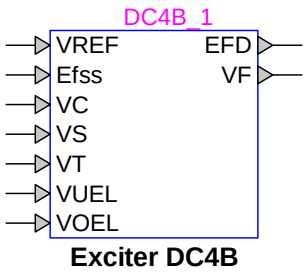
Exciters and Governors: Exciter DC4B



Exciter DC4B

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1 Description

This device is an implementation of the IEEE type DC4B 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
VT	Input	Terminal voltage of synchronous machine	pu
VUEL	Input	Under Excitation Limiter signal	pu
VOEL	Input	Over Excitation Limiter signal	pu
EFD	Output	Field voltage signal	pu
VF	Output	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_A**: voltage regulator gain

2. **Time constant T_A**: voltage regulator time constant
3. **Maximum regulator output V_{Rmax}**: Maximum regulator voltage output
4. **Minimum regulator output V_{Rmin}**: Minimum regulator voltage output
5. **Gain K_P**: regulator proportional gain
6. **Gain K_I**: regulator integral gain
7. **Gain K_D**: regulator derivative gain
8. **Time constant T_D**: regulator derivative filter time constant
9. **Gain K_F**: excitation control system stabilizer gain
10. **Time constant T_F**: excitation control system stabilizer time constant
11. Under Excitation Limiter option: see explanations below.
12. Over Excitation Limiter option: see explanations below.

There are two 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 two 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 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
3. **Minimum output voltage V_{EMIN}**: exciter minimum output voltage
4. **Field voltage E_{FD1}**: The field exciter voltage point which is near the exciter ceiling voltage
5. **Field voltage E_{FD2}**: The field exciter voltage point which is near 75% of E_{FD1}
6. **Saturation function output SE_E_{FD1}**: The exciter saturation function value at E_{FD1}
7. **Saturation function output SE_E_{FD2}**: The exciter saturation function value at E_{FD2}

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:

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

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

In the literature [2] $E_{FD1} = E_{FD_{max}}$ and $E_{FD2} = E_{FD_{0.75max}}$.

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 421.5-2005.

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