# VEDIC MATHEMATICS IN THE BINARY NUMBER SYSTEM

**Kuldeep Singh**

**Abstract**

We will understand the benefits of implementing Vedic Maths into the Binary Number System. In today's digital life binary number calculations are present in almost every electronic device we use. By applying the methods of Vedic Mathematics we can reach much faster processing speeds. This paper explores various Vedic calculating procedures as applied to base-2 arithmetic.

**Objectives**

- Understanding the benefits of implementing Vedic Maths in Binary Number System
- How can we use Vedic Maths in Binary Number System
- Understanding different methods of VM and implementing these methods into Binary Numbers

**Understanding Binary Numbers**

In the decimal number system we use 10 different symbols to represent 10 different values. These symbols are:

0, 1, 2, 3, 4, 5, 6, 7, 8 and 9

In the binary number system we use only 2 symbols to represent 2 different values. These symbols are:

0 and 1 (to represent two different states i.e., Off and On.)

**Place Value in Decimal System (Base 10)**

In base 10 the value of each digit is a multiple of a power of 10 according to position.

**Example** 7493

$$
\begin{aligned}
& 7\times10^3+4\times10^2+9\times10^1+3\times10^0 \\
= & 7\times1000+4\times100+9\times10+3\times1
\end{aligned}
$$

**Place Value in Binary System (Base 2)**

Similarly, in base 2 the value of each digit is according to position but as multiples of powers of 2.

**Example** 1101

$$
\begin{aligned}
& 1\times2^3+1\times2^2+0\times2^1+1\times2^0 \\
= & 8 + 4 + 0 + 1 = 13
\end{aligned}
$$

## Binary System In Our Daily Life

The binary system is in common use throughout digital technology. Calculations in computer processors are done using binary.

We see GB memory within PCs, tablets, and mobiles allocated in terms of base 2, such as 1, 2, 4, 8, 16, 32, 64, 128 GB, and so on.

Interestingly, prior to June 1964, subdivisions of the Indian Rupee were based on powers of 2.

| | | | |
|---|---|---|---|
| One Rupee | = | 2 Athanni | ($2^1$) |
| One Rupee | = | 4 Chawanni | ($2^2$) |
| One Rupee | = | 8 Dawanni | ($2^3$) |
| One Rupee | = | 16 Annas | ($2^4$) |
| One Rupee | = | 32 Taka | ($2^5$) |
| One Rupee | = | 64 Paise | ($2^6$) |
| One Rupee | = | 128 Dhela | ($2^7$) |
| One Rupee | = | 256 Damari | ($2^8$) |

## Benefits of Implementing VM in Binary Number System

Some of the benefits of applying Vedic mathematic techniques to base-2 arithmetic are as follows:

- ALU (Arithmetic Logic Unit) of a processor can process 15 to 20 times faster,
- The processing speed will enhance significantly in real time applications like aviation and weather forecasting,
- Technology will be 8-10 years ahead with VM (Technology will double in every 2 years – Moore's law)

## Implementing Vedic Mathematics In Binary Number System:

Most of the Vedic methods can be used in the binary system. This paper will consider the following four Vedic techniques in binary:

- All from nine and last from ten
- Vertically and crosswise for multiplication
- Duplex method of squaring
- Base method of squaring

## All from nine and last from ten

The complement of a number is found by subtracting each digit from 9 and the last from 10. Examples are shown below.

100 – 87 = 13 (9 - 8 and 10 - 3)

1000 – 564 = 436 (9 - 5, 9 - 6 and 10 - 4)

10000 – 8375 = 1625 (9 - 8, 9 - 3, 9 - 7 and 10 - 5)

In binary the rule becomes, *All from 1 and the last from 10* (2).

| Binary | Decimal equivalent |
|---|---|
| 1000 – 101 = 011 (1 - 1, 1 - 0 and 10 - 1) | 8 - 5 = 3 |
| 10000 – 0111 = 1001 (1 - 0, 1 - 1, 1 - 1 and 10 - 1) | 16 – 7 = 9 |
| 100000 – 10011 = 01101 (1 - 1, 1 - 0,1 - 0, 1 - 1 and 10 - 1) | 32 – 19 = 13 |

**Vertically and Crosswise**

In base-10, each digit in the multiplicand is multiplied by each number in the multiplier and the sums are found mentally. For example,

$$\begin{array}{r} 5\ 0\ 2 \\ \times\ 7\ 1\ 3 \\ \hline 355_{2}926 \end{array}$$

Exactly the same procedure is used in binary as shown in the examples below.

$3\times 2 = 11\times 10$

$$\begin{array}{rl} 1\ 1 & (3) \\ \times\ 1\ 0 & (2) \\ \hline 110 & (6) \end{array}$$

$6\times 5 = 110\times 101$

$$\begin{array}{rl} 1\ 1\ 0 & (6) \\ \times\ 1\ 0\ 1 & (5) \\ \hline 1\,1\,1\,1\,0 & (30) \end{array}$$

$6\times 7 = 110\times 111$

$$\begin{array}{rl} 1\ 1\ 0 & (6) \\ \times\ 1\ 1\ 1 & (7) \\ \hline 10\,{}_{1}1\,{}_{1}010 & (42) \end{array}$$

$22\times 25 = 10110\times 11001$

$$\begin{array}{rl} 1\ 0\ 1\ 1\ 0 & (22) \\ \times\quad 1\ 1\ 0\ 0\ 1 & (25) \\ \hline 10\,{}_{1}0\,{}_{1}0\,{}_{1}1\,{}_{1}00110 & (550) \end{array}$$

$7\times 7 = 111\times 111$

$$\begin{array}{rl} 1\ 1\ 1 & (7) \\ \times\quad 1\ 1\ 1 & (7) \\ \hline 1\,1\,{}_{10}0\,{}_{10}0\,{}_{1}0\,1 & (49) \end{array}$$

$7\times 7$ can more easily be done using vinculums since $111 = 100\bar{1}$.

$$\begin{array}{rl} 1\ 0\ 0\ \bar{1} & (7) \\ \times\ 1\ 0\ 0\ \bar{1} & (7) \\ \hline 1\ 0\ {}_{\bar{1}}0\ 0\ 0\ 1 & (49) \\ \hline 1\ 1\ 0\ 0\ 0\ 1 & \end{array}$$

**Duplex Method of Squaring**

Straight squaring in the decimal system is a condencement of *Vertically and crosswise*. For example,

$$\begin{array}{c} \underline{23^2} \\ 529 \end{array}$$

Here are examples in base-2.

$$\frac{1\ \ 1^2}{1\,0\,_1 0\,1}\qquad\qquad \frac{1\ 0\ 1\ 1^2}{1\,1_1 1_1 1\,_1 0\,_1 0\,1}\quad \begin{array}{l}(11)\\(121)\end{array}$$

**Base Method of Squaring**

Using *All from 9 and last from 10* together with the *Yavadunam* sub-sutra, this is done mentally.

Below the base

$$\frac{98^2}{9604}$$

Above the base

$$\frac{106^2}{11236}$$

The same method can be used in binary as shown in the following examples:

Below the base

$$\frac{1\ 1\ 1\ 1 - 0\ 0\ 0\ 1}{1\ 1\ 1\ 0\ \ 0\ 0\ 0\ 1}\quad \begin{array}{l}(15)\\(225)\end{array}$$

Above the base

$$\frac{1\ 0\ 0\ 1 + 0\ 0\ 1}{1\ 0\ 1\ 0\ \ 0\ 0\ 1}\quad \begin{array}{l}(9)\\(81)\end{array}$$

**Conclusion**

This paper shows that Vedic maths can easily be used for binary operations. The binary system is used in almost every computer device but these technological devices are using conventional maths at the implementation part of ALU (Arithmetic and Logic Unit). Using Vedic maths methods instead of conventional methods could help speed up computer processing.

**References**


[1] Bharati Krishna Tirthaji Maharaja, (1994). Vedic Mathematics. Delhi: Motilal Banarasidas

[2] Kenneth R Williams, (2006). Discover Vedic Mathematics. Delhi: Motilal Banarasida

[3] M.Morris Mano, (2004). Digital Logic and Computer Design. Pearson