Keywords: 4-20mA transmitters, precision current mirrors, current-sense resistor ratios

APPLICATION NOTE 4508

Precision Current-Sink/Source Circuits Configure as Mirrors or Amplifiers

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Abstract: The precision current mirrors shown allow you to transform one type of 4–20mA transmitter to another, or to create a repeater for the purpose of extending the length of the current loop. The circuits include an input-sink/output-sink mirror and an input-source/output-source mirror.

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The 4–20mA transmitters used in industrial current-control loops can be implemented as powered current sources, remote non-powered current sinks, or with several other I/O combinations.

A useful building block for some of these applications is a precision current mirror, which allows you to transform one type of transmitter to another, or to create a repeater for the purpose of extending the loop length. Circuit examples include an input-sink/output-sink mirror (**Figure 1a**), and an input-source/output-source mirror (**Figure 1b**). These circuits have similar configurations but differ slightly in performance. You can also build input-sink/output-source mirrors and input-source/output-sink mirrors by chaining one circuit type to the other.

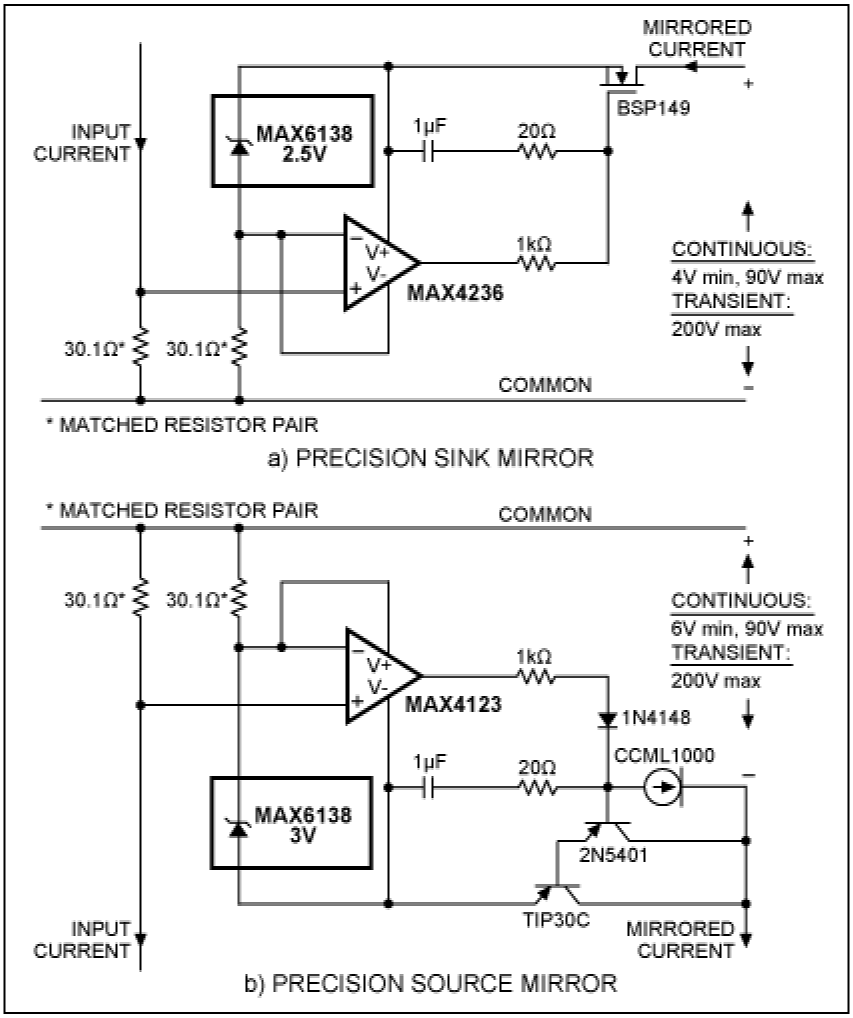

Figure 1. A unity-gain, input-sink/output-sink current mirror (a), and a unity-gain, input-source/output-source mirror (b).

The Figure 1a–1b circuits have output impedances in the range 10^8 to 10^9 ohms, and a current-mirror accuracy that is defined (for Figure 1a) by the precision of its matched-resistor ratio. The use of resistors matched to 0.1%, for instance, produces a mirroring accuracy equivalent to 10-bit resolution. Within a range of values, the absolute value of these matched current-sensing resistors has no effect on the mirroring accuracy. The value shown (30.1Ω) is somewhat arbitrary, and you can increase it at the cost of an added input drop and an increase in the minimum operating output voltage.

With sense-resistor values as shown, the Figure 1b circuit adds an offset uncertainty of one 10-bit LSB at full scale, due to the larger offset of the MAX4123 (600µV) vs. that of the MAX4236 (20µV) used in Figure 1a. The use of higher-valued sense resistors reduces this uncertainty.

The compliance range for operating voltage extends from a minimum of 4V (both circuits) to a maximum that is slightly lower for the Figure 1a circuit (90V), because of its different output device. To configure either of these circuits as a current amplifier, you simply adjust the current gain by altering the ratio of the current-sense resistors. More information, including MAX4236 and MAX6138 data sheets, is available at www.maximintegrated.com.

Related Parts		
MAX4123	Single/Dual/Quad, Wide-Bandwidth, Low-Power, Single-Supply Rail-to-Rail I/O Op Amps	Free Samples
MAX4236	SOT23, Very High Precision, 3V/5V Rail-to-Rail Op Amps	Free Samples

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