Keywords: positive supply current, monitoring, load current, power supply, opamp, operational amplifiers, op amps

APPLICATION NOTE 69

Micropower Circuit Monitors Positive Supply Current

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Abstract: The following application note shows a circuit that converts the load current of a positive power supply into a ground referenced signal voltage using the ICL7612 operational amplifier.

The inexpensive circuit of **Figure 1** converts the load current of a positive power supply to a ground-referenced signal voltage, without recourse to the instrumentation amplifier, extra power supply, and matched sets of resistors typical of such circuits. The output current I_O (proportional to supply current) flows through R_O to produce V_O. Because I_O is generated by a true current source, you can reference V_O to ground or to any reasonable level within the supply range. The measurement is independent of variations in the supply voltage.

Because the op amp's common-mode range includes the supply rails, it can sense small voltages near the positive rail, such as those across R_S. Feedback resistor R_F should equal $100R_S$ or $1000R_S$. The op amp drives P-channel MOSFET Q_1, whose drain-source current produces a voltage across R_F equal to that across R_S, subject to an error of $\pm V_{OS}$. As a result,

$I_O = (I_L R_S)(1/R_F)$ and,
$V_O = (I_L R_S)(R_O/R_F)$.

The component values shown provide a V_O range of 0 to 1V for the supply-current range 0 to 1A. You can add a trimming potentiometer to null V_{OS}. The remaining gain error depends on the tolerance of R_S, R_F or R_O. The op amp draws 20µA and operates with a voltage as low as 2.5V. This op amp supply is produced by the five diodes, which are biased by R_Z and the input supply voltage as shown in the table.
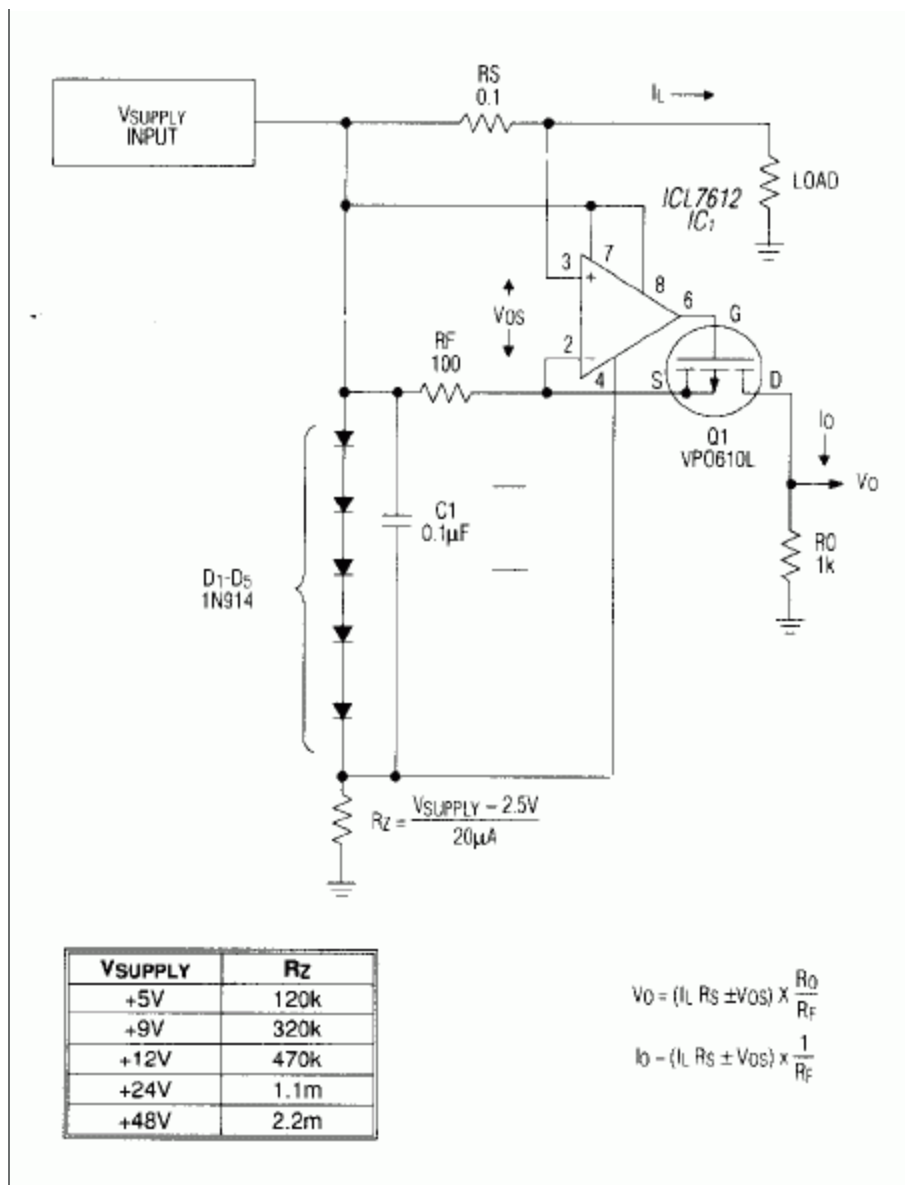
Figure 1. This simple load-current monitor produces a proportional signal voltage V_O.

The circuit includes:
- V_{SUPPLY} INPUT
- RS 0.1
- $I_L \longrightarrow$
- LOAD
- ICL7612 IC_1
- pins 3, 7, 8, 6, 2, 4
- V_{OS}
- G, S, D
- Q_1 VPO610L
- RF 100
- D_1-D_5 1N914
- C_1 0.1µF
- I_O
- V_O
- RO 1k
- $$R_Z = \frac{V_{SUPPLY} - 2.5V}{20\mu A}$$

VSUPPLY	Rz
+5V	120k
+9V	320k
+12V	470k
+24V	1.1m
+48V	2.2m

$$V_O = (I_L \, R_S \pm V_{OS}) \times \frac{R_O}{R_F}$$

$$I_O - (I_L \, R_S \pm V_{OS}) \times \frac{1}{R_F}$$