

2.3 NUMBER CONVERSIONS

The binary number system is the most important one in digital systems as it is very easy to implement in circuitry. The decimal system is important because it is universally used to represent quantities outside a digital system.

In addition to binary and decimal, octal and hexadecimal number systems find widespread application in digital systems. These number systems (octal and hexadecimal) provide an efficient means for representing large binary numbers. As we shall see, both these number systems have the advantage that they can be easily converted to and from binary.

Table 2.2 Powers of 2

2^n	n	2^{-n}
1	0	1.0
2	1	0.5
4	2	0.25
8	3	0.125
16	4	0.0625
32	5	0.03125
64	6	0.015625
128	7	0.0078125
256	8	0.00390625
512	9	0.001953125
1024	10	0.0009765625
2048	11	0.00048828125
4096	12	0.000244140625
8192	13	0.0001220703125
16384	14	0.00006103515625
32768	15	0.000030517578125
65536	16	0.0000152587890625
131072	17	0.00000762939453125
262144	18	0.000003814697265625
524288	19	0.0000019073486328125
1048576	20	0.00000095367431640625
2097152	21	0.000000476837158203125
4194304	22	0.0000002384185791015625
8388608	23	0.00000011920928955078125
16777216	24	0.000000059604644775390625
33554432	25	0.0000000298023223876953125
67108864	26	0.00000001490116119384765625
134217728	27	0.000000007450580596923828125
268435456	28	0.0000000037252902984619140625
536870912	29	0.00000000186264514923095703125
1073741824	30	0.000000000931322574615478515625
2147483648	31	0.0000000004656612873077392578125
4294967296	32	0.00000000023283064365386962890625
8589934592	33	0.000000000116415321826934814453125
17179869184	34	0.0000000000582076609134874072265625
34359738368	35	0.00000000002910383045673370361328125
68719476736	36	0.000000000014551915228366851806640625

In a digital system, three or four of these number systems may be in use at the same time, so that an understanding of the system operation requires the ability to convert from one number system to another. This section discusses how to perform these conversions. So, let us discuss them one by one.

2.3.1 Decimal-to-Binary Conversion

There are two procedures for converting (integers) from decimal to binary.

The first method requires a table of powers of 2 (table 2.2). Because of this restriction, it is more useful for small numbers where these powers have been memorized. Starting with the decimal number to be evaluated, obtain the largest power of 2 from the table without exceeding the original number. Record this. Then subtract the table obtained number from the original number. Repeat the process for the remainder, and continue until the remainder is zero. Finally, add the binary numbers obtained from the table. The result is the answer.