External Resistor Minimizes Digipot Loading

By: Leo Sahlsten
Jun 02, 2003

Abstract: This article discusses how to improve linearity (due to loading of the wiper) and mid-range frequency response of a digital potentiometer in VCO control applications by adding a single external resistor between H and W.

Digital potentiometer ICs (digital pots, or digipots) are convenient for controlling voltage-controlled devices such as VCOs and as an economical alternative for a DAC. In a typical application (Figure 1), a MAX5160 digipot controls the frequency of a VCO, via a 3-wire interface.

![Figure 1](image)

Figure 1. Adding a resistor (R_{EXT}) to this VCO-control circuit minimizes nonlinearity while enhancing the mid-range frequency resolution.

The ideal relationship between wiper position and control voltage is a straight line (Figure 2). If the digipot's output resistance is high, however, the loading effect of the VCO input resistance (R_{IN}) tends to make the relationship nonlinear and nonsymmetrical. See the "Without R_{EXT}" curve in Figure 2, for which R_{IN} is 0.3 times the digipot's nominal output resistance.
Figure 2. These curves for wiper position vs. normalized control voltage in Figure 1 show the effect of adding a simple resistor \( R_{\text{IN}} \) to the circuit.

Connecting a resistor \( R_{\text{EXT}} \) from \( V_{\text{CONTROL}} \) to \( V_{\text{DD}} \) reduces the loading effect of \( R_{\text{IN}} \). Making \( R_{\text{EXT}} = R_{\text{IN}} \) brings the control curve closer to the ideal, and also makes it symmetrical with regard to the middle position. (See "With \( R_{\text{EXT}} \" curve.) As an added bonus for VCO control, adding \( R_{\text{EXT}} = R_{\text{IN}} \) provides finer resolution around the mid-range frequency, where control is usually the most critical.

**Related Parts**

| MAX5160     | Low-Power Digital Potentiometers | Free Samples |

**More Information**

For Technical Support: [http://www.maximintegrated.com/support](http://www.maximintegrated.com/support)

For Samples: [http://www.maximintegrated.com/samples](http://www.maximintegrated.com/samples)

Other Questions and Comments: [http://www.maximintegrated.com/contact](http://www.maximintegrated.com/contact)

Application Note 2095: [http://www.maximintegrated.com/an2095](http://www.maximintegrated.com/an2095)

APPLICATION NOTE 2095, AN2095, AN 2095, APP2095, Appnote2095, Appnote 2095

Copyright © by Maxim Integrated Products