7929 SW Burns Way
Suite B
Wilsonville, OR

Phone: 503 344-5085
Fax: 503 682-9014
sales@rinehartmotion.com

Shudder Compensation

Revision 0.2

7929 SW Burns Way
Suite B
Wilsonville, OR

Phone: 503 344-5085
Fax: 503 682-9014
sales@rinehartmotion.com

Revision History

Version	Description of Versions / Changes	Responsible Party	Date
0.1	Initial version	Chris Brune	1/4/2011
0.2	Added “Shudder_Speed_Fade” to the parameter table.	Azam Khan	1/19/2011

Table of Contents

7929 SW Burns Way
Suite B
Wilsonville, OR

Phone: 503 344-5085
Fax: 503 682-9014
sales@rinehartmotion.com

1. Introduction

Using an electric motor in a vehicle can expose driveline resonances (shudder) that might not normally be noticed in an ICE vehicle. Typically these resonances occur at very low speeds and moderate torque levels.

The shudder compensation system implemented on the PMxxx family converters provides a mechanism for the user to try and counteract the resonance.

The basic idea is to provide a compensating torque that tries to drive any AC components of the speed to zero. That is if the speed is found to be varying (oscillating) and additional torque is added to the command that attempts to remove the oscillation.

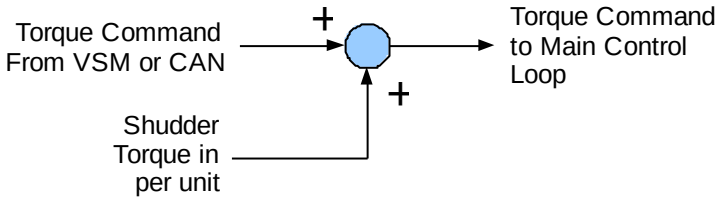

Figure 1: Shudder Torque Implementation

Figure 1 shows the mechanism for including the shudder compensation torque into the torque command. If shudder compensation is enabled the shudder torque value will be added to the normal torque command that comes from the VSM (vehicle state machine) or from a CAN command.

The mechanism for calculating the correct value of shudder torque compensation is shown in Figure 2. The compensation algorithm compares the electrical speed of the motor to a filtered version of the speed. The output of the comparison is then clamped to a value between +TCLAMP and –TCLAMP. This value is then phased out based on two speed parameters, Shudder Speed Lo and Shudder Speed Hi.

7929 SW Burns Way
Suite B
Wilsonville, OR

Phone: 503 344-5085
Fax: 503 682-9014
sales@rinehartmotion.com

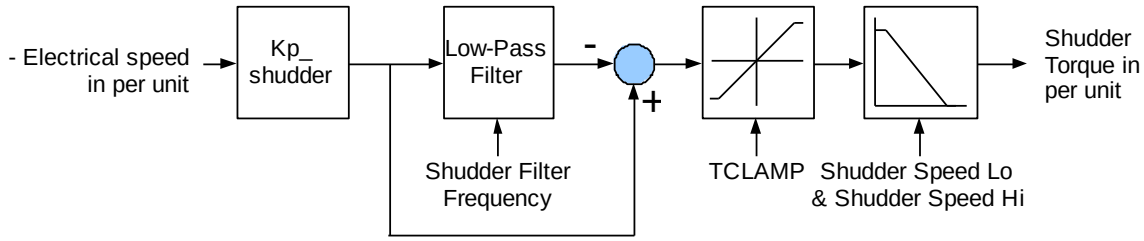

Figure 2: Shudder Compensation Algorithm

2. Parameters

There are several parameters used to control the Shudder Compensation system. These parameters are EEPROM parameters and can be accessed either via CAN or through the GUI software. Refer to the appropriate manual for more information on how to access the EEPROM.

Parameter	Description
Shudder_Compensation_Enable	This parameter is used to enable or disable the shudder compensation system. The default value is 0 for disabled. To enable the system change the value to a 1.
Kp_Shudder	This parameter defines the gain of the shudder compensation controller. This parameter has a scaling factor of 100. Thus a setting of 100 gives a gain of 1.00. The default value of the gain is 20 (or a parameter setting of 2000). Testing of the vehicle system will be necessary to determine the best gain setting.
Shudder_Filter_Freq	This parameter determines the frequency of the low-pass filter used in the shudder compensation algorithm (See Figure 2). The parameter has a scaling factor of 10. Thus a setting of 10 gives a frequency of 1.0 Hz. The default value of the parameter is 3.0 Hz (setting of 30). The filter frequency should be lower than the frequency of resonance of the drive-line. Again it may be necessary to perform testing on the vehicle to determine the correct value.
TCLAMP_Shudder	This parameter defines the maximum amount of compensation torque that will be added to the commanded torque. The parameter has a scaling factor of 10. Thus a setting of 10 gives a torque of 1.0

	Nm. The default value is 19.9 Nm.
Shudder_Speed_Fade	This parameters is used to define the linear phase in of the shudder torque compensation at lower speeds starting from 0 RPM. Between this value and Shudder_Speed_Lo, full value of shudder torque is used. This value must be lower than Shudder_Speed_Lo value.
Shudder_Speed_Lo Shudder_Speed_Hi	These two parameters are used to define the phase out of the shudder torque compensation at higher speeds. Both parameters are in RPM. Below Shudder_Speed_Lo the full value of the shudder torque is used. Between Shudder_Speed_Lo and Shudder_Speed_Hi the shudder torque is linearly decreased. Above Shudder_Speed_Hi the shudder torque value is 0. At higher speeds drive-line compensation may not be necessary. These two parameters allow the system to be phased out at higher speeds. The default values are 300 rpm for Shudder_Speed_Lo and 400 rpm for Shudder_Speed_Hi. Shudder_Speed_Lo must be less than Shudder_Speed_Hi.