Gecko Gripper
User Manual

Table of Contents

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https://onrobot.com/products/gecko-gripper/

1. Preface: Gecko Gripper Technology

The Gecko Gripper is a robot gripper that uses gecko-inspired adhesion to pick up flat objects without an air system.

1.1. Gecko Gripper Nomenclature

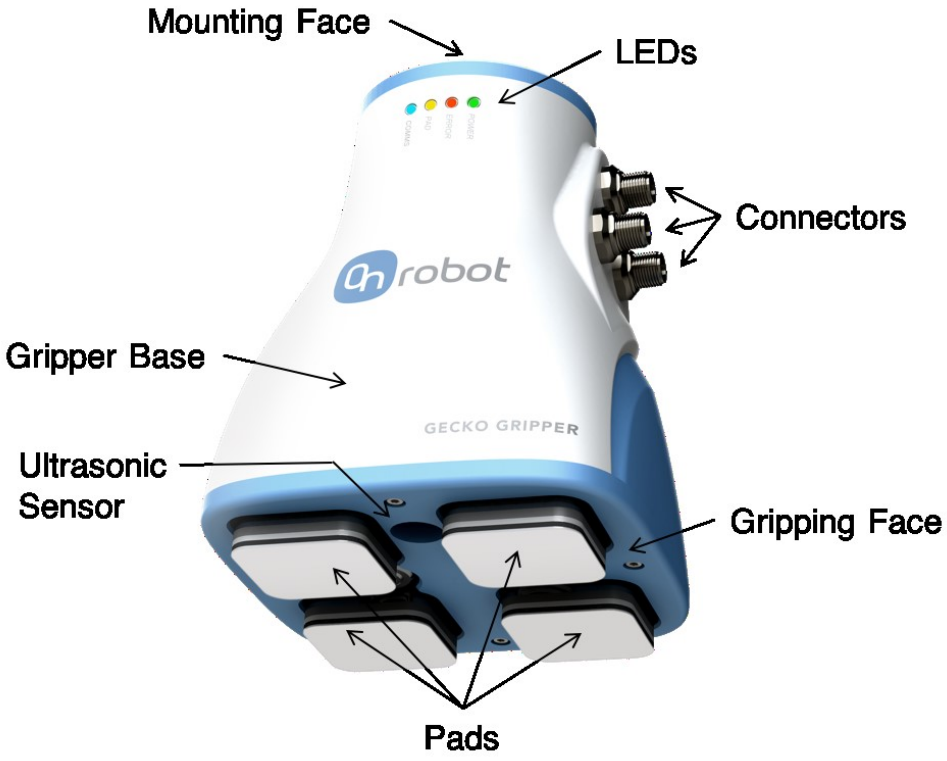

Figure 1. Gecko Gripper Nomenclature.

The gripper design features a structural **base** that also encompasses the sensing and control electronics. The top of the structural base is the **mounting face**, which is physically mounted on the robot. Opposite the mounting face, the **gripping face** presents four gripper **pads** arranged in a 2x2 grid that perform the adhesion action. The pads have a proprietary adhesive gripping technology that enables the gripper to efficiently attach and lift flat and smooth objects *without* an air system. The gripper pads are removable and can be fully replaced as part of a recommended routine maintenance schedule. The gripping face also contains an **ultrasonic sensor** that monitors an object's presence. The front face of the gripper base displays four (4) **LEDs** that display information about the gripper's state. The three (3) **connectors** for gripper power, communication, and power for the optional autonomous piezoelectric cleaning system are located on the right side of the gripper base. Power (24V) is supplied through the I/O connector. Data is passed via either the Ethernet connector (8 pins) or the I/O connector (10 pins).

1.2. How the Gecko Gripper Works

The Gecko Gripper attaches to flat and smooth object surfaces through the same mechanism used by an actual gecko (van der Waals forces). This is accomplished through contact with adhesive pads in a *preload-hold-detach* fashion.

The gripper creates adhesion by preloading the pads with a small force normal to the object's surface.

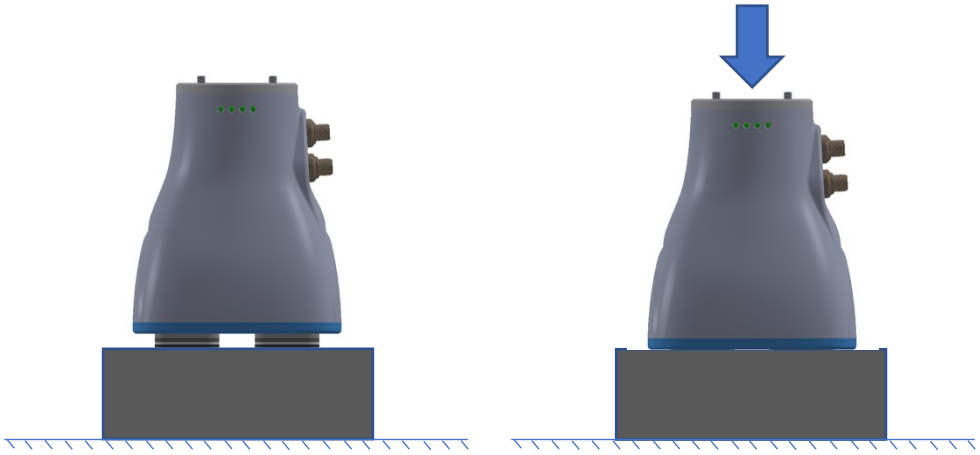

Figure 2 Gecko Gripper placement on substrate (left) and applying a preload force, compressing the pads (right).

After preloading, the gripper can hold and move the object with no additional force application.

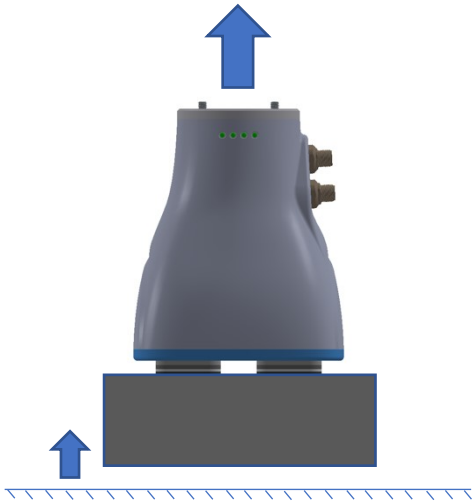

Figure 3 The gripper can lift the substrate.

As specified by the robot protocol, the gripper will detach from the object by withdrawing the pads into the gripper housing. The gripper pads are reusable and do not leave "sticky" residue on surfaces. The pads will wear out over time (dependent upon the object's material) and can be easily replaced using the pad replacement tool. Furthermore, the

gecko-like pad technology enables the gripper to attach and detach on fast timescales (e.g. detachment 500msec).

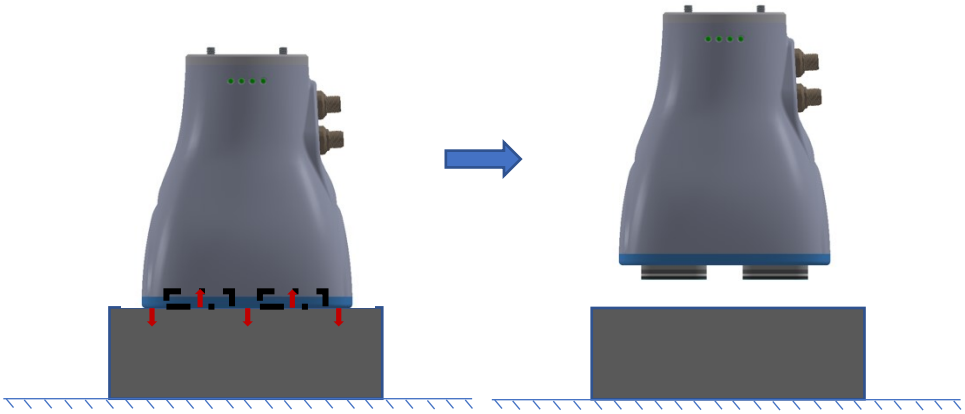

Figure 4. The Gecko Gripper retracts the adhesive pads in order to detach from the substrate.

1.3. Overview of Key Operating Principles

Because of the Gecko Gripper's unique mechanism of action, it is important to understand the following key operating principles to use the gripper correctly and to achieve optimal gripper performance. **This is VERY important.**

- **Surface Roughness Affects Gripping**
  The Gecko Gripper works best with highly polished surfaces that allow for maximal contact between the adhesive pads and the substrate surface. As the surface becomes less smooth, more preload force is required to grip substrates. Matte surfaces should be considered the maximal surface roughness limit which the gripper is able to grip.
  See Section 8.4 for further information.

- **Environmental Conditions Affect Gripping**
  The adhesive pads use van der Waals forces to attach to a substrate. If there is dust or debris on the substrate surface, the pads will interact with these particles instead. Dusty, greasy, oily, or wet substrates will **not** adhere to the Gecko Gripper. The Gripper works best with clean, smooth, and dry surfaces.
  See Section 8.5 for further information.

- **Preload Force Determines Maximum Payload Force**
  The adhesion force is also dependent on the amount of preload force applied to the surface. This preload force also depends on the surface smoothness or roughness. A minimum threshold of preload force is required to grip and move any payload. The payload force then increases with a corresponding increase in preload force. Finally, payload force is also saturable at some preload force specific to the material and operating conditions.
  See Section 8.4 for further information.

- **Reconcile Gripper Function with Robot Collision Detection or Other Safety Systems**
  When using the Gecko Gripper with a robot in position control, care must be taken during the gripping phase of the object as to not trip off the robot's collision detection system. The most force the gripper will ever need to exert on an object is 150N for maximal adhesion. Based upon your robot type and object, it may be necessary to adjust the robot's collaborative or collision settings to preclude tripping off the robot upon contact.

- **Pick Location and Object Moments Can Overcome Gripping Force**
  Gripper adhesion specifications assume that the center of gravity of the object is equidistant from the gripper pads. If the center of gravity of the object is not centered or moments are applied to the object, robot-object movement can decrease the adhesion force of the gripper causing it to drop the objects.
  See Section 8.5 for further information.

- **Pads will Wear Out**
  Over time, the gecko pads will wear and require replacement. There is no deterministic way to determine how worn the pads are, so the user must be mindful of the pad change-out interval. This will depend on the environment in which the pads are used. While pad wear cannot be measured, a dropped part can be detected, and the robot informed of the event. The "pad wear" LED will also light up, informing the user that action is required.
  See Section 7.1, 7.2 and 10 for further information.

2. Safety

The Gecko Gripper is a piece of industrial equipment, intended as an end-effector or tool for industrial robots. It is intended for pick and place operations of flat, smooth objects. Misuse can cause damage to the Gripper or the connected equipment.

2.1. Validity and Responsibility

The information in this manual is not a guide to design a complete robotic application. The safety instructions are limited to the Gecko Gripper only and does not cover the safety precautions of a complete application. The complete application must be designed and installed, in accordance with the safety requirements specified in the standards and regulations of the country where the application is installed.

The application integrators are responsible for ensuring that the applicable safety laws and regulations in the country concerned are observed and that any significant hazards in the complete application are eliminated.

This includes, but is not limited to:

- Making a risk assessment for the complete application.
- Validating that the complete application is designed and installed correctly.

2.2. Limitations of Liability

The safety instructions and other information in this manual is **not** a guarantee that the user will not suffer injury, even if all instructions are followed.

2.3. Warnings in this Manual

DANGER! This indicates a very dangerous situation which, if not avoided, could result in injury or death.

CAUTION This indicates a potentially hazardous situation which, if not avoided, could result in injury or damage to the equipment.

NOTICE This indicates additional information such as tips or recommendations.

2.4. General Warnings

This section contains general warnings regarding use of the Gecko Gripper.

1. Make sure that the Gripper is properly mounted.

2. Make sure the Gripper does not collide with obstacles.

3. Never use a damaged Gripper.

4. Make sure not to have any limbs in contact with or between the Gripper housing and mounting face when it is operating or in teach mode.

5. Make sure to follow the safety instructions of all equipment in the application.

6. Never modify the Gripper! A modification might cause dangerous situations.

7. OnRobot A/S DISCLAIMS ANY LIABILITY IF THE PRODUCT IS CHANGED OR MODIFYED IN ANY WAY.

8. When mounting external equipment, make sure that the safety instructions both herein and in the external manual are followed.

9. If the Gripper is used in applications where it is not connected to a UR robot, it is important to make sure that the connections resemble the analogue input, digital inputs, outputs and the power connections. Make sure you use a Gecko Gripper programming script that is adapted to fit your specific application. For more information, please contact your supplier.

10. When the Gripper is combined with or working with machines capable of damaging the Gripper, it is highly recommended to test all functions separately outside the potentially hazardous workspace.

11. When the Gripper feedback (I/O ready signal) is relied upon for continues operation and a malfunction will cause damage to the Gripper and/or other machines, it is highly recommended to use external sensors in addition to the Gripper feedback for insuring correct operations even if a failure should occur. OnRobot A/S cannot be held responsible for any damages caused to the Gripper or other equipment due to programming errors of the Gripper.

12. Never let the Gripper come in contact with corrosive substances, soldering splashes, or abrasive powders as they may damage the Gripper.

13. Observe collaborative standards if personnel stand within the operating range of the Gripper.

14. Never operate the Gripper if the machine on which it is fitted does not comply with safety laws and standards of your country.

2.5. Intended Use

The Gripper is industrial equipment intended as an end-effector or tool for industrial robots. It is intended for pick and place operations of a variety of different objects.

Collaborative use of the Gripper, with humans close to or within the work area, is only intended for non- hazardous applications, where the complete application, including the object, is without any significant risks according to the risk assessment of the specific application.

Any use or application deviating from the intended use is deemed to be impermissible misuse. This includes, but is not limited to:

1. Use in potentially explosive environments.
2. Use in medical and life critical applications.
3. Use before performing a risk assessment.

2.6. Risk Assessment

It is important to make a risk assessment. Because the Gripper is considered partly completed machinery, it is also important to follow the guidelines in the manuals of all additional machines in the application. OnRobot A/S recommends that the integrator uses ISO 12100 and ISO 10218-2 guidelines to conduct the risk assessment.

The integrator should consider the following potentially dangerous situations when performing the risk assessment. There may be additional dangerous situations depending on the specific situation or application.

1. Entrapment of limbs between the Gripper and substrate.
2. Penetration of skin by sharp edges and sharp points on the grabbed object.
3. Consequences due to incorrect mounting of the Gripper.
4. Objects falling out of the Gripper, e.g. due to incorrect gripping force or to high acceleration from a robot.

3. Getting Started: Contents

3.1. Gecko Gripper

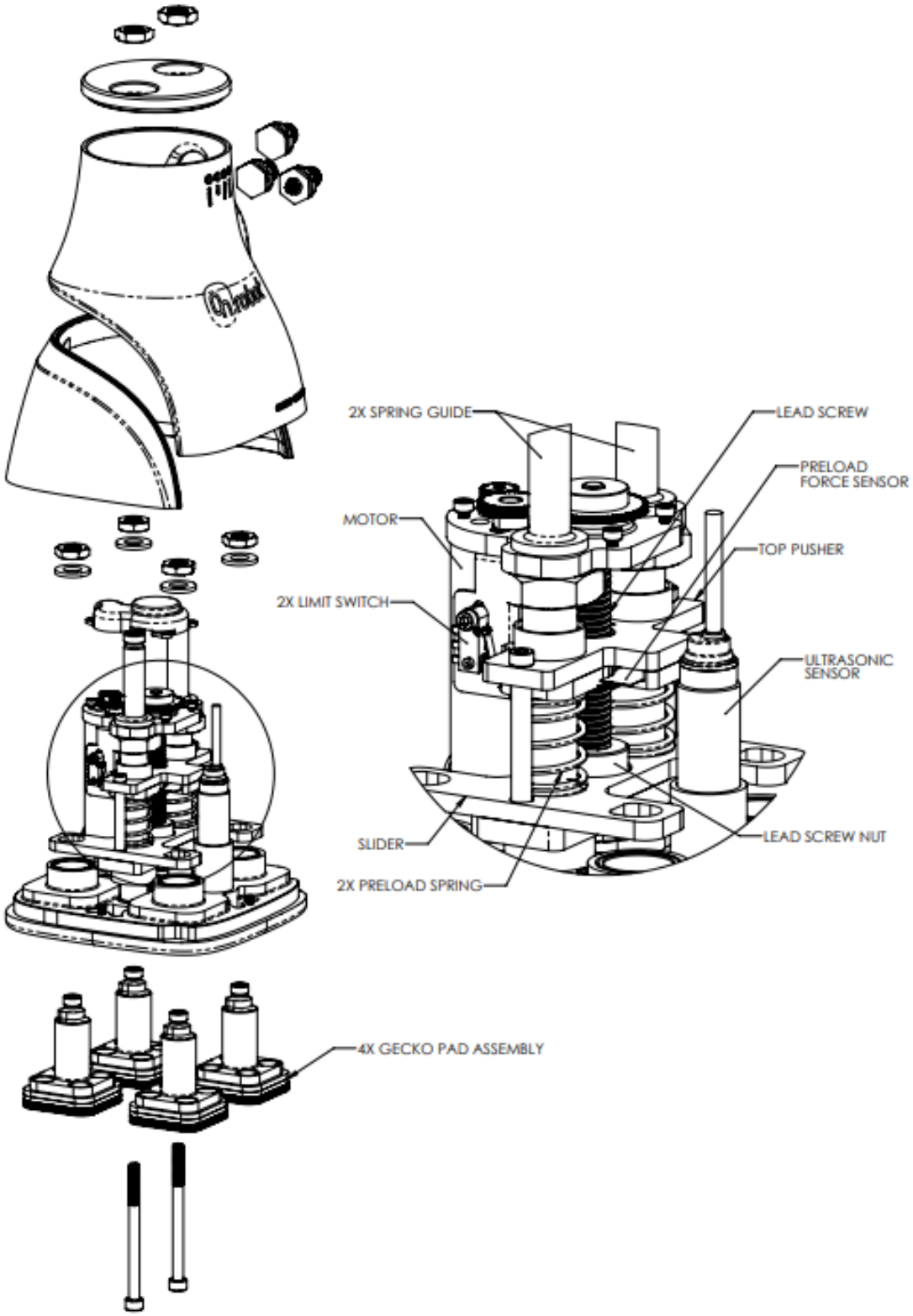

Figure 5 CAD drawing of the Gecko Gripper and pads.

3.2. Parts List

Part Name	Description
Gecko Gripper V5	Gecko Gripper, Version 5
Gecko Gripper Pad Assembly, 1 set of 4 pads	Gecko Gripper Pad Assembly, 1 set of 4 pads
Turck Cable - 10 wire, I/O	Cable, 10-wire, Double-ended cord set, straight female connector to straight male connector, M12 Eurofast connectors
Turck Cable - 8 wire Ethernet RJ45	Cable, 8-wire, Ethernet, Male, M12, 5M
Gripper Mounting Bolts	M6X1.0 80mm Length SS Socket Head Cap Screw
Hex Key - 5mm for mounting robot, 9" overall length	Hex Key - 5mm for mounting robot, 9" overall length
Gecko Pad Removal Tool	Blade Putty Knife, 1-1/4" Wide x 0.075" Thick Blade with Beveled Edge
OnRobot A/S USB Drive - user guides & GUIs	USB Stick - user guides & GUIs
AC/DC DESKTOP ADAPTER 24V 90W	AC/DC DESKTOP ADAPTER 24V 90W
Quick Start Guide	

Table 1 Parts list for Gecko Gripper and optional additions.

3.3. Gecko Gripper Software

User interface software for configuring and operating the Gecko Gripper can be downloaded from either the accompanying OnRobot A/S USB flash drive or from the OnRobot A/S website:

https://onrobot.com/products/gecko-gripper/

4. Quick Start Guide

Safety Reminders

Installation and operation of the Gecko Gripper should be performed by trained professionals only.

DANGER **Improper handling of the gripper and its parts while connected could result in injury or death.**

STEP 1: Install Pads and Mount Gripper

Install the four Gecko Gripper pads by inserting them into the gripping face of the gripper. The Gecko Gripper uses two screws (M6-1-80) to mount directly to a Universal robot. Otherwise, a mounting plate must be used (for other robot brands). Use the 5mm hex key to insert and tighten in the bolts to 8 Nm.

STEP 2: Power Gripper

The Gecko Gripper is powered through the I/O cable.

Upon powering up, the gripper's blue Comms light will blink twice after a slight delay to indicate that the gripper has completed its power-on sequence. It is now recommended that you test all the gripper functions using the Windows Desktop GUI.

A 4-pin connector is also attached to the gecko gripper but is only used for internal troubleshooting.

STEP 3: Install Gecko Gripper GUI

Install the Gecko Gripper Windows Desktop GUI from the supplied USB flash drive or the OnRobot A/S website.

STEP 4: Set Gripper Parameters

We recommend using the robot-agnostic Desktop GUI to test gripper functionality and program the gripper. This easy-to-use interface allows you to specify several gripper parameters that designate a gripper state.

STEP 5: Operate Gripper

You can operate the Gecko Gripper through two different communication modes: Digital I/O and Ethernet TCP. Using these modes, you can create a fully-customized gripping protocol tailored to your needs.

5. Installing the Gripper on the Robot

Mounting the gripper on the robot is a quick and simple process. For all Universal Robots models, the gripper can be mounted directly to the robot and does not require the mounting plate. For other robot models, a mounting plate or other adapter is required.

5.1. Required Supplies, Tools, & Equipment

Assemble the following supplies, tools, and equipment prior to installation:

Parts *Gripper components.*	✓ Gecko Gripper V5 ✓ Gecko Gripper Pad Assembly ✓ Turck Cable, 10-wire, I/O ✓ Turck Cable, 8-wire, Ethernet RJ45 ✓ Gripper Mounting Bolts (M6-1-80) ✓ OnRobot A/S USB Drive containing user guides and GUIs
Supplies *Consumables.*	✓ Zip ties (recommended) ✓ Mounting plate for alternate robot models (optional)
Tools *Required for installation or repair but not operation.*	✓ Hex key, 5mm (included) ✓ Gecko Pad Removal Tool (included)
Equipment *Required for operation.*	✓ AC/DC Desktop Adapter 24V 90W (included) ✓ 24V DC power supply

Table 2 Installation Materials.

5.2. Mechanical Installation: Mounting the Gripper

5.2.1. Parts List

The following parts are included in the Gecko Gripper delivery:

- ✓ Gecko Gripper
- ✓ Gecko Gripper Pad Assembly
- ✓ Mounting Screws x2
- ✓ Hex key, 5mm (for mounting gripper)

5.2.2. Safety notices:

DANGER! **Improper installation can lead to damage to the gripper, robot, materials, or bodily harm or death to operators. Make sure that the gripper is installed correctly by a trained professional.**

CAUTION **Ensure that the robot is powered off or is stationary (not running a program) prior to installing the gripper.**

5.2.3. Procedure for Mounting the Gripper

For Universal robots, proceed to Step 2 as no mounting plate is required.

Step 1: Install the Gecko pads on the gripper prior to installing the gripper on the robot.

Figure 6 The Gecko Gripper gripping face where the four pads will be inserted.

Attach the four (4) Gecko Gripper pads to the gripping face by aligning the notch in the mounting hole with the reciprocal tab on the pad assembly.

Figure 7 Notch in mounting hole (left) and tab on pad assembly (right).

Figure 8 Aligning the pad assembly for insertion into the mounting hole.

The strong magnets of the pad attachment system will help pull the pads into place. Once installed, they should be completely flush with the surface of the gripper's mounting face.

Figure 9 Installing the final pad on the gripper. Notice that the silver plate of each the installed pad is flush with the gripper housing.

Step 2: Attach the mounting plate to the robot using two mounting screws (M6-1-80). Tightened each screw to 8 Nm using a 5mm hex key.
This step is for non-Universal Robots brands only.

Figure 10 Mounting plate for non-Universal robots.

Step 3: Align the holes on the mounting face of the Gecko Gripper with the mounting holes on the robot (or mounting plate/custom adapter).

Figure 11 The two mounting holes on the mounting face of the gripper.

Insert each mounting screw (M6-1-80) into the front of the gripper, down the clearance tube, and use the supplied 5mm hex key to screw into place. *Tighten each screw to 8 Nm using the 5mm hex key.*

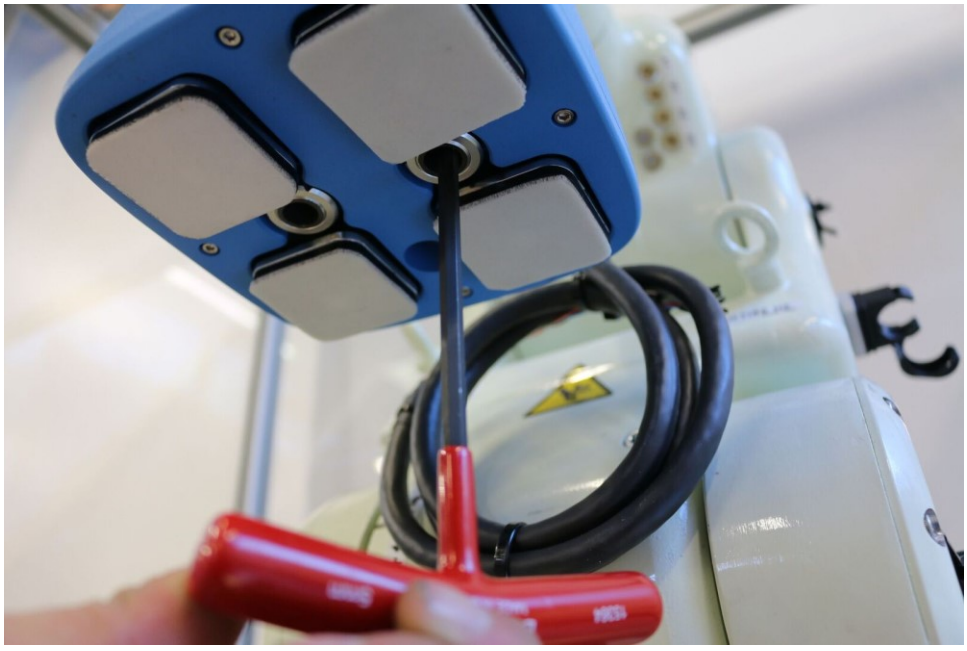

Figure 12 Tightening the mounting screws to attach the gripper to the robot using the 5mm hex key.

The Gecko Gripper tool center point has no *x*- or *y*-axis offset with respect to the robot. Therefore**, the tool center point is located 185mm (*z*-axis direction) away from the robot arm mounting face.**
See Section 9.1 for detailed gripper dimensions.

You are now ready to wire the mounted gripper (Section 6.3).

5.3. Electrical Installation: Powering & Communicating with the Gripper

5.3.1. Power Supply Specifications

The Gecko Gripper itself is powered through the I/O cable. The flying leads on the accompanying cable will need to be terminated at the power supply that meets your needs. This may include connecting to:

- 24V DC, 48W (nominal; 28V maximum) external power supply (via included barrel connector)
- The robot controller's integrated 24V DC power supply

5.3.2. Communications

Depending on your power and communication needs, there are two possible gripper cable configurations (that include the autonomous cleaning system):

- Power and communications using Digital I/O (1 Cable)
- Power using Digital I/O, Communications via Ethernet TCP/IP (2 Cables)

The optional piezo cleaning system requires an additional 4-pin cable.

Digital I/O

- ✓ Communication and 24V power over 10-pin connector (8-pin connector is not used for Digital I/O communication, only Ethernet, *see below*).
- ✓ Can be controlled by any type of robot with simple I/O signals.
- ✓ Desired set points (*e.g*. position control spec, force control spec, preload spec, *etc.*) are first set using the Windows Desktop GUI, then the Gripper is controlled using the I/O interface.
- ✓ No robot software installation is necessary.

You can power the Gecko Gripper in one of two ways using the I/O:

1. You can plug in barrel jack connector directly to the included power supply.
2. You can remove the barrel jack connector and use a 24V power supply on your preferred robot controller (or another source). The Gecko Gripper draws less than 1 Amp (peak and RMS).

The Digital I/O cable is supplied with ports for connecting to the gripper and pigtails on the opposite end for direct and customizable wiring as necessary to integrate them with your system.

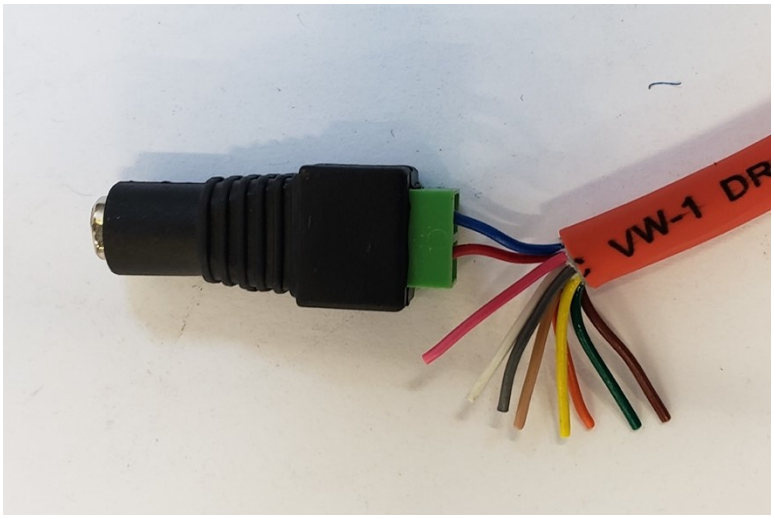

Figure 13 Digital I/O cable terminal with barrel jack connector (for direct connection to power supply) and other input/output wires.

For wiring of the I/O channels to their proper connections, see Section 8.1 Digital I/O Communications.

Ethernet

- ✓ Communication over 8-pin connector.
- ✓ Can be controlled by custom Universal Robot, Kawasaki, and FANUC Teach Pendant interfaces.
- ✓ Can also be controlled with the Windows Desktop GUI by direct Ethernet connection between the computer and Gripper.

Ethernet communication allows for dynamic adjustment of the gripper parameters whereas in I/O the gripper parameters cannot be dynamically adjusted without the Windows Desktop GUI.

5.3.3. Procedure for Powering and Wiring the Gripper

After mounting the gripper to the robot (Section 6.2) and identifying an appropriate power supply, you are ready to wire the gripper.

You will need the power and communication cables supplied with the gripper (*Turck Cable, 10-wire, I/O*, and *Turck Cable, 8-wire, Ethernet RJ45*) as well as several zip ties or similar supplies to secure the cables so as not to be disturbed by the robot's full range of motion.

CAUTION **Make sure to check the integrity of the connectors on the gripper base as the pins may be easily bent and damaged.**

Step 1: Connect the dual Digital I/O and power cable to its connector mate located on the gripper base.

Figure 14 Connecting the power/digital I/O cable to the matching gripper connector.

Step 2: If using Ethernet communications, attach the Ethernet cable to its connector mate located on the gripper base.

Figure 15 Attaching the Ethernet cable to the matching connector on the gripper base.

Step 3: Run the cable(s) away from the gripper along the robot to the power supply and controller.
Make sure to leave sufficient cable slack so that the cables are not under tension during the robot's full range of motion.

Figure 16 Cables are routed loosely along the robot arm.

Step 4: Secure the cables so that they will remain safely out of the robot and substrate's range of motion. Exercise the robot through all the expected

motions to ensure that the cables are not damaged during operation (see example of rotating J-6 below).

Figure 17 Rotating J-6 where the power and communications cables are not damaged by robot motion.

We recommend the use of zip ties; however, other adhesives or fasteners may be better suited for your needs.

NOTICE **Depending on your protocol or operating conditions, you may consider adding additional structural or insulating protection to the cables.**

5.3.4. LEDs Indicate Electrical and Communication States

The Gecko Gripper base has LEDs that provide quick visual information about the status of four different states.

The LED indicators and their meanings are shown in the table below:

LED Name and Color	Steady Color	Slow Blink	Fast Blink
Power *Green*	Power connected	N/A	N/A
Error *Red*	N/A	Warning (internal errors); Gripper needs maintenance; Check error logs for details	Major Error; Gripper should be stopped immediately and investigated
Pad *Orange*	N/A	A part has been dropped	Parts have been repeatedly dropped and error logs updated
Comms *Blue*	Communications connected	N/A	N/A

Table 3 LED indicators and their meanings.

After connecting the power and wiring the communication cables between gripper and its power source and controller, check that the LEDs on the gripper base indicate the gripper is functioning nominally: steady green, steady blue, no red or orange lights.

Figure 18 LEDs indicate the gripper is functioning nominally (steady green Power, steady blue Comms, Error and Pad are off).

5.4. Installation Notes for Different Robots

For additional installation information for different robot brands, visit the OnRobot A/S website for the Gecko Gripper:

https://onrobot.com/products/gecko-gripper/

6. Setting the Gripper Parameters

You can create a fully-customized gripping protocol tailored to your protocol specifications using the Gecko Gripper GUI. Within the GUI, you may specify gripper preload force and ultrasonic range set points and save multiple gripper states for future use.

6.1. Installing the Windows Desktop GUI

OnRobot A/S provides a user-friendly Windows desktop graphical user interface (GUI) for the programming and control of the Gecko Gripper via an Ethernet cable.

Recommended Software Requirements:

- ✓ Installed Windows 7 with Service Pack 1 or higher (x86 or x64 version)
- ✓ Installed .NET Framework 4.7 or higher

6.1.1. Installing the Desktop GUI:

Step 1: Install the application by opening the “Gecko Gripper Desktop GUI setup” file from the accompanying OnRobot A/S USB flash drive or from the OnRobot A/S website.

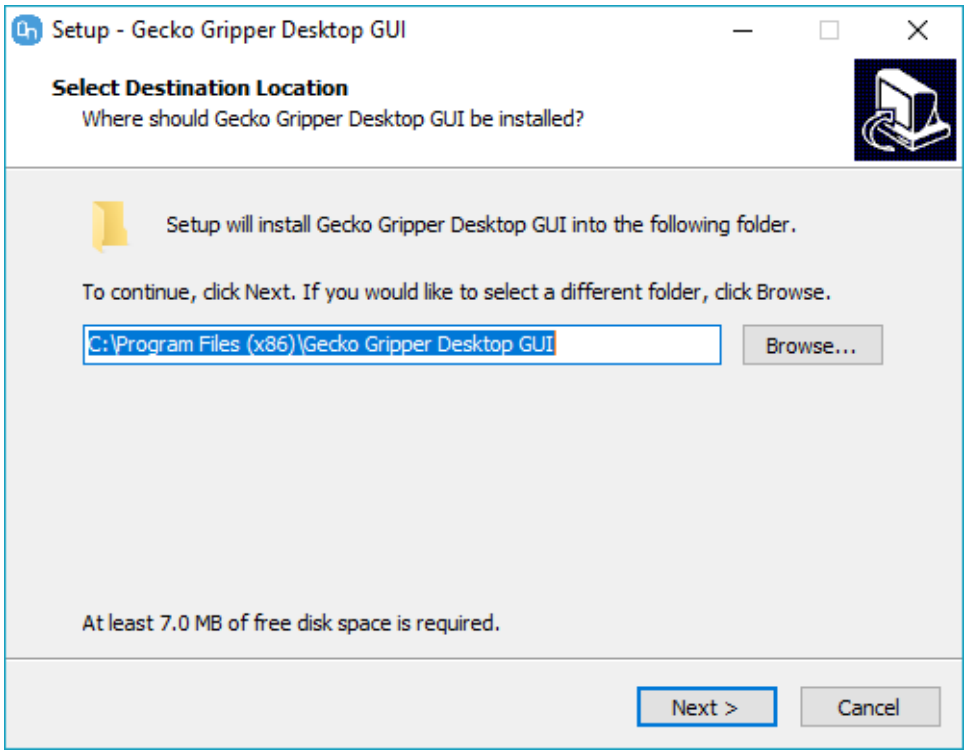

Figure 19 Beginning the Gecko Gripper GUI installation.

Step 2: Select the “Launch Gecko Desktop GUI” checkbox when installation completes. This will start the application.

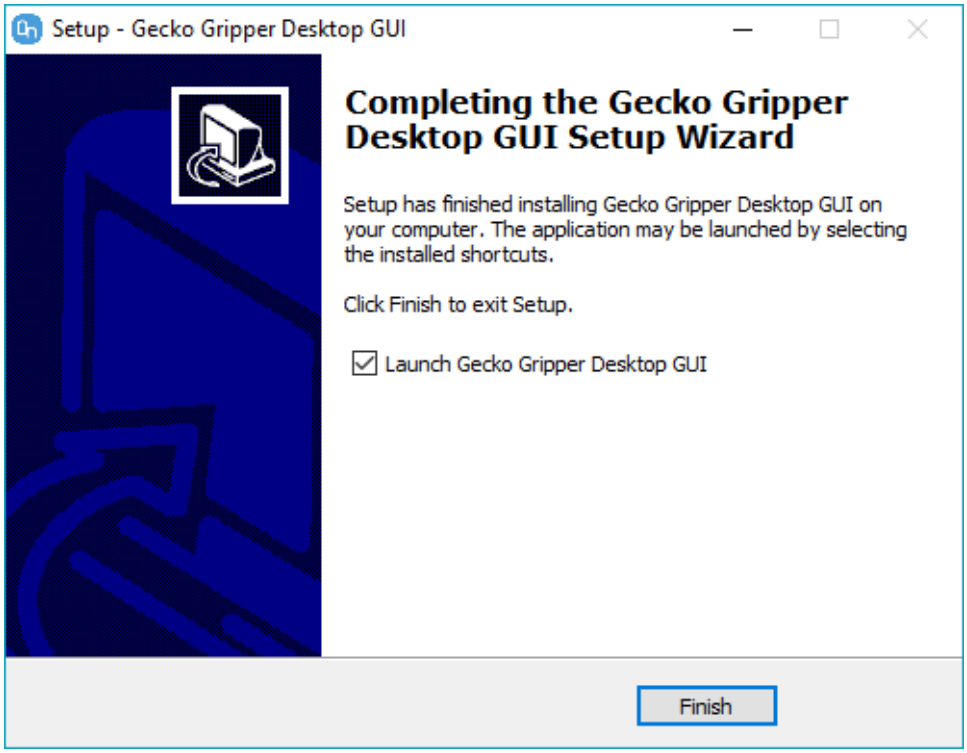

Figure 20 Launching the Gecko Gripper Desktop GUI after installation.

You may now start the application at any time by opening the “PerceptionRobotics.GeckoWpfClient.exe” from the folder in which it was installed.

Step 3: Enter the Gecko Gripper’s IP address when prompted by the start screen to enable communication to the Gecko Gripper.

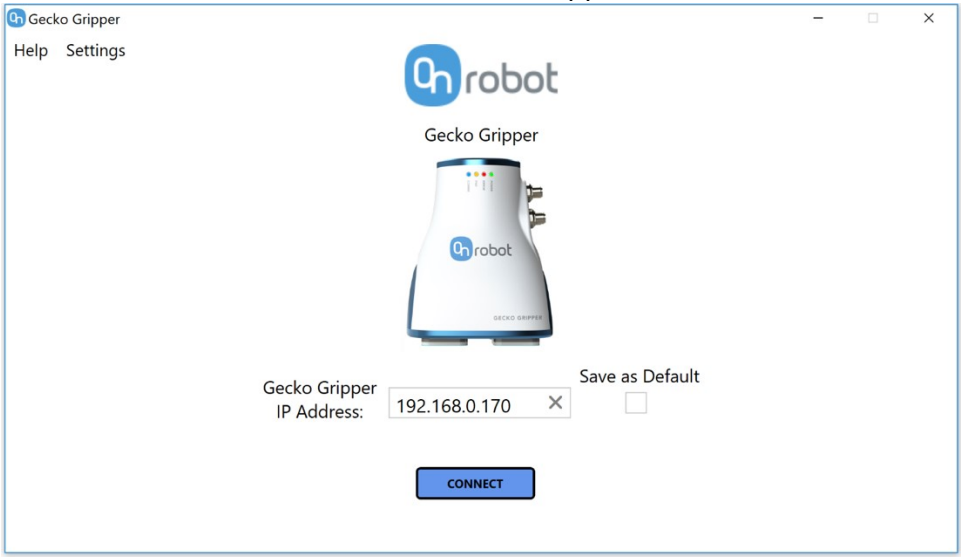

Figure 21 Gecko Gripper Start Screen.

You may also change the IP or port configuration under the “Settings” tab in the main menu bar. The gripper’s default IP address is 192.168.0.170 and the default port number is 30000.

Select the “Save as Default” checkbox to automatically use this IP address for the Gecko Gripper the next time the application is opened.

6.2. Setting Up Static IP for the Desktop GUI.

The Gecko Gripper and the Desktop computer must share the same local network in order to communicate successfully. The following steps detail how to set up the Desktop IP address to pair with that of the Gecko Gripper.

Step 1: Open Control Panel and click “View network status and tasks.”

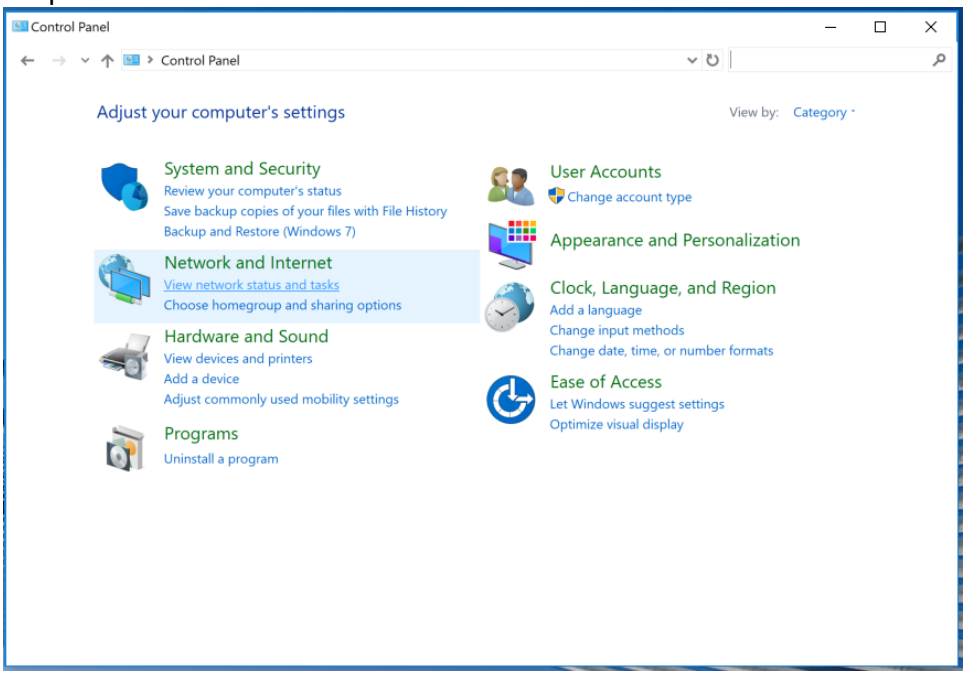

Figure 22 Locating network status within the computer's control panel (highlighted in blue).

Step 2: Click “Change adapter settings” on the top-left panel in the window.

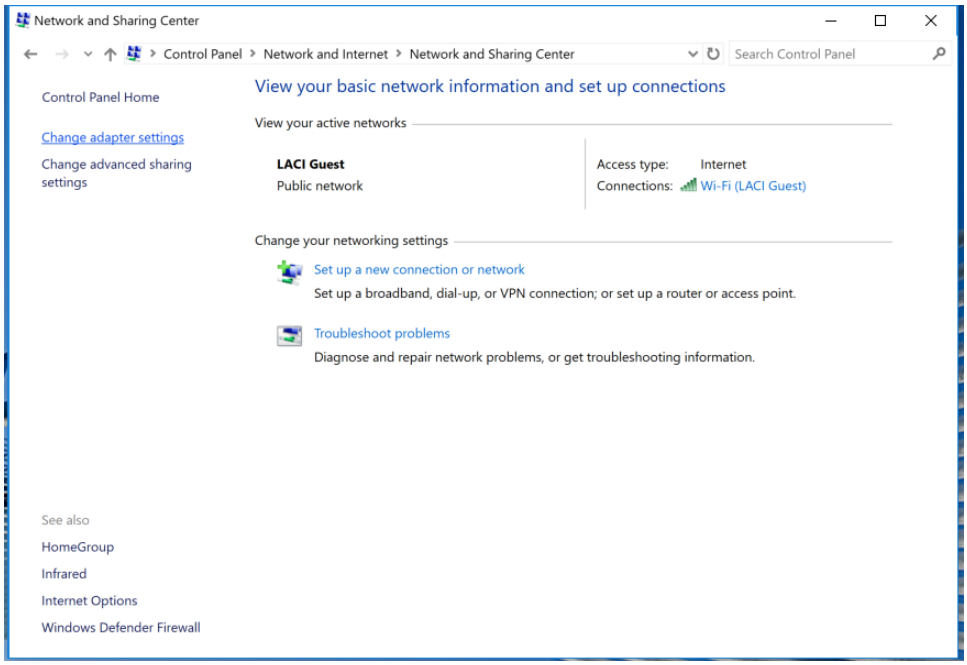

Figure 23 Locating the "Change adapter settings" link (underlined blue text).

Step 3: In the next window, right-click on “Ethernet” to reveal a drop-down menu, then select “Properties.”

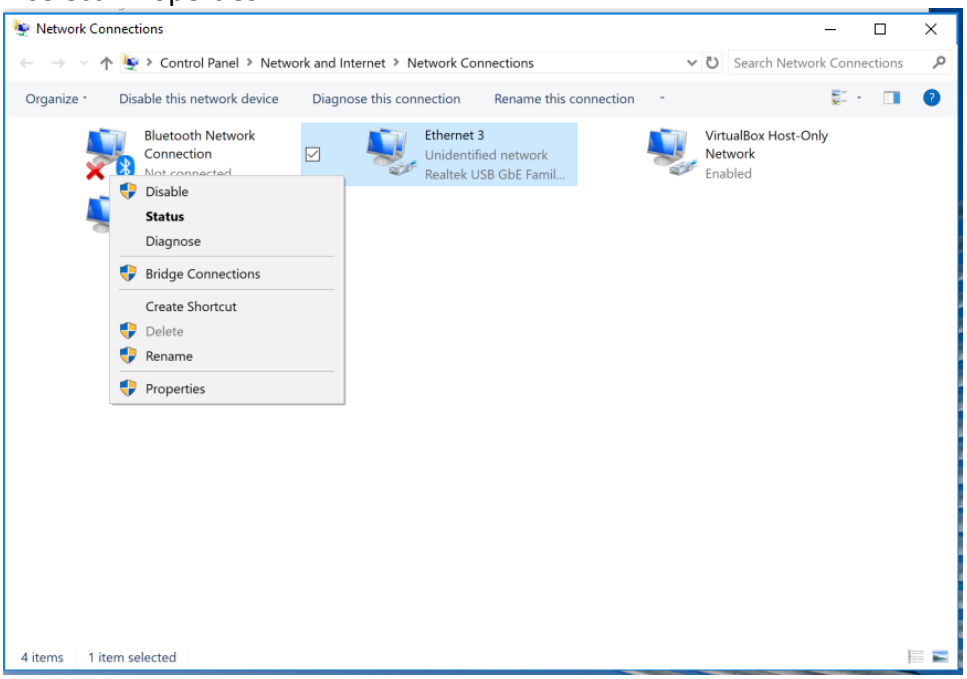

Figure 24 Accessing the Ethernet Properties menu item.

Step 4: Within the Ethernet Properties pop-up menu, find and select “Internet Protocol Version 4 (TCP/IPv4).” When selected, click on the “Properties” button.

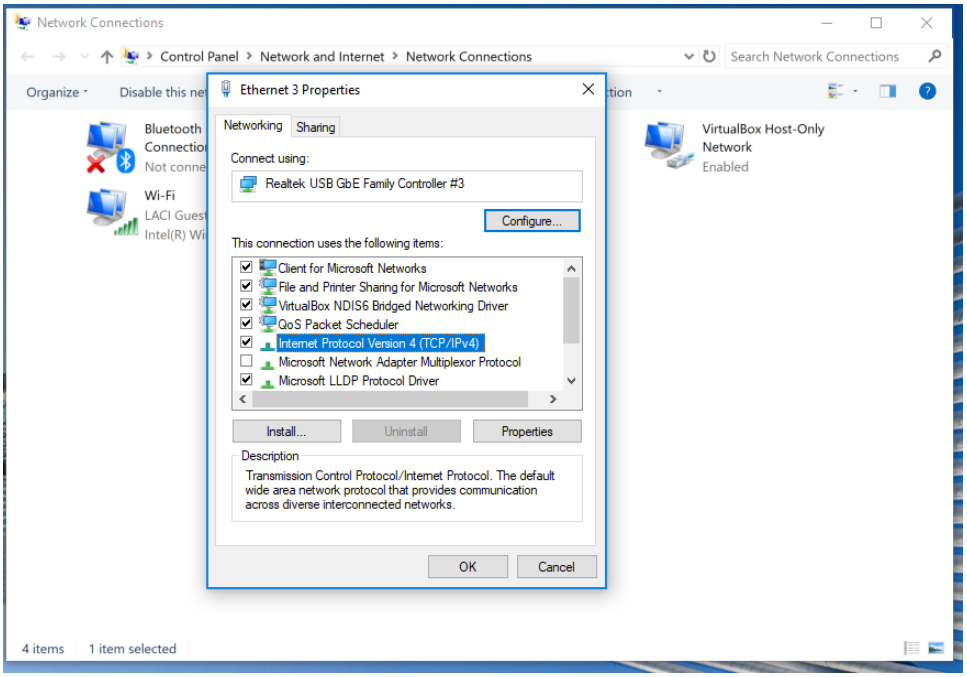

Figure 25 Accessing Properties for the Internet Protocol Version 4 (TCP/IPv4) item.

Step 5: In the resultant pop-up window, select the radio button “Use the following IP address.”

In the box for “IP address,” enter “192.168.0.X,” where X is any integer between 0-255 **other than 170** because “192.168.0.170” is the Gecko Gripper IP address. For example, is “192.168.0.3” is a valid IP address for the Desktop GUI which will allow communication with the Gecko Gripper (*see figure)*.

In the box for “Subnet mask,” enter “255.255.255.0”.

Leave the “Default gateway” box empty.

Click “OK” to finish assigning the IP address to the Desktop GUI. The GUI is now able to locate and connect to the Gecko Gripper.

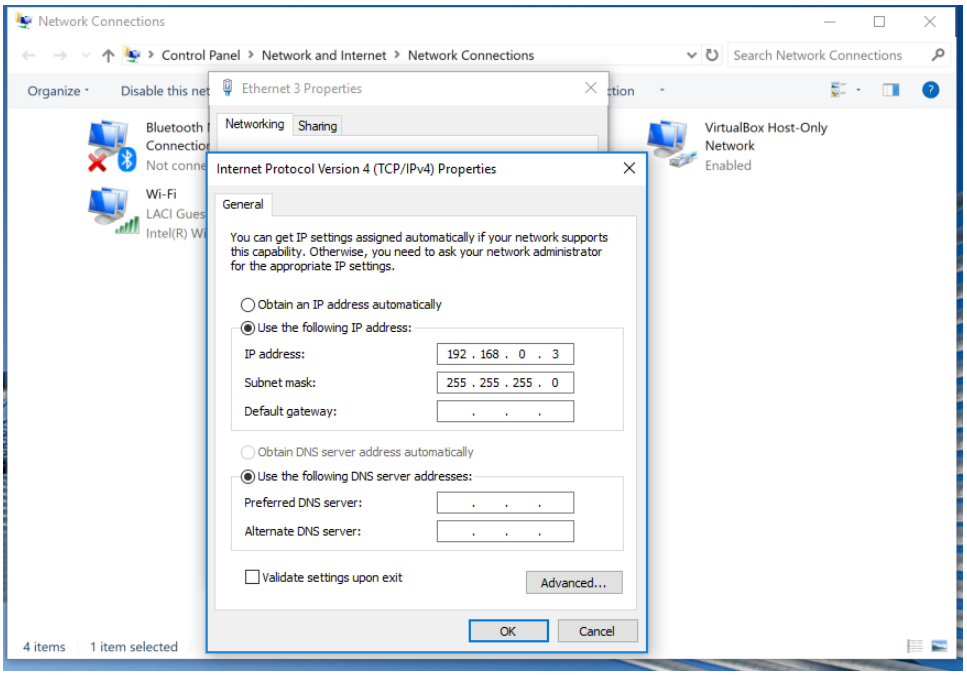

Figure 26 Entering a valid IP address for the Desktop GUI.

6.3. Setting Gripper Parameters Using the Windows Desktop GUI

When a connection to the Gecko Gripper has been successfully established, the Training Mode Screen will appear. Note that you can disconnect the Gripper at any time by selecting “Disconnect” from the menu bar.

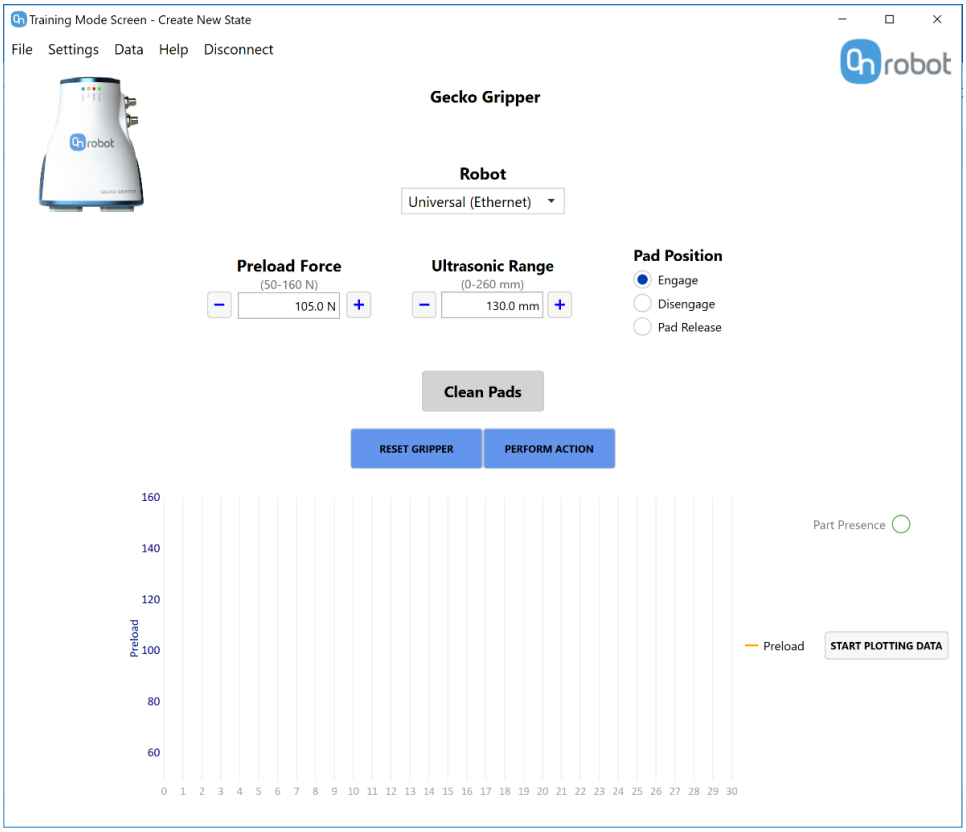

Figure 27 Training Mode (Create New State) desktop screen.

Check that the Gecko Gripper User Interface Software is up to date. The software version is listed on the “About” page under “Help” in the main menu bar.

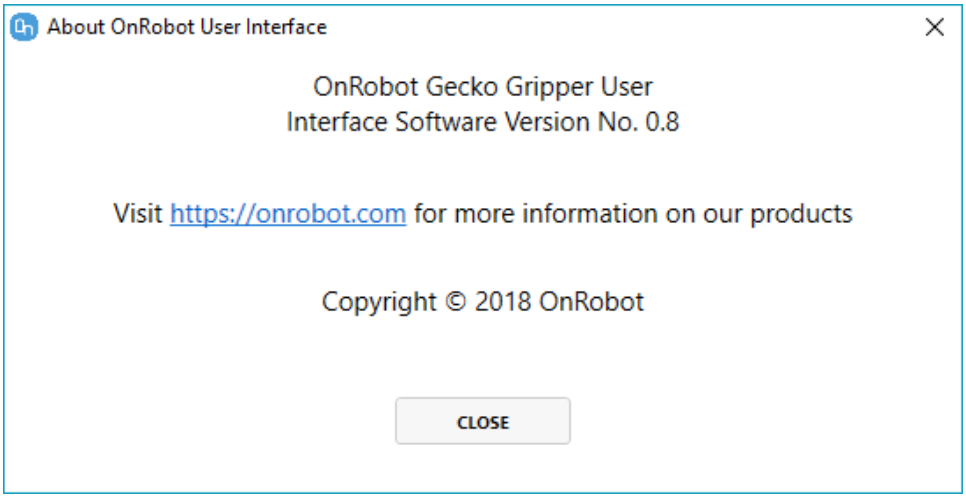

Figure 28 The “About Dialog” box.

For information on troubleshooting and support, click on “Support” under the “Help” tab in the main menu bar.

You may configure the desired units (Metric, Imperial, or Percentage) under the “Settings” tab on the menu bar.

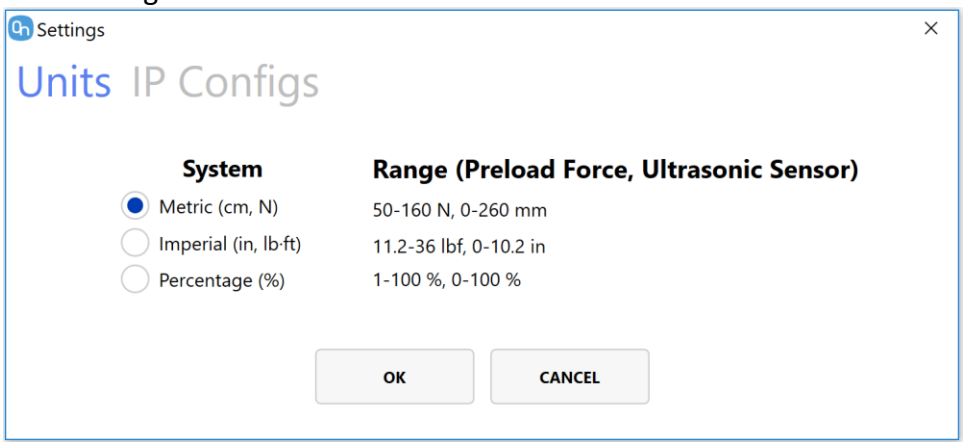

Figure 29 Changing units within the “Settings” dialog box.

You are now ready to Verify Gripper Functionality and Configure the Gripper from the Desktop.

6.3.1. Create New State: Programming a gripper function for the first time

Step 1: Open the Gecko Gripper application. The “Training Mode Screen” should appear.

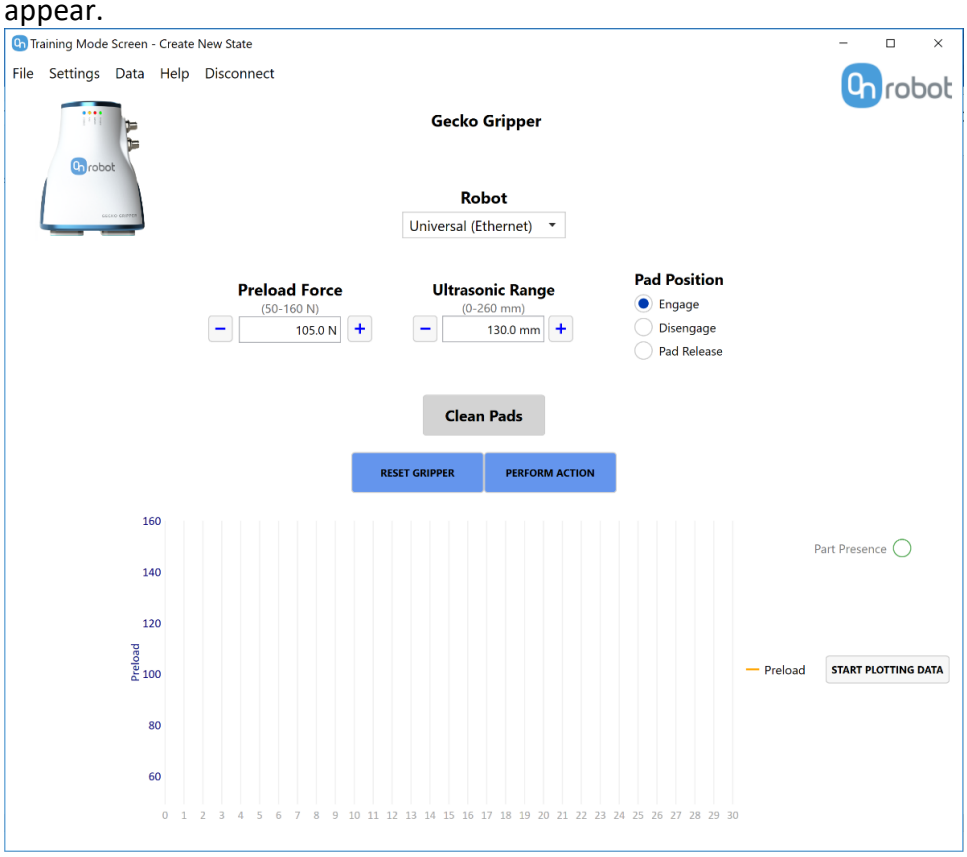

Figure 30 Training Mode (Create New State) Desktop screen.

Step 2: Select the appropriate Robot and communication mode from the “Robot” drop-down menu in the center-right of the GUI.

Step 3: Set the desired Preload Force.
This setting modifies at what force level the gripper notifies the robot that it has reached a certain load. For example, in picking a large piece of glass where 100 N preload force is required, when 100N is reached in I/O mode, pin 5 is set HIGH; in Ethernet mode, packet index 9 is set from 0 to 1.
For more information on selecting an appropriate preload force for your task and material, see Section 9.4.

NOTE: The gecko grippers pre-load sensing range is 30 to 150N, it ***CANNOT sense below 30N***

Step 4: Set the Ultrasonic Range.
Like setting the Preload Force, this setting notifies the robot at which *range* the designated Preload Force is reached. This feature is useful for picking flat objects out of a pile as it allows the robot programmer to run the robot at maximum speed until the gripper detects that it is approaching a pickup point. An example of this use case is described in Section 8.1, Step 2.
Default ultrasonic range is 125.0mm.

Step 5: Select Pad Position.
To test basic gripper functionality, the user can try to perform an action with each pad position (“Engage” and “Disengage”).
Default Pad Position is “Engage.”

Step 6: When you are have completed setting up the new state, select “Perform Action” to set the gripper to the state that matches the selected parameters.
These parameters are written to the gripper’s memory. If the gripper is run in I/O configuration, it will reference those parameters to set the gripper’s state. If the gripper used in Ethernet mode, it will reference those parameters as initial state, but they can be dynamically modified.

Step 7: To display real-time gripper force and position data, select “Start Plotting Data.” To stop showing data, select “Stop Plotting Data.”

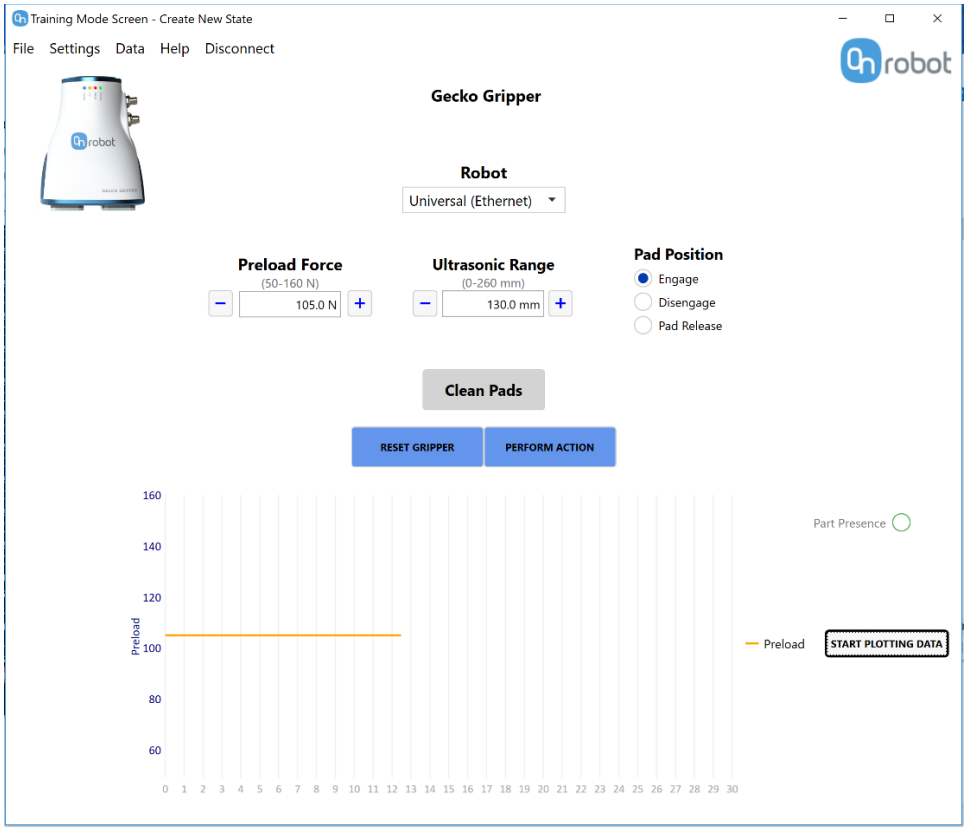

Figure 31 Plotting gripper data within the Desktop GUI.

Step 8: To view real-time gripper data, including the Parts Presence, Wear, Preload Force, and Pad Position, navigate to “View Data” located under the “Data” tab on the menu bar.

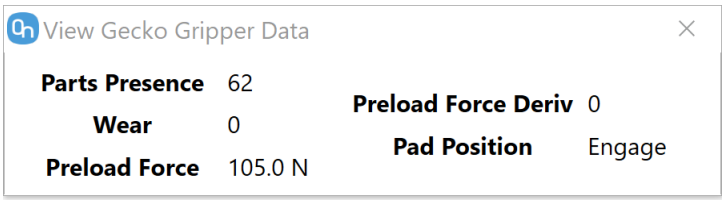

Figure 32 View gripper data within the Desktop GUI.

Additional Actions:

Save Gripper Configuration (see Section 7.3.2)
Load Existing Gripper Configuration (see Section 7.3.3)
Reset Gripper (see Section 7.3.4)
Error Handling (see Section 7.3.5)
Clean Pads (see Section 7.3.6)

6.3.2. Save Gripper Configuration

If you wish to use multiple gripper parameter configurations, it may be useful to save individual configurations to a file and access them later. This feature is useful if multiple objects are being picked and the robot needs to be re-tasked periodically.

Step 1: Select "File → Save Action to File" from the menu bar.

Choose whether to save state parameters to XML file via dialog box.

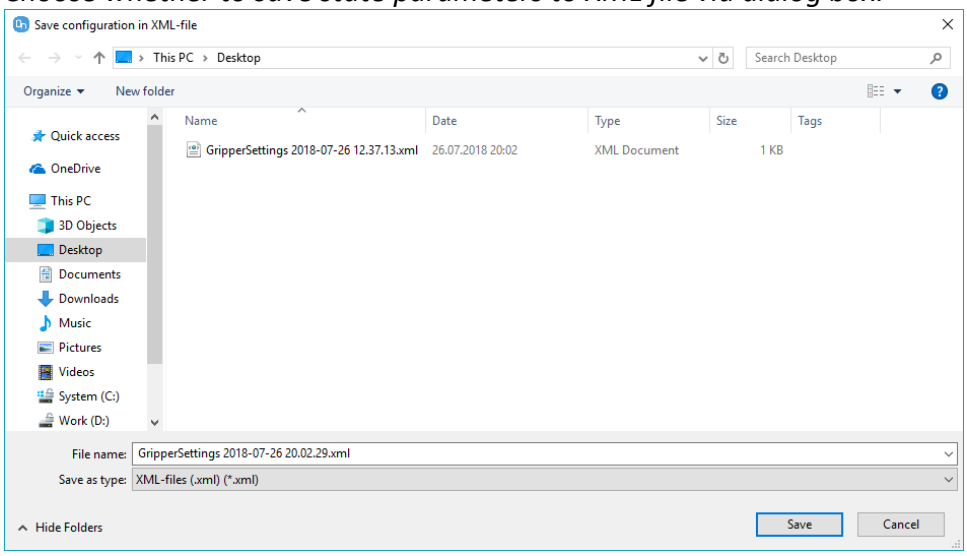

Figure 33 Saving an XML file with Gecko Gripper parameters.

6.3.3. Load Configuration: Using an existing or previously saved gripper state

If you have multiple gripper configurations saved, you can load them to quickly set a gripper to a previously used state.

Step 1: Select "File → Load Configuration" from the menu bar.
An Open File dialog box will appear.

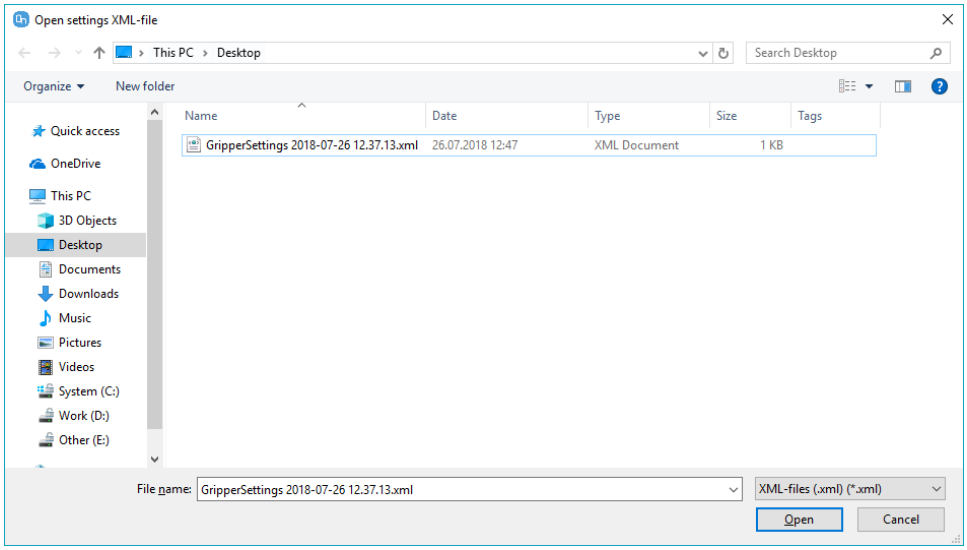

Figure 34 Using the Desktop GUI to open an XML file with a previously saved gripper configuration.

Step 2: Select to open a previously saved XML file.
This will load the Gecko Gripper state settings saved within that file and return you to Training Mode (Load State) Screen.

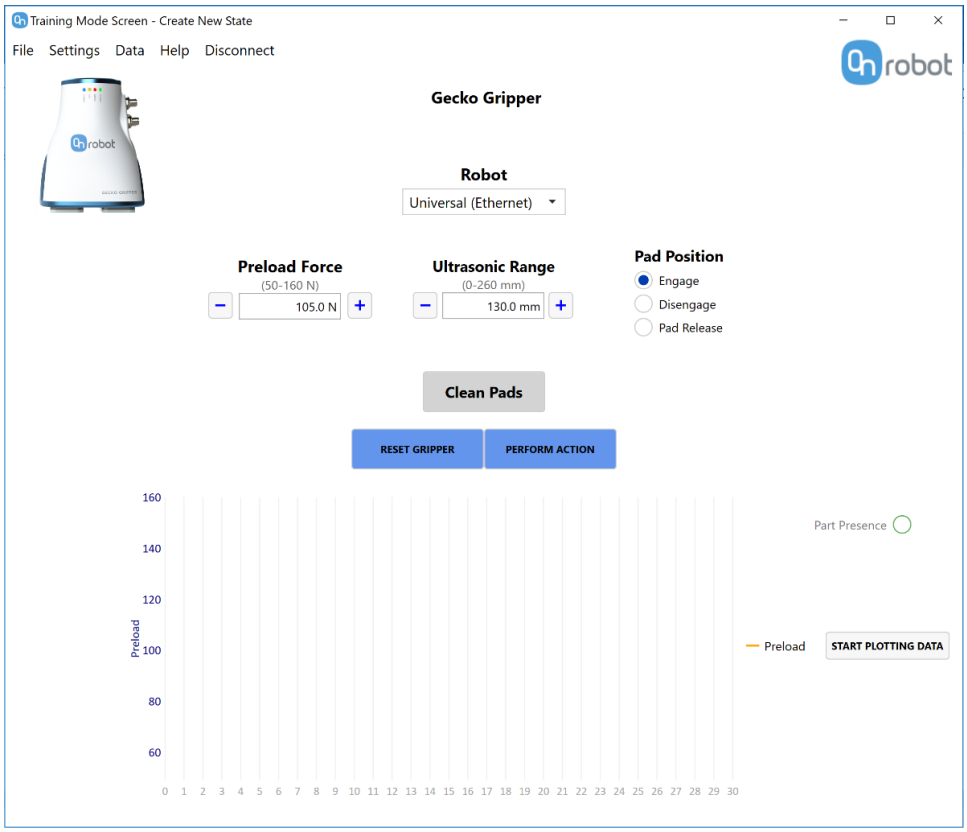

Figure 35 Training Mode (Load State) screen with loaded state parameters from a previously saved state.

Step 3: Select “Perform Action” to actuate the gripper to the state loaded in the previous step.

6.3.4. Resetting the Gripper

This action resets all changes made to the gripper state parameters since the last time they were saved in the associated XML file. If there are no previously saved versions, resetting the gripper reverts the gripper parameters to their default values (*see Section 8*).

Step 1: Reach the Training Mode screen from either a New State or after selecting Load Existing State.

Step 2: Click the “Reset Gripper” button on the bottom left of the screen.

6.3.5. Error Handling

The Gecko Gripper GUI saves detailed information about unexpected events or errors during program execution. These error logs can be retrieved from the “Help” menu bar by clicking on “Error Logs.” Click “Load Logs” for error log information. The error logs can be saved to a file to assist in troubleshooting. To clear all logs on the screen, click “Clear All.” Select “Cancel” to return to the Training Mode Screen.

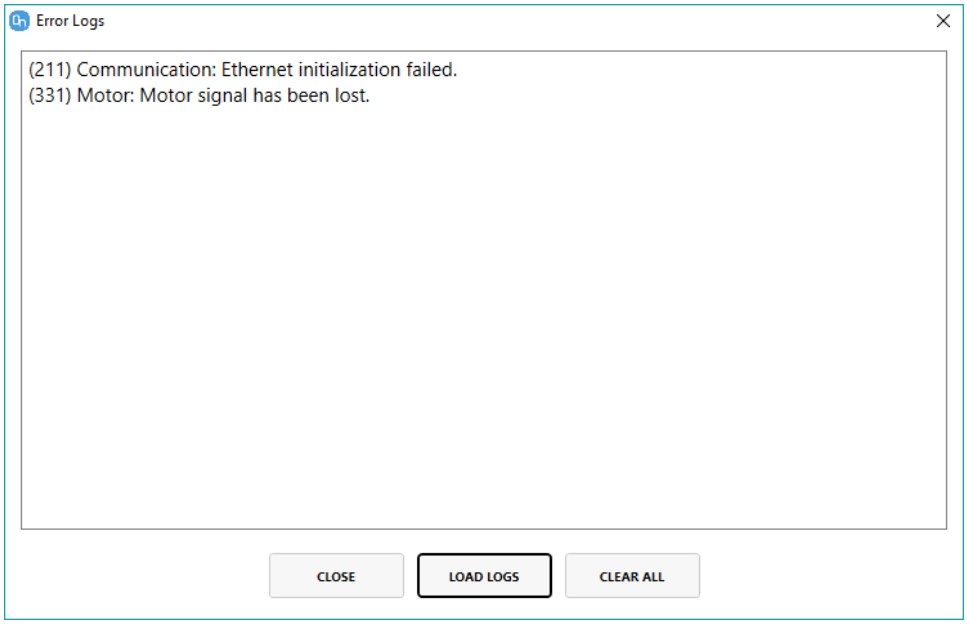

Figure 36 Event logging and error details.

6.3.6. Clean Pads

The “Clean Pads” feature is used with the optional autonomous piezoelectric cleaning system.

See the Piezoelectric Cleaning System Appendix for more information.

7. Operating the Gripper

Protocols for operating the gripper will depend largely upon the communication mode: Digital I/O or Ethernet TCP. Significantly more information can be conveyed through Ethernet communications. *Additional operating conditions for specific robot brands can be found in appendices located on the OnRobot A/S Gecko Gripper website*.

The gripper performs the following major tasks, each of which can be actuated through any communication mode:

- Attaching
- Detaching

7.1. Digital I/O Communications

This section details how to operate the gripper to perform specific tasks using Digital I/O communications.

NOTICE **If using Digital I/O communications to operate the gripper, we suggest using the Windows Desktop interface. Programming using the Desktop GUI is important for exercising all features of gripper.**

Step 1: Use the Windows Desktop interface to set up values for the following set points (*see Section 7 for more details)*:

- Preload
- Ultrasonic Range
- Pad Position
- Cleaning Time (if option is installed)

When the gripper is controlled by I/O, its behavior is determined by the parameters saved in the gripper's memory. The gripper parameters are saved to memory only when "Perform Action" is selected from the GUI Training Mode screen. In I/O control, the gripper parameters are static, but the gripper's behavior and sensor data can be accessed through I/O control.

Step 2: Use the robot to control the gripper in I/O. The I/O pinout is given in the table below:

10-Pin Connector (Power, I/O)			
Pin	**Color**	**In/Out**	**Gecko Parameter**
1	White	IN	ENGAGE
2	Brown	IN	DISENGAGE
3	Green	OUT	ULTRASONIC
4	Yellow	OUT	PART
5	Gray	OUT	PRELOAD
6	Pink	OUT	PAD SERVICE (WEAR)
7	Blue	PWR	24VIN
8	Red	PWR	GNDIN
9	Orange	OUT	ERROR
10	Tan	IN	EARTH GROUND

Figure 37 Pinout for the 10-pin connector.

One can consider the IN/OUT pin assignment as being from the perspective of the gripper: for inputs, the gripper expects to *receive* in a 24V HIGH or LOW signal; for outputs, the gripper will *send* a 24V HIGH or LOW signal to the robot.

Inputs

ENGAGE (pin 1)

Use the robot to send a 24V signal to move the pads to Engage position. Note that the gripper will only move the pads to the Engage position if the DISENGAGE signal is LOW. If both ENGAGE and DISENGAGE signals are HIGH, the pads will not move.

DISENGAGE (pin 2)

Use the robot to send a 24V signal to move the pads to the Disengage position. Note that the gripper will only move the pads to the Disengage position if the ENGAGE signal is LOW. If both ENGAGE and DISENGAGE signals are HIGH, the pads will not move.

Outputs

ULTRASONIC (pin 3)

The ULTRASONIC output will read HIGH if there is a part within a distance *less* than the value set in the Windows GUI. Otherwise it will read LOW as there is no part within the specified distance.

Example Use Case: Picking Flat Objects Out of a Stack

These steps detail how you might use the ULTRASONIC signal to program the gripper to pick objects out of a stack.

1. Use the Windows GUI to set the Ultrasonic Range to 50 mm.

2. During the robot's pick-and-place routine, it hovers over the stack. If the ULTRASONIC output is LOW, the robot can *rapidly* approach the stack, as the ultrasonic output indicates that the gripper is not within range (50 mm).
3. When the ULTRASONIC output goes HIGH, the gripper has detected an object within 50 mm. The robot should slow down, allowing the Gecko Gripper to do its picking action in order to pick an object out of a stack.
4. The robot completes its pick-and-place motion. The next time the robot picks out of the stack, the gripper can dynamically compensate for the change in the height of the stack.

PARTS PRESENCE (pin 4)

The PARTS PRESENCE output will read HIGH if the gripper detects that it has picked up an object. It will read LOW if the gripper does not hold an object. This signal can be used to confirm that the gripper has correctly picked a part.

If a part is dropped, this will cue an error in the error logs and the "Pad" LED will begin to blink (orange) on the gripper itself.

PRELOAD (pin 5)

The PRELOAD output will read HIGH if the Preload Force exerted by the gripper is greater than the value set in the Windows GUI. Otherwise, the PRELOAD output will read LOW. The Preload Force exerted by the Gecko Gripper depends how far the robot arm moves toward the object.

Example Use Case: Preloading to Pick an Object

These steps detail how you might use the PRELOAD signal to monitor gripper force on the object being picked

1. Use the Windows GUI to set the Preload to 100 N.
2. During the robot's pick-and-place routine, assume the robot approaches downwards to apply a preload to pick up the object. While the PRELOAD output is LOW, the robot should continue its downwards motion.
3. When the PRELOAD output goes HIGH, the gripper has reached or exceeded the 100 N Preload threshold of 100 N. The robot should stop its downwards motion as it has applied the desired preload force to pick up the object.

PAD SERVICE (pin 6)

The PAD SERVICE output (*also referred to as "Wear"*) will read HIGH when the Gecko pads begin to wear. The operator should consider replacing the Gecko pads at this time.

ERROR (pin 9)

The ERROR output will read HIGH whenever an error occurs and is written to the Error Log for the gripper. This event will be accompanied by the flashing orange "Error" LED

on the gripper base. The error log and error codes can be retrieved from the gripper through the Windows GUI (*see Section 6.3.5)*.

7.2. Ethernet TCP/IP Communications

Controlling the gripper in Ethernet allows for dynamic and complete control of the gripper's parameters. The table below shows the full list of input/output parameters the user can control in Ethernet mode.

TCP/IP Parameter	IN/OUT	Description
Gripper Mode (Ethernet & I/O)	In	Communication mode (Ethernet or I/O)
Live Data Stream	In	Enable/disable real-time data readings
Pad Position (Engage/Disengage)	In	Move gecko pads to engage or disengage for pick and place
Save Settings for Gripper I/O	In	Save current gripper settings to memory for I/O control
Preload Force Spec	In	Setting for the preload sensor. If the preload sensor reads a greater value than this setting, then it triggers the preload force I/O output to be HIGH
Ultrasonic Range Spec	In	Setting for the ultrasonic sensor. If the ultrasonic sensor detects an object is closer than this setting, then it triggers the ultrasonic range sensor I/O output to be HIGH
Enable Cleaning	In	Enable the piezo self-cleaning system (only for grippers with the piezo system included)
Cleaning Time (Single Cycle)	In	Cleaning time for a single cycle of the piezo self-cleaning system
Preload Force Reached	Out	Set to HIGH if the preload force is greater than the preload force spec, otherwise it is LOW since the preload force is less than the preload force spec
Part Presence	Out	The parts presence output will read HIGH if the gripper detects that it has picked up an object, and it will read LOW if the gripper does not have an object.
Wear	Out	The wear output will read HIGH when the gecko pads begin to wear. The operator should consider replacing the gecko pads when this output reads HIGH.
Error Detected	Out	The error output will read HIGH whenever an error occurs. This will be accompanied by an orange error LED flash, along with an error log written to

		the gripper that can be retrieved via the Windows or robot-specific GUI.
Error Code	Out	This gives the error code number for the most recent error.
Preload Force Data	Out	Gives the current value of the preload force sensor
Ultrasonic Range Sensor	Out	Gives the current value of the ultrasonic range sensor
Gripper Mode (Ethernet & I/O)	In	Communication mode (Ethernet or I/O)
Live Data Stream	In	Enable/disable real-time data readings

Table 4 Gecko Gripper TCP/IP Parameters

The gripper can be controlled in Ethernet TCP/IP mode through OnRobot's robot user interfaces, which are supported for Universal Robots, Fanuc, and Kawasaki.

7.3. Setting the Tool Center Point

The Gecko Gripper tool center point has no *x*- or *y*-axis offset with respect to the robot. Therefore, the tool center point is located 185mm (*z*-axis direction) away from the robot arm mounting face (s*ee Section 9.1 for detailed gripper dimensions).*

Make sure the plane of the gripper is aligned with the plane of the object being gripped. Set the robot's perch point (yaw, pitch, roll) value to be coplanar with the object's position.

When picking up the object, the gripper should move onto the object until the desired preload force is reached or before the pads bottom out, whichever is first.

7.4. Operating the Gripper with Robot Collision Detection or Other Safety Systems

When using the Gecko Gripper with a robot in position control, care must be taken during the gripping phase of the object as to not trip off the robot's collision detection system. The most force the gripper will ever need to exert on an object is 150N for maximal adhesion. Based upon your robot type and object, it may be necessary to adjust the robot's collaborative or collision settings to preclude tripping off the robot upon contact.

7.5. Gecko Gripper Use Case: Picking and Placing a Small Solar Panel

When picking and placing an object with the Gecko Gripper, observe the following steps:

Step 1: Prior to picking, drive the robot and gripper to a "perch" position above the object. Ensure the object's center of gravity is under the center of the gripper. Also ensure the pads of the gripper and the object are coplanar, i.e. not tilted.

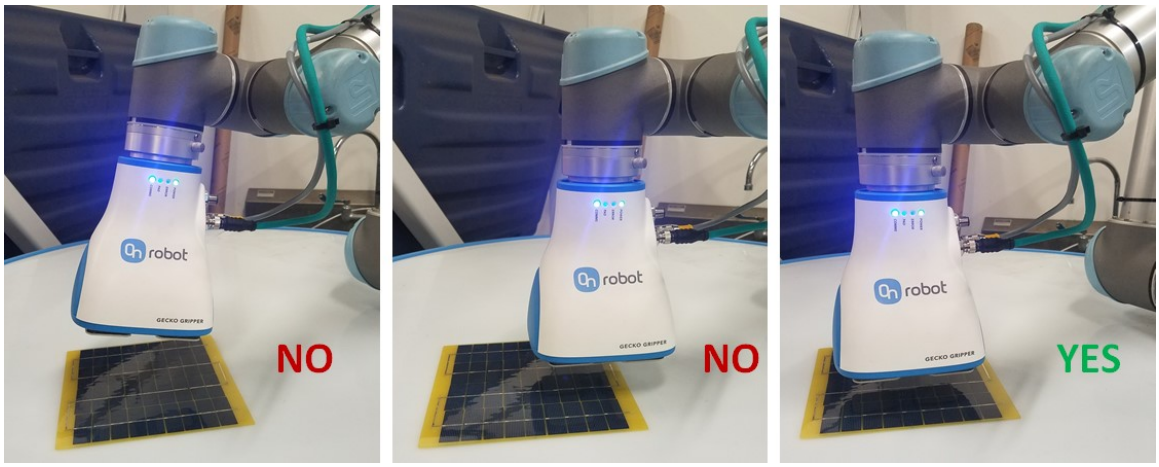

Figure 38 Incorrect (left, center) and correct (right) perch positions.

Step 2: When picking, drive the gripper slowly towards the object (in this case, downwards) while ensuring the gripper pads and the object surface are coplanar.

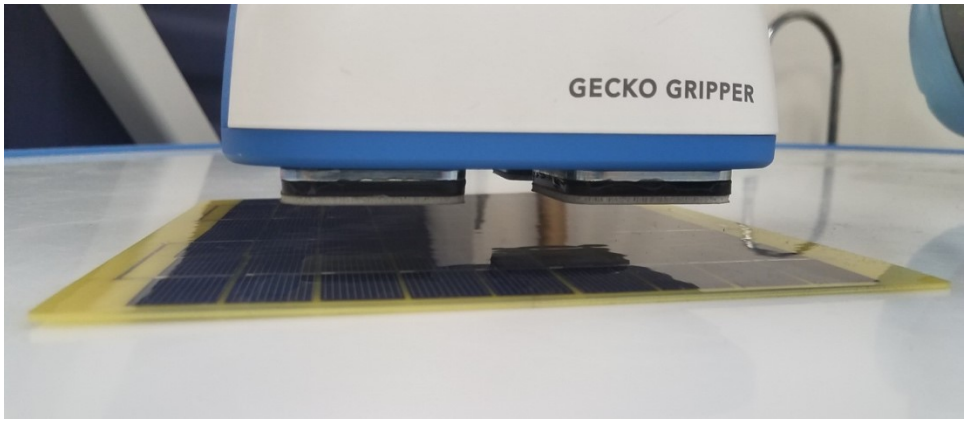

Figure 39 A visual check that the pads and the surface of the solar panel are coplanar.

Step 3: Contact the object with the gripper and drive in until the desired preload force is achieved. The preload force may be read from the robot interface or Windows GUI.

NOTICE **Maximum pre-load force for the Gecko Gripper is 150N. Settings on the robot may need to be adjusted to approach this maximum force.**

If adequate preload is not of concern (e.g. very low object weight), the gripper can be visually guided into contact in position control. In all cases, it is important to ensure the gripper housing does not contact the object. This can damage the object and trip off the robot's collision safeties.

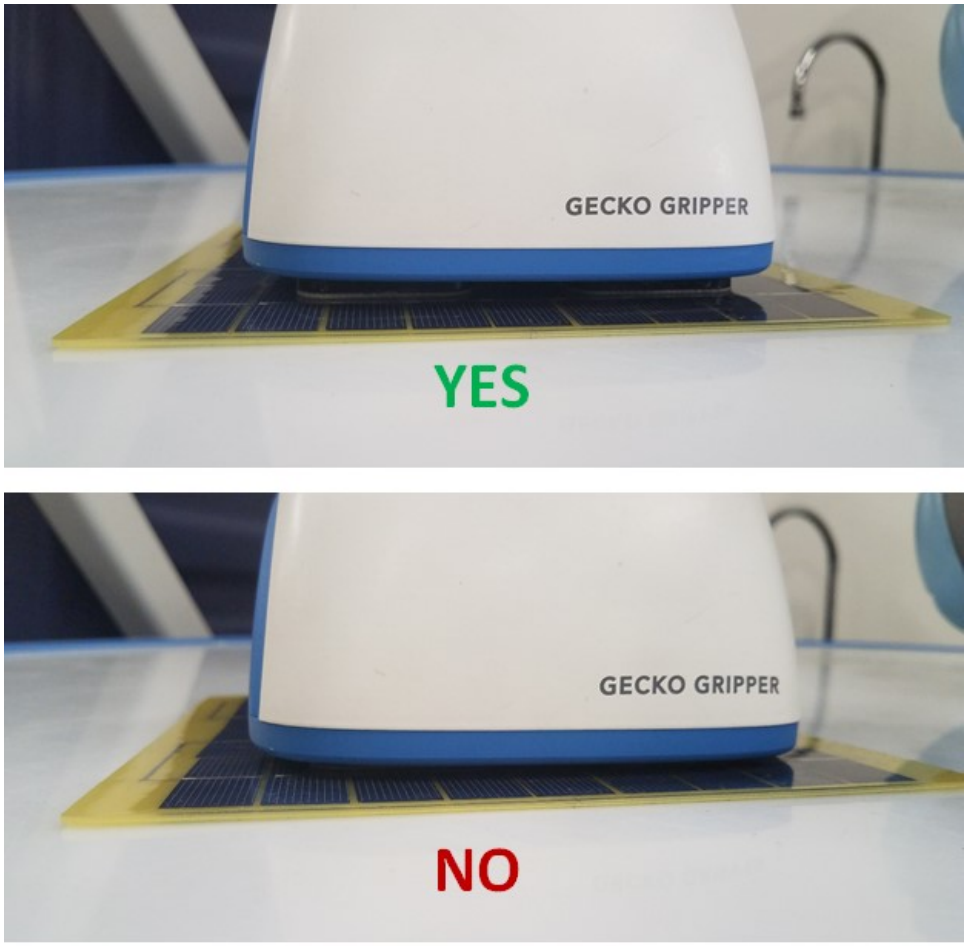

Figure 40 Correct (top) and incorrect (bottom) proximity of the gripper housing to the object being picked (here, the solar panel).

Step 4: To release the object, follow the specific instructions for your selected communication type, either I/O or Ethernet.

If using I/O communications, drive the appropriate I/O channel for DISENGAGE to HIGH (for 1 second or less) and then to LOW. This will retract the pads within the gripper. Once the object has been placed, the

pads should move to ENGAGE by holding the appropriate I/O channel HIGH momentarily, then back to LOW to prepare for the next pick.

If using Ethernet communications, the same result can be achieved by setting the proper Ethernet packet HIGH or LOW similarly to I/O usage.

Placing the object requires the pads to retract. It is important to note that during pad retraction, the object will drop the distance between the gripper housing and the surface on which the object is placed. *See Section 9.1 for more details on gripper dimensions.*

8. Gecko Gripper Specifications

8.1. Technical Specifications

8.1.1. Gecko Gripper Dimensions

The dimensions of the Gecko Gripper are illustrated below in metric units (mm).

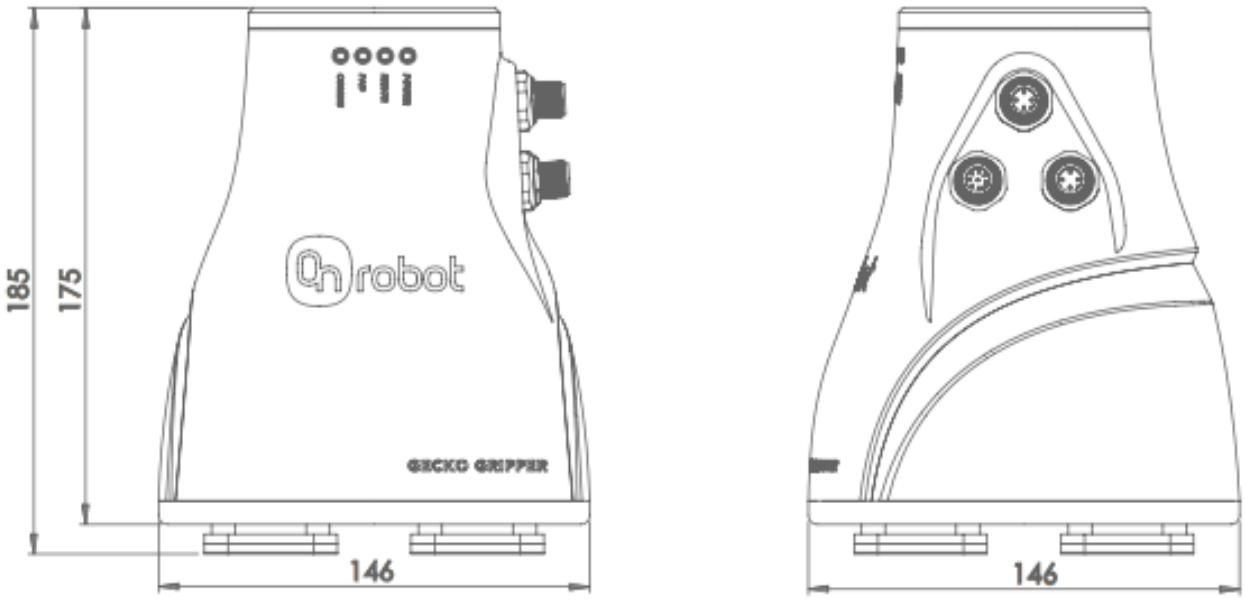

Figure 41 Gecko Gripper front and side dimensions.

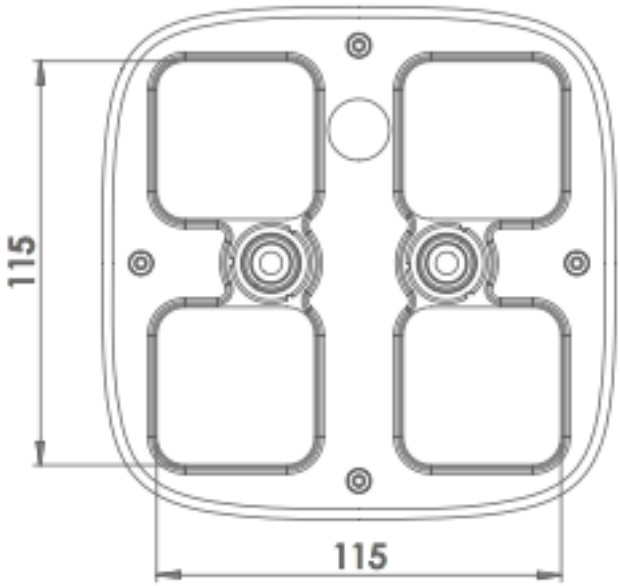

Figure 42 Gecko Gripper gripping face (bottom) dimensions.

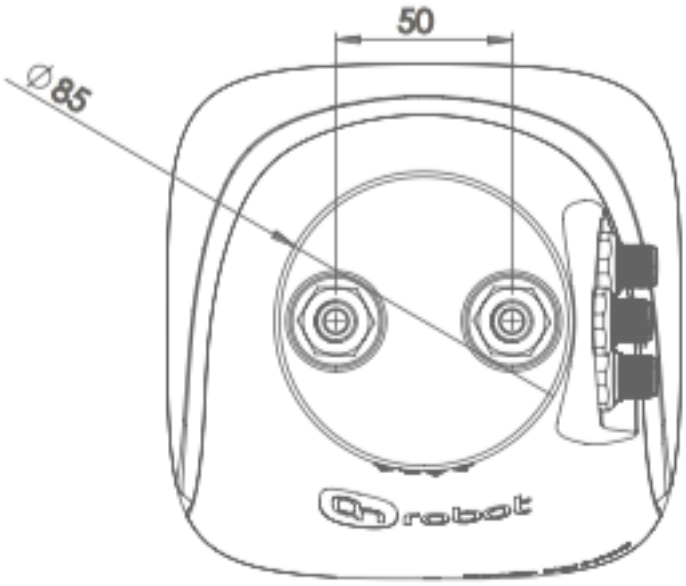

Figure 43 Gecko Gripper mounting face (top) dimensions.

8.2. Environmental and Operating Conditions

Condition	Minimum Value	Optimal Value	Maximal Value	Notes
Temperature	0°C	N/A	50°C	Storage up to 60°C
Surface Characteristics	Matte finish	Highly polished	N/A	Smoother surfaces require less preload force for a desired payload force.

Table 5 Environmental and operating conditions for the Gecko Gripper.

8.3. Mechanical Specifications

8.3.1. Gripper Specifications

Specification or Feature	Target value
Maximum Payload (kg) ***Native Adhesion*** ***After Safety Factor (x2)*** ***With Cleaning System***	Polished Steel / Acrylic/ Glass/ Sheet Metal 8.2 / 8.1 / 6.6 / 6.1 8.2 / 8.1 / 6.6 / 6.1 1.6 / 1.6 / 1.3 / 1.3
Gripper Weight	2.4 kg
Suggested pre-load required for max adhesion	125 N (*reduction in preload results in reduction in adhesion; see Section 9.4 for more information); 150 N maximal preload force.*
Detachment time	500 msec
Certifications	FCC Part 15 / Canada ISED CE - EMC

IP Rating	54
Error handling	LED and Graphic User Interface
User Interface	Teach Pendant (Universal, Kawasaki, Fanuc) Windows PC
Holds part on power loss?	Yes
Communication options	Digital I/O Ethernet TCP (custom protocol)
Working Temperature	0C - 50C
Power requirements	Peak: 24VDC, 0.8 A RMS: 24VDC, 0.5 A
Cable/ Power options	2 Cables: Power & I/O, Piezo driver (M12) 3 Cables: Power, Ethernet, Piezo driver (M12)

Table 6 Gecko Gripper specifications.

8.3.2. Pad Specifications

Specification or Feature	Target value
Parts Presence Sensing	Yes (Ultrasonic)
Pad Material	Proprietary silicone blend
Wear Properties	Depends on surface roughness
Pad Attachment Mechanism	Magnetic
Change-out interval	100,000 – 200,000 cycles (dependent on surface)
Manual cleaning system	Silicone roller
Manual cleaning interval and % recovery	Variable / 100%

Table 7 Specifications for the Gecko Gripper Pads.

8.3.3. Preload Sensor Specifications

The preload sensor system is based on piezo-resistive Tekscan sensor technology. Basal sensor data can be located on the Tekscan website (below), but each sensor system is calibrated for each gripper.

https://www.tekscan.com/flexiforce-load-force-sensors-and-systems

8.3.4. Ultrasonic Range Sensor

Range and parts presence sensing is based on ultrasonic sensing technology. Further information can be found here:

https://cdn.automationdirect.com/static/specs/prox18mmultrauk6.pdf

8.4. Selecting an Appropriate Preload Force

Selecting an appropriate preload force is essential for optimal gripper operation and depends heavily on the details of your specific application. For example, substrate material, robot-object movements, and environmental conditions will all impact the amount of preload force that is necessary.

8.4.1. Adhesion Strength Increases with Preload Force (Dependent on Material)

The Gecko Gripper works best with highly polished surfaces that allow for maximal contact between the adhesive pads and the substrate surface. As the surface becomes less smooth, more preload force is required to grip substrates. Matte surfaces should be considered the maximal surface roughness limit which the gripper is able to grip.

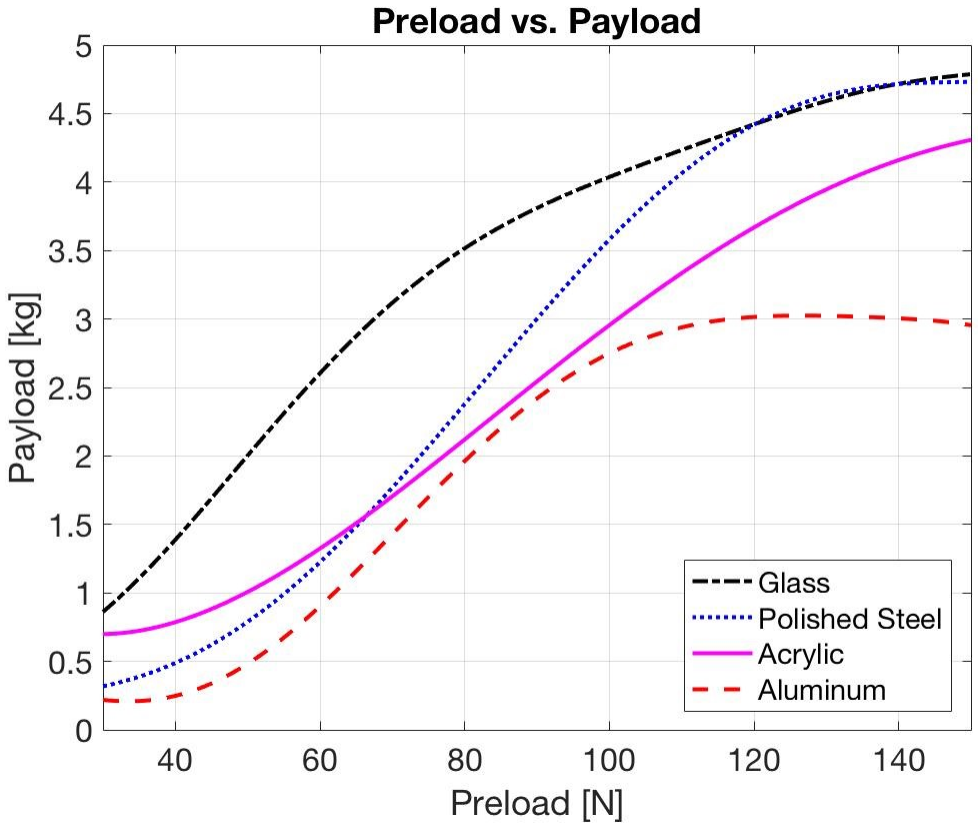

Figure 44 Payload force for a given preload force is dependent on the smoothness or roughness of the substrate.

Adhesion specifications assume that the center of gravity of the object is equidistant from the gripper pads. If the center of gravity of the object is not centered or moments are applied to the object, this can decrease the adhesion force of the gripper causing it to drop the objects.

The optimal preload force for your application will depend on the surface roughness of the object and should be experimentally determined under your specific operating conditions.

Flexible materials, so long as they are smooth and rigid in shear (non-stretching), can also be picked up by the Gecko Gripper (e.g. aluminum foil and plastic wrap). The preload force required to pick up these materials depends on both the surface roughness and the rigidity of the backing/support on which those surfaces are held. The optimal preload force should be determined experimentally.

8.5. Pick Location and Limits of Payload Movement

Users will also need to account for G-forces or other forces that act on the picked part that could potentially overcome the gripping force of the Gecko Gripper. Applying a moment to the object can result in peeling of the object from the pads and possible dropping of the object. This problem is magnified as the footprint of the object greatly exceeds the footprint of the gripper.

9. Gripper Maintenance

9.1. Maintenance Overview and Schedule

Gecko Gripper pads are made from a precision cast silicone or polyurethane film with a gecko microstructure. Contact with sharp objects may damage the pad surface and impair function. The Gecko Gripper performance is maximized when the pads are clean and dry. The pads can collect dust, so it is best to use the Gecko Gripper in a clean environment and/or establish a routine cleaning schedule.

Part	Description of Maintenance	Frequency
Pads	*Routine cleaning:* • Manual – Tacky Roller • Programmed – Cleaning Station *Replacement*:	*Dependent on operating conditions. Guidelines are:* • Every 10,000 cycles in ISO 9 environment (but will ultimately depend on individual conditions). Every 100,000-200,000 cycles (depending on environment)
Connectors	Replacement due to bent pins	As needed

9.2. Cleaning the Gripper Pads

To clean the pads manually, inspect the pads and use the provided tacky roller to remove surface dust or debris. Pads should be cleaned every 10,000 cycles as a baseline and adjusted based on the environment.

Figure 45 Manually cleaning the gripper pads with the tacky roller.

9.3. Replacing the Gripper Pads

Gecko Gripper pads are designed to last for 100,000-200,000 cycles under typical operating conditions. If the pads do not seem to be gripping properly, even with routine cleaning (*see Section 10.2)*, we recommend fully replacing the gripper pads.

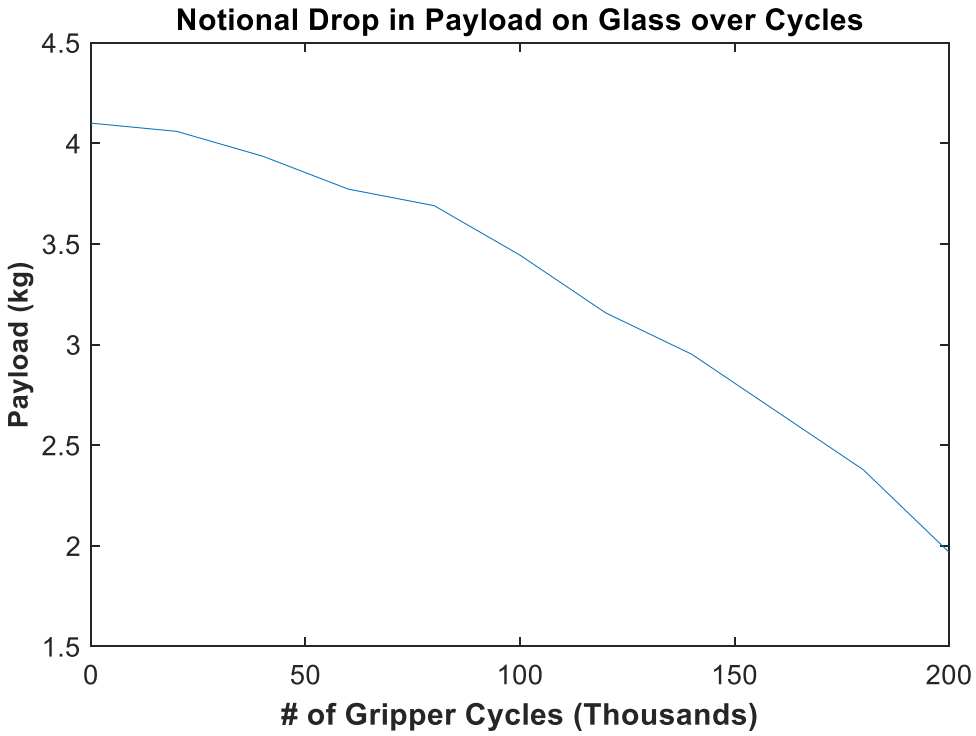

Figure 46: Notional drop in adhesion due to pad wear

To replace the gripper pads, use the provided pad removal tool.

Step 1: Move gripper pads to the maximum extruded setting such that the pads are maximally exposed/visible.

Figure 477 Gecko Gripper pads in their maximally extruded position and the pad removal tool.

Step 2: Insert the edge of the pad removal tool between the shiny silver plate of the pads and the dull backing plate. Leverage the pad removal tool against the gripper housing to pry off the used pad. Repeat for all pads.

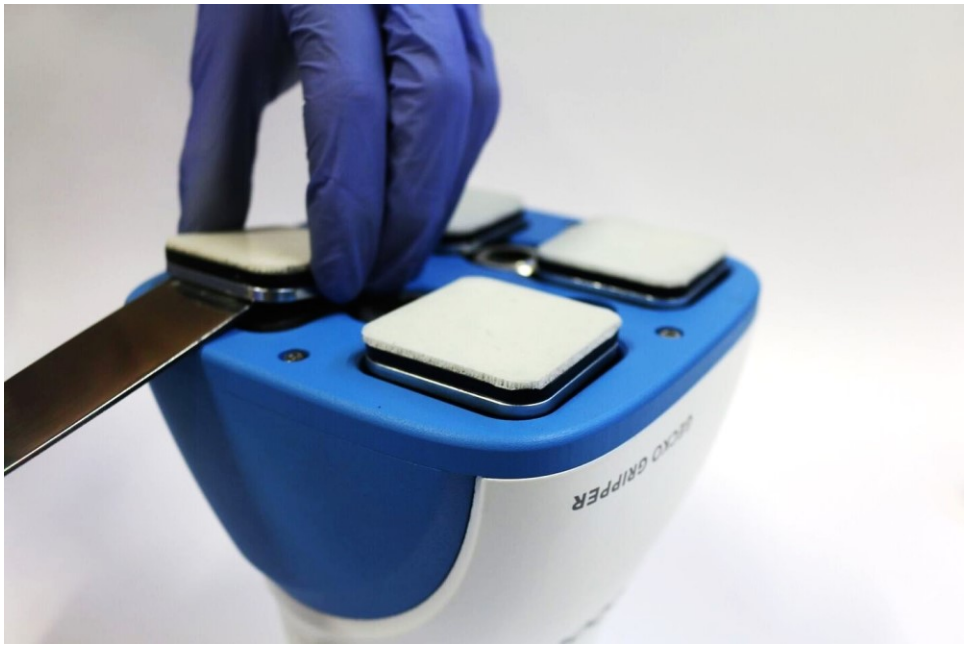

Figure 48 Leveraging the pad removal tool to replace worn pads.

Step 3: To install new replacement pads, align the notch of the pad with the tab in the mounting hole. Push the pad into the gripper until there are no gaps between the shiny silver pad plate and backing plate.

Figure 489 Installing new replacement pads by aligning the notch of the mounting plate with the tab of the replacement pad.

10. Troubleshooting

10.1. Error Handling

Unexpected events and errors are recorded by the gripper program during a run and can be saved to either a local file if running the Desktop GUI (*see Section 6.3.5 on Error Handling.)*

10.2. LED States

There are status LEDs on the gripper for power (“Power”), general error (“Error”), pad state (“Pads”), and communication (“Comms”). The LED indicators and their meanings are shown in the table below:

LED Name and Color	Steady Color	Slow Blink	Fast Blink
Power *Green*	Power connected	N/A	N/A
Error *Red*	N/A	Warning (internal errors); Gripper needs maintenance; Check error logs for details	Major Error; Gripper should be stopped immediately and investigated
Pad *Orange*	N/A	A part has been dropped	Parts have been repeatedly dropped and error logs updated
Comms *Blue*	Communications connected	N/A	N/A

Table 8 LED indicators and their meanings.

11. Warranty

Please see OnRobot A/S website for Warranty information or email info@onrobot.com

12. Contact

OnRobot A/S
Teglvaerksvej 47H
5220 Odense, Denmark
info@onrobot.com

13. Declarations and Certifications

- Immunity:
  - EN 61000-6-2 with C1: Heavy Industrial
- Emissions:
  - EN 55011 with A1: Heavy Industrial
  - FCC Part 15 / Canada ISED
- IP-42
- Components ROHS and UL Compliant