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Introduction

CATIA Version 5 Electrical Design

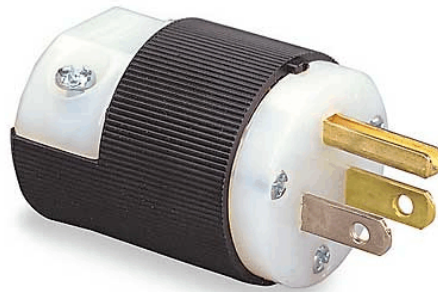
Upon completion of this course the student should have a full understanding of the following topics:

- Defining electrical parts and assemblies
- Defining electrical connection points
- Defining support parts
- Storing electrical parts into catalogs
- Assembling electrical parts

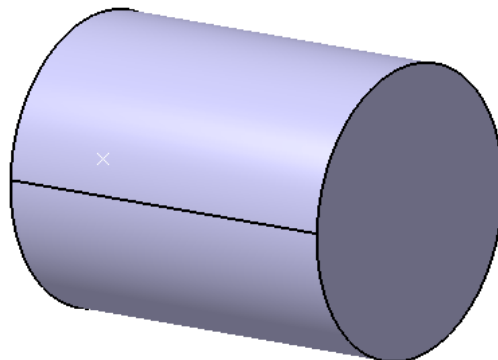
Electrical Design

Electrical Design is the first phase of defining an electrical harness. Before you can begin defining the wire segments and bundles, you need to build the electrical parts. The actual building of the parts is done utilizing part design, generative shape design, and other part related workbenches. Once the model is developed, you are ready to begin defining the electrical properties for that model. Any part that is to be used with the electrical harness should have all necessary electrical properties defined prior to trying to build a harness.

There are three stages to defining an electrical part. You must first always build the part. This can generally be the most difficult aspect since you will need to determine the level of complexity for the part. The more complex you make the part, the more detailed it will become, and the more information you can put into and take out of the part. Take, for example, a simple electrical cord plug.

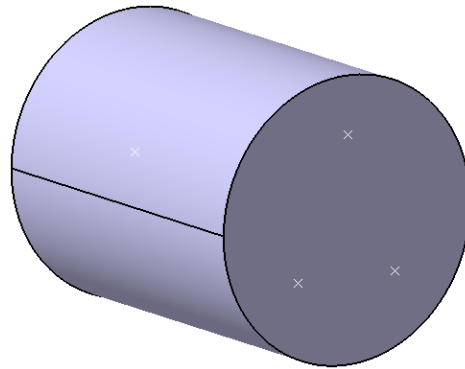


This type of plug can be modeled and electrified in a number of different degrees of complexity. You could model the plug as a single cylinder where only the wire connection point is identified.



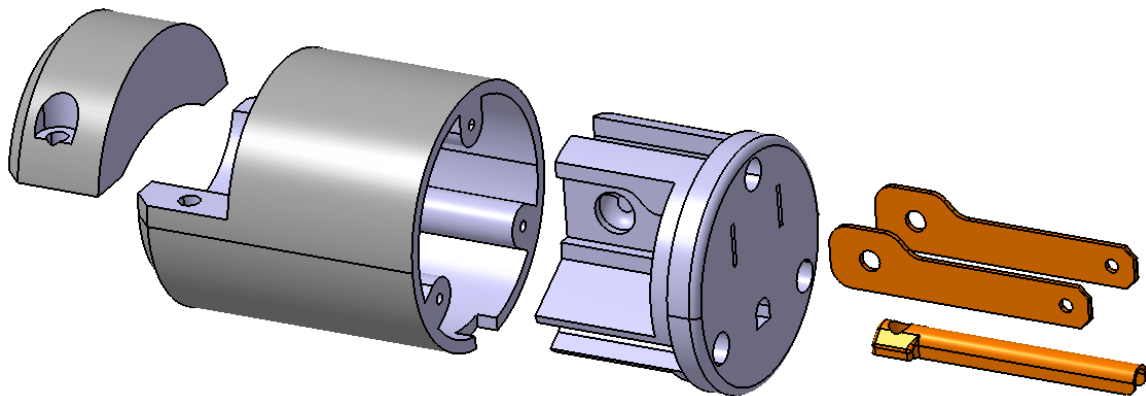
This type of model is easily created and can rapidly be used when defining electrical properties, but it lacks a lot of information. In this case, you would indicate that the wire bundle would connect to the connector via one termination point. You would then need adequate documentation to indicate which wire was to connect to which terminal, as well as the number of terminals, terminal arrangement, etc. This type of plug is used more for space reservation and rapid proof of concept rather than a final design.

The next level of complexity would be to indicate that the plug has three connection points.



Although there is little change in the model, you will be able to define more information with the electrical terminations on this model, such as each specific termination and the route of the wire from pin to pin. There is not a high amount of part detail, but you will have a higher amount of electrical detail just by adding a few extra points in the model.

The highest level of detail would be to define the entire product.



At this point, you would have a very high level of detail for both the digital design of the model and the electrical properties for this assembly. You would not only be able to define the contacts for the electrical part, but you would also be able to define the shells, back shells, supports, and all other components for the plug. Keep in mind, although this type of assembly does show and have the most detail, it also takes the longest to build.

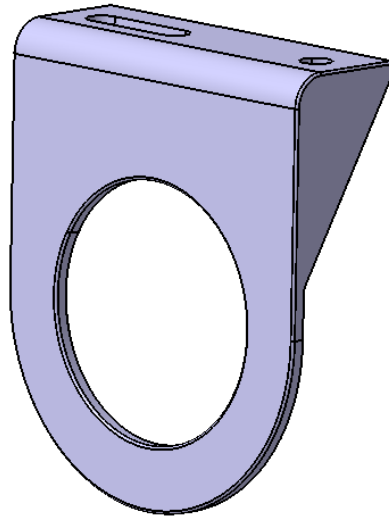
When determining what you will need to build, be sure to take into account how much time you want to spend building the part, and what information you need to pull from the part. If you find you need a high level of information from the part, you will need to be highly detailed for the product.

In this course, you will utilize two electrical workbenches, along with all your part and assembly workbenches. It will be assumed that you have a good understanding of Part Design and Assembly Design, as well as some understanding of wireframe and surfaces. In this course you will primarily be using the Electrical Part Design and Electrical Assembly Design workbenches to electrify your parts and products.

Mounting Equipment with Cavity

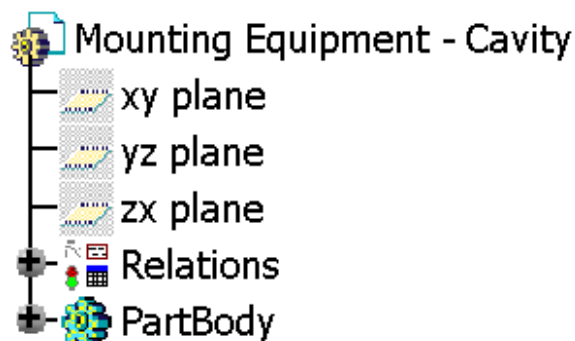
Mounting equipment with a cavity will generally be a mount that has a hole or pocket in it to allow another part to connect. If you refer to the earlier chart, you will find that you can mount other mounting equipment, equipment, shells, etc into the cavity.

Open the Mounting Equipment - Cavity document. This is a simple gage mount bracket that you will define electrical properties and a cavity in the large hole.



If not already there, switch to the Electrical Part Design workbench. The Electrical Part Design workbench will allow you to define all the necessary electrical properties for a detail part.

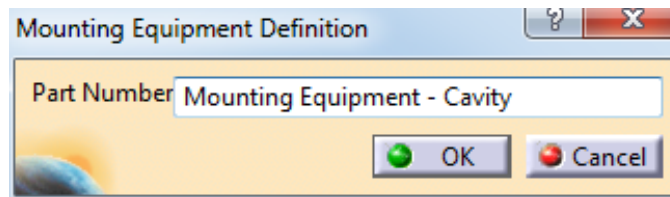
Before going too much further, notice this is a standard part design part.



Select the **Define Mounting Equipment** icon.  This icon will change the selected part to mounting equipment.

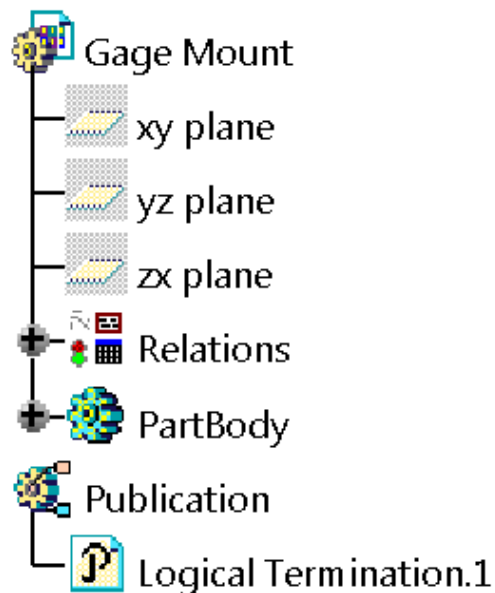
Select the part either from the graphical workspace or from the specification tree. Equipment properties are always applied to the entire part. Therefore, it does not matter if you select the part from the graphical workspace or from the specification tree.

Notice a *Mounting Equipment Definition* window displays.



This will allow you to change the part number for the mounting equipment as you define it.

Change the *Part Number* to Gage Mount and select *OK*. Notice the name of the part changes. You should also notice that the icon for the part document changes slightly, and a publication is created.



The publication does not necessarily point to a specific element, but instead defines electrical termination properties for the device.


At this point, you have defined the part as an electrical device. Now you need to define the electrical connection point.

Defining a Cavity

Cavities are essentially cutouts or holes in a part that will allow another part to connect via a cavity connection point. Cavities can only be defined in the following type of equipment:

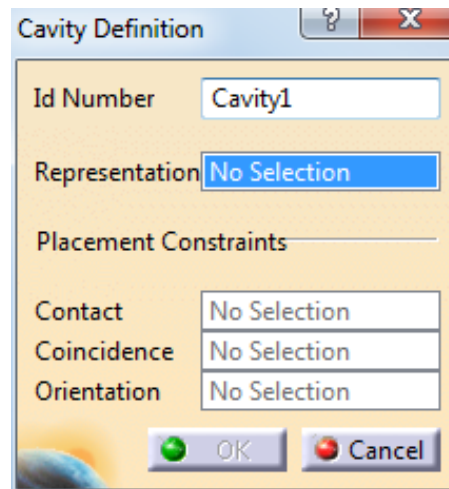
Mounting Equipment	Stud
Equipment	Terminal Strip
Shell	Terminal Block
Single Insert Connector	Back Shell

Now to create the cavity for the mounting equipment.

Select the Define Cavity icon.  This icon will allow you to define a cavity on the mounting equipment.

Select the gage mount. Again, this can be defined via the specification tree or the workspace. Since the cavity is applied to the entire part, it does not matter if you select the part graphically or from the tree.

This will display the *Cavity Definition* window. Take a moment to look at the window and its various fields.



Id Number This defines the name for the cavity

Representation This defines the geometry that will highlight when the cavity is selected. You can pick faces, geometrical elements, or sketch based features

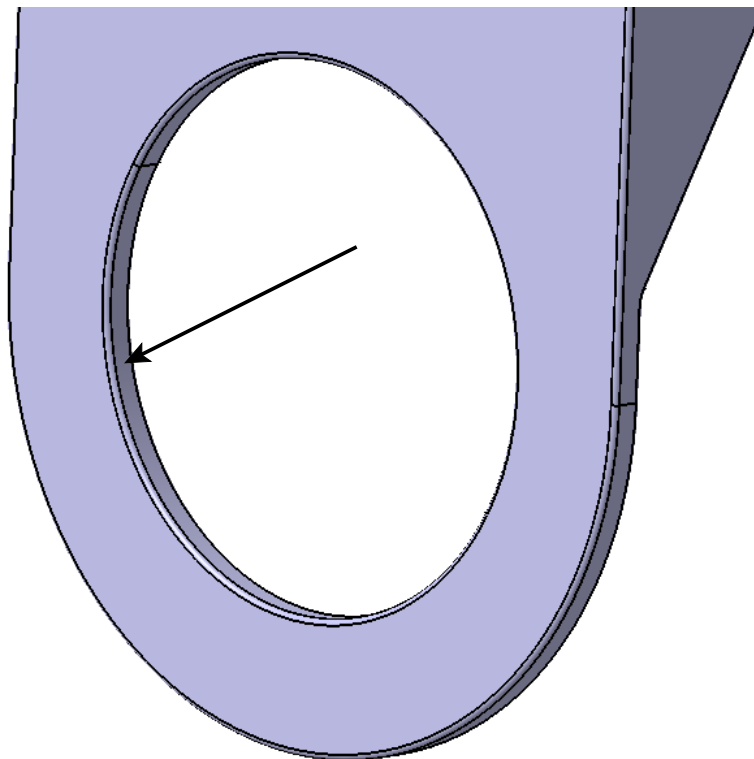
Placement Constraints

<i>Contact</i>	This defines the surface that will be contacted against the cavity connection point contact surface. When a planar face is selected, a contact constraint will be generated. Generally, this will be the mating face for the equipment
<i>Coincidence</i>	This defines an element that will get a coincidence constraint with the coincidence element from the cavity connection point. In many cases, this will generally be a centerline for the connection
<i>Orientation</i>	This defines an orientation element that will coincidence with the orientation element on the mating part. A coincidence constraint will be generated between the two elements

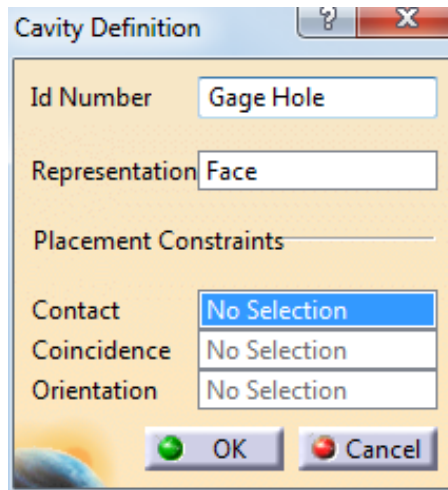
The placement constraints are optional fields. Many times you may not have an orientation or coincidence definition. Without these definitions, you will want to be sure to switch back to the Assembly Design workbench and define any additional constraints necessary to fully constrain the electrical assembly.

Change the *Id Number* to Gage Hole. This will better identify the cavity within the part.

Select the inner surface of the large hole (*Hole.2*) as the *Representation*. You can also select *Hole.2* from the specification tree. This defines the surfaces that will highlight when the cavity is selected.



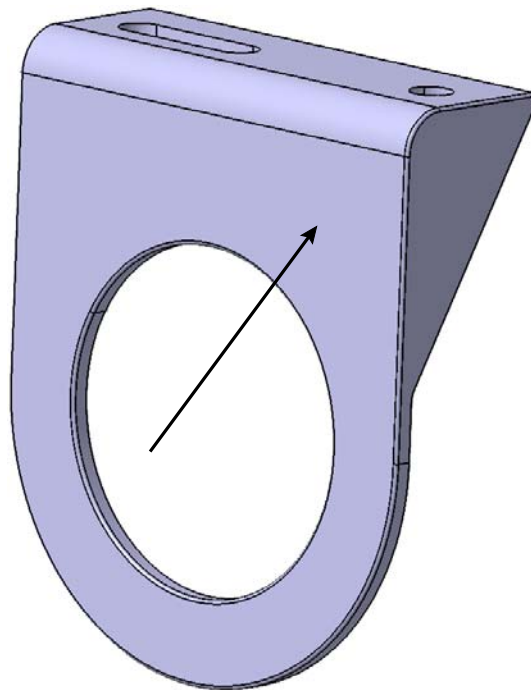
At this point, you should notice that you can now select *OK* to the *Cavity Definition* window.



Without any placement constraints defined, no constraints will be established when the two parts are electrically assembled. The two parts will be related electrically, but you will still need to manually assemble them.

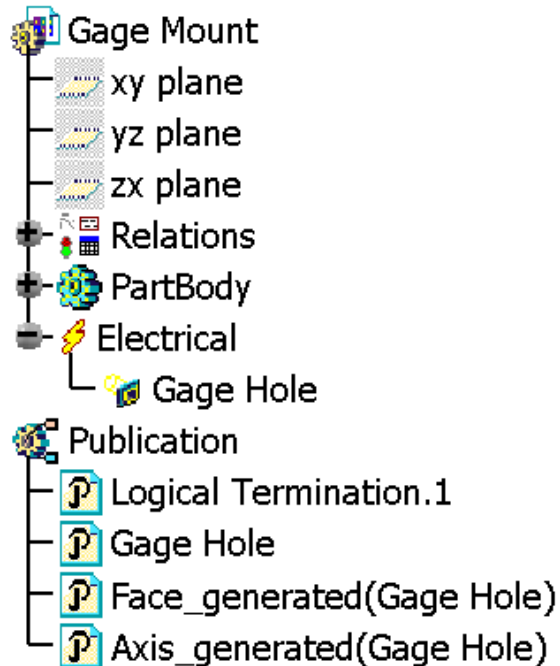
In this case, you will go ahead and define a few of the placement constraints.

Select the front face for the *Contact* placement constraint. This will define the face for the contact constraint.



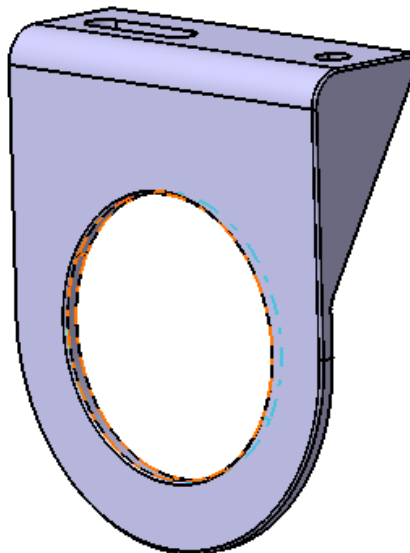
Select the hole centerline for the *Coincidence* placement constraint. It can be selected by clicking on the cylindrical surface of the hole.

Select **OK** to the *Cavity Definition* window. There are a few additions to the specification tree.

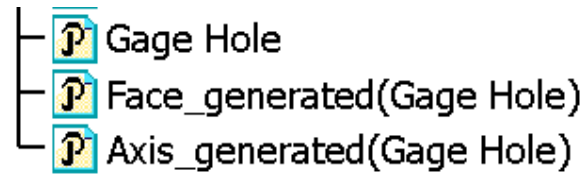


Notice the new *Electrical* branch. This branch will hold all connection point information. With the existence of the *Electrical* branch, this part has become electrified and can now be used in an electrical harness.

Point the cursor at the *Gage Hole* cavity in the *Electrical* branch. The geometry that was defined as a representation should highlight in the workspace.



You should also notice the three new publication elements.



The first publication, *Gage Hole*, is the publication of the electrical cavity definition. This publication will not be associated to any geometry. The other publications are for the placement constraint elements selected when defining the cavity. Since you only selected two elements for the placement constraints, only two publications were created. In this case, you have the face publication for the contact constraint and the axis constraint for the centerline coincidence.

At this point, you are done defining the Mounting Equipment electrical device.

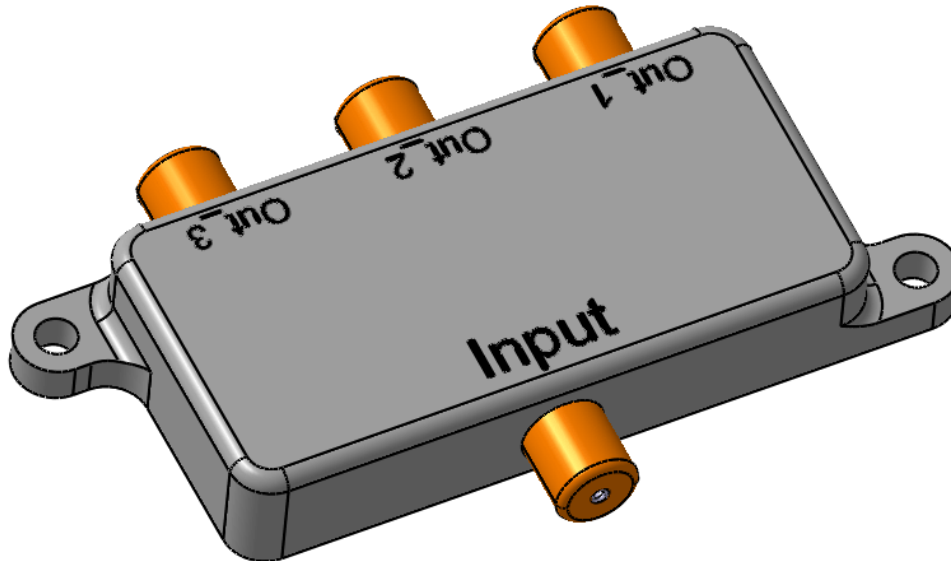
Save and close your document. It is recommended that you save your documents since you can use them later.

Multi Insert Connectors

Multi insert connectors only allow for connections to single insert connectors and mounting equipment. Generally, multi insert connectors work well for “Y” adapters or splitters where you will have multiple single insert connectors connecting. Multi insert connectors can also be used in the place of an external splice when several connectors are connecting together, rather than the bundle segments themselves.

Multi Insert Connector Connection Type	Can Connect to this Connection Type	On this type of Device
Connector Connection Point	Connector Connection Point	Single Insert Connector
Cavity Connection Point	Cavity	Mounting Equipment


Open the **Multi Insert Connector** document. This is a mockup of a coax cable splitter.



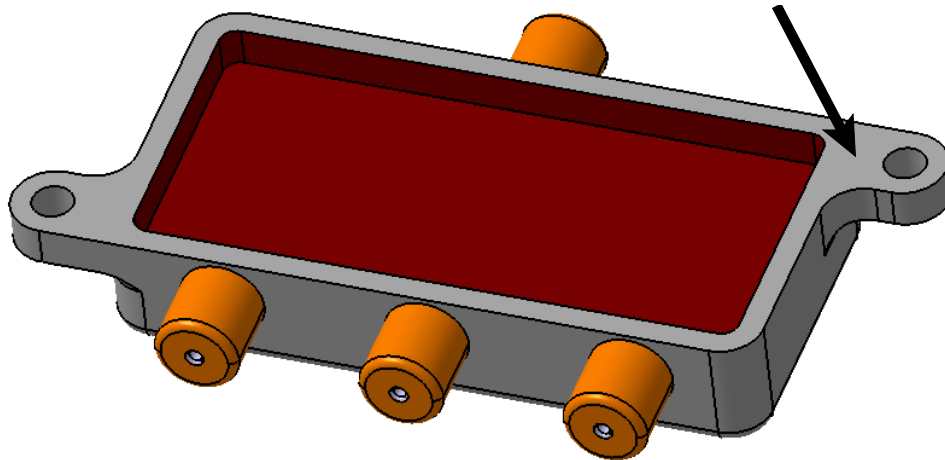
Using the **Define Connector** icon, define this part as a *Multi Insert Connector*. 

Change the *Part Number* to **Cable TV Splitter** and leave the *Number of Terminations* at zero, then select **OK**. Even though you are going to end up defining eight terminations for this model (two per connector), you will be learning to define them after the fact for this connector.


Now that the device is defined as a multi insert connector, you are now ready to define the cavity connection point for mounting to other mounting equipment devices.

Select the **Define Cavity Connection Point** icon and select the connector.  You will be defining the cavity connection point with just a contact constraint. Since this type of connector does not specifically go into a cavity, just the contact placement constraint will suffice.

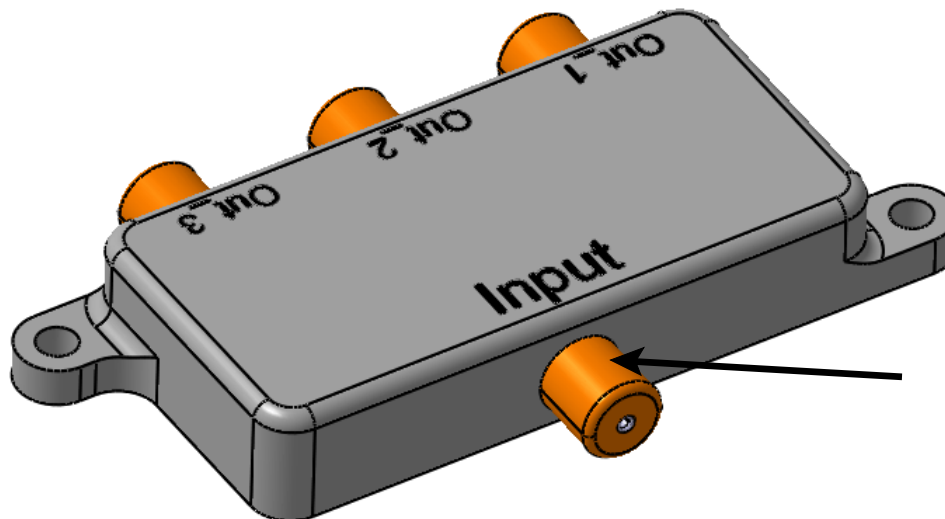
Change the *Name* to **Connection Face** and select the bottom face of the connector as shown below for the *Representation* and the *Contact* placement constraint. This will define the cavity connection point.



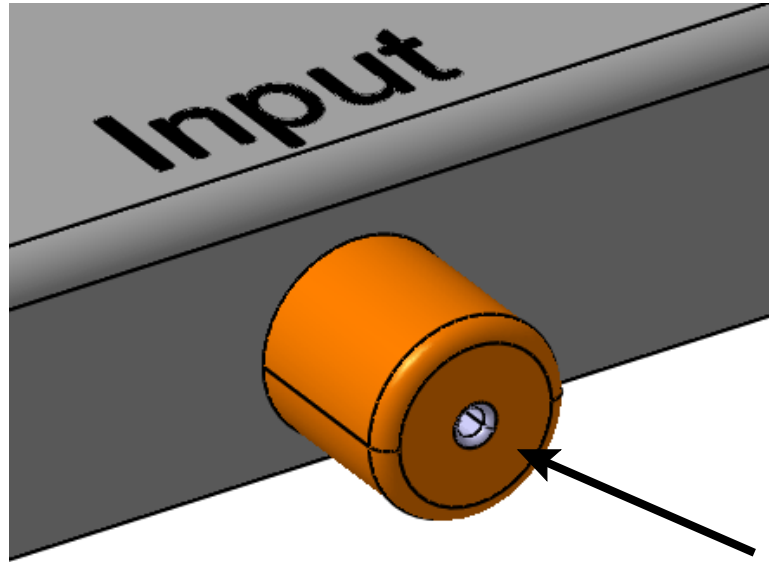
Select **OK** when done. Now you are ready to start defining the connector connection points.

Select the **Define Connector Connection Point** icon and select the connector.  This will start the connector connection point. The first connection point you will define will be the input connection point.

Change the *Name* to **Input** and select the cylinder for the *Representation*. This surface is shown below.



Select the front face of the connector as the *Contact* placement constraint. Again, this surface is shown.




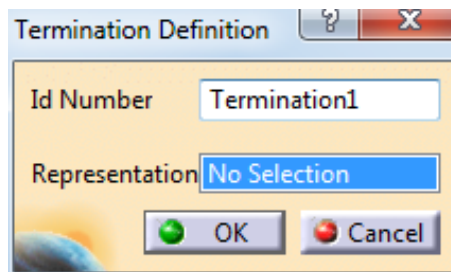
Select the centerline of the connector as the *Coincidence* placement constraint, then select **OK**. Now all you need to do is define the terminations for the input connector connection point.

Defining Terminations

Terminations can be defined on any type of connector. Keep in mind, the terminations are just simply the termination of a wire at the connector. Terminations can only be defined in the following type of equipment:

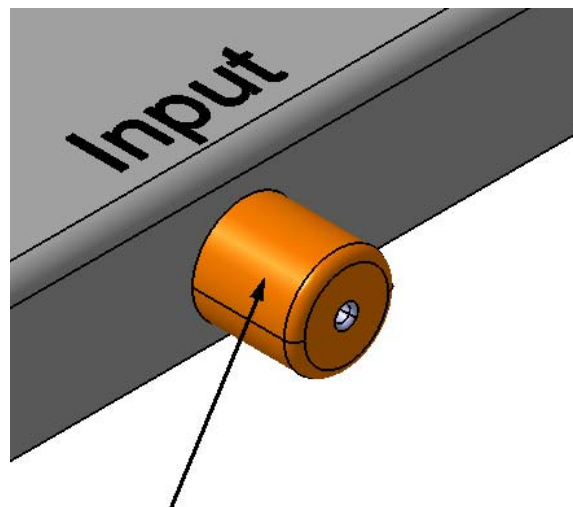
Equipment	Shell
Single Insert Connector	Multi Insert Connector
Stud (only one)	External Splice
Internal Splice	Terminal Strip
Contact (Only One)	

Select the **Define Termination** icon and select the connector.  This will display the *Termination Definition* window.

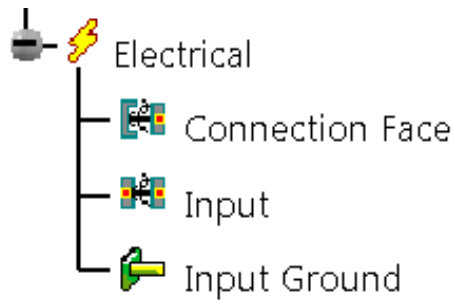



This window should look familiar. It is the same window that is displayed when you double select on a termination from the tree. If you remember, the *Id Number* simply defines the termination identifier and the *Representation* defines the geometry that will highlight when the terminal is selected.

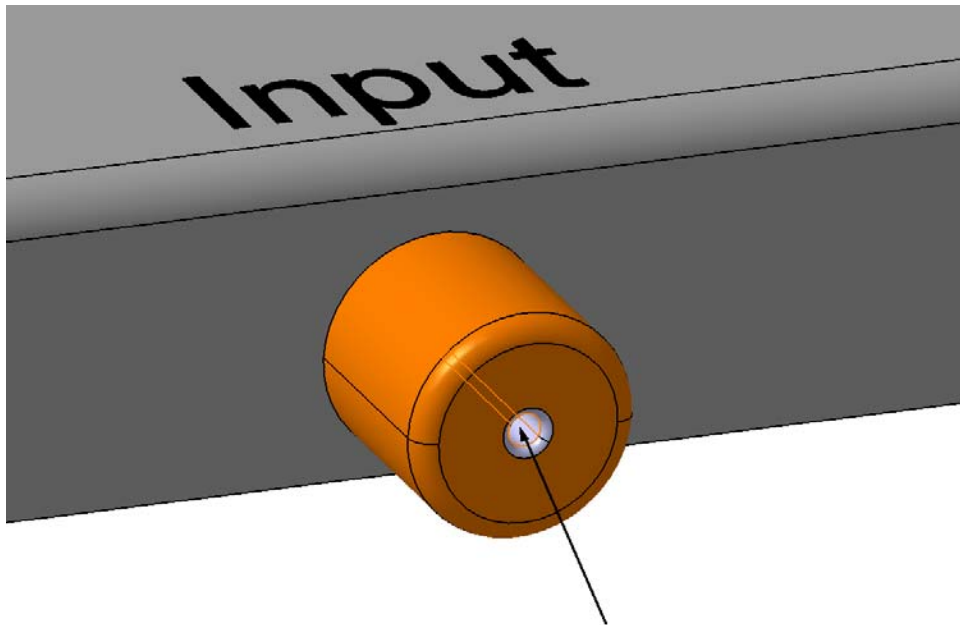
Change the *Id Number* to **Input Ground** and select the outer surface of the input connector as the *Representation*. This surface is shown below.



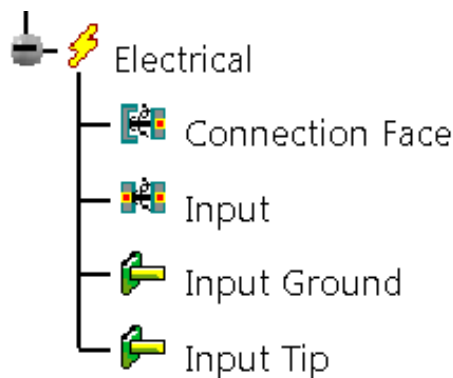
Select **OK** when done. This will define your first termination.



Using the **Define Termination** icon, define another termination for the tip.  Set the **Id Number** to **Input Tip** and select the inner cylindrical surface as the **Representation**. This is shown below.

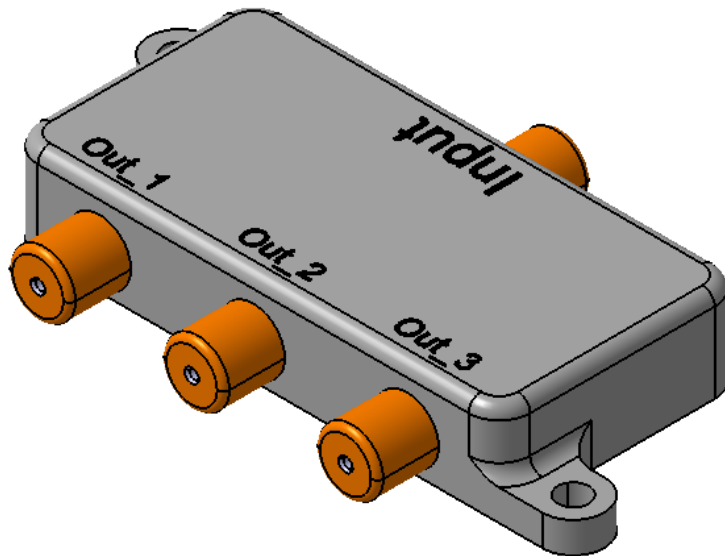


Select **OK** when done. This will have the two terminations defined for the input.



Create the necessary connector connection points and terminations for the three output connectors. This will leave the part with all necessary connections and terminations defined.

- Cable TV Splitter
- xy plane
- yz plane
- zx plane
- Relations
- PartBody
- Electrical
 - Connection Face
 - Input
 - Input Ground
 - Input Tip
 - Output 1
 - Output 1 Ground
 - Output 1 Tip
 - Output 2
 - Output 2 Ground
 - Output 2 Tip
 - Output 3
 - Output 3 Ground
 - Output 3 Tip




Note: Publications not shown for clarity.

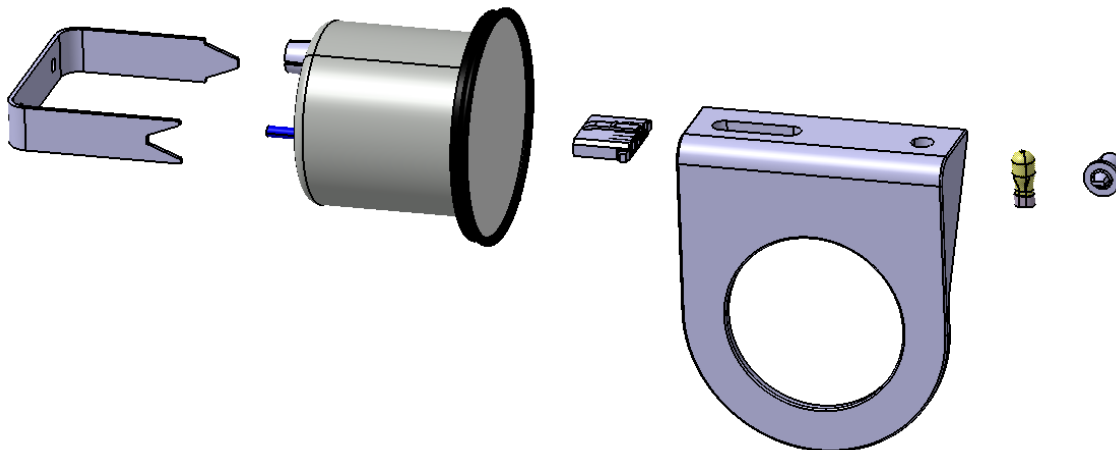
Save and close your document.

Assembling Electrical Devices

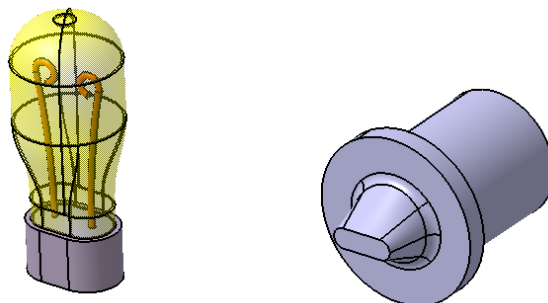
The best use of the Electrical Assembly Design workbench is the ability to electrically assemble devices together. All of the various connection points you have been defining allow you to electrically assemble these devices together to ensure the proper connections and relations between them. Keep in mind though, unless all electrical placement constraints have been defined, the assemblies might not fully come together. You may also have parts in your electrical assemblies that actually do not have nor do they need electrical properties associated. Any parts that do not fully assemble together will simply need assembly constraints to tie them together. The main goal you are after is the ability to electrically relate the parts that you assemble.

Create a new product in the Electrical Assembly Design workbench called Electrical Gage. You are going to electrically assemble a gage that has a series of parts and connections associated with it.

Select the **Existing Component** icon and select the *Electrical Gage* product. Insert all of the detail parts found in the *Assemble Electrical Devices* directory.  You should find six different parts in the folder. Be sure to spread the parts apart so you can see all of them in the workspace.



The first two parts that you are going to look at assembling with electric properties will be the light bulb and the light socket.

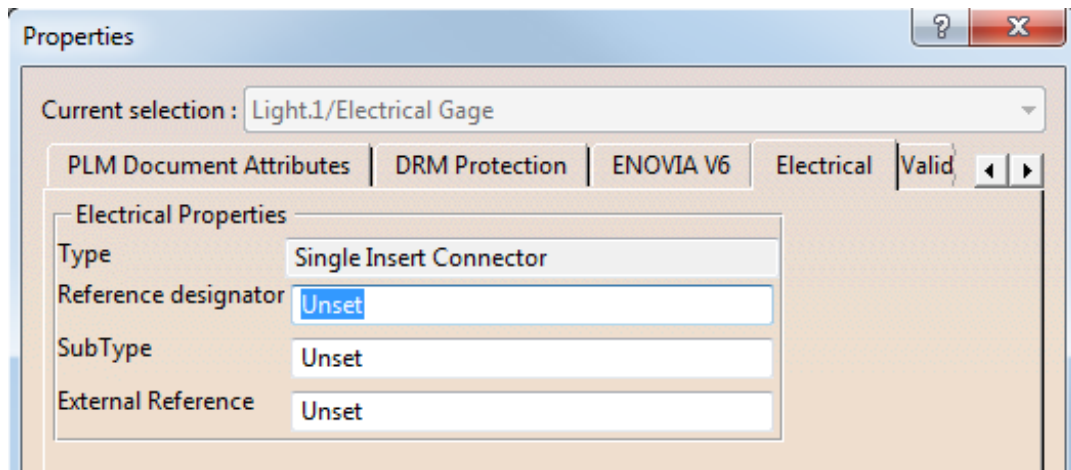


Since these two models are given to you, take a moment to investigate the various connections applied to each device.

With the third mouse button, select on the *Light.1* instance from the specification tree and select *Properties*. This will display the properties for the light bulb.

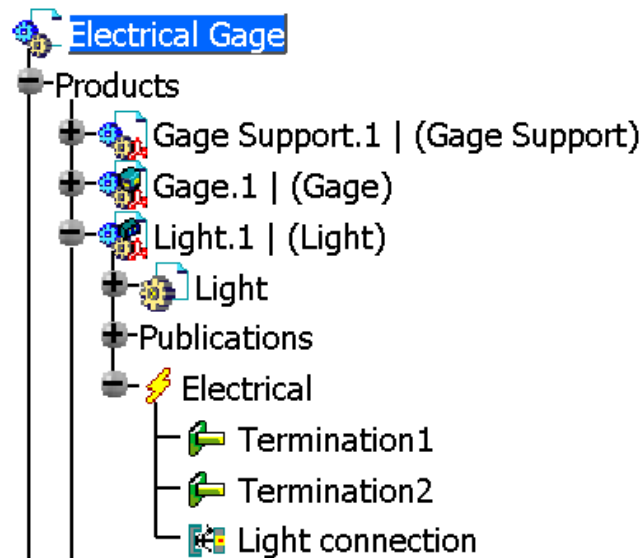
Select *More...* Be patient, this can sometimes take a few moments to load.

You should now notice several new tabs, including the *Electrical* tab.



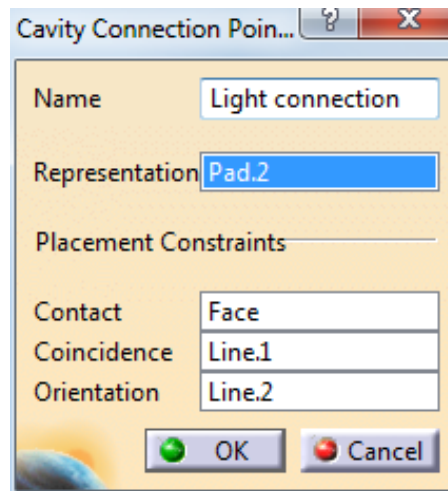
This shows the electrical properties for the light. In this case, the light was defined as a *Single Insert Connector*.

Select *OK* to the *Properties* window and expand the specification tree for *Light.1* until you can see the electrical connections for the light.

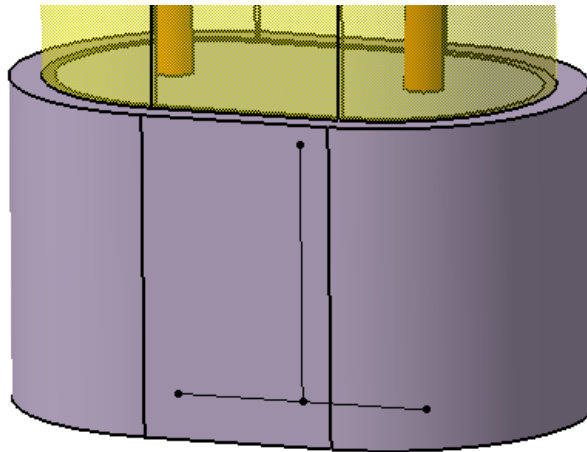


This device has a cavity connection point called *Light connection*.

Double select on the *Light connection* cavity connection point from the specification tree until you can see the *Cavity Connection Point* definition window. You may need to do this twice. The first double select will activate the detail part. The second double click will actually display the connection point window.



All three placement constraints are defined. If you unhide *Line.1* and *Line.2* you would find that they make a “T” shape at the bottom of the light to allow the coincidence of the centerline and the orientation of the socket.

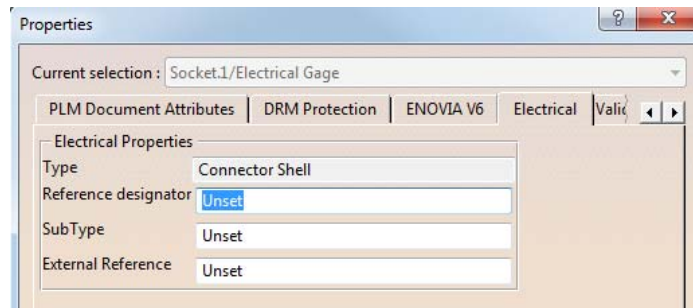


Note: The lines are shown here for illustration purposes and do not actually need to be shown.

Many times, if you want to be able to define all three placement constraints, you will have to generate extra geometry.

Select *Cancel* to the *Cavity Connection Point* definition window. Double select on the *Electrical Gage* product at the top of the specification tree. This will activate the product again.

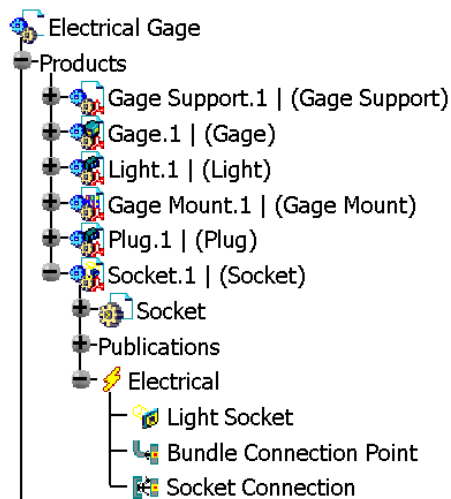
Check the electrical properties for the *Socket* to determine the type of device applied to this part. Remember, you must select the *More...* button to be able to view the electrical properties.



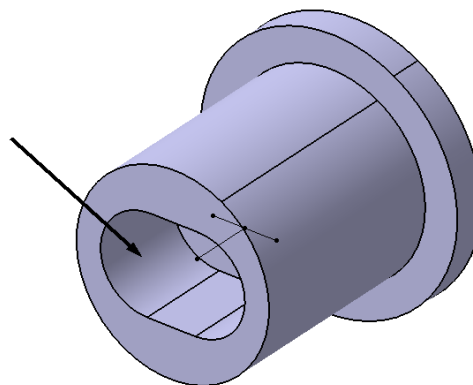
Notice this is defined as a *Connector Shell* (a *Shell*) device. Shells allow single insert connectors to connect via a cavity and a cavity connection point.

Select **OK** to the *Properties* window.

Examine the electrical connections in the *Socket*.




This shell has three electrical connections. A cavity (*Light Socket*) is defined inside the hole of the shell. If you look closely, you will notice that it too has the same “T” shape, defined as the same placement constraints.



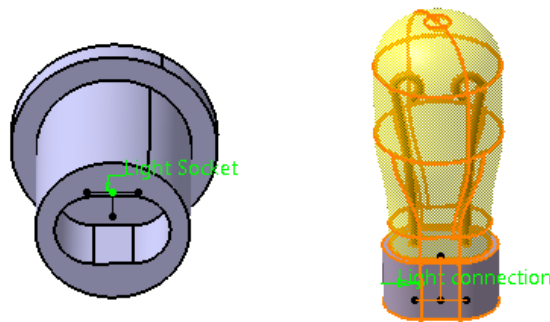
Now you are ready to electrically assemble the two items together.

If not already there, switch to the Electrical Assembly Design workbench. Rather than use the assembly design tools, you will electrically connect the two items together.

Select the **Connect Electrical Devices icon.**  This will electrically connect two devices together via their connection points.

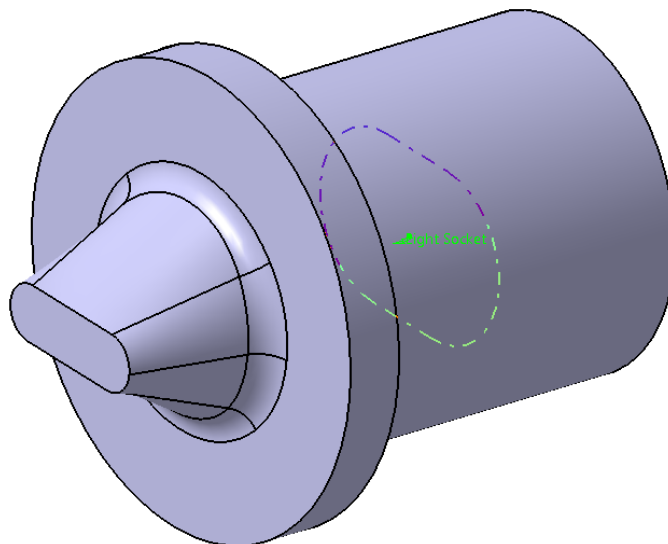
Select the light from the workspace. This will indicate that you are connecting the light with another device.

Point to the socket, but do not select it yet. Notice the text that appears on each item.



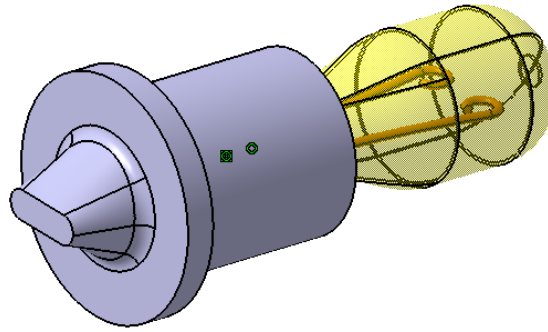
When you point to the second electrical device, any available connections will automatically show the name of the connection to allow you to connect the two together.

Point to the *Light Socket* text on the socket device.



Although it is difficult to see in the image, you should notice the representation for the light socket highlight. This is where defining a good representation is useful. By defining a good representation, you allow the electrical assembly to display the two areas that are being connected.

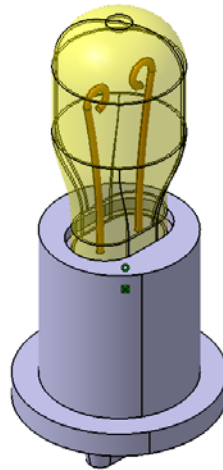
Select the **Light Socket** connection. Notice this assembles the two items together.



Select **Undo**. This will disassemble them from each other.

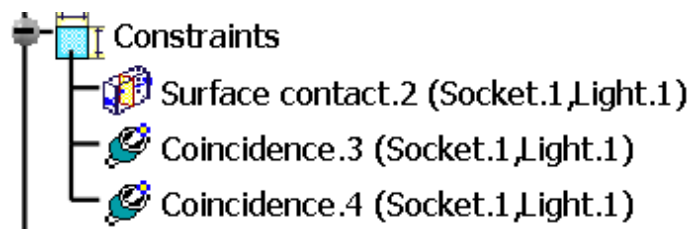
Select the **Connect Electrical Devices** icon again.  This time you are going to select them in the opposite order.

Select the socket, then select the light. Notice anything different?



This time, instead of the light moving to the socket, the socket moved to the light. This is only important to note when you desire not to have one item move. The first item selected will always move to the second item. Just like in Assembly Design, it is a good idea to always fix a component first, then assemble everything around the fixed item.

Expand the **Constraints** branch of the specification tree.



Notice that by connecting the two devices, you are automatically creating constraints.

Electrical Assembly Constraints

When you electrically connect two devices together, you are automatically creating the necessary assembly constraints to hold the two together. This is done through the placement constraints. If you remember right, there were three basic placement constraints that you defined; a *Contact*, *Coincidence*, and *Orientation* placement constraint. Each of these placement constraints will constrain to each other when the two have been defined. If you had one device that had an *Orientation* placement constraint and another that did not have one, you would not get a constraint.

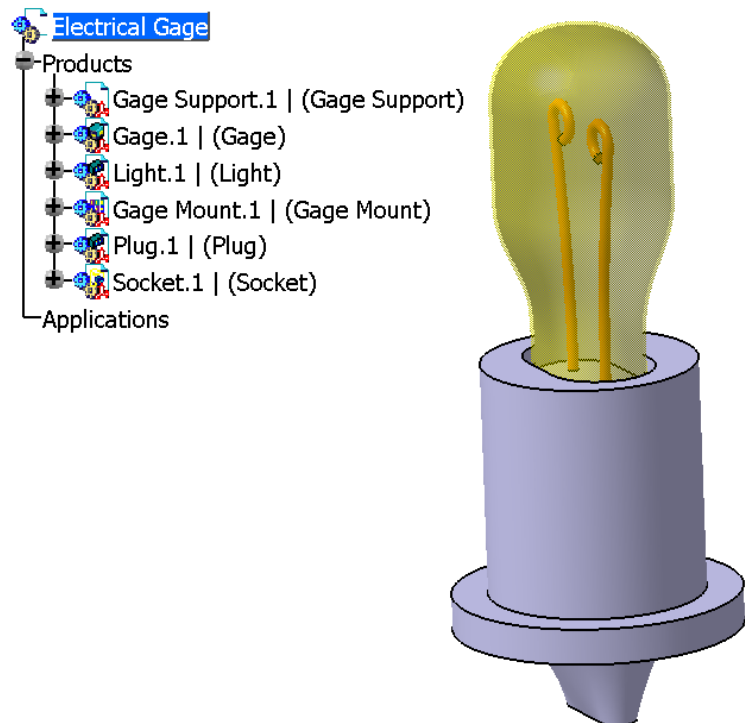
The method in which the constraints are defined is simple. Anytime two faces are defined for the same placement constraint, a surface contact constraint is applied. Anytime any other geometry, or combination of geometry is defined for a placement constraint, a coincidence constraint is defined. This is why you want to be sure to have all the geometry for each placement constraint in the exact same location for each model. If you were to pick edges of a part as the orientation placement constraint, and it did not exactly match the other device's orientation edge, then you would have an over constrained assembly.

At this point, you are ready to move on.

Select the **Disconnect Electrical Devices** icon and select the socket and the light.




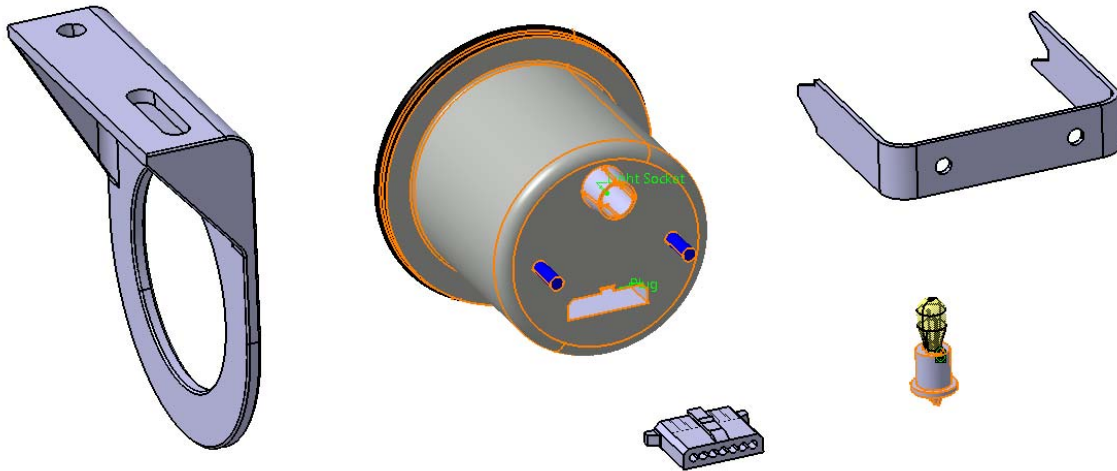
This will disassemble them.



Notice the two parts did not physically separate, the constraints were deleted. More importantly, the electrical connectivity between the two items was also removed.

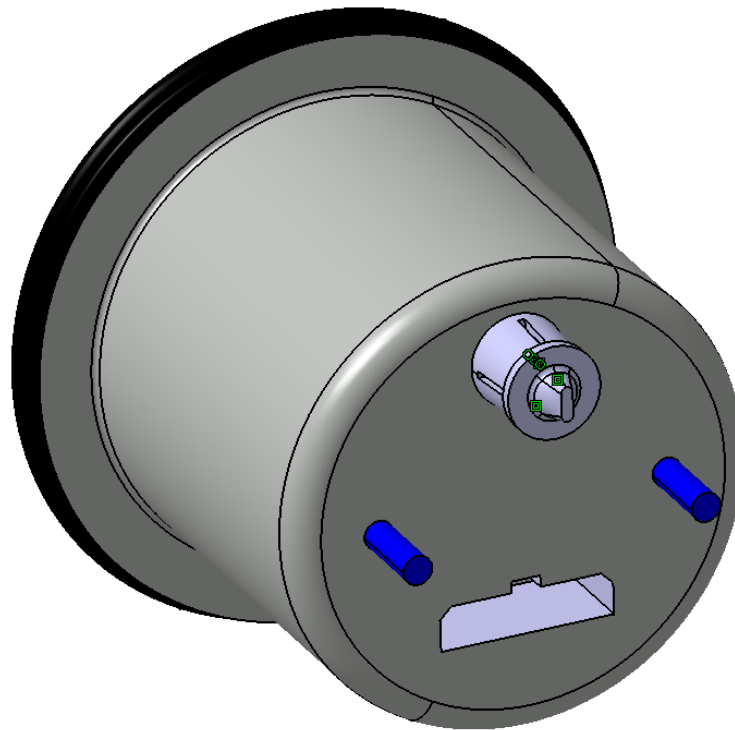
Connect the light and the socket together. All you will need to do is select the Connect Electrical Devices icon and select the Light and the Socket.

Select the **Connect Electrical Devices icon and select the socket and the gage.** Notice nothing happens other than the gage highlighting. 



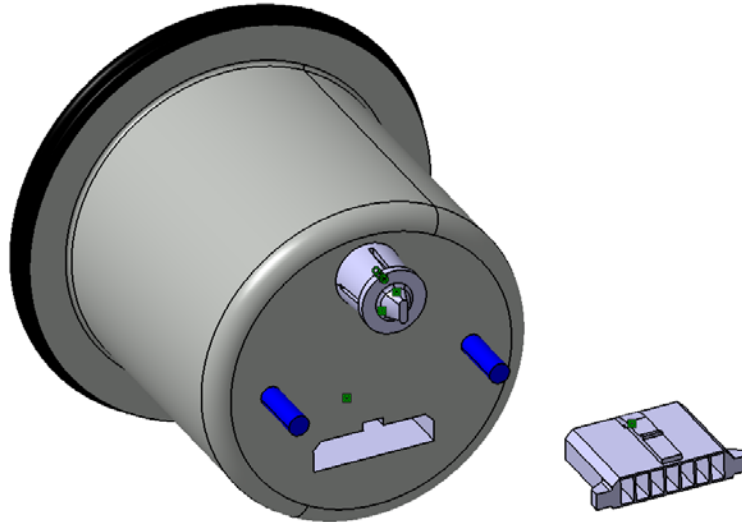
This is due to the gage having multiple cavities that the socket can connect to.

Select the *Light Socket* text on the gage. This will assemble the light socket to the gage.



Select the **Connect Electrical Devices** icon and select the plug and the gage. 

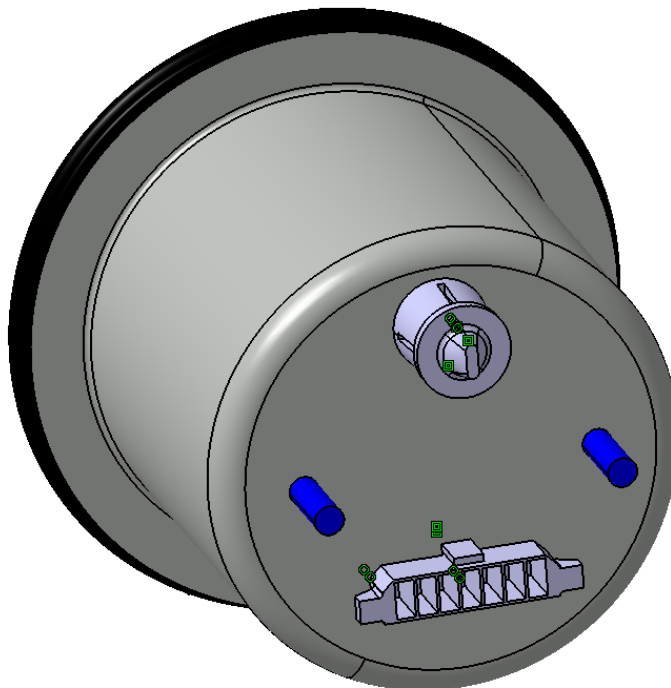
Even though there are two cavities, since one of them is already filled, the plug automatically associates to the other cavity. Notice, however, that the plug does not go into the proper location.



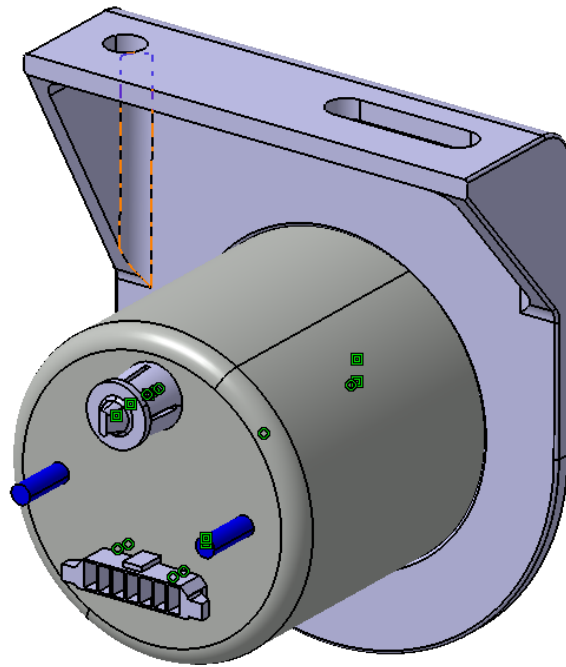
This time you only obtained one constraint. Since the plug connection point only had the contact placement constraint defined, then only the contact constraint is created.

In order to define the remaining constraints, you will need to switch to the Assembly Design workbench and add the additional constraints necessary.

Create the additional necessary constraints to place the plug into the gage. This can be done with a few coincidence constraints or surface contact constraints.



Electrically connect the gage to the gage mount. Remember, you will need to switch back to the Electrical Assembly Design workbench to assemble the two together. Now all you will have left is to constrain the gage support to the rest of the assembly.



Switch back to Assembly Design workbench and assemble the support to the gage. Add a fix constraint to the gage mount before adding any other constraints.

This will have the assembly created and constrained.

