Circuit Shop Help

Topic Tree

The following topic tree shows the structure of and provides quick access to the Circuit Shop help topics.

Circuit Shop Files

Circuit Shop files hold device and schematic information, and diagram annotations.   By default, they have the file type .CS1.

Creating and Editing Diagrams

The following topics describe Circuit Shop's diagram creation and editing capabilities:

Adding a Wire Vertex

To add a vertex to a wire:

1. Ensure a device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the wire portion where the vertex is to be added.
4. Press the left mouse button and drag the wire to the desired vertex location.
5. Release the mouse button.

Related topics:

Moving a wire vertex
Deleting a wire vertex
Creating and editing diagrams
Connecting devices - adding wires
Menu commands
Device and drawing toolkits

Adding a Device or Object

To add a device or object to a diagram:

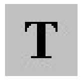
1. Ensure the device or object toolkit is visible. (hint1)
2. Using the mouse, choose a device or object icon on the toolkit.
3. Move the mouse onto the diagram to where the device or object is to be located.
4. Click the mouse to place the selected device or object on the diagram.

Related topics:

Creating and editing diagrams
Menu commands
Device and drawing toolkits

Adding a Text Object

To add a text object to a diagram:

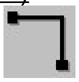
1. Ensure the paint toolkit is visible. (hint2)
2. Using the mouse, choose  on the toolkit.
3. Move the mouse onto the diagram to where the text is to be located.
4. Click the mouse to place the text object on the diagram. The initial value of the text object will be "(empty)".

Related topics:

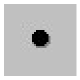
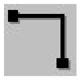
Edit Text dialog box
Modifying object values and attributes
Creating and editing diagrams
Adding devices or objects to a diagram
Menu commands
Device and drawing toolkits

Connecting Devices - Adding Wires and Connectors

Adding a wire to connect two devices:

1. Ensure the device toolkit is visible. (hint1)
2. Using the mouse, choose the wire icon  on the toolkit.
3. Move the mouse onto the diagram over a device terminal.
4. Press the left mouse button and drag the wire to another device terminal.
5. Release the mouse button.

Adding a connector to connect multiple devices:

1. Ensure the device toolkit is visible. (hint1)
2. Using the mouse, choose the connector icon  on the toolkit.
3. Move the mouse onto the diagram to where the connector is to be located and click the mouse to place the connector on the diagram.
4. Using the mouse, choose the wire icon  on the toolkit.
5. Move the mouse onto the diagram over a device terminal to be connected to the connector object.
6. Press the left mouse button and drag the wire to the connector.
7. Release the mouse button.

8. Repeat steps (5) through (7) on the other devices to be connected to the connector object.

Related topics:

Creating and editing diagrams
Adding - moving - deleting a wire vertex
Menu commands
Device and drawing toolkits

Creating a New Diagram Window

Use 

on the toolbar or menu command File|New to create a new diagram window.

Related topics:

- Creating and editing diagrams
- Menu commands
- Device and drawing toolkits

Deleting a Wire Vertex

To delete a vertex from a wire:

1. Ensure a device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the vertex to be deleted.
4. Press the left mouse button and drag the vertex so that the wire forms a straight line.
5. Release the mouse button.   The vertex will be deleted from the wire.

Related topics:

- Adding a wire vertex
- Moving a wire vertex
- Creating and editing diagrams
- Connecting devices - adding wires
- Menu commands
- Device and drawing toolkits

Deleting a Device or Object

To delete a device or object from a diagram:

1. Ensure the device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram to the device or object to be deleted.
4. Click the mouse to select the device or object.
5. Use the Edit|Delete menu command to delete the device or object.

Related topics:

Creating and editing diagrams
Menu commands
Device and drawing toolkits

Modifying Device or Object Attributes

Circuit Shop allows devices to be updated via dialog boxes.   To modify a device's value or attribute:

1. Ensure the device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the device or object to be modified.
4. Double click the left mouse button to display the device or object's dialog box.   For example, double clicking on a resistor will open the Edit Device dialog box.

Related topics:

Creating and editing diagrams
Dialog boxes
Menu commands
Device and drawing toolkits

Moving a Wire Vertex

To move a wire vertex:

1. Ensure a device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the vertex to be moved.
4. Press the left mouse button and drag the vertex to the desired location.
5. Release the mouse button. The wire will be redrawn with the vertex in its new location.

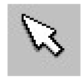
Note: If the new vertex location causes the wire to be straight, the vertex will be automatically deleted. See deleting a vertex.

Related topics:

Adding a wire vertex
Creating and editing diagrams
Connecting devices - adding wires
Menu commands
Device and drawing toolkits

Moving an object

To move a device or object:

1. Ensure the device toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the device or object to be moved.
4. Press the left mouse button and drag the device to the new location.
5. Release the mouse button.

Related topics:

Creating and editing diagrams
Menu commands
Device and drawing toolkits

Opening an Existing Diagram

Use 

on the toolbar or menu command File|Open to invoke the Open Circuit Shop File dialog box. On successful completion of the dialog box, a new diagram window will be opened with an existing circuit shop file.

Related topics:

- Creating and editing diagrams
- Menu commands
- Device and drawing toolkits
- Dialog boxes

Rotating a device

To rotate a device:

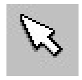
1. Ensure the device or object toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over a device terminal.
4. Press the left mouse button and drag the device terminal to the new location.
5. Release the mouse button.

Related topics:

Creating and editing diagrams
Menu Commands
Toolbar commands
Device and drawing toolkits

Selecting an object

To select an object:

1. Ensure the device toolkit is visible. (hint1)
2. Using the mouse, choose the pointer icon  on the toolkit.
3. Move the mouse onto the diagram over the device or object to be selected.
4. Click the left mouse button to select the object.

Related topics:

Creating and editing diagrams
Edit|Delete command
Menu commands
Toolbar commands
Device and drawing toolkits

Analysing a Circuit

Once a circuit has been constructed, use the Tool|Analyse menu command or the toolbar icon 

to analyse the circuit.   As a side effect of the analysis, device meters are updated.

Related topics:

- Creating and editing diagrams
- Viewing circuit voltage and current values
- Menu commands
- Toolbar commands
- Device and drawing toolkits

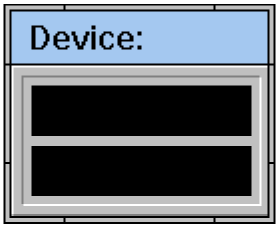
Viewing Circuit Voltage and Current Values

Circuit shop provides the following meter types to view circuit voltage and current values.

- Device meter provides information on how to add a meter to a diagram, and link it to a device to measure the device's voltage and current.

Related topics:

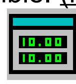
Analysing a circuit
Tool|Analyse command
Creating and editing diagrams



Device Meter

A device meter can be used to view the voltage across a device and the current flowing through a device.   The voltage and current values are set when a circuit is analysed.

To add a device meter to the diagram:

1. Ensure the analog device toolkit is visible. (hint1)
2. Using the mouse, click the meter icon  on the toolkit.
3. Move the mouse onto the diagram to where the meter is to be placed.
4. Click the mouse to place the meter on the diagram.   Adding objects provides additional details.

To link the meter to a device:

1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the meter.
3. Double click the mouse on the meter to open the Edit Meter dialog box.   Modifying object values provides additional details.
4. To link the meter to a device, select the device type and enter the device's id.

Related topics:

Creating and editing diagrams
Tool|Analyse command

Edit menu

The Edit menu provides commands undo the previous command, clear the diagram window and delete a selected object.

- Undo
- Clear
- Delete

Edit|Clear Command

This command removes all objects from the diagram.

Related topics:

Edit commands
Menu commands

Edit|Delete Command

This command removes selected objects from the diagram.

Related topics:

Edit commands

Menu commands

Edit|Undo Command

This command restores the diagram in the current window to the way it was before the most recent object change, addition or deletion.

Related topics:

- Edit commands
- Menu commands

File menu

The File menu provides commands for creating new circuit shop files, opening existing files, saving files, printing files, and exiting Circuit Shop.

New
Open
Save
Save as
Revert to saved
Close

Print
Print preview
Printer setup

Exit

File|New Command

This command opens a new circuit shop file drawing window with the default name (Untitled). (Untitled) windows are used as temporary edit buffers. Circuit Shop prompts for a filename when the window is closed or saved.

The toolbar icon 

can also be used to execute this command.

Related topics:

- File commands
- Menu commands
- Toolbar commands

File|Open Command

This command displays the Open Circuit Shop File dialog box. In this dialog box, you select the existing circuit shop file you want to open. When the file is successfully opened, a drawing window is opened.

The toolbar icon 

can also be used to execute this command.

Related topics:

- File commands
- Menu commands
- Toolbar commands

File|Save Command

This command saves a Circuit Shop file to disk.

If the file has not been named, Circuit Shop opens the Save Circuit Shop File As dialog box. This dialog box allows you to specify the filename and optionally save it in a different directory or different drive.

If an existing filename is used to name the file, Circuit Shop will ask if you want to overwrite the existing file.

The toolbar icon 

can also be used to execute this command.

Related topics:

- File commands
- Menu commands
- Toolbar commands

File|Save As Command

This command opens the Save Circuit Shop File As dialog box. This dialog box allows the active drawing window to be saved under a different name, different directory, or different drive.

If an existing filename is used to name the file, Circuit Shop will ask if you want to overwrite the existing file.

The toolbar icon  can also be used to execute this command.

Related topics:

- File commands
- Menu commands
- Toolbar commands

File|Revert To Saved Command

This command deletes the current contents of the drawing window and reloads the window from the last saved Circuit Shop file.

Any changes made since the last time the file was saved will be lost.

Related topics:

File commands
Menu commands

File|Close Command

This command deletes the current drawing window.

If the drawing window has been modified, Circuit Shop prompts to save the Circuit Shop file before deleting the drawing window.

Related topics:

File commands
Menu commands

File|Print Command

This command displays the Print dialog box.   In this dialog box, you select the print quality, select output to a file and number of copies.

The OK button on the dialog box will generate the printout.

Related topics:

- File|Print preview command
- File|Printer setup command
- File commands
- Menu commands

File|Print Preview Command

This command opens a window with a rendition of what will be sent to the printer if the File|Print command was invoked.

The preview window must be closed before further Circuit Shop commands can be invoked.

Related topics:

File|Print command
File|Printer setup command
File commands
Menu commands

File|Printer Setup Command

This command displays the Printer Setup dialog box.   In this dialog box, you select the default or specific printer, the orientation of portrait or landscape, and paper size and source.

The OK button on the dialog box will save the current settings to be used in subsequent print commands.

Related topics:

- File|Print command
- File|Print preview command
- File commands
- Menu commands

File|Exit Command

This command exits Circuit Shop.

If you have modified a Circuit Shop file without saving it, Circuit Shop prompts you to do so before exiting.

Related topics:

- File commands
- Menu commands

Help menu

The Help menu provides commands to obtain information on how to use Circuit Shop.

Contents
- Displays Circuit Shop help contents.

Search For Help On
- Displays the help search dialog box.

How to Use Help
- Displays the standard How To Use Help information.

About Circuit Shop
- Displays the About Circuit Shop dialog box.

Purchasing
- Displays purchasing information.

Menu Commands

The menu bar at the top of the Circuit Shop main window provides access to the menus. To go to the menu bar, press F10 or click anywhere on it. You can choose any of the following commands on the menu bar:

File commands
Edit commands
View commands
Tool commands
Help commands

Related topics:

Toolbar commands

Limitations
This version of Circuit Shop has the following limitations:

Circuit analysis
- The circuit analysis function only supports circuits containing fixed resistors and batteries.

Related topics:
Creating and editing diagrams

Purchasing

You may purchase Circuit Shop

- by cheque
- by CompuServe shareware registration

Purchasing by Cheque

To purchase Circuit Shop by cheque, complete the following form and send a cheque to Cherrywood Systems at the indicated address. (To make a copy of the form, select the above File|Print Topic command.)

On receipt of payment, you will be sent a registration number. If included below, the registration number will be sent to the specified e-mail address.

```
NAME        ____________________________

COMPANY     ____________________________

STREET      ____________________________

CITY        ____________________________

STATE ZIP   ______________   ___________

COUNTRY     ____________________________

TELEPHONE   ____________________________

E-MAIL      ____________________________


Product:            Cost      Copies          Total

Circuit Shop      $29.00      ______     $ _________

Make checks payable to: Cherrywood Systems

               Mail to: Cherrywood Systems
                        5143 Galway Dr.
                        Tsawwassen B.C.
                        Canada
                        V4M 3R4
```

Purchasing by CompuServe Shareware Registration

If you are a CompuServe member, Circuit Shop can be purchased using CompuServe's shareware registration mechanism.

After logging into CompuServe, GO SWREG and follow the directions.

The Registration ID is: 16305.

Warranty

"Circuit Shop" is licensed without any warranty of merchantability, fitness of particular purpose, performance, or otherwise. All warranties are disclaimed. By using "Circuit Shop", you agree that neither Cherrywood Systems nor any of its employees, affiliates, owners, or other related parties will be liable to you or any third party for any use of (or inability to use) this software, or for any damages whatsoever, even if Cherrywood Systems and/or the authors are apprised of the possibility of such damages occurring. Cherrywood Systems and/or the authors assume no liability for losses or damages, of a physical, financial, or of whatever nature, direct or consequential, resulting from the use of, or purported use of "Circuit Shop" or any of the files in the package, for any purpose whatsoever.

You use "Circuit Shop" entirely at your own risk.

Starting and Exiting Circuit Shop

Starting Circuit Shop

Circuit Shop can be started from the:

- Program Manager
- File Manager
- Command Line

When you start Circuit Shop, it will open its Main Window.

Starting from the Program Manager

Like most Windows applications, you can start Circuit Shop by double-clicking on its icon. The location of the icon depends on how Circuit Shop was installed. If the default setup was used, the icon is in the Circuit Shop group.

Starting from the File Manager

Circuit Shop is started from the File Manager by double-clicking on CIRC.EXE, or by highlighting it and pressing <Enter>. CIRC.EXE can be found in the drive and directory that was selected during installation. If the default setup was used, CIRC.EXE is in C:\CSHOP1.

Starting from the Command Line

To start Circuit Shop from the Windows command line:

1. Select "File" in the menubar, then select "Run".
2. Enter Circuit Shop's full filename path, i.e. Circuit Shop's drive and directory, followed by "CIRC.EXE". If the default setup was used, type "C:\CSHOP1\CIRC.EXE".
3. Click the OK Button or press <Enter>.

Exiting

Exit Circuit Shop like most Windows programs:

1. Select "Exit" in Circuit Shop's File Menu.
2. Double-click Circuit Shop's Main Window Control Box.
3. Press <Alt> + <F4>.
4. Select "Exit" in Circuit Shop's Main Window's Control Menu.

Technical Support

If you have product questions or suggestions you can contact the developers via the Internet at

Cherrywood@compuserve.com

Product suggestions from registered and unregistered users are always welcome. If you have any suggestions or comments which would make Circuit Shop a useful tool to you or in your environment, please send them along. We will analyze your request and attempt to schedule/add any feature that fits into the product vision and our development resources permit.

Related topics:

Circuit Shop limitations
Purchasing information

Tool menu

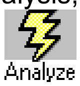
The Tool menu provides commands to analyse a circuit, and control drawing tools such as pen size, pen color and drawing grid size.

Analyse
Pen Size
Pen Foreground Color
Pen Background Color
Font
Grid X Size
Grid Y Size

Tool|Analyse Command

This command invokes Circuit Shop's circuit analysis function. On the first execution of this command or if the previous analysis window has been closed, an iconified analysis window is opened to report analysis results. On subsequent executions of this command the analysis window is updated.

As part of the analysis, device meter voltage and current values are updated.

The toolbar icon 

can also be used to execute this command.

See limitations for a description of the analysis capabilities of this version Circuit Shop.

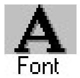
Related topics:

- Menu commands
- Toolbar commands

Tool|Font Command

This command opens the select font dialog box to set a new default font. New devices or objects placed on the drawing after selecting a new default font will be drawn with the new font.

If a device or object with text has been selected prior to executing this command, its font will also be changed.

The toolbar icon 

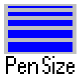
can also be used to execute this command.

Related topics:

Menu commands
Toolbar commands

Tool|Pen Size Command

This command opens a dialog box to set a new pen size. New devices and objects placed on the drawing will be drawn with the new size.

The toolbar icon 

can also be used to execute this command.

Related topics:

- Menu commands
- Toolbar commands

Tool|Pen Foreground Color Command

This command opens a dialog box to set a new foreground color.   New devices and objects placed on the drawing will be drawn with the new color.

The toolbar icon 

can also be used to execute this command.

Related topics:

- Menu commands
- Toolbar commands

Tool|Pen Background Color Command

This command opens a dialog box to set a new background color.   New objects such as filled rectangles placed on the drawing will be drawn with the new color.

Related topics:

- Menu commands
- Toolbar commands

Tool|Grid X Size Command

This command opens a dialog box to set a size for the drawing grid in the x or horizontal direction. New devices and objects placed on the drawing will be centred on the new grid value.

Related topics:

- Menu commands
- Toolbar commands

Tool|Grid Y Size Command

This command opens a dialog box to set a size for the drawing grid in the y or vertical direction. New devices and objects placed on the drawing will be centred on the new grid value.

Related topics:

Menu commands
Toolbar commands

Device and Drawing Toolkits

Circuit shop provides the following device and drawing toolkits:

Digital Device Toolkit

The digital device toolkit allows digital devices such as logic gates (and, or, not, exclusive-or, nand, nor and exclusive-nor) and integrate circuits to be added to a diagram.

Use 

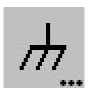
on the toolbar or menu command View|Digital device toolkit to display or dismiss this toolkit.

Analog Device Toolkit

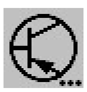
The analog device toolkit allows basic analog devices such as resistors, batteries and transistors to be added to a diagram and provides tools (wire and connector objects) to connect them.

Use 

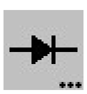
on the toolbar or menu command View|Analog device toolkit to display or dismiss this toolkit. Use the indicated icon on the analog device toolkit to display or dismiss the sub-toolkit:

 **Ground Toolkit**

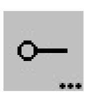
The ground toolkit provides access to the different ground and antenna device types.

 **Transistor Toolkit**

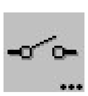
The transistor toolkit provides instant access to the different transistor related device types and orientations.

 **Diode Toolkit**

The diode toolkit provides access to the different diode device types.

 **Terminal and Plug Toolkit**

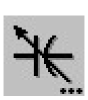
The terminal and plug toolkit provides access to different terminal and plug types, including plug ins, receptacles and 2 & 3 prong female and male plugs.

 **Switch Toolkit**

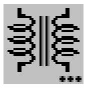
The switch toolkit provides access to the different switch types, including push buttons, fuses and relays.

 **Resistor Toolkit**

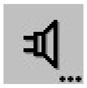
The resistor toolkit provides access to the different resistor device types.

 **Capacitor Toolkit**

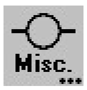
The capacitor toolkit provides access to fixed and variable capacitor types.

 **Inductor Toolkit**

The inductor toolkit provides access to the different inductor and transformer types.

 **Audio Toolkit**

The audio toolkit provides access to the different audio device types such as speakers and earphones.



Miscellaneous Toolkit

The miscellaneous toolkit provides access to the miscellaneous devices such as general meters, DC motors, AC generators, lamps, crystals, and operational amplifiers.

Paint Toolkit

The paint toolkit allows simple objects such as text, lines, ovals and rectangles to be added to a diagram.

Use 

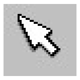
on the toolbar or menu command View|Paint toolkit to display or dismiss this toolkit.

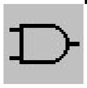
Related topics:

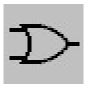
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Connecting devices - adding wires
- View commands

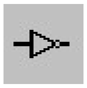
Digital Device Toolkit

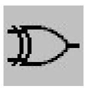
The digital device toolkit provides access to digital devices.   To select a device or tool, click the mouse on the desired icon.   You can choose any of the following:

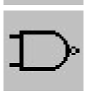
 pointer tool - allows device selection

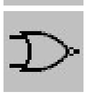
 And gate

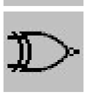
 Or gate

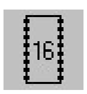
 Not gate

 Exclusive-or gate

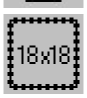
 Nand gate

 Nor gate

 Exclusive-nor gate



16 pin integrated circuit



18x18 pin integrated circuit

Note: the number of pins on an integrated circuit can be changed using the Edit IC dialog box. (hint4)

Use 

on the toolbar or menu command View|Digital device toolkit to display or dismiss this toolkit.

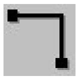
Related topics:

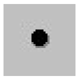
- Analog device toolkit
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

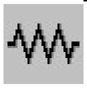
Analog Device Toolkit

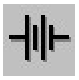
The analog device toolkit provides access to analog devices, associated tools sub-toolkits. To select a device, tool or sub-toolkit, click the mouse on the desired icon. You can choose any of the following:

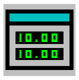
 pointer tool - allows device selection

 wire tool - connects devices

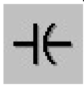
 connector tool - provides a connection point for wires

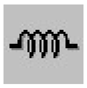
 resistor

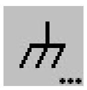
 battery

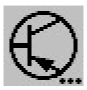


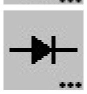
device meter - measures voltages and current

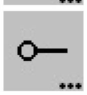
 capacitor

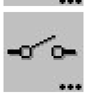
 inductor

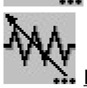
 ground toolkit

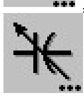
 transistor toolkit

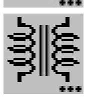
 diode toolkit

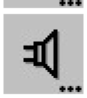
 terminal and plug toolkit

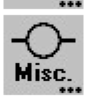
 switch toolkit

 resistor toolkit

 capacitor toolkit

 inductor toolkit

 audio toolkit



miscellaneous toolkit

Use 

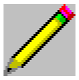
on the toolbar or menu command View|Analog device toolkit to display or dismiss this toolkit.

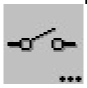
Related topics:

- Digital device toolkit
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

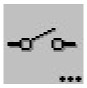
Paint Toolkit

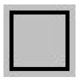
The paint toolkit provides access to simple drawing tools.   To select a tool, click the mouse on the desired icon.   You can choose any of the following tools:

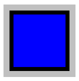
 pen tool - draws a line

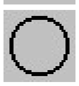
 pointer tool - allows object or device selection

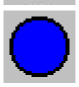
 fill tool - fills an area with a color

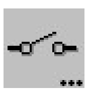
 text tool - adds a text object

 rectangle tool - draws a rectangle

 filled rectangle tool - draws a filled rectangle

 ellipse tool - draws an ellipse

 filled ellipse tool - draws a filled ellipse

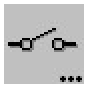
Use  on the toolbar or menu command View|Paint Toolkit to display or dismiss this toolkit.

Related topics:

- Creating and editing diagrams
- Adding devices or objects to a diagram
- Device and drawing toolkits
- View commands

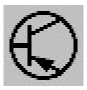
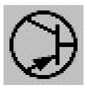
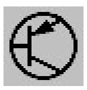
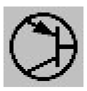
Transistor Toolkit

The transistor toolkit is an extension of the analog device toolkit to add transistor and field effect transistor (FET) devices to circuits. This toolkit provides instant access to the different transistor related device types and orientations.

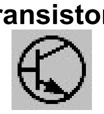
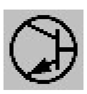
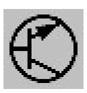
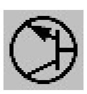
Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select a transistor type and initial orientation, click the mouse on the desired icon.

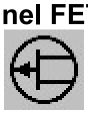
PNP transistors:

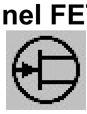
NPN transistors:

N channel FET:



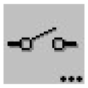
P channel FET:



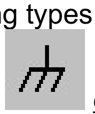
Related topics:
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

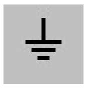
Ground Toolkit

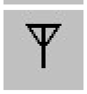
The ground toolkit is an extension of the analog device toolkit to add ground points and antennas to circuits.

Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select a ground or antenna, click the mouse on the desired icon.   You can choose from the following types:

 chassis ground

 earth ground

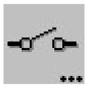
 antenna

Related topics:

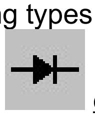
Creating and editing diagrams
Adding devices or objects to a diagram
Device and drawing toolkits
View commands

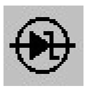
Diode Toolkit

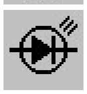
The diode toolkit is an extension of the analog device toolkit and provides access to the different diode related device types.

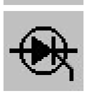
Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

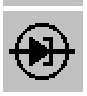
To select a diode device type, click the mouse on the desired icon.   You can choose from the following types:

 diode

 zener diode

 LED - light emitting diode

 SCR - silicon controlled rectifier

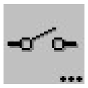
 Tunnel diode

Related topics:

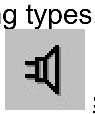
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

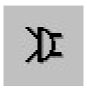
Audio Toolkit

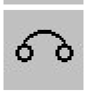
The audio toolkit is an extension of the analog device toolkit and provides access to the different audio device types.

Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select an audio device type, click the mouse on the desired icon.   You can choose from the following types:

 speaker

 microphone

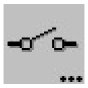
 earphones

Related topics:

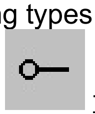
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

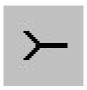
Terminal and Plug Toolkit

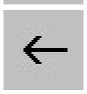
The terminal and plug toolkit is an extension of the analog device toolkit and provides access to the different terminal and plug types.

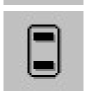
Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

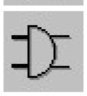
To select a terminal or plug type, click the mouse on the desired icon.   You can choose from the following types:

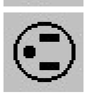
 terminal

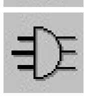
 receptacle

 plug in

 2 prong female plug

 2 prong male plug

 3 prong female plug

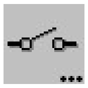
 3 prong male plug

Related topics:

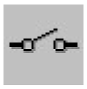
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

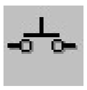
Switch Toolkit

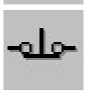
The switch toolkit is an extension of the analog device toolkit and provides access to the different switch types.

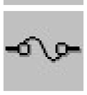
Use  on the analog device toolkit to display or dismiss this toolkit. (hint1)

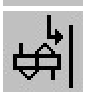
To select a switch type, click the mouse on the desired icon.   You can choose from the following types:

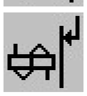
 single-throw single-pole switch

 normally open push button

 normally closed push button

 fuse

 normally open relay

 normally closed relay

Related topics:

- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

Resistor Toolkit

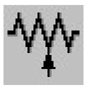
The resistor toolkit is an extension of the analog device toolkit and provides access to the different resistor device types.

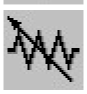
Use 

on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select a resistor type, click the mouse on the desired icon.   You can choose from the following types:

fixed resistor

 potentiometer

 variable resistor

Related topics:

- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

Capacitor Toolkit

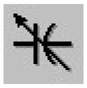
The capacitor toolkit is an extension of the analog device toolkit and provides access to fixed and variable capacitor device types.

Use 

on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select a capacitor type, click the mouse on the desired icon. You can choose from the following types:

- 

fixed capacitor
-  variable capacitor

Related topics:

- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

Inductor Toolkit

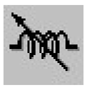
The inductor toolkit is an extension of the analog device toolkit and provides access to the different inductor and transformer device types.

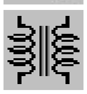
Use 

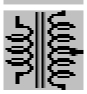
on the analog device toolkit to display or dismiss this toolkit. (hint1)

To select an inductor or transformer type, click the mouse on the desired icon.   You can choose from the following types:

fixed inductor


variable inductor


transformer


tapped transformer

Related topics:

- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

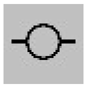
Miscellaneous Toolkit

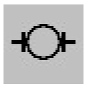
The miscellaneous toolkit is an extension of the analog device toolkit and provides access to various miscellaneous devices.

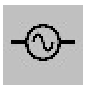
Use 

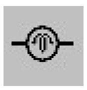
on the analog device toolkit to display or dismiss this toolkit. (hint1)

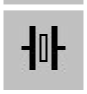
To select a device, click the mouse on the desired icon.   You can choose from the following devices:

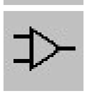
 general meter

 DC motor

 AC generator

 Lamp

 Crystal

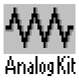
 Operational amplifier

Related topics:

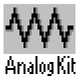
- Creating and editing diagrams
- Adding devices or objects to a diagram
- Rotating devices or objects
- Device and drawing toolkits
- View commands

Toolbar Commands

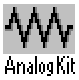
The toolbar at the top of the Circuit Shop main window provides quick access to common menu commands. To execute a toolbar command, click the mouse on the desired icon. You can choose any of the following commands on the toolbar:



File|New command



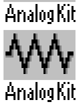
File|Open command



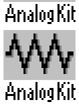
File|Save command

File|Save as command

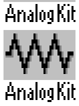
Tool|Analyse command



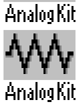
View|Digital device toolkit command



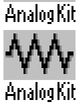
View|Analog device toolkit command



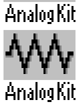
View|Paint toolkit command



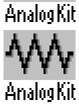
Tool|Pen Size command



Tool|Pen foreground color command



Tool|Font command



Help|Contents command

Related topics:

Menu commands

Value Slider

The value slider is not implemented in this version of Circuit Shop.

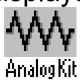
View Menu

The View menu provides commands display or dismiss a device or tool toolkit.

Digital device toolkit
Analog device toolkit
Paint toolkit

View|Digital Device Toolkit Command

This command displays or dismisses the digital device toolkit.

The toolbar icon 

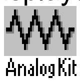
can also be used to execute this command.

Related topics:

- Menu commands
- Toolbar commands
- Device and drawing toolkits

View|Analog Device Toolkit Command

This command displays or dismisses the analog device toolkit.

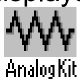
The toolbar icon  can also be used to execute this command.

Related topics:

- Menu commands
- Toolbar commands
- Device and drawing toolkits

View|Paint Toolkit Command

This command displays or dismisses the paint toolkit.

The toolbar icon 

can also be used to execute this command.

Related topics:

- Menu commands
- Toolbar commands
- Device and drawing toolkits

What is Circuit Shop

Circuit Shop allows you to create and learn electronic circuits and concepts. Circuit Shop is an easy to use CAD tool to allow simple digital and analog electronic circuits to be constructed and analyzed. It includes:

- Drawing tools to construct simple electronic circuit schematics consisting of digital and analog devices such as logical gates, ICs, transistors, resistors, batteries, etc.
- A tutorial which teaches basic electronic concepts.
- A simple paint toolkit to allow text, lines, ovals and rectangles to be added as circuit annotations.

Circuit Shop is distributed in its full form and is not disabled in any way, there are no extra files, and no additional capabilities provided after registration. There is no written manual, all documentation is supplied in this help file.

Keywords: electronic digital analog device circuit IC schematic CAD educational tutorial drawing paint toolkit

Related Topics:

Topic tree
Creating and editing diagrams
Resistors and simple circuits tutorial
Purchasing information

Circuit Shop Dialog Boxes

Circuit Shop includes the following dialog boxes:

Edit Device dialog box
Edit IC dialog box
Edit Meter dialog box
Edit Text dialog box
Open Circuit Shop File dialog box
Print dialog box
Printer Setup dialog box
Save Circuit Shop File As dialog box
Select Font dialog box

Related topics:

Creating and editing diagrams
Menu commands
Toolbar commands

Edit Device Dialog Box

The Edit Device dialog box is where device values and other attributes are initialised or modified.

Device Id Input Box
Where a numeric identifier for the device is entered. A numeric value of zero will suppress the output of the device Id. Examples of valid device Ids: 1, 5, 27 and 1039.

Device Value Input Box
Where a numeric value for the device is entered. Examples of valid device values: 1, 500, 1000 and 55000.

Device Name Input Box
Where an optional text description for the device is entered.

Value Slider Check Box
Where a value slider can be enabled or disabled for the device.

OK Button
Saves the current dialog box settings.

Cancel Button
Closes the dialog window without changing the current device values and attributes.

Help Button
Displays this help topic.

Related topics:

- Modifying device values or other object attributes
- Creating and Editing Diagrams
- Dialog boxes

Edit IC Dialog Box

The Edit IC dialog box is where integrated circuit device values and other attributes are initialised or modified.

Id Input Box
Where a numeric identifier for the device is entered. A numeric value of zero will suppress the output of the device Id. Examples of valid device Ids: 1, 5, 27 and 1039.

Name Input Box
Where an optional text description for the device is entered.

Part Num Input Box
Where an optional part number text string for the device is entered.

Inputs: Side & Top Input Box
Where the number of pins or inputs is specified for the sides and top/bottom.

OK Button
Saves the current dialog box settings.

Cancel Button
Closes the dialog window without changing the current device values and attributes.

Help Button
Displays this help topic.

Related topics:

- Modifying device values or other object attributes
- Creating and Editing Diagrams
- Dialog boxes

Edit Meter Dialog Box

The Edit Meter dialog box is where a meter's attributes are initialised or modified.

Meter Type Input Box
Where the meter type is defined. This version of Circuit Shop only supports device meters.

Device Type Input Box
Where the device type to be metered is defined.

Device Id Input Box
Where a numeric identifier for the device to be metered is entered. Examples of valid device Ids: 1, 5, 27 and 1039.

OK Button
Saves the current dialog box settings.

Cancel Button
Closes the dialog window without changing the current meter values and attributes.

Help Button
Displays this help topic.

Related topics:

- Viewing circuit voltage and current values - adding meters
- Creating and Editing Diagrams
- Dialog boxes

Edit Text Dialog Box

The Edit Text dialog box is where a text object's value is modified.

The New value input box is where the new string value is entered.

The OK button will save the current dialog box value.

The Cancel button will close the dialog window without changing the current text object value.

Related topics:

- Adding text objects to a diagram
- Creating and Editing Diagrams
- Dialog boxes

Open Circuit Shop File dialog box

This dialog box is where you open a circuit shop file by typing the file name in the input box or using the list boxes to find and open the file.

The File Name input box is where you enter the name of the file to load, or the filename mask to use as a filter for the Files list box.

The Files list box displays the names of files in the current directory that match the filename mask in the File Name input box, plus the parent directory and all subdirectories.

The Directories list box displays the contents of different directories by selecting a directory name in the Directories list box.

The OK button will attempt to open the selected file.

The Cancel button will close the dialog window without opening a file.

You can also use shortcut keys to get to the area of the dialog box you want. For example, pressing Alt+D outlines the first directory in the Directories list box.

Related topics:

- File|Open command
- Opening an existing diagram
- Creating and Editing Diagrams
- Dialog boxes

Print Dialog Box

The Print dialog box sets the printout parameters and generates a printout of the contents of a circuit shop window.

The Print Quality input box is where the printer resolution is specified.

The Print to File check box is where the printer output can be directed to a file. If this check box is selected a dialog box will be opened to specify the output filename.

The Copies input box is where the number of printed copies is specified.

The OK button will generate the printout and send it to the selected printer or file.

The Cancel button will close the dialog window without generating a printout.

The Setup button invokes the Printer Setup dialog box to select the default or specific printer, the page orientation of portrait or landscape, and paper size and source.

Related topics:

File|Print command
File|Printer setup command
Dialog boxes

Printer Setup Dialog Box

The Printer Setup dialog box sets printer parameters for subsequent print commands. Parameters include using the windows default or a specific printer, the page orientation of portrait or landscape, and paper size and source.

The Printer radio button box is where the printer is specified. If Default Printer is selected, the current windows default printer is used. If Specific Printer is selected, the drop down selection box can be used to select a specific printer from the known set of printers.

The Orientation radio button box is where the the page orientation of Portrait or Landscape is selected.

The Paper input box is where the paper size and source is selected.

The OK button will save the current dialog box settings to be used in subsequent print commands.

The Cancel button will close the dialog window without changing the printer settings.

The Options button will display a dialog box to set additional printer details including dithering and intensity.

Related topics:

- File|Print command
- File|Print preview command
- File|Printer setup command
- Dialog boxes

Save Circuit Shop File As Dialog Box

The Save Circuit Shop File As dialog box is where you enter the initial or new name for a circuit shop file.

If you choose an existing file name, Circuit Shop asks if you want to overwrite the existing file.

The File Name input box is where you enter the name of the file to save to, or the filename mask to use as a filter for the Files list box.

The Files list box displays the names of files in the current directory that match the filename mask in the File Name input box, plus the parent directory and all subdirectories.

The Directories list box displays the contents of different directories by selecting a directory name in the Directories list box.

The OK button will attempt to save to the specified file.

The Cancel button will close the dialog window without saving.

Related topics:

- File|Save As command
- File|Open command
- Creating and Editing Diagrams
- Dialog boxes

File Name Input Box

The File Name input box is where you enter the name of the file to load, or the file-name mask to use as a filter for the Files list box.

To open a file you can choose any of these actions:

- Type in a file name (if the file is not in your current directory, include the full path name) and choose OK or press Enter.

- Type in a file name with * and ? wildcards, which filters the files in the Files list box to match your specifications when you choose OK or press Enter.

Related topics:

Open Circuit Shop File dialog box
Save Circuit Shop File As dialog box
File|Open command
File|Save As command

Files List Box

The Files list box displays the names of files in the current directory that match the filename mask in the File Name input box , plus the parent directory and all subdirectories.

The Files list box is updated to show the files in the currently chosen directory.

If the file you want to open is listed in the list box, double-click on it to open or select the file.

If you are using the keyboard, Tab to the Files list box and use the Up or Down arrow to reach the file you want to open.   Press Enter to open or select the file.

Press the Spacebar or an arrow key to select the first item.   Press Enter to open or select the item.

Related topics:

- Open Circuit Shop File dialog box
- Save Circuit Shop File As dialog box
- File|Open command
- File|Save As command

Directories list box

The Directories list box lists the names of available directories and drives.

To work with directories, press Alt+D.   The first directory in the Directories list box will be outlined.

Double-click directories in the Directories list box to change to a different directory.

If you are using your keyboard, use the arrow keys to select the directory or drive you want to open and choose OK or press Enter.

If you see and double-click the [..] symbol, the directory will change to the parent directory of the current subdirectory.

Related topics:

- Open Circuit Shop File dialog box
- Save Circuit Shop File As dialog box
- File|Open command
- File|Save As command

Select Font Dialog Box

The Select Font dialog box is where a font is selected.

The Font input box is where the font is selected.

The Font Style input box is where a style is selected.   Examples of font styles: Regular, Italic, Bold and Bold Italic.

The Size input box is where the point size is specified.

Related topics:

- Tool|Font command
- Creating and editing diagrams
- Dialog boxes

Hints

Hint1 - to display the analog device toolkit.
Hint2 - to display the paint toolkit.
Hint3 - to display the digital device toolkit.
Hint4 - to change the number of pins on an integrated circuit.

Hint1

Use 

on the toolbar or menu command View|Analog device toolkit to display the analog device toolkit.

Hint2

Use 

on the toolbar or menu command View|Paint toolkit to display the paint toolkit.

Hint3

Use 

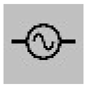
on the toolbar or menu command View|Digital device toolkit to display the digital device toolkit.

Hint4

To change the number of pins, or inputs on an integrated circuit, move the pointer over the integrated circuit, double-click to open the Edit IC dialog box, modify the Inputs: boxes and press OK.

Glossary

Push button
Receptacle
Relay
Resistor
Resistance
SCR
Series circuit
Silicon controlled rectified
Speaker
SPST switch
Switch
Terminal
Transformer
Transistor
Tunnel diode
Vertex
Voltage
Watt
Watt-hour
Wire
Zener diode



AC Generator

Definition: A rotating machine which converts mechanical energy into electrical energy in the form of alternating current (AC).

Alternating Current (AC)

Definition: A variable valued current which repeatedly increases to a maximum flow in one direction, decreases to zero, reverses, then increases to a maximum flow in the other direction. The number of times this cycle this is repeated per second is called the frequency. The average current over one cycle is zero.

Ampere

Definition: The usual measure of current in an electric circuit. One Ampere of current is produced by an electromotive force of one volt acting through a resistance of one ohm.

And Gate

Nand Gate

Definition: An And gate is a digital device with a high output (logic value 1) if all inputs are high. If any input is low, (logic value 0) the output will be low.

A Nand (Not and) gate is an inverted And gate.

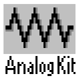
Input 1	Input 2	And Output	Nand Output
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

Antenna

Definition: A device to radiate or receive radio waves.

Battery

Definition: A device connected into an electrical circuit to introduce a specified direct current (DC) voltage.



Capacitor

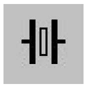
Definition: A device connected into an electrical circuit to introduce a specified capacitance.

Capacitance

Definition: The property of a circuit which impedes a change in voltage.   Capacitance is measured in farads in honor of Michael Faraday.   In electronic circuits, the usual measure of capacitance is microfarads (μF) or picofarads (pF), 1e-6 or 1e-12 farads respectively.

Connector

Definition: A device to allow one or more wires or devices to be electrically connected together.

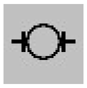


Crystal

Definition: A thin plate of quartz which is ground to a certain thickness to vibrate at a specific frequency when energy is applied.

Current

Definition: The rate of flow of electrons in a circuit measured in amperes.



DC Motor

Definition: A rotating machine which converts direct current (DC) electrical energy into mechanical energy.

Dieletric

Definition: The insulating material between the two plates of a capacitor.

Diode

Definition: A semiconductor device with two electrodes which allows current to flow in one direction. In the above icon, the left and right electrodes are called the anode and cathode respectively.

Direct Current (DC)

Definition: A constant valued current which flows in one direction.

Earphones

Definition: An electroacoustic transducer intended to be used near the ears which converts electrical power into acoustic power with approximately the same waveform as the electrical input.

Energy

Definition: The amount of work performed. Whereas power is the rate at which work is done, energy is the amount of work actually performed in a period of time. In an electrical circuit, energy is equal to the power times the time duration. Electrical energy is measured in watt-hours, one watt-hour is equivalent to one watt of power used for one hour.

Exclusive-or Gate

Exclusive-nor Gate

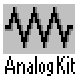
Definition: An Exclusive-or gate is a digital device with a high output (logic value 1) if one and only one input is high.

An Exclusive-nor (Not exclusive-or) gate is an inverted exclusive-or gate.

Input 1	Input 2	Exclusive Or Output	Exclusive Nor Output
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

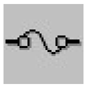
Farad

Definition: The measure of capacitance in an electric circuit. One Farad of capacitance causes one ampere of current to flow when the applied voltage is changing at a rate of one volt per second.



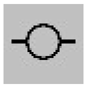
Field Effect Transistor

Definition: An active semiconductor device having three electrodes. In the above icon, starting with the electrode with the arrow, in a clockwise direction, the electrodes are called the gate, drain and source. The resistance between the drain and the source depends on the field produced by the voltage applied to the gate.



Fuse

Definition: A protective device which breaks the path in an electrical circuit when the current exceeds the rated value.



General Meter

Definition: A graphical representation of a circuit meter.

Note: Use the text tool 

on the paint toolkit to add V, A or OHM annotations to the center of the general meter to indicate a voltmeter, ammeter or ohmmeter respectively.

Chassis Ground

Earth Ground

Definition: The voltage reference in the circuit. There may or may not be an actual connection to the earth.

Henry

Definition: The measure of inductance in an electric circuit. One Henry of inductance causes one volt of counter electromotive force when the circuit current is changing at a rate of one ampere per second.

Analog Kit

Inductor

Definition: A device connected into an electrical circuit to introduce a specified inductance.

Inductance

Definition: The property of a circuit which impedes a change in current. Inductance is measured in henrys. In electronic circuits, the usual measure of inductance is henrys (H), milihenrys (mH) or microhenrys (μH), 1, 1e-3 or 1e-6 henrys respectively.

Integrated Circuit

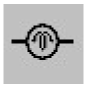
Definition: An electronic circuit composed of many transistors and other devices on a single, very small silicon chip or wafer. The silicon chip is encased in a protective package with connecting pins that are used to connect to other external devices.

Kirchoff's Current Law

Definition: The sum of the branch currents entering a node is equal to the sum of the currents leaving a node.

Kirchoff's Voltage Law

Definition: The sum of the voltage rises around a circuit loop is equal to the sum of the voltage drops around the loop.



Lamp

Definition: A light producing device.

AnalogKit Light Emitting Diode (LED)

Definition: A special type of diode which produces light when current flows in the forward direction.

Microphone

Definition: An electroacoustic transducer which converts acoustic power into electrical power with approximately the same waveform as the acoustic input.

Not Gate

Definition: A single input digital device whose output level is the reverse of the input level. For example, if the input level is high, (logic value 1) the output is low, (logic value 0).

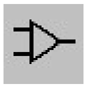
Input	Output
0	1
1	0

Ohm

Definition: The usual measure of resistance in an electric circuit.   One Ohm of resistance in a conductor allows one ampere of current to flow when one volt of electromotive force is applied.

Ohm's Law

Definition: The current in an electric circuit is inversely proportional to the resistance of the circuit and is directly proportional to the electromotive force (or voltage) in the circuit.

 **Operational Amplifier**

Definition: A general purpose high-gain amplifier to which feedback components are added in various configurations to perform various functions such as differential amplifier, differentiator and integrator.

Or Gate

Nor Gate

Definition: An Or gate is a digital device with a high output (logic value 1) if any input is high.

A Nor (Not or) gate is an inverted Or gate.

Input 1	Input 2	Or Output	Nor Output
0	0	0	1
0	1	1	0
1	0	1	0
1	1	1	0

Parallel Circuit

Definition: A circuit which contains more than one path for the current to flow through.

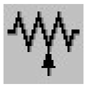
Two Prong Female and Male Plug

Three Prong Female and Male Plug

Definition: A device, with pins or receptacales which can complete a connection in an electrical circuit usually associated with 120 or 220 volts.

Plug In

Definition: A device, usually with pins which can complete a connection in an electrical circuit. A plug in device is usually associated with a receptacle.



Potentiometer (POT)

Definition: A three terminal electromechanical resistive device with two fixed end terminals and one terminal connected to an adjustable contact. The adjustable contact provides a variable resistance.

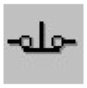
Power

Definition: The rate of doing work. In an electrical circuit, power is equal to the applied voltage times the resulting current. Power is measured in watts in honor of James Watt, the Scottish mechanical engineer who invented the steam engine.

One watt of electrical power is equal to one volt multiplied by one ampere.

Push Button

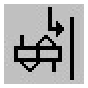
- Normally Open

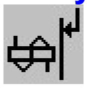

- Normally Closed

Definition: A device which momentarily completes (normally open) or breaks (normally closed) the current path in an electrical circuit.

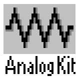
AnalogKit Receptacle

Definition: A device, usually stationary with sockets which can complete a connection in an electrical circuit.   A receptacle is usually associated with a plug in.

Relay  - Normally Open

 - Normally Closed

Definition: An electromechanical device consisting of a coil and an armature. Depending on the relay type, the armature has contacts which are normally open or closed. A voltage applied to the coil causes the armature to move and the contacts are either closed (from normally open) or opened (from normally closed).



Resistor

Definition: A device connected into an electrical circuit to introduce a specified resistance.

Resistance

Definition: The property of a conductor which impedes the passage of electric current. Resistance is measured in ohms in honor of the German physicist George Simon Ohm who investigated and formulated the relationship between voltage, current and resistance (Ohm's law).

Series Circuit

Definition: A circuit which contains only one possible path for the current to flow through.

Silicon Controlled Rectifier (SCR)

Definition: A special type of diode with an additional electrode called a gate. A voltage applied to the gate will turn the SCR on and allow current to flow. In the above icon, the left, right and bottom electrodes are called the anode, cathode and gate respectively.

Speaker

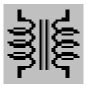
Definition: An electroacoustic transducer which converts electrical power into acoustic power into the air with approximately the same waveform as the electrical input.

Switch

Definition: A device which breaks or completes the current path in an electrical circuit, or depending on the type of switch, sends the current in a different path.

Terminal

Definition: A point of connection for two or more electrical circuit conductors.



Transformer

Definition: A device which uses electromagnetic induction to transfer energy from one circuit to another at the same frequency but with different voltage and current.

Transistor

Definition: An active semiconductor device, usually made of silicon or germanium and usually having three electrodes. In the above icon, starting with the electrode with the arrow, in a clockwise direction, the electrodes are called the emitter, base and collector.

AnalogKit

Tunnel Diode

Definition: A special type of diode which has the characteristic that for a certain voltage range, as the voltage increases the current decreases. In other words, for a certain voltage range, as the voltage increases the resistance also increases, thus allowing less current to flow. This voltage range is called the "negative resistance region."

Vertex

Definition: A point along a wire or line where the direction changes.

Voltage

Definition: The usual measure of electromotive force in a circuit. One Volt is the amount of energy supplied to an electric circuit in one second to produce one ampere of electric current in the circuit.

Watt

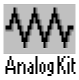
Definition: The usual measure of power in an electric circuit.   One watt of electrical power is equal to one volt multiplied by one ampere.

Watt-hour

Definition: The usual measure of energy in an electric circuit.   One watt-hour is equivalent to one watt of power used for one hour.

Wire

Definition: One solid conductor or several conductors stranded together with a low resistance to current flow. Usually made from copper and insulated.



Zener Diode

Definition: A special type of diode which maintains a constant voltage across its terminals. Zener diodes are used in voltage regulator circuits. In the above icon, the left and right electrodes are called the anode and cathode respectively.

General Tutorial Introduction and Instructions

Each tutorial is structured in a consistent manner and consists of several exercises, and each exercise consists of several topics. For example the

Resistors and Simple Circuits Tutorial consists of:

- Ohm's law exercise
- Series circuit exercise
- Parallel circuit exercise
- Power and energy exercise

Each exercise is structured in a consistent manner and where applicable, consists of theory, examples, demonstration circuit and detailed demonstration circuit construction topics. For example the

Ohm's law exercise consists of:

- Theory
- Examples
- Demonstration circuit
  - Demonstration circuit construction

To keep track of where you are in a tutorial, print the tutorial topic tree using the above File|Print Topic command and tick off the exercises as they are completed.

Within a tutorial, each exercise builds on the previous, thus it is recommended that the tutorial be completed from beginning to end.

If your terminal screen is large enough, move the help window to one side and the Circuit Shop application window to the other. If both the help window and the Circuit Shop application window cannot be shown without an overlap, resize the help window to cover approximately one half of the screen. While working through the tutorial, you will have to switch from one window to another.

Alternatively, before starting an exercise, select the topic on the tutorial topic tree and print the exercise using the above File|Print Topic command. The hardcopy can be used to add personal notes to the exercise.

Related topics:

Tutorial topic tree

Tutorial Topic Tree

The following topic tree shows the structure of and provides quick access to the various tutorial topics.

Related Topics:

Topic tree

Resistors and Simple Circuits Tutorial

This tutorial covers the following topics:

- Ohm's law and the relationship between resistance, voltage and current.
- The properties of series and parallel circuits.
- Power and energy.

Exercises:

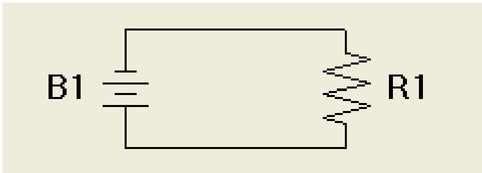
Ohm's Law
Series Circuits
Parallel Circuits
Power and Energy

Related topics:

Tutorial topic tree

Resistors and Simple Circuits Tutorial

Ohm's Law Exercise



Theory
The Ohm's law equation and the relationship between voltage, current and resistance can be found in theory.

Examples
The use of Ohm's law to determine a circuit's current, voltage or resistance can be found in examples.

Demonstration
Ohm's law demonstration provides instructions to construct a simple Circuit Shop circuit to show the relationships between voltage, current and resistance.

Related topics:

- Ohm's law theory
- Ohm's law examples
- Ohm's law demonstration circuit
- Ohm's law demonstration circuit construction
- Ohm's law
- Voltage
- Current
- Resistance
- Tutorial topic tree

Resistors and Simple Circuits Tutorial

Ohm's Law Exercise

Theory

The relationship between voltage, current and resistance is fundamental to electricity and electronics. Ohm's law defines this relationship. Ohm's law states

- The current in a circuit is directly proportional to the applied voltage. In other words, the greater the voltage, the greater the current.
- The current in a circuit is inversely proportional to the resistance in the circuit. In other words, the greater the resistance, the lower the current.

In equation form

$$I \text{ (amperes)} = \frac{E \text{ (volts)}}{R \text{ (ohms)}}$$

where

I = the circuit current in amperes
E = the applied voltage in volts
R = the circuit resistance in ohms

The above equation can be arranged as

$$E = I \times R \qquad I = \frac{E}{R} \qquad R = \frac{E}{I}$$

Using the various forms of the Ohm's law equation, if any two variables is known, the third variable can be determined. See Ohm's law examples.

When using Ohm's law, all variable values must be in the same basic units, for example **E** in volts, **I** in amperes and **R** in ohms. See unit conversions.

Related topics:

- Ohm's law exercise
- Ohm's law examples
- Ohm's law demonstration circuit
- Ohm's law
- Voltage
- Current
- Resistance

Resistors and Simple Circuits Tutorial

Ohm's Law Exercise

Examples

Example 1

Given a current of 1 ampere and a resistance of 100 ohms in a circuit, what is the applied voltage?

$$E = I \times R = 1 \times 100 = 100 \text{ volts}$$

Example 2

Given a voltage of 200 volts and a resistance of 50 ohms in a circuit, what is the current in the circuit?

$$I = \frac{E}{R} = \frac{200}{50} = 4 \text{ amperes}$$

Example 3

Given a voltage of 150 volts and a current of 25 amperes in a circuit, what is the resistance in the circuit?

$$R = \frac{E}{I} = \frac{150}{25} = 6 \text{ ohms}$$

Related topics:

- Ohm's law theory
- Ohm's law exercise
- Ohm's law
- Voltage
- Current
- Resistance

Resistors and Simple Circuits Tutorial

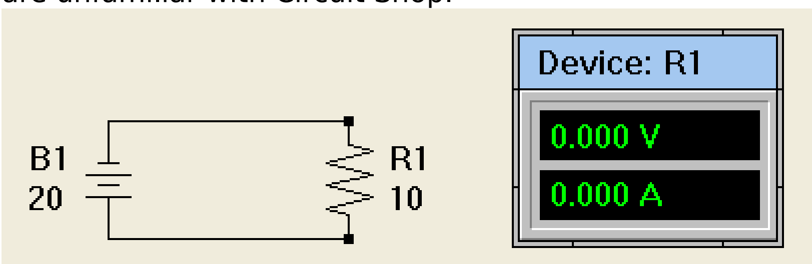
Ohm's Law Exercise

Demonstration Circuit

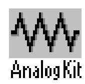
This circuit demonstrates Ohm's law and shows the relationship between voltage, current and resistance.

Step 1 - construct the circuit

Use Circuit Shop tools to construct the following circuit.   See detailed instructions if you are unfamiliar with Circuit Shop.



Step 2 - analyse the circuit

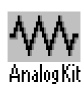
Use the Tool|Analyse menu command or the toolbar icon 

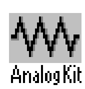
to analyse the circuit. Analysing a circuit provides additional details.

If the circuit has been correctly constructed and the device meter correctly linked to the resistor, after the analyse command has been executed, the device meter should display 20 volts and 2 amps.   In the circuit, battery B1 applies 20 volts across resistor R1 causing a current of 2 amps to flow.   Using Ohm's law, the current through the resistor may be calculated as follows:

```
     E       20
I = ---  =  ----  =  2 amperes
     R       10
```

Step 2 - increase the voltage

1. Using the mouse, click the pointer icon 

on the analog device toolkit.
2. Move the mouse onto the diagram over the battery.
3. Double click the mouse on the battery to open the Edit Device dialog box. Modifying device values provides additional details.
4. In the value field, enter **30** as the battery's new value.
5. Use the Tool|Analyse menu command or the toolbar icon 

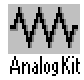
to analyse the circuit.
6. After the analyse command has been executed, the device meter should display 30 volts and 3 amps.   In the circuit, battery B1 now applies 30 volts across resistor R1's 10 ohms causing a current of 3 amps to flow.   Using Ohm's law, the current through the resistor may be calculated as follows:

```
     E       30
I = ---  =  ----  =  3 amperes
```

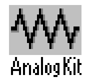
```
     R        10
```

As stated by Ohm's law, the increase in voltage has increased the current flow in the circuit.

Step 3 - increase the resistance

1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the resistor.
3. Double click the mouse on the resistor to open the Edit Device dialog box.

Modifying device values provides additional details.

4. In the value field, enter **60** as the resistor's new value.
5. Use the Tool|Analyse menu command or the toolbar icon  to analyse the circuit.
6. After the analyse command has been executed, the device meter should display 30 volts and 500 milli amps. In the circuit, battery B1 applies 30 volts across resistor R1's 60 ohms causing a current of 500 milli amps to flow. Using Ohm's law, the current through the resistor may be calculated as follows:

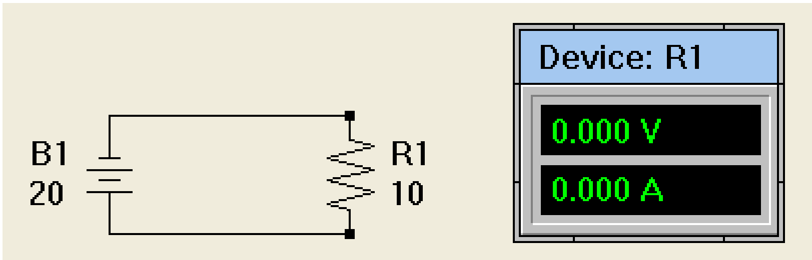
```
     E        30
I = ---  =  ----  =  0.5 amperes
     R        60
                  =  500 milli amps
```

As stated by Ohm's law, the increase in resistance has decreased the current flow in the circuit.

Related topics:

Resistors and Simple Circuits - Tutorial
Ohm's law exercise
Ohm's law theory
Ohm's law examples
Ohm's law demonstration circuit construction
Ohm's law
Voltage
Current
Resistance

Resistors and Simple Circuits Tutorial
Ohm's Law Exercise
Demonstration Circuit
Circuit Construction



This topic provides detailed instructions to construct the Ohm's law demonstration circuit shown in the title bar above.

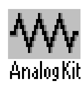
Open a diagram window and display the analog device toolkit:

1. Use the File|New menu command or the toolbar icon 

 to open a new diagram window. Creating a new diagram window provides additional details.
2. Ensure the analog device toolkit is visible. If the toolkit is not visible, use the View|Analog Device Toolkit menu command or the toolbar icon 

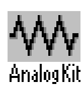
 to display it.

Add a resistor to the diagram:

1. Using the mouse, click the resistor icon 

 on the analog device toolkit.
2. Move the mouse onto the diagram to approximately the center of the diagram window.
3. Click the mouse to place the resistor on the diagram. Adding devices provides additional details.

Add a battery to the diagram:

1. Using the mouse, click the battery icon 

 on the analog device toolkit.
2. Move the mouse onto the diagram to where the battery is to be located. See circuit layout in title bar.
3. Click the mouse to place the battery on the diagram.

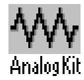
Layout the circuit and rotate the devices:

1. Using the mouse, click the pointer icon 

 on the analog device toolkit.
2. If necessary, move either the resistor or battery so they are horizontally aligned. See circuit layout in title bar. To move a device, press the left mouse button over a device and drag it to the new location. Moving devices provides additional details.
3. By default, Circuit Shop places resistors and batteries on a diagram in a horizontal orientation. To rotate the resistor, press the left mouse button over one of the resistor terminals and drag it to a vertical orientation. Rotating devices provides additional details.
4. Repeat step (3) to rotate the battery. After this step, both devices should be side

by side and vertically aligned as shown in the title bar above.

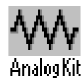
Add wires to connect the devices:

1. Using the mouse, click the wire icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the top battery terminal.
3. Press the left mouse button and drag the wire to the top resistor terminal.

Connecting devices provides additional details.

4. Repeat steps (2) and (3) to connect the bottom device terminals. At this point the circuit connections are complete and should look as shown in the title bar above.

Add ids and values to the devices:

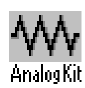
1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the resistor.
3. Double click the mouse on the resistor to open the Edit Device dialog box.

Modifying device values provides additional details.

4. Enter **1** as the resistor id and **10** ohms as its value.
5. Repeat step (3) on the battery and enter **1** as the battery id and **20** volts as its value.
6. Because of the vertical device orientation, the displayed ids and values, called annotations, need to be moved. See the circuit layout in title bar above for suggested annotation locations. To move an annotation, press the left mouse button over the annotation and drag it to the new location. Moving objects provides additional details.

   At this point the circuit is complete. The devices have been added, wires have been added to connect the devices, and their ids and values have been defined.

Add a device meter to the diagram:

1. Using the mouse, click the device meter icon  on the analog device toolkit.
2. Move the mouse onto the diagram to a position just to the right of the resistor as shown in the title bar above.
3. Click the mouse to place the meter on the diagram. Adding objects provides additional details.

Link the meter to the resistor:

1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the device meter.
3. Double click the mouse on the meter to open the Edit Meter dialog box.

Modifying object values provides additional details.

4. To link the meter to the resistor, select **Resistor** as the device type and **1** as the id.

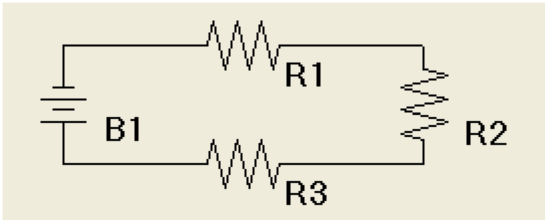
At this point the circuit construction is complete. Return to Ohm's law demonstration to complete the exercise.

Related topics:

Creating and editing diagrams
Menu commands
Toolbar commands
Device and drawing toolkits
Dialog boxes

Resistors and Simple Circuits Tutorial

Series Circuit Exercise



Theory

The relationship between voltage, current and resistance in a series circuit can be found in theory.

Examples

The use of Ohm's law to determine a series circuit's current, voltage or resistance can be found in examples.

Demonstration

Series circuit demonstration provides instructions to construct a simple Circuit Shop circuit to show the relationships between voltage, current and resistance in a series circuit.

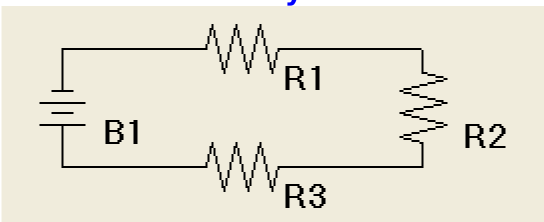
Related topics:

- Series circuit theory
- Series circuit examples
- Series circuit demonstration circuit
- Series circuit demonstration circuit construction
- Parallel circuit exercise
- Ohm's law exercise
- Series circuit
- Parallel circuit
- Ohm's law
- Voltage
- Current
- Resistance
- Tutorial topic tree

Resistors and Simple Circuits Tutorial

Series Circuit Exercise

Theory



A series circuit is composed of circuit components connected end-to-end. A characteristic of a series circuit is that all circuit current flows through each circuit component. In other words, the same amount of current flows through each series circuit component.

Series circuit resistance
The total resistance in a series circuit is the sum of the individual resistances. In the above circuit

```
R (total)  =  R1 + R2 + R3
```

In general, the total resistance for a series circuit with resistances **R1**, **R2**, **R3**, **R4**, ... is

```
R (total)  =  R1 + R2 + R3 + R4 + ...
```

Series circuit current
Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance. In the above circuit

```
                 E (total)
I (total)  =   -----------
                 R (total)
```

Voltage drop
Using Kirchoff's voltage law, the sum of voltage drops around a series circuit is equal to the applied voltage. Using the fact the same circuit current flows through each device, Ohm's law can be used to determine the voltage drop across each resistor.

```
E (R1)  =  I (total) x R1
E (R2)  =  I (total) x R2
E (R3)  =  I (total) x R3
```

The sum of the of the voltage drops equal the applied voltage.

```
E (B1)  =  E (R1)  +  E (R2)  +  E (R3)
```

Series circuit examples works through an example of the use of the above equations.

Power
Series circuit power describes how power is calculated in a series circuit.

Related topics:

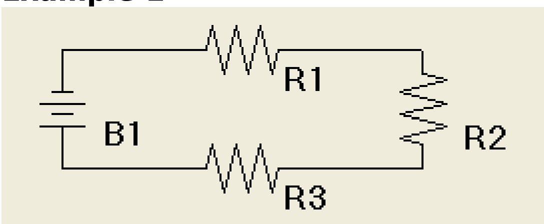
Kirchoff's voltage law
Series circuit exercise
Series circuit examples
Series circuit demonstration circuit
Power and energy exercise

Resistors and Simple Circuits Tutorial

Series Circuit Exercise

Examples

Example 1



Circuit values

```
B1 = 120 volts
R1 =  10 ohms
R2 =  20 ohms
R3 =  30 ohms
```

The total resistance in a series circuit is the sum of the individual resistances. In the above circuit

```
R (total)  =  R1  +  R2  +  R3
           =  10  +  20  +  30
           =  60 ohms
```

Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance. In the above circuit

```
I (total)  =  E (total) / R (total)
           =  120 / 60
           =  2 amps
```

Using the fact the same circuit current flows through each device, Ohm's law can be used to determine the voltage drop across each resistor.

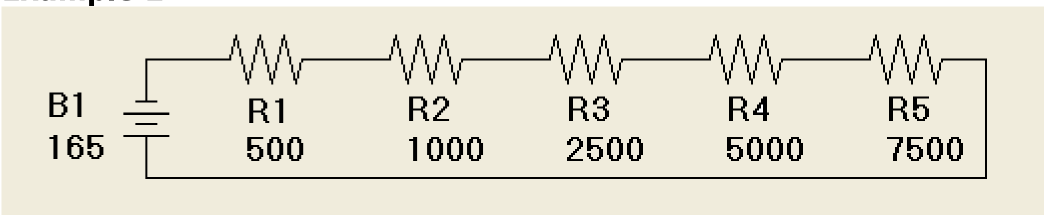
```
E (R1)   =  I (total) x R1
         =  2 x 10
         = 20 volts

E (R2)   =  I (total) x R2
         =  2 x 20
         = 40 volts

E (R3)   =  I (total) x R3
         =  2 x 30
         = 60 volts
```

Kirchoff's voltage law states the sum of voltage drops around a series circuit is equal to the applied voltage.

```
E (drops)    =  E (R1)  +  E (R2)  +  E (R3)
             =  20 + 40 + 60
             =  120 volts
```

```
E (applied)  =  B1
             =  120 volts
```

Example 2



Given a series circuit with five resistors as shown and an applied voltage of **165** volts, determine the circuit current.

The total resistance in a series circuit is the sum of the individual resistances. In the above circuit

```
R (total)  =  R1  + R2   + R3   + R4   + R5
           =  500 + 1000 + 2500 + 5000 + 7500
           =  16500 ohms
```

Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance.

```
I (total)  =  E (total) / R (total)
           =  165 / 16500
           =  0.01 amps
           =  10 mA
```

Related topics:

Series circuit theory
Series circuit exercise
Series circuit

Resistors and Simple Circuits Tutorial

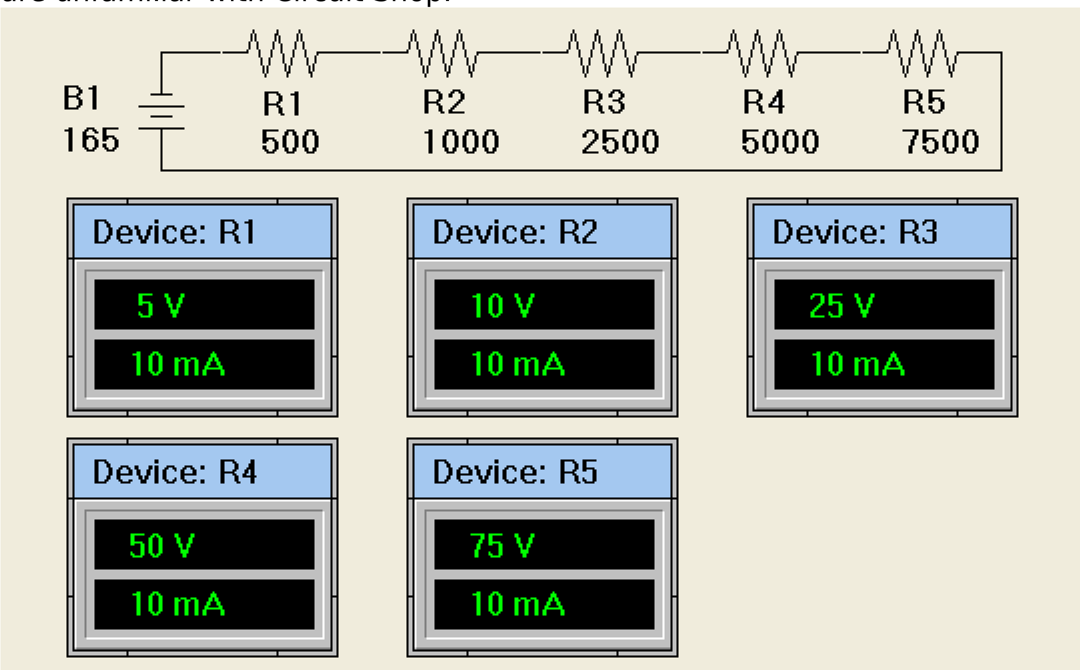
Series Circuit Exercise

Demonstration Circuit

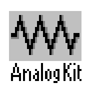
This circuit demonstrates the relationship between voltage, current and resistance in a series circuit.

Step 1 - construct the circuit

Use Circuit Shop tools to construct the following circuit.   See detailed instructions if you are unfamiliar with Circuit Shop.



Step 2 - analyse the circuit

Use the Tool|Analyse menu command or the toolbar icon 

to analyse the circuit. Analysing a circuit provides additional details.

If the circuit has been correctly constructed and the device meters correctly linked to the resistors, after the analyse command has been executed, the device meters should display the following voltages and currents.

	Voltage (volts)	Current (mA)
R1	5	10
R2	10	10
R3	25	10
R4	50	10
R5	75	10
	===	
	165	

As stated in Kirchoff's voltage law, the sum of the device meter voltages, **165** volts is equal to the applied voltage by battery B1.

The total resistance in a series circuit is the sum of the individual resistances.

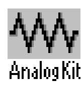
```
R (total)  =  R1   + R2   + R3   + R4   + R5
           =  500 + 1000 + 2500 + 5000 + 7500
           =  16500 ohms
```

Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance.

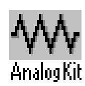
```
I (total)  =  E (total) / R (total)
           =  165 / 16500
           =  0.01 amps
           =  10 mA
```

As shown in each device meter, this current flows through each resistor. Series circuits have the property that the current is the same through each device.

Step 2 - increase the voltage

1. Using the mouse, click the pointer icon 

on the analog device toolkit.
2. Move the mouse onto the diagram over the battery.
3. Double click the mouse on the battery to open the Edit Device dialog box. Modifying device values provides additional details.
4. In the value field, enter **200** as the battery's new value. This doubles the applied voltage.

5. Use the Tool|Analyse menu command or the toolbar icon 

to analyse the circuit.
6. After the analyse command has been executed, the device meter should display the following voltages and currents.

	Voltage (volts)	Current (mA)
R1	10	20
R2	20	20
R3	50	20
R4	100	20
R5	150	20
	===	
	300	

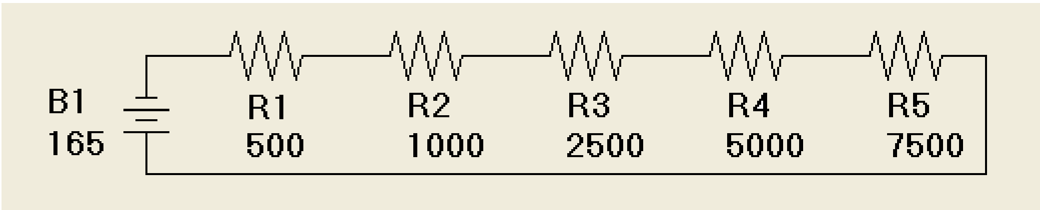
As expected, since the applied voltage was doubled, the resulting circuit current doubled to **20** mA and the voltage across each resistor doubled. Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance.

```
I (total)  =  E (total) / R (total)
           =  300 / 16500
           =  0.02 amps
           =  20 mA
```

Related topics:

- Resistors and Simple Circuits - Tutorial
- Series circuit exercise
- Series circuit theory
- Series circuit examples
- Series circuit demonstration circuit construction
- Parallel circuit exercise
- Ohm's law exercise
- Ohm's law
- Voltage
- Current
- Resistance

Resistors and Simple Circuits Tutorial
Series Circuit Exercise
Demonstration Circuit
Circuit Construction



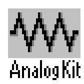
This topic provides detailed instructions to construct the series circuit demonstration circuit shown in the title bar above.

Open a diagram window and display the analog device toolkit:

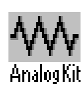
1. Use the File|New menu command or the toolbar icon  to open a new diagram window. Creating a new diagram window provides additional details.
2. Ensure the analog device toolkit is visible. If the toolkit is not visible, use the

View|Analog Device Toolkit menu command or the toolbar icon  to display it.

Add resistors to the diagram:

1. Using the mouse, click the resistor icon  on the analog device toolkit.
2. Move the mouse onto the diagram to approximately the center of the diagram window.
3. Click the mouse to place the resistor on the diagram. Adding devices provides additional details.
4. Repeat step (3) to add five resistors to the diagram as shown in the title bar above.

Add a battery to the diagram:

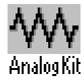
1. Using the mouse, click the battery icon  on the analog device toolkit.
2. Move the mouse onto the diagram to where the battery is to be located. See circuit layout in title bar.
3. Click the mouse to place the battery on the diagram.

Layout the circuit and rotate the devices:

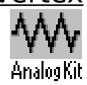
1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. If necessary, move the resistors so they are horizontally aligned. See circuit layout in title bar. To move a device, press the left mouse button over a device and drag it to the new location. Moving devices provides additional details.
3. By default, Circuit Shop places resistors and batteries on a diagram in a horizontal orientation. To rotate the battery, press the left mouse button over one of the battery terminals and drag it to a vertical orientation. Rotating devices provides additional details.
4. Move the battery so the top battery terminal is aligned with the left-most resistor

terminal.   See circuit layout in title bar.

Add wires to connect the devices:

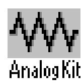
1. Using the mouse, click the wire icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the top battery terminal.
3. Press the left mouse button and drag the wire to the left-most resistor terminal.

Connecting devices provides additional details.

4. Repeat steps (2) and (3) to connect each of the resistor terminals to form a "string" of resistors.
5. Repeat steps (2) and (3) to connect the right-most resistor terminal to the bottom battery terminal.
6. To "square" up the circuit, a vertex needs to be added to the wire.   Using the mouse, click the pointer icon  on the analog device toolkit.   To add a vertex, move the pointer over the wire added in step (5), press the left mouse button and drag the wire to the new location.   Adding a wire vertex provides additional details.

   At this point the circuit connections are complete and should look as shown in the title bar above.

Add ids and values to the devices:

1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the left-most resistor.
3. Double click the mouse on the resistor to open the Edit Device dialog box.

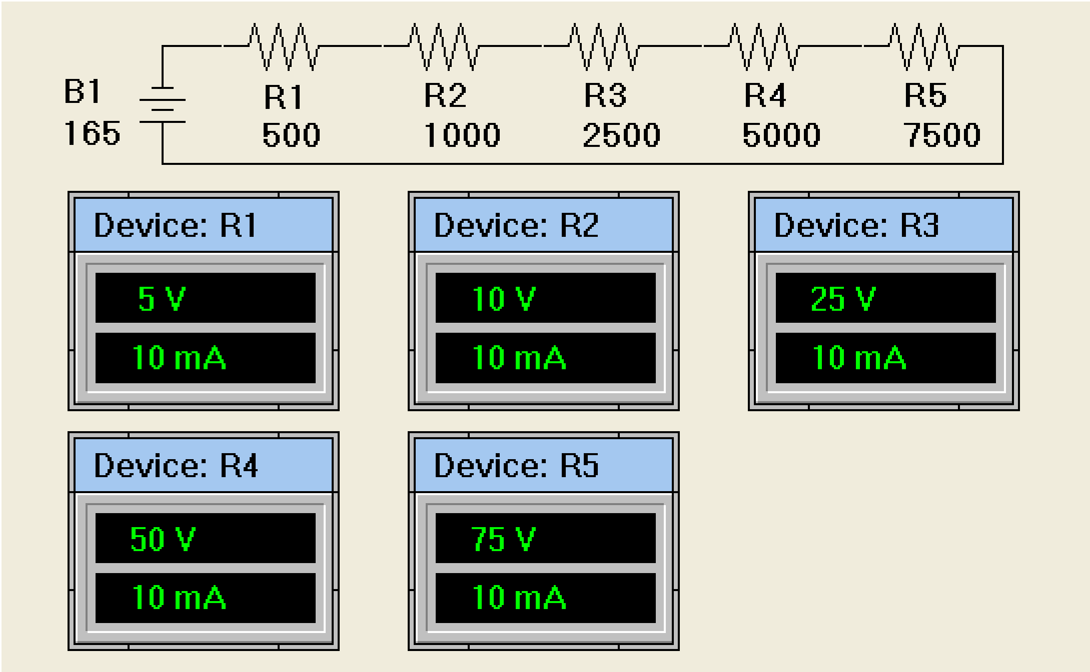
Modifying device values provides additional details.

4. Enter **1** as the resistor id and **500** ohms as its value.
5. Repeat steps (3) and (4) on the other resistors, enter **2**, **3**, **4** and **5** as the resistor ids and **1000**, **2500**, **5000**, **7500** ohms as their values.
6. Repeat step (3) on the battery and enter **1** as the battery id and **165** volts as its value.
6. Because of the vertical device orientation of the battery, the displayed id and value, called annotations, need to be moved.   See the circuit layout in title bar above for suggested annotation locations.   To move an annotation, using the pointer, press the left mouse button over the annotation and drag it to the new location.   Moving objects provides additional details.

   At this point the circuit is complete.   The devices have been added, wires have been added to connect the devices, and their ids and values have been defined.

Add device meters to the diagram:

1. Using the mouse, click the device meter icon  on the analog device toolkit.
2. Five device meters need to be added to the diagram as shown below.



To add the first meter, move the mouse onto the diagram to a position just under the battery as shown in the title bar above.

3. Click the mouse to place the meter on the diagram. Adding objects provides additional details.
4. Repeat step (3) to add the other four meters as shown above.

Link the meters to the resistors:

1. Using the mouse, click the pointer icon  on the analog device toolkit.
2. Move the mouse onto the diagram over the first device meter.
3. Double click the mouse on the meter to open the Edit Meter dialog box.

Modifying object values provides additional details.

4. To link the meter to the resistor, select **Resistor** as the device type and **1** as the id.
5. Repeat steps (2), (3) and (4) on the other meters, select **Resistor** as the device type and enter **2**, **3**, **4** and **5** as the device ids.

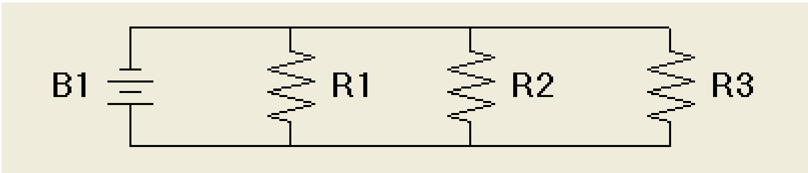
At this point the circuit construction is complete. Return to series circuit demonstration to complete the exercise.

Related topics:

Creating and editing diagrams
Menu commands
Toolbar commands
Device and drawing toolkits
Dialog boxes

Resistors and Simple Circuits Tutorial

Parallel Circuit Exercise



Theory
The relationship between voltage, current and resistance in a parallel circuit can be found in theory.

Examples
The use of Ohm's law to determine a parallel circuit's current, voltage or resistance can be found in examples.

Demonstration
Parallel circuit demonstration provides instructions to construct a simple Circuit Shop circuit to show the relationships between voltage, current and resistance in a parallel circuit.

Related topics:

- Parallel circuit theory
- Parallel circuit examples
- Parallel circuit demonstration circuit
- Parallel circuit demonstration circuit construction
- Series circuit exercise
- Ohm's law exercise
- Parallel circuit
- Series circuit
- Ohm's law
- Voltage
- Current
- Resistance
- Tutorial topic tree

Resistors and Simple Circuits Tutorial
Parallel Circuit Exercise
Theory

A parallel circuit is composed of circuit components connected side-by-side such that the circuit current has multiple paths.

Parallel circuit current
In the above circuit, R1 and R2 are connected in "parallel" to battery B1, i.e. battery B1 applies its voltage equally across resistors R1 and R2.

Using Ohm's law, the current in each branch of the parallel circuit is equal to the voltage applied across the branch divided by the branch resistance. In the above circuit, the current through R1's branch is the voltage applied by B1 divided by the resistance of the branch. The current through R2's branch may be found in a similar manner.

$$I\ (R1) = E\ (B1)\ /\ R1$$
$$I\ (R2) = E\ (B1)\ /\ R2$$

Kirchoff's current law states the total current in a parallel circuit is equal to the sum of the branch currents. In the above circuit, the total current is the sum of the currents through each branch.

$$I\ (total) = I\ (R1) + I\ (R2)$$

In general, the total current in a parallel circuit with branch currents **I1**, **I2**, **I3**, ... is

$$I\ (total) = I1 + I2 + I3 + ...$$

Parallel circuit resistance
The general formula for finding the total resistance of resistances in parallel (sometimes called the reciprocal of reciprocals) is

$$R\ (total) = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + ...}$$

Note: The total resistance of resistors in parallel is always less than the lowest branch resistance value. This is because the total current for a parallel circuit is always greater than the current through any individual branch.

For two resistors in parallel, the formula can be arranged as

$$R\ (total) = \frac{R1 \times R2}{R1 + R2}$$

For **N** parallel resistors of equal value **R**, another special case formula can be used

```
                 R
R (total) = ---
                 N
```

A second approach to determining the total resistance of a parallel circuit:

1. Use Ohm's law to determine the current through each branch.
2. Sum the branch currents to determine the total circuit current.
3. Use Ohm's law again to determine the total resistance based on the applied voltage divided by the total circuit current.

For example, for a circuit with a voltage source **E1** and three parallel resistors, **R1**, **R2** and **R3**.

```
1.     I1  =  E1 / R1
       I2  =  E1 / R2
       I3  =  E1 / R3

2.     I (total)  =  I1 + I2 + I3

3.     R (total)  =  E1 / I (total)
```

Parallel circuit examples works through an example of the use of the above equations.

Power

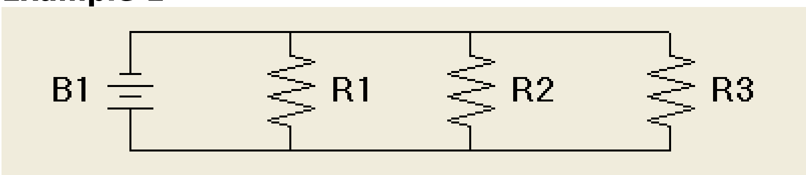
Parallel circuit power describes how power is calculated in a parallel circuit.

Related topics:

- Kirchoff's current law
- Parallel circuit exercise
- Parallel circuit examples
- Parallel circuit demonstration circuit
- Power and energy exercise

Resistors and Simple Circuits Tutorial
Parallel Circuit Exercise
Examples

Example 1



Circuit values

```
B1 =  120 volts
R1 =  100 ohms
R2 =  500 ohms
R3 = 2000 ohms
```

As described in parallel circuit theory, the total resistance in a parallel circuit may be found using the following general formula.

```
                          1
R (total) = ---------------------
             1     1     1
            --- + --- + --- + ...
             R1    R2    R3
```

Using the circuit values

```
R (total)
  = 1 / ( 1/R1  + 1/R2  + 1/R3   )
  = 1 / ( 1/100 + 1/500 + 1/2000 )
  = 1 / ( 0.01  + 0.002 + 0.0005 )
  = 1 / 0.0125
  = 80 ohms
```

Using Ohm's law, the total current in a parallel circuit is equal to the total applied voltage divided by the total resistance.   In the above circuit

```
I (total)  =  E (total) / R (total)
           =  120 / 80
           =  1.5 amps
```

The total resistance and total current of a parallel circuit may be verified as follows:

1. Use Ohm's law to determine the current through each branch.
2. Sum the branch currents to determine the total circuit current.
3. Use Ohm's law again to determine the total resistance based on the applied voltage divided by the total circuit current.

In the above circuit

```
1.      I1  =  E1 / R1  =  120 /  100  =  1.2  amps
        I2  =  E1 / R2  =  120 /  500  =  0.24 amps
        I3  =  E1 / R3  =  120 / 2000  =  0.06 amps
```

```
2.      I (total)  =   I1 +   I2 +   I3
                   =  1.2 + 0.24 + 0.06
                   =  1.5 amps

3.      R (total)  =   E1 / I (total)
                   =  120 / 1.5
                   =  80 ohms
```

Example 2

Circuit values

```
B1 =  120 volts
R1 =  100 ohms
R2 =  400 ohms
```

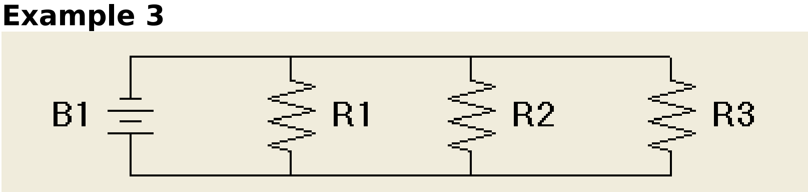
As described in parallel circuit theory, the total resistance in a parallel circuit containing two resistors may be found using the following special case formula.

```
                  R1 x R2
R (total) = -----------
                 R1  +  R2
```

In the above circuit

```
R (total)
  = (100 x 400) / (100 + 400)
  = 40000 / 500
  = 80 ohms
```

Example 3



Circuit values

```
B1 =  120 volts
R1 =  150 ohms
R2 =  150 ohms
R3 =  150 ohms
```

As described in parallel circuit theory, the total resistance in a parallel circuit containing resistors of equal value may be found using the following special case formula.

```
                 R
R (total) = ---
                 N
```

In the above circuit

```
R (total) = 150 / 3
          = 50 ohms
```

Related topics:

- Parallel circuit theory
- Parallel circuit exercise
- Parallel circuit

Resistors and Simple Circuits Tutorial

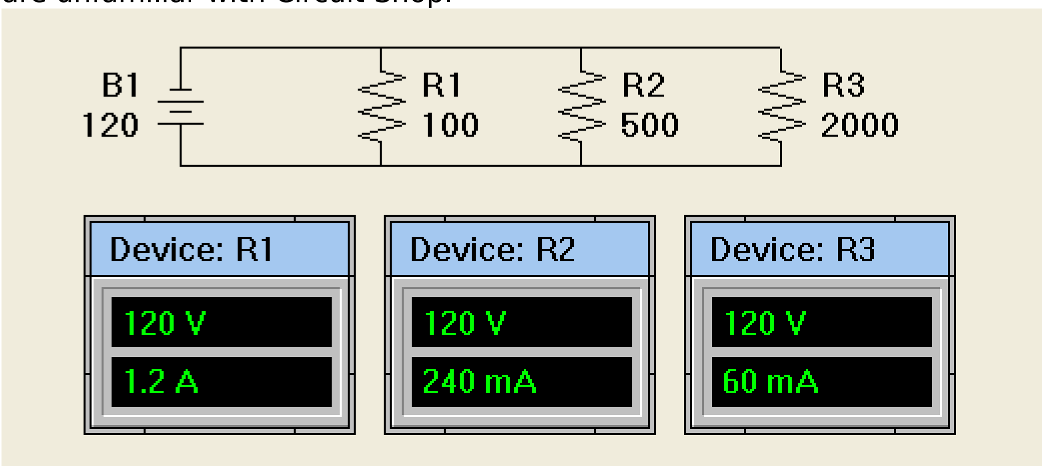
Parallel Circuit Exercise

Demonstration Circuit

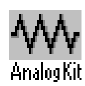
This circuit demonstrates the relationship between voltage, current and resistance in a parallel circuit.

Step 1 - construct the circuit

Use Circuit Shop tools to construct the following circuit. See detailed instructions if you are unfamiliar with Circuit Shop.



Step 2 - analyse the circuit

Use the Tool|Analyse menu command or the toolbar icon 

to analyse the circuit. Analysing a circuit provides additional details.

If the circuit has been correctly constructed and the device meters correctly linked to the resistors, after the analyse command has been executed, the device meters should display the following voltages and currents.

	Voltage (volts)	Current (mA)		
R1	120	1200		
R2	120	240		
R3	120	60		
		====		
		1500	=	1.5 amps

As stated in Kirchoff's current law, the sum of the branch currents as shown by the device meter currents, **1.5** amps, is the total current in the parallel circuit.

Using Ohm's law, the total resistance in a parallel circuit is equal to the total applied voltage divided by the total current. For the above circuit

```
R (total)  =  E (total) / I (total)
           =  120 / 1.5
           =  80 ohms
```

As described in parallel circuit theory, the total resistance in a parallel circuit is always less than any individual branch resistance.   In the above circuit, the total resistance is **80** ohms which is less than the lowest branch resistance, **100** ohms.

Related topics:

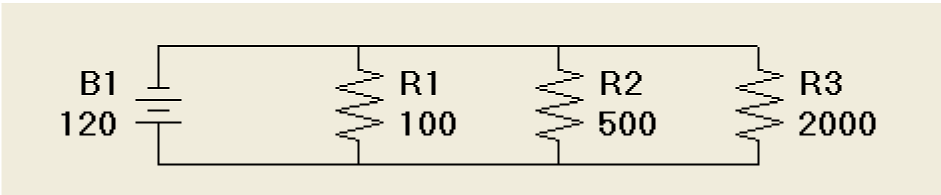
- Resistors and Simple Circuits - Tutorial
- Parallel circuit exercise
- Parallel circuit theory
- Parallel circuit examples
- Parallel circuit demonstration circuit construction
- Series circuit exercise
- Ohm's law exercise
- Ohm's law
- Voltage
- Current
- Resistance

Resistors and Simple Circuits Tutorial

Parallel Circuit Exercise

Demonstration Circuit

Circuit Construction



This topic provides detailed instructions to construct the parallel circuit demonstration circuit shown in the title bar above.

Open a diagram window and display the analog device toolkit:

1. Use the File|New menu command or the toolbar icon AnalogKit to open a new diagram window. Creating a new diagram window provides additional details.
2. Ensure the analog device toolkit is visible. If the toolkit is not visible, use the

View|Analog Device Toolkit menu command or the toolbar icon AnalogKit to display it.

Add resistors to the diagram:

1. Using the mouse, click the resistor icon AnalogKit on the analog device toolkit.
2. Move the mouse onto the diagram to approximately the center of the diagram window.
3. Click the mouse to place the resistor on the diagram. Adding devices provides additional details.
4. Repeat step (3) to add two more resistors to the diagram as shown in the title bar above.

Add a battery to the diagram:

1. Using the mouse, click the battery icon AnalogKit on the analog device toolkit.
2. Move the mouse onto the diagram to where the battery is to be located. See circuit layout in title bar.
3. Click the mouse to place the battery on the diagram.

Layout the circuit and rotate the devices:

1. Using the mouse, click the pointer icon AnalogKit on the analog device toolkit.
2. If necessary, move the battery and resistors so they are horizontally aligned. See circuit layout in title bar. To move a device, press the left mouse button over a device and drag it to the new location. Moving devices provides additional details.
3. By default, Circuit Shop places resistors and batteries on a diagram in a horizontal orientation. To rotate the battery and each resistor, press the left mouse button over one of the device's terminals and drag it to a vertical orientation. Rotating devices provides additional details.

Add wires to connect the devices:

1. Using the mouse, click the wire icon AnalogKit on the analog device toolkit.
2. Move the mouse onto the diagram over the top battery terminal.
3. Press the left mouse button and drag the wire to the left-most resistor top terminal. Connecting devices provides additional details.
4. Repeat steps (2) and (3) to connect each top resistor terminal, the bottom battery terminal to the left-most resistor bottom terminal, and each bottom resistor terminal.

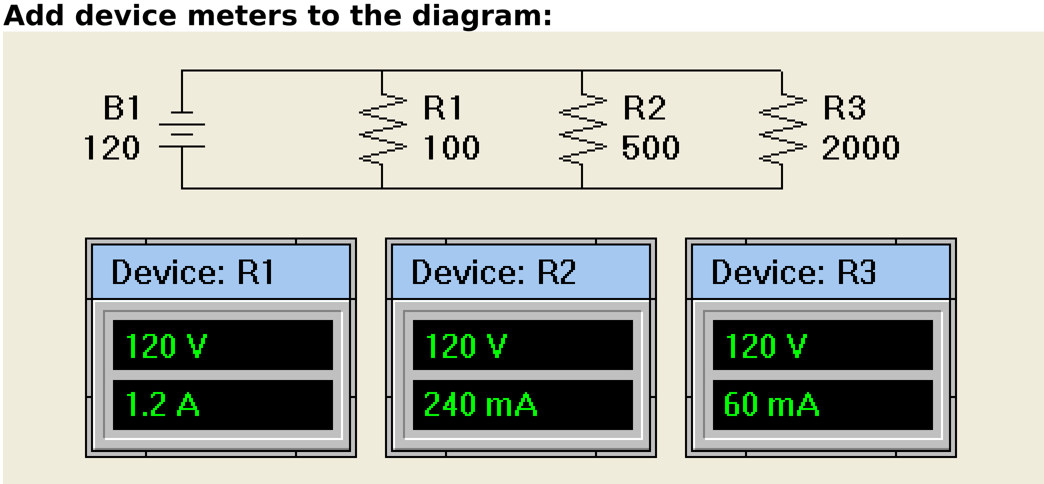
At this point the circuit connections are complete and should look as shown in the title bar above.

Add ids and values to the devices:

1. Using the mouse, click the pointer icon AnalogKit on the analog device toolkit.
2. Move the mouse onto the diagram over the left-most resistor.
3. Double click the mouse on the resistor to open the Edit Device dialog box. Modifying device values provides additional details.
4. Enter **1** as the resistor id and **100** ohms as its value.
5. Repeat steps (3) and (4) on the other resistors, enter **2** and **3** as the resistor ids and **500**, **2000** ohms as their values.
6. Repeat step (3) on the battery and enter **1** as the battery id and **120** volts as its value.
6. Because of the vertical device orientation of the devices, the displayed ids and values, called annotations, need to be moved. See the circuit layout in title bar above for suggested annotation locations. To move an annotation, using the pointer, press the left mouse button over the annotation and drag it to the new location. Moving objects provides additional details.

At this point the circuit is complete. The devices have been added, wires have been added to connect the devices, and their ids and values have been defined.

Add device meters to the diagram:



1. Using the mouse, click the device meter icon AnalogKit on the analog device toolkit.

2. Three device meters need to be added to the diagram. To add the first meter, move the mouse onto the diagram to a position just under the battery as shown above.
3. Click the mouse to place the meter on the diagram. Adding objects provides additional details.
4. Repeat step (3) to add the other two meters as shown above.

Link the meters to the resistors:

1. Using the mouse, click the pointer icon 

on the analog device toolkit.
2. Move the mouse onto the diagram over the first device meter.
3. Double click the mouse on the meter to open the Edit Meter dialog box. Modifying object values provides additional details.
4. To link the meter to the resistor, select **Resistor** as the device type and **1** as the id.
5. Repeat steps (2), (3) and (4) on the other meters, select **Resistor** as the device type and enter **2** and **3** as the device ids.

   At this point the circuit construction is complete. Return to parallel circuit demonstration to complete the exercise.

Related topics:

Creating and editing diagrams
Menu commands
Toolbar commands
Device and drawing toolkits
Dialog boxes

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Power

Theory

The equation for power in an electrical circuit and the relationship between voltage, current and resistance can be found in theory.

Examples

The use of the equation for power to determine a circuit's power consumption can be found in examples.

Energy

Theory

The equation for energy in an electric circuit and the relationship to power can be found in theory.

Examples

The use of the equation for energy to determine a circuit's energy consumption can be found in examples.

Related topics:

Ohm's law
Voltage
Current
Resistance
Tutorial topic tree

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Power - Theory

Power is the rate of doing work. Electrical power in a resistance is turned into heat. The greater the power, the faster heat is generated.

- The power in a circuit is directly proportional to the product of the applied electromotive force and the resulting circuit current. In other words, the greater the voltage and current, the greater the power.

- The power in watts in a circuit is equal to the voltage in volts times the circuit current in amperes.

Power is measured in watts, named after James Watt, the Scottish mechanical engineer who invented the steam engine.

In equation form

P (watts) = E (volts) x I (amperes)

where

P = the circuit power in watts
E = the applied voltage in volts
I = the circuit current in amperes

By substituting the Ohm's law equivalent for **E, I** and **R,** (see Ohm's law theory) the above equation can be arranged as

```
     E**2
P = ------      P = I**2 x R
      R
```

Using the various forms of the above equations, if any two variables is known, the third variable can be determined. See power examples.

When using any of the above equations, all variable values must be in the same basic units, for example **E** in volts, **I** in amperes and **R** in ohms. See unit conversions.

Power calculation in a series and parallel circuits is described in series circuit power and parallel circuit power respectively.

Related topics:

Power examples
Power and energy exercise
Voltage
Current
Resistance

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Power - Examples

Example 1

Given a voltage of 10 volts and a current of 5 amperes, what is the power in the circuit?

```
P = E x I
  = 10 x 5
  = 50 watts
```

Example 2

Given a voltage of 20 volts and a resistance of 50 ohms, what is the power in the circuit?

```
     E**2      20**2     400
P = ------ =   ----- = ----- = 20 watts
      R          50        50
```

Example 3

Given a current of 10 amperes and a resistance of 20 ohms, what is the power in the circuit?

```
P = I**2  x R
  = 10**2 x 20
  = 100   x 20
  = 2000 watts
```

Related topics:

- Power theory
- Power and energy exercise
- Series circuit power
- Parallel circuit power
- Voltage
- Current
- Resistance

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Series Circuit Power

AnalogKit

Power can be calculated as the product of the total voltage times the total current. In the above circuit, using the following circuit values

```
B1 = 120 volts
R1 =  10 ohms
R2 =  20 ohms
R3 =  30 ohms
```

The total resistance in a series circuit is the sum of the individual resistances. In the above circuit

```
R (total)   =  R1  +  R2  +  R3
            =  10  +  20  +  30
            =  60 ohms
```

Using Ohm's law, the total current in a series circuit is equal to the total applied voltage divided by the total resistance. In the above circuit

```
I (total)   =  E (total) / R (total)
            =  120 / 60
            =  2 amps
```

When the total voltage and current is known, the power may be determined as

```
P (total)   =  E (total)   x I (total)
            =  120 (volts) x 2 (amps)
            =  240 watts
```

Alternatively, power can be calculated as the sum of the power requirements for each device. In the above circuit, using the same circuit values, power may be calculated using the `P = I**2 x R` formula developed in the power theory topic. Note, this formula can be used because the same current flows through each device.

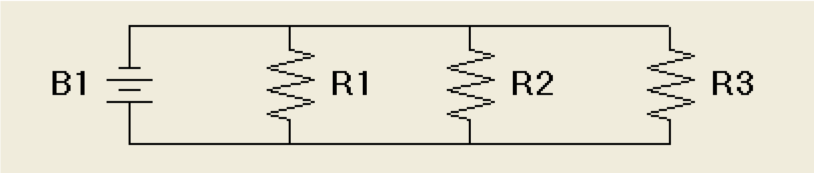
```
P (R1)   =  I (total)**2 x R1
         =  2**2 x 10
         =  4    x 10
         =  40 watts

P (R2)   =  I (total)**2 x R2
         =  2**2 x 20
         =  80 watts

P (R3)   =  I (total)**2 x R3
         =  2**2 x 30
         =  120 watts
```

```
P (total)  =  P (R1)  +  P (R2)  +  P (R3)
           =  40      +  80      +  120
           =  240 watts
```

Related topics:

- Power theory
- Power and energy exercise
- Series circuit exercise
- Parallel circuit power

Resistors and Simple Circuits Tutorial
Power and Energy Exercise
Parallel Circuit Power



Power can be calculated as the product of the total voltage times the total current. In the above circuit, using the following circuit values

```
B1 =  120 volts
R1 =  100 ohms
R2 =  500 ohms
R3 = 2000 ohms
```

As described in parallel circuit theory, the total resistance in a parallel circuit may be found using the following general formula.

```
                      1
R (total) = ---------------------
             1     1     1
            --- + --- + --- + ...
             R1    R2    R3
```

Using the circuit values

```
R (total)
  = 1 / ( 1/R1  + 1/R2  + 1/R3   )
  = 1 / ( 1/100 + 1/500 + 1/2000 )
  = 1 / ( 0.01  + 0.002 + 0.0005 )
  = 1 / 0.0125
  = 80 ohms
```

Using Ohm's law, the total current in a parallel circuit is equal to the total applied voltage divided by the total resistance. In the above circuit

```
I (total)  =  E (total) / R (total)
           =  120 / 80
           =  1.5 amps
```

When the total voltage and current is known, the power may be determined as

```
P (total)  =  E (total)   x I (total)
           =  120 (volts) x 1.5 (amps)
           =  180 watts
```

Alternatively, power can be calculated as the sum of the power requirements for each device. In the above circuit, using the same circuit values, power may be calculated using the `P = E**2 / R` formula developed in the power theory topic. Note, this formula can be used because the same voltage is applied to each device.

```
P (R1)   =  E (total)**2 / R1
         =  120**2       / 100
         =  14400        / 100
         =  144 watts

P (R2)   =  I (total)**2 / R2
         =  120**2       / 500
         =  28.8 watts

P (R3)   =  I (total)**2 / R3
         =  120**2       / 2000
         =  7.2 watts

P (total)   =  P (R1)   +  P (R2)   +  P (R3)
            =  144      +  28.8     +  7.2
            =  180 watts
```

Related topics:

- Power theory
- Power and energy exercise
- Parallel circuit exercise
- Series circuit power

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Energy - Theory

Whereas power is the rate at which work is done, energy is the amount of work actually performed in a period of time. In other words, a small amount of power for a long period of time can use the same amount of energy as a large amount of power for a short period of time.

- The energy used in a circuit is directly proportional to the product of the power and the time duration. In other words, the greater the power and time, the greater the energy.

- The energy in watt-hours used in a circuit is equal to the power in watts multiplied by the time duration in hours.

Energy is measured in watt-hours, one watt-hour is equivalent to one watt of power used for one hour. The usual household measure of energy is kilowatt-hours which is 1000 watt-hours (1 watt for 1000 hours or 1000 watts for 1 hour).

In equation form

$$W \text{ (watt-hours)} = P \text{ (watts)} \times t \text{ (hours)}$$

where

W = the circuit energy in watt-hours
P = the circuit power in watts
t = the time duration in hours

Related topics:

Power examples
Power and energy exercise
Power

Resistors and Simple Circuits Tutorial

Power and Energy Exercise

Energy - Examples

Example 1

Given a power of 10 watts and a time duration of 3 hours, what is the energy used in the circuit?

```
W = P x t
  = 10 x 3
  = 30 watt-hours
```

Example 2

Given a power of 2000 watts and a time duration of 2 hours, what is the energy used in the circuit?

```
W = P x t
  = 2000 x 2
  = 4000 watt-hours
  = 4 kilowatt-hours
```

Example 3

Given a voltage of 12 volts and a current of 0.5 amperes and a time duration of 24 hours, what is the energy used in the circuit?

First calculate the circuit power

```
P = E x I
  = 12 x 0.5
  = 6 watts
```

Using the circuit power, calculate the energy used

```
W = P x t
  = 6 x 24
  = 144 watt-hours
```

Related topics:

- Energy theory
- Power theory
- Power examples
- Power and energy exercise
- Energy
- Power

Capacitors and Inductors Tutorial

This tutorial covers the following topics:

- Capacitors and the theory of capacitance.
- The properties of capacitors in series and parallel circuits.

- Inductors and the theory of inductance.
- The properties of inductors in series and parallel circuits.

Exercises:

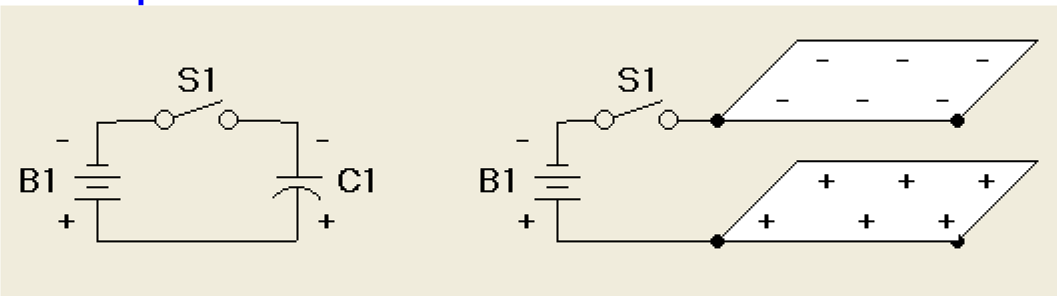
Capacitor exercise
Inductor exercise

Related topics:

Tutorial topic tree

Capacitors and Inductors Tutorial

Capacitor Exercise



Theory

Capacitance and the relationship to voltage and current can be found in theory.

Capacitors in series and parallel describes how to calculate the resulting capacitance of capacitors connected in series and parallel.

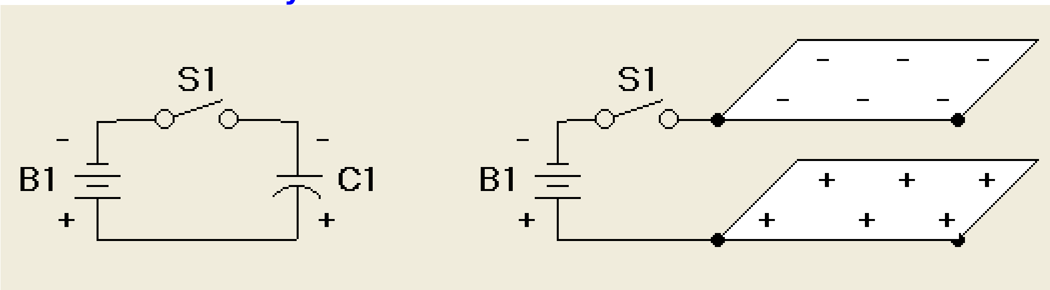
Examples

The use of capacitors in series and parallel circuits can be found in examples.

Related topics:

Inductor exercise
Capacitors and inductors tutorial
Tutorial topic tree

Capacitors and Inductors Tutorial
Capacitor Exercise
Theory



A capacitor in its simplest form, is two metal plates placed very close together, but not touching. On the right hand side of the above diagram is a circuit composed of a battery B1, a switch S1 and two plates forming a capacitor C1.

When the switch is closed, the circuit path is completed, and an electric charge or current will migrate from the battery to the capacitor. The electric current will flow until the voltage across the capacitor equals the battery voltage. This charging process is usually very fast.

If the switch is opened, i.e. the circuit path is broken, the electric charge will remain on the capacitor. Energy has been transferred from the battery to the capacitor.

The amount of charge or quantity of energy whch can be placed on a capacitor is proportional to the applied voltage and the capacitance of the capacitor. The larger the metal plate area, the smaller the spacing between the plates, and the greater the ability of the material between the plates to store energy, the greater the capacitance.

In a capacitor, the material between the plates is called the dieletric. Some materials are better at storing energy than others and are thus better dieletrics. For example, glass is 5 to 10 times better than air.

In a DC circuit, current flows until the capacitor is charged. Once the capacitor is charged, i.e. the capacitor voltage equals the applied voltage, no further current flows.

In an AC circuit, current flows in one direction until the capacitor is charged. When the current direction changes, the capacitor attempts to hold the voltage at the charged level and thus capacitance has the property that it opposes a change in voltage.

Capacitance is measured in farads in honor of Michael Faraday. In electronic circuits, the usual measure of capacitance is microfarads (µF) or picofarads (pF), 1e-6 or 1e-12 farads respectively.

Related topics:

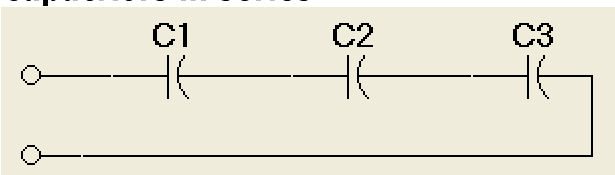
- Capacitors in series and parallel
- Capacitor examples
- Capacitor exercise
- Capacitors and inductors tutorial
- Voltage
- Current

Capacitors and Inductors Tutorial

Capacitor Exercise

Capacitors in Series and Parallel

Capacitors in series



Capacitors are sometimes connected in series to allow the set of capacitors to withstand a larger voltage. The general formula for finding the total capacitance of capacitors connected in series is

$$C\ (total) = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \ldots}$$

Note: The total capacitance of capacitors in series is always less than the lowest individual capacitance value.

For two capacitors in series, the formula can be arranged as

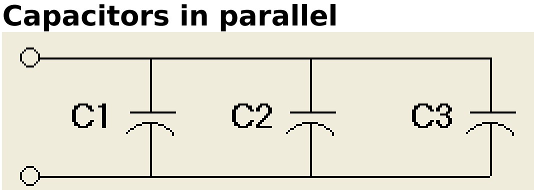
$$C\ (total) = \frac{C1 \times C2}{C1 + C2}$$

For N capacitors in series of equal value C, another special case formula can be used

$$C\ (total) = \frac{C}{N}$$

When capacitors are connected in series, the applied voltage is divided between them in a similar manner to resistors in series.

Capacitors in parallel



Capacitors are connected in parallel to obtain a larger total capacitance than provided by each component. The total capacitance of capacitors connected in parallel is the sum of the individual capacitances. In the above circuit

$$C\ (total) = C1 + C2 + C3$$

In general, the total capacitance for capacitors connected in parallel with capacitances C1, C2, C3, C4, ... is

```
C (total)  =  C1 + C2 + C3 + C4 + ...
```

Related topics:

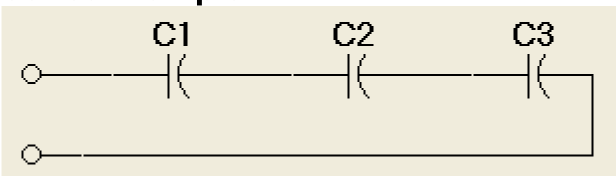
- Capacitor examples
- Capacitor exercise
- Capacitors and inductors tutorial

Capacitors and Inductors Tutorial

Capacitor Exercise

Examples

Series Example 1



Circuit values

```
C1 =  1 µF
C2 =  5 µF
C3 = 20 µF
```

As described in capacitors in series and parallel theory, the total capacitance of capacitors in series may be found using the following general formula.

```
                           1
     C (total) = ---------------------
                  1     1     1
                 --- + --- + --- + ...
                  C1    C2    C3
```

Using the circuit values

```
     C (total)
       = 1 / ( 1/1 + 1/5 + 1/20 )
       = 1 / ( 1   + 0.2 + 0.05 )
       = 1 / 1.25
       = 0.8 µF
```

Series Example 2

Given a circuit with two capacitors in series with circuit values

```
C1 =  10 µF
C2 =  40 µF
```

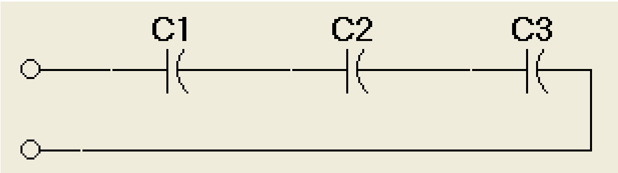
As described in capacitors in series and parallel theory, the total capacitance of two capacitors in series may be found using the following special case formula.

```
                   C1 x C2
     C (total) = -----------
                  C1  +  C2
```

Using the above values

```
     C (total)
       = (10 x 40) / (10 + 40)
       = 400 / 50
       = 8 µF
```

Series Example 3



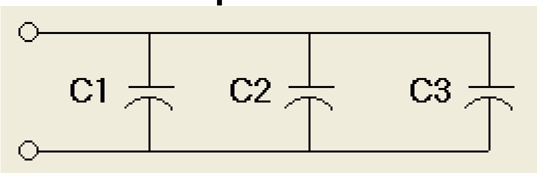
As described in capacitors in series and parallel theory, the total capacitance of equal value capacitors in series may be found using the following special case formula.

```
                C
C (total) = ---
                N
```

Given a circuit with three equal value capacitors in series, each with a value of 15 µF, using the above formula

```
C (total) = 15 / 3
          = 5 µF
```

Parallel Example 1



Circuit values

```
C1 =  10 µF
C2 =  20 µF
C3 =  30 µF
```

The total capacitance of capacitors in parallel is the sum of the individual capacitances. In the above circuit

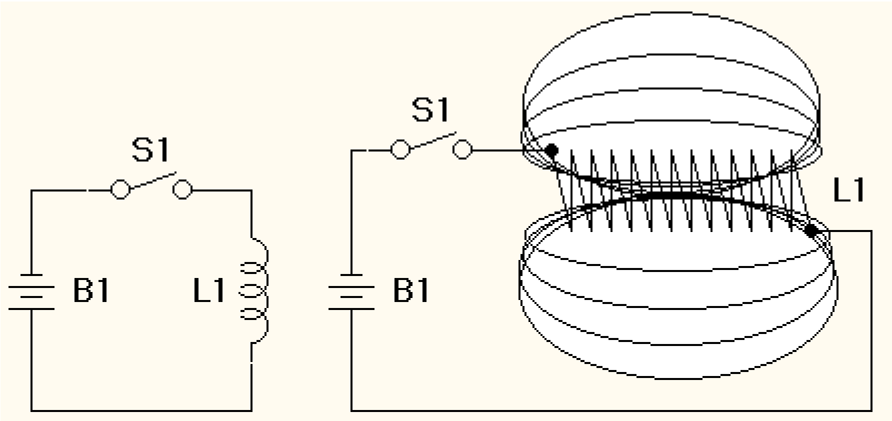
```
C (total)  =  C1  +  C2  +  C3
           =  10  +  20  +  30
           =  60 µF
```

Related topics:

- Capacitor theory
- Capacitor exercise
- Capacitors and inductors tutorial

Capacitors and Inductors Tutorial

Inductor Exercise



Theory

Inductance and the relationship to voltage and current can be found in theory.

Inductors in series and parallel describes how to calculate the resulting inductance of inductors connected in series and parallel.

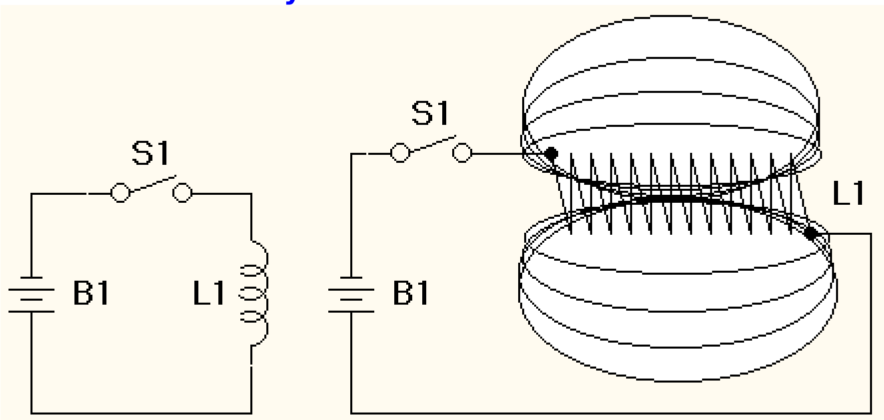
Examples

The use of inductors in series and parallel circuits can be found in examples.

Related topics:

- Capacitor exercise
- Capacitors and inductors tutorial
- Tutorial topic tree

Capacitors and Inductors Tutorial
Inductor Exercise
Theory



An inductor in its simplest form, is a coil of wire. On the right hand side of the above diagram is a circuit composed of a battery B1, a switch S1 and a coil of wire forming an inductor L1.

When the switch is closed, the circuit path is completed, and an electric current will flow from the battery, through the switch and through the inductor. When current flows through a coil, a magnetic field is generated. Energy is transferred from the battery to the inductor to generate the magnetic field.

The amount of energy whch can be placed in an inductor is proportional to the current and the inductance of the inductor. Inductance depends on the physical characteristics of the inductor. The greater the number of turns of wire, the greater the inductance. The greater the ability to form a magnetic field, the greater the inductance, i.e. a coil will have a greater inductance if placed on an iron core.

In a DC circuit, current flows continuously and the inductor's magnetic field is constant.

In an AC circuit, current flows in one direction until the magnetic field is fully formed. When the current direction changes, the magnetic field attempts to hold the current at the previous level and thus inductance has the property that it opposes a change in current.

Inductance is measured in henrys.

Related topics:

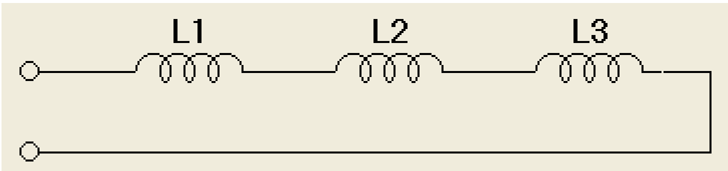
- Inductors in series and parallel
- Inductor examples
- Inductor exercise
- Capacitors and inductors tutorial
- Voltage
- Current

Capacitors and Inductors Tutorial

Inductor Exercise

Inductors in Series and Parallel

Inductors in series



The total inductance of inductors connected in series is the sum of the individual inductances.   In the above circuit

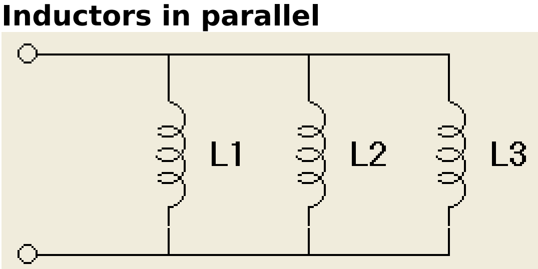
$$L\ (total) = L1 + L2 + L3$$

In general, the total inductance for inductors connected in series with inductances L1, L2, L3, L4, ... is

$$L\ (total) = L1 + L2 + L3 + L4 + \ldots$$

When inductors are connected in series, the applied voltage is divided between them in a similar manner to resistors in series.

Inductors in parallel



The general formula for finding the total inductance of inductors connected in parallel is

$$L\ (total) = \frac{1}{\frac{1}{L1} + \frac{1}{L2} + \frac{1}{L3} + \ldots}$$

Note: The total inductance of inductors in parallel is always less than the lowest individual inductance value.

For two inductors in parallel, the formula can be arranged as

$$L\ (total) = \frac{L1 \times L2}{L1 + L2}$$

For N inductors in parallel of equal value L, another special case formula can be used

```
                 L
L (total) = ---
```

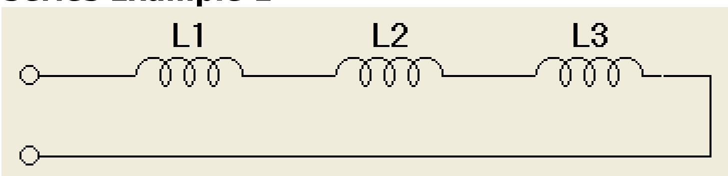
N

Related topics:

- Inductor examples
- Inductor exercise
- Capacitors and inductors tutorial

Capacitors and Inductors Tutorial
Inductor Exercise
Examples

Series Example 1



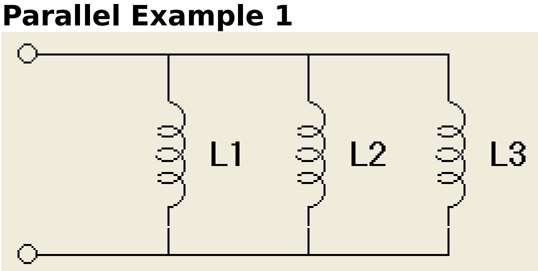
Circuit values

```
L1 =  10 mH
L2 =  20 mH
L3 =  30 mH
```

The total inductance of inductors in series is the sum of the individual inductances.   In the above circuit

```
L (total)  =  L1  +  L2  +  L3
           =  10  +  20  +  30
           =  60 mH
```

Parallel Example 1



Circuit values

```
L1 =  1 mH
L2 =  5 mH
L3 = 20 mH
```

As described in inductors in series and parallel theory, the total inductance of inductors in parallel may be found using the following general formula.

```
                          1
L (total) = ---------------------
              1     1     1
             --- + --- + --- + ...
              L1    L2    L3
```

Using the circuit values

```
L (total)
  = 1 / ( 1/1 + 1/5 + 1/20 )
  = 1 / ( 1   + 0.2 + 0.05 )
  = 1 / 1.25
  = 0.8 mH
```

Parallel Example 2

Given a circuit with two inductors in series with circuit values

```
L1 =  10 mH
L2 =  40 mH
```

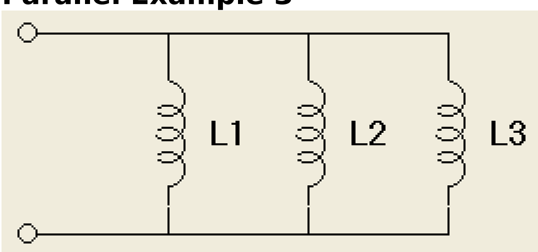
As described in inductors in series and parallel theory, the total inductance of two inductors in parallel may be found using the following special case formula.

```
                  L1 x L2
L (total) = -----------
                 L1  +  L2
```

Using the above values

```
L (total)
  = (10 x 40) / (10 + 40)
  = 400 / 50
  = 8 mH
```

Parallel Example 3



As described in inductors in series and parallel theory, the total inductance of equal value inductors in parallel may be found using the following special case formula.

```
             L
L (total) = ---
             N
```

Given a circuit with three equal value inductors in series, each with a value of 15 mH, using the above formula

```
L (total) = 15 / 3
          = 5 mH
```

Related topics:

- Inductor theory
- Inductor exercise
- Capacitors and inductors tutorial