Chapter 10

Comparators and Timers
Comparators
Most signals have electronic noise associated. This noise often comes from capacitive and/or inductive pickup in a circuit. This can be greatly cleaned up by carefully laying out the printed circuit board with appropriate ground planes, etc., but it can never be fully removed.

Some devices generate their own noise. A detector, for example, converts signals from the object it is detecting into an electronic signal. Often noise, or "dark current," is associated with the detector when no signal is detected. A scope output might look like:

\[ i_{\text{signal}} \approx I_{\text{dark current}} \]

When a signal is detected, it would be much larger. In order to discriminate between noise and signal, one uses a comparator. The comparator compares a signal to a threshold level. If the signal is above (or below) the threshold, a pulse digital pulse is output; otherwise there is no output.

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However, when the pulse signal is near threshold, if there's noise on the signal, it might cause the comparator to oscillate.

\[ (67) \]

Schmitt Trigger

Developed to avoid this problem. It works by having a \( HI \rightarrow LO \) threshold different than a \( LO \rightarrow HI \) threshold. This is accomplished using positive feedback:

\[ \Delta V = \left( \frac{\beta - 1}{A} \right) (V_h - V_L) \]

where \( \Delta V \) is the hysteresis, \( \Delta V \) and is given by:

- \( \beta = \frac{R_2}{R_1 + R_2} \) if feedback fraction,
- \( A \) is open loop gain,
- \( V_h \) and \( V_L \) are output logic levels.
So

Oscillator

Add an RC network to a Schmitt trigger to get a relaxation oscillator.

Then \[ v = \left[ 2RC \ln \left( \frac{2R_1}{R_2} + 1 \right) \right] \]

HW: Design a Schmitt trigger for a ±12V OpAmp that has a 1V hysteresis gap and a \( V_{\text{thigh}} = 2V \).
(Use resistances \( 1k \Omega \leq R \leq 1M \Omega \).)