Mechanical Model (PMSM BLDC)

Mechanical Model Configuration Page

In the **System Explorer** window configuration tree, expand the **Power Electronics Add-On** custom device and select **Circuit Model >> PMSM BLDC >> Mechanical Model** to display this page. Use this page to configure the PMSM BLDC Mechanical model.

This page includes the following components:

Name	Specifies the name of the model.
Description	Specifies a description for the model.

Configuration

	Symbol	Units	Default	Description
Viscous Damping	F_v	Newton*meter*second per radian	0.00190986 Nm*s /rad	Combined viscous damping of the rotor and load, proportional to the angular velocity of the machine.
Static Friction	T_f	Newton-meter	0.3665 Nm	Static friction resisting initial rotation when the machine is at rest.
Inertia	J	Kilogram-meter^2	0.0167309 Kg*m^2	Moment of inertia of the rotor and load.

Mechanical Model Section Channels

This section includes the following custom device channels:

Channel Name	Symbol	Type	Units	Default Value	Description
Mechanical Model Mode		Input		0 (Speed Controlled)	Set this channel to one of the following values: • **0** - Sets the mechanical model to Speed Controlled mode. The mechanical parameters are ignored in this case. • **1** - Sets the mechanical model to Torque Controlled mode. See the **Mechanical Model Mode** section for more information.
User-Defined Speed	user	Input	RPM	0 RPM	Forces the speed of the machine to the defined value. This parameter is used in Speed Controlled mode, and ignored in Torque Controlled mode.
Load Torque	T_L	Input	Nm	0 Nm	Torque applied to the shaft of the machine. This parameter is used in Torque Controlled mode, and ignored in Speed Controlled mode.
Mechanical Angle	m	Output	Degrees	0°	Mechanical rotor position. If this signal is routed to a **Waveform Channel** or an **Analog Output Channel**, its value is expressed in Turns. The signal ranges in value from 0 to 1, with 1 representing a full rotation.
Speed	m	Output	RPM	0 RPM	Rotation speed of the machine rotor in RPM.
Total Torque	T_{total}	Output	Nm	0 Nm	$T_{total} = T_e - T_L - T_f$

Mechanical Model Description

Attached to the machine model's shaft is a basic mechanical model. This model was chosen due to its common application, and the ability to extend its functionality. The behavior of the model varies depending upon whether the **Mechanical Model Mode** is set to **Torque Controlled (1)** or **Speed Controlled (0)**.

Torque Controlled

When the **Mechanical Model Mode** is set to **Torque Controlled (1)**, the equation of the mechanical model can be expressed as follows:

(1)
$$\frac{\partial \omega_m}{\partial t} = \frac{1}{J} * (T_{total} - F_v \omega_m)$$

where

(2) $$T_{total} = T_e - T_L - T_f$$

There is a dead-zone implementation with the static friction torque; if the **Electromagnetic Torque (T_e)** does not exceed the **Static Friction (T_f)** torque, the speed remains at zero.

Note that in equation (1), the value of the mechanical speed ($_m$) is in radians per second, while the output of the **Mechanical Speed** channel will be in RPM. The equation for the **Electromagnetic Torque (T_e)** of each type of machine can be found on its specific description page under the **Machine Section**.

The following equation is used to calculate the machine power:

(3) $$P_m = T_{total} * \omega_m$$

Speed Controlled

When the **Mechanical Model Mode** is set to **Speed Controlled (0),** the mechanical parameters (**Viscous Damping**, **Static Friction**, **Inertia**) are ignored. Instead, the rotor speed is directly set using the **User-Defined Speed** parameter, $_{user}$.

Choosing a Mechanical Model Mode

Select **Speed Controlled** mode if:

1. Your project requires you to manually set the speed of the machine
2. Your project has a mechanical model that requires you to input the speed of the machine in to the model

Select **Torque Controlled** mode if:

1. Your project requires you to manually set the load torque of the machine
2. Your project has a mechanical model that requires you to input the load toque of the machine in to the model