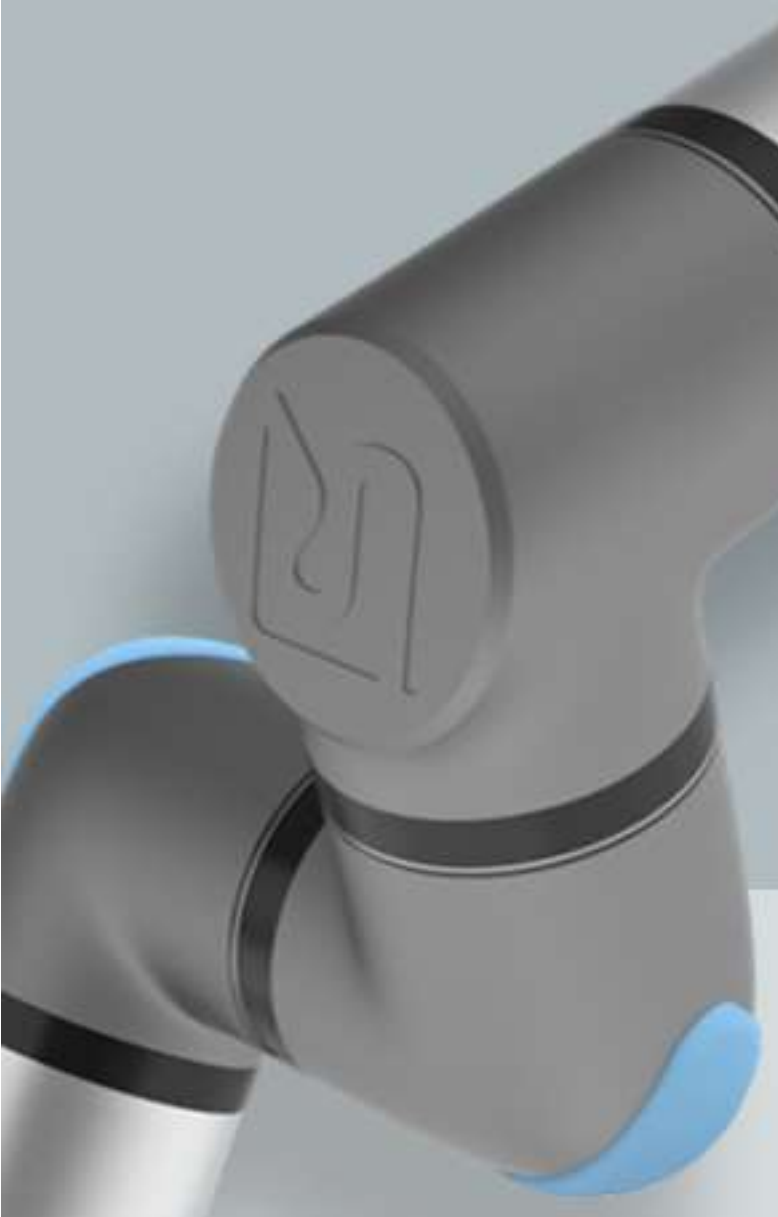
UNIVERSAL ROBOTS

Analysis Report

Performance Check

Serial number: 201955XXXXX
TS Case number: TS0XXXXX



Customer	: Manufacturing Ltd
System integrator	: -
Distributor	: PowerDistribution
Date of the report	: 15. March 2023

Introduction

The Analysis Report is the result of a Performance Check.

Data collected from the cobot has been analyzed by an expert from Universal Robots, to identify concrete and actionable recommendations for the program and installation settings.

The recommendations are based on a best practice knowledge database, and aims to:

- **Reduce the risk of unplanned stops** (e.g., protective stops) by avoiding operation near the physical limits and safety limits of the cobot.
- **Reduce mechanical stress** when possible while maintaining similar cycle times.

Reading guide

A checklist with all topics first provides an overview of the analysis results.

In the following sections all observations and recommendations are presented in more detail.

The detailed presentation is ordered by the severity and expected impact, with the highest impact first.

Next steps

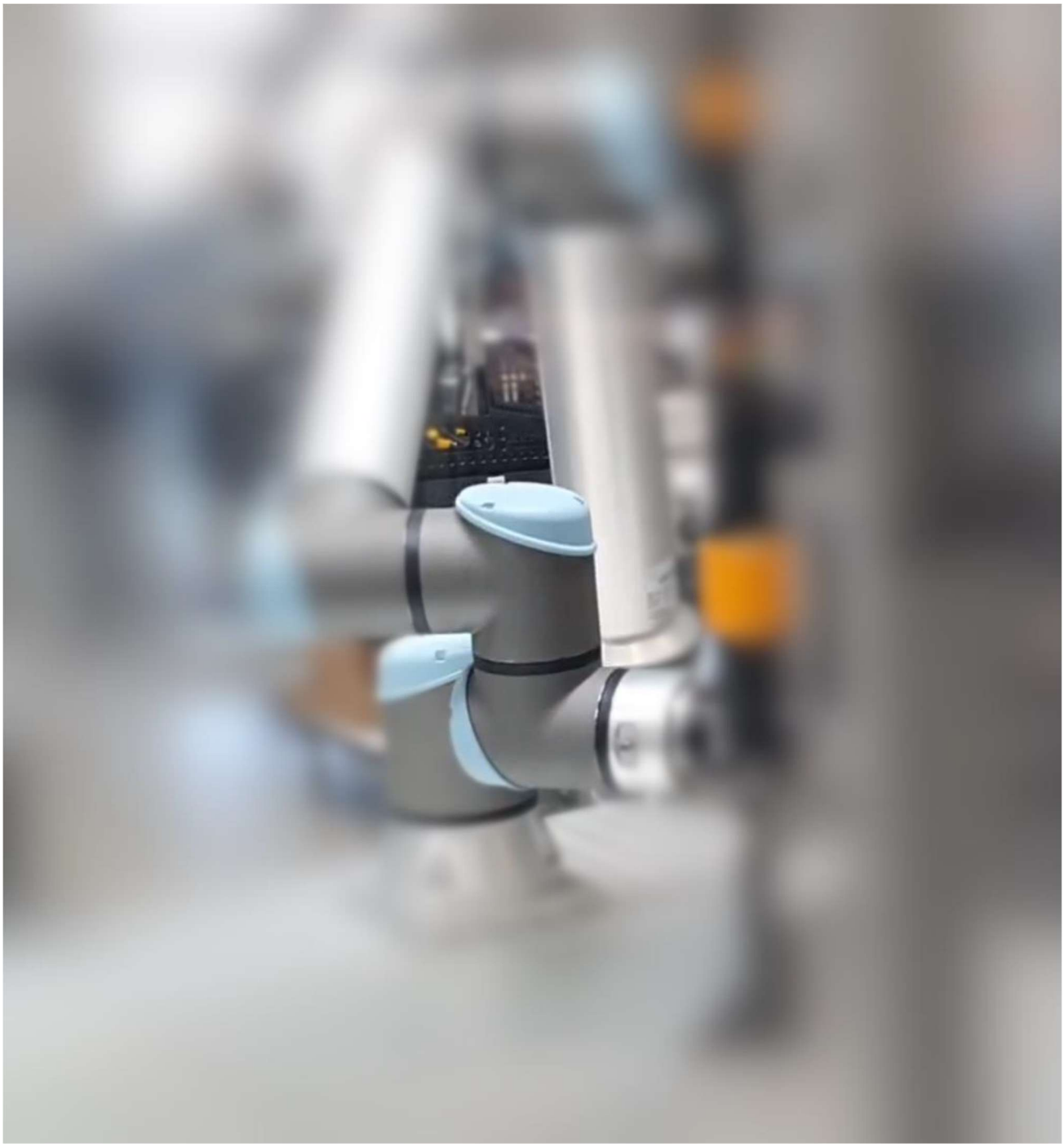
A review meeting will be offered through the myur portal, to elaborate on the findings and discuss how the recommendations can be implemented.

Robot installation overview

Installation data	
Serial number	201955XXXXX
TS Case number	TS0XXXXX
Date of extraction	23. January 2023 12:34
Robot model	UR5e
Robot mount	Floor
Robot software version	5.11.11
Application type	Quality
Sub Application type	Testing
Running program	BestProgram
Program last saved	8. December 2022 9:26
Safety checksum	1738092437
TCP	x: 0m, y: 0m, z: 0.4505m, rx: 0rad, ry: 0rad, rz: 0rad
Payload	4.20Kg
CoG	x: 0m, y: 0m, z: 0m
Inertia	ixx: 0Kg*m², iyy: 0Kg*m², izz: 0Kg*m², ixy: 0Kg*m², ixz: 0Kg*m², iyz: 0Kg*m²
Installed UR caps	0: Ethernet/IP, 1: Profinet, 2: RG - On Robot, 3: Conveyor Tracking, 4: polyscope-pallet-impl, 5: polyscope-screwdriving-impl
Related cases	TS0XXXXYZ

Robot work environment

Picture of the robot work environment.



Performance review checklist

The checklist shows an overview of the topics that have been analyzed, and it indicates any recommendation findings using the following severities:

Severity levels	
✓	No findings.
i	Best practice.
!	Potential performance improvement.
✕	Performance improvement.

Analysis Summary	
1. Environment	✓
2. Payload configuration	!
3. Robot load	✓
4. External forces and collisions	!
5. Motion parameters	!
6. Blends and motion flow	✕
7. Force mode	✓
8. Tool contact	✓
9. Functions	!
10. Software version	i
11. Stops and transitions	✓
12. Health	✓
13. System performance	✓

2. Payload configuration

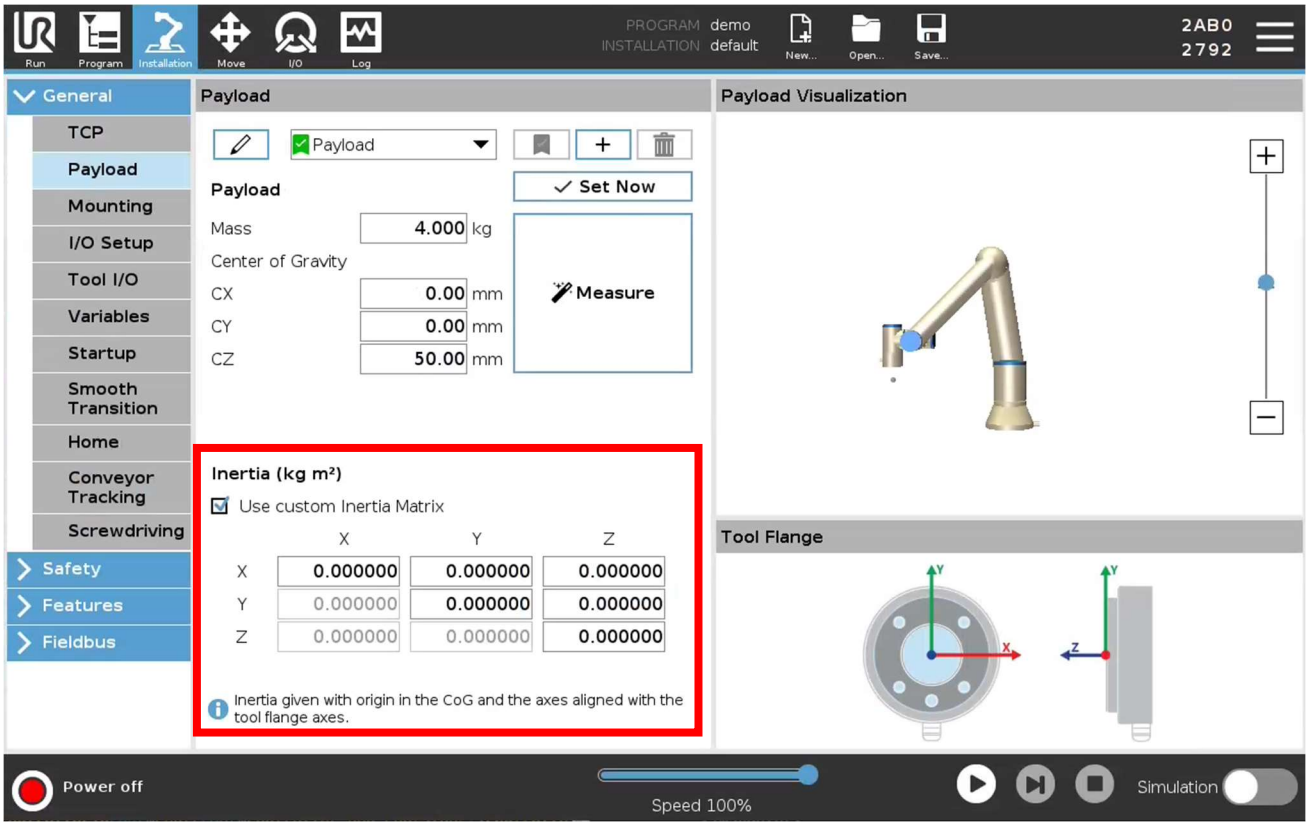
Overview of the recommendations ordered by importance and the expected impact.

Title	Severity
Payload inertia configuration	
Payload mass and cog configuration	

Payload inertia configuration

Observation

The payload inertia is configured with default values while the robot is carrying payload of significant size and mass. Furthermore, the motor current charts below show unwanted oscillations in the actual current.



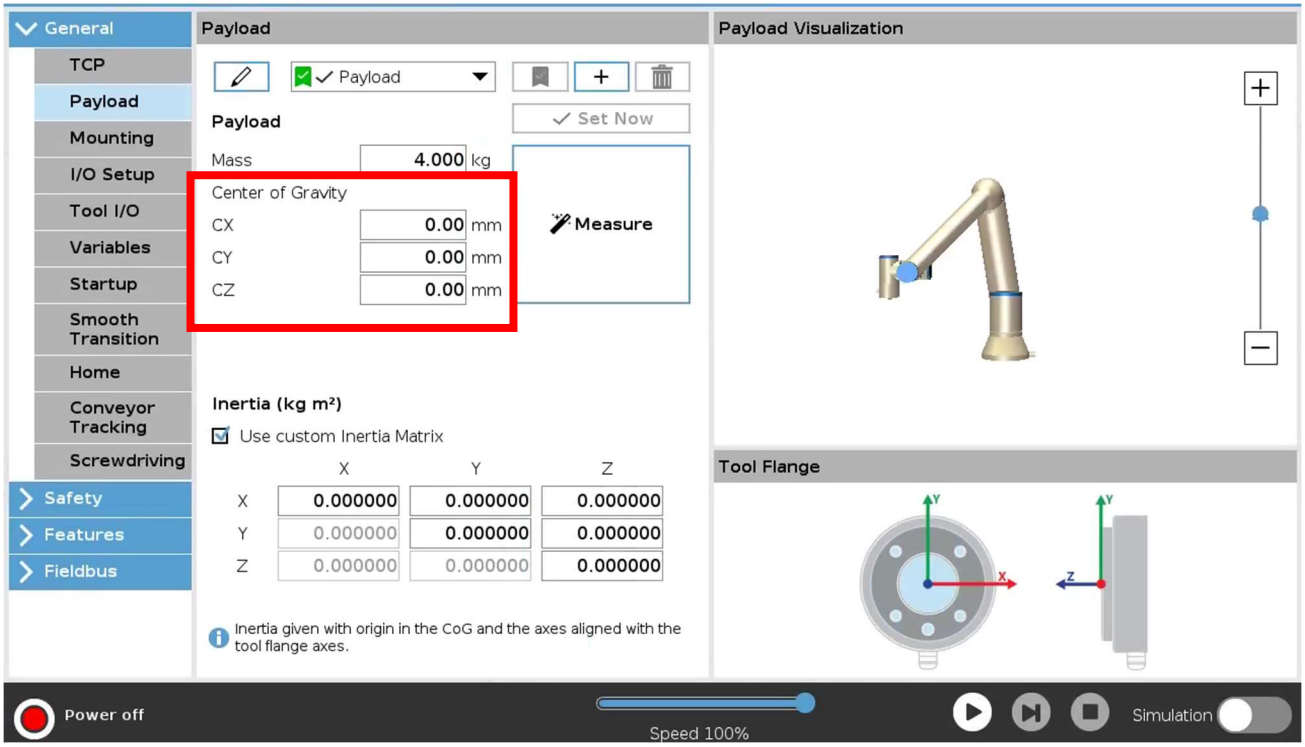
Recommendation

Provide a more accurate inertia matrix when using large and flexible tools. This is important to optimize robot performance and reduce the risk of vibrations and protective stops.

Payload mass and cog configuration

Observation

The actual load on the robot has an almost constant deviation to the expected load, which is seen in the current chart below as a deviation between target and actual currents.
This can indicate that the payload configuration is not accurate, and it is noted that the payload center-of-gravity is configured to zero.



Recommendation

The mass and center of gravity of the payload (including end-effector) at the end of the robot arm must always be configured accurately. The payload mass and center of gravity must be updated each time the robot picks up or puts down a workpiece.

E-series

For E-series robots on software version 5.10+ use the set_target_payload(m, cog) script function or the "Set Payload" PolyScope node.

Payload profiles for different tool and workpiece combinations can be defined in the Payload Installation tab. Here you also find the Payload Estimation Wizard that allows you to measure payload mass and cog values using the built-in force/torque sensor.

PolyScope will display a warning when the payload is not set in the Installation tab.

4. External forces and collisions

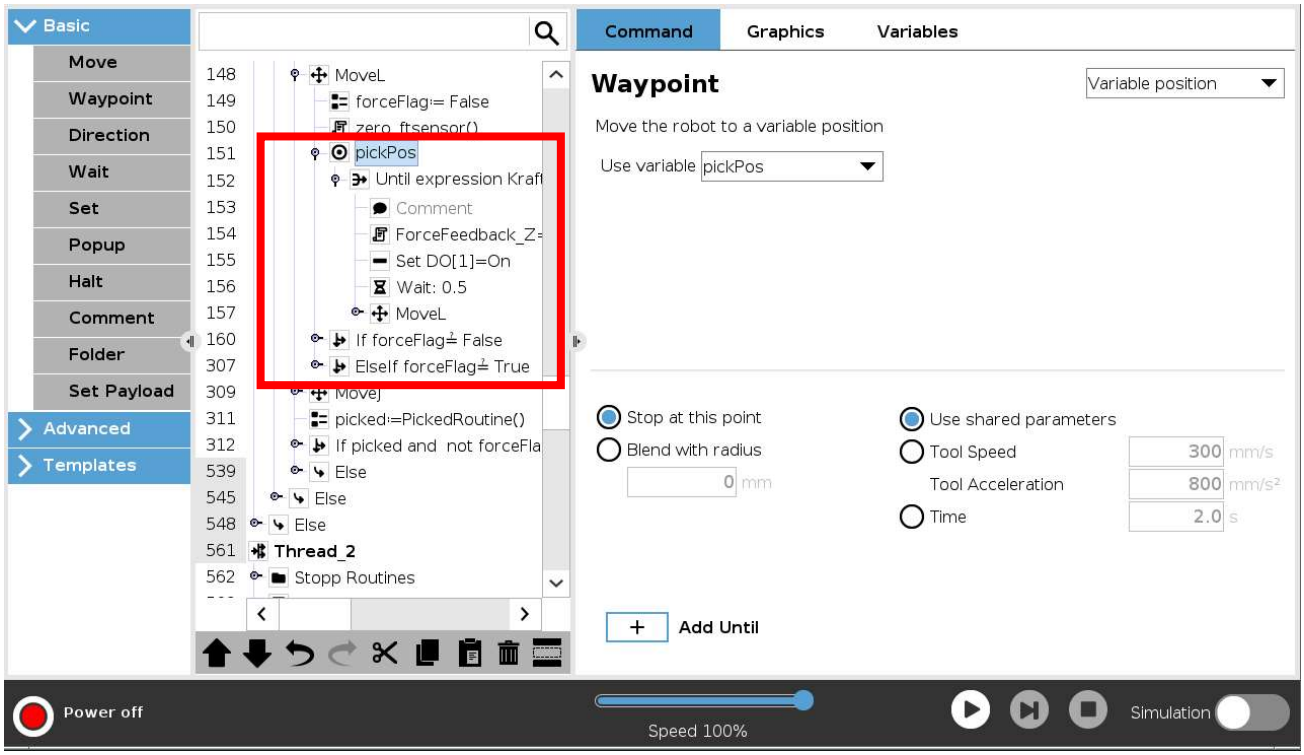
Overview of the recommendations ordered by importance and the expected impact.

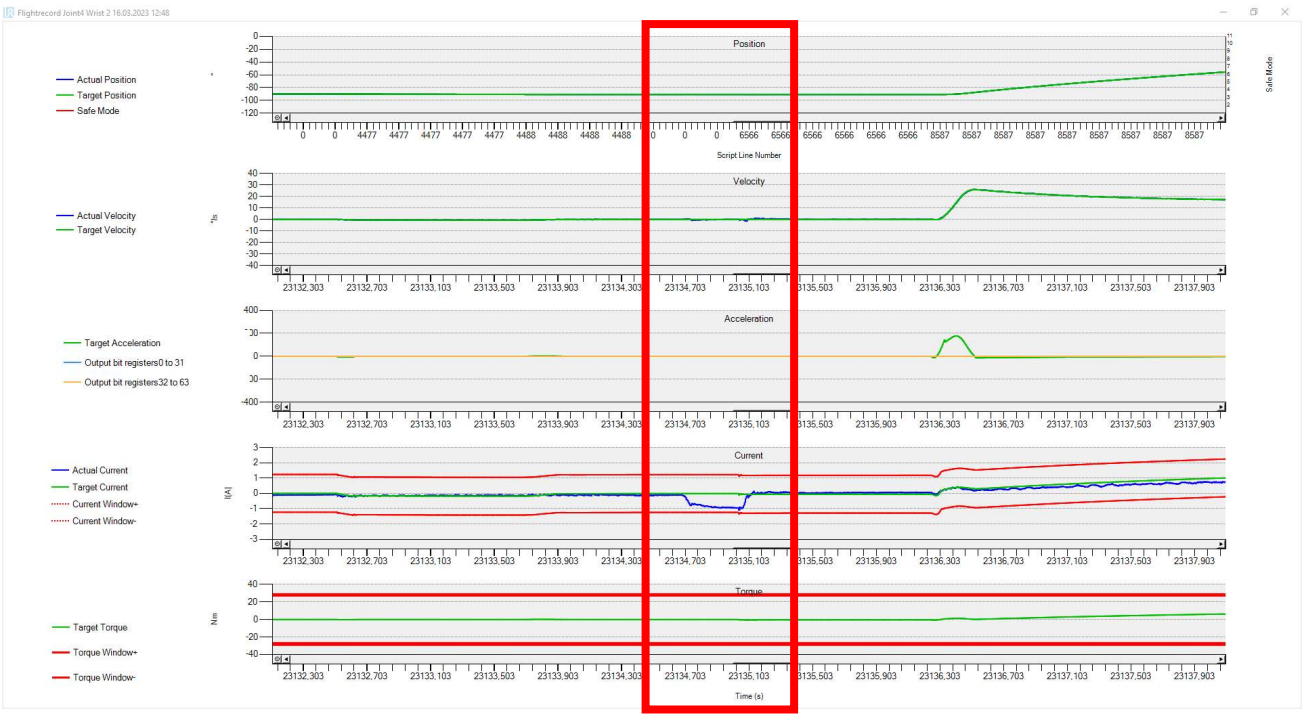
Title	Severity
External force	!

External force

Observation

There is a risk of protective stops due to unexpected forces exerted between the robot and the environment. The tool is colliding with an object while the robot is in position control mode which can cause protective stops because of a deviation from the expected path. In the current chart below this collision is seen as a short deviation between actual and target currents until the movement is stopped.





Recommendation

Reduce the risk of protective stops and damage of equipment by using force mode if possible in the robot program to limit forces (E-series manual), or ensure proper alignment between the robot and the surroundings.

A speed of 100.0mm/s is recommended for detecting a tool contact.

5. Motion parameters

Overview of the recommendations ordered by importance and the expected impact.

Title	Severity
Trajectory deviation	
Velocity not reached	

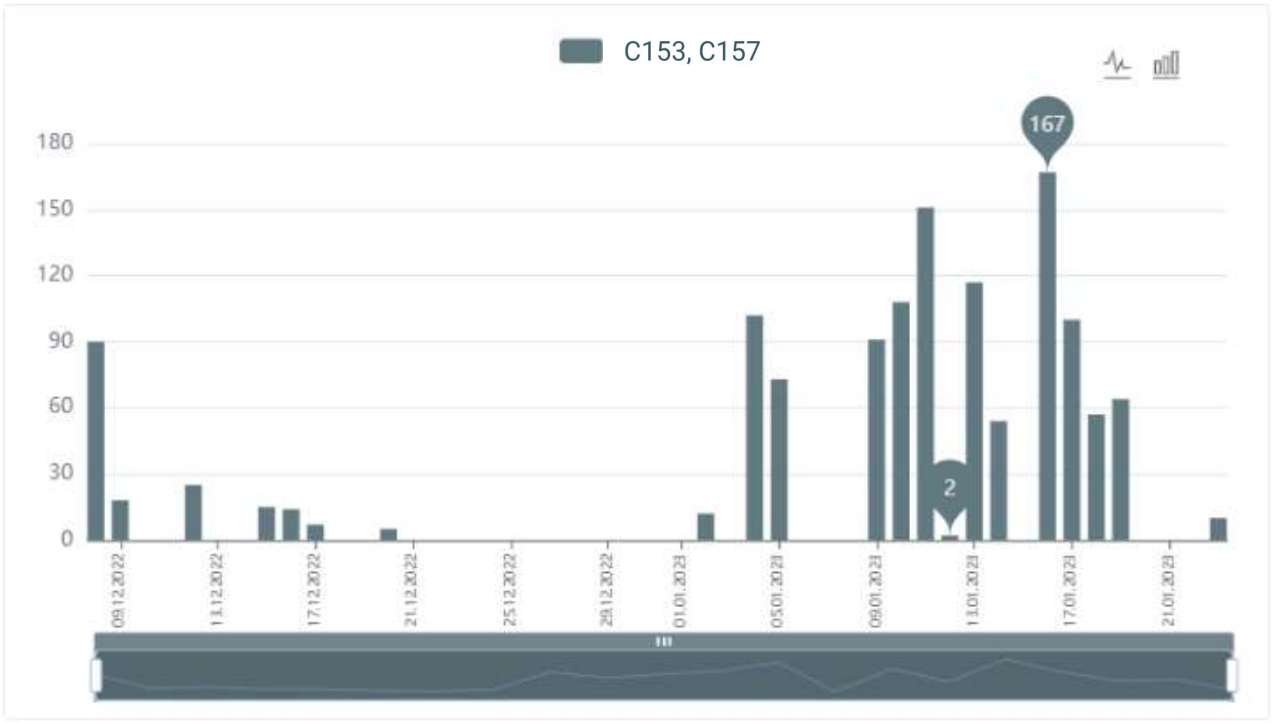
Trajectory deviation

Observation

A high number of trajectory deviations have been detected. More than 1000 times in the last month, the planned trajectory causes protective stops due to a deviation from the expected path.

Error Code	Last day	Last month	Last 4 months
C153	10	922	1064
C157	0	186	218

LOG CHART



Recommendation

These protective stops indicate a problem with the robot deployment or payload configuration and should be thoroughly investigated.
They are triggered when the robot is unable to follow the planned trajectory, due to e.g. a safety or physical limit.
Several things can cause this. A short checklist is available here and a more general guide for resolving typical issues is found here.
The script command position_deviation_warning() can be used to check whether the robot is deviating from its planned path while running a program. No deviations over a threshold of 0.2 is recommended.

Velocity not reached

Observation

A specified velocity parameter will not be achieved given the acceleration parameter and distance to travel.

Script Line	Polyscope Line	Command
9130	373	movej
9396	391	movej
9406	396	movej
9680	412	movej
10473	497	movej
10739	515	movej
10749	520	movej
11023	536	movej

Recommendation

Avoid target velocities that are not reached by either increasing the acceleration, typically for longer distances or reducing the target velocity for shorter distances.

To get smoother movements the robot should not change directly from acceleration to deacceleration.

Also, it is sometimes preferred when the velocity parameters of the robot program reflect the actual velocities achieved in operation.

6. Blends and motion flow

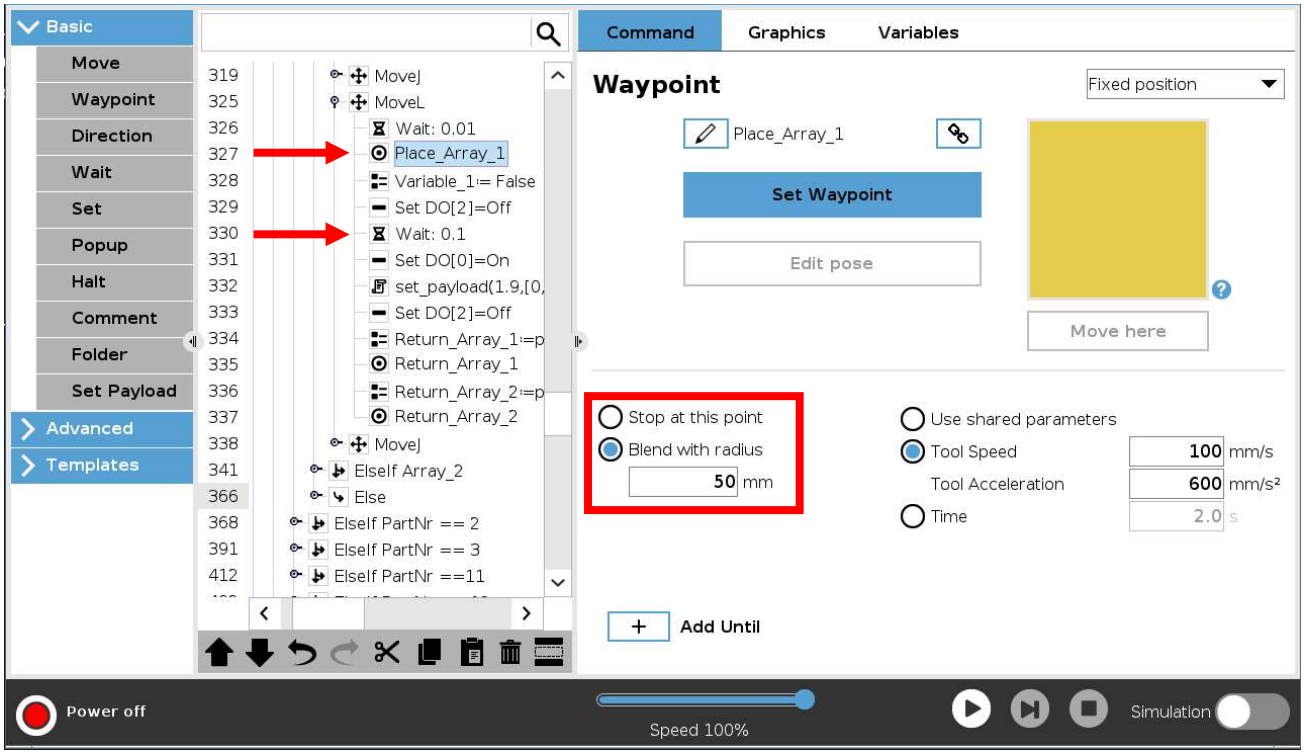
Overview of the recommendations ordered by importance and the expected impact.

Title	Severity
Aborted blend	
Missing use of blends	

Aborted blend

Observation

A waypoint configured with a blend is followed by a blocking function which can cause unnecessary hard decelerations.
An aborted blend requires the robot to stop, and this will be done at high deceleration to limit the movement. This high deceleration can be reduced by either removing the configured blend or actively defining the stop movement with a call to e.g., the stopj script function.



Script Line	Polyscope Line	Command
8618	327	movel

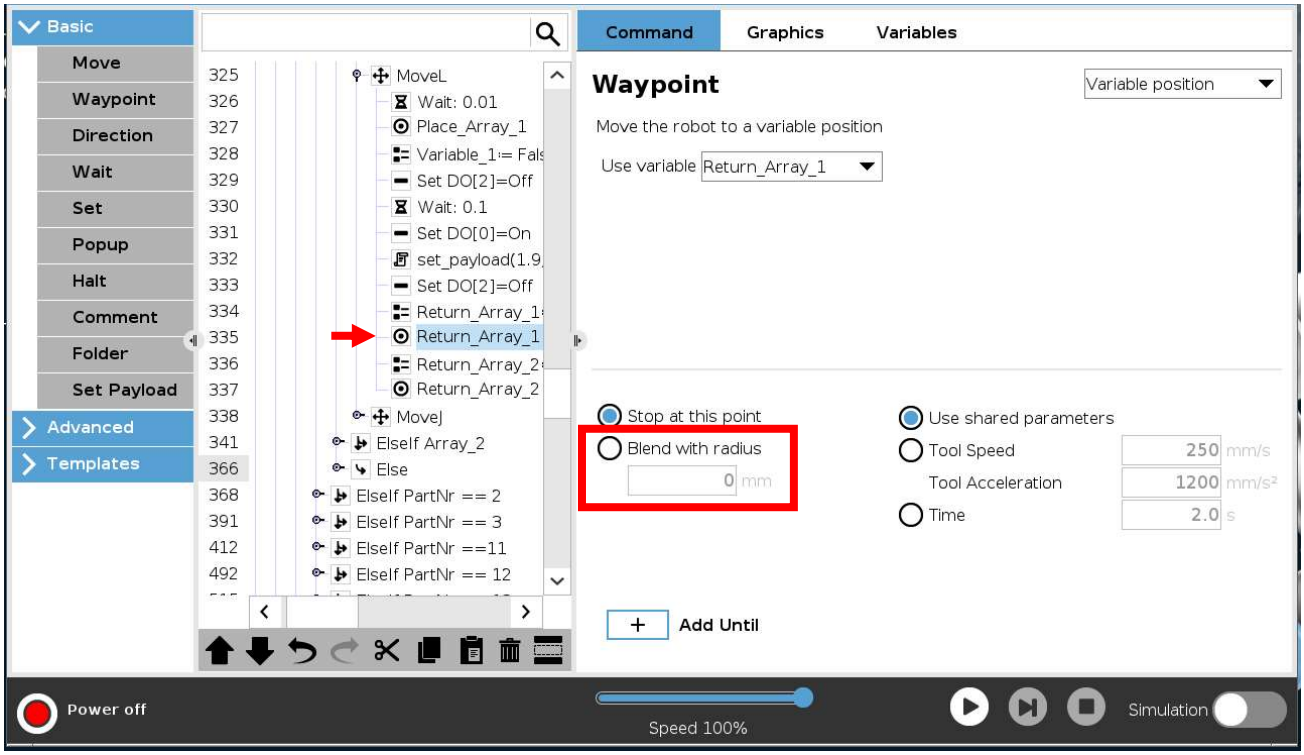
Recommendation

Make sure that all paths through the robot program generate continuous robot movement, i.e., a waypoint with a blend radius should not be followed by e.g. a wait, sync, halt, popup or similar blocking command. Remove the configured blend, or make sure the blended movement is continued into another move or stop command.

Missing use of blends

Observation

Potential blend candidates have been found, i.e. move commands followed by another move with no blend configured.



Script Line	Polyscope Line	Command
399	21	movel
416	30	movel
433	39	movel
8843	335	movel
9932	433	movel

Recommendation

Consider introducing blends at identified waypoints when the robot does not need to stop in this context. This is to ensure more smooth movements, avoid unnecessary accelerations and at the same time improve cycle time.

9. Functions

Overview of the recommendations ordered by importance and the expected impact.

Title	Severity
Use of deprecated functions	!

Use of deprecated functions

Observation

Use of deprecated functions.

Script Line	Polyscope Line	Deprecated Function	Alternative
258	0	set_payload(...)	set_target_payload(...)
1539	74	set_payload(...)	set_target_payload(...)
1752	76	set_payload(...)	set_target_payload(...)
1783	77	set_payload(...)	set_target_payload(...)
2132	635	set_payload(...)	set_target_payload(...)

Recommendation

Deprecated script functions are typically replaced by new ones with improved functionality that should be preferred.
It is recommended to use the new functions when deploying a new robot application or using an old program as a basis for a new deployment.

When upgrading the software on a robot or copying a PolyScope program from a robot with old software to a robot with newer software, the potential use of script functions that are deprecated in the new software will continue. This is to ensure compatibility and means that some old program nodes need to be updated to benefit from new features or to avoid mixing old and new behavior when new nodes are inserted in the program.

10. Software version

Overview of the recommendations ordered by importance and the expected impact.

Title	Severity
Up-to-date software versions	

Up-to-date software versions 

Observation

The robot is currently running PolyScope software version 5.11.11.

The latest version is 5.13.0.

Recommendation

A new software version is available. When deploying a new robot application, it is recommended to use up-to-date software.
The latest software update can be found here.
Instructions on how to perform updates can be found in the service manual.