

ZABER



ZABER TECHNOLOGIES

X-Series Device
Getting Started Guide

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Precautions

1. Zaber's devices may produce enough force to cause personal injury. Be careful to keep hair, body parts, jewelry, and clothing from being caught in moving components. Pinch labels are used on our devices to indicate areas of particular concern.
2. During continuous operation, a device's motor may get hot. Some models may reach 90°C or more (this is noted in the manual and heat warning stickers are included on affected surfaces). This is generally expected behaviour; take caution when handling the motors of devices during or after operation. Burnt smells or smoke are not expected during normal operation; if encountered, discontinue operation and contact Customer Support.
3. To reduce the risk of electrostatic damage, avoid touching the electrical contacts of the data cables included with your device(s).
4. Before storing your device(s), retract any extended components in order to keep them clean and to protect them from damage.
5. Do not expose device(s) to vibration or shock.
6. Do not expose device(s) to extreme conditions, such as temperatures exceeding device ratings, radiation, and dusty or humid environments.
7. Do not submerge device(s) in liquid.
8. Do not disassemble. Please contact Customer Support for service and/or repairs.
9. Check the manual online for any additional precautions and warnings related to your devices.
10. 10. Power devices after all communication cables have been securely connected. Plugging and unplugging communication cables while powered can cause damage.

Maintenance

Please refer to our online manuals at www.zaber.com/support for maintenance information on your specific positioner, including whether re-greasing is necessary and on what schedule. If a component is exposed to dust or dirt, it should be gently wiped with isopropyl alcohol. We do not recommend using stronger solvents, as they can damage non-metal components.

Returns, Warranty, and Repairs

All of Zaber's standard products (those that appear on our website) are backed by a 30-day satisfaction guarantee. If you are not satisfied with your purchase for any reason, you may return the item(s) in saleable and unmarked condition within 30 days of the purchase date for a refund, less applicable shipping costs.

High vacuum (10^{-6} Torr) devices cannot be returned for refund once they have been removed from their sealed packaging.

All standard products are warrantied against defects in manufacture and design for one full year from the purchase date. This warranty excludes products that have been misused, modified, or disassembled by the customer. Misuse includes operating the devices in abnormal conditions, such as in extreme temperatures, in proximity of radiation or strong magnets, or in wet environments. If you are not sure whether your conditions are acceptable under our warranty, please contact Customer Support.

Aside from issues covered under warranty, we are also happy to inspect any other problems that may arise, and we offer reasonably priced repairs. Simply email contact@zaber.com for assistance.

Please refer to www.zaber.com/policies for more information about our policies.

Common Terminology

Positioner

A motorized product with moving mechanics, such as a linear stage, a rotational stage, or a stepper motor.

Peripheral

A positioner that includes a motor and mechanics but does not include an integrated controller. Peripherals are designed for use with Zaber's motor controllers, but they can also be used with compatible third-party motor drivers and controllers.

Device

A stand-alone controller or a positioner with an integrated controller. Stand-alone controllers are designed for use with Zaber's peripherals, but they can also be used with compatible third-party peripherals.

Joystick

A product that allows multi-axis manual input and push-button input for positioners. Joysticks do not function as controllers; instead, they are designed to communicate with Zaber's motor controllers when connected in series.

X-Series, A-Series, and T-Series

Devices that share common features, such as connectors, protocols, and power. The series is indicated by the first letter of the device's name. For example, the X-LSM025A model belongs to the X-Series family. This guide specifically relates to X-Series devices. See an older version of the manual for setup instructions for T-Series or A-Series devices at:

www.zaber.com/documents/Getting-started-guide.pdf.

Closed-Loop and Servo Devices

For Zaber devices, closed-loop refers to any device where encoder feedback is used to inform the trajectory of the controller. Servo devices refer to a sub-set of these where encoder feedback is also required for the driver. Direct-drive stages are servo devices.

Stepper motor devices with encoders use closed-loop control but are not servo devices, as the driver controls stepping directly without encoder feedback. Encoder feedback is still used to inform the trajectory of the controller on these.

Servo devices require tuning of their control loop to get the best performance (more on page 9). They also use encoder counts as their unit of resolution, as opposed to stepper motors, which use microsteps (more on page 8).

Quick Set-up Checklist

Checklist Item	Page
<input type="checkbox"/> Check for and remove shipping guards or fasteners (select devices)	4
<input type="checkbox"/> Connect to peripheral (if using a peripheral)	5
<input type="checkbox"/> Connect daisy-chain (if using multiple devices)	5
<input type="checkbox"/> Connect to computer	6
<input type="checkbox"/> Connect power	6
<input type="checkbox"/> Install USB drivers (if using USB)	6
<input type="checkbox"/> Install Zaber Launcher	7
<input type="checkbox"/> Home the device using software or the manual knob to confirm set-up	10
<input type="checkbox"/> Fine tune the servo control loop after mounting a load (servo devices only)	9

Shipping Guards

Some devices include guards, such as plates, inserts, covers, or fasteners, which prevent movement of devices during shipping and limit potential damage from shock loads. If they are present for a device, they will either be clearly visible and intuitive to remove or clearly marked with labels and instructions. Following those instructions, remove any such components before powering the device. Read the manual online for more details on shipping security features.

Vacuum Devices

While some of the information covered in this guide applies to our vacuum compatible devices, please refer to the online product manuals for detailed connection recommendations or read our technical article on “Considerations for Vacuum Applications”:
www.zaber.com/VacuumTechnicalArticle.

Connect

Most systems will be quick and easy to connect with four steps. Our Quick Set-Up Tool also provides specific connection recommendations, which you can find here: www.zaber.com/QuickSetupTool.

Connect Peripherals (if applicable)

If using a stand-alone controller, plug it into the motorized axis.



Depending on the controller and peripheral, the motor cable may be an MC03 (DB-15 M-F), MC10T3 (DB15 to DB26), or MC10 (DB26 M-F) cable. Cables are high-flex with specific wire bundling; using cables from Zaber is recommended.

Connect Daisy-chain (if applicable)

Connect multiple devices in series to create a chain. They will share power and a single computer connection.



X-Series devices can be daisy-chained using an M8 cable, such as the X-DC02.

Connect to Computer

Connect the first controller (built into the device or stand-alone) to your computer via USB or Ethernet†.



X-Series devices can connect to a computer's USB port with an X-USBDC* cable.



Stand-alone controllers also have the option to connect directly to a computer's USB port with a U-DC06 cable or over Ethernet.

Connect Power

Connect a power supply to a device to power the whole chain.



Devices connect to a 24-48VDC power supply. The number of devices you can power will depend on the combined draw of the devices and the current capacity of the power supply.

*Drivers may be required if COM port does not appear. Download and installation instructions here: www.zaber.com/software.

†See X-MCC manual for Ethernet setup: www.zaber.com/manuals/X-MCC.

Control

Once your Zaber device is powered and connected to a computer, you are ready to start controlling it. To begin communicating with your device, you will need to select a software interface. The following sections outline some of the software options available.

Zaber Launcher

Zaber Launcher is a cross-platform application that helps you set up, control, and explore your devices. This guide assumes that this is the software you are using. Find it at: software.zaber.com/zaber-launcher.



ASCII Commands

Communication protocols dictate the way in which commands are formatted to send to a device. Zaber ASCII is the recommended and default protocol for the X-Series.

ASCII Manual

www.zaber.com/manuals/ASCIIProtocol

Programming Libraries

In order to make working with Zaber devices as easy as possible, Zaber offers fully-featured programming libraries with comprehensive APIs and examples in a number of programming languages.

LabVIEW

www.zaber.com/software/LabVIEWASCII

Python 3

C#

C++

JavaScript

Java

MATLAB

www.zaber.com/software/ZML

Resolution - Stepper & Servo Motors

The resolution of a device is the smallest increment you can command it to move. For example, sending the ASCII protocol command `/move rel 1` instructs a device to move forward by 1 increment. The physical distance corresponding to this increment depends on the type of motor that drives the device. For devices driven by stepper motors, an increment is a microstep of the motor, and the size of an increment is the device's Microstep Size specification. For servo devices, an increment is an encoder count, and the size of an increment is the device's Encoder Resolution specification.

Microstepping

Stepper motors are designed for position control. In a motor revolution, they have a number of equally-spaced full-step positions. Most stepper motors in Zaber devices have 200 steps per revolution.

Zaber's drivers sub-divide each motor step into a number of smaller increments called microsteps. By default, most devices use a resolution of 64 microsteps per step (although this is adjustable), so by default they can move to 12800 microstep positions for every motor revolution.

Many devices use lead screws or gearing to move the actuators or stages, so a motor revolution will move the device a certain distance. That distance can be divided by the number of

microsteps per revolution to get the distance moved per microstep. This is the Microstep Size. The Microstep Size will vary from device to device; the value for your device is available on our website under the 'Series Specs' tab for each product.

Encoder Counts

Unlike stepper motors, servo motors are designed with force control in mind; they can be driven using position control, but the resolution is very coarse. To achieve fine-resolution positioning, Zaber's servo devices feature a variety of digital and analog position encoders for feedback. An encoder count is the smallest movement of the encoder that will be registered by the controller.

Speed and Acceleration

While microsteps (for stepper motor devices) or encoder counts (for direct drive devices) are the increments of position on Zaber devices, there are conversion factors required to calculate the increments of speed and acceleration.

Zaber Launcher and the programming libraries will handle this conversion for you if you are using them. Otherwise, see the table below for the conversion formula.

$$\begin{aligned} \text{speed (in microsteps or encoder counts/second)} &= \text{Data} / 1.6384 \\ \text{acceleration (in microsteps or encoder counts/second}^2) &= \text{Data} / 1638.4 \end{aligned}$$

Servo Device Tuning

Servo devices should be tuned to optimize their performance for a specific load. The default parameters used assume there is no load added to the stage. You can tune the parameters for your load, and to adjust the smoothness, accuracy, and responsiveness of the performance, using the Servo Tuner app in Zaber Launcher. It also provides options for tuning with PID parameters and saving or loading tuning sets.

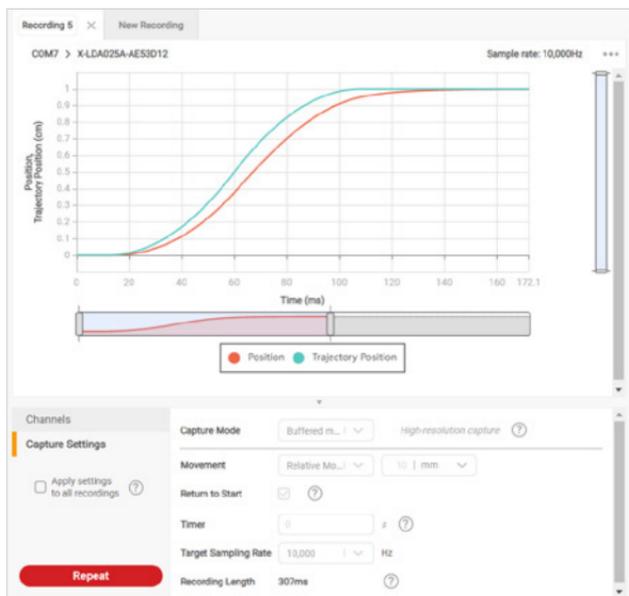
The controller can store multiple tuning presets for different loading conditions. There is also a separate live tuning set, which is the active tuning. A setting determines which stored preset is loaded at power up. The Servo Tuner app lets you load and store between the presets and the live set.

If an invalid tuning is loaded to the live set, the motion may become unstable. Press Disable Driver to quickly cut power to the motor.

The screenshot displays the Servo Tuner application interface. At the top, there are three parameter fields: 'Acceleration & Deceleration' set to 4.3 m/s², 'Settle Tolerance' set to 1 μm, and 'Settle Period' set to 100 ms. Below these is a 'Live Tuning' section with a list of six presets (Preset 1 to Preset 6), where Preset 1 is currently active. The main tuning area is divided into tabs: 'Simple' (selected), 'PID', 'Advanced', 'Load Preset', and 'Import/Export'. Under the 'Simple' tab, there is a 'Load Mass' dropdown set to 1 kg, an unchecked checkbox for 'I'm using a custom carriage mass', and a 'Stiffness' slider ranging from 'Smooth' to 'Stiff', with the current value set at 0.5. At the bottom of the interface, there are four buttons: 'Apply to Live', 'Save Tuning', 'Open Oscilloscope', and 'Disable Driver'.

Oscilloscope

Use the Oscilloscope app in Zaber Launcher to view high-resolution data about the device. For example, you can view the target trajectory and the encoder measured position for servo devices in order to validate the active tuning parameters.



Manual Knobs

Most Zaber devices include a manual knob for moving the unit without a computer connection. Devices still need to be connected to a power source for the manual knob to work.

Knob Functionality

Turning the knob	Moves the device based on the direction the knob is turned (clockwise moves in the positive direction).
Pressing the knob	Decelerates and stops the device (identical to a Stop command). Pressing the knob also instantly stops the device if the device is already decelerating.
Pressing and holding the knob for 1 second	Toggles between Velocity Mode * and Displacement Mode †.

***Velocity Mode**: each knob turn increments the speed of the axis in a continuous movement.

†**Displacement Mode**: each knob turn moves the axis a specific distance, as indicated by the *knob.distance* setting.

Joystick

Zaber's joystick can be used to control up to 3 Zaber devices manually; the joystick's programmable buttons can also save commands for ease of use.

The joystick is designed to connect at the start of a daisy-chain, where it can send instructions to all of the other devices over the chain. However, these joysticks are not intended to act as controllers, so each axis will still require an integrated controller or a stand-alone controller.

Default Key Configuration for X-JOY3

Key	Short Press	Long Press
1	Stop	Home
2	Send alerts* 1, 2	Send alerts* 1, 3, 4
3	Move to saved position	Save position
4	Move to saved position	Save position
5	Move to saved position	Save position
6	Axis 1 low speed	Axis 1 high speed
7	Axis 2 low speed	Axis 2 high speed
8	Axis 3 low speed	Axis 3 high speed

*When `comm.alert` is set to 1.



The X-JOY3 with programmable buttons to control devices manually.

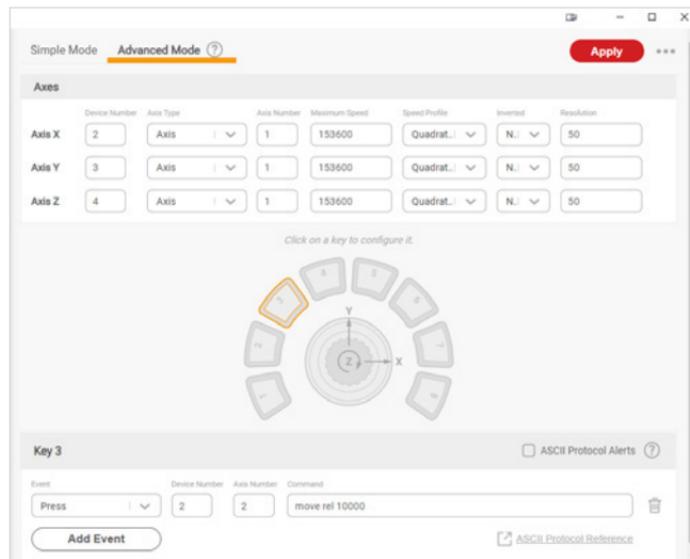
Joystick Start-up Instructions

Connect

The joystick must be connected to a computer to configure it. Once it is configured, you can operate it with or without a computer connection. The joystick should be the first device in the daisy-chain. Once all devices are connected to the chain, send the `renumber` command to all device. The joystick will be device 1, and the joystick will control devices 2, 3, and 4 (the three devices daisy-chained after it).

Configure

Zaber Launcher includes an app that lets you customize the behaviour of the joystick and define what commands the buttons will send. You can also save and load the configuration.



Troubleshooting

Some general troubleshooting information is included here. See the online product manual for additional information.

Firmware Update

Access new features and bug fixes by updating your devices to the latest firmware version using Zaber Launcher.

Slipping and Stalling

If the positioner is making unusual noises when in motion, and/or it is not traveling the expected distance or not traveling at all, then the positioner is likely slipping or stalling.

If the positioner is slipping or stalling, and it has encoders, the blue LED on the controller will also flash. To correct the problem, try the following steps:

1. Lower the *maximum speed setting*.
2. Lower the *maximum acceleration setting*.
3. Reduce the load on the positioner.

If the positioner continues to stall with no external load at default speed and acceleration settings, or if the steps above cannot be performed given your application requirements, please contact Customer Support for assistance.

Resetting to Factory Default

If the device is unable to communicate, operating erratically, or performing in unexpected ways, a manual factory reset can be performed through the following steps:

1. **Power Off** the device.
2. Push and hold the knob (use axis 1 knob for a multi-axis device).
3. **Power On** the device.
4. Continue to hold the knob in (for ~5 seconds) until one or more LEDs are fading or the blue LED is lit, then release.

Indicators

Device LED	Green	On	Device is powered
		Off	Device is not powered
		Blinking at 2 Hz	Voltage or temperature outside of acceptable range
	Yellow	Flashing	Device is receiving communication
		Blinking at 2 Hz	Device received a corrupt packet - checksum mismatch
	Red	On or Blinking	A critical error has occurred
Axis LED	Yellow	On	Positioner is moving
		Blinking	Positioner is moving under manual control
		Fading in and out	A peripheral with AutoDetect is plugged in and requires activation
	Blue	On	Peripheral was disconnected and the axis is deactivated
		Fading in and out	Positioner is parked
		Flashing	Positioner is slipping
		Blinking at 0.5 Hz	Positioner has stalled
		Blinking at 2 Hz	Driver is disabled; see warning flags for explanation
		2 flash burst at 1 Hz	Stationary positioner was displaced
		5 flash burst at 0.5 Hz	Encoder has encountered an error

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