Experiment 1

Introduction of Digital IC and Equipments

OBJECTIVE

To familiarize with equipment and ICs used in digital electronics laboratory.

INTRODUCTION

Digital electronics is a branch of electronics which deals with arithmetic of digits, design of digital and logic circuits. To control and process various systems, digital circuits are mostly used. The term digit is derived from the digits. So, the systems, whose operation is based on digits, are categorized as digital system. Digital electronics involves the passage of electronic pulses along logic circuits.

DIGITAL INTEGRATED CIRCUITS (IC)

The word ‘integration’ signifies the collection of millions of electronic components and devices on a single chip. The integrated circuit is also abbreviated as an IC.

LEVEL OF INTEGRATION

Logic gates and memory devices are fabricated as integrated circuits (IC). With the advancement in technology, the level of integration enhances. The various active or passive components are interconnected within the chip, to form a digital circuit. The chip is mounted on the metal or plastic package, the connections are welded externally to form an IC.

Now a days, cost, size and speed are the main constraints of a designer and manufacturer. So, the number of components per chip is enhancing on the accelerating ratio. The table 1.1 shows the various level of integration, for an integrated circuit.

Table 1.1 IC Integration Level

Level of integration	Number of gates/chips
Small Scale Integration (SSI)	<12
Medium Scale Integration (MSI)	12-99
Large Scale Integration (LSI)	1000
Very Large Scale Integration (VLSI)	10k
Ultra Large Scale Integration (ULSI)	100k
Giga Scale Integration (GSI)	1 Meg

The logic gates IC is under SSI, combinational logic circuits are part of MSI and microprocessor is the part of LSI and VLSI level.

NOMENCLATURE OF IC

The manufacturer of integrated circuits, follow a standard numbering scheme, in which suffix, middle and prefix parts have some significance. For example, 7400 series IC and its derivatives are shown in fig.1.1.

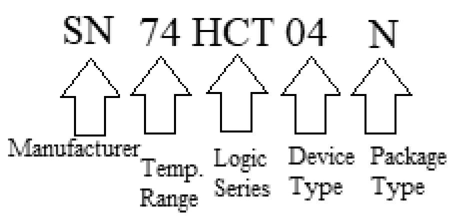

Fig. 1.1 IC number SN74HCT04N

Significance of IC number:

- **(a)** ***Manufacturer:*** This code consists of two alphabets e.g. SN is used for Texas instruments, HEF for Mullard/Philips, DM for National semiconductors and S for Signetics.
- **(b)** ***Temperature range:*** This code consists of two numeric. 74 signifies temperature range 0-70^{o}C commercial, 54 military –55 to 125 ^{o}C.
- **(c)** ***Logic series:*** This signifies sub family. 7400 series are most widely used in consumer applications.
- **(d)** ***Device type:*** This indicates device type of function. For example, 04 indicates hex/inverter.
- **(e)** ***Package type:*** It signifies the package type of IC for example, N is for plastic dual in line, W is for ceramic flat pack, D surface mounted plastic package.

FEW COMMONLY USED DIGITAL IC

The commonly used digital integrated circuits are listed as in Table 1.2.

Table 1.2 Digital Circuit IC Numbers

S. No	Digital Logic	Parameter	IC/Board Number
1	Logic gates	Quad 2-input AND logic gate	7408
2		Quad 2-input OR logic gate	7432
3		NOT logic gate/hex inverter	7404
4		Quad 2-input NAND logic gate	7400
5		Quad 2-input NOR logic gate	7402
6		Quad 2-input Exclusive OR logic gate	7486
7		Quad 2-input Exclusive NOR logic gate	74266 (TTL) 4077 (CMOS)
8	Multiplexer	2:1 Multiplexer	74157
9		4:1 Multiplexer	74153
10		8:1 Multiplexer	74151
11		16:1 Multiplexer	74150
12	Demultiplexer	1:2 Demultiplexer	74LVC1G19
13		1:4 Demultiplexer	74139
14		1:8 Demultiplexer	74138
15		1:16 Demultiplexer	74154
16	Decoder	2: 4 Decoder	74155 (TTL)
17		3:8 Decoder	74137/74138
18		4:16 Decoder	74154
19		BCD to decimal decoder	7441
20		BCD to seven segment decoders	7446/7447
21	Encoder	8:3 Priority Encoder	74148
22		10:4 Priority Encoder	74147
23	Digital Comparator	4-bit magnitude Comparator	7485
24		8-bit magnitude Comparator	74682
25	Flip-flop	SR Flip-flop	74279
26		JK Flip-flop	7470
27		JK Master Slave Flip-flop	7471
28		D Flip-flop	7474/7479
29		T Flip-flop	7473 short J & K
30	Shift register	8-bit Serial-In-Serial-Out register (SISO)	7491
31		8-bit Serial-In-Parallel-Out register (SIPO)	74164
32		16-bit Parallel-in-Serial-Out register (PISO)	74674
33		4-bit Parallel-in-Parallel-Out register (PIPO)	7495
34	ADC and DAC	16-bit A/D converter	ADS5482 (TI)
35		16- bit D/A converter	DAC8728 (TI)
36	Adder & Subtractor	2-bit Full Adder	7482
37		4-bit Full Adder	7483
38		4-bit Full Subtractor	74385

Table 1.2 ***Contd…***

S. No	Digital Logic	Parameter	IC/Board Number
39	Counter	Up-down binary counter	74191
40		Up-down decade counter	74190
41		Modulo 10 counters	74416
42	Programmable Logic Devices (PLD)	Field Programmable Gate Array (FPGA)	SPARTAN 6 family, ARTIX 7 family
43		Complex Programmable Logic Device (CPLD)	ALTERA MAX 7000 series
44	Memories	16-bit RAM	7481/7484
45		64-bit RAM	7489
46		256-bit ROM	7488
47		512-bit ROM	74186 (open collector)
48		256-bit PROM with open collector output	74188
49		2048-bit PROM with open collector output	74470
50		2048-bit PROM with three state output	74471
51		1024-bit PROM with three state output	74287

Sometimes the chip manufacturer may denote the first pin by a small indented circle above the first pin of the chip. Pin 1 is often identified by a dot or a notch next to it on the chip package. Generally, an IC has four gates and each gate has two inputs and one output.

BREADBOARD

A breadboard is a device that is used to build connections of digital circuits. It is one of the most fundamental pieces when learning how to build circuits. A typical breadboard is shown as in fig. 1.2.

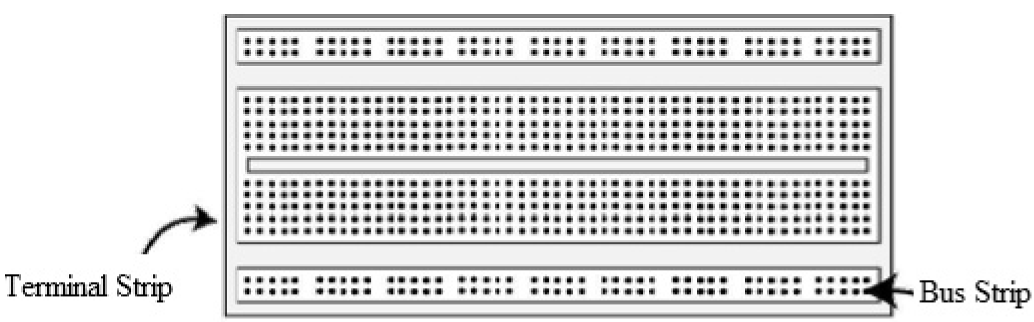

Fig. 1.2 Breadboard

Basically, the breadboard is consisted of two types of strips: terminal strip and bus strip. There is often a gap in between terminal and bus strip. Furthermore, each bus strip has two rows, each of the two rows of contacts are known as node,which are connected inside the breadboard. The bus strips are mostly used for power supply connections or in case when any node requires large number of connections.

The terminal strip is divided in two parts with a center. Each part has sixty rows and five columns. Each row of five contacts is known as node. The circuits can be built on the terminal strips by inserting the leads of circuit components into the contact receptacles and making connections with wire. It is a good practice to wire +5V and 0V power supply connections to separate bus strips.

DIGITAL IC TESTER

An Integrated Circuit tester (IC tester) is used to test Integrated Circuits (ICs). We can easily test any digital IC using this kind of an IC tester. It is necessary for the users to test the ICs before inserting them in respective project.

To test a particular digital IC, one needs to insert the IC into the IC socket and enter the IC number using the keyboard and then press the "ENTER" key. The IC number gets displayed in the 7-segment display unit.

Fig. 1.3 Digital IC Tester

If the digital IC is faulty, it will display "FAIL" and if the digital IC is in working mode then it will display "PASS". It has potential free 40 pin universal ZIF socket. There is an audio alarm which indicates the user about faulty product.

POWER SUPPLY AND GROUND

The designer should connect the circuit with +5V for power supply and 0V for ground purpose. The voltage of power supply should not be exceeded beyond 5V to avoid any damage to ICs, during the conduct of experiments.

Incorrect connection of power to the ICs could result in them exploding or becoming extremely hot, with the possible serious injury occurring to the people working on the experiment. Ensure that the power supply polarity and all components and connections are correct before switching on power.

CIRCUIT DESIGNING PROCESS

The students should follow the following steps carefully, while designing the digital circuits in the laboratory.

1. Turn the power (Trainer Kit) off before you build anything.
2. Make sure the power is off before you build anything!
3. Connect the +5V and ground (GND) leads of the power supply to the power and ground bus strips on your breadboard.
4. Connect the components and ICs on the breadboard. Point all the ICs in the same direction with pin 1 at the upper-left corner.
5. Connect +5V and GND pins of each IC to the power and ground bus strips on the breadboard.
6. Select a connection on your schematic and place a piece of hook-up wire between corresponding pins of the ICs on your breadboard. It is better to make the short connections before the longer ones. Mark each connection on your schematic as you go, so as not to try to make the same connection again at a later stage.
7. Check the connections, before you turn the power on.
8. If an error is made and is not spotted before you turn the power on. Turn the power off immediately before you begin to rewire the circuit.

POST EXPERIMENT PROCESS

1. At the end of the laboratory session, remove the wires, ICs and all equipment and return them to the instructor.
2. Tidy the area that you were working in and leave it in the same condition as it was before you started.
3. In case, any equipment of IC has damaged during the experiment, do not put the faulty pieces in the equipment box. Convey the instructor about the same.

COMMON ERRORS

1. Not connecting the ground and/or power pins for all chips.
2. Not turning on the power supply before checking the operation of the circuit.

3. Loose connections.
4. Plugging wires into the wrong holes.
5. Driving a single gate input with the outputs of two or more gates.
6. Modifying the circuit with the power on.
7. Use of faulty equipment and ICs.
8. Use of wrong IC or component.