Resolver (PMSM BLDC)

Resolver Configuration Page

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

This page includes the following components:

Name				Specifies the name of the resolver.
Description				Specifies a description for the resolver.
Angle Conditioning				
	Symbol	**Units**	**Default**	**Description**
Number of Pole Pairs	pp		1	A gain applied to the mechanical angle of the machine, $_m$, before it is translated to an electrical resolver signal. Modify this parameter if the resolver is attached to a gear box rather than connected directly to the rotor. To generate resolver signals whose speed corresponds to the mechanical speed of the machine, set this value to 1. See the **Resolver Model Equations** for more information.
Angle Offset	$_{Offset}$	Degrees	0°	Offset from the mechanical angle of the machine, $_m$.
Speed Sign			Clockwise	Select one of the following options: • **Clockwise** - The resolver outputs a positive speed when the machine rotates clockwise. • **Counter Clockwise** - The resolver outputs a positive speed when the machine rotates counter clockwise.
	Symbol	**Units**	**Default**	**Description**
Sine.Sine Gain	Sin.Sin		1	Sine gain applied to the **Sine** output signal. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information.
Sine.Cos Gain	Sin.Cos		0	Cosine gain applied to the **Sine** output signal. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information.
Cos.Sin Gain	Cos.Sin		0	Sine gain applied to the **Cosine** output signal. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information.
Cos.Cos Gain	Cos.Cos		1	Cosine gain applied to the **Cosine** Output signals. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information.
	Symbol	**Units**	**Default**	**Description**
Carrier Sampling Time	T_s	Seconds	1E-6	The period at which the Excitation Carrier signal is sampled to determine the **Sine** and **Cosine** outputs.
Carrier Phase Delay	T_{pd}	Seconds	0	Creates a phase delay in the output **Sine** and **Cosine** signals. This is used to simulate a physical delay in non-ideal resolvers.
Carrier Measurement				Selects the Analog Input channel to use as the carrier.
	Symbol	**Units**	**Default**	**Description**
Initial Carrier Angle	$_{init}$	Degrees	0°	Angle of the resolver upon initialization.
Excitation Frequency	f_{ex}	Hz	10000	Sets the frequency of the internal excitation carrier
Enable Internal Carrier			False	Enables the resolver model to use an internal excitation signal rather than an external signal from an Analog Input channel.
Force Initial Angle			False	Forces the **Initial Carrier Angle** parameter to be used during initialization.
Enable Resolver Parameters as Channels			False	Allows certain Resolver parameters to be exposed as tunable VeriStand Channels. See the **Advanced Channels** section below for more details.

Resolver Channels

This section includes the following custom device channels:

Channel Name	Symbol	Type	Units	Default Value	Description
Sine	Sin	Output		0	Sine signal generated by the resolver. When combined with **Cosine**, can be used to determine the machine's position.
Cosine	Cos	Output		0	Cosine signal generated by the resolver. When combined with **Sine**, can be used to determine the machine's position.
Carrier		Output		0	The Excitation signal used to calculate **Sine** and **Cosine** outputs as defined in equations (1) and (2).
Angle	resolve	Output	Degrees	0	The angle the resolver is "resolving," defined as $\theta_{resolve} = pp * (\theta_m - \theta_{offset})$ 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.

Advanced Resolver Channels

The following VeriStand channels are displayed under the **Advanced** section when the **Enable Resolver Parameters as Channels** option is enabled on the Resolver configuration page.

Channel Name	Symbol	Type	Units	Default Value	Description
Angle Offset	Offset	Input	Degrees	0° (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value describes the offset from the mechanical angle of the machine, $_m$. This value can be modified while the simulation is running.
Carrier Phase Delay	T_{pd}	Input	Seconds	0s (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value creates a phase delay in the output **Sine** and **Cosine** signals. This is used to simulate a physical delay in non-ideal resolvers. This value can be modified while the simulation is running.
Cosine Cosine Gain	Cos.Cos	Input		1 (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value applies a Cosine Gain to the **Cosine** Output signals. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information. This value can be modified while the simulation is running.
Cosine Sine Gain	Cos.Sine	Input		0 (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value applies a Sine Gain to the **Cosine** Output signals. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information. This value can be modified while the simulation is running.
Number of Pole Pairs	pp	Input		1 (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value applies a gain to the mechanical angle of the machine, $_m$, before it is translated to an electrical resolver signal. Modify this parameter if the resolver is attached to a gear box rather than connected directly to the rotor. To generate resolver signals whose speed corresponds to the mechanical speed of the machine, set this value to 1. See the **Resolver Model Equations** for more information. This value can be modified while the simulation is running.
Sine Cosine Gain	Sin.Cos	Input		0 (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value applies a Cosine Gain to the **Sine** Output signals. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information. This value can be modified while the simulation is running.
Sine Sine Gain	Sin.Sin	Input		1 (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value applies a Sine Gain to the **Sine** Output signals. This value must be a number between 0 and 1. See the **Resolver Model Equations** for more information. This value can be modified while the simulation is running.

Speed Sign		Input		Clockwise (value defined in the Resolver Configuration page)	When the **Enable Resolver Parameters as Channels** checkbox is checked, this value determines the speed sign based on the rotation of the resolver as follows: • **Clockwise** - The resolver outputs a positive speed when the machine rotates clockwise. • **Counter Clockwise** - The resolver outputs a positive speed when the machine rotates counter clockwise. This value can be modified while the simulation is running.

Resolver Model Description

A resolver is a sensor that provides feedback about the angular position and velocity of a rotating component, such as the rotor of an electrical motor.

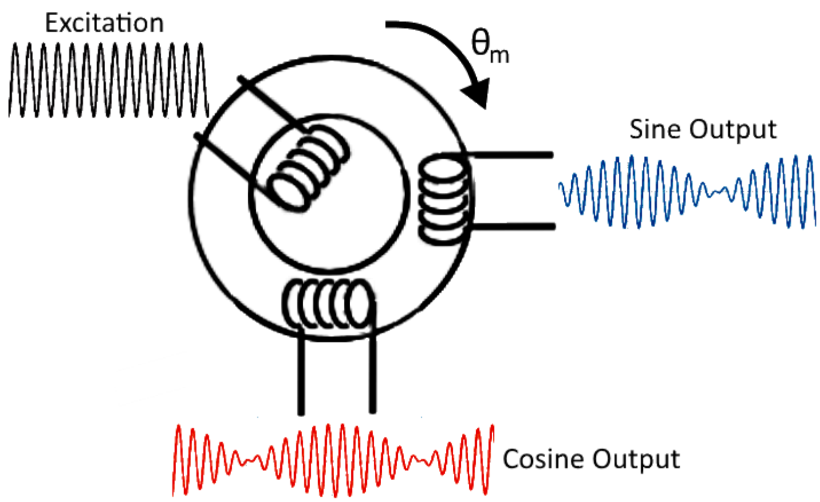

Figure 1. An example of a operating resolver where a sinusoidal excitation signal is input into the resolver and the result is two output signals, Sine Output and Cosine Output

During operation, a sinusoidal excitation signal is provided to the resolver. The resolver modulates the input excitation signal to produce two outputs representing sin(x) and cos(x), where x is the angle of the rotor. From the sin(x) and cos(x) signals controllers are reconstituted to calculate angular position of the machine.

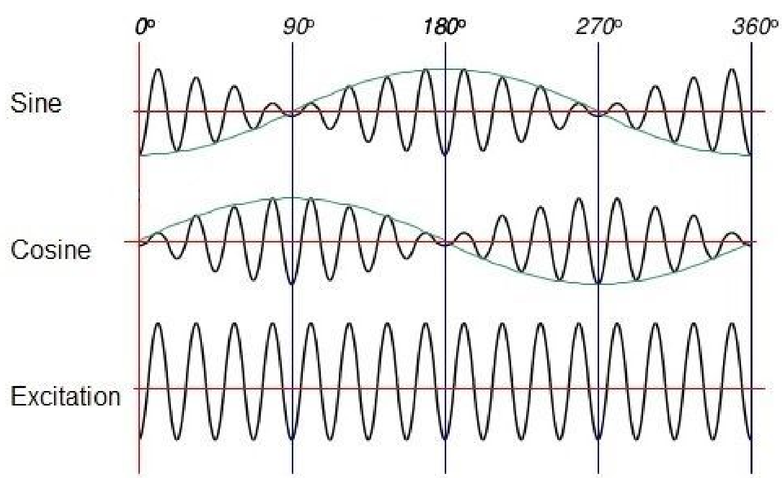

Figure 2. Sine and Cosine signals generated by a resolver with an input Excitation sinusoidal signal.

Resolver Model Equations

The resolver model outputs are calculated using the following sets of equations:

(1)

$$Sine\ Output = [Sin.Sin * sin(pp(\theta_m - \theta_{Offset})) + Sin.Cos * cos(pp * \theta_m - \theta_{Offset}))] * Excitation$$

(2)

$$Cosine\ Output = [Cos.Sin * sin(pp(\theta_m - \theta_{Offset})) + Cos.Cos * cos(pp * \theta_m - \theta_{Offset}))] * Excitation$$

Where Sin.Sin, Sin.Cos, Cos.Sin, and Cos.Cos represent gains that are applied to simulate a non-ideal resolver. To simulate an ideal resolver, set the **Sin.Sin** and **Cos.Cos** gains to 1, set the **Sin.Cos** and **Cos.Sin** gains to 0, set the **pp** to 1, and set the $_{\textbf{Offset}}$ to 0. This results in the following equations:

(3)

$$Sine\ Output = sin(\theta_m) * Excitation$$

(4)

$$Cosine\ Output = cos(\theta_m) * Excitation$$

Depending on the selected **Hardware Configuration**, some resolvers allow for their excitation to come from an external source and/or some excitation signals can come from a simulated circuit. Typical excitation signals are sinusoidal and greater than 1 kHz frequency.