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White Paper

Achieve Fast and Accurate Over-Current Detection Using Optically Coupled Sigma-Delta Modulators

Wong Chee Heng (IC Design Engineer, Isolation Products Division) and Lim Shiun Pin (Technical Marketing Engineer, Isolation Products Division)

Introduction

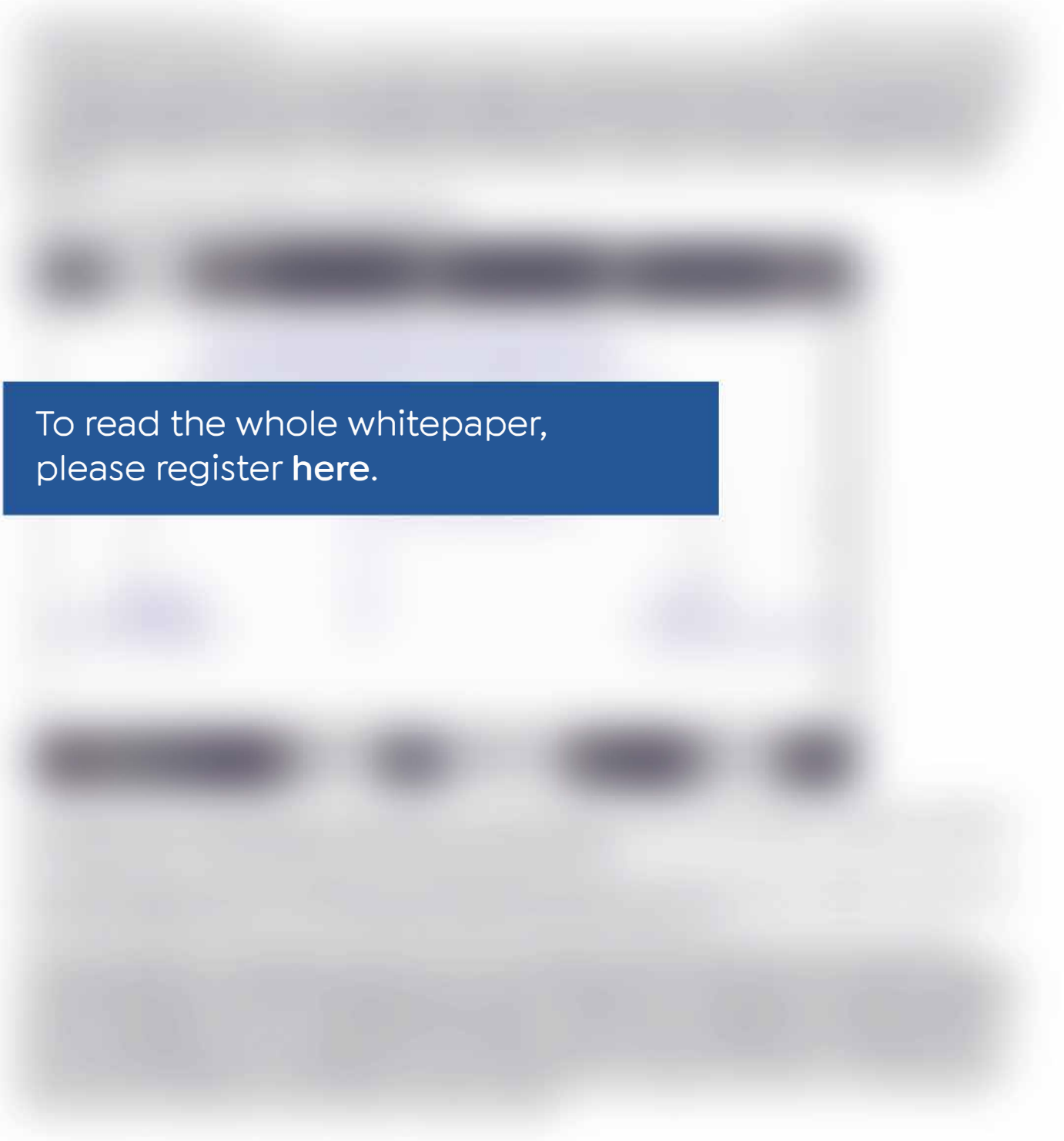
In an industrial motor control system, sensing and feedback of various parameters such as motor phase, DC bus current and voltage, torque, direction, and speed are required for proper operation of the system. As the trend of the system moves towards higher precision, power, speed, multi-axis, and multi-directional, these requirements become increasingly important. As the motor encoder measures the torque, speed, and direction, the sigma-delta modulator provides high accuracy, high linearity, wide dynamic range, fast-response current, and voltage sensing. Traditionally, current sensing is done by using current transformer (CT) or a Hall effect sensor (HES), but these solutions are bulky, expensive, and less accurate over operating temperature. A smaller, low-cost solution can be realized by directly connecting a shunt resistor to the sigma-delta modulator. Phase current flows through the shunt resistor with a resistance value selected such that the maximum current range corresponds to an optimum low voltage of about ±50 mV (for ACPL-C799) or ±200 mV at the input of the sigma-delta modulator. At this low voltage, power dissipation loss across the shunt resistor is minimized. Figure 1 illustrates the phase current sensing and DC bus voltage and current sensing of a sigma-delta modulator in a motor control system.

Optically Coupled Sigma-Delta Modulators

One of the most expensive devices in a motor control system is a power semiconductor switching device like the IGBT or power MOSFET. Switching at high frequency, these power devices introduce unintended noise and high-voltage transients across the control system. This high-frequency transient may affect the normal operation of the sensitive, costly microcontroller. Sigma-delta modulators in combination with superior optical coupling isolation technology deliver high noise margins and excellent immunity against isolation mode transients. With a minimum distance through insulation (DTI) of 0.5 mm, these sigma-delta modulators provide reliable double protection and a high working voltage suitable for fail-safe designs. This proven isolation performance is superior to magnetic or capacitive-based isolators, where DTI is only a third of 0.1 mm.

Sigma-delta modulators[1,2,3,4] convert the analog input signal into high-speed single-bit data streams by means of a second-order sigma-delta over-sampling modulator. The time average of the modulator data is directly proportional to the input signal voltage. This white paper specifically discusses the ACPL-796J and ACLP-C799 optically isolated sigma-delta modulators.

1. "ACPL-C799 Optically Isolated ±50 mV Sigma-Delta Modulator", pub-005830 Data Sheet, August 26, 2016
2. "ACPL-C797 Optically Isolated ±50 mV Sigma-Delta Modulator", AV02-2581EN Data Sheet, November 18, 2013
3. "ACPL-796J Optically Isolated Sigma-Delta Modulator", AV02-1670EN Data Sheet, March 6, 2015
4. "ACPL-798J Optically Isolated Sigma-Delta Modulator with LVDS Interface", AV02-4339EN Data Sheet, August 8, 2015



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