

## Introduction

This Note lists a number of application circuits for Intersil's digitally-controlled (XDCP) potentiometers. The application circuits, shown in *basic form*, illustrate the wide variety of possible functions that can be implemented using the variability of the potentiometer in conjunction with standard active devices like operational amplifiers and comparators. The types of circuits include control circuits, converters, filters, signal processing circuits, regulators, waveshapers, analog computing circuits, and signal sources. In the detail design of these circuits, proper supply filtering and proper grounding techniques must be used.

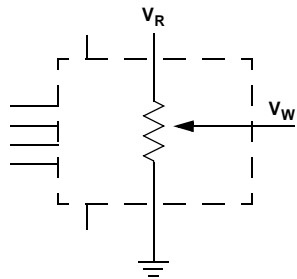
Intersil's potentiometers are controlled through the 2-wire, 3-wire, or SPI computer serial-interfaces or buses. For front panel, pushbutton type applications, Intersil's pushpots are

recommended. General technical publications and other Intersil application notes discuss the various computer serial-interfaces to the electronic potentiometer.

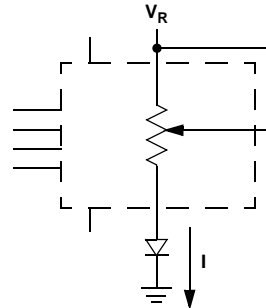
Electronic Digitally-controlled (XDCP) potentiometers provide three powerful application advantages; (1) the variability and reliability of a solid-state potentiometer, (2) the flexibility of computer-based digital controls, and (3) the retentivity of nonvolatile memory used for the storage of multiple potentiometer settings or data. In addition, the packages of the potentiometers are completely compatible with other electronic components and hence reduce manufacturing assembly costs.

Expanded versions of many of the circuits listed in this paper are available in other Intersil application notes. The reader is invited to examine the Application Note Index for these cases.

## Applications



Three terminal Potentiometer;  
Variable voltage divider

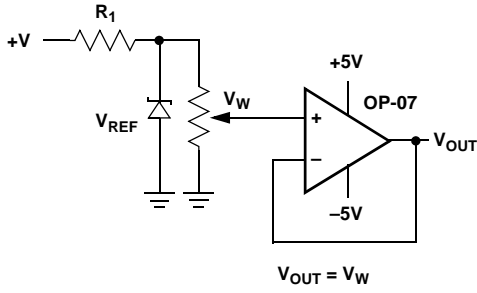


Two terminal Variable Resistor;  
Variable current

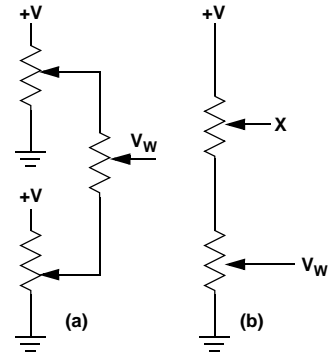
FIGURE 1. Basic Configurations of Electronic Potentiometers

Application Circuits

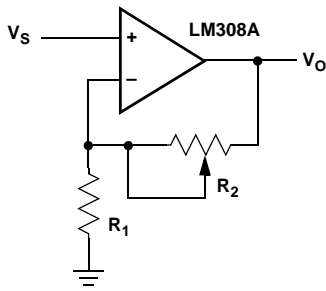
Buffered Reference Voltage



Cascading Techniques

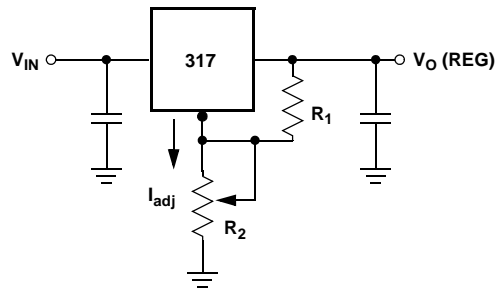


Noninverting Amplifier



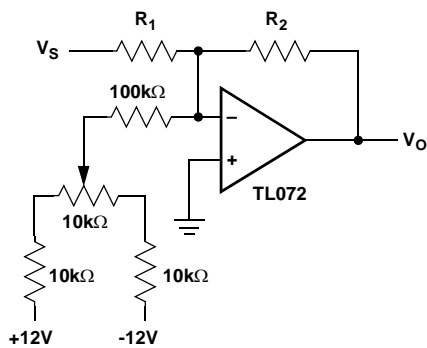
$$V_O = (1 + R_2/R_1)V_S$$

Voltage Regulator

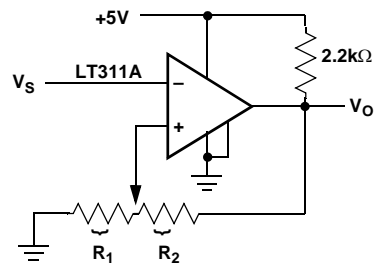


$$V_O (\text{REG}) = 1.25V (1 + R_2/R_1) + I_{\text{adj}} R_2$$

Offset Voltage Adjustment



Comparator with Hysteresis

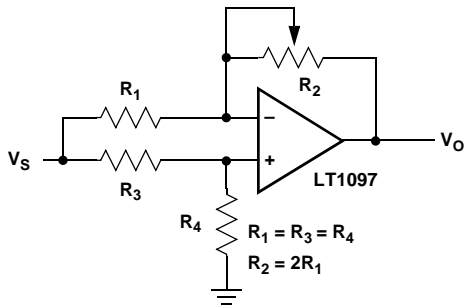


$$V_{UL} = \{R_1/(R_1 + R_2)\} V_O(\text{max})$$

$$V_{LL} = \{R_1/(R_1 + R_2)\} V_O(\text{min})$$

Application Circuits

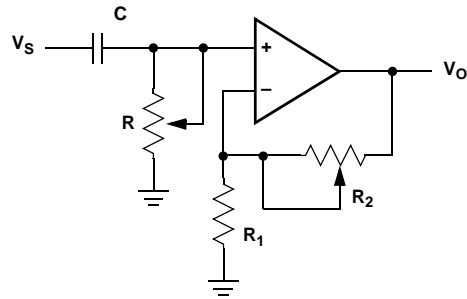
Attenuator



$$V_O = G V_S$$

$$-1/2 \leq G \leq +1/2$$

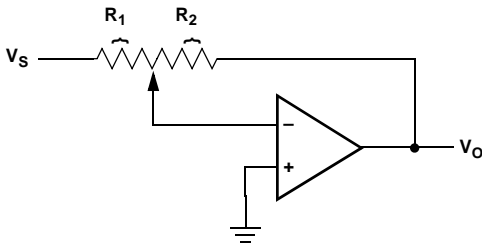
Filter



$$G_O = 1 + R_2/R_1$$

$$f_c = 1/(2\pi RC)$$

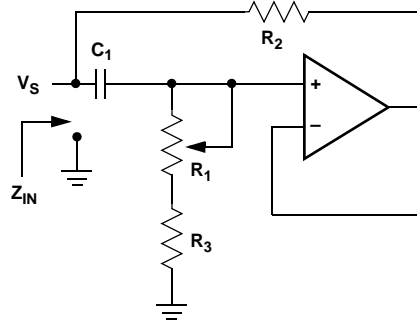
Inverting Amplifier



$$V_O = G V_S$$

$$G = -R_2/R_1$$

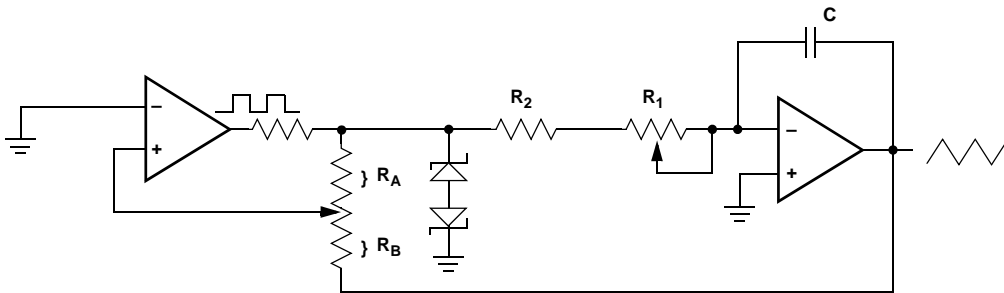
Equivalent L-R Circuit



$$Z_{IN} = R_2 + s R_2 (R_1 + R_3) C_1 = R_2 + s L_{eq}$$

$$(R_1 + R_3) \gg R_2$$

Function Generator

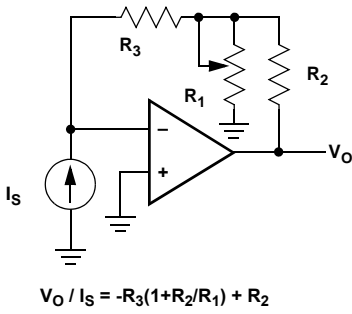


$$\text{frequency} \propto R_1, R_2, C$$

$$\text{amplitude} \propto R_A, R_B$$

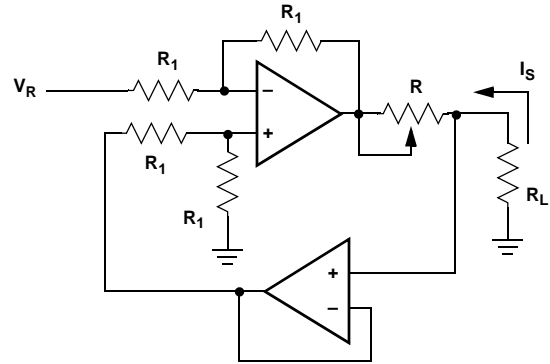
Application Circuits

I to V Converter



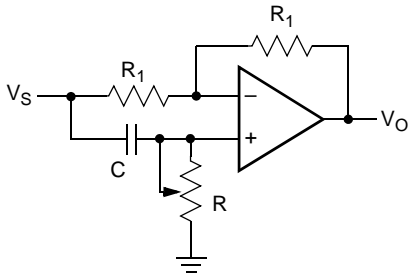
$$V_o / I_s = -R_3(1 + R_2/R_1) + R_2$$

Current Source



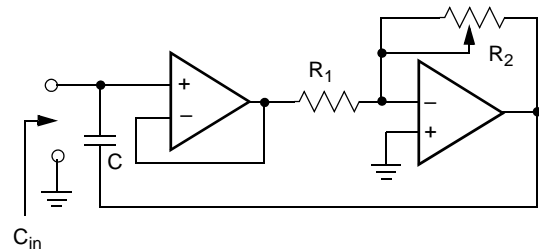
$$I_s = V_R/R$$

Phase Shifter



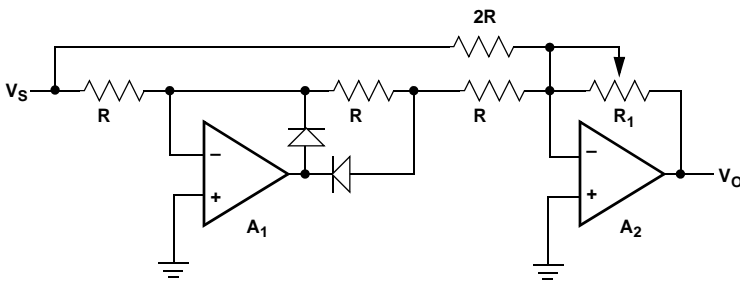
$$\angle V_o/V_s = 180^\circ - 2 \tan^{-1} \omega RC$$

Capacitance Multiplier



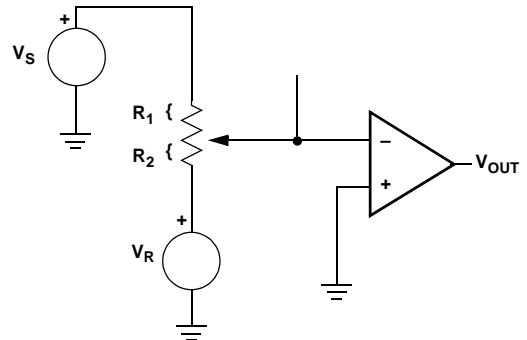
$$C_{IN} = C (1 + R_2/R_1)$$

Absolute Value Amplifier with Gain



$$V_o = |V_s| \frac{R_1}{R}$$

Level Detector



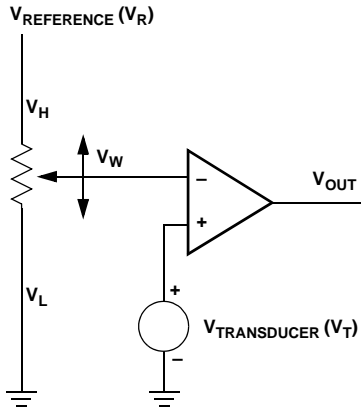
$$V_{OUT} = \text{High for } V_s < -\frac{R_1}{R_2} V_R$$

$$V_{OUT} = \text{Low for } V_s > -\frac{R_1}{R_2} V_R$$

$$R_1 + R_2 = R_{POT}$$

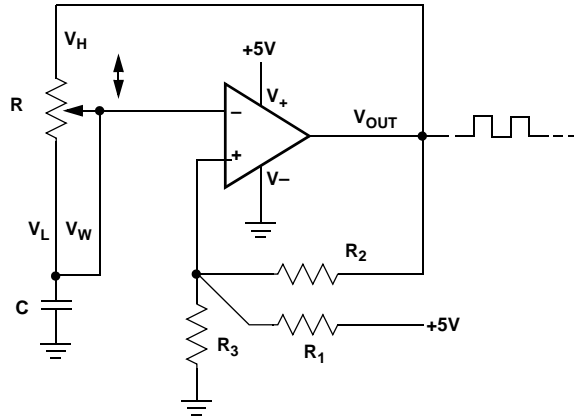
Application Circuits

Level Detector



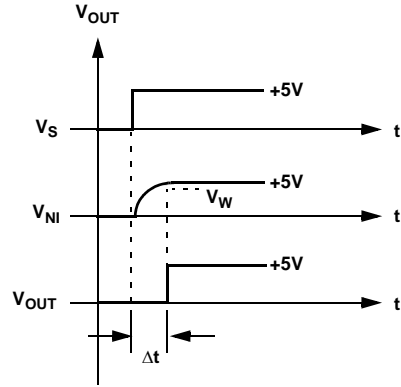
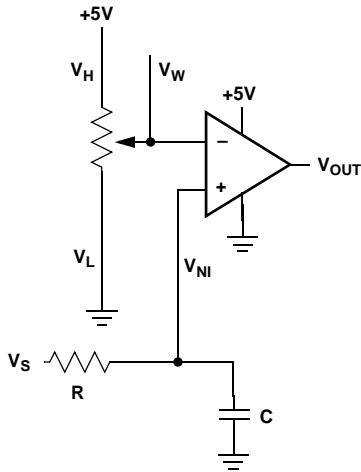
$V_T > V_W, V_{OUT} = \text{High}$   
 $V_T < V_W, V_{OUT} = \text{Low}$

Oscillator



Frequency  $\propto R, C$   
 Duty Cycle  $\propto R_1, R_2, R_3$

Time Delay



$$\Delta t = RC \ln \left( \frac{5V}{5V - V_W} \right)$$

Intersil Corporation reserves the right to make changes in circuit design, software and/or specifications at any time without notice. Accordingly, the reader is cautioned to verify that the Application Note or Technical Brief is current before proceeding.

For information regarding Intersil Corporation and its products, see [www.intersil.com](http://www.intersil.com)