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$$(1) \left[2^5 \times \frac{11}{16} \right] + \left[2^4 \times \left(-\frac{9}{16} \right) \right]$$

$$[2^5 \times 11/16]_{\text{阶补尾补}} = 00,101; 00.101100 \quad [2^4 \times (-9/16)]_{\text{阶补尾补}} = 00,100; 11.011100$$

$$\textcircled{1} \text{对阶: } [2^4 \times (-9/16)]_{\text{阶补尾补}} = 00,100; 11.011100 = 00,101; 11.001110$$

$$\textcircled{2} \text{尾数求和: } 00.101100 + 11.001110 = 00.011010$$

$$\textcircled{3} \text{规格化: } 00,101; 00.011010 = 00,100; 00.110100$$

④舍入: 无需

⑤溢出: 无

最终结果为 $x+y=00,100; 00.110100=2^4 \times 13/16=13$



$$(2) \left[2^{-3} \times \frac{13}{16} \right] - \left[2^{-4} \times \left(-\frac{5}{8} \right) \right]$$

$$[x]_{\text{阶补尾补}} = 11,101; 00.110100 \quad [-y]_{\text{阶补尾补}} = 11,100; 00.101000$$

$$\textcircled{1} \text{对阶: } [-y]_{\text{阶补尾补}} = 11,101; 00.010100$$

$$\textcircled{2} \text{尾数相减: } 00.110100 + 00.010100 = 01.001000$$

$$\textcircled{3} \text{规格化 } 11,101; 01.001000 = 11,110; 00.100100$$

④舍入: 无需

⑤溢出: 无

最终结果为 $x-y=11,010; 00.100100=2^{-2} \times 9/16=9/64$



$$(3) \left[2^3 \times \frac{13}{16} \right] \times \left[2^4 \times \left(-\frac{9}{16} \right) \right]$$

$$[x]_{\text{阶补尾补}} = 00,011; 00.110100 \quad [y]_{\text{阶补尾补}} = 00,100; 11.011100$$

$$\textcircled{1} \text{阶码相加: } 00,011 + 00,100 = 00,111$$

②尾数相乘: $[S_x]_{\text{补}}=00.110100$ $[-S_x]_{\text{补}}=11.001100$ $[S_y]_{\text{补}}=1.011100$

补码一位乘

部分积	乘数	y_{i+1}	操作
00.000000	1.011100	0	->1
00.000000	01.01110	0	->1
00.000000	001.0111	0	$+[-S_x]_{\text{补}}$
+11.001100			
11.001100			->1
11.100110	0001.011	1	->1
11.110011	00001.01	1	->1
11.111001	100001.0	1	$+ [S_x]_{\text{补}}$
+00.110100			
00.101101			->1
00.010110	1100001.	0	$+ [-S_x]_{\text{补}}$
+11.001100			
11.100010	110000		最后一步不移位

$[S_x \times S_y]_{\text{补}} = 11.100010 \ 110000$

③规格化: $00,111; 11.100010 \ 110000 = 00,110; 11.000101 \ 100000$

④舍入: 采取 0 舍 1 入法得 $[x \times y]_{\text{阶补尾补}} = 00,110; 11.000110$

⑤溢出: 无

最终结果为 $x \times y = 00,110; 11.111010 = 2^6 \times (-3/32)$



$$(4) \quad [2^6 \times (-\frac{11}{16})] \div [2^3 \times (-\frac{15}{16})]$$

$[x]_{\text{阶补尾补}} = 00,110; 11,101100$ $[y]_{\text{阶补尾补}} = 00,011; 11.111100$

①阶码相减: $00,110 - 00,011 = 00,110 + 11,101 = 00,011$

②尾数相除: $[S_x]_{\text{补}} = 11.101100$ $[S_y]_{\text{补}} = 11.000100$ $[-S_y]_{\text{补}} = 00.111100$

补码加减交替法

z 被除数 (余数)	商	操作
11.101100	0.000000	z、 S_y 同号
+00.111100		$+ [-S_y]_{\text{补}}$
00.010000	0.	异号, 上商 0

00.100000		1<-
+11.000100		+ [Sy]补
11.100100	0.1	同号, 上商 1
11.001000		1<-
+00.111100		+ [-Sy]补
00.000100	0.10	异号, 上商 0
00.001000		1<-
+11.000100		+ [Sy]补
11.001100	0.101	同号, 上商 1
10.011000		1<-
+00.111100		+ [-Sy]补
11.010100	0.1011	同号, 上商 1
10.101000		1<-
+00.111100		+ [-Sy]补
11.100100	0.10111	同号, 上商 1
11.001000		1<-
+00.111100		+ [-Sy]补
00.000100	0.101111	末位恒置 1

$[Sx \div Sy]补 = 0.101111$

③规格化 00,011; 00.101111 已经是规格化数

④舍入: 无需

⑤溢出: 无

最终结果为 $x \div y = 00,011; 00.101111 = 2^3 \times 47/64$



$$(5) \quad [2^3 \times (-1)] \times [2^{-2} \times \frac{57}{64}]$$

$[x]_{阶补尾补} = 00,011; 11.000000$ $[y]_{阶补尾补} = 11,110; 00.111001$

①阶码相加: $00,011 + 11,110 = 00,001$

②尾数相乘: $[Sx]补 = 11.000000$ $[-Sx]补 = 01.000000$ $[Sy]补 = 0.111001$

补码一位乘

部分积	乘数	y_{i+1}	操作
00.000000	0.111001	0	+ [-Sx]补
+01.000000			
01.000000			-> 1

00.100000 +11.000000	00.11100	1	+ [Sx]补
11.100000 11.110000 11.111000 +01.000000	000.1110 0000.111	0 0	->1 ->1 + [-Sx]补
00.111000 00.011100 00.001110 00.000111 +11.000000	00000.11 000000.1 0000000.	1 1 1	->1 ->1 ->1 + [Sx]补
11.000111	000000		最后一步不移位

$[Sx \times Sy]补 = 11.000111\ 000000$

③规格化: 00,001; 11.100010 110000 = 00,110; 11.000101 100000

④舍入: 采取 0 舍 1 入法得 $[x \times y]_{阶补尾补} = 00,110; 11.000110$

⑤溢出: 无

最终结果为 $x \times y = 00,110; 11.111010 = 2^6 \times (-3/32)$



(6) $[2^{-6} \times (-1)] \div [2^7 \times (-\frac{1}{2})]$

$[x]_{阶补尾补} = 11,010; 11,000000$ $[y]_{阶补尾补} = 00,111; 11.100000$

①阶码相减: $11,010 - 00,111 = 00,110 + 11,001 = 11,111$

②尾数相除: $[Sx]补 = 11,000000$ $[Sy]补 = 11.100000$ $[-Sy]补 = 00.100000$

补码加减交替法

z 被除数 (余数)	商	操作
11.000000 +11.100000	0.000000	z、Sy 异号 + [Sy]补
10.100000 01.000000 +00.100000	1.	同号, 上商 1 1 < - + [-Sy]补
01.100000 11.000000 +11.100000	1.0	异号, 上商 0 1 < - + [Sy]补
10.100000	1.01	同号, 上商 1

01.000000		1 < -
+00.100000		+[-Sy]补
01.100000	1.010	异号, 上商 0
11.000000		1 < -
+11.100000		+ [Sy]补
10.100000	1.0101	同号, 上商 1
01.000000		1 < -
+00.100000		+[-Sy]补
01.100000	1.01010	异号, 上商 0
11.000000		1 < -
+11.100000		+ [Sy]补
10.100000	1.010101	末位恒置 1

$[Sx \div Sy]补 = 1.010101$

③规格化 11,111; 11.010101 已经是规格化数

④舍入: 无需

⑤溢出: 无

最终结果为 $x \div y = 11,001; 11.101011 = 2^{-1} \times (-43/64)$



$$(7) 3.3125 + 6.125 = 53/16 + 49/8 = 2^2 \times 53/64 + 2^3 \times 49/64$$

$[x]$ 阶补尾补 = 00,010; 00.110101 $[y]$ 阶补尾补 = 00,011; 00.110001

①对阶: $[x]$ 阶补尾补 = 00,010; 00.110101 = 00,011; 00.011010

②尾数求和: 00.011010 + 00.110001 = 01.001011

③规格化: 00,011; 01.001011 = 00,100; 00.100101

④舍入: 无需

⑤溢出: 无

最终结果为 $x + y = 00,100; 00.100101 = 2^4 \times 37/64$



$$(8) 14.75 - 2.4375 = 59/4 - 39/16 = 2^4 \times 59/64 - 2^2 \times 39/64$$

$[x]_{\text{阶补尾补}} = 00,100; 00.111011$ $[y]_{\text{阶补尾补}} = 00,010; 00.100111$

①对阶: $[y]_{\text{阶补尾补}} = 00,010; 00.100111 = 00,100; 00.001001$

②尾数相减: $00.111011 - 00.001001 = 00.111011 + 11.110111 = 00.110010$

③规格化: $00,100; 00.110010$ 已经是规格化数

④舍入: 无需

⑤溢出: 无



最终结果为 $x-y = 00,100; 00.110010 = 2^4 \times 25/32$

6.31

若采用双重分组跳跃进位链

完成加法总时间 $= 4 \times 2.5t_y = 10t_y = 300\text{ns} = 0.3\mu\text{s} < 0.6\mu\text{s}$

进位链框图: