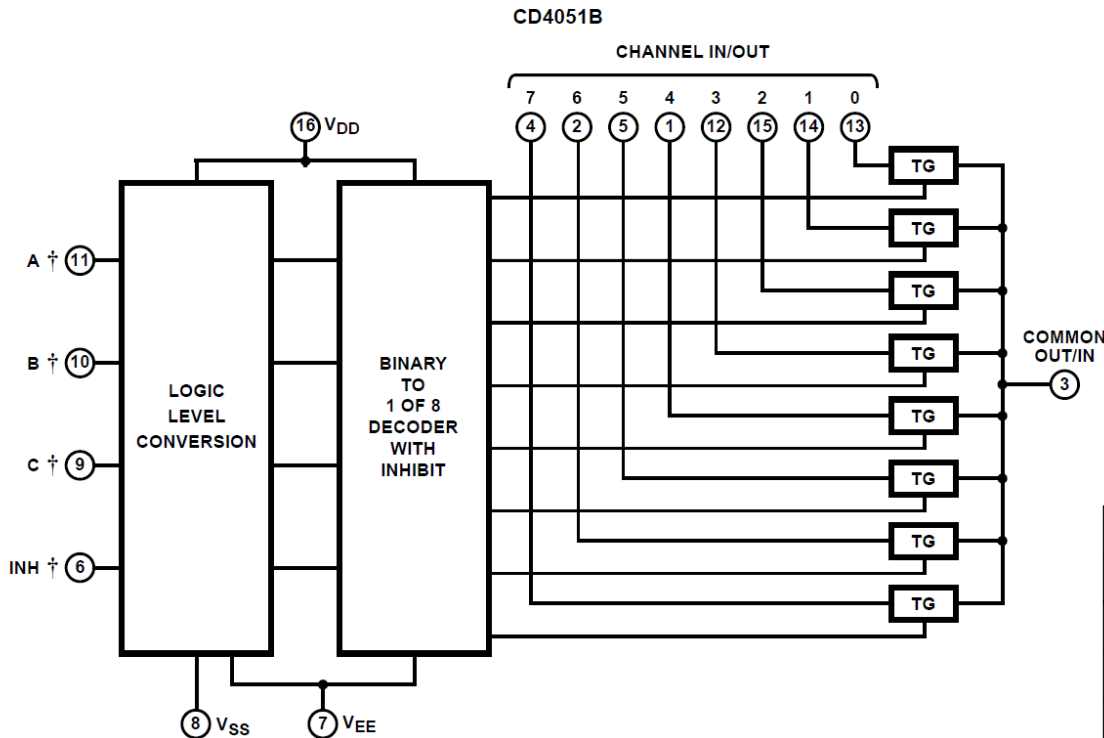# ELECTRONIC SYSTEM DESIGN

PART 2: BASIC ELECTRONIC INTEGRATED CIRCUITS AND THEIR APPLICATIONS

Prof. Yasser Mostafa Kadah

Analog Multiplexer/Demultiplexer

CD4051B

CHANNEL IN/OUT

7	6	5	4	3	2	1	0
(4)	(2)	(5)	(1)	(12)	(15)	(14)	(13)

(16) V_{DD}

A † (11)

B † (10)

C † (9)

INH † (6)

LOGIC LEVEL CONVERSION

BINARY TO 1 OF 8 DECODER WITH INHIBIT

TG

TG

TG

TG

COMMON OUT/IN

(3)

TG

TG

TG

TG

(8) V_{SS} (7) V_{EE}

- Wide Range of Digital and Analog Signal Levels
  - Digital . . . . 3V to 20V
  - Analog. . . . . ≤20V$_{P-P}$
- Low ON Resistance, 125Ω (Typ) Over 15V$_{P-P}$ Signal Input Range for V_{DD}-V_{EE} = 18V
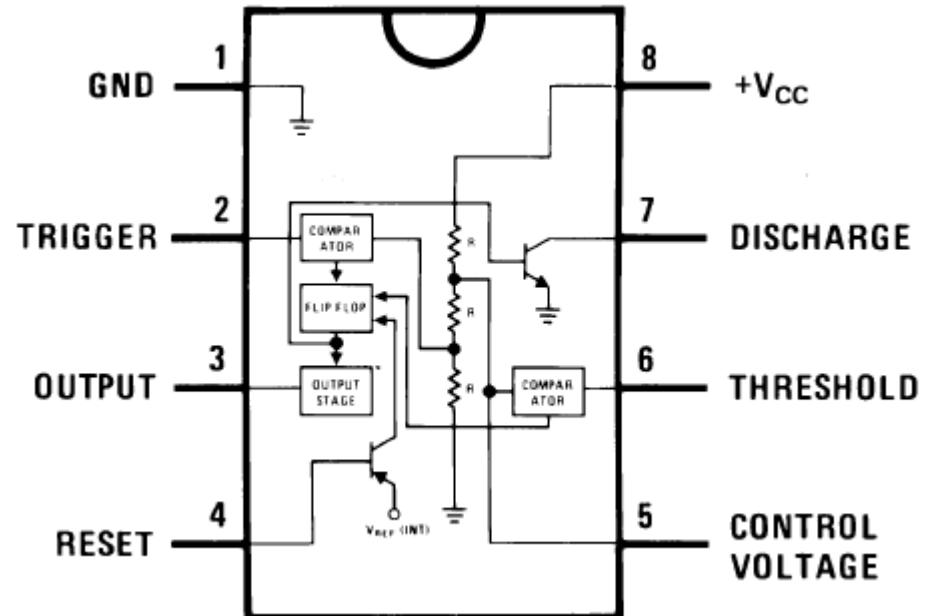- High OFF Resistance, Channel Leakage of ±100pA (Typ) at V_{DD}-V_{EE} = 18V

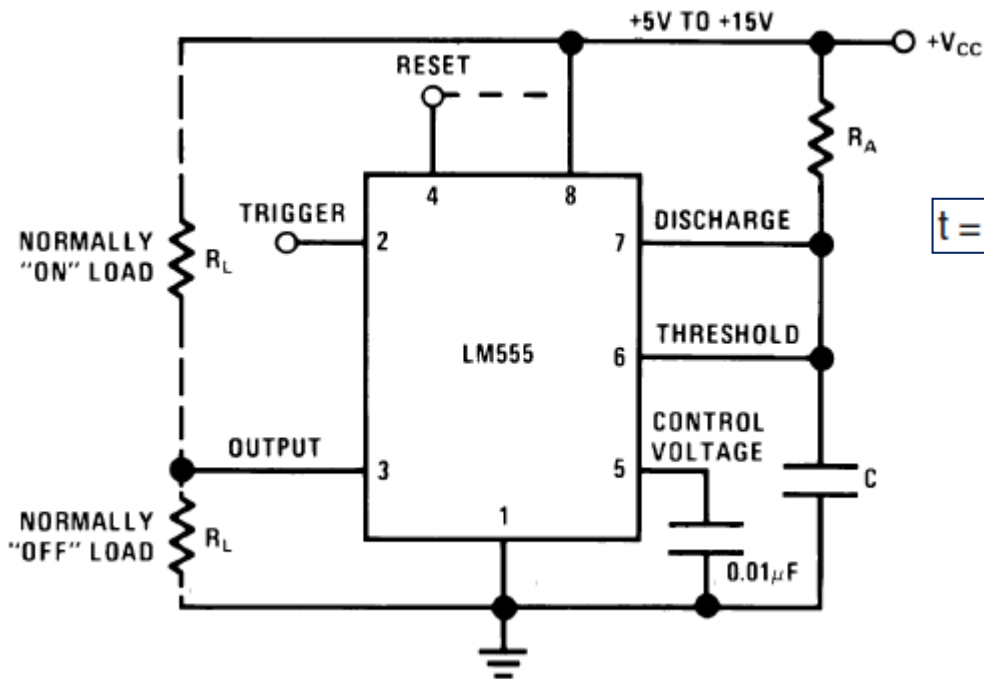| INPUT STATES				"ON" CHANNEL(S)
INHIBIT	C	B	A	
CD4051B				
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7
1	X	X	X	None

The 555 Timer

Applications

- Precision timing
- Pulse generation
- Sequential timing
- Time delay generation
- Pulse width modulation
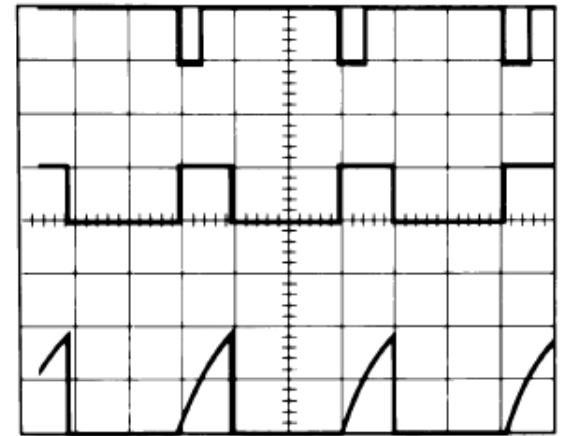- Pulse position modulation
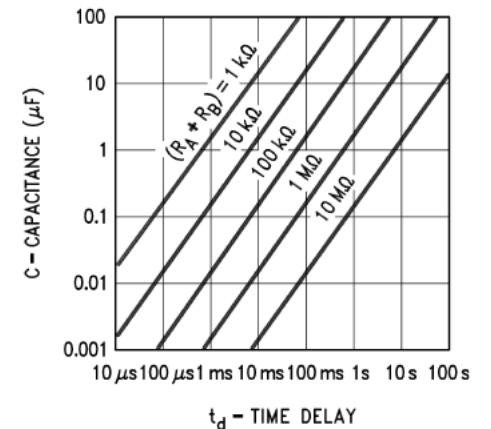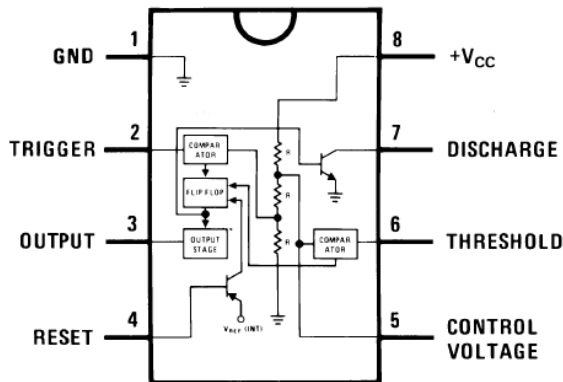- Linear ramp generator

555: Monostable Operation

$$t = 1.1 \, R_A \, C$$

$V_{CC} = 5V$ Top Trace: Input 5V/Div.

TIME = 0.1 ms/DIV.   Middle Trace: Output 5V/Div.

$R_A = 9.1k\Omega$ Bottom Trace: Capacitor Voltage 2V/Div.

$C = 0.01\mu F$

00785106

555: Astable Operation
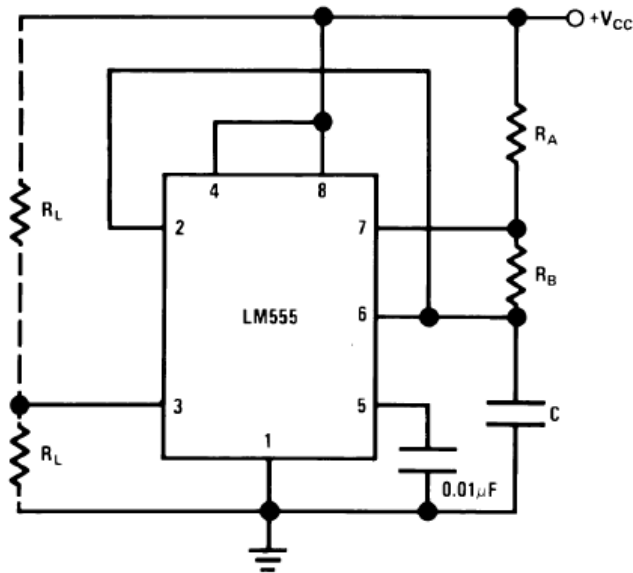
The duty cycle is:

$$D = \frac{R_B}{R_A + 2R_B}$$
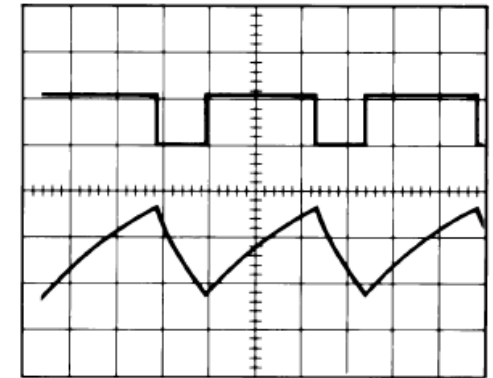
00785109

$V_{CC} = 5V$ Top Trace: Output 5V/Div.

$TIME = 20\mu s/DIV.$ Bottom Trace: Capacitor Voltage 1V/Div.

$R_A = 3.9k\Omega$

$R_B = 3k\Omega$

$C = 0.01\mu F$

The charge time (output high) is given by:

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

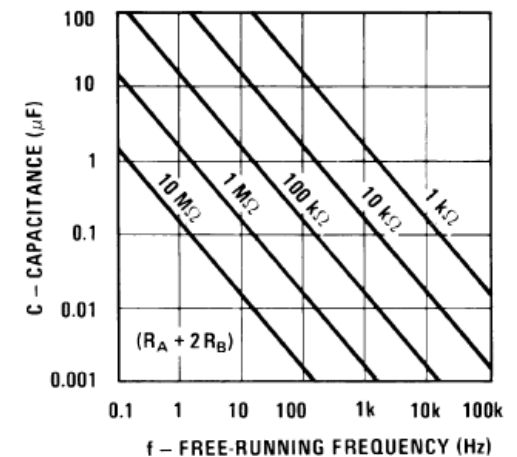And the discharge time (output low) by:

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

Thus the total period is:

$$T = t_1 + t_2 = 0.693\ (R_A + 2R_B)\ C$$
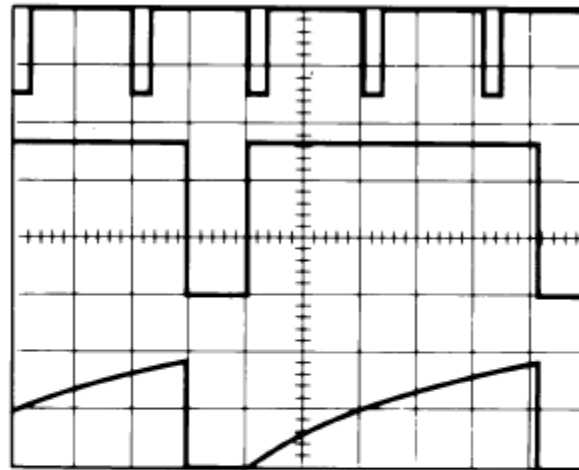
The frequency of oscillation is:

$$f = \frac{1}{T} = \frac{1.44}{(R_A + 2\,R_B)\ C}$$

555: Frequency Divider

☐ Same as monostable operation circuit

  ▪ Adjustment of period to be long enough

00785111

V_{CC} = 5V   Top Trace: Input 4V/Div.

TIME = 20µs/DIV.   Middle Trace: Output 2V/Div.

R_A = 9.1kΩ   Bottom Trace: Capacitor 2V/Div.

C = 0.01µF

555: Pulse Width Modulator
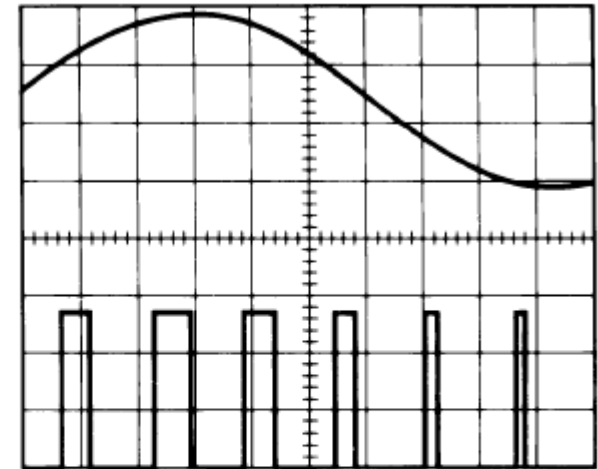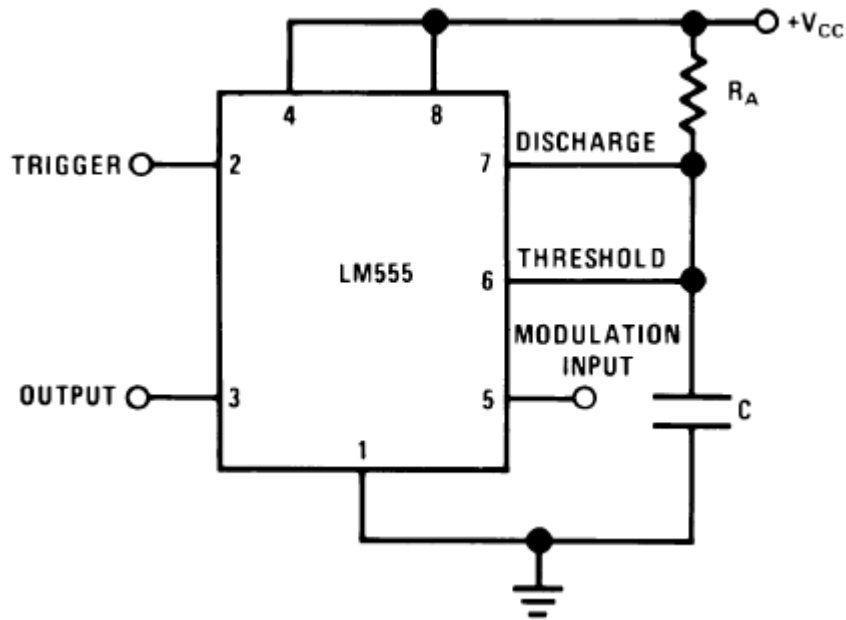
V_{CC} = 5V   Top Trace: Modulation 1V/Div.
TIME = 0.2 ms/DIV.   Bottom Trace: Output Voltage 2V/Div.
R_A = 9.1kΩ
C = 0.01µF

Optocoupler/Optoisolator/Optotriac

- Digital
- Transistor
- Triac/SCR

CNY17F1M/2M/3M/4M
MOC8106M/7M

ANODE 1   6 V_{CC}
CATHODE 2   5 GND
3   4 V_O
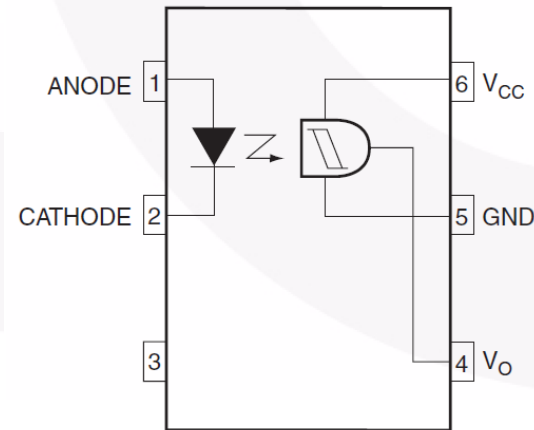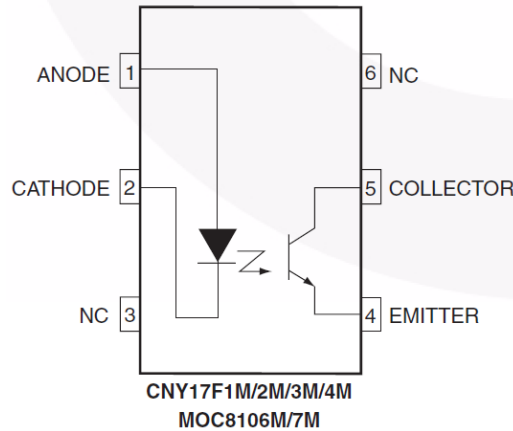
Truth Table

Input	Output
H	L
L	H

ANODE 1   6 BASE
CATHODE 2   5 COLLECTOR
N/C 3   4 EMITTER

ANODE 1   6 MAIN TERM.
CATHODE 2   5 NC*
N/C 3   4 MAIN TERM.
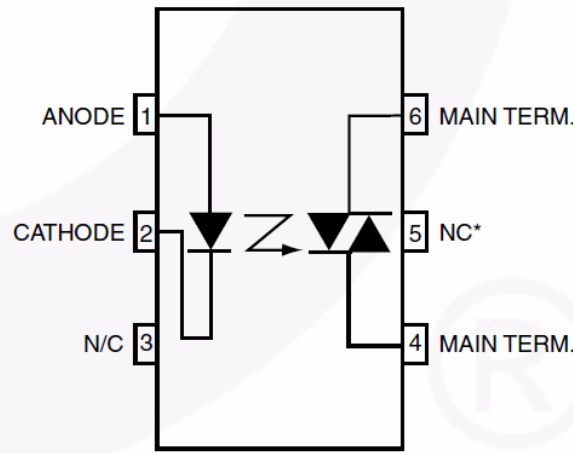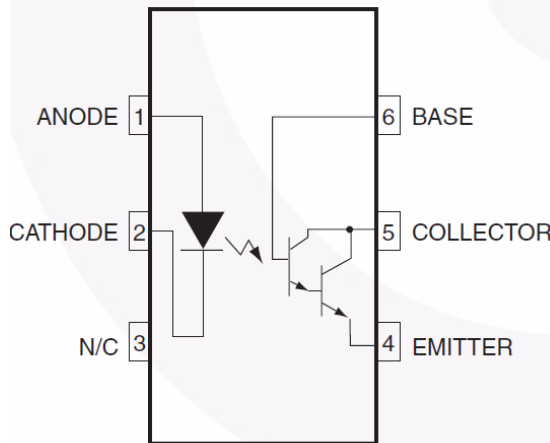
*DO NOT CONNECT
(TRIAC SUBSTRATE)

Assignments

- Buy and assemble a 4051 analog multiplexer circuit and test it in the lab.

- Buy a 555 timer chip and assemble and test the monostable, astable and pulse width modulation circuits.

- Buy an optoisolator and test its operation in the lab.

- Write a report on your experiments and submit to the TA.