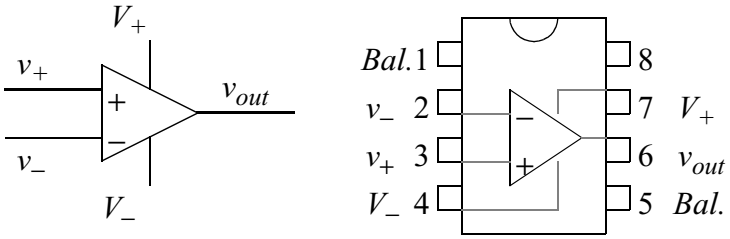
Physics 475, Laboratory 20
Phase Shift and Detection

Overview

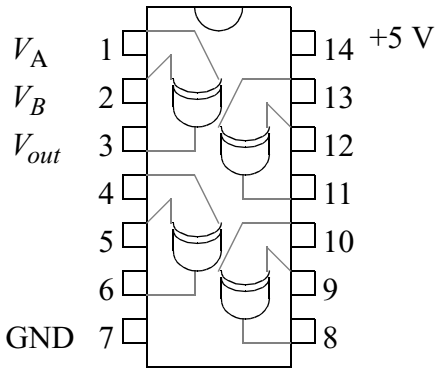
The purpose of these is to use feedback to shift the phase of a signal and to build a circuit that time averages the phase difference to measure the phase.

Components

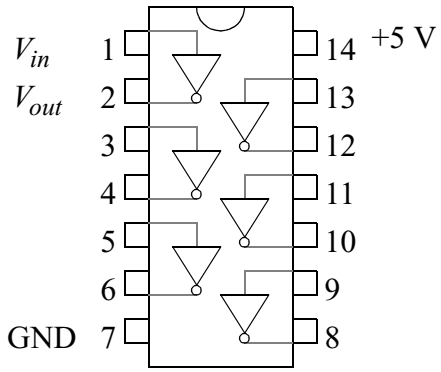
The TL071 op-amp is an integrated circuit based on JFET inputs and biploar transistor outputs (BIFET) and comes in an 8-pin dual in-line package (DIP). The connections for the chip looking down with the notch facing up is:



The 74LS86 is an integrated circuit based on low-power schottky technology that includes 4 XOR gates. The 74HC04 is an integrated circuit based on CMOS technology that includes 6 inverters. The pinouts for the 74LS86 and 74HC04 are shown below.



74LS86



74HC04

To use any of the gates in the chip, it must be attached to both power (+5 V) and ground.

1. Phase Shifting Amplifier

Connect an op-amp to form the circuit in figure 1. Use $R_1 = R_2 = 10$ kΩ and a 10 kΩ potentiometer for R; select a capacitor C so that $1/RC << \omega$; and use +15 V and -15 V for the op-amp power supply.

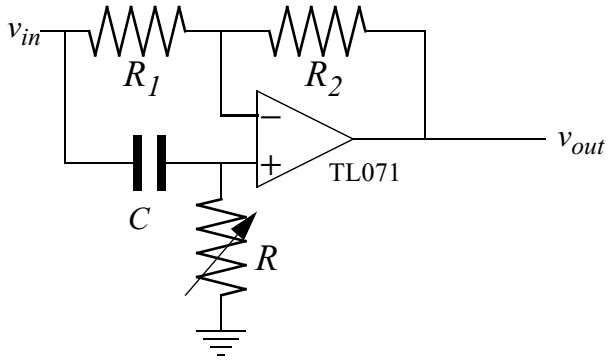


Figure 1: Phase Shifting Amplifier

Set the function generator to provide v_{in} with a sine wave of 1 kHz and 2.5 V amplitude. Measure V_{out} and v_{in} with the oscilloscope and make a graph of v_{out} as a function of v_{in}. Vary the potentiometer and note the change in phase. Plot ϕ as a function of R. Use the X-Y setting of the oscilloscope to view the phase difference directly. How does the value of R compare to $1/\omega C$ when the phase is $\pi/2$?

2. Phase Detector

Modify the circuit in figure 1 by adding additional filters and logic gates as shown in figure 2.

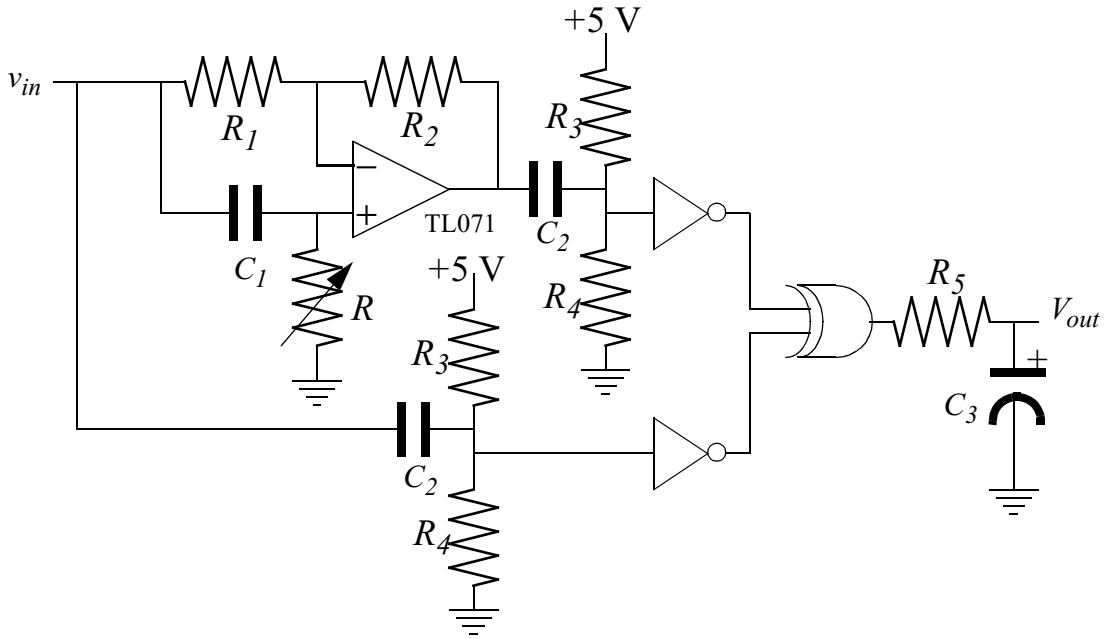


Figure 2: Phase Detector

Use the oscilloscope to observe the signals at the inputs and output of the XOR compared to the v_{in}. Observe how V_{out} changes with changing R. Measure V_{out} with a DMM and make a plot of V_{out} as a function of R. Use the table in part 1 to make a table of ϕ vs. R.