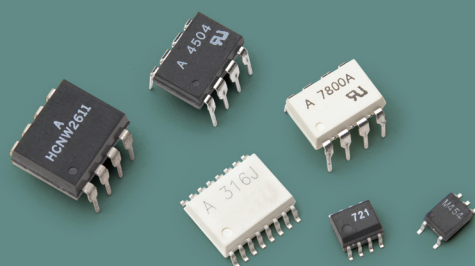


Isolation Products for Industrial Applications



Application Reference



Avago Technologies is the worldwide leader in isolation solutions for industrial applications

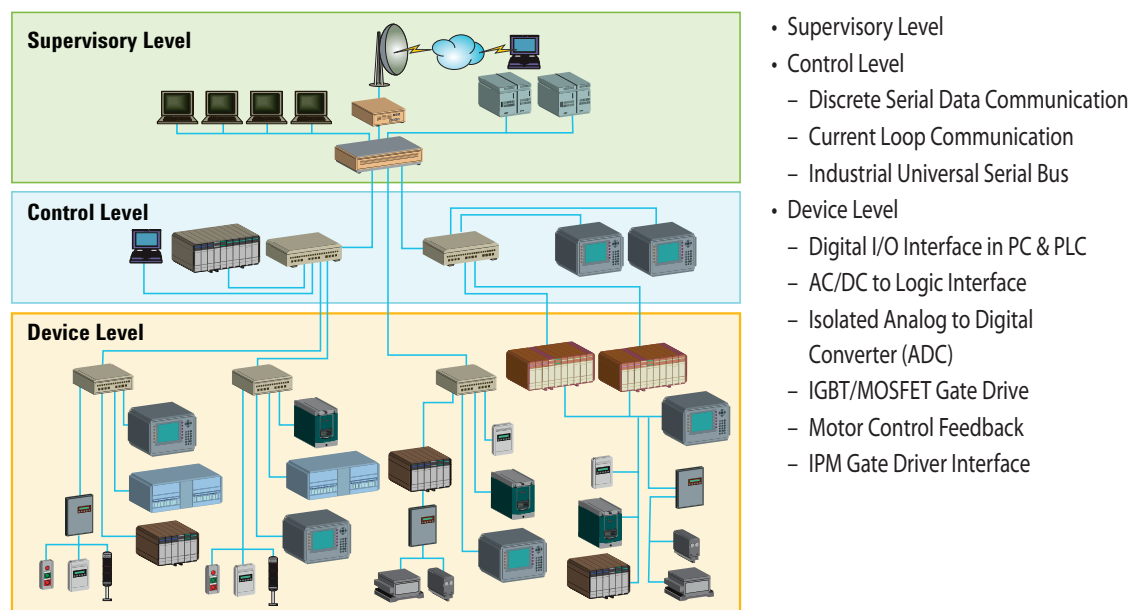
In an industrial environment where high voltages, magnetic fields and noise are commonly present, reliability is critical to avoid downtime and ensure data accuracy. In this environment circuit designers use optocouplers to insulate high voltages and isolate unwanted signals. As the worldwide leader, Avago Technologies delivers optocouplers that are designed and manufactured to meet the stringent requirements of industrial applications. Our optocouplers comply with worldwide regulatory standards, including IEC (International Electrotechnical Commission), UL (Underwriters Laboratories, Inc.), CSA (Canadian Standard Association) and the EN (European Union) approvals.

Avago high-speed CMOS optocouplers are commonly used in Industrial Fieldbus applications with speeds of up to 50 MBd. The high linearity analog parts are suitable for systems that demand high accuracy, and our voltage detection parts detect and isolate interfaces. We also offer a lower speed family with speeds starting at 100 kBd for industrial I/O modules, as well as integrated gate drivers and current sense devices which are well suitable for motor control applications.

A wide range of Avago's isolation products are available to suit the various industrial applications. Together with our high CMR performance, high maximum insulation voltage and industrial temperature range, you can not go wrong when choosing Avago for your isolations needs.

Solutions to your industrial isolation and insulation needs are now available in three primary levels, see figure 1 for a full view of industrial applications.

Figure 1: Three Primary Levels of an industrial applications

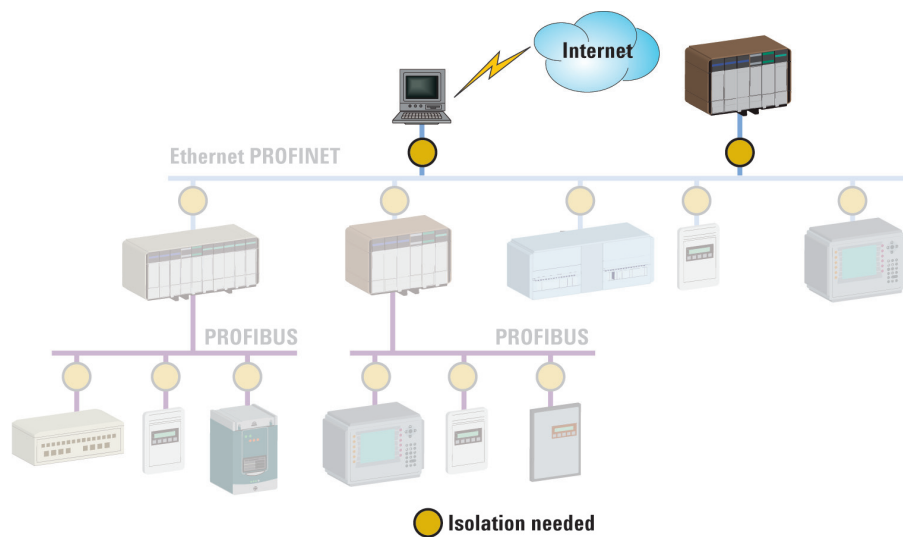


Supervisory Level – Industrial Ethernet

Industrial networking requires a more robust and reliable standard compared to the office LAN (Local Area Network). These networks need to endure the harsh, factory floor environment, while providing reliability, security, and data accuracy (see figure 2).

In industrial Ethernet networks that use twisted pair cables, isolation is needed between end-devices and the network to protect devices from voltage surges and ground loop currents. Avago's high speed digital CMOS optocouplers, available at speeds of between 12 MBd and 50 MBd, can be used as an alternative to isolate transformers.

Figure 2: Networking Architecture



Control Level

There are over 250 industrial networks today. Many of them employ small, proprietary protocols, although standards such as PROFIBUS and DeviceNet dominate the segment. At the control level (see figure 1), communication between PLCs (Programmable Logic Controllers) and other PLCs; PLCs and HMIs (Human-Man Interface); and PLCs and SCADA (Supervisory Control and Data Acquisition), are very common.

Avago's Optocouplers are used widely in PLC applications for isolation, especially in a factory environment where noise and magnetic inference are always present. As illustrated in the PLC block diagram (figure 3), optocouplers can be used in Fieldbus modules, analog modules, digital modules, temperature controller modules, motor control modules and communication modules. From general purpose parts for multi-point discrete signals, to high speed CMOS parts for higher speed communications interfaces, to applications specific parts, users need features such as 4-20mA signal transmission. Avago is able to provide isolation solutions for all these applications.

Discrete Serial Data Communication

Avago's digital optocouplers offer speeds from 100 kBd to 10 MBd/15 MBd (5V/3.3V). They are extremely important in serial digital data transmission and communications, such as RS-232, RS-422 and RS-485

The HCPL-063L (3.3 V, dual channels, 15 MBd) or ACSL-6210 (3.3 V, dual channels, bi-directional 15 MBd and HCPL-0661 (5 V, dual channels, 10 MBd) provide isolation between bus transceivers and other digital logic with bus controllers (see figure 4). Both parts meet serial data communication requirements such as noise elimination (due to high CMR functions) and low power consumption (due to low drive current) with high insulation voltage. Avago digital optocouplers are also offered in DIP8 packages (HCPL-263L/HCPL-4661).

Figure 3 – Programmable Automation Controller* block diagram

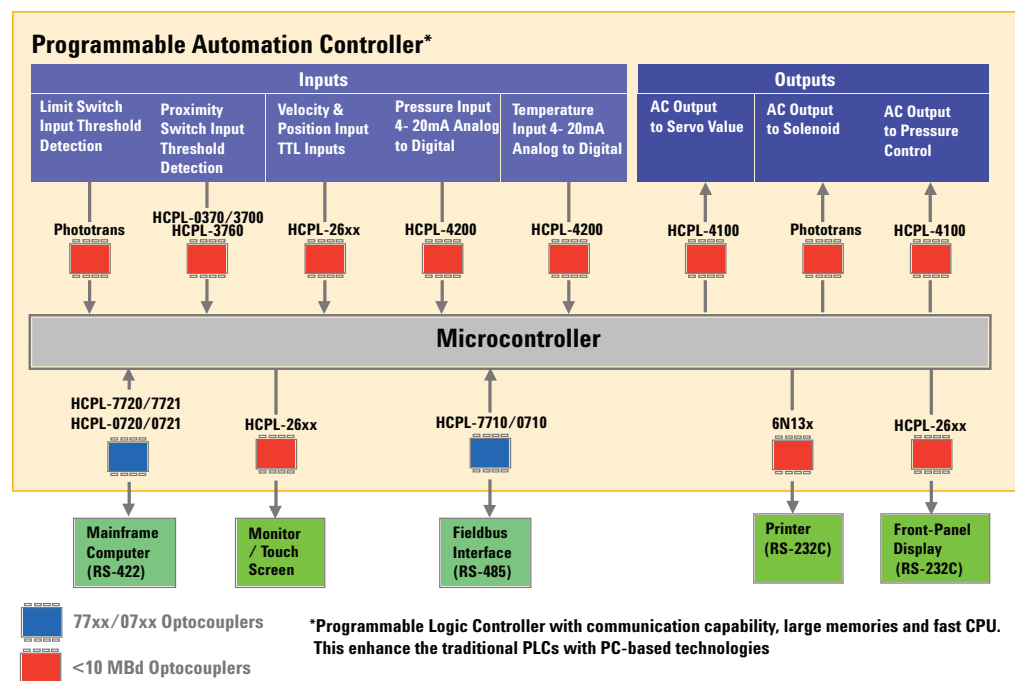
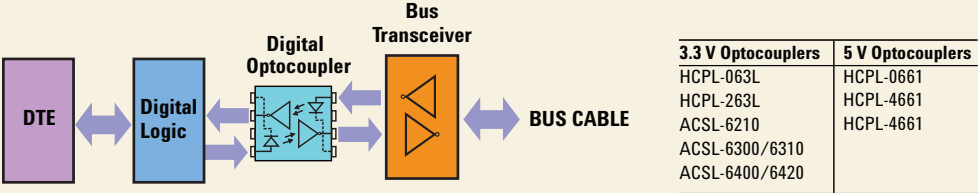


Figure 4 – Serial Bus Interface Isolation block diagram



Current Loop Communication

Today's popular industrial-control applications, such as programmable logic controllers, factory process control, computer numeric control (CNC) and intelligent transmitters, require the use of 4-20 mA current loops. This has become a well-established part of the analog communications between the host computer and smart transmitters in a factory environment. For transmitting low-amplitude, low-frequency signals over a few hundred yards in a noisy industrial-control environment, current is preferred over voltage. This is because the current at any instant is constant over the entire length of the cable. Avago's HCPL-4100 and HCPL-4200 are designed to operate as a transmitter/receiver (see figure 5) in equipment using 20mA current loop. Optical coupling of the signal from the logic input to the 20mA current loops breaks ground loops and provides a very high immunity to common mode interference as well as high voltage insulation and galvanic isolation for safety protection. Both the HCPL-4100 and HCPL-4200 are compatible with LSTTL, TTL or CMOS logic interfaces. The internal shield allows a guaranteed min 1000V/ μ s common mode transient immunity. The HCPL-4100 provides 20 kBd data rate at 40 meters line length while the HCPL-4200 stretches up to 1400 meters. Both are available in DIP8 packages.

Figure 5 – Current Loop Communication block diagram

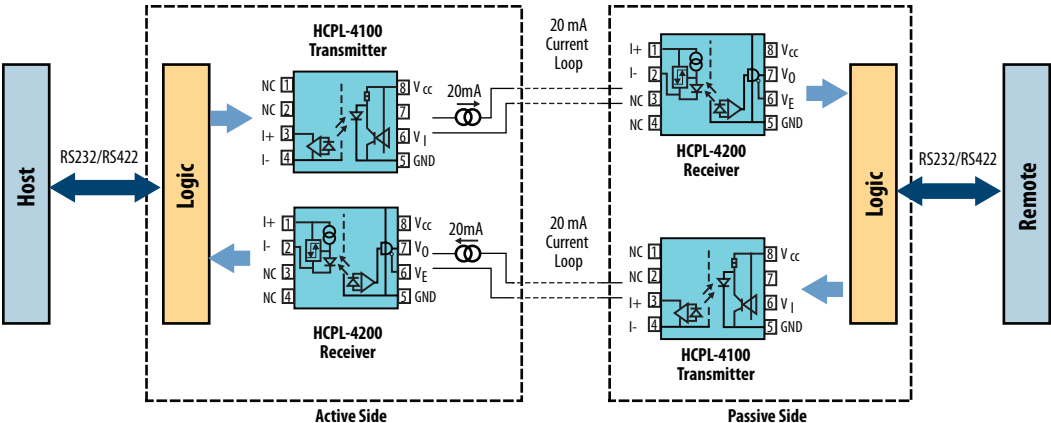
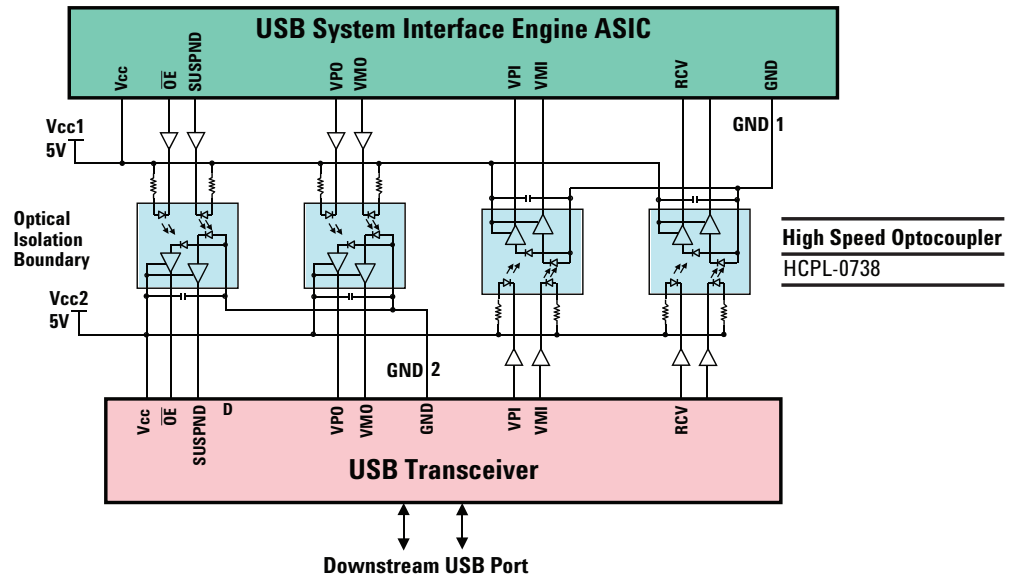


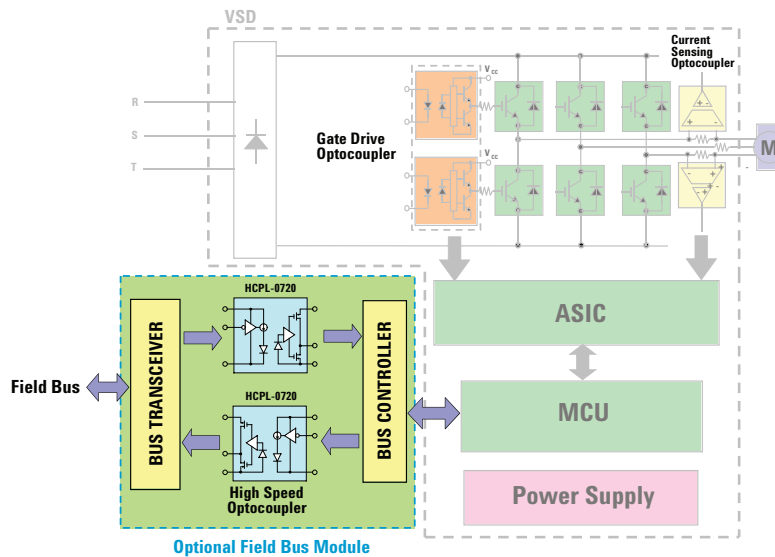
Figure 6 – Industrial Universal Serial Bus block diagram



Industrial USB

USB is intended to be used as a user friendly, hot plug and play bus for office environment. Integration from the control center to the factory floor has seen USB extended to devices meant for data acquisition and control using serial, parallel, Ethernet and other communications standards (see figure 6). Due to the extension in length and the harsh industrial environment, optical isolation has to be used to prevent ground loops, spikes and surges. In this application, Avago small platform, S08 package, high speed digital CMOS optocouplers can be used to provide the necessary safety insurance to achieve the highest safety standards and reliability.

Figure 7 - Variable Speed Drive with Network Card block diagram

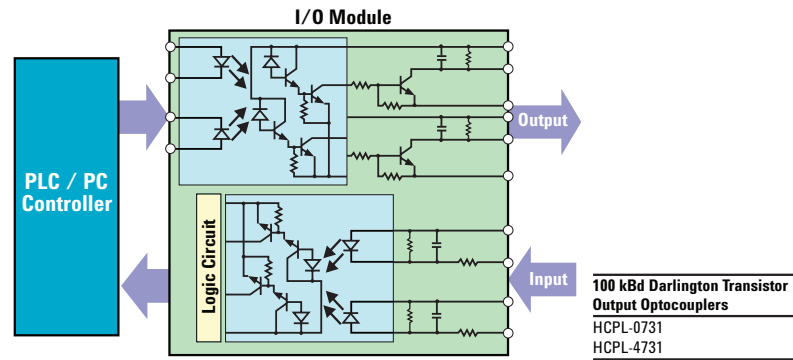


Device Level – Smart Sensor and Smart Variable Speed Drive (VSD)

As industrial networking continues to evolve, we will see many significant improvements made at the device level. Data from the factory floor can be accessed almost instantly (determinism) at the main control center with just a touch of a button. Communications can be achieved with optional hardware, a Fieldbus option card mounted onto the end devices (e.g. VSD, or Temperature Controller). With this setup, the end devices can connect to the bus systems where data can then be transferred to and from the control center (see figure 7).

Avago's optocouplers are used to protect the devices from high voltage in the bus line. The parts used are usually high-speed CMOS digital optocouplers for the option cards and gate drivers and current sensors for the VSD.

Figure 8. Digital I/O Module in Programmable Logic Controller (PLC) or Industrial PC



Digital I/O Interface in PC & PLC

Avago offers a wide range of low speed photo-IC 100kBd optocouplers used in general purpose digital input/output signal isolation. The HCPL-0731 and HCPL-4731 are dual channel optocouplers that have a very low drive current. These optocouplers are designed into multi point I/O modules for PLCs or PCs (see figure 8).

AC/DC to Logic Interface

The use of electronic logic circuitry in most applications outside of a controlled environment can cause problems and hazards involved in interfacing between the logic function and the control function. These issues have always been particularly evident in the field of industrial control where the electrically 'noisy' environment produced by motors, power lines, lightning and other sources of interference may mask the desired signals, and some in cases even result in the destruction of the logic control system. Avago HCPL-0370/3700/3760 (see figure 9) are developed to address this logic interface problem. They are highly integrated AC/DC logic interface devices incorporating ease of design, low external component count, better predictability and reliability. These optocouplers incorporate AC/DC inputs for flexibility of input monitoring signals. The low input current version HCPL-3760 offers excellent operating efficiency, as the LED provides high light output at lower drive current. In addition, the hysteresis buffer provides threshold sensing which permits control of threshold levels over a wider range of input voltages with a single external resistor. DIP 8 and SO8 packages are available.

Figure 9. Industrial Monitoring Control block diagram

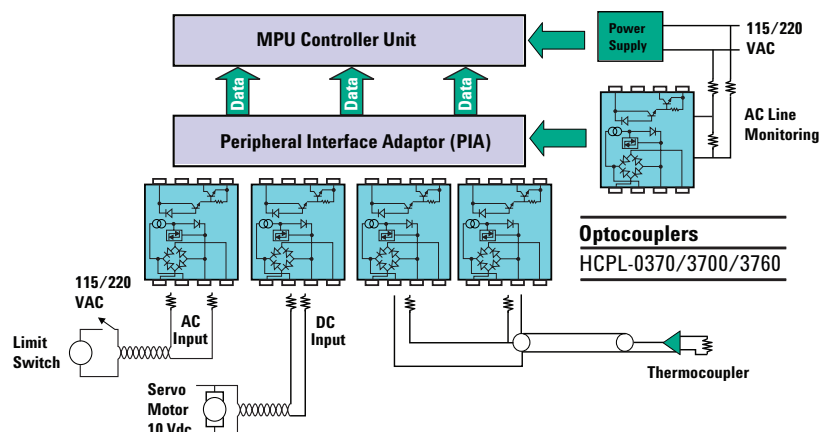
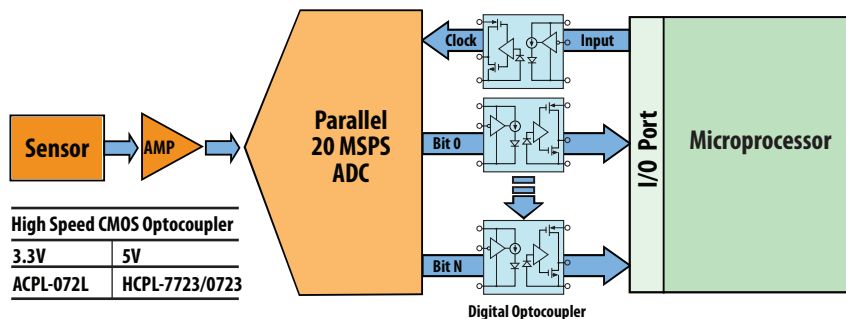


Figure 10 –Parallel A/D conversion Isolation



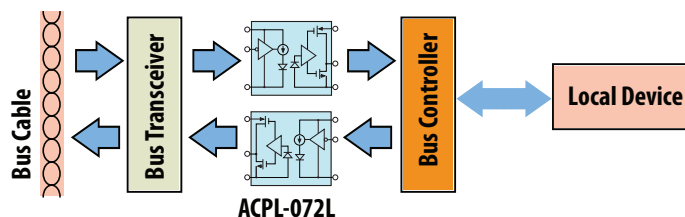
Isolated ADC

Analog signals detected from sensors which measure temperature, pressure and weight are converted to digital data and transmitted to a controller via fieldbuses. Avago's high speed digital CMOS parts, the HCPL-0720/0721/0723 and ACPL-072L-000E are recommended for this application. For isolated ADC applications, the optocouplers are connected between the ADC chip and the microprocessor (see figure 10 and 11). They break ground current loops and eliminate noise from differences in ground potential. This is usually critical in high speed and high accuracy analog to digital data conversion. Avago's wide range of high-speed optocouplers are applicable to both serial and parallel A/D converted data streams.

IGBT/MOSFET Gate Drive

IGBT/MOSFET power devices in power conversion stages switch high voltage/current in equipment such as switching power supplies, uninterrupted power supplies, and motor inverters. Avago's gate drive optocouplers, such as the HCPL-316J, provide isolation for direct drive power devices, and isolate low voltage control system's MCU/PWM controllers and high voltage power devices (see figure 12). It also features high insulation voltage, high CMR, minimum peak output current up to 2A, the fastest switching available, and IGBT desaturation detection and fault status feedback. These integrated drivers eliminate extra circuitry, resulting in reduced board space and lower costs to the user.

Figure 11 – Fieldbus Networks (PROFIBUS/RS485/DeviceNet/CAN)



Fieldbus Networks

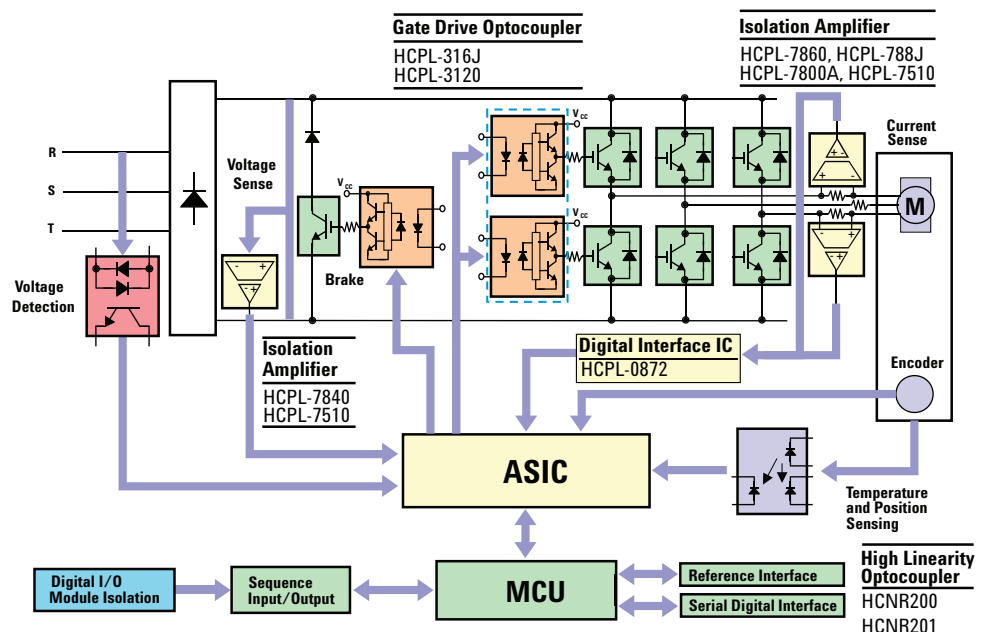
With the advent of digital fieldbus communication networks such as DeviceNet, PROFIBUS and Smart Distributed Systems (SDS), it is recommended to provide galvanic isolation using high speed optocouplers. The isolated nodes would employ devices with serial/parallel ports, RS232/422/485. With the popular trends of 3.3 V devices, Avago's ACPL-072L-000E is the industry's fastest 3.3V/5V optocoupler transmitting data at minimum guaranteed speed of 25 MBd. It also features low pulse width distortion of 6ns and built-in level shifter for operation in dual voltages.

Motor Control Feedback

The most common circuit for driving a motor is, as shown in figure 12, an inverter. A typical inverter takes power from a high-voltage dc line, then rapidly switches on and off to approximate a smooth sinusoidal ac voltage appropriate for driving an electric motor. The six basic applications in motor control inverter systems that use optical isolation technology are the power switch, voltage sensor, current sensor, temperature feedback, position sensing and data communication circuits.

Advanced motor drivers like inverter or servo motor apply close loop/vector control technology through phase current feedback, Avago isolated amplifier (HCPL-7800A) and isolated modulator (HCPL-7860) are the de facto current sensing devices. They provide high linearity and resolution across the industrial operation temperature range. They are also optimized for general current and voltage sensing.

Figure 12 – 3-Phase Motor block diagram

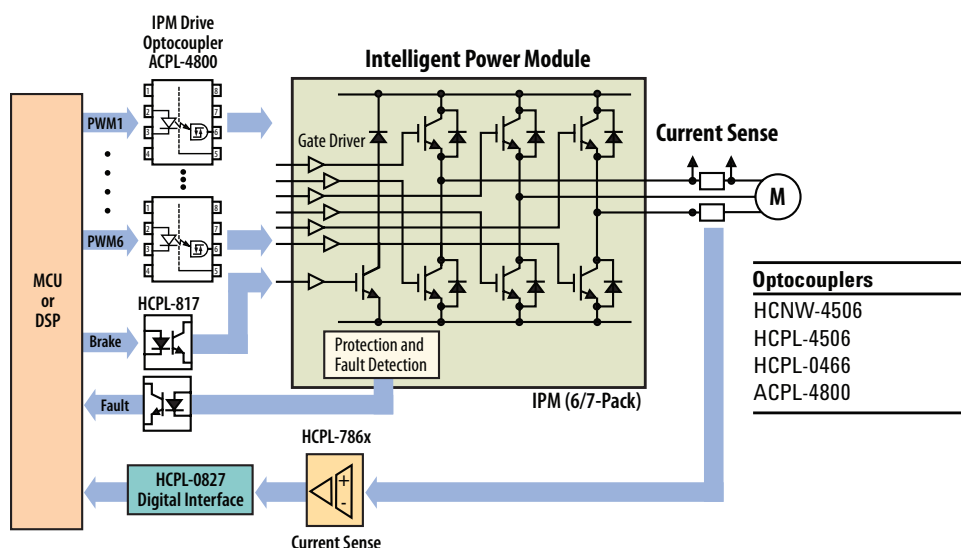


The HCNR200/201 can be used to isolate analog sensing signals in the motor temperature and position feedback loop, requiring excellent signal stability, high linearity and bandwidth. The HCNR200/201 is very flexible and capable of operating in many different modes, including unipolar/bipolar. The high accuracy and wide dynamic range of the temperature and position circuit is achieved by using a low cost precision op-amp that interfaces to the micro-controller. Both devices have a non-linearity of 0.01%, transfer gain of $\pm 15\%$ and $\pm 5\%$ respectively, and are available in DIP8/SMD Gullwing packages.

IPM Gate Driver Interface

Intelligent Power Modules (IPMs) integrates gate drive circuits with IGBT power devices. The ACPL-4800 with HVCMR of 30kV/us at 1kV-V_{cm} and propagation delay of 50ns maximum, is considered the fastest IPM optocoupler in the market. This device has a built-in schmitt trigger that provides logic compatible waveforms that eliminate the need for additional wave shaping, a totem pole output so that a pull up resistor is not required, and a positive input/output logic inverter. This device also comes with a high output driving current capability of up to 50mA. Avago's 1 Mbd logic optocouplers (the HCNW4506; HCPL-4506; HCPL-0466) are extremely important in providing isolation between MCU/PWM controllers and IPMs (see figure 13). The 1 Mbd logic optocouplers are designed with low drive current at high Common Mode Rejection (CMR) capabilities. They also have high insulation voltage (3750/5000V), a wide operating temperature range (-40 to 100° C), and a wide supply voltage range (4.5 to 30V) which meets IPM industrial requirements.

Figure 13 – Inverter Motor Drive



About Avago Technologies

Avago Technologies is a leading global supplier of analog, mixed-signal and optoelectronic components and subsystems. The company serves three primary product categories comprising optoelectronics, RF/microwave components and enterprise ASICs.

Avago Technologies' product solutions include fiber optic transceivers and ICs for storage, computing and networking. For mobile handsets, Avago offers RF components, infrared transceivers, light and proximity sensors, CMOS image sensors, and LEDs for camera flash as well as keypad and display backlighting. Avago's optoelectronics solutions include a broad range of LEDs, the world's most comprehensive line of isolation devices, an illumination and color management system for backlighting LCD flat-panel TVs, motion control components for office automation and industrial systems, optical navigation sensors for computer mice, and fiber optics transmitters and receivers for industrial and automotive applications.

Avago Technologies combines the capabilities and track record of an established global leader with the vigor and responsiveness of a startup. Avago's heritage of technical innovation dates back 40 years to its Agilent/Hewlett-Packard roots. During those years, the company amassed more than 2,000 patents and applications, and a reputation for innovation, quality and superior customer service.

For product information and a complete list of distributors, please go to our web site:

www.avagotech.com
www.avagotech.com/optocouplers

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