

## MAKE A PRECISION CURRENT SOURCE OR CURRENT SINK

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A frequently asked question, not answered by the guide, has been: "How do I make the world's most accurate current source and current sink?" Figures 1 and 2 respectively show the circuits for making precision current sources and sinks.

The precision current source and sink are based on the new REF102 10.0V voltage reference. With 2.5ppm/°C  $V_{OUT}$  drift, and better than 5ppm/1000hrs long-term stability (see table on page 2), this buried-zener-based voltage reference offers the best performance available from a single-chip voltage reference today. The REF200 uses a band-gap type reference to allow low-voltage two-terminal operation. This makes it a good general-purpose part, but its drift and stability and initial accuracy cannot compare to that of the REF102.

The current source is shown in Figure 1. The voltage-follower connected op amp forces the voltage reference ground connection to be equal to the load voltage. The reference output then forces an accurate 10.0V across  $R_1$  so that the current output is  $10V/R_1$ .

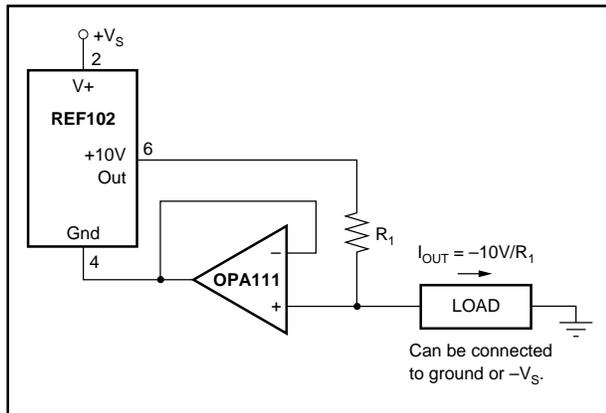


FIGURE 1. Precision Current Source.

The current sink is shown in Figure 2. The op amp drives both the voltage reference ground connection and the current-scaling resistor,  $R_1$ , so that the voltage reference output is equal to the load voltage. This forces  $-10.0V$  across  $R_1$  so that the current sink output is  $-10V/R_1$ . The  $R_2, C_1$  network provides local feedback around the op amp to assure loop stability. It also provides noise filtering. With the values shown, the reference noise is filtered by a single pole with  $f_{-3dB} = 1/(2 \cdot \pi \cdot R_2 \cdot C_1) = 16kHz$ .

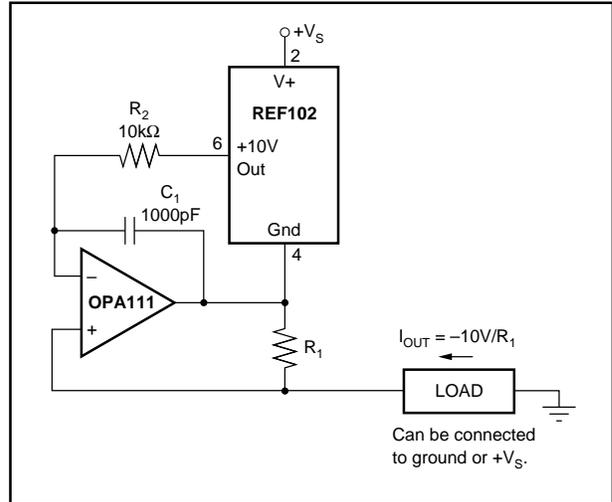


FIGURE 2. Precision Current Sink.

Compliance of the circuit depends on input and output range of the op amp used and the 11.4V minimum supply range of the REF102. The application guide goes into more detail.

Keep in mind that the accuracy of a voltage-reference-based current source depends on the absolute accuracy of the current scaling resistor ( $R_1$ ). The absolute TCR and stability of the resistor directly affect the current source temperature drift and stability. If you use a 50ppm/°C resistor (common for 1% metal film resistors), the precision current source will have approximately 50ppm/°C drift with temperature—worse than the 25ppm/°C drift of a REF200.

The performance of circuits using current source references depends only on the ratio accuracy of the scaling resistors. It is much easier to get good resistor ratio accuracy than to get good absolute accuracy, especially when using resistor networks.

Burr-Brown offers a wide variety of support components which are excellent choices for generation or conversion of current. Application Guide (AN-165) has proven valuable in selecting these components.

## REF102CM +10.0V REFERENCE STABILITY vs TIME

$T_A = 25^\circ\text{C}$ ,  $V_S = +15\text{V}$ .

UNIT	$V_{OUT}$ CHANGE FROM 1 HR TO 168 HRS [ppm]	$V_{OUT}$ CHANGE FROM 1 HR TO 1008 HRS [ppm]	$V_{OUT}$ CHANGE FROM 1 HR TO 2016 HRS [ppm]	$V_{OUT}$ CHANGE FROM 1 HR TO 3072 HRS [ppm]	$V_{OUT}$ CHANGE FROM 1 HR TO 5136 HRS [ppm]	$V_{OUT}$ CHANGE FROM 1 HR TO 14205 HRS [ppm]
1	6.8	5.5	7.1	4.7	8.2	11.7
2	5.1	1.0	1.2	-2.1	0.1	1.3
3	9.4	6.5	3.2	1.0	1.8	2.0
4	9.6	6.9	7.7	5.6	7.6	10.3
5	12.9	7.8	9.6	6.7	9.5	12.8
6	10.5	6.4	5.3	3.0	5.4	9.4
7	10.3	5.7	6.2	3.7	5.8	8.2
8	17.0	14.5	12.9	9.2	9.9	13.7
9	6.2	5.1	3.8	1.7	2.7	4.1
10	7.1	1.7	1.3	0.1	1.0	2.4
11	13.0	9.6	9.6	10.0	13.0	16.5
12	7.5	4.7	3.9	4.2	5.0	7.4
13	13.0	9.5	10.4	8.2	9.9	13.7
14	4.2	3.0	0.5	-0.3	4.2	2.8
15	7.3	4.3	2.6	1.8	4.1	3.9

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