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Setting up the PM Controller to run with Siemens Motors

Revision 0.3

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Revision History

Version	Description of Versions / Changes	Responsible Party	Date
0.1	Initial version	Chris Brune	9/20/2013
0.2	Add 1PV5138-4WS24 motor. Clarify the motor phase connections.	Chris Brune	7/23/2014
0.3	Clarify encoder signal names	Chris Brune	7/23/2014

1. Setup

This document describes setting up the Siemens Induction Motors for use on the PM Family inverters.

There several different Siemens induction motors available. The table below shows the configurations that have been configured for use with the PM Family controllers.

Motor Designation	Rated DC Voltage	Peak Power	Peak Torque	RMS Controller
1PV5135-4WS28	650V	150kW	360Nm	PM150DZ
1PV5135-4WS14	300V	84kW	200Nm	PM100DX
1PV5138-4WS24	650V	150kW	530Nm	PM150DZ

Note that motor ratings are given per Siemens specifications. Actual performance will also depend on the system DC Bus voltage and the available current of the inverter. Generally speaking available DC bus voltage will significantly affect the Peak Power capability. Available motor current / inverter current will directly affect the Peak Torque capability.

The Siemens motors use an encoder. The encoder and internal temperature sensor are connected to the inverter via a circular connector on the motor.

The encoder is connected to the inverter via the 12 pin circular connector on the top of the motor. The pins are assigned as shown in the table below.

There are potentially a number of different types of connectors that will work with the motor connector. The cable used by RMS was provided by Siemens, but Internet research provided the following alternatives:

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Amphenol, MA1CAE1200

Motor Pin	PM100 Pin	Function (Siemens signal name)
1	J2-9 or J2-16	Encoder A Output (Ua2)
2	J2-16 or J2-9	Encoder B Output (Ua1)
3	n/a	Not used
4	J2-1	5V Power (+5V…+20V)
5	J2-10	Ground (0V)
6	n/a	Not used
7	n/a	Not used
8	n/a	Not used
9	J1-24	Temperature Sensor 1+ (+1R1)
10	J1-2	Temperature Sensor 1-/2- (-1R1/-2R2)
11	n/a	Temperature Sensor 2+ (+2R1)
12	n/a	Not used

The motor comes with two KTY 84 temperature sensors. The software is only configured to actively look at one sensor. The sensor is connected to the AIN2 input of the inverter. A pull-up resistor must also be added to the harness between 5V power (J1-1) and the AIN2 input (J1-24). For the software to correctly read the temperature the pull-up resistor value must be 1K ohm.

The 2nd sensor can be connected to one of the unused analog inputs (with a pull-up resistor). It will be up to the user to convert the resulting analog voltage read by the controller into motor temperature.

The PM Controller is sensitive to how the motor phases are connected relative to the encoder connections. Generally speaking with 3 phase motors swapping two of the phases will “reverse” the direction of rotation. That is the motor will want to turn in the opposite direction. In the case of the PM Controller the rotation direction based on the motor phases MUST match the direction of rotation based on the encoder connections. If the two do not match the motor will have a tendency to lock at zero speed.

The Siemens motors generally have wires that are marked UVW. The connections can be made as follows:

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Motor Side	Inverter Side Connections					
U	B	A	C	A	C	B
V	A	C	B	B	A	C
W	C	B	A	C	B	A
Ua2 (pin 1)	J2-9 ENC A			J2-16 ENC B		
Ua1 (pin 2)	J2-16 ENC B			J2-9 ENC A		
Rotation	CCW			CW		

The Rotation direction is when the user is facing the shaft side of the motor.
In our experience the motor connection closest to the encoder connector is W.

2. Setting the 'Motor Type'

The PM Family firmware has the ability to drive many different motor types. The user must tell the controller what type of motor it is to be used with.

The PM Family firmware is divided into two separate firmware files. The Group 1 firmware is for motors that have a motor type number less than 60. Group 2 is for motors that have a motor type number of 60 or higher.

The controller must be programmed with the correct firmware version for the motor type that is selected.

The user sets the motor type via the Motor_Type_EEPROM parameter. Refer to the Programming EEPROM Parameters using GUI manual for more information on programming EEPROM parameters.

Motor Info	Motor Type	Firmware
1PV5135-4WS28	2	Group 1
1PV5135-4WS14	61	Group 2
1PV5138-4WS24	77	Group 2

When you set the motor type via the GUI it will automatically adjust some default parameters. However, there are several additional parameters that should be reviewed and adjusted if desired.

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EEPROM Parameter	Description
Veh_Flux_EEPROM_(Wb)_x_1000	This is the back EMF (flux) constant for the motor. It will automatically default to the correct value when the motor type is changed. There is no need to change this.
IQ_Limit_EEPROM_(Amps)_x_10	This parameter sets the maximum value of the torque producing current that can be commanded. The amount of allowable current is dependent on the motor type and the controller type. The controller is the limiting factor for the motor current. Set the IQ_limit to be 636 Apk (450Arms). The current is set in peak Amps times 10. For example, 300 A_{rms} = 4250.
ID_Limit_EEPROM_(Amps)_x_10	This parameter sets the maximum ID current.
Mtr_OverTemp_Limit_EEPROM_(C)_x_10	This parameter sets the motor over-temperature fault limit. It is set in degrees C times 10. Thus for 150°C it would be set to 1500. The motor does not have a linear sensor so the motor will read 25°C when the sensor is not tripped and 155°C when the sensor is tripped. So a setting of 150°C will trip the inverter when the sensors reads 155°C.
Motor_Overspeed_EEPROM_(RPM)	This parameter sets the speed at which an over-speed fault will be generated. It should be set based on the needs of the vehicle system for over-speed protection.
Max_Speed_EEPROM_(RPM)	This parameter sets the maximum speed that the controller will command.
Break_Speed_EEPROM_(RPM)	The Break Speed is the speed at which the torque capability of the motor starts to decrease due to lack of voltage from the motor controller. This value should be set based on information from either RMS or Parker on the performance of the motor with the particular battery voltage being used.
Motor_Torque_Limit_EEPROM_(Nm)_x_10	This sets the maximum torque command when operating in VSM mode.
Regen_Torque_Limit_EEPROM_(Nm)_x_10	This sets the maximum regen torque command when operating in VSM mode.

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2.1 Recommended Settings for Parameters

The table below shows the RMS recommended settings for the parameters that are motor specific. There are many factors that may influence a decision to deviate from these settings. If there are questions about setting please contact RMS for more information

	1PV5135-4WS28 w/ PM150DZ	1PV5135-4WS14 w/ PM100DX	1PV5138-4WS24 w/ PM150DZ
Motor Type	2	61	77
Veh_Flux	*	*	*
IQ_Limit	354 Apk	396 Apk	425 Apk
ID_Limit	100 Apk	190 Apk	100 Apk
Motor_Overspeed	10500 rpm	10500 rpm	10500 rpm
Max_speed	10000 rpm	10000 rpm	10000 rpm
Break_Speed	4000 rpm	4000 rpm	2500 rpm
Torque_Limit (Regen or Motor)	360 Nm	200 Nm	530 Nm

* Do not change the Veh_Flux level from the default that is set when the motor type is changed.