BROADCOM®

Time to upgrade your current sensing technology!

Third Edition

Leading edge current sensing solutions for industrial applications

Target 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
- General Purpose Inverter

Broadcom has been producing optocouplers for about 50 years! The first product was low-speed transistor output device that over time developed into high performance device with space-grade reliability and high data rate. 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 Broadcom current/voltage sensing isolation amplifiers in your next design!

A single component capable of current and voltage sensing

Introduction

Isolation amplifiers are used to sense (current & voltage like a transducer) and isolate voltage systems. They are typically used to sense & measure, with shunt resistors, phase currents 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 **response time** for analog parts is in the range of 1.6µs and **clock frequency of 20 MHz** for sigma-delta digital output parts, fast enough for fault detection and protection in most applications.

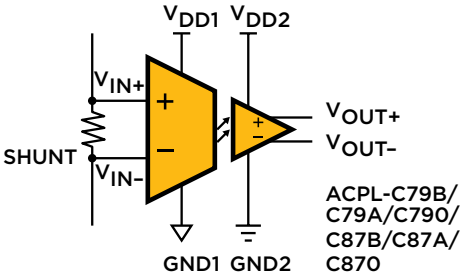
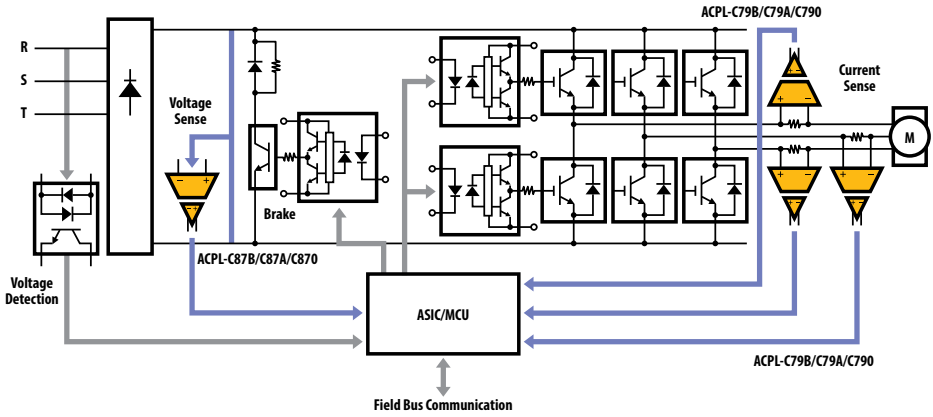


Figure 1. Voltage and current sensing in a three phase motor drive application



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

Optical Isolation Technology

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

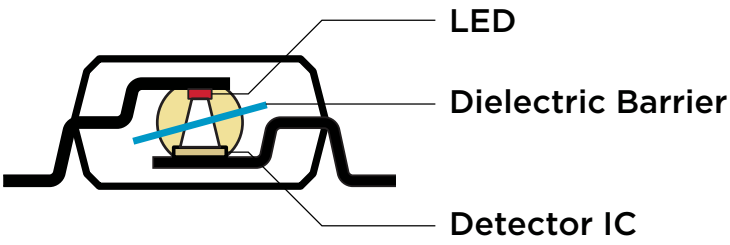
The use of optical isolation technology allows for an optimum design tradeoff between low power consumption and separation distance.

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 Broadcom isolation amplifiers (with option 060) have 100% partial discharge testing at 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 Broadcom optically isolated products.

More information on safety and isolation technologies can be found in the Broadcom white paper *"Safety Consi derations When Using Optocouplers and Alternative Isolators for Providing Protection Against Electrical Hazards",* available at www.broadcom.com under the Support, then Product 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 Broadcom optocouplers, measured across the isolation barrier is > 16kV.

Reliability and Quality of LEDs

The LEDs used in Broadcom 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 Broadcom that has been developed over 40 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 and 110°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.

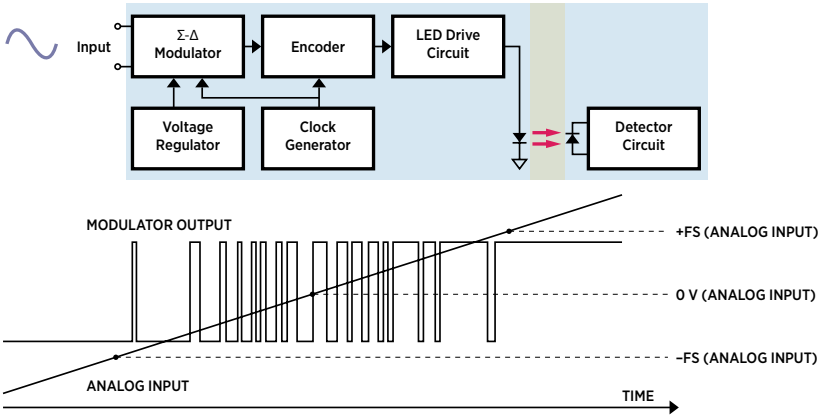
Low Voltage Differential Signaling (LVDS) Interface

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 longer distance between placement of Sigma-Delta Modulator and FPGA / ASICs.

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 & ACPL-C87B isolation amplifier, featuring 0.5% gain accuracy, a designer can achieve excellent solution accuracy even without calibration, as shown in Table 1.

Table 1. ACPL-C79B Iso-Amp Key Specifications

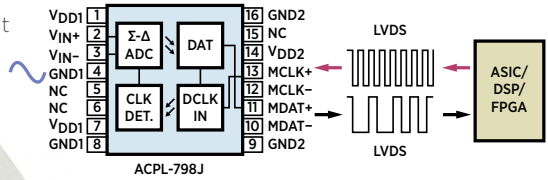
	Gain	Input Offset	Non-Linearity
Absolute Tolerance	0.5%	0.4mV	0.05%
Temperature Drift	50 ppm/°C	0.8µV/°C	0.0003%/°C

Small footprint saves PCB space in comparison to traditional current transducers

New Products Highlight

ACPL-798J

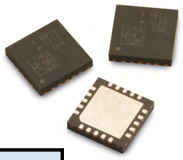
- 5 MHz to 25 MHz external clock input range
- LVDS clock and data interface
- 16 bit (12-bit ENOB) resolution
- 82 dB typical SNR
- SO16 package

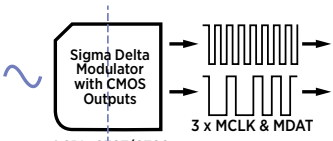


ACPL-798J

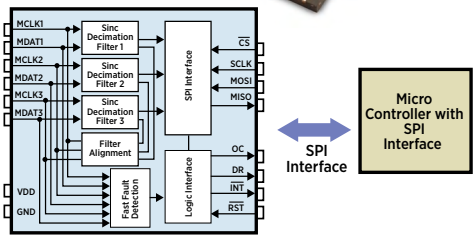
ACPL-0873*

- 3 channels digital filter
- SPI Interface ADC Data Output
- 4 decimation ratios for Sinc2 mode and 3 decimation ratios for Sinc3 mode
- Offset calibration for each channel
- Over-current detection for each channel, signaling over voltage/current conditions
- Operating temperature -40°C to 125°C





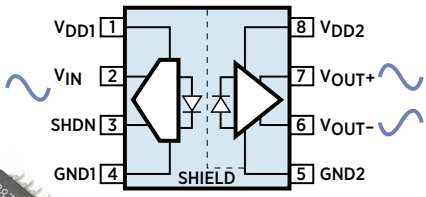
ACPL-C797/C799



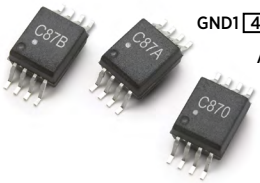
ACPL-0873

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%)
- 100 kHz bandwidth
- 2.2 µs response
- Stretched SO8 package (50% smaller than the SO16)



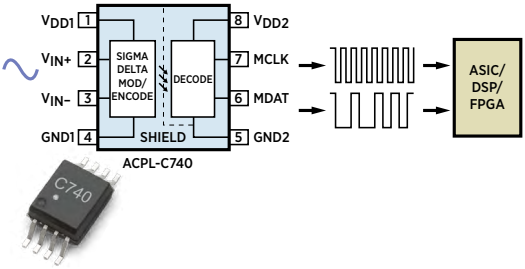
ACPL-C87B/C87A/C870



Advanced Information

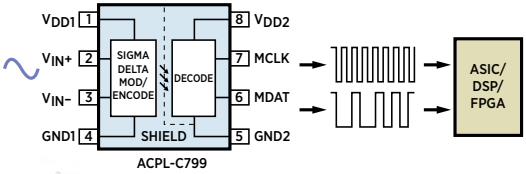
ACPL-C740*

- ±200mV Linear input signal range, Sigma Delta Output
- 20 MHz internal clock frequency
- 16 bit resolution (12-bit ENOB)
- 83 dB typical SNR
- Stretched SO8 (50% smaller than SO16)



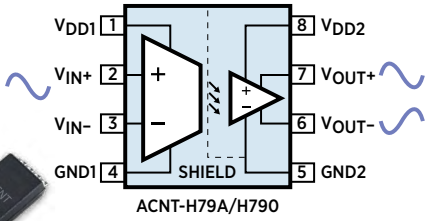
ACPL-C799

- ±50mV linear input signal range, Sigma Delta Output
- 10 MHz internally clock frequency
- 16 bit resolution (12-bit ENOB)
- 77 dB typical SNR
- Stretched SO8 package (50% smaller than the SO16)



ACNT-H79B (0.5% gain)
ACNT-H79A (1% gain)
ACNT-H790 (3% gain)

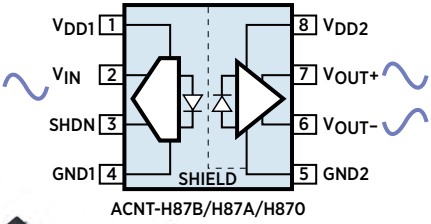
- 15 mm creepage and clearance, suitable for 690V drives
- Differential Analog Output
- Available with 3 gain tolerances (0.5%, 1%, 3%)
- 200 kHz bandwidth
- 1.6 µs response
- 60 dB typical SNR



ACNT-H87B (0.5% gain)
ACNT-H87A (1% gain)
ACNT-H870 (3% gain)

- 15 mm creepage and clearance, suitable for 690V drives
- 2V input range, 1 GOhm input impedance, suitable for isolated voltage sensing
- Differential Analog Output
- Available with 3 gain tolerances (0.5%, 1%, 3%)
- 100 kHz Bandwidth
- 2.2 µs response time

**Advanced Information*



Miniature Isolation Amplifier Product Selection

Part No.	Package	Operating Temp.°C	Linear I/p Signal mV	Gain Error % Max. at 25°C	Non-Linearity % Typ.	Band-width kHz Typ.	V_{DD2} V	V_{ISO} V_{RMS} Min.	V_{IORM} V_{Peak}	V_{IOTM} V_{Peak}
ACNT-H87B	15mm Stretched S08	-40 to +110	0-2V	±0.5	0.05	100	3 - 5.5	7500	2262	12000
ACNT-H87A	15mm Stretched S08	-40 to +110	0-2V	±1	0.05	100	3 - 5.5	7500	2262	12000
ACNT-H870	15mm Stretched S08	-40 to +110	0-2V	±3	0.05	100	3 - 5.5	7500	2262	12000
ACNT-H79B	15mm Stretched S08	-40 to +105	±200	±0.5	0.055	200	3 - 5.5	7500	2262	12000
ACNT-H79A	15mm Stretched S08	-40 to +105	±200	±1	0.055	200	3 - 5.5	7500	2262	12000
ACNT-H790	15mm Stretched S08	-40 to +105	±200	±3	0.055	200	3 - 5.5	7500	2262	12000
ACPL-C87B	Stretched S08	-40 to +105	0-2V	±0.5	0.05	100	3 - 5.5	5000	1414	8000
ACPL-C87A	Stretched S08	-40 to +105	0-2V	±1	0.05	100	3 - 5.5	5000	1414	8000
ACPL-C870	Stretched S08	-40 to +105	0-2V	±3	0.05	100	3 - 5.5	5000	1414	8000
ACPL-790B	DIP8	-40 to +105	±200	±0.5	0.05	200	3 - 5.5	5000	891	8000
ACPL-790A	DIP8	-40 to +105	±200	±1	0.05	200	3 - 5.5	5000	891	8000
ACPL-7900	DIP8	-40 to +105	±200	±3	0.05	200	3 - 5.5	5000	891	8000
ACPL-C79B	Stretched S08	-40 to +105	±200	±0.5	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C79A	Stretched S08	-40 to +105	±200	±1	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C790	Stretched S08	-40 to +105	±200	±3	0.05	200	3 - 5.5	5000	1414	8000
ACPL-C78A	Stretched S08	-40 to +85	±200	±1	0.0037	100	4.5 - 5.5	5000	1414	8000
ACPL-C780	Stretched S08	-40 to +85	±200	±3	0.0037	100	4.5 - 5.5	5000	1414	8000
ACPL-C784	Stretched S08	-40 to +85	±200	±5	0.0037	100	4.5 - 5.5	5000	1414	8000
ACPL-785J	S016	-40 to +85	±200	±5	0.06	30	4.5 - 5.5	5000	1414	8000
HCPL-788J	S016	-40 to +85	±200	±3	0.06	30	4.5 - 5.5	5000	1414	8000
HCPL-7840	DIP8	-40 to +85	±200	±5	0.0037	100	4.5 - 5.5	3750	891	6000
HCPL-7800	DIP8	-40 to +85	±200	±3	0.0037	100	4.5 - 5.5	3750	891	6000
HCPL-7800A	DIP8	-40 to +85	±200	±1	0.0037	100	4.5 - 5.5	3750	891	6000
HCPL-7520	DIP8	-40 to +85	±200	±5	0.06	100	4.5 - 5.5	3750	891	6000
HCPL-7510	DIP8	-40 to +85	±200	±3	0.06	100	4.5 - 5.5	3750	891	6000

Isolated Sigma-Delta Modulator Product Selection

Part No.	Package	Operating Temp.°C	Linear I/p Signal mV	Gain Error % Max. at 25°C	INL LSB Typ.	ENOB Bits Typ.	V_{DD2} V	Clock MHz Typ.	V_{ISO} V_{RMS} Min.	V_{IOTM} V_{Peak}	V_{IOTM} V_{Peak}
ACPL-C740	Stretched S08	-40 to ±110	±200	±1	5	12	3 - 5.5	20, Internal	5000	1414	8000
ACPL-C799	Stretched S08	-40 to ±105	±50	±1	8	12	3 - 5.5	10, Internal	5000	1414	8000
ACPL-7970	DIP8	-40 to ±105	±200	±1	3	12	3 - 5.5	10, Internal	3750	891	8000
ACPL-798J	S016	-40 to ±105	±200	±1	3	12	3 - 5.5	LVDS, 5-25, External	5000	1414	8000
ACPL-C797	Stretched S08	-40 to ±105	±200	±1	3	12	3 - 5.5	10, Internal	5000	1414	8000
ACPL-796J	S016	-40 to ±105	±200	±1	3	12	3 - 5.5	5-20, External	5000	1414	8000
HCPL-786J	S016	-40 to ±85	±200	±2	3	11	4.5 - 5.5	10, Internal	3750	1414	8000
HCPL-7860	DIP8	-40 to ±85	±200	±1 (Matching)	3	11	4.5 - 5.5	10, Internal	3750	891	6000

Digital SinC Filter IC for Sigma-Delta Modulator Interface to Microcontroller

Part No.	Package	Operating Temp.°C	No. of Channels	Mod. Clk. Max. Freq. MHz	SPI Clk. Max. Freq. MHz	V_{DD} V	SinC Filter Mode
ACPL-0873	QFN-20	-40 to +125	3	25	17	3 - 5.5	SinC2 (DR=128, 256, 512, 1024) SinC3 (DR=64, 128, 256)




Optoisolation Products

Broadcom Inc. offers the industry's best optical isolation technology along with the industry's leading CMR performance. Broadcom also provides a broad range of isolation products with performance features and benefits that are unmatched in the industry for industrial, automotive and EV charging, renewable energy and storage, robotics, data center and mission critical power supply, communications, medical, military and aerospace markets.

Broadcom's extensive product portfolio serves multiple applications within four primary end markets: wired infrastructure, wireless communications, enterprise storage and industrial & others. Applications for our product in these end markets include: data center networking, home connectivity, broadband access, telecommunications equipment, smartphones and base stations, data center servers and storage, factory automation, power generation and alternative energy systems, and displays.

Broadcom combines global scale, engineering depth, broad product portfolio diversity and superior execution and operational focus to deliver category-leading connectivity products so its customers can build and grow successful businesses today and in the future.

Product Portfolio

- Multi-Channel Bi-Directional Digital Optocoupler
- High Speed Digital CMOS Logic
- 20 MBd Logic Gate Optocoupler
- 10 MBd Logic Gate/CMOS Optocoupler
- 8 MBd Logic Gate Optocoupler
- 5 MBd Logic Gate Optocoupler
- 1 MBd Transistor Output Optocoupler
- 100 kBd Darlington Transistor Output Optocoupler
- R^2Coupler®
- Digital Isolator
- Miniature Analog Isolation Amplifier
- Integrated Gate Drive Optocoupler
- Intelligent Power Module Interface Optocoupler
- Isolated Line Receiver
- Isolated 20mA Current Loop
- Isolated Voltage/Current Detector
- High Linearity Analog Optocoupler
- Wideband Analog/Video Optocoupler

Optocoupler Publications and Resources

Selection Guide
Designer's Guide
Regulatory Guide
Application Notes and White Papers

Options

020 = UL 1577 5000 Vrms/1 Minute
060 = IEC/EN/DIN EN 60747-5-5
300 = Gull Wing SMD
500 = Tape and Reel Package
xxxE = Lead-Free

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For more product information: broadcom.com

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