Three, Four, Five, Six, Seven, Nine And Thirty Two Number Systems in Digital Electronics

Dussa Sudha Mohan

Asst. Professor, Vidya bharathi institute of technology and sciences Pembarthi, Jangaon

Abstract- **Number system is a basis for counting various items. On hearing the word "number", all of us immediately think of the familiar decimal number system with its '10' digits: 0,1,2,3,4,5,6,7,8 and 9.**

Modern computers communicate and operate with binary numbers [combination of 0's and 1's]. Let us consider decimal number '08'. This number is represented in binary as '1000'. In the example, if decimal number is considered, we require only 'two digits' to represent the number, whereas if binary number is considered we required 'four digits. Therefore, we can say that, when decimal numbers are represented in the binary form, they take more digits. For large decimal numbers peoples have to deal with very large binary strings and therefore, they do not like working with binary numbers. This fact gave rise to three number systems: Octal, Hexadecimal and Binary Coded Decimal (BCD). These number systems represent binary numbers in a compressed form. Therefore, these systems are now widely used to compress large strings of binary numbers.

In this article, I introduce the new number systems such as three, four and five, six, seven, nine and thirty-two number systems.

Index Terms- **Computers, decimal numbers, Octal, Hexadecimal and Binary Coded Decimal (BCD).**

INTRODUCTION

Three means "three numbers". The three number system uses only "three" symbols [numbers]. They are "0", "1" and "2". Hence, the radix [base] of the three number system is "3".

Decimal number	Three number system
0	0
1	1
2	2
3	10
4	11
5	12
6	20
7	21
8	22
9	100
10	101
11	102
12	110
13	111
14	112
15	120
16	121
17	122
18	200
19	201
20	202

Conversation of three number system into decimal number system:

Procedure:

If a three system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(112)_3 = ()_{10}$

Solution:

1	1	2
3^2 [9]	3^1 [3]	3^0 [1]
1X9	1X3	2X1
9	3	2

$(14)_{10}$

Example-2:

$(100)_3 = ()_{10}$

Solution:

1	0	0
3^2 [9]	3^1 [3]	3^0 [1]
1X9	0X3	0X1
9	0	0

$(9)_{10}$

Example-3:

$(200)_3 = ()_{10}$

Solution:

2	0	0
3^2 [9]	3^1 [3]	3^0 [1]
2X9	0X3	0X1
18	0	0

$(18)_{10}$

Example-4:

$(201)_3 = ()_{10}$

Solution:

2	0	1
3^2 [9]	3^1 [3]	3^0 [1]
2X9	0X3	1X1
18	0	1

$(19)_{10}$

Conversation of decimal number system into three number system:

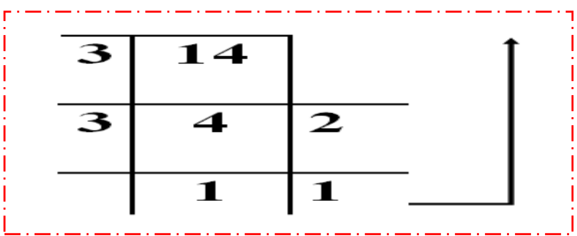
Procedure:

For converting decimal number into three number system, divide the decimal number by '3', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the three number system.

Example-1:

$(14)_{10} = ()_3$

Solution:

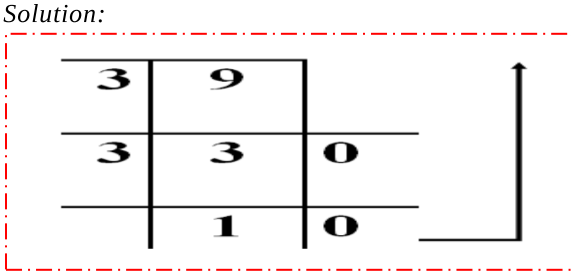


$(112)_3$

Example-2:

$(9)_{10} = ()_3$

Solution:

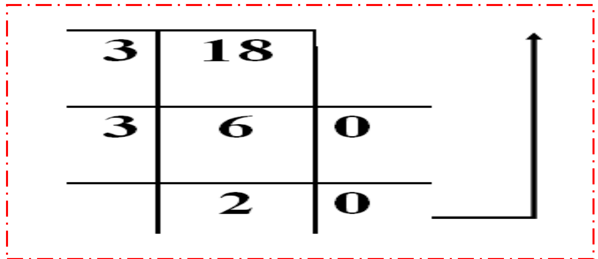


$(100)_3$

Example-3:

$(18)_{10} = ()_3$

Solution:

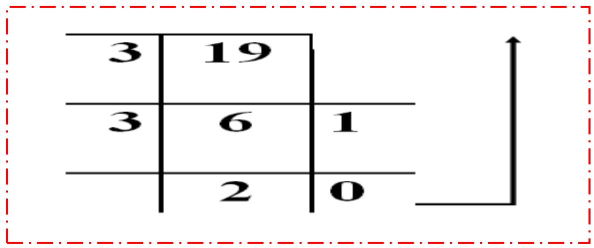


$(200)_3$

Example-4:

$(19)_{10} = ()_3$

Solution:



$(201)_3$

Four number system:

Four means "four numbers". The four number system uses only "four" symbols [numbers]. They are "0", "1", "2" and "3". Hence, the radix [base] of the four number system is "4".

Decimal number	Three number system
0	0
1	1
2	2
3	3
4	10
5	11
6	12
7	13
8	20
9	21
10	22
11	23
12	30
13	31
14	32
15	33
16	100
17	101

18	102
19	103
20	110

Conversation of four number system into decimal number system:

Procedure:

If a four system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(112)_4 = ()_{10}$

Solution:

1	1	2
4^2 [16]	4^1 [4]	4^0 [1]
1X16	1X4	2X1
16	4	2

$(22)_{10}$

Example-2:

$(100)_4 = ()_{10}$

Solution:

1	0	0
4^2 [16]	4^1 [4]	4^0 [1]
1X16	0X4	0X1
16	0	0

$(16)_{10}$

Example-3:

$(200)_4 = ()_{10}$

Solution:

2	0	0
4^2 [16]	4^1 [4]	4^0 [1]
2X16	0X4	0X1
32	0	0

$(32)_{10}$

Example-4:

$(110)_4 = ()_{10}$

Solution:

1	1	0
4^2 [16]	4^1 [4]	4^0 [1]
1X16	1X4	2X1
16	4	0

$(20)_{10}$

Conversation of decimal number system into four number system:

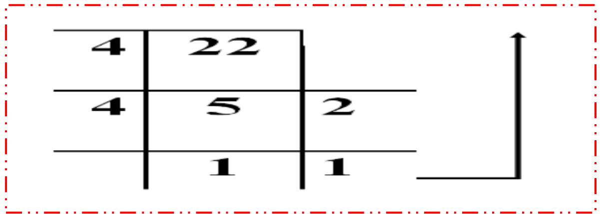
Procedure:

For converting decimal number into four number system, divide the decimal number by '4', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the four number system.

Example-1:

$(22)_{10} = ()_4$

Solution:

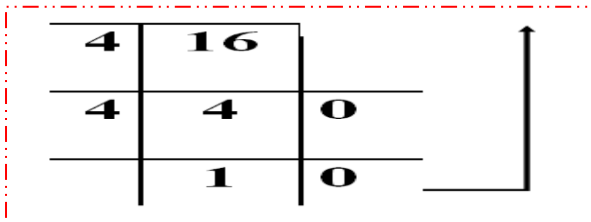


$(112)_4$

Example-2:

$(16)_{10} = ()_4$

Solution:

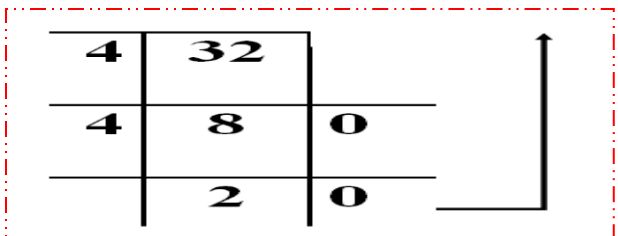


$(100)_4$

Example-3:

$(32)_{10} = ()_4$

Solution:

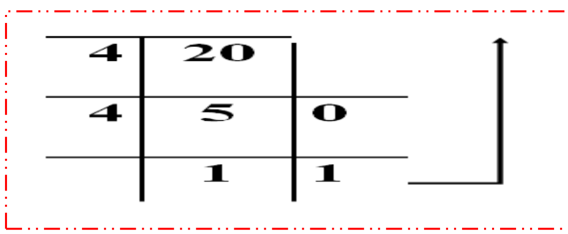


$(200)_4$

Example-4:

$(20)_{10} = ()_4$

Solution:



$(110)_4$

Five number system:

Five means "five numbers". The five number system uses only "five" symbols [numbers]. They are "0", "1", "2", "3" and "4". Hence, the radix [base] of the five number system is "5".

Decimal number	Three number system
0	0
1	1
2	2
3	3
4	4
5	10
6	11
7	12
8	13
9	14
10	20
11	21
12	22
13	23
14	24
15	30
16	31
17	32
18	33
19	34
20	40

Conversation of five number system into decimal number system:

Procedure:

If a five system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(32)_5 = ()_{10}$

Solution:

3 2
5^1 [5] 5^0 [1]
3X5 2X1
15 2
$(17)_{10}$

Example-2:

$(100)_5 = ()_{10}$

Solution:

1 0 0
5^2 [25] 5^1 [5] 5^0 [1]
1X25 0X5 0X1
25 0 0
$(25)_{10}$

Example-3:

$(10)_5 = ()_{10}$

Solution:

1 0
5^1 [5] 5^0 [1]
1X5 0X1
5 0
$(5)_{10}$

Example-4:

$(110)_5 = ()_{10}$

Solution:

1 1 0
5^2 [25] 5^1 [5] 5^0 [1]
1X25 1X5 0X1
25 5 0
$(30)_{10}$

Conversation of decimal number system into five number system:

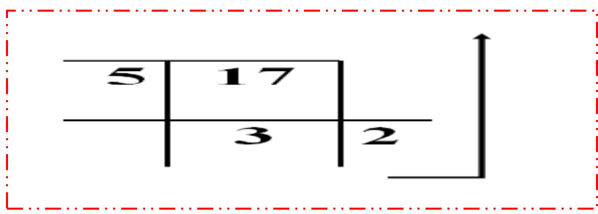
Procedure:

For converting decimal number into five number system, divide the decimal number by '5', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the five number system.

Example-1:

$(17)_{10} = ()_5$

Solution:

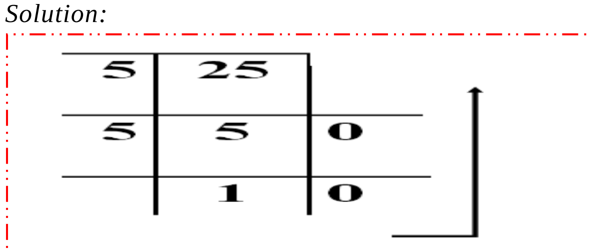


$(32)_5$

Example-2:

$(25)_{10} = ()_5$

Solution:

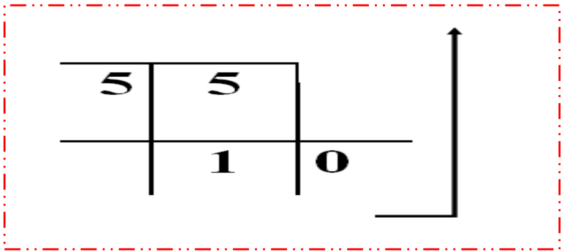


$(100)_5$

Example-3:

$(5)_{10} = ()_5$

Solution:

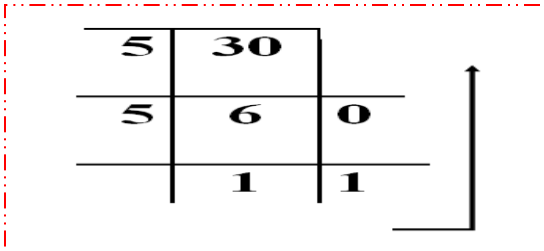


$(10)_5$

Example-4:

$(30)_{10} = ()_5$

Solution:



$(110)_5$

Six number system:

Six means "six numbers". The six number system uses only "six" symbols [numbers]. They are "0", "1", "2", "3", "4" and "5". Hence, the radix [base] of the six number system is "6".

Decimal number	Six number system
0	0
1	1
2	2
3	3
4	4
5	5
6	10
7	11
8	12
9	13
10	14
11	15
12	20
13	21
14	22
15	23
16	24
17	25
18	30
19	31
20	32

Conversation of six number system into decimal number system:

Procedure:

If a six system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(030)_6 = ()_{10}$

Solution:

0	3	0
6^2 [36]	6^1 [6]	6^0 [1]
0X36	3X6	0X1
0	18	0

$(18)_{10}$

Example-2:

$(100)_6 = ()_{10}$

Solution:

1	0	0
6^2 [36]	6^1 [6]	6^0 [1]
1X36	0X6	0X1
36	0	0

$(36)_{10}$

Example-3:

$(200)_6 = ()_{10}$

Solution:

2	0	0
6^2 [36]	6^1 [6]	6^0 [1]
2X36	0X6	0X1
72	0	0

$(72)_{10}$

Example-4:

$(102)_6 = ()_{10}$

Solution:

1	0	2
6^2 [36]	6^1 [6]	6^0 [1]
1X36	0X6	2X1
36	0	2

$(38)_{10}$

Conversation of decimal number system into six number system:

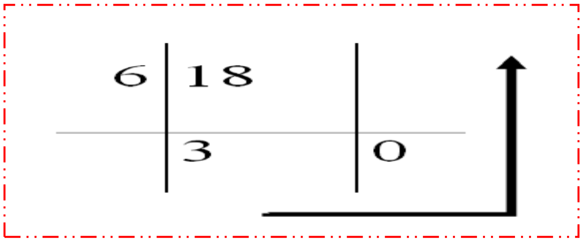
Procedure:

For converting decimal number into six number system, divide the decimal number by '6', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the six number system.

Example-1:

$(18)_{10} = ()_6$

Solution:

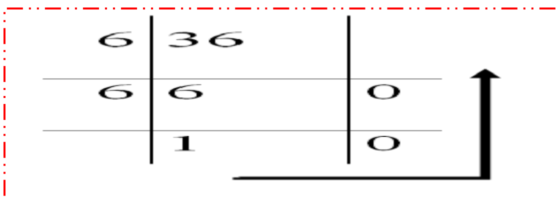


$(30)_6$

Example-2:

$(36)_{10} = ()_6$

Solution:

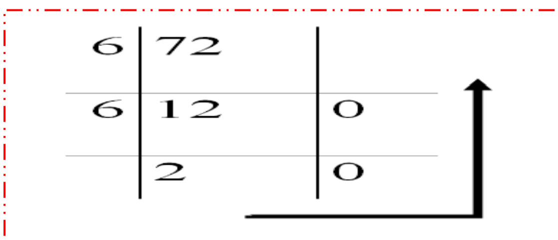


$(100)_6$

Example-3:

$(72)_{10} = ()_6$

Solution:

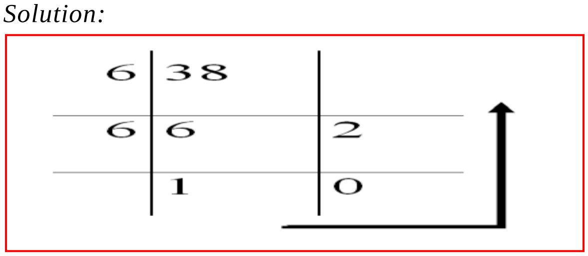


$(200)_6$

Example-4:

$(38)_{10} = ()_6$

Solution:



$(102)_6$

Seven number system:

Seven means "seven numbers". The seven number system uses only "seven" symbols [numbers]. They are "0", "1", "2", "3", "4", "5" and "6". Hence, the radix [base] of the seven number system is "7".

Decimal number	Seven number system
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	10
8	11
9	12
10	13
11	14
12	15
13	16
14	20
15	21
16	22
17	23
18	24
19	25
20	26

Conversation of seven number system into decimal number system:

Procedure:

If a seven system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(15)_7 = ()_{10}$

Solution:

0	1	5
7^2 [49]	7^1 [7]	7^0 [1]
0X49	1X7	5X1
0	7	5

$(12)_{10}$

Example-2:

$(23)_7 = ()_{10}$

Solution:

0	2	3
7^2 [49]	7^1 [7]	7^0 [1]
0X49	2X7	3X1
0	14	3

$(17)_{10}$

Example-3:

$(26)_7 = ()_{10}$

Solution:

0	2	6
7^2 [49]	7^1 [7]	7^0 [1]
0X49	2X7	6X1
0	14	6

$(20)_{10}$

Example-4:

$(102)_7 = ()_{10}$

Solution:

1	2	0
7^2 [49]	7^1 [7]	7^0 [1]
1X49	2X7	0X1
49	14	0

$(63)_{10}$

Conversation of decimal number system into seven number system:

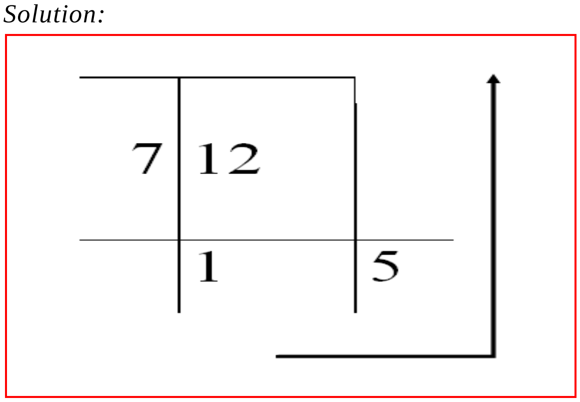
Procedure:

For converting decimal number into seven number system, divide the decimal number by '7', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the seven number system.

Example-1:

$(12)_{10} = ()_7$

Solution:

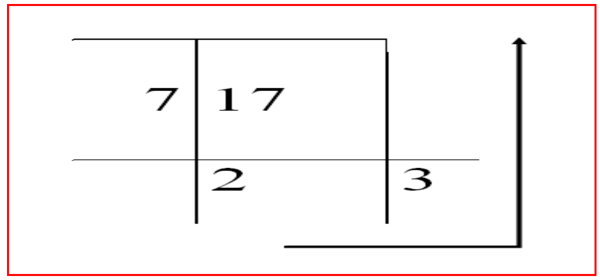


$(15)_7$

Example-2:

$(17)_{10} = ()_7$

Solution:

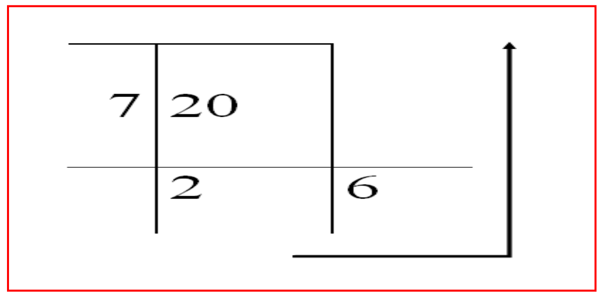


$(23)_7$

Example-3:

$(20)_{10} = ()_7$

Solution:

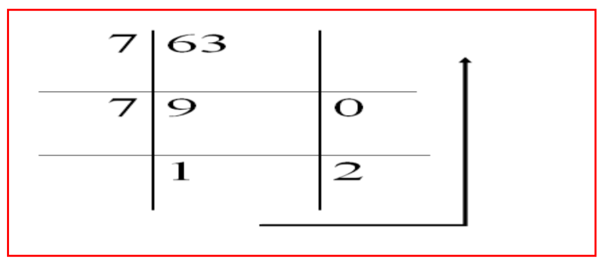


$(26)_7$

Example-4:

$(63)_{10} = ()_7$

Solution:



$(120)_7$

Nine number system:

Nine means "nine numbers". The nine number system uses only "nine" symbols [numbers]. They are "0", "1", "2", "3", "4", "5", "6", "7" and "8". Hence, the radix [base] of the nine number system is "9".

Decimal number	Six number system
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7

8	8
9	10
10	11
11	12
12	13
13	14
14	15
15	16
16	17
17	18
18	20
19	21
20	22

Conversation of nine number system into decimal number system:

Procedure:

If a nine system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(10)_9$ = () $_{10}$

Solution:

0	1	0
9^2 [81]	9^1 [9]	9^0 [1]
0X81	1X9	0X1
0	9	0

$(9)_{10}$

Example-2:

$(15)_9$ = () $_{10}$

Solution:

0	1	5
9^2 [81]	9^1 [9]	9^0 [1]
0X81	1X9	5X1
0	9	5

$(14)_{10}$

Example-3:

$(20)_9$ = () $_{10}$

Solution:

0	2	0
9^2 [81]	9^1 [9]	9^0 [1]
0X81	2X9	0X1
0	18	0

$(18)_{10}$

Example-4:

$(22)_9$ = () $_{10}$

Solution:

0	2	2
9^2 [81]	9^1 [9]	9^0 [1]
0X81	2X9	2X1
0	18	2

$(20)_{10}$

Conversation of decimal number system into nine number system:

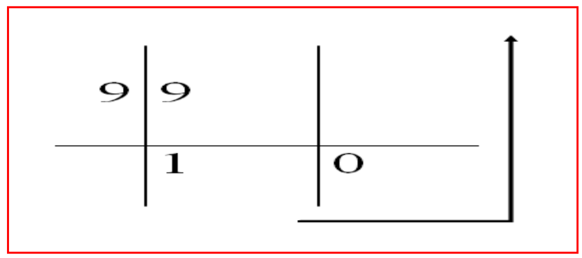
Procedure:

For converting decimal number into nine number system, divide the decimal number by '9', writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the nine number system.

Example-1:

$(9)_{10}$ = () $_9$

Solution:

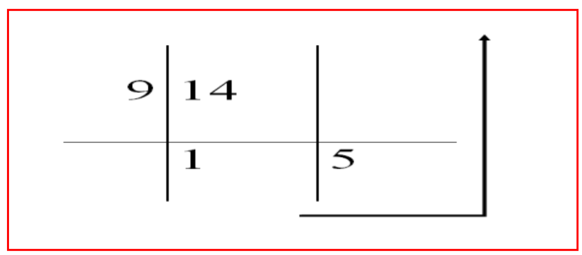


$(10)_9$

Example-2:

$(14)_{10}$ = () $_9$

Solution:



$(15)_9$

32-bit number system:

32 means "32 numbers". The 32 number system uses "32" symbols [numbers]. They are numbers "from 0 to 9" and alphabets "from A to V". Hence, the radix [base] of the 32 number system is "32".

Decimal number	32 number system	Binary values
0	0	00000
1	1	00001
2	2	00010
3	3	00011

4	4	00100
5	5	00101
6	6	00110
7	7	00111
8	8	01000
9	9	01001
10	A	01010
11	B	01011
12	C	01100
13	D	01101
14	E	01110
15	F	01111
16	G	10000
17	H	10001
18	I	10010
19	J	10011
20	K	10100
21	L	10101
22	M	10110
23	N	10111
24	O	11000
25	P	11001
26	Q	11010
27	R	11011
28	S	11100
29	T	11101
30	U	11110
31	V	11111

Conversation of 32 number system into decimal number system:

Procedure:

If a 32 system number has to be converted into decimal number, then we should multiply, the positional values of each bit with the bit value and add shown in examples 1, 2, 3 and 4.

Example-1:

$(A)_{32} = ()_{10}$

Solution:

0 0 A

32^2 [1024] 32^1 [32] 32^0 [1]

0X1024 0X32 10X1

0 0 10

$(10)_{10}$

Example-2:

$(A2)_{32} = ()_{10}$

Solution:

0 A 2

32^2 [1024] 32^1 [32] 32^0 [1]

0X1024 10X32 2X1

0 320 2

$(322)_{10}$

Example-3:

$(5A)_{32} = ()_{10}$

Solution:

0 5 A

32^2 [1024] 32^1 [32] 32^0 [1]

0X1024 5X32 10X1

0 160 10

$(170)_{10}$

Example-4:

$(1EA)_{32} = ()_{10}$

Solution:

1 E A

32^2 [1024] 32^1 [32] 32^0 [1]

1X1024 14X32 10X1

1024 448 10

$(1482)_{10}$

Example-5:

$(VVV)_{32} = ()_{10}$

Solution:

31 31 31

32^2 [1024] 32^1 [32] 32^0 [1]

31X1024 31X32 31X1

1024 448 31

31744 992 31

$(32767)_{10}$

Conversation of decimal number system into four number system:

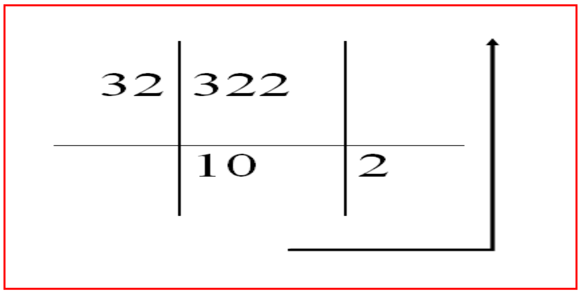
Procedure:

For converting decimal number into 32 number system, divide the decimal number by ‘32’, writing down the reminder after each division. The reminders taken in reverse order [down to up] to form the 32 number system.

Example-1:

$(322)_{10} = ()_{32}$

Solution:

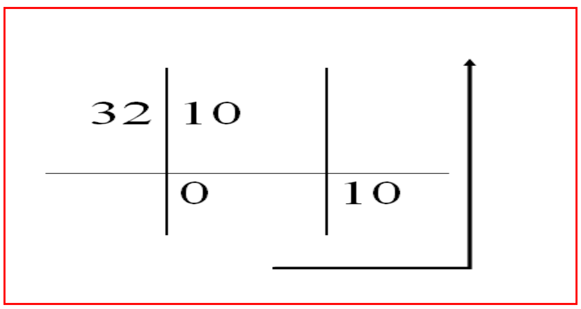


$(A2)_{32}$

Example-2:

$(32)_{10} = ()_{32}$

Solution:

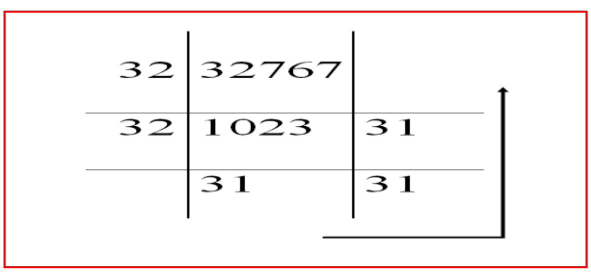


$(A)_{32}$

Example-3:

$(32767)_{10} = ()_{32}$

Solution:



$(VVV)_{4}$

CONCLUSION

- The "32-bit number system" or simply "32" numbering system uses the Base of 32 system and are a popular choice for representing long binary values because their format is quite compact and much easier to understand compared to the long binary strings of 1's and 0's.
- Being a Base-32 system, the 32-bit numbering system therefore uses 32 (thirty-two) different digits with a combination of numbers from 0 through to 31 [V]. In other words, there are 32 possible digit symbols.
- In the everyday use of the decimal numbering system we use groups of three digits or 000's from the right hand side to make a very large number such as a million or trillion, easier for us to understand and the same is also true in digital systems.
- However, there is a potential problem with using this method of digit notation caused by the fact that the decimal numerals of 10 to 31 are normally written using two adjacent symbols. For example, if we write 10 in 32 number system, do we mean the decimal number ten, or the binary number of two (1 + 0). To get around this tricky problem 32-bit system numbers that identify the values of ten, eleven, . . . , fifteen are replaced with capital letters of A to V respectively.
- Also, since 32 in the decimal system is the fourth power of 2 (or 2^5), there is a direct relationship between the numbers 2 and 32 so one 32 number system digit has a value equal to five binary digits so now V is equal to "31".

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