SOT-23 Superbeta Op Amp Saves Board Space
in Precision Applications – Design Note 266
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INTRODUCTION
The tiny new LT®1880 achieves precision unprecedented in a SOT-23 package without resorting to autozeroing techniques. Input offset voltage and drift are typically 40μV and 0.3μV/°C, respectively, with guarantees of 200μV and 1.2μV/°C maximum over temperature. The device operates on total supplies from 2.7V to 40V with rail-to-rail outputs, giving a dynamic range of 120dB. Unlike some competitors’ SOT-23 op amps, which claim to maintain good precision, the LT1880 supports its input precision with a high open loop gain of 1.6 million, as well as 135dB CMRR and PSRR. It is available in commercial and industrial temperature grades.

APPLICATIONS

Getting Rail-to-Rail Operation without Rail-to-Rail Inputs
The LT1880 does not have rail-to-rail inputs, but for most inverting applications and noninverting gain applications, this is largely inconsequential. Figure 1 shows the basic op amp configurations, what happens to the op amp inputs, and whether or not the op amp must have rail-to-rail inputs.

The circuit of Figure 2 shows an extreme example of the inverting case. The input voltage at the 1M resistor can swing ±13.5V and the LT1880 will output an inverted, divided-by-ten version of the input voltage. The gain accuracy is limited by the resistors to 0.2%. Output referred, this error becomes 2.7mV at 1.35V output. The 40μV input offset voltage contribution, plus the additional error due to input bias current times the ~100k effective source impedance, contribute negligible error.

Precision Photodiode Amplifier
Photodiode amplifiers usually employ JFET op amps because of their low bias current; however, when precision is required, JFET op amps are generally inadequate due to their relatively high input offset voltage and drift. The LT1880 provides a high degree of precision with very low bias current (IB = 150pA typical) and is therefore

Figure 1. Some Op Amp Configurations Do Not Require Rail-to-Rail Inputs to Achieve Rail-to-Rail Outputs

Figure 2. Extreme Inverting Case: Circuit Operates Properly with Input Voltage Swing Well Outside Op Amp Supply Rails
applicable to this demanding task. Figure 3 shows an LT1880 configured as a transimpedance photodiode amplifier. The transimpedance gain is set to 51.1kΩ by RF. The feedback capacitor, CF, may be as large as desired where response time is not an issue, or it may be selected for maximally flat response and highest possible bandwidth given a photodiode capacitance CD. Figure 4 shows a chart of CF and rise time versus CD for maximally flat response. Total output offset is below 262μV, worst-case, over temperature (0°C to 70°C). With a 5V output swing this implies a minimum 86dB dynamic range, sustained over temperature (0°C to 70°C), and a full-scale photodiode current of 98μA.

Figure 3. Precision Photodiode Amplifier

Figure 4. Feedback CF and Rise Time vs Photodiode CD

Single-Supply Current Source for Platinum RTD

The precision, low bias current input stage of the LT1880 makes it ideal for precision and high impedance circuits. The rail-to-rail output stage renders the op amp capable of driving other devices as simply as possible with extended dynamic range, while the 2.7V to 40V operation means that it will work on almost all supplies. The small SOT-23 package makes it a compelling choice where board space is at a premium or where a composite amplifier is competing against a larger single-chip solution.

Conclusion

The precision, low bias current input stage of the LT1880 makes it ideal for precision and high impedance circuits. The rail-to-rail output stage renders the op amp capable of driving other devices as simply as possible with extended dynamic range, while the 2.7V to 40V operation means that it will work on almost all supplies. The small SOT-23 package makes it a compelling choice where board space is at a premium or where a composite amplifier is competing against a larger single-chip solution.