

## Brushless DC Motor System Solution

### Overview

A brushless DC motor (BLDC) is a DC-powered synchronous electrical motor which has an electronically controlled commutation system instead of a mechanical commutator used in brushed DC motors.

The electromagnets in a BLDC motor do not move. Instead, the permanent magnets rotate and the armature coil-windings remain static. In order to obtain a rotating magnetic field to turn the rotor, the brush-system assembly is replaced with an electronic controller.

The pulsewidth-modulated control signals and the commutation sequence are generated by the microcontroller HVC 22xyA (HVC). This is a highly integrated microcontroller operating directly at 12V supply voltage. To determine the correct commutation time slot, the mechanical rotor position is detected by three Hall switches embedded into the stator. The HAL<sup>®</sup> 2xy/HAL 5xy family is ideally suited for this purpose. When the magnetic poles of the rotor pass the Hall sensors, they give a High or Low signal, indicating that the North or South pole is passing the sensors. Due to the combination of these three Hall sensor signals, the exact commutation sequence can be determined.

### System Description

The Micronas system solution goes one step ahead compared to today's available solutions. In a classical BLDC application, all control functionality including microcontroller and motor bridge are located outside the motor. The proposed system described here includes all these components. The employed microcontroller is a member of the Micronas HVC 22xyA family, the Hall switches are members of the Micronas HAL 2xy/ HAL5xy family.

Two motor version are of interest:

- ◆ A simple two-wire version which provides a variable motor speed depending on the supply voltage
- ◆ A version with three or four wires including control/configuration signals (this could be e.g. a serial bus interface or a pulse/revolution monitor signal)

### Micronas Products Used in System

#### High-Voltage Controller Family HVC

The high-voltage controller family HVC 22xyA operates directly at 12V and features an 8-bit CPU core. It is based on the 8051 processor with a two-clock machine cycle and operates at a maximum clock frequency of 24 MHz. An internal oscillator with PLL provides the system clock. The internal RC clock is used for the independent window watchdog.

I/O ports have multiple functions, all of them can withstand even the automotive battery voltage range and ISO 7637-2:2004 with a serial resistor only. The built-in active EMI suppression helps to reduce the peak values.

#### Hall Switch Family HAL 2xy/HAL 5xy

The Hall switches of the HAL 2xy/HAL 5xy family include a temperature-compensated Hall plate with active offset compensation, a comparator, and an open-drain output transistor.

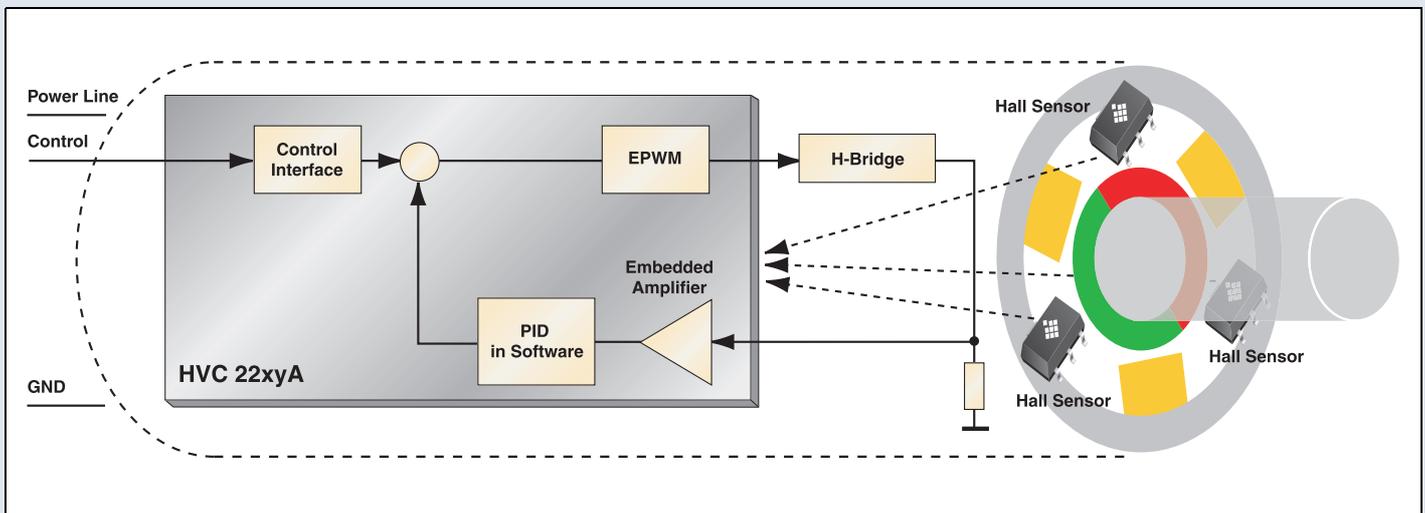
The comparator compares the actual magnetic flux through the Hall plate (Hall voltage) with the fixed reference values (switching points). Accordingly, the output transistor is switched on or off.

**Simple Two-Wire Motor with Power Supply only**

The internal driver electronics provide the control similar to a conventional DC motor. By increasing the applied voltage, the speed and the torque are also increased. The HVC controls the complete motor current and can, for instance, automatically limit the motor current to protect the motor against stall conditions.

**Motors with more than two Wires (Power + one or two Control Signals)**

A more enhanced motor version can feature control or communication means to include a speed/torque control loop. The HVC with its integrated features, such as EPWM, internal amplifier, etc. provides a complete velocity control system within the motor. The motor speed can be controlled by means of an analog signal (0..5 V) or a serial bus system. Optionally, an additional output pin can provide a PWM signal for frequency counting. Fig. 1 shows a simplified control circuit of the motor.



**Fig. 1:** Brushless DC motor with integrated control electronics

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