Atlas Scientific™
Environmental Robotics

V 5.2

Revised 11/24

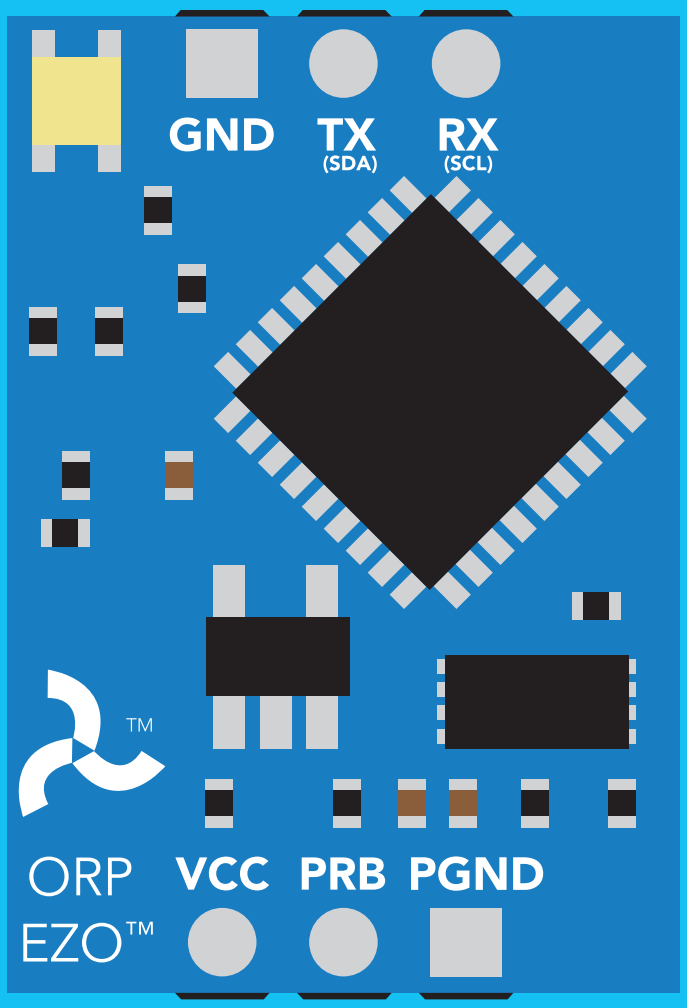
EZO-ORP™

Embedded ORP Circuit

ISO 11271 Compliant

(determination of redox potential)

Reads	**ORP**
Range	**-1020mV – 1020mV**
Accuracy	**+/– 1mV**
Response time	**1 reading per sec**
Supported probes	**Any type & brand**
Calibration	**Single point**
Temp compensation	**N/A**
Data protocol	**UART & I²C**
Default I²C address	**98 (0x62)**
Operating voltage	**3.3V – 5V**
Data format	**ASCII**



RoHS COMPLIANT

PATENT PROTECTED

Written by Jordan Press
Designed by Noah Press

This is an evolving document, check back for updates.

✓ Available data protocols

UART

Default

I²C

X Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

Atlas Scientific™ Environmental Robotics

STOP

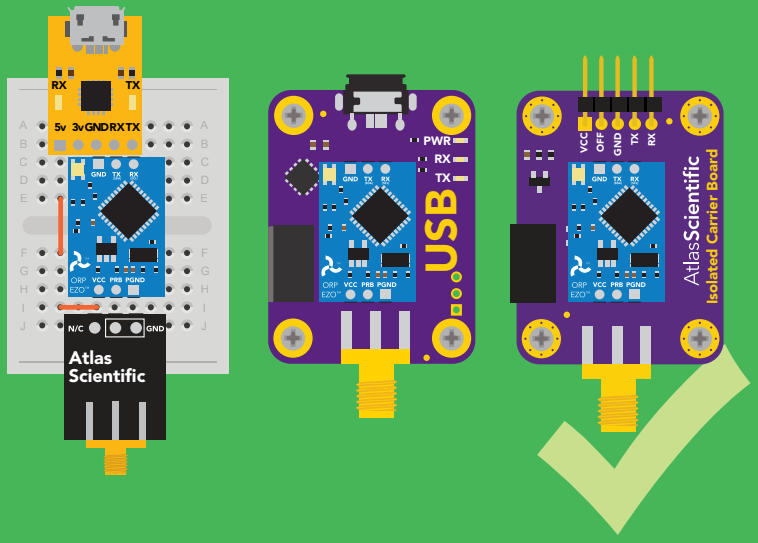
SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

Are there specific soldering instructions? Yes, see page 61.

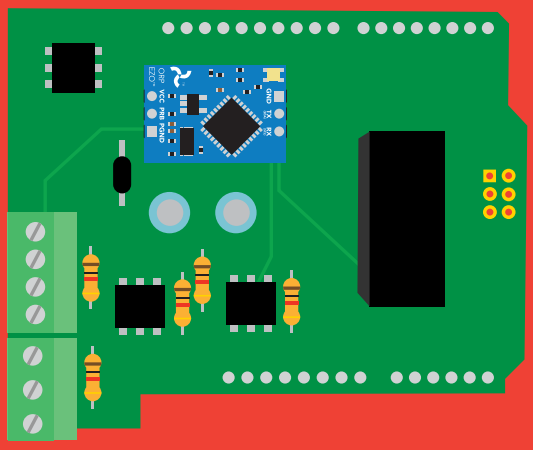
Can you make a warranty claim after soldering? No.

If you have not used this product before; Observe how a properly working sensor behaves *BEFORE* embedding it into your PCB.

Get this device working using one of these methods first.



Do not embed before you have experience with this sensor.



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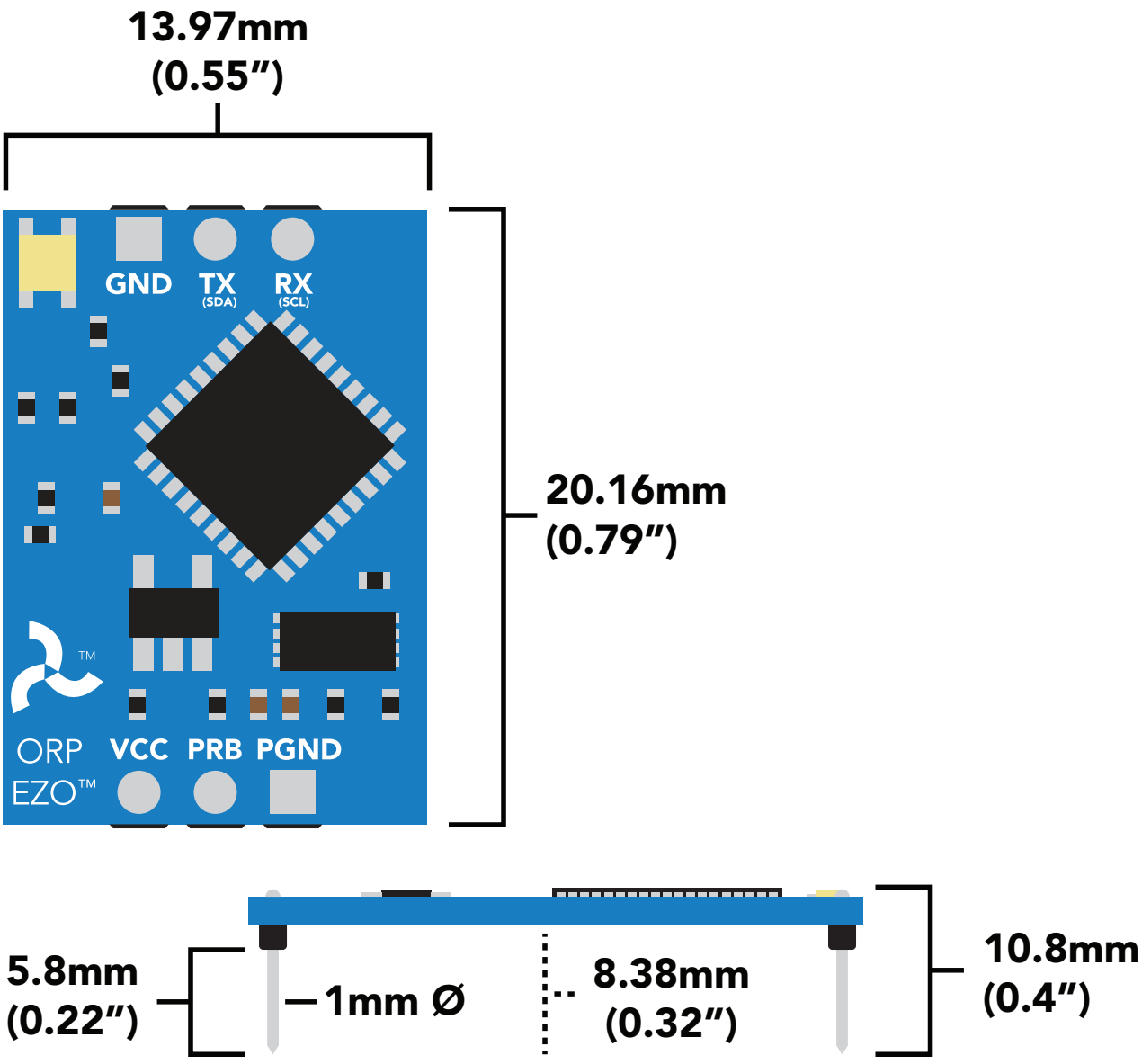
UART

I²C

EZO™ circuit dimensions



Power consumption

	LED	MAX	STANDBY	SLEEP
5V	ON	18.3 mA	16 mA	1.16 mA
	OFF	13.8 mA	13.8 mA	
3.3V	ON	14.5 mA	13.9 mA	0.995 mA
	OFF	13.3 mA	13.3 mA	

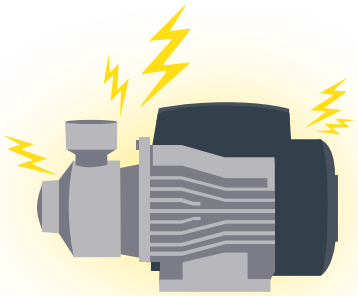
Absolute max ratings

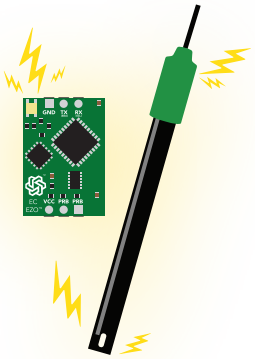
Parameter	MIN	TYP	MAX
Storage temperature (EZO™ ORP)	-65 °C		125 °C
Operational temperature (EZO™ ORP)	-40 °C	25 °C	85 °C
VCC	3.3V	5V	5.5V

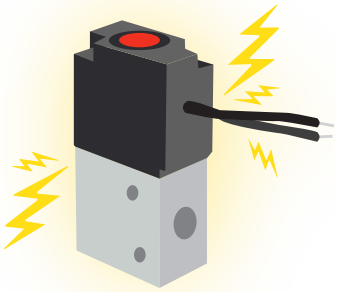
Electrical isolation

The Atlas Scientific EZO™ ORP circuit is a very sensitive device. This sensitivity is what gives the ORP circuit its accuracy. This also means that the ORP 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 ORP 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 ORP probe in a cup of water by itself. The readings should stabilize quickly, confirming that electrical noise was the issue.



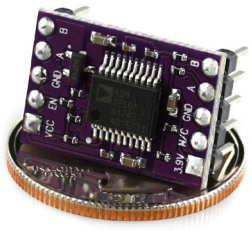




Advice:

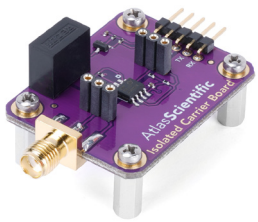
1. When reading ORP along with other sensors, electrical isolation is strongly recommended.
2. Never build a commercial product without electrical isolation.

Atlas Scientific offers several different electrical isolation products that can be used in your design. Select the electrical isolation product that works best for your design.

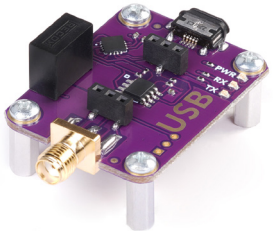


Basic EZO™
Inline Voltage Isolator

Vertical Isolator



Electrically Isolated
EZO™ Carrier Board



Gen 2 Electrically Isolated
USB EZO™ Carrier Board

i1 InterLink

i2 InterLink

i3 InterLink

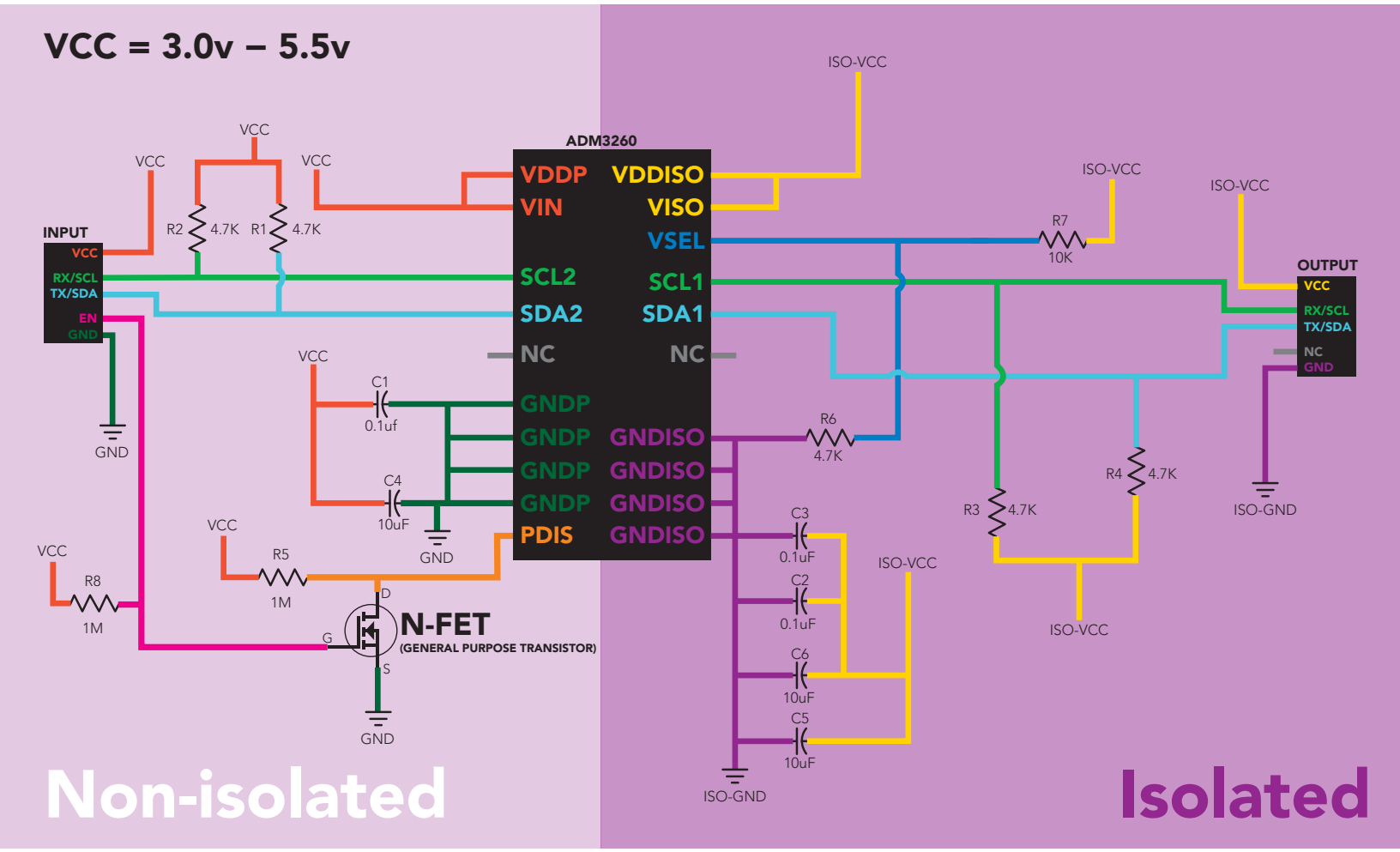
Electrically Isolated EZO™
Carrier Board (old style)

For various reasons, you may need to build your own electrical isolator. Because electrical isolation is so important, we have published our isolation schematic for anyone to use.

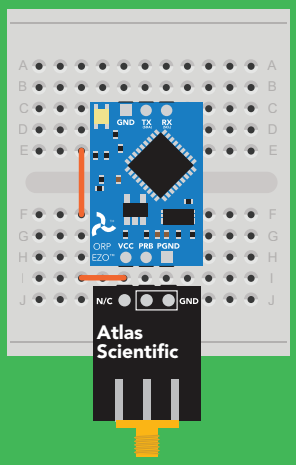
This isolation schematic is based on the ADM3260, which can output up to 150 mW of isolated power. PCB layout requires special attention for EMI/EMC and RF Control. Having good ground planes and keeping the capacitors as close to the chip as possible are crucial for proper performance.

The two data channels have a 4.7kΩ 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 (R6 and R7). This produces a voltage of 3.9V regardless of your input voltage.

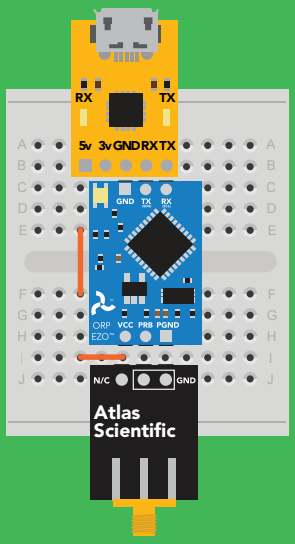
Isolated ground is different from non-isolated ground, these two lines should not be connected together.



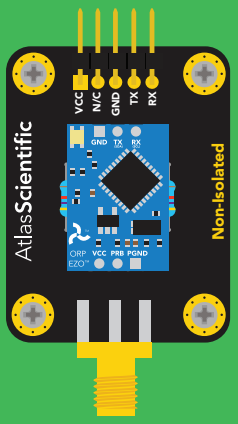
✓ Correct wiring



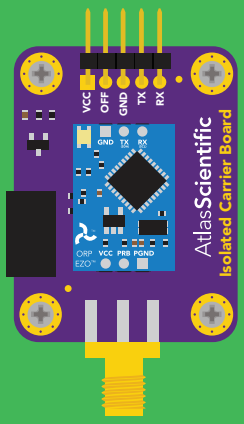
Bread board



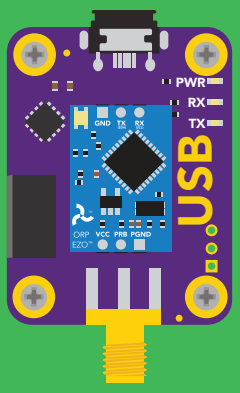
Bread board via USB



Non-Isolated
EZO™ Carrier Board



Electrically Isolated
EZO™ Carrier Board

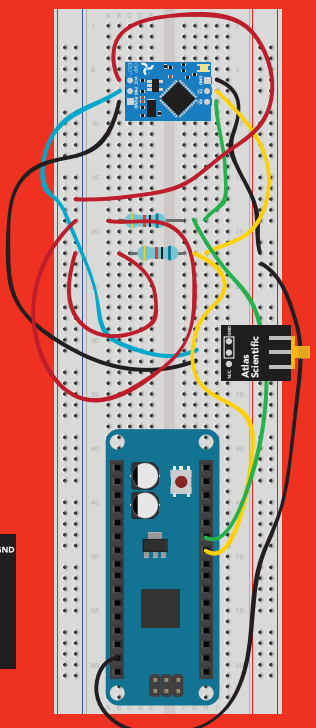


USB
carrier board

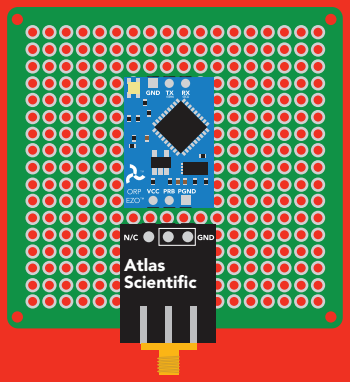
X Incorrect wiring

Extended leads

Sloppy setup

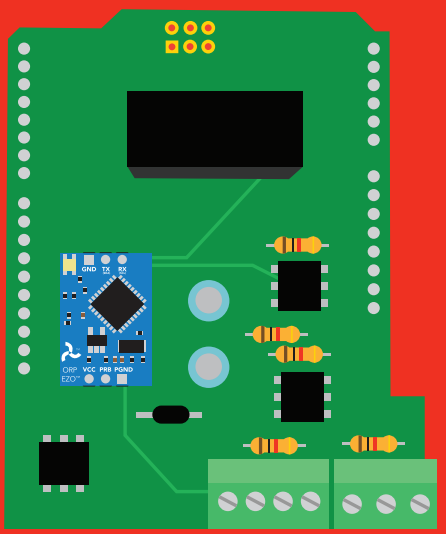


Perfboards or Protoboards



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

*Embedded into your device



***Only after you are familar with EZO™ circuits operation**

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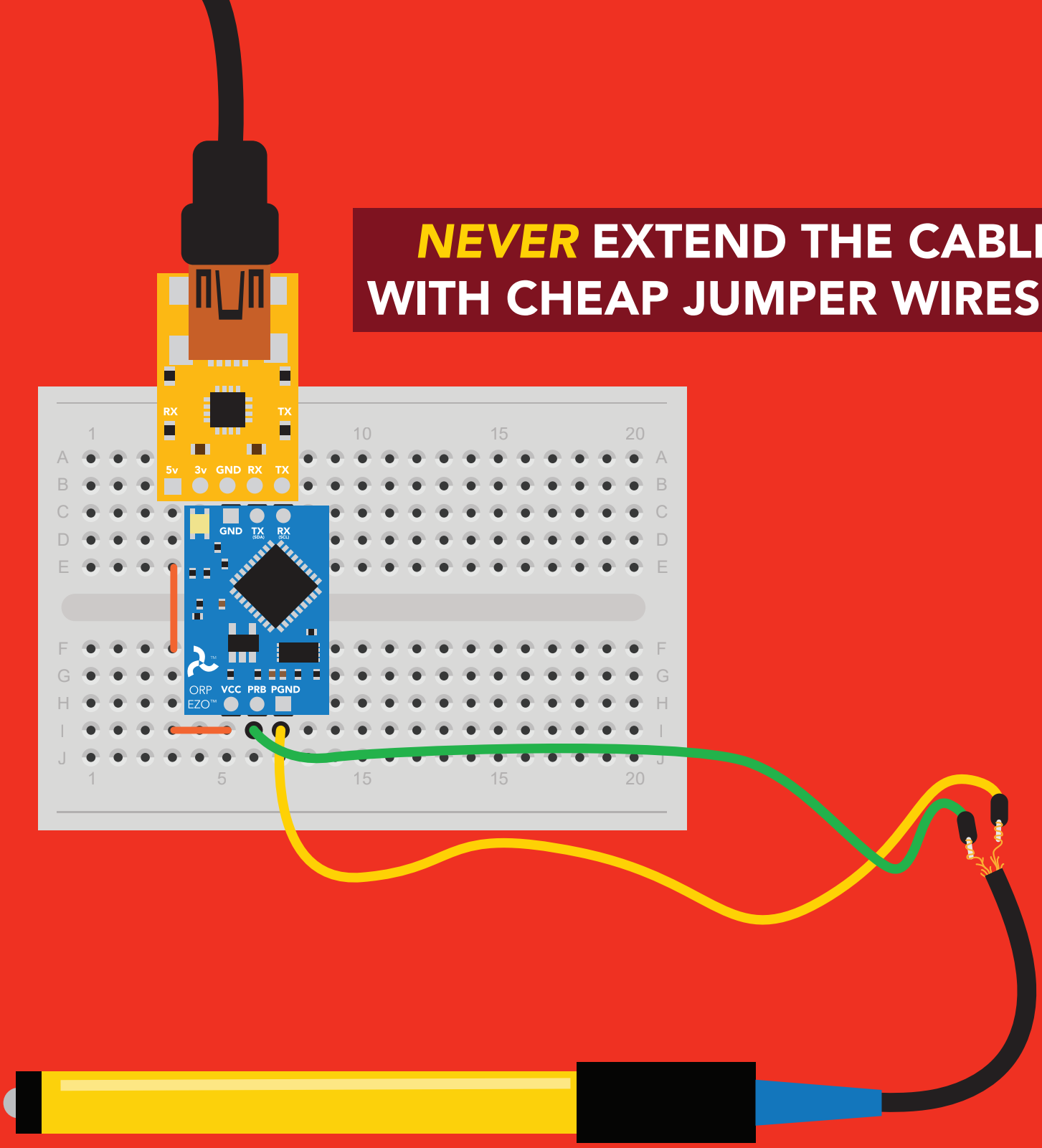
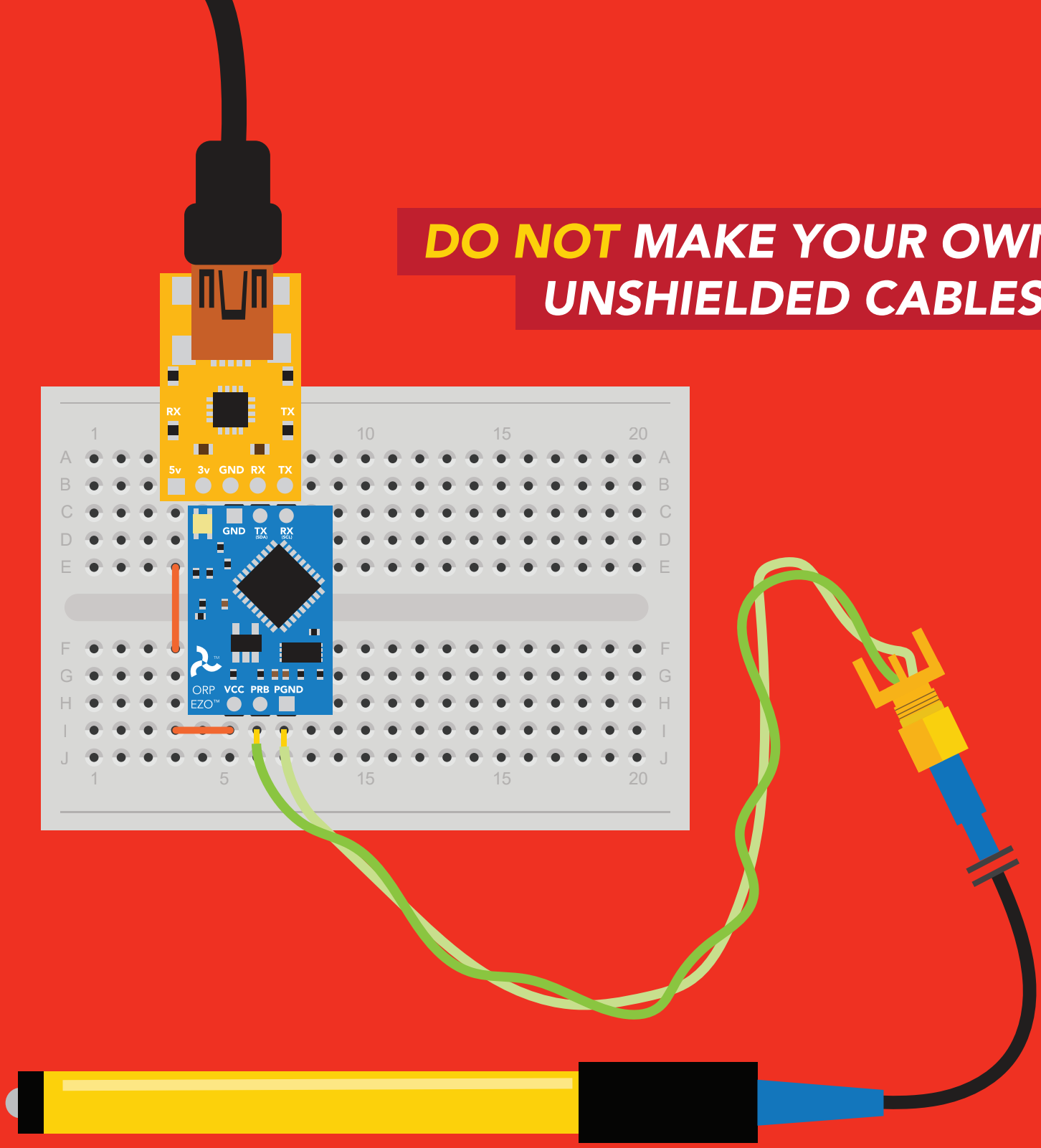
Environmental Robotics



NEVER EXTEND THE CABLE WITH CHEAP JUMPER WIRES!

DO NOT CUT THE PROBE CABLE WITHOUT REFERING TO *THIS DOCUMENT!*



DO NOT MAKE YOUR OWN UNSHIELDED CABLES!

ONLY USE SHIELDED CABLES.

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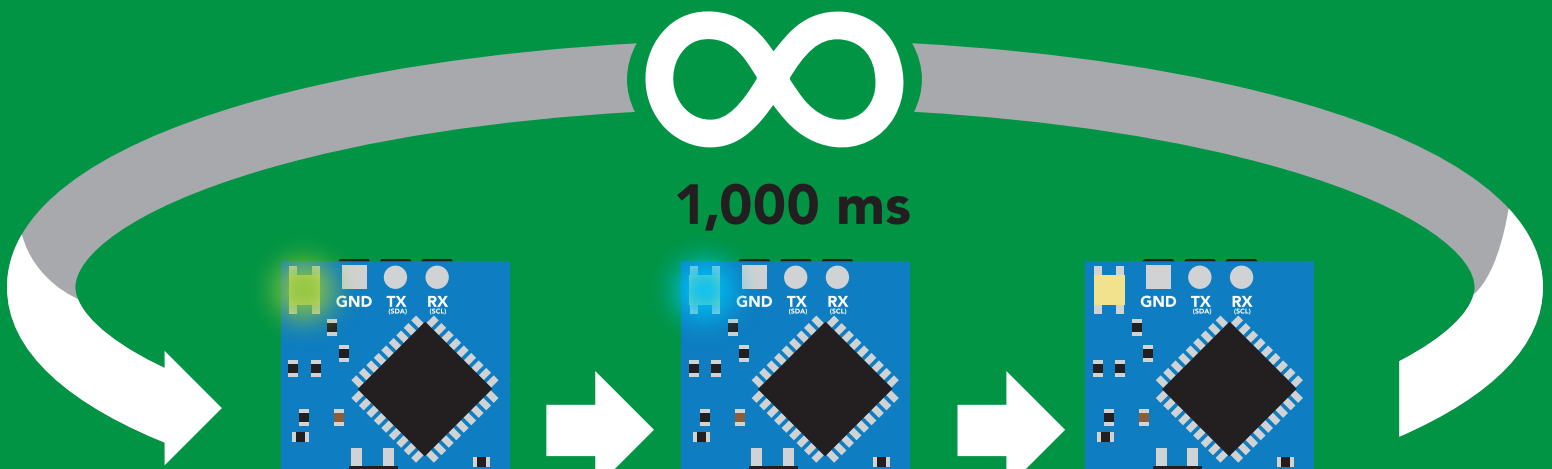
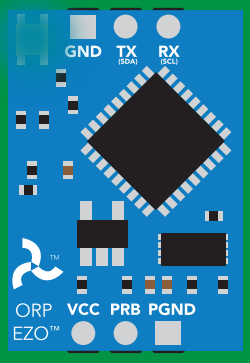
Environmental Robotics

Default state
UART mode

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





Solid Blue LED
in I²C mode
Not UART ready

Atlas Scientific™ Environmental Robotics

UART mode

8 data bits	no parity
1 stop bit	no flow control

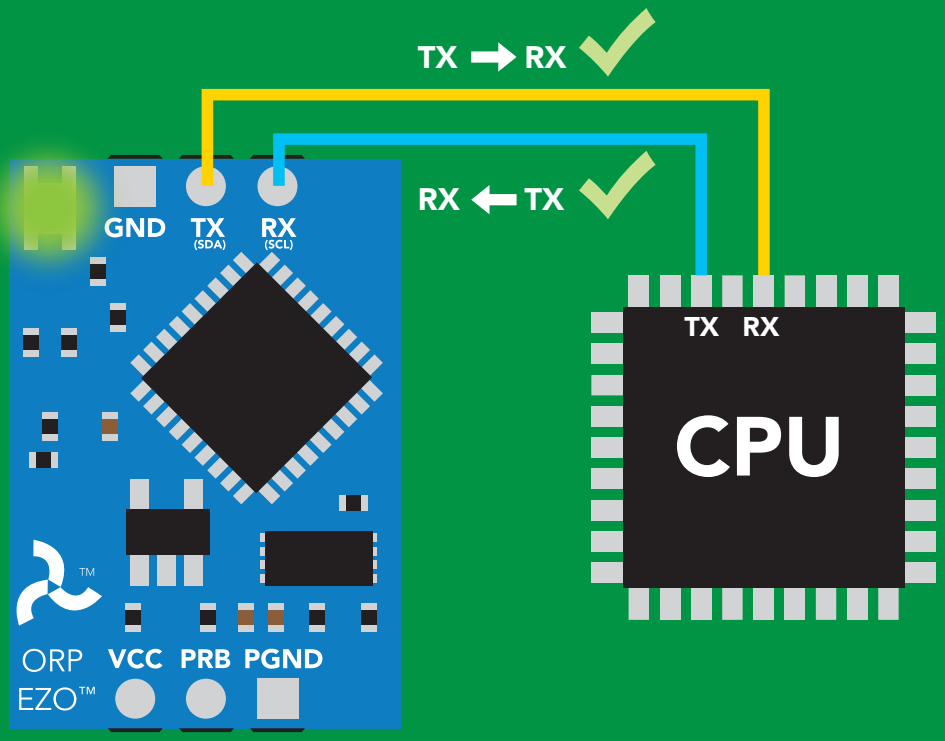
Baud

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

RX
Data in

TX
Data out

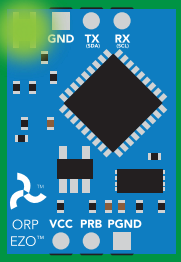
Vcc 3.3V – 5.5V



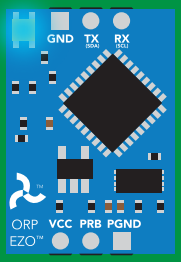
Data format

Reading	**ORP**	**Data type**	**floating point**
Units	**mV**	**Decimal places**	**1**
Encoding	**ASCII**	**Smallest string**	**2 characters**
Format	**string**	**Largest string**	**40 characters**
Terminator	**carriage return**		

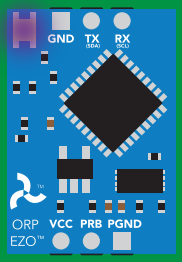
LED color definition



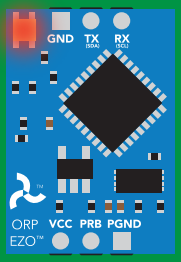
Green
UART standby



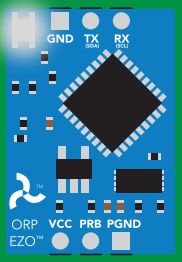
Cyan
Taking reading



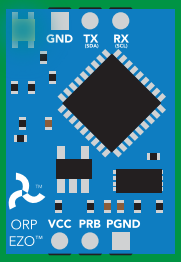
Purple
Changing baud rate



Red
Command not understood



White
Find



Blue
I2C standby

	LED ON
5V	**+2.2 mA**
3.3V	**+0.6 mA**

Settings that are retained if power is cut

Baud rate
Calibration
Continuous mode
Device name
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

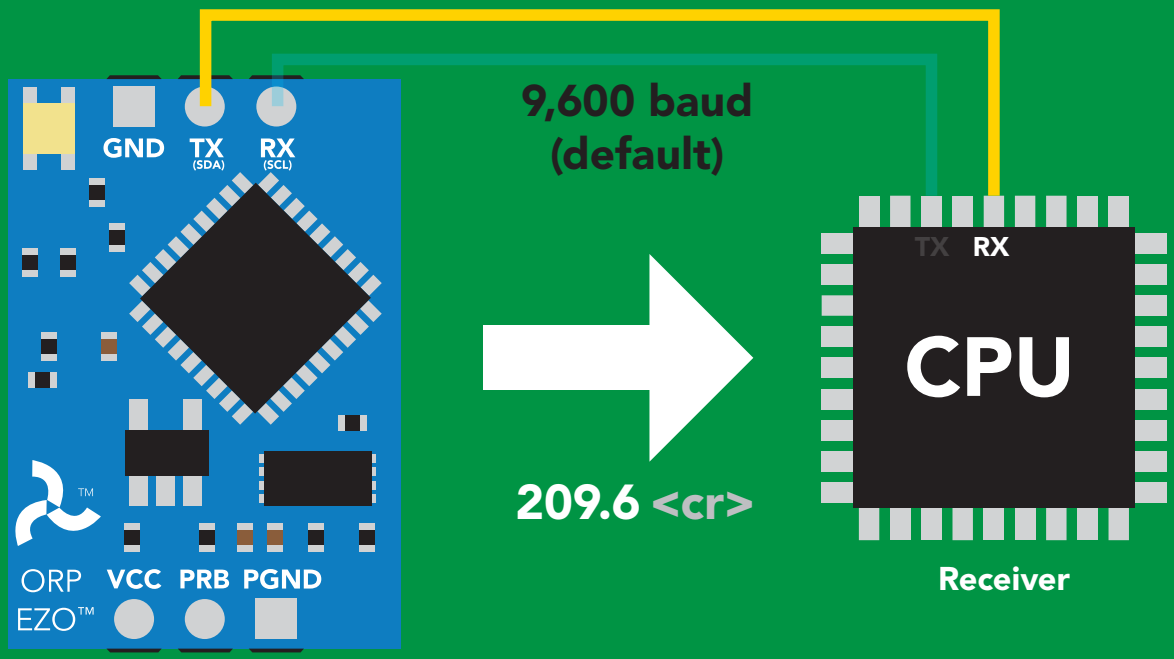
Find
Sleep mode

Receiving data from device

2 parts

ASCII data string
Command

Carriage return <cr>
Terminator



Advanced

ASCII:	2	0	9	.	6	<cr>
Hex:	32	30	39	2E	36	0D
Dec:	50	48	57	46	54	13

Sending commands to device

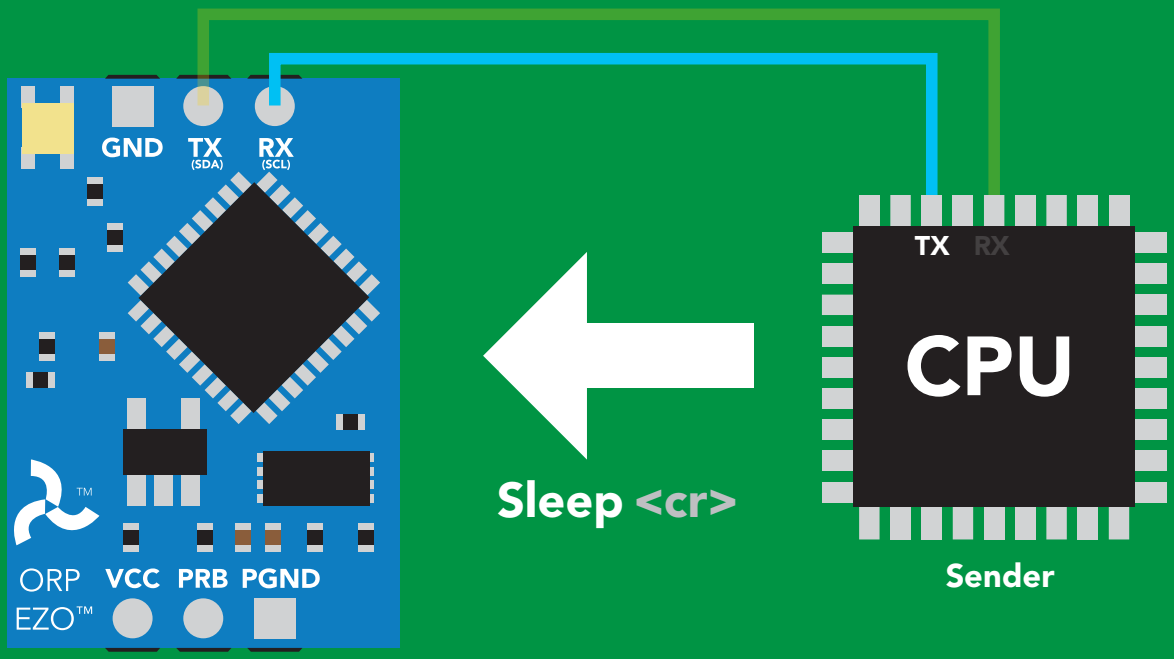
2 parts

Command (not case sensitive)

ASCII data string

Carriage return <cr>

Terminator



Advanced

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

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UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function		Default state
Baud	change baud rate	pg. 30	9,600
C	enable/disable continuous reading	pg. 19	enabled
Cal	performs calibration	pg. 21	n/a
Export	export calibration	pg. 22	n/a
Factory	enable factory reset	pg. 32	n/a
Find	finds device with blinking white LED	pg. 18	n/a
i	device information	pg. 26	n/a
I2C	change to I²C mode	pg. 33	not set
Import	import calibration	pg. 23	n/a
L	enable/disable LED	pg. 17	enabled
Name	set/show name of device	pg. 25	not set
ORPext	enable/disable extended ORP scale	pg. 24	disabled
Plock	enable/disable protocol lock	pg. 31	disabled
R	returns a single reading	pg. 20	n/a
Sleep	enter sleep mode/low power	pg. 29	n/a
Status	retrieve status information	pg. 28	n/a
*OK	enable/disable response codes	pg. 27	enable

LED control

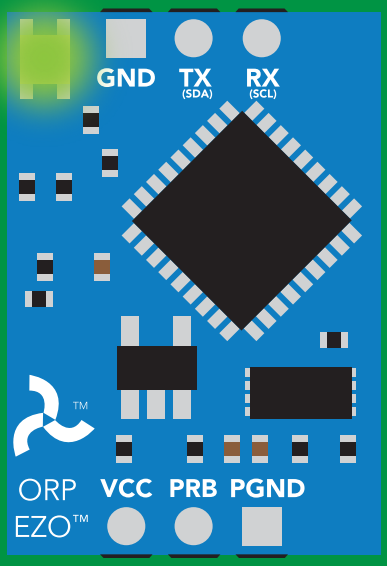
Command syntax

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

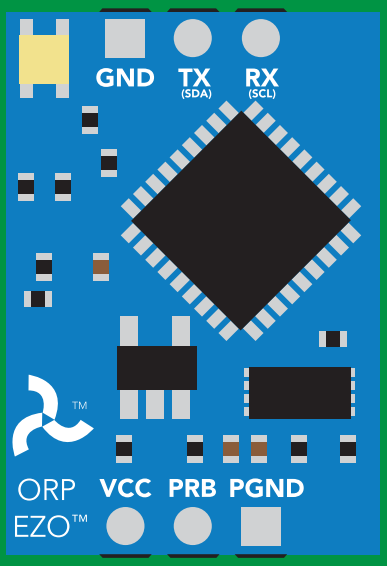
L,0 <cr> LED off

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

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



L,1



L,0

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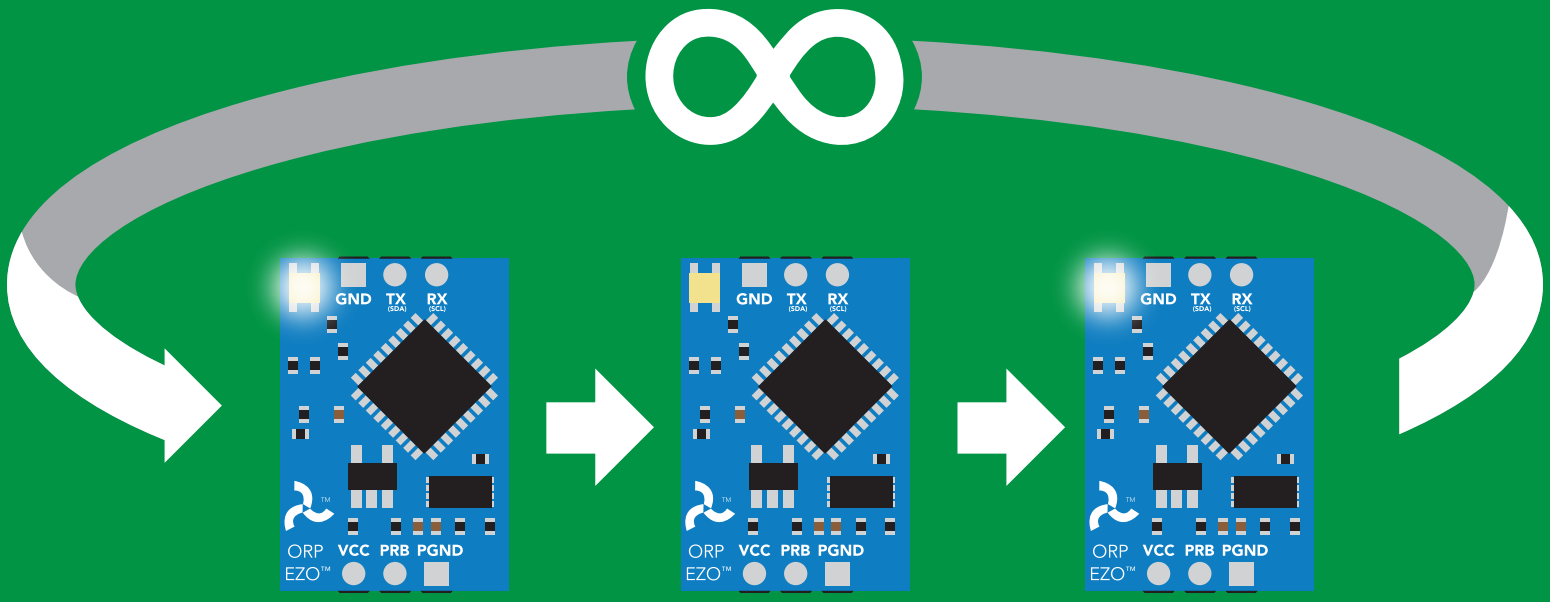
Find

Command syntax

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

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

Example	Response
Find <cr>	*OK <cr>



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?

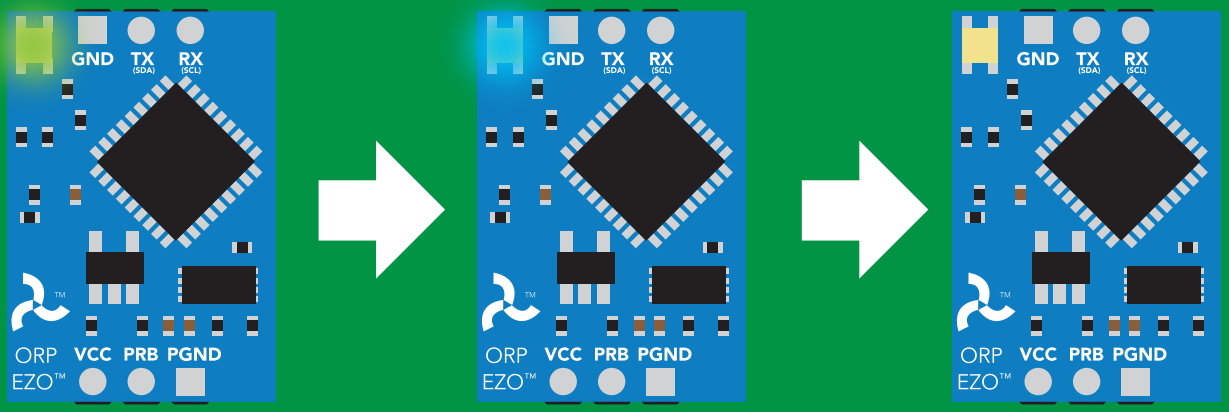
Example	Response
C,1 <cr>	*OK <cr> ORP (1 sec) <cr> ORP (2 sec) <cr> ORP (n sec) <cr>
C,30 <cr>	*OK <cr> ORP (30 sec) <cr> ORP (60 sec) <cr> ORP (90 sec) <cr>
C,0 <cr>	*OK <cr>
C,? <cr>	?C,1 <cr> or ?C,0 <cr> or ?C,30 <cr> *OK <cr>

Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	209.6 <cr> *OK <cr>



Green
Standby

Cyan
Taking reading

Transmitting

800 ms

Calibration

Command syntax

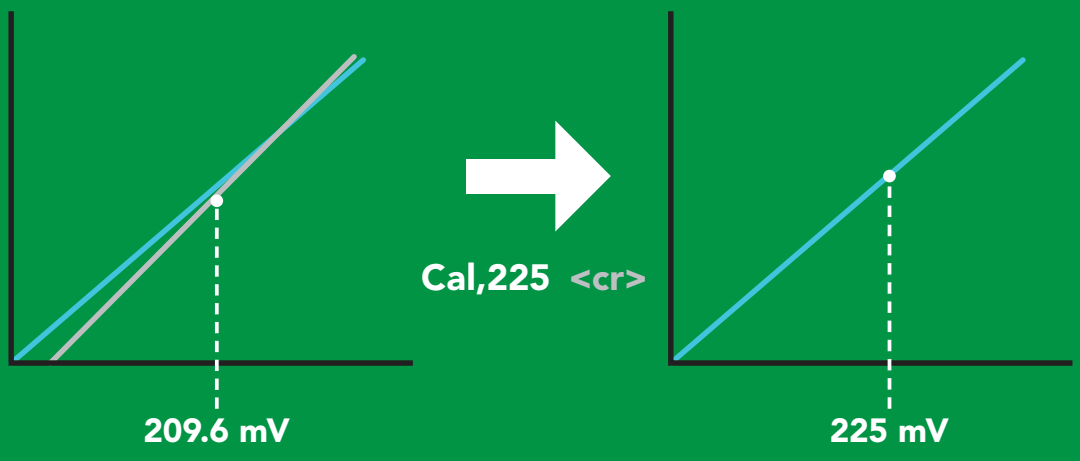
The EZO™ ORP circuit can be calibrated to any known ORP value

Cal,n <cr> calibrates the ORP circuit to a set value

Cal,clear <cr> delete calibration data

Cal,? <cr> device calibrated?

Example	Response
Cal,225 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,0 <cr> or ?Cal,1 <cr> *OK <cr>



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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

Response

Export,? <cr>

10,120 <cr>

Response breakdown

10, **120**

↑ # of strings to export

↑ # of bytes to export

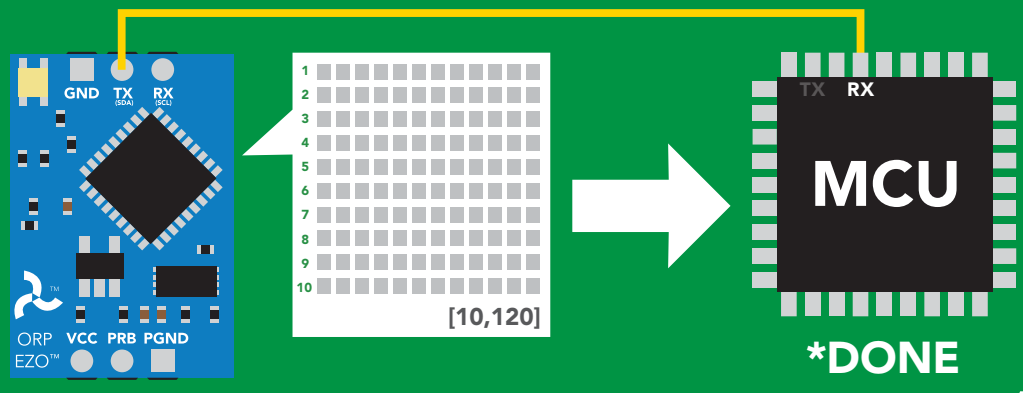
Export strings can be up to 12 characters long, and is always followed by <cr>

Export <cr>
Export <cr>
(7 more)
Export <cr>
Export <cr>

59 6F 75 20 61 72 <cr> **(1 of 10)**
65 20 61 20 63 6F <cr> **(2 of 10)**
⋮
6F 6C 20 67 75 79 <cr> **(10 of 10)**
***DONE**

Disabling *OK simplifies this process

Export <cr>



Atlas Scientific™ Environmental Robotics

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)

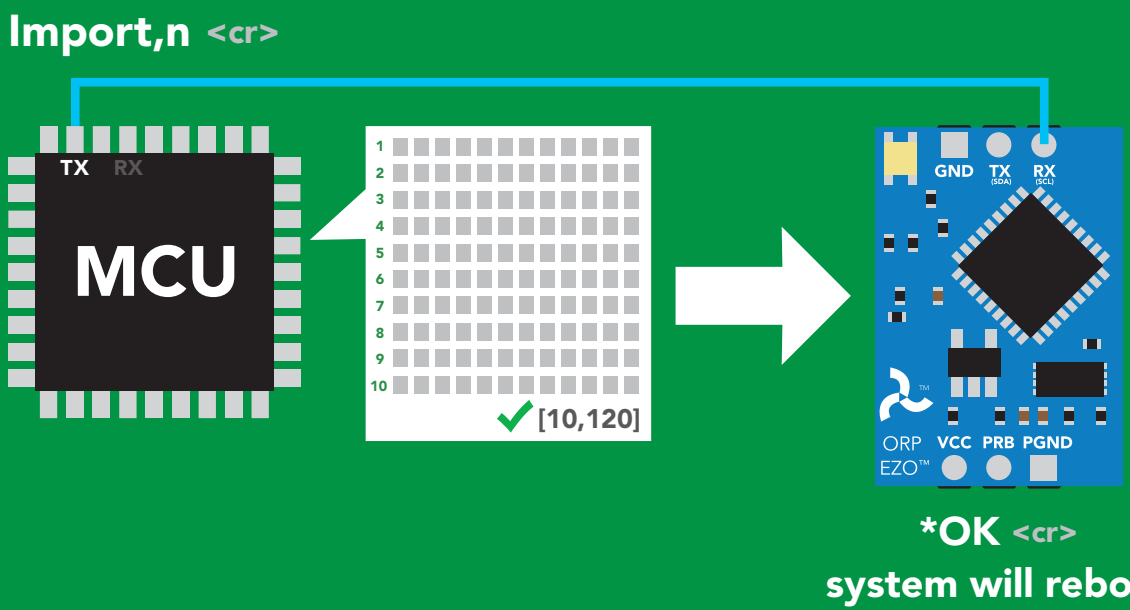
Response

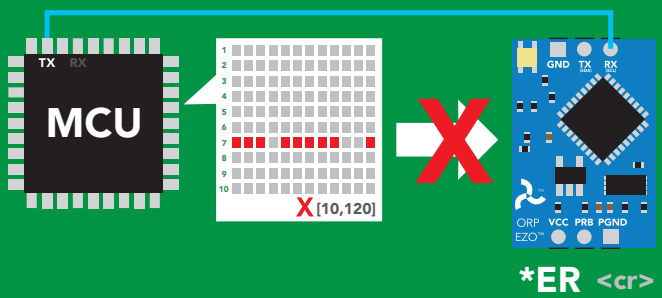
*OK <cr>

*OK <cr>

⋮

*OK <cr>





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

Atlas Scientific™ Environmental Robotics

Extended ORP scale

You must power the EZO-ORP circuit with 5V, to run the Extended ORP scale.

Lowest possible reading: **-2040mV**
Highest possible reading: **2040mV**

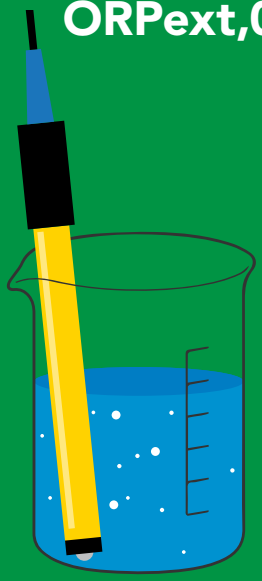
Important: When Extended ORP scale is active, accuracy is reduced to +/– 2mV instead of +/– 1mV.

Command syntax

ORPext,0	<cr>	extended ORP scale off (-1020mV – 10120mV)	default
ORPext,1	<cr>	extended ORP scale on (-2040mV – 2040mV)	
ORPext,?	<cr>	extended ORP scale on/off?	

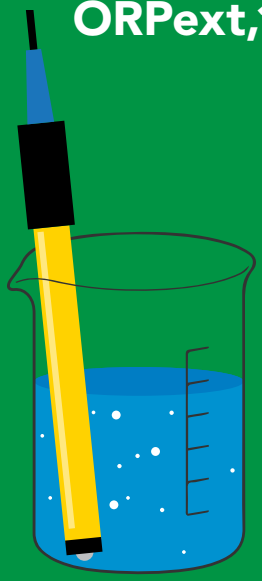
Example	Response
ORPext,1 <cr>	*OK <cr>
ORPext,0 <cr>	*OK <cr>
ORPext,? <cr>	?ORPext,1 <cr> or ?ORPext,0 <cr>

ORPext,0



ORP = -1020mV

ORPext,1



ORP = -2040mV

Naming device

Command syntax

Do not use spaces in the name

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

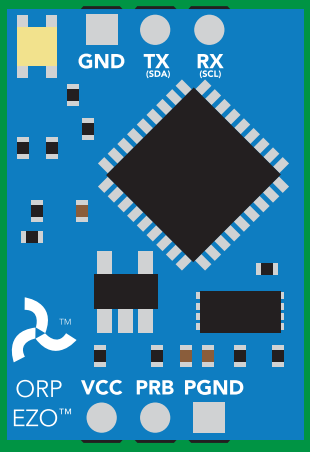
n =

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

Up to 16 ASCII characters

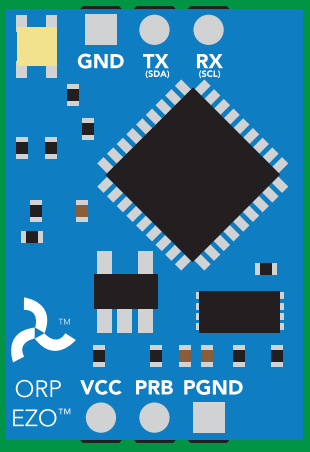
Example		Response	
Name,	<cr>	*OK <cr>	name has been cleared
Name,zzt	<cr>	*OK <cr>	
Name,?	<cr>	?Name,zzt <cr> *OK <cr>	

Name,zzt



*OK <cr>

Name,?



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

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Device information

Command syntax

i <cr> **device information**

Example	Response
i <cr>	**?i,ORP,1.97** <cr> ***OK** <cr>

Response breakdown

?i, ORP, 1.97

ORP, ↑ Device

1.97 ↑ 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>	209.6 <cr> *OK <cr>
*OK,0 <cr>	no response, *OK disabled
R <cr>	209.6 <cr> *OK disabled
*OK,? <cr>	?*OK,1 <cr> or ?*OK,0 <cr>

Other response codes

*ER	unknown command
*OV	over volt (VCC>=5.5V)
*UV	under volt (VCC<=3.1V)
*RS	reset
*RE	boot up complete, ready
*SL	entering sleep mode
*WA	wake up

These response codes cannot be disabled

Reading device status

Command syntax

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

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

Response breakdown

?Status, P, 5.038

- P: Reason for restart
- 5.038: Voltage at Vcc

Restart codes

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

Sleep mode/low power

Command syntax

Send any character or command to awaken device.

Sleep <cr> enter sleep mode/low power

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

	STANDBY	SLEEP
5V	16 mA	1.16 mA
3.3V	13.9 mA	0.995 mA

Standby
16 mA

Sleep
1.16 mA

Atlas Scientific™ Environmental Robotics

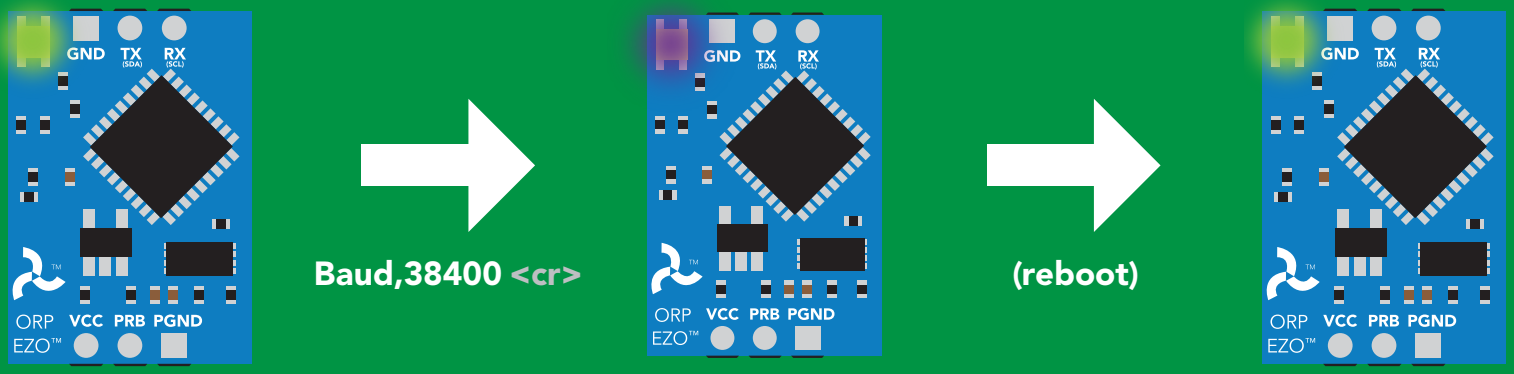
Change baud rate

Command syntax

Baud,n <cr> change baud rate

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

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



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Protocol lock

Command syntax

Locks device to UART mode.

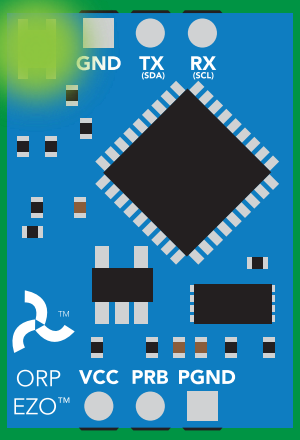
Plock,1 <cr> enable Plock

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

Plock,? <cr> Plock on/off?

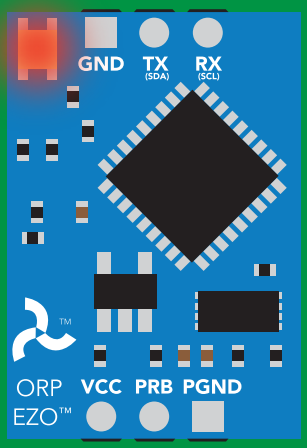
Example	Response
Plock,1 <cr>	*OK <cr>
Plock,0 <cr>	*OK <cr>
Plock,? <cr>	?Plock,1 <cr> or ?Plock,0 <cr>

Plock,1



*OK <cr>

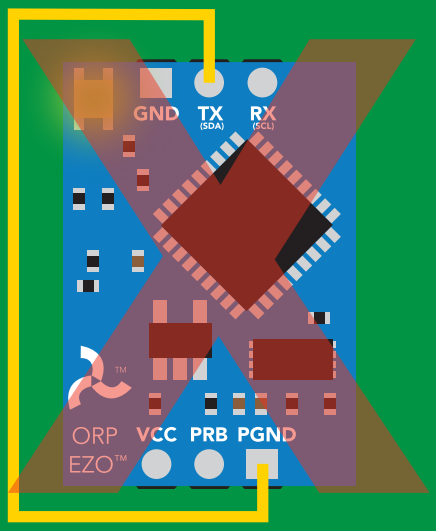
I2C,100



cannot change to I²C

*ER <cr>

Short



cannot change to I²C

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Factory reset

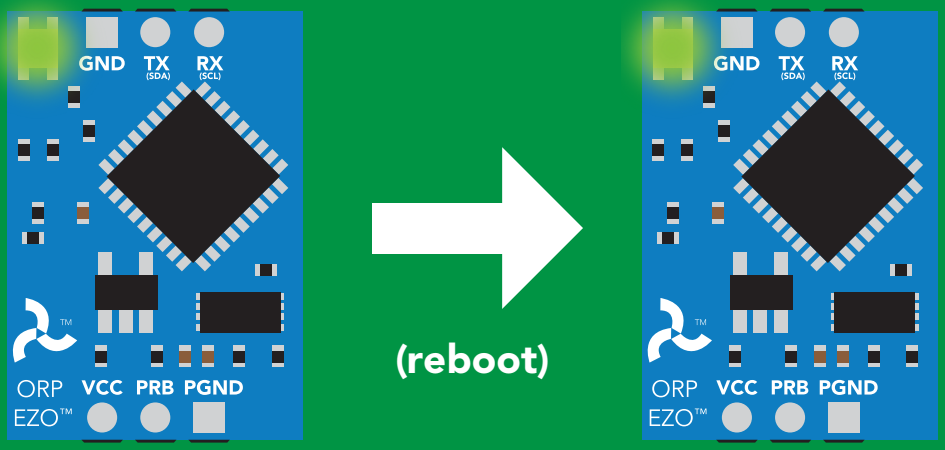
Command syntax

Clears calibration LED on "*OK" enabled

Factory <cr> enable factory reset

Example	Response
Factory <cr>	*OK <cr>

Factory <cr>



*OK <cr>

*RS <cr>
*RE <cr>

Baud rate will not change

Change to I²C mode

Command syntax

Default I²C address 98 (0x62)

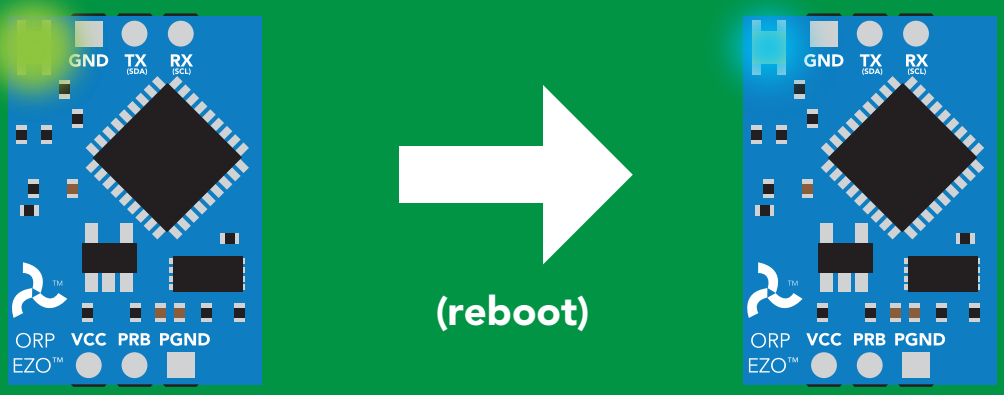
I2C,n <cr> sets I²C address and reboots into I²C mode

n = any number 1 – 127

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

Wrong example	Response
I2C,139 <cr> n ≯ 127	*ER <cr>

I2C,100



Green
*OK <cr>

Blue
now in I²C mode

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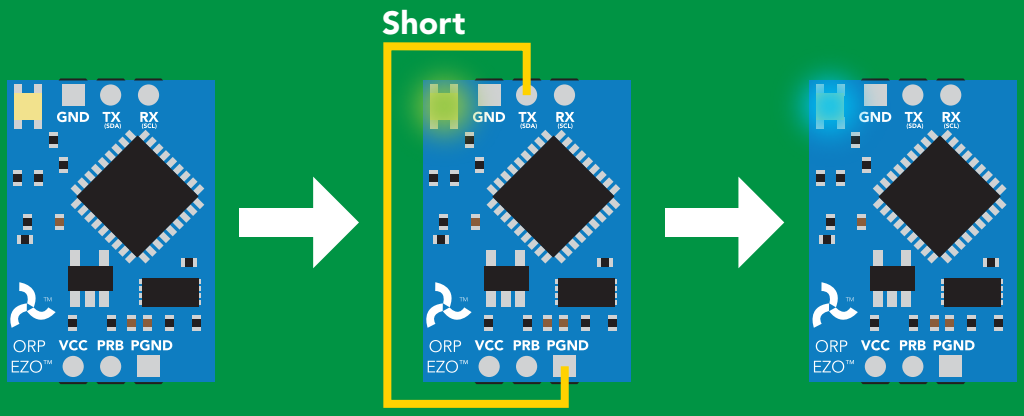
Manual switching to I²C

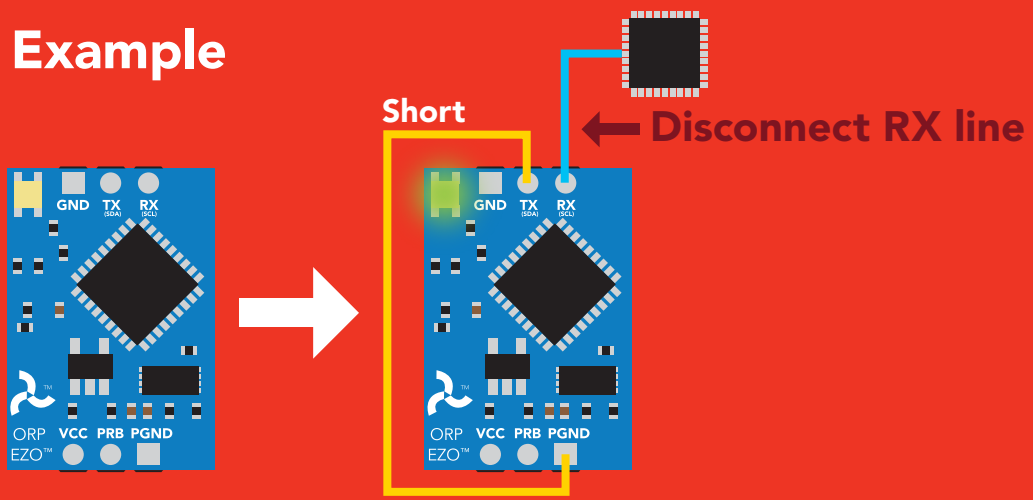
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PGND
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Green to Blue
- Disconnect ground (power off)
- Reconnect all data and power

Manually switching to I²C will set the I²C address to 98 (0x62)

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
Hardware switch to UART mode
LED control
Protocol lock
Software switch to UART mode

Settings that are *NOT* retained if power is cut

Find
Sleep mode

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I²C mode

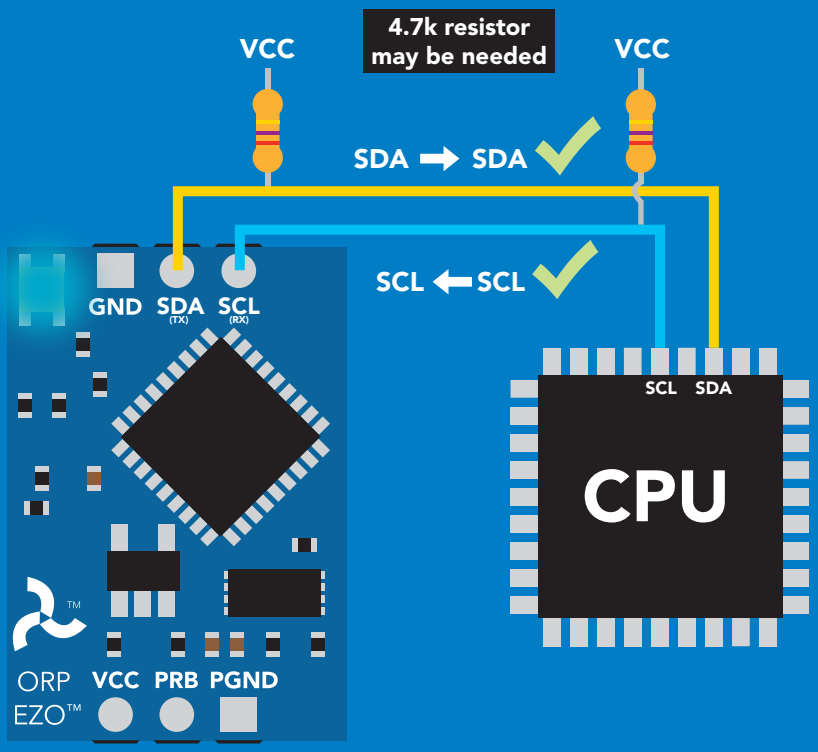
I²C address (0x01 – 0x7F)
98 (0x62) default

Vcc 3.3V – 5.5V

Clock speed 100 – 400 kHz

SDA

SCL



Data format

Reading	**ORP**	**Data type**	**floating point**
Units	**mV**	**Decimal places**	**1**
Encoding	**ASCII**	**Smallest string**	**2 characters**
Format	**string**	**Largest string**	**40 characters**

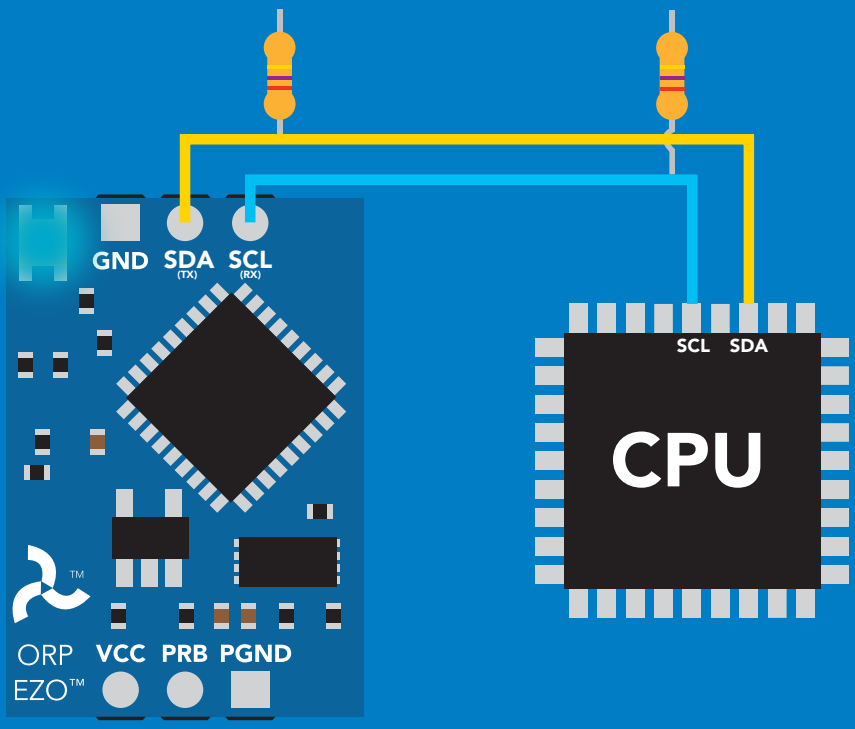
Sending commands to device

5 parts

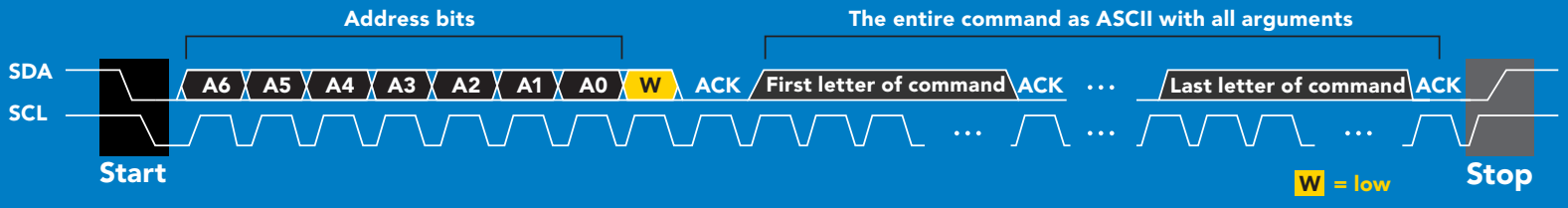
Start	I²C address	Write	Command (not case sensitive)	Stop
	98 (0x62)		ASCII command string	

Example

Start	98 (0x62)	Write	Sleep	Stop
	I²C address		Command	



Advanced



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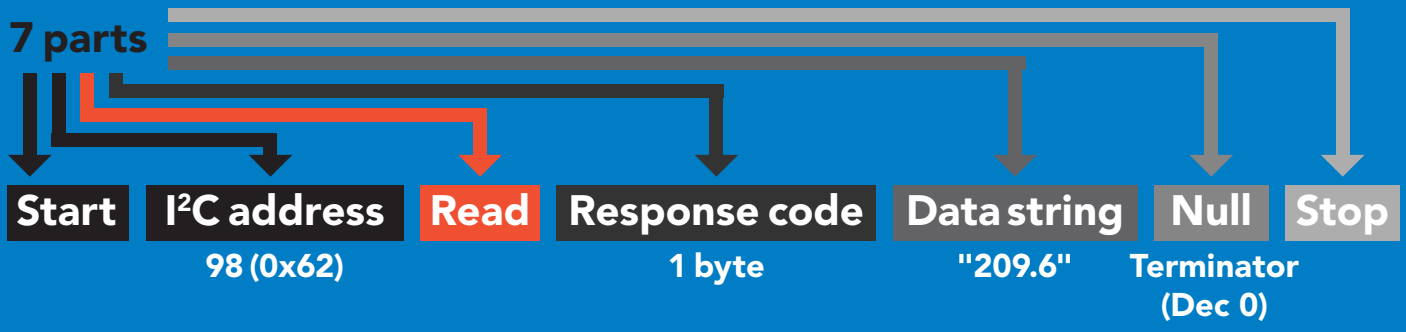
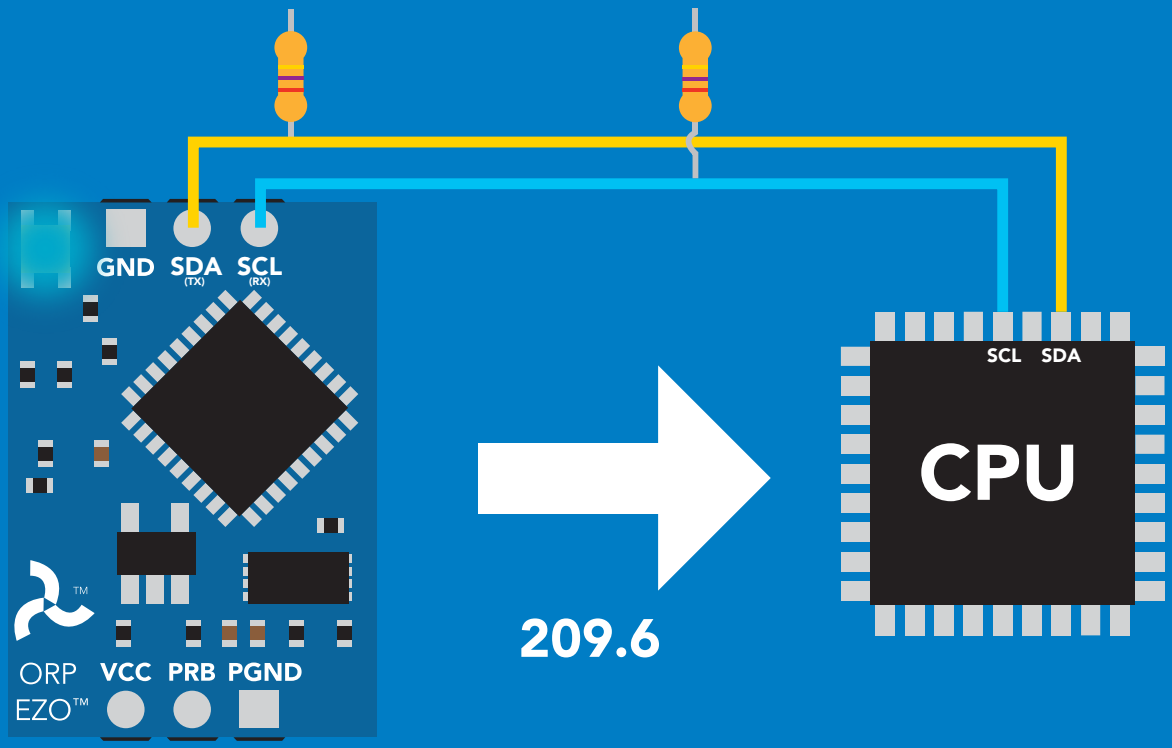
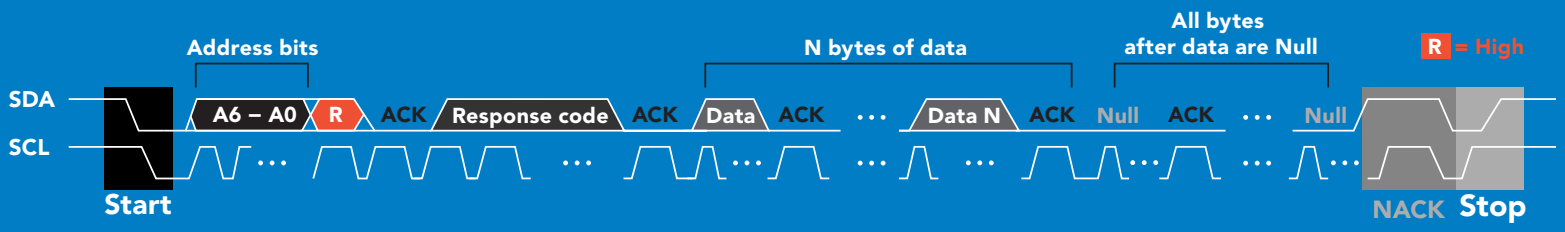
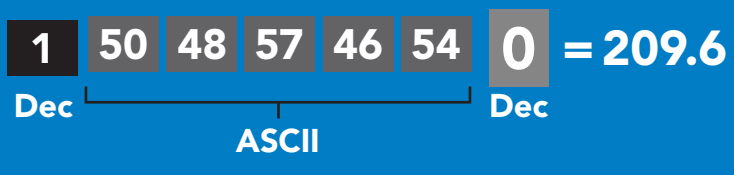
Requesting data from device





Advanced





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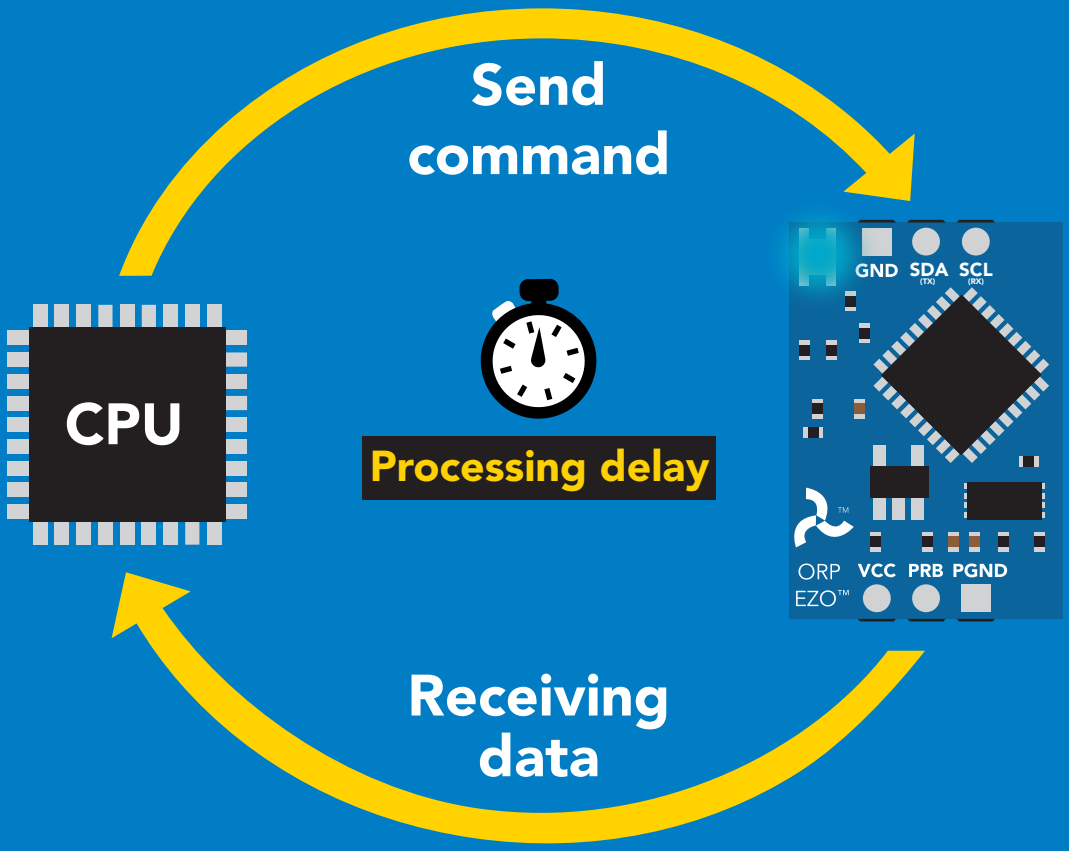
Response codes

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

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



Example

```
I2C_start;
I2C_address;
I2C_write(EZO_command);
I2C_stop;

delay(300);   Processing delay

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

If there is no processing delay or the processing delay is too short, the response code will always be 254.

Response codes

Single byte, not string

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

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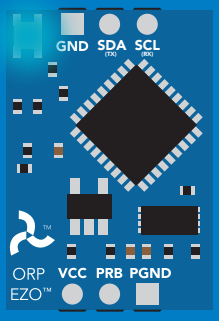
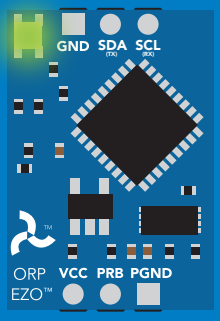
LED color definition



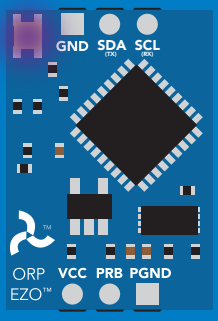
Blue

I²C standby



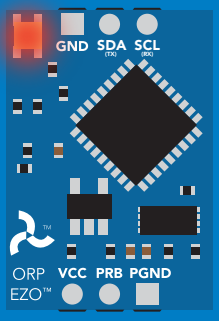
Green

Taking reading



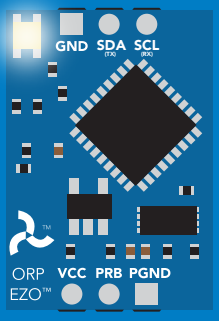
Purple

Changing I²C address



Red

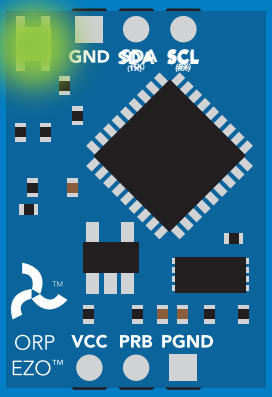
Command not understood



White

Find

	LED ON
5V	**+2.2 mA**
3.3V	**+0.6 mA**



Solid Green LED

in UART mode
Not I²C ready

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I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 56
Cal	performs calibration	pg. 45
Export	export calibration	pg. 46
Factory	enable factory reset	pg. 55
Find	finds device with blinking white LED	pg. 43
i	device information	pg. 50
I2C	change I²C address	pg. 54
Import	import calibration	pg. 47
L	enable/disable LED	pg. 42
Name	set/show name of device	pg. 49
ORPext	enable/disable extended ORP scale	pg. 48
Plock	enable/disable protocol lock	pg. 53
R	returns a single reading	pg. 44
Sleep	enter sleep mode/low power	pg. 52
Status	retrieve status information	pg. 51

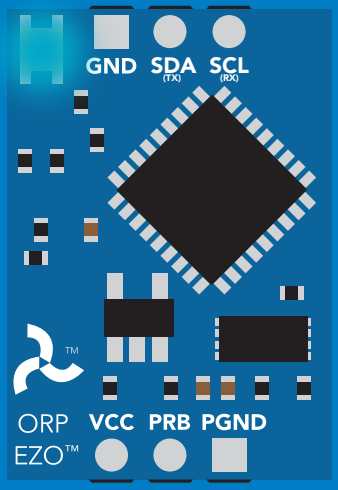
LED control

Command syntax

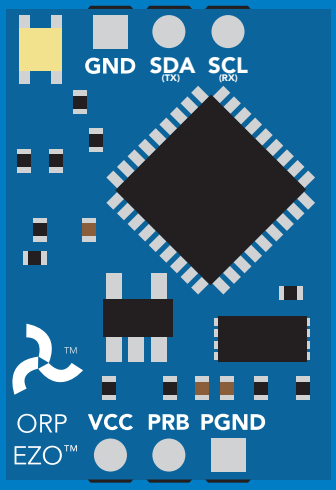
300ms processing delay

L,1	LED on	default
L,0	LED off	
L,?	LED state on/off?	

Example	Response
L,1	Wait 300ms → 1 (Dec) 0 (Null)
L,0	Wait 300ms → 1 (Dec) 0 (Null)
L,?	Wait 300ms → 1 (Dec) ?L,1 (ASCII) 0 (Null) or 1 (Dec) ?L,0 (ASCII) 0 (Null)



L,1



L,0

Atlas Scientific Environmental Robotics

Find

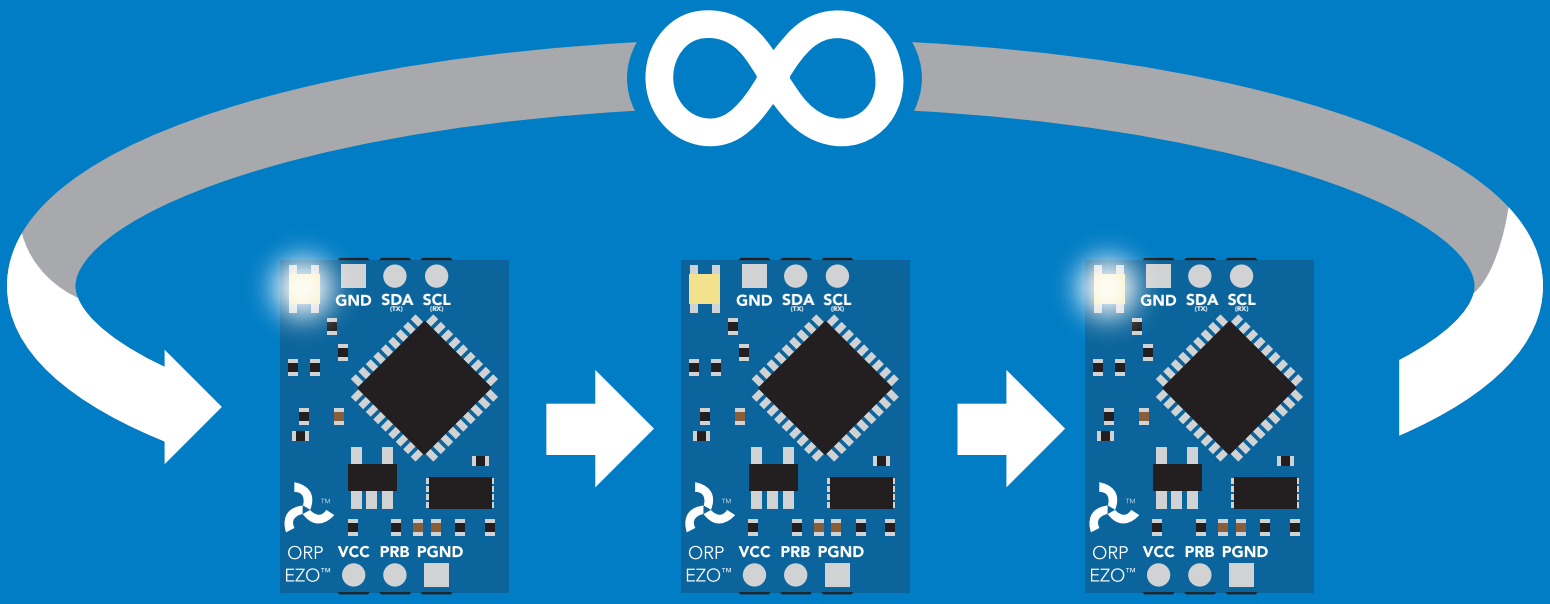
300ms processing delay

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



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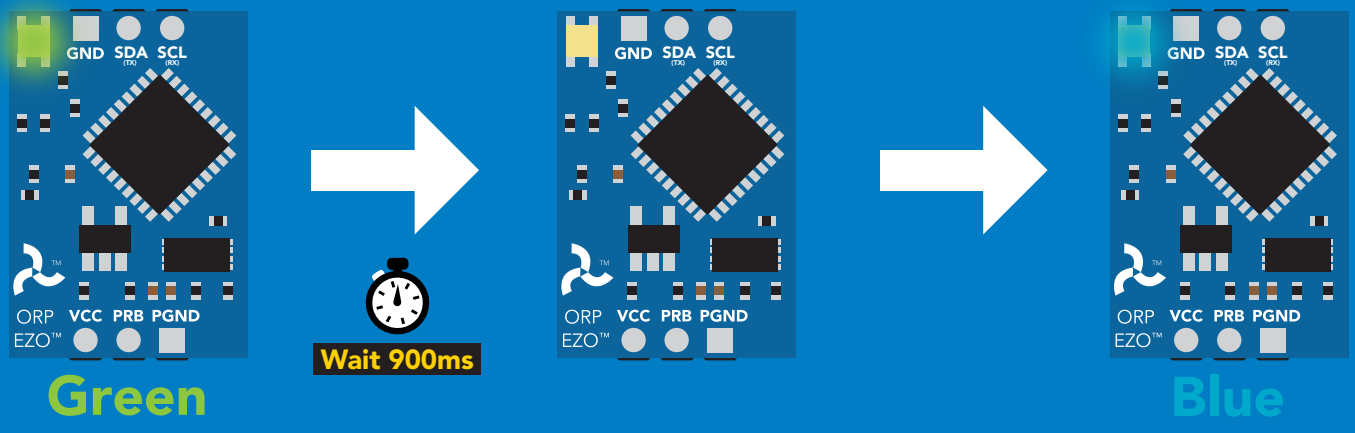
Taking reading

Command syntax

900ms processing delay

R return 1 reading

Example	Response
R	Wait 900ms 1 Dec 209.6 ASCII 0 Null



Calibration

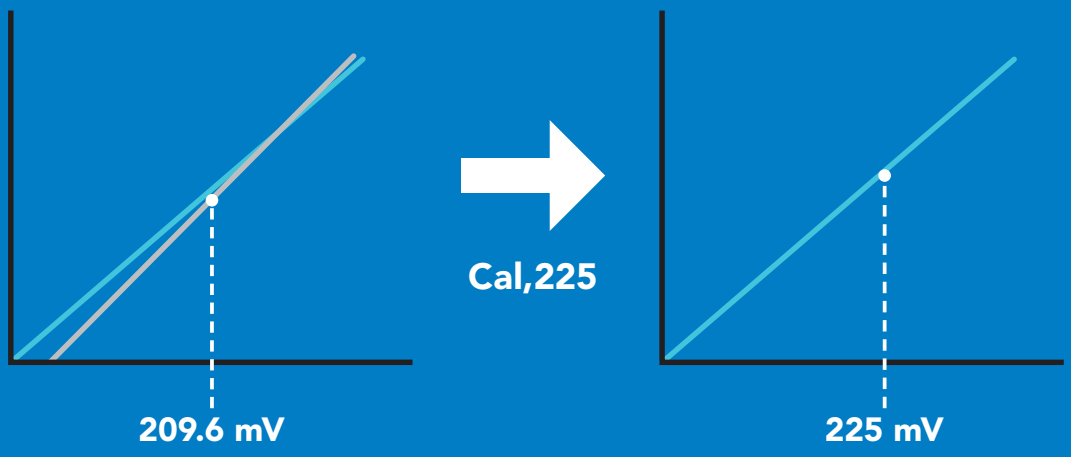
Command syntax

900ms processing delay

Cal,n	calibrates the ORP circuit to a set value
Cal,clear	delete calibration data
Cal,?	device calibrated?

The EZO™ ORP circuit can be calibrated to any known ORP value

Example	Response
Cal,225	Wait 900ms → 1 (Dec) 0 (Null)
Cal,clear	Wait 300ms → 1 (Dec) 0 (Null)
Cal,?	Wait 300ms → 1 (Dec) ?Cal,0 (ASCII) 0 (Null) or 1 (Dec) ?Cal,1 (ASCII) 0 (Null)



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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

Response

(optional)
Export,?

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

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

(1 of 10)

Export

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

(2 of 10)

(7 more)

Export

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

(10 of 10)

Export

1	*DONE	0
Dec	ASCII	Null

Atlas Scientific™ Environmental Robotics

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

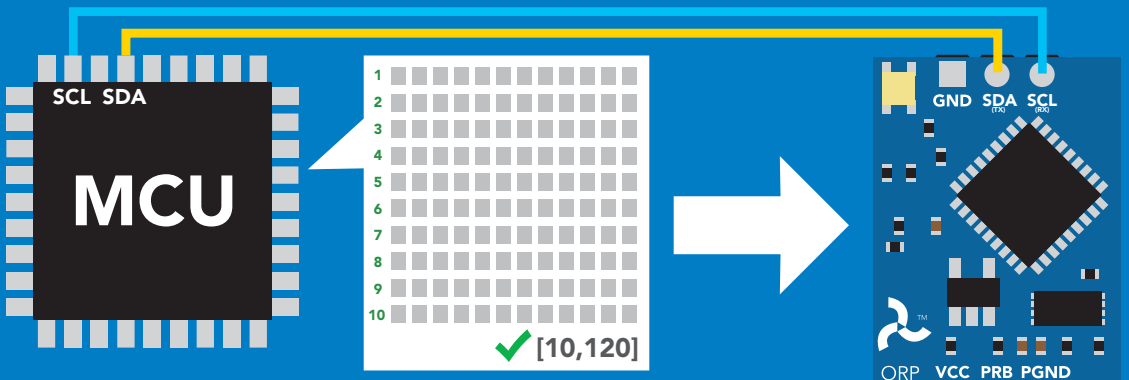
Wait 300ms | 1 Dec | 0 Null

Wait 300ms | 1 Dec | 0 Null

⋮

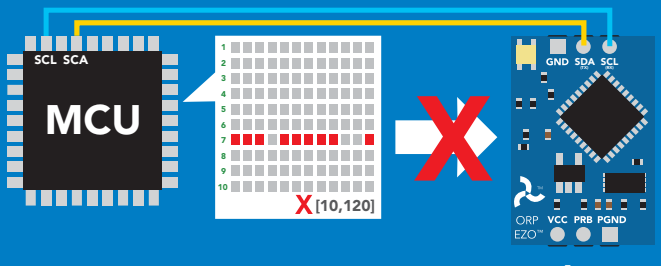
Wait 300ms | 1 Dec | 0 Null

Import,n



1 Dec | *Pending ASCII | 0 Null

system will reboot



reboot

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

Atlas Scientific Environmental Robotics

Extended ORP scale

300ms processing delay

You must power the EZO-ORP circuit with 5V, to run the Extended ORP scale.

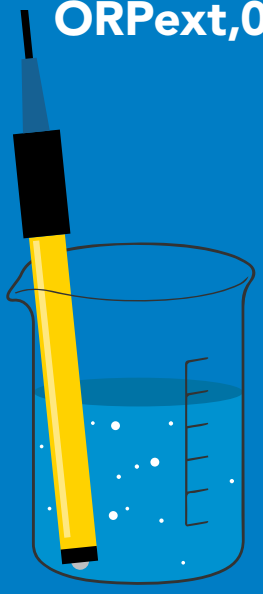
Lowest possible reading: **-2040mV**
Highest possible reading: **2040mV**

Important: When Extended ORP scale is active, accuracy is reduced to +/– 2mV instead of +/– 1mV.

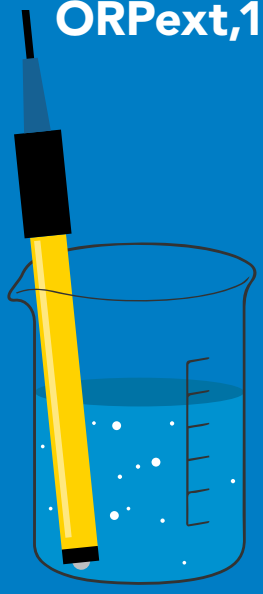
Command syntax

ORPext,0	extended ORP scale off (-1020mV – 10120mV)	default
ORPext,1	extended ORP scale on (-2040mV – 2040mV)	
ORPext,?	extended ORP scale on/off?	

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



ORP = -1020mV



ORP = -2040mV

Atlas Scientific Environmental Robotics

Naming device

300ms processing delay

Command syntax

Do not use spaces in the name

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

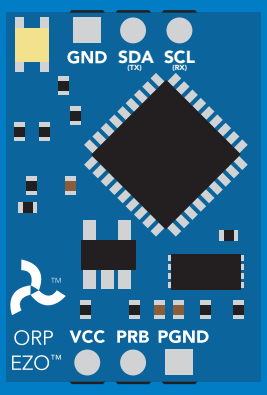
n = _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

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

Up to 16 ASCII characters

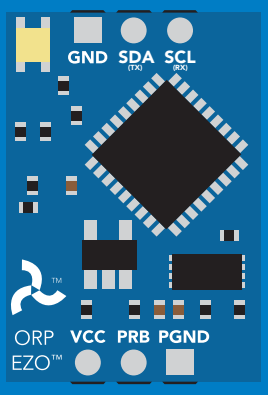
Example	Response
Name,	Wait 300ms — 1 (Dec) 0 (Null) — name has been cleared
Name,zzt	Wait 300ms — 1 (Dec) 0 (Null)
Name,?	Wait 300ms — 1 (Dec) ?Name,zzt (ASCII) 0 (Null)

Name,zzt



1 0

Name,?



1 ?Name,zzt 0

Atlas Scientific™ Environmental Robotics

Device information

Command syntax

300ms processing delay

i device information

Example

i

Response

1 Dec | **?i,ORP, 19.7** ASCII | **0** Null

Response breakdown

?i, ORP, 1.97

ORP, ↑ Device

1.97 ↑ Firmware

Atlas Scientific™ Environmental Robotics

Reading device status

Command syntax

300ms processing delay

Status voltage at Vcc pin and reason for last restart

Example

Status

Response

Wait 300ms

1	?Status,P,5.038	0
Dec	ASCII	Null

Response breakdown

?Status, P, 5.038

P, ↑ Reason for restart

5.038 ↑ Voltage at Vcc

Restart codes

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

Atlas Scientific Environmental Robotics

Sleep mode/low power

Command syntax

Sleep	enter sleep mode/low power

Send any character or command to awaken device.

Example	Response
Sleep	no response
Any command	wakes up device

Do not read status byte after issuing sleep command.

	STANDBY	SLEEP
5V	16 mA	1.16 mA
3.3V	13.9 mA	0.995 mA

Standby

Sleep

Atlas Scientific™ Environmental Robotics

Protocol lock

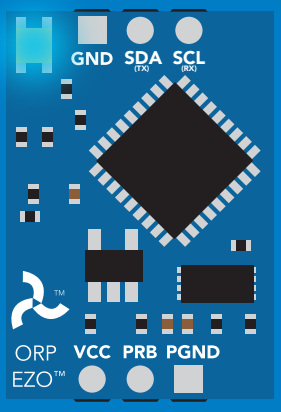
Command syntax

300ms processing delay

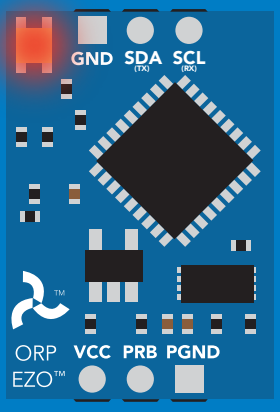
Plock,1	enable Plock	Locks device to I²C mode.
Plock,0	disable Plock	default
Plock,?	Plock on/off?	

Example	Response
Plock,1	Wait 300ms — 1 Dec — 0 Null
Plock,0	Wait 300ms — 1 Dec — 0 Null
Plock,?	Wait 300ms — 1 Dec — ?Plock,1 ASCII — 0 Null

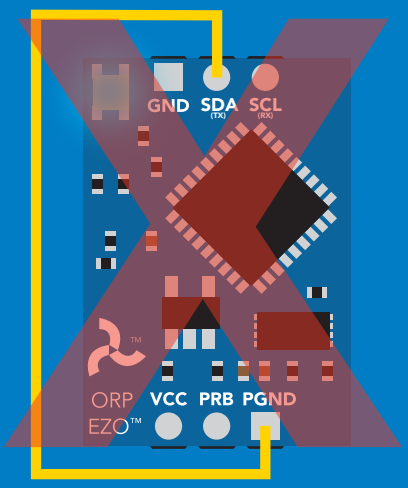
Plock,1



Baud, 9600



cannot change to UART



cannot change to UART

Atlas Scientific™ Environmental Robotics

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)

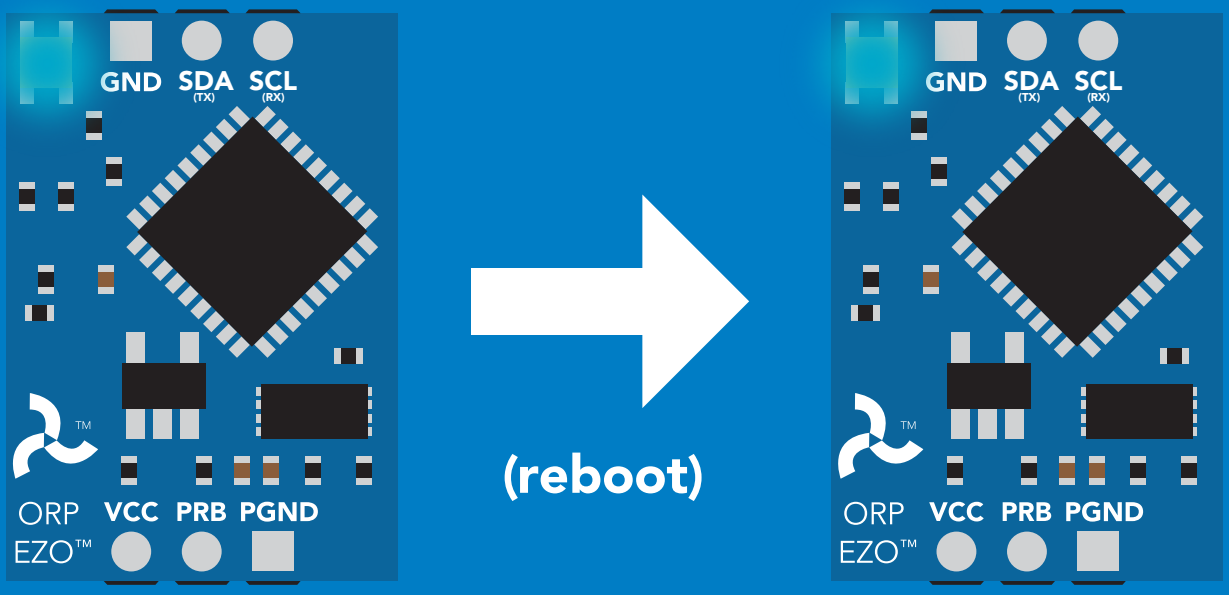
n = any number 1 – 127

Warning!

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

Default I²C address is 98 (0x62).

I2C,100



Atlas Scientific™ Environmental Robotics

Factory reset

Command syntax

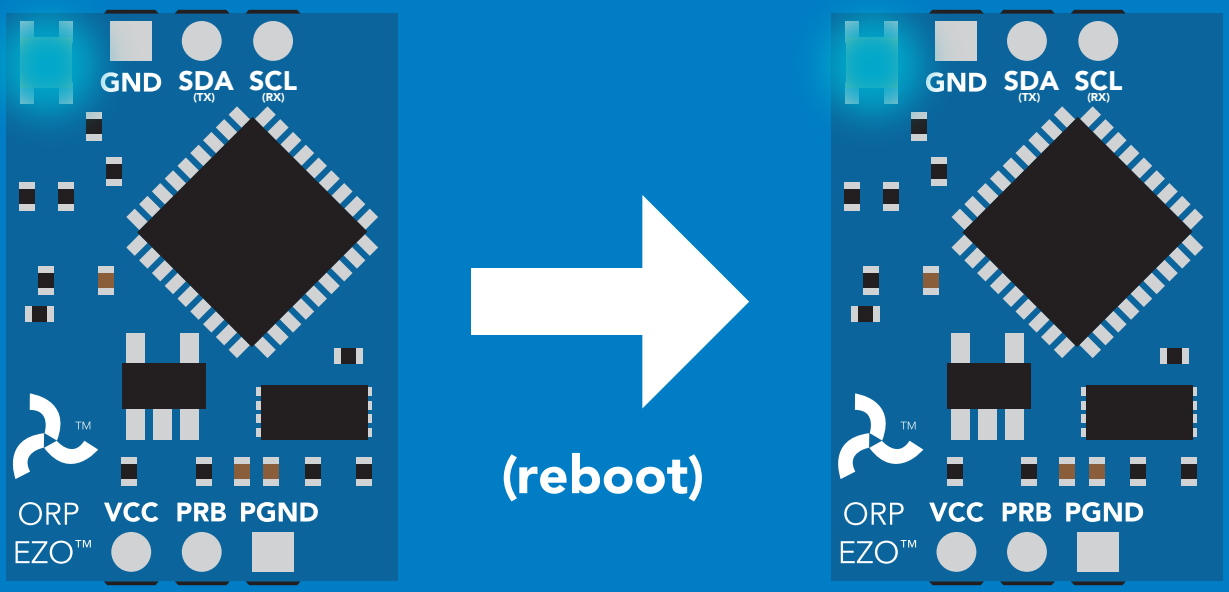
Factory reset will not take the device out of I²C mode.

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



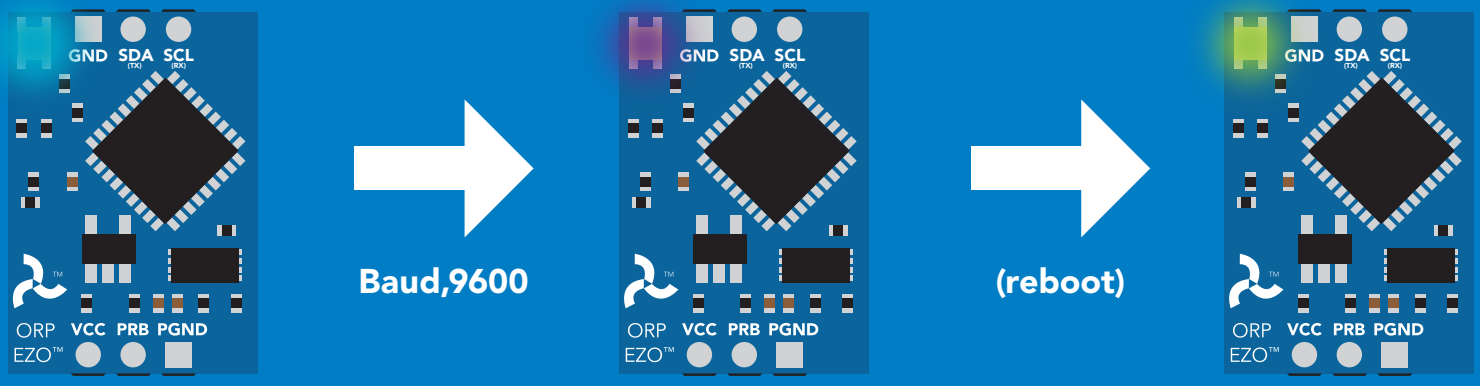
Change to UART mode

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



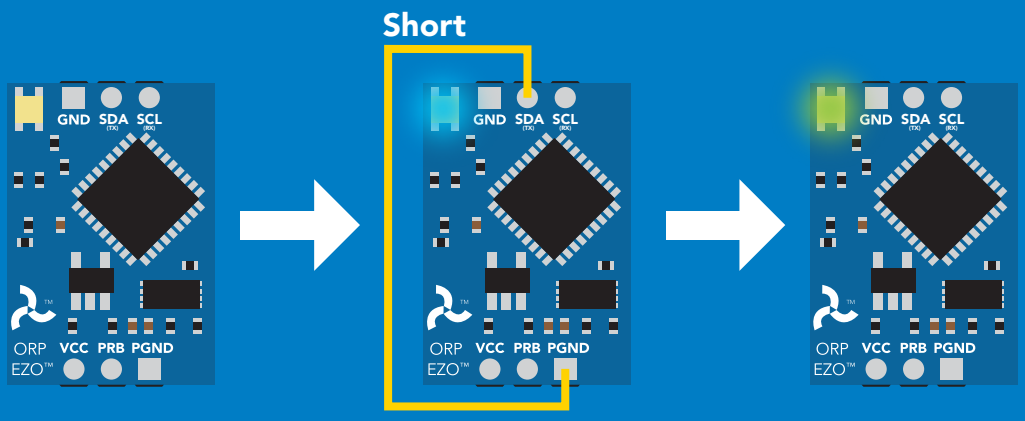
Changing to UART mode

Atlas Scientific™ Environmental Robotics

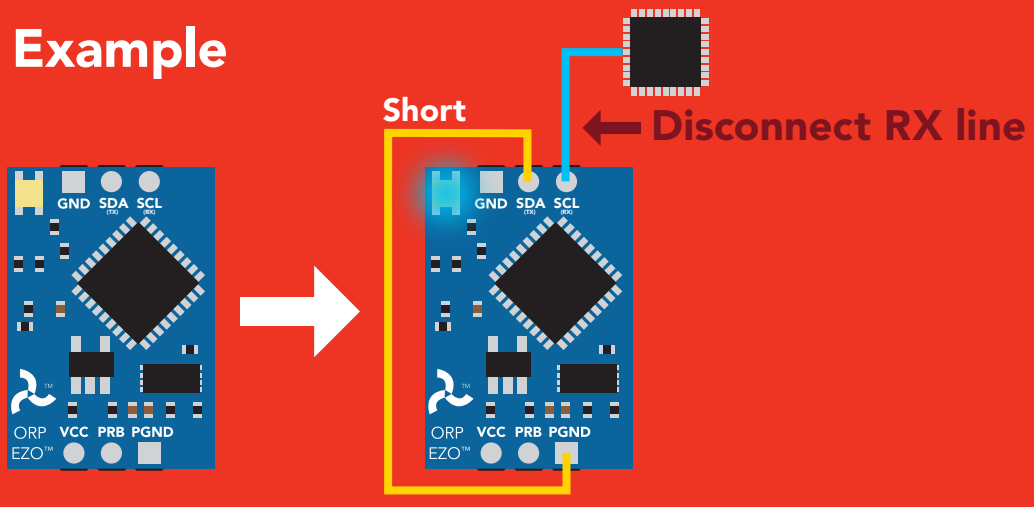
Manual switching to UART

- 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



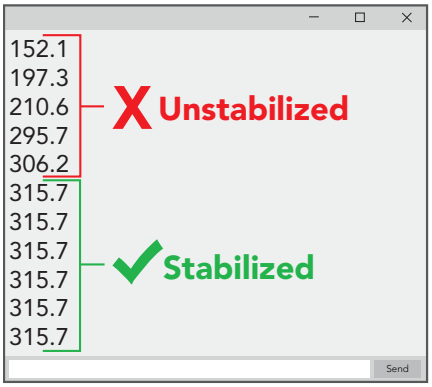
Calibration theory

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).

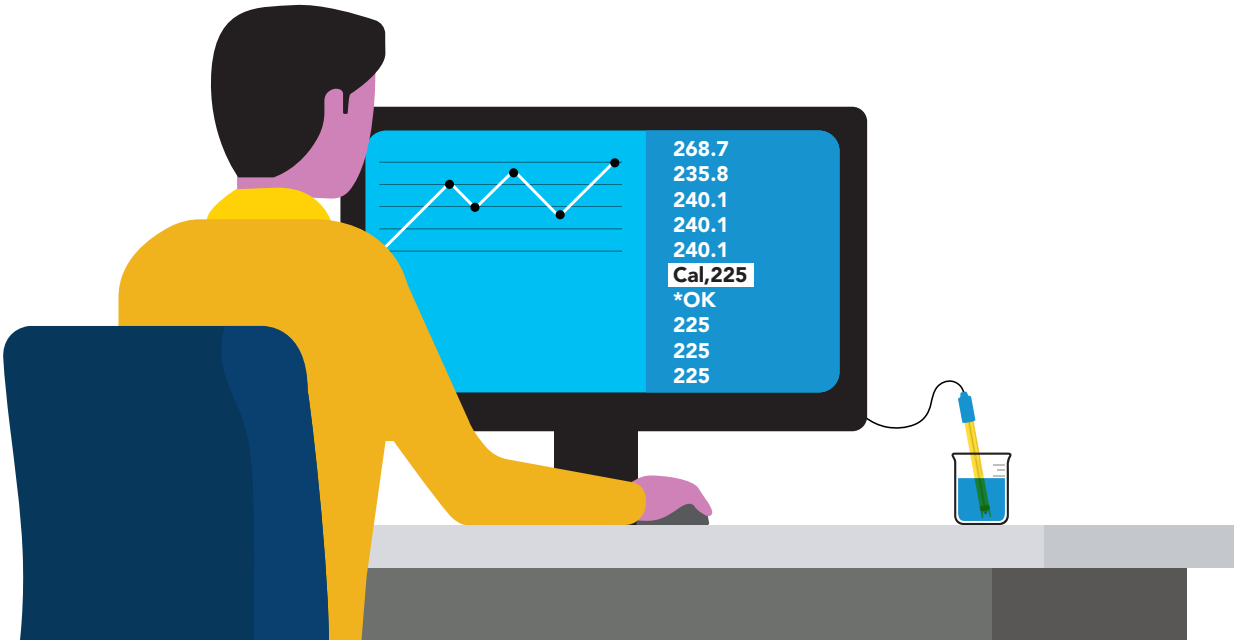
Switching the device to I²C mode after calibration ***will not*** affect the stored calibration. If the device must be calibrated in I²C mode be sure to ***continuously request readings*** so you can see the output from the probe.

The Atlas Scientific EZO™ ORP circuit has a flexible calibration protocol, allowing single point calibration to ***any off the shelf calibration solution.***

However, If this is your first time calibrating the EZO™ ORP circuit, Atlas Scientific recommends using the 225mv calibration solution.

Best practices for calibration

Always watch the readings throughout the calibration process.
Issue calibration commands once the readings have stabilized.

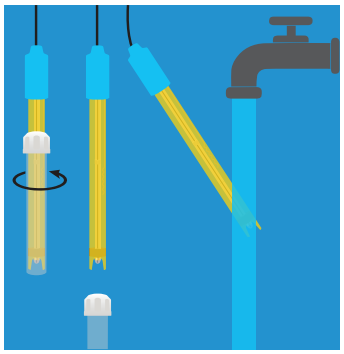


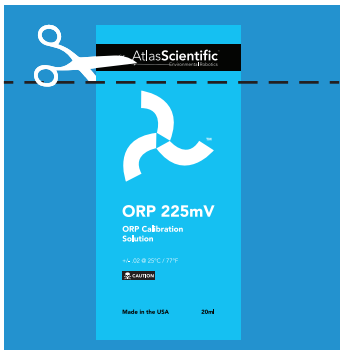
⚠ Never do a blind calibration! ⚠

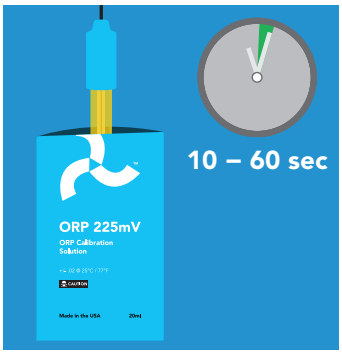
Issuing a calibration command before the readings stabilize will result in drifting readings.

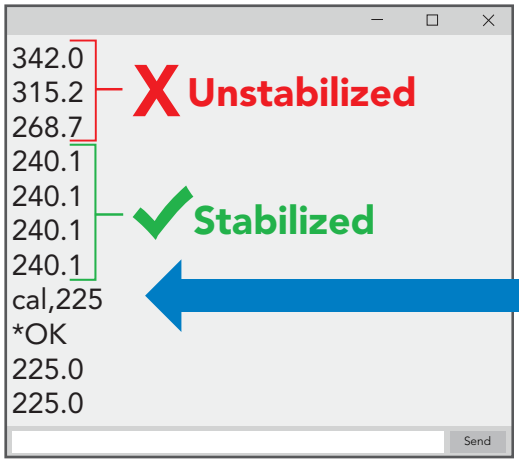
Single point calibration

Remove the soaker bottle and rinse off the ORP probe. Remove the top of the **ORP 225mV** calibration solution pouch. Insert the ORP probe directly into the pouch, and let the probe sit in the calibration solution until the readings stabilize *(small movement from one reading to the next is normal)*.









Once the readings have stabilized, issue the calibration command. In this case **"cal,225"**

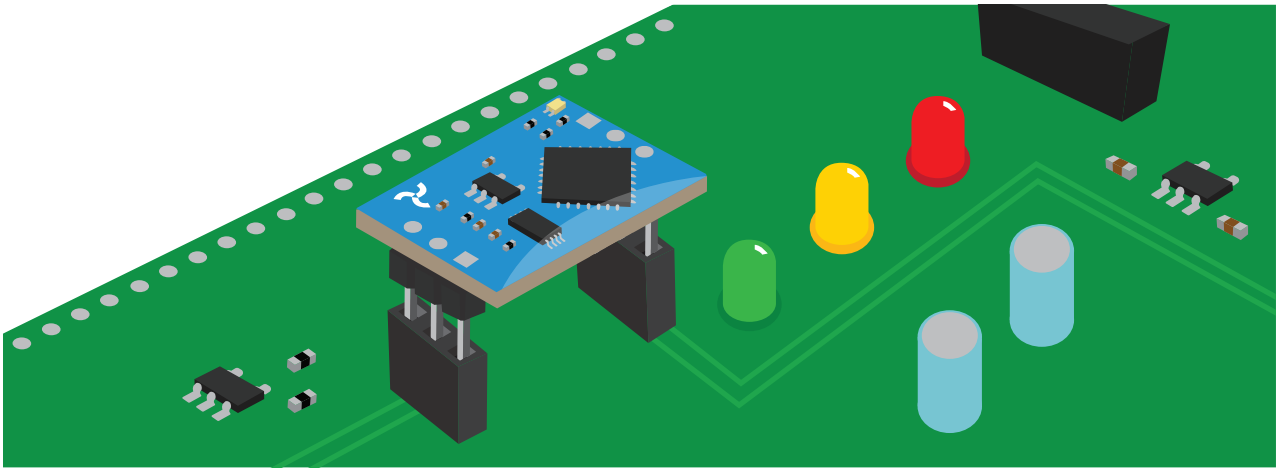
Calibration should be done at least once per year

If the ORP that's being read is continuously on the extremes of the scale *(~ -900mV or +900mV)* calibration may have to be done more often. The exact frequency of calibration will have to be determined by your engineering team.

Soldering

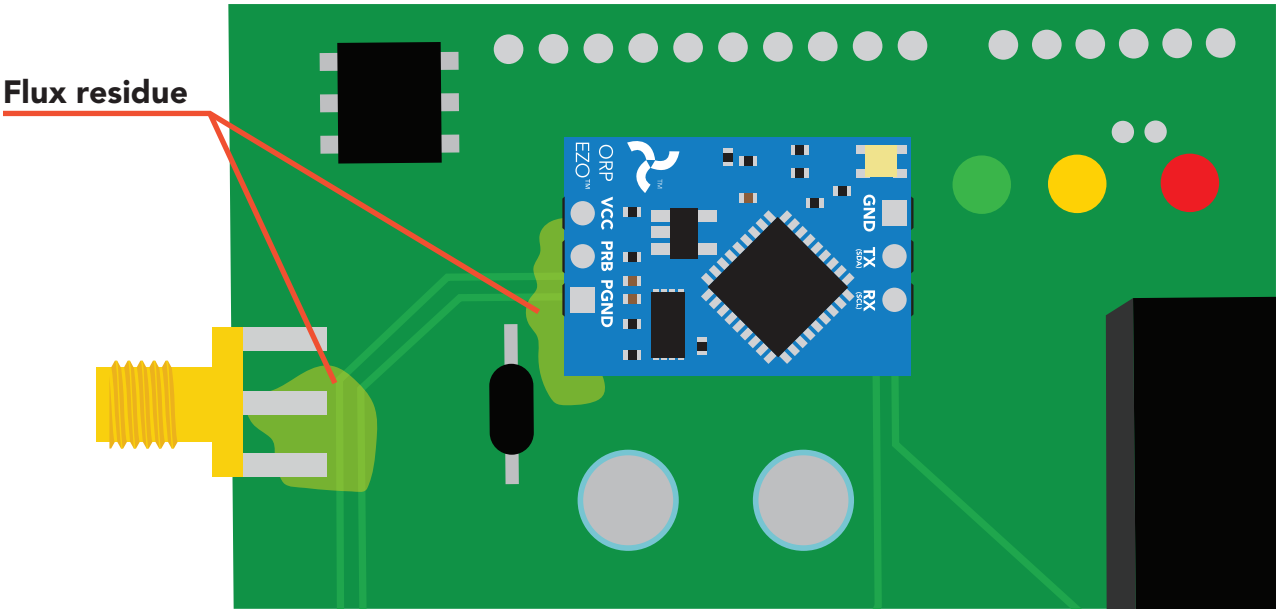
Do not directly solder an EZO circuit to your PCB. If something goes wrong during the soldering process it may become impossible to correct the problem. It is simply not worth the risk.

Instead, solder female header pins to your PCB and place the EZO device in the female headers.



Avoid using rosin core solder.
Use as little flux as possible.

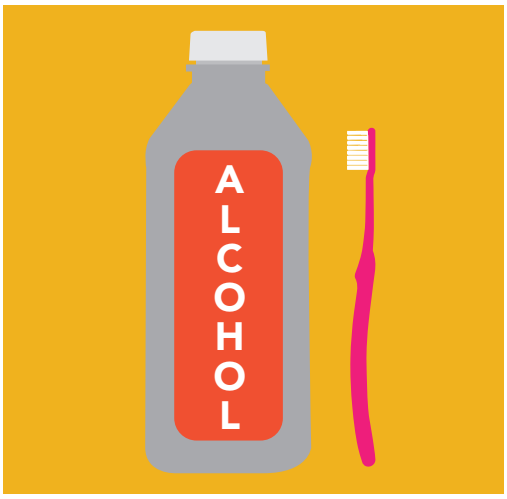
Flux residue will severely affect your readings. Any Flux residue that comes in contact with the PRB pins or your probes connector will cause a "flux short".

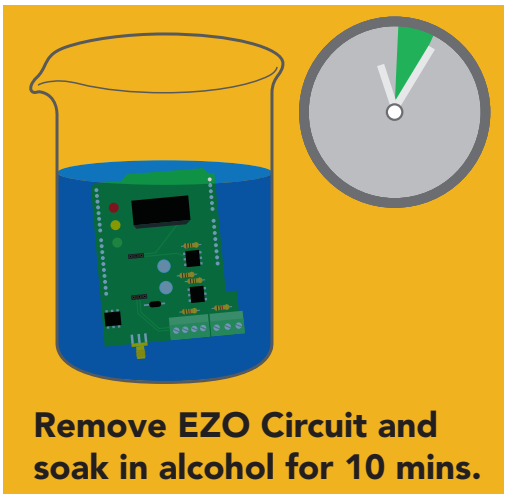


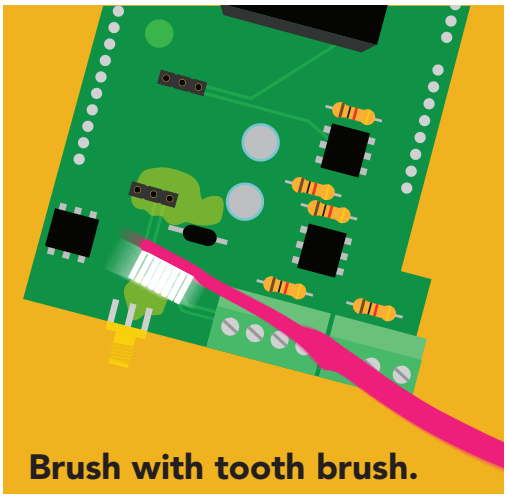
You ***MUST*** remove all the flux residue from your PCB after soldering.

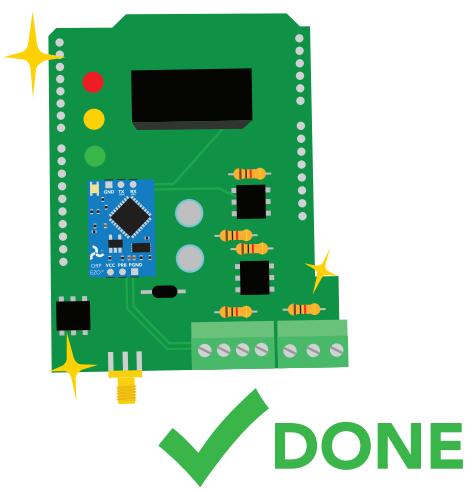
Soldering

Removing flux residue can be done with commercially available products such as flux off or you can use alcohol and a tooth brush.





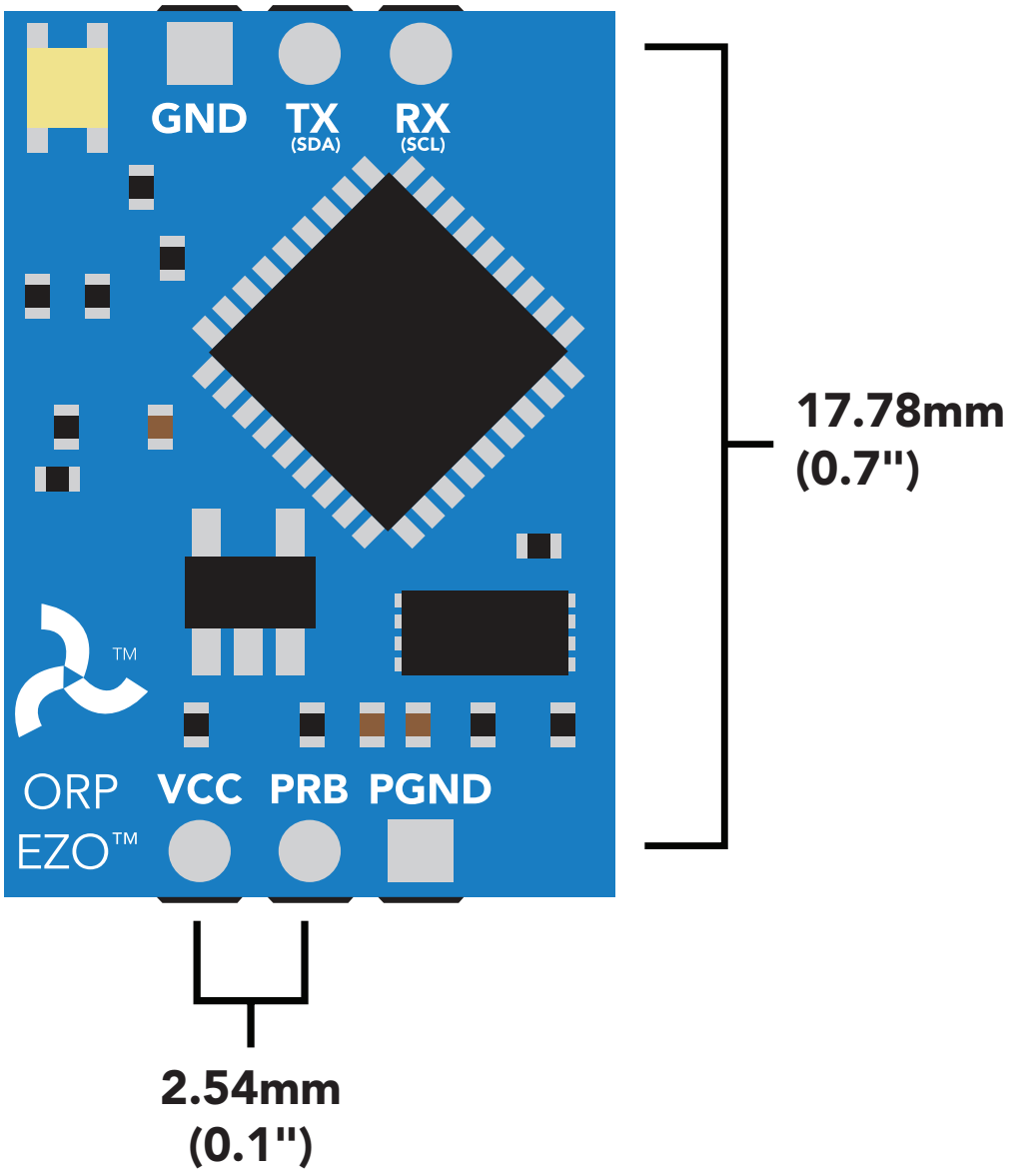




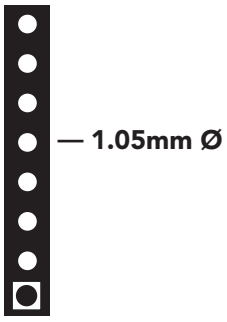
What does a flux short look like?

Readings move slowly and take serval minutes to reach the correct value.

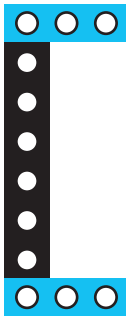
EZO™ circuit footprint



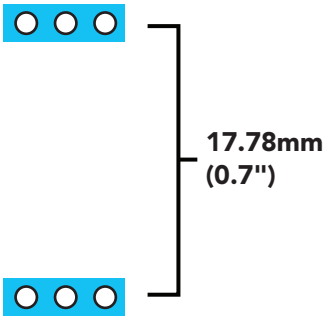
1 In your CAD software place a 8 position header.



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



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



AtlasScientific™
Environmental Robotics

Datasheet change log

Datasheet V 5.2

Added Extended ORP scale on pages 24 & 48.

Datasheet V 5.1

Added information for soldering on page 59.

Datasheet V 5.0

Revised naming device info on pages 29 & 52.

Datasheet V 4.9

Revised single point calibration information and art on pg 13.

Datasheet V 4.8

Moved Default state to pg 14.

Datasheet V 4.7

Updated firmware to V2.11 on pg 63.

Datasheet V 4.6

Revised response for the sleep command in UART mode on pg 33.

Datasheet V 4.5

Revised calibration theory on page 12, and added more information on the Export calibration and Import calibration commands.

Datasheet V 4.4

Revised isolation schematic on pg. 10

Datasheet V 4.3

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

Datasheet V 4.2

Removed note from certain commands about firmware version.

Datasheet V 4.1

Added information to calibration theory on pg 8.

Datasheet V 4.0

Revised definition of response codes on pg 42.

Datasheet V 3.9

Revised isolation information on pg 9.

Datasheet V 3.8

Revised Plock pages to show default value.

Datasheet V 3.7

Added new commands:
"Find" pages 23 (UART) & 46 (I^2C).
"Export/Import calibration" pages 27 (UART) & 49 (I^2C).
Added new feature to continous mode "C,n" pg 24.

Datasheet V 3.6

Revised circuit illustrations throughout datasheet.

Datasheet V 3.5

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

Datasheet V 3.4

Revised entire datasheet.

Firmware updates

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 ORP
- Added calibration saving and loading

V2.10 – (May 9, 2017)
- Added "Find" command.
- Added "Export/import" command.
- Modified continuous mode to be able to send readings every "n" seconds.

V2.11 – (July 17, 2017)
- Fixed bug where calibration would restore itself after restart, despite being cleared.

V2.12 – (Oct 18, 2021)
- Internal update for new part compatibility.

V2.13 – (Nov 12, 2021)
- Fixed bug in I2C mode with timing and sleep mode.

V2.14 – (May 30, 2023)
- Added Extended ORP Scale option.

Warranty

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

The debugging phase

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

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

