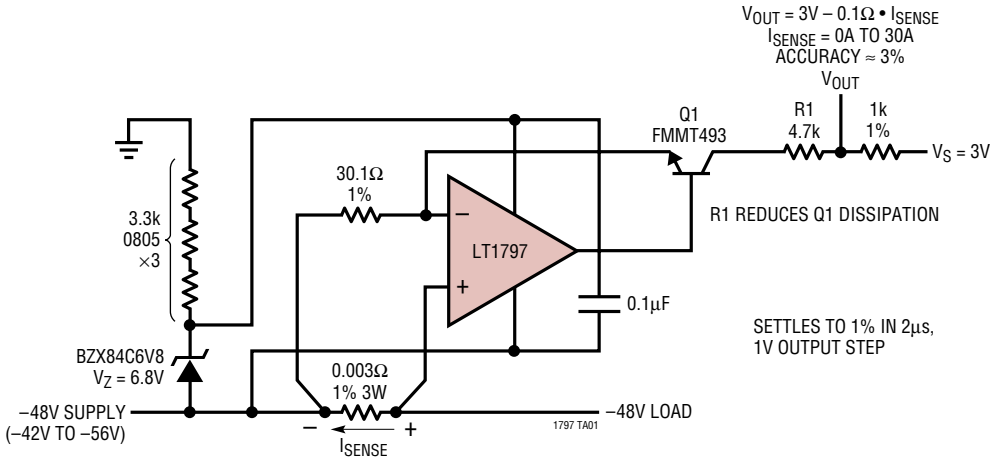
High Speed

Current monitoring is not normally a particularly high speed requirement unless excessive current flow is caused by a fault of some sort. The use of fast amplifiers in conventional current sense circuits is usually sufficient to obtain the response time desired.

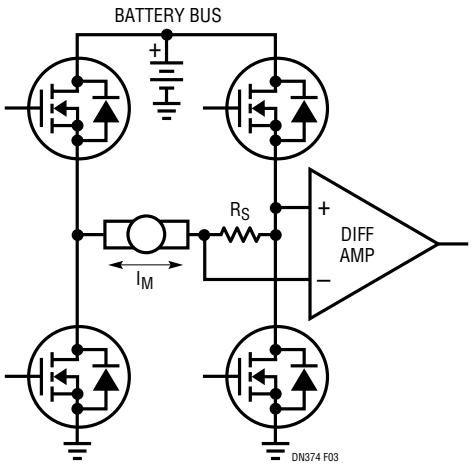
To see other chapters in this Application Note, return to the Introduction.

Fast Compact –48V Current Sense



This amplifier configuration is essentially the complementary implementation to the classic high-side configuration. The op amp used must support common-mode operation at its lower rail. A "floating" shunt-regulated local supply is provided by the Zener diode, and the transistor provides metered current to an output load resistance (1kΩ in this circuit). In this circuit, the output voltage is referenced to a positive potential and moves downward when representing increasing –48V loading. Scaling accuracy is set by the quality of resistors used and the performance of the NPN transistor.

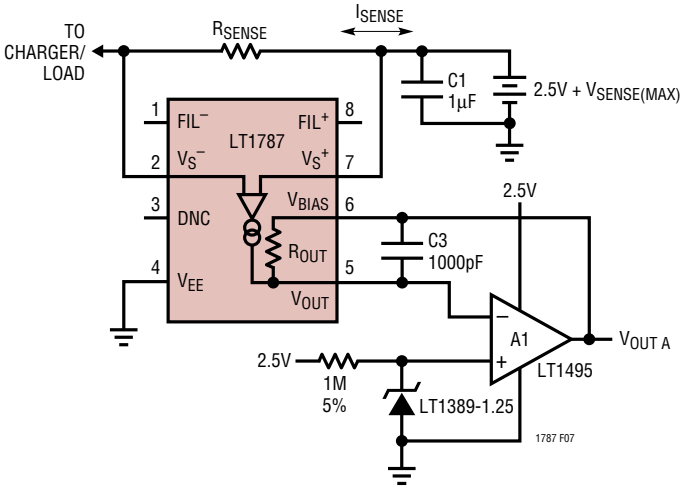
Conventional H-Bridge Current Monitor



Many of the newer electric drive functions, such as steering assist, are bidirectional in nature. These functions are generally driven by H-bridge MOSFET arrays using pulse-width-modulation (PWM) methods to vary the commanded torque. In these systems, there are two main purposes for current monitoring. One is to monitor the current in the load, to track its performance against the desired command (i.e., closed-loop servo law), and another is for fault detection and protection features.

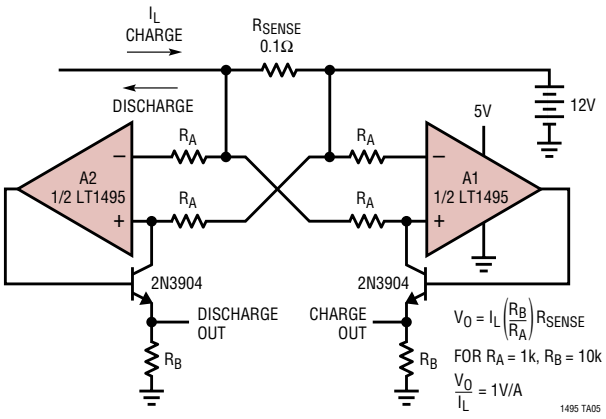
A common monitoring approach in these systems is to amplify the voltage on a "flying" sense resistor, as shown. Unfortunately, several potentially hazardous fault scenarios go undetected, such as a simple short to ground at a motor terminal. Another complication is the noise introduced by the PWM activity. While the PWM noise may be filtered for purposes of the servo law, information useful for protection becomes obscured. The best solution is to simply provide two circuits that individually protect each half-bridge and report the bidirectional load current. In some cases, a smart MOSFET bridge driver may already include sense resistors and offer the protection features needed. In these situations, the best solution is the one that derives the load information with the least additional circuitry.

Single Supply 2.5V Bidirectional Operation with External Voltage Reference and I/V Converter



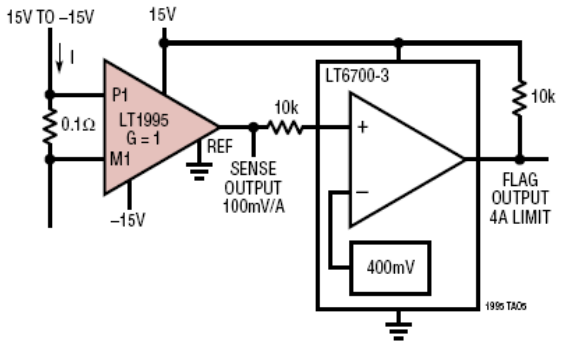
The LT1787's output is buffered by an LT1495 rail-to-rail op-amp configured as an I/V converter. This configuration is ideal for monitoring very low voltage supplies. The LT1787's V_{OUT} pin is held equal to the reference voltage appearing at the op amp's non-inverting input. This allows one to monitor supply voltages as low as 2.5V. The op-amp's output may swing from ground to its positive supply voltage. The low impedance output of the op amp may drive following circuitry more effectively than the high output impedance of the LT1787. The I/V converter configuration also works well with split supply voltages.

Battery Current Monitor



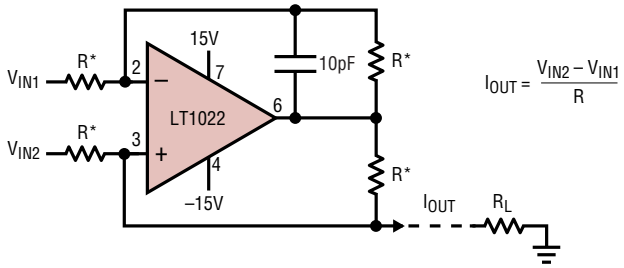
One LT1495 dual op-amp package can be used to establish separate charge and discharge current monitoring outputs. The LT1495 features Over-the-Top operation allowing the battery potential to be as high as 36V with only a 5V amplifier supply voltage.

Fast Current Sense with Alarm



The LT1995 is shown as a simple unity gain difference amplifier. When biased with split supplies the input current can flow in either direction providing an output voltage of 100mV per Amp from the voltage across the 100mΩ sense resistor. With 32MHz of bandwidth and 1000V/usec slew rate the response of this sense amplifier is fast. Adding a simple comparator with a built in reference voltage circuit such as the LT6700-3 can be used to generate an over-current flag. With the 400mV reference the flag occurs at 4A.

Fast Differential Current Source



*MATCH TO 0.01%
FULL-SCALE POWER BANDWIDTH
= 1MHz FOR $I_{OUT}R = 8V_{P-P}$
= 400kHz FOR $I_{OUT}R = 20V_{P-P}$
MAXIMUM $I_{OUT} = 10mA_{P-P}$
COMMON-MODE VOLTAGE AT LT1022 INPUT = $\frac{I_{OUTP-P} \bullet R_L}{2}$

LT1022 • TA07

This is a variation on the Howland configuration, where load current actually passes through a feedback resistor as an implicit sense resistance. Since the effective sense resistance is relatively large, this topology is appropriate for producing small controlled currents.