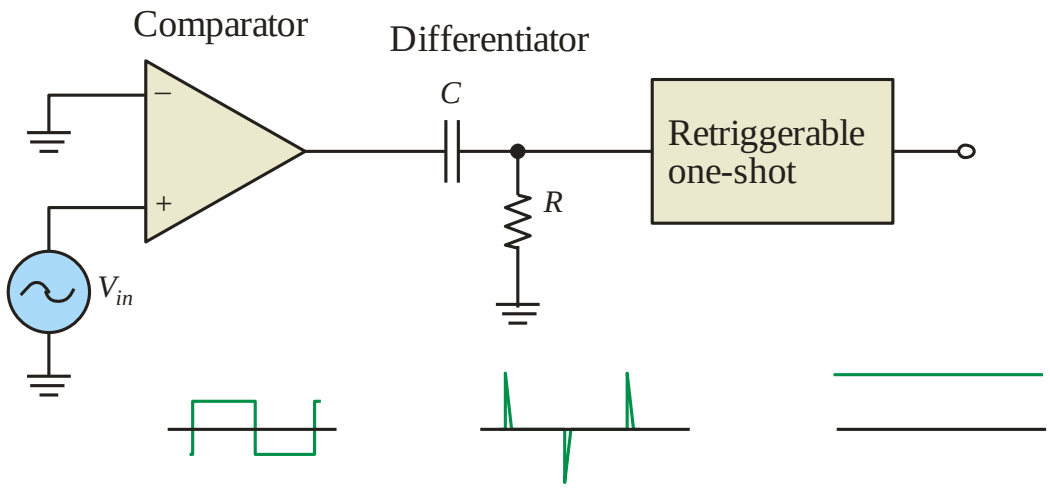
Lecture 12: Operational Amplifiers (3)

Comparator, Level Detection, Output Bounding, Applications of Comparators, Summing Amplifier

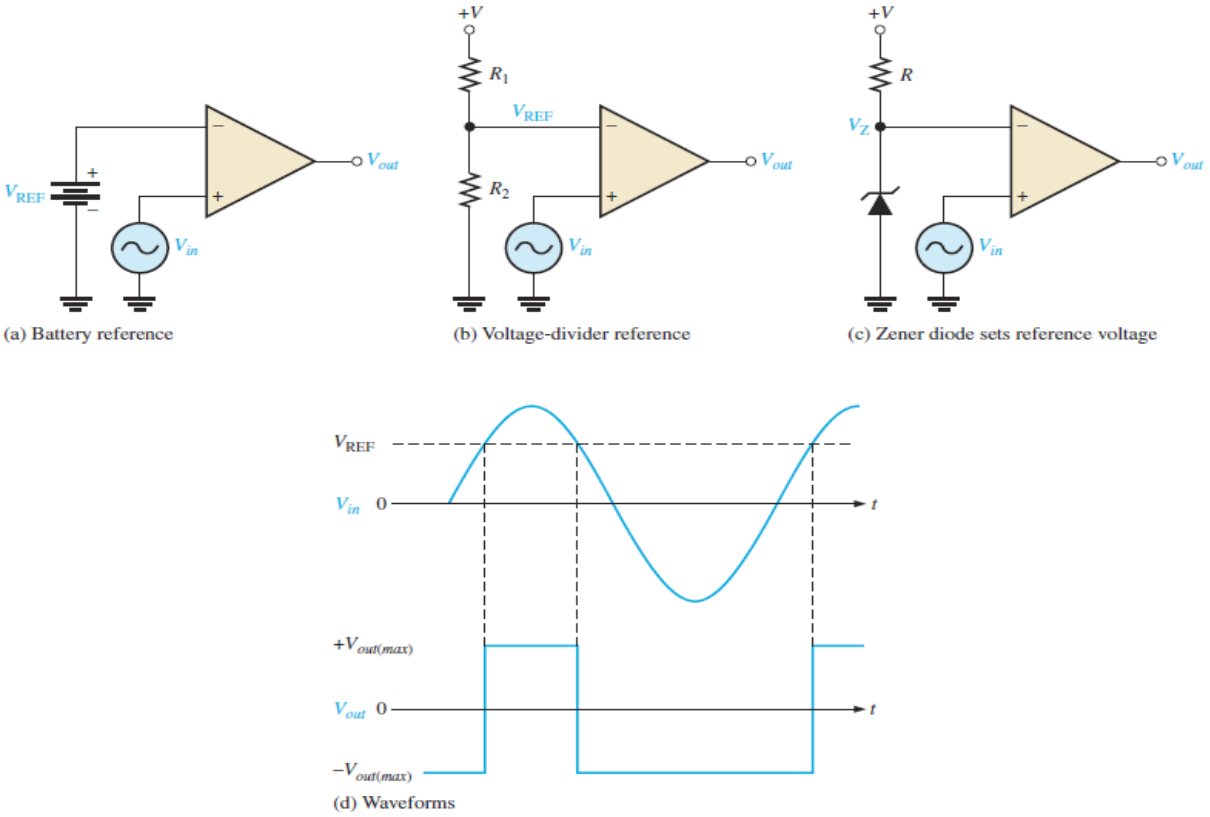
Comparator

A **comparator** is a specialized nonlinear op-amp circuit that compares two input voltages and produces an output state that indicates which one is greater. Comparators are designed to be fast and frequently have other capabilities to optimize the comparison function.

An example of a comparator application is shown. The circuit detects a power failure in order to take an action to save data. As long as the comparator senses V_{in}, the output will be a dc level.



Non Zero Level Detection

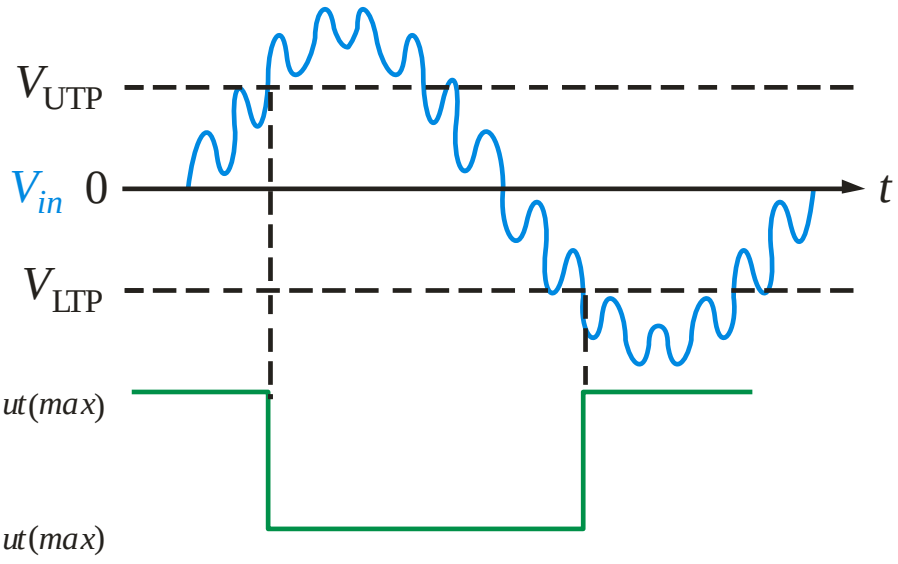


Different levels can be detected using different circuit configurations

Comparators with Hysteresis

Sometimes the input signal to a comparator may vary due to noise superimposed on the input. The result can be an unstable output. To avoid this, hysteresis can be used.

Hysteresis is incorporated by adding regenerative (positive) feedback, which creates two switching points: the upper trigger point (UTP) and the lower trigger point (LTP). After one trigger point is crossed, it becomes inactive and the other one becomes active.

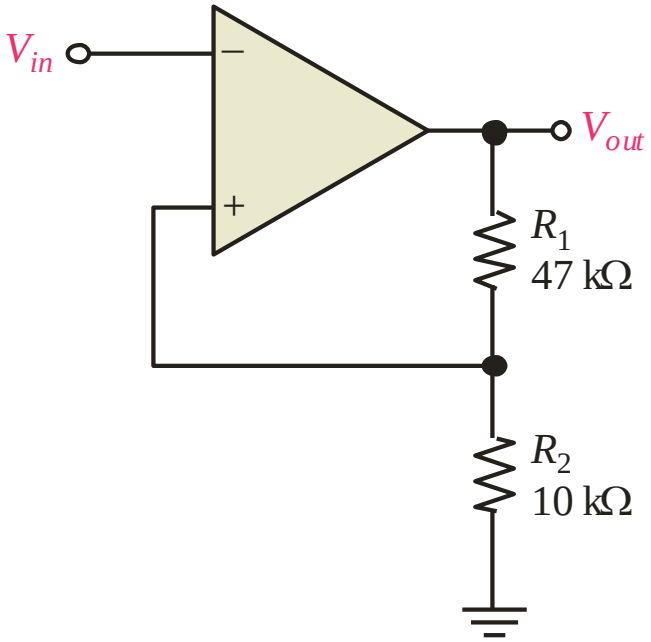


Schmitt Trigger

A comparator with hysteresis is also called a **Schmitt trigger**. The trigger points are found by applying the voltage-divider rule:

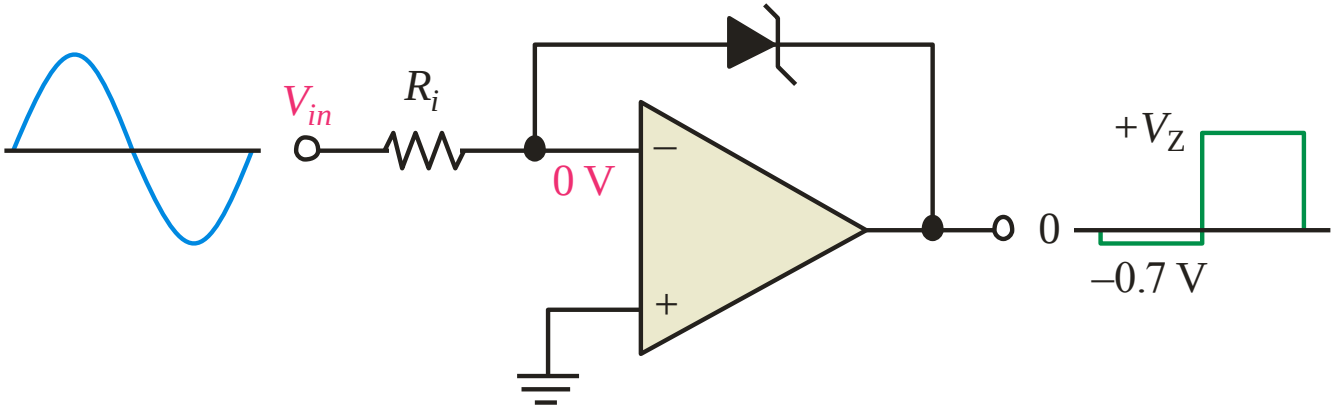
$$V_{\text{UTP}} = \frac{R_2}{R_1 + R_2}\left(+V_{out(max)}\right)$$

$$V_{\text{LTP}} = \frac{R_2}{R_1 + R_2}\left(-V_{out(max)}\right)$$



Output Bounding

Some applications require a limit to the output of the comparator (such as a digital circuit). The output can be limited by using one or two Zener diodes in the feedback circuit.

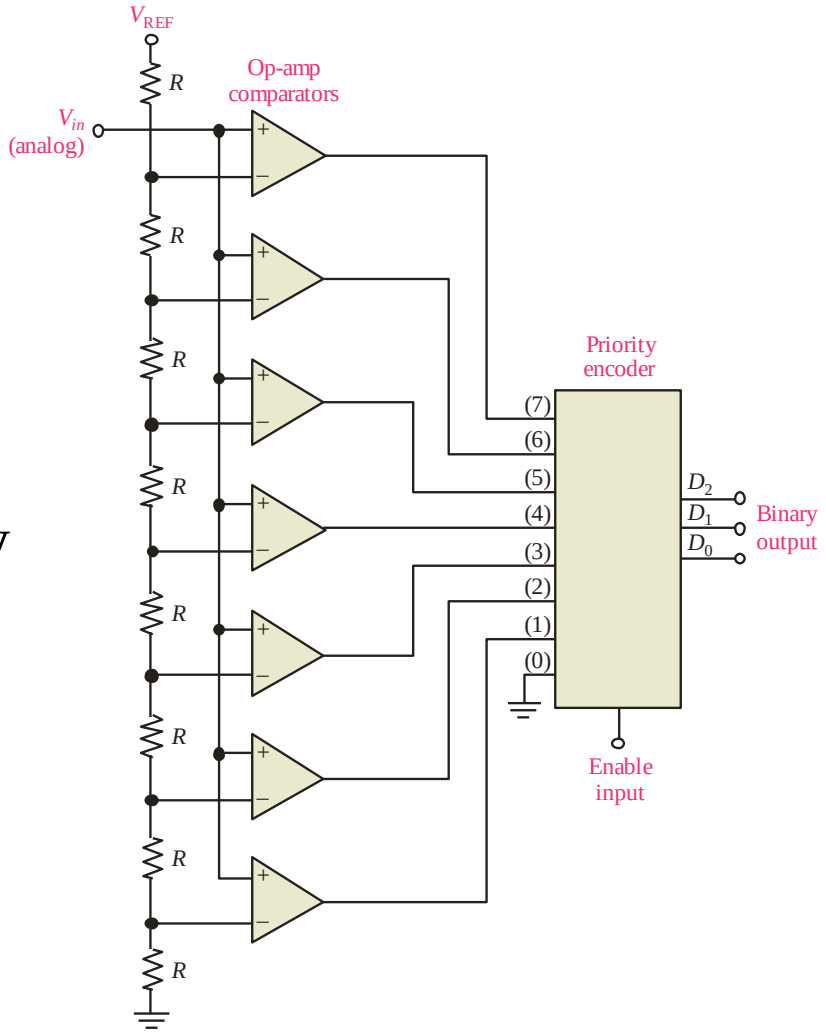


The circuit shown here is bounded as a positive value equal to the Zener breakdown voltage.

A/D Converter

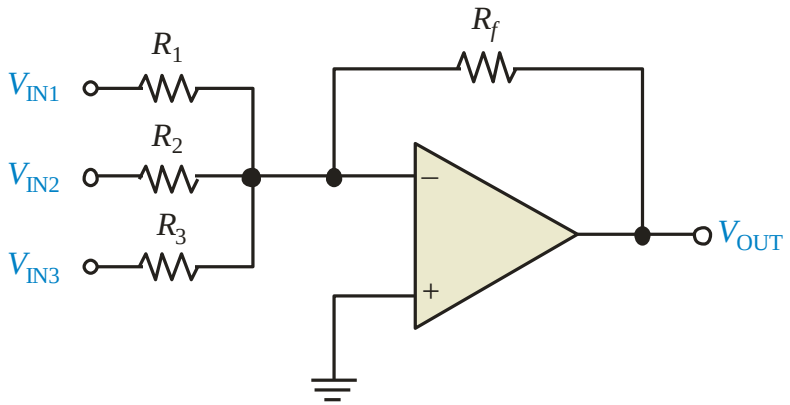
Simultaneous or flash analog-to-digital converters use 2^n-1 comparators to convert an analog input to a digital value for processing.

In IC flash converters, the priority encoder usually includes a latch that holds the converter data constant for a period of time after the conversion.



Summing Amplifier

A **summing amplifier** has two or more inputs; normally all inputs have unity gain. The output is proportional to the negative of the algebraic sum of the inputs.



$$V_{OUT} = -R_f \left(\frac{V_{IN1}}{R_1} + \frac{V_{IN2}}{R_2} + \frac{V_{IN3}}{R_3} \right)$$