User Manual

Version 1.0

2025/01/10

STP

Switch Testing Platform Graphical User Interface

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1. Document History

Ver.	Chapter	Description / Changes	Date
1.0		Initial release	2025.01.10

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2. Document Coverage

This document provides the user with a basic and detailed explanation of how to use ADMOTEK STP (Switch Testing Platform). It is expected that the user has a basic understanding of motion systems and motion control concepts.

This manual focuses only on concepts that might not be self-explanatory. It does not cover interface elements that are simple enough for the user to understand.

3. Prerequisites

This chapter provides an overview of the STP software prerequisites and the recommended minimum specifications.

3.1. Operating System

This software requires the following operating system to perform best:

- Windows 7, 32/64 bit or later.

Note that Windows 10, 32/64 bit is recommended.

3.2. Screen Resolution

A minimum display resolution of 1024x768 is required for the STP software.

A resolution of 1600x900 or higher is recommended for a better experience.

3.3. Additional Software

Although the STP software is standalone, it is recommended to install Microsoft Excel to help with the post-processing of the logged data.

3.4. Installation

The STP software does not require an installation process and is provided as a portable single-package executable file.

4. Introduction

This chapter provides an introduction to the STP software, its structure, and the main sections.

4.1. Structure

This software comprises several sections as listed below and shown in Figs. 1-4.

1- Menu
2- Dark Mode Button
3- Single Switch Tab
4- Multi Switch Tab
5- Test Configuration Tab
6- Bands Configuration Tab

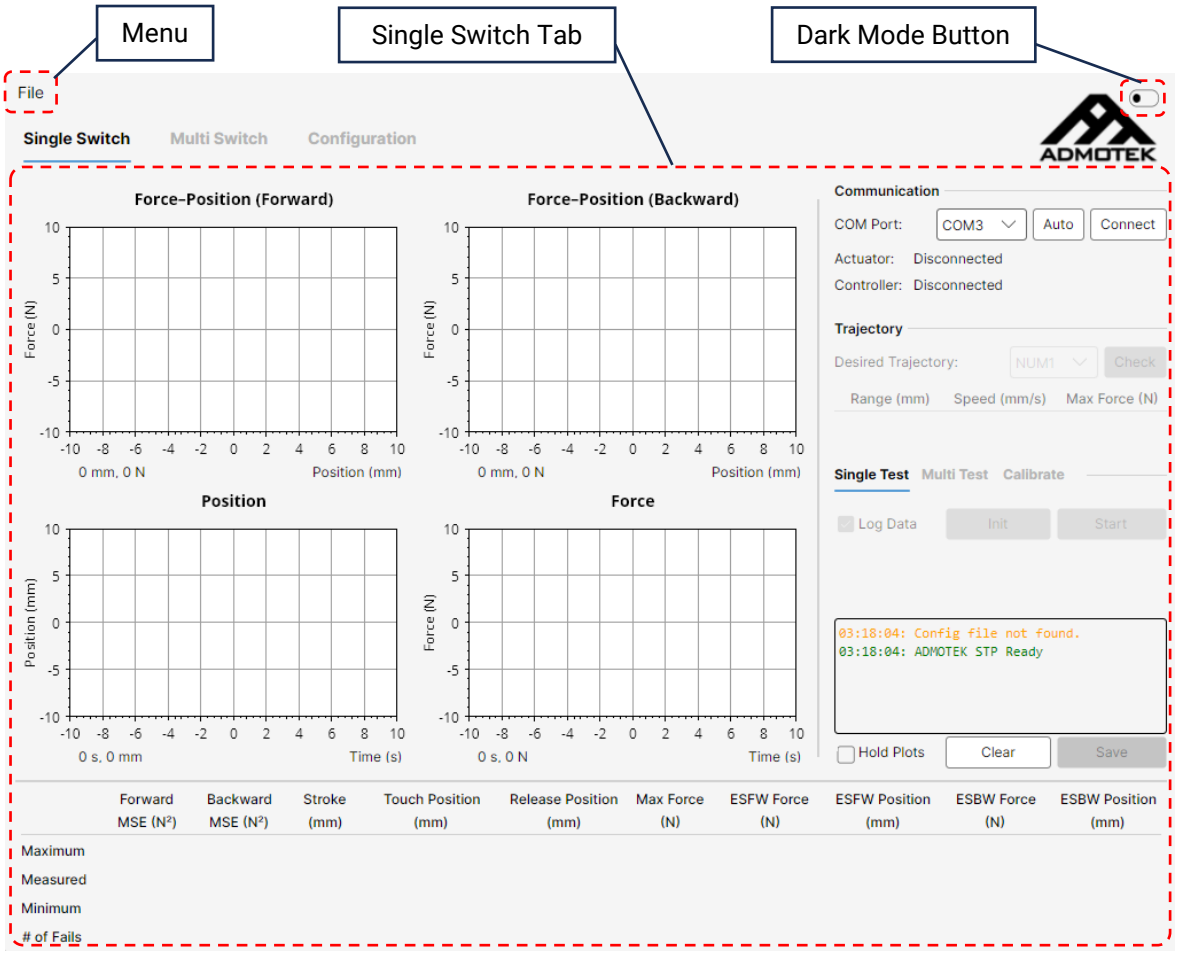


Fig. 1. STP Structure: Single Switch Tab.

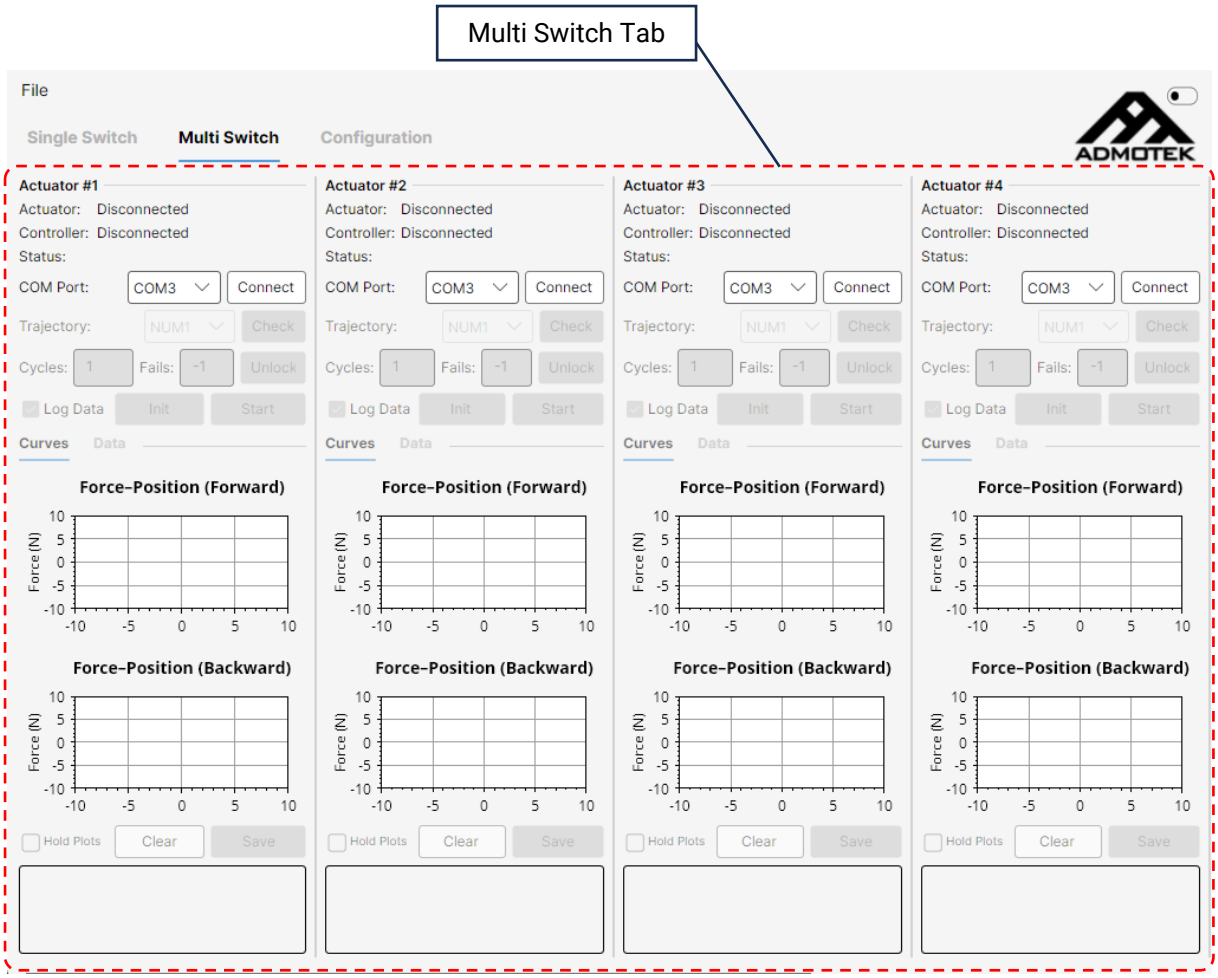


Fig. 2. STP Structure: Multi Switch Tab.

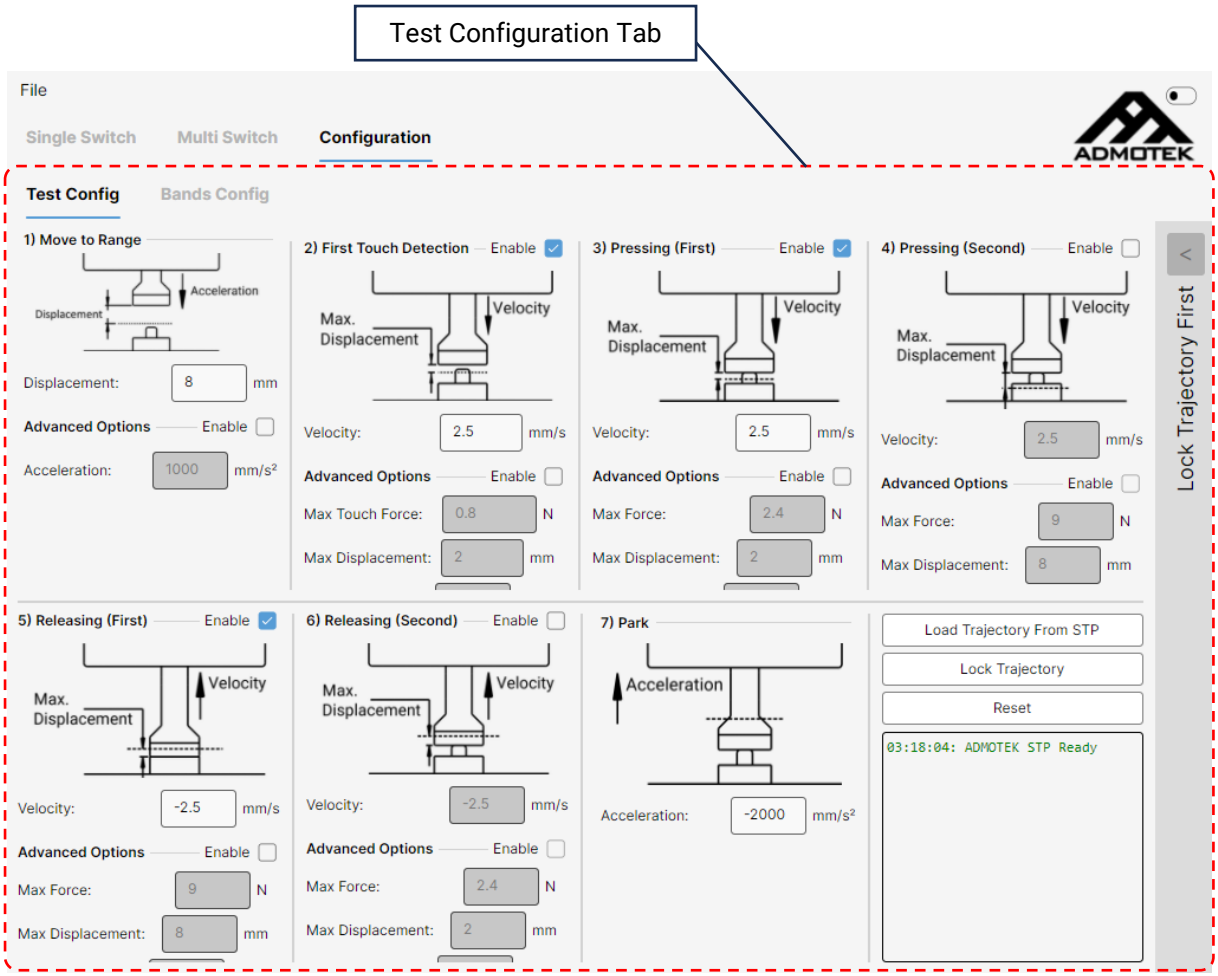


Fig. 3. STP Structure: Test Configuration Tab.

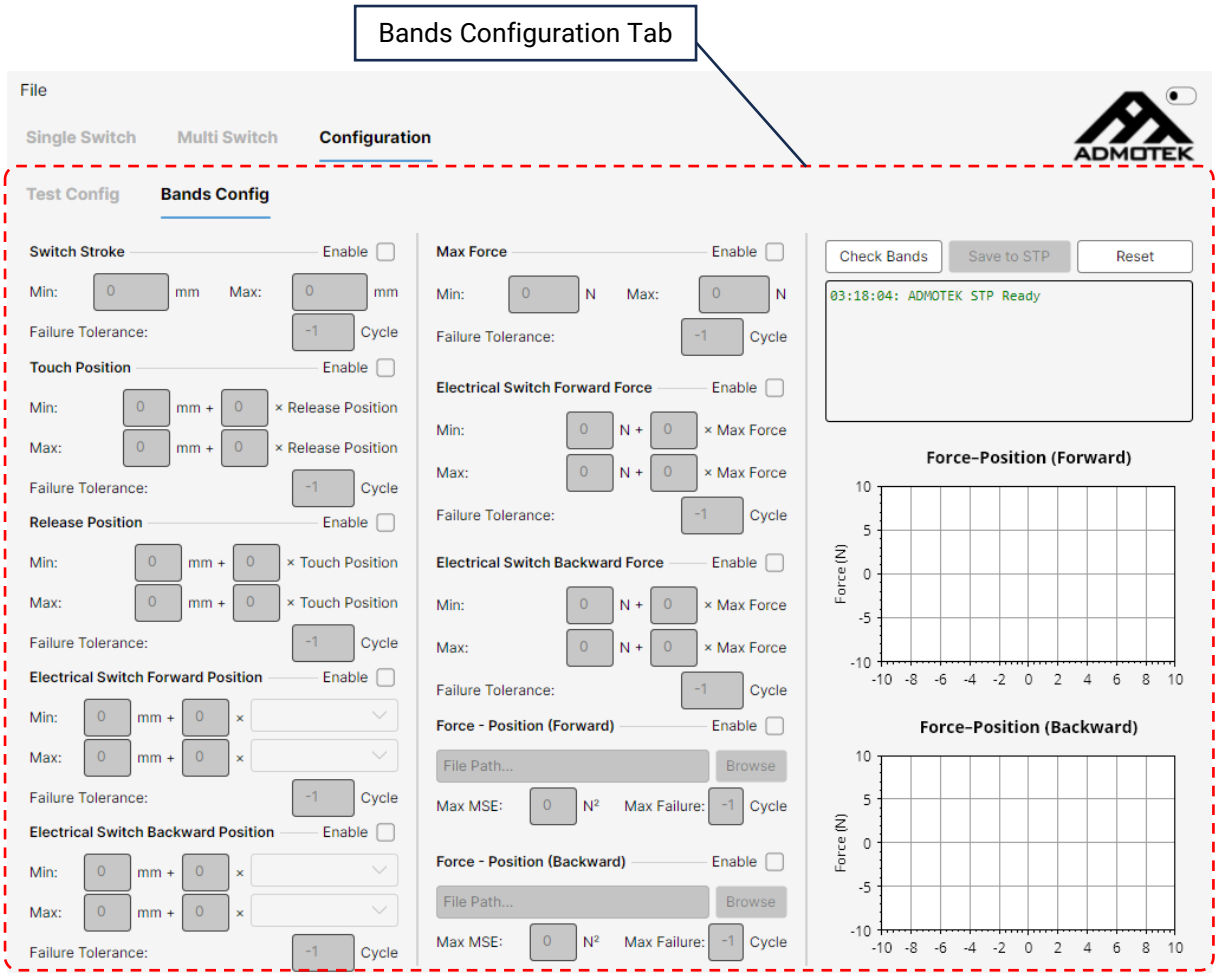


Fig. 4. STP Structure: Bands Configuration Tab.

4.2. Single Switch Tab

This section can be used to test one switch and comprises of the following sub-sections:

1- Forward Force – Position Plot:

This plot contains the curve known as the spring curve of the switch (The switch press force vs its displacement), but only for the pressing trajectory. This means that the plotted data starts at the touch position and ends at the bottom of the switch. It does not include the releasing trajectory data and the data before the first touch.

Note that if the test does not contain a pressing trajectory, this plot will be left empty.

This plot can also contain a red asterisk, showing the point where the electrical contact is changed. For this asterisk to be plotted, the electrical contact change must be enabled and monitored.

This plot supports crosshair. The crosshair is shown when the mouse pointer hovers over the plotted curve and is positioned at the closest data point to the mouse pointer position. When mouse hovers the plot, the closest data point values (position and force in this plot) are shown in the text below the plot.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

2- Backward Force – Position Plot:

This plot contains the curve known as the spring curve of the switch, but only for the releasing trajectory. This means that the plotted data starts at the bottom of the switch and ends at the release point. It does not include the touch data, the pressing data, and the parking trajectory data.

Note that if the test does not contain a release trajectory, this plot will be left empty.

This plot can also contain a red asterisk, showing the point where the electrical contact is changed. For this asterisk to be plotted, the electrical contact change must be enabled and monitored.

This plot supports crosshair. The crosshair is shown when the mouse pointer hovers over the plotted curve and is positioned at the closest data point to the mouse pointer position. When mouse hovers the plot, the closest data point values (position and force in this plot) are shown in the text below the plot.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

3- Position Plot:

This plot contains the position vs time curve for the whole test.

This plot can also contain red cross marks, showing the touch and release points. It can also contain a red asterisk marks, showing the point where the electrical contact is changed. For asterisks to be plotted, the electrical contact change must be enabled and monitored.

This plot supports crosshair. The crosshair is shown when the mouse pointer hovers over the plotted curve and is positioned at the closest data point to the mouse pointer position. When mouse hovers the plot, the closest data point values (time and position in this plot) are shown in the text below the plot.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

4- Force Plot:

This plot contains the force vs time curve for the whole test. Note that the reported force is true only if the rotor is moving with a constant velocity. This means that any acceleration in the rotor motion results in errors in the estimated force.

This plot can also contain red cross marks, showing the touch and release points. It can also contain red asterisk marks, showing the point where the electrical contact is changed. For asterisks to be plotted, the electrical contact change must be enabled and monitored.

This plot supports crosshair. The crosshair is shown when the mouse pointer hovers over the plotted curve and is positioned at the closest data point to the mouse pointer position. When mouse hovers the plot, the closest data point values (time and force in this plot) are shown in the text below the plot.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

5- Single Switch Test Control Panel:

This panel contains the controls required for testing a single switch. It consists of the following parts:

- Communication
- Trajectory

- Single Test
- Multi Test
- Calibrate
- Single Swith Console
- Plot Controls

6- Bands Table

This table contains the pass/fail band values and test values along with the number of failed tests for each band parameter. The abbreviations used in this table are as follows:

- Forward MSE: Mean squared error of the forward force – position curve.
- Backward MSE: Mean squared error of the backward force – position curve.
- ESFW Force: The required force when the electrical contact changes in the pressing trajectory.
- ESFW Position: The displacement of the switch when the electrical contact changes in the pressing trajectory.
- ESBW Force: The required force when the electrical contact changes in the releasing trajectory.
- ESBW Position: The displacement of the switch when the electrical contact changes in the releasing trajectory.

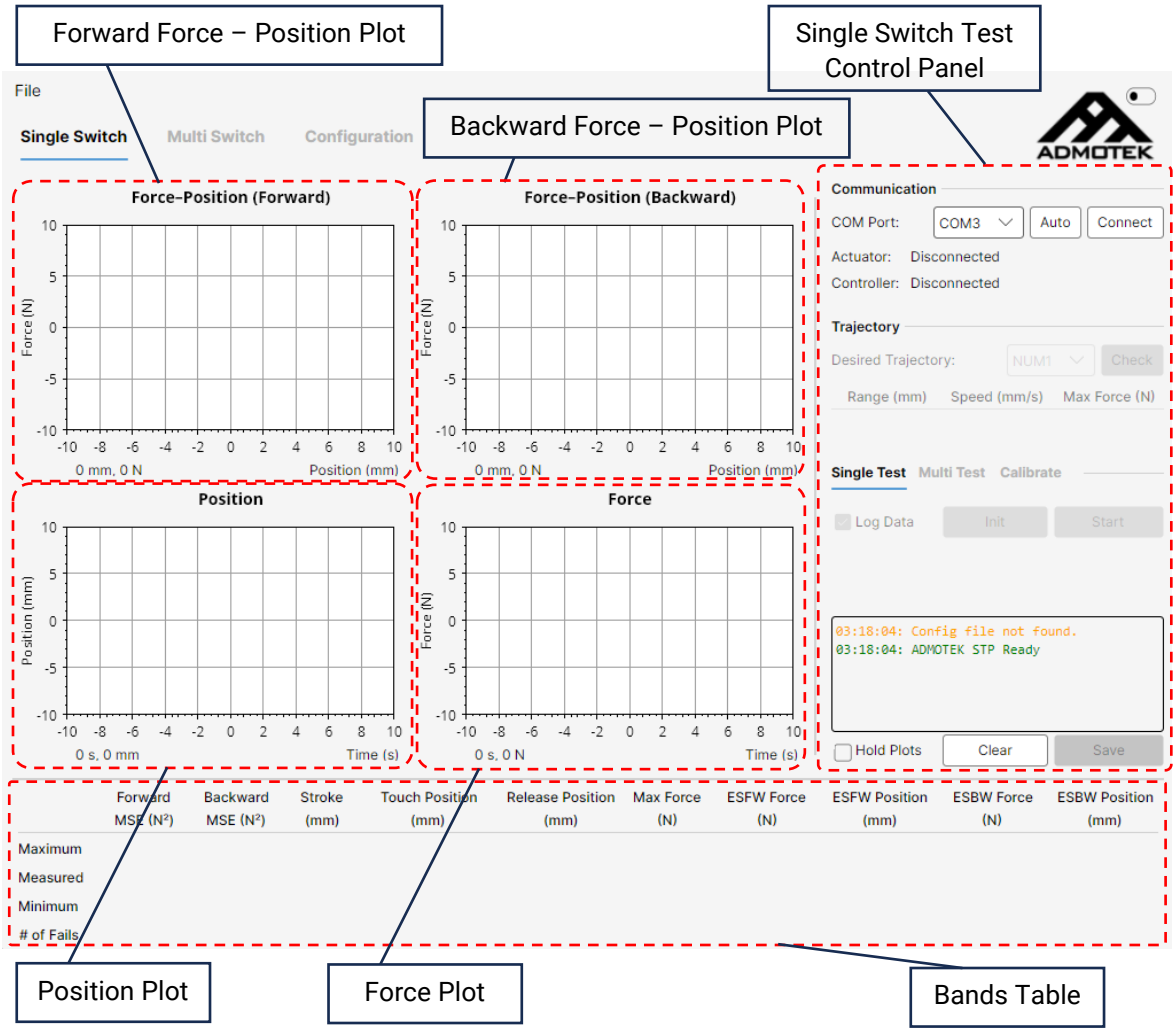


Fig. 5. Single Switch Tab.

4.3. Multi Switch Tab

This section can be used to test multiple switches (up to 6) at a time and comprises of the following sub-sections:

1- Test Control Panel:

This panel contains the controls required for testing a switch. It consists of the following parts:

- Status
- Communication
- Trajectory
- Cycles

- Start/Stop buttons

2- Curves Tab:

This tab contains two plots:

2-1- Forward Force – Position Plot:

This plot contains the curve known as the spring curve of the switch, but only for the pressing trajectory. This means that the plotted data starts at the touch position and ends at the bottom of the switch. It does not include the releasing trajectory data and the data before the first touch.

Note that if the test does not contain a pressing trajectory, this plot will be left empty.

This plot can also contain a red asterisk, showing the point where the electrical contact is changed. For this asterisk to be plotted, the electrical contact change must be enabled and monitored.

This plot does not support crosshair.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

2-2- Backward Force – Position Plot:

This plot contains the curve known as the spring curve of the switch, but only for the releasing trajectory. This means that the plotted data starts at the bottom of the switch and ends at the release point. It does not include the touch data, the pressing data, and the parking trajectory data.

Note that if the test does not contain a release trajectory, this plot will be left empty.

This plot can also contain a red asterisk, showing the point where the electrical contact is changed. For this asterisk to be plotted, the electrical contact change must be enabled and monitored.

This plot does not support crosshair.

To save this plot, one can simply right-click on it and choose “Save Image”. Left and middle mouse button are used respectively as pan and zoom. Also an “Autoscale” option is available by right-clicking on the plot.

3- Data Tab:

This tab contains a table for the pass/fail band values and test values along with the number of failed tests for each band parameter. The abbreviations used in this table are as follows:

- FW_MSE: Mean squared error of the forward force – position curve.
- BW_MSE: Mean squared error of the backward force – position curve.
- ESFW_F: The required force when the electrical contact changes in the pressing trajectory.
- ESFW_P: The displacement of the switch when the electrical contact changes in the pressing trajectory.
- ESBW_F: The required force when the electrical contact changes in the releasing trajectory.
- ESBW_P: The displacement of the switch when the electrical contact changes in the releasing trajectory.

4- Plot Controls

Plot controls facilitate using the plots.

5- Console

This console reports each action with its result and a timestamp.

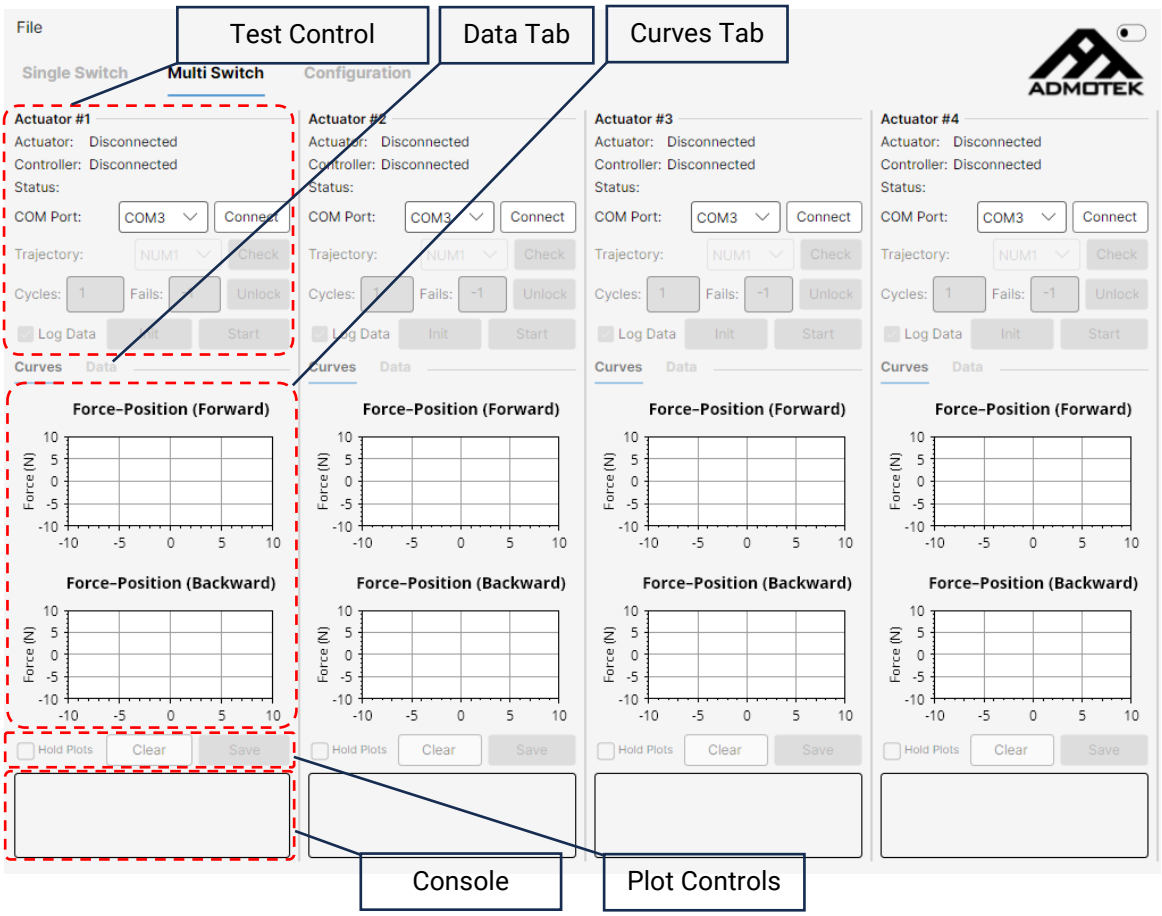


Fig. 6. Multi Switch Tab.

4.4. Configuration Tab

This section consists of two parts:

1- Test Configuration

Test configuration tab is made up of three main sections:

1-1- Trajectory

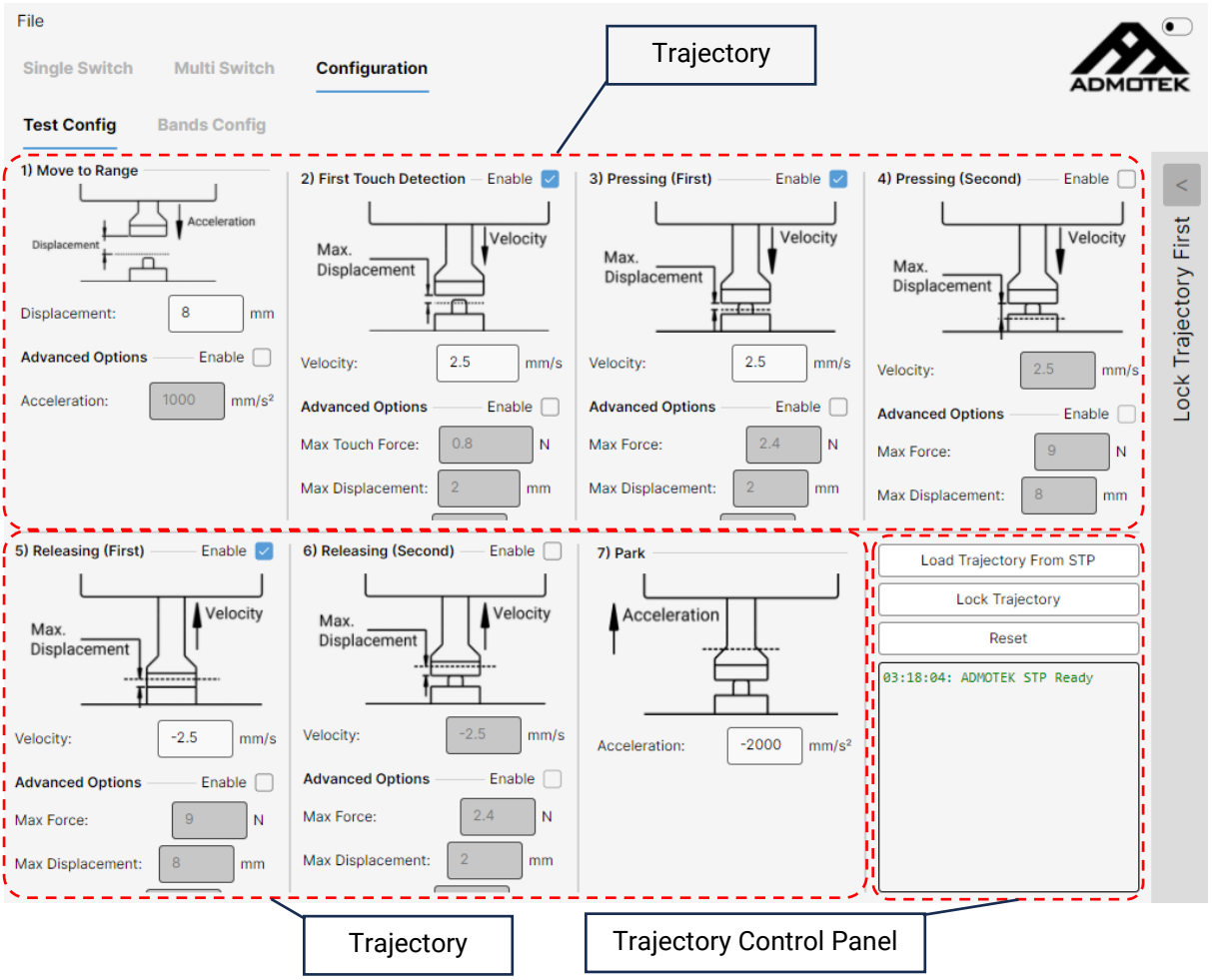
The trajectory comprises seven sub-sections as seven parts of the switch testing trajectory.

1-2- Trajectory Control Panel

This panel can be used to finalize a trajectory.

1-3- Controller Side Panel

This panel can be used to change the controller configuration and send the trajectory and configuration data to the controller.



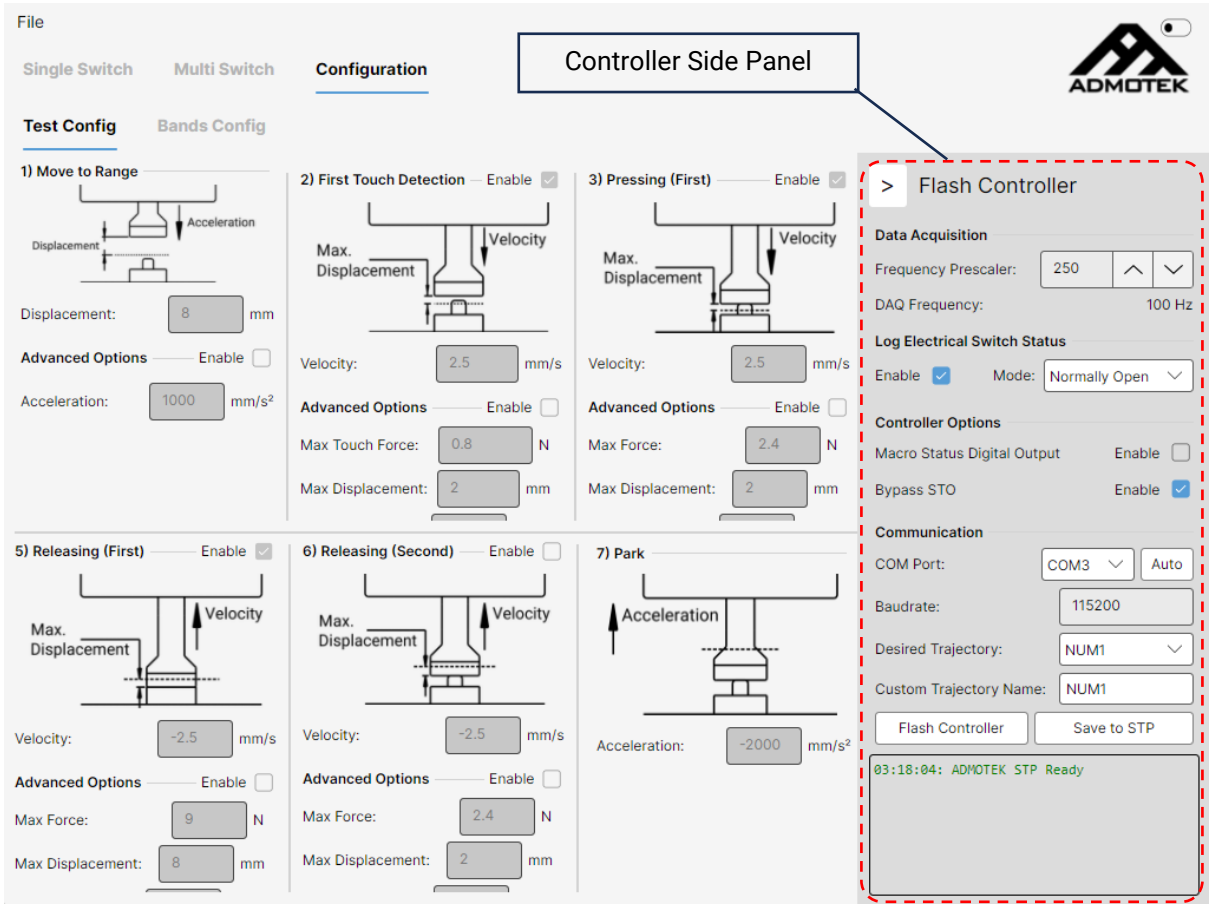


Fig. 7. Test Configuration Tab.

2- Bands Configuration

The bands configuration tab is made up of three main sections as well:

1-1- Band Parameters

Ten pass/fail band parameters are available to test various aspects of a switch.

1-2- Bands Control Panel

This panel can be used to check and save the bands.

1-3- Band Plots

These plots preview the bands that are entered by the user.

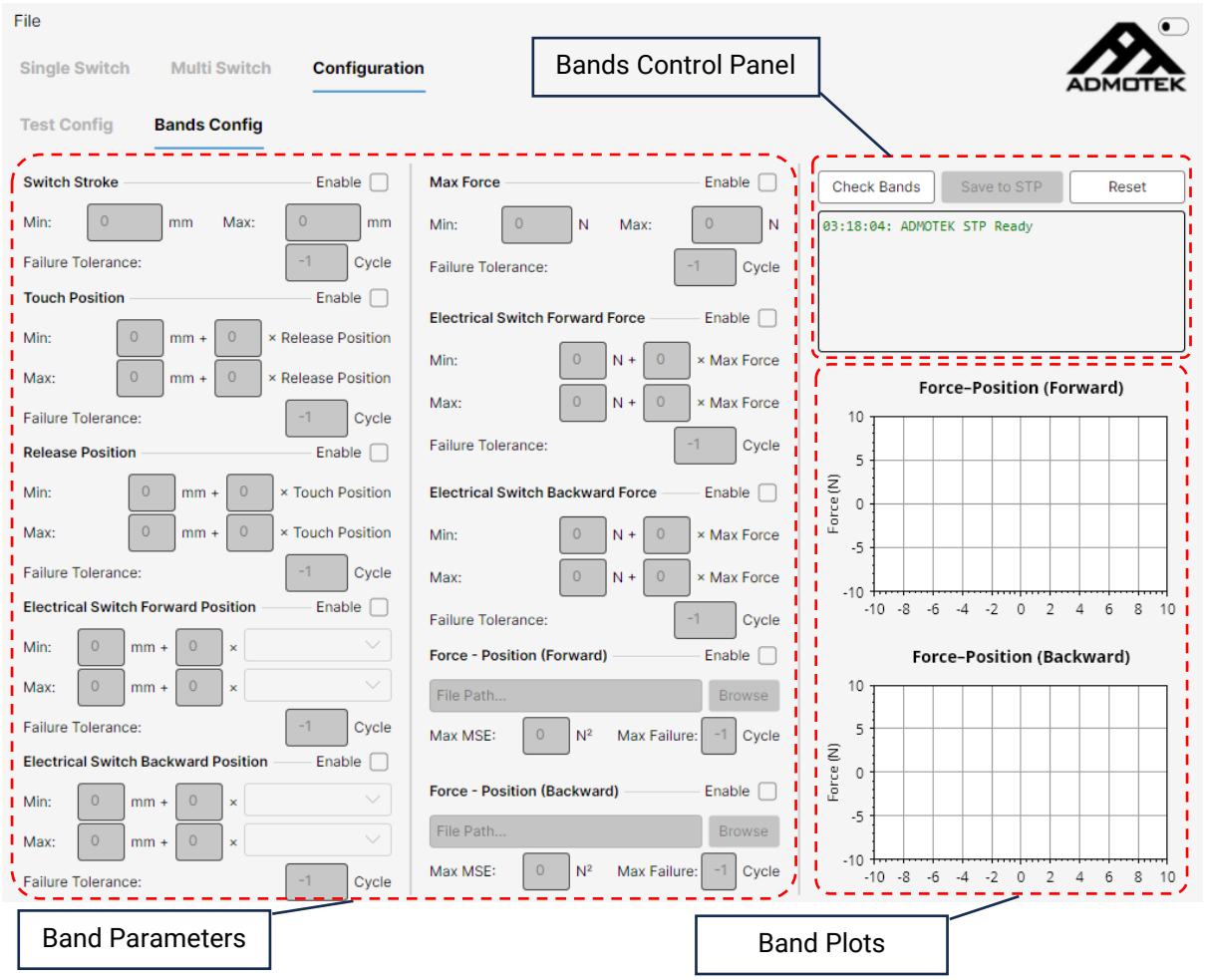


Fig. 8. Bands Configuration Tab.

5. Configuration Tab

This chapter focuses on the configuration tab, specially the approach for defining a new trajectory, changing the controller configuration, and changing the pass/fail bands.

5.1. Test Configuration Tab

To define a new trajectory, the user must start with the trajectory sub-sections, as shown in Fig. 7.

1- Move to Range:

As the first section of the desired trajectory, the user can define a constant acceleration trajectory with a high acceleration to move the rotor close to the top of the switch and reduce the test cycle time. The parameters of this part are:

Displacement: The total displacement of this part (in millimeters). This value should be set with regards to the switch position. For a better repeatability, leave some space (1mm - 2mm) for the first touch detection part.

Acceleration: The acceleration of the rotor (in millimeters per square second). The rotor moves with a positive acceleration of this value for the half of the time, and a negative acceleration of this value for the other half.

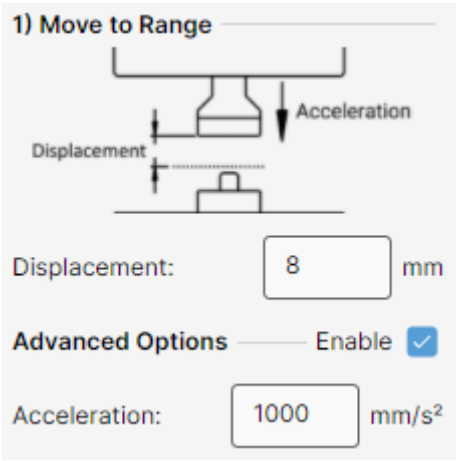


Fig. 9. Move to Range.

2- First Touch Detection:

In this part, the user can define the Soft-Touch algorithm parameters to detect the switch surface. With this algorithm, the rotor moves with a constant and usually slow velocity to detect the surface of the switch. The parameters of this part are:

Velocity: The velocity of the rotor (in millimeters per second). This value should be set with regards to the required accuracy of the surface detection. For a better accuracy, use lower velocities.

Max. Displacement: The maximum allowable displacement for this part (in millimeters). The touch detection finishes if the rotor moves as much as this value, regardless of a successful detection.

Max. Touch Force: The maximum allowable external force of the rotor (in Newtons). The rotor external force will be limited to this value after it passes the transient displacement. Set this value as high as possible for the best repeatability. Using values less than 0.4 N can result in wrong detections and require frequent calibrations.

Transient Displacement: The displacement in which the rotor force is not limited (in millimeters). When the rotor starts a constant velocity trajectory (like this one), the velocity controller needs to tune the velocity to the desired value and needs to excert high forces to the rotor. This parameters defines the displacement required for the velocity controller to achieve a steady-state. Set this value as high as possible for the best repeatability. Using values less than 0.5 mm can result in wrong detections.

Error Threshold: Threshold of the velocity control error that triggers a touch detection (in millimeters per second). When the rotor touches a surface, the path impedance increases, resulting in an increase in the velocity control error. The controller tries to compensate this error by increasing the force, but it’s limited by the Max. Touch Force parameter. This results in aggregation of error, eventually triggering the error threshold. Using values less than 0.05 mm/s can result in wrong detections.

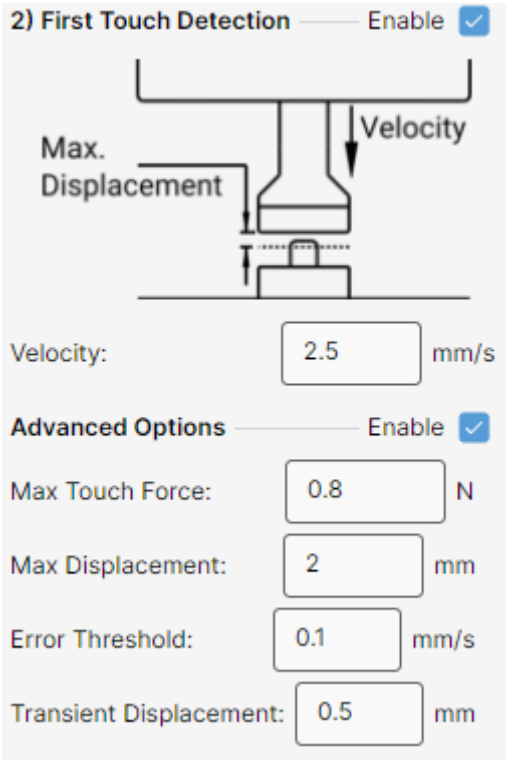


Fig. 10. First Touch Detection.

3- Pressing (First):

The user can define another Soft-Touch trajectory in this part. With this algorithm, the rotor moves with a constant velocity and can detect the change of path impedance. The parameters of this part are:

Velocity: The velocity of the rotor (in millimeters per second). This value should be set with regards to the required standard or test. For a better accuracy, use lower velocities.

Max. Displacement: The maximum allowable displacement for this part (in millimeters). This part finishes if the rotor moves as much as this value, regardless of a detection.

Max. Force: The maximum allowable external force of the rotor (in Newtons). The rotor external force will be limited to this value after it passes the transient displacement. Set this value as high as possible for the best repeatability. Using values less than 0.4 N can result in wrong detections and require frequent calibrations.

Transient Displacement: The displacement in which the rotor force is not limited (in millimeters). When the rotor starts a constant velocity trajectory (like this one), the velocity controller needs to tune the velocity to the desired value and needs to excert high forces to the rotor. This parameters defines the displacement required for the velocity

controller to achieve a steady-state. Set this value as high as possible for the best repeatability. Using values less than 0.5 mm can result in wrong detections.

Error Threshold: Threshold of the velocity control error that triggers a touch detection (in millimeters per second). The path impedance increase results in an increase in the velocity control error. The controller tries to compensate this error by increasing the force, but it's limited by the Max. Force parameter. This results in aggregation of error, eventually triggering the error threshold. Using values less than 0.05 mm/s can result in wrong detections.

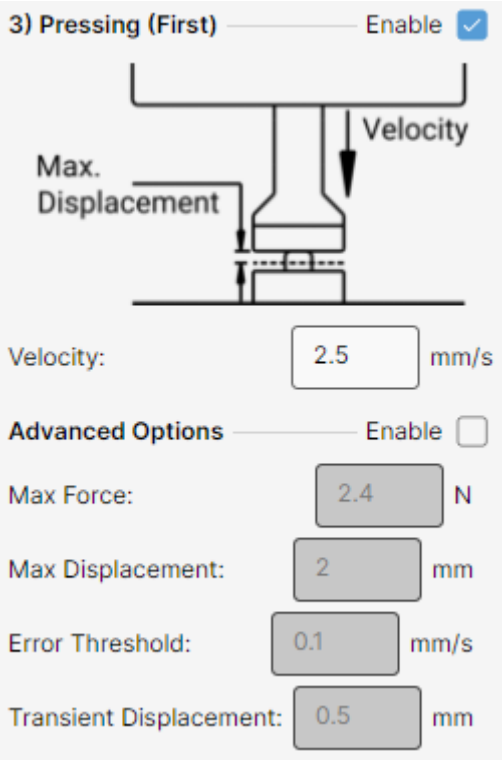


Fig. 11. Pressing (First).

Using this part, the user can accomplish one of the following:

- Detect the end of the switch:
  - Increase the Max. Force to a bit higher than the maximum force of the switch.
  - Increase Error Threshold to achieve a repeatable detection of the end of the switch.
  - The Max. Displacement should be set to a value higher than the stroke.

- The Transient Displacement should be set to a value lower than the stroke.

- Detect a change of impedance while pressing the switch.
  - Increase the Max. Force to a bit higher than the required force to pass the desired point.
  - Use an Error Threshold as low as possible.
  - The Max. Displacement should be set to a value higher than the desired point.
  - The Transient Displacement should be set to a value lower than the desired point.
- Press the switch for a predefined displacement.
  - Increase the Max. Force to a higher value than the maximum force of the switch.
  - Set Error Threshold as high as the velocity.
  - Set the desired displacement as the Max. Displacement and the Transient Displacement.
- Press the switch up to a predefined force.
  - Set the desired force as the Max. Force.
  - Set Error Threshold with regards to the required repeatability.
  - The Max. Displacement should be set to a value higher than the stroke.
  - Use a Transient Displacement as low as possible.

4- Pressing (Second):

The user can define another Soft-Touch trajectory in this part. With this algorithm, the rotor moves with a constant velocity and can detect the change of path impedance. The parameters of this part are:

Velocity: The velocity of the rotor (in millimeters per second). This value should be set with regards to the required standard or test. For a better accuracy, use lower velocities.

Max. Displacement: The maximum allowable displacement for this part (in millimeters). This part finishes if the rotor moves as much as this value, regardless of a detection.

Max. Force: The maximum allowable external force of the rotor (in Newtons). The rotor external force will be limited to this value after it passes the transient displacement. Set this value as high as possible for the best repeatability. Using values less than 0.4 N can result in wrong detections and require frequent calibrations.

Transient Displacement: The displacement in which the rotor force is not limited (in millimeters). When the rotor starts a constant velocity trajectory (like this one), the velocity controller needs to tune the velocity to the desired value and needs to excert high forces to the rotor. This parameters defines the displacement required for the velocity controller to achieve a steady-state. Set this value as high as possible for the best repeatability. Using values less than 0.5 mm can result in wrong detections.

Error Threshold: Threshold of the velocity control error that triggers a touch detection (in millimeters per second). The path impedance increase results in an increase in the velocity control error. The controller tries to compensate this error by increasing the force, but it's limited by the Max. Force parameter. This results in aggregation of error, eventually triggering the error threshold. Using values less than 0.05 mm/s can result in wrong detections.

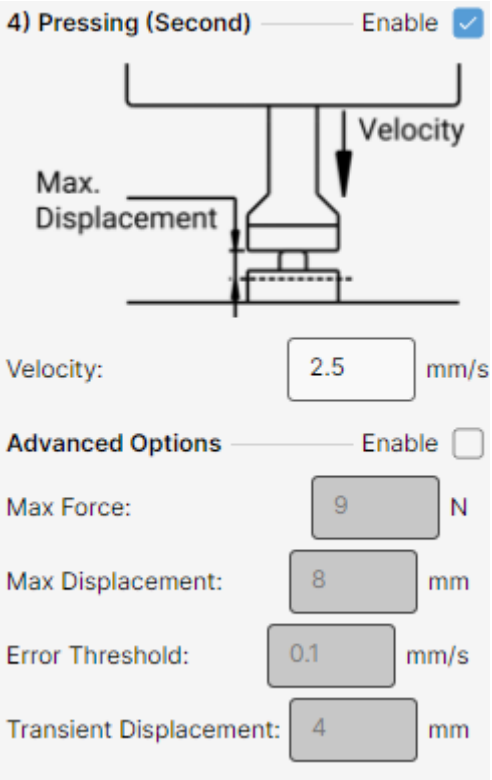


Fig. 12. Pressing (Second).

Using this part, the user can accomplish one of the following:

- Detect the end of the switch:
  - Increase the Max. Force to a bit higher than the maximum force of the switch.
  - Increase Error Threshold to achieve a repeatable detection of the end of the switch.
  - The Max. Displacement should be set to a value higher than the stroke minus the first pressing displacement.
  - The Transient Displacement should be set to a value lower than the stroke minus the first pressing displacement.
- Detect a change of impedance while pressing the switch.
  - Increase the Max. Force to a bit higher than the required force to pass the desired point.
  - Use an Error Threshold as low as possible.

- The Max. Displacement should be set to a value higher than the desired point.
- The Transient Displacement should be set to a value lower than the desired point.

- Press the switch for a predefined displacement.
  - Increase the Max. Force to a higher value than the maximum force of the switch.
  - Set Error Threshold as high as the velocity.
  - Set the desired displacement as the Max. Displacement and the Transient Displacement.
- Press the switch up to a predefined force.
  - Set the desired force as the Max. Force.
  - Set Error Threshold with regards to the required repeatability.
  - The Max. Displacement should be set to a value higher than the stroke.
  - Use a Transient Displacement as low as possible.

5- Releasing (First):

The user can define another Soft-Touch trajectory in this part, but with a negative velocity to release the switch. With this algorithm, the rotor moves with a constant negative velocity and can detect the change of path impedance. The parameters of this part are:

Velocity: The velocity of the rotor (in millimeters per second). This value should be set with regards to the required standard or test. For a better accuracy, use lower velocities.

Max. Displacement: The maximum allowable displacement for this part (in millimeters). This part finishes if the rotor moves as much as this value, regardless of a detection.

Max. Force: The maximum allowable external force of the rotor (in Newtons). The rotor external force will be limited to this value after it passes the transient displacement. Set this value as high as possible for the best repeatability. Using values less than 0.4 N can result in wrong detections and require frequent calibrations.

Transient Displacement: The displacement in which the rotor force is not limited (in millimeters). When the rotor starts a constant velocity trajectory (like this one), the velocity controller needs to tune the velocity to the desired value and needs to excert high forces to the rotor. This parameters defines the displacement required for the velocity controller to achieve a steady-state. Set this value as high as possible for the best repeatability. Using values less than 0.5 mm can result in wrong detections.

Error Threshold: Threshold of the velocity control error that triggers a detection (in millimeters per second). The path impedance decrease results in an increase in the velocity control error. The controller tries to compensate this error by decreasing the force, but it's limited by the Max. Force parameter. This results in aggregation of error, eventually triggering the error threshold. Using values less than 0.05 mm/s can result in wrong detections.

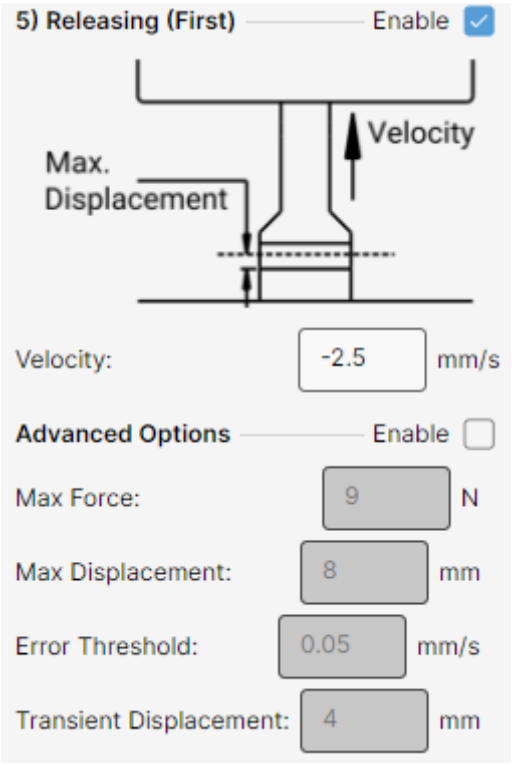


Fig. 13. Releasing (First).

Using this part, the user can accomplish one of the following:

- Detect the release point:

- Increase the Max. Force to a bit higher than the maximum force of the switch.
- Use an Error Threshold as low as possible.
- The Max. Displacement should be set to a value higher than the stroke.
- The Transient Displacement should be set to a value lower than the stroke.

o Detect a change of impedance while releasing the switch.

- Increase the Max. Force to a bit higher than the maximum force of the switch.
- Use an Error Threshold as low as possible.
- The Max. Displacement should be set to a value higher than the desired point.
- The Transient Displacement should be set to a value lower than the desired point.

o Release the switch for a predefined displacement.

- Increase the Max. Force to a bit higher than the maximum force of the switch.
- Set Error Threshold as high as the velocity.
- Set the desired displacement as the Max. Displacement and the Transient Displacement.

6- Releasing (Second):

The user can define another Soft-Touch trajectory in this part, but with a negative velocity to release the switch. With this algorithm, the rotor moves with a constant negative velocity and can detect the change of path impedance. The parameters of this part are:

Velocity: The velocity of the rotor (in millimeters per second). This value should be set with regards to the required standard or test. For a better accuracy, use lower velocities.

Max. Displacement: The maximum allowable displacement for this part (in millimeters). This part finishes if the rotor moves as much as this value, regardless of a detection.

Max. Force: The maximum allowable external force of the rotor (in Newtons). The rotor external force will be limited to this value after it passes the transient displacement. Set this value as high as possible for the best repeatability. Using values less than 0.4 N can result in wrong detections and require frequent calibrations.

Transient Displacement: The displacement in which the rotor force is not limited (in millimeters). When the rotor starts a constant velocity trajectory (like this one), the velocity controller needs to tune the velocity to the desired value and needs to excert high forces to the rotor. This parameters defines the displacement required for the velocity controller to achieve a steady-state. Set this value as high as possible for the best repeatability. Using values less than 0.5 mm can result in wrong detections.

Error Threshold: Threshold of the velocity control error that triggers a detection (in millimeters per second). The path impedance decrease results in an increase in the velocity control error. The controller tries to compensate this error by decreasing the force, but it's limited by the Max. Force parameter. This results in aggregation of error, eventually triggering the error threshold. Using values less than 0.05 mm/s can result in wrong detections.

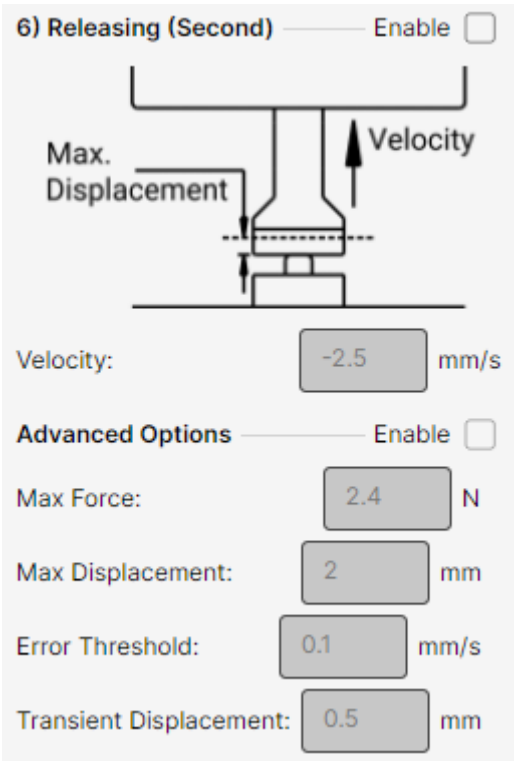


Fig. 14. Releasing (Second).

Using this part, the user can accomplish one of the following:

- Detect the release point:
  - Increase the Max. Force to a bit higher than the force of the point of start of this part.
  - Use an Error Threshold as low as possible.
  - The Max. Displacement should be set to a value higher than the remaining displacement.
  - The Transient Displacement should be set to a value lower than the remaining displacement.
- Release the switch for a predefined displacement.
  - Increase the Max. Force to a bit higher than the force of the point of start of this part.
  - Set Error Threshold as high as the velocity.
  - Set the desired displacement as the Max. Displacement and the Transient Displacement.

7- Park:

As the end of the trajectory, this part parks the rotor at home position. The user can define the acceleration for this part:

Acceleration: The acceleration of the rotor (in millimeters per square second). The rotor moves with a negative acceleration for the half of the time, and a positive acceleration for the other half.

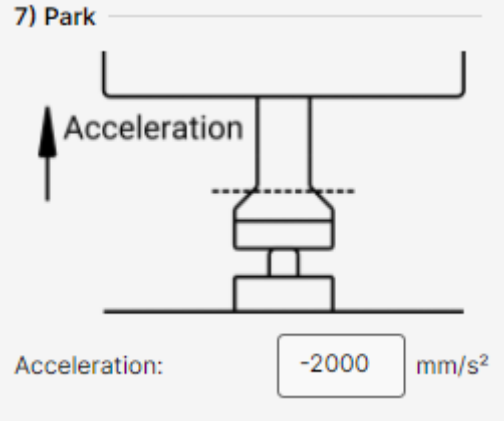


Fig. 15. Park.

8- Trajectory Control Panel:

To continue defining a new trajectory, the control panel (shown in Fig. 7 is used). Three buttons are available:

Load Trajectory From STP: This load the latest trajectory that was saved to the software.

Lock Trajectory: This locks the defined trajectory and enables the controller side panel. Note that the defined trajectory is also reported in the console if the user wishes to configure the controller using other methods.

Reset: This reset the trajectory inputs to the default values.

9- Controller Side Panel:

After designing and locking a trajectory, the controller side panel is accessible. As shown in Fig. 7, the available options in the controller side panel are as follows:

Frequency Prescaler: This is the data acquisition frequency prescaler. The controller records the data at 25 kHz which is too high for an online data transmission. Use a frequency prescaler of at least 25 (resulting in 1 kHz). A value of 250 (resulting in 100 Hz) is recommended.

Log Electrical Switch Status: Using this option, the user can enable the detection of the electrical contact change and set it to Normally Open or Normally Close. Refer to CTRL1-48-5-G4 user manual for the switch wiring guideline.

Macro Status Digital Output: This option enables a digital output for each macro transition. Refer to CTRL1-48-5-G4 user manual for further information.

Bypass STO: This option can bypass STO (Safe Torque Off). Enable it if you don't use STO. Refer to CTRL1-48-5-G4 user manual for further information.

COM Port: This list contains the list of COM ports of the computer. Either select the controller's COM port or use the Auto button.

Auto Button: This button searches the available COM ports to find the controller. Note that it stops with the first controller found (Be aware of using this, if you have several controllers connected).

Baudrate: This option can change the controller's RS485/RS422 baudrate. Note that the RS232's baudrate can't be changed (Refer to CTRL1-48-5-G4 user manual for further information).

Desired Trajectory: This list contains the nine available trajectories that can be saved on controller's flash memory. Select the one you wish to save the designed trajectory.

Custom Trajectory Name: This option can save a custom name for the designed trajectory. Note that this name is not saved on the controller and is only available inside the STP.

Flash Controller: This button sends the trajectory and configuration data to the controller. The result of the process is printed in the console. Note that in most scenarios, you need to click on "Save to STP" as well.

Save to STP: This button saves the trajectory and configuration data in the STP's config file. Note that in most scenarios, you need to click on "Flash Controller" as well.

5.2. Bands Configuration Tab

Using this tab, the user can define and tune the pass/fail bands that are used to verify the switch performance. The band parameters are as follows:

1- Switch Stroke:

The user can set a minimum and maximum for the switch stroke using this parameter. Also, a failure tolerance can be defined for this parameter. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to

disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

Fig. 16. Switch Stroke Band.

2- Touch Position:

The user can set a minimum and maximum for the touch position using this parameter. Also, it is possible to set these values with regards to the Release Position. If constant values are desired, use zero as the gain of the Release Position.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

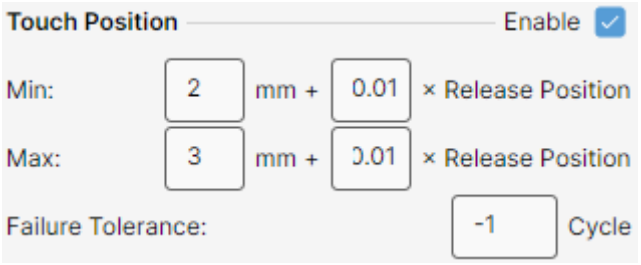


Fig. 17. Touch Position Band.

3- Release Position:

The user can set a minimum and maximum for the release position using this parameter. Also, it is possible to set these values with regards to the Touch Position. If constant values are desired, use zero as the gain of the Touch Position.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to

disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

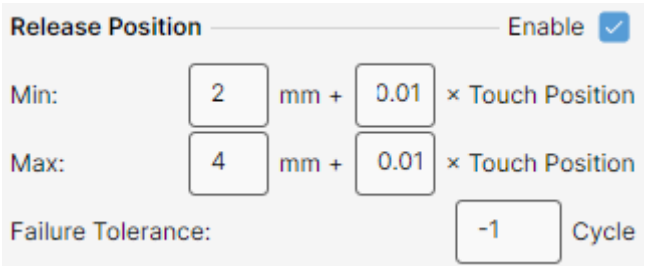


Fig. 18. Release Position Band.

4- Electrical Switch Forward Position:

The user can set a minimum and maximum for the position of the electrical contact changing point (while pressing) using this parameter. Also, it is possible to set these values with regards to:

- Touch Position
- Release Position
- End Stroke Position

If constant values are desired, use zero as the gain of the these.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

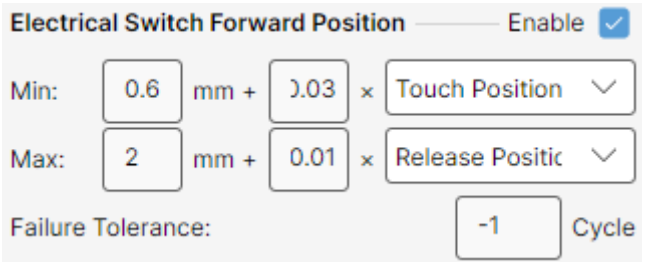


Fig. 19. Electrical Switch Forward Position Band.

5- Electrical Switch Backward Position:

The user can set a minimum and maximum for the position of the electrical contact changing point (while releasing) using this parameter. Also, it is possible to set these values with regards to:

- Touch Position
- Release Position
- End Stroke Position

If constant values are desired, use zero as the gain of the these.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

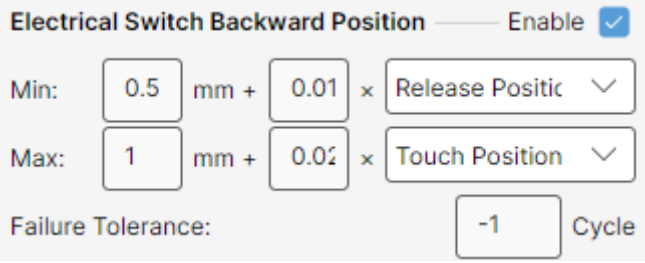


Fig. 20. Electrical Switch Backward Position Band.

6- Max Force:

The user can set a minimum and maximum for the maximum force using this parameter. Also, a failure tolerance can be defined for this parameter. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

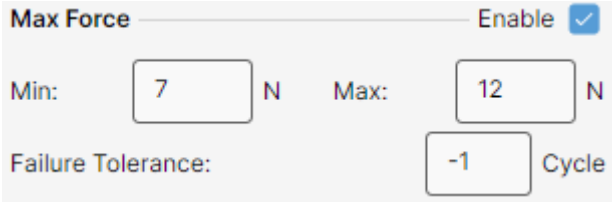


Fig. 21. Max Force Band.

7- Electrical Switch Forward Force:

The user can set a minimum and maximum for the force of the electrical contact changing point (while pressing) using this parameter. Also, it is possible to set these values with regards to the Max. Force. If constant values are desired, use zero as the gain.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

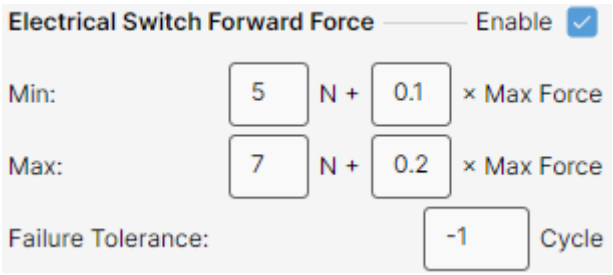


Fig. 22. Electrical Switch Forward Force Band.

8- Electrical Switch Backward Force:

The user can set a minimum and maximum for the force of the electrical contact changing point (while releasing) using this parameter. Also, it is possible to set these values with regards to the Max. Force. If constant values are desired, use zero as the gain.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

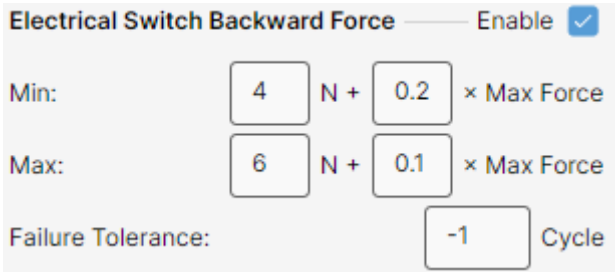


Fig. 23. Electrical Switch Backward Force Band.

9- Forward Force – Position Band:

For this pass/fail band, the user can use two curves to set lower and upper limits for the forward force – position curve. These curves must be formatted in a CSV file. The first column represents the lower limit and the second column represents the higher limit. Starting from row#0, each row represents a 0.01 mm displacement. Note that neither columns nor rows should have titles. The described format is as follows:

```
<lower_limit_for_x=0.00>,<higher_limit_for_x=0.00>
<lower_limit_for_x=0.01>,<higher_limit_for_x=0.01>
<lower_limit_for_x=0.02>,<higher_limit_for_x=0.02>
<lower_limit_for_x=0.03>,<higher_limit_for_x=0.03>
<lower_limit_for_x=0.04>,<higher_limit_for_x=0.04>
.
.
.
<lower_limit_for_x=n>,<higher_limit_for_x=n>
```

Along with the CSV file, a Max. MSE must be entered as well. To verify the curve, each point on the forward force – position curve is compared with the corresponding lower limit and upper limit. If the point is out of the bands, the error is calculated based on the point's value and the closest limit (lower or upper, at the same position). The mean squared error of the forward force – position curve is then calculated and compared to the Max. MSE. A failed cycle happens only when the calculated MSE is higher than the Max. MSE.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to

disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

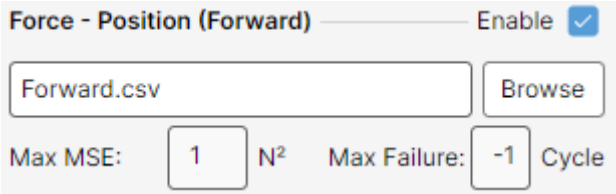


Fig. 24. Forward Force – Position Band.

10- Backward Force – Position Band:

For this pass/fail band, the user can use two curves to set lower and upper limits for the backward force – position curve. These curves must be formatted in a CSV file. The first column represents the lower limit and the second column represents the higher limit. Starting from row#0, each row represents a 0.01 mm displacement. Note that neither columns nor rows should have titles. The described format is as follows:

```
<lower_limit_for_x=0.00>,<higher_limit_for_x=0.00>
<lower_limit_for_x=0.01>,<higher_limit_for_x=0.01>
<lower_limit_for_x=0.02>,<higher_limit_for_x=0.02>
<lower_limit_for_x=0.03>,<higher_limit_for_x=0.03>
<lower_limit_for_x=0.04>,<higher_limit_for_x=0.04>
.
.
.
<lower_limit_for_x=n>,<higher_limit_for_x=n>
```

Along with the CSV file, a Max. MSE must be entered as well. To verify the curve, each point on the backward force – position curve is compared with the corresponding lower limit and upper limit. If the point is out of the bands, the error is calculated based on the point's value and the closest limit (lower or upper, at the same position). The mean squared error of the backward force – position curve is then calculated and compared to the Max. MSE. A failed cycle happens only when the calculated MSE is higher than the Max. MSE.

A failure tolerance can be defined for this parameter as well. If the number of failed cycles of this parameter exceeds the failure tolerance, the Multi Test (either in Single Switch or Multi Switch) stops with a Max. Failure Reached error. Set Failure Tolerance as -1 to

disable this function. Note that a Failure Tolerance of 0 stops the Multi Test at the first failed cycle.

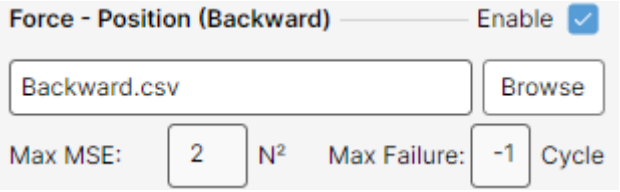


Fig. 25. Backward Force – Position Band.

After the pass/fail band parameters are set, the bands control panel must be used. There are three buttons available on the bands control panel:

1- Check Bands:

This button verifies and locks the band parameters and plots the forward and backward curve limits on the band plots. If the bands are verified, Save to STP button gets enabled, otherwise, the error is reported in the console.

2- Save to STP:

As the name suggests, this button saves the band parameters in the STP's config file.

3- Reset:

This button resets and disables all the band parameters. Note that this does not affect the STP's config and will just reset the GUI fields.

6. Single Switch

This chapter focuses on the single switch tab and goes through the process of calibrating the actuator, single test, and multi test.

To start, the user must connect to the controller using the Communication section (shown in Fig. 26). A COM Port list is available in that section where the user can choose the controller's COM port or use the Auto button. This button searches the COM ports and finds the first controller. Note that if several controllers are connected to the computer, the Auto function stops at the first controller found.

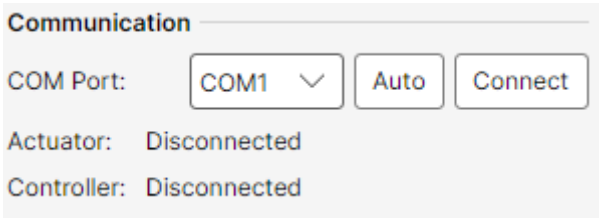


Fig. 26. Communication Section.

By successfully connecting to a controller, the communication section's status updates and shows the actuator and controller serial numbers and temperatures, as shown in Fig. 27. Note that while the STP is connected to the controller, other tabs (Multi Switch and Configuration) are disabled.

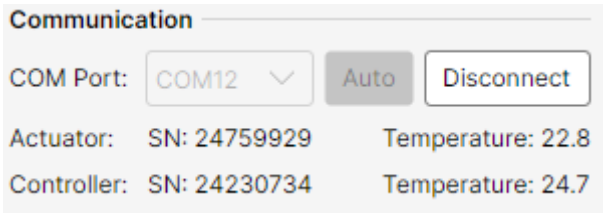


Fig. 27. Communication section after a successful connection.

After connecting to a controller, the user must choose a trajectory. Trajectory list contains all the possible trajectories that can be saved on the controller. If a trajectory has a custom name saved on the STP, the custom name is shown instead of the default name. By choosing the desired trajectory and clicking on the Check button, the STP communicates with the controller and retrieves the selected trajectory. Then it compares the retrieved trajectory with the one saved on the STP's database. If the trajectories match, the other panels get enabled but if the trajectories does not match, a warning is printed to the console. The user can continue to start the test, even if the trajectories does not match. The trajectory section after verifying it is shown on Fig. 28.

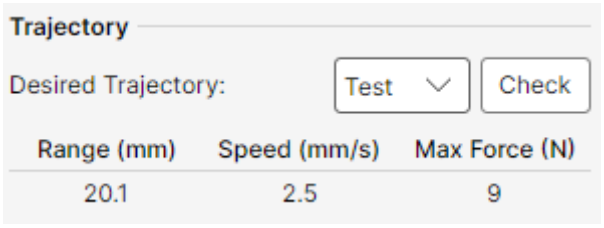


Fig. 28. Trajectory section.

After verifying a trajectory, three tabs are available to the user:

6.1. Single Test

Fig. 29 shows the Single Test tab. Each time the controller is restarted or the actuator is disconnected from the controller, the actuator's encoder needs to be initialized. The Init button is responsible for this initialization. If the encoder is already initialized, the Start button will get enabled; otherwise, the user will have to click on the Init button. Note that the encoder initialization process includes moving the rotor for several millimeters. Refer to CTRL1-48-5-G4 user manual for further information.

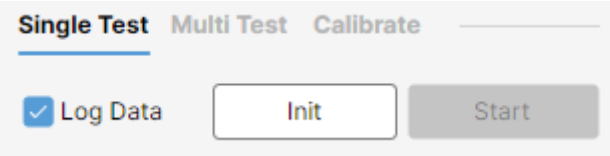


Fig. 29. Single Test Tab.

After a successful encoder initialization, the user can use the Start button to start a single test. During the test, the other buttons get disabled and only the Start button and the Disconnect buttons are available. In the case of an emergency or need, the user might click on each of these buttons to stop the test.

If the cycle finishes successfully, the curves are plotted and the parameters are updated in the pass/fail bands table. Otherwise, the error code along with the description are printed into the console.

6.2. Multi Test

Fig. 30 shows the Multi Test tab. The user can use this tab to test the switch for reliability and other means. The difference between this tab and the Single Test tab is the counter functionality. Cycles input define the number of cycles to test and the Max Fails input define the maximum failure tolerance. If the number of failed cycles exceeds the failure tolerance, the test stops with a Max. Failure Reached error. Set this to -1 to disable this function. Note that a Max Fails of 0 stops the test at the first failed cycle.

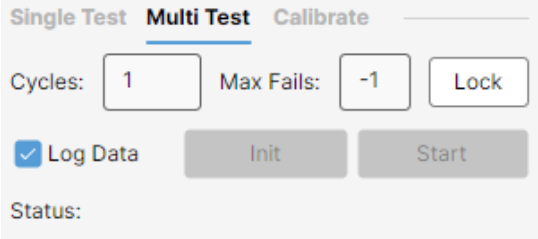


Fig. 30. Multi Test Tab.

The lock button locks the counter data and allows the user to start the test. The counter data won't reset even after closing the STP. To reset the counter, simply click on the Unlock button. Due to the importance of the counter data, the user must click again on that button within 5 seconds; otherwise, the counter data won't be reset.

6.3. Calibrate

Fig. 31 shows the Calibrate tab. The user can use this tab to calibrate the actuator. Without a calibration, the actuator won't be able perform Soft-Touch correctly and the force data are not reliable. The calibration needs a range. The user can change this range according to the fixture setup. Note that while calibrating, the rotor must move freely in the defined range.

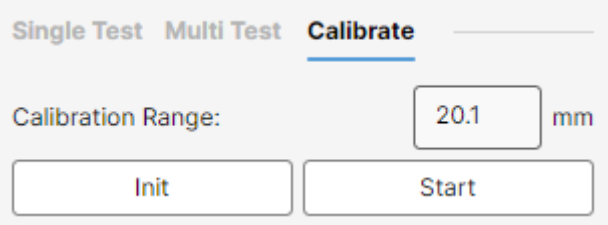


Fig. 31. Calibrate Tab.

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