# Electrical Calculations

## Overview

Electrical Calculations is made up of multiple small applications to solve specific problems in electrical and electronics design and test. A reference section is included in this help file with formulas, definitions, standard value tables and color codes.

For maximum flexibility and to reduce memory requirements, each application may be operated independent of the others. Multiple applications can be opened and multiple copies of each application may be opened at the same time.

## Instructions

All of the applications operate in a similar manner and follow Windows convention. Minor differences between applications are due to the requirements of the calculations.

## Editing

1. Values may be pasted into or copied from text boxes using normal Windows cut, copy, and paste procedures.

2. In a text box, values may be edited using the Backspace and Del keys.

### Clear All

Click the Clear All icon to clear all values and reset the display for a new calculation.

### About

Click the About icon for copyright and registration information. Click on the **OK** button or strike Enter to close the About Form.

### Exit

To exit the program and return to Windows click on the Exit icon. Click on the **OK** button or strike Enter to exit to Windows. Select **Cancel** to remain in the program.

## Definitions

AC
Ampere
Capacitance
Current
DC
Farad
Impedance
Ohm
Power
Reactance
Resistance
Text Box
Volt
Watt

## Formulas

## Standards

Color Codes
Standard Capacitor Values
Standard Resistor Values

**A.C.**

Alternating Current - Current that flows in both directions through a conductor. The frequency of change in direction is measured in Hertz (Hz). The standard electrical power supplied to homes, businesses, etc. is alternating current.

Peak A.C. Voltage - Maximum positive and negative values of an alternating current.

RMS A.C. Voltage - An A.C. voltage that equals a D.C. voltage that does the same work. For a sine wave, RMS = 0.707 X Peak.

Average A.C. voltage = 0.9 X RMS or 0.637 X Peak

RMS A.C. voltage = 1.11 X Average or 0.7.7 X Peak

Peak A.C. voltage = 1.57 X Average or 1.414 X RMS

RMS - Root Mean Square

**Ampere**

The unit of measure of current.

**Capacitance**

The ability to hold or store electrical energy. Capacitance is measured in farads.

**Current**

The quantity of electrons passing a given point. Current is measured in amperes.

**D.C.**

Direct Current - Current that flows in only one direction through a conductor. The flow may be steady or in pulses. A battery supplies direct current.

**Farad**

Unit of measure of electrical capacitance. Since the farad is so large, capacitors are normally rated in microfarads (0.000 001 farads), picofarads (0.000 000 000 001 farads), and occasionally, nanofarads (0.000 000 001 farads).

**Impedance**

The opposition to current flow in an AC circuit. Impedance is measured in ohms.

**Ohm**

The unit of measure of electrical resistance.

**Phase Angle**

The difference in degrees between current and voltage. Applies to AC circuits.

Current leads voltage in capacitive circuits.

Voltage leads current in reactive circuits.

In resistive circuits the phase angle is 0 thus power is calculated as if it were a DC circuit.

**Power**

The work performed by an electrical current. Power is measured in watts.

**Reactance**

Opposition to the flow of current, disregarding resistance, in an AC circuit. Capacitors and inductors are reactive elements in an AC circuit.

**Resistance**

Opposition to the flow of current in a conductor. Resistance is measured in ohms.

**Text Box**


The yellow rectangular box for entering data. The entry is completed by striking the Enter key. Data may be edited with the Delete and Backspace keys.

**Volt**

Unit of measure of electrical force or pressure.

**Watt**

Unit of measure of power or work.

**Capacitors in Parallel Formula**

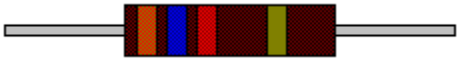

Ct = C1 + C2 + C3. . . Cn

**Capacitors in Series Formula**


$$Ct = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{Cn} \ldots \frac{1}{}}$$

**Color Codes**

Standard color codes used to identify values of resistors and inductors.



Color bands are read from left to right. The first band is the one closest to the end of the part.

| First and Second Bands | | | Third Band - Multiplier | | | Fourth Band - Tolerance | | |
|---|---|---|---|---|---|---|---|---|
| Black | - | 0 | Black | - | 1 | Silver | - | ± 10% |
| Brown | - | 1 | Brown | - | 10 | Gold | - | ± 5% |
| Red | - | 2 | Red | - | 100 | No Band | - | ± 20% |
| Orange | - | 3 | Orange | - | 1,000 | | | |
| Yellow | - | 4 | Yellow | - | 10,000 | | | |
| Green | - | 5 | Green | - | 100,000 | | | |
| Blue | - | 6 | Blue | - | 1,000,000 | | | |
| Violet | - | 7 | Silver | - | 0.01 | | | |
| Gray | - | 8 | Gold | - | 0.1 | | | |
| White | - | 9 | | | | | | |

**Ohm's Law Formula**


E - Voltage in volts
I - Current in amperes
R - Resistance in ohms

**Basis:** 1 Volt is required to force 1 Ampere through 1 Ohm.

E = I x R
I = E/R
R = E/I

Note: D.C. circuits are assumed.

**Power Formula**

E - Voltage in volts
I - Current in amperes
R - Resistance in ohms
P - Power in watts
Z - Impedance in ohms
$\theta$ - Phase angle in degrees

1. D.C. circuits or A.C. resistive circuits.

   P = I x E or P = I2 x R

2. A.C. capacitive or reactive circuits.

   P = I x E x Cosine $\theta$

**Resistors in Parallel Formula**


$$R_t = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{Rn} \ldots \frac{1}{}}$$

**Resistors in Series Formula**


Rt = R1 + R2 + R3. . . Rn

**Standard Capacitor Values**

| | | | |
|---|---|---|---|
| 1.0 | 1.8 | 3.3 | 5.6 |
| 1.2 | 2.2 | 3.9 | 6.8 |
| 1.5 | 2.7 | 4.7 | 8.2 |

Decade multiples of the values shown on the chart above are valid
from:
1.0pf (0.000 000 000 001 farad)
to:
82,000mf (0.082 farad).

Other values may be available in certain types of capacitors.

mf = microfarads
nf = nanofarads
pf = picofarads

1 farad = 1,000,000mf = 1,000,000,000nf = 1,000,000,000,000pf
1mf = 0.000 001farad = 1,000nf = 1,000,000pf
1nf = 0.000 000 001farad = 0.001mf = 1,000pf
1pf = 0.000 000 000 001farad = 0.000 001mf = 0.001nf

**Standard Resistor Values**

| 1% Tolerance | | | | | | 2% & 5% Tol. | | 10% Tol. |
|---|---|---|---|---|---|---|---|---|
| 10.0 | 14.7 | 21.5 | 31.6 | 46.4 | 68.1 | 10.0 | 33.0 | 10.0 |
| 10.2 | 15.0 | 22.1 | 32.4 | 47.5 | 69.8 | 11.0 | 36.0 | 12.0 |
| 10.5 | 15.4 | 22.6 | 33.2 | 48.7 | 71.5 | 12.0 | 39.0 | 15.0 |
| 10.7 | 15.8 | 23.2 | 34.0 | 49.9 | 73.2 | 13.0 | 43.0 | 18.0 |
| 11.0 | 16.2 | 23.7 | 37.8 | 51.1 | 75.0 | 15.0 | 47.0 | 22.0 |
| 11.3 | 16.5 | 24.3 | 35.7 | 52.3 | 76.8 | 16.0 | 51.0 | 27.0 |
| 11.5 | 16.9 | 24.9 | 36.5 | 53.6 | 78.7 | 18.0 | 56.0 | 33.0 |
| 11.8 | 17.4 | 25.5 | 37.4 | 54.9 | 80.6 | 20.0 | 62.0 | 39.0 |
| 12.1 | 17.8 | 26.1 | 38.3 | 56.2 | 82.5 | 22.0 | 68.0 | 47.0 |
| 12.4 | 18.2 | 26.7 | 39.2 | 57.6 | 84.5 | 24.0 | 75.0 | 56.0 |
| 12.7 | 18.7 | 27.4 | 40.2 | 59.0 | 86.6 | 27.0 | 82.0 | 68.0 |
| 13.0 | 19.1 | 28.0 | 41.2 | 60.4 | 88.7 | 30.0 | 91.0 | 82.0 |
| 13.3 | 19.6 | 28.7 | 42.2 | 61.9 | 90.9 | | | |
| 13.7 | 20.0 | 29.4 | 43.2 | 63.4 | 93.1 | | | |
| 14.0 | 20.5 | 30.1 | 44.2 | 64.9 | 95.3 | | | |
| 14.3 | 21.0 | 30.9 | 45.3 | 66.5 | 97.6 | | | |

Decade multiples of the values shown on the chart above are valid to:
Value X 1,000,000

Example:

| | | | |
|---|---|---|---|
| 91 ohms | 910 ohms | 9,100 ohms | 91,000 ohms |
| 910,000 ohms | 91,000,000 ohms | | |

**Voltage Divider - 2 Resistors**


$$Vout = \frac{Vin \times R2}{R1 + R2}$$

## Icons

**Clear All**


**Exit Program**

**Help**


**Capacitors in Parallel**


**Capacitors in Series**


**Ohm's Law**


**Resistors in Parallel**


**Resistors in Series**


**Voltage Divider**

# Capacitors in Parallel Calculations



**Reference Information**


## Overview - Capacitors in Parallel

Capacitors in Parallel Calculations provides a fast and easy method of calculating the total capacitance of up to ten capacitors of varying values in a parallel circuit.

- Individual capacitor values may be entered until the desired total is reached.
- A total capacitance value may be entered along with the desired number of capacitors and the value of each capacitor will be calculated.
- Standard values may be selected and the program will calculate the nearest standard value to the input value for each capacitor and the total of the standard values.

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**Operational Notes**

1. A math coprocessor is not required for this application and use of one will have minimal impact on the speed of calculations.
2. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Capacitors in Parallel

Individual capacitor values may be entered in the test boxes and the program will calculate the total or, a total capacitance and the quantity of capacitors may be entered and the value of each capacitor will be calculated.

### Capacitor value entry

To calculate the sum of up to ten capacitors in a parallel circuit:

1. Type the values in the text box and complete each entry by striking the Enter key. The text box background color will change to white and the total will be recalculated upon completion of each entry.

2. The scroll bars may be used for entry. Click on the arrows to move one unit or click inside the arrows to move ten units. Only integers may be entered using the scroll bars.

3. Values may also be pasted into or copied from text boxes using normal Windows cut, copy, and paste procedures.

### Total capacitance entry

To calculate the values of up to ten capacitors in a parallel circuit when the total is known:

1. Click on the capacitor labels (C1, C2, C3. . . ) for the number of capacitor desired. The background color of the label will change to white. If too many capacitors are selected, double click on the label to remove it from the calculation.

2. Enter the desired total capacitance value in the C Total text box. Complete the entry by striking the Enter key.

3. The value entered into C Total will be divided evenly among the capacitors selected. A border will be added to the selected capacitor labels and the text box will change to white to indicate a calculated value.

4. Additional capacitors may be added by repeating steps 1 and 2 above.

### Standard values

To calculate standard values for individual capacitors and the total capacitance:

1. In the C Values frame, click on the round button for Standard Values. All capacitor values will be changed to the closest standard value and a total of the standard values will be displayed. The difference between C Total and Standard Total is shown as an error.

2. Click on the round button for Actual Values to return the display to the input values. All input values will be displayed and the Standard Total and Error displays will be closed.

## Formulas - Capacitors in Parallel

## Standards

Standard Capacitor Values
All Standards

# Capacitors in Series Calculations



**Reference Information**

## Overview - Capacitors in Series

Capacitors in Series Calculations provides a fast and easy method of calculating the total capacitance of up to ten capacitors of varying values in a series circuit.

- Individual capacitor values may be entered until the desired total is reached.
- A total capacitance value may be entered along with the desired number of capacitors and the value of each capacitor will be calculated.
- Standard values may be selected and the program will calculate the nearest standard value to the input value for each capacitor and the total of the standard values.

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**Operational Notes**

1. A math coprocessor is not required for this application and use of one will have minimal impact on the speed of calculations.

2. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Capacitors in Series

Individual capacitor values may be entered in the text boxes and the program will calculate the total or, a total capacitance and the quantity of capacitors may be entered and the value of each capacitor will be calculated.

### Capacitor value entry

To calculate the sum of up to ten capacitors in a series circuit:

1. Type the values in the text box and complete each entry by striking the Enter key. The total will be recalculated upon completion of each entry.

2. The scroll bars may be used for entry. Click on the arrows to move one unit or click inside the arrows to move ten units. Only integers may be entered using the scroll bars.

3. Values may also be pasted into or copied from text boxes using normal Windows cut, copy, and paste procedures.

### Total capacitance entry

To calculate the values of up to ten capacitors in a series circuit when the total is known:

1. Click on the capacitor labels (C1, C2, C3. . . ) for the number of capacitors desired. The background color of the label will change to white.

2. Enter the desired total capacitance value in the C Total text box. Complete the entry by striking the Enter key.

3. The value entered into C Total will be divided evenly among the capacitors selected. A border will be added to the selected capacitor labels to indicate a calculated value and the text box color will change to white.

4. Additional capacitors may be added by repeating steps 1 and 2 above.

### Standard values

To calculate standard values for individual capacitors and the total capacitance:

1. In the C Values frame, click on the round button for Standard Values. All capacitor values will be changed to the closest standard value and a total of the standard values will be displayed. The difference between C Total and Standard Total is shown as an error.

2. Click on the round button for Actual Values to return the display to the input values. All input values will be displayed and the Standard Total and Error displays will be closed.

## Formulas - Capacitors in Series

## Standards

Standard Capacitor Values
All Standards

## Ohm's Law Calculations



**Reference Information**

## Overview - Ohm's Law

This program provides a fast and easy way to perform ohm's law calculations and learn the relationship of voltage, current, and resistance in direct current circuits.

- **Input volts and amperes -** calculate resistance.
- **Input volts and ohms -** calculate current in amperes.
- **Input amperes and ohms -** calculate volts.
- Standard values of 1%, 2%, 5%, or 10% may be selected and the program will calculate the nearest standard value to the input value.
- When a standard value is selected, calculations will be made with the standard value.

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**Operational Notes**

1. A math coprocessor is not required for this application and use of one will have minimal impact on the speed of calculations.
2. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Ohm's Law

### To calculate current

1. Click on the **I** portion of the triangle to set the input sequence. The background of the **I** will change to white.

2. Enter a value in the Resistance text box and strike Enter. The cursor will move to the Voltage text box.

3. Enter a value in the Volts text box and strike enter. The value for Current will be calculated and displayed in the Current text box and the background will change to white.

### To calculate volts

1. Click on the **E** portion of the triangle to set the input sequence. The background of the **E** will change to white.

2. Enter a value in the Current text box and strike enter. The cursor will move to the Resistance text box.

3. Enter a value in the Resistance text box and strike Enter. The voltage value will be calculated and displayed in the Volts text box and the background will change to white.

### To calculate resistance

1. Click on the **R** portion of the triangle to set the input sequence. The background of the **R** will change to white.

2. Enter a value in the Current text box and strike enter. The cursor will move to the Voltage text box.

3. Enter a value in the Voltage text box and strike Enter. The resistance value will be calculated and displayed in the Resistance text box and the background will change to white.

### Standard values

To calculate standard values for the resistor and recalculate volts and current:

1. In the R Values frame, click on the round button for the desired tolerance range - 1%, 2% & 5%, or 10%. The resistor value will change to the closest standard value and volts and current will be recalculated. The difference between the input or calculated resistance value and the closest standard value is shown in R Error.

2. Click on the round button for Actual Values to return the display to the input or calculated value. All input or calculated values will be displayed and the R Error display will be closed.

3. Standard values may be selected at any time and volts, current, and resistance will be recalculated.

### Scroll bars

1. The scroll bars may be used at any time to enter or change values. Click on the arrows to change in

increments of one unit or inside the arrows to change ten units.

2. Only integer values may be input using the scroll bars.

3. The range of the scroll bars is 0 to 1,000 units.

## Formulas - Ohm's Law

## Standards

Color Codes
Standard Resistor Values
All Standards

# Resistors in Parallel Calculations



**Reference Information**

## Overview - Resistors in Parallel

Resistors in Parallel Calculations provides a fast and easy method of calculating the total resistance of up to ten resistors of equal or varying values in a parallel circuit.

- Individual resistor values may be entered until the desired total is reached.
- A total resistance value may be entered along with the desired number of resistors and the value of each resistor will be calculated.
- Standard values of 1%, 2% & 5%, or 10% may be selected and the program will calculate the nearest standard value to the input value and the total of the standard values.

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**Operational Notes**

1. A math coprocessor is not required for this application and use of one will have minimal impact on the speed of calculations.

2. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Resistors in Parallel

Individual resistor values may be entered in the text boxes and the program will calculate the total or, a total resistance and the quantity of resistors may be entered and the value of each resistor will be calculated.

### Resistor value entry

To calculate the sum of up to ten resistors in a parallel circuit:

1. Type the values in the text box and complete each entry by striking the Enter key. The total will be recalculated upon completion of each entry.

2. The scroll bars may be used for entry. Click on the arrows to move one unit or click inside the arrows to move ten units. Only integers may be entered using the scroll bars.

3. Values may also be pasted into or copied from text boxes using normal Windows cut, copy, and paste procedures.

### Total resistance entry

To calculate the values of up to ten resistors in a parallel circuit when the total is known:

1. Click on the resistor labels (R1, R2, R3. . . ) for the number of resistor desired. The background color of the label will change to white.

2. Enter the desired total resistance value in the R Total text box. Complete the entry by striking the Enter key.

3. The value entered into R Total will be divided evenly among the resistors selected. A border will be added to the selected resistor labels to indicate a calculated value and the text box color will change to white.

4. Additional resistors may be added by repeating steps 1 and 2 above.

5. Entering a smaller total value without first clearing the existing values will cause an error.

### Standard values

To calculate standard values for individual resistors and the total resistance:

1. In the R Values frame, click on the round button for the desired tolerance range - 1%, 2% & 5%, or 10%. All resistor values will be changed to the closest standard value and a total of the standard values will be displayed in the Standard Total text box. The difference between R Total and the total of the standard values is shown as an error.

2. Click on the round button for Actual Values to return the display to the input values. All input values will be displayed and the Standard Total and Error displays will be closed.

## Formulas

## Standards

Color Codes
Standard Resistor Values
All Standards

# Resistors in Series Calculations



**Reference Information**

## Overview - Resistors in Series

Resistors in Series Calculations provides a fast and easy method of calculating the total resistance of up to ten resistors of equal or varying values in a series circuit.

- Individual resistor values may be entered until the desired total is reached.
- A total resistance value may be entered along with the desired number of resistors and the value of each resistor will be calculated.
- Standard values of 1%, 2% & 5%, or 10% may be selected and the program will calculate the nearest standard value to the input value and the total of the standard values.

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**Operational Notes**

1. A math coprocessor is not required for this application and use of one will have minimal impact on the speed of calculations.

2. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Resistors in Series

Individual resistor values may be entered in the text boxes and the program will calculate the total or, a total resistance and the quantity of resistors may be entered and the value of each resistor will be calculated.

### Resistor value entry

To calculate the sum of up to ten resistors in a series circuit:

1. Type the values in the text box and complete each entry by striking the Enter key. The total will be recalculated upon completion of each entry.

2. The scroll bars may be used for entry. Click on the arrows to move one unit or click inside the arrows to move ten units. Only integers may be entered using the scroll bars.

3. Values may also be pasted into or copied from text boxes using normal Windows cut, copy, and paste procedures.

### Total resistance entry

To calculate the values of up to ten resistors in a series circuit when the total is known:

1. Click on the resistor labels (R1, R2, R3. . . ) for the number of resistor desired. The background color of the label will change to white.

2. Enter the desired total resistance value in the R Total text box. Complete the entry by striking the Enter key.

3. The value entered into R Total will be divided evenly among the resistors selected. A border will be added to the selected resistor labels to indicate a calculated value and the text box color will change to white.

4. Additional resistors may be added by repeating steps 1 and 2 above.

5. Entering a smaller total value without first clearing the existing value will cause an error.

### Standard values

To calculate standard values for individual resistors and the total resistance:

1. In the R Values frame, click on the round button for the desired tolerance range - 1%, 2% & 5%, or 10%. All resistor values will be changed to the closest standard value and a total of the standard values will be displayed in the Standard Total text box. The difference between R Total and the total of the standard values is shown as an error.

2. Click on the round button for Actual Values to return the display to the input values. All input values will be displayed and the Standard Total and Error displays will be closed.

## Formulas - Resistors in Series

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Resistors in Series
All Formulas

## Standards

Color Codes
Standard Resistor Values
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# Voltage Divider Calculations



**Reference Information**

## Overview - Voltage Divider

Voltage Divider Calculations provides a fast and easy method of calculating the values of resistors required to reduce a D.C. voltage. Calculation options are:

- **Select input voltage and output voltage -** the program will calculate the two resistor values required.
- **Select input voltage and the two resistor values -** the program will calculate output voltage.
- **Select input voltage and a resistance ratio -** the program will calculate output voltage.
- **Standard values of 1% or 2% and 5% may be selected -** the program will calculate the nearest standard value to the input value.

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**Operational Notes**

1. To reduce the time required for calculating values, a table of calculated values is loaded with the program. This increases the time required to load the program but significantly reduces the time required for each calculation.
2. The calculated values table is in the file RLOG.DAT which must be in the same directory as VDIV_2R.EXE.
3. A math coprocessor will reduce the calculation time since there are several floating point calculations required for each value.
4. Scroll bars are not used for data entry in this application.
5. These calculations are for general purpose use and may not be suitable where high accuracy is required. D.C. circuits are assumed.

## Instructions - Voltage Divider

To calculate the output voltage - Vout, of the divider circuit when other values are known:

**Voltage Input - Vin and Vout are known.**

1. Select the desired standard resistor values by clicking on the round button in the Standard R frame. Default - 1% values.

2. Enter the known input voltage at the Vin text box and strike Enter.

3. Enter the desired output voltage at Vout and strike Enter. There may be a short delay while values are calculated.

   The resistor ratio - R Ratio, R1, R2, the actual output voltage - Vout and voltage error - V Error will be calculated and displayed.

**Resistor Input - Vin, R1, and R2 are known.**

1. Select the desired standard resistor values by clicking on the round button in the Standard R frame. Default - 1% values.

2. Enter the known input voltage at Vin and strike Enter.

3. Click on the R1 text box or strike Tab to move the cursor to it. Enter the resistor value and strike Enter. The cursor will move to the R2 text box.

4. Enter the value for R2. There may be a short delay while values are calculated.

   The resistor ratio - R Ratio, the actual output voltage - Vout and voltage error - V Error will be calculated and displayed.

**Resistor Ratio Input - Vin and the resistor ratio are known.**

1. Select the desired standard resistor values by clicking on the round button in the Standard R frame. Default - 1% values.

2. Enter the known input voltage at Vin and strike Enter.

3. Click on the R Ratio text box or strike Tab to move the cursor to it. Enter the desired resistor ratio and strike Enter. There may be a short delay while values are calculated.

   Values for R1, R2, the actual output voltage - Vout and voltage error - V Error will be calculated and displayed.

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**Find a Standard R value.**

1. In the R Values frame, click on the round button for the desired tolerance range - 1%, 2% & 5%, or

Actual. Default is Actual.

2. Click on the R2 text box or strike Tab to move the cursor to it. Enter the resistor value and strike Enter. The closest standard value to the input value will be displayed in the R2 text box. The difference from the input value is shown in the V Error text box as a percentage.

2. Click on the round button for Actual Values to return the display to the input values. All input values will be displayed.

## Formulas - Voltage Divider

## Standards

Color Codes
Standard Resistor Values
All Standards