*Presentation Topic:*

# ANALOG TO DIGITAL CONVERSION (ADC)

# ADC Basic Principle:

- The basic principle of operation is to use the comparator principle to determine whether or not to turn on a particular bit of the binary number output.
- It is typical for an ADC to use a digital-to-analog converter (DAC) to determine one of the inputs to the comparator.

# 3 Basic Types

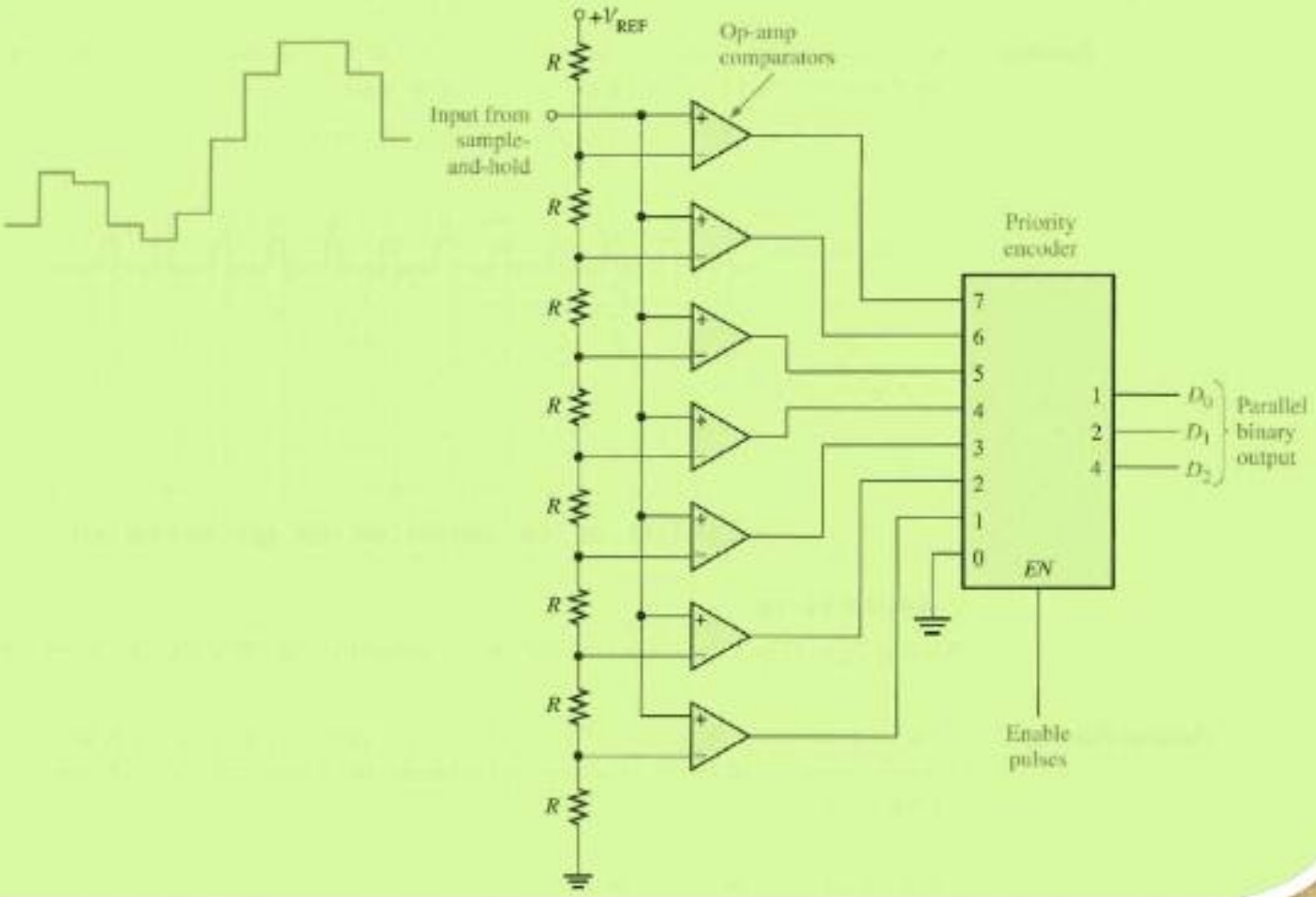
- Flash ADC
- Digital-Ramp/Dual slope/Counter slope ADC
- Successive Approximation ADC

# 1-> Flash ADC

- Consists of a series of comparators, each one comparing the input signal to a unique reference voltage.

- The comparator outputs connect to the inputs of a priority encoder circuit, which produces a binary output

# 3 bit Flash ADC Circuit



# How Flash Works

- As the analog input voltage exceeds the reference voltage at each comparator, the comparator outputs will sequentially saturate to a high state.
- The priority encoder generates a binary number based on the highest-order active input, ignoring all other active inputs.

# Flash

## *Advantages*

- Simplest in terms of operational theory
- Most efficient in terms of speed, very fast
  - limited only in terms of comparator and gate propagation delays

## Disadvantages

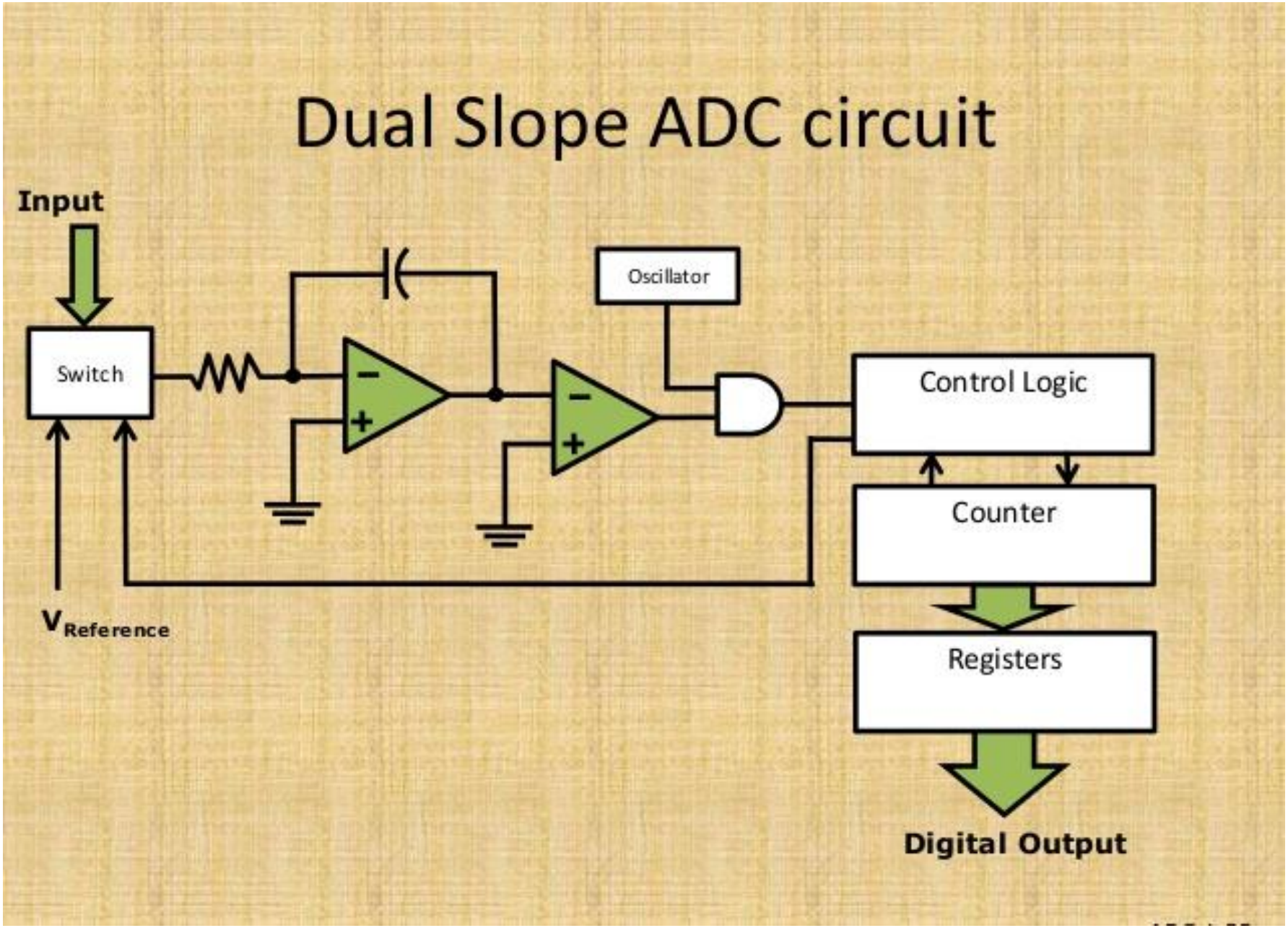
- Lower resolution
- Expensive
- For each additional output bit, the number of comparators is doubled
  - i.e. for 8 bits, 256 comparators needed

# 2-> Dual Slope ADC

- Also known as Counter-Ramp or Digital Ramp ADC

- A dual slope ADC is commonly used in measurement instruments (such as DVM's).

# Dual Slope ADC circuit

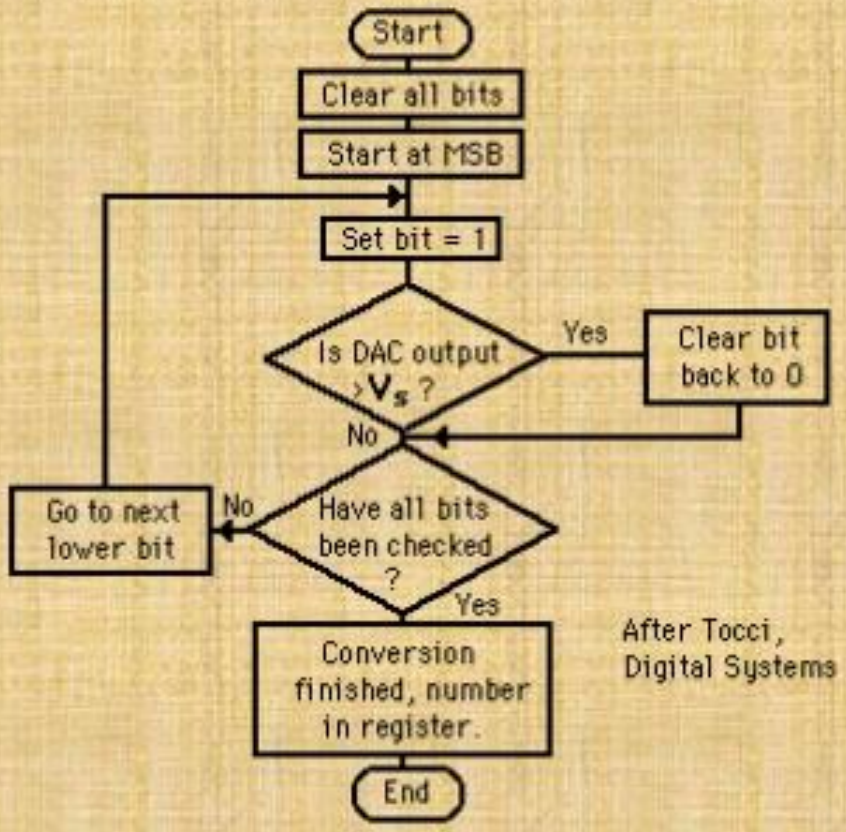


# Dual Slope Function

- The Dual Slope ADC functions in this manner:
  - When an analog value is applied the capacitor begins to charge in a linear manner and the oscillator passes to the counter.
  - The counter continues to count until it reaches a predetermined value. Once this value is reached the count stops and the counter is reset. The control logic switches the input to the first comparator to a reference voltage, providing a discharge path for the capacitor.
  - As the capacitor discharges the counter counts.
  - When the capacitor voltage reaches the reference voltage the count stops and the value is stored in the register.

# Successive approximation ADC

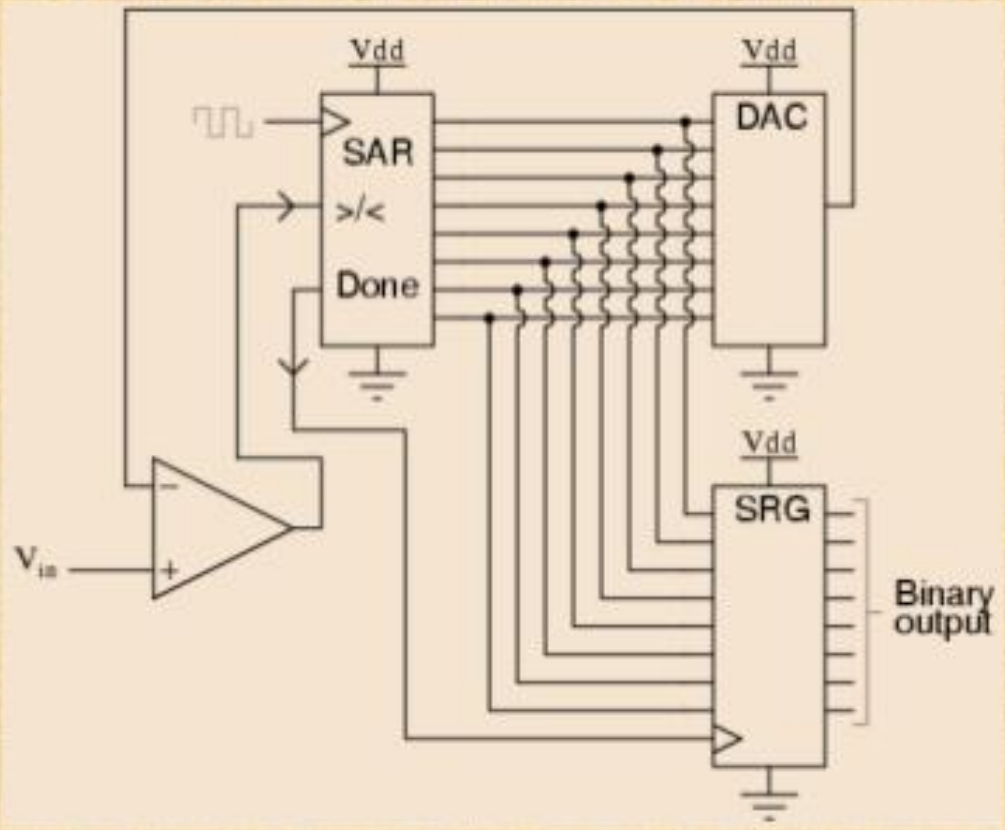
- Much faster than the digital ramp ADC because it uses digital logic to converge on the value closest to the input voltage.
- A comparator and a DAC are used in the process.



# Successive Approximation ADC

- A Successive Approximation Register (SAR) is added to the circuit
- Instead of counting up in binary sequence, this register counts by trying all values of bits starting with the MSB and finishing at the LSB.
- The register monitors the comparators output to see if the binary count is greater or less than the analog signal input and adjusts the bits accordingly

# Successive Approximation ADC Circuit



# Examples of A/D Applications

- Microphones - take your voice varying pressure waves in the air and convert them into varying electrical signals
- Strain Gages - determines the amount of strain (change in dimensions) when a stress is applied
- Thermocouple – temperature measuring device converts thermal energy to electric energy
- Voltmeters
- Digital Multimeters