DT0006
Design tip

A low cost current sensor for design work

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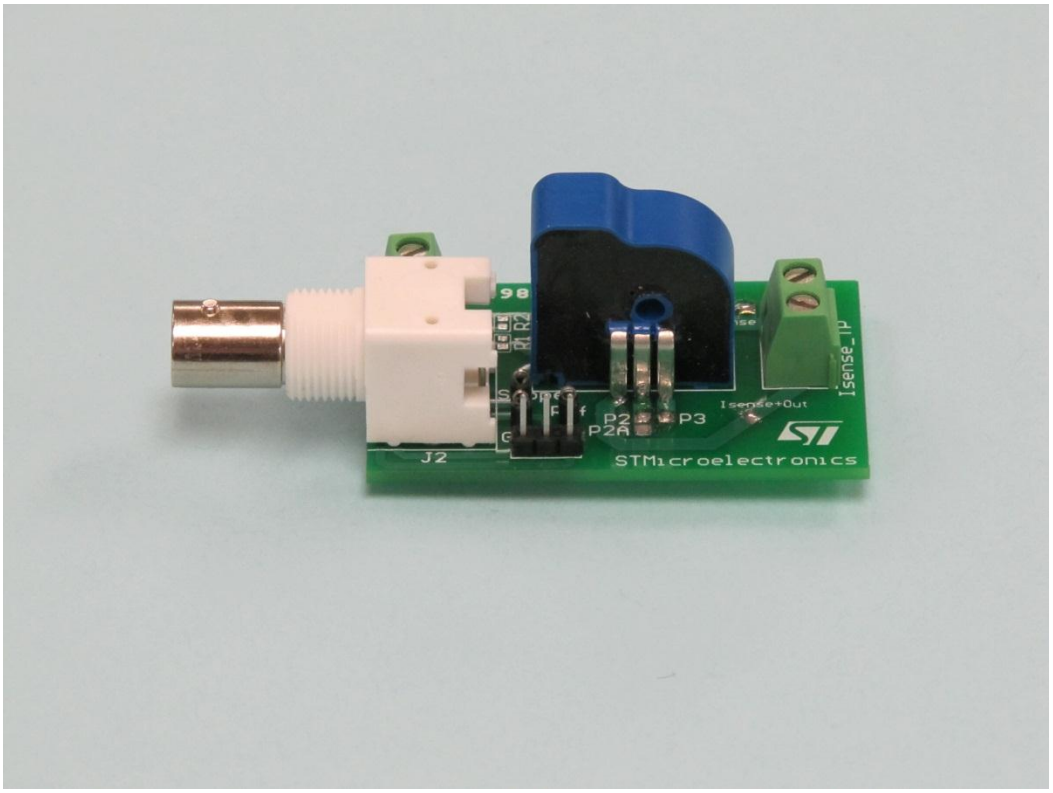
Purpose and benefits

When designing motor control or power supplies, it is imperative to be able to monitor the winding current of the motor or the inductor/transformer current in a power supply. The preferred method to make this measurement is to use a Hall Effect based DC current probe. However, a good quality current probe is not always available. This design tip describes a low cost alternative that is easy to make with readily available components and works well for monitoring the currents encountered in most motor control and power supply circuits. The major drawback to this sensor is that, unlike commercial current probes, the sensor does not have a clamp on type arrangement so the wire must be cut and the sensor wired in series with the load being monitored. Using multiple sensors provides an inexpensive way to monitor multiple currents at the same time and is much more compact than a typical commercial current probe.

Figure 1. Current sensor board



Description

The circuit is based on the LTSR 6-NP Hall Effect current transducer from LEM. The key parameters of the LEM device are:

I_{PN}	Primary nominal current	6	At
I_{PM}	Primary current measurement range	± 19.2	At
G	Sensitivity	104	mV/At
BW	Frequency bandwidth (-0.5 dB)	DC to 100	kHz
di/dt	di/dt followed accurately	> 15	A/µS
V_d	Isolation (RMS voltage for isolation test)	3	kV
V_C	Supply voltage (± 5%)	5	V
V_{out}	Output Voltage @I_P = 0	2.5	V
	Output Voltage @ I_P	2.5 ± (0.625 I_P/I_{PN})	V
X	Accuracy @ I_{PN}, T_A = 25 ^{O}C	±0.2	%

Using a simple circuit, shown in Figures 1 and 2, the LEM device can easily be configured to be connected to the oscilloscope input. The circuit requires only an isolated 5V supply to power the circuitry in the LEM sensor. The Isense_TP is connected in series with the load current to be measured.

The LEM device has three independent turns on the primary that can be connected in various series/parallel combinations to give current measurement ranges of 104mV/A, 208mV/A and 312mV/A. If a higher sensitivity is desired to measure lower currents, the user can add additional turns to the primary. For example, wrapping 10 turns of 30 gauge wire through the center of the LEM device and leaving the three primary turns of the device unconnected gives a sensitivity of 1.04 V/A and a usable measurement range of ± 1.92 A.

A jumper on P1 is used to connect the ring of the BNC connector to either the LEM reference or the LEM ground. With P1 in the reference position, the 2.5V offset (which is intended for use with unipolar analog to digital converters) is effectively removed so that the scope trace is centered naturally at zero volts. When an isolated 5V supply is used there is no possible ground loop.

Table 1. Jumper connections to select current scale

Primary Nominal Current A	Usable Range A	Output Voltage mV/A	Recommended Connections
6A	± 19A	104	P5 to P6 P2 to P3 Isense In to P5A Isense Out to P2A
± 3A	± 9.5A	208	P3 to P6 P5 unconnected P2 unconnected
± 2A	± 6.3A	312	P3 to P5 P2 to P6
± 0.6A	± 1.9A	1040	10 turns of 30 gauge wire through center of sensor running from Isense In to Isense out. P2, P3, P5, P6 unconnected

Figure 2. Circuit diagram

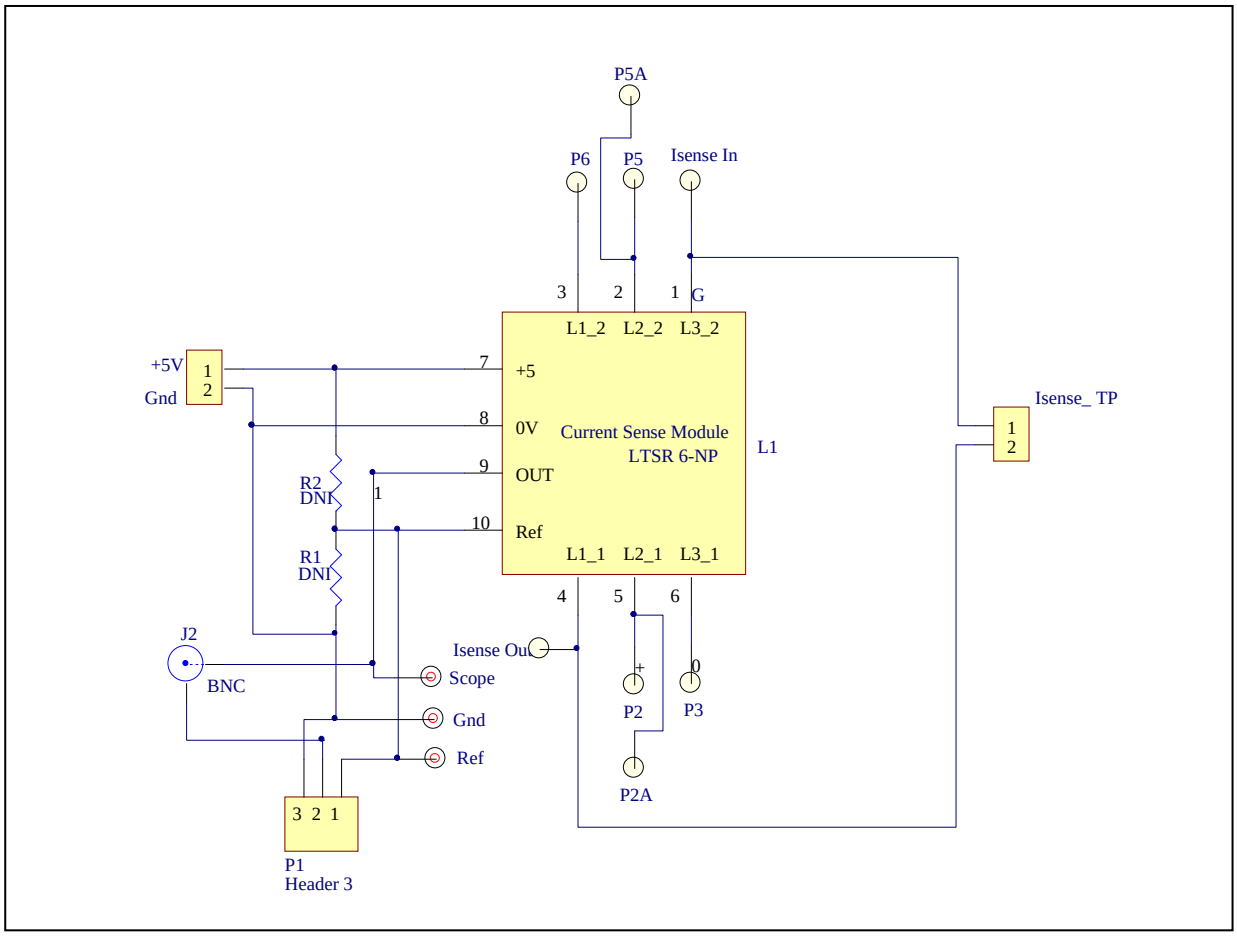


Table 2. Bill of Materials

Quantity	Reference	Value/Generic Part Number	Manufacturer	Manufacturers Part Number	Supplier	Supplier Ordering Code
1	J2	Right Angle BNC Connector	Tyco	5227161-1	DigiKey	A32244
1	L1	LTSR 6- NP	LEM	LTSR 6-NP	DigiKey	398-1021-5
1	P1	3 Pos. 100 Header	Sullins	PEC36SAAN	DigiKey	S1012E-36
2	+5V, Isense_ TP	5mmPCB Connector	Phoenix Contact	1729018	DigiKey	277-1236
2	R1, R2	DNI, Optional				

Figure 3 shows the connections to monitor the current in one coil of a stepper motor. In this example the L6470 is driving the stepper motor in microstepping mode with 128 microsteps per step. One of the motor leads is cut and connected to the input connection of the current sense board. The current sense board is configured with 10 turns of wire so that the sensitivity is 1.04 V/A, as shown in table 1. Figure 4 shows the current waveform on channel 4 and the PWM voltage waveform for the same output on channel 1.

Figure 3. Connection to monitor current in a stepper motor

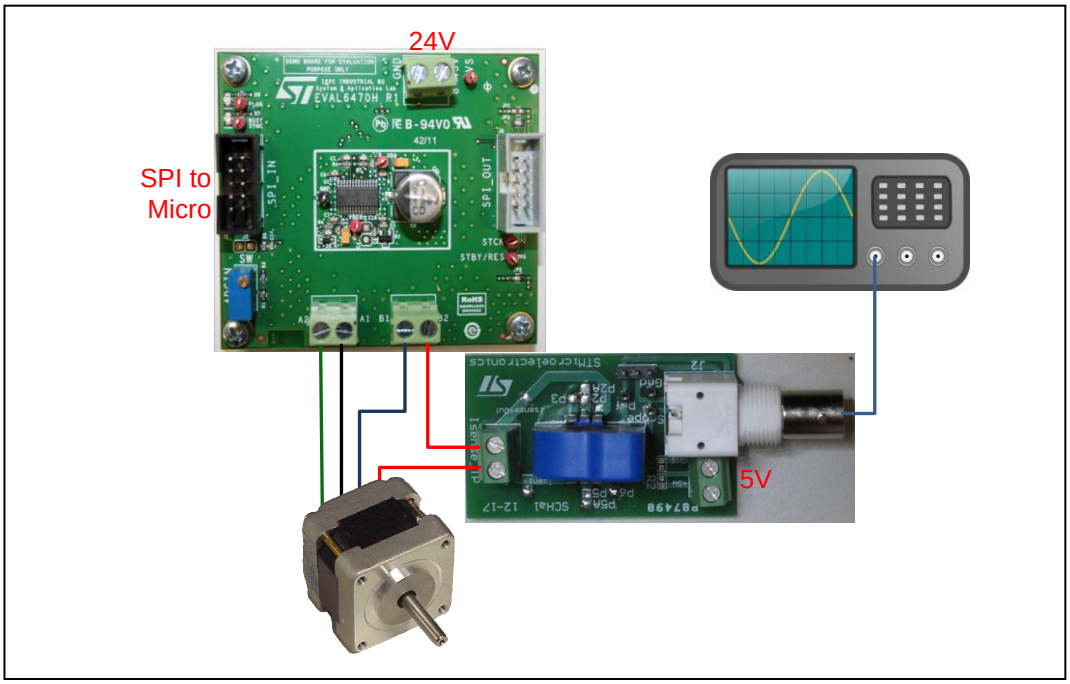
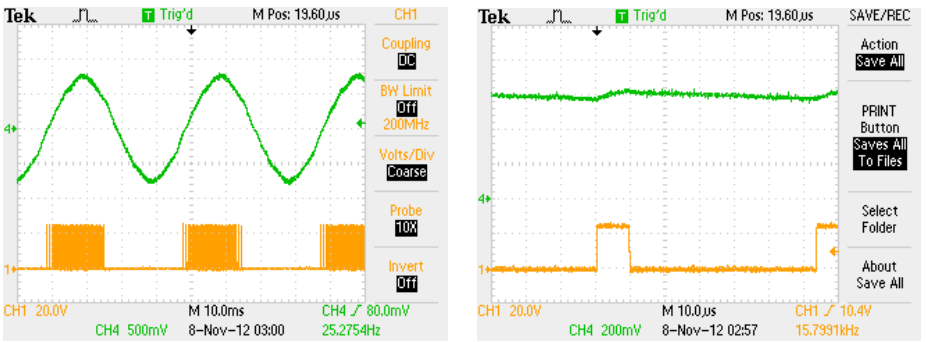


Figure 4. Microstepping current waveforms for stepper motor



a) Microstepping current waveform

b) Ripple near peak of sine wave

For higher current applications, 15A (LTSR 15-NP) and 25A (LTSR 25-NP) current sensors are available from LEM and may be used in a similar way. Both devices have the same footprint as the LTSR 6-NP.

Support material

Related design support material
LEM LTSR 6-NP data sheet: http://www.lem.com/docs/products/ltsr%206-np.pdf

Revision history

Date	Version	Changes
8-Nov-2012	1	Initial release