ROBOTICS

Application manual

Servo Gun Setup

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Application manual

Servo Gun Setup

RobotWare 6

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Revision: E

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Original instructions.

Table of contents

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Overview of this manual

About this manual

This manual describes the steps of the Servo Gun Setup wizard that covers the setup necessary for most servo guns. This manual also contains a subset of the motion parameters used to configure a servo gun on the IRC5 controller. For a complete documentation on these and other motion parameters, see the *Application manual - Additional axes and stand alone controller*.

Usage

This manual should be used during setup of a servo gun for an IRC5 controller.

Who should read this manual?

The intended audience are servo gun manufacturers or advanced users, who need to tune a servo gun.

Prerequisites

The Servo Gun Setup wizard requires RobotWare 6.06 or later.

The reader should be familiar with:

- IRC5 programming and usage
- Additional axes (see *Application manual - Additional axes and stand alone controller*)
- RobotWare Spot Servo (see *Application manual - Spot options*)
- TuneMaster

References

Reference	Document ID
Application manual - Additional axes and stand alone controller	*3HAC051016-001*
Application manual - Spot options	*3HAC050979-001*
Application manual - Mechanical Unit Manager	*3HAC050959-001*
Operating manual - IRC5 with FlexPendant	*3HAC050941-001*
Operating manual - RobotStudio	*3HAC032104-001*
Technical reference manual - System parameters	*3HAC050948-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC050917-001*
Application manual - TuneMaster	*3HAC063590-001*

Note

The document numbers that are listed for software documents are valid for RobotWare 6. Equivalent documents are available for RobotWare 5.

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Revisions

Revision	Description
A	First edition.
B	Added installation description.
C	• Added possibility to run speed limit and acceleration tuning also in manual full speed mode. • Delta position check restricted only to manual operating mode. • Corrected a problem with transmission check.
D	• Misc. documentation improvements. • Added possibility to enter a decimal value in transmission check. • Added possibility to enter acceleration data manually. • Reduction of Teach Max Speed Main/DSP at the end of tuning. • Added speed limit information displayed on TPU. • Max torque reduced at the end of tuning. • Added possibility to run force calibration again after completed tuning. • Other minor improvements.
E	Released with RobotWare 6.12. • Added information about Movable Gun Arm Search.

Product documentation

Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.

Tip

All documents can be found via myABB Business Portal, *www.abb.com/myABB*.

Product manuals

Manipulators, controllers, DressPack/SpotPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

Technical reference manuals

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

Application manuals

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.
- Examples of how to use the application.

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Operating manuals

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and troubleshooters.

1 Introduction

1.1 About Servo Gun Setup

Basic approach

For most servo guns it is enough to follow the Servo Gun Setup wizard, see *Servo Gun Setup wizard on page 17*. Here you can specify known data or, in many steps of the wizard, get recommended values for good performance.

Gun families

Within the same family, guns share mechanical characteristics such as motor, transmission ratio, friction (to some extent), stiffness, inertia, max allowed force, arm length and max opening distance.

The force may vary somewhat between guns of the same family. The reason is that the friction level, which has some influence on force, often differs a lot within the family. Therefore a force calibration and an update of the delta position should always be done for each individual gun.

Gun design

The design of the gun also affects the tuning procedure. Flexible copper gun arms driven by linear actuators are the easiest guns to tune. Aluminum arms are rigid and present a challenge.

The recommendations and start values in this manual are mainly intended for guns with copper arms.

1.2 Requirements

Requirements on motor and resolver

The motor and resolver should comply with the requirements given in *Application manual - Additional axes and stand alone controller*.

Spot Servo option required

Use a system with the RobotWare Spot Servo option installed.

Measuring equipment

The following equipment is required:

- Force calibration sensor (required for force measurements)
- Dial indicators (optional for gun deflection measurements)

TuneMaster

The TuneMaster program is useful for studying signals for position, speed, torque, etc. It is not required when using the Servo Gun Setup wizard, but if there is some unwanted behavior, TuneMaster is useful for detecting what happens and what parameter that may need to be tuned.

TuneMaster can be downloaded from:

http://new.abb.com/products/robotics/robotstudio

System parameters

For the normal procedure, the configuration of most system parameters will be done automatically by the Servo Gun Setup wizard. For some cases, there may be a need to manually configure system parameters.

A list of the system parameters that are primarily of interest when configuring a servo gun is presented in *System parameters on page 57*. Detailed description of the system parameters are found in *Technical reference manual - System parameters*.

How to set system parameters with RobotStudio is described in *Operating manual - RobotStudio*.

How to set system parameters with the FlexPendant is described in *Operating manual - IRC5 with FlexPendant*.

1.3 Preparations

Tool and payload settings

Before using Servo Gun Setup, the tool and the payload must be defined correctly.

Basic verification

Find out if there are any basic problems (i.e. bad parameters or ripple). These problems must be fixed before the tuning of force and position control is started.

For complete speed tuning, see *Application manual - Additional axes and stand alone controller*.

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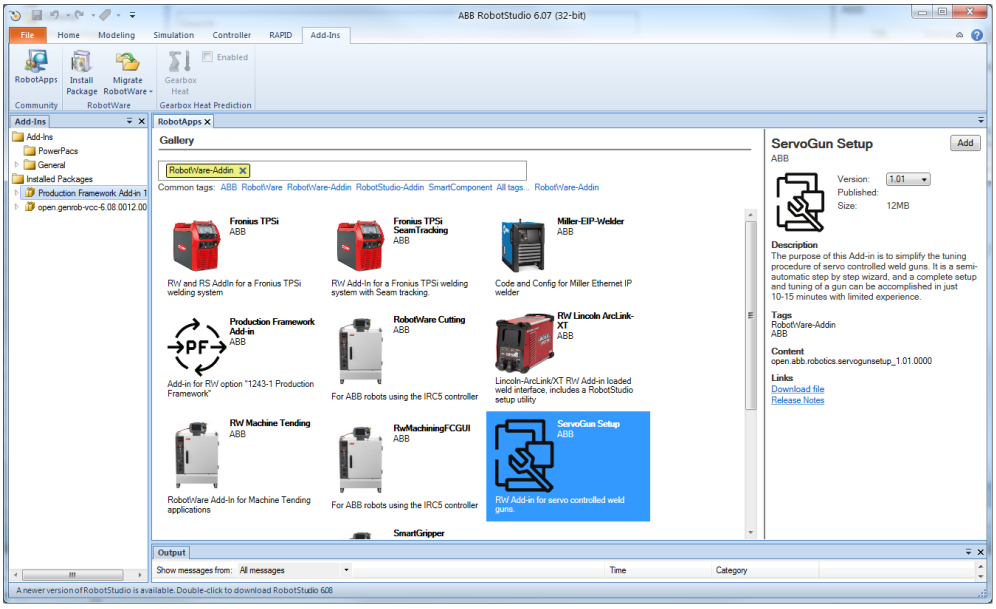
2 Installation

Installing the Servo Gun Setup Add-in

1 In RobotStudio, click on the **Add-Ins** tab.

2 Select **ServoGun Setup**.

3 In the frame to the right, click **Add**.



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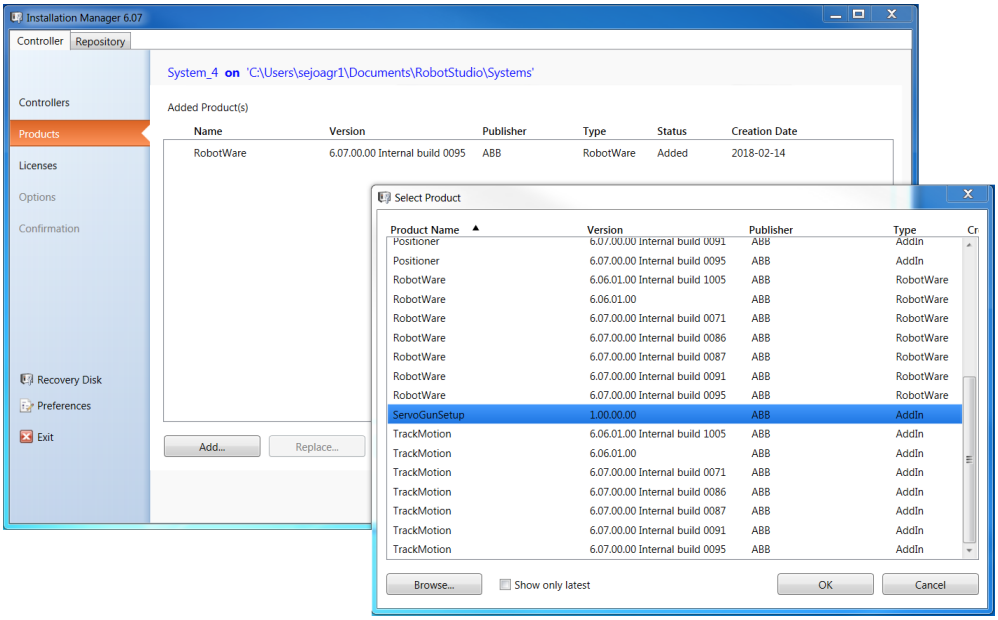
Adding Servo Gun Setup to a system

The product **ServoGunSetup** can be added when creating a new system, or added to an existing system. In both cases it is done in Installation Manager in RobotStudio. In the tab **Products**, add **ServoGunSetup** in the same way as **RobotWare**. For more information about the Installation Manager, see *Operating manual - RobotStudio*.



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3 Servo Gun Setup wizard

3.1 How to use the Servo Gun Setup wizard

The parts of Servo Gun Setup

Servo Gun Setup is a wizard that step-by-step takes you through the following:

- Load system parameter configuration file
- Change motor type
- Change connection
- Change gun specific data
- Fine calibration
- Tune servo gun, which can be divided into:
  - Tune transmission
  - Set alarm torque
  - Check delta collision position (initial value)
  - Force calibration (initial value)
  - Tune speed limit
  - Tune acceleration
  - Check delta collision position (final value)
  - Force calibration (final value)
  - Tune gun deflection parameters
- Save the configuration

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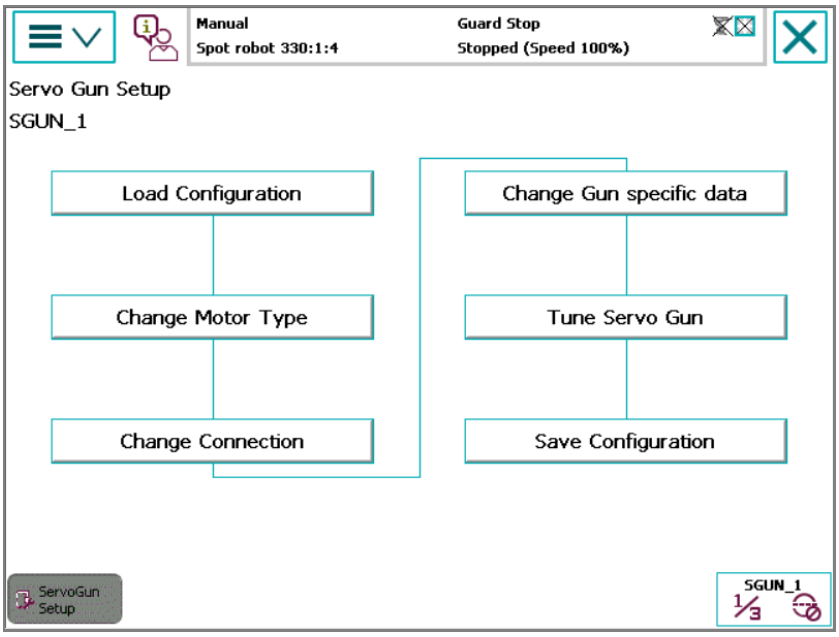
Main view

By going through the wizard, step by step, all these parts are being set up automatically. In some steps, there is a button **Main view** that takes you to an overview of the setup wizard:



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Tapping on one of the parts will take you directly to that part of the wizard (if you only want to use one part of the Servo Gun Setup).

Meaning of buttons

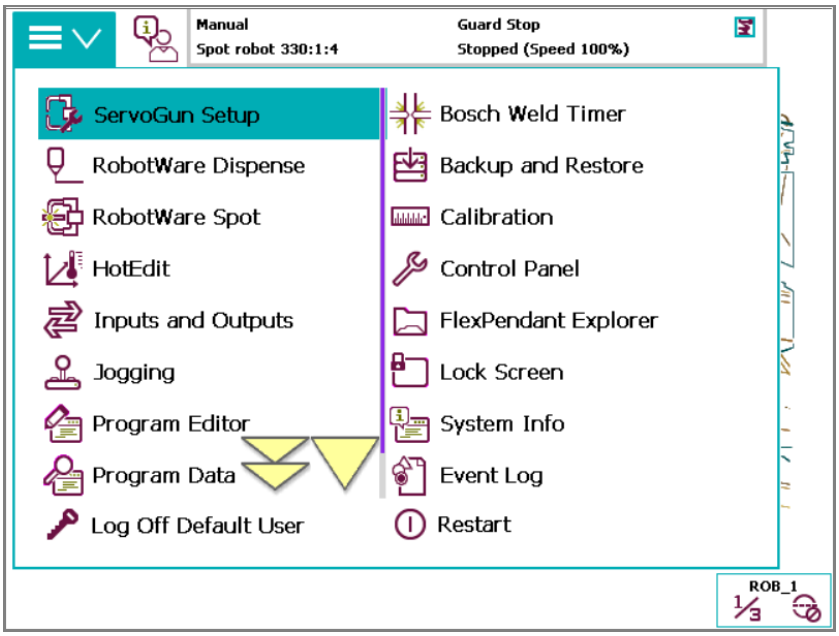
The steps of the Servo Gun Setup provides different choices.

- **Next** - Continue to the next step.
- **Back** - return to the previous step.
- **Skip** - Skips this part of the setup and jumps to the next part.
- **Change** - Manually enter a value yourself instead of accepting the suggested value.
- **Update** - Update the controller with the value suggested by Servo Gun Setup.

3.2 Running the Servo Gun Setup wizard

Start Servo Gun Setup

On the FlexPendant, tap the **ABB** menu and select **ServoGun Setup**.



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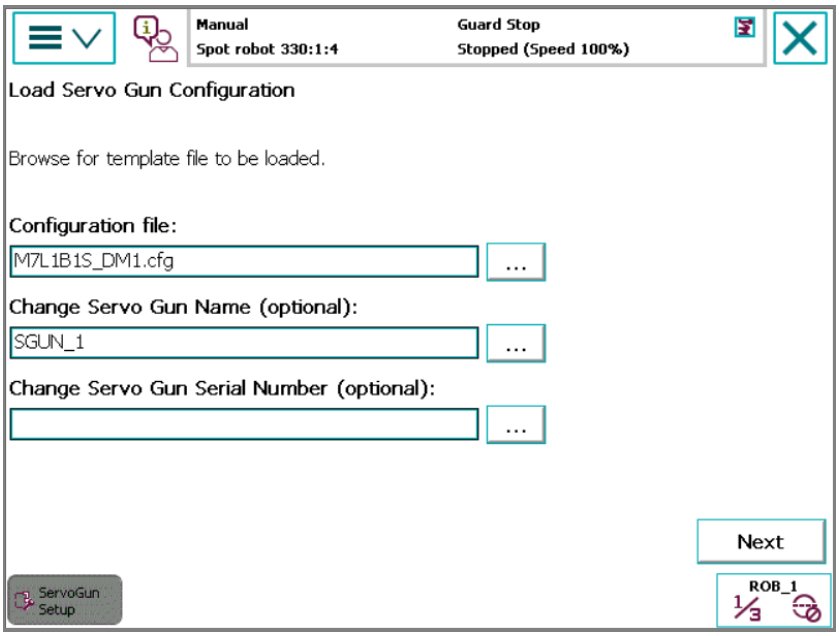
Load configuration

Load a system parameter configuration file for a servo gun. Browse to select the desired template file. For more information about template files, see *Application manual - Additional axes and stand alone controller*.

If you want to change the name of the servo gun, type the new name.

If you want, you can add the serial number of the servo gun. This will then be included in the saved data.



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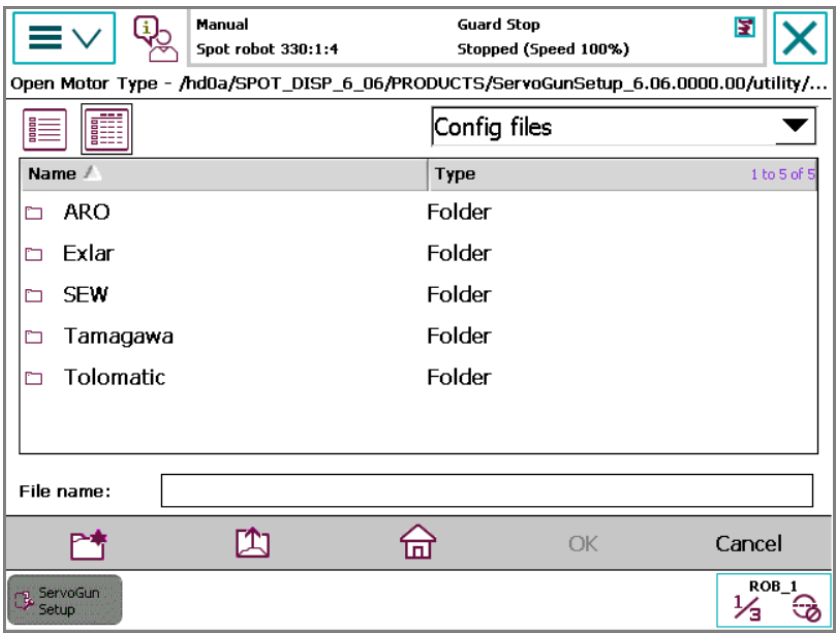
Change motor type

Load a file with the motor data. The motor type file can be on the controller or loaded from a USB. For information about the motor type file, see *Motor type file on page 77*.

1 Browse to select the file for your servo gun motor, then tap **OK**.



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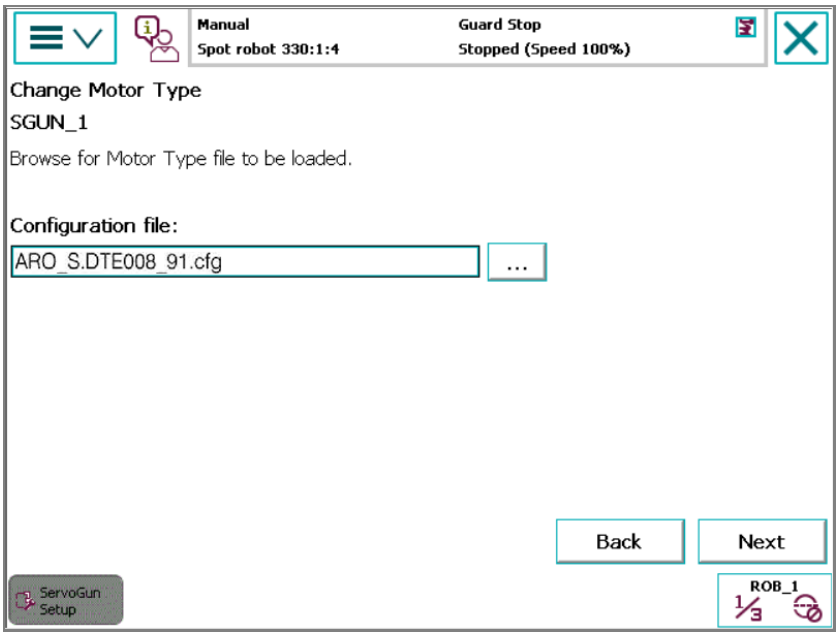
2 When a file is selected, tap **Next**.



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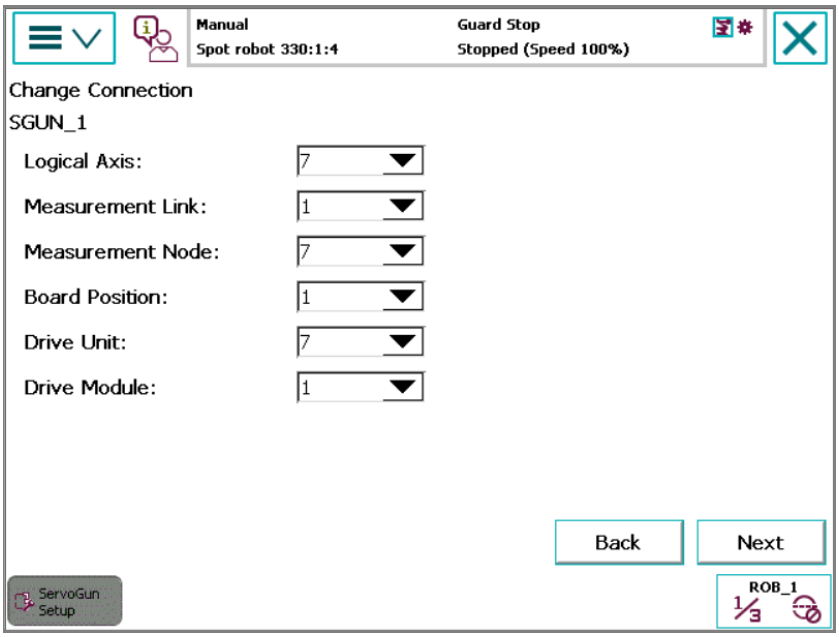
Change connection

If previously loaded configuration file does not have the correct settings, change them to the values that apply to your servo gun. For information about the measurement system, see *Application manual - Additional axes and stand alone controller*.

Tap **Next**.



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Change gun specific data

The default values comes from `Stress Duty Cycle` in the motor type file.

The **Temporary Max Torque** is used during the first steps of the tuning, until it is known how much torque is needed to reach the desired max force. If the max

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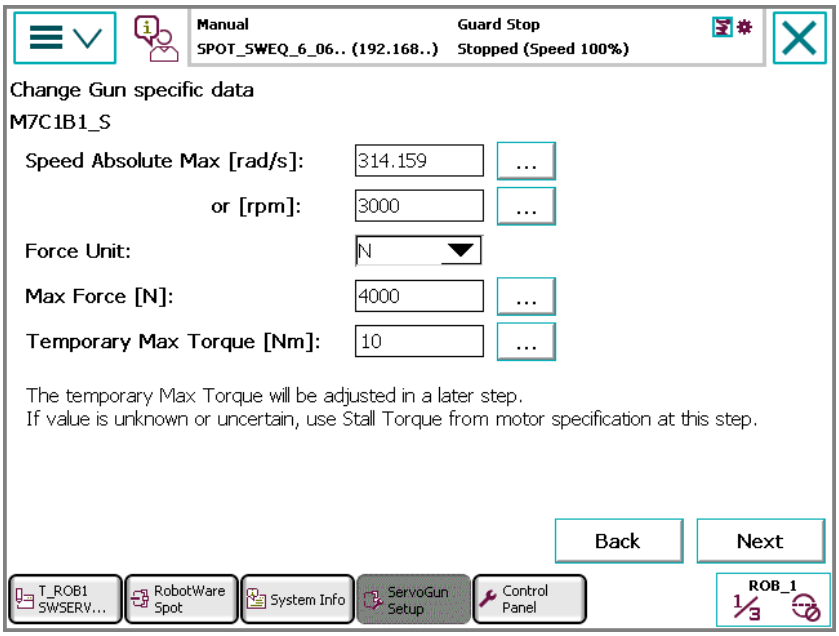
torque is not known, use the stall torque or the continuous torque from the motor data sheet.

1 If needed, change values. Then tap **Next**.



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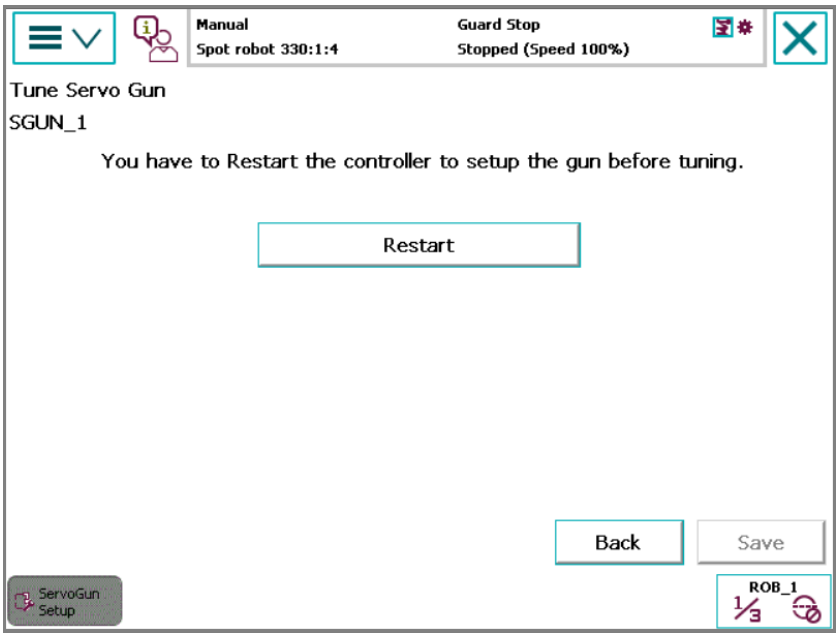
2 A restart is required for the changes to take effect. Tap **Restart**.



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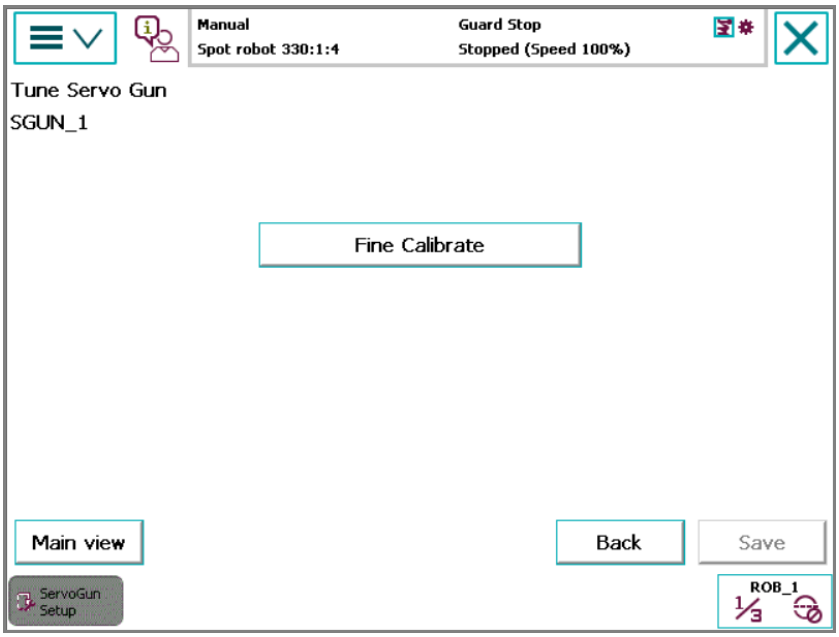
Fine calibration

After restart, the following page is shown if the servo gun is not already fine calibrated. Press **Fine Calibrate** to perform this calibration.



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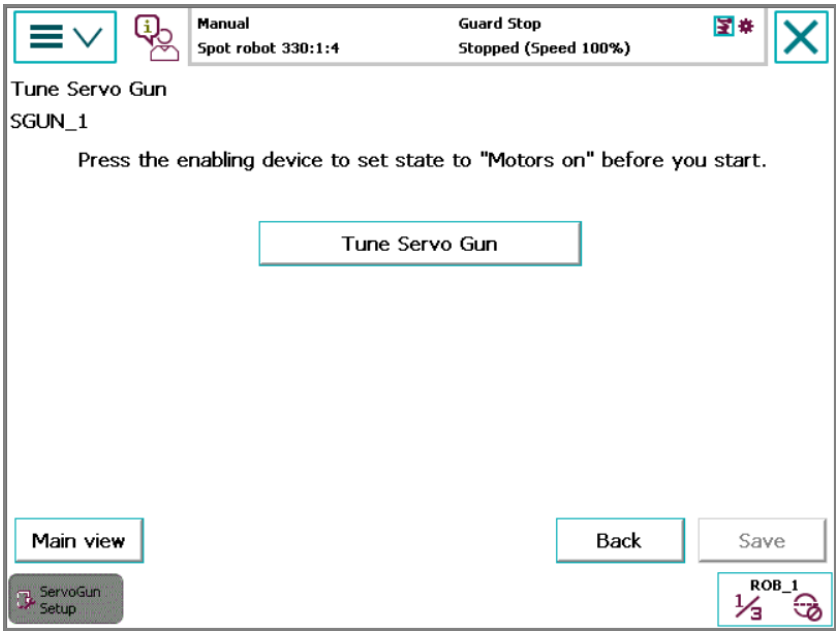
Tune servo gun

1 To start the routine that tunes the servo gun, press the enabling device on the FlexPendant and tap **Tune Servo Gun**.



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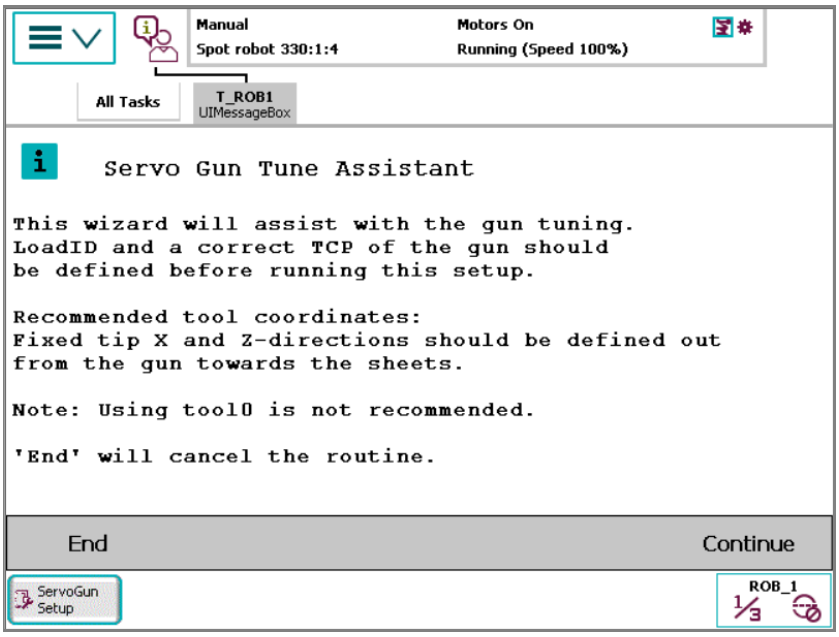
2 Tap **Continue**.



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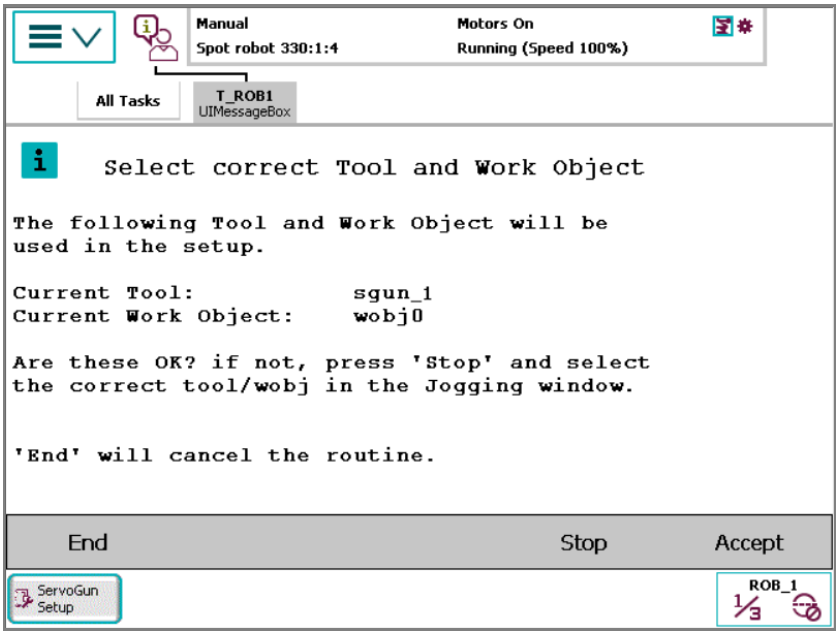
3 If the correct tool and work object is used, tap **Accept**.



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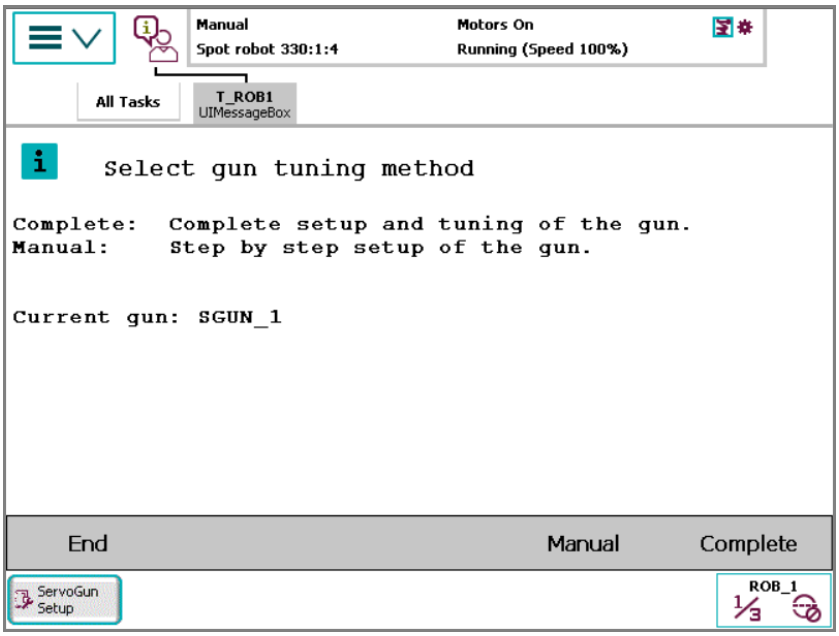
4 To let the wizard perform a complete tuning, tap **Complete**.
To manually perform selected steps of the tuning, tap **Manually**.



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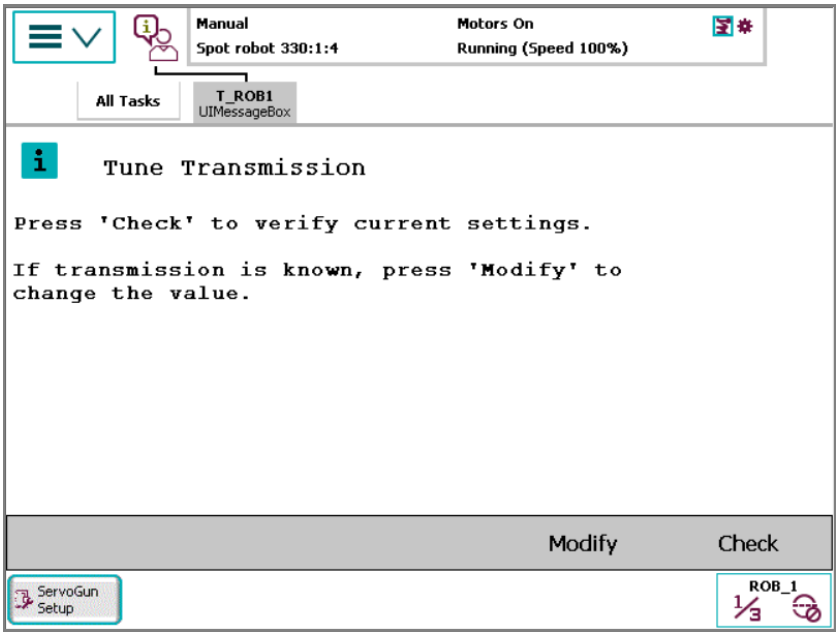
Tune transmission

1 If the transmission gear ratio is known, tap **Modify** and type the value.
To automatically detect the transmission, tap **Check**.



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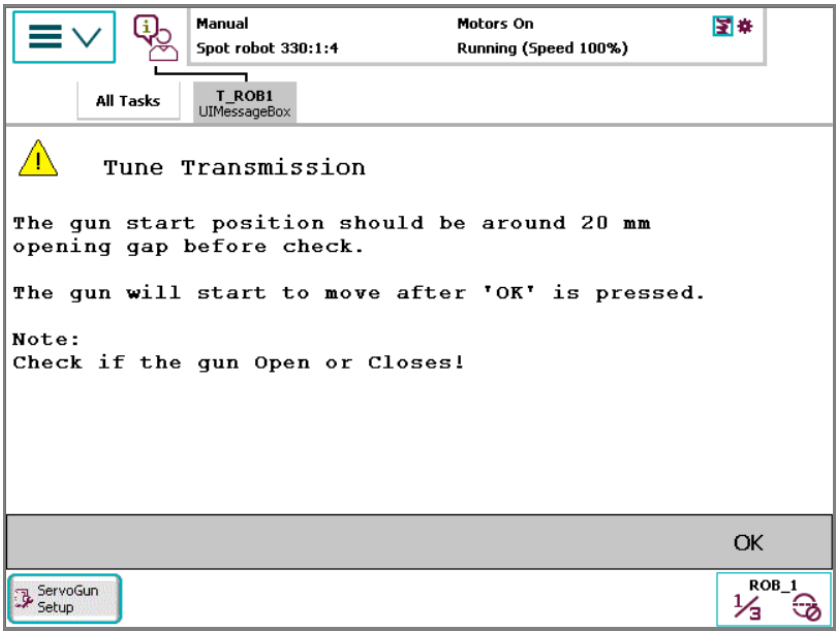
2 Make sure the gun is opened approximately 20 mm. If not, open the Jogging window and jog the servo gun to 20 mm.

Observe the servo gun when pressing **OK**.



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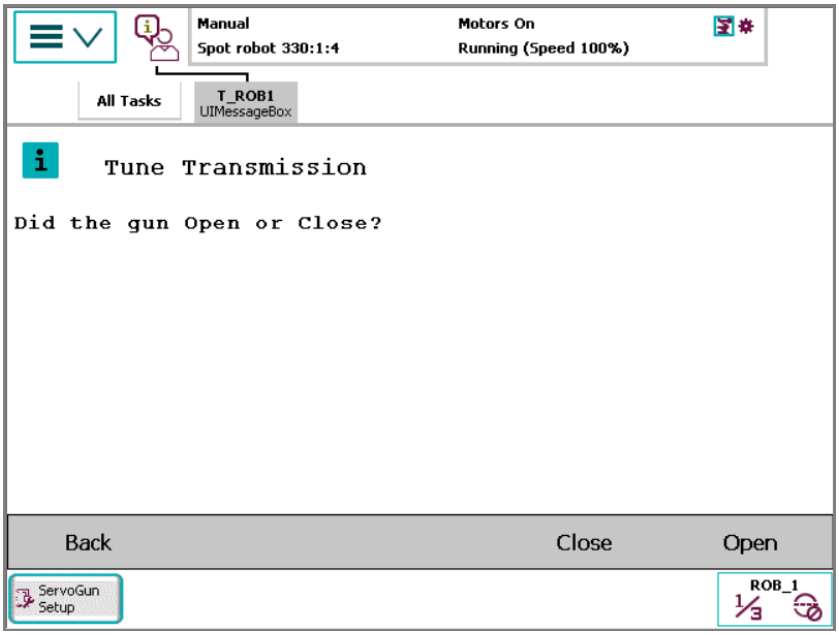
3 Observe the direction of the movement. If the gun opened, tap **Open**. If the gun closed, tap **Close**.



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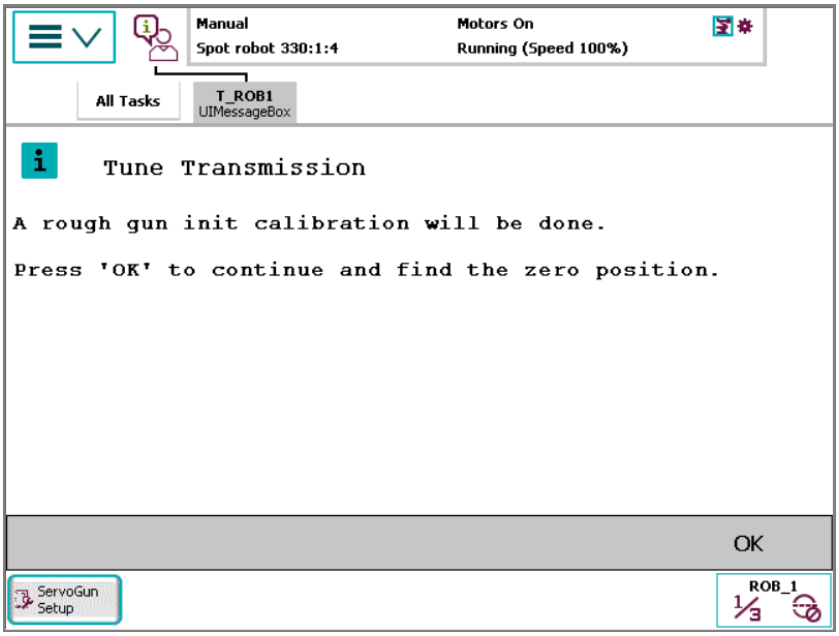
4 Tap **OK** to do an `STCalib` with low force to find an initial value for the servo gun's zero position.



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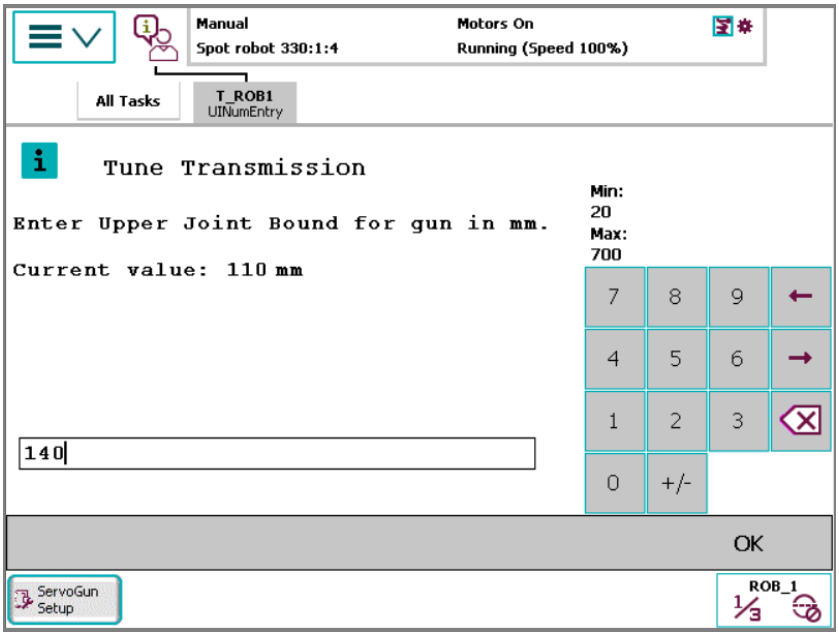
5 Type the upper limit of the servo gun opening and tap **OK**.



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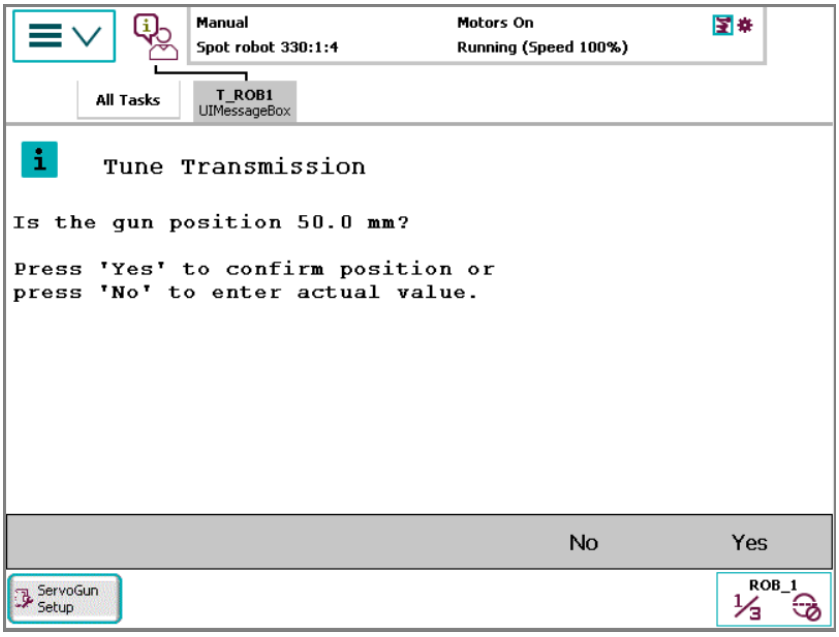
6 Measure the gun opening. If it is not exactly 50 mm, tap **No** and type the measured value.



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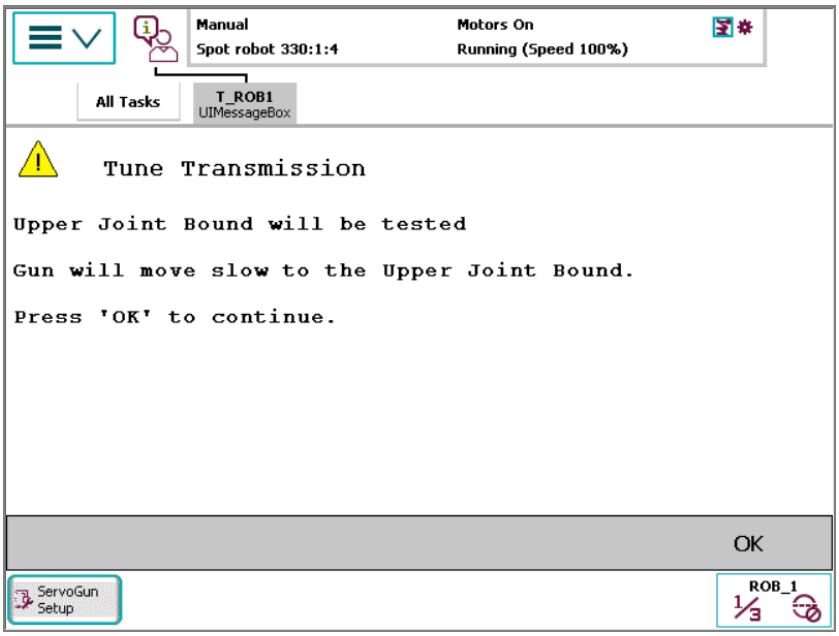
7 Tap **OK** to continue.



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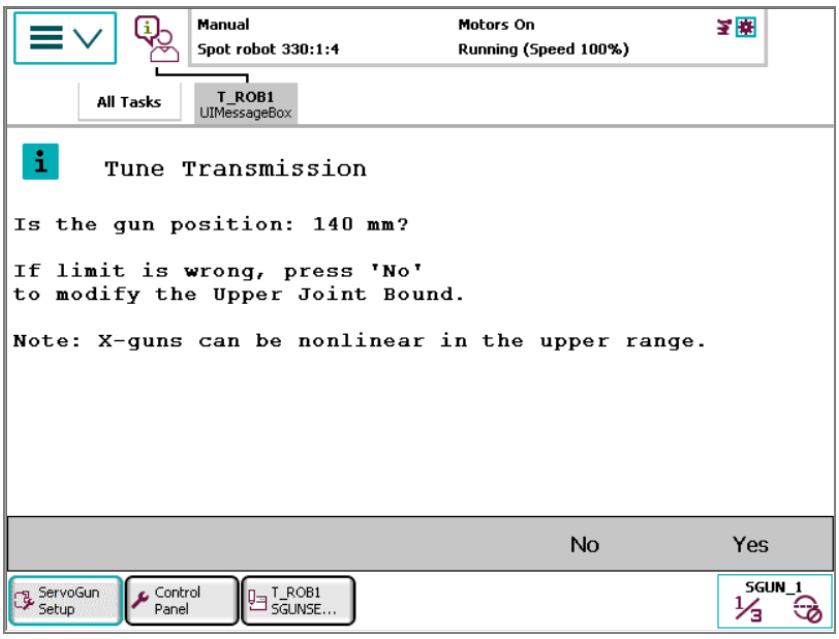
8 Measure the gun opening. If the measured value is not equal to the the value in the text (140 mm in our example), tap **No** and type the measured value.



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Note

X-guns are more or less non-linear. It may be necessary to accept a position error in the upper range. The important thing is that they are accurate in the lower range.

See the following illustration.

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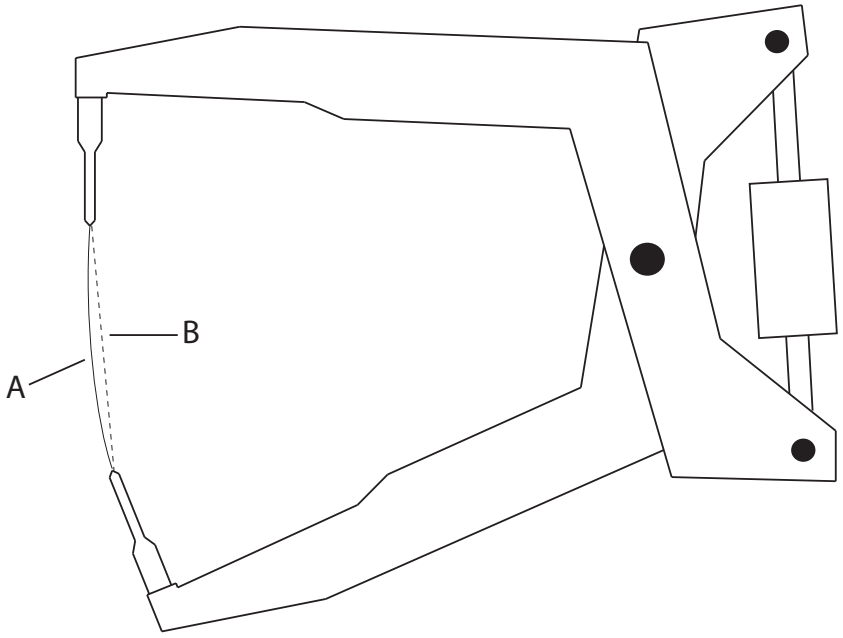

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A	The servo gun movement follows a circular arc path.
B	The measured distance between the tips.

The presented value is based on the servo gun movement which is longer (for example 140 mm) than the measured distance between the tips (for example 138 mm). The greater the angle the x-gun opens to, the greater the difference will be.

Continues on next page

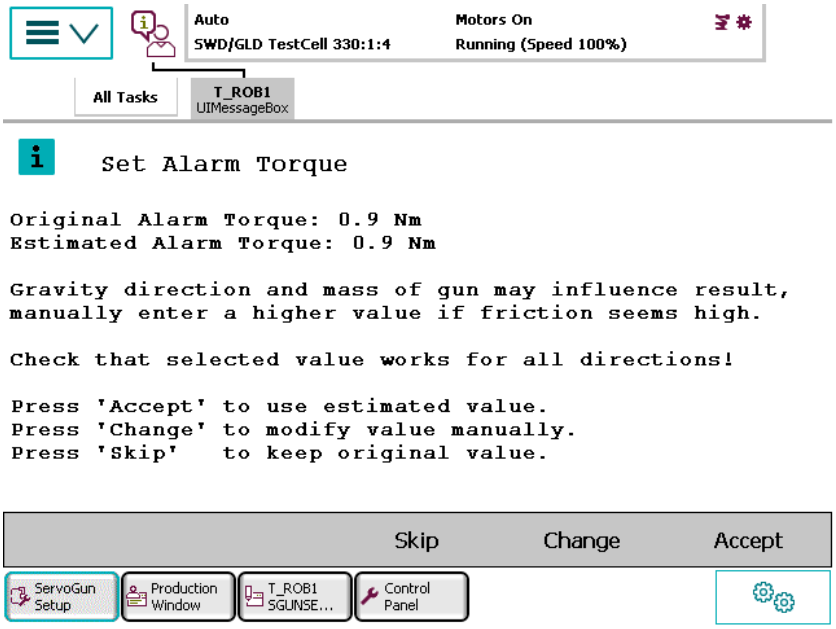
Set alarm torque

The gun will move slowly to measure the friction torque. An estimated alarm torque is then presented.

Tap **Accept** to use the estimated value.

Tap **Change** to type a value.

Tap **Skip** to keep the original value.



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Note

Depending on the gravity direction and mass of the moveable gun arm, the measured value may need to be increased manually.

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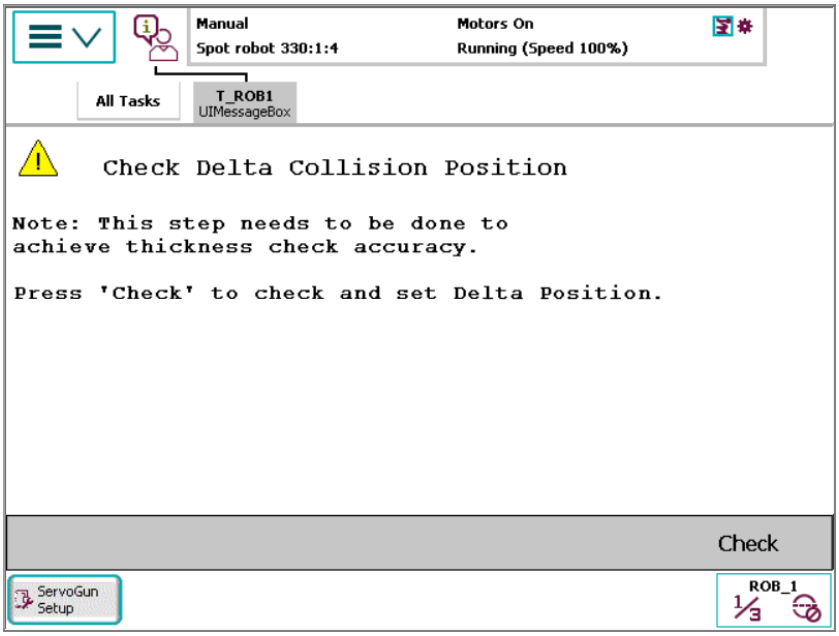
Check delta position (initial value)

The robot controller shall be in Manual speed mode.

1 Finding the servo gun's zero position is necessary to have an initial value for thickness estimation.

Tap **Check** to perform this.



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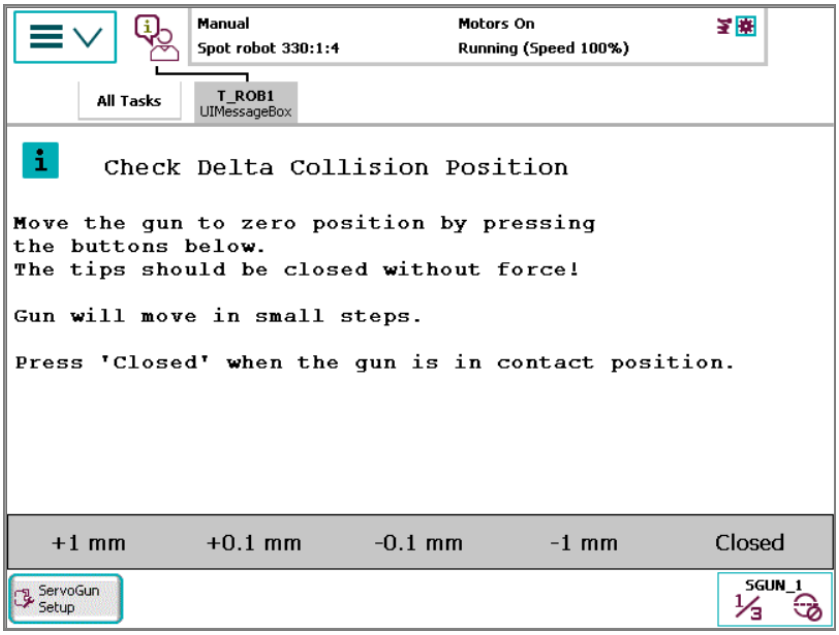
2 Look at the gap and tap the buttons to adjust the gap until it is closed without any force.

Tip: If the gun is closed, tap **+0.1 mm** until there is a visible gap, then tap **-0.1 mm** to close the gap.

When the gun is closed, tap **Closed**.

Note

It is important that there is no force applied on the servo gun tips.



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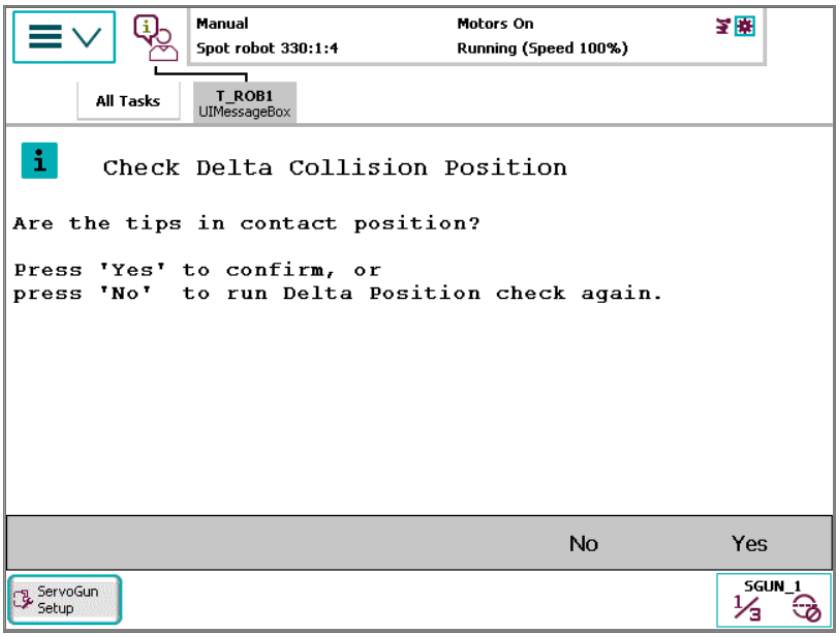
3 The gun opens and closes.

If the tips are in contact after this, tap **Yes**.

If the tips are not in contact, tap **No** to redo the check of delta collision position.



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Force calibration (initial value)

For this initial force calibration, it is enough to use two measurements at different force levels. Repeat the procedure until approximately reaching the max force (typically 2-3 times).

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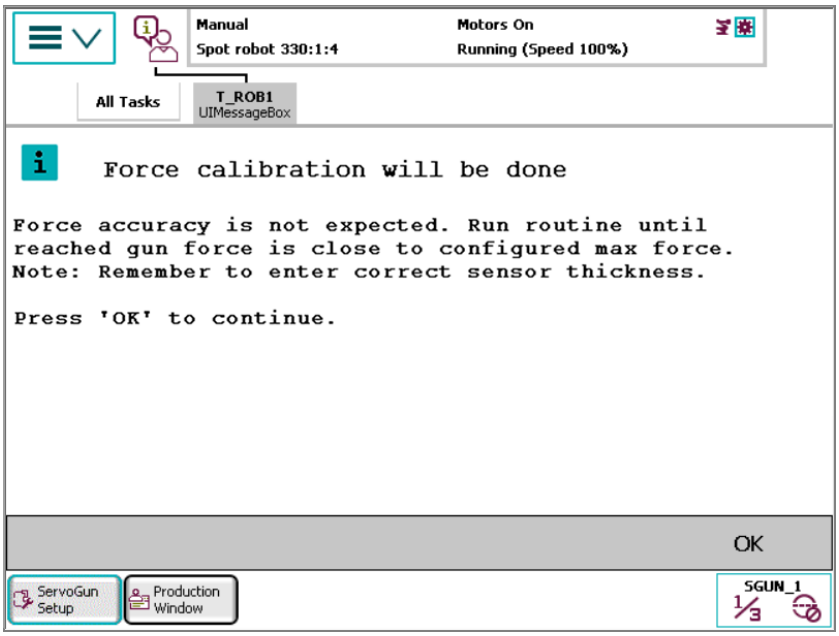
Do not expect good repeatability in this initial force calibration. A more precise force calibration is made later in the wizard.

1 Tap **OK** to continue with the force calibration.



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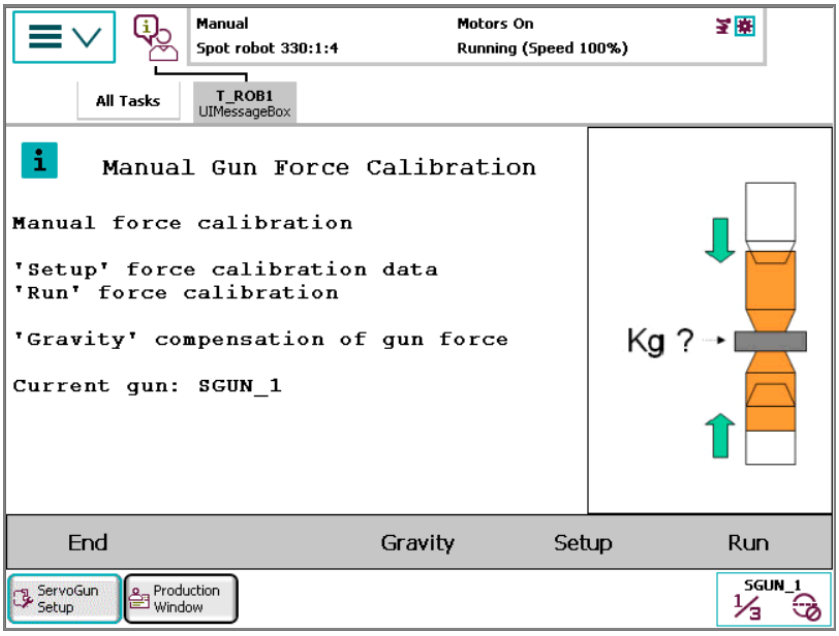
2 Tap **Setup**.



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3 By default, the force calibration is performed by doing two force measurements (typically at half max force and at max force). To change number of measurements, tap **1** and then enter the number of measurements.

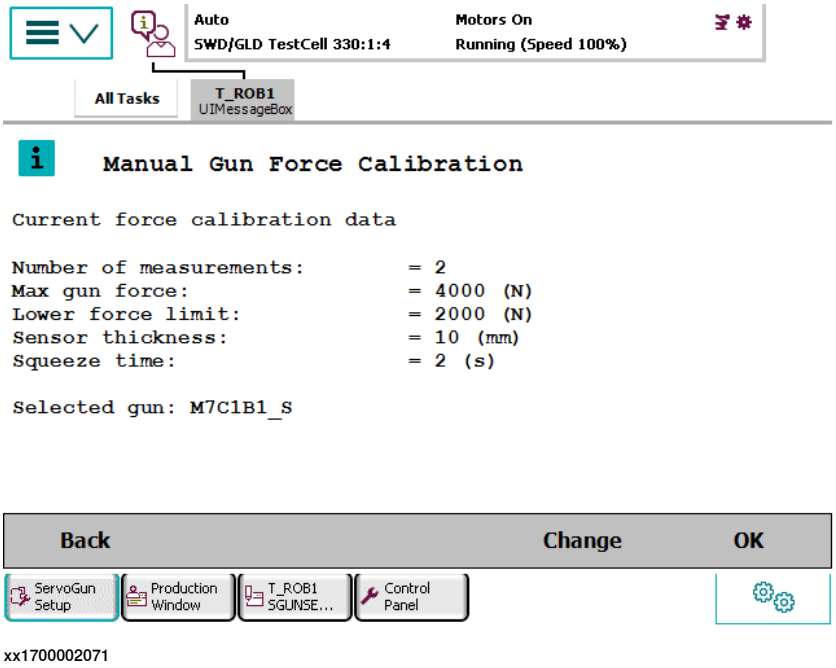
To change the max force that the servo gun shall reach, tap **2** and then enter the new value.

To set the sensor thickness, tap **3** and enter the thickness of the sensor.

> **CAUTION**
>
> Incorrect value of the sensor thickness can damage the servo gun.

To change the time that the servo gun maintain the specified force, tap **4** and enter the new time.

When the setup is done, tap **Back**.



xx1700002071

4 To start the force calibration, tap **Run**.

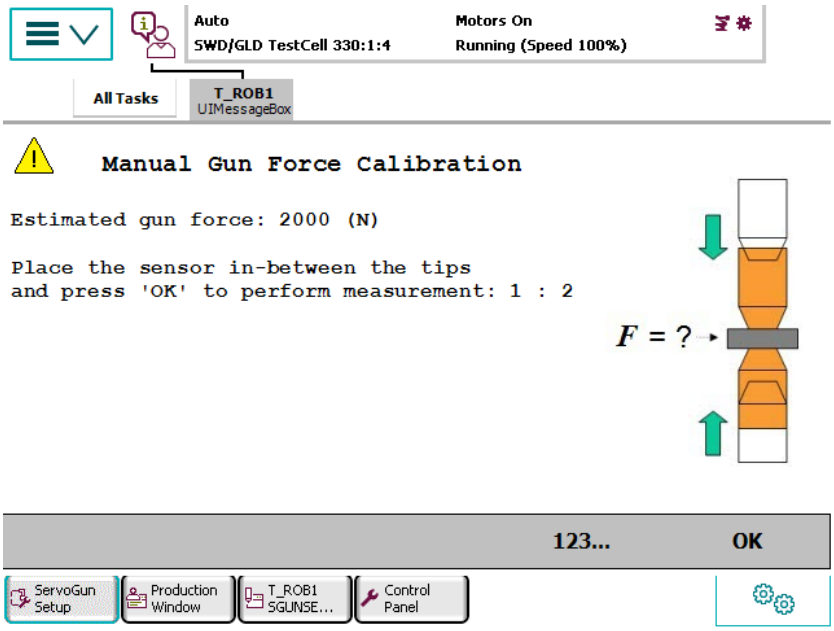
5 Verify that the setup and tap **OK** if it is correct.

Continues on next page

6 The default force for the first measurement is half the max force. To change it, type a new value.

Hold the force sensor between the gun tips.

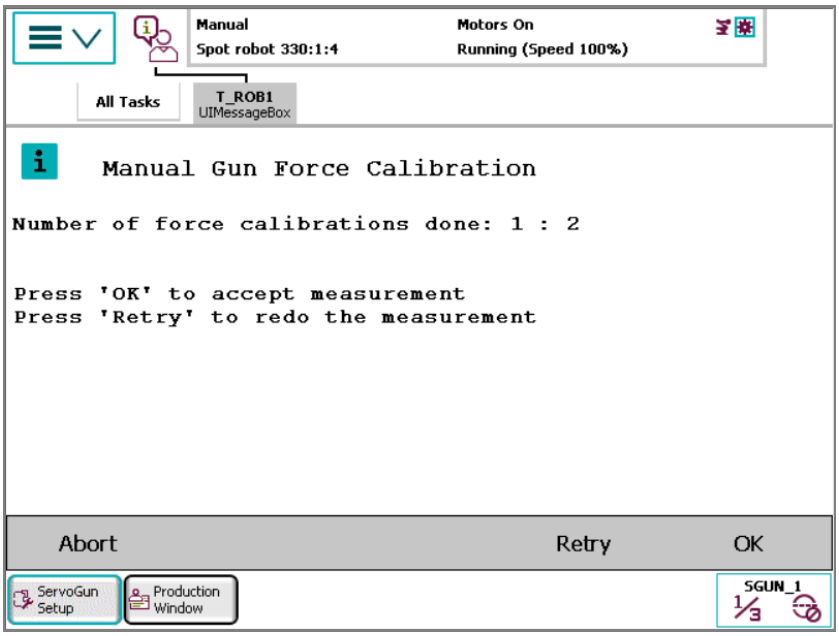
Tap **OK** and read the measured force on the force sensor.



xx1700002073

7 If the measurement was successful and you read the value, tap **OK**.

If you missed reading the value on the force sensor, just tap **Retry**.



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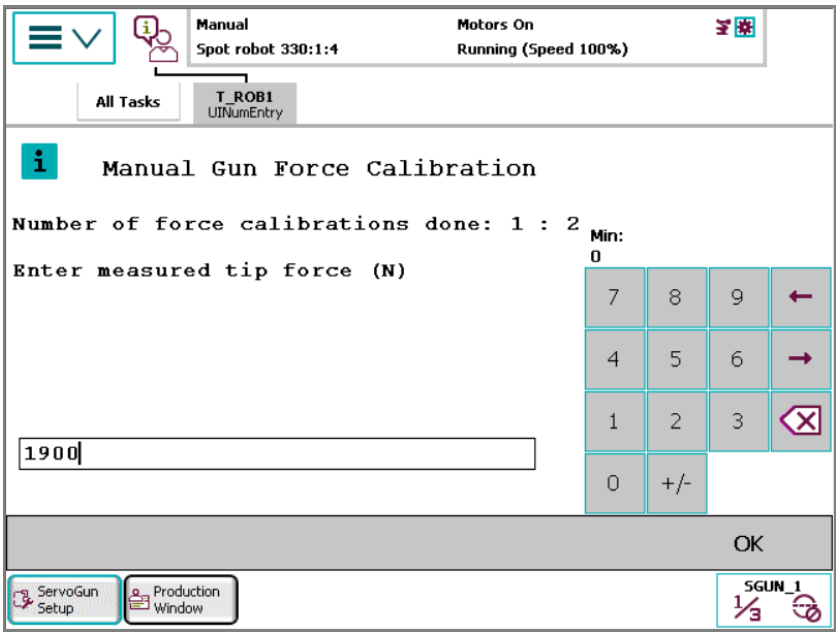
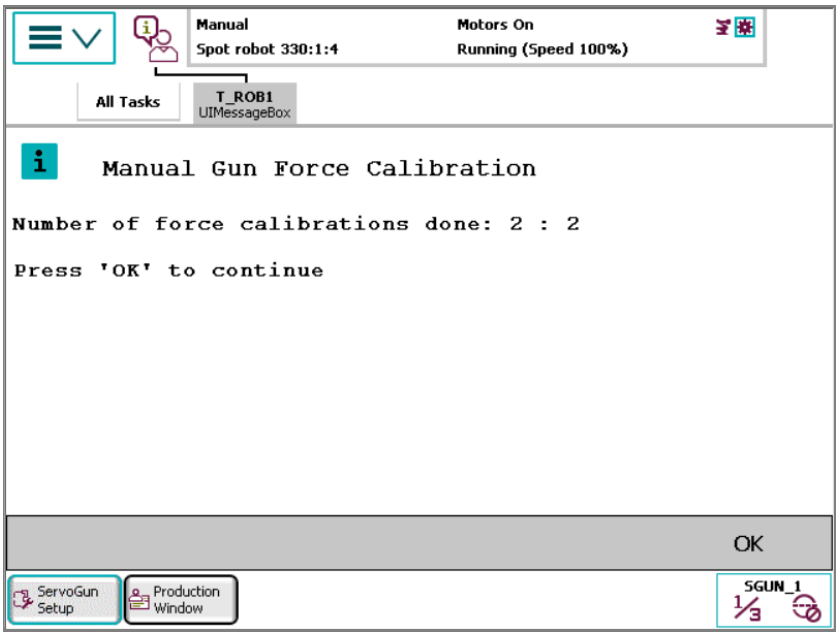
8 Type the measured value and tap **OK**.



xx1700002075

9 Repeat step *6-8* for the second measurement, but with max force. (If more than two measurements are used, repeat for each measurement with increasing force.)

10 Tap **OK**.



xx1700002076

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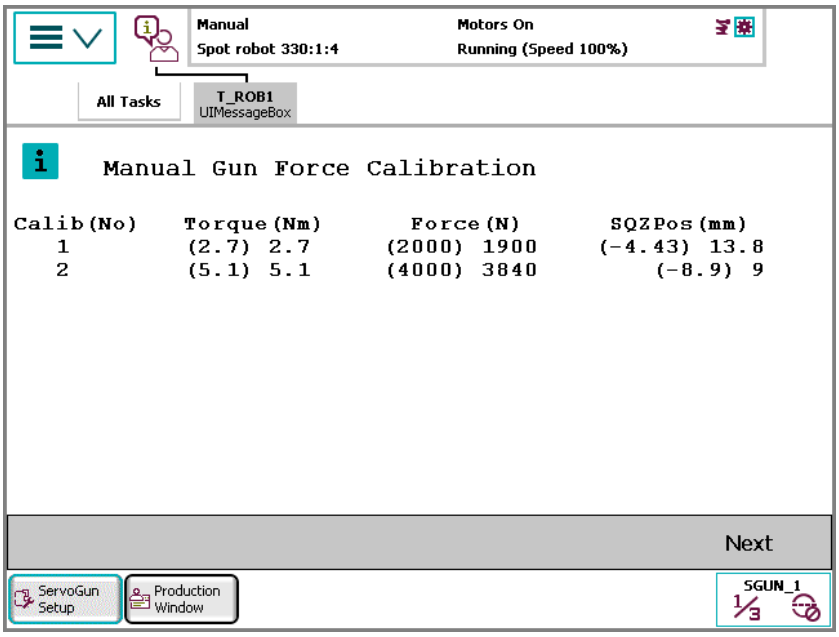
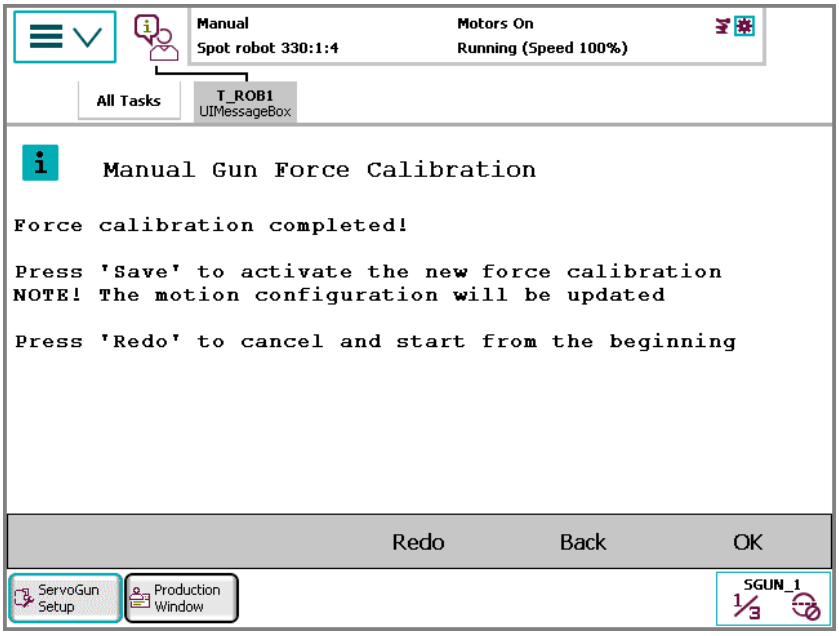
11 The torque and force of the measurements are presented. Tap **Next**.



xx1700002077

12 Tap **OK** to update the servo gun's force calibration with the new measurements.



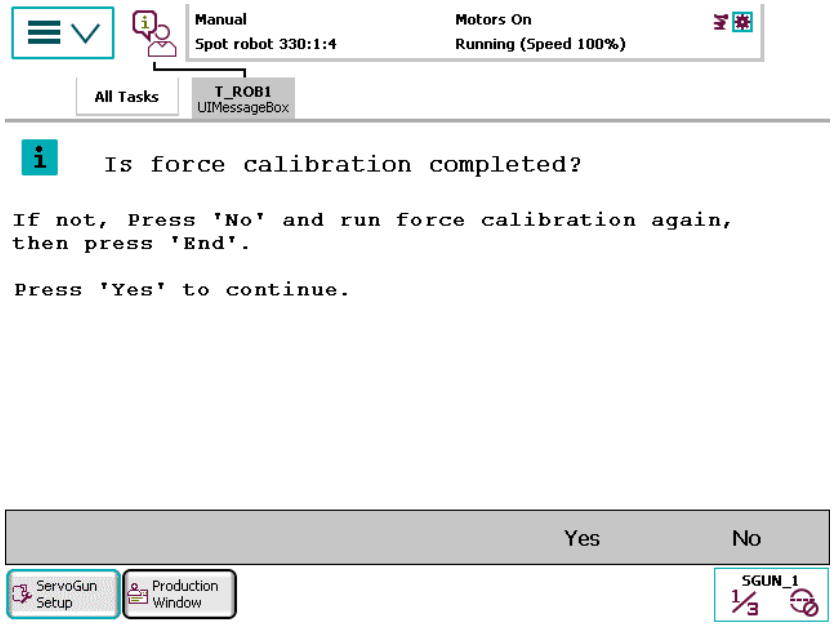
xx1700002078

13 Repeat step *4* to *12* until the max force has been reached (typically 2-3 times). Then tap **End**.

If the temporary max torque (see *Change gun specific data on page 22*) was set too low, you will be asked if this value can be increased in order to achieve the desired force.

Continues on next page

14 Confirm that the desired max force was reached by tapping **Yes**.



xx1700002079

Tune speed limit

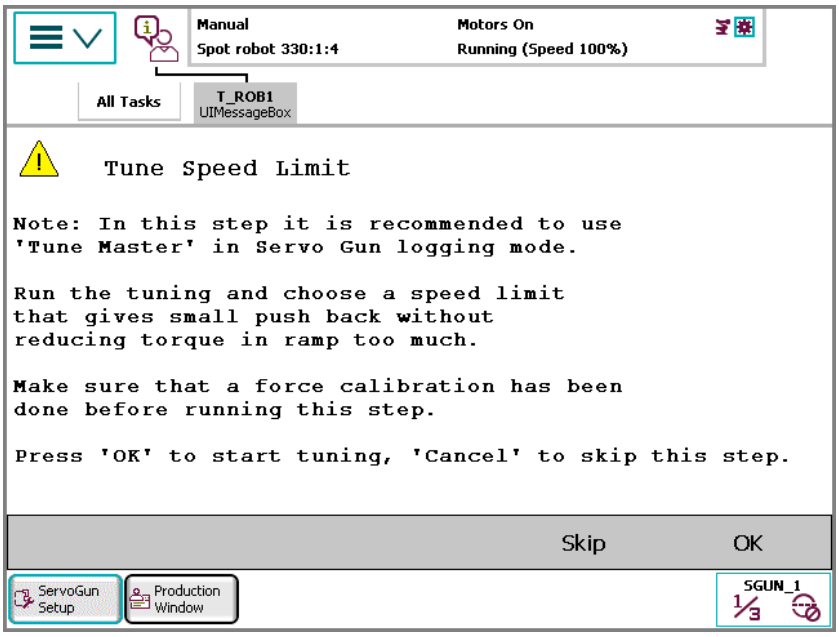
Tip

A recommendation is to use TuneMaster to view relevant signals during the speed tuning. If any problems occur, this can help you study the course of events in detail. For more information, see *Speed limit tuning on page 68*.

1 Set the robot controller in Auto or Manual full speed mode and press the start button ( ) on the FlexPendant to resume the wizard.

Continues on next page

2 Tap **OK** to perform an automatic tuning of the speed limit.



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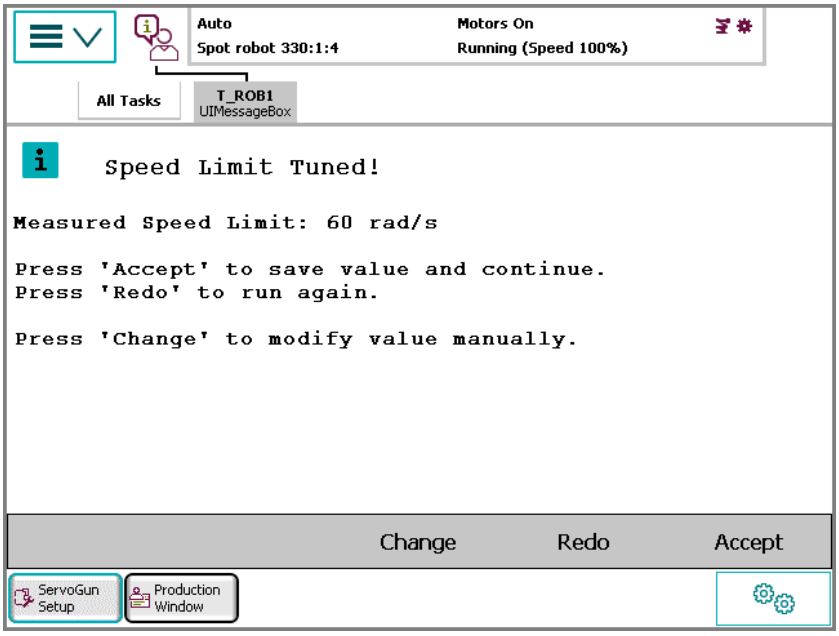
3 The servo gun will close to force mode several times to test the speed limitation during force mode. A suggested speed limit is presented. Tap **Accept** to set this value as speed limit or tap **Change** to set the speed limit manually.



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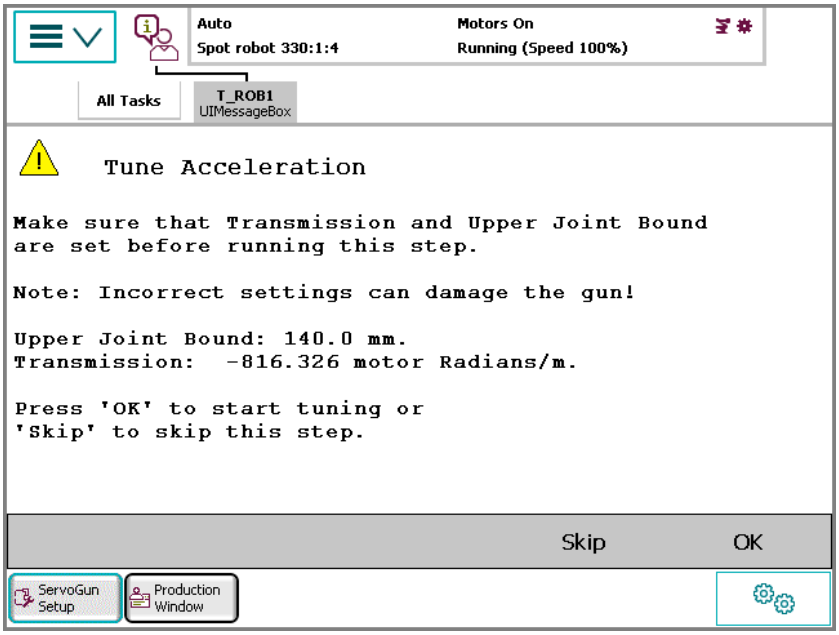
Tune acceleration

Tip

A recommendation is to use TuneMaster to view relevant signals during the acceleration tuning. If any problems occur, this can help you study the course of events in detail. For more information, see *Acceleration tuning on page 69*.

The robot controller shall be in Auto or Manual full speed mode.

1 Make sure the Upper Joint Bound and Transmission are correct, and then tap **OK** to perform an automatic tuning of the acceleration.



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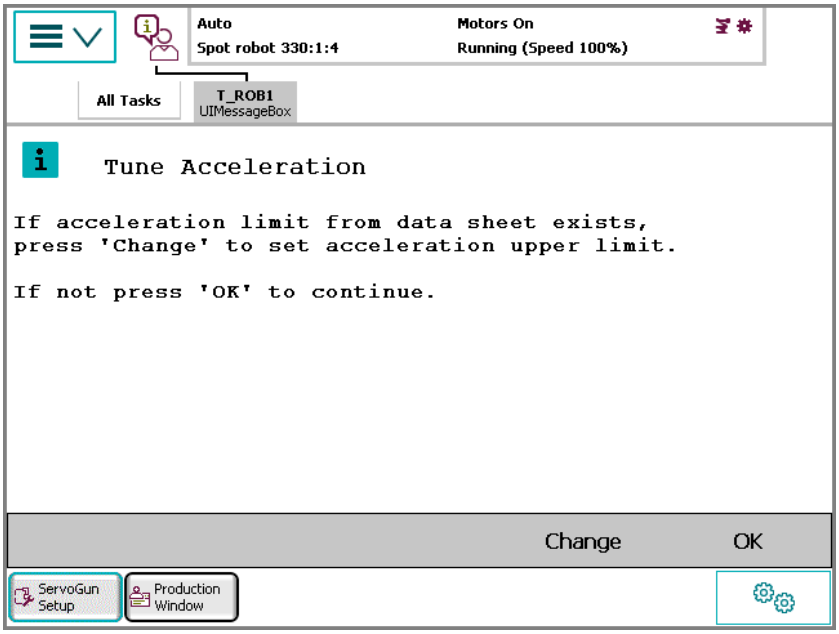
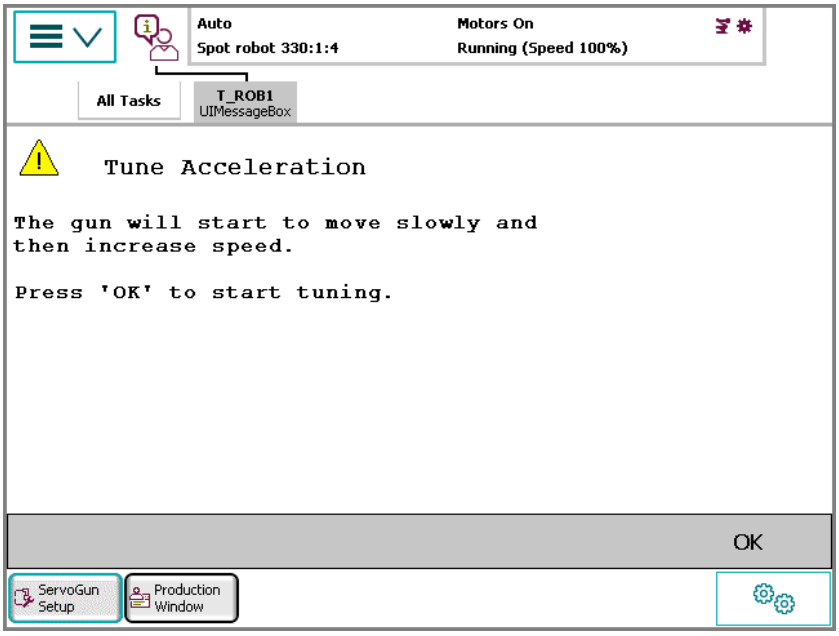
2 If there is a known upper limit from data sheet or mechanical design, tap **Change** and enter the value.

If the acceleration limit is unknown, tap **OK** to detect it automatically.



xx1700002083

3 Tap **OK** to start the tuning.



xx1700002084

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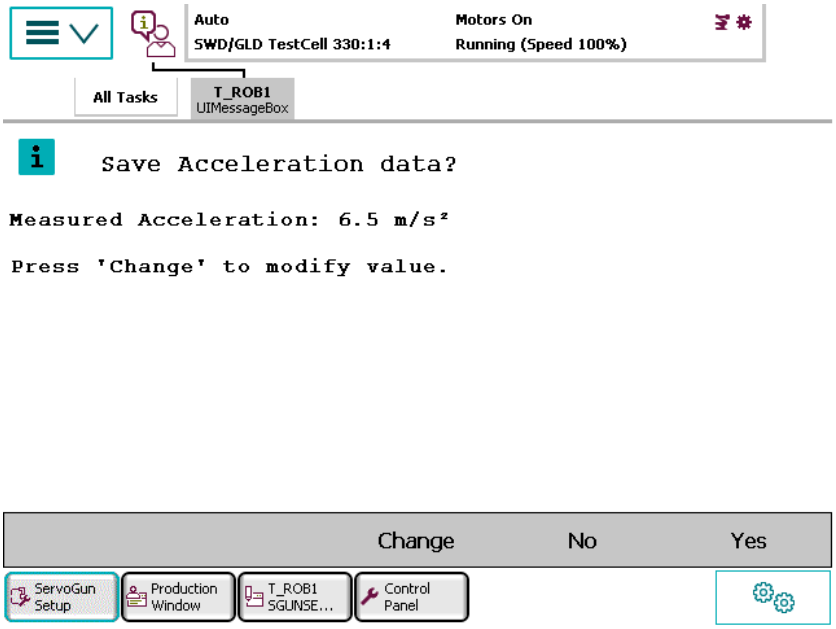
4 The servo gun opens and closes to test the acceleration. A suggested acceleration limit is presented.

Tap **Yes** to set this value as acceleration limit.



xx1700002085

Check delta position (final value)

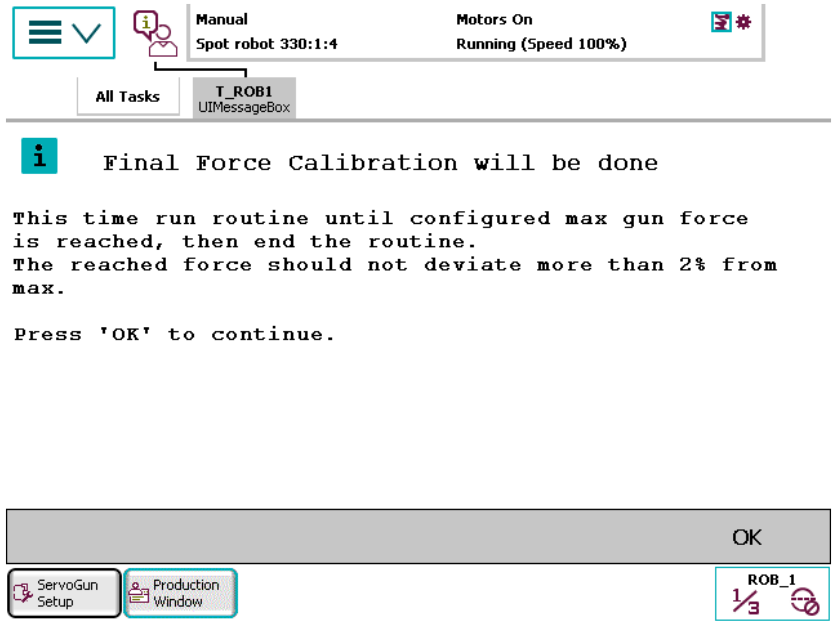
Now that force, speed and acceleration are calibrated, the servo gun's zero position has probably changed. Perform a new delta position check. See *Check delta position (initial value) on page 33*.

Continues on next page

Force calibration (final value)

Now that the delta position is definitively defined, a final force calibration can be made.

Perform this calibration just like *Force calibration (initial value) on page 35* with the difference that this time it is more important with the accuracy of the force calibration.



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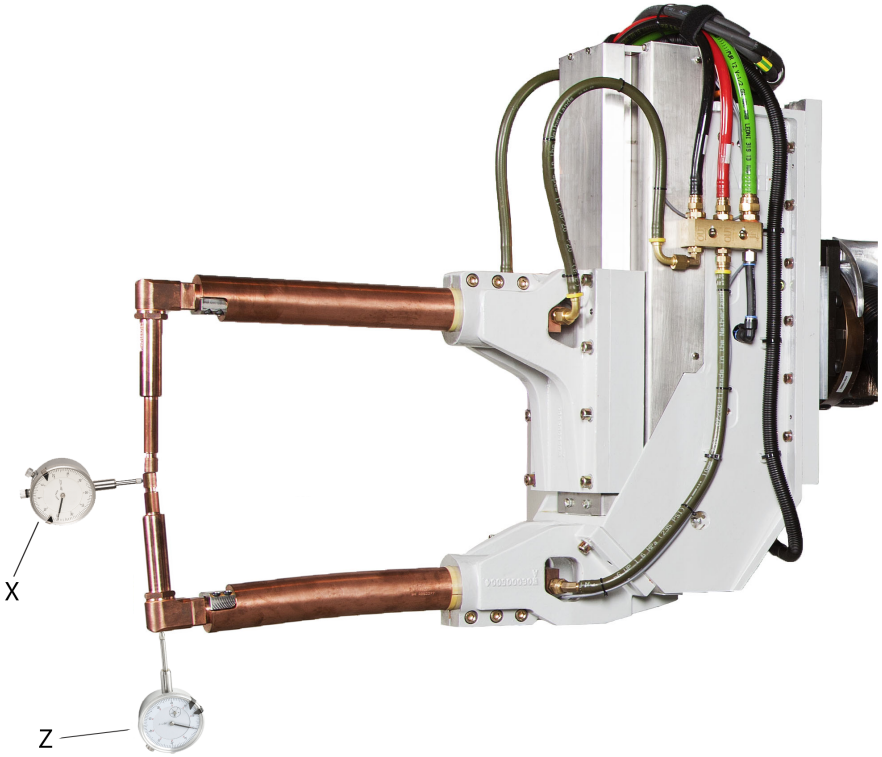
Tune gun deflection parameters

Place dial indicators that measures the servo gun deflection in z and x direction. Normally there is no deflection in y direction, but if there is, measure this too.



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X	Dial indicator for detecting movement in x direction
Z	Dial indicator for detecting movement in z direction

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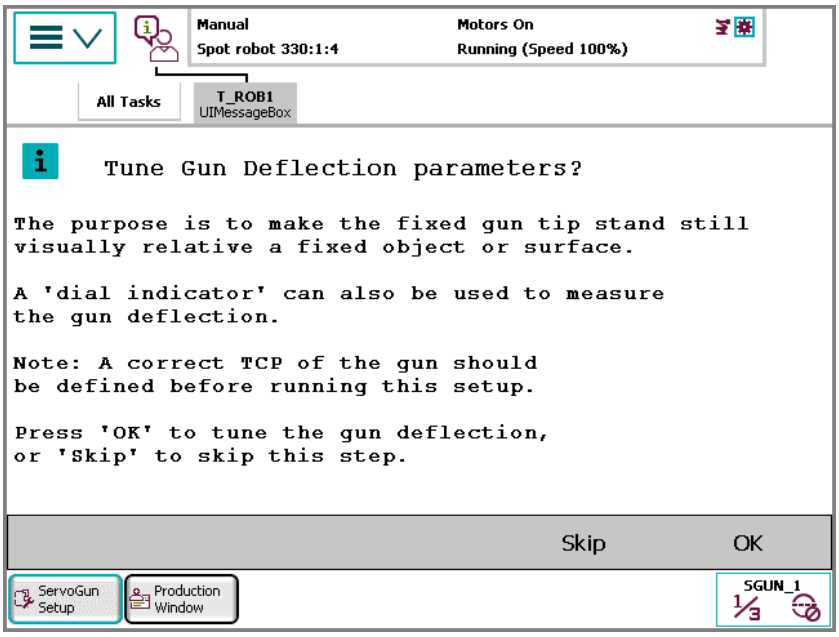
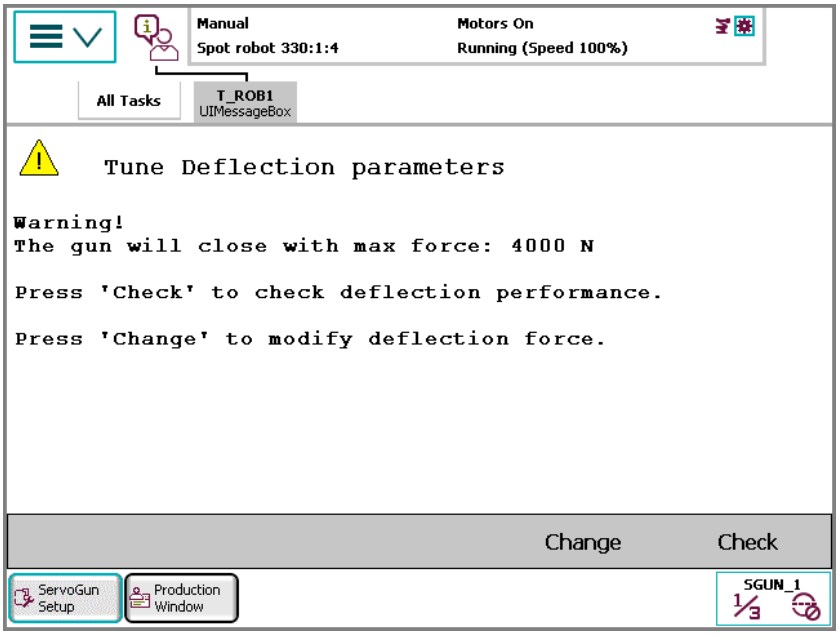
1 Tap **OK** to perform the gun deflection tuning.



xx1700002086

2 The suggested force for the gun deflection tuning is the max force. To change this, tap **Change** and enter desired force value.

Observe the dial indicators and tap **Check** to start the gun deflection tuning.



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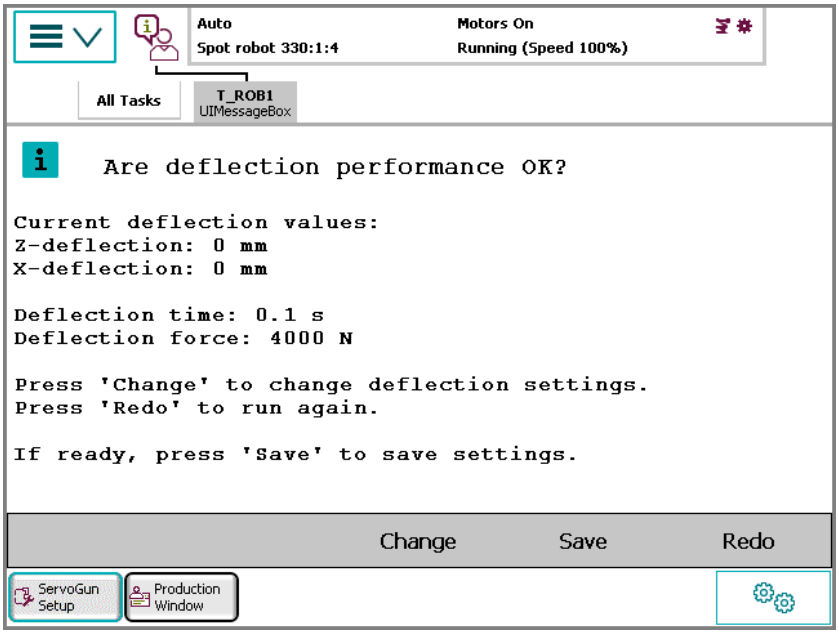
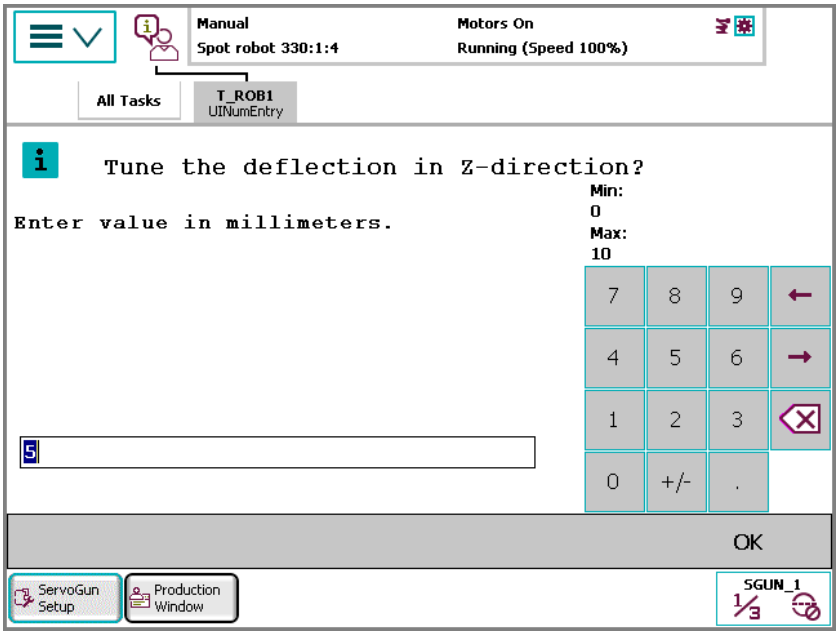
3 Read the deflection values from the dial indicators.

The current deflection values are presented. If these values are correct, tap **Save**. To change the values, tap **Change**.



xx1700002088

4 Type the measured deflection in Z direction and tap **OK**.



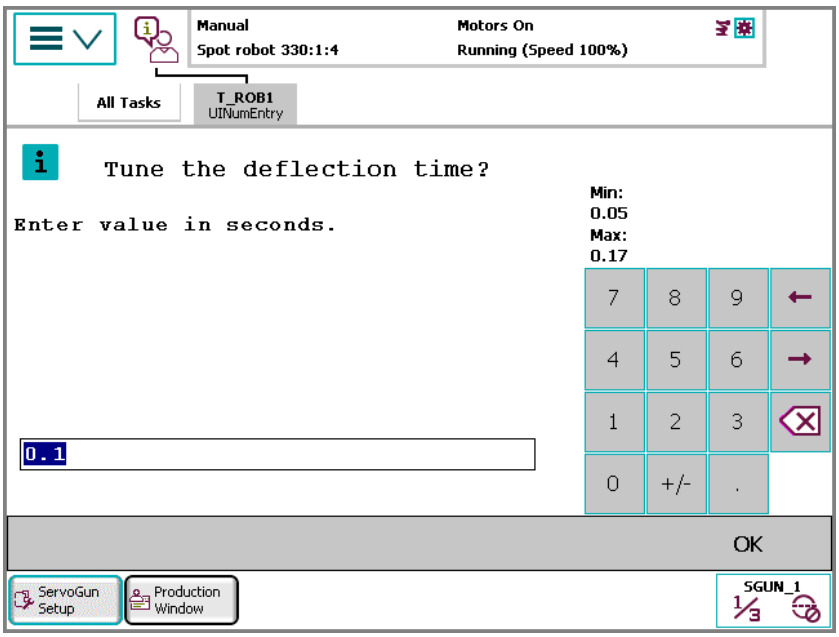
xx1700002089

5 Type the measured deflection in X direction and tap **OK**.

6 Type the measured deflection in Y direction (normally 0) and tap **OK**.

Continues on next page

7 The default deflection time is 0.1 mm. If the time it takes to build up the deflection differ from this, type the correct value and tap **OK**.



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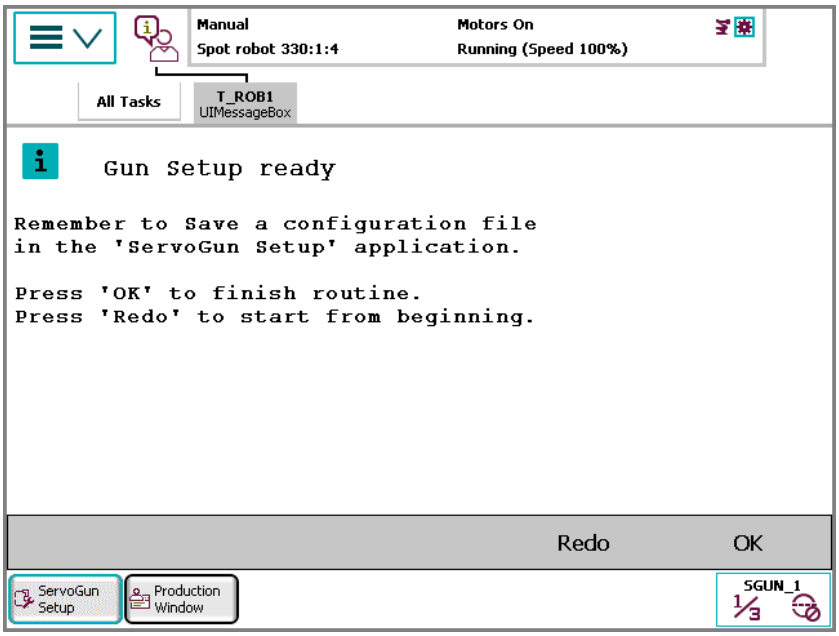
8 Tap **Save** to save the deflection values you have entered.

9 Tap **OK** to confirm the saving of the deflection parameters.

End the Tune Servo Gun routine

Tap **OK** to step out of the Tune Servo Gun routine.



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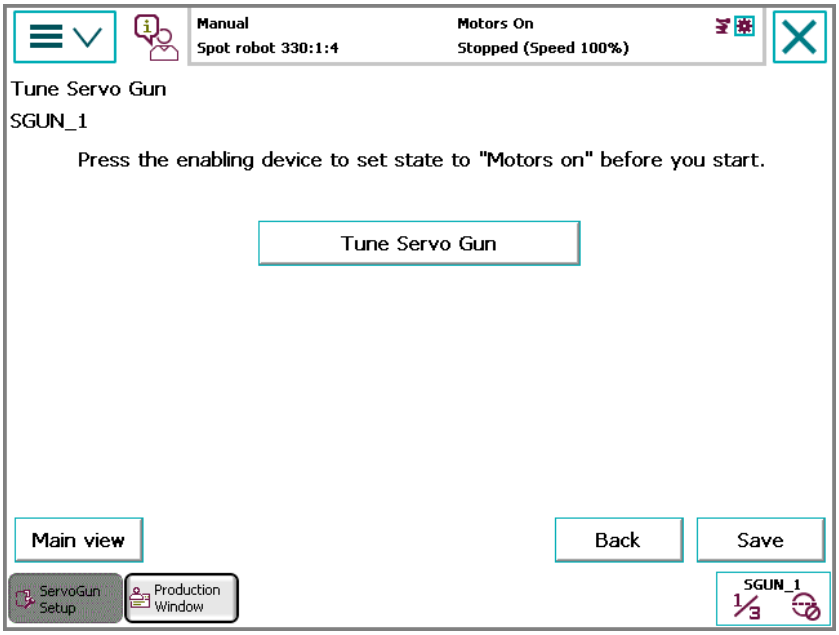
Save the configuration

1 Tap **Save** to save the configuration.



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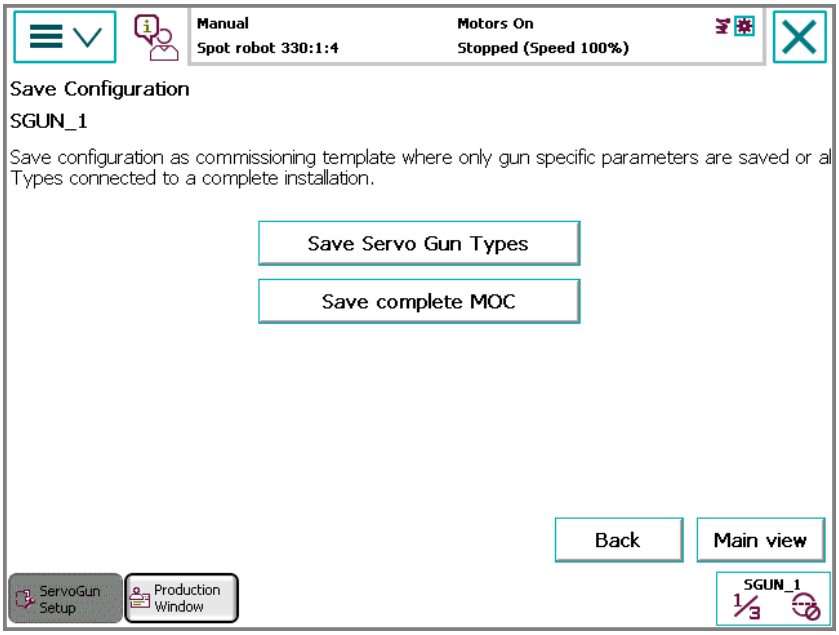
2 To save only the servo gun data to file, tap **Save Servo Gun Types** and select name and location for the file.

To save the servo gun data and all system parameters in the topic *Motion*, tap **Save complete MOC** and select name and location for the file.



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Tip

If the gun should be used in many configurations, it is recommended to use the tool Mechanical Unit Manager to create variants of this configuration file. See *Application manual - Mechanical Unit Manager*.

End the Servo Gun Setup wizard

The setup of the servo gun is now finished.

Close the wizard by tapping the cross in the upper right corner.

3.3 Commissioning mode

About commissioning mode

If you already have a file with configured servo gun data (button **Save Servo Gun Types**, see *Save the configuration on page 51*), a special commissioning mode allows for a shortcut through the Servo Gun Setup wizard.

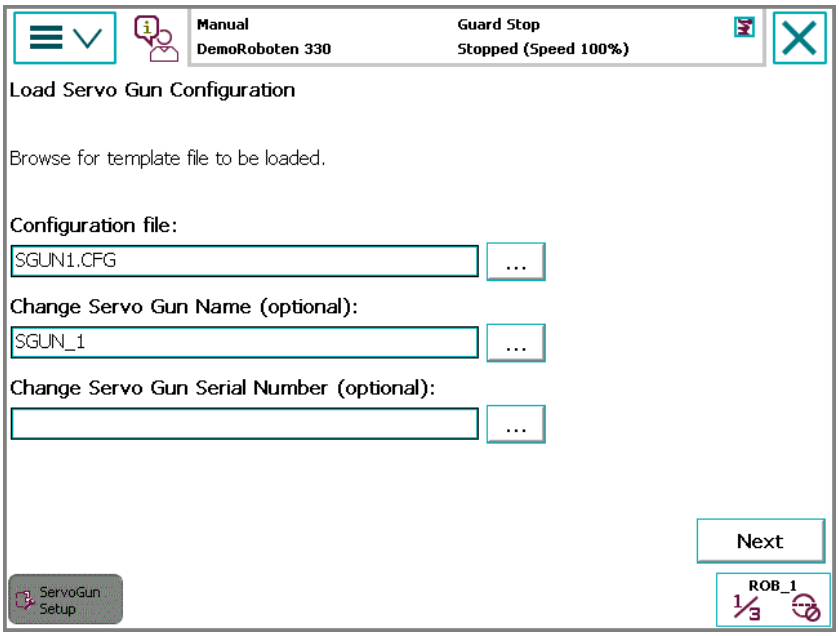
Running the Servo Gun Setup wizard in commissioning mode

Start the Servo Gun Setup wizard.

Load the configuration file saved from previous configuration with the Servo Gun Setup wizard. Browse to select the file.

If you want to change the name of the servo gun, type the new name.

If you want, you can add the serial number of the servo gun. This will then be included in the saved data.



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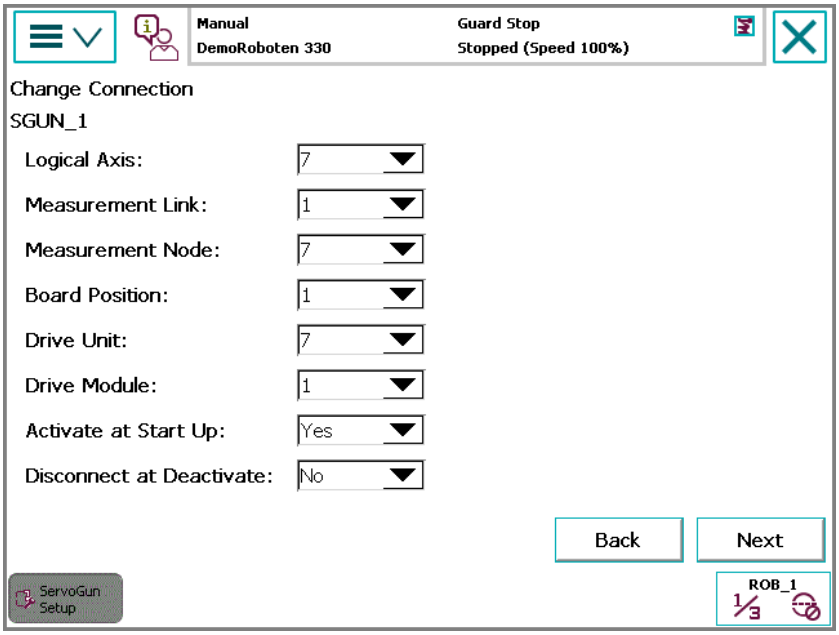
If previously loaded configuration file does not have the correct settings, change them to the values that apply to your servo gun. For information about the measurement system, see *Application manual - Additional axes and stand alone controller*.

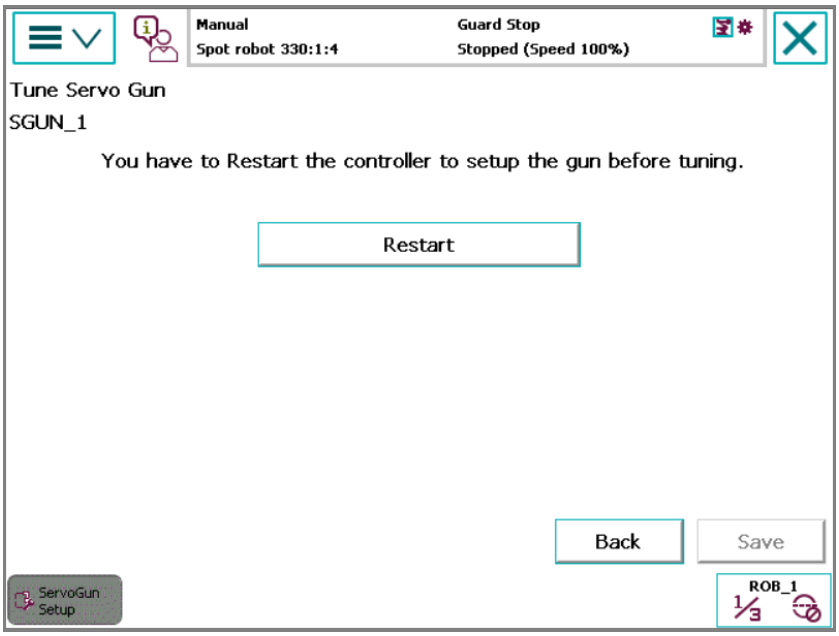
Active at Start Up and **Disconnect at Deactivate** only needs to be changed if using a tool changer.

Tap **Next**.



xx1800000012

4 A restart is required for the changes to take effect. Tap **Restart**.



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5 After the restart, start the Servo Gun Setup wizard again.

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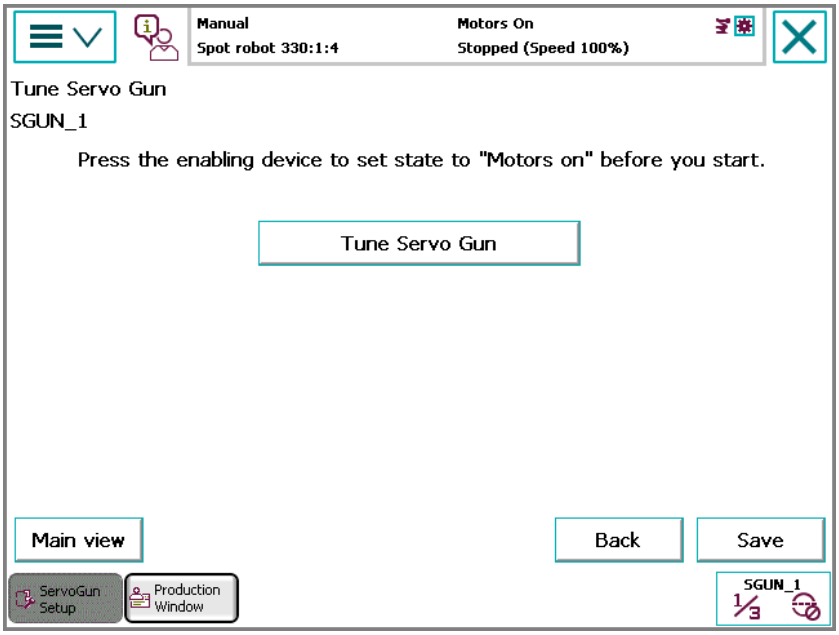
6 If you want to change anything in the configuration, press the enabling device on the FlexPendant and tap **Tune Servo Gun** (see *Tune servo gun*). Configure the steps necessary and skip the steps that are not needed.



xx1700002093

7 Tap **Save** to save the configuration.

8 To save only the servo gun data to file, tap **Save Servo Gun Types** and select name and location for the file.

To save the servo gun data and all system parameters in the topic *Motion*, tap **Save complete MOC** and select name and location for the file.

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4 System parameters

About this section

This section only describes the system parameters that are most important for servo guns. How to configure additional axis in general is described in *Application manual - Additional axes and stand alone controller*. All system parameters are described in *Technical reference manual - System parameters*.

Acceleration Data

Choose values for the acceleration parameters so that the gun can be controlled even if the friction is sightly higher and also works in worst case gravity position.

Cfg name	Parameter name	Description
wc_acc	Nominal Acceleration	Servo gun acceleration in m/s^2. If the value is too high, the motor will reach the torque limit and result in poor path performance. Setting the value too low will create problems during the release force movement. The recommendation is to have about 20% margin to torque limit during acceleration phase of the movement.
wc_dec	Nominal Deceleration	Servo gun deceleration in m/s^2. It is recommended to use the same value for *Nominal Deceleration* as for and *Nominal Acceleration* (although it often is possible to have a slightly higher value of *Nominal Deceleration* since the friction always helps to decelerate the movement).

Arm

Cfg name	Parameter name	Description
upper_joint_bound	Upper Joint Bound	Upper bound for the servo gun (in meters). The gun cannot be opened beyond this limit during jogging or program execution. **Note:** X-guns are non-linear in the upper range, see step *8 on page 30*.
lower_joint_bound	Lower Joint Bound	This parameter defines the minimum opening stroke (in meters). Set it to -0.005. A negative value is needed in order to keep the gun inside the working range if a stop occurs during force control.

Force Master

Cfg	Parameter name	Description
bandwidth_ramping	References Bandwidth	This defines the bandwidth (in Hz) of a low pass filter used to filter the reference values. A too high value can make the servo gun vibrate due to irregular movements. A too low value will make the servo gun slow. In most cases, the default value can be used.
ramp_time_switch	Use Ramp Time	Parameter is kept for backward compatibility. Always use *Ramp Time*.

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Continued

Cfg	Parameter name	Description
ramp_torque_ref_closing	Ramp when Increase Force	Parameter is kept for backward compatibility. Should not be used.
ramp_time	Ramp Time	Determines how fast force is built up while closing the tool. This should normally be between 0.050 and 0.090 s. Setting too high value could cause skidding/sliding.
bandwidth_lp	Collision LP Bandwidth	This defines the bandwidth (in Hz) of a low pass filter used during tip wear calibration. In most cases, the default value can be used.
alarm_torque	Collision Alarm Torque	Determines how hard the tool tips will be pressed together during the first gun closing of new tips calibrations and tool change calibrations. Calculated by the wizard.
col_speed	Collision Speed	Determines the servo gun speed (m/s) during the first gun closing of new tips calibrations and tool change calibrations.
distance_to_contact_position	Collision Delta Position (m)	Defines the distance the servo tool has gone beyond the contact position when the motor torque has reached the value specified in *Collision Alarm Torque*.
force_ready_detection_bandwidth	Force Detection Bandwidth	The feedback motor speed is filtered through a LP filter with this bandwidth. This is to avoid that variations in the speed will trigger the force detection too early.
force_ready_detection_speed	Force Detection Speed	When the feedback motor speed is below this value, it is considered that the ordered force is reached. **Tip:** If thickness check fails, both *Force Detection Bandwidth* and *Force Detection Speed* can be reduced . This will slightly increase the cycle time.
delay_ramp	Delay Ramp	Delays the starting of torque ramp when force control is started. **Tip:** If the speed signal shows a big overshoot just before the mode change of force mode, this parameter can be increased to avoid degrading performance of squeeze mode.
search_speed_leak_subtrahend	Search Leak Subtrahend	When search for plate is activate in a spot welding instruction, the servo gun will perform a movement towards the plate and stops immediately when the plate is found. The plate is considered to be found when the signal value is bigger than *Search Threshold*.
search_speed_filter_bandwidth	Search filter bandwidth	To avoid false search stops due to noisy signals the speed error is filtered by a Low Pass filter. The cut-off frequency is set by the parameter *Search filter bandwidth*.
search_speed_threshold	Search Threshold	When search for plate is activate in a spot welding instruction, the servo gun will perform a movement towards the plate and stops immediately when the plate is found. The plate is considered to be found when the signal value is bigger than *Search Threshold*.

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Continued

Cfg	Parameter name	Description
search_reverse_dist	Search reverse distance	When search for plate is activate in a spot welding instruction, the servo gun will perform a movement towards the plate and stops immediately when the plate is found. To reduce search impact as much as possible the gun will automatically move in the opposite direction directly after the plate is found. The return distance is set by the parameter *Search reverse distance*.

Force Master Control

Cfg name	Parameter name	Description
no_of_posts	No. of Speed Limits	The number of points used to define speed limit and speed loop gain as functions of the torque. Up to 6 points can be defined, but normally it is enough to use 2.
torque_1 - torque_6	Torque 1- Torque 6	The torque levels, corresponding to the ordered tip force, for which the speed limit and speed loop gain values are defined.
speed_lim_1 - speed_lim_6	Speed Limit 1-6	*Speed Limit 1* to *Speed Limit 6* are used to define the maximum speed depending on the ordered tip force.
Kv_1 - Kv_6	Kv 1-6	*Kv 1* to *Kv 6* are used to define the speed loop gain for reducing the speed when the speed limit is exceeded. In most cases, the default value can be used.
search_speed	Search Speed	When a spot instruction is using a search argument, the gun will start a movement toward the plate with the speed defined in the parameter *Search Speed*.
search_Kv	Search Kv	*Search Kv* is the proportional gain in the speed loop during the search process. To be able to have a fixed search tuning of the speed loop a special proportional gain is used in the speed loop. This can in many cases be same value as in the parameter *Kv* of *Lag Control Master*, but might in some cases have to be tuned.
search_Ti	Search Ti	*Search Ti* defines the integration time in the speed loop during the search process. To be able to have a fixed search tuning of the speed loop an integration time can be used in the speed loop. This can in many cases be same value as in the parameter *Ti* of *Lag Control Master*, but might in some cases have to be tuned.

Lag Control Master 0

Cfg name	Parameter name	Description
Kp	Kp, Gain Position Loop	The amplification of the position control. For a servo gun this can normally be kept at default value. Otherwise, tune it according to the tuning chapter in *Application manual - Additional axes and stand alone controller*.

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Continued

Cfg name	Parameter name	Description
Kv	Kv, Gain speed loop	The amplification of the velocity control. A high value gives better high frequency stiffness, better response speed and low overshoot. If the value is too high the servo gun will vibrate. This is setup by the wizard according to the motor parameters. If the gun behaves poorly, tune it according to the tuning chapter in *Application manual - Additional axes and stand alone controller*. **Tip:** Use TuneMaster in Additional Axis mode when tuning Kv.
Ti	Ti, Integration Time Speed Loop	Integration time in the speed regulation loop. Keep the standard value of 0.1 s.
ffw_mode	FFW Mode	Feed Forward mode. For servo gun, always use Spd (1).

Motor Calibration

Cfg name	Parameter name	Description
com_offset	Commutator Offset	The motor angle when voltage is applied between the phases S and T. For ABB motors *Commutator offset* should always be 1.5708.
cal_offset	Calibration Offset	The offset value used to indicate physical zero position of the gun. Can be updated by moving the gun to its calibration position and then fine calibrate.
valid_com_offset	Commutator Offset Valid	Yes If com_offset is valid.
valid_cal_offset	Calibration Offset Valid	Yes if cal_offset is valid.

Motor Type

These parameters should not be edited manually and should only be changed after a confirmation from motor supplier and ABB.

Cfg name	Parameter name	Description
pole_pairs	Pole Pairs	Number of pole pairs.
inertia	Inertia	Motor and resolver inertia on motor side. The unit is kgm^2.
torque_0	Stall Torque	The torque the motor can produce at no speed and during an infinite time. The unit is Nm.
ke	ke Phase to Phase	The induced voltage (phase to phase) that corresponds to the speed 1 rad/s.
i_max	Max Current	Max. current without irreversible demagnetization. The unit is A rms.
r_stator_20	Phase Resistance	Stator phase resistance at 20 degrees Celsius. If the resistance is measured phase-to-phase, the value should be divided by 2. The unit is ohm.

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Continued

Cfg name	Parameter name	Description
l_stator	Phase inductance	Stator phase inductance at zero current. The value should be measured at a frequency of about 120Hz to correspond to what the drive expects. If the inductance is measured phase-to-phase, the value should be divided by 2. The unit is Henry.
ke_temp_coef_20[i]	-	Temperature reduction coefficient for ke, at 20 degrees. The unit is 1/K.
ke_stability_coef_20[i]	-	Long-term stability reduction constant for ke after 4000 hours.
ke_tolerance_min[i]	-	Minimum tolerance for ke (%/100) Min. ke= ke*(1+ke_tolerance_min).
ke_tolerance_max[i]	-	Maximum tolerance for ke (%/100). Max. ke= ke*(1+ke_tolerance_max).
ke_red_2i0[i]	-	Current dependant reduction of ke at two times rated current (%/100).
torque_losses_at_speed1[i]	-	Total torque losses due to friction and iron losses at speed1. The unit is Nm.
torque_losses_at_speed2[i]	-	Total torque losses due to friction and iron losses at speed2. The unit is Nm.
torque_losses_at_speed3[i]	-	Total torque losses due to friction and iron losses at speed3. The unit is Nm.
speed1[i]	-	The speed at which torque_losses_at_speed1 is defined in rad/s.
speed2[i]	-	The speed at which torque_losses_at_speed2 is defined in rad/s.
speed3[i]	-	The speed at which torque_losses_at_speed3 is defined in rad/s.
temp_stator_max[i]	-	Maximum temperature for the stator winding. The unit is degrees Celsius.
temp_stator_rise[i]	-	Maximum temperature rise for the stator winding. The unit is degrees Celsius.
temp_rotor_max[i]	-	Maximum temperature for the rotor. The unit is degrees Celsius.
temp_rotor_rise[i]	-	Maximum temperature rise for the rotor. The unit is degrees Celsius.
r_stator_temp_coef_20[i]	-	Temperature coefficient for the stator resistance at 20 degrees Celsius.

i The parameter is recommended but not mandatory to use.

Continues on next page

Continued

SG Process

Cfg name	Parameter name	Description
min_close_time_adjust	Close Time Adjust	Constant time adjustment (s), positive or negative, of the moment when the gun tips reach contact during a gun closure. This value is normally zero. May be used to delay the closing slightly when the synchronized pre closing is used for welding. Normally not used.
close_position_adjust	Close Position Adjust	When the tool tips reach the position (plate thickness) ordered by the close instruction, the force control starts. This tool tip position can be adjusted with *Close Position Adjust* to make the force control start earlier. Normally set to 0.001 to avoid that the gun hits the plates before force mode.
pre_sync_delay_time	Force Ready Delay	Constant time delay (s) before sending the weld ready signal after reaching the programmed force. Normally set to 0.
max_motor_torque	Max Force Control Motor Torque	Maximum allowed motor torque (Nm) during force control. The parameter will protect the gun from too high programmed force, by reducing the resulting motor torque to this upper level. A warning will be logged whenever this happens. The value must not be set higher than the *Torque abs. max* (type *Stress duty cycle*) which defines the maximum output of motor torque during both force and position control. This value is also used as torque limit in manual mode to avoid hard crashes when jogging.
post_sync_time	Post-synchronization Time	Release time anticipation (s) of the next robot movement after a weld. This parameter can be tuned to synchronize the gun opening with the next robot movement. The synchronization may fail if the parameter is set too high. Can normally be kept at zero.
calib_mode	Calibration Mode	The number of closings performed during a Tipwear calibration. Normally 2 closings will be ok. An increase may improve the accuracy of thickness detection for some servo guns.
calib_force_high	Calibration Force High	The maximum tip force (N) used during a Tip-Wear calibration. The recommendation is that this value should be between 2/3 of max force and max force.
calib_force_low	Calibration Force Low	The minimum tip force (N) used during a Tip-Wear calibration. For best result of the thickness detection, it is recommended to use the minimum programmed weld force. The recommendation is that this value should be about a 1/3 of max force but never lower than the minimum force used for the gun.

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Continued

Cfg name	Parameter name	Description
calib_time	Calibration Time	The wait time (s) during a calibration before the positional gun tip correction is done. Recommended value ca: 0.5 s.
no_of_active_db_posts	Number of Stored Forces	Number of stored forces in the force VS motor torque table. The minimum value allowed is 2. Normally this is set to between 2 and 4.
squeeze_force_1 - squeeze_force_10	Tip Forces 1 - 10	Gun tip force 1 (N) - Gun tip force 10 (N).
squeeze_torque_1 - squeeze_torque_10	Motor Torque 1 - 10	Motor torque 1 (Nm) - Motor torque 10 (Nm).

Stress Duty Cycle

Cfg name	Parameter name	Description
speed_absolute_max	Speed Absolute Max	The absolute highest motor speed to be used. (rad/s)
torque_absolute_max	Torque Absolute Max	The absolute highest motor torque to be used. (Nm) If torque_absolute_max is too high, it may result in a configuration error at restart. To avoid this, make sure that: torque_absolute_max < √(3) * ke * i_max.
speed_max_reduction_active	-	Automatically reduce the max speed if there is no more available current at higher speed.

Supervision

Cfg name	Parameter name	Description
speed_supervision_on	Speed Supervision	Speed supervision should be On.
position_supervision_on	Position Supervision	Position supervision should be On.
counter_supervision_on	Counter Supervision	Counter supervision On.
jam_supervision_on	Jam Supervision	Jam supervision On.
load_supervision_on	Load Supervision	Load supervision On.
power_up_position_on	Power Up Position Supervision	Power up position supervision On, default is Off.
in_position_range	In Position Range	Keep at default.
normalized_zero_speed	Zero Speed (%)	Keep at default.
joint_affect_forced_Kp	Affects Forced Control	Determines whether this joint effects forced gain control. Normally not used for servo gun. Keep at default value.
Kp_forced_on_limit	Forced on Position Limit	The upper position limit for forced gain control. Normally not used for servo gun. Keep at default value.

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Continued

Cfg name	Parameter name	Description
Kp_forced_off_limit	Forced off Position Limit	The lower limit for forced gain control. Normally not used for servo gun. Keep at default value.

Supervision Type

Cfg name	Parameter name	Description
static_power_up_position_limit	-	Static power up position error limit at zero speed.The unit is radians, Min.=0 and Max.=30. Normally not used for servo gun. Keep at default value.
fc_position_limit	-	Distance (in meters) that the gun can bend in force. Normally at default value.
fc_speed_limit_factor	-	Makes speed supervision less sensitive in force mode. Normally at default value.
dynamic_power_up_position_limit	Dynamic Power Up Position Limit	Dynamic power up position error limit at zero speed, the unit is radians. Normally not used for servo gun. Keep at default value.
static_position_limit	-	Position error limit at zero speed, the unit is radians on motor side. Normally not used for servo gun. Keep at default value.
dynamic_postion_limit	-	Position error limit at max speed, the unit is radians on motor side. Normally not used for servo gun. Keep at default value.
static_normalized_speed_limit	-	Speed error limit at zero speed. (% max. speed).
dynamic_normalized_speed_limit	-	Speed error limit at max speed (% max speed).
max_overload_time	-	Defines the maximum allowed time with maximum torque while moving. The unit is seconds, Min.=0 and Max.=20.
max_jam_time	Max Jam Time	Defines the maximum allowed time with maximum torque at zero speed. The unit is seconds, Min.=0 and Max.=20.
teach_mode_speed_max_main	Teach Max Speed Main	Maximum ordered speed ratio in teach mode (% max speed). Min.=0, Max.=1, Deafult=0.15. This should be set according to chapter *Limit peripheral speed of external axis* in *Application manual - Additional axes and stand alone controller*.

Continues on next page

Continued

Cfg name	Parameter name	Description
teach_mode_speed_max_dsp	Teach Max Speed DSP	Maximum supervision speed ratio in teach mode for axis computer (% max speed). Min.=0, Max.= 1, Default=0.28. Take the value from teach_mode_speed_max_mainand add a margin for noise and vibrations.

Transmission

Cfg name	Parameter name	Description
transm_joint	Transmission Gear Ratio	Gear ratio between motor and gun, specified as motor rotation in radians per meter linear move (-1050 denotes that when the motor rotates 1050 radians - the axis moves 1 m).

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5 TuneMaster and tuning

5.1 TuneMaster

About TuneMaster

TuneMaster can be used to study signals for position, speed, torque, etc.

TuneMaster can be downloaded from:

http://new.abb.com/products/robotics/robotstudio

For more information about TuneMaster, see *Application manual - TuneMaster*.

Define test signals with TuneMaster

The following test signals should be defined for the servo gun:

Signal	Recommended scale
6 speed	0.1
9 torque_ref	1
200 position	1000
55 positive torque_limit	1
56 negative torque_limit	1
5 force mode	5
4 speed_ref	0.1

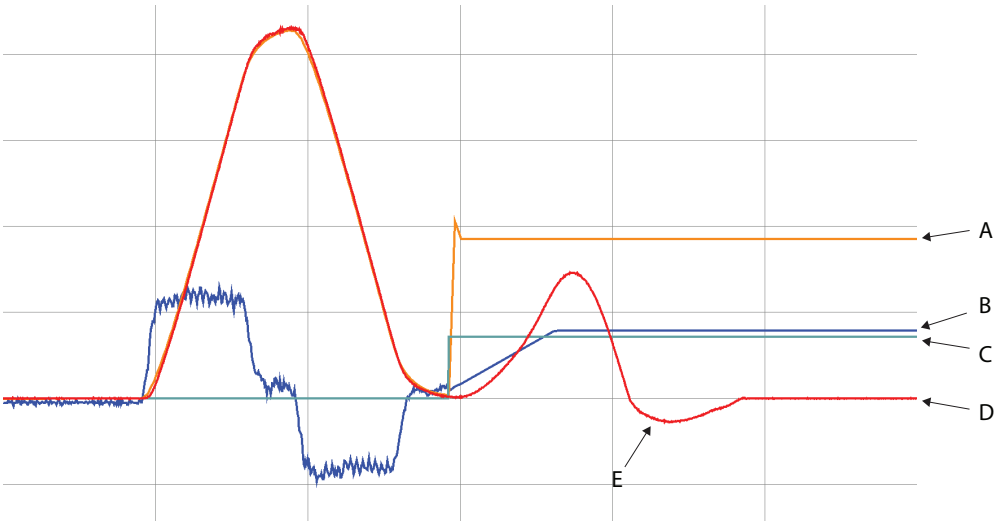
Continues on next page

5.1 TuneMaster
Continued

Speed limit tuning

When tuning the speed limit, you want to allow as fast speed as possible without getting a pushback from the servo gun that can severely reduce the accuracy of the force control.

Example of bad speed limit



xx1700001576

A	Speed limit signal
B	Torque signal
C	Force control mode signal
D	Speed signal
E	Large pushback from the servo gun is shown as a negative speed when the speed should be zero and full force should be applied. This can cause the actual force to differ from the ordered force.

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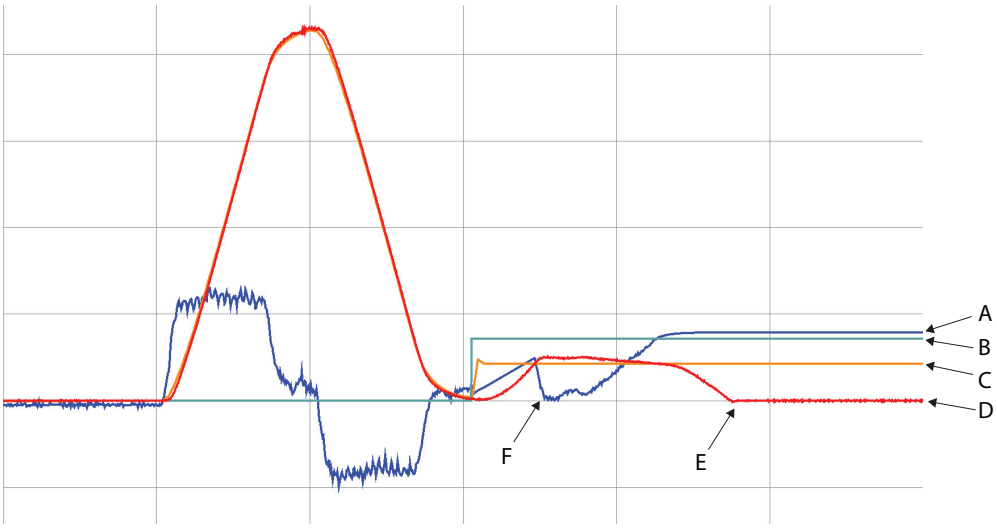
Example of good speed limit



xx1700001577

A	Torque signal
B	Force control mode signal
C	Speed limit signal
D	Speed signal
E	No pushback from the servo gun.
F	A reduction in the torque when the speed reach the speed limit is perfectly normal.

Acceleration tuning

During acceleration tuning, it is important to look at the signal for the torque.

- The torque during acceleration when opening and when closing should be fairly symmetrical. If gravity affects the servo gun, the acceleration torque for opening and closing will not be totally symmetrical. If there are large deviations from symmetry, verify that the commutation of the servo gun is correct (see *Application manual - Additional axes and stand alone controller*).
- The torque during acceleration should be approximately 80% of the torque limit.

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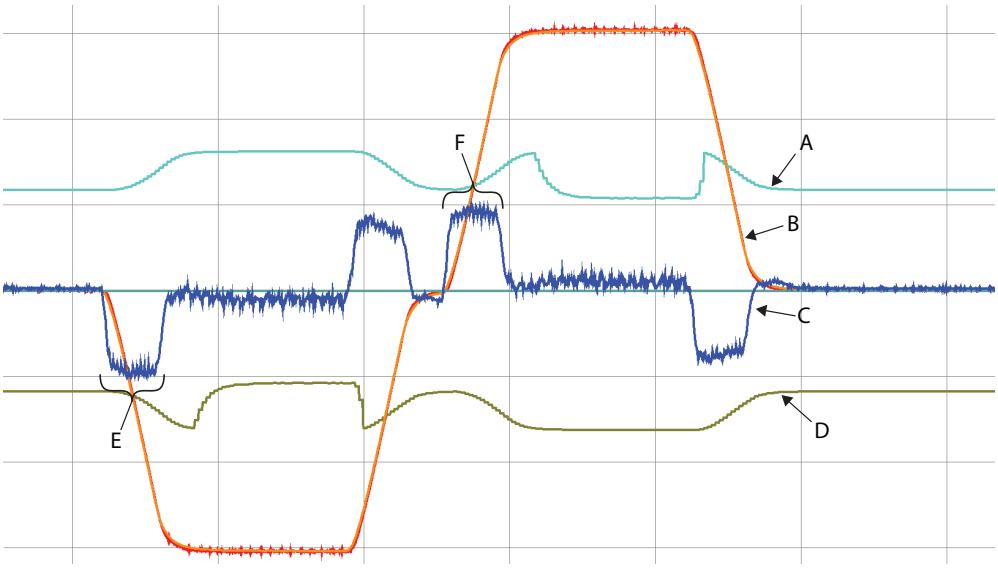
5.1 TuneMaster

Continued

Example of acceleration tuning



xx1700001578

A	Positive torque limit signal
B	Speed signal
C	Torque signal
D	Negative torque limit signal
E	Torque during acceleration when opening the gun
F	Torque during deceleration when closing the gun

5.2 Tuning with movable gun arm search

5.2.1 Movable gun arm search

About the functionality

The tuning of moveable gun arm search is done by repeating search movements and changing system parameters.

Run the RAPID instruction `SearchMoveCheck` to perform a test run while finding values for parameters. The following test signals are useful in the tuning.

Signal	Signal number	Scale
Speed reference	4	0.1
Speed feedback	6	0.1
Speed error	33	1
Search signal	1230	1

During the movement from `GunOpenPos` between `GunOpenPos` and 5 mm before closed the signals should be observed.

Tuning of movable gun arm search is done in the following steps.

1 Tune the speed loop gain.
2 Check and tune the speed error filter.
3 Tune the leakage.
4 Verify the threshold.

System parameters

The following system parameters are used for movable gun arm search:

- *Search Leak Subtrahend*
- *Search filter bandwidth*
- *Search Threshold*
- *Search reverse distance*
- *Search Speed*
- *Search Kv*
- *Search Ti*

See the descriptions for *Force Master on page 57* and *Force Master Control on page 59*.

Procedure

1 Tune the speed gain.

Note that *Search Kv* and *Search Ti* are assumed to be tuned in a regular manner for a fast step response without overshoot or oscillations, see below for an example.

Rule of thumb: *search Kv* = 1.4* *LCM0 Kv* = 1,400 x *Motor Inertia*

During the search sequence the servo gains of speed loop replaces the values set in LCM0.

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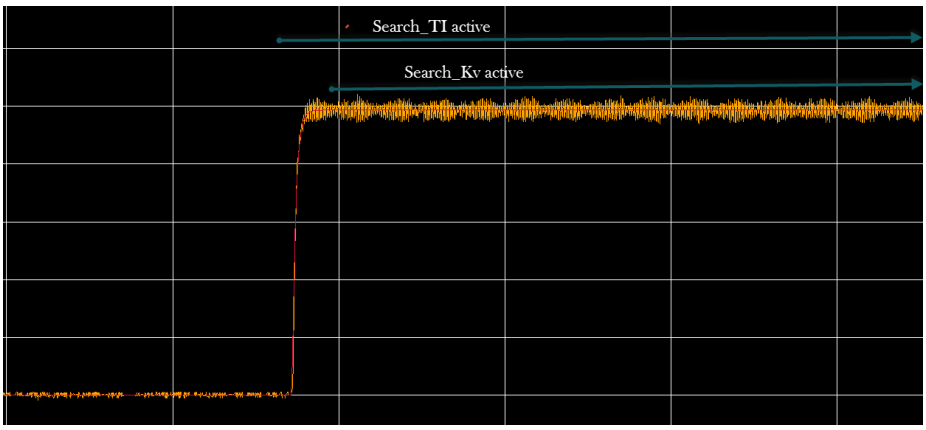
5.2.1 Movable gun arm search
Continued

Search Ti is active during ramp and search and *Search Kv* is active during the search.



xx2000001903

2 Check and tune the speed error filter.

Run the search movement with selected values of *Search Kv* and *Search Ti* from the previous step.

Look at test signal 33. If there is an obvious pattern or noise speed then the error filter can be lowered to flatten out the speed error. If no such pattern is seen, keep the value quite high, that is, 15 Hz or higher.

3 Tune the leak and the threshold. Look at signal 1230 in TuneMaster.

Leak:

The goal is to find a value of search_speed_leak_subtrahend where about 50% of the samples (seem in signal 1230) are equal to zero.

In many cases it can be tricky to find start value so it is recommended to do a rough first tuning followed by a more detailed.

Non wanted behaviors:

- There is a clear trend in the search signal, either increasing or decreasing. This might be due to a poorly tuned gun. Ti should be re-tuned in order to remove trends. Try decrease Ti in steps of 50% until the trends disappears.
- A spike in the beginning of the search signal is much larger than the rest. This might be due to either a poorly tuned gun or due to a short If the problem does not go away or the spike is during a longer period of time try re-tuning the gun by decreasing Ti.
- There are a lot of oscillations in the search signal. Oscillations can be reduced by increasing Kv. Increase Kv until the signal looks appear to be noisy rather than oscillatory. By looking at signal 33 (Speed Error) in TuneMaster it is easier to spot an oscillatory behavior.
- There is a clear pattern that comes cyclic (from gearbox etc) Then decrease of speed error filter bandwidth (FilterCoeff) can help.

Iterate the leak tuning until signal 1230 looks noisy but controlled.

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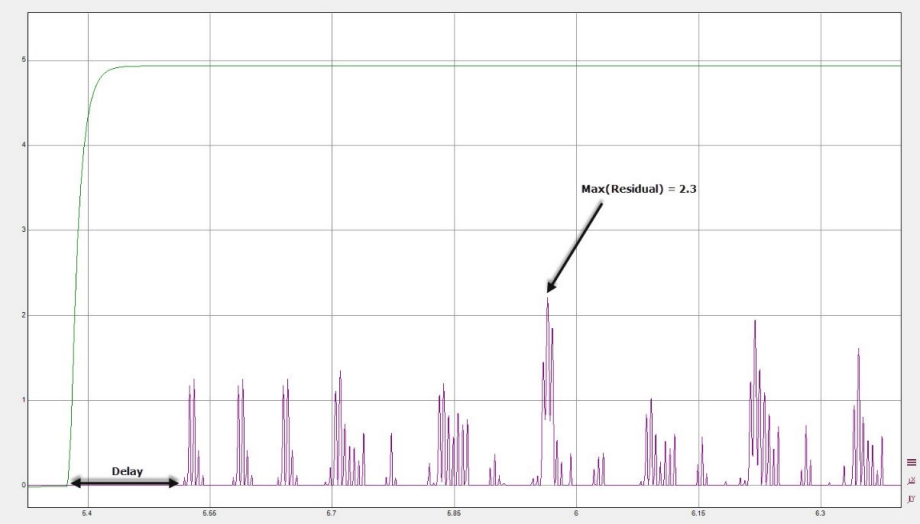
An example of a correctly tuned gun can be seen in the following figure, note that even though Kv is increased by about 200% an oscillatory behavior is seen and this is probably due to ripple effects in the motor.



xx2000001904

In the figure above, about 50% of the samples in the search signal are equal to zero. The Leak parameter is correctly tuned. Oscillations is due to ripple. Less ripple in the speed signal means less oscillations in the search signal. Note that speed is scaled by 0.1 and search signal is scaled by 10. The maximal value of the search signal is 0.23, threshold is therefore set to 0.5.

4 Verify the threshold.

When search_speed_leak_subtrahend has been set it is time for checking the threshold.

Run search movement with all kinds of angles of the gun with respect to gravity and see what they highest value of 1230 is. Set threshold to 1.5-2 times higher than that value.

Possible problems:

- The guns detects false collisions. Increase the Threshold parameter. If the false detections are removed but the force (either measured or seen by detecting a plate) is too high tuning of Ti and Kv might need a better tuning or the speed needs to be decreased.

5 Proceed with the configuration.

6 When all tuning is done, all values should be saved to the configuration.

5.2.2 RAPID references for MGAS

5.2.2.1 SearchMoveCheck

Usage

`SearchMoveCheck` is used to do search movements without any contact to repeat movements during tuning procedures. A tuning procedure is typically used to find an optimal value for a parameter. A test movement (that is, a program execution with a `SearchMoveCheck`) is repeated when using different parameter tune values set up by `TuneDetectionParams`.

Basic examples

The following example illustrates the instruction `SearchMoveCheck`.

```
SearchMoveCheck gun1, \GunOpenPos:=100;
```

Arguments

```
SearchMoveCheck gunnum [\GunOpenPos]
```

`gunnum`

Data type: `num`

Used gun number. Corresponding to the element number in the `gundata` array `curr_gundata` in the module SWUSER.SYS.

`[\GunOpenPos]`

Data type: `num`

Optional parameter. The gun will open to the specified position [mm] (only servo guns).

Syntax

```
SearchMoveCheck
  [GunNo ':='] < expression (IN) of num >
  ['\' GunOpenPos ':=' < expression (IN) of num > ] ';'
```

5.2.2.2 TuneDetectionParams

Usage

`TuneDetectionParams` is used to change search parameters during tuning procedures. A tuning procedure is typically used to find an optimal value for a parameter. A test movement (that is, a program execution with a `SearchMoveCheck`) is repeated when using different parameter tune values set up by `TuneDetectionParams`.

Basic examples

The following example illustrates the instruction `TuneDetectionParams`.

```
FOR i FROM 1 TO 10 DO
  TuneDetectionParams
       Gun1\Threshold:=10000\LeakSubtrahend:=1e-10\SearchKv:=
       0.1*i;
  SearchMoveCheck gun1, \GunOpenPos:=100;
ENDFOR
```

Arguments

```
TuneDetectionParams gunnum [\Threshold] [\LeakSubtrahend]
     [\LeakSubtrahend] [\SearchKv] [\SearchTi] [\SearchSpeed]
     [\FilterCoeff]
```

`gunnum`

Data type: `num`

Used gun number. Corresponding to the element number in the `gundata` array `curr_gundata` in the module SWUSER.SYS.

`\Threshold`

Data type: `num`

The value that should trigger the search stop. Start with high value to avoid false alarms during initial tuning.

`\LeakSubtrahend`

Data type: `num`

Value used to control the leak rate of the search signal seen in test signal 1230. Start with low value too see the search signal and gradually increase.

`\SearchKv`

Data type: `num`

Proportional gain in the speed regulation loop during the search part of the movement.

`\SearchTi`

Data type: `num`

Integration time in the speed regulation loop during the search part of the movement.

Continues on next page

5.2.2.2 TuneDetectionParams
Continued

`\SearchSpeed`

Data type: `num`

Speed during search movement mm/s.

`\FilterCoeff`

Data type: `num`

Cut off frequency for the speed error filter (Hz).

Syntax

```
TuneDetectionParams
  [gunnum ':='] <expression (IN) of num>
  ['\' Threshold ':=' <expression (IN) of num>]
  ['\' LeakSubtrahend ':=' <expression (IN) of num>]
  ['\' SearchKv ':=' <expression (IN) of num>]
  ['\' SearchTi ':=' <expression (IN) of num>]
  ['\' SearchSpeed ':=' <expression (IN) of num>]
  ['\' FilterCoeff ':=' <expression (IN) of num>]';'
```

6 Motor type file

Content of motor type file

The motor type file must include the types:

- MOTOR_TYPE
- STRESS_DUTY_CYCLE

If not using the default values for standard ABB motors, the motor type file can include (for example):

- MOTOR_CALIB
- LCM0
- AXC_FILTER

Example of motor type file

```
MOC:CFG_1.0::
#Technical spec S.DTE 008-91

#
MOTOR_TYPE:
-name "ARO_S.DTE008_91"\
-pole_pairs 4\
-inertia 0.00165\
-torque_0 18\
-ke 0.98365\
-ke_temp_coef_20 0.00035\
-ke_stability_coef_20 0.03\
-ke_tolerance_min -0.05\
-ke_tolerance_max 0.05\
-ke_red_2i0 0.06\
-i_max 19.5\
-torque_losses_at_speed1 0.2\
-torque_losses_at_speed2 0.3\
-torque_losses_at_speed3 0.4\
-speed1 104.72 -speed2 209.44\
-speed3 314.16\
-r_stator_20 1.225\
-r_stator_temp_coef_20 0.00263\
-l_stator 0.00325

#
STRESS_DUTY_CYCLE:
-name "SGUN_1"\
-speed_absolute_max 314\
-torque_absolute_max 30\
-speed_max_reduction_active
```

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