# 10.4. Software Safety Restrictions

**Description**

**NOTICE**

Configuring planes is entirely based on features. We recommend you create and name all features before editing the safety configuration, as the robot is powered off once the Safety Tab has been unlocked and moving the robot will be impossible.

Safety planes restrict robot workspace. You can define up to eight safety planes, restricting the robot tool and elbow. You can also restrict elbow movement for each safety plane and disable by deselecting the checkbox. Before configuring safety planes, you must define a feature in the robot installation. The feature can then be copied into the safety plane screen and configured.

**WARNING**

Defining safety planes only limits the defined Tool spheres and elbow, not the overall limit for the robot arm. This means that specifying a safety plane, does not guarantee that other parts of the robot arm will obey this restriction.

**Safety Planes Modes**

You can configure each plane with restrictive **Modes** using the icons listed below.

| | | |
|---|---|---|
| | Disabled | The safety plane is never active in this state. |
| | Normal | When the safety system is in Normal mode, a normal plane is active and it acts as a strict limit on the position. |
| | Reduced | When the safety system is in Reduced mode, a reduced mode plane is active and it acts as a strict limit on the position. |
| | Normal & Reduced | When the safety system is either in Normal or Reduced mode, a normal and reduced mode plane is active and acts as a strict limit on the position. |
| | Trigger Reduced Mode | The safety plane causes the safety system to switch to Reduced mode if the robot Tool or Elbow is positioned beyond it. |
| | Show | Pressing this icon hides or shows the safety plane in the graphics pane. |
| | Delete | Deletes the created safety plane. There is no undo/redo action. If a plane is deleted in error, it must be remade. |
| | Rename | Pressing this icon allows you to rename the plane. |

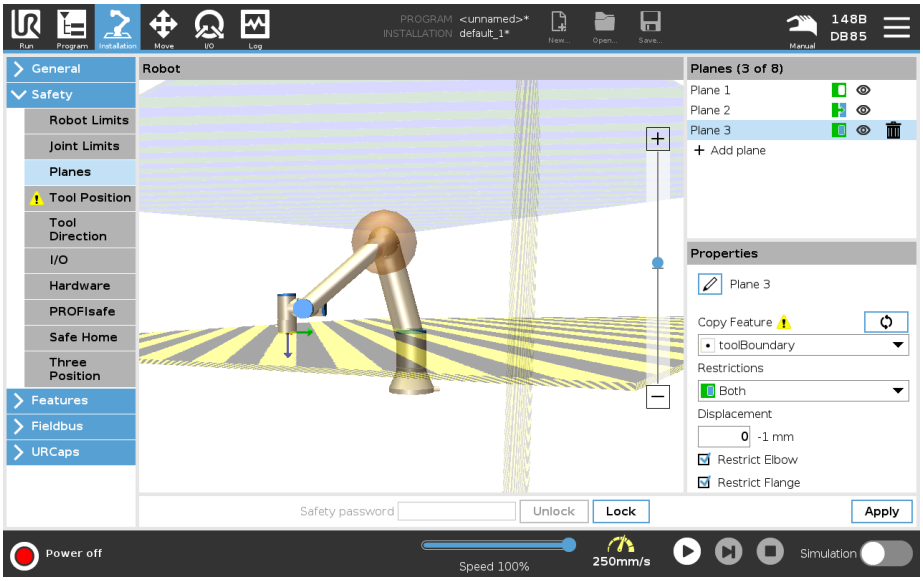
### Configuring safety planes

1. In your PolyScope header, tap **Installation**.
2. In the Side Menu on the left of the screen, tap Safety and select **Planes**.
3. On the top right of the screen, in the Planes field, tap **Add plane**.
4. On the bottom right of the screen, in the **Properties** field, set up Name, Copy Feature and Restrictions.

### Copy Feature

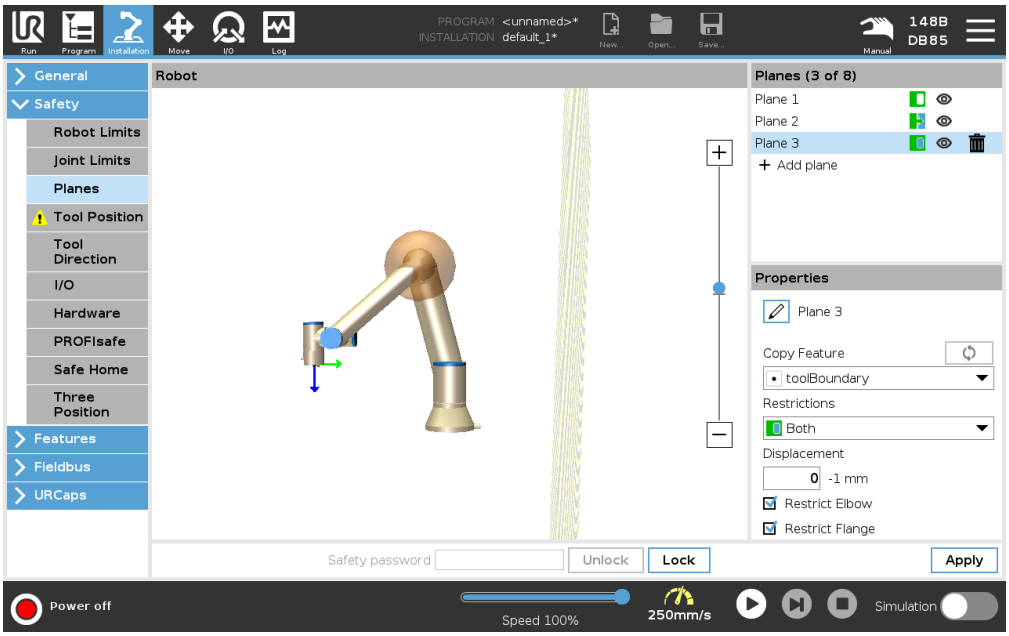
In **Copy Feature**, only Undefined and Base are available. You can reset a configured safety plane by selecting **Undefined**

If the copied feature is modified in the Features screen, a warning icon appears to the right of the Copy Feature text. This indicates that the feature is out of sync i.e. the information in the properties card is not updated to reflect the modifications that may have been made to the Feature.



**Color Codes**

| | |
|---|---|
| *Gray* | Plane is configured but disabled (A) |
| *Yellow & Black* | Normal Plane (B) |
| *Blue & Green* | Trigger Plane (C) |
| *Black Arrow* | The side of the plane the tool and/or elbow is allowed to be on (For Normal Planes) |
| *Green Arrow* | The side of the plane the tool and/or elbow is allowed to be on (For Trigger Planes) |
| *Gray Arrow* | The side of the plane the tool and/or elbow is allowed to be on (For Disabled Planes) |

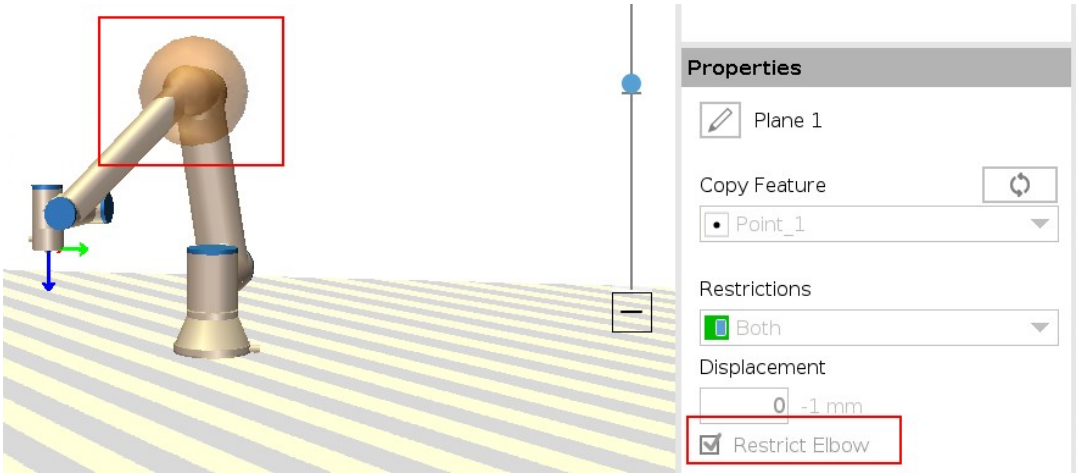


**Elbow Restriction**

You can enable **Restrict Elbow** to prevent robot elbow joint from passing through any of your defined planes. Disable Restrict Elbow for elbow to pass through planes.
The diameter of the ball that restricts the elbow is different for each size of robot.

| | |
|---|---|
| UR3e | 0.1 m |
| UR5e | 0.13 m |
| UR10e / UR16e | 0.15 m |
| UR20 / UR30 | 0.19 m |

The information about the specific radius can be found in the *urcontrol.conf* file on the robot under the section [Elbow].




**Tool Flange Restriction**

Restricting the tool flange prevents the tool flange and the attached tool from crossing a safety plane. When you restrict the tool flange, the unrestricted area is the area inside of the safety plane, where the tool flange can operate normally.
The tool flange cannot cross the restricted area, outside of the safety plane.

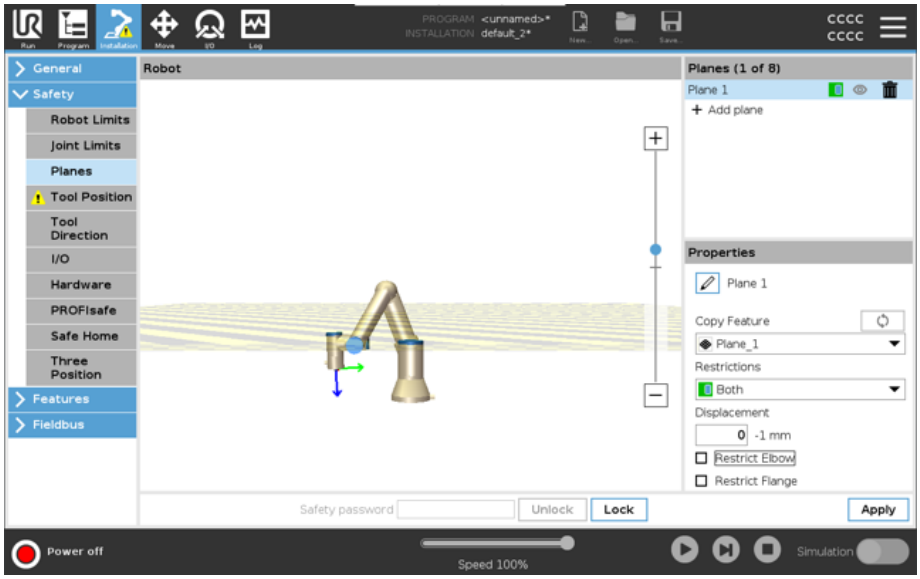
Removing the restriction allows the tool flange to go beyond the safety plane, to the restricted area, while the attached tool remains inside of the safety plane.

You can remove the tool flange restriction when working with a large tool off-set. This will allow extra distance for the tool to move.

Restricting the tool flange requires the creation of a plane feature. The plane feature is used to set up a safety plane later in the safety settings.

**Adding a plane feature example**

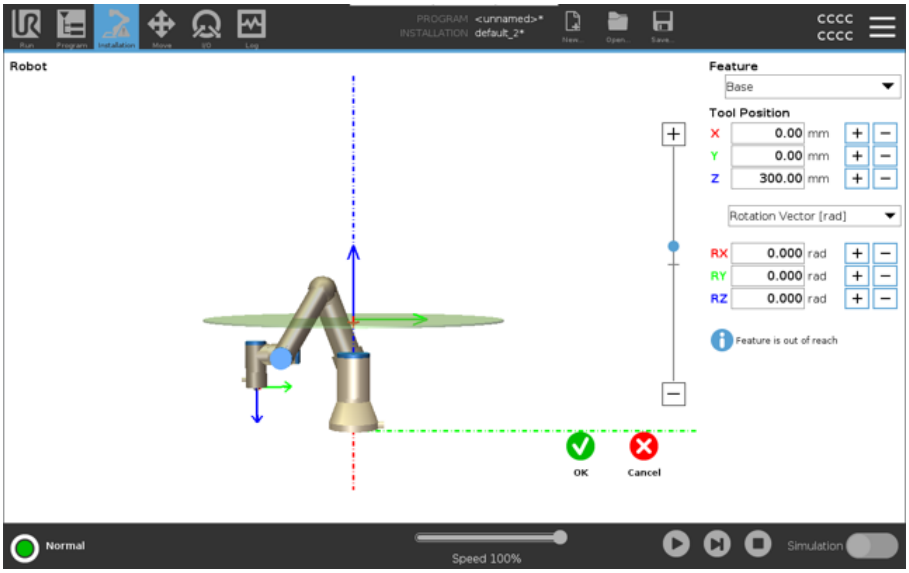
Displacement offsets the plane in either the positive or negative direction along the plane normal (Z-axis of the plane feature).
Deselect the checkbox for the Elbow and the Tool Flange so they do not trigger the safety plane. The Elbow can remain checked as needed by your application.




The unrestricted tool flange can cross a safety plane, even when no tool is defined.
If no tool is added, a warning on the Tool Position button prompts you to correctly define the tool.
When working with an unrestricted tool flange and a defined tool, it is ensured that the dangerous part of the tool can't go above and/or beyond certain area. The unrestricted tool flange can be used for any application where safety planes are needed, like Welding or Assembly.

**Tool flange restriction example**

In this example, an X-Y-plane is created with an offset of 300mm along the positive Z-axis with reference to the base feature.
The Z-axis of the plane can be thought of as “pointing” towards the restricted area.
If the safety plane is needed on e.g., the surface of a table, rotate the plane 3.142 rad or 180° around either the X- or Y-axis so the restricted area is under the table.
(TIP: Change the display of rotation from “Rotation Vector [rad]” to “RPY [°]”)




If needed it is possible to offset the plane in either positive or negative Z-direction later in the safety settings.
When satisfied with the position of the plane, tap OK.

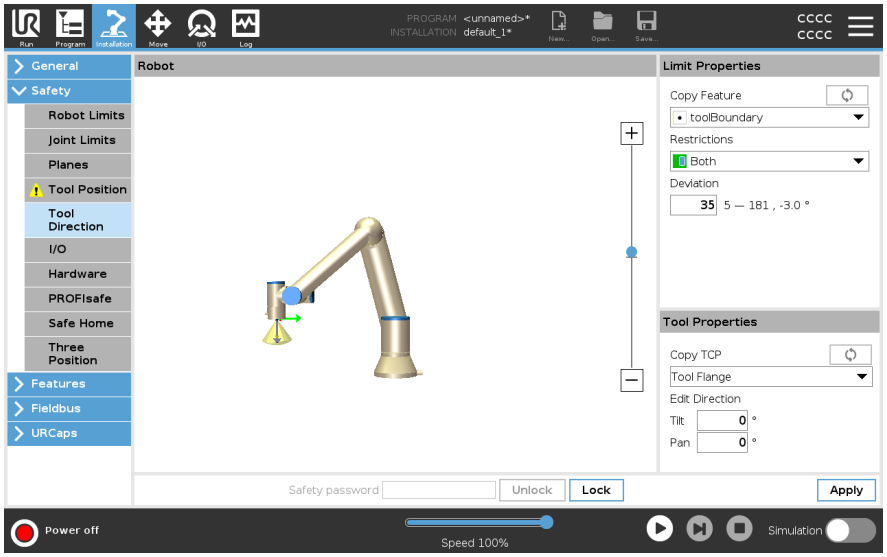
## 10.4.1. Tool Direction Restriction

**Description**

The Tool Direction screen can be used to restrict the angle in which the tool is pointing. The limit is defined by a cone that has a fixed orientation with respect to the robot arm Base. As the robot arm moves around, tool direction is restricted so it remains within the defined cone. The default direction of the tool coincides with the Z-axis of the tool output flange. It can be customized by specifying tilt and pan angles.
Before configuring the limit, you must define a point or plane in the robot installation. The feature can then be copied and its Z axis used as the center of the cone defining the limit.

**NOTICE**

Configuration of the tool direction is based on features. We recommend you create desired feature(s) before editing the safety configuration, as once the Safety Tab has been unlocked, the robot arm powers off making it impossible to define new features.



**Limit Properties**

The Tool Direction limit has three configurable properties:

1. **Cone center**: You can select a point or plane feature from the drop-down menu, to define the center of the cone. The Z axis of the selected feature is used as the direction around which the cone is centred.
2. **Cone angle**: You can define how many degrees the robot is allowed to deviate from center.

| | |
|---|---|
| Disabled Tool direction limit | Never active |
| Normal Tool direction limit | Active only when safety system is in **Normal mode** |
| Reduced Tool direction limit | Active only when the safety system is in **Reduced mode** |
| Normal & Reduced Tool direction limit | Active when the safety system is in **Normal mode** as well as when it is in **Reduced mode**. |

You can reset the values to default or undo the Tool Direction configuration by setting the copy feature back to "Undefined".

**Tool Properties**

By default, the tool points in the same direction as the Z axis of the tool output flange. This can be modified by specifying two angles:

- **Tilt angle**: How much to tilt the Z axis of the output flange towards the X axis of the output flange
- **Pan angle**: How much to rotate the tilted Z axis around the original output flange Z axis.

Alternatively, the Z axis of an existing TCP can be copied by selecting that TCP from the drop-down menu.

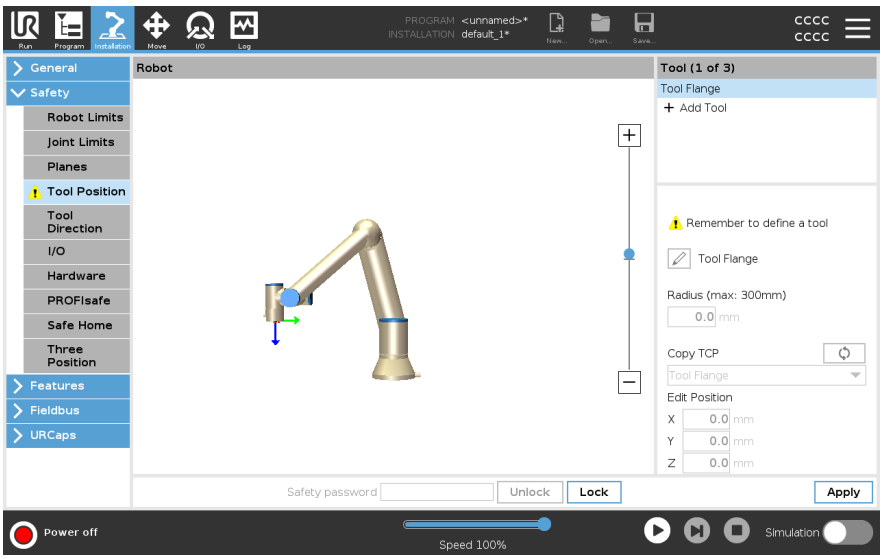
# 10.4.2. Tool Position Restriction

**Description**

The Tool Position screen enables more controlled restriction of tools and/or accessories placed on the end of the robot arm.

- **Robot** is where you can visualize your modifications.
- **Tool** is where you can define and configure a tool up to two tools.
- **Tool_1** is the default tool defined with values x=0.0, y= 0.0, z=0.0 and radius=0.0. These values represent the robot tool flange.

Under Copy TCP, you can also select **Tool Flange** and cause the tool values to go back to 0.
A default sphere is defined at the tool flange.

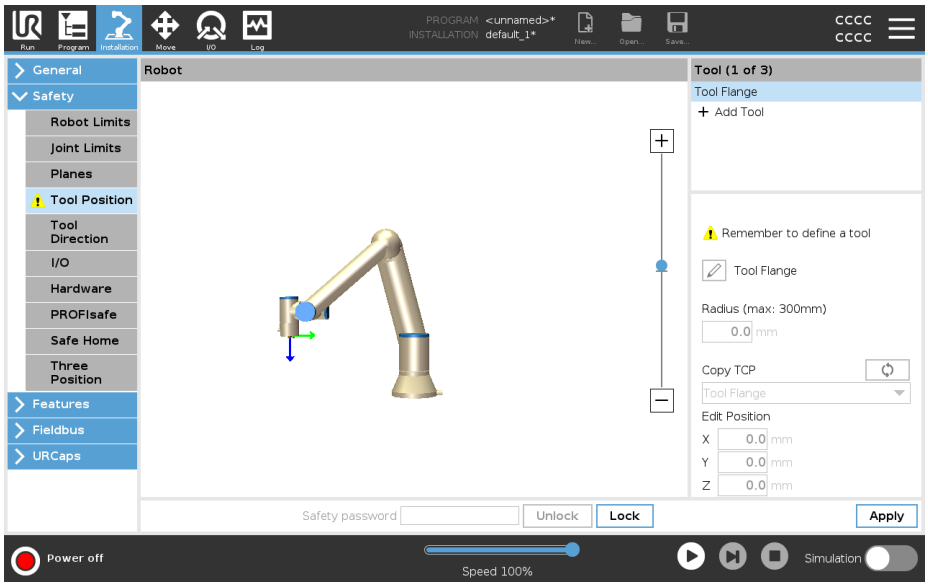


**User defined tools**

For the user defined tools, the user can change:

- **Radius** to change the radius of the tool sphere. The radius is considered when using safety planes. When a point in the sphere passes a reduced mode trigger plane, the robot switches to *Reduced* mode. The safety system prevents any point on the sphere from passing a safety plane (see Software Safety Restrictions).
- **Position** to change the position of the tool with respect to the tool flange of the robot. The position is considered for the safety functions for tool speed, tool force, stopping distance and safety planes.

You can use an existing Tool Center Point as a base for defining new tool positions. A copy of the existing TCP, predefined in General menu, in TCP screen, can be accessed in Tool Position menu, in Copy TCP drop-down list.
When you edit or adjust the values in the **Edit Position** input fields, the name of the TCP visible in the drop down menu changes to **custom**, indicating that there is a difference between the copied TCP and the actual limit input. The original TCP is still available in the drop down list and can be selected again to change the values back to the original position. The selection in the copy TCP drop down menu does not affect the tool name.
Once you apply your Tool Position screen changes, if you try to modify the copied TCP in the TCP configuration screen, a warning icon appears to the right of the Copy TCP text. This indicates that the TCP is out of sync i.e. the information in the properties field is not updated to reflect modifications that may have been made to the TCP. The TCP can be synced by pressing the sync icon (see ).
The TCP does not have to be synced in order to define and use a tool successfully.
You can rename the tool by pressing the pencil tab next to the displayed tool name. You can also determine the Radius with an allowed range of 0-300 mm. The limit appears in the graphics pane as either a point or a sphere depending on radius size.



**Tool Position Warning**

You must set a Tool Position within the safety settings, for the safety plane to trigger correctly when the tool TCP approaches the safety plane.
The warning remains on the Tool Position if:

- You fail to add a new tool under Tool Flange.

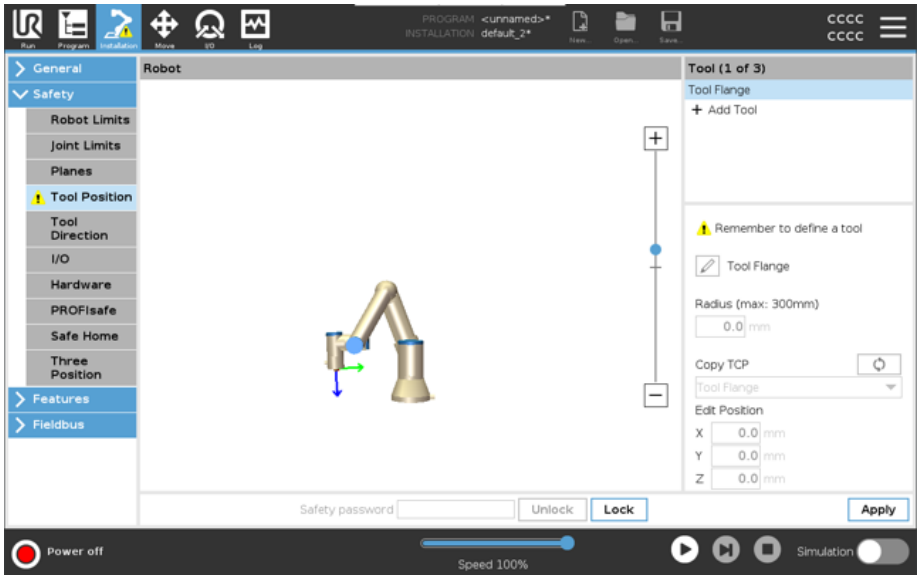
To configure the tool position

1. In the Header tap **Installation**.
2. On the left side of the screen, under Safety, tap **Tool Position**.
3. On the right side of the screen, select **Add Tool**.
   - The newly added tool has a default name: **Tool_x**.
4. Tap the edit button to rename **Tool_x** to something more identifiable.
5. Edit the Radius and Position to match that of the tool you are currently using, or use the Copy TCP drop-down and choose a TCP from the General>TCP settings if such is defined.

**Tool Position Warning example**

In this example, a Radius of 0.8mm is set and the TCP position to XYZ [20, 0, 400] in millimeters respectively. Optionally you can choose to ”Copy TCP” by using the drop-down menu if one has already been set in the ->General/TCP settings. Once the Apply is tapped in the bottom right corner of the screen, you are DONE.

The warning on the Tool Position button indicates a tool is not added under Tool Flange.




Tool Position button without the warning indicates a tool (other than the Tool Flange) is added.