Introduction to Logic Families

This handout will introduce the basic concepts related to digital circuit devices (integrated circuits). A digital integrated circuit consists of transistors, resistors, and capacitors that are configured to perform a certain logic function. Such functions include **AND,OR, INVERT, NAND, NOR, EXCLUSINE-OR, EXCLUSIBE-NOR, FLIP/FLOPS,COUNTERS, DECODERS, MULTIPLEXORS, MEMORY, LINE DRIVERS**, etc.

A digital logic circuit is described by using standard logic symbols, truth tables, Boolean equations, timing and delay parameters, voltage and current requirements, and package configurations. For example a 7486 device (which is an exclusive-or logic block) can be described using Table 1 given as:

1A(input)	1B(input)	1Y(output)
0	0	0
0	1	1
1	0	1
1	1	0

Table 1 - Truth Table for Exclusive-Or Gate

The logical symbol of the exclusive-or gate is shown in Figure 1.

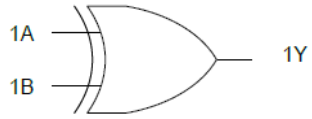

Figure 1 - Symbol of Exclusive-Or Gate

The following equation gives the Boolean relationship between the gate's inputs (1A, 1b) and output (1Y)

$$1Y = \overline{1A} \bullet 1B + 1A \bullet \overline{1B}$$

The relationship between the exclusive-or logic gate and how the symbol's inputs and output are assigned to package pin numbers is shown in Figure 2

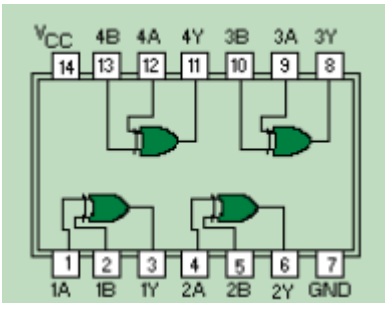

Figure 2

For example, input 1A is assigned to pin 1, 1B to pin 2, and 1Y to pin 3.

Logic families are groups of logic circuits that are based on particular types of elements (resistors, transistors, and so forth). Logic circuits are manufactured as integrated circuits and packaged in dual-inline packages (DIP), modified transistor outlines (TO), quad flat packs (QFP), ball grid array (BGA), pin grid array (PGA), small outline integrated circuit (SOIC), leadless chip carrier (LCC), etc.

Circuitry in a package is normally shown using standard logic symbols instead of individual components such as transistors, diodes, and so forth. See Figure 2 which shows an example of a DIP package with four gates. The numbered blocks labeled 1-14 are the pins on the package. Circuit packages are also identified by a manufacturer's part number printed on the top of the package. Similar circuits produced by different manufacturers will not carry the same identification numbers in all cases. Integrated circuits have been traditionally classified by the number of gates it takes to implement the desired functionality.

Table 2 shows a classification by complexity and approximate number of gates as well as some examples for each class listed.

Complexity	Number of Gates	Example
Small Scale Integration (SSI)	Fewer than 12	Basic gates
Medium Scale Integration (MSI)	12 to 99	Flip-Flops, Registers
Large Scale Integration (LSI)	100-9999	Memories
Very Large Scale Integration (VLSI)	10,000-99,999	Simple 8 bit Microprocessors
Ultra Large Scale Integration (ULSI)	100,000 or more	Advanced Microprocessors

Table 2 – Logic Device Complexity

Table 3 lists the family of logic devices in the TTL series. For example the exclusive-or device would have a part number of 7486 in the standard series, 74L86 in the low power series, 74S86 in the Schottky series, 74LS86 in the low-power Schottky series, etc.

TTL Series	Prefix	Example	
Standard TTL	74	7400	Oldest, slowest, most power hungry member of the TTL Family (Obsolete)
Low Power TTL	74L	74L00	Old, but optimized to consume less power than the “Standard” TTL (obsolete)
Schottky TTL	74S	74S00	Old, but optimized for speed. Consumes too much power (obsolete)
Low-Power Schottky TTL	74LS	74LS00	Faster and lower power than the subfamilies listed above (obsolete)
Advanced S TTL	74AS	74AS00	Very fast, but is quite power hungry
Advanced LS TTL	74ALS	74ALS00	Very good speed-power ratio. Still a popular member of the TTL family
FAST TTL	74F	74F00	Fairchild’s fast TTL family. Excellent speed-power ratio product

Table 2 – Logic Device Complexity

Figure 3 shows a logic gate symbol, package configuration, and geometry of a 14 pin DIP package. Most 14 pin DIP packages conform to this standard geometry so they can easily be mounted in a standard socket or printed circuit board (PCB) layout.

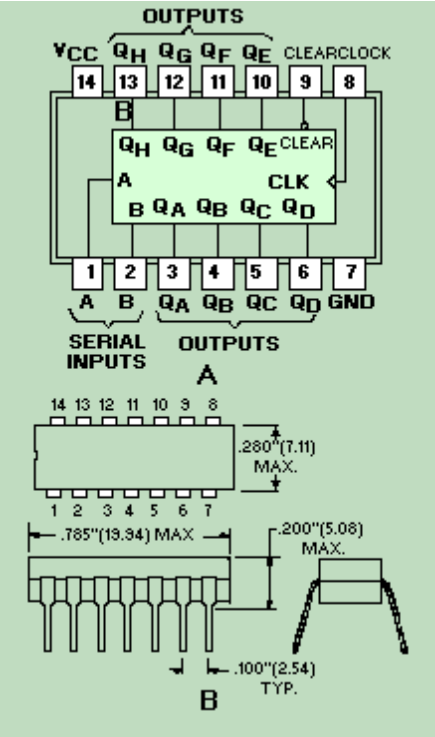

Figure 3 – Package Configuration Specification

Detailed descriptions of all devices in a logic family are available in logic books and on manufactures' web sites. Manufactures of SSI logic gates include Texas Instruments, Fairchild Semiconductor, and National Semiconductor.