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**Умножение чисел с плавающей запятой**

Домашняя работа №7

Вариант №66

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**Задание**

1. Заданные числа ***А*** (множимое) и ***В*** (множитель) представить в форматах *Ф*1 и *Ф2* с укороченной мантиссой (12 двоичных разрядов). Метод округления выбирается произвольно.

*Примечание:* общее число разрядов в формате – 20.

1. Выполнить операцию умножения операндов в формате *Ф1*, используя метод ускоренного умножения мантисс на два разряда множителя.
2. Выполнить операцию умножения операндов в формате *Ф2*, используя метод ускоренного умножения мантисс на четыре разряда множителя.
3. Результаты представить в форматах операндов, перевести в десятичную систему счисления и проверить их правильность.
4. Определить абсолютную и относительную погрешности результатов и обосновать их причину.
5. Сравнить погрешности результатов аналогичных операций для форматов *Ф1* и *Ф2* и объяснить причины их сходства или различия.

**Выполнение**

* + - 1. A = 1,1; B=0,023

Формат Ф1:

A = 1,1 = (1,1(9))16 = (0,11(9))16 \* 161

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |

B = 0,023 = 0,05E316 = 0,5E3 \* 16-1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |

Формат Ф2:

A = 1,1 = (1,1(9))16 = 1,0001 1001 10012  = 0,1000 1100 11002 \*21

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |

B = 0,023 = 0,05E3516  = 0,0000 0101 1110 0011 01012 = 0,1011 1100 0110 1012 \* 2-5

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |

2.Выполнить операцию умножения операндов в формате *Ф1*, используя метод ускоренного умножения мантисс на два разряда множителя

Sign*C* = Sign*A* Sign *B.*

*XA* = P*A* + *d*; *XB* = P*В* + *d*;

*XC* = *XA* + *XB* – *d;*

P*C*+ *d* = **P*A* + *d* + P*B***+ *d – d.*

P*C*

***XA***= 1 0 0 0 0 0 1

+

***XB***=0 1 1 1 1 1 1

***XA+XB*** = 1 0 0 0 0 0 0 0

-

***d***  = 1 0 0 0 0 0 0

***XC*** = 1 0 0 0 0 0 0

P*C* = 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Операнды | СПЧ(Старшие разряды) | | | | | | | | | | | | | | | | | В/СЧП (Младшие разряды) | | | | | | | | | | | | | | | | | | | | | | | Признак коррекции |
| 0 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | 0 | | **1** | | **1** | | 0 |
|  | [-MA]доп | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | | -MA | | | |  |
| 1 | СЧП | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | 0 | | 1 | | 1 | | 1 |
|  | СЧП→2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | **0** | | **0** | |  |
|  | MA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |  | | | | | | | | | | | | | | | | | | | +MA | | | | 0 |
| 2 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | 0 | |
|  | СЧП→2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 1 | | **1** | | **0** |
| 3 | 2MA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |  | | | | | | | | | | | | | | | | | | | 2MA | | | | 0 |
|  | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | | 1 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | |
|  | СЧП→2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | | 0 | | 1 | | **1** | | **1** | |
| 4 | [-MA]доп | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |  | | | | | | | | | | | | | | | | | | | -MA | | | | 1 |
|  | СЧП | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 1 | |
|  | СЧП→2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | | **0** | | **1** | |  |
| 5 | 2MA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |  | | | | | | | | | | | | | | | | | | | 2MA | | | | 0 |
|  | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | | 0 | | 1 | |
|  | СЧП→2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | | 0 | | 0 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | **0** | | **1** | |  |
| 6 | MA | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |  | | | | | | | | | | | | | | | | | | | +MA | | | |  |
|  | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | | 0 | | 0 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | | 0 | | 1 | |
|  | СЧП→2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | | 1 | | 0 | | 0 | | 0 | | 1 | | 0 | | 1 | | 0 | | 1 | | 1 | |  |

*C\** = (0,000001100111)2 \* 160 = 0,025146

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |

*C*T = 0,0253

Δ*С* = *С*Т - *С*\* = 0,0253 – 0,025146 = 0,000154

δ*С* = · 100% = 0,000154/0,0253 \* 100% = 0,6%.

3. Выполнить операцию умножения операндов в формате *Ф2*, используя метод ускоренного умножения мантисс на четыре разряда множителя

***XA***= 1 0 0 0 0 0 0 1

+

***XB***= 0 1 1 1 1 0 1 1

***XA+XB*** = 1 1 1 1 1 1 0 0

-

***d***  = 1 0 0 0 0 0 0 0

***XC*** = 0 1 1 1 1 1 0 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Операнды | СПЧ(Старшие разряды) | | | | | | | | | | | | | | | | | | В/СЧП (Младшие разряды) | | | | | | | | | | | | | | | | | | | | | | | Признак коррекции |
| 0 | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | | 1 | | 1 | | 1 | | 1 | | 0 | | 0 | | **0** | | **1** | | **1** | | **0** | | 0 |
| 2MA | 0 | 0 | 0 | 0 | 1 | 0 | | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |  |  | |  | |  | |  | |  | |  | |  | | 4MA | | | | 2MA | | | |
| 4MA | 0 | 0 | 0 | 1 | 0 | 0 | | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| СЧП | 0 | 0 | 0 | 1 | 1 | 0 | | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
| СЧП→4 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | | 0 | | 0 | | 1 | | 0 | | 1 | | 1 | | **1** | | **1** | | **0** | | **0** | |
|  | [-4MA]доп | 1 | 1 | 1 | 0 | 1 | 1 | | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |  | | | | | | | | | | | | | | | | | | | -4A | | | | 1 |
| 1 | СЧП | 1 | 1 | 1 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | СЧП→4 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | | 1 | | 0 | | 0 | | 1 | | 0 | | 0 | | 0 | | **1** | | **0** | | **1** | | **1** |
| 2 | [-4MA]доп | 1 | 1 | 1 | 0 | 1 | 1 | | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |  | | | | | | | | | | | | | | | | | | | -4A | | | | 1 |
|  | СЧП | 1 | 1 | 1 | 0 | 1 | 1 | | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |
|  | СЧП→4 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | | 0 | | 1 | | 1 | | 1 | | 0 | | 0 | | 1 | | 0 | | 0 | | 0 | |
|  | MA | 0 | 0 | 0 | 0 | 0 | 1 | | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |  |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  |
|  | СЧП | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | | 0 | | 1 | | 1 | | 1 | | 0 | | 0 | | 1 | | 0 | | 0 | | 0 | |  |

P*C* = -4

*С\** = (0,0110 0111 1001)2  \* 2-4  = 0,0000 0110 0111 10012 = 0,025283

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |

*C*T = 0,0253

Δ*С* = *С*Т - *С*\* = 0,0253 – 0,025283 = 0,000017

δ*С* = · 100% = 0,000017· 100% = 0,0017%.

Погрешности результатов вызваны неточным представлением операндов. В формате *Ф2* операнды представлены точнее и погрешность меньше.