

# LTC2050, Zero-Drift Operational Amplifier in SOT-23 Package Minimizes Board Area without Compromising Specs

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## Introduction

The LTC2050 is a zero-drift operational amplifier available in the 5- or 6-lead SOT-23 and SO-8 packages. It minimizes board area while providing uncompromising DC performance, including 3 $\mu$ V (max) DC offset and 30nV/ $^{\circ}$ C (max) DC offset drift. It operates from a 2.7V supply while still supporting 5V applications. The power consumption is 800 $\mu$ A and the versions in the 6-lead SOT-23 and SO-8 packages offer power shutdown.

Other key features of this new device include:

- ❑ Small 5- or 6-lead SOT-23 package
- ❑ 2.7V operation
- ❑ 3 $\mu$ V maximum offset voltage
- ❑ 30nV/ $^{\circ}$ C maximum offset voltage drift
- ❑ 1.5 $\mu$ V<sub>P-P</sub> typical noise (0.1Hz to 10Hz)
- ❑ More than 130dB of DC PSRR, CMRR and gain (typical)
- ❑ Output swings rail-to-rail with 1k $\Omega$  loads
- ❑ Extended common mode input range
- ❑ Power shutdown below 10 $\mu$ A (available in 6-lead SOT-23 and SO-8)

## Extended Input Common Mode Range with Uncompromising CMRR

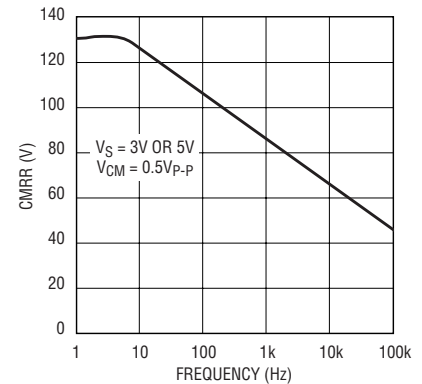
At room temperature, with the input common mode level at mid-supplies, the LTC2050 typically has 0.5 $\mu$ V of input-referred offset (input-referred offset is guaranteed to be less than  $\pm$ 3 $\mu$ V). To ensure this DC accuracy over the common mode input range, the LTC2050 has exceptionally high

CMRR over a wide common mode range from the negative supply typically to within 0.9V of the positive rail, as shown in Figure 1. For example, as the input is varied over the entire common mode range, the input referred offset changes typically by less than 0.4 $\mu$ V at 5V and less than 0.3 $\mu$ V at 3V. Figure 2 shows the CMRR over frequency, illustrating more than 80dB at 1kHz.

Similar levels of PSRR (typically less than 0.1 $\mu$ V of offset per volt of supply change) and the near-zero temperature drift ensure that the offset does not exceed 5 $\mu$ V over the entire supply and commercial temperature range.

## Rail-to-Rail Output Drive with a 1k Load

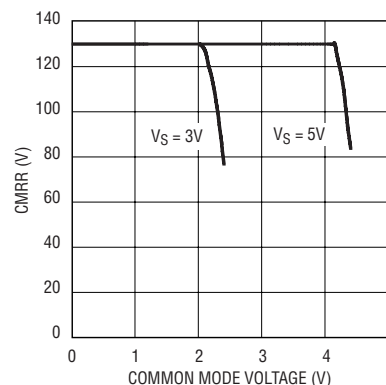
The LTC2050 maintains its DC characteristics while driving resistive loads requiring source or sink current as high as 5mA with a 3V or 5V supply. Figure 3 shows the op amp rail-to-rail swing versus output resistance loading. With a 1k or 5k load, the output typically swings to within 100mV or 30mV, respectively, of the rails.



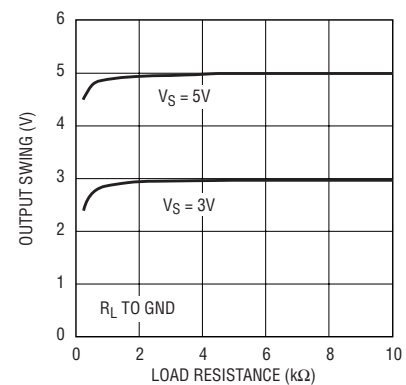
**Figure 2. LTC2050 common mode rejection ratio vs frequency**

## Clock Feedthrough Virtually Eliminated

The LTC2050 uses autozeroing circuitry to achieve its zero-drift offset and other DC specifications. In the LTC2050, the clock used for autozeroing is typically 7.5kHz. The term clock feedthrough is used to indicate visibility of this clock in the op amp output spectrum. There are typically two types of clock feedthrough in autozeroed op amps such as the LTC2050.



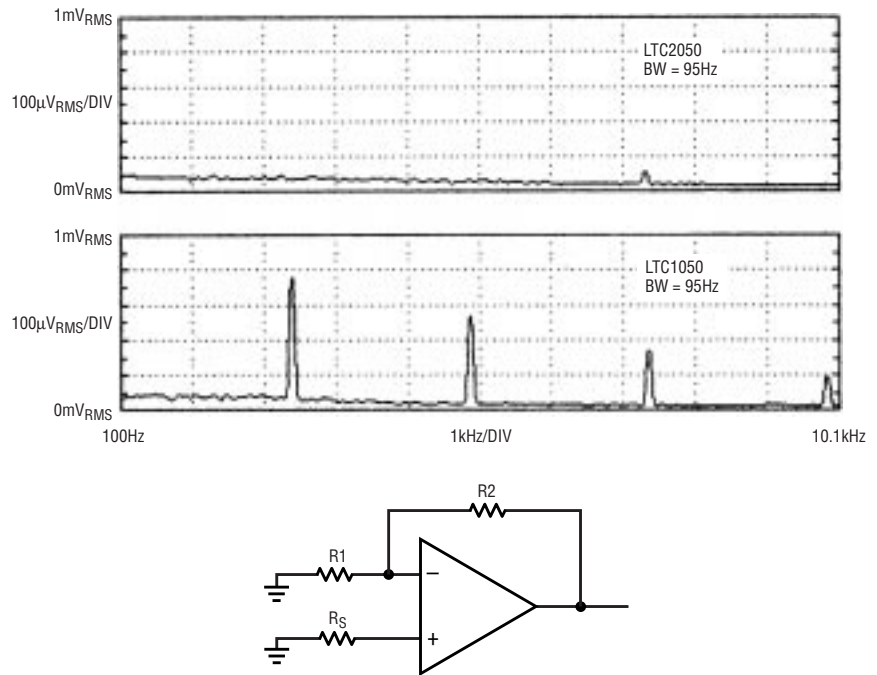
**Figure 1. LTC2050 DC common mode rejection ratio vs common mode input voltage**



**Figure 3. LTC2050 output voltage swing vs load resistance**

The first source is caused by the settling of the internal sampling capacitor and is input referred; that is, it is multiplied by the closed loop gain of the op amp. *This form of clock feedthrough is independent of input source resistance or gain setting resistors.* Figure 4 shows the spectrum of the LTC2050 with a closed loop gain of  $-100$  with  $R_2 = 100k$ , and  $R_1 = R_S = 1k$ . There is a residue clock feedthrough of less than  $1\mu V_{RMS}$  (input-referred) at  $7.5kHz$ . This very low clock feedthrough is achieved in the LTC2050 by internal circuitry that improves settling of the internal auto-zero storage capacitors. Also in Figure 4, the clock feedthrough of the LTC2050 is compared with that of the very popular LTC1050.


The second form of clock feedthrough appears when the input has a large source resistance or the gain-setting resistors are large. In this case, the charge injection caused by the internal MOS switches creates input-referred clock feedthrough currents that are multiplied by the impedance seen at the input terminals of the op amp. This form of clock feedthrough is not significant in the LTC2050 when  $R_S$  and  $R_1$  in Figure 4 are below approximately  $10k$ . Placing a capacitor across  $R_2$  reduces either form of clock feedthrough by lowering the bandwidth of the closed-loop response.



**Figure 4. Output spectrum with a gain of 100;  $R_2 = 100k$ ;  $R_1 = R_S = 1k$**

## Conclusion

The LTC2050 is the latest member of Linear Technology's family of zero-drift operational amplifiers. It provides small packaging while still maintaining precision DC specifications. In

addition, it operates at supplies as low as  $2.7V$  and includes a power shutdown in the 6-lead SOT-23 package. 

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