Speed Controllers for Motors with Analogue Hall Sensors

Motivation

When using analogue Hall sensors, a speed resolution many times that of digital Hall sensors is achieved.
For systems with digital Hall sensors, only 6 pulses are available per revolution; for analogue Hall sensors, 2048 increments are available for Speed Control systems.
The advantages and special features of these drives with SC are explained here.

Applies to

2232BX4 SC 3692	2250BX4 SC 3692	3242BX4 SC 3692	3268BX4 SC 3692
SC5008 4289	SC2804 4289	SC1801 4289	

Description

Minimum speeds

SC with analogue Hall sensors:	50 rpm
SC with digital Hall sensors:	500 rpm
MC with analogue Hall sensors:	5 rpm

Accuracy:

Above these speeds, accuracies of approx. Δn 2% … 5% can be reached for systems with analogue Hall sensors (MC and SC) depending on motor type, load and inertia.
For digital Hall sensors, the speed accuracy may also lie outside of this corridor.

Example measurement with 2232S012BX4 at 24V, load inertia J = 15 g cm²

Speed setpoint in rpm	5	50	500	5000	Controller
Δn in rpm	+/- 3	+/- 5	+/- 20	+/- 20	SC analogue Hall
Δn in rpm	+/- 1	+/- 2	+/- 15	+/- 20	MC
Δn in rpm	Not possible	Not possible	+/- 20	+/- 20	SC digital Hall

Boundary condition for the measurement: No load changes
Observation:
The speed fluctuations occur cyclically within an electrical revolution (1/2 motor revolution for 4-pin motor).

Operation at even lower speeds:

Below the specified minimum speeds, the speed fluctuations increase considerably; this is particularly pronounced when using digital Hall sensors. Speeds below approx. 200 - 500 rpm cannot, thus, be controlled in a meaningful manner.
When using analogue sensors, approx. 2 rpm is also possible if there are no special requirements placed on the speed accuracy.

Dynamic behaviour

The control properties of systems with digital Hall sensors are limited, i.e., larger fluctuations can be corrected only slowly.

When using analogue Hall sensors, both the behaviour of the command variable (= setpoint change) as well as that of the disturbance variable (=load change) is improved considerably compared to systems with digital Hall sensors. This is made apparent by a considerably faster control time of a load step or response time to a new speed setpoint.

Example measurement
3564K024 at 24V, load inertia J = 20 gcm² [1]

SC digital Hall	Correction of load step and command variable step	each approx. 3 sec
SC analogue Hall	Correction of load step and command variable step	each approx. 0.8 - 1 sec

[1] The transition times of the control are heavily dependent on the given application.

Controller parameters

To achieve the given speeds, accuracies and a dynamic behaviour, it is often necessary to adapt the controller parameters to the application. The tuning assistant of the Motion Manager provides support when adjusting applicable parameters.

For Speed Controllers, a programming adapter is necessary for this purpose.

When using analogue Hall sensors, it is possible to use the same controller parameters over a very large speed range. On delivery, the parameters are already set relatively strictly. Thus, adjustment to the application is often not necessary.

For digital Hall sensors, the controller parameters are set relatively lax on delivery in order to have a controller that is initially stable in a variety of load situations and speed ranges.
Adjustment to the application, particularly with respect to the speed range, is often necessary here.

Note on the adjustment:
For Speed Control and Motion Control systems, the controller parameters are scaled differently. For manual fine-tuning, this means that the parameters for SCs can be adjusted in increments of 50 or 100; for the MC, on the other hand, adjustments in increments of 5 or 10 are more meaningful.

Maximum speeds

DFF Speed Controllers generally operate with block commutation, even if analogue Hall sensors are used. Compared to pure sinus commutation, this has the advantage that a larger voltage amplitude can be output to the motor.

<u>Example measurement</u>
2232S012BX4 at 24V:

	Max. achievable speed
SC	13200 rpm
MC – standard setting (pure sinus commutation)	11700 rpm
MC – deactivation of pure sinus commutation	12900 rpm

If the maximum possible speed range of the motor is to be fully utilized, Speed Control systems thus have a slight advantage over Motion Control systems.

Summary

In operation, analogue Hall sensors in Speed Control systems hold the following advantages over systems with digital Hall sensors:

- Lower speeds are possible
- Faster correction of load fluctuations
- Faster correction of speed setpoint changes
- Larger speed range covered with the same controller parameters

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