Semiconductor Highlight: Using A Current Monitor

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Using A Current Monitor To Create An Elegant Precision Rectifier Design

Classic precision rectifier designs suffer from factors such as a high component count, resistor synchronization issues, and a double-ended power requirement. Here is one way to address those concerns.

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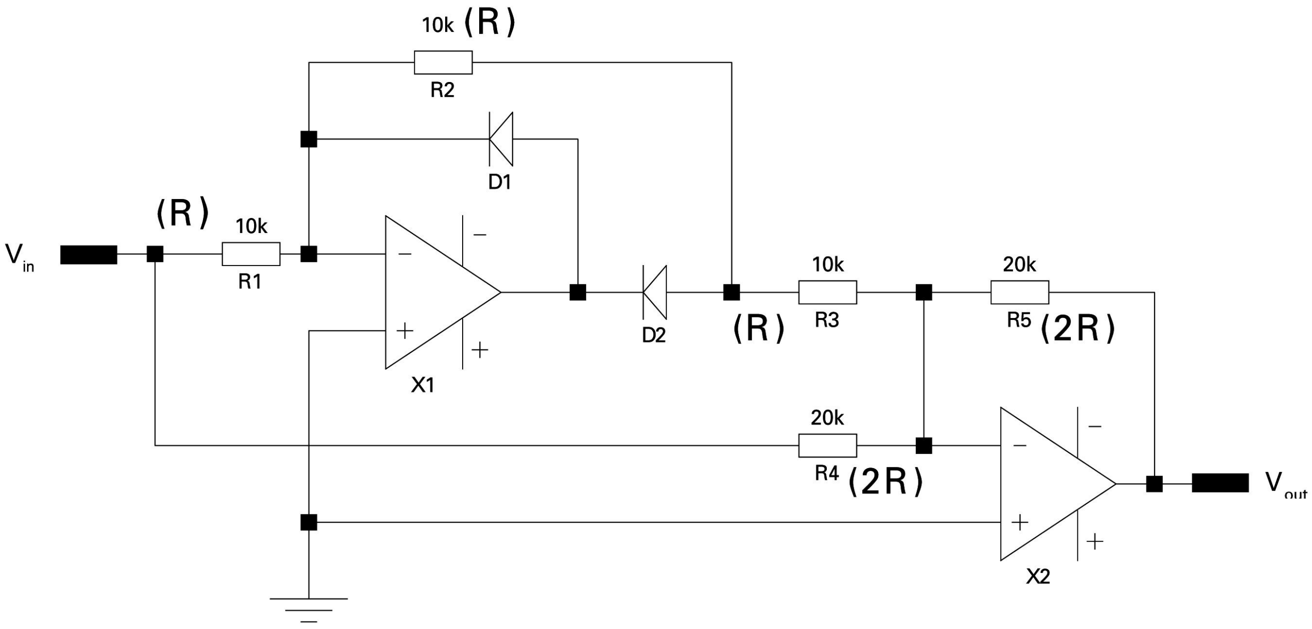
Traditionally, precision full wave rectifiers1 used in a range of instrumentation applications have employed between 7 and 9 discrete circuit components. These are typically 2 op-amps, 2 diodes and 3 to 5 resistors. This article will show that an alternative approach, using a standard current monitor IC, reduces the component count to just five and greatly simplifies circuit configuration and produces a more elegant overall solution.

The classic precision rectifier

Why is a precision rectifier required? Since a diode has a forward voltage drop of typically 0.6V, any signal not an order of magnitude larger than this will suffer major distortion. The problem is exacerbated for full wave rectification, where the signal must overcome two diode drops.

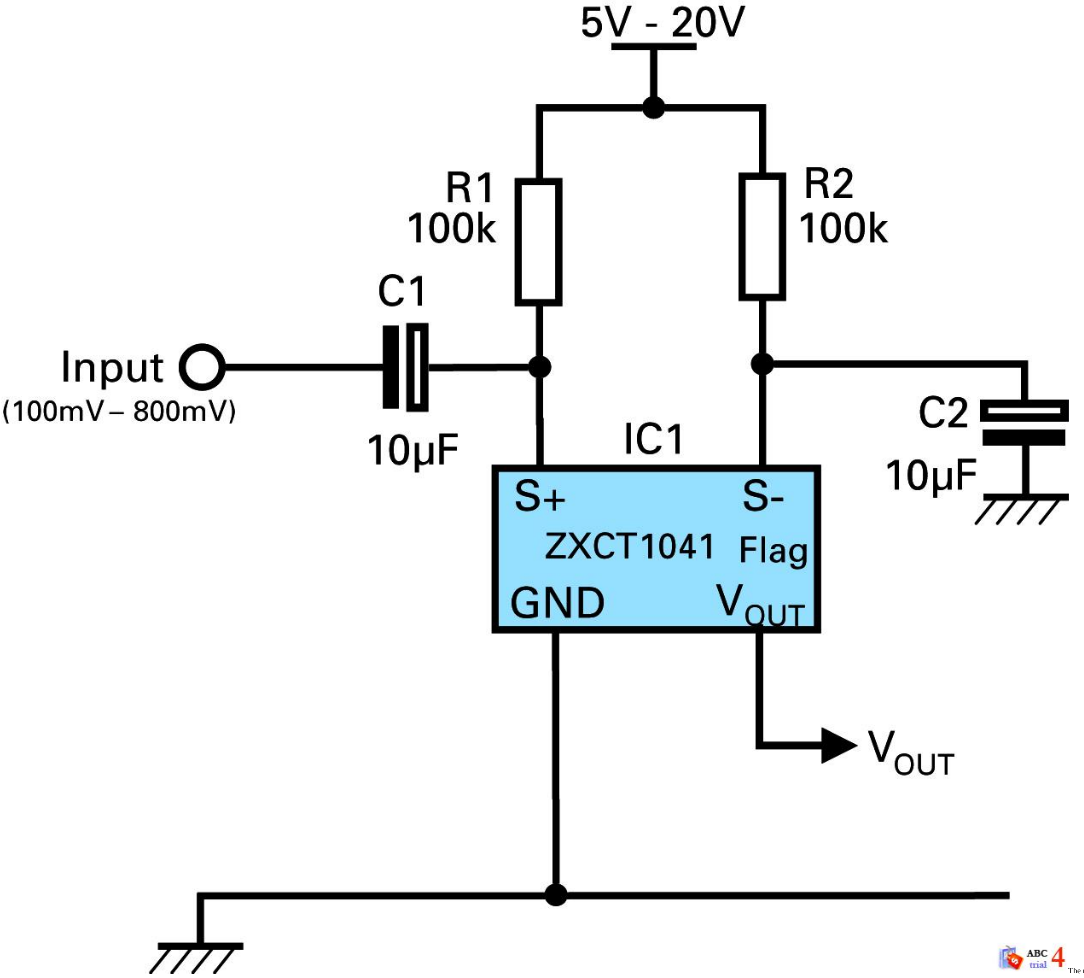
Even a voltage as ‘large’ as 10V will suffer significant distortion when full-wave rectified using diodes, at least 12% of the signal being subjected to severe distortion. Quite often however, the signal to be rectified is far less than 1 volt.



Illustrated in Figure 1, classic solutions used to address this problem feature diodes in the feedback path of an operational amplifier. This effectively changes the normal diodes into near perfect diodes, i.e. devices that conduct unidirectionally with zero forward voltage drop.

To better appreciate the advantages offered by the proposed current monitor based design, the operation of the classic precision full wave rectifier shown in Figure 1 is best considered first. Inspection shows the following.

There are two ways that the values could be arranged for precision rectification to take place. One way, shown in Figure 1 is to make R1, R2 and R3 the same value (R), and then make R4 and R5 equal to 2R for unity gain. The other way is to make R1, R3, R4 and R5 the same value (R), and then make R2 equal to 2R. This second option, while it works OK, will have a slightly reduced bandwidth compared to the first and is therefore not the preferred option.



The major drawbacks of this classic precision rectifier design can therefore be summarised as follows:

1. Component count comparatively high.
2. Good performance depends on getting four resistors in perfect balance.

3. Requires a double-ended power supply.

The current monitor is normally used to provide bi-directional current monitoring. It produces an amplified output (gain = 10) that is always positive regardless of the polarity of the voltage across its S+ and S- terminals (sense voltage or VSENSE). This sense voltage is normally derived by using a sense resistor (RS) in series with the load in order to make VSENSE proportional to the load current.

Consider now the current monitor's use in the alternative precision full wave rectifier circuit shown in Figure 2. Here, resistors R1 and R2 provide DC bias for IC pins S+ and S- respectively. Pin S- is decoupled by C2, effectively making it an AC ground. This means that any signal that is coupled onto pin S+ will appear across pins S+ and S- as sense voltage. This voltage is then amplified by the current monitor which also produces a unipolar output. It is therefore an amplified full wave rectification of the AC component of the input voltage.

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