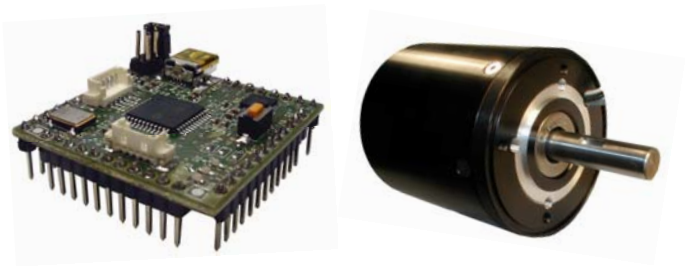

Motion control with iCM4011

Application note

development tools

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1 Introduction

A motor controller is a device that takes charge of motor movements, trying to maximize its efficiency at the same time it minimizes the deviations from the premises established by the user (position, speed, acceleration, etc.).

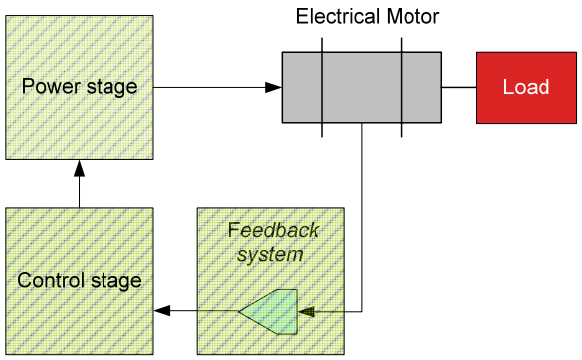

Figure 1: Basic stages of a motion control system

This document presents a motion control solution for a **Permanent Magnet Synchronous Motor** (here onwards referred as PMSM) based on an iCM4011 device. It shows how to connect the different components to perform a closed loop control by using Hall-effect sensors, trapezoidal commutation and PWM modulation.

2 Motion control with iCM4011

The chosen components for this application are:

- Electric motor (PSMS): Crouzet direct drive brushless DC - 30 Watts (nominal voltage: 24V, nominal speed: 2.200 rpm, nominal intensity: 1,9 A) [5]
- Feedback system: Hall-effect sensors
- Control stage: iCM4011 device
- Power stage: Apex SA305 power driver
- Power system: 12V (logic) and 24V (motor).

Figure 2 shows the schema of a trapezoidal commutation controller with a current closed loop.

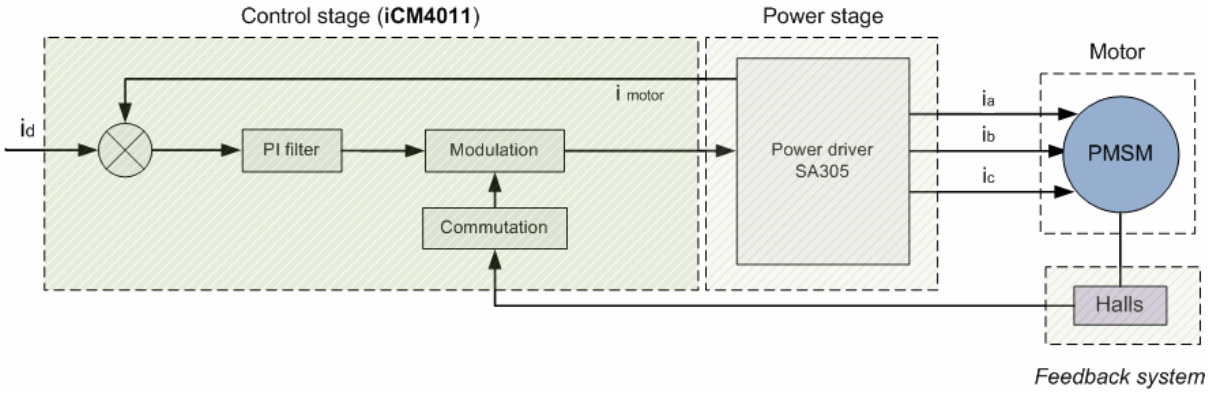

Figure 2: Trapezoidal commutation controller schema using an iCM4011

2.1 Control stage (iCM4011)

Thanks to iCM4011 features, such as its high computation capacity and its wide set of communication interfaces, it can perform the following necessary control stage functions:

- Application of movements algorithms
- Stages coordination
- Communications

According to the controller schema shown in Figure 2, the functions of iCM4011 are explained in next points.

2.1.1 Commutation

A closed loop control is developed in this application by using Hall-effect sensors. To properly perform the commutation in the motor windings, the controller must obtain the absolute rotor position within an electrical cycle. Three Hall-effect sensors provide the iCM4011 device with the rotor position information. These sensors are distributed along the stator in such a way that they generate six different logic states per electrical cycle. The sensors are powered through the iCM4011 voltage regulator.

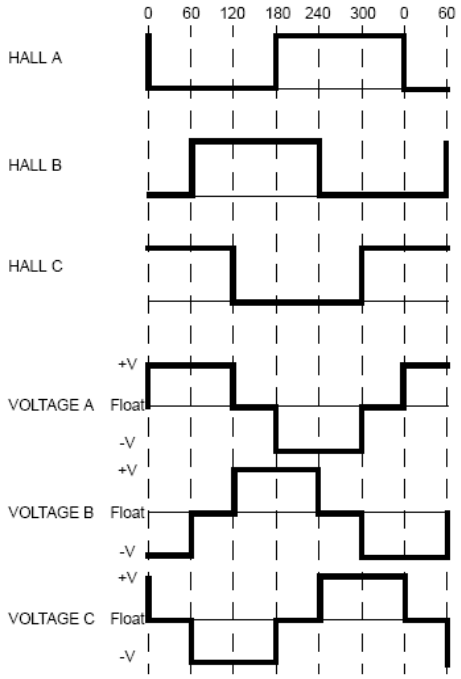

Figure 3: Six-step commutation for trapezoidal PMSM.

2.1.2 Current closed loop

In this loop, the current that circulates through the pair of active terminals (i_{motor}) is compared with the user's demanded current (i_d). The A/D converter of the iCM4011 is used to digitalize the current that flows through the motor and then substracted from the premise. The resulting difference (error) of the above mentioned subtraction is applied to a PI (Proportional-Integrative) filter that tries to correct the deviation and, therefore, minimizes the error. In this example a PI filter has been chosen. However, the user may apply another type of filter according to his requirements and needs of control. With this technique we manage to keep constant the current that circulates through motor windings [2].

2.1.3 Modulation

Pulse Width Modulation (PWM) is a method to control the power given to a load. It uses a square wave whose duty cycle is modulated resulting in the variation of the average value of the waveform.
In our case, the load is the PMSM and PWM signals are directly generated by iCM4011.
With PWM the same modulation is applied to all motor phases. An application example is shown in Figure 4: changing duty cycle, motor velocity will change [4].

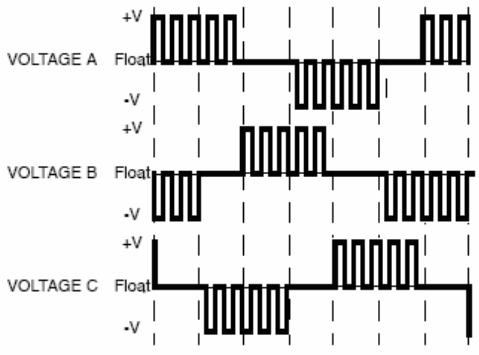

Figure 4: PWM application example

2.2 Power stage

The power stage provides the motor with the necessary current, which will be converted into movement and motor torque. For this application a power driver is needed, because iCM4011 can not perform this task.
The selection of an appropriate driver is directly related to the motor voltage and intensity. A SA305 Apex driver fits the requirements of this application because it can be powered up to 60V with an output current of up to 5A per half-bridge [3].

Figure 5 shows a connection diagram with the different components of the application. The PWM modulation signals come from iCM4011 device and are directly connected to the power driver.

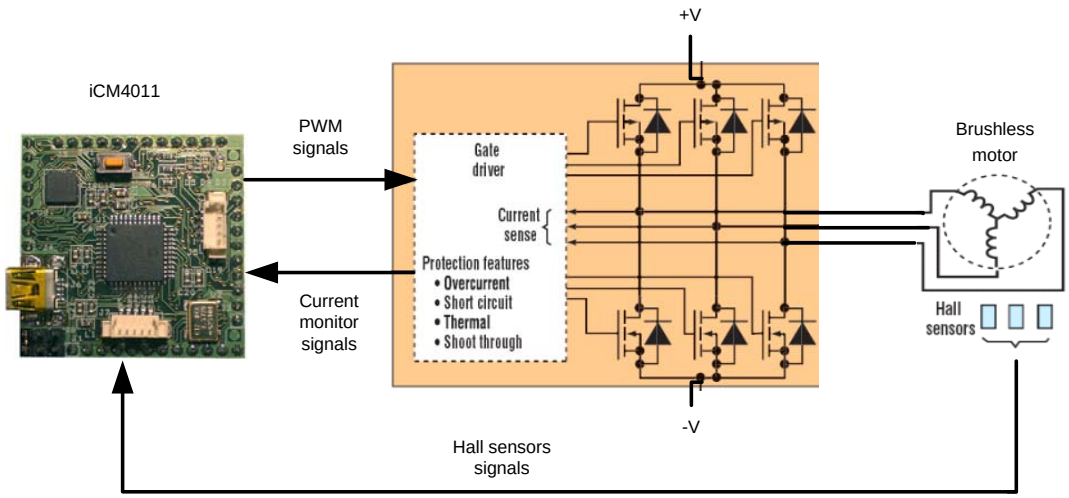

Figure 5: Connection diagram

3 Conclusions

A motion control solution based on iCM4011 for permanent magnet synchronous motors has been presented in this document. Trapezoidal commutation with pulse width modulation has been the technique chosen to perform the control.
Trapezoidal commutation gives to the user a first control approach thanks to its fast and easy implementation. However sinusoidal commutation could be more suitable for motion control applications that require higher precision. iCM4011 also has enough computation room for sinusoidal commutation, and direct inputs for quadrature encoder feedback signals.

One key point that helps to minimize the development time is the rapid way to reprogram iCM4011 device. The processor is pre-programmed in factory with a bootloader firmware that allows users to load programs thought RS232 or USB ports in few seconds, without the need of an external programmer or additional software.

Regarding the communications between the stage control and the host, user can choose among the multiple communication set that iCM4011 device incorporates (CAN, RS232, RS485, I^2C, SPI).

4 References

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