ZABER

ASCII_Protocol_Manual Product
User's Manual
Firmware 6.14

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Conventions used throughout this document

- `Fixed width` type indicates ASCII characters communicated to and from a device.
- The symbol indicates a carriage return, which can be achieved by pressing enter when using a terminal program.

Previous Versions

As new features are added to the ASCII protocol, archived versions of this manual will become available below. Please consult the correct manual for your device version.

Low Version	High Version	Manual
6.06	6.08	ASCII Protocol Manual 6.06 - 6.08.pdf
6.09	6.10	ASCII Protocol Manual 6.09 - 6.10.pdf
6.11	6.11	ASCII Protocol Manual 6.11 - 6.11.pdf
6.12	6.12	ASCII Protocol Manual 6.12 - 6.12.pdf
6.13	6.13	ASCII Protocol Manual 6.13 - 6.13.pdf

Quick Start

Connecting

Zaber A-Series devices support connecting to user equipment over standard serial connections using a human-readable, text-based protocol. This allows A-Series devices to interface with a variety of equipment and software, including:

- Zaber Console
- Terminal Emulators
- User programs
- PLCs
- Automation and Instrumentation packages

Zaber's range of A-Series devices can be up and running in a matter of minutes, no matter what environment is being used.

A-Series devices typically communicate over RS232 at 9600 or 115200 baud, with 8 bits, 1 stop bit and no parity, however please refer to the RS232 Communications section of the device-specific User Manual for the correct settings. Characters are not echoed by the device, so if a terminal emulator is being used, it is advisable to turn on local echo.

For detailed instructions on how to set up and configure various communication software, please refer to the Communication Software section below.

Talking to Zaber Devices

Zaber devices listen for Commands sent to them over a serial port and then immediately respond with a Reply. Commands always begin with a `/` and end with a new line. Some commands take parameters, which are separated by spaces. Two example commands are:

```
/1 help
/1 move abs 10000
```

Where the `move` command has parameters of `abs` and `10000`.

Replies begin with a `@`, have 4 or more parameters and end with a new line. For example, the most common reply is:

```
@01 0 OK IDLE -- 0
```

Which can be broken down into:

```
@                   A Reply
 01                 The id of the device sending the reply
    0               The reply scope. 0 for the device or all axes, 1 onwards for an individual a
      OK            The command succeeded.
          IDLE      The device isn't moving, otherwise BUSY if it is moving.
               --   No faults or warnings in the device
                  0 The return value, typically 0.
```

A complete description of the reply fields is available in the Replies section.

Devices can also send two other types of messages; Alerts, starting with ! and Info, starting with #. Info messages are commonly seen in response to a help command.

Making it Move

Before a device can moved, it first needs to establish a reference to the home position. This is achieved by sending the home command, as shown below:

```
/home
@01 0 OK BUSY WR 0
```

If the device isn't homed and a move command is attempted, the device will respond with a rejection reply and the Invalid Reference (WR) flag set:

```
/move rel 10000
@01 0 RJ IDLE WR BADDATA
```

Once the device has been homed, you can make the device move by sending a move command. For example, to move 10000 microsteps forward from the current position:

```
/move rel 10000
@01 0 OK BUSY -- 0
```

To move 10000 microsteps away from the home position, regardless of the current position:

```
/move abs 10000
@01 0 OK BUSY -- 0
```

Changing a Device Setting

All of the device settings are read and modified using the get and set commands. For example, to query the device maxspeed:

```
/get maxspeed
@01 0 OK IDLE -- 153600
```

The maximum speed setting is currently 153600. The speed in microsteps/sec is calculated as data/1.6384, which equates to 93570 microsteps/sec for the data value of 153600.

On a multi axis device, the same command would return a value for each of the axes. For example:

```
/get maxspeed
@01 0 OK IDLE -- 153600 153600
```

To set the device to move at a target speed of 50000 microsteps/sec, the speed setting would be modified as shown below:

```
/set maxspeed 81920
@01 0 OK IDLE -- 0
```

On a multi axis device, the command above would set the speed for all axes. To only query or set a value for a specific axis, see the Talking to an Individual Axis section below.

Talking to an Individual Device

Up until now all the commands that have been sent haven't included a device address. If you have more than one device in a chain, you may have noticed that all of the devices moved at once in the Making it Move example above and that multiple responses were received. While this is a handy feature for initial setup, general use requires a way to instruct only an individual device to move.

Devices can be addressed by including their device number before the command. For example, the following command instructs only device 1 to move:

```
/1 move abs 10000
@01 0 OK BUSY -- 0
```

The valid device addresses are from 1 - 99 inclusive and can include a leading zero for devices 1 - 9. For example either 01 or 1 would both refer to device 1.

Talking to an Individual Axis

On multi axis devices, all the commands shown above would have affected all axes in the device. In order to get only a single axis to move an axis number has to be provided after the device number. The following command would instruct the first axis on a device to move to position 10000.

```
/1 1 move abs 10000
@01 1 OK BUSY -- 0
```

Note that this time the response scope is 1, indicating that the following information applies to axis 1.

Valid axis numbers are 0 - 9 inclusive, where 0 means all axis of the device, depending on the command or setting.

Built-in Help

All Zaber A-Series devices feature built-in help, providing a quick and easy reference for all Commands and Settings that the device has. Help commands require a device number to be provided. For example to access the built-in help for device 1, send: `/1 help .`

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

```
/1 help
@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.
```

Note that you can view a list of all the top level commands available to device 1 by using `/1 help commands` . 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
```

Quick Command Reference

The following table offers a quick command and setting reference for ASCII devices. For more detailed information, refer to the Command Reference or Device Settings below.

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	Description
estop	Axis		0	Performs an emergency stop on the axis.
get	Device and Axis	*setting*	*value*	Retrieves the current value of the device or axis setting.
help	Device	commands reply *command ...*	0	Displays the help information for the system.
home	Axis		0	Moves the axis to the home position.
io info	Device	[ai|ao|do|di]	*ports*	Returns the number of I/O channels the device has.
io get	Device	ai|ao|do|di [*channel*]	*value*	Returns the current value of the specified I/O channel type.
io set	Device	ao *channel value* do *channel value* do port *value value2...*	0	Sets the specified output *channel* to *value*.
move	Axis	abs|rel|vel *value*	0	Moves the axis to various positions along its travel.
move	Axis	min|max	0	Moves the axis to the limits of travel.
move	Axis	stored *number*	0	Moves the axis to a previously stored position.
renumber	Device	*value*	0	Renumbers all devices in the chain.
set	Device and Axis	*setting value*	0	Sets the device or axis setting *setting* to the *value*.
stop	Axis		0	Decelerates the axis and brings it to a halt.

stream	Device	Refer to the documentation below	Refer to the documentation below	Performs an action related to streamed, interpolated multi-axis motion.
system reset	Device		0	Resets the device, as it would appear after power up.
system restore	Device		0	Restores common device settings to their default values.
tools echo	Device	(*message*)	0	Echoes the provided message (if any) back to the user.
tools findrange	Axis		0	Uses the home and away sensors to set the valid range of the axis.
tools gotolimit	Axis	*limit dir action update*	0	Moves the axis to a limit sensor and performs the provided actions.
tools parking	Device	state|park|unpark	0|1	Parking allows the device to be turned off and used at a later time without first having to home.
tools setcomm	Device	*rs232baud protocol*	0	Sets RS232 baud rate and communication protocol for RS232 and USB.
tools storepos	Axis	*number* [*position*|current]	0|*position*	Stores a number of positions for easy movement.
trigger	Device	Refer to the documentation below	0	Configures actions to be performed on the device when a certain condition is met.
trigger dist	Device	*number axis displacement* *number* enable [*count*] *number* disable	0	Configures a trigger to toggle a digital output line every *displacement* microsteps.
trigger time	Device	*number period* *number* enable [*count*] *number* disable	0	Configures a periodic trigger to toggle a digital output line every *period* milliseconds.
warnings	Axis	[clear]	0	Displays the active device and axis warnings, optionally clearing them if applicable.

Quick Device Settings

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

Setting	Scope	Writable	Description
accel	Axis	Yes	Sets the acceleration used to modify the speed.
cloop.counts	Axis	Yes	The number of counts generated by the encoder for one full revolution.
cloop.mode	Axis	Yes	Sets the closed loop control mode.
cloop.stalltimeout	Axis	Yes	The amount of time to wait after a stall/displacement condition, in milliseconds.
cloop.steps	Axis	Yes	The number of full steps required for the motor to complete one revolution.
comm.address	Device	Yes	The device address.

comm.alert	Device	Yes	The device will send alert messages when this setting is 1.
comm.checksum	Device	Yes	The device includes checksums in its messages if this setting is set to 1.
comm.protocol	Device	Yes	The communications protocol used by the device on the current interface.
comm.rs232.baud	Device	Yes	The baud rate used by RS232 Prev and Next interfaces.
comm.rs232.protocol	Device	Yes	The protocol used by RS232 Prev and Next interfaces.
comm.rs485.baud	Device	Yes	The baud rate used by RS485 interface.
comm.rs485.enable	Device	Yes	Enables the RS485 interface.
comm.rs485.protocol	Device	Yes	The protocol used by RS485 interface.
comm.usb.protocol	Device	Yes	The protocol used by the usb interface.
deviceid	Device	No	The device id for the unit.
driver.current.hold	Axis	Yes	Current used to hold the motor in position, as a percentage of maximum.
driver.current.run	Axis	Yes	Current used to drive the motor as percentage of maximum.
driver.dir	Axis	Yes	Reverse the motor driver output direction.
driver.temperature	Axis	No	The current temperature of the axis driver, in degrees Celsius.
encoder.count	Axis	Yes	The recorded counts of the axis encoder.
encoder.dir	Axis	Yes	Inverts the counting direction for the axis encoder.
encoder.filter	Axis	Yes	Enable and set up digital filtering of the encoder inputs.
encoder.index.count	Axis	Yes	The recorded counts of the axis encoder index pulse.
encoder.index.mode	Axis	Yes	The operating mode of the axis encoder index signal.
encoder.index.phase	Axis	Yes	The required phase for an index pulse to be counted.
encoder.mode	Axis	Yes	The operating mode of the axis encoder.
knob.dir	Axis	Yes	Sets the movement direction for the knob.
knob.distance	Axis	Yes	Sets how far the device moves with each step of the knob in displacement mode, in units of microsteps.
knob.enable	Axis	Yes	Disable the use of the knob when set to 0.
knob.maxspeed	Axis	Yes	The maximum speed that can be reached using the knob in velocity mode.
knob.mode	Axis	Yes	Sets the mode of the knob. 0 for velocity mode, 1 for displacement mode.
knob.speedprofile	Axis	Yes	Sets the profile to be used per increment when in velocity mode.
limit.approach.maxspeed	Axis	Yes	Maximum speed used when approaching a limit sensor.
limit.detect.decelonly	Axis	Yes	Deceleration used when stopping after a limit sensor has triggered.
limit.detect.maxspeed	Axis	Yes	Maximum speed used when moving away from a limit sensor.
limit.swapinputs	Axis	Yes	Reverses the limit positions by swapping the home and away sensors.
limit.home.action	Axis	Yes	Automatic limit switch action.
limit.home.edge	Axis	Yes	Sensor edge to align action to.
limit.home.posupdate	Axis	Yes	Position update to occur when sensor is triggered.
limit.home.preset	Axis	Yes	The default position of the home sensor.
limit.home.state	Axis	No	The state of the home sensor.
limit.home.triggered	Axis	No	Whether the home sensor has been triggered previously.

limit.home.type	Axis	Yes	The type of home sensor connected.
limit.away.action	Axis	Yes	Automatic limit switch action.
limit.away.edge	Axis	Yes	Sensor edge to align action to.
limit.away.posupdate	Axis	Yes	Position update to occur when sensor is triggered.
limit.away.preset	Axis	Yes	The default position of the away sensor.
limit.away.state	Axis	No	The state of the home sensor.
limit.away.triggered	Axis	No	Whether the away sensor has been triggered previously.
limit.away.type	Axis	Yes	The type of away sensor connected.
limit.c.action	Axis	Yes	Automatic limit switch action.
limit.c.edge	Axis	Yes	Sensor edge to align action to.
limit.c.pos	Axis	Yes	The updated position of the sensor, when triggered.
limit.c.posupdate	Axis	Yes	Position update to occur when sensor is triggered.
limit.c.preset	Axis	Yes	The default position of the c limit sensor.
limit.c.state	Axis	No	The state of the c limit sensor.
limit.c.triggered	Axis	No	Whether the c limit sensor has been triggered previously.
limit.c.type	Axis	Yes	The type of c limit sensor connected.
limit.d.action	Axis	Yes	Automatic limit switch action.
limit.d.edge	Axis	Yes	Sensor edge to align action to.
limit.d.pos	Axis	Yes	The updated position of the sensor, when triggered.
limit.d.posupdate	Axis	Yes	Position update to occur when sensor is triggered.
limit.d.preset	Axis	Yes	The default position of the d limit sensor.
limit.d.state	Axis	No	The state of the d limit sensor.
limit.d.triggered	Axis	No	Whether the d limit sensor has been triggered previously.
limit.d.type	Axis	Yes	The type of d limit sensor connected.
limit.max	Axis	Yes	The maximum position the device can move to, measured in microsteps.
limit.min	Axis	Yes	The minimum position the device can move to, measured in microsteps.
maxspeed	Axis	Yes	The maximum speed the device moves at.
motion.accelonly	Axis	Yes	Sets the acceleration used to increase the speed.
motion.decelonly	Axis	Yes	Sets the deceleration used when decreasing the speed.
peripheralid	Axis	Yes	The id of the connected peripheral.
pos	Axis	Yes	The current absolute position of the device.
resolution	Axis	Yes	Microstep resolution
stream.numbufs	Device	No	The number of stream buffers provided in the device.
stream.numstreams	Device	No	The number of streams provided in the device.
system.access	Device	Yes	Sets the access level of the user.
system.axiscount	Device	No	The number of axes in the device.
system.current	Device	No	The current being drawn by the device and motors.
system.led.enable	Device	Yes	Enables the front panel LEDs.
system.temperature	Device	No	The current temperature of the unit, in degrees Celsius.
system.voltage	Device	No	The voltage being applied to the device.
version	Device	No	The firmware version of the device.

Message Format

The protocol uses a command-reply model, such that:

- Communication must be initiated by a user sending a device a command.
- The device always responds with one reply immediately after a command has been received (except the case mentioned in the Message IDs section below).
- Unless explicitly enabled, a device will not send any message other than a reply to a command.

The contents of the message is space delimited, with consecutive spaces being treated as a single space. There is only one command or response per message. Sending multiple commands in a single message is not supported. See the Message IDs section below for an alternate message format option.

Commands

Commands are sent from the user to one or more devices, which always and immediately respond with a Reply. The data field in the command is case sensitive, space delimited and depends on the command being executed. See the Command Reference for all the available commands.

A command instructs the device to perform an operation. A typical command message and associated fields are:

```
/1 1 move abs 10000
/n a xxxx yyy yyyyy[:CC]ff
```

`/` - Message Type

Length: 1 byte.
The message type for a command is always `/`.
This field, and the footer, are the only required fields, all others are optional.

`n` - Device Address

Length: 1+ bytes.
The address indicates which device number should perform the command. The address is optional and if left out, or set to zero, the command is executed by all devices on the chain. Device addresses range from 1 - 99 inclusive.
Examples of acceptable addresses are:

`0, 00, 1, 01, 000001, 76, 99, 0x00, 0x01, 0x5A, 0x5a`

Invalid addresses include:

`100, -1, 0x65` - The addresses are out of range and while the message may be valid, no device will respond.

`a` - Axis Number

Length: 1 bytes.
The axis number indicates which axis within a device should perform the command. The axis number is optional and if left out, or set to zero, the command is executed by all axes in the device. Axis numbers range from 0 - 9 inclusive.

`xxxx...` - Command

Length: Variable.

Message data containing command information. The contents are space delimited.
The Command Reference below covers the available commands.

`yyy...` - Command Parameters
Length: Variable.
Message data containing command parameters and data, the contents are space delimited.
Numerical values can be in decimal, or hexadecimal when prefixed with `0x`.
Negative values are prefixed with '−'; positive values may optionally be prefixed with '+'.
The Command Reference below covers the contents of the parameters field for the available commands.

`CC` - Message Checksum
Length: 3 bytes.
If provided, the device will reject messages that have been corrupted during transmission.
More information and code examples are provided in the Checksumming section below.

`ff` - Message Footer
Length: 1 - 2 bytes.
A newline, typically achieved by pressing enter or return. For convenience, the device accepts any ASCII combination of Carriage Return (CR, `\r`) and/or Line Feed (LF, `\n`) as a message footer.

Smallest Command

The smallest valid command is just `/` which generates a response from all devices in the chain, as demonstrated below:

```
/
@01 0 OK IDLE -- 0
@03 0 OK IDLE -- 0
@02 0 OK IDLE -- 0
```

This can be used as a quick way to check that communications and all devices are functioning as expected.

Replies

A reply is sent by the device as soon as it has received a command and determined if it should respond. A typical response message and associated fields are:

```
@01 0 OK IDLE -- 0
@nn a fl bbbb ww x[:CC]ff
```

`@` - Message Type
Length: 1 byte.
This field always contains `@` for a reply message.

`nn` - Device Address
Length: 2 bytes.
This field contains the address of the device sending the reply, always formatted as two digits.

`a` - Axis Number

Length: 1 byte.
This field contains the reply scope, from 0 to 9. 0 indicates that the following fields apply to the whole device and all axes on it, otherwise the fields apply to the specific axis indicated.

`fl` - Reply Flags

Length: 2 bytes.
The reply flag indicates if the message was accepted or rejected and can have the following values:

- ◊ `OK` - The command was valid and accepted by the device.
- ◊ `RJ` - The command was rejected. The data field of the message will contain one of the following reasons:
  - · `BADDATA` - The data provided in the command is incorrect or out of range.
  - · `BADCOMMAND` - The command or setting is incorrect or invalid.
  - · `PARKED` - The device cannot move because it is currently parked.
  - · `STATUSBUSY` - The device cannot be parked, nor can certain settings be changed, because it is currently busy.
  - · `DEVICEONLY` - An axis number was specified when trying to execute a device only command.
  - · `AGAIN` - The command cannot be processed right now. The user or application should send the command again. Occurs only during streamed motion.
  - · `FULL` - The device has run out of permanent storage and cannot accept the command. Occurs when storing to a stream buffer.

`bbbb` - Device Status

Length: 4 bytes.
This field contains `BUSY` when the axis is moving and `IDLE` otherwise. All movement commands, including stop, put the axis into the `BUSY` state, while they are being executed. During streamed motion, wait commands are considered to be busy, not idle. If the reply message applies to the whole device, the status is BUSY if any axis is busy and IDLE if all axes are idle.

`ww` - Warning Flags

Length: 2 bytes.
Contains the highest priority warning currently active for the device or axis, or `--` under normal conditions. A full description of the flags is available in the Warning Flags Section.

`xxx..` - Response Data

Length: 1+ bytes.
The response for the command executed. The contents and format of this field vary depending on the command, but is typically `0` (zero).

`CC` - Message Checksum

Length: 3 bytes.
A device will append a checksum to all replies if the comm.checksum setting is configured to 1. More information and code examples are provided in the Checksumming section below.

`ff` - Message Footer

Length: 2 bytes.
This field always contains a CR-LF combination (`\r\n`) for a reply message.

Replies on Multi axis Devices

For replies with an axis number of 0, the status and warning flags apply to the whole device. If any axis on the device is moving, then the reply status will be busy. Similarly the warning flags show the highest warning across all axes.

For replies with an axis number of 1 or above, the status and warning flags only apply to the axis indicated.

Warning Flags

A warning flag is provided in each device-to-user reply message, indicating whether any device fault or warning is active. If more than one condition is active, it shows the one with highest precedence.

The warning flags are defined as follows, with the highest priority first:

`FD` - Driver Disabled.
: The driver has disabled itself due to overheating.
This warning persists until the driver returns to normal operating conditions.

`FS` - Stalled and Stopped.
: Stalling was detected and the axis has stopped itself.
This warning persists until acknowledged and cleared by the user with the warnings command.

`FB` - Stream Bounds Error
: A previous streamed motion could not be executed because it failed a precondition (e.g. motion exceeds device bounds, calls nested too deeply).
This warning persists until acknowledged and cleared by the user with the warnings command; also, until the warning is cleared, no further streamed motions can be sent to the failed stream.

`FP` - Interpolated Path Deviation.
: Streamed motion was terminated because an axis slipped and thus the device deviated from the requested path.
This warning persists until acknowledged and cleared by the user with the warnings command.

`FE` - Limit Error.
: The axis took too long to reach the target limit sensor.
This warning persists until acknowledged and cleared by the user with the warnings command.

`WL` - Unexpected Limit Trigger.
: A limit sensor triggered unexpectedly. This occurs when an automatic limit sensor action is carried out on a previously triggered sensor.
This warning persists until acknowledged and cleared by the user with the warnings command.

`WV` - Voltage out of range.
: The supply voltage is outside the recommended operating range of the device. Damage could result to the device if not remedied.
This warning persists until the condition is remedied.

`WT` - System Temperature High
: The internal temperature has exceeded the recommended limit for the device.
This warning persists until the over temperature condition is remedied.

`WM` - Displaced when stationary.
: While not in motion, the axis has been forced out of its position.
This warning persists until the axis is moved.

`WR` - No Reference Position.
: Axis has not had a reference position established.
This warning persists until the axis position is updated via homing or any command/action that sets position.

`NC` - Manual Control.

Axis is busy due to manual control via the knob.
This warning persists until a movement command is issued.

NI - Command Interrupted.
A movement operation (command or manual control) was requested while the axis was executing another movement command. This indicates that a movement command did not complete.
This warning persists until a movement command is issued when the axis is either idle or executing a manual control movement.

ND - Stream Discontinuity
The device has slowed down while following a streamed motion path because it has run out of queued motions.
This warning persists until the stream has enough motions queued that it no longer needs to decelerate for that reason, or until the stream is disabled.

NU - Setting Update Pending.
A setting is pending to be updated.
This warning is cleared automatically, once the settings have been updated.

To see and clear all current warnings, use the warnings command.

Info

This message type contains extra information from the device for testing/debugging/programming purposes. One or more info messages can follow a reply or alert message. This message type is designed to be read by the user and to be ignored by software.

A typical info message and its fields are:

```
#01 0 Visit www.zaber.com for instruction manuals.
#nn a xxxxxxxxxxxxx...[:CC]ff
```

\# - Message Type
Length: 1 byte.
This field always contains # for an info message.

nn - Device Address
Length: 2 bytes.
This field contains the address of the device sending the reply, always formatted as two digits.

a - Axis number.
Length: 1 byte.
Always 0 for info messages.

xxx.. - Data
Length: 1+ bytes.
The data for the info message, typically human readable text.

CC - Message Checksum
Length: 3 bytes.
A device will append a checksum to all info messages if the comm.checksum setting is configured to 1. More information and code examples are provided in the Checksumming section below.

`ff` - Message Footer
Length: 2 bytes.
This field always contains a CR-LF combination (`\r\n`) for a info message.

The common occurrence of info messages is in reply to a help command, e.g.:

```
/1 help
@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.
```

Alerts

An alert message is sent from a device when a motion command has completed.

If it is enabled, this message can be sent at any time without being preceded by a command from the user. This message type is used for informational purposes or time-sensitive operations.

Alerts are controlled by the `comm.alert` setting, which has to be 1 for the device to send status alerts.

A typical alert message and its fields are:

```
!01 0 IDLE --
!nn a ssss ww[:CC]ff
```

`!` - Message Type
Length: 1 byte.
This field always contains `!` for an alert message.

`nn` - Device Address
Length: 2 bytes.
This field contains the address of the device sending the alert, always formatted as two digits.

`a` - Axis Number
Length: 1 byte.

`ssss` - Device status.
Length: 4 bytes.
This field contains BUSY when the axis is moving and IDLE when the axis is stopped.

`ww` - Warning flags.
Length: 2 bytes.
Contains the highest priority warning currently active for the axis, or -- under normal conditions. A full description of the flags is available in the Warning Flags Section.

`CC` - Message Checksum

Length: 3 bytes.
A device will append a checksum to all alert messages if the comm.checksum setting is configured to 1. More information and code examples are provided in the Checksumming section below.

`ff` - Message Footer
Length: 2 bytes.
This field always contains a CR-LF combination (`\r\n`) for an alert message.

Multi axis Alerts

On a multi axis device with completion alerts enabled, an alert will be generated each time an axis stops. In the example below, axis 2 is closer to it's maximum position than axis 1 is:

```
/move max
@01 0 OK BUSY -- 0
!01 2 IDLE --
!01 1 IDLE --
```

The first alert is generated when axis 2 stops, and as that axis is idle, the axis-scope reply has `IDLE` in its `ssss` field, even though the device as a whole is still busy due to axis 1 moving. The second alert is generated when axis 1 stops.

Command Reference

The following section details all commands that are available in the ASCII protocol. For specific device support of a command, please refer to that device's User Manual.

For commands with a device scope, specifying an axis number other than zero in the command will result in a DEVICEONLY error, as shown below:

```
/1 tools parking park
@01 0 OK IDLE -- 0
/1 0 tools parking park
@01 0 OK IDLE -- 0
/1 1 tools parking park
@01 1 RJ IDLE -- DEVICEONLY
```

For commands with an axis scope, specifying an axis number of zero or not including any axis number will both apply the command to all axes on the device. If one of the axes is unable to complete the command, a BADDATA response will be returned and none of the axes will perform the command. For example, moving to a position that is outside the range of one axis, but within for another axis will result in an error:

```
/1 get limit.max
@01 0 OK IDLE -- 3038763 6062362
/1 move abs 4750000
@01 0 RJ IDLE -- BADDATA
```

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 needs to be provided.

estop

Performs an emergency stop on the axis.

Scope
: Axis

Parameters
: none

The device is forced to zero velocity, no control of deceleration is performed.

Example Usage:

```
/1 1 estop
@01 1 OK IDLE -- 0
```

get

Retrieves the current value of the device or axis setting.

Scope
: Device and Axis

Parameters
: *setting* The name of one of the Device Settings.

See Device Settings for a detailed list or settings and what they do.

Example Usage:

Viewing the device id:

```
/get deviceid
@01 0 OK IDLE -- 20022
```
Device id is 20022 (A-LSQ150B)

Viewing an invalid setting:

```
/get cloop.mode
@01 0 RJ IDLE -- BADCOMMAND
```
cloop.mode is only valid on devices with encoders, and this device does not have one. Attempting to read an invalid setting results in a BADCOMMAND rejection reply.

help

Displays the built-in help.

Scope
: Device

Parameters
: `[commands|reply|warnflags|enums`*`command`*`]`
`commands list`

Displays the help information for the system, commands and replies or a specific *command* as applicable. This command will always return a successful reply and the help information will be returned in info messages.

`help warnflags` displays information about the warning flags that can be present in a reply.

`help commands list` can be used to list all supported commands and settings of the device.

As the built-in help is specific to each device, a device number is required when sending the command. Issuing a help command without a device number will result in each device in the chain requesting that a device number be specified, as shown below:

```
/help
@01 0 OK IDLE -- 0
#01 0 Please provide a device address for querying help
```

```
@02 0 OK IDLE -- 0
#02 0 Please provide a device address for querying help
```

Example Usage:

View the built-in help for the estop command

```
/1 help estop
@01 0 OK IDLE -- 0
#01 0 estop Emergency stop
```

Help for an invalid command returns successfully:

```
/1 help dlkjsfbi
@01 0 OK IDLE -- 0
#01 0 No help found
```

home

Moves the axis to the home position.

Scope
: Axis

Parameters
: none

The axis is moved towards the home position (closest to the motor generally) at the lesser of the limit.approach.maxspeed and maxspeed settings. Once the home position is reached, the current position is reset to the limit.home.preset. Additionally, limit.home.triggered is set to 1, and the No Reference Position (WR) warning flag is cleared. This command is equivalent to `tools gotolimit home neg 2 0`.

Example Usage:

```
/home
@01 0 OK BUSY WR 0
```

NOTE: Upon power up or setting changes, this command should be issued to obtain a reference position. Otherwise, motion commands may respond with a rejection reply or behave unexpectedly.

io info

Returns the number of I/O channels the device has.

Scope
: Device

Parameters

```
[ao|ai|do|di]
```

The parameters are used to specify the channel type: ai for Analog Input, ao for Analog Output, di for Digital Input and do for Digital Output. Channel numbers start at 1 for each type.

If the channel type is not specified, all channels will be returned in the following order: analog out, analog in, digital out, digital in

Example Usage:

Getting the available io configuration:

```
/io info
@01 0 OK IDLE -- 0 4 4 4
```
Device has no analog outputs, 4 analog input channels, 4 digital outputs and 4 digital inputs.

Getting the configuration of a specific port type:

```
/io info ao
@01 0 OK IDLE -- 0
```
Device has no analog output capabilities

Invalid port type:

```
/io info as
@01 0 RJ IDLE -- BADCOMMAND
```

io get

Get the current value of the specified I/O channel type.

Scope
: Device

Parameters
: `ao|ai|do|di [`*`channel`*`]`

If *channel* isn't specified a space delimited list of all channels of the requested type are returned.

For digital channels, a value of 0 indicates that the input or output is not conducting and a value of 1 indicates that the channel is conducting.

For analog channels, the vaule returned is a measurement of the voltage present on the input with enough decimal places to cover the available resolution. To see the available resolution, please consult the Series Specs Tab on the device Product Page.

Example Usage:

Reading an analog input:

```
/io get ai 2
@01 0 OK IDLE -- 7.5
```
Analog input 2 has 7.5V on it

Reading all digital outputs:

```
/io get do
@01 0 OK IDLE -- 0 0 1 0
```
Digital output 3 is high while the rest are low.

Invalid port type:

```
/io get as 0
@01 0 RJ IDLE -- BADCOMMAND
```

Invalid channel number, using the available channels from the io info command above:

```
/io get ai 5
@01 0 RJ IDLE -- BADDATA
/io get ao
@01 0 RJ IDLE -- BADDATA
```
The analog output port has no channels and can't be displayed.

io set

Sets the specified output.

Scope
: Device

Parameters
: `do` *`channel value`*
: `do port` *`value value2...`*

Sets the specified output *channel* to *value*.

For digital channels, a *value* of 0 clears the output while any other value sets it.

Specifying 'port' allows setting of all digital outputs at once.

Example Usage:

Clear digital output 3:

```
/io set do 3 0
@01 0 OK IDLE -- 0
```

Using the port command to set digital output 1, 3, 4 and clear output 2:

```
/io set do port 1 0 1 1
@01 0 OK IDLE -- 0
```

Invalid port type:

```
/io set ad 2 50
@01 0 RJ IDLE -- BADCOMMAND
```

Port type that's not an output or has no channels:

```
/io set ai 2 50
@01 0 RJ IDLE -- BADDATA
/io set ao 2 50
@01 0 RJ IDLE -- BADDATA
```

Invalid channel number:

```
/io set do 8 1
@01 0 RJ IDLE -- BADDATA
```

move

Moves the device to various positions along its travel.

Scope

Axis

Parameters

`abs|rel|vel` *`value`*
`min|max`
`stored` *`number`*

value is in units of microsteps.

abs moves to the absolute position of *value*. *Value* must be in the range [limit.min,limit.max].

rel moves the axis by *value* microsteps, relative to the current position. *Value* must be in the range [limit.min - pos, limit.max - pos].

vel moves the axis at the velocity specified by *value* until a limit is reached. *Value* must be in the range [-resolution*16384, resolution*16384].

min moves the axis to the minimum position, as specified by limit.min.

max moves the axis to the maximum position, as specified by limit.max.

stored moves the axis to a previously stored position. *number* specifies the stored position number, from 1 - 16. Refer to the tools storepos command for more information.

Example Usage:

Move all axes on the device forward by 200000 microsteps:

```
/move rel 200000
@01 0 OK BUSY -- 0
```

No reference point:

```
/move rel 2000000
@01 0 RJ IDLE WR BADDATA
```

The WR flag indicates that there is no reference point and the axis has not been homed. Sending the home command will allow the move command to succeed.

Invalid position:

```
/get limit.max
@01 0 OK IDLE -- 305381
/move abs 305888
@01 0 RJ IDLE -- BADDATA
```

A bad data rejection was received because the position specified is beyond the range of the axis.

Parked:

```
/move abs 10000
@01 0 RJ IDLE -- PARKED
```

Axes cannot be moved when the device is parked. Either unpark or home it.

renumber

Renumbers a device, or all devices in a chain.

Scope
: Device

Parameters
: [*value*] Valid range: 1 - 99.

The global version of this command sequentially renumbers all devices in the chain, starting with *value*, if provided, or 1. The global renumber command only works on interfaces that support daisy chaining; issuing a global renumber command over an interface that doesn't support daisy chaining will be rejected with a BADCOMMAND. Please consult the device User Manual to determine which interfaces support daisy chaining.

When a specific device address is sent the renumber command, the renumber command will change the device number to *value* (in which case *value* is required).

When a device receives a renumber command, it will use the new device number for it's response.

Example Usage:

Renumbering all devices in the chain:

```
/renumber
@01 0 OK IDLE -- 0
@02 0 OK IDLE -- 0
```

The devices renumbered, with the device closest to the computer being at address 1, and the next closest being at address 2.

Renumbering a specific device:

```
/2 renumber 4
@04 0 OK IDLE -- 0
```

Device 2 renumbered and replied on address 4.
This is equivalent to `/2 set comm.address 4`

Invalid device number:

```
/renumber 999
@01 0 RJ IDLE -- BADDATA
```

The requested device number was outside of the allowable range.

NOTE: The device will reply on its new address, not the address the command was sent to.

set

Sets the device setting.

Scope
: Device and Axis

Parameters
: *setting value*

Sets the device setting *setting* to the *value*. See Device Settings for a detailed list or settings and what they do.

Example Usage:

Writing a device setting:

```
/set knob.enable 1
@01 0 OK IDLE -- 0
```

The device setting was successfully configured.

Invalid value:

```
/set knob.enable 7
@01 0 RJ IDLE -- BADDATA
```

Invalid setting:

```
/get system.voltage
@01 0 OK IDLE -- 0
/set system.voltage 0
@01 0 RJ IDLE -- BADCOMMAND
```

It's possible to read from some settings but not write to them.

stop

Decelerates an axis and brings it to a halt.

Scope
: Axis

Parameters
: none

To quickly stop an axis, see the estop command.

Example Usage:

```
/stop
@01 0 OK BUSY -- 0
```

stream

Performs an action related to streamed, interpolated multi-axis motion.

Scope
: Device

Parameters
: *number* setup live *axes*
number setup store *buf axiscount*
number setup disable
buffer *buf* erase
buffer *buf* print
number arc abs|rel cw|ccw *centrex centrey endx endy*
number call *buf*
number circle abs|rel cw|ccw *centrex centrey*
number fifo cork|uncork
number info
number io set do *channel value*
number io set do port *value value2…*
number line abs|rel *endx endy…*
number set maxspeed *value*
number set tanaccel *value*
number set centripaccel *value*
number wait *milliseconds*
number wait io ai|di *channel* ==|<>|<|>|<=|>= *value*

While most commands will pre-empt previous commands, a stream allows the execution of a series of subsequent commands and movements in order. Streamed movement commands can also be interpolated linear or circular movements.

Setup

Devices that allow stream commands will have a non-zero stream.numstreams setting, showing how many simultaneous streams you can have. The number of the stream you are addressing is the *number* parameter in any of the above stream commands.

Streams are initiated and ended with the `setup` parameters. The `setup live` command will run stream commands as they are entered, and the *axes* parameter sets which axis or axes will respond to the stream. Live streams can only be initiated for axes that have been homed and are idle.

The `setup store` command will save any commands to buffer *buf* (the stream.numbufs setting indicates the number of available buffers) and the *axiscount* is how many axes are in the stream. See section on buffering for more information on buffers.

The `setup disable` command will close the stream. A stream is also automatically disabled if a non-streamed motion command is sent to one of the axes in the stream.

Example Usage:

Initiating a live stream:

```
/01 stream 1 setup live 1 2
@01 0 OK IDLE -- 0
```
Stream 1 is opened, addressing axes 1 and 2.

Streaming before homing:

```
/01 stream 1 setup live 1 2
@01 0 RJ IDLE WR BADDATA
```
The stream command will be rejected and BADDATA will be returned if one or more of the axes have not been homed.

Ending a stream:

```
/01 stream 1 setup disable
@01 0 OK IDLE -- 0
```
Streams should be disabled once they are no longer in use.

Single axis stream:

```
/01 stream 1 setup live 1
@01 0 OK IDLE -- 0
```
Streams can also be created to control a single axis.

Interpolated Movement (Lines, Arcs, and Circles)

Three basic streamed motions are available: straight lines, circular arcs, and full circles. If the `abs` parameter is used, the end points/centre points will be with reference to the home position, while the `rel` parameter indicates the end points/centre points will be with reference to the starting position. If the `cw` parameter is used, any circular motion will move in a clockwise direction while using `ccw` will move counter-clockwise.

Using `line` will move the axes in a straight line to the endpoints *endx*, *endy*…. The line command will coordinate as many axes as are in the stream.

Using `arc` will move in a circular arc from the starting position to the end position *endx* and *endy*, with the circular arc centred at *centrex* and *centrey*. It's possible to enter coordinates that aren't congruent with a single circle, so it's up to the user to ensure that the points conform to a circle. Small corrections may be made if the difference is within a certain tolerance, otherwise the command will be rejected.

Using `circle` will move in a complete circle, starting and ending at the initial position. The centre of the circle is specified by *centrex centrey*, which also defines the radius of the circle.

Example Usage:

Moving in a line to an absolute position:

```
/01 stream 1 line abs 5000 5000
@01 0 OK IDLE ND 0
```

For live streams, the ND flag will indicate the movement will slow towards the end of the path. See warning flags for more information.

Moving in a clockwise circle:

```
/01 stream 1 circle rel cw 0 10000
@01 0 OK IDLE -- 0
```

Moves in a circle centred 10000 microsteps from the initial position in the Y axis. The radius would also be 10000 microsteps in this case.

Moving in an arc:

```
/01 stream 1 arc rel ccw 5000 0 5000 -5000
@01 0 OK IDLE -- 0
```

Moves a quarter-circle to the end position 5000, -5000 (microsteps) from the start position. The centre of the quarter circle is at 5000, 0 (microsteps) from the start position.

Invalid arc:

```
/01 stream 1 arc rel ccw 5000 0 10000 10000
@01 0 OK IDLE -- 0
/
@01 0 OK IDLE FB 0
```

There is no circle with a relative centre 5000, 0 (microsteps) that also passes through 10000, 10000. While the invalid command is accepted, the FB fault flag becomes active once the controller determines the path is invalid.

Single axis movements:

```
/01 stream 1 line abs 5000
@01 0 OK IDLE -- 0
```

Single axis streams can use the line command, but circle and arc commands can only be used in 2-axis streams.

Trajectory Control

Three physical limits are defined that apply to streamed motion:

- `maxspeed` is the maximum speed in the direction of motion. If not explicitly set, this defaults to the lower of the maxspeed settings for the axes.
- `tanaccel` is the maximum acceleration rate for the device to speed up and slow down. If not explicitly set, this defaults to the lower of the motion.accelonly and motion.decelonly settings for the axes, divided by ?2.
- `centripaccel` is the maximum acceleration rate used for arcs and circles. If not explicitly set, this defaults to the lower of the motion.accelonly and motion.decelonly settings for the axes, divided by ?2.

These settings can be changed with the `stream set` command. The settings do not change immediately, but in sequence after the previous stream command is completed.

The device manages its speed to ensure that all limits are obeyed at all times; for example, if `maxspeed` is increased between two movement commands, the device will speed up **after** passing the end position of the first movement, whereas if it is decreased, the device will slow down **before** reaching the end position of the first movement.

Example Usage:

Changing speeds during a movement:

```
/01 stream 1 line rel 5000 0
@01 0 OK IDLE -- 0
/01 stream 1 set maxspeed 50000
@01 0 OK IDLE -- 0
/01 stream 1 set tanaccel 200
@01 0 OK IDLE -- 0
/01 stream 1 line rel 10000 0
@01 0 OK IDLE -- 0
```

The speed and acceleration will be in effect after the first movement. If the new speed is lower, it will decelerate before the first line is completed.

IOs and Waiting

You can insert other commands as well in sequence, such as waiting a certain amount of time (`wait` *`milliseconds`*), changing outputs (`io set do`) or waiting for input conditions (`wait io`).

Example Usage:

Set digital output:

```
/01 stream 1 io set do 4 1
@01 0 OK IDLE -- 0
```

Digital output 4 is enabled at a point in the stream.

Wait for a certain amount of time:

```
/01 stream 1 wait 1000
@01 0 OK IDLE -- 0
```

Stream waits for 1000 ms at the point in the stream before continuing.

Wait for analog value to be above a certain value:

```
/01 stream 1 wait io ai 1 > 5
@01 0 OK IDLE -- 0
```

Stream will stop and wait until analog input 1 is above 5. `Wait io` commands will decelerate to a stop because the input isn't checked until after the last command is complete.

Communication Flow Control and Buffers

To ensure commands are executed continuously, the device can hold a queue of stream commands.

- Once the queue becomes full, the device cannot accept any more commands until some have finished executing. If one is sent while the queue is full, it is rejected with the AGAIN message to indicate you should resend the command until it is accepted. Sending again must be handled on the application end.
- If the queue is almost empty, the movement will slow down and stop as the last available movement command is finishes. As soon as it starts slowing down, it sets warning flag ND indicating there's been a discontinuity in the motion.
- You can fill up the queue before starting movement using the `fifo cork` command. It will automatically start executing once the queue is full, or you can use `fifo uncork` to start before then.

Instead of sending the stream commands while they are being executed (live mode), you can save a series of stream commands to buffer locations on the device using the `setup store` command. After setting up the stream in store mode, send the stream commands you'd like to save and then disable the stream. During a live stream you're able to execute those stored stream commands using the `call` command. Use the `buffer` *`buf`* `erase` to clear the saved commands from the buffer location before saving to that location again. You can display the sequence of stored commands with the `buffer` *`buf`* `print` command.

Example Usage:

Using cork to add commands to the queue:

```
/01 stream 1 fifo cork
@01 0 OK IDLE -- 0
/01 stream 1 line rel 5000 1000
@01 0 OK IDLE -- 0
/01 stream 1 line rel -5000 -1000
```

```
@01 0 OK IDLE -- 0
/01 stream 1 fifo uncork
@01 0 OK IDLE -- 0
```
The line movements won't be executed until uncork is sent or the queue is full.

Using cork while commands are currently executing:

```
/01 stream 1 fifo cork
@01 0 RJ BUSY ND BADCOMMAND
```
The cork command will be rejected if commands are already being executed.

Storing a command to run later:

```
/01 stream 1 setup store 3 2
@01 0 OK IDLE -- 0
/01 stream 1 line rel 10000 50000
@01 0 OK IDLE -- 0
/01 stream 1 setup disable
@01 0 OK IDLE -- 0
/01 stream 1 setup live 1 2
@01 0 OK IDLE -- 0
/01 stream 1 call 3
@01 0 OK IDLE -- 0
```
The line movement will execute after it buffer 3 is called in the live stream.

Clear a buffer:

```
/01 stream buffer 3 erase
@01 0 OK IDLE -- 0
```

Printing out the contents of a buffer:

```
/01 stream buffer 2 print
@01 0 OK IDLE WR 0
#01 0 setup store 2 2
#01 0 line abs 400000 500000
#01 0 io set do 4 1
#01 0 wait 100
#01 0 arc rel ccw 100000 -100000 200000 0
#01 0 setup disable
```
Replacing the `#01 0` with `/01 stream 1` in each line yields a sequence of commands that perfectly reproduces the stored sequence when sent to another device (or the same device if the buffer is erased first).

Printing an empty buffer:

```
/01 stream buffer 3 print
@01 0 RJ IDLE WR BADDATA
```
Buffer 3 was erased or was never used, so it cannot be printed.

Information

To read out information about a stream, use the `stream info` command. This command returns a list of space-separated values which are, in order:

1. the stream mode (one of `disabled`, `live`, or `store`)
2. the axis count, or − if the stream is disabled
3. the maximum centripetal acceleration, or − if the stream is not in live mode
4. the maximum tangential acceleration, or − if the stream is not in live mode
5. the maximum speed, or − if the stream is not in live mode
6. an error reason indicating why flag `FB` was set, or − if `FB` was not set on this stream

The possible error reasons are:

`axislimit`
: a motion tried to move the device beyond the positional limits

`setting`
: a `stream set` tried to set a setting to an illegal value

`stackdepth`
: stream operations were nested too deeply, most likely due to a buffers calling each other to too deep a level

`arcradius`
: an arc was not congruent to a circle, meaning that the arc's "radius" was significantly different between the start and end of the arc

`bufempty`
: a `stream call` tried to call an empty buffer

`buflocked`
: a `stream call` tried to call a buffer while it was being written to or erased

`bufaxes`
: a `stream call` tried to call a buffer that was recorded with the wrong number of axes

system reset

Resets the device, as it would appear after power up.

Scope
: Device

Parameters
: none

Example Usage:

```
/system reset
@01 0 OK IDLE -- 0
```

system restore

Restores common device settings to their default values.

Scope
: Device

Parameters
: none

This command resets common settings to their default for the device and peripheral. Communications settings are not modified.

Example Usage:

```
/system restore
@01 0 OK IDLE -- 0
```

tools echo

Echoes the provided message (if any) back to the user.

Scope
: Device

Parameters
: [*message*]

This command always returns a successful response, with any message provided by the user.

Example Usage:

```
/tools echo hi there
@01 0 OK IDLE -- hi there
```

tools findrange

Uses the home and away sensors to set the valid range of the axis for the current session.

Scope
: Axis

Parameters
: none

This command replaces the home command on an axis equipped with both home and away limit sensors. The axis is first homed and the current position set to limit.home.preset. If there is an away sensor present, the axis is then moved to the away sensor. Once the away sensor is triggered, the limit.max setting is updated to the current position for the current session.

This command is equivalent to the following set of commands issued in order:

: tools gotolimit home neg 2 0 (or equivalently, home)

```
tools gotolimit away pos 1 1
```

NOTE: Upon power up or setting changes, this command should be issued to obtain a reference position and valid range. Otherwise, motion commands may respond with a rejection reply or behave unexpectedly.

tools gotolimit

Moves the axis to a limit sensor and performs the provided actions.

Scope
: Axis

Parameters
: *sensor direction action update*

sensor specifies one of the limit switches to move to. Can be one of `home`, `away`, `c` or `d`.

direction specifies the travel direction to the sensor. Can be one of `pos` or `neg` for a positive or negative direction of travel, respectively.

action specifies the action to perform when the sensor is triggered. This parameter shares the same values and effects as the limit.*sensor*.action setting, except that it cannot be `0 (Disabled)`.

update how to update the sensor position setting. This parameter shares the same values and effects as the limit.*sensor*.posupdate setting.

This command moves the axis in the *direction* specified and waits for *sensor* to trigger. The axis will then align itself to the sensor edge specified by limit.*sensor*.edge and perform the limit switch action and position update specified by *action* and *update*. limit.*sensor*.triggered is set to 1. If *action* is `2 (Retract and update current position)`, the No Reference Position (WR) warning flag is cleared.

The automatic action settings as specified in limit.*sensor*.action and limit.*sensor*.posupdate are ignored.

Example Usage

Go home and reset the current position
```
/tools gotolimit home neg 2 0
@01 0 OK BUSY -- 0
```
Equivalent to the `home` command.

Adjust the effective travel range
```
/tools gotolimit away pos 1 1
@01 0 OK BUSY -- 0
```
Assuming that there is already a reference established, the command above leaves the current position as it is when the away sensor it triggered. The limit.max setting is then updated to the current position.

tools parking

Parks the device.

Scope
: Device

Parameters
: `state|park|unpark`

Parking allows the device to be turned off and then used at a later time without first having to home the axes.

The parking state can be queried with the state option, returning 1 if parked or 0 if not.

A device can be parked with the park option. Once parked, any movement commands will result in a PARKED error, except for home, which will home the respective axis and clear the parked state.

A parked device can be restored by powering it on and issuing the unpark command.

Example Usage:

Parking:

```
/tools parking park
@01 0 OK IDLE -- 0
```

Unparking:

```
/tools parking unpark
@01 0 OK IDLE -- 0
```

Parking when busy:

```
/tools parking park
@01 0 RJ BUSY -- STATUSBUSY
```
The device cannot be parked while it is busy.

NOTE: Parking should not be used when there is a load on the device that could cause it to slip when the motor hold current is turned off.

tools setcomm

Sets the RS232 baud rate and communication protocol for RS232 and USB.

Scope
: Device

Parameters
: *rs232baud protocol*

rs232baud specifies the desired RS232 baud rate. This parameter shares the same values as comm.rs232.baud.

protocol specifies the desired communication protocol, which must be supported on USB and RS232. This parameter shares the same values as comm.rs232.protocol and comm.usb.protocol.

This command sets comm.rs232.baud, comm.rs232.protocol and comm.usb.protocol.

This command sets the Setting Update Pending (NU) notification flag and replies on the current communication settings. Once all communication channels have been quiet for 500 milliseconds, the device switches to the new settings and clears the Setting Update Pending (NU) flag.

Example Usage:

Switching RS232 baud rate and protocol:

```
/tools setcomm 9600 1
@01 0 OK IDLE NU 0
```
Configures the device to communicate at 9600 baud rate and in Binary protocol.

tools storepos

Stores a number of positions for axes for ease of movement.

Scope
: Axis

Parameters
: *number* [*position*|current]

number is the stored position number to be set or retrieved. The valid range is 1 - 16.

position is a valid axis position to move to and must be in the range of limit.min to limit.max. The position defaults to 0 if not set.

current specifies that the specified stored position number be set to the current position, pos.

If none of the optional arguments are provided, the current value of the stored position number will be returned.

Example Usage:

Storing a position:

```
/1 1 move abs 74920
/1 1 tools storepos 1 current
@01 1 OK IDLE -- 74920
```
Stores the current position of 74290 microsteps to position number 1 for axis 1.

Setting a position:

```
/1 1 tools storepos 1 150000
@01 1 OK IDLE -- 0
```

Stored position 1 has been set to a position of 150000 microsteps for axis 1.

Retrieving a stored position:

```
/1 1 tools storepos 1
@01 1 OK IDLE -- 150000
```

The stored position 1 has a value of 150000 for axis 1.

Moving to a stored position:

```
/move stored 1
@01 0 OK BUSY -- 0
/get pos
@01 0 OK IDLE -- 150000 0
```

All axes on the device will move to their respective stored position. In the example above, axis 2 didn't have a value set for position 1 and moved to a position of 0.

trigger

Configures actions to be performed when an event is triggered.

Scope

Device

Parameters

`info`
`show`
`number` `enable [`*`count`*`]`
`number` `disable`
`number` `when` *`condition configuration`*
`number` `action` *`act`* *`command configuration`*

Triggers allow certain actions to be performed when an event occurs.

The `trigger info` command returns four values, the number of triggers in the device, the number of available actions per trigger, the number of time triggers and the number of distance triggers. For example:

```
/1 trigger info
@01 0 OK IDLE -- 6 2 2 2
```

There are 6 triggers in total, each with 2 actions that can be performed. There are 2 time triggers available and 2 distance triggers available. In this case *number* has a range of 1 - 6 inclusive and *act* has a range of 'a' - 'b' inclusive.

The `trigger show` command returns the state of the device triggers. For example:

```
/1 trigger show
@01 0 OK IDLE -- e d 500 d d d
```

Trigger 1 is enabled, trigger 3 will fire 500 more times before disabling and the rest of the triggers are disabled.

The `enable` parameter turns on the specified trigger, executing the actions whenever the trigger fires. If the *count* parameter is specified, the trigger action(s) are only performed *count* times. **NOTE:** The count parameter itself is non-volatile but the value is not updated as the triggers fire. Upon reset, the value is restored to the configured value, allowing the device to be configured and then powered off and installed without a PC connection. The `disable` parameter turns off the specified trigger.

Note that the following settings either cannot be used in trigger conditions or actions, or can be used but have special meanings:

- accel - Use motion.accelonly and/or motion.decelonly.
- comm.protocol - Use comm.rs232.protocol, comm.rs485.protocol, or comm.usb.protocol.
- driver.temperature
- peripheralid
- system.current
- system.temperature - Works, but measured in tenths of a °C when used in trigger conditions.
- system.voltage - Works, but measured in tenths of a volt when used in trigger conditions.
- version

Condition Configuration

Valid parameters

```
when io ao|ai|do|di chan trigger_condition value
when setting trigger_condition value
when axis setting trigger_condition value
```

Trigger Conditions

== Equal To
<> Not Equal To
< Less Than
> Greater Than
<= Less Than or Equal To
>= Greater Than or Equal To

The `when io` parameter sets a trigger to fire when a io type and channel compares to a provided value. The available channels for each io type (`ai|ao|do|di`) can be queried with the io info command.

The `when setting` parameter sets a trigger to fire when a device setting compares to a provided value.

The `when axis setting` parameter sets a trigger to fire when a axis setting compares to a provided value. The *axis* parameter indicates the axis number that the setting applies to.

Note that for firmware versions earlier than 6.11, not-equal-to must be written as != instead of <>.

Example Usage:

Triggering when an analog input exceeds a set voltage

```
/1 trigger 1 when io ai 2 > 7.5
@01 0 OK IDLE -- 0
```

Trigger 1 will fire when analog input 2 exceeds 7.5 volts.

Triggering when an axis position exceeds a value

```
/1 trigger 1 when 1 pos >= 750000
@01 0 OK IDLE -- 0
```

Trigger 1 will fire when the position of axis 1 hits or exceeds 750000 microsteps.

Command Configuration

Valid parameters

```
action act none
action act io do chan toggle|value
action act axis stop|move value
action act axis setting =|+= value
```

The `action ... none` parameter removes the specified action from the trigger.

The `action ... io` parameter sets a io digital output channel to the specified value, or toggles it. The available channels for each io type (`ai|ao|do|di`) can be queried with the io info command.

The `action ... stop|move` parameter stops or performs one of the move commands on the specified axis.

The `action ... setting` parameter adjusts a setting for the specified axis. The setting can be configured to a certain value using the = option, or incremented by a set amount using the += option.

NOTE: No range checking or validity is performed on any of the *value* parameters. It is up to the user to ensure that the provided value is always valid, otherwise the trigger will fail to carry out the desired action under certain conditions.

Example Usage:

Moving to a position

```
/1 trigger 1 action a 1 move rel 10000
@01 0 OK IDLE -- 0
```

When trigger 1 fires, axis 1 of the device will move forward 10000 microsteps as the first action.

Toggle a digital output line

```
/1 trigger 1 action b io do 1 toggle
@01 0 OK IDLE -- 0
```

When trigger 1 fires, the device will toggle the state of digital output 1 as the second action.

Trigger Usage

The following examples demonstrate how to use the various trigger commands to perform actions.

Stopping when a digital input activates

The following commands will stop axis 1 when digital input 1 activates

```
/1 trigger 1 when io di 1 == 1
/1 trigger 1 action a 1 stop
/1 trigger 1 action b 1 stop
```
If the second action is also stop, the device will perform an emergency stop
```
/1 trigger 1 enable
```

Cycling back and forth

The following commands will cycle axis 1 between 0 and 100000 microsteps. The maximum speed is adjusted so that forward travel is twice as fast as backwards travel.

```
/1 trigger 1 when 1 pos == 0
/1 trigger 1 action a 1 move abs 100000
/1 trigger 1 action b 1 maxspeed = 150000
/1 trigger 2 when 1 pos == 100000
/1 trigger 2 action a 1 move abs 0
/1 trigger 2 action b 1 maxspeed = 75000
/1 trigger 1 enable
/1 trigger 2 enable
```

trigger dist

Toggles a digital output channel when the axis travels a certain number of microsteps.

Scope

Device

Parameters

number enable [*count*]
number disable
number axis interval

Once configured and enabled, the distance trigger will toggle a digital output channel every *interval* number of microsteps. The trigger can be set up to fire a certain number of times by specifying the *count* parameter to the enable command, otherwise it will fire until disabled.

The digital output channel that toggles is hard coded for each distance trigger. Trigger 1 on a device toggles output 1, trigger 2 toggles output 2 and so on. The initial state of the channel can be set using the io set command. The distance triggers will conflict with other commands that use the same digital outputs, resulting in the state of the line changing arbitrarily.

Example Usage:

Set up the distance trigger 1 on axis 1 to toggle every 1000 microsteps and enable it.

```
/trigger dist 1 1 1000
@01 0 OK IDLE -- 0
/trigger dist 1 enable
@01 0 OK IDLE -- 0
```

trigger time

Toggles a digital output channel at a certain interval.

Scope
    Device
Parameters
    number enable [*count*]
    number disable
    number interval

Once configured and enabled, the time triggers will toggle the digital outputs every *interval* milliseconds. Each trigger can be set up to fire a certain number of times by specifying the *count* parameter to the enable command, otherwise they will fire until disabled.

The digital output channel is hard coded, where time trigger 1 toggles the last digital output, time trigger 2 toggles the second last output and so on. The initial state of the channel can be set using the io set command. The time triggers will conflict with other commands that use the same digital output, resulting in the state of the line changing arbitrarily.

Example Usage:

Set up time trigger 1 to toggle every 250ms (2Hz output rate) for 60 seconds (60/0.25 = 240 counts) and enable it.

```
/trigger time 1 250
@01 0 OK IDLE -- 0
/trigger time 1 enable 240
@01 0 OK IDLE -- 0
```

warnings

Displays the active warnings for the device and axes.

Scope
    Axis
Parameters
    [clear]

Warnings prints out a 2 digit count of active warnings and then all the active warning flags, as described in Warning Flags above. If this is sent to all axes on a device, the active warnings across all the axes will be displayed, otherwise only the warnings for the specified axis will be displayed.

If the optional parameter `clear` is given, all the clearable warnings are reset.

Example Usage:

Normal response

```
/1 warnings
@01 0 OK IDLE -- 00
```

No warnings are active on the device

Axis warnings

```
/1 2 warnings
@01 2 OK IDLE FS 03 FS WD WR
```

There are 3 warnings active on axis 2, A stall fault, a displacement warning and a invalid reference warning.

Device Settings

The following section covers all device settings that are available in the ASCII protocol, as such some of these settings may not be available for a particular device. To see the available settings, consult the Device Settings section of the product User Manual or the built-in help via: `/1 help get .`

All the settings listed below are used with the get and set commands to read and change their value. All settings that can be modified require an integer value within the valid range. Some of the settings may return dotted decimals or multiple values.

A get command on a setting that applies to an axis where a specific axis number has not been supplied will result in a value being returned for each axis. For example, on a two axis device:

```
/1 get pos
@01 0 OK IDLE -- 10000 15000
```

Similarly, configuring an axis setting without specifying an axis number will result in the value being applied to all axes on the device. For example, on a two axis device:

```
/1 set maxspeed 75000
@01 0 OK IDLE -- 0
/1 get maxspeed
@01 0 OK IDLE -- 75000 75000
```

If the specified value is outside the valid range for any axis, none of the axes will be set and a BADDATA reply will be returned.

Settings labelled Read-Only cannot be configured and will reply with a BADCOMMAND error if the set command is used with them. Configuring a setting with a value outside of its specified range will result in a BADDATA reply.

For the default values of the settings please refer to the Device and Peripheral Pages.

accel

Determines the acceleration and deceleration used when changing speed.

Scope: Axis.
Valid Range: 0 - 32767.
Access Level: norm.

When a movement command is issued, the axis will increase and decrease its speed at a rate determined by this setting. The actual acceleration is calculated as `accel`*10000/1.6384 microsteps/sec^2. A value of 0 specifies infinite acceleration.

To modify only the acceleration or deceleration see the motion.accelonly and motion.decelonly settings. When queried, this setting returns the value of the acceleration setting, regardless of the deceleration setting.

cloop.counts

The number of encoder counts for a full revolution.

Scope: Axis.
Valid Range: 1 - 65535.
Access Level: adv.

Specifies the number of encoder counts used for the closed loop mode encoder count to motor step ratio.

This number is typically 4x the encoder lines per revolution.

cloop.mode

The closed loop control mode.

Scope: Axis.
Valid Range: 0 - 5.
Access Level: norm.

Valid settings are:

- 0 - Disabled.
  Encoder input is ignored and the axis behaves as a open-loop device.
- 1 - Passive Mode.
  Slip conditions are detected and cause the blue LED to blink, but no position correction is made nor is a warning flag set.
- 2 - Stall Detection.
  Same as passive mode but the axis will also detect and report stall conditions.
  If a stall condition is detected the axis will stop after a stall timeout
- 3 - Position Correction (Default).
  Axis detects, reports and recovers from slip conditions. Stall conditions are detected and reported.
- 4 - Stall Recovery.
  Same as Position Correction, however if stalling is detected, the axis will stop and resume after a stall timeout.
- 5 - Displace Recovery
  Same as Stall Recovery, however if a stationary axis is forced out of position, the axis will restore to the original location after a timeout.

Closed loop mode can be enabled on devices with built-in encoder.

To use closed loop modes with a third party encoder, enable encoder.mode and configure all encoder related settings. Set encoder.dir so that encoder.count increments in the same direction as pos. Adjust cloop.steps and cloop.counts to reflect the correct ratio between motor full steps and encoder counts.

cloop.stalltimeout

Stall recovery time out.

Scope: Axis.
Valid Range: 0 - 65535.
Access Level: norm.

Specifies, in milliseconds, the amount of time to wait after a stall/displacement condition before attempting to recover from it for closed loop modes.

cloop.steps

Steps per revolution

Scope: Axis.
Valid Range: 1 - 255.
Access Level: adv.

Specifies the number of stepper motor full steps used for the closed loop mode encoder count to motor step ratio.

This value is typically the number of full steps required for the motor to complete one revolution.

comm.address

The device address.

Scope: Device.
Valid Range: 1 - 99.
Access Level: norm.

The device will change its address and then respond when being set, e.g.:

```
/01 set comm.address 5
@05 0 OK IDLE -- 0
```

comm.alert

Alert Messages.

Scope: Device.
Valid Range: 0 - 1.
Access Level: norm.

The device sends Alert messages when this setting is 1.

comm.checksum

Send message checksums.

Scope: Device.
Valid Range: 0 - 1.

Access Level: norm.

The device includes checksums in its messages if this setting is 1.

comm.protocol

The communications protocol used by the device on the current interface.

Scope: Device.
Valid Range: Refer to the protocol setting for the current interface.
Access Level: norm.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies in the current protocol. Once all the communications interfaces are idle, the device switches to the new protocol and clears the Setting Update Pending (NU) flag.

comm.rs232.baud

The baud rate used by RS232 Prev and Next interfaces.

Scope: Device.
Valid Range: 9600 - 115200.
Access Level: norm.

Valid Settings:

- 9600
- 19200
- 38400
- 57600
- 115200.

All other serial parameters are 8 bits, 1 stop bit, No parity and no flow control.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies in the current baud rate. Once all the communications interfaces are idle, the device switches to the new baud rate and clears the Setting Update Pending (NU) flag.

To set RS232 baud rate and protocol at the same time, use the tools setcomm command.

comm.rs232.protocol

The communications protocol used by the device on the RS232 Prev and Next interfaces.

Scope: Device.
Valid Range: See below.
Access Level: norm.

Valid settings are:

- 1 - Binary Only.
  Legacy T-Series binary protocol only.
- 2 - ASCII Only.
  A-Series ASCII protocol only.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies over the current interface. Once all the communications interfaces are idle, the device switches to the protocol on the specified interface and clears the Setting Update Pending (NU) flag.

comm.rs485.baud

The baud rate used by RS485 interface.

Scope: Device.
Valid Range: 1200 - 115200.
Access Level: advanced.

Valid Settings:

- 1200
- 4800
- 9600
- 19200
- 38400
- 57600
- 115200

All other serial parameters are 8 bits, 1 stop bit, No parity and no flow control.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies in the current baud rate. Once all the communications interfaces are idle, the device switches to the new baud rate and clears the Setting Update Pending (NU) flag.

comm.rs485.enable

Enables the RS485 interface.

Scope: Device.
Valid Range: 0 - 1.
Access Level: advanced.

Setting to 1 enables the RS485 interface. If a lower priority interface is currently in use the device will respond on the current interface and then switch to the RS485 interface, disabling the lower priority interface. For the supported interfaces and their priorities, please consult the User Manual for your device.

When writing to this setting and the current interface is a lower priority then RS485, the device raises the Setting Update Pending (NU) notification flag and replies on the current interface. Once all the communications interfaces are idle, the device switches to the new interface and clears the Setting Update Pending (NU) flag.

comm.rs485.protocol

The communications protocol used by the device on the RS485 interface.

Scope: Device.
Valid Range: See below.
Access Level: advanced.

Valid settings are:

- 2 - ASCII Only.
  A-Series ASCII protocol only.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies over the current interface. Once all the communications interfaces are idle, the device switches to the protocol on the specified interface and clears the Setting Update Pending (NU) flag.

comm.usb.protocol

The communications protocol used by the device on the USB interface.

Scope: Device.
Valid Range: See below.
Access Level: norm.

Valid settings are:

- 1 - Binary Only.
  Legacy T-Series binary protocol only.
- 2 - ASCII Only.
  A-Series ASCII protocol only.

When writing to this setting, the device raises the Setting Update Pending (NU) notification flag and replies over the current interface. Once all the communications interfaces are idle, the device switches to the protocol on the specified interface and clears the Setting Update Pending (NU) flag.

deviceid

The device id for the unit.

Scope: Device.
Valid Range: Any value defined at Zaber Support - Device IDs.
Access Level: norm, Read Only.

The id specifying the model of the Zaber device. Each device and its associated id number is listed at Zaber Support - Device IDs.

driver.current.hold

Current used to hold the motor in position.

Scope: Axis.
Valid Range: 0 - 100.
Access Level: norm.

The hold current is applied when the axis is not in motion. The value of this settings is a percentage of the maximum drive current of the axis (2.5A typically for A-Series devices).

driver.current.run

Current used to drive the motor.

Scope: Axis.
Valid Range: 0 - 100.
Access Level: norm.

The value of this setting is a percentage of the maximum drive current of the axis (2.5A typically for A-Series devices).

driver.dir

The direction of motor driver output.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Inverts the output direction of the motor driver.

driver.temperature

The current temperature of driver, in degrees Celsius.

Scope: Axis.
Valid Range: 0 - 150.
Access Level: norm, Read-Only.

Example:

```
/1 1 get driver.temperature
@01 1 OK IDLE -- 53.5
```

The driver is currently at 53.5°C.

encoder.count

The position as reported by the axis encoder.

Scope: Axis.
Valid Range: -214783648 - 214783647.
Access Level: norm, Read-Only; adv, Read-Write.

The encoder count, where present. Units are arbitrary and dependent on the encoder used.

encoder.dir

The direction of encoder count.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Inverts the counting direction for the axis encoder.

encoder.filter

Enable and set up digital filtering of the encoder inputs.

Scope: Axis.
Valid Range: 0, 1, 2, 4, 16, 32, 64, 128, 256.
Access Level: adv.

A value of 0 disables filtering and any other value proportionally rejects noises while reducing the maximum speed the encoder can update at.

encoder.index.count

The recorded counts of the axis encoder index pulse.

Scope: Axis.
Valid Range: -32768 - 32767.
Access Level: norm, Read-Only; adv, Read-Write.

For encoders that support an index pulse, this setting tracks the number of index pulses received.

encoder.index.mode

Specifies the operating mode of the encoder index pulse.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Valid settings are:

- 0 - Disabled.
  No encoder index is present.
- 1 - Normal.
  Encoder index pulses are counted.

encoder.index.phase

Specifies the value of the encoder phase for a valid index pulse.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

When this setting is 0, the encoder index line needs to go high when both the encoder phase lines are low for the index pulse to be counted.

When this setting is 1, the encoder index line needs to go high when both the encoder phase lines are high for the index pulse to be counted.

encoder.mode

Specifies the operating mode of the encoder.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Valid settings are:

- 0 - Disabled.
  No encoder is present.
- 1 - Normal.
  The encoder input is enabled.

knob.dir

Knob movement direction.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: norm.

Sets the movement direction for the knob. 0 and the device moves in a positive direction for clockwise rotation. 1 reverses the direction.

knob.distance

The distance moved via the knob.

Scope: Axis.
Valid Range: 0 - limit.max.
Access Level: norm.

Sets how far the axis moves with each step of the knob in displacement mode, in microsteps.

knob.enable

Enables the knob.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: norm.

Enables the use of the knob when set to 1.

knob.maxspeed

The maximum speed that can be achieved with the knob in velocity mode..

Scope: Axis.
Valid Range: 1 - resolution*16384.
Access Level: norm.

When in velocity mode, the axis will move up to a maximum speed determined by this setting. The actual speed is calculated as `knob.maxspeed`/1.6384 microsteps/sec.

knob.mode

Sets the mode of the knob.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: norm.

Valid Settings:

- 0 - Velocity mode.
  The knob controls the velocity of the axis, varying for the amount turned.
  Velocity mode is defined by knob.speedprofile and knob.maxspeed setting.
- 1 - Displacement mode.
  Each step of the knob moves the axis a specific distance, as indicated by the knob.distance setting.

knob.speedprofile

Velocity increment profile.

Scope: Axis.
Valid Range: 1 - 3.
Access Level: norm.

Sets the profile to be used per increment when in velocity mode. Valid settings are:

- 1 - Linear
- 2 - Quadratic
- 3 - Cubic

limit.approach.maxspeed

The maximum speed to be used when approaching a limit sensor.

Scope: Axis.
Valid Range: 1 - resolution*16384.
Access Level: adv.

When approaching a limit sensor, the axis will travel at the lesser of limit.approach.maxspeed and maxspeed. The actual speed is calculated as `maxspeed`/1.6384 microsteps/sec.

limit.detect.decelonly

The deceleration to be used when a limit sensor has been triggered.

Scope: Axis.
Valid Range: 0 - 32767.
Access Level: adv.

When a limit sensor is triggered, the axis will slow down to a stop at the rate specified. The actual deceleration is calculated as `decel`*10000/1.6384 microsteps/sec^2. A value of 0 specifies infinite acceleration.

limit.detect.maxspeed

The maximum speed to be used when moving away from a limit sensor.

Scope: Axis.
Valid Range: 1 - resolution*16384.
Access Level: adv.

When a limit sensor is triggered, the axis will move away from the sensor at the speed specified.. The actual speed is calculated as `maxspeed`/1.6384 microsteps/sec.

limit.swapinputs

Reverses the home and away sensor inputs.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Setting to 1 swaps the home and away input pins.

limit.*sensor*.action

Automatic limit switch action.

Scope: Axis.
Valid Range: 0 - 2.
Access Level: adv.

Specifies the automatic limit sensor action to be performed when *sensor* becomes active during axis movement. The sensor is one of home, away, c or d. Valid setting are:

- 0 - Disabled.
  No action is performed when this sensor is triggered.
- 1 - Retract.
  Retract to the side of the sensor specified in limit.*sensor*.edge.
- 2 - Retract and update current position.
  In addition to above, the value of limit.*sensor*.preset is written to pos. The No Reference Position (WR) warning flag is cleared.

Sensor is active when limit.*sensor*.state is 1.

If an automatic limit sensor action is triggered and limit.*sensor*.triggered is 1, the Unexpected Limit Trigger (WL) warning flag is set.

limit.*sensor*.edge

Specifies the side of the sensor for alignment during limit actions.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv.

Specifies the side of the sensor to align with when the *sensor* is triggered. The sensor is one of home, away, c or d.

A value of 0 aligns the axis with the positive side of the sensor, a value of 1 aligns with the negative side of the sensor.

The positive and negative directions follow the orientation of the axis position.

limit.*sensor*.pos

The updated position of the sensor.

Scope: Axis.
Valid Range: -1000000000 - 1000000000.
Access Level: adv.

Can be updated to the current position of the sensor, depending on the setting of limit.*sensor*.posupdate. The sensor is one of home, away, c or d.

The settings limit.home.pos and limit.away.pos have alternative names of limit.min and limit.max, respectively. These two settings represent the boundary of pos and determine the valid travel range of the axis.

limit.*sensor*.posupdate

Specifies how to update the sensor position after an automatic limit switch action.

Scope: Axis.
Valid Range: 0 - 2.
Access Level: adv.

Specifies whether to update the sensor position setting after an automatic limit switch action. The sensor is one of home, away, c or d. Valid setting are:

- 0 - Disabled.
  The sensor position is not updated.
- 1 - Set to current.
  The current position (pos) is written to limit.*sensor*.pos for this session only.
- 2 - Set to current and save.
  The current position (pos) is written to limit.*sensor*.pos. The value of limit.*sensor*.pos is saved to non-volatile memory and persists over power cycle.

The sensor position is updated after the automatic limit sensor action has been carried out. This setting has no effect if automatic limit sensor action is disabled (limit.*sensor*.action is `0 (Disabled)`).

If sensor is one of home or away, this mechanism affects the valid travel range of the axis. See limit.min and limit.max.

limit.*sensor*.preset

The default position of the sensor.

Scope: Axis.
Valid Range: -1000000000 - 1000000000.
Access Level: adv.

Specifies the default position of the sensor, which can be used to update the current position, depending on the limit.*sensor*.action setting. The sensor is one of home, away, c or d.

limit.*sensor*.state

The current state of the sensor.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv, Read-Only.

This setting is 1 when the sensor is active, and 0 otherwise. The sensor is one of home, away, c or d.

If limit.*sensor*.type is `0 (Disabled)`, this setting is always 0.

limit.*sensor*.triggered

Whether the sensor has been triggered previously.

Scope: Axis.
Valid Range: 0 - 1.
Access Level: adv, Read-Only.

This setting is set to 0 at start up. The setting is set to 1 after a limit sensor command such as home, or an automatic limit sensor action. The sensor is one of home, away, c or d.

If an automatic limit sensor action is triggered and this setting is 1, the Unexpected Limit Trigger (WL) warning flag is set.

limit.*sensor*.type

The type of connected sensor.

Scope: Axis.
Valid Range: 0 - 2.
Access Level: adv.

Specifies the type of connected sensor. The sensor is one of home, away, c or d. Valid settings are:

- 0 - Disabled:
  No sensor is connected.
- 1 - Active Low:
  When active, the sensor outputs a logic low.
- 2 - Active High:
  When active, the sensor outputs a logic high.

limit.max

The maximum position of the device, in microsteps.

Scope: Axis.
Valid Range: -1000000000 - 1000000000.

Access Level: norm.

Use this setting to limit the range of travel to a value other than the default. This setting is an alternative name for the limit.away.pos setting.

NOTE: Exercise caution when modifying this setting, since it is possible to set the range to a value greater than the physical limits of the axis.

limit.min

The minimum position the device can move to, measured in microsteps.

Scope: Axis.
Valid Range: -1000000000 - 1000000000.
Access Level: norm.

The range of travel (limit.max - limit.min) is axis dependent. This setting is an alternative name for the limit.home.pos setting.

NOTE: Exercise caution when modifying this setting, since it is possible to set the range to a value greater than the physical limits of the axis.

maxspeed

The maximum speed the axis moves at.

Scope: Axis.
Valid Range: 1 - resolution*16384.
Access Level: norm.

When a movement command is issued, the axis will move at a speed determined by this setting. The actual speed is calculated as `speed`/1.6384 microsteps/sec.

motion.accelonly

Determines the acceleration used when increasing the speed.

Scope: Axis.
Valid Range: 0 - 32767.
Access Level: norm.

When a movement command is issued, the axis will accelerate up to the maximum speed at a rate determined by this setting. The actual acceleration is calculated as `accel`*10000/1.6384 microsteps/sec^2. A value of 0 specifies infinite acceleration.

motion.decelonly

Sets the deceleration used when slowing down.

Scope: Axis.
Valid Range: 0 - 32767.
Access Level: norm.

When a movement command is issued, the axis will decelerate at a rate determined by this setting. The actual deceleration is calculated as `decel`*10000/1.6384 microsteps/sec^2. A value of 0 specifies infinite acceleration.

peripheralid

The ID of the Zaber peripheral connected to a controller.

Scope: Axis.
Valid Range: Any of the values listed at Zaber Support - Peripheral IDs or 0.
Access Level: norm.

All Zaber peripheral IDs are specified at Zaber Support - Peripheral IDs.

pos

The current absolute position of the axis, in microsteps.

Scope: Axis.
Valid Range: limit.min - limit.max
Access Level: norm.

NOTE: Changing the value of this setting could result in the axis attempting to drive past its physical limits.

resolution

Microstep resolution.

Scope: Axis.
Valid Range: 1 - 256.
Access Level: norm.

Defines the number of microsteps per step of the motor. A typical A-Series motorized axis has 200 steps per revolution and a default microstep resolution of 64, therefore it takes 12800 microsteps to make one full revolution of the motor. For the parameters for a specific device, please refer to the device specific product page at http://www.zaber.com/products.

NOTE: When the resolution is updated, the `motion.accelonly`, `motion.decelonly`, `limit.min`, `limit.max`, `limit.`*n*`.pos`, `limit.`*n*`.preset`, `knob.maxspeed`, `knob.distance`, and `maxspeed` settings are updated according to their **default** values and not their current values. After changing this setting, the axis should be homed before any movement is performed.

stream.numbufs

Number of stream buffers.

Scope: Device.
Valid Range: 0 - 4.
Access Level: norm.

Reports the number of stream buffers provided on the device.

stream.numstreams

Number of streams.

Scope: Device.
Valid Range: 0 - 1.
Access Level: norm.

Reports the number of streams provided on the device.

system.access

Specifies the access level of the user.

Scope: Device.
Valid Range: 1 - 2.
Access Level: norm

Some commands require an access level of 'advanced' as they can potentially cause damage to the device and stage. To use those commands and setting, system.access has to be set to access level 2.

system.axiscount

Reports the number of axes in the device.

Scope: Device.
Valid Range: 1 - 2.
Access Level: norm, Read Only

This setting reports the number of axes in the queried device.

system.current

The current being drawn by the device and motors.

Scope: Device.
Valid Range: 0 - 5.
Access Level: norm, Read-Only.

system.led.enable

Enables and disables the indicator LEDs.

Scope: Device.
Valid Range: 0 - 1.
Access Level: norm.

Setting to 0 disables all front panel LEDs on the device.

system.temperature

The current temperature of the unit, in degrees Celsius.

Scope: Device.
Valid Range: 0 - 150.
Access Level: norm, Read-Only.

Example:

```
/get system.temperature
@01 0 OK IDLE -- 26.8
```
The device is currently at 26.8°C.

system.voltage

The voltage being applied to the device.

Scope: Device.
Valid Range: 10 - 50.
Access Level: norm, Read-Only.

Example:

```
/get system.voltage
@01 0 OK IDLE -- 47.1
```
The device is currently receiving 47.1V from the supply.

version

The firmware version of the device.

Scope: Device.
Valid Range: 6.0 - 6.99
Access Level: norm, Read-Only.

Example usage:

```
/get version
```

```
@01 0 OK IDLE -- 6.06
```

Message IDs

There are some cases where you may want to match responses with a particular command, or may not want a device to respond to certain commands. Message IDs are available to help accomplish this.

In addition to the standard command format, the ASCII protocol also permits a variation of the format where a message ID is included in a command. Whenever a command with a message ID is sent, all responses generated by that command also include the same message ID. This applies to reply responses and info messages (alerts never include a message ID because they are not sent in direct response to a command).

If a message ID is included in a command, it must follow the device address and axis number but precede the command. Both the device number and axis number must be explicit if a message ID is included. The valid range of message IDs is 0 to 99. The message ID in the response will be 2 digits, and will also follow the device address and axis number, and precede the reply flag of a reply or the data of an info message.

Example Usage:

Including a message ID:

```
/2 1 8 move rel 10000
@02 1 08 OK IDLE -- 0
```

A message ID of 8 is specified in the above command to axis 1 of device 2.

Sending a command to all devices and axes with a message ID:

```
/0 0 25 stop
@01 1 25 OK BUSY -- 0
@01 2 25 OK IDLE -- 0
@02 1 25 OK BUSY -- 0
```

To include a message ID while sending a broadcast command, you can use 0 for the device address and axis number

Using message IDs to request no responses are sent for a command:

```
/1 1 -- set maxspeed 200000
```

You can use -- for the message ID in order to instruct devices not to send any responses to a command.

Checksumming

The Longitudinal Redundancy Check (LRC) is employed. This allows corrupted message detection but does not provide error correction.

Devices will verify a message checksum if it appears in the message. Devices will only send checksums if the `comm.checksum` variable is set to 1.

- A device will verify the checksum if the 3rd last character of a command (excluding footers) is a colon.
- The colon is a reserved character for checksum indication and should not appear in the message data.
- The checksum is repesented as 2 hexadecimal characters, which are case insensitive.
- The checksum is calculated from the first byte after the message type. The leading `/@!#` of the message is ignored.

If the checksum is invalid, the device will ignore the message and flash the yellow LED(s) until the next command is received.

For example if the message is:

```
01 tools echo
```

the checksum is:

```
((48 + 49 + 32 + 116 + 111 + 111 + 108 + 115 + 32 + 101 + 99 + 104 + 111)
^ 0xFF) + 1 = ((1137 & 0xFF) ^ 0xFF) + 1 = 143 = 0x8F
```

and the final message is:

```
/01 tools echo:8F\r\n
```

Verification

To verify a message checksum the 8-bit sum of all the bytes in the message is calculated and added to the transmitted checksum, which has been converted to an integer. The message is valid when the 8-bit result of the sum is zero. The colon in the message is only used as a seperator and is otherwise ignored. Using the example above:

```
(1137 + 0x8F) & 0xFF = 0
```

Example Code

The following examples show how to calculate a message checksum and verify a received message in several languages.

C

Calculating a checksum

```
#define CSUM_NOTPRESENT (-2)
#define CSUM_NOSPACE    (-1)
#define CSUM_FAIL       (0)
#define CSUM_OK         (1)

int csum_message(char *message, unsigned int max_length)
{
        unsigned char c_sum = 0;
        char *p = message+1;                            //skip the type character

        if(strlen(message) + 6 < max_length)            //is there room for the checksum?
        {
                while(*p != 0x00)
                {
                        c_sum += (unsigned char)*p++;   //calculate the checksum
                }
                c_sum = ~c_sum + 1;                     //negate

                //add the checksum to the message
                sprintf(p, ":%02X\r\n", c_sum);
                return CSUM_OK;
        }
        return CSUM_NOSPACE;
}
```

Verifying a received message

```
int csum_verify(char *message)
{
        unsigned char c_sum = 0;
        char *p = message+1;                            //skip the type character

        while(*p != 0x00)
        {
                c_sum += (unsigned char)*p++;           //calculate the sum

                if(*p == ':')                           //found the checksum field, process
                {
                        c_sum += strtol(++p, NULL, 16); //convert the sent checksum
                        return((c_sum == 0) ? CSUM_OK : CSUM_FAIL);
                }
        }
        return CSUM_NOTPRESENT;
}
```

Python

Calculating a message checksum

```
def csum_message(msg):
    c_sum = 0
    for c in msg[1:]:
        c_sum += ord(c)                     #calculate the sum of the message to be transmitted
    c_sum = 256 - (c_sum & 0xFF)            #take the ones compliment (negate)
    return '%s:%02X\r\n' % (msg, c_sum)     #return the full message
```

Verifying a received message

```
def csum_verify(msg):
```

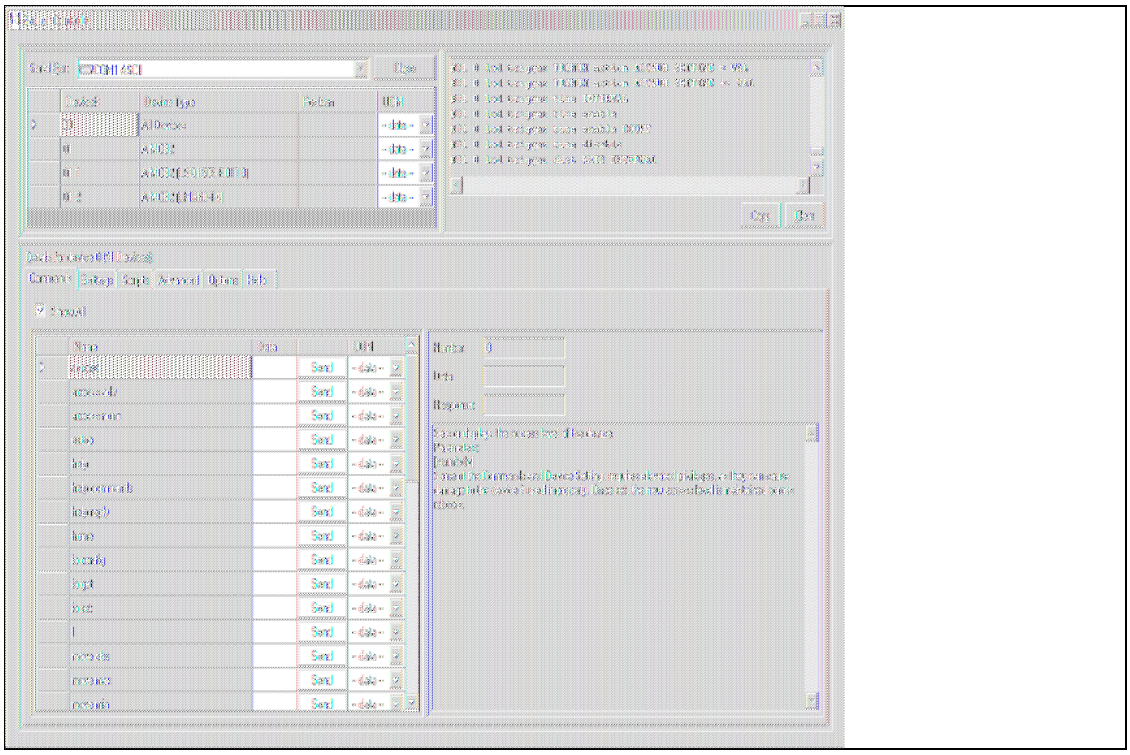
```
c_sum = 0
if msg.find(':') < 0:
    return None                          #return nothing if the checksum isn't present

x_msg, x_sum = msg.split(':', 1)         #seperate out the message and checksum

for c in x_msg[1:]:
    c_sum += ord(c)                      #recalculate the sum of the received message
c_sum = (c_sum + int(x_sum, 16)) & 0xFF  #add in the received checksum and truncate to a 8-bi

return (c_sum == 0)                      #return true if the message passed checksum verifica
```

Appendix A - Communication Software

Zaber Console

Zaber Console is the recommended application for controlling Zaber devices on Windows systems.

1. Download the Zaber Console and install it.
2. Launch Zaber Console
3. Select the serial port and protocol from the list and click Open
4. Zaber Console will automatically find and list the devices in the chain, as shown below.

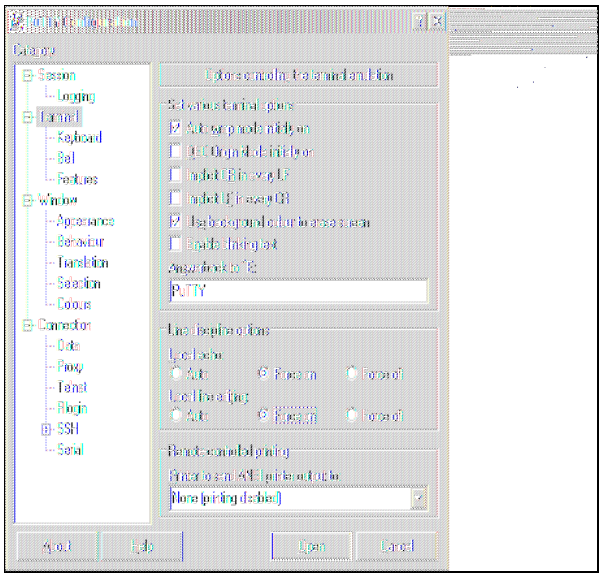


◊ Using the Advanced tab, text commands can be sent to the device(s)

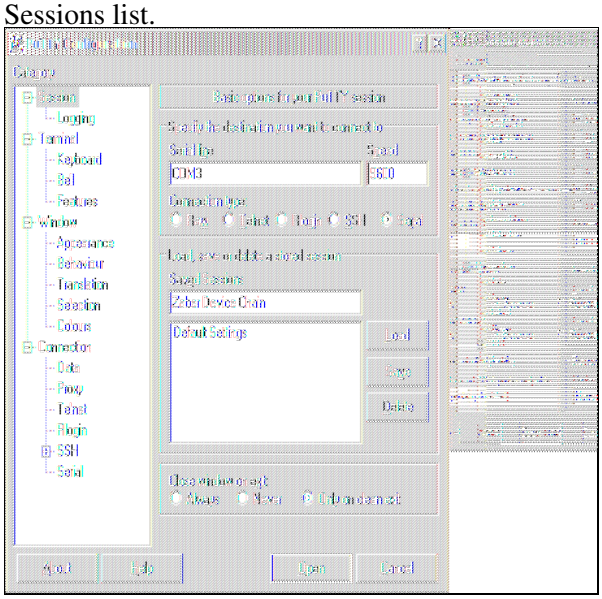
PuTTY

PuTTY, a terminal emulator, can be used to control Zaber devices in ASCII mode on Windows.

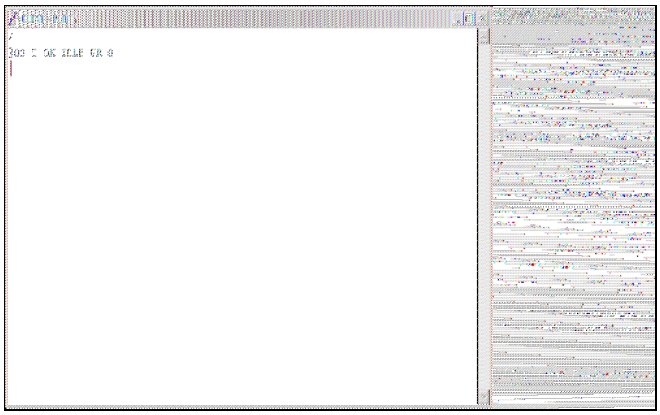
1. Download putty-0.62-installer.exe from http://www.chiark.greenend.org.uk/~sgtatham/putty/download.html and install it
2. Launch PuTTY
3. Under the Terminal category:
   - ♦ Set Local echo to Force on
   - ♦ Set Local line editing to Force on



4. Under the Session category
    - Set the connection type to Serial
    - Set the speed to 9600
    - Enter the COM port the device(s) are connected to. Typically COM1 if directly connected to a computer, COM3 if using a USB adapter.
    - Enter a connection description, Zaber Device Chain in this example, and click save. Next time the connection can be opened by double-clicking on 'Zaber Device Chain' in the Saved Sessions list.



5. Click Open. A window similar to the one shown below will appear. Send a command, in this case `/`, and press enter. The device should respond as shown below.

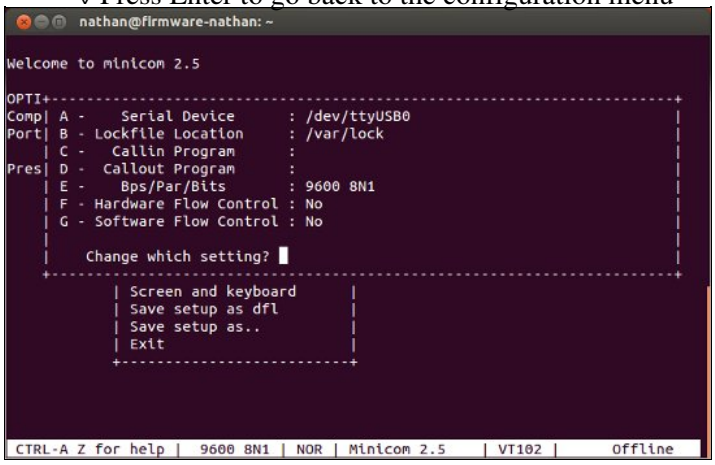


◊ Send a test command to check the connection. In this case `/help` was sent and data was received.

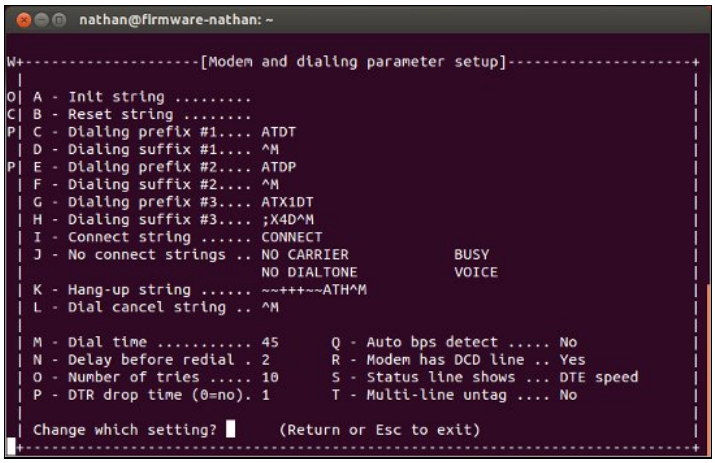
Minicom

Minicom is the recomended application for controling Zaber devices in ASCII mode on Linux.

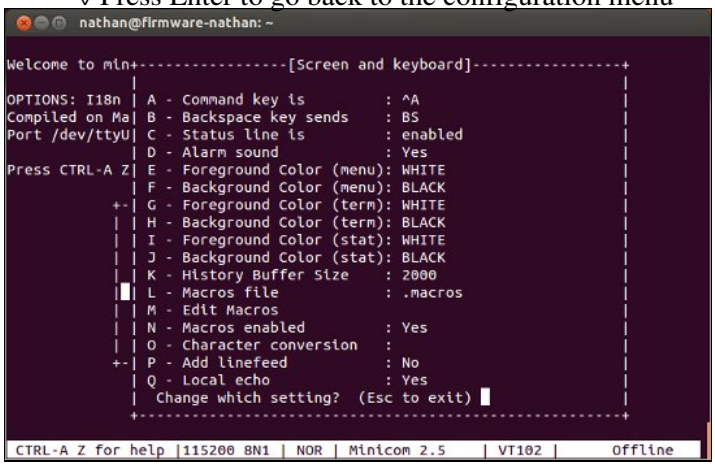
1. Install Minicom using your distributions package manager, e.g. for Debian and Ubuntu:
   ```
   sudo apt-get install minicom
   ```
2. Run Minicom from a terminal
3. Press Ctrl-A then O to open the options menu
   - ♦ Select Serial port setup
     - ◊ Set the serial device (A) to the correct device
     - ◊ Set the baud rate (E) to 9600
     - ◊ Disable hardware and software flow control (F, G)
     - ◊ Press Enter to go back to the configuration menu



   - ♦ Select Modem and dialing
     - ◊ Clear out the Init and Reset strings (option A, B)
     - ◊ Press Enter to go back to the configuration menu

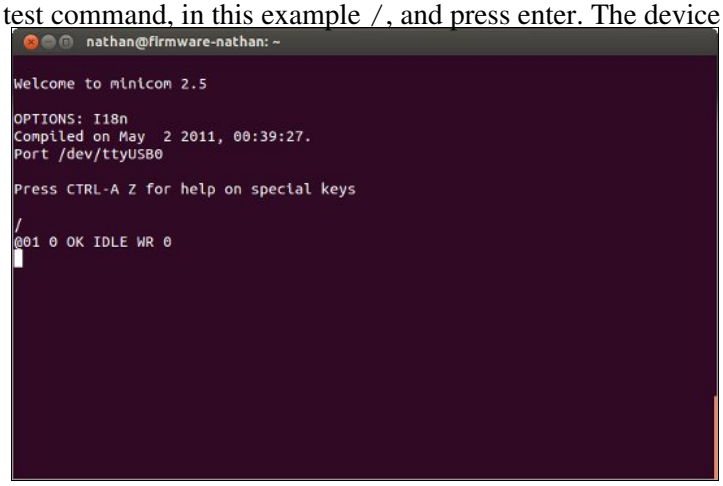


- Select Screen and keyboard
  - ◊ Set Local echo (Q) to Yes
  - ◊ Press Enter to go back to the configuration menu



- Save the setup as default
- Exit

4. Type a test command, in this example /, and press enter. The device should respond as shown below.



5. Minicom can be exited by pressing Ctrl-A then X.

Troubleshooting

- If no data is received from the device(s) check the following:

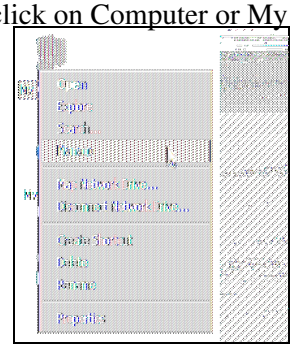
- The correct serial port and baud rate are being used. Refer to the device specific User Manual for the correct settings.
- The devices are powered on. Each device should have a green light on the front panel.
- The devices are connected to the computer correctly.

Appendix B - Available Serial Ports

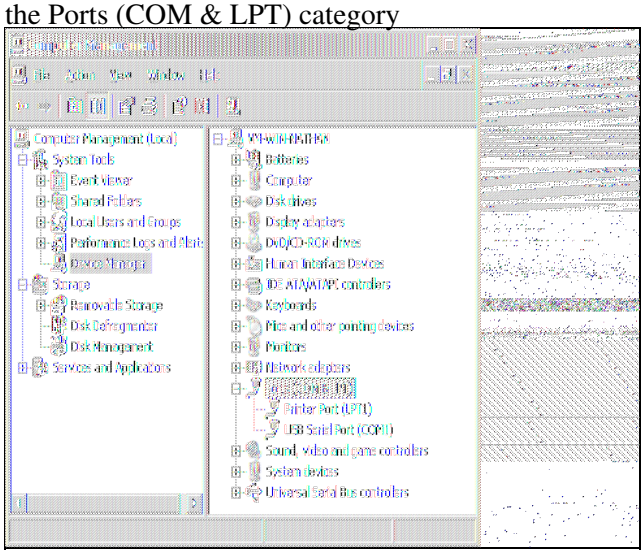
Finding Installed Serial Ports

Windows

1. Right click on Computer or My Computer and select Manage.



2. Select Device Manager from the Computer Management list
3. Expand the Ports (COM & LPT) category



- In this example there is one serial port installed (COM1), which is a USB adaptor.

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.

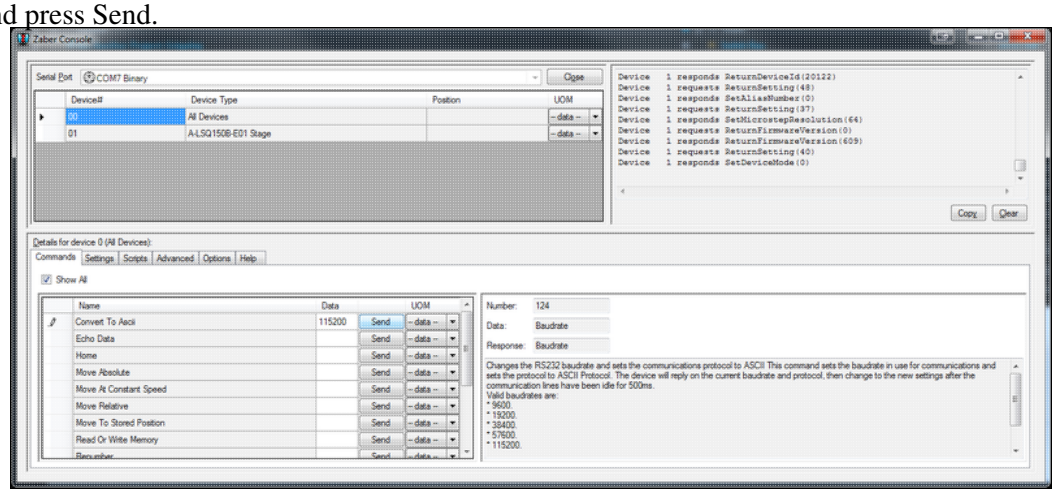
Appendix C - Switching between Binary and ASCII Protocols

If your device has firmware 6.06 or higher, it can be set to use either the Binary command protocol or the ASCII command protocol. By default, all devices will start with the Binary protocol except the A-MCB2, which starts with the ASCII protocol. We suggest using our Zaber Console software to configure which protocol you would like to use, although the commands to configure will be available to any software.

Binary to ASCII

In order to change your device from Binary to ASCII, follow these steps:

1. Open Zaber Console.
2. Select the Binary version of the COM port the device is connected to from the Serial Port dropdown and press Open.
3. Highlight the device you would like to change from the Device list.
4. Under the commands tab, select the Show All checkbox.
5. You should see the command Convert To Ascii (cmd 124). Enter a value of 115200 into the Data field and press Send.

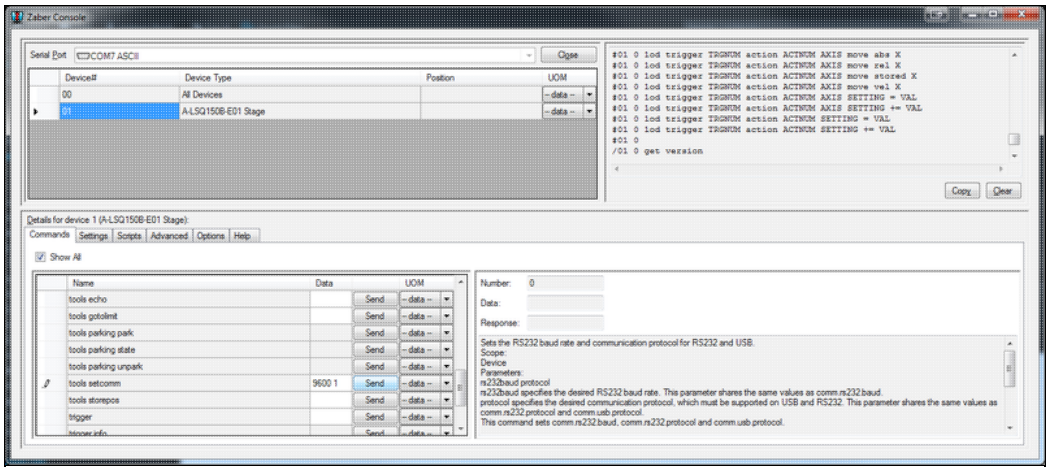


6. Close the Serial Port, change to the ASCII version of the COM port the device is connected to, and press Open.
7. Confirm that the device is visible.

ASCII to Binary

In order to change your device from ASCII to Binary, follow these steps:

1. Open Zaber Console.
2. Select the ASCII version of the COM port the device is connected to from the Serial Port dropdown and press Open.
3. Highlight the device you would like to change from the Device list.
4. Under the commands tab, select the Show All checkbox.
5. You should see the command 'tools setcomm'. Enter a value of '9600 1' into the Data field and press Send.



6. Close the Serial Port, change to the Binary version of the COM port the device is connected to, and press Open.
7. Confirm that the device is visible.

Resetting to Default Protocol

If something happened when attempting the above that results in the device showing up in neither of the ASCII or Binary port options in Zaber Console, you can reset the device to use the default by following these steps:

1. Unplug the power supply of the device
2. Push the manual knob and hold it in
3. Plug in the power supply again while continuing to hold the knob in
4. Keep holding the knob in until the Blue LED is lit (~5 seconds), then release the knob.

If you're still unable to see the device, contact Zaber's technical support.