

Using the TLV246x as a Multiplexer With Gain in a Data Acquisition System

Application Report

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Application Report

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Abstract

Using the TLV246x as a multiplexer lends itself to certain applications where system signals are only measured at power up, or are measured infrequently or periodically at slow sampling rates during operation. This application report describes the circuit and discusses measurement of key parameters.

Contents

Introduction	1
Signal Feed-Through in Shutdown Circuit Test Results	2
Turn-On and Turn-Off Circuit Test Results	3
System Considerations	3
Summary	3

Figures

1-1 TLV246x as a Multiplexer	2
1-2 Signal Attenuation Test Circuit for the TLV2460 in Shutdown	2
1-3 Attenuation vs Frequency of TLV246x in Shutdown	2

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Introduction

In some designs, there are signals that need to be sampled only occasionally. Such signals may be reference voltages, battery voltages, temperature sensor signals, light sensor signals, etc. They may need to be tested only on power up, on reset, or infrequently during operation. If the signal is not high-speed and switching between signals is not high speed, the shutdown feature of the TLV246x operational amplifier may provide the necessary circuit functions without adding more components to the system. In effect, the TLV246x can be thought of as a multiplexer with gain.

Figure 1–1 shows a simple signal conditioning application where the TLV246x is used to multiplex two signals into one analog-to-digital converter (ADC) channel. Signals IN1 and IN2 are the signal sources that require periodic sampling. The processor controls the sampled signal through a general I/O pin (SD1/SD2) and an inverter. Gain and frequency response can be achieved in either amplifier independent of the other by selection of the appropriate components.

The key parameters in such a system, aside from the normal considerations, are the signal attenuation from input to output in the amplifier that is in shutdown, and the turn-on and turn-off times of the amplifiers.

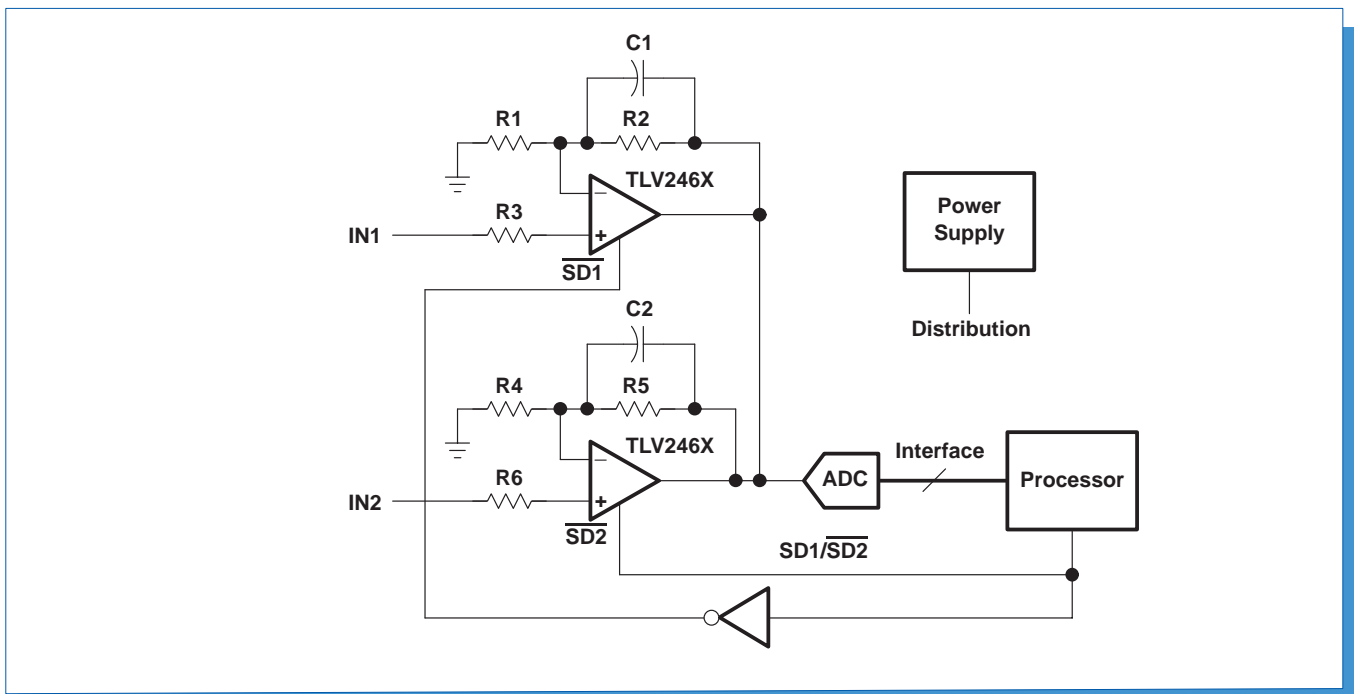


Figure 1–1. TLV246x as a Multiplexer

Signal Feed-Through in Shutdown Circuit Test Results

To test the circuit parameters to see what performance can be expected, the *Universal Op Amp EVM W/Shutdown*, SLOP224, from Texas Instruments was used to build evaluation circuits.

Figure 1–2 shows a schematic of the circuit used to test the attenuation of the input signal with the TLV2460CD in shutdown. A similar test circuit was used to measure the attenuation of the TLV2463 (dual) op amp in shutdown.

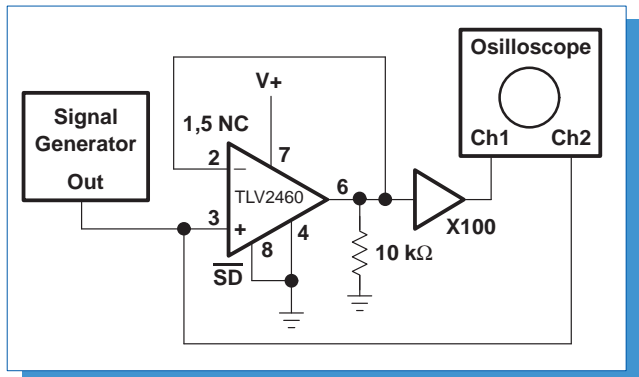


Figure 1–2. Signal Attenuation Test Circuit for the TLV2460 in Shutdown

Using a 5-V peak-to-peak input sine wave signal, the amplitude of the signal present at the output of the amplifiers was measured. Figure 1–3 is a plot of the attenuation vs frequency of the TLV2460 (single) and the TLV2463 (dual) op amps in shutdown.

Below 10 kHz the attenuation of the input signal is ≥ 60 dB. Below 500 Hz the feed-through signal was increasingly harder to distinguish from the noise floor of the instrumentation. Worst case attenuation occurred at about 150 kHz with 45 dB.

To measure the feed-through at dc, a 6 1/2 digit voltmeter with resolution of 0.1 mV was used. No change in the output could be measured when the input was changed between 0 V and 5 V. Assuming a practical measurement tolerance 10 times the resolution of the meter, the signal attenuation at dc was > 134 dB.

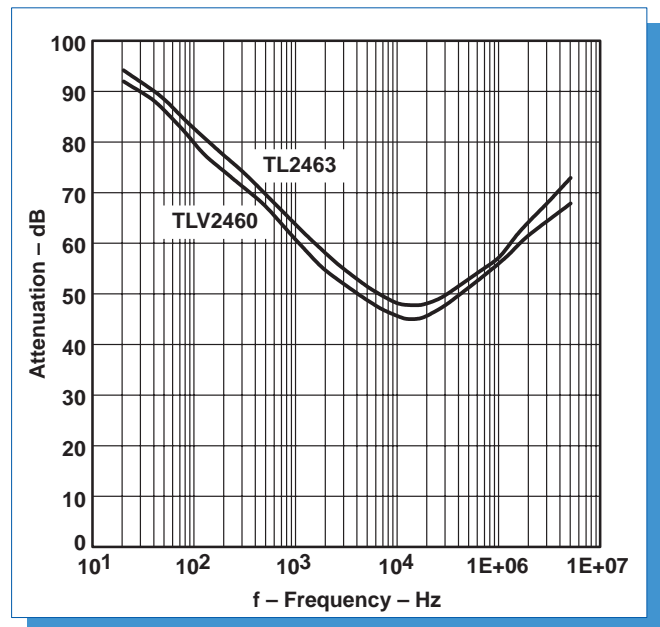


Figure 1–3. Signal Attenuation Test Circuit for the TLV2460 in Shutdown

Feed-through was also measured on circuits with gains of 10 and 100. The input signal was reduced accordingly to keep the output of the op amp from saturating during normal operation.

With a gain of 10, feed-through signals were not measurable below 10 kHz as they were in the noise floor of the instrumentation. Tests confirmed that feed-through was the same as with unity gain for signals between 10 kHz and 2 MHz.

With a gain of 100 the feed-through signals were too low to measure.

Turn-On and Turn-Off Circuit Test Results

Using a square-wave to drive the $\overline{\text{SHDN}}$ pin, the turn-on and turn-off time of the TLV2460 and TLV2463 was measured. The maximum turn-on time measured was $< 8 \mu\text{s}$ and turn-off was $< 4 \text{ ns}$. These times are very near the typical as published in the data sheet, and make it possible to turn one amplifier on and another off simultaneously without regard to output conflict issues.

System Considerations

Assuming an input signal to the TLV246x that is a 10-kHz sine wave with peak-to-peak amplitude equal to full-scale of an 8-bit ADC, 60 dB of isolation is equivalent to 1/4 LSB. If the input signal is not full-scale and gain is required, then the required attenuation for the same 1/4 LSB is reduced by an equivalent amount; that is, reducing the input signal to 1/10 of full-scale reduces the required isolation to 40 dB.

Using a 25% guard band from typical, the maximum turn-on time is $1.25 \times 8 \mu\text{s} = 10 \mu\text{s}$. This provides for the full 85 kps sampling speed of the TLV1544 ADC when operated from a 5-MHz I/O clock. In operation, the TLV1544 samples the active channel for 6 I/O clock cycles, then the input channel is changed; by the end of the 10- μs conversion period, the new channel is ready to be sampled, and the process repeats.

Summary

The applications for using the TLV246x as a multiplexer with gain are numerous. The information presented here only shows the feasibility of such an approach.