Gate Drive Optocoupler Simplifies Inverter Design

Replacing conventional single and multi-speed electric motors with semiconductor-based variable-speed drives offers significant energy savings. A growing number of engineers choose to use integrated gate drive optocouplers in their inverter designs. First of all, integrated gate drive optocouplers provide both level shifting and reinforced (safe) isolation at the interface between the power stage and the control circuitry. The new ACPL-H312 integrated gate drive optocoupler is a basic building block for all kinds of inverters.

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As an effect of high energy prices and increased attention to environmental issues, the market for energy-saving or 'green' technology is soaring. Replacing conventional single- and multi-speed electric motors with semiconductor-based variable-speed drives offers significant energy savings and a return on investment which can readily be seen in the electricity bill. By introducing the same type of technology into cars (hybrid electrical vehicles), the automotive industry is able to save 20 to 30% on total fuel consumption. On the supply side of the energy equation, semiconductor-based inverters are enabling efficient conversion of green energy, for example solar or wind energy, into electrical power. In the examples mentioned above, the investment in new technology is offset by a savings in energy consumption. For such investments to make sense, it is critical to keep maintenance costs as low as possible. Therefore, producers of drives are challenged to provide smaller and more feature-rich products, while maintaining or improving the overall system performance and reliability.

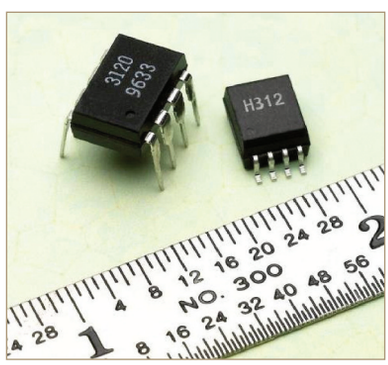


Figure 1: **ACPL-H312 (right) next to HCPL-3120**

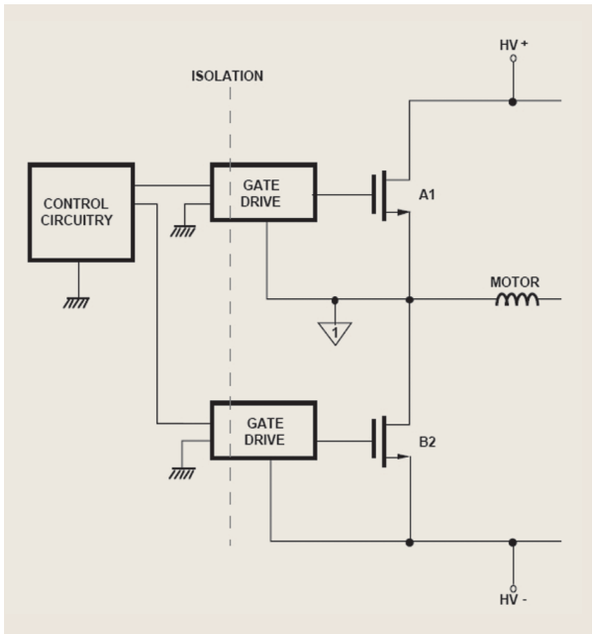
Reduced footprint

The new ACPL-H312 integrated gate drive optocoupler is a smaller version of the well-known Avago HCPL-3120 (see Figure 1), a basic building block for all kinds of inverters. Providing the same output current (2.5 A), but packaged in a 'stretched' SO-8 package, the new device saves 40% on board space, compared to the previous DIP-8 version, while providing the same isolation properties. The supply current needed to power up the output side is specified at 3mA maximum, allowing for a low cost bootstrap power supply.

The ACPL-H312 contains a GaAsP LED. The LED is optically coupled to an integrated circuit with a power output stage. These optocouplers are ideally suited for driving power IGBTs and MOSFETs used in motor control inverter applications. The high operating voltage range of the output stage provides the drive voltages required by gate controlled devices. The voltage and current supplied by these optocouplers make them suited for directly driving IGBTs with ratings up to 1200V/100A. For IGBTs with higher ratings, the ACPL-H312 series can be used to drive a discrete power stage which drives the IGBT gate.

A fundamental strength of optocouplers is their ability to suppress common-mode noise transients. A power inverter of the type shown in Figure 2 is an application where such transients exist naturally. The half-bridge configuration can, for example, be a part of a three-phase motor drive which converts the high voltage DC link into an alternating (AC) current by switching the power transistors on and off in a synchronised manner. The control

Figure 2: **Half-bridge power inverter**



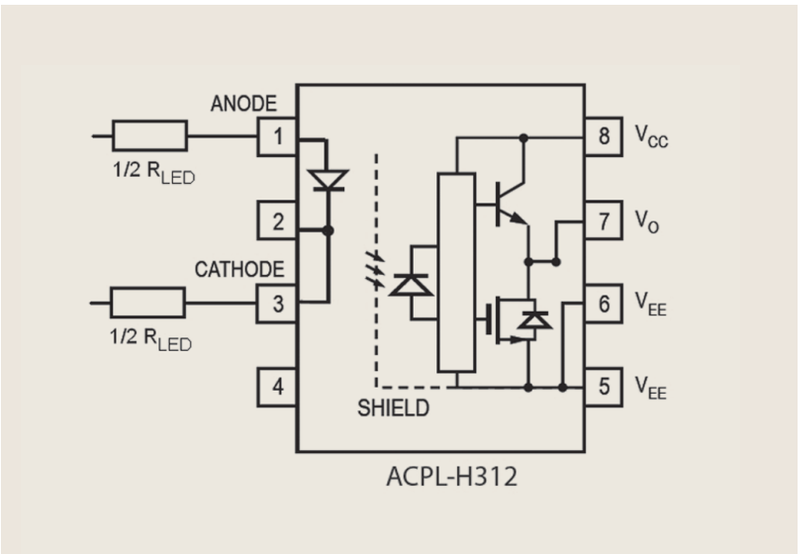


Figure 3: **Common-mode transient suppression**

circuitry and the gate drive optocouplers on the isolated side are all connected to the same ground. On the power side, however, the ground of the high side (upper) gate driver is actually floating, connected to the source of power transistor A1. Through switching the power transistors on and off, common-mode transients (of thousands of volts per microsecond in typical applications) are created between the control side and the power side in this application. Such common-mode transients could potentially cause an erroneous turn-on of a power transistor which, in turn, could cause permanent damage to the drive. The performance in terms of common mode transient rejection of the gate drive stage is therefore directly linked to the reliability of the inverter.

Optocouplers such as the ACPL-H312 outperform other technologies in terms of common-mode transient rejection. A good optocoupler design minimises the capacitive coupling between the input and the output sides and also minimises the adverse effects of leakage currents that flow across the isolation barrier. One reason is that by using optical coupling technology, the physical separation distance at the signal coupling interface (inside the package) can be kept as wide as possible. The large separation distance and proprietary packaging technology provides a very low parasitic capacitance across the device.

In addition to the wide internal separation distance, optical isolation technology has the advantage that a grounded Faraday shield can be deployed to cover the receiver IC. The Faraday shield will divert transient currents flowing from the input side directly to the output ground to prevent the gate drive IC from turning on due to leakage currents flowing from the isolated side. On the input side, there are several ways of designing LED drive circuitry that ensures that the LED is kept in its desired state. For example, by using two LED resistors instead of one (see Figure 3), the system is made less sensitive to common-mode transients. This subject is further discussed in data sheets and application notes published on the Avago website. Figure 4 shows a typical application circuit with negative IGBT gate drive.

Conclusion

Avago is developing, producing and continually improving LEDs for use in optocouplers. Concerns are sometimes raised that light output degradation of the LED could cause devices to stop functioning after a certain time in use. Indeed, high temperatures and drive currents will have an impact on light output – but it is important to stress that the recommended operating conditions in datasheets have significant guard bands to ensure that this will not happen in practice. In addition to the guard banded specifications, the quality of the LEDs are monitored and stress tested at extreme temperatures and drive currents. LED degradation is not likely to cause problems in real applications.

The new ACPL-H312 integrated 2.5A gate drive optocoupler will enable power electronic designers to shrink their PCB layouts without compromising system performance or isolation properties.

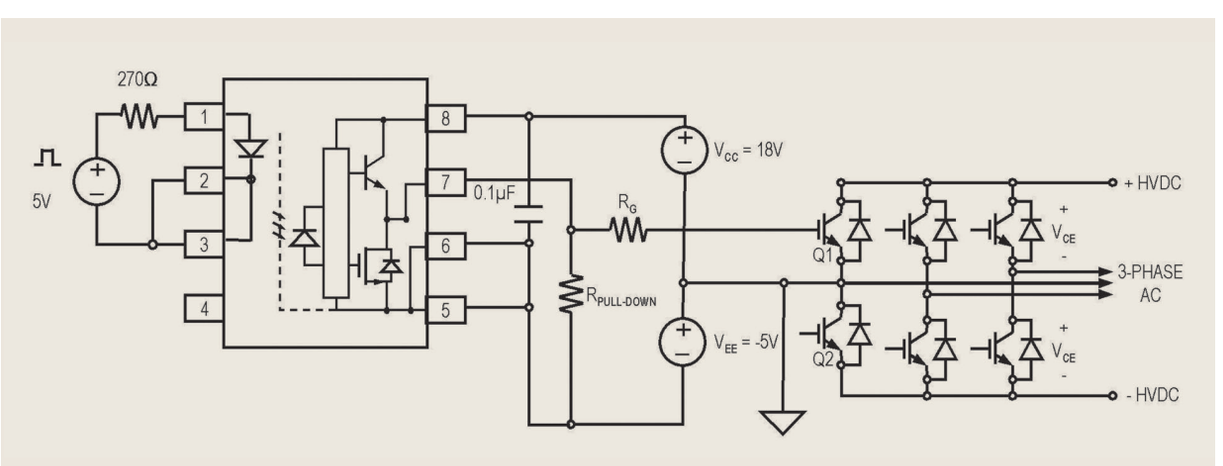


Figure 4: **Typical application circuit with negative IGBT gate drive**