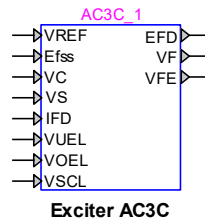


# Exciters and Governors: Exciter AC3C



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## 1 Description

This device is an implementation of the IEEE type AC3C 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 9 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
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
VF	Output	The excitation system stabilizer 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  $K_{PR}$** : Voltage regulator proportional gain
2. **Gain  $K_{IR}$** : Voltage regulator integral gain
3. **Gain  $K_{DR}$** : Voltage regulator derivative gain
4. **Time constant  $T_{DR}$** : Lag time constant for derivative channel of PID controller
5. **Maximum PID regulator output  $V_{PIDmax}$** : Maximum PID regulator voltage output
6. **Minimum PID regulator output  $V_{PIDmin}$** : Minimum PID regulator voltage output
7. **Time constant  $T_C$** : Regulator numerator (lead) time constant
8. **Time constant  $T_B$** : Regulator denominator (lag) time constant
9. **Gain  $K_A$** : Voltage regulator output gain
10. **Time constant  $T_A$** : Voltage regulator output time constant
11. **Maximum regulator output  $V_{Amax}$** : Maximum regulator voltage output
12. **Minimum regulator output  $V_{Amin}$** : Minimum regulator voltage output
13. **Time constant  $T_F$** : Rate feedback time constant
14. **Constant  $K_R$** : Constant associated with regulator and alternator field power supply
15. **Gain  $K_F$** : Rate feedback excitation system stabilizer gain
16. **Gain  $K_N$** : Rate feedback excitation system stabilizer gain
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 Under Excitation Limiter option:

1. VUEL not available
2. VUEL connected to the high value gate (HV gate)

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

1. VOEL not available
2. VOEL connected to the low value gate (LV gate)

There are three 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 high value gate (HV gate).
3. VSCL connected to the 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. **Exciter voltage  $E_{FDN}$** : Value of  $E_{FD}$  at which feedback gain changes
4. **Field current limit  $V_{FEmax}$** : Exciter field current limit
5. **Minimum exciter voltage output  $V_{Emin}$** : Minimum of exciter voltage output
6. **Demagnetizing factor  $K_D$** : Demagnetizing factor, function of exciter alternator reactances
7. **Rectifier loading factor  $K_C$** : Rectifier loading factor proportional to commutating reactance
8. **Voltage  $V_{E1}$** : The exciter voltage point which is near the exciter ceiling voltage
9. **Voltage  $V_{E2}$** : The exciter voltage point which is near 75% of  $V_{E1}$
10. **Saturation function output  $SE_{V_{E1}}$** : The exciter saturation function value at  $V_{E1}$
11. **Saturation function output  $SE_{V_{E2}}$** : The exciter saturation function value at  $V_{E2}$

The exciter saturation function is defined as

$$S_E = A_{EX} e^{B_{EX} E_{FD}} \quad (1)$$

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:

$$A_{EX} = \frac{S_{VE2}^4}{S_{VE1}^3} \quad (2)$$

$$B_{EX} = \frac{4}{V_{E1}} \ln \left( \frac{S_{VE1}}{S_{VE2}} \right) \quad (3)$$

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.