OPERATIONS MANUAL

USING URCAP FOR UNIVERSAL ROBOTS

Abstract

This manual is for operating the pneumagiQ, casemagiQ and pneuvaQ series using URCap for Universal Robots.

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Dear customer,

At Impaqt Robotics, we aim to deliver an impact with every robot deployed globally. This is how we enable simple & faster deployment of robots and impact our partners' bottom line in deploying Robots.

If you have any questions or need help with the product, don't hesitate to get in touch with us through support@impaqt-robotics.com.

Best Regards,
Impaqt Robotics team

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Technical changes:

We reserve the right to make alterations for technical and structural improvement.

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Operations Manual – Using URCap for Universal Robots

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1 Revisions

1.1 Revision 16 November 2023

- Beta Release

1.2 Revision 29 November 2023

- Updated the latest URCap version screens.

1.3 Revision 10 April 2024

- Added pneumagiQ PQ0-1G2S.

1.4 Revision 3 September 2024

- Added casemagiQ CM100.
- Added pneuvaQ PV21.

2 General Inputs

Download more information and documentation of the products at https://www.impaqt-robotics.com.

2.1 Variants

This operations manual applies to the following variants:

- pneumagiQ PQ0-1G2S
- pneumagiQ PQ90-2G2S
- pneumagiQ PQ180-2G4S
- pneumagiQ PQ9020-2G4S
- casemagiQ CM100
- pneuvaQ PV21

2.2 Compatible Robots

pneumagiQ compatible with all models of Universal Robots.

Recommended minimum version of polyscope in UR is as follows:

- For CB3 starts from v3.12.1
- For E series starts from v5.11.1

2.3 Applicable Documents

- Catalog of the products
- Manuals of the products
- Manuals of the accessories

2.4 Safety Considerations

2.4.1 Personnel Qualifications

Only authorized personnel with a working knowledge of handling pneumatic and electrical circuits should operate the product. Anyone managing the product should have understood the different product manuals.

2.4.2 Notes for operation

Always switch-off pneumagiQ by disconnecting the I/O cable before adding or removing accessories. Before switching off, neutralize the pressure inside by shutting off the pneumatic supply and actuating the air blow-off or the air outlet ports using the URCap (Refer to operations manual).

3 pneumagiQ

pneumagiQ is a compact Universal Pneumatic EOAT Interface designed to seamlessly mount two pneumatic EOATs. The compact design of pneumagiQ makes it ideal for tight-spaced material handling applications such as machine tending and material handling. The lightweight design maximizes the payload of the robot for handling heavier parts which is especially important for collaborative robots.

These are variants of pneumagiQ:

- pneumagiQ PQ0-1G2S
- pneumagiQ PQ90-2G2S
- pneumagiQ PQ180-2G4S
- pneumagiQ PQ9020-2G4S

The URCap used for all three models are the same.

3.1 pneumagiQ State

While pneumagiQ is in operation, the status indicators are used to communicate the current state of the product.

3.1.1 Status Indicator

The status indicator is on the front cover of pneumagiQ on both sides of the 8-pin I/O connector.

LED Color	State
Red	1. Flickering - Powering up. 2. Gripper actuation 3. Initiating Air blow-off
Green	1. Idle 2. Ready for operation

3.1.2 Status Indicator: Green

The status indicator is green when pneumagiQ is idle & ready for operation.

3.1.3 Status Indicator: Red

The status indicator is red when:

- Powering up the product.
    - During power-up the status indicator flickers in Red.
- Receiving communication from the robot through the URCap

3.1.4 Status Indicator: switched off.

The status indicator is switched-off only when:

- No power supply is provided to pneumagiQ.
- I/O cable is not connected properly.
- Universal Robot is not in ‘Normal mode’.
- Tool I/O interface of Universal Robot URCap is not set to pneumagiQ.

4 casemagiQ

casemagiQ is a compact Universal Case Forming EOAT designed to seamlessly form cases of wide range of dimensions. The compact design of casemagiQ is ideal for case forming / carton erection applications with minimal footprint.

These are variants of casemagiQ:

- casemagiQ CM100
- casemagiQ CM50

The URCap used for all variants are the same.

4.1 casemagiQ State

While casemagiQ is in operation, the status indicators are used to communicate the current state of the product.

4.1.1 Status Indicator

The status indicator is on the front cover of pneumagiQ on both sides of the 8-pin I/O connector.

LED Color	State
Red	1. Flickering - Powering up. 2. Vacuum Actuation 3. Cylinder Actuation
Green	1. Idle 2. Ready for operation

4.1.2 Status Indicator: Green

The status indicator is green when casemagiQ is idle & ready for operation.

4.1.3 Status Indicator: Red

The status indicator is red when:

- Powering up the product.
    - During power-up the status indicator flickers in Red.
- Receiving communication from the robot through the URCap

4.1.4 Status Indicator: switched off.

The status indicator is switched-off only when:

- No power supply is provided to casemagiQ.
- I/O cable is not connected properly.
- Universal Robot is not in ‘Normal mode’.
- Tool I/O interface of Universal Robot URCap is not set to pneumagiQ/ casemagiQ/ pneuvaQ.

5 pneuvaQ

pneuvaQ is a compact Integrated Pneumatic & Vacuum Interface designed to simplify building custom EOATs for applications such as machine tending for injection molding and press brake. The compact design of pneuvaQ is ideal for adding to custom EOATs to enable quick control of pneumatics and vacuum outlets.

The variant name PV21 has a specific nomenclature. P is for pneumatics, denoting the number of compressed air outlets and V is for vacuum, denoting the number of vacuum outlets. Hence, in this case, PV21 has two compressed air outlets and one vacuum outlet. These are variants of pneumagiQ:

- pneuvaQ PV21

The URCap used for all variants are the same.

5.1 pneuvaQ State

While pneuvaQ is in operation, the status indicators are used to communicate the current state of the product.

5.1.1 Status Indicator

The status indicator is on the front cover of pneuvaQ on both sides of the 8-pin I/O connector.

LED Color	State
Red	4. Flickering - Powering up. 5. Compressed Air actuation 6. Vacuum actuation
Green	3. Idle 4. Ready for operation

5.1.2 Status Indicator: Green

The status indicator is green when pneuvaQ is idle & ready for operation.

5.1.3 Status Indicator: Red

The status indicator is red when:

- Powering up the product.
    - During power-up the status indicator flickers in Red.
- Receiving communication from the robot through the URCap

5.1.4 Status Indicator: switched off.

The status indicator is switched-off only when:

- No power supply is provided to pneuvaQ.
- I/O cable is not connected properly.
- Universal Robot is not in ‘Normal mode’.
- Tool I/O interface of Universal Robot URCap is not set to pneuvaQ.

6 Operating pneumagiQ, casemagiQ & pneuvaQ

To control the pneumagiQ, casemagiQ and pneuvaQ from the Universal Robot, one needs the respective URCap to be installed in the robot. With it, each of the pneumatic EOATs, the air blow-off ports, compressed air outlets, vacuum outlets, flap position can be controlled easily. There are different URCaps for pneumagiQ, casemagiQ and pneuvaQ.

6.1 Installation of URCap

The URCap of pneumagiQ, casemagiQ and pneuvaQ is available in the respective product pages. Download the URCap to a USB drive and plug the USB drive to the Universal Robot's USB port either in the teach pendant or the robot controller.

1. To install URCap, tap the Hamburger icon (☰) on the top right from anywhere in the Polyscope.
2. Select **Settings**.
3. In the side menu on the left, choose **System**.
4. Go to **URCaps**.
5. Click the '**+**' button, navigate to the USB disk, and add the corresponding URCap (example: pneumagiQ-X.XX.urcap).
   a. Make sure to always use the latest version of URCap from the product page on our website.

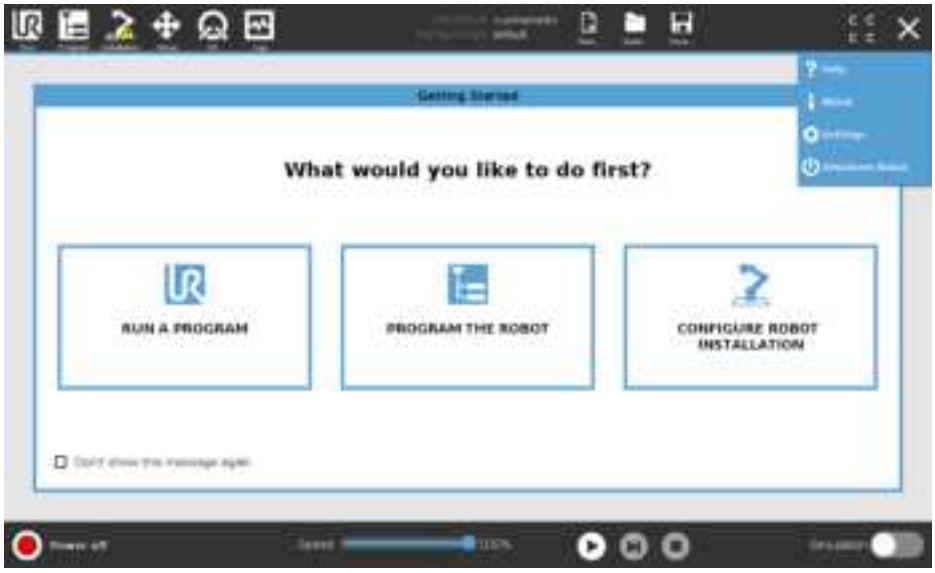

Figure 1: Hamburger menu

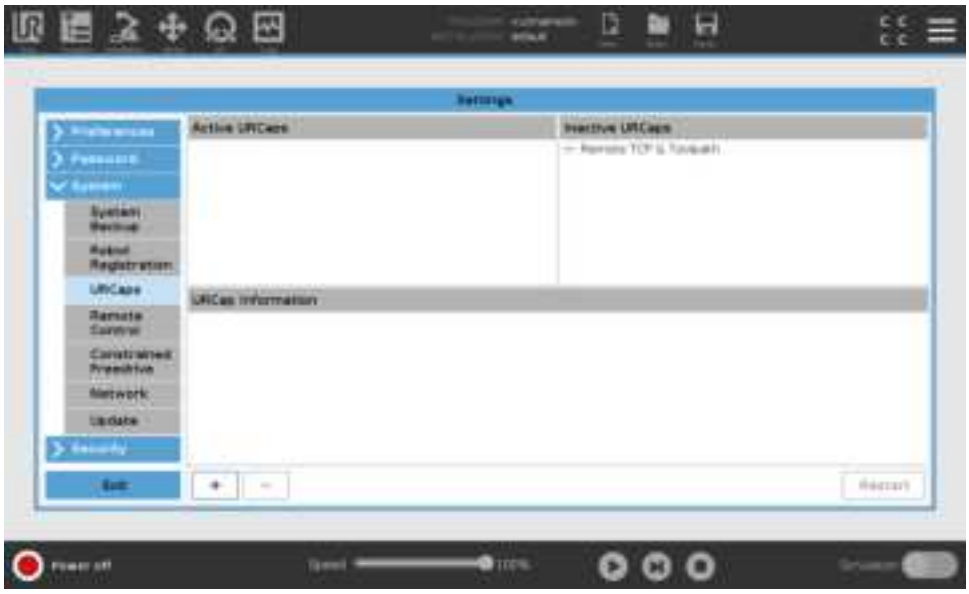

Figure 2: Use the '+' button at the bottom left to install the pneumagiQ URCap

Figure 3: Ensure that there is a green check mark next to pneumagiQ

6. Once the URCap is installed, ensure that there is a green check mark next to pneumagiQ in the Active URCaps section as shown in Figure 5.
7. Restart the robot after installing URCap.

To remove the URCap, select pneumagiQ from under active URCaps and click the '**-**' button at the bottom. As always restart the robot after removing the URCap.

Figure 4: Ensure that there is a green check mark next to pneuvaQ

6.2 Setting up the Installation Tab

To control the pneumagiQ with Universal Robots, need to set the right settings in the installation tab as follows:

Figure 5: Ensure that there is a green check mark next to casemagiQ

Figure 6: In the installation tab, under URCaps select the pneumagiQ variants

6.2.1 URCaps > pneumagiQ Settings

In the **Installation** tab, under **URCaps**, under **pneumagiQ Settings**, choose the pneumagiQ Variant from the drop-down box, **Tool Type** as **Pneumatic Grippers** and select the gripping mode of both Tool 1 & Tool 2 as either **External Gripping** or **Internal Gripping**. By default, the gripping mode is in external gripping mode.

To identify the tool quickly in the pneumagiQ PQ90 & PQ9020, Tool Mounting Face 1 is marked with a single dot, while Tool Mounting Face 2 has two dots, on both sides of the product. In the case of pneumagiQ PQ180, it is marked as 1 & 2 on the bottom face. Refer to the Installation Manual for the corresponding pneumagiQ variant to know more.

6.2.2 URCaps > casemagiQ Settings

In the **Installation** tab, under **URCaps**, under **casemagiQ Settings**, choose the casemagiQ Variant from the drop-down box, and the mode of communication, which is whether is it connected to the UR Tool Port or the robot controller.

Figure 7: In the installation tab, under URCaps select the Tool Gripping mode for pneumagiQ

Figure 8: In the installation tab, for casemagiQ & pneuvaQ

6.2.3 URCaps > pneuvaQ Settings

In the **Installation** tab, under **URCaps**, under **pneuvaQ Settings**, choose the pneuvaQ Variant from the drop-down box, and the mode of communication, which is whether is it connected to the UR Tool Port or the robot controller.

6.2.4 General > Tool I/O

Now, the Tool I/O interface of the robot needs to be controlled by pneumagiQ. Only then, the appropriate Analog Inputs, Communication Interface and Digital Output modes can be set as needed by pneumagiQ. Hence, in the installation tab, in the side menu under **General**, choose **Tool I/O**.

Under the **I/O Interface Control**, for **controlled by**, select **pneumagiQ or casemagiQ or pneuvaQ** depending on the URCap installed. This will set all the correct settings for the Tool I/O Interface to be controlled by pneumagiQ or casemagiQ or pneuvaQ. Now that the Tool I/O setting has been set properly, the product will switch-on with red light flickers in the status indicator. Refer to section 3.1 or 4.1 or 5.1 to know more about Status Indicator.

Figure 9: TCP for Tool Mounting Face 1 for pneumagiQ PQ90

Figure 10:Under I/O Interface Control, for 'Controlled by' choose product based on the URCap installed

6.2.5 Tool Center Point

The Tool Center Point is the specific point of the EOAT that the robot's control system uses to position and orient the EOAT. By default, the TCP of Universal Robots is set at the end of the robot arm.

Note: In this manual, we are providing the TCP only from the Top Mounting Face of the product until the center point of the Tool Mounting Face (Refer to the respective product installation manuals to know more.). Hence, while calculating the TCP, one must take into consideration the Robot Coupler, Tool Coupler, tool type, tool peripherals such as fingers/jaws and the specific robot application. So, the TCP needs to be calculated by the integrator/ end user depending on the final application setup.

(1) pneumagiQ

In pneumagiQ as there are two EOATs, we need to set two different TCPs for each of the EOATs. The TCP value also changes for each of the pneumagiQ variants. Hence, use the data from the Table 1 to create a TCP for each of the Tool Mounting Faces 1 & 2 as shown in the Figure 9.

Product	PQ0	PQ90		PQ180		PQ9020	
Tool Mounting Face	1	1	2	1	2	1	2
X	0	-33.65	-33.65	-200.00	200.00	-38.89	38.89
Y	0	0	0	0	0	0	0
Z	34.00	48.64	48.64	37.5	37.5	53.89	53.89
Rx	0	0	0	0	0	0	0
Ry	0	-45	45	0	0	-45	45
Rz	0	0	0	0	180	0	0

Table 1: Tool Center Point up to the Tool Mounting Face of pneumagiQ

(2) casemagiQ

In case of casemagiQ, there is only one face for the case/carton to be picked. Hence, it is much more straightforward.

Product	CM100
X	0
Y	0
Z	93.7
Rx	0
Ry	0
Rz	0

Table 2: Tool Center Point up to the suction cups of casemagiQ

Product	CM100
X	0
Y	0
Z	25
Rx	0
Ry	0
Rz	0

Table 3: Tool Center Point up to the Bottom Mounting Face of pneuvaQ

6.2.6 Payload

The payload for Universal Robots refers to the total weight the robot must lift. By default, the payload is considered as 0kg at the end of the robot arm. In the case of pneumagiQ, there are 2 EOATs, that hold payloads further away from the end of the robot arm. Hence, the Center of Gravity (CoG) becomes a critical factor.

The Center of Gravity (CoG) refers to the point where the total weight of the robot is concentrated. This is critical for the robot control system for Balance, Stability, Motion Planning, Payload Handling and Robot Safety.

(1) CoG for pneumagiQ

As there are 2 separate EOATs coupled through pneumagiQ, 4 different Payloads must be created along with respective unique CoGs as follows:

1. pneumagiQ No-Load Payload includes:
    - pneumagiQ variant
    - all peripherals
        - I/O Cable
        - 8mm pneumatic tube
        - Robot Couplers
        - Tool Couplers
        - EOATs
        - EOAT peripherals such as fingers/jaws, sensors, etc.
2. Tool 1 Payload includes:
    - pneumagiQ No-Load Payload
    - Part handled by Tool 1
3. Tool 2 Payload includes:
    - pneumagiQ No-Load Payload

Figure 11: Setting the Payload for pneumagiQ

- Part handled by Tool 2

4. pneumagiQ Full Payload includes:
   - pneumagiQ No-Load Payload
   - Part handled by Tool 1
   - Part handled by Tool 2

Refer to Table 4 for the Payload of all the variants of pneumagiQ and it can be added to the Universal Robots as shown in Figure 11. This is only for the product. As mentioned at the top, all the payloads mentioned above need to be calculated by the integrator/ end user depending on the final application setup.

Product	PQ0	PQ90	PQ180	PQ9020
Weight	0.41 Kg	.58 Kg	.87 Kg	1.1 Kg
Cx	0	0	0	0
Cy	0	-0.92	-1.2	-4
Cz	16.5	32.12	30.3	30.2

Table 4: pneumagiQ CoG until the Tool Mounting Face

(2) CoG for casemagiQ

The CoG for casemagiQ is a bit different. As the product can extend up to 100mm and the case forming flap can be turned on or off. Hence, the CoG will change depending on the configuration of the casemagiQ.

Product	Not Extended		Extended – 100 mm	
	Flap off	Flap on	Flap off	Flap on
Weight	1.352 Kg	1.352 Kg	1.352 Kg	1.352 Kg
Cx	14.4	-15.2	4.2	5.0
Cy	-2.6	-2.6	-2.6	-2.6
Cz	53.0	58.3	53.0	58.3

Table 5: casemagiQ CoG until the suction cups

(3) CoG for pneuvaQ

The CoG for casemagiQ is a bit different. As the product can extend up to 100mm and the case forming flap can be turned on or off. Hence, the CoG will change depending on the configuration of the casemagiQ.

Product	Flap off
Weight	0.3 Kg
Cx	7.3
Cy	0.4
Cz	11.5

Table 6: casemagiQ CoG until the suction cups

6.3 Program Tab

To start using pneumagiQ with Universal Robots and control the EOATs, go to the **Program** tab. In the side menu, under **URCaps**, all the commands of all the URCaps installed in the robot will be shown here.

6.3.1 pneumagiQ Tools

In the robot program tree, to actuate the EOATs, need to use the **pneumagiQ Tool** node. For example, if the Tool Type is selected as Pneumatic Grippers in the pneumagiQ Settings in Installation tab, then choose either Gripper 1 or Gripper 2 tab. Then, set the gripper action as either Grip or Release. The action Grip denotes the fingers/ jaws of the grippers moving towards each other for External Gripping while for Internal Gripping, it denotes the fingers/ jaws of the gripper moving away from each other.

For example, if the end user has a hardware change in the application and must now use Internal Gripping instead of External Gripping, there is no need to change the complete program tree by swapping Grip and Release actions. Instead,

Figure 12: pneumagiQ PQ90 Gripper1 action node

simply change the Tool's gripping mode from External Gripping to Internal Gripping and the program nodes will automatically update themselves.

(1) Sensor Feedback

To understand the current state of the pneumatic grippers, connect the sensors such as Reed switches to gripper and sensor connector of the pneumagiQ. Now, when the checkbox of **Sensor Feedback** is selected, the pneumagiQ control system will pause the program tree until the receiving feedback from the sensor ports. The **Sensor Feedback** checks for the following conditions to confirm the Grip or Release action.

pneumagiQ Variant	Node Action	Gripper 1		Gripper 2	
		1P	1Q	2P	2Q
PQ0-1G2S	Grip	On			
	Release		On		
PQ90-2G2S	Grip	On		On	
	Release	Off		Off	
PQ180-2G4S PQ9020-2G4S	Grip	On		On	
	Release		On		On

Table 7: Sensor Mapping for pneumagiQ

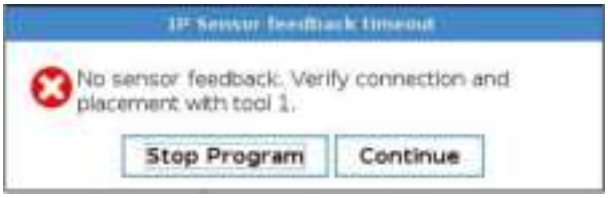

Figure 13: Sensor Timeout dialog box

(2) Sensor Timeout

As the name denotes, this is the timeout duration for the Sensor Feedback. The timeout duration is 2 seconds. If the node doesn't receive sensor feedback within this duration, the program tree will be paused and will show the dialog box as show in the Figure 13. The user can either continue the program or stop it from this point.

6.3.2 pneumagiQ Air blow-off

Figure 14: pneumagiQ PQ180, PQ9020 & PQ0 Air blow-off node

In the Air blow-off node can do 3 different actions: Active, Inactive and Pulse.

- Activate: the activate node inserted will activate the Air blow-off, thereby blowing compressed air through the Air blow-off port.
- Inactivate: the inactive node inserted will deactivate the Air blow-off, thereby stopping the flow of compressed air through the Air blow-off port.
- Pulse: the pulse node will activate the Air blow-off port for the set duration as determined by the slider value and then deactivates it.
    - The duration of the pulse can be varied from 0.5 seconds to 10 seconds at an increment of 0.5 seconds.

Note: Both pneumagiQ PQ90-2G2S and PQ9020-2G4S have only one Air blow-off port while the pneumagiQ PQ180-2G4S has two Air blow-off ports.

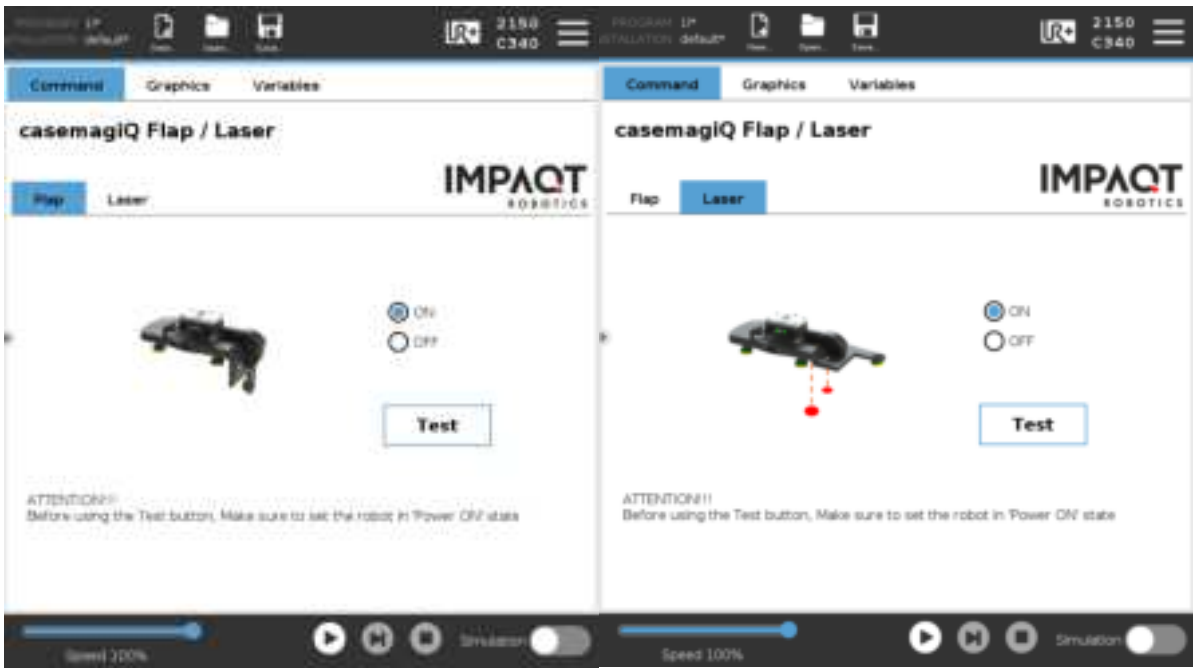

Figure 15: casemagiQ Flap / Laser node

6.3.3 casemagiQ Flap / Laser

The casemagiQ Flap / Laser node is used to control the case forming flap and the laser aligner. As shown in Figure 15, the case forming flap can be switched on or off use this node. This is used to bend and shape the flat cases / cartons into an open cuboid ready for taping.

The same node can also be used to switch on / off the laser aligner. The laser aligner becomes an easy guide for the robot programmer to align the casemagiQ right at the fold of the case / carton when positioning the pickup point. This way, the case forming flap is positioned perfectly to bend the flat case / carton at the fold into a cuboid.

6.3.4 casemagiQ Vacuum

The casemagiQ Vacuum node is used to control both the main vacuum used to hold the case / carton and the flap vacuum used to hold the side face of the case / carton.

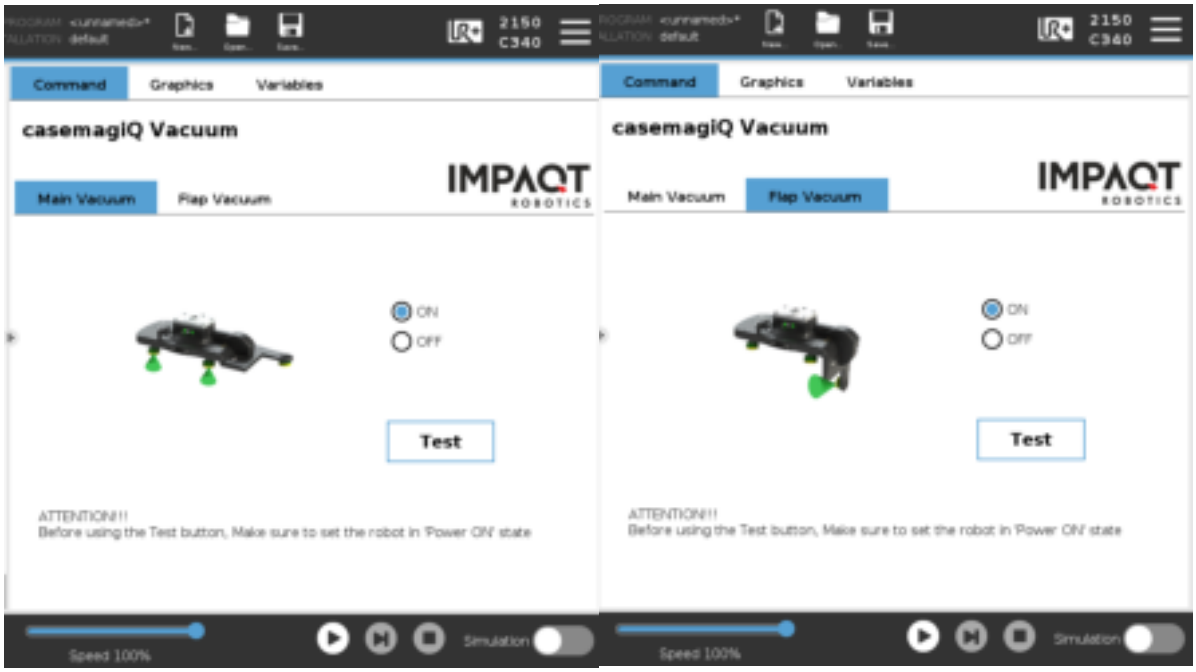

Figure 16: casemagiQ Main / Flap Vacuum node

Figure 17: pneuvaQ Comp. Air node

6.3.5 pneuvaQ Comp. Air

The pneuvaQ Comp. Air node is used to control both the compressed air outlets. They can be individually switched on and off using the pneuvaQ URCap. For other variants of pneuvaQ, the pneuvaQ Comp. Air node will have extra tabs to be able to control all the compressed air outlets.

6.3.6 pneuvaQ Vacuum

The pneuvaQ Vacuum node is used to control the vacuum outlet. The vacuum can be switched on and off using the pneuvaQ URCap. For other variants of pneuvaQ, the pneuvaQ Vacuum node will have extra tabs to be able to control all the vacuum outlets.

Figure 18: pneuvaQ Vacuum node

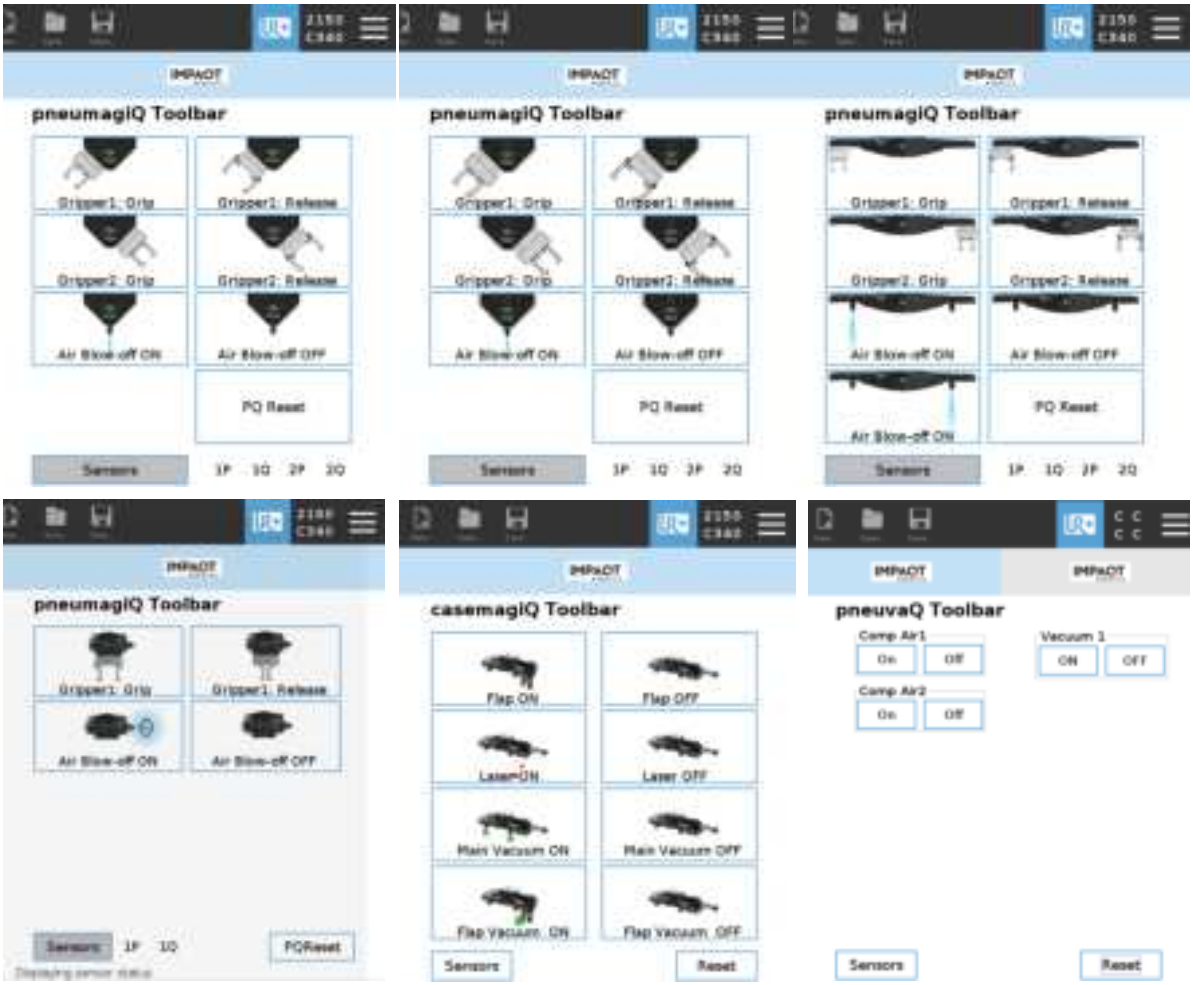

Figure 19: UR+ button for PQ90, PQ9020, PQ180, PQ0, CM100 & PV21

6.3.7 Test button

The pneumagiQ, casemagiQ and pneuvaQ nodes have a built-in Test button that can be used to assess the current operational state of the node. Hence, before running the code in the robot program tree, evaluate it for all possible options to understand the complete workflow of the node.

6.4 UR+ button

The UR+ button on the title bar provides easy access to actuating all the nodes of pneumagiQ, casemagiQ & pneumagiQ and quickly showcases the status of the Sensors. The UR+ button is always on the top right of the UR teach pendant as shown in

6.5 Updating URCap

The URCap of pneumagiQ is constantly updated to provide the most seamless integration & operation of the pneumagiQ. Hence, one should always install the latest version of URCap. The URCap is available in the respective product page in the Impaqt Robotics page.