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[1]. The popularity of these fuel-efficient vehicles is driven by erratic fuel prices, increased emissions regulations by different countries and lowering cost disparities between HEV and gasoline vehicles. Most of the world's developed countries' governments are encouraging the adoption of alternative vehicle technology to reduce the reliance on gasoline worldwide, as well as support programs to cut pollutions.. By doing so, different world government agencies are providing incentives or subsidies in the form of tax deductions, tax credits, free tolls, or smog-inspection exemptions to use alternative "environmental friendly" vehicles. The HEV top markets will come from the US, Western Europe and Japan, with China, Korea increasing their hybrid market.

Based on a report from Strategy Analytics[2], demand for hybrid vehicles will grow from 335,000 cars in 2005 to over 3 million cars in 2013, representing 4% of worldwide vehicle production. This shows a high increase in demand for the electronic parts for the hybrid vehicle.

Toyota Motors has been in the forefront in developing the HEVs since 1997 when the first-generation Prius was introduced in the Japan market (Fortune Magazine, 6 Mar 06). The worldwide adoption of this vehicle began to grow after Toyota successfully sold a sizable number of Prius vehicles both in Japan and in the United States. Most top car manufacturers have since started to design and introduce similar hybrid vehicles targeted at emissions and environmentally conscious consumers.

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

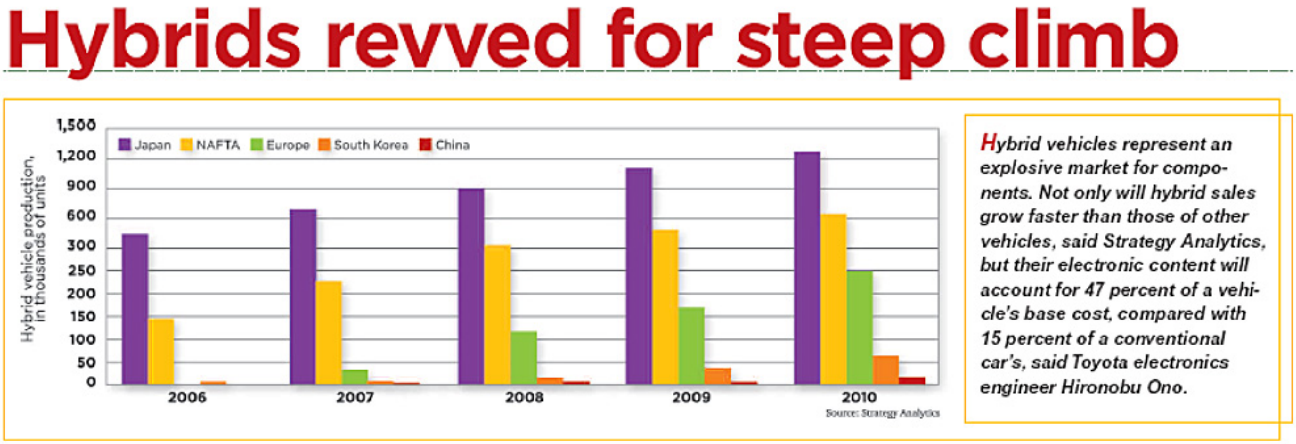

Figure 1. Source - Strategy Analytics on EETimes - Hybrids revved for steep climb (26 Jun'06)

Notes:
1. As predicted by research firm Fredonia Group (Title: World Hybrid-Electric Vehicles to 2010)
2. Title: Hybrid vehicles offer electronics expansion

HEVs have several advantages over conventional gasoline vehicles such as:

- Regenerative braking capability that recover energy loss from braking to slow down or stop a vehicle and generate energy back to the battery system
- Increased fuel efficiency by utilizing the battery system to propel the vehicle at the start rather than the gasoline engine
- Reduced emissions

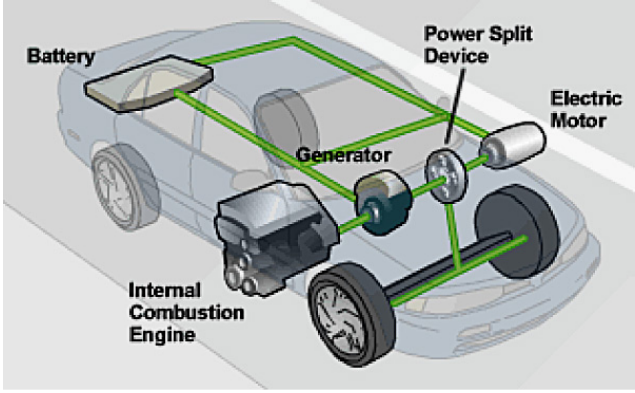

Figure 2. Source - How Hybrid Works from www.fueleconomy.com

Many configurations are possible for HEVs. Essentially, a hybrid combines an energy storage system (the battery, commonly Nickel Metal Hydride, Lithium Ion and ultra-capacitors for propulsion boost), a power unit (power supplies in the form of DC-DC and DC-AC inverter), 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 3a & 3b illustrates the typical engine control system of an HEV and inverter voltage sensing of the battery system. The controls, including a built-in AC inverter, the inverter for the motor, DC - DC converter for reducing high voltage to 12V, and the battery and motor 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 3a), 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 battery/inverter voltage system, the automotive isolation amplifier with advanced Sigma-Delta Converter Technology offers the best devices and features to monitor the voltages precisely and providing better control of the battery charging system.

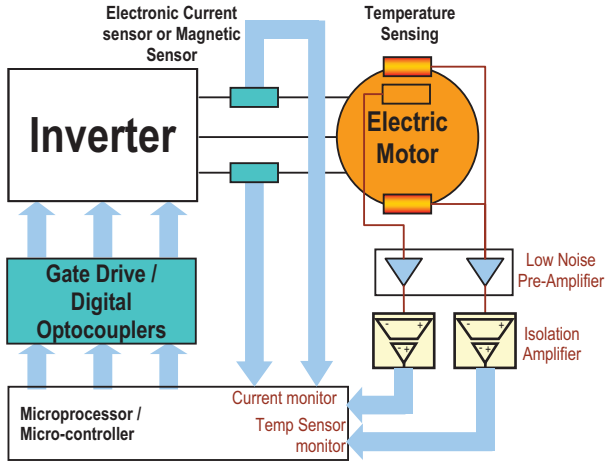

Figure 3a. Electric Motor Drive System

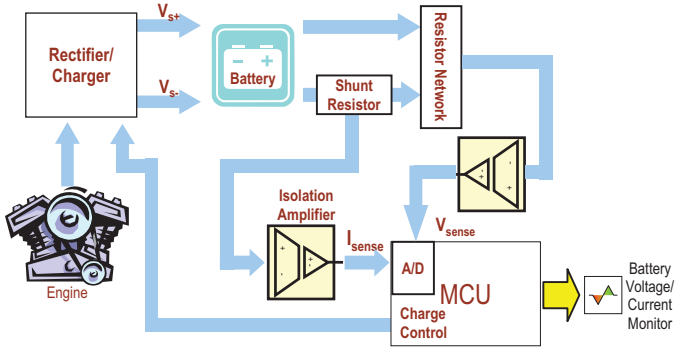

Figure 3b. Inverter Voltage Sensing using Isolation Amplifier

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

For the communication media of the vehicles, there are several types including LIN, CANbus, MOST and FlexRay. The most common communication protocol used by HEV's is CANBus, as it is easy to implement and only requires two wires to control the electrical system in the air-conditioning, Power Systems electronic control units, body control modules or diagnostic interfaces. CANbus has been used throughout the world in various vehicle systems. It has the bandwidth which can be used for real time control as well as data collection. The transmission speed of a CANBus is up to 1Mbps. The electrical automotive system's stability will be helped with the use of optical isolation devices in the automotive electronics (Figure 4).

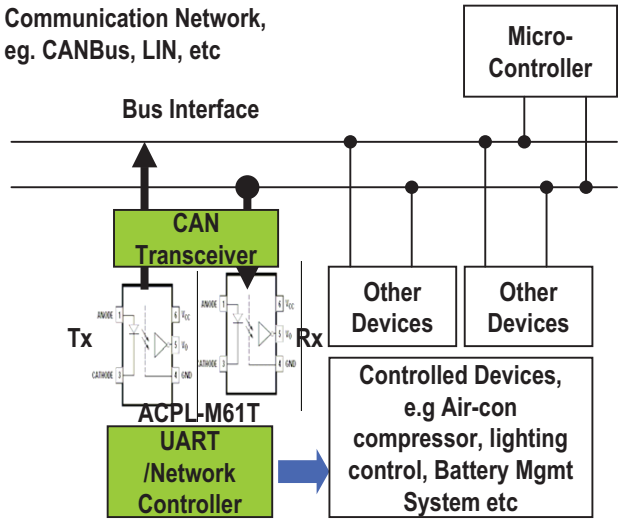

Figure 4. Car Network System

To cater to the growing demand of the HEV market, Avago Technologies has introduced the first automotive isolation device, ACPL-M43T-000E (Automotive 1MBd Transistor Output High Temperature Optocouplers), for use in the electric motor inverter and DC-DC power packs (Figure 3a & 3b). Following the additional needs of isolation requirement in the HEVs communication interfaces, Avago introduced the automotive 10MBd logic gate output digital interface optocoupler (ACPL-M61T-000E) to be used in the CANBus communications network interfaces.

The key automotive product development features from Avago Technologies offer:

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

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

The outlook for hybrid vehicles is very positive for a variety of reasons. HEV market trends worldwide will only increase with the growing concern of higher gasoline prices as well as environmental issues. The rate

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