Low-cost circuit incorporates mixing and amplifying functions

Guus Colman, Guy Torfs, Johan Bauwelinck, and Jan Vandewege,
INTEC/IMEC, Ghent University, Ghent, Belgium

In many applications, the frequency-conversion steps comprise a buffer, preferably with some extra voltage gain; a mixer; and some filtering. Instead of including an amplifier in front of the mixer, you can easily integrate the mixer function with the amplifier. A low-cost implementation uses an amplifier with a power-down-disable feature. When a square-wave local oscillator drives the disable pin, a square wave at the oscillator's frequency multiplies the input signal, and frequency conversion takes place.

The circuit in **Figure 1** uses an Analog Devices (www.analog.com) low-cost, 300-MHz, rail-to-rail AD8063 amplifier. The test circuit comprises a noninverting-op-amp circuit, which drives a load of 4 kΩ. The two resistors in the feedback loop regulate the voltage-conversion gain. In the test circuit, the voltage gain is 20 dB. However, you must consider the switching loss, which is about 10 dB when using an ideal switch and a 50%-duty-cycle clock. This scenario results in a 10-dB voltage-conversion gain.

Because the switching interrupts the power-supply current, the device's turn-on and turn-off times have a nonnegligible influence on conversion gain and nonlinearities. The AD8063's turn-on time, at 40 nsec, is less than the turn-off time of 300 nsec. In these cases, more signal power passes to the output, which results in an increase in voltage-conversion gain. **Figure 2** shows the voltage-conversion gain of the test circuit when downconverting an input signal to 12 kHz with a local-oscillator duty cycle of 50%. You can easily adjust this conversion gain by changing the two resistors in the feedback loop.

Another aspect of a mixer's ac performance is distortion. The test circuit maintains a second-order harmonic distortion of 35 dB and a third-order harmonic distortion of 43 dB when mixing a 5-MHz signal to a 12-kHz, 1V-p-p output signal. The circuit can downconvert two sine waves of identical power at 5 and 5.002 MHz to 12 and 14 kHz, respectively, with an intermodulation distortion of 47 dB. EDN

DIs Inside

▶ What are your design problems and solutions? Publish them here and receive $150! Send your Design Ideas to edndesignideas@reedbusiness.com.

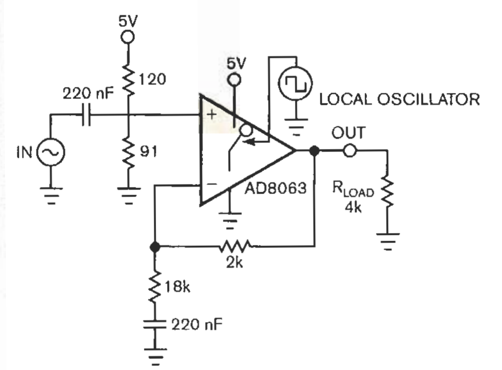

Figure 1 This circuit integrates the mixer function with a noninverting amplifier. The two resistors in the feedback loop set the voltage-conversion gain.

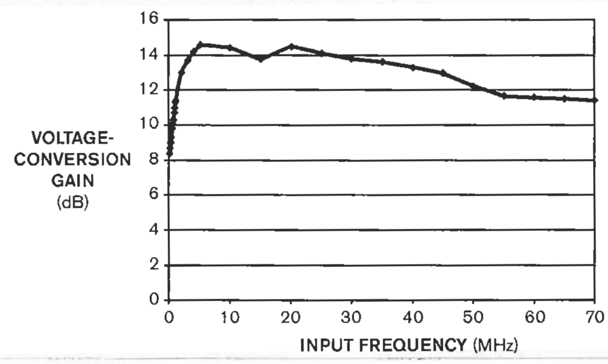

Figure 2 This graph shows the voltage-conversion gain of the test circuit when downconverting an input signal to 12 kHz with a local-oscillator duty cycle of 50%. You can easily adjust this conversion gain by changing the two resistors in the feedback loop.