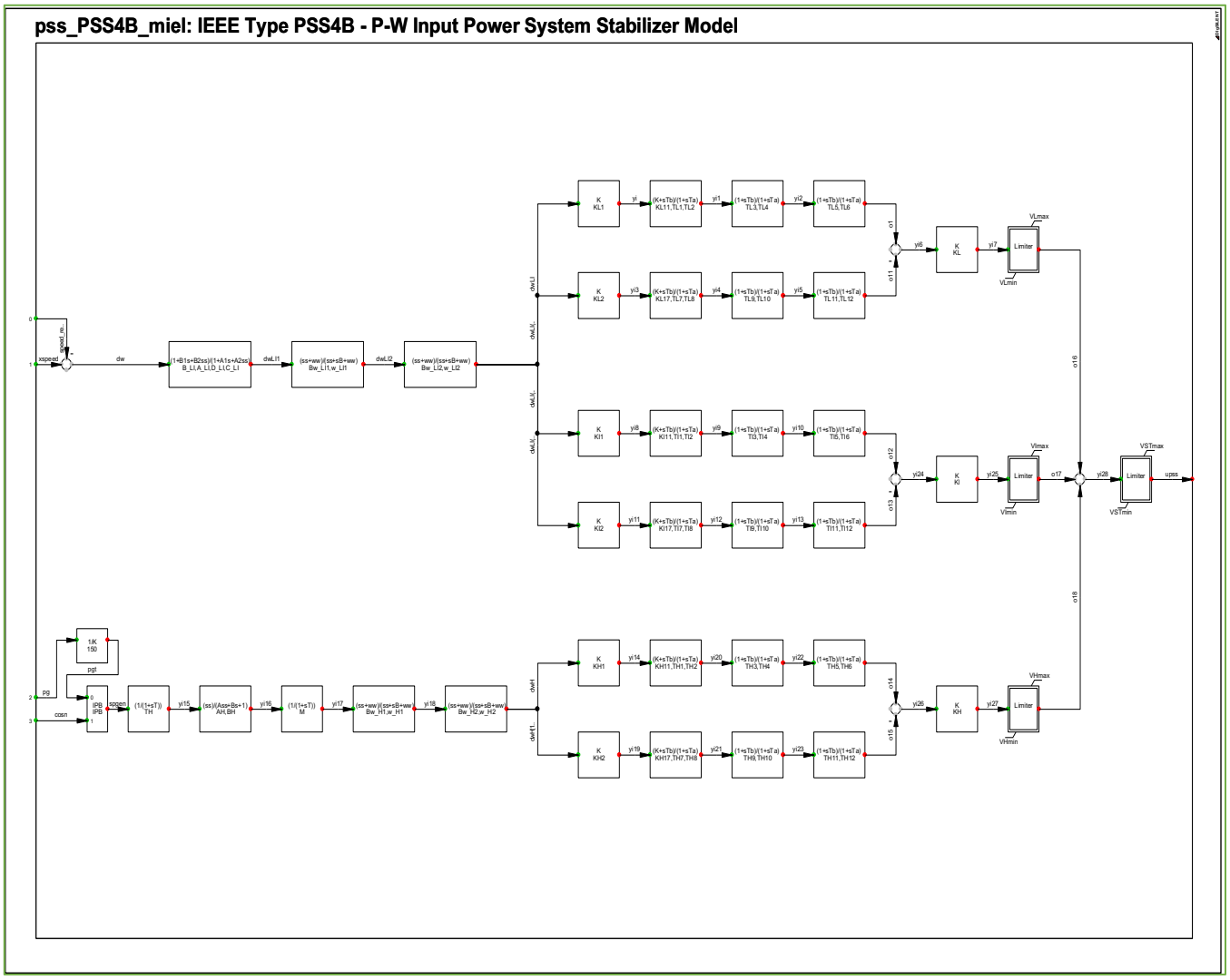
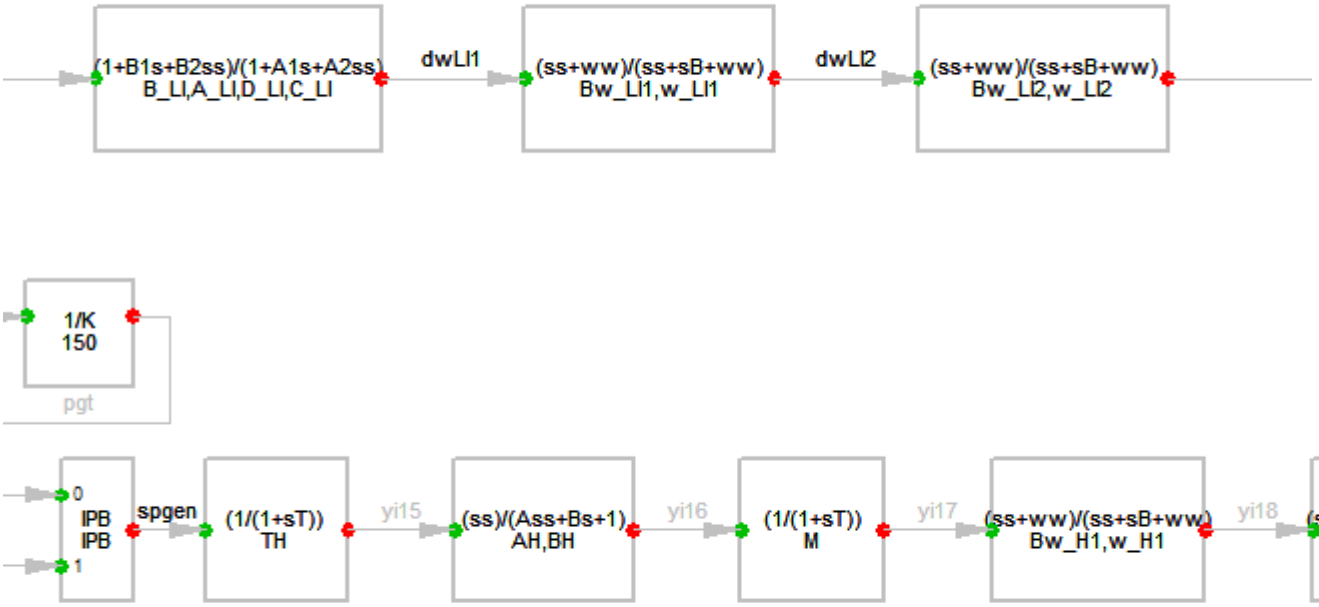


Figura 18. Modelo PSS4B.


(1+B1s+B2ss)/(1+A1s+A2ss)
B_LI,A_LI,D_LI,C_LI
dwLI1
(ss+ww)/(ss+sB+ww)
Bw_LI1,w_LI1
dwLI2
(ss+ww)/(ss+sB+ww)
Bw_LI2,w_LI2
1/K
150
pgt
0
IPB
IPB
1
spgen
(1/(1+sT))
TH
yi15
(ss)/(Ass+Bs+1)
AH,BH
yi16
(1/(1+sT))
M
yi17
(ss+ww)/(ss+sB+ww)
Bw_H1,w_H1
yi18

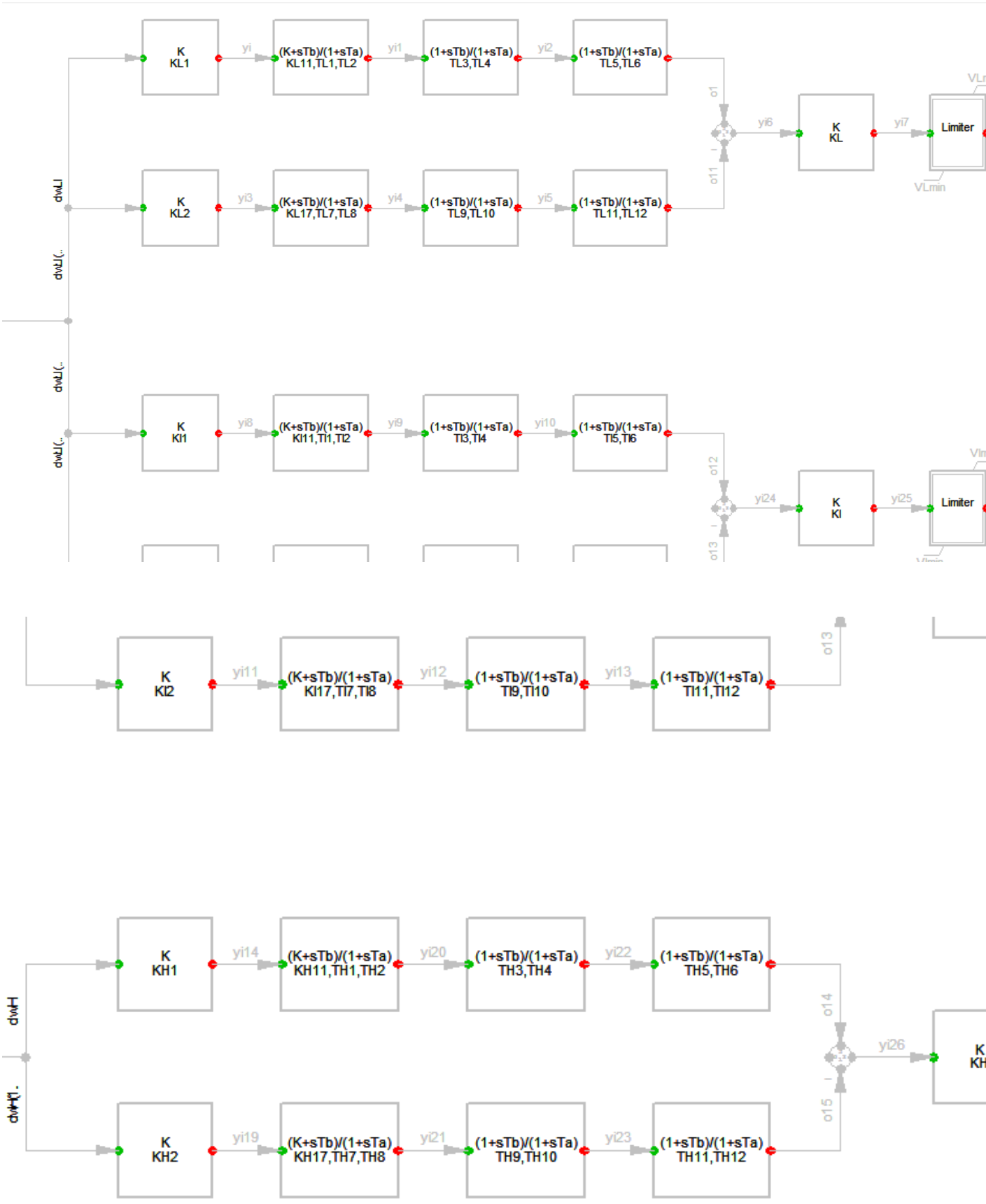

K
KL1
yi
(K+sTb)/(1+sTa)
KL11,TL1,TL2
yi1
(1+sTb)/(1+sTa)
TL3,TL4
yi2
(1+sTb)/(1+sTa)
TL5,TL6
o1
yi6
K
KL
yi7
Limiter
VLmin
K
KL2
yi3
(K+sTb)/(1+sTa)
KL17,TL7,TL8
yi4
(1+sTb)/(1+sTa)
TL9,TL10
yi5
(1+sTb)/(1+sTa)
TL11,TL12
o11
K
KI1
yi8
(K+sTb)/(1+sTa)
KI11,TI1,TI2
yi9
(1+sTb)/(1+sTa)
TI3,TI4
yi10
(1+sTb)/(1+sTa)
TI5,TI6
o12
o13
yi24
K
KI
yi25
Limiter
K
KI2
yi11
(K+sTb)/(1+sTa)
KI17,TI7,TI8
yi12
(1+sTb)/(1+sTa)
TI9,TI10
yi13
(1+sTb)/(1+sTa)
TI11,TI12
o13
K
KH1
yi14
(K+sTb)/(1+sTa)
KH11,TH1,TH2
yi20
(1+sTb)/(1+sTa)
TH3,TH4
yi22
(1+sTb)/(1+sTa)
TH5,TH6
o14
yi26
K
KH2
yi19
(K+sTb)/(1+sTa)
KH17,TH7,TH8
yi21
(1+sTb)/(1+sTa)
TH9,TH10
yi23
(1+sTb)/(1+sTa)
TH11,TH12
o15

Tabla 11. Parámetros del PSS.

PSS Network Model >> Network Data >> Grid >>U2_PSS	
Parámetro	Valor
B_LI	0.017823
A_LI	0.00012739
D_LI	0.001759
C_LI	0
Bw_LI1	0
w_LI1	1
Bw_LI2	0
w_LI2	1
KL1	0.375
KL2	0.375
KI1	0
KI2	0
KL11	1
TL1	35.58
TL2	7.11
TL3	25.94
TL4	6.406
TL5	4.84
TL6	3.66
KL17	1
TL7	7.11
TL8	1.42

PSS Network Model >> Network Data >> Grid >>U2_PSS	
Parámetro	Valor
TL9	25.94
TL10	6.4
TL11	4.84
TL12	3.66
KL	3.754
KI11	1
TI1	8.37
TI2	1.674
TI3	0.648
TI4	0.16
TI5	0.25
TI6	0.194
KI17	1
TI7	1.674
TI8	0.334
TI9	0.648
TI10	0.16
TI11	0.256
TI12	0.194
KI	5.139
IPB	-1
TH	0.0125

PSS Network Model >> Network Data >> Grid >>U2_PSS	
Parámetro	Valor
AH	1
BH	2
Bw_H1	0
w_H1	1
M	9.1
Bw_H2	0
w_H2	1
KH1	0
KH2	0.375
KH11	1
TH1	0.406
TH2	0.081
TH3	0.12
TH4	0.029
TH5	0.027
TH6	0.0204
KH17	1
TH7	0.081
TH8	0.016
TH9	0.012
TH10	0.0297
TH11	0.027

PSS	
Network Model >> Network Data >> Grid >>U2 PSS	
Parámetro	**Valor**
TH12	0.0204
KH	40.721
VLmin	-0.075
VImin	-0.1
VHmin	-0.1
VSTmin	-0.2
VLmax	0.075
VImax	0.1
VHmax	0.1
VSTmax	0.2

Regulador de Velocidad/Potencia y Turbina

Conducción y turbina hidráulica

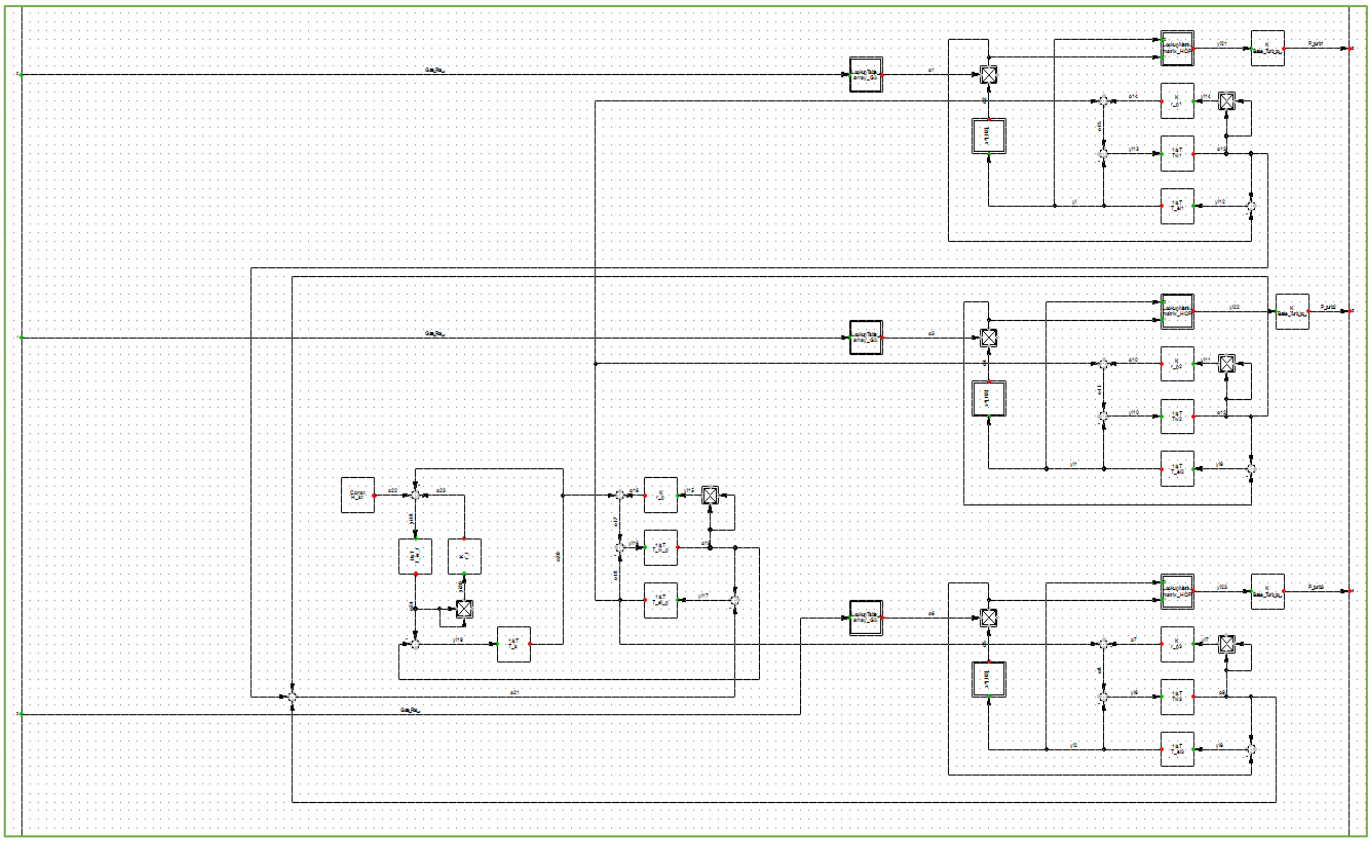


Figura 19. Modelo conjunto conducción y turbinas.

Modelo de la conducción

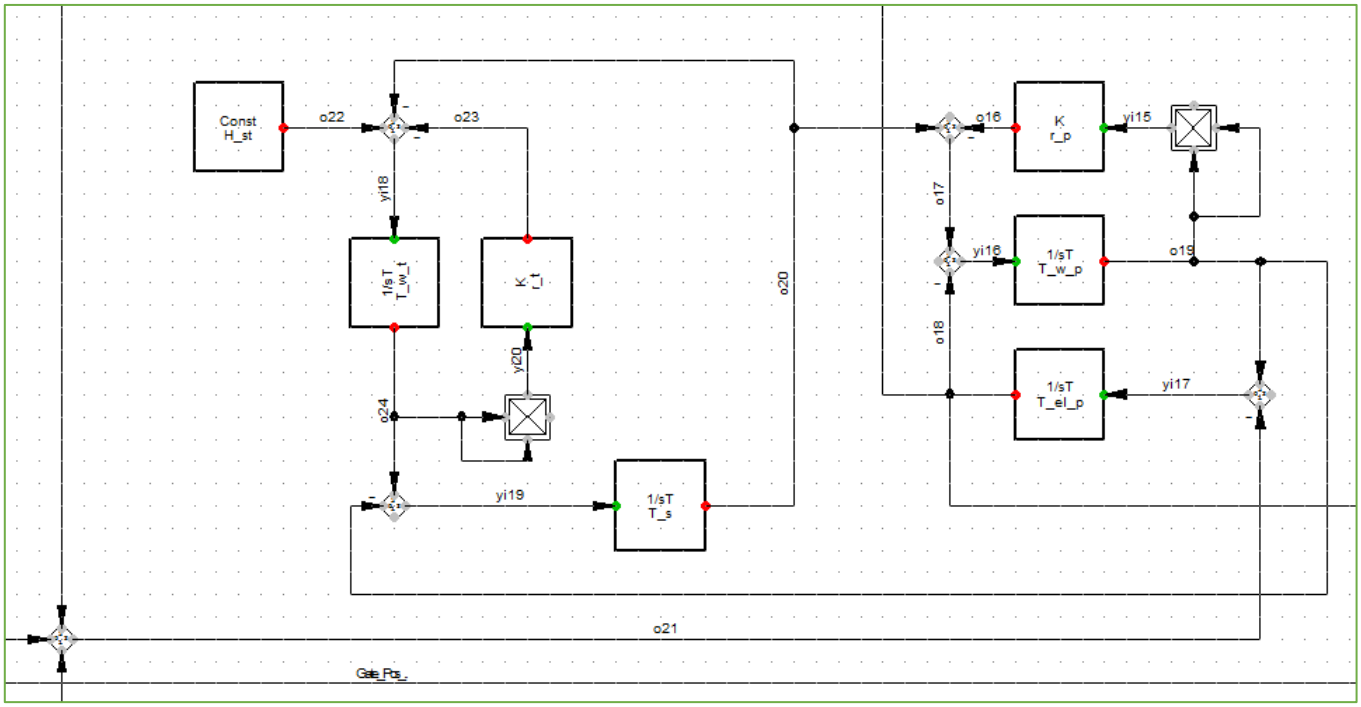


Figura 20. Modelo Túnel de energía y almenara

Modelo turbina Hidráulica

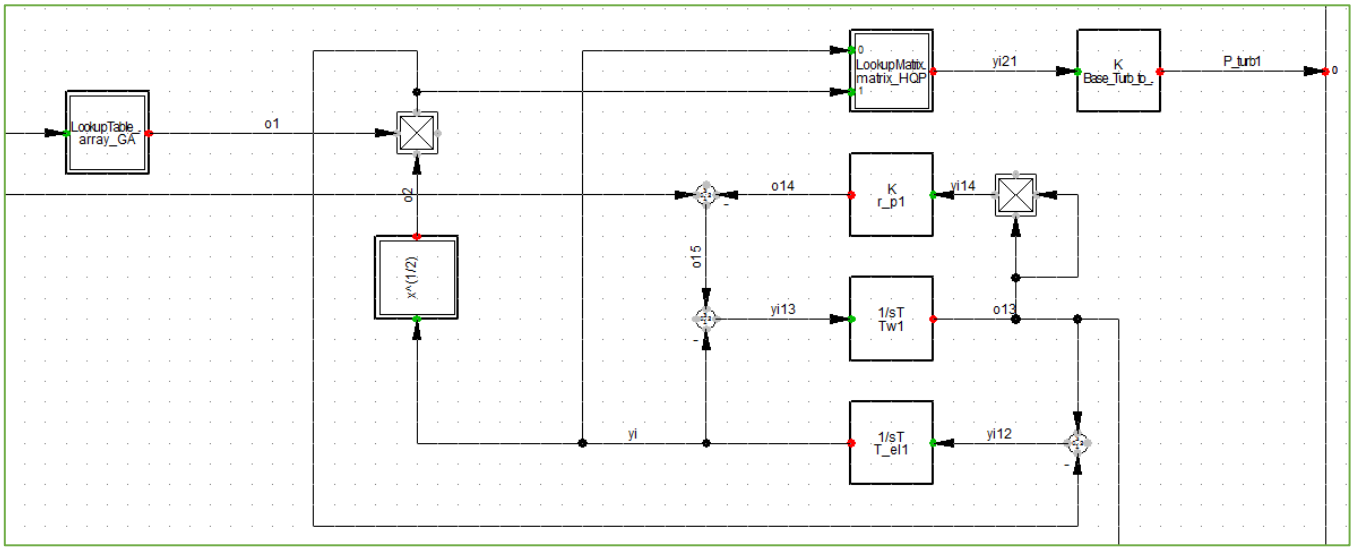


Figura 21. Modelo turbina Hidráulica

Tabla 12. Parámetros de conducción y turbina

Parámetros de conducción y turbina	
Network Model >> Network Data >> Grid >> Full_Turb_model	
Parámetro	Valor
Base_Turb_to_Gen	1.1111
H_st	0.984055
Tw3 (U3)	0.179
T_w_t	0.076
T_w_p	0.32
Tw1 (U1)	0.179
Tw2 (U2)	0.168
T_el2 (U2)	0.0014
T_el3 (U3)	0.0015
T_el1 (U1)	0.0015
r_p3 (U3)	0.01
r_p1 (U1)	0.01
r_t	0.002
r_p	0.002
T_el_p	0.0366
r_p2 (U2)	0.01
T_s	274.27
Pbase	135

Tabla 13. Características de posición – área de flujo del acctuador

Características de posición – área de flujo del acctuador	
Network Model >> Network Data >> Grid >>Full_Turb_model>>GA	
Apertura [p.u.]	Área de flujo [p.u.]
0	0
0.2617	0.3013768
0.3424	0.3420008
0.4131	0.3907275
0.4681	0.461077
0.5251	0.5239942
0.5772	0.6003013
0.6663	0.7621623
0.7121	0.8403952
0.7715	0.9381117
0.7829	0.9686905

Hoja de cálculo de
Microsoft Excel 97-20

	GA_x	GA_y
Size	11,	0,
1	0,	0,
2	0,2617	0,3013768
3	0,3424	0,3420008
4	0,4131	0,3907275
5	0,4681	0,461077
6	0,5251	0,5239942
7	0,5772	0,6003013
8	0,6663	0,7621623
9	0,7121	0,8403952
10	0,7715	0,9381117
11	0,7829	0,9686905

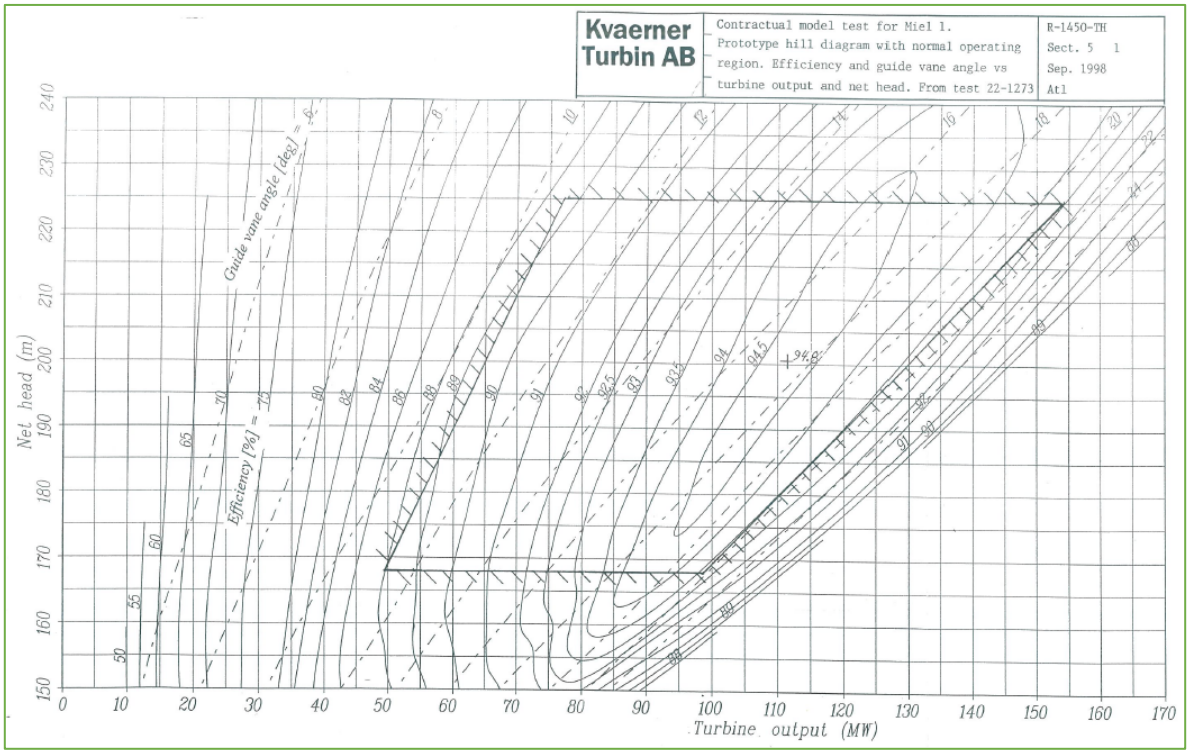


Figura 22. Superficie de eficiencia turbina.

Modelo del Regulador de Velocidad

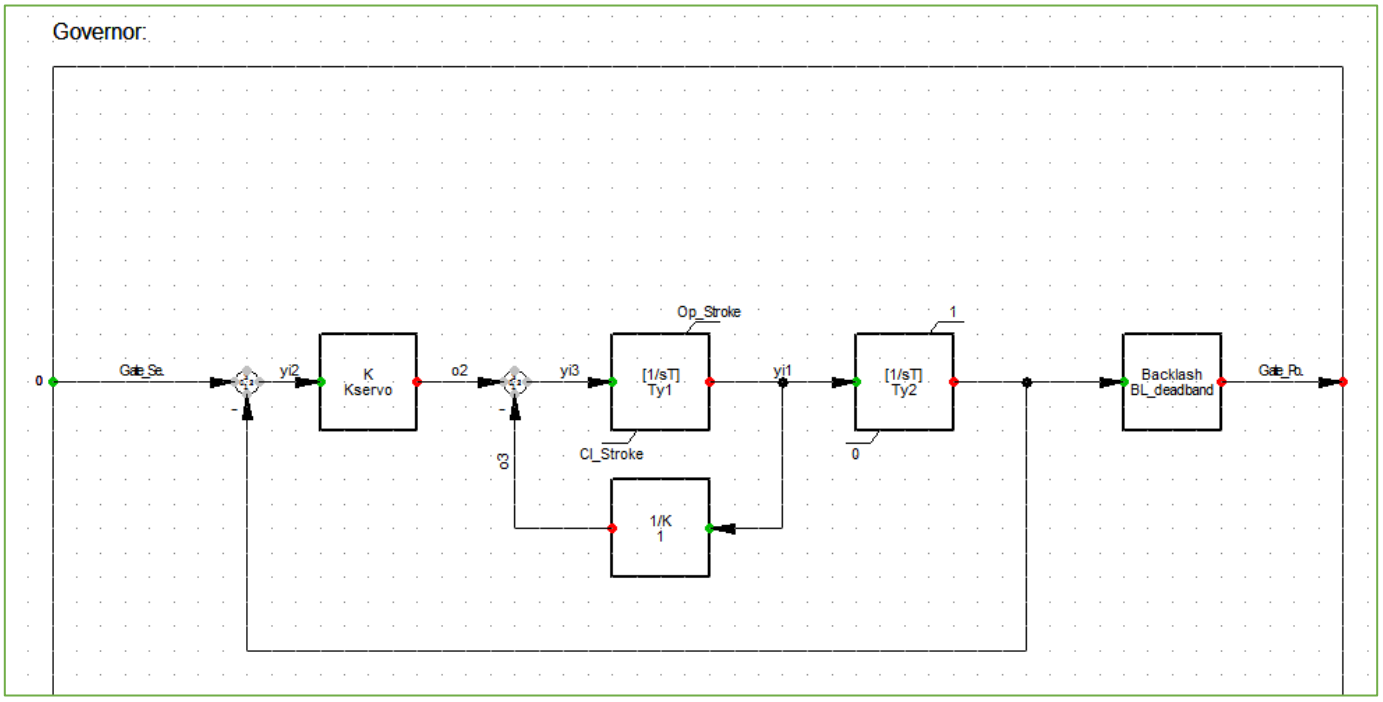


Figura 23. Modelo del gobernador de la turbina.

Tabla 14. Parámetros de gobernador.

PARÁMETROS DE GOBERNADOR	
Network Model >> Network Data >> Grid >>Governor_u2	
PARÁMETRO	**VALOR**
Kservo	10
Ty1	0.005
Ty2	0.02
BL_deadband	0.005
Cl_Stroke	-0.16
Op_Stroke	0.08

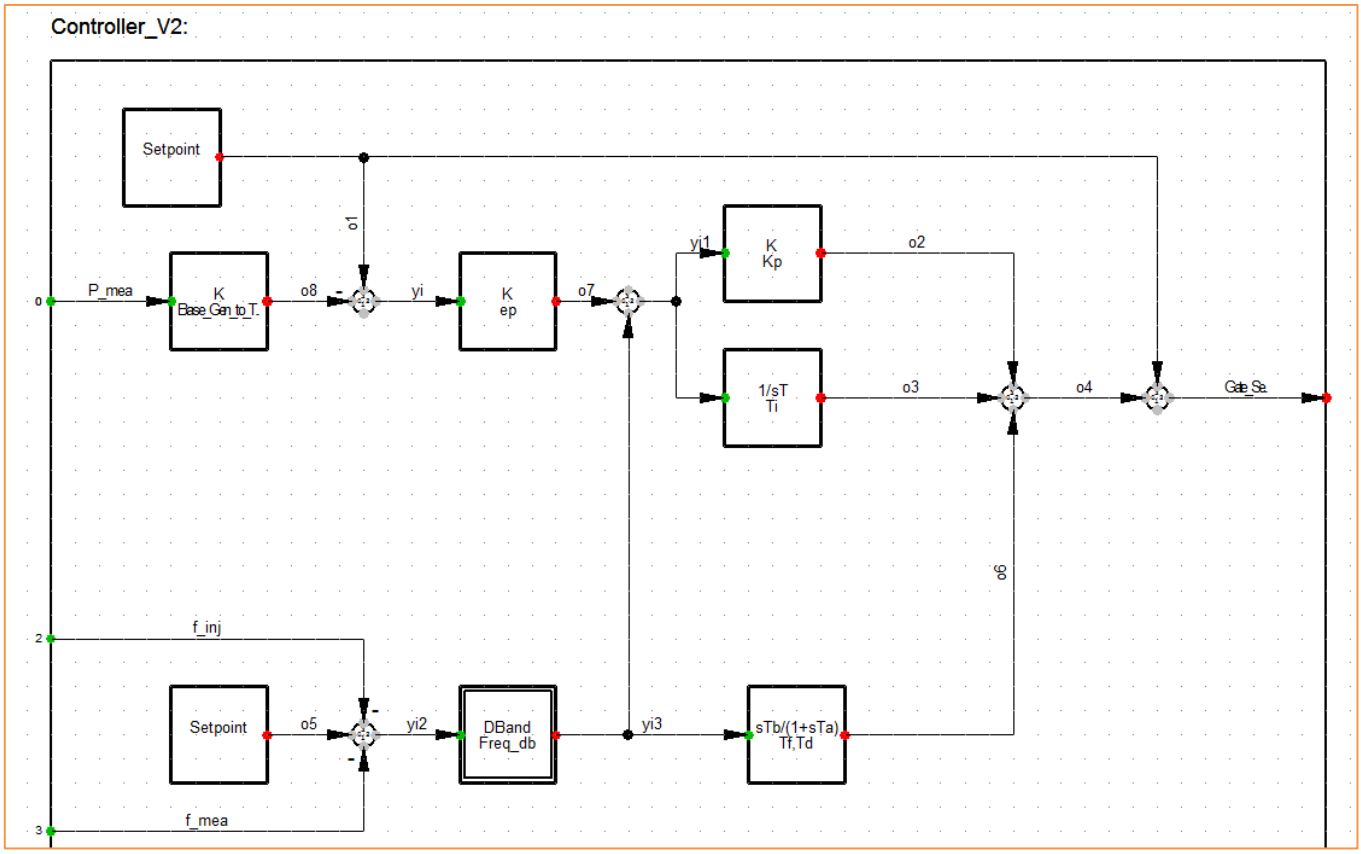


Figura 24. Modelo controlador de velocidad / potencia.

Tabla 15. Parámetros de control de velocidad / potencia.

PARÁMETROS DE CONTROL DE VELOCIDAD / POTENCIA	
Network Model >> Network Data >> Grid >> Controller_u2	
PARÁMETRO	**VALOR**
Freq_db	0.0005
Base_Gen_to_Turb	0.9267522
Ep	0.04
Kp	4
Ti	0.175
Tf	1.2
Td	0.4

ANEXO 4

DIAGRAMAS DE BLOQUE Y TABLAS DE VALORES DE LOS PARÁMETROS DE CONTROL DE LA UNIDAD 3

Sistema de Excitación

Parámetros Regulador de tensión (AVR) y Limitadores

Tabla 16. Parámetros AVR y Limitadores

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U3_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Measurement Time Constant	Tr	[s]	0.001
Maximum thermal stator current limit	ITth	[p.u.]	2.55
Measurement time constant	TR_scl	[s]	0.001
ST5C not active selection	AVR_mode_disable_scl	[logic]	0
Release of IGnd limiter	ignd_onoff	[logic]	1
Release of IGCap limiter	igcap_onoff	[logic]	0
Measurement Time Constant	Tr_e	[s]	0.05
Measurement Time Constant	TR_uel	[s]	0.001
Direct axis synchronous reactance	Xd	[pu]	1.35
Quadrature axis synchronous reactance	Xq	[pu]	0.75
ST5C not active selection	AVR_mode_disable_uel	[pu]	0
OEL active/deactive selector	uel_onoff	[logic]	1
Maximum thermal field current limit	IFth	[pu]	2
Maximum field current limit	IFmax	[pu]	2.1
Measurement Time Constant	TR_oel	[s]	0.001
ST5C not active selection	AVR_mode_disable_oel	[pu]	0
OEL active/deactive selector	oel_onoff	[logic]	1
Controller Gain	KR1	[pu]	500
Steady state gain	KR2	[p.u.]	500
Steady state gain adjustment	KR2i	[p.u.]	0.8
Fixed time integration constant	KToI	[1/s]	0
Cooling integration constant	KCI	[1/s]	0.01
Inverse time characteristic integration constant	KHI	[1/s]	0.0381
	MC_Sn		150
Steady state gain	KR4	[p.u.]	250
Steady state gain adjustment	KR4i	[p.u.]	0.5

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U3_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Reactive Power Measurement Gain	KIR	[pu]	0
Steady State Gain	KR6	[pu]	500
Active Power Measurement Gain	KIA	[pu]	0
Lead-time constant	TC26	[s]	0.1
Lag-time constant	TB26	[s]	0.1
Lead-time constant	TC16	[s]	1.52
Lag-time constant	TB16	[s]	9.5
Steady State Gain Adjustment	KR6i	[pu]	0.4
Steady State Gain	KR3	[pu]	500
Steady State Gain Adjustment	KR3i	[pu]	0.3
Fixed integration time	KToF	[s]	0.1
Cooling integration time	KCF	[s]	0
Inverse time characteristic integration time	KHF	[s]	0.0429
Exponent factor of inverse time characteristic	KexpIT	[-]	2
Controller first lag time constant	TB12	[s]	9.5
Controller first lead time constant	TC12	[s]	1.52
Controller second lag time constant	TB22	[s]	0.1
Controller second lead time constant	TC22	[s]	0.1
Controller first lag time constant	TB14	[s]	25
Controller first lead time constant	TC14	[s]	3
Controller second lag time constant	TB24	[s]	0.01
Controller second lead time constant	TC24	[s]	0.01
Lag-time constant	Tb21	[s]	21.56
Lead-time constant	Tc21	[s]	3.45
Lag-time constant	Tb11	[s]	0.1
Lead-time constant	Tc11	[s]	0.1
Exponent factor of inverse characteristic	KexpIF	[pu]	1
Lag-time constant	TB13	[s]	9.5
Lead-time constant	TC13	[s]	1.52
Lag-time constant	TB23	[s]	0.1
Lead-time constant	TC23	[s]	0.1
1st Lead Lag Minimum Limit	LL12minlim	[pu]	-0.2
2st Lead Lag Minimum Limit	LL22minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL14minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL24minlim	[pu]	-0.4
2st Lead Lag Minimum Limit	LL21_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL11_minlim	[pu]	-0.2
1st Lead Lag Minimum Limit	LL13minlim	[pu]	-0.2
2st Lead Lag Minimum Limit	LL23minlim	[pu]	-1.25

Parámetros AVR y limitadores			
Network Model >> Network Data >> Grid >>U3_AVR_LIM			
Descripción	Parámetro	Unidad	Valor
Voltage Regulator Minimum Output	VA_min	[pu]	-100
2st Lead Lag Minimum Limit	LL26minlim	[pu]	-1.25
1st Lead Lag Minimum Limit	LL16minlim	[pu]	-0.2
1st Lead Lag Maximum Limit	LL12maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL22maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL14maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL24maxlim	[pu]	0.4
2st Lead Lag Maximum Limit	LL21_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL11_maxlim	[pu]	0.2
1st Lead Lag Maximum Limit	LL13maxlim	[pu]	0.2
2st Lead Lag Maximum Limit	LL23maxlim	[pu]	1.25
Voltage Regulator Maximum Output	VA_max	[pu]	100
2st Lead Lag Maximum Limit	LL26maxlim	[pu]	1.25
1st Lead Lag Maximum Limit	LL16maxlim	[pu]	0.2

Lookup Table_lin array_UEL	
UEL_x	UEL_y
0	-0,6
0,2	-0,6
0,4	-0,6
0,6	-0,55
0,8	-0,45
1	-0,3

Modelo Regulador de tensión (AVR)

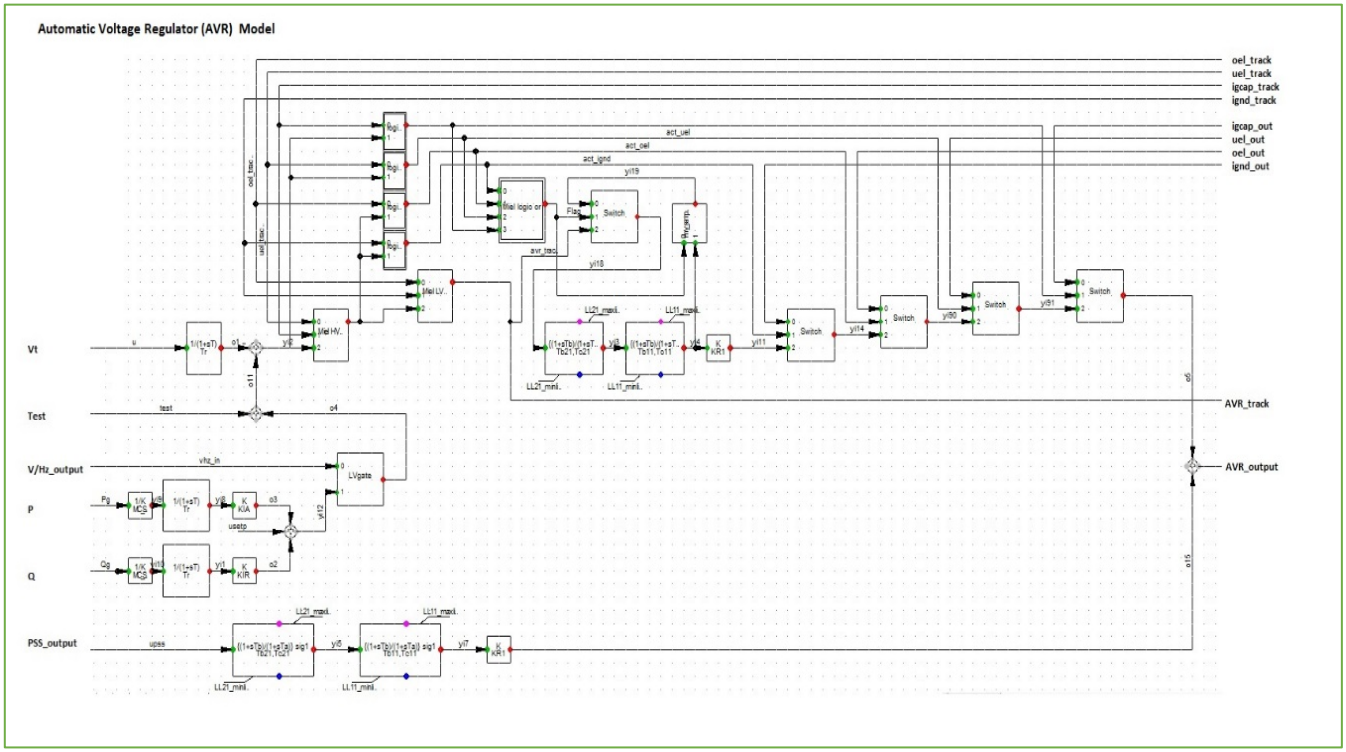
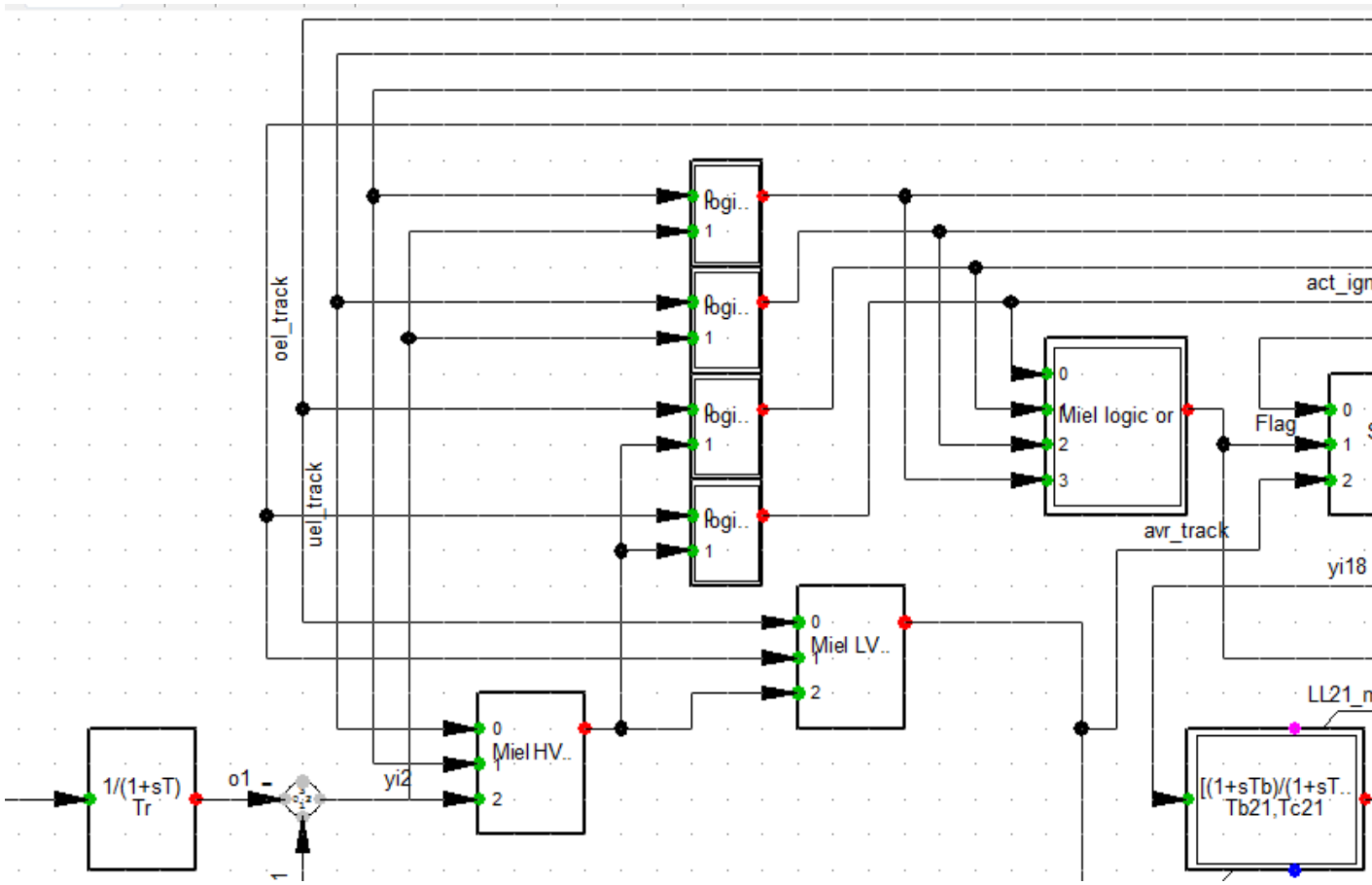
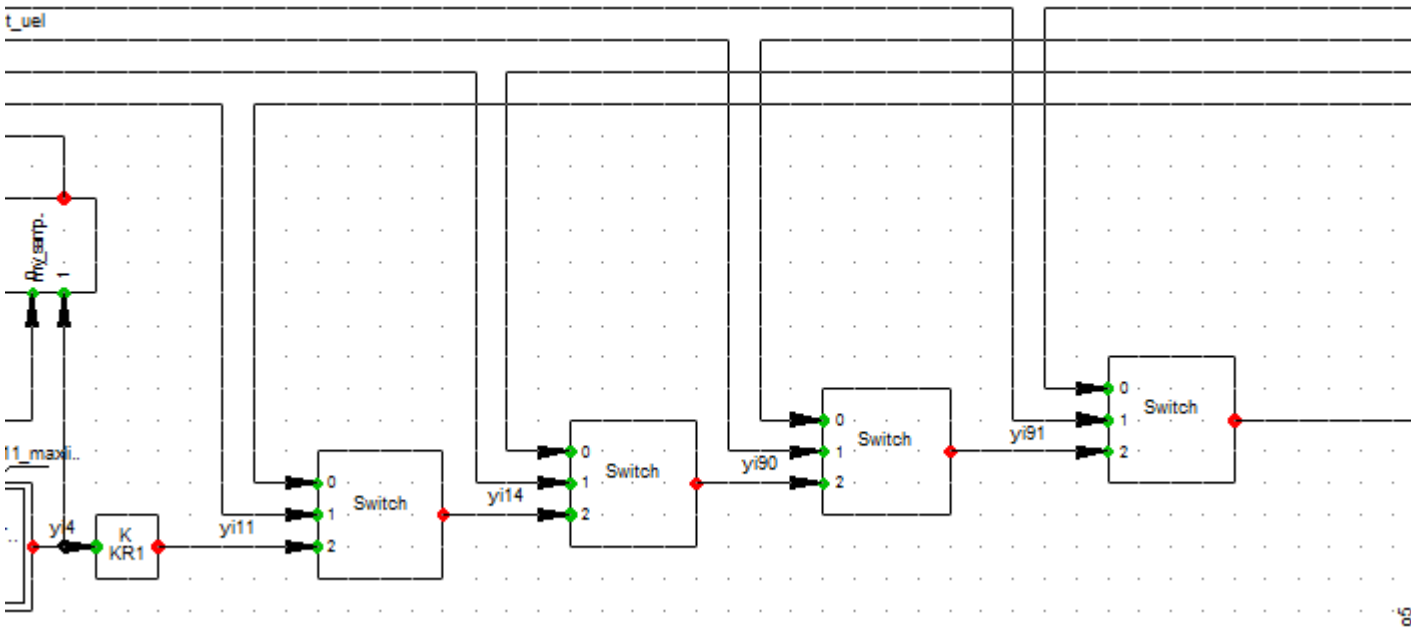
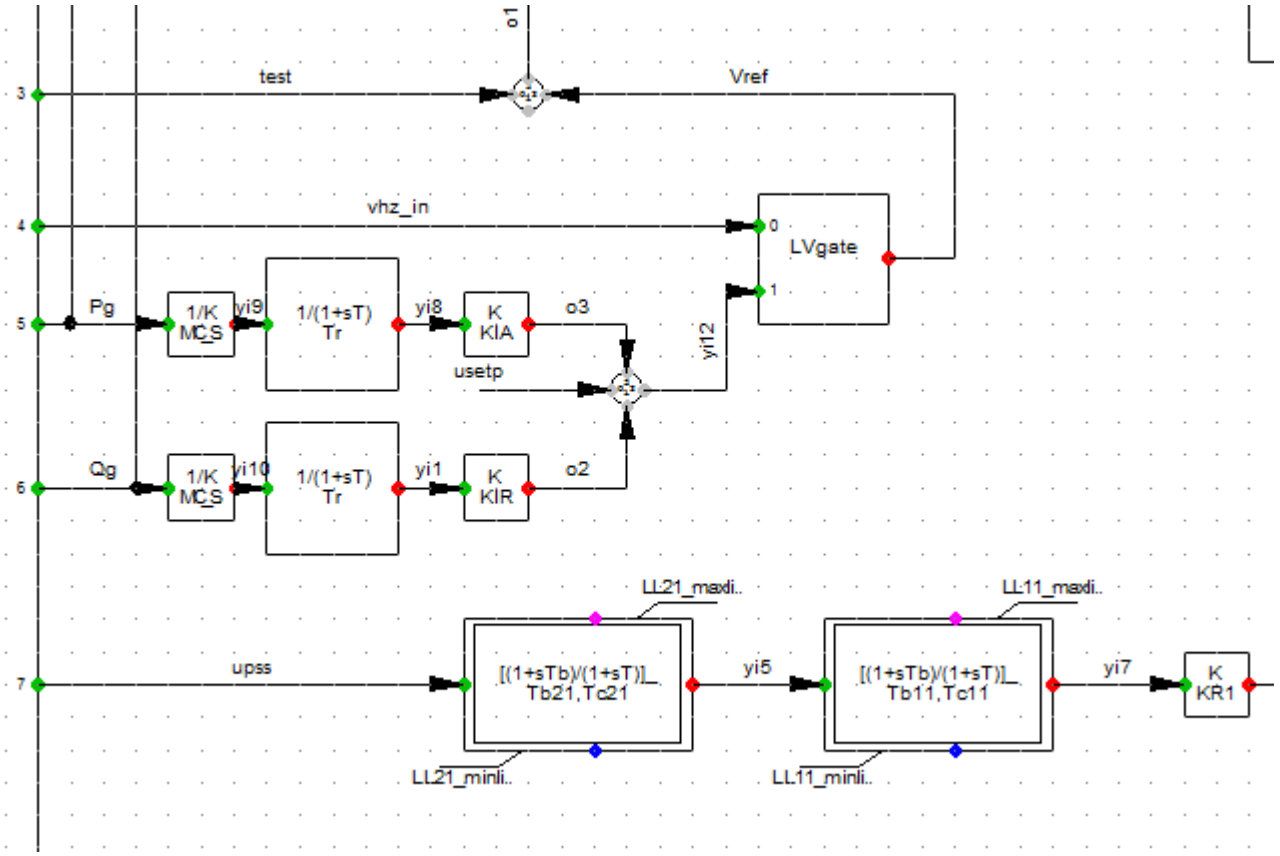
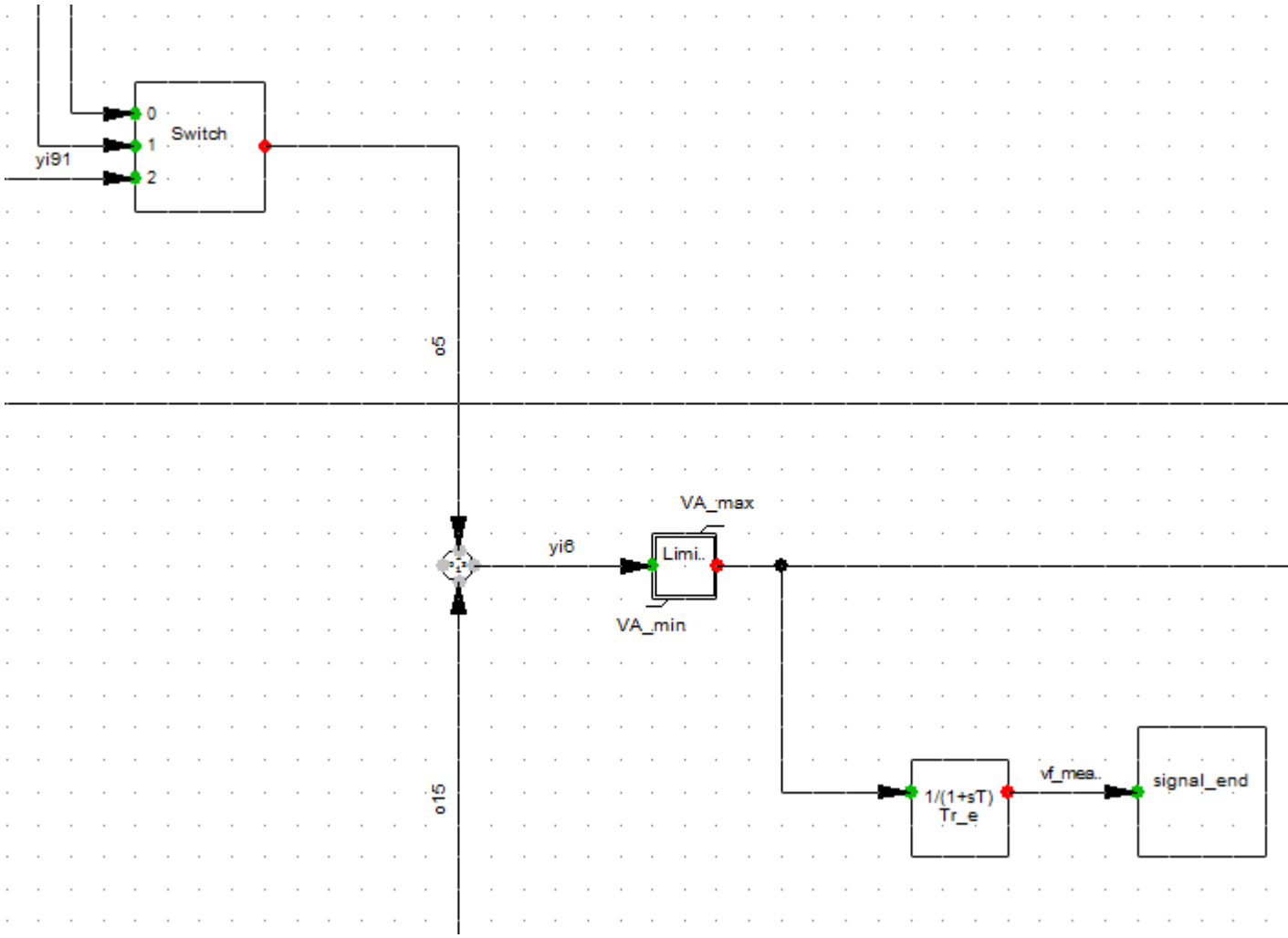


Figura 25. Modelo AVR.


oel_track
uel_track
Logi..
Logi..
Logi..
Logi..
Miel logic or
act_ign
Flag
avr_track
yi18
Miel LV..
Miel HV..
LL21_n
1/(1+sT)
Tr
o1
yi2
[(1+sTb)/(1+sT..
Tb21,Tc21


t_uel
Switch
Switch
Switch
Switch
yi4
K
KR1
yi11
yi14
yi90
yi91


o1
3
test
Vref
4
vhz_in
0
LVgate
1
5
Pg
1/K
MCS
yi9
1/(1+sT)
Tr
yi8
K
KIA
o3
usetp
yi12
6
Qg
1/K
MCS
yi10
1/(1+sT)
Tr
yi1
K
KIR
o2
LL21_maxdi..
LL11_maxdi..
7
upss
[(1+sTb)/(1+sT)]_
Tb21,Tc21
yi5
[(1+sTb)/(1+sT)]_
Tb11,Tc11
yi7
K
KR1
LL21_minli..
LL11_minli..


0
1
2
Switch
yi91
o5
VA_max
yi6
Limi..
VA_min
o15
1/(1+sT)
Tr_e
vf_mea..
signal_end

Modelo Limitador de Limitador de subexcitación (UEL)

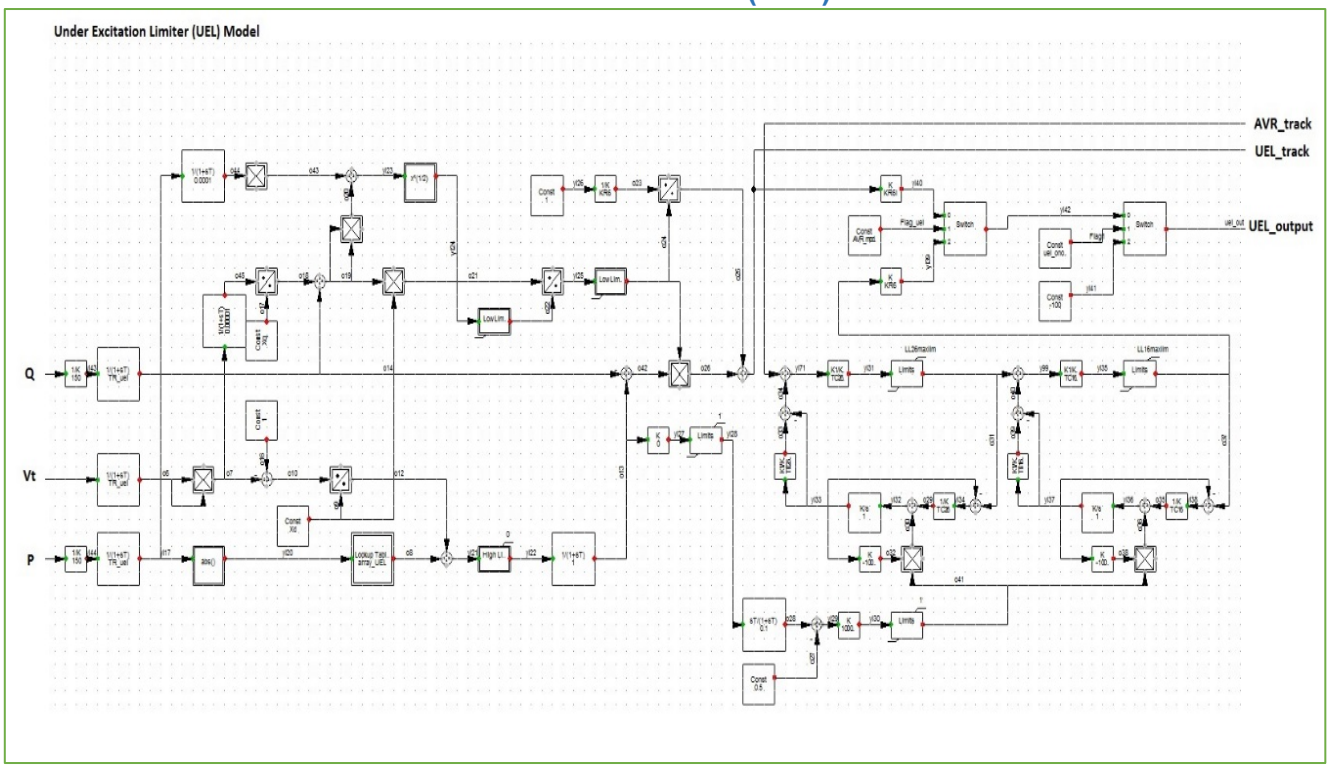
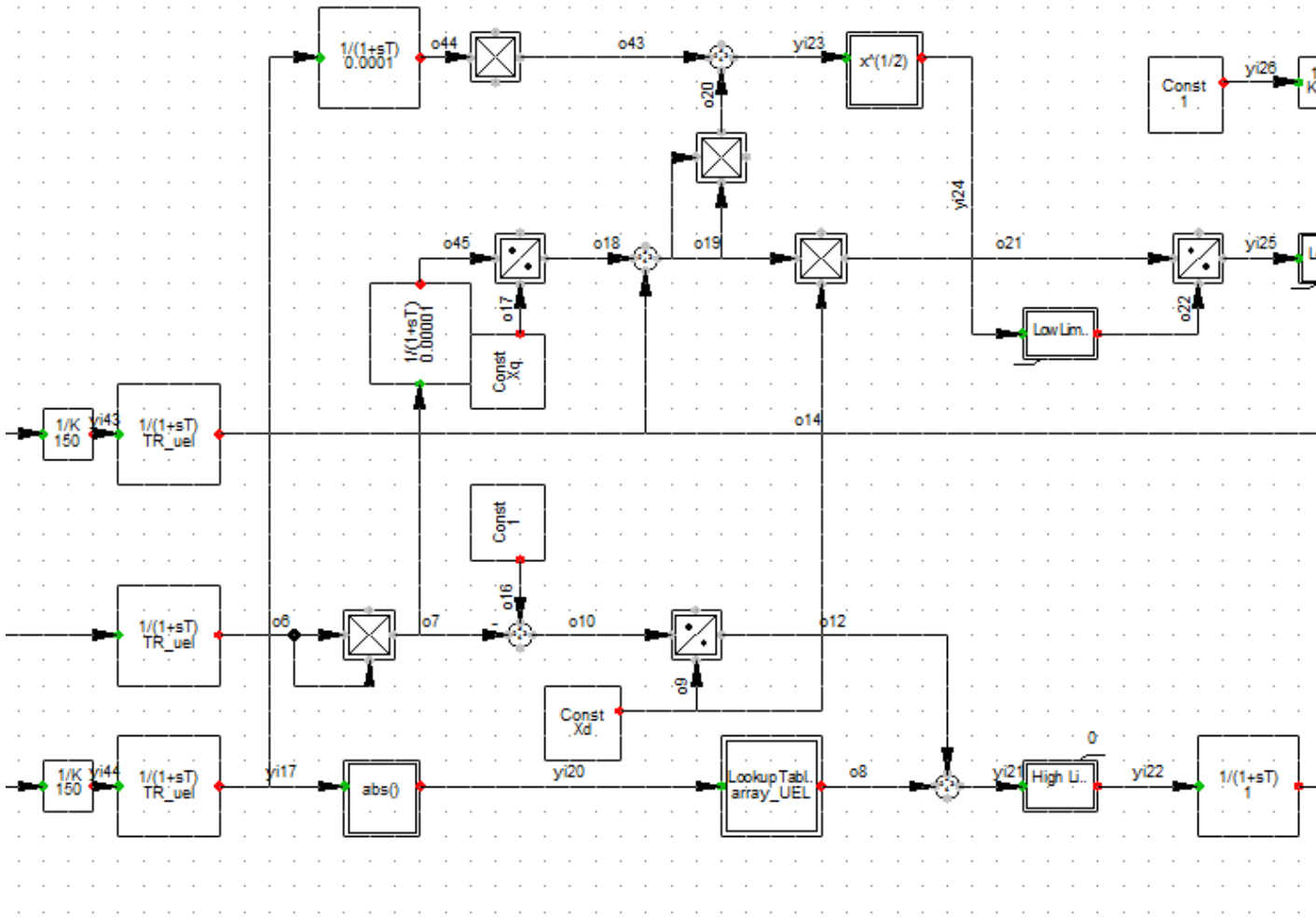
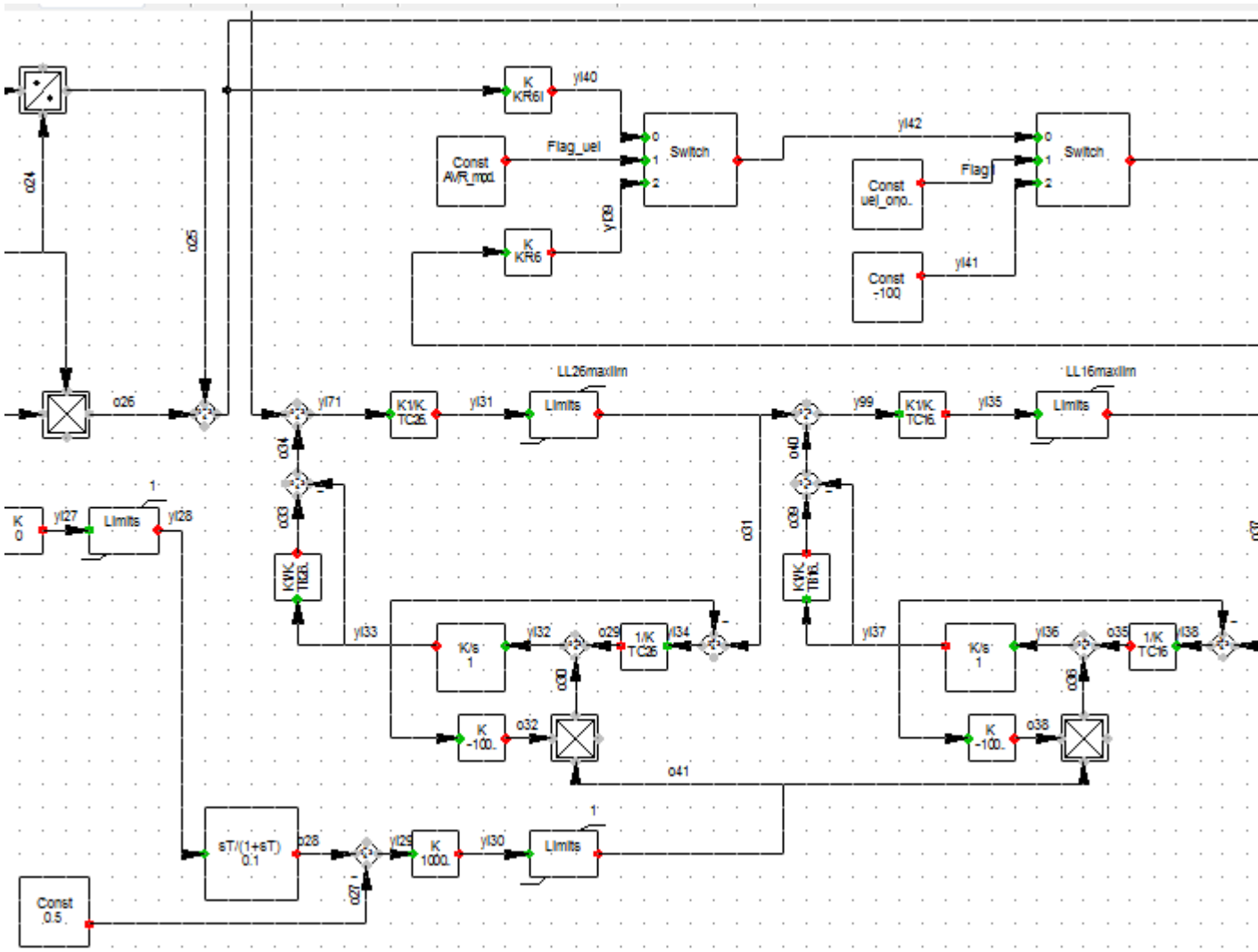


Figura 26. Modelo del limitador – UEL


1/(1+sT)
0.0001
o44
o43
yi23
x^(1/2)
Const
1
yi26
o20
yi24
o45
o18
o19
o21
yi25
1/(1+sT)
0.00001
o17
Const
Xq
Low Lim..
o22
1/K
150
yi43
1/(1+sT)
TR_uel
o14
Const
1
o16
1/(1+sT)
TR_uel
o6
o7
o10
o12
o9
Const
Xd
1/K
150
yi44
1/(1+sT)
TR_uel
yi17
abs()
yi20
Lookup Tabl.
array_UEL
o8
0
yi21
High Li..
yi22
1/(1+sT)
1



Modelo Limitador de Limitador de sobrexcitación (OEL)

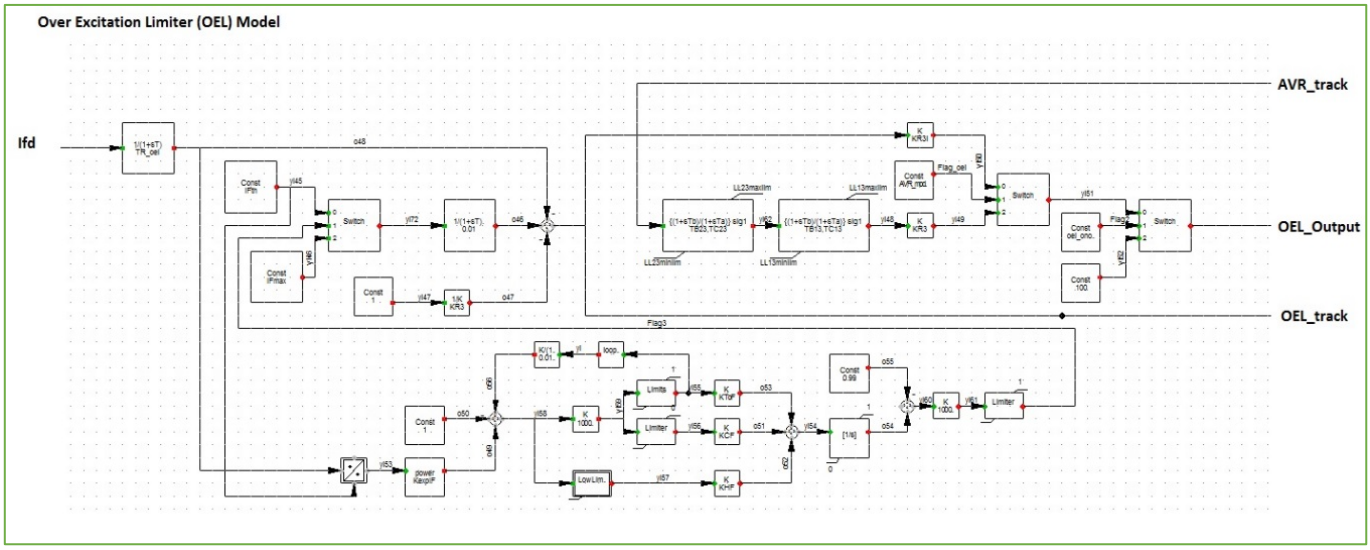
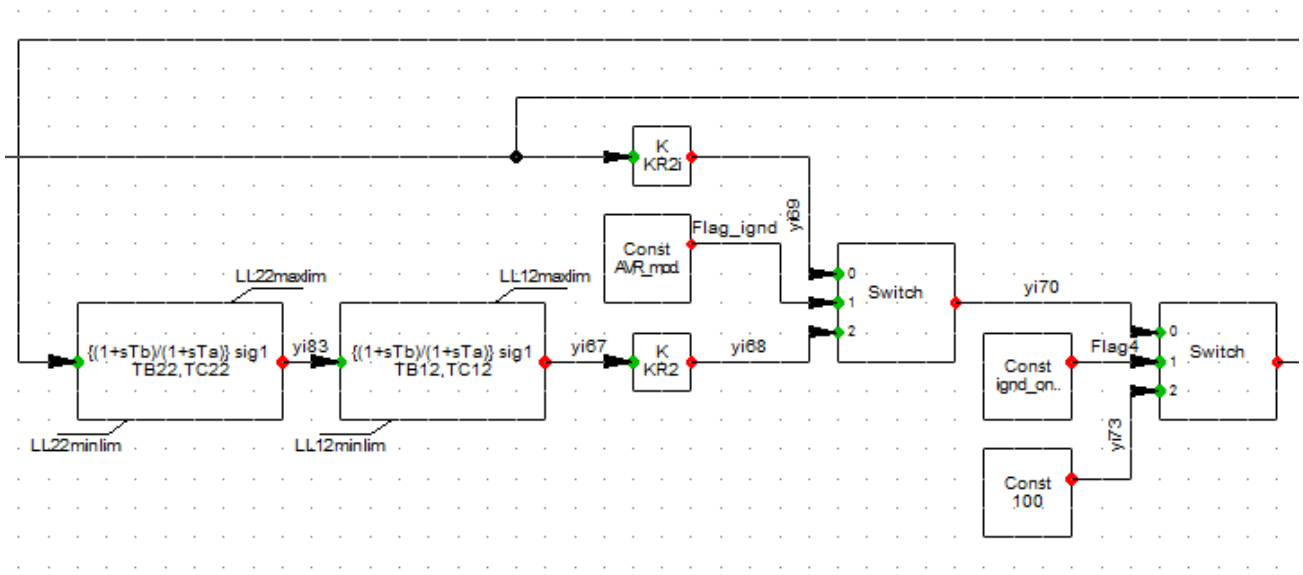


Figura 27. Modelo del limitador – OEL.



Limitador de corriente estatórica (SCL)

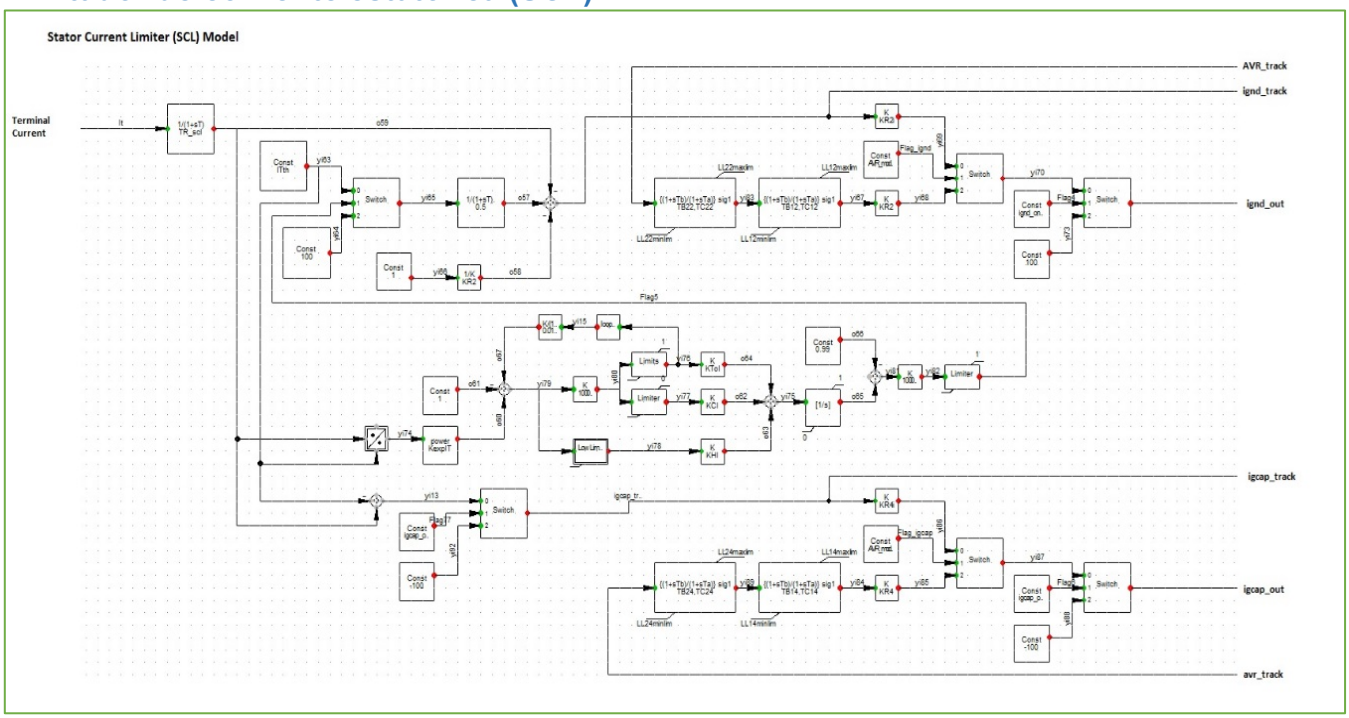
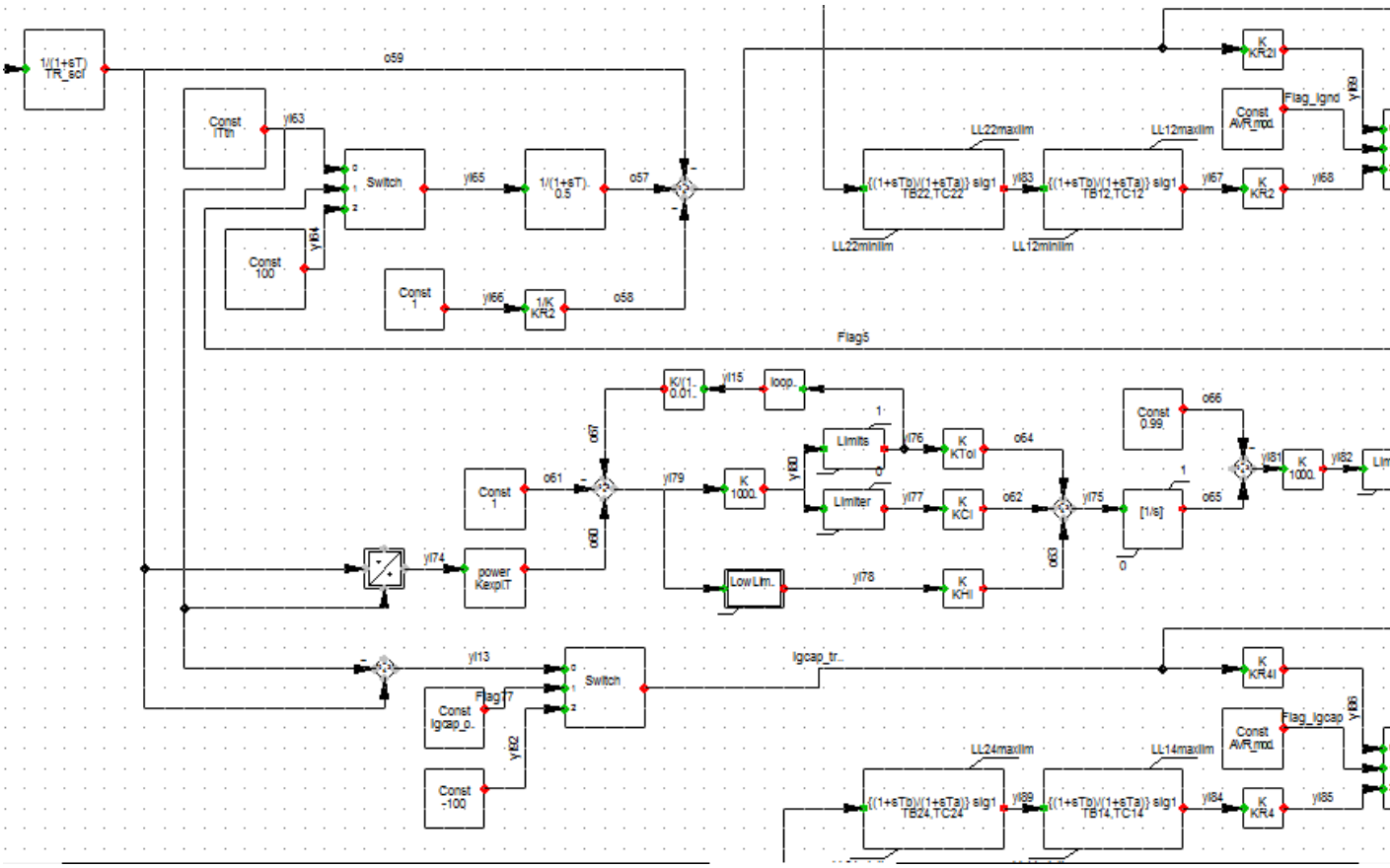


Figura 28. Modelo del limitador – SCL.



Limitador V/HZ

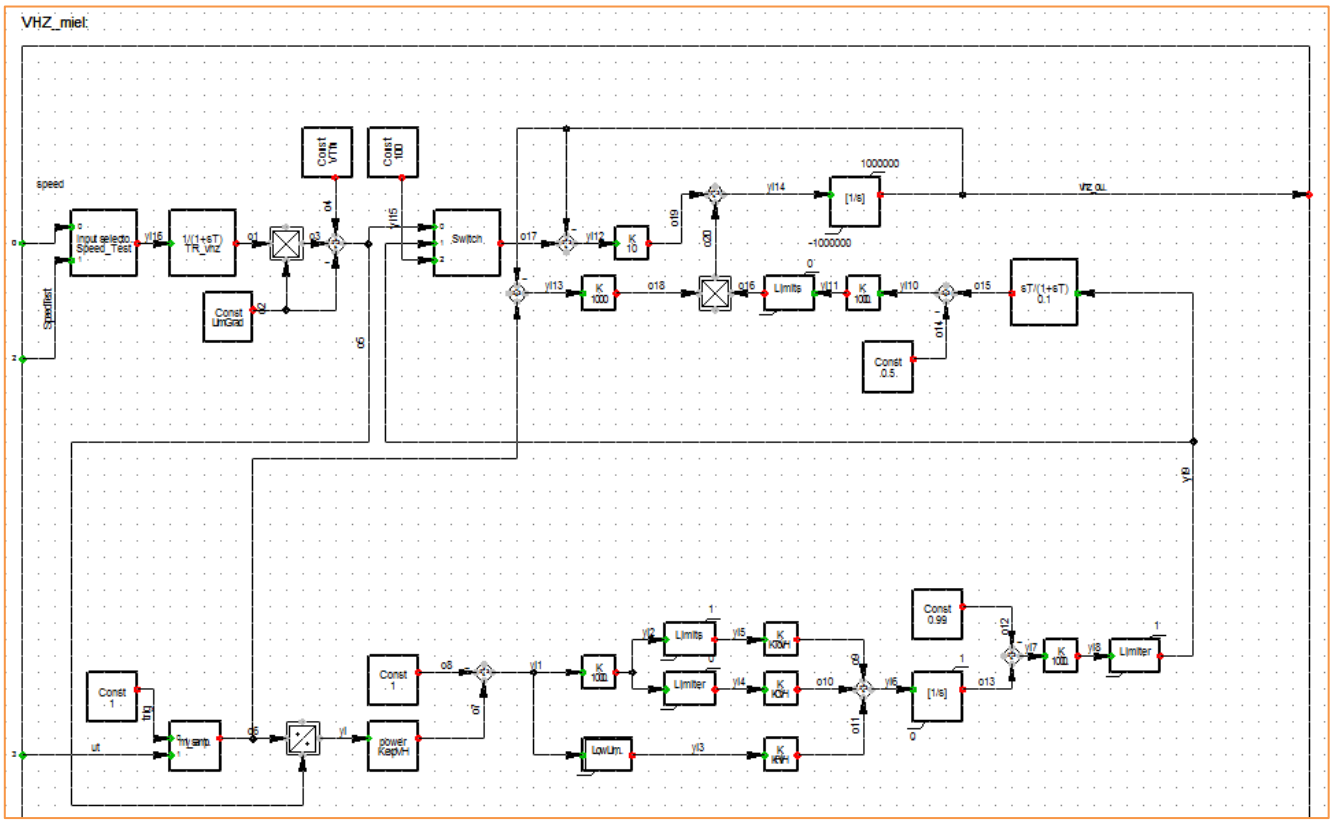


Figura 29. Modelo del limitador V/Hz. MIEL 1.

Tabla 17. Parámetros V/Hz.

PARÁMETROS V/Hz			
Network Model >> Network Data >> Grid >>U2_VHZ			
Descripción	**Parámetro**	**Unidad**	**Valor**
Maximum V/Hz Gradient	VTfn	[pu]	1.1
Maximum generator voltage	LimGrad	[pu]	1.5
Test enable (0 = normal mode, 1 = test mode)	Speed_Test	-	0
Measurement Time Constant	TR_vhz	[s]	0.001
Fixed integration time	KToVH	[s]	1000
Cooling integration time	KCVH	[s]	0.001
Inverse time characteristic integration time	KHVH	[s]	0
Exponent factor of inverse characteristic	KexpVH	[pu]	1

Estabilizador del Sistema de Potencia

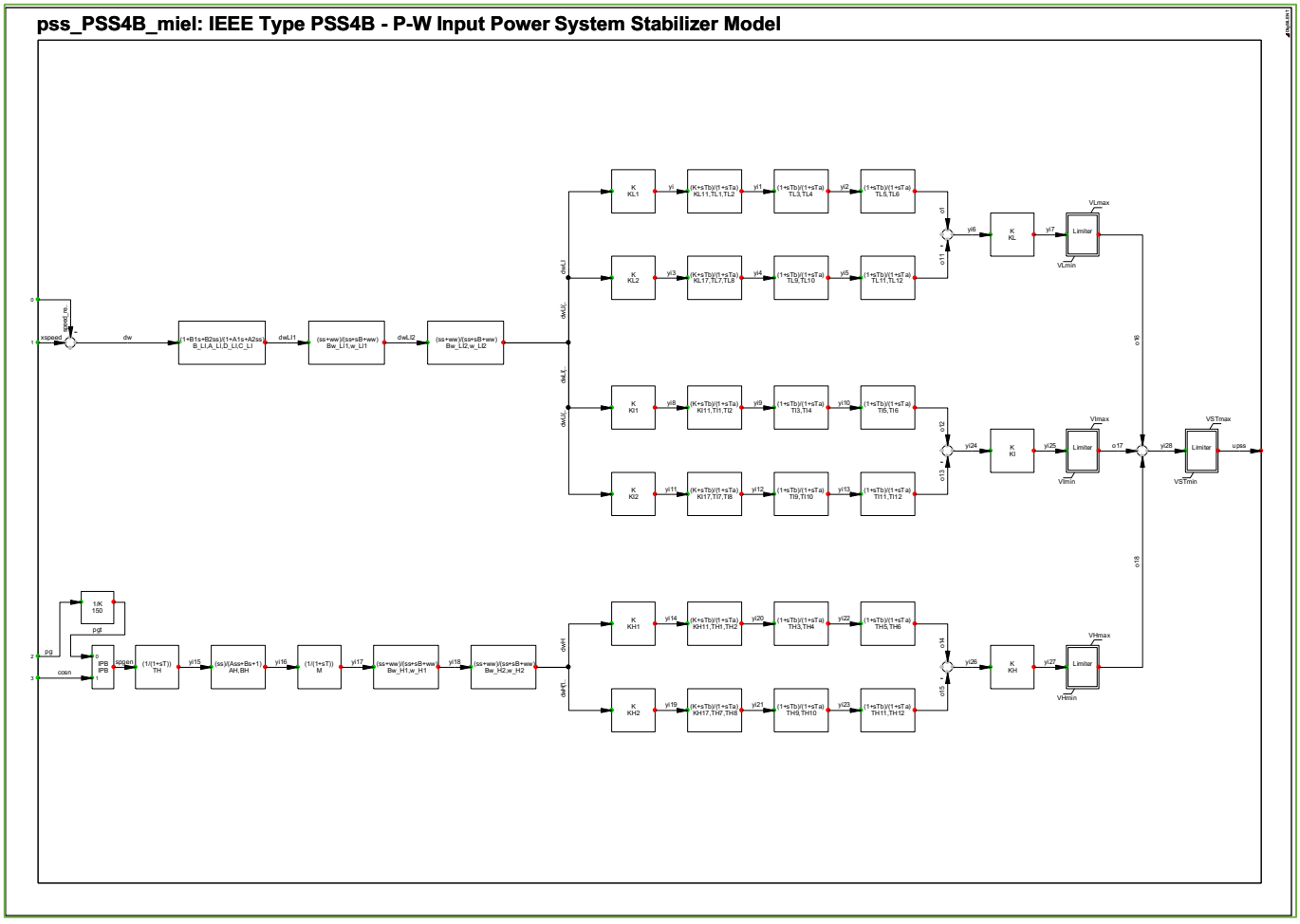
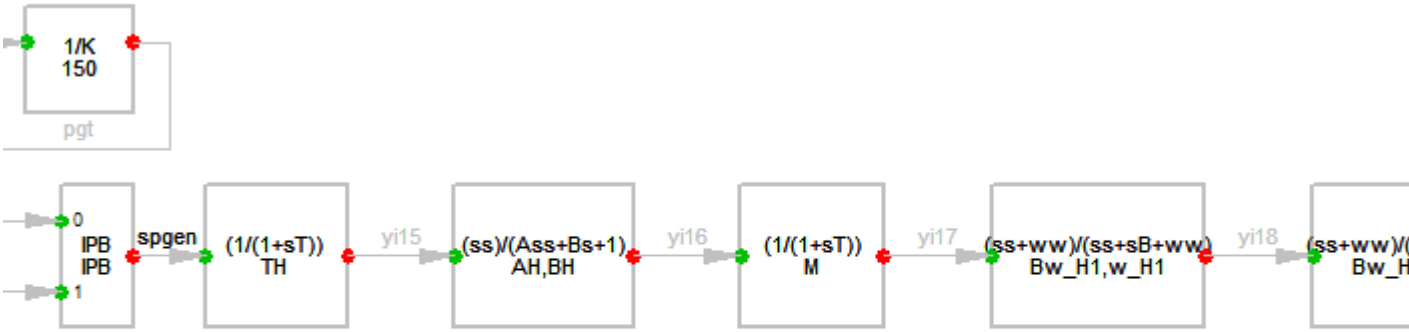
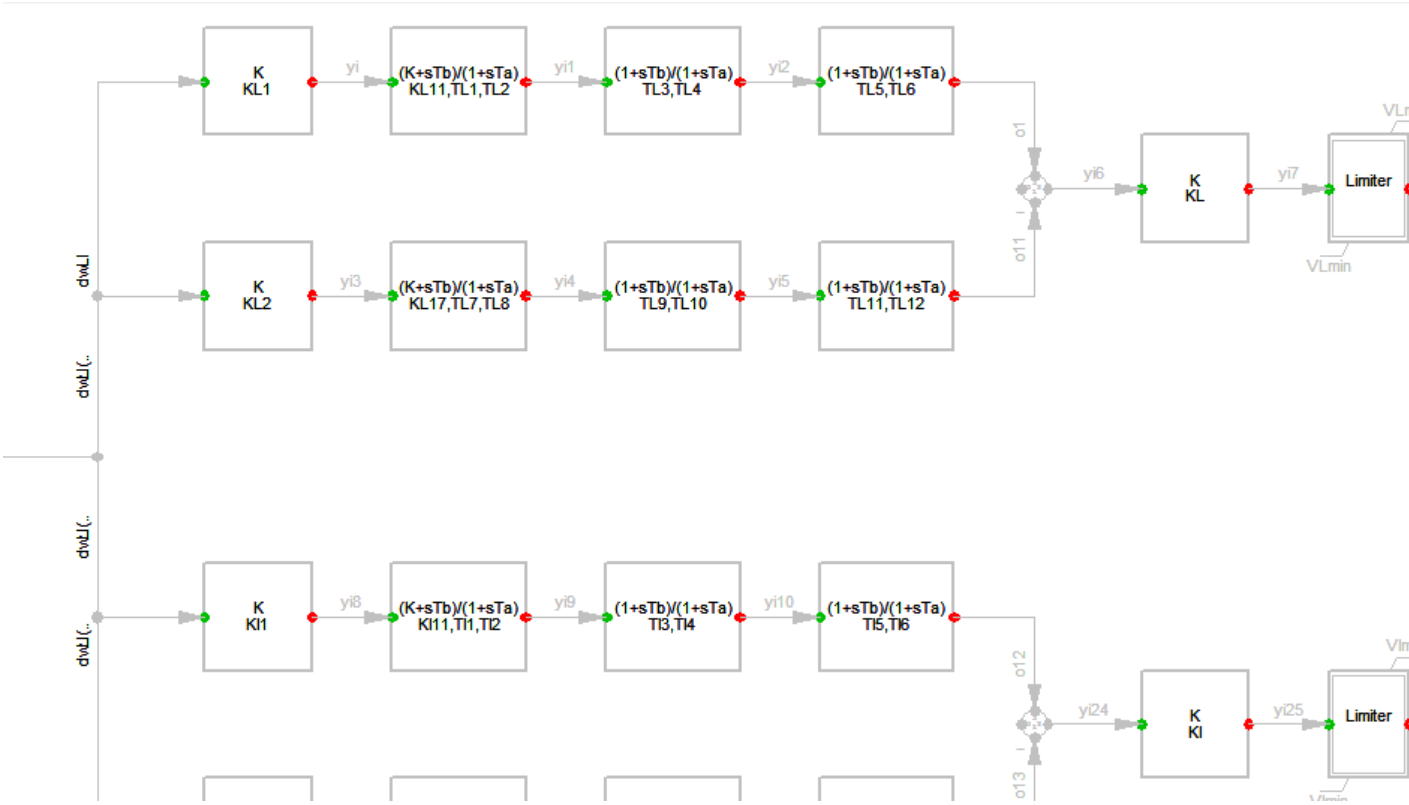


Figura 30. Modelo PSS4B.


1/K
150
pgt
0
IPB
IPB
1
spgen
(1/(1+sT))
TH
yi15
(ss)/(Ass+Bs+1)
AH,BH
yi16
(1/(1+sT))
M
yi17
(ss+ww)/(ss+sB+ww)
Bw_H1,w_H1
yi18


K
KL1
yi
(K+sTb)/(1+sTa)
KL11,TL1,TL2
yi1
(1+sTb)/(1+sTa)
TL3,TL4
yi2
(1+sTb)/(1+sTa)
TL5,TL6
o1
yi6
K
KL
yi7
Limiter
VLmin
K
KL2
yi3
(K+sTb)/(1+sTa)
KL17,TL7,TL8
yi4
(1+sTb)/(1+sTa)
TL9,TL10
yi5
(1+sTb)/(1+sTa)
TL11,TL12
o11
K
KI1
yi8
(K+sTb)/(1+sTa)
KI11,TI1,TI2
yi9
(1+sTb)/(1+sTa)
TI3,TI4
yi10
(1+sTb)/(1+sTa)
TI5,TI6
o12
o13
yi24
K
KI
yi25
Limiter

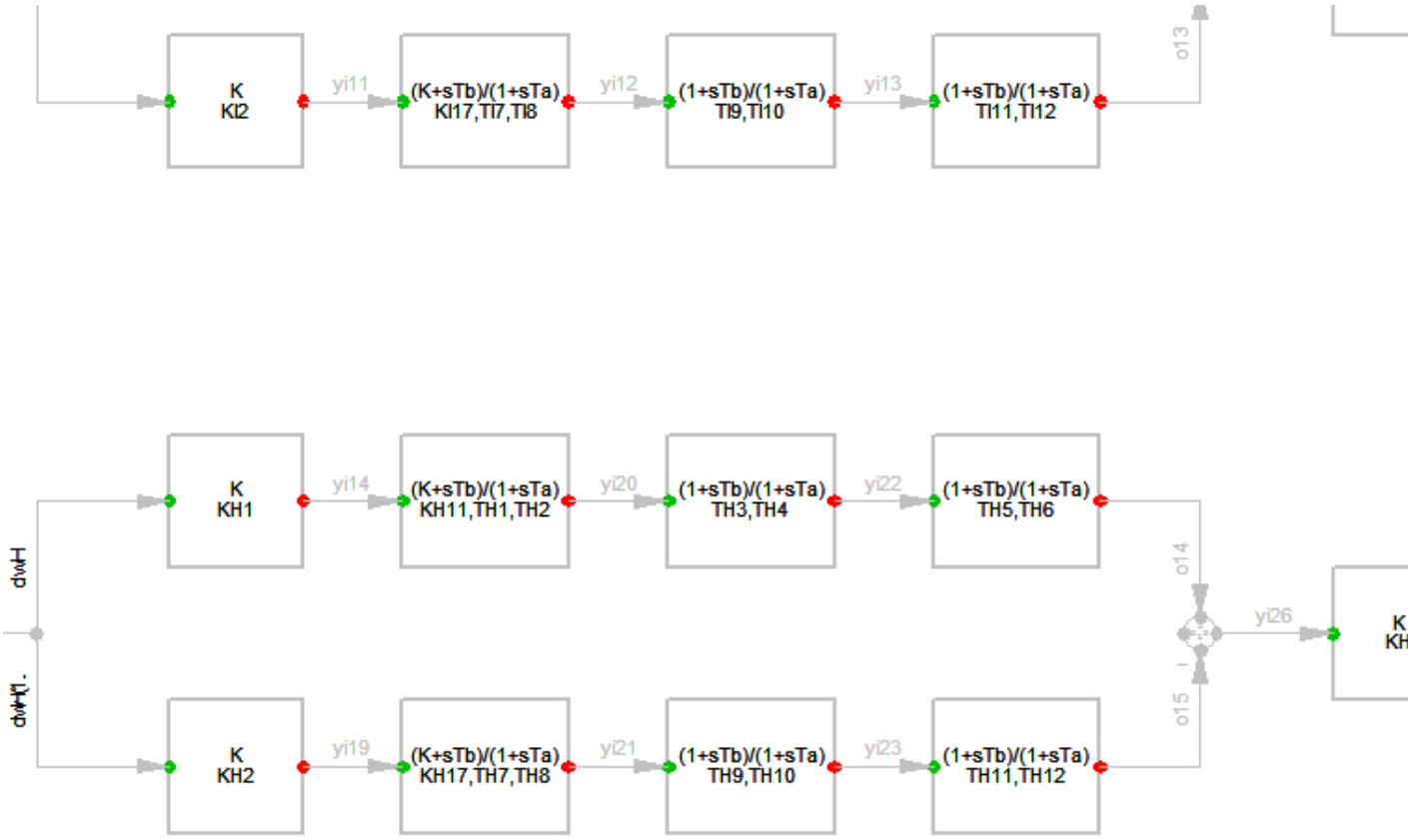


Tabla 18. Parámetros del PSS.

PSS	
Network Model >> Network Data >> Grid >>U3_PSS	
Parámetro	Valor
B_LI	0.017823
A_LI	0.00012739
D_LI	0.001759
C_LI	0
Bw_LI1	0
w_LI1	1
Bw_LI2	0
w_LI2	1
KL1	0.375
KL2	0.375
KI1	0
KI2	0
KL11	1
TL1	35.58
TL2	7.11
TL3	25.94
TL4	6.406
TL5	4.84
TL6	3.66
KL17	1
TL7	7.11
TL8	1.42
TL9	25.94
TL10	6.4
TL11	4.84
TL12	3.66
KL	3.754
KI11	1
TI1	8.37
TI2	1.674
TI3	0.648
TI4	0.16
TI5	0.25
TI6	0.194
KI17	1
TI7	1.674
TI8	0.334
TI9	0.648
TI10	0.16

PSS	
Network Model >> Network Data >> Grid >>U3_PSS	
Parámetro	Valor
TI11	0.256
TI12	0.194
KI	5.139
IPB	-1
TH	0.0125
AH	1
BH	2
Bw_H1	0
w_H1	1
M	9.1
Bw_H2	0
w_H2	1
KH1	0
KH2	0.375
KH11	1
TH1	0.406
TH2	0.081
TH3	0.12
TH4	0.029
TH5	0.027
TH6	0.0204
KH17	1
TH7	0.081
TH8	0.016
TH9	0.012
TH10	0.0297
TH11	0.027
TH12	0.0204
KH	40.721
VLmin	-0.075
VImin	-0.1
VHmin	-0.1
VSTmin	-0.2
VLmax	0.075
VImax	0.1
VHmax	0.1
VSTmax	0.2

Regulador de Velocidad/Potencia y Turbina

Conducción y turbina hidráulica

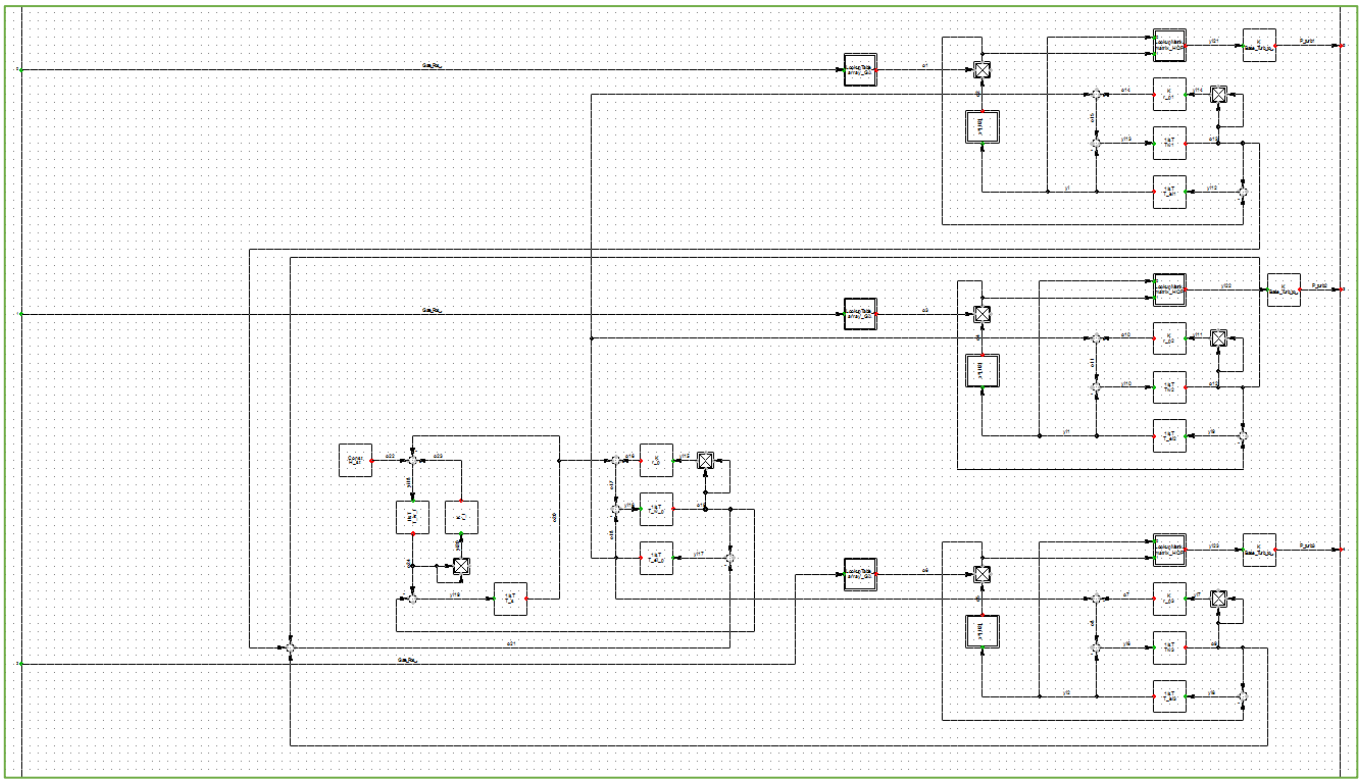


Figura 31. Modelo conjunto conducción y turbinas.

Modelo de la conducción

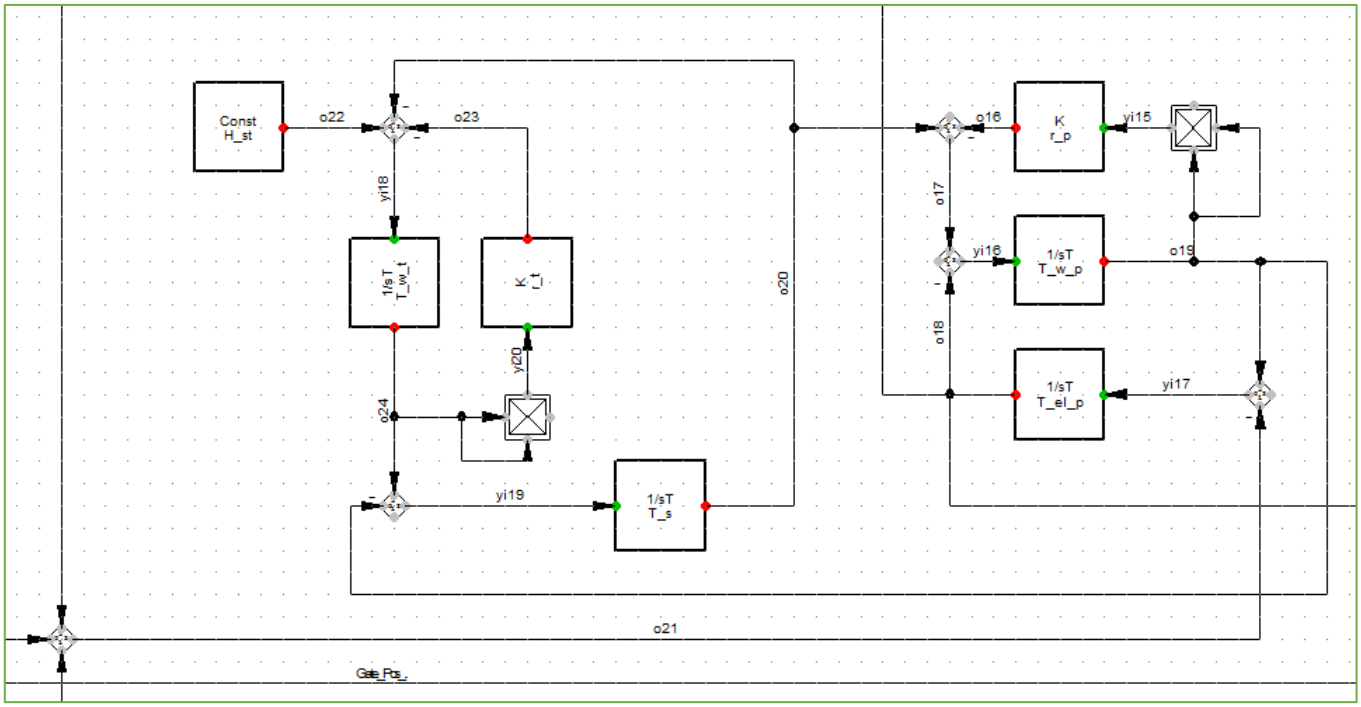


Figura 32. Modelo Túnel de energía y almenara

Modelo turbina Hidráulica

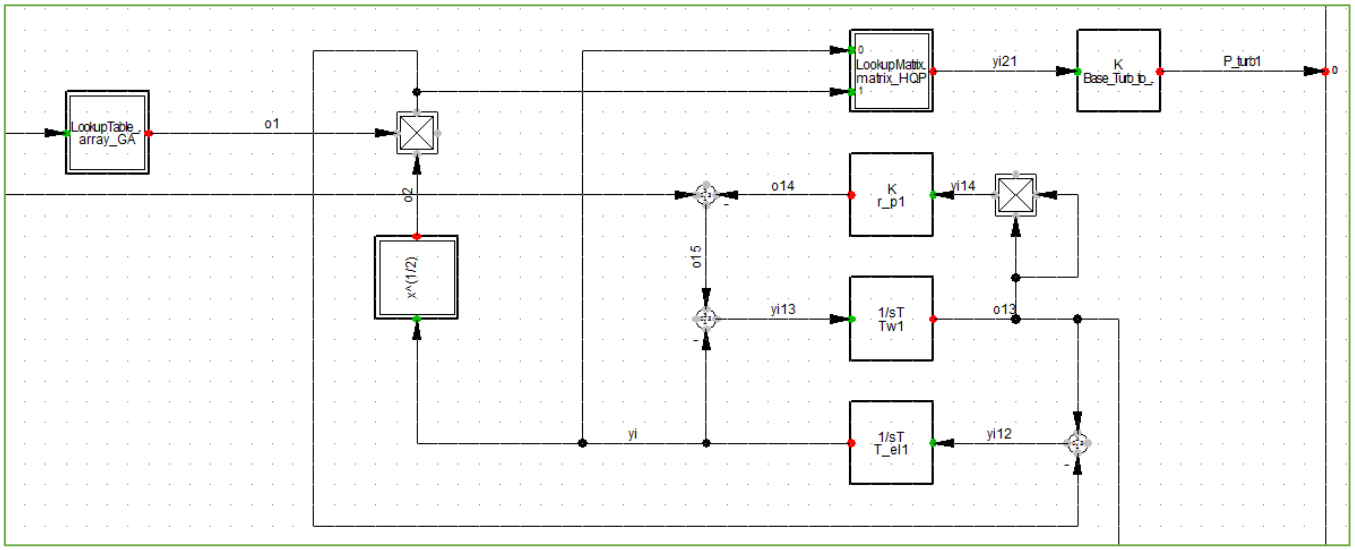


Figura 33. Modelo turbina Hidráulica

Tabla 19. Parámetros de conducción y turbina

Parámetros de conducción y turbina	
Network Model >> Network Data >> Grid >> Full_Turb_model	
Parámetro	Valor
Base_Turb_to_Gen	1.1111
H_st	0.984055
Tw3 (U3)	0.179
T_w_t	0.076
T_w_p	0.32
Tw1 (U1)	0.179
Tw2 (U2)	0.168
T_el2 (U2)	0.0014
T_el3 (U3)	0.0015
T_el1 (U1)	0.0015
r_p3 (U3)	0.01
r_p1 (U1)	0.01
r_t	0.002
r_p	0.002
T_el_p	0.0366
r_p2 (U2)	0.01
T_s	274.27
Pbase	135

Tabla 20. Características de posición – área de flujo del acctuador

Características de posición – área de flujo del acctuador	
Network Model >> Network Data >> Grid >>Full_Turb_model>>GA	
Apertura [p.u.]	Área de flujo [p.u.]
0	0
0.2617	0.3013768
0.3424	0.3420008
0.4131	0.3907275
0.4681	0.461077
0.5251	0.5239942
0.5772	0.6003013
0.6663	0.7621623
0.7121	0.8403952
0.7715	0.9381117
0.7829	0.9686905

	GA_x	GA_y
Size	11,	0,
1	0,	0,
2	0,2617	0,3013768
3	0,3424	0,3420008
4	0,4131	0,3907275
5	0,4681	0,461077
6	0,5251	0,5239942
7	0,5772	0,6003013
8	0,6663	0,7621623
9	0,7121	0,8403952
10	0,7715	0,9381117
11	0,7829	0,9686905

Hoja de cálculo de
Microsoft Excel 97-20

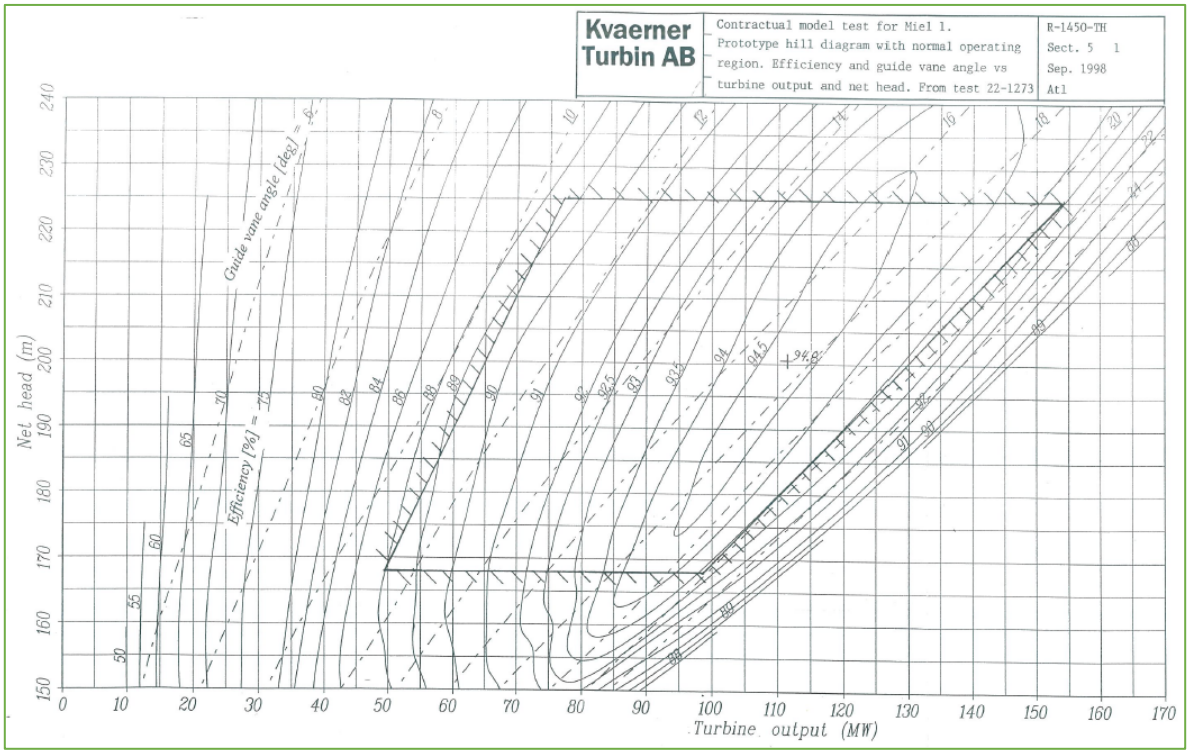


Figura 34. Superficie de eficiencia turbina.

Modelo del Regulador de Velocidad

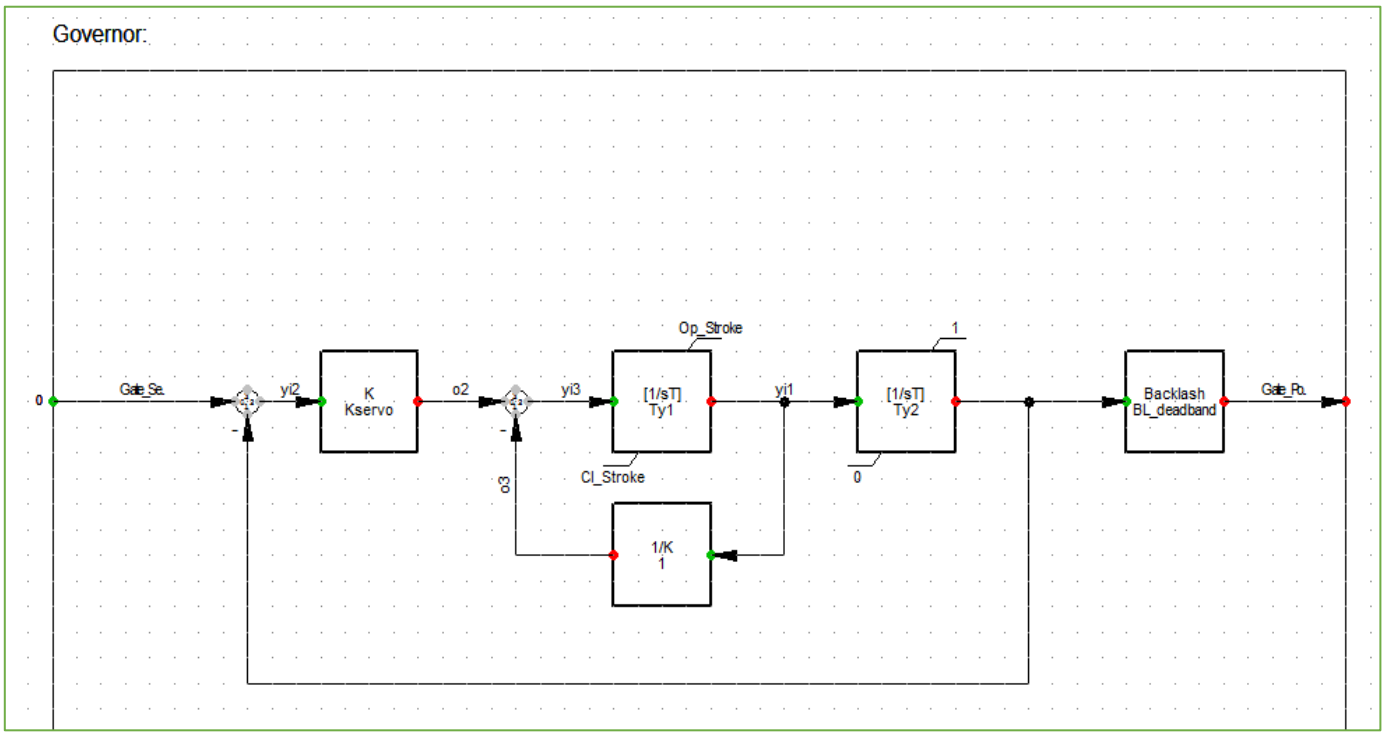


Figura 35. Modelo del gobernador de la turbina.

Tabla 21. Parámetros de gobernador.

PARÁMETROS DE GOBERNADOR	
Network Model >> Network Data >> Grid >>Governor_u3	
PARÁMETRO	**VALOR**
Kservo	10
Ty1	0.005
Ty2	0.02
BL_deadband	0.005
Cl_Stroke	-0.16
Op_Stroke	0.08

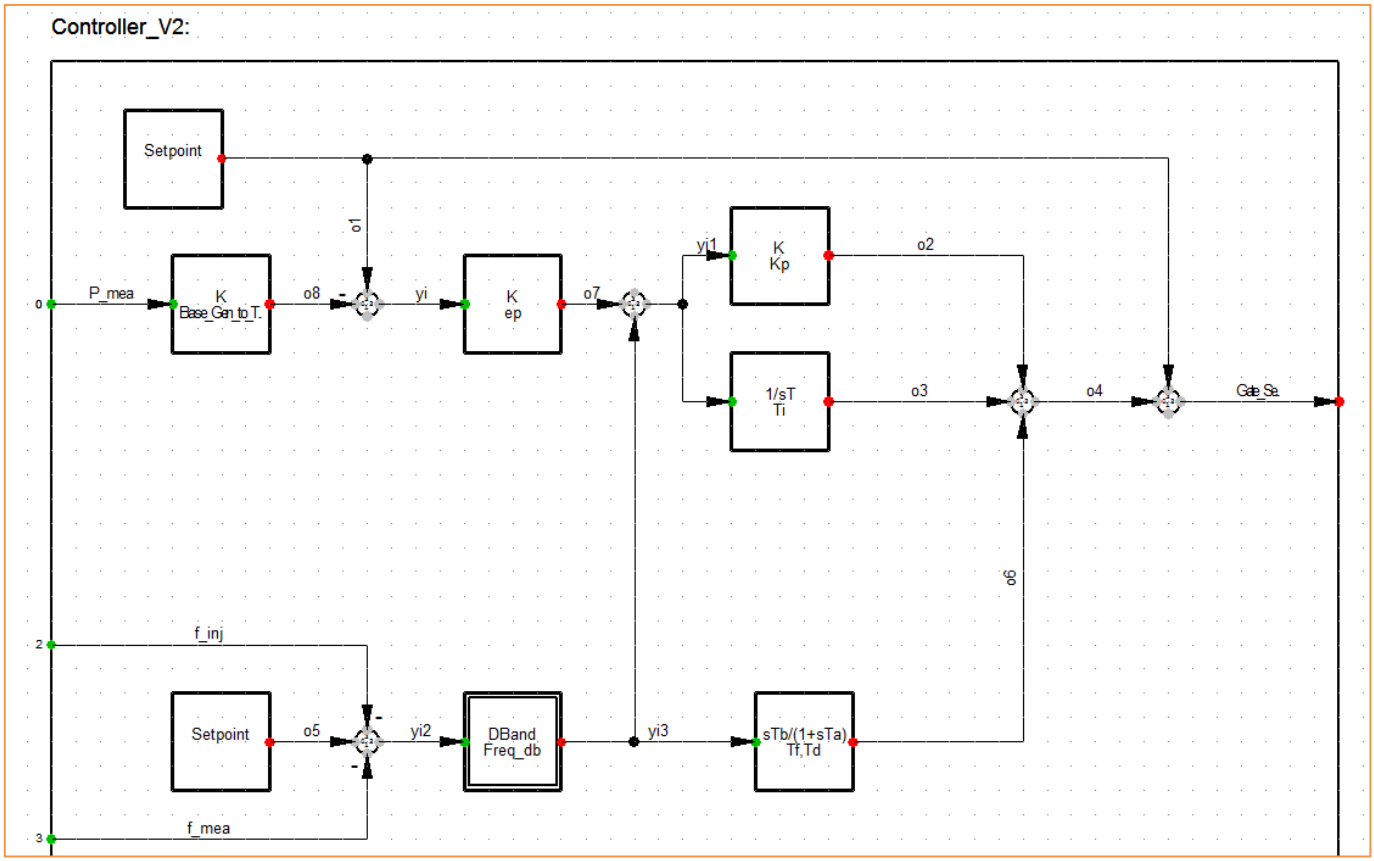


Figura 36. Modelo controlador de velocidad / potencia.

Tabla 22. Parámetros de control de velocidad / potencia.

PARÁMETROS DE CONTROL DE VELOCIDAD / POTENCIA	
Network Model >> Network Data >> Grid >> Controller_u3	
PARÁMETRO	**VALOR**
Freq_db	0.0005
Base_Gen_to_Turb	0.9267522
Ep	0.04
Kp	4
Ti	0.175
Tf	1.2
Td	0.4