EZO-PMP-L™

Large Embedded Dosing Pump

Flow rate	**10ml to 750ml/min**
Accuracy	**+/- 2%, +/-2ml**
Modes of operation	**Continuous dispensing** **Volume dispensing** **Dose over time** **Constant flow rate** **Dispense at startup**
Connector	**5 lead data cable**
Calibration	**Single point**
Tubing size	**Any 8mm O.D. tubing**
Data protocol	**UART & I²C**
Default I²C address	**109 (0x6D)**
Operating voltage	**3.3V – 5V (logic)** **24V (motor)**
Pump head	**10.3 meters (34')**
Data format	**ASCII**
Food safe	**Yes**

RoHS COMPLIANT

This is an evolving document, check back for updates.

Table of contents

UART

I²C

Attention

The EZO-PMP-L Embedded Dosing Pump requires two power supplies to operate.

24V
to drive the motor
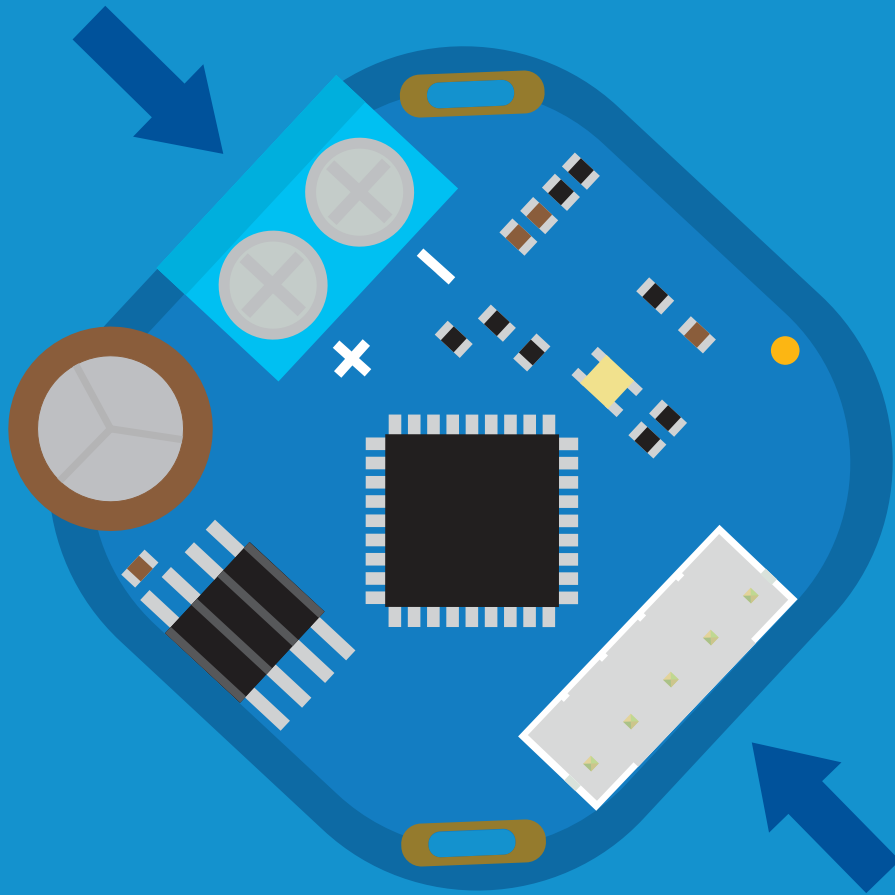
Control system
(Back side of dosing pump)

3.3V – 5.5V
for the control system

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EZO-PMP-L™ dimensions
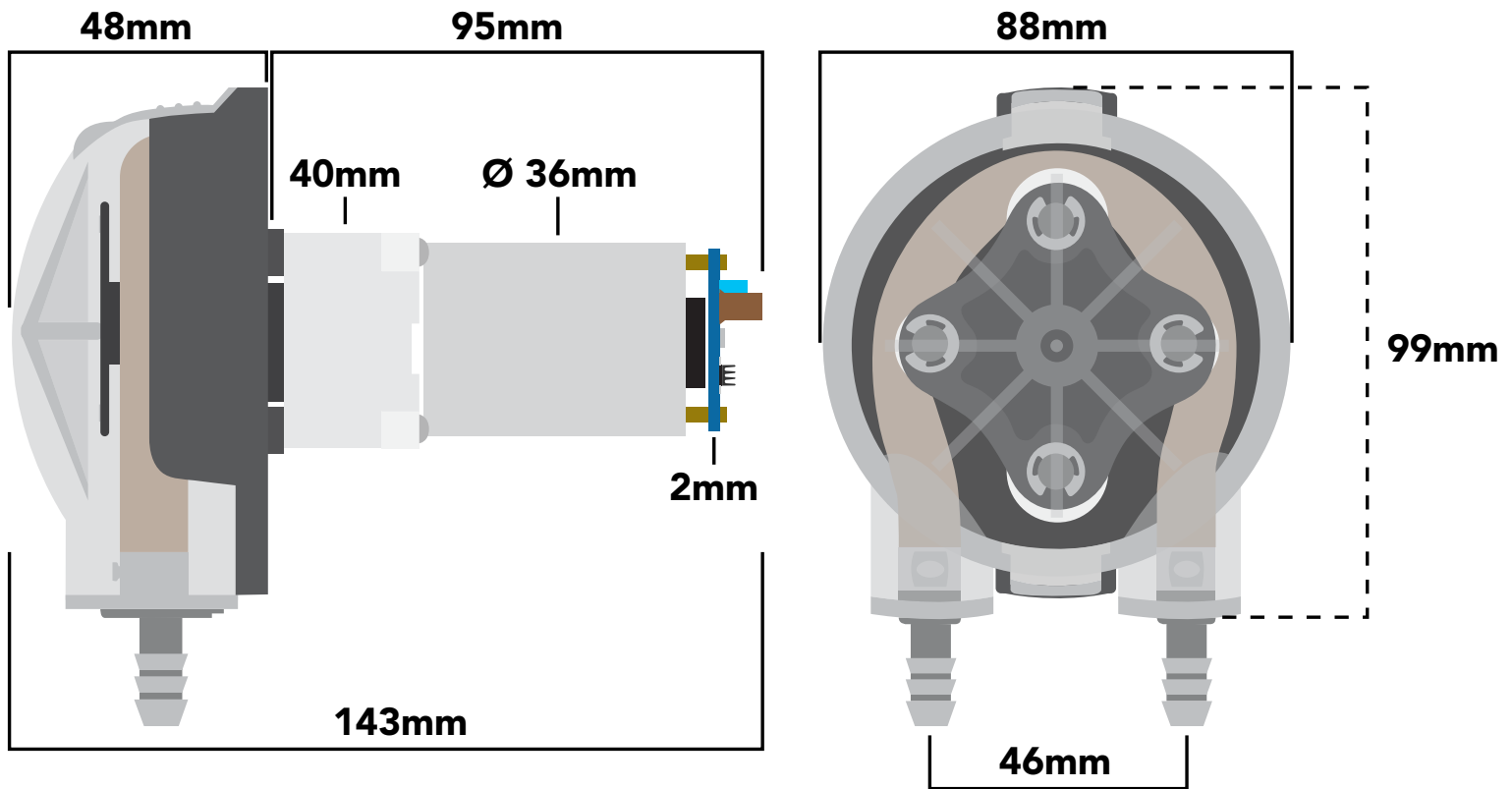
Weight 405g

Power consumption

	LED	MAX	STANDBY	SLEEP
5V	ON	13.7 mA	13.4 mA	0.415 mA
	OFF	13.1 mA	12.8 mA	
3.3V	ON	12.5 mA	12.4 mA	0.13 mA
	OFF	12.3 mA	12.2 mA	
Motor	24V = ~700mA			

Tubing life span	+1,000 hrs.
Cassette life span	1,500 hrs.
Motor life span	5,000 hrs.

Absolute max ratings

Parameter	MIN	TYP	MAX
Storage temperature (EZO-PMP-L™)	-65 °C		125 °C
Operational temperature (EZO-PMP-L™)	-40 °C	25 °C	85 °C
VCC	3.3V	5V	5.5V
Motor	17V	24V	26V
Max input / output pressure			101.3 kPa

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EZO-PMP-L™ tubing
NSF/ANSI 51 Compliant

Tan tubing
Saint-Gobain™ PharMed™ BPT tubing
Length: 15.24cm
Outer diameter: 10mm
Inner diameter: 8mm

This tubing is highly chemically resistant and has 30X more resistant to mechanical wear than silicone tubing.

Food safe ✔

Hose barb fitting
ETFE
Length: 2.1cm
Outer diameter: 10mm
Inner diameter: 4.4mm

Food safe ✔

Blue tubing
Silicone
Length: 2x 30.48cm
Outer diameter: 8mm
Inner diameter: 6mm
Bend radius: 24mm
Temperature -67°C to 200°C
Max pressure: 34 kPa (5 PSI)

Food safe ✔

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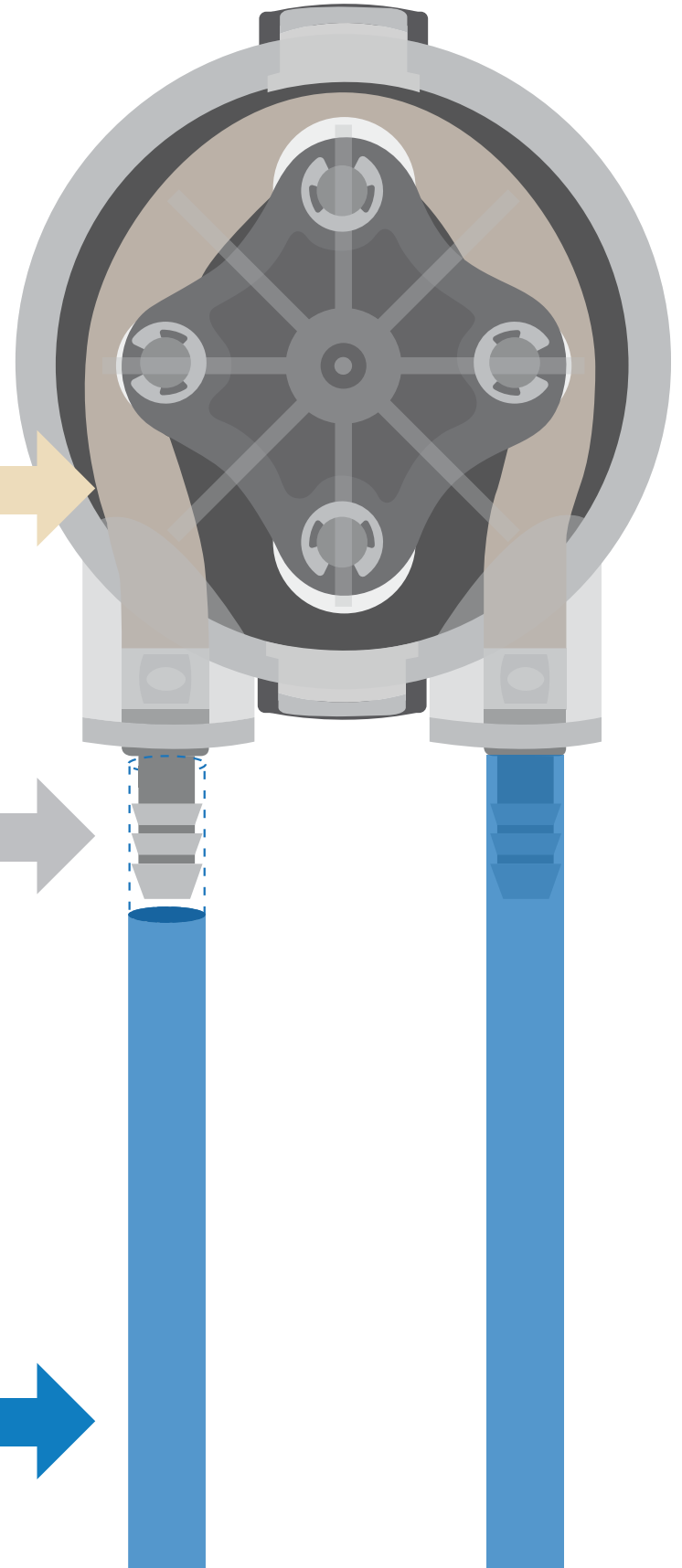
Operating principle

✔ Self-priming
✔ Run dry

A **B** **C**

Max input
vacuum
-101.3 kPa

Max output
pressure
101.3 kPa
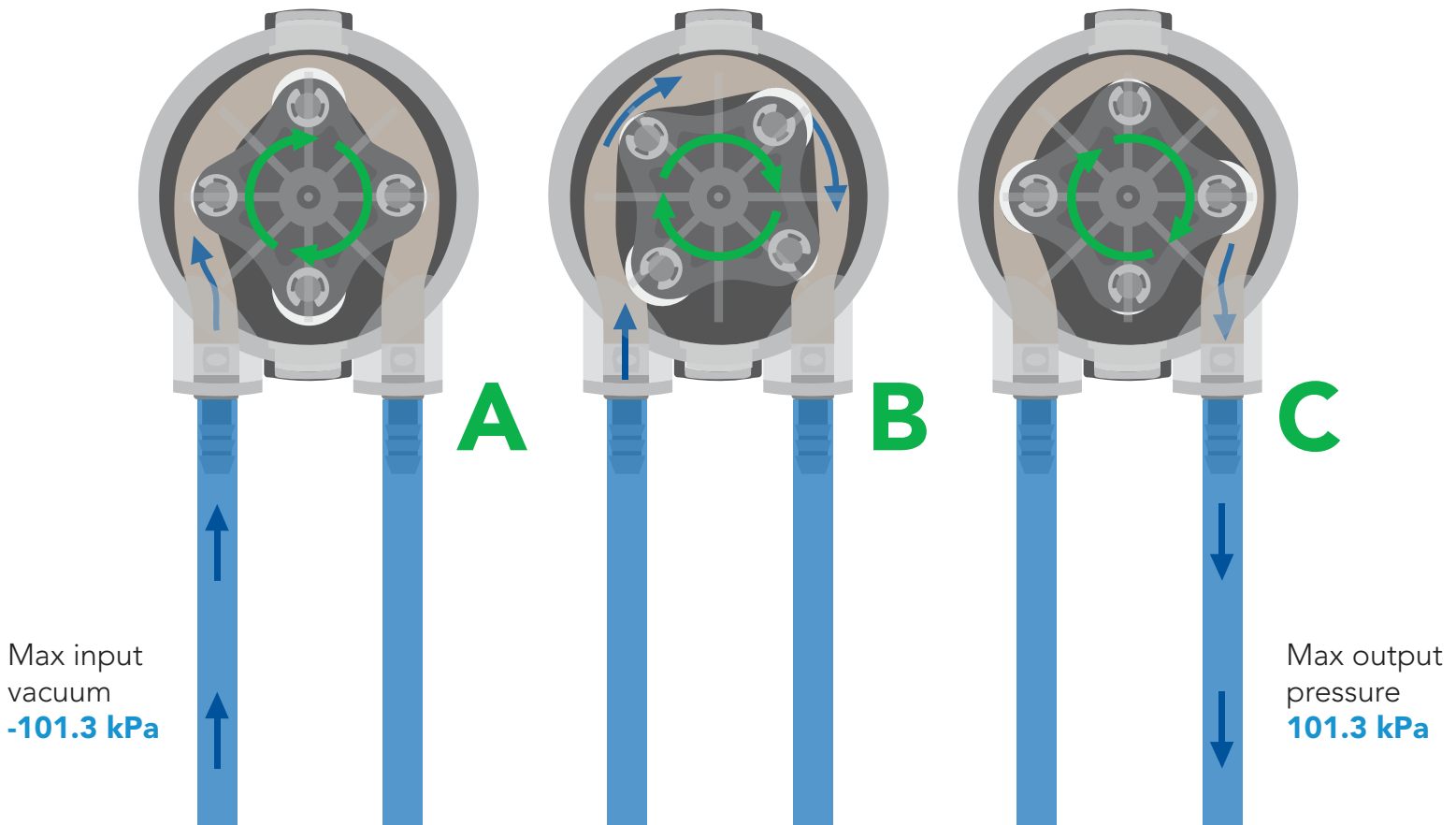
Operating modes

The EZO-PMP-L™ can operate in four different modes.

Continuous dispensing
Run the pump continuously
750ml/min ∞ *(with supplied tubing)*

Volume dispensing
Pump a specific volume
(Smallest possible volume is 10 ml)

Volume is always in ml.

Dose over time
Pump a specific volume over a set time

Constant flow rate
Pump a specific volume per minute

Dispense at startup
• Dispense a specific volume at startup
• Continuous dispensing at startup
• Dose over time at startup

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The Atlas Scientific EZO-PMP-L™ consists of three main components.
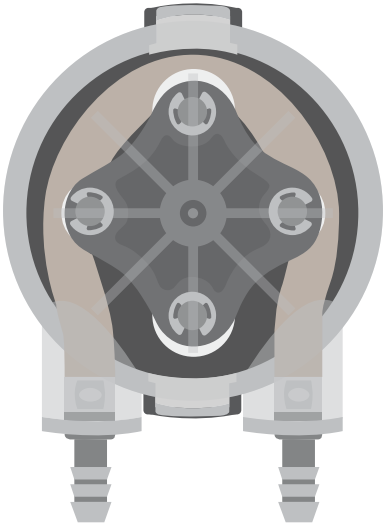
Cassette

Cassettes can be autoclave sterilized
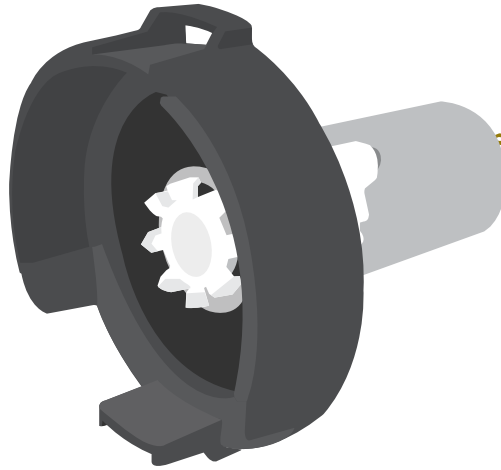
24 volt motor
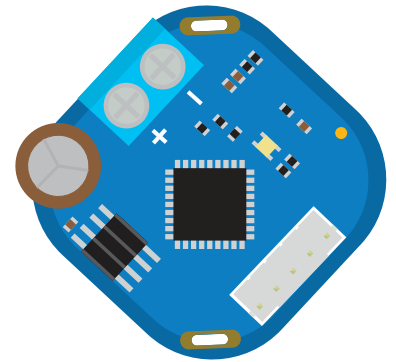
Control system

The actual peristaltic pumping is done within the cassette. It has been designed to be easily detached from the motor and disassembled.

The 24 volt motor and control system have been soldered together. Both components are designed to operate as one single unit.
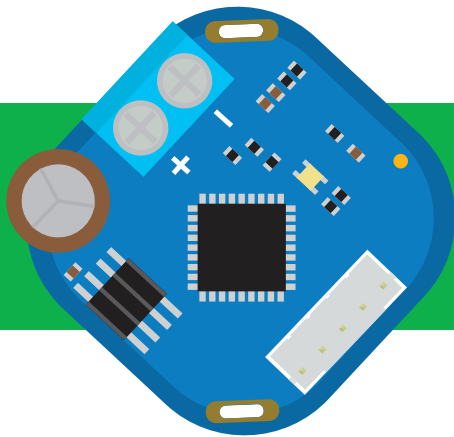
The control system has three main components

Keyed data and power connector
24 volt power input
Status indicator LED

Data and power cable pinout

White – RX/SCL
Green – TX/SDA
Black – GND
Red – VCC
Blue – INT

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Power supplies
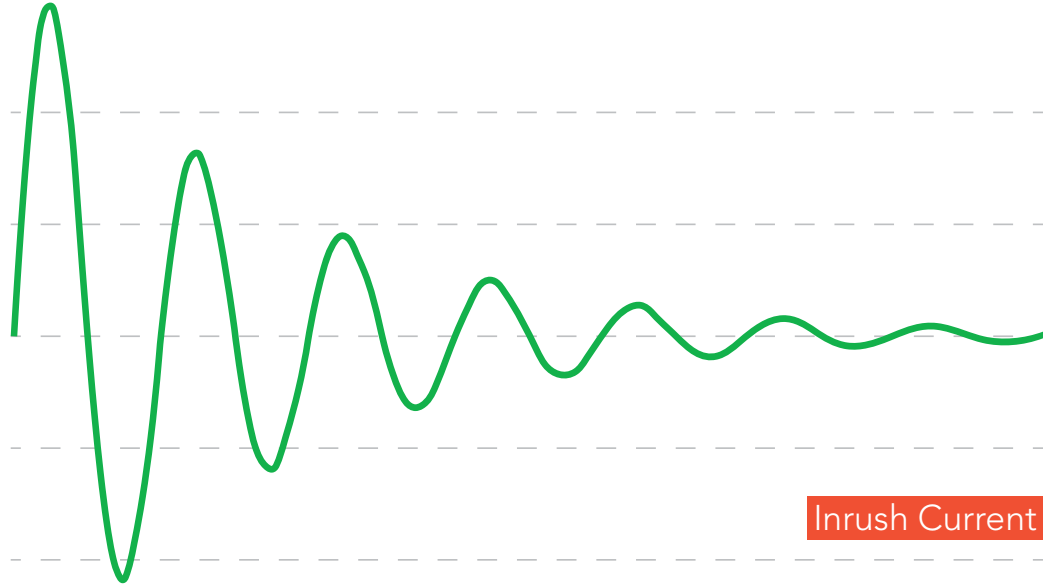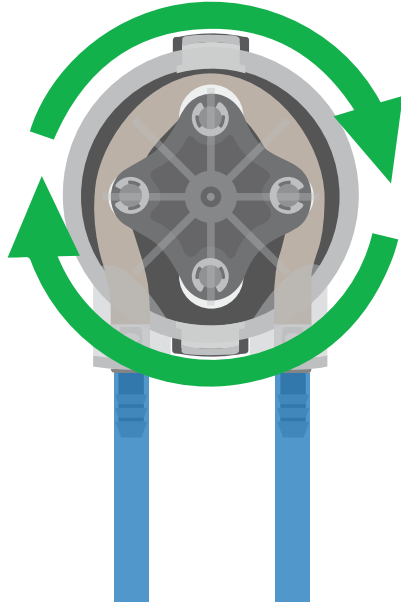
Inrush Current

Most power supplies have a built in protection against inrush currents and will prevent the motor from spinning. It has become very difficult to determine which power supplies will and won't work for the EZO-PMP-L™, as the manufacturers do not list whether it can handle inrush currents in the specs.

Atlas Scientific has tested both of these two power supplies, and can verify that they work with the EZO-PMP-L™.

Mean Well #GE30I24-P1J

Mean Well #EDR-120-24

Included with the EZO-PMP-L™ Kit

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Dispensing volumes

The EZO-PMP-L™ can only dispense volumes in whole numbers. The pump will not reject a request to dispense a volume with a decimal place, it will just ignore the decimal.

Example

MCU — Dispense 22ml → ✓ OK, 22ml

MCU — Dispense 56.78ml → ✓ OK, 56ml
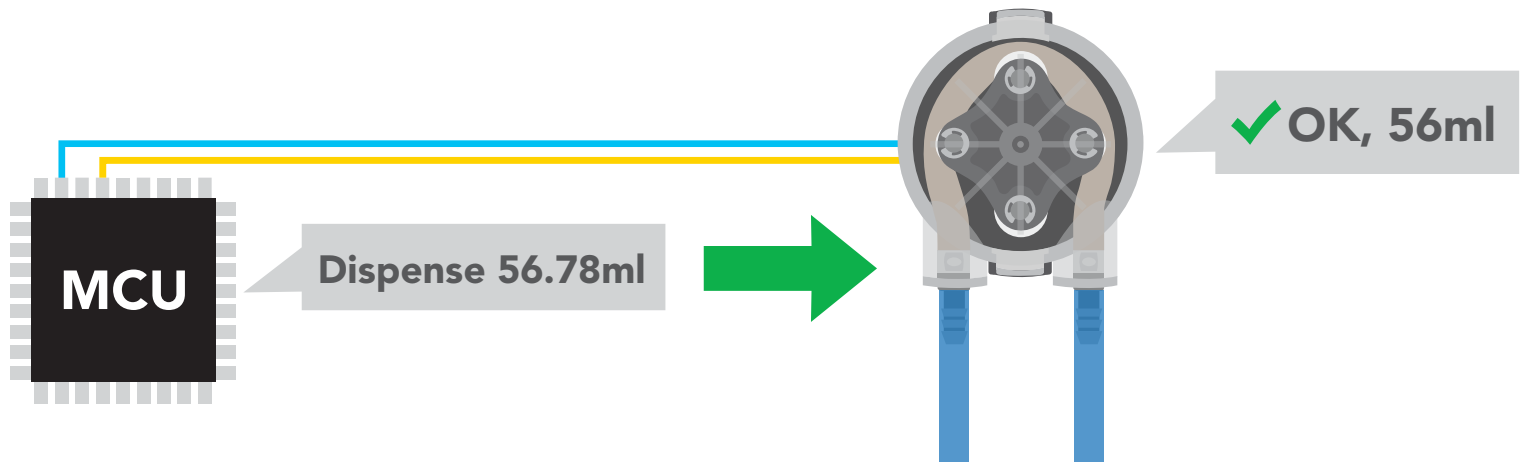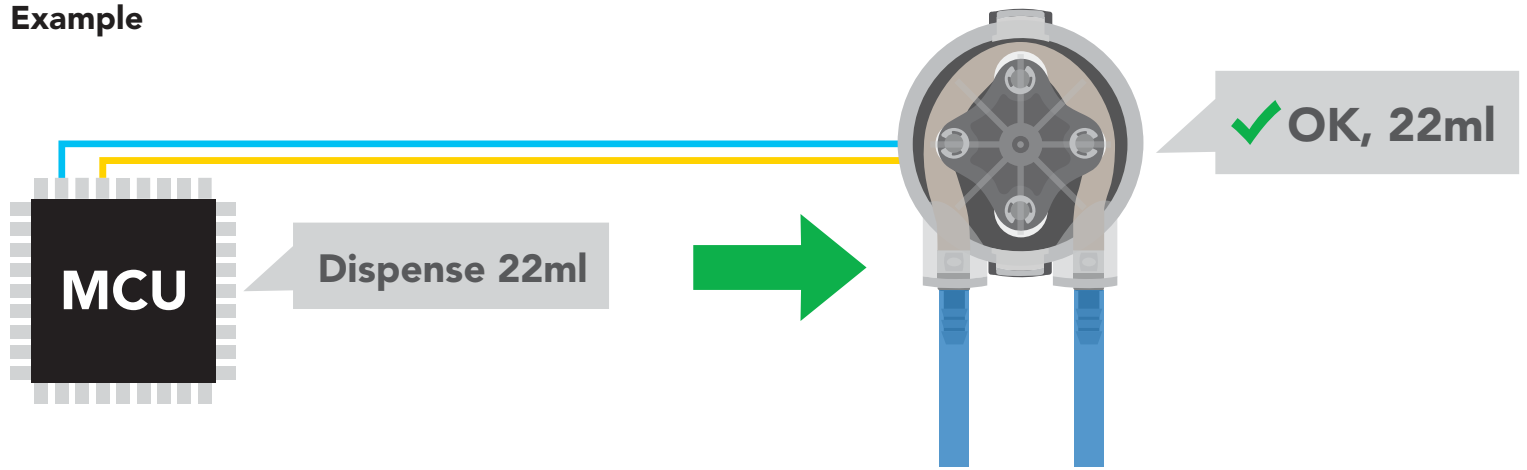
The minimum volume the EZO-PMP-L™ can dispense is 10 ml.

Example

MCU —
Dispense 9ml
Dispense 10ml
Dispense 11ml
Dispense 18ml
Dispense 1453.15ml
→
X Too small, 9ml
✓ OK, 10ml
✓ OK, 11ml
✓ OK, 18ml
✓ OK, 1453ml

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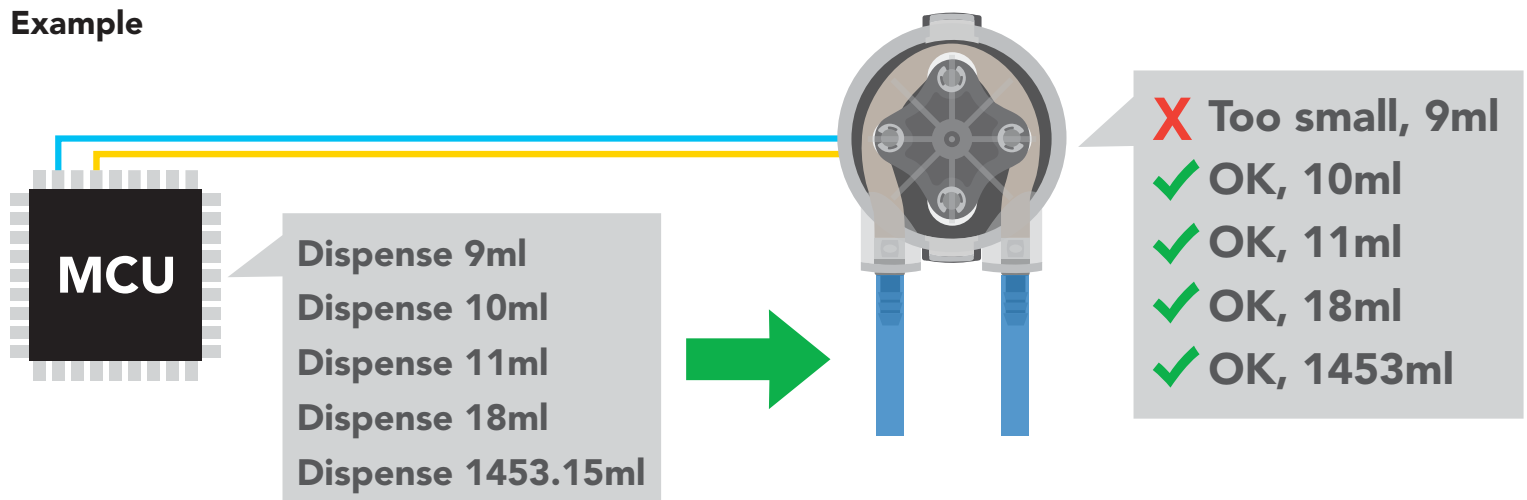
✓ Available data protocols

UART

Default

I²C

✗ Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

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Default state
UART mode

Baud	9,600
Readings	continuous
Speed	1 reading per second
LED	on

∞

1,000 ms

Green
Standby

Cyan
Taking reading

Transmitting

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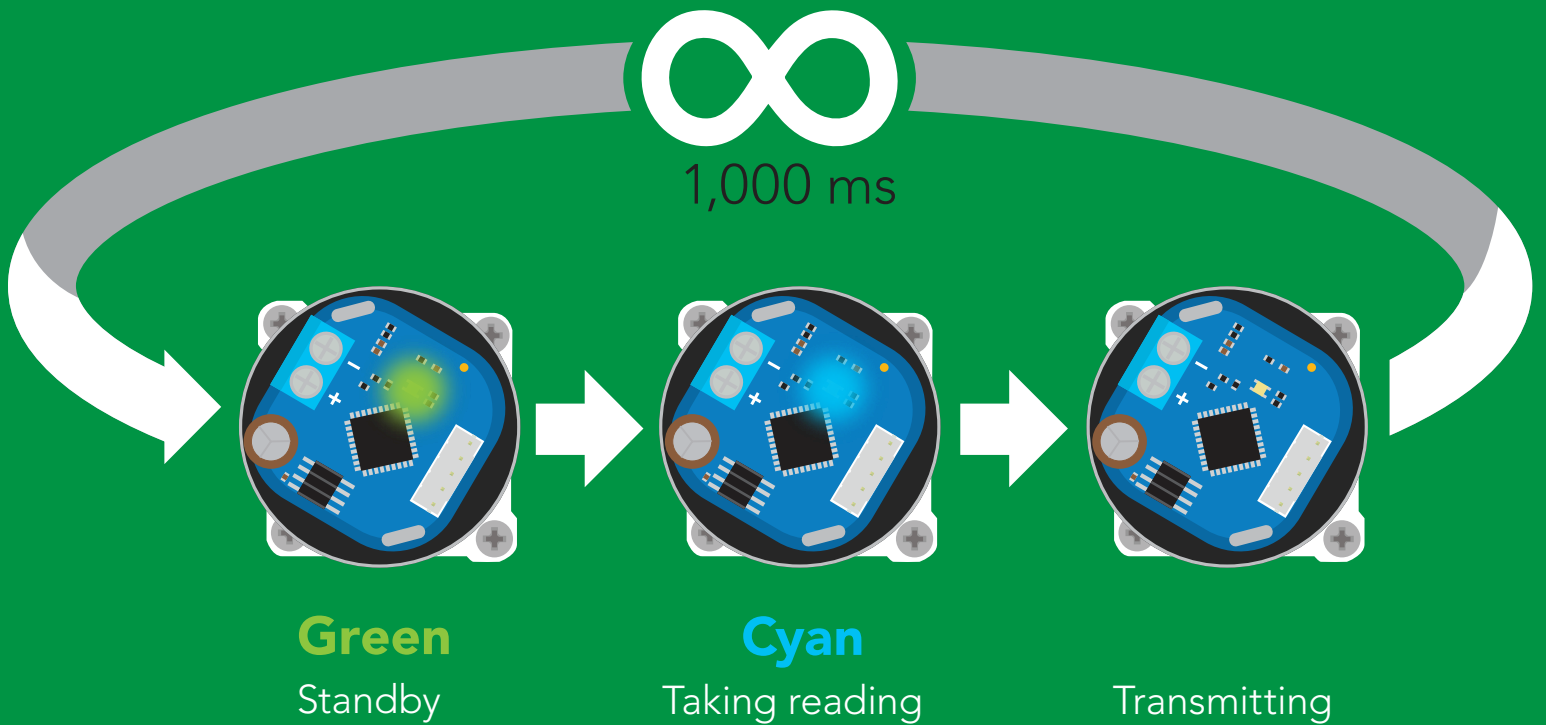
UART mode

Settings that are retained if power is cut

Baud rate
Calibration
Continuous mode
Device name
Enable/disable parameters
Enable/disable response codes
Hardware switch to I^{2}C mode
Invert
LED control
Protocol lock
Software switch to I^{2}C mode

Settings that are *NOT* retained if power is cut

Absolute total volume
Find
Sleep mode
Total volume

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UART mode

Baud
300
1,200
2,400
9,600   default
19,200
38,400
57,600
115,200

RX
Data in

TX
Data out

Vcc   3.3V – 5.5V

VCC

0V   0V

TX ➡ RX ✓   RX ⬅ TX ✓

RX   TX

CPU

RX
TX

Data format

Output	volume		**Terminator**	carriage return
Units	ml		**Data type**	long int
Encoding	ASCII		**Decimal places**	none
Format	string		**Smallest string**	3 characters
			Largest string	39 characters

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Receiving data from device

2 parts

ASCII data string	Carriage return <cr>
Command	**Terminator**

9,600 baud (default)

RX ← TX ✓

TX → RX ✓

CPU

TX

RX

Sender

Receiver

413 <cr>

Advanced

ASCII:	4	1	3	<cr>
Hex:	34	31	33	0D
Dec:	52	49	51	13

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Sending commands to device

2 parts

Command (not case sensitive)	Carriage return <cr>
ASCII data string	Terminator

RX ← TX ✓

TX

CPU

RX
TX
RX

TX → RX ✓

Receiver

Sender

Sleep <cr>

Advanced

ASCII:	S	l	e	e	p	<cr>
Hex:	53	6C	65	65	70	0D
Dec:	83	108	101	101	112	13

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LED color definition

Green
UART standby

Cyan
Taking reading

Purple
Changing
baud rate

Red
Command
not understood

White
Find

	LED ON
5V	**+2.5 mA**

3.3V	**+1 mA**

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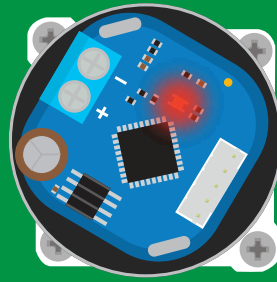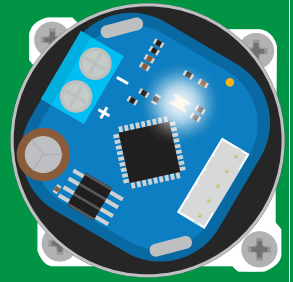
UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function		Default state
Baud	change baud rate	pg. 41	9,600
C	enable/disable continuous mode	pg. 20	enabled
Cal	performs calibration	pg. 33	n/a
D	dispense modes	pg. 22 – 28	n/a
Factory	enable factory reset	pg. 43	n/a
Find	finds device with blinking white LED	pg. 19	n/a
i	device information	pg. 37	n/a
Invert	invert dispensing direction	pg. 31	n/a
I2C	change to I²C mode	pg. 44	not set
L	enable/disable LED	pg. 18	enabled
Name	set/show name of device	pg. 36	not set
O	enable/disable parameters	pg. 34	all enabled
P	pause dispensing	pg. 29	n/a
Plock	enable/disable protocol lock	pg. 42	disabled
Pv	check pump voltage	pg. 35	n/a
R	returns a single reading	pg. 21	n/a
Sleep	enter sleep mode/low power	pg. 40	n/a
Status	retrieve status information	pg. 39	enable
Tv	total volume dispensed	pg. 32	n/a
X	stop dispensing	pg. 30	n/a
*OK	enable/disable response codes	pg. 38	enable

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LED control

Command syntax

L,1 **<cr>** **LED on** `default`

L,0 **<cr>** **LED off**

L,? **<cr>** **LED state on/off?**

Example	Response
L,1 <cr>	***OK <cr>**
L,0 <cr>	***OK <cr>**
L,? <cr>	**?L,1 <cr> or ?L,0 <cr>** ***OK <cr>**
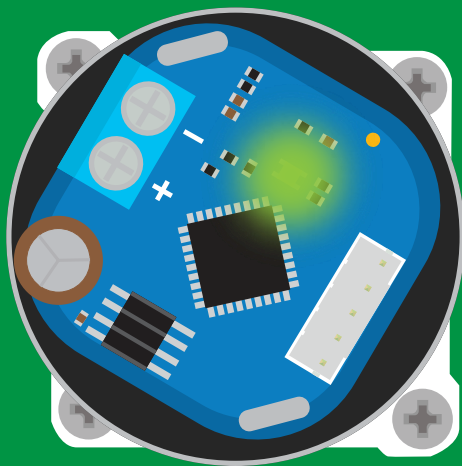
L,1
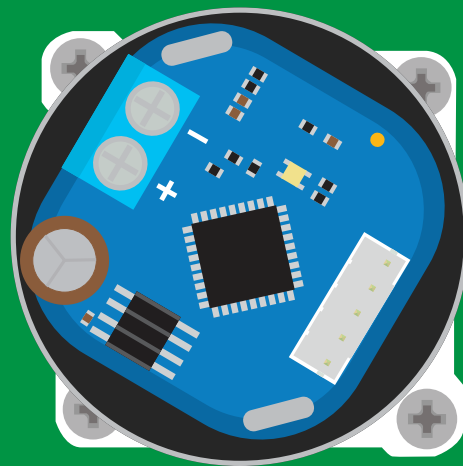
L,0

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Find

Command syntax

Find <cr> LED rapidly blinks white, used to help find device

Example

Response

Find <cr>

*OK <cr>

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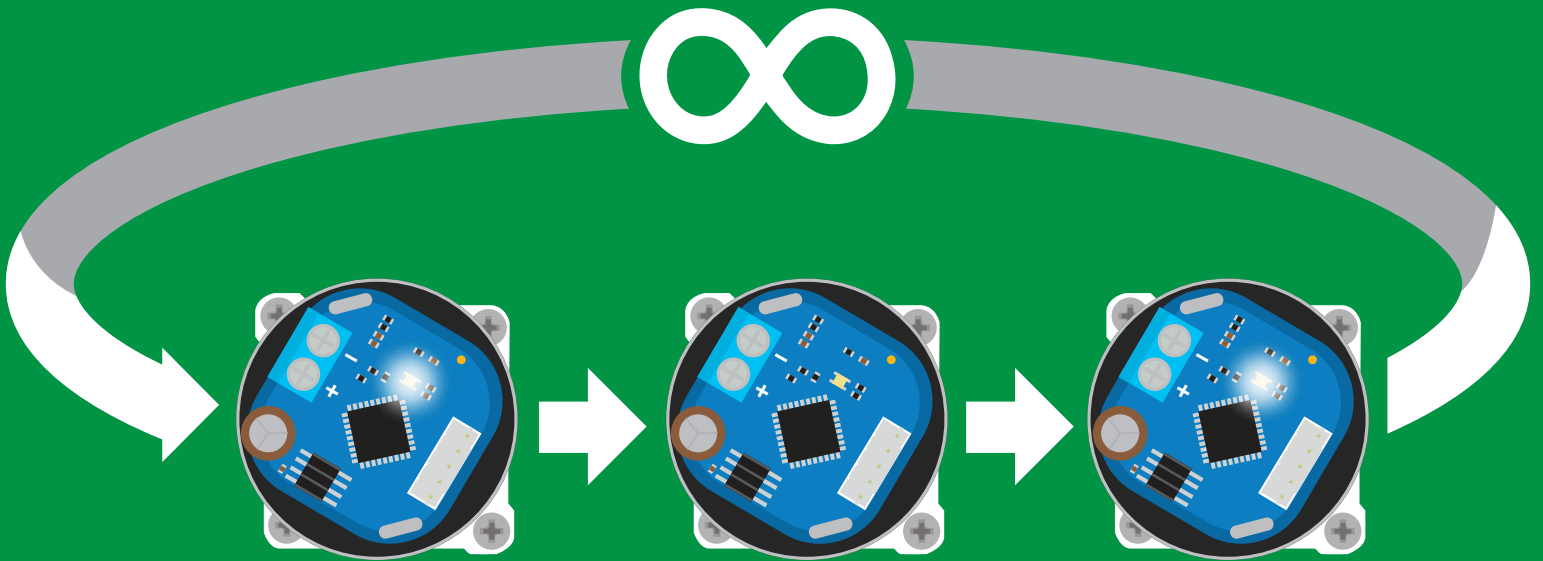
Continuous mode

Command syntax

C,* `<cr>` continuously reports volume once per second `default`

C,1 `<cr>` continuously reports volume only when pumping

C,0 `<cr>` disable continuous reporting

C,? `<cr>` continuous reporting mode on/off?

Example	Response
dispense 23ml C,* `<cr>`	18 `<cr>` 23 `<cr>` *Done,23 `<cr>` 23 `<cr>` 23 `<cr>`
C,1 `<cr>`	18 `<cr>` 23 `<cr>` *Done,23 `<cr>`
C,0 `<cr>`	*Done,23 `<cr>`
C,? `<cr>`	?C,1 `<cr>` or ?C,0 `<cr>` or ?C,* `<cr>` *OK `<cr>`

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Single reading mode

Command syntax

R <cr> returns a single value showing dispensed volume

Example	Response	
R <cr>	**25** <cr> ***OK** <cr>	**(If issued half way through dispensing 50ml)**
	50 <cr> ***OK** <cr>	**(If issued once dispensing has stopped)**

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Continuous dispensing
Pump on/pump off

Command syntax

D,* <cr> dispense until the stop command is given

D,-* <cr> dispense in reverse until the stop command is given

D,? <cr> dispense status

Example | Response

Example	Response	
D,* <cr>	*OK <cr>	pump will continuously run at ~750ml/min (with supplied tubing)
D,-* <cr>	*OK <cr>	pump will continuously run in reverse at ~750ml/min (with supplied tubing)
D,? <cr>	?D,*,1 <cr> *OK <cr>	

Response breakdown

?D,*,1

last volume requested — pump on

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Volume dispensing

Pump a specific volume

Command syntax

where [ml] is any volume in millimeters >= 0.5

D,[ml]   \<cr\>   dispense [this specific volume]

D,[-ml]   \<cr\>   dispense [*in reverse* this specific volume]

D,?   \<cr\>   dispense status

Example | Response

Example	Response
D,15 \<cr\>	***OK \<cr\>** 15 ml will be dispensed
D,-40 \<cr\>	***OK \<cr\>** 40 ml will be dispensed *in reverse*
D,? \<cr\>	**?D,-40,0 \<cr\>** ***OK \<cr\>**

Response breakdown

?D,-40,0

↑ last volume dispensed   ↑ pump off

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Dose over time

Pump a fixed volume over a fixed time

Command syntax

D,[ml],[min]   <cr>   Dispense [this volume], [over this many minutes]

Example

Response

D,7000,20 <cr>   *OK <cr> Dispense 7000ml over 20 minutes

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Constant flow rate

Maintain a constant flow rate

Command syntax

DC,[ml/min],[min or *] <cr>   [maintain this rate],[for this much time]

DC,? <cr>   reports maximum possible flow rate

[ml/min] = a single number (int or float) representing the desired flow rate
[min or *] = the number of minutes to run or (*) indefinitely
A negative value for ml/min = reverse

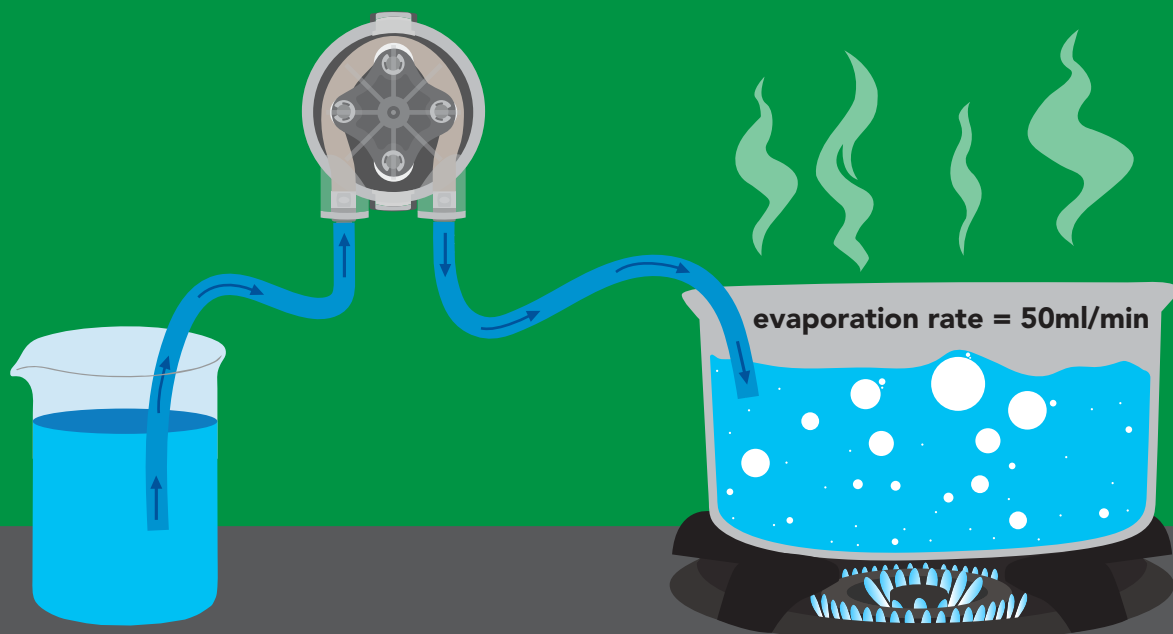| Example	Response
DC,50,40 <cr>	*OK <cr> Dispense 50ml per minute for 40 minutes
DC,? <cr>	?MAXRATE,385 <cr> *OK <cr>

The maximum flow rate is determined after calibration.
If the flowrate entered is too fast the EZO-PMP-L™ will send an error.

*TOOFAST <cr>
*ER <cr>

evaporation rate = 50ml/min

flow rate = 50ml/min

Dispense at startup
Pump a specific volume at startup and then stop
Use this command to make a simple fixed-volume pump

Command syntax

Dstart,[ml]   <cr>   dispense [this specific volume] at startup

Dstart,off   <cr>   disables dispense at startup mode

Dstart,?   <cr>   startup dispense status

Example   Response

Example	Response
Dstart,100 <cr>	*OK <cr>
Dstart,off <cr>	*OK <cr>
Dstart,? <cr>	?Dstart,100 <cr> or ?Dstart,0 <cr> *OK <cr>

ON

Power

OFF

INT pin

100ml
Dispensed

100ml
Dispensed

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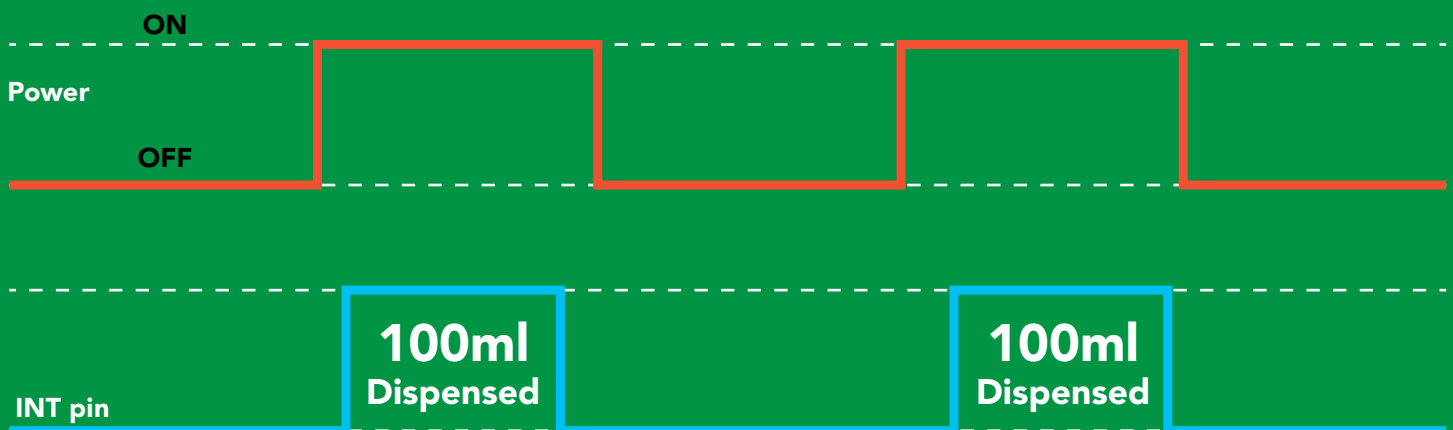
Continuous dispensing at startup

Pump on & continuously dispense

Command syntax

Dstart,* <cr>   dispense at startup until the stop command is given

Dstart,-* <cr>   dispense in reverse at startup until the stop command is given

Dstart,? <cr>   startup dispense status

Example   ## Response

Example	Response	
Dstart,* <cr>	*OK <cr>	Pump will startup and continuously run at ~750ml/min (with supplied tubing)
Dstart,-* <cr>	*OK <cr>	Pump will startup and continuously run in reverse at ~750ml/min (with supplied tubing)
Dstart,? <cr>	?Dstart,* <cr>	

ON

Power

OFF

INT pin

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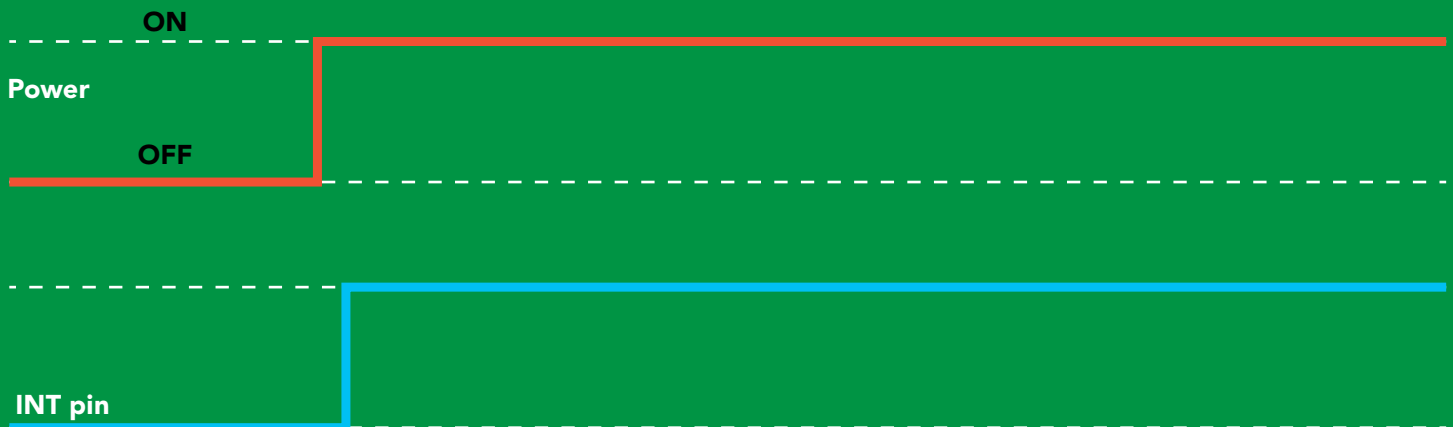
Dose Over time at startup

Pump a fixed volume over a fixed time at startup

Command syntax

D,[ml],[min] <cr>	Dispense [this volume], [over this many minutes] at startup

Example

Response

Dstart,7000,20 <cr>	*OK <cr> Pump will startup and dispense 7000ml over 20 minutes
Dstart,? <cr>	?Dstart,7000,20.00 <cr>

ON

Power

OFF

INT pin

7000ml
Dispensed

20 Minutes

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Pause dispensing

Command syntax

P \<cr\>   pauses the pump during dispensing

P,? \<cr\>   pause status

Example   Response

P \<cr\>

*OK \<cr\>

P,? \<cr\>

?P,1 \<cr\> **or** **?P,0** \<cr\>
paused   unpaused

*OK \<cr\>

dispensing → **P** paused → **P** dispensing

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Stop dispensing

Command syntax

X <cr> stop dispensing

Example   Response

X <cr>

*DONE,v <cr>   v = volume dispensed

X
dispensing

➡ *DONE,645.8
Stopped

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Invert dispensing direction

Command syntax

Invert **<cr>** changes dispensing direction of pump

Example	Response
Invert **<cr>**	*OK **<cr>**
Invert,? **<cr>**	?Invert,1 **<cr>** or ?Invert,0 **<cr>** inverted uninverted *OK **<cr>**

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Total volume dispensed

Command syntax

TV,?   `<cr>`   shows total volume dispensed

ATV,? `<cr>`   absolute value of the total volume dispensed

Clear `<cr>`   clears the total dispensed volume

Example	Response
TV,? `<cr>`	?TV,434.50 `<cr>`
ATV,? `<cr>`	?ATV,623.00 `<cr>`
Clear `<cr>`	*OK `<cr>` total now 0.00

This data will be lost if the power is cut.

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Calibration

Command syntax

Cal,v	<cr>	v = corrected volume
Cal,clear	<cr>	delete all calibration data
Cal,?	<cr>	device calibrated?

This command is used for both, single dose and dose over time calibrations.

Example	Response
Cal,146.2 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,1 <cr> or ?Cal,2 <cr> or fixed volume volume/time ?Cal,3 <cr> or ?Cal,0 <cr> both uncalibrated *OK <cr>

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Enable/disable parameters from output string

Command syntax

O, [parameter],[1,0] <cr>   enable or disable output parameter
O,?   <cr>   enabled parameter?

Example	Response	
O,V,1 <cr>	*OK <cr>	enable volume being pumped
O,TV,0 <cr>	*OK <cr>	disable total volume pumped
O,ATV,1 <cr>	*OK <cr>	enable absolute volume pumped
O,? <cr>	?,O,V,TV,ATV <cr>	if all three are enabled

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Pump voltage

Command syntax

PV,? **\<cr>** **check pump voltage**

Example

Response

PV,? **\<cr>**

?PV,24.67 **\<cr>**
*OK **\<cr>**

Response breakdown

?PV, **24.67**
↑
Pump input voltage

Naming device

Command syntax

Name,n <cr> set name

Name, <cr> clears name

Name,? <cr> show name

n = ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗ ‗
  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

Up to 16 ASCII characters

Example | Response

Example	Response
Name, <cr>	***OK** <cr> name has been cleared
Name,zzt <cr>	***OK** <cr>
Name,? <cr>	**?Name,zzt** <cr> ***OK** <cr>

Name,zzt

Name,?

*OK <cr>

?Name,zzt <cr>
*OK <cr>

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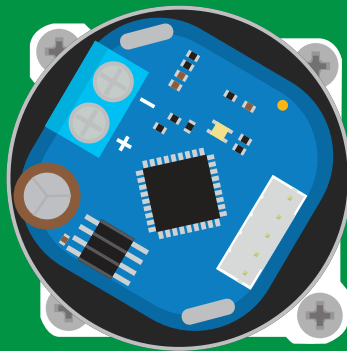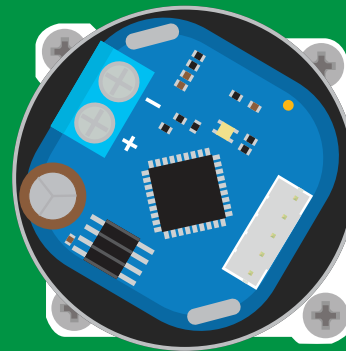
Device information

Command syntax

i **<cr>** device information

Example	Response
i **<cr>**	?i,PMPL,1.1 **<cr>** *OK **<cr>**

Response breakdown

?i, **PMPL**, **1.1**

↑ Device   ↑ Firmware

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Response codes

Command syntax

*OK,1 <cr> enable response **default**
*OK,0 <cr> disable response
*OK,? <cr> response on/off?

Example	Response
R <cr>	413 <cr> *OK <cr>
*OK,0 <cr>	no response, *OK disabled
R <cr>	413 <cr> *OK disabled
*OK,? <cr>	?*OK,1 <cr> or ?*OK,0 <cr>

Other response codes

*ER	unknown command
*OV	over volt (VCC>=5.5V)
*UV	under volt (VCC<=3.1V)
*RS	reset
*RE	boot up complete, ready
*SL	entering sleep mode
*WA	wake up
*DONE	dispensing complete
*MINVOL	dispense amount too low
*TOOFAST	ml/min set to fast

These response codes cannot be disabled

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Reading device status

Command syntax

Status <cr> voltage at Vcc pin and reason for last restart

Example   Response

Status <cr>

?Status,P,5.038 <cr>
*OK <cr>

Response breakdown

?Status,	P,	5.038
	↑	↑
	Reason for restart	Voltage at Vcc

Restart codes

P	powered off
S	software reset
B	brown out
W	watchdog
U	unknown

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Sleep mode/low power

Command syntax

Sleep <cr> enter sleep mode/low power

Example	Response
Sleep <cr>	*OK <cr> *SL <cr>
Any command	*WA <cr> wakes up device

	STANDBY	SLEEP
5V	**13.4 mA**	**0.415 mA**
3.3V	**12.4 mA**	**0.13 mA**

Sleep <cr>

Standby
13.4 mA

Sleep
0.415 mA

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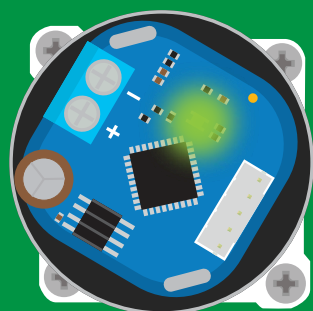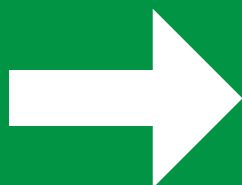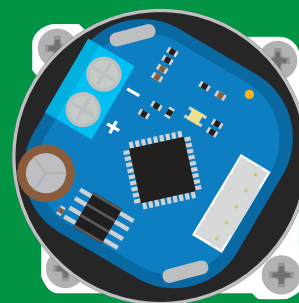
Change baud rate

Command syntax

Baud,n <cr> **change baud rate**

Example

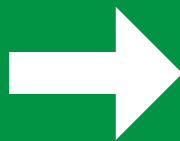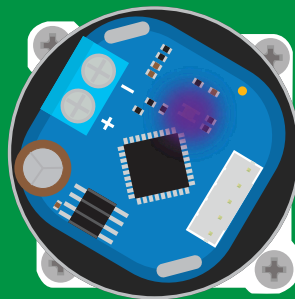| Example	Response
Baud,38400 <cr>	***OK** <cr>
Baud,? <cr>	**?Baud,38400** <cr> ***OK** <cr>

n =
- 300
- 1200
- 2400
- **9600 default**
- 19200
- 38400
- 57600
- 115200

Standby → Baud,38400 <cr> **Changing baud rate**
 *OK <cr> → (reboot) **Standby**
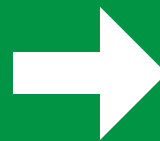
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Protocol lock

Command syntax

Plock,1 <cr>   enable Plock
Plock,0 <cr>   disable Plock   default
Plock,? <cr>   Plock on/off?

Example	Response
Plock,1 <cr>	*OK <cr>
Plock,0 <cr>	*OK <cr>
Plock,? <cr>	?Plock,1 <cr> or ?Plock,0 <cr>

Plock,1
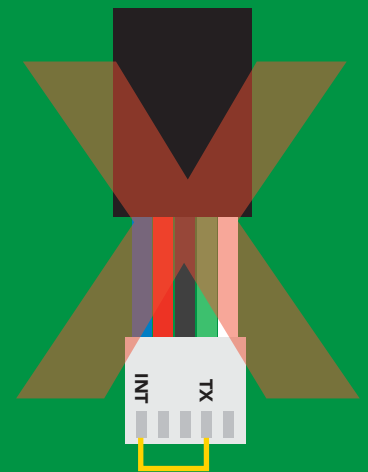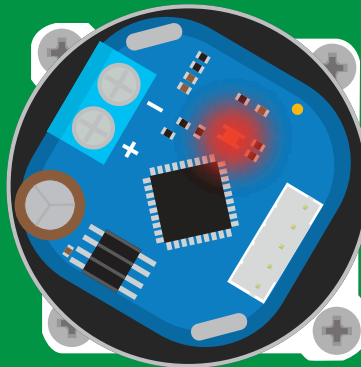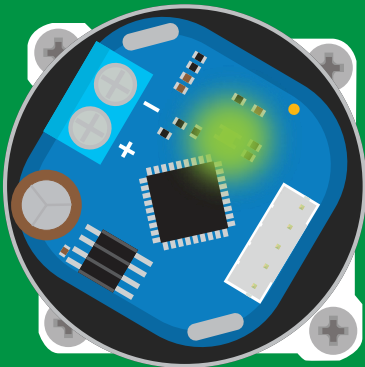
*OK <cr>

I2C,100

cannot change to I²C
*ER <cr>

cannot change to I²C

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Factory reset

Command syntax

Factory <cr> enable factory reset

Example	Response
Factory <cr>	*OK <cr>

Factory <cr>

(reboot)

*OK <cr>
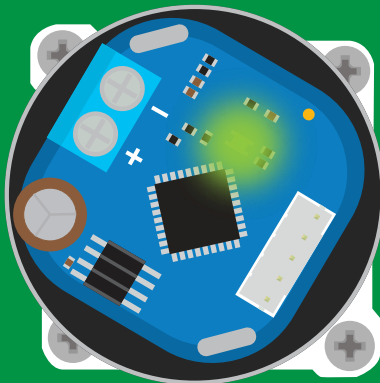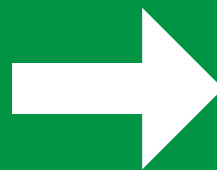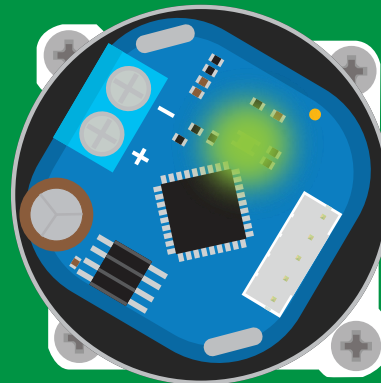
*RS <cr>
*RE <cr>

Baud rate will not change

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Change to I²C mode

Command syntax

I2C,n \<cr\> sets I²C address and reboots into I²C mode

n = any number 1 – 127

Example   Response

I2C,100 \<cr\>   *OK (reboot in I²C mode)

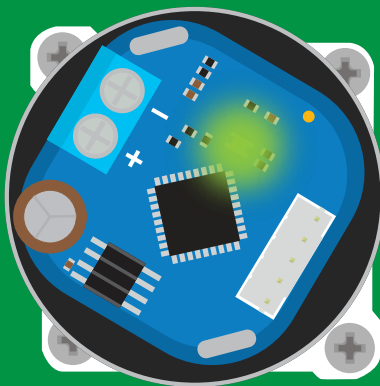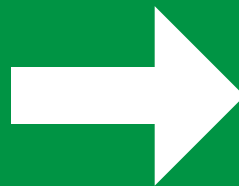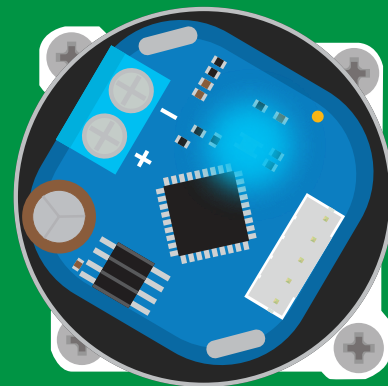## Wrong example   Response

I2C,139 \<cr\> n ≯ 127   *ER \<cr\>

I2C,100

(reboot)

Green
*OK \<cr\>

Blue
now in I²C mode

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Manual switching to I²C

- **Disconnect ground (power off)**
- **Disconnect TX and RX**
- **Connect TX to INT**
- **Confirm RX is disconnected**
- **Connect ground (power on)**
- **Wait for LED to change from Green to Blue**
- **Disconnect ground (power off)**
- **Reconnect all data and power**

Manually switching to I²C will set the I²C address to 109 (0x6D)

Example

Short

TX   INT

Wrong Example

Disconnect RX line ➡

Short

RX

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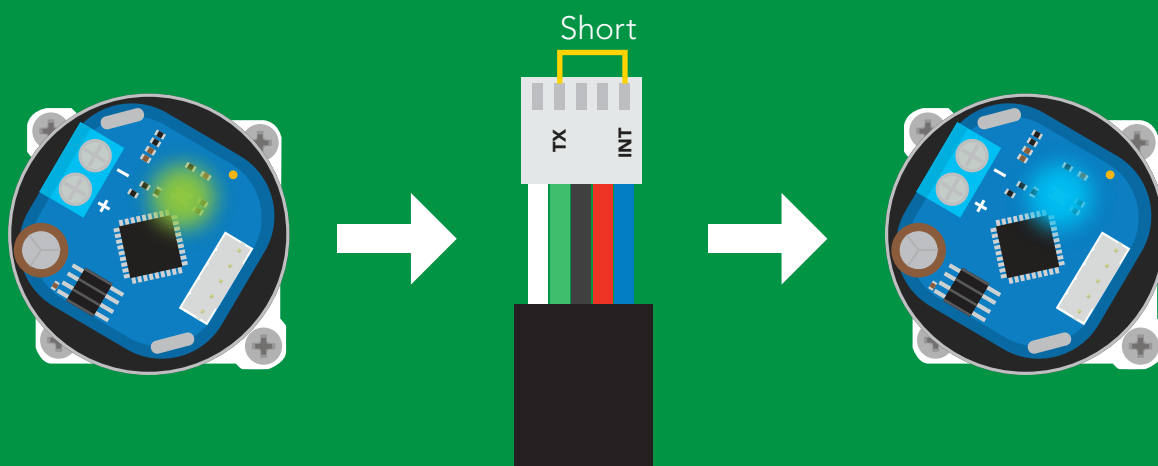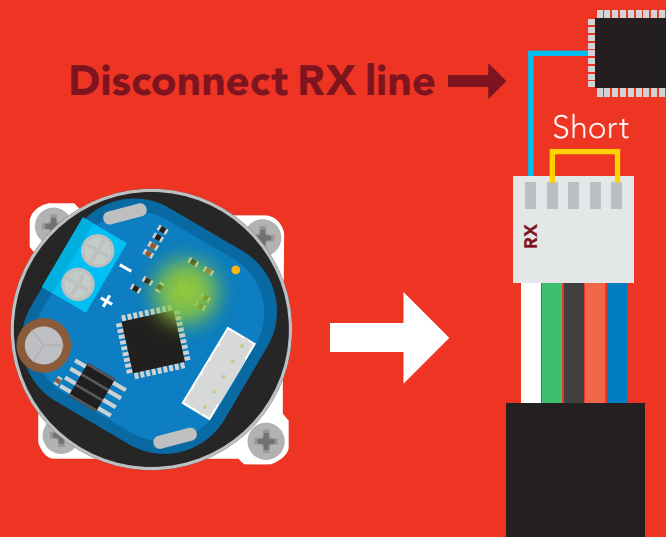
I²C mode

The I²C protocol is *considerably more complex* than the UART (RS–232) protocol. Atlas Scientific assumes the embedded systems engineer understands this protocol.

To set your EZO-PMP-L™ into I²C mode click here

Settings that are retained if power is cut

Calibration
Change I²C address
Enable/disable parameters
Hardware switch to UART mode
Invert
LED control
Protocol lock
Software switch to UART mode

Settings that are *NOT* retained if power is cut

Absolute total volume
Find
Sleep mode
Total volume

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I²C mode

I²C address (0x01 – 0x7F)
109 (0x6D) default

Vcc 3.3V – 5.5V

Clock speed 100 – 400 kHz

SDA

SCL

VCC
0V   0V

4.7k resistor
may be needed

VCC —●—   —●— VCC

SCL ← SCL ✓   SDA ← SDA ✓

SCL   SDA

CPU
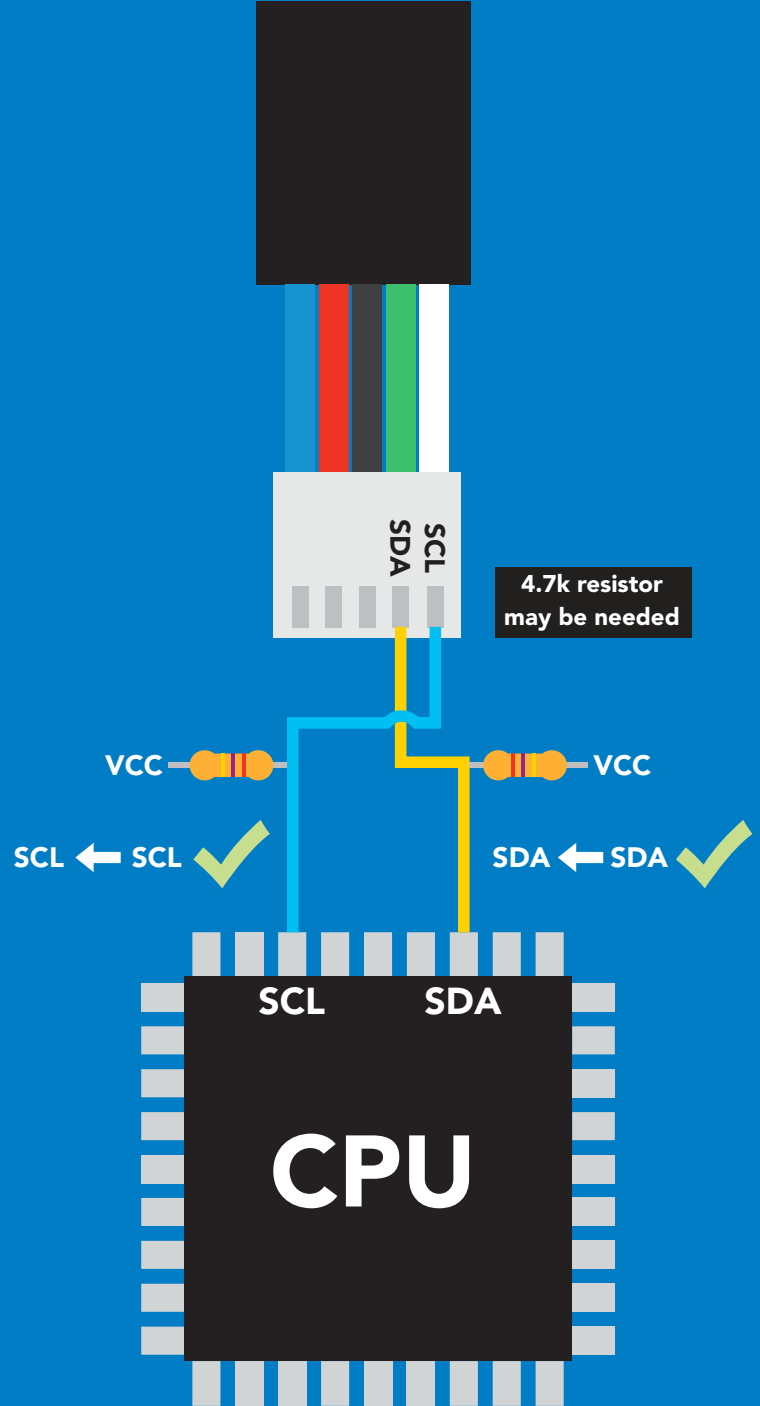
Data format

Reading volume
Units ml
Encoding ASCII
Format string

Data type long int
Decimal places none
Smallest string 3 characters
Largest string 39 characters

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Sending commands to device

5 parts

Start	I²C address	Write	Command (not case sensitive)	Stop
	109 (0x6D)		ASCII command string	

Example

Start	109 (0x6D)	Write	Sleep	Stop
	I²C address		Command	

SDA ← SDA ✓

SCL ← SCL ✓

SDA
SCL

CPU

Advanced

Address bits

The entire command as ASCII with all arguments

SDA
SCL

Start | A6 A5 A4 A3 A2 A1 A0 W ACK First letter of command ACK ... Last letter of command ACK | Stop

W = low

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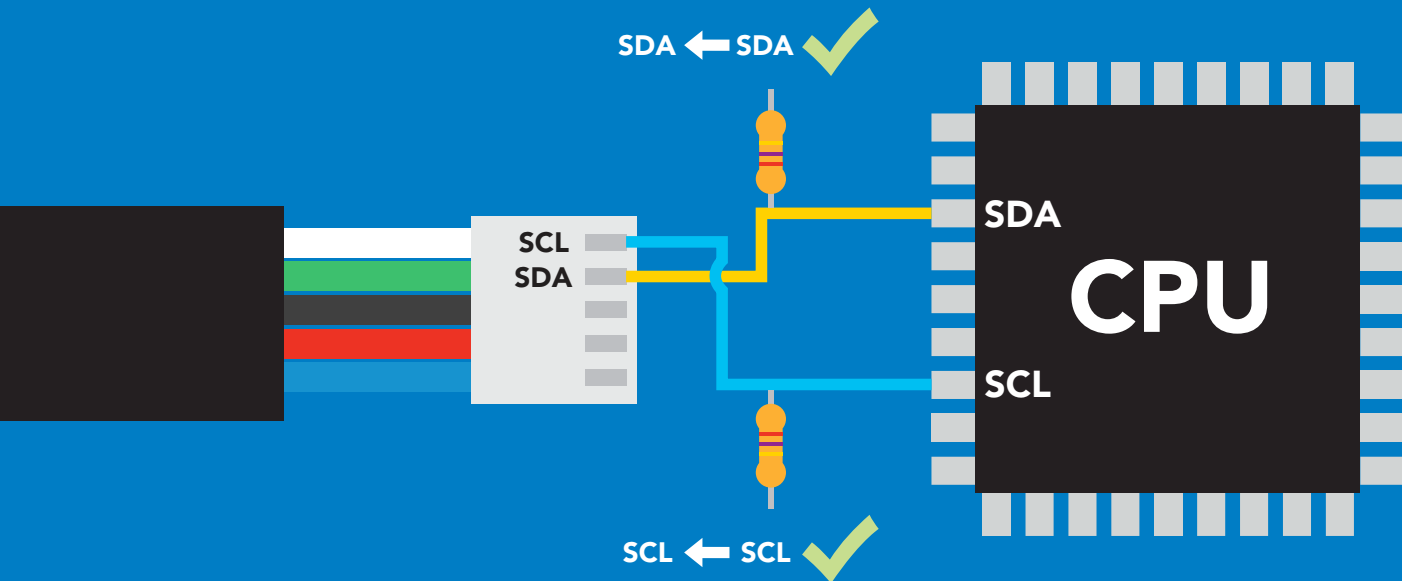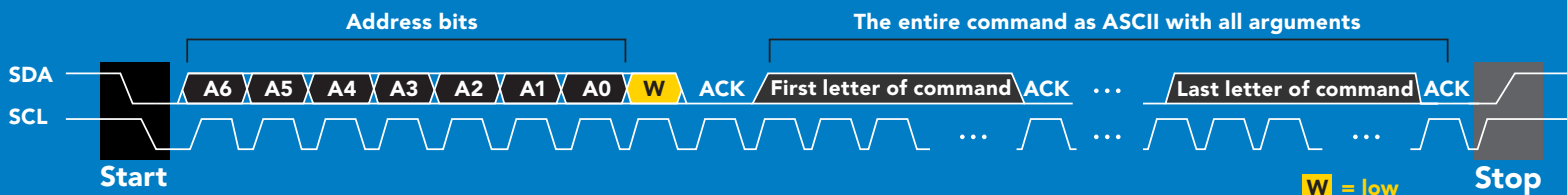
Requesting data from device

7 parts

Start	I²C address	Read	Response code	Data string	Null	Stop
	109 (0x6D)		1 byte	"413"	Terminator (Dec 0)	

413

SDA ← SDA ✓

SCL
SDA

SDA

CPU

SCL

SCL ← SCL ✓

Advanced

	Address bits		N bytes of data	All bytes after data are Null	R = High

SDA — Start — A6 – A0 R ACK Response code ACK Data ACK ... Data N ACK Null ACK ... Null — NACK Stop

SCL
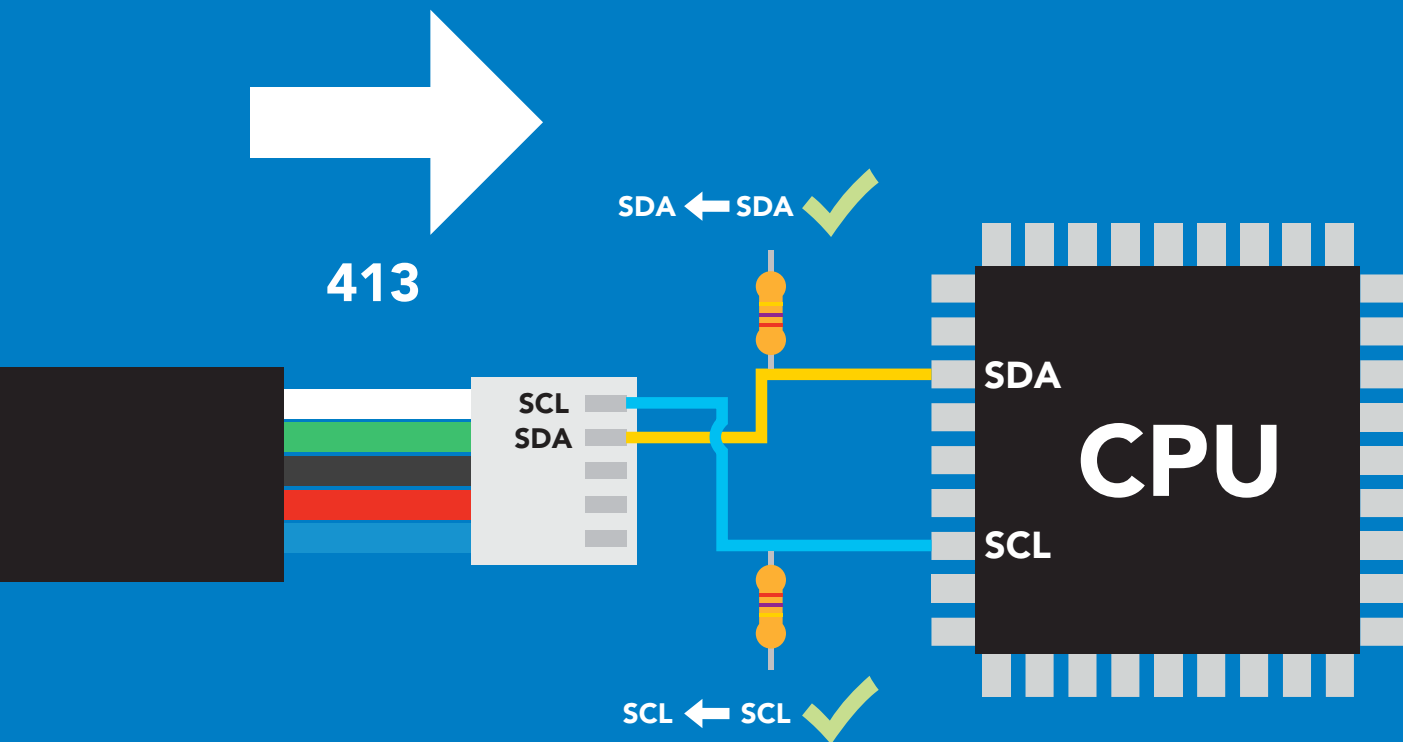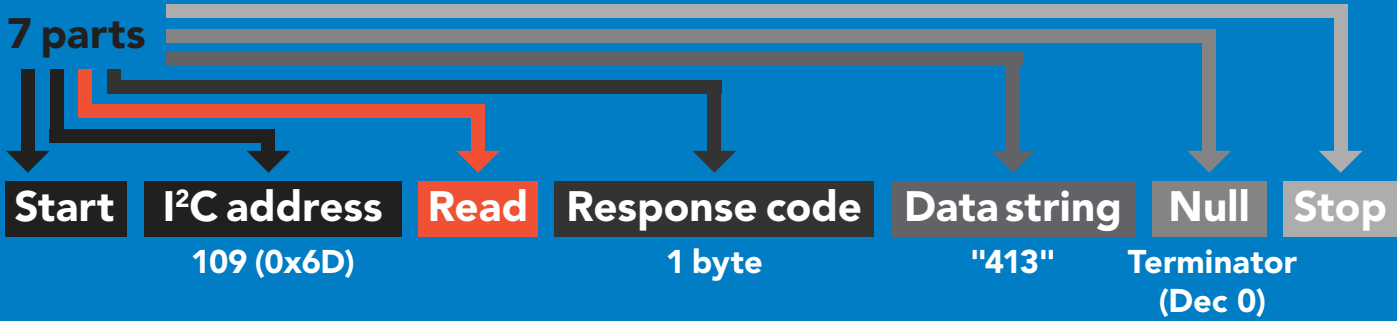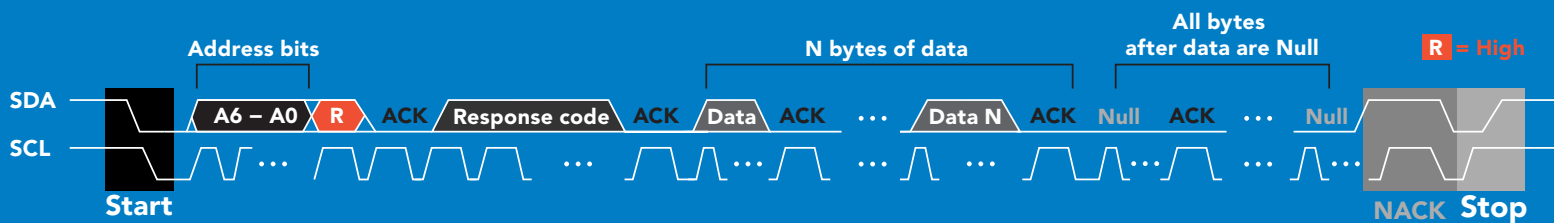
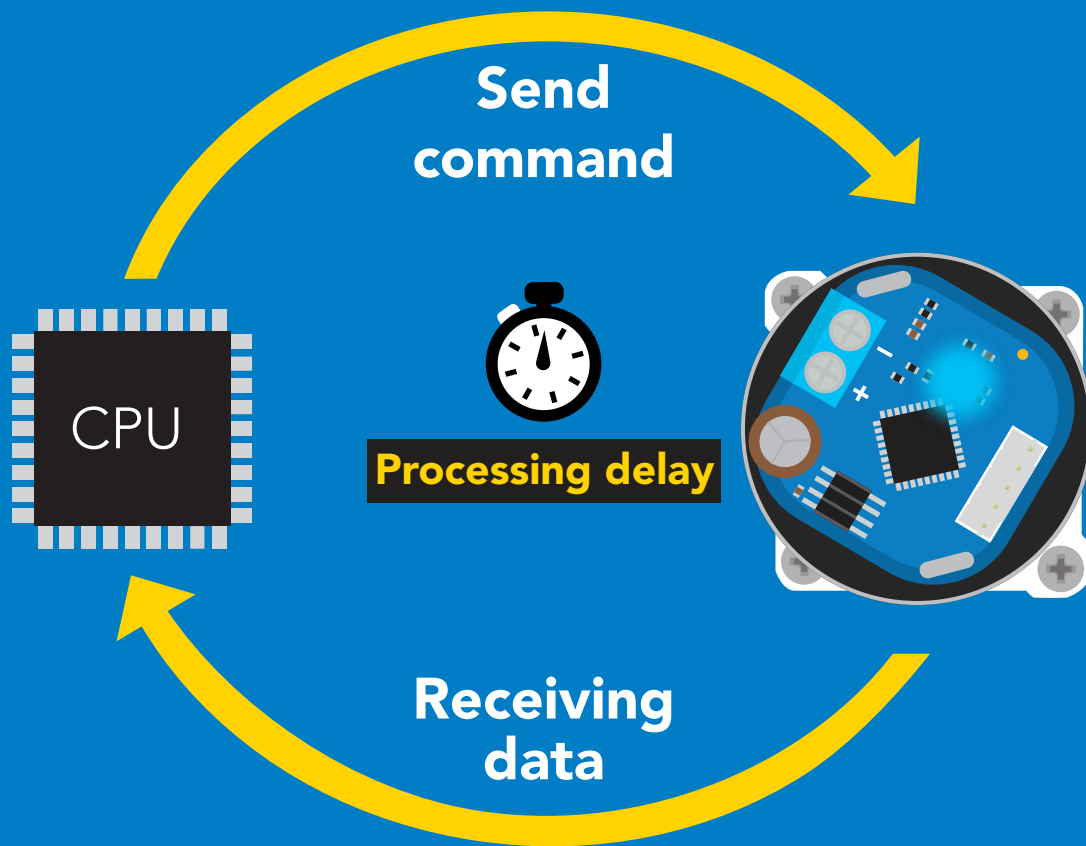| 1	52	49	51	0	= 413
Dec		ASCII		Dec	

Response codes

After a command has been issued, a 1 byte response code can be read in order to confirm that the command was processed successfully.

Reading back the response code is completely optional, and is not required for normal operation.

Send command

CPU

Processing delay

Receiving data

Example

I2C_start;
I2C_address;
I2C_write(EZO_command);
I2C_stop;

delay(300); → **Processing delay**

I2C_start;
I2C_address;
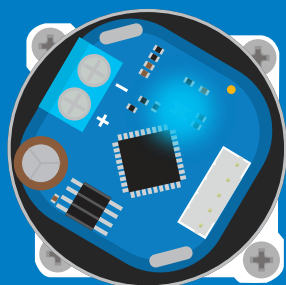**Char[ ] = I2C_read;**
I2C_stop;

If there is no processing delay or the processing delay is too short, the response code will always be 254.
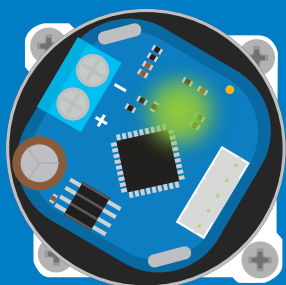
Response codes
Single byte, not string

255	**no data to send**
254	**still processing, not ready**
2	**syntax error**
1	**successful request**

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LED color definition

Blue

I^{2}C standby

Green

Taking reading
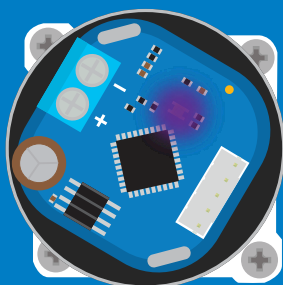
Purple

Changing
I^{2}C address

Red

Command
not understood

White

Find

	LED ON
5V	**+2.5 mA**

3.3V	**+1 mA**

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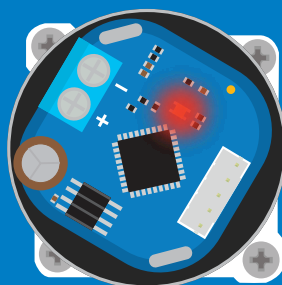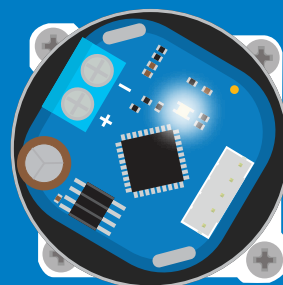
I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 77
Cal	performs calibration	pg. 67
D	dispense modes	pg. 56 – 62
Factory	enable factory reset	pg. 76
Find	finds device with blinking white LED	pg. 54
i	device information	pg. 71
I2C	change I²C address	pg. 75
Invert	invert dispensing direction	pg. 65
L	enable/disable LED	pg. 53
Name	set/show name of device	pg. 70
O	enable/disable parameters	pg. 68
P	pauses the pump during dispensing	pg. 63
Plock	enable/disable protocol lock	pg. 74
Pv	check pump voltage	pg. 69
R	returns a single reading	pg. 55
Sleep	enter sleep mode/low power	pg. 73
Status	retrieve status information	pg. 72
Tv	total volume dispensed	pg. 66
X	stop dispensing	pg. 64

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LED control

L,1   LED on   `default`

L,0   LED off

L,?   LED state on/off?

Example	Response							
L,1	Wait 300ms	**1** Dec	**0** Null					
L,0	Wait 300ms	**1** Dec	**0** Null					
L,?	Wait 300ms	**1** Dec	**?L,1** ASCII	**0** Null	or	Wait 300ms	**1** Dec	**?L,0** ASCII	**0** Null

L,1   **L,0**

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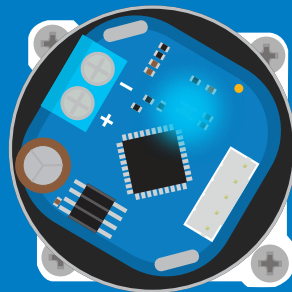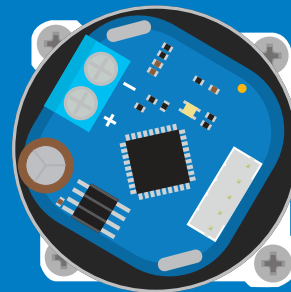
Find

Command syntax

This command will disable continuous mode
Send any character or command to terminate find.

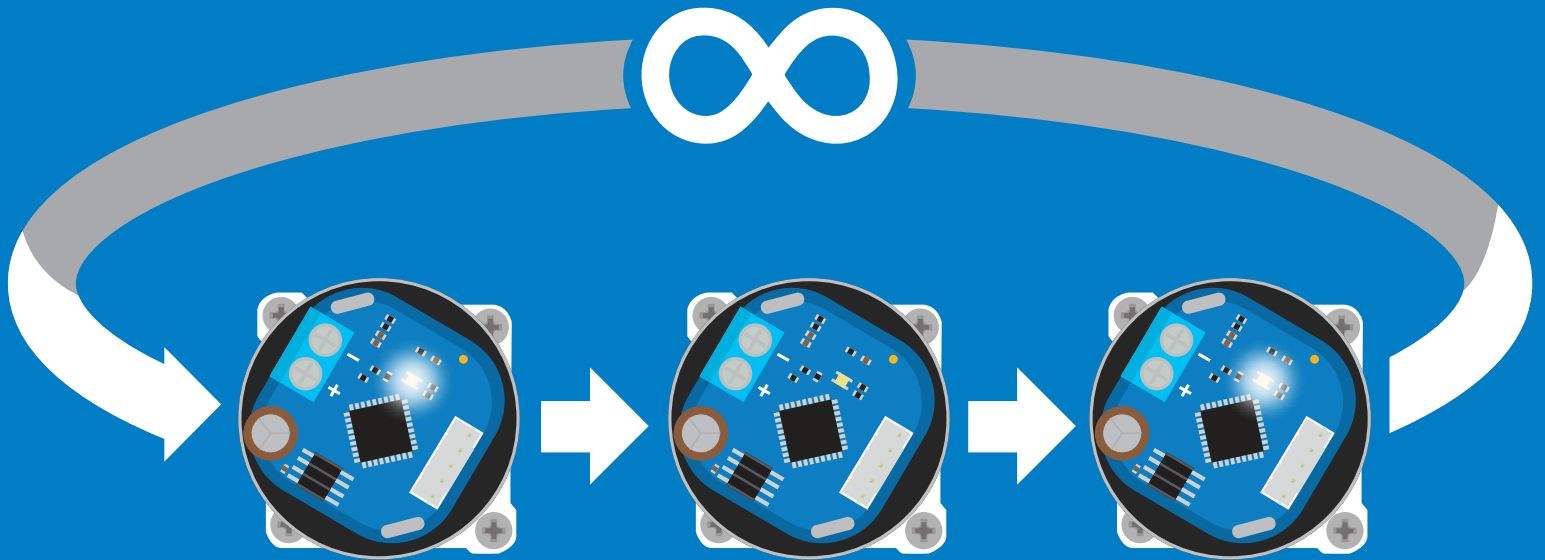**Find**   LED rapidly blinks white, used to help find device

Example   Response

Find

⏱ **Wait 300ms**   **1** Dec   **0** Null

∞

Single report mode

Command syntax　　　　　　300ms ⏱ processing delay

R returns a single value showing dispensed volume
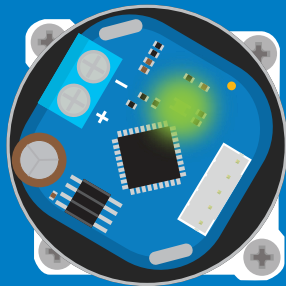
Example　　Response

R

⏱ **Wait 300ms**　| **1** Dec | **25** ASCII | **0** Null | **(If issued half way through dispensing 50ml)**

⏱ **Wait 300ms**　| **1** Dec | **50** ASCII | **0** Null | **(If issued once dispensing has stopped)**

Green
Taking reading
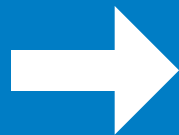
⏱ **Wait 600ms**
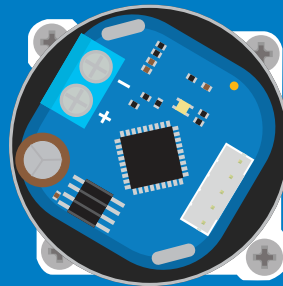
Transmitting

Blue
Standby

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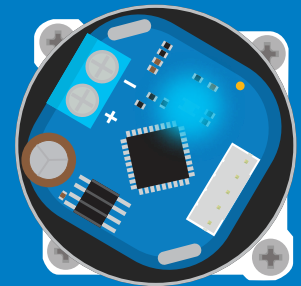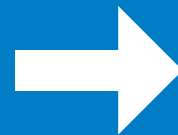
Continuous dispensing

Pump on/pump off

300ms ⏱ **processing delay**

Command syntax

D,* dispense until the stop command is given

D,-* dispense in reverse until the stop command is given

D,? dispense status

Example | Response

Example	Response			
D,*	⏱ Wait 300ms	**1** Dec	**0** Null	pump will continuously run at ~750ml/min (with supplied tubing)
D,-*	⏱ Wait 300ms	**1** Dec	**0** Null	pump will continuously run in reverse at ~750ml/min (with supplied tubing)
D,?	⏱ Wait 300ms	**1** Dec	**?D,*,1** ASCII	**0** Null

Response breakdown

?D,*,1
↑ last volume requested
↑ pump on

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Volume dispensing

Pump a specific volume

300ms ⏱ **processing delay**

Command syntax

where [ml] is any volume in millimeters >= 0.5

D,[ml]   dispense [this specific volume]

D,[-ml]   dispense [*in reverse* this specific volume]

D,?   dispense status

Example | Response

D,15

⏱ **Wait 300ms** | **1** Dec | **0** Null | **15 ml will be dispensed**

D,-40

⏱ **Wait 300ms** | **1** Dec | **0** Null | **40 ml will be dispensed** *in reverse*

D,?

⏱ **Wait 300ms** | **1** Dec | **?D,-40,0** ASCII | **0** Null

Response breakdown

?D,-40,0

↑ last volume dispensed   ↑ pump off

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Dose over time

Pump a fixed volume over a fixed time

Command syntax

300ms ⏱ processing delay

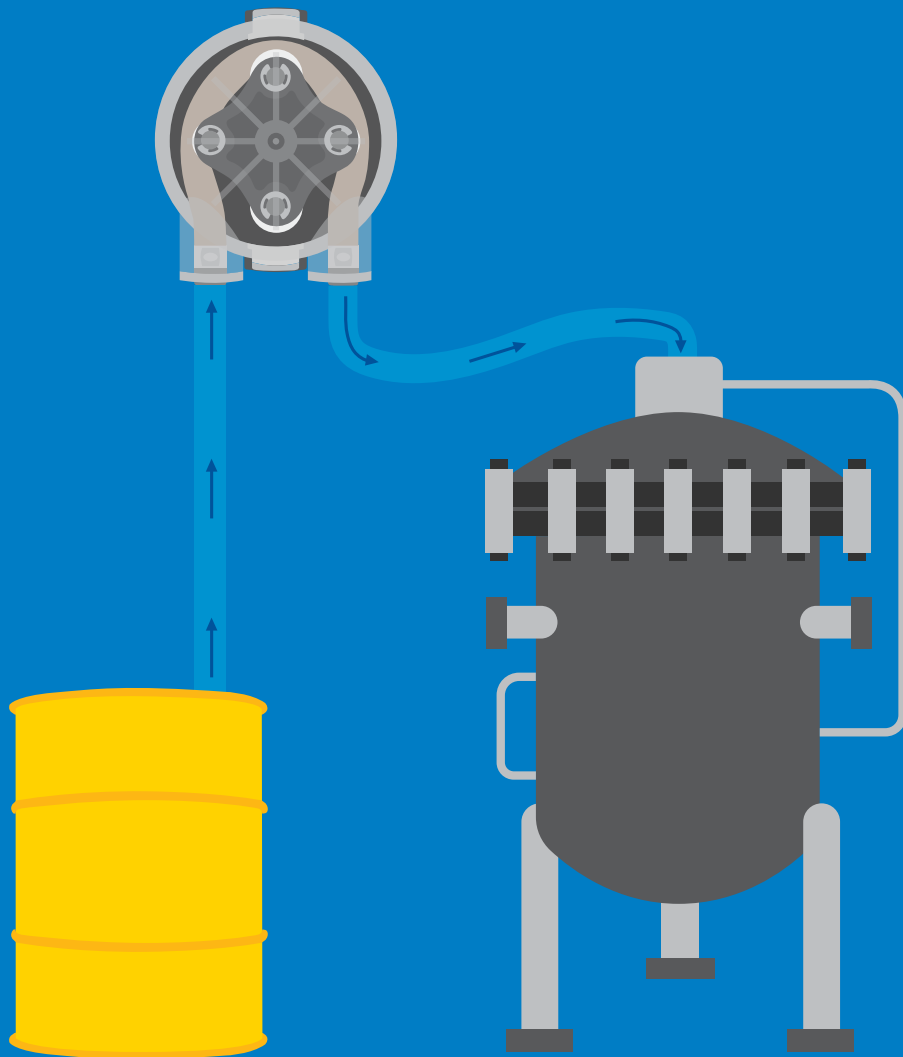**D,[ml],[min]   Dispense [this volume], [over this many minutes]**

Example   Response

D,7000,20

⏱ **Wait 300ms**   **1** Dec   **0** Null   **Dispense 7000ml over 20 mins**

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Constant flow rate

Maintain a constant flow rate

Command syntax

After running in continuous mode for 20 days the EZO-PMP-L™ will reset.

DC,[ml/min], [min or *]   [maintain this rate], [for this much time]

DC,?   reports maximum possible flow rate

[ml/min] = a single number (int or float) representing the desired flow rate
[min or *] = the number of minutes to run or (*) indefinitely
A negative value for ml/min = reverse

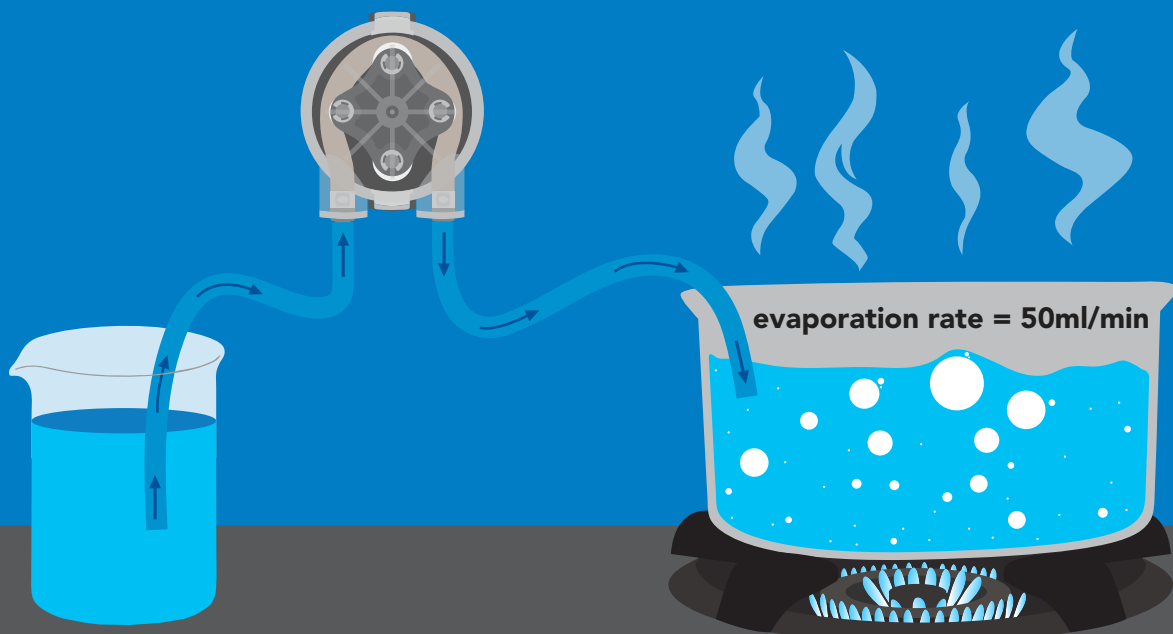| Example	Response			
DC,50,40	⏱ Wait 300ms	**1** Dec	**0** Null	Dispense 50ml per minute for 40 minutes
DC,?	⏱ Wait 300ms	**1** Dec	**?maxrate,385** ASCII	**0** Null —

**The maximum flow rate is determined after calibration.
If the flowrate entered is too fast the EZO-PMP-L™ will send an error.**

***TOOFAST
*ER**

evaporation rate = 50ml/min

flow rate = 50ml/min

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Dispense at startup

Pump a specific volume at startup and then stop

Use this command to make a simple fixed-volume pump

Command syntax   300ms ⏱ processing delay

Dstart,[ml]	dispense [this specific volume] at startup
Dstart,off	disables dispense at startup mode
Dstart,?	startup dispense status

Example   Response
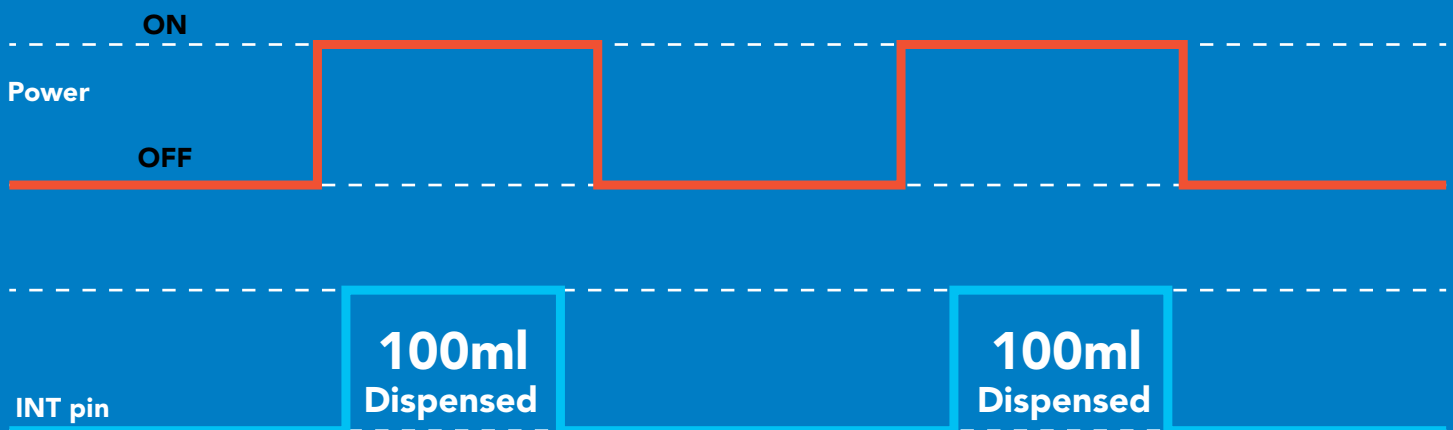
Dstart,100

⏱ Wait 300ms | **1** Dec | **0** Null

Dstart,off

⏱ Wait 300ms | **1** Dec | **0** Null

D,?

⏱ Wait 300ms | **1** Dec | **?Dstart,100** ASCII | **0** Null | or | ⏱ Wait 300ms | **1** Dec | **?Dstart,0** ASCII | **0** Null

ON

Power

OFF

INT pin

100ml Dispensed   **100ml** Dispensed

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Continuous dispensing at startup

Pump on & continuously dispense

300ms ⏱ **processing delay**

Command syntax

After running in continuous mode for 20 days the EZO-PMP-L™ will reset.

Dstart,*	dispense at startup until the stop command is given
Dstart,-*	dispense in reverse at startup until the stop command is given
Dstart,?	startup dispense status

Example   Response

Dstart,*

⏱ Wait 300ms   **1** Dec   **0** Null   Pump will startup and continuously run at ~750ml/min (with supplied tubing)
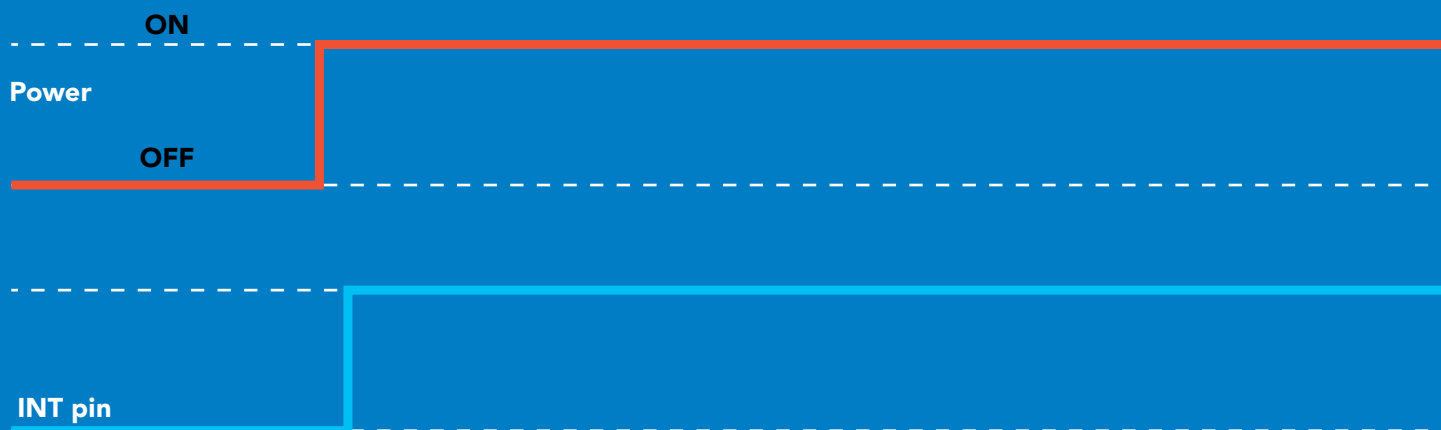
Dstart,-*

⏱ Wait 300ms   **1** Dec   **0** Null   Pump will startup and continuously run in reverse at ~750ml/min (with supplied tubing)

Dstart,?

⏱ Wait 300ms   **1** Dec   **?Dstart,*** ASCII   **0** Null

ON
Power
OFF

INT pin

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Dose Over time at startup

Pump a fixed volume over a fixed time at startup

Command syntax   300ms ⏱ processing delay

D,[ml],[min]   Dispense [this volume], [over this many minutes] at startup

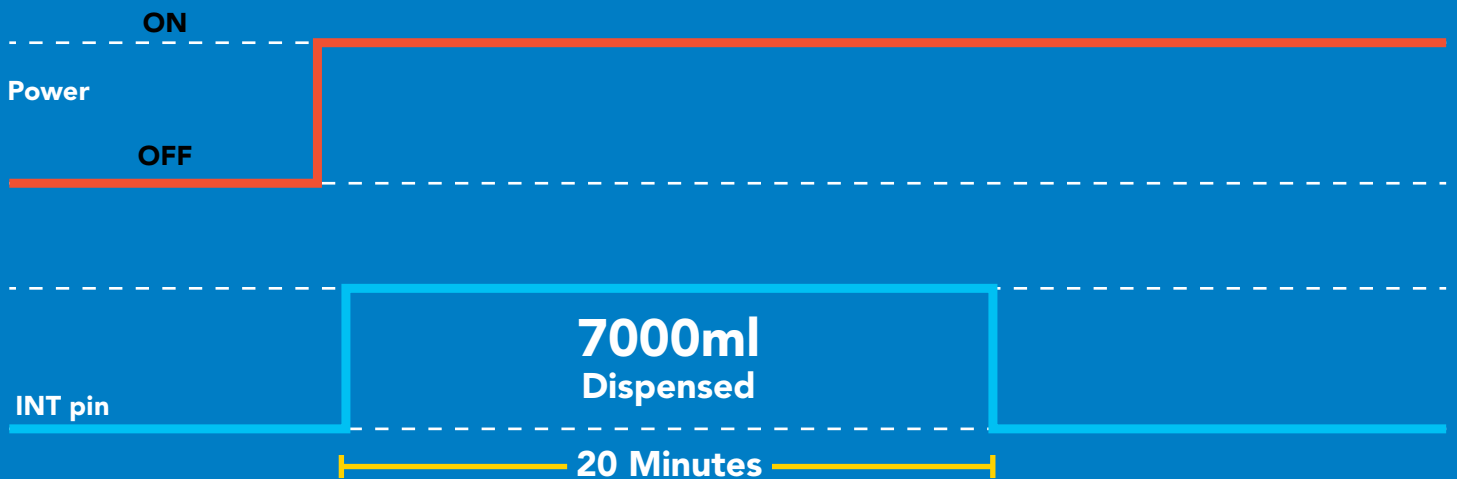## Example   Response

Dstart,7000,20

⏱ **Wait 300ms** | **1** Dec | **0** Null | **Pump will startup and dispense 7000ml over 20 minutes**

Dstart,?

⏱ **Wait 300ms** | **1** Dec | **?Dstart,7000,10.00** ASCII | **0** Null

ON
Power
OFF

INT pin

7000ml
Dispensed

20 Minutes

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Pause dispensing

Command syntax

P   pauses the pump during dispensing

P,?   pause status

Example   ## Response

P

Wait 300ms   **1** Dec   **0** Null

P,?

Wait 300ms   **1** Dec   **?P,1** ASCII paused   **0** Null   **or**   Wait 300ms   **1** Dec   **?P,0** ASCII unpaused   **0** Null

dispensing   **P** →   paused   **P** →   dispensing

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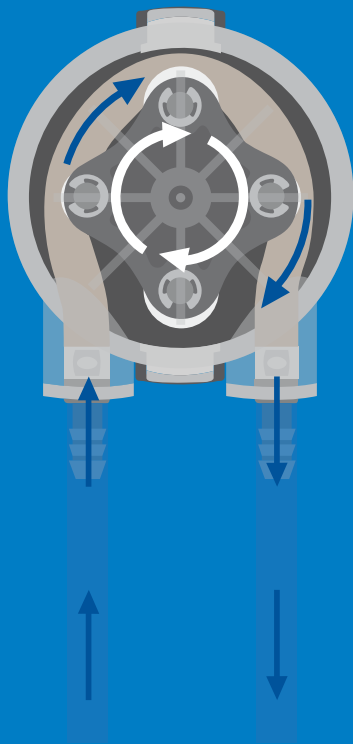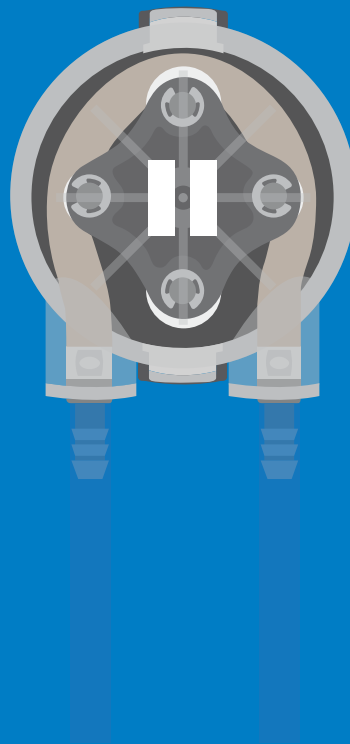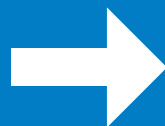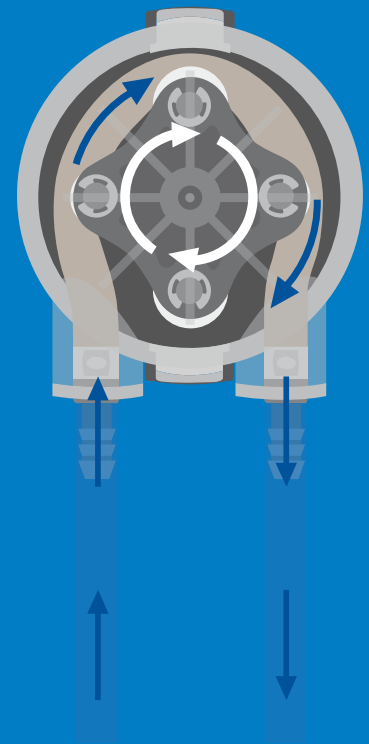
Stop dispensing

Command syntax

300ms ⏱ processing delay

X   stop dispensing

Example

Response

X

⏱ **Wait 300ms** | **1** Dec | ***DONE,v** ASCII | **0** Null | **v = volume dispensed**

X
dispensing

➡

*DONE,645.8
Stopped

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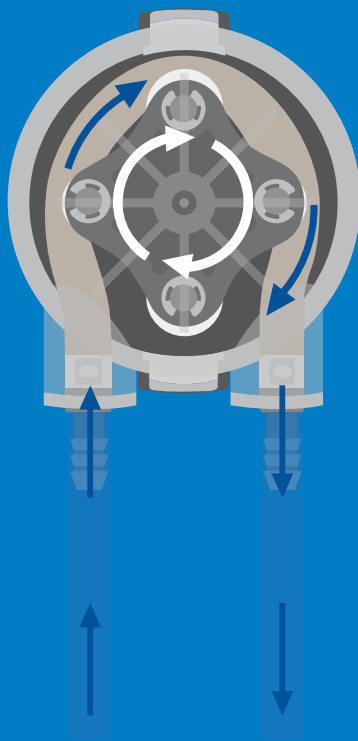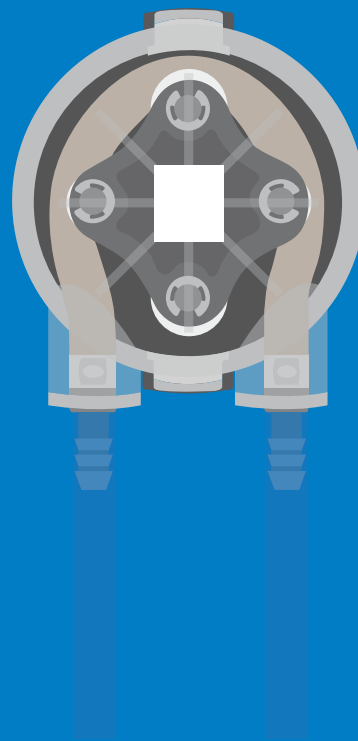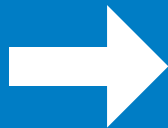
Invert dispensing direction

300ms ⏱ **processing delay**

Command syntax

Invert direction will be retained if power is cut

Invert   changes dispensing direction of pump

Example	Response			

Invert

⏱ **Wait 300ms**   **1** Dec   **0** Null

Invert,?

⏱ **Wait 300ms**   **1** Dec   **?Invert,1** ASCII *inverted*   **0** Null   **or**   ⏱ **Wait 300ms**   **1** Dec   **?Invert,0** ASCII *uninverted*   **0** Null

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Total volume dispensed

Command syntax

TV,?   shows total volume dispensed
ATV,?   absolute value of the total volume dispensed
Clear   clears the total dispensed volume

Example   ## Response

TV,?

⏱ **Wait 300ms** | **1** Dec | ?TV,623.00 ASCII | **0** Null

ATV,?

⏱ **Wait 300ms** | **1** Dec | ?ATV,434.50 ASCII | **0** Null

clear

⏱ **Wait 300ms** | **1** Dec | **0** Null   **total now 0.00**

This data will be lost if the power is cut.

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Calibration

Command syntax

300ms ⏱ processing delay

Calibrate to the actual volume dispensed.

Command	Description
Cal,v	v = corrected volume
Cal,clear	delete calibration data
Cal,?	device calibrated?

Example   Response

Cal,146.2

Wait 300ms   **1** Dec   **0** Null

Cal,clear

Wait 300ms   **1** Dec   **0** Null

Cal,?

Wait 300ms   **1** Dec   **?Cal,1** ASCII (fixed volume)   **0** Null   **or**   Wait 300ms   **1** Dec   **?Cal,2** ASCII (volume/time)   **0** Null

Wait 300ms   **1** Dec   **?Cal,3** ASCII (both)   **0** Null   **or**   Wait 300ms   **1** Dec   **?Cal,0** ASCII (uncalibrated)   **0** Null

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Enable/disable parameters from output string

Command syntax

O, [parameter],[1,0]   enable or disable output parameter
O,?   enabled parameter?

Example	Response	
O,V,1	⏱ Wait 300ms **1** Dec **0** Null	enable volume being pumped
O,TV,0	⏱ Wait 300ms **1** Dec **0** Null	disable total volume pumped
O,ATV,1	⏱ Wait 300ms **1** Dec **0** Null	enable absolute volume pumped
O,?	⏱ Wait 300ms **1** Dec ?,O,V,TV,ATV ASCII **0** Null	if all three are enabled

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Pump voltage

PV,? check pump voltage

Example   Response

PV,?

⏱ **Wait 300ms** | **1** Dec | **?PV,24.67** ASCII | **0** Null

Response breakdown

?PV, 24.67
↑
Pump input voltage

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Naming device

300ms ⏱ processing delay

Command syntax

Name,n	set name	$n =$ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___ ___
Name,	clears name	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Name,?	show name	**Up to 16 ASCII characters**

Example — Response

Name,

⏱ Wait 300ms | **1** Dec | **0** Null → **name has been cleared**

Name,zzt

⏱ Wait 300ms | **1** Dec | **0** Null

Name,?

⏱ Wait 300ms | **1** Dec | **?Name,zzt** ASCII | **0** Null

Name,zzt → **Name,?**

1 **0** → **1** **?Name,zzt** **0**

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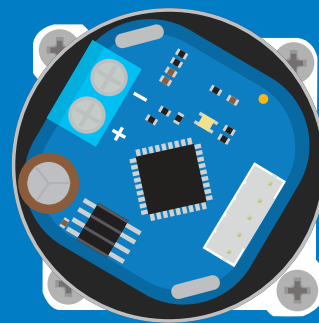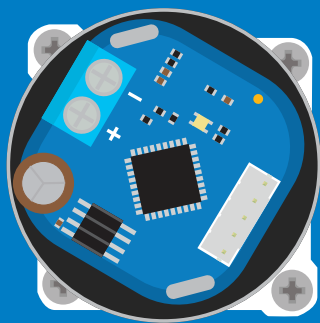
Device information

Command syntax   300ms ⏱ processing delay

i   device information

Example   Response

i

⏱ **Wait 300ms**   **1** Dec   **?i,PMPL, 1.1** ASCII   **0** Null

Response breakdown

?i, PMPL, 1.1
     ↑ Device   ↑ Firmware

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Reading device status

Command syntax

300ms ⏱ processing delay

Status voltage at Vcc pin and reason for last restart

Example   Response

Status

⏱ **Wait 300ms**   **1** Dec   **?Status,P,5.038** ASCII   **0** Null

Response breakdown

?Status,   **P,**   **5.038**

↑ Reason for restart   ↑ Voltage at Vcc

Restart codes

P	powered off
S	software reset
B	brown out
W	watchdog
U	unknown

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Sleep mode/low power

Command syntax

Sleep	enter sleep mode/low power	Send any character or command to awaken device.

Example | Response

Sleep	no response	Do not read status byte after issuing sleep command.
Any command	wakes up device	
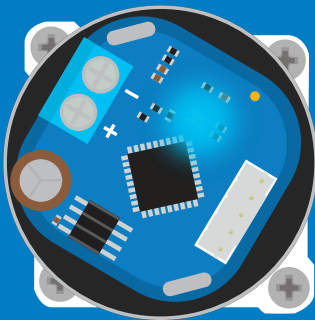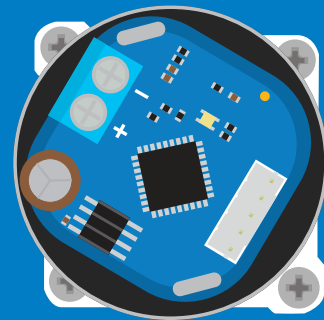
		STANDBY	SLEEP
5V		13.4 mA	0.415 mA
3.3V		12.4 mA	0.13 mA

Sleep

Standby

Sleep

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Protocol lock

Command syntax

Plock,1   enable Plock

Plock,0   disable Plock   **default**

Plock,?   Plock on/off?

Locks device to I²C mode.

Example   Response

Plock,1

Wait 300ms | **1** Dec | **0** Null

Plock,0

Wait 300ms | **1** Dec | **0** Null

Plock,?

Wait 300ms | **1** Dec | **?Plock,1** ASCII | **0** Null

Plock,1   Baud, 9600
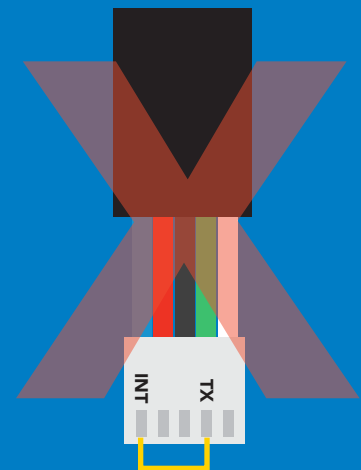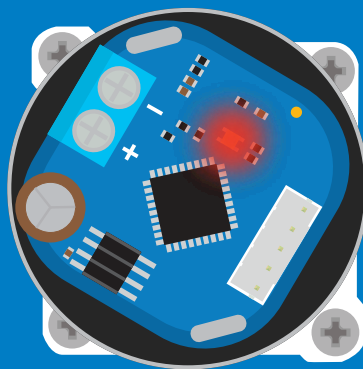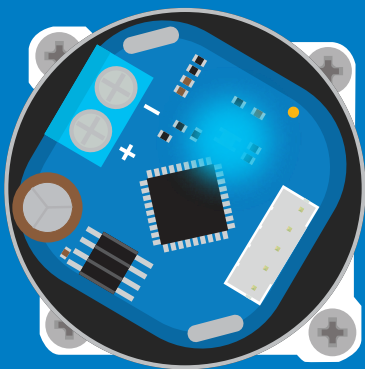
cannot change to UART   cannot change to UART

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I²C address change

I2C,n   sets I²C address and reboots into I²C mode

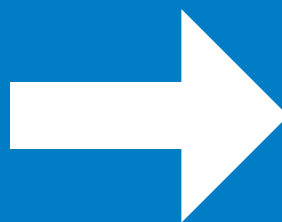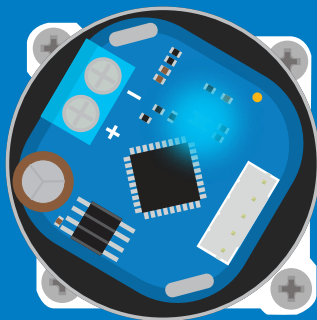| Example	Response
I2C,101	**device reboot** (no response given)

Warning!

Changing the I²C address will prevent communication between the circuit and the CPU until the CPU is updated with the new I²C address.
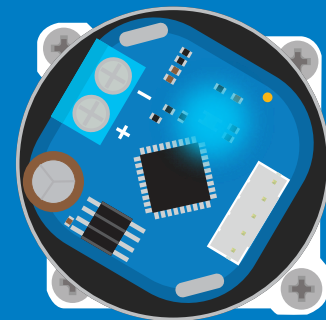
Default I²C address is 109 (0x6D.

n = any number 1 – 127

I2C,101

(reboot)

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Factory reset

Command syntax

Factory   enable factory reset

I²C address will not change

Example	Response
Factory	**device reboot** **(no response given)**

Clears calibration
LED on
Response codes enabled

Factory
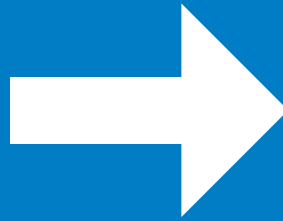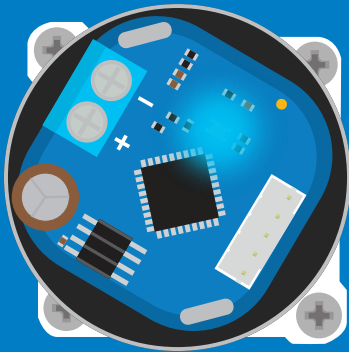
(reboot)
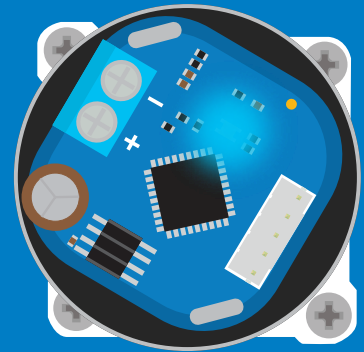
Change to UART mode

Command syntax

Baud,n   switch from I^{2}C to UART

Example	Response
Baud,9600	**reboot in UART mode** **(no response given)**

$$n = \begin{cases} 300 \\ 1200 \\ 2400 \\ 9600 \\ 19200 \\ 38400 \\ 57600 \\ 115200 \end{cases}$$

Baud,9600   **(reboot)**

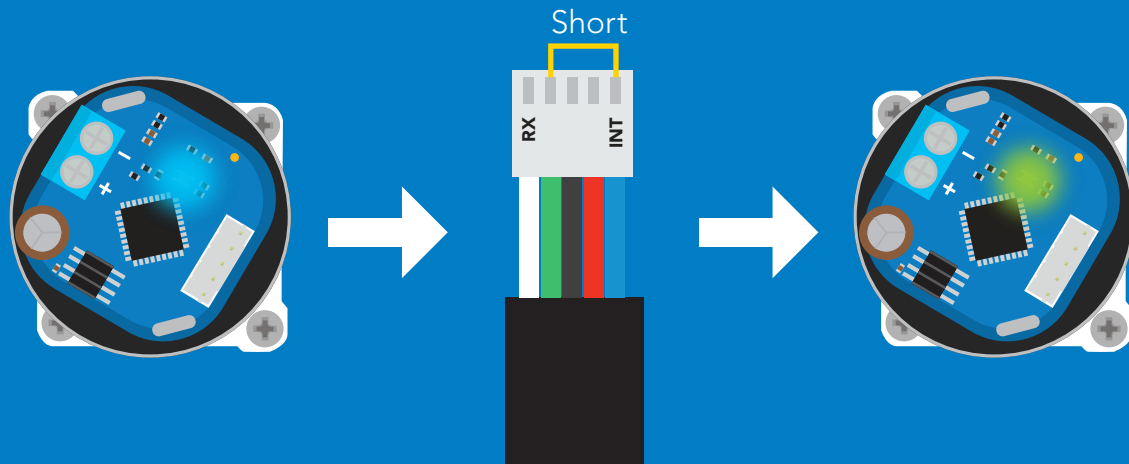**Changing to UART mode**

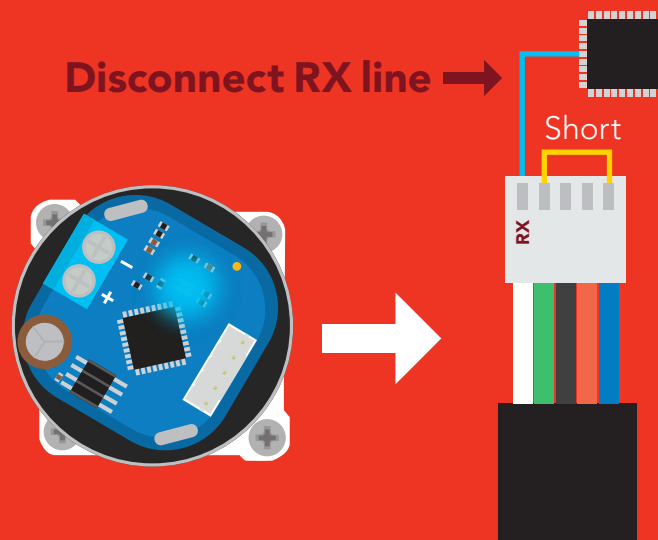AtlasScientific™
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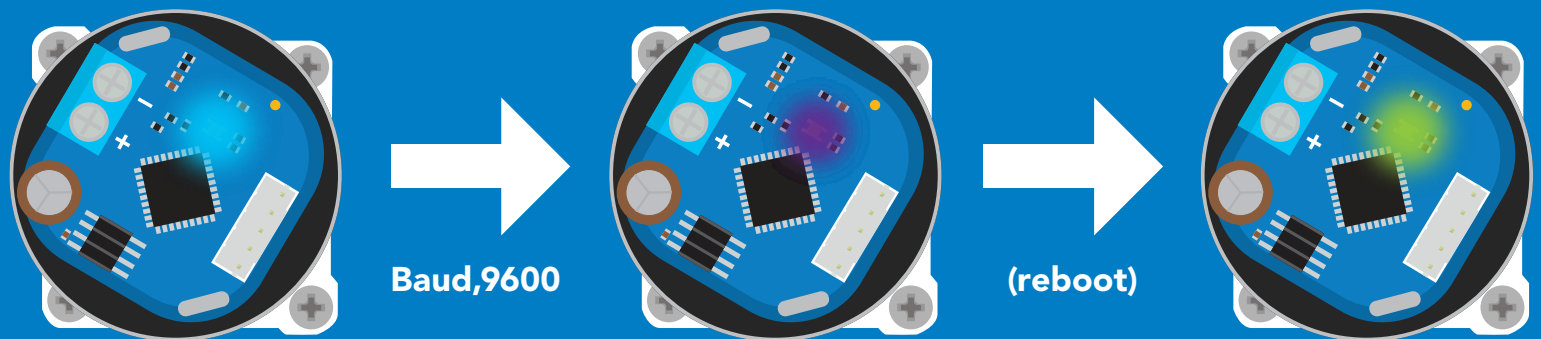
Manual switching to UART

- **Disconnect ground (power off)**
- **Disconnect TX and RX**
- **Connect TX to INT**
- **Confirm RX is disconnected**
- **Connect ground (power on)**
- **Wait for LED to change from Blue to Green**
- **Disconnect ground (power off)**
- **Reconnect all data and power**

Example

Short

RX   INT

Wrong Example

Disconnect RX line

Short

RX

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Calibration theory

Before calibration is attempted all the air bubbles should be removed from the tubing. This is done by running the pump while tapping the tubing. If air bubbles are not removed from the tubing they will slowly group together into larger air bubbles. Over time this will lead to accuracy issues.

Not ready for calibration ✗   ✓ **Ready for calibration**
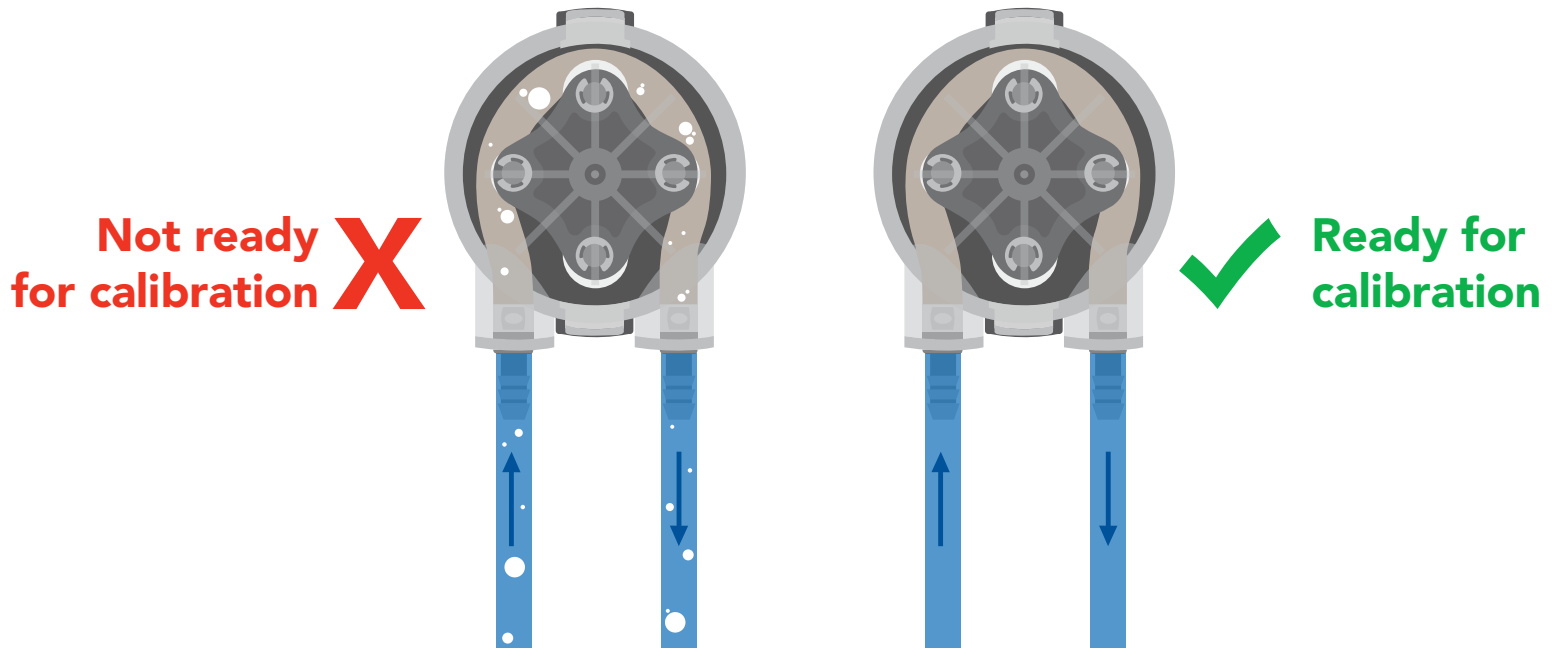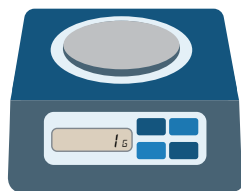
Calibration types

Volume calibration
Volume over time calibration

Calibration is optional. Both types of calibration are independent of each other and can be done at any time. Calibration can be done at any volume however; Atlas Scientific recommends using volumes above 150ml.

Equipment needed for calibration

Or

1 gram of water = 1ml
250 grams of water = 250ml
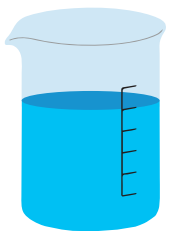
An accurate beaker
of at least 250ml.

An accurate scale with a
resolution of at least 1 gram.

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Calibration procedure

Calibration should be done with water and not a chemical

Make sure the tubing is full of water and has no bubbles before calibrating.
1. Instruct the pump to dispense a volume of water.
2. Measure the dispensed amount to determine how much water was actually dispensed.
3. Calibrate the pump by sending it the volume of liquid you have measured.

Example
Calibrate the pump by dispensing 150ml.

**1** "D,150" 98.1 G   **2** 146.2ml 146.2 G   **3** "Cal,146.2" 146.2 G
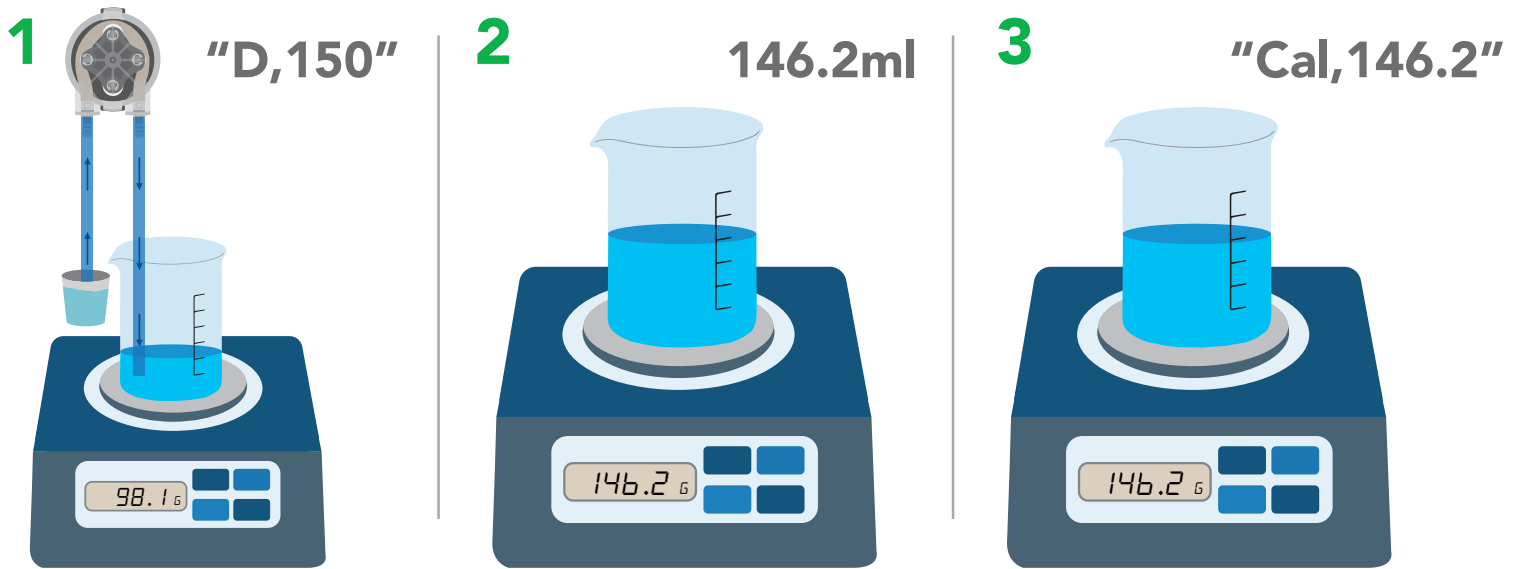
1. Instruct the pump to dispense 150ml into a beaker on a scale.
2. Measure the amount of liquid that was actually dispensed.
3. Inform the pump how much liquid was actually dispensed.
4. Calibration is now complete.

Once the pump has been calibrated it will accurately dispense any volume of liquid. It has not been calibrated specifically to the volume used during the calibration procedure (150ml). It has now been calibrated to all volumes.

Use the same procedure to perform a volume over time calibration.

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Pump speed vs. voltage

There is no change in pump speed at different voltages.

5 RPM = **5 RPM**
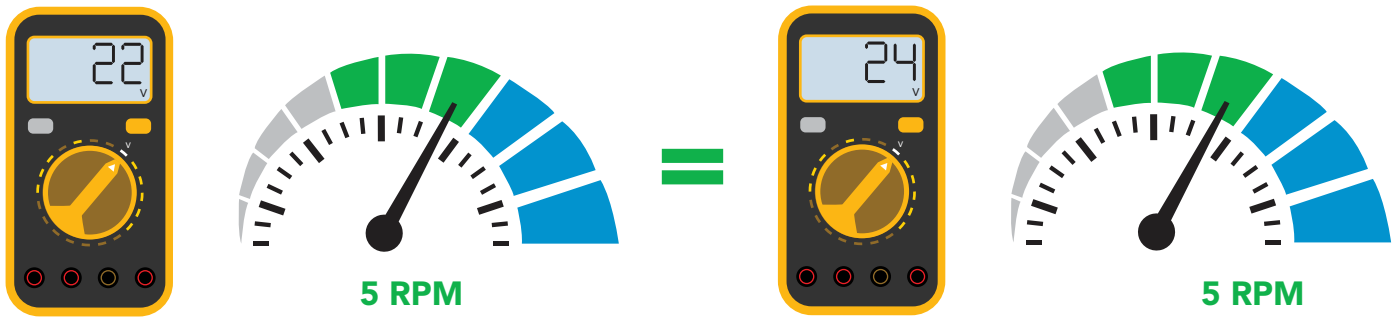
Interrupt pin

When the pump is dispensing the interrupt pin goes high.

"D,150"

INT

*Done

Removing cassette

1
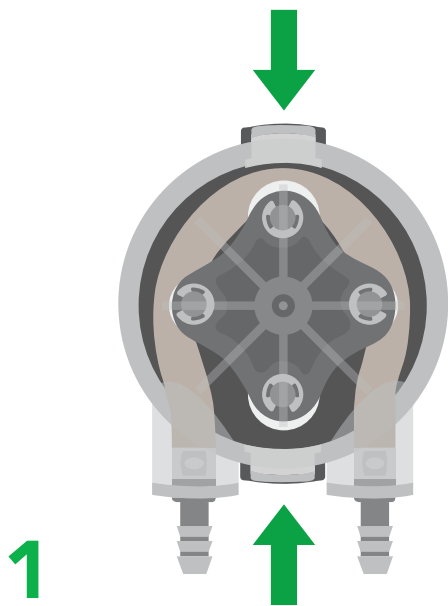
Press both release tabs on the cassette.

2
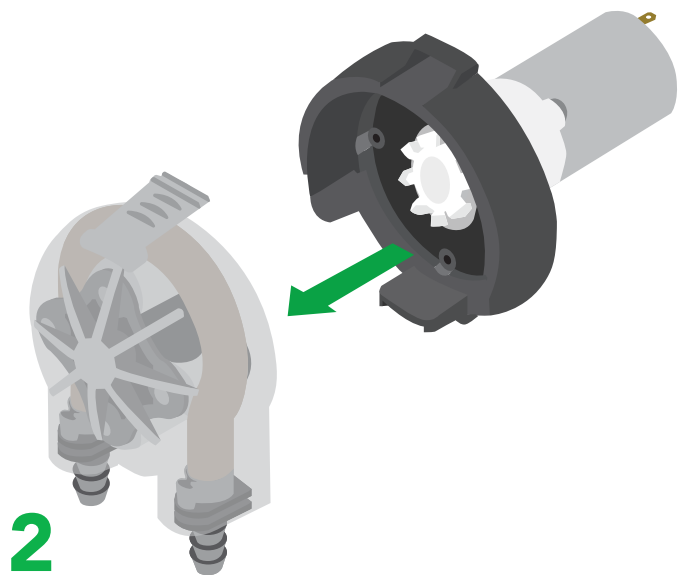
Pull the cassette off of the motor.

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Mounting plate (optional)

The cassette must be removed before you can screw the pump onto the mounting plate. Once the pump has been connected to the mounting plate, reattach the cassette.

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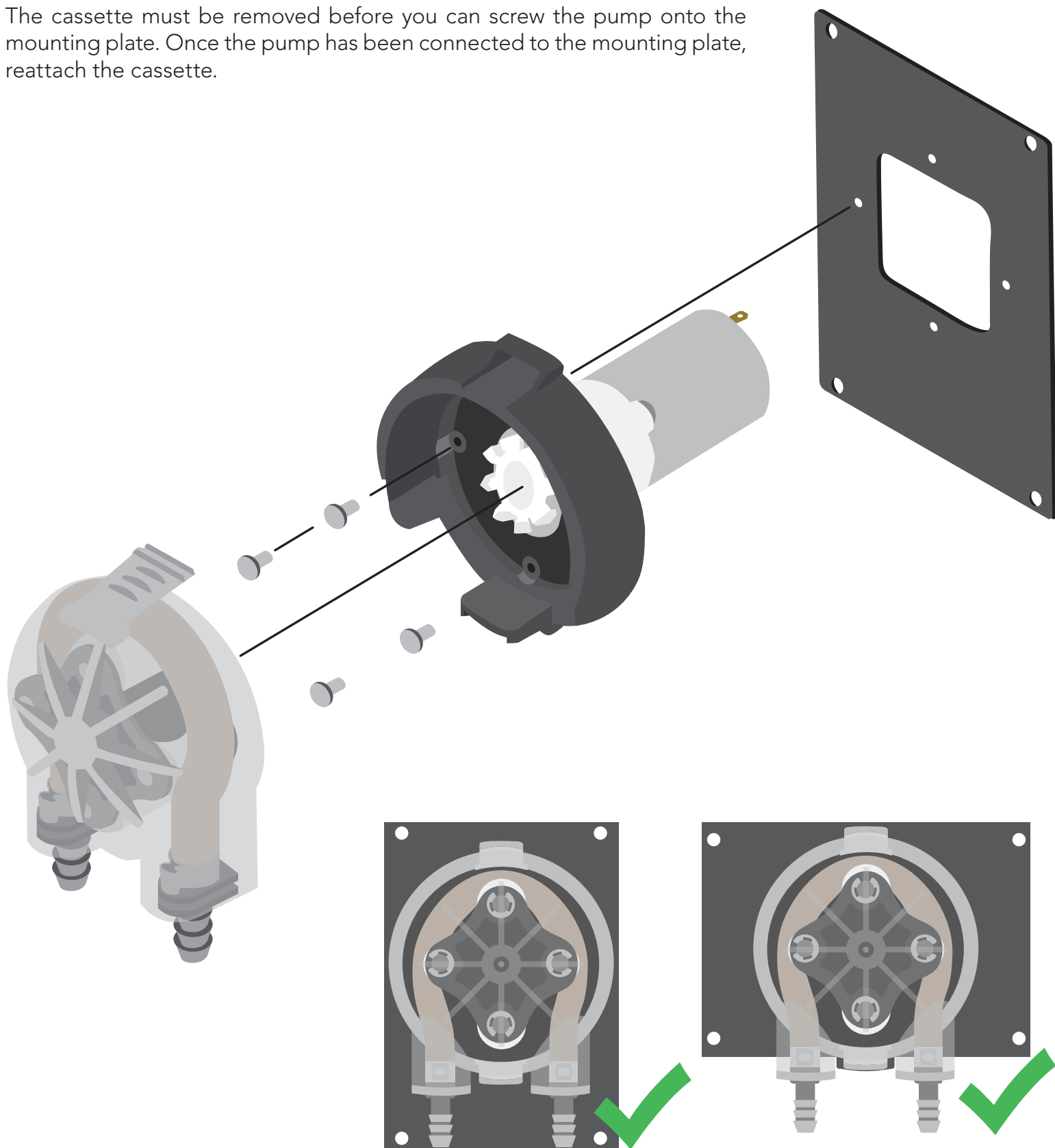
Datasheet change log

Datasheet V 1.4

Added a new page about power supplies on page 8.

Datasheet V 1.3

Revised table of contents and added invert dispensing direction command on pages 30 & 64.

Datasheet V 1.2

Revised naming device info on pages 36 & 67.

Datasheet V 1.1

Added Mounting plate info on pg. 9

Datasheet V 1.0

New Datasheet.

Firmware updates

V1.0 – Initial release (March, 2021)

V1.01 - (May 26, 2021)
- Changed minimum voltage for activation

V1.02 - (Feb 15, 2022)
- Internal update for new part compatibility.

V1.03 - (April 20, 2022)
- Expands dstart command with * and dispense over time

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Warranty

Atlas Scientific™ Warranties the EZO-PMP-L™ Large Embedded Dosing Pump to be free of defect during the debugging phase of device implementation, or 30 days after receiving the EZO-PMP-L™ Large Embedded Dosing Pump (which ever comes first).

The debugging phase

The debugging phase as defined by Atlas Scientific™ is the time period when the EZO-PMP-L™ Large Embedded Dosing Pump is inserted into a bread board, or shield. If the EZO-PMP-L™ Large Embedded Dosing Pump is being debugged in a bread board, the bread board must be devoid of other components. If the EZO-PMP-L™ Large Embedded Dosing Pump is being connected to a microcontroller, the microcontroller must be running code that has been designed to drive the EZO-PMP-L™ Large Embedded Dosing Pump exclusively and output the EZO-PMP-L™ Large Embedded Dosing Pump data as a serial string.

It is important for the embedded systems engineer to keep in mind that the following activities will void the EZO-PMP-L™ Embedded Dosing Pump warranty:

- **Soldering any part of the EZO-PMP-L™ Large Embedded Dosing Pump.**

- **Running any code, that does not exclusively drive the EZO-PMP-L™ Embedded Dosing Pump and output its data in a serial string.**

- **Embedding the EZO-PMP-L™ Large Embedded Dosing Pump into a custom made device.**

- **Removing any potting compound.**

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Reasoning behind this warranty

Because Atlas Scientific™ does not sell consumer electronics; once the device has been embedded into a custom made system, Atlas Scientific™ cannot possibly warranty the EZO-PMP-L™ Large Embedded Dosing Pump, against the thousands of possible variables that may cause the EZO-PMP-L™ Large Embedded Dosing Pump to no longer function properly.

Please keep this in mind:

1. All Atlas Scientific™ devices have been designed to be embedded into a custom made system by you, the embedded systems engineer.

2. All Atlas Scientific™ devices have been designed to run indefinitely without failure in the field.

3. All Atlas Scientific™ devices can be soldered into place, however you do so at your own risk.

Atlas Scientific™ is simply stating that once the device is being used in your application, Atlas Scientific can no longer take responsibility for the EZO-PMP-L™ Large Embedded Dosing Pump continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.

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