

# WINGMAN

## THE COBOT TOOL CHANGER SYSTEM













PLUG AND PLAY  
AUTOMATIC & MANUAL TOOL CHANGE  
FOR COBOTS

**USER GUIDE**

Version 1.11

## SPECIFICATIONS

-  **AUTOMATIC & MANUAL** change in one device
-  Integrates with **most** cobots and tools
-  Rated payload **33 kg / 73 lbs**
-  Weight on cobot **260 g / 0.57 lbs**
-  Combined height **30 mm / 0.18 in**
-  Repeatability **+/-0,03 mm / +/-0.0012 in**
-  Automatic tool change setup in **1 minutes**
-  Pass-through **adaptability**
-  All highly **durable** metal alloys
-  Cobot safe (**ISO/TS 15066**)



### PLUG AND PLAY

Installed in few minutes out-of-the-box.  
Automatic tool change setup in 1 minute.



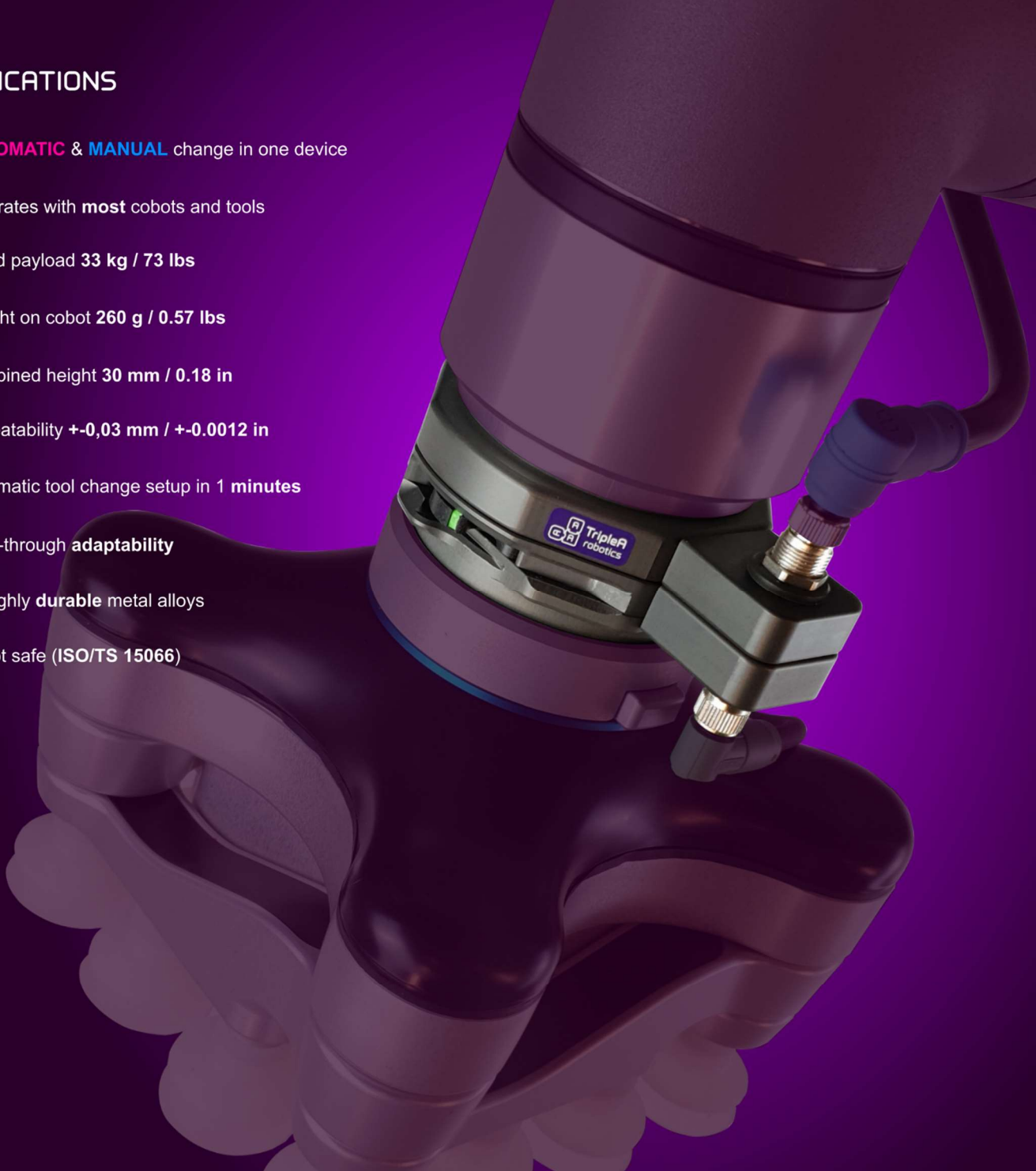
### ONE FITS ALL

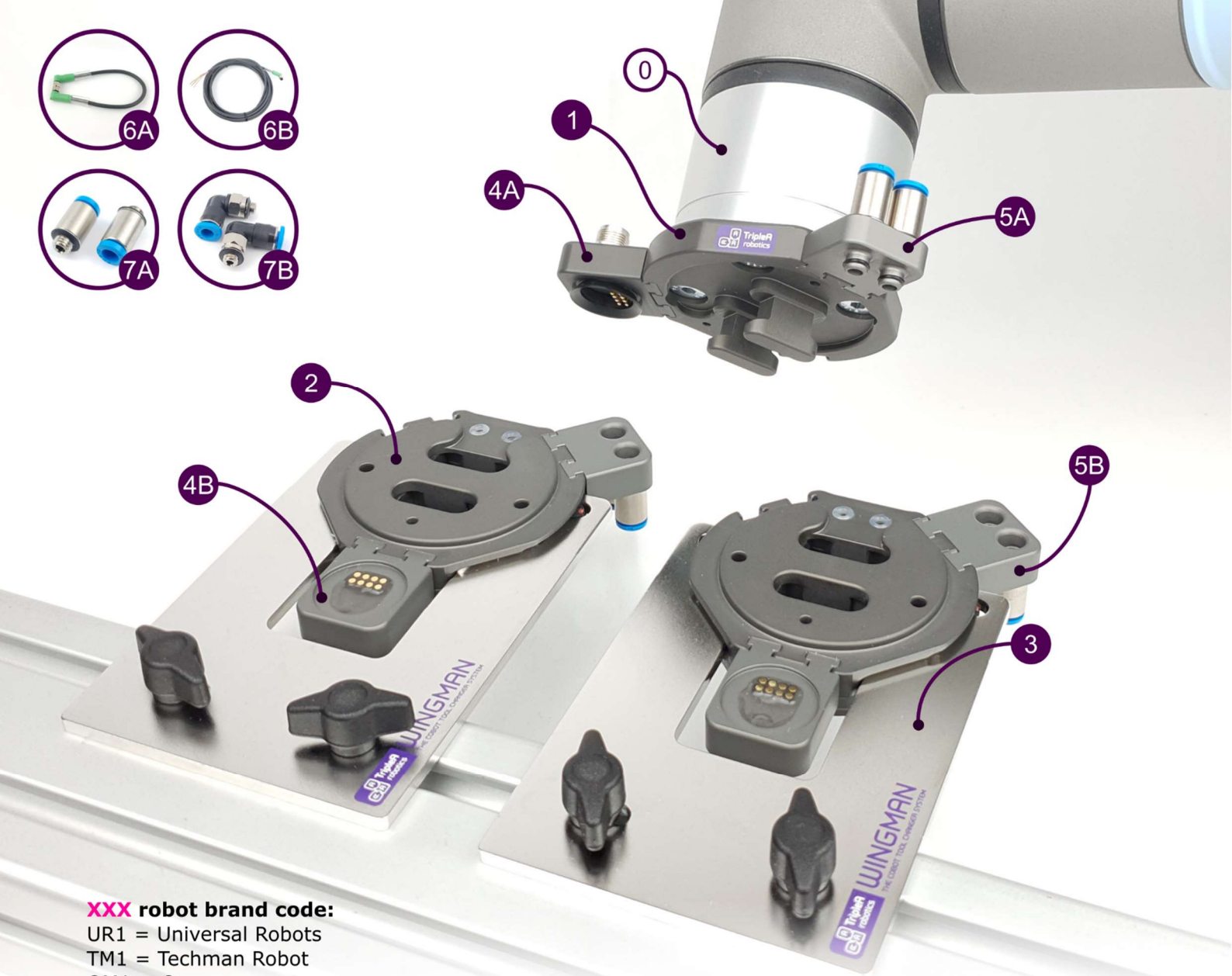
Automatic and manual tool change in one.  
Standard ISO flange – Strong and light.



### COBOT SAFE

Designed & tested for ISO/TS 15066  
compliance and with redundant safety lock.





**XXX robot brand code:**

- UR1 = Universal Robots
- TM1 = Techman Robot
- OM1 = Omron
- DR1 = Doosan Robotics
- FA1 = Fanuc CRX

## INTERFACE OVERVIEW

Pos.:	Part number:	Description:	Interfaces with:
0		Robot / Cobot	1 6A 6B
1	WM1-P-01-01- <b>XXX</b>	Robot Part	0 2 4A 5A 7A 7B
2	WM1-P-02-01	Tool Part	1 3 4B 5B 7A 7B
3	WM1-P-03-01	Tool Part Holder	2
4A	WM1-A-01-01- <b>XXX</b>	El pass-through module for Robot Part	1 4B
4B	WM1-A-01-02- <b>XXX</b>	El pass-through module for Tool Part	2 4A
5A	WM1-A-03-01	Air pass-through module for Robot Part	1 5B
5B	WM1-A-03-02	Air pass-through module for Tool Part	2 5A
6A	WM1-A-02-01- <b>XXX</b>	Cable for robot tool flange connector	0 4A
6B	WM1-A-02-03	Cable for robot controller	0 4A
7A	WM1-A-06-01	Fittings straight for built-in air pass-through	1 2
7B	WM1-A-06-02	Fittings angled for built-in air pass-through	1 2

# WINGMAN STANDARD KITS



## XXX robot brand code:

UR1 = Universal Robots  
 TM1 = Techman Robot  
 OM1 = Omron  
 DR1 = Doosan Robotics  
 FA1 = Fanuc CRX



1: Robot Part  
 (Including URcap software for UR)  
 WM1-P-01-01-XXX



2: Tool Part  
 WM1-P-02-01



3: Tool Part Holder with wing screws  
 WM1-P-03-01



4A: Electrical pass-through for mount on Robot Part, M8 connector  
 WM1-A-01-01-XXX



4B: Electrical pass-through for mount on Tool Part, M8 connector  
 WM1-A-01-02-XXX



5A: High flow air pass-through for mount on Robot Part, 2xØ6 mm hose  
 WM1-A-03-01



5B: High flow air pass-through for mount on Tool Part, 2xØ6 mm hose  
 WM1-A-03-02



6A: Electrical cable for connection with the robots tool flange connector  
 WM1-A-02-01-XXX



6B: Electrical cable for installation along robot arm to controller, 5 m  
 WM1-A-02-03



7A: Fittings set I-shape for Robot Part & Tool Part for 2xØ4 mm hose  
 WM1-A-04-01



7B: Fittings set L-shape for Robot Part & Tool Part for 2xØ4 mm hose  
 WM1-A-04-02



Case for two-way kits  
 WM1-A-05-01

	One-way manuel kit WM1-K-01-00-XXX	Two-way manuel kit WM1-K-02-00-XXX	Two-way automatic kit, built-in pneumatic WM1-K-03-00-XXX	Two-way automatic kit, built-in pneumatic + electric modules WM1-K-04-00-XXX	Two-way automatic kit, built-in pneumatic + electric + high flow modules WM1-K-05-00-XXX	Two-way automatic kit, Trainer/demo in case WM1-DK-05-00-XXX	Accessories kit WM1-AK-01-00-XXX
1: Robot Part (Including URcap software for UR) WM1-P-01-01-XXX	1	1	1	1	1	1	
2: Tool Part WM1-P-02-01	1	2	2	2	2	2	
3: Tool Part Holder with wing screws WM1-P-03-01			2	2	2	2	
4A: Electrical pass-through for mount on Robot Part, M8 connector WM1-A-01-01-XXX				1	1	1	
4B: Electrical pass-through for mount on Tool Part, M8 connector WM1-A-01-02-XXX				2	2	2	
5A: High flow air pass-through for mount on Robot Part, 2xØ6 mm hose WM1-A-03-01					1	1	
5B: High flow air pass-through for mount on Tool Part, 2xØ6 mm hose WM1-A-03-02					2	2	
6A: Electrical cable for connection with the robots tool flange connector WM1-A-02-01-XXX						1	1
6B: Electrical cable for installation along robot arm to controller, 5 m WM1-A-02-03							1
7A: Fittings set I-shape for Robot Part & Tool Part for 2xØ4 mm hose WM1-A-04-01						3	3
7B: Fittings set L-shape for Robot Part & Tool Part for 2xØ4 mm hose WM1-A-04-02							3
Case for two-way kits WM1-A-05-01						1	

## Table of Contents

<b>TABLE OF CONTENTS</b> .....	<b>4</b>
<b>1 IMPORTANT INFORMATION</b> .....	<b>1</b>
1.1 IMPORTANT NOTES.....	1
1.2 SIGNS .....	2
1.3 MAIN WARNINGS.....	3
<b>2 DEFINITIONS</b> .....	<b>4</b>
<b>3 TOOL CHANGER COMPONENTS AND ORDERING</b> .....	<b>6</b>
<b>4 UNBOXING YOUR KIT</b> .....	<b>7</b>
4.1 MANUEL KITS.....	7
4.2 AUTOMATIC KITS .....	8
<b>5 INTENDED USE</b> .....	<b>9</b>
<b>6 INSTALLATION</b> .....	<b>10</b>
6.1 INSTALLATION ENVIRONMENT, SPECIFICATIONS AND SAFETY .....	10
6.2 PRE-INSTALLATION PREPARATION.....	10
6.3 INSTALLING THE ROBOT PART.....	10
6.4 INSTALLING THE <i>TOOL PART</i> .....	12
6.5 INSTALLING PASS-THROUGH MODULES .....	13
6.6 INSTALLING THE <i>TOOL PART HOLDER</i> .....	15
<b>7 MANUAL USE</b> .....	<b>18</b>
7.1 LOCKING AND UNLOCKING .....	18
<b>8 AUTOMATIC USE</b> .....	<b>19</b>
8.1 IMPORTANT ABOUT WAYPOINTS .....	20
8.2 IMPORTANT ABOUT COBOT SPEED .....	21
8.3 IMPORTANT ABOUT END-EFFECTOR SELECTION AND PARAMETERS.....	21
8.3.1 <i>The end-effector's automatic tool change capability</i> .....	21
8.3.2 <i>The end-effector's energy requirements</i> .....	22
8.3.3 <i>The end-effectors weight and center of gravity</i> .....	22
8.4 GOOD PRACTICE FOR SETTING UP TOOL CHANGES .....	23
8.5 PROGRAMMING TOOL CHANGE ON UNIVERSAL ROBOTS COBOTS .....	23
8.5.1 <i>Preparation</i> .....	25
8.5.2 <i>How the URcap software works</i> .....	25
8.5.3 <i>Basic setup of tool change movement</i> .....	27
8.5.4 <i>Basic setup of end-effector parameters</i> .....	30
8.5.5 <i>Powerful TEST feature and good programming practice</i> .....	32
8.5.6 <i>Advanced: Setup of tool change movement</i> .....	35
8.5.7 <i>Advanced: Setup of end-effector settings</i> .....	37
8.5.8 <i>Advanced: Setup of odd orientation of the robot part</i> .....	39
8.5.9 <i>Advanced: Sharing end-effectors between more Robot Programs and cobots</i> .....	40
8.5.10 <i>Advanced: Remote activated automatic tool change</i> .....	41
8.6 PROGRAMMING TOOL CHANGE ON OTHER COBOTS .....	42
<b>9 SAFETY</b> .....	<b>43</b>
9.1 LIMITATION OF LIABILITY: .....	43
9.2 RESPONSIBILITY OF THE SYSTEM INTEGRATOR .....	43
9.3 RESPONSIBILITY OF THE USER.....	43
9.4 MAIN HAZARDS .....	44
9.5 THE TOOL SPACE .....	45

9.6	COBOT REQUIREMENTS .....	46
9.7	LOAD LIMITING AND COLLABORATIVE SAFETY SETTINGS .....	46
9.8	CHECKLISTS, RISK REDUCTION AND RESIDUAL RISKS .....	46
9.8.1	<i>Pre-deployment checklist and residual risk</i> .....	47
9.8.2	<i>Startup checklist</i> .....	48
9.8.3	<i>Interval checklist</i> .....	48
9.9	ID TAG SYSTEM.....	49
9.10	WARNING SIGNS .....	49
<b>10</b>	<b>REPAIR AND MAINTENANCE .....</b>	<b>50</b>
10.1	LIFE SPAN AND MAINTENANCE.....	50
10.1.1	<i>Wear</i> .....	50
10.1.2	<i>Cleaning</i> .....	50
10.1.3	<i>Lubing the tool changer</i> .....	51
10.1.4	<i>Lubing the pass-through modules</i> .....	51
10.2	DAMAGE AND REPAIR .....	52
<b>11</b>	<b>TROUBLESHOOTING .....</b>	<b>53</b>
<b>12</b>	<b>WARRANTY AND LIABILITY.....</b>	<b>57</b>
12.1	PATENTS .....	57
12.2	PRODUCT WARRANTY .....	57
12.3	DISCLAIMER.....	57
<b>EC</b>	<b>- DECLARATION OF INCORPORATION .....</b>	<b>58</b>
<b>DATASHEETS</b>	<b>.....</b>	<b>59</b>
	DATASHEET - TOOL CHANGER.....	65
	DATASHEET - TOOL PART HOLDER .....	69
	DATASHEET - ELECTRIC PASS-THROUGH MODULE .....	71
	DATASHEET – HIGH FLOW PASS-THROUGH MODULE.....	73
	DATASHEET – URCAP SOFTWARE .....	75

---

# 1 IMPORTANT INFORMATION

*(This page must always stay on page 1 as signs on products are referring to this page 1 with important information)*

This page is a **MUST** read before planning automatic tool change with the WINGMAN Cobot Tool Changer system.

**This page 1 is an addition to the detailed content of the User Guide.**

**It is always the user's responsibility to read, understand and comply with the complete User Guide as a whole.**

---

## 1.1 Important notes

1. Check specification of the Tool Changer:
  - a. See the [DATASHEET – TOOL CHANGER](#) (data for the Robot Part and Tool Part) to check that the WINGMAN comply with the relevant payloads, interfaces etc. in your application.
2. Check specifications of the Tool Part Holder:
  - a. See the [DATASHEET - TOOL PART HOLDER](#) to make sure that your end-effector's (tool) weight and balance is within the limits of the Tool Part Holder (**often overlooked by users**). Find more details in chapter [The end-effectors weight and center of gravity](#).
3. Check and plan pass-through of energy and control to the end-effector:
  - a. See the chapter [Important about end-effector selection and parameters](#) to help you evaluate your end-effectors in terms of use in an automatic tool change application (**often overlooked by users**).
  - b. See the [DATASHEET's](#) to check that the WINGMAN can provide the pass-through that you need.
    - i. Electrical pass-through connectors: Power must be turned off before tool change takes place to prevent the WINGMAN's electrical connectors from excessive wear and end-effector's unintended behavior (**often overlooked by users**).
    - ii. Vacuum/pneumatic pass-through: Residual vacuum/pressure must be released from the system to prevent damage to the WINGMAN's parts and end-effector's unintended behavior.
  - c. It is important to plan exactly what WINGMAN parts are necessary to pass-through energy and control to the end-effector (**often overlooked by users**).
    - i. E.g. switching between two end-effectors that each have their own designated power source will require to electrical connectors installed on the Robot Part. The WINGMAN can provide a solution for this.
    - ii. E.g. pass-through modules on the WINGMAN Robot Part might have open connectors (not allowed) if they are not in used for the specific end-effector that is connected at the present time. The WINGMAN can provide a solution for this.
4. Setup Robot Limits:
  - a. The cobots Robot Limits (feature that limits the force that the robot can achieve) must be set to a maximum of **100 N** and must apply when automatic tool change takes place (**often overlooked by users**). This is important to prevent an overload situation and consequential damage to the levers inside the WINGMAN Tool Part. The WINGMAN's levers are designed to break in case of an overload situation exceeding 100 N and can be replaced in a few minutes.

5. Safety and check lists:

- a. The chapter [Safety](#) contains instructions and check lists that must be always complied with.

---

## 1.2 Signs



**DANGER!**

**Warning texts** are important instructions to ensure human safety and must always be complied with.



**ATTENTION!**

**Attention texts** are important guidelines for best practice that will prevent hardware damage and ensure a long life span of your product.



**INFO / TIP**

**Tip texts** are tips that will ensure you the best user experience.

---

## 1.3 Main warnings



**DANGER!**

**WARNING!** You must read, understand, and follow all safety information in this user guide, and the robot manual and all associated equipment before initiating robot motion. Failure to comply with safety information could result in serious injury or even death.

**WARNING!** The information in this user guide does not cover designing, installing, and operating a complete robot application, nor does it cover other peripheral equipment that can influence the safety of the complete system. It is the *system integrators* responsibility that the complete system is designed and installed in accordance with the safety requirements set forth in the standards and regulations of the country where the product covered in this user guide is installed.

**WARNING!** Any safety information provided in this manual must not be construed as a warranty, by TripleA robotics ApS, that the robot application will not cause injury or damage, even if the robot application complies with all safety instructions.

**WARNING!** TripleA robotics ApS disclaims any and all liability if any of TripleA robotics ApS products are damaged, changed or modified in any way. TripleA robotics ApS cannot be held responsible for any damages caused to any of TripleA robotics ApS products, the robot, or any other equipment due to programming errors or malfunctioning of any of TripleA robotics ApS products.

**WARNING!** The system integrator and user must observe and comply with the “SAFETY” chapter before the robot application is deployed.

## 2 Definitions

<i>cobot</i>	<i>Cobots</i> , or collaborative robots, are robots intended to interact with humans in a shared space or to work safely in close proximity. Cobots are usually also very easy and fast to setup and program.
<i>collaborative applications</i>	A <i>collaborative application</i> is a cobot application where the <i>cobot</i> is installed and deployed without a physical safety guard protecting humans.
<i>collaborative operation</i>	<i>Collaborative operation</i> is a state in which purposely designed <i>cobots</i> work in direct cooperation with a human within the defined workspace.
<i>collaborative workspace</i>	<i>Collaborative workspace</i> is the space within the safeguard space where a <i>cobot</i> and a human can perform tasks simultaneously during production operation.
<i>Controller</i>	A <i>controller</i> is an electrical devise with terminals for I/O's and a computer logic between the Input(I) and the outputs(O). Usually a <i>cobot</i> is delivered with a <i>controller</i> . A controller can also be a separate control unit that provide control of pneumatic flow etc.
<i>End-effector</i>	An <i>end-effector</i> is a robot tool / service specially designed for attachment to a cobot's mechanical interface ( <i>tool flange</i> ) to enable the cobot to perform its task. Example: Gripper, nutrunner, welding gun, dispenser, screwdriver etc.
<i>I/O's</i>	"I" stands for Input and "O" stands for Output. I/O is a brad term covering all electrical Input and Output connectivity and control between a <i>controller</i> and an <i>end-effector</i> .
<i>Installed Center of Gravity (ICoG)</i>	The <i>ICoG</i> is the center of gravity for the <i>tool part</i> ( <i>WINGMAN Tool Changer part</i> ) and the <i>end-effector</i> assembly perceived as one body as this is installed in the <i>tool part holder</i> ( <i>WINGMAN Tool Changer part</i> ). The location of the <i>tool part + end-effector</i> body's <i>ICoG</i> will depend on the angle in which the <i>tool part holder</i> is installed.
<i>System integrator</i>	A <i>System Integrator</i> is a person or an entity who installs and deploys a robot application, such as a <i>collaborative application</i> . In case the end-user (person or entity) installs and deploys a robot application, the end-user will be the <i>System Integrator</i> and have the <i>System Integrators'</i> responsibilities among other to safety approve the application.
<i>Pass-through connectivity</i> <i>Pass-through connections</i> <i>Pass-through modules</i>	<i>Pass-through connectivity</i> are means ( <i>pass-through modules</i> ) that allow energy and control such electricity, pneumatic and vacuum to flow to/from the <i>end-effector</i> . Tool changers for automatic use will need to facilitate the necessary <i>pass-through connectivity</i> .
<i>Robot limits</i>	A cobot's <i>robot limits</i> is a set of threshold limits that will result in a <i>protective stop</i> of the cobot if exceeded. <i>Robot limits</i> can be but is not limited to threshold limits associated with: - Power limit. - Force limit. - Speed limit.
<i>protective stop</i>	A <i>protective stop</i> is a type of interruption of a <i>cobot's</i> operation that allows a cessation of motion for safeguarding purpose and which retains the program logic to facilitate a restart.

<p><i>Quasi-static contact</i> <i>Transient contact</i></p>	<p><i>Quasi-static contact</i> and <i>transient contact</i> are two types of potentially harmful (human injury) contact that are defined and handled in standard ISO/TS 15066:2016. <i>Quasi-static contact</i> is a human limb being pinching between a fixed object and a moving object such as a <i>cobot</i>. <i>Transient contact</i> is a human being hit by a moving object such as a <i>cobot</i>.</p>
<p><i>residual risk</i></p>	<p><i>Residual risk</i> is the risk that remains after all planned risk reducing initiatives have been ensured. A <i>collaborative application</i> will have a residual risk that must be accepted by the <i>System Integrator</i> and the user before the <i>collaborative application</i> can be deployed.</p>
<p><i>teach-in</i></p>	<p><i>Teach-in</i> is a feature that some <i>cobots</i> have and that allow the user to program the <i>cobot's</i> motion in a simple way by moving the <i>cobot</i> to <i>waypoints</i> by hand.</p>
<p><i>teach pendant</i></p>	<p>A <i>cobot teach pendant</i> is a computerized control panel that allows a user to set up and program the <i>cobot</i>. A <i>teach pendant</i> is usually connected to the <i>cobot</i> via a cable.</p>
<p><i>tool changer system</i></p>	<p>A <i>tool changer system</i> is a complete system of parts, that allow a user to complete manual or automatic tool changes in a quick and easy way.</p>
<p><i>tool space</i></p>	<p>The <i>tool space</i> is a space surrounding the rack that stores the <i>end-effectors</i> when these are not attached to the <i>cobot</i>. The <i>tool space</i> is safeguarded by <i>robot limits</i> only. As the user is NOT allowed to access the <i>tool space</i> while the <i>cobot</i> is in operation, the <i>tool space</i> cannot be perceived as part of the <i>collaborative workspace</i>.</p>
<p><i>URcap software</i></p>	<p>An <i>URcap software</i> is a piece of software that can be use with Universal Robots (UR) <b>only</b> and provides an intuitive graphic user interface (GUI) that runs directly on the UR <i>teach pendant</i> in the original UR software named Polyscope.</p>
<p><i>Waypoint</i></p>	<p>A <i>waypoint</i> is a X, Y, Z coordinate and RX, RY, RZ rotation of a <i>cobot's tool flange</i> in space. A <i>cobot</i> moves between such <i>waypoints</i>.</p>

## 3 Tool changer components and ordering

In this chapter, you will find a brief presentation of each component in the WINGMAN Tool Changer System. To find more details on components, please visit the chapter [Product data](#) in the end of this user guide.

To order components:

1. Identify the part number(s) you need.
2. Contact your local distributor or visit TripleA robotics website and fill out the online quote form.

[www.TripleA-robotics.com](http://www.TripleA-robotics.com)



## 4 Unboxing your kit

### 4.1 Manuel kits

The **manual kit** enables you to complete quick and easy **manual** exchange between cobot tools and is provided with all the necessary parts for installation on a cobot that is featured with the ISO 9409-1-50-4-M6 tool flange like cobots from Universal Robots, Techman robots and other.

The manual kit is featured with pneumatic *pass-through connections* built into the housing. If additional *pass-through connectivity* is needed, pass-thought modules are available for purchase. See available pass-through modules in chapter [Product data](#) in the end of this user guide.



## 4.2 Automatic kits

The **automatic kits** enable you to complete quick and easy **manual and automatic** exchange between cobot tools and is provided with all the necessary parts for installation on a cobot that is featured with the ISO 9409-1-50-4-M6 tool flange like on cobots from Universal Robots, Techman robots and other.

The kits are featured with pneumatic *pass-through connections* build into the housing and can be included with additional modules for electricity and for pneumatic/vacuum pass-through. See available **automatic kits** and pass-through modules in chapter [Product data](#) in the end of this user guide.

Example picture of one of our standard kits (case is optional)



---

## 5 Intended use

The WINGMAN Tool Changer System is intended for industrial use with collaborative robots from Universal Robots and other cobot brands. The WINGMAN Tool Changer System is intended for easy exchange between *end-effectors* either manually by the user or automatic by the cobot it is installed onto.

The WINGMAN Tool Changer System can be deployed in combination with collaborative robots (cobots) for use in *collaborative operation* when all requirements in this user guide have been complied with.

The WINGMAN Tool Changer System is not allowed to be used in applications that poses a risk to human life in case the WINGMAN would fail.

Any kind of use that deviates from the intended use described in this user guide is misuse and is not allowed. This includes but is not limited to:

- Use in explosive environments, offshore installations and aircraft operation.
- Use in medical and food production lines or in combination with vital equipment.
- Use before a full risk assessment has been performed to local legislation/standards by the *system integrator*.
- Use as lifting equipment on cranes.
- Use outside of declared specifications and parameters.
- Use close to a human's head, face and eye area.
- Use before all requirements in this user guide have been complied with and residual risks are understood and accepted.

## 6 Installation

### 6.1 Installation environment, specifications and safety

A stress free and clean environment surrounding the work area will promote safety and long product life span. Please read chapter [9 Safety](#) for information on safety before commencing the installation and read chapter [10 Repairs and maintenance](#) for information on the topic of life span.

### 6.2 Pre-installation preparation

The tool changers *maximum allowed payload* must be evaluated using the equations or graphs provided in the tool changer datasheet chapter [Data sheet – TOOL CHANGER](#).

Investigate if the *end-effector(s)* you plan to deploy is suitable for automatic tool change applications. If in doubt, please ask the *end-effector* manufacturer or do your own preliminary test by simulating an automatic tool change as described in chapter [8.3 Important about end-effector selection and parameters](#).



INFO / TIP

**TIP!** A few electrical *end-effectors* are installed with a failsafe feature that will stop the robot program if the *end-effector* is disconnect from the cobot while the robot program is running. Ask your *end-effector* vendor how to bypass this failsafe feature.



DANGER!

**WARNING!** Deploying the WINGMAN Tool Changer System outside the framework of intended use and technical specifications such as *maximum allowed payload* can result in hardware damage, serious injury and even death.

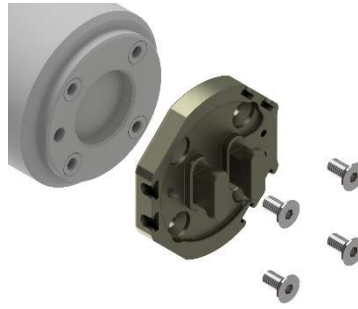
### 6.3 Installing the robot part

The *robot part* fits directly onto *cobots* from Universal Robot and other cobots with a standard *ISO 9409-1-50-4-M6* flange. If your *cobot* does not have this flange, you can install an adaptor flange in between (not provided by TripleA robotics).

Step 1. Install the pin in the *robot part*.



Step 2. Install the *robot part* on the *cobot* using all four provided bolts (ISO 10642 M6x12mm). Tighten all four bolts with the torque specified for your *cobot*.



INFO / TIP

**TIP for Universal Robots!** In the UR-cap software provided by TripleA robotics, you can adjust the orientation of how the *robot part* is installed on the UR cobot. If you have used the pin as per step 1, no adjustment of the orientation is needed.

- Step 3. Install the *pass-through modules* you need for your application if any and install the necessary cables/hoses between your chosen *controller* and the pass-through modules. See chapter [6.5 Installing pass-through modules](#) to learn about pass-through modules.



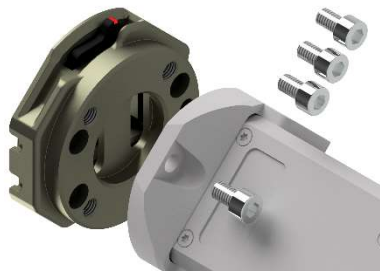
ATTENTION!

**ATTENTION!** It is important that all cables/hoses are fixed securely to the cobot arm and cannot be caught and damaged while the cobot moves.

## 6.4 Installing the *tool part*

You can fit the *tool part* on most cobot *end-effectors* that have the *standard ISO 9409-1-50-4-M6* flange. If your cobot *end-effector* does not have this flange, you can install an adaptor flange in between (not provided by TripleA robotics).

- Step 1. Install your *end-effector* on the *tool part* using the bolts provided with your *end-effector* and tighten the bolts as per instructed in the *end-effector* documentation (maximum 8 Nm).



ATTENTION!

**ATTENTION!** Do not install bolts that protrudes more than maximum 7 mm into the *tool part*. If too long bolts are attempted installed, the *tool part* can be damage beyond repair.

- Step 2. Install the *pass-through modules* onto the *tool part* that mates with the *pass-through modules* you installed onto the *robot part*. See chapter [6.5 Installing pass-through modules](#) to learn about pass-through modules. Make sure to locate the *pass-through modules* in the correct place to mate correctly with the counterpart *pass-through module* on the *robot part*. Install your *end-effector's* cables/hoses to the *pass-through module*.



INFO / TIP

**TIP!** If a *pass-through module* and/or cable cannot be installed because the *end-effector* is taking up too much space, you can install a 30 mm distance adaptor between the *end-effector* and the *tool part* (not provided by TripleA robotics).



ATTENTION!

**ATTENTION!** Locating pass-through modules incorrectly can result in hardware damage.

- Step 3. Attach and lock the *robot part* and the *tool part* to each other (see chapter [7 MANUAL USE](#)) and test all the *end-effector's* functions on the *cobot* in a controlled test environment before starting programming and deployment into production.

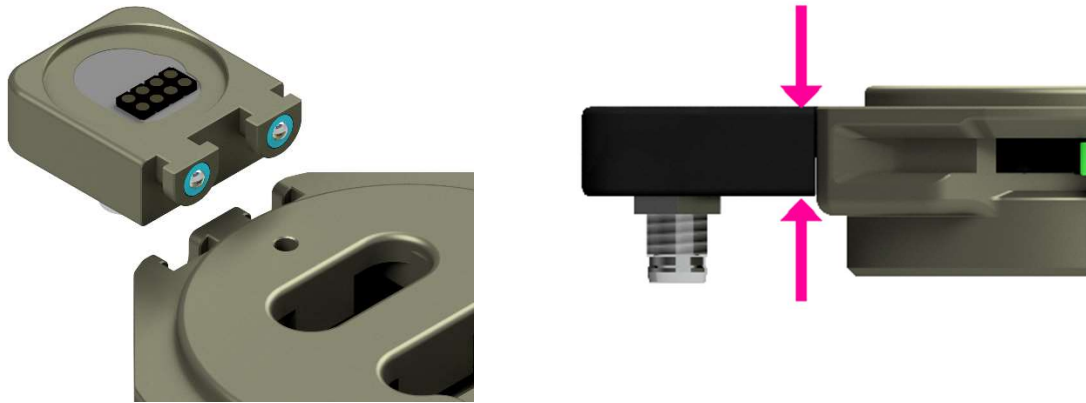


DANGER!

**WARNING!** Connecting and disconnecting an *end-effector* from its source of energy and control can in some cases pose a risk to human health if the *end-effector* reacts unintentionally/unpredictably. Therefore make sure that energy and control is turned off before connection/disconnecting *end-effectors*.

## 6.5 Installing pass-through modules

Pass-through modules are installed and uninstalling **WITHOUT** use of tools simple by “clicking” them into place. The pass-through modules are a tight fit and requires you to wiggle carefully with the modules to install and uninstall while applying even pressure on the module as close to the *tool part / robot part* as possible.



The pass-through modules for the *robot part* will **ONLY** fit to the *robot part* and pass-through modules for the *tool part* will **ONLY** fit to the *tool part*. The **blue** and **orange** dots guide's for correct fit.

*Tool part*



*Robot part*



The pass-through modules are correctly installed when they align with the *tool part / robot part* surface.



ATTENTION!

**ATTENTION!** Never use tools of any kind to install or uninstall a pass-through module and never try to force a pass-through module into place or out of place.

**ATTENTION!** Never touch delicate parts of pass-through modules such as electrical terminals etc. as these can get damaged easily.

**ATTENTION!** A little silicone-based grease must be applied on all rubber parts such as O-rings and gaskets, on the pass-through modules to ensure long lift span and prevent leaks.



DANGER!

**WARNING!** Do not install a pass-through module on the *robot part* without also installing the matching pass-through modules on **ALL** the *tool parts* you deploy. If you are not using a pass-through module located on a *tool part*, install the provided plug on the connector(s) of the pass-through module. Failing in doing so will result in the cobot performing its tasks with exposed open connectors (electrical, pneumatic etc.) which can result in hardware damage and injury.

**WARNING!** Always ensure before deployment that *end-effectors* are provided with the correct type and level of energy/control that they are intended for. An *end-effectors* provided with incorrect energy/control

---

can pose a risk of hardware damage and injury. The *pass-through modules* **do not** provide protecting against such errors and injury.

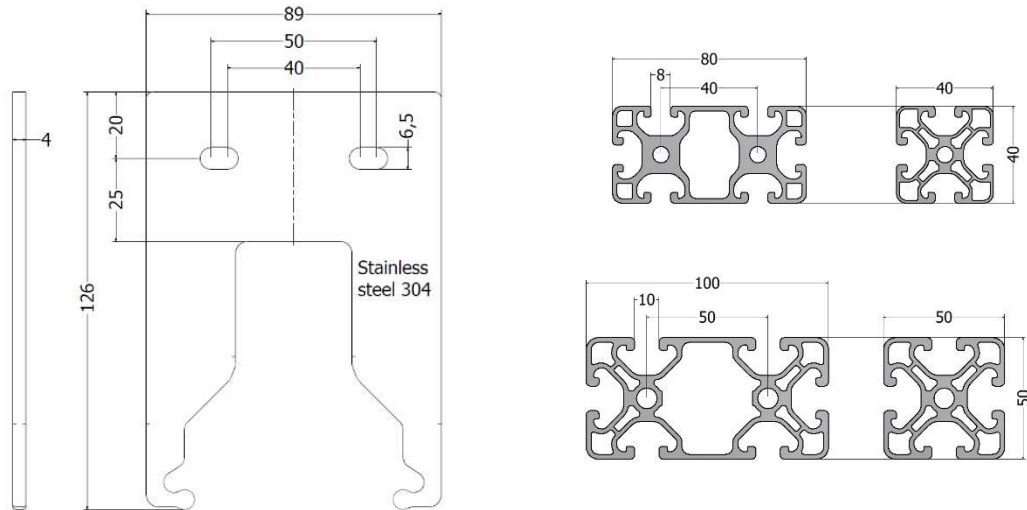
**WARNING!** Do not use the *pass-through modules* outside their specifications and **NEVER** use the electrical *pass-through modules* for voltage level that can be harmful for humans such as 110/220 volts.

**WARNING** Energy (electricity, vacuum, air pressure) to a pass-through module must be turned off and any residual electricity, air pressure, vacuum etc. in the system must be eliminated before tool change takes place. Failing in doing so will result in hardware damage (e.g. damage to electrical connectors) and can result in injury.

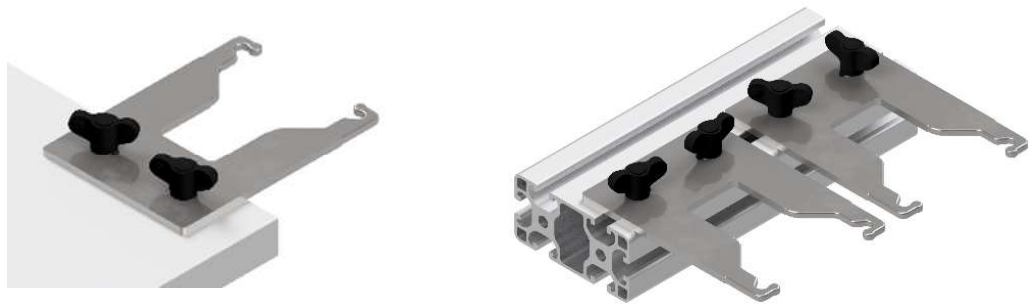
## 6.6 Installing the *tool part holder*

The *tool part holder* supports an end-effector of up to 5 kg (rated couple payload) installed in the *tool part holder* with a center of gravity that results in up to 1 Nm of torque between the *tool part holder* and the *tool part* (Rated couple torque).

The *tool part holder* has two elongated holes intended for 6 mm bolts for installation. The two mounting holes makes installation easy on a tabletop or on standard aluminum profiles such as: 50\*100 mm / 50\*50 mm / 40\*80 mm / 40\*40 mm.



Installation options for a rigid installation:



INFO / TIP

**TIP!** Tool change with heavier tools than 5 kg is possible but will require a custom-made solution to support the tool weight as coupling and decoupling takes place, to ensure that the weight on the *tool part holder* does not exceed the *tool part holder's* rated couple payload and rated couple torque.

Step 1. The *tool part holder* must be installed in a suitable place and as per the following requirements:

- a. Tool part holders must be installed horizontally on a sturdy/rigid structure that does not move relative to the *cobot* as tool change takes place.



ATTENTION!

**ATTENTION!** The levers in the *tool part* are designed to break in case of overload. Such overload can happen if the *tool part holders* are installed onto an unsteady/unrigid structure that can move relative to the *cobot*.

- b. in a position, that will allow the *cobot's* collaborative safety settings (*robot limits*) to work as intended (consult your *cobot's* user guide).



DANGER!

**WARNING!** Always ensure that you install the *tool part holder* in a place where your *cobot's* collaborative safety settings (*robot limits*) will work as intended as the *cobot* moves in proximity of the *tool part holder*. Failing to ensure that your *cobot's* *robot limits* works as intended can cause serious injury and even death.

- c. in a position, that allow the *cobot* to have a rigid posture as it performs movements associated with tool change.
- d. in a position that will allow for safe passage of the *end-effector* moved by the *cobot* to and from the *tool space* (see chapter [9.5 The Tool Space](#)).
- e. in a position that will allow for safe and clean keeping of the *tool space* (no metal chips flying around etc.)
- f. In a position that will allow fluids e.g. from CNC machinery to run off the end-effector and tool changer parts without causing hardware damage such as damage to electrical parts.
- g. in a position where all deployed *tool part holders* preferable can be placed close to each other and close to the working area so that the *cobot's* movement is minimal when exchanging between *end-effectors*.
- h. In a position where an *end-effectors* fall from a *tool part holder* cannot cause unacceptable hardware damage or injury to a user or a spectator.
- i. In a position that preferable is out of reach for users and spectators and in general promote safety with considerations to:
  - i. users not having routine tasks in the immediate proximity and
  - ii. where users and spectators are unlikely to put their limbs by accident, coincidence or by convenience and
  - iii. where users/spectators head/face does not risk contact with the *tool part holder(s)*.



DANGER!

**WARNING!** Users and spectators are NOT allowed to move limbs into the *tool space* as a robot program is executing. Even though all safety instructions in this user guide are followed, a user or spectator risk injury if limbs are moved into the *tool space* as the robot program is executing.

- Step 2. The *end-effector*, *tool part* and *tool part holder* configuration must comply with the limits for *rated couple payload* and the *rated couple torque* set out in datasheet chapter [Data sheet – TOOL PART HOLDER](#).

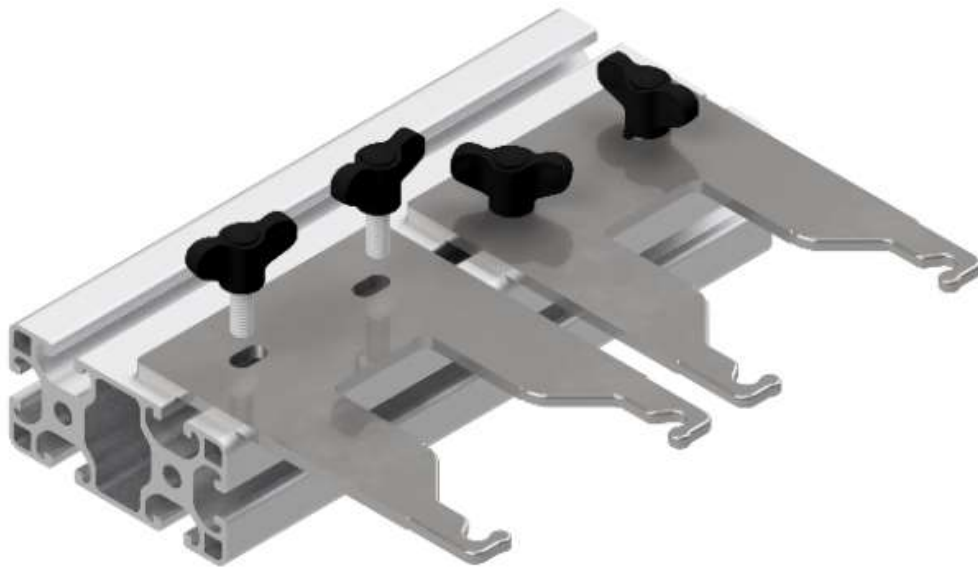


DANGER!

**WARNING!** The *end-effector* can fall from the *tool part holder* if the cobot or the user unintentionally pushes it out of the *tool part holder*. If an *end-effector's* fall from the *tool part holder* poses an unacceptable risk of injury or hardware damage, the *end-effector* in question should not be used in combination with the WINGMAN Tool Changer System.

**WARNING!** Never install the *tool part holder* in a way so gravity can cause the *tool part* to fall out of the *tool part holder*.

- Step 3. Install the *tool part holder* by using the supplied M6 wing screws and tighten firmly with your fingers to prevent the *tool part holder* to move as tool change takes place.



DANGER!

**WARNING!** Never install the *tool part holder* without using the supplied wing bolts which are there for safety reasons. In case the cobot stops with a person being caught between the cobot arm and the *tool part holder*, the wing screws are there to ensure that the person can escape by uninstalling the wing screws.

## 7 Manual use



**WARNING!** Before engage/disengage the tool changer's *robot part* and *tool part*, make sure that all energy and control to the *end-effector* has been turned off. Failing in doing so can cause serious injury and even death.

### 7.1 Locking and unlocking

Step 1. **Unlocked:** Move both *levers* on the *tool part* (one on each side) with your fingers to the unlocked position where the **red** markers on the *levers* are visible, and the **green** markers are not visible.



(Only one *lever* is shown in above illustration)

Step 2. **Pre-locked:** Engage the *tool part* with the *robot part* and **PRESS** on both *levers* with your fingers so that they move to the *pre-lock position* where the **red** marker and the **green** marker are both visible on both *levers*.



**PRESS**



*Pre-locked position*



**WARNING!** It is not allowed to deploy the tool changer when in **pre-locked** position as the tool changer will not have full strength.

Step 3. **Locked:** **PRESS** again on both *levers* with your fingers to the *locked position* where only the **green** markers are visible, and you feel a "click" as the *levers* move into place.



**PRESS** again



*Locked position*

Step 4. Unlocking is in the reversed order.



**ATTENTION!** Do not use tools of any kind such as screw drivers etc. to move the levers as this will permanently damage the levers.

## 8 Automatic use



**WARNING!** You must read, understand and fully comply with all the requirements in chapter [9 Safety](#) before commencing cobot motion.

**WARNING!** Before you start programming and testing automatic tool changes, you must ensure to do it in a safe way. Failing in doing so can cause hardware damage, injury and even death. Among other you must:

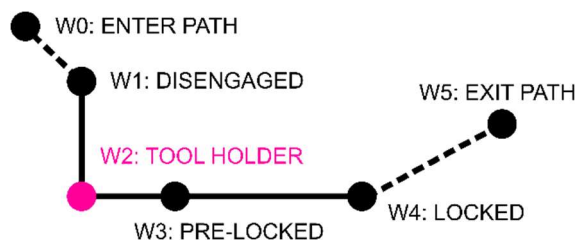
- adjust the cobot's *robot limits* (collaborative safety limits) to a setting that correspond your risk assesment,
- adjust the cobot's speed to a low setting that allow you time to move free from moving parts,
- prevent unintended/unexpected movement of the cobot and of the *end-effector(s)*,
- prevent incorrect energy levels to reach the *end-effector* (e.g. 24 volts to an *end-effector* designed for 12 volts) and
- ensure that the *end-effectors* you plan to deploy are suitable for automatic tool change.

**WARNING!** The cobot retrieving an incorrect/unintended *end-effector* poses a risk of hardware damage, injury and even death.

- When setting up an *end-effector*, you must always pair the *end-effector* with its designated *Tool part holder* by applying corresponding ID tags on both parts (not provided by TripleA robotics).
- In your Robot Program, you must always use a corresponding ID tag for your GET TOOL and PUT TOOL commands for that particular *end-effector*.
- When deploying a new robot application or redeploying and existing robot application, you must always test the Robot Program at slow speed and in a controlled test environment to confirm that *end-effectors* are located correctly and everything executes safely and as intended.

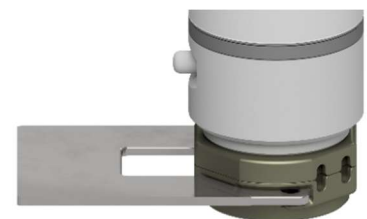
The WINGMAN Tool Changer System is a mechanical tool changer system that activates the lock/unlock mechanism by means of the cobot's motion through space – Hence, there is no need for electricity nor pneumatic installations to achieve automatic tool changes.

The cobot's motion through space executes tool changes via four mandatory *waypoints* (W1, **W2**, W3 and W4).



The mechanisms patented construction allows for inaccurate programming of *waypoints* however, accurate *waypoints* will ensure smooth tool changes and long life span.

Waypoint **W2** is the reference point for W1, W3 and W4 and is the cobot's position when the *robot part*, the *tool part* and the *tool part holder* are all fully engaged with each other.





INFO / TIP

**TIP!** There are two build in pneumatic *pass-through connections* and *three pass-through module* interfaces available which allows you to exchange between **four end-effectors** that all use different sources of energy/control and an **infinite** number of *end-effectors* that share the same source of energy/control.



INFO / TIP

**TIP for Universal Robots!** With use of the URcap software provided by TripleA robotics, you will only have to teach **W2**. The remaining mandatory waypoints (W1, W3 and W4) are calculated automatically.

## 8.1 Important about waypoints

WAYPOINTS		
W0	<p><b>ENTER PATH</b> (optional)</p> <p>Use a waypoint to ensure free passage of the cobot arm into and away from the <i>tool space</i>.</p>	
W1	<p><b>DISENGAGED</b> (mandatory):</p> <p>Robot part and tool part aligned on the same axis ready to engage.</p>	
W2	<p><b>TOOL HOLDER</b> (mandatory):</p> <p>Robot part, tool part and tool part holder are <b>FULLY</b> engaged. <b>W2</b> is the reference waypoint for all other waypoints. Fully engagement is important to ensure smooth tool change.</p> <p> <b>WARNING!</b> Energy and control (electricity, vacuum, air pressure) for the <i>end-effector</i> must be turned off before moving from W1 to <b>W2</b> and before moving from <b>W2</b> to W1.</p>	
W3	<p><b>PRE-LOCKED</b> (mandatory):</p> <p>The tool changer is in <i>pre-lock position</i>. In this position the payload and COG are toggled to fit the <i>end-effector</i>. Default distance between <b>W2</b> and W3 is 12 mm.</p>	
W4	<p><b>Locked position</b> (mandatory):</p> <p>The movement between W2 and W4 should be with a slight incline to reduce wear. The tool changer is in <i>locked position</i>. In this position other <i>end-effector</i> parameters are toggles such as TCP, Tool Voltage, Tool I/O's etc.</p>	
W5	<p><b>EXIT PATH</b> (optional):</p> <p>Use a waypoint to ensure free passage of the cobot arm into and away from the <i>tool space</i>.</p>	



ATTENTION!

**ATTENTION!** It is important that the *cobot* moves between waypoint W1 and W4 in **linear motion** with a maximum radius of 0,5 mm between change in direction.



ATTENTION!

**ATTENTION!** Even if the *tool space* is inaccessible for the user, e.g. behind safety guards, the *robot limits* that ensure collaborative safety must always be setup as per instructed in chapter [9 safety](#) to prevent overload and damage to the levers in the *tool part*. The levers are designed to break in case of overload.

---

## 8.2 Important about cobot speed

Among other, the cobot's speed must be considered in the Integrator's mandatory risk assessment.



ATTENTION!

**ATTENTION!** High tool change speed will increase wear and increase risk of hardware damage. If the tool change emits significant noise, the speed should be reduced, and the [11 Troubleshooting](#) chapter should be consulted. The levers are designed to break in case of the excessive force.



DANGER!

**WARNING!** For safe *collaborative operation* and long life span, the cobot's speed must be considered to ensure that a user/spectator has time to predict the cobots movement and has time to move limbs away to avoid quasi-static contact between moving and fixed bodies being part of the tool change process. The cobot's speed must also be considered to avoid quasi-static pressure being able to build up to an unacceptable level in case a person's limb is not moved in time.

---

## 8.3 Important about end-effector selection and parameters

It is important to plan your automatic tool application. Among other you must consider what end-effectors you will use and if they are capable for automatic tool change and suitable for automatic tool change with the WINGMAN Cobot Tool Changer system. The main topics are listed in this chapter.



DANGER!

**WARNING!** Providing an *end-effector* with incorrect energy/control can cause hardware damage, injury and even death. If you are in doubt of what parameters to use for your *end-effector*, you must consult the *end-effector's* technical documentation or contact the *end-effector* supplier. Tool change between *end-effectors* must always be thoroughly tested before deployed into production.

---

### 8.3.1 The end-effector's automatic tool change capability

As a tool change takes place from one *end-effector* to another, the cobot needs to toggle parameters like voltage, pneumatic and vacuum ON/OFF. Before tool change takes place all electrical, pneumatic and vacuum must be turned OFF and with no residual electricity, air pressure, vacuum etc. in the system.

Some "smart" end-effectors for cobots, that depend on designated software to run on the robot (e.g. URcap software on Universal Robots) or on an designated control box for the end-effector, are not prepared for automatic tool change by the end-effector manufacturer and some are.

"Smart" end-effectors that **are not** supported for automatic tool change might shut down the robot program from executing when the end-effector is disconnected from the cobot (communication is interrupted). In some cases, it is easy to circumvent such end-effectors shutting down of the robot program from executing and in some cases it is very difficult. It might also be a option to plan your automatic tool change application in such away that the cable stays connected to the end-effector at all times.

"Smart" end-effectors that **are** supported for automatic tool change often have a designated initialization function to power the end-effector back up after reconnecting.

As a general rule, you should always investigate with the end-effector manufacturer or his local representative if the end-effector supports automatic tool change.

If you already have the end-effector and the cobot, you can test if the end-effector is capable of automatic tool change simply by manually imitating an automatic tool change while the robot program is executing.



**WARNING!** Manually imitating an automatic tool change comes with a risk as you will be manually disconnecting and reconnecting the end-effector while the cobot is moving. Therefore imitating an automatic tool change must only be performed by trained personnel and in a safe environment and with cobot settings that ensure human safety.



**ATTENTION!** Disconnecting and reconnecting an end-effector while manually imitating an automatic tool change must be conducted as per the end-effector's instructions to prevent hardware damage.

### 8.3.2 The end-effector's energy requirements

First of all, you must make sure that your end-effector's energy consumption, connections etc. is supported by the WINGMAN's pass-through options. Specifications for the WINGMAN's pass-through options can be found in the chapter [Datasheets](#).

Secondly, if the end-effectors you will be changing between does not use the same energy source e.g., that all connects at the cobot's electrical tool flange connector, then you will need to plan how to get each energy source to the end-effector.

In some cases it is the best solution or even necessary not route the energy to the end-effector through the WINGMAN's pass-through options but instead plan the application so that the energy and control cables/lines are connected at all times. Cables/lines can be supported by a wire spring reel installed on a post.



### 8.3.3 The end-effectors weight and center of gravity

The end-effectors weight and center of gravity is important when evaluation if the end-effector will be suitable for automatic tool change with the WINGMAN Tool Changer system.

When the end-effector is installed in the *tool part holder*, the *tool part holder's* specifications must be complied with. The *tool part holder's* specifications are found in the chapter [Datasheets](#).

In case it is difficult/impossible to comply with the *tool part holder's* specifications, a custom mechanical construction (not provided by TripleA robotics) can be installed to support the end-effector's weight when it slides in and out of the *tool part holder*.

## 8.4 Good practice for setting up tool changes

When setting up automatic tool change, good practice will reduce risk of hardware damage and injury.

- Step 1. Install the *end-effector* you intend to deploy onto the cobot by follow the instructions provided in chapter [6 Installation](#).
- Step 2. Determine, test and note down the parameters necessary for the *end-effector* to work properly such as:
- Tool Center Point (TCP).
  - Payload.
  - Center of Gravity (COG).
  - Tool voltage.
  - Tool IO setup.
- Step 3. Uninstalling all *pass-through modules* on the *robot part* and on the *tool part* and move the *end-effector/tool part* assembly to the designated *tool part holder*.
- Step 4. Program and test the tool change movement as per instructed in the following chapter [8.5 Programming tool change on Universal Robots cobots](#) or chapter [8.6 Programming tool change on other cobots](#).



DANGER!

**WARNING!** To reduce risk of hardware damage and human injury, always test tool changes thoroughly, at low cobot speed and in a controlled and safe test environment.

**WARNING!** Programming the cobot movement without the *pass-through modules* installed is important to prevent hardware damage and injury.

- Step 5. Install the *pass-through modules* and means for connectivity and program/test the *end-effector's* functionality in conjunction with the automatic tool change movement as per instructed in chapter [8.5.4 Basic setup of end-effector parameters](#) and chapter [8.5.7 Advanced setup of end-effector parameters](#).
- Step 6. Now test the full tool change process thoroughly to ensure that tool changes are executed with a high level of reliability/stability.



DANGER!

**WARNING!** Failing to test the full tool change process thoroughly and ensure reliability before deploying into production will increase risks significantly as a user might feel tempted to intervene in a running process, which is **NOT** allowed and can cause injury.

- Step 7. Follow step 1 through 6 for all other *end-effectors* you plan to deploy and finalize your Robot Program.

## 8.5 Programming tool change on Universal Robots cobots

The URcap software from TripleA robotics provides easy and fast programming of tool changes on cobots from Universal Robots in few minutes. The URcap software is compatible with:

- **CB3 series** Polyscope version 3.13 or later and
- **e-series** Polyscope version 5.8 or later.

To prevent conflicts with third party URcap software installed on your cobot, the URcap software from TripleA robotics is passive with no “threads” running in the background. The URcap simply helps you build perfect tool change programs easy and fast.

The PolyScope screenshots used in this user guide are based on e-series URsoftware version 5.8. The CB3 series will look very different but will have the same functionality.



ATTENTION!

**ATTENTION!** The required *robot limits* explained in chapter [9 Safety](#) must be setup not only for safety reasons but also to limit the cobot's strength to prevent damage to the levers in the tool changer.



DANGER!

**WARNING!** You must read, understand and fully comply with all the requirements in chapter [9 Safety](#) before commencing cobot motion. Failing in doing so can cause serious injury and even death.



DANGER!

**WARNING!** Programming automatic tool change must always be conducted as per instructed in chapter [8.4 Good practice for setting up tool changes](#).

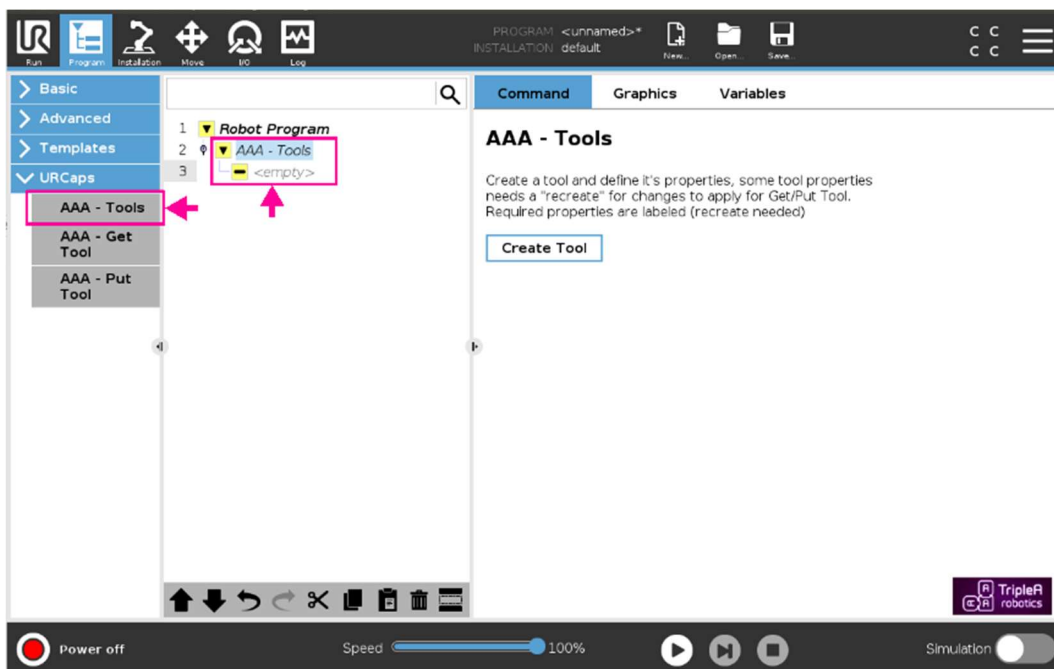
### 8.5.1 Preparation

- Step 1. Update your Polyscope to the latest version.
- Step 2. Install the URcap software from the USB stick provided by TripleA robotics.

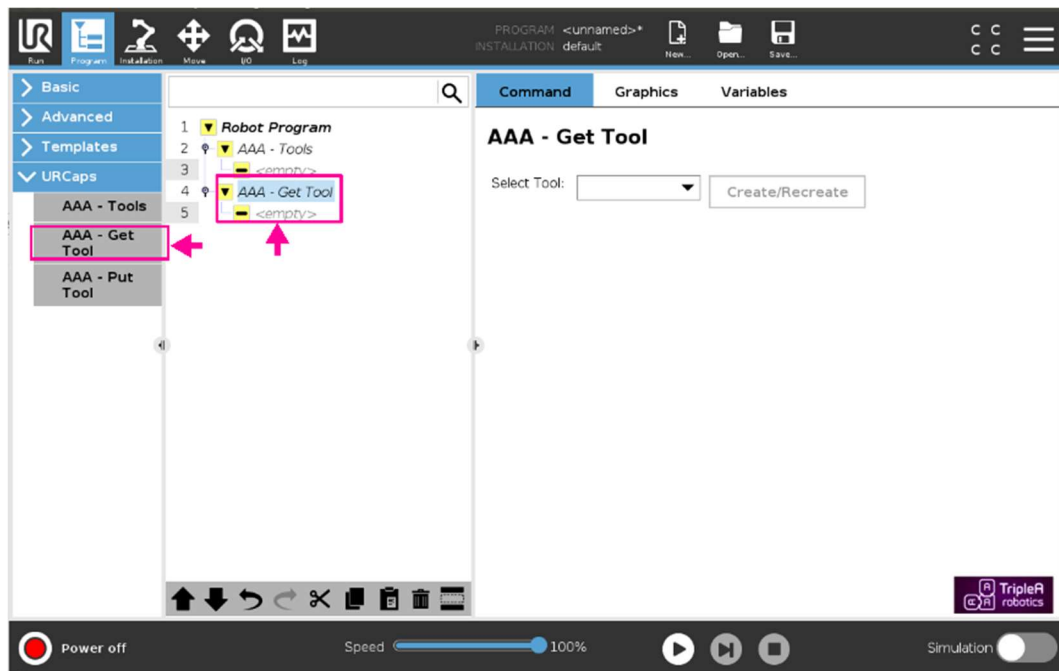
### 8.5.2 How the URcap software works

The URcap automatically generates the tool change program trees for you. The autogenerated program trees will include control of waypoints, payloads, COGs, TCPs and Tool I/O's for each *end-effector* you deploy. The URcap allows you to add the following three types of nodes to your Robot Program.

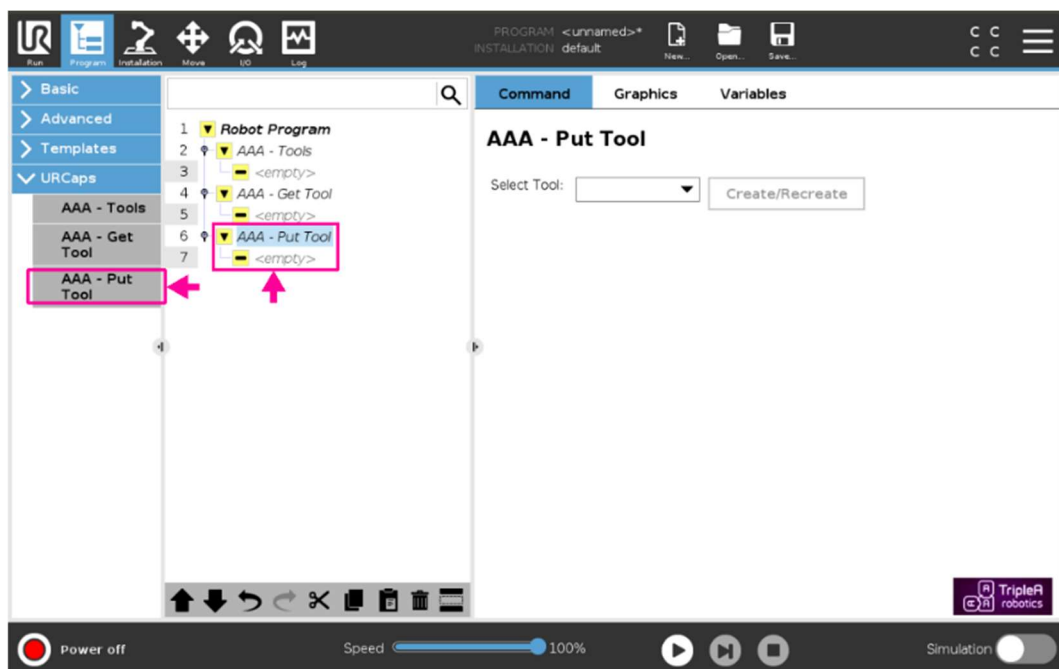
- **AAA - Tools:** This is the first node you will add to your Robot Program. The **AAA – Tools** node will hold tool change parameters for all your *end-effectors* like a database. Only one **AAA – Tools** node is allowed in your Robot Program.



- **AAA – Get Tool:** Add this node to your Robot Program when you want the cobot to collect a specific *end-effector* from its designated *tool part holder*.



- AAA Put Tool:** Add this node to your Robot Program when you want the cobot to return a specific tool to its designated *tool part holder*.



Adjustments to a tool change setup is done in the **AAA – Tools** node. If you make adjustments to a tool that has a **AAA – Get Tool** or a **AAA Put Tool** node assigned in the program tree, these nodes will become inactive (yellow) until you have visited the nodes and >recreated< them.



INFO / TIP

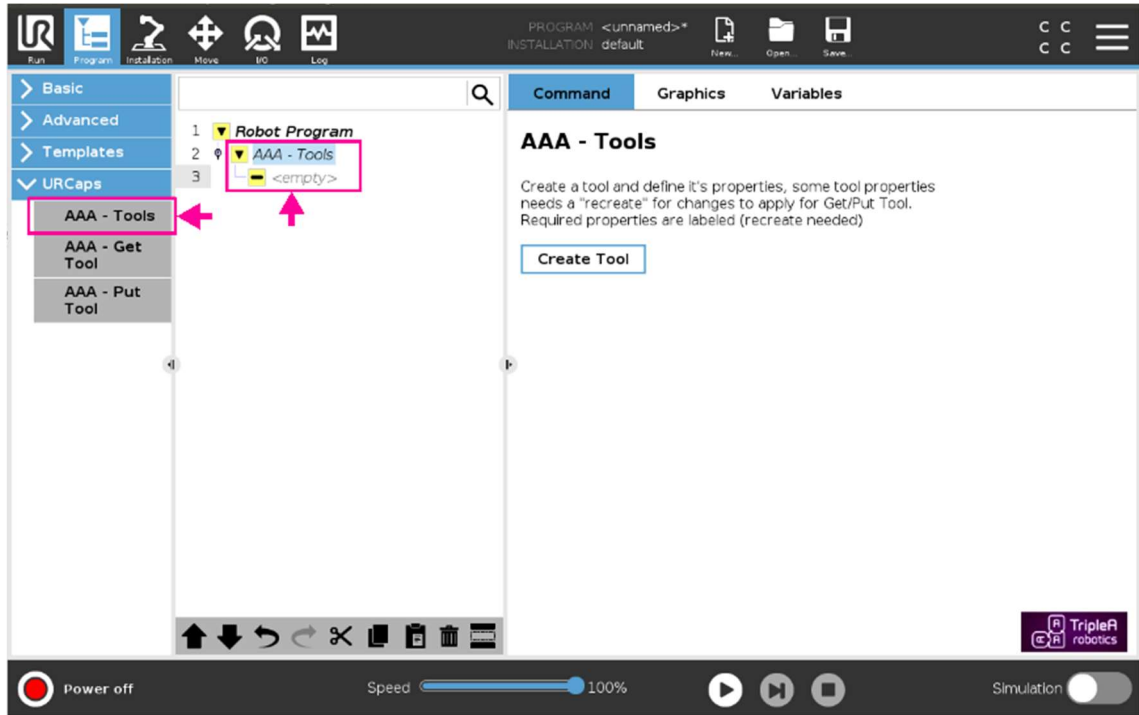
**TIP!** Some third-party URcaps runs threats in the background that overwrites the *active TCP*. Third-party URcpas might also change other parameters in ways that can be difficult to predict. In case the cobot moves in an un-logical/unintended way, this is most likely caused by a third-party URcap running a thread in the background. To find out, uninstall third-party URcaps one by one and test.



**WARNING!** The URcap software provided by TripleA robotics does **NOT** provide the mandatory collaborative safety settings, the *robot limits*. Instead these must be setup manually before it is allowed to deploy cobot motion. Details are provided in chapter [9.7 Load limiting and collaborative safety settings](#)

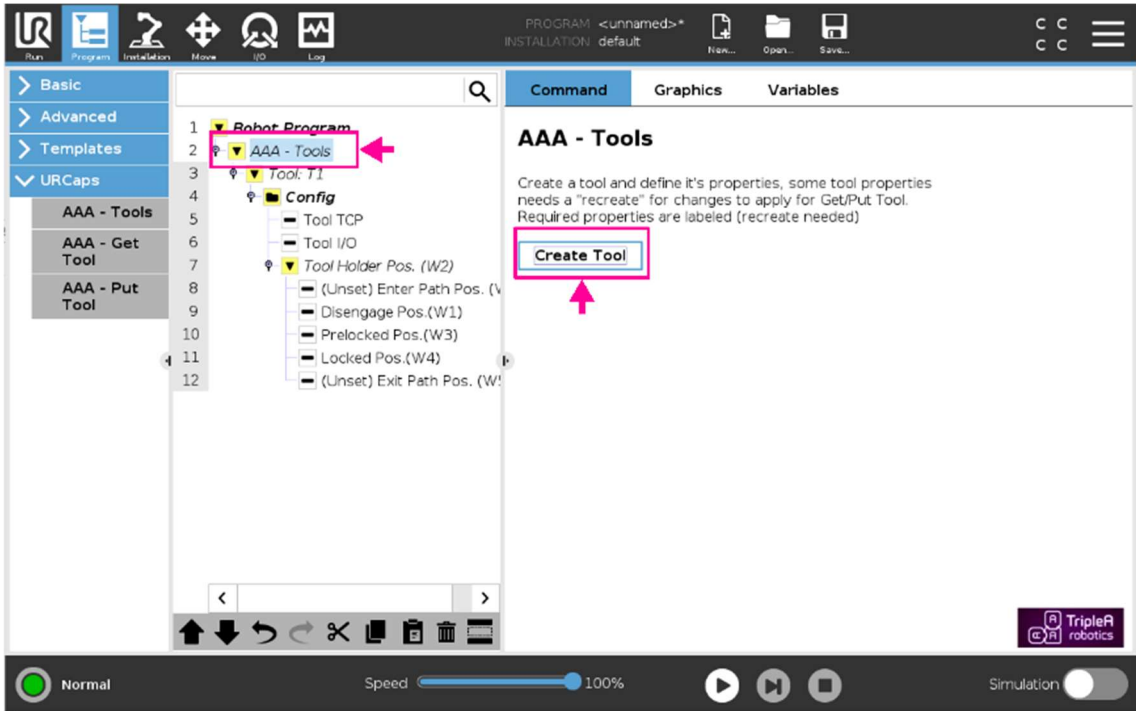
### 8.5.3 Basic setup of tool change movement

- Step 1. Start a new Robot Program and navigating to *URCaps > AAA – Tools* to add a **AAA – Tools** node to your Robot Program. If a popup appears, confirm to create the node.



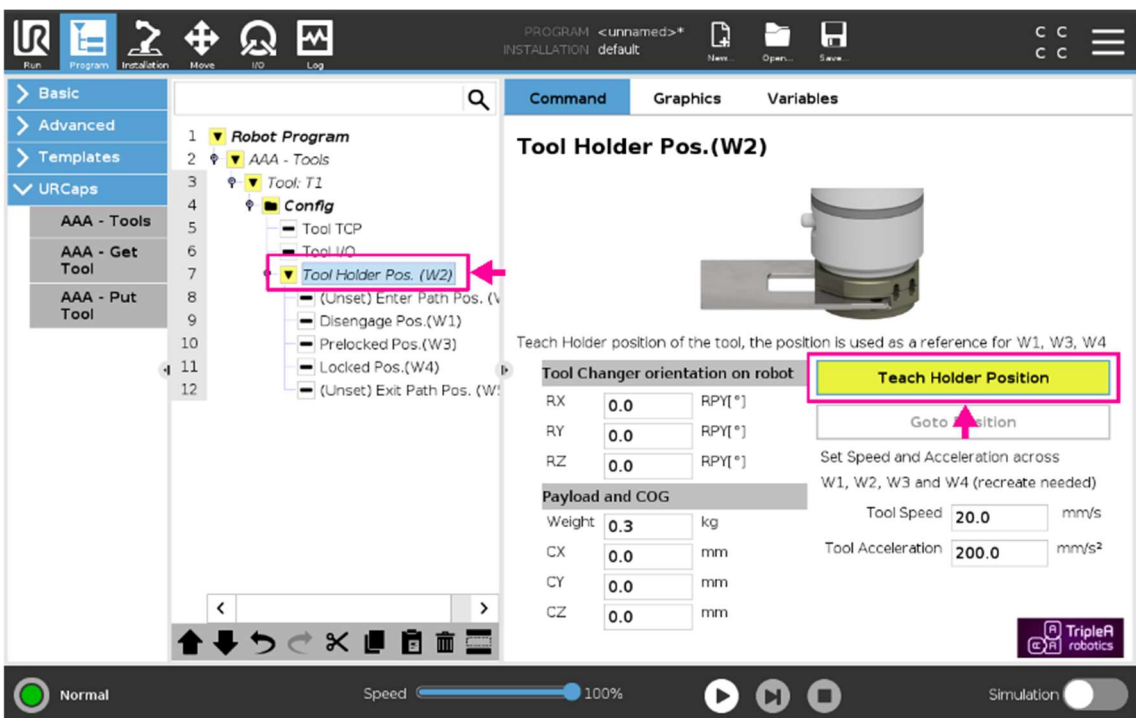
**TIP!** The popup makes sure that there is only one active **AAA – Tools** node in your Robot Program. Creating a second **AAA – Tools** node will overwrite the first **AAA – Tools** node. The **AAA – tools** node that is superseded will be labeled “Delete Me” and must be deleted manually before the Robot Program can execute.

- Step 2. Create your first *end-effector(Tool)* by navigating to *Robot Program > AAA – Tools* and press the *>Create Tool<* button. This will autogenerate the *Tool: T1* program tree which holds all your settings for your *end-effector* called “T1”.



- Step 3. Navigate to the *Robot Program > AAA – Tools > Tool: T1* and change the *>Name<* to correspond to your *end-effector's* ID tag (In this user guide we keep the “T1” ID tag). See chapter [9.9 ID Tag system](#).

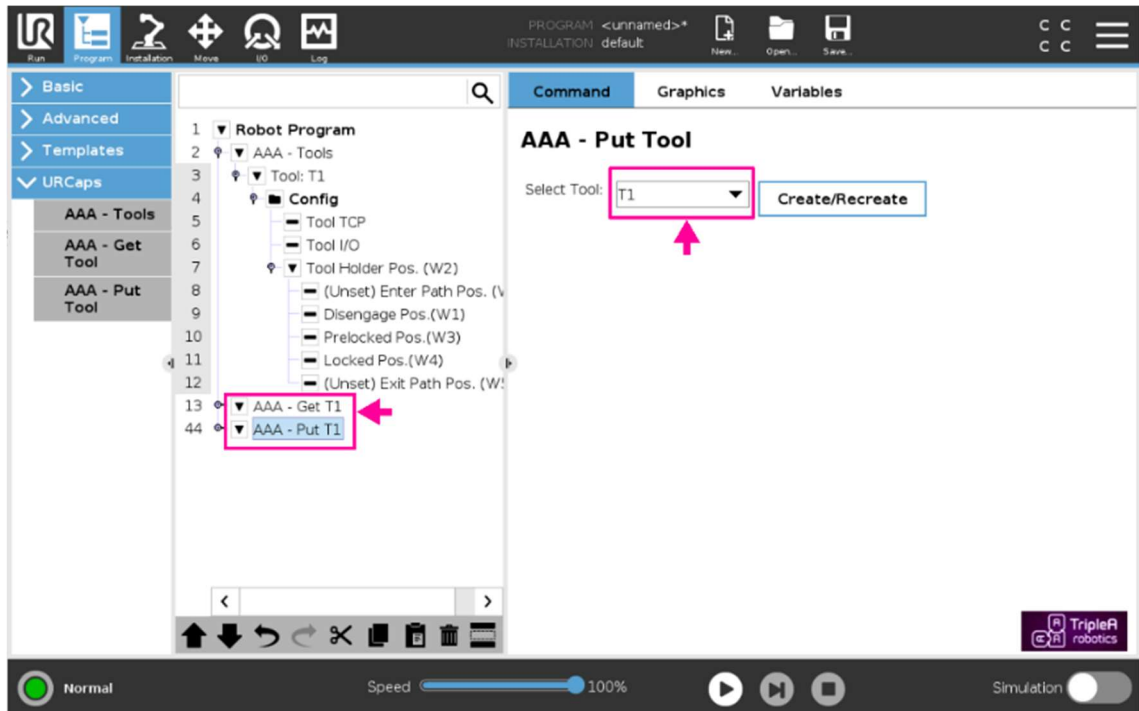
- Step 4. Navigate to the *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2)* and press the *>Teach Holder Position<* button to teach waypoint **W2** for the *end-effector* location. See more about waypoint **W2** in chapter [8.1 Important about waypoints](#).



After teaching waypoint **W2**, all other waypoints necessary for tool change are calculated automatically by the URcap software. You are now done setting up the basic tool change movement.

Step 5. Prepare a tool change test by navigating to *URCaps > AAA – Get Tool* and place a **AAA – Get Tool** node in the end of your Robot Program.

Now navigating to *URCaps > AAA – Put Tool* node and place a **AAA – Put Tool** node in the end of your Robot Program. In both nodes, choose the *end-effector's* ID tag name(T1) from the dropdown and press the **>Create/Recreate<** button.



Step 6. Remove all *end-effector(s)* hardware from the robot application, stand clear of the cobot and run the Robot Program at very low speed and observe if the tool change movement looks as expected.



INFO / TIP

**TIP!** A common cause of error is if the *robot part* is not installed onto to *cobot's tool flange* in its standard orientation using the 6 mm positioning pin. If the *robot part* cannot be installed in its standard orientation, please see solution in chapter [8.5.8 Odd orientation of the robot part on the cobot's tool flange](#). In case of other issues, please refer to chapter [11 Troubleshooting](#).

Step 7. If the cobot's movement looks ok, stop the program and place the *end-effector* hardware in the *tool part holder* and run the program again to observe the actual tool change taking place. Test the cobot movement **without** the pass-through modules installed to reduce the risk of hardware damage.



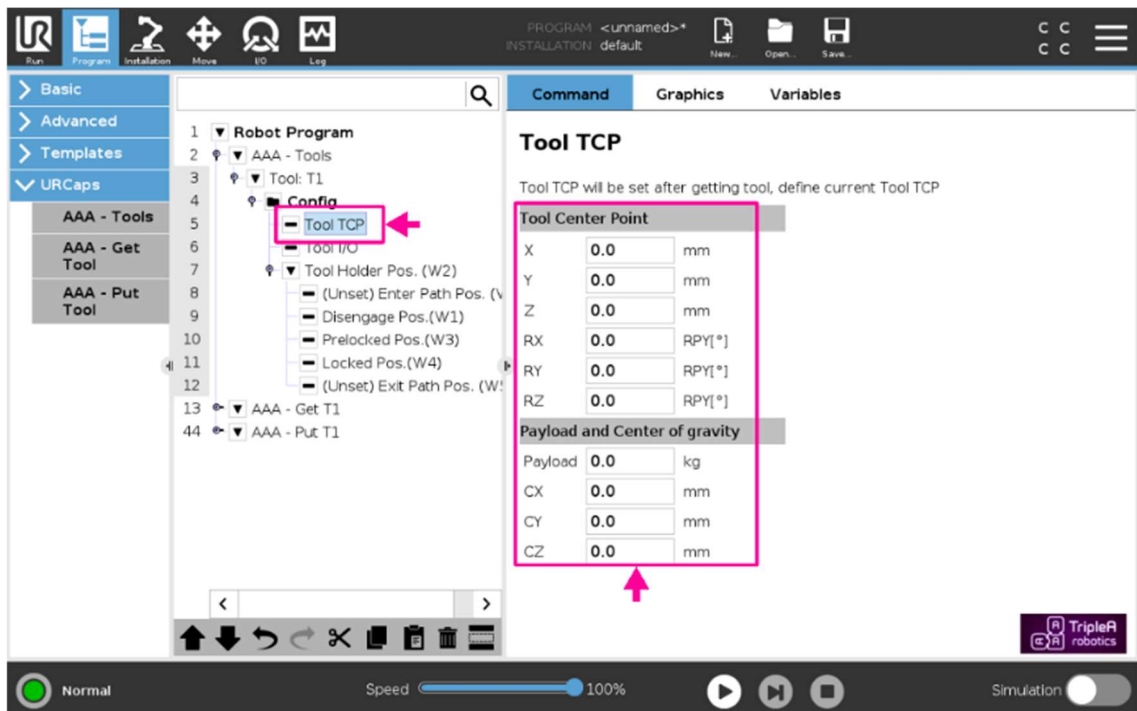
INFO / TIP

**TIP!** To test **AAA – Get Tool** nodes and **AAA – Put Tool** nodes individually in a flexible way, see the guide in chapter [8.5.5 Powerful TEST feature and good programming practice](#).

### 8.5.4 Basic setup of end-effector parameters

After you have tested thoroughly that tool change movement executes correctly, it is time to install, setup and test the *end-effector* connectivity and functionality.

- Step 1. To set up your *end-effector's* TCP, payload and COG, navigate to *Robot Program > AAA – Tools > Tool: T1 > Config > Tool TCP* and type in the parameters for your *end-effector*.



INFO / TIP

**TIP!** As an **AAA – Get Tool** node is run, it will set the tool's TCP using URscript. This has the disadvantage that when you test parts of your Robot Program and not initiate your test with calling the **AAA – Get Tool** node for the tool you are using, then the TCP is be set incorrectly to the default PolyScope TCP setting from the installation tap.

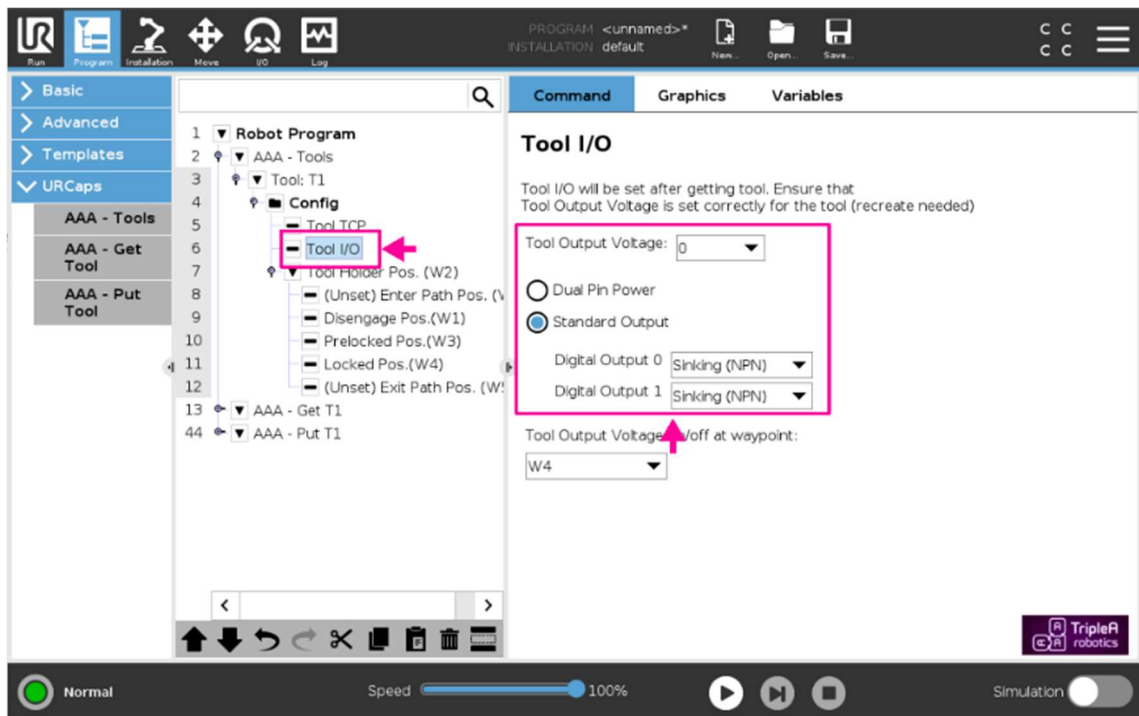
It is therefore recommended only to use the *Payload and Center of Gravity* settings (Payload, CX, CY and CZ) and **not** the *Tool Center Point* settings X, Y, Z, RX, RY and RZ settings. Instead leave the *Tool Center Point* settings at zero and create a new tool and setup it up in the *Installation > TCP* menu. In your Robot Program's *MoveL/MoveJ/MoveP* nodes select the tool you are using in the *Set TCP* drop down menu. Make sure you have the correct tool selected in the *Installation > TCP* menu when you teach in your Robot Program.

- Step 2. If you are deploying an electrical *end-effector* connected to the cobot's Tool I/O's available at the cobot's *tool flange*, you can put in your *end-effectors* parameters in the **Tool I/O** setup found in the Robot Program > AAA – Tools > Tool: T1 > Config > Tool I/O node. The UR-cap will automatically turn off/on the voltage as tool change takes place to prevent damage to the electrical connectors.



DANGER!

**WARNING** Energy (electricity, vacuum, air pressure) to a pass-through module must be turned off and any residual electricity, air pressure, vacuum etc. in the system must be eliminated before tool change takes place. Failing in doing so will result in hardware damage (damage to electrical connectors etc.) and can result in injury.

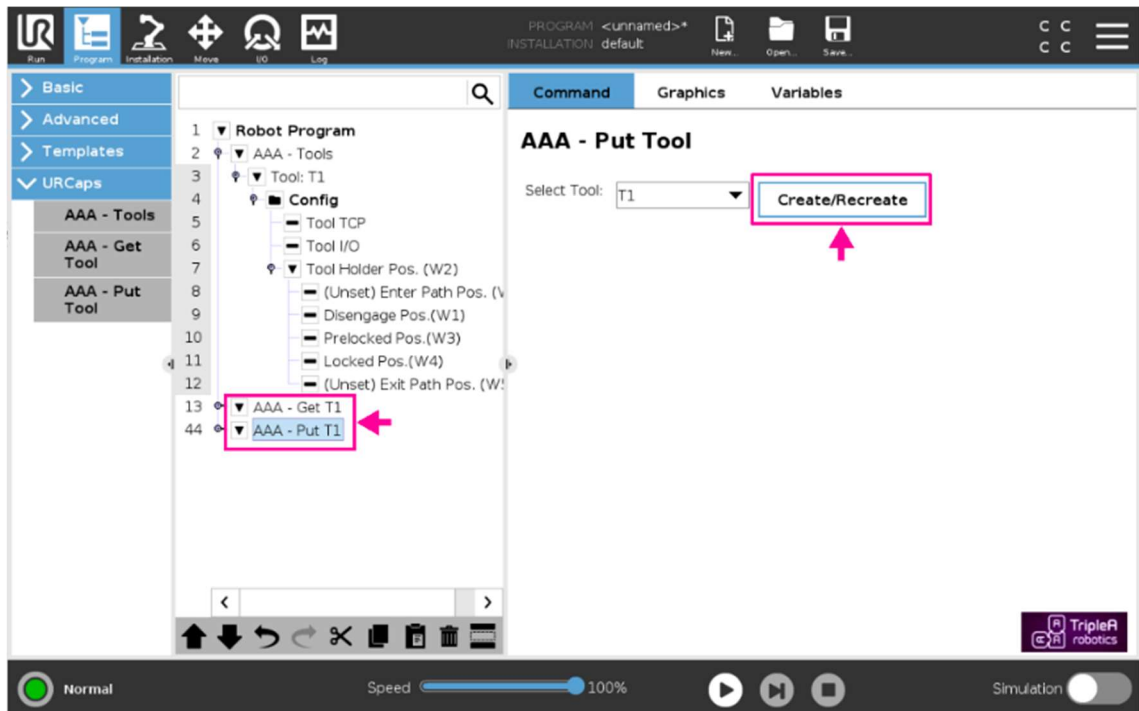


If you are deploying an *end-effector* that is using other I/O's then the cobot's Tool I/O's available at the cobot's *tool flange* or if you need more control over the cobot's Tool I/O's, please see chapter [8.5.7 Advanced setup of end-effector setting](#).



**ATTENTION!** Be aware that when you test your Robot Program with a tool already located on the robot, the voltage is automatically set to the default setting found in the INSTALLATION>TOOL I/O if the relevant **AAA-GET TOOL** node is not run first to collect the tool and set the correct voltage. As you program and test your programming for a particular tool, the voltage in the INSTALLATION>TOOL I/O can be set to the correct voltage for this particular tool to avoid the voltage resetting each time you test your Robot Program without first calling the relevant **AAA-GET TOOL** node. To avoid the risk of incorrect voltage to a tool, the voltage in the INSTALLATION>TOOL I/O should be set to 0V, when you have finished the Robot Program for this particular tool.

Step 3. Navigate to the *Robot Program* > **AAA – Get T1** node and the *Robot Program* > **AAA – Put T1** node and press the >Create/Recreate< button for the Tool I/O settings you completed in step 2 to have effect.



Step 4. Test the tool change including the *end-effector* parameters. You can test by applying functionality to your Robot Program between the **AAA – Get T1** node and the **AAA – Put T1** node.



**WARNING!** To reduce risk of hardware damage and human injury, always test tool changes thoroughly at low cobot speed and in a controlled and safe test environment.

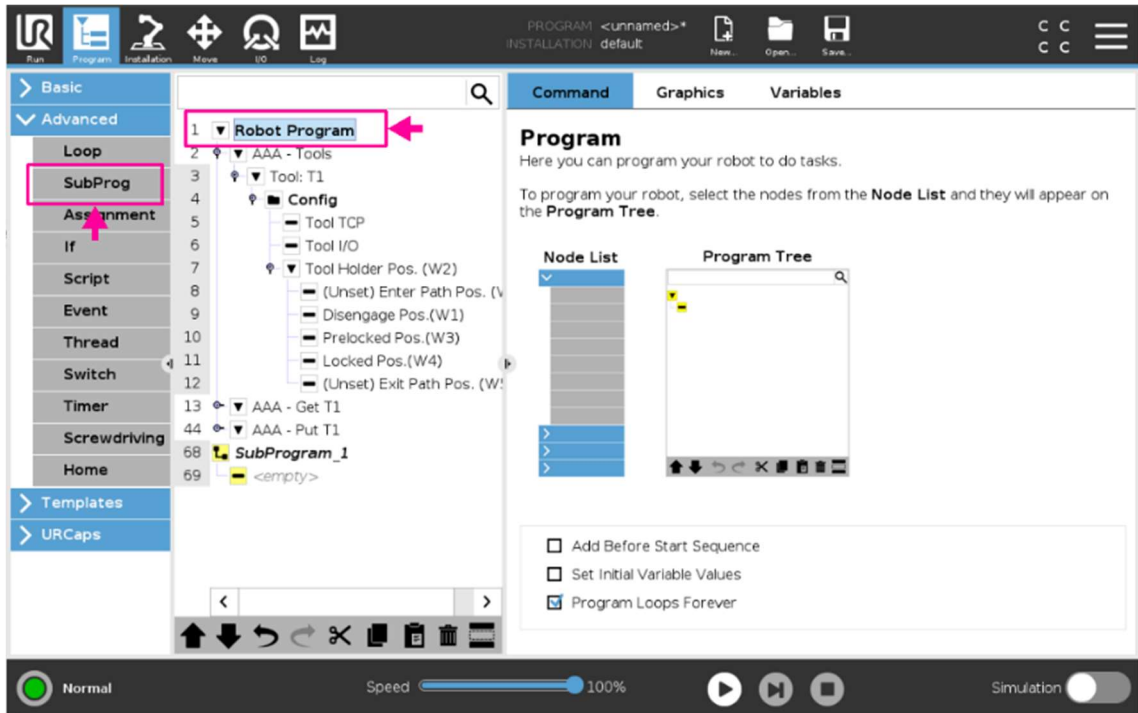
### 8.5.5 Powerful TEST feature and good programming practice

Making use of SubPrograms in your Robot Program is good practice and provide you with several benefits:

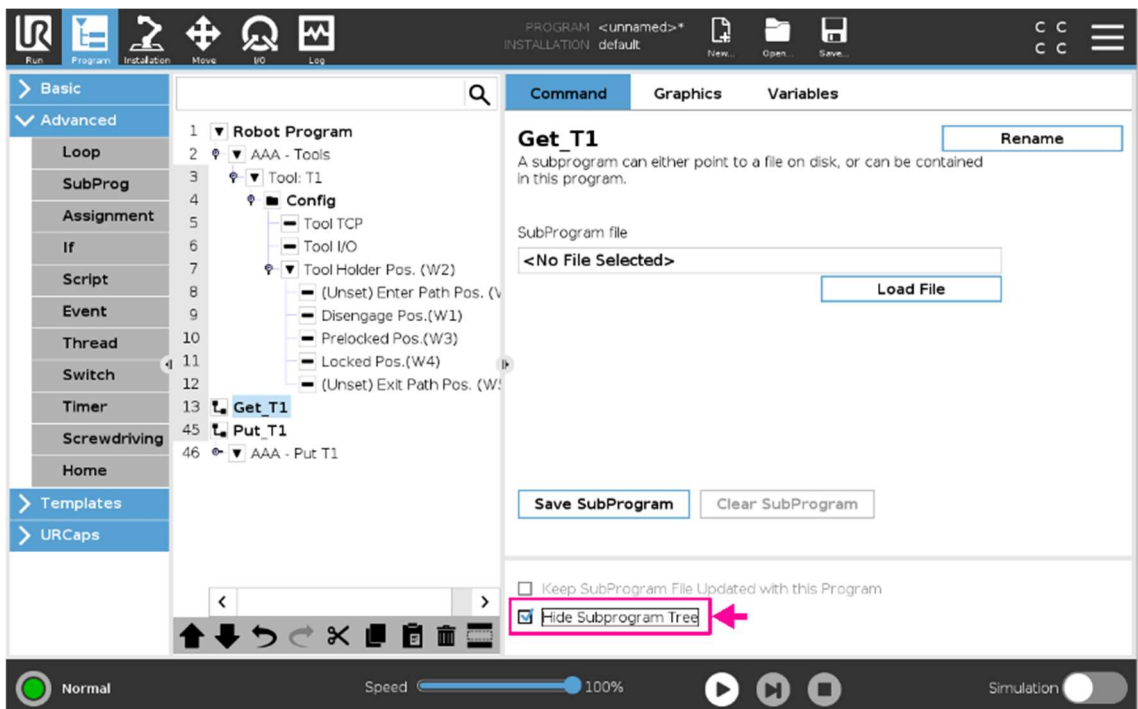
- Keeping all the **AAA – Get Tool** and **AAA – Put Tool** nodes program trees collapsed at all times.
- Accomplish only one **AAA – Get Tool** and one **AAA – Put Tool** node for each *end-effector*.
- Making a simple yet powerful TEST node to run a single **AAA – Put Tool** or **AAA – Get Tool** node.

#### 8.5.5.1 Deploy SubPrograms

Step 1. Navigate to the Robot Program and press the >SubProg< button in the advanced menu. This will create an empty SubProgram in the end of your Robot Program.



Step 2. Cut and paste your **AAA – Get T1** node into the SubProgram and rename the SubProgram “Get T1”. Repeat step 1 and 2 to move **AAA – Put T1** node into another SubProgram named “Put T1”. Now you can check the check box “*Hide Subprogram Tree*” to prevent the nodes from unfolding when the Robot Program executes.

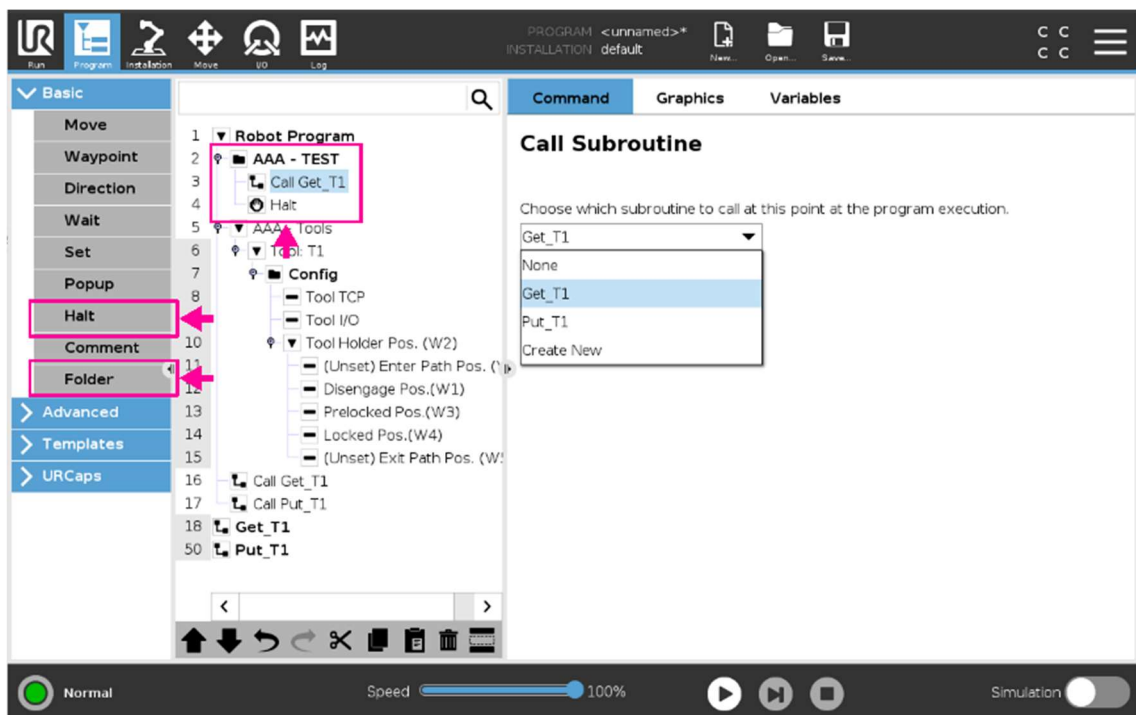


8.5.5.2 Powerful TEST node

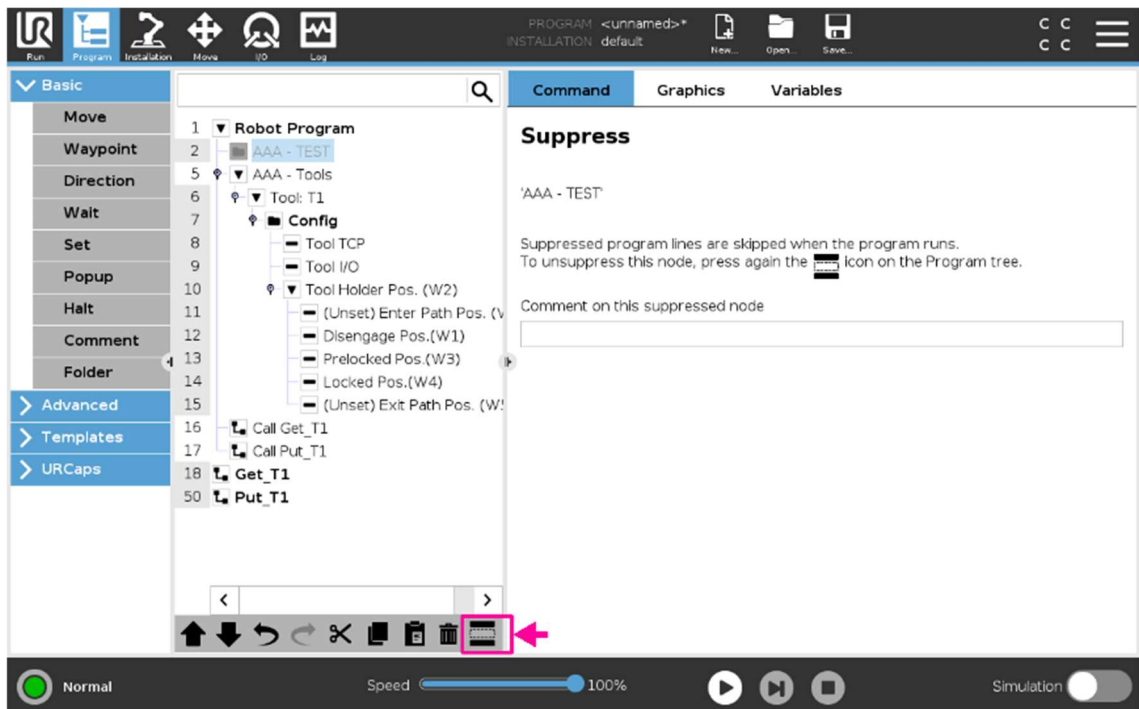
You can use the method described in this chapter to run a **AAA – Get T1** or a **AAA – Put T1** node one time. This is helpful when you want to:

1. test a GET or a PUT command individually or
2. when you want to have the cobot retrieve an *end-effector* or put an *end-effector* back or
3. when you want to redeploy an existing Robot Program and you want to make sure, that all *end-effectors* are placed in their designated *tool part holders* simply by letting the cobot move each *end-effector* to its *tool part holder* one by one.

- Step 1. Follow the steps in chapter 9.5.5.1 Deploy SubPrograms to put your **AAA – Get T1** or a **AAA – Put T1** nodes in a SubPrograms.
- Step 2. Create a *Folder* in top of your Robot Program and rename the folder “AAA – TEST”. Put a *Call* function and a *Halt* function beneath it inside the folder.
- Step 3. Now visit the *Call* function and choose the SubProgram you want run/test from the dropdown.

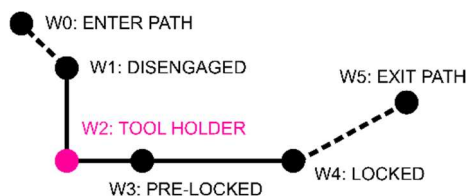


- Step 4. Now run the Robot Program. It will run the SubProgram you have chosen one time only and the terminate.
- Step 5. When you have finished testing, simply make the folder inactive by pressing the icon in the bottom corner of the Robot Program tree. With that, the Robot Program will execute the full Robot Program and ignore your **AAA – TEST** node.



### 8.5.6 Advanced: Setup of tool change movement

Waypoint W1, W3 and W4 are based on **W2** and are calculated from a set of default values. These default values can be adjusted and additional two optional waypoints (waypoint W0 and W5) can be added.



Waypoint W0 and W5 is optional to allow you free passage waypoints to and from the *tool space*. See details about the *tool space* in chapter 9.5 [The tool space](#) and see details about waypoints in chapter 8.1 [Important about waypoints](#).

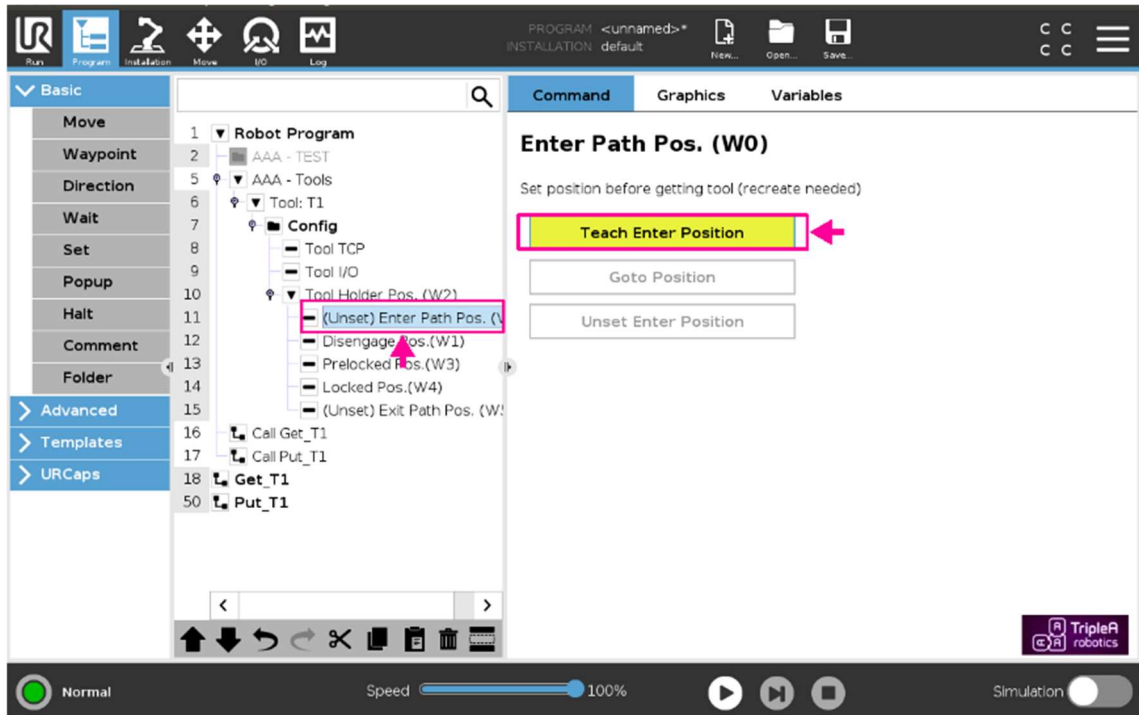


**WARNING!** It is the *system integrators* risk assessment that determines how the cobot can move safely to and from the *tool space* among other at what speed the cobot is allowed to move. Be aware that the optional waypoint W0 and W5 uses the cobots default speed which might be too fast to ensure collaborative safety in your robot application.

### 8.5.6.1 How do deploy the optional waypoints:

Step 1. Navigate to the *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2) > (Unset) Enter Part Pos. (W0)* and press the *>Teach Enter Position<*. Now teach the position that ensures free passage to/from the tool space.

Do the same for *(Unset) Exit Part Pos. (W5)*



Step 2. Navigate to the **AAA – Get T1** and the **AAA – Put T1** notes for the *end-effector* named “T1” and press the *>Create/Recreate<* button for your adjustments to have effect.

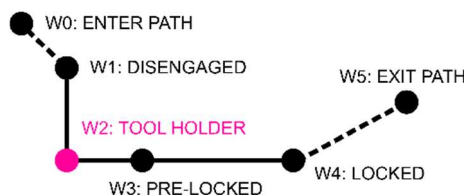
Step 3. Set the cobots speed to a VERY low setting(!) and then test.

### 8.5.6.2 How to adjust the mandatory waypoints:

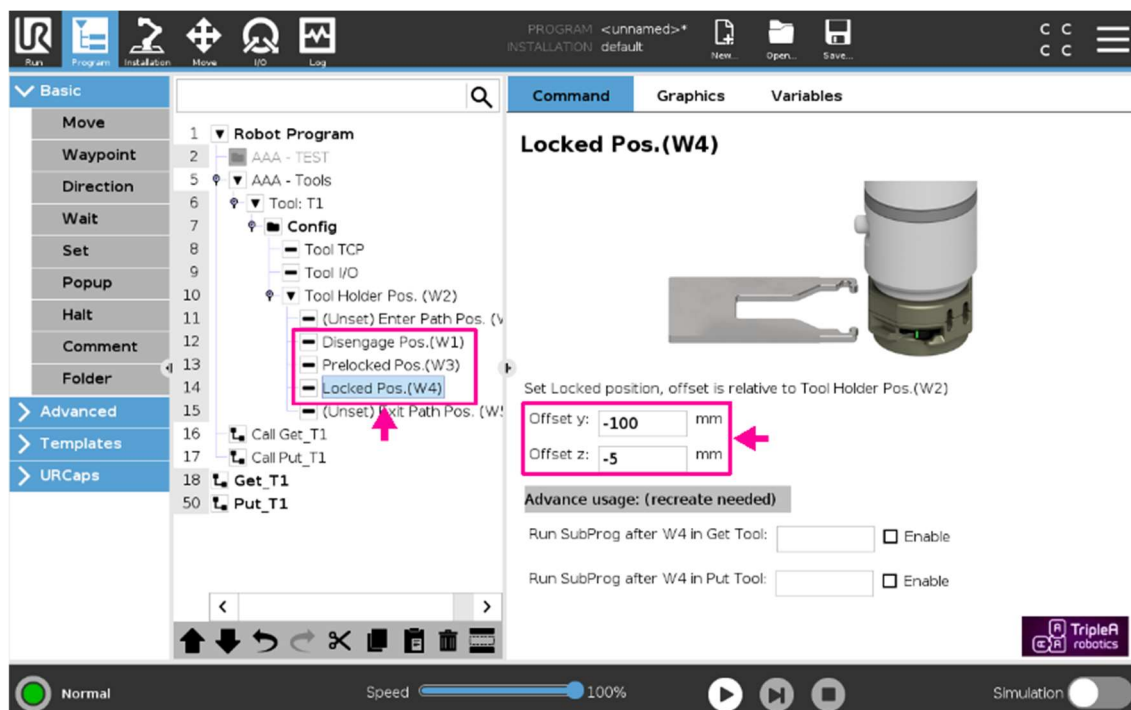
The mandatory waypoints W1, W3 and W4 can be adjusted if necessary.

Step 1. Navigate to the *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2) >*

- *Disengaged Pos.(W1)*
- *Prelocked Pos.(W3)*
- *Locked Pos.(W4)*



Here you can adjust fields that contain the Offset values with reference to **W2**.



If you need to change waypoint *Tool Holder Pos.(W2)*, you can do so by teaching in this waypoint again. Doing so will have influence on waypoints W1, W3 and W4.

The robot's speed between W1 and W4 has a default speed at 20 mm/s. This speed can be adjusted by navigating to the *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2)* node.



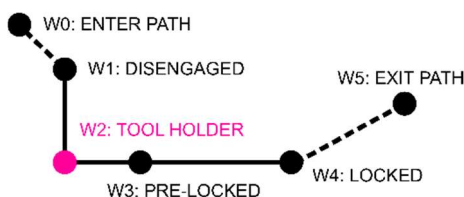
**WARNING!** Do not increase the robot's speed between W1 and W4 beyond the speed that the *system integrator's* risk assessment permits. Also be aware that high tool change speeds may result in your product wearing out faster.

### 8.5.7 Advanced: Setup of end-effector settings

In some cases, you will need to setup special I/O configurations to get your *end-effector* to work properly e.g. if your *end-effector* makes use of Analog Tool I/O's or other I/O's than the Tool I/O's available at the robot *tool flange*.

You can create a SubProgram that holds your *end-effector's* settings and call the SubProgram from the WINGMAN URcap software. The SubProgram can be called:

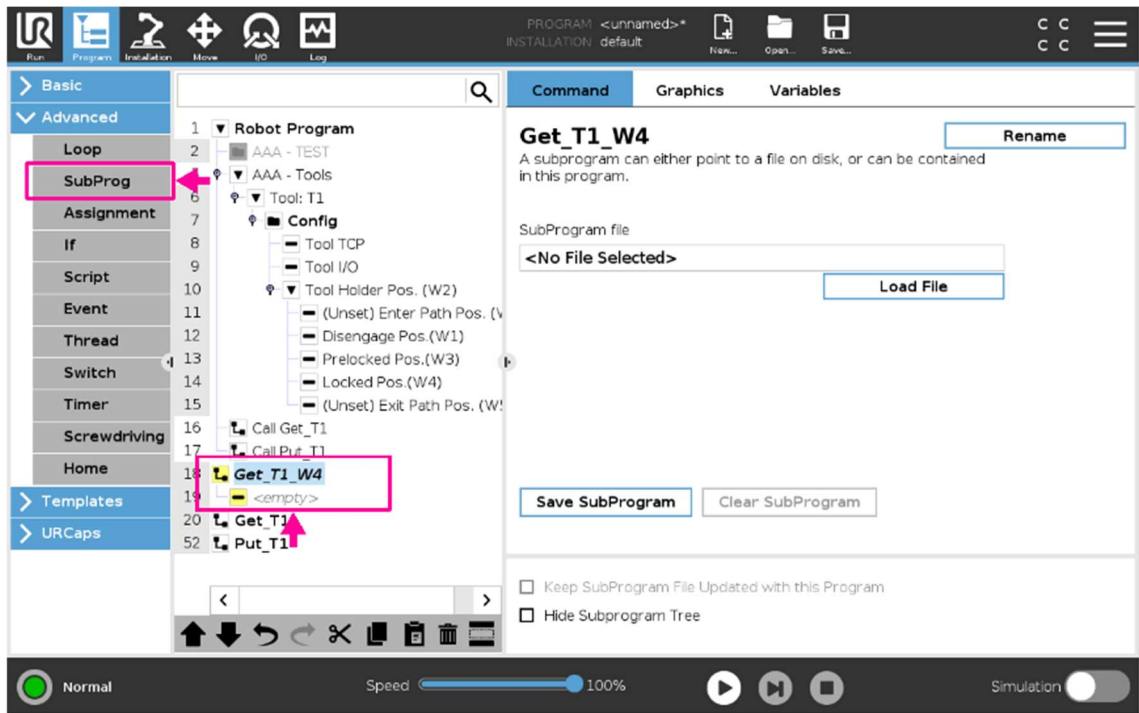
- at waypoint W1 where the *robot part* and *tool part* are separated from each other and
- at waypoint W4 where the *robot part* and *tool part* are locked to each other.



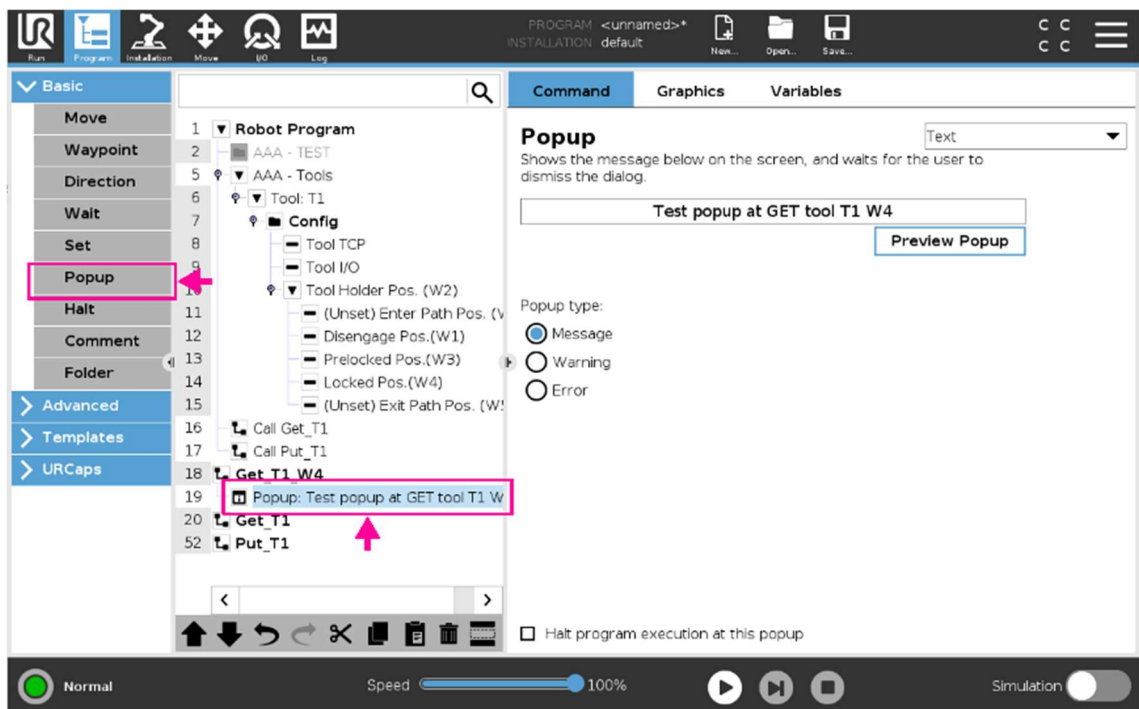
Your SubProgram can hold anything from a simple standard "SET" node, where you can configure all available I/O's, to your own bespoke complex UR script code. Calling a subprogram from the WINGMAN

URcap will always overrule the URcap's standard *end-effector* settings in case of duplication. This allows you to have full control and flexibility even in very advanced tool change applications.

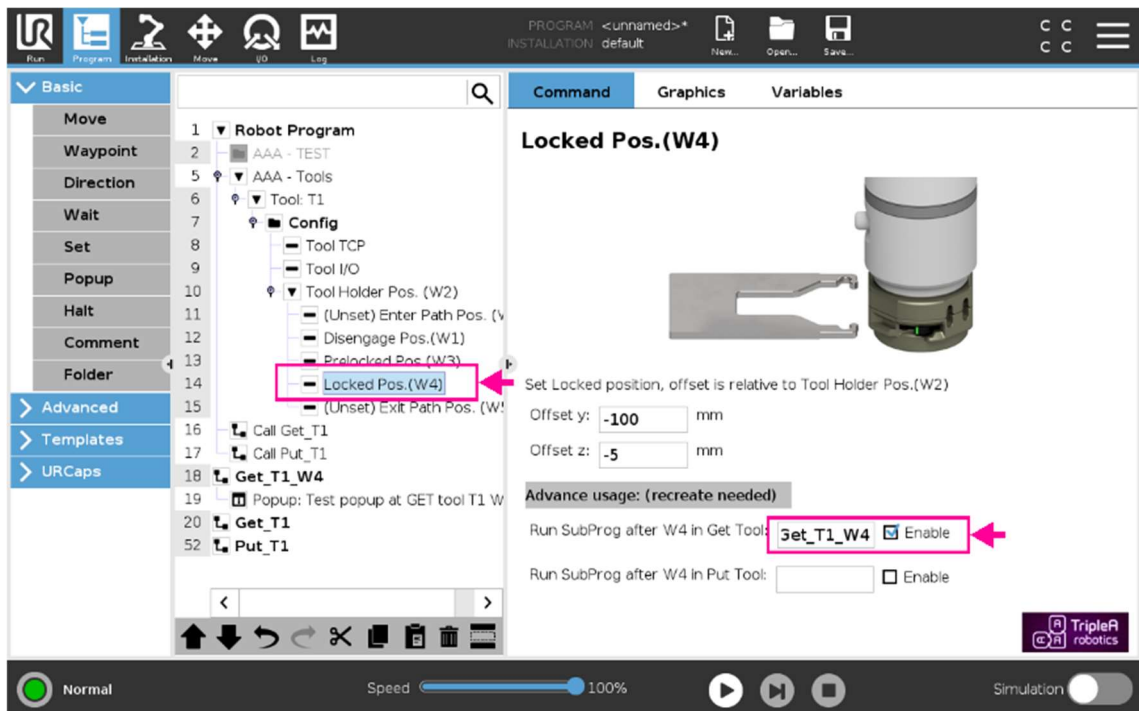
Step 1. Add a SubProgram to your Robot Program and rename it "Get\_T1\_W4".



Step 2. Provide the SubProgram with the content you need. For a simple test, try just to add a popup.



Step 3. Navigate to *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2) > Locked Pos.(W4)* and write the **EXACT** name "Get\_T1\_W4" of your SubProgram in the field labeled "Run SubProgram after W4 in Get Tool".

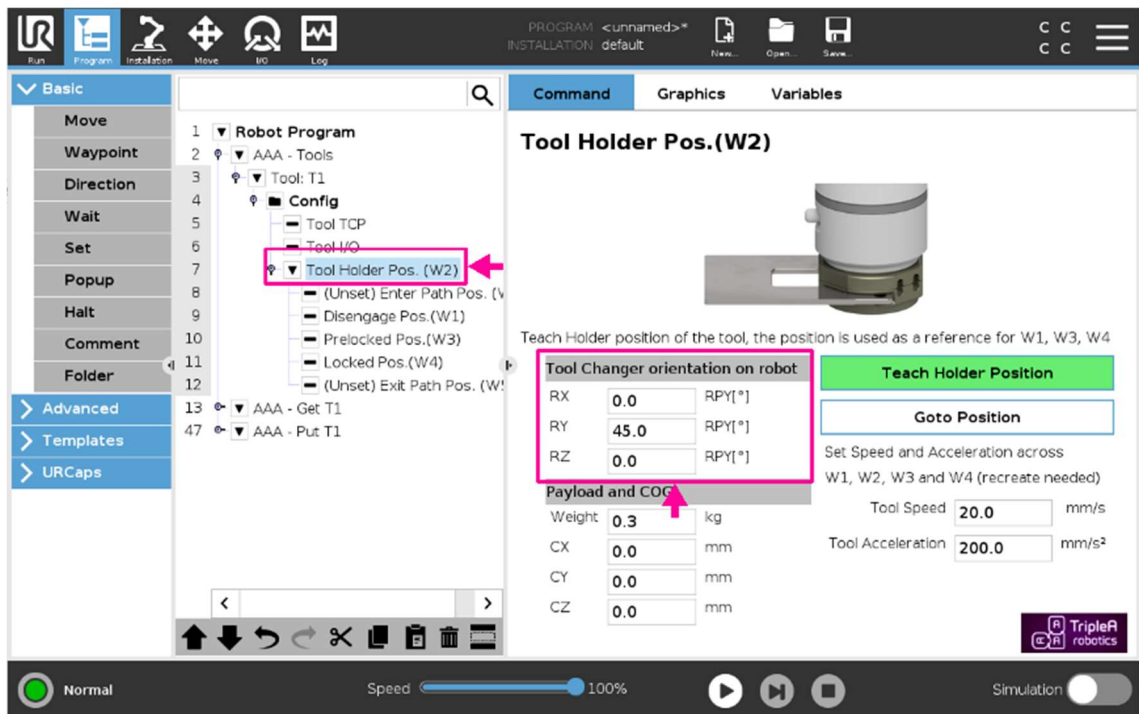


- Step 4. Navigate to the **AAA – Get T1** node and press the **>Create/Recreate<** button for your change to have effect (found inside the subprogram **Get\_T1** in the example illustration).
- Step 5. Run your Robot Program to test that the popup appears as the cobot reaches waypoint W4.

### 8.5.8 Advanced: Setup of odd orientation of the robot part

If the *robot part* is installed in an odd orientation (not directly onto the cobots *tool flange* or positioned without use of the 6 mm positioning pin, you will need to do a minor adjustment in the WINGMAN URcap software to compensate.

- Step 1. Navigate to *Robot Program > AAA – Tools > Tool: T1 > Config > Tool Holder Pos.(W2)* and change the settings in the RX, RY, RZ fields (default 0 degrees) to match the orientation of the *robot part* on the cobot.



Copyright © 2020 by TripleA robotics ApS. All rights reserved.



INFO / TIP

**TIP!** If you have installed the *robot part* on a Y-mount that adds weight to the cobot arm, it might be necessary to change the *Payload* and *COG* settings for the Tool Changer in the settings below the orientation settings. The *Payload* and *COG* settings in this view will apply after the Robot Program has executed a **AAA – Put T1** node hence where there is no *end-effector* on the cobot.

Step 2. Now press the **>Teach Holder Position<** button and teach in waypoint **W2** to use the new orientation settings you have typed in in step 1.

Step 3. Repeat step 1 and step 2 for all your *end-effectors* for which the odd *robot part* orientation is relevant.



INFO / TIP

**TIP!** In case you have installed two *robot parts* on the cobot, e.g. on a Y-mount, you can setup both *robot parts* to use the same *end-effector* by creating one tool in the **AAA – Tools** node for each *robot part + end-effector* combination.

### 8.5.9 Advanced: Sharing end-effectors between more Robot Programs and cobots

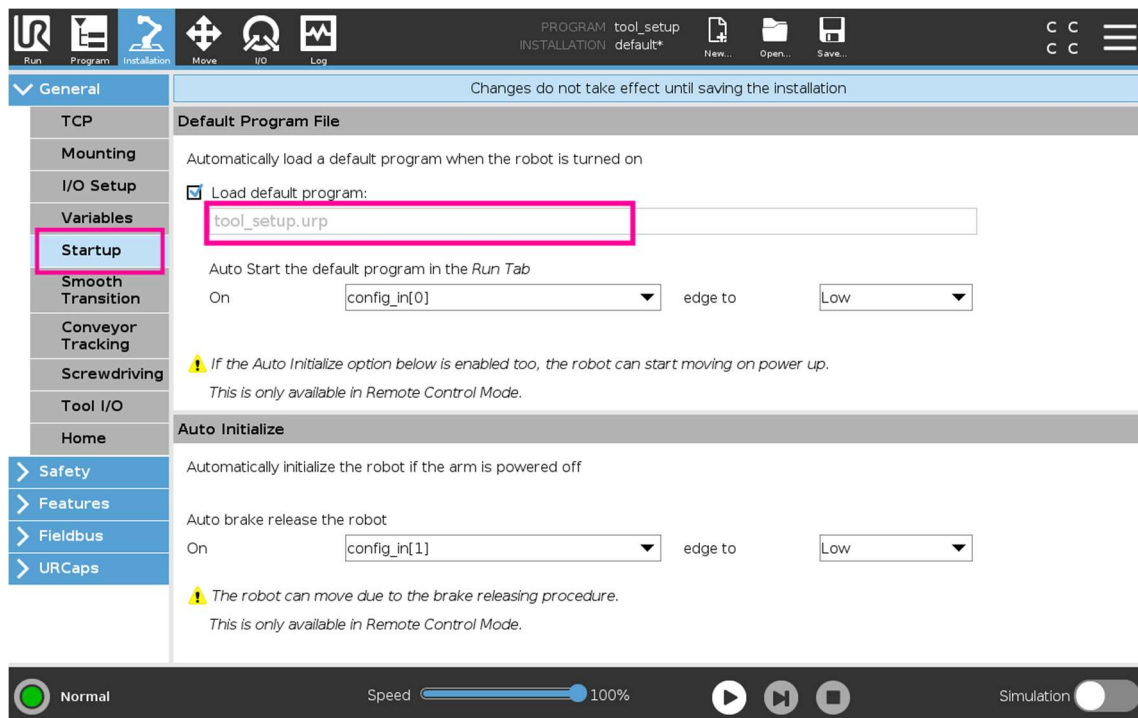
You can share *end-effector* setups between more Robot Programs and cobots by maintaining a Robot Program template that holds all your *end-effectors* setups in a **AAA – Tools** node acting as a database that you can copy between Robot Programs and cobots. This will be a good idea if you have several *end-effectors* that you deploy in several applications.

### 8.5.10 Advanced: Remote activated automatic tool change

In advanced applications, it might be necessary to activate automatic tool change remotely by calling a tool change sequence via a connection from external hardware/software to the robot controller - Usually through a modbus connection. This type of remote control will work directly with the URcap from TripleA robotics after the robot program, that includes the “AAA Tools” node, has been loaded. The robot program needs to load as this will startup a server software (daemon) that takes care of communication with the URcap from TripleA robotics.

If remote control must work right after restart of the robot controller and without manually loading the robot program, the robot program can be loaded automatically upon robot controller start-up with help of the following setup.

Navigate to *Installation > Startup* and set up so your robot program is loaded upon startup.



## 8.6 Programming tool change on other cobots



INFO / TIP

**TIP!** There is valuable information and inspiration to be found for robot programming in chapter [8.5 Programming tool change on Universal Robots cobots](#) even though you are not using a cobot from Universal Robots.



ATTENTION!

**ATTENTION!** The required *robot limits* explained in chapter [9 Safety](#) must be setup not only for safety reasons but also to limit the cobot's strength to prevent damage to the levers in the tool changer.



DANGER!

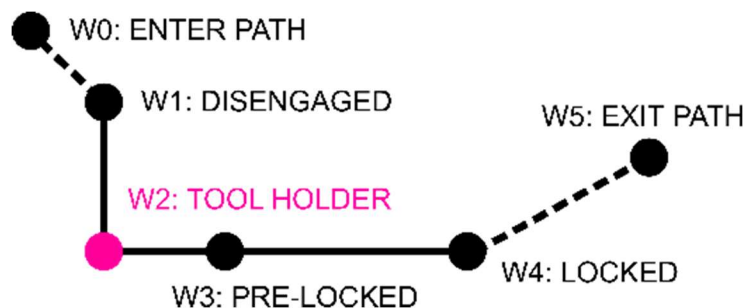
**WARNING!** You must read, understand and fully comply with all the requirements in chapter [9 Safety](#) before commencing cobot motion. Failing in doing so can cause serious injury and even death.

**WARNING!** Programming automatic tool change must always be conducted as per instructed in chapter [8.4 Good practice for setting up tool changes](#).

**WARNING!** To reduce risk of hardware damage and human injury, always test tool changes thoroughly at low cobot speed and in a controlled and safe test environment before deploying in production.

**WARNING!** Programming the cobot movement without the *pass-through modules* installed is important to prevent unintended movement of *end-effectors* which can pose a risk to human health and to prevent hardware damage.

**WARNING!** Energy (electricity, vacuum, air pressure) to a pass-through module must be turned off and any residual electricity, air pressure, vacuum etc. in the system must be eliminated before tool change takes place. Failing in doing so will result in hardware damage and can result in injury.



The WINGMAN Tool Changer System can be deployed in combination with all cobots that comply with the safety requirements found in chapter [9 Safety](#) and which are able to move in two axis or more.

- Step 1. Install the *tool part + end-effector* assemblies in the *tool part holders* you will be deploying.
- Step 2. Program waypoint **W2**. For details about waypoints and cobot movement please visit chapter [8.1 Important about waypoints](#).
- Step 3. Program waypoint W1 which is a straight movement aligned with the *robot part* Z-axis relative to waypoint **W2**.
- Step 4. Program waypoint W4 which is a straight movement radial to the *robot part* Z-axis relative to waypoint **W2**.
- Step 5. Investigate how your *cobot* automatically can toggle between parameters for the deployed *end-effectors* and incorporate this toggle in Waypoint W4.

## 9 Safety

### 9.1 Limitation of liability:

All information provided in this user guide may not be perceived as a warranty by TripleA Robotics ApS that this industrial part-machine cannot cause personal injury or property damage, even if all safety instructions and parameters are complied with.

### 9.2 Responsibility of the System Integrator

The WINGMAN Tool Changer System is categorized as a *partly completed machine* according to the *Machine Directive 2006/42/EC* and it is therefore the responsibility of the *system integrator*, who installs and deploys the WINGMAN Tool Changer System, to ensure that:

- installation guidelines and other instructions in this user guide are followed in full and
- a risk assessment is completed and documented for the full robot application and
- test that the tool change process performs with high level of reliability.
- that the full robot application is safety approved before deployment.
- that users have received the proper training to operate the application safely.

Among other, the *system integrator's* risk assessment must include *end-effector* and *cobot* movement to and from the *tool space* (see chapter [9.5 The Tool Space](#)) and inside the *tool space* while tool change is executed between waypoint W1 and W4 (see chapter [8.1 Important about waypoints](#)). And the *System Integrator* must:

- deploy and maintain the *Pre-deployment Checklist* provided in chapter [9.8.1 Pre-deployment checklist and residual risks](#) and
- deploy and maintain the *Startup Checklist* provided in chapter [9.8.2 Startup checklist](#).



**WARNING!** The System Integrators failure to complying with his responsibilities can result in hardware damage, serious injury and even death.

### 9.3 Responsibility of the user

The user must:

- follow the instructions provided in this user guide and
- follow the instructions provided by the *system integrator* and
- never put limbs inside the *tool space* while the robot application is active and
- deploy and maintain the *Startup Checklist* provided in chapter [9.8.2 Startup checklist](#) and
- deploy and maintain the *Interval Checklist* provided in chapter [9.8.3 Interval checklist](#).



**WARNING!** Failing in complying with above requirements can result in hardware damage, serious injury and even death.

## 9.4 Main hazards

The main hazards related to automatic tool changes deployed using the WINGMAN Tool Changer System are:

1. A user receiving *quasi-static contact* as the cobot moves the *robot part* towards the *tool part holder*.



**DANGER!**

2. A user receiving *quasi-static contact* as the cobot moves the end-effector towards the *tool part holder*.



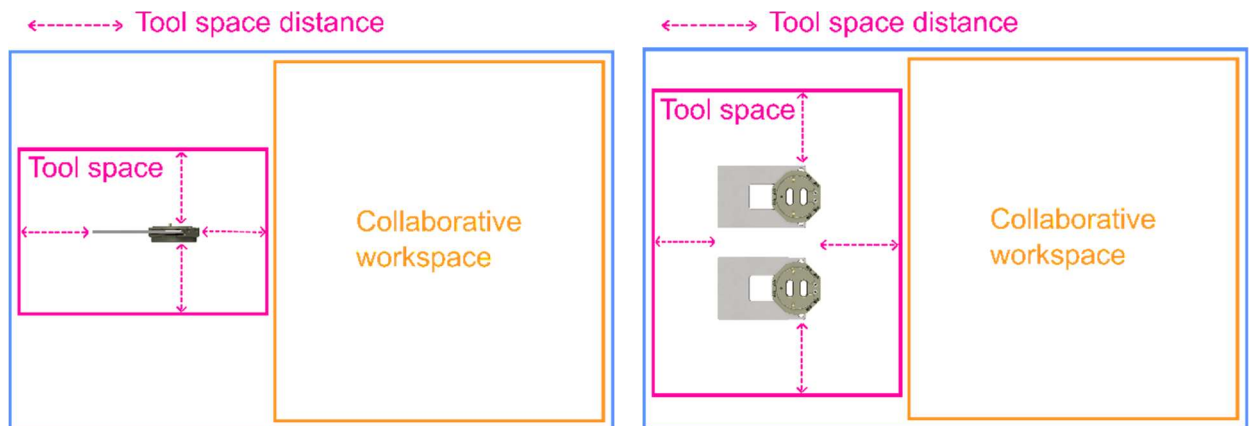
**DANGER!**

The above two main hazard can be reduced by complying with the content of chapter [9 Safety](#) and warnings in this user guide.

## 9.5 The tool space

The *tool space* is defined by a distance of 50 mm to any part of a *tool part holder* and *tool part* installed in a *tool part holder*. The *tool space* is **NOT** part of the *collaborative workspace* where the cobot intentionally interacts with humans in a shared space. However, a set of *robot limits*, ensuring *collaborative safety*, apply inside the *tool space*. Even though *robot limits* apply in the *tool space*, the user is **NOT** allowed to access the *tool space* as the *robot application* runs.

Instructions for a suitable *tool space* placement are provided in chapter [6.6 Installing the tool part holder](#).



The settings provided in chapter [9.7 Load limiting and collaborative safety settings](#) apply for the *tool space* while another set of collaborative safety setting can be required for the *collaborative workspace* which is determined by the *system integrator's* risk assessment.



**ATTENTION!** High tool change speeds will increase wear and increase risk hardware damage in case that tool change is prevented.



**WARNING!** Users and spectators have no reason and are not allowed to put limbs into the *tool space* whilst the robot application is running. Doing so may result in injury.

**WARNING!** It is the *system integrators* risk assessment that determines how the cobot can move safely to and from the *tool space* and inside the *tool space* among other at what speed the cobot is allowed to move to ensure users time to move limbs free from moving parts.

## 9.6 Cobot requirements

If the WINGMAN Tool Changer System is deployed in *collaborative operation*, the cobot, that the WINGMAN Tool Changer System is installed onto, must comply with standard EN ISO 10218-1:2012 section 5.10 *collaborative operation requirements*.



INFO / TIP

**TIP for Universal Robots users:** All *cobots* from Universal Robots are certified to standard EN ISO 10218-1:2012 section 5.10 *collaborative operation requirement*.



DANGER!

**WARNING!** Deploying the WINGMAN Tool Changer System in *collaborative operation* on a robot that is not certified for collaborative operation as per EN ISO 10228-1:2012 can result in hardware damage, serious injury and even death.

## 9.7 Load limiting and collaborative safety settings



ATTENTION!

**ATTENTION!** Even if the *tool space* is inaccessible for the user, e.g. behind safety guards, the collaborative safety settings (*robot limits / load limits*) must still be setup accordingly to prevent overload and hardware damage to the levers inside the *tool part*.



DANGER!

**WARNING!** The URcap software provided by TripleA robotics does **NOT** provide the mandatory collaborative safety settings (*robot limits*) for cobot movement inside or outside the *tool space*. Instead these must be setup manually by the *system integrator*.

Required collaborative safety settings e.g. *robot limits* (load limits) and maximum cobot speed must be evaluated and determined in the *System Integrators* risk assessment and the *System Integrator* must ensure these are setup correctly in the cobot's software before deployed the *robot application* into production.

In terms of *quasistatic contact* **NOT** considering any other parts in the *robot application* besides the three tool changer parts being the *robot part*, the *tool part* and the *tool part holder*, a maximum *quasistatic contact* between the three said parts of up to 100N can be permitted within the framework given in standard ISO/TS 15066.

In terms of preventing hardware damage to the levers inside the *tool part*, a maximum allowed force generated on the cobots tool flange of 100N is allowed.

The cobot's maximum allowed speed inside and outside the *tool space* must be part of the *System Integrators* risk assessment to ensure that users and spectators are able to predict the cobot's movement and have time to remove limbs before quasi-static contact can occur on users and spectators limbs.

## 9.8 Checklists, risk reduction and residual risks

This chapter contains three checklists to help understand the *residual risk* and promote collaborative safety whilst installing and using the WINGMAN Tool Changer System in *collaborative operation*. The *residual risk* must be observed and accepted in the *system integrator's* risk assessment and by the user.

If the *system integrator* or user cannot accept the *residual risk* associated with *collaborative operation*, the WINGMAN Tool Changer System may not be deployed in the robot application in question before the *system integrator* has deployed own initiatives to bring down the *residual risk* to a level that can be accepted by the *system integrator* and the user.

### 9.8.1 Pre-deployment checklist and residual risk

To ensure that the WINGMAN Tool Changer System can be deployed in *collaborative operation*, all risk reducing requirements throughout this user guide must be observed and complied with by the *system integrator* and by the user. In beneath a checklist is provided that summarize the most important risk reducing requirements and explain associated *residual risks*.



**DANGER!**

**WARNING!** The *system integrator* and user must among other observe and comply with the “PRE-DEPLOYMENT CHECKLIST AND RESIDUAL RISKS” before the robot application is deployed.

**WARNING!** All though all safety requirements in this user guide have been complied with, a user can receive *quasi-static contact* which can cause injury.

PRE-DEPLOYMENT CHECKLIST AND RESIDUAL RISKS				
EN ISO 12100:2010 Safety of machinery — General principles for design — Risk assessment and risk reduction	Pre-deployment checklist:			
RESIDUAL RISKS	No.:	Description:	Chapter:	Checked OK:
-	1	<b>Ensure</b> that the <i>system integrator</i> has observed and complied with his responsibilities among other completing a risk assessment for the complete robot application and calculation payload limits etc. to ensure compliance with intended use.	5 6.2 9.2	<input type="checkbox"/>
5.5.2.2 Severity of harm  <b>Evaluated residual risk:</b> Level 2 - Reversible injury.  ISO/TS 15066:2016 Robots and robotic devices — Collaborative robots	2	<b>Ensure</b> that the cobot is certified to EN ISO 10218-1:2012 section 5.10 <i>collaborative operation requirements</i> .	9.6	<input type="checkbox"/>
	3	<b>Ensure</b> that load limiting, and collaborative safety have been risk evaluated, setup correctly and successfully tested.	9.7	<input type="checkbox"/>
	4	<b>Ensure</b> that the <i>tool part holder</i> and the <i>cobot</i> has been installed correctly also considering that the <i>cobot's robot limits</i> must work properly in the <i>cobot posture</i> as it performs tool changes.	6.6	<input type="checkbox"/>
5.5.2.3.1 Exposure of persons to hazards  <b>Evaluated residual risk:</b> Level 1 – Low exposure.	5	<b>Ensure</b> that an end-effector's fall from the <i>tool part holder</i> cannot poses an unacceptable risk to human health or hardware damage.		<input type="checkbox"/>
	6	<b>Ensure</b> that the <i>Tool part holder</i> is located where the user does not have routine tasks in the immediate proximity and where users and spectators are unlikely to put their limbs by accident - Preferable out of reach and never in head height of a standing user or of a user bending down or bending forward over a work table.	6.6	<input type="checkbox"/>
5.5.2.3.2 Occurrence of hazardous events  <b>Evaluated residual risk:</b> Level 1 – Well proven technology.	7	<b>Ensure</b> that users have received the proper training among other: - safe use according to this user guide - how to deploy the Startup Checklist in chapter 10.9.2 Startup checklist - how to deploy the Interval Checklist in chapter 10.9.3 Interval checklist - never to move limbs inside the <i>tool space</i> or in proximity of the <i>tool part holders</i> (by accident, coincidence or by convenience) as the <i>cobot</i> is executing a robot program		<input type="checkbox"/>
	8	<b>Ensure</b> that the tool change process has been tested and performs with high level of reliability.	8.4	<input type="checkbox"/>
	9	<b>Ensure</b> that the users have received instruction in using the <i>Startup Checklist</i> and the <i>Interval Checklist</i> .	9.8.2 9.8.3	<input type="checkbox"/>
5.5.2.3.3 Possibilities of avoiding or limiting harm  <b>Evaluated residual risk:</b> Level 1 - Avoidable	10	<b>Ensure</b> that <i>tool part holders</i> , <i>end-effectors</i> and GET/PUT commands in the Robot Program have been ID tagged correctly or in another way ensured against the <i>cobot</i> picking up incorrect <i>end-effectors</i> .	9.9	<input type="checkbox"/>
	11	<b>Ensure</b> that <i>safety-rated monitored speed</i> in Cartesian space is set to a speed that will allow users and spectators to predict the <i>cobot's</i> movement and time to remove limbs before quasi-static contact can occur on limbs.	9.5 9.6 9.7	<input type="checkbox"/>
	12	<b>Ensure</b> that warning signs have been installed as per instructed in the user guide and per instructed in the risk assessment completed by the <i>system integrator</i> .	9.10	<input type="checkbox"/>

## 9.8.2 Startup checklist

Each time the robot application embodying the WINGMAN Tool Changer System is started up, beneath startup checklist must be completed.

STARTUP CHECKLIST		
No.:	Check description:	Checked OK:
1	Check that new users have received the required trained in operating the WINGMAN Tool Changer System and that existing users have received follow-up training.	<input type="checkbox"/>
2	Check that warning signs are visible and that all <i>tool part holders</i> can be un-installed without use of tools if a person should get caught between a <i>tool part holder</i> and a stopped cobot arm.	<input type="checkbox"/>
3	Complete startup checks required for other components in the robot application such as the cobot.	<input type="checkbox"/>
4	a. Take down all <i>end-effectors</i> from their designated <i>tool part holders</i> . b. Inspect each <i>end-effector</i> to see if there are any obvious errors. c. Put all <i>end-effectors</i> back in their designated <i>tool part holder</i> using the ID tag system to identify what <i>end-effector</i> must be placed in what <i>tool part holder</i> .	<input type="checkbox"/>
5	Start the robot application and complete a few cycles at very low speed to ensure, that all tool changes complete as planned and the robot application executes correctly and runs reliable.	<input type="checkbox"/>



**WARNING!** Failing in completing the startup checklist can result in an *end-effector* being placed in a wrong *tool part holder* causing the cobot to collect a wrong *end-effector* which can cause hardware damage, serious injury and even death.

## 9.8.3 Interval checklist

All parts of the WINGMAN Tool Changer System and user training must be submitted to a routine check at intervals.

INTERVAL CHECKLIST				
No.:	Interval:	Check description:	Check criteria:	Checked OK:
1	For each 10.000 cycles or when needed.	a. Cleaning as per instructed in chapter <a href="#">10.1.2 Cleaning</a> . b. Lubing tool changer parts and rubber parts on all rubber parts, such as O-rings and gaskets, of the pass-through modules as per instructed in chapter <a href="#">10.1.3 Lubing the tool changer</a>	Clean tool changer parts that convey smooth tool changes.	<input type="checkbox"/>
2	For each 50.000 cycles or  one time annually or  when deployment in a new application  - Whatever comes first.	Check that no structural damage has occurred to any parts of the WINGMAN Tool Changer System such as. a. Check that no micro cracks have formed on the <i>robot parts</i> locking parts. b. Check that no micro cracks have formed on the <i>tool parts</i> locking parts. c. Check that the <i>tool part holders</i> is secured in place.	If structural damage is found on a part, this part must be scrapped.	<input type="checkbox"/>
3		a. Check that the required warning signs as per instructed in chapter <a href="#">9.10 Warning signs</a> are in place and are visible for users.	Warning signs are correctly in place.	<input type="checkbox"/>



**WARNING!** Failing in completing the Interval Checklist can result in hardware failing while in operation resulting in consequential hardware damage and human injury and even death.

---

## 9.9 ID tag system

It is important to prevent a scenario where the cobot collects an incorrect *end-effector* which can happen, if the user has placed an *end-effector* in a wrong *tool part holder*. To prevent this scenario, it must be possible for the user to determine what *end-effectors* goes with what *tool part holder* with use of a simple ID tag system.

The *System Integrator* must deploy an ID tagging system, e.g. stickers with matching numbers, to allow users to match *end-effectors* and *tool part holders* together in order

---

## 9.10 Warning signs

The *system integrator* must ensure that warning signs are visible for users and spectators. The warning signs must warn users and spectators that the *tool space* area poses a pinch points hazard (quasi-static contact) and that users and spectators are not allowed to put their limbs into the *tool space* area. The warning sign used should be beneath or equivalent (not provided by TripleA robotics).



---

## 10 Repair and maintenance

---

### 10.1 Life span and maintenance

The WINGMAN Tool Changer System requires maintenance to an extent determined by the conditions of use and the surrounding environment.

The life span of the WINGMAN Tool Changer System is determined by a combination of the:

- external environment (clean or dirty)
- tool change parameters (e.g. couple load, waypoint accuracy, Installed Center of Gravity (ICoG), cobot speed)
- maintenance (cleaning and lubing intervals)



**WARNING!** Deploying the WINGMAN Tool Changer System in a dirty environment is only allowed if tool change is reliable and stable and does not require frequent intervention by the user. Unstable tool change can tempt users to intervene in tool change while the cobot moves which can cause injury.

---

#### 10.1.1 Wear

Wear will be visible over time, as the tool changer is being used. Typical normal and expected wear is the grey surface treatment wearing off in the areas where tool changer parts are engaging/disengaging with each other. Wear will result in small deposits of very fine oxides and polymers that can easily be removed with compressed air and cloth.

The WINGMAN Tool Changer System takes a significant number of tool change cycles to wear in. As this process takes place, tool changes can in some cases be a little rough running and produce more oxides and polymers deposits then will be the case after the wearing in process has completed.

When a tool changer part is worn to the extent where the aluminum beneath the surface treatment is exposed over large areas, the tool changer part is worn out and must be replaced. Such wear and tear is normal and expected and is not covered by warranty even though a tool changer part wears out within the warranty period.

As the WINGMAN is a mechanical device, all tool changer parts are considered as wear part and all can be replaced over time.

---

#### 10.1.2 Cleaning

Cleaning will be necessary with intervals that depends on the conditions of use.

Cleaning is done using compressed air and cloth and a cleaning spray suitable for alloys and polymers can be used. Normally, cleaning of the *tool parts* internal mechanical parts will only be necessary rarely if at all and is done by disassembling the *tool part* and cleaning and lubing the insides.

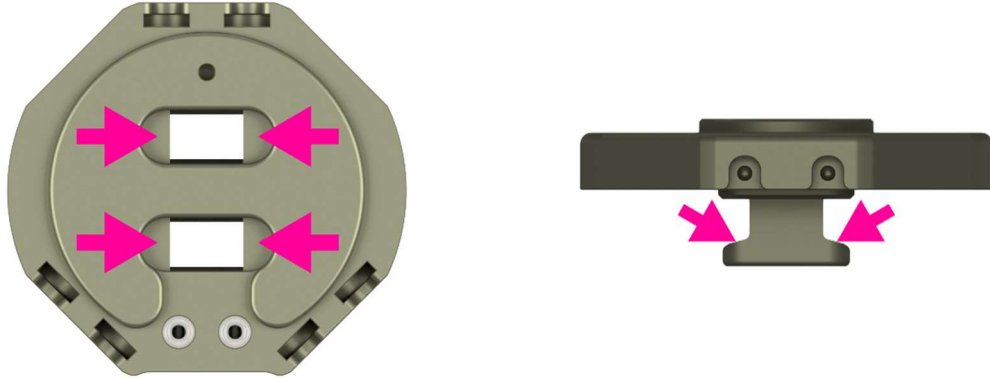
Cleaning electrical connectors must be done with isopropyl alcohol and a cotton swab.



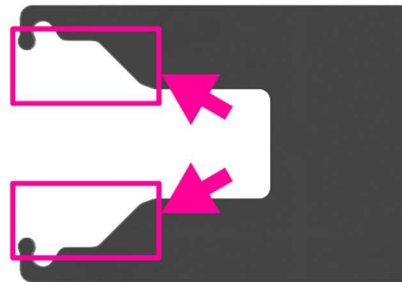
**ATTENTION!** Disassembling the *tool part* for cleaning will depreciate the warranty on your product.

### 10.1.3 Lubing the tool changer

The *tool part* comes pre-lubricated and will not need lubrication until a cleaning process is performed. After cleaning, the beneath places should be re-lubricated with a **silicone-based grease** suitable for metal alloys and polymers applied in a thin layer



The *tool part holder* does not come pre-lubricated. Lubrication of the *tool part holder* is optional but will be necessary to achieve long life span and smooth tool change. For end-effector that result in a *rated couple payload* > 1 kg and a *rated couple torque* > 0 Nm lubrication is mandatory. After cleaning, the beneath places should be re-lubricated with a **silicone-based grease** suitable for metal alloys and polymers applied in a VERY thin layer.



### 10.1.4 Lubing the pass-through modules

Occasionally, a little silicone-based grease must be applied on all rubber parts, such as O-rings and gaskets, on pass-through modules to ensure long lift span and prevent leaks.

## 10.2 Damage and repair

Mainly the levers are exposed to wear and possible damage if the tool changer is used incorrectly or in high stress tool change cycles (high speed, high tool change load, high ICoG).

The *tool part* can be disassembled, repaired, and reassembled in case of damage to the levers, springs or bearings inside.

Follow beneath guide to disassemble and reassemble the *tool part*.

DISASSEMBLY AND ASSEMBLY OF TOOL PART		
Step no.:	Description:	Pictures:
1	Move the levers to locked position.	(PICTURE)
2	Uninstall the four bolts using a t25 torx tool.	(PICTURE)
3	Carefully move the two housings apart while you hold the levers to the top part.	(PICTURE)
4	Remove the two visible bearings from the pins.	(PICTURE)
5	Remove the pins from each lever.	(PICTURE)
6	Carefully remove the lock assembly from the housing with attention to not loosing the two bearings installed on the pins on the other side.	(PICTURE)
7	Remove the two remaining bearings from the lock assembly.	(PICTURE)
8	Remove the two long springs from the lock assembly.	(PICTURE)
9	Carefully remove the pins from each side of the lock assembly. Be aware that the assembly is spring loaded, so you will need to hold down on the lock spring support as you remove the pin.	(PICTURE)
10	Remove the lock spring support and the short springs from the lock.	(PICTURE)
11	Clean all parts and replace if needed.	(PICTURE)
12	Reassemble is completed in reversed order.	(PICTURE)
13	Tighten the t25 torx screws with 5 Nm.	(PICTURE)

# 11 Troubleshooting

TROUBLESHOOT		
ID:	Symptom:	Cause and remedy:
<b>1. WHILE AUTOMATIC TOOL CHANGE OCCURS</b>		
1.1	The Tool Changer parts makes a “clonking” noise when engaging and/or disengaging.	<p>A “clonking” noise is often associated with the <i>tool part tilting</i> as it moves in and/or out of the <i>tool part holder</i>. A little <i>tilting</i> (3-5 degrees), is normal if the ICoG is not ideally centered. However, <i>tilting</i> should not be accompanied by a “clonking” noise and should always be minimized as this will increase wear. <i>Tilting</i> is usually caused by a combination of the ICoG not being ideal centered and the cobot being receptive for “repelling forces” allowing <i>tilting</i>.</p> <p><b>a. Adjustment and alignment:</b></p> <ul style="list-style-type: none"> <li>- Check that the structure onto which the <i>tool part holders</i> is stable and not moving as tool change takes place and that the <i>tool part holders</i> are firmly fastened.</li> <li>- Check that the Tool Part Holder is firmly fastened.</li> <li>- Check and maybe readjust the Tool Holder Position (W2) for better alignment. See chapter <a href="#">8.1 Important about waypoints</a>.</li> </ul> <p><b>b. Cleaning:</b></p> <ul style="list-style-type: none"> <li>- Check if the tool changer parts needs cleaning and clean as per instructed in chapter <a href="#">10.1.2 Cleaning</a>.</li> </ul> <p><b>c. Lubing:</b></p> <ul style="list-style-type: none"> <li>- Reduce friction between the <i>tool part holder</i> and the <i>tool part</i> and inside the <i>tool part</i> with use of lubrication. See chapter <a href="#">10.1.3 Lubing</a>.</li> </ul> <p><b>d. Coupling payload and Installed Center of Gravity:</b></p> <ul style="list-style-type: none"> <li>- Check if the ICoG is exceeding the limit of 1 Nm and adjust accordingly by following the instruction in chapter <a href="#">6.6 Installing the tool part holder</a>.</li> <li>- Check if the coupling payload is exceeding the <i>rated couple payload</i> of 5 kg and reduce the coupled payload if necessary. See chapter <a href="#">6.6 Installing the tool part holder</a>.</li> </ul> <p><b>e. Speed:</b></p> <ul style="list-style-type: none"> <li>- Reduce the tool change speed and see if the “clonking” noise is reduced or disappears.</li> </ul> <p><b>f. Payload:</b></p> <ul style="list-style-type: none"> <li>- Check that you have set the correct payload in you Robot Program. If the payload is set incorrect, the cobot can be more receptive for “repelling forces” which occurs when <i>tilting</i> occurs, and this can cause the cobot to give in for <i>tilting</i>. You can even try to set incorrect and exaggerated payload to see if it changes the level of <i>tilting</i>. See chapter <a href="#">8.5.4 Basic setup of end-effector parameters</a>.</li> </ul> <p><b>g. Cobot posture:</b></p> <ul style="list-style-type: none"> <li>- If your cobot reaches far out to collect the <i>end-effector</i>, your cobot arm might be less sturdy in this position and more receptive for <i>repelling forces</i>. In that case you will have to move the <i>tool part holder</i> to a position where the cobot arm is sturdier.</li> </ul> <p><b>h. Robot limits:</b></p> <ul style="list-style-type: none"> <li>- For a test, try to set the <i>robot limits</i> to a high level and observe if this has an impact of the cobot being compliant and allowing <i>tilting</i> (NEVER deploy the application with <i>robot limit</i> values outside values given by the <i>Integrator</i>).</li> </ul>
1.2	The tool changer has a difficult time exiting the <i>tool part holder</i> from waypoint W2 to W4.	<p>The force needed for the tool changer to exit the <i>tool part holder</i> can be reduced by addressing the following:</p> <ul style="list-style-type: none"> <li>a. Reduce <i>tilting</i>. See ID 1.1</li> <li>b. Reduce the couple distance - Distance between the <i>robot part</i> and the <i>tool part</i> in engagement in waypoint W2. See chapter <a href="#">8.1 Important about waypoints</a>.</li> <li>c. If possible, reduce the payload.</li> </ul>
1.3	The tool changer is building up a deposit of fine white dust between the engaging parts.	<p>The fine dust is aluminum oxide and polymers and comes from the surface treatment and bearing material inside the tool changer. It is common that the tool changer parts produce a bit of such dust as the parts wear-in and are used in general. It can be minimized by:</p> <ul style="list-style-type: none"> <li>a. Fine tuning the <i>Tool Holder Position (W2)</i>.</li> <li>b. Lubrication. See chapter <a href="#">10.1.3 Lubing</a>.</li> <li>b. By addressing <i>tilting</i> and noise. See ID 1.1.</li> </ul>

2. SOFTWARE RELATED ISSUES (ONLY UNIVERSAL ROBOTS)		
2.1	The URcap software from TripleA robotics return an error.	<p>The URcap software is thoroughly tested by TripleA robotics and should run error free.</p> <p>a. Check that the URsoftware (PolyScope) is a compatible version and update if necessary. See chapter <a href="#">8.5.1 Preparation</a>.</p> <p>b. Report the error to TripleA robotics on this email: <a href="mailto:info@TripleA-robotics.com">info@TripleA-robotics.com</a>            Include the following information:</p> <ul style="list-style-type: none"> <li>- TripleA robotics URcap software version.</li> <li>- URsoftware (PolyScope) version.</li> <li>- Picture of the expanded error message.</li> <li>- Picture with the list of other URcaps installed.</li> <li>- Description of the actions that triggered the error to happen.</li> </ul>
2.2	The cobot goes into protective stop in waypoint W2.	<p>The cobot is most likely trying to move in a direction from waypoint W2 that is blocked.</p> <p>a. Make sure that the <i>tool changer robot part</i> and <i>tool part</i> are fully engaged in waypoint W2. See chapter <a href="#">8.1 Important about waypoint</a>.</p> <p>b. Check if the <i>robot part</i> orientation on the cobot is odd (not using the 6 mm positioning pin or not directly on the cobots tool flange). If installed in an odd orientation see solution in chapter <a href="#">8.5.8 Odd orientation of the robot part on the cobot's tool flange</a>.</p> <p>d. Remove the <i>tool part</i> from the <i>tool part holder</i>. Run the Robot Program at very low speed and observe what happens.</p> <p>e. Try install the empty <i>tool changer tool part</i> (without the end-effector attached) in the <i>tool part holder</i> and test the tool change.            If the tool change is completed correctly, either:</p> <ul style="list-style-type: none"> <li>- the end-effector is too heavy or</li> <li>- the ICoG is unfavorable. See chapter <a href="#">6.6 Installing the tool part holder</a>.</li> </ul> <p>If the tool change is not completed correctly, either:</p> <ul style="list-style-type: none"> <li>- the <i>robot part</i> is damaged (see ID 3.1) or</li> <li>- the <i>tool part</i> is damaged (see ID 3.2 and 3.3) or</li> <li>- the <i>tool part holder</i> is damaged.</li> </ul>
2.3	The UR cobot moves differently than expected.	<p>This is most likely caused by either:</p> <p>a. Odd orientation of the <i>robot part</i> on the cobot's tool flange. See chapter <a href="#">8.5.8 Odd orientation of the robot part on the cobot's tool flange</a>.</p> <p>b. Some third-party URcaps for <i>end-effectors</i> runs threads in the background and manipulates the active TCP which can interfere with tool change movement. To find out, uninstall third-party UR caps one by on and test.</p>
2.4	The cobot gives a clunking sound in waypoint W1 and/or W4/W5. Or the cobot goes into protective stop at W1 and/or W4/W5	<p>This can happen if the blending radius is used incorrectly and might even result in a protective stop if the payload is high.</p> <p>a. Find the waypint at which the cobot gives a clunking sound or stops in the robot program. Try and toggle the adjustment for this waypint in regards to blending with a radius and observe if this changes the cobots behavior.</p>
2.5	TCP behaving odd or resets back to default.	<p>This can happen if you have used the TCP settings in the URcap and you are starting your Robot Program without first collecting the tool (AAA-GET TOOL). When you start your Robot Program, the TCP settings are set to the selected in the INSTALLATION&gt;TCP tap. For this reason we generally recommend not the use the TCP settings in the URcap software, but instead the settings in the PolyScope.</p> <p>a. Reset the TCP settings back to zero for the tool in the URcap. Create a new tool in the INSTALLATION&gt;TCP tap and set up its TCP settings. In your Robot Program, select this tool from the drop down menu found in the MoveI/MoveJ/MoveP nodes for which it is relevant. <a href="#">8.5.4 Basic setup of end-effector parameters</a></p>
2.6	Voltage to the tool turns off when you run the program.	<p>The tool voltage is set to your settings for the particular tool when you call the relevant <b>AAA-GET TOOL</b> node. If you run your Robot Program without first calling the relevant <b>AAA-GET TOOL</b> node, the tool voltage is set to the default found in the INSTALLATION&gt;TOOL I/O tab.</p> <p>a. Check that you have set the voltage correctly in the Robot Program &gt; AAA – Tools &gt; Tool: T1 &gt; Config &gt; Tool I/O node.</p> <p>b. Detach the tool from the robot and move it to the tool part holder. Run the relevant <b>AAA-GET TOOL</b> node first and then your robot program for this particular tool to see if voltage is still turning off. If it does, the problem is not the URcap settings.</p>

		<p>c. If you don't want to run the relevant <b>AAA-GET TOOL</b> node each time you test a part of your Robot Program, you can turn on the power for the tool permanently (until you run a <b>AAA-GET TOOL</b> or <b>AAA-PUT TOOL</b> node) in the INSTALLATION&gt;TOOL I/O tab. Be careful not to leave the default voltage setting higher than 0V as this can cause damage to hardware if other hardware is attached.</p>
2.7	Your electrical end-effector does not work for normal use after installing and using the TripleA robotics URcap.	<p>If you have installed and used the TripleA robotics URcap, a scenario can occur where you cannot get your electrical end-effector to work for ordinary use without using the TripleA robotics URcap. This can happen if the last thing you did was to run a <b>AAA-PUT TOOL</b> note which turns off the power to the end-effector or an <b>AAA-GET TOOL</b> note which you have setup to 0V.</p> <p>a. To turn the power back on to your end-effector for manual use:</p> <ul style="list-style-type: none"> <li>- Install &gt; Tool I/O &gt; Controlled by: Se to "User".</li> <li>- Install &gt; Tool I/O &gt; Tool Output Voltage: Set to "0V".</li> <li>- Install &gt; Tool I/O &gt; Tool Output Voltage: Set back to "24V".</li> <li>- Install &gt; Tool I/O &gt; Controlled by: Se to "Robotiq_Grippers".</li> </ul> <p>(tested on UR Polyscope 5.10.2)</p>
2.7	Your electrical end-effector does not work for automatic tool change.	<p>"Smart" end-effectors that depend on designated URcap software or a separated control box to work will not always be able to your for automatic tool change. However, the cause can also be another reason:</p> <p>a. Make sure, you have set up the TripleA robotics URcap to provide your end-effector with the correct voltage after it is being picked up. See chapter <a href="#">8.3.1 The end-effector's automatic tool change capability</a>.</p> <p>b. Test your end-effector if it at all will be able to do automatic tool change as per described in chapter <a href="#">8.3 Important about end-effector selection and parameters</a>.</p>

3. TOOL CHANGER HARDWARE DAMAGE		
3.1	One or both <i>rotors</i> in the <i>tool part</i> has broken.	<p>This can happen if the cobot applies too much force when retracting a <i>tool part</i> from the <i>tool part holder</i> or is forced into a non-conforming position by repelling forces.</p> <p><u>Instruction if the Tool Part and Robot Part are stuck together:</u>            To remove a tool part with a broken lever from the robot, the locking mechanism can be manipulated using a small flat screwdriver from the outside. If this is not possible, the <i>tool part</i> can be removed by disassembling it as per chapter <a href="#">10.2 Damage and repair</a>.</p> <p><u>How to prevent:</u></p> <ol style="list-style-type: none"> <li>Ensure that the Tool Part Holders have been installed as per chapter <a href="#">6.6 Installing the tool part holder</a>. It is of special importance that the Tool Part Holders are installed on a ridge structure that does not move relative to the cobot as tool change takes place.</li> <li>Ensure that the cobot's <i>robot limits</i> have been configured and tested as per instructed in chapter: <a href="#">9.7 Load limiting and collaborative safety settings</a></li> <li>Ensure smooth tool change ID 1.1.</li> </ol> <p><u>How to repair:</u></p> <ol style="list-style-type: none"> <li>See chapter <a href="#">10.2 Damage and repair</a>.</li> </ol>
3.2	Structural damage, such as cracks and deformation, to tool changer locking parts.	<p>This can happen if the tool changer locking parts are submitted to momentary forces that exceeds the <i>force limits</i> provided in the <a href="#">Data sheet – TOOL CHANGER</a>.</p> <p><u>How to prevent:</u></p> <ol style="list-style-type: none"> <li>Calculate and check the <i>maximum allowed payload</i> using the equation in the tool changer datasheet <a href="#">Data sheet – TOOL CHANGER</a>.</li> <li>Ensure that the <i>maximum allowed payload</i> and that the dynamic forces used for the calculation is not exceeded.</li> </ol> <p><u>How to repair:</u>            No repair is possible. Damaged parts must be scrapped!</p>
3.3	The levers do not move freely in one or both sides.	<p>This can be caused by dirt inside the <i>tool part</i> or hardware damage.</p> <ol style="list-style-type: none"> <li>Clean the internal parts of the <i>tool part</i> see chapter <a href="#">10.1.2 Cleaning</a>.</li> <li>The <i>tool part</i> is damaged because you have attempted to install a bolt that is too long. The <i>tool part</i> must be replaced.</li> </ol>
4. ELECTRICAL PASS-THROUGH CONNECTOR DAMAGED		
4.1	The electrical pass-through connectors are no longer passing through electricity.	<p>Observe if the connecting surfaces are dirty</p> <ol style="list-style-type: none"> <li>Observe if the connecting surfaces are dirty and clean if necessary. See chapter <a href="#">10.1.2 Cleaning</a>.</li> <li>If you find one or more connecting surfaces burned (dark/black and rough surface), the pass-through connector is damaged beyond repair. Burned connectors are usually caused by tool changes taking place while there is still flowing current through the connector. A connector's lifespan will be limited to a few hundred tool changer cycles if current is flowing while tool changes is completed. Voltage must ALWAYS be 0V as tool change is completed and turned on after the electrical connection has been made.</li> </ol>

---

## 12 Warranty and liability

---

### 12.1 Patents

Products of TripleA robotics ApS are protected by several patents: some still in global publication process (Patents pending). All manufacturers of copies and similar products violating any patent claims will be prosecuted.

---

### 12.2 Product warranty

Without prejudice to any claim the user may have in relation to the dealer or retailer, the user shall be granted a manufacturer's warranty under the conditions set out below. For any warranty issue as well as general product support, the user (end-customer) must contact the dealer or retailer from where the user purchased the product.

In the case of new devices and their components exhibiting defects resulting from manufacturing and/or material faults within 12 months of entry into service (maximum of 15 months from shipment from TripleA robotics ApS), TripleA robotics ApS shall provide the necessary spare parts, while the dealer or user shall provide working hours to replace the spare parts, either replace the part with another part reflecting the current state of the art, or repair the said part. This warranty shall be invalid if the defect is caused by improper treatment and/or failure to comply with information contained in the user guides. This warranty shall not apply to or extend to services performed by the authorized dealer or the customer themselves (e.g. installation, configuration, software downloads). Claims under the warranty must be submitted without delay and latest two months after the warranty default becoming evident. The purchase receipt, together with the date of purchase, shall be required as evidence for invoking the warranty. Ownership of devices or components replaced by TripleA robotics ApS shall vest in TripleA robotics ApS and shall be returned to TripleA robotics ApS. Any other claims resulting out of or in connection with the device shall be excluded from this warranty. The duration of the warranty shall not be extended by services rendered under the terms of the warranty. Insofar as no warranty default exists, TripleA robotics ApS reserves the right to charge the dealer/user for replacement or repair. In case of a device exhibiting defects, TripleA robotics ApS shall not be liable for any indirect, incidental, special or consequential damages, including but not limited to, lost profits, loss of use, loss of production or damage to other production equipment. In case of a device exhibiting defects, TripleA robotics ApS shall not cover any consequential damage or loss, such as loss of production or damage to other production equipment.

---

### 12.3 Disclaimer

TripleA robotics ApS continues to improve reliability and performance of its products, and therefore reserves the right to upgrade the product without prior warning. TripleA robotics ApS ensures that the content of this user guide is precise and correct but takes no responsibility for any errors or missing information.

## EC - declaration of incorporation

According to European Machinery Directive 2006/42/EC annex II 1.B., the manufacturer

TripleA robotics ApS  
Forskerparken 10  
5000 Odense C  
DENMARK

hereby declares that the product

Type	:	Cobot Tool Changer System
Model	:	WINGMAN
Serial number	:	0 – 99999999

may not be put into service before the machinery in which it will be incorporated is declared in conformity with the provisions of Directive 2006/42/EC, including amendments, and with the regulations transposing it into national law.

The product is prepared for compliance with all essential requirements of Directive 2006/42/EC under the correct incorporation conditions, see instructions and guidance in this user guide.

Compliance with all essential requirements of Directive 2006/42/EC relies on the specific robot installation and the final risk assessment.

Technical documentation is compiled according to Directive 2006/42/EC annex VII part B and available in electronic form to national authorities upon legitimate request. Undersigned is based on the manufacturer address and authorized to compile this documentation.

Additionally, the product declares in conformity with the following directives, according to which the product is CE marked:

2014/68/EU — Pressure Equipment Directive (PED)

Odense, June 30th, 2020



Christian Lyhr Jensen  
CEO

---

## Datasheets

# WINGMAN

## THE COBOT TOOL CHANGER SYSTEM













PLUG AND PLAY  
AUTOMATIC & MANUAL TOOL CHANGE  
FOR COBOTS

**DATASHEETS**

Version 1.11

## SPECIFICATIONS

-  **AUTOMATIC & MANUAL** change in one device
-  Integrates with **most** cobots and tools
-  Rated payload **33 kg / 73 lbs**
-  Weight on cobot **260 g / 0.57 lbs**
-  Combined height **30 mm / 0.18 in**
-  Repeatability **+/-0,03 mm / +/-0.0012 in**
-  Automatic tool change setup in **1 minutes**
-  Pass-through **adaptability**
-  All highly  **durable** metal alloys
-  Cobot safe (**ISO/TS 15066**)



### PLUG AND PLAY

Installed in few minutes out-of-the-box.  
Automatic tool change setup in 1 minute.



### ONE FITS ALL

Automatic and manual tool change in one.  
Standard ISO flange – Strong and light.



### COBOT SAFE

Designed & tested for ISO/TS 15066  
compliance and with redundant safety lock.

## THE TOOL CHANGER

The WINGMAN is suitable for use on cobots of all sizes and will fit in applications with only little space.

Combined height	30 mm / 0.18 in
Combined weight	260 g / 0.57 lbs
Rated payload	33 kg / 73 lbs
Repeatability	+/-0,03 mm / 0.0012 in

## THE TOOL HOLDER

The holder provides a standard solution to store end-effectors and the holder is part of the automatic tool change mechanism.

Holder's maximum payload	5 kg / 11 lbs
Maximum tool imbalance	1 Nm
Material	Stainless steel



## THE HIGH FLOW PASS-THROUGH MODULES

The modules click on the WINGMAN's housing without use of tools. The WINGMAN can hold three sets of modules.

Maximum pressure	10 bar
Push-in fittings	2 x Ø6 mm hoses
Pass-through clearance	Ø4 mm



## ELECTRICAL PASS-THROUGH MODULES

The modules click on the WINGMAN's housing without use of tools. There is room for three sets of module, which allow for three different sources of electrical power/control.

Connectors	Std. cobot M8 / 8 pin
Rated voltage/amps	30 ACDC / 1,5 A
IP classification	IP54



## BUILT-IN AIR PASS-THROUGH

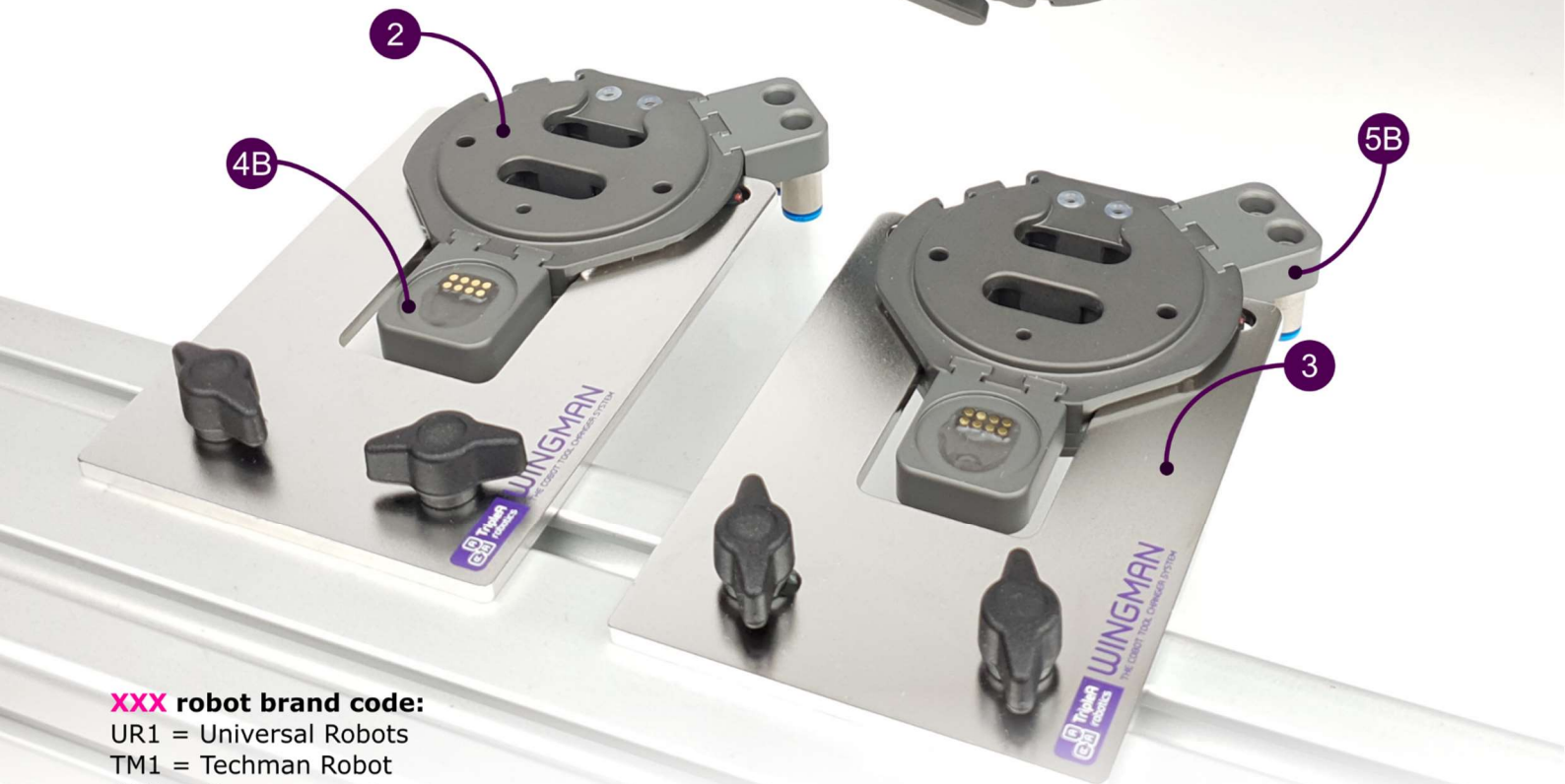
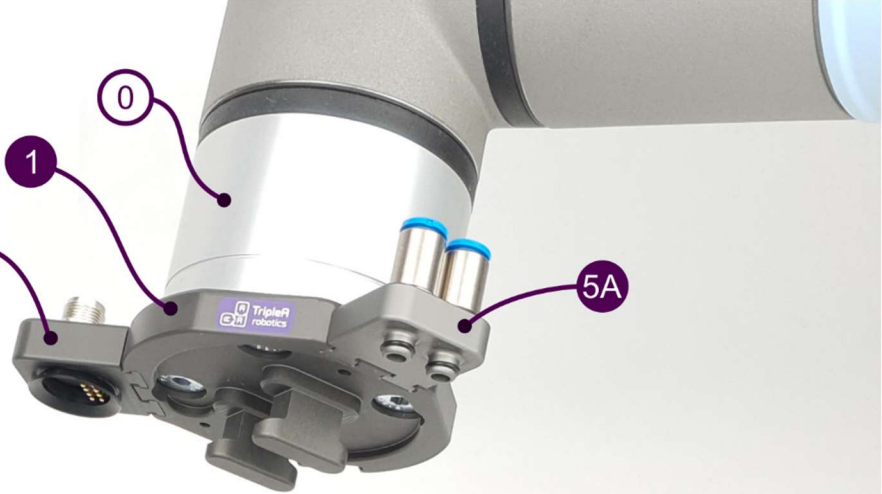
The WINGMAN Tool Changer housings feature built-in channels for pneumatic pass-through.

Maximum pressure	10 bar
Channels for fittings	2 x Ø4 mm hoses
Pass-through clearance	Ø2,7 mm

## HIGH QUALITY

The WINGMAN Tool Changer System is made of precision machined metal parts.

Manufacturing country	DENMARK
Material	High grade aluminium
Surface treatment	Special



**XXX robot brand code:**

- UR1 = Universal Robots
- TM1 = Techman Robot
- OM1 = Omron
- DR1 = Doosan Robotics
- FA1 = Fanuc CRX

## INTERFACE OVERVIEW

Pos.:	Part number:	Description:	Interfaces with:
0		Robot / Cobot	1 6A 6B
1	WM1-P-01-01-XXX	Robot Part	0 2 4A 5A 7A 7B
2	WM1-P-02-01	Tool Part	1 3 4B 5B 7A 7B
3	WM1-P-03-01	Tool Part Holder	2
4A	WM1-A-01-01-XXX	El pass-through module for Robot Part	1 4B
4B	WM1-A-01-02-XXX	El pass-through module for Tool Part	2 4A
5A	WM1-A-03-01	Air pass-through module for Robot Part	1 5B
5B	WM1-A-03-02	Air pass-through module for Tool Part	2 5A
6A	WM1-A-02-01-XXX	Cable for robot tool flange connector	0 4A
6B	WM1-A-02-03	Cable for robot controller	0 4A
7A	WM1-A-06-01	Fittings straight for built-in air pass-through	1 2
7B	WM1-A-06-02	Fittings angled for built-in air pass-through	1 2

# WINGMAN STANDARD KITS



### XXX robot brand code:

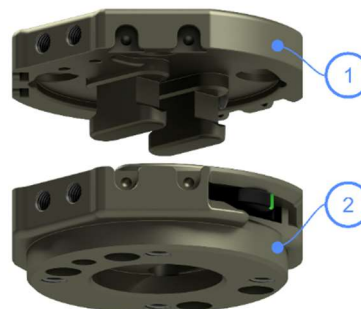
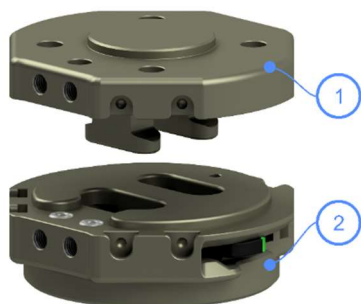
- UR1 = Universal Robots
- TM1 = Techman Robot
- OM1 = Omron
- DR1 = Doosan Robotics
- FA1 = Fanuc CRX

	One-way manuel kit WM1-K-01-00-XXX	Two-way manuel kit WM1-K-02-00-XXX	Two-way automatic kit, built-in pneumatic WM1-K-03-00-XXX	Two-way automatic kit, built-in pneumatic + electric modules WM1-K-04-00-XXX	Two-way automatic kit, built-in pneumatic + electric + high flow modules WM1-K-05-00-XXX	Two-way automatic kit, Trainer/demo in case WM1-DK-05-00-XXX	Accessories kit WM1-AK-01-00-XXX
1: Robot Part (Including URcap software for UR) WM1-P-01-01-XXX	1	1	1	1	1	1	
2: Tool Part WM1-P-02-01	1	2	2	2	2	2	
3: Tool Part Holder with wing screws WM1-P-03-01			2	2	2	2	
4A: Electrical pass-through for mount on Robot Part, M8 connector WM1-A-01-01-XXX				1	1	1	
4B: Electrical pass-through for mount on Tool Part, M8 connector WM1-A-01-02-XXX				2	2	2	
5A: High flow air pass-through for mount on Robot Part, 2xØ6 mm hose WM1-A-03-01					1	1	
5B: High flow air pass-through for mount on Tool Part, 2xØ6 mm hose WM1-A-03-02					2	2	
6A: Electrical cable for connection with the robots tool flange connector WM1-A-02-01-XXX						1	1
6B: Electrical cable for installation along robot arm to controller, 5 m WM1-A-02-03							1
7A: Fittings set I-shape for Robot Part & Tool Part for 2xØ4 mm hose WM1-A-04-01						3	3
7B: Fittings set L-shape for Robot Part & Tool Part for 2xØ4 mm hose WM1-A-04-02							3
Case for two-way kits WM1-A-05-01						1	

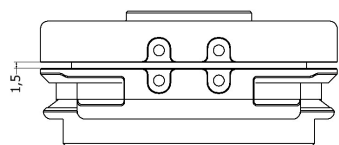


## Datasheet - TOOL CHANGER

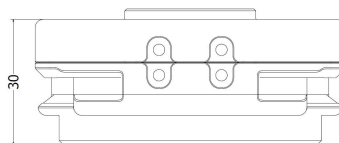
### PICTURES AND DRAWINGS



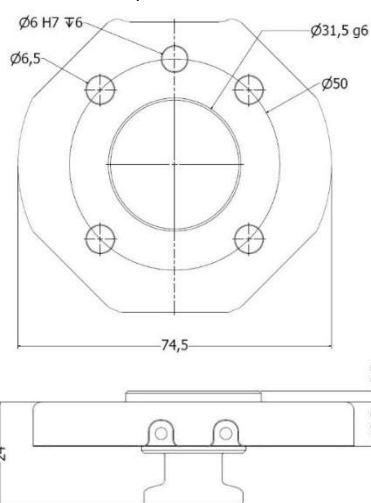
Maximum couple distance in automatic use



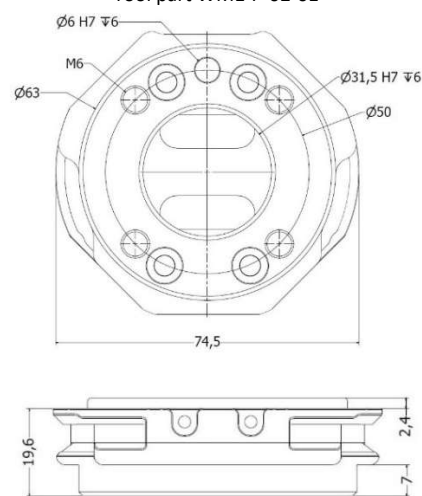
Assembled height



Robot part WM1-P-01-01



Tool part WM1-P-02-01



### PART NUMBERS

Pos.:	Part no.:	Description:	Interfaces with:
1	WM1-P-01-01-XXX	Robot part including: 4 pcs. screws M6x12mm ISO 10642 1 pcs. positioning pin 6mmH6	Pos.: 2, 4A, 5A, 6A
2	WM1-P-02-01-XXX	Tool part	Pos.: 1, 3, 4B, 5B, 6B
	WM1-S-01-01	Spare part kit for Tool part WM1-P-02-01 including 2 pcs. levers, 4 pcs. bearings, 4 pcs. Springs and 4 pcs. pins.	Pos.: 2

### TECHNICAL DATA

Weight, tool changer assembled:	260 g
Rated payload* (Maximum payload):	33 kg (100kg)
Tool changer assembly height:	30 mm
Repeatability:	+0,03 mm
Pass-through, pneumatic build in and suggested push-in fittings (not included):	2 x M5 pneumatic (max 10 bar) Festo 133004 or Festo 153333
Pass-through, modules:	3 sets can be fitted
Material:	Surface treated aluminum
Interface flanges on robot part and tool part:	ISO 9409-1-50-4-M6

\* The rated payload is based on the payload's center of gravity being 100 mm from the center of the tool changer, a dynamic force of maximum 2G and a safety factor of 5. Maximum allowed payload must always be calculated for the application.

**Tool Changer**



**Part no.: WM1-P-01-01-XXX**



**Part no.: WM1-P-01-02-XXX**



### STATIC LOAD LIMITS

The WINGMAN Tool Changer has a proven *breaking load* at 20.770 N (2.150 kg) and a *yield load* at approx. 14.000 N (1.425 kg) in direction, F.

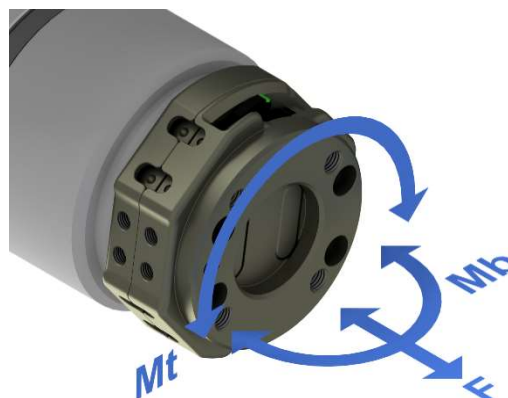
The WINGMAN's **maximum static payload and torques of  $F_{max} = 100kg$ ,  $Mb_{max} = 80 Nm$ ,  $Mt_{max} = 80 Nm$**  are calculated based on a very conservative theoretical *minimum yield load* of 5.000 N and with a safety factor of 5 which results in the given payload and torques.

The WINGMAN's **Rated Payload of 33kg** is based on the *maximum static payload and torque* and a typical application with a maximum of 2G acceleration/deacceleration and a distance from the WINGMAN to the payload's center of 100 mm.

**How to calculate if the WINGMAN's maximum allowed static payload & torque limits are within those present in your application:**

1. Calculate the forces (F , Mb , Mt), which the WINGMAN will be exposed to in your application considering the cobots worst-case acceleration/deacceleration of the payload and the payloads interaction with other objects.

3. Now compare the calculated worst-case forces present in your application with the WINGMAN's maximum allowed static payload & torque limits ( $F_{max}$  ,  $Mb_{max}$  ,  $Mt_{max}$ ).



#### THE WINGMAN'S MAXIMUM ALLOWED STATIC LOAD & TORQUE

Rated Payload	33 kg.
$F_{max}$ : (Maximum static payload)	1000 N (100 kg)
$Mb_{max}$ : (Maximum static torque)	80 Nm
$Mt_{max}$ : (Maximum static torque)	80 Nm

#### MAXIMUM ALLOWED APPLICATION PAYLOAD CALCULATION

To calculating the **maximum application payload** for your application, determine the:

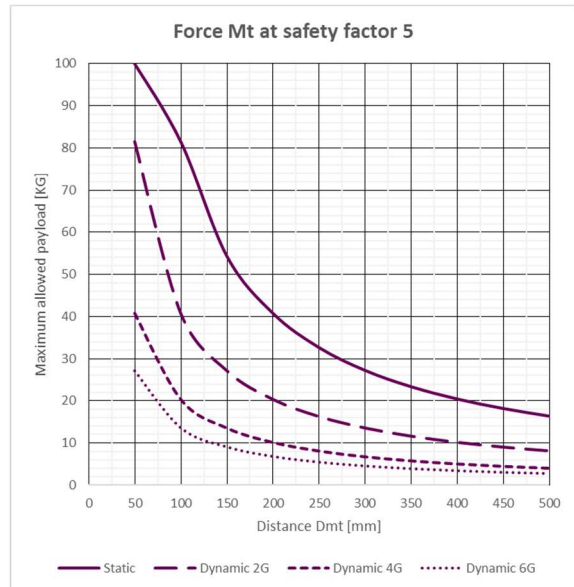
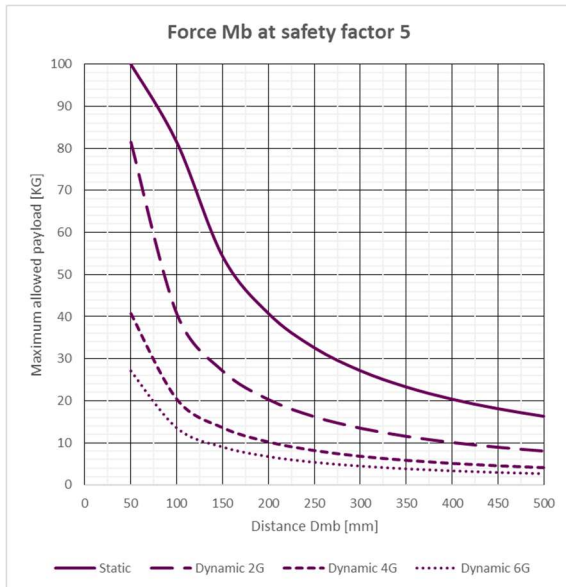
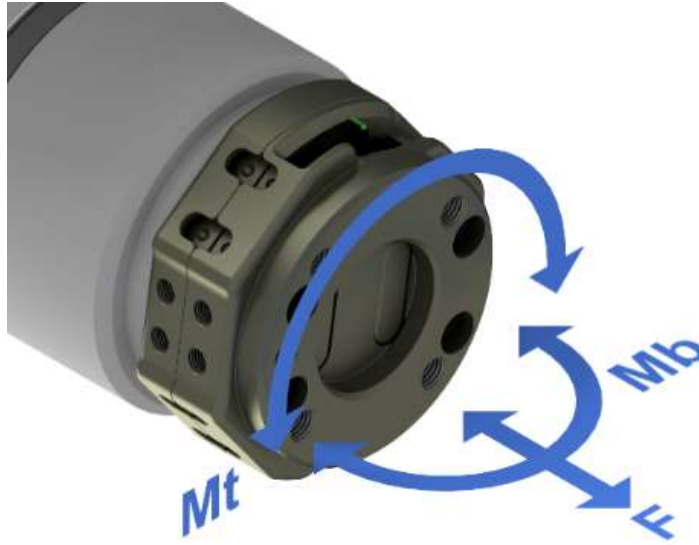
- $G_{max}$  => Maximum *dynamic forces*.  
To determine the *dynamic forces*( $G_{max}$ ), consult your cobot's documentation to find out the maximum acceleration / deacceleration for your cobot.
- $Dmb$  => Distance ( $Dmb$ ) from the *tool part* center to the payloads Center of Gravity in meters that causes  $Mb$  type torque.
- $Dmt$  => Distance ( $Dmt$ ) from the *tool part* center to the payloads Center of Gravity in meters that causes  $Mt$  type torque.

	F	Mb	Mt
<i>Maximum allowed application payload</i> =	$F_{max} / G_{max} / 9,82$	$Mb_{max} / G_{max} / Dmb / 9,82$	$Mt_{max} / G_{max} / Dmt / 9,82$
<i>Maximum allowed application payload</i> EXAMPLE cal.=	<ul style="list-style-type: none"> <li><math>F_{Max} = 1000 N</math></li> <li><math>Mb_{max} = 80 Nm</math></li> <li><math>Mt_{max} = 80 Nm</math></li> <li>Maximum dynamic force, <math>G_{max} = 2</math>.</li> <li>Distance, <math>Dmt = 0,1 m</math>.</li> <li>Distance, <math>Dmb = 0,12 m</math>.</li> </ul> $1000 N / 2 / 9,82$ = 50 Kg	$80 Nm / 2 / 0,12 m / 9,82$ = 33 Kg	$80 Nm / 2 / 0,10 / 9,82$ = 40 kg

<i>Maximum application payload</i> EXAMPLE cal. RESULT =	<p>The <b>lowest</b> relevant calculated value for F, Mb and Mt determines the <i>maximum application payload</i>.</p> <p>In case that the cobot movement result in only F type force on the tool changer:</p> <p style="text-align: center;"><i>Maximum allowed application payload</i> = 50 kg.</p> <p>In case that the cobot movement result is both F, Mb and Mt type loads on the tool changer:</p> <p style="text-align: center;"><i>Maximum allowed application payload</i> = 33 kg.</p>
--	---

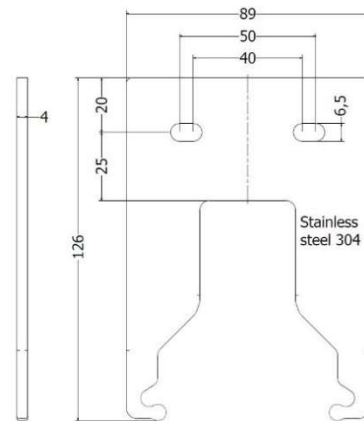
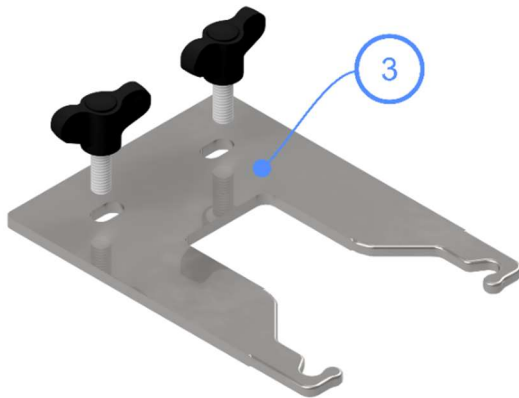
Alternatively, to calculating the *maximum allowed payloads* for a robot application, the *maximum allowed payloads* can be determined from the graphs on the next page.

**MAXIMUM ALLOWED APPLICATION PAYLOAD GRAPHS**



## Datasheet - TOOL PART HOLDER

### PICTURES AND DRAWINGS



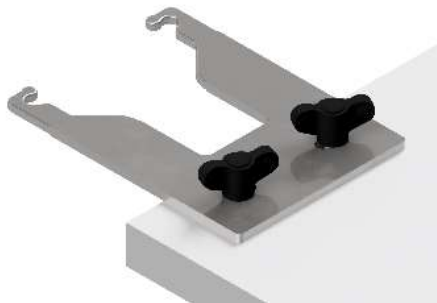
### PART NUMBERS

Pos.:	Part no.:	Description:	Interfaces with:
3	WM1-P-03-01	Tool part holder including 2 pcs. finger screws.	Pos.: 2

### TECHNICAL DATA

Material:	Electro polished stainless steel 304 (surface gloss may vary)
Rated couple payload / Rated couple torque (See USER GUIDE chapter 7.6 <a href="#">Installing the tool part holder</a> )	5 kg / 1 Nm
Mounting means:	2 x M6 wing screws
Installation:	Horizontally on a rigid structure

### HORIZONTAL INSTALLATION FOR A RIGID INSTALLATION



Part no.: WM1-P-03-01



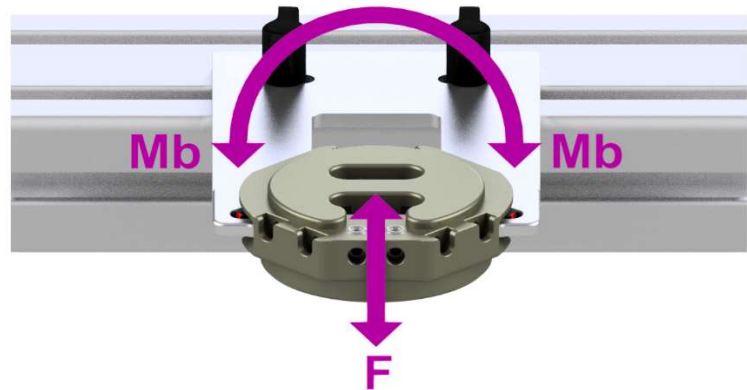
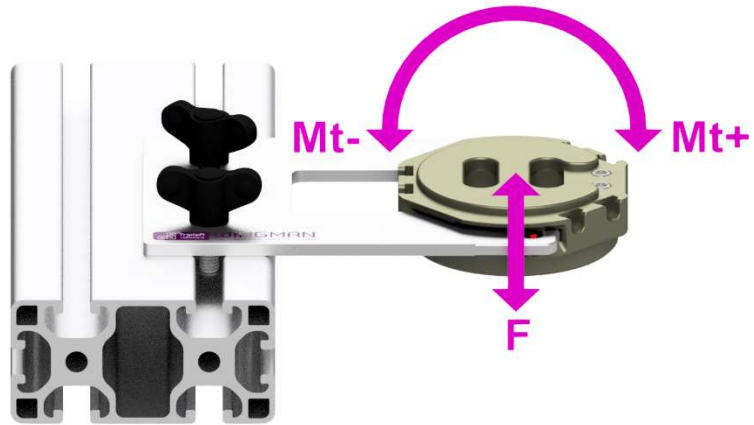
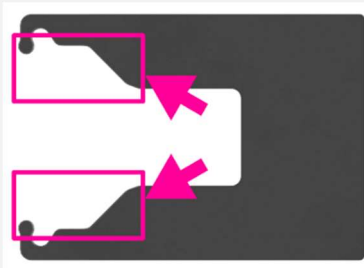
**STATIC LOAD LIMITS FOR TOOL PART HOLDER**

Automatic tool change with the WINGMAN Tool Changer System will work best and will provide the longest product life span when used within the limits for *rated couple payload* and *rated couple torque*.

The WINGMAN Tool Changer System will do automatic tool change even though the limits are exceeded however, use outside the limits is not recommended and will be on the *system integrators* (user) own risk.

**Lubrication:**

The tool part holder does not come pre-lubricated. Lubrication of the tool part holder is optional but will be necessary to achieve long life span and smooth tool change. For end-effector that result in a *rated couple payload*( $F$ ) > 1 kg and/or a *rated couple torque*( $M+$  &  $Mb$ ) > 0 Nm lubrication is mandatory. For lubrication is used a silicone based grease.

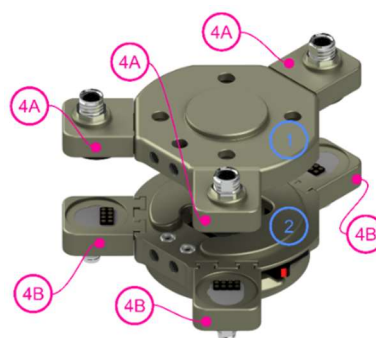
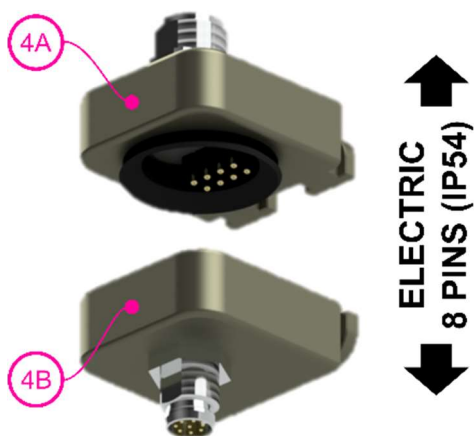


**MAXIMUM ALLOWED STATIC LOAD**

$F_{max}$ (Rated couple payload):	50 N / 5 kg
$Mt+$ , max (Rated couple torque):	1 Nm
$Mt-$ , max (Rated couple torque):	0 Nm
$Mb$ , max (Rated couple torque):	1 Nm

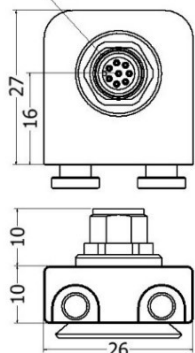
## Datasheet - ELECTRIC PASS-THROUGH MODULE

### PICTURES AND DRAWINGS



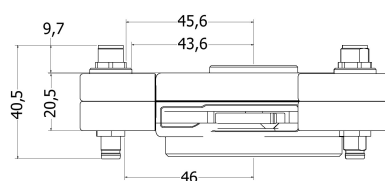
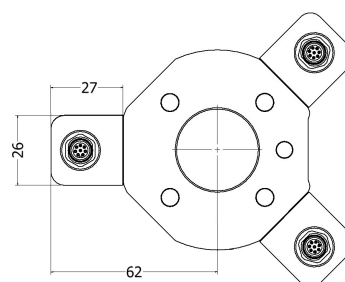
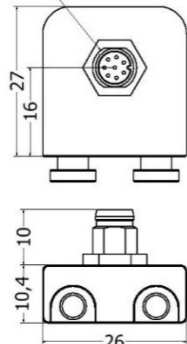
Part no.: WM- A-01-01-01

ELECTRICAL CONNECTOR:  
- Female 8 pin  
- Internal threaded M8



Part no.: WM1-A-01-02-01

ELECTRICAL CONNECTOR:  
- Male 8 pin  
- External threaded M8



### PART NUMBERS

Pos.:	Part no.:	Description:	Interfaces with:
4A	WM1 A-01-01-01	Pass-through module, electric for robot part, M8 8 positions.	Pos.: 1
4B	WM1-A-01-02- <del>XXX</del>	Pass-through module, electric for tool part, M8 8 positions.	Pos.: 2
	WM1 A-02-01- <del>XXX</del>	Electric cable 0,22 m for pass-through module, M8 8 pin, connector L shape.	Pos.: 4A
	WM1 A-02-02- <del>XXX</del>	Electric cable 5 m with M8 connector to open-end. For connection between pass-through module on <b>tool part</b> to end-effector.	Pos.: 4A
	WM1 A-02-03- <del>XXX</del>	Electric cable 5 m with M8 connector to open-end. For connection between pass-through module on <b>robot part</b> to robot controller cabinet.	Pos.: 4A

### TECHNICAL DATA

Housing material:	Surface treated aluminum
Rated voltage (AC/DC):	30 V
Rated current at 40°C per pin (peak):	1,5 A (3,0 A)
Number of positions:	8
IP classification when connected:	IP54
Gold plated contacts:	10 μm
Connector type facing robot (4A)	M8, 8 pin connector - IEC 61076-2-104 (Female)
Connector type facing tool (4B)	M8, 8 pin connector - IEC 61076-2-104 (Female or male depending on robot brand/model)



**WARNING** Electricity to a pass-through module must be turned off and any residual electricity must be eliminated before tool change takes place. Failing in doing so will result in damage to the electric connectors and can result in injury.



Part no.: WM1-A-01-01

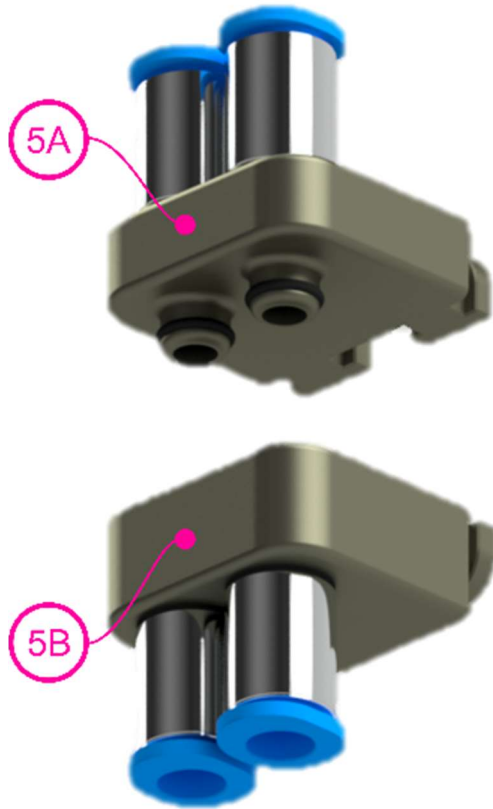


Part no.: WM1-A-01-02

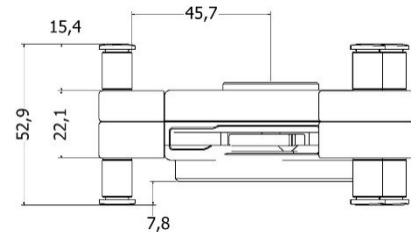
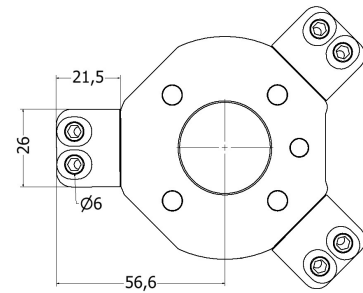
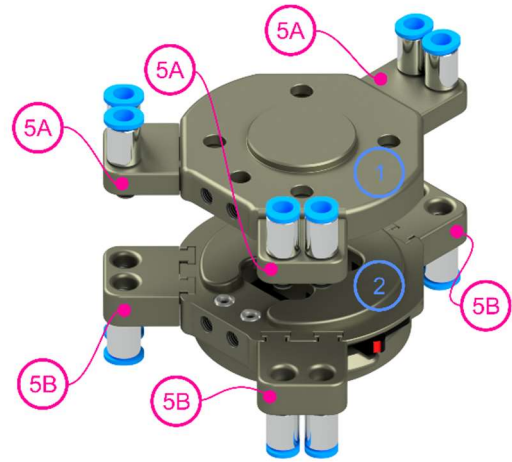


Datasheet – HIGH FLOW PASS-THROUGH MODULE

PICTURES AND DRAWINGS



  
**PNEUMATIC**  
**10 BAR**  

**PART NUMBERS**

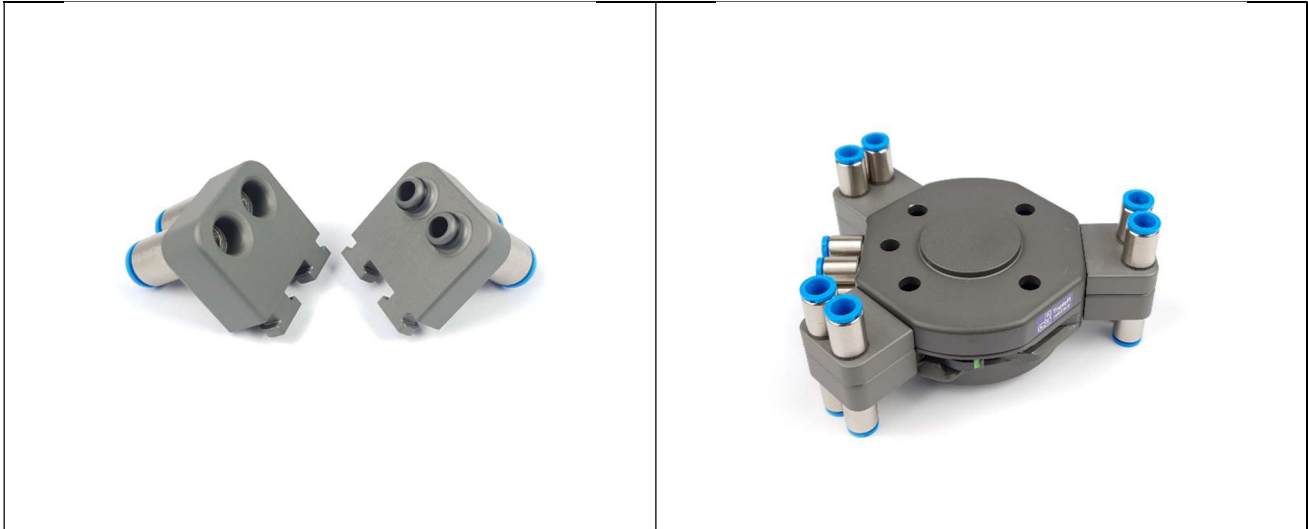
Pos.:	Part no.:	Description:	Interfaces with:
5A	WM1-A-03-01	Pass-through module, High Flow for <b>robot part</b> , 2 x Ø6 mm hose fittings.	Pos.: 1
5B	WM1-A-03-02	Pass-through module, High Flow for <b>tool part</b> , 2 x Ø6 mm hose fittings.	Pos.: 2

**TECHNICAL DATA**

Material:	Surface treated aluminum
Maximum air pressure:	10 bar
Pass-through clearance diameter	Ø4 mm
Pass-through fittings (included):	PUSH-IN for Ø6 mm hose
O-ring sealing (wear part):	2 pcs. Ø6/Ø4 NBR shore 70



**WARNING** Energy (vacuum, air pressure) to a pass-through module must be turned off and any residual air pressure or vacuum in the system must be eliminated before tool change takes place. Failing in doing so can result in hardware damage and injury.



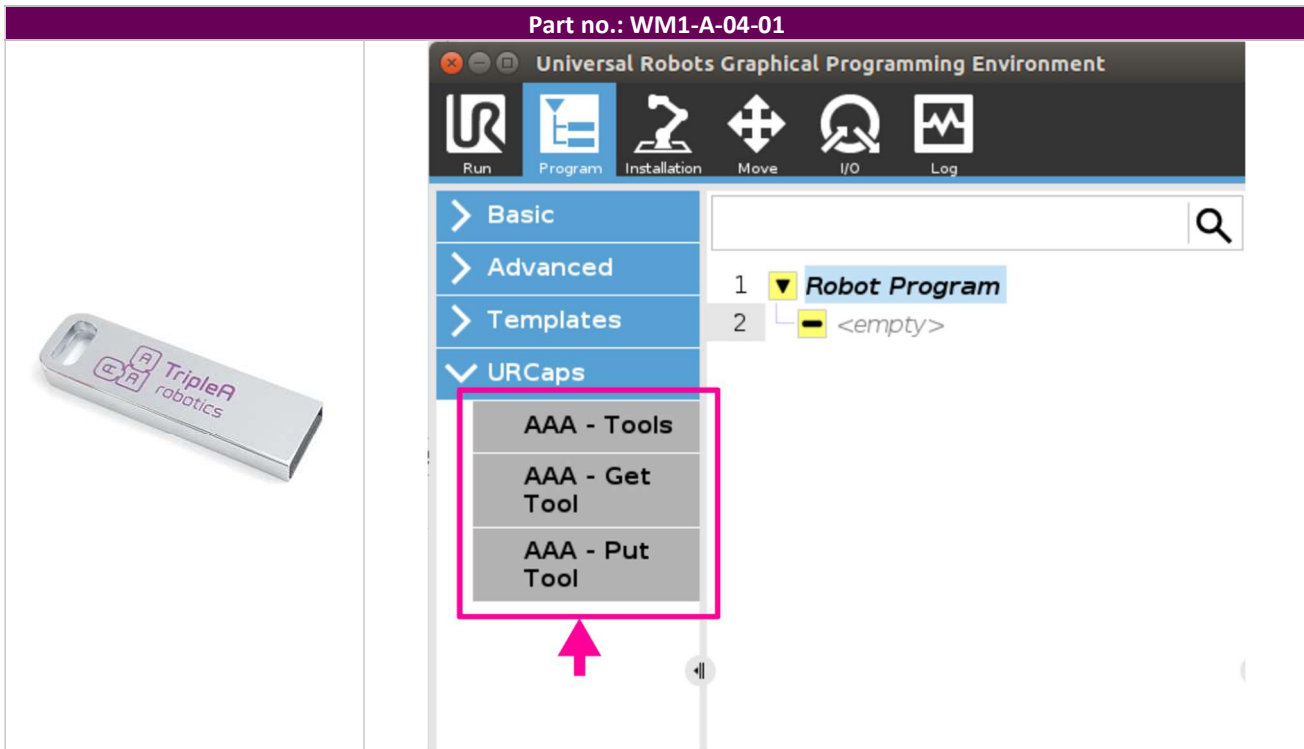
Part no.: WM1-A-03-01



Part no.: WM1-A-03-02



## Datasheet – URcap software



### PART NUMBERS

Pos.:	Part no.:	Description:	Interfaces with:
	WM1-A-04-01	UR cap software. License for use on one robot.	Universal robots

### TECHNICAL DATA

For use on:	Universal Robots: <b>CB3 series</b> installed with Polyscope version 3.13 or later and <b>e-series</b> installed with Polyscope version 5.8 or later.
License:	License for use on one robot only.
Main features:	AAA – Tools > Add this node in top of your robot program and configure your end-effectors here. AAA – Get Tools > Add this node to you robot program when you want the robot to get an end-effector. AAA – Put Tool > Add this node to you robot program when you want the robot to put back an end-effector. <ol style="list-style-type: none"> <li>1. 1-minute tool change setup as only one waypoint must be taught per end-effector.</li> <li>2. Store data in the robot program for all your favorite end-effectors.</li> <li>3. Easy toggle of e.g. payload, TCP, COG and tool voltage in tool changes.</li> <li>4. Optional exit and enter waypoints to ensure free passage to and from the tool area.</li> <li>5. Adjustment of the tool changers orientation on the robot to allow odd orientation e.g. for use in double mount applications.</li> <li>6. Several possibilities to optimize tool change waypoints.</li> <li>7. Optimized to ensure no conflicts with other URcaps installed on the robot (e.g. no threads running in the background and no interference with Tool IO's).</li> </ol>