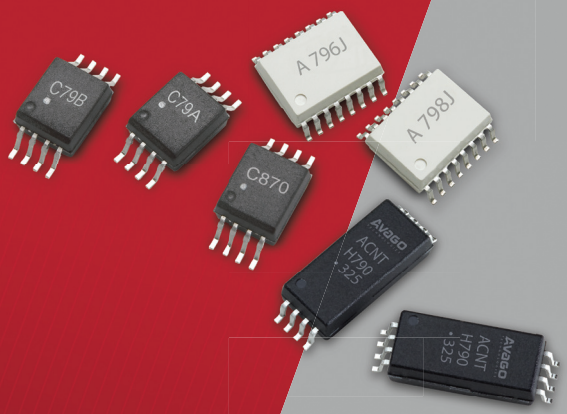
Your **Imagination.** Our **Innovation.**

AVAGO TECHNOLOGIES

Time to upgrade your current sensing technology!

Second Edition



Leading edge current sensing solutions for industrial applications

Avago has produced optocouplers for about 40 years! The first products were low speed transistor output devices that over time developed into high performance devices with space grade reliability and high data rates. The need for reliable isolation solutions has grown substantially, driven by the parallel revolutions in digital signal processing technology and high voltage power electronics. Today, applications such as variable speed drives, electrical vehicles, induction cookers and solar inverters all use optocouplers as the preferred solution for insulation and isolation.

Enhancing our first generation of isolation products, we have recently released new isolation amplifier (iso-amps) products with higher performance and smaller packages. This booklet highlights our new products and the technology that they use, as well as the benefits that they can bring to you.

In case you are still using traditional current or voltage transducers, it's time for you to consider using Avago Technologies current/voltage sensing isolation amplifiers in your next design!

Targeted Applications:

- Current/Voltage Sensing in AC and Servo Motor Drives
- Solar and Wind Turbine Inverters
- Industrial Process Control
- Data acquisition systems
- Switching Power Supply Signal Isolation
- General Purpose Analog Signal Isolation
- Replaces traditional current transducers, such as Hall effect devices

A single component capable of current and voltage sensing

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 1.6µs for analog parts and 20MHz for sigma-delta outputs which is fast enough for fault detection and protection in most applications.

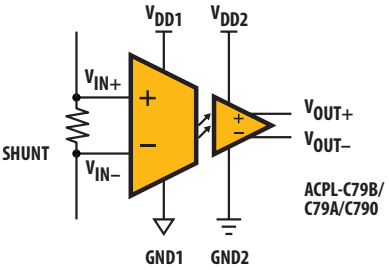
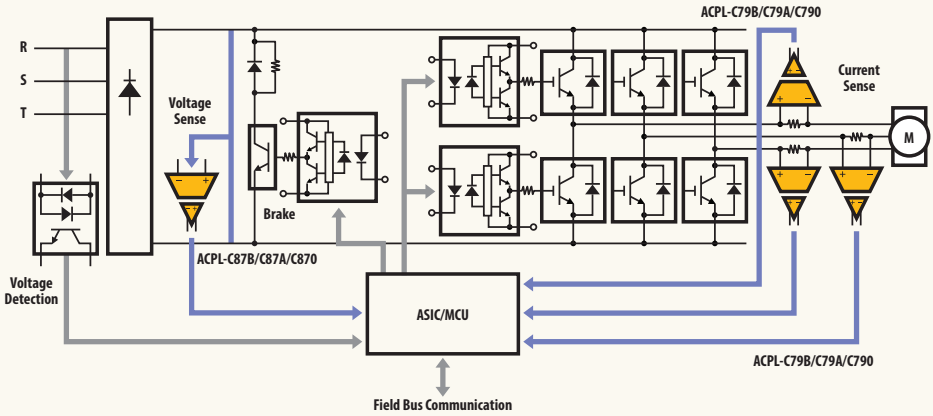


Figure 1. Voltage and current sensing in a three phase motor drive application



Robust and reliable optical isolation technology enables high noise rejection and safety

Optical Isolation Technology

Figure 2 shows the construction of an Avago optical isolator. An infrared LED on the primary side is used to transmit information across the multi-layer insulation barrier to a detector IC on the galvanically isolated secondary side.

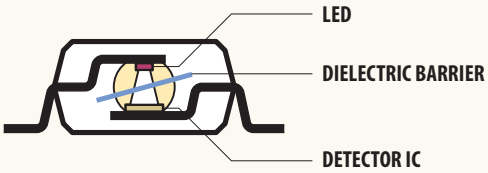
The use of optical isolation technology allows for an optimum design tradeoff between low power consumption and separation distance.

The relatively large internal separation distance in turn is a key to (common mode) noise rejection and insulation capability in high voltage environments.

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 noise rejection in real-world applications.

Figure 2. Optical isolator construction



Reinforced insulation suitable for failsafe design

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 in this booklet 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.

Resistance to ESD and other High Voltage Transients

One important aspect of an isolator is the transient voltage rejection, not only between inputs and ground but also between the two isolated grounds. The surge test for Avago optocouplers, measured across the isolation barrier is > 16kV.

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 it's 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.

High over sampling ratio sigma-delta A-D conversion technology ensures effective resolution

Sigma-Delta Technology

Isolation amplifiers encode the analog input signals using sigma-delta technology before transmitting the information across the insulation barrier, see figure 3. 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 de-code 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.

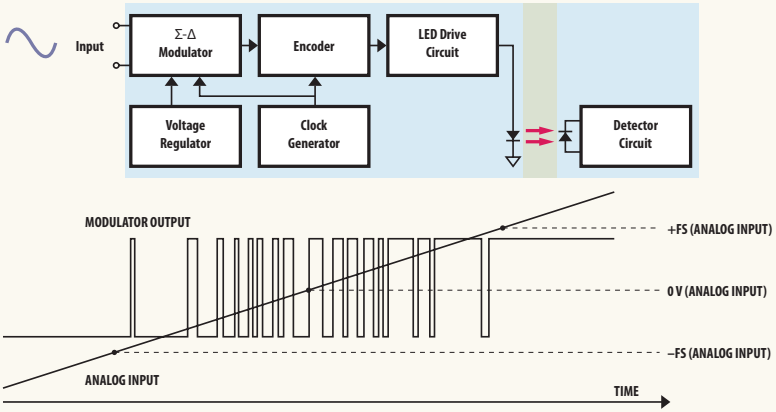
Low Voltage Differential Signaling (LVDS) Interface

An LVDS interface is used for both the clock input and the modulator data output in the recently introduced ACPL-798J. LVDS digital interface helps make the communication between the modulator and the controller more robust and less susceptible to electromagnetic interference (EMI) from the surroundings. It also helps reduce EMI emissions associated with high speed digital signaling. This is important for designs with stringent EMC requirement to meet.

Optocoupler itself uses light to communicate across isolation barrier, which literally produces no EM noise emissions. This provides an advantage over alternative isolation technologies (such as the magnetic- and capacitive-based isolators) that utilize high-frequency carrier signals to transfer low speed signals across isolation barriers. Combining precision Sigma-Delta A-D conversion, robust optical coupling and LVDS interface technologies, the ACPL-798J is an ideal current sensor for many industrial applications that are subject to high-intensity magnetic and electric fields.

A designer also has the option to use isolation amplifiers with analog outputs. Avago offers iso-amps with both differential and single-ended outputs with bandwidths up to 200 kHz.

Figure 3. Sigma-Delta Analog to Digital Conversion



With 0.5% accuracy, designers can achieve excellent solution accuracy without the need of calibration

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, as shown in Table 1.

Voltage Sensing Optocouplers

Isolation amplifiers optimized for current sensing applications normally have an input range of ±200 mV to keep power dissipation on shunt resistor low. For voltage sensing applications, input dynamic range needs to be wider for better signal to noise ratio. The ACPL-C87x input voltage range of 2 V is 10 times wider than previous generation isolation amplifiers. With a 1 GOhm input impedance, signal source loading errors are minimized.

Packaged in stretched SO-8 package, this isolation amplifier family include three gain accuracy options, i.e., ±0.5% (ACPL-C87B), ±1% (ACPL-C87A) and ±3% (ACPL-C870). Rated at 5000 V double protection isolation, the ACPL-C87X is an ideal device for isolated voltage sensing.

Table 1. ACPL-C79B Iso-Amp Key Specifications

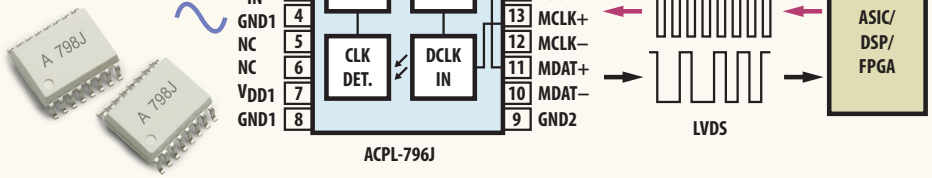
	Gain	Input Offset	Non-Linearity
Absolute Tolerance	0.5%	0.3%	0.05%
Temperature Drift	50ppm/°C	3 µV/°C	0.0003%/°C

Small footprint saves PCB space in comparison to traditional current transducers

New Products Highlight

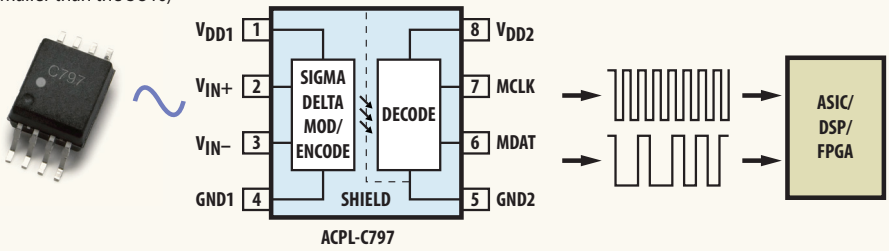
ACPL-798J

- 5 MHz to 25 MHz external clock input range
- LVDS clock and data interface
- 16 bit (12bit ENOB) resolution
- 75dB Typical SNDR
- SO16 package



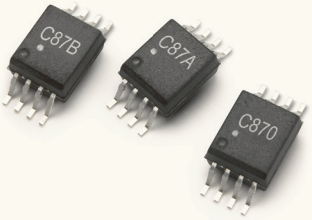
ACPL-C797

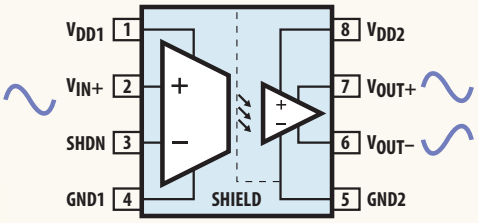
- Sigma Delta Output
- 10MHz internally set clock frequency
- 16 bit resolution (12-bit ENOB)
- 60dB min. SNR
- Stretched SO8 package (50% smaller than the SO16)



ACPL-C87B (0.5% gain)
ACPL-C87A (1% gain)
ACPL-C870 (3% gain)

- 2V input range, 1 GOhm input impedance, suitable for isolated voltage sensing
- Differential Analog Output
- Available with three gain tolerances (0.5%, 1%, 3%)
- 100kHz Bandwidth
- 2.2 µs response



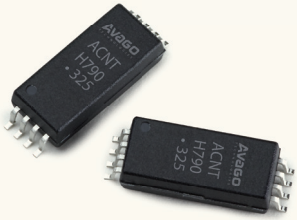


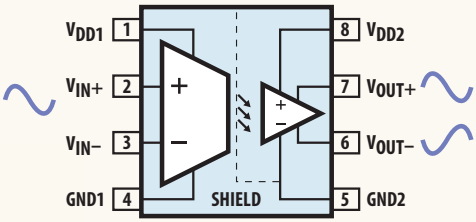
ACPL-C87B/C87A/C870

ACNT-H79A (1% gain)*
ACNT-H790 (3% gain)*

- 14.2mm creepage and clearance, suitable for 690V drives
- Differential Analog Output
- Available with two gain tolerances (1%, 3%)
- 200 kHz Bandwidth
- 1.6 µs response
- 60dB SNR

* Advanced information.





ACNT-H79A/H790

Miniature Isolation Amplifier Product Selection

Part No.	Package	Operating Temperature °C	Gain Error at 25 °C % Max.	Non-Linearity % Typ.	Band-width kHz Typ.	V_{DD2} V	V_{ISO} V_{RMS} Min.	V_{IORM} V peak	V_{IOTM} V peak
ACNT-H79A^	14.2mm Stretched SO8	-40 to +105	±1	0.05	200	3 - 5.5	7500	2262	12000
ACNT-H790^	14.2mm Stretched SO8	-40 to +105	±3	0.05	200	3 - 5.5	7500	2262	12000
ACPL-C87B	Stretched SO8	-40 to +105	±0.5	0.04	100	3 - 5.5	5000	1414	8000
ACPL-C87A	Stretched SO8	-40 to +105	±1	0.04	100	3 - 5.5	5000	1414	8000
ACPL-C870	Stretched SO8	-40 to +105	±3	0.04	100	3 - 5.5	5000	1414	8000
ACPL-C79B	Stretched SO8	-40 to +105	±0.5	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C79A	Stretched SO8	-40 to +105	±1	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C790	Stretched SO8	-40 to +105	±3	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C78A	Stretched SO8	-40 to +85	±1	0.0037	100	4.5 - 5.5	5000	1414	8000
ACPL-C780	Stretched SO8	-40 to +85	±3	0.0037	100	4.5 - 5.5	5000	1414	8000
ACPL-C784	Stretched SO8	-40 to +85	±5	0.0037	100	4.5 - 5.5	5000	1414	8000
HCPL-7800	DIP8	-40 to +85	±3	0.0037	100	4.5 - 5.5	3750	891	6000
HCPL-7800A	DIP8	-40 to +85	±1	0.0037	100	4.5 - 5.5	3750	891	6000
HCPL-7840	DIP8	-40 to +85	±5	0.0037	100	4.5 - 5.5	3750	891*	6000
HCPL-788J	SO16	-40 to +85	±3	0.06	30	4.5 - 5.5	3750	1414^	8000
ACPL-785J	SO16	-40 to +85	±5	0.06	30	4.5 - 5.5	3750	1414^	8000
HCPL-7510	DIP8	-40 to +85	±3	0.06	100	4.5 - 5.5	3750	891*	6000
HCPL-7520	DIP8	-40 to +85	±5	0.06	100	4.5 - 5.5	3750	891*	6000

Notes: * - with IEC/EN/DIN EN 60747-5-2/5 Option 060. ^ - Advanced information.

Isolated Sigma-Delta Modulator Product Selection

Part No.	Package	Operating Temperature °C	Gain Error at 25 °C % Max.	INL LSB Typ.	ENOB Bits Typ.	V_{DD2} V	Clock MHz Typ.	V_{ISO} V_{RMS} Min.	V_{IORM} V peak	V_{IOTM} V peak
ACPL-798J	SO16	-40 to +105	±1	3	12	3 - 5.5	LVDS, 5 - 25, External	5000	1414	8000
ACPL-C797	Stretched SO8	-40 to +105	±1	3	12	3 - 5.5	10, Internal	5000	1414	8000
ACPL-796J	SO16	-40 to +105	±1	3	12	3 - 5.5	5 - 20, External	5000	1414^	8000
HCPL-786J	SO16	-40 to +85	±2	3	11	4.5 - 5.5	10, Internal	3750	1414^	8000
HCPL-7860	DIP8	-40 to +85	±1 (Matching)	3	11	4.5 - 5.5	10, Internal	3750	891	6000

Notes: * - with IEC/EN/DIN EN 60747-5-2/5 Option 060. ^ - Advanced information.

For a complete list of product selection, pls refer to Optoisolation Selection Catalog, publication number AV00-0254EN, at **www.avagotech.com/optocouplers**.

About Avago Technologies

Avago Technologies is a leading designer, developer and global supplier of a broad range of analog, digital, mixed signal and optoelectronics components and subsystems with a focus in III-V compound semiconductor design and processing. Backed by an extensive portfolio of intellectual property, Avago products serve four primary target markets: wireless communications, wired infrastructure, enterprise storage, and industrial and other. Avago has a global employee presence and rich heritage of technical innovation spanning over six decades.

Avago has strong market positions across a broad range of market segments with highly differentiated products that include:

- Film Bulk Acoustic Resonator (FBAR) Filters
- RF Frond End Modules
- Parallel Optics Transceivers
- High Speed SerDes ASIC
- HDD Read Channel & PreAmps
- RAID and SAS I/O Controllers
- PCIe Switches
- Optocouplers
- Motion Encoders
- Industrial Fiber Solutions
- LED Display & Signage Solutions

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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