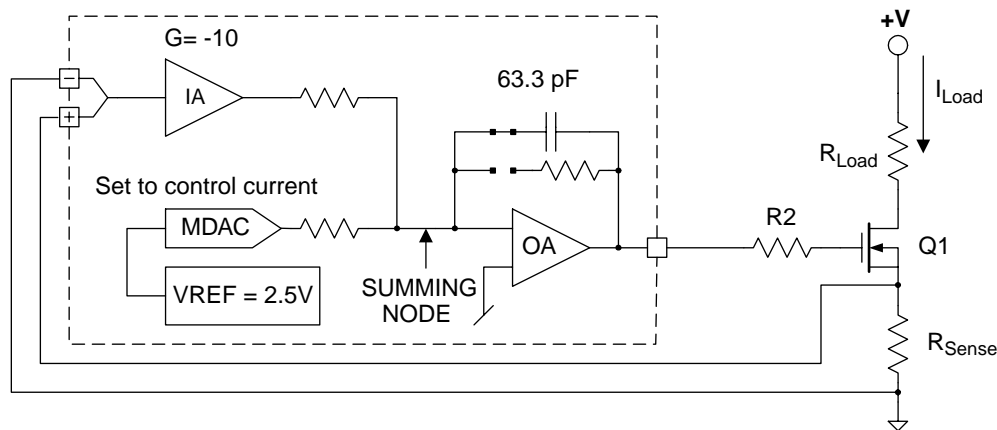


Constant current sinks are used in a variety of applications, from low currents that bias sensors to high currents used to generate magnetic fields. Resistive temperature detectors (RTDs) and thermistors are usually biased with a small constant current. Small constant currents are generally used to reduce the self-heating of the sensor and improve the accuracy of the measurement. Biasing a temperature sensor with a constant current simplifies the task of measuring the resistance to simply measuring the voltage drop, which is a function of temperature. In electromechanical devices, such as motors or generators, the current in the field coil can be adjusted to control speed, output voltage or power. Constant current circuits generally consist of a reference, feedback control loop, pass transistor and sense resistor. The ispPAC30 allows a current sink to be implemented with minimal external components, as illustrated in Figure 1. Note that only half of the ispPAC30 is used for a current sink, thus two programmable current sinks could be constructed from one device. Alternatively, the second voltage reference and MDAC could be connected to the summing node for an offset or gain trim.

Figure 1. ispPAC30 Programmable Current Sink



The ispPAC30 can implement a servo loop to accurately control current through a load and pass transistor. With the Output Amplifier (OA) in open loop mode, the feedback path is completed with the voltage drop across a small sense resistor, which is amplified by the Input Amplifier (IA). Constant load current is maintained by the ispPAC30 driving the external pass transistor (Q1) as a function of the feedback. The voltage drop across the sense resistor (R_{Sense}) is amplified by the inverting gain of the IA to complete the feedback. The Voltage Reference (VREF) and Multiplying DAC (MDAC) are programmed to establish the desired current, as the MDAC and IA will add to zero when the desired current passes through the sense resistor. The 63.3 pF capacitor is in the circuit to stabilize the loop and minimize the noise in the output current. Resistor R2 (500 to 1K) is used to buffer the large gate capacitance of Q1 from the OA to prevent parasitic oscillations. The following equation can be used to compute the constant load current.

$$I_{LOAD} = \frac{-VREF \cdot MDAC}{IA_{Gain} \cdot R_{Sense}}$$

VREF can be set to one of seven fixed values, and MDAC can assume a value of 0.0 to 1.0 in 128 steps. IA_{Gain} can be set from -1 to -10 in integer steps, and R_{Sense} can be any off-the-shelf resistor value. Thus, the load current can be adjusted for a variety of applications by changing any of the above values. The values in Table 1 illustrate the range of possible combinations for several circuit solutions.

By taking advantage of the ispPAC30's architecture, the current source can have a known power up state, which is stored in E²CMOS[®] memory. Values can be changed by shifting new data through the SPI port after the device has powered up. Thus, unlimited adjustments can be made without using up the limited number of E² write cycles and

the current in the load can be changed digitally by the SPI port or statically held using the internal E²CMOS memory.

Table 1. Various Programmable Current Sink Configurations

R_{Sense}	$I_{A_{Gain}}$	V_{REF}	Step Current	Max Current
1000	-10	64 mV	50.0 nA*	6.4 μ A
100	-10	512 mV	4 μ A*	512 μ A
10	-10	1.024 V	80.6 μ A*	10.24 mA
0.1	-10	2.5V	19.50 mA	2.5 Amps
0.1	-5	2.5V	195.0 mA	5.0 Amps

* A low leakage transistor for Q1 (such as a DMOS FET) is recommended for these designs.

Note: for the higher currents (1.0 Amps and above) the sense resistor and pass transistor need to be rated for the power dissipated and attention to thermal management is advised.

For additional information regarding Lattice products, please visit the Lattice web site at www.latticesemi.com.

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