

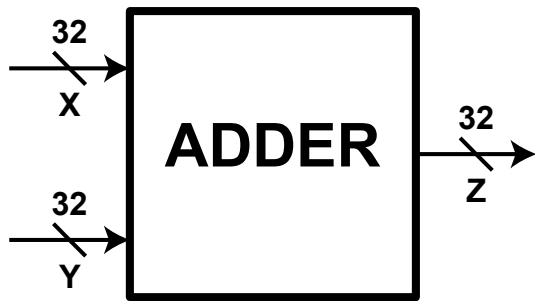
IEEE 754 Floating Point Adder

Description

The IEEE 754 standard for the floating point adder establishes a single, global standard that computer companies use to ensure compatibility between diverse hardware platforms. Across numerous technical disciplines, the need to handle basic arithmetic operations with precision and reliability is essential. To satisfy that need, the IEEE 754 standard represents the most efficient representation of real numbers in computer hardware and software.

This document describes the implementation of an IEEE 754 floating point adder: a digital arithmetic component that will execute the addition of two signed/unsigned, floating point 32-bit binary values.

Specification

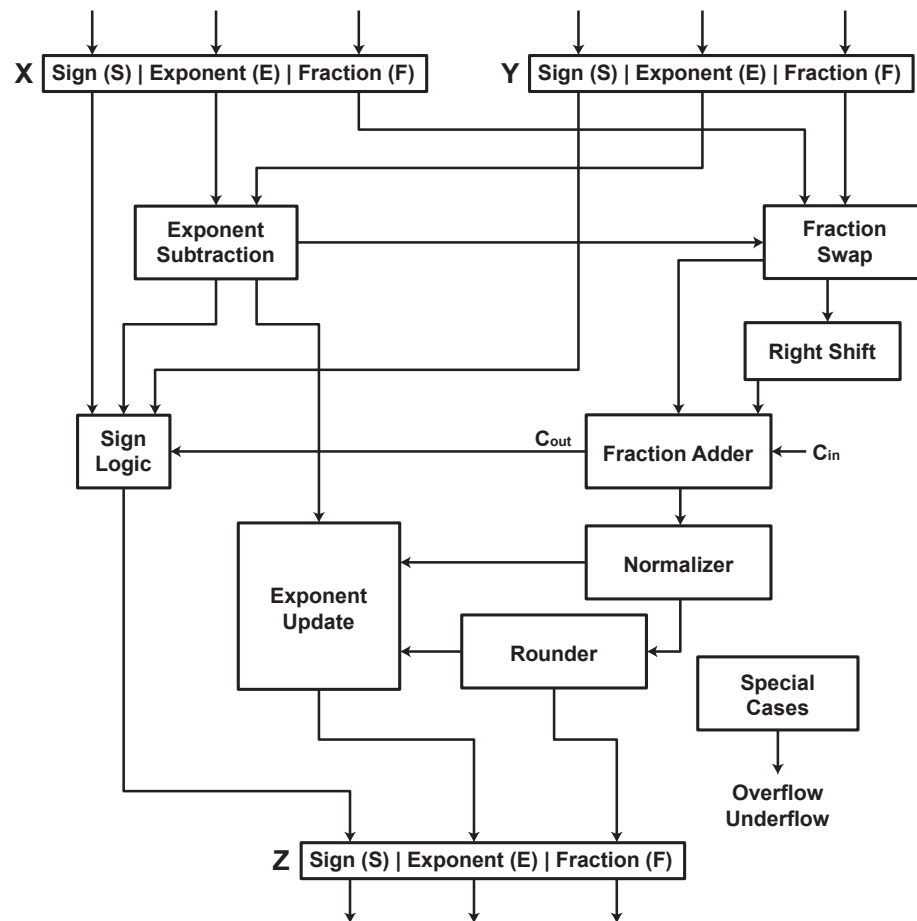


Sign (S)	Exponent (E)	Fraction (F)
1 bit +/-	8 bits XXXX XXXX	23 bits .XXXX XXXX XXXX XXXX XXXX XXX

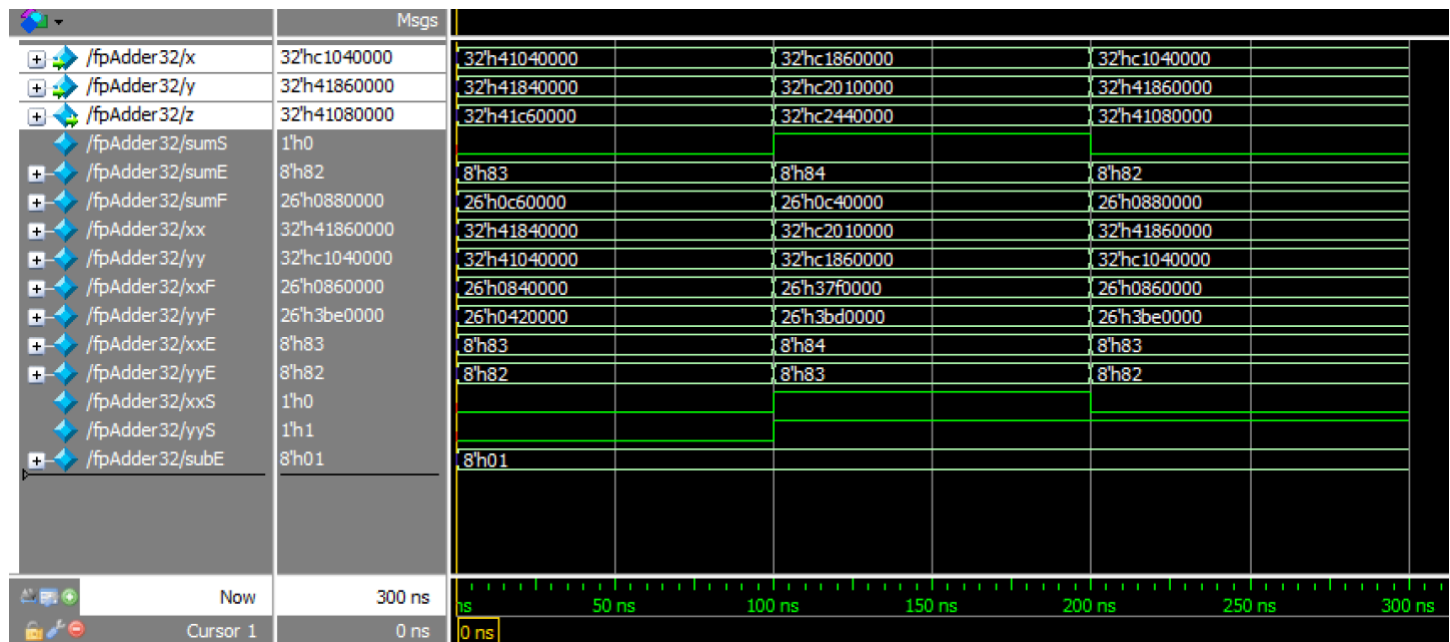
IEEE 754 Single Precision Data Format (32-bits)

FLT_MAX	$+3.4 \times 10^{38}$	Overflow	$Z > \text{FLT_MAX}$
FLT_MIN	-3.4×10^{38}	Underflow	$Z < \text{FLT_MIN}$
FLT_EPSILON	$1 - (+3.4 \times 10^{-38})$		

Diagram



Simulation



The simulation results of some input samples shows the correct output for the single precision floating point adder.

Decimal

$+8.25 + 16.50 = 24.75$
 $-16.75 - 32.25 = -49.00$
 $-8.25 + 16.75 = 8.50$

Hexadecimal

$0x41040000 + 0x41840000 = 0x41C60000$
 $0xC1860000 + 0xC2010000 = 0xC2440000$
 $0xC1040000 + 0x41860000 = 0x41080000$

The results shown are not an exhaustive test of all boundary condition cases to account for the following:

- Overflow/Underflow
- Zero Handling

Synthesis

- Total Area: 4777.696029 outputDir/area_report.txt
- Total Power: 1.3659 mW outputDir/power_report.txt
- Total Performance: Not Applicable* outputDir/timing_report.txt

* The circuit is combinational only and timing results are not conclusive.

Placement

cutSequence Default

encounter ##> reportNetLen
*** Net length and connection length statistics
(cell fpAdder32) ***

Total net length = 1.351e+04 (6.051e+03
7.461e+03)

Avg net length = 1.609e+01 (sigma =
1.767e+01)
Sqrt of avg square net length = 2.389e+01

Avg connection length = 6.686e+00 (sigma =
5.303e+00)
Sqrt of avg square connection length =
8.534e+00

Net and connection length distribution:

[length range]	#net	#connection
[0.00e+00 5.60e+00]:	252	439
[5.60e+00 1.12e+01]:	227	236
[1.12e+01 1.68e+01]:	107	104
[1.68e+01 2.24e+01]:	54	33
[2.24e+01 2.80e+01]:	48	15
[2.80e+01 3.36e+01]:	46	8
[3.36e+01 3.92e+01]:	25	2
[3.92e+01 4.48e+01]:	17	3
[4.48e+01 5.04e+01]:	17	0
[5.04e+01 5.60e+01]:	13	0
[5.60e+01 6.16e+01]:	10	0
[6.16e+01 6.72e+01]:	6	0
[6.72e+01 7.28e+01]:	6	0
[7.28e+01 7.84e+01]:	2	0
[7.84e+01 8.40e+01]:	2	0
[8.40e+01 8.96e+01]:	2	0
[8.96e+01 9.52e+01]:	1	0
[9.52e+01 1.01e+02]:	2	0
[1.29e+02 1.34e+02]:	2	0
[1.46e+02 1.51e+02]:	1	0

cutSequence VVVHHH

encounter ##> reportNetLen
*** Net length and connection length statistics
(cell fpAdder32) ***

Total net length = 1.440e+04 (5.153e+03
9.243e+03)

Avg net length = 1.714e+01 (sigma =
1.902e+01)
Sqrt of avg square net length = 2.560e+01

Avg connection length = 7.123e+00 (sigma =
6.300e+00)
Sqrt of avg square connection length =
9.509e+00

Net and connection length distribution:

[length range]	#net	#connection
[0.00e+00 5.60e+00]:	260	447
[5.60e+00 1.12e+01]:	203	233
[1.12e+01 1.68e+01]:	106	72
[1.68e+01 2.24e+01]:	60	43
[2.24e+01 2.80e+01]:	52	20
[2.80e+01 3.36e+01]:	35	12
[3.36e+01 3.92e+01]:	29	2
[3.92e+01 4.48e+01]:	16	2
[4.48e+01 5.04e+01]:	20	3
[5.04e+01 5.60e+01]:	12	3
[5.60e+01 6.16e+01]:	12	2
[6.16e+01 6.72e+01]:	11	1
[6.72e+01 7.28e+01]:	5	0
[7.28e+01 7.84e+01]:	2	0
[7.84e+01 8.40e+01]:	3	0
[8.40e+01 8.96e+01]:	4	0
[8.96e+01 9.52e+01]:	2	0
[9.52e+01 1.01e+02]:	2	0
[1.01e+02 1.06e+02]:	4	0
[1.06e+02 1.12e+02]:	1	0
[1.18e+02 1.23e+02]:	1	0

cutSequence HHHVVV

encounter ##> reportNetLen
*** Net length and connection length statistics
(cell fpAdder32) ***

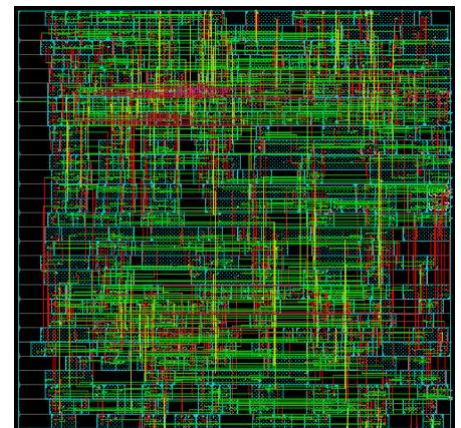
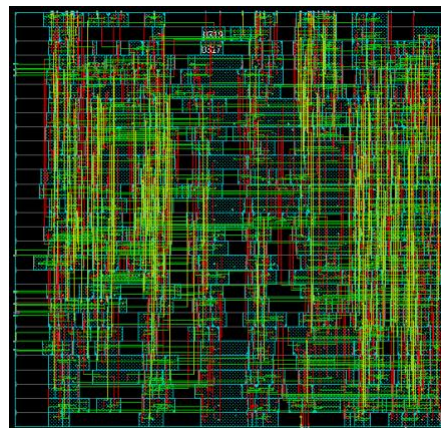
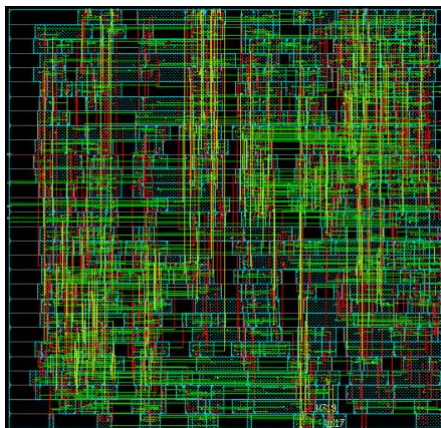
Total net length = 1.453e+04 (9.262e+03
5.267e+03)

Avg net length = 1.730e+01 (sigma =
1.925e+01)
Sqrt of avg square net length = 2.588e+01

Avg connection length = 7.189e+00 (sigma =
6.170e+00)
Sqrt of avg square connection length =
9.474e+00

Net and connection length distribution:

[length range]	#net	#connection
[0.00e+00 5.60e+00]:	264	446
[5.60e+00 1.12e+01]:	204	218
[1.12e+01 1.68e+01]:	105	102
[1.68e+01 2.24e+01]:	56	34
[2.24e+01 2.80e+01]:	42	17
[2.80e+01 3.36e+01]:	37	12
[3.36e+01 3.92e+01]:	22	8
[3.92e+01 4.48e+01]:	26	0
[4.48e+01 5.04e+01]:	24	2
[5.04e+01 5.60e+01]:	9	1
[5.60e+01 6.16e+01]:	10	0
[6.16e+01 6.72e+01]:	13	0
[6.72e+01 7.28e+01]:	8	0
[7.28e+01 7.84e+01]:	9	0
[7.84e+01 8.40e+01]:	2	0
[8.40e+01 8.96e+01]:	3	0
[8.96e+01 9.52e+01]:	2	0
[9.52e+01 1.01e+02]:	1	0
[1.06e+02 1.12e+02]:	1	0
[1.23e+02 1.29e+02]:	1	0
[1.34e+02 1.40e+02]:	1	0



Routing

Use **Default** cutSequence from Placement

Total net length: Default < VVVHHH < HHHVVV

#Complete Global Routing.

#Total wire length = 13542 um.

#Total half perimeter of net bounding box = 14241 um.

#Total wire length on LAYER metal1 = 0 um.

#Total wire length on LAYER metal2 = 4546 um.

#Total wire length on LAYER metal3 = 5546 um.

#Total wire length on LAYER metal4 = 2862 um.

#Total wire length on LAYER metal5 = 571 um.

#Total wire length on LAYER metal6 = 0 um.

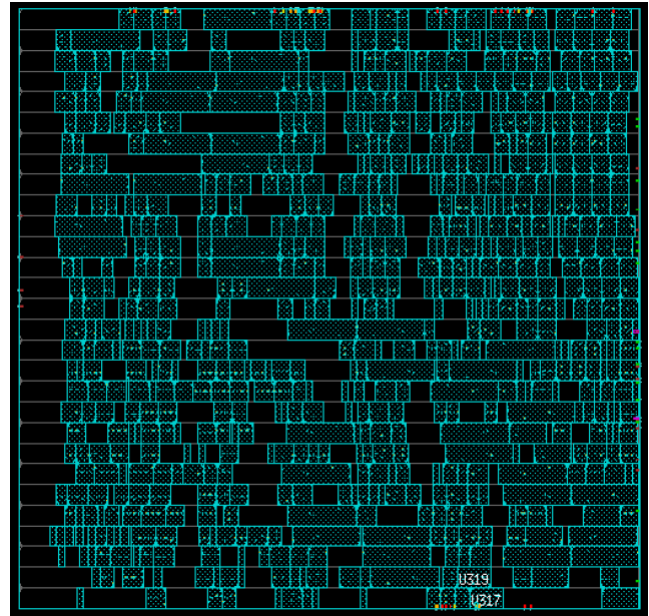
#Total wire length on LAYER metal7 = 0 um.

#Total wire length on LAYER metal8 = 18 um.

#Total number of vias = 4610

#Up-Via Summary (total 4610):

```
#
#-----
# Metal 1      2629
# Metal 2      1524
# Metal 3       365
# Metal 4        71
# Metal 5        13
# Metal 6         5
# Metal 7         3
#-----
#              4610
```



#Complete Detail Routing.

#Total wire length = 14284 um.

#Total half perimeter of net bounding box = 14241 um.

#Total wire length on LAYER metal1 = 120 um.

#Total wire length on LAYER metal2 = 5373 um.

#Total wire length on LAYER metal3 = 5726 um.

#Total wire length on LAYER metal4 = 2596 um.

#Total wire length on LAYER metal5 = 372 um.

#Total wire length on LAYER metal6 = 61 um.

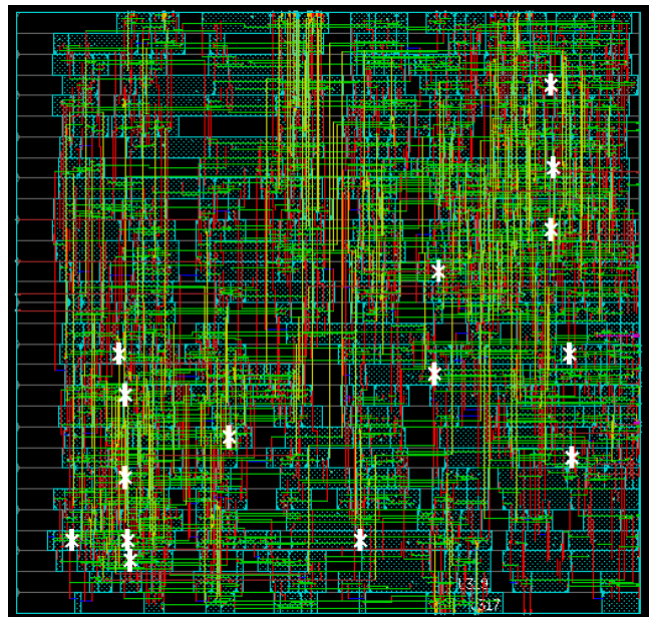
#Total wire length on LAYER metal7 = 6 um.

#Total wire length on LAYER metal8 = 29 um.

#Total number of vias = 5861

#Up-Via Summary (total 5861):

```
#
#-----
# Metal 1      2802
# Metal 2      2541
# Metal 3       449
# Metal 4        48
# Metal 5        13
# Metal 6         5
# Metal 7         3
#-----
#              5861
```



Verification

```
encounter ##> checkPlace
Begin checking placement ... (start mem=436.6M, init mem=436.6M)
*info: Placed = 734
*info: Unplaced = 0
Placement Density:70.05%(4778/6821)
Finished checkPlace (cpu: total=0:00:00.0, vio checks=0:00:00.0; mem=436.6M)
0
```

```
encounter ##> verifyGeometry
*** Starting Verify Geometry (MEM: 672.6) ***

VERIFY GEOMETRY ..... Starting Verification
VERIFY GEOMETRY ..... Initializing
VERIFY GEOMETRY ..... Deleting Existing Violations
VERIFY GEOMETRY ..... Creating Sub-Areas
..... bin size: 4960
VERIFY GEOMETRY ..... SubArea : 1 of 1
VERIFY GEOMETRY ..... Cells      : 0 Viols.
VERIFY GEOMETRY ..... SameNet    : 15 Viols.
VERIFY GEOMETRY ..... Wiring     : 0 Viols.
VERIFY GEOMETRY ..... Antenna     : 0 Viols.
VERIFY GEOMETRY ..... Sub-Area : 1 complete 15 Viols. 0 Wrngs.
VG: elapsed time: 0.00
Begin Summary ...
Cells      : 0
SameNet    : 15
Wiring     : 0
Antenna    : 0
Short      : 0
Overlap    : 0
End Summary

Verification Complete : 15 Viols. 0 Wrngs.

*****End: VERIFY GEOMETRY*****
*** verify geometry (CPU: 0:00:00.5 MEM: 14.1M)
```

```
encounter ##> verifyConnectivity
VERIFY_CONNECTIVITY use new engine.

***** Start: VERIFY CONNECTIVITY *****
Start Time: Sat Apr 28 00:20:58 2018

Design Name: fpAdder32
Database Units: 1000
Design Boundary: (0.0000, 0.0000) (84.0550, 81.2000)
Error Limit = 1000; Warning Limit = 50
Check all nets

Begin Summary
Found no problems or warnings.
End Summary

End Time: Sat Apr 28 00:20:58 2018
Time Elapsed: 0:00:00.0

***** End: VERIFY CONNECTIVITY *****
Verification Complete : 0 Viols. 0 Wrngs.
(CPU Time: 0:00:00.0 MEM: 0.000M)
```
