

Trinary System

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You have invented a technology that enables the efficient implementation of a trinary (3 state) system. The company to which you've sold your invention, TriStateCorp., has asked you to design a base-3 floating-point system that is at least as accurate as an IEEE binary32 binary floating point system. How many digits would you propose for your system? You should discuss the reasons behind your proposal.

1 Sign Digits

By default the system receives 1 implicit digit, since there is no need for more than 1 positive or negative digit to indicate sign.

S digits = 1

2 Exponent

IEEE binary 32 bit system has 256 values which is 2^8 which means it uses 8 w digits. If we use 8 w digits for this system, that would be 3^8 which is 6561 values. This is much larger than what IEEE provides, so we can reduce it, 3^5 gives us 243. 243 is actually lower than what we need since we need at least 256. 3^6 gives us 729 which is more than what we need.

W digits = 6

3 Significand

The IEEE has 24 ($23 + 1$) digits, which leads to $2^{23} = 8,388,608$ digits. If we want something equal or larger to this for our system, I am going to start from 10

$3^{10} = 59,049$ this isn't close to enough so I'm going to jump ahead
 $3^{14} = 4,782,969$ Almost there
 $3^{15} = 14,348,907$ That's good enough
(I could have also done $\log_3(2^{23}) \approx 14.5$)

P digits = 16 (15 + 1)

In total there are 22 (6 w digits + 16 p digits) digits in my system.

S digits = 1
W digits = 6
P digits = 16

Total Number of digits = 22

To be at least as accurate as IEEE 32 digit system, my system would be required to be a 22 digit system