Current Control

This chapter collects a variety of techniques useful in generating controlled levels of current in circuits.

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

800 mA/1A White LED Current Regulator

![Circuit Diagram]

The LT6100 is configured for a gain of either 40V/V or 50V/V depending on whether the switch between A2 and VEE is closed or not. When the switch is open (LT6100 gain of 40V/V), 1A is delivered to the LED. When the switch is closed (LT6100 gain of 50V/V), 800mA is delivered. The LT3436 is a boost switching regulator which governs the voltage/current supplied to the LED. The switch “LED ON” connected to the SHDN pin allows for external control of the ON/OFF state of the LED.

Bidirectional Current Source

The LT1990 is a differential amplifier with integrated precision resistors. The circuit shown is the classic Howland current source, implemented by simply adding a sense resistor.

Two Terminal Current Regulator

The LT1635 combines an op amp with a 200mV reference. Scaling this reference voltage to a potential across resistor R3 forces a controlled amount of current to flow from the +terminal to the –terminal. Power is taken from the loop.
**Variable Current Source**

A basic high-side current source is implemented at the output, while an input translation amplifier section provides for flexible input scaling. A Rail-to-Rail input capability is required to have both amplifiers in one package, since the input stage has common-mode near ground and the second section operates near $V_{CC}$.

**Precision Voltage Controlled Current Source with Ground Referred Input and Output**

The ultra-precise LTC2053 instrumentation amplifier is configured to servo the voltage drop on sense resistor $R$ to match the command $V_C$. The LTC2053 output capability limits this basic configuration to low current applications.

**Switchable Precision Current Source**

This is a simple current-source configuration where the op amp servos to establish a match between the drop on the sense resistor and that of the 1.2V reference. This particular op amp includes a shutdown feature so the current source function can be switched off with a logic command. The 2$k$ pull-up resistor assures the output MOSFET is off when the op amp is in shutdown mode.
This is a classical Howland bidirectional current source implemented with an LT1990 integrated difference amplifier. The op amp circuit serves to match the RSENSE voltage drop to the input command VCTL. When the load current exceeds about 0.7mA in either direction, one of the boost transistors will start conducting to provide the additional commanded current.

**Boosted Bidirectional Controlled Current Source**

The LT1995 amplifies the sense resistor drop by 5V/V and subtracts that from \( V_{IN} \), providing an error signal to an LT1880 integrator. The integrated error drives the PMOSFET as required to deliver the commanded current.

**Fast Differential Current Source**

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.

**0A to 2A Current Source**

The LT1995 amplifies the sense resistor drop by 5V/V and subtracts that from \( V_{IN} \), providing an error signal to an LT1880 integrator. The integrated error drives the PMOSFET as required to deliver the commanded current.

**1A Voltage-Controlled Current Sink**

This is a simple controlled current sink, where the op amp drives the NMOSFET gate to develop a match between the 1Ω sense resistor drop and the \( V_{IN} \) current command. Since the common-mode voltage seen by the op amp is near ground potential, a “single-supply” or Rail-to-Rail type is required in this application.

**Current Control-3**
Voltage Controlled Current Source

Adding a current sense amplifier in the feedback loop of an adjustable low dropout voltage regulator creates a simple voltage controlled current source. The range of output current sourced by the circuit is set only by the current capability of the voltage regulator. The current sense amplifier senses the output current and feeds back a current to the summing junction of the regulator’s error amplifier. The regulator will then source whatever current is necessary to maintain the internal reference voltage at the summing junction. For the circuit shown a 0V to 5V control input produces 500mA to 0mA of output current.

Adjustable High-Side Current Source

The wide-compliance current source shown takes advantage of the LT1366’s ability to measure small signals near the positive supply rail. The LT1366 adjusts Q1’s gate voltage to force the voltage across the sense resistor (RSENSE) to equal the voltage between VDC and the potentiometer’s wiper. A rail-to-rail op amp is needed because the voltage across the sense resistor is nearly the same as VDC. Q2 acts as a constant current sink to minimize error in the reference voltage when the supply voltage varies. At low input voltage, circuit operation is limited by the Q1 gate drive requirement. At high input voltage, circuit operation is limited by the LT1366’s absolute maximum ratings.
The current output can be controlled by a variable resistor (\(R_{\text{PROG}}\)) connected from the PROG pin to ground on the LT1620. The LT1121 is a low-dropout regulator that keeps the voltage constant for the LT1620. Applying a shutdown command to the LT1121 powers down the LT1620 and eliminates the base-drive to the current regulation pass transistor, thereby turning off \(I_{\text{OUT}}\).

**Snap Back Current Limiting**

The LT1970 provides current detection and limiting features built-in. In this circuit, the logic flags that are produced in a current-limiting event are connected in a feedback arrangement that in turn reduces the current limit command to a lower level. When the load condition permits the current to drop below the limiting level, then the flags clear and full current drive capability is restored automatically.