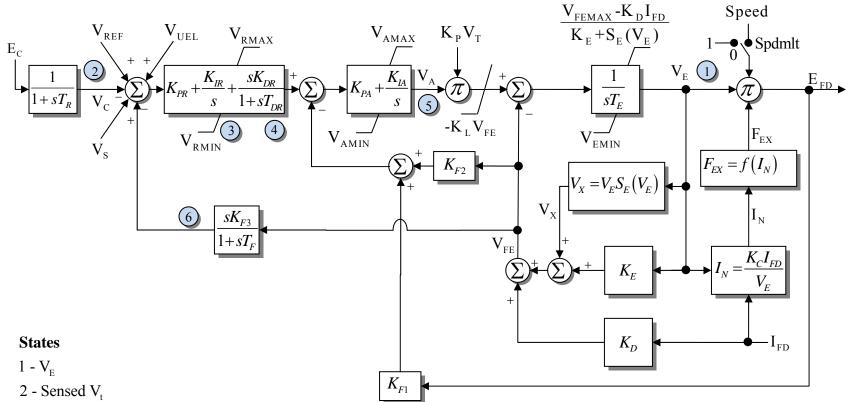
### **Exciter AC7B and ESAC7B**

### Exciter AC7B and ESAC7B IEEE 421.5 2005 Type AC7B Excitation System Model



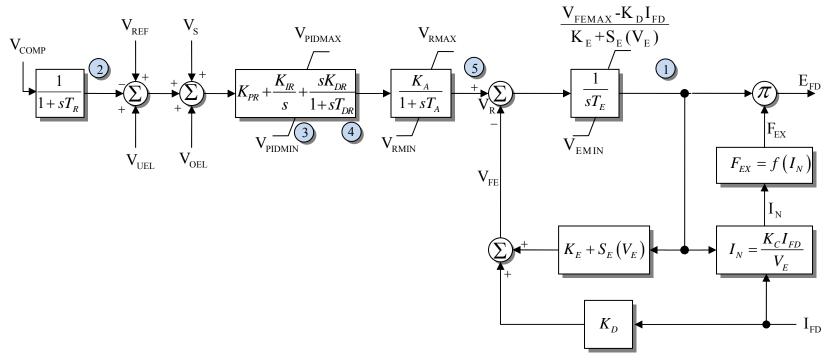
- $3 K_{IR}$
- $4 K_{DR}$
- $5 V_A$
- 6 Feedback

AC7B supported by PSSE

ESAC7B supported by PSLF with optional speed multiplier

## **Exciter AC8B**

# Exciter AC8B IEEE 421.5 2005 AC8B Excitation System



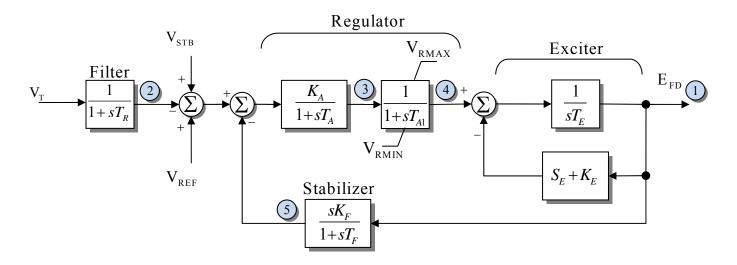
### **States**

- $1 V_E$
- 2 Sensed V<sub>t</sub>
- 3 PID 1
- 4 PID 2
- $5 V_R$

Model supported by PSSE

## **Exciter BPA\_EA**

# Exciter BPA\_EA Continuously Acting DC Rotating Excitation System Model

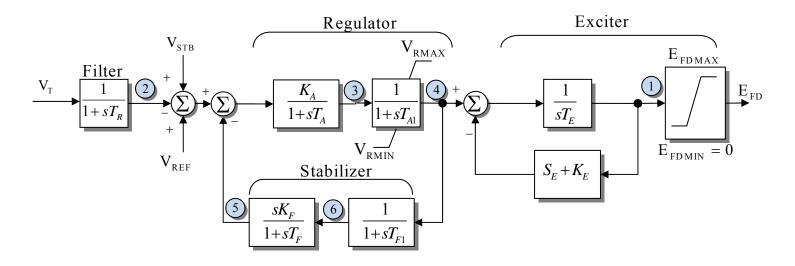


### States

- 1 E<sub>FD</sub>
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_{R1}$
- $5 V_F$

## **Exciter BPA EB**

# Exciter BPA EB Westinghouse Pre-1967 Brushless Excitation System Model

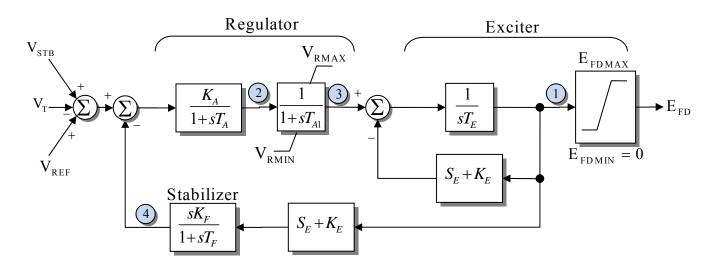


### **States**

- 1  $E_{\scriptscriptstyle FD}$  before limit
- 2 Sensed  $V_t$
- $3 V_R$
- $4 V_{R1}$
- $5 V_F$
- $6 V_{F1}$

## **Exciter BPA EC**

# Exciter BPA EC Westinghouse Brushless Since 1966 Excitation System Model

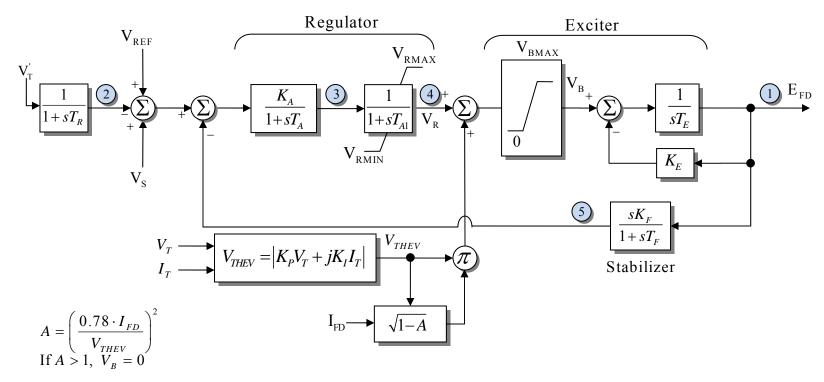


### States

- 1  $E_{\mbox{\tiny FD}}$  before limit
- $2 V_R$
- $3 V_{R1}$
- $4 V_F$

### **Exciter BPA ED**

# Exciter BPA ED SCPT Excitation System Model

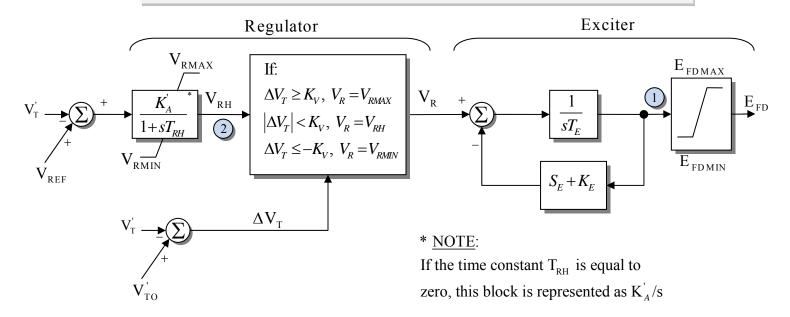


### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_A$
- 4 V<sub>R</sub>
- 5 Feedback

### **Exciter BPA EE**

# Exciter BPA EE Non-Continuously Active Rheostatic Excitation System Model

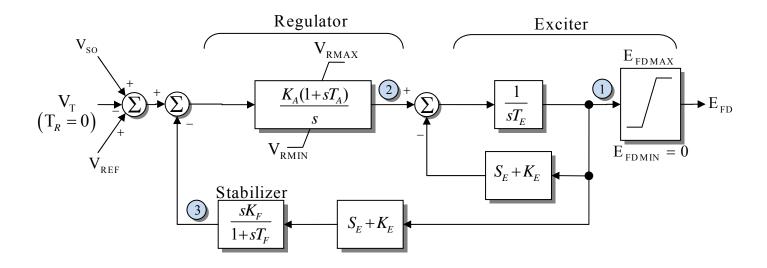


### **States**

- 1 EField before limit
- $2 V_{RH}$

### **Exciter BPA EF**

# Exciter BPA EF Westinghouse Continuous Acting Brushless Rotating Alternator Excitation System Model

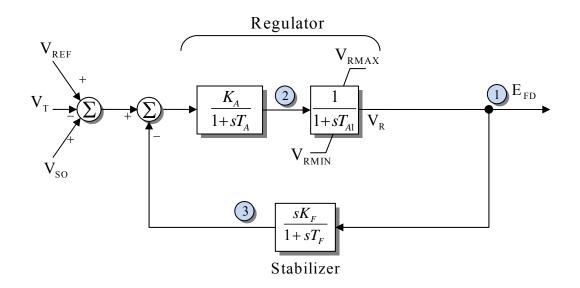


### **States**

- 1 EField before limit
- $2 V_R$
- $3 V_F$

## **Exciter BPA EG**

# Exciter BPA EG SCR Equivalent Excitation System Model

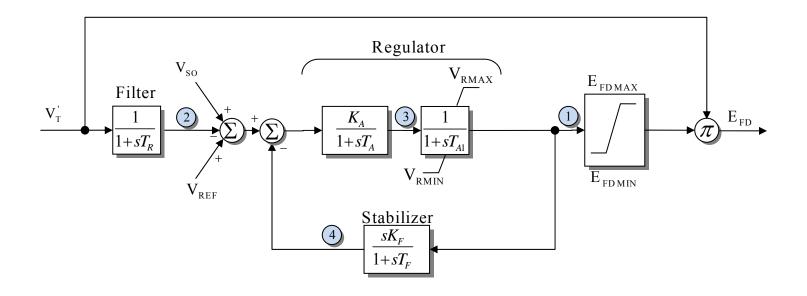


### **States**

- 1 EField
- $2 V_A$
- $3 V_F$

## **Exciter BPA EJ**

# Exciter BPA EJ Westinghouse Static Grand Couple PP#3 Excitation System Model

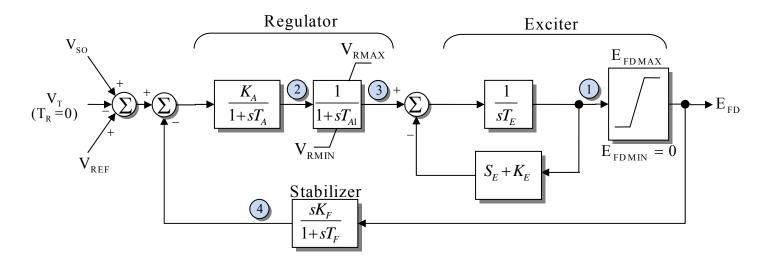


### **States**

- 1 EField before limit
- 2 Sensed  $V_t$
- $3 V_R$
- $4 V_F$

## **Exciter BPA EK**

# Exciter BPA EK General Electric Alterrex Excitation System Model

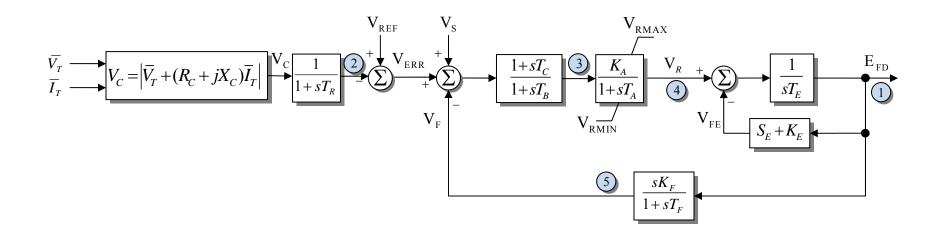


### **States**

- 1 EField before limit
- $2 V_R$
- $3 V_{R1}$
- 4 V<sub>F</sub>

## **Exciter BPA FA**

# Exciter BPA FA WSCC Type A (DC1) Excitation System Model

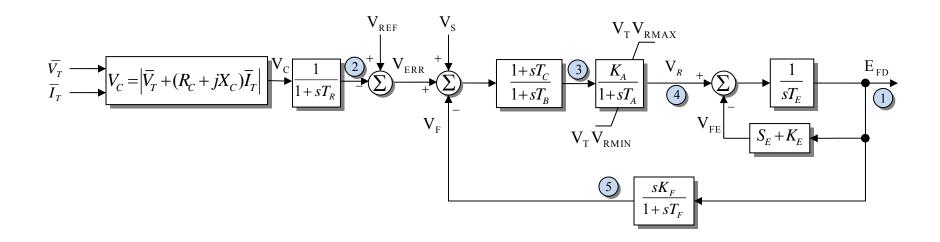


### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_B$
- $4 V_R$
- 5 V<sub>F</sub>

## **Exciter BPA FB**

# Exciter BPA FB WSCC Type B (DC2) Excitation System Model

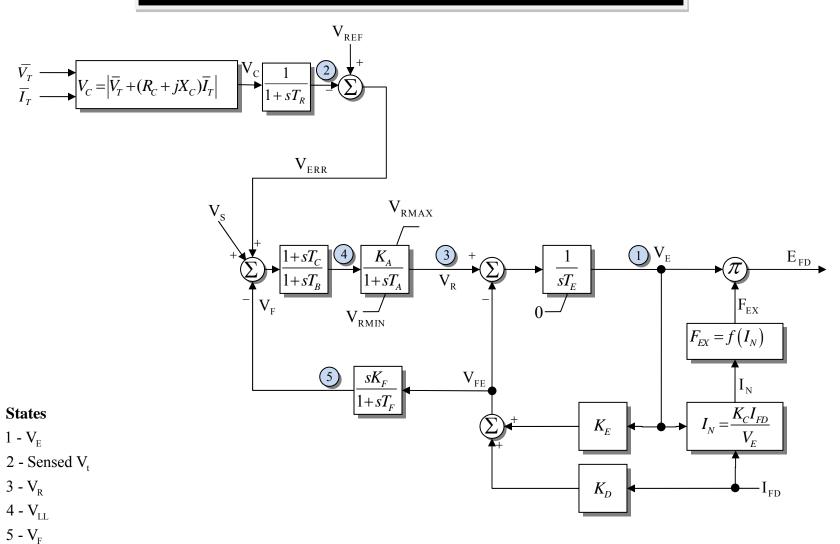


### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_B$
- $4 V_R$
- $5 V_{\rm F}$

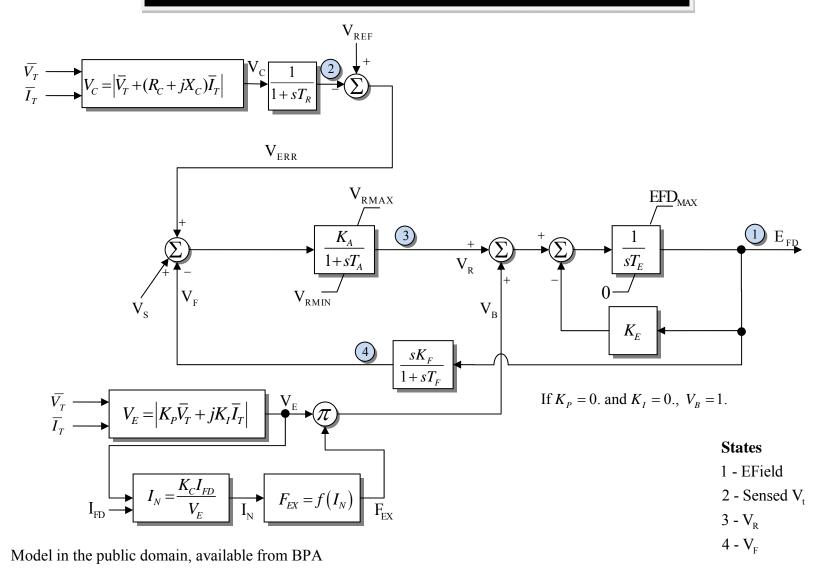
## **Exciter BPA FC**

# Exciter BPA FC WSCC Type C (AC1) Excitation System Model



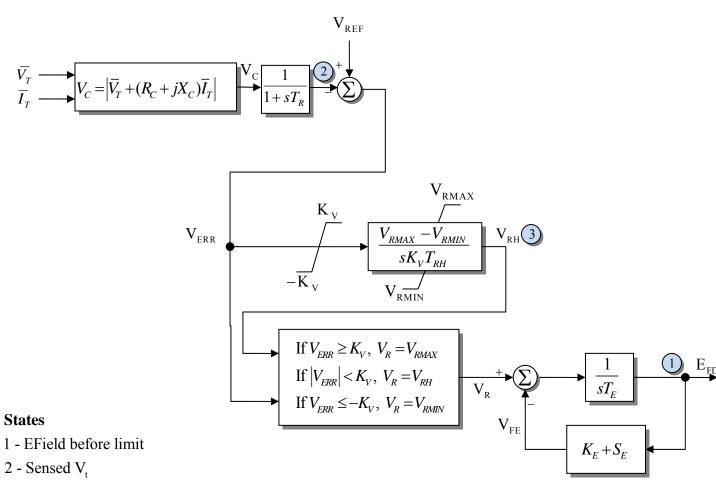
## **Exciter BPA FD**

# Exciter BPA FD WSCC Type D (ST2) Excitation System Model



## **Exciter BPA FE**

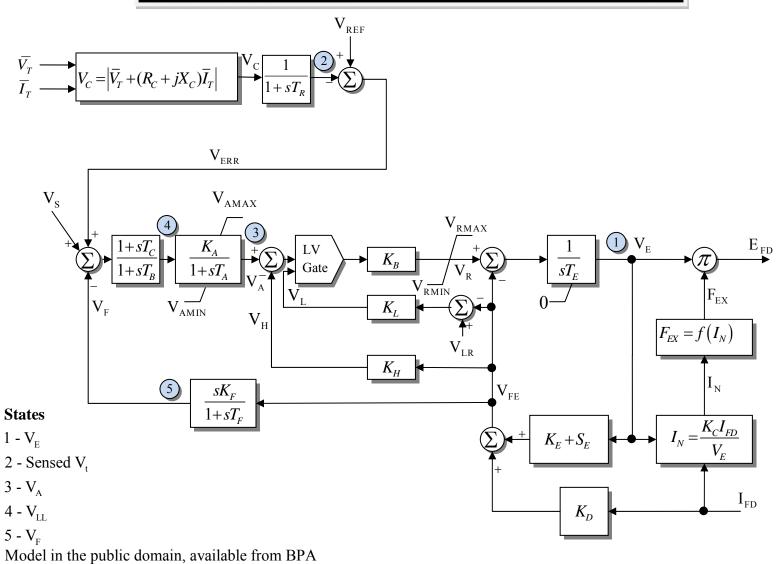
### Exciter BPA FE WSCC Type E (DC3) Excitation System Model



- $3 V_{RH}$

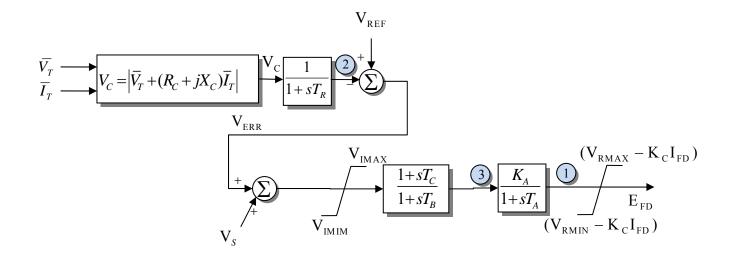
## **Exciter BPA FF**

# Exciter BPA FF WSCC Type F (AC2) Excitation System Model



## **Exciter BPA FG**

# Exciter BPA FG WSCC Type G (AC4) Excitation System Model

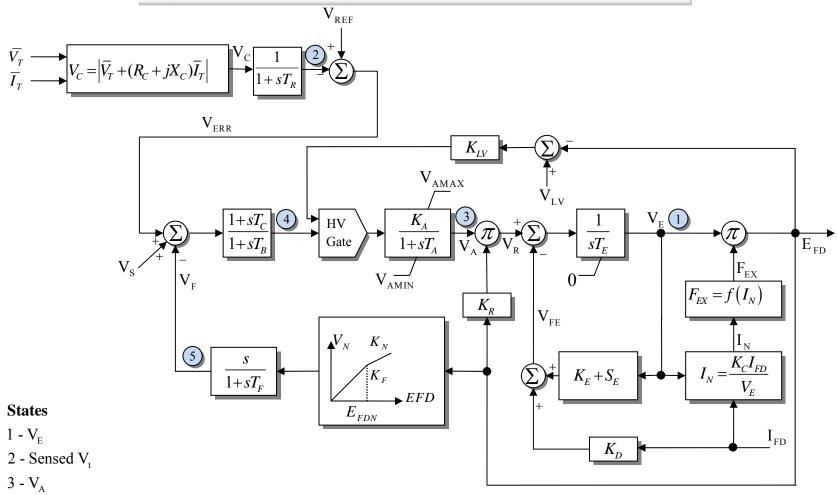


### **States**

- 1 EField before limit
- 2 Sensed V<sub>t</sub>
- $3 V_{LL}$

## **Exciter BPA FH**

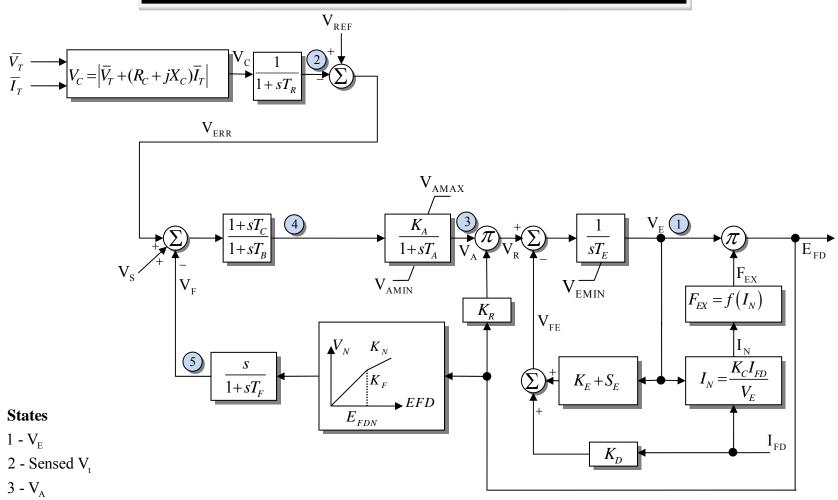
# Exciter BPA FH WSCC Type H (AC3) Excitation System Model



- 4  $V_{\scriptscriptstyle LL}$
- $5 V_F$

### **Exciter BPA FH**

### Exciter BPA FH WSCC Type H Excitation System Model

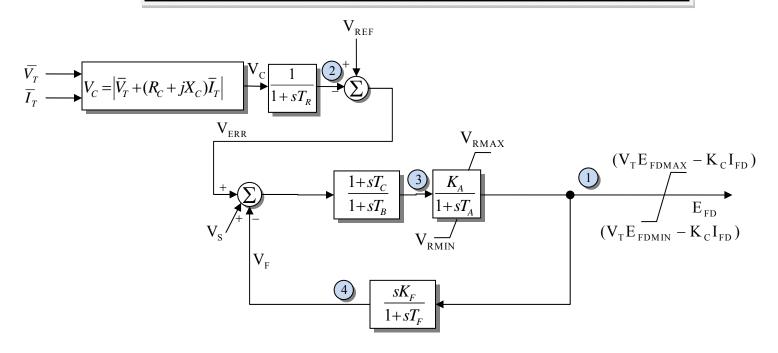


4 -  $V_{\scriptscriptstyle LL}$ 

 $5 - V_F$ 

## **Exciter BPA FJ**

# Exciter BPA FJ WSCC Type J Excitation System Model

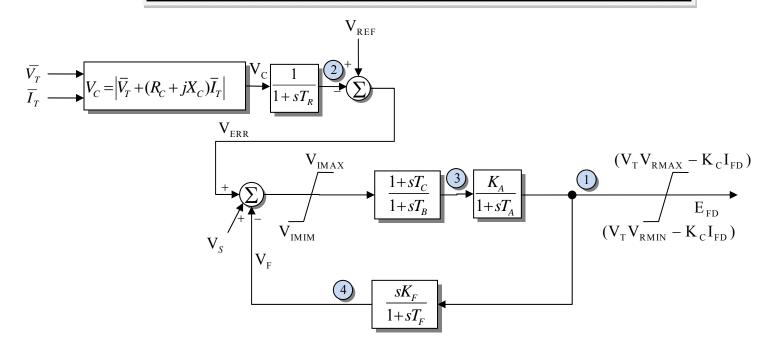


### States

- 1 EField before limit
- 2 Sensed V<sub>t</sub>
- 3  $V_{\scriptscriptstyle LL}$
- $4 V_F$

### **Exciter BPA FK**

# Exciter BPA FK WSCC Type K (ST1) Excitation System Model

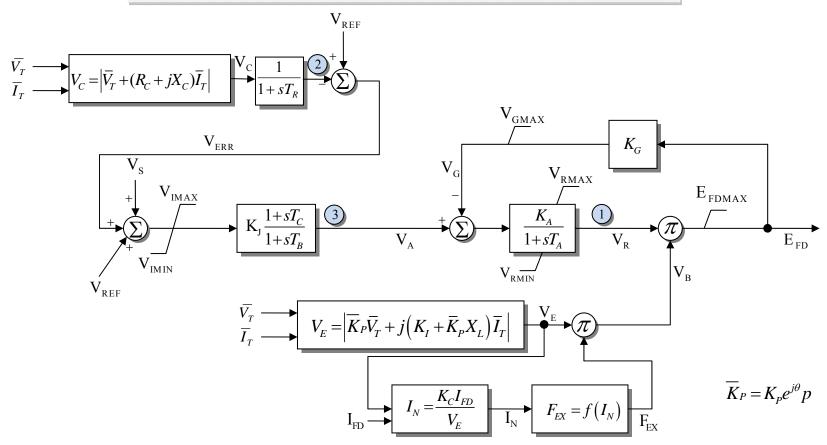


### **States**

- 1 EField before limit
- 2 Sensed V<sub>t</sub>
- 3  $V_{\scriptscriptstyle LL}$
- $4 V_F$

## **Exciter BPA FL**

# Exciter BPA FL WSCC Type L (ST3) Excitation System Model



### **States**

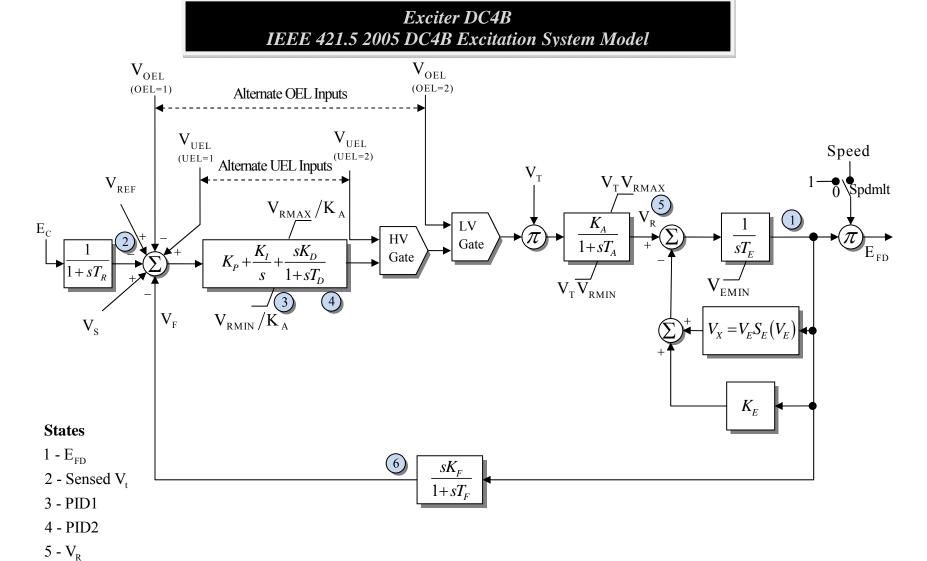
- $1 V_{M}$
- 2 Sensed V<sub>t</sub>
- $3 V_{LL}$

## **Exciter BPA FM through BPA FV**

Exciter BPA FM through BPA FV

No block diagrams have been created

### **Exciter DC4B**

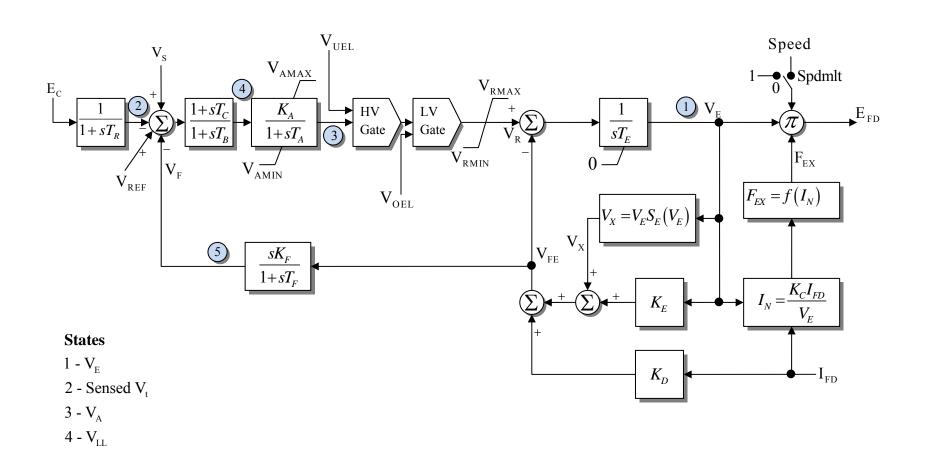


6 - Feedback

Model supported by PSSE

### **Exciter ESAC1A**

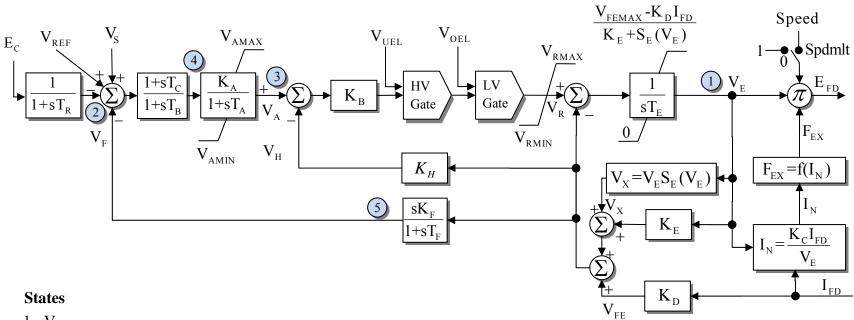
### Exciter ESAC1A IEEE Type AC1A Excitation System Model



 $5 - V_F$ Model supported by PSSE

### **Exciter ESAC2A**

### Exciter ESAC2A IEEE Type AC2A Excitation System Model

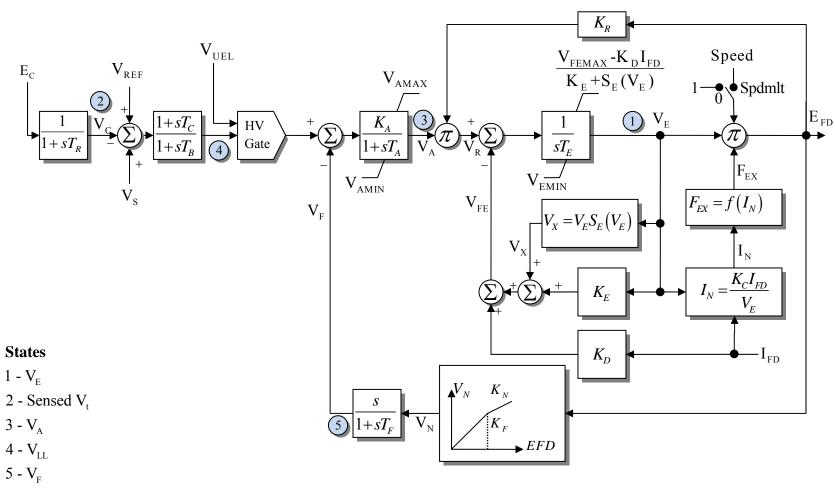


- $1 V_E$
- 2 Sensed V<sub>t</sub>
- $3 V_A$
- $4 V_{LL}$
- $5 V_F$

Model supported by PSSE

## **Exciter ESAC3A**

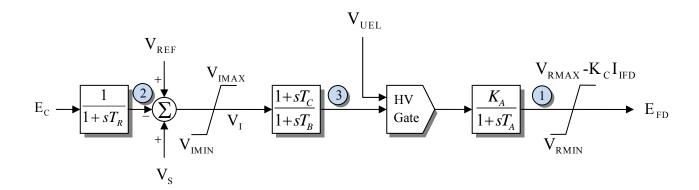
### Exciter ESAC3A IEEE Type AC3A Excitation System Model



Model supported by PSSE

### **Exciter ESAC4A**

### Exciter ESAC4A IEEE Type AC4A Excitation System Model



### **States**

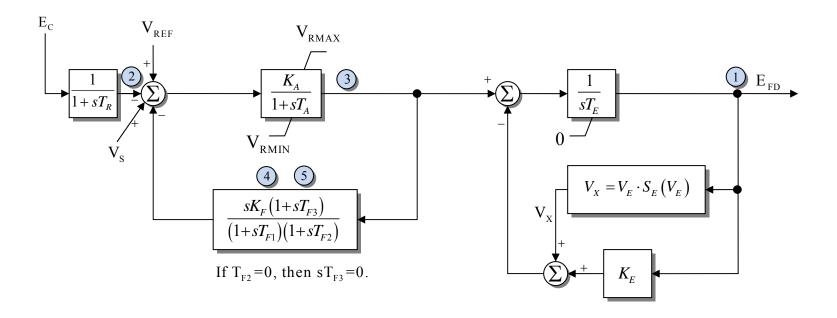
- 1 EField before limit
- 2 Sensed V<sub>t</sub>
- $3 V_{LL}$

Model supported by PSLF and PSSE

PSSE uses nonwindup limit on  $\boldsymbol{E}_{\scriptscriptstyle FD}$ 

## **Exciter ESAC5A**

### Exciter ESAC5A IEEE Type AC5A Excitation System Model



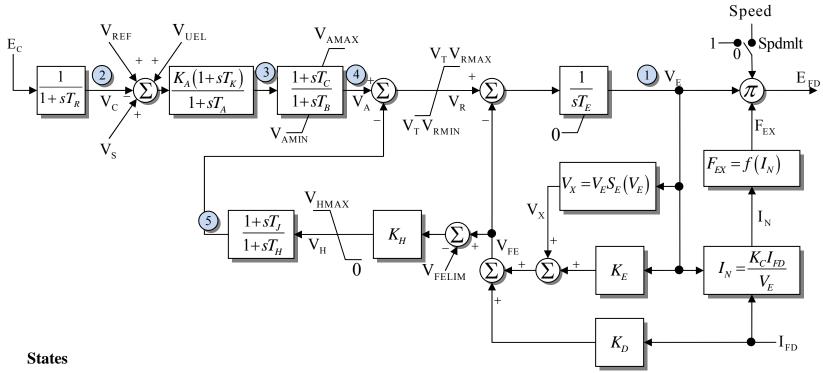
### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- 4 Feedback 1
- 5 Feedback 2

Model supported by PSLF and PSSE

## **Exciter ESAC6A**

### Exciter ESAC6A IEEE Type AC6A Excitation System Model

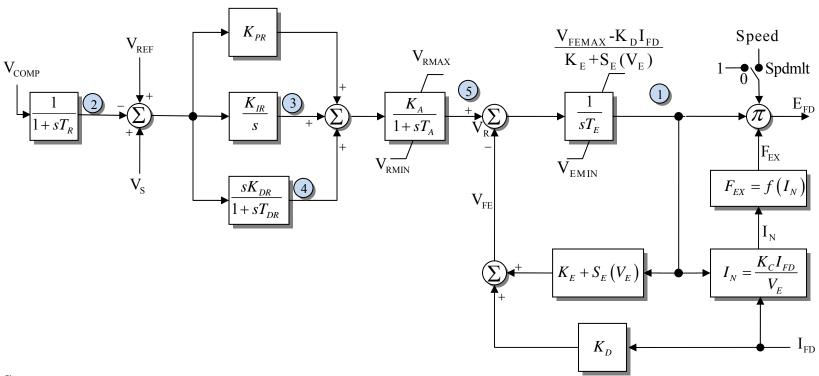


- $1 V_E$
- 2 Sensed V<sub>t</sub>
- 3 T<sub>A</sub> Block
- $4 V_{LL}$
- $5 V_{\rm F}$

Model supported by PSSE

## Exciter ESAC8B\_GE

# Exciter ESAC8B\_GE IEEE Type AC8B with Added Speed Multiplier.



### **States**

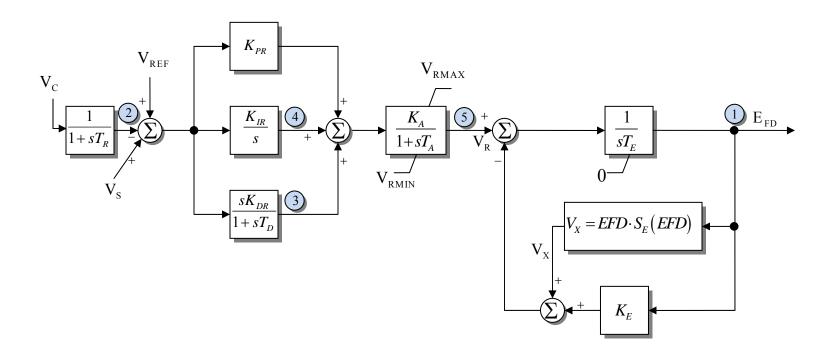
- $1 V_E$
- 2 Sensed V<sub>t</sub>
- 3 PID 1
- 4 PID 2
- $5 V_R$

Model supported by PSLF

If 
$$V_{\text{TMULT}} \iff 0$$
,  $V_{\text{RMAX}} = V_{\text{T}} \square V_{\text{RMAX}}$  and  $V_{\text{RMIN}} = V_{\text{T}} \square V_{\text{RMIN}}$ 

## Exciter ESAC8B\_PTI

# Exciter ESAC8B\_PTI Rasler DECS Model



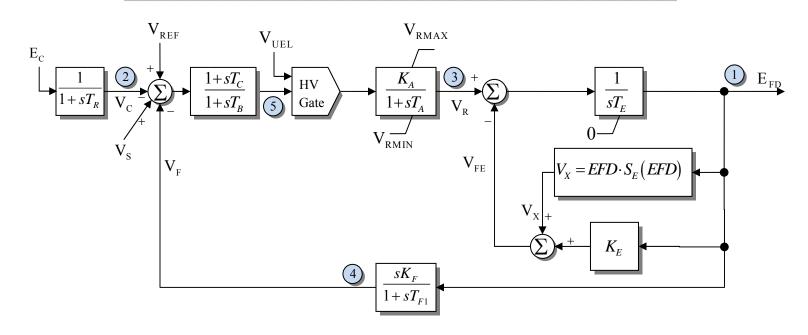
### **States**

- 1 E<sub>FD</sub>
- 2 Sensed V<sub>t</sub>
- 3 Derivative Controller
- 4 Integral Controller
- $5 V_R$

Model supported by PSSE

### **Exciter ESDC1A**

# Exciter ESDC1A IEEE Type DC1A Excitation System Model



### **States**

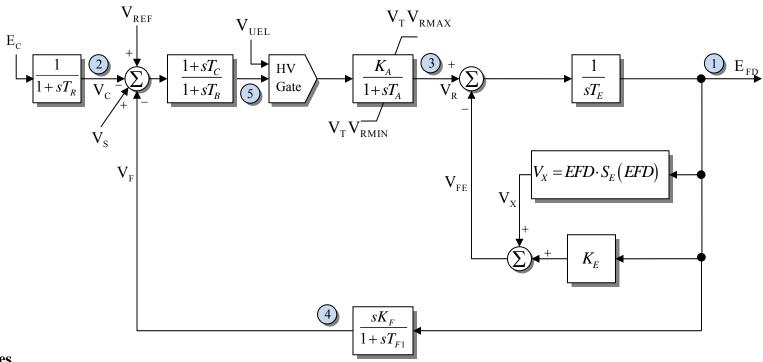
- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$
- 5 Lead-Lag

Model supported by PSSE

Model supported by PSLF includes spdmlt, exclim, and UEL inputs that are read but not utilized in the Simulator implementation

## **Exciter ESDC2A**

# Exciter ESDC2A IEEE Type DC2A Excitation System Model



### **States**

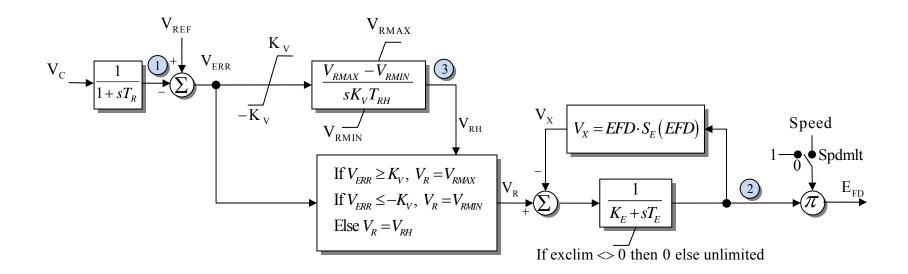
- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$
- 5 Lead-Lag

Model supported by PSSE

Model supported by PSLF includes spdmlt, exclim, and UEL inputs that are read but not utilized in Simulator

## **Exciter ESDC3A**

# Exciter ESDC3A IEEE Type DC3A with Added Speed Multiplier

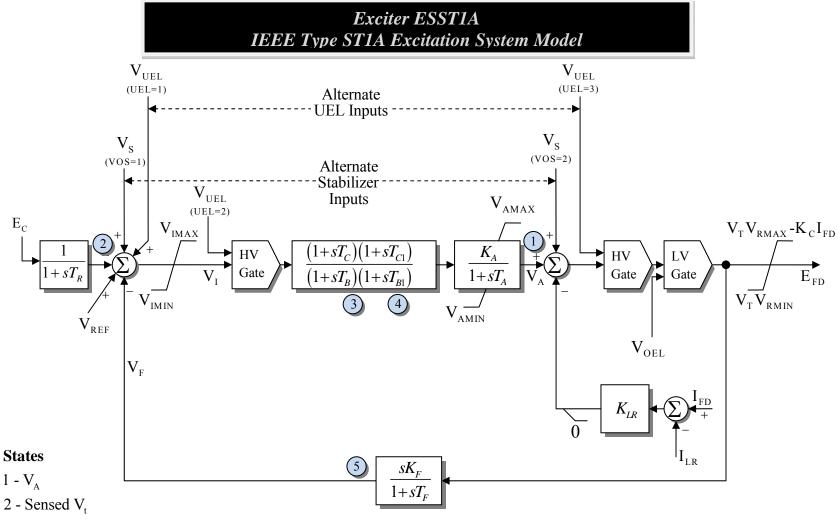


### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_{RH}$

Model supported by PSLF

## **Exciter ESST1A**

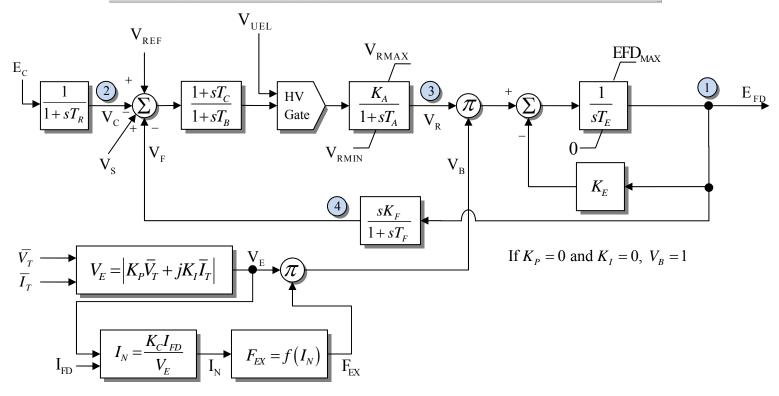


- 3 LL
- 4 LL1
- 5 Feedback

Model supported by PSLF and PSSE

## **Exciter ESST2A**

# Exciter ESST2A IEEE Type ST2A Excitation System Model



### **States**

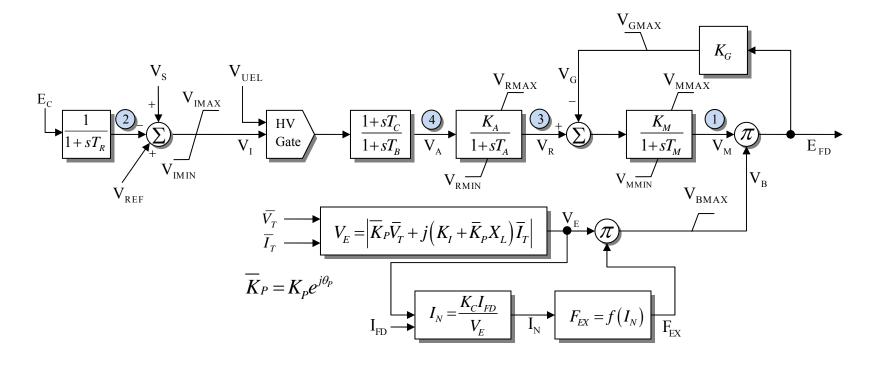
- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$

Model supported by PSSE

Model supported by PSLF includes UEL input that is read but not utilized in Simulator

## **Exciter ESST3A**

# Exciter ESST3A IEEE Type ST3A Excitation System Model



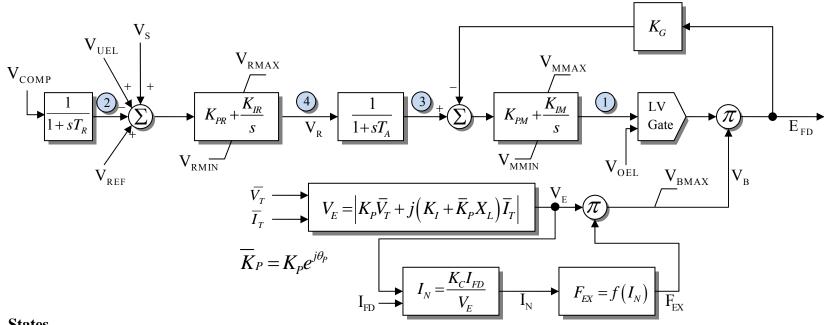
### **States**

- $1 V_{M}$
- 2 Sensed  $V_t$
- $3 V_R$
- 4 LL

Model supported by PSLF and PSSE

## **Exciter ESST4B**

## Exciter ESST4B IEEE Type ST4B Potential- or Compound-Source Controlled-Rectifier Exciter Model



### **States**

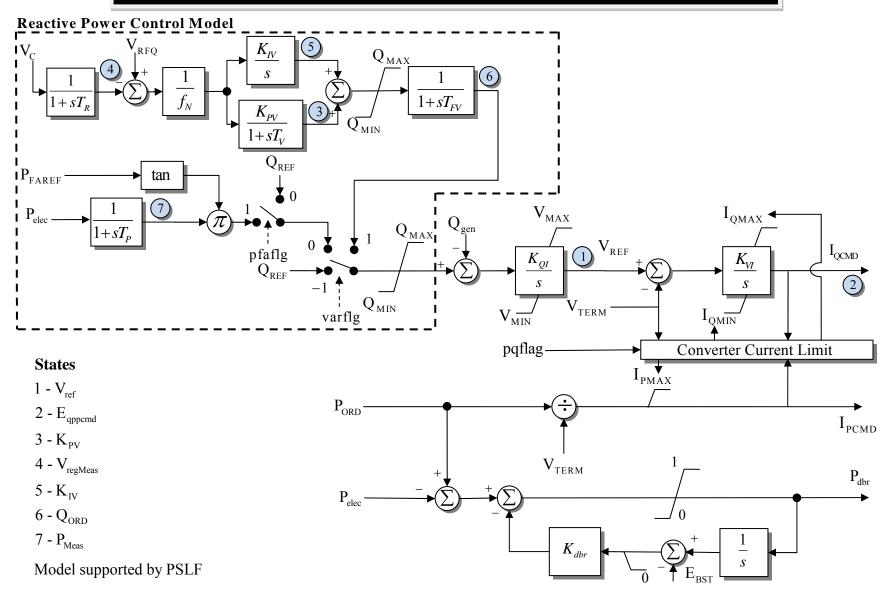
- $1 V_{\rm M}$
- 2 Sensed V<sub>t</sub>
- $3 V_A$
- $4 V_R$

Model supported by PSSE

Model supported by PSLF includes  $V_{\text{GMAX}}$  input that is read but not utilized in Simulator

## **Exciter EWTGFC**

# Exciter EWTGFC Excitation Control Model for Full Converter GE Wind-Turbine Generators

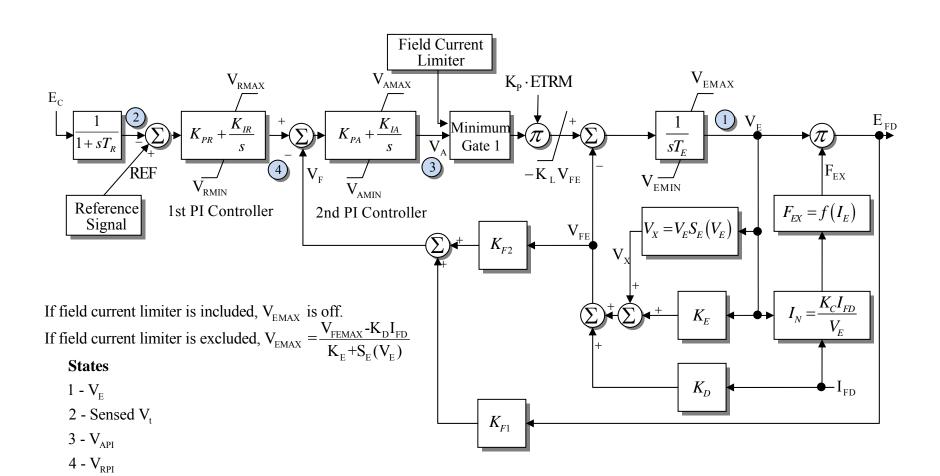


### **Exciter EX2000**

5 - LL6 - IFD<sub>PI</sub>

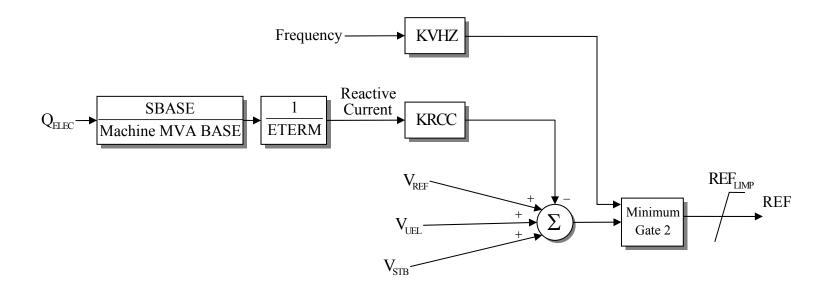
Model supported by PSSE

## Exciter EX2000 IEEE Type AC7B Alternator-Rectifier Excitation System Model



## **Exciter EX2000 REFERENCE SIGNAL MODEL**

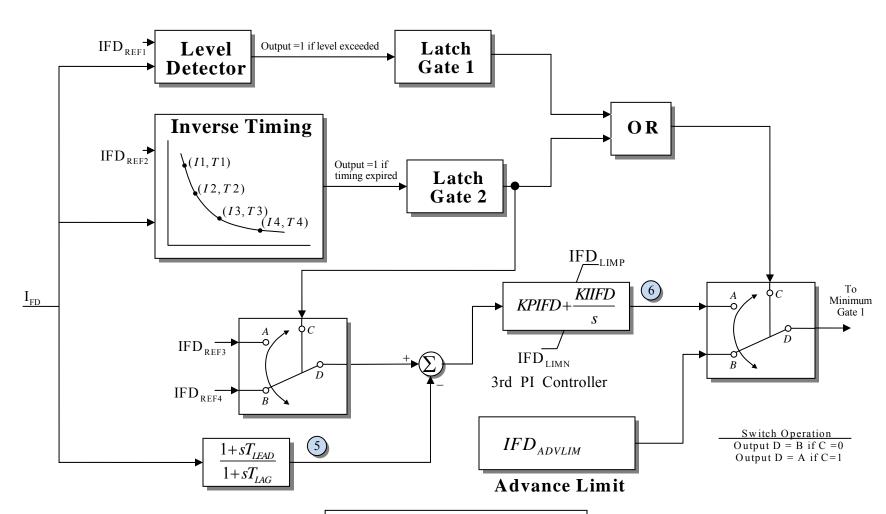
## Exciter EX2000 Reference Signal Model



Reference Signal Model

### **Exciter EX2000 FIELD CURRENT LIMITER MODEL**

### Exciter EX2000 Field Current Limiter Model

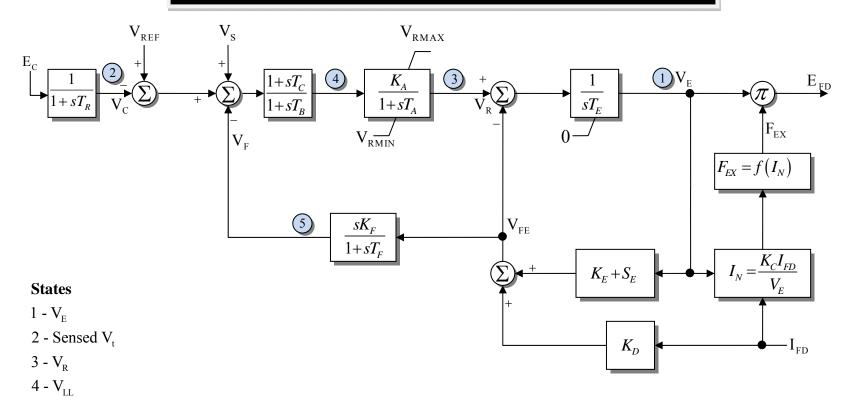


Model supported by PSSE

Field Current Limiter Model (Over Excitation Limiter)

### **Exciter EXAC1**

# Exciter EXAC1 IEEE Type AC1 Excitation System Model



Model supported by PSSE

 $5 - V_F$ 

Model supported by PSLF also uses  $\boldsymbol{V}_{\text{AMIN}}$  and  $\boldsymbol{V}_{\text{AMAX}}$ 

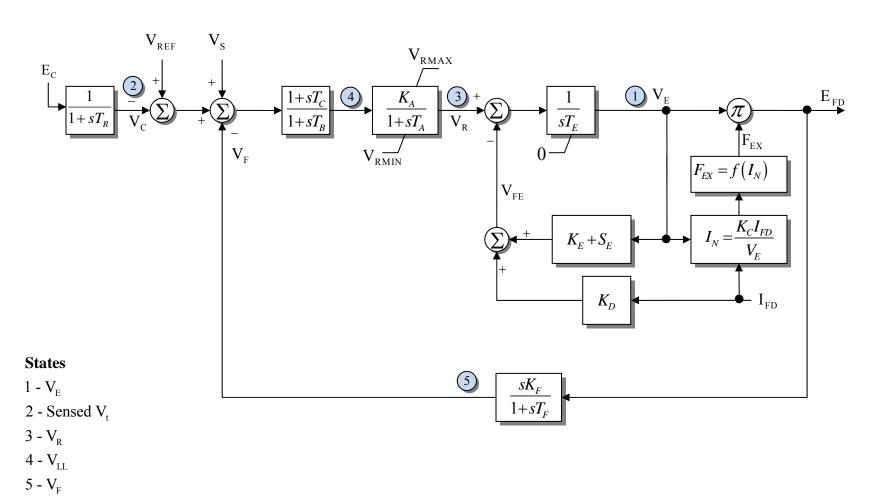
Simulator will narrow the limit range as appropriate when loading the DYD file

If 
$$V_{AMIN} > V_{RMIN}$$
 then  $V_{RMIN} = V_{AMIN}$ 

If 
$$V_{AMAX} < V_{RMAX}$$
 then  $V_{RMAX} = V_{AMAX}$ 

## **Exciter EXAC1A**

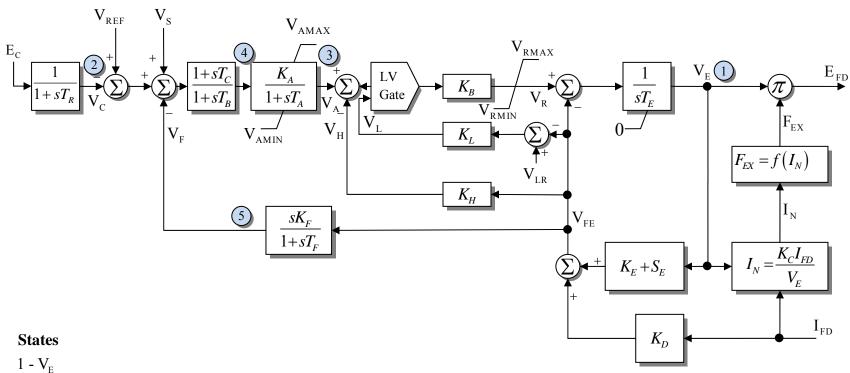
# Exciter EXAC1A Modified Type AC1 Excitation System Model



Model supported by PSSE

## **Exciter EXAC2**

## Exciter EXAC2 IEEE Type AC2 Excitation System Model

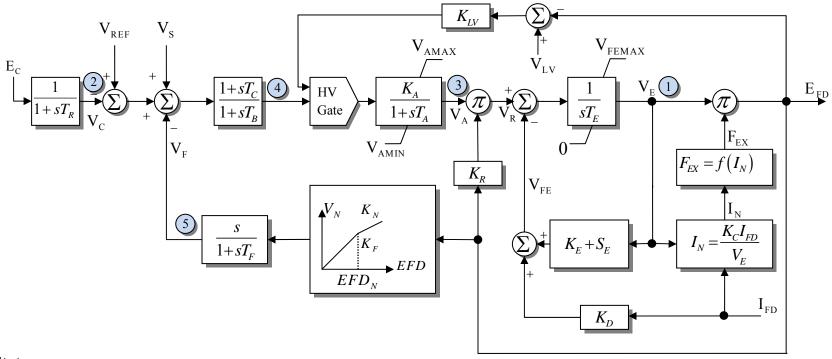


- 2 Sensed V<sub>t</sub>
- $3 V_A$
- $4 V_{LL}$
- $5 V_F$

Model supported by PSSE

## **Exciter EXAC3**

# Exciter EXAC3 IEEE Type AC3 Excitation System Model



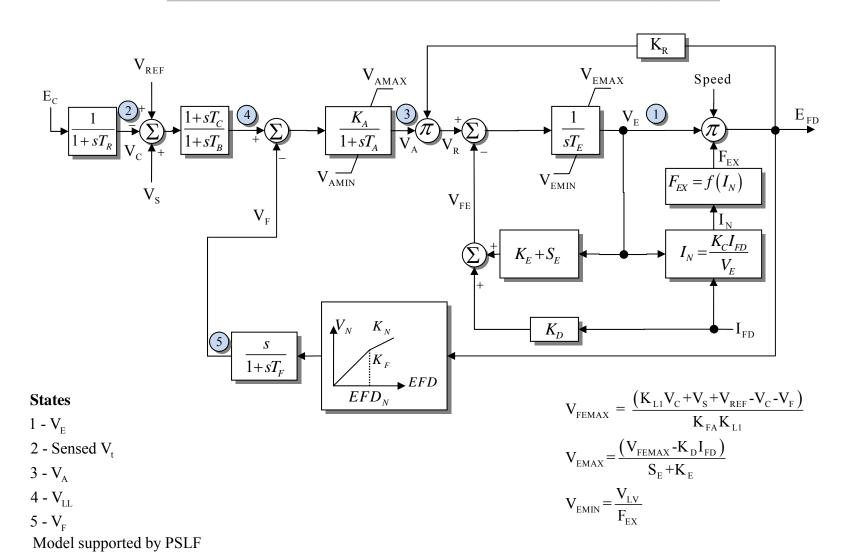
#### **States**

- $1 V_E$
- 2 Sensed V<sub>t</sub>
- $3 V_A$
- 4 V<sub>LL</sub>
- $5 V_F$

Model supported by PSSE

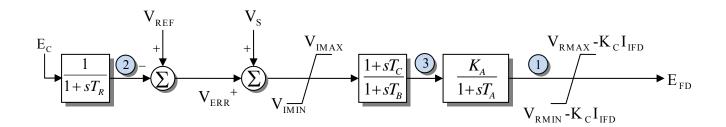
## **Exciter EXAC3A**

# Exciter EXAC3A IEEE Type AC3 Excitation System Model



## **Exciter EXAC4**

## Exciter EXAC4 IEEE Type AC4 Excitation System Model



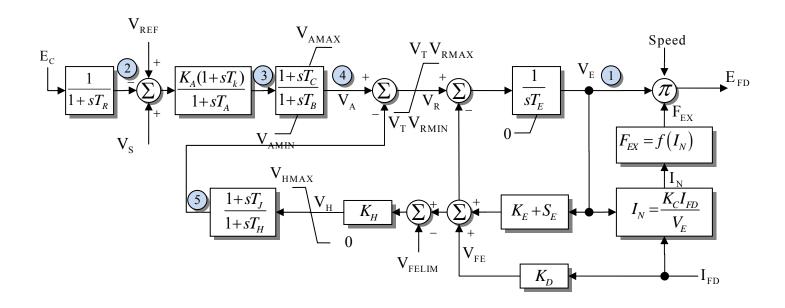
### **States**

- 1 EField before limit
- 2 Sensed V<sub>t</sub>
- $3 V_{LL}$

Model supported by PSLF and PSSE

## **Exciter EXAC6A**

## Exciter EXAC6A IEEE Type AC6A Excitation System Model

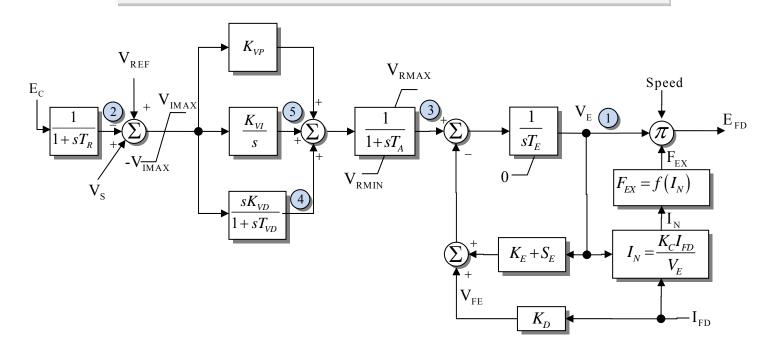


### **States**

- $1 V_E$
- 2 Sensed V<sub>t</sub>
- 3 T<sub>A</sub> Block
- $4 V_{LL}$
- $5 V_F$

## **Exciter EXAC8B**

# Exciter EXAC8B Brushless Exciter with PID Voltage Regulator

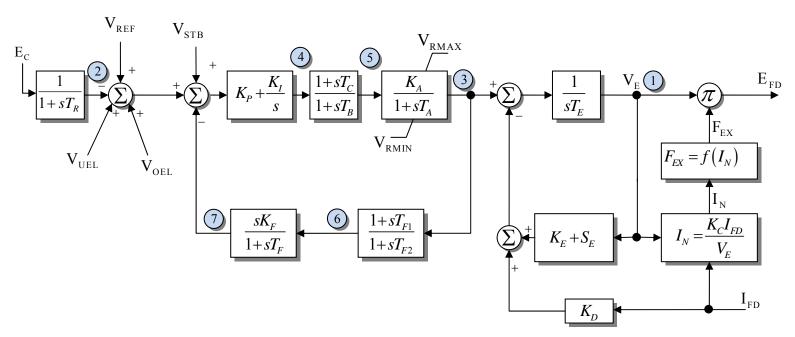


### **States**

- $1 V_E$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- 4 Derivative
- 5 Integral

## **Exciter EXBAS**

# Exciter EXBAS Basler Static Voltage Regulator Feeding DC or AC Rotating Exciter Model

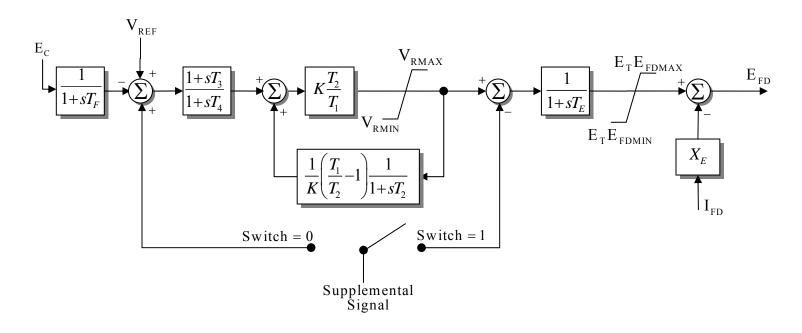


### **States**

- $1 V_E$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- 4 PI
- 5 LL
- 6 Feedback LL
- 7 Feedback

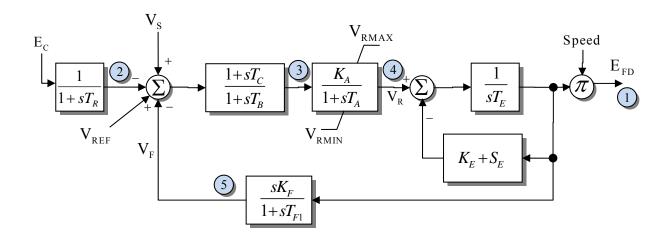
## **Exciter EXBBC**

# Exciter EXBBC Transformer-fed Excitation System



## **Exciter EXDC1**

# Exciter EXDC1 IEEE DC1 Excitation System Model

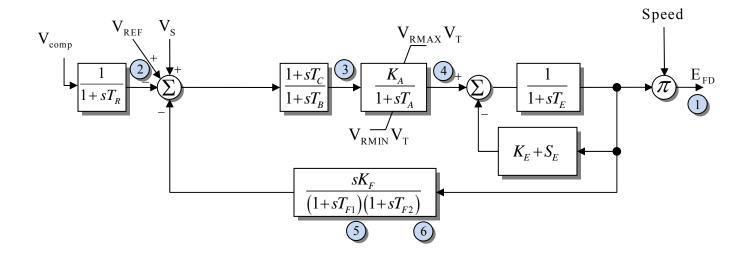


### **States**

- 1 E<sub>FD</sub>
- 2 Sensed V<sub>t</sub>
- $3 V_{\rm B}$
- $4 V_R$
- $5 V_F$

## **Exciter EXDC2\_GE**

# Exciter EXDC2\_GE IEEE Type DC2 Excitation System Model

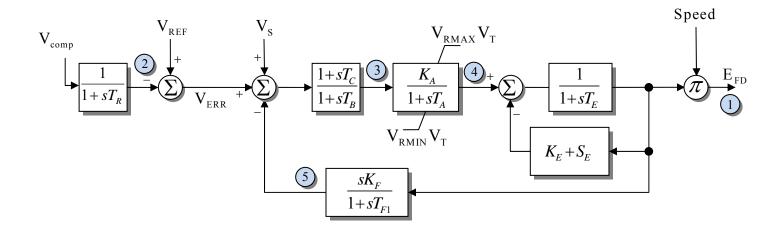


### **States**

- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_B$
- $4 V_R$
- $5 V_{F1}$
- $6 V_{F2}$

## **Exciter EXDC2\_PTI**

# Exciter EXDC2\_PTI IEEE Type DC2 Excitation System Model

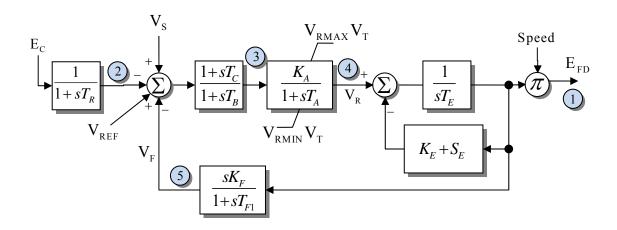


### States

- 1 E<sub>FD</sub>
- 2 Sensed V<sub>t</sub>
- $3 V_B$
- $4 V_R$
- $5 V_F$

## **Exciter EXDC2A**

# Exciter EXDC2A IEEE Type DC2 Excitation System Model

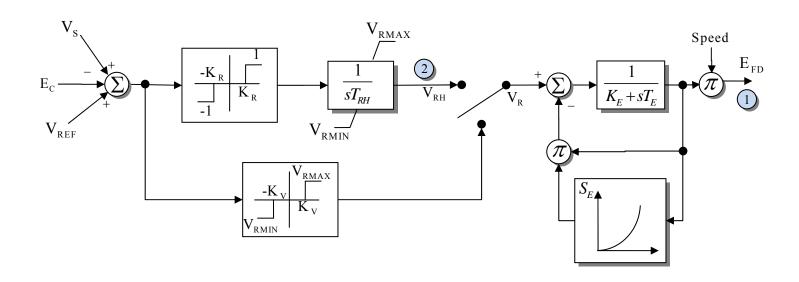


### **States**

- $1 E_{FD}$
- 2 Sensed  $V_t$
- $3 V_B$
- $4 V_R$
- $5 V_F$

## **Exciter EXDC4**

# Exciter EXDC4 IEEE Type 4 Excitation System Model

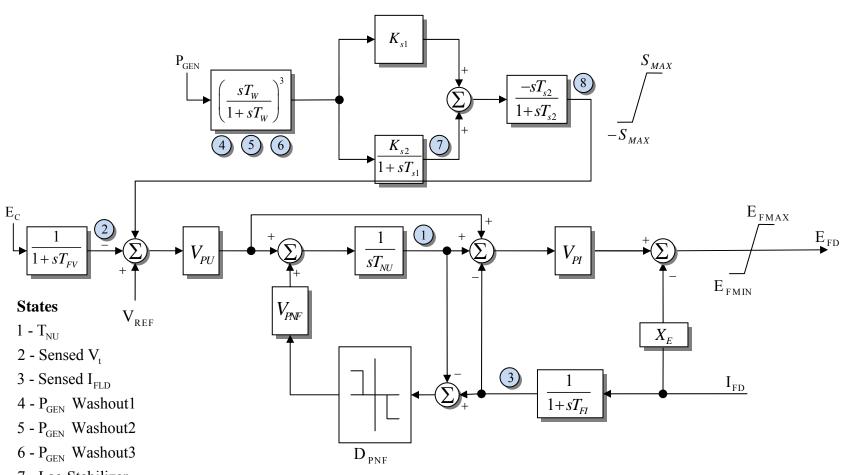


### **States**

- $1 E_{FD}$
- $2 V_{RH}$

## **Exciter EXELI**

## Exciter EXELI Static PI Transformer Fed Excitation System Model



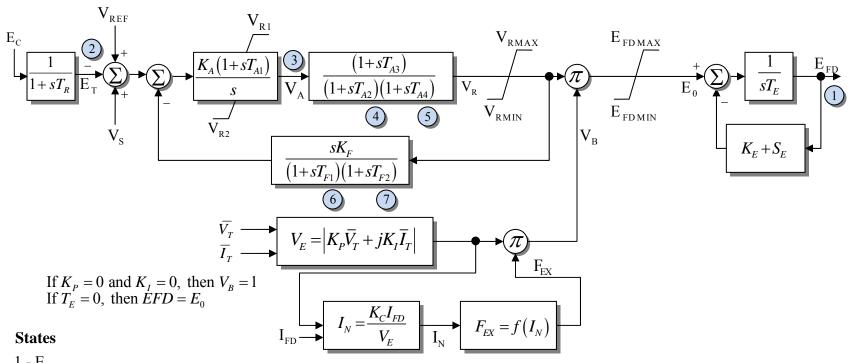
7 - Lag Stabilizer

8 - Washout Stabilizer

Model supported by PSLF and PSSE

## **Exciter EXPIC1**

## Exciter EXPIC1 Proportional/Integral Excitation System Model

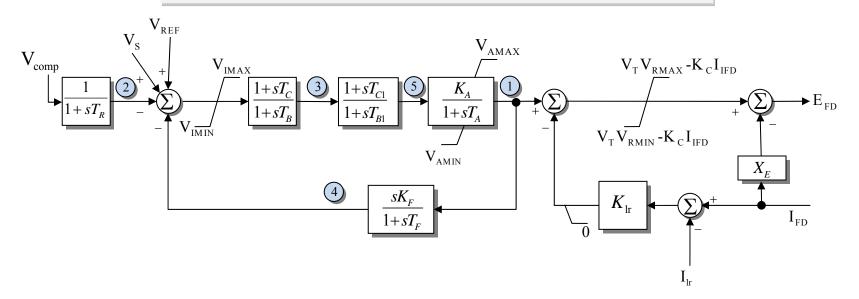


- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_A$
- 4  $V_{\mbox{\scriptsize R1}}$
- $5 V_R$
- $6 V_{F1}$
- $7 V_F$

Model supported by PSLF and PSSE

## **Exciter EXST1\_GE**

# Exciter EXST1\_GE IEEE Type ST1 Excitation System Model

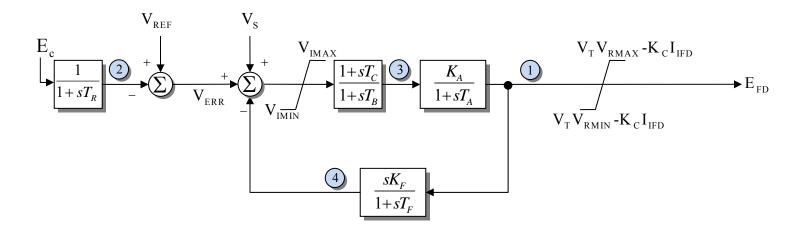


### **States**

- $1 V_A$
- 2 Sensed V<sub>t</sub>
- 3  $V_{\rm LL}$
- $4 V_F$
- $5 V_{LL1}$

## **Exciter EXST1\_PTI**

# Exciter EXST1\_PTI IEEE Type ST1 Excitation System Model

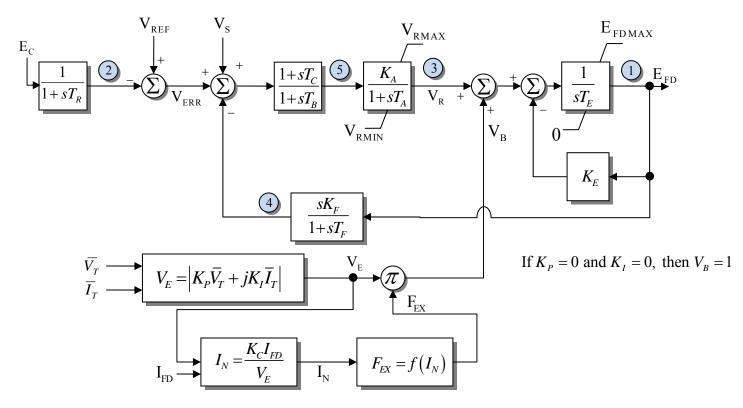


### **States**

- 1  $E_{\mbox{\tiny FD}}$  before limit
- 2 Sensed V<sub>t</sub>
- 3  $V_{\rm LL}$
- $4 V_F$

## **Exciter EXST2**

# Exciter EXST2 IEEE Type ST2 Excitation System Model



### **States**

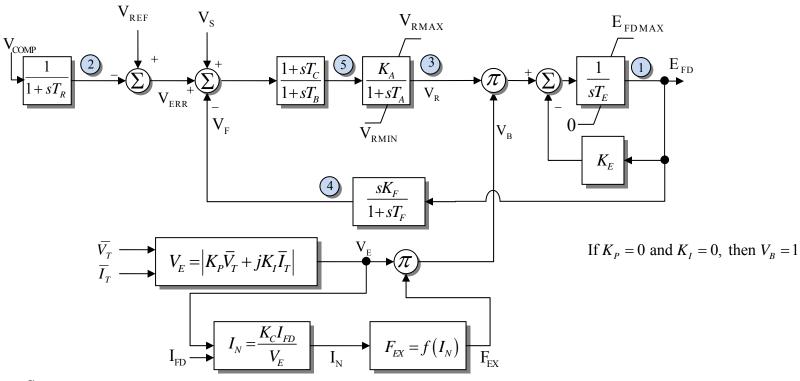
- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$
- $5 V_{LL}$

Model supported by PSLF

Model supported by PSSE does not include  $\rm T_{\rm B}$  and  $\rm T_{\rm C}$  inputs

## **Exciter EXST2A**

# Exciter EXST2A Modified IEEE Type ST2 Excitation System Model



### **States**

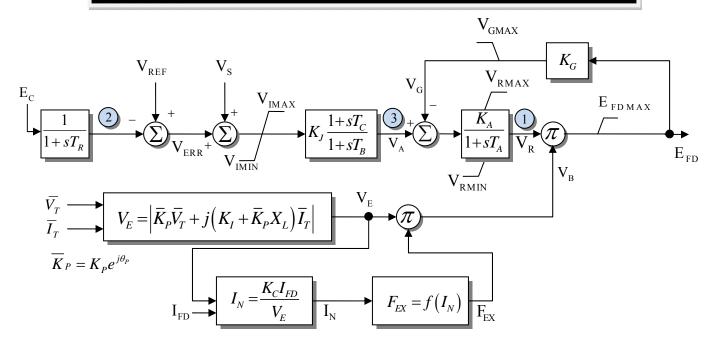
- $1 E_{FD}$
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$
- $5 V_{LL}$

Model supported by PSLF

Model supported by PSSE does not include T<sub>B</sub> and T<sub>C</sub> inputs

## **Exciter EXST3**

# Exciter EXST3 IEEE Type ST3 Excitation System Model



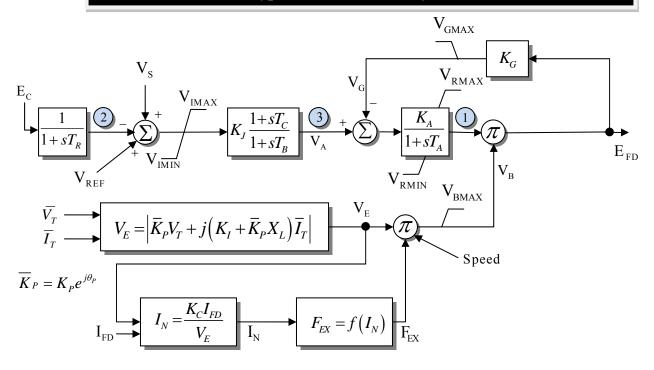
#### **States**

- $1 V_R$
- 2 Sensed V<sub>t</sub>
- 3 LL

Model supported by PSSE

## **Exciter EXST3A**

# Exciter EXST3A IEEE Type ST3 Excitation System Model

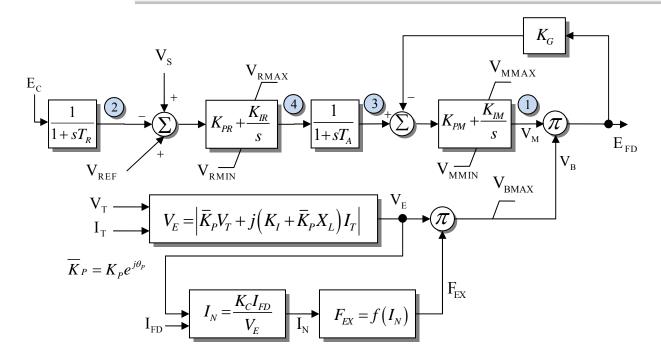


### **States**

- $1 V_R$
- 2 Sensed  $V_t$
- 3 LL

## **Exciter EXST4B**

# Exciter EXST4B IEEE Type ST4B Excitation System Model

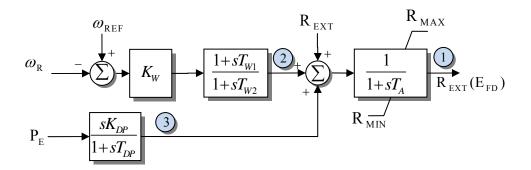


### **States**

- $1 V_{MInt}$
- 2 Sensed  $V_t$
- $3 V_A$
- $4 V_R$

## **Exciter EXWTG1**

# Exciter EXWTG1 Excitation System Model for Wound-Rotor Induction Wind-Turbine Generators

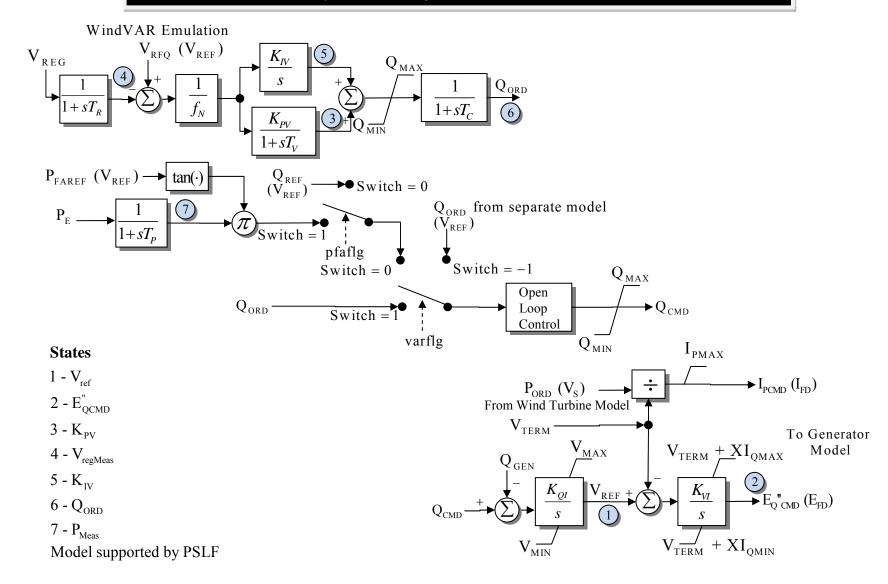


### **States**

- 1 R<sub>external</sub>
- 2 SpeedReg
- 3 Washout

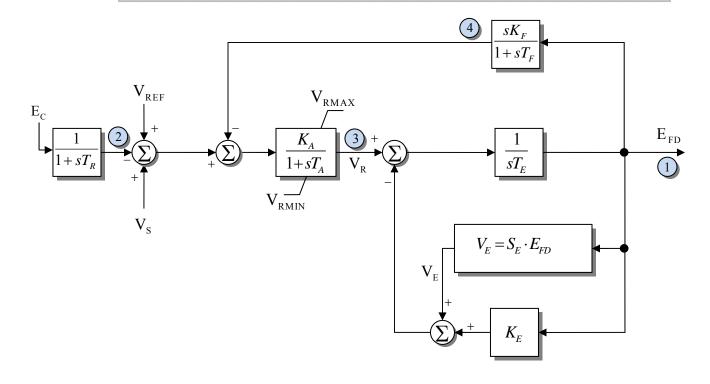
### **Exciter EXWTGE**

### Exciter EXWTGE Excitation System Model for GE Wind-Turbine Generators



## **Exciter IEEET1**

# Exciter IEEET1 IEEE Type 1 Excitation System Model



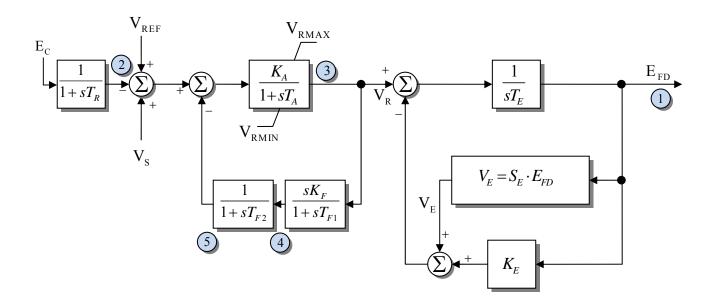
### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$

Model supported by PSSE

## **Exciter IEEET2**

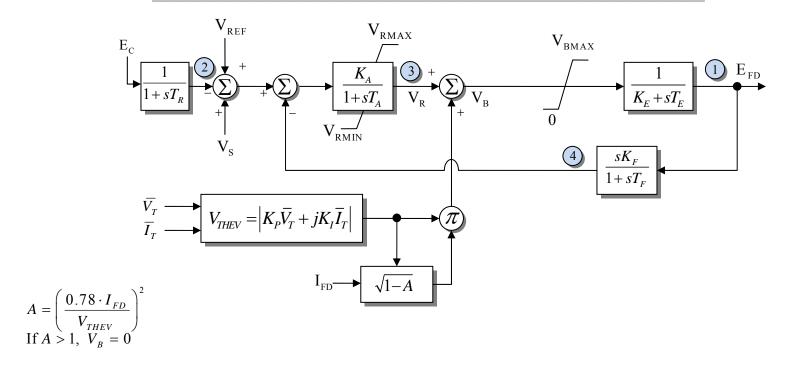
# Exciter IEEET2 IEEE Type 2 Excitation System Model



### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_{F1}$
- $5 V_{F2}$

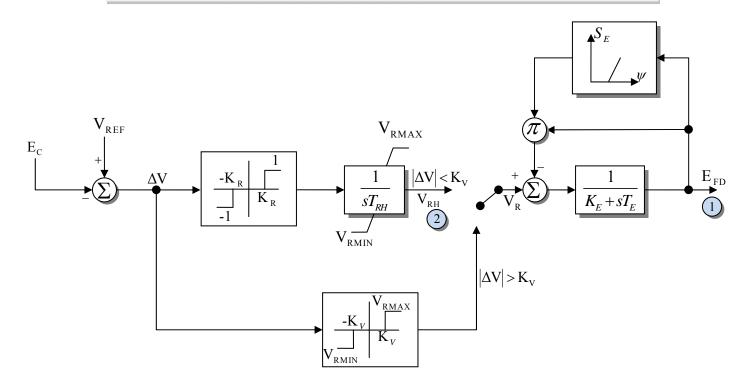
### Exciter IEEET3 IEEE Type 3 Excitation System Model



#### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$

### Exciter IEEET4 IEEE Type 4 Excitation System Model

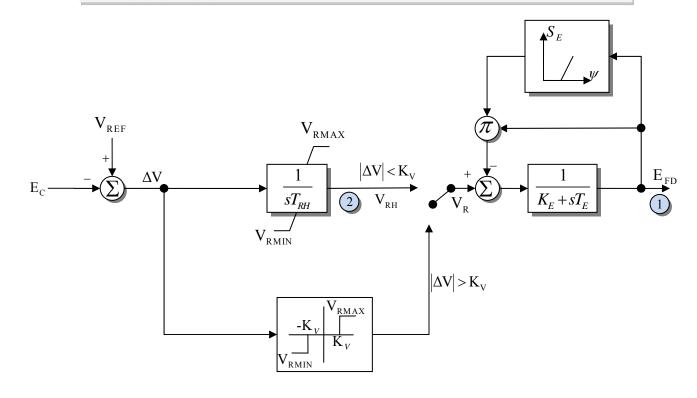


#### **States**

1 - EField

 $2 - V_{RH}$ 

### Exciter IEEET5 Modified IEEE Type 4 Excitation System Model

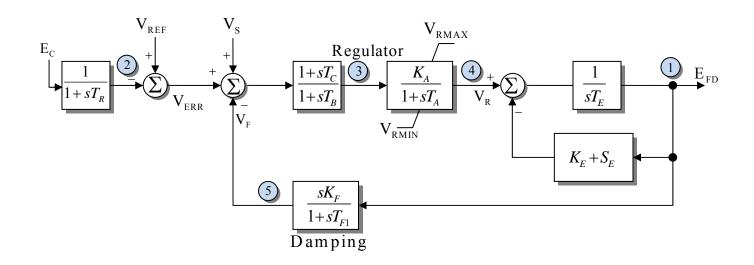


#### **States**

1 - EField

 $2 - V_{RH}$ 

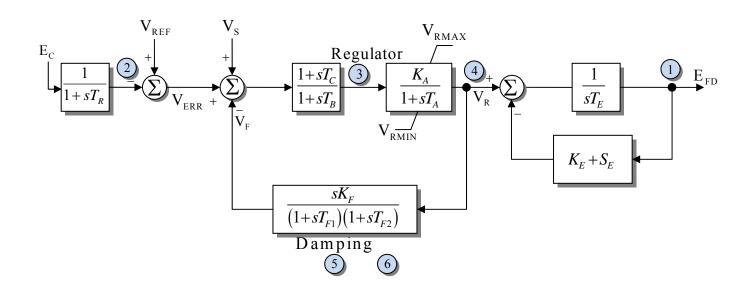
### Exciter IEEEX1 IEEE Type 1 Excitation System Model



#### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_B$
- $4 V_R$
- $5 V_F$

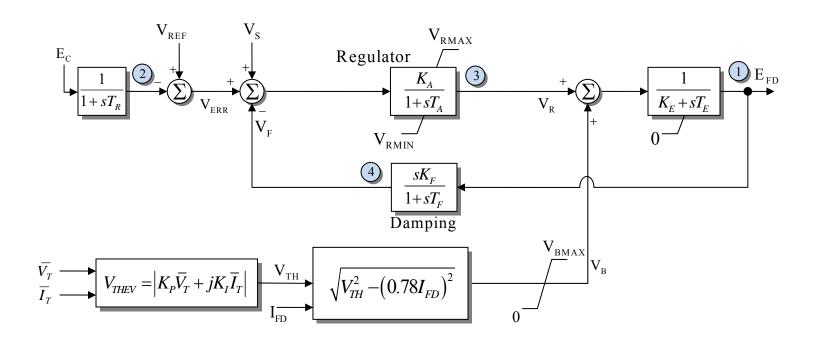
### Exciter IEEEX2 IEEE Type 2 Excitation System Model IEEEX2



#### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- 3 LL
- $4 V_R$
- $5 V_{F1}$
- $6 V_{F2}$

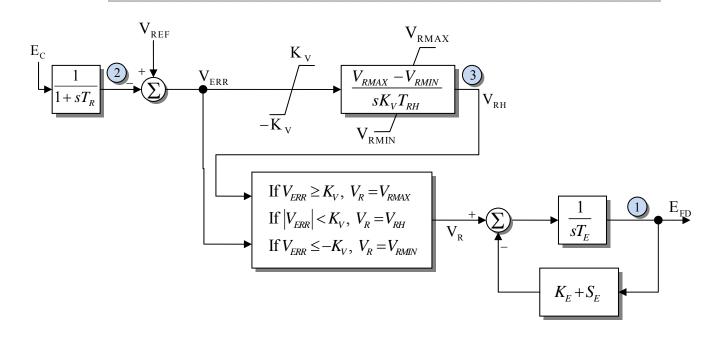
### Exciter IEEEX3 IEEE Type 3 Excitation System Model



#### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_R$
- $4 V_F$

### Exciter IEEEX4 IEEE Type 4 Excitation System Model

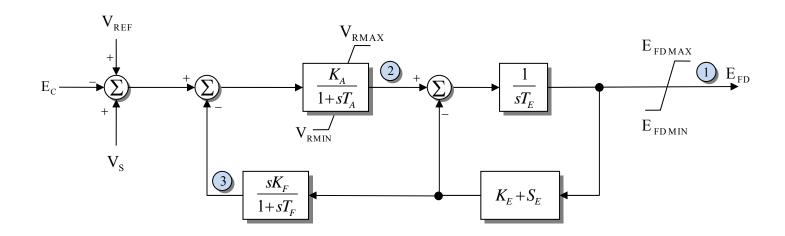


#### **States**

- 1 EField
- 2 Sensed V<sub>t</sub>
- $3 V_{RH}$

### **Exciter IEET1A**

### Exciter IEET1A Modified IEEE Type 1 Excitation System Model

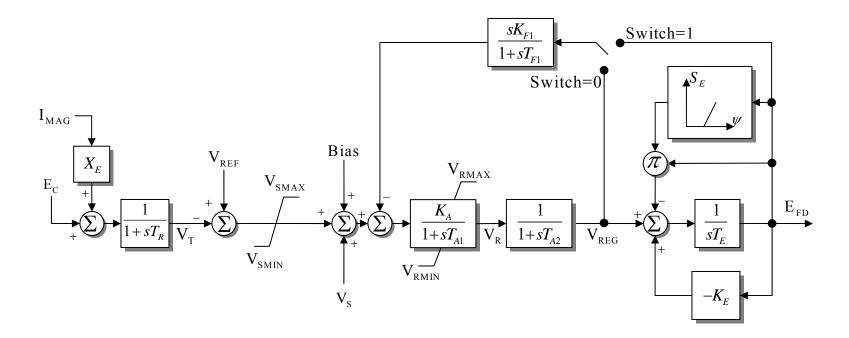


#### **States**

- 1 EField
- $2 V_R$
- $3 V_F$

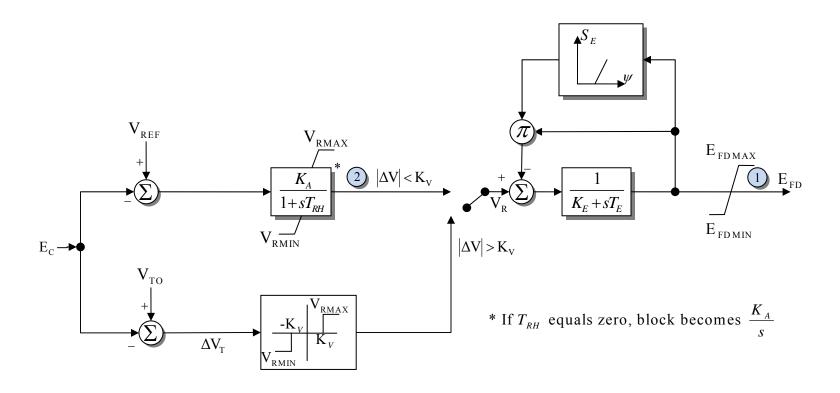
### **Exciter IEET1B**

### Exciter IEET1B Modified IEEE Type 1 Excitation System Model



### **Exciter IEET5A**

### Exciter IEET5A Modified IEEE Type 4 Excitation System Model

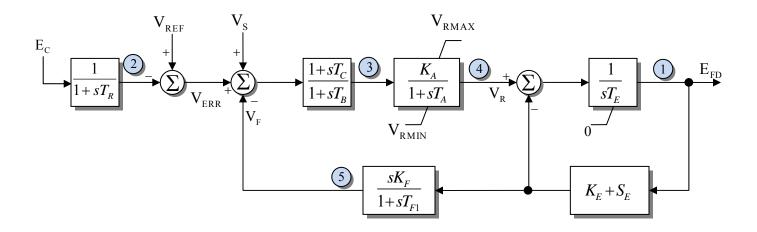


#### **States**

- 1 EField
- $2 V_{RH}$

### **Exciter IEEX2A**

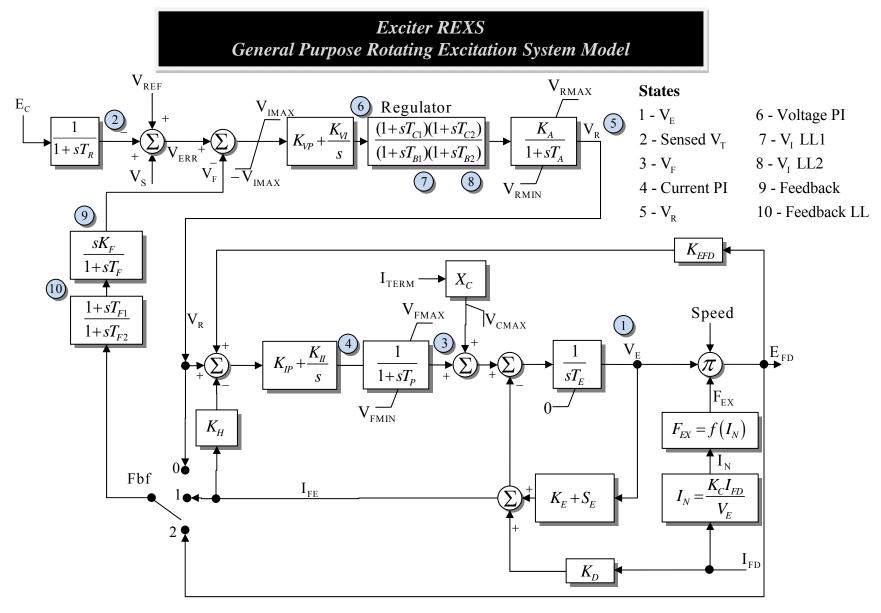
### Exciter IEEX2A IEEE Type 2A Excitation System Model



#### **States**

- 1 EField
- 2 Sensed  $V_t$
- $3 V_B$
- $4 V_R$
- $5 V_F$

### **Exciter REXS**



 $Model \ supported \ by \ PSLF. \ If \ flimf = 1 \ then \ multiply \ V_{RMIN}, V_{RMAX}, V_{FMIN}, \ and \ V_{FMAX} \ by \ V_{TERM}.$ 

#### **Exciter REXSY1**

 $5 - V_R$ 

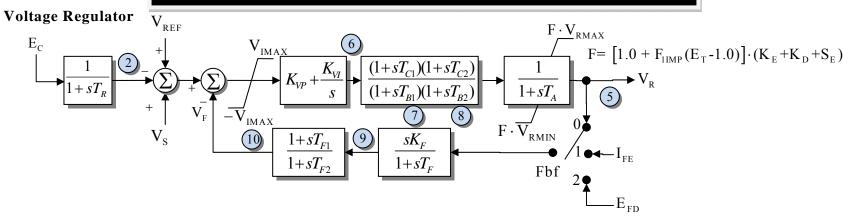
Model supported by PSSE

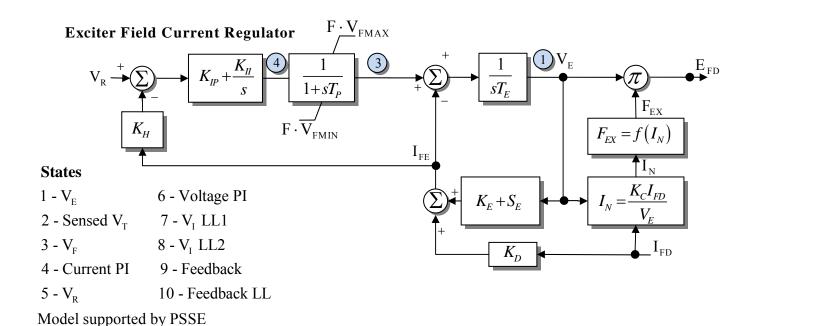
10 - Feedback LL

#### Exciter REXSY1 General Purpose Rotating Excitation System Model Voltage Regulator $F \cdot V_{RMAX}$ $V_{\underline{\underline{\mathsf{IM}}}\, \underline{\mathsf{A}}\underline{\mathsf{X}}}$ $E_{\rm C}$ $F = [1.0 + F_{1IMF}(E_T - 1.0)] \cdot (K_E + K_D + S_E)$ $(1+sT_{C1})(1+sT_{C2})$ $(1+sT_{B1})(1+sT_{B2})$ 7 $\overline{-V}_{\text{IMAX}}$ (8) $F \cdot \overline{V}'_{RMIN}$ 10 $1+sT_{F1}$ $sK_F$ $\dot{V_{\scriptscriptstyle S}}$ $1 + sT_{F2}$ $1+sT_F$ Fbf 2● $-E_{FD}$ $X_{C}$ $\boldsymbol{I}_{\text{term}}$ $|V_{\scriptscriptstyle CMAX}|$ $F \cdot V_{FMAX}$ **Exciter Field Current Regulator** $F \cdot \overline{V}_{\text{FMIN}}$ $K_{H}$ $F_{EX} = f(I_N)$ $\boldsymbol{I}_{\text{FE}}$ **States** $1 - V_E$ 6 - Voltage PI $K_E + S_E$ 2 - Sensed $V_T$ $7 - V_I LL1$ $3 - V_F$ 8 - V<sub>1</sub> LL2 $I_{FD}$ $\overline{K_D}$ 9 - Feedback 4 - Current PI

### **Exciter REXSYS**

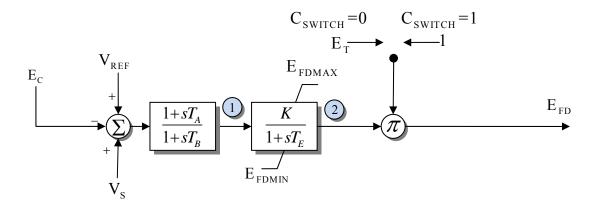
### Exciter REXSYS General Purpose Rotating Excitation System Model





### **Exciter SCRX**

### Exciter SCRX Bus Fed or Solid Fed Static Excitation System Model



#### **States**

1 - Lead-Lag

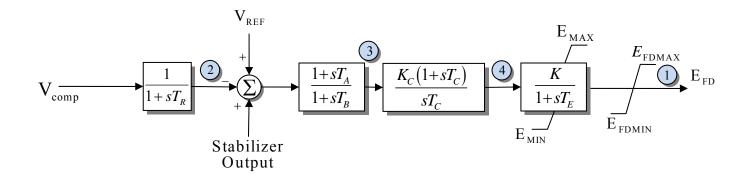
 $2 - V_E$ 

Model supported by PSLF

Model supported by PSSE has  $C_{SWITCH} = 1$ 

### **Exciter SEXS\_GE**

### Exciter SEXS\_GE Simplified Excitation System Model

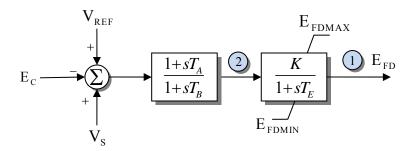


#### **States**

- 1 EField
- 2 Sensed  $V_t$
- 3 LL
- 4 PI

### **Exciter SEXS\_PTI**

### Exciter SEXS\_PTI Simplified Excitation System Model



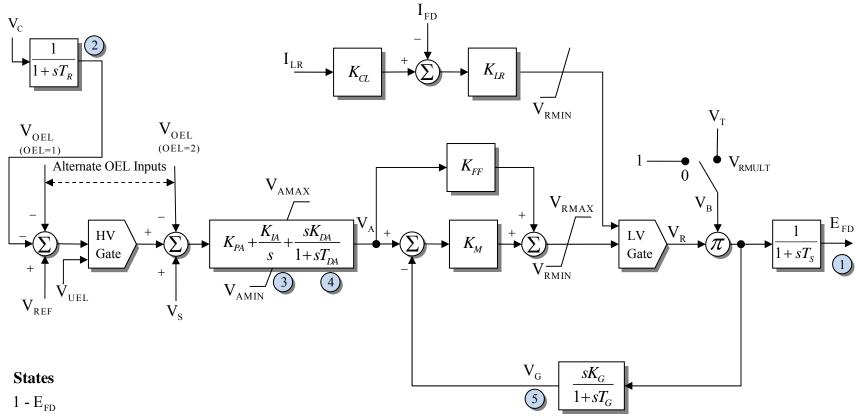
#### **States**

1 - EField

2 - LL

### **Exciter ST6B**

### Exciter ST6B IEEE 421.5 2005 ST6B Excitation System Model



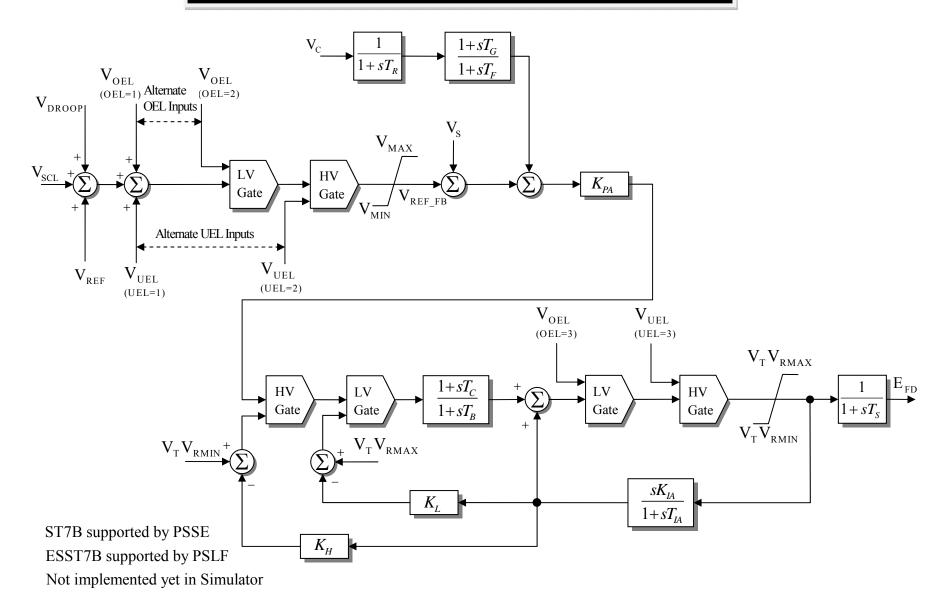
- 2 Sensed V,
- 3 PID1
- 4 PID2
- $5 V_G$

ST6B supported by PSSE

ESST6B supported by PSLF with optional  $V_{\text{RMULT}}$ 

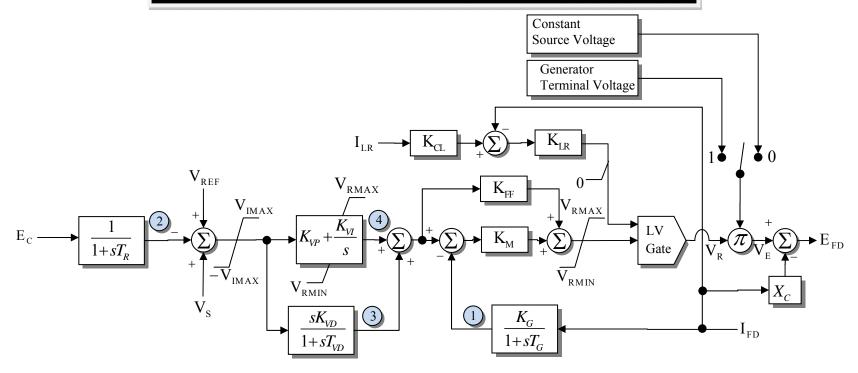
### **Exciter ST7B**

### Exciter ST7B IEEE 421.5 2005 ST7B Excitation System Model



### **Exciter TEXS**

### Exciter TEXS General Purpose Transformer-Fed Excitation System Model

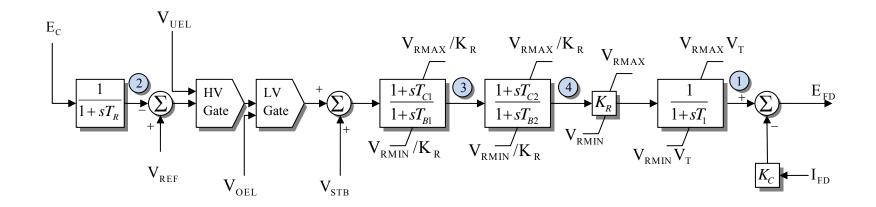


#### **States**

- 1 Feedback
- 2 Sensed V<sub>t</sub>
- 3 Derivative Controller
- 4 Integral Controller

### **Exciter URST5T**

### Exciter URST5T IEEE Proposed Type ST5B Excitation System Model

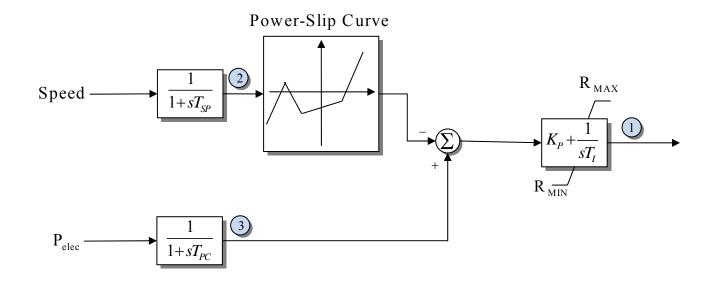


#### **States**

- $1 V_R$
- 2 Sensed  $V_t$
- 3 LL1
- 4 LL2

### **Exciter WT2E1**

### Exciter WT2E1 Rotor Resistance Control Model for Type 2 Wind Generator

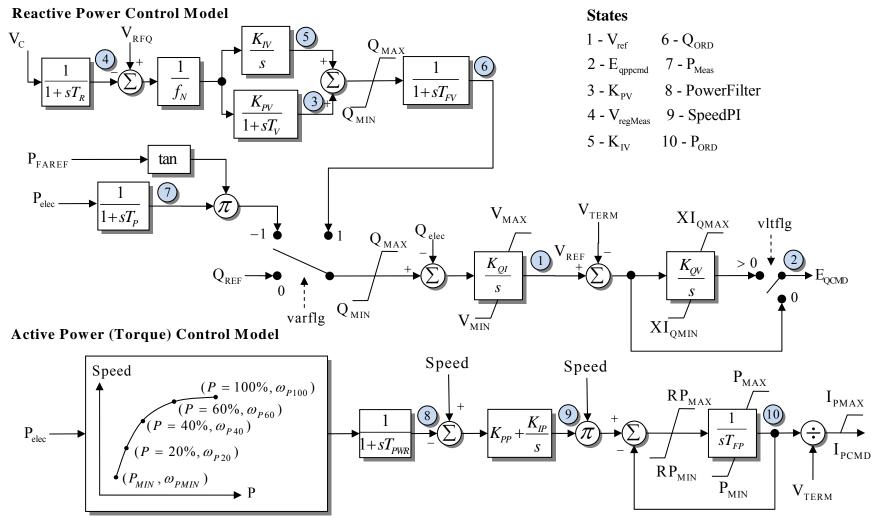


#### **States**

- 1 R<sub>external</sub>
- 2 Speed
- 3 P<sub>elec</sub>

#### **Exciter WT3E and WT3E1**

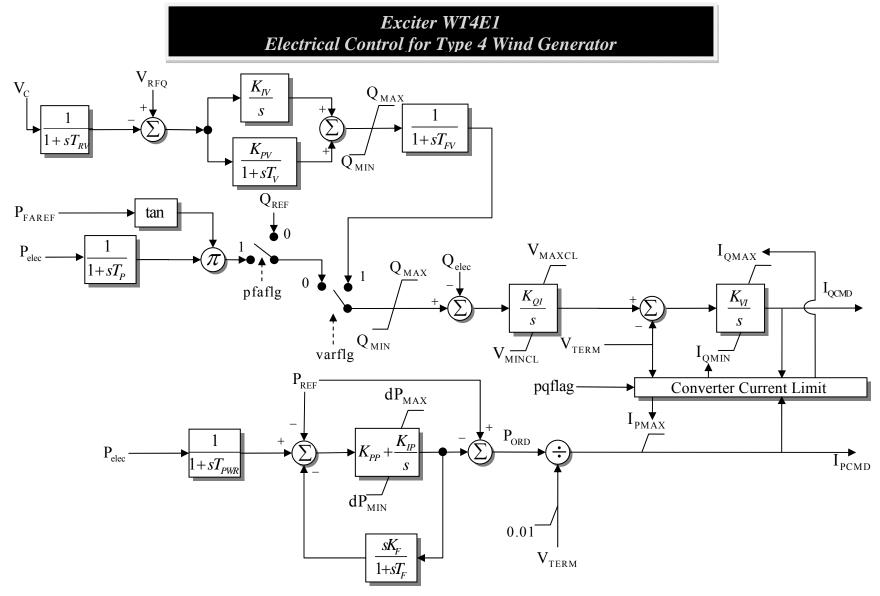
### Exciter WT3E and WT3E1 Electrical Control for Type 3 Wind Generator



WT3E supported by PSLF with  $RP_{MAX} = P_{wrat}$  and  $RP_{MIN} = -P_{wrat}$ ,  $T_{FV} = T_{C}$ 

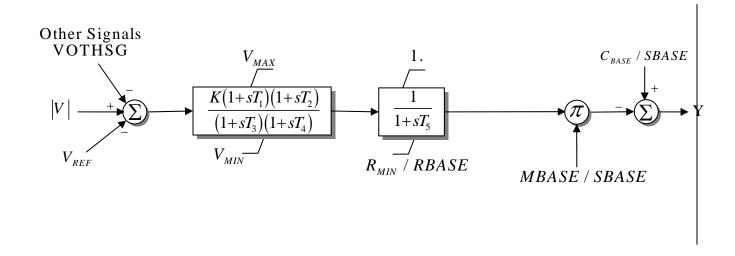
WT3E1 supported by PSSE uses vltflg to determine the limits on  $E_{OCMD}$ . When vltflg > 0 Simulator always uses  $XI_{OMAX}$  and  $XI_{OMIN}$ .

### **Exciter WT4E1**



Model supported by PSSE but not yet implemented in Simulator

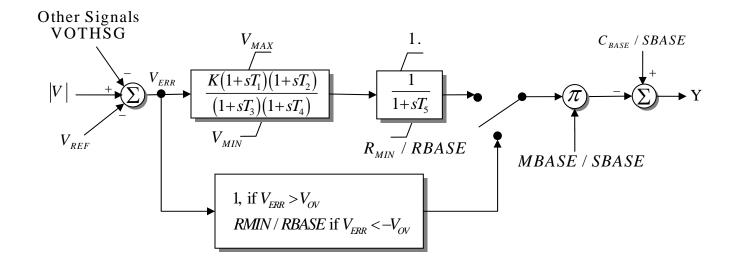
### Machine Model CSVGN1 Static Shunt Compensator CSVGN1



RBASE = MBASE

**Note:** |V| is the voltage magnitude on the high side of generator step-up transformer if present.

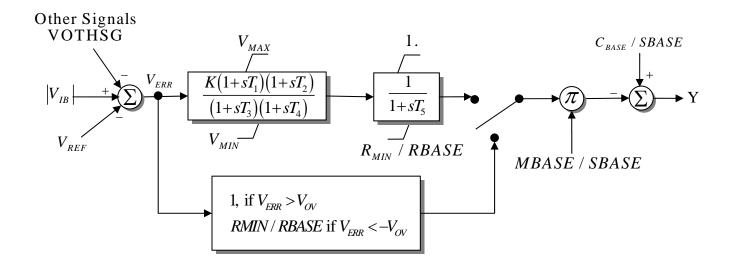
### Machine Model CSVGN3 Static Shunt Compensator CSVGN3



RBASE = MBASE

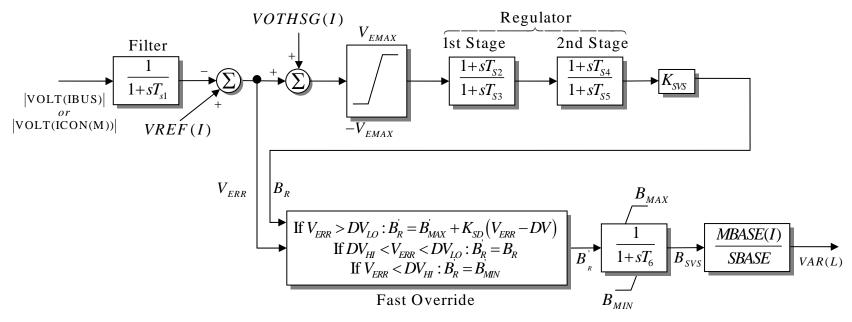
**Note:** |V| is the voltage magnitude on the high side of generator step-up transformer if present.

### Machine Model CSVGN4 Static Shunt Compensator CSVGN4



RBASE = MBASE

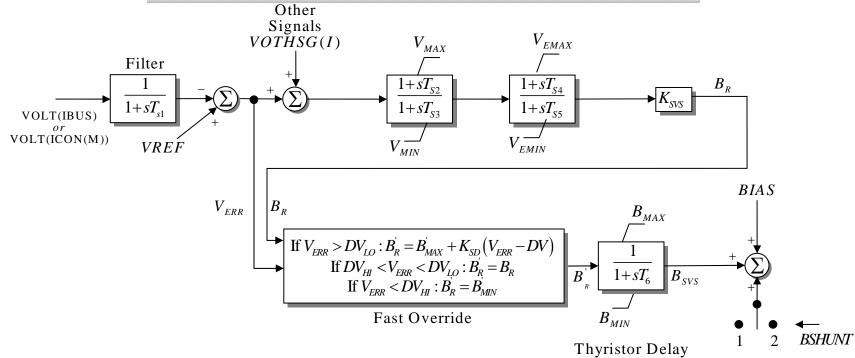
### Machine Model CSVGN5 Static Var Compensator CSVGN5



Thyristor Delay

If 
$$DV = 0$$
, If  $DV > 0$ , 
$$DV_{LO} = B'_{MAX} / K_{SVS} \qquad DV_{LO} = DV$$
$$DV_{HI} = B'_{MIN} / K_{SVS} \qquad DV_{HI} = -DV$$

### Machine Model CSVGN6 Static Var Compensator CSVGN6



If 
$$DV = 0$$
,  

$$DV_{LO} = B'_{MAX} / K_{SVS}$$

$$DV_{HI} = B'_{MIN} / K_{SVS}$$

If 
$$DV > 0$$
,  

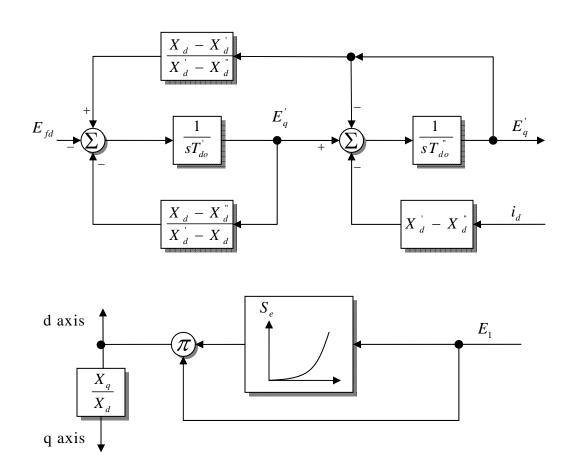
$$DV_{LO} = DV$$

$$DV_{HI} = -DV$$

Position 1 is normal (open) If  $V_{ERR} > DV2$ , switch will close after TDELAY cycles.

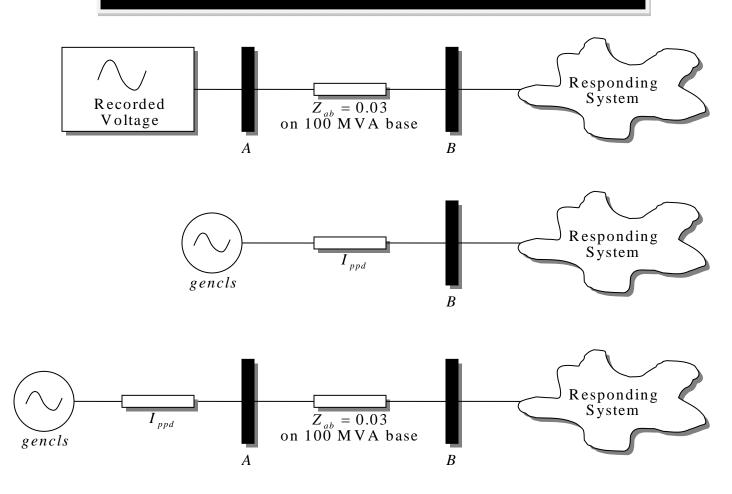
### **Machine Model GENCC**

# Machine Model GENCC Generator represented by uniform inductance ratios rotor modeling to match WSCC type F



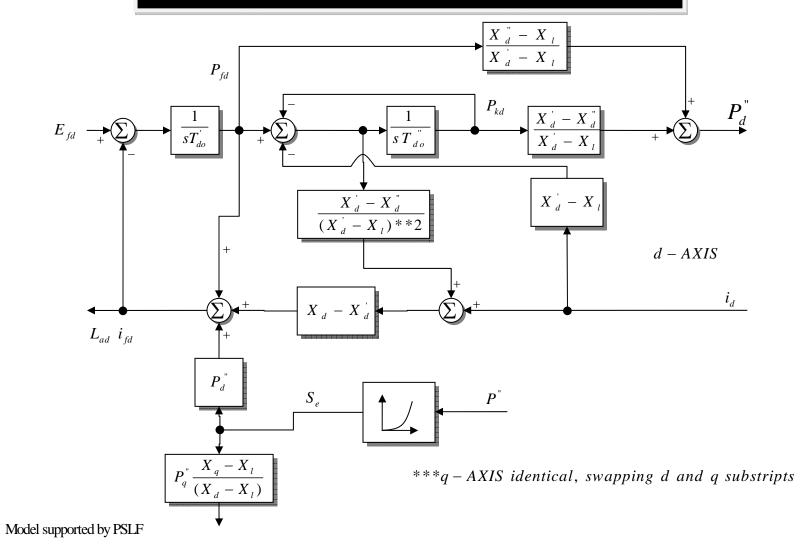
#### **Machine Model GENCLS**

# Machine Model GENCLS Synchronous machine represented by "classical" modeling or Thevenin Voltage Source to play Back known voltage/frequency signal



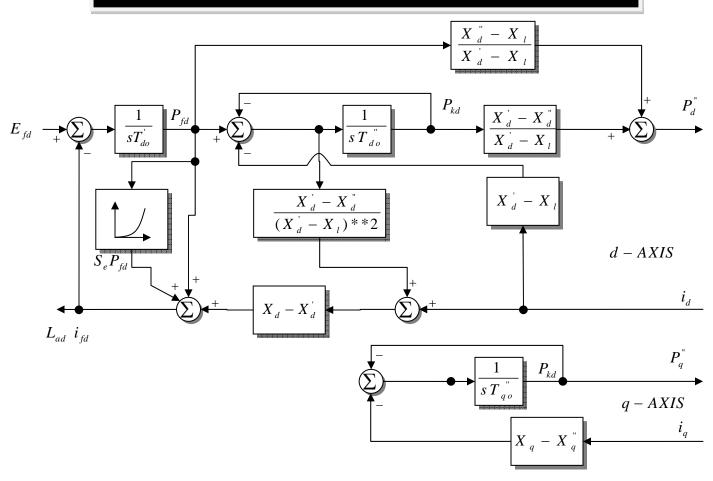
### **Machine Model GENROU**

# Machine Model GENROU Solid Rotor Generator represented by equal mutual inductance rotor modeling



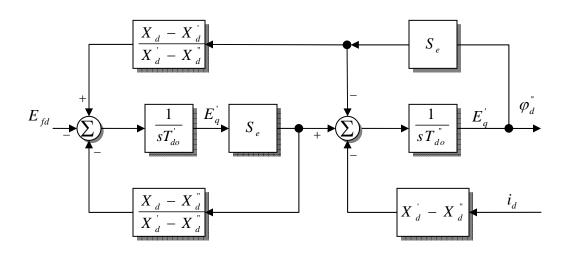
### **Machine Model GENSAL**

# Machine Model GENSAL Salient Pole Generator represented by equal mutual inductance rotor modeling



### **Machine Model GENTPF**

# Machine Model GENTPF Generator represented by uniform inductance ratios rotor modeling to match WSCC type F



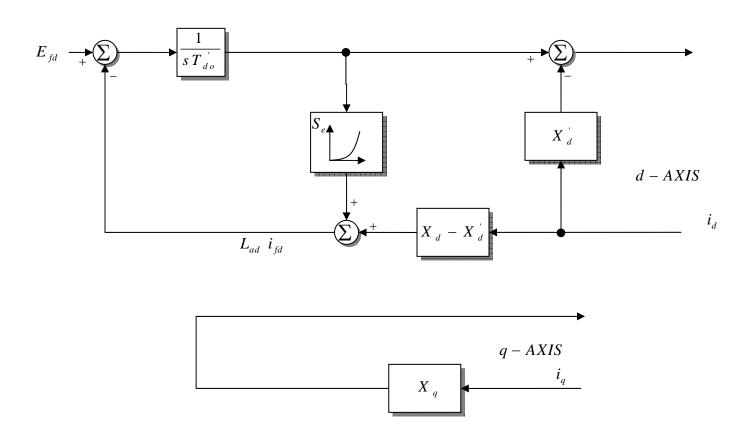
$$S_e = 1. + fsat(\varphi_{ag})$$

Q - Axis Similar except:

$$S_e = 1. + \frac{X_q}{X_d} (\varphi_{ag})$$

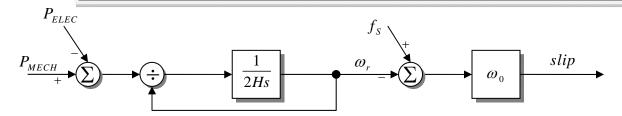
### **Machine Model GENTRA**

### Machine Model GENTRA Salient Pole Generator without Amortisseur Windings



#### **Machine Model GENWRI**

#### Machine Model GENWRI Wound-rotor Induction Generator Model with Variable External Rotor Resistance



$$R2Tpo = \frac{(L_s - L_l)}{\omega_0 (L_s - L')}$$

$$T_0' = \frac{R2Tpo}{(R2ex + R2)}$$

$$\dot{\varphi}_{fd} = -\frac{(\varphi_{fd} + S_d + (L_s - L')i_d)}{T_0'} + (slip)\varphi_{fq}$$

$$\dot{\varphi}_{fq} = -\frac{(\varphi_{fq} + S_q + (L_s - L')i_q)}{T_0'} + (slip)\varphi_{fd}$$

$$\varphi_{g}' = \varphi_{fq}$$

$$\varphi_{g}' = \varphi_{fq}$$

 $R\ 2\ T\ p\ o$  is a constant which is equal to  $T_0$  times the total rotor resistance.

R 2 is the internal rotor resistance

$$R\ 2\ e\ x\ is\ th\ e\ in\ term\ a\ l\ ro\ to\ r\ re\ sistan\ c\ e$$

$$e_{q} = \omega_{s} \varphi_{d} - Li_{d} - R_{a}i_{q}$$

$$e_{d} = -\omega_{s} \varphi_{q} + Li_{q} - R_{a}i_{d}$$

$$\varphi' = \sqrt{(\varphi_{d}')^{2} + (\varphi_{q}')^{2}}$$

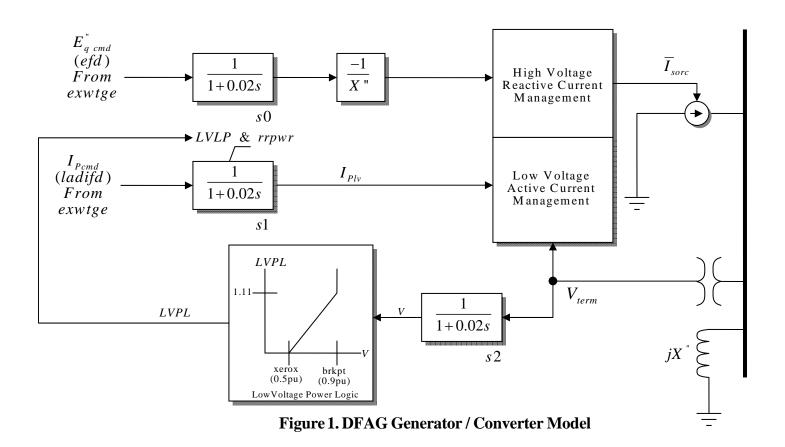
$$S_{e} = f_{sat}(\varphi')$$

$$S_{d} = S_{e}(\varphi_{d}')$$

$$S_{q} = S_{e}(\varphi_{d}')$$

#### **Machine Model GEWTG**

Machine Model GEWTG
Generator/converter model for GE wind turbines –
Doubly Fed Asynchronous Generator (DFAG) and
Full Converter (FC) Models



# Machine Model GEWTG Generator/converter model for GE wind turbines – Doubly Fed Asynchronous Generator (DFAG) and Full Converter (FC) Models

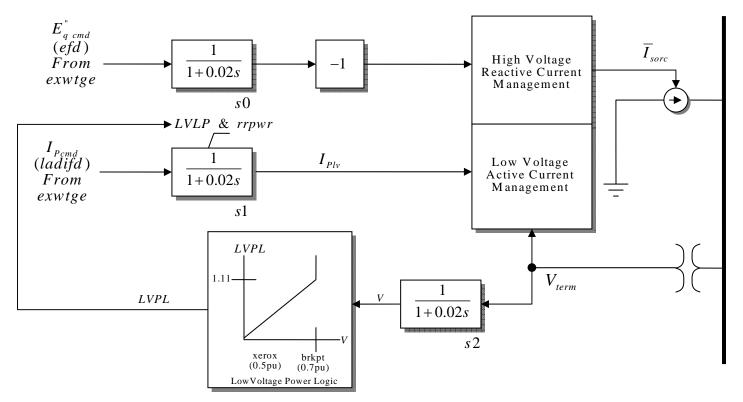
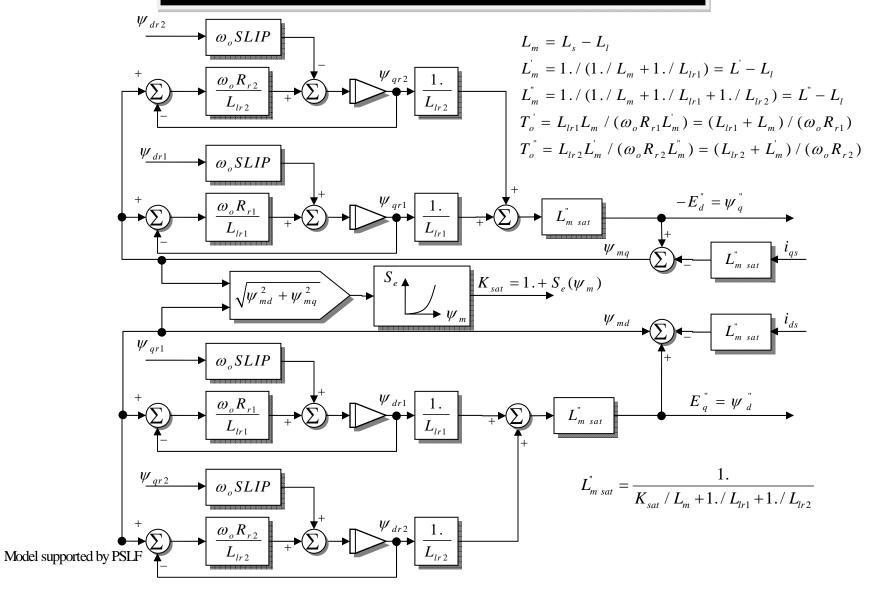


Figure 1. Full Converter Generator / Converter Model

#### **Machine Model MOTOR1**

# Machine Model MOTOR1 "Two-cage" or "one-cage" induction machine



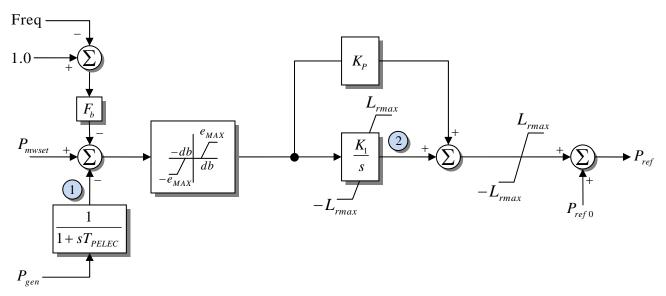
#### **Machine Model SVCWSC**

#### Machine Model SVCWSC Static Var device compatible with WSCC Vx/Wx models Voltage Clamp Logic if Vbus<V1vcl, Kvc = 0. if Vbud>V2vcl for Tdvcl sec., Kvc =1. $V_{1MAX}$ $B_{\rm \it MAX}$ $K_{VC} * V_{2MAX}$ $\boldsymbol{V}_{\text{emax}}$ $\frac{1\!\!+\!\!sT_{\!_{C}}}{1\!\!+\!\!sT_{\!_{S1}}}$ $B_{SVS}$ Fast $1 {+} s T_{s2}$ $1 {+} s T_{s4}$ $K_{SVS}$ Over $1 + sT_{s3}$ $1+sT_{ss}$ $1+sT_{s6}$ Ride $V_{\text{EMIN}}$ $V_{1MIN}$ $B_{MIN}^{-}$ $K_{VC}$ $\overline{*}V_{2MIN}$ $V_{SCS} + V_{S}$ $V_{S}$ (from external PSS) $V_{\text{RET}}$ $X_{C}$ $\underline{K_{\underline{s}\underline{1}}}$ Input 1 $1+sT_8$ $1+sT_{s7}$ $1+sT_{s9}$ $\boldsymbol{V}_{\text{SCSMAX}}$ $V_{SCS}$ $sT_{s13}$ $K_{s3}$ $1+sT_{s14}$ $\overline{V_{\text{SCSMIN}}}$ $\overline{K}_{\underline{S2}}$ $1+sT_{11}$ Input 2 $1+sT_{s10}$ $1+sT_{s12}$

Model supported by PSLF

# **Generator Other Model LCFB1**

# Turbine Load Controller Model LCFB1



Frequency Bias Flag - fbf, set to 1 to enable or 0 to disable Power Controller Flag - pbf, set to 1 to enable or 0 to disable

#### **States**

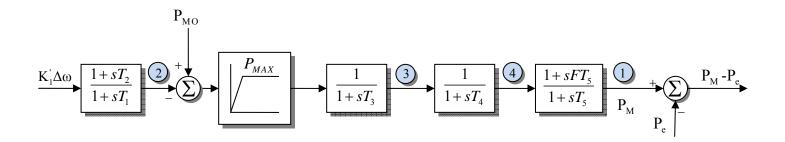
1 - P<sub>elec</sub> Sensed

 $2 - K_{I}$ 

Model supported by PSLF

# **Governor BPA GG**

# Governor BPA GG WSCC Type G Governor Model

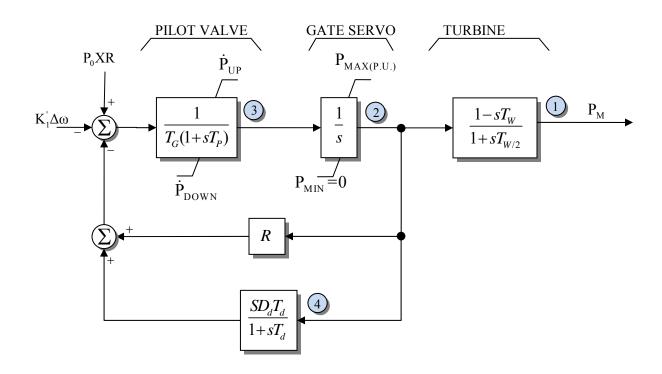


#### States

- $1 P_{mech}$
- 2 Lead-Lag 1
- 3 Integrator 3
- 4 Integrator 4

# **Governor BPA GH**

# Governor BPA GH WSCC Type H Hydro-Mechanical Governor Turbine Model



#### States

- $1 P_{mech}$
- 2 P gate valve
- 3 y3
- 4 Feedback

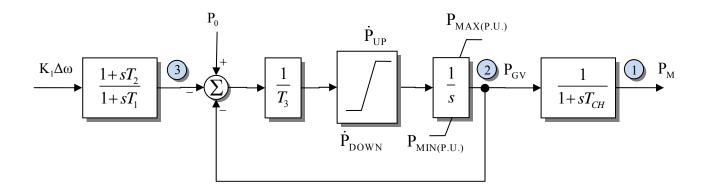
# Governor BPA GIGATB, BPA GJGATB, BPA GKGATB, and BPA GLTB

Governor BPA GIGATB, BPA GJGATB, BPA GKGATB, and BPA GLTB

No block diagrams have been created

# **Governor BPA GSTA**

# Governor BPA GSTA WSCC Type S Steam System Governor And Nonreheat Turbine (Type A) Model

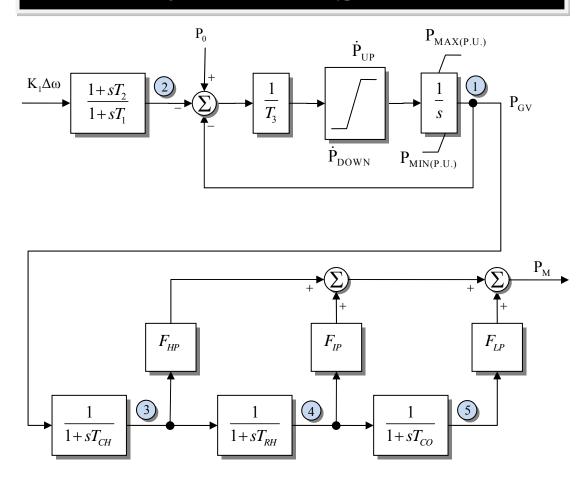


#### **States**

- 1 P<sub>mech</sub>
- 2 P gate valve
- 3 Lead-lag

#### **Governor BPA GSTB**

# Governor BPA GSTB WSCC Type S Steam System Governor and Tandem Compound Single Reheat Turbine (Type B) Model

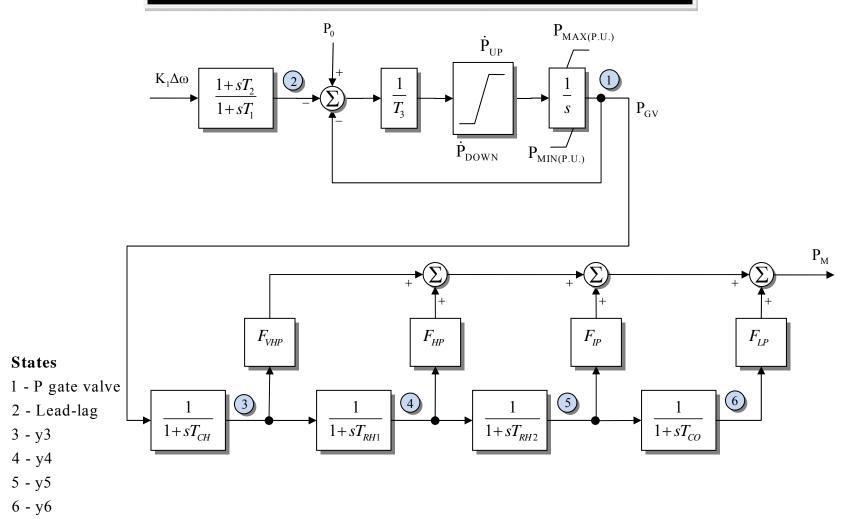


#### States

- 1 P gate valve
- 2 Lead-lag
- 3 y3
- 4 y4
- 5 y5

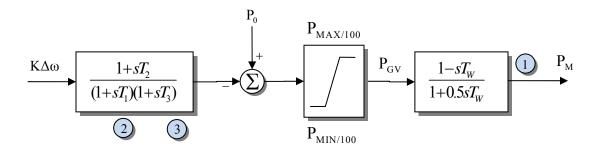
#### **Governor BPA GSTC**

# Governor BPA GSTC WSCC Type S Steam System Governor and Tandem Compound Double Reheat Turbine (Type C) Model



#### **Governor BPA GWTW**

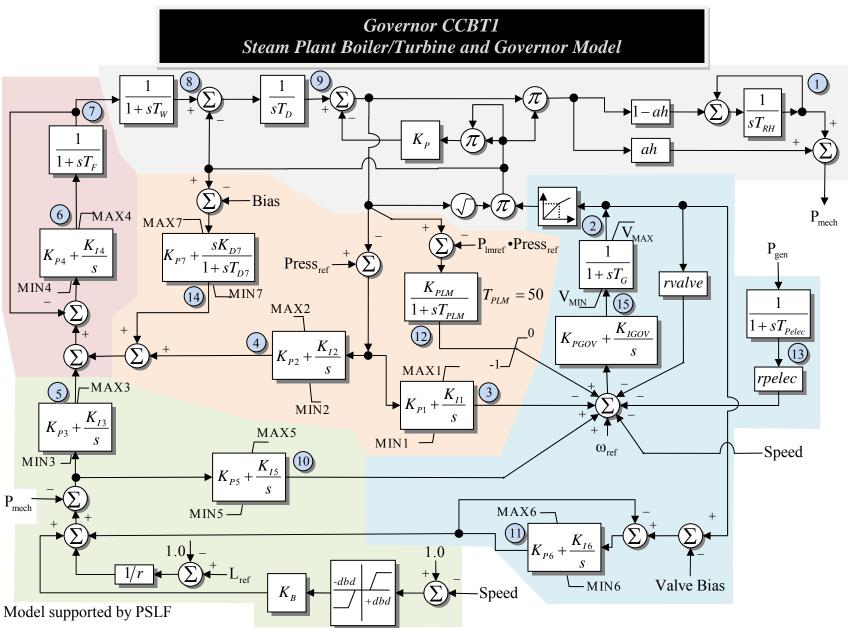
# Governor BPA GWTW WSCC Type W Hydro Governor System And Hydro Turbine (Type W) Model



#### States

- $1 P_{mech}$
- 2 y0
- 3 y1

# **Governor CCBT1**



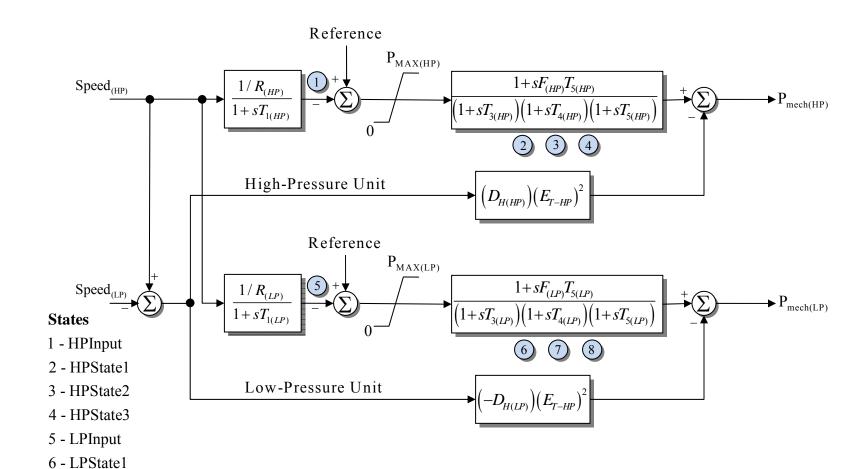
Proportional-integral blocks 1-6 also have rate limits not shown in the block diagram

# **Governor CRCMGV**

7 - LPState28 - LPState3

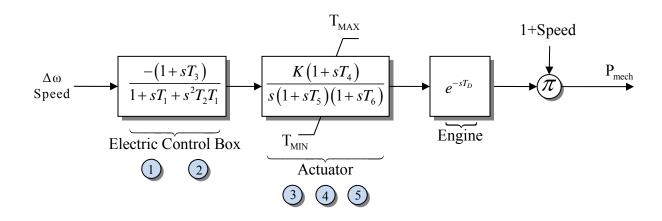
Model supported by PSLF and PSSE

### Governor CRCMGV Cross Compound Turbine-Governor Model



# **Governor DEGOV**

### Governor DEGOV Woodward Diesel Governor Model



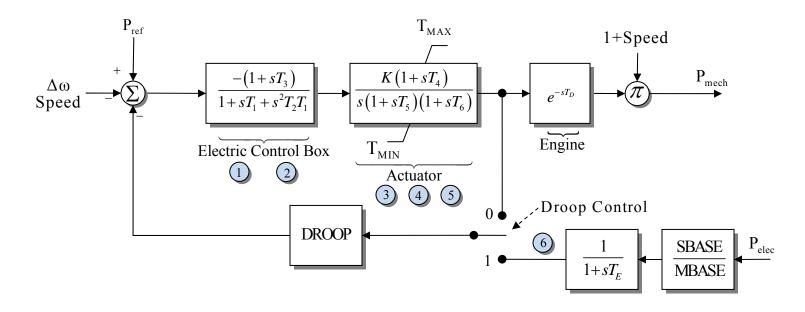
#### States

- 1 Control box 1
- 2 Control box 2
- 3 Actuator 1
- 4 Actuator 2
- 5 Actuator 3

Model supported by PSSE

# **Governor DEGOV1**

### Governor DEGOVI Woodward Diesel Governor Model



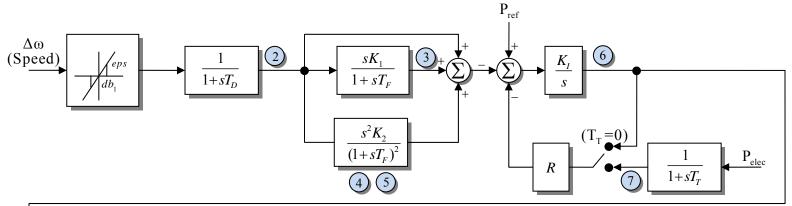
#### States

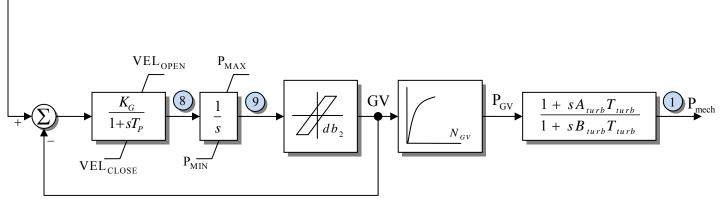
- 1 Control box 1
- 2 Control box 2
- 3 Actuator 1
- 4 Actuator 2
- 5 Actuator 3
- 6 Droop Input

Model supported by PSSE

#### **Governor G2WSCC**

# Governor G2WSCC Double Derivative Hydro Governor and Turbine Represents WECC G2 Governor Plus Turbine Model



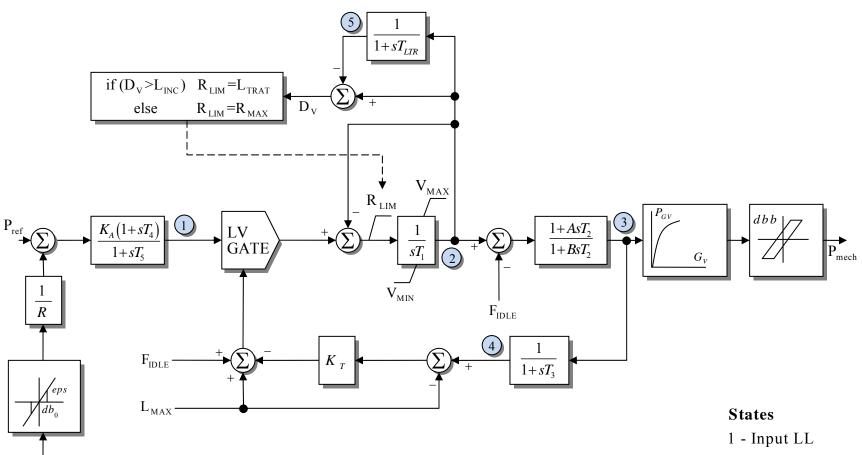


Model supported by PSLF GV1, PGV1...GV6, PGV6 are the x,y coordinates of  $N_{GV}$  block

- 1 P<sub>mech</sub>
- $2 T_D$
- $3 K_1$
- 4 K<sub>2</sub> first
- 5 K<sub>2</sub> second
- 6 Integrator
- 7 P<sub>elec</sub> Sensed
- 8 Valve
- 9 Gate

# **Governor GAST\_GE**

# Governor GAST\_GE Gas Turbine-Governor Model



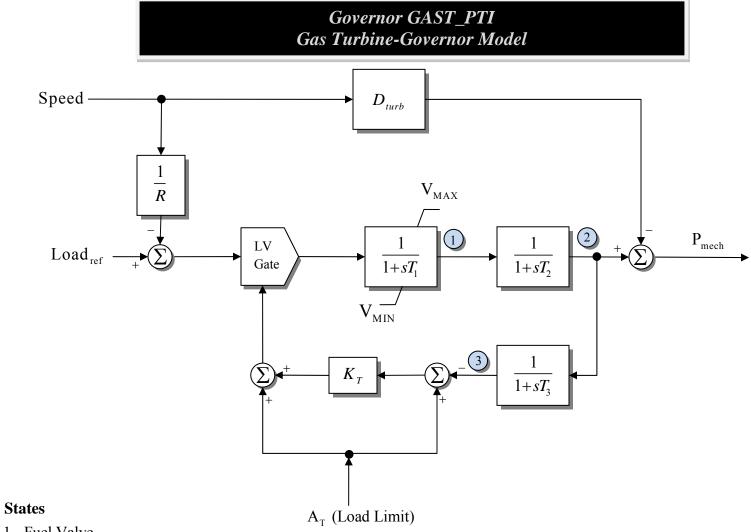
Model supported by PSLF

 $\Delta\omega$  (Speed)

GV1, PGV1...GV6, PGV6 are the x,y coordinates of  $P_{GV}$  vs. GV block

- 2 Integrator
- 3 Governor LL
- 4 Load Limit
- 5 Temperature

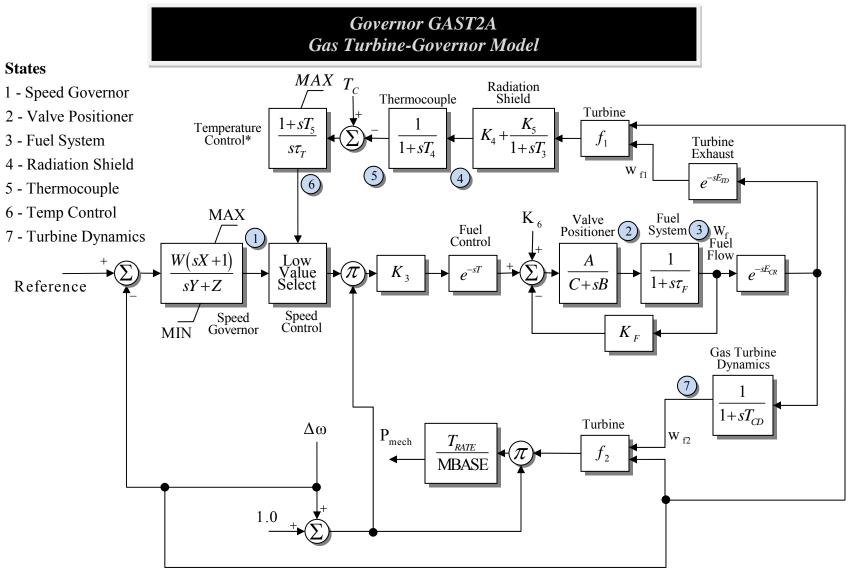
# **Governor GAST\_PTI**



- 1 Fuel Valve
- 2 Fuel Flow
- 3 Exhaust Temperature

Model supported by PSSE

#### **Governor GAST2A**



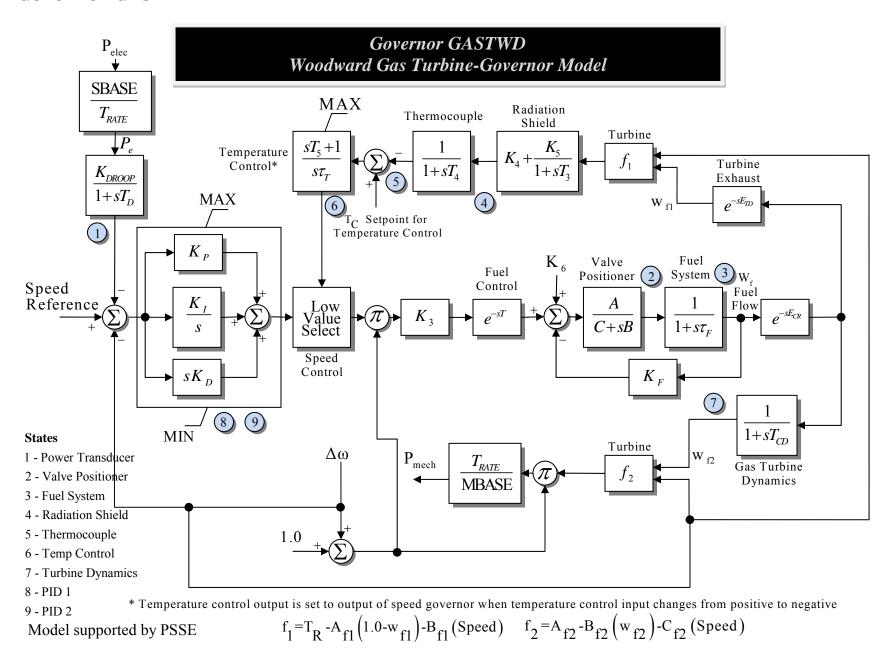
\* Temperature control output is set to output of speed governor when temperature control input changes from positive to negative

Model supported by PSSE

$$f_1 = T_R - A_{f1} \left( 1.0 - w_{f1} \right) - B_{f1} \left( Speed \right)$$
  $f_2 = A_{f2} - B_{f2} \left( w_{f2} \right) - C_{f2} \left( Speed \right)$ 

$$f_2 = A_{f2} - B_{f2} (w_{f2}) - C_{f2} (Speed)$$

#### **Governor GASTWD**



#### **Governor GGOV1**

#### Governor GGOV1 - GE General Governor-Turbine Model If $D_m > 0$ , (Speed) $D_m$ If $D_m < 0$ , $(Speed + 1)^{\frac{1}{2}}$ $L_{\underline{\text{dref}}} / K_{turb}) + w_{fnl}$ $1 + sT_{SA}$ $1+sT_{Fload}$ $1 + sT_{SB}$ $1 + sT_{\rm p}$ aset . Timestep Speed Low $K_{A}\Delta t^{\blacktriangle}$ Value Select $V_{\underline{M}AX}$ $K_{Pgov}$ $\boldsymbol{V}_{\text{max}}$ maxerr $K_{\underline{Igov}}$ $1+sT_{ACT}$ $I_{db}$ $\overline{V}_{\text{min}}$ minerr -Flag $sK_{Dgov}$ $\overline{V_{_{MIN}}}$ $\mathbf{w}_{\mathsf{fnl}}$ $+sT_{Dgoo}$ -1.1r governor output 1.0 (Speed+1) $P_{mwset}$ valve stroke **States** Rselect 5 - Turbine LL 1 - P<sub>elec</sub> Measured $P_{\text{ele\underline{c}}}$ 2 - Governor Differential Control 6 - Turbine Load Limiter $1 + sT_{Pelec}$ 3 - Governor Integral Control 7 - Turbine Load Integral Control Model supported by PSLF 4 - Turbine Actuator 8 - Supervisory Load Control Model supported by PSSE does not include non-windup limits on $K_{\rm IMW}$ block 9 - Accel Control $R_{\text{UP}}$ , $R_{\text{DOWN}}$ , $R_{\text{CLOSE}}$ , and $R_{\text{OPEN}}$ inputs not implemented in Simulator 10 - Temp Detection LL

# **Governor GGOV2**

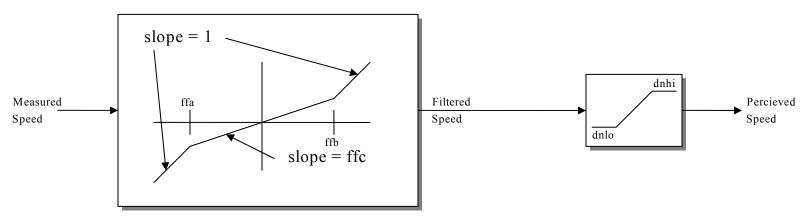
#### Governor GGOV2 - GE General Governor-Turbine Model If $D_m > 0$ , (Speed) If $D_m < 0$ , $(S_{\underline{peed+1}})^{\frac{1}{2}}$ $L_{\underline{\text{dref}}} / K_{turb}) + w_{fnl}$ $P_{\text{MECH}}$ $1+sT_{sa}$ $1+sT_{fload}$ $1+sT_{sb}$ $1 \stackrel{\frown}{K_{pload}}$ *s*9 *s*5 $1+sT_c$ Speed 23456 1.0 $1+sT_b$ $K_{iload}$ fsrt aset Frequency-dependent limit ·Timestep Speed fsra $\overline{1+sT_a}$ Lowropen $K_{\underline{pgov}}$ vmaxValue $\boldsymbol{V}_{\text{max}}$ maxerr Selectfsrn $I_{db}$ $1+sT_{act}$ minerr $\overline{V}_{MIN}$ -Flag $sK_{dgov}$ vmin $\mathbf{w}_{\mathrm{fnl}}$ rclose $1+sT_{dgov}$ *s*1 governor output 1.0 (Speed+1) -1.Tr valve stroke `Rselect $P_{\text{ELEC}}$ $\overline{1+sT}_{Pelec}$ s0

Model supported by PSLF

#### **Governor GGOV3**

#### Governor GGOV3 - GE General Governor-Turbine Model If $D_m > 0$ , (Speed) $P_{\text{MECH}}$ If $D_m < 0$ , $(S\underline{peed+1})^{**D_m}$ $L_{\underline{\text{dref}}} / K_{turb}) + w_{fnl}$ $1+sT_{so}$ $1+sT_{fload}$ $1+sT_{sb}$ $1+sT_c$ $1+sT_b$ $K_{pload}$ 1.0 aset Timestep Percieved Speed Low $V_{\text{MAX}}$ $K_{\underline{pgov}}$ Value $V_{\underline{\mathtt{MA}}_X}$ $1+sT_{bd}$ Maxerr Select $1+sT_{act}$ Minerr $\overline{V}_{\text{min}}$ -Flag $sK_{dgov}$ $\overline{1+s}T_{dgov}$ governor output 1.0 (Speed+1) valve stroke **States** Rselect 1 - P<sub>elec</sub> Measured 5 - Turbine LL 9 - Accel Control $P_{\text{ELEC}}$ 2 - Governor Differential Control 6 - Turbine Load Limiter 10 - Temp Detection LL $\overline{1+s}T_{Pelec}$ 7 - Turbine Load Integral Control 11 - Fuel System Lead Lag 3 - Governor Integral Control 4 - Turbine Actuator 8 - Supervisory Load Control Model supported by PSLF dnrate, $R_{\text{UP}},\,R_{\text{DOWN}},\,R_{\text{CLOSE}},$ and $R_{\text{OPEN}}$ inputs not implemented in Simulator

# Governor GGOV3 - GE General Governor-Turbine Model

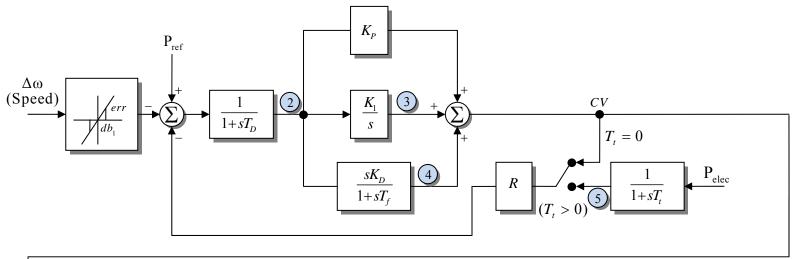


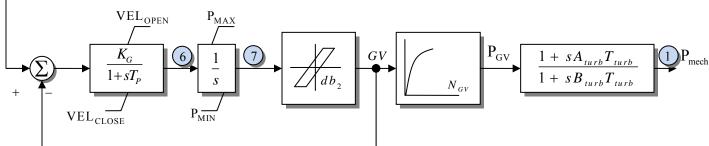
**Nonlinear Speed Filter** 

Model supported by PSLF Rate limit dnrate not used in Simulator

# **Governor GPWSCC**

# Governor GPWSCC PID Governor-Turbine Model





Model supported by PSLF GV1, PGV1...GV6, PGV6 are the x,y coordinates of  $N_{GV}$  block

#### **States**

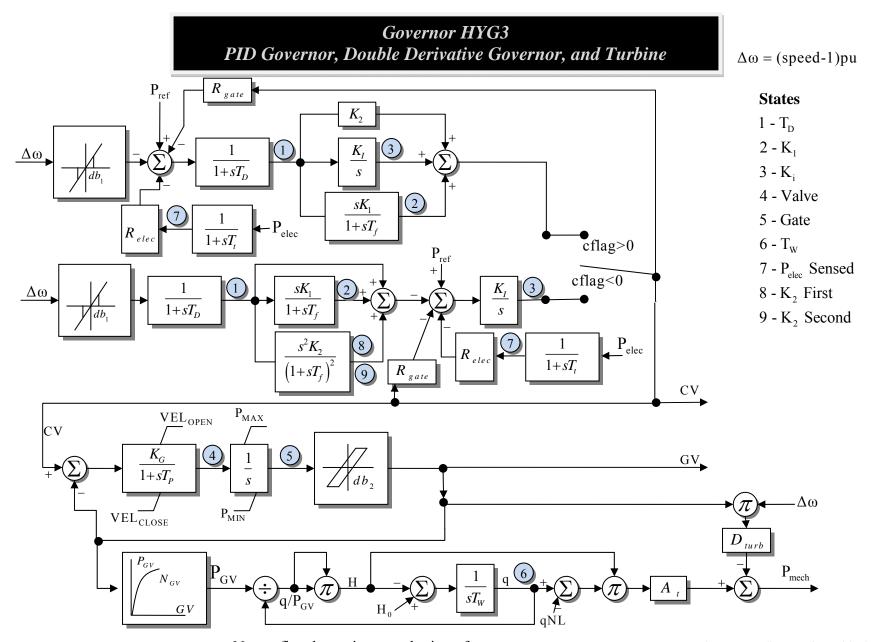
1 - P<sub>mech</sub> 5 - P<sub>elec</sub> Sensed

 $2 - T_D$  6 - Valve

3 - Integrator 7 - Gate

4 - Derivative

#### **Governor HYG3**



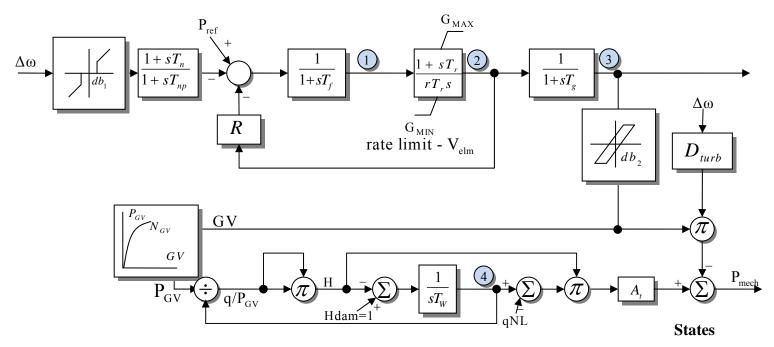
Model supported by PSLF

Note: cflag determines numbering of states

GV1, PGV1...GV6, PGV6 are the x,y coordinates of  $N_{GV}$  block

#### **Governor HYGOV**

# Governor HYGOV Hydro Turbine-Governor Model



- 1 Filter Output
- 2 Desired Gate
- 3 Gate
- 4 Turbine Flow

Model supported by PSSE and PSLF

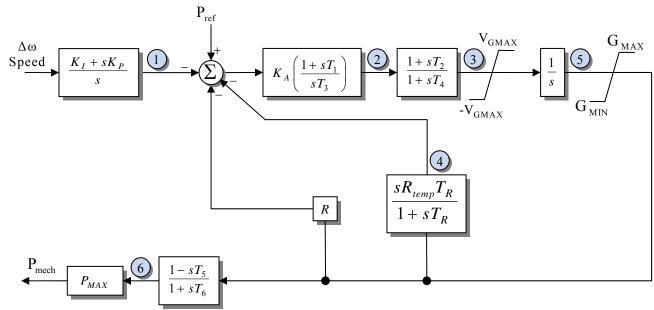
Rperm shown as R, Rtemp shown as r

GV0, PGV0...GV5, PGV5 are the x,y coordinates of  $N_{GV}$  block

Ttur, Tn, Tnp, db1, Eps, db2, Bgv0...Bgv5, Bmax, Tblade not implemented in Simulator

# **Governor HYGOV2**

# Governor HYGOV2 Hydro Turbine-Governor Model



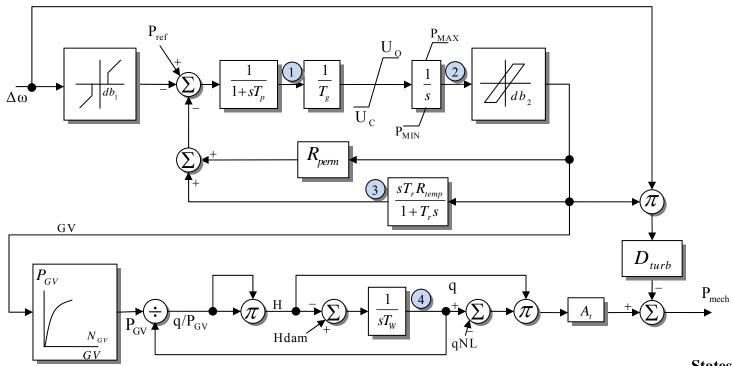
#### **States**

- 1 Filter Output
- 2 Governor
- 3 Governor Speed
- 4 Droop
- 5 Gate
- 6 Penstock

The  $G_{\mbox{\scriptsize MAX}}$   $G_{\mbox{\scriptsize MIN}}$  limit is modeled as non-windup in PSSE but as a windup limit in Simulator. Model supported by PSSE

#### **Governor HYGOV4**

# Governor HYGOV4 Hydro Turbine-Governor Model

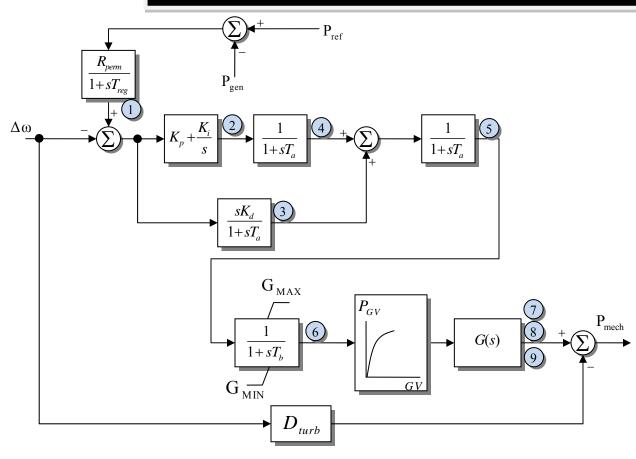


- 1 Velocity
- 2 Gate
- 3 Rtemp
- 4 T<sub>w</sub>

Bgv0...Bgv5, Bmax, Tblade not implemented in Simulator GV0, PGV0...GV5, PGV5 are the x,y coordinates of  $N_{GV}$  block Model supported by PSLF

#### **Governor HYST1**

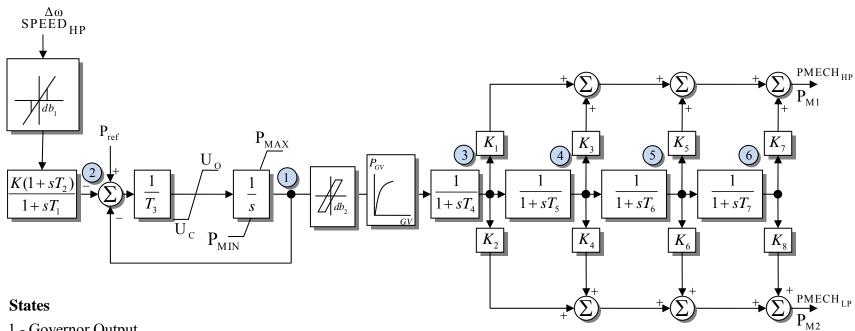
Governor HYST1
Hydro Turbine with Woodward Electro-Hydraulic PID Governor,
Surge Tank, and Inlet Tunnel



Not yet implemented in Simulator Model supported by PSLF

#### **Governor IEEEG1**

## Governor IEEEG1 IEEE Type 1 Speed-Governor Model

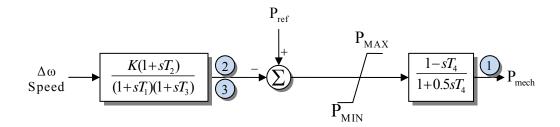


- 1 Governor Output
- 2 Lead-Lag
- 3 Turbine Bowl
- 4 Reheater
- 5 Crossover
- 6 Double Reheat

Model supported by PSLF includes hysteresis that is read but not implemented in Simulator Model supported by PSSE does not include hysteresis and nonlinear gain GV1, PGV1...GV6, PGV6 are the x,y coordinates of  $P_{GV}$  vs. GV block

# **Governor IEEEG2**

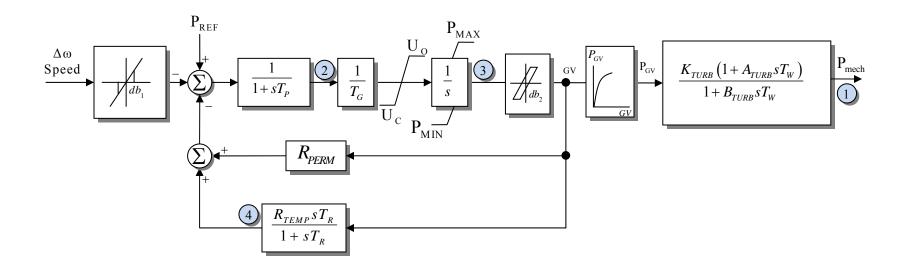
# Governor IEEEG2 IEEE Type 2 Speed-Governor Model



- $1 P_{mech}$
- 2 First Integrator
- 3 Second Integrator

# **Governor IEEEG3\_GE**

# Governor IEEEG3\_GE IEEE Type 3 Speed-Governor Model IEEEG3

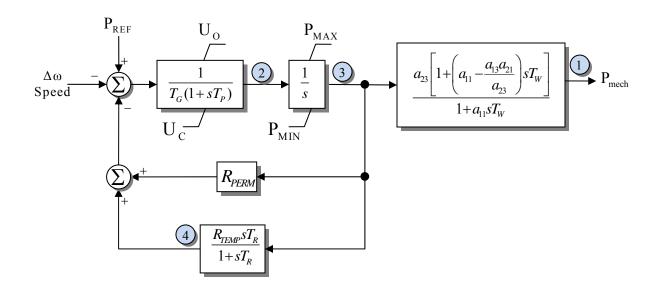


# PSLF model includes db1, db2, and Eps read but not implemented in Simulator Model supported by PSLF

- 1 P<sub>mech</sub>
- 2 Servomotor position
- 3 Gate position
- 4 Transient droop

# **Governor IEEEG3\_PTI**

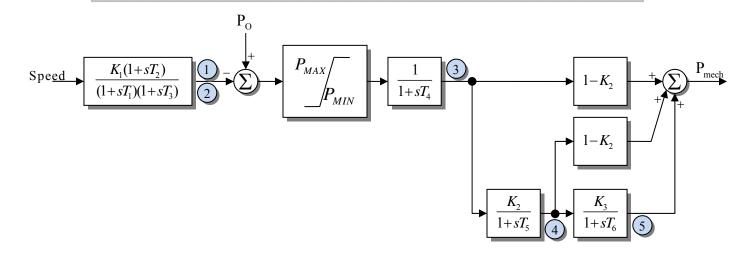
# Governor\_IEEEG3\_PTI IEEE Type 3 Speed-Governor Model IEEEG3



- $1 P_{mech}$
- 2 Servomotor position
- 3 Gate position
- 4 Transient droop

# **Governor IEESGO**

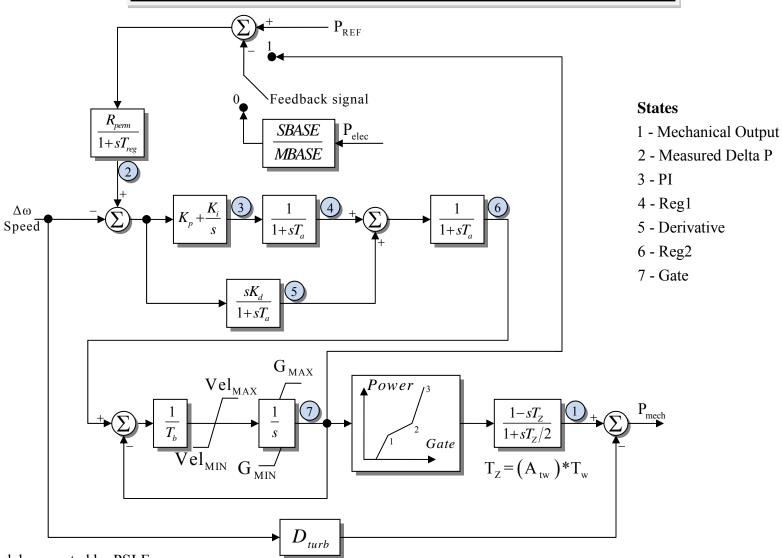
### Governor IEESGO IEEE Standard Model IEEESGO



- 1 First Integrator
- 2 Second Integrator
- 3 Turbine T4
- 4 Turbine T5
- 5 Turbine T6

## **Governor PIDGOV**

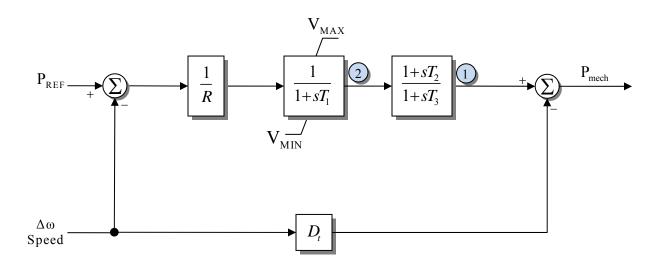
# Governor PIDGOV - Hydro Turbine and Governor Model PIDGOV



Model supported by PSLF Model supported by PSSE

(G0,0), (G1,P1), (G2,P2), (1,P3) are x,y coordinates of Power vs. Gate function

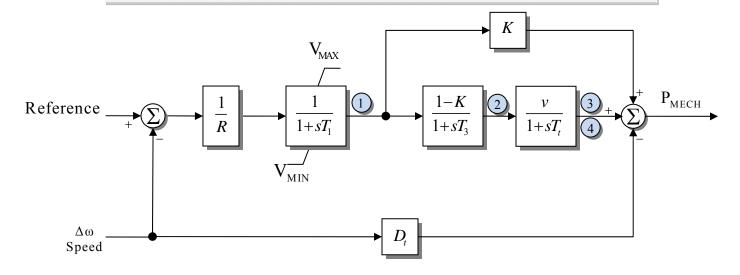
## Governor TGOV1 Steam Turbine-Governor Model TGOV1



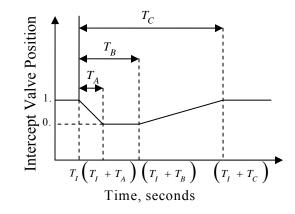
#### **States**

- 1 Turbine Power
- 2 Valve Position

# Governor TGOV2 Steam Turbine-Governor with Fast Valving Model TGOV2



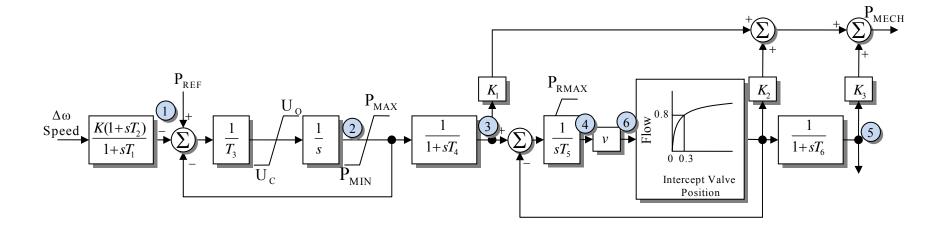
- T<sub>1</sub>: Time to initiate fast valving.
- $T_A$ : Intercept valve,  $\nu$ , fully closed  $T_A$  seconds after fast valving initiation.
- T<sub>B</sub>: Intercept valve starts to reopen T<sub>B</sub> seconds after fast valving initiation.
- $T_{\rm C}$ : Intercept valve again fully open  $T_{\rm C}$  seconds after fast valving initiation.



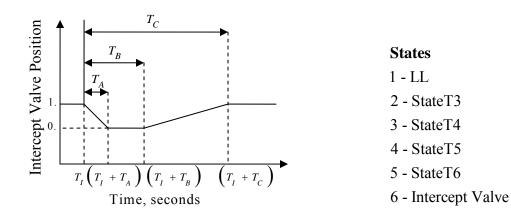
#### **States**

- 1 Throttle
- 2 Reheat Pressure
- 3 Reheat Power
- 4 Intercept Valve

# Governor TGOV3 Modified IEEE Type 1 Speed-Governor with Fast Valving Model

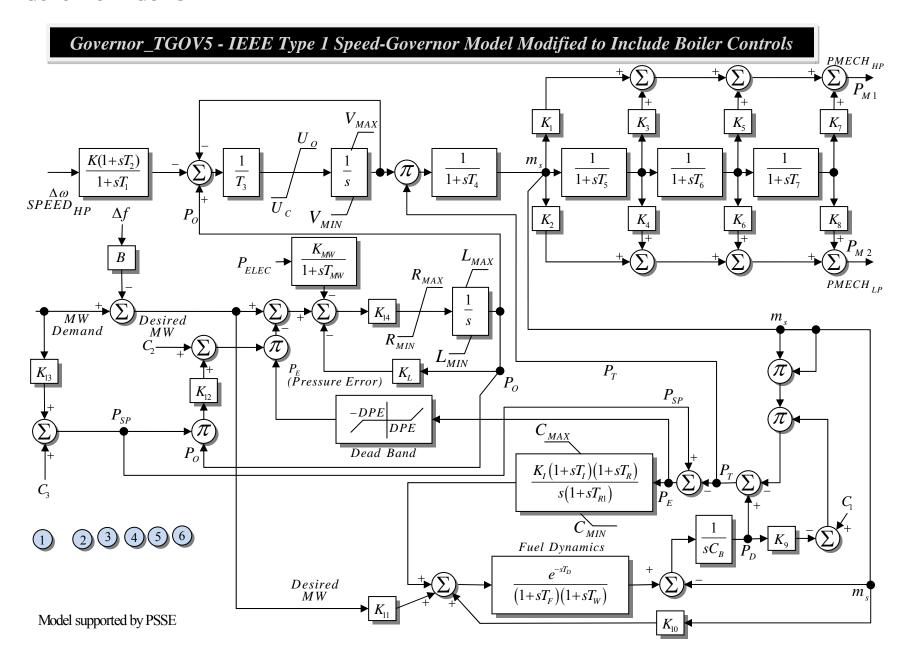


- $T_{I}$ : Time to initiate fast valving.
- $T_A$ : Intercept valve,  $\nu$ , fully closed  $T_A$  seconds after fast valving initiation.
- T<sub>B</sub>: Intercept valve starts to reopen T<sub>B</sub> seconds after fast valving initiation.
- $T_C$ : Intercept valve again fully open  $T_C$  seconds after fast valving initiation.



Model supported by PSLF Model supported by PSSE

Gv1,Pgv1 ... Gv6, Pgv6 are x,y coordinates of Flow vs. Intercept Valve Position function



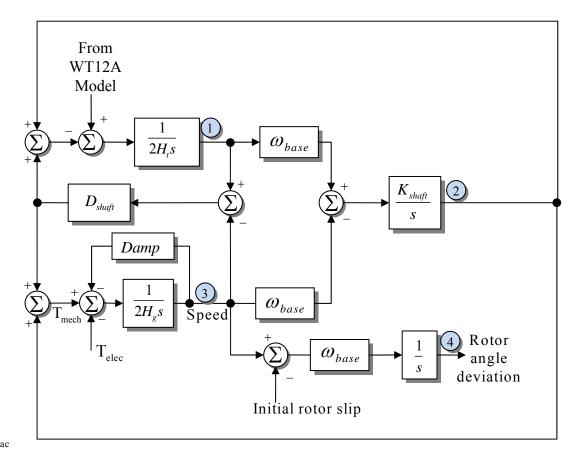
## **Governor URGS3T**

## Governor URGS3T WECC Gas Turbine Model States (5) $\overline{1 + sT_{LTR}}$ 1 - Input LL 2 - Integrator If $(D_V > L_{INC})$ , then $R_{LIM} = L_{TRAT}$ else, $R_{LIM} = R_{MAX}$ 3 - Governor LL 4 - Load Limit 5 - Temperature $V_{\underline{M}\underline{A}\underline{X}}$ -►R<sub>LIM</sub> $K_a(1+sT_4)$ $1 + AsT_2$ LV $\frac{1}{sT_1}$ **GATE** $1 + BsT_2$ $F_{\text{IDLE}}$ $V_{MIN}$ $F_{\text{IDLE}}$ $\frac{1}{R}$ $\overline{1+sT_3}$ $L_{\text{MAX}} \cdot$ Speed $D_{ ext{turb}}$

Model supported by PSSE GV1, PGV1...GV5, PGV5 are the x,y coordinates of  $P_{GV}$  vs. GV block

## **Governor WT12T1**

# Governor WT12T1 Two-Mass Turbine Model for Type 1 and Type 2 Wind Generators



 $H_t = H \times H_{tfrac}$  $H_g = H - H_t$ 

$$K_{shaft} = \frac{2H_t \times H_g \times (2\pi \times Freq1)^2}{H \times \omega_0}$$

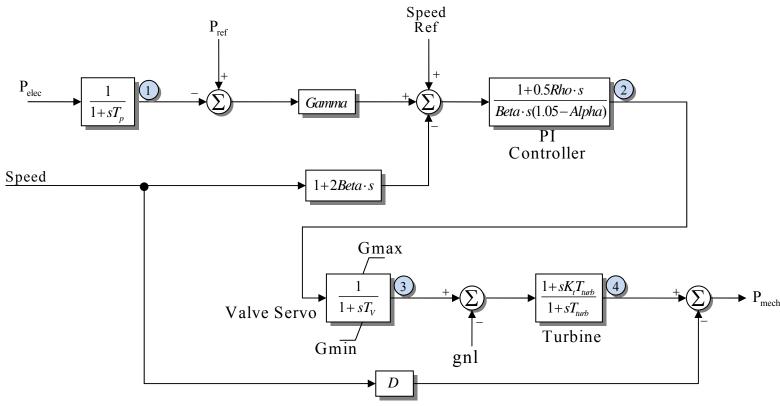
Model supported by PSSE

#### States

- 1 TurbineSpeed
- 2 ShaftAngle
- 3 GenSpeed
- 4 GenDeltaAngle

## **Governor W2301**

## Governor W2301 Woodward 2301 Governor and Basic Turbine Model



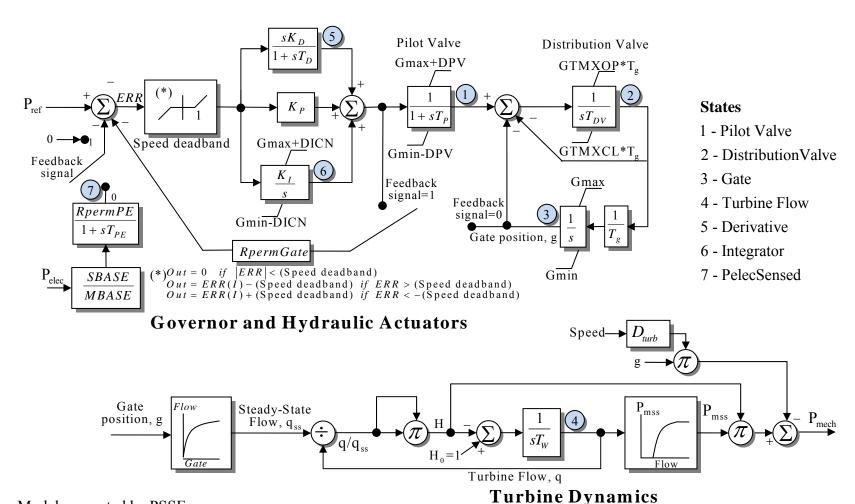
#### **States**

- 1 PelecSensed
- 2 PI
- 3 Valve
- 4 Turbine

Gain, Velamx read but not implemented in Simulator. Model supported by PSLF

#### **Governor WEHGOV**

## Governor WEHGOV Woodward Electric Hydro Governor Model

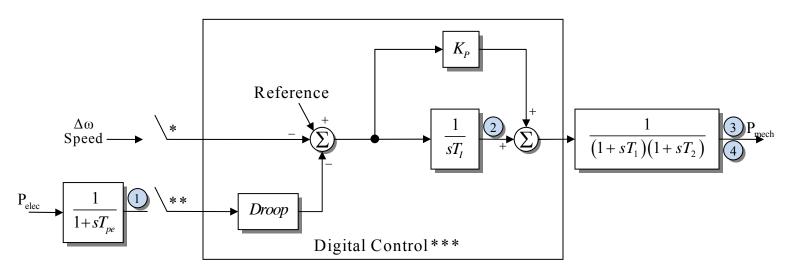


Model supported by PSSE

(Gate 1, Flow G1)...(Gate 5, Flow G5) are x,y coordinates of Flow vs. Gate function (Flow P1, PMECH 1)...(Flow P10, PMECH 10) are x,y coordinates of Pmss vs. Flow function

### **Governor WESGOV**

## Governor WESGOV Westinghouse Digital Governor for Gas Turbine Model



- \*Sample hold with sample period defined by Delta TC.

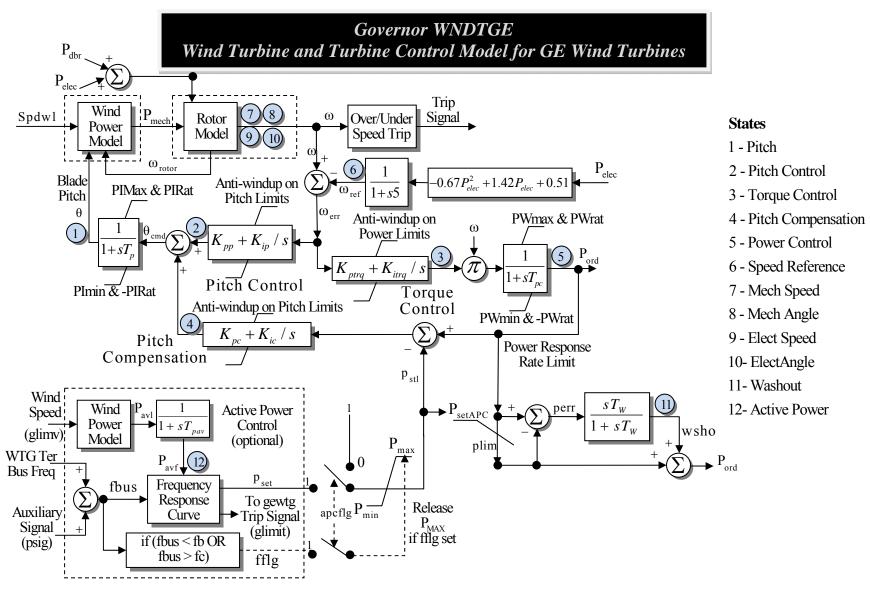
  \*\*Sample hold with sample period defined by Delta TP.

  \*\*Maximum change is limited to A<sub>lim</sub> between sampling times.

#### **States**

- 1 PEMeas
- 2 Control
- 3 Valve
- 4 PMech

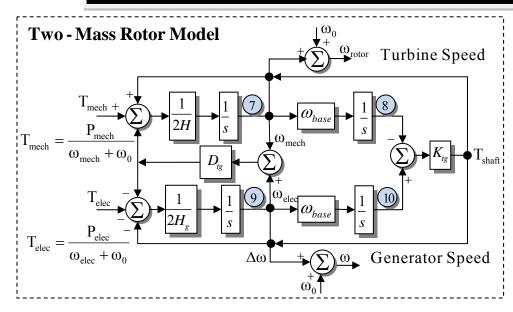
#### **Governor WNDTGE**



Model supported by PSLF

Apcflg is set to zero. Limits on states 2 and 3 and trip signal are not implemented. Simulator calculates initial windspeed Spdwl.

# Governor WNDTGE Wind Turbine and Turbine Control Model for GE Wind Turbines



# **Wind Power Model**

$$P_{\text{mech}} = \frac{\rho}{2} A_{\nu} v_{w}^{3} C_{p} (\lambda, \theta)$$

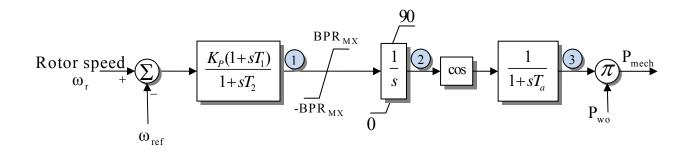
$$\lambda = K_b(\omega/v_w)$$

$$C_p(\lambda, \theta) = \sum_{i=0}^{4} \sum_{j=0}^{4} \alpha_{ij} \theta^j \lambda^j$$

See charts for curve fit values

# **Governor WNDTRB**

# Governor WNDTRB Wind Turbine Control Model

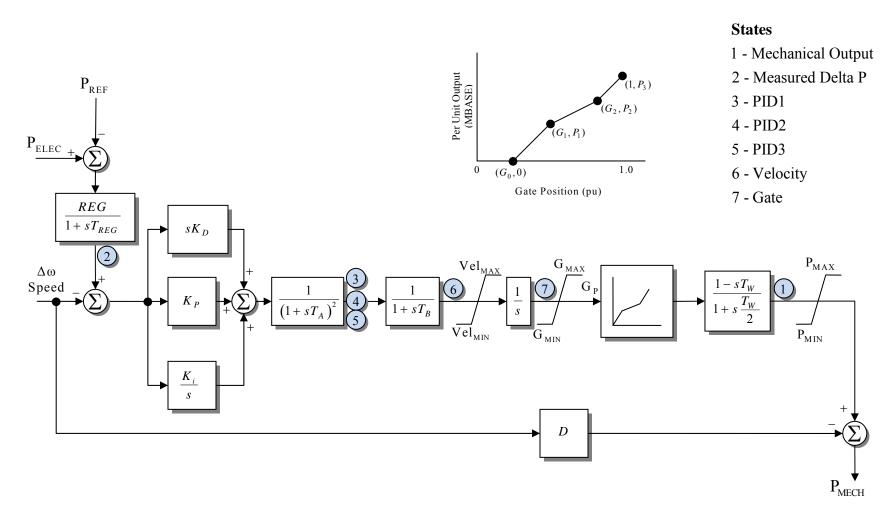


### **States**

- 1 Input
- 2 Blade Angle (Deg)
- 3 Blade Pitch Factor

## **Governor WPIDHY**

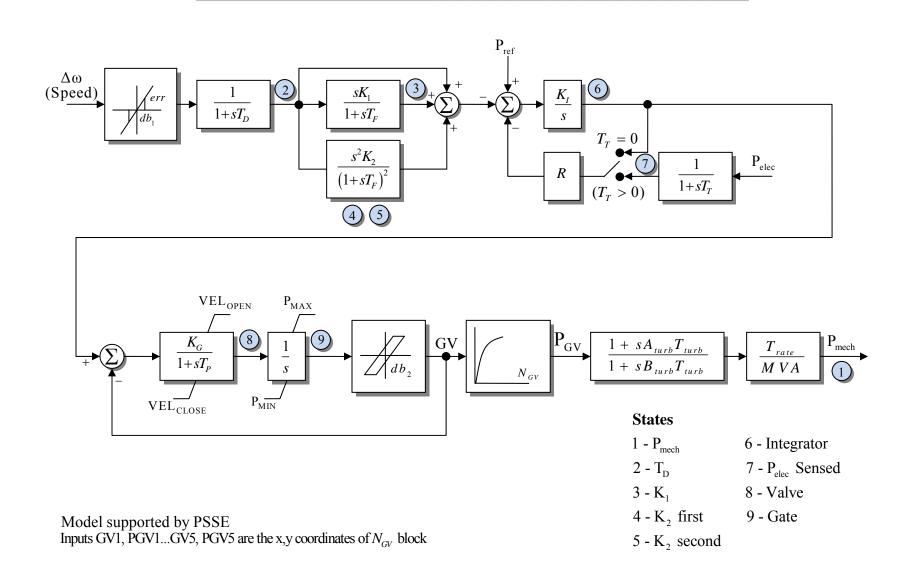
# Governor WPIDHY Woodward PID Hydro Governor Model



Model supported by PSSE

## **Governor WSHYDD**

## Governor WSHYDD WECC Double-Derivative Hydro Governor Model



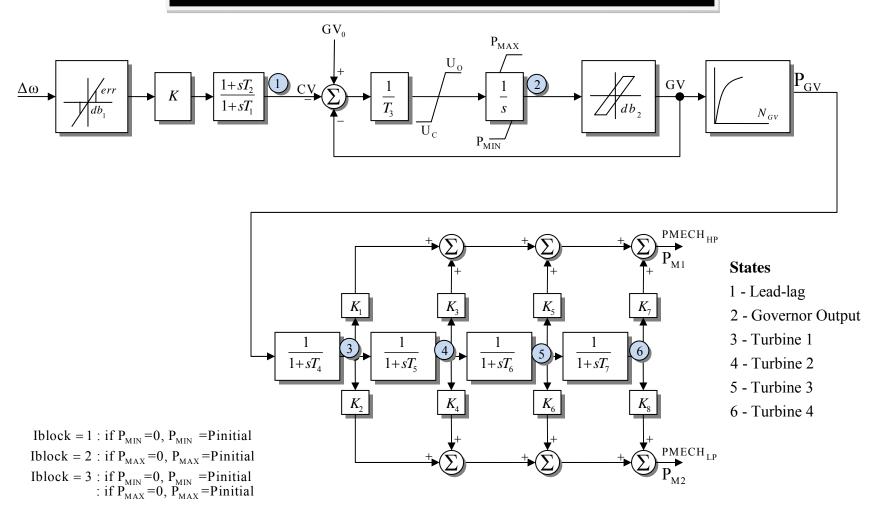
## **Governor WSHYGP**

### Governor WSHYGP WECC GP Hydro Governor Plus Model $K_{P}$ $P_{\text{ref}}$ $\Delta \omega$ |2|CV(Speed) $\overline{1+sT_D}$ $T_t = 0$ $P_{\underline{elec}}$ $sK_D$ $\left(4\right)$ $(T_t > 0)$ $1+sT_f$ $1+sT_t$ $\mathrm{VEL}_{\mathrm{OPEN}}$ $\underline{P_{MA}}_X$ $\frac{1 + sA_{turb}T_{turb}}{1 + sB_{turb}T_{turb}}$ P<sub>mech</sub> $T_{rate}$ MVA $P_{MIN}$ $\mathrm{VEL}_{\mathrm{CLOSE}}$ **States** 5 - P<sub>elec</sub> Sensed $1 - P_{\text{mech}}$ $2 - T_D$ 6 - Valve 3 - Integrator 7 - Gate Model supported by PSSE 4 - Derivative

GV1, PGV1...GV5, PGV5 are the x,y coordinates of  $N_{GV}$  block

## **Governor WSIEG1**

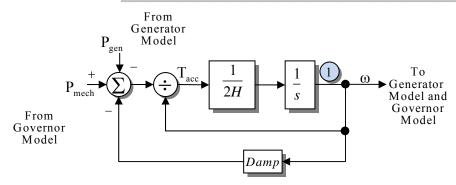
# Governor WSIEG1 WECC Modified IEEE Type 1 Speed-Governor Model



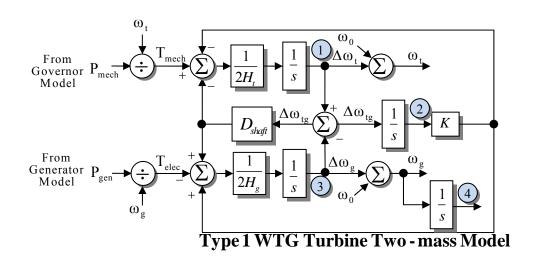
GV1, PGV1...GV5, PGV5 are the x,y coordinates of  $N_{GV}$  block Model supported by PSSE

## **Governor WT1T**

# Governor WT1T Wind Turbine Model for Type-1 Wind Turbines



Type 1 WTG Turbine One - mass Model



#### States

- 1 TurbineSpeed
- 2 ShaftAngle
- 3 GenSpeed
- 4 GenDeltaAngle

$$H_{t} = H \times H_{tfrac}$$

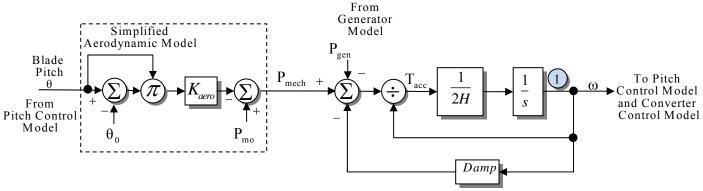
$$H_{g} = H - H_{t}$$

$$K = \frac{2H_{t} \times H_{g} \times (2\pi \times Freq1)^{2}}{H}$$

Model supported by PSLF

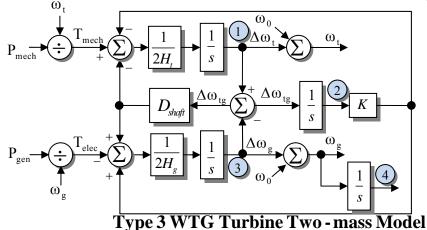
# **Governor WT3T**

# Governor WT3T Wind Turbine Model for Type-3 (Doubly-fed) Wind Turbines



Type 3 WTG Turbine One - mass Model

When windspeed > rated windspeed, blade pitch initialized to  $\theta = \frac{Theta2}{0.75} \left( 1 - \frac{1}{V_W^2} \right)$ 



#### States

- 1 TurbineSpeed
- 2 ShaftAngle
- 3 GenSpeed
- 4 GenDeltaAngle

$$H_{t} = H \times H_{tfrac}$$

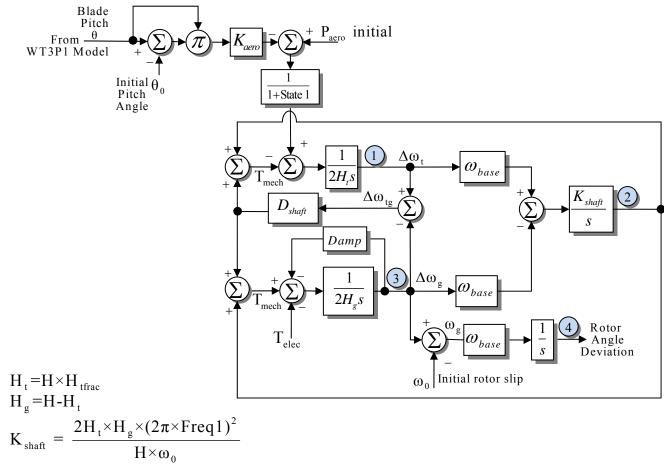
$$H_{g} = H - H_{t}$$

$$K = \frac{2H_{t} \times H_{g} \times (2\pi \times Freq1)^{2}}{H}$$

Model supported by PSLF

# **Governor WT3T1**

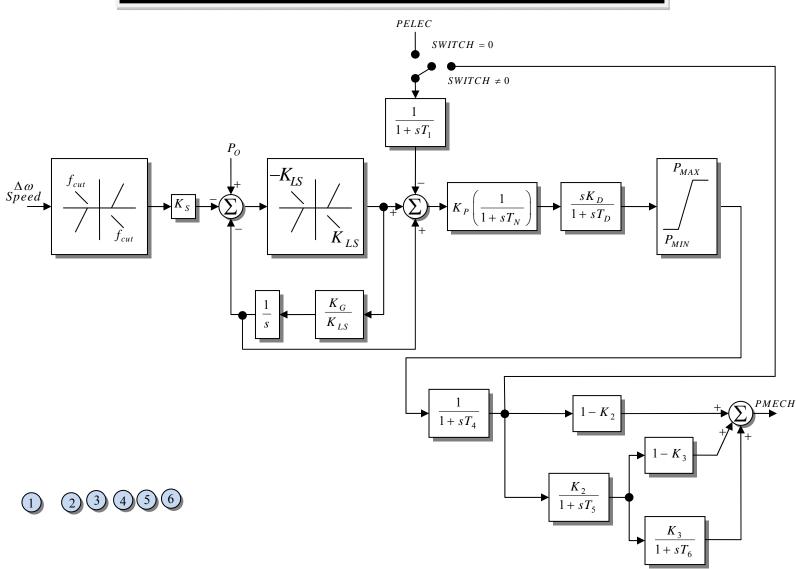
# Governor WT3T1 Mechanical System Model for Type 3 Wind Generator



Model supported by PSSE

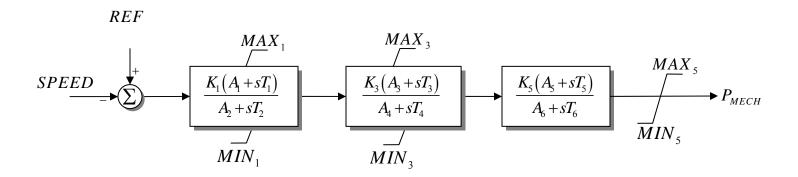
# **Governor BBGOV1**

# European Governor Model BBGOV1



# **Governor IVOGO**

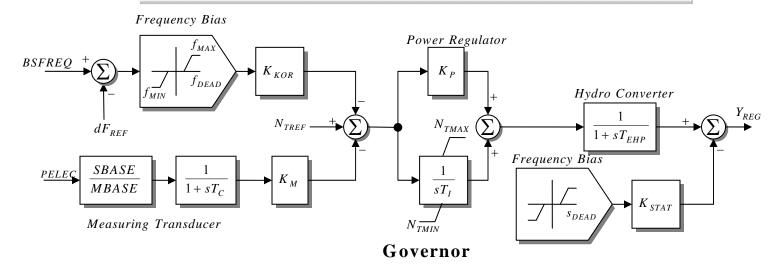
# IVO Governor Model IVOGO

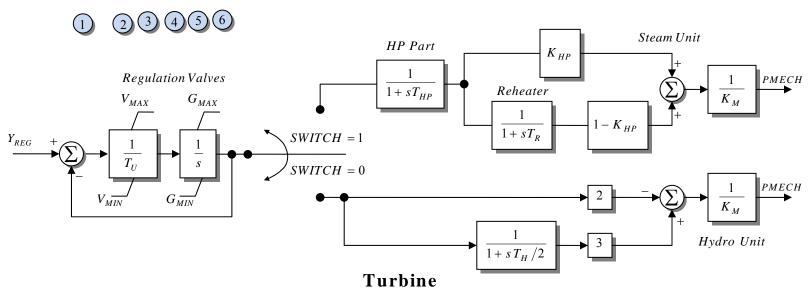




## **Governor TURCZT**

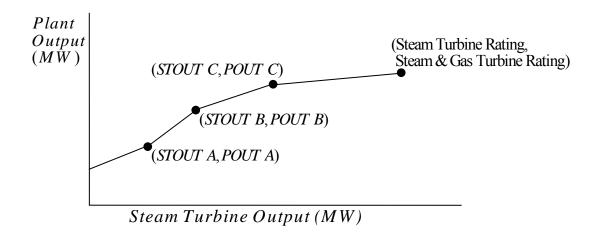
# Czech Hydro and Steam Governor Model TURCZT





# **Governor URCSCT**

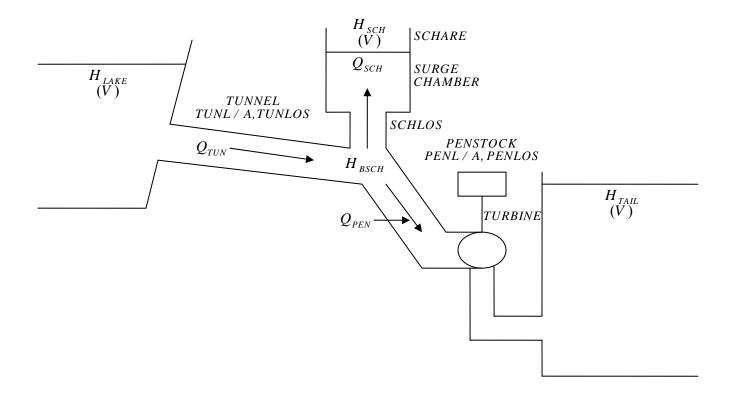
# Combined Cycle on Single Shaft Model URCSCT





# **Governor HYGOVM**

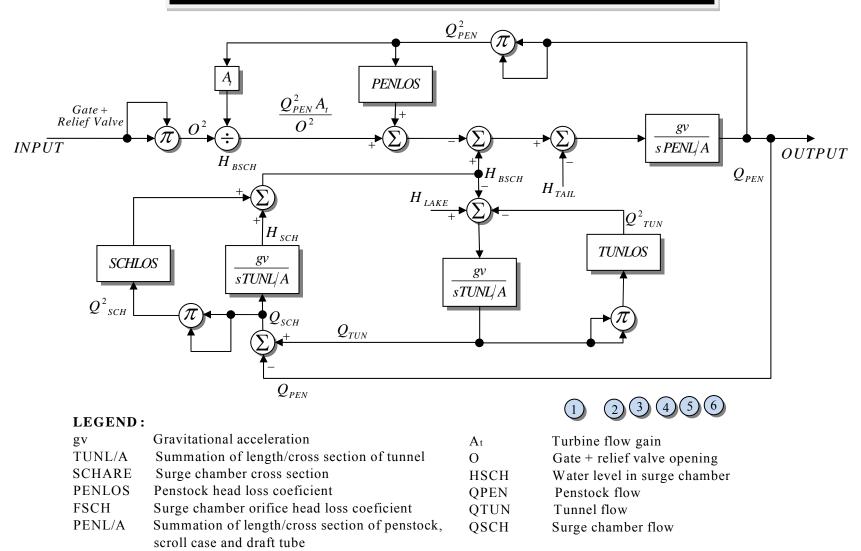
# Hydro Turbine-Governor Lumped Parameter Model HYGOVM



Hydro Turbine Governor Lumped Parameter Model

### **Governor HYGOVM**

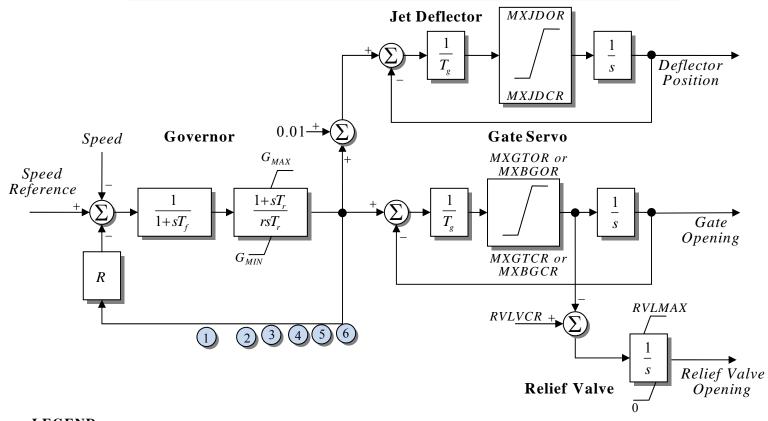
## Hydro Turbine-Governor Lumped Parameter Model HYGOVM



Hydro Turbine Governor Lumped Parameter Model

## **Governor HYGOVM**

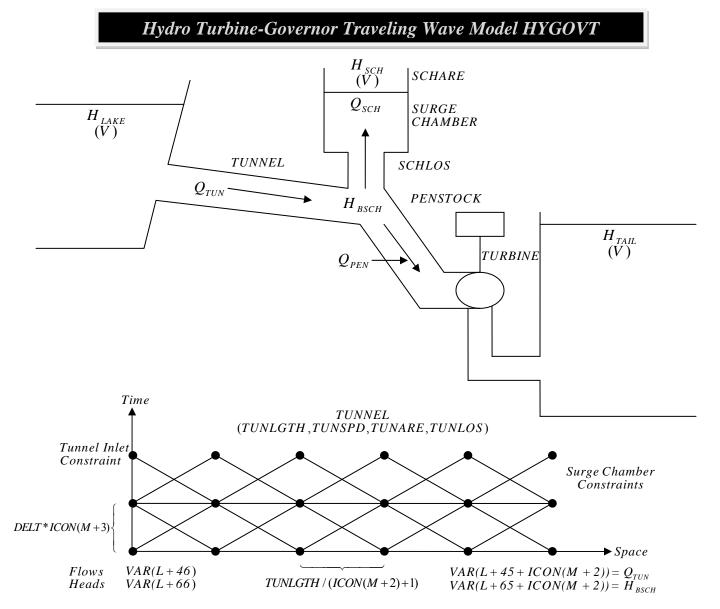
# Hydro Turbine-Governor Lumped Parameter Model HYGOVM



#### **LEGEND:**

R	Permanent droop	MXBGCR	Maximum buffered gate closing opening
r	Temporary droop	GMAX	Maximum gate limit
$T_r$	Governor time constant	GMIN	Minimum gate limit
$T_{\rm f}$	Filter time constant	RVLVCR	Relief valve closing rate
$T_{g}$	Servo time constant	RVLMAX	Maximum relief valve limit
MXGTOR	Maximum gate opening rate	MXJDOR	Maximum jet deflector opening rate
MXGTCR	Maximum gate closing rate	MXJDCR	Maximum jet deflector closing rate
MXBGOR	Maximum buffered gate opening rate		

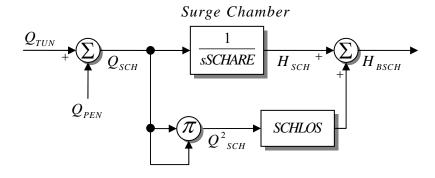
## **Governor HYGOVT**

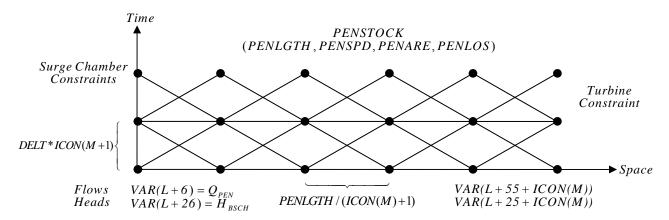


Hydro Turbine Governor Traveling Wave Model

## **Governor HYGOVT**

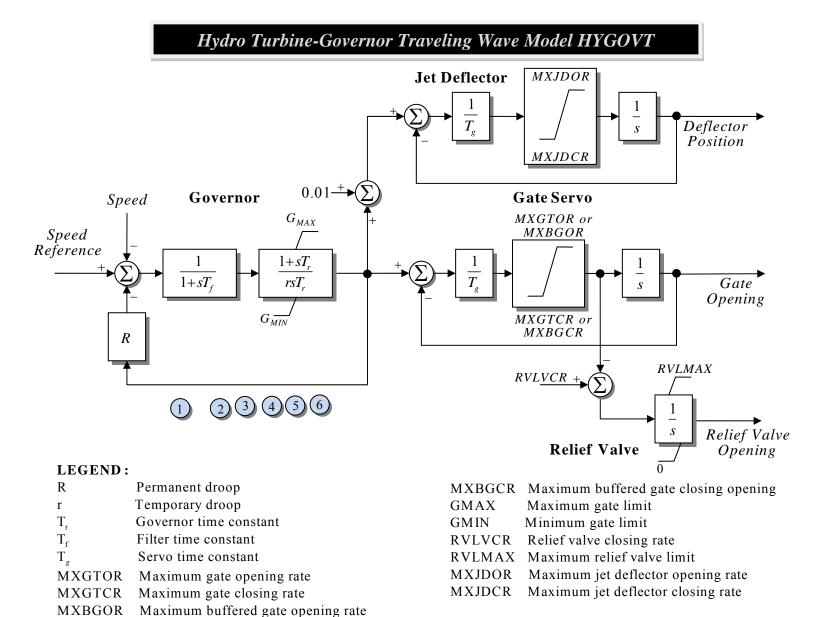
# Hydro Turbine-Governor Traveling Wave Model HYGOVT





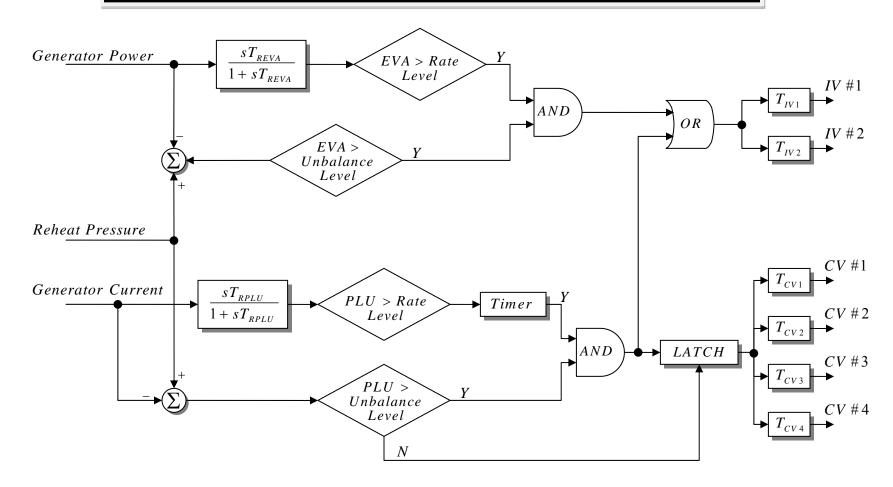
Hydro Turbine Governor Traveling Wave Model

### **Governor HYGOVT**



Hydro Turbine Governor Traveling Wave Model

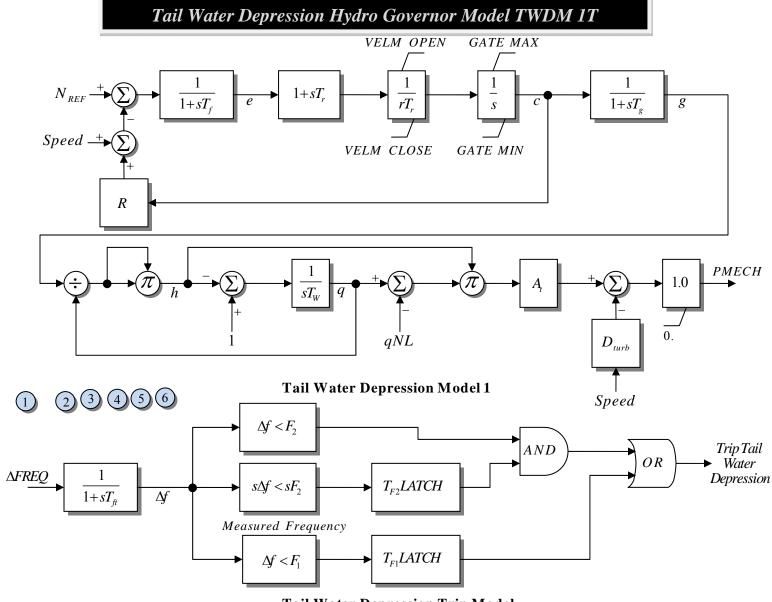
# Modified IEEE Type 1 Speed-Governor Model with PLU and EVA Model TGOV4





PLU and EVA Logic Diagram

## **Governor TWDM1T**



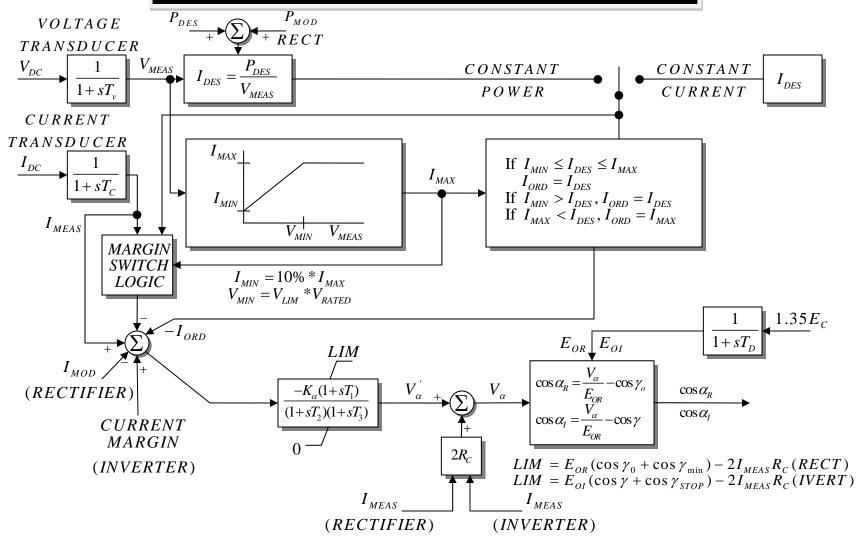
**Tail Water Depression Trip Model** 

## **Governor TWDM2T**

#### Tail Water Depression Hydro Governor Model TWDM 2T $G_{ATMX}$ $V_{\scriptscriptstyle ELMX}$ TWD Lock MAX $\Delta\omega$ SPEED\_ **LOGIC** $(1+sT_A)^2$ $1+sT_R$ TwoReg $V_{ELMN}$ TWD Lock MIN Trip $\overline{1+sT}_{REG}$ $K_{P}$ $P_{REF}$ $sK_D$ $P_{ELECT}$ PMECH1.0 $sT_{W}$ qNL $D_{\it turb}$ Tail Water Depression Model 2 23456 $\Delta f < F_2$ Trip Tail ANDORWater ΔFREQ Depression $T_{F2}LATCH$ $s\Delta f < sF_2$ $1+sT_{ft}$ Δf Measured Frequency $T_{F1}LATCH$ $\Delta f < F_1$

**Tail Water Depression Trip Model** 

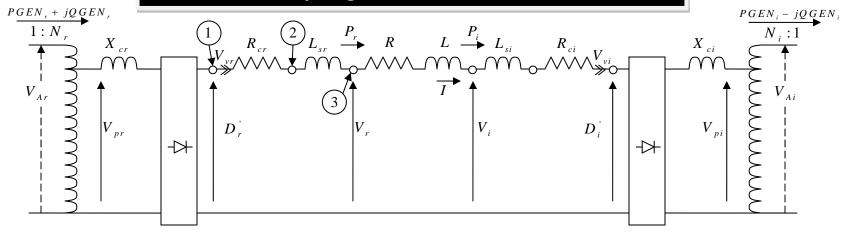
# HVDC Two Terminal DC Control Diagram



Model in the public domain, available from BPA

### **HVDC**

### WSCC Stability Program Two-Terminal DC Line Model



$$E_{r} = \frac{3\sqrt{2}}{\pi} N_{r} V_{AR} = \frac{3\sqrt{2}}{\pi} V_{pr} \qquad \cos \gamma_{r} = \frac{IX_{cr}}{\sqrt{2}V_{pr}} - \cos \theta_{r} \qquad E_{i} = \frac{3\sqrt{2}}{\pi} N_{i} V_{Ai} = \frac{3\sqrt{2}}{\pi} V_{pi} \qquad \cos \beta_{i} = \cos \theta_{i} - \frac{IX_{ci}}{\sqrt{2}V_{pi}}$$

$$D_{r}^{'} = E_{r} \cos \alpha - \frac{3I}{\pi} X_{cr} \qquad \text{PGEN}_{r} = D_{r}^{'} I \qquad D_{i}^{'} = E_{i} \cos \alpha - \frac{3I}{\pi} X_{ci} \qquad \text{PGEN}_{i} = D_{i}^{'} I$$

$$\cos \theta_{r} = \frac{D_{r}^{'}}{E_{r}} \qquad \cos \theta_{i} = \frac{D_{i}^{'}}{E_{i}}$$

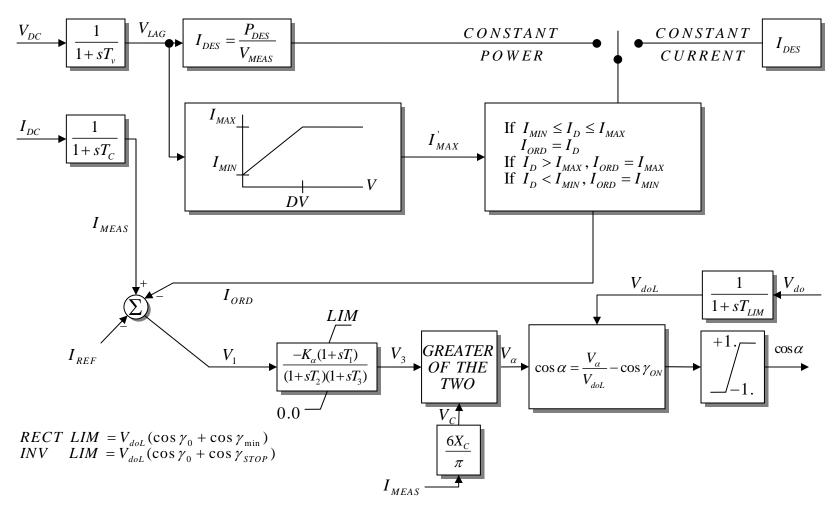
$$I'' = (E_r \cos \alpha_{MIN} - E_i \cos \gamma_{MIN} - V_{vr} - V_{vi}) / R_{TOT}$$

$$I''' = (E_r \cos \alpha_{MIN} + E_i \cos \gamma_{STOP} - V_{vr} - V_{vi}) / R_{TOT}$$

$$W H E R E R_{TOT} = R + R_{cr} + R_{ci} + \frac{3}{\pi} (X_{cr} - X_{ci})$$

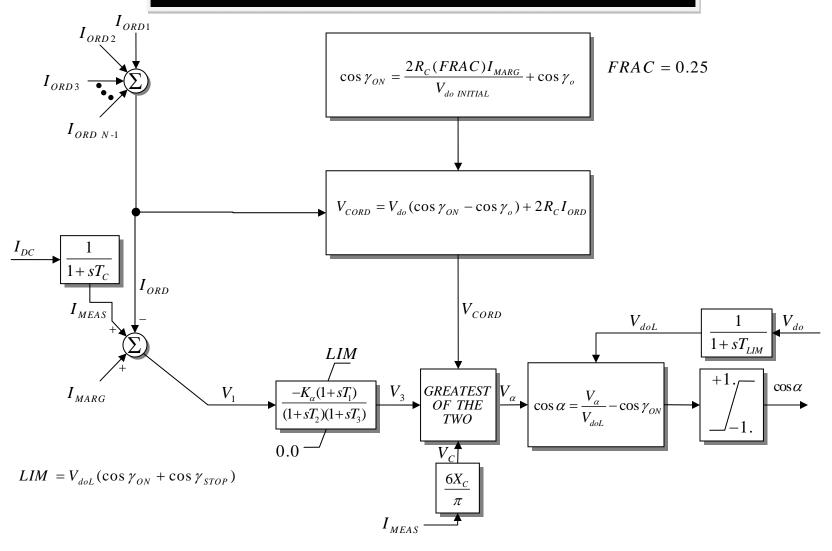
Model in the public domain, available from BPA

# HVDC-MTDC Control System for Rectifiers and Inverters without Current Margin



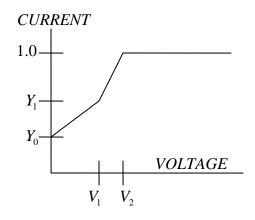
Model in the public domain, available from BPA

# HVDC-MTDC Control System for Terminals with Current Margin

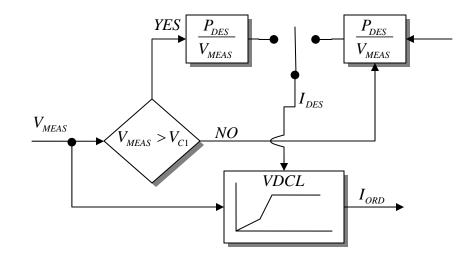


Model in the public domain, available from BPA

# HVDC Detailed VDCL and Mode Change Card Multi-Terminal

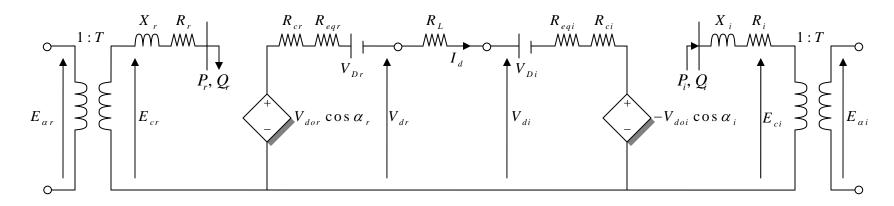


 $\begin{array}{ccc} & & \text{VDCL} \\ Y_1, \ Y_0 & \text{PU Current on rated Current base} \\ V_1, \ V_2 & \text{PU Voltage on rated Voltage base} \end{array}$ 

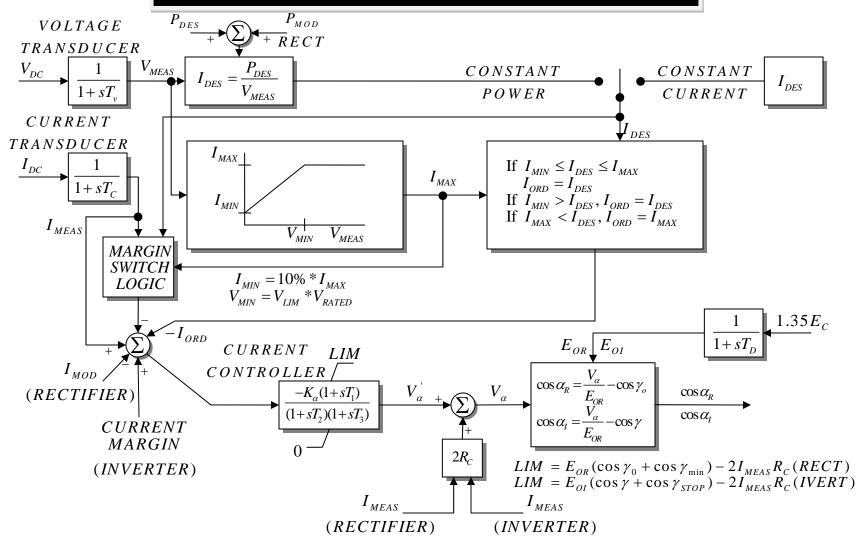


Mode Change  $V_{C1}$  PU rated DC Voltage below which mode is changed to constant I from constant P

# HVDC Equivalent Circuit of a Two Terminal DC Line

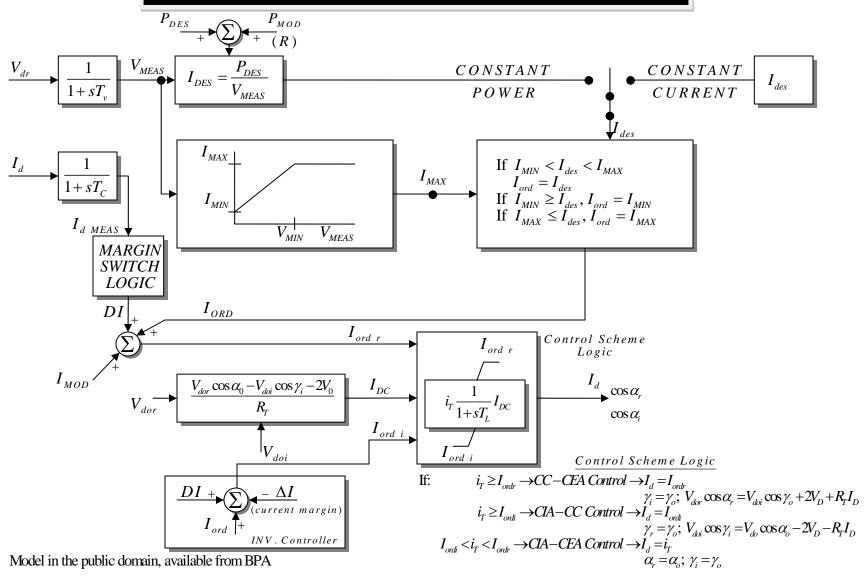


### HVDC BPA Converter Controller

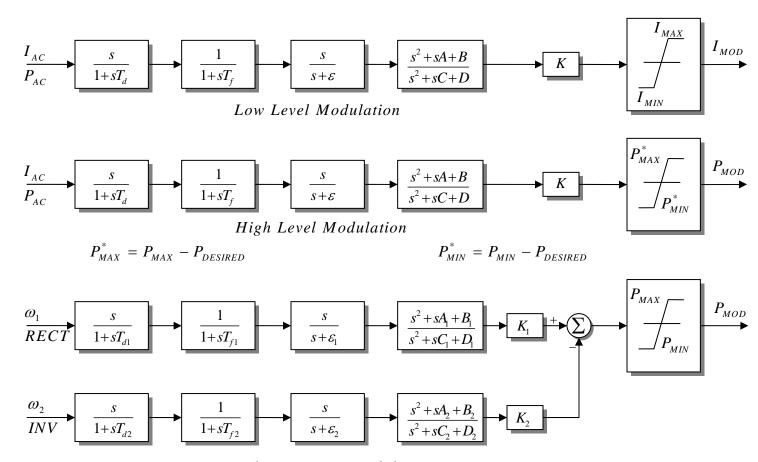


Model in the public domain, available from BPA

# HVDC BPA Block Diagram of Simplified Model



# HVDC BPA Block Diagram of Simplified Model

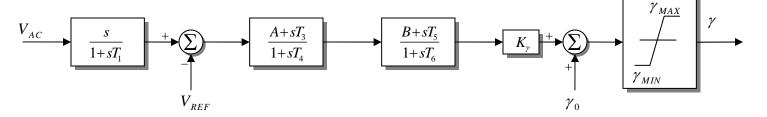


Dual Frequency Modulation

Model in the public domain, available from BPA

# HVDC BPA Block Diagram of Simplified Model

#### Gamma Modulation

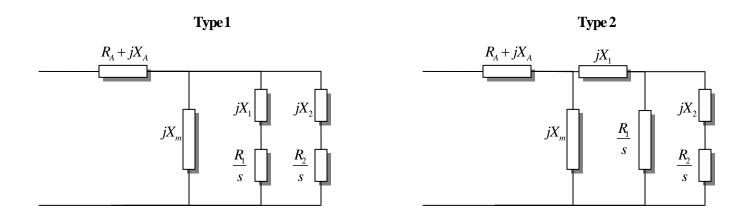


 $T_1$ ,  $T_3$ ,  $T_4$ ,  $T_5$  are in secs.  $\gamma_{\text{MAX}}$ ,  $\gamma_{\text{MIN}}$  are in degrees HILO must be 5

 $K_{\gamma}$  is in degrees/pu volts A, B must be 1 or zero

#### **Load Characteristic CIM5**

# Load Characteristic CIM5 Induction Motor Load Model



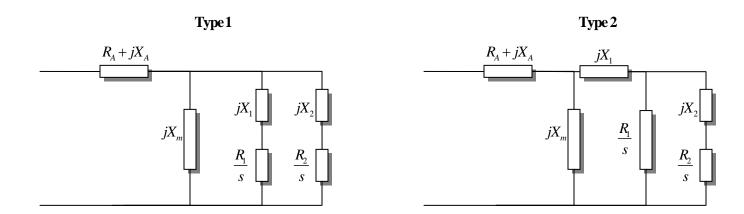
#### Impedances on Motor MVA Base

#### Model Notes:

- 1. To model single cage motor: set  $R_2 = X_2 = 0$ .
- 2. When MBASE = 0.; motor MVA base = PMULT\*MW load. When MBASE > 0.; motor MVA base = MBASE
- 3. Load Torque,  $T_L = T(1+D_{\omega})^D$
- 4. For motor starting,  $T=T_{nom}$  is specified by the user in CON(J+18). For motor online studies,  $T=T_0$  is calculated in the code during initialization and stored in VAR(L+4).
- 5.  $V_{\parallel}$  is the per unit voltage level below which the relay to trip the motor will begin timing. To display relay, set  $V_{\parallel}=0$
- 6.  $T_{\parallel}$  is the time in cycles for which the voltage must remain below the threshold for the relay to trip.  $T_{\parallel}$  is the breaker delay time cycles.

#### **Load Characteristic CIM6**

# Load Characteristic CIM6 Induction Motor Load Model



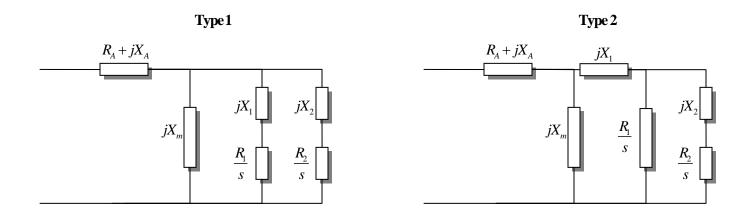
#### Impedances on Motor MVA Base

#### Model Notes:

- 1. To model single cage motor: set  $R_2 = X_2 = 0$ .
- 2. When MBASE = 0.; motor MVA base = PMULT\*MW load. When MBASE > 0.; motor MVA base = MBASE
- 3. Load Torque,  $T_L = T(A_\omega^2 + B_\omega + C_0 + D_\omega^E)^D$
- 4. For motor starting,  $T=T_{nom}$  is specified by the user in CON(J+22). For motor online studies,  $T=T_0$  is calculated in the code during initialization and stored in VAR(L+4).
- 5.  $V_{\parallel}$  is the per unit voltage level below which the relay to trip the motor will begin timing. To display relay, set  $V_{\parallel}=0$
- 6.  $T_{\parallel}$  is the time in cycles for which the voltage must remain below the threshold for the relay to trip.  $T_{\parallel}$  is the breaker delay time cycles.

#### **Load Characteristic CIMW**

### Load Characteristic CIMW Induction Motor Load Model

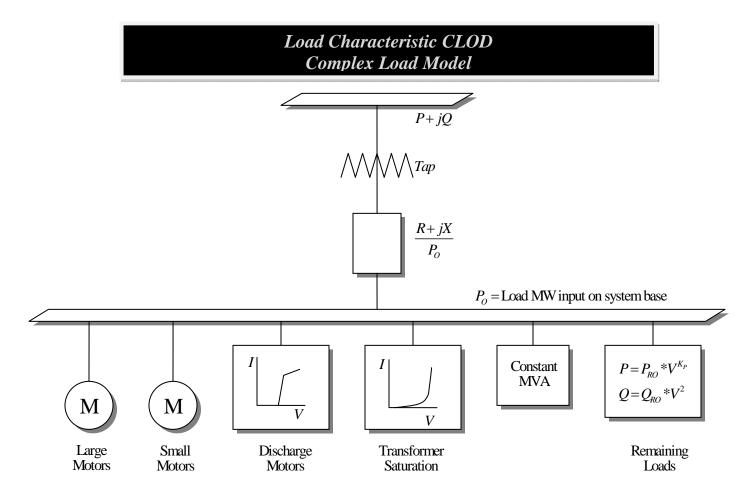


#### Impedances on Motor MVA Base

#### Model Notes:

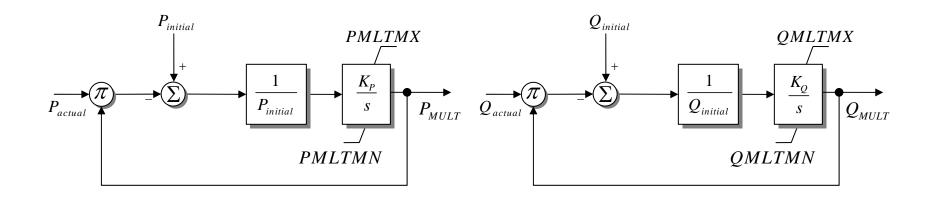
- 1. To model single cage motor: set  $R_2 = X_2 = 0$ .
- 2. When MBASE = 0; motor MVA base = PMULT\*MW load. When MBASE > 0; motor MVA base = MBASE
- 3. Load Torque,  $T_L = T(A_{\omega}^2 + B_{\omega} + C_0 + D_{\omega}^E)^D$  where  $C0 = 1 A_{\omega}^2 B_{\omega_0} D_{\omega_0}^E$ .
- 4. This model cannot be used formotor starting studies.  $T_0$  is calculated in the code during initialization and stored in VAR(L+4).
- 5.  $V_{\parallel}$  is the per unit voltage level below which the relay to trip the motor will begin timing. To display relay, set  $V_{\parallel}=0$
- 6.  $T_{\parallel}$  is the time in cycles for which the voltage must remain below the threshold for the relay to trip.  $T_{\parallel}$  is the breaker delay time cycles.

# **Load Characteristic CLOD**



# **Load Characteristic EXTL**

# Load Characteristic EXTL Complex Load Model



# **Load Characteristic IEEL**

# Load Characteristic IEEL Complex Load Model

$$P = P_{load} \left( a_1 v^{n_1} + a_2 v^{n_2} + a_3 v^{n_3} \right) \left( 1 + a_7 \Delta f \right)$$

$$Q = Q_{load} \left( a_4 v^{n_4} + a_5 v^{n_5} + a_6 v^{n_6} \right) \left( 1 + a_8 \Delta f \right)$$

# **Load Characteristic LDFR**

# Load Characteristic LDFR Complex Load Model

$$P = P_{o} \left(\frac{\omega}{\omega_{o}}\right)^{m}$$

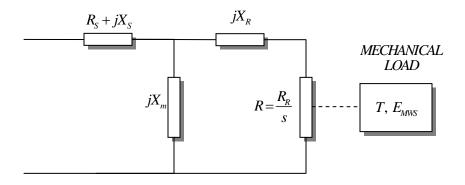
$$Q = Q_{o} \left(\frac{\omega}{\omega_{o}}\right)^{n}$$

$$I_{p} = I_{po} \left(\frac{\omega}{\omega_{o}}\right)^{r}$$

$$I_{q} = I_{qo} \left(\frac{\omega}{\omega_{o}}\right)^{s}$$

# **Load Characteristic BPA INDUCTION MOTOR I**

### Load Characteristic BPA Induction MotorI Induction Motor Load Model



#### Model Notes:

Mechanical Load Torque, 
$$T=(A\omega^2+B\omega+C)T_O$$
  
where  $\underline{C}$  is calculated by the program such that 
$$A\omega^2+B\omega+C=1.0$$
  $\omega=1-\omega$ 

# **Load Characteristic BPA TYPE LA**

# Load Characteristic BPA Type LA Load Model

$$P = P_0 \left( P_1 V^2 + P_2 V + P_3 + P_4 \left( 1 + \Delta f * L_{DP} \right) \right)$$

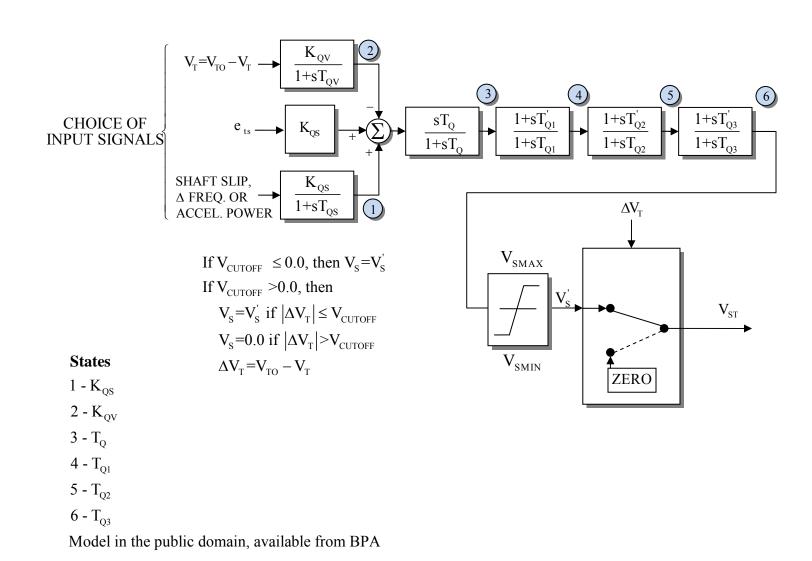
# **Load Characteristic BPA TYPE LB**

# Load Characteristic BPA Type LB Load Model

$$P = P_0 (P_1 V^2 + P_2 V + P_3) (1 + \Delta f * L_{DP})$$

### Stabilizer BPA SF, BPA SP, BPA SS, and BPA SG

### Stabilizer BPA SF, BPA SP, BPA SS, and BPA SG Stabilizer Models



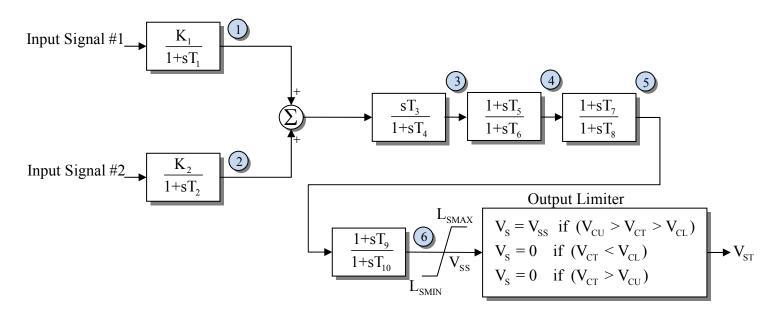
# Stabilizer BPA SH, BPA SHPLUS, and BPA SI

Stabilizer BPA SH, BPA SHPLUS, and BPA SI Stabilizer Models

No block diagrams have been created

# Stabilizer IEE2ST

# Stabilizer IEE2ST IEEE Stabilizing Model with Dual-Input Signals

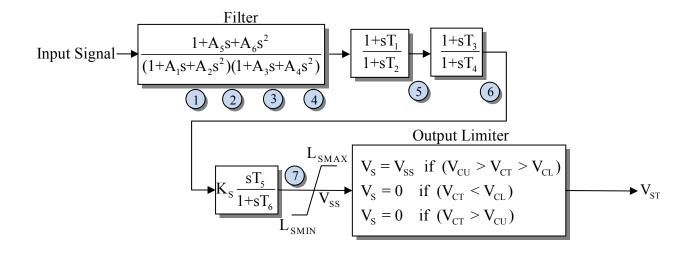


#### **States**

- 1 Transducer1
- 2 Transducer2
- 3 Washout
- 4 LL1
- 5 LL2
- 6 Unlimited Signal

### **Stabilizer IEEEST**

# Stabilizer IEEEST IEEE Stabilizing Model



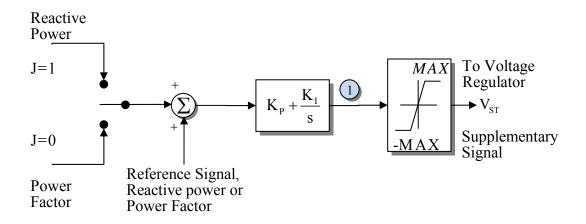
#### **States**

- 1 Filter 1
- 2 Filter 2
- 3 Filter 3
- 4 Filter Out
- 5 LL1
- 6 LL2
- 7 Unlimited Signal

Model supported by PSLF with time delay that is not implemented in Simulator Model supported by PSSE

# Stabilizer PFQRG

# Stabilizer PFQRG Power-Sensitive Stabilizing Unit

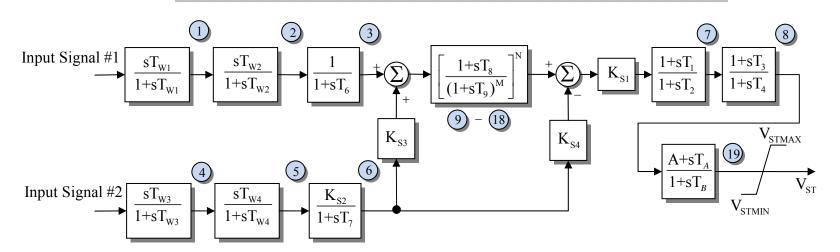


#### **States**

1 - PI

#### Stabilizer PSS2A

### Stabilizer PSS2A IEEE Dual-Input Stabilizer Model



#### **States**

1 - WOTW1 11 - RampFilter3

2 - WOTW2 12 - RampFilter4

3 - Transducer 1 13 - RampFilter 5

4 - WOTW3 14 - RampFilter6

5 - WOTW4 15 - RampFilter7

6 - Transducer2 16 - RampFilter8

7 - LL1 17 - RampFilter9

8 - LL2 18 - RampFilter10

9 - RampFilter1 19 - LLGEOnly

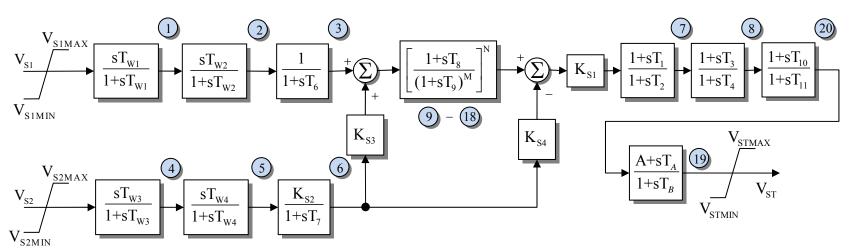
10 - RampFilter2

Model supported by PSLF

Model supported by PSSE without  $T_A$ ,  $T_B$  lead/lag block and with  $K_{S4} = 1$ 

### Stabilizer PSS2B

### Stabilizer PSS2B IEEE Dual-Input Stabilizer Model



#### **States**

- 1 WOTW1 11 RampFilter3
- 2 WOTW2 12 RampFilter4
- 3 Transducer 1 13 RampFilter 5
- 4 WOTW3 14 RampFilter6
- 5 WOTW4 15 RampFilter7
- 6 Transducer2 16 RampFilter8
- 7 LL1 17 RampFilter9
- / EE1 1/ Rampi mer)
- 8 LL2 18 RampFilter10
- 9 RampFilter1 19 LLGEOnly
- 10 RampFilter2 20 LL3

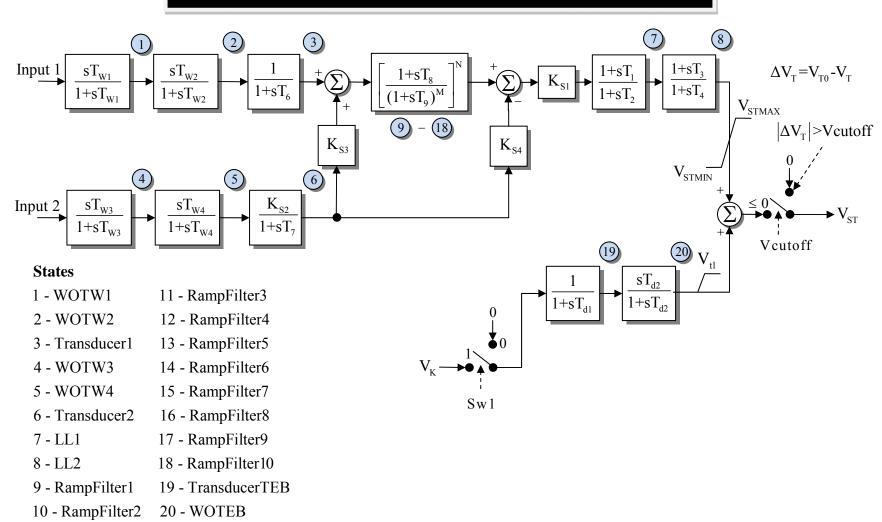
Model supported by PSLF

Model supported by PSSE without  $T_A$ ,  $T_B$  lead/lag block and with  $K_{S4} = 1$ 

#### Stabilizer PSSSB

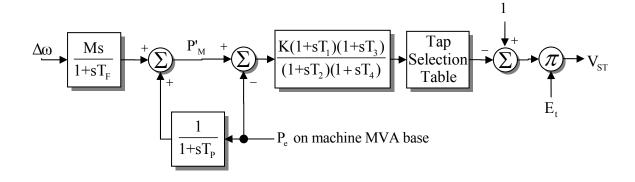
Model supported by PSLF

# Stabilizer PSSSB IEEE PSS2A Dual-Input Stabilizer Plus Voltage Boost Signal Transient Stabilizer and Vcutoff



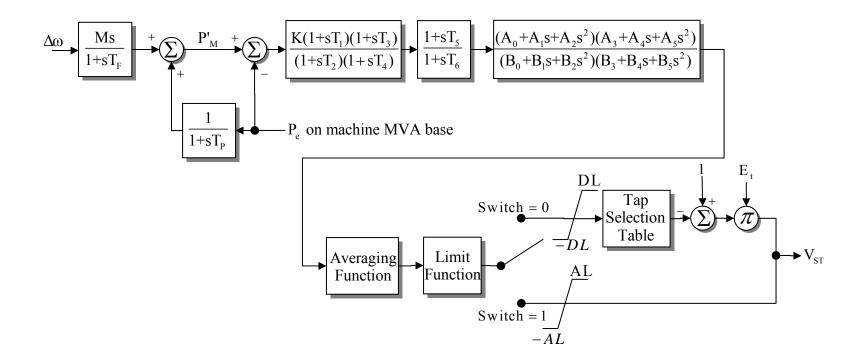
# **Stabilizer PTIST1**

# Stabilizer PTIST1 PTI Microprocessor-Based Stabilizer



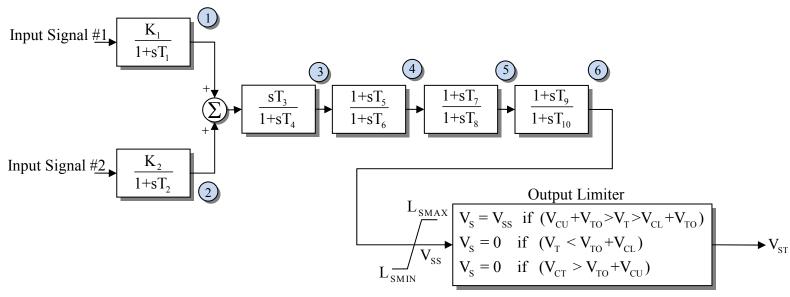
# **Stabilizer PTIST3**

# Stabilizer PTIST3 PTI Microprocessor-Based Stabilizer



#### Stabilizer ST2CUT

# Stabilizer ST2CUT Stabilizing Model with Dual-Input Signals



 $V_{TO}$  = initial terminal voltage

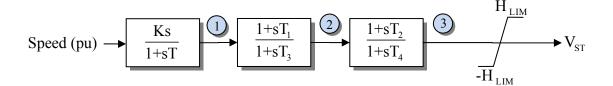
 $V_T$  = terminal voltage

#### **States**

- 1 Transducer1
- 2 Transducer2
- 3 Washout
- 4 LL1
- 5 LL2
- 6 Unlimited Signal

# **Stabilizer STAB1**

# Stabilizer STAB1 Speed-Sensitive Stabilizing Model

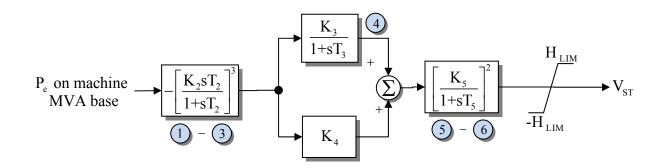


#### States

- 1 Washout
- 2 Lead-lag 1
- 3 Lead-lag 2

# Stabilizer STAB2A

# Stabilizer STAB2A Power-Sensitive Stabilizing Unit

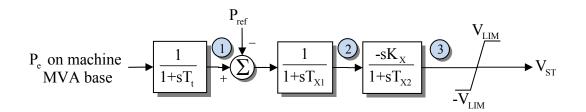


#### **States**

- 1 Input State 1
- 2 Input State 2
- 3 Input State 3
- 4 T<sub>3</sub>
- 5 Output State 1
- 6 Output State 2

# **Stabilizer STAB3**

# Stabilizer STAB3 Power-Sensitive Stabilizing Unit

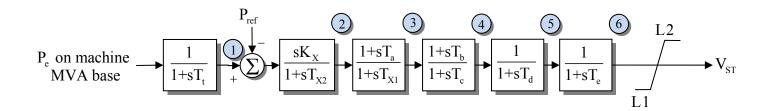


#### **States**

- 1 Int T,
- 2 Int T<sub>X1</sub>
- 3 Unlimited Signal

# **Stabilizer STAB4**

# Stabilizer STAB4 Power-Sensitive Stabilizer

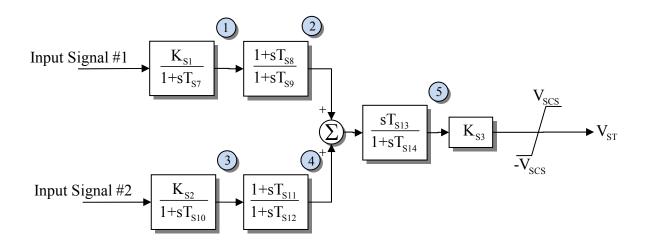


#### States

- 1 Input
- 2 Reset
- 3 LL1
- 4 LL2
- $5 T_d$
- 6 Unlimited Signal

### **Stabilizer STBSVC**

### Stabilizer STBSVC WECC Supplementary Signal for Static var Compensator



#### States

- 1 Transducer1
- 2 LL1
- 3 Transducer2
- 4 LL2
- 5 Washout

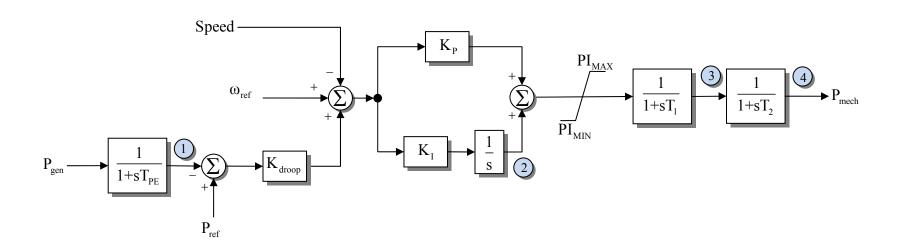
# **Stabilizer WSCCST**

#### Stabilizer WSCCST WSCC Power System Stabilizer **States** $\overline{K}_{qv}$ 1 1 - Transducer1 2 - Transducer2 3 - WashoutTq 4 - LL1 $\boldsymbol{K}_{\text{qs}}$ 5 - LL2 6 - LL3 K, signal 2 U speed $1+sT_{qs}$ $\overline{1+sT_3}$ $1+sT_4$ accpw freq 2 3 $\Delta V_{T} = V_{T0} - V_{T}$ $|\Delta V_{T}| > V \text{cutoff}$ $\boldsymbol{V}_{\text{SMAX}}$ ≤ 0、 **(6)** 1+sT'<sub>q2</sub> $1 + sT_{q3}$ $1+sT_{q1}'$ $1+sT_{q1}$ $1+sT_{q2}$ $1+sT_{q3}$ $1+sT_a$ Vcutoff $\overline{V_{\text{SLOW}}}$ $V_{tl}$ $sT_{d2}$ $1+sT_{d1}$ $1+sT_{d2}$ Sw1Model supported by PSLF

Blocks in gray have not been implemented in Simulator

# Stabilizer WT12A1 and WT1P

# Stabilizer WT12A1 and WT1P Pseudo Governor Model for Type 1 and Type 2 Wind Turbines



#### States

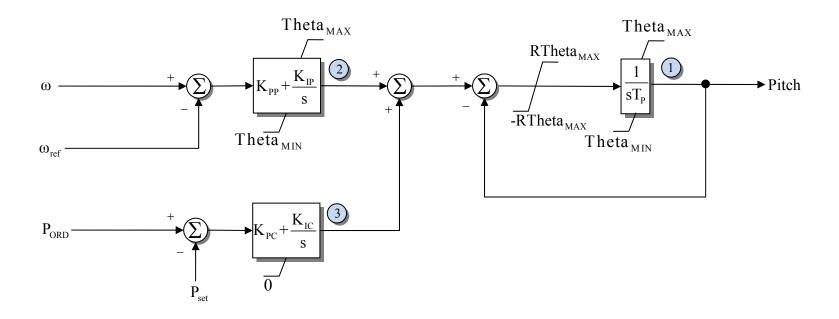
- 1 P<sub>gen</sub>
- 2 K<sub>I</sub>
- $3 T_1$
- $4 P_{mech}$

WT12A1 supported by PSSE with  $K_I = \frac{1}{T_I}$ 

WT1P supported by PSLF

# Stabilizer WT3P and WT3P1

# Stabilizer WT3P and WT3P1 Pitch Control Model for Type 3 Wind Generator



#### **States**

- 1 Pitch
- 2 PitchControl
- 3 PitchComp

WT3P supported by PSLF

 $T_P = T_{PI}$ , Theta<sub>MAX</sub> =  $PI_{MAX}$ , Theta<sub>MIN</sub> =  $PI_{MIN}$ , and RTheta<sub>MAX</sub> =  $PI_{RATE}$ 

WT3P1 supported by PSSE with no non-windup limits on pitch control