Robotiq Adaptive Gripper, S Model Instruction Manual

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Revisions

Robotiq may modify this product without notice, when necessary, due to product improvements, modifications or changes in specifications. If such modification is made, the manual will also be revised, see revision information. See the latest version of this manual online at http://support.robotiq.com/.

Revision 110515
Manual release

1. General presentation

The Robotiq Adaptive Gripper is a robotic peripheral that is designed for industrial applications. Its design makes it a unique robotic end-of-arm tool to pick, place and handle a large range and volume of parts of varying sizes and shapes.

The Adaptive Gripper has three articulated fingers, i.e. finger A in front of finger B and finger C, that each have three joints (three phalanxes per finger), as shown in Figure 1.1. The gripper can engage up to ten points of contact with objects (three on each of the phalanges plus the palm). The fingers are underactuated, meaning they have fewer motors than the total number of joints. This configuration allows the fingers to automatically adapt to the shape of object they grip and it also simplifies the control of the gripper.

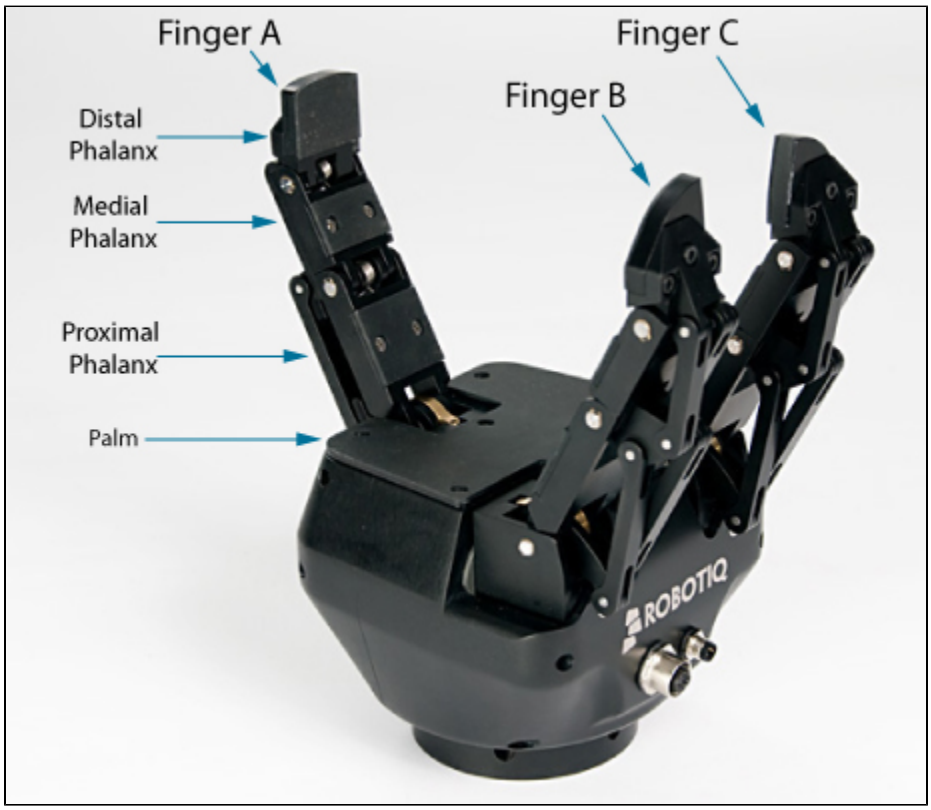


Figure 1.1 – The Adaptive Gripper.

Two different types of movements can be performed with the gripper. The first one simultaneously changes the orientation of fingers B and C as shown in Figure 1.2. That movement is referred to as changing OperationModes. The Operation Mode is determined by the user prior to the grip in function of the size or the shape of the object and for the task that has to be done.

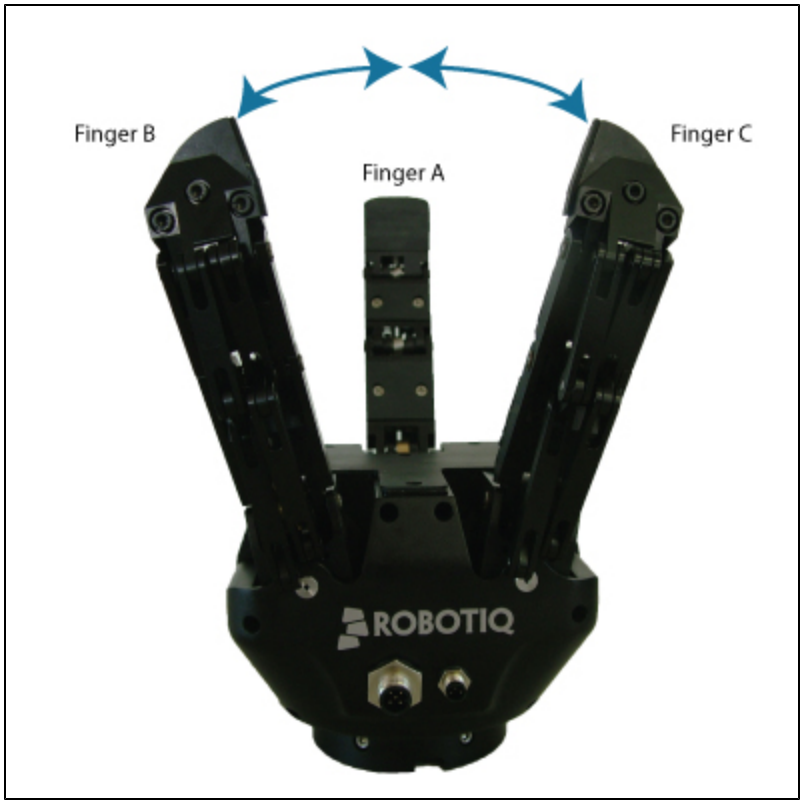


Figure 1.2 – First type of movement of the Adaptive Gripper: changing the Operation Mode

1. The ***basic mode*** is the most versatile Operation Mode. It is best suited for objects that have one dimension longer then the two others but can grip a large variety of objects.
2. The ***wide mode*** is optimal for gripping round or large objects.
3. The ***pinch mode*** is used for small objects that have to be picked precisely. This Operation Mode can only grip objects between the distal phalanxes of the fingers.
4. The ***scissor mode*** is used primarily for tiny objects. This mode is not very powerful but is precise. In scissor mode, it is not possible to surround an object. Here, fingers B and C move laterally towards each other while finger C remains still.

The four preset Operation Modes can be chosen by the user (see Figure 1.3).

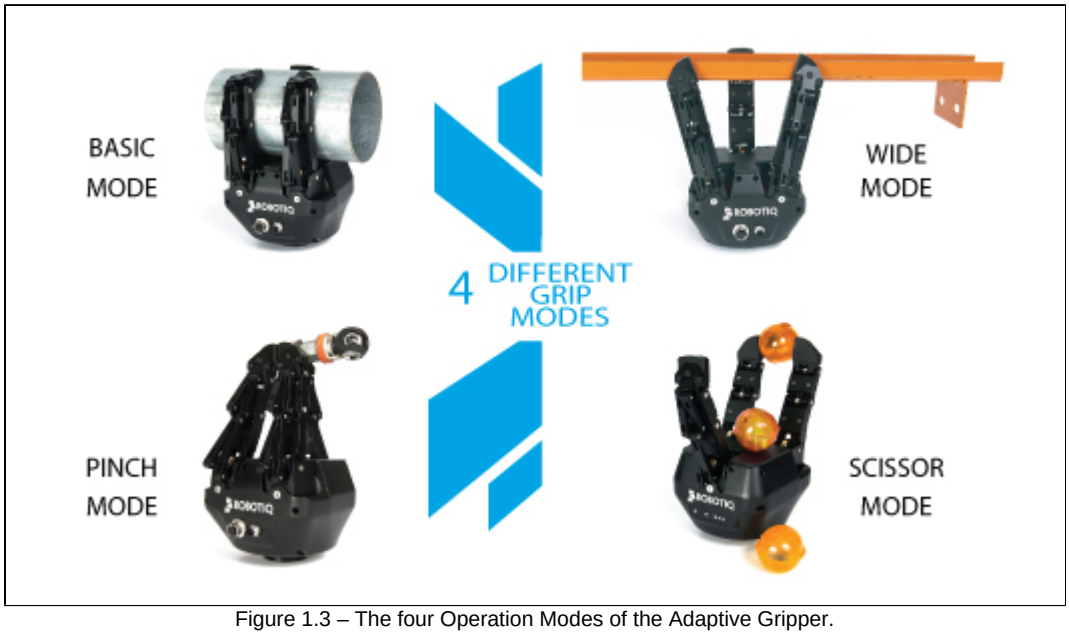


Figure 1.3 – The four Operation Modes of the Adaptive Gripper.

The second movement of the gripper is the closing and opening of the fingers as shown in Figure 1.4. This action is performed with a single input from a user. Each finger is not controlled independently; the gripper itself closes each finger until it reaches a stable configuration, on an object or against the gripper palm. Note that a user can specify the relative speed at which the fingers will close and the relative force that will be applied to an object.

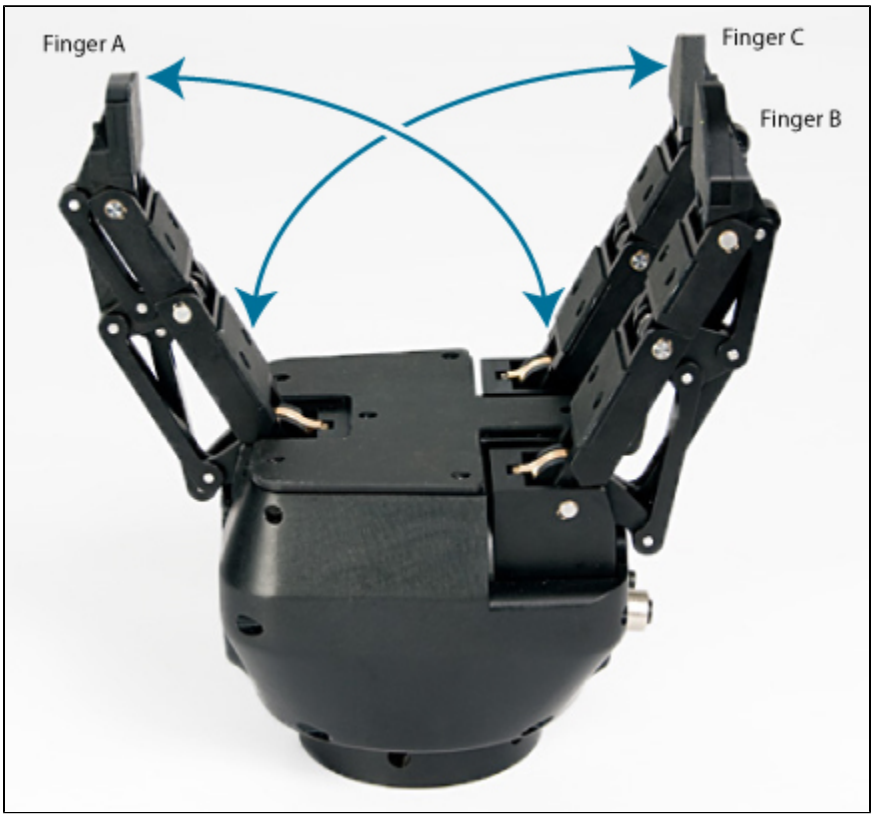


Figure 1.4 – Second movement of the Adaptive Gripper: closing and opening the fingers.

Two types of grips occur when closing the Adaptive Gripper on an object: Fingertip Grip or Encompassing Grip.

- The **Fingertip Grip** is when an object is only held by the distal phalanxes. This type of grip is similar to what is done with conventional industrial parallel grippers. In this situation, the stability of the grip is mainly related to the friction between the fingers and the object.
- The **Encompassing Grip** is when the fingers surround an object. The object is encompassed within the fingers and the stability of the grip is no longer related to friction. We suggest using the Encompassing Grip whenever possible to increase grip stability. Figure 1.5 shows the two types of grips.

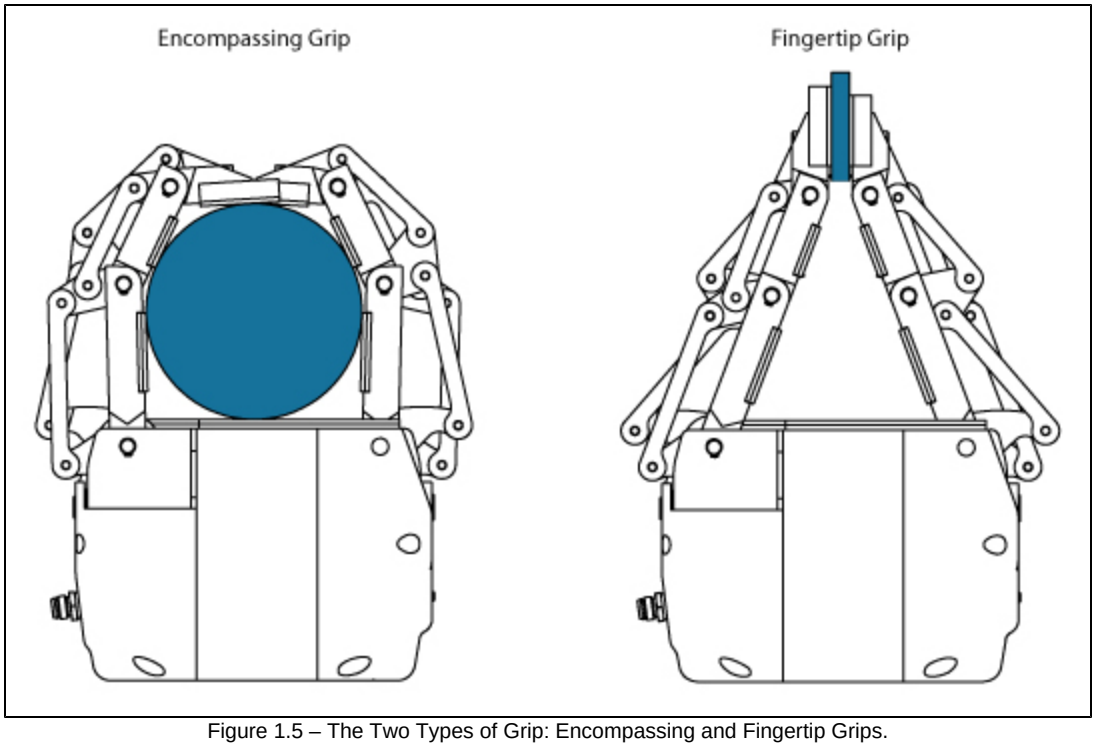


Figure 1.5 – The Two Types of Grip: Encompassing and Fingertip Grips.

It is important to note that a Fingertip Grip can only be performed when the fingers touch the object with the distal phalanxes first. Inversely, for an Encompassing Grip, the fingers must touch the object with the proximal or medial phalanxes first. Also, to ensure stability, the object should be held against the gripper palm before doing an Encompassing Grip.

Note that the Encompassing Grip cannot occur in all Operation Modes. Thereby, in Pinch and Scissor modes, it is only possible to do Fingertip Gripping. On the other side, the Fingertip Grip can occur in all four Operation Modes. Figure 1.6 summarizes the Types of Grip possible for each Operation Mode.

Operation Modes are inputs to the gripper. **Whether the fingers close to produce an Encompassing or Fingertip grip is decided at the gripper level automatically**. It will depend on:

- The Operation Mode;
- The part's geometry;
- The relative position of the part with respect to the gripper.
  In other words, picking the same part using the same Operation Mode could result in either an encompassing or fingertip grip based on a part's position and geometry.

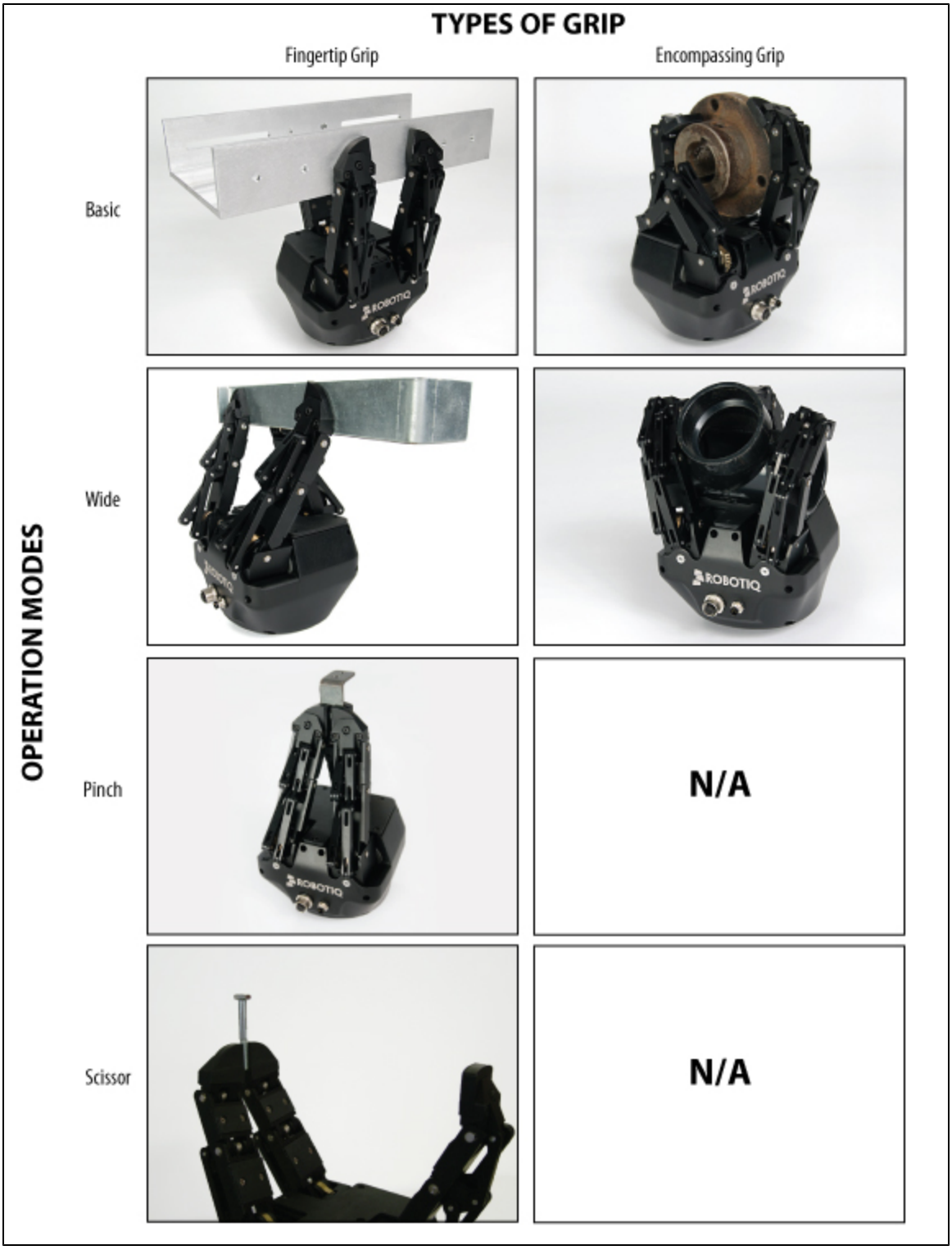


Figure 1.6 – Operation Modes vs. Types of Grip.

2. Safety

Warning
Read this section carefully before installation, operation, maintenance or inspection of the Robotiq Adaptive Gripper.

This documentation explains the various components of the Adaptive Gripper and general operation. Read this documentation and be sure to understand its contents before handling the Adaptive Gripper.

The drawings and photos in this documentation are representative examples and differences may exist between them and the delivered product.

2.1 Warning

Warning

- The gripper needs to be properly secured before operating the robot.
- Do not install or operate a gripper that is damaged or lacking parts.
- Never supply the gripper with an alternative current source.
- Make sure all cord sets are always secured at both ends, at the gripper and at the robot.
- Always respect the recommended keying for electrical connections.
- Be sure no one is in the robot and gripper path before initializing the robot's routine.
- Always respect the gripper payload.
- Set the gripper pinch force and speed accordingly, based on your application.
- Keep fingers and clothes away from the gripper while the power is on.
- Do not use the gripper on people or animals.
- For welding applications, make sure there are no gripper parts on the ground path of the welding power source.
  Any usage of the gripper beyond these definitions is inappropriate and may cause injury or damage.

2.2 Intended use

The gripper unit is designed for gripping and temporary secure holding of parts.

Caution
The gripper is NOT intended for applying force against objects or surfaces.

The unit may be used only within the range of its technical data. Any other use of the product is deemed improper and unintended use. Robotiq will not be liable for any damages resulting from improper use.

3. Installation

Warning
Be sure to read and understand the safety instructions related to the Adaptive Griper prior to installation.

Warning
Do not operate the gripper, or even turn on the power supply, before it is firmly anchored. The gripper fingers may move and cause injury or damage.

3.1 Environmental and operating conditions

The gripper is designed for industrial applications. Always respect the specified storage and operating environment conditions:

Minimum storage/transit temperature	-22°F [-30°C]
Maximum storage/transit temperature	140°F [60°C]
Minimum operating temperature	14°F [-10°C]
Maximum operating temperature	122°F [50°C]
Humidity (non-condensing)	20-80% RH
Vibration	< 0.5G
Others	• Free from dust, soot or water • Free from corrosive gases, liquids or explosive gases • Free from powerful electromagnetic interference sources

3.2 Mechanical connections

You must use a faceplate to attach the gripper to the robot. Be sure to use the faceplate related to your robot model. If there is no faceplate for your robot, you can modify a blank faceplate model or Robotiq can create a custom version for you. (Please refer to the Faceplate Specification Section for details on different faceplate models)

Here are the steps to follow for the installation of the gripper (see Figure 3.1). Note that all screws must be loctited (loctite 248).

1. Screw the faceplate to your robot arm (if your cables are running through the robot, be sure to use a faceplate with a groove).
2. Insert the gripper in the faceplate and align the indexing dowel pin with the associated hole.
3. Secure the gripper with the radial screws.

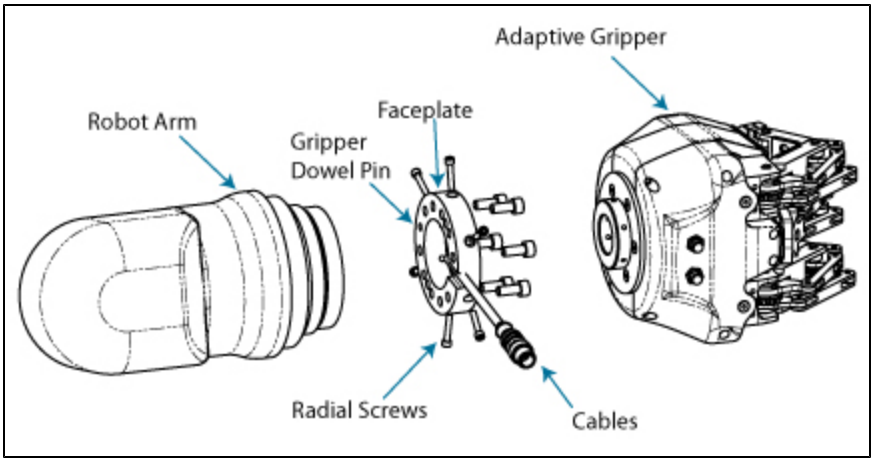


Figure 3.1 – Attaching the Adaptive Gripper to a robot arm with the Faceplate.

3.3 Power supply specifications

The gripper needs to be supplied by a DC voltage source. This power supply is not included with the gripper. The following table shows the specifications regarding the power supply required to operate the gripper properly.

Output voltage	24 V DC
Output current	2 A
Ripple	2-3 % peak-peak
Output regulation	2% maximum
Overcurrent	4 A fuse at 77°F [25°C]
Maximum fuse I^2t factor	100 A^2s at 77°F [25°C]
Overvoltage protection	Not required[1]

1 The gripper has built-in overvoltage protection.

3.4 Wiring

Two connections are needed for the Adaptive Gripper, one for the power and one for the communication. On the gripper, both are located on the Connection Panel shown in Figure 3.2.

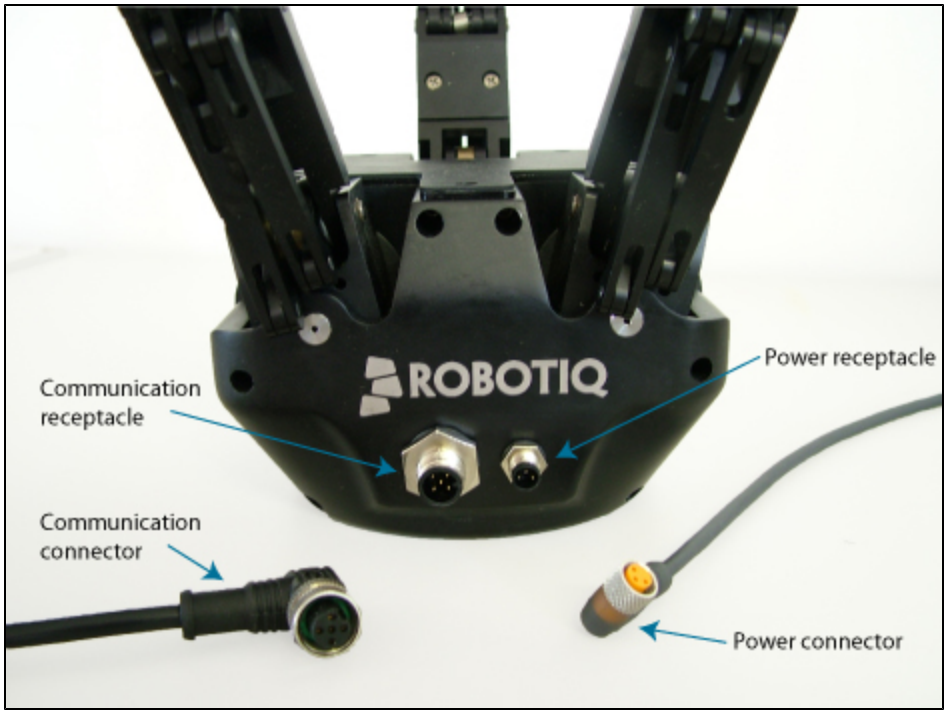


Figure 3.2 – Power and Communication receptacles and connectors.

3.4.1 Power connection

Here is the way the gripper should be connected to a power source.

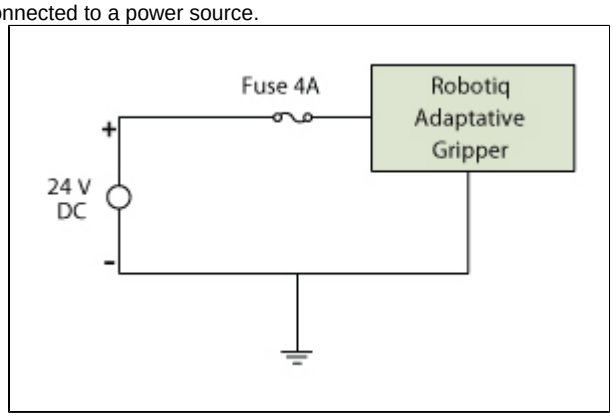
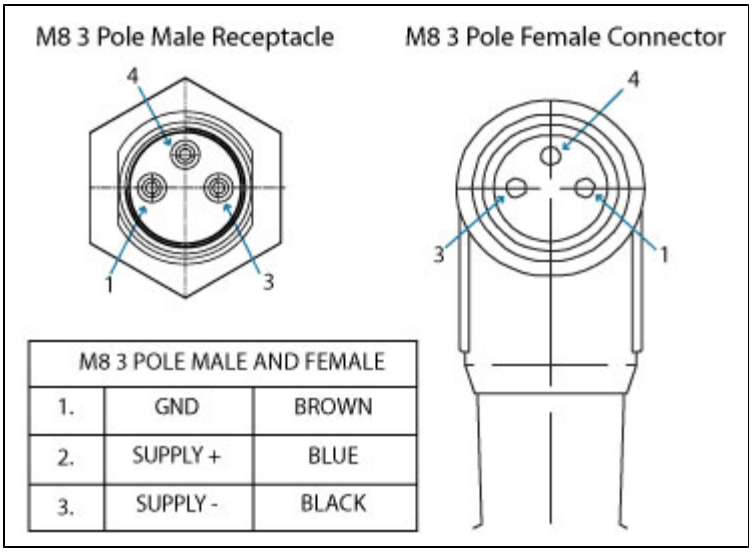


Figure 3.3 – Power connection diagram of the Adaptive Gripper.

The pinout of the power connectors is detailed in Figure 3.4.



M8 3 POLE MALE AND FEMALE		
1.	GND	BROWN
2.	SUPPLY +	BLUE
3.	SUPPLY -	BLACK

Figure 3.4 – Gripper Power Inlet and Power Connector.

The gripper should be supplied with cables that have the following specifications:

- #22 AWG TEW, 300 V or 600 V.
- 3 Conductors, 2 for the supply and one for the protective ground.
- Shielding, depending on the application. Shield must be grounded in robot controller.

3.4.2 Communication connection

The following table summarizes the communication protocols available for the gripper. Note that only one protocol option is available in a given gripper unit. The gripper that you have was configured before shipment with only one of the following protocols.

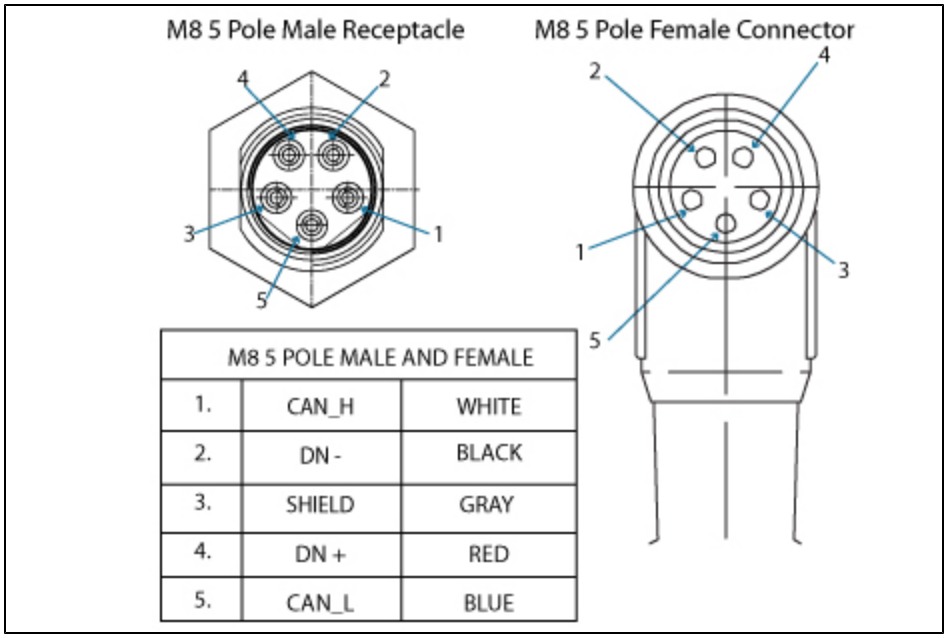
Family	Protocol
Real-Time-Ethernet	EtherNetIP
	Modbus TCP/IP
	EtherCAT
Fieldbus	DeviceNet
Serial	Modbus RTU

The same communication cable and connectors are used for all the protocols but each protocol has its own pinout.

Warning
Be sure to use the appropriate cables and pinouts for your communication protocol as any other setup may damage the gripper.

DeviceNet communication protocol

Figure 3.6 shows the pinout for the DeviceNet communication protocol.



M8 5 POLE MALE AND FEMALE		
1.	CAN_H	WHITE
2.	DN -	BLACK
3.	SHIELD	GRAY
4.	DN +	RED
5.	CAN_L	BLUE

Figure 3.6 – DeviceNet communication pinout.

Caution

- There is no terminating resistor mounted in the gripper.
- The shield of the cable must be grounded in the robot controller.

The DeviceNet communication and the Adaptive Gripper use 24 V supply. Robotiq suggests to separate power supplies as shown in Figure 3.7.

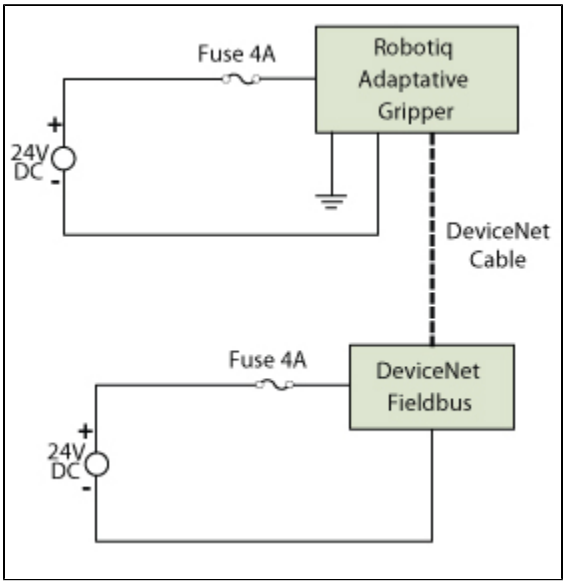
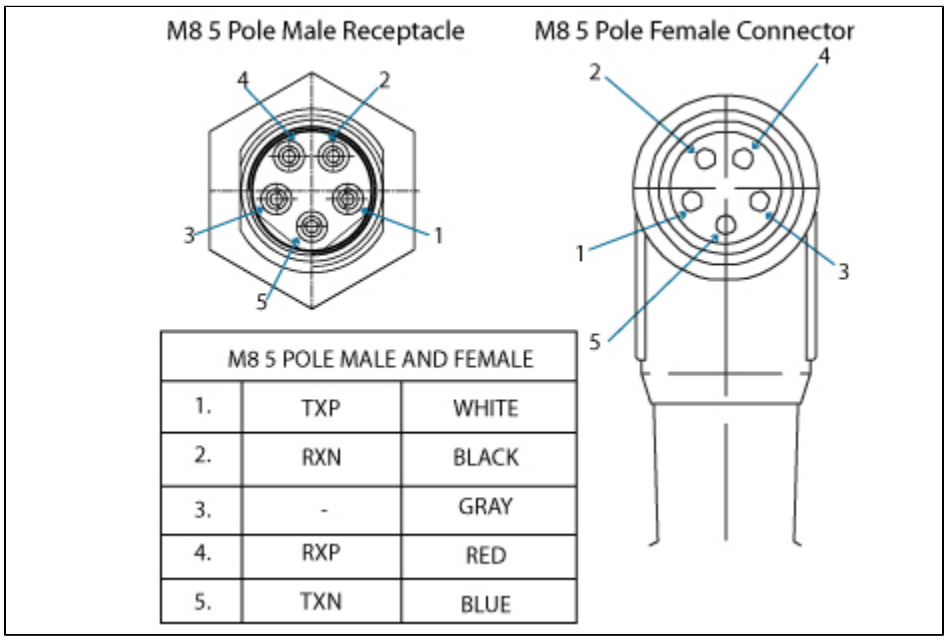


Figure 3.7* *-- Power connection diagram of the Adaptive Gripper using DeviceNet Fieldbus.

Real-time Ethernet communication protocol

Real-time Ethernet communication includes Ethernet/IP, EtherCAT and Modbus TCP/IP protocols.

See the Real-Time Ethernet pinout diagram below (Figure 3.5).



M8 5 POLE MALE AND FEMALE		
1.	TXP	WHITE
2.	RXN	BLACK
3.	-	GRAY
4.	RXP	RED
5.	TXN	BLUE

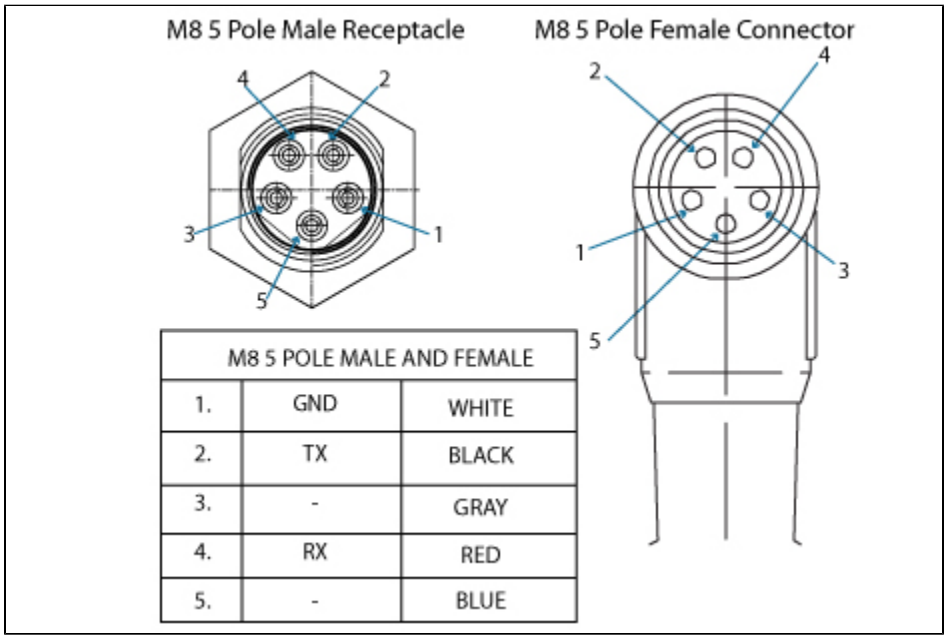
Figure 3.5 – Real-time Ethernet communication pinout.

Note

The crossover on the RX/TX signals is made inside the gripper.

Serial communication protocol

Figure 3.8 shows the pinout of the communication connectors when used in serial mode.



M8 5 POLE MALE AND FEMALE		
1.	GND	WHITE
2.	TX	BLACK
3.	-	GRAY
4.	RX	RED
5.	-	BLUE

Figure 3.8 – Serial communication pinout.

4. Control

4.1 Generalities

The Robotiq Adaptive Gripper is controlled from the robot controller (see Figure 4.1) using an industrial protocol (EternetIP, DeviceNet, EtherCat, etc.). The programming of the gripper can be done with the *Teach Pendant* of the robot or by offline programming.

- The three fingers always close/open at the same time with a single command (the motion of each mechanical phalanx is done automatically).
- For each Operation Mode, the operator can control the partial closing / opening position, the force and the speed of the fingers.

Since the Robotiq Adaptive Gripper has its own internal controller, high-level commands such as *Open* or *Close* are used to control it. The embedded Robotiq Controller takes care of the regulation of the speed and the force prescribed, while the mechanical design of the fingers automatically adapts to the shape of objects.

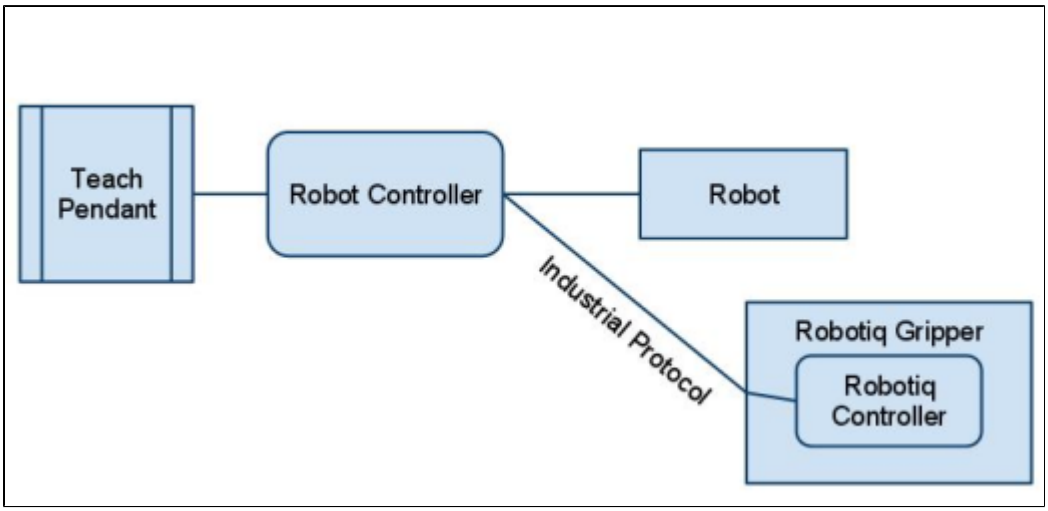


Figure 4.1 – Adaptive Gripper connections.

4.2 Status overview

- Global Gripper Status - A global Gripper Status is available. This gives information such as which Operation Mode is currently active or if the gripper is closed or open.
- Object Status - There is also an Object Status that let you know if there is an object in the gripper and, in the affirmative, how many fingers are in contact with it.
- Fault Status - The Fault Status gives additional details about the cause of a fault_._
- Motor Encoder Status - The information of the encoders of the four motors is also available.
- Current Status - The current of the motors can also be known. Since the torque of the motor is a linear function of the current, this gives information about the force that is applied at the actuation linkage of the finger.

4.3 Control overview

The gripper controller has an internal memory that is shared with the robot controller. One part of the memory is for the robot output, **gripper functionalities**. The other part of the memory is for the robot input, **gripper status** (see Figure 4.2). Two types of actions can then be done by

the robot controller:

1. Write in the **robot output** registers to activate **functionalities**;
2. Read in the **robot input** registers to get the **status** of the gripper.
   Note that the gripper must be initialized at power on. This procedure takes a few seconds and allows the gripper to be calibrated against internal mechanical stops.

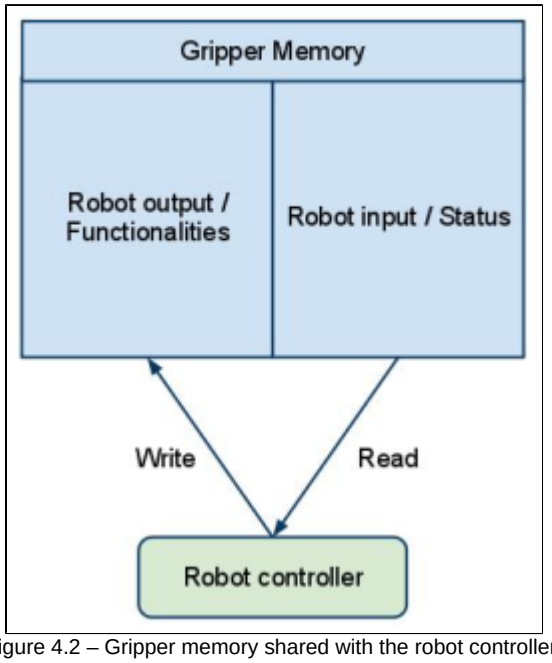


Figure 4.2 – Gripper memory shared with the robot controller.

4.4 Status LEDs

Three status LED lights provide general information about the Adaptive Gripper Status. Figure 4.3 shows the LEDs and their locations.

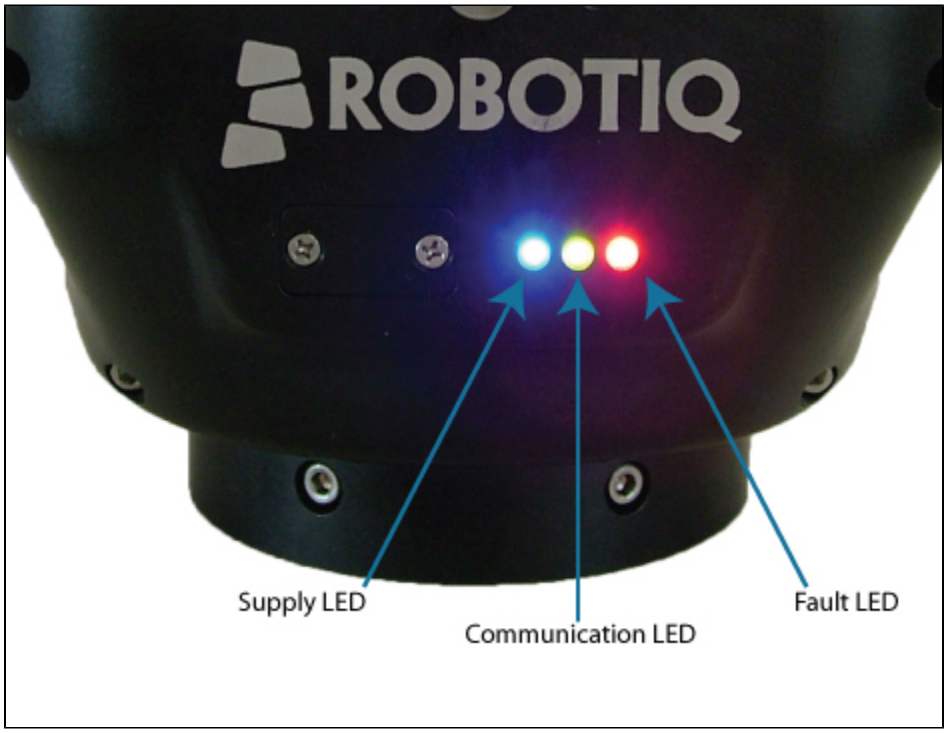


Figure 4.3 – Status LEDs.

4.4.1 Supply LED

Color	State	Information
Blue	Off	Gripper is not power supplied
Blue	On	The gripper is correctly supplied and the control board is running

4.4.2 Communication LED

Color	State	Information
Green	Off	No network detected
Green	Blinking	A network has been detected and no connection has been established
Green	On	A network has been detected and at least one connection is in the established state

4.4.3 Fault LED

Color	State	Information
Red	Off	No fault detected
Red	Blinking	Action and/or communication fault occurred
Red	On	A major fault occurred

Note:
A major fault refers to a situation where the gripper must be reinitialized.

4.5 Gripper register mapping

The register mapping is valid for all communication protocols, unless specified.

Info:
Register format is Little Endian (Intel format), namely from LSB (Less Significant Bit) to MSB (Most Significant Bit).

Register	Robot Output / Functionalities	Robot Input / Status
Byte 0	ACTION REQUEST	GRIPPER STATUS
Byte 1	SAFETY SHUTDOWN (RS232 Modbus RTU only)	OBJECT STATUS
Byte 2	SPEED	RESERVED
Byte 3	FORCE	FAULT STATUS
Byte 4	PARTIAL OPEN	FINGER A POSITION
Byte 5	PARTIAL CLOSE	FINGER B POSITION
Byte 6		FINGER C POSITION
Byte 7		SCISSOR POSITION
Byte 8		FINGER A CURRENT
Byte 9		FINGER B CURRENT

Byte 10		FINGER C CURRENT
Byte 11		SCISSOR CURRENT

4.6 Robot output registers & functionalities

Register: ACTION REQUEST
Address: Byte 0

Bit	Name	Description
0	rINI	0 – Reset Gripper 1 – Initialize Gripper (Must stay on after initialization is completed)
1 2	rMOD	00 – Go to Basic Mode 10 – Go to Pinch Mode 01 – Go to Wide Mode 11 – Go to Scissor Mode
3 4	rGRP	00 – Stop 10 – Open 01 – Close 11 – Stop
5	rPRO	0 – Set opening displacement to maximal opening 1 – Set opening displacement up to requested position (See Register PARTIAL OPEN)
6	rPRC	0 – Set closing displacement to maximal closing 1 – Set closing displacement up to requested position (See Register PARTIAL CLOSE)
7	rRS1	Reserved

rINI: First action to be made when the power is turned on. Prior to any other action the gripper **must be** initialized and **rINI bit must stay on afterwards for any other action to be performed**. Set **rINI** to 0 to reset gripper and fault status.

rMOD: The gripper has four different Grasping Modes to accommodate objects of different shapes. When the Grasping Mode is changed, the gripper automatically opens completely first to avoid interferences between the fingers.

rGRP: The gripper will close or open at a speed corresponding to the value set in register **rVEL**. 00 and 11 bits on the rGRP register have the same effect.

rPRO, **rPRC**: It is possible to determine the position at which the finger will stop while closing or opening. We call this a Partial Close or a Partial Open. This functionality is useful when you want to optimize the cycle time of the sequence of the gripper. These registers enable or disable that function. The gripper will open or close to a position corresponding relatively to the value set in the registers **rPPO** and **rPPC**.

Register: SAFETY SHUTDOWN (**RS232 Modbus only**)
Address: Byte 1

Bit	Name	Description
0 – 3	rRS2	Reserved
4 - 7	rSSH	Timeout between successive requests before shutdown 0x0 – No Shutdown 0x1 – 20ms 0x2 – 40ms 0x3 – 80ms 0x4 – 160ms 0x5 – 320ms 0x6 – 640ms 0x7 – 1280ms 0x8 – 2560ms 0x9 – 5120ms 0xA to 0xF – 10240ms

rSSH: Sets safety shutdown delay in ms. Safety shutdown delay is the maximum accepted delay between two successive commands. If the delay

between two successive commands is higher than this value, the gripper will automatically shutdown. **Only active in Modbus RTU**. This function is automatically enabled for other communication protocols and depends on the connection status.
Register: SPEED
Address: Byte 2

Bit	Name	Description
0 – 7	rSPD	Set Grasping Speed 0x00 (Minimum velocity) to 0xFF (Maximum velocity)

This register is used to setup the gripper's closing or opening speed. Setting a speed will not initiate a motion. However, for motions that have already been initiated, changing the gripper speed will directly influence the gripper closing speed. Note that 0x00 speed does not mean absolute zero speed. It is the minimum speed of the gripper.
Register: FORCE
Address: Byte 3

Bit	Name	Description
0 – 7	rFOR	Set Gripping Force 0x00 (Minimum force) to 0xFF (Maximum force)

The user can change the final gripping force. Note that 0x00 force does not mean zero force; it is the minimum force that the gripper can apply.

Register: PARTIAL OPEN
Address: Byte 4

Bit	Name	Description
0 – 7	rPPO	Set position for partial opening 0x00 (Full opening) to 0xFF (No opening)

This register is used to setup the position for Partial Opening. Setting a Partial Opening will not initiate a motion. See Figure 4.4 and Figure 4.5 for the relationship between the Partial Opening value and the distance between the fingers.

Register: PARTIAL CLOSE
Address: Byte 5

Bit	Name	Description
0 – 7	rPPC	Set position for partial closing (0x00 – 0xFF) 0x00 (No closing) to 0xFF (Full closing)

This register is used to setup the position for partial closing. Setting a partial closing will not initiate a motion. See the following figures for a chart of the positions. See Figure 4.4 and Figure 4.5 for the relationship between the Partial Closing value and the distance between the fingers.

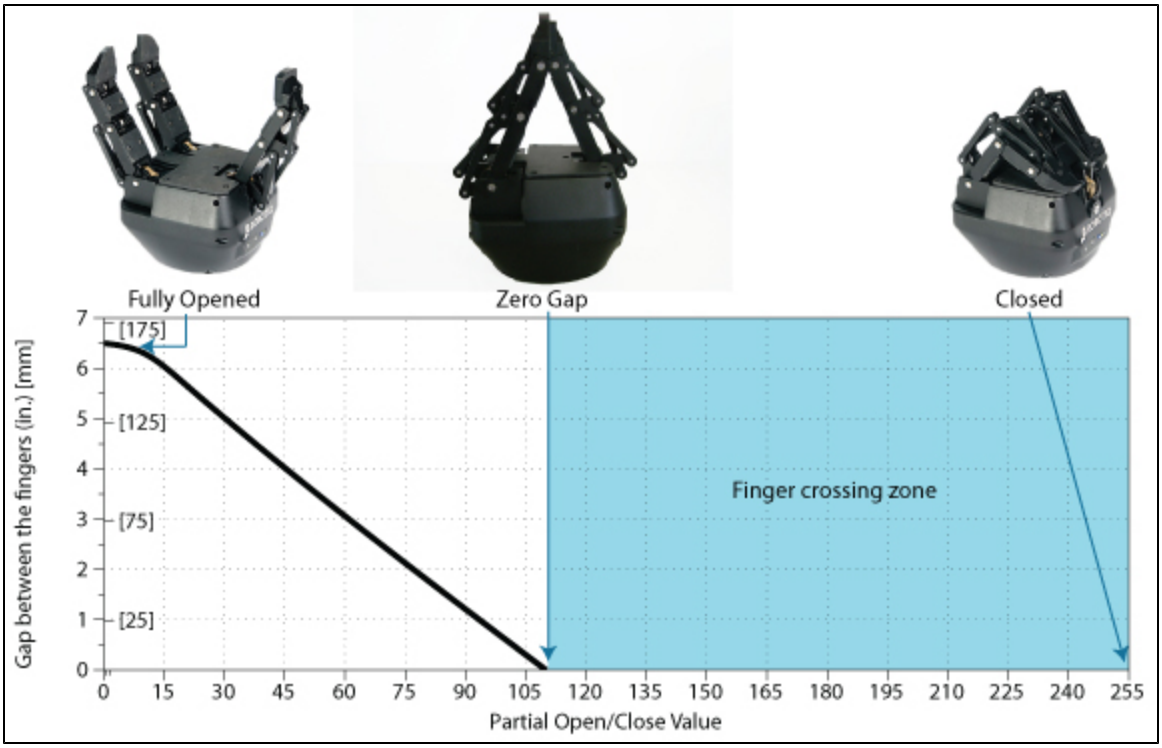


Figure 4.4 – Partial Close graph for Wide, Basic and Pinch Modes.

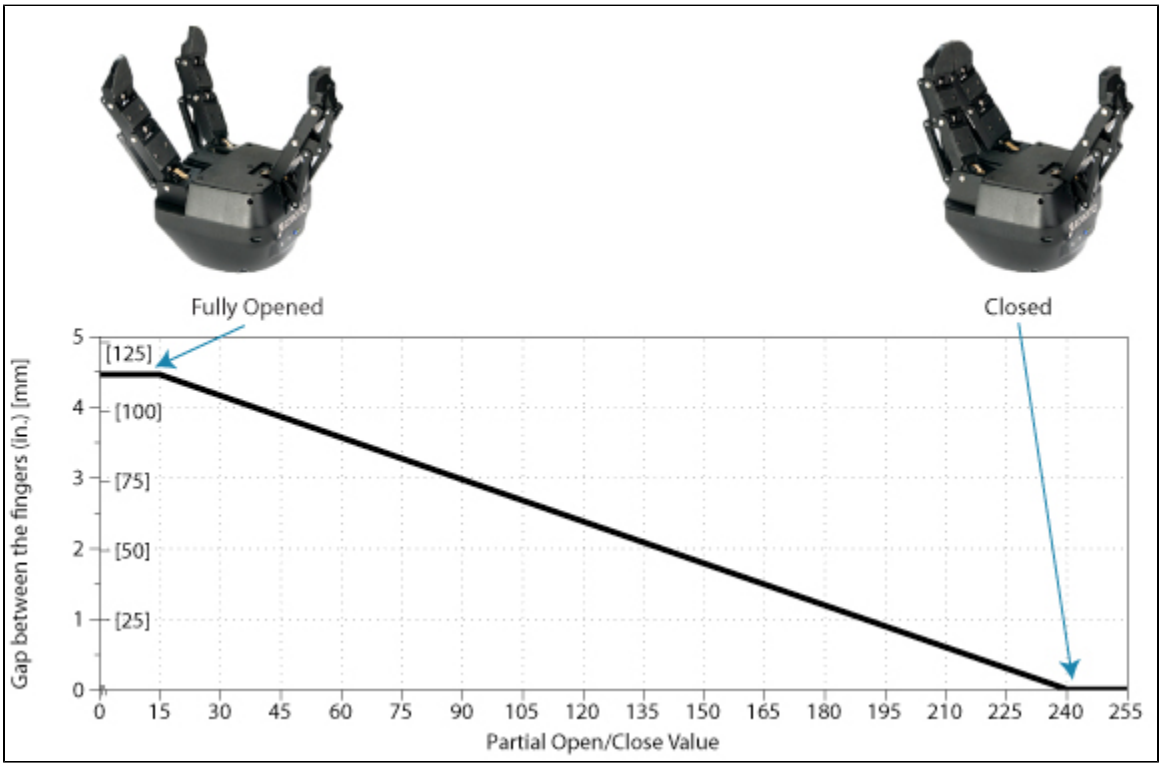


Figure 4.5 – Partial Close graph for Scissor Mode.

4.7 Robot input registers & status

Register: GRIPPER STATUS
Address: Byte 0

Bit	Name	Description
0	gINI	0 – Gripper Reset 1 – Initialization completed
1 2	gMOD	00 – Basic Mode 10 – Pinch Mode 01 – Wide Mode 11 – Scissor Mode
3 4	gGRP	00 – Stop 10 – Open 01 – Close 11 – Mode Change, Initialization
5 6	gSTA	00 – Requested action has faulted (see Register FAULT STATUS) 10 – Requested action is in progress 01 – Invalid/Undefined 11 – Requested action was successfully completed
7	gRS1	Reserved. Set to 1

Register: OBJECT STATUS
Address: Byte 1

Bit	Name	Description
0 1	gOBJ	00 – No part detected 10 – One finger detected a part (Invalid for Scissor mode) 01 – Two fingers detected a part (Invalid for Scissor mode) 11 – All fingers (or Scissor fingers in Scissor modes) detected a part
2	gOBA	0 – No part was detected by Finger A 1 – A part was detected by Finger A
3	gOBA	0 – No part was detected by Finger A 1 – A part was detected by Finger A
4	gOBA	0 – No part was detected by Finger A 1 – A part was detected by Finger A
5	gOBB	0 – No part was detected by Finger B 1 – A part was detected by Finger B
6 7	gRS2	Reserved. Set to 0

⚠ The object detection is precise only to the order of a few mm. Therefore in some circumstances, object detection may not be accurate and it is possible that it won't detect an object. A good example of this is when picking up a thin object in a fingertip grip. For this reason, we suggest to use this feature with caution. In fact, in most applications the "action successfully completed" status of register gSTA is sufficient to proceed to the next step of the routine.

Register: RESERVED
Address: Byte 2

Bit	Name	Description
0	gRS3	Reserved. Set to 0

Register: FAULT STATUS
Address: Byte 3

Bit	Name	Description
0 – 7	gFLT	0x00 – No Fault Priority Fault 0x11 – Action delayed, initialization must be completed prior to action 0x12 – Action delayed, mode change must be completed prior to action Communication Fault 0x21 – Communication timeout, Gripper is stopped 0x22 – Insufficient supply voltage, Gripper is stopped Action Fault 0x31 – Changing mode fault, interferences detected on Scissor 0x32 – Gripper opening fault, interferences detected on Fingers 0x33 – Gripper opening fault, interferences detected on Scissor 0x34 – Gripper closing fault, abnormal displacement of Fingers 0x35 – Gripper closing fault, abnormal displacement of Scissor fingers Major Fault. Reset is required 0x41 – Initialization fault, insufficient Scissor displacement 0x42 – Initialization fault, insufficient Finger(s) displacement

Register: FINGER A POSITION
Address: Byte 4

Bit	Name	Description
0	gPOA	Position of Finger A 0x00 (Fully opened) to 0xFF (Fully closed)

Register: FINGER B POSITION
Address: Byte 5

Bit	Name	Description
0	gPOB	Position of Finger B 0x00 (Fully opened) to 0xFF (Fully closed)

Register: FINGER C POSITION
Address: Byte 6

Bit	Name	Description
0	gPOC	Position of Finger C 0x00 (Fully opened) to 0xFF (Fully closed)

Register: SCISSOR POSITION
Address: Byte 7

Bit	Name	Description
0	gPOS	Position of the Scissor 0x00 (Fully opened) to 0xFF (Fully closed)

Register: FINGER A CURRENT
Address: Byte 8

Bit	Name	Description
0	gCUA	Current of Finger A 0.1 * Current (in mA)

Register: FINGER B CURRENT

Address: Byte 9

Bit	Name	Description
0	gCUB	Current of Finger B 0.1 * Current (in mA)

Register: FINGER C CURRENT
Address: Byte 10

Bit	Name	Description
0	gCUC	Current of Finger C 0.1 * Current (in mA)

Register: SCISSOR CURRENT
Address: Byte 11

Bit	Name	Description
0	gCUS	Current of the Scissor 0.1 * Current (in mA)

4.8 Example

Figure 4.6 shows how the gripper should be controlled with a robot. Note that all the "Wait for" blocks are request status operations intended for security reasons and are therefore, in some cases, optional.

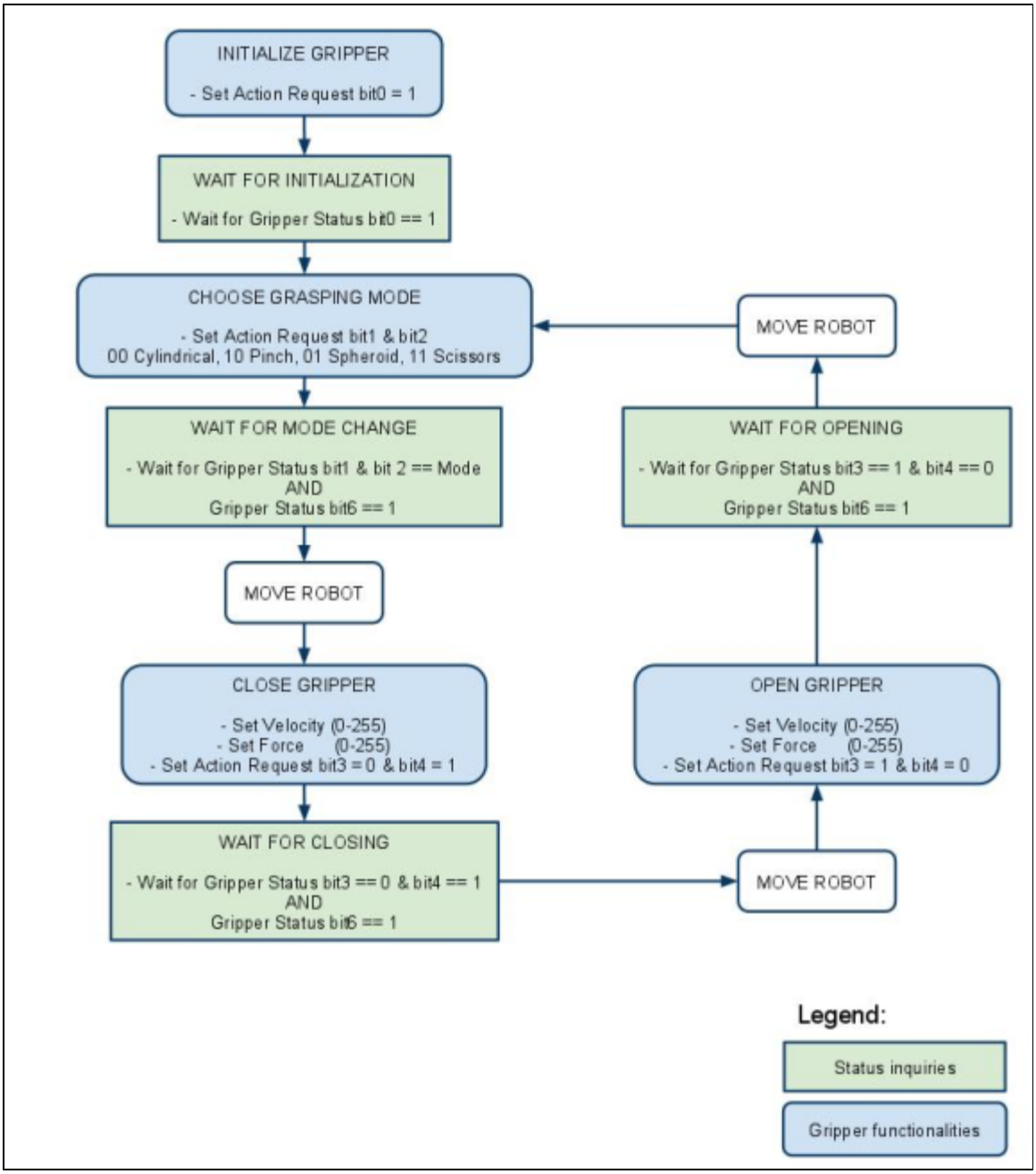


Figure 4.6 – Robotiq Gripper flow chart.

4.9 MODBUS RTU communication protocol

The Robotiq Adaptive Gripper can be controlled over RS232 using the Modbus RTU protocol. This section is intended to provide guidelines for setting up a Modbus scanner that will adequately communicate with the gripper.

For a general introduction to Modbus RTU and for details regarding the CRC algorithm, the reader is invited to read the Modbus over serial line specification and implementation guide available http://www.modbus.org/docs/Modbus_over_serial_line_V1.pdf.

For debug purposes, the reader is also invited to download one of many free Modbus scanners such as the *CAS Modbus Scanner* from *Chipkin Automation Systems* available http://www.chipkin.com/cas-modbus-scanner.

4.9.1 Connection setup

The following table describes the connection requirement for controlling the Robotiq Adaptive Gripper using the Modbus RTU protocol.

Physical Interface	RS232
Baud Rate	115,200 bps
Data Bits	8
Stop Bit	1
Parity	None
Number Notation	Hexadecimal
Supported Function	Read Holding Registers (FC03) Preset Single Register (FC06) Preset Multiple Registers (FC16)
Exception Responses	Not supported
Slave ID	0x0009 (9)
Robot Output / Gripper Input First Register	0x03E8 (1000)
Robot Input / Gripper Output First Register	0x07D0 (2000)

Each register (word - 16 bits) of the Modbus RTU protocol is composed of **2** registers (bytes – 8 bits) from the Robotiq Adaptive Gripper. The first gripper output Modbus register (0x07D0) is composed from the first **2** Robotiq Adaptive Gripper registers (byte 0 and byte 1).

4.9.2 Read holding registers (FC03)

Function code 03 (FC03) is used for reading the status of the gripper (robot input). Examples of such data are gripper status, object status, finger position, etc.

Ex: This message asks for register 0x07D0 (2000) and register 0x07D1 (2001) which contains Gripper Status, Object Status, Reserved and Fault Status.

Request is:

09 03 07 D0 00 02 C5 CE

where

09	SlaveID
03	Function Code 03 (Read Holding Registers)
07D0	Address of the first requested register
0002	Number of registers requested (2)
C5CE	Cyclic Redundancy Check (CRC)

Response is:

09 03 04 E0 00 00 00 44 33

where

09	SlaveID
03	Function Code 03 (Read Holding Registers)
04	Number of data bytes to follow (2 registers x 2 bytes/register = 4 bytes)
E000	Content of register 07D0
0000	Content of register 07D1
4433	Cyclic Redundancy Check (CRC)

4.9.3 Preset single register (FC06)

Function code 06 (FC06) is used to activate functionalities of the gripper (robot output). Examples of such data are action request, velocity, force, etc.

Ex: This message requests to initialize the gripper by setting register 0x03E8 (1000), which contains Action Request and Safety Shutdown registers, to 0x0100.
Request is:

09 06 03 E8 01 00 09 62

where

09	SlaveID
06	Function Code 06 (Preset Single Register)
03E8	Address of the register
0100	Value to write
0000	Content of register 07D1
0962	Cyclic Redundancy Check (CRC)

Response is an echo:

09 06 03 E8 01 00 09 62

where

09	SlaveID
06	Function Code 06 (Preset Single Register)
03E8	Address of the register
0100	Value written
0000	Content of register 07D1
0962	Cyclic Redundancy Check (CRC)

4.9.4 Preset multiple registers (FC16)

Function code 06 (FC16) is used to activate functionalities of the gripper (robot output). Examples of such data are action request, velocity, force, etc.

Ex: This message requests to set speed, force and partial closing/opening positions of the gripper by setting register 0x03E9 (1001) and 0x03EA.

Request is:

09 10 03 E9 00 02 04 60 E6 3C C8 EC 7C

where

09	SlaveID
10	Function Code 16 (Preset Multiple Registers)
03E9	Address of the first register
0002	Number of registers to write
04	Number of data bytes to follow (2 registers x 2 bytes/register = 4 bytes)
60E6	Value to write to register 0x03E9
3CC8	Value to write to register 0x03EA

EC7C	Cyclic Redundancy Check (CRC)

Response is:

09 10 03 E9 00 02 91 30

where

09	SlaveID
10	Function Code 16 (Preset Multiple Registers)
03E9	Address of the first register
0002	Number of written
9130	Cyclic Redundancy Check (CRC)

5. Specifications

5.1 Technical dimensions

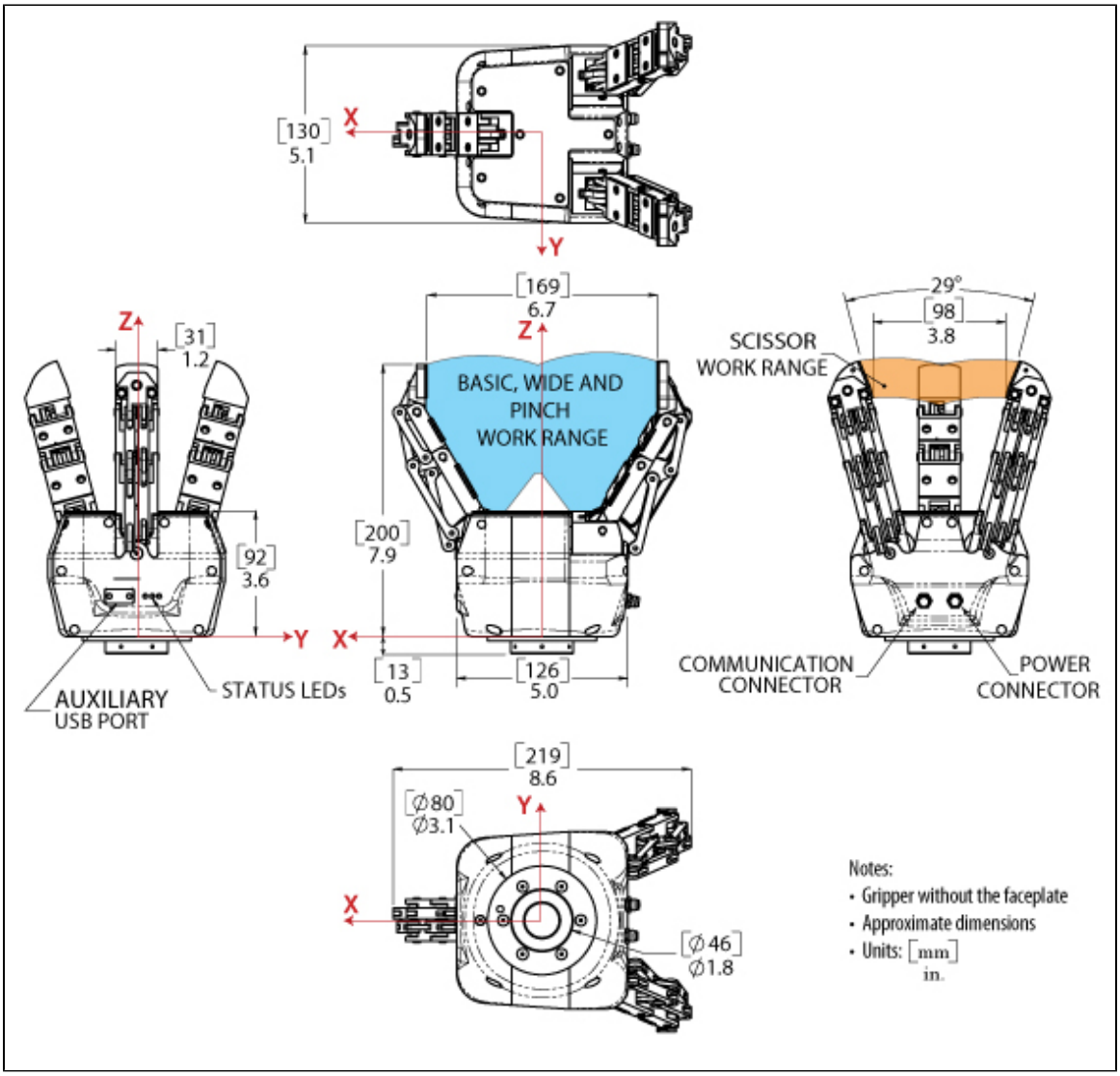


Figure 5.1 – Robotiq Gripper technical dimensions.

5.2 Mechanical specifications

Gripper Opening (see Figure 5.1)	0-6.7 in	[0-169 mm]
Gripper Approximate Weight	5 lbs	[2.3 kg]
Recommended Payload (Encompassing Grip)	22 lbs	[10 kg]
Recommended Payload (Fingertip Grip)	6.6 lbs	[3 kg]
Maximum Grip Force (Fingertip Grip)	10 lbf	[40 N]
Maximum Break Away Force	22 lbf	[100 N]

Maximum Closing Speed (Fingertip Grip)	4.3in/sec	[110mm/sec]

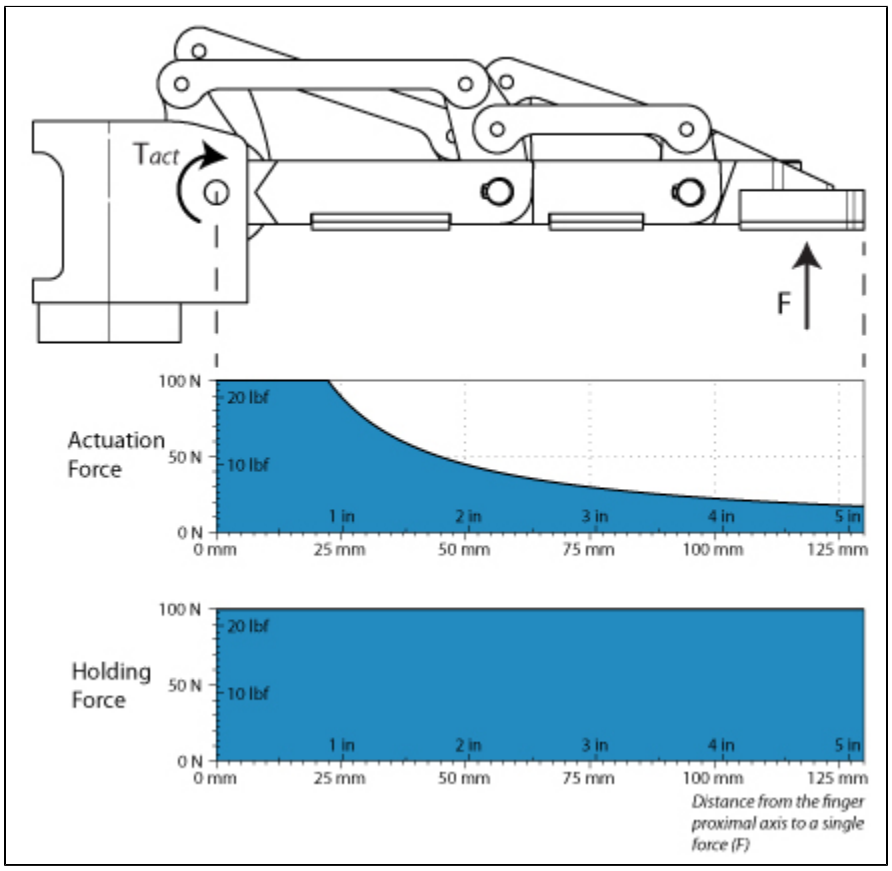


Figure 5.2 – Action and Holding Forces allowed in a single finger.

- The "Actuation Force" is the force that can be applied to an object by the motors of the gripper while the "Break Away Force" is the force that the gripper can sustain
- Because the gripper is self-locking, the Break Away Force is higher than the Actuation Force (see Figure 5.2).
- In Pinch Mode, fingers B and C will force against finger A. As finger A is locked, the pinch Actuation Force is the sum of the Actuation Force from fingers B and C, 20+20 = 40 N.

The user of the gripper must always ensure that the result of the forces against the finger is always lower then the maximum Break Away Force.

When doing a fingertip grip, the weight that can be lifted is defined by

$$W = \frac{2 * F * C_f}{S_f}$$

Where,

- *F* is the force that is applied to the load by the gripper. Note that at the fingertips, the maximum force that can be applied is when fingers B and C force against finger A. In this case, the force can be up to twice the Maximum Actuation Force, so 40N.

- C_f is the coefficient of friction between the fingertip pads and the load.
- S_f is a safety factor to be determined by the robot integrator.

5.3 Moment of inertia and center of mass

The coordinate system used for calculating the moment of inertia and center of mass of the gripper is shown Figure 5.1. We consider a configuration where the fingers are fully open in Wide Mode.

Here is the approximate moment of inertia matrix of the gripper:

$$I = \begin{bmatrix} I_{xx} & I_{xy} & I_{zz} \\ I_{yz} & I_y & I_{yz} \\ I_{zx} & I_{zy} & I_{zz} \end{bmatrix} = \begin{bmatrix} 7300 & 0 & -650 \\ 0 & 8800 & 0 \\ -650 & 0 & 7000 \end{bmatrix} kg * mm^2 = \begin{bmatrix} 24.8 & 0 & -2.2 \\ 0 & 29.9 & 0 \\ -2.2 & 0 & 23.8 \end{bmatrix} lb * in^2$$

Here is the approximate position of the center of mass:

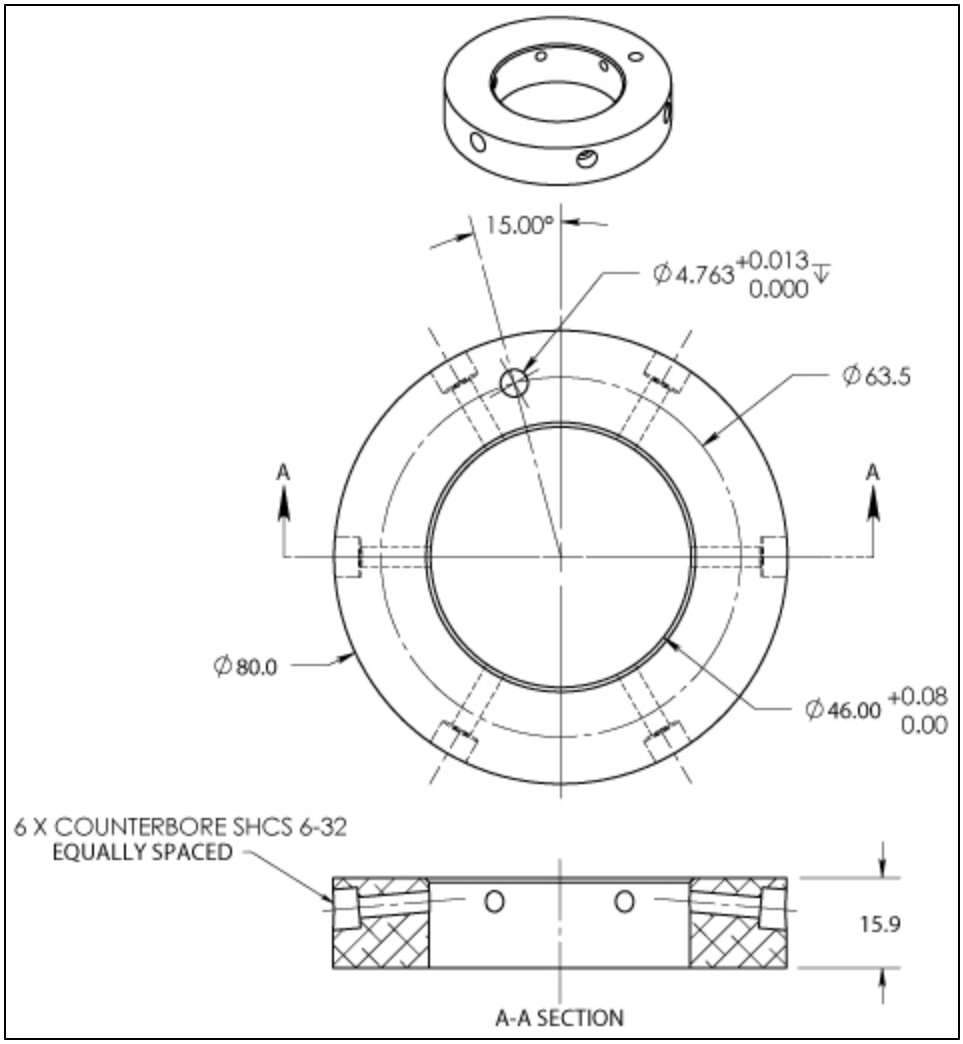
$$G = \begin{bmatrix} G_x \\ G_y \\ G_z \end{bmatrix} = \begin{bmatrix} -8 \\ 0 \\ 65 \end{bmatrix} mm = \begin{bmatrix} -0.031 \\ 0 \\ 2.560 \end{bmatrix} in$$

5.4 Electrical ratings

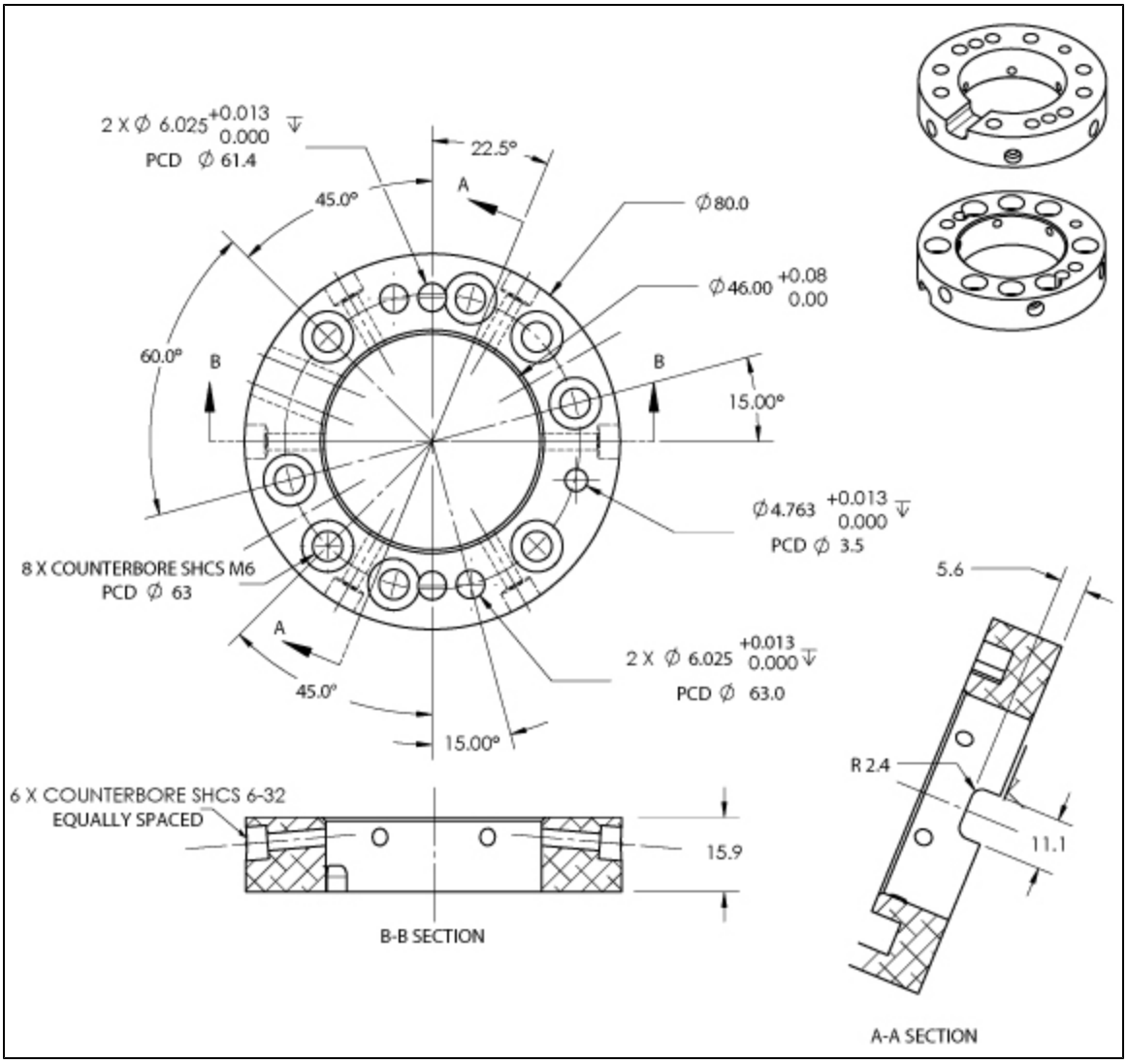
Nominal Supply Voltage	24 V
Quiescent Power (minimum power consumption)	4.1 W
Peak Power (at maximum gripping force)	35 W
Maximum RMS Supply Current (supply voltage at 24V)	1.4 A

5.5 Faceplates

5.5.1 Blank faceplate



5.5.2 Yaskawa SDA-5D_10D faceplate


2 X Ø 6.025 +0.013 0.000
PCD Ø 61.4
22.5°
45.0°
A
Ø80.0
Ø46.00 +0.08 0.00
60.0°
B
B
15.00°
Ø4.763 +0.013 0.000
PCD Ø 3.5
8 X COUNTERBORE SHCS M6
PCD Ø 63
A
2 X Ø 6.025 +0.013 0.000
PCD Ø 63.0
45.0°
15.00°
6 X COUNTERBORE SHCS 6-32
EQUALLY SPACED
15.9
B-B SECTION
5.6
R 2.4
11.1
A-A SECTION

6. Warranty

Robotiq warrants this equipment against defects in material and workmanship for a period of one year from the date of reception when utilized as intended with the specified maintenance. Robotiq also warrants that this equipment will meet applicable specifications under normal use.

During the warranty period, Robotiq will repair or replace any defective product, as well as verify and adjust the product free of charge if the equipment should need to be repaired or if the original adjustment is erroneous. If the equipment is sent back for verification during the warranty period and found to meet all published specifications, Robotiq will charge standard verification fees.
The unit is considered defective when at least one of the following condition occurs:

- The gripper fingers can not close or open;
- The gripper can be switched among Operation Modes;
- The gripper feedback necessary for the robot program is not accessible.

Parts that come into contact with the workpiece and wearing parts such as the finger and palm pads are not covered by the warranty.

Caution
The warranty will become null and void if the:

- Unit has been tampered with, repaired or worked on by unauthorized individuals.
- Warranty sticker has been removed.
- Screws, other than as explained in this guide, have been removed.
- Unit has been opened other than as explained in this guide.
- Unit serial number has been altered, erased, or removed.
- Unit has been misused, neglected, or damaged by accident.

This warranty is in lieu of all other warranties expressed, implied, or statutory, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose. In no event shall Robotiq be liable for special, incidental, or consequential damages.

Robotiq shall not be liable for damages resulting from the use of the product, nor shall be responsible for any failure in the performance of other items to which the product is connected or the operation of any system of which the product may be a part.

Exclusion
Robotiq reserves the right to make changes in the design or construction of any of its products at any time without incurring obligation to make any changes whatsoever on units already purchased.

This warranty excludes failure resulting from: improper use or installation, normal wear and tear, accident, abuse, neglect, fire, water, lightning or other acts of nature, causes external to the product or other factors beyond Robotiq's control.

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