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Introduction

CATIA 3DEXPERIENCE 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

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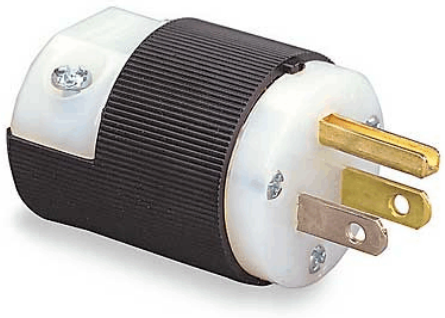
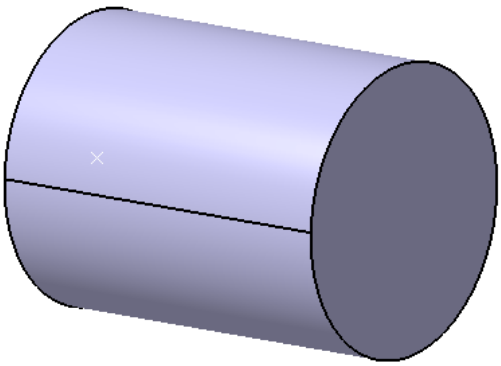
Electrical Design

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.

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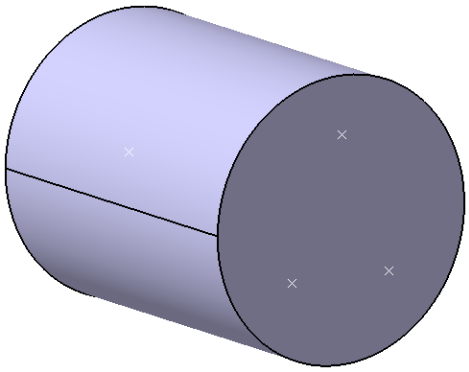
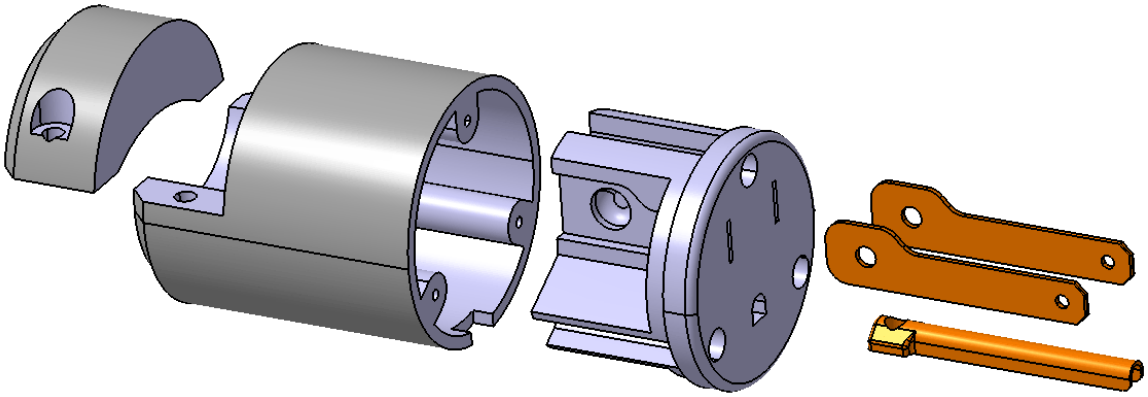
The next level of complexity would be to indicate that the plug has three connection points.



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 3D Part Design and Electrical 3D Design workbenches to electrify your parts and products.

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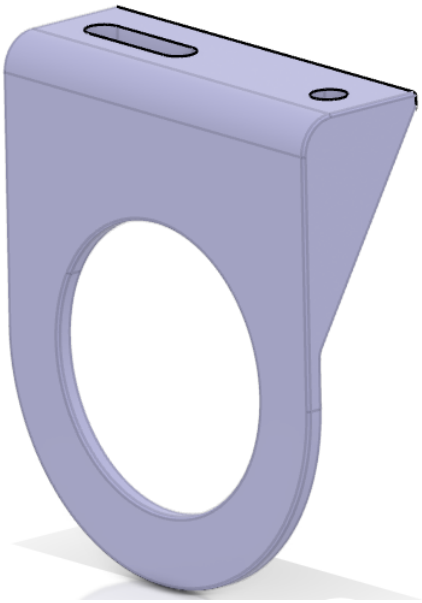
Mounting Equipment with Cavity

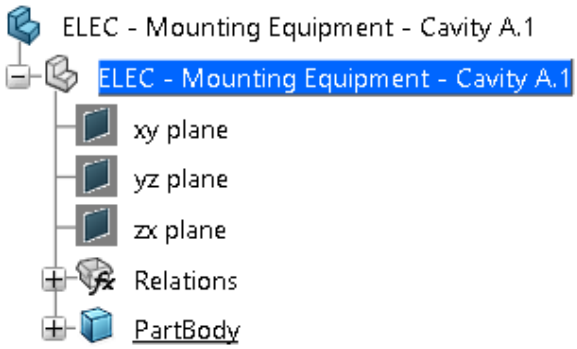
Mounting equipment with a cavity will generally be a mount of some sort that has a hole or a pocket it in to allow another part to connect. If you refer to the earlier chart, you will find that you can place mounting equipment, equipment, shells, etc., into the cavity.

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



Ensure you are in the Electrical 3D Part Design workbench. From here, you will be able to define all the necessary electrical properties for a detail part.

First, notice in the tree that this is a standard, Part Design part.



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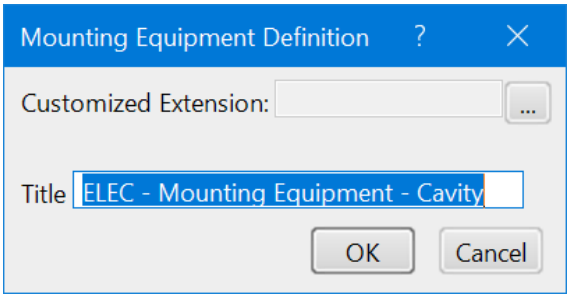
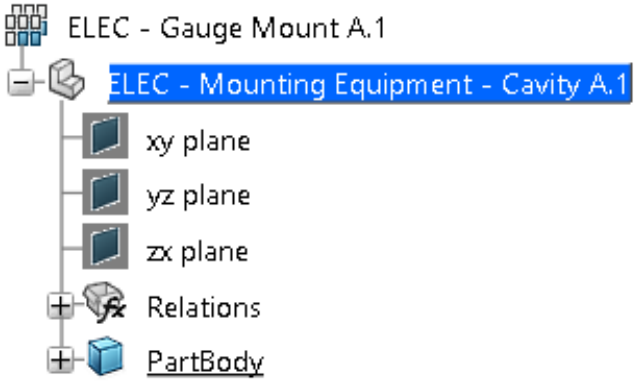
Select the Mounting Equipment icon. It is located within the sub-toolbar of the Backshell icon in the *Device* section. This will change the part to mounting equipment. Equipment properties are always applied to the entire part. The *Mounting Equipment Definition* window appears, allowing you to change the name of the mounting equipment.



Change the *Title* to ELEC - Gauge Mount and select *OK*. In the tree, the name of the part at the instance level and its symbol have changed.



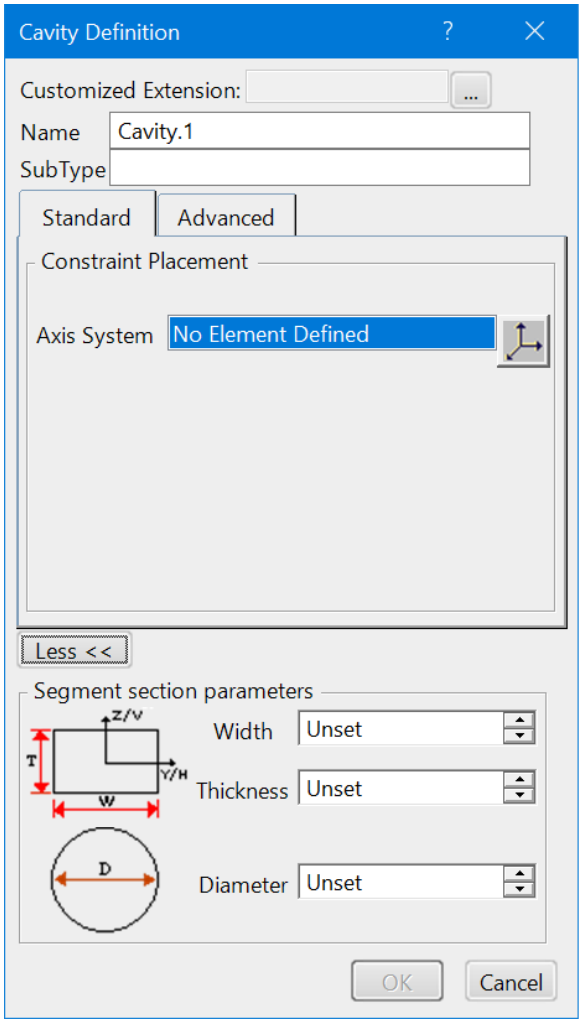
The part has been defined as an electrical device. Now you must define the electrical connection point.

Defining a Cavity

Cavities are essentially cutouts or holes in a part that allow other parts to connect to it via cavity connection points. Cavities can only be defined in the following types of equipment:

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

Select the Cavity icon, then select the part. It is located under the Backshell Connection Point icon. You can select the part from the specification tree or from the workspace. It does not matter where you select it from, since the cavity is applied to the entire part. The *Cavity Definition* window appears.



Name The name of the cavity

SubType A description or category for the cavity

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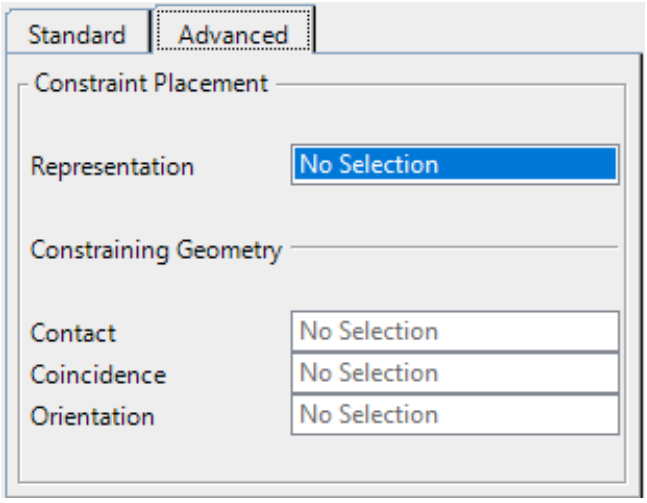
Standard tab

Axis System — Places the cavity via a pre-existing axis system. You can also create a new axis system by selecting the icon next to this field.

Advanced tab



Constraint Placement — Uses existing features for the cavity's display

Representation — The geometry that will highlight when the cavity is selected; you can choose faces, geometrical elements, or sketch based features

Constraining Geometry — These fields define the cavity's placement

Contact — The surface that will touch the cavity connection point contact surface. When a planar face is selected, a contact constraint will be generated. Generally, this is the mating face for the equipment.

Coincidence — The element that will align with the coincidence element from the cavity connection point. In many cases, this will be a centerline for the connection.

Orientation — The element that will be constrained with the orientation element on the mating part. A coincidence constraint will be generated between the two elements.

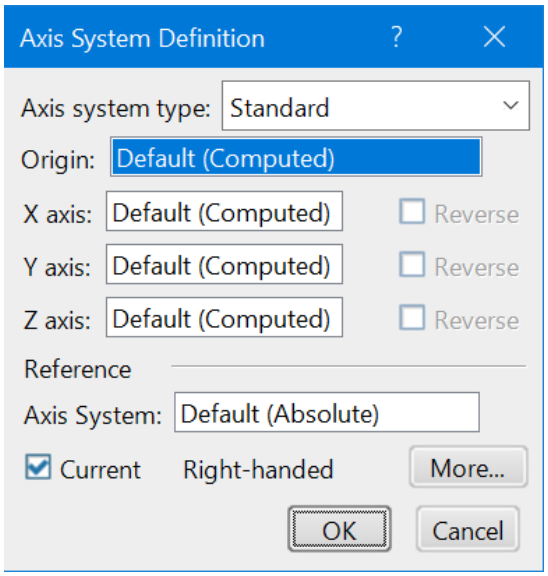
More >> button

Segment section parameters	Defines the profile of the connected branches
Width	Sets the width of the profile
Thickness	Sets the length of the profile
Diameter	Sets the diameter of the profile; this is only visible if *Width* or *Thickness* is set to zero

The *Coincidence* and *Orientation* fields under the *Advanced* tab are optional. Many times, you may not have those definitions available in the part. If left unspecified, you will want to fully constrain the electrical assembly in the Assembly Design workbench.

Change the *Name* to Gauge Hole. This identifies the cavity in the part.

Select the icon beside the *Axis System* field. You will create an axis system on the fly. The *Axis System Definition* window appears.



Press the third mouse button in the *Origin* field and select *Insert Wireframe*, then select *Create Point*. The *Point* window appears.

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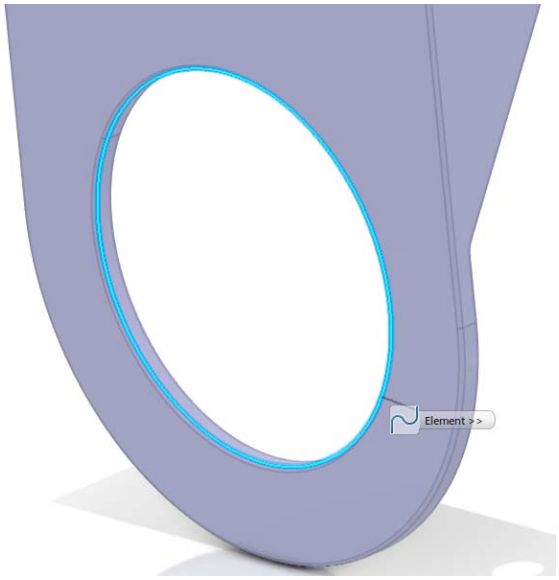
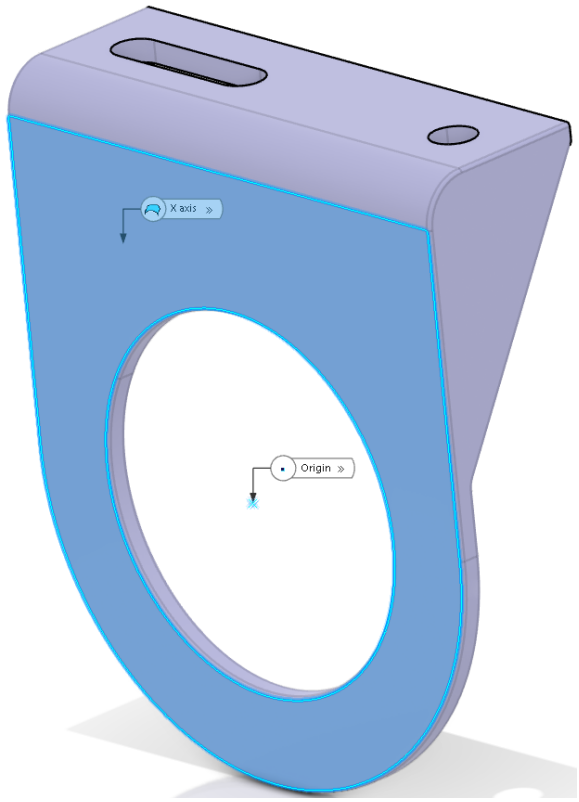
Change the *Point type* drop-down menu to *Circle/Sphere/Ellipse center*, then select the edge of the large hole, as shown below. A point will be placed in the center of the selected circle.

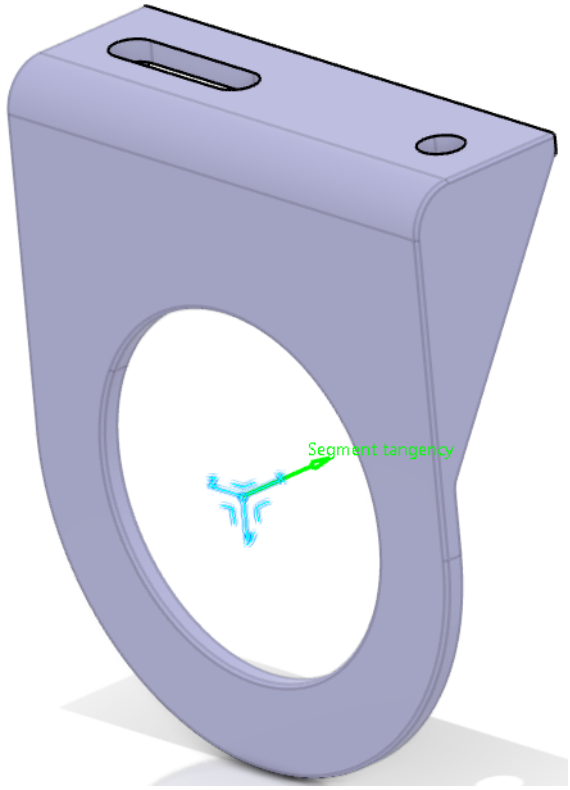


Select *OK*. The *Axis System Definition* window re-appears. Typically, the X axis points toward the part for female devices, and away from the part for male devices.

Select in the *X axis* field, then select the highlighted face shown below. This specifies the direction that a connecting part will use when mated with the current part.



Select *OK.* The *Cavity Definition* window re-appears, and a green arrow labeled *Segment tangency* should be visible on the newly created axis, pointing in toward the part. If ever the green arrow is pointing opposite the desired direction, click the icon beside the *Axis System* field and select the *Reverse* checkbox beside the *X axis* field.



Select *Cancel.* You will now define the cavity from existing geometry.

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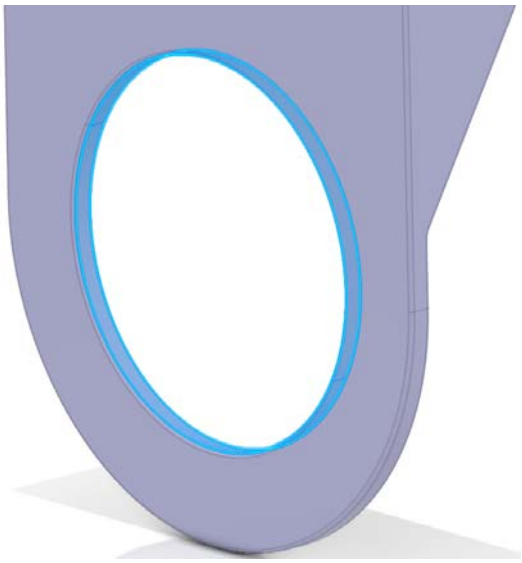
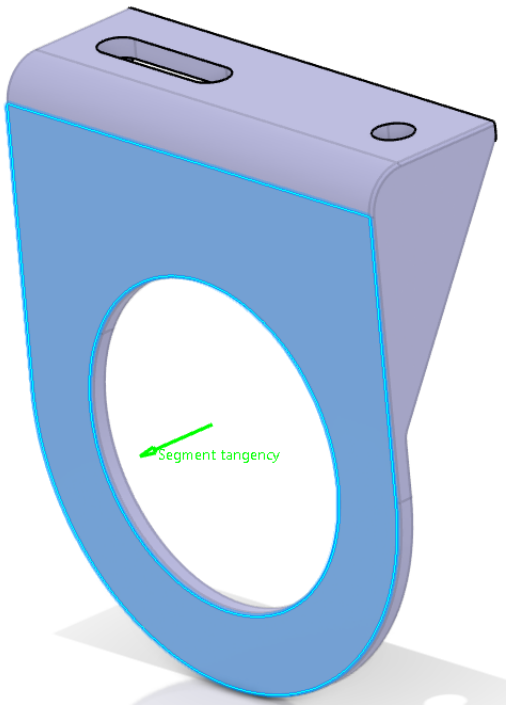
Select the Cavity icon, then select the part and change the name to Gage Hole.

Select the *Advanced* tab, then select the inner surface of the large hole as the *Representation*. You can also select *Hole.2* from the specification tree. The *Representation* element will highlight when the cavity is selected.



Next you will define the *Constraining Geometry*. This will define how the part will be constrained when it is electrically assembled to another part.

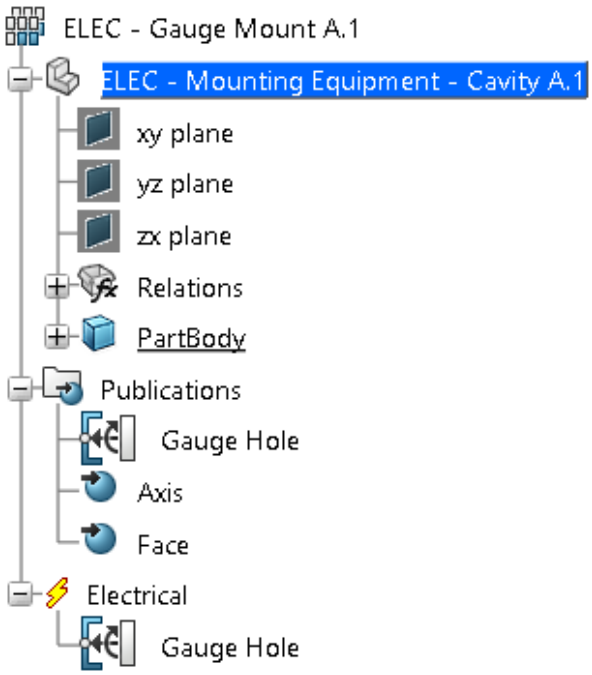
Select the face indicated below for the *Contact* field. The green arrow is pointing away from the part. When using the *Advanced* method, the direction of the *Segment tangency* arrow cannot be reversed.



Once the *Contact* element is specified, the *OK* button becomes selectable. However, without the other *Constraining Geometry* elements defined, constraints will be missing when the part is electrically assembled to another. This means the two parts would be related electrically, but you would still need to manually assemble them. In this case, you will only define one other *Constraining Geometry* element.

Select the hole centerline for the *Coincidence* element. This can be selected by choosing the cylinder surface of the hole.

Select *OK* to the *Cavity Definition* window. There are some 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, the part is now electrified and can be used in an electrical harness. There is also a Publications branch containing links to the geometries selected curing the cavity creation.

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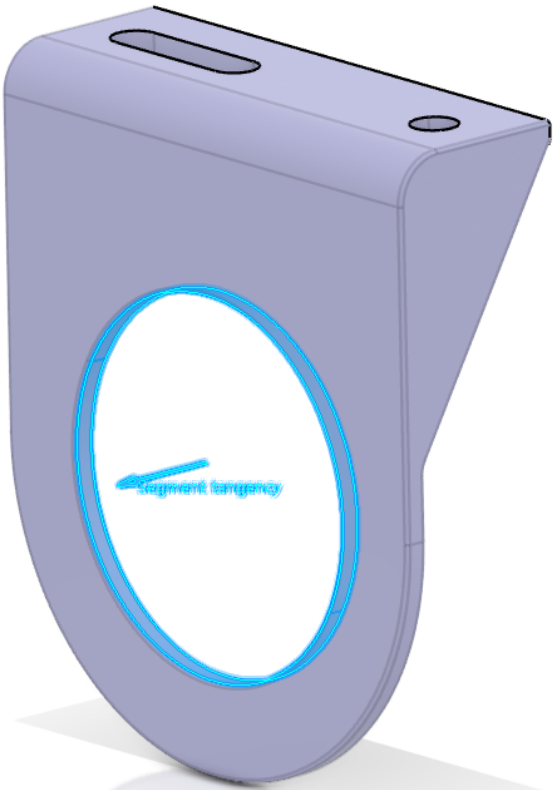
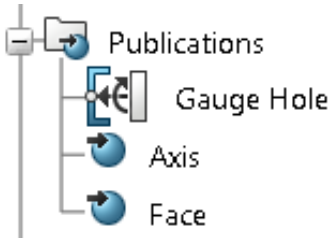
Select *Gauge Hole* in the *Electrical* branch. The geometry that was defined as the *Representation* highlights in the workspace.



You should also notice the three new publication elements.



The first publication, *Gauge 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.

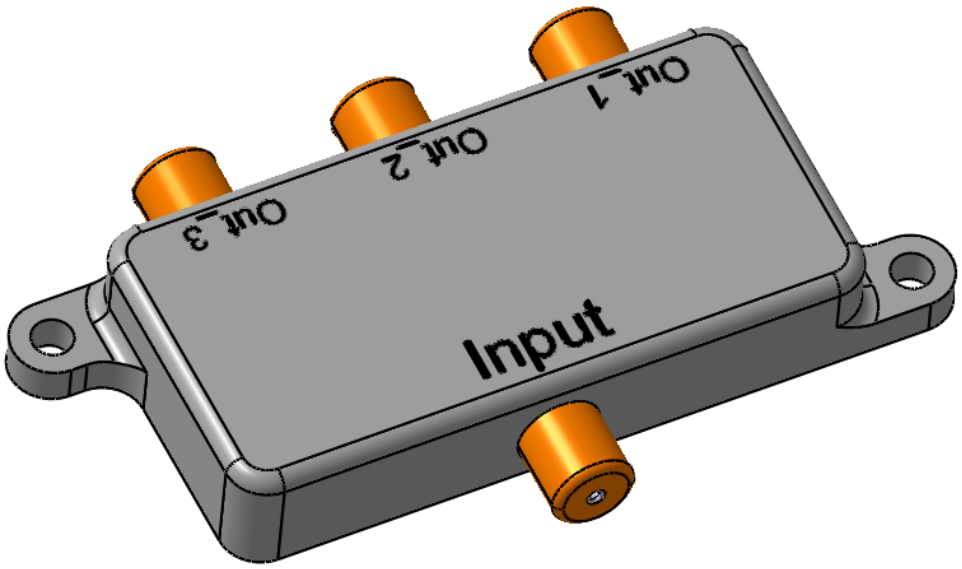
Save and close the document. It is recommended that you save, since you can use the parts later.

Multi Insert Connectors

Multi insert connectors only allow for connections to single insert connectors and mounting equipment. Generally, multi insert connectors work good for "Y" adapters or splitters where there will be a number of single insert connectors connecting. Multi insert connectors can also be used in the place of a 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 ELEC - Multi Insert Connector document. This is a mockup of a coax cable splitter.



Define this part as a *Multi Insert Connector* named ELEC - Cable Splitter. With the device 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 Cavity Connection Point icon, then select the connector. You will define the cavity connection point with only a contact constraint. Since this type of connector does not specifically mate into a cavity, the *Contact* constraint will suffice.

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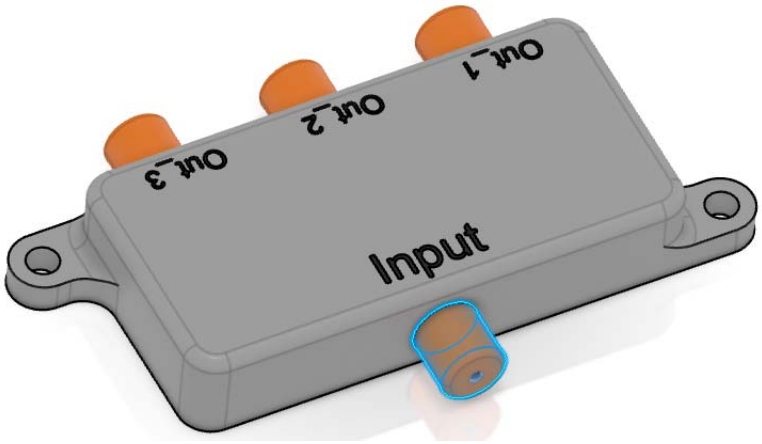
Change the *Name* to Connection Face, then select the face shown below for both the *Representation* and *Contact* elements. This will define the cavity connection point.

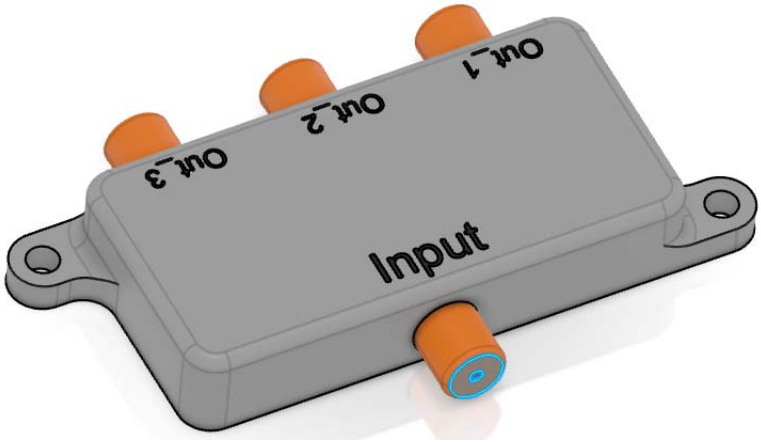
Select *OK*. You are now ready to define the connector connection points.

Select the Connector Connection Point icon, then select the connector. The first connection point to define will be for the input.

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 for the *Coincidence* field, then select *OK*.

Feel free to define the other 3 connector connection points in the same manner.

Save and close the document when finished.

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Electrical 3D Design

The Electrical 3D Design workbench provides the ability to electrically assemble devices together. All of the various connection points that have been discussed will ensure that the proper connections and relations exist between electrical parts. Keep in mind that, unless all electrical placement constraints have been defined, the components might not fully come together. There may also be parts in electrical assemblies that do not have, nor need, electrical properties. Any parts that do not fully assemble in the model will need assembly constraints to tie them together. The main goal is the ability to electrically relate assembled parts.

Assembling Electrical Devices

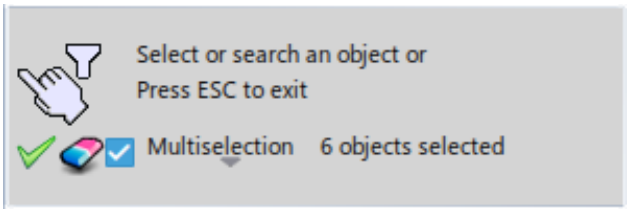
You will assemble a gauge that has a series of parts and connections associated with it.

Create a new product called ELEC030 - Electrical Gauge.

Press the third mouse button on the *ELEC030 - Electrical Gauge* branch and select *Insert*, then *Existing 3D Part.* You need to perform a search for the part.

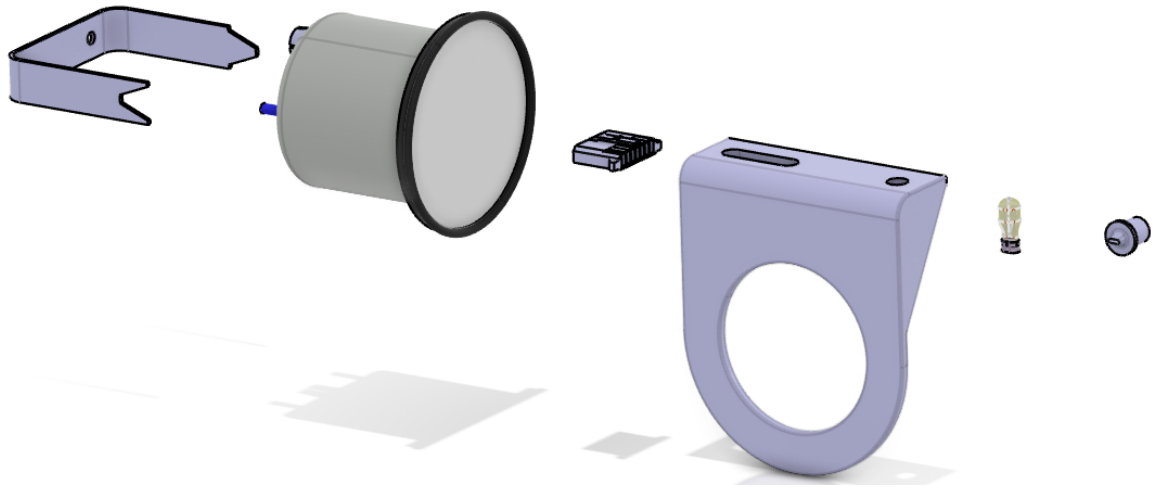
Search for the ELEC030 parts. A list of parts appears.

Check the *Multiselection* box in the search window, then select all of the parts in the list.



Select the Accept All icon. Six parts are added to the assembly.

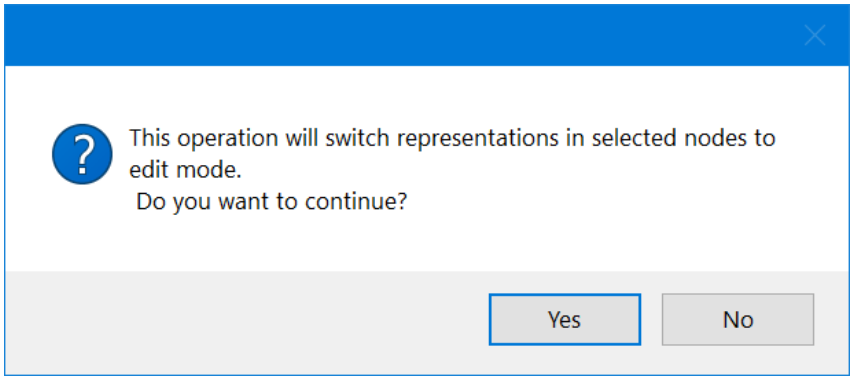
Arrange the parts as shown here.



The first two parts you will assemble via electrical properties are 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.

Right select on the top level product and select *Switch to Edit Mode*. A warning window appears.



Select *Yes*. This will load all of the parts, including their electrical definitions.

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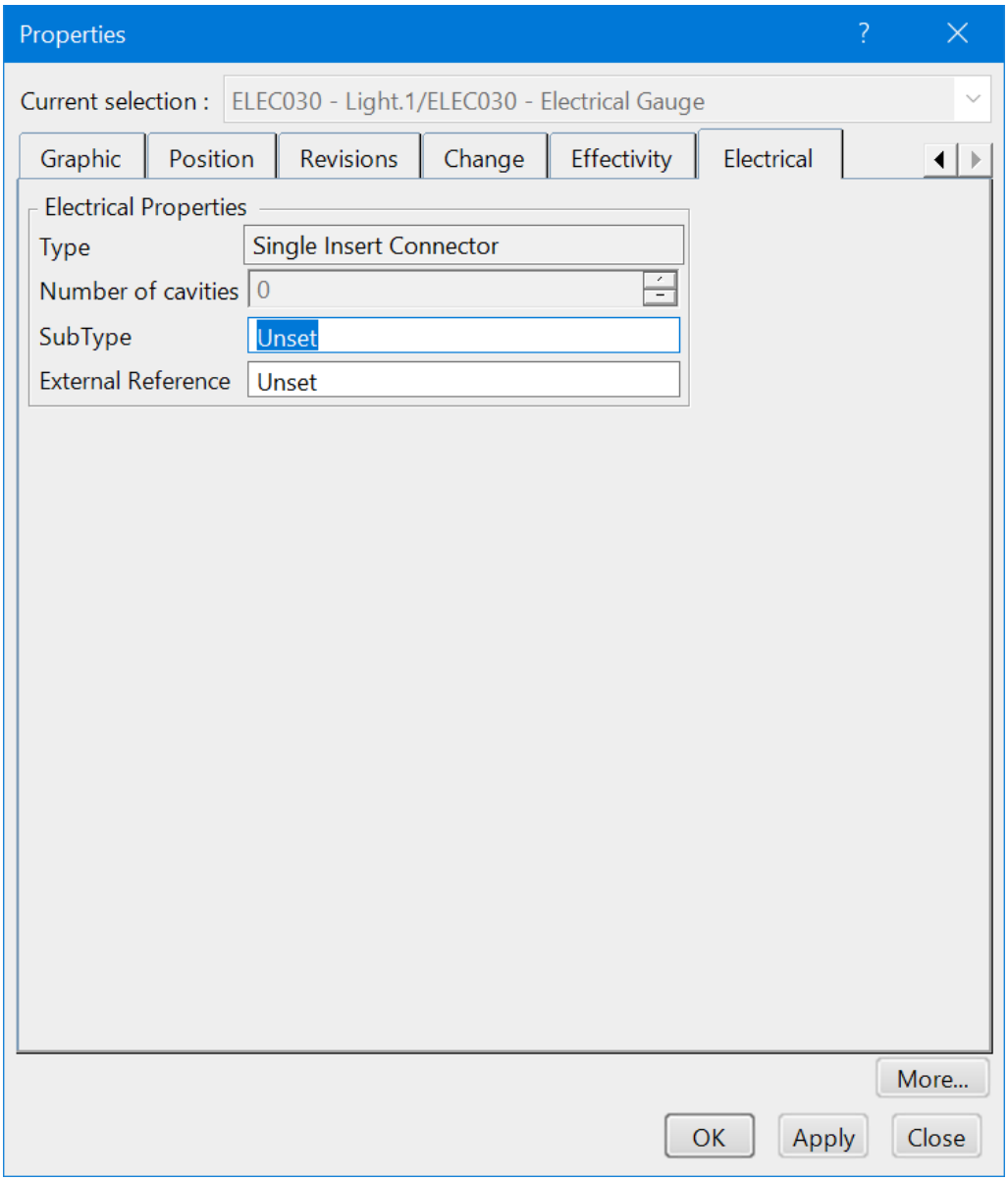
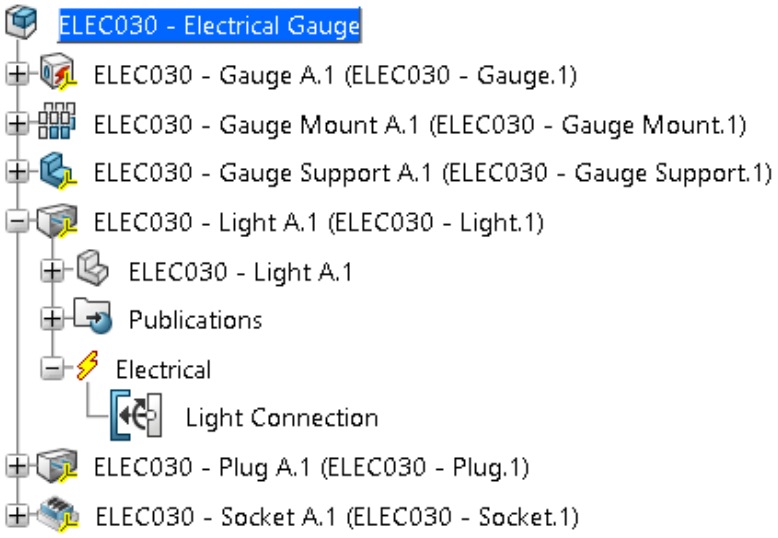
Press the third mouse button on *ELEC030 - Light* in the tree and select *Properties*. The *Properties* window appears.

Select the *Electrical* tab. The light has been defined as a *Single Insert Connector*.

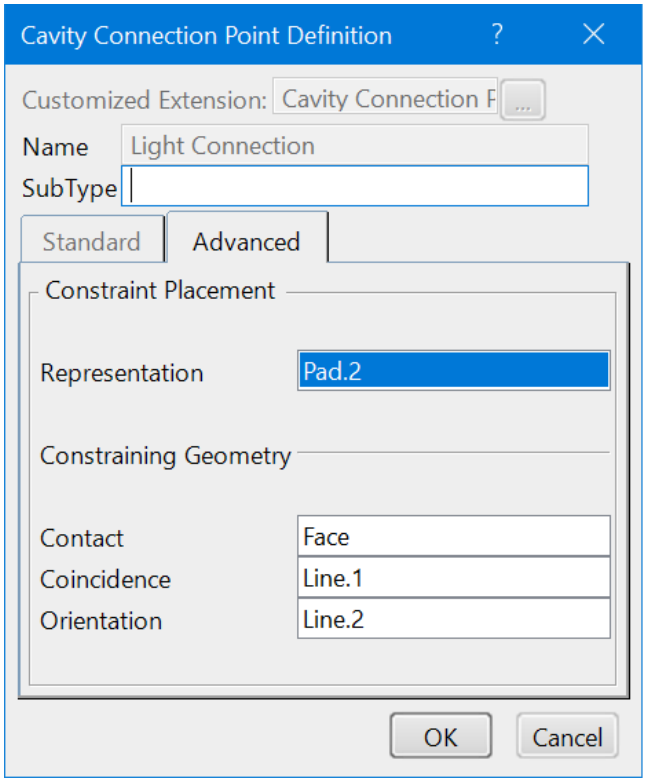


Select *Close*, then expand *ELEC030 - Light* in the tree as shown.



The light has a cavity connection point called *Light Connection*.

Double-select on the *Light Connection* cavity, then double-select again. The first double-click activates the detail part. The second double-click displays the *Cavity Connection Point Definition* window.



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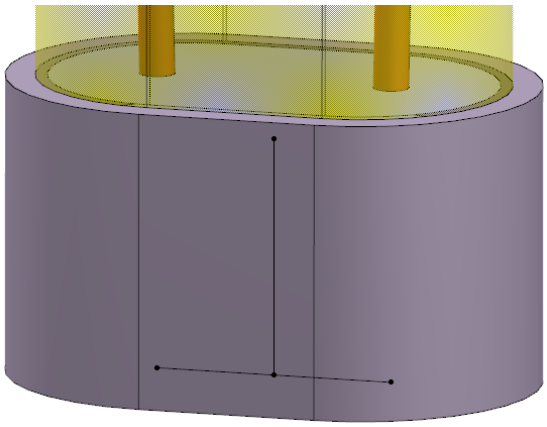
All three placement constraints are defined. If you were to show *Line.1* and *Line.2*, you would find they make a T shape at the bottom of the light to allow for a coincidence on the centerline and an orientation of the socket.

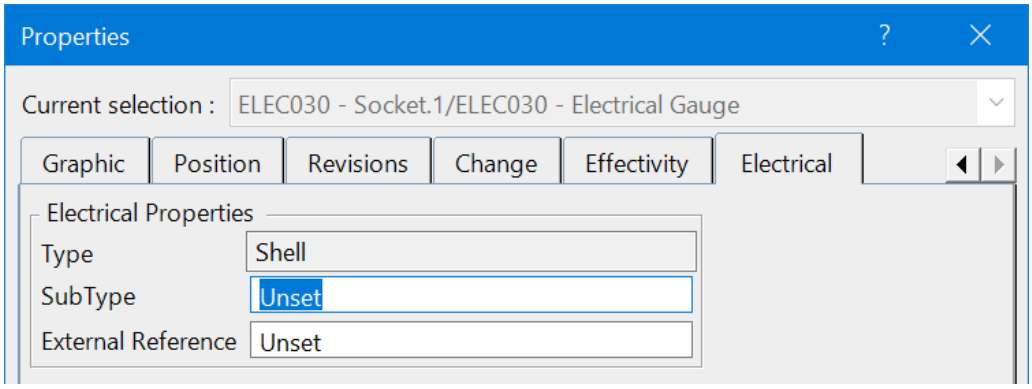


Note: The lines are displayed above for illustration purposes; they do not need to be shown.

Many times, to define all three placement constraints, additional geometry must be created.

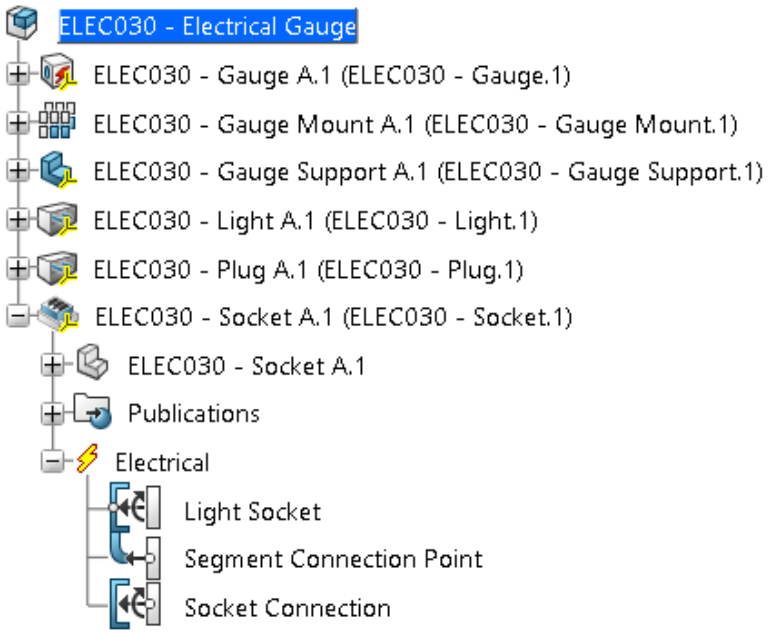
Select *Cancel* to the *Cavity Connection Point Definition* window, then double-select on the *ELEC - Electrical Gauge* product at the top of the specification tree. This will activate the product again.

Check the electrical properties of *ELEC030 - Socket* to determine which type of device it is.

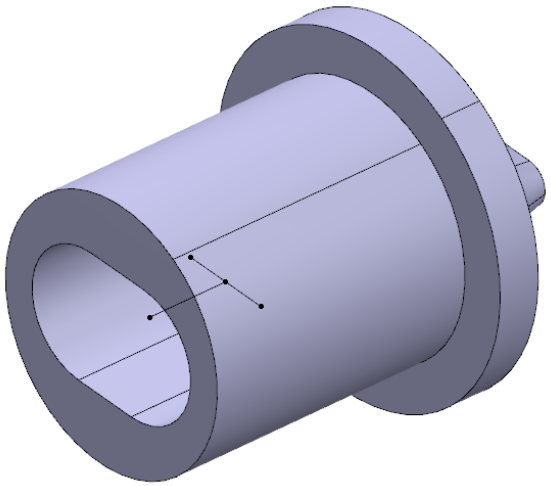


The socket is a shell. Shells are allowed to connect via a cavity and a cavity connection point.

Close the *Properties* window and examine the electrical connections in the socket part.



This shell has three electrical connections. A cavity is defined inside the hole of the shell. It also has the same T shape, which is defining the same placement constraints.



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

Ensure you are in the Electrical 3D Design workbench, then select the Connect Devices icon from the *Device* section. 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 to another device.

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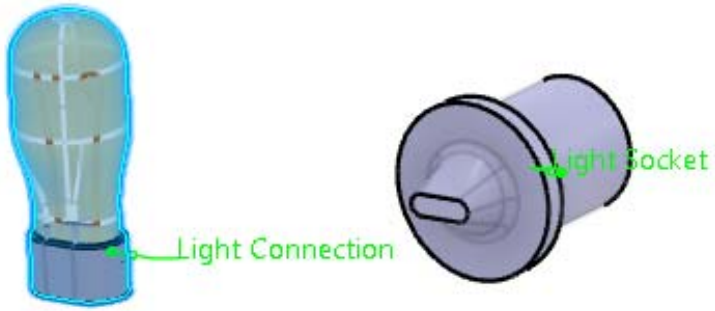
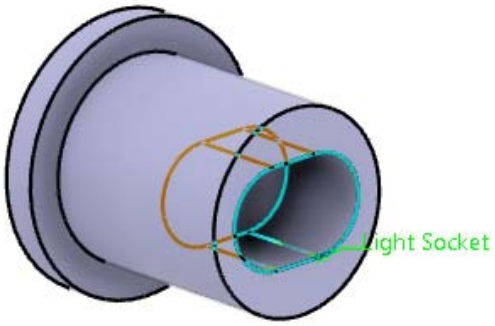
Point to the socket, but do not select it yet. Text appears on each item.



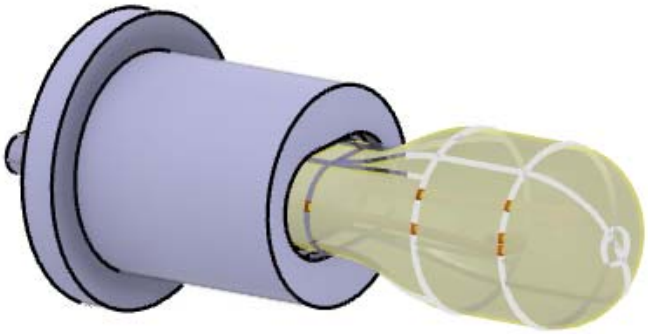
When you point to the second electrical device, the name of any available connections will automatically be displayed.

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

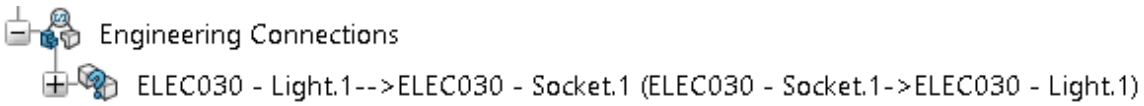


The representation for the light socket highlights. This is why defining a good representation is useful. It allows the electrical assembly to display the two areas that will be connected.

Select the *Light Socket* connection. The two items assemble together.



An *Engineering Connections* branch is automatically added to the tree.



Electrical Assembly Constraints

When two devices are electrically connected, an engineering connection is created to hold the parts together. The type of engineering connection created is based upon the *Contact*, *Coincidence*, and *Orientation* elements specified during the connection point definition. These elements constrain to each other when the two parts have been defined. If one device has an *Orientation* element specified and the other does not, a constraint will be missing, which allows additional degrees of freedom.

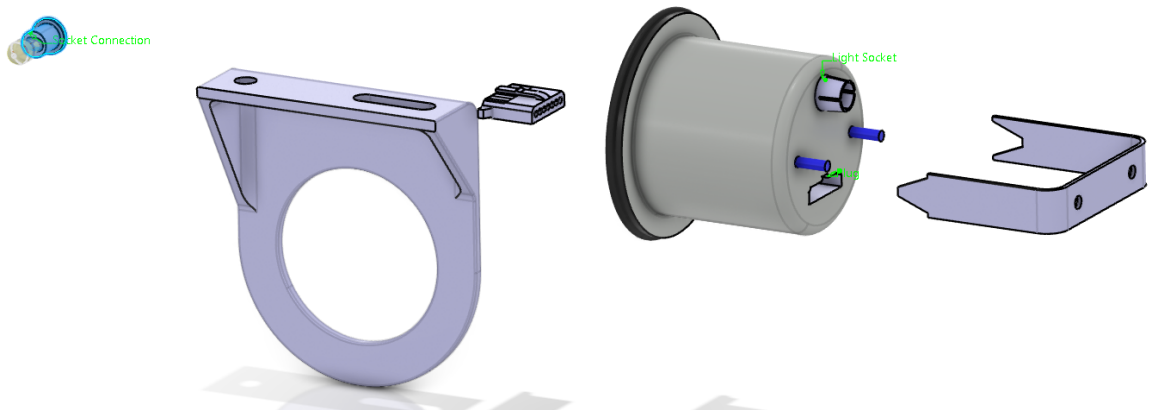
The method in which the constraints are defined is simple. Anytime two faces are defined for the same placement constraint, a surface contact constraint is applied. Anytime geometry is defined for a placement constraint, a coincidence constraint is applied. This is why the constraining geometry should be in the exact same location for each model. If you were to pick an edge of a part for the *Orientation* element, and it did not exactly match the other device's orientation edge, you would have an error in the engineering connection.

Select the Disconnect Devices icon, then select the socket and the light. They will no longer be connected.

The two parts did not physically separate, but the engineering connection was deleted. More importantly, the electrical connectivity between the two items has been removed.

Re-connect the light and the socket. All you will need to do is select the Connect Devices icon, then select the light and the socket.

Select the Connect Devices icon, then select the socket and the gage. The parts highlight, but nothing else appears to happen. This is due to the gage having multiple cavities that the socket can connect to.



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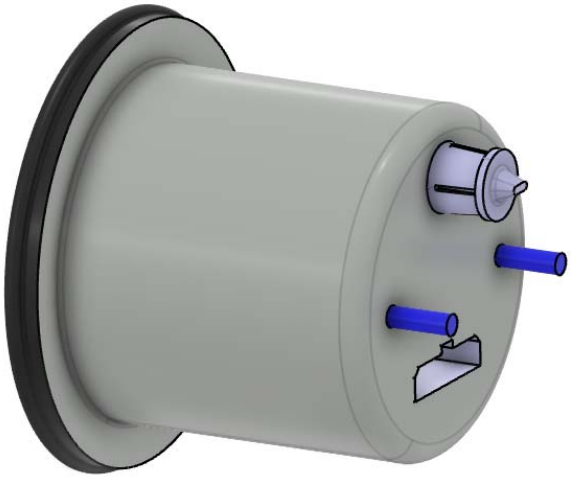
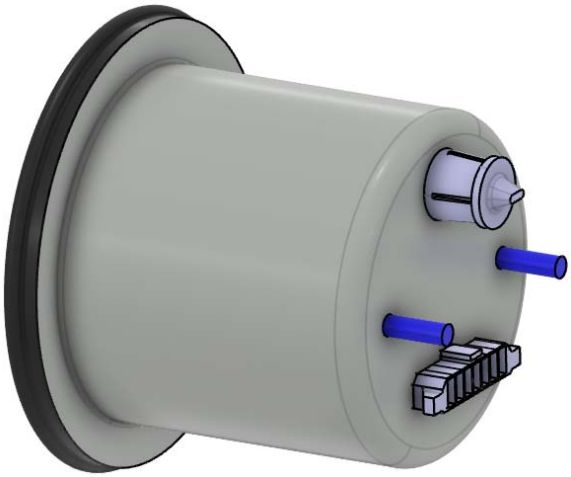
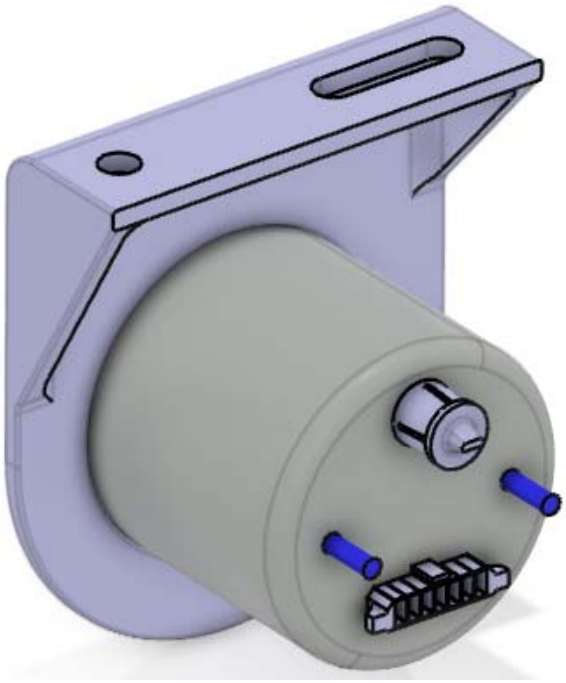
Select the *Light Socket* text on the gauge. The light socket is assembled to the gauge. A revolute engineering connection is created, meaning it has two degrees of freedom: one linear and one rotational.



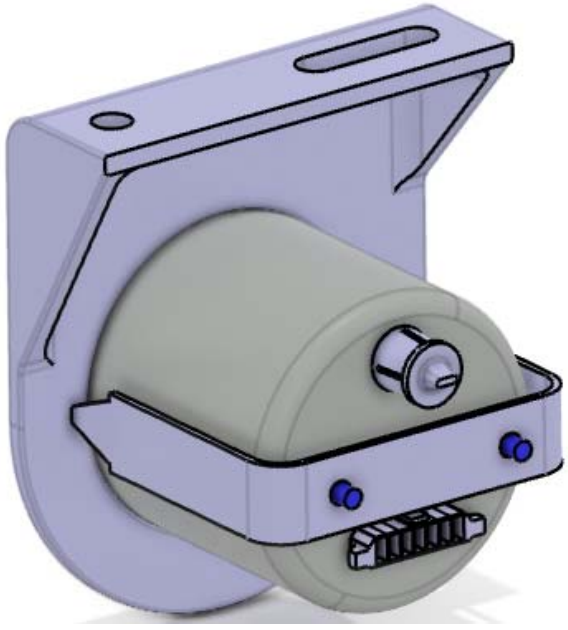
Select the Connect Devices icon, then select the plug and the guage. Even though there are two cavities, one is already filled, so the plug automatically associates to the other cavity.



Electrically connect the gauge to the gauge mount. A revolute engineering connection is created. If you want to make it rigid in order to eliminate the gauge's rotation within the mount, you can double-select the last engineering connection and add a parallel or perpendicular constraint.



Switch to the Assembly Design workbench and create the necessary engineering connections to assemble the support to the gauge. You will want to add a fix engineering connection constraint to the gauge mount first.



Save and close all documents.

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