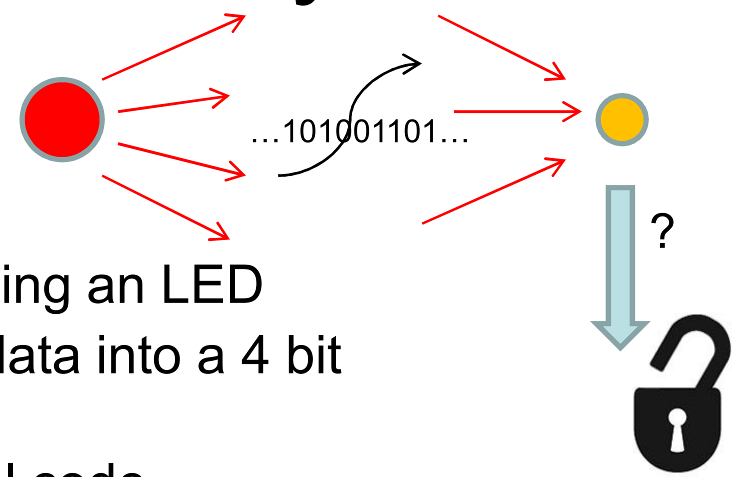
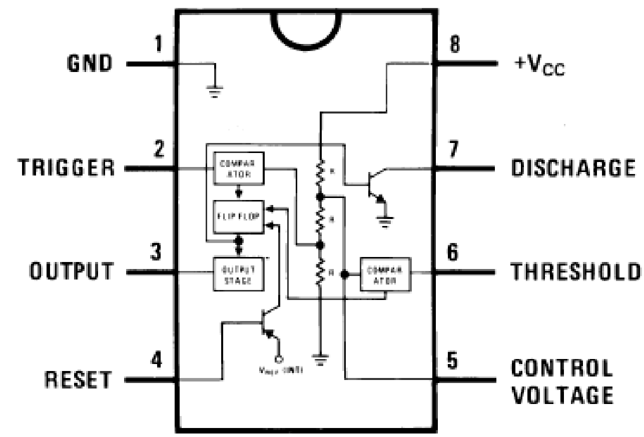
Project: security lock system



- Idea:
  - Create a 4bit password using switches
  - Send data serially (one bit at a time) using an LED
  - Receive the code serially and convert data into a 4 bit number
  - Compare the received data with original code
  - Unlock the key if it matches!
- Potential uses: TV/ DVD/Car unlock … remote control
- Components:
  - Timer -- Switch
  - Shift Register -- Comparators
  - Amplifier
- Optional: extending the system into 8-bit

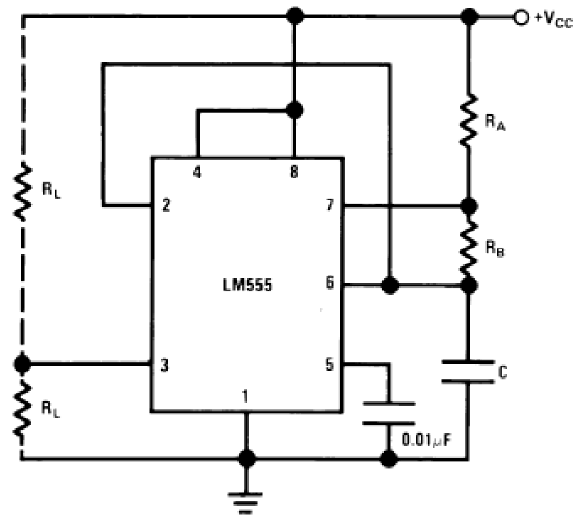
LM555 Timer



- Used as an oscillator to drive a speaker
- **Trigger:** when < $^1/_3$ Vcc, the output is high (Vcc)
- **Threshold input:** when > $^2/_3$ Vcc and the trigger is > $^1/_3$ Vcc, the output is low (0V). If the trigger is < $^1/_3$ Vcc, it overrides the threshold input and holds the output high.
- **Reset input:** when less than about 0.7V, all other inputs are overridden and the output is low.
- **Discharge pin:** This is connected to 0V when the timer output is low and is used to discharge the timing capacitor in astable operation.

LM555 Timer as an oscillator

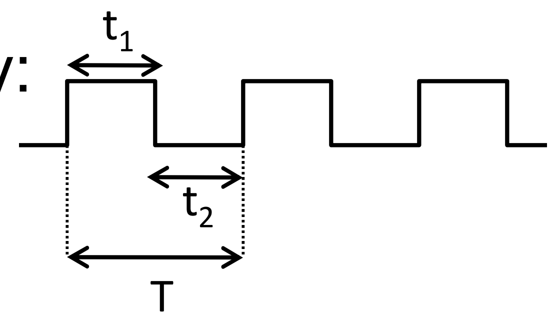
- Astable operation: The circuit oscillates on its own.
- With the output high, the capacitor C is charged by current flowing through R_A and R_B.
- The threshold and trigger inputs monitor the capacitor voltage and when it reaches ${}^{2}/_{3}$Vcc (threshold), the output becomes low and the discharge pin is connected to 0V.
- The capacitor discharges with current flowing through R_B into the discharge pin. When the voltage falls to ${}^{1}/_{3}$Vcc (trigger) the output becomes high again and the discharge pin is disconnected, allowing the capacitor to start charging again.
- Adjust duty cycle (time on : total time) by adjusting the ratio between R_A and R_B.
- Note that pin 4 (reset) is held at Vcc here. You will need change the connection for light sensitivity.



From http://www.national.com/ds/LM/LM555.pdf

LM555 Timer

- Some equations for astable operation:



The charge time (output high) is given by:

$$t_1 = 0.693\,(R_A + R_B)\,C$$

And the discharge time (output low) by:

$$t_2 = 0.693\,(R_B)\,C$$

Thus the total period is:

$$T = t_1 + t_2 = 0.693\,(R_A + 2R_B)\,C$$

The frequency of oscillation is:

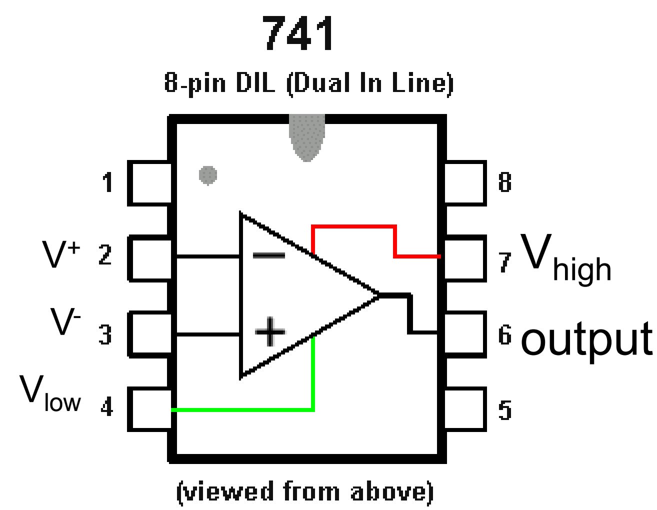
$$f = 1/T = 1.44/\,(R_A + 2R_B)\,C$$

And the duty cycle is:

$$D = t_1/(t_1 + t_2) = (R_A + R_B)/(R_A + 2R_B)$$

Comparator

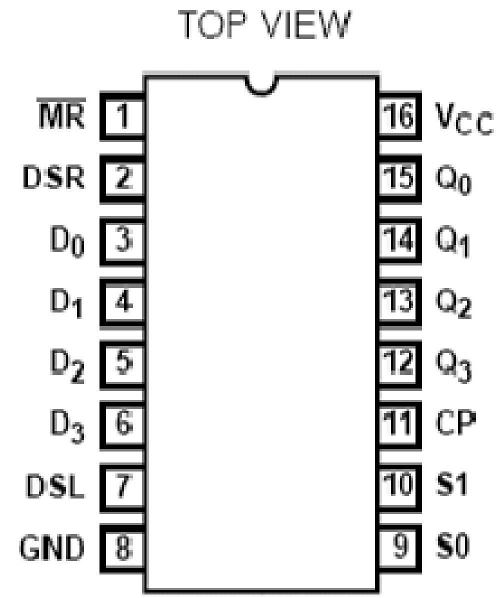
- Built using an op-amp (a 741 will do)
- Compares it’s “+” and “-” inputs
  – If $V^+ > V^-$ then output = V_{High} (a digital “1”)
  – If $V^+ < V^-$ then output = V_{low} (a digital “0”)
- Useful for converting small analog voltages into big, digital signals
- To power up, attach V_{low} to -6V, V_{high} to +6V



- Test: attach output to LED in series with a 1kΩ resistor to ground
- Set V+, V- with SMUs, confirm that LED turns on when V+ > V-

Shift register (1)

- A shift register is a kind of digital memory
- It has 6 data inputs:
  - Parallel data D0,D1,D2,D3
  - Serial data DSR, DSL
- It has three controls:
  - Shift controls, S0, S1
  - Clock
- It has 4 outputs:
  - Q0,Q1,Q2,Q3
  - These outputs change only when the clock changes from 0 to 1



Set VCC to 5V, VSS to 0V, pin 1 to 5V

Shift register (2)

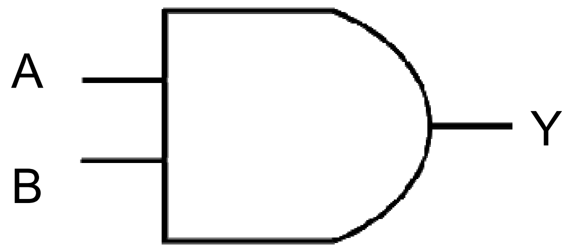
- The shift register has 4 modes, set by S0, S1, and triggered by the clock
- When S0=1, S1 =1,
  - Q0 = D0, Q1 = D1, etc
- When S0 = 0, S1 = 0
  - Q0,Q1,Q2,Q3 hold their value
- When S0 = 0, S1 = 1
  - Data shifts left: Q1 = Q0 (from before clock) Q2= Q1, etc
  - Q0 = DSR
- When S0 = 1, S1 = 0
  - Data shifts right: Q2 = Q3 (from before clock) Q1= Q2, etc
  - Q3 = DSL

- Test:
  - attach outputs to 4 LEDs in series with 1kΩ resistors to ground
  - Set function generator to make a 5V square wave (2.5V offset) with frequency = 1Hz, attach it to the clock input
  - Short D0, D2, D3, SDR to ground, short D1, SDL to 5V
- Try different combinations of S0, S1.
- What happens?
  - You should see things shift left or right.

Comparator (1)

- Includes combination of AND and XOR gated:

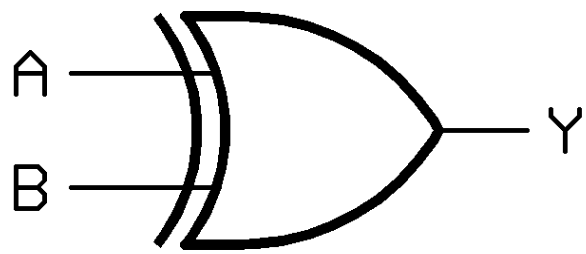
- AND:



Y=1 if A=B=1,

otherwise Y=0

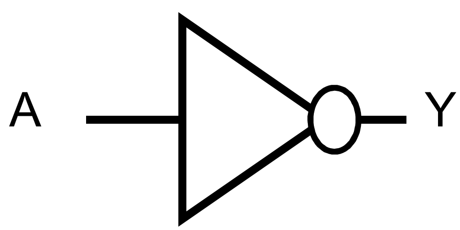
- XOR:



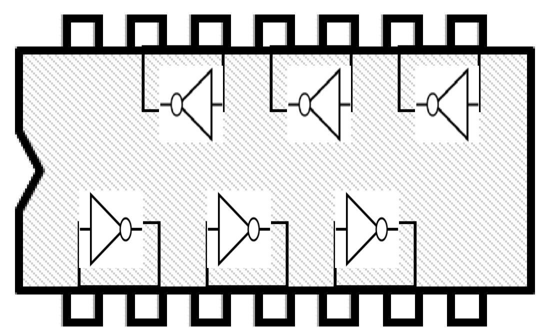
False if A=B

True if A≠B

- NOT

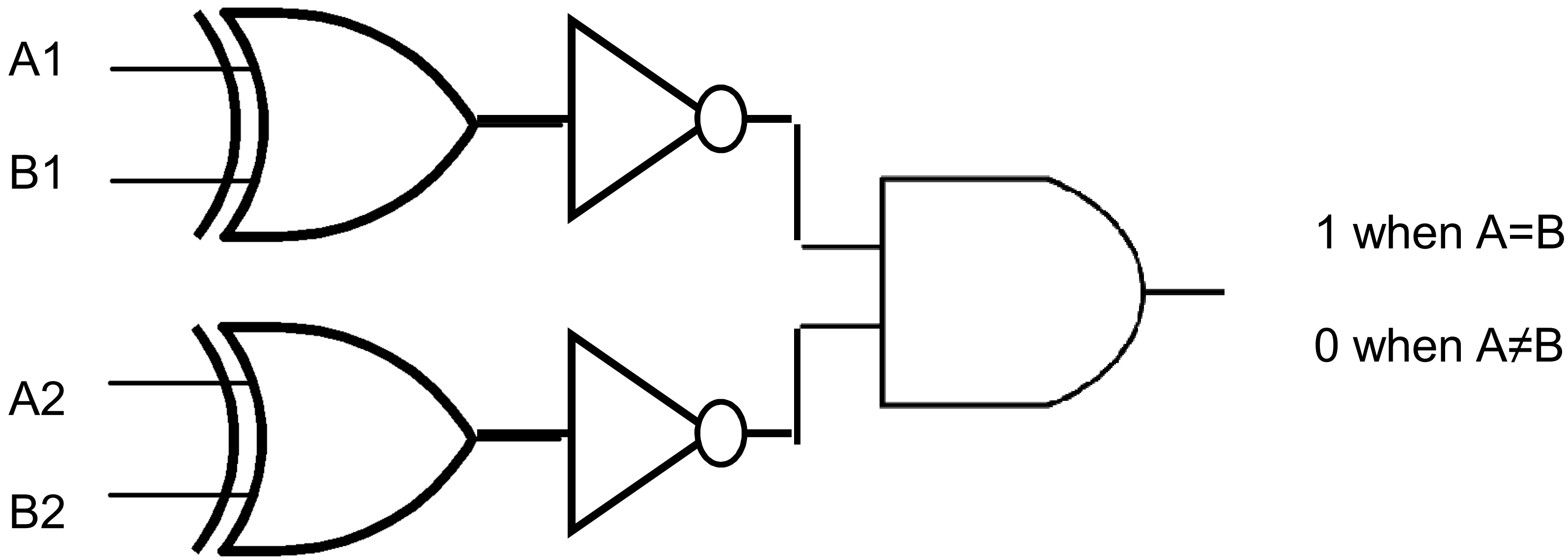


If A=1, Y=0, if A=0, Y=1

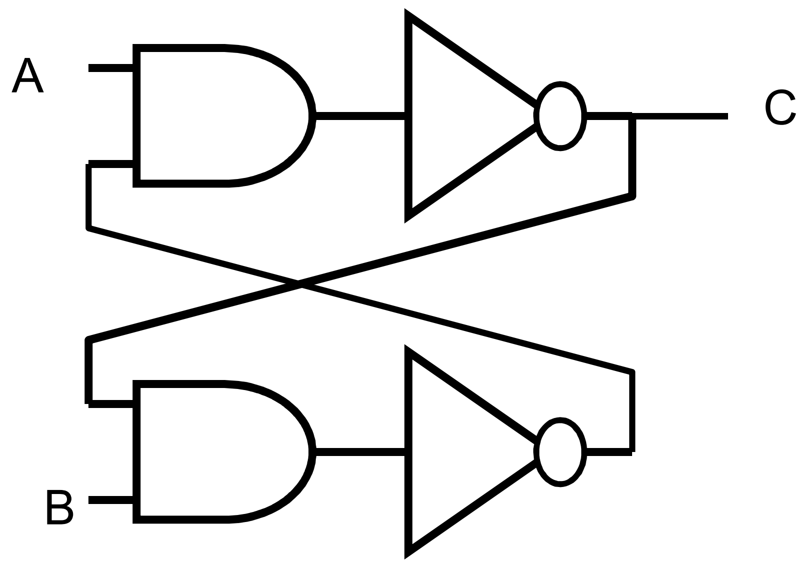


Comparator (2)

- Comparing two 2-bit numbers: $A = A_2,A_1$ $B= B_2,B_1$



Latch circuit



Question: write a truth table for this circuit: what happens when A=B=1?

Test: hook up and gates as you did yesterday, test its function: does it behave as you predicted?