A Compendium of Application Circuits for Xicor's Digitally-Controlled (XDCP) Potentiometers

Chuck Wojslaw (March 1998)

Introduction

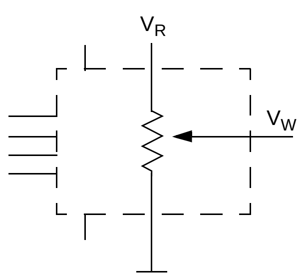
This Note lists a number of application circuits for Xicor's digitally-controlled (XDCP) potentiometers. The application circuits, shown in *basic form*, illustrate the wide variety of possible functions that can be implemented using the variability of the potentiometer in conjunction with standard active 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.

Xicor's potentiometers are controlled through the 2-wire, 3-wire, or SPI computer serial-interfaces or buses. For front panel, pushbutton type applications, Xicor's pushpots are recommended. General technical publications and other Xicor application notes discuss the various computer serial-interfaces to the electronic potentiometer.

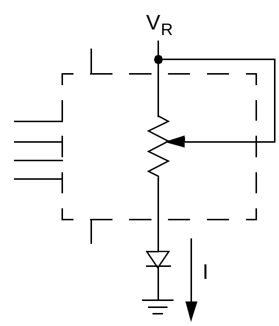
Electronic Digitally-controlled (XDCP) potentiometers provide three powerful application advantages; (1) the variability and reliability of a solid-state potentiometer, (2) the flexibility of computer-based digital controls, and (3) the retentivity of nonvolatile memory used for the storage of multiple 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 Xicor application notes. The reader is invited to examine the Application Note Index for these cases.

Applications



Three terminal Potentiometer;
Variable voltage divider

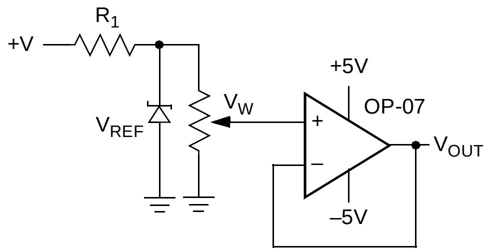


Two terminal Variable Resistor;
Variable current

Figure 1. Basic Configurations of Electronic Potentiometers

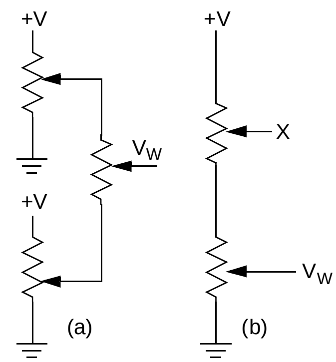
Application Circuits

Buffered Reference Voltage

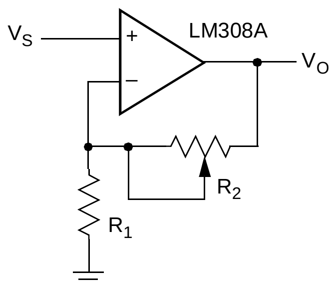


$V_{OUT} = V_W$

Cascading Techniques

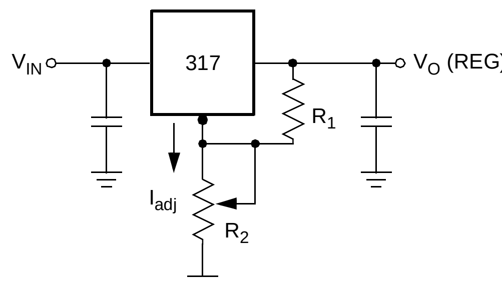


Noninverting Amplifier



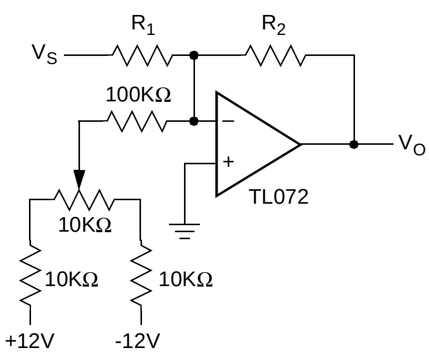
$V_O = (1+R_2/R_1)V_S$

Voltage Regulator

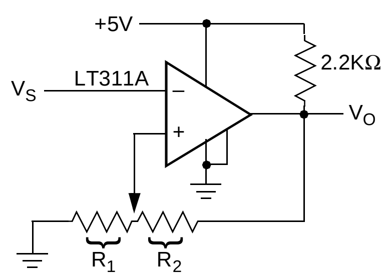


$V_O\ (REG) = 1.25V\ (1+R_2/R_1)+I_{adj}\ R_2$

Offset Voltage Adjustment



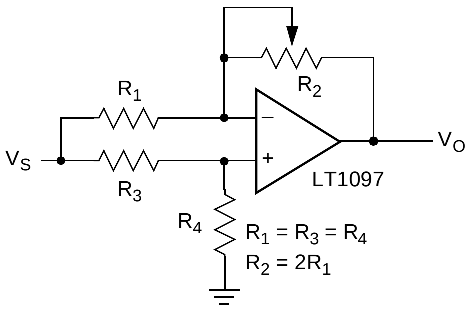
Comparator with Hysterisis



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

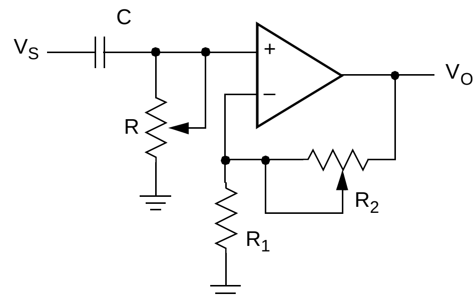
Application Circuits

Attenuator



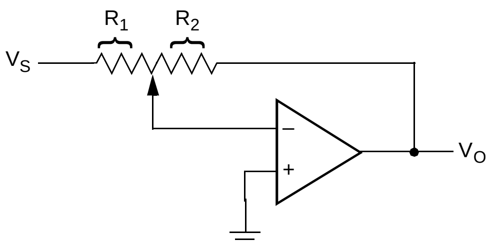
$V_O = G\ V_S$
$-1/2 \le G \le +1/2$

Filter



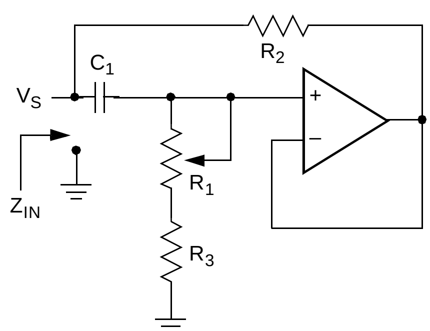
$G_O = 1 + R_2/R_1$
$fc = 1/(2\pi RC)$

Inverting Amplifier



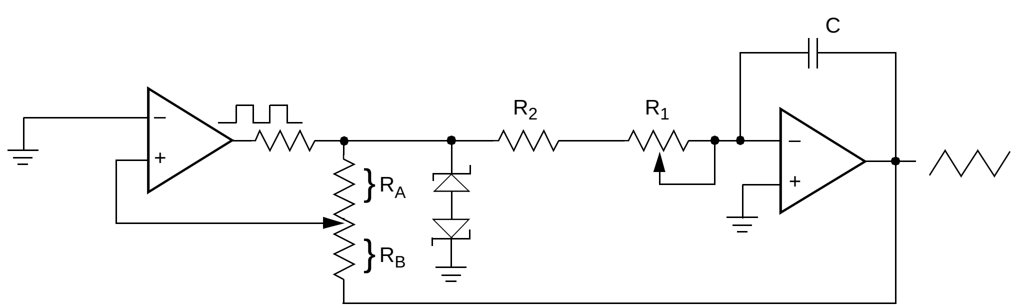
$V_O = G\ V_S$
$G = -R_2/R_1$

Equivalent L-R Circuit



$Z_{IN} = R_2 + s\ R_2\ (R_1 + R_3)\ C_1 = R_2 + s\ Leq$
$(R_1 + R_3) >> R_2$

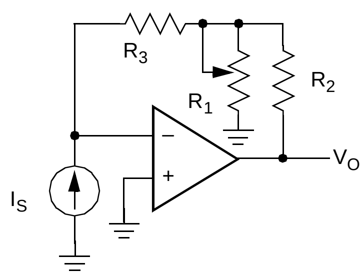
Function Generator



frequency $\propto R_1, R_2, C$
amplitude $\propto R_A, R_B$

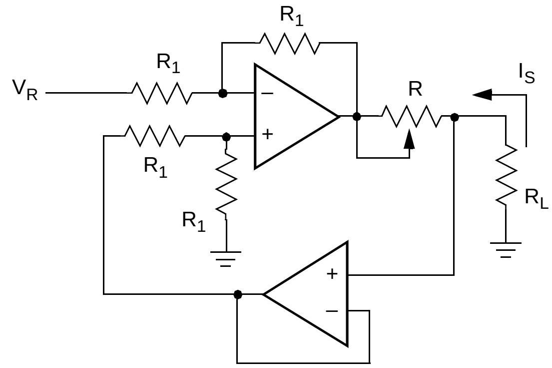
Application Circuits

I to V Converter



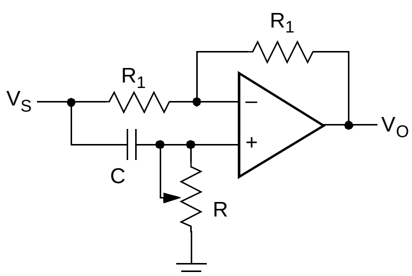
$V_O / I_S = -R_3(1+R_2/R_1) + R_2$

Current Source



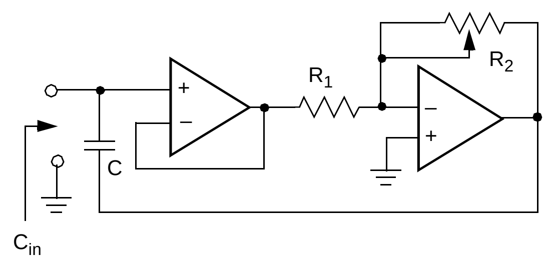
$I_S = V_R/R$

Phase Shifter



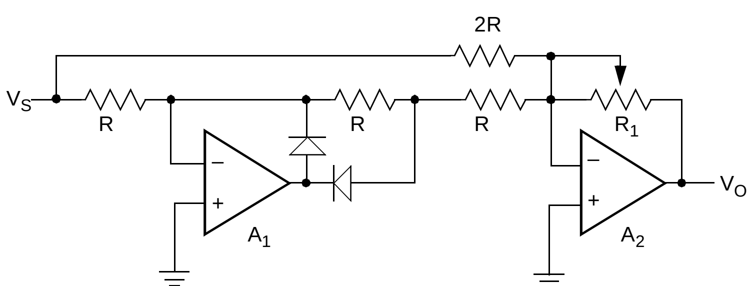
$\measuredangle\ V_O/V_S = 180° - 2\tan^{-1}\omega RC$

Capacitance Multiplier



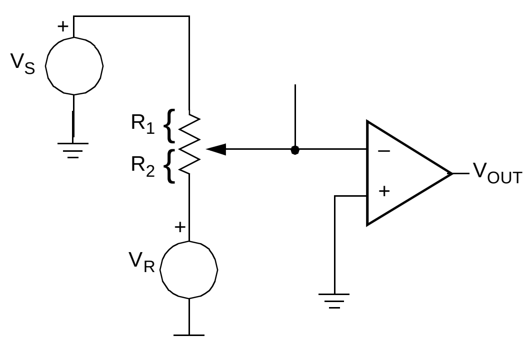
$C_{IN} = C\,(1 + R_2/R_1)$

Absolute Value Amplifier with Gain



$V_O = |V_S|\frac{R_1}{R}$

Level Detector



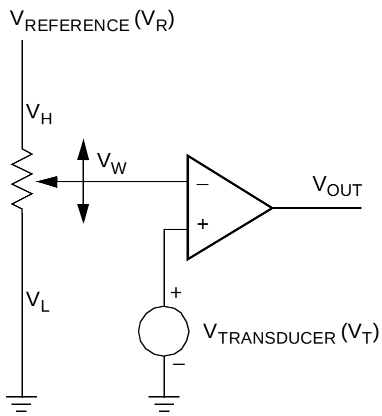
$V_{OUT} = \text{High for } V_S < -\frac{R_1}{R_2}V_R$

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

$R_1 + R_2 = R_{POT}$

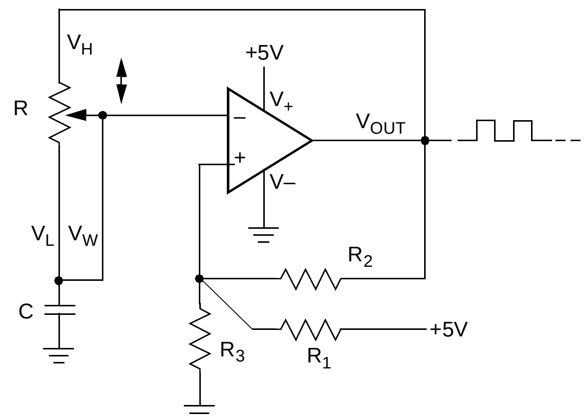
Application Circuits

Level Detector



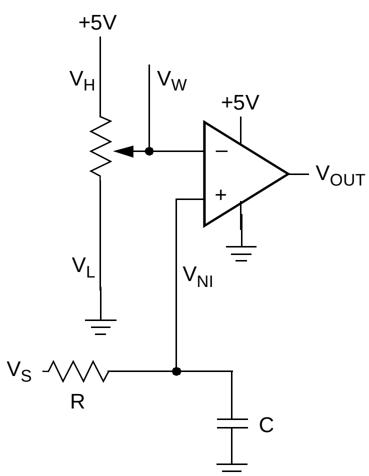
$V_T > V_W$, V_{OUT} = High
$V_T < V_W$, V_{OUT} = Low

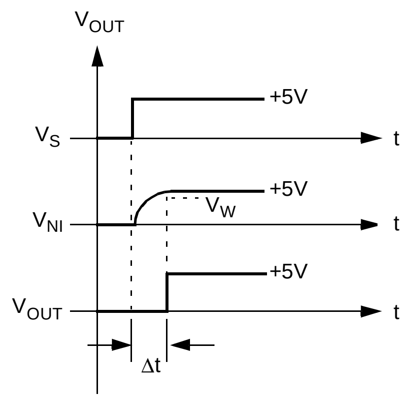
Oscillator



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

Time Delay





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