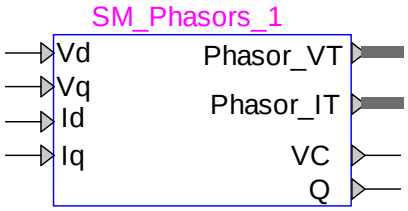
Exciters and Governors: Synchronous machine Phasors



Synchronous Machine phasors

Tshibain Tshibungu, Jean Mahseredjian, 5/18/2017 2:03 PM

1 Description

This device is the calculator of synchronous machine phasors (current and terminal voltage), reactive power and terminal voltage transducer (with optional current-compensation elements). The mathematical calculation of phasors is explained below. Implementation details can be viewed by inspecting the subcircuit of this device.

1.1 Pins

This device has 8 pins:

Pin name	Type	Description	Units
Vd	Input	d-axis terminal voltage of the synchronous machine	pu
Vq	Input	q-axis terminal voltage of the synchronous machine	pu
Id	Input	d-axis current of the synchronous machine	pu
Iq	Input	q-axis current of the synchronous machine	pu
Phasor_VT	Output, bundle	Terminal voltage of the synchronous machine (phasor, magnitude and phase)	pu
Phasor_IT	Output, bundle	Current of the synchronous machine (phasor, magnitude and phase)	pu
VC	Output	Terminal voltage transducer	pu
Q	Output	Reactive power	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. **Resistance R_C**: resistive component of load compensation
2. **Reactance X_C**: reactive component of load compensation
3. **Time constant T_r**: time constant
4. **Natural frequency f_n**: naturel frequency
5. **Damping** ξ : damping ratio
6. Filter Model Order option: see explanations below.

There are two possible selections for the Filter Model Order option:

1. Low-pass 1st order
2. Low-pass 2nd order

Assuming that the synchronous machine is under balanced conditions, the synchronous machine phasors (current and voltage) are calculated as follows.

The current phasor is found from:

$$I_T = \sqrt{I_d^2 + I_q^2} \tag{1}$$

$$\alpha_I = tg^{-1}\left(\frac{I_d}{I_q}\right) \tag{2}$$

where I_T is the calculated current magnitude (pu) from the I_d and I_q measurements, and α_I is the current phase angle (rad) with q-axis as the reference.

The terminal voltage phasor is found from:

$$V_T = \sqrt{V_d^2 + V_q^2} \tag{3}$$

$$\alpha_V = tg^{-1}\left(\frac{V_d}{V_q}\right) \tag{4}$$

where V_T is the terminal voltage magnitude (pu) from the V_d and V_q measurements and α_V is the terminal voltage phase angle (rad) with q-axis as the reference.

2 References

[1] "IEEE Recommended Practice for Excitation System Models for Power System Models for Power System Stability Studies," IEEE Standard 421.5-2005.