**+Conversions**

1. **Rapid conversions**
2. **Substitution method**
3. **Successive divisions and multiplications**
4. **Rapid conversions:** conversions between bases which are powers of2.
   1. **Conversion from the source base p=2k , p****{4=22,8=23,16=24} into the destination base 2**

**Rule**:

**Each digit from the source number in base *p*=2*k*, the integer part and the fractional one, will be replaced by the corresponding group of *k* binary digits (adding if it is necessary insignificant zeros to the left).**

* 1. **. Conversion from base 2 into the destination base q=2k** ,  **q{4=22,8=23,16=24}**

**Rules:**

* **for the *integer/fractional part*: from *right/left* to *left/right* (relative to the decimal point) make groups of *k* binary digits (eventually we add to the *left/right* insignificant zeros to have a complete group);**
* **the groups will be replaced by the corresponding digits in base *q*=2*k .***

**Example 1:**

**637,125 (8) = 110 011 111, 001 010 101 (2)**

**= 0001 1001 1111, 0010 1010 1000 (2) = 19F, 2A8 (16)**

**Example 2:**

**23122,12312 (4) = 02 31 22,12 31 20 (4)= 2DA,6D8 (16)**

**22(4)=2\*4^0 + 2\*4^1 = 2 + 8 = 10 = A(16)**

**Example 3:**

**2F8,9C (16) = 02 33 20, 21 30 (4)**

**F(16)=15=3\*4^1+3\*4^0=33(4)**

**8(16)=8=2\*4^1+0\*4^0=20 (4)**

**.**

1. **Substitution method**

* **calculations in the destination base**
* **it is recommended for *b < h*, *b* (source base), *h*(destination base)**

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***Steps:***

* **all the digits from the source representation are converted into the destination base: **
* **the base *b* is converted into base *h*: **
* **we calculate in base *h* the following sum:**

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**Example 4:with a precision of 2 digits at the fractional part in the destination---- representation**

**432,24 (5) = (8)**

**4(5)=4(8), 3(5)=3(8), 2(5)=2(8), 5=5(8)**

**432,24 (5)= 4(8)\*5(8)^2+3(8)\*5(8)^1+2(8)\*5(8)^0+2(8)\*5(8)^-1+4(8)\*5(8)^-2**

**=144(8)+17(8)+2(8)+0,31(8)+ 0,12(8)**

**C`alculations in base 8!!**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **c** | **3** | **0** |  | **1** | **0** | **0** |  | **1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **5** | **\*** |  | **3** | **1** | **\*** |  | **3** | **\*** |  | **2** |  | **\*** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **5** |  |  |  | **4** |  |  | **5** |  |  | **1** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **3** | **1** |  | **1** | **4** | **4** |  | **1** | **7** |  |  | **2** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**5(8)\*5(8)=5\*5=25, 25/8=3 ,25%8=1**

**0(8)+3(8)\*4(8)=0+3\*4=12, 12/8=1, 12%8=4**

**3(8)\*5(8) = 3\*5=15, 15/8=1, 15%8= 7**

|  |  |  |  |  |  |  |
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| **2,00(8)** | **:5(8)** | **4,00(8)** | **:5(8)** | **0,63(8)** | **:5(8)** |  |
| **20** | **0,31** | **40** | **0,63** | **6** | **0,12** |
| **10** | | **20** | | **13** | |
|  | |  | |  | |
|  | |  | |  | |
|  | |  | |  | |

**20(8)=2\*8+0=16, 16div 5=3 , 16 mod 5=1**

**10(8)=1\*8+0=8,**  **8 div 5 =1, 8mod 5=3**

**40(8)=4\*8+0=32 , 32 div 5 = 6 , 32 mod 5 =2**

**13(8) = 1\*8 +3 = 11, 11div 5 =2 , 11 mod 5 =1**

**432,24 (5)= 4(8)\*5(8)^2+3(8)\*5(8)^1+2(8)\*5(8)^0+2(8)\*5(8)^-1+4(8)\*5(8)^-2**

**=144(8)+17(8)+2(8)+0,31(8)+ 0,12(8) = 165,43(8)**

|  |  |  |  |  |  |  |  |
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| **carries** |  | **0** | **1** | **0** | **+(8)** | **00** | **0** |
|  |  | **1** | **4** | **4** | **,** |  |  |
|  |  |  | **1** | **7** | **,** |  |  |
|  |  |  |  | **2** | **,** |  |  |
|  |  |  |  | **0** | **,** | **3** | **1** |
|  |  |  |  | **0** | **,** | **1** | **2** |
| **sum** |  | **1** | **6** | **5** | **,** | **4** | **3** |
|  |  |  |  |  |  |  |  |

**4+7+2=13**

**13/8=1, 13%8=5**

**Example 5:with a precision of 2 digits at the fractional part in the destination representation**

**265,43 (7) = , (16)**

**265,43 (7) =2(16)\*7(16)^2+6(16)\*7(16)^1+5(16)\*7(16)^0+4(16)\*7(16)^(-1)+3(16)\*7(16)^(-2)**

**= 62(16) + 2A(16) +5(16)+0,92(16)+0,0F**

**Calculations in base 16!!!**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **c** | **3** | **0** |  |  | **0** | **0** |  |  | **2** | **0** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **7** | **\*** |  | **3** | **1** | **\*** |  |  | **6** | **\*** |  |  |  | **\*** |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | **7** |  |  |  | **2** |  |  |  | **7** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | **3** | **1** |  |  | **6** | **2** |  |  | **2** | **A** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**7(16) \* 7(16) = 7 \* 7 = 49, 49 / 16 = 3, 49 % 16 = 1**

**0(16) + 2(16) \* 1(16) = 2 (16)**

**6(16) \* 7(16) = 6 \* 7 = 42, 42 / 16 = 2 , 42 % 16 = 10 = A(16)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **4,00(16)** | **:7(16)** | **3,00 (16)** | **:7 (16)** | **0,6D (16)** | **:7 (16)** |  |
| **40** | **0,92** | **30** | **0, 6D** | **6D** | **0, 0F** |
| **10** | | **60** | |  | |
|  | |  | |  | |
|  | |  | |  | |

**40(16)=64 , 64 div 7 = 9 , 64 mod 7 = 1**

**10(16)=16, 16 div 7 = 2 , 16 mod 7**

**30(16) = 48, 48 div 7= 6, 48 mod 7 = 6**

**60(16) = 96, 96 div 7 = 13 = D(16)**

**6D(16) = 6\*16 + 13 =109, 109 div 7 = 15 = F (16)**

**265,43 (7) =2(16)\*7(16)^2+6(16)\*7(16)^1+5(16)\*7(16)^0+4(16)\*7(16)^(-1)+3(16)\*7(16)^(-2)**

**= 62(16) + 2A(16) +5(16)+0,92(16)+0,0F(16)=91,A1(16)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **carries** |  |  | **1** | **0** |  | **+(16)** | **1** | **0** |
|  |  |  | **6** | **2** |  | **,** |  |  |
|  |  |  | **2** | **A** |  | **,** |  |  |
|  |  |  |  | **5** |  | **,** |  |  |
|  |  |  |  | **0** |  | **,** | **9** | **2** |
|  |  |  |  | **0** |  | **,** | **0** | **F** |
| **sum** |  |  | **9** | **1** |  | **,** | **A** | **1** |
|  |  |  |  |  |  |  |  |  |

1. **The method of successive divisions/multiplications**

* **it is recommended for *h < b*, *b* –source base and *h*- destination base.**
* **calculations in the source base**

**Integer part**: **successive divisions** by the destination base (***h***) are performed

* the process of successive divisions ends when 0 is obtained as quotient.
* the remainders, in the reverse order, are the digits of the new representation in base *h.*

**Fractional part**: **successive multiplications** by the destination base (***h***) are performed

* the fractional part is multiplied by ***b*** obtaining a number with an integer part and a fractional one;
* we continue with the multiplication of this new fractional part,...
* the process of the successive multiplications continues until one of the following conditions is satisfied:

a) the fractional part becomes 0;

b) an established number of digits of the fractional part were calculated;

c) periodicity is obtained.

* the integer parts, in the order of obtaining them during the multiplications process, are the digits of the fractional part in the destination representation.

**Example 6: with a precision of 3 digits at the fractional part in the destination representation**

**, (8) = , (5)**

**Conversion of the integer part**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r |

**Calculations:**

**Conversion of the fractional part**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **c** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **0** | **,** |  |  | **\*** |  |  |  |  | **\*** |  |  |  |  | **\*** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

**Calculations:**

**Example 7: with a precision of 3 digits at the fractional part in the destination representation**

**, (16) = ,  (7)**

**Conversion of the integer part**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r | |  / |  /    /    /  r |

**Calculations:**

**Conversion of the fractional part**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **c** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **0** | **,** |  |  | **\*** |  |  |  |  | **\*** |  |  |  |  | **\*** |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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**Calculations:**