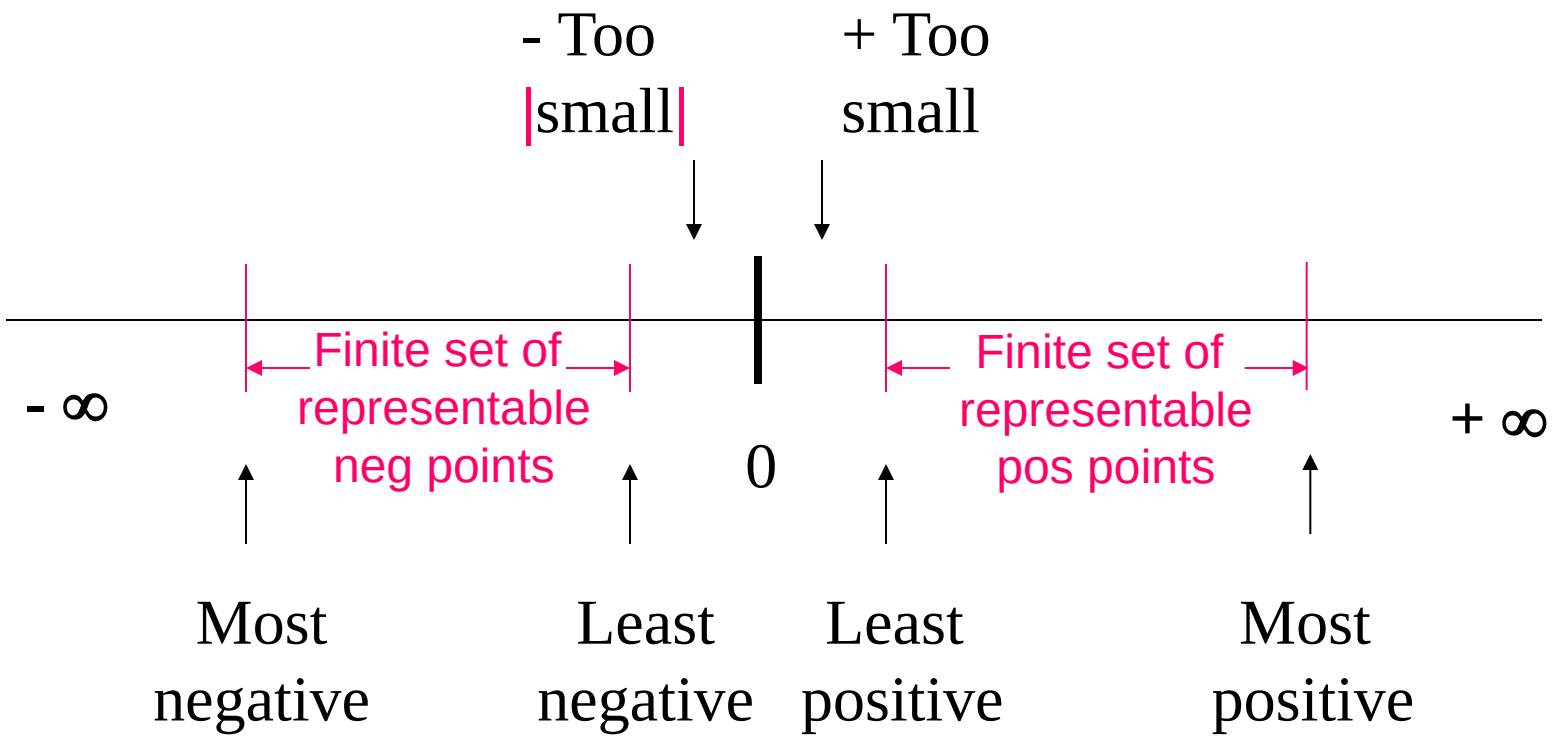
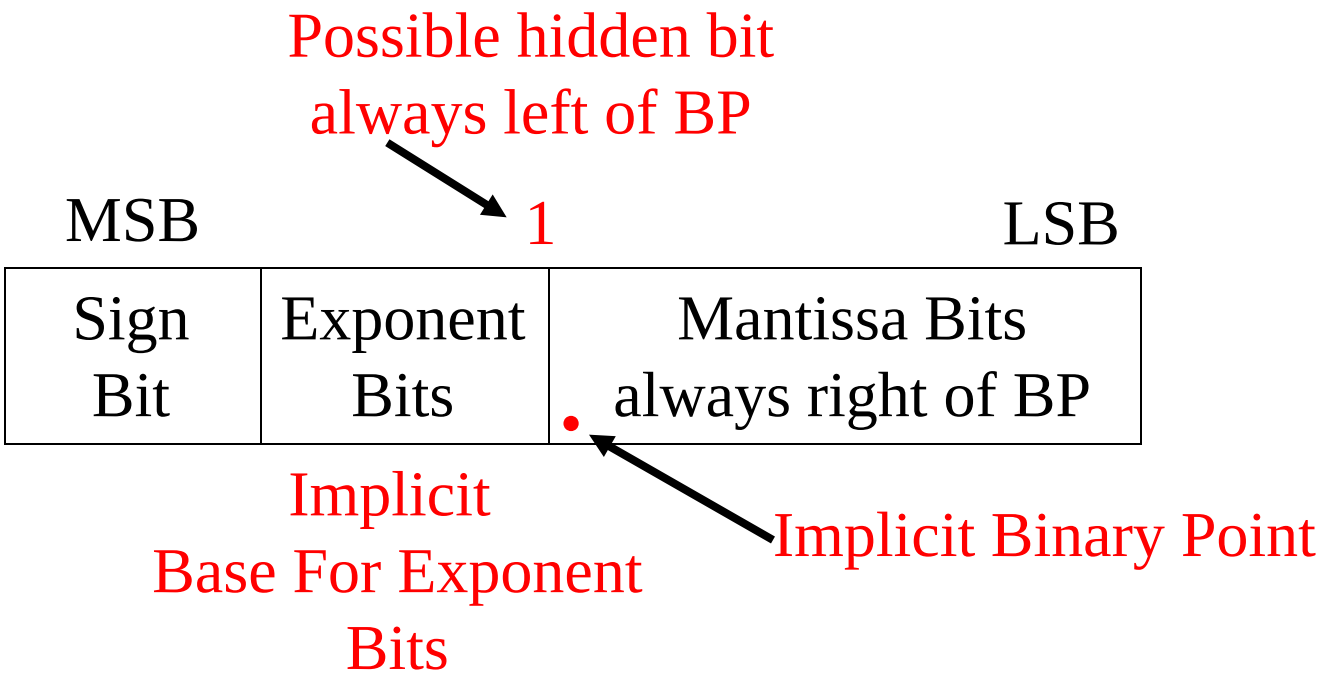
Floating Point Representation



General Floating Format

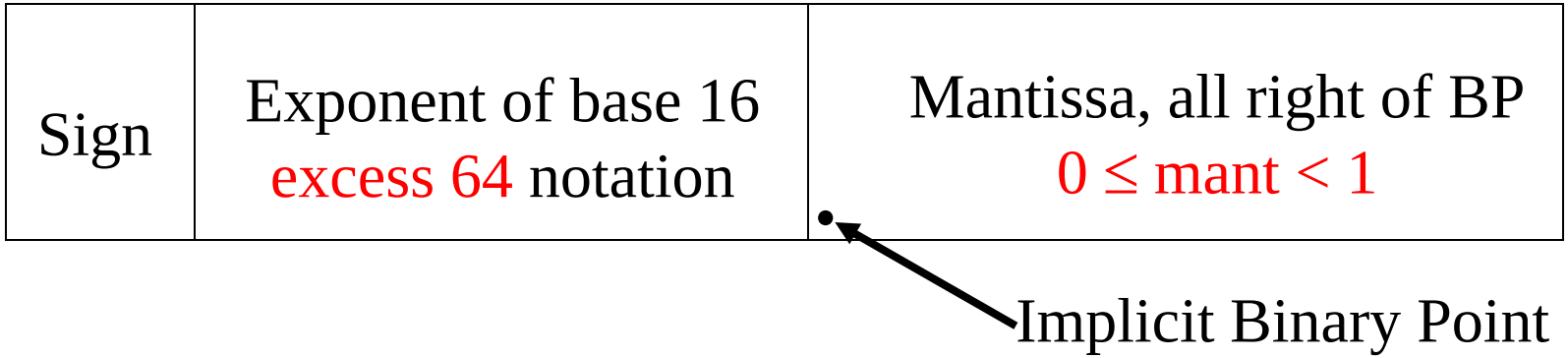


Maybe 16 so 16 exponent bits * mantissa

Maybe 2 so 2 exponent bits * mantissa

IBM Format

No hidden bit in IBM Format



0 100 0001 1100 … 0000

Positive sign bit

Excess 64, here is 65 so 16^{+1}

Mantissa has 1/2 + 1/4 so .75

So value is $16^{+1} * .75 =$ **12.0**

IBM Format

0 100 0101 → 69 0110 … 0000

16^{+5} * .375 = + 393216.0

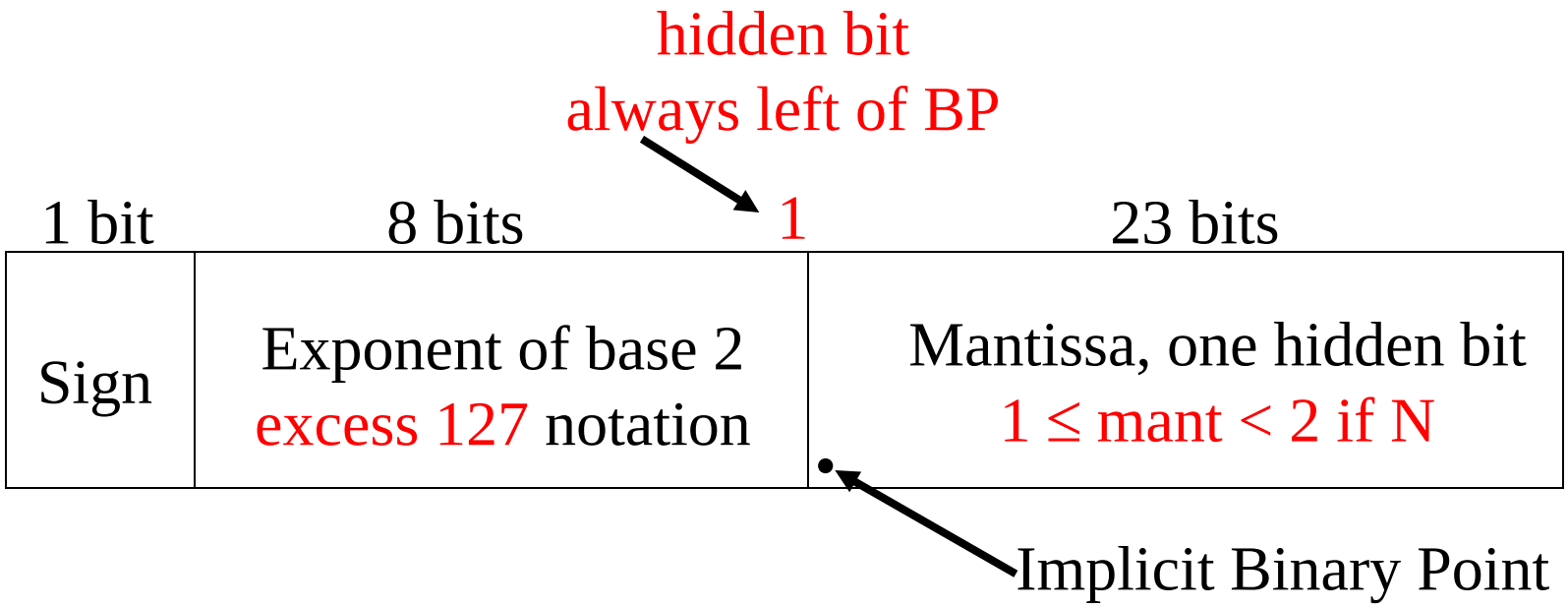
0 011 1111 → 63 1010 … 0000

16^{-1} * .625 = + .0390 ...

1 011 1101 → 61 1100 … 0000

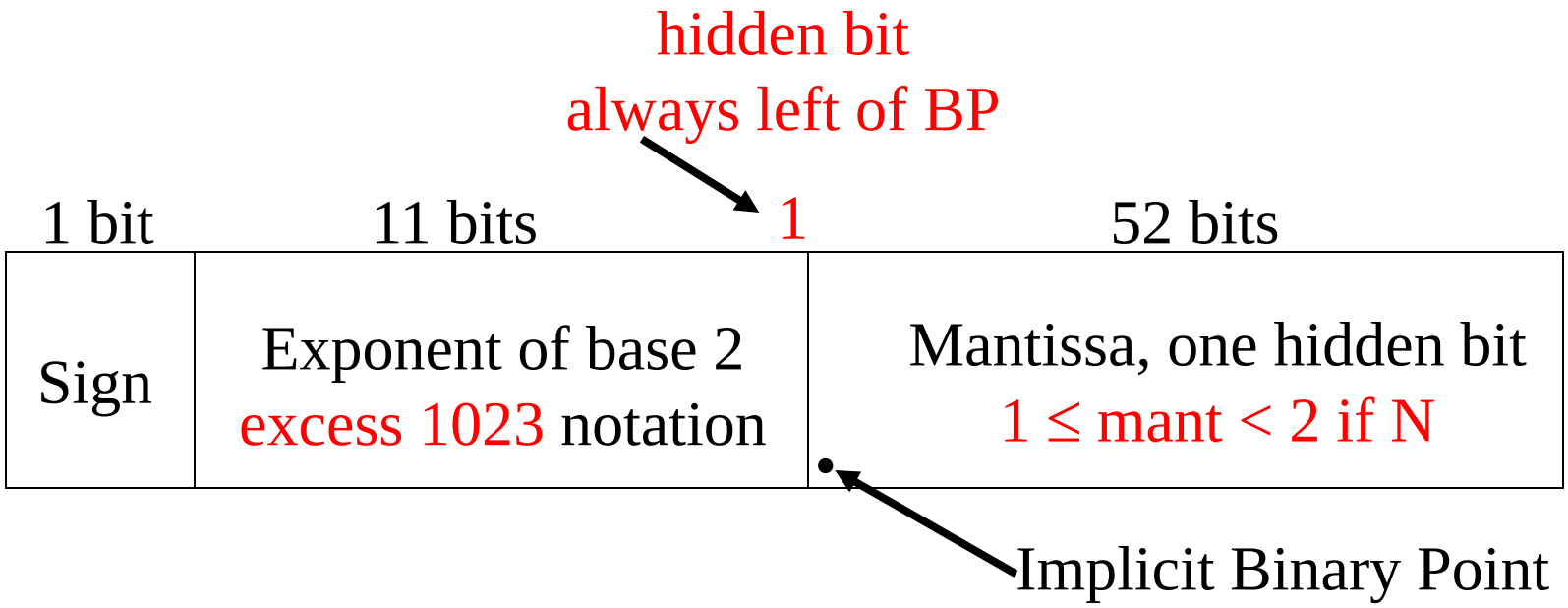
16^{-3} * .75 = - .000183 ...

IEEE 754 Format



So value is $2^{+2} * 1.75 =$ **7.0**

IEEE 754 Format, Double Precision



So value is $2^{+2} * 1.75 = \mathbf{7.0}$

IEEE 754 Format

0 1000 0101 → 133 0110 … 0000

2^{+6} * 1 .375 = + 88.0

0 0111 1110 → 126 1010 … 0000

2^{-1} * 1.625 = + .8125

1 0111 1100 → 124 1100 … 0000

2^{-3} * 1.75 = - .21875

Floating Point Possibilities, IEEE 754

Least positive N	0 0000 0001	0000 … 0000 = 2^{-126}, ≅ 10^{-38}
Most positive	0 1111 1110	1111 … 1111 ≅ 2^{+128} , ≅ 10^{+38}
Least negative N	1 0000 0001	0000 … 0000 = -2^{-126}, ≅ -10^{-38}
Most negative	1 1111 1110	1111 … 1111 ≅ -2^{+128} , -10^{+38}
Least pos/neg DN	$^1/_0$ 0000 0000	0000 … 0001 = $^+/-\ 2^{-149}$, ≅ 10^{-45}
Zero	0 0000 0000	0000 … 0000
Pos/neg infinity	$^1/_0$ 1111 1111	0000 … 0000 = $^+/-$ ∞
NAN	$^1/_0$ 1111 1111	Any non-zero pattern = NAN

Floating Point Possibilities, IEEE 754 (cont'd)

0 1000 0101 .0110 … 0000

2^{+6} * 1.375 = + 88.0

0 0000 0001 .0000 … 0000

2^{-126} * 1.0 ≅ $+ 1.175 * 10^{-38}$

0 0000 0000 .0000 … 0000

= + 0.0

1 1111 1111 .0110 … 0000

= **NAN**

1 1111 1111 .0000 … 0000

= - ∞

Un-normalized small

0 0000 0000 .00001 … 0000

2^{-126} * 2^{-5} = + 2^{-131} ≅ $+ 3.674 * 10^{-40}$

```
please enter a floating point number and new-line: 234765.579335

  mantissa:     0x654365        or:             110 0101 0100 0011 0110 0101
  exponent:     0x90            or:   1001 0000
      sign:     0x0             or: 0
in base 10:     234765.6        or: 0 1001 0000 110 0101 0100 0011 0110 0101

please enter a floating point number and new-line: 234765.579

  mantissa:     0x654365        or:             110 0101 0100 0011 0110 0101
  exponent:     0x90            or:   1001 0000
      sign:     0x0             or: 0
in base 10:     234765.6        or: 0 1001 0000 110 0101 0100 0011 0110 0101

please enter a floating point number and new-line: 234765.571

the floating value for INPUT_NUMBER is broken out as:
  mantissa:     0x654365        or:             110 0101 0100 0011 0110 0101
  exponent:     0x90            or:   1001 0000
      sign:     0x0             or: 0
in base 10:     234765.6        or: 0 1001 0000 110 0101 0100 0011 0110 0101

please enter a floating point number and new-line: 234765.57

  mantissa:     0x654364        or:             110 0101 0100 0011 0110 0100
  exponent:     0x90            or:   1001 0000
      sign:     0x0             or: 0
in base 10:     234765.6        or: 0 1001 0000 110 0101 0100 0011 0110 0100
```

```
-bash-4.1$ ./subtract

please enter a floating point number and new-line: 234765.579335
please enter a floating point number and new-line: 234765.571
the difference between the two numbers entered is:  0.000000


-bash-4.1$ ./subtract

please enter a floating point number and new-line: 234765.579335
please enter a floating point number and new-line: 234765.57
the difference between the two numbers entered is:  0.015625
```

Adding 754 FP Numbers

			1 HB			
0	1000 0101		.0110	…	0000	
	2^{+6}	*	1.375	=	+ 88.0	
+			1 HB			
0	0111 1110		.1010	…	0000	
	2^{-1}	*	1.625	=	+ .8125	

		1 HB			
0	0111 1110	.1010	…	0000	

Shift mantissa of smaller number right 7 places, note hidden bit

	0	1000 0101	.0000 0011	0100	… 0000	0 0 0 0 0
+			1 HB			
	0	1000 0101	.0110		… 0000	
			1 HB			
	0	1000 0101	.0110 0011	0100	… 0000	

Result is normalized as is: **1 + 1/4 + 1/8 + 1/128 + 1/256 + 1/1024**

2^{+6} * 1 .3876953 = + 88.8125

Adding 754 FP Numbers (cont'd)

1 HB

0 1000 0101 .1110 … 0000

2^{+6} * 1 .875 = + 120.0

\+

1 HB

0 1000 0010 .1011 … 0000

2^{+3} * 1.6875 = + 13.5

1 HB

0 1000 0010 .1011 … 0000

Shift mantissa of smaller number right 3 places, note hidden bit

0 1000 0101 .0011 0110 … 0000 0 0 0

\+

1 HB

0 1000 0101 .1110 … 0000

---

10 HB + Carry Out

0 1000 0101 .0001 0110 … 0000

Normalize result

1 HB

0 1000 0110 .0000 10110 … 0000 0

2^{+7} * 1 .04296875 = + 133.5

Adding 754 FP Numbers (cont'd)

			1 HB		
0	1000 0101		.1110	…	0000
	2^{+6}	*	1 .875	=	+ 120.0
+					
			1 HB		
0	1000 0101		.1011	…	0000
	2^{+6}	*	1.6875	=	+ 108.0

		1 HB		
0	1000 0101	.1011	…	0000
+		1 HB		
0	1000 0101	.1110	…	0000
		11 HB + Carry Out		
0	1000 0101	.1001	…	0000

Normalize result →

			1 HB		
0	1000 0110		.1100 1000	…	0000 0
	2^{+7} ↑	*	1 .78125	=	+ 228