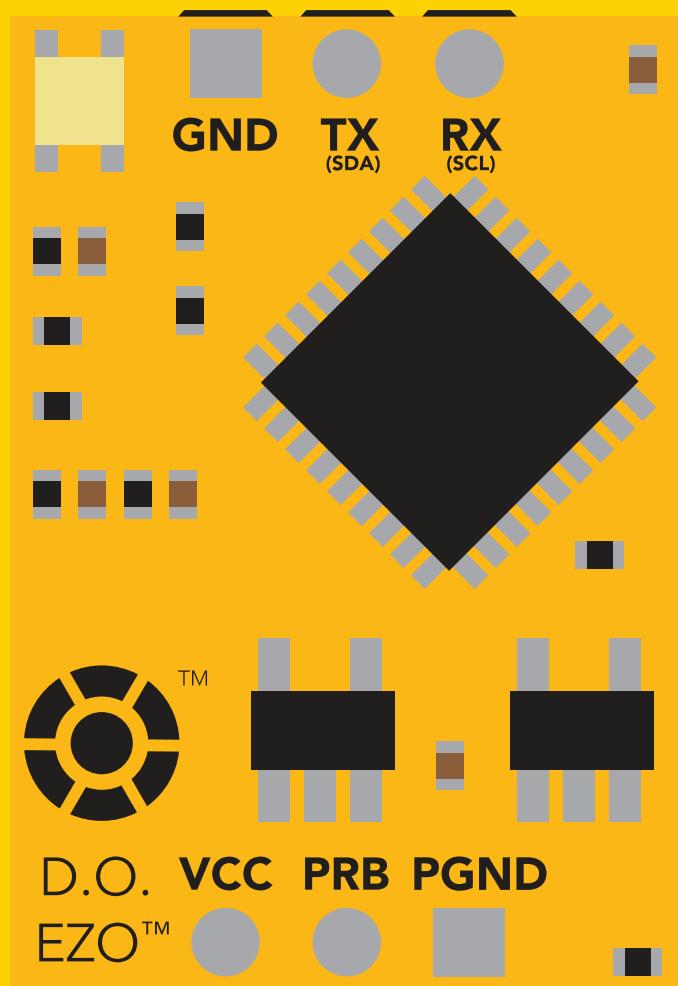


# Dissolved Oxygen EZO™

## Circuit

Reads	<b>Dissolved Oxygen</b>
Range	<b>0.01 – 100+ mg/L</b> <b>0.1 – 380 % saturation</b>
Accuracy	<b>+/- 0.05 mg/L</b>
Max rate	<b>1 reading per sec</b>
Supported probes	<b>Any galvanic probe</b>
Calibration	<b>1 or 2 point</b>
Temperature, salinity and pressure compensation	<b>Yes</b>
Data protocol	<b>UART &amp; I<sup>2</sup>C</b>
Default I <sup>2</sup> C address	<b>97 (0x61)</b>
Operating voltage	<b>3.3V – 5V</b>
Data format	<b>ASCII</b>



PATENT PROTECTED



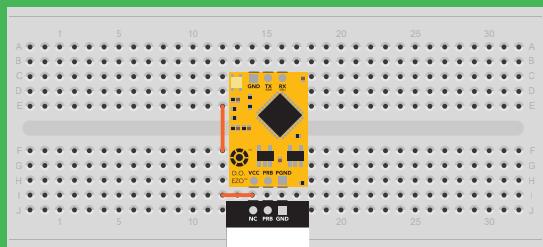
# STOP

**SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.**

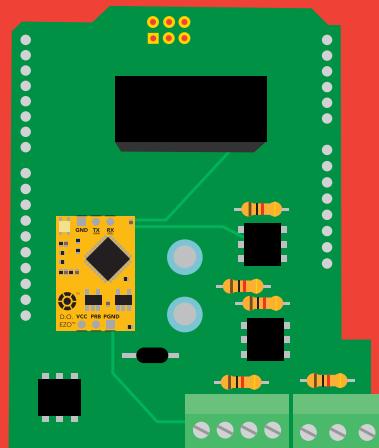
**This is sensitive electronic equipment. Get this device working in a solderless breadboard first. Once this device has been soldered it is no longer covered by our warranty.**

**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!**



# Table of contents

Circuit dimensions	4	Calibration theory	7
Power consumption	4	Preserve calibration solution	8
Absolute max ratings	4	Power and data isolation	9
EZO™ circuit identification	5	Correct wiring	11
Operating principle	6	Available data protocols	12

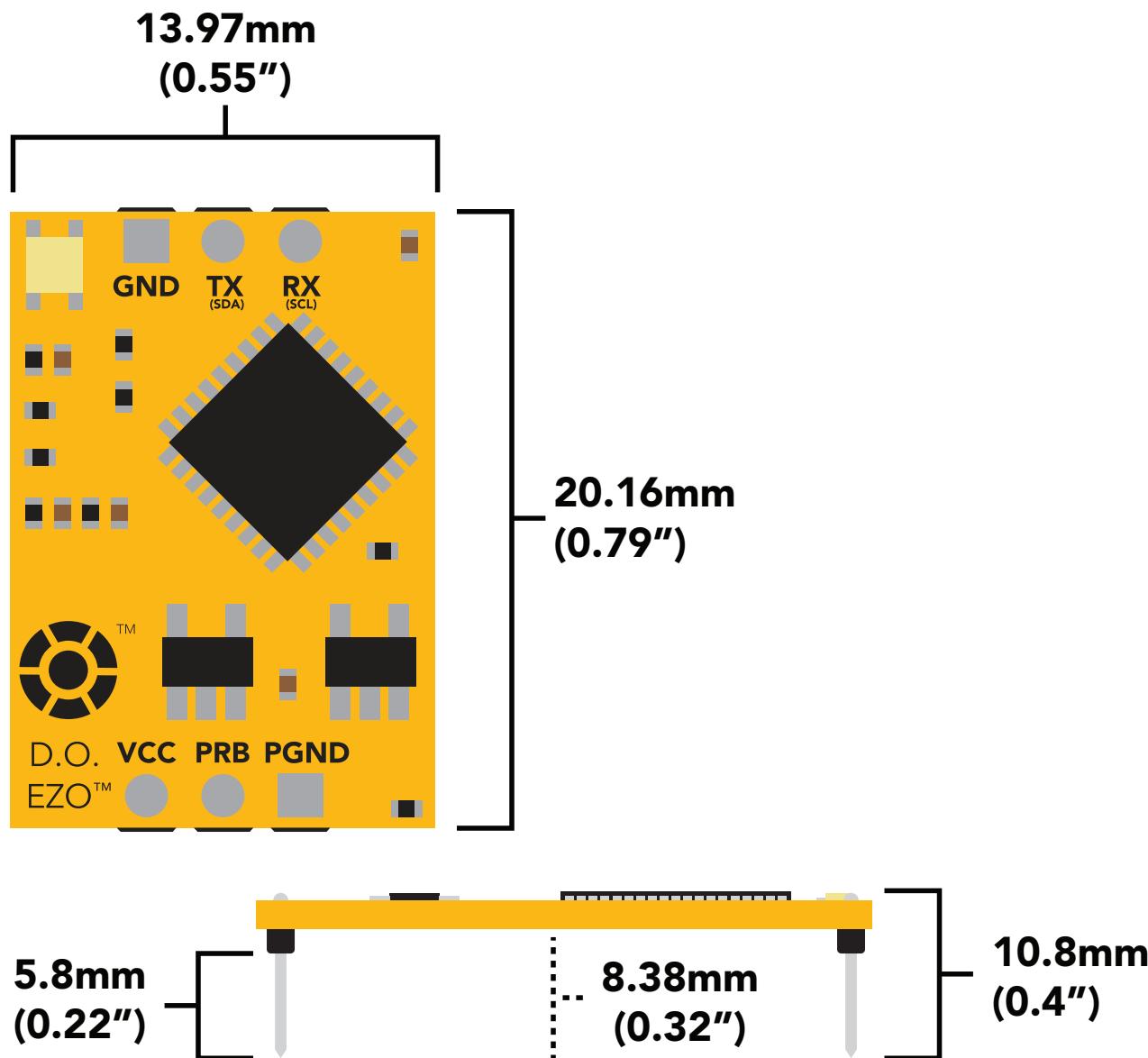
## UART

UART mode	14
Default state	15
Receiving data from device	16
Sending commands to device	17
LED color definition	18
UART quick command page	19
LED control	20
Find	21
Continuous reading mode	22
Single reading mode	23
Calibration	24
Export/import calibration	25
Temperature compensation	26
Salinity compensation	27
Pressure compensation	28
Enable/disable parameters	29
Naming device	30
Device information	31
Response codes	32
Reading device status	33
Sleep mode/low power	34
Change baud rate	35
Protocol lock	36
Factory reset	37
Change to I <sup>2</sup> C mode	38
Manual switching to I <sup>2</sup> C	39

## I<sup>2</sup>C

I <sup>2</sup> C mode	41
Sending commands	42
Requesting data	43
Response codes	44
LED color definition	45
I <sup>2</sup> C quick command page	46
LED control	47
Find	48
Taking reading	49
Calibration	50
Export/import calibration	51
Temperature compensation	52
Salinity compensation	53
Pressure compensation	54
Removing parameters	55
Device information	56
Reading device status	57
Sleep mode/low power	58
Protocol lock	59
I <sup>2</sup> C address change	60
Factory reset	61
Change to UART mode	62
Manual switching to UART	63
Circuit footprint	64
Datasheet change log	65
Warranty	67

# EZO™ circuit dimensions



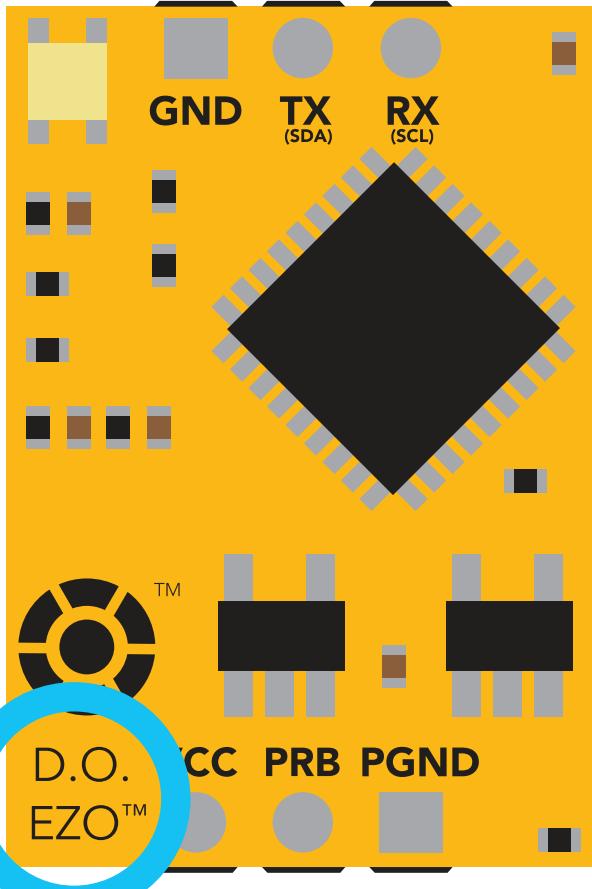
## Power consumption

	LED	MAX	STANDBY	SLEEP
5V	ON	13.5 mA	13.1 mA	0.66 mA
	OFF	12.7 mA	12.7 mA	
3.3V	ON	12.1 mA	12 mA	0.3 mA
	OFF	11.9 mA	11.9 mA	

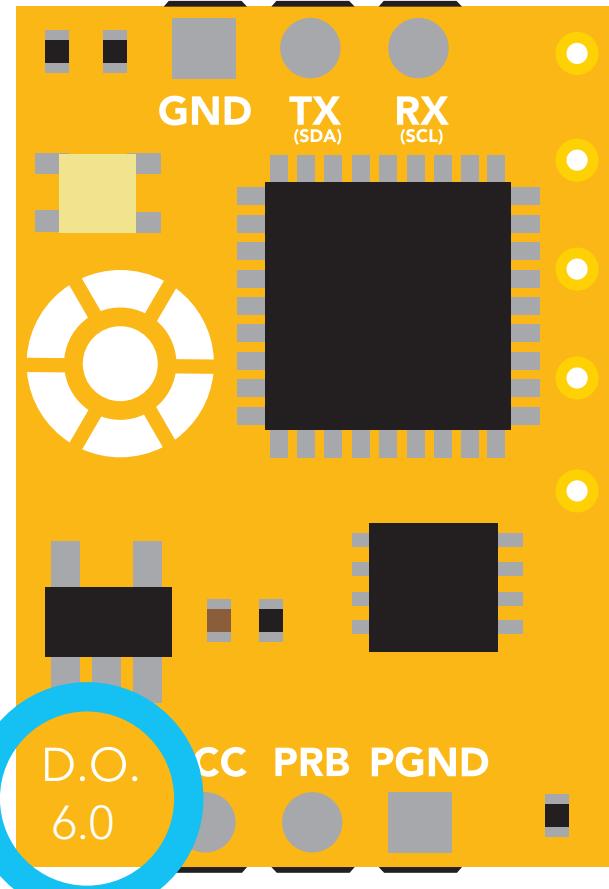
## Absolute max ratings

Parameter	MIN	TYP	MAX
Storage temperature (EZO™ D.O.)	-65 °C		125 °C
Operational temperature (EZO™ D.O.)	-40 °C	25 °C	85 °C
VCC	3.3V	5V	5.5V

# EZO™ circuit identification



EZO™ Dissolved Oxygen circuit



Legacy Dissolved Oxygen circuit



**Viewing correct datasheet**



**Viewing incorrect datasheet**

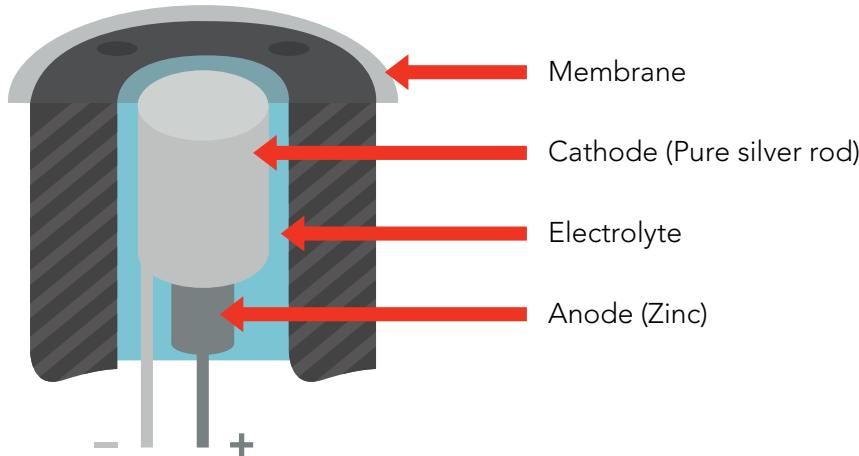
[Click here to view legacy datasheet](#)

# Operating principle

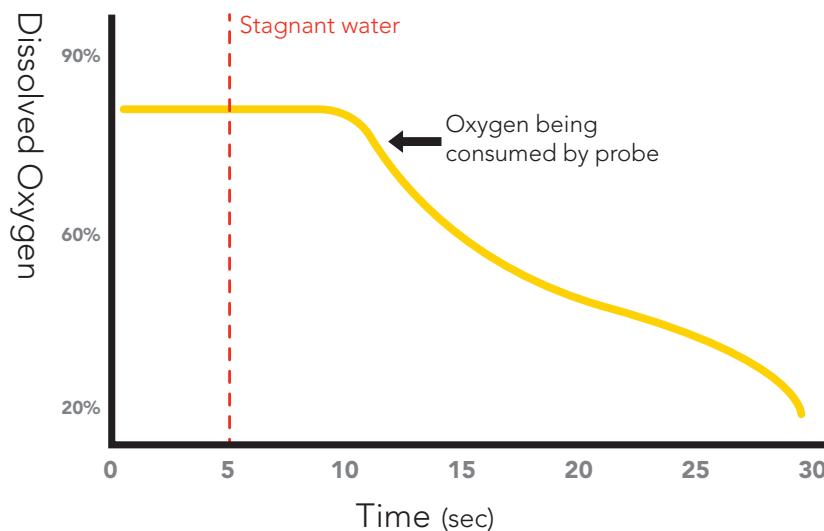
The Atlas Scientific™ EZO™ Dissolved Oxygen circuit works with:

X Optical probe	Slow response, requires external power, expensive.
X Polar Graphic probe	Requires external power, output in $\mu\text{A}$ .
✓ Galvanic probe	Requires no external power, output in mV.

A galvanic dissolved oxygen probe consists of a Polytetrafluoroethylene membrane, an anode bathed in an electrolyte and a cathode. Oxygen molecules diffuse through the probe's membrane at a constant rate (without the membrane the reaction happens too quickly). Once the oxygen molecules have crossed the membrane they are reduced at the cathode and a small voltage is produced. If no oxygen molecules are present, the probe will output 0 mV. As the oxygen increases so does the mV output from the probe. Each probe will output a different voltage in the presence of oxygen. The only thing that is constant is that **0mV = 0 Oxygen**. (A galvanic dissolved oxygen probe can also be used to detect the Oxygen content in gases).



## Flow Dependence



One of the drawbacks from using a galvanic probe is that it consumes a **VERY** small amount of the oxygen it reads. Therefore, a small amount of water movement is necessary to take accurate readings. **Approximately 60 ml/min.**

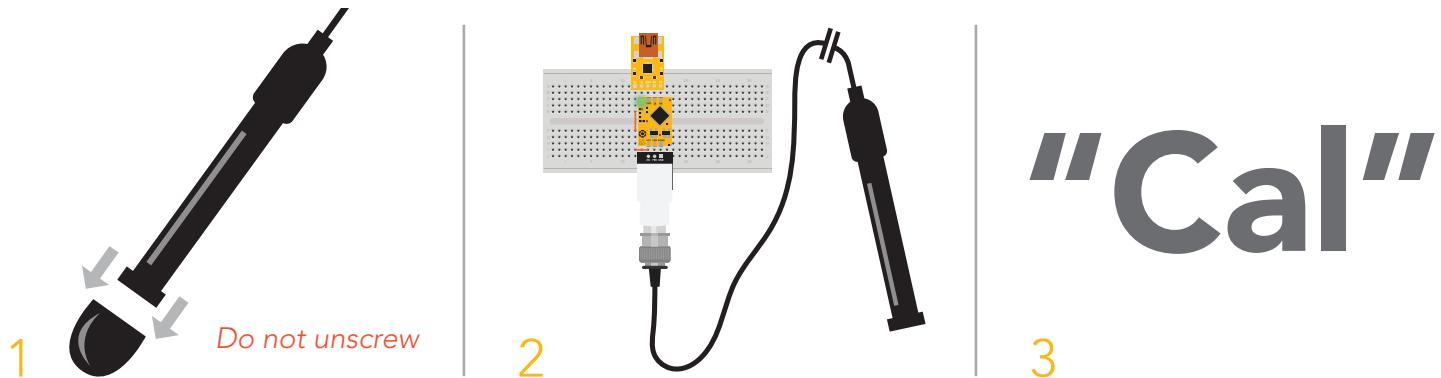
# Calibration theory

**Calibrate first, compensate later.**

Temperature, salinity and pressure compensation values have no effect on calibration.

The Atlas Scientific EZO™ Dissolved Oxygen circuit, has a flexible calibration protocol, allowing for **single point** or **dual point** calibration.

## Single point calibration



1. Pull off and discard cap from the Dissolved Oxygen probe. *(only used to protect probe during shipping)*
2. Let the Dissolved Oxygen probe sit, exposed to air until readings stabilize (5–30 sec).
3. Calibrate using the command "Cal".
4. After calibration is complete, you should see readings **~8.82mg/L**  
*(only if temperature, salinity and pressure compensation are at default values)*

## Dual point calibration (optional)

**Only perform this calibration if you require accurate readings **below** 1.0 mg/L**

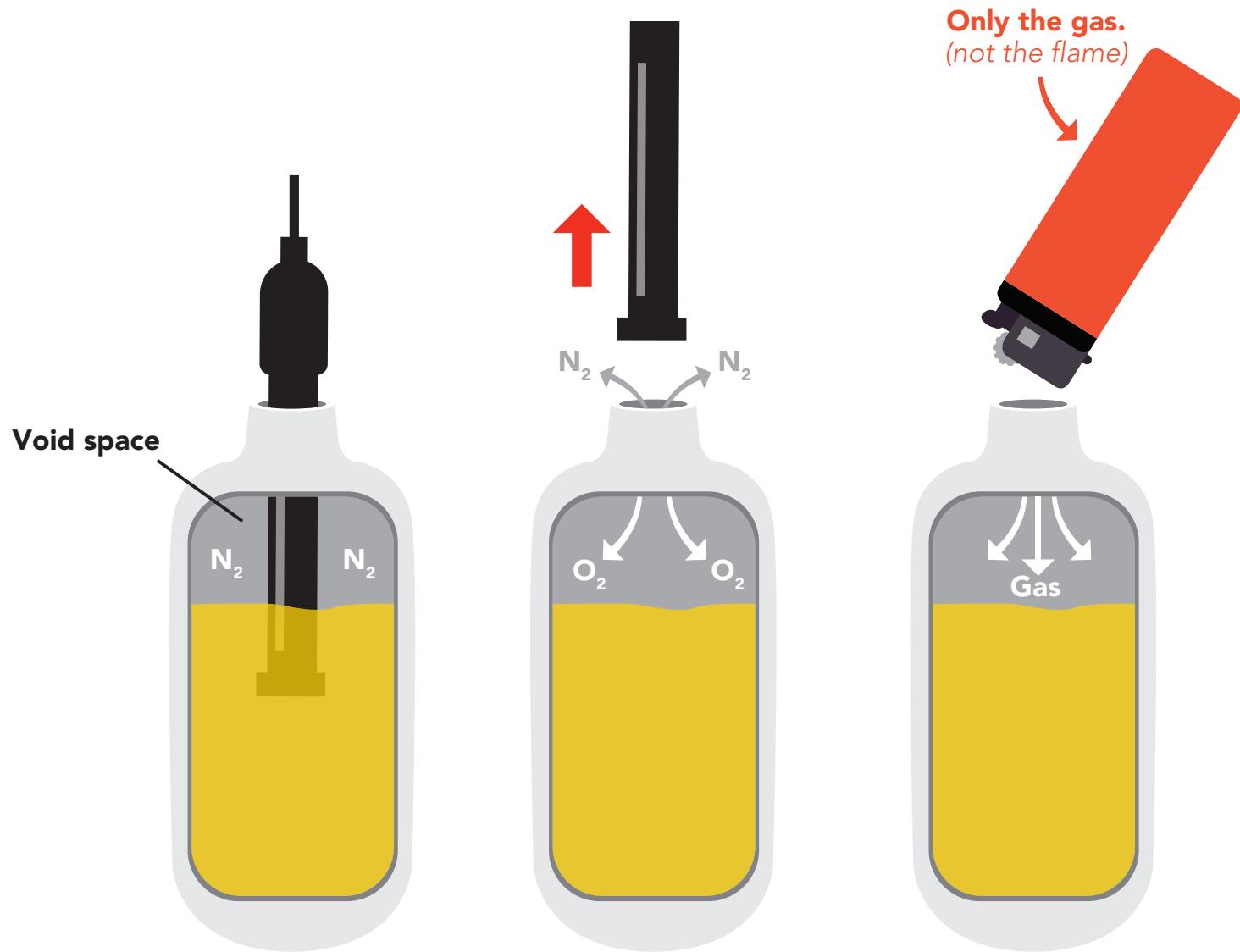
After you have calibrated using the command "Cal"



1. Stir probe in Zero D.O. calibration solution to remove trapped air, (which could cause readings to go high).
2. Let the probe sit in Zero D.O. calibration solution until readings stabilize (0:10 – 1:30).
3. Calibrate using the command "Cal,0".

# How to preserve the Zero D.O. calibration solution

Oxygen is everywhere. The Zero D.O. calibration solution has been designed to chemically absorb oxygen. Once the bottle has been opened the test solution has been exposed to oxygen and will slowly stop working.



Inside each bottle of the calibration solution is a small amount of nitrogen gas that helps displace oxygen out of the bottle during the filling process. When the Dissolved Oxygen probe is removed from the bottle, oxygen will enter the bottle and begin to dissolve into the solution.

In order slow down this process, fill the void space of the bottle with any gas (other than oxygen) to preserve the calibration solution. Gas from a lighter works great if other gases are currently unobtainable.

# Power and data isolation

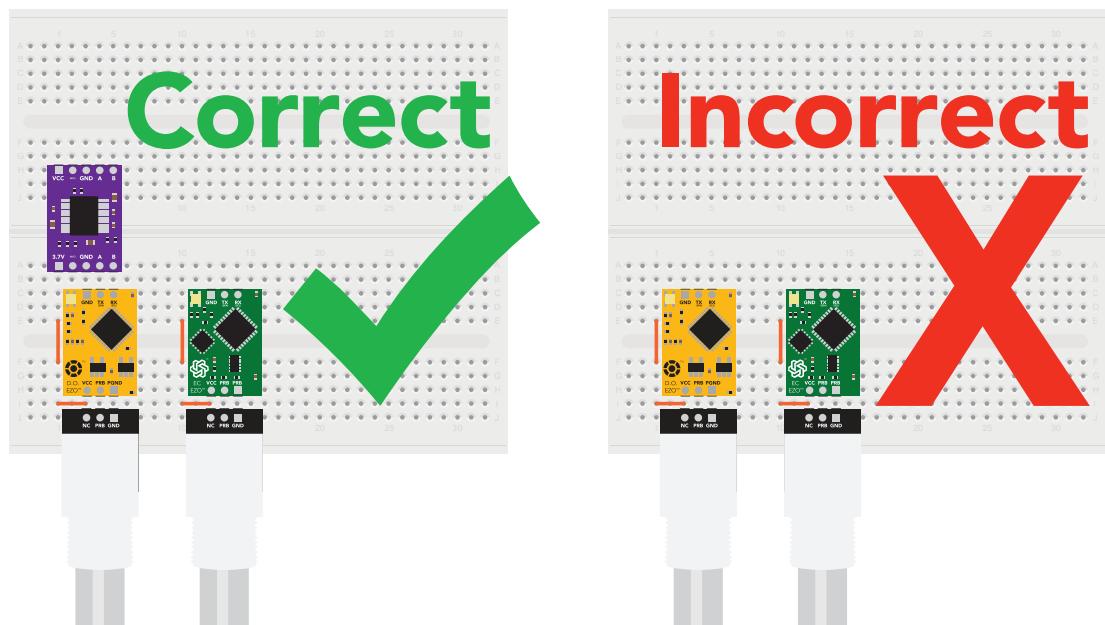
The Atlas Scientific EZO™ Dissolved Oxygen circuit is a very sensitive device. This sensitivity is what gives the Dissolved Oxygen circuit its accuracy. This also means that the Dissolved Oxygen circuit is capable of reading micro-voltages that are bleeding into the water from unnatural sources such as pumps, solenoid valves or other probes/sensors.

When electrical noise is interfering with the Dissolved Oxygen readings it is common to see rapidly fluctuating readings or readings that are consistently off. To verify that electrical noise is causing inaccurate readings, place the Dissolved Oxygen probe in a cup of water by itself. The readings should stabilize quickly, confirming that electrical noise was the issue.



When reading Dissolved Oxygen and Conductivity together, it is **strongly recommended** that the EZO™ Dissolved Oxygen circuit is electrically isolated from the EZO™ Conductivity circuit.

Basic EZO™  
Inline Voltage Isolator

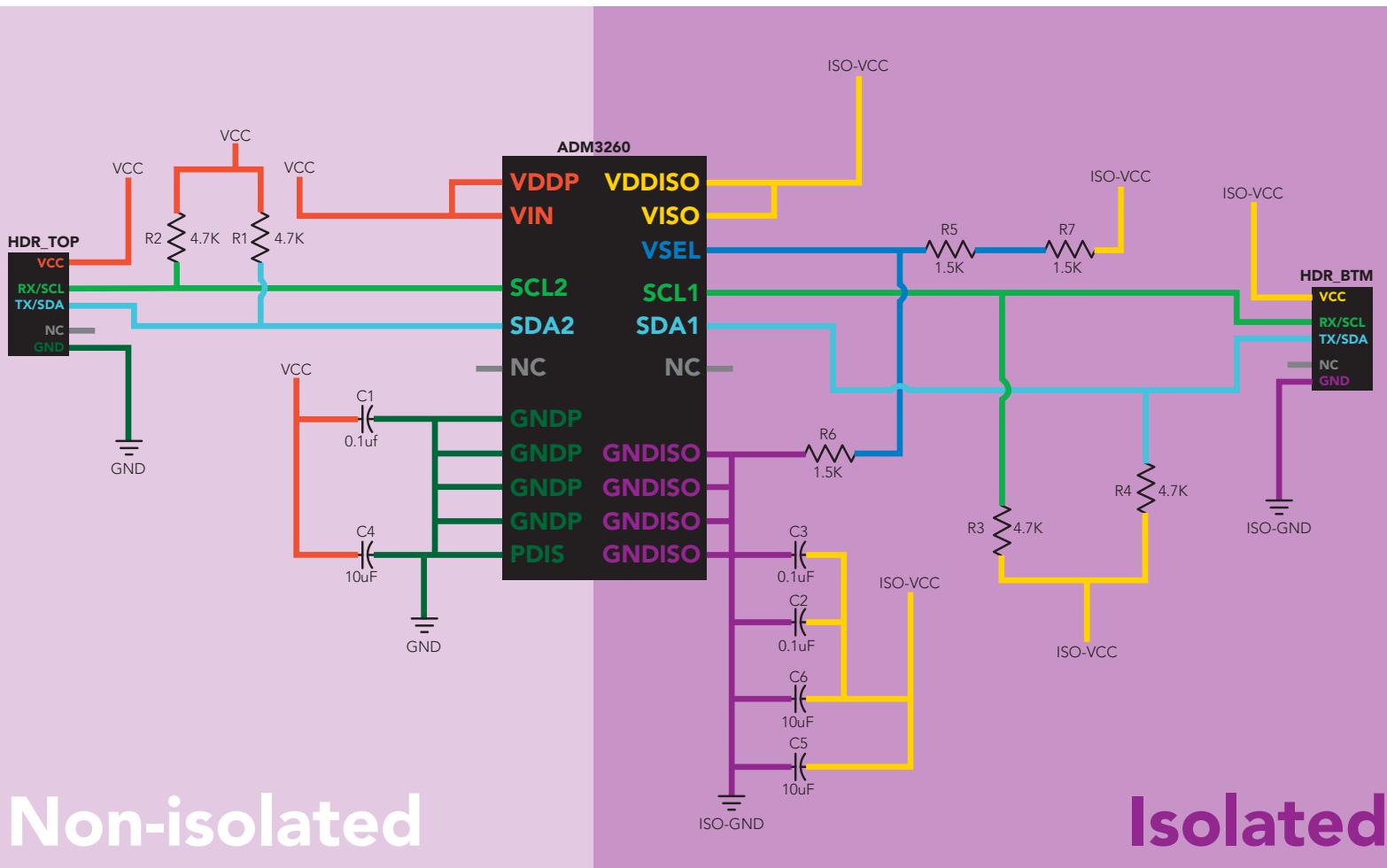


**Without isolation, Conductivity readings will effect Dissolved Oxygen accuracy.**

This schematic shows exactly how we isolate data and power using the [ADM3260](#) and a few passive components. The ADM3260 can output isolated power up to 150 mW and incorporates two bidirectional data channels.

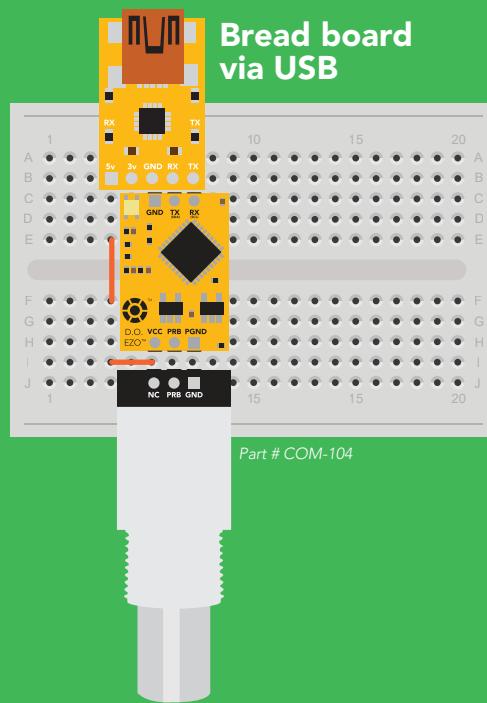
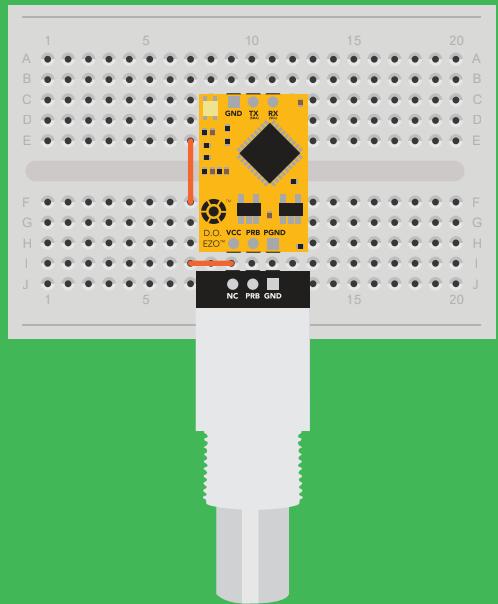
This technology works by using tiny transformers to induce the voltage across an air gap. PCB layout requires special attention for EMI/EMC and RF Control, having proper ground planes and keeping the capacitors as close to the chip as possible are crucial for proper performance. The two data channels have a  $4.7\text{k}\Omega$  pull up resistor on both the isolated and non-isolated lines (R1, R2, R3, and R4) The output voltage is set using a voltage divider (R5, R6, and R7) this produces a voltage of 3.7V regardless of your input voltage.

**Isolated ground is different from non-isolated ground, these two lines should not be connected together.**

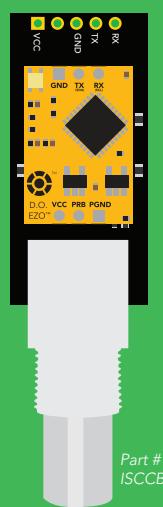


# ✓ Correct wiring

Bread board



Carrier board



USB carrier board

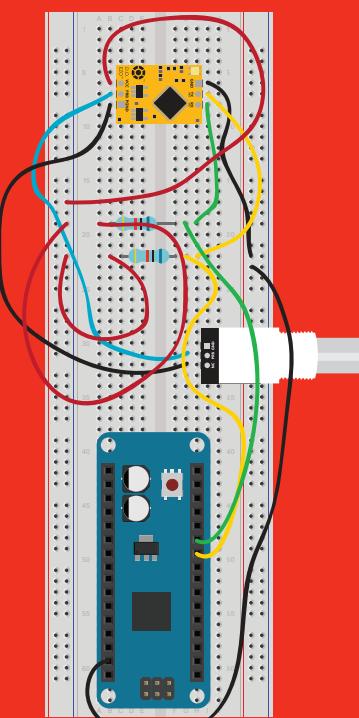


# ✗ Incorrect wiring

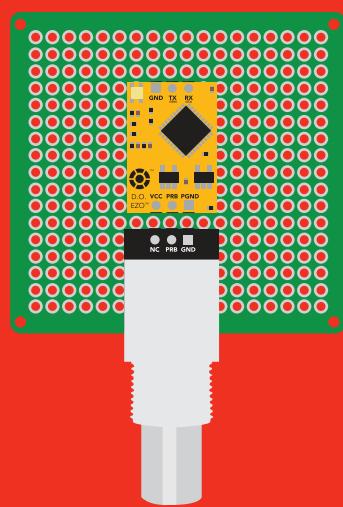
Extended leads



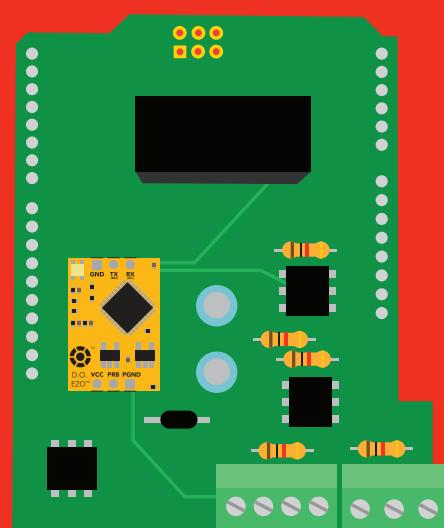
Sloppy setup



Perfboards or Protoboards



\*Embedded into your device



**NEVER**  
use Perfboards  
or Protoboards

\*Only after you are familiar  
with EZO™ circuits operation

 Available data protocols

**UART**

**Default**

**I<sup>2</sup>C**

 Unavailable data protocols

**SPI**

**Analog**

**RS-485**

**Mod Bus**

**4–20mA**

# 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<sup>2</sup>C mode  
LED control  
Protocol lock  
Software switch to I<sup>2</sup>C mode

## Settings that are **NOT** retained if power is cut

Find  
Pressure compensation  
Salinity compensation  
Sleep mode  
Temperature compensation

# 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

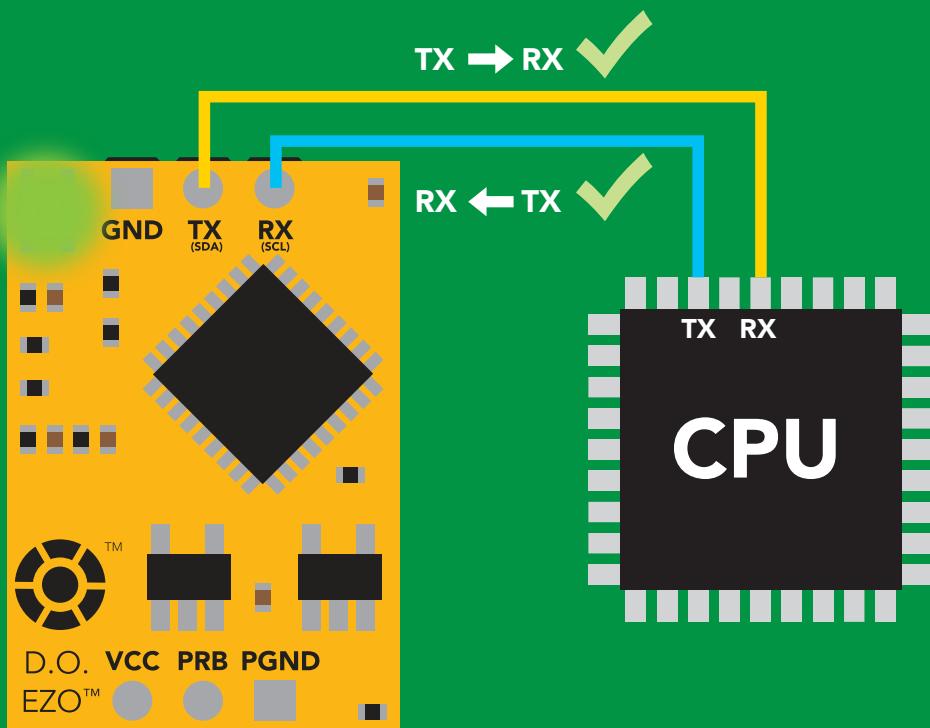


**TX** Data out



**Vcc** 3.3V – 5.5V

0V VCC 0V



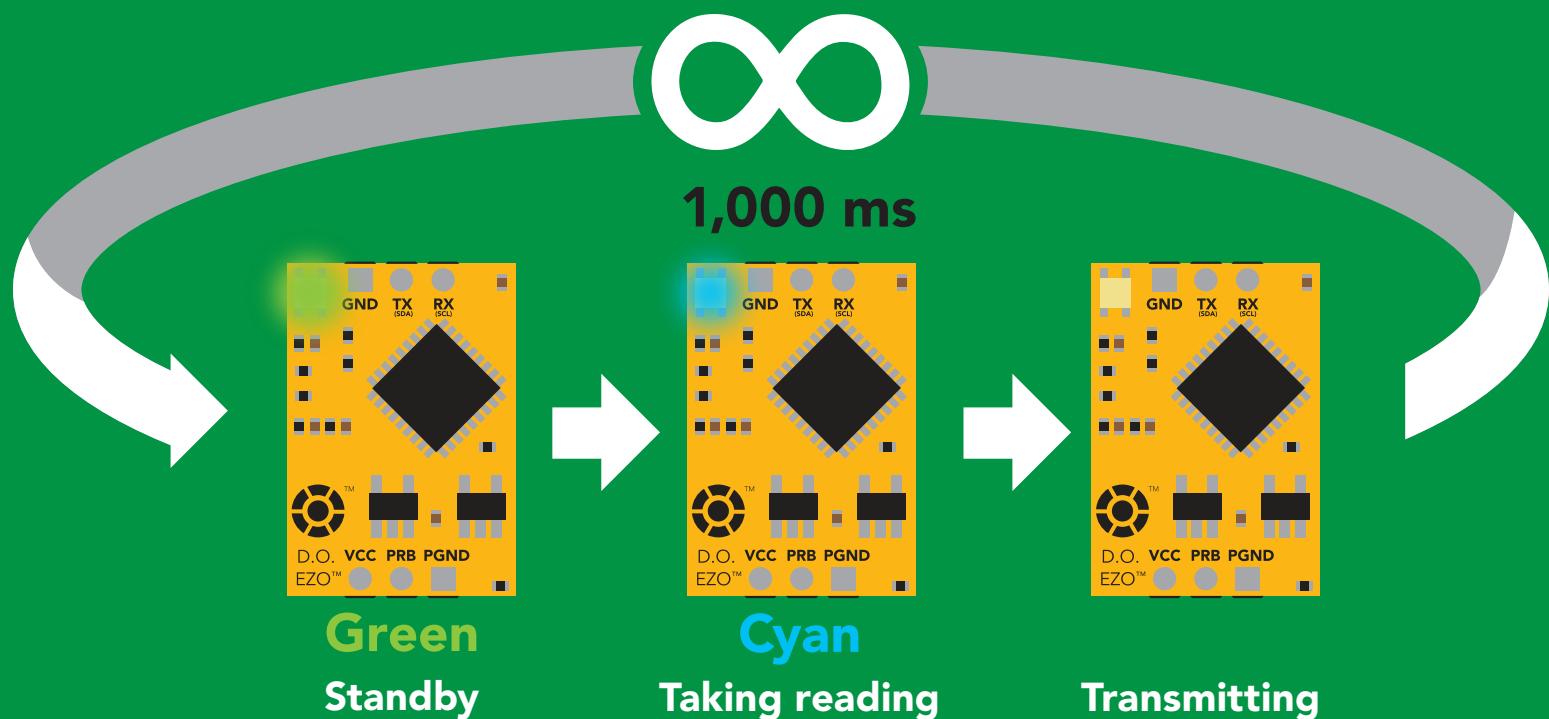
## Data format

Reading	D.O.
Units	mg/L & (% sat) <small>when enabled</small>
Encoding	ASCII
Format	string <small>(CSV string when % sat is enabled)</small>
Terminator	carriage return

Data type	<b>floating point</b>
Decimal places	mg/L = 2 % sat = 1
Smallest string	<b>4 characters</b>
Largest string	<b>16 characters</b>

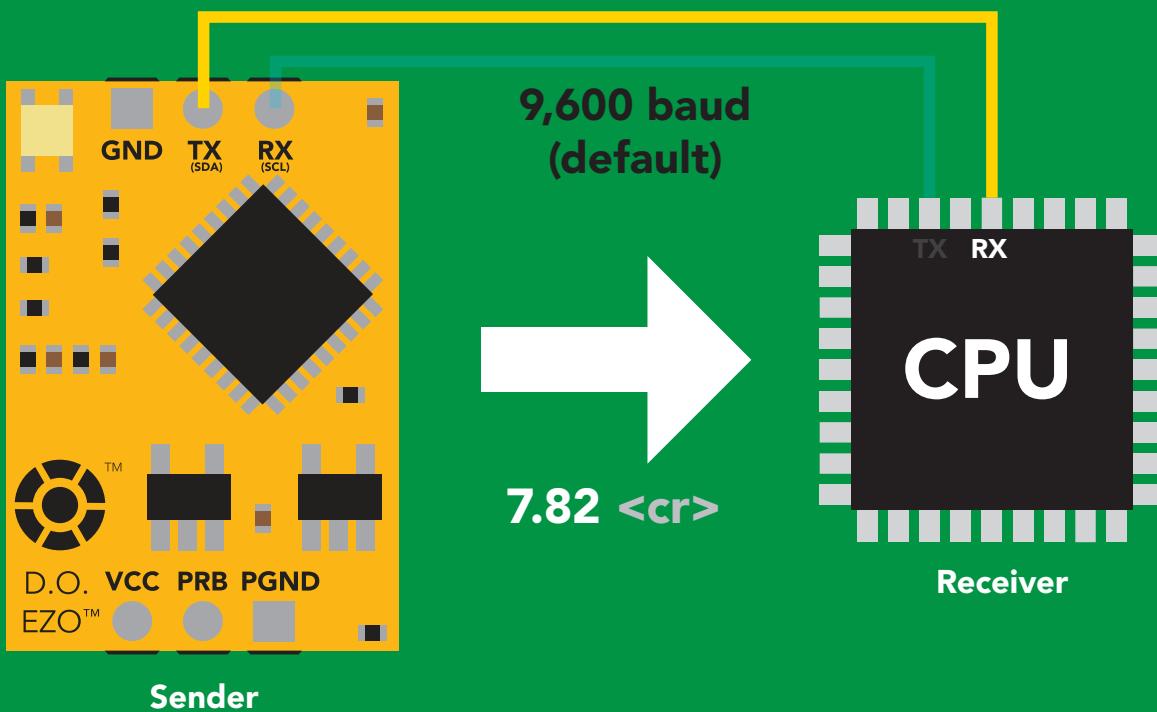
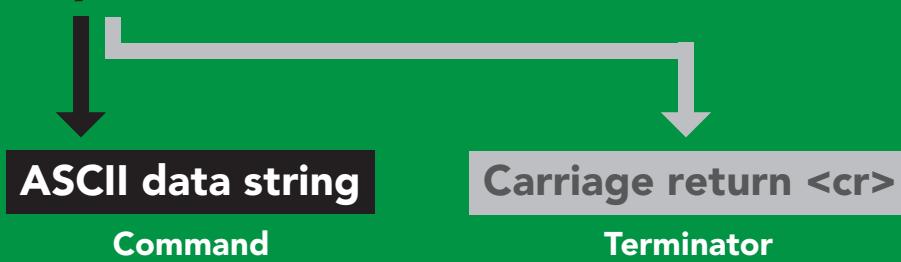
# Default state

Mode	UART
Baud	9,600
Readings	continuous
Speed	1 reading per second
Readings without probe	18.17
Temperature compensation	20 °C
Salinity compensation	0 (Fresh water)
Pressure compensation	101.3 kPa (Sea level)
LED	on



# Receiving data from device

2 parts



## Advanced

ASCII: 7 . 8 2 <cr>

Hex: 37 2E 38 32 0D

Dec: 55 46 56 50 13

# Sending commands to device

2 parts

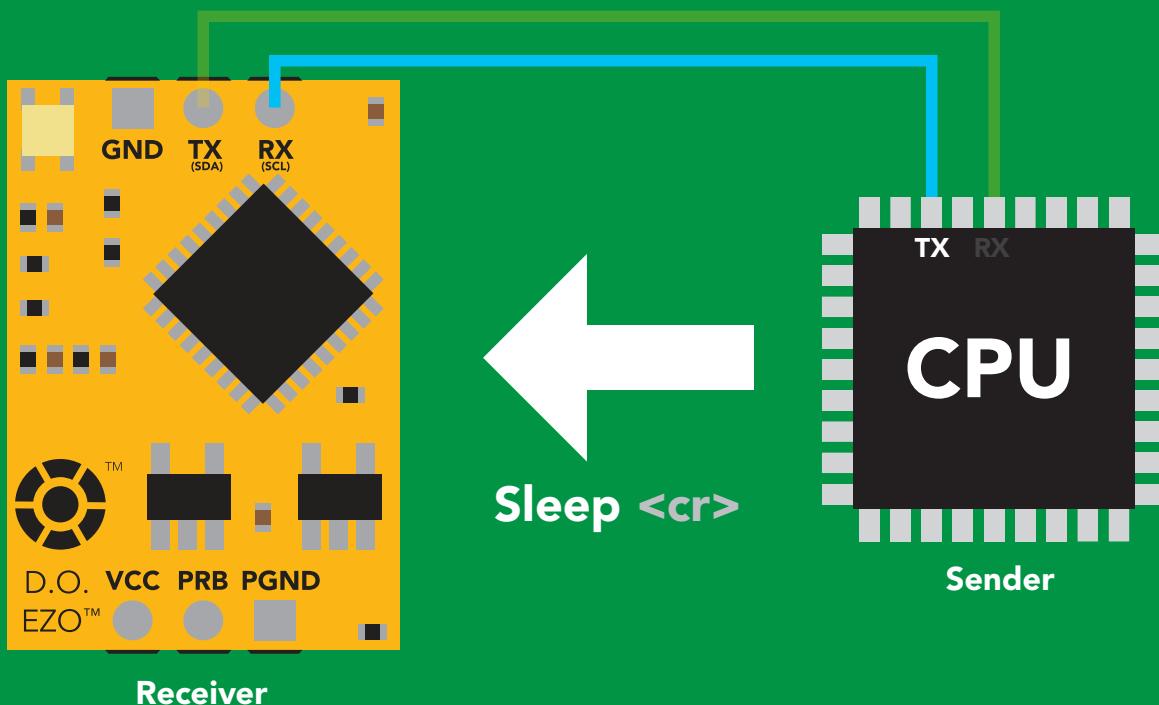


Command (not case sensitive)

ASCII data string

Carriage return <cr>

Terminator



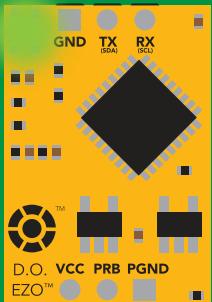
## Advanced

ASCII: S I e e p <cr>

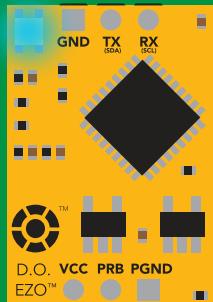
Hex: 53 6C 65 65 70 0D

Dec: 83 108 101 101 112 13

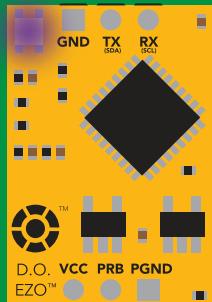
# LED color definition



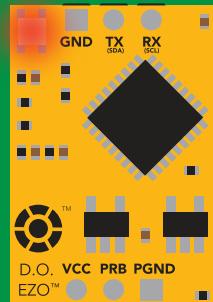
**Green**  
UART standby



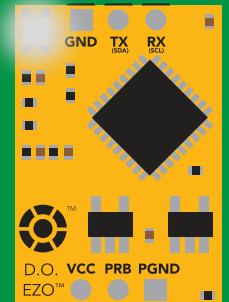
**Cyan**  
Taking reading



**Purple**  
Changing baud rate



**Red**  
Command not understood



**White**  
Find

<b>5V</b>	LED ON <b>+0.4 mA</b>
<b>3.3V</b>	<b>+0.2 mA</b>

# UART mode

## command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	Default state
Baud	change baud rate	pg. 35 9,600
C	enable/disable continuous reading	pg. 22 enabled
Cal	performs calibration	pg. 24 n/a
Export/import	export/import calibration	pg. 25 n/a
Factory	enable factory reset	pg. 37 n/a
Find	finds device with blinking white LED	pg. 21 n/a
i	device information	pg. 31 n/a
I2C	change to I <sup>2</sup> C mode	pg. 38 not set
L	enable/disable LED	pg. 20 enabled
Name	set/show name of device	pg. 30 not set
O	enable/disable parameters	pg. 29 mg/L
P	pressure compensation	pg. 28 101.3 kPa
Plock	enable/disable protocol lock	pg. 36 disabled
R	returns a single reading	pg. 23 n/a
S	salinity compensation	pg. 27 n/a
Sleep	enter sleep mode/low power	pg. 34 n/a
Status	retrieve status information	pg. 33 n/a
T	temperature compensation	pg. 26 20°C
*OK	enable/disable response codes	pg. 32 enable

# LED control

## Command syntax

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

L,0 <cr> LED off

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

### Example

L,1 <cr>

\*OK <cr>

L,0 <cr>

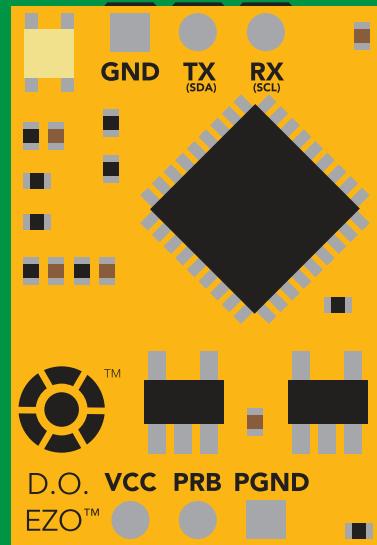
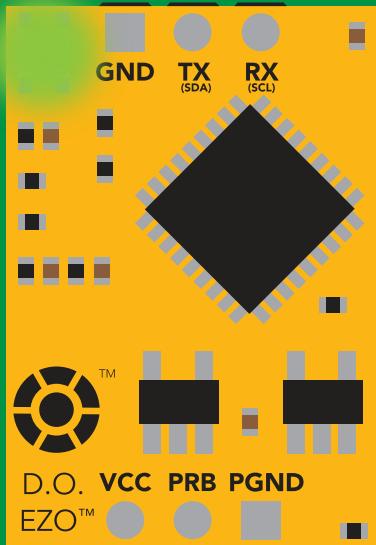
\*OK <cr>

L,? <cr>

?L,1 <cr> or ?L,0 <cr>

\*OK <cr>

### Response



L,1

L,0

# Find

## Command syntax

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

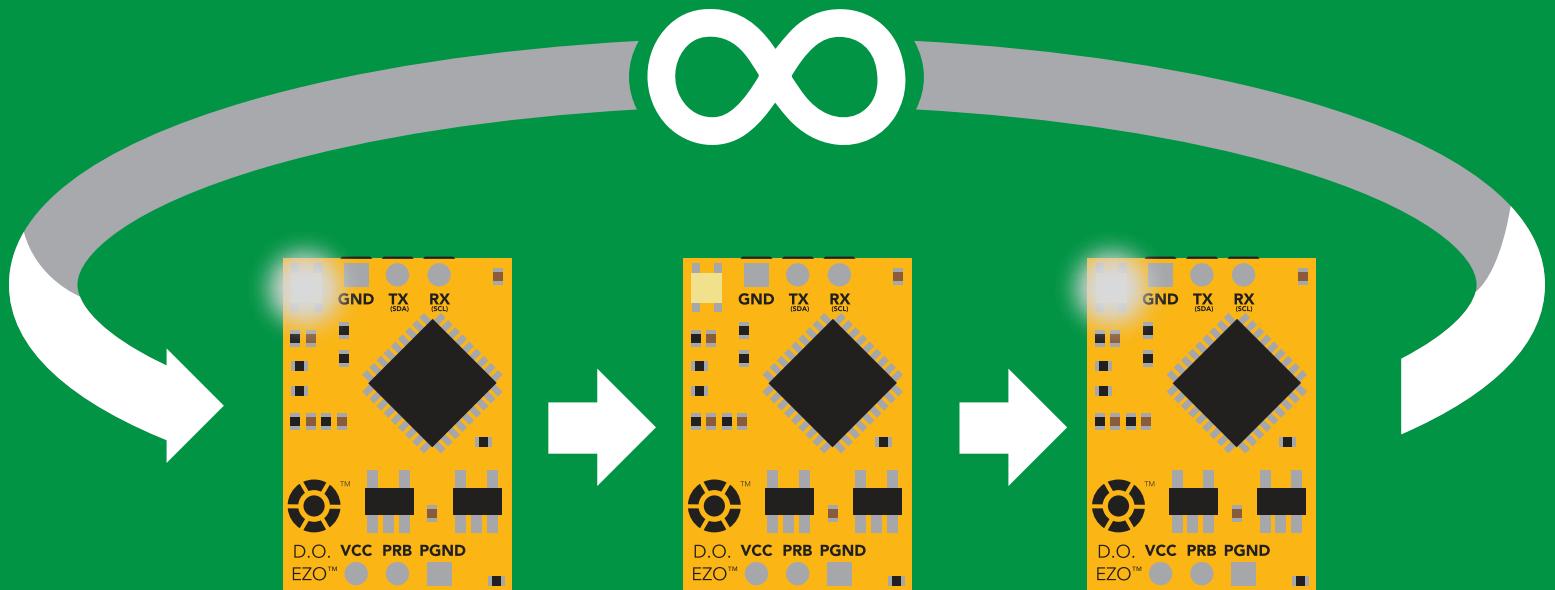
Find <cr> LED rapidly blinks white, used to help find device\*

\*This command is only available for firmware version 2.10 and above.

## Example Response

Find <cr>

\*OK <cr>



# 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?

\*This command is only available for firmware version 2.10 and above.

## Example Response

C,1 <cr>	*OK <cr> DO (1 sec) <cr> DO (2 sec) <cr> DO (3 sec) <cr>
C,30 <cr>	*OK <cr> DO (30 sec) <cr> DO (60 sec) <cr> DO (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

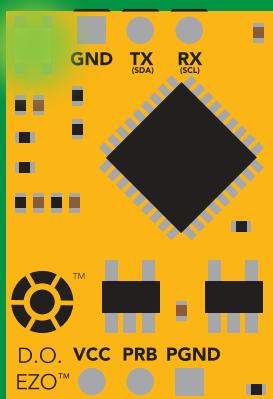
R <cr> takes single reading

### Example Response

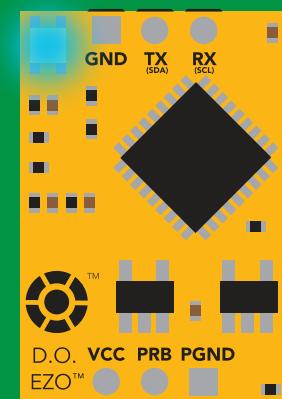
R <cr>

7.82 <cr>

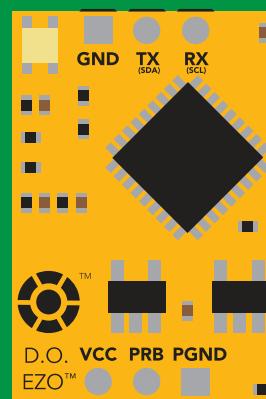
\*OK <cr>



Green  
Standby



Cyan  
Taking reading



Transmitting



# Calibration

## Command syntax

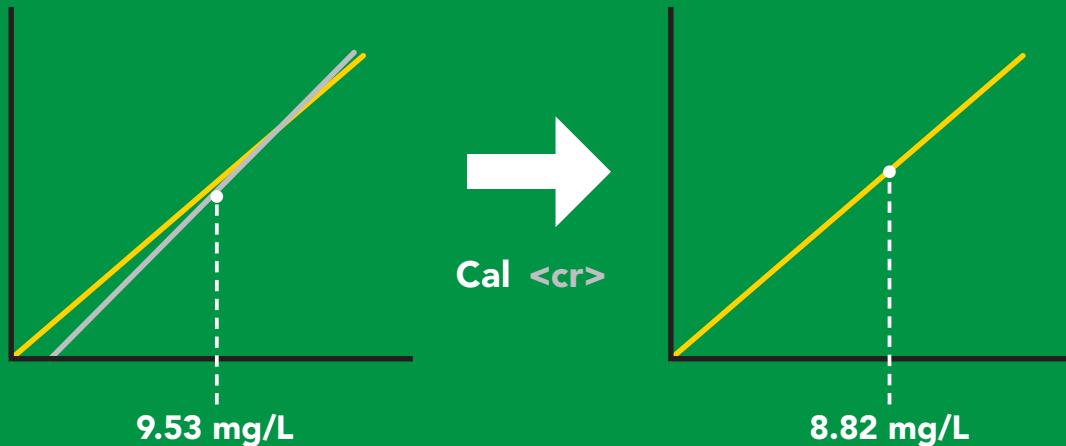
The EZO™ Dissolved Oxygen circuit uses single and/or two point calibration

Cal	<cr> calibrate to atmospheric oxygen levels
Cal,0	<cr> calibrate device to 0 dissolved oxygen
Cal,clear	<cr> delete calibration data
Cal,?	<cr> device calibrated?

## Example Response

Cal <cr>	*OK <cr>
Cal,0 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,0 <cr> or ?Cal,1 <cr> or ?Cal,2 <cr> *OK <cr>

single point      two point



# Export/import calibration

## Command syntax

Export: Use this command to save calibration settings  
Import: Use this command to load calibration settings to one or more devices.

**Export <cr> export calibration string from calibrated device\***  
**Import <cr> import calibration string to new device\***  
**Export,? <cr> calibration string info\***

\*This command is only available for firmware version 2.10 and above.

## Example

Export,? <cr>

## Response

10,120 <cr>

### Response breakdown

10, 120

↑      ↑  
# of strings to export # of bytes to export

Export strings can be up to 12 characters long, and is always followed by <cr>

Export <cr>

59 6F 75 20 61 72 <cr> (1 of 10)

Export <cr>

65 20 61 20 63 6F <cr> (2 of 10)

Export <cr>

6F 6C 20 67 75 79 <cr> (3 of 10)

...

Disabling \*OK simplifies this process

Import, n  
(FIFO)

Import, 59 6F 75 20 61 72 <cr> (1 of 10)

...

# Temperature compensation

## Command syntax

Default temperature = 20°C  
Temperature is always in Celsius

T,n <cr> n = any value; floating point or int

T,? <cr> compensated temperature value?

## Example

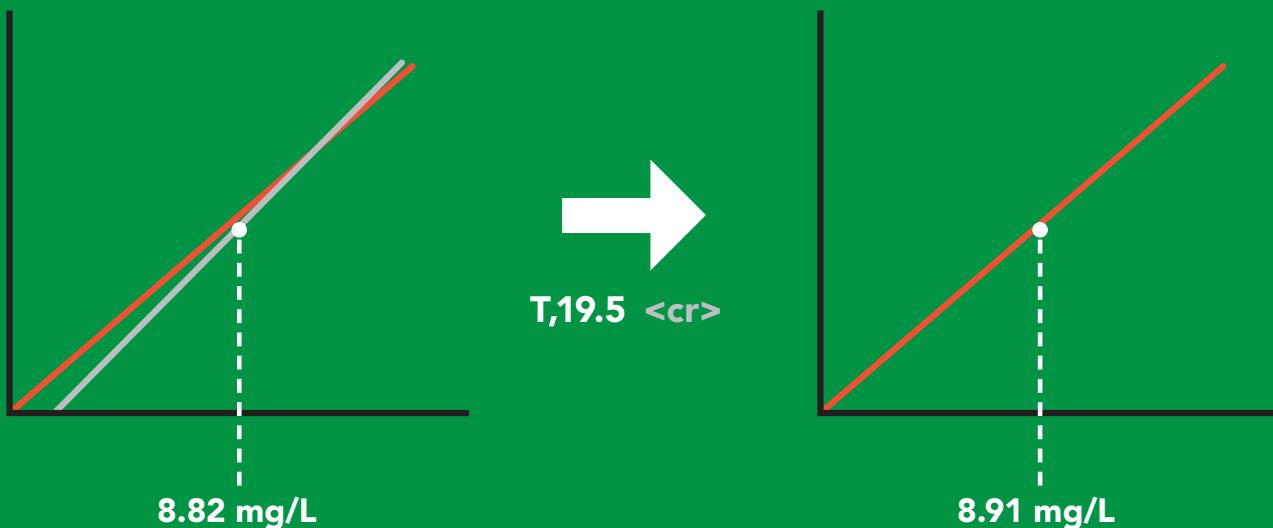
T,19.5 <cr>

## Response

\*OK <cr>

T,? <cr>

?T,19.5 <cr>  
\*OK <cr>



# Salinity compensation

## Command syntax

Default value = 0  $\mu\text{s}$

If the conductivity of your water is less than 2,500 $\mu\text{S}$  this command is irrelevant

**S,n** <cr> n = any value in microsiemens

**S,n,ppt** <cr> n = any value in ppt

**S,?** <cr> compensated salinity value?

## Example

**S,50000 <cr>**

## Response

\*OK <cr>

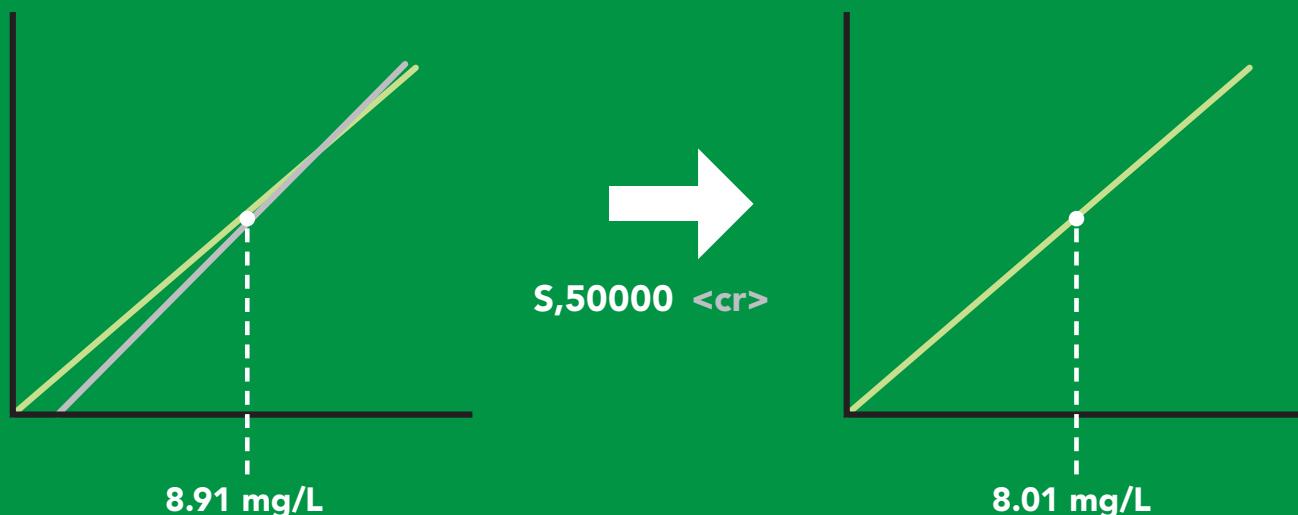
**S,37.5,ppt <cr>**

**S,? <cr>**

\*OK <cr>

?S,50000, $\mu\text{S}$  <cr> or ?S,37.5,ppt <cr>

\*OK <cr>



# Pressure compensation

## Command syntax

Default value = 101.3 kPa  
This parameter can be omitted if the water is less than 10 meters deep

P,n <cr> n = any value in kPa

P,? <cr> compensated pressure value?

## Example

P,90.25 <cr>

## Response

\*OK <cr>

P,? <cr>

?P,90.25 <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,%,0 <cr>	*OK <cr> disable percent saturation
O,%,1 <cr>	*OK <cr> enable percent saturation
O,mg,0 <cr>	*OK <cr> disable mg/L
O,mg,1 <cr>	*OK <cr> enable mg/L
O,? <cr>	? , O, %, mg <cr> if both are enabled

Parameters	
%	percent saturation
mg	mg/L
Followed by 1 or 0	
1	enabled
0	disabled

# Naming device

## Command syntax

Name,n <cr> set name

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

Name,? <cr> show name

Up to 16 ASCII characters

## Example

Name,zzt <cr>

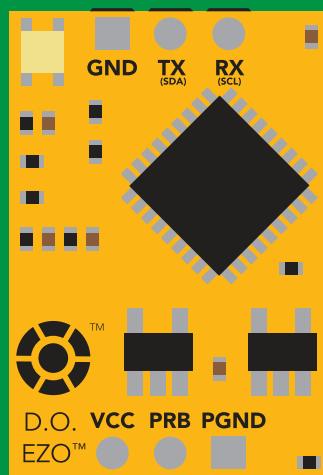
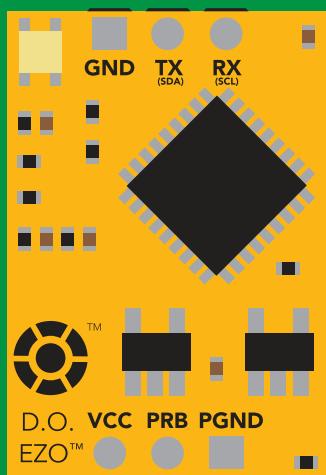
\*OK <cr>

Name,? <cr>

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

## Response

## Name,?



\*OK <cr>

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

# Device information

## Command syntax

i <cr> device information

### Example      Response

i <cr>

?i,D.O.,1.98 <cr>  
\*OK <cr>

### Response breakdown

?i, D.O., 1.98  
↑            ↑  
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>

**7.82 <cr>**

**\*OK <cr>**

**\*OK,0 <cr>**

**no response, \*OK disabled**

R <cr>

**7.82 <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

Reason for restart

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

Sleep <cr>

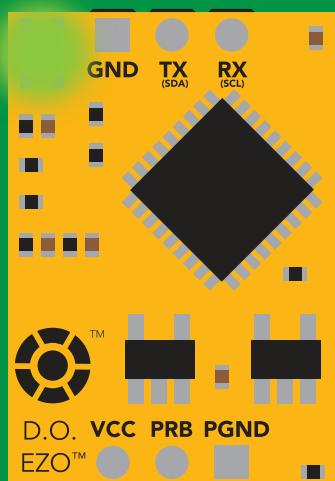
### Response

\*SL

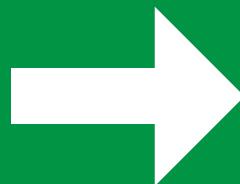
### Any command

\*WA <cr> wakes up device

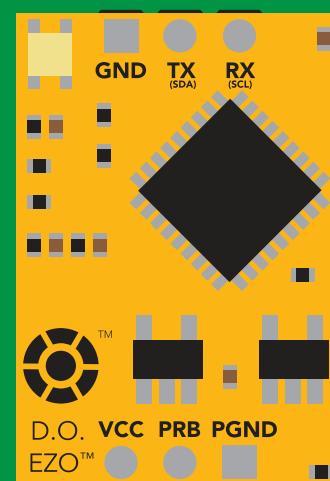
	STANDBY	SLEEP
<b>5V</b>	<b>13.1 mA</b>	<b>0.66 mA</b>
<b>3.3V</b>	<b>12 mA</b>	<b>0.3 mA</b>



**Standby**  
**13.1 mA**



**Sleep <cr>**



**Sleep**  
**0.66 mA**

# Change baud rate

## Command syntax

Baud,n <cr> change baud rate

### Example

Baud,38400 <cr>

### Response

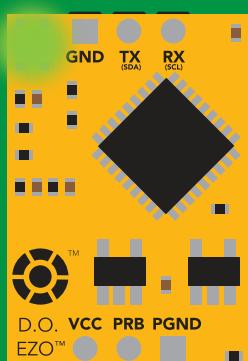
\*OK <cr>

Baud,? <cr>

?Baud,38400 <cr>

\*OK <cr>

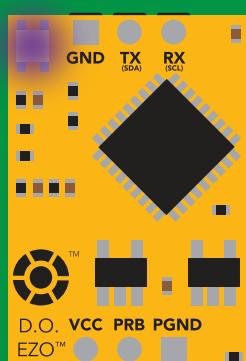
n = [ 300  
1200  
2400  
**9600 default**  
19200  
38400  
57600  
115200 ]



Standby



Baud,38400 <cr>

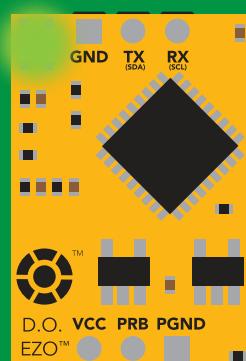


Changing baud rate

\*OK <cr>



(reboot)



Standby

# 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

Plock,1 <cr>

\*OK <cr>

Plock,0 <cr>

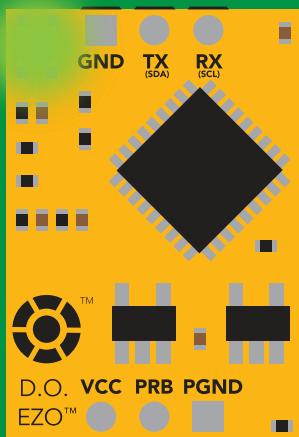
\*OK <cr>

Plock,? <cr>

?Plock,1 <cr> or ?Plock,0 <cr>

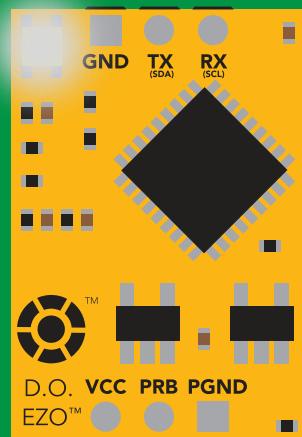
## Response

Plock,1



\*OK <cr>

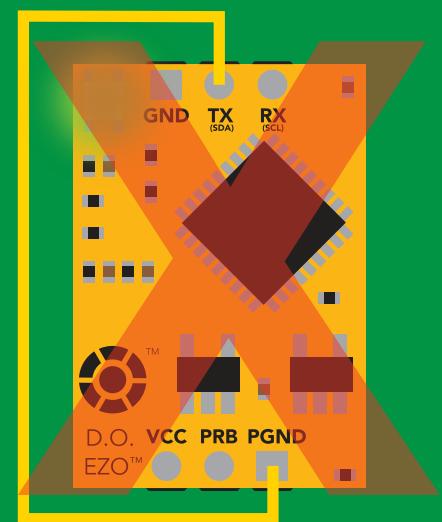
I2C,100



cannot change to I<sup>2</sup>C

\*ER <cr>

Short



cannot change to I<sup>2</sup>C

# Factory reset

## Command syntax

Clears calibration  
LED on  
"\*OK" enabled

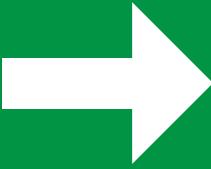
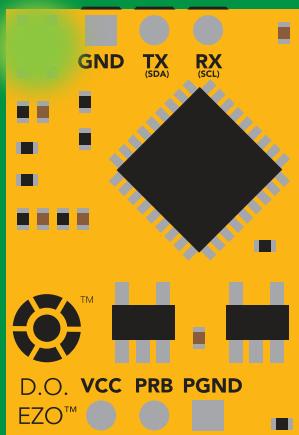
Factory <cr> enable factory reset

## Example Response

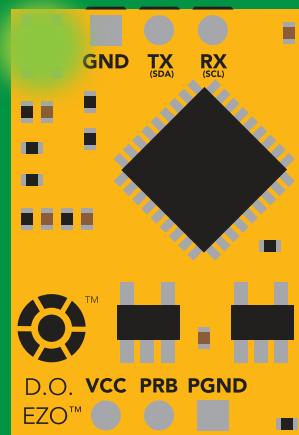
Factory <cr>

\*OK <cr>

Factory <cr>



(reboot)



\*OK <cr>

\*RS <cr>

\*RE <cr>

Baud rate will not change

# Change to I<sup>2</sup>C mode

## Command syntax

Default I<sup>2</sup>C address 97 (0x61)

I<sup>2</sup>C,n <cr> sets I<sup>2</sup>C address and reboots into I<sup>2</sup>C mode

n = any number 1 – 127

## Example      Response

I<sup>2</sup>C,100 <cr>

\*OK (reboot in I<sup>2</sup>C mode)

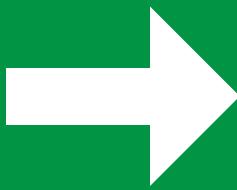
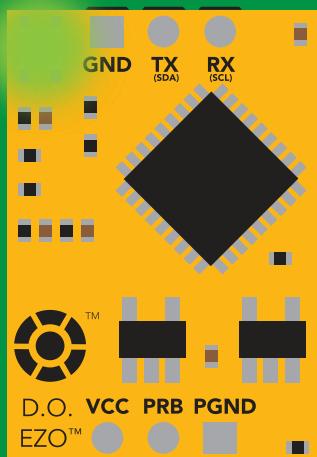
## Wrong example

I<sup>2</sup>C,139 <cr> n ≠ 127

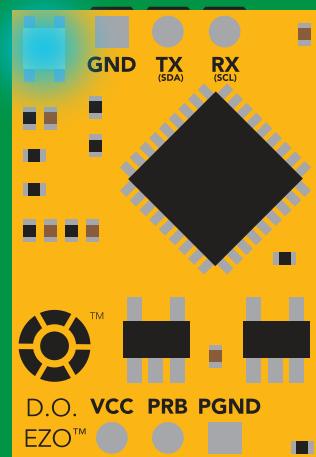
## Response

\*ER <cr>

I<sup>2</sup>C,100



(reboot)



Green  
\*OK <cr>

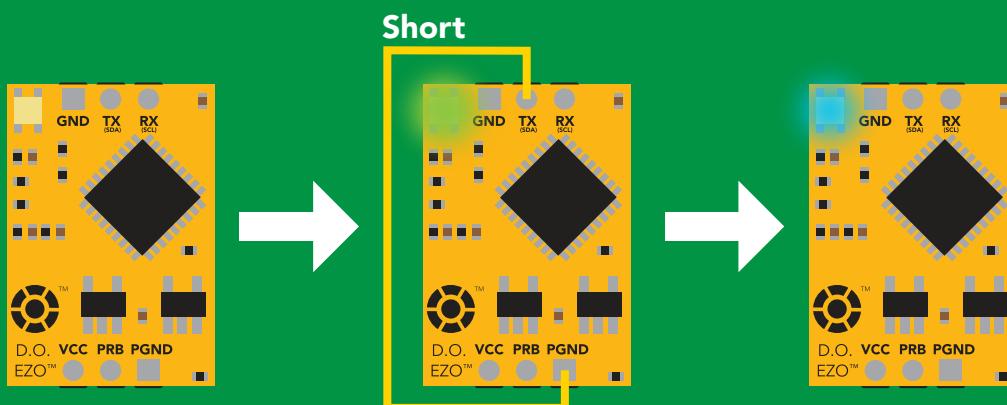
Blue  
now in I<sup>2</sup>C mode

# Manual switching to I<sup>2</sup>C

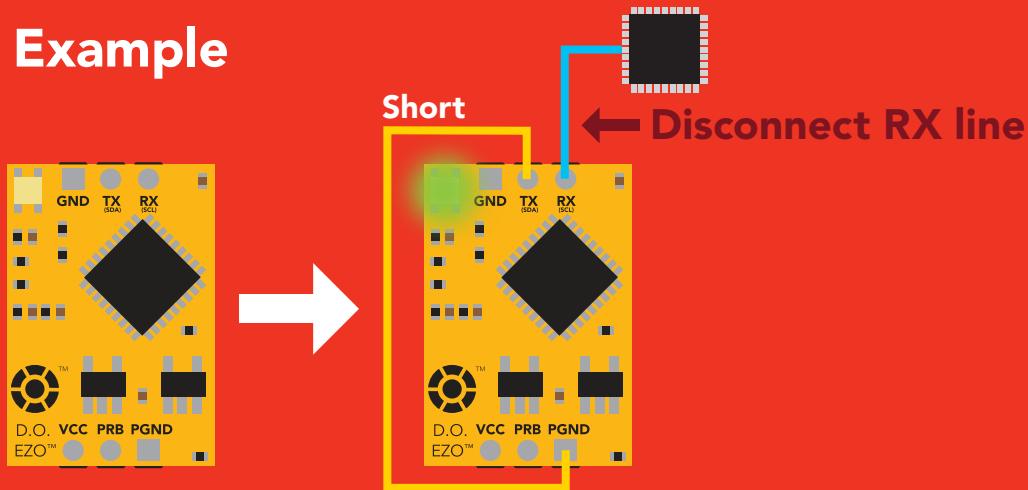
- Make sure Plock is set to 0
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PGND
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Green to Blue
- Disconnect ground (power off)
- Reconnect all data and power

Manually switching to I<sup>2</sup>C will set the I<sup>2</sup>C address to 97 (0x61)

## Example



## Wrong Example



# I<sup>2</sup>C mode

The I<sup>2</sup>C 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 I<sup>2</sup>C mode [click here](#)

## Settings that are retained if power is cut

- Calibration
- Change I<sup>2</sup>C address
- Enable/disable parameters
- Hardware switch to UART mode
- LED control
- Protocol lock
- Software switch to UART mode

## Settings that are **NOT** retained if power is cut

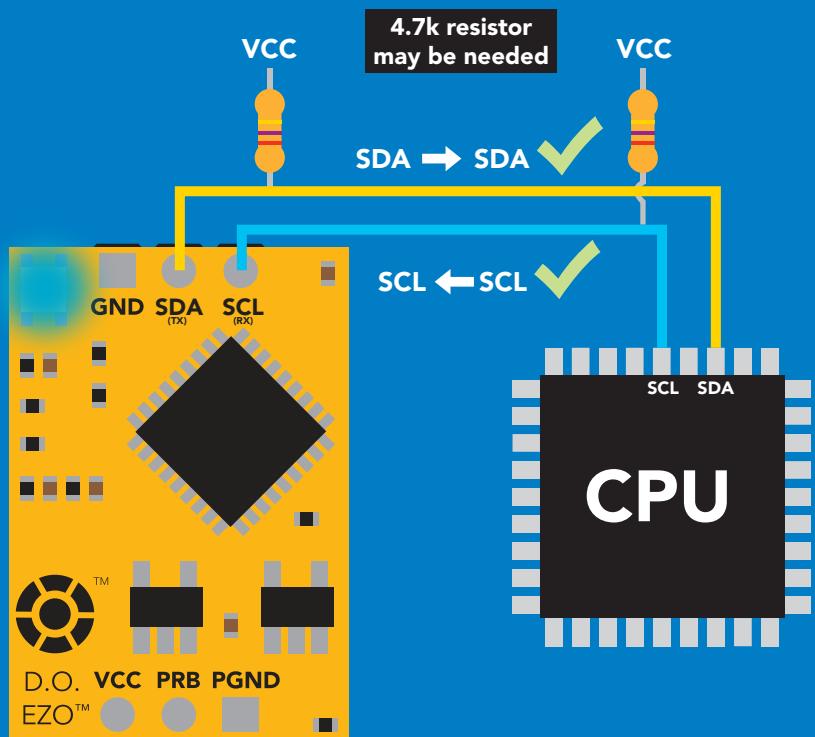
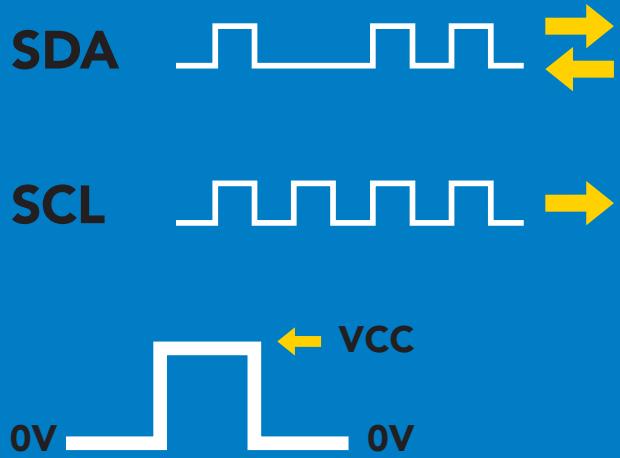
- Find
- Pressure compensation
- Salinity compensation
- Sleep mode
- Temperature compensation

# I<sup>2</sup>C mode

I<sup>2</sup>C address (0x01 – 0x7F)  
**97 (0x61) default**

V<sub>cc</sub> 3.3V – 5.5V

Clock speed 100 – 400 kHz



## Data format

Reading D.O.  
Units mg/L & (% sat)  
when enabled  
Encoding ASCII  
Format string  
(CSV string when  
% sat is enabled)  
Terminator carriage return

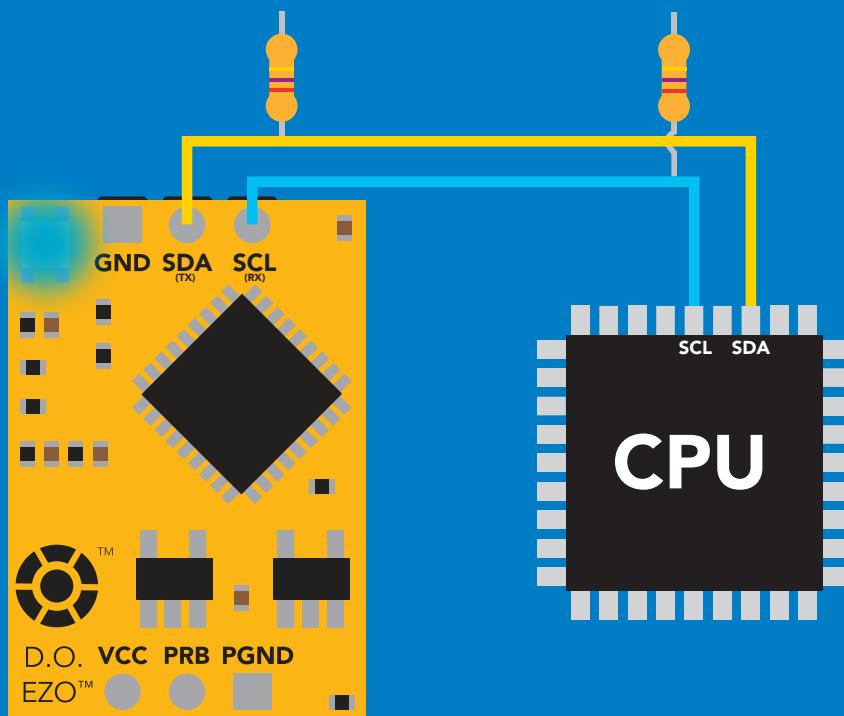
Data type floating point  
mg/L = 2  
% sat = 1  
Decimal places 4 characters  
Smallest string 16 characters  
Largest string

# Sending commands to device

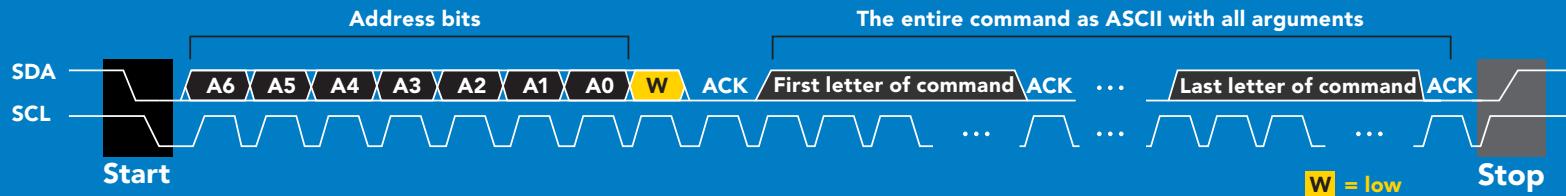


## Example

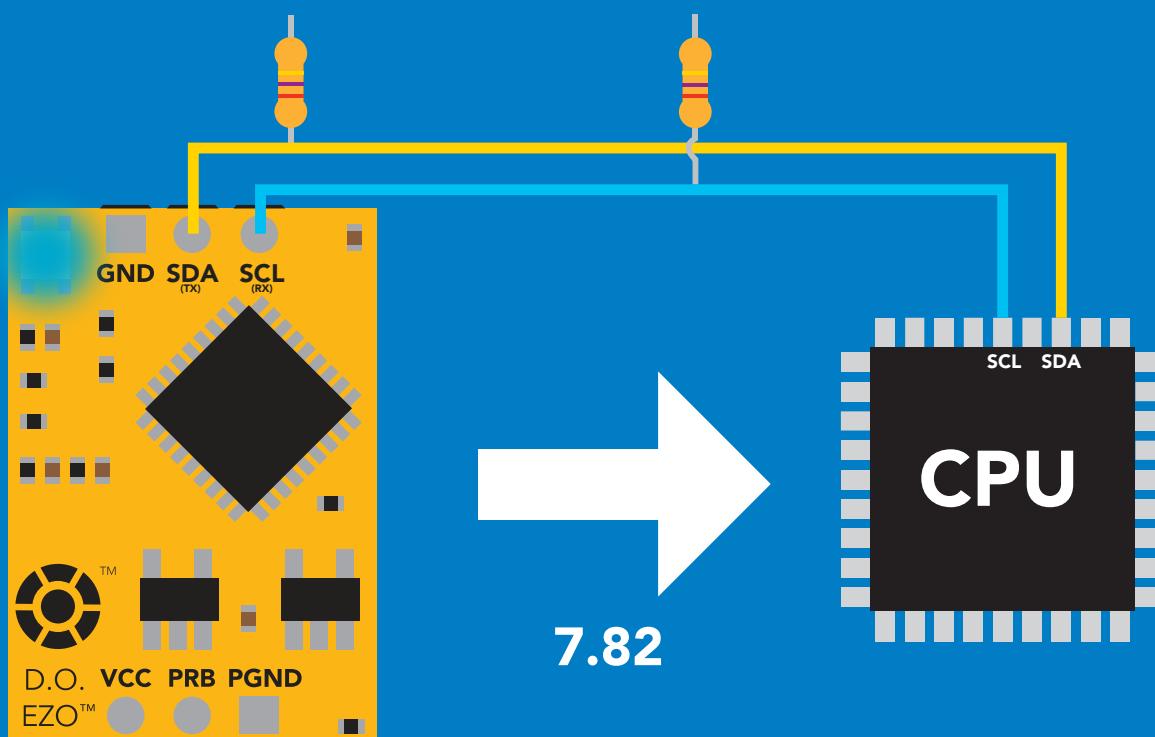
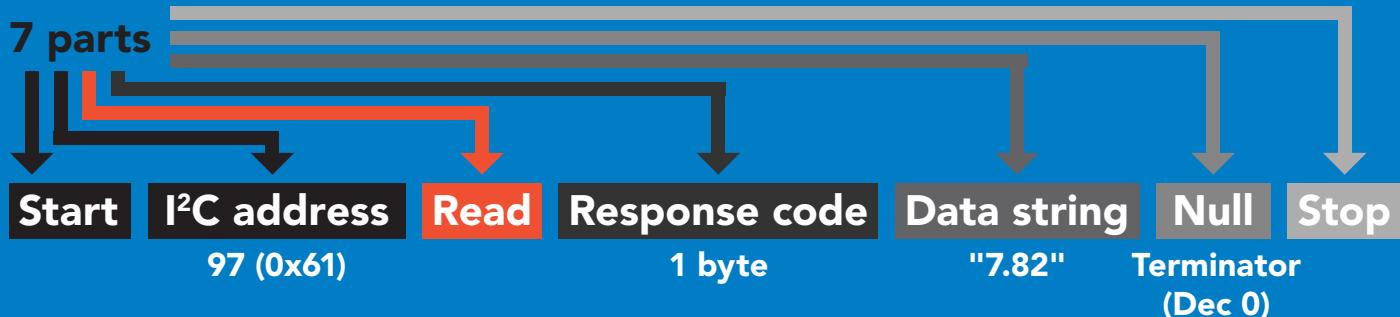
Start    97 (0x61)    Write    Sleep    Stop  
I<sup>2</sup>C address                      Command



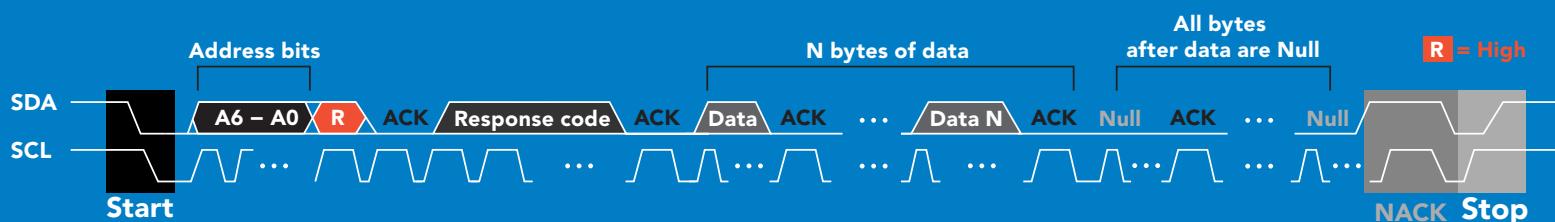
## Advanced



# Requesting data from device



## Advanced



1 55 46 56 50 0 = 7.82

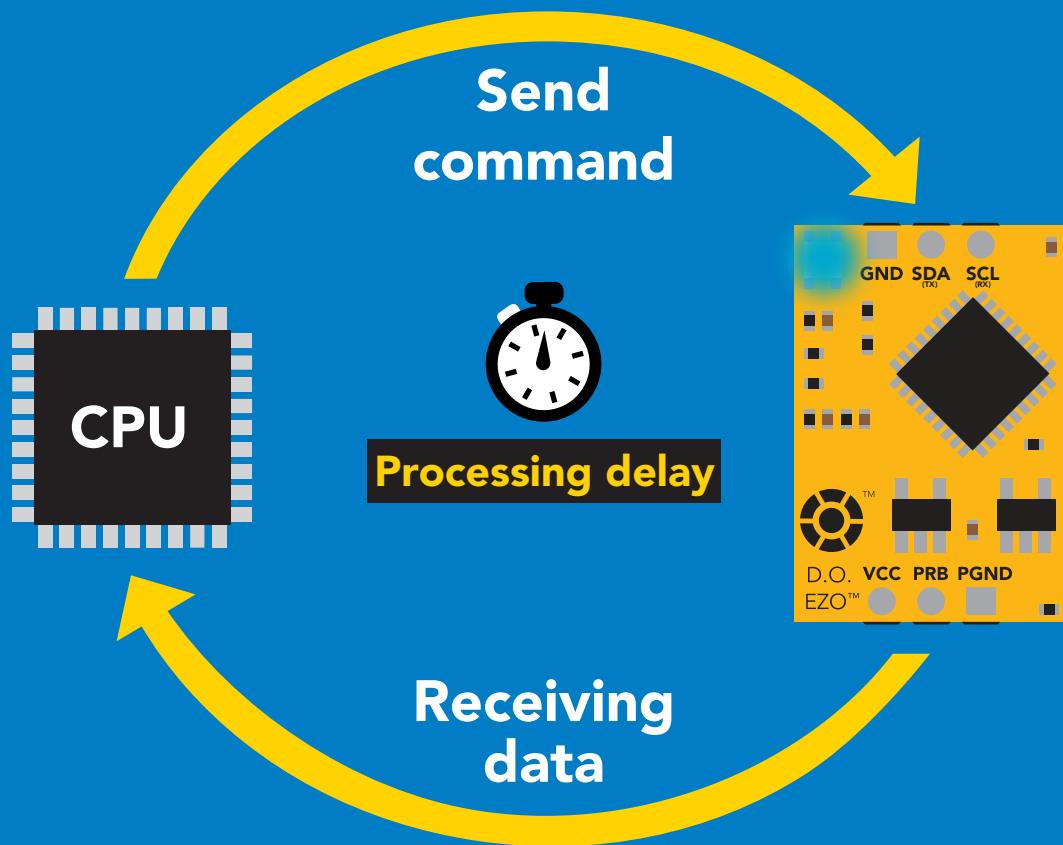
Dec Dec

ASCII

# 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;
```

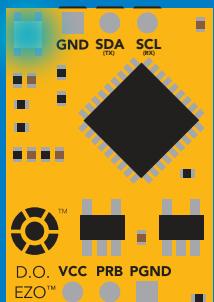
The response code will always be 254, if you do not wait for the processing delay.

### Response codes

Single byte, not string

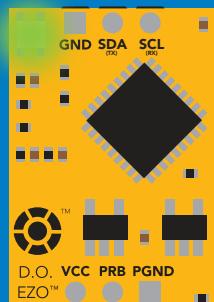
255	no data to send
254	still processing, not ready
2	error
1	successful request

# LED color definition



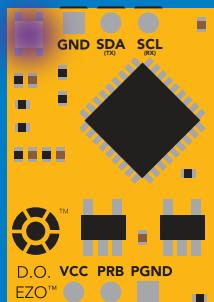
**Blue**

I<sup>2</sup>C standby



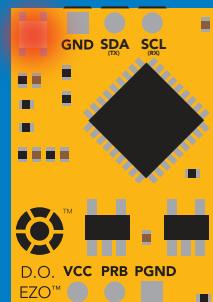
**Green**

Taking reading



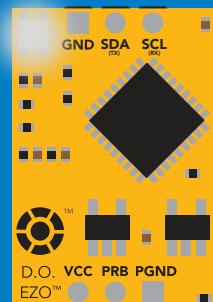
**Purple**

Changing I<sup>2</sup>C ID#



**Red**

Command not understood



**White**

Find

<b>5V</b>	LED ON <b>+0.4 mA</b>
<b>3.3V</b>	<b>+0.2 mA</b>

# I<sup>2</sup>C mode

## command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	change back to UART mode	pg. 62
Cal	performs calibration	pg. 50
Export/import	export/import calibration	pg. 51
Factory	enable factory reset	pg. 61
Find	finds device with blinking white LED	pg. 48
i	device information	pg. 56
I2C	change I <sup>2</sup> C address	pg. 62
L	enable/disable LED	pg. 47
O	removing parameters	pg. 55
P	pressure compensation	pg. 54
Plock	enable/disable protocol lock	pg. 59
R	returns a single reading	pg. 49
S	salinity compensation	pg. 53
Sleep	enter sleep mode/low power	pg. 58
Status	retrieve status information	pg. 57
T	temperature compensation	pg. 52

# LED control

## Command syntax

300ms  processing delay

L,1 LED on **default**

L,0 LED off

L,? LED state on/off?

## Example

L,1

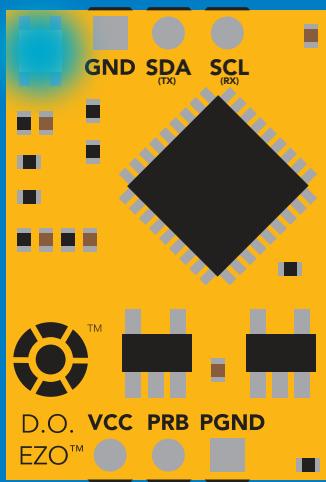
 Wait 300ms  
1 Dec 0 Null

L,0

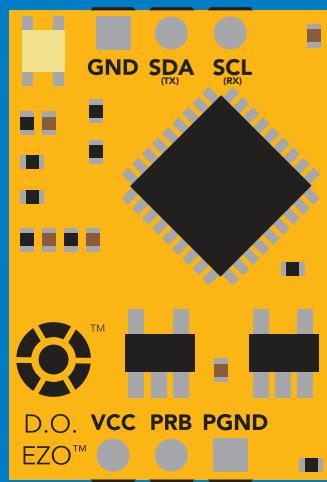
 Wait 300ms  
1 Dec 0 Null

L,?

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



L,1



L,0

# Find

300ms  processing delay

## 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\*

\*This command is only available for firmware version 2.10 and above.

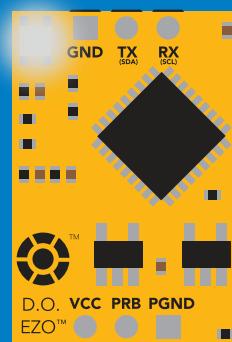
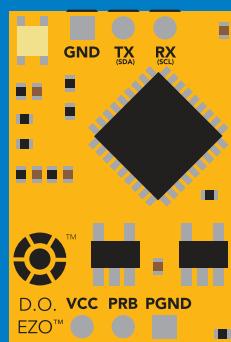
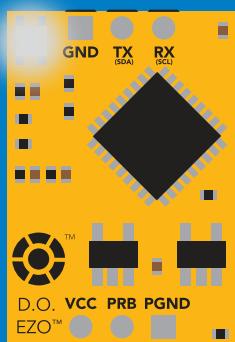
## Example

## Response

Find <cr>

 Wait 300ms

1 Dec 0 Null



# Taking reading

Command syntax

600ms  processing delay

R return 1 reading

Example

Response

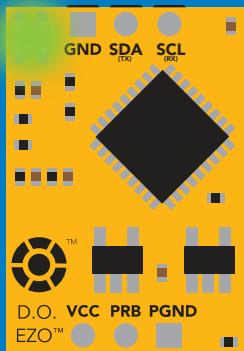
R



1  
Dec

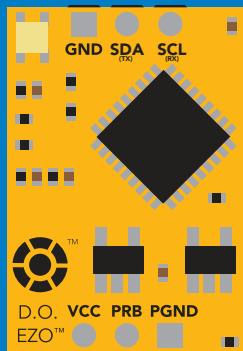
7.82  
ASCII

0  
Null

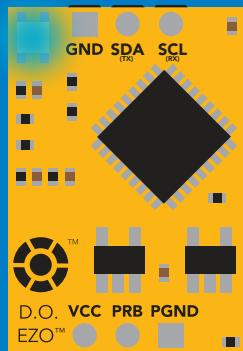


Green

Taking reading



Wait 600ms



Blue

Transmitting

# Calibration

## Command syntax

1300ms  processing delay

Cal	calibrate to atmospheric oxygen levels
Cal,0	calibrate device to 0 dissolved oxygen
Cal,clear	delete calibration data
Cal,?	device calibrated?

The EZO™ Dissolved Oxygen circuit uses single and/or two point calibration

## Example

## Response

Cal

 Wait 1300ms  
1 Dec 0 Null

Cal,0

 Wait 1300ms  
1 Dec 0 Null

Cal,clear

 Wait 300ms  
1 Dec 0 Null

Cal,?

 Wait 300ms  
1 Dec ?Cal,0 0 or 1 Dec ?Cal,1 0  
or 1 Dec ?Cal,2 0

# Export/import calibration

## Command syntax

Export: Use this command to save calibration settings  
Import: Use this command to load calibration settings to one or more devices.

Export

**export calibration string from calibrated device\***

Import

**import calibration string to new device\***

Export,?

**calibration string info\***

300ms  processing delay

\*This command is only available for firmware version 2.10 and above.

## Example

## Response

Export,?

  
Wait 300ms

**1 10,120 0**  
Dec ASCII Null

**Response breakdown**

**10, 120**  
↑ ↑  
# of strings to export # of bytes to export

Export strings can be up to 12 characters long

Export

  
Wait 300ms

**1 59 6F 75 20 61 72 0**  
Dec ASCII Null

(1 of 10)

**Export**

  
Wait 300ms

**1 65 20 61 20 63 6F 0**  
Dec ASCII Null

(2 of 10)

...

Import, n  
(FIFO)

**Import, 59 6F 75 20 61 72 (1 of 10)**

ASCII

...

# Temperature compensation

## Command syntax

300ms  processing delay

T,n n = any value; floating point or int

Temperature is always in Celsius

T,? compensated temperature value?

## Example

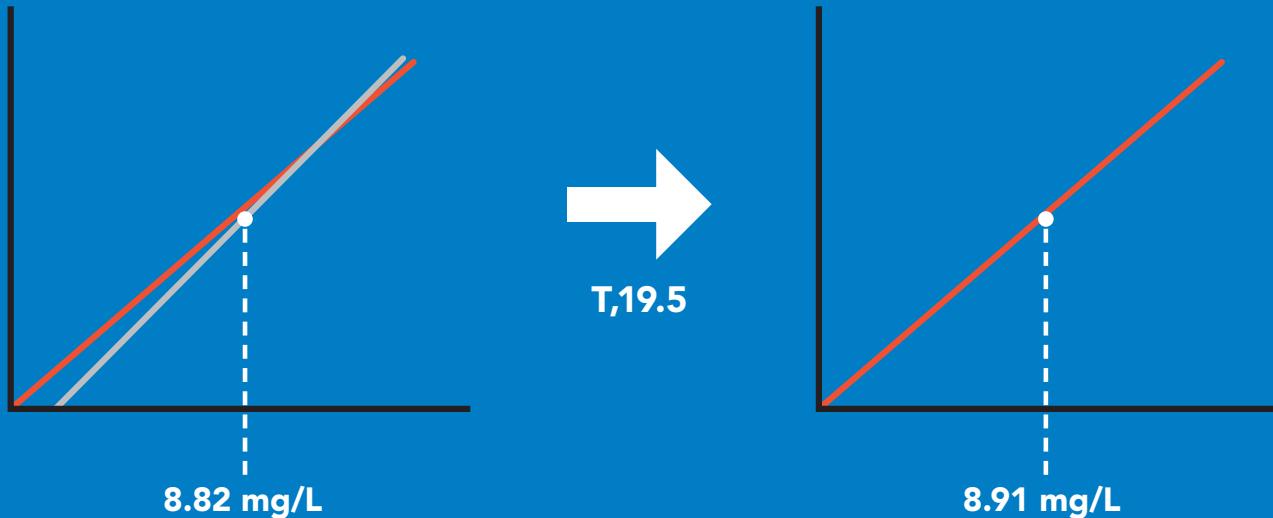
T,19.5

## Response

 Wait 300ms  
1 Dec 0 Null

T,?

 Wait 300ms  
1 Dec ?T,19.5 0 ASCII Null



# Salinity compensation

## Command syntax

300ms  processing delay

**S,n**      n = any value in microsiemens      default

**S,n,ppt**    n = any value in ppt

**S,?**       compensated salinity value?

## Example

**S,50000**

## Response

 Wait 300ms  
1 Dec 0 Null

**S,37.5,ppt**

 Wait 300ms  
1 Dec 0 Null

**S,?**

 Wait 300ms  
1 Dec ?S,50000,µS 0 ASCII Null

or

1 ?S,37.5,ppt 0 ASCII Null

If the conductivity of your water is less than 2,500µS this command is irrelevant

# Pressure compensation

## Command syntax

P,n n = any value in kPa

P,? compensated pressure value?

300ms  processing delay

This parameter can be omitted if the water is less than 10 meters deep

## Example

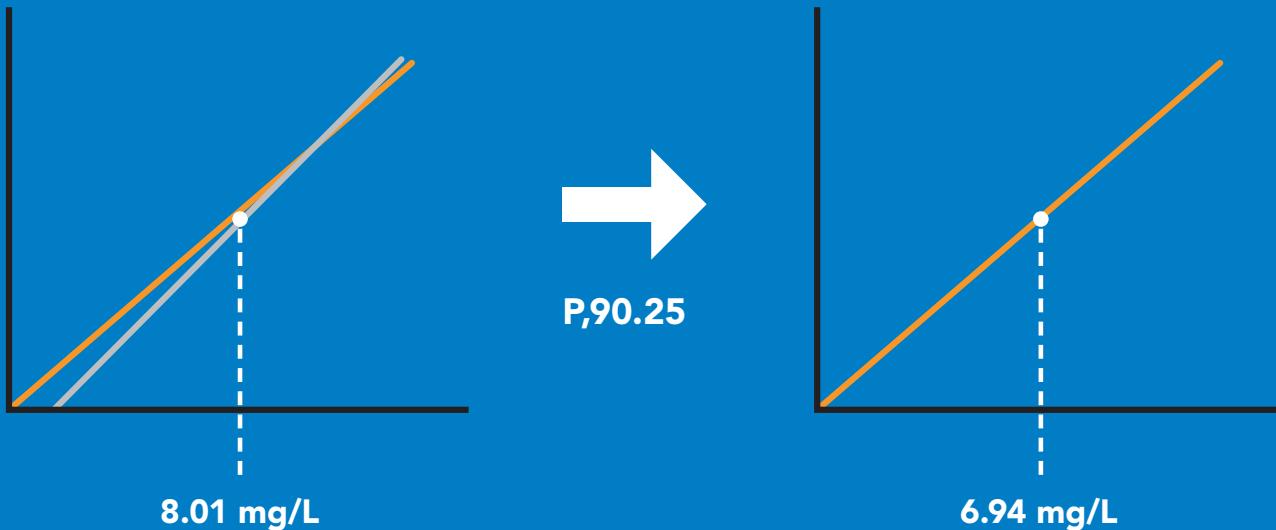
P,90.25

## Response

 Wait 300ms  
1 Dec 0 Null

P,?

 Wait 300ms  
1 ?,P,90.25 0 Null  
Dec ASCII



# Removing parameters from the output string

## Command syntax

O, [parameter],[1,0]

O,?

300ms  processing delay

enable or disable output parameter

enabled parameter?

## Example

O,%,0

O,%,1

O,mg,0

O,mg,1

O,?

## Response



Wait 300ms

1  
Dec

0  
Null

disable percent saturation



Wait 300ms

1  
Dec

0  
Null

enable percent saturation



Wait 300ms

1  
Dec

0  
Null

disable mg/L



Wait 300ms

1  
Dec

0  
Null

enable mg/L



Wait 300ms

1  
Dec

? , O, %, mg

0  
Null

if both are enabled

## Parameters

% saturation percentage

DO dissolved oxygen

## Followed by 1 or 0

1 enabled

0 disabled

# Device information

Command syntax

300ms  processing delay

i device information

Example Response

i



Wait 300ms

1  
Dec

?i,D.O.,1.98  
ASCII

0  
Null

Response breakdown

?i, D.O., 1.98  
↑      ↑  
Device Firmware

# Reading device status

## Command syntax

300ms  processing delay

Status voltage at Vcc pin and reason for last restart

## Example Response

Status



Wait 300ms

1

?Status,P,5.038

Dec

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

# 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**

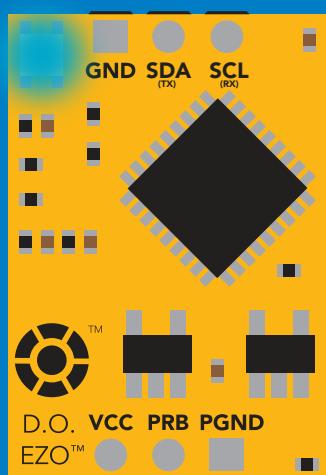
Do not read status byte after issuing sleep command.

**Any command**

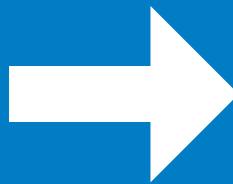
**wakes up device**

5V	STANDBY	SLEEP
	<b>13.1 mA</b>	<b>0.66 mA</b>

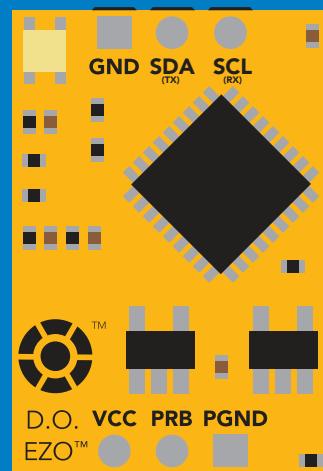
3.3V	12 mA	0.3 mA
------	-------	--------



**Standby**



**Sleep**



**Sleep**

# Protocol lock

## Command syntax

300ms  processing delay

Plock,1 enable Plock

Locks device to I<sup>2</sup>C mode.

Plock,0 disable Plock **default**

Plock,? Plock on/off?

## Example

Plock,1

 Wait 300ms  
1 Dec 0 Null

Plock,0

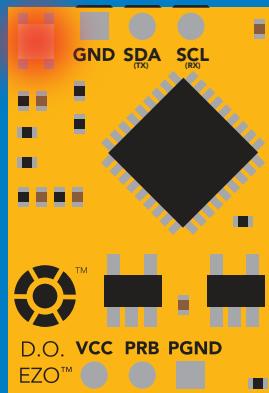
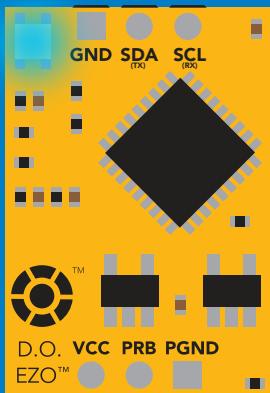
 Wait 300ms  
1 Dec 0 Null

Plock,?

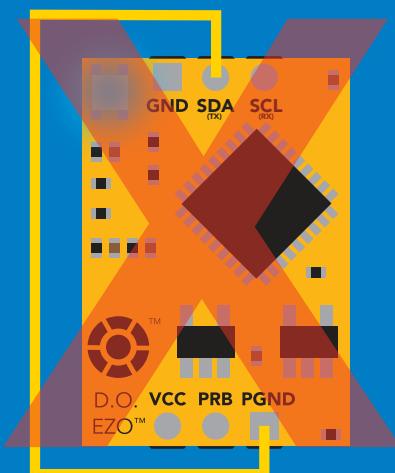
 Wait 300ms  
1 Dec ?Plock,1 ASCII 0 Null

Plock,1

Serial, 9600



cannot change to UART



cannot change to UART

# I<sup>2</sup>C address change

## Command syntax

300ms  processing delay

I<sup>2</sup>C,n sets I<sup>2</sup>C address and reboots into I<sup>2</sup>C mode

## Example Response

I<sup>2</sup>C,100

device reboot

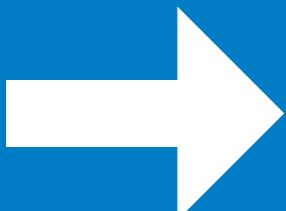
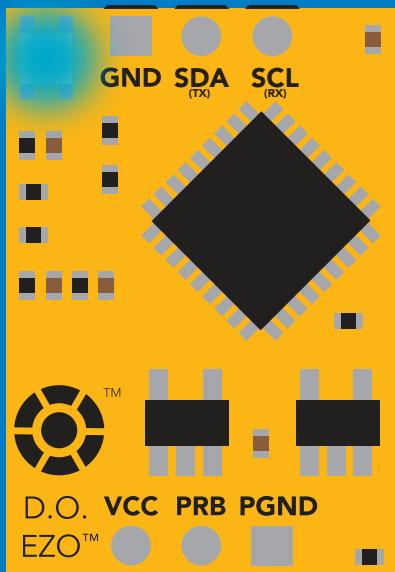
### Warning!

Changing the I<sup>2</sup>C address will prevent communication between the circuit and the CPU, until your CPU is updated with the new I<sup>2</sup>C address.

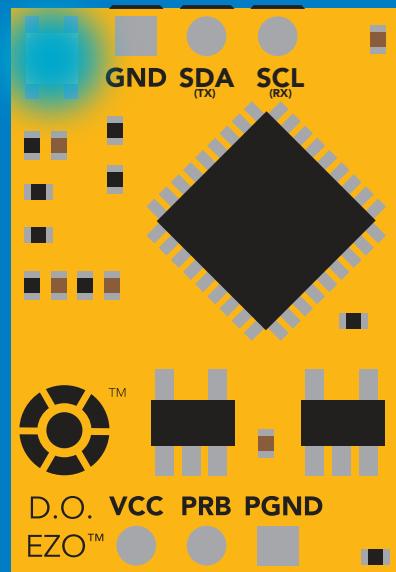
Default I<sup>2</sup>C address is 97 (0x61).

n = any number 1 – 127

I<sup>2</sup>C,100



(reboot)



# Factory reset

## Command syntax

Factory reset will not take the device out of I<sup>2</sup>C mode.

Factory enable factory reset

I<sup>2</sup>C address will not change

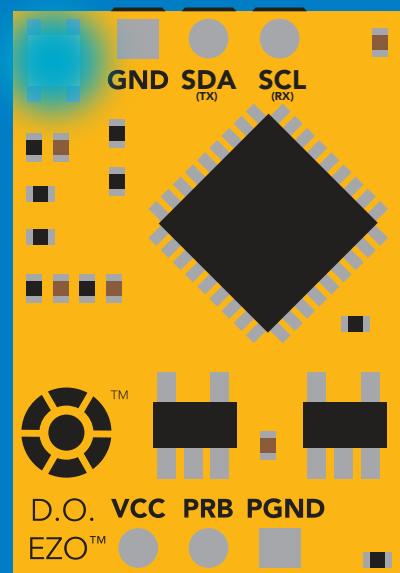
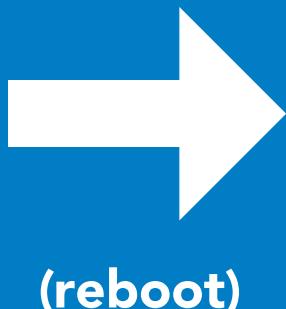
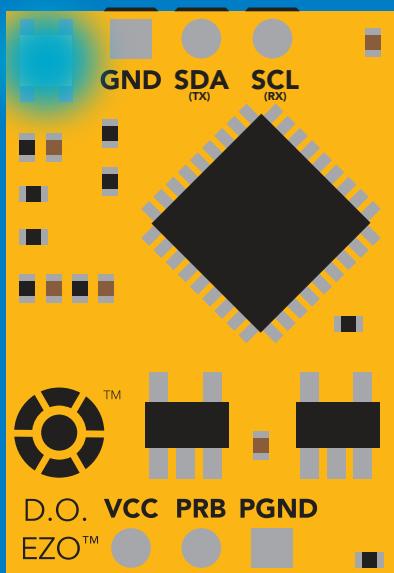
## Example Response

Factory

device reboot

Clears calibration  
LED on  
Response codes enabled

Factory



# Change to UART mode

## Command syntax

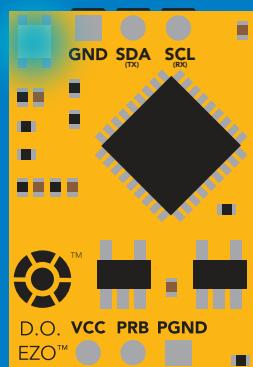
Baud,n switch from I<sup>2</sup>C to UART

### Example Response

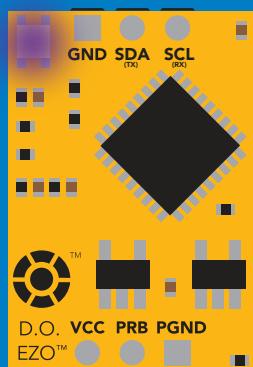
Baud,9600

reboot in UART mode

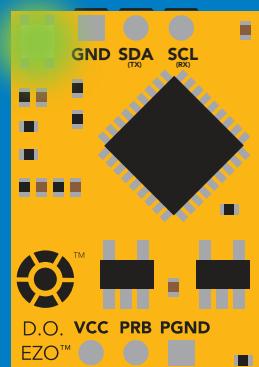
n = [ 300  
1200  
2400  
9600  
19200  
38400  
57600  
115200 ]



Serial,9600



(reboot)

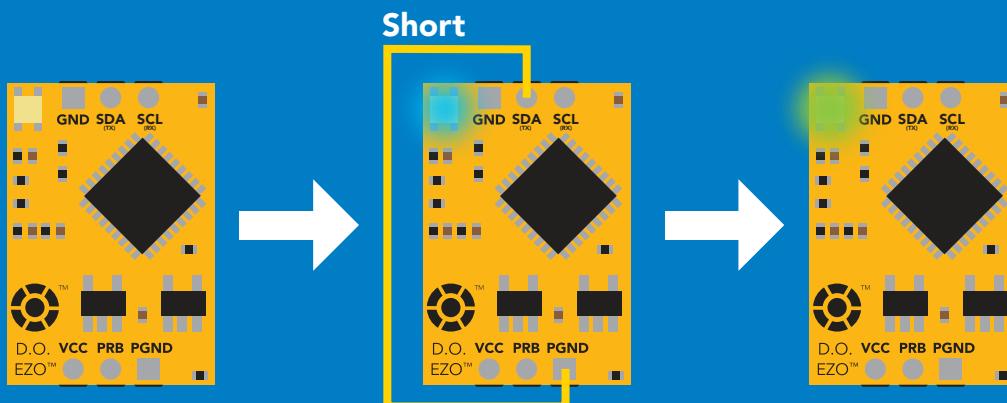


Changing to UART  
mode

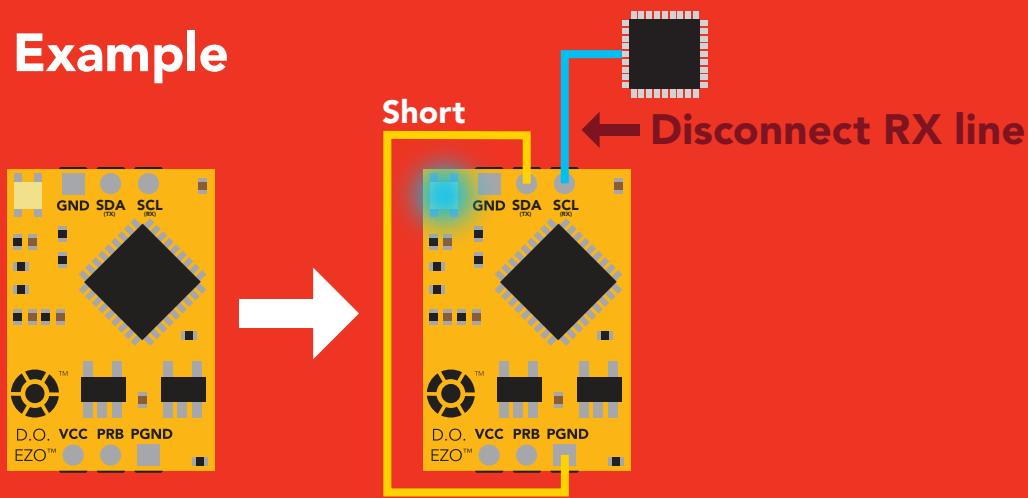
# Manual switching to UART

- Make sure Plock is set to 0
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PGND
- 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

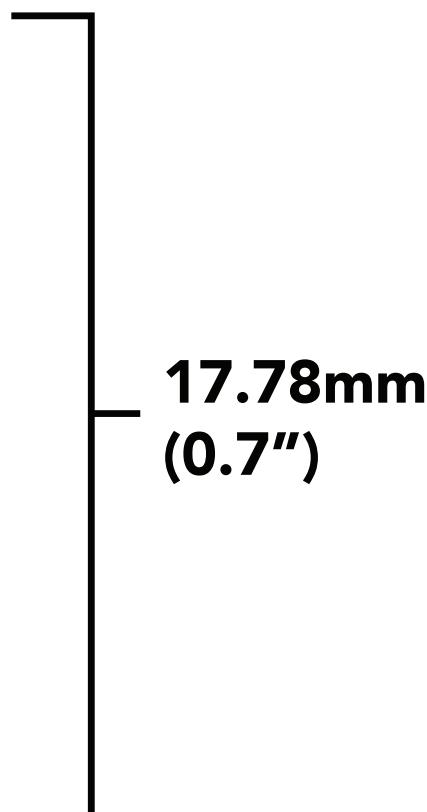
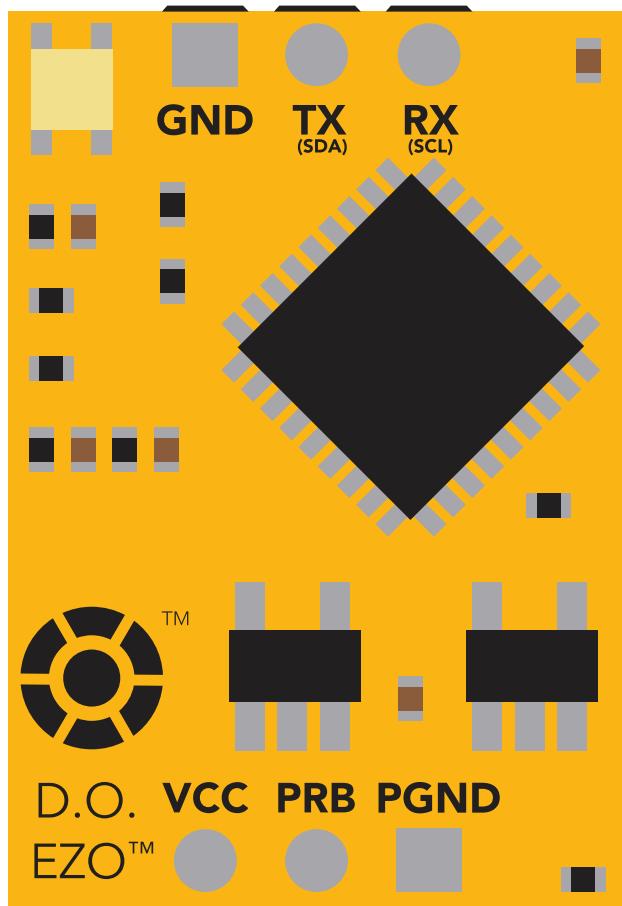
## Example



## Wrong Example



# EZO™ circuit footprint

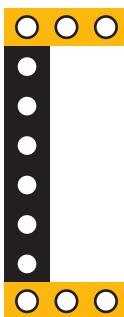


**2.54mm  
(0.1")**

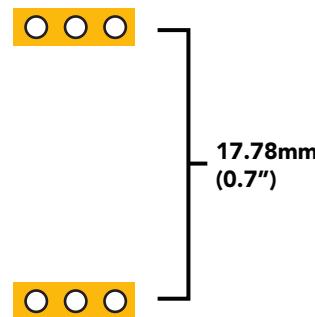
**1** In your CAD software place an 8 position header.



**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.



# Datasheet change log

## Datasheet V 3.9

Revised information on cover page.

## Datasheet V 3.8

Update firmware changes on pg. 66

## Datasheet V 3.7

Revised Plock pages to show default value.

## Datasheet V 3.6

### **Added new commands:**

"Find" pages 21 & 48.

"Export/Import calibration" pages 25 & 51.

Added new feature to continuous mode "C,n" pg 22.

## Datasheet V 3.5

Added accuracy range on cover page, and revised isolation info on pg 10.

## Datasheet V 3.4

Added manual switching to UART information on pg. 59

## Datasheet V 3.3

Updated firmware changes to reflect V1.99 update

## Datasheet V 3.2

Revised entire datasheet

## Dissolved Oxygen circuit firmware changes

V1.1 – Initial release (Oct 30, 2014)

- Change output to mg/L, then percentage (was previously percentage, then mg/L)

V1.5 – Baud rate change (Nov 6, 2014)

- Change default baud rate to 9600

V1.6 – I<sup>2</sup>C bug (Dec 1, 2014)

- Fix I<sup>2</sup>C bug where the circuit may inappropriately respond when other I<sup>2</sup>C devices are connected.

V1.7 – Factory (April 14, 2015)

- Changed "X" command to "Factory"

V1.95 – Plock (March 31, 2016)

- Added protocol lock feature "Plock"

V1.96 – EEPROM (April 26, 2016)

- Fixed glitch where EEPROM would get erased if the circuit lost power 900ms into startup

V1.97 – EEPROM (Oct 10, 2016)

- Fixed glitch in the cal clear command, improves how it calculates the DO, adds calibration saving and loading

V1.98 – EEPROM (Nov 14, 2016)

- Updated firmware for new circuit design.

V1.99 – (Feb 2, 2017)

- Revised "O" command to accept mg.

V2.10 – (April 12, 2017)

- Added "Find" command.
- Added "Export/import" command.
- Modified continuous mode to be able to send readings every "n" seconds.

V2.11 – (Sept 28, 2017)

- fixed glitch where the temperature would default to 0 on startup

# Warranty

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

## The debugging phase

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

- **Soldering any part of the EZO™ class Dissolved Oxygen circuit.**
- **Running any code, that does not exclusively drive the EZO™ class Dissolved Oxygen circuit and output its data in a serial string.**
- **Embedding the EZO™ class Dissolved Oxygen 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 Dissolved Oxygen circuit, against the thousands of possible variables that may cause the EZO™ class Dissolved Oxygen 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 Dissolved Oxygen circuits continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.