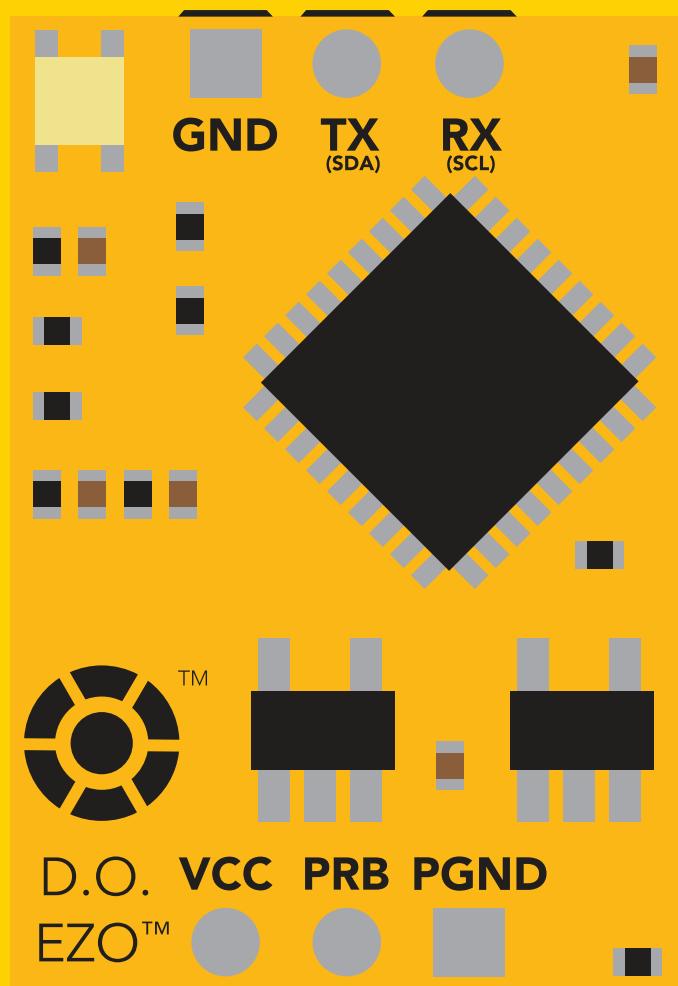


EZO-DO™

Embedded Dissolved Oxygen Circuit

ISO 5814 Compliant

Reads	Dissolved Oxygen
Range	0.01 – 100+ mg/L 0.1 – 400+ % saturation
Accuracy	+/- 0.05 mg/L
Response time	1 reading per sec
Supported probes	Any galvanic probe
Calibration	1 or 2 point
Temperature, salinity and pressure compensation	Yes
Data protocol	UART & I²C
Default I ² C address	97 (0x61)
Operating voltage	3.3V – 5V
Data format	ASCII





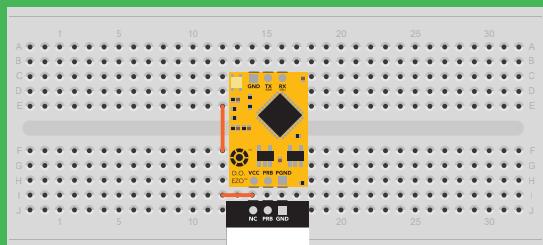
STOP

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!

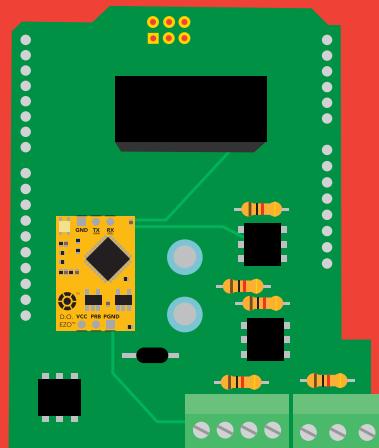


Table of contents

Circuit dimensions	4	Correct wiring	8
Power consumption	4	Calibration theory	9
Absolute max ratings	4	Preserve calibration solution	12
Operating principle	5	Default state	13
Power and data isolation	6	Available data protocols	14

UART

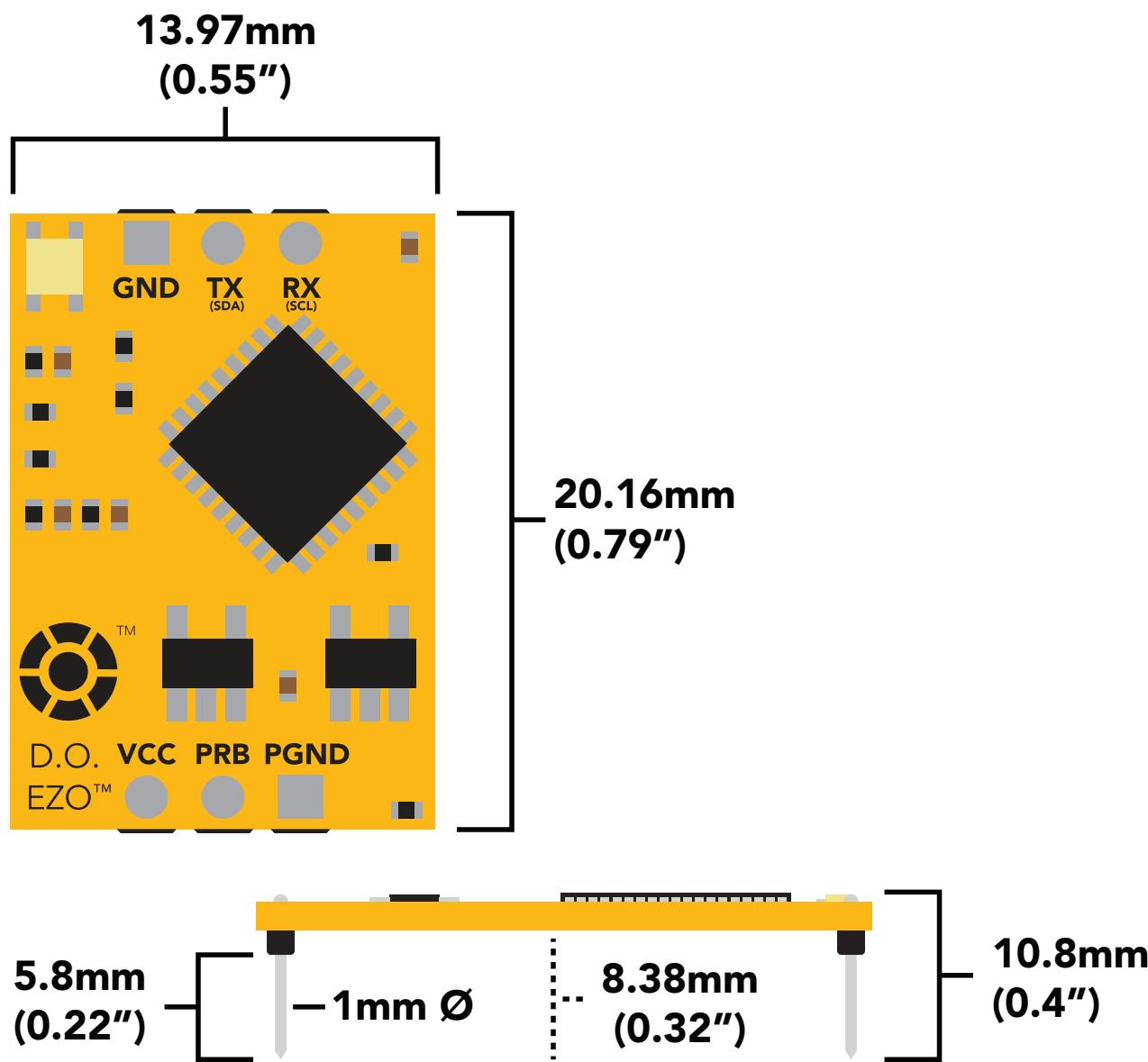
UART mode	16
Receiving data from device	17
Sending commands to device	18
LED color definition	19
UART quick command page	20
LED control	21
Find	22
Continuous reading mode	23
Single reading mode	24
Calibration	25
Export calibration	26
Import calibration	27
Temperature compensation	28
Salinity compensation	29
Pressure compensation	30
Enable/disable parameters	31
Naming device	32
Device information	33
Response codes	34
Reading device status	35
Sleep mode/low power	36
Change baud rate	37
Protocol lock	38
Factory reset	39
Change to I ² C mode	40
Manual switching to I ² C	41

I²C

I ² C mode	43
Sending commands	44
Requesting data	45
Response codes	46
LED color definition	47
I ² C quick command page	48
LED control	49
Find	50
Taking reading	51
Calibration	52
Export calibration	53
Import calibration	54
Temperature compensation	55
Salinity compensation	56
Pressure compensation	57
Enable/disable parameters	58
Naming device	59
Device information	60
Reading device status	61
Sleep mode/low power	62
Protocol lock	63
I ² C address change	64
Factory reset	65
Change to UART mode	66
Manual switching to UART	67

Circuit footprint	68
Datasheet change log	69
Warranty	73

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

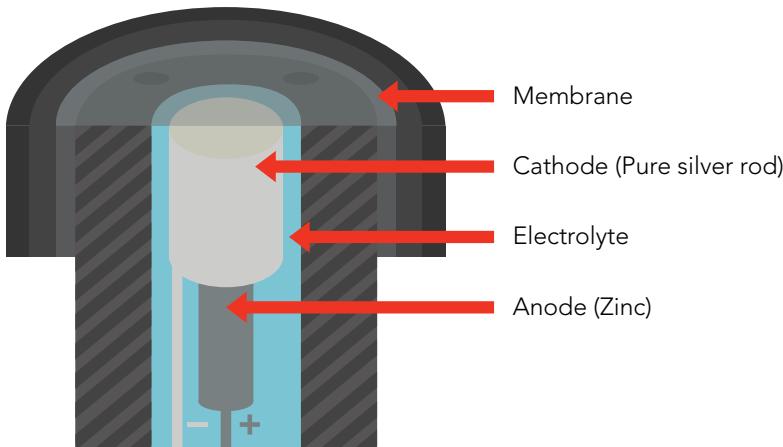
	Parameter	MIN	TYP	MAX
	Storage temperature (EZO™ D.O.)	-65 °C		125 °C
	Operational temperature (EZO™ D.O.)	-40 °C	25 °C	85 °C
	VCC	3.3V	5V	5.5V

Operating principle

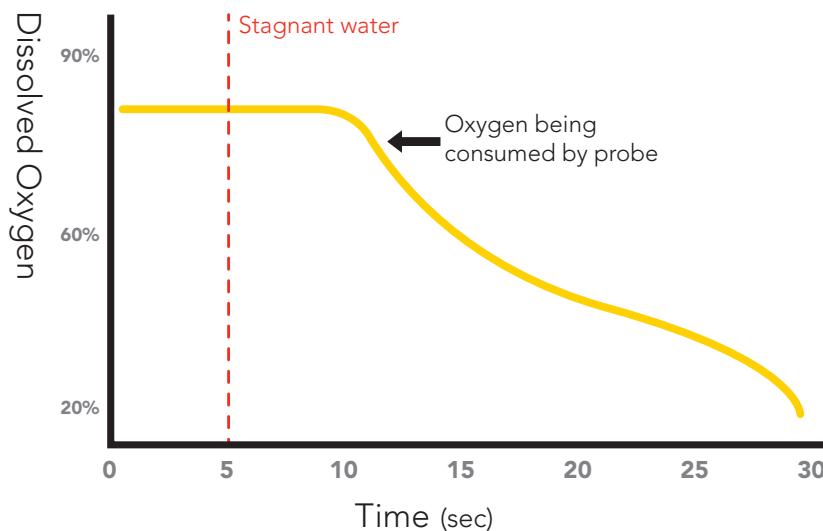
The Atlas Scientific™ EZO™ Dissolved Oxygen circuit works with:

- | | |
|------------------------------|----------------------------------------------------|
| X Optical probe | Slow response, requires external power, expensive. |
| X Polar Graphic probe | Requires external power, output in μA . |
| ✓ Galvanic probe | Requires no external power, output in mV. |

A galvanic dissolved oxygen probe consists of a PTFE 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.**

Power and data isolation

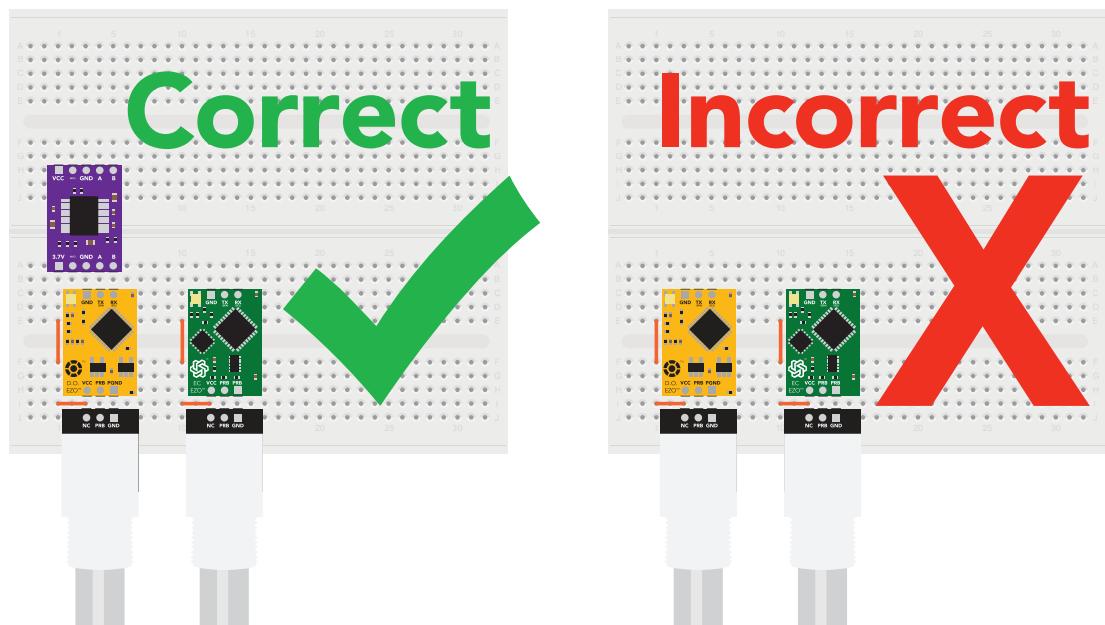
The Atlas Scientific EZO™ Dissolved Oxygen circuit is a very sensitive device. This sensitivity is what gives the Dissolved Oxygen circuit its accuracy. This also means that the Dissolved Oxygen circuit is capable of reading micro-voltages that are bleeding into the water from unnatural sources such 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



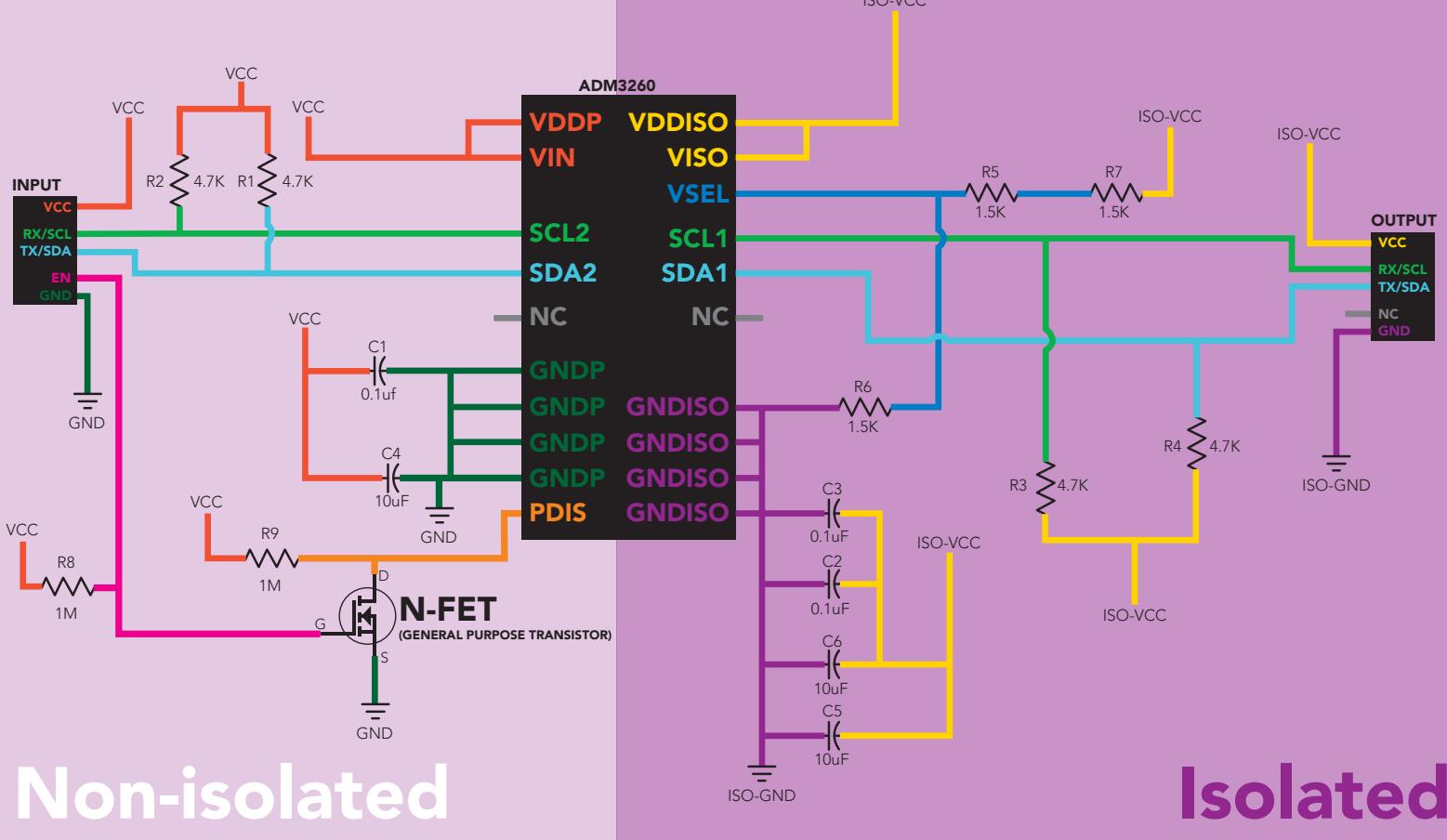
**Without isolation, Conductivity readings
will effect Dissolved Oxygen accuracy.**

This schematic shows exactly how we isolate data and power using the 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 3.9V regardless of your input voltage.

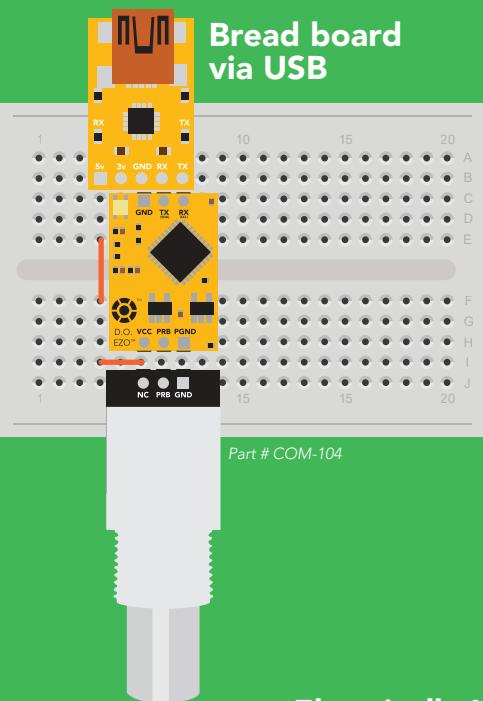
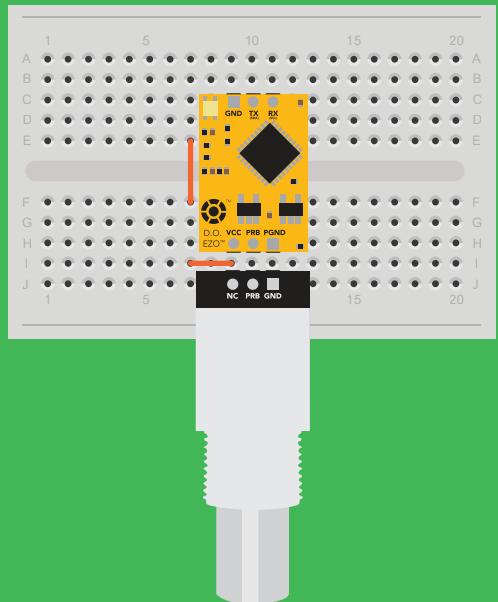
Isolated ground is different from non-isolated ground, these two lines should not be connected together.

VCC = 3.0v – 5.5v



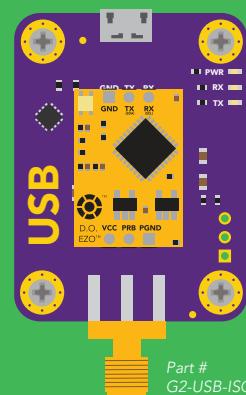
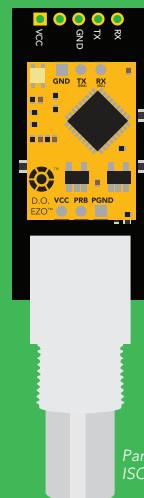
✓ Correct wiring

Bread board



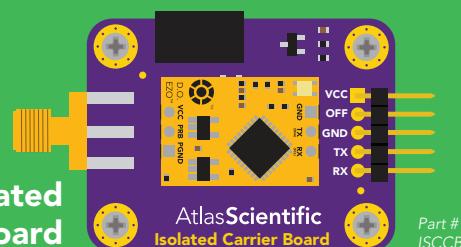
Carrier board

USB carrier board



Part # ISCCB

G2-USB-ISO



AtlasScientific
Isolated Carrier Board

Part # ISCCB-2

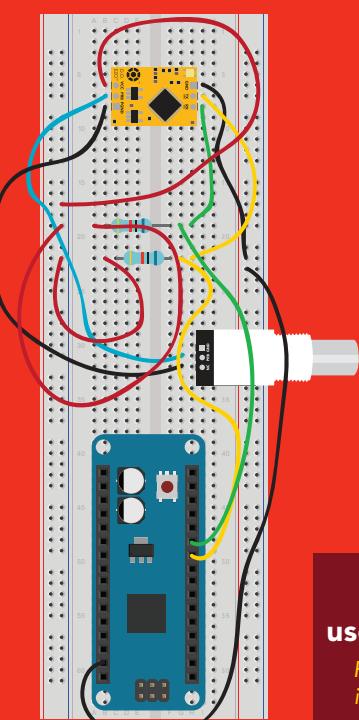
Electrically Isolated EZO™ Carrier Board

✗ Incorrect wiring

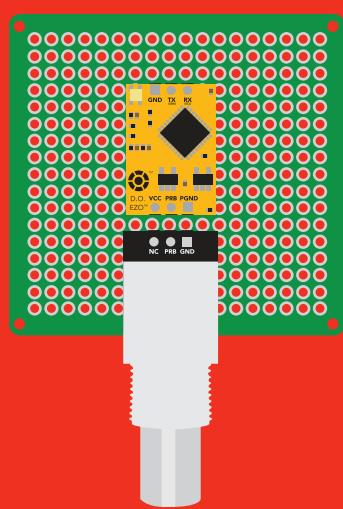
Extended leads



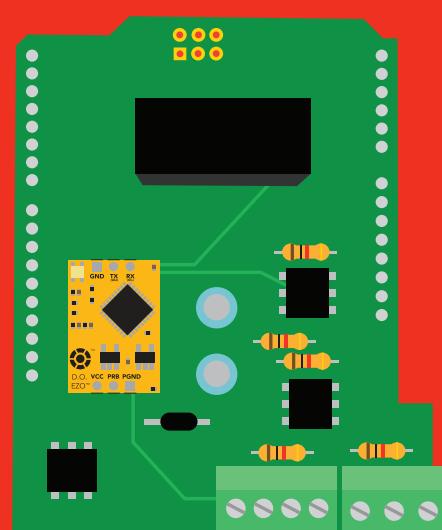
Sloppy setup



Perfboards or Protoboards



*Embedded into your device



NEVER
use Perfboards or Protoboards
Flux residue and shorting wires make it very hard to get accurate readings.

*Only after you are familiar with EZO™ circuits operation

Calibration theory

Simple calibration

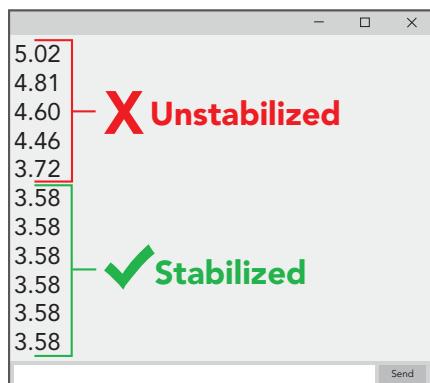
UART
mode

Continuous readings

Advanced calibration

I²C
mode

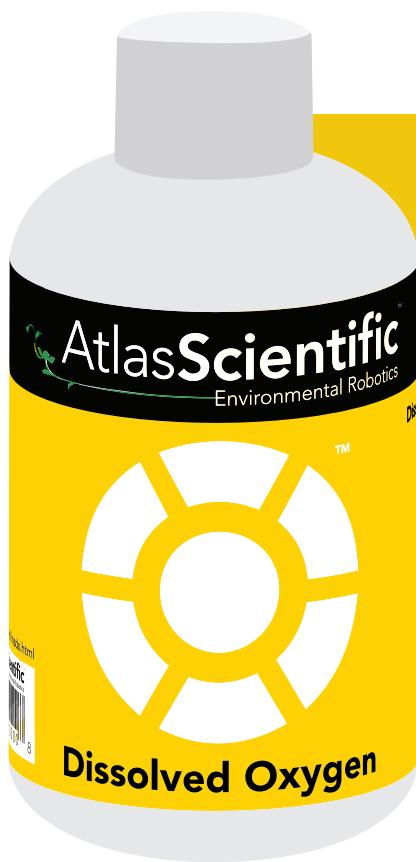
Continuously request readings



The most important part of calibration is watching the readings during the calibration process.

It's easiest to calibrate the device in its default state (UART mode, with continuous readings enabled).

Switching the device to I²C mode after calibration **will not** affect the stored calibration. If the device must be calibrated in I²C mode be sure to **continuously request readings** so you can see the output from the probe.



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

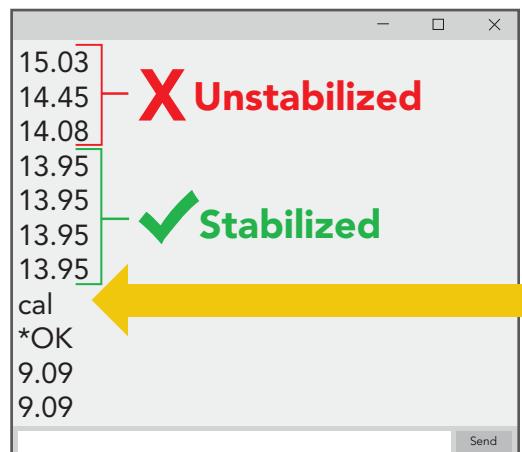
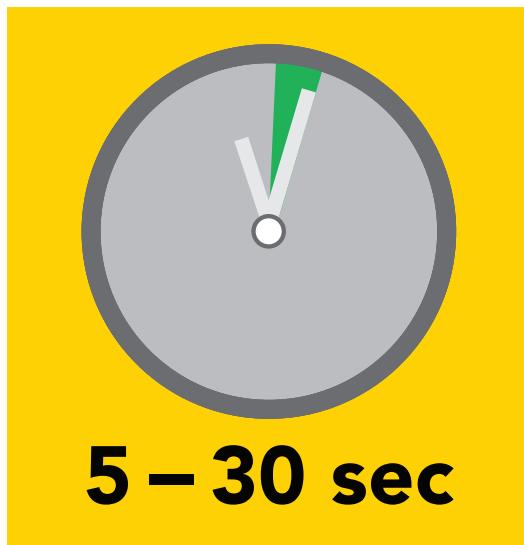
Calibrate first, compensate later.

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



Single point calibration

Let the Dissolved Oxygen probe sit, exposed to air until the readings stabilize. (small movement from one reading to the next is normal).



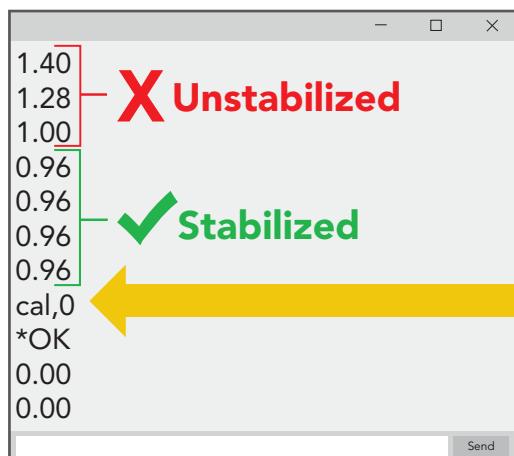
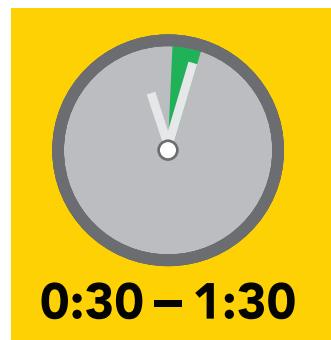
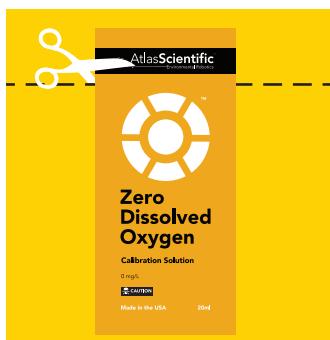
Once the readings have stabilized,
issue the calibration command.
"cal"

After calibration is complete, you should see readings between **9.09 – 9.1X mg/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 the EZO™ Dissolved Oxygen circuit using the "Cal" command; Remove the top of the Zero Dissolved Oxygen calibration solution pouch, and Insert the probe and stir it around to remove any trapped air (which could cause readings to go high). Let the probe sit in Zero D.O. calibration solution until readings stabilize. (small movement from one reading to the next is normal).

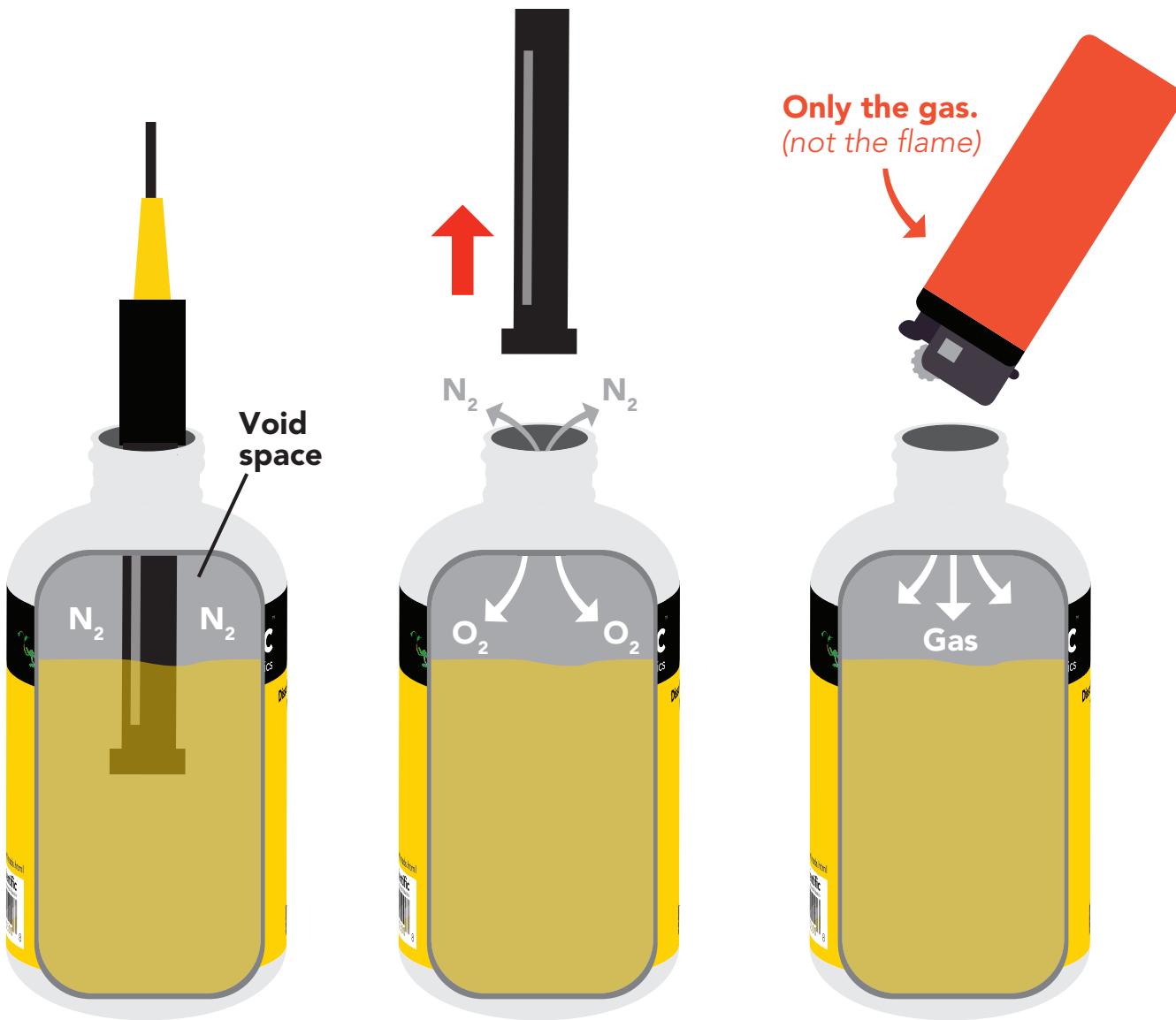


Once the readings have stabilized,
issue the calibration command.
"cal,0"

After 24 hours, the calibration solution inside an open pouch is no longer considered accurate.

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.

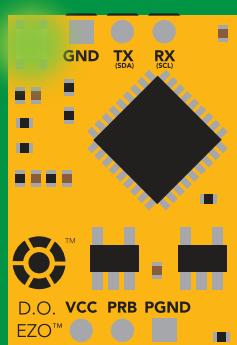
Default state

UART mode

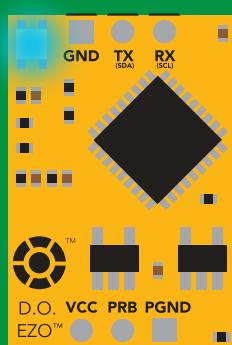
Baud	9,600
Readings	continuous
Speed	1 reading per second
Temperature compensation	20 °C
Salinity compensation	0 (Fresh water)
Pressure compensation	101.3 kPa (Sea level)
LED	on



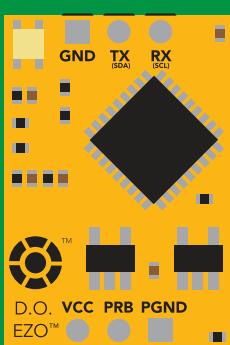
1,000 ms



Green
Standby



Cyan
Taking reading



Transmitting

 Available data protocols

UART

Default

I²C

 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 I²C mode
LED control
Protocol lock
Software switch to I²C mode

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

Find
Pressure compensation
Salinity compensation
Sleep mode
Temperature compensation

UART mode

8 data bits
1 stop bit

no parity
no flow control

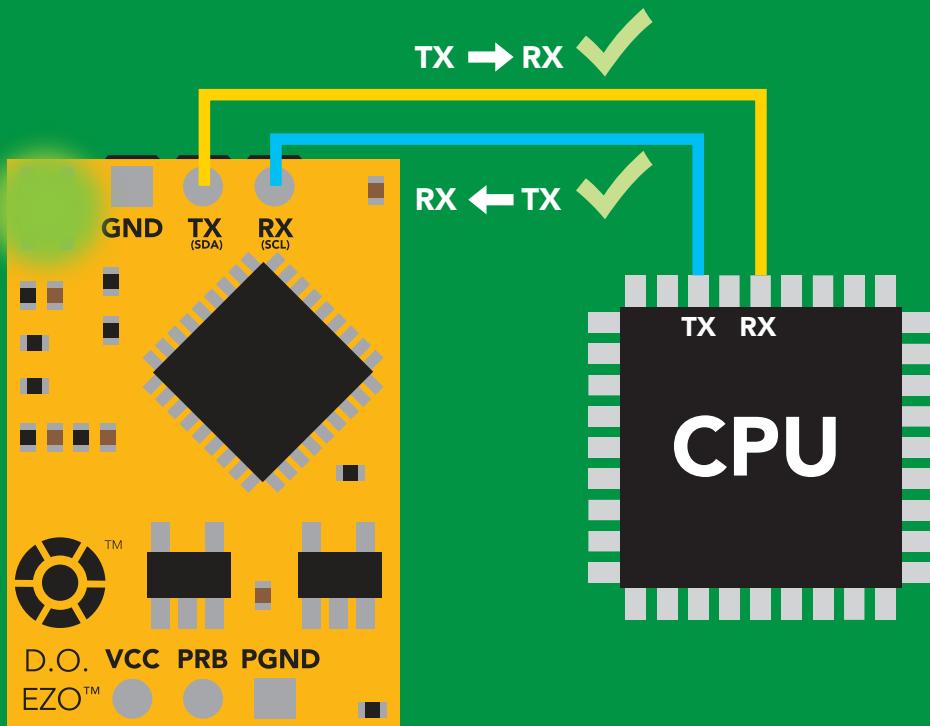
Baud 300
1,200
2,400
9,600 default
19,200
38,400
57,600
115,200

RX Data in

TX Data out

Vcc 3.3V – 5.5V

0V VCC 0V



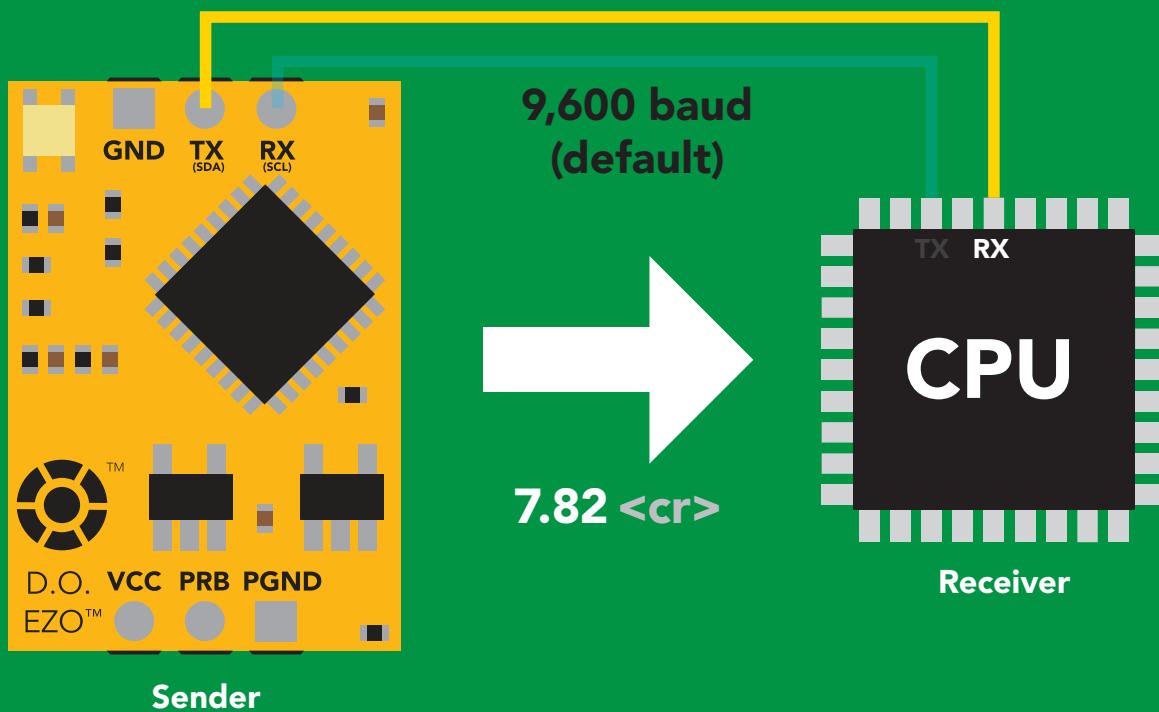
Data format

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

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

Receiving data from device

2 parts



Advanced

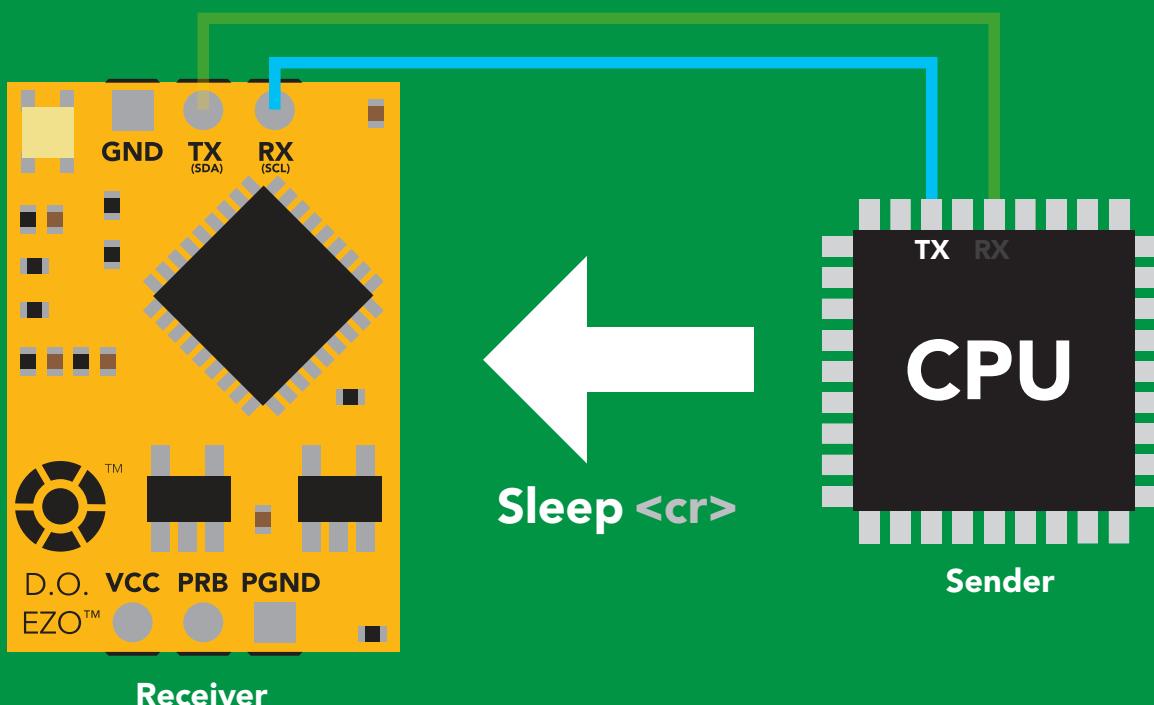
ASCII: 7 . 8 2 <cr>

Hex: 37 2E 38 32 0D

Dec: 55 46 56 50 13

Sending commands to device

2 parts



Advanced

ASCII:

S	I	e	e	p	<cr>
---	---	---	---	---	------

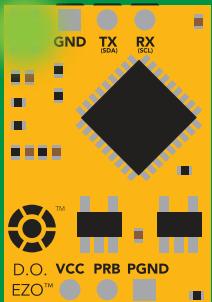
Hex:

53	6C	65	65	70	0D
----	----	----	----	----	----

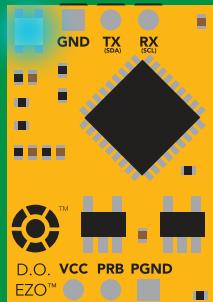
Dec:

83	108	101	101	112	13
----	-----	-----	-----	-----	----

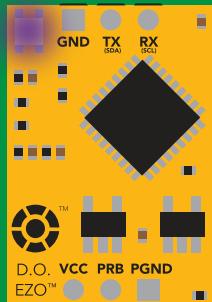
LED color definition



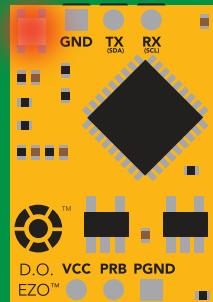
Green
UART standby



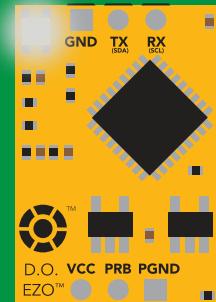
Cyan
Taking reading



Purple
Changing baud rate



Red
Command not understood



White
Find

5V	LED ON +0.4 mA
3.3V	+0.2 mA

UART mode

command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	Default state
Baud	change baud rate	pg. 37 9,600
C	enable/disable continuous reading	pg. 23 enabled
Cal	performs calibration	pg. 25 n/a
Export	export calibration	pg. 26 n/a
Factory	enable factory reset	pg. 39 n/a
Find	finds device with blinking white LED	pg. 22 n/a
i	device information	pg. 33 n/a
I2C	change to I ² C mode	pg. 40 not set
Import	import calibration	pg. 27 n/a
L	enable/disable LED	pg. 21 enabled
Name	set/show name of device	pg. 32 not set
O	enable/disable parameters	pg. 31 mg/L
P	pressure compensation	pg. 30 101.3 kPa
Plock	enable/disable protocol lock	pg. 38 disabled
R	returns a single reading	pg. 24 n/a
S	salinity compensation	pg. 29 n/a
Sleep	enter sleep mode/low power	pg. 36 n/a
Status	retrieve status information	pg. 35 n/a
T	temperature compensation	pg. 28 20°C
*OK	enable/disable response codes	pg. 34 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>

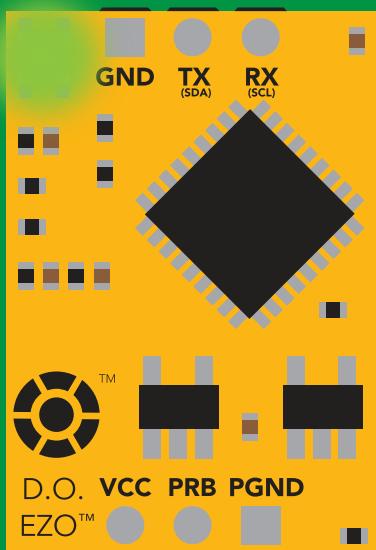
*OK <cr>

L,? <cr>

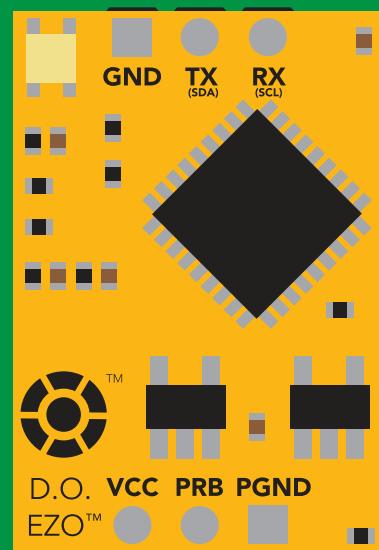
?L,1 <cr> or ?L,0 <cr>

*OK <cr>

Response



L,1



L,0

Find

Command syntax

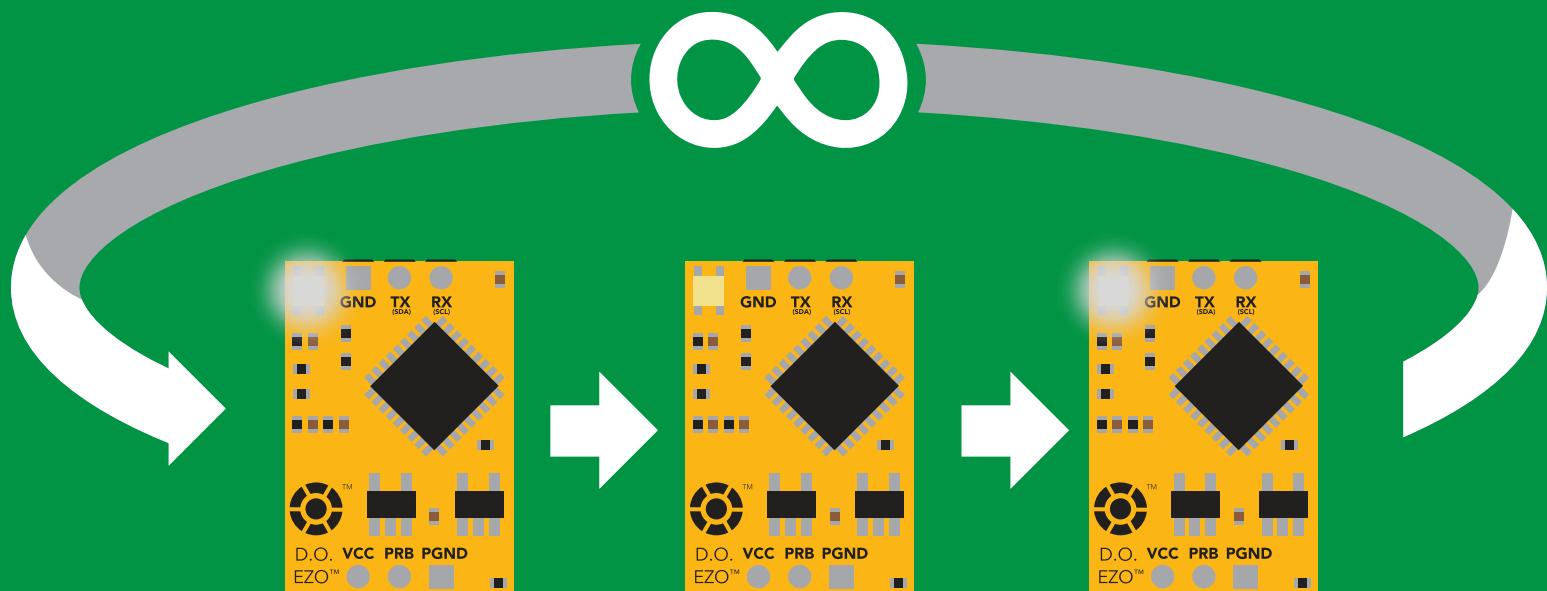
This command will disable continuous mode
Send any character or command to terminate find.

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

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?

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

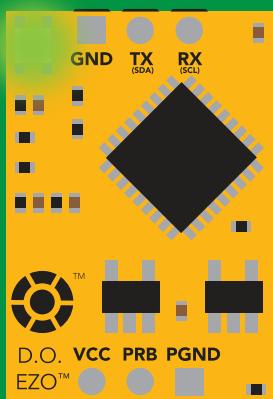
R <cr> takes single reading

Example Response

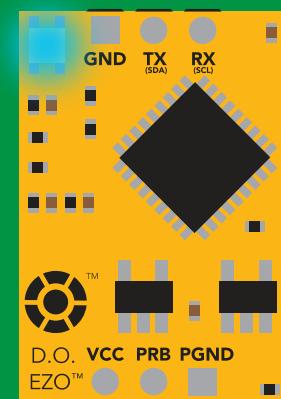
R <cr>

7.82 <cr>

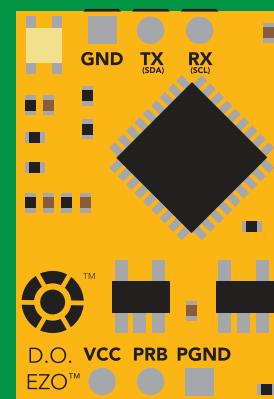
*OK <cr>



Green
Standby



Cyan
Taking reading



Transmitting



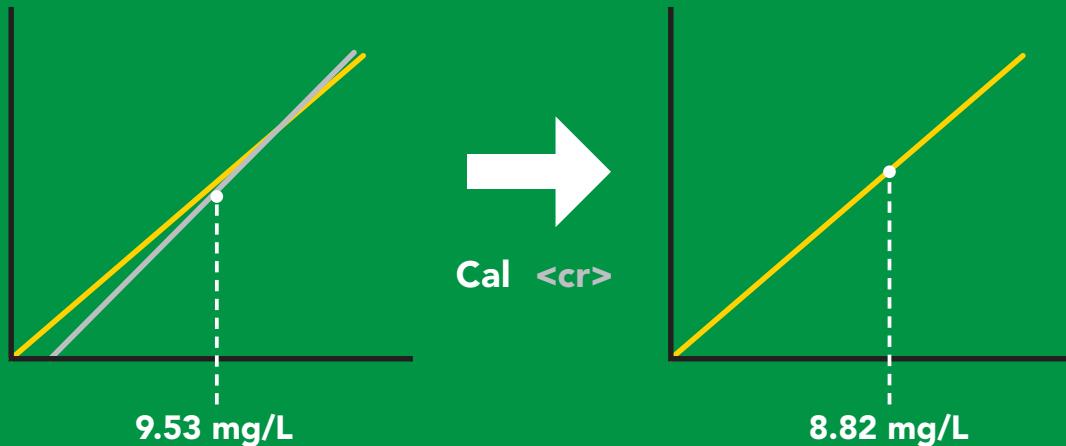
Calibration

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>



Export calibration

Command syntax

Export: Use this command to download calibration settings

Export,? <cr> calibration string info

Export <cr> export calibration string from calibrated device

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)

(7 more)

⋮

Export <cr>

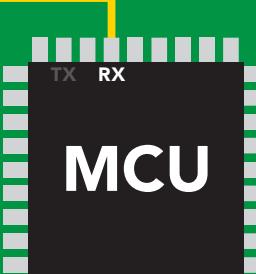
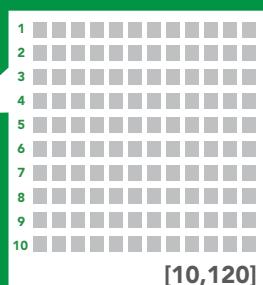
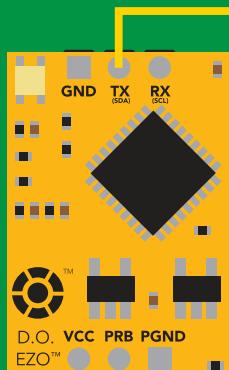
6F 6C 20 67 75 79 <cr> (10 of 10)

Export <cr>

*DONE

Disabling *OK simplifies this process

Export <cr>



*DONE

Import calibration

Command syntax

Import: Use this command to upload calibration settings to one or more devices.

Import,n <cr> import calibration string to new device

Example

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

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

⋮

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

Response

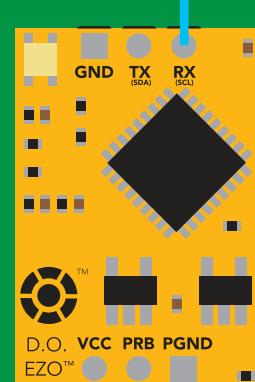
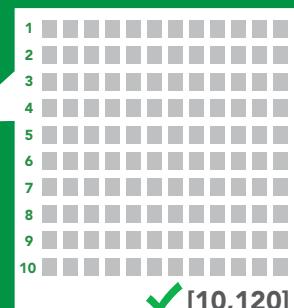
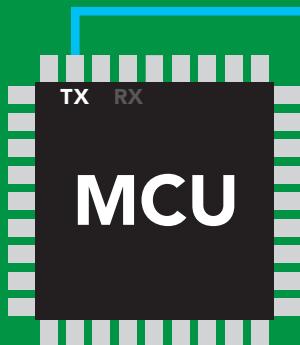
*OK <cr>

*OK <cr>

⋮

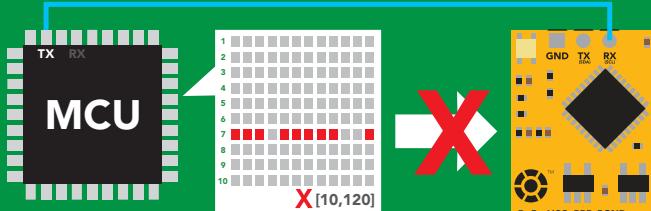
*OK <cr>

Import,n <cr>



*OK <cr>

system will reboot



*ER <cr>

* If one of the imported strings is not correctly entered, the device will not accept the import, respond with *ER and reboot.

Temperature compensation

Command syntax

Default temperature = 20°C
Temperature is always in Celsius
Temperature is not retained if power is cut

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

T,? <cr> compensated temperature value?

RT,n <cr> set temperature compensation and take a reading*

This is a new command
for firmware V2.13

Example

T,19.5 <cr>

Response

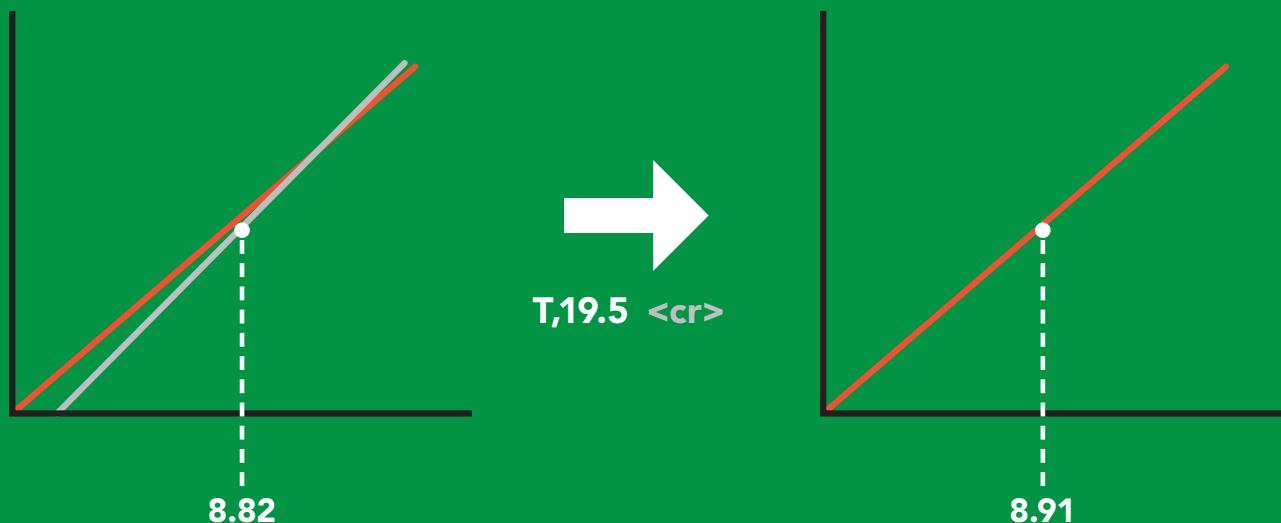
***OK <cr>**

RT,19.5 <cr>

***OK <cr>**
8.91 <cr>

T,? <cr>

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



Salinity compensation

Command syntax

Default value = 0 μs

If the conductivity of your water is less than 2,500 μS 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>

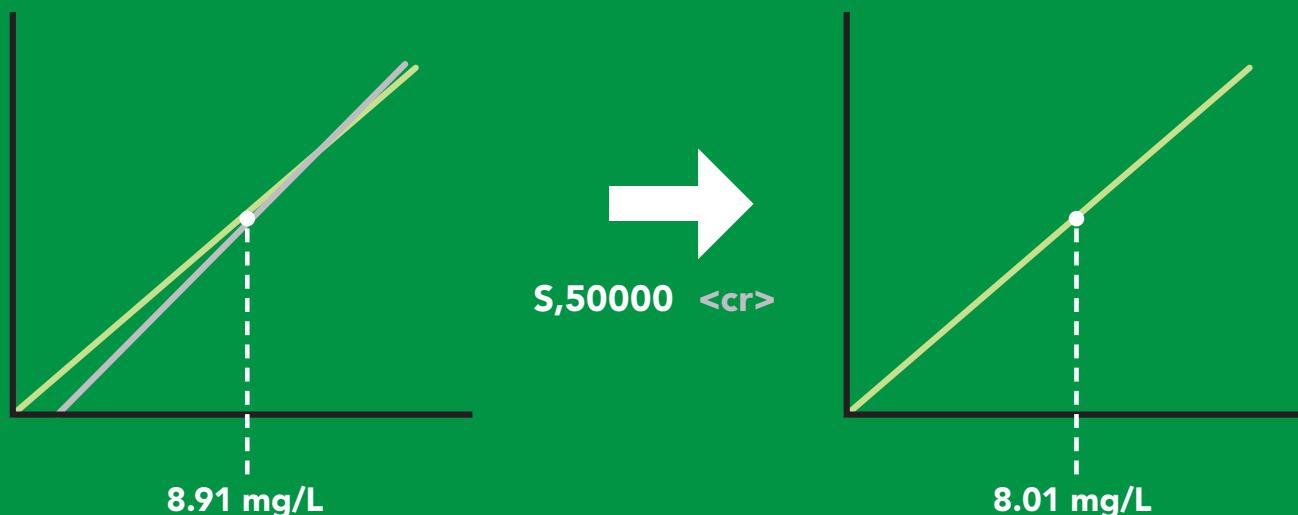
S,37.5,ppt <cr>

S,? <cr>

*OK <cr>

?S,50000, μS <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

O,mg,1 / O,mg,0 <cr>

Response

*OK <cr> enable / disable mg/L

O,%,1 / O,%,0 <cr>

*OK <cr> enable / disable percent saturation

O,? <cr>

? ,O,%,mg <cr> if both are enabled

Parameters

mg mg/L

% percent saturation

Followed by 1 or 0

1 enabled

0 disabled

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

Naming device

Command syntax

Do not use spaces in the name

Name,n <cr> set name

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

Name, <cr> clears name

Up to 16 ASCII characters

Name,? <cr> show name

Example

Name, <cr>

***OK <cr> name has been cleared**

Name,zzt <cr>

***OK <cr>**

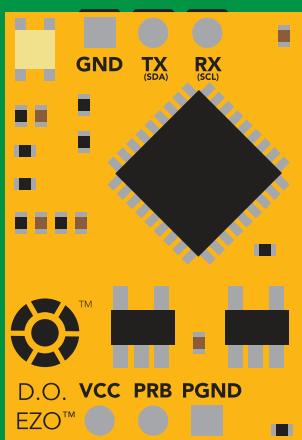
Name,? <cr>

?Name,zzt <cr>

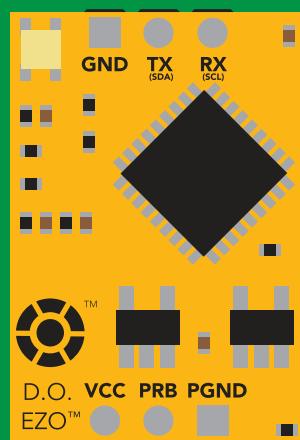
***OK <cr>**

Response

Name,zzt



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

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>

Response

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

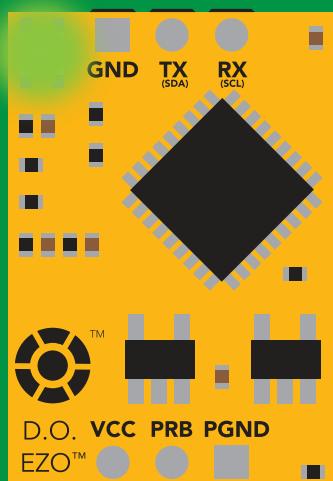
Sleep <cr>

*OK <cr>
*SL <cr>

Any command

*WA <cr> wakes up device

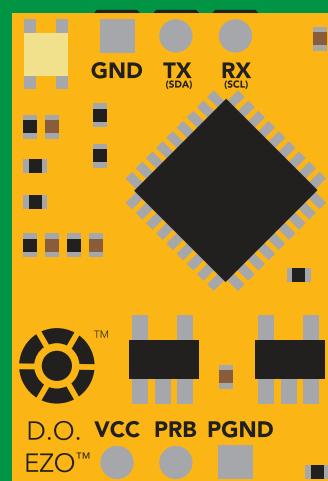
	STANDBY	SLEEP
5V	13.1 mA	0.66 mA
3.3V	12 mA	0.3 mA



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>

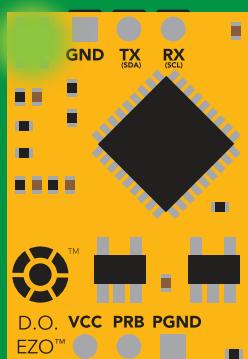
Example

Baud,? <cr>

?Baud,38400 <cr>

*OK <cr>

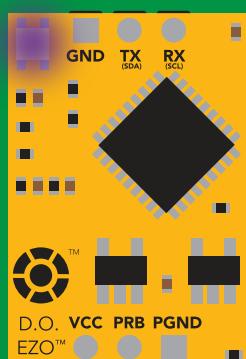
n = [300
1200
2400
9600 default
19200
38400
57600
115200]



Standby



Baud,38400 <cr>

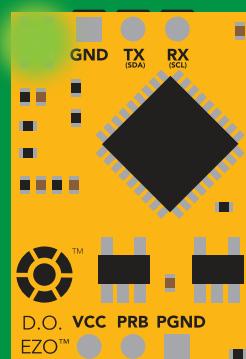


Changing
baud rate

*OK <cr>



(reboot)



Standby

Protocol lock

Command syntax

Plock,1 <cr> enable Plock

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

Plock,? <cr> Plock on/off?

Locks device to UART mode.

Example

Plock,1 <cr>

Response

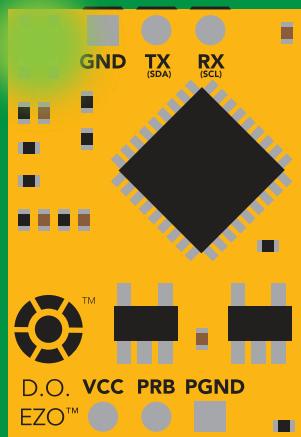
*OK <cr>

Plock,0 <cr>

*OK <cr>

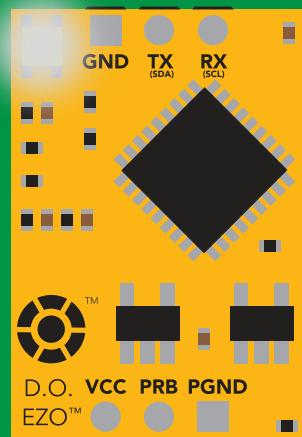
Plock,? <cr>

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



*OK <cr>

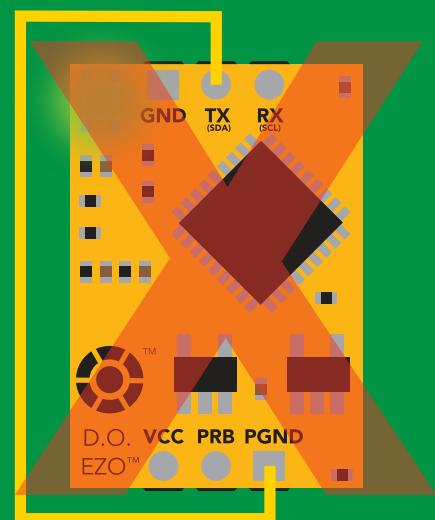
I2C,100



cannot change to I²C

*ER <cr>

Short



cannot change to I²C

Factory reset

Command syntax

Clears calibration
LED on
"*OK" enabled

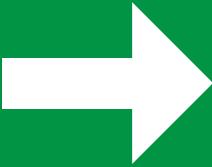
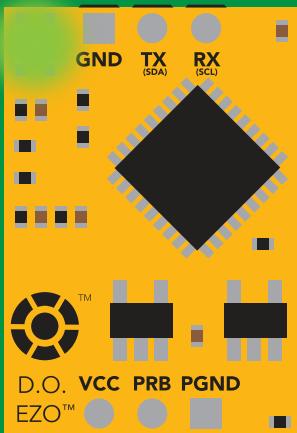
Factory <cr> enable factory reset

Example Response

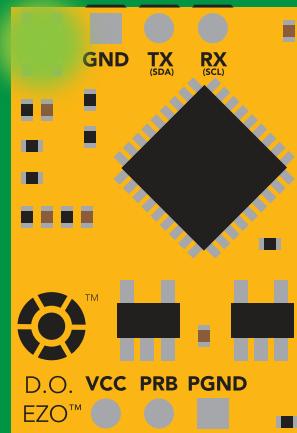
Factory <cr>

*OK <cr>

Factory <cr>



(reboot)



*OK <cr>

*RS <cr>

*RE <cr>

Baud rate will not change

Change to I²C mode

Command syntax

Default I²C address 97 (0x61)

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)

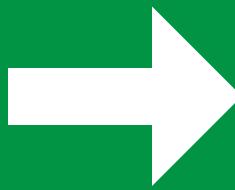
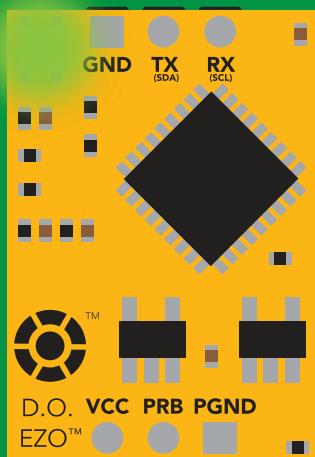
Wrong example

I²C,139 <cr> n ≠ 127

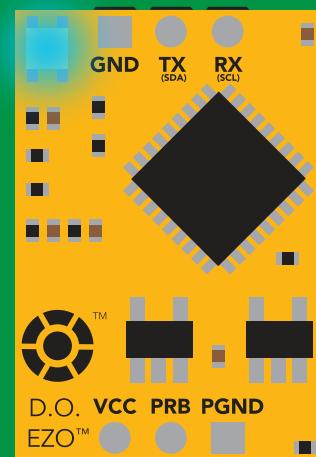
Response

*ER <cr>

I²C,100



(reboot)



Green
*OK <cr>

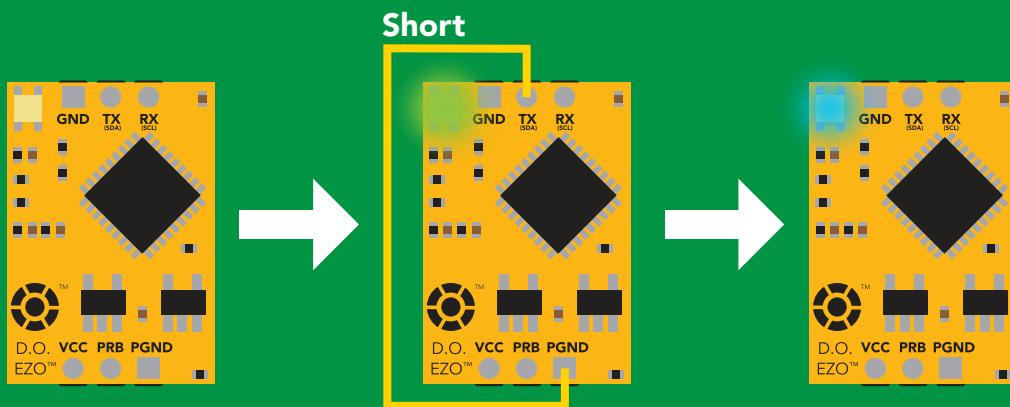
Blue
now in I²C mode

Manual switching to I²C

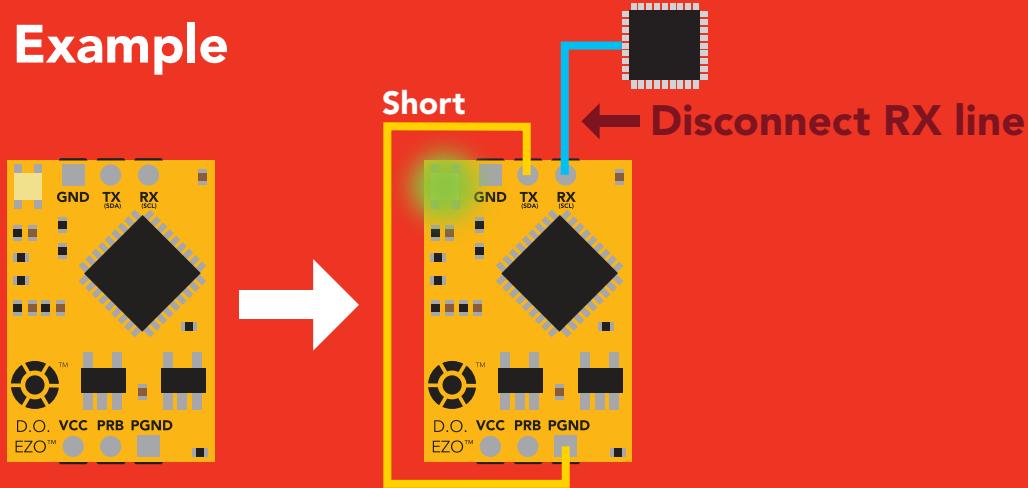
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PGND
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Green to Blue
- Disconnect ground (power off)
- Reconnect all data and power

Manually switching to I²C will set the I²C address to 97 (0x61)

Example



Wrong Example



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

- Calibration
- Change I²C 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

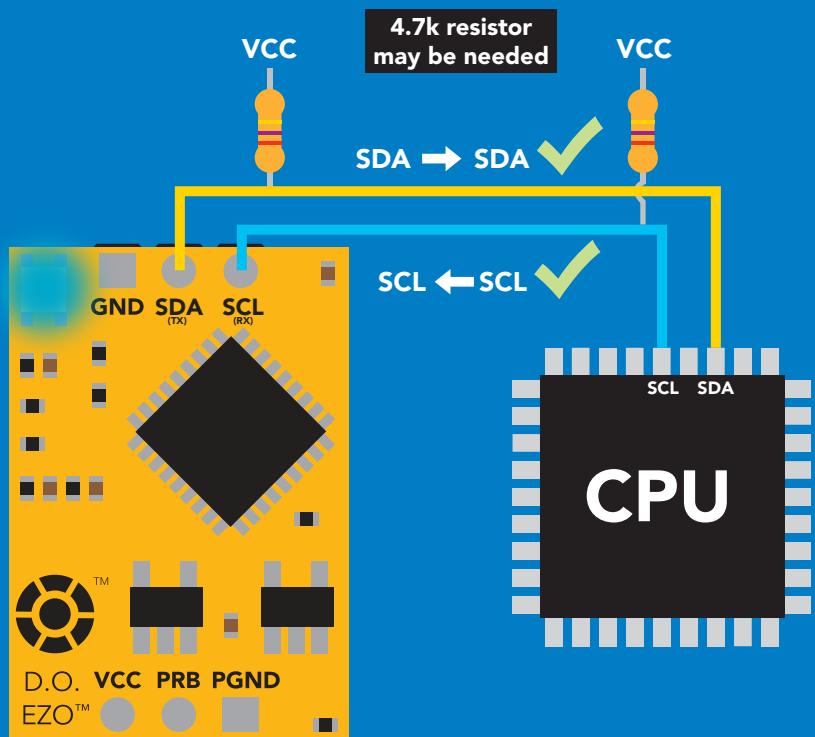
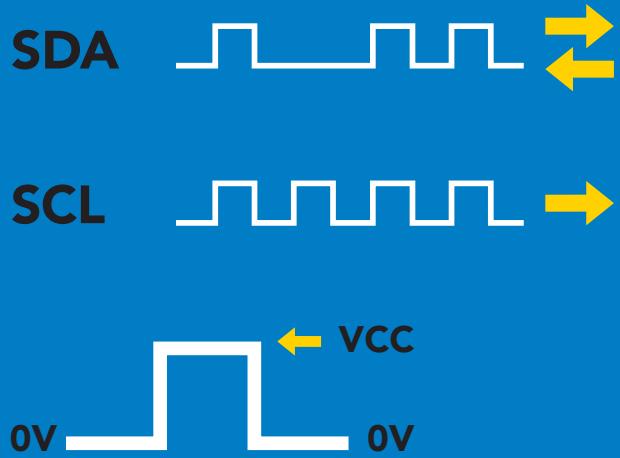
- Find
- Pressure compensation
- Salinity compensation
- Sleep mode
- Temperature compensation

I²C mode

I²C address (0x01 – 0x7F)
97 (0x61) default

V_{cc} 3.3V – 5.5V

Clock speed 100 – 400 kHz



Data format

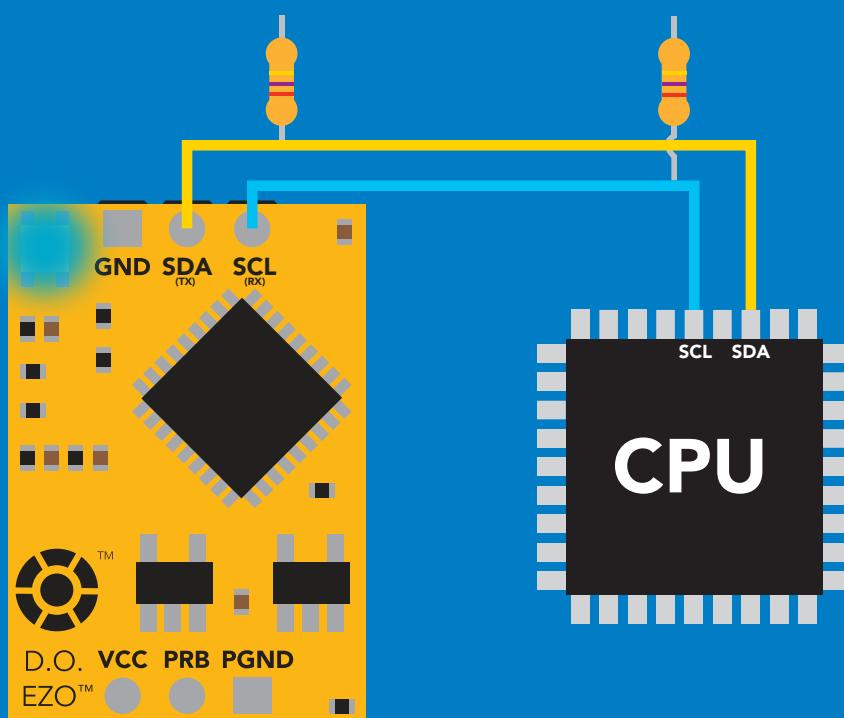
Reading	Dissolved Oxygen	Data type	floating point
Units	mg/L & (% sat) <small>when enabled</small>	Decimal places	mg/L = 2 % sat = 1
Encoding	ASCII	Smallest string	4 characters
Format	string <small>(CSV string when % sat is enabled)</small>	Largest string	16 characters

Sending commands to device

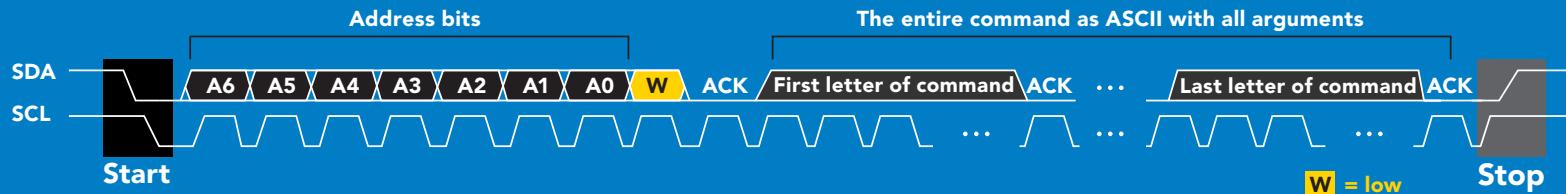


Example

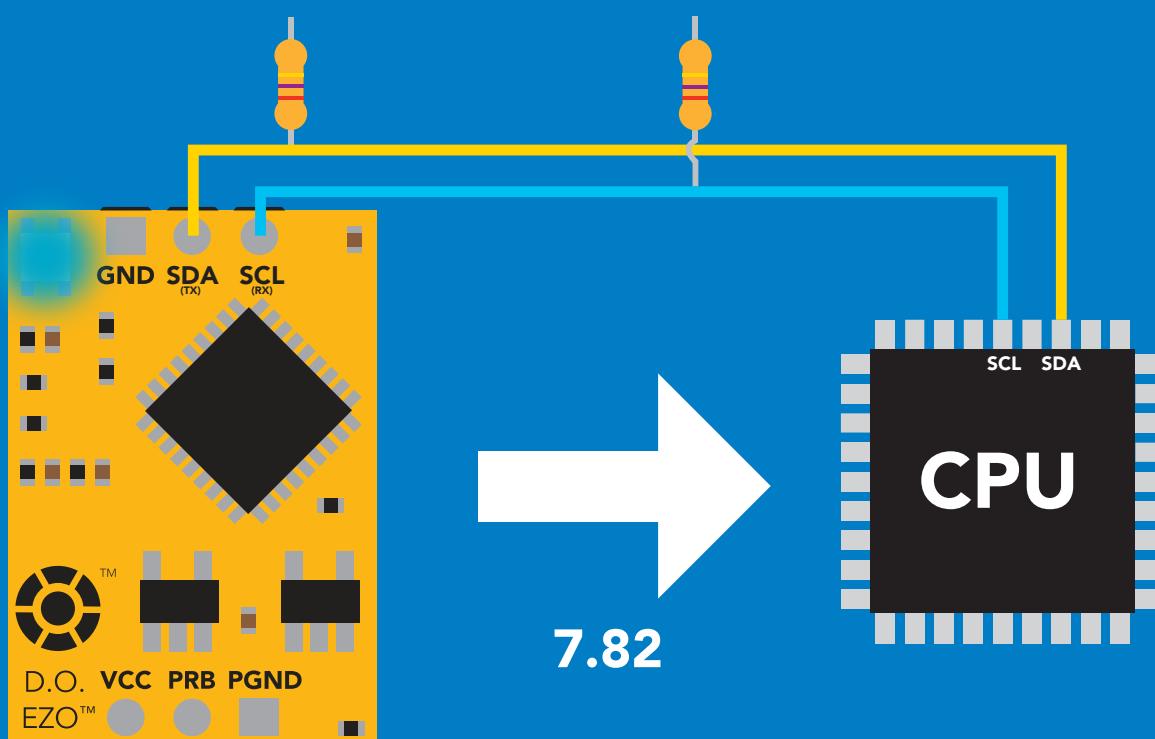
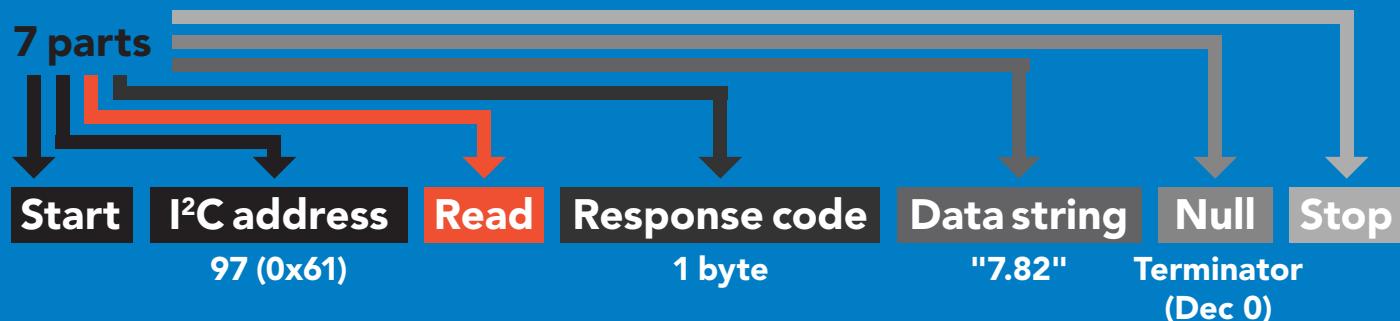
Start **97 (0x61)** **Write** **Sleep** **Stop**
I²C address **Command**



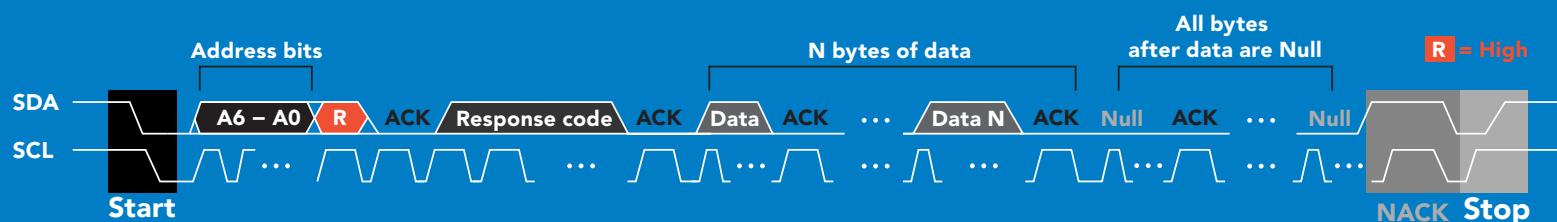
Advanced



Requesting data from device



Advanced

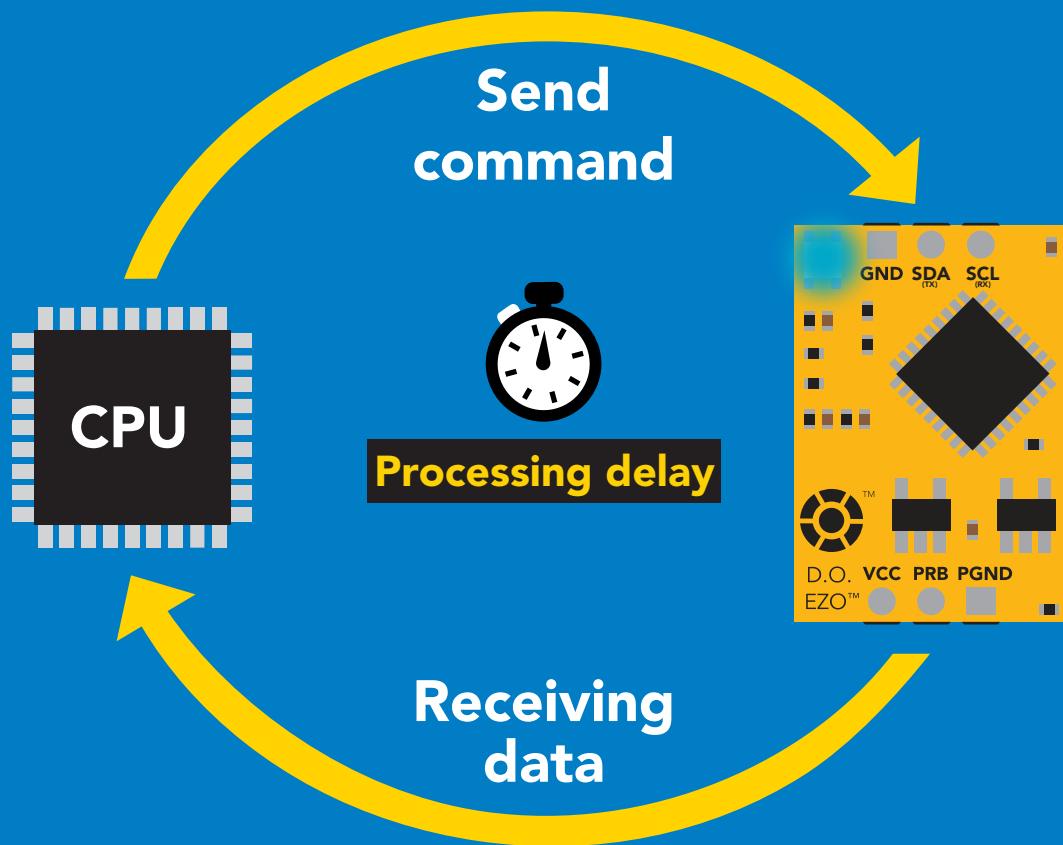


1 55 46 56 50 0 = 7.82

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;
```

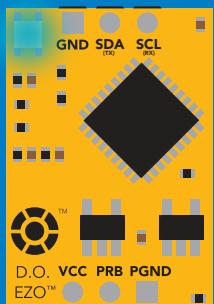
The response code will always be 254, if you do not wait for the processing delay.

Response codes

Single byte, not string

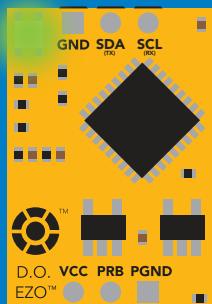
255	no data to send
254	still processing, not ready
2	syntax error
1	successful request

LED color definition



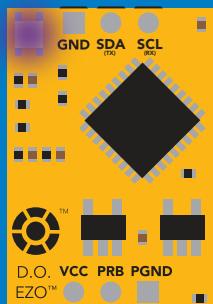
Blue

I²C standby



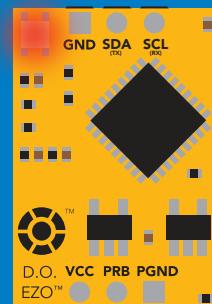
Green

Taking reading



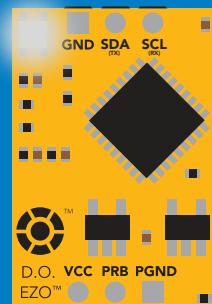
Purple

Changing I²C address



Red

Command not understood



White

Find

5V	LED ON +0.4 mA
3.3V	+0.2 mA

I²C mode

command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	change back to UART mode	pg. 66
Cal	performs calibration	pg. 52
Export	export calibration	pg. 53
Factory	enable factory reset	pg. 65
Find	finds device with blinking white LED	pg. 50
i	device information	pg. 60
I2C	change I ² C address	pg. 64
Import	import calibration	pg. 54
L	enable/disable LED	pg. 49
Name	set/show name of device	pg. 59
O	removing parameters	pg. 58
P	pressure compensation	pg. 57
Plock	enable/disable protocol lock	pg. 63
R	returns a single reading	pg. 51
S	salinity compensation	pg. 56
Sleep	enter sleep mode/low power	pg. 62
Status	retrieve status information	pg. 61
T	temperature compensation	pg. 55

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

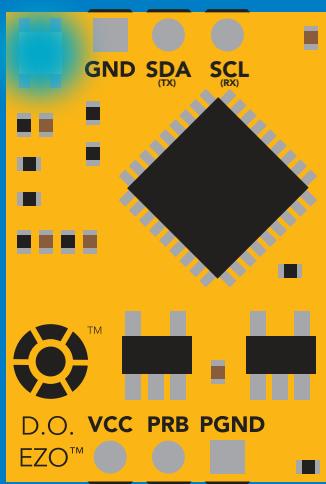
L,?


Wait 300ms

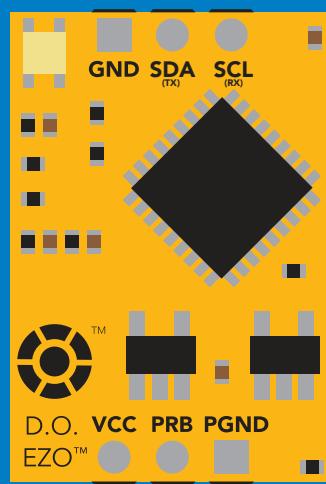
1 **?L,1** **0**
Dec ASCII Null

or

1 **?L,0** **0**
Dec ASCII Null



L,1



L,0

Find

300ms  processing delay

Command syntax

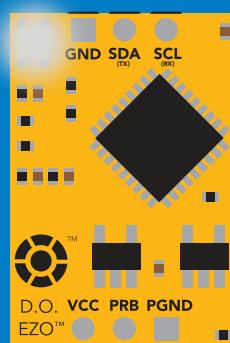
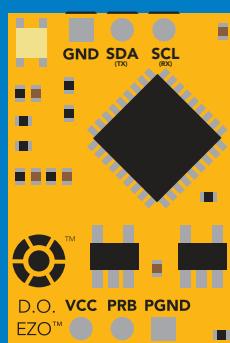
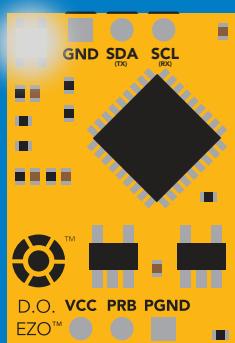
This command will disable continuous mode
Send any character or command to terminate find.

Find LED rapidly blinks white, used to help find device

Example Response

Find


Wait 300ms
1 Dec **0** Null



Taking reading

Command syntax

600ms  processing delay

R return 1 reading

Example

Response

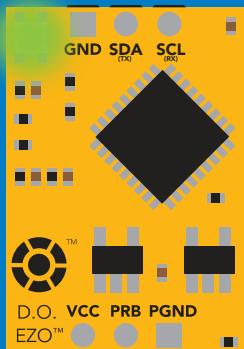
R



1
Dec

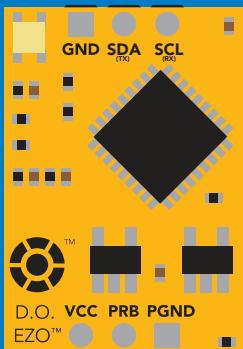
7.82
ASCII

0
Null

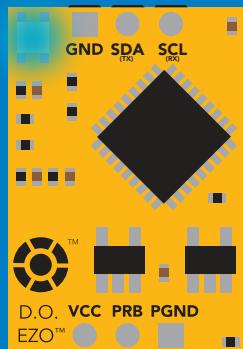


Green

Taking reading



Transmitting



Blue

Standby

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 calibration

300ms  processing delay

Command syntax

Export: Use this command to download calibration settings

Export,? calibration string info

Export export calibration string from calibrated device

Example

Export,?

Response



Wait 300ms

1 Dec 10,120 ASCII 0 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 Dec 59 6F 75 20 61 72 ASCII 0 Null

(1 of 10)

Export



Wait 300ms

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

(2 of 10)

(7 more)



Export



Wait 300ms

1 Dec 6F 6C 20 67 75 79 ASCII 0 Null

(10 of 10)

Export



Wait 300ms

1 Dec *DONE ASCII 0 Null

Import calibration

300ms  processing delay

Command syntax

Import: Use this command to upload calibration settings to one or more devices.

Import,n import calibration string to new device

Example

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

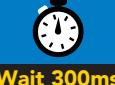
Import, 65 20 61 20 63 6F (2 of 10)

⋮

Import, 6F 6C 20 67 75 79 (10 of 10)

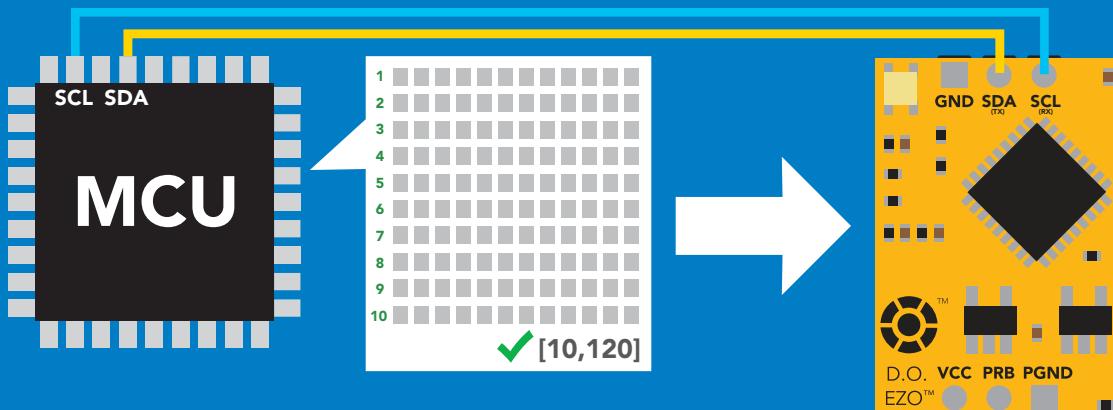
Response

 1 0 Null
Wait 300ms

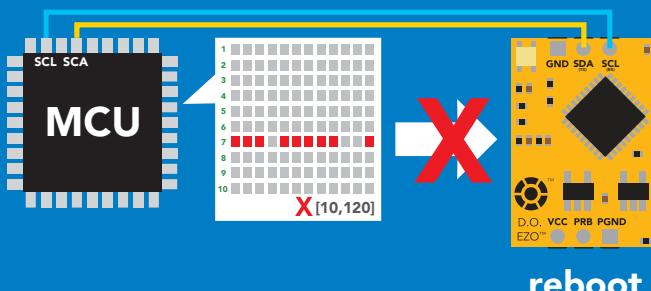
 1 0 Null
Wait 300ms

⋮
 1 0 Null
Wait 300ms

Import,n



system will reboot



* If one of the imported strings is not correctly entered, the device will not accept the import and reboot.

Temperature compensation

Command syntax

Default temperature = 20°C
Temperature is always in Celsius
Temperature is not retained if power is cut

- T,n n = any value; floating point or int 300ms  processing delay
- T,? compensated temperature value?
- RT,n set temperature compensation and take a reading*

This is a new command
for firmware V2.13

Example

T,19.5

Response

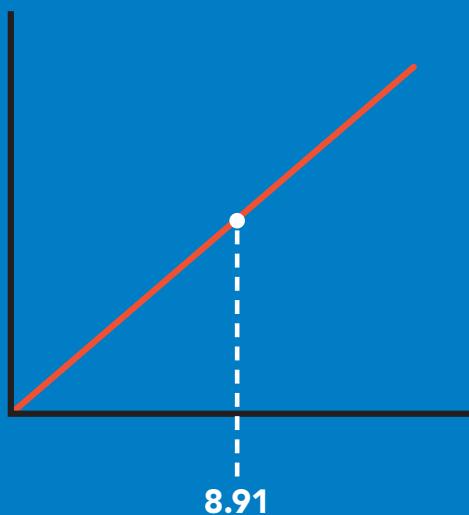
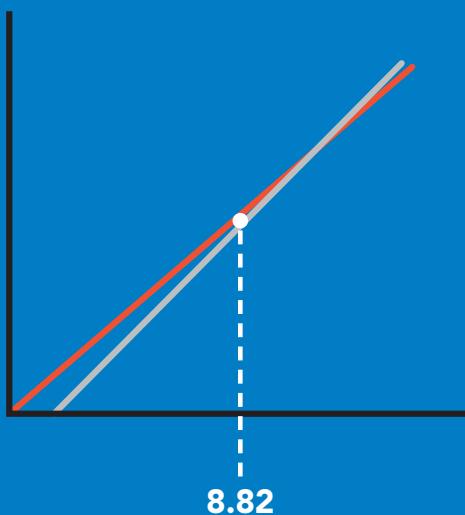
 Wait 300ms 1 Dec 0 Null

RT,19.5

 Wait 900ms 1 Dec 8.91 0 Null

T,?

 Wait 300ms 1 Dec ?T,19.5 0 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 Dec 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

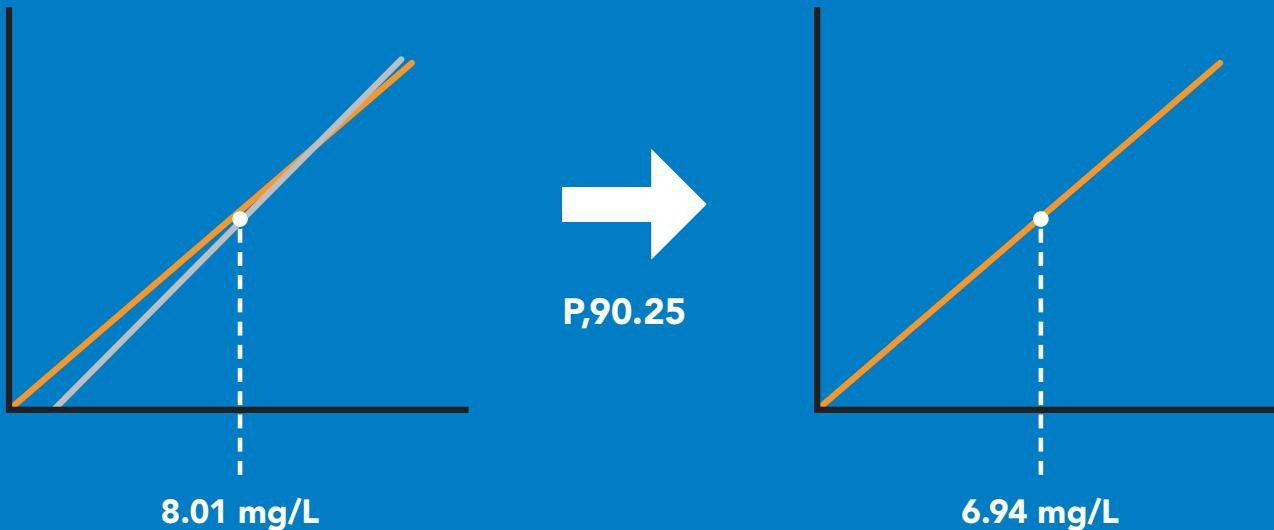
P,90.25

Response

 Wait 300ms
1 Dec 0 Null

P,?

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



Enable/disable parameters from output string

Command syntax

O, [parameter],[1,0]

O,?

300ms  processing delay

enable or disable output parameter
enabled parameter?

Example

O,mg,1 / O,mg,0



1 Dec 0 Null

enable / disable mg/L

O,%,1 / O,%,0



1 Dec 0 Null

enable / disable percent saturation

O,?



1 Dec 0 Null

if both are enabled

Parameters

mg mg/L

% percent saturation

Followed by 1 or 0

1 enabled

0 disabled

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

Naming device

300ms  processing delay

Command syntax

Do not use spaces in the name

Name,n set name n =

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

Name, clears name

Up to 16 ASCII characters

Name,? show name

Example

Response

Name,



1
Dec
0
Null

name has been cleared

Name,zzt



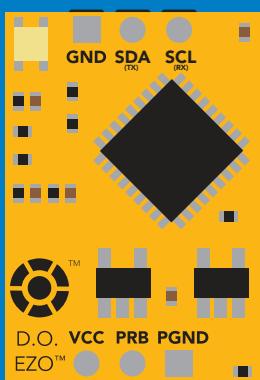
1
Dec
0
Null

Name,?

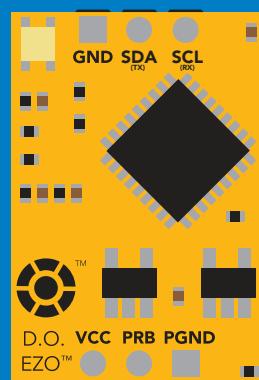


1
Dec
?Name,zzt
ASCII
0
Null

Name,zzt



Name,?



1 0

1 ?Name,zzt 0

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,
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

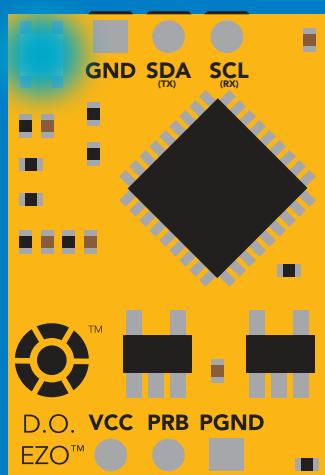
Do not read status byte after issuing sleep command.

Any command

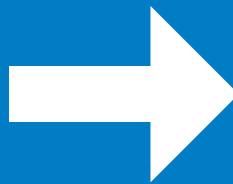
wakes up device

5V	STANDBY	SLEEP
	13.1 mA	0.66 mA

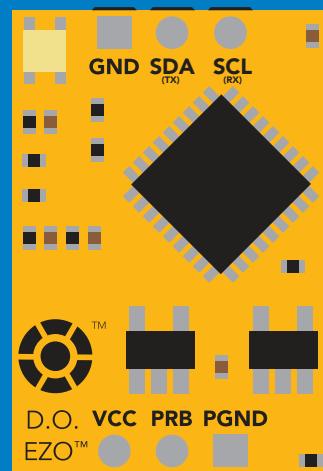
3.3V	12 mA	0.3 mA
------	-------	--------



Standby



Sleep



Sleep

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

Plock,1

 Wait 300ms
1 Dec 0 Null

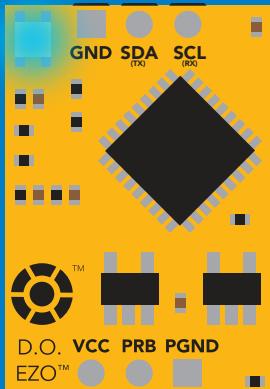
Plock,0

 Wait 300ms
1 Dec 0 Null

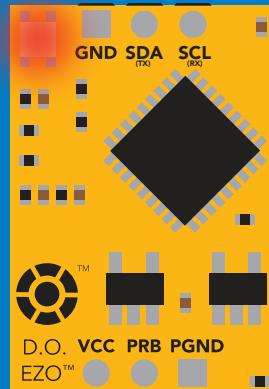
Plock,?

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

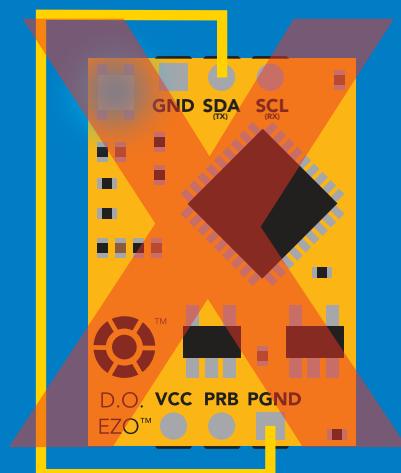
Plock,1



Baud, 9600



cannot change to UART



cannot change to UART

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)

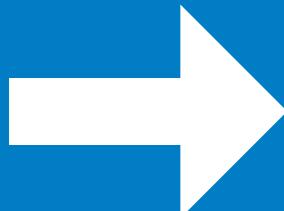
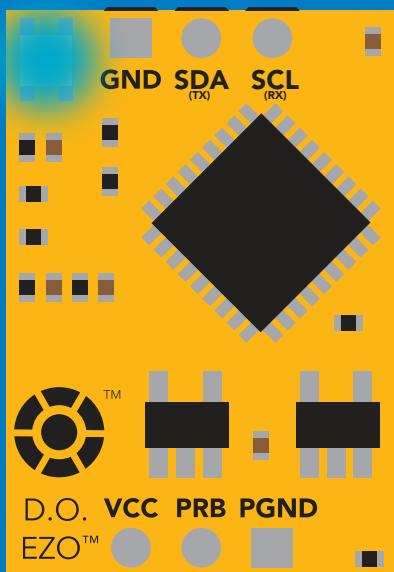
Warning!

Changing the I²C address will prevent communication between the circuit and the CPU until your CPU is updated with the new I²C address.

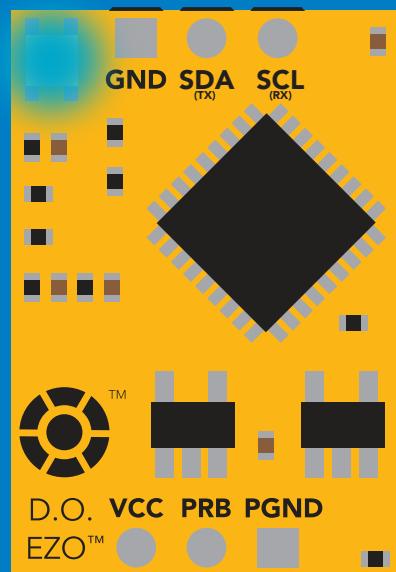
Default I²C address is 97 (0x61).

n = any number 1 – 127

I²C,100



(reboot)



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

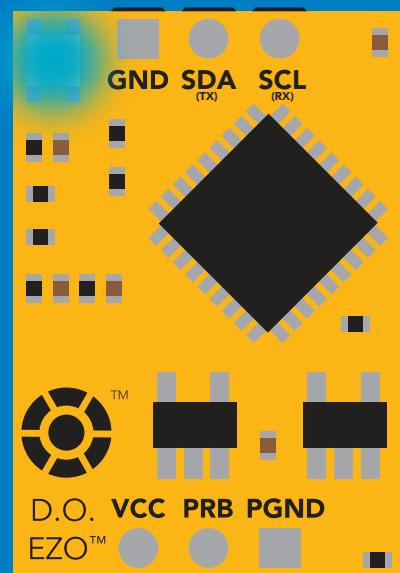
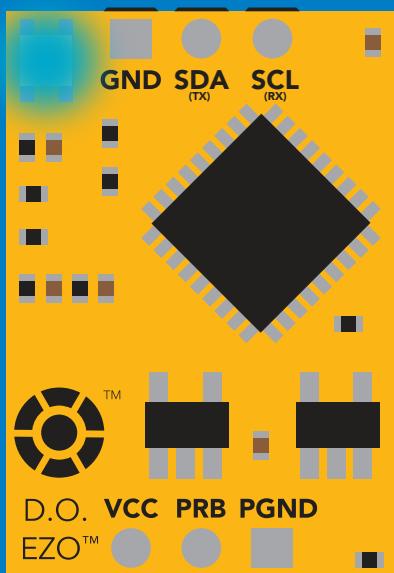
Factory

device reboot

(no response given)

Clears calibration
LED on
Response codes enabled

Factory



Change to UART mode

Command syntax

Baud,n switch from I²C to UART

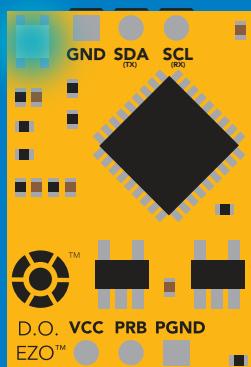
Example Response

Baud,9600

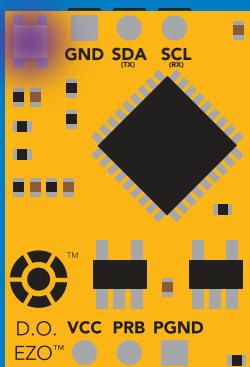
reboot in UART mode

(no response given)

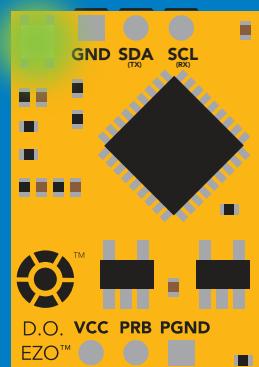
n = [300
1200
2400
9600
19200
38400
57600
115200]



→
Baud,9600



→
(reboot)

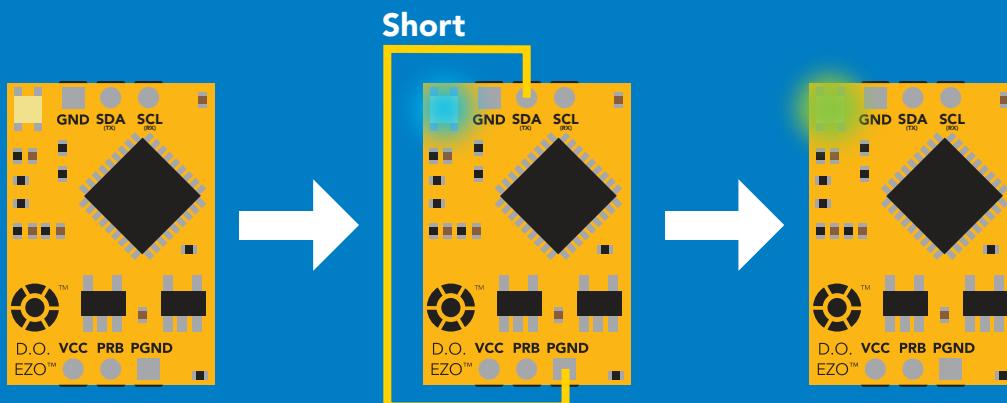


Changing to
UART mode

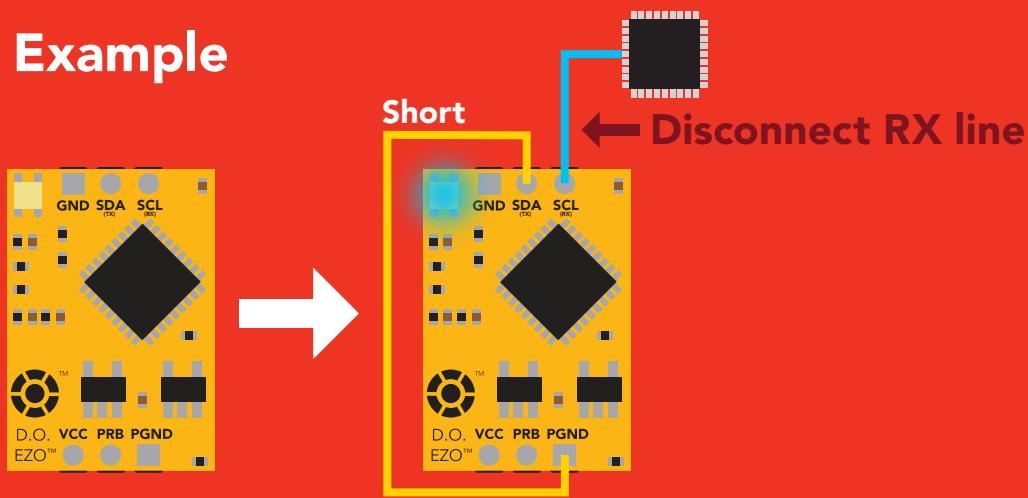
Manual switching to UART

- 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

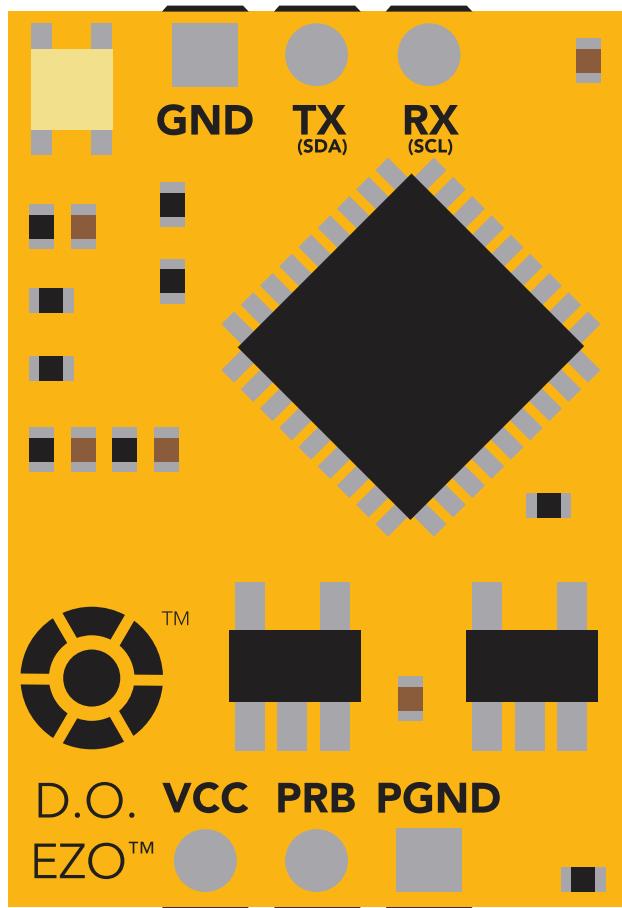
Example



Wrong Example



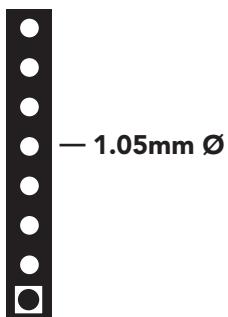
EZO™ circuit footprint



17.78mm
(0.7")

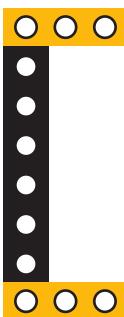
2.54mm
(0.1")

1 In your CAD software place a 8 position header.

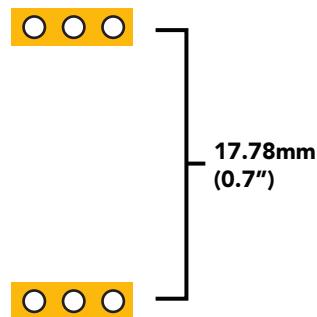


— 1.05mm Ø

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 5.5

Revised naming device info on pages 32 & 59.

Datasheet V 5.4

Revised artwork within datasheet.

Datasheet V 5.3

Moved Default state to pg 13.

Datasheet V 5.2

Updated firmware changes on page 70.

Datasheet V 5.1

Revised response for the sleep command in UART mode on pg 36.

Datasheet V 5.0

Revised calibration theory on page 9, and added more information on the Export calibration and Import calibration commands.

Datasheet V 4.9

Corrected temperature compensation typo on pages 26 & 52.

Datasheet V 4.8

Revised isolation schematic on pg. 10

Datasheet V 4.7

Added new command:

"RT,n" for Temperature compensation located on pages 26 (UART) & 52 (I²C).
Added firmware information to Firmware update list.

Datasheet V 4.6

Added more information about temperature compensation on pages 26 & 52.

Datasheet V 4.5

Changed "Max rate" to "Response time" on cover page.

Datasheet V 4.4

Removed note from certain commands about firmware version.

Datasheet V 4.3

Added information to calibration theory on pg 7.

Datasheet V 4.2

Revised definition of response codes on pg 44.

Datasheet V 4.1

Updated firmware changes on pg. 66.

Datasheet V 4.0

Revised Enable/disable parameters information on pages 29 (UART) & 55 (I²C).

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 change log

Datasheet V 3.6

Added new commands:

"Find" pages 21 (UART) & 48 (I²C).

"Export/Import calibration" pages 25 (UART) & 51 (I²C).

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.

Firmware updates

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 – I²C bug (Dec 1, 2014)

- Fixed I²C bug where the circuit may inappropriately respond when other I²C 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 bug where EEPROM would get erased if the circuit lost power 900ms into startup.

V1.97 – EEPROM (Oct 10, 2016)

- Fixed bug 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 bug where the temperature would default to 0 on startup.

V2.12 – (Dec 19, 2017)

- Improved accuracy of dissolved oxygen equations.

V2.13 – (July 16, 2018)

- Added "RT" command to Temperature compensation.

V2.14 – (June 7, 2019)

- Fixed bug where the output buffer overflows when the cal and cal,0 point are too close together.

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.