World of Electronics Study
Electronics Study from basic to advanced

Basic Electronics Series

Electricity is a form of energy that exists within the fundamental structure of the atom. The study of electricity and electronics provides an understanding of how electric energy can be harnessed for practical application. Many electrical quantities are extremely small or extremely large. The math used for calculations and expressing component values needs to be covered before getting into electrical concepts. If you are truly serious about understanding and learning electronics, study this first unit and don't make the mistake of skipping it.

Lesson One: Primary Math Concepts

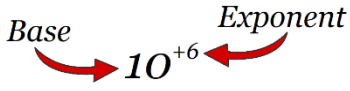
Decimal System

Using Decimal Numbers is our standard way of writing numbers without expressing them using powers of ten. The decimal point has no fixed position for numbers in the standard form. For this reason, standard decimal numbers are sometimes called floating point decimal numbers.

Due to the nature of electrical quantities, other methods have been developed to express these quantities. These methods utilize powers of ten and/or metric prefixes to facilitate the expression of and the math operations required in science.

Powers of Ten

Powers of Ten is a notation used when dealing with extremely large or small numbers. The decimal system uses the numerals zero thru nine. That is a total of ten possible digits which is what establishes the base of the decimal system. In science Powers of ten is used as a multiplier or an exponent to eliminate the need for multiple zeros.

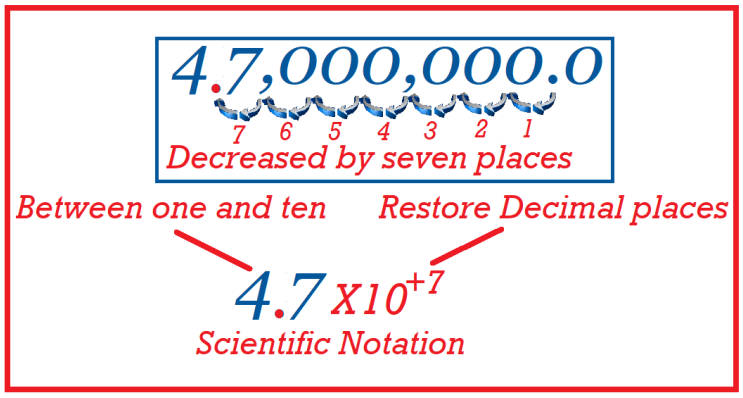


Two tips to keep in mind regarding the value of Powers of Ten are as follows:

- First that ten to the zero power is one &
- Second that ten to first power is equal to ten

Scientific Notation

By using powers of ten, a process known as Scientific Notation allows large and small numbers to be more manageable. To express a number using Scientific Notation, the decinal is moved to render a value greater than one but less than ten. A power of ten whose exponent makes up for the number of places that the decimal was moved is used as a multiplier.



Engineering Notation

Another form in which powers of ten is used is Engineering Notation. The decimal point is moved to result in a value between one and one thousand and a metric prefix is used to compensate for the position change. Commonly used in Electronics, Engineering Notation is combined with the prefixes of the metric system as shown in the following table:

++ →+
+− →−
−+ →−
−− →+

Metric Prefix		Power of Ten	Standard Notation
Tera	T	10^{12}	1,000,000,000,000
Giga	G	10^{9}	1,000,000,000
Mega	M	10^{6}	1,000,000
kilo	k	10^{3}	1,000
Units		10^{0}	1
milli	m	10^{-3}	.001
micro	u	10^{-6}	.000001
nano	n	10^{-9}	.000000001
pico	p	10^{-12}	.000000000001

Engineering Notation

$47{,}000{,}000 = 47 \times 10^{6} = 47M$

Math operations using powers of ten

1. Addition & Subtraction

Step1. All the numbers need to be expressed using the same power of ten.
Step2. The numbers can then be added or subtracted using standard math.
Step3. The original power of ten is to be used with the result.

Addition

$33{,}000 + 470{,}000 = 503{,}000$
$33k + 470k = 503k$

$6.8m + 200u = ?$
$6.8 \times 10^{-3} + 200 \times 10^{-6} =$
$6.8 \times 10^{-3} + .200 \times 10^{-3} =$
$7.0 \times 10^{-3} = 7.0m$

Subtraction

$470{,}000 - 33{,}000 =$
$470k - 33k = 437k$

$6.8m - 200u = ?$
$6.8 \times 10^{-3} - 200 \times 10^{-6} =$
$6.8 \times 10^{-3} - .200 \times 10^{-3} =$
$6.78 \times 10^{-3} = 6.78m$

2. Multiplication

Step1. Multiply the numbers using standard math rules.
Step2. As a separate operation, add the exponents of the powers of ten portion of the two numbers.
Step3. Form the answer using the results from step one and use the powers of ten results from step two.

Multiplication

$4{,}700 \times 330 =$
$(4.70 \times 10^{+3})(330 \times 10^{0}) =$
$(4.7 \times 330)(10^{+3} + 10^{0}) =$
$1551 \times 10^{+3} = 1.551 \times 10^{+6} =$
$1.551M$

$.009 \times 76000 =$
$(9 \times 10^{-3})(76 \times 10^{+3}) =$
$(9 \times 76)(10^{-3} + 10^{+3}) =$
$684 \times 10^{0} = 684$

++ → +
+− → −
−+ → −
−− → +

3. Division

Step1. Divide the numbers using standard math rules.
Step2. Subtract the exponent of the powers of ten exponent of the denominator from that of the numerator.

Step3. Form the answer using the results from step one and use the power of ten resulting from step two.

Division $\frac{Numerator}{Denominator}$ ++→+ +−→− −+→− −−→+

$$1.38x10^{+2}/840x10^{-3}=$$
$$(1.38/840)x(10^{-3}-10^{+2})=$$
$$.0016428x10^{+5}$$
$$164.28$$

4. Finding the Reciprocal

To find the reciprocal of a power of ten, change the sign of the exponent of the power of ten.

$$56.0x10^{+3} \text{ Reciprocal} \rightarrow 56.0x10^{-3}$$

5. Squaring

To square a number that is in powers of ten form, the process is as follows:

Step1. Square the numerical part of the power of ten.

Step2. Double the exponent of the power of ten.

Step3. The answer is the result of step one using the result of step two as the power of ten.

$$(9x10^{+4})^2 \text{ Squared} \rightarrow 81x10^{+8}$$

6. Finding the Square Root

To find the square root of a number that is in powers of ten form, the process is as follows:

Step1. Find the square root of the numerical part of the power of ten.

Step2. Divide the exponent of the power of ten by two.

Step3. The square root will be the result of step one using the power of ten found in step two.

The square root of $31.640625 \times 10^{+6} = 5.625 \times 10^{+3}$

This concludes the review of the rules regarding the treatment of powers of ten. Lesson Two will start you on a journey leading to your understanding of Electronics. As a precursor you need to study the terms and concepts of electricity.