Appendix C Working with Binary and Hexadecimal Numbers

The Decimal Number System

The decimal system is the base-10 system that you use every day. A number in this system--for example, 342--is expressed as powers of 10. The first digit (counting from the right) gives 10 to the 0 power, the second digit gives 10 to the 1 power, and so on. Any number to the 0 power equals 1, and any number to the 1 power equals itself. Thus, continuing with the example of 342, you have:

3	$3 * 10^2 = 3 * 100 = 300$
4	$4 * 10^1 = 4 * 10 = 40$
2	$2 * 10^0 = 2 * 1 = 2$
	Sum = 342

The base-10 system requires 10 different digits, 0 through 9. The following rules apply to base 10 and to any other base number system:

- A number is represented as powers of the system's base.
- The system of base *n* requires *n* different digits.

Now let's look at the other number systems.

The Binary System

The binary number system is base 2 and therefore requires only two digits, 0 and 1. The binary system is useful for computer programmers, because it can be used to represent the digital on/off method in which computer chips and memory work. Here's an example of a binary number and its representation in the decimal notation you're more familiar with, writing 1011 vertically:

1	$1 * 2^3 = 1 * 8 = 8$
0	$0 * 2^2 = 0 * 4 = 0$
1	$1 * 2^1 = 1 * 2 = 2$
1	$1 * 2^0 = 1 * 1 = 1$
	Sum = 11 (decimal)

Binary has one shortcoming: It's cumbersome for representing large numbers.

The Hexadecimal System

The hexadecimal system is base 16. Therefore, it requires 16 digits. The digits 0 through 9 are used, along with the letters A through F, which represent the decimal values 10 through 15. Here is an example of a hexadecimal number and its decimal equivalent:

2	$2 * 16^2 = 2 * 256 = 512$
D	$13 * 16^1 = 13 * 16 = 208$
A	$10 * 16^0 = 10 * 1 = 10$
	Sum = 730 (decimal)

The hexadecimal system (often called the *hex* system) is useful in computer work because it's based on powers of 2. Each digit in the hex system is equivalent to a four-digit binary number, and each two-digit hex number is equivalent to an eight-digit binary number. Table C.1 shows some hex/decimal/binary equivalents.

Table C.1. Hexadecimal numbers and their decimal and binary equivalents.

Hexadecimal Digit	Decimal Equivalent	Binary Equivalent
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
A	10	1010
B	11	1011
C	12	1100
D	13	1101
E	14	1110
F	15	1111
10	16	10000
F0	240	11110000
FF	255	11111111