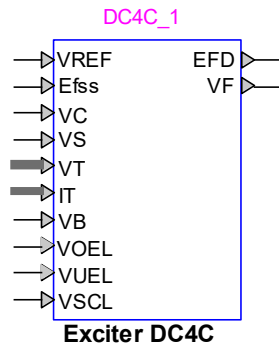


# Exciters and Governors: Exciter DC4C



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## 1 Description

This device is an implementation of the IEEE type DC4C 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 7 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
VS	Input	Power System Stabilizer signal	pu
VC	Input	Terminal voltage of synchronous machine, transducer output	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
VF	Output	The excitation system stabilizer signal	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  $K_{PR}$** : Regulator proportional gain
2. **Gain  $K_{IR}$** : Regulator integral gain
3. **Gain  $K_{DR}$** : Regulator derivative gain
4. **Time constant  $T_{DR}$** : Regulator derivative filter time constant
5. **Gain  $K_A$** : Regulator output gain
6. **Time constant  $T_A$** : voltage regulator time constant
7. **Maximum regulator output  $V_{Rmax}$** : Maximum regulator voltage output
8. **Minimum regulator output  $V_{Rmin}$** : Minimum regulator voltage output
9. **Gain  $K_F$** : Rate feedback gain
10. **Time constant  $T_F$** : Rate feedback time constant
11. **Gain  $K_P$** : Potential circuit gain coefficient
12. **Phase angle  $\Theta_{\alpha}$** : Potential circuit phase angle (degrees)
13. **Gain  $K_I$** : Potential circuit (current) gain coefficient
14. **Reactance  $X_L$** : Reactance associated with potential source
15. **Rectifier loading factor  $K_{C1}$** : Rectifier loading factor proportional to commutating reactance
16. **Voltage  $V_{Bmax}$** : Maximum available exciter field voltage
17. Stator Current Limiter option: see explanations below.
18. Under Excitation Limiter option: see explanations below.
19. Over Excitation limiter option: see explanation below.

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 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 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 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 gain
2. **Time constant  $T_E$** : Exciter time constant
20. **Minimum output voltage  $V_{EMIN}$** : Exciter minimum output voltage
3. **Field voltage  $E_{FD1}$** : The field exciter voltage point which is near the exciter ceiling voltage
4. **Field voltage  $E_{FD2}$** : The field exciter voltage point which is near 75% of  $E_{FD1}$
5. **Saturation function output  $SE_{E_{FD1}}$** : The exciter saturation function value at  $E_{FD1}$

6. **Saturation function output SE<sub>E<sub>FD2</sub></sub>**: The exciter saturation function value at E<sub>FD2</sub>

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<sub>FD</sub> (exciter output voltage). According to [2] (see pages 562 and 563), the coefficients A<sub>EX</sub> and B<sub>EX</sub> can be found from:

$$A_{EX} = \frac{S_{E_{FD2}}^4}{S_{E_{FD1}}^3} \quad (2)$$

$$B_{EX} = \frac{4}{E_{FD1}} \ln \left( \frac{S_{E_{FD1}}}{S_{E_{FD2}}} \right) \quad (3)$$

In the literature [2] E<sub>FD1</sub> = E<sub>FD<sub>max</sub></sub> and E<sub>FD2</sub> = E<sub>FD<sub>0.75max</sub></sub>.

## 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.