User Guide

ACPL-C72B, ACPL-C72A, and ACPL-C720

±50 mV High Current Isolation Amplifier Evaluation Board

The Broadcom® ACPL-C72x device is suited for use to sense much higher currents as the current sense device's input voltage gets lower, as the shunt will dissipate lower power. This User Guide provides the necessary steps to set it up for the proper sensing of input current.

Quick Start

Visual inspection is needed to ensure that the Evaluation Board is received in good condition, as shown in Figure 1. Once visual inspection is done, the Evaluation Board can be powered up in just four simple steps.

1. Select either one of the provided shunt resistors (50 μΩ, 100 μΩ, or 200 μΩ), or user's own sensing resistor and mount it (through provided 2 x M3 screws, washers, and nuts) on pads provided for Rsense+ and Rsense- on the Evaluation Board. Note that the shunt resistors are scaled for full range peak current sensing of 1000A, 500A, and 250A, respectively.
2. Plug a piece of the provided 5-pin flat ribbon cable to the H1 connector (with contact surfaces facing the bottom side).
3. Connect the necessary power supplies and current source as shown in Figure 2.
   a. Connect an isolated 5V DC supply (+5Vcc) to pin 1 with respect to pin 5 (Gnd2) of the H1 connector through the flat ribbon cable as shown. The 3.3V DC supply (Vdd2) voltage will be derived from the internal circuit of U5 and appears at pin 2 of the H1 connector.
   b. Connect, through proper cable lugs, the required input current source (for sensing) cables as shown in Figure 2 to the two mounting holes of the selected shunt resistor.
4. Supply the input current (subject to a maximum signal level of 100 mVpp, or ±50 mV peak across the shunt resistor Rsense+ and Rsense–) through the cables (as shown in Figure 2). Monitor the output signal level (Vout) at pin 3 of the H1 connector through an oscilloscope.

Figure 1: ACPL-C72x Evaluation Board

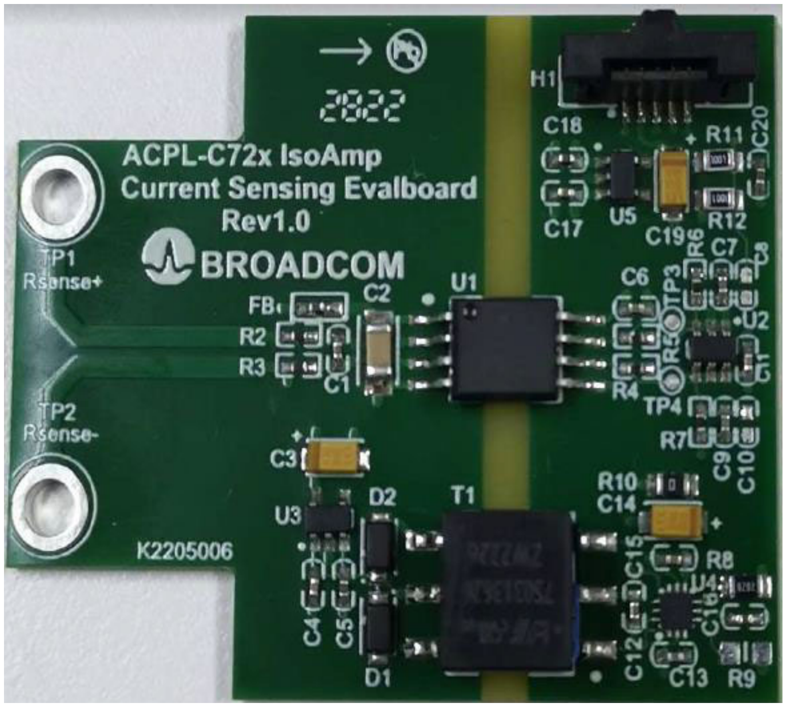
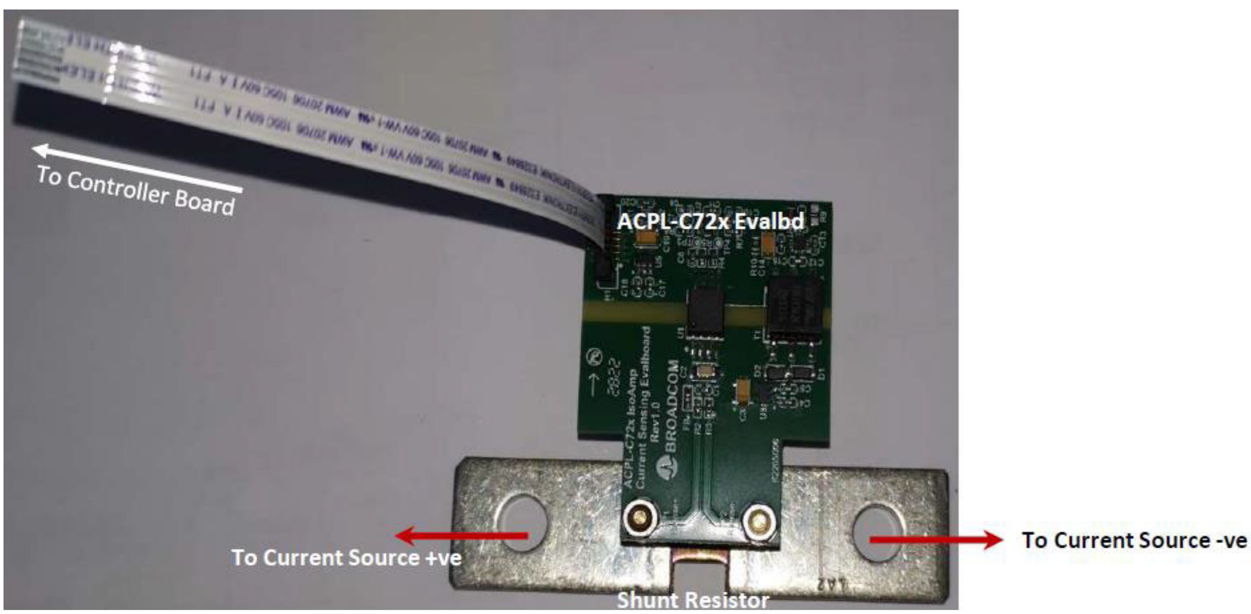


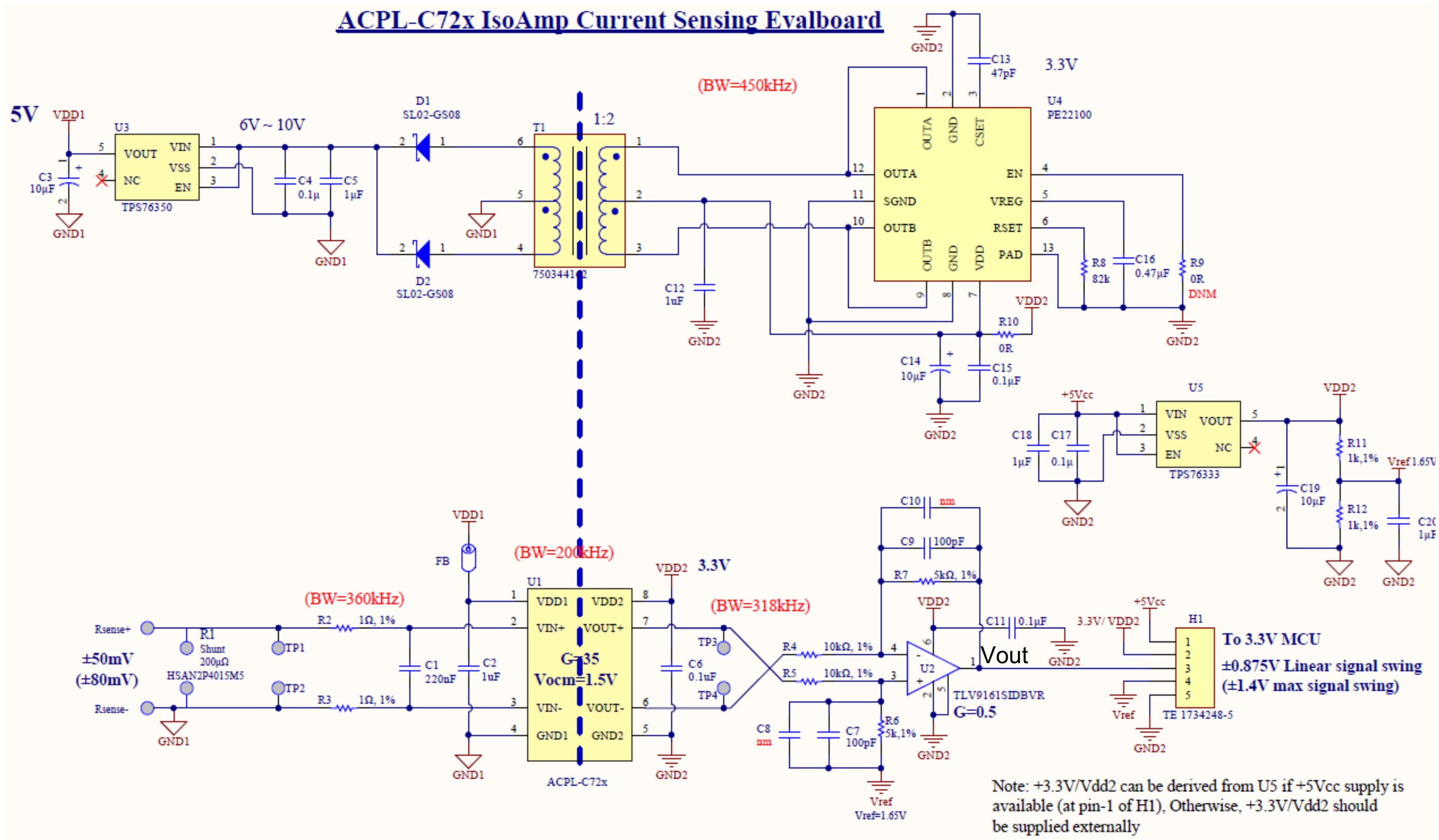
Figure 2: Default Test Setup of ACPL-C72x Evaluation Board



Schematics

Schematics of the Evaluation Board are as shown in the following figure.

Figure 3: Schematics of the ACPL-C72x Evaluation Board



Board Description

The central piece of operating action for this High Current Sense Evaluation Board is done by the Broadcom ACPL-C72x Isolation Amplifier IC. Designed to reduce power loss on shunt resistor, the ACPL-C72B/C72A/C720 product series are optimized to accept ±50 mV (full scale ±80 mV) input voltage range. The product operates from a single 3.3V or 5V supply for both Vdd1 and Vdd2 and provides excellent linearity and dynamic performance of 65 dB SNR. With 200 kHz bandwidth, 1.6 µs fast response time, it captures transients in short circuit and overload conditions. The high common-mode transient immunity (at 15 kV/µs) of the ACPL- C72B/C72A/C720 IC provides the precision and stability needed to accurately monitor motor current in high noise control environments.

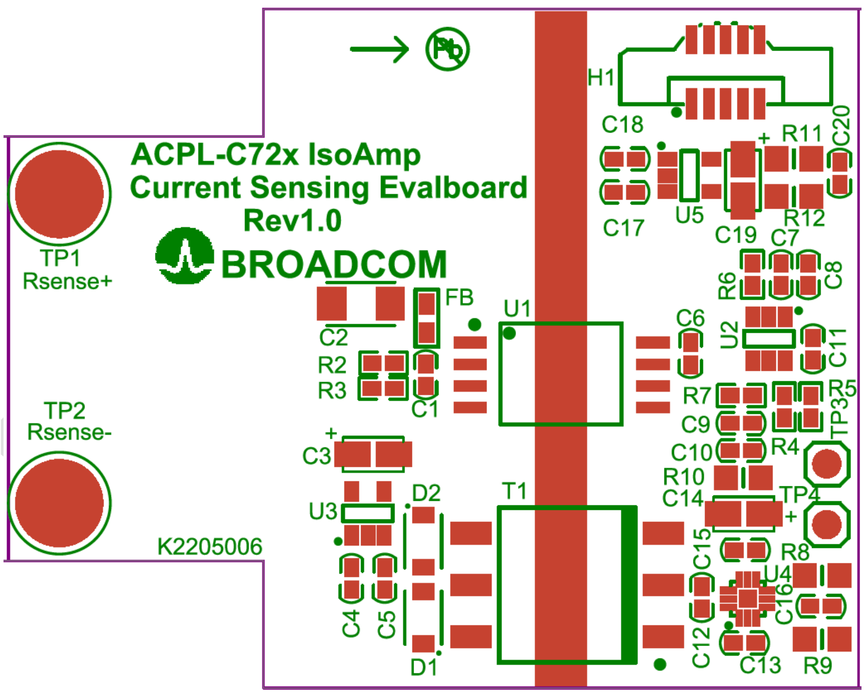
The ACPL-C72X evaluation board component layout (shown in Figure 4), can accommodate either a ACPL-C72B (0.5% tolerance), ACPL-C72A (1% tolerance), or ACPL-C720 (3% tolerance) device as U1, to demonstrate the high linearity and low-offset capability of the Broadcom Isolation Amplifier over a wide range of input current conditions. It allows a designer to easily test the performance of the high-precision isolation amplifier in an actual application under real-life operating conditions. Many of the circuit recommendations discussed in Application Note 1078 are implemented on the board. Operation requires merely a low-resistance shunt resistor on the input side of the isolation amplifier. The board has holes for mounting a through-hole shunt. The board may also be used for general voltage isolation without any shunt resistor.

As can be seen on the board, the isolation circuitry is easily contained within a small area while maintaining adequate spacing for good voltage isolation and easy assembly.

In this Evaluation Board design, only a single external DC supply +5Vcc is needed to power up the whole circuit including both primary and secondary sides. The +5Vcc DC supply is to be connected across pins 1 and 5 of H1 connector at the secondary side. Secondary side 3.3V DC supply will be derived through a low-drop output (LDO) linear regulator U5 and is used to power up Vdd2 of U1 (ACPL-C72x) and as an input to the DC/DC converter IC PE22100 to convert it to a 5V isolated supply Vdd1 at the primary side through a push-pull transformer T1 and another LDO U3.

If +5Vcc DC supply is not available externally, a +3.3V DC supply should be supplied externally instead. Everything will work as per normal except that U5 will not be operable.

Figure 4: Top View of ACPL-C72x Evaluation Board



Using the Board

The evaluation board is easily prepared for use. Only minor preparations (a simple connection of shunt resistor through 2 x M3 screws and nuts, wire connections for sense current path, and a 5-wire flat ribbon cable for +5Vcc, Gnd2, and Output Signal Voltage) are required. The evaluation board has a default setup 1 as shown in the table when shipped to the customer. The customer is free to choose either of the two setup configurations as shown in the table, depending on the availability of +5Vcc.

	Recommended Vin for Better Linearity[a]	+5Vcc Pin 1 of H1 from Controller Board	Vdd2	Vref	Vdd1 (isolated)
Default Setup 1	≤50 mVpp	+5V To be supplied from Controller Board through pin 1 of H1 connector if available	+3.3Vdc (derived	+1.65Vdc (derived)	+5V (derived)
Setup 2	≤50 mVpp	N/A If not available	+3.3Vdc To be supplied from Controller Board if +5Vcc is not available	+1.65Vdc (derived)	+5V (derived)

a. Linear input range is limited by the post-amp output swing range. To avoid this limitation, measure directly the Vout+, Vout- of the isolation amplifier.

The output signal voltage is measured between the Vout and GND2 terminals (across pin 3 and pin 5 of the H1 connector). With all connections made and +5Vcc DC supply turned on, the approximate relationship of output voltage to input current is:

Vout = 17.5 x Vin

where

Vin = RSENSE x Iin = 100 mVpp

Therefore,

Vout = 17.5 x 100 mVpp

= 1.75 Vpp

With the shunt resistor in place, the maximum differential input voltage swing for linear operation is ±50 mV (or 100 mVpp) as specified in the data sheet. However, input voltage as high as ±80 mV (or 160 mVpp) can be safely applied with minimal performance degradation.

When 100 pF capacitance is selected for both C7 and C9, the bandwidth of the differential amplifier will be limited to 318 kHz. But since the isolation device has an inherent 200 kHz bandwidth, the overall bandwidth is just limited to 200 kHz.

Output Measurement

A sample of Vout vs. Vin waveforms are captured and shown in Figure 5.

Vin+ = ±50 mVpk, 100 kHz.

Vout is taken at pin 3 of the H1 connector.

See Table 1 for input and output signaling amplitude across the useful spectrum.

Figure 5: Vout (Blue) vs. Vin (Green) Voltage Waveforms

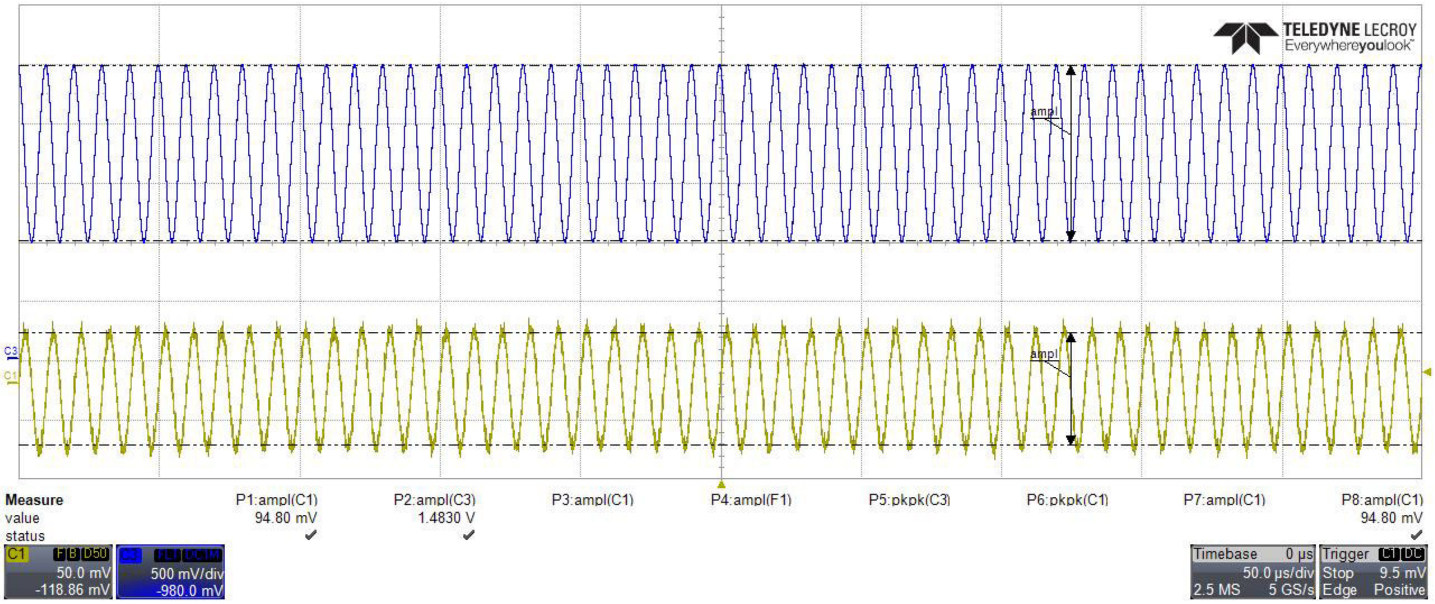


Table 1: ACPL-C72x Evalboard Input/Output Signal Records

Signal Gen.		Probe Calibration (Vpp)		Output	Gain	Attenuation
Vinpp	**ƒ (kHz)**	**Vin @Shunt**	**Vin @ACPL-C72x**	**Vopp**	**Unity**	**dB**
–50 mVpk to +50 mVpk	1	0.0950	—	1.6304	17.2	0.0
	10	0.0949	—	1.6100	17.0	–0.1
	20	0.0949	—	1.6070	16.9	–0.1
	30	0.0949	—	1.6050	16.9	–0.1
	40	0.0949	—	1.6000	16.9	–0.2
	50	0.0949	—	1.5884	16.7	–0.2
	60	0.0949	—	1.5730	16.6	–0.3
	70	0.0949	—	1.5560	16.4	–0.4
	80	0.0949	—	1.5400	16.2	–0.5
	90	0.0949	—	1.5200	16.0	–0.6
	100	0.0949	—	1.4850	15.6	–0.8
	110	0.0949	—	1.4540	15.3	–1.0
	120	0.0949	—	1.4300	15.1	–1.1
	130	0.0949	—	1.4000	14.8	–1.3
	140	0.0949	—	1.3600	14.3	–1.6
	150	0.0949	—	1.3220	13.9	–1.8
	160	0.0949	—	1.2890	13.6	–2.0
	170	0.0949	—	1.2500	13.2	–2.3
	180	0.0949	—	1.2100	12.8	–2.6
	190	0.0949	—	1.1700	12.3	–2.9
	200	0.0949	—	1.1320	11.9	–3.2

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