VBX Series Machinist’s Manual

Use and Applications

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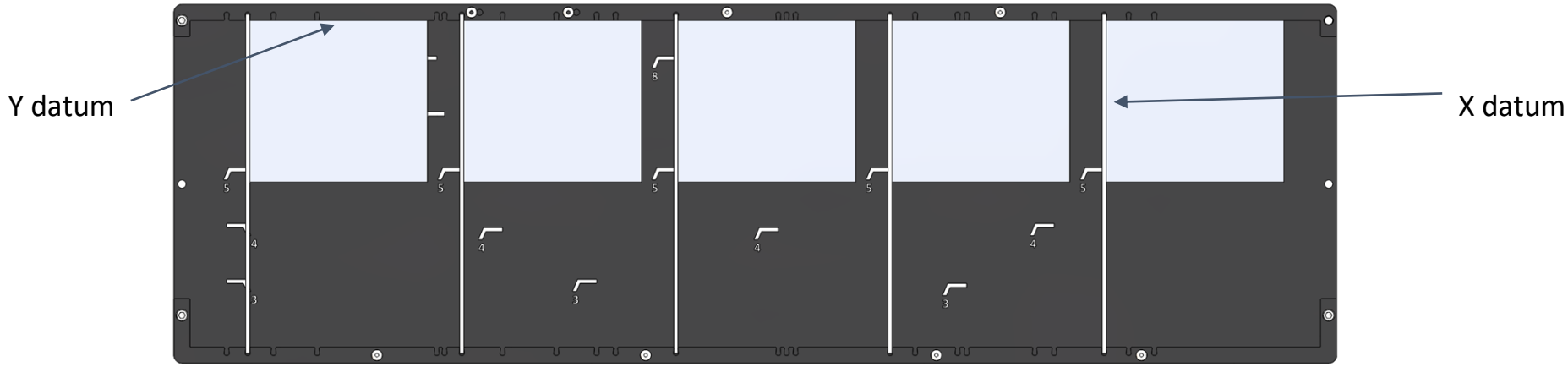
- Jaw Storage Plates
- Gate Posts
- Rinse and Dry Tank
- Robot Controller and Air/Electrical Panel
- VBXC User Interface

VBX-160 Racks and Shelves

- Two racks with 8 shelves per rack
- Top most shelf reserved for MultiGrip Jaws
- 7 shelves (#2 through #8) are reserved for part storage
- Each shelf holds a Universal Part Locator
- Universal Part Locators are easily configurable to optimally store parts depending on part width

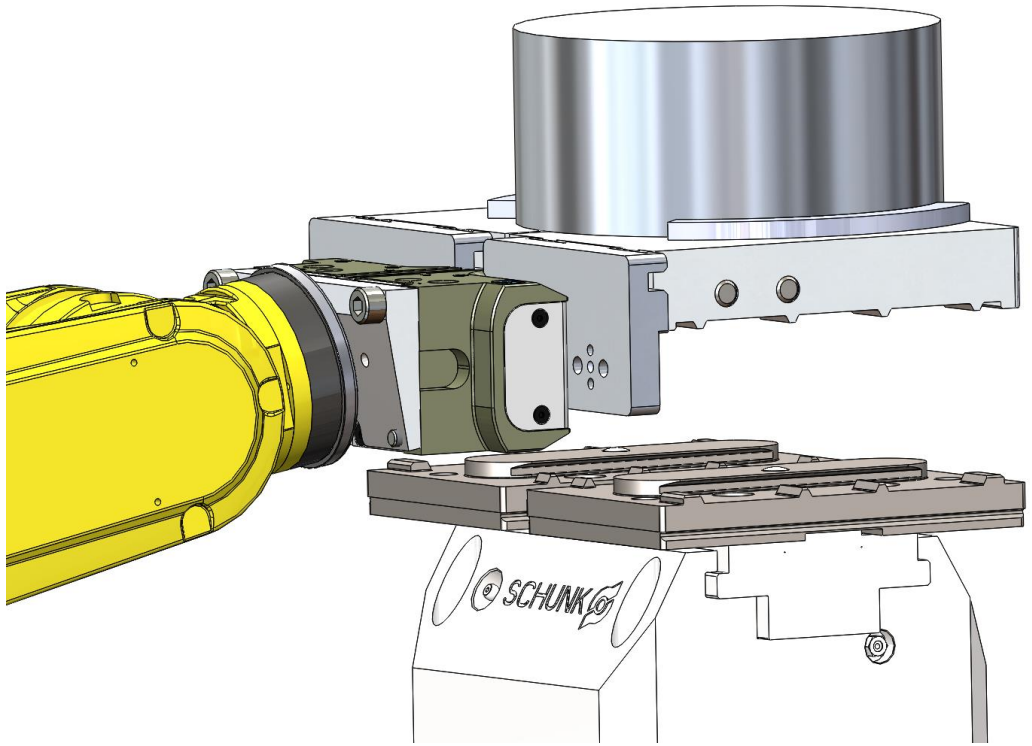
VBX-160 Universal Part Locators

- Part locator system
- Aligns the part in X and Y for robot pickup
- Optimizes VBX-160 infeed capacity based upon part width
- Flexible, quick and easy to setup
- Works with rounds and rectangles and any part that can be properly located with a single X and Y datum



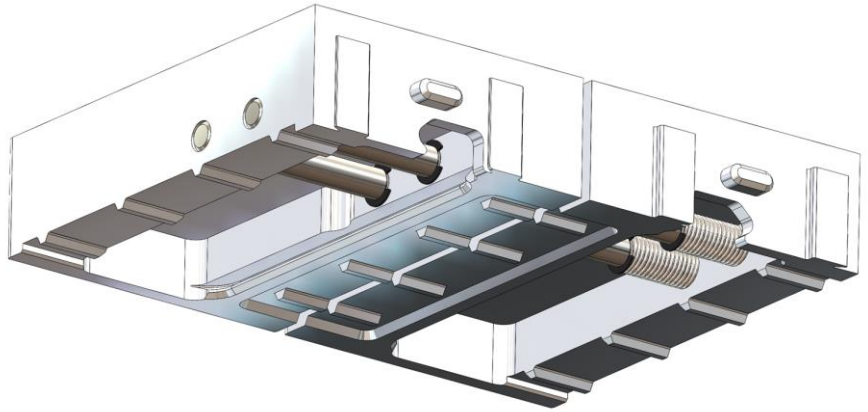
VBX-160 MultiGrip Gripper

- Pneumatic centering gripper with MultiGrip Jaw interface
- Built-In tool changer configured to pick or place MultiGrip Jaws from Jaw Storage Plates or MultiGrip Vise
- MultiGrip Gripper with MultiGrip Jaws attached can pick and place parts



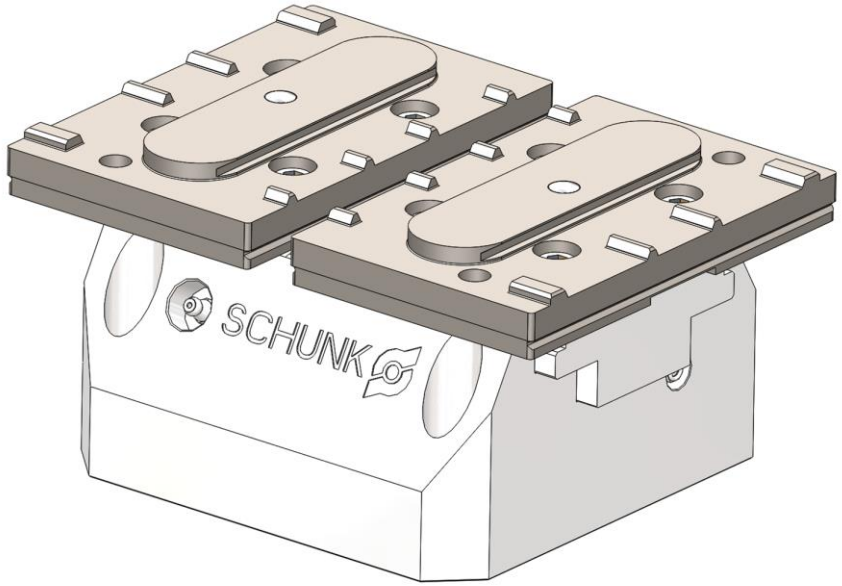
VBX-160 MultiGrip Jaws

- Machinable top jaws system that works with MultiGrip Gripper and MultiGrip Base Jaws.
- Options available to suit a wide variety of CNC machine tending requirements



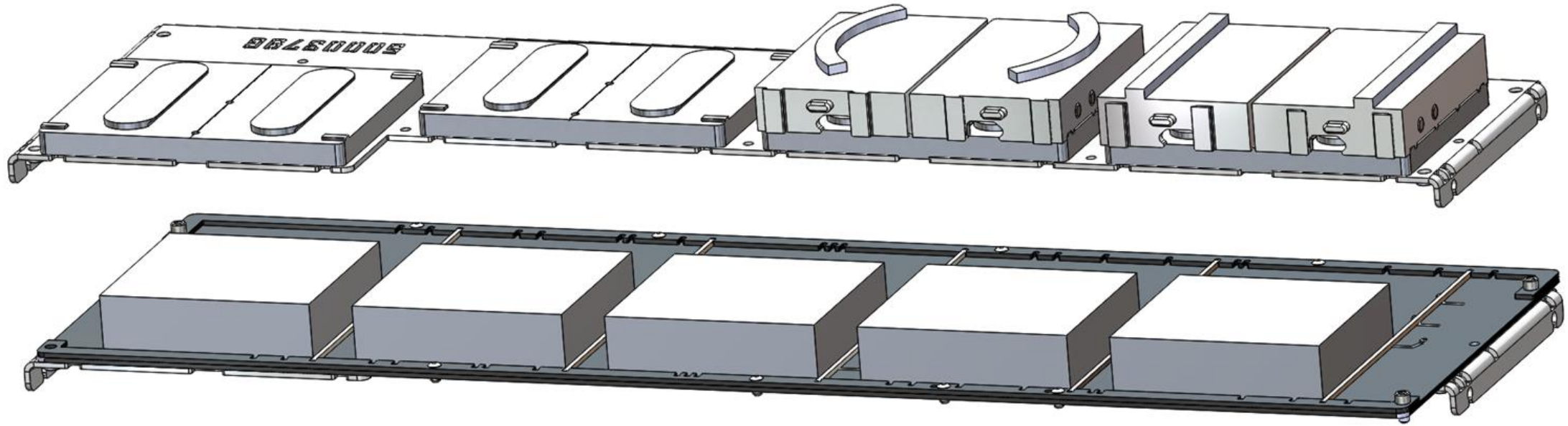
VBX-160 MultiGrip Vise

- High-force centering pneumatic vise
- Repeatability of less than 0.0008”
- MultiGrip intermediate vise jaw interface for engaging and disengaging MultiGrip jaws
- May be robot loaded using MultiGrip Gripper or hand loaded by operator



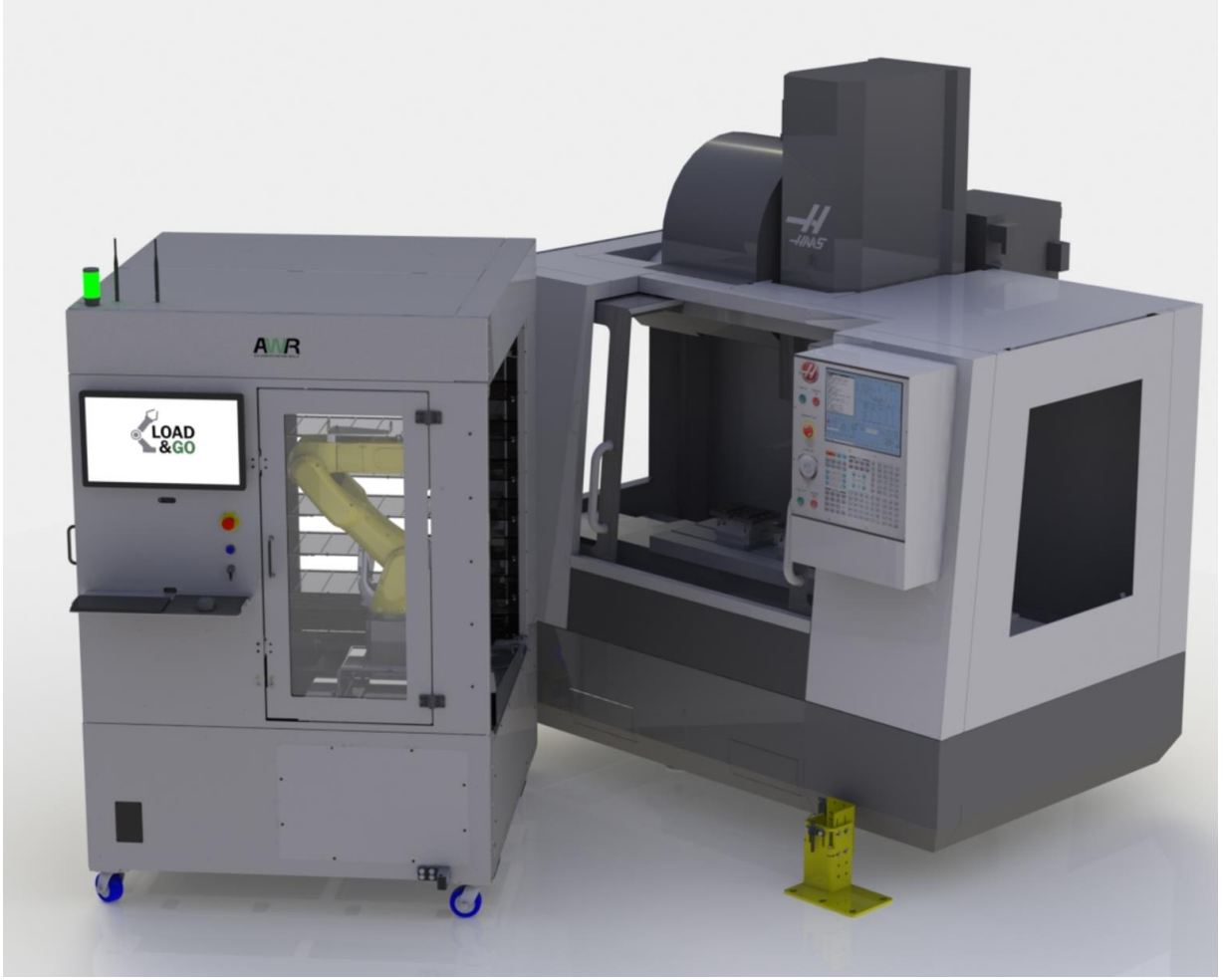
VBX-160 Jaw Storage Plates

- Holds MultiGrip Jaws for use by the robot during part processing
- Operator loads MultiGrip Jaws onto Jaw Storage Plates during job setup
- VBX-160 includes 8 Jaw Storage Plates allowing for multiple jobs to be setup and processing simultaneously



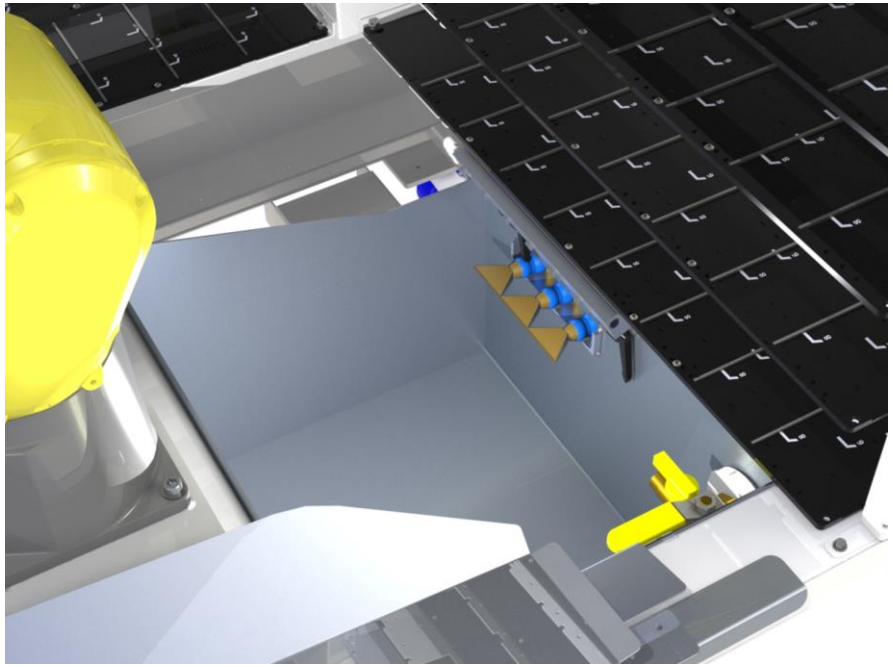
VBX-160 Gate Posts

- Anchored to the shop floor to provide a rigid mount for the VBX-160 in front of the CNC
- Includes a pivot post and gate post
- Gate post includes a quick-pull lock-pin that when pulled allows the VBX-160 to be pivoted away from CNC by the operator in seconds
- Operator can pivot the VBX-160 back into position and lock the VBX-160 into place with the lock-pin in seconds

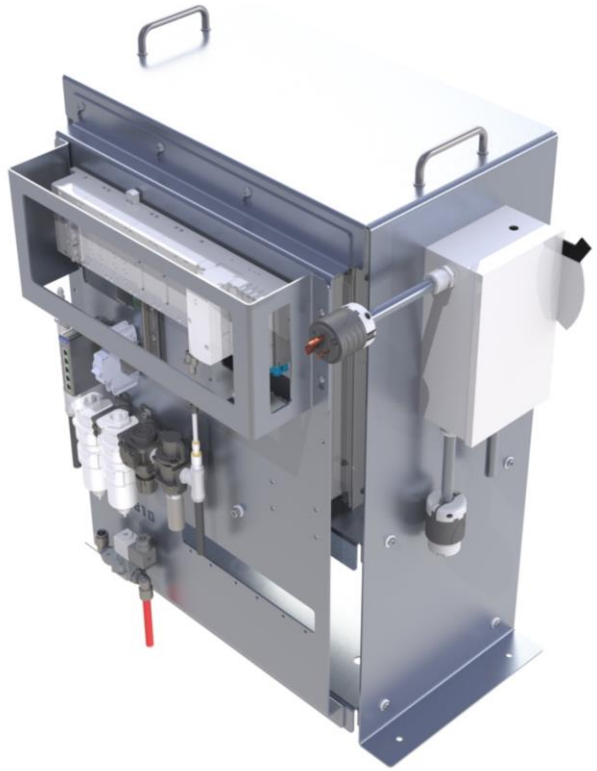


VBX-160 Rinse and Dry Tank

- Tank in VBX-160 used to rinse coolant and chips away from MultiGrip Jaws
- Air-knife uses compressed air to blow excess water after rinse
- Built-in pump includes diverter valve and standard garden hose bib to ease removal of dirty rinse water



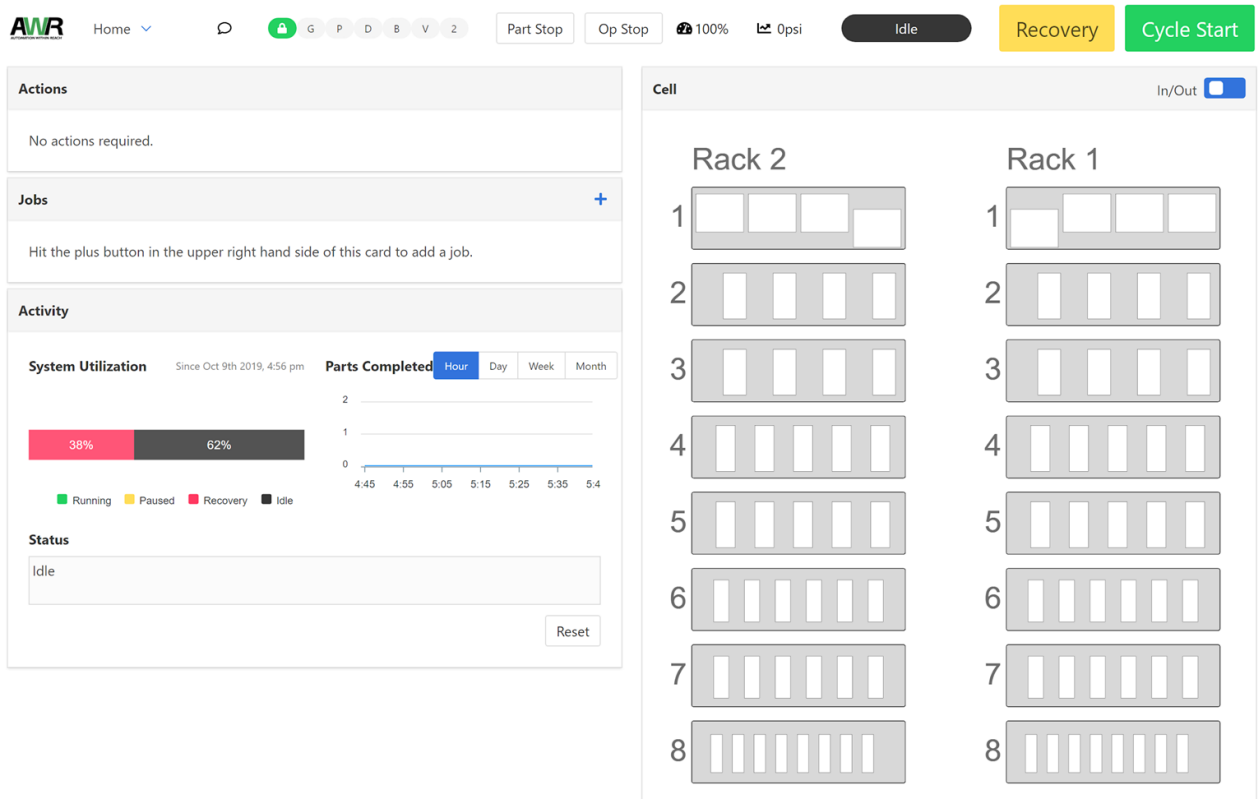
VBX-160 Robot Controller and Air/Electrical Panel



- IP-54 rated robot controller cabinet suitable for use in machine shop environment
- Robot controller is typically set to the side of the CNC
- Air/Electrical panel mounted on the robot controller controls pneumatic and electrical signals used by the VBX-160

VBX-160 VBXC Interface

- Controls the robot and the CNC
- Intuitive interface is simple to use but powerful
- Stores all automation part configuration related information
- Operator selects part number and quantity and the VBXC prompts the operator to setup the job
- Recovery panel helps operator restart the system after an error occurs

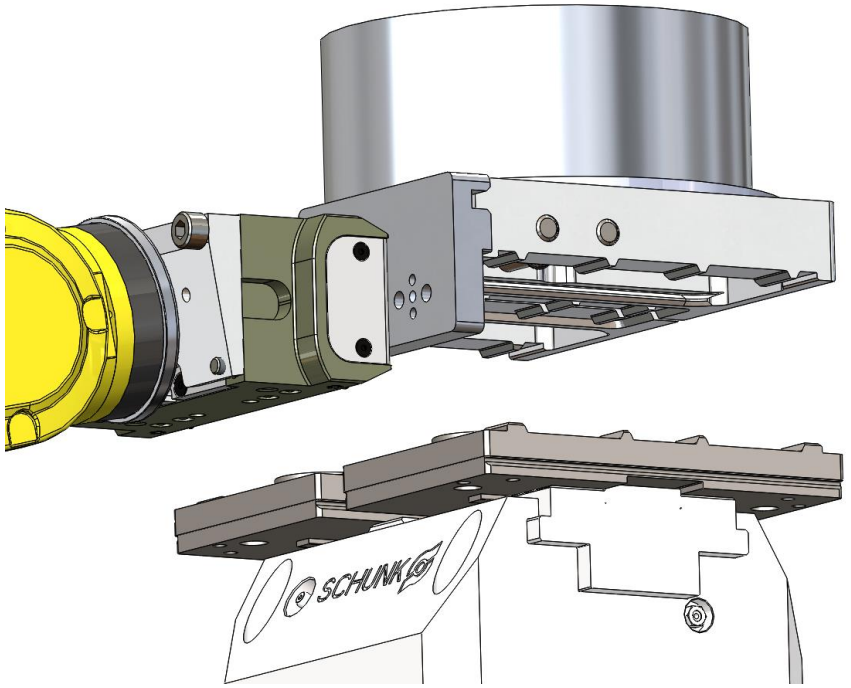


MultiGrip Overview

Section 2

MultiGrip Overview

- Automation-Ready CNC Workholding System
- Highly Repeatable, Quick-Change Jaw System
  - Manual tending
  - Robot Tending
- Complete MultiGrip System Includes:
  - MultiGrip Gripper for the robot
  - MultiGrip Jaws
  - MultiGrip Vise



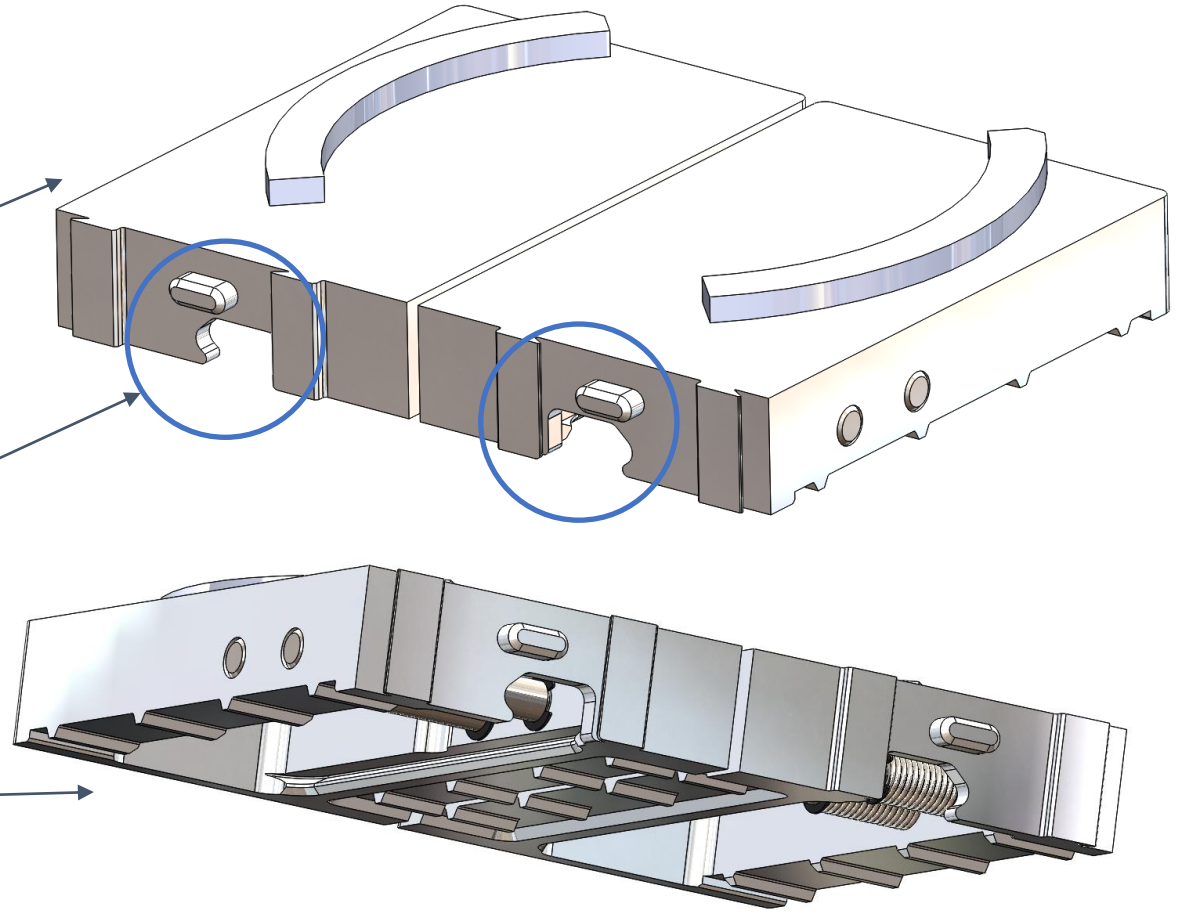
MultiGrip Overview

- MultiGrip Jaws may be used for the following:
  - Picking parts from the VBX-160 shelves
  - Holding parts in a MultiGrip vise
  - Placing parts in a chuck or non-MultiGrip vise
  - Performing a first operation to second operation transfer
  - Placing completed parts to the VBX-160 shelves
- Each type of use has unique requirements for successful automation
- Understand how your MultiGrip jaws will be used and ensure that all design considerations are met for the use

MultiGrip Overview

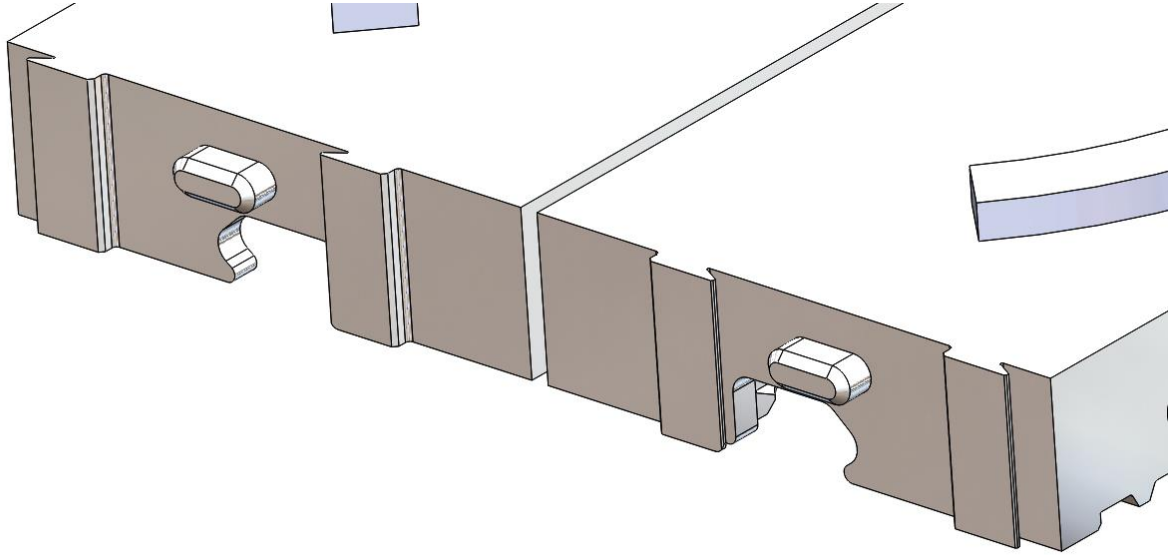
Three interfaces:

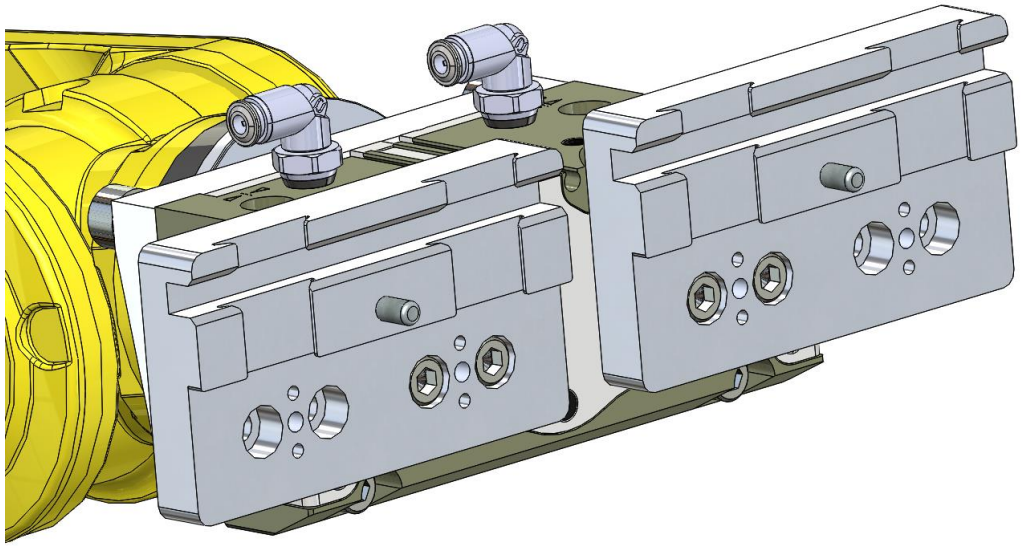
- Part Interface
- Robot gripper Interface
- Vise Interface



MultiGrip Overview

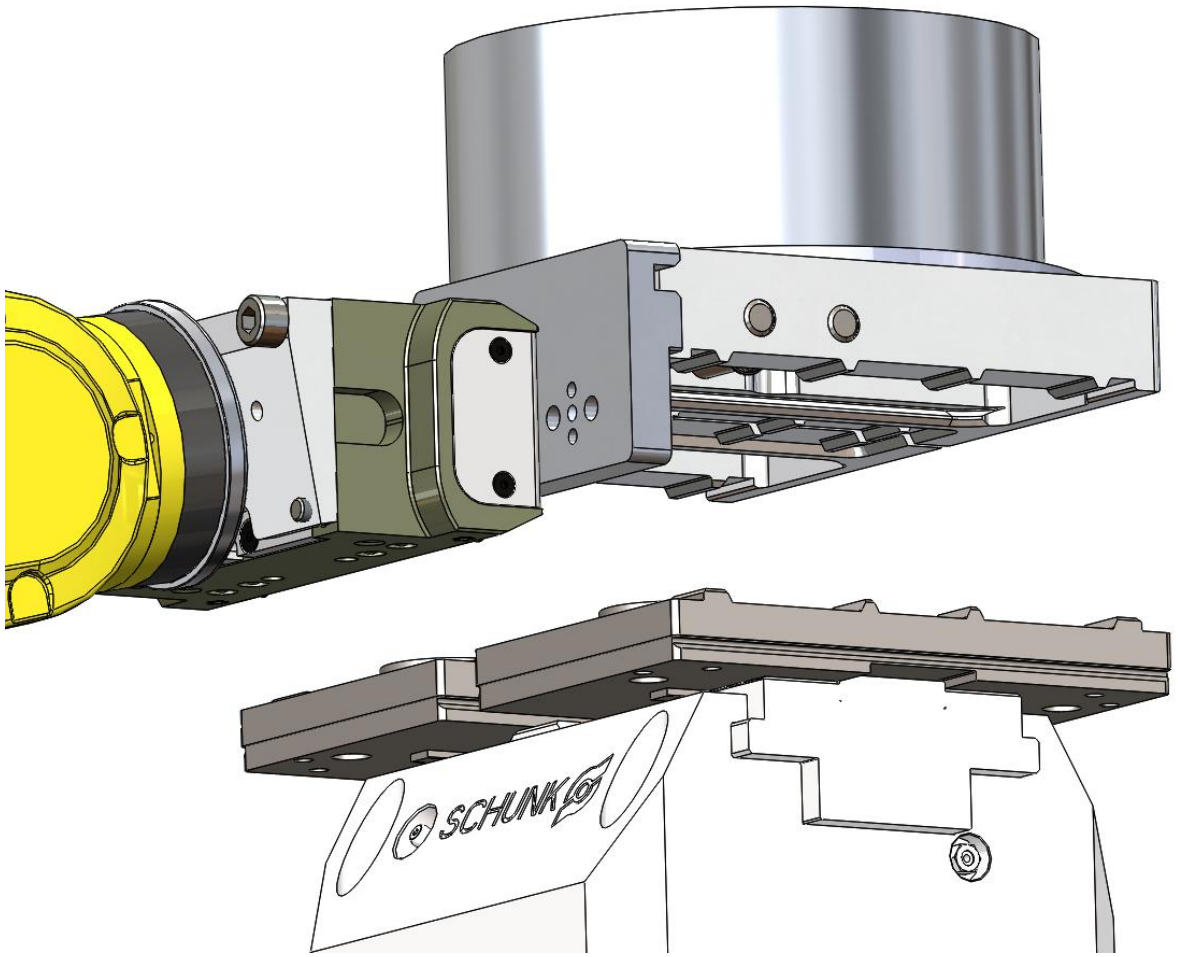
Gripper interface allows robot to pick and place jaws





MultiGrip Overview

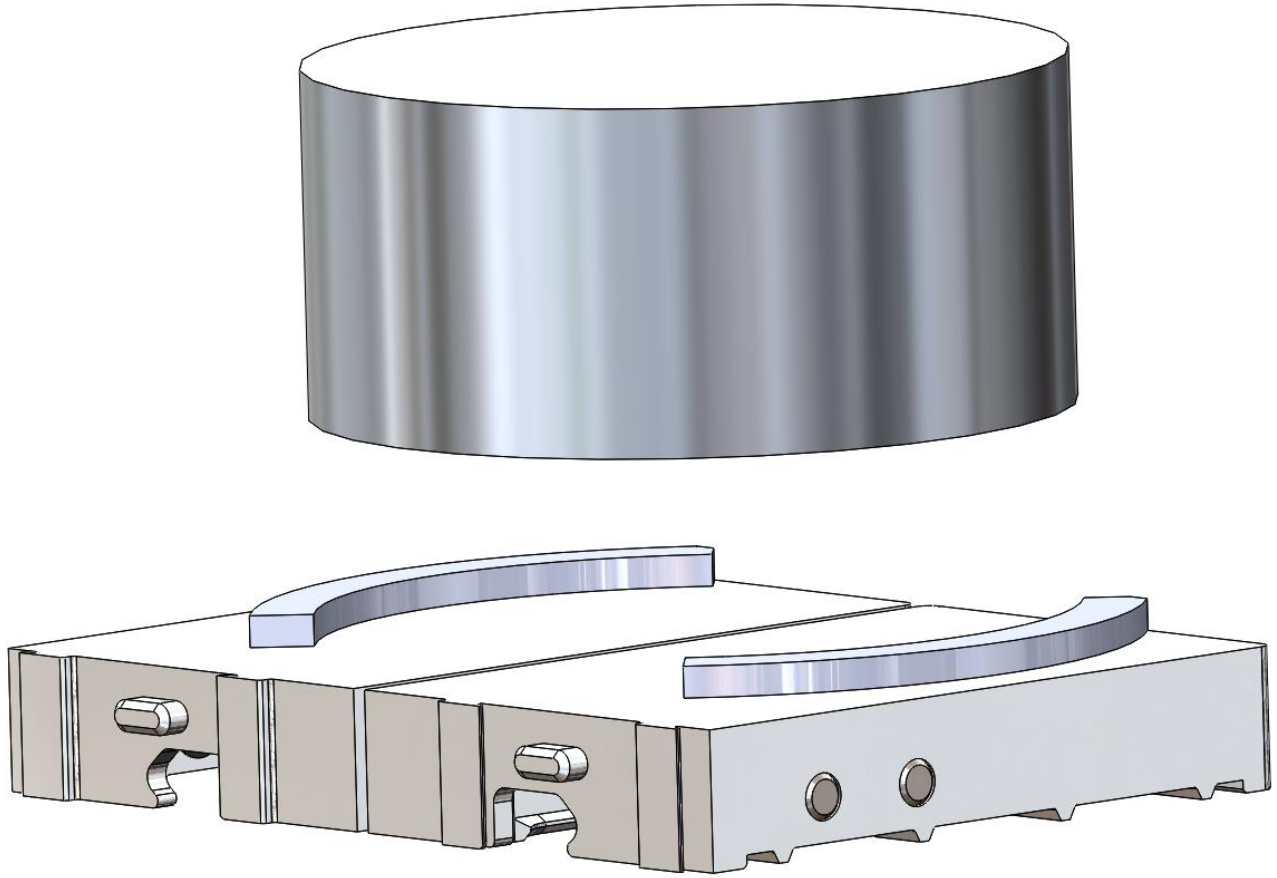
Vise interface allows vise to secure part and jaws for processing



MultiGrip Overview

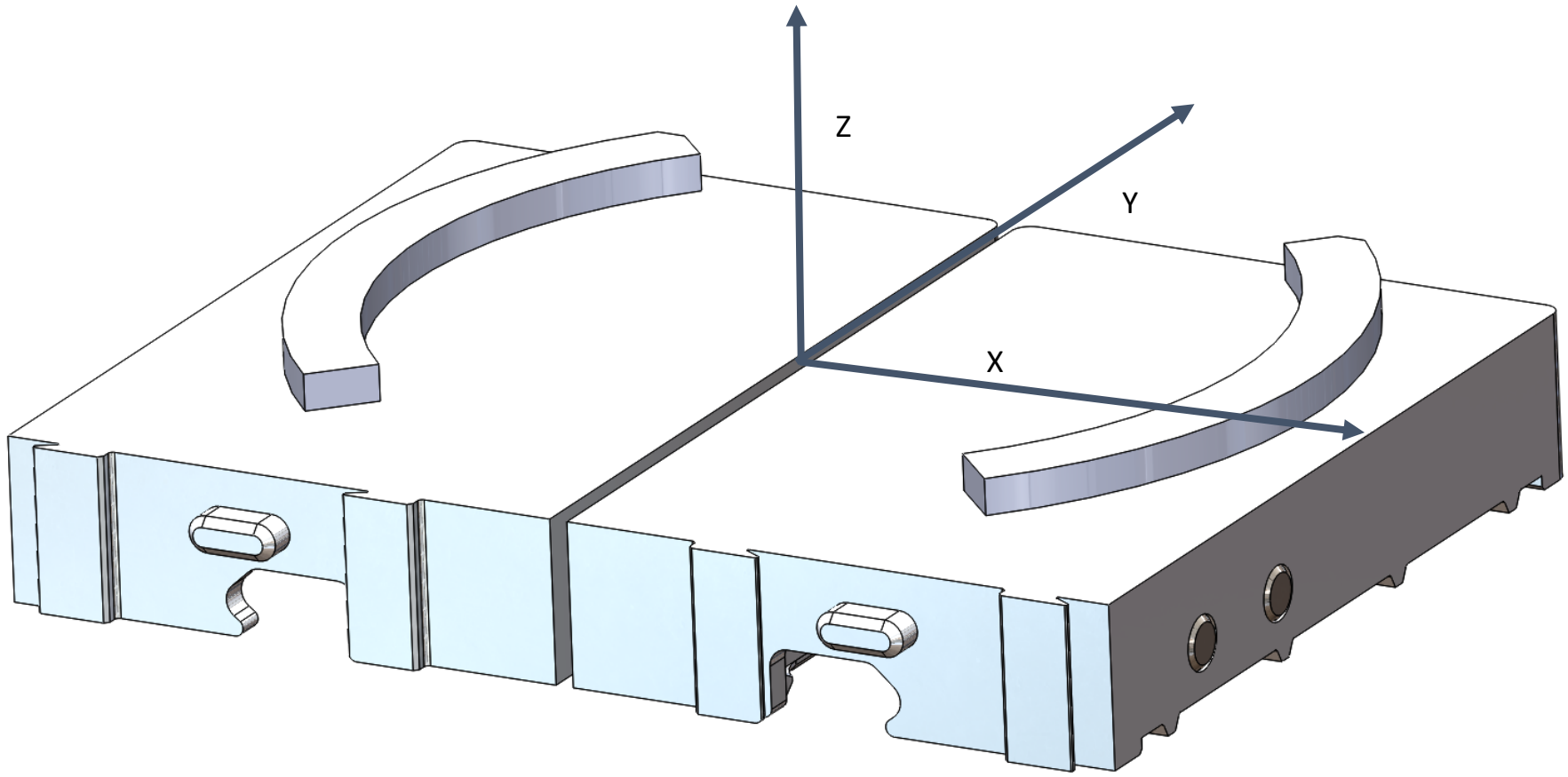
Part interface:

Top jaws are machined to hold the part



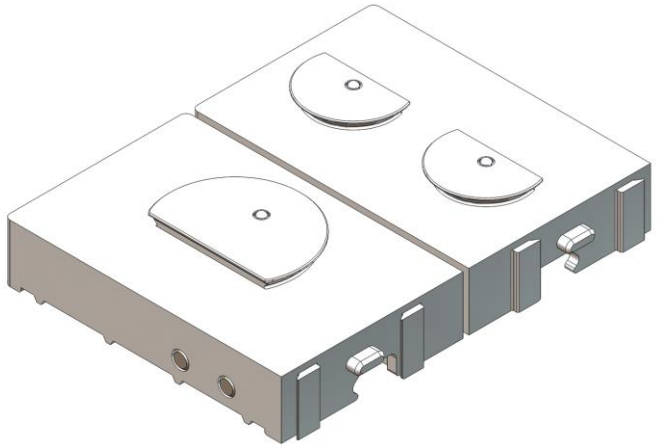
MultiGrip Overview

XYZ axis aligned with typical CNC axis

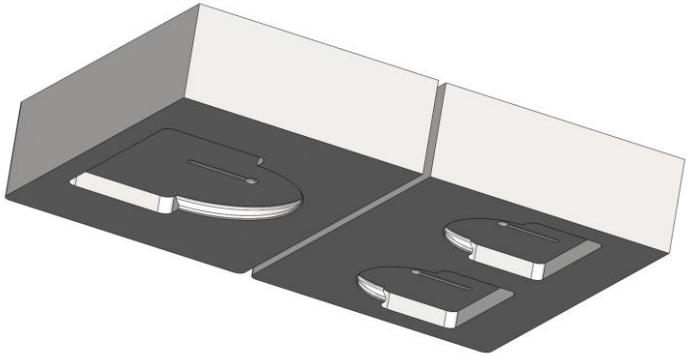


MultiGrip Jaw Types

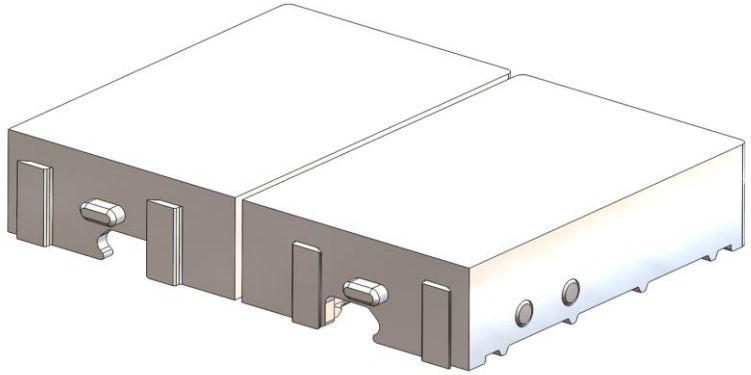
MultiGrip Base Jaws



MultiGrip Top Jaws

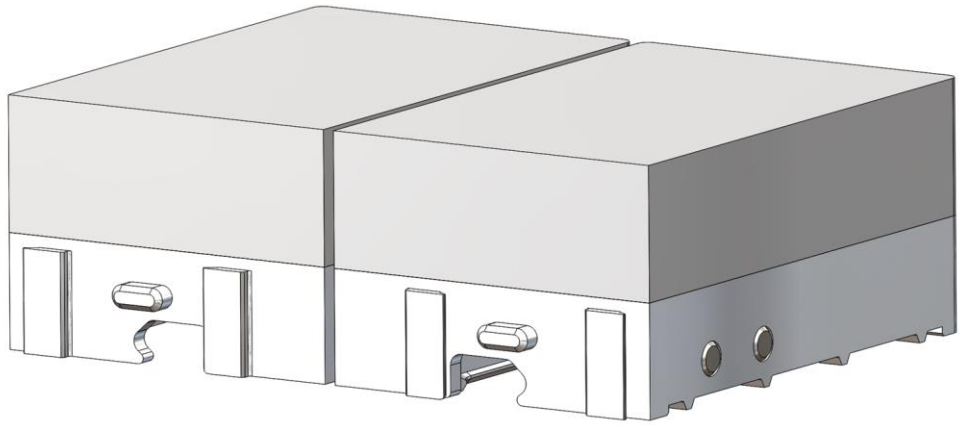


MultiGrip Fixed Jaws



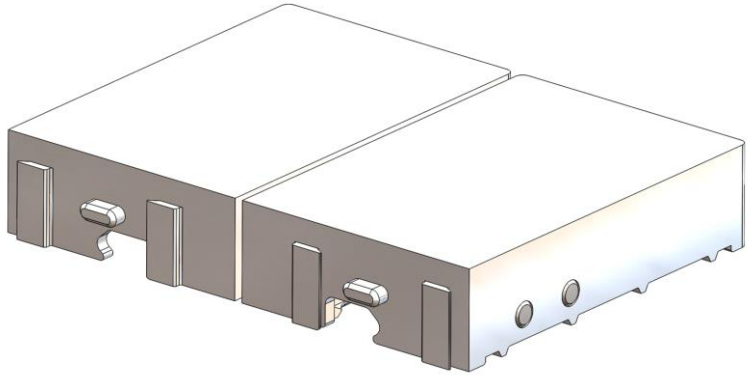
MultiGrip Top Jaws

- Part pocket machined into low-cost exchangeable Top Jaws
- Top Jaws snap into place on MultiGrip Base Jaws in seconds
- One fixed Top Jaw, one swivel Top Jaw
- Swivel Top Jaw allows jaws to conform better, increases gripping force on part
- Slightly heavier and slightly taller than MultiGrip Fixed Jaws
- Top Jaws are available in standard and over-sized versions, OD clamping styles, with thickness of 1”, 1.5” and 2”



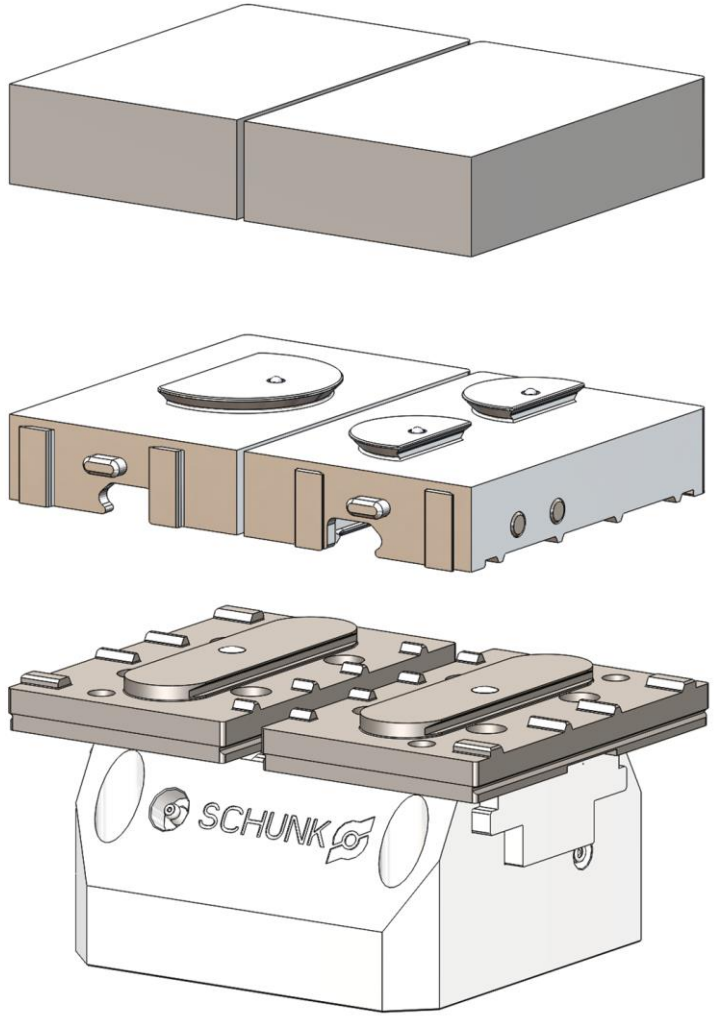
MultiGrip Fixed Jaws

- Solid top surface to machine part pocket
- Typically single part use
- Used when low overall jaw height or low jaw weight is required
- Minimum overall height of 1.125”
- Considerations must be made to accomodate jaw deflection during gripper pick of rectangular parts (See section on part picking below for more information)



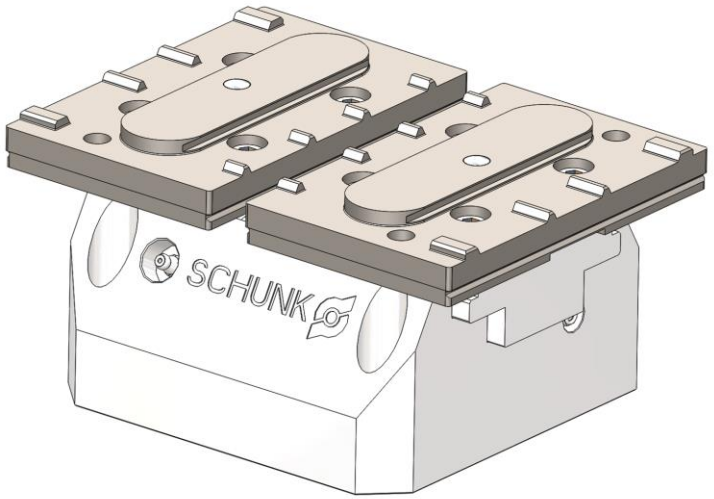
MultiGrip Jaws and Repeatability

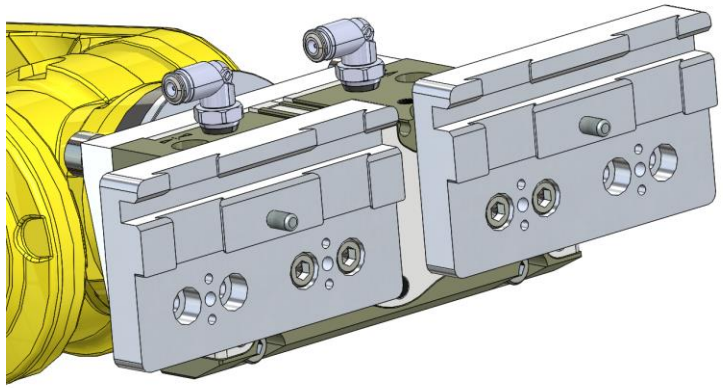
- Best repeatability is achieved when MultiGrip Jaws are paired with the MultiGrip vise they were originally machined on
- For MultiGrip Top Jaws, best repeatability is achieved when the machined Top Jaws are paired with with the MultiGrip Base Jaws and the MultiGrip vise they were originally machined on
- When Top Jaws are moved onto a different set of MultiGrip Base Jaws or any MultiGrip Jaw is moved to a different vise, confirm location of XYZ pocket
    - Generally, there will less error in XY and more error in Z when moving Jaws

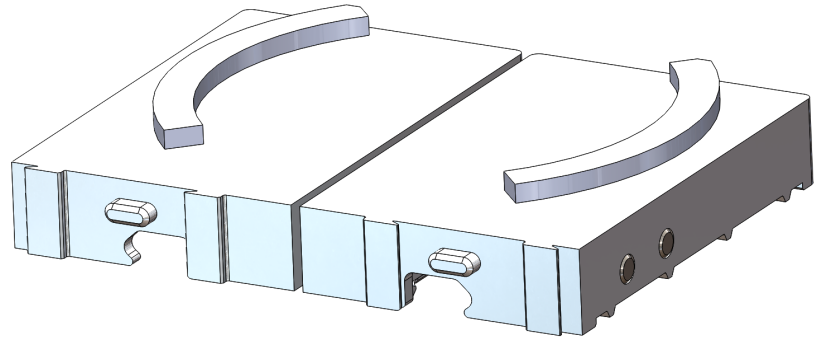


Dry Machining with MultiGrip

- MultiGrip relies on CNC coolant to lubricate the vise interface, the gripper interface and the Jaws
- When dry machining, use of a dry lubricant is required to be applied at least daily to the vise interface, gripper interface of the jaws, cross-pins of the jaws, and the gripper face







Fundamentals of Successful Automation

Section 3

Fundamentals for Successful Automation

- Transitioning from operator to robot CNC machine tending is best done in steps
- A successful automation process starts with understanding the CNC process and shifting towards controlling the CNC process through scheduled activities as opposed to operators reacting to changes they observe
- Automation can be introduced when there is an understanding of how long (or many parts) can be run before operator intervention is required and a schedule is in place to ensure the necessary activities are performed by an operator to assure CNC process success
- Initially, the automation process may only run a short time before the operator is required to measure parts or make adjustments to the CNC process
- As the CNC process is better understood, improved and controlled, the automation process may be able to run 24 hours or more without operator intervention

Fundamentals for Successful Automation

- Step 1: Start by assessing how the current operators keep the CNC machine tending process successful
- What is the operator doing to maintain the CNC process and how often?
  - Measuring parts
  - Adjusting tool wear offsets
  - Washing down chips
  - Adding coolant
  - Cleaning coolant tanks or filters

Fundamentals for Successful Automation

- Step 2: Create a schedule to maintain CNC process control
  - With an understanding of what operators do to maintain the CNC process, measure how frequently they do it and make a schedule to ensure those steps are performed on a schedule instead of by intuition or reaction to a failure
  - Typical items on an initial CNC process control schedule might include:
    - Part inspection
    - Tool wear offsets and tool replacement
    - In CNC chip wash down
    - Emptying chip bins
    - Coolant levels and concentration

Fundamentals for Successful Automation

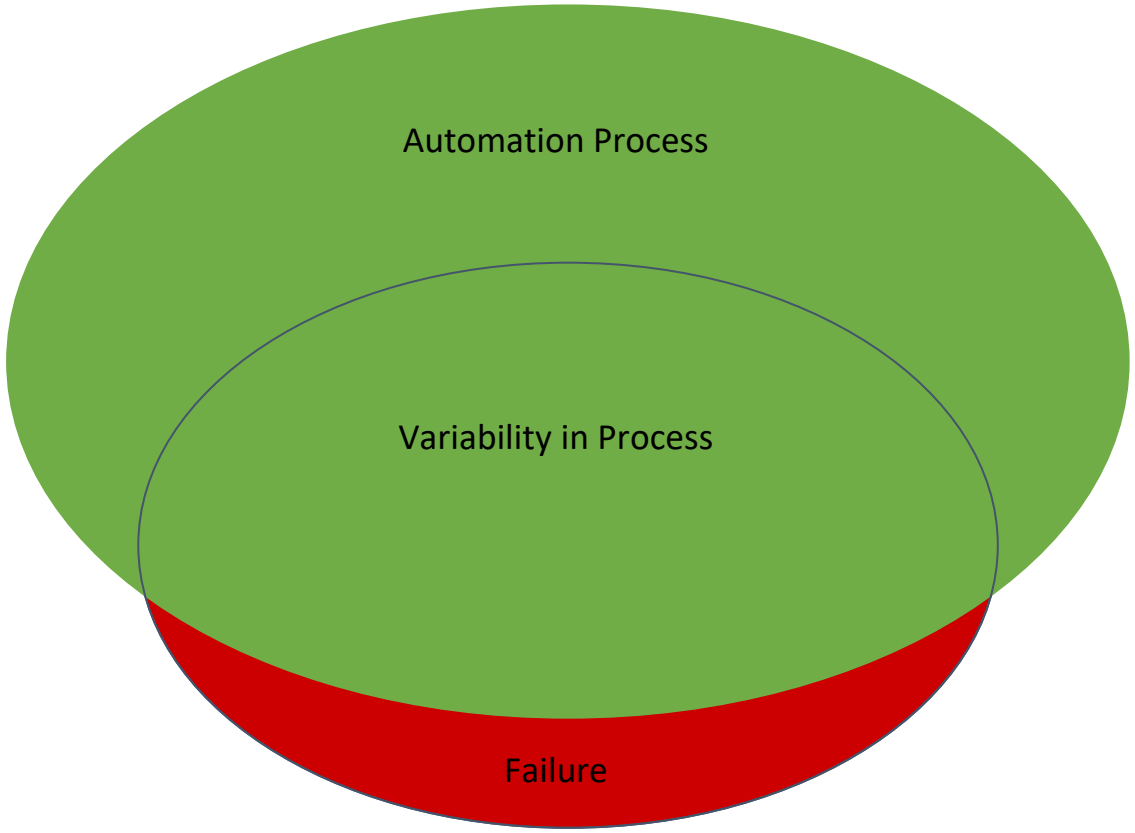
- Step 3: Introduce the automation process
  - Follow manufacturer's guidelines for process and fixturing
  - Emphasize simplicity and reliability in the automation process over speed
  - Start by monitoring process closely, carefully investigate any failures, determine root cause and adjust process as required
  - If available, use spindle probe, tool probe and tool breakage detection to monitor and control the CNC process

Fundamentals for Successful Automation

- Step 4: Expand the scope of and improve the CNC process control schedule
  - Objective is to increase process reliability and time before operator intervention is required
  - Chip management: observing where chips collect, mitigating chip collection in the CNC using auxiliary coolant or other means, understanding how often operator intervention is required to prevent CNC process problems
  - Predictive tool management: measuring how long tools last and using that data to define tool inspection or replacement periods; use of CNC control to expire tools or swap in backup tools
  - CNC maintenance including maintaining coolant levels, oil levels, filters, sumps, vises, chucks, tool holders, spindles and verifying machine accuracy
  - Move towards relying on understanding, measuring and controlling the process to make good parts

Fundamentals for Successful Automation

Develop processes that handle a wide range of variability then control and minimize variability in the process



Picking Parts with MultiGrip

Section 4

Picking Parts with MultiGrip

1. Weight of Part and Gripping Force
2. Jaw Pocket Width and Depth
3. Universal Part Locators
4. Clearing Adjacent Parts
5. Clearing Top of Part During Pick/Place
6. Clearance Between Part and Jaw Pocket During Pick
7. MultiGrip Fixed Jaw Deflection During Grip
8. Accommodating Large Diameter and Long Parts
9. Locating Part in Y Using Gripper Settle

Weight of Part and Gripping Force

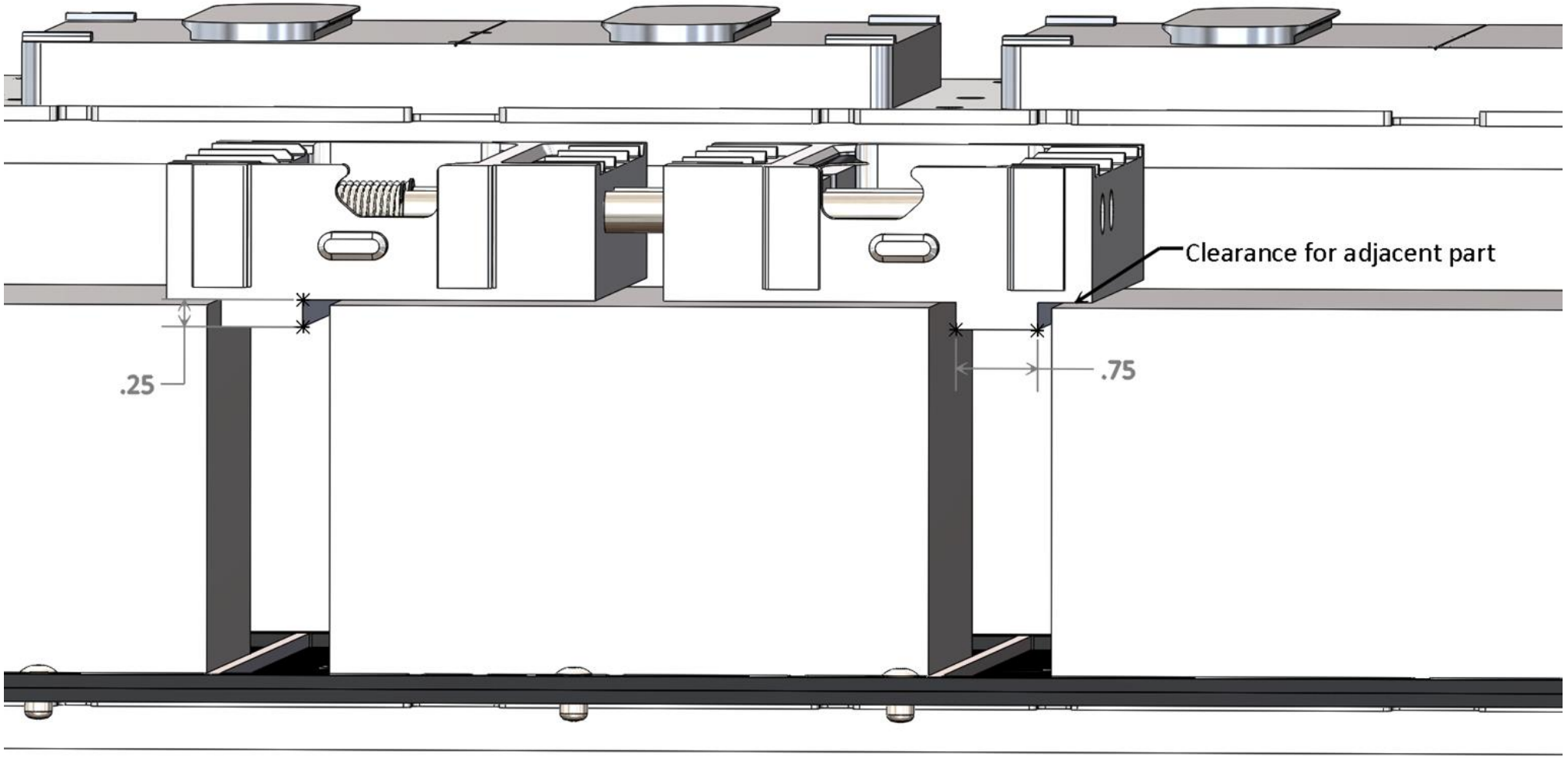
- MultiGrip Gripper is generally sized with enough gripping force to grip any part within the total load capacity of the robot (considering the weight of the MultiGrip Gripper, Jaws and part together)
- Whenever possible and especially when picking and placing heavier parts, the weight of the MultiGrip jaws should be kept to a minimum
- The maximum load capacity of the robot should never be exceeded

- For the VBX-160 with the Fanuc LR-Mate 200id 7L robot, the maximum weight of parts and jaws is 11 pounds (5kg)

MultiGrip Jaw Pocket Width and Depth

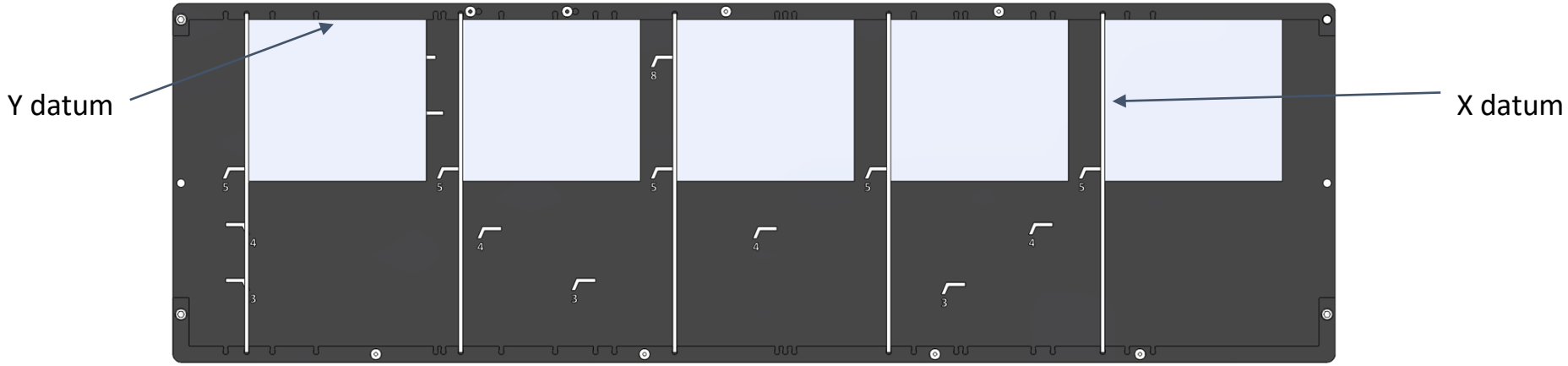
- Inadequate jaw pocket depth during part pick is a leading cause of automation failures
- Jaw pocket depth must be sufficient to adequately engage the part for gripping and considering variance due to part size and position variation and robot position variation
- When using MutliGrip Jaws to pick a part from the shelf, we recommend a minimum pocket depth of 0.25”
- Shorter pocket depths may be used on parts less than 3” wide x 3” deep or parts that have little variance in height and parallelism
- Machining considerations may require deeper pocket depths
- Jaw pocket width must be kept to less than 0.75” to avoid collisions with adjacent parts
- If a lower gripping profile is required during CNC machining use a pre-operation
- See Section 5: Machining with MultiGrip for more information

MultiGrip Jaw Pocket Width and Depth



Universal Part Locators

- Universal Part Locators (UPL) are a flexible part locating system that help an operator locate parts on the shelf in a position where the robot can successfully pick parts
- UPL is configured for 3, 4 , 5, 6 or 8 picks per shelf depending on the width of the part
- The VBXC Part Configuration screen will automatically choose the proper UPL picks per shelf during part configuration based upon part width entered
- Note: the VBXC Part Configuration screen will automatically add a pick offset of 0.04” (1mm) in X and Y to prevent the gripper from pushing oversize material into the X or Y datums of the UPL



Universal Part Locators

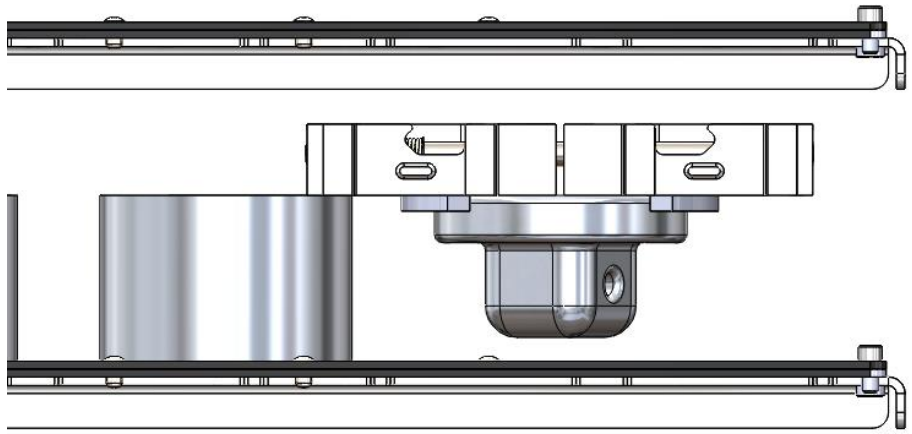
Part Width Pick Template Table

Parts per shelf:	8-Pick	6-Pick	5-Pick	4-Pick	3-Pick*
Part Width	0.0” - 2.79”	2.80” - 4.49”	4.5” - 5.74”	5.75” - 6.99”	7.0” - 8.5”
Part Diameter	0.0” - 2.79”	2.80” - 4.49”	4.5” - 5.74”	5.75” - 6.99”	7.0” - 7.5”

* 3-Pick requires use of Oversize MultiGrip Top Plates

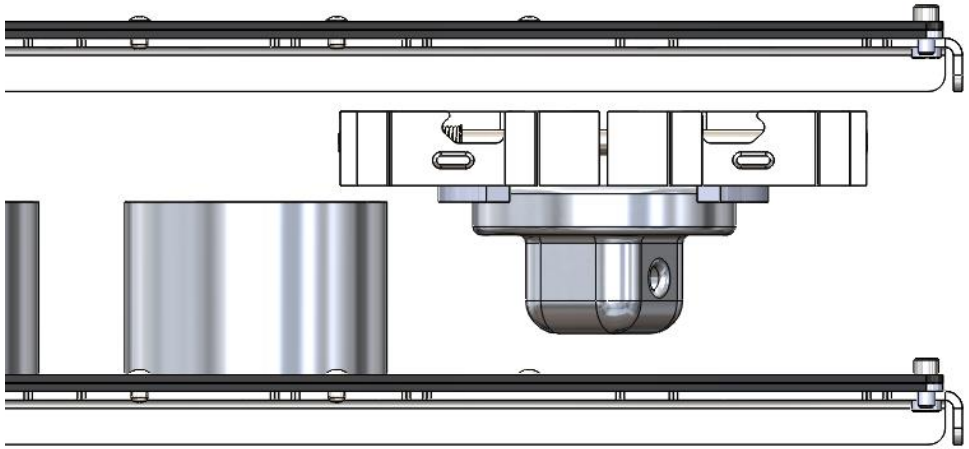
Clearing Adjacent Parts

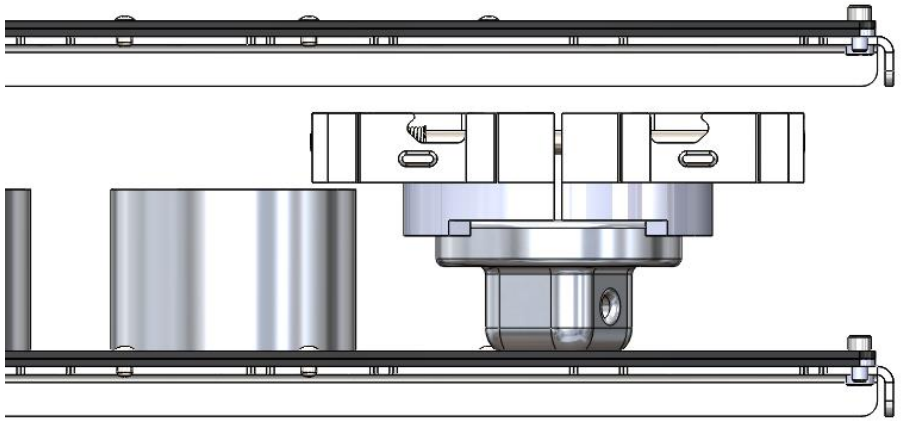
- During part pick, all raw material will be approximately the same height
- Following Universal Part Locator part width guidelines and jaw pocket width guidelines will prevent collisions with adjacent parts on the shelf during pick
- During place, the part may have decreased in overall height substantially
- Without proper consideration a collision with an adjacent part could occur



Clearing Adjacent Parts

- Two options to avoid collisions during place:
  - Drop the part a small distance onto the shelf
  - Increase the overall height of the jaws so the part can be placed on the shelf without colliding with the adjacent part



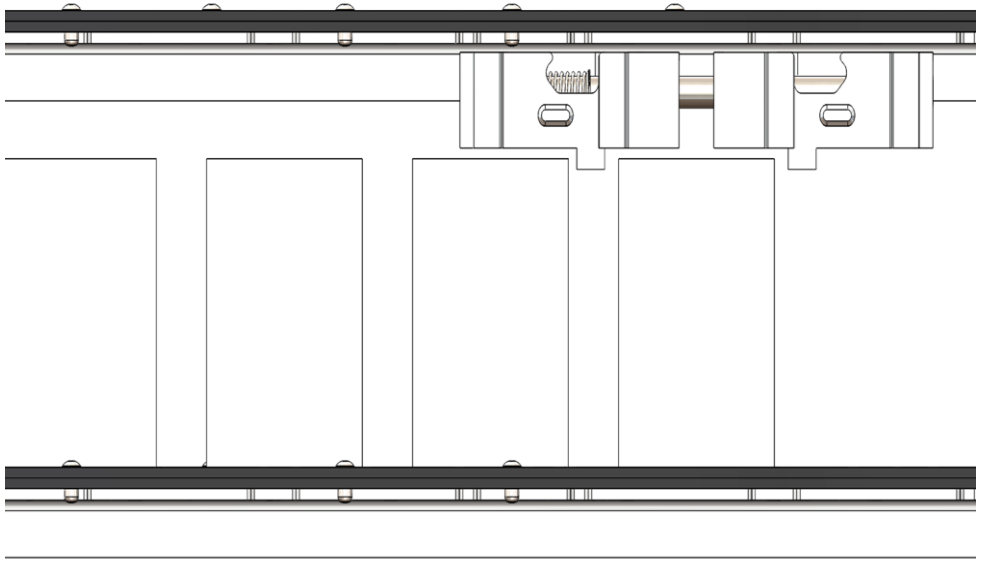


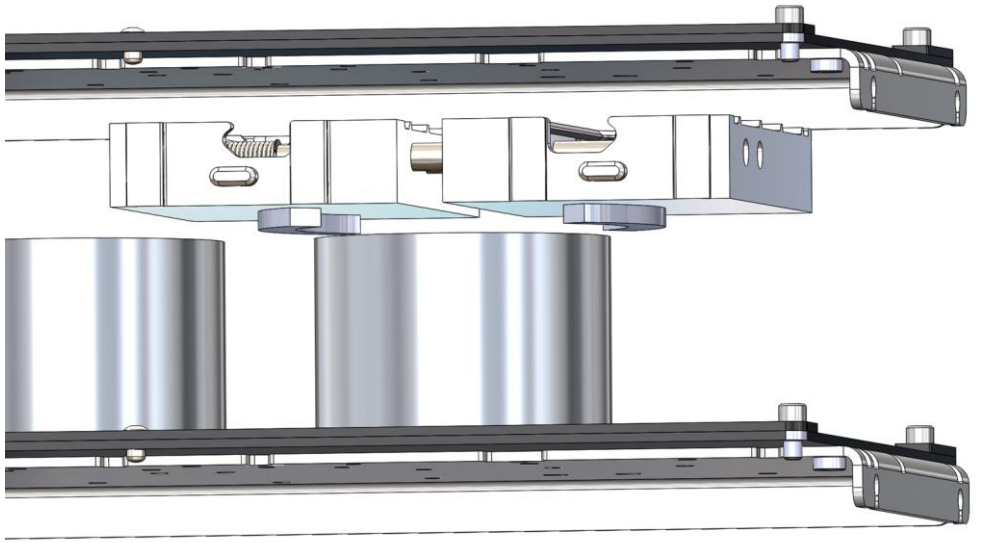
Clearing Top of Part During Pick/Place

- During the Pick and Place process, the robot will move into the shelf so that the MultiGrip Jaws are at their maximum height above the part without colliding with the shelf above
- As the robot moves the MultiGrip Jaws into the shelf, all parts of the Jaws must clear the part to avoid a collision
- On a standard VBX-160 system, available space between shelves is approximately 5”. Space between shelves can be increased to 10” by removing the shelf above
- Maximum height of a part with all shelves in place is approximately 3.875”, with the shelf above removed maximum part height is increased to 8.875”

Clearing Top of Part During Pick/Place

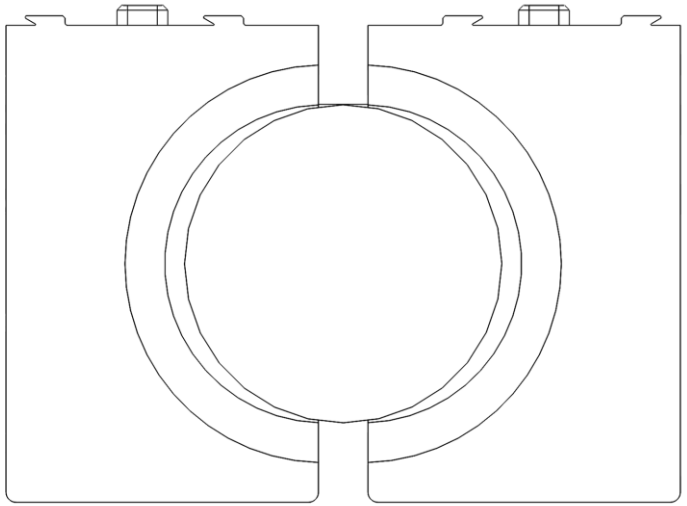
- If space is tight, it may be necessary for the jaws to slide over the top of the part
- For rectangular parts, there will be no interference from sides of jaw pocket as robot enters the shelf over the part
- For round parts or parts with an irregular shape along the X axis of the jaws, generally all portions of the jaw will need to clear the part in Z



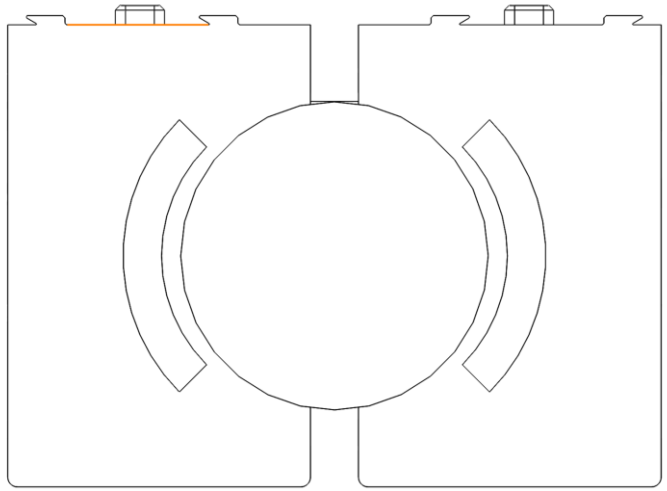


Clearance Between Jaw Pocket and Part During Pick

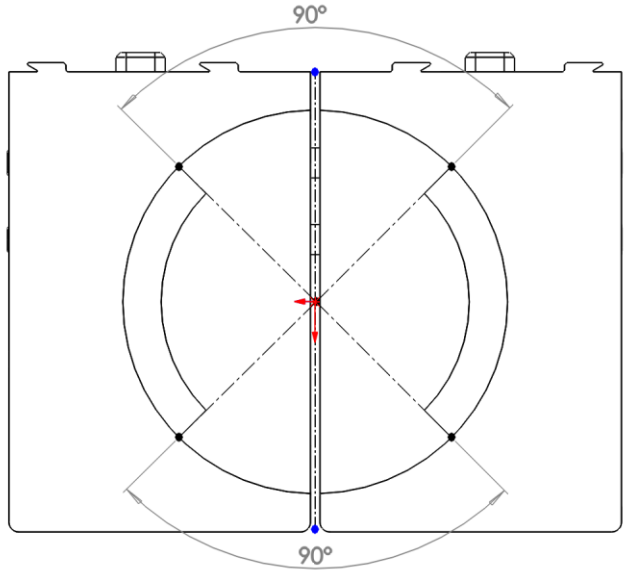
- Design part pocket so that when the jaws are fully open, there is adequate clearance between the the part and pocket
- Avoid pocket features that approach parallelism with the X plane of the jaws
- For round parts we recommend a 90 degree clearance cut along both sides of Y axis



Not enough clearance between part and jaws during pick



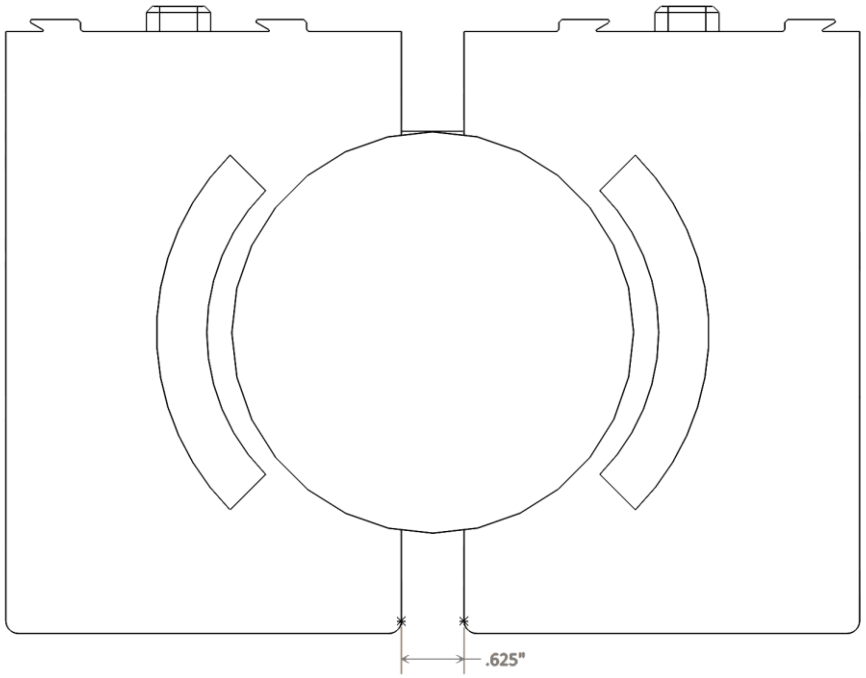
Plenty of clearance between part and jaws during pick

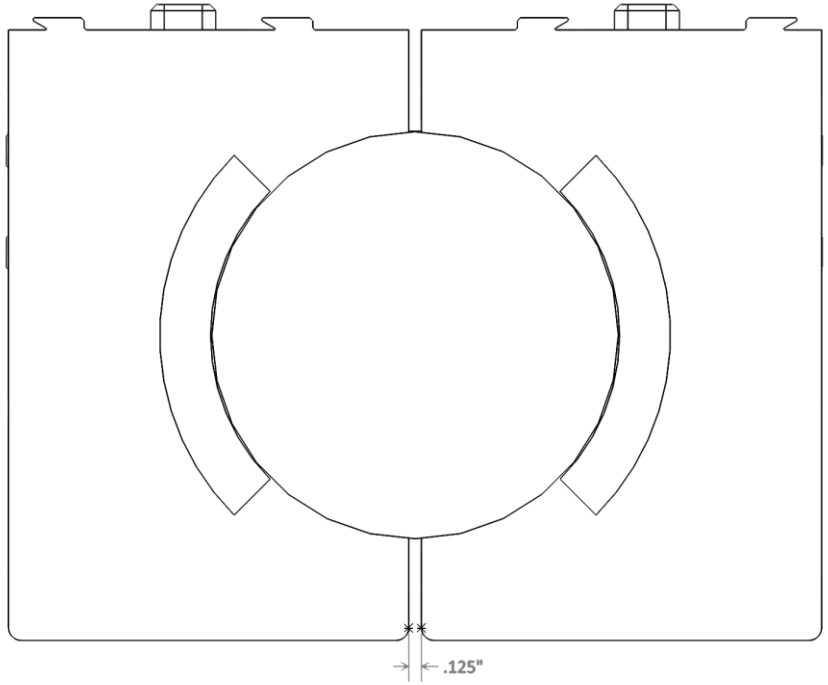


90 degree cut along Y axis for part clearance

Clearance Between Jaw Pocket and Part During Pick

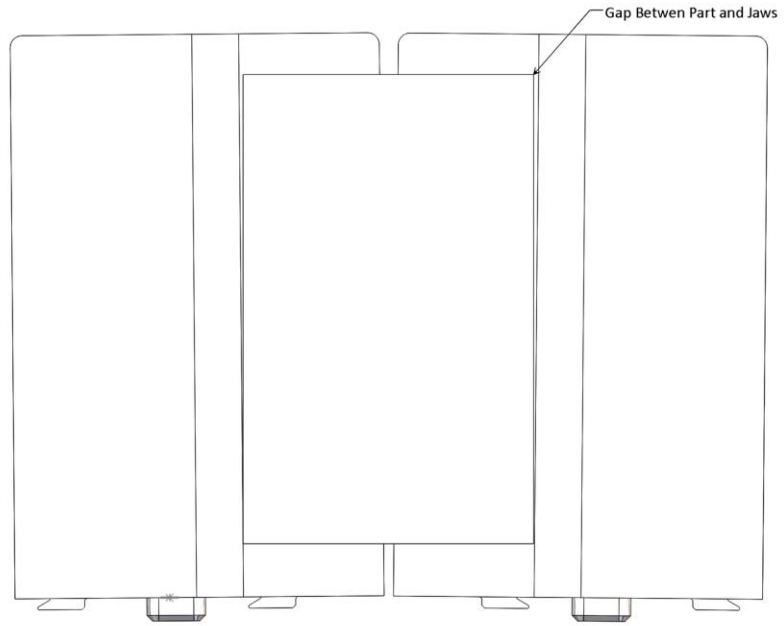
- Consider the jaw stroke and nominal clamp positions during pick
- OD jaws max opening = 0.625”, nominal clamp = 0.125”





MultiGrip Fixed Jaw Deflection During Pick

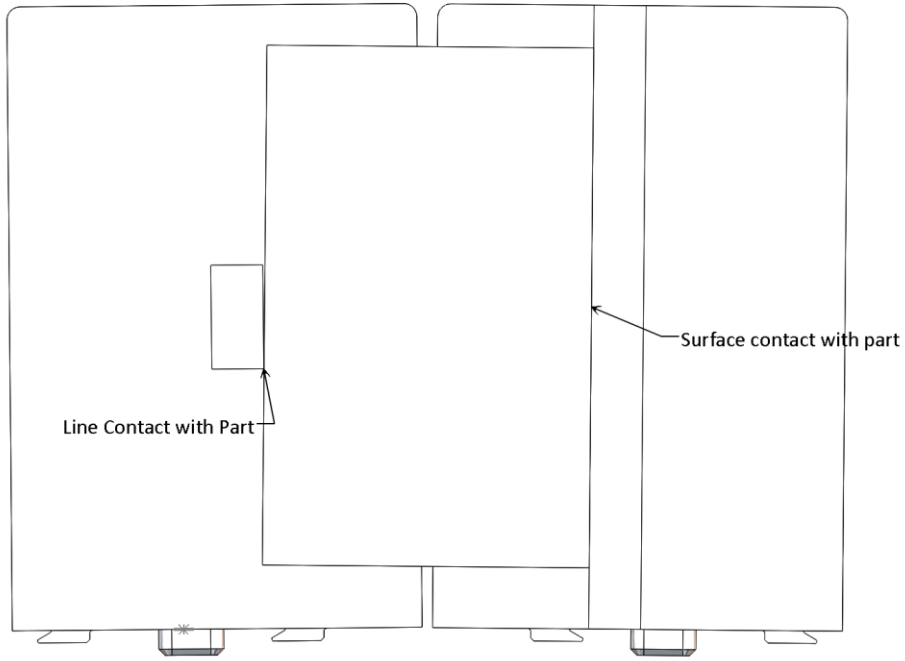
- The MultiGrip Gripper allows the MultiGrip Jaws to deflect a small amount during part grip*
- MultiGrip Top Jaws include a fixed jaw and a swivel jaw; the swivel jaw is designed to rotate to ensure full part contact with the part during during part pick as the jaw deflects
- MultiGrip Fixed Jaws do not have a swivel jaw and will not be able to pick some part shapes without additional considerations



* This type of jaw deflection does not occur when MultiGrip Jaws are loaded into a MultiGrip Vise

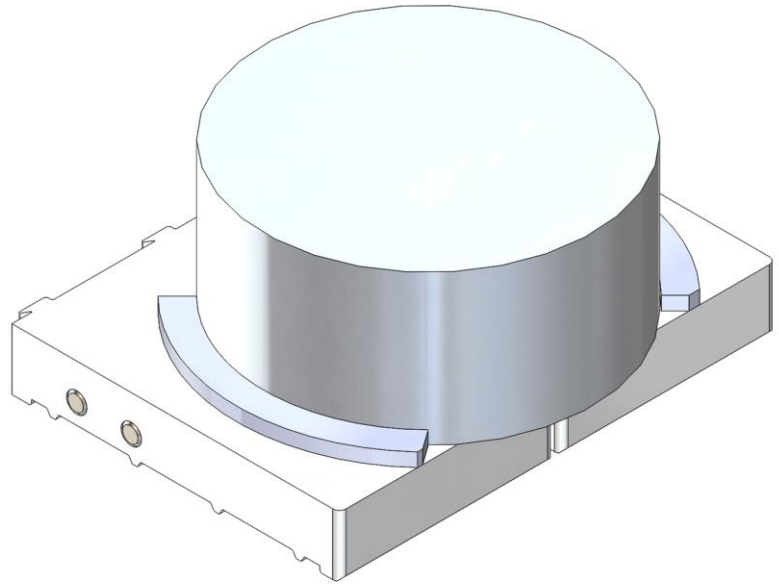
MultiGrip Fixed Jaw Deflection During Pick

- When using MultiGrip Fixed Jaws with rectangular parts, triangulation of the jaw pocket will typically provide good results during pick
- Triangulation of the of the jaw pocket is not necessary for round parts using MultiGrip Fixed Jaws



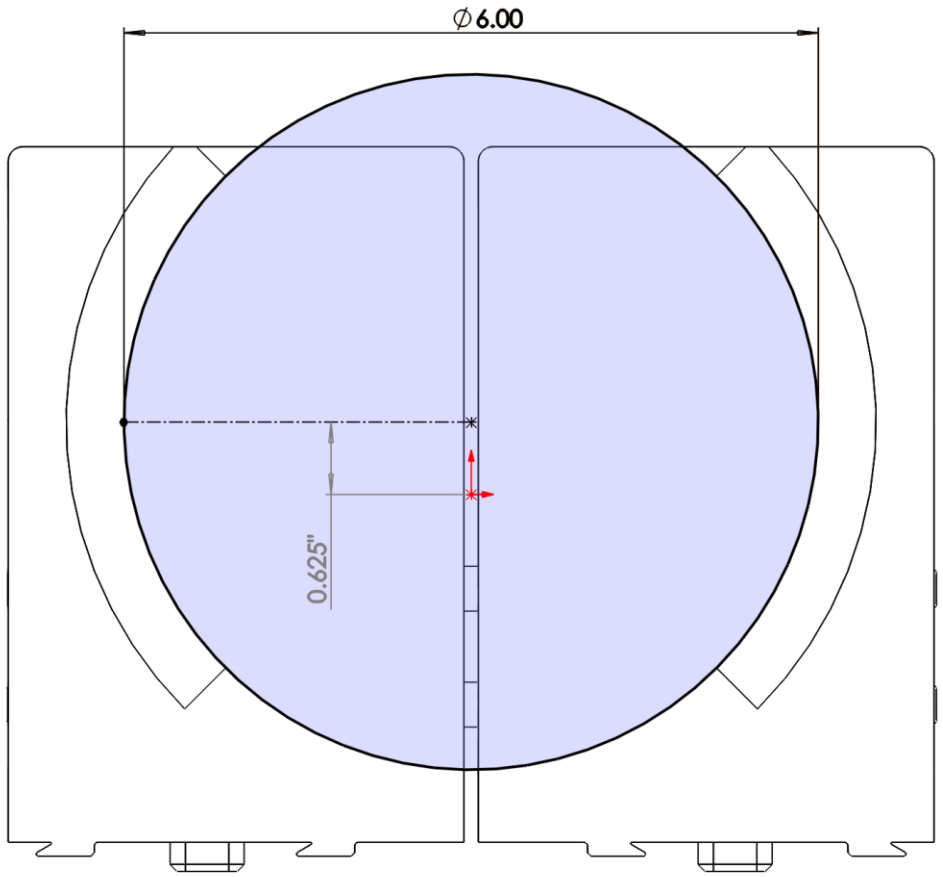
Accommodating Large Diameter and Long Parts

- The maximum entry depth from the center of the MultiGrip jaws to the Y datum of the Universal Part Locator is 2.375”
- For round parts greater than 4.75” in diameter, it is necessary to offset the jaw pocket in positive Y direction to pick the part
- The maximum diameter of a part using MultiGrip Fixed Jaws or standard Top Jaws is 6”
- The maximum diameter of a part using Oversized Top Jaws is 7.5”



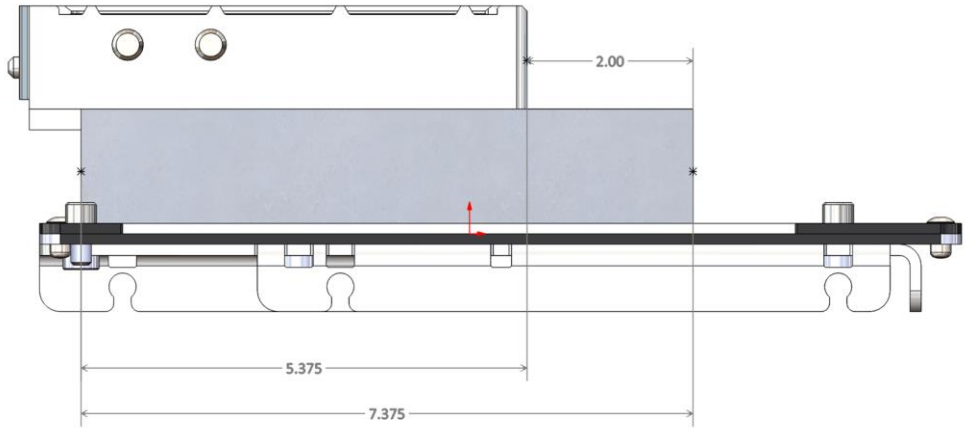
Accommodating Large Diameter and Long Parts

- For round parts greater than 4.75” in diameter, the positive Y offset for a round part pocket is calculated as:
- Part diameter - 4.75 divided by 2
- Example for 6” round part: (6 - 4.75) / 2 = 0.625



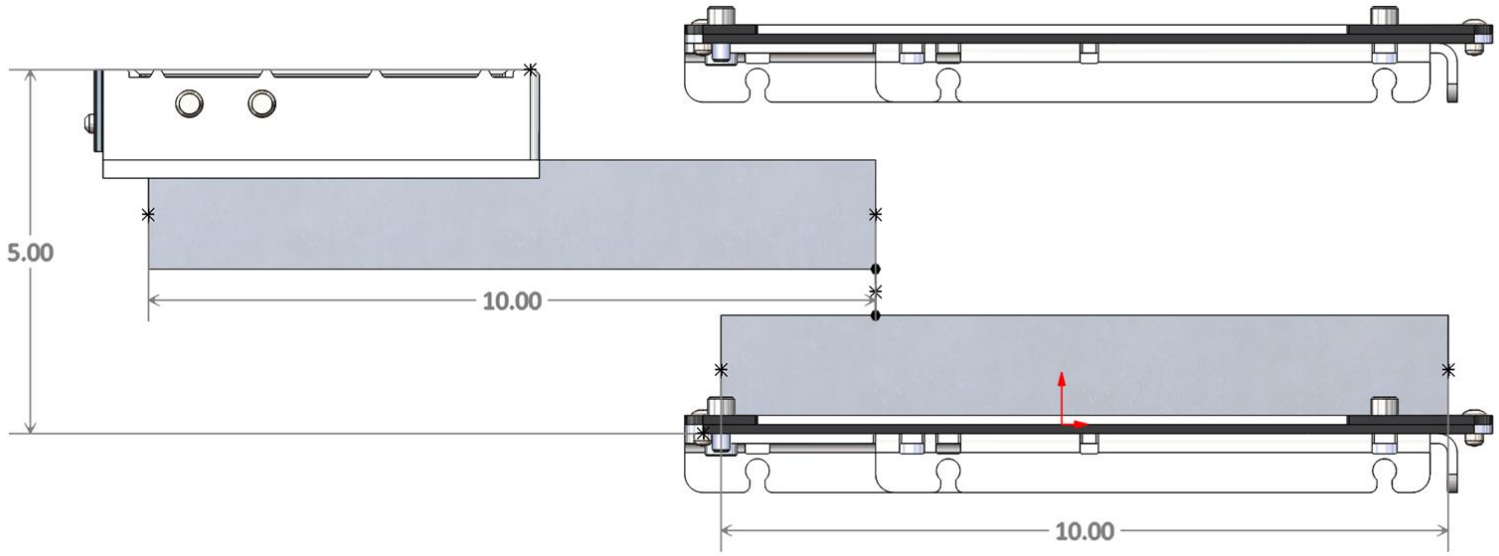
Accommodating Large Diameter and Long Parts

- For rectangular parts, the maximum pick depth from the Y datum to the edge of the jaws is 5.375”
- Rectangular parts greater than 5.375” in length, the part will be picked with a displacement in the positive Y direction
- The part can be better centered in the jaws after the pick using a gripper settle or vise settle operation
- See sections 4.10 or section 5 for more information on gripper and vise settle operations



Accommodating Large Diameter and Long Parts

- Generally, the maximum a part may overhang the front edge of the jaws is 2” or a total part length of 7.375”
- If the total height of the jaws and part allow the bottom of the picked part to clear the remaining parts in Z, the robot will sweep over the other parts on the shelf before exiting the shelf completely preventing a collision
- In this case, the maximum length of a part is 10”



Accommodating Large Diameter and Long Parts

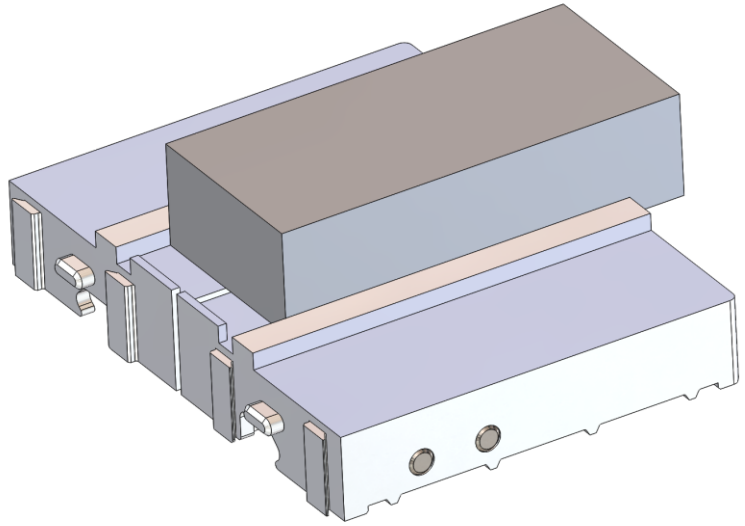
- During the machining process, the part may be repositioned such that up 1” of the part is overhanging the jaws in the negative Y direction
- After the place some portion of the part may overhang the front edge of the Universal Part Locator
- This is generally not a problem but note that when the robot enters the next lower shelf during pick, the gripper may push any completed part that is overhanging the front edge of the shelf forward a small amount
- If during place, the part will overhang the front edge of the Universal Part locator, increase the Z height of the place so as to not interfere with the front raised edge of the Universal Part Locator

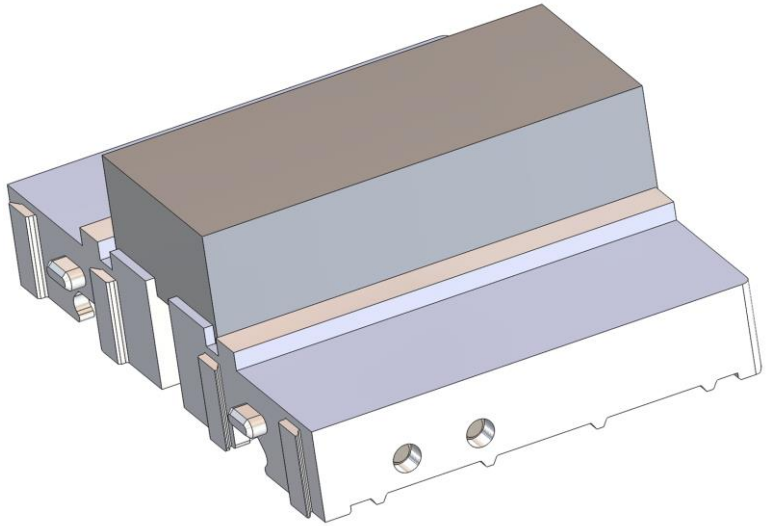
Locating Rectangular Part in Y Using Gripper Settle

- Picking parts from the infeed is an imprecise process
- After pick, the part may not be located along the Y axis as precisely as expected or necessary
- As part of the VBXC part configuration, a gripper settle operation can be selected
- If the gripper settle operation is selected, after pick, the robot will move the MultiGrip Jaws to the selected angle, then open the jaws, then close the jaws before proceeding
- If more precise setting positioning is needed, a CNC vise settle operation can be performed (see section 5)

Locating Rectangular Part in Y Using Gripper Settle

- To use Gripper Settle to locate a part in Y, the jaws should be designed with a datum in Y, generally near the negative Y edge of the jaws
- The datum should be positioned so the part is centered in the jaws if the part is less than 5.375” in length; for longer parts, the datum should be at the front edge of the jaws and the part will overhang the jaws in the positive Y direction





Locating Rectangular Parts in Y Using Gripper Settle

- Generally, parts less than 0.75” wide cannot be settled using Gripper Settle with standard MultiGrip Top Jaws or MultiGrip Fixed Jaws unless additional considerations are made
- When the gripper opens, the gap between the jaws is 0.625” and the part will fall into the gap
- If required, a “bridge” can be built between the jaws to prevent the part from falling into the gap during a settle operation
- See section 5.3 for information on vise settling

Machining Parts with MultiGrip

Section 5

Machining Parts with MultiGrip

1. MultiGrip Jaw Pocket Design for Machining
2. Pre-Operations
3. Part Settling
4. Using a CNC Probe to Verify 2nd Operation Load
5. Jaw Durability
6. Part Release During Place to Outfeed
7. Repeatability
8. Using Oversized Top Jaws
9. Cutting MultiGrip Jaws
10. Vise Wash Program and Chip Management
11. Dry Machining
12. MultiGrip Jaw Design Constraints

MultiGrip Jaw Pocket Design for Machining

- Jaws that are optimized for the infeed pick, may not be optimal for the machining process
- Typical conflicts between pick requirements and CNC machining requirements:
  - Jaw pocket depth for machining is greater than or less than can be used during infeed pick
  - Machining requires use of gripping inserts with less than recommended pick depth
  - Jaws that need to raise the part in Z for tool access in 4 or 5 axis applications become too tall for infeed pick
- When any of these conflicts occur, add a pre-operation

Pre-Operations

- A pre-operation is generally used when the MultiGrip Jaw used to pick the part from infeed is not well suited to complete the first machining operation
- A pre-operation may also be used to verify part settling after the first operation
- Although not required, the pre-operation will typically include a small amount of machining to better prepare the part surface for capture by the first operation jaws
- Typical pre-operation machining:
  - Cut the top of the part flat
  - Optionally cut XY datums that can be used to verify part settling with a CNC probe after the robot has loaded the second operation
  - Cut a dovetail feature for the first operation jaws to capture

Pre-Operations

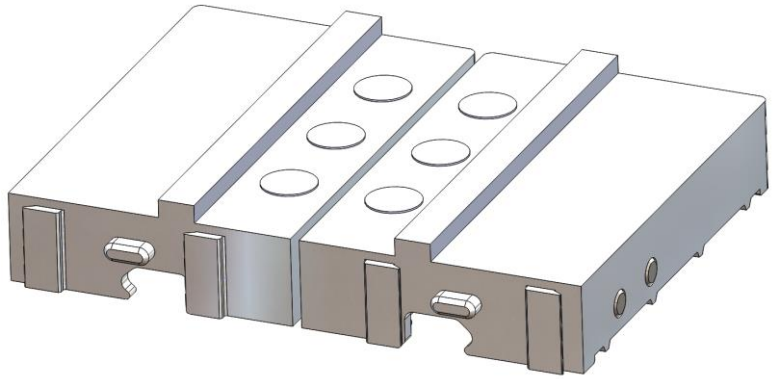
- A pre-operation will increase processing time
  - Additional CNC processing time is required in the pre-operation; expect the pre-operation to take between one to five minutes
  - The time it takes for the robot to move the part through the automation process is less efficient; adding a pre-operation to a two operation part will increase robot processing time by between one to four minutes
- Plan to cut MultiGrip Jaws for each operation in the vise that will be used during processing
  - Pre-op will generally be done in vise 1
  - First operation will generally be done in vise 2
  - Second operation will generally be done in vise 1
  - VBXC will allow vise selection to begin in either vise

Part Settling

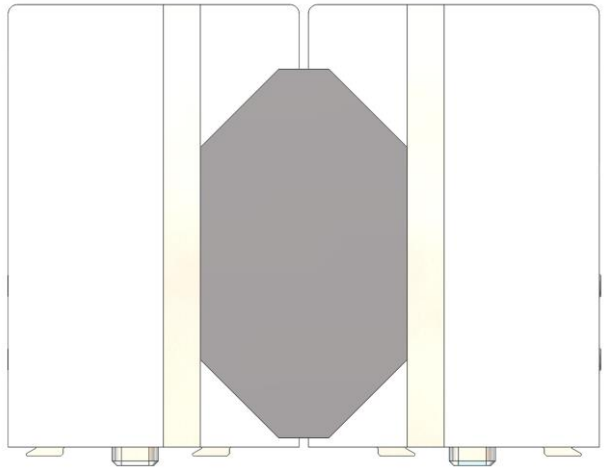
- Part settling is the term used to accurately position a part in the MultiGrip jaw pocket for CNC processing
- Accuracy and repeatability of the workpiece in the workholding can be affected by the part geometry, part weight and the jaw pocket design
- Almost any part can be accurately positioned in MultiGrip Jaws for automated processing using the right combination of tools for the part being settled:
  - Sound jaw pocket design
  - VBXC gripper or vise settle option
  - CNC settling programs and part settling tools
  - CNC spindle probes

Part Settling

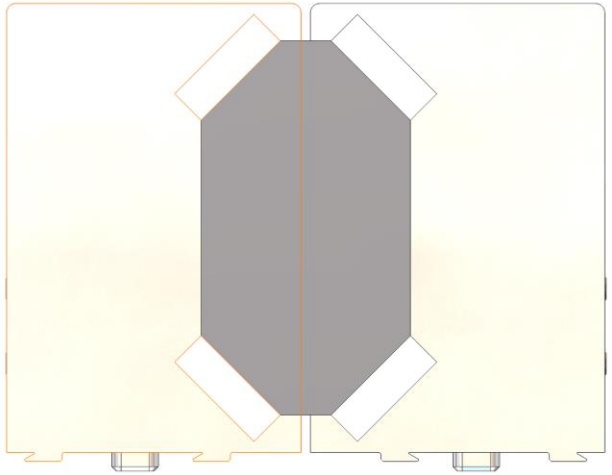
- To prevent part lift in Z during clamp, avoid a sharp corner between the Z locating surface of the jaws and the jaw pocket wall
  - Pads on the floor of the jaw pocket are a simple solution
- When possible, use the shape of the part to locate the part in Y and if required, rotation about Z



Pads on floor of Jaw Pocket



Jaw Pocket does not locate part in Y



Jaw Pocket locates part in Y

Part Settling

- The vise settle option in the VBXC part configuration (section 6) is simple, fast and will settle most parts in Z accurately
  - Vise settle option opens and then closes the vise using gravity to settle the part
  - Vise settle is more accurate at settling parts in Z than the gripper settle operation (section 4.10)
  - Vise settle cannot be used on parts less than 0.75” wide, the part will fall between the jaws when the vise opens
  - For parts less than 0.75” wide, use a a Z support to bridge the gap between the jaws when the part opens or use a Z-push tool and vise pressure control commands in a CNC settle program (see following pages)

Part Settling

- The VBX-160 includes vise control sub-programs for some CNC controls
- CNC vise control commands include:
  - Vise open
  - Vise close
  - Set vise pressure
- See the VBX-160 CNC Manual for details on CNC vise control commands specific to your CNC's control

Part Settling

- Using the CNC vise control commands with special part settling tools allows for custom part settling options
- Standard Y-push and Z-push part settling tools are available or custom settling tools may be developed
- Part settling tools are mounted in a CNC tool holder and can be used at the start of a CNC program to position the part
- A CNC settling program will typically use vise control commands to change pressure of the vise and/or open and close the vise in conjunction with a settling tool to properly settle and clamp the part

Using a CNC Probe to Verify 2nd Operation Load

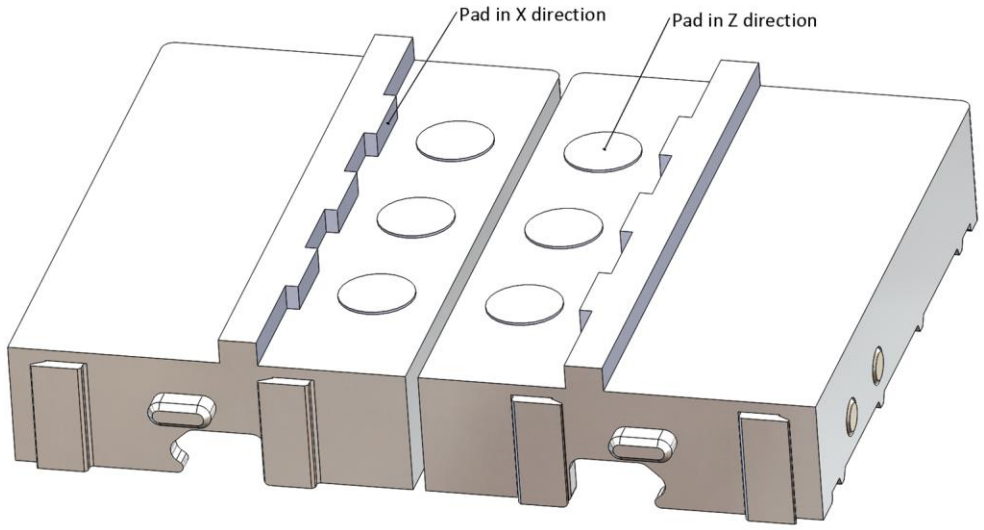
- When making a two operation part from raw material, after the first operation, the raw material for the second operation becomes available for inspection to a CNC spindle proble
- To validate the part is settled in the second operation, the part should be probed for XY position and the Z plane should be validated for height and parallelism
- Without a pre-operation, rough raw material will not be accurate to validate if the part was settled correctly in the second operation jaws
- By using a pre-operation, a flat surface and an XY datum can be cut so that when the part is loaded into the second operation jaws, the machined surfaces from the pre-operation can be used to validate the part was settled correctly in the second operation jaws

Jaw Durability

- MultiGrip jaw components are made from 6061-T6 aluminum for a good balance between low weight and durability
- When machining harder materials, additional considerations may be required for long jaw life:
  - Will vertical surfaces of the jaw pocket deform from hard part materials under vise clamping pressure?
    - If the clamping surfaces of the part are smooth and total vertical clamping surface area is greater than 1” squared, bare aluminum will generally suffice
    - Otherwise, we recommend a jaw pocket be made from hardened steel and bolted to the jaws as an insert
  - Will chips from the cutting process strike critical portions of the jaws with enough force to wear the jaws?
    - Hard anodizing the MultiGrip Top Jaws or the use of a hardened steel insert will generally manage wear issues

Part Release During Place to Outfeed

- Lighter parts with lots of surface area between the part and jaws in a machining environment that uses coolant may not release from the jaws during place
- When machining lighter parts with large surface areas, minimize surface contact between part and jaws
- Use “pads” in Z and X clamping surfaces as necessary to reduce surface area:



Repeatability

- Best repeatability of the MultiGrip workholding system is achieved when MultiGrip Top Jaws are paired with the MultiGrip Base Jaws and the MultiGrip Vise they were originally machined on
  - In this configuration, repeatability of the workholding is generally better than 0.0008” total
- A good practice is to dedicate at least one set of MultiGrip Base Jaws to each vise
  - Engrave an identifier on each Base Jaw that encodes the CNC machine and vise the Base Jaw is dedicated too
  - When machining Top Jaws, engrave both a part number for the Top Jaws and the identifying number of the Base Jaw it was machined on to make it easy for operators to match the correct Top Jaw and Base Jaw together

Using Over-Sized Top Jaws

- Over-Sized Top Jaws are two inches wider and two inches longer than standard Top Jaws
- Over-Sized Top Jaws can be used to better support larger parts during the CNC machining process
- Over-Sized Top Jaws must be used when using the Universal Part Locator 3-pick template
- The width of Over-Sized Top Jaws must be trimmed to no more than 1.5” wider than the width of the part
- The length of the Over-Sized Top Jaws should be trimmed to match the part machining requirements

Cutting MultiGrip Jaws

- For best repeatability, MultiGrip Top-Jaws should be cut on the base jaws and on the vise where they will be used
- Before cutting MultiGrip jaws, with fresh coolant on the vise, load the empty jaws into vise and cycle the jaws open and closed several times
- Position the included 0.125” wide machinable jaw spacer in the jaws so that the bottom of the jaw spacer is between 0.125” and 0.250” below the lowest part of the jaw pocket cut
- Set the vise clamping pressure at least 20% higher than the intended clamping pressure during automated processing or maximum clamping pressure

Vise Wash Program

- The vise wash program is an easily overlooked but critical part of the automation process - it is worth your careful attention and time to get right
- The vise wash program is a CNC program whose primary objective is to remove chips from the empty vise that is about to be loaded
- A secondary objective of the vise wash program may be to remove excess coolant from the MultiGrip jaws that will be unloaded after the wash
- Vise wash will run twice per two operation part - it should be thorough but not waste time
- Flood coolant is often the best tool to remove chips from the vise; when using through spindle coolant a tool holder that will flow a lot of coolant instead of a small diameter high pressure flow is preferred
- A chip fan can be used to remove excess coolant from the part to be unloaded
  - Flood coolant is generally superior to a chip fan for removing chips
  - Chip fan speed should be set to minimize vaporization of coolant into the air

Vise Wash Program

- Vise wash programs can be operation specific:
  - Vise wash after first operation: wash the first operation vise, then wash the second operation vise - this can help prevent chips being washed off the part and jaws in the first operation vise from being washed onto the second operation vise that is about to be loaded
- Vise wash programs are generally developed as sub-programs and added to the bottom of each machining program just before the end of the program
- Vise wash program must be added/called at the bottom of each CNC machining operation program and perform the following:
  - At least wash the vise that is about to be loaded
  - Position the CNC table in the home position for VBX-160 robot load
  - Set the VBXC completition flag variable to signal to the VBXC that the machining operation completed successfully

Dry Machining

- The MultiGrip workholding system was designed to be used with CNC machine coolant as a lubricant
- When dry machining, the MultiGrip workholding system must be lubricated using a dry lubricant
- Dry lubricant must be applied to the Vise Intermediate Jaws, the vise interface and gripper interface of the MultiGrip Base Jaws and Fixed Jaws and the interface between the MultiGrip Base Jaws and Top Jaws
- Generally lubricant should be applied every 12 hours but more or less frequency may be required to prevent automation processing errors

MultiGrip Jaw Design Constraints

- Using the following design constraints will provide long life to all of the MultiGrip system components when used at air pressures up to 150psi
  - Maximum overall height of jaws: 3”
  - Maximum Y part center offset from center of jaws non-rectangular parts:
    - 1.25”
  - Y part center offset from center of jaws for rectangular parts:
    - For parts less than 2” in length: ¼ of part length
    - For parts greater than 2” in length: at least 1” of part length either side of center

VBXC Part Configuration

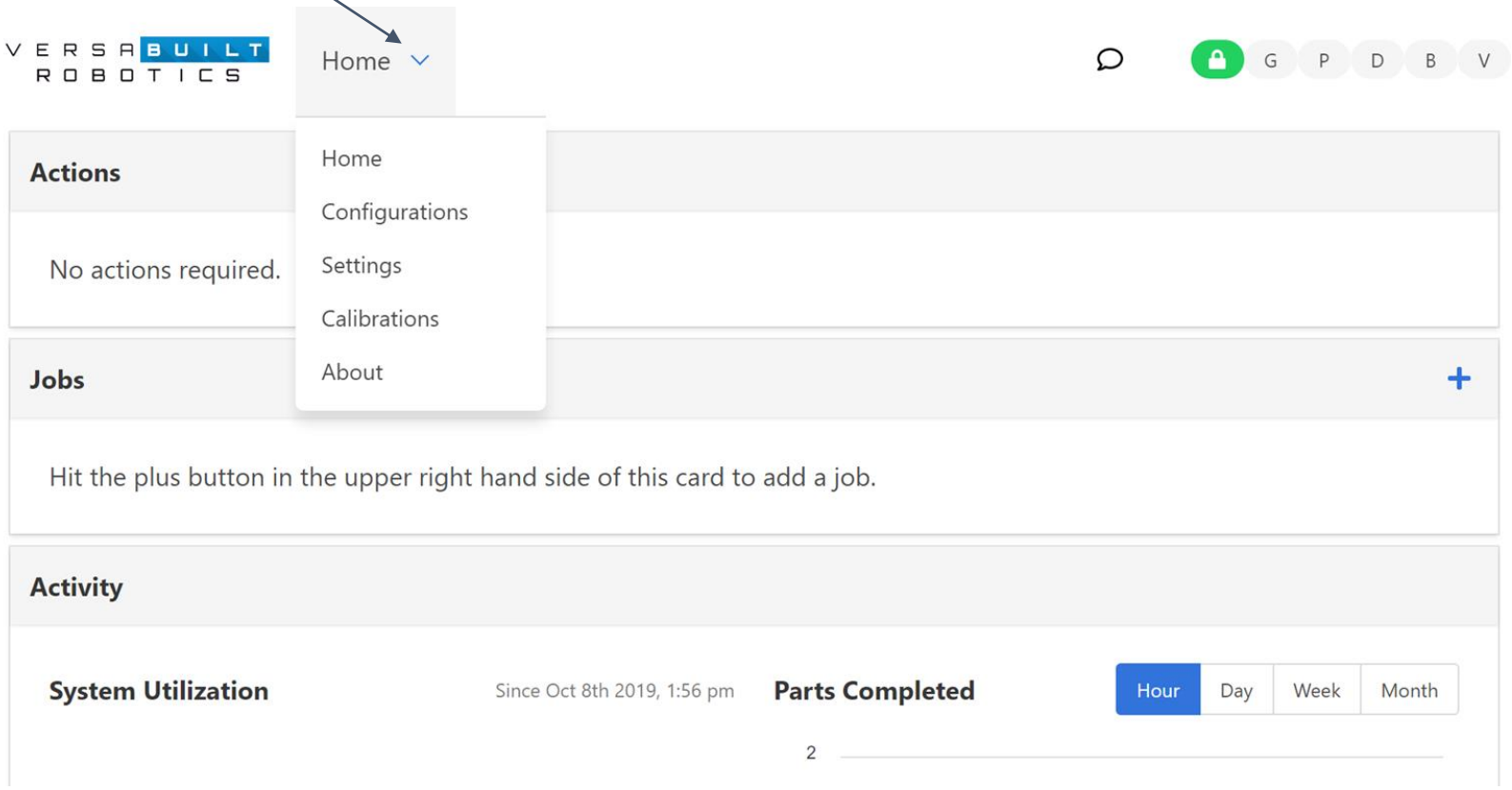
Section 6

VBXC Part Configuration

1. VBXC Configuration Screen
2. Adding MultiGrip Jaws to the VBXC
3. VBXC Automation Process Scripts
4. Adding Part Configurations to the VBXC
5. Editing or Deleting Jaw and Part Configurations

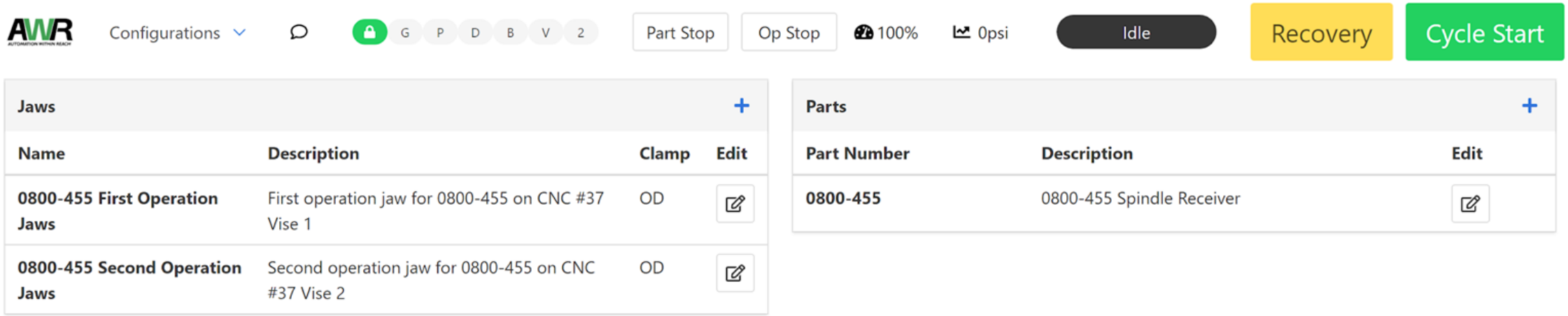
VBXC Configuration Screen

- To get to the VBXC Configuration Screen, in the upper left part of the screen click the down arrow then select Configurations



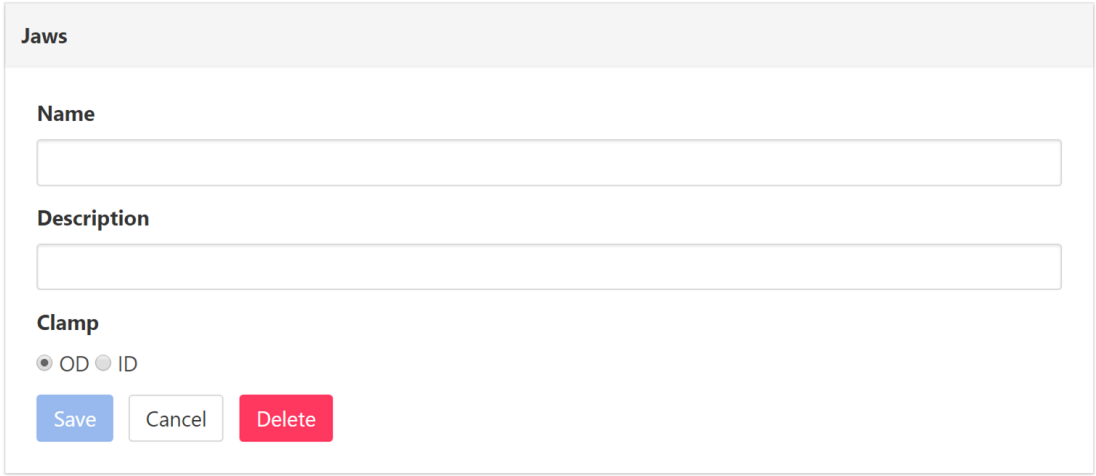
VBXC Configuration Screen

- The VBXC Configuration Screen has two panels: Jaws and Parts
- The Jaws panel is used to add, edit or delete Jaw definitions stored in the VBXC
- The Parts panel is used to add, edit or delete Part definitions stored in the VBXC



Adding MultiGrip Jaws to the VBXC

- Jaws are configured separately in the VBXC from parts because jaws may be shared by more than one part
- Jaw Parameters:
  - Name: The identifier the VBXC will used for the jaws
  - Description: A description of the jaws that will be displayed to the operator when the VBXC references the jaws
  - Clamp: the clamping style of the jaws
    - OD jaws clamp the part by closing



VBXC Automation Process Scripts

- Each part configuration will require a Process Script selection
- A VBXC Automation Process Script defines how the automation process works and the parameters that will be stored with each part configuration
- The VBX-160 includes 3 standard Process Scripts according to the number of operations required to complete the part:
  - One Op
  - Two Op
  - Three Op
- Standard Process Scripts will suit most applications, custom Process Scripts can be developed at an additional cost to support unique application needs
- An outline of the steps for each Process Script:

VBXC Automation Process Scripts

One Op:

1. Pick MutliGrip Jaws from Jaw Storage Plate
2. Pick a part from the shelf
3. Load MultiGrip Jaws and part into the selected vise
4. Run CNC machining operation
5. Wait for CNC machining operation to complete
6. Unload MutliGrip Jaws and part from the CNC
7. Place the completed part on the shelf
8. If not all parts are completed, go to step #2
9. Place MutliGrip Jaws onto Jaw Storage Plate

VBXC Automation Process Scripts

Two Op:

1. Pick First MutliGrip Jaws from Jaw Storage Plate
2. Pick a part from the shelf with First MultiGrip Jaws
3. Load First MultiGrip Jaws and part into the vise 1
4. Run first operation CNC machining operation
5. Pick Second MutliGrip Jaws from Jaw Storage Plate
6. Wait for CNC operation to complete
7. Pick completed first operation part from the First MutliGrip Jaws in the vise 1 using Second MultiGrip Jaws
8. Load Second MultiGrip Jaws and part into vise 2
9. Unload First MultiGrip Jaws from vise 1
10. Run second operation CNC machining operation
11. If all parts complete, go to step #20
12. Pick a part from the shelf with First MultiGrip Jaws
13. Wait for CNC operation to complete
16. Load First MultiGrip Jaws and part into the vise 1
17. Unload Second MultiGrip Jaws and completed part from vise 2
18. Place the completed part on the shelf
19. If not all parts are completed, go to step #6
20. Place First MutliGrip Jaws onto Jaw Storage Plate
21. Unload Second MultiGrip Jaws and completed part from vise 2
22. Place the completed part on the shelf
23. Place Second MutliGrip Jaws onto Jaw Storage Plate

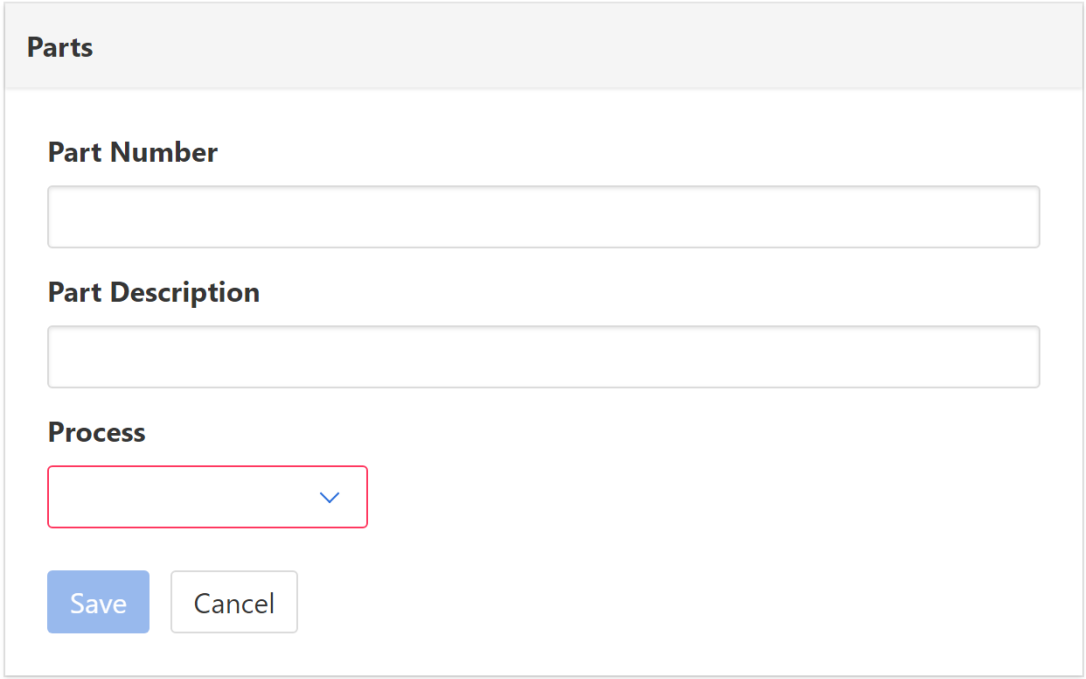
VBXC Automation Process Scripts

Three Op:

1. Pick First MutliGrip Jaws from Jaw Storage Plate
2. Pick a part from the shelf with First MultiGrip Jaws
3. Load First MultiGrip Jaws and part into first vise 1
4. Run first CNC machining operation
5. Pick Second MutliGrip Jaws from Jaw Storage Plate
6. Wait for CNC operation to complete
7. Pick completed first operation part from the First MutliGrip Jaws in vise 1 using Second MultiGrip Jaws
8. Load Second MultiGrip Jaws and part into vise 2
9. Unload First MultiGrip Jaws from vise 1
10. Run second CNC machining operation
11. Place First MutliGrip Jaws onto Jaw Storage Plate
12. Pick Third MutliGrip Jaws from Jaw Storage Plate
13. Wait for CNC operation to complete
14. Pick completed second operation part from the Second MutliGrip Jaws in the vise 2 using Third MultiGrip Jaws
15. Load Third MultiGrip Jaws and part into vise 1
16. Unload Second MultiGrip Jaws from vise 2
17. Run third CNC machining operation
18. Place Second MutliGrip Jaws onto Jaw Storage Plate
19. Wait for CNC operation to complete
20. Unload Third MultiGrip Jaws and completed part from vise 1
21. Place completed part on shelf
22. If not all parts are completed, go to step #1

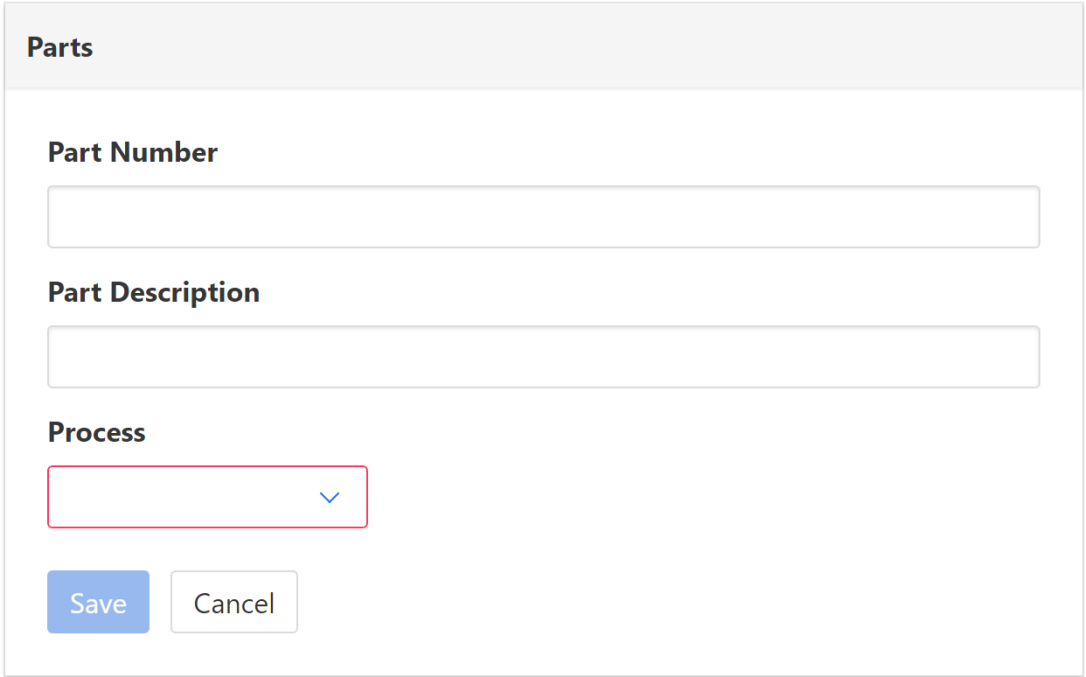
Adding Part Configurations to the VBXC

- A Part Configuration stores all the information the VBX-160 needs to run a batch of parts through the automation process
- After selecting the Part Configuration and entering a quantity from the home screen, the VBXC will prompt the operator to properly setup the VBX-160 without the need to re-enter all of the detailed information required to process the job



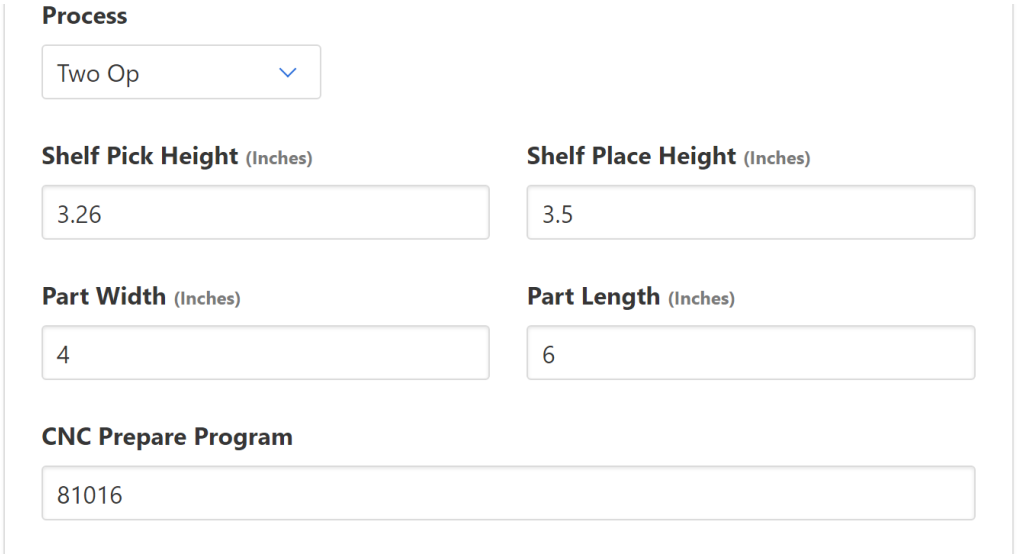
Adding Part Configurations to the VBXC

- Part Number: descriptive part number for the operator
- Part Description: descriptive information about the part for the operator
- Process: the automation process script to run the part based upon the number of operations in to perform on the part
  - Once the Process has been selected, the configuration parameters for that script will appear



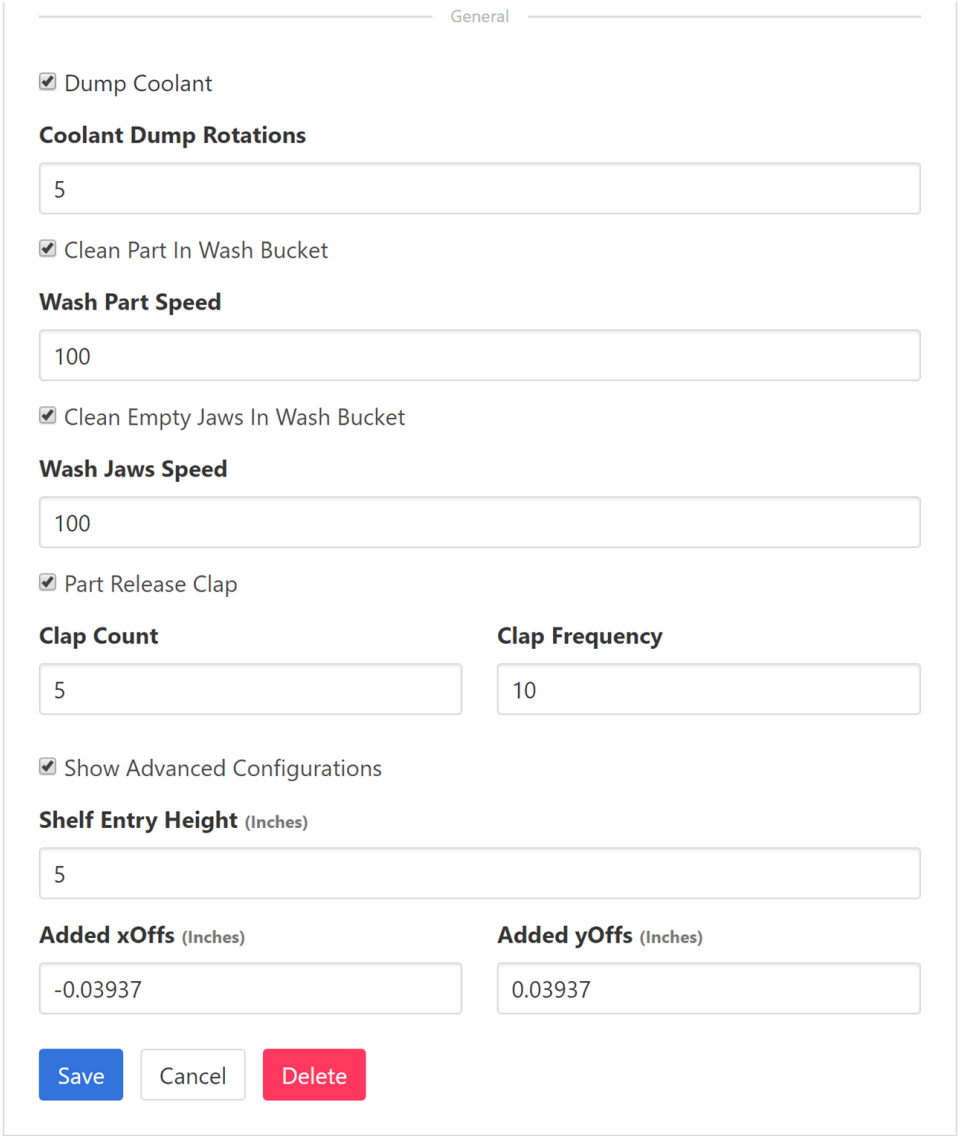
Adding Part Configurations to the VBXC

- Shelf Pick Height: pick height of the part on the shelf
- Shelf Place Height: height the part will be placed on the shelf after machining is completed
- Part Width: width of the part on the shelf
  - Note: the width of the part will determine the pick template that will be used during processing and the position of the jaws in X on the shelf
- Part Length: the length of the part in inches
  - Note: length calculates the position of the jaws in Y on the shelf; the max Y offset is 2.375 inches - parts longer than 4.75” will be offset in Y during the pick (see section 4.8)
- CNC WashProgram: CNC program that runs at the start of the job to clean the vises and position the CNC table for robot load



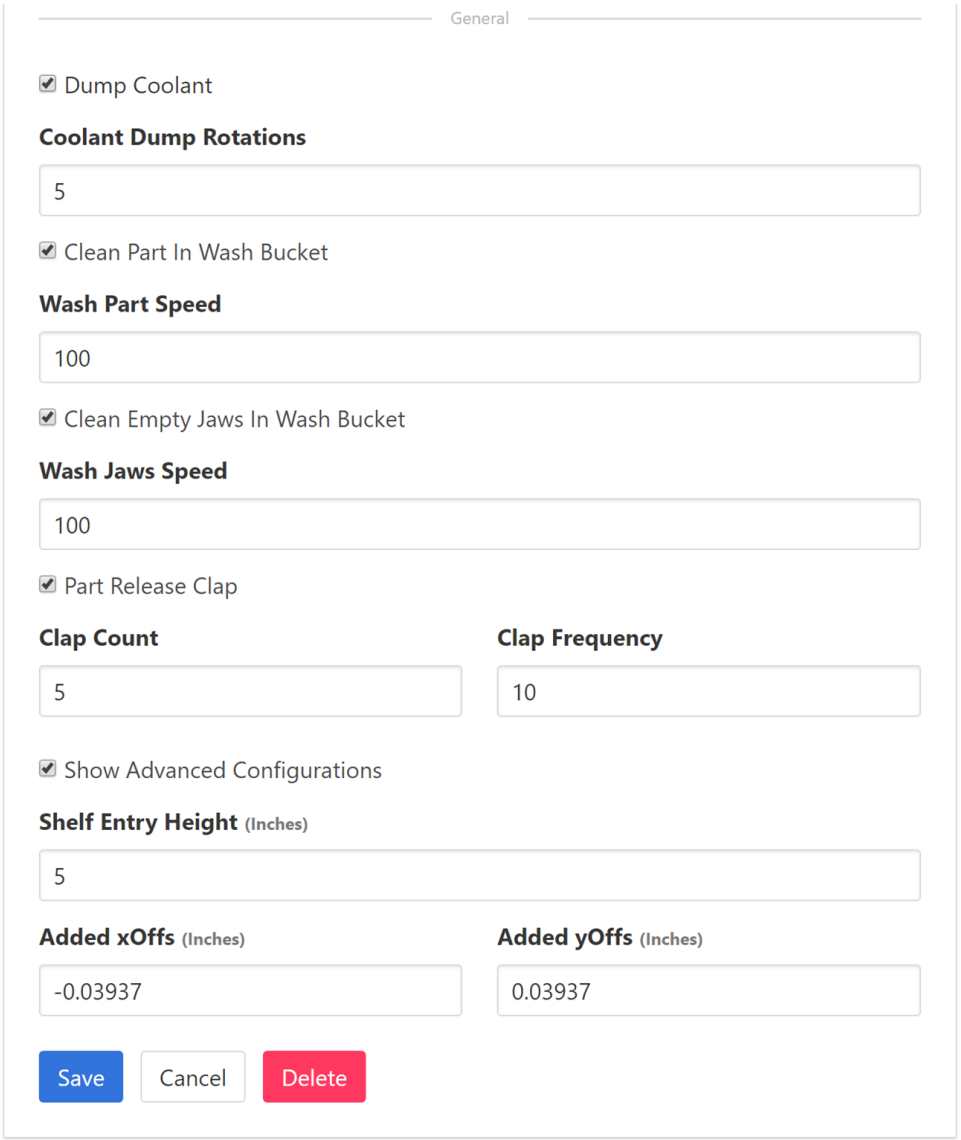
Adding Part Configurations to the VBXC

- Dump Coolant
  - when selected, the robot will tilt the jaws down in the CNC and slowly rotated the jaws the specified number of times
- Clean Part In Rinse Bucket
  - when selected, the robot will rinse the part before placing it back on the shelf; the speed the robot moves through the rinse bucket can be varied from 1 to 100% of max speed
- Clean Empty Jaws In Rinse Bucket
  - when selected, the robot will rinse the jaws before continuing the automation process; the speed the robot moves through the rinse bucket can be varied from 1 to 100% of max speed
  - **NOTE:** failing to clean the empty jaws before continuing with the automation process can cause repeatability problems
- Part Release Clap
  - When selected, during place of the completed part on the shelf, the robot will open and close the gripper Clap Count times at a rate of Clap Frequency per second



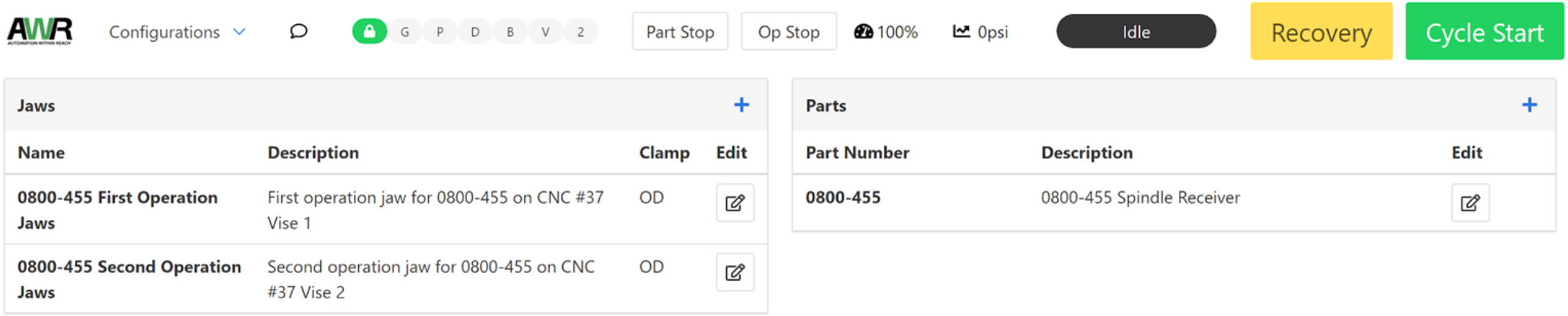
Adding Part Configurations to the VBXC

- Show Advanced Configurations
  - When selected, shows advanced part configuration options
- Shelf Entry Height
  - Height of the jaws above the shelf as the robot enters the shelf during part pick or place
  - 5” is normally the max entry height, if every other shelf above is removed, the entry height can be adjusted up to 10”
- Added xOffs and yOffs
  - During part pick and place, these amounts will be added to the calculated pick position to ensure the part does not get pushed into the X or Y datum of the Universal Part Locator

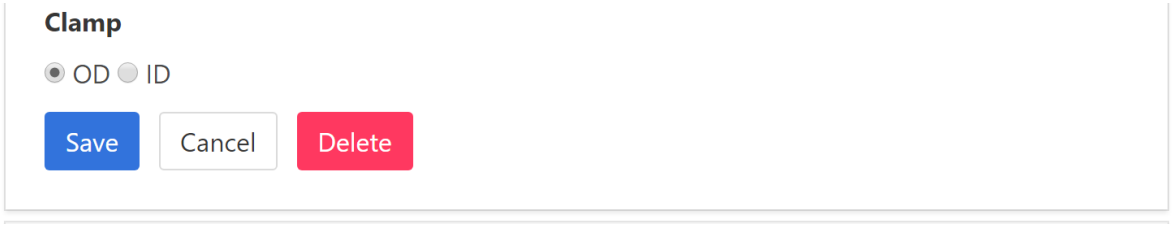


Editing and Deleting Part and Jaw Configurations

- Click on the Edit button next to the jaw or part you wish to edit



- Edit the jaw or part configuration as necessary to to delete the jaw or part configuration, scroll down to the bottom the configuration and click the Delete button



Introducing a New Part for Automation Using the VBX-160

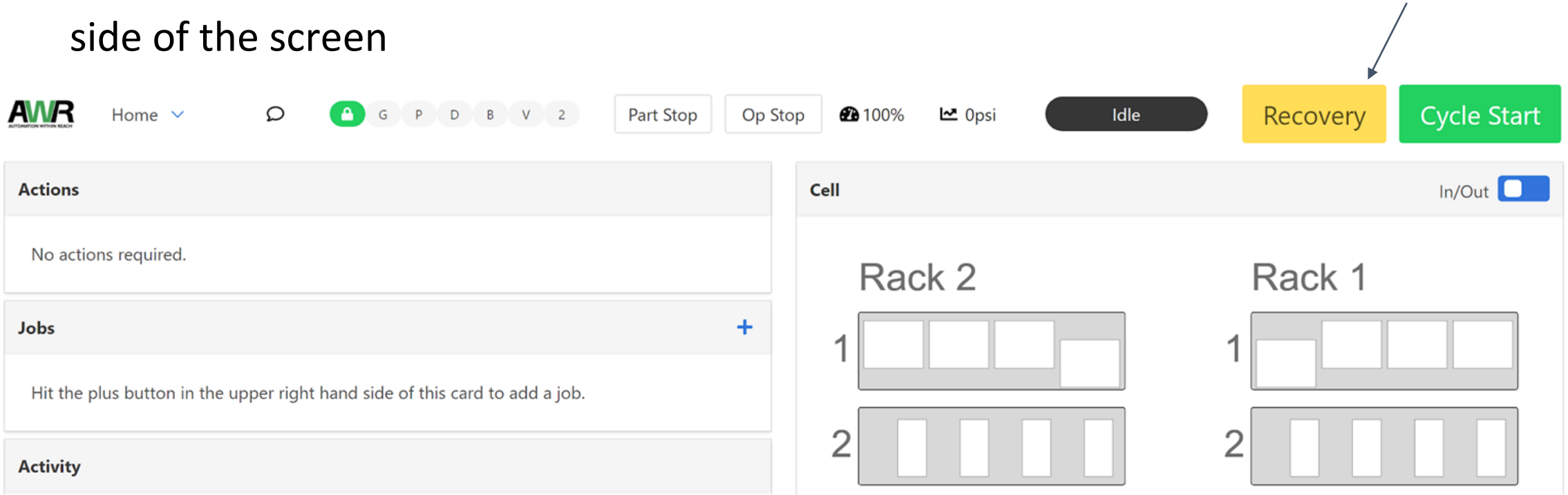
Section 7

Introducing a New Part for Automation Using the VBX-160

1. Using VBXC Recovery to Validate Automation Process
2. Steps to Introduce a New Part to VBX-160
3. Monitoring and Improving the Automation and CNC Processes

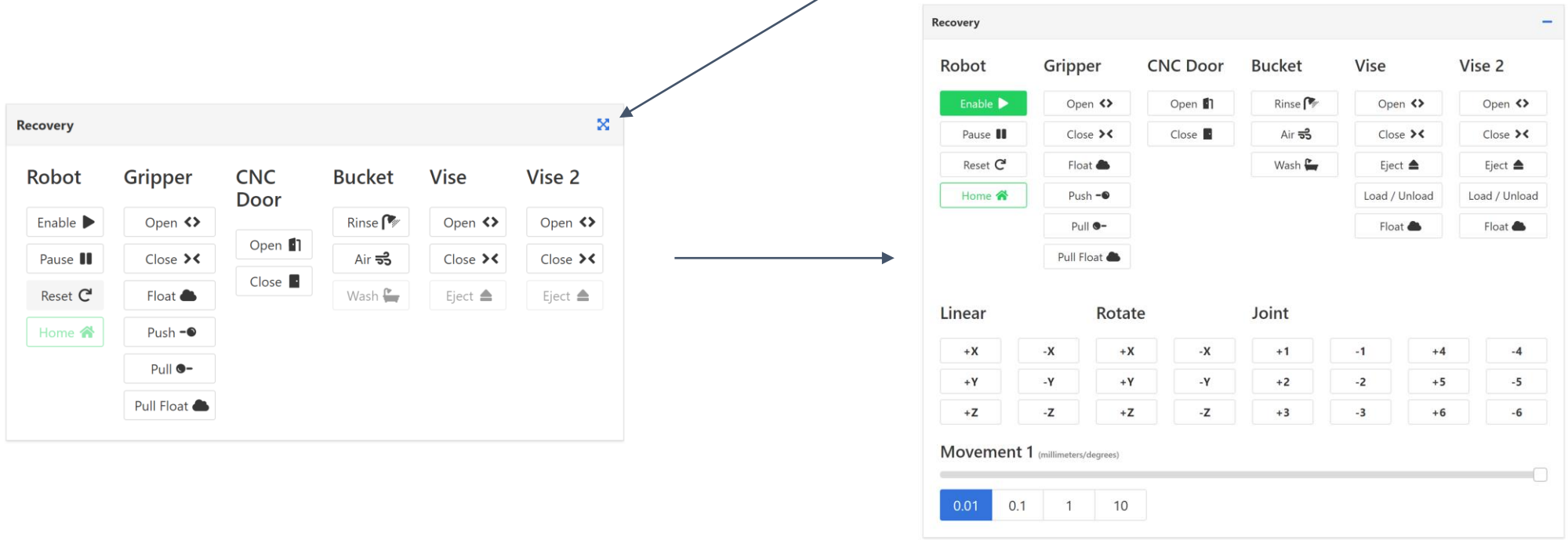
Using VBXC Recovery to Validate Automation Process

- The VBXC Home Screen can be used to manually pick, place, load and unload jaws and parts to validate the steps of the automation process without entering and running a complete part configuration
- With the VBXC idle, click on the yellow Recovery button in the upper right-hand side of the screen



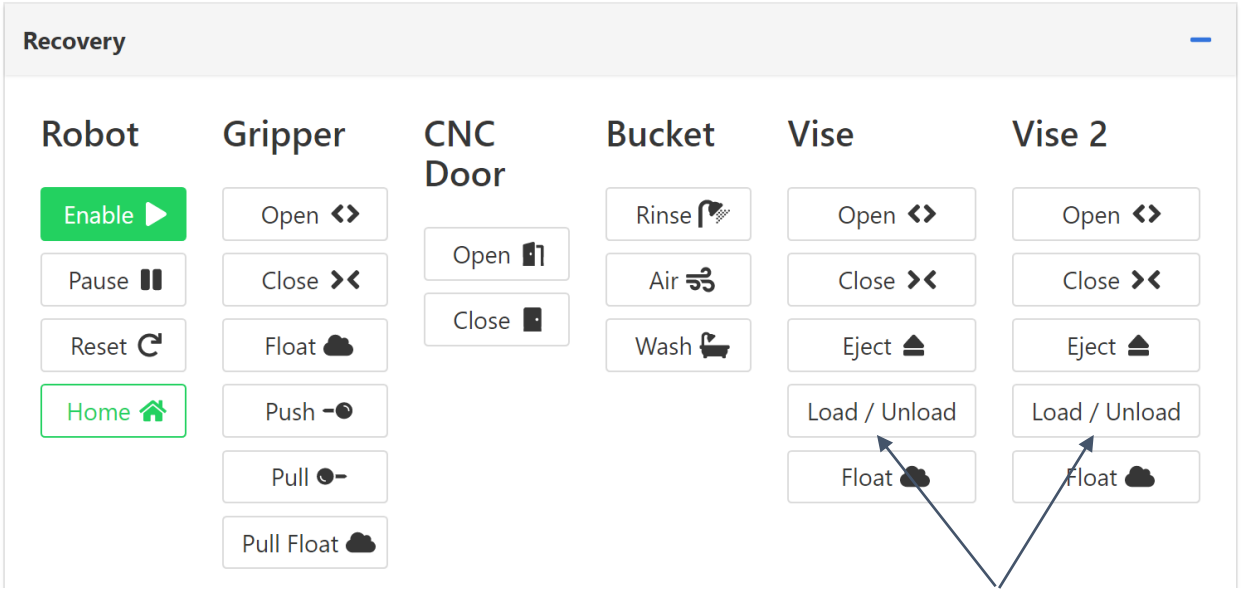
Using VBXC Recovery to Validate Automation Process

- The VBXC recovery panel will then be displayed in the upper left panel of the VBXC screen
- To access extended recovery functions, click the blue expand button in the upper right corner of the Recovery panel



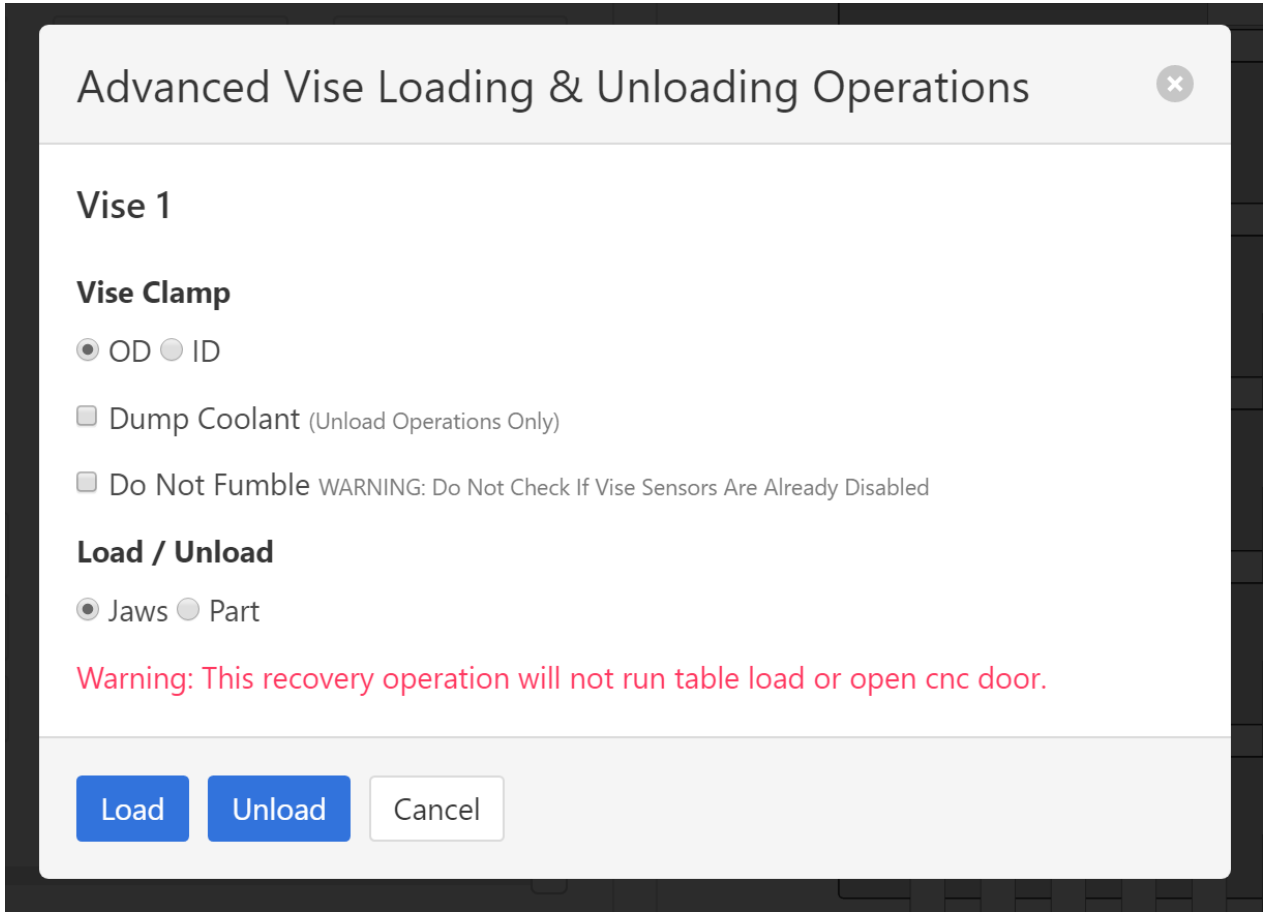
Using VBXC Recovery to Validate Automation Process

- To Load/Unload jaws to a vise or Pick a part from a vise, click on the Load/Unload button for the vise you wish to use
- Make sure the CNC door is open and the CNC table is in calibrated position for the robot to access the vises



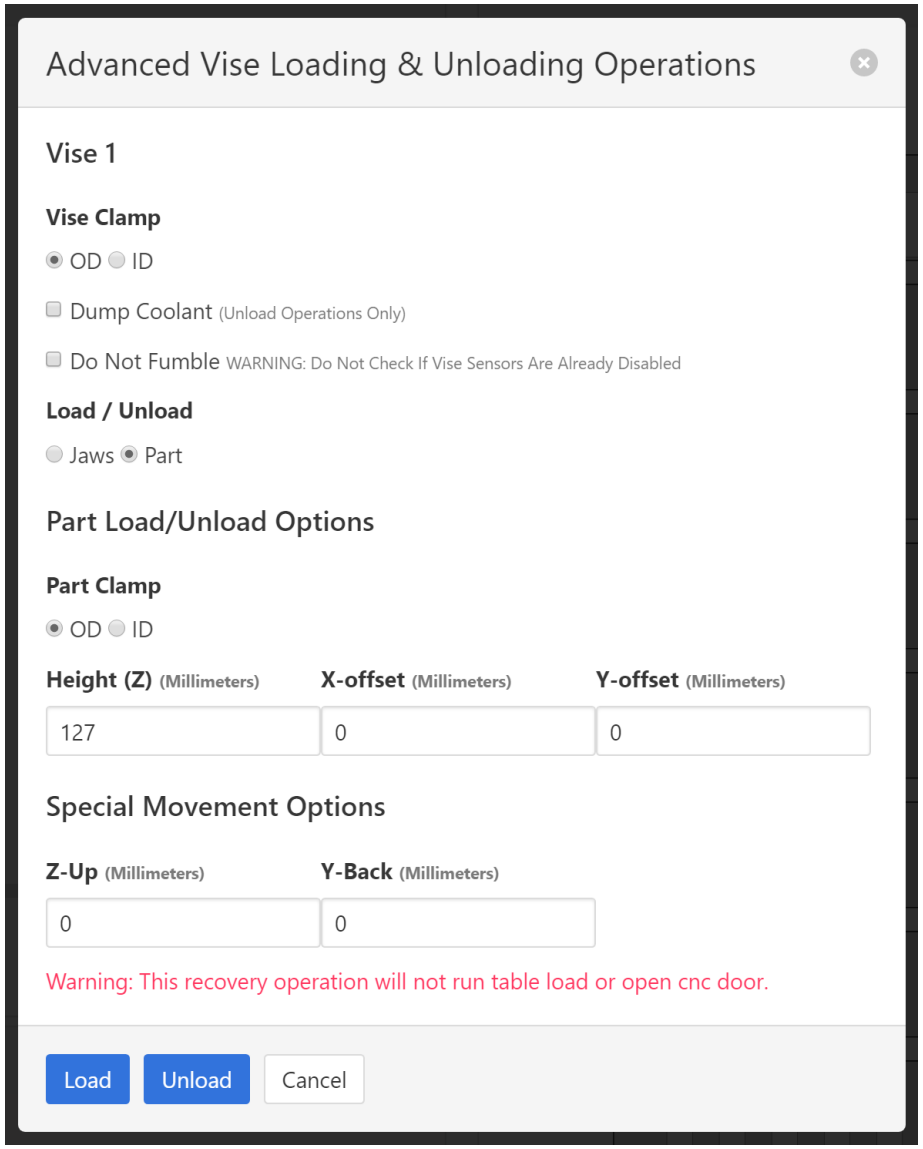
Using VBXC Recovery to Validate Automation Process

- To Load/Unload jaws to a vise, select Jaws under Load/Unload option, OD clamp and if the jaws are not holding a part, click on the Do Not Fumble option



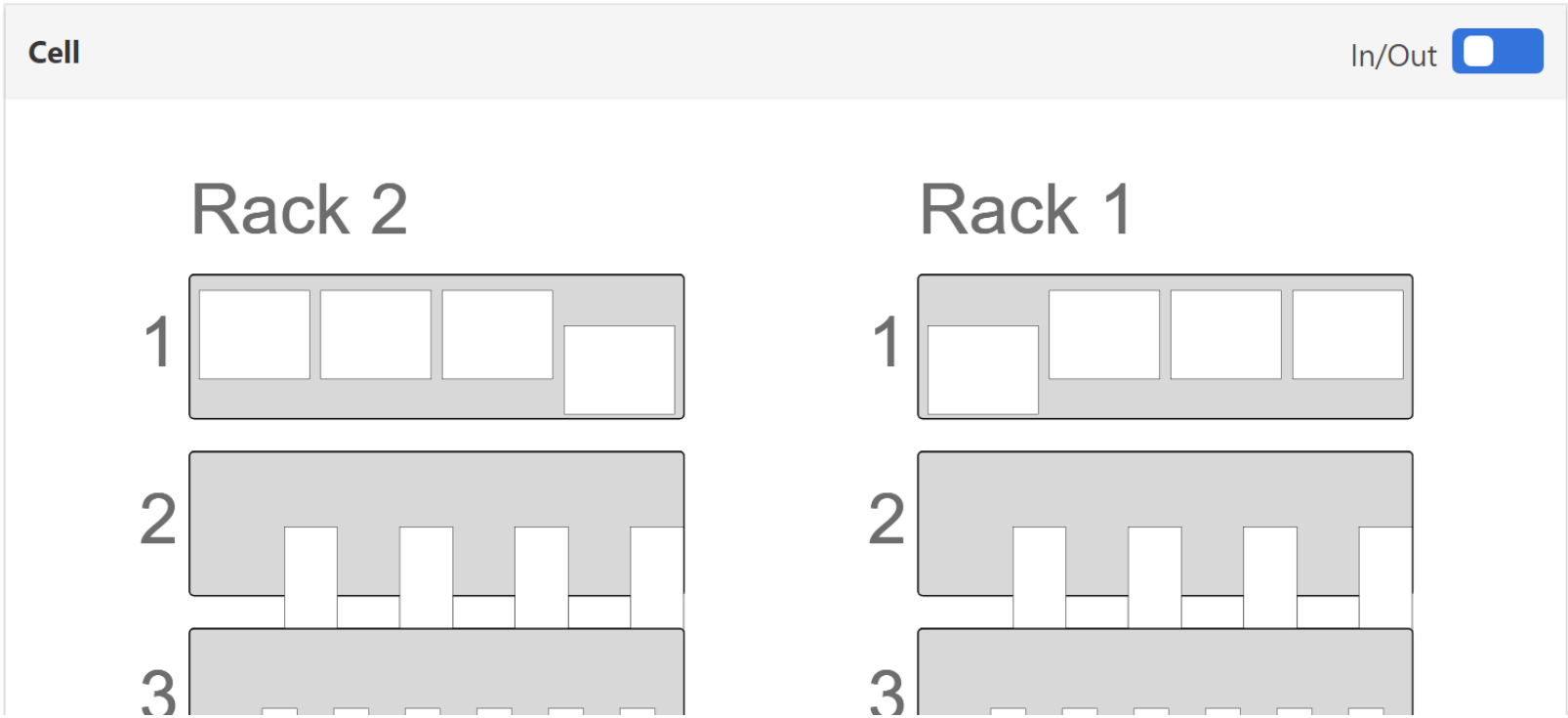
Using VBXC Recovery to Validate Automation Process

- To Unload a part held by jaws in a vise, select Part under Load/Unload option, OD clamp, the pick height and optionally an X and Y offset to the pick



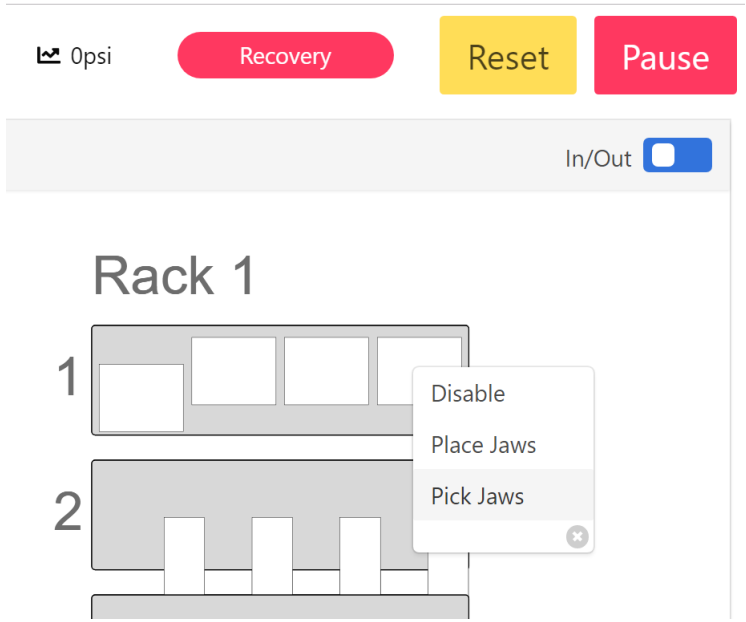
Using VBXC Recovery to Validate Automation Process

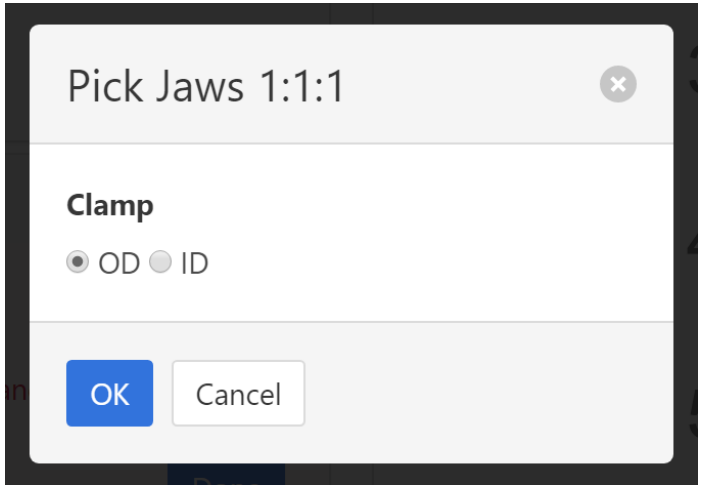
During the part introduction process, you will use the Cell Panel on the Home Page to Pick and Place Jaws from the Jaw Storage Plates and Pick and Place parts to the shelves.



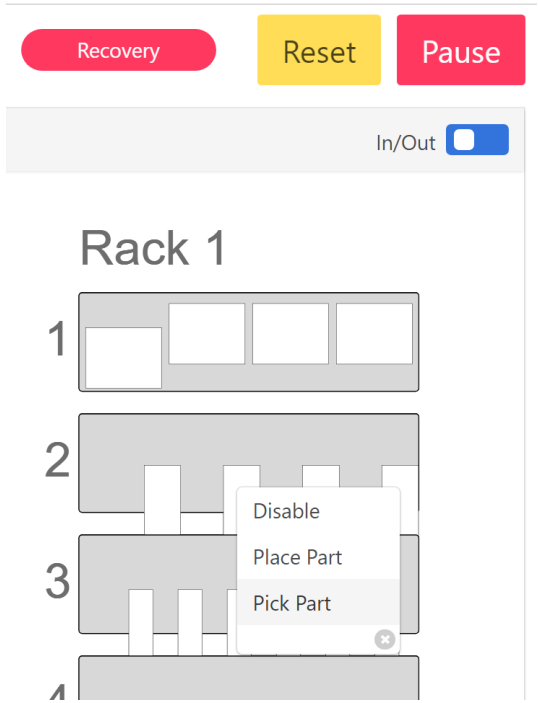
Using VBXC Recovery to Validate Automation Process

- Pick Jaws/Place Jaws - right click on the desired square Jaw Storage Plate slot on shelf 1 of either Rack 1 or Rack 2 to pick/place the jaw at that location
- You will be prompted to select whether the jaws are OD or ID

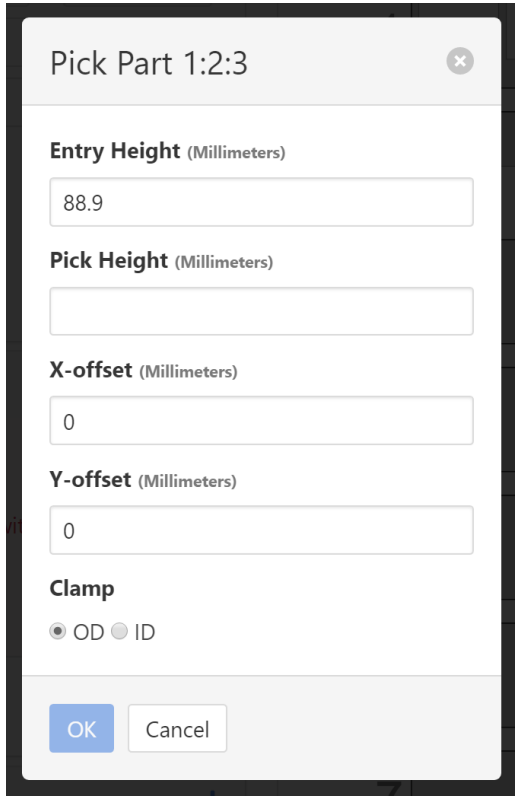




Using VBXC Recovery to Validate Automation Process



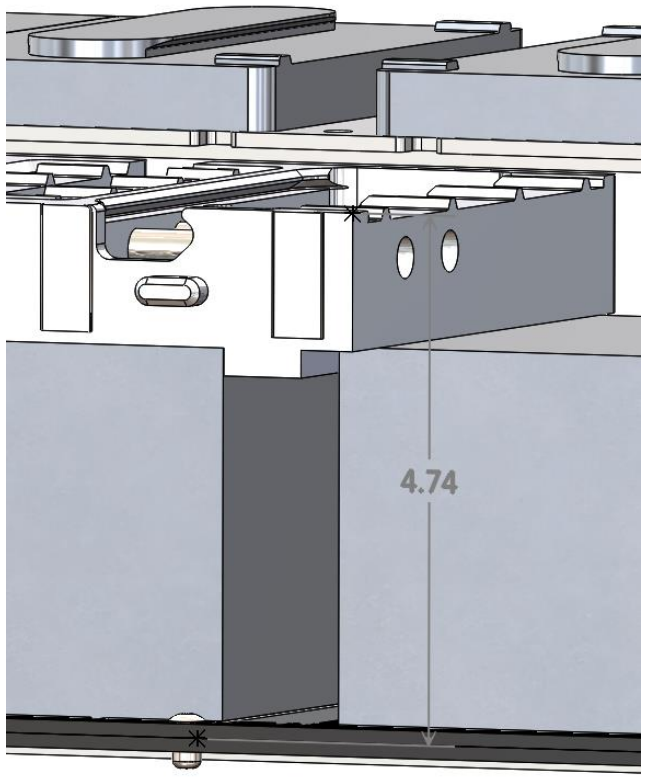
- Pick/Place Part - right click on the desired rectangular shelf part slot to pick/place the part at that location
- Enter the Pick Height, Part Width, Part Length/Diameter and if the part should be clamped OD or ID



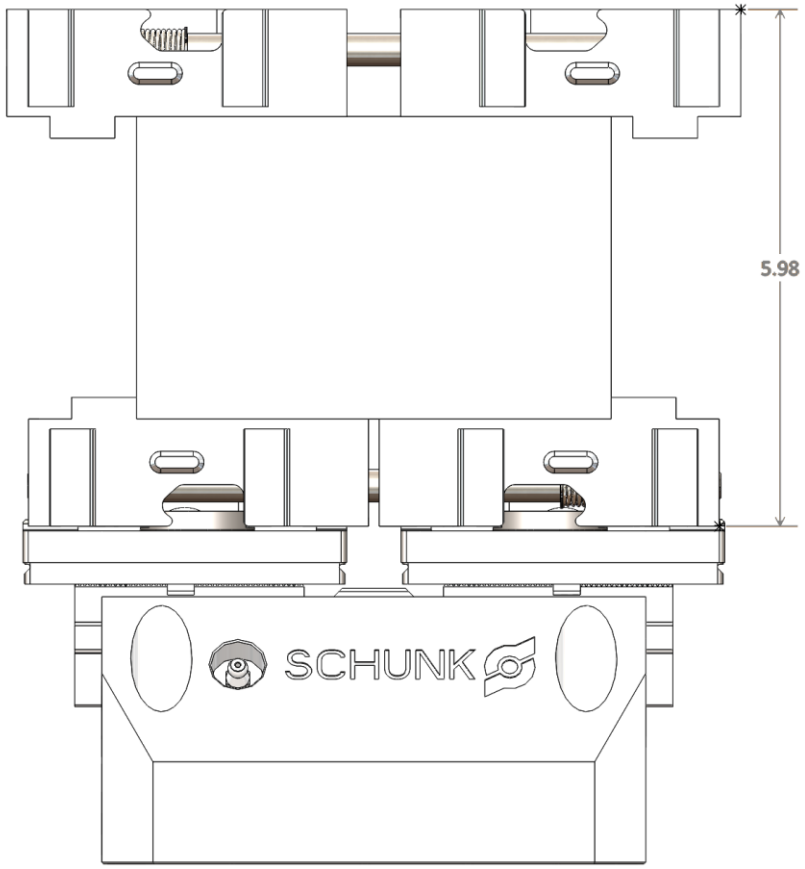
Steps to Introduce New Part to VBX-160

1. Design automation process
    a. Will there be a pre-operation step?
    b. How many operations? 1 operation, 2 operations or 3 operations including pre-operation?
2. Design and cut MultiGrip Jaws
    a. Be sure to read and understand this entire manual before cutting MultiGrip Jaws
3. Prove CNC process by hand-loading parts
    a. Validate each operation in the CNC process makes good parts
    b. Add vise wash, table position and the VBXC Completion Flag variable to end of each CNC program (see section 5 and the VBXC CNC Manual included with your system for more information)
    c. Verify that vise wash adequately removes chips from the open vise
    d. Save a version of the part after each CNC process step - these parts will be used during the automation process verification steps

Steps to Introduce New Part to VBX-160



4. Determine Pick/Place heights:
    a. For pick from shelf and place to shelf, height is calculated from bottom of part to top of jaws
    b. For pick from vise during CNC operation transfer, height is calculated from the bottom of the jaws on the vise to the top of the jaws the robot is holding for the pick



Steps to Introduce New Part to VBX-160

5. Prove automation process by testing pick, place and load using the VBXC recovery panel to test each automation operation:
    a. During this process, carefully observe how the robot picks and places the parts
        i. Observe and/or test for expected variability in the process
        ii. Are there sufficient margins available in the process to manage variability?
    b. Load all jaws used in the automation process onto jaw storage plates in the VBX-160
    c. Configure at least one shelf to the pick template corresponding to the width or diameter of the part (see section 4.3) and load at least one piece of raw material on the shelf
    d. Use the VBXC to pick first operation jaws

Steps to Introduce New Part to VBX-160

5. (continued):
    e. Use the VBXC to pick the part from the shelf entering pick height determined in step #4
        i. Note if pick height is correct, make adjustments and test again as necessary and note correct height for final part configuration
    f. Use the VBXC to load the jaws and part into the first vise
    g. Replace the raw material in the jaws of the first vise with the after first operation part made in step #3
        i. Use the VBXC to open the vise
        ii. Pivot the VBX-160 away from the CNC, remove the raw material and replace with after first operation part with the finished side up
        iii. Move the VBX-160 back into place and close the vise; make sure the part is properly located in the jaws

Steps to Introduce New Part to VBX-160

5. (continued):
    h. Use the VBXC to pick the second operation jaws from the Jaw Storage Plates
    i. Use the VBXC to unload the part from the first vise using the pick height determined in step #4
    j. Note if pick height is incorrect, make adjustments and test again as necessary and note correct height for final part configurationUse the VBXC to unload the first operation jaws and put the first operation jaws back on the Jaw Storage Plate
    k. Complete steps “h” through “j” until all operations are complete
    l. Use the VBXC to unload the completed part and jaws from the vise
    m. Place the part on the shelf using the place height determined in step #4
        i. Note if pick height is correct, make adjustments and test again as necessary and note correct height for final part configuration
6. Enter VBXC Part Configuration using pick heights tested in step #5
7. Run and observe full automation process

Monitoring and Improving the Automation and CNC Processes

- Take each and every failure of the automation or CNC process as an opportunity to improve the process
  - If the automation or CNC process fails, carefully review what variable or variables caused the failure
    - Can a variable be identified that caused the failure?
      - Oversized raw material
      - Change in air pressure
      - Unstable cutting conditions
      - Unknown tool life
      - Blocked coolant flow or coolant concentration out of specification
    - Can the variability be better controlled or can the process be changed to handle more variability?
- Accept that some level of process failure will always exist and that as the initial process failures are corrected, the cost to reduce infrequent failures may exceed the benefit