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# Self Sensing Assist Manual

**Revision 0.4**

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# 1. Introduction

A Self Sensing Assist mode is available for select motors in the Gen 5 Code base. Self Sensing Assist mode utilizes a synchronous frame back-EMF observer position estimate and a vector tracking observer to correct for resolver error at high speed and power. This mode utilizes the current sensor measurements, known motor parameters, and a low resolution position signal, (heavily filtered resolver output) to derive an accurate motor position for control.

This is not a full Self Sensing or Sensorless approach and is used exclusively for high speed operation in conjunction with an existing motor position signal. This Self Sensing Assist mode was designed and implemented to address oscillation issues of the HVH250-115-DOM motor present in the iM225DX-D and iM375DZ-D products.

This approach utilizes the full fidelity of the installed resolver for low speed or low power operation and then switches to Self Sensing Assist mode at higher speed and power such that the Self Sensing Assist mode still utilizes a heavily filtered speed signal from the resolver but otherwise uses Self Sensing techniques to derive the true motor position. This, in effect, filters out any magnetic coupling or noise in the resolver without adding any lag to the system such that full capability control is still possible.

The general architecture of control is presented below in Figure 1.

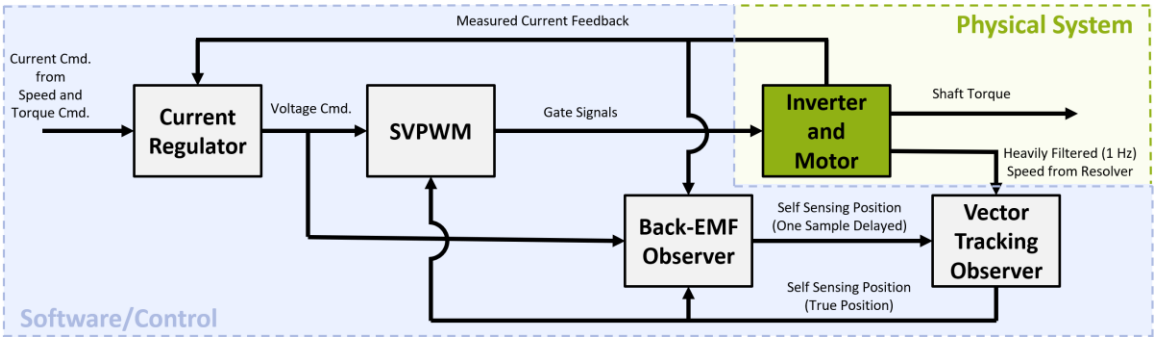


*Figure 1. General architecture of Self Sensing Assist mode.*

# 2. Implementation

## *2.1 Overview*

Self Sensing Assist mode is implemented in the code base only for specific motor types. These motor types are listed in the table below. To utilize the Self Sensing mode one of these motor types must be used and the Self_Sense_Assist_Enabled_EEPROM must be set to 1 to enable use of the mode, this is detailed more in following sections. Each of these motor types also have their own respective transition points in and out of the Self Sensing Assist mode. To enter Self Sensing assist mode all five criteria must be met; speed transition, torque transitions, greater than the minimum PWM frequency, and EEPROM enable.

| Self Sensing Assist Motor Types | Speed Threshold [RPM] | Torque Threshold [Nm] | Torque Max [Nm] | Minimum PWM Freq. [kHz] |
|---|---|---|---|---|
| 5 | 2100 | 55 | 500 | 6 |
| 21 | 2100 | 55 | 500 | 6 |
| 10 | 2100 | 55 | 580 | 6 |
| 28 | 2100 | 55 | 580 | 6 |

These transition points also have some built in hysteresis such that once enabled Self sensing Assist mode will stay on until 80% of the speed threshold is met or 50% of the torque threshold is crossed.

Note: Self Sensing Assist mode will never be active during regen operation.

i.e. For motor type 5, during a speed ramp at 100 Nm (with the PWM at 6 kHz or greater), Self Sensing Assist will turn on once the speed crosses 2100 rpm. Self Sensing Assist will turn off if the speed drops below 1680 rpm, the torque drops below 27.5 Nm, torque goes above 450Nm, or the PWM frequency drops below 6 kHz.

## *2.2 Safety Features/Limitations*

Self Sensing Assist mode also has some inherent built-in safety features. These are all internal to the code and require no user configuration but may be useful to understand for some users. During turn on and running conditions the inverter software will constantly be looking for large angle error between the resolver and the Self Sensing Assist mode. If this error is too large, Self Sensing Assist will either not turn on or will turn off. Excessively large angle error will lead to loss of inverter control and inverter faults which would shut down the inverter, reverting to the resolver signal ensures constant inverter operation even if the Self Sensing Assist mode fails. To reinitialize the Self Sensing assist mode the user must lower the torque or speed of the motor below the respective threshold and then Self Sensing Assist will attempt to turn on again in the next instance which meets all five criteria listed above.

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## *2.3 Self Sensing Assist Mode Settings*

The following EEPROM settings are used to enable the Self Sensing Assist mode in the RMS GUI.

| RMS GUI Parameter | GUI Address | CAN Address | Value Range | Description |
|---|---|---|---|---|
| Self_Sense_Assist_Enabled_EEPROM | 0x01C1 | 251 | 0 or 1 | This parameter determines whether Self Sensing Assist mode is active or not. Note: The motor type must also support Self Sensing Assist for the mode to be active. The value will not program to 1 if the motor type does not support the Self Sensing Assist functionality.<br>1 = ON<br>0 = OFF |

Additionally, in firmware 6522 and beyond, a new signal is relayed over CAN which reports when Self Sensing Assist Mode is enabled/active or not. This message, INV_Self_Sense_Enable, is in the latest CAN iM-225 DBC file.

# Revision History

| Version | Description of Versions / Changes | Responsible Party | Date |
|---|---|---|---|
| 0.1 | Initial version. | Christian Tigges | 6/6/2022 |
| 0.2 | Added Safety Features/Limitations section | Christian Tigges | 7/17/2022 |
| 0.3 | Added Motor Type 10 and 28 | Christian Tigges | 9/13/2022 |
| 0.4 | Removed Self Sensing in Regen | Christian Tigges | 12/1/2022 |