

## X-MCA Series User's Manual

Single axis stepper motor controllers (chopper drive) without I/O



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# 1. Disclaimer

Zaber's devices are not intended for use in any critical medical, aviation, or military applications or situations where a product's use or failure could cause personal injury, death, or damage to property. Zaber disclaims any and all liability for injury or other damages resulting from the use of our products.

# 2. Precautions

The X-MCA controller is intended to drive a wide variety of stepper motors. If you are controlling a third-party motor, you will need to configure settings to match the motor you are driving, especially `driver.current.run` (T:38) and `driver.current.hold` (T:39). For a Zaber peripheral, simply set the `peripheralid` (T:66) with the peripheral's ID number. See the detailed usage examples for more information on how to modify the settings, particularly for non-Zaber peripherals. Damage to the device may result if the settings are not correct.

⚠ **WARNING:** Serious damage can occur to stepper motor products when operated with significantly higher-than-rated current. The X-MCA controller can provide up to 1.4A of current to a peripheral. **BEFORE CONNECTING A NEW DEVICE** to the X-MCA controller, it is important to set the correct motor parameters in the controller. Please check the rated current for any peripheral device before changing the current settings on the X-MCA from the default values. To put the X-MCA controller into safe-mode (low current) settings, configure the `peripheralid` (T:66) setting to 0. If you have any questions, please contact Zaber Technical Support

⚠ **BURN HAZARD:** The bottom metal surface of the X-MCA controller can become hot enough to burn skin under certain conditions. For high duty-cycle operation with higher current peripherals (1000mA/phase or greater), it is recommended that the controller be mounted on a heat sinking surface, such as a metal plate.

METAL SURFACES MAY BECOME HOT DURING OPERATION



### 3. Conventions used throughout this document

- Fixed width type indicates communication to and from a device. The `↵` symbol indicates a carriage return, which can be achieved by pressing enter when using a terminal program.
- An ASCII command followed by (T:xx) indicates a legacy T-Series Binary Protocol command that achieves the same result. For example, `move abs 10000 (T:20:10000)` shows that a move abs ASCII command can also be achieved with Binary command number 20.

Not all ASCII commands have an equivalent Binary counterpart.

### 4. Quick Tutorial

We recommend using Zaber Console to communicate with the device(s). For other software options, see the Software page. Please refer to the ASCII Protocol Manual and/or Binary Protocol Manual for more detailed information on the available commands.

## 4.1. Initial Set-up



NOTE: Ensure no motors are connected to the controller before applying power for the first time. It is important that the controller is set to control the correct peripheral ID in order to avoid sending too much current to the motor. We try to set controllers for the peripherals they ship with, but it's good to check that they are correct, especially if you receive multiple peripherals of different models.

1. Power up all integrated devices and controllers and daisy chain them together using the RS-232 "Prev" and "Next" connectors (see Daisy-Chaining Devices for more details). Many products share power through the daisy-chain cables. The power indicator on each should light up.
2. Download and install Zaber Console. Start Zaber Console and select the communications port the first controller is connected to. For instructions on how to find the available communication ports on your system, please refer to: Appendix A - Available Communications Ports.
3. From the Console, issue a renumber (T:2) command to all devices (Zaber Console may prompt you to do this also). The first device in the chain (closest to the computer) will become Device 1, the next will become Device 2, and so on.
4. On the new unit, configure the peripheralid (T:66) setting of each axis in Zaber Console

with either the peripheralid setting in ASCII or the Peripheral Id setting in Binary. The Peripheral ID for a Zaber peripheral can be found on it's label as the PID. Alternatively a full list of Peripheral IDs can be found at: Zaber Support - Peripheral IDs. This step needs to be performed whenever a new model of motorized peripheral is connected to the controller. If a third-party peripheral is being driven, please contact Zaber Technical Support for assistance.

5. Connect the motorized peripherals.

## 4.2. Initialization

Every time the controller is powered up or reset, the motorized peripheral(s) should be returned to the home position. This is achieved by sending the home (T:1) command to the individual unit or all units. Until this is done, most devices will only allow motion in one direction, towards the sensor.

If it is not possible in your application to home the device after every power-up, see the tools parking (T:65) command. Parking allows the device to be turned off and then used at a later time without first having to home the axes.

## 4.3. Using the Device

Several commonly used ASCII commands, and their Binary equivalents, are shown below. For a full list of available commands, please refer to the Command Reference section below.

Command	Description
/1 1 get pos (T:60)	Query the current position of Device #1 Axis #1.
/1 1 move abs 10000 (T:20:10000)	Move Device #1, Axis #1 to position 10000 microsteps.
/2 1 move rel -12800 (T:21:-12800)	Move Device #2, Axis #1 in the negative direction by 12800 microsteps.
/1 stop (T:23)	Decelerate and stop ALL axes on Device 1. An axis number of 0 or no axis number implies all axes on the device, or the device itself.
/move vel 153600 (T:22:153600)	Move ALL devices and ALL axes in the positive direction at the speed 153600. A device address of 0 or no device address implies all devices in the chain.

### 4.3.1. Modifying Device Settings

Here are some examples if you would like to customize particular device settings. Refer to the ASCII Settings or Command Reference section for detailed descriptions of each setting.

Command	Description
/1 set maxspeed 100000 (T:42:100000)	Set the speed of all axes on the device.
/1 get maxspeed (T:53:42)	Query the axes' speed.
/1 system restore (T:36)	Restore all the settings of Device 1 to the default.

### 4.3.2. Built-In Help

Zaber X-Series devices feature a built-in help guide, providing a quick and easy reference for all Commands and Settings that the device has. To access the help, send: /1 help +↓ (for help with Device 1). The device number must be specified in the help command. This feature is only available in the ASCII protocol.

The device will respond with a detailed description on how to access specific information about commands and replies, as shown below:

```
@01 0 OK IDLE WR 0
#01 0 COMMAND USAGE:
#01 0  '/stop'      stop all devices
#01 0  '/1 stop'   stop device number 1
#01 0  '/1 2 stop' stop device number 1 axis number 2
#01 0
#01 0 Type '/help commands' for a list of all top-level commands.
#01 0 Type '/help reply' for a quick reference on reply messages.
#01 0 Visit www.zaber.com/support for complete instruction manuals.
```

To access help for a specific command, for example the move command, send:



```

/1 help move
@01 0 OK IDLE -- 0
#01 0 move abs {x}           Move to absolute position
#01 0 move rel {x}          Move by relative position
#01 0 move vel {x}          Move at constant velocity
#01 0 move min              Move to minimum position
#01 0 move max              Move to maximum position

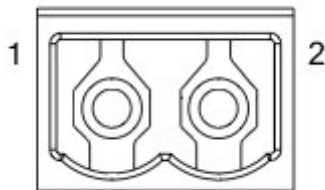
```

## 5. Device Overview

### 5.1. Connectors

All images are shown looking into the device.

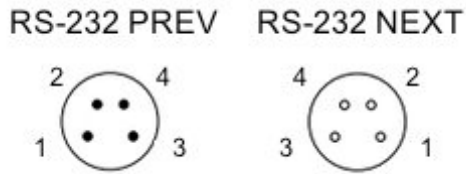
#### 5.1.1. Power



Pin	Description
1	24 - 48V
2	GND (Note: Zaber's power supplies ground this pin to AC Earth)

Note: To prevent damage to the device due to static buildup, the device should be properly grounded. The power supplies Zaber provides for X-Series devices are non-isolated and thus ground the device chassis to Earth via the negative terminal of the power supply. If for any reason you are using an isolated power supply, please ensure your device is grounded by connecting the negative terminal of the power connector to AC Earth.

### 5.1.2. RS-232 Communications



Pin	Previous	Next
1	Power	Power
2	Ground	Ground
3	Receive	Transmit
4	Transmit	Receive

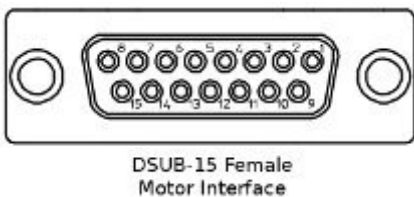
#### Default Settings:

- Baud Rate: 115200
- Protocol: Zaber ASCII

#### Specifications

- Supported Protocols: Zaber ASCII, Zaber Binary
- Supported Baudrates: 9600, 19200, 38400, 57600, 115200
- Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

### 5.1.3. Motor Interface



Pin	Description
1	+5V
2	Reserved
3	Reserved
4	Away Limit Sensor
5	Home Limit Sensor
6	Ground
7	Motor B1
8	Motor A1
9	Encoder +5V

10	Encoder A
11	Encoder B
12	Encoder Index
13	Encoder Ground
14	Motor B2
15	Motor A2

NOTE: The limit sensor inputs are pulled up to the internal supply rail and are designed to be pulled low by an open collector.

NOTE: All sensor and encoder inputs are non-isolated 5V TTL lines.

## 5.2. Indicators

### Green - Power

- On: Controller is operational.
- Blinking at 2Hz: The power supply voltage or device temperature is out of range.
- Fading in and out slowly: The device is parked. See the tools parking (T:65) command.

### Red - Error

- On/blinking: Device has lost its settings, or an error has occurred. Please contact Zaber Technical Support.

### Yellow - Communication/Busy

- On: Device is moving, or data is being transferred.
- Blinking at fixed rate: Packet corruption has occurred for ASCII commands sent with a checksum.

### Blue - Slip/Stall

- On: The device is slipping.
- On-Off cycle every 2 sec: The device has stalled and stopped.
- Flashes: The stationary device has been forced out of position (2 short flashes every 1 sec), or the encoder has encountered a read error and raised the FQ warning flag (5 short flashes every 2 sec).

## 6. Installation

The X-MCA can be connected to a computer as follows:

1. Either plug the M8 to D-SUB serial adaptor (X-SDC) into the computer's serial port, or the M8 to USB adaptor (X-USBDC) into one of your computer's USB ports, then attach the device to the adaptor. For the USB adaptor, new computers will often be able to install the necessary drivers automatically when the cable is plugged in for the first time. If the computer reports that the driver installation was unsuccessful, you can download the drivers for Windows, Mac, or Linux [here](#). Installation instructions and troubleshooting information are available for each operating system [here](#). You may need to use a cable extension to reach your computer. There is no need to power-down or reboot the computer.
2. Connect the power plug of your power supply to the power connector of the unit. The green LED should light up indicating the unit has power.
3. Additional devices can simply be daisy-chained to the first. See [Daisy-Chaining Devices](#) below.
4. Install software from the [Software](#) page. For the initial setup, using Zaber Console is recommended.



As a simple first test, try entering:

```
/renumber ↵ (T:2)
```

```
/1 home ⌘ (T:1)
```

```
/1 move rel 10000 ⌘ (T:21:10000)
```

The parameter of 10000 in the move command above specifies 10000 microsteps. To see the microstep size (default resolution) for the peripheral and how it translates to displacement, first go to the product overview page, find your device, click through to the device's webpage, and click on the "Series Specs" tab. The microstep size (default resolution) will be shown in the list of product specs either in the "Group Specifications" section or the "Comparison" section.

## 6.1. Daisy-Chaining Devices

Multiple devices can be connected together in a chain through the Prev and Next connectors. This allows any number of devices to be controlled from a single connection to a computer, reducing cabling demands. In addition, X-Series devices carry power through the daisy chain, so in most cases a power supply only needs to be connected to one device in the chain. Whenever a device is added or removed from a chain, a renumber (T:2) command should be sent to prevent device-address conflicts.



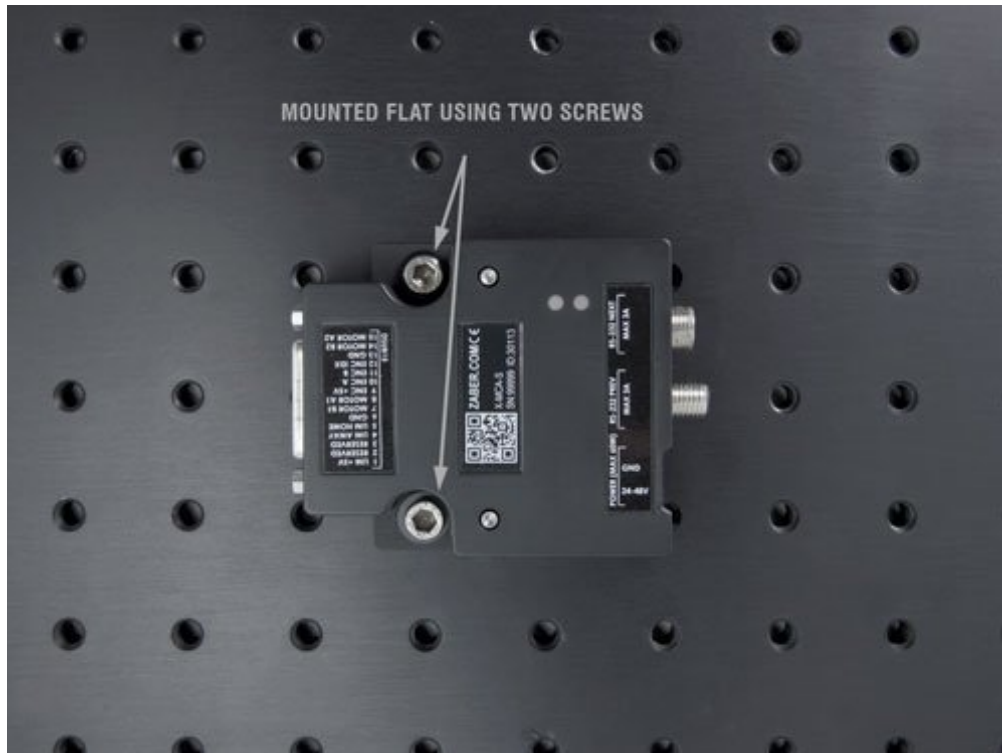
To daisy-chain X-Series devices with T-Series and A-Series devices:

- Ensure all devices are set to the same communication protocol and baud rate before connecting them. If any T-Series devices will be in the chain, then the communication protocol must be Binary at 9600 baud rate.
- Connect any X-Series devices at the start of the chain (closest to the computer). This configuration will reduce the number of adaptor cables required.
- Connect a T-XDC (or S-XDC for daisy-chaining an A-MCB2) adaptor cable to the Next port of the last X-Series device in the chain, and to the Prev port of the T-Series or A-Series device.
- Power supplied to an X-Series device will not be transmitted to any T-Series or A-Series devices in the chain.

- Contact Zaber Technical Support for assistance selecting connecting cables when daisy-chaining multiple series.

## 6.2. Physical Installation

The X-MCA is designed to mount to 25mm or 1" pitch optical breadboards using M6 or 1/4" screws, respectively, or for use on a desk or table. With optional mounting accessories AB158 & AB159 it provides additional mounting options including 90 degree stacking on breadboards and 35 mm DIN rail mounting respectively.

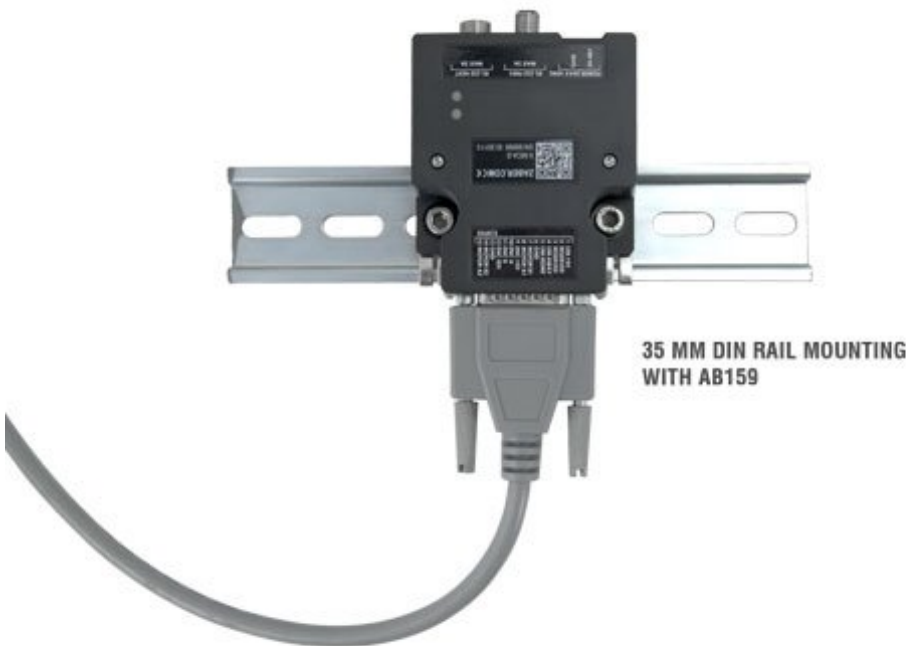




TIP: Mount the device before connecting cables, or the cables will interfere with tightening fasteners.



DEVICES MOUNTED SIDE-BY-SIDE  
WITH 2x AB158



35 MM DIN RAIL MOUNTING  
WITH AB159



## 7. Trajectory Control and Behaviour

This section describes the behaviour of the device trajectory when a movement command is issued.

### 7.1. Software Position Limits

The travel range of the device is limited by the Minimum Position and Maximum Position settings. The factory settings for the devices are configured to match the physical travel range. If a customized range is desired, it can be changed by configuring the `limit.min` (T:106) and `limit.max` (T:44) settings to appropriate values.

#### Minimum Position

When the Current Position is less than the Minimum Position value, the device cannot move in the negative direction (towards the motor).

#### Maximum Position

When the Current Position is greater than the Maximum Position value, the device cannot move in the positive direction (away from the motor).

### 7.2. Movement Speed

The movement speed of the device depends on device status and various speed settings. If the device has not been initialized by the home (T:1) command or by moving towards the home end of the device, movement speed will be constrained to fail-safe values. The home status of the device can be determined by reading the `limit.sensor.triggered` (T:53) setting (the binary command additionally requires a value of 103).

Movement speed of the device is specified below:

#### **move vel (T:22)**

The device will move at the specified speed regardless of home status.

#### **Other movement commands - when the device has not been homed**

The device will move at the slower of the `maxspeed` (T:42) and `limit.approach.maxspeed` (T:41) settings.

#### **Other movement commands - when the device has been homed**

The device will move at the speed specified by the `maxspeed` (T:42) setting.

## 8. Quick Command Reference

All X-Series devices ship with the ASCII Protocol enabled by default but the Binary Protocol is also supported.

### 8.1. ASCII Protocol

The following table offers a quick command and setting reference for the X-MCA. Follow the links to view a detailed description of each instruction or refer to the ASCII Protocol Manual.

#### 8.1.1. Quick Commands

Parameters in square brackets, e.g. [clr], indicate that the parameter is optional.

Parameters in italics, e.g. *value*, indicate that data, typically a number, needs to be provided.

Parameters separated by a pipe, e.g. abs|rel, indicate that one of the parameters in the set need to be provided.

Command	Scope	Parameter(s)	Returns	Firmware Versions	Description
<b>calibration</b>	Device	Refer to the documentation	0	6.24+	Configure linear encoder calibration.
<b>estop</b>	Axis		0	6.06+	Instantly stops motorized movement.
<b>get</b>	Device and Axis	setting	value	6.06+	Retrieves the current value of the device or axis setting.
<b>help</b>	Device	commands reply warnflags enums command ... enum	0	6.06+	Displays the help information for the system.
<b>home</b>	Axis		0	6.06+	Moves the axis to the home position.
<b>move</b>	Axis	abs rel vel <i>value</i> min max stored number index number (6.21+) sin amplitude period [count] (6.22+) sin stop (6.22+)	0	6.06+	Moves the axis to various positions along its travel.
<b>renumber</b>	Device	<i>value</i>	0	6.06+	Rennumbers all devices in the chain.

<b>set</b>	Device and Axis	setting value	0	6.06+	Sets the device or axis setting to the value.
<b>stop</b>	Axis		0	6.06+	Decelerates the axis and brings it to a halt.
<b>stream</b>	Device	Refer to the documentation	Refer to the documentation	6.12+	Performs an action related to streamed, interpolated motion.
<b>system reset</b>	Device		0	6.06+	Resets the device, as it would appear after power up.
<b>system restore</b>	Device		0	6.06+	Restores common device settings to their default values.
<b>tools echo</b>	Device	(message)	0	6.06+	Echoes the provided message (if any) back to the user.
<b>tools findrange</b>	Axis		0	6.10+	Uses the home and away sensors to set the valid range of the axis.
<b>tools gotolimit</b>	Axis	limit dir action update	0	6.06+	Moves the axis to a limit sensor and performs the provided actions.
<b>tools parking</b>	Device	state park unpark	0 1	6.06+	Parking allows the device to be turned off and used at a later time without first having to home.
<b>tools setcomm</b>	Device	rs232baud protocol	0	6.06+	Sets RS232 baud rate and communication protocol for RS232 and USB.
<b>tools storepos</b>	Axis	number [position current]	0 position	6.06+	Stores a number of positions for easy movement.
<b>trigger</b>	Device	Refer to the documentation	0	6.06+	Configures actions to be performed on the device when a certain condition is met.
<b>warnings</b>	Axis	[clear]	0	6.06+	Displays the active device and axis warnings, optionally clearing them if applicable.

### 8.1.2. Quick Device Settings

The settings listed below can be inspected and modified with the get and set commands described above.

Setting	Scope	Writable	Firmware Versions	Description
<b>accel</b>	Axis	Yes	6.06+	Sets the acceleration used to modify the speed.
<b>calibration.type</b>	Axis	No	6.24+	The type of calibration saved for the axis.
<b>cloop.counts</b>	Axis	Yes	6.06+	The number of counts generated by the encoder for one full revolution.
<b>cloop.displace.tolerance</b>	Axis	Yes	6.19+	The minimum deviation in the position of a stationary axis that will register as a displacement.
<b>cloop.duration.max</b>	Axis	Yes	6.17+	The duration for attempting fine position correction.
<b>cloop.mode</b>	Axis	Yes	6.06+	The closed-loop (slip, stall, and displacement detection and recovery) control mode.
<b>cloop.stalltimeout</b>	Axis	Yes	6.06+	The amount of time to wait after a stall/displacement condition, in milliseconds.
<b>cloop.steps</b>	Axis	Yes	6.06+	The number of full steps required for the motor to complete one revolution.
<b>comm.address</b>	Device	Yes	6.06+	The device address.
<b>comm.alert</b>	Device	Yes	6.06+	The device will send alert messages when this setting is 1.
<b>comm.checksum</b>	Device	Yes	6.06+	The device includes checksums in its messages if this setting is set to 1.
<b>comm.protocol</b>	Device	Yes	6.06+	The communications protocol used by the device on the current interface.
<b>comm.rs232.baud</b>	Device	Yes	6.06+	The baud rate used by RS232 Prev and Next interfaces.
<b>comm.rs232.protocol</b>	Device	Yes	6.09+	The protocol used by RS232 Prev and Next interfaces.
<b>deviceid</b>	Device	No	6.06+	The device ID for the unit.
<b>driver.current.hold</b>	Axis	Yes	6.06+	Current used to hold the motor in position, in 20 mA DC increments.
<b>driver.current.max</b>	Axis	No	6.16+	Maximum legal value of driver.current.hold and driver.current.run.
<b>driver.current.run</b>	Axis	Yes	6.06+	Current used to drive the motor, in 14.1 mA RMS (20 mA peak) increments.
<b>driver.dir</b>	Axis	Yes	6.06+	Reverse the motor driver output direction.

<b>driver.temperature</b>	Axis	No	6.06+	The current temperature of the axis driver, in degrees Celsius.
<b>encoder.count</b>	Axis	Yes	6.06+	The recorded counts of the axis encoder.
<b>encoder.count.calibrated</b>	Axis	No	6.24+	The calibrated counts of the axis encoder.
<b>encoder.dir</b>	Axis	Yes	6.06+	Inverts the counting direction for the axis encoder.
<b>encoder.error</b>	Axis	No	6.17+	Position error measured by encoder.
<b>encoder.filter</b>	Axis	Yes	6.06+	Enable and set up digital filtering of the encoder inputs.
<b>encoder.index.count</b>	Axis	Yes	6.06+	The recorded counts of the axis encoder index pulse.
<b>encoder.index.mode</b>	Axis	Yes	6.06+	The operating mode of the axis encoder index signal.
<b>encoder.index.phase</b>	Axis	Yes	6.06+	The required phase for an index pulse to be counted.
<b>encoder.mode</b>	Axis	Yes	6.06+	The operating mode of the axis encoder.
<b>encoder.pos</b>	Axis	No	6.17+	Position measured by encoder.
<b>knob.dir</b>	Axis	Yes	6.06+	Sets the movement direction for the knob.
<b>knob.distance</b>	Axis	Yes	6.06+	Sets how far the device moves with each step of the knob in displacement mode, in units of microsteps.
<b>knob.enable</b>	Axis	Yes	6.06+	Disable the use of the knob when set to 0.
<b>knob.maxspeed</b>	Axis	Yes	6.06+	The maximum speed that can be reached using the knob in velocity mode.
<b>knob.mode</b>	Axis	Yes	6.06+	Sets the mode of the manual control knob.
<b>knob.speedprofile</b>	Axis	Yes	6.06+	Sets the profile to be used per increment when in velocity mode.
<b>limit.approach.maxspeed</b>	Axis	Yes	6.06+	Maximum speed used when approaching a limit sensor.
<b>limit.cycle.dist</b>	Axis	Yes	6.20+	The length of one full rotation.
<b>limit.detect.decelonly</b>	Axis	Yes	6.06+	Deceleration used when stopping after a limit sensor has triggered.
<b>limit.detect.maxspeed</b>	Axis	Yes	6.06+	Maximum speed used when moving away from a limit sensor.
<b>limit.home.action</b>	Axis	Yes	6.06+	Automatic limit switch action.
<b>limit.home.edge</b>	Axis	Yes	6.06+	Sensor edge to align action to.
<b>limit.home.pos</b>	Axis	Yes	6.06+	The updated position of the sensor, when triggered.

<b>limit.home.posupdate</b>	Axis	Yes	6.06+	Position update to occur when sensor is triggered.
<b>limit.home.preset</b>	Axis	Yes	6.06+	The default position of the home sensor.
<b>limit.home.state</b>	Axis	No	6.06+	The state of the home sensor.
<b>limit.home.triggered</b>	Axis	No	6.06+	Whether the home sensor has been triggered previously.
<b>limit.home.type</b>	Axis	Yes	6.06+	The type of home sensor connected.
<b>limit.away.action</b>	Axis	Yes	6.06+	Automatic limit switch action.
<b>limit.away.edge</b>	Axis	Yes	6.06+	Sensor edge to align action to.
<b>limit.away.pos</b>	Axis	Yes	6.06+	The updated position of the sensor, when triggered.
<b>limit.away.posupdate</b>	Axis	Yes	6.06+	Position update to occur when sensor is triggered.
<b>limit.away.preset</b>	Axis	Yes	6.06+	The default position of the away sensor.
<b>limit.away.state</b>	Axis	No	6.06+	The state of the home sensor.
<b>limit.away.triggered</b>	Axis	No	6.06+	Whether the away sensor has been triggered previously.
<b>limit.away.type</b>	Axis	Yes	6.06+	The type of away sensor connected.
<b>limit.max</b>	Axis	Yes	6.06+	The maximum position the device can move to, measured in microsteps.
<b>limit.min</b>	Axis	Yes	6.06+	The minimum position the device can move to, measured in microsteps.
<b>limit.start.pos</b>	Axis	Yes	6.19+	Start up position of the axis.
<b>limit.swapinputs</b>	Axis	Yes	6.06+	Reverses the limit positions by swapping the home and away sensors.
<b>maxspeed</b>	Axis	Yes	6.06+	The maximum speed the device moves at.
<b>motion.accelonly</b>	Axis	Yes	6.06+	Sets the acceleration used to increase the speed.
<b>motion.decelonly</b>	Axis	Yes	6.06+	Sets the deceleration used when decreasing the speed.
<b>motion.index.dist</b>	Axis	Yes	6.21+	The distance between consecutive index positions.
<b>motion.index.num</b>	Axis	No	6.22+	The current index number.
<b>peripheralid</b>	Axis	Yes	6.06+	The ID of the connected peripheral.
<b>peripheral.serial</b>	Axis	Yes	6.24+	The serial number of the attached peripheral.
<b>pos</b>	Axis	Yes	6.06+	The current absolute position of the device.
<b>resolution</b>	Axis	Yes	6.06+	Microstep resolution

<b>stream.numbufs</b>	Device	No	6.14+	The number of stream buffers provided in the device.
<b>stream.numstreams</b>	Device	No	6.14+	The number of streams provided in the device.
<b>system.access</b>	Device	Yes	6.06+	Sets the access level of the user.
<b>system.axiscount</b>	Device	No	6.06+	The number of axes in the device.
<b>system.led.enable</b>	Device	Yes	6.06+	Enables the front panel LEDs.
<b>system.serial</b>	Device	No	6.15+	The serial number of the device.
<b>system.voltage</b>	Device	No	6.06+	The voltage being applied to the device.
<b>version</b>	Device	No	6.06+	The firmware version of the device.
<b>version.build</b>	Device	No	6.17+	The build number of the device's firmware.

## 8.2. Binary Protocol

The following table offers a quick command reference for the X-MCA. For convenience, you may sort the table below by instruction name, command number, or reply number. Follow the links to view a detailed description of each instruction or refer to the Binary Protocol Manual.

<b>Instruction Name</b>	<b>Command#</b>	<b>Command Data</b>	<b>Command Type</b>	<b>Reply Data</b>
<b>Reset</b>	0	Ignored	Command	None
<b>Home</b>	1	Ignored	Command	Final position (in this case 0)
<b>Renumber*</b>	2	Ignored	Command	Device ID
<b>Read Register</b>	5	Register Address	Command	Data
<b>Set Active Register</b>	6	Register Address	Setting	Register Address
<b>Write Register</b>	7	Data	Command	Data
<b>Move Tracking</b>	8	n/a	Reply	Tracking Position
<b>Limit Active</b>	9	n/a	Reply	Final Position
<b>Manual Move Tracking</b>	10	n/a	Reply	Tracking Position
<b>Manual Move</b>	11	n/a	Reply	Final Position
<b>Slip Tracking</b>	12	n/a	Reply	Tracking Position
<b>Unexpected Position</b>	13	n/a	Reply	Final Position
<b>Store Current Position*</b>	16	Address	Command	Address

<b>Return Stored Position</b>	17	Address	Command	Stored Position
<b>Move To Stored Position</b>	18	Address	Command	Final Position
<b>Move Absolute</b>	20	Absolute Position	Command	Final Position
<b>Move Relative</b>	21	Relative Position	Command	Final Position
<b>Move At Constant Speed</b>	22	Speed	Command	Speed
<b>Stop</b>	23	Ignored	Command	Final Position
<b>Restore Settings*</b>	36	Peripheral ID	Command	Peripheral ID
<b>Set Microstep Resolution*</b>	37	Microsteps	Setting	Microsteps
<b>Set Running Current*</b>	38	Value	Setting	Value
<b>Set Hold Current*</b>	39	Value	Setting	Value
<b>Set Device Mode*</b>	40	Mode	Setting	Mode
<b>Set Home Speed*</b>	41	Speed	Setting	Speed
<b>Set Target Speed*</b>	42	Speed	Setting	Speed
<b>Set Acceleration*</b>	43	Acceleration	Setting	Acceleration
<b>Set Maximum Position*</b>	44	Range	Setting	Range
<b>Set Current Position</b>	45	New Position	Setting	New Position
<b>Set Home Offset*</b>	47	Offset	Setting	Offset
<b>Set Alias Number*</b>	48	Alias Number	Setting	Alias Number
<b>Return Device ID</b>	50	Ignored	Read-Only Setting	Device ID
<b>Return Firmware Version</b>	51	Ignored	Read-Only Setting	Version
<b>Return Power Supply Voltage</b>	52	Ignored	Read-Only Setting	Voltage
<b>Return Setting</b>	53	Setting Number	Command	Setting Value
<b>Return Status</b>	54	Ignored	Read-Only Setting	Status
<b>Echo Data</b>	55	Data	Command	Data
<b>Return Firmware Build</b>	56	Ignored	Read-Only Setting	Build Number
<b>Return Current Position</b>	60	Ignored	Read-Only Setting	Position



<b>Return Serial Number</b>	63	Ignored	Read-Only Setting	Serial Number
<b>Set Park State*</b>	65	Park State	Setting	Position
<b>Set Peripheral ID*</b>	66	Peripheral ID	Setting	Peripheral ID
<b>Return Digital Input Count</b>	67	Ignored	Read-Only Setting	Pin Count
<b>Return Digital Output Count</b>	70	Ignored	Read-Only Setting	Pin Count
<b>Return Analog Input Count</b>	75	Ignored	Read-Only Setting	Pin Count
<b>Return Analog Output Count</b>	77	Ignored	Read-Only Setting	Pin Count
<b>Move Index</b>	78	Index Number	Command	Final Position
<b>Set Index Distance</b>	79	Distance	Setting	Distance
<b>Set Cycle Distance</b>	80	Distance	Setting	Distance
<b>Return Encoder Count</b>	82	Ignored	Read-Only Setting	Encoder Count
<b>Return Calibrated Encoder Count</b>	83	Ignored	Read-Only Setting	Calibrated Encoder Count
<b>Return Calibration Type</b>	84	Ignored	Read-Only Setting	Calibration Type
<b>Return Calibration Error</b>	85	Ignored	Read-Only Setting	Calibration Error
<b>Set Peripheral Serial Number*</b>	86	Peripheral Serial Number	Setting	Peripheral Serial Number
<b>Set Auto-Reply Disabled Mode*</b>	101	Auto-Reply Mode	Setting	Auto-Reply Mode
<b>Set Message ID Mode*</b>	102	Message ID Mode	Setting	Message ID Mode
<b>Set Home Status</b>	103	Home Status	Setting	Home Status
<b>Set Home Sensor Type*</b>	104	Home Sensor Type	Setting	Home Sensor Type
<b>Set Auto-Home Disabled Mode*</b>	105	Auto-Home Disabled Mode	Setting	Auto-Home Disabled Mode
<b>Set Minimum Position*</b>	106	Minimum Position	Setting	Minimum Position

<b>Set Knob Disabled Mode*</b>	107	Knob Disabled Mode	Setting	Knob Disabled Mode
<b>Set Knob Direction*</b>	108	Direction	Setting	Direction
<b>Set Knob Movement Mode*</b>	109	Movement Mode	Setting	Movement Mode
<b>Set Knob Jog Size*</b>	110	Jog Size	Setting	Jog Size
<b>Set Knob Velocity Scale*</b>	111	Velocity Scale	Setting	Velocity Scale
<b>Set Knob Velocity Profile*</b>	112	Velocity Profile	Setting	Velocity Profile
<b>Set Acceleration Only*</b>	113	Acceleration	Setting	Acceleration
<b>Set Deceleration Only*</b>	114	Deceleration	Setting	Deceleration
<b>Set Move Tracking Mode*</b>	115	Tracking Mode	Setting	Tracking Mode
<b>Set Manual Move Tracking Disabled Mode*</b>	116	Tracking Mode	Setting	Tracking Mode
<b>Set Move Tracking Period*</b>	117	Tracking Period	Setting	Tracking Period
<b>Set Closed-Loop Mode*</b>	118	Closed-Loop Mode	Setting	Closed-Loop Mode
<b>Set Slip Tracking Period*</b>	119	Tracking Period	Setting	Tracking Period
<b>Set Stall Timeout*</b>	120	Timeout	Setting	Timeout
<b>Set Device Direction*</b>	121	Direction	Setting	Direction
<b>Set Baud Rate*</b>	122	Baud Rate	Setting	Baud Rate
<b>Set Protocol*</b>	123	Protocol	Setting	Protocol
<b>Convert To Ascii*</b>	124	Baud Rate	Command	Baud Rate
<b>Error</b>	255	n/a	Reply	Error Code

\* The settings for these commands are saved in non-volatile memory, i.e. the setting persists even if the device is powered down. To restore all settings to factory default, use command 36.

## 9. Troubleshooting X-Series Motion Devices

The following sections contain tips for troubleshooting common problems.

### 9.1. Front Panel Indicators

#### Green LED On

The device is powered on and is operating normally.

#### Green LED Fades In and Out

The device is parked.

Issue a tools parking unpark (T:65) command, or home (T:1) the device.

#### Green LED Flashes Slowly

The operating conditions of the device are outside of the recommended range.

This will occur when the supply voltage is either over or under the recommended range, the internal temperature has exceeded the set limit, or the driver has been disabled. Check the following:

- The input voltage is within the operational range of the device. This can be read from the device with the `get system.voltage` command.
- The device temperature is within range. This can be read from the device with the `get system.temperature` command.
- The driver is not disabled. If the driver is disabled the result of the `warnings` command will contain the FD flag.

#### Green LED Off

The device is not powered.

Check the supply connections and power adaptor for correct operation.

#### Red LED On or Flashing.

A critical error has occurred.

Please contact Zaber Technical Support.

#### Blue LED On or Flashing.

The device has slipped or stalled.

Please see the Slipping and Stalling section below.

### **Yellow LED Always Off or Flashes but No Reply.**

There are communication errors.

Please see the Communication Errors section below.

## **9.2. Unexpected Behaviour**

### **The device doesn't respond to a move command.**

The device needs to be homed before use.

Send the home (T:1) command.

### **The device is moving on its own and running against the ends of travel.**

The position encoder has de-synchronized.

Reset the device by power cycling it or sending the system reset (T:0) command, then re-initialize it with the home (T:1) command.

### **The device is moving very slowly. It used to move faster.**

The speed settings may have been changed inadvertently.

Send a system restore (T:36) command.

### **The device makes louder than normal noise during travel and is frequently slipping.**

This condition happens if the thrust needed is more than the thrust available from the device.

Check the following:

- The force on the device is less than the maximum thrust.
- The voltage matches the specified voltage. Read the voltage using the get system.voltage command. Voltage less than the specified voltage for the device will reduce the device's maximum thrust.

Test the following:

- Try a slower target velocity. Stepper motors produce more thrust when moving slowly.
- Try a lower acceleration and deceleration.
- Clean the screw and lightly re-grease it with a grease that does not degrade plastics.

### **The device has repeatability errors smaller than 4 full steps.**

If steps aren't being skipped, friction or loose parts may still cause some variation when returning to a position.

Please contact Zaber Technical Support.

### **The device doesn't cover the full range of travel, or runs into the end.**

A setting might have been inadvertently changed.

- home (T:1) the device to see if this corrects the behaviour.
- Send a system restore (T:36) command.

## **9.3. Communication Errors**

### **There is no communication with the device; the Yellow LED does not come on or flash.**

There are several things that should be checked:

- Make sure the correct serial port is selected. Try selecting other serial ports in the software.
- Check the baud rate, hand shaking, parity, stop bit, etc. when configuring the serial communications software. The required settings are listed in the RS-232 Communications section above.
- Make sure there are no bent pins in the ends of all the data cables
- Make sure the device is powered. The Green LED should be on.
- If the computer is a laptop running on batteries, try plugging in the power. Some laptops disable the serial ports when running on batteries.
- Make sure a null modem adaptor or cable is not being used.
- Make sure the correct adaptors(if any) are being used. Refer to the pinouts in the RS-232 Communications section above.
- If the problem was encountered when trying to control the device with custom software, try using one of the demo programs from the Zaber website to verify that the hardware is functioning properly.

### **Two or more devices both respond to commands sent to device 1.**

Most devices are shipped with their device number set as 1. If you connect the devices through Zaber Console, you will be prompted to renumber them. If you aren't able to install and open Zaber Console, send the renumber (T:2) command in the software you are using to set all of the device numbers to different values.

### **The Yellow LED comes on briefly when sending a command, but the device does not move and does not reply.**

Check baud rate, hand shaking, parity, stop bit, etc. are set as per the RS-232 Communications defaults.

The device numbers may not be what is expected, issue a renumber (T:2) command.

Make sure that the computer does not transmit anything else while the devices renumber.

If using the Binary Protocol, check the following:

- 6 bytes are transmitted and that the device number and command are valid.
- The software does not transmit any control characters such as line feed and spaces.
- That the serial port is not configured with a termination character (it often defaults to linefeed).

If problems are encountered when using custom software, try using one of the demo programs from the Zaber website to verify that the hardware works.

**The device does not behave as expected when software sends it a series of commands.**

The computer might be set to Unicode. This is common for languages that use non-Latin based characters. Go to Control Panel/Regional and Language Options/Advanced. Select a language for non-unicode programs. This should be English or another Latin based character language.

Check what is being sent out of the serial port. [stackoverflow.com](http://stackoverflow.com) has a list of some tools to monitor serial ports.

**In Binary mode, the device does not send replies but otherwise works.**

Auto-reply might have been disabled via T:101.

Send a system restore (T:36) command.

If the problem is encountered when trying to control the device with custom software:

- Use a demo program from the Zaber website to verify that the hardware is functioning properly.
- Make sure that the receiving part of the code or commercial package is correct.
- Check the serial port settings are correct.
- Check connectors for bent or broken pins.

**In Binary mode, the device sometimes returns fewer than 6 bytes.**

This typically indicates a problem with the serial port settings. Some serial ports are set to automatically recognize and remove specific control characters such as carriage returns when they appear in the RS-232 receive buffer.

Check that the settings are correct and are not removing or replacing characters.

## 9.4. Slipping and Stalling

**The device moves smoothly, but only moves for a short time then stops. The Blue LED is flashing but the device is not actually slipping or stalling.**

The internal encoder counter needs to be re-initialized. Reset the device by power cycling it or sending system reset (T:0) command, then re-initialize it with the home (T:1) command. Ground the device and avoid operating it under statically noisy environment.

**The device makes noise but does not move. The Blue LED is flashing.**

The device is stalling.

Try removing all external loads. If the device now extends and retracts normally, the problem is excessive load. Try to reduce the load and ensure the load is less than the maximum thrust. A higher thrust or torque can be achieved by lowering the speed of the device using the maxspeed (T:42) setting.

If a device is stalling with no external load at default speed and acceleration settings then it requires servicing.

## 10. Warranty and Repair

For Zaber's policies on warranty and repair, please refer to the Ordering Policies.

### 10.1. Standard products

Standard products are any part numbers that do not contain the suffix ENG followed by a 4 digit number. Most, but not all, standard products are listed for sale on our website. All standard Zaber products are backed by a one-month satisfaction guarantee. If you are not satisfied with your purchase, we will refund your payment minus any shipping charges. Goods must be in brand new saleable condition with no marks. Zaber products are guaranteed for one year. During this period Zaber will repair any products with faults due to manufacturing defects, free of charge.

## 10.2. Custom products

Custom products are any part numbers containing the suffix ENG followed by a 4 digit number. Each of these products has been designed for a custom application for a particular customer. Custom products are guaranteed for one year, unless explicitly stated otherwise. During this period Zaber will repair any products with faults due to manufacturing defects, free of charge.

## 10.3. How to return products

Customers with devices in need of return or repair should contact Zaber to obtain an RMA form which must be filled out and sent back to us to receive an RMA number. The RMA form contains instructions for packing and returning the device. The specified RMA number must be included on the shipment to ensure timely processing.

## 11. Email Updates

If you would like to receive our periodic email newsletter including product updates and promotions, please sign up online at [www.zaber.com](http://www.zaber.com) (news section). Newsletters typically include a promotional offer worth at least \$100.

## 12. Contact Information

Contact Zaber Technologies Inc by any of the following methods:

<b>Fax</b>	<b>1-604-648-8033</b>
<b>Mail</b>	<b>#2 - 605 West Kent Ave. N., Vancouver, British Columbia, Canada, V6P 6T7</b>
<b>Web</b>	<b><a href="http://www.zaber.com">www.zaber.com</a></b>
<b>Email</b>	<b>Please visit our website for up to date email contact information.</b>

The original instructions for this product are available at <https://www.zaber.com/manuals/X-MCA>.



## 13. Appendix A - Available Communications Ports

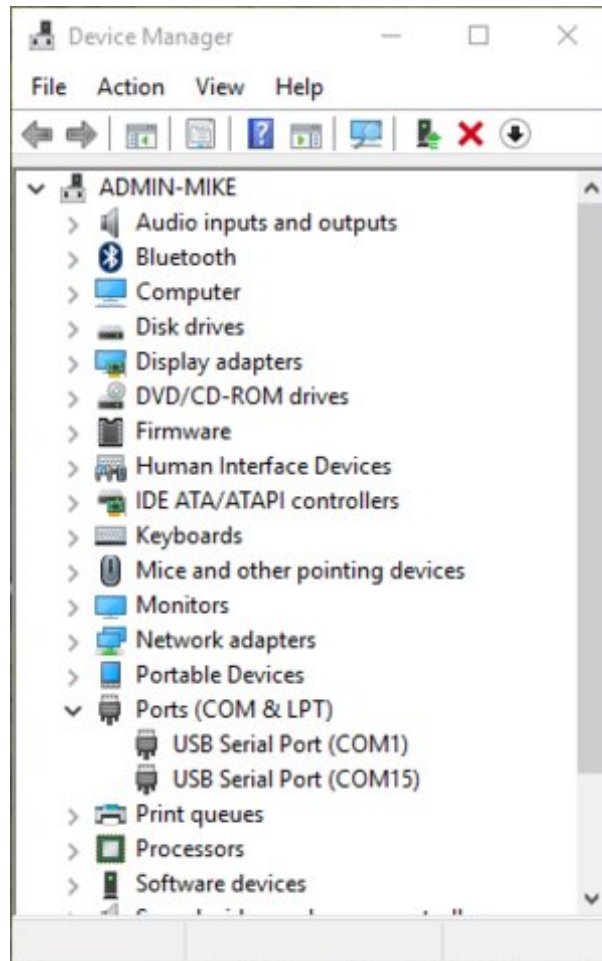
### 13.1. Finding Installed Serial Ports

#### 13.1.1. Windows

1. Open Search or Run from the Start Menu or Taskbar, type "Device Manager" and press enter.



2. Expand the Ports (COM & LPT) category.



- In this example there are two serial ports available (COM1 and COM15), which are both USB adaptors.

### 13.1.2. Linux

#### 1. Finding devices

- Open a terminal and execute the following command:

```
dmesg | grep -E ttyU?S ↵
```

- The response will be similar to the following:
 

```
[ 2.029214] serial8250: ttyS0 at I/O 0x3f8 (irq = 4) is a 16550A
[ 2.432572] 00:07: ttyS0 at I/O 0x3f8 (irq = 4) is a 16550A
[ 2.468149] 0000:00:03.3: ttyS4 at I/O 0xec98 (irq = 17) is a 16550A
[ 13.514432] usb 7-2: FTDI USB Serial Device converter now attached to ttyUSB0
```

- This shows that there are 3 serial ports available: ttyS0, ttyS4 and ttyUSB0 (a

USB adaptor)

## 2. Checking port permissions

- Using the ports found above, execute the following command

```
ls -l /dev/tty{S0, S4, USB0} ↵
```

- The permissions, given below, show that a user has to be root or a member of the dialout group to be able to access these devices

```
crw-rw---- 1 root dialout  4, 64 Oct 31 06:44 /dev/ttyS0
crw-rw---- 1 root dialout  4, 68 Oct 31 06:45 /dev/ttyS4
crw-rw---- 1 root dialout 188,  0 Oct 31 07:58 /dev/ttyUSB0
```

## 3. Checking group membership groups ↵

- The output will be similar to the following:  
adm cdrom sudo dip plugdev users lpadmin sambashare  
Notice that dialout is not in the list
- A user can be added to the dialout group with the following command

```
sudo adduser $USER dialout ↵
```

- Group membership will not take effect until the next logon.

### 13.1.3. OSX

#### 1. Finding devices

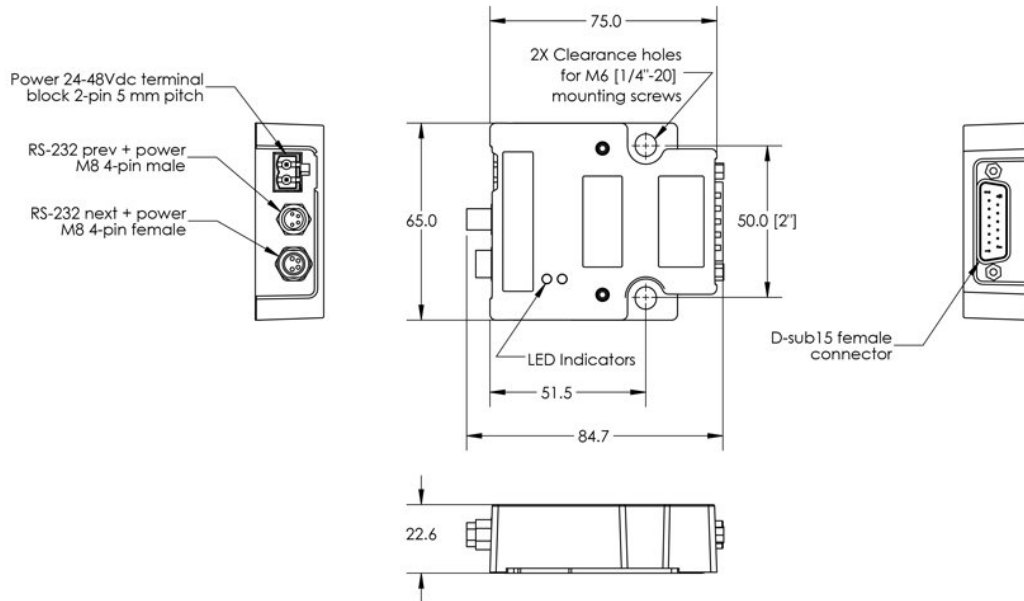
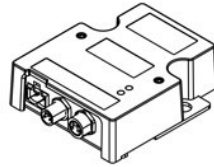
- Open a terminal and execute the following command:

```
ls /dev/cu.*serial*
```

- The response will be similar to the following:  
/dev/cu.usbserial-FTB3QAET  
/dev/cu.usbserial-FTEJJ1YW
- This shows that there are two serial ports available, both of which happen to be USB adaptors.
- There may be other devices that match this query, such as keyboards or some web cameras. To determine which one corresponds to your USB serial cable, try repeating the command with and without the cable connected to the computer, to see which one appears and disappears.

# 14. Product Drawing

**ZABER**  
X-MCA-S Stepper Motor Controller  
dimensions in mm



DWG 1274-001A

## 15. Specifications

Specification	Value	Alternate Unit
Communication Interface	RS-232	
Communication Protocol	Zaber ASCII (Default), Zaber Binary	
Maximum Current Draw	Motor and supply voltage dependent	
Power Supply	24-48 VDC	
Power Plug	2-pin Screw Terminal	
Controller Maximum Current Per Phase	1000 mA	1,418 mA peak
Motor Connection	D-Sub 15 female	
Default Resolution	1/64 of a step	
Data Cable Connection	Locking 4-pin M8	
Manual Control	None	
Axes of Motion	1	
LED Indicators	Yes	
Operating Temperature Range	0 to 50 °C	
RoHS Compliant	Yes	
CE Compliant	Yes	
Limit Sensors per Axis	2	
Weight	0.070 kg	0.154 lb