

APPLICATION NOTE 2095

External Resistor Minimizes Digipot Loading

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.

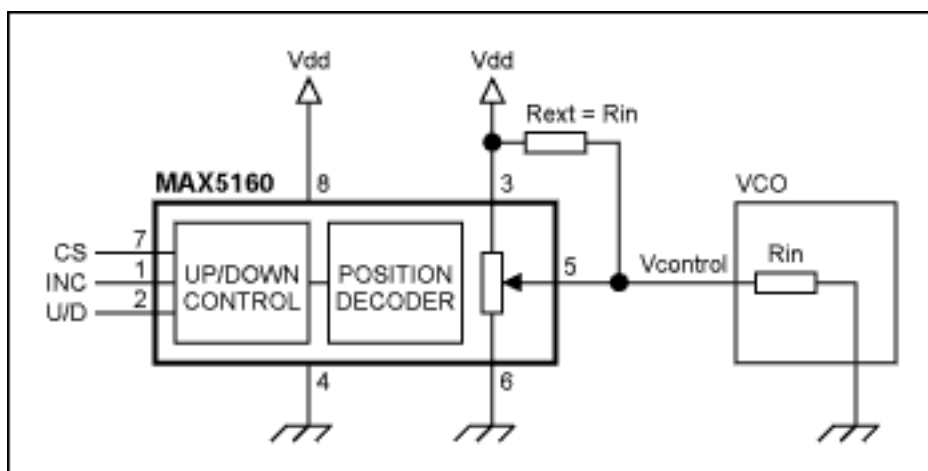


Figure 1. Adding a resistor (R_{ext}) to this VCO-control circuit minimizes nonlinearity while enhancing the mid-range frequency resolution.

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.

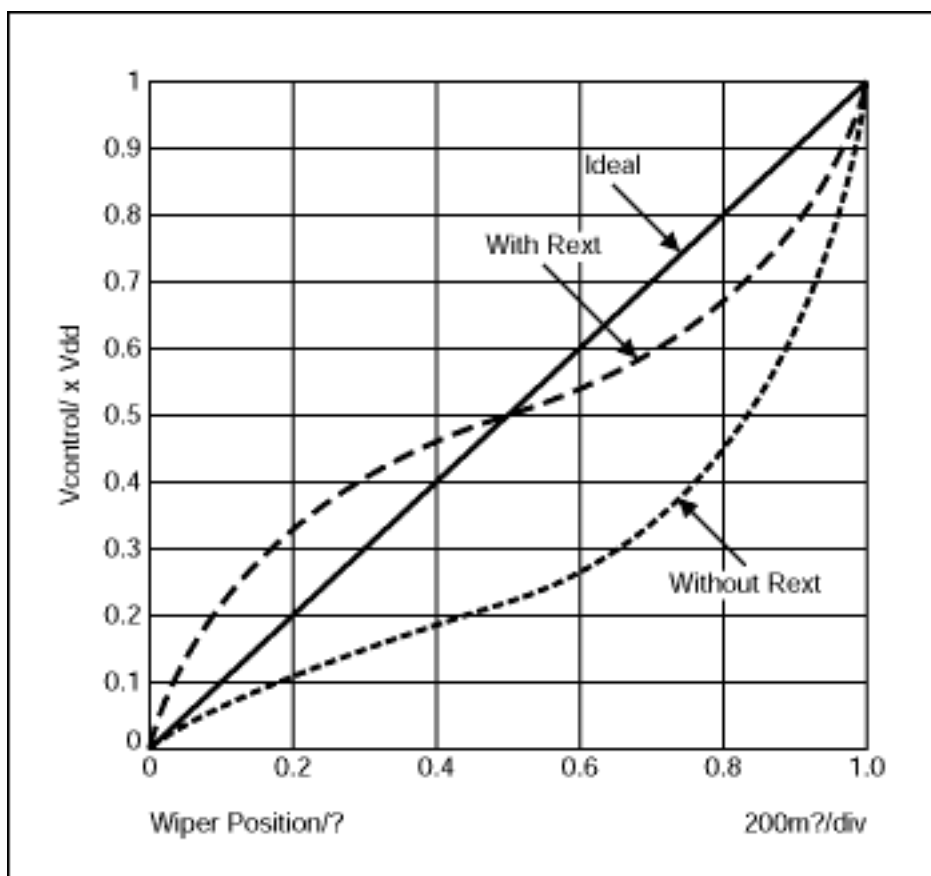


Figure 2. These curves for wiper position vs. normalized control voltage in Figure 1 show the effect of adding a simple resistor (R_{IN}) to the circuit.

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

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