Current source for I²L saves energy

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To capitalize on the low-power advantages of integrated injection logic (I^2L), a power source that also dissipates relatively small amounts of energy is required. This switched-mode supply provides programmable currents of up to 300 milliamperes at 2.3 volts to boards utilizing I^2L loads, with an overhead of only a few milliamperes needed for running the circuit.

The voltage-current characteristics of I^2L devices resemble those of the standard switching diode, whose operation is determined by the amount of driving current available. It is therefore necessary to drive these loads with a current source. Although a single high-value resistor in series with a voltage source would serve to deliver constant current, large amounts of power would be dissipated in the resistor. The difficulty is overcome with this circuit.

Q_1 and its associated components provide a reference current for the complementary-MOS quad analog switch, A_1, in the reference-resistance subcircuit. The R_2C_3 combination helps to stabilize the output against changes in input voltages.

A_1's switches are wired together such that its equivalent series resistance may be set to one of two values by a control signal. It is possible to order as many as five current levels with this switch if additional programming inputs are introduced.

A_1, with the aid of R_3, serves partly as a current-to-voltage converter, so that low-power oscillator A_2 sees the reference current as a representative voltage at its inverting input. This potential will cause Q_2 to switch on periodically. R_4 provides positive feedback for hysteresis, thus controlling the rate at which A_2 and Q_2 are switched—16 kilohertz, in this case. The 10 to 30 millivolts of hysteresis also appears at the output, but this poses no problem with I^2L loads.

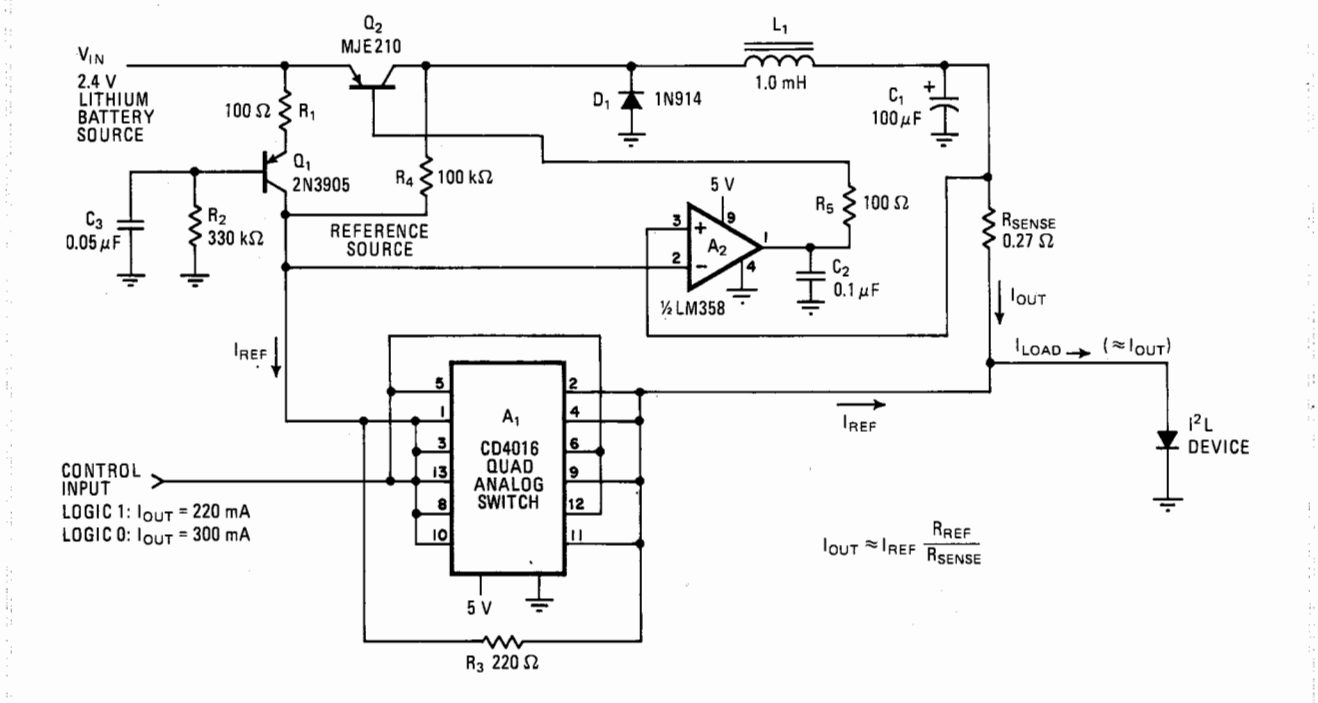
L_1 and C_1 comprise the switcher's required storage elements, acting to release energy to the load through R_{sense} when Q_2 is off. R_{sense} is part of a feedback network used to set I_{out}.

Because the reference current and the output current at summed at the output node, A_2's input sees only the difference of these currents scaled to a voltage by their respective resistors, R_{sense} and R_{ref}. Thus the output current is set solely by the feedback loop. As a consequence of this arrangement, $I_{out} \approx I_{ref}/R_{sense}$. The efficiency of the supply is maximized by using a lower value of R_{sense}, a faster op amp for A_2, and a storage inductor (L_1) with as little dc resistance as possible.

With R_3 = 220 ohms and with I_{ref} = 0.60 mA, I_{out} = 220 mA if a logic 1 is applied to the control input. I_{out} = 300 mA for a logic 0. These values can be changed by suitable selection of I_{ref}, of course, but R_3 may also be varied. Note that:

$$R_{ref} = [(r_{on}/n)R_3]/[(r_{on}/n)+R_3]$$

where n = number of switches and r_{on} = on-state resistance of one switch in A_1, typically 600 Ω. □



Injecting current. Switching source delivers constant current to members of low-power I^2L logic family without wasting much power. Small reference current, C-MOS switches, and low-power oscillator contribute to circuit efficiency. Two-level current source, which generates up to 300 milliamperes at 2.3 volts, can provide one of five current values if additional programming inputs are introduced at switch A_1.