Atlas Scientific™
Environmental Robotics

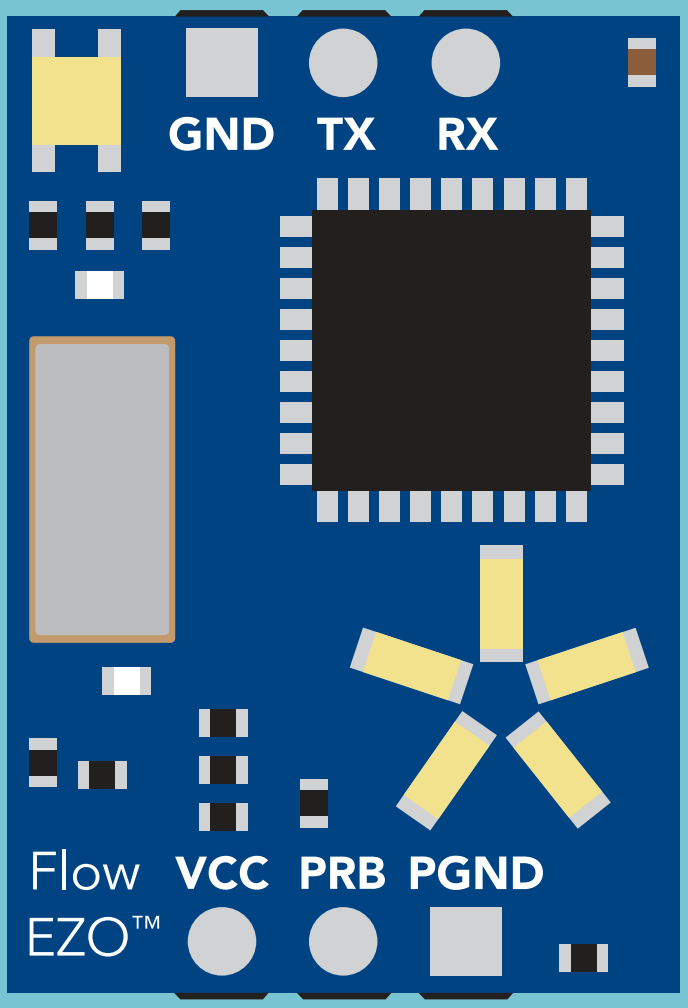
V 2.7

Revised 3/23

EZO-FLO™

Embedded Flow Meter Totalizer

Reads	**Total flow and flow rate**
Preprogrammed	**Works with all Atlas Scientific flow meters**
Programmable	**Can work with most off-the-shelf flow meters**
Visual display	**Real time turbine rotation**
Data protocol	**UART & I²C**
Default I²C address	**104 (0x68)**
Operating voltage	**3.3V – 5V**
Data format	**ASCII**

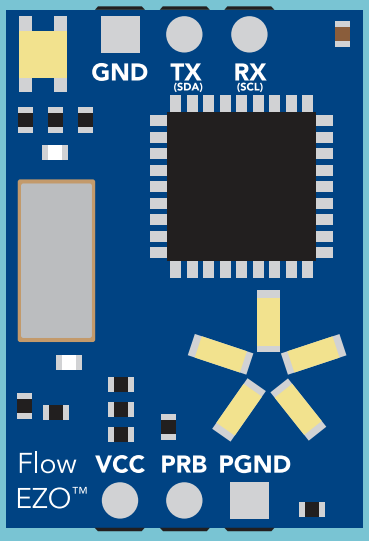


RoHS COMPLIANT

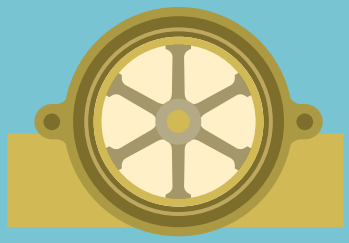
Written by Jordan Press
Designed by Noah Press

This is an evolving document, check back for updates.

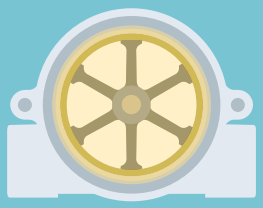
Attention



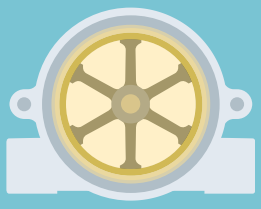
The EZO-FLO™ circuit is fully compatible with any flow meter sold by Atlas Scientific.



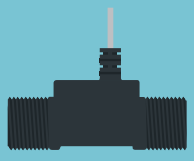
3/4" Flow Meter



1/2" Flow Meter (default)



1/4" Flow Meter



3/8" Flow Meter

See page **16** to see how set the flow meter in **UART mode**

See page **42** to see how set the flow meter in **I²C mode**

The EZO-FLO™ circuit is also compatible with most off the shelf, volumetric flow meters.
See page **59** for more information about how to use the EZO-FLO™ with your own flow meter.

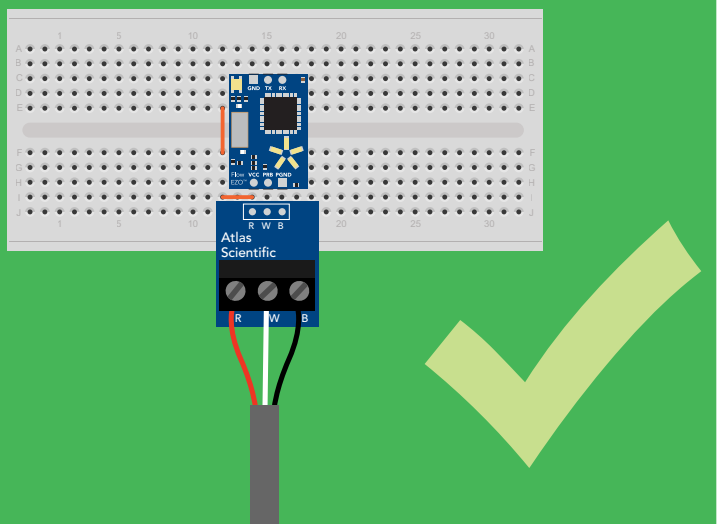
STOP

SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

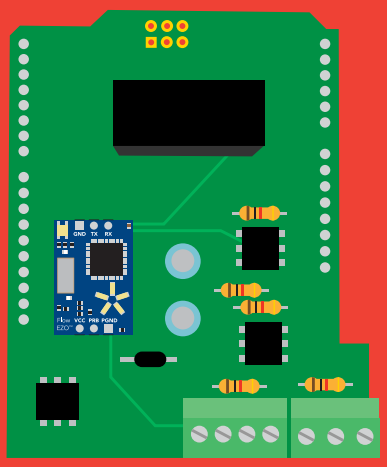
This is sensitive electronic equipment. Get this device working in a solderless breadboard first. Once this device has been soldered, it is no longer covered by our warranty.

This device has been designed to be soldered and can be soldered at any time. Once that decision has been made, Atlas Scientific no longer assumes responsibility for the device's continued operation. The embedded systems engineer is now the responsible party.

Get this device working in a solderless breadboard first!



Do not embed this device without testing it in a solderless breadboard!



r 0.1

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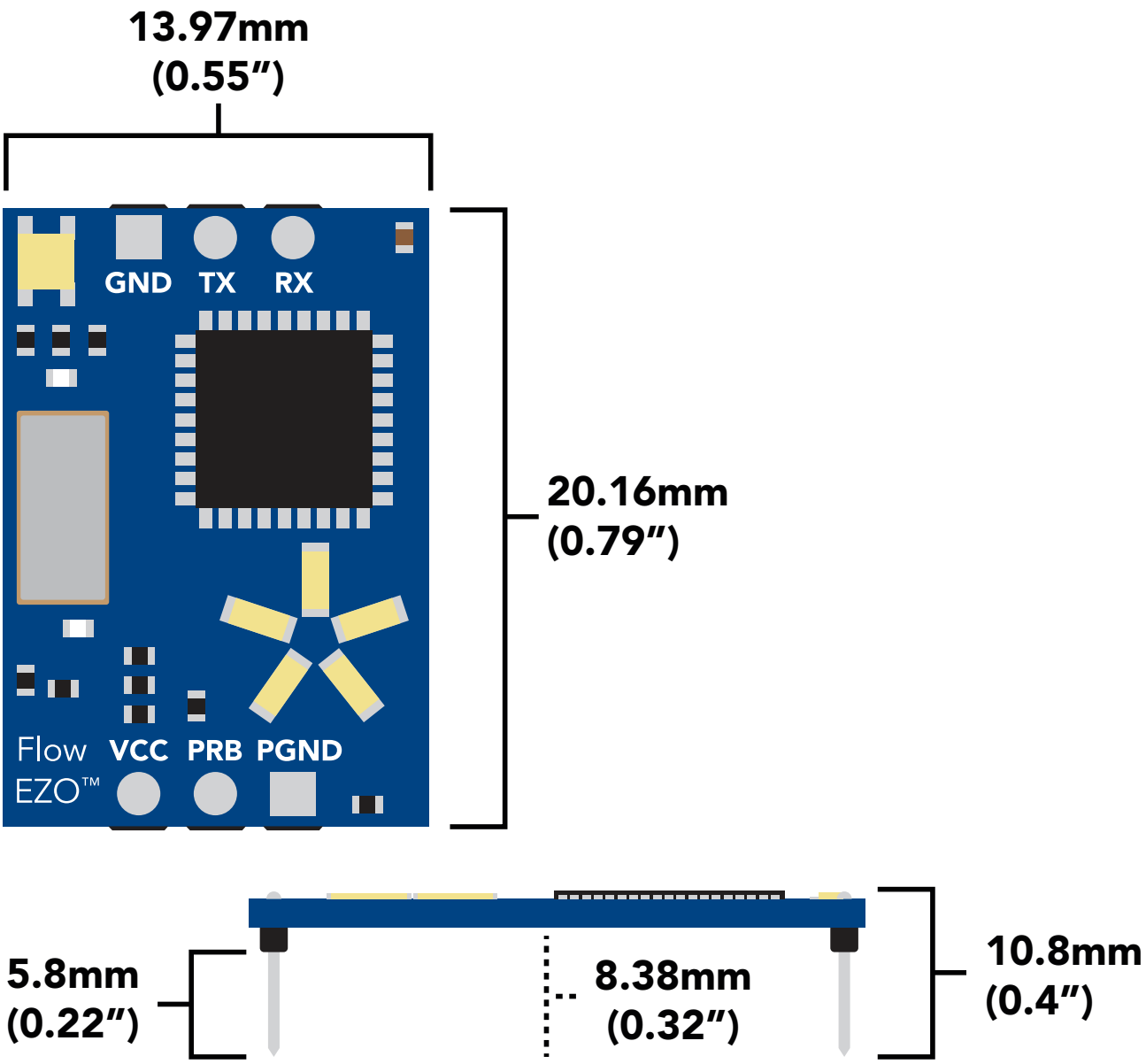
EZO™ circuit dimensions



Power consumption

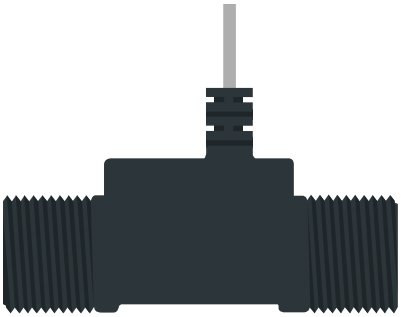
	LED	MAX	STANDBY	SLEEP
5V	ON	21.0 mA	20.5 mA	300µA
	OFF	17.0 mA	16.5 mA	
3.3V	ON	16.6 mA	16.1 mA	131µA
	OFF	15.0 mA	15.0 mA	

Absolute max ratings

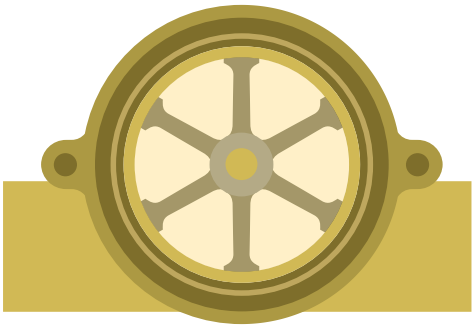
Parameter	MIN	TYP	MAX
Storage temperature (EZO™ FLO)	-40 °C		125 °C
Operational temperature (EZO™ FLO)	-30 °C	25 °C	100 °C
VCC	3.3V	5V	5.5V

Operating principle

The most common types of volumetric flow meters on the market today are turbine and paddled wheel flow meters.

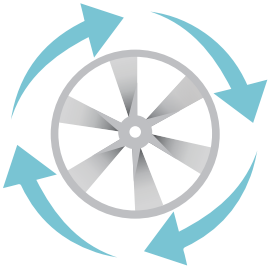


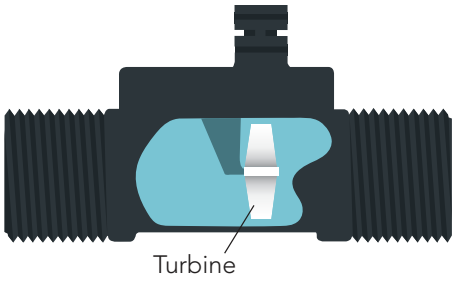
Turbine flow meter



Paddled wheel flow meter

Generally speaking, turbine flow meters are the simplest to work with and offer the highest accuracy. With this type of flow meter, each rotation of the turbine represents a volume of liquid passing through the meter.

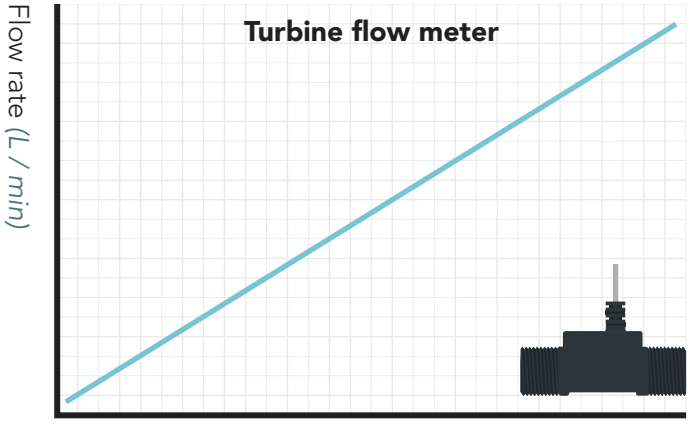




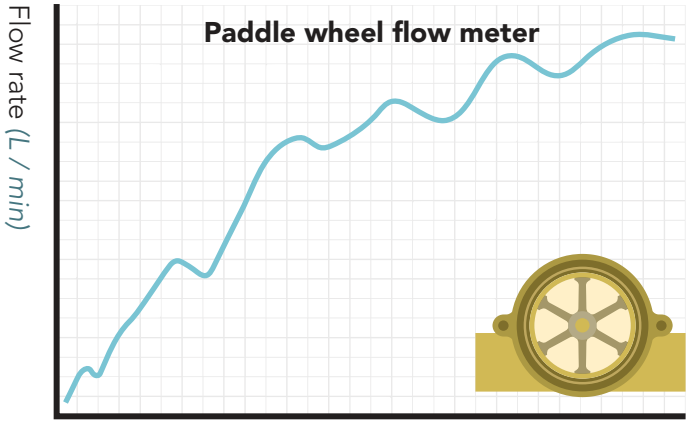
1 rotation = 367µL

Although these flow meters are highly accurate and easy to work with, they are only cost-effective in small sizes. (A turbine flow meter just twice the size of the one pictured above, cost six times as much).

Unlike turbine flow meters, paddled wheel flow meters use frequency to calculate water flow. The frequency is a representation of the water current traveling through the flow meter. Most times the relationship between water current (frequency) and volume is not linear, and complex math must be used to derive the flow rate.



Flow meter output *(Rotation)*



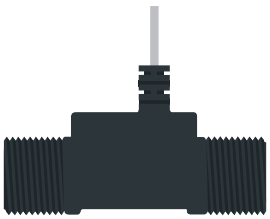
Flow meter output *(Hz)*

No matter what type of flow meter is used, the output from that flow meter must be rapidly calculated and totalized continuously. The computer system that converts the output of a flow meter to a meaningful value is called a flow meter totalizer.

Flow meter totalization should always be done on a separate computer system that has been specifically designed to calculate the flow rate continuously. If not, the engineer runs the risk of missing a few pulses here and there while the computer system is performing other tasks. This can lead to VAST miscalculations in flow rates over a relativity short amount of time.

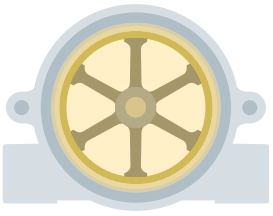
Atlas Scientific flow meters

Although this device can be used with many different types of flow meters, Atlas Scientific has preprogrammed the EZO-FLO™ to work with 4 different types of flow meters. These flow meters have been selected because of their quality, durability, accuracy, and repeatability.



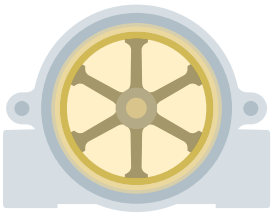
3/8" Flow Meter

Flow rate 760 mL – 7.6 L / min
Accuracy ±2%
Inlet/outlet port 3/8 NPT male
Operating pressure 0 – 200 PSI
Default output Liters / L per min
Operating temperature -20°C to 80°C
Approvals NSF 61 (Drinking Water Safe)



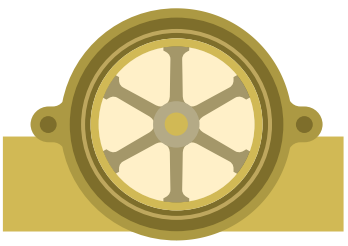
1/4" Flow Meter

Flow rate 378 mL – 19 L / min
Accuracy ±10%
Inlet/outlet port 1/4 NPT female
Operating pressure 0 – 100 PSI
Default output Liters / L per min
Operating temperature -29°C to 82°C
Approvals NSF 61 (Drinking Water Safe)



1/2" Flow Meter

Flow rate 378 mL – 19 L / min
Accuracy ±10%
Inlet/outlet port 1/2 NPT female
Operating pressure 0 – 100 PSI
Default output Liters / L per min
Operating temperature -29°C to 82°C
Approvals NSF 61 (Drinking Water Safe)



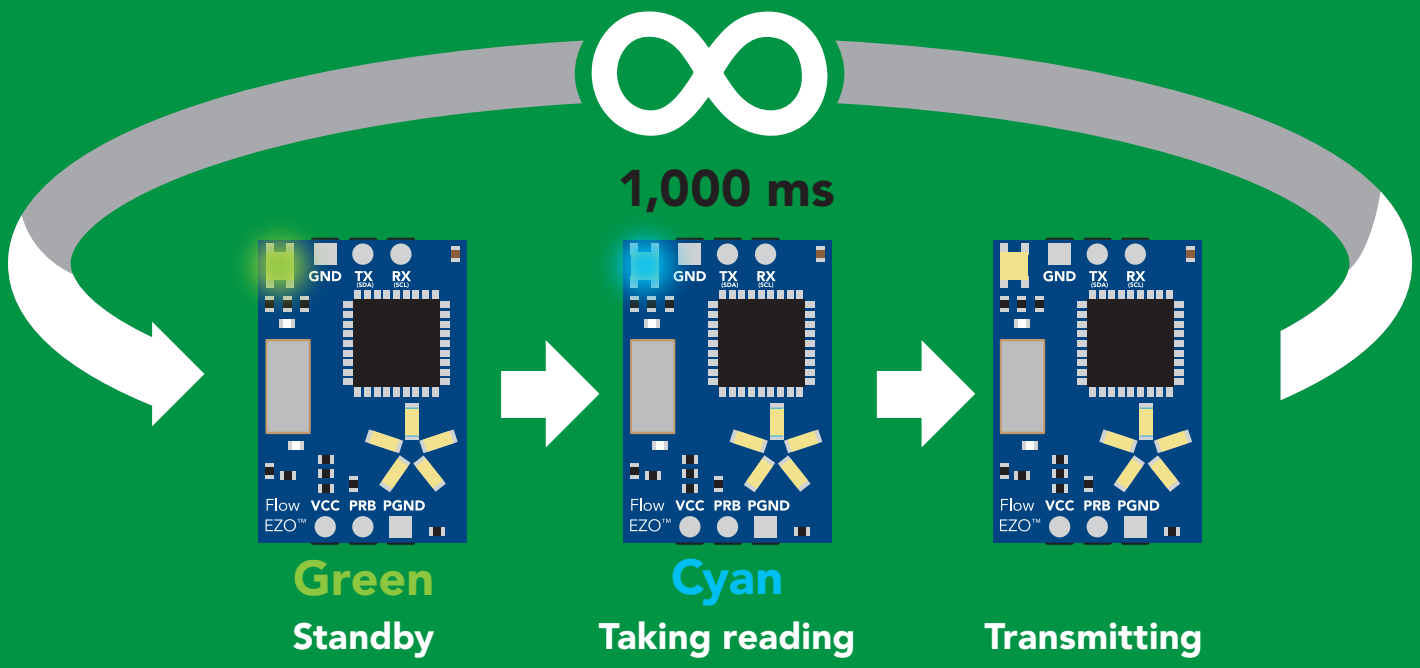
3/4" Flow Meter

Flow rate 19 L – 114 L / min
Accuracy ±10%
Inlet/outlet port 3/4 NPT female
Operating pressure 0 – 200 PSI
Default output Liters / L per min
Operating temperature -29°C to 100°C
Approvals NSF 61 (Drinking Water Safe)

Default state

UART mode

Baud	**9,600**
Readings	**continuous**
Flow meter	**1/2" Flow meter**
Units	**total volume**
Speed	**1 reading per second**
LED	**on**



See page 22 to enable the secondary output:
flow rate per (min, sec or hour)

See page 16 to set your flow meter type.

✓ Available data protocols

UART

Default

I²C

X Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

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UART mode

Settings that are retained if power is cut

Baud rate
Continuous mode
Conversion factor
Device name
Enable/disable response codes
Flow meter settings
Hardware switch to I²C mode
LED control
Protocol lock
Software switch to I²C mode

Settings that are *NOT* retained if power is cut

All calculated flow
Find
Sleep mode

UART mode

8 data bits	no parity
1 stop bit	no flow control

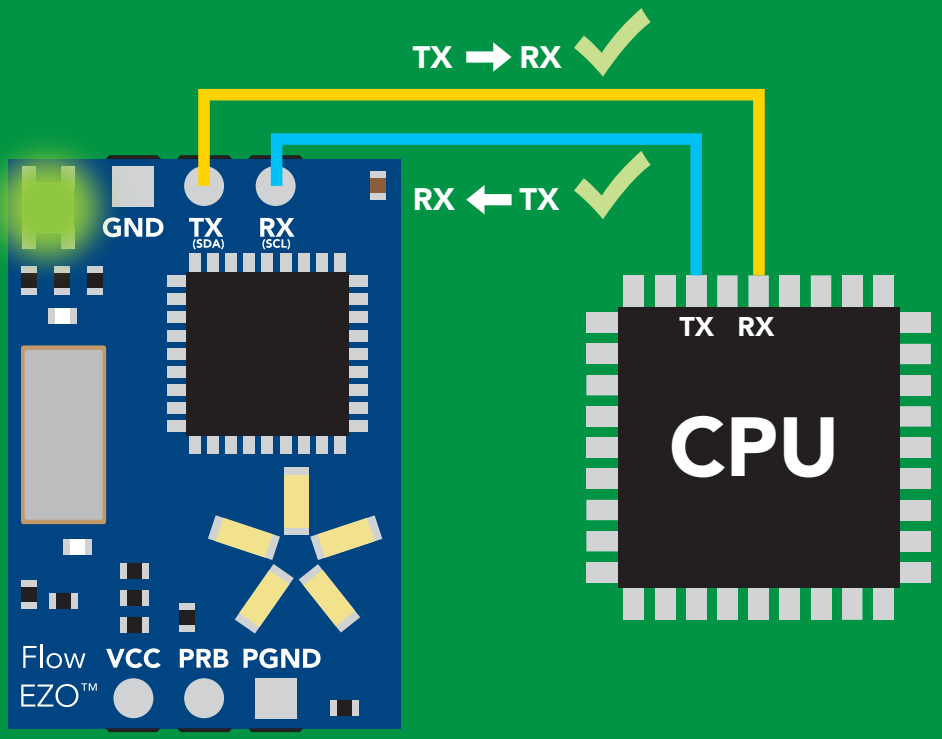
Baud

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



Data format

Reading	Total volume and Flow rate per (sec, min or hour)
Units	Liters and liters per min
Encoding	ASCII
Format	string
Terminator	carriage return
Data type	floating point
Decimal places	2
Smallest string	3 characters
Largest string	32 characters

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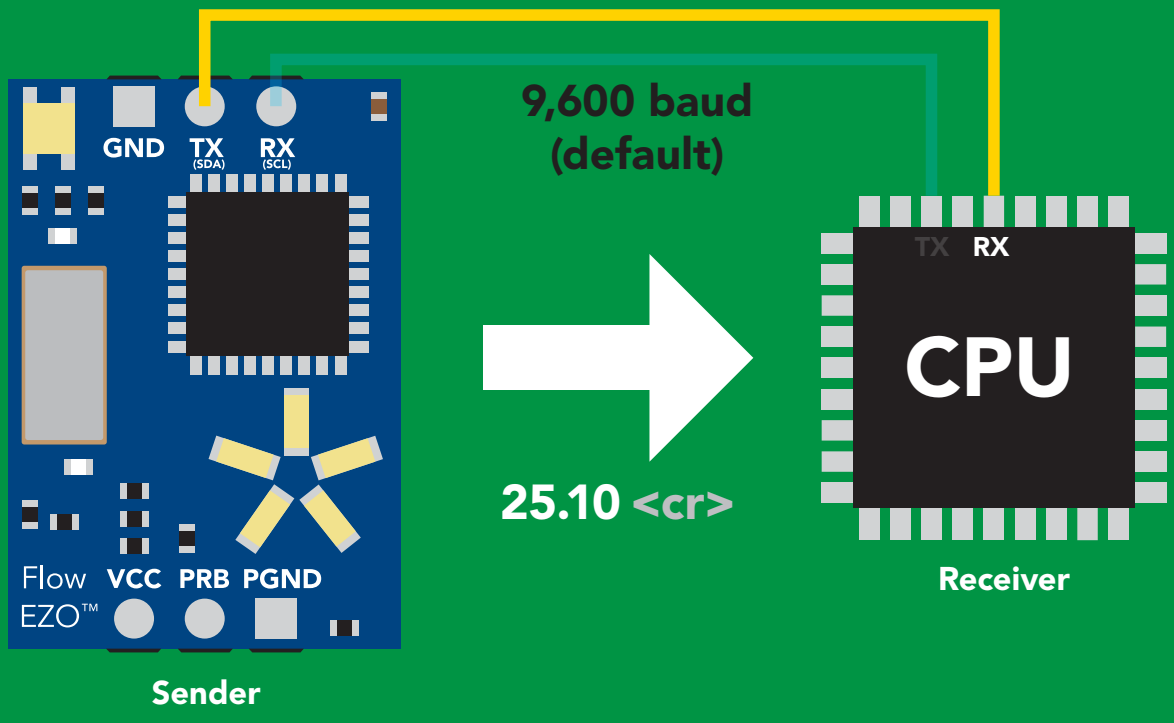
Receiving data from device

2 parts

ASCII data string
Command

Carriage return <cr>
Terminator



Advanced

ASCII:	2	5	.	1	0	<cr>
Hex:	32	35	2E	31	30	0D
Dec:	50	53	46	49	48	13

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Sending commands to device

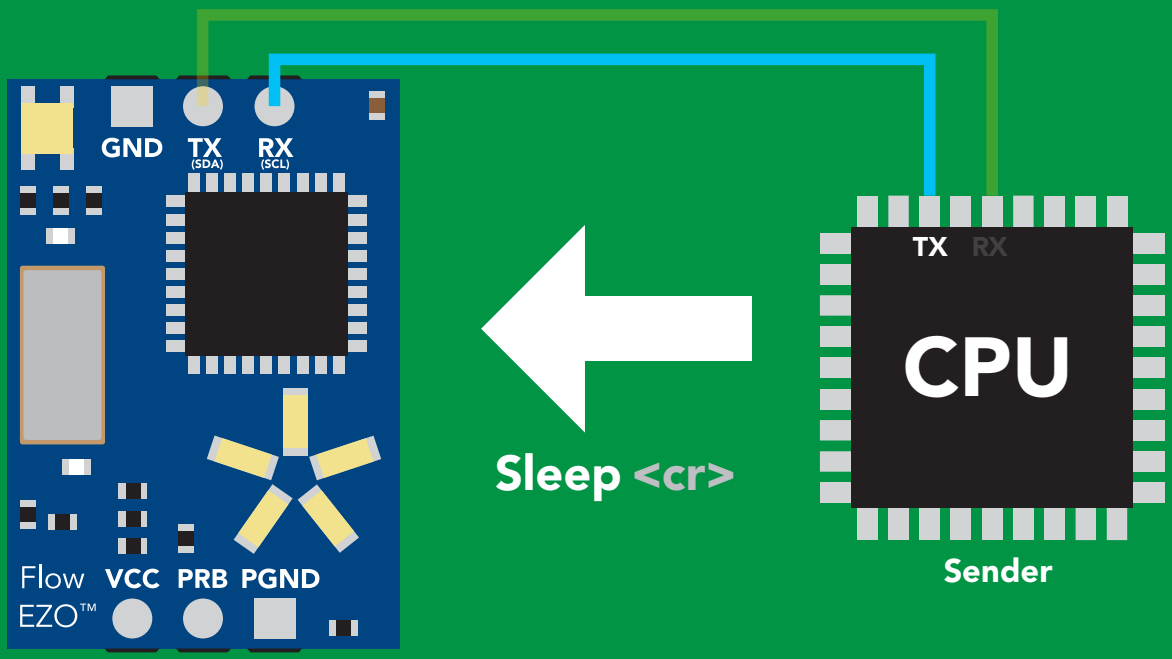
2 parts

Command (not case sensitive)

ASCII data string

Carriage return <cr>

Terminator



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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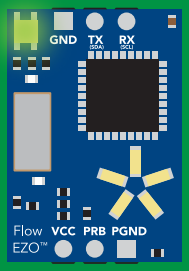
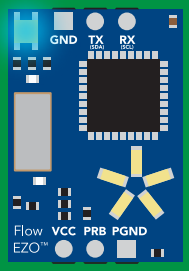
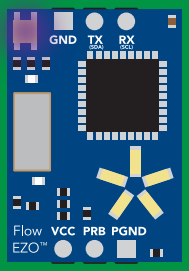
LED color definition



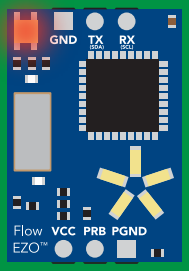
Green
UART standby



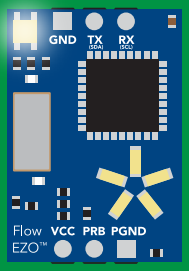
Cyan
Taking reading



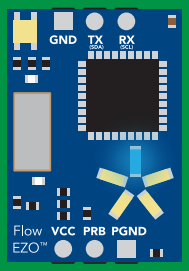
Purple
Changing baud rate



Red
Command not understood



White
Find



Blue
Set flow meter type

	LED ON
5V	**+2.6 mA**
3.3V	**+0.7 mA**

UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function		Default state
Baud	change baud rate	pg. 30	9,600
C	enable/disable continuous reading	pg. 19	enabled
CF	conversion factor	pg. 23	n/a
Clear	clearing the total volume	pg. 21	n/a
Factory	enable factory reset	pg. 32	n/a
Find	finds device with blinking white LED	pg. 18	n/a
Frp	change flow rate calculation	pg. 22	minute
i	device information	pg. 26	n/a
I2C	change to I^2C mode	pg. 33	not set
L	enable/disable LED	pg. 17	enabled
Name	set/show name of device	pg. 25	not set
O	enable/disable parameters	pg. 24	all enabled
Plock	enable/disable protocol lock	pg. 31	disabled
R	returns a single reading	pg. 20	n/a
Set	set flow meter type	pg. 16	n/a
Sleep	enter sleep mode/low power	pg. 29	n/a
Status	retrieve status information	pg. 28	n/a
*OK	enable/disable response codes	pg. 27	enable

Set flow meter type

Command syntax

Set,3/8 <cr> set to 3/8" flow meter

Set,1/4 <cr> set to 1/4" Flow meter

Set,1/2 <cr> set to 1/2" Flow meter **default**

Set,3/4 <cr> set to 3/4" Flow meter

Set,? <cr> show set flow meter

Example	Response
Set,1/4 <cr>	*OK <cr>
Set,? <cr>	?Set,1/4" <cr> (1/4" flow meter) or ?Set,0 <cr> (no flow meter) or Set,custom <cr> (set to a custom flow meter)

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LED control

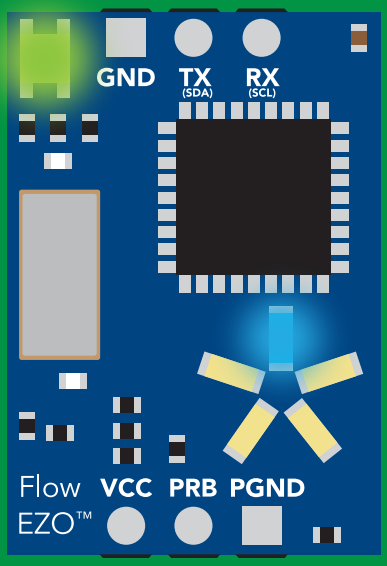
Command syntax

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

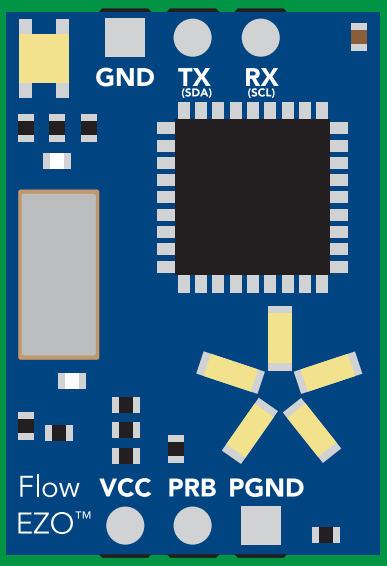
L,0 <cr> LED off

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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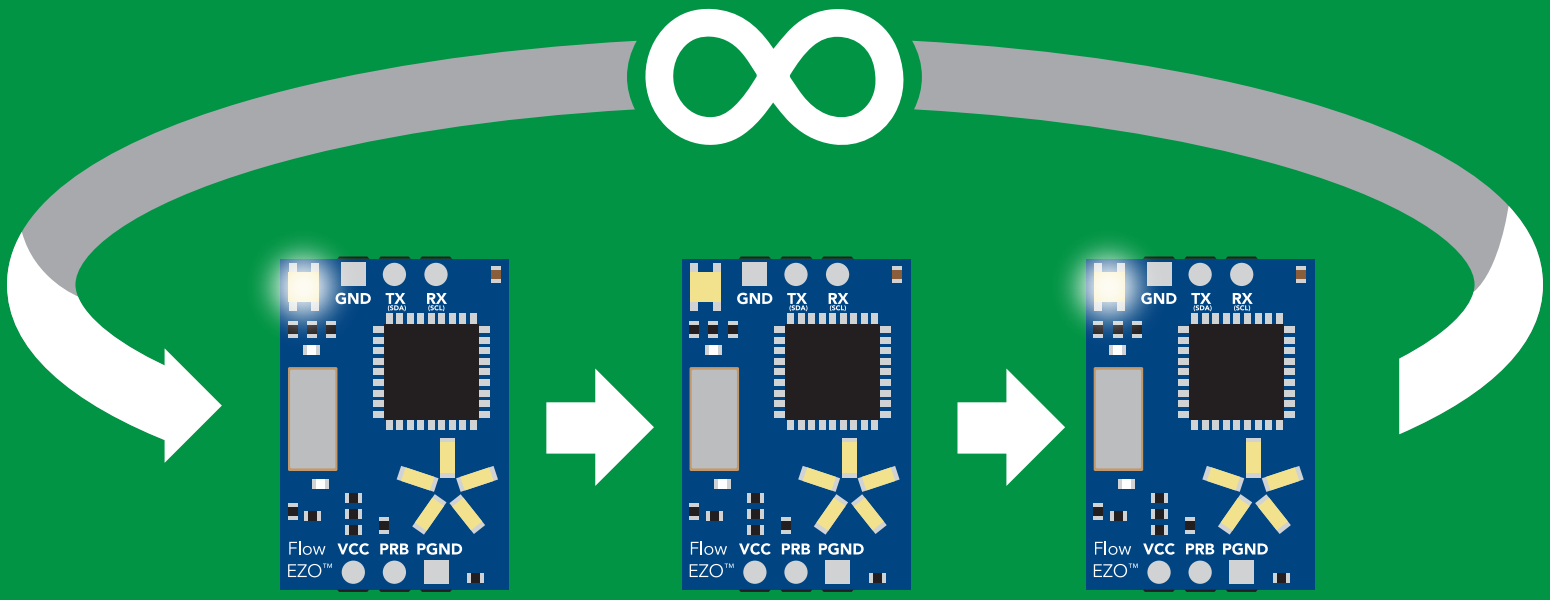
Find

Command syntax

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

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

Example	Response
Find <cr>	***OK** <cr>



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Continuous reading mode

Command syntax

C,1 <cr> enable continuous readings once per second **default**

C,n <cr> continuous readings every n seconds (n = 2 to 99 sec)

C,0 <cr> disable continuous readings

C,? <cr> continuous reading mode on/off?

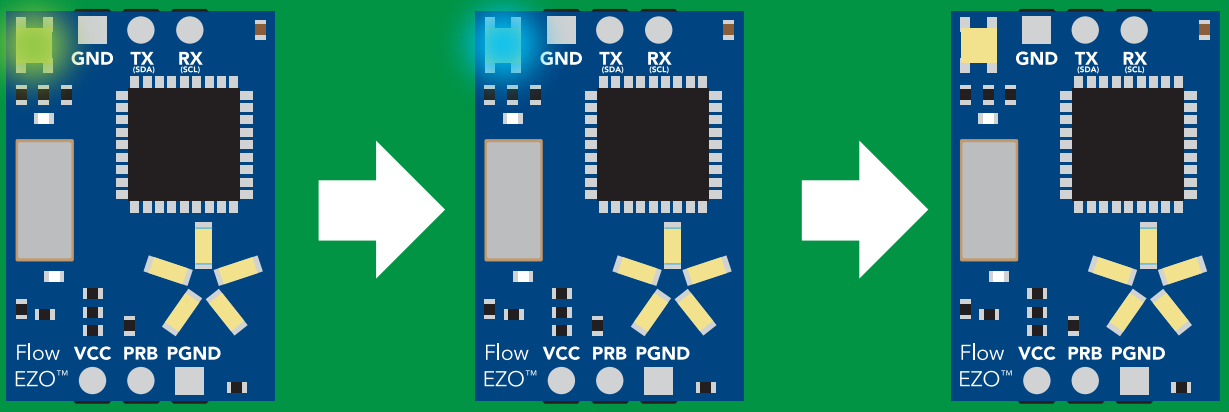
Example	Response
C,1 <cr>	*OK <cr> Volume, flow rate (1 sec) <cr> Volume, flow rate (2 sec) <cr> Volume, flow rate (n sec) <cr>
C,30 <cr>	*OK <cr> Volume, flow rate (30 sec) <cr> Volume, flow rate (60 sec) <cr> Volume, flow rate (90 sec) <cr>
C,0 <cr>	*OK <cr>
C,? <cr>	?C,1 <cr> or ?C,0 <cr> or ?C,30 <cr> *OK <cr>

Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	101.34 <cr> *OK <cr>



Green
Standby

Cyan
Taking reading

Transmitting

600 ms

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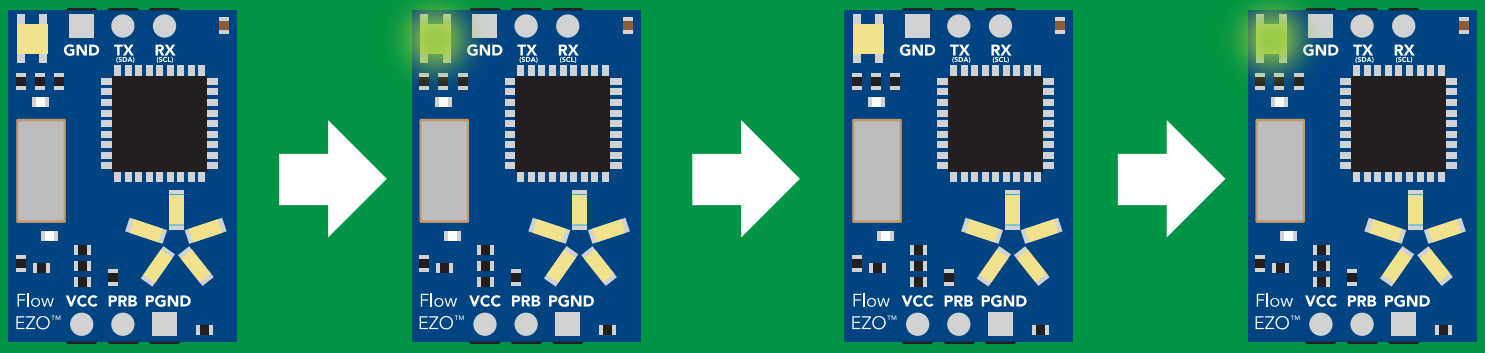
Clearing the total volume

Command syntax

Clear <cr> clears the total volume, resets counter to 0.00

Example	Response
Clear <cr>	*OK <cr>



R <cr> → 534.26 <cr> → Clear <cr> → 0.00 <cr>

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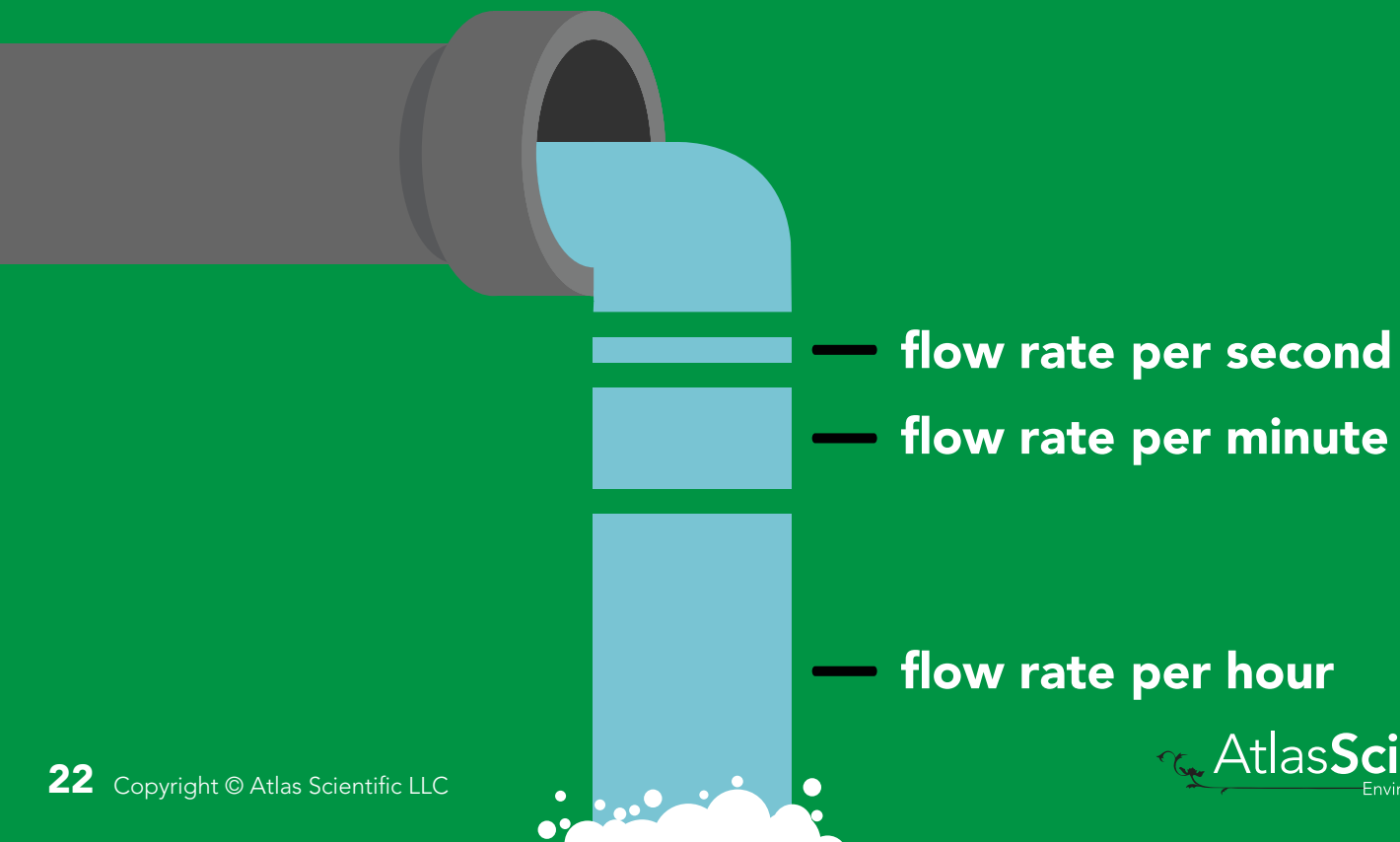
Change flow rate display

This command changes the time base of the flow rate.
Total volume / flow rate

Command syntax

Frp,s	<cr>	calculate flow rate per second
Frp,m	<cr>	calculate flow rate per minute **default**
Frp,h	<cr>	calculate flow rate per hour
Frp,?	<cr>	calculate flow rate per?

Example	Response
Frp,h <cr>	*OK <cr>
Frp,? <cr>	?Frp,h <cr> *OK <cr>



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Conversion factor

By default all readings are in L/LPM. The Conversion factor command lets you convert the readings to a different measurement.

Conversion factor range= 0.001 - 1,000,000

Liters x CF = converted reading

Example conversion factors:
Liters to milliliters =1,000
Liters to gallon = 0.264

Command syntax

default conversion factor = 1

CF,n	<cr>	set conversion factor
CF,?	<cr>	show conversion factor

Example	Response
R <cr>	5.74 (liters) <cr> *OK <cr>
CF, 0.264 <cr>	*OK <cr>
R <cr>	1.51 (gallons) <cr> *OK <cr>
CF, ? <cr>	?CF,0.264 <cr> *OK <cr>

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,TV,1 / O,TV,0 <cr>	*OK <cr> enable / disable total volume
O,FR,1 / O,FR,0 <cr>	*OK <cr> enable / disable flow rate
O,? <cr>	?O,TV,FR <cr> if both are enabled

Parameters

TV	total volume
FR	flow rate

Followed by 1 or 0

1	enabled
0	disabled

* If you disable all possible data types your readings will display "no output".

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Naming device

Command syntax

Do not use spaces in the name

Name,n	<cr>	set name
Name,	<cr>	clears name
Name,?	<cr>	show name

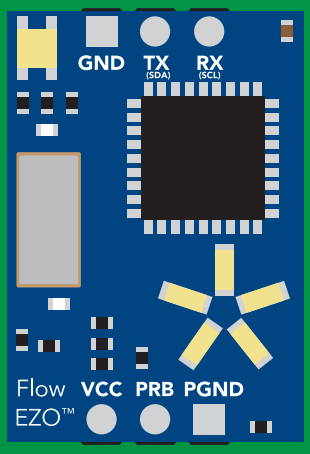
n =

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

Up to 16 ASCII characters

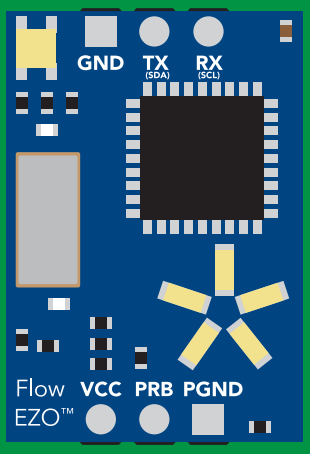
Example		Response	
Name,	<cr>	*OK <cr>	name has been cleared
Name,zzt	<cr>	*OK <cr>	
Name,?	<cr>	?Name,zzt <cr> *OK <cr>	

Name,zzt



*OK <cr>

Name,?



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

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Device information

Command syntax

i <cr> **device information**

Example	Response
i <cr>	?i,FLO,2.00 <cr> *OK <cr>

Response breakdown

?i,	FLO,	2.00
	↑ Device	↑ Firmware

Response codes

Command syntax

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

Example	Response
R <cr>	25.10 <cr> *OK <cr>
*OK,0 <cr>	no response, *OK disabled
R <cr>	25.10 <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

These response codes cannot be disabled

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

- P, ↑ Reason for restart
- 5.038 ↑ Voltage at Vcc

Restart codes

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

Sleep mode/low power

Command syntax

Send any character or command to awaken device.

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	16.9 mA	300µA
3.3V	13.2 mA	131µA

Standby
15.40 mA

Sleep
3.00 mA

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Change baud rate

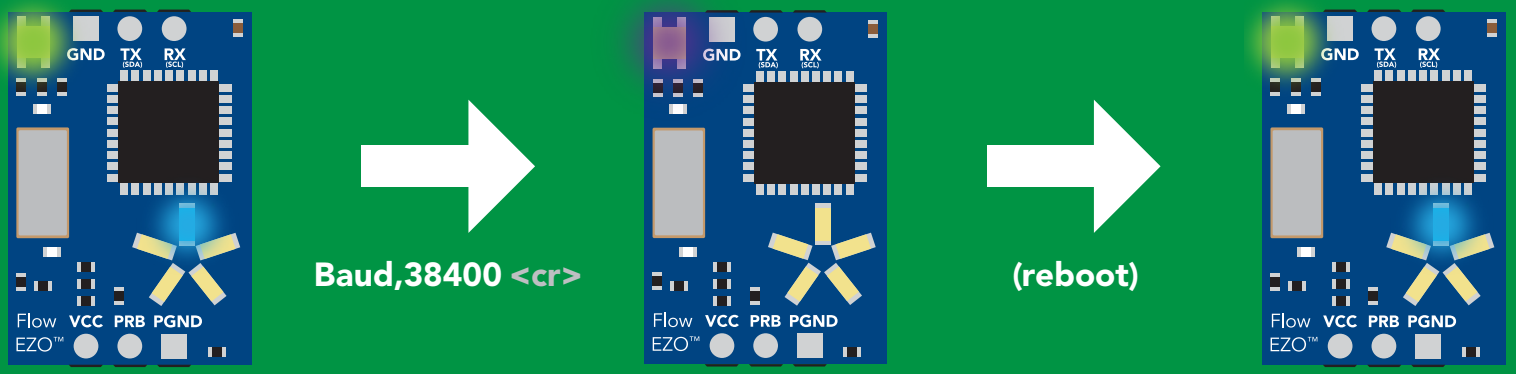
Command syntax

Baud,n <cr> change baud rate

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

Changing baud rate

*OK <cr>

Standby

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Protocol lock

Command syntax

Locks device to UART mode.

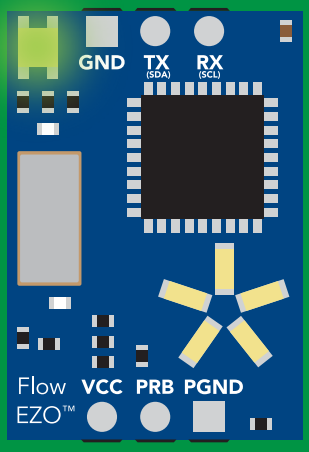
Plock,1 <cr> enable Plock

Plock,0 <cr> disable Plock **default**

Plock,? <cr> Plock on/off?

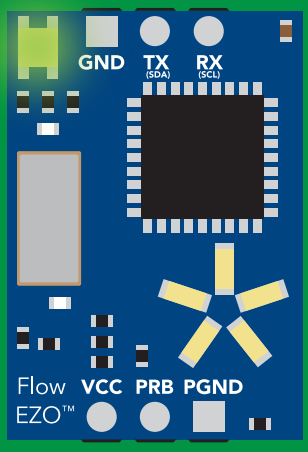
Example	Response
Plock,1 <cr>	*OK <cr>
Plock,0 <cr>	*OK <cr>
Plock,? <cr>	?Plock,1 <cr> or ?Plock,0 <cr>

Plock,1



*OK <cr>

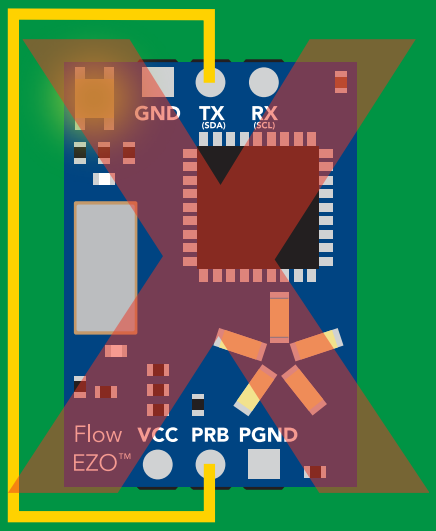
I2C,100



cannot change to I²C

*ER <cr>

Short



cannot change to I²C

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Factory reset

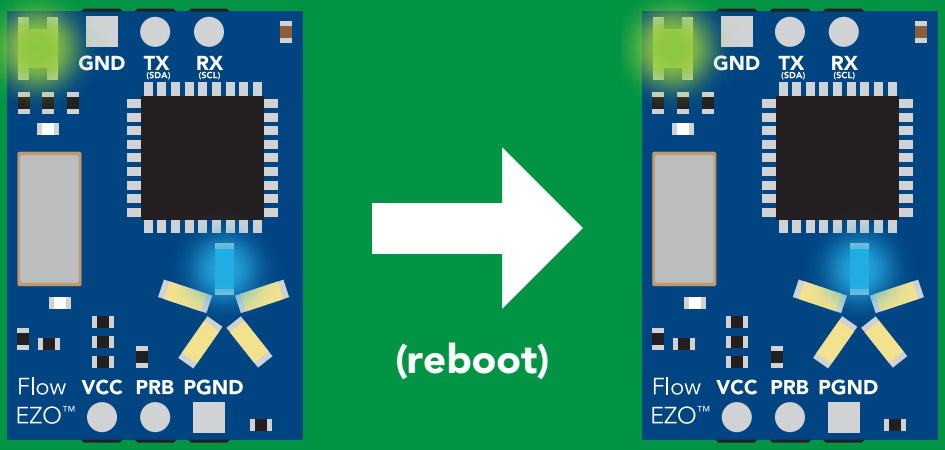
Clears all flow meter settings
Total volume
LED on
"*OK" enabled

Command syntax

Factory <cr> enable factory reset

Example	Response
Factory <cr>	*OK <cr>

Factory <cr>



*OK <cr>

*RS <cr>
*RE <cr>

Baud rate will not change

Change to I²C mode

Command syntax

Default I²C address 104 (0x68)

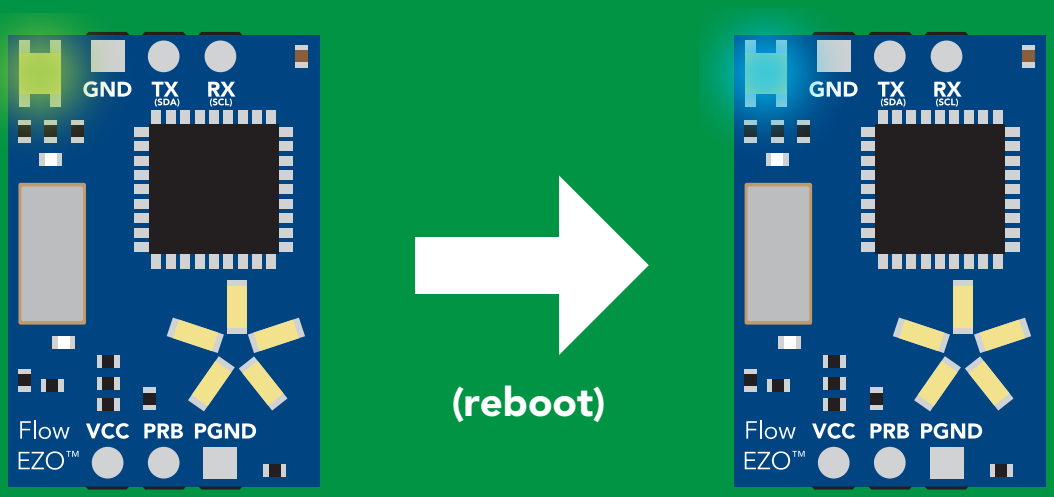
I2C,n <cr> sets I²C address and reboots into I²C mode

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



Green
*OK <cr>

Blue
now in I²C mode

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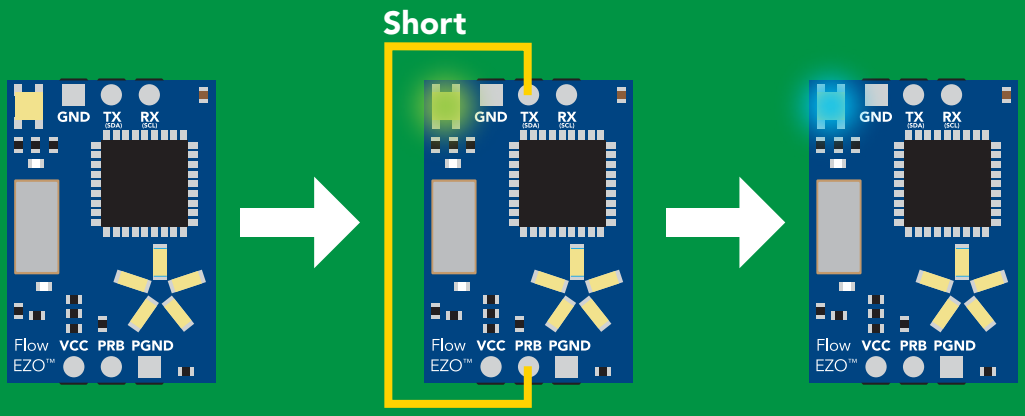
Manual switching to I²C

- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PRB
- 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

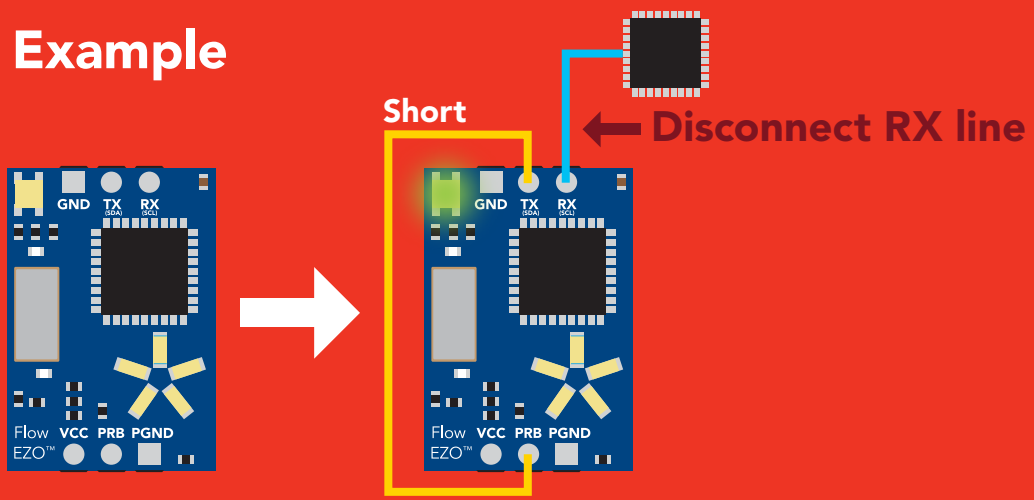
Connecting TX to PRB only works for the EZO-RTD™ and the EZO-FLO™ circuits

Manually switching to I²C will set the I²C address to 104 (0x68)

Example



Wrong Example



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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™ device into I²C mode click here

Settings that are retained if power is cut

Change I²C address
Conversion factor
Flow meter settings
Hardware switch to UART mode
LED control
Protocol lock
Software switch to UART mode

Settings that are *NOT* retained if power is cut

All calculated flow
Find
Sleep mode

I²C mode

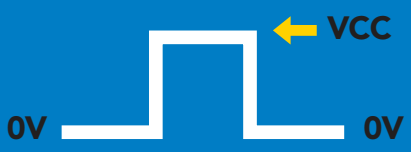
I²C address (0x01 – 0x7F)
104 (0x68) default

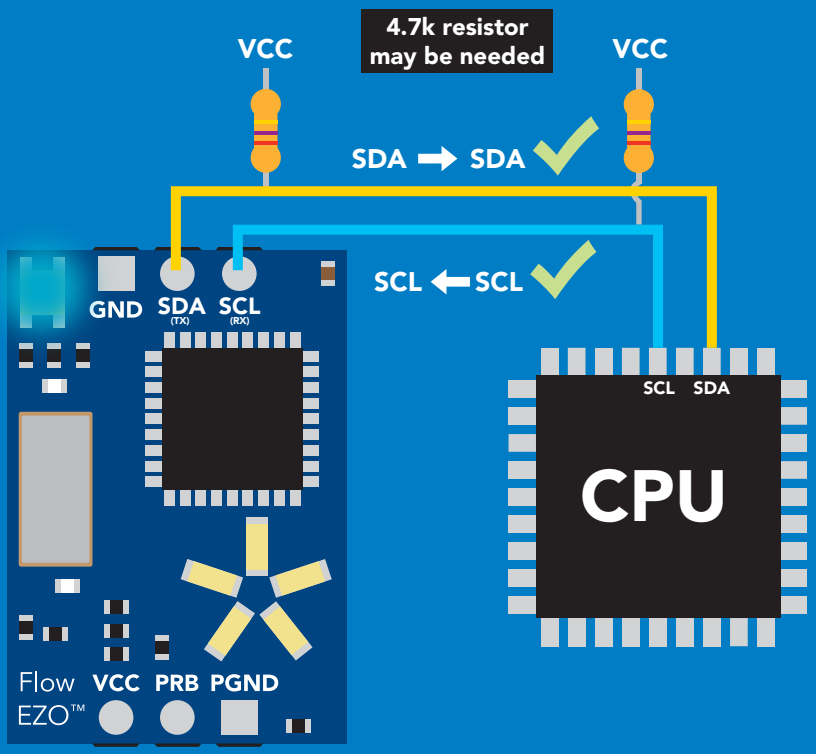
Vcc 3.3V – 5.5V

Clock speed 100 – 400 kHz

SDA

SCL





Data format

Reading Total volume and Flow rate per (sec, min or hour)

Units Liters and liters per min

Encoding ASCII

Format string

Data type floating point

Decimal places 2

Smallest string 3 characters

Largest string 32 characters

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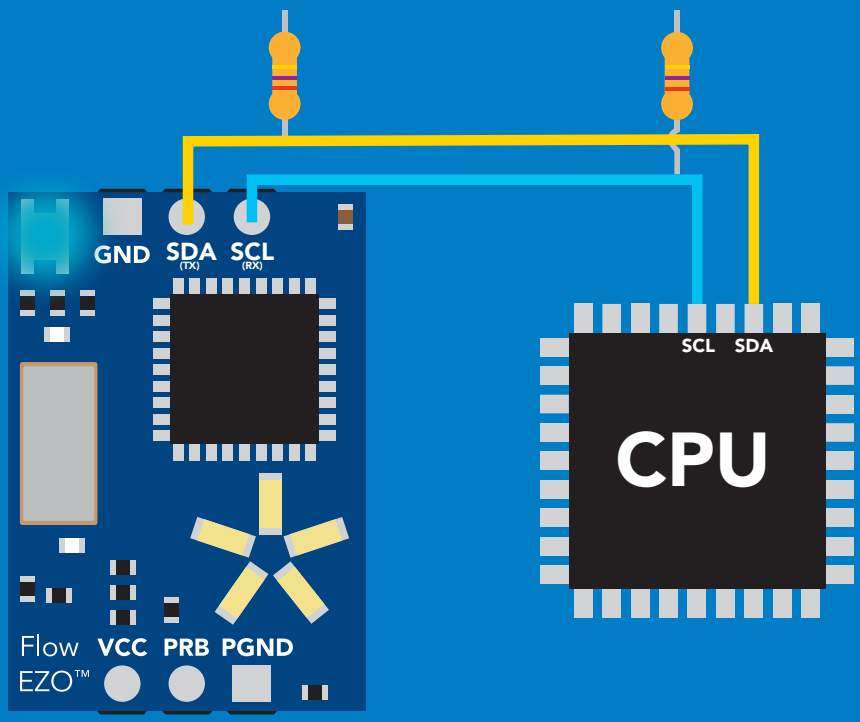
Sending commands to device

5 parts

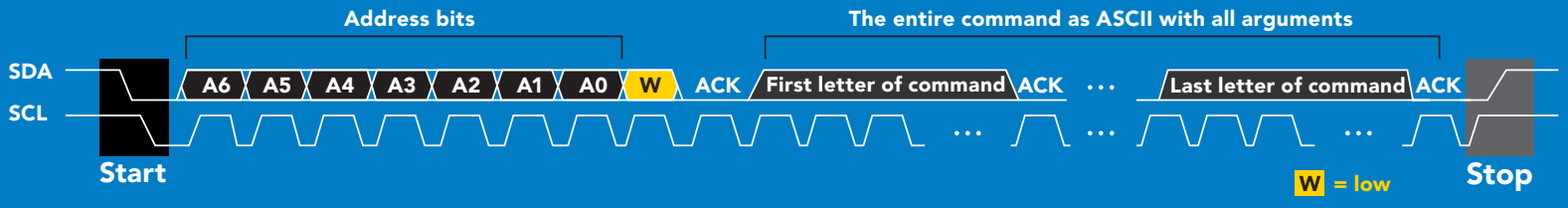
Start	I²C address	Write	Command (not case sensitive)	Stop
	104 (0x68)		ASCII command string	

Example

Start	104 (0x68)	Write	Sleep	Stop
	I²C address		Command	



Advanced



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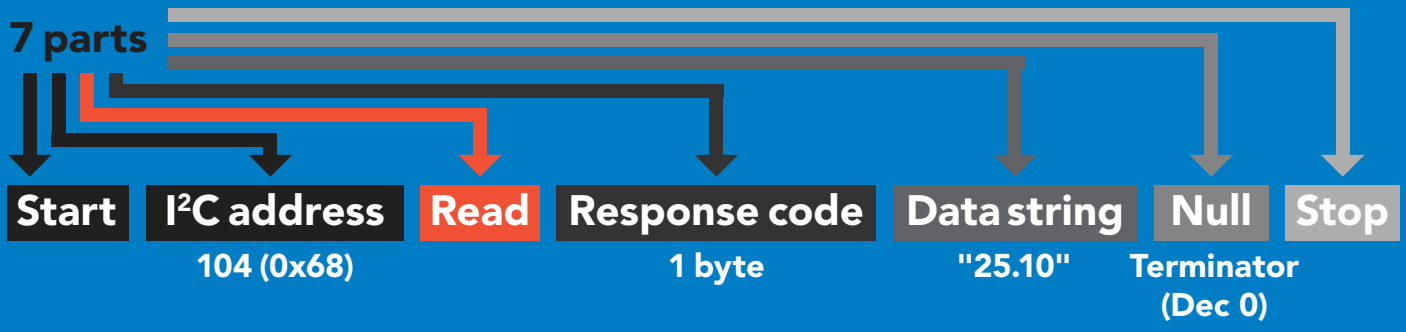
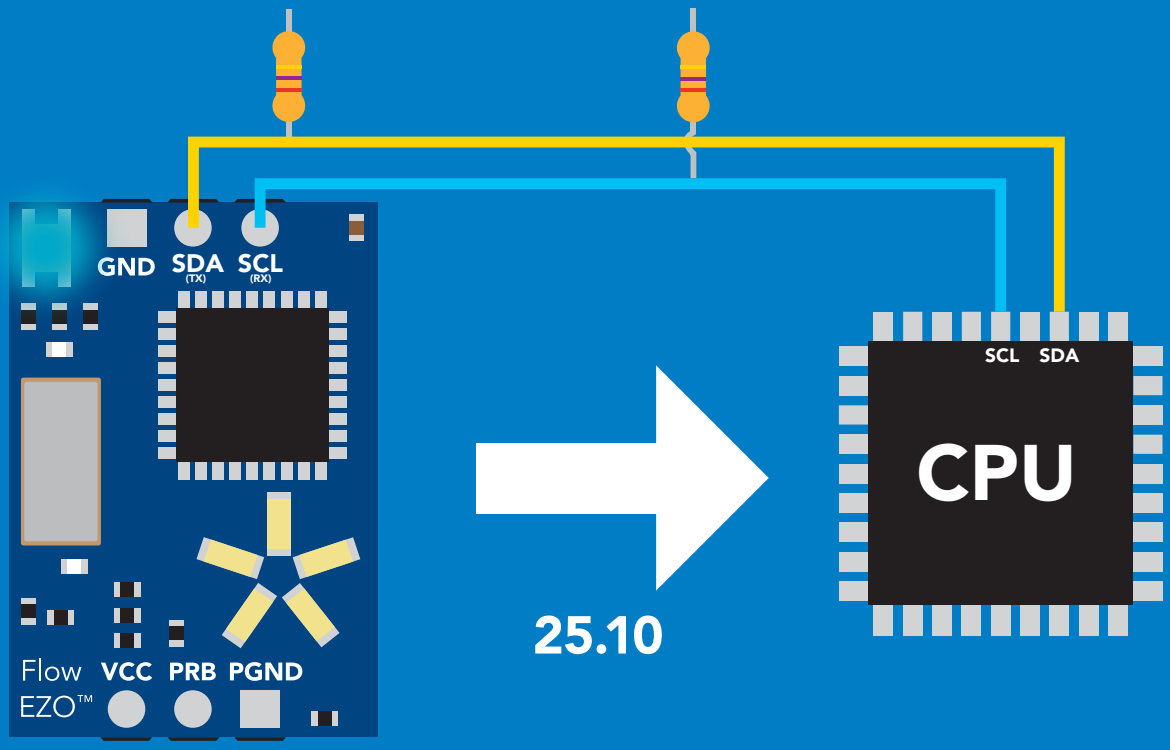
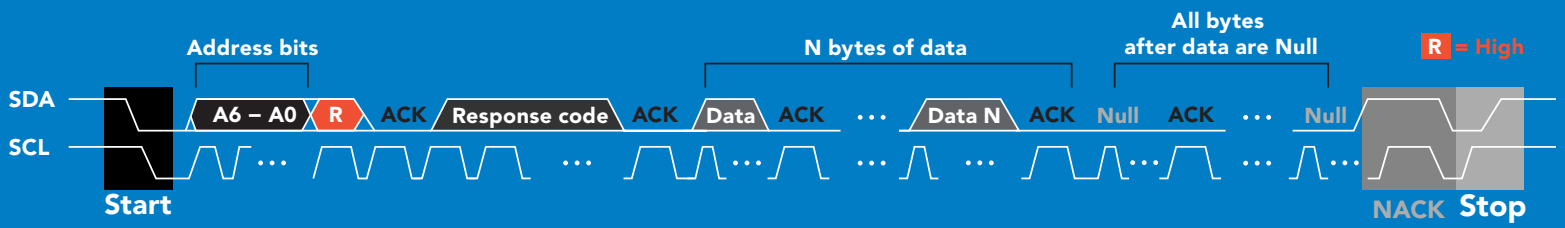
Requesting data from device





Advanced



= 25.10

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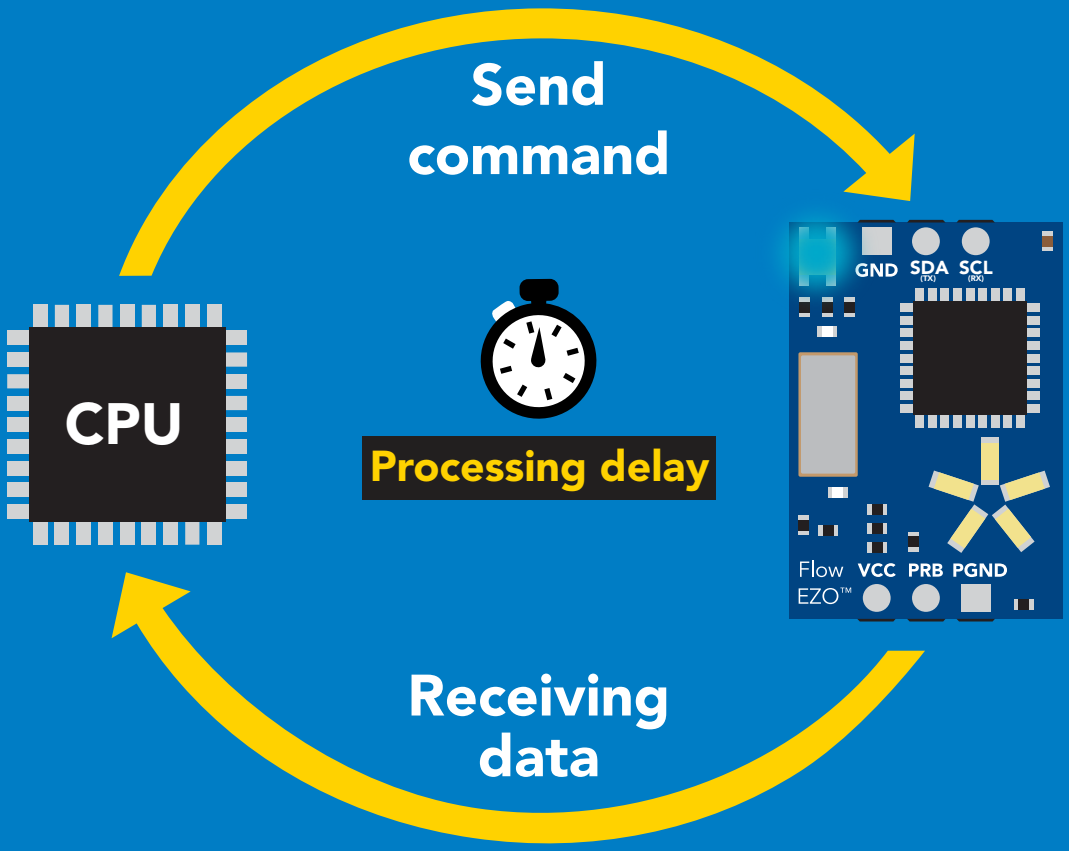
Response codes

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.



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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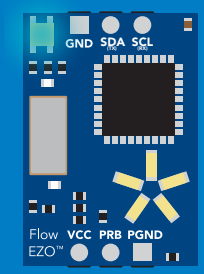
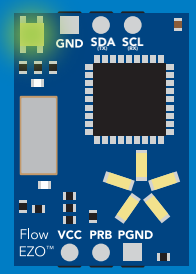
r 0.2

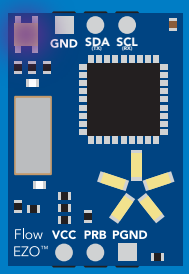
LED color definition



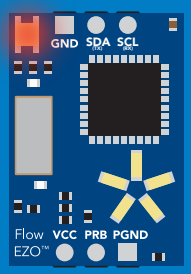
Blue
I2C standby



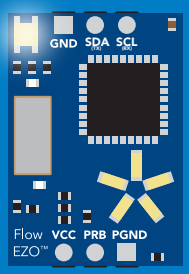
Green
Taking reading



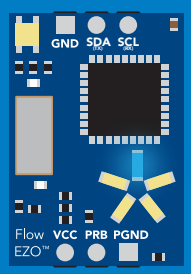
Purple
Changing I2C address



Red
Command not understood



White
Find



Blue
Set flow meter type

	LED ON
5V	**+2.6 mA**
3.3V	**+0.7 mA**

I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 57
CF	conversion factor	pg. 48
Clear	clearing the total volume	pg. 46
Factory	enable factory reset	pg. 56
Find	finds devices with white blinking LED	pg. 44
Frp	change flow rate calculation	pg. 47
i	device information	pg. 51
I2C	change I²C address	pg. 55
L	enable/disable LED	pg. 43
Name	set/show name of device	pg. 50
O	enable/disable parameters	pg. 49
Plock	enable/disable protocol lock	pg. 54
R	returns a single reading	pg. 45
Set	set flow meter type	pg. 42
Sleep	enter sleep mode/low power	pg. 53
Status	retrieve status information	pg. 52

Set flow meter type

Command syntax

300ms processing delay

Set,3/8	set to 3/8” flow meter	
Set,1/4	set to 1/4” Flow meter	
Set,1/2	set to 1/2” Flow meter	default
Set,3/4	set to 3/4” Flow meter	
Set,?	show set flow meter	

Example

Response

Set,1/4

Wait 300ms

1	0
Dec	Null

Set,?

Wait 300ms

1	?Set,1/4	0
Dec	ASCII	Null

1/4" flow meter

or

1	?Set,0	0
Dec	ASCII	Null

no flow meter

or

1	?Set,custom	0
Dec	ASCII	Null

set to a custom flow meter

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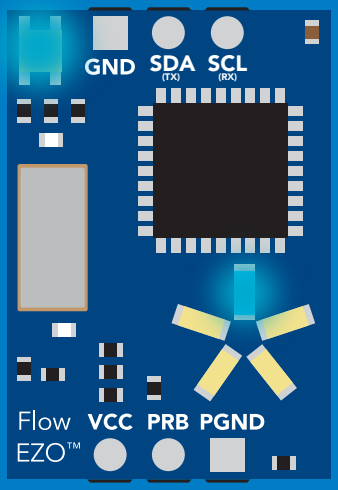
LED control

Command syntax

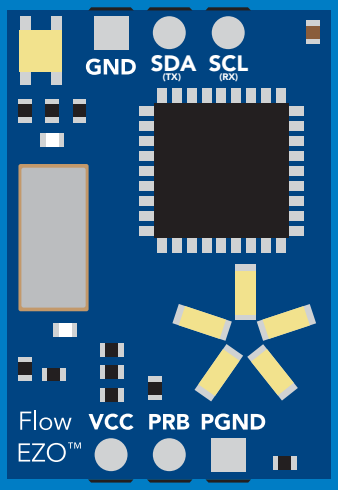
300ms processing delay

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 1 (Dec) ?L,0 (ASCII) 0 (Null)



L,1



L,0

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r 0.1

Find

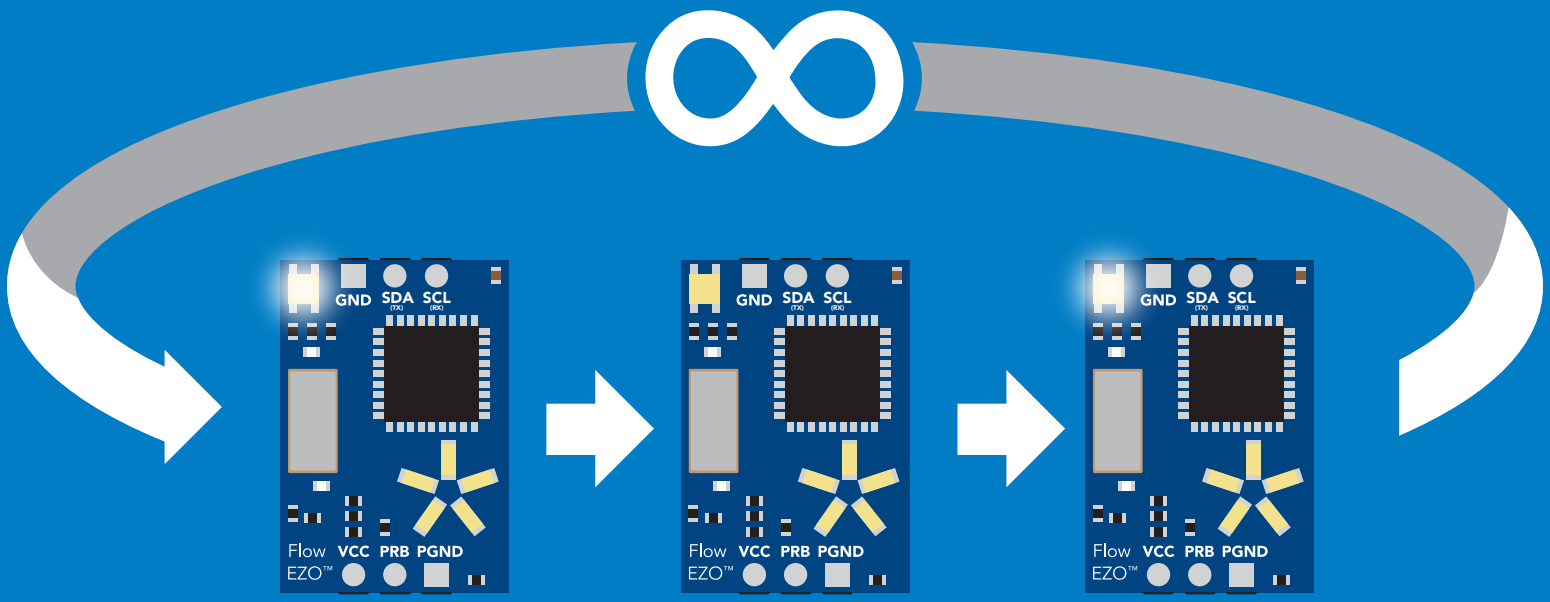
300ms processing delay

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 <cr>	Wait 300ms 1 Dec 0 Null



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r 0.1

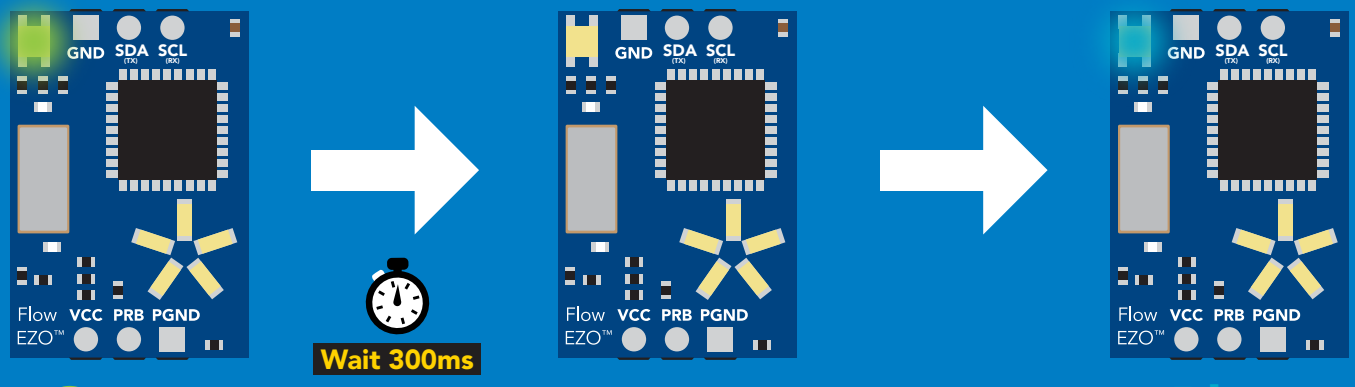
Taking reading

Command syntax

300ms processing delay

R return 1 reading

Example	Response
R	Wait 300ms 1 Dec 25.10 ASCII 0 Null



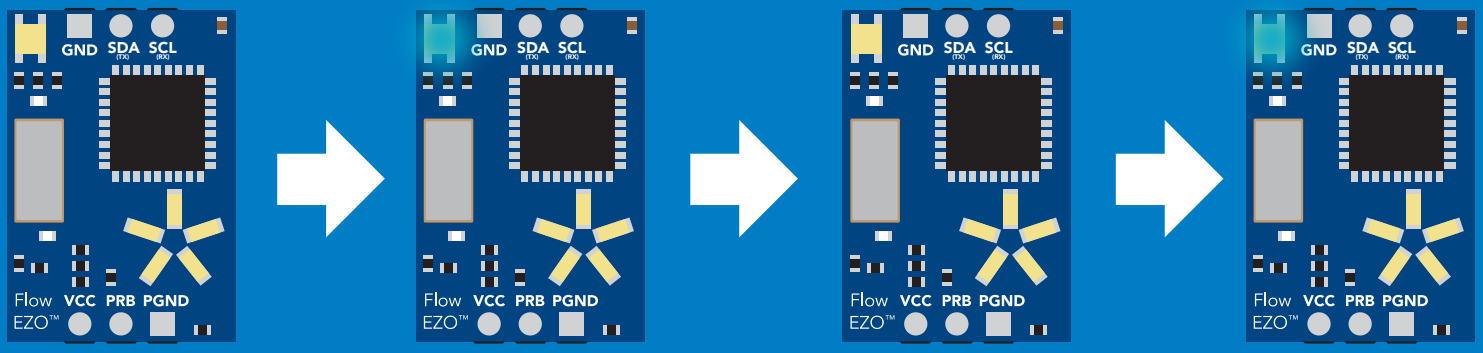
Clearing the total volume

Command syntax

300ms processing delay

Clear clears the total volume, resets counter to 0.00

Example	Response
Clear	Wait 300ms 1 Dec 0 Null



R → 534.26 → Clear → 0.00

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r 0.1

Change flow rate display

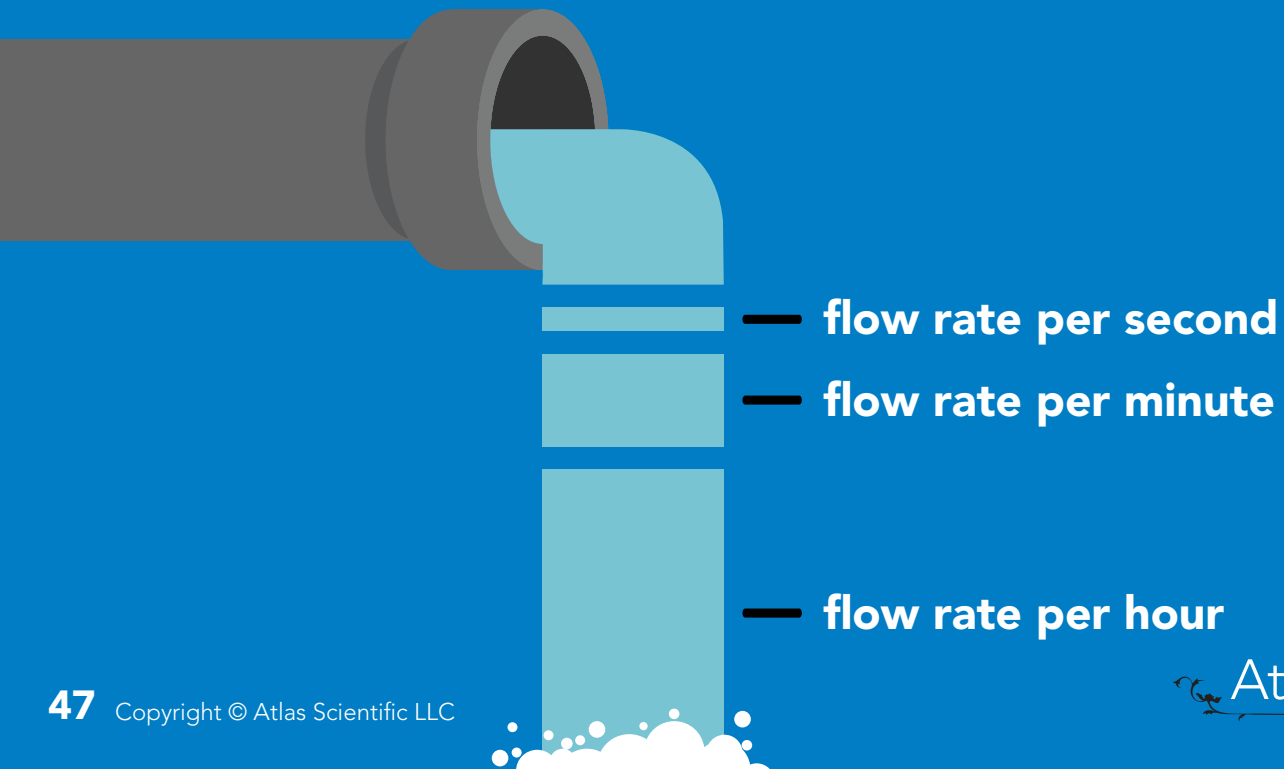
This command changes the time base of the flow rate.
Total volume / flow rate

Command syntax

300ms processing delay

Frp,s	calculate flow rate per second
Frp,m	calculate flow rate per minute
Frp,h	calculate flow rate per hour
Frp,?	calculate flow rate per?

Example	Response
Frp,h	Wait 300ms — 1 (Dec) — 0 (Null)
Frp,?	Wait 300ms — 1 (Dec) — ?Frp,h (ASCII) — 0 (Null)



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Conversion factor

By default all readings are in L/LPM. The Conversion factor command lets you convert the readings to a different measurement.

Conversion factor range= 0.001 - 1,000,000

Liters x CF = converted reading

Example conversion factors:
Liters to milliliters =1,000
Liters to gallon = 0.264

300ms processing delay

Command syntax

default conversion factor = 1

CF,n	set conversion factor
CF,?	show conversion factor

Example	Response
R	Wait 300ms → 1 (Dec) · 5.74 (liters) (ASCII) · 0 (Null)
CF, 0.264	Wait 300ms → 1 (Dec) · 0 (Null)
R	Wait 300ms → 1 (Dec) · 1.51 (gallons) (ASCII) · 0 (Null)
CF, ?	Wait 300ms → 1 (Dec) · ?CF,0.264 (ASCII) · 0 (Null)

Enable/disable parameters from output string

Command syntax

300ms processing delay

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

Example / Response

Example	Response
O,TV,1 / O,TV,0	Wait 300ms — 1 (Dec) 0 (Null) enable / disable total volume
O,FR,1 / O,FR,0	Wait 300ms — 1 (Dec) 0 (Null) enable / disable flow rate
O,?	Wait 300ms — 1 (Dec) ?O,TV,FR (ASCII) 0 (Null) if both are enabled

Parameters

TV	total volume
FR	flow rate

Followed by 1 or 0

1	enabled
0	disabled

* If you disable all possible data types your readings will display "no output".

Atlas Scientific Environmental Robotics

Naming device

300ms processing delay

Command syntax

Do not use spaces in the name

Name,n	set name
Name,	clears name
Name,?	show name

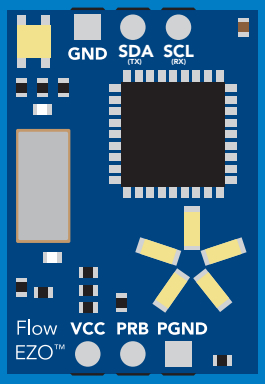
n =

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

Up to 16 ASCII characters

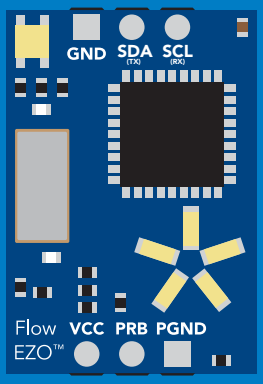
Example	Response
Name,	Wait 300ms — 1 Dec — 0 Null — name has been cleared
Name,zzt	Wait 300ms — 1 Dec — 0 Null
Name,?	Wait 300ms — 1 Dec — ?Name,zzt ASCII — 0 Null

Name,zzt



1 0

Name,?



1 ?Name,zzt 0

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Device information

Command syntax

300ms processing delay

i device information

Example

i

Response

1 Dec

?i,FLO,2.00 ASCII

0 Null

Response breakdown

?i, FLO, 2.00

FLO, ↑ Device

2.00 ↑ Firmware

Reading device status

Command syntax

300ms processing delay

Status voltage at Vcc pin and reason for last restart

Example Response

Status

1	?Status,P,5.038	0
Dec	ASCII	Null

Response breakdown

?Status, P, 5.038

P, ↑ Reason for restart

5.038 ↑ Voltage at Vcc

Restart codes

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

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
Any command	wakes up device

Do not read status byte after issuing sleep command.

	STANDBY	SLEEP
5V	16.9 mA	300µA
3.3V	13.2 mA	131µA

Standby

Sleep

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Protocol lock

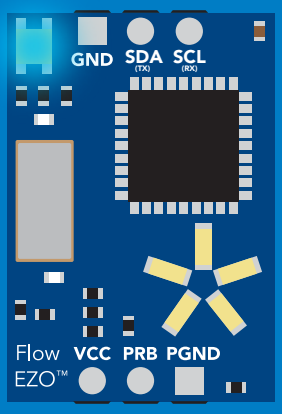
Command syntax

300ms processing delay

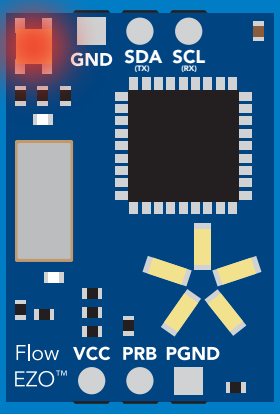
Plock,1	enable Plock	Locks device to I²C mode.
Plock,0	disable Plock	default
Plock,?	Plock on/off?	

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)

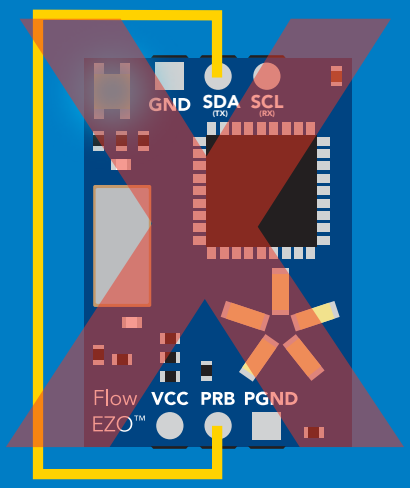
Plock,1



Baud, 9600



cannot change to UART



cannot change to UART

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I²C address change

Command syntax

300ms processing delay

I2C,n sets I²C address and reboots into I²C mode

Example	Response
I2C,100	device reboot (no response given)

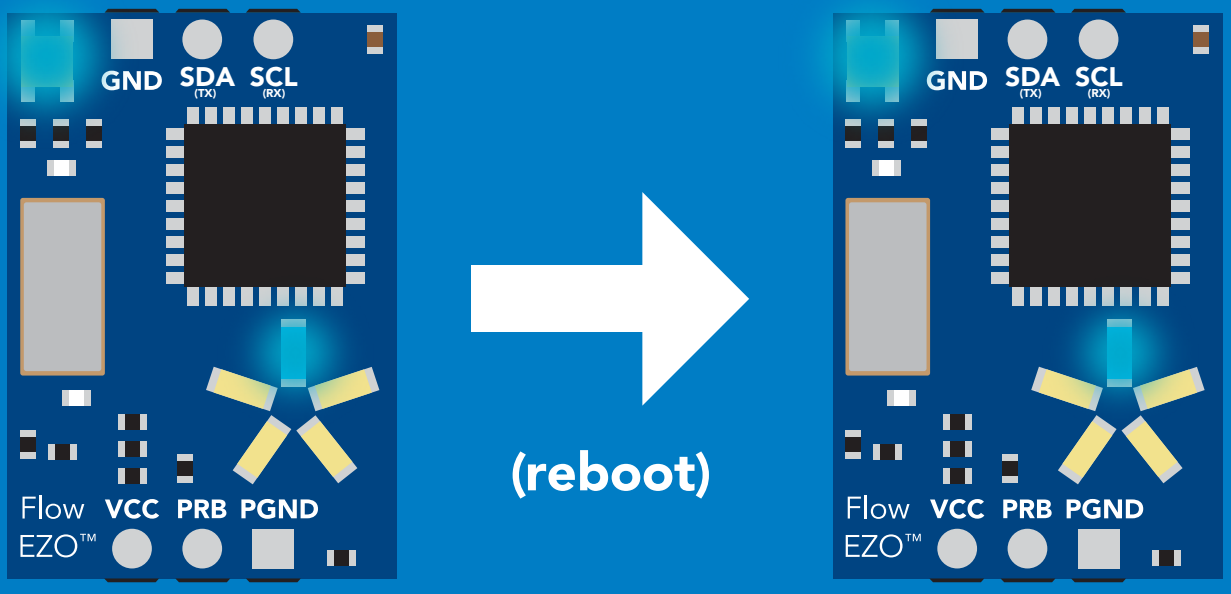
Warning!

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 104 (0x68).

n = any number 1 – 127

I2C,100



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Factory reset

Command syntax

Factory reset will not take the device out of I²C mode.

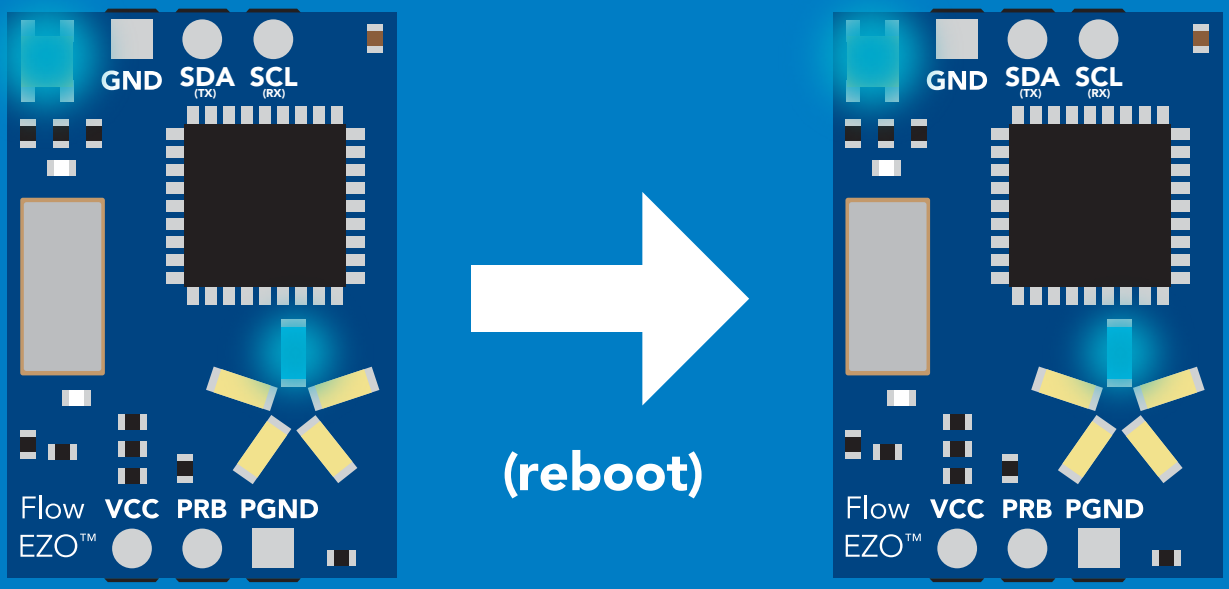
Factory enable factory reset

I²C address will not change

Example	Response
Factory	device reboot (no response given)

Clears all flow meter settings
Total volume
LED on

Factory



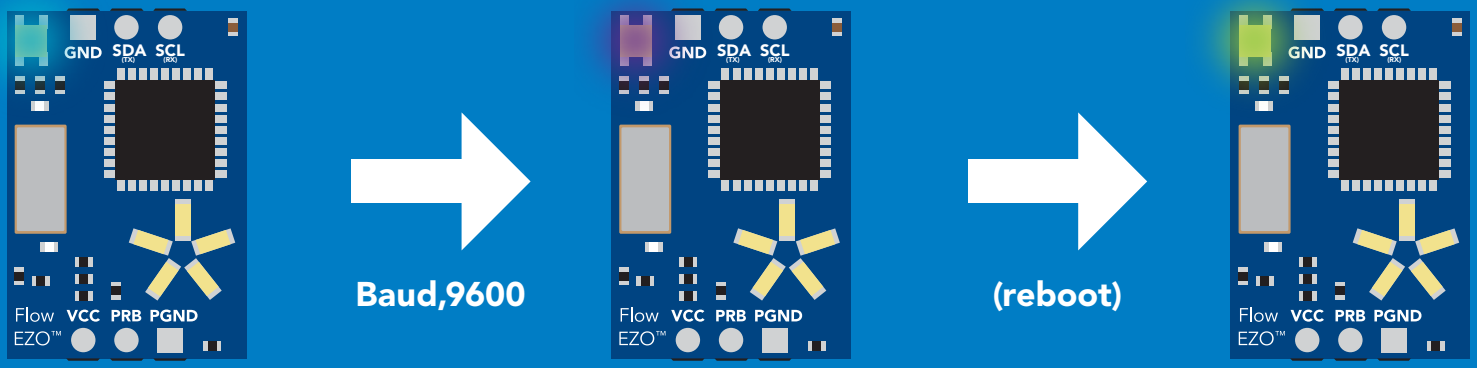
Change to UART mode

Command syntax

Baud,n switch from I²C to UART

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

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

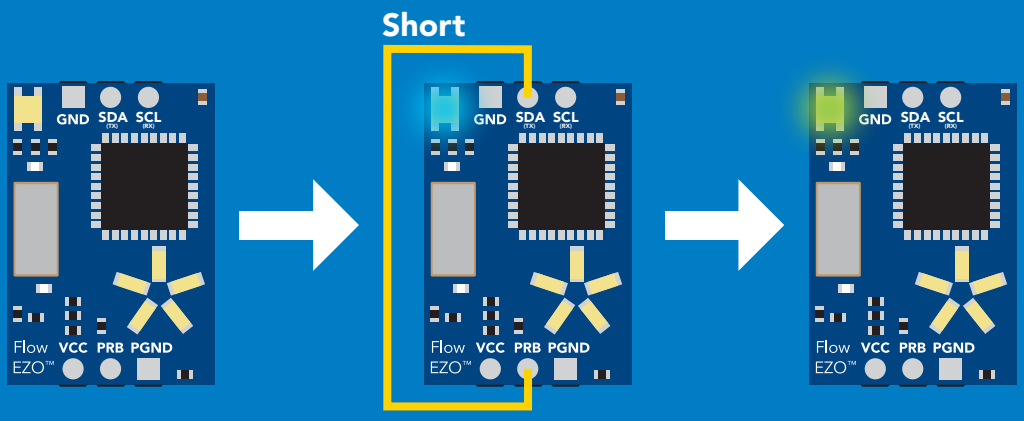


Manual switching to UART

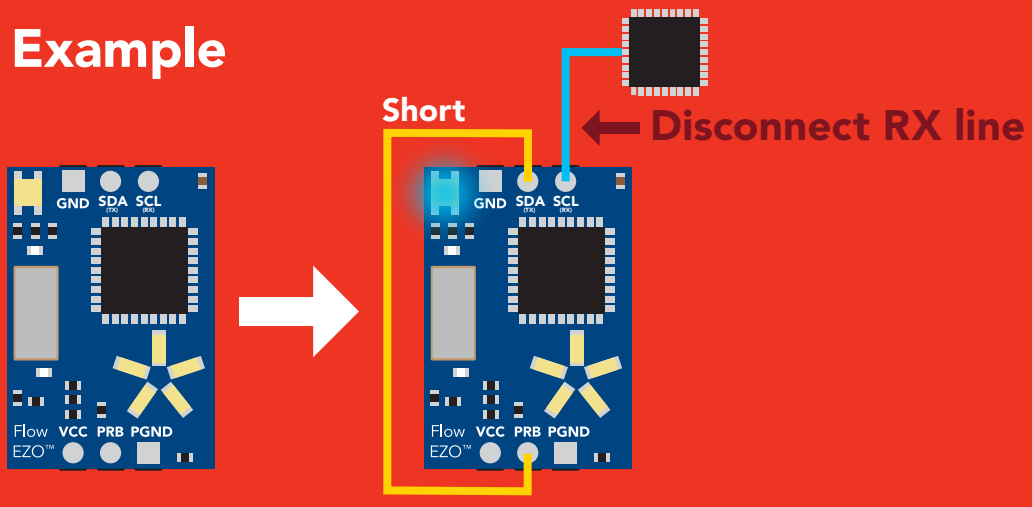
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PRB
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Blue to Green
- Disconnect ground (power off)
- Reconnect all data and power

Connecting TX to PRB only works for the EZO-RTD™ and the EZO-FLO™ circuits

Example



Wrong Example



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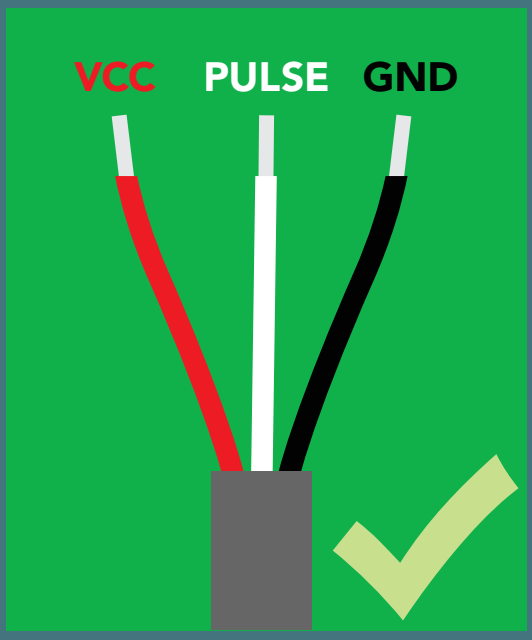
Using your own flow meter

Compatibility

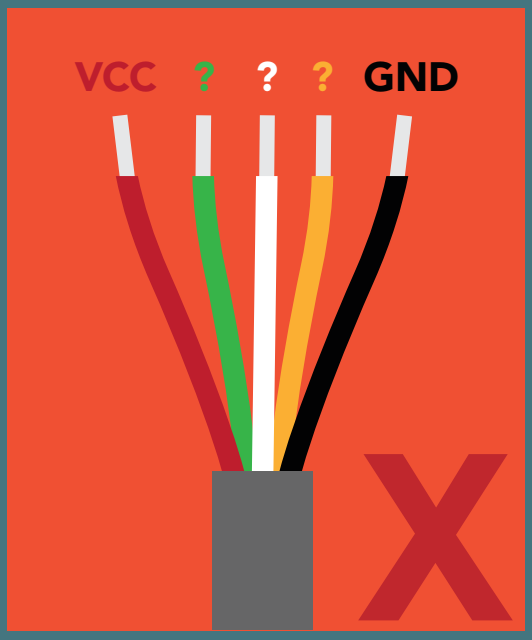
To be sure that your flow meter is compatible with the EZO-FLO™ it must meet ***ALL*** of the compatibility requirements listed below.

Number of leads

3 leads

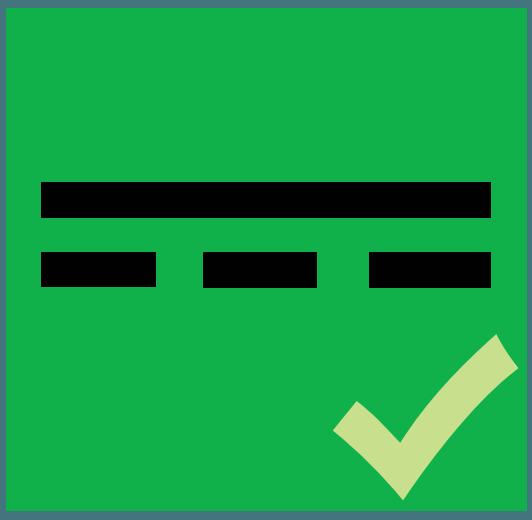


> 3 leads



Operating voltage

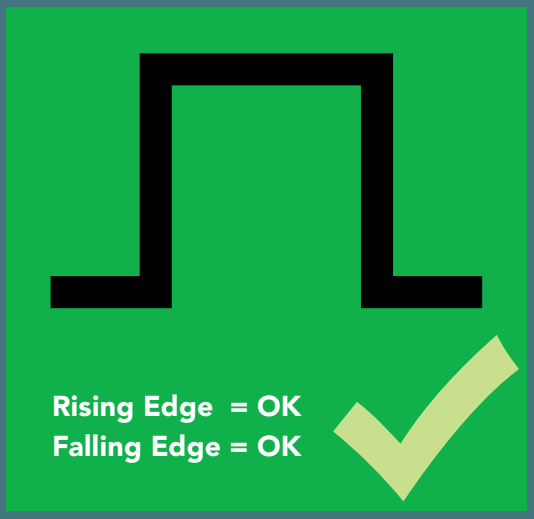
3.3 – 5 VDC



AC voltage
DC voltage > 5V

Data output

Pulsed DC square wave only



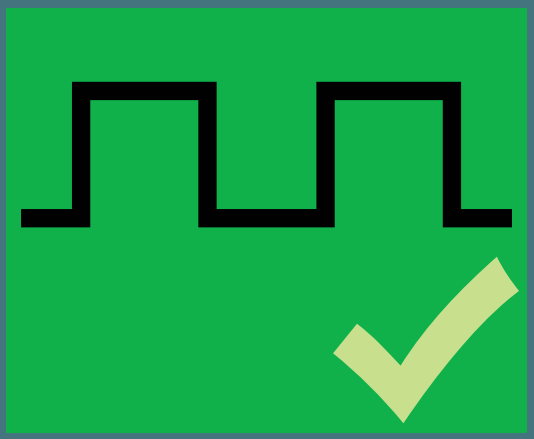
4–20mA

Mod Bus

RS-485

Square wave frequency

0Hz – 8KHz



8+ KHz

K Factor

Your flow meter must have at least 1 K factor, but no more than 16 K factors.

K Factor

≥1 & ≤16

K Factor

0 or >16

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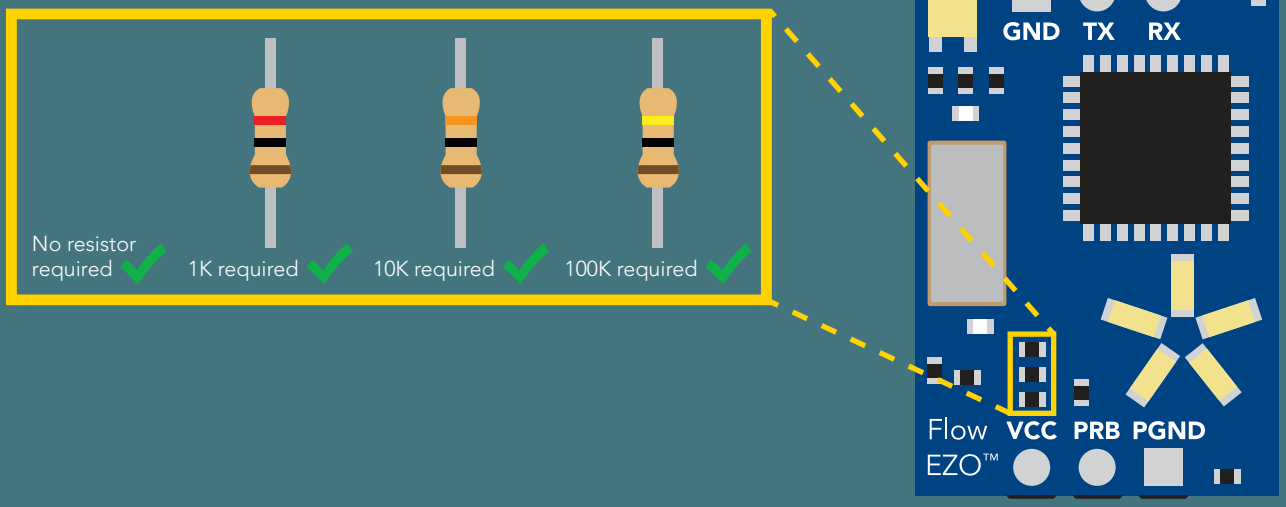
Take notice

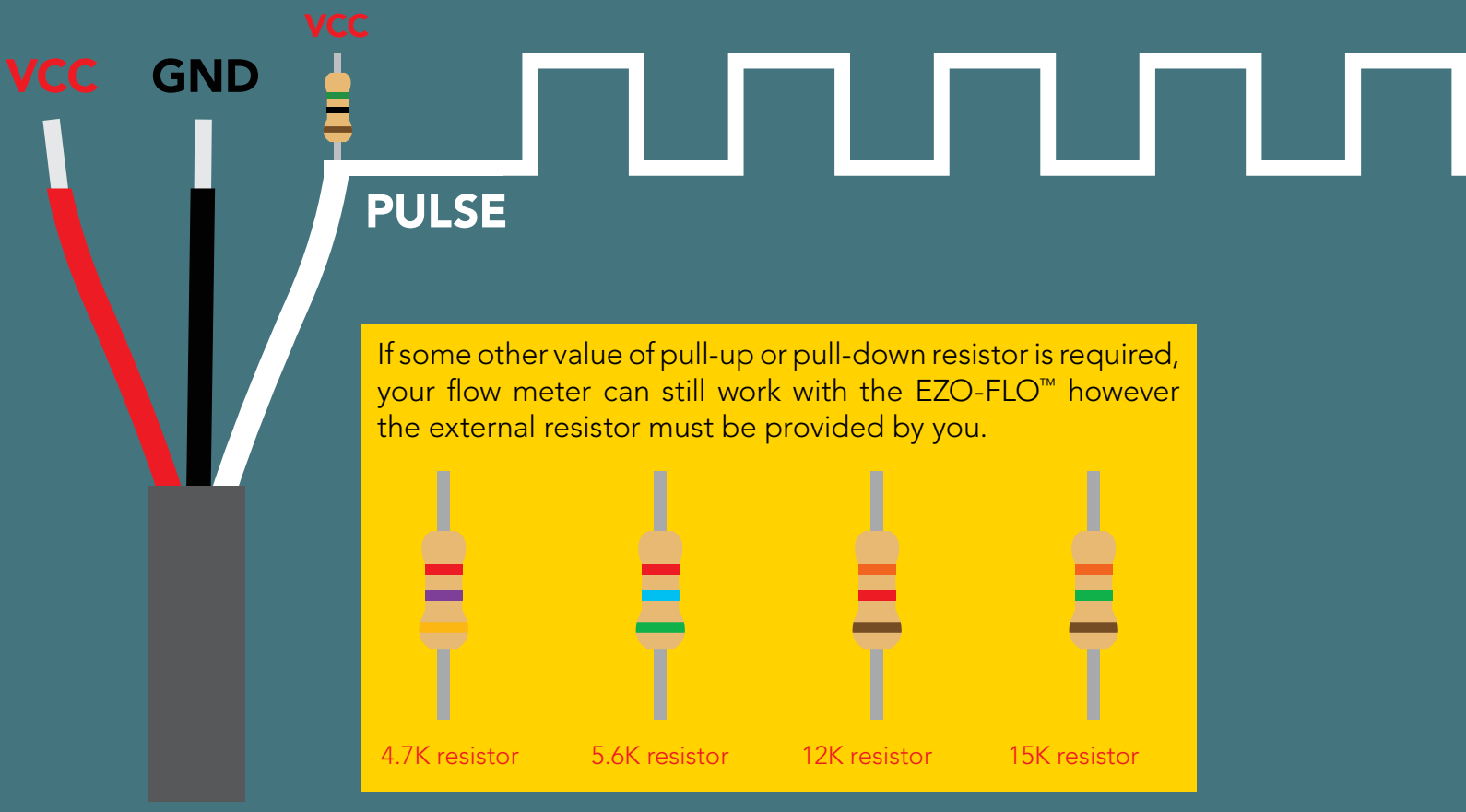
Some flow meters will require an external pull-up or pull-down resistor on the pulse lead.
The EZO-FLO™ has 3 on-board pull-up or pull-down resistors available

On-board resistors



External pull-up / pull-down resistor

Does your flow meter require a pull-up or pull-down resistor on the pulse lead?



If some other value of pull-up or pull-down resistor is required, your flow meter can still work with the EZO-FLO™ however the external resistor must be provided by you.

4.7K resistor | 5.6K resistor | 12K resistor | 15K resistor

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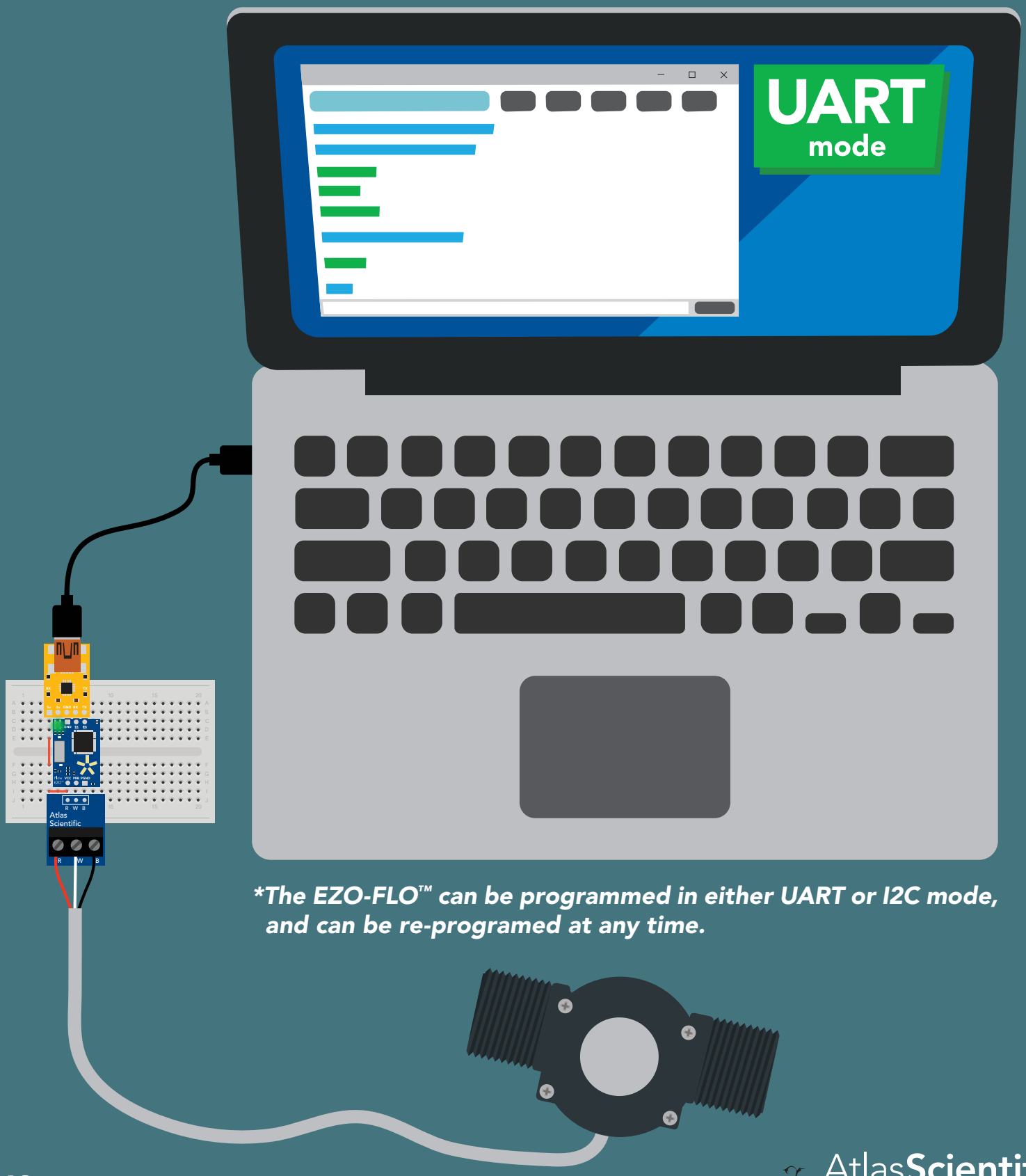
Programing

Programing the EZO-FLO™ is easiest to do in **UART mode**, connected to a computer and programed through a serial terminal.



The EZO-FLO™ can be programmed in either UART or I2C mode, and can be re-programed at any time.

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Setting the K values

UART mode

Command syntax

K,[volume],[(per) number of pulses]	<cr>	for flow meters with 1 K value
K,[flow rate],[pulse rate in Hz]	<cr>	for flow meters with many K values
K,all	<cr>	query the programmed K-value(s)
K,clear	<cr>	clear all programmed K-values

Example	Response
K,10,1 <cr> for flow meters with 1 K value (10mL / pulse)	*OK <cr>
K,0.1,13 <cr> K,0.25,41 <cr> K,0.5,90 <cr> ... Up to 16 in total for flow meters with many K values (0.1 LPM @ 13Hz) (0.25 LPM @ 41Hz) (0.5 LPM @ 90Hz)	*OK <cr> *OK <cr> *OK <cr>
K,all <cr>	?1:K,0.1,13 <cr> ?2:K,0.25,41 <cr> ?3:K,0.5,90 <cr>
K,clear <cr>	*OK <cr>

Setting the K values

I²C mode

Command syntax

300ms processing delay

K,[volume],[(per) number of pulses]	for flow meters with 1 K value
K,[flow rate],[pulse rate in Hz]	for flow meters with many K values
K,n	returns the nth K value
K,?	returns the number of K values stored
K,clear	clear all programmed K-values

Example	Response
K,10,1 for flow meters with 1 K value (10mL / pulse)	Wait 300ms → 1 (Dec), 0 (Null)
K,0.1,13 for flow meters with many K values (0.1 LPM @ 13Hz)	Wait 300ms → 1 (Dec), 0 (Null)
K,1	Wait 300ms → 1 (Dec), ?1:K,0.1,13 (ASCII), 0 (Null)
K,?	Wait 300ms → 1 (Dec), ?K,1 (ASCII), 0 (Null)
K,clear	Wait 300ms → 1 (Dec), 0 (Null)

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Setting the flow meter time base

UART mode

This step is only needed for flow meters with multiple K values

In step one you programed all the K values into the EZO-FLO.
Now you have to set the time base.

0.1 LPM @ 13Hz
0.25 LPM @ 41Hz
0.5 LPM @ 90Hz

The 3 example K values above are in liters per min. The time base for these K values is in Liters per min. Use the command VP,M. If your K values were in Gallons per hour you would set the time base to VP,H.

Command syntax

Vp,s	<cr>	**set time base to volume per second**
Vp,m	<cr>	**set time base to volume per minute**
Vp,h	<cr>	**set time base to volume per hour**
Vp,?	<cr>	**set time base to volume per?**

Example	Response
Vp,h <cr>	***OK** <cr>
Vp,? <cr>	**?Vp,h** <cr>

Setting the flow meter time base

I²C mode

This step is only needed for flow meters with multiple K values

In step one you programed all the K values into the EZO-FLO.
Now you have to set the time base.

0.1 LPM @ 13Hz
0.25 LPM @ 41Hz
0.5 LPM @ 90Hz

The 3 example K values above are in liters per min. The time base for these K values is in Liters per min. Use the command VP,M. If your K values were in Gallons per hour you would set the time base to VP,H.

Command syntax

300ms processing delay

Vp,s	**set time base to volume per second**
Vp,m	**set time base to volume per minute**
Vp,h	**set time base to volume per hour**
Vp,?	**set time base to volume per?**

Example	Response
Vp,h	Wait 300ms → **1** (Dec) **0** (Null)
Vp,?	Wait 300ms → **1** (Dec) **?Vp,h** (ASCII) **0** (Null)

Setting the onboard pull-up or pull-down resistors

UART mode

This step is only needed if your flow meter requires an external pull-up or pull-down resistor on the pulse lead.

Command syntax

P,1	<cr>	enable a 1K Ω on board pull-up resistor
P,-1	<cr>	enable a 1K Ω on board pull-down resistor
P,10	<cr>	enable a 10K Ω on board pull-up resistor
P,-10	<cr>	enable a 10K Ω on board pull-down resistor
P,100	<cr>	enable a 100K Ω on board pull-up resistor
P,-100	<cr>	enable a 100K Ω on board pull-down resistor
P,0	<cr>	disable the pull-up / pull-down resistor
P,?	<cr>	query the pull-up / pull-down resistor

Example	Response
P,10 <cr>	*OK <cr>
P,? <cr>	?P,10 <cr> *OK <cr>

Setting the onboard pull-up or pull-down resistors

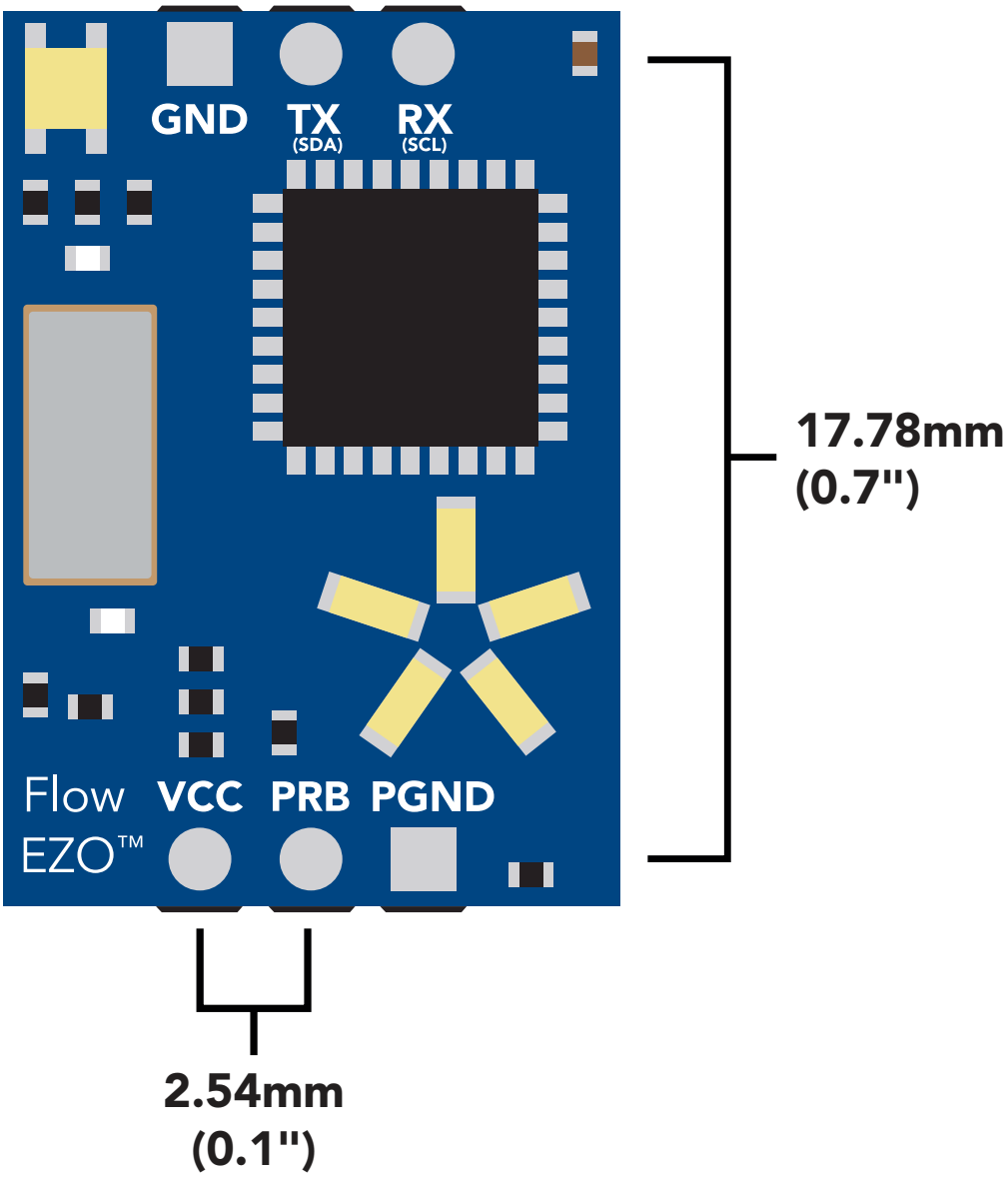
This step is only needed if your flow meter requires an external pull-up or pull-down resistor on the pulse lead.

Command syntax

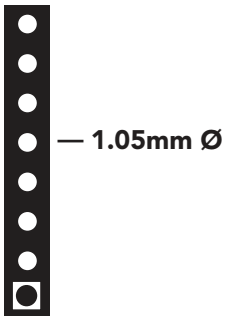
P,1	enable a 1K Ω on board pull-up resistor
P,-1	enable a 1K Ω on board pull-down resistor
P,10	enable a 10K Ω on board pull-up resistor
P,-10	enable a 10K Ω on board pull-down resistor
P,100	enable a 100K Ω on board pull-up resistor
P,-100	enable a 100K Ω on board pull-down resistor
P,0	disable the pull-up / pull-down resistor
P,?	query the pull-up / pull-down resistor

Example	Response
P,10	Wait 300ms → 1 (Dec) 0 (Null)
P,?	Wait 300ms → 1 (Dec) ?P,10 (ASCII) 0 (Null)

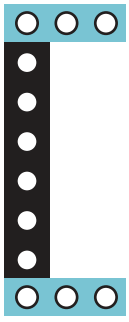
EZO™ circuit footprint



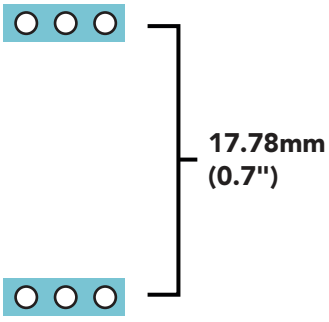
1 In your CAD software place a 8 position header.



2 Place a 3 position header at both top and bottom of the 8 position.



3 Delete the 8 position header. The two 3 position headers are now 17.78mm (0.7") apart from each other.



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Datasheet change log

Datasheet V 2.7

Revised page order in UART section.

Datasheet V 2.6

Revised naming device info on pages 25 & 50.

Datasheet V 2.5

Clarified default values on pages 7,11 and 36.
Added the "conversion factor" command pages 23 and 48.

Datasheet V 2.4

Added "Name device" command for I^2C on pg 48.

Datasheet V 2.3

Firmware update

Datasheet V 2.2

Moved Default state to pg 8.

Datasheet V 2.1

The1/2" flow meter is now the default setting.

Datasheet V 2.0

Revised entire datasheet.

Firmware updates

v2.0 - (May 8, 2019)
- I²C mode enabled

v2.01 - (June 6, 2019)
- The 1/2" flow meter is now the default setting.
- Flow rate gets calculated every read command for better output at polling rates faster than 1 second.

v2.02 - (Nov 12, 2019)
- Changed the default pull-up resistor in 3/4" flow meter setting to 100k.

v2.03 - (Oct 8, 2020)
- Defined all readings to be in L/LMP by default.
- Added the "CF" command.
- Fixed bug where some readings only had one decimal, not two.

v2.04 - (Mar 26, 2021)
- Fixed bug where flow leds dont spin in I2C mode.

v2.05 - (Dec 12, 2021)
- Fixed bug where spinning LEDs would jump and glitch where the set,? response would erroneously contain a newline.

Warranty

Atlas Scientific™ Warranties the EZO™ class FLO circuit to be free of defect during the debugging phase of device implementation, or 30 days after receiving the EZO™class FLO circuit *(which ever comes first).*

The debugging phase

The debugging phase as defined by Atlas Scientific™ is the time period when the EZO™ class FLO circuit is inserted into a bread board, or shield. If the EZO™ class FLO circuit is being debugged in a bread board, the bread board must be devoid of other components. If the EZO™ class FLO circuit is being connected to a microcontroller, the microcontroller must be running code that has been designed to drive the EZO™ class FLO circuit exclusively and output the EZO™ class FLO circuit 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™ class FLO circuit warranty:

- **Soldering any part of the EZO™ class FLO circuit.**
- **Running any code, that does not exclusively drive the EZO™ class FLO circuit and output its data in a serial string.**
- **Embedding the EZO™ class FLO circuit into a custom made device.**
- **Removing any potting compound.**

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™ class FLO circuit, against the thousands of possible variables that may cause the EZO™ class FLO circuit 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™ class FLO circuits continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.