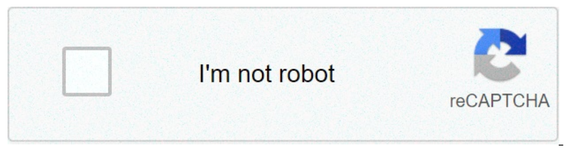

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Hexadecimal to binary conversion calculator

To convert hexadecimal to binary is very simple, we just need the table below to perform the conversion, each digit of the hexadecimal is composed of 4 bits. Hexadecimal Binary 0 0000 1 0001 2 0010 3 0011 4 0100 5 0101 6 0110 7 0111 8 1000 9 1001 A 1010 B 1011 C 1100 D 1101 E 1110 F 1111 Find the binary value of AF185: Number hexadecimal: A F 1 8 5 Result: 1010 1111 0001 1000 0101 AF18516 = 101011110001100001012 Eugene is a qualified control/instrumentation engineer Bsc (Eng) and has worked as a developer of electronics & software for SCADA systems.The Hexadecimal Numbering SystemThe base 16, also known as hexadecimal (abbreviated to hex) numbering system is regularly used in computer coding for conveniently representing a byte or word of data. This guide shows you how to convert from hex to binary and binary to hexadecimal.Hex and binary representations of a number© Eugene BrennanDecimal, the Base 10 Numbering SystemBefore we learn how to convert hex to binary, let's try and understand how the base 10 system works.The decimal, also known as the denary or base 10 numbering system that we use in everyday life makes use of ten symbols or numerals: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9.So to count you start with 0, then continue 1...2...3...4...5...6...7...8...9What happens when you get to ten? There's no numeral for ten, so it's represented as10Which means 1 ten and no unitsSimilarly when you get to 99, there's no numeral for one hundred, so you write one hundred as 100.So writing a number in the base 10 system involves using numerals in a "units", "tens", "hundreds", "thousands" place and so onSo 145 really means "one hundred, 4 tens and 5 units" although we just think of it as the number one hundred and forty five.Hexadecimal, the Base 16 Numbering SystemHexadecimal or "hex" is a numbering system which uses 16 different numerals. We saw that decimal used ten numerals from 0 to 9. Hex expands on this by adding six more, the capital letters A, B, C, D, E and F.So to count from 0 to 9 you go 0...1...2...3...4...5...6...7...8...9But what happens next?Simply continue with A...B...C...D...E...F which represents 10, 11, 12, 13, 14 and 15 decimal.So now to count to 15 we go 0...1...2...3...4...5...6...7...8...9...A...B...C...D...E...FIn the decimal system, we saw that when we got to nine, there was no numeral for ten so it was represented as 10 or "one ten and no units".In the hex system when we get to F which is 15 decimal, we have to represent the next number sixteen as 10 or "one 16 and no units".Binary, the Base 2 Numbering SystemThe binary system used by computers is based on 2 numerals; 0 and 1. So you count 0, 1, there is no numeral for 2, so 2 is represented by 10 or "one 2 and no units". In the same way that there is a units, tens, hundreds, thousands place in the decimal system, in the binary system there is a units, twos, fours, eights, sixteens place etc. in the binary system.Decimal to Hex and Binary TableBinary, decimal and hex equivalents.DecimalHexBinary000111221033114410055101661107711881000991001 10A101011B101112C110013D110114E111015F111116101000017111000181210010191310012014101 00.....251911001261A11010271B11011281C11100291D11101301E11110311F1111132201000003321100001342210001 0Indicating the Base of a NumberIf a number isn't decimal (base 10), the base can be explicitly indicated by a subscript to avoid confusion. Sometimes the subscript is omitted to avoid excessive detail if the base has been specified earlier in a discussion or if numbers are listed in a table (e.g. numbers may be indicated as hex in the title of the table).So for instance 1F hex (31 decimal) can be written 1F16Steps to Convert Hex to BinaryHex is very easy to convert to binary.Write down the hex number and represent each hex digit by its binary equivalent number from the table above. Use 4 digits and add insignificant leading zeros if the binary number has less than 4 digits. E.g. Write 102 (2 decimal) as 00102. Then concatenate or string all the digits together. Discard any leading zeros at the left of the binary number. Converting hex to binary© Eugene BrennanMost Significant Bit (MSB) and Least Significant Bit (LSB)For a binary number, the most significant bit (MSB) is the digit furthermost to the left of the number and the least significant bit (LSB) is the rightmost digit.Most significant bit (MSB) and least significant bit (LSB).© Eugene BrennanSteps to Convert Binary to HexBinary is also easy to convert to hex.Start from the least significant bit (LSB) at the right of the binary number and divide it up into groups of 4 digits. (4 digital bits is called a "nibble"). Convert each group of 4 binary digits to its equivalent hex value (see table above). Concatenate the results together, giving the total hex number. Converting binary to hex© Eugene BrennanTest Yourself!For each question, choose the best answer. The answer key is below.Convert ABCD hex to binary1010101010101011110011011111111101100110111110000111010 10What is 10101010 in hex?Convert FFFF to decimalAnswer KeyWhat is Hex Used For?Because of the ease of converting from hex to binary and vice versa, it's a convenient shorthand for representing byte values i.e. numbers from 0 to 255. Also it is compact, requiring only 2 digits for a byte and 4 digits for a word.Typical uses of hex:Hex dumps are listings of the bytes in a file in hex format. Assembly language is written as a series of mnemonic (short, easy to remember word) instructions for a microprocessor. The operand (the data operated on by an opcode) is commonly specified as a hex value. It's also used to indicate the storage location of data Example of assembly language instructionIn the short code segment below, MOV is the opcode (instruction) and 61 hex is the operand that the opcode acts on. AL is a register that stores a value temporarily so that arithmetic can be done on it before it's moved to memory. A program called an assembler converts the human understandable assembly language to machine code.MOV AL, 61H ; Load AL register with 61 hex (97 decimal)Assembly Language Program for an 8 Bit MicroprocessorAn assembly language listing for a Motorola 6800 8-bit microprocessorOriginal image public domain via Wikimedia CommonsHex Dump of a FileA "hex dump" or byte value listing of a JPG file as viewed in a file editor. On the left, each byte is displayed as a hex value. On the right, alphanumeric characters corresponding to ASCII values of the bytes are shown.© Eugene BrennanASCII Code TableTwo hex numerals also conveniently represent the 255 codes of the extended ASCII character set, used in computing for communication and text storage and display.Yuriy Arabskyy, CC-SA-3.0 via Wikimedia CommonsHow to Convert Decimal to BinaryTo convert decimal to binary and binary to decimal, see my other guide:How to Convert Decimal to Binary and Binary to DecimalWhat is Binary Used For?For more details on how binary is used in computer systems and digital electronics, see my other article:Why is Binary Used In Computers and Electronics?How to Convert Hex to DecimalYou can convert hex to decimal by simply multiplying each hex numeral by the placeholder's value as a power of 16 and adding the result. (F16 = 15 decimal and A16 = 10 decimal)Example: What is the decimal equivalent of 52FA16 ?52FA16 = 5 x 163 + 2 x 162 + 15 x 161 + 10 x 160= 5 x 4096 + 2 x 256 + 5 x 16 + 10 x 1= 21,242Questions & AnswersQuestion: What is the hexadecimal value of 10110?Answer: It's 16.Question: What is an octal number?Answer: Octal numbers use 8 symbols rather than 10 as in the base 10 or denary system we use for normal counting. So in octal, we count 0, 1, 2, 3, 4, 5, 6, 7 Eight is represented as 10 because we don't use the symbols 8 and 9 This is like the way ten is represented in the base 10 system by the symbols 1 and 0, i.e. we write ten as 10 because there's no symbol for ten. Everytime an octal number reaches a power of 8, we add a new place digit. So 64 is 100 in octal just like one hundred is 100 in the base 10 numbering system Question: What is a use of octal?Answer: It can be used as a shorter representation of binary (just like hex). For instance, the number 01011101 can be grouped into groups of three digits (in this case add a lead "0"), The number then becomes 135 octal.© 2018 Eugene BrennanCommentsEugene Brennan (author) from Ireland on April 28, 2020:Thanks Sasha for the kind comment!Sasha on April 28, 2020:This really helps me in school in one of my subjects.Uttam on February 07, 2020:Thank you for sharing great knowledgesSanga nwaka on November 26, 2019:Great knowledges gainedThanks alot..Umay habeeba on October 20, 2019:Very interesting yet informative .Thnxonesmus on August 24, 2019:thank youcaptain marvel on August 18, 2019:thank you for the information.....Athena Crane on August 18, 2019:nice ive learned home / math / hex calculator RelatedBinary Calculator | IP Subnet Calculator The hexadecimal number system (hex) functions virtually identically to the decimal and binary systems. Instead of using a base of 10 or 2 respectively, it uses a base of 16. Hex uses 16 digits including 0-9, just as the decimal system does, but also uses the letters A, B, C, D, E, and F (equivalent to a, b, c, d, e, f) to represent the numbers 10-15. Every hex digit represents 4 binary digits, called nibbles, which makes representing large binary numbers simpler. For example, the binary value of 1010101010 can be represented as 2AA in hex. This helps computers to compress large binary values in a manner that can be easily converted between the two systems. Below are some typical conversions between hex, binary, and decimal values: Hex/Decimal Conversion Converting between decimal and hex involves understanding the place values of the different number systems. A more in-depth discussion is available on the binary calculator page. Note that converting between decimal and hex is quite similar to converting between decimal and binary. The ability to perform the conversion of either should make the other relatively simple. As previously mentioned, hex functions using the base of 16. This means that for the value 2AA, each place value represents a power of 16. Starting from the right, the first "A" represents the "ones" place, or 160. The second "A" from the right represents 161, and the 2 represents 162. Remember that "A" in hex is equivalent to 10 in decimal. Knowing this information, it is then possible to convert from hex to decimal, as shown below: EX:2AA = (2 × 162) + (A × 161) + (A × 160) = (2 × 256) + (10 × 16) + (10 × 1) = 512 + 160 + 10 = 682 Converting from decimal to hex is slightly more involved, but uses the same concepts. Refer to the steps and examples below. It is important to work through the example provided in conjunction with the listed steps in order to understand the process: Find the largest power of 16 that is less than or equal to the number to be converted, which will be referred to as X. Determine how many times the power of 16 found in Step 1 goes into X, and take note of that number. Multiply the number found in Step 2 by the power of 16 and subtract this value from X. This new value will be referred to as Y. Note that the number found in Step 2 will be the value written in the place value for the power of 16 that was found. If, for example, the largest power of 16 was found to be 164, and the number in Step 2 was found to be 3, the hex value would have the number 3 in its 164 place value: 3qrst, where qrst represents the 160 through 3 place values. Repeat Steps 1-3 using Y as the new starting value. Continue the process until 16 is larger than the remaining value, and assign the remainder to the 160 place value. Assign each of the values found in each iteration of Step 2 to its respective place value to determine the hex value. EX:Convert decimal 1500 to hex (1)Largest power = 162 = 256 (2)256 × 5 = 1280, so (5 × 162) (3)1500 - 1280 = 220 (4)16 × 13 = 208, so (13 × 161) (5)220 - 208 = 12 (6)16 is larger than 12, so 12 is the value in the 160 place value (7)1500 = (5 × 162) + (13 × 161) + (12 × 160) (8)Remember that 10-15 have letter numerals In hex: 13 = D, and 12 = C (9)Therefore the hex value of 1500 is: 5DC Converting from hex to decimal utilizes the same principles, but is arguably simpler. Multiply each digit in the hex value by its corresponding place value, and find the sum of each result. The process is the same regardless of whether the hex value contains letter numerals or not. EX:Convert hex 1024 to decimal (1)(1 × 163) + (0 × 162) + (2 × 161) + (4 × 160) (2)4096 + 0 + 32 + 4 = 4132 Hex Addition Hex addition follows the same rules as decimal addition with the only difference being the added numerals A, B, C, D, E, and F. It may be convenient to have the decimal equivalent values of A through F handy when performing hex operations if the values have not yet been committed to memory. Below is an example of hex addition. Work through the example, and refer to the text below it for further details. EX: Hex addition involves calculating basic decimal addition while converting between hex and decimal when values larger than 9 (the numerals A through F) are present. In the example above, B + 8 in decimal is 11 + 8 = 19. 19decimal is 13hex, since there is 1 set of 16, with 3 left over. Just like in decimal addition, the 1 carries over to the next column. Hence, the next column works out to be 1 + A (10) + 7 = 18decimal, or 12hex. Carry over the 1 to the final column resulting in 1 + 8 + B (11) = 20decimal, or 14hex. This yields the result of 1423hex. Hex Subtraction Hex subtraction can be computed much the same way as hex addition; by performing the operation while converting between hex and decimal values. The most significant difference between hex and decimal subtraction involves borrowing. When borrowing in hex, the "1" that is borrowed represents 16decimal rather than 10decimal. This is because the column that is being borrowed from is 16 times larger than the borrowing column (the same reason that the borrowed 1 in decimal represents 10). As long as this is noted, and conversions of the letter numerals A-F are done carefully, hex subtraction is not any more difficult than decimal subtraction. Work through the example, and refer to the text below it for further details. EX: In the first column on the right of the above example, C, or 12decimal, is smaller than F, or 15decimal. As such, it is necessary to borrow from the next column. This reduces the D, to C, and lends 1, or 16decimal to the first column. 16decimal + 12decimal - 15decimal = 13decimal, or D in the first column. The following columns require no borrowing, making the calculations simple. Since 1 was borrowed, C - A = 12decimal - 10decimal = 2, and 5 - 3 = 2 yielding the final result of 22D. In the case where the number being subtracted is larger than the number being subtracted from, simply change the positions of the numbers, calculate the subtraction, and add a negative sign to the result. If the above example were instead 3AF - 5DC, it would then be written as is, except that the solution would be -22D. Hex Multiplication Hex multiplication can be tricky because the conversions between hex and decimal when performing the operations require more effort since the numerals tend to be larger. Having a hexadecimal multiplication table can be helpful (one is provided below). Otherwise, manual conversion between decimal and hex will be necessary for each step. Below is an example of hex multiplication. To the right of the example, each of the multiplication and addition steps is shown. Note that all of the numerals used are hex. Refer to the addition section if necessary. EX: FA 3 × A = 1E; 1 carried to F × C33 × F = 2D, + 1 = 2E 2EE C × A = 78; 7 carried to F + BB80C × F = B4, + 7 = BB = BE6E Hex Division Long division in hex is identical to long division in decimal, except that the multiplication and subtraction occur in hex. It is also possible to convert to decimal and perform long division in decimal, then convert back once complete. For illustrative purposes, the division example will be calculated entirely in hex. As with multiplication, having a hexadecimal multiplication table (one is provided below) would be convenient while conducting hex division. Below is an example. Note that all numerals in the example are hex. Although no borrowing occurs in the example below, remember that borrowing in hex results in 16decimal being borrowed, rather than 10decimal. Refer to the hex subtraction section for further details. Hexadecimal Multiplication Table