Servo Gripper User Guide

UMI-33-640

Rev.	Revision History	Date
001	Original Issue	00-03

Additional copies of this guide, or other CRS Robotics literature, may be obtained from the Sales Department or from your distributor.

About This Guide

This user guide contains installation instructions, specifications, and operating procedures for the 65 mm [2.6 in] servo gripper for A255, A465, and F3 robots.

Most procedures in this manual can also be used for the 50 mm [2 in] servo gripper. However, all measurements and specifications are provided for the 65 mm [2.6 in] servo gripper only.

Who Uses This Guide

This installation guide is intended for users who have already attended a CRS Robotics robot system training course. It is not intended as a self-teaching tool.

How to Use This Guide

Throughout this manual warnings are marked by a "!" symbol in the left margin. Failure to comply with these warnings can result in system errors, memory loss, or damage to the robot and its surroundings.

This manual is task-based and uses navigational aids to help you quickly find the topics and information you need.

Before attempting to follow instructions in a section, read the entire section first.

This guide consists of the following chapters:

- **Introducing the Servo Gripper** describes how the gripper is used in a typical robot application. This chapter also includes complete part lists for each CRS servo gripper kit.
- **Installing or Replacing the Fingers** provides instructions for replacing or installing fingers on your servo gripper.
- **Installing the Servo Gripper** explains how to connect the gripper to your A255, A465, or F3 arm.
- **Testing and Calibration** includes configuration procedures and testing routines to help verify that your gripper is functioning normally.
- **Using the Servo Gripper** discusses the two gripper control modes and reviews the commands that are used to control the gripper.
- **Maintenance Procedures** describes how to inspect the gripper for wear and perform basic adjustments on the serviceable gripper components.
- **Troubleshooting Procedures** helps you to resolve common problem situations that you may encounter when using the gripper.
- **Appendix A, "Servo Gripper Dimensions"** provides reference drawings with measurements for a gripper with standard or microplate fingers.

For More Information

Additional information is available in the following documents, contained on your documentation CD:

- *Application Development Guide*
- *Application Shell Guide*
- *RAPL-3 Programming Manual*
- *Robcomm3 User Manual*
- *F3 User Guide*
- *A465 User Guide for C500C*
- *A255 User Guide for C500C*
- *C500C User Guide*

You can obtain copies of these documents, or other CRS Robotics literature, from the Customer Support Group.

Training

We offer training courses at our facility in Burlington, Ontario Canada, or on-site at your facility. For additional information, contact the CRS Training Department.

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CHAPTER 1

Introducing the Servo Gripper

The servo gripper is an electric gripper designed for use with CRS Robotics A255, A465, and F3 arms. The fingers open to a maximum of 65 mm. A potentiometer inside the servo gripper provides accurate feedback on finger position to the controller.

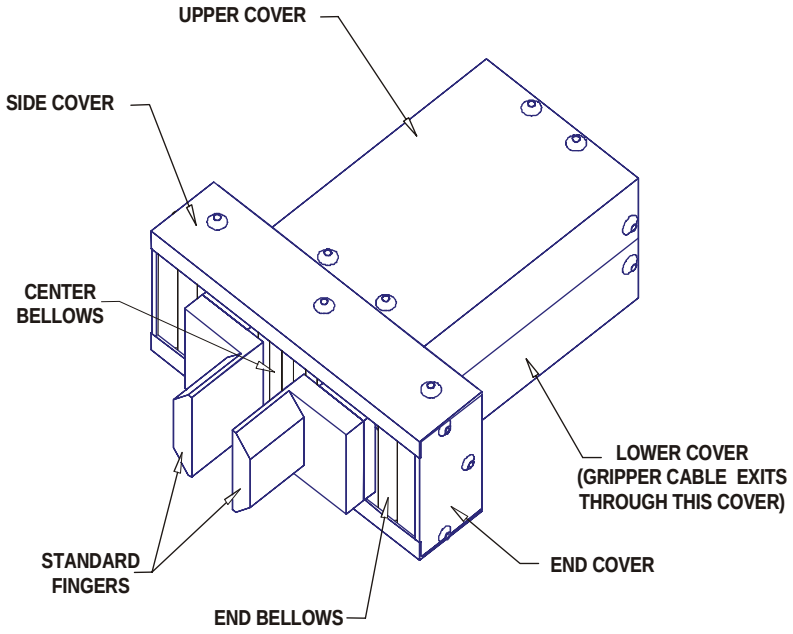


Figure 1-1: External view of the servo gripper with standard fingers

CRS supplies two types of fingers for the servo gripper:

- Standard fingers, which can be custom machined for specific robot applications.
- Microplate fingers, which are specially designed for lab system automation.

Custom fingers may also be designed for specific application use.

Warning! *When an E-Stop is engaged, A465 and A255 robot systems equipped with a servo gripper may lose power to the gripper and drop their payload. Ensure that you have adequately designed your gripper fingers for robot safety, as described in "Servo Gripper Safety" on page 2-1.*

Servo Gripper Kits Available from CRS

Before installing your servo gripper, verify that all required components and fasteners are included in your servo gripper kit. If any components are missing, please contact your CRS representative for assistance.

A255 Servo Gripper Kits

Table 1-1: *A255 servo gripper with standard fingers*

Quantity	Part	Notes
1	servo gripper	
2	standard fingers	• shipped pre-assembled
8	4-40 x 3/8 socket head cap screws	• for fastening standard fingers to the gripper • shipped pre-assembled
2	M5 x 12 mm dowel pins	• for positioning the gripper against the tool flange
4	10-24 x 3/8 in. socket head cap screws	• for fastening the gripper to the tool flange

Table 1-2: *A255 servo gripper with microplate fingers*

Quantity	Part	Notes
1	servo gripper	
2	microplate fingers	
8	4-40 x 1/2 in. socket head cap screws	• for fastening microplate fingers to the gripper pads
4	8-32 x 1/2 in. flat head cap screws	• replacement screws for the microplate finger sides
2	M5 x 12 mm dowel pins	• for positioning the gripper against the tool flange.
4	10-24 x 3/8 in. socket head cap screws	• for fastening the gripper to the tool flange
1	0.035 in. hex key	• for adjusting microplate finger grip points
1	3/32 in. hex key	• for replacing the 8-32 in. flat head cap screws

A465 Servo Gripper Kits

Table 1-3: *A465 servo gripper with standard fingers*

Quantity	Part	Notes
1	servo gripper	
2	standard fingers	• shipped pre-assembled
1	A465 tool flange adapter plate	
1	gripper adapter plate	
8	4-40 x 3/8 in. socket head cap screws	• for fastening standard fingers to the gripper • shipped pre-assembled
2	M5 x 12 mm dowel pins	• for positioning the adapter against the gripper
1	8-32 x 3/8 in. flat head cap screw	• for positioning and fastening the two adapter plates together
3	8-32 x 1/4 in. socket head cap screws	• for fastening the two adapter plates together
8	10-24 x 3/8 in. socket head cap screws	• 4 for fastening the adapter to the tool flange • 4 for fastening the adapter to the gripper
1	A465 tool flange key	• for positioning the adapter against the tool flange.

Table 1-4: *A465 servo gripper with microplate fingers*

Quantity	Part	Notes
1	servo gripper	
2	microplate fingers	
1	A465 tool flange adapter plate	• fastens to the tool flange
1	gripper adapter plate	• fastens to the back of the gripper
2	M5 x 12 mm dowel pins	• for positioning the adapter against the gripper
1	8-32 x 3/8 in. flat head cap screw	• for positioning and fastening the two adapter plates together
3	8-32 x 1/4 in. socket head cap screws	• for fastening the two adapter plates together
8	10-24 x 3/8 in. socket head cap screws	• 4 for fastening the adapter to the tool flange • 4 for fastening the adapter to the gripper
1	A465 tool flange key	• for positioning the adapter against the tool flange.
8	4-40 x 1/2 in. socket head cap screws	• for fastening microplate fingers to the gripper pads
4	8-32 x 1/2 in. flat head cap screws	• replacement screws for the microplate finger sides
1	0.035 in. hex key	• for adjusting microplate finger grip points
1	3/32 in. hex key	• for replacing the 8-32 in. flat head cap screws

F3 Servo Gripper Kits

Table 1-5: *F3 servo gripper with standard fingers*

Quantity	Part	Notes
1	servo gripper	
2	standard fingers	• shipped pre-assembled
1	F3 tool flange adapter plate	• fastens to the tool flange
1	gripper adapter plate	• fastens to the back of the gripper
8	4-40 x 3/8 in. socket head cap screws	• for fastening standard fingers to the gripper • shipped pre-assembled
4	10-24 x 3/8 in. socket head cap screws	• for fastening the adapter to the gripper
2	M5 x 12 mm dowel pins	• for positioning the adapter against the gripper
1	M6 x 10 mm dowel pin	• for positioning the adapter against the tool flange. • pre-installed on the adapter plate
1	M4 x 0.7 x 10 mm flat head cap screw	• for positioning and fastening the two adapter plates together
3	M4 x 0.7 x 10 mm socket head cap screws	• for fastening the two adapter plates together
4	M6 x 8 mm socket head cap screws	• for fastening the adapter to the tool flange

Table 1-6: *F3 servo gripper with microplate fingers*

Quantity	Part	Notes
1	servo gripper	
2	microplate fingers	
1	F3 tool flange adapter plate	
1	gripper adapter plate	
4	10-24 x 3/8 in. socket head cap screws	• for fastening the adapter to the gripper
2	M5 x 12 mm dowel pins	• for positioning the adapter against the gripper
1	M6 x 10 mm dowel pin	• for positioning the adapter against the tool flange • pre-installed on the adapter plate
1	M4 x 0.7 x 10 mm flat head cap screw	• for positioning and fastening the two adapter plates together
3	M4 x 0.7 x 10 mm socket head cap screws	• for fastening the two adapter plates together
8	4-40 x 1/2 in. socket head cap screws	• for fastening microplate fingers to the gripper pads
4	8-32 x 1/2 in. flat head cap screw	• replacement screws for the microplate finger sides
1	0.035 in. hex key	• for adjusting microplate finger grip points
1	3/32 in. hex key	• for replacing the 8-32 in. flat head cap screws

Finger Replacement Kit

Table 1-7: *Microplate Finger Replacement Kit*

Quantity	Part	Notes
2	microplate finger sides	
2	microplate finger base	• fastens to the tool flange
8	4-40 x 1/2 in. socket head cap screws	• for fastening microplate fingers to the gripper pads
4	8-32 x 1/2 in. flat head cap screws	• replacement screws for the microplate finger sides
1	0.035 in. hex key	• for adjusting microplate finger grip points
1	3/32 in. hex key	• for replacing the 8-32 in. flat head cap screws

CHAPTER 2

Installing or Replacing the Fingers

You may have received your gripper with standard fingers, microplate fingers, or no fingers attached. This chapter discusses gripper finger safety and design issues and explains how you remove and install fingers on your gripper.

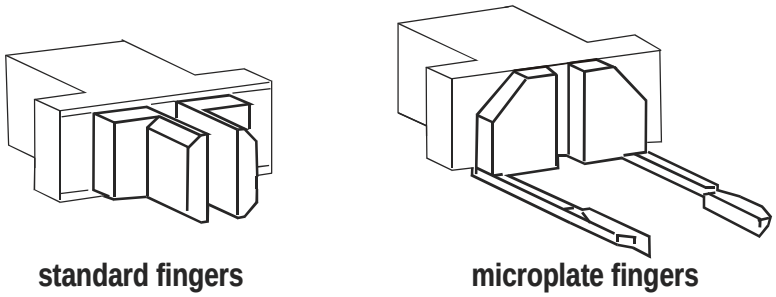


Figure 2-1: Different finger types allow you to customize the gripper for specific robot applications.

Servo Gripper Safety

When an E-Stop is engaged on A255 and A465 systems, the gripper fingers may lose grip force and drop their payload. For applications where a dropped payload could be hazardous to operators or the robot arm, you must remove the fingers and re-design them to hold an object even when grip force is removed. Custom machine the standard fingers, or add springs or some other mechanism to ensure that objects are not dropped when an E-Stop button is struck.

The F3 system maintains power to the gripper fingers during an E-Stop and a redesign is not required.

Warning! Never power up the controller with an object held in the gripper. *During the controller power-up sequence, the gripper fingers may occasionally separate and then close again. This could cause the gripper to drop its payload on power up.*

Using Non-Standard Gripper Fingers

The length and weight of the fingers used with the servo gripper can affect the total gripping force and maximum payload for the arm. If you have made significant modifications to your gripper fingers, or are using custom gripper fingers, contact your CRS representative for assistance.

Warning! Fingers which are too long or too heavy can damage the gripper motor. Contact CRS for assistance in designing custom fingers for your robot application.

Removing Gripper Fingers

The base of each gripper finger is fastened to the gripper pads with four 4-40 (imperial) socket head cap screws.

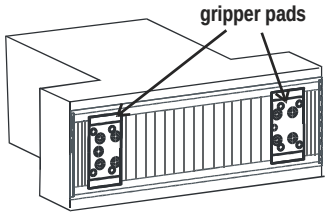


Figure 2-2: The gripper pads are located beneath the gripper fingers

To remove the gripper fingers:

- Using a 3/32 in. hex key (supplied), remove the four socket head cap screws holding the base of each finger to the gripper pad.

Attaching Gripper Fingers

When attaching non-symmetric fingers, such as microplate or custom designed fingers, you must first determine the orientation of the gripper in your robot system.

Gripper Orientation

For applications where the gripper must approach an object close to a tabletop or other obstruction, orient the gripper so that the cable exits on top to avoid potential collisions with the table. For applications where the gripper picks up objects from beneath, you may want the cable to exit below the gripper.

Ensure that the cable is not under strain when it connects to the round Hirose connector on the arm.

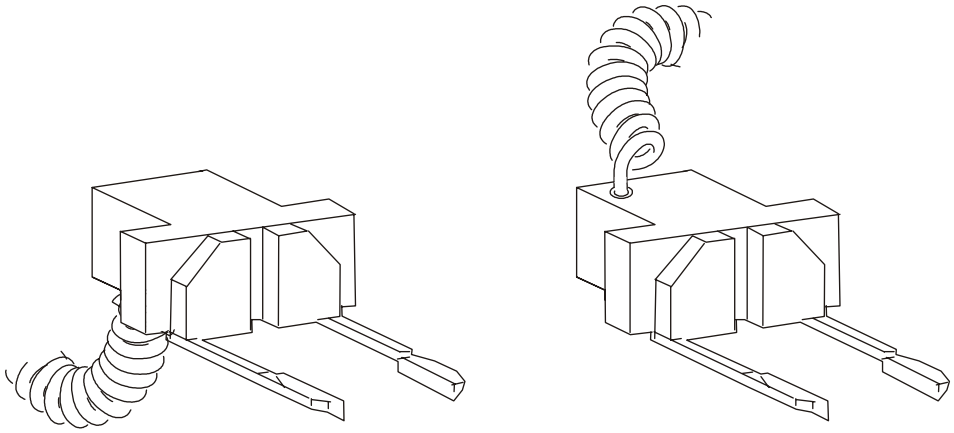


Figure 2-3: Orient the gripper to prevent the cable from colliding with obstructions

Attaching Microplate Fingers

The microplate fingers each attach to the gripper pads with four 4-40 x 1/2 in. socket head cap screws.

Note: Use only 4-40 x 1/2 in. socket head cap screws. The 4-40 screws provided with the standard fingers are too short to connect the microplate fingers securely.

To attach the microplate fingers:

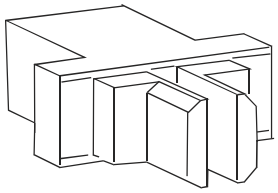
1. Determine an orientation for the gripper.
2. Using a 3/32 in. hex key, mount the fingers on the gripper as shown in Figure 2-3. Loosely screw each finger into place with the four 4-40 x 1/2 in. cap screws.
3. Press the fingers together firmly and tighten the screws into place. This ensures that the zero position is correctly calibrated for your gripper.

Attaching Standard Fingers

The standard fingers each attach to the gripper pads with four 4-40 x 3/8 in. socket head cap screws.

To attach the standard fingers:

1. Using a 3/32 in. hex key, mount the fingers on the gripper, as shown. Loosely screw each finger into place with the four 4-40 x 3/8 in. cap screws.
2. Squeezing from the finger base, press the fingers together firmly and tighten the screws into place. This ensures that the zero position is correctly calibrated for your gripper.



Attaching Custom Fingers

Custom-designed fingers must be fastened to each gripper pad with four 4-40 screws. The holes in the gripper pads are 8 mm [0.3 in.] deep. When determining the length of the screws for your custom fingers, you must take the depth of the holes into account to ensure that the screws do not protrude through the back of the gripper pads.

Warning! Gripper performance may be degraded if the screws protrude beneath the gripper pads. *Ensure that the screws used to fasten the fingers to the gripper are the correct length.*

Note: For more detailed gripper specifications, see Appendix A, “Servo Gripper Dimensions”.

Adjusting Microplate Finger Grip Points

Microplate fingers have two small grip points to ensure that objects are held securely. You may need to adjust the depth or location of the grip points to suit your robot application.

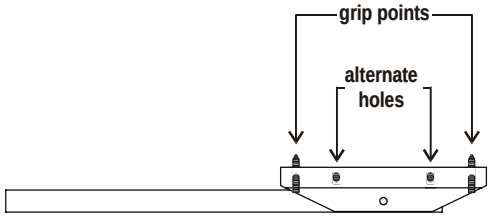


Figure 2-4: Microplate finger grip points

To adjust the grip points:

- When adjusting the grip points, apply Blue permalock MM115 locking compound to the threads to ensure a secure fit. If MM115 locking compound is not available, apply a dab of Super Bond glue to the grip points once they are accurately in position.
- If the grip points extend too far or do not extend far enough, use the 0.035 in. hex key supplied with your microplate fingers to position the grip points to the exact distance required.
- If the grip points are too far apart, you can remove the grip points and screw them into the other set of threaded holes on the finger.
- Always adjust grip points on both fingers so that the gripper fingers match.

CHAPTER 3

Installing the Servo Gripper

You can use the servo gripper with all CRS arms. The gripper fits directly onto the tool flange of the A255 arm. For the A465 and F3 arms, however, you need a pair of adapter flanges to fit the gripper to the tool flange.

The gripper and tool flange adapters are included with your servo gripper kit.

Note: For 65 mm servo grippers purchased prior to April 2000, the gripper case and adapter flanges may differ slightly from those shown here. If you need additional help, please contact CRS customer support.

Note: If no fingers are attached to your servo gripper, please see Chapter 2, "Installing or Replacing the Fingers" before installing the servo gripper on the arm.

Preparing to Install the Gripper

Before installing the servo gripper, prepare your robot system as follows:

- Ensure that the fingers are in place on the gripper.
- Place the tool flange in an easily accessible position.
- Remove power from the arm.

Before installing on an A255 system:

1. With the robot system powered on, open a Robcomm3 session on the development computer and place the robot in the ready position.

   Note: If the A255 arm is not homed, simply place it in any convenient position for accessing the tool flange.

2. Limp joints 4 and 5 by entering the command:

   ```
   $ limp 4, 5
   ```
   This makes it easier to manipulate the A255 wrist joint.

3. Remove arm power, either by pressing an E-Stop button or by shutting down the controller.

Before installing on an A465 system:

1. Place the arm in the ready position. If the arm is not homed, simply place it in any convenient position for accessing the tool flange.
2. Remove arm power, either by pressing an E-Stop button or by shutting down the controller.

Before installing on an F3 system:

1. Place the arm in the ready position.
2. Shut down and turn off the controller.

Installing A465 and F3 Tool Flange Adapters

The CRS servo gripper fits exactly onto the tool flange of the A255 arm. For A465 and F3 arms, adapter flanges are necessary to ensure a snug fit between the servo gripper and the tool flange.

Fastening the Adapter to the Gripper

If you are connecting the servo gripper to an A465 or F3 robot system, your your servo gripper kit contains two adapter flanges. The thinner of the two, shown in Figure 3-1, must be fastened to the back of the servo gripper.

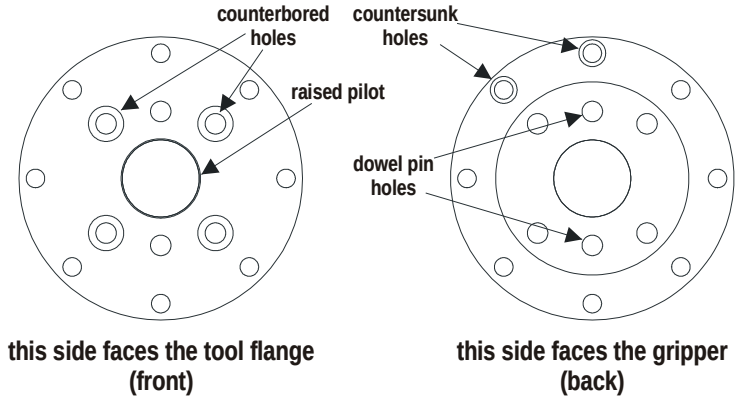


Figure 3-1: Gripper adapter flange for A465 and F3 robot systems

Note: If you are using a homing bracket with your A465 arm, install the tool adapter plate for the homing bracket between the gripper and the gripper adapter flange. For more information on the homing bracket, refer to the Homing Bracket User Guide shipped with your bracket.

To fasten the adapter to the back of the gripper:

1. Line up the gripper adapter flange with the servo gripper so that the holes in the adapter match up with the holes in the back of the gripper.
2. Verify that the countersunk holes on the back of the adapter are on the side opposite the gripper cable. If they are not opposite the cable, turn the adapter clockwise by 180°.

   Note: Placing the countersunk holes opposite the cable makes it easier to fasten the adapter flanges together.

3. Loosely screw four 10-24 x 3/8 in. socket head cap screws into the counterbored holes on the front of the adapter until they are finger-tight.
4. Pressing the tapered end in first, insert the two M5 x 12mm dowel pins into the dowel pin holes. The dowel pins allow you to accurately re-position the gripper in alignment if you need to remove it from the arm.

   Note: The dowel pins are not fixed in place and can easily fall out when the gripper is not attached to the arm.

5. Using a 5/32 in. hex key (not supplied), tighten the cap screws into the back of the gripper.

Fastening the Adapter to the Arm

The thicker of the two adapter flanges mounts onto the tool flange of the arm to provide a secure mount for the gripper adapter.

Note: If you are also installing a force sensor on the arm, use the adapter plate shipped with the force sensor instead of the tool flange adapter shown here. For more information on force sensor installation, refer to the Force Sensor User Guide.

Fastening the Adapter to the A465 Arm

The A465 adapter flange uses four cap screws and a keyway to lock the adapter in place.

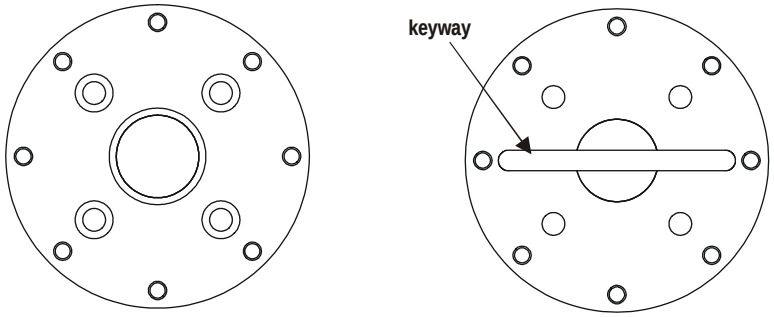


Figure 3-2: Tool flange adapter for A465 robot systems

To install the A465 tool flange adapter

1 Insert the key (shown at right) into the keyway on the tool flange.

2 Press the tool flange adapter against the tool flange, holding the key into place.

3 Loosely screw four 10-24 x 3/8 in. socket head cap screws into the counterbored holes on the front of the tool flange adapter until they are finger-tight.

4. Using a 5/32 in. hex key (not supplied), tighten the cap screws into the tool flange.

Fastening the Adapter to the F3 Arm

A fixed dowel pin and a raised pilot on the F3 tool flange adapter accurately position the adapter on the arm. The dowel pin on the adapter fits into either the tight press-fit hole on the F3 tool flange (for permanent installation), or into the slightly larger dowel pin hole beside it.

Because a press fit requires specialized tools and procedures, you should generally use the larger of the two dowel pin holes. To install the adapter using a press fit, please contact CRS customer service for additional information.

Note: The dowel pin is glued in place on the adapter to prevent it from slipping into contact with joint 6. If the tool flange on your F3 arm is an older model without dowel pin holes, you can remove the dowel pin from the adapter by firmly tapping the pin with a hammer.

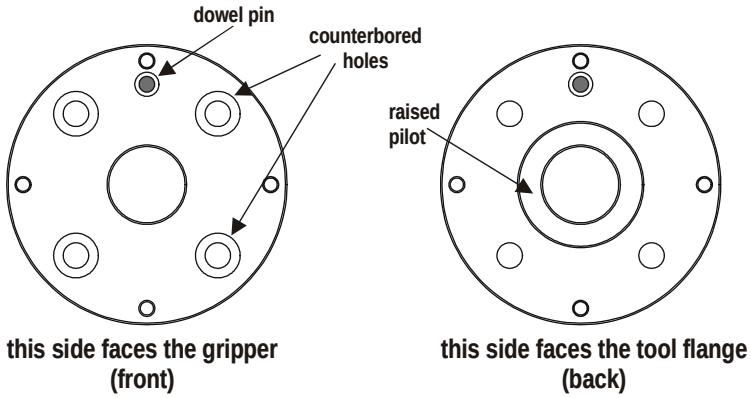


Figure 3-3: Tool flange adapter for F3 robot systems

To install the F3 tool flange adapter

1. Line up the adapter with the tool flange so that the dowel pin fits into the dowel pin hole and the raised pilot (shown in Figure 3-3) mates with the pilot hole on the F3 tool flange. If the dowel pin does not go in easily, turn the adapter counter-clockwise by 90°.
2. Loosely screw four M6 x 8mm socket head cap screws into the counterbored holes on the front of the tool flange adapter until they are finger-tight.
3. Using a 5mm hex key (not supplied), tighten the cap screws into the tool flange.

Mounting the Gripper in the Tool Flange

Once you have installed the required adapter flanges, you are ready to mount the servo gripper on the arm. For the A255 arm, no adapter flanges are required.

Note: If you are using a homing bracket, install the tool adapter plate for the homing bracket between the back of the gripper and the tool flange. For more information on the homing bracket, refer to the Homing Bracket User Guide shipped with your bracket.

To mount the servo gripper in the A255 tool flange:

1. Ensure that the arm is powered off and located in the ready position with joints 4 and 5 limped, as described in “Preparing to Install the Gripper” on page 3-1.
2. Press the two M5 x 12 mm dowel pins into the A255 tool flange.
3. Line up the holes on the back of the servo gripper with the dowel pins and press the gripper onto the A255 tool flange.
4. Using a 5/32 in. ball-head hex key (not supplied), screw the four 10-24 x 3/8 in. socket head cap screws through the tool flange and into the back of the servo gripper,

   Note: The threaded holes for the screws are close to the edge of the tool flange and can be difficult to reach. Use the ball end of the hex key and rotate the wrist joint as needed.

To mount the servo gripper in the A465 tool flange:

1. Ensure that the arm is powered off and located in the ready position.
2. Orient the servo gripper against the tool flange adapter with the cable on top or underneath the gripper.

   Note: When orienting the gripper, consider typical gripper uses in your robot application. For more detail, see “Gripper Orientation” on page 2-2.

3. Press the raised pilot on the servo gripper adapter into the pilot hole in the A465 tool flange adapter.
4. Using a 3/32 in. hex key, insert the 8-32 x 3/8 in. flat head screw into one of the two countersunk holes in the gripper adapter and loosely tighten it into place.

   Note: The countersunk screw helps to accurately locate the gripper in the same position each time the gripper is mounted onto the tool flange.

5. Using a 9/64 in. hex key (not supplied), screw the three 8-32 x 1/4 in. socket head cap screws into place. Only 4 of the 8 holes on the tool flange are used. Choose holes which are easily accessible and are not blocked by the servo gripper covers.

To mount the servo gripper in the F3 tool flange:

1. If you have not already done so, remove arm power, either by pressing an E-Stop button or by shutting down the controller.
2. Align the raised pilot in the servo gripper adapter with the pilot hole in the F3 tool flange adapter.
3. Orient the servo gripper against the tool flange adapter with the cable on top or underneath the gripper.
4. Using a 2.5 mm hex key (not supplied), insert the M4 0.7 x 10 mm flat head screw into one of the two countersunk holes in the gripper adapter and loosely tighten it into place.

   Note: The countersunk screw helps to accurately locate the gripper in the same position each time the gripper is mounted onto the tool flange.

5. Using a 3 mm hex key (not supplied), screw the three M4 0.7 x 10 mm socket head cap screws into place. Only 4 of the 8 holes on the tool flange are used. Choose holes which are easily accessible and are not blocked by the servo gripper covers.

Connecting the Servo Gripper Cable

The servo gripper cable plugs into the round Hirose connector on the side of the wrist. The same cable and connector are used for all CRS arms.

Note: The F3 end of arm I/O option and the servo gripper use similar Hirose connectors to connect to the arm. You can tell the connectors apart by careful visual inspection: the gripper connector uses 5 of the available pins, the end of arm I/O connector uses 11.

To connect the servo gripper cable:

1. If the servo gripper connector is covered with a small black plug, remove the plug and save it for future use.
2. With the arm powered off, align the white dots on the connector and the servo gripper cable.
3. Press until you hear a click.

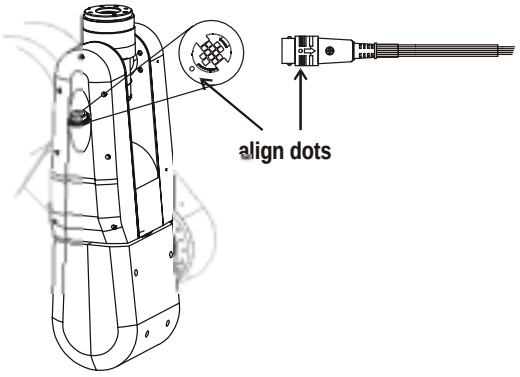


Figure 3-4: When plugging the gripper cable into the arm, align the dots and press until you hear a click.

CHAPTER 4

Testing and Calibration

This chapter explains how to test and calibrate the gripper for use.

In order to test the gripper, you will need a development computer with Robcomm3 and an otherwise functional robot system. This chapter assumes that you have set up and tested your system as described in the User Guide, and that you are aware of safety considerations within the robot workspace.

Setting the Gripper Type

Before using the servo gripper, you must set the gripper type to 'servo'.

To set the gripper type from ash:

1. Turn on the robot system and open a terminal window in Robcomm3.
2. At the $ prompt, enter `ash test`. This opens the Application Shell (ash).
3. Set the gripper type to "servo gripper" by entering:

   ```
   test> gtype servo
   ```

4. Save this setting in the robot system configuration file by entering:

   ```
   test> cfg_save
   ```

   Note: You can also set the gripper type using RAPL-3 commands. See the command `griptype_set` on page 5-5 for a detailed explanation.

Testing the Gripper

If the gripper is properly configured, you should be able to move the gripper fingers.

Testing the gripper from ash:

1. If you have not already done so, turn on arm power.
2. From ash, close and open the gripper fingers by entering:

   ```
   test> grip_close
   test> grip_open
   ```

3. If the gripper fingers do not open or close, perform the following checks:
   - Verify that the controller arm power light is on and no E-Stops have been triggered.
   - Ensure that the gripper cable is firmly connected to the connector on the arm, as shown in Figure 3-4 on page 3-6.
   - Inspect the servo gripper fuse and replace it if necessary. See "Checking the Servo Gripper Fuse" on page 6-6.

   If the gripper still does not work properly, contact CRS customer service.

Calibrating the Servo Gripper

The calibration routine sets the unit scale used by the gripper and stores it permanently in a file on the controller. Under normal use, you will only need to calibrate the servo gripper once, before developing your application.

1. From the ash prompt, enter `\diag\calgrip` to run the gripper calibration routine. The gripper fingers move to their maximum separation and you are prompted to enter a value.

2. Measure the distance between the fingers at maximum separation.

   Note: The separation should be measured in the units you use in your robot applications. If you want to use metric units in your robot applications, enter the distance in mm.

3. Enter the calibration value. For a gripper with standard fingers, the maximum separation is about 65 mm [2.56 in.]

4. The gripper fingers now move to their minimum separation. Using the same units, measure and enter a calibration value for the minimum separation distance. For a gripper with standard fingers, the minimum separation is 0 mm [0 in.]. However, if you are using microplate fingers or have added pads or made modifications the standard fingers, the minimum separation may be larger than 0.

5. Test your calibration by entering `grip` *`gripdistance`*, where *`gripdistance`* is a value between 0 and 65 mm [0 and 2.5 in.] in the units you used to set the open and close position. For example, to move the gripper 50 mm with a metric-calibrated gripper, enter the ash command:

   ```
   test> grip 50
   ```

6. Measure the distance between the gripper fingers. If the gripper is properly calibrated, the distance should be accurate to within 2.4% of the specified distance.

7. If the calibration not accurate to within 2.4%, perform the following checks:

   - Verify that the fingers are tightly fastened to the gripper pads. If the fingers are loose, see “Attaching Gripper Fingers” on page 2-2.

   - Check for backlash. The gripper pads should have a small backlash, not more than ± 0.8 mm [0.03 in]. If the pads slip without engaging the gears, the gripper needs adjustment. See “Adjusting the Set Screws” on page 6-3.

   - Run `\diag\calgrip` again, and measure the distance between the fingers.

   If the gripper still does not function properly, contact CRS customer service for assistance.

Setting the Tool Transform

The tool transform defines the origin for the tool frame of reference as an offset from the center of the tool flange. By default, the origin of the tool frame of reference corresponds to the center of the tool flange.

By setting a tool transform, you can redefine the origin of the tool frame of reference so that movements in tool mode (e.g. `tx`, `txs`, `roll`, `rolls`) are performed around the midpoint between the gripper fingers, or around a fixed location such as a nest.

Warning! *An improperly set tool transform can result in collisions between the tool and objects in the workcell.*

You can set the tool transform in RAPL-3, using the command `tool_set`, or in ash, using the command `tool`. For robot applications where the gripper is the only tool installed on the arm, the ash command `tool` provides a simple means of setting the transform. However, if you need to change end of arm tools between tasks, use the RAPL-3 command `tool_set` to change the tool transform from within a robot application.

See the RAPL-3 Language Reference Guide and the Application Shell guide on your documentation CD for a more detailed discussion of RAPL-3 and ash commands.

Standard Tool Transform Offset Values

Standard values for the X, Y, and Z components of the servo gripper tool transform are given in Table 4-1. The yaw, pitch, and roll components of the transform are always set to zero for a servo gripper mounted directly on the arm.

Note: The offset values in Table 4-1 are different for each robot system because the adapter flanges increase the distance between the fingers and the the tool flange..

Caution! *These offset values are not applicable if you are using non-standard fingers or have installed additional components on the arm.*

Table 4-1: *X, Y, and Z components of the tool transform for a gripper with standard or microplate fingers*

Arm	Fingers Used	X offset	Y offset	Z offset
A255	standard fingers	112.7 mm [4.44 in]	0.0 mm [0.00 in]	0.0 mm [0.00 in]
	microplate fingers	179.1 mm [7.05 in]	0.0 mm [0.00 in]	-28.6 mm [-1.13 in]
A465	standard fingers	125.4 mm [4.94 in]	0.0 mm [0.00 in]	0.0 mm [0.00 in]
	microplate fingers	191.9 mm [7.55 in]	0.0 mm [0.00 in]	-28.6 mm [-1.13 in]
F3	standard fingers	0.0 mm [0.00 in]	0.0 mm [0.00 in]	127.05 mm [5.00 in]
	microplate fingers	28.6 mm [1.13 in]	0.0 mm [0.00 in]	193.5 mm [7.62 in]

Note: If you are using a homing bracket, add 4.8 mm [0.19 in.] to the X offset value for your A465 or A255 arm.

Calculating the Tool Transform

If you are using additional components such as a force sensor or have installed non-standard fingers on your gripper, you will need to calculate the tool transform yourself.

Be careful to assign your measurements to the correct axes for your arm, shown in Figure 4-1.

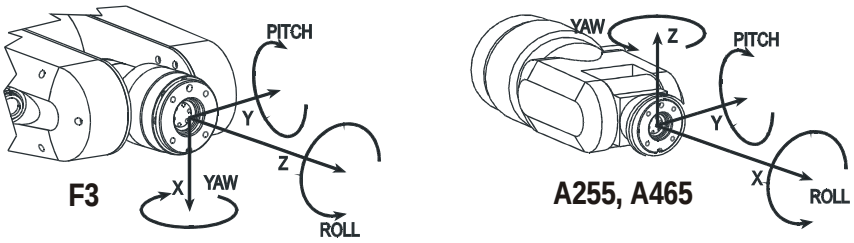


Figure 4-1: The tool frame of reference for the F3 arm is different from the tool frame of reference for the A255 and A465 arms.

Each component added to the end of the arm increases the offset you will need to add to the tool transform. Offset values for common end of arm components used with the servo gripper are provided in Table 4-2.

Table 4-2: *Offsets for end of arm components*

end of arm component	offset added to the transform
servo gripper, no fingers	96.8 mm [3.81 in]
servo gripper + standard fingers	112.7 mm [4.44 in]
servo gripper + microplate fingers	• 179.1 mm [7.05 in] *(out)* • 28.6 mm [1.12 in] *(down)*
gripper adapter	6.4 mm [0.25 in]
F3 tool flange adapter	7.9 mm [0.31 in]
A465 tool flange adapter	6.4 mm [0.25 in]
homing bracket adapter	4.8 mm [0.19 in]
force sensor adapter	6.4 mm [0.25 in]

To calculate the transform:

1 Determine a point that you want to use as the new center for the tool frame of reference, such as the midpoint between the gripper fingers.

2 Calculate the distance from the center of the tool flange to the tool center point along the X, Y, and Z axes of the tool coordinate system. For example, for an A465 with a servo gripper with microplate fingers:

$$X_{offset} = (gripper + fingers) + (gripper\ adapter) + (A465\ tool\ flange\ adapter)$$

$$X_{offset} = 179.1 + 6.4 + 6.4 = 191.9$$

$$Y_{offset} = 0$$

$$Z_{offset} = -28.6$$

Note: In addition to the values in Table 4-2, you may want to consult Appendix A, "Servo Gripper Dimensions" at the end of this User Guide for exact dimensions of the gripper and fingers.

3 Determine the tool transform for your gripper. From the calculation above, using millimeters, the tool transform would be:

```
(191.9, 0, -28.6, 0, 0, 0)
```

The yaw, pitch, and roll about the tool flange are always set to zero.

Setting the Tool Transform Value

You define a tool transform by declaring a cloc variable and setting its value to the coordinates of the new tool center point. However, unlike other cloc variables, you only need to specify X, Y, Z, yaw, pitch, and roll for the tool transform. All other members of the cloc structure are ignored by the `tool_set` and `tool` commands.

You can change the tool transform from ash or from within a RAPL-3 program application. Once set, the motion control engine (MCE) uses the tool transform to calculate trajectories for all robot applications.

Note: Unless they are saved to the configuration file, variables in memory are lost when the controller is shut down.

To set the tool transform:

1 Set the tool transform using the coordinates from Table 4-1 on page 4-3 or your calculated offset coordinates for the tool center point.

- In ash, by entering `tool` *`X, Y, Z, yaw, pitch, roll`*
- In RAPL-3, by typing `tool_set(cloc{0,`*`X, Y, Z, yaw, pitch, roll,`* `0, 0})`

where *X*, *Y*, *Z*, *yaw*, *pitch*, and *roll* are the distances calculated from the tool flange center. This saves the new transform in memory on the controller.

2 To permanently save the tool transform, you must update the system configuration file with the new settings. Save the configuration as follows:

- In ash, by entering `cfg_save`
- In RAPL-3, by entering `robot_cfg_save()`

3 The tool transform is now set for your gripper.

CHAPTER 5

Using the Servo Gripper

This chapter explains how to integrate the gripper into your robot system. You can control the gripper both by issuing commands directly from the Application Shell (ash), and by using gripper commands in your RAPL-3 development applications. You can also issue simple commands from the teach pendant.

In order to program applications which use the gripper, you need a development computer with Robcomm3 and an otherwise functional robot system. This chapter assumes that you have set up and tested your system as described in the User Guide, and that you are familiar with application development. If you are unfamiliar with the RAPL-3 terms and syntax used in this chapter, review the material in the Application Shell guide and the RAPL-3 Language Reference Guide included on your documentation CD before continuing.

An example in RAPL-3 and a summary of all gripper commands are included at the end of this chapter.

Warning! Take care not to over-rotate joint 6 when using the gripper with an F3 robot system. *The F3 wrist (joint 6) can rotate through more than 360°. Over-rotating the wrist will wind the gripper cable tighter and tighter around the joint. The strain could damage the gripper, the gripper cable, and the F3 arm.*

Gripper Control Modes

The servo gripper operates in two distinct control modes: *force mode* and *position mode*. Force mode commands let you open or close the gripper fingers with a precise amount of force, but give you no control over position. In position mode, you can accurately position the gripper fingers but you cannot control the amount of force.

Warning! Never use a positional gripper command to grip an object. *Position commands are used to accurately position the gripper fingers and operate at maximum gripper force. When applied to an object, this force can damage the gripper motor and shorten the life of your gripper.*

Executing a Force Mode Command

When a force mode command is executed, the servo gripper voltage increases until the fingers are moving with the specified amount of force. The motor continues to operate at this voltage until the fingers contact an object or a hard stop limit.

Note: A force of 30% or greater is required when opening or closing the gripper fingers from a stationary position. This force is required in order to overcome the stiction of the fingers. For very fragile objects, you can reduce the grip force once the fingers are in motion.

If there is nothing available to grip, the fingers move to the end of their travel. The specified force is maintained until another gripper command is issued.

Warning! Take care not to damage the microplate fingers. *Grip forces greater than 50% can bend microplate fingers out of shape and may cause damage over time. Take care when selecting the grip force for your application.*

Executing a Position Mode Command

Position mode commands let you accurately set or read the position of the gripper fingers. In position mode, the gripper fingers move **at maximum gripper force** until the feedback potentiometer detects that the fingers are at the specified location. At the commanded position, the gripper fingers stop moving and maintain their position.

Use position mode commands to improve the efficiency of your gripper application. By precisely specifying how far apart the fingers should open or close for a particular task, you can reduce the time necessary to complete the operation.

After calibration with the ash routine `\diag\calgrip`, positional gripper commands are accurate to within 2.4%.

Operating the Gripper from the Teach Pendant

You can use the teach pendant keys shown in Figure 5-1 to position the gripper fingers when teaching robot locations from within the robot workcell. The teach pendant must be in manual operation mode for the gripper keys to be operational.

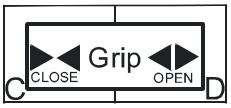


Figure 5-1: Use the Grip Close and Grip Open keys on the teach pendant to operate the gripper.

To open or close the gripper with the teach pendant:

1. With the teach pendant in motion mode, hold in the live-man switch and press the Grip Close or the Grip Open key.
2. The gripper fingers move in the specified direction with 100% force until you release the key or the fingers reach the end of their travel.
3. When you release the key, the fingers maintain their position until another gripper command is issued. If an object is held between the fingers, grip force is maintained.

Gripper Command Syntax

This section provides a review of the RAPL-3 gripper commands and lists the ash command where one exists. For a more complete reference to RAPL-3 and ash commands, you should refer to your Application Development Guide.

Note: A summary of common servo gripper commands and a commented RAPL-3 example are included at the end of this section.

grip

RAPL-3: **`grip`**(*`distance`*)

ash: **`grip`** *`distance`*

Position mode command. Moves the gripper fingers to the specified separation distance with maximum gripper force. The distance must be specified in the same units used to calibrate the gripper. See “Calibrating the Servo Gripper” on page 4-2 for a description of the gripper calibration routine.

Warning! Never use the `grip` ***command to directly grip or hold an object.*** *All position commands operate at maximum gripper force. When applied to an object, this force can damage the gripper motor and shorten the life of your gripper.*

Use `grip` to improve efficiency when releasing a part or preparing to grip an object. Do not use `grip` to pick up objects, use the force commands `grip_open` or `grip_close` instead.

grip_cal

RAPL-3: **grip_cal**(*mindist, maxdist*)
ash: **\diag\calgrip**

Sets the unit scale used by the gripper and stores it permanently in a file on the controller. See "Calibrating the Servo Gripper" on page 4-2 for a more detailed description of how to calibrate the gripper from ash. In RAPL-3, you can specify the calibration as follows:

```
grip_cal(0,65)          ;; for fingers with a travel distance of 65 mm.
```

grip_close

RAPL-3: **grip_close**(*%force*)
ash: **grip_close** *%force*

Force mode command. Closes the gripper fingers on an object with the specified % force. For example, in RAPL-3,

```
grip_close(50)          ;; closes the gripper with 50% maximum force
```

grip_open

RAPL-3: **grip_open**(*%force*)
ash: **grip_open** *%force*

Force mode command. Opens the gripper fingers inside an object with the specified % force. For example, in RAPL-3,

```
grip_open(50)           ;; opens the gripper with 50% maximum force
```

gripdist_get

RAPL-3: **gripdist_get**(*distance*)
ash: **wgrip**

Reads the current finger separation as a value relative to the gripper calibration. I.e., if the gripper is calibrated in millimeters, the value returned will also be in millimeters. For example, in RAPL-3:

```
int distance;; defines a variable called distance
gripdist_get(distance)  ;; sets distance equal to the finger separation
```

gripisfinished

RAPL-3: **gripisfinished**()

Used to determine whether the gripper fingers are still in motion. This can be used to synchronize applications with gripper motion. For example, in RAPL-3:

```
while not gripisfinished()    ;; while the gripper fingers are moving
  printf("Gripping... Wait.\n") ;; print a status message
  delay(100)                  ;; wait 100 millisecords
else
  printf("Done.\n")           ;; print a different status message.
end while
```

gripper_stop

RAPL-3: **gripper_stop**()

Stops gripper motion. If an object is held in the gripper when the gripper_stop() command is issued, grip force is maintained. Otherwise the fingers remain in place in positional mode.

griptype_get

RAPL-3: **griptype_get**(*gtype*)

ash: **gtype**

Returns the current gripper type setting. See griptype_set.

griptype_set

RAPL-3: **griptype_set**(*gtype*)

ash: **gtype_set** *type*

Sets the type of gripper used by the robot application. For servo gripper applications, always set the gripper type to GTYPE_SERVO (RAPL-3) or servo (ash).

Note: For pneumatic applications, gripper type is set to GTYPE_AIR (RAPL-3) or air (ash).

robot_cfg_save

RAPL-3: **robot_cfg_save**()

ash: **cfg_save**

Saves the robot configuration in memory to the configuration file \conf\robot.cfg on the controller. See “Setting the Tool Transform” on page 4-3 for an example using this command.

tool_set

RAPL-3: **tool_set**(*transform*)

ash: **tool** *x*, *y*, *z*, *yaw*, *pitch*, *roll*

Sets the tool transform for the tool frame of reference used by the robot system. The default tool frame of reference is relative to center of the tool flange. You can use tool_set to reposition the center of the tool frame of reference between the gripper fingers, so that movements are effected about the center of the gripped object.

Note: Tool transforms set from ash are erased on exiting the shell. Use the RAPL-3 tool_set command to set the tool transform for robot applications.

Servo gripper command summary

Table 5-1 presents a summary of the RAPL-3 and ash commands discussed in this chapter. For more detail, see the Application Development Guide for your robot system.

Table 5-1: *Alphabetic list of gripper commands*

Servo Gripper Commands		Application Use
RAPL-3	**ash**	
grip(*distance*) **gripdist_set**(*distance*)	**grip** *distance*	Move the gripper fingers to the specified separation distance **at maximum gripper force**.
grip_cal(*mindist, maxdist*)	**\diag\calgrip**	Calibrate the positional servo system for the gripper. This defines the unit scale used in position mode for all robot applications.
grip_close(*%force*)	**grip_close** *%force* **gclose** *%force* **gc** *%force*	Close the gripper with the specified percentage of maximum gripper force.
grip_finish()		Wait for the gripper fingers to finish moving before continuing with the next command.
grip_open(*%force*)	**grip_open** *%force* **gopen** *%force* **go** *%force*	Open the gripper with the specified percentage of maximum gripper force.
gripdist_get(*distance*)	**wgrip**	Get the distance between the gripper fingers.
gripisfinished()		Used to synchronize applications with gripper motion.
gripper_stop()		Stop gripper motion. If an object is held in the gripper fingers, grip force is maintained.
griptype_get()	**gtype**	Get the current gripper type.
griptype_set(*gtype*)	**gtype** *type*	Set the gripper type. In RAPL-3, *gtype* can be set to GTYPE_SERVO or GTYPE_AIR. In ash, *type* can be set to servo or air.
robot_cfg_save()	**cfg_save**	Saves the robot configuration in memory (including gripper type and the tool transform) to the configuration file \conf\robot.cfg.
tool_set(*transform)*	**tool**	Set the tool transform. The *transform* must be a valid cloc tool transform. **An incorrectly specified tool tranform can cause a collision.**

A RAPL-3 Example

The following example illustrates how gripper commands in RAPL-3 can be used to grip a part and perform measurements. For more detail on RAPL-3 programming, see the Application Development Guide for your robot system.

Note: Although this example sets the gripper type and calibration in order to illustrate command syntax, these are usually saved to the calibration file and do not need to be specified for each application.

Gripping and measuring an object

```
main
  teachable cloc pick          ;; define the teachable location 'pick'
  float MinSize, PartSize
  griptype_set(GTYPE_SERVO)    ;; set griptype to servogripper
  grip_cal(0.0,65.0)           ;; define maximum gripper travel as 65 mm
  MinSize= 25                  ;; define a minimum part size
  appro(pick, 50)              ;; approach pick,stop at a distance of 50 mm
  grip(70)                     ;; move gripper fingers 70 mm apart
  grip_finish()                ;; wait for the gripper to finish moving
  move(pick)                   ;; move to the ‘pick’ location
  finish()                     ;; wait for the arm to finish moving
  grip_close(50)               ;; close the gripper with 50% force
  grip_finish()                ;; wait for the gripper to finish moving
  depart(100)                  ;; depart to a distance of 100 mm
  gripdist_get(PartSize)       ;; get the distance between the fingers
  if(PartSize < MinSize)       ;; see if an object was gripped
     printf("Error! No part within reach.\n") ;; if not, report an error
  else
     printf("Part found. \nPart measures {} mm\n", PartSize) ;; print the
size
  end if
  move(pick)                   ;; return the part to the pick location
  finish()
  grip_open()                  ;; release the part
  grip_finish()
  ctl_rel()                    ;; release point of control
end main
```

CHAPTER 6

Maintenance Procedures

Under normal use, your gripper should require little or no maintenance. However, due to operating conditions or collisions within the workcell, you may occasionally need to clean or repair the gripper. This chapter contains basic maintenance and repair procedures for the servo gripper.

Inspecting the Gripper for Wear

Inspect the servo gripper for signs of wear or damage at least twice a year. If the gripper is exposed to harsh operating conditions, perform inspections more frequently.

Servo Gripper Inspection points:

- **Dust and contaminants.** If necessary, clean any accumulated dust or other contaminants from the surface of the gripper.
    - The bellows should be cleaned with a dry cloth. **Do not use water or other solvents to clean the bellows.** Chemical cleaners may damage the lubricated bellows material.
    - The gripper body and fingers can be cleaned with a damp cloth. **Do not use spray cleaners**. The gripper is not sealed and can be damaged if liquids enter inside the gripper casing.
- **Deterioration of the bellows.** The bellows between the gripper fingers protect the gears inside the gripper from damage due to contaminants.
    - Visually inspect the bellows for frayed edges, holes, cracks or tears.
    - Look for any folds which bend backwards and impede the motion of the fingers.
    - If the folds stay stuck together when the fingers are opened, see “Lubricating the Bellows” on page 6-3.

    If you detect evidence of wear or damage, the bellows must be replaced. Contact your CRS representative for assistance.
- **Screw tightness.** Under normal use, the gripper screws should not become loose.
    - If the screws connecting the gripper fingers to the gripper pads are loose, remove the screws as in “Removing Gripper Fingers” on page 2-2, and add a thread locking compound such as Loctite to the holes before re-tightening.
    - If the screws connecting the microplate finger sides to the finger base are loose, **DO NOT TIGHTEN**. See “Recovering from a Collision” on page 6-5.

Warning! Never try to tighten the flat head screws on the sides of the microplate fingers. *These screws are designed to break off in order to protect the fingers. Loose screws are damaged and must be replaced.*

- **Gripper pad backlash**. The metal pads beneath the gripper fingers should not move without engaging the gears inside the gripper. If you find that the gripper pads seem loose, or ‘wiggle’ when gently pushed, the gripper may require adjustment. See “Adjusting the Set Screws” on page 6-3.

Lubrication

Regular lubrication can extend the life of your gripper. If you are operating the gripper under harsh conditions, the lubricant covering the bellow material may need replacing. Lubricating internal bearings and gears also helps to prolong the life of your gripper.

Note: The servo gripper gear head does not require lubrication.

Lubricating the Bellows

If you notice that the bellow folds stick together when the fingers are opened, re-lubricate the bellows with a light coat of LPS silicone spray.

Use only LPS silicone spray to lubricate the bellows. *Other lubricants can damage the bellows material and interfere with the operation of the gripper.*

Lubricating the Gripper

According to the manufacturer's specifications, the linear bearings inside the gripper may require re-lubrication every 100 km, or once yearly. Contact CRS customer service for more information on returning your servo gripper for re-lubrication and whether this is necessary for your application.

Adjusting the Set Screws

A pair of brass set screws on the top and bottom of the gripper lock the rails into place within the gripper body, as shown in Figure 6-1.

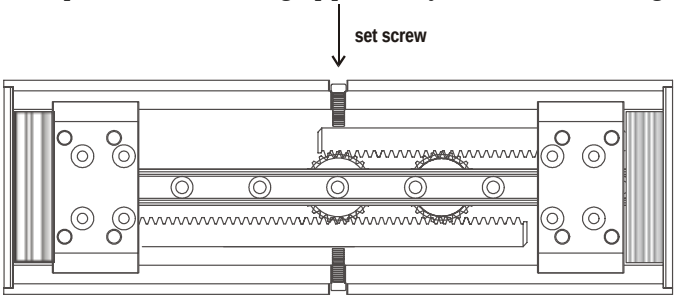


Figure 6-1: Cut-away front view of the inside of the gripper, showing the brass set screws.

If the pads slip without engaging the gears, or the gripper fingers are hard to open and close, you may need to adjust the position of the set screws.

Take care when adjusting set screws. Only a small adjustment is generally required. *Adjusting the set screws too far in or out may further degrade the performance of your gripper. Excessive manipulation will loosen the set screws.*

Each time you adjust the set screws, they become indented where the tip contacts the rail. Subsequent adjustments degrade the screws further, and adjustments will need to be performed more and more often.

If the set screws become too loose, you can apply a drop of low strength thread locking compound (e.g. Blue Permalock MM115) to the threads. Replacement set screws for the servo gripper are also available from CRS Robotics.

Correcting Backlash

If the gripper fingers can be moved more than ± 0.8 mm [0.03 in] without engaging the gears inside the gripper, the set screws must be tightened.

To tighten the set screws:

1. Using a 5/64 in. hex key, tighten the top and bottom set screws by a small increment. Both screws should be adjusted by the same amount.

   Note: Generally 1/32 of a turn or less is required to correct backlash.

2. If the fingers are still loose, tighten the set screw and check the play in the finger pads again. Continue tightening the set screw by small increments until the fingers are no longer loose.
3. Using your hand, push the gripper fingers open and closed. The gripper fingers should move smoothly in the gears, without excessive resistance. If the gripper fingers are difficult to open and close, you have overtightened the set screws.

If the backlash cannot be corrected by adjusting the set screws, a component inside the gripper may need to be replaced. Contact CRS customer service for assistance.

Correcting Gripper Stiffness

If the gripper fingers are stiff and difficult to open and close, you may need to loosen the set screws.

To loosen the set screws:

1. Using a 5/64 in. hex key, loosen the top and bottom set screws by a small increment. Both screws should be adjusted by the same amount.

   Note: Generally 1/32 of a turn or less is required.

2. If the fingers are still difficult to open and close, loosen the screws further.
3. Verify that the metal pads beneath the gripper fingers do not move without engaging the gears inside the gripper. If you find that the gripper pads ‘wiggle’ when gently pushed, the set screws are too loose.

If adjusting the set screws does not help, your gripper may require more serious maintenance to return it to alignment. Contact your CRS representative for assistance.

Recovering from a Collision

If the gripper collides with an object while microplate fingers are installed, or you suspect damage to the microplate fingers, perform the following inspection and remove or repair the fingers as required.

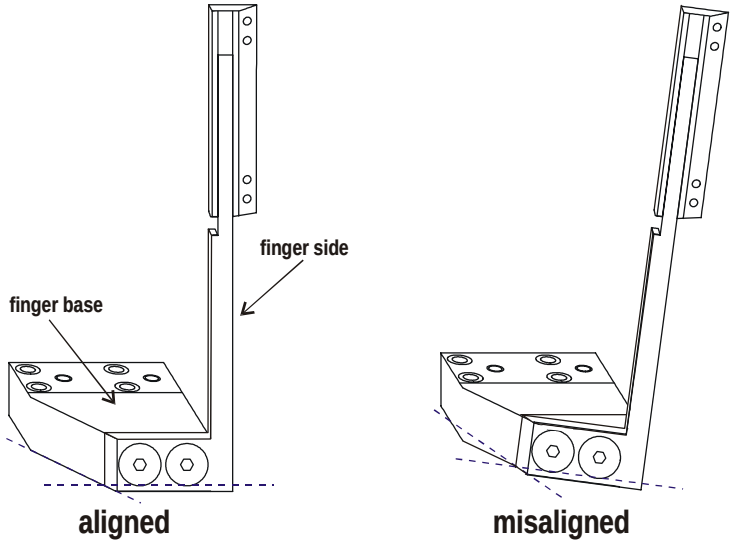


Figure 6-2: Alignment and misalignment of the microplate finger side and base

To inspect the fingers for damage:

1. Sight along the finger sides and determine whether the fingers are bent out of shape. The finger sides should be straight and parallel.
2. Push the gripper fingers to their full separation distance and carefully examine the alignment between the finger sides and the finger base. The finger sides should be exactly aligned and flush with the bottom of the finger base, as shown in Figure 6-2.
3. Verify that the finger sides are fastened securely to the finger base. The finger sides should not move relative to the base.

Warning! Never try to tighten the flat head screws on the sides of the microplate fingers. *These screws are designed to fail in order to protect the fingers. Loose screws are damaged and must be replaced.*

4. If you discover any evidence of misalignment, you must remove the finger sides and replace the flat head screws used to secure them.

Any deviation from alignment indicates that the screws have been stretched and damaged by the collision. If the damaged screws are not replaced, they will eventually break off inside the finger assembly and may be difficult to remove. Do not reuse damaged screws.

If the fingers are bent out of alignment, you can order replacement finger sides from CRS. To avoid downtime, you can also attempt to straighten the finger sides with hand tools. **Always remove the finger sides from the gripper before attempting to straighten them.** Finger sides which have been straightened after a collision may not be as accurate.

To remove the microplate finger sides from the base:

1 Using a 3/32 in. hex key, remove the two 8-32 x 1/2 in. flat head cap screws from the sides of each finger. You do not need to remove the finger base from the gripper pads.

Note: Damage to the screws may not be visible to the eye. Always discard screws which might have been damaged in a collision.

2 Remove the finger sides from the base.

To replace the microplate finger sides on the base:

1 Insert two 8-32 x 1/2 in. flat head cap screws into the finger side and loosely tighten until they just contact the countersunk hole in the finger side.

Note: To ensure a tight fit, you can apply Loctite to the holes in the finger base before tightening the finger sides to the base.

Warning! Do not apply locking compounds to the flat head screws on the finger sides. *These screws are designed to fail in order to protect the fingers. A locking compound can make these screws very difficult to remove.*

2 Carefully align the finger side with the finger base, as shown in Figure 6-2. The bottom of the finger side must be parallel with the base.

3 Using a 3/32 in. hex key, tighten the screws to 36 in-lb. [41.5 kg-cm], or turn the screws 1/8 turn from the contact position. **Do not over-tighten**. The threaded holes in the finger base are easily stripped. 1/8 turn is sufficient to secure the finger sides to the base.

Checking the Servo Gripper Fuse

Under normal operating conditions, the servo gripper fuse should not need replacing. A blown fuse may indicate a more serious problem with your controller or the servo gripper. If you replace the gripper fuse often within a short period of time, contact CRS customer support for assistance.

To inspect and replace the servo gripper fuse:

1 With the controller shut down and powered off, open the fuse panel on the front panel of the C500C controller.

2 Remove the servo gripper fuse:

- The F3 does not have a dedicated servo-gripper fuse. The servo gripper is fused through the 24 V power supply (fuse clip F4)
- For the A255 and A465 arms, the servo gripper fuse is in fuse clip F8.

3 Measure the resistance across the fuse. If the resistance is larger than 2 Ω, the fuse has blown and must be replaced.

4 Insert a new fuse in the fuse clip:

- For the F3, use a 1A, 250 VAC slow-blow fuse.
- For the A255 and A465 arms, use a 0.38 A, 250 VAC slow-blow fuse.

5 Close the fuse panel and try to use the gripper. If the gripper still does not function normally, see “Resolving Connection Problems” on page 7-2.

CHAPTER 7

Troubleshooting Procedures

This chapter contains diagnostic procedures to help you correct problems with the gripper. If a problem cannot be resolved easily, contact CRS customer service for assistance.

Warning! The servo gripper does not contain any user serviceable parts. Do not open the servo gripper covers. *Your servo gripper has been precisely aligned and calibrated at the factory and should only be opened by CRS-qualified service personnel.*

Decreased Accuracy

Your servo gripper should be accurate to within 2.4% of the maximum separation distance. If you notice that the accuracy of your servo gripper has degraded, perform the following checks:

- Verify that the fingers are tightly fastened to the gripper pads. If the fingers are loose, see “Attaching Gripper Fingers” on page 2-2.
- Check for backlash. The gripper pads should not move without engaging the gears inside the gripper. If the pads slip against the gears, the gripper needs adjustment. See “Adjusting the Set Screws” on page 6-3.
- Re-calibrate the gripper as described in “Calibrating the Servo Gripper” on page 4-2.

If the gripper still does not function properly, contact CRS customer service.

Fingers Are ‘Locked’ and Do Not Move

If you cannot open or close the fingers on your servo gripper, perform the following checks:

1. With the gripper unplugged from the arm and arm power off, open and close the fingers by pushing against them with your hand.
2. If the fingers open and close smoothly with the gripper unplugged from the arm, check the servo gripper fuse. If the fuse is intact, there may be a connection problem inside the arm. See “Resolving Connection Problems” on page 7-2.
3. If the fingers cannot be moved manually, the set screws may be too tight. See “Adjusting the Set Screws” on page 6-3.

If you still cannot move the fingers, contact CRS customer service.

Resolving Connection Problems

If you suspect that there is a problem with the connection between the servo gripper and the arm, you should begin by inspecting the cable and connector.

To inspect the cable and connector:

1. Visually inspect the cable for damage. There should not be any breaks in the cable insulation. Make sure that the cable is strain relieved at both ends.
2. Unplug the servo gripper from the connector on the arm.
   a. Verify that the pins are straight and free of dust or debris.
   b. Plug the servo gripper back into the arm connector and press firmly until you hear a click.
3. Issue a gripper command and observe the result.

If the gripper still does not respond, there may be a connection problem within the arm. If you have an F3 robot system, you can test communication with the amplifiers in the arm, including the amplifier on the servo gripper board. Otherwise, contact CRS customer support for assistance.

Testing communication with the gripper on an F3:

1. Using your development computer, issue the following command at the ash prompt:

   ```
   test> ampstat
   ```

2. The `ampstat` command returns the status of all amplifiers in the F3 arm. Verify that all amplifiers report OK. If any amplifiers report error status, contact CRS customer service for assistance.
3. At the ash prompt, enter:

   ```
   test> wgrip
   ```

   The `wgrip` command should return a value for the finger separation distance.

If an error message is reported, contact CRS customer service for assistance.

APPENDIX A

Servo Gripper Dimensions

This appendix contains exact measurements for the servo gripper with both standard and microplate fingers. When planning a robot application or designing custom fingers, refer to these diagrams for specific dimensions.

Servo Gripper with Standard Fingers

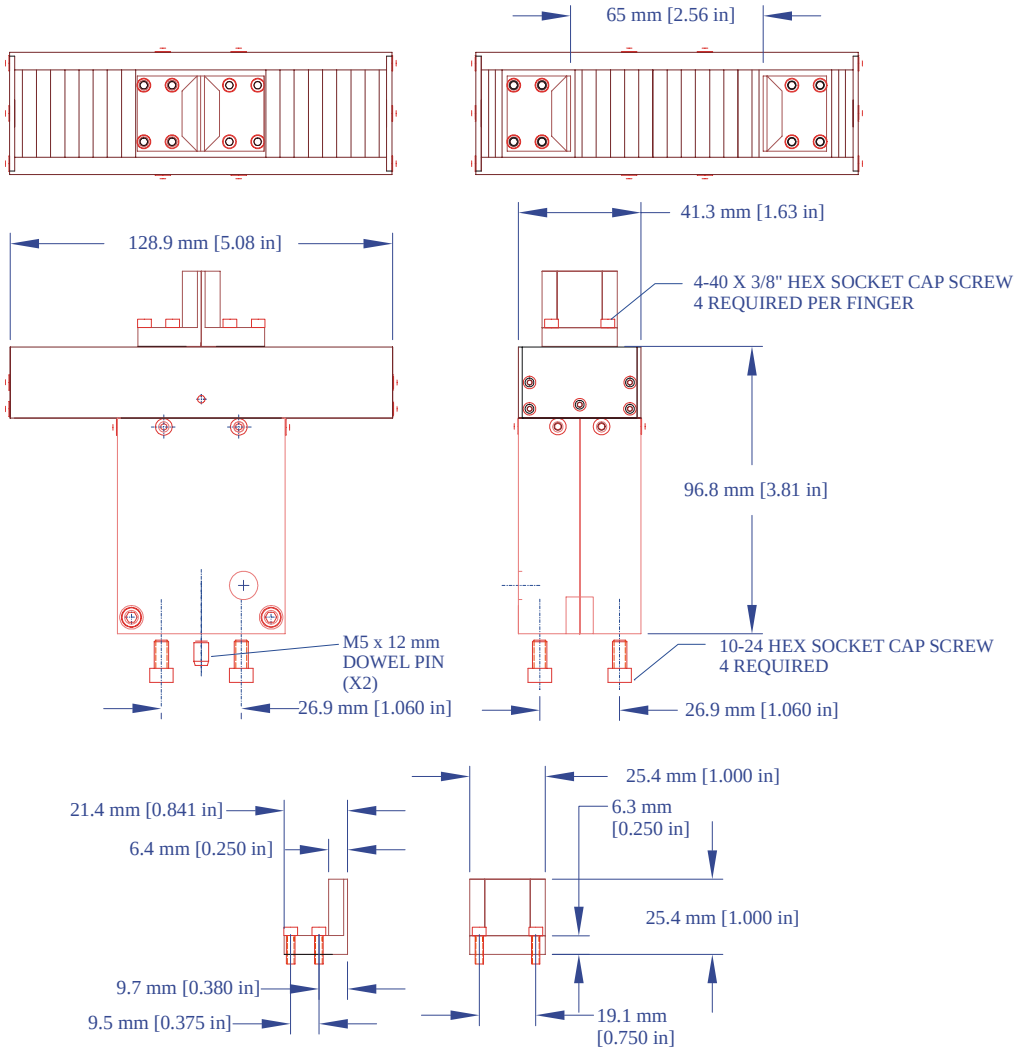


Figure A-1: Dimensions of the servo gripper and standard fingers.

Servo Gripper with Microplate Fingers

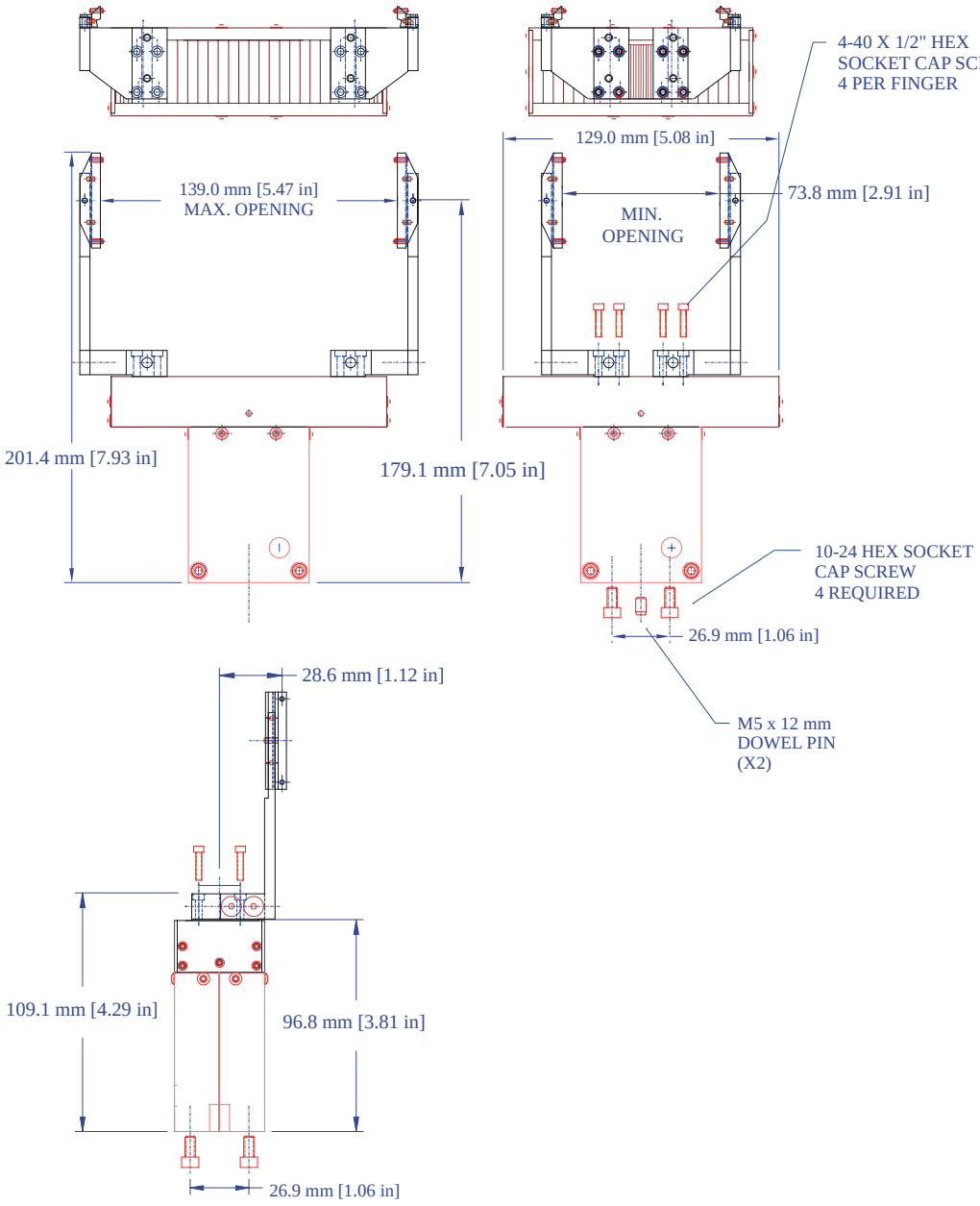


Figure A-2: Dimensions of the servo gripper and microplate fingers.

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