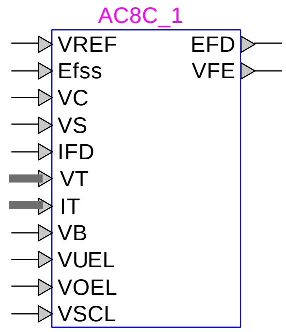
Exciters and Governors: Exciter AC8C



Exciter AC8C

Hossein Ashourian, Jean Mahseredjian, 5/20/2021 11:10 PM

1 Description

This device is an implementation of an IEEE type AC8C excitation system model. This device is implemented as described in [1]. Implementation details can be viewed by inspecting the subcircuit of this device.

1.1 Pins

This device has 13 pins:

Pin name	Type	Description	Units
VREF	Input	Reference voltage of the stator terminal voltage	pu
Efss	Input	Steady-state field voltage at t = 0, for initialization	pu
VC	Input	Terminal voltage of synchronous machine, transducer output	pu
VS	Input	Power System Stabilizer signal	pu
IFD	input	Field current	pu
VT	Input, bundle	Terminal voltage (phasor) of synchronous machine (magnitude and phase)	pu
IT	Input, bundle	Current (phasor) of synchronous machine (magnitude and phase)	pu
VB	Input	Available exciter voltage	pu
VUEL	Input	Under Excitation Limiter signal	pu
VOEL	Input	Over Excitation Limiter signal	pu
VSCL	Input	Stator Current Limiter signal	pu
EFD	Output	The field voltage signal	pu

VFE	Output	Signal proportional to exciter field current	pu

1.2 Parameters

The default set of parameters can be found in [1].

1.2.1 Data tab

The parameters on the Data tab are:

1. **Gain K_A**: Voltage regulator gain
2. **Time constant T_A**: Voltage regulator time constant
3. **Maximum regulator output V_{RMAX}**: Maximum regulator internal voltage output
4. **Minimum regulator output V_{RMIN}**: Minimum regulator internal voltage output
5. **Gain K_{PR}**: Voltage regulator proportional gain
6. **Gain K_{IR}**: Voltage regulator integral gain
7. **Gain K_{DR}**: Voltage regulator derivative gain
8. **Time constant T_{DR}**: Lag time constant for derivative channel of PID controller
9. **Gain K_P**: Potential circuit (voltage) gain coefficient
10. **Phase angle $Theta_P$**: Potential circuit phase angle (degrees)
11. **Gain K_I**: Potential circuit (current) gain coefficient
12. **Reactance X_L**: Reactance associated with potential source
13. **Gain K_{C1}**: Rectifier loading factor proportional to commutating reactance
14. **Voltage V_{Bmax}**: Maximum available exciter voltage
15. **Excitation Type option**: see explanations below.
16. **Current Control Type option**: see explanations below.
17. **Under Excitation Limiter option**: see explanations below.
18. **Over Excitation Limiter option**: see explanations below.
19. **Stator Current Limiter option**: see explanations below.

There are two possible selections for the Excitation Type option:

1. Excitation system is self-excited: VT and IT inputs must be connected.
2. Excitation system comes from a separate source: VB input must be connected

There are two possible selections for the Current Control Type option:

1. Feedback from generator field voltage E_{FD}.
2. Feedback from exciter field current V_{FE}.

There are three possible selections for the Under Excitation Limiter option:

1. VUEL not available or added to the reference voltage: this option can be selected when the VUEL input signal is zero (not connected) or when it is connected and added to the reference voltage.
2. VUEL connected to the first high value gate (HV gate).
3. VUEL connected to the second high value gate (HV gate).

There are three possible selections for the Over Excitation Limiter option:

1. VOEL not available or added to the reference voltage: this option can be selected when the VOEL input signal is zero (not connected) or when it is connected and added to the reference voltage.
2. VOEL connected to the first low value gate (LV gate).
3. VOEL connected to the second low value gate (LV gate).

There are five possible selections for the Stator Current Limiter option:

1. VSCL not available or added to the reference voltage: this option can be selected when the VSCL input signal is zero (not connected) or when it is connected and added to the reference voltage.
2. VSCL connected to the first high value gate (HV gate).

3. VSCL connected to the first low value gate (LV gate).
4. VSCL connected to the second high value gate (HV gate).
5. VSCL connected to the second low value gate (LV gate).

1.2.2 Exciter tab

The exciter tab allows to input:

1. **Gain K_E**: Exciter field proportional constant
2. **Time constant T_E**: Exciter field time constant
3. **Field current limit V_{FEmax}**: Maximum exciter field current
4. **Voltage V_{Emin}**: Minimum of exciter voltage back of commutating reactance
5. **Demagnetizing factor K_D**: Demagnetizing factor, function of exciter alternator reactances
6. **Rectifier loading factor K_C**: Rectifier loading factor proportional to commutating reactance
7. **Field voltage V_{E1}**: The exciter voltage point which is near the exciter ceiling voltage
8. **Field voltage V_{E2}**: The exciter voltage point which is near 75% of V_{E1}
9. **Saturation function output SE_V_{E1}**: The exciter saturation function value at V_{E1}
10. **Saturation function output SE_V_{E2}**: The exciter saturation function value at V_{E2}

The exciter saturation function is defined as

$$S_E = A_{EX} e^{B_{EX} E_{FD}} \tag{1}$$

which gives the approximation saturation for any E_{FD} (exciter output voltage). According to [2] (see pages 562 and 563), the coefficients A_{EX} and B_{EX} can be found from:

$$A_{EX} = \frac{S_{V_{E2}}^4}{S_{V_{E1}}^3} \tag{2}$$

$$B_{EX} = \frac{4}{V_{E1}} \ln\left(\frac{S_{V_{E1}}}{S_{V_{E2}}}\right) \tag{3}$$

In the literature [2] $V_{E1} = V_{E_{max}}$ and $V_{E2} = V_{E_{0.75max}}$.

2 Initial conditions

The reference voltage VREF can be manually or automatically set by connecting or not connecting the input signal VREF, respectively. When VREF is not connected (the signal is zero), the reference voltage is internally found from the steady-state solution. When VREF is connected, its initial value must match the per unit steady-state voltage of the stator terminal voltage, since otherwise the generator voltage will not start at the actual steady-state.

3 References

[1] "IEEE Recommended Practice for Excitation System Models for Power System Models for Power System Stability Studies," IEEE Standard 421.5-2016.

[2] P. M. Anderson and A. A. Fouad, "Power system control and stability", second edition, IEEE Press, Wiley Interscience, 2003.