

Highly accurate and safely isolated current voltage sensing using Avago isolation amplifiers

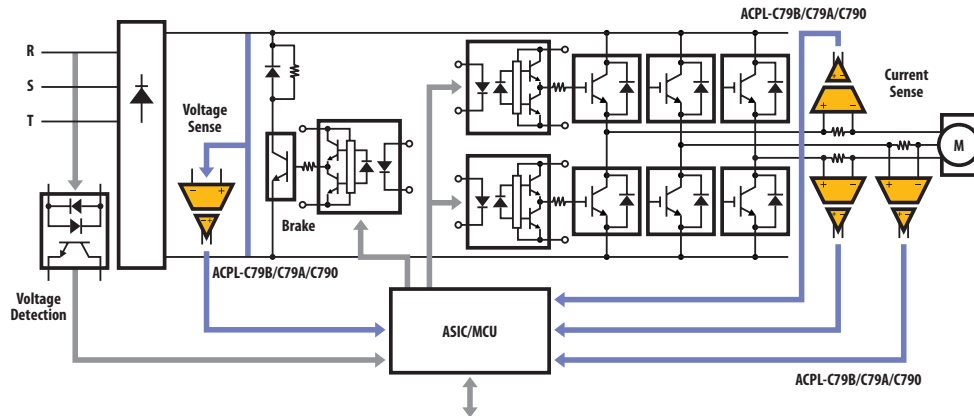


Figure 1. Voltage and current sensing in a 3-phase motor drive application

Introduction

Isolation amplifiers are used to sense and isolate voltages and are typically used to measure phase currents (with shunt resistors) or DC-link voltages in three phase frequency converter power applications as shown in Figure 1.

The maximum current is limited by the input voltage range and power dissipation in the shunt resistor. With 200mV input voltage range, currents of 150A are easily implemented. However, if state of the art shunt resistors and thermal management is applied, currents of 500A are within reach. The bandwidth/response time is in the range of 1.6 μ s for analog parts and 20MHz for sigma-delta outputs which is fast enough for fault detection and protection in most applications.

Sigma Delta Technology

Isolation amplifiers encode the analog input signals using sigma-delta technology before transmitting the information across the insulation barrier, see Figure 2. The digital transmission makes the solution immune to changes in LED light output over temperature. In addition, sigma-delta encoding reduces the overall sensitivity to noise and EMI commonly found in industrial and power conversion equipment and environments.

Designers can use the isolated sigma delta output directly from the isolation amplifier and decode the data stream using digital filters in an FPGA or ASIC. The benefit, compared to for example an SPI serial interface, is that the sigma-delta output is not sensitive to lost bits caused by noise or EMI. A designer also has the option to use isolation amplifiers with analog outputs. Avago offers state-of-the-art iso-amps with both differential and single-ended outputs with bandwidths up to 200 kHz.

Accuracy

Accuracy can be divided into gain accuracy, offset error and non-linearity. In general, isolation amplifiers have very low drift over temperature but a certain tolerance on gain accuracy before calibration. For systems where a calibration takes place in the production line, the temperature drift specification is usually the more relevant parameter. With the new ACPL-C79B isolation amplifier, featuring 0.5% gain accuracy, a designer can achieve excellent solution accuracy even without calibration.

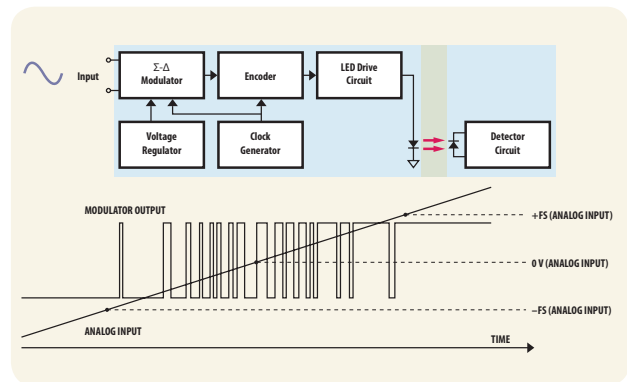


Figure 2. Sigma-Delta (Σ - Δ) analog to digital conversion

Analog Output

Part No.	Package	Temp Range	Gain Error 25°C, max %	BW kHz typ	NL % Typ	V _{dd2}	V _{iso}	V _{ioirm} , V _{peak}	V _{iotm} , V _{peak}
ACPL-C79B	Stretched S08 (8mm)	-40 to 105°C	±0.5	200	0.0037	3-5.5V	5kVrms	1230	8000
ACPL-C79A	Stretched S08 (8mm)	-40 to 105°C	±1	200	0.0037	3-5.5V	5kVrms	1230	8000
ACPL-C790	Stretched S08 (8mm)	-40 to 105°C	±3	200	0.0037	3-5.5V	5kVrms	1230	8000

Digital Output

Part No.	Package	Clock	Temp Range	INL LSB typ	ENOB bits	V _{dd2}	V _{iso}	V _{ioirm} , V _{peak}	V _{iotm} , V _{peak}
ACPL-C797	Stretched S08 (8mm)	CLK out	-40 to 105°C	3	12	3-5.5V	5kVrms	1230	8000
ACPL-796J	S016	CLK in	-40 to 105°C	3	12	3-5.5V	5kVrms	1230	8000

Outstanding Insulation and Isolation Performance with Optical Isolation Technology

Figure 3 shows the construction of an Avago optical isolator. The use of optical isolation technology allows for an optimum design tradeoff between low power consumption and separation distance. The relatively large internal separation distance in turn is a key to (common mode) noise rejection and insulation capability in high voltage environments.

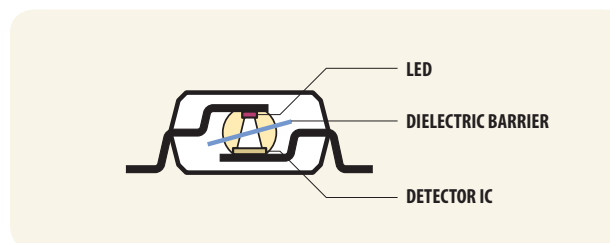


Figure 3. Optical isolator construction

Dynamic and Static Common Mode Noise Rejection

The internal separation and Faraday shield covering the detector IC reduces the coupling capacitance across the isolator to under 0.5 pF. This low capacitance, combined with level triggered signals and sigma-delta encoding, gives Avago isolation amplifiers best-in-class dynamic and static noise rejection in real-world applications.

Reliability and Quality of LEDs

The LEDs used in Avago isolation amplifiers are dimensioned so that they pose no limitation on the end product life time. The infrared LED technology used for optocouplers is a core competency for Avago that has been developed over 35 years. Avago continues to do R&D and LED production in house to maintain its technological leadership, reliability and quality.

Isolation amplifiers, whose performance and reliability depend on quality LED technology, are available in industrial grade (105°C), automotive grade (125°C) and space/military grade (hermetic, 125°C) versions.

Robustness to Long Term High Voltage Stress

As isolators are often used in applications with specific electrical safety requirements, it is extremely important to ensure – by construction and testing – that the insulation capability of products do not degrade over time when subjected to high continuous or transient voltages. The relevant aging mechanism used for the insulation construction in optical isolators, presented here is called Partial Discharge. All Avago isolation amplifiers (with option 060) have 100% partial discharge testing to the rated working and transient voltages. Other known aging mechanisms, such as space charge degradation (thin spin-on polyimides) or time dependent break down (SiO₂) are not activated or applicable to Avago optically isolated products.

More information on safety and isolation technologies can be found in the Avago white paper “Safety Considerations When Using Optocouplers and Alternative Isolators for Providing Protection Against Electrical Hazards” available at: www.avagotech.com under the Resources tab.

Contact us for your design needs at: www.avagoresponsecenter.com/608

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