

Exploring Binary

Topics

Many of my articles address common topics; I've grouped them here for your convenience.

Properties of the Powers of Two

Binary numbers are made of [powers of two](#); these articles discuss their properties:

- [How to Find the Last Digits of a Positive Power of Two](#)
- [Patterns in the Last Digits of the Positive Powers of Two](#)
- [Cycle Length of Powers of Two Mod Powers of Ten](#)
- [Seeing Powers of Five in Powers of Two and Vice Versa](#)
- [Patterns in the Last Digits of the Positive Powers of Five](#)
- [Cycle Length of Powers of Five Mod Powers of Ten](#)
- [Ending Digits of Powers of Five Form a Binary Tree](#)

Properties of Binary Numbers

These articles discuss properties of binary numerals:

- [A Pattern in Powers of Ten and Their Binary Equivalents](#)
- [Nines in Binary](#)

Binary Arithmetic

These articles discuss binary arithmetic:

- [Binary Addition](#)
- [Binary Subtraction](#)
- [Binary Multiplication](#)

- [Binary Division](#)

Bicimals

These articles discuss bicimals, the binary equivalent of decimals:

- [Bicimals](#)
- [Converting a Bicimal to a Fraction \(Subtraction Method\)](#)
- [Converting a Bicimal to a Fraction \(Direct Method\)](#)
- [Converting a Bicimal to a Fraction \(Series Method\)](#)
- [“0.1 Repeating” In Binary Equals 1](#)
- [Number of Decimal Digits In a Binary Fraction](#)

Binary Palindromes

These articles discuss binary palindromes (numbers like 1001001):

- [Finding Numbers That Are Palindromic In Multiple Bases](#)
- [Counting Binary and Hexadecimal Palindromes](#)
- [The Structure of Binary/Hexadecimal Palindromes](#)
- [Counting Binary/Hexadecimal Palindromes](#)
- [In Search of Decimal/Binary/Hexadecimal Palindromes](#)

Visualizing Binary Numbers

These articles discuss ways to visualize binary numbers:

- [Visualizing Consecutive Binary Integers](#)
- [What a Binary Counter Looks and Sounds Like](#)

Correctly Rounded Decimal to Floating-Point Conversion

These articles discuss conversion of decimal strings to floating-point binary numbers:

- [Quick and Dirty Decimal to Floating-Point Conversion](#)
- [Decimal to Floating-Point Needs Arbitrary Precision](#)
- [Incorrectly Rounded Conversions in Visual C++](#)
- [Incorrectly Rounded Conversions in GCC and GLIBC](#)
- [Correctly Rounded Conversions in GCC and GLIBC](#)
- [GCC Conversions Are Incorrect, Architecture or Otherwise](#)
- [real.c Rounding Is Perfect \(GCC Now Converts Correctly\)](#)
- [GLIBC strtod\(\) Incorrectly Converts \$2^{1075}\$](#)
- [Visual C++ and GLIBC strtod\(\) Ignore Rounding Mode](#)
- [Correct Decimal To Floating-Point Using Big Integers](#)
- [How strtod\(\) Works \(and Sometimes Doesn't\)](#)
- [How GLIBC's strtod\(\) Works](#)
- [How GCC Converts Decimal Literals to Floating-Point](#)
- [Fast Path Decimal to Floating-Point Conversion](#)
- [strtod\(\)'s Initial Decimal to Floating-Point Approximation](#)
- [Using Integers to Check a Floating-Point Approximation](#)
- [Adjusting the Floating-Point Approximation in strtod\(\)](#)
- [Bigcomp: Deciding Truncated, Near Halfway Conversions](#)
- [Properties of the Correction Loop in David Gay's strtod\(\)](#)
- [Incorrect Directed Conversions in David Gay's strtod\(\)](#)
- [A Bug in the Bigcomp Function of David Gay's strtod\(\)](#)
- [Gay's strtod\(\) Returns Zero For Inputs Just Above \$2^{1075}\$](#)
- [A Better Way to Convert Integers in David Gay's strtod\(\)](#)
- [Double Rounding Errors in Floating-Point Conversions](#)
- [GCC Avoids Double Rounding Errors With Round-To-Odd](#)
- [Incorrect Decimal to Floating-Point Conversion In SQLite](#)
- [PHP Hangs On Numeric Value 2.2250738585072011e-308](#)
- [Why "Volatile" Fixes the 2.2250738585072011e-308 Bug](#)
- [A Better Fix for the PHP 2.2250738585072011e-308 Bug](#)

- [Java Hangs When Converting 2.2250738585072012e-308](#)
- [A Closer Look at the Java 2.2250738585072012e-308 Bug](#)
- [PHP Converts 2.2250738585072012e-308 Incorrectly](#)
- [Incorrectly Rounded Subnormal Conversions in Java](#)
- [Nondeterministic Floating-Point Conversions in Java](#)
- [Visual C++ strtod\(\): Still Broken](#)
- [17 Digits Gets You There, Once You've Found Your Way](#)
- [Double Rounding Errors in Decimal to Double to Float Conversions](#)
- [Direct Generation of Double Rounding Error Conversions in Kotlin](#)

Correctly Rounded Floating-Point to Decimal Conversion

These articles discuss conversion of floating-point binary numbers to decimal strings:

- [Quick and Dirty Floating-Point to Decimal Conversion](#)
- [Incorrect Floating-Point to Decimal Conversions](#)
- [Inconsistent Rounding of Printed Floating-Point Numbers](#)
- [Fifteen Digits Don't Round-Trip Through SQLite Reals](#)
- [15-Digit Quick and Dirty Conversions Don't Round-Trip](#)
- [The Shortest Decimal String That Round-Trips: Examples](#)
- [Incorrect Round-Trip Conversions in Visual C++](#)
- [The Shortest Decimal String That Round-Trips May Not Be The Nearest](#)
- [Java Doesn't Print The Shortest Strings That Round-Trip](#)

Printing the Contents of a Floating-Point Variable

These articles show different ways to display the exact contents of an IEEE 754 floating-point variable:

- [Nine Ways to Display a Floating-Point Number](#)
- [Displaying the Raw Fields of a Floating-Point Number](#)
- [Hexadecimal Floating-Point Constants](#)

- [Displaying IEEE Doubles in Binary Scientific Notation](#)
- [Converting Floating-Point Numbers to Binary Strings in C](#)
- [Nine Ways to Display a Floating-Point Number](#)

The Theory Behind Round-Trip Floating-Point Conversions

These articles discuss the mathematics that govern round-trip floating-point conversions:

- [The Spacing of Decimal Floating-Point Numbers](#)
- [The Spacing of Binary Floating-Point Numbers](#)
- [7 Bits Are Not Enough for 2-Digit Accuracy](#)
- [Number of Digits Required For Round-Trip Conversions](#)
- [The Inequality That Governs Round-Trip Conversions: A Partial Proof](#)
- [Decimal Precision of Binary Floating-Point Numbers](#)

Length Of Numbers In Decimal Vs. Binary

These articles discuss the length of numbers when expressed in decimal vs. binary:

- [Number of Bits in a Decimal Integer](#)
- [Number of Decimal Digits In a Binary Integer](#)
- [Number of Decimal Digits In a Binary Fraction](#)
- [Maximum Number of Decimal Digits In Binary Floating-Point Numbers](#)

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