Laboratory 1
Basic Logic Circuit

CO 2206 Computer Organization

Objectives

- To investigate logic gates and circuit in practical (physically)
- To get some hands on with prototyping electronic circuit (logic circuit in particular)
  - breadboarding
  - inputs simulation
  - outputs monitoring

Datasheet

- A datasheet is a document summarizing the performance and other characteristics of a component, e.g. an IC.
    - A screen shot of the first page of a datasheet for logic IC 7400 is shown next.
- For logic IC, important characteristics are the function and layout of the logic components in the IC.
- Other performance characteristics will be voltage (levels), current (sink and source) capability and time response. The minimum, maximum and/or nominal values are usually given.

FAIRCHILD
SEMICONDUCTOR™

September 1986
Revised February 2000
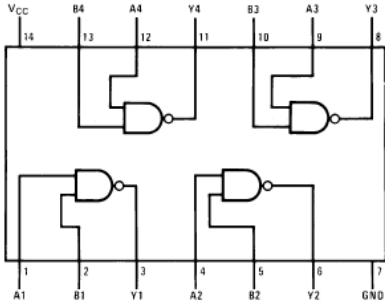
DM7400

Quad 2-Input NAND Gates

General Description
This device contains four independent gates each of which performs the logic NAND function.

Ordering Code:

Order Number	Package Number	Package Description
DM7400M	M14A	14-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150 Narrow
DM7400N	N14A	14-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300 Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

Connection Diagram

Function Table

$Y = \overline{AB}$

Inputs		Output
A	B	Y
L	L	H
L	H	H
H	L	H
H	H	L

H = HIGH Logic Level
L = LOW Logic Level

DM7400 Quad 2-Input NAND Gates

Task 1: Datasheet

- You are given some electronic components including some logic ICs. Determine the function of the given logic ICs (from their part number) and determine their internal and pin layout.

    – E.g. DM7400N is a "Quad 2-input NAND Gates" from Fairchild Semiconductor with the following IC layout.


7400
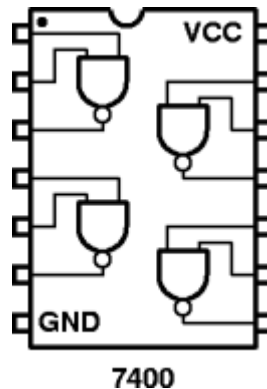
Testing Logic Circuit

- The following actions (minimal) are required when testing logic circuit practically:
    - turn ON the IC, i.e. give it the required power supply
    - provide the necessary input(s)
    - check the output(s) and verify that it/they is/are correct

- Take note of the orientation of IC to identify Pin 1 as shown below
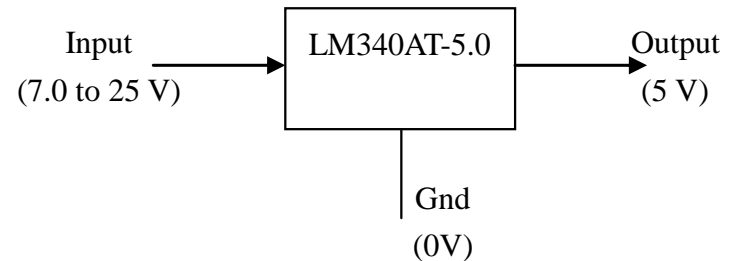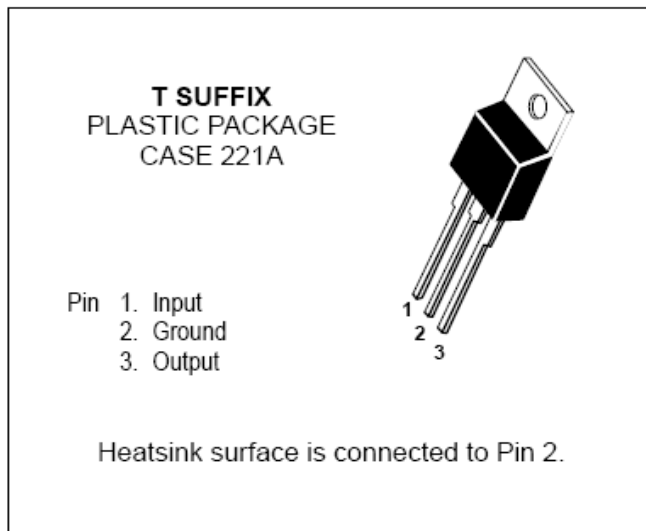
1

dot or slot
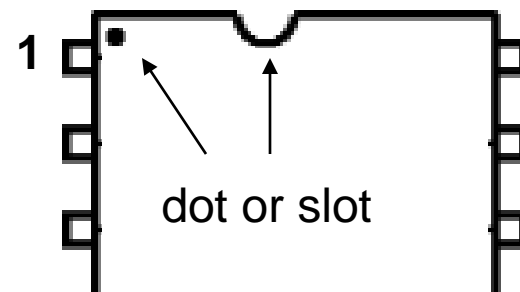
Power Up the IC

- Every logic IC will have two power supply pins. For TTL they are:
  - Vcc
  - Gnd
- For TTL the required Vcc is usually $5V \pm 0.5V$
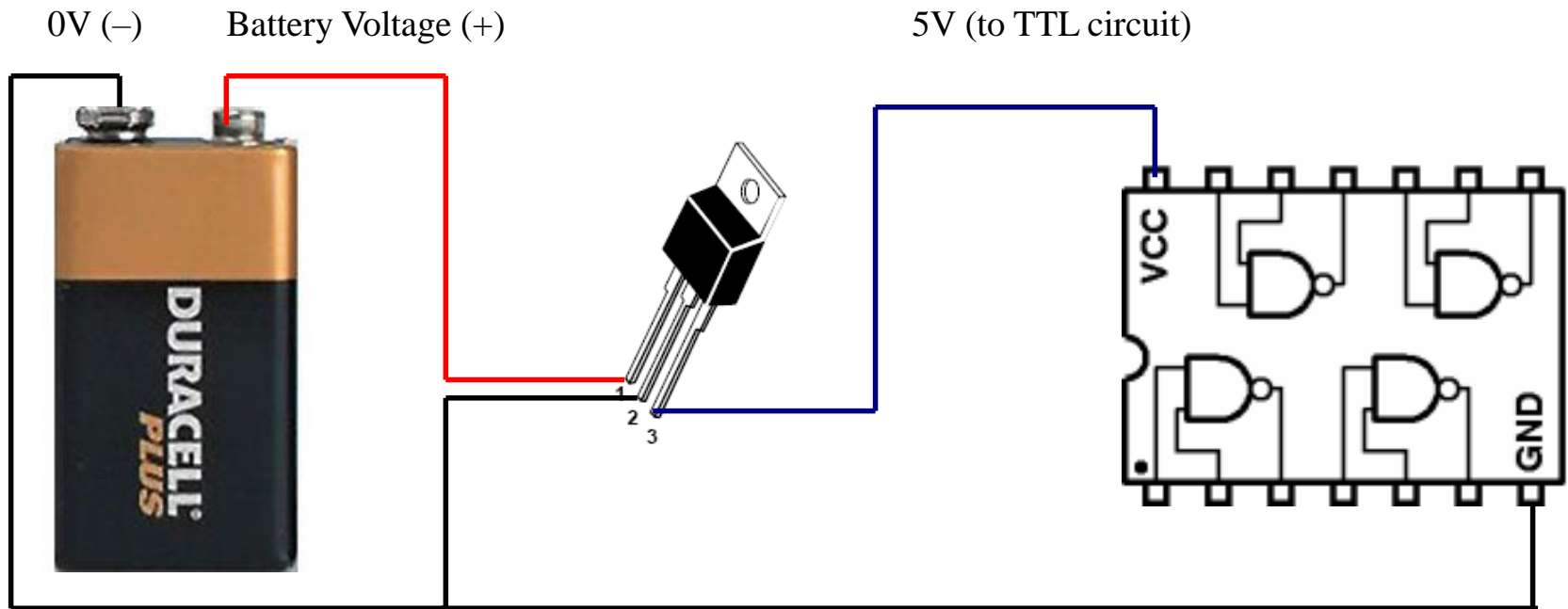- This power supply can be provided by a battery (or any DC supply)
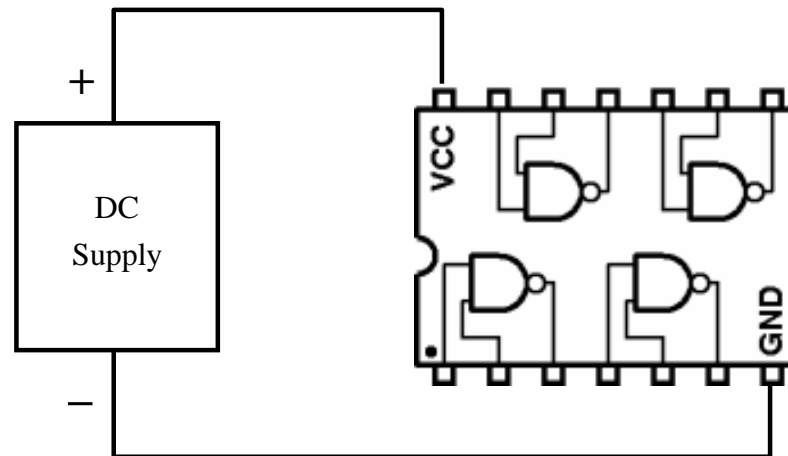
Power Up the IC: Using the Regulator - 1

- However, commercially available batteries do not come in 5V

- Usual practice is to use a "5V Voltage Regulator" to "step down" the battery voltage and "maintain" at 5V
  - LM340AT-5.0 provided will do just that

T SUFFIX
PLASTIC PACKAGE
CASE 221A

Pin 1. Input
2. Ground
3. Output

Heatsink surface is connected to Pin 2.

Input
(7.0 to 25 V)

LM340AT-5.0

Output
(5 V)

Gnd
(0V)

Power Up the IC: Using the Regulator - 2

0V (–)   Battery Voltage (+)   5V (to TTL circuit)
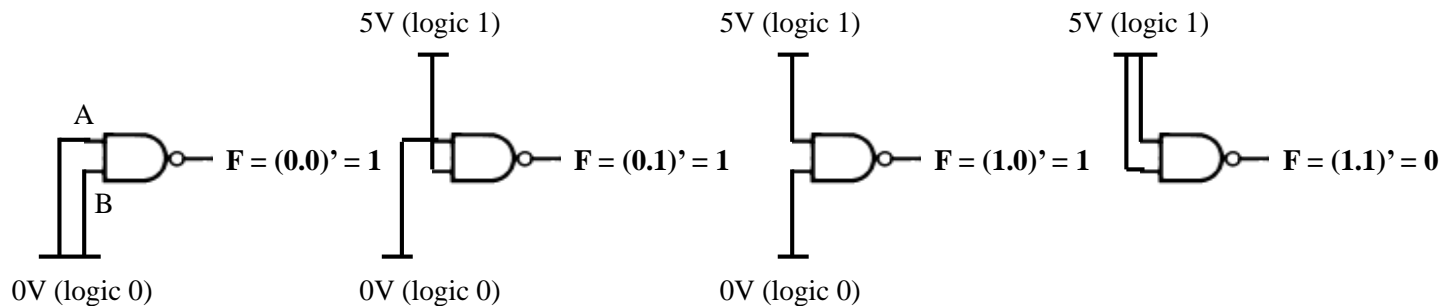
Inputs

- Logic input can take the logic level of 1 or 0
- In TTL, a 5V connected to the input will provide logic 1, while a 0V will give logic 0

5V (logic 1) 5V (logic 1) 5V (logic 1)

A

B

$F = (0.0)' = 1$ $F = (0.1)' = 1$ $F = (1.0)' = 1$ $F = (1.1)' = 0$
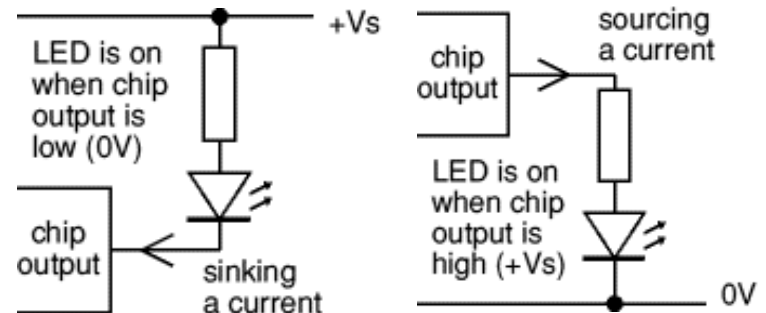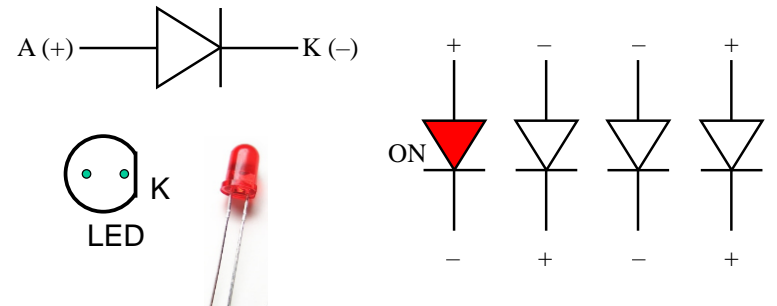
0V (logic 0) 0V (logic 0) 0V (logic 0)

Inputs		Output
A	B	F
0	0	1
0	1	1
1	0	1
1	1	0

Outputs - 1

- Logic output can be at logic level of 1 or 0
- In TTL, an output at logic 1 will measure 5V while at logic 0 will measure 0V
- Instead of making measurements at the output, it is convenient to provide a visible indicator at each output
- Usual practice is to use an LED (Light Emitting Diode) to do that
  - The output level will turn ON/OFF the LED

Outputs - 2

- An LED will be turned ON when its Anode (A) is connected to +ve while Cathode (K) is connected to –ve

- LED will only require around 1V to turn ON
  - a series resistor shall be provided to avoid overloading (excessive current at) the output as well as to avoid damaging the LED and the IC

- There are two ways to connect an LED to indicate the output level

A (+) ——▷|—— K (–)

K

LED

ON

+   –   –   +

–   +   –   +

LED is on when chip output is low (0V)

+Vs

chip output

sinking a current

chip output

sourcing a current

LED is on when chip output is high (+Vs)

0V

Solderless Prototyping: Breadboarding

- Breadboard is a common equipment in testing electronic circuits

- A breadboard has many strips of metal which run underneath the board

  - the metal strips are laid out as shown in red, horizontally along the two lines at the top and bottom, and vertically to join six holes together in the central section

  - strips connect the holes on the top of the board

 - easy to connect components together to build circuits

Breadboarding Techniques

- To use the breadboard, the legs of components are placed in the holes (the sockets)
  - The holes are made so that they will hold the component in place
  - Each hole is connected to one of the metal strips running underneath the board.
- The long top and bottom row of holes are usually used for power supply connections
- The rest of the circuit is built by placing components and connecting them together with jumper wires
  - Chips can be placed in the middle of the board so that half the legs are on one side of the middle line and half are on the other side
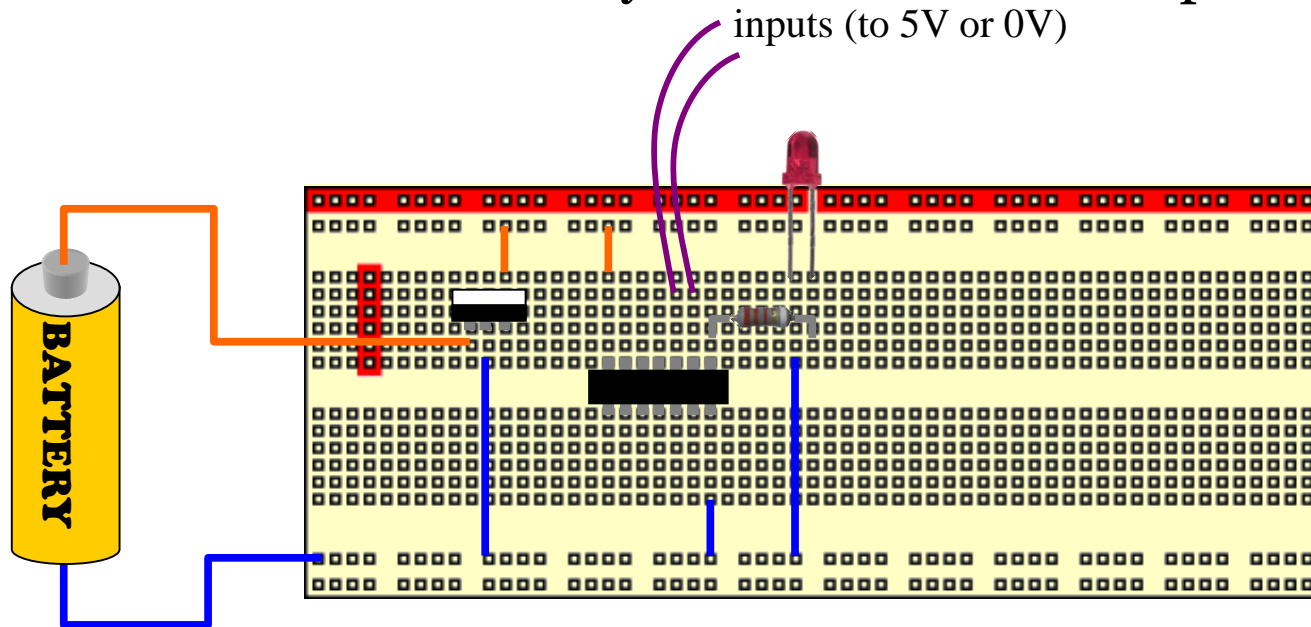
Breadboarding: Example

- A completed circuit might look like the following
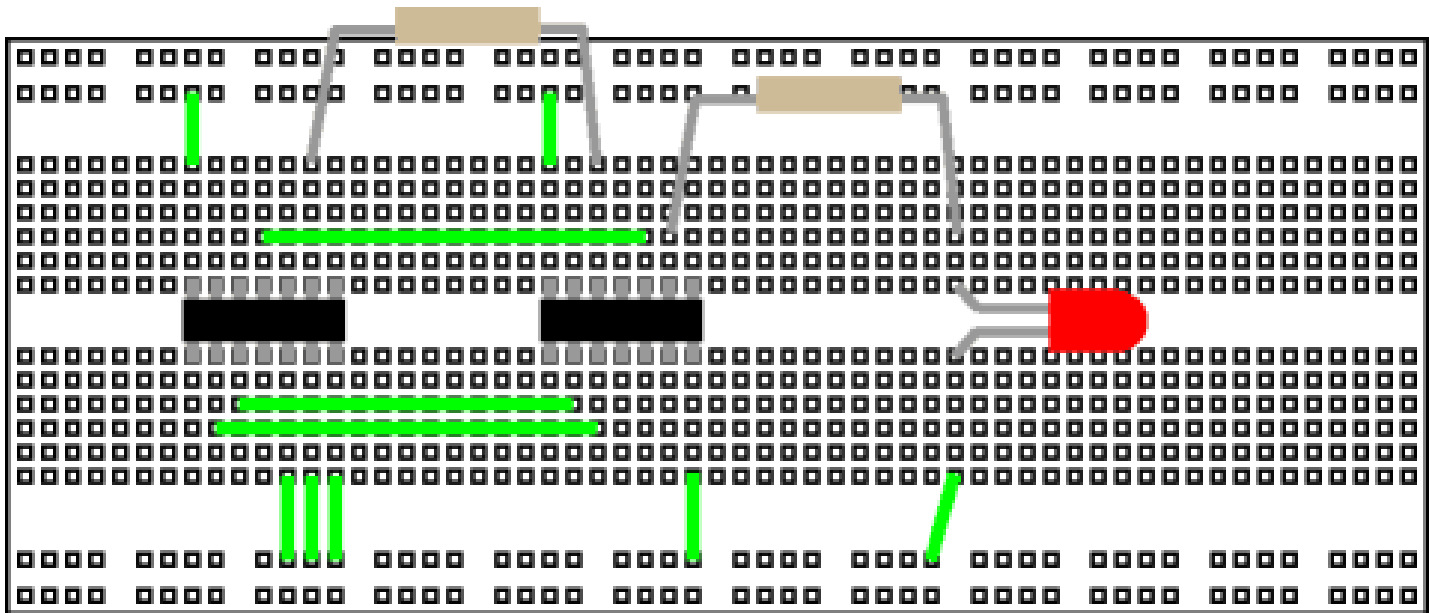
(an illustration only)

Task 2: Logic Gates

- Test each of the logic IC using LEDs and wires (for input to either 5V or 0)
  - Draw the truth table for each gate in each IC
    - this will verify the IC function and pin layout

inputs (to 5V or 0V)

(an illustration only)

Task 3: Simple Logic Circuit

- Implement (draw the circuit diagram) and construct (connect) the following circuit on the breadboard and derive their truth table practically
  - F = B'D' + BD
  - F = (B'+D)(B+D')
  - F' = BC' + AC'D +A'CD + A'BC