Isolation Device in Hybrid Electric Vehicles Application

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White Paper

The global market demand for hybrid-electric vehicles (HEVs) will grow approximately twenty percent annually through 2010 predicts the research firm, Fredonia Group (Title: World Hybrid-Electric Vehicles to 2010). The popularity of these fuel-efficient vehicles will be driven by erratic fuel prices, increased emissions regulations, and reduced cost disparities between HEVs and gasoline vehicles. In addition, most of the governments in the developed countries are encouraging the adoption of alternative vehicle technology to reduce the reliance on gasoline and supporting programs that cut pollution. A number of government agencies are providing incentives or subsidies in the form of tax deductions, tax credits, free tolls, smog-inspection exemptions to encourage the use of alternative "environmentally friendly" vehicles. The top HEV markets will come from the U.S., Western Europe, and Japan, with the Chinese and Korean markets displaying rapid growth.

Based on another report from Strategy Analytics titled "Hybrid vehicles offer electronics expansion," demand for hybrid vehicles will grow from 335,000 units in 2005 to over 3 million units in 2013, representing 4% of the worldwide vehicle production. This will result in a marked increase in the demand for electronic parts for hybrid vehicles.

Toyota Motors has been in the forefront of HEV development since 1997 when the first-generation Prius was introduced in the Japanese market (Fortune Magazine, March 6, 2006). Since then, Toyota has improved the technology and expanded its hybrid lineup to include the Lexus GS 450h sedan, the Lexus RX 400h sport utility vehicle (SUV), the Toyota Highlander SUV, and the popular Camry sedan. Then Honda Motors entered the market in many countries with its Honda Insight and Honda Civic models. The worldwide adoption of HEVs increased after Toyota successfully sold a sizable number of vehicles both in Japan and in the United States. Most leading car manufacturers have started designing and introducing similar vehicles targeted at environmentally-conscious consumers with an interest in fuel efficiency. This includes alliances among Europe's Volkswagen, Audi and Porsche, as well as GM with BMW and Daimler Chrysler—Autonews Europe.

HEVs combine the benefits of gasoline engines and electric motors and can be configured to achieve different objectives, such as improved fuel economy, increased power, or additional auxiliary power for electronic devices and power tools.

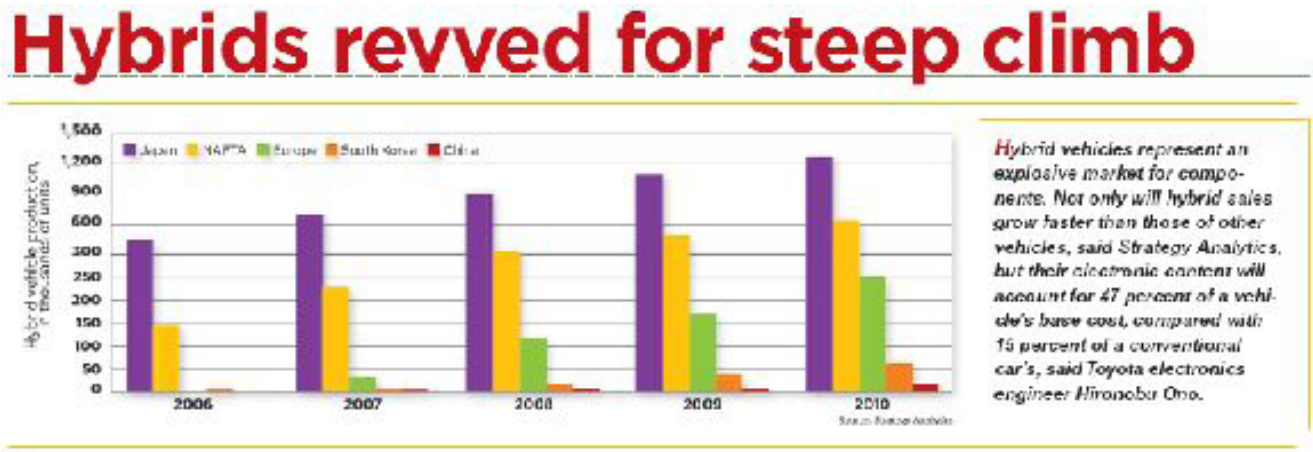

Figure 1. Source: Strategy Analytics on EETimes—Hybrids revved for steep climb (June 26, 2006)

HEVs have several advantages over conventional gasoline vehicles:

- Regenerative braking capability that recovers energy loss from braking to slow down or stop a vehicle and generates energy to the battery system
- Increased fuel efficiency by utilizing the battery system, rather than the gasoline engine, to initially propel the vehicle
- Reduced emissions since these vehicles utilize electric and gasoline engines interchangeably while in motion.

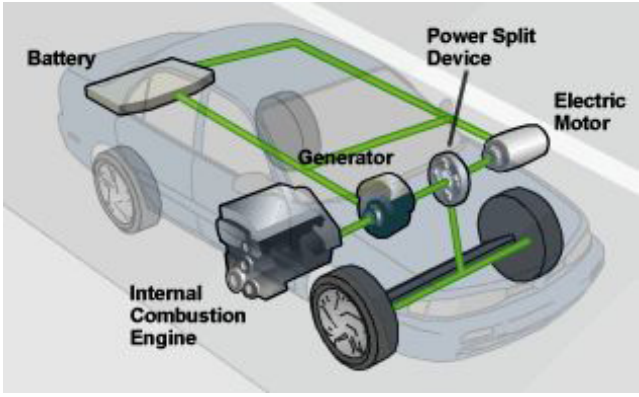

Figure 2. Source—How Hybrids Work from www.fueleconomy.com

Many HEV configurations are possible. Essentially, a hybrid combines an energy storage system (the battery, commonly Nickel Metal Hydride, Lithium Ion and ultracapacitors for propulsion boost), a power unit (power supplies in the form of DC-DC and DC-AC inverters), and a vehicle propulsion system (electric/gasoline) motor. A hybrid's efficiency and emissions depend on the particular combination of subsystems, how these subsystems are integrated into a complete system, and the control strategy that integrates the subsystems.

Figure 3 illustrates the typical engine control system of an HEV. The controls, including a built-in AC inverter, the inverter for the motor, DC to DV converter for reducing high voltage to 12V, the battery and motor and battery electronics, are all packaged in a well ventilated assembly (usually air or water-cooled) mounted behind the rear seat of an HEV.

In the electric motor drive control module (Figure 3), either gate drive optocouplers (up to 2A gate drive) or Intelligent Power Module digital optocouplers (1MBd speed) help interface between the motor inverter and the microcontroller system. To monitor the electric motor current, the isolation amplifier (current sensing with up to 1% gain tolerance capability) offers the best package and features to measure the current precisely. Likewise, it can also be used to monitor the car battery status providing electronic visibility of the electrical system.

In today's automotive technology, there is an increasing trend for vehicles to adopt the X-by-wire (the replacement of mechanical functions in a vehicle by a combination of mechanicals, electronics, and software). This combination has an electronic interface between high voltage electrical and low voltage digital circuits in the systems. An electrical isolation is ideal in order to provide stable operation, and eliminate electrical noise and interference between systems.

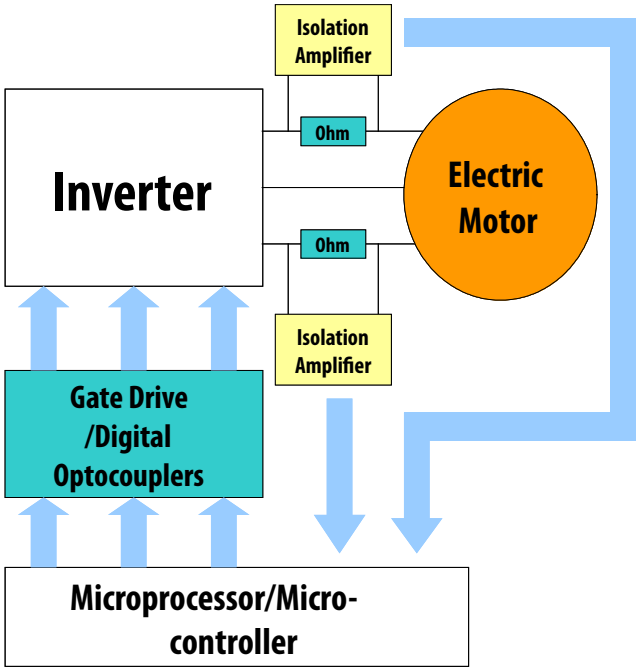

Figure 3. Electric Motor Drive System

Several types of communication media exist for use in the vehicles, including LIN, CANbus, MOST, and FlexRay. The most common communication protocol used by HEVs is CANBus. It is easy to implement and only requires two wires to control the electrical system, as demonstrated in the air-conditioning, power systems electronic control units, body control modules, and diagnostic interfaces. CANbus was originally developed by Bosch in the 1980s for automotive applications and has since been used in vehicles throughout the world. It has the bandwidth necessary for real time control as well as data collection. The transmission speed of a CANBus is up to 1Mbps. The stability of the electrical automotive system is improved through the use of optical isolation devices in the automotive electronics (Figure 4).

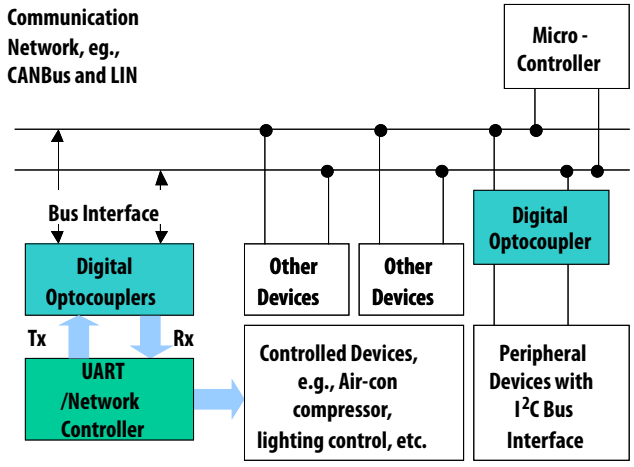

Figure 4. Car Network System

Hybrid vehicles represent an explosive market for components. To satisfy the growing demand of the HEV market, Avago Technologies has introduced the first automotive isolation device, the ACPL-M43T (Automotive 1MBd Transistor Output High Temperature Optocouplers) in May 2006 for use in the electric motor inverter and DC-DC power packs (Figure 3). To fulfill the additional isolation requirements in HEV communications interfaces, Avago Technologies then introduced in November 2006 the automotive 10MBd logic gate output digital interface optocoupler to be used in the CANBus communications network interfaces.

The key product development features of Avago Technologies' products for the automotive market are:

- Double wire bonding processes for added reliability
- New improved LEDs for high brightness, with low driving currents to reduce overall power consumption and provide better signal coupling
- Improved lead frames for better heat dissipation
- Special product lot numbering system to improve traceability

In addition, these products have a wide operating temperature range (-40 to 125°C) and are qualified under the AECQ100 quidelines for reliability and qualification tests that suit automotive applications.

The outlook for hybrid vehicles is very positive for a variety of reasons. The worldwide HEV market will continue to grow as the concerns regarding higher gasoline prices and the environment increase. The rate of demand will increase significantly as HEVs undergo technological improvements. As HEVs equal or surpass the performance of conventional cars, their consumer acceptance will grow.

For product information and a complete list of distributors, please go to our web site: **www.avagotech.com**

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