Automotive Applications using brushless DC motors

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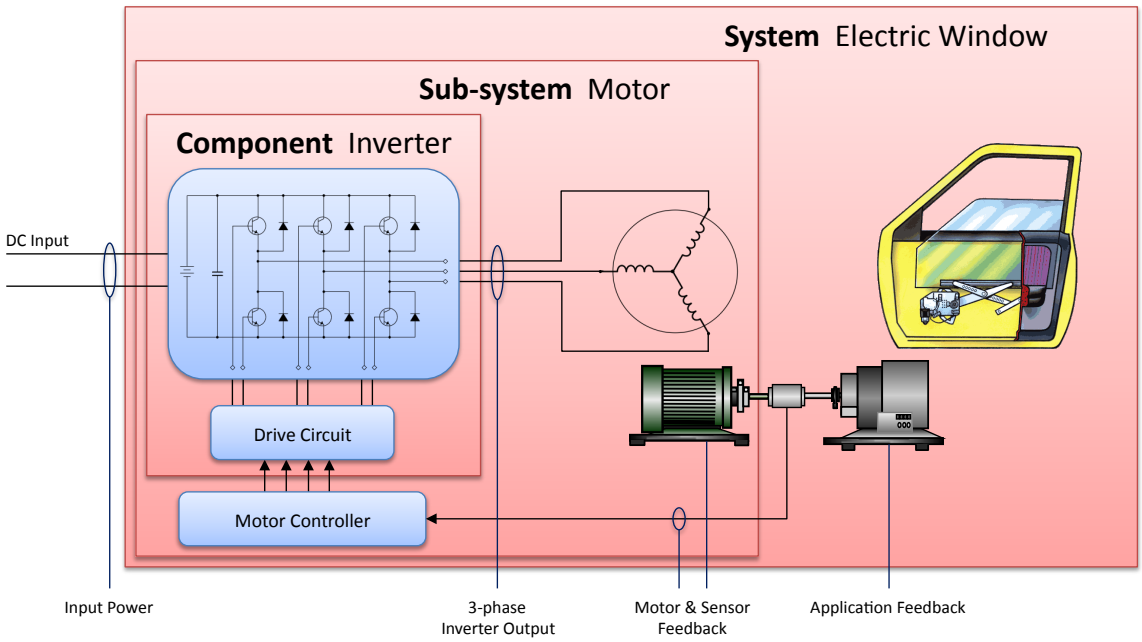

Figure 1: Brushless DC motor in an electric window application

What is a ScopeCorder

A ScopeCorder is a powerful portable data acquisition recorder that combines features of a multi-channel digital oscilloscope and a high-performance oscillographic recorder. As such, it can capture and analyse both short-term transient events and long-term trends for periods up to 200 days. Using flexible modular inputs it combines measurements of electrical signals, physical data (sensors) and CAN, LIN and SENT serial buses. A ScopeCorder's' Real-Time analysis capability enables triggering on calculated electrical power variables (e.g. active power, harmonics) or more common analysis functions (e.g. integrals, differentials).

Motors are everywhere

In-vehicle systems become increasingly more electromechanical. Think of motorised seat adjustment, electric window, power steering, HVAC fans, pumps, etc. In many of these systems one or even multiple motors are used as actuators. Various types of motors are in use, but specifically 3-phase brushless DC (BLDC) motors are gaining popularity as they provide important advantages:

- Improved speed vs. torque characteristics
- High dynamic response
- High efficiency
- Extended speed ranges
- Long operation life

BLDC motors use electric switches for current commutation, and thus continuously rotate the motor. For 3-phase BLDC motors in general a three-phase bridge structure (inverter) is used as shown in figure 1. In order to easily and efficiently limit the start-up current, control speed and torque, pulse-width modulation (PWM) is applied to some or all switches.

By changing the switching frequency for the inverter, the motor behaviour and performance can be influenced. Increasing the switching frequency will also increase PWM losses, whereas lowering the switching frequency will limit the system's bandwidth and can damage or shut down the BLDC motor driver.

Start your measurements

Dependent on the development goal and the set requirements, tests need to be performed on single components (e.g. inverter), sub-systems (e.g. motor including electronics) and/or systems (e.g. electric windows).

A perfect start for tests is the oscilloscope already at your desk. It is a known product, easy-to-use, provides 2, 4 or even 8 channels and solves quite a bit of the measurement and analysis needs. The

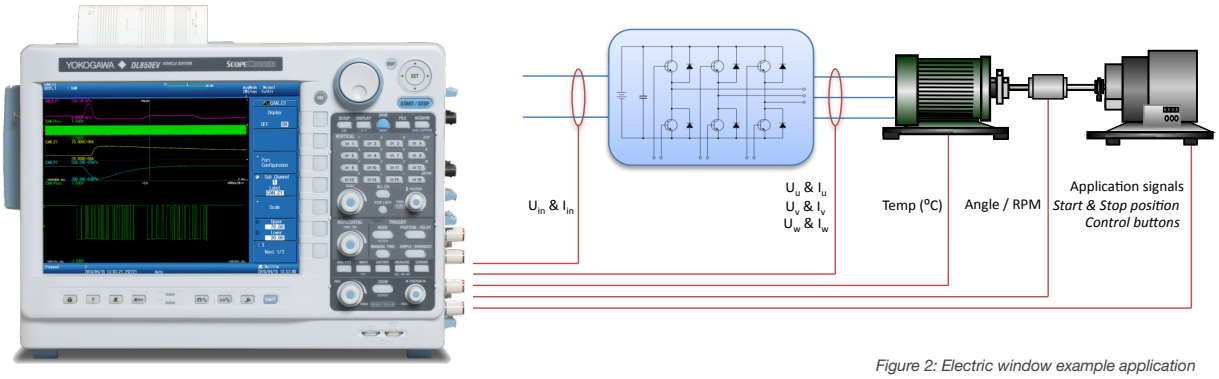

Figure 2: Electric window example application

Yokogawa DLM2000 or DLM4000-series could easily be this perfect starting point. Using an oscilloscope however also presents some challenges. To connect to the high voltage signals coming from the inverter you need channel isolation or differential probes. The vertical resolution and effective accuracy (noise reduction and stability) can be insufficient for precise electrical or sensor measurements and the appropriate signal conditioning is lacking.

With the example application of an electric window tester as shown in figure 1, you can soon run out of channels:

- Input Power – 2 channels (U and I)
- 3-phase Inverter Output – 6 channels (3 time U and I)
- Motor & Sensor Feedback – 3 channels (RPM, Angle and Temperature)
- Application Feedback – multiple digital channels (position switches, control buttons)

You can consider adding a second oscilloscope, but this will not solve the before mentioned issues. In fact, it will add complexity to the entire measurement setup and post-measurement data processing.

One flexible solution

At this time a ScopeCorder is the solution to be considered. Its modular design and software flexibility will save you a lot of time in the implementation phase of your application.

As you can choose modules with the appropriate signal conditioning and isolation specifically tied to your application, you no longer have a need for differential probes and (custom) signal conditioning electronics, cutting costs and allowing you to start measuring immediately after taking it out of the box.

Your experience with oscilloscopes and their way of working, allows you to quickly start working with the ScopeCorder, considering its oscilloscope-based user interface.

Because all measurement channels are integrated into a single instrument there is no need for external synchronisation.

This same instrument also features a wide range of analysis functions that can be used in your measurement application, giving you the option to implement the entire application on the ScopeCorder. In addition you can choose to store the measurement and analysis data to perform offline analysis.

Besides making your life as an engineer easier, a ScopeCorder will save test development and test analysis time resulting in a lower cost of test for your application.

Will it suit your application?

If you want to learn more about a ScopeCorder's many other features and how they can solve your measurement needs, please also read "10 reasons to choose a ScopeCorder as your next measuring instrument"

Do you want to verify whether a ScopeCorder meets your application needs? Let us demonstrate its capabilities while measuring on your signals! Request a free on-site demonstration here.

Example Configuration

The configuration to solve the electric window application shown in figure 2 could be:

Main Frame

ScopeCorder DL850E-F-HE/M2/HD1/G5/P4

-F	VDE power connection
-HE	English menu and panel
/M2	Increased memory for faster or longer measurements
/HD1	Internal HDD for measurement storage or longer measurements
/G5	Real-Time analysis of signals (e.g. power measurements)
/P4	Power supply outputs for probes

Modules

4 modules (type 720211 – 2ch, 100MS/sec, 12-bit inputs) to measure the voltages and currents (U_{in}, U_u, U_v, U_w, I_{in}, I_u, I_v & I_w)

1 module (type 720230 – 2port Logic Input) to measure the angular sensor and the digital signals from the application

1 module (type 701281 – 2ch Frequency Input) to measure the motor RPM / speed

1 module (type 701261 – 2ch Voltage/Temperature Input) to measure the motor temperature