EZO-ORP™

Embedded ORP Circuit

Reads	**ORP**
Range	**-1019.9mV – 1019.9mV**
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**

GND TX (SDA) RX (SCL)

ORP EZO™

VCC PRB PGND

RoHS COMPLIANT

PATENT PROTECTED

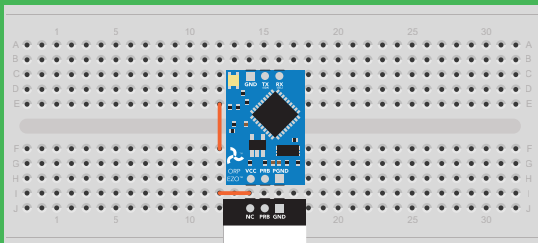This is an evolving document, check back for updates.
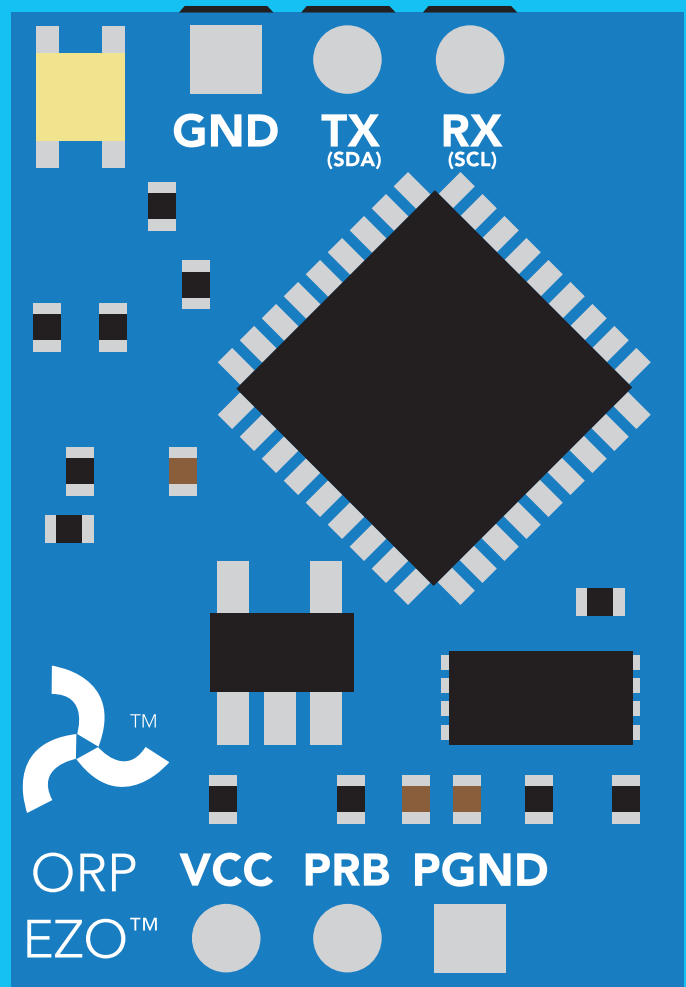
STOP

SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

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

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

Get this device working in a solderless breadboard first!

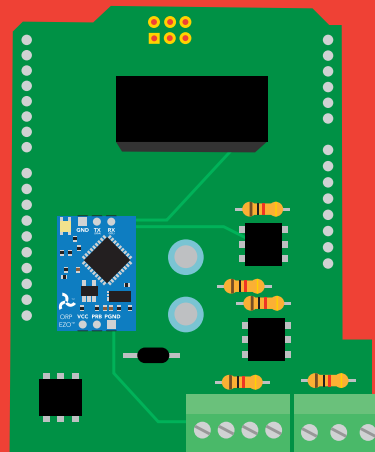**Do not embed this device without testing it in a solderless breadboard!**

r 0.1

Table of contents

UART

I²C

AtlasScientific
Environmental Robotics

EZO™ circuit dimensions

13.97mm (0.55")

GND   TX (SDA)   RX (SCL)

20.16mm (0.79")

ORP EZO™   VCC   PRB   PGND

5.8mm (0.22")   **1mm Ø**   **8.38mm (0.32")**   **10.8mm (0.4")**

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

AtlasScientific
Environmental Robotics
r 0.1

Operating principle

ORP stands for *oxidation/reduction potential*. Oxidation is the loss of electrons and reduction is the gain of electrons. The output of the probe is represented in millivolts and can be positive or negative.

Just like a pH probe measures hydrogen ion activity in a liquid; an ORP probe measures electron activity in a liquid. The ORP readings represents how strongly electrons are transferred to or from substances in a liquid. Keeping in mind that the readings do not indicate the amount of electrons available for transfer.

pH Probe

ORP Probe

H^+ H^+ H^+

H^+ H^+ H^+

H^+ H^+

e^- e^- e^-

e^- e^- e^-

e^- e^-

Atlas Scientific
Environmental Robotics
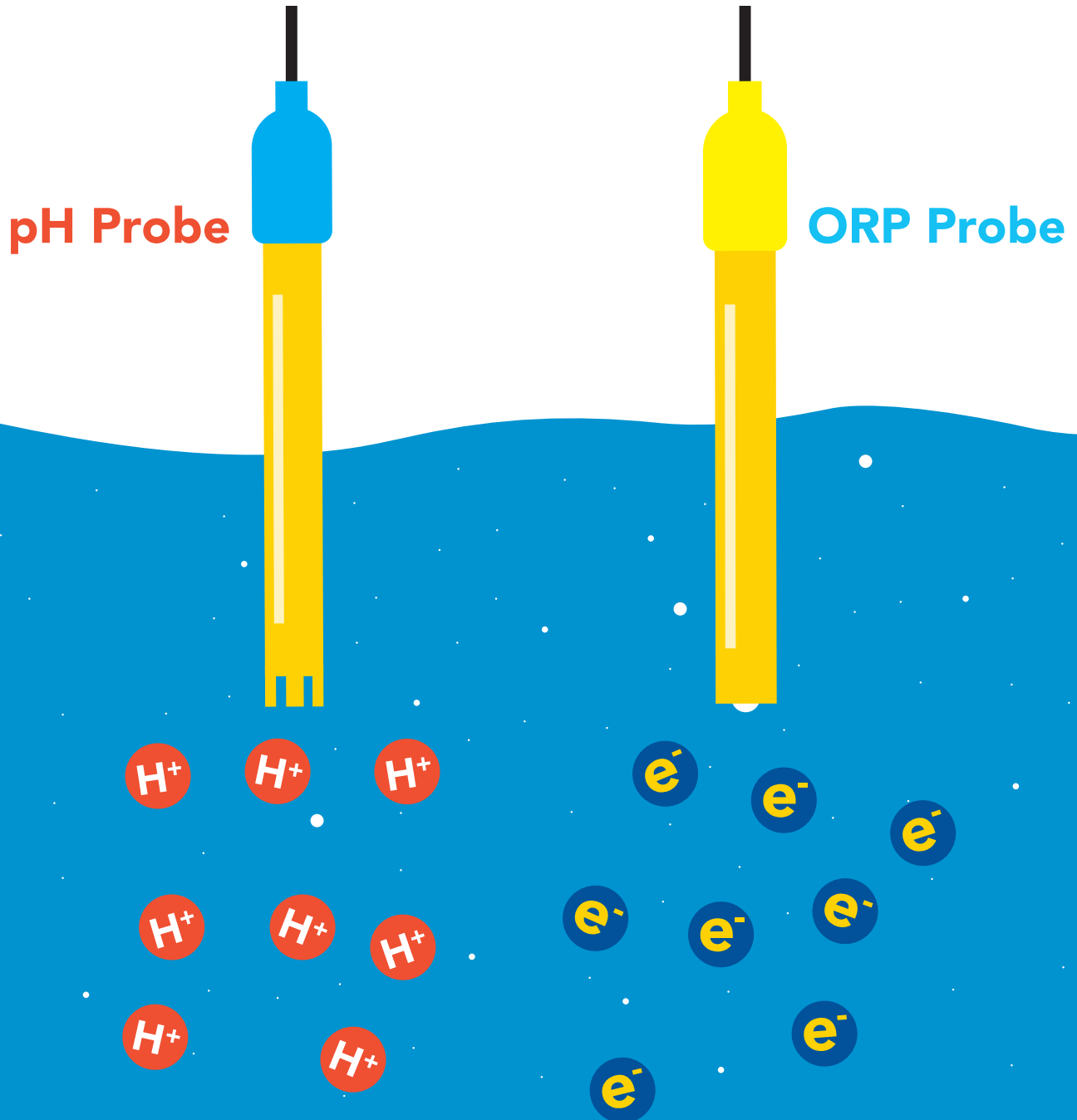
When reading the ORP of a liquid that has very few electrons available for transfer ORP readings can appear to be inconsistent.

-234.6
Reading A

24.2
Reading B
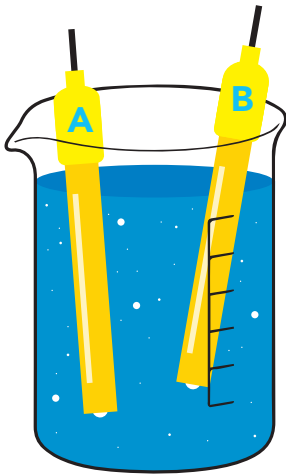
Tap water

606.9
Reading A
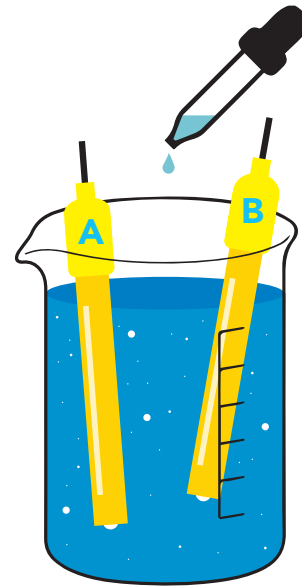
605.3
Reading B

Tap water

Add just a drop of bleach
(which is an oxidizing agent)

An ORP probe has a platinum tip that is connected to a silver wire, surrounded by silver chloride. That silver wire is then connected to a KCL reference solution. Because platinum is an unreactive metal it can "silently observe" the electron activity of the liquid without becoming apart of whatever reaction is occurring in the liquid.

Platinum tip

Silver chloride

Silver wire

Reference wire

KCL reference solution

AtlasScientific™
Environmental Robotics
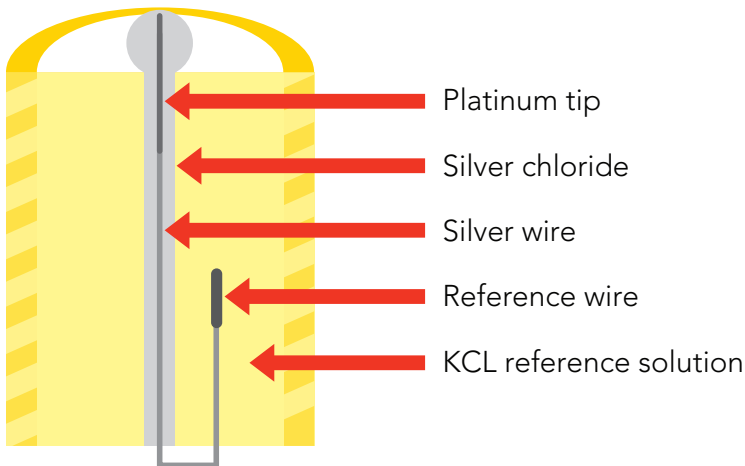
# Power and data isolation

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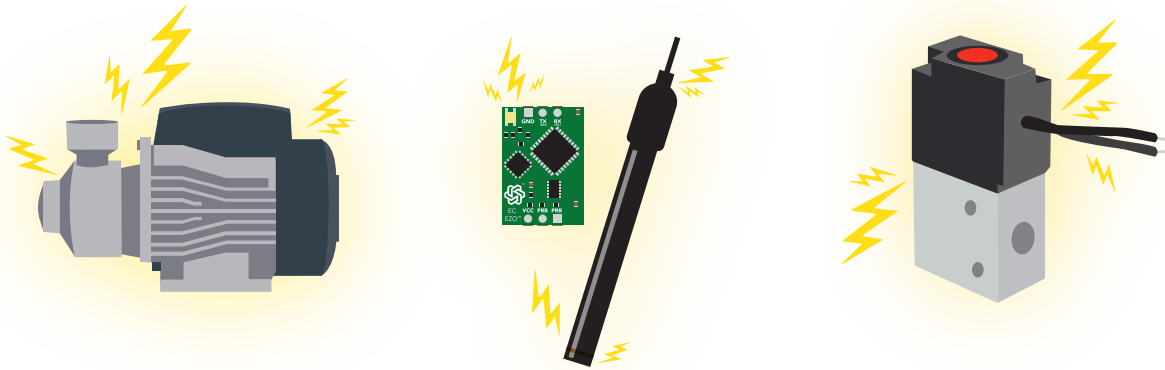
When reading ORP and Conductivity or Dissolved Oxygen together, it is **strongly recommended** that the EZO™ ORP circuit is electrically isolated from the EZO™ Conductivity or Dissolved Oxygen circuit.

Basic EZO™ Inline Voltage Isolator

Correct

Incorrect
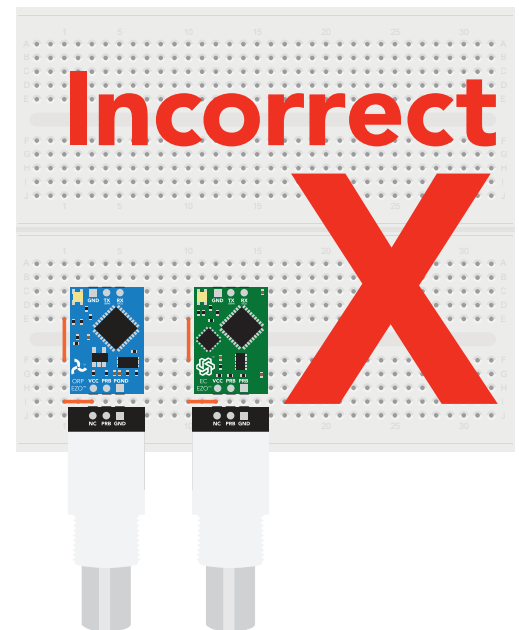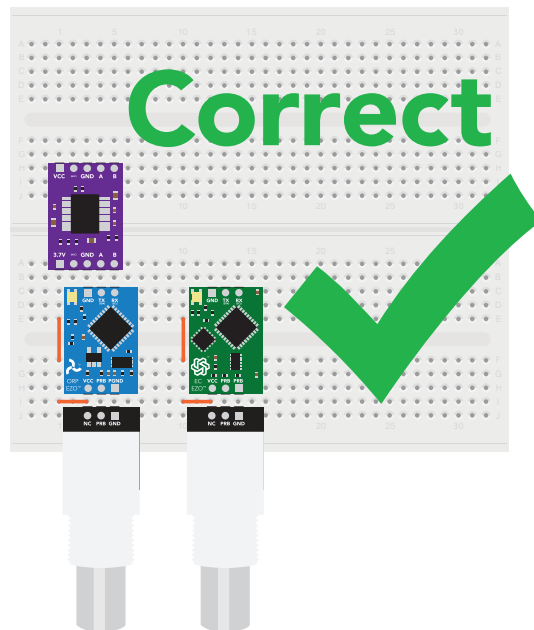
Without isolation, Conductivity and Dissolved Oxygen readings will effect ORP accuracy.

Atlas**Scientific**
Environmental Robotics
r 0.1

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

This technology works by using tiny transformers to induce the voltage across an air gap. PCB layout requires special attention for EMI/EMC and RF Control, having proper ground planes and keeping the capacitors as close to the chip as possible are crucial for proper performance. The two data channels have a 4.7kΩ 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 (R5, R6, and R,7) 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.

AtlasScientific
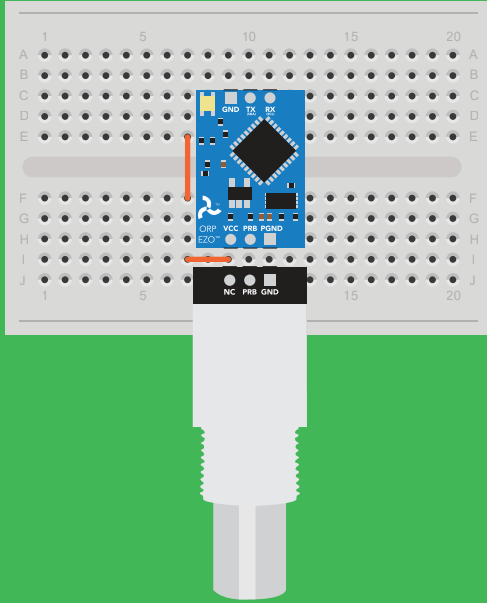Environmental Robotics
r 0.1
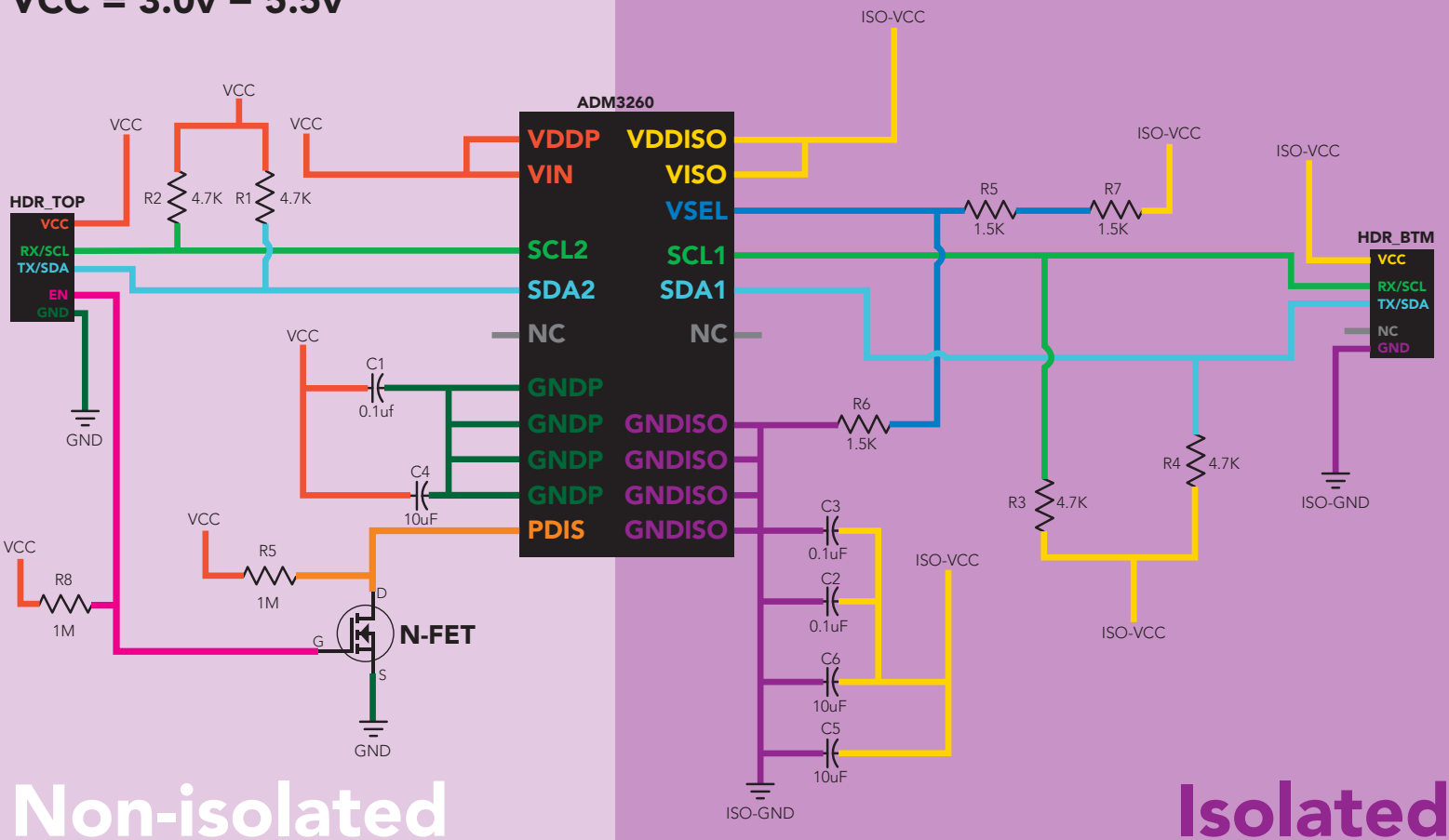
✓ Correct wiring

Bread board

Bread board via USB

Part # COM-104

Carrier board

Part # ISCCB

USB carrier board

Part # USB-ISO
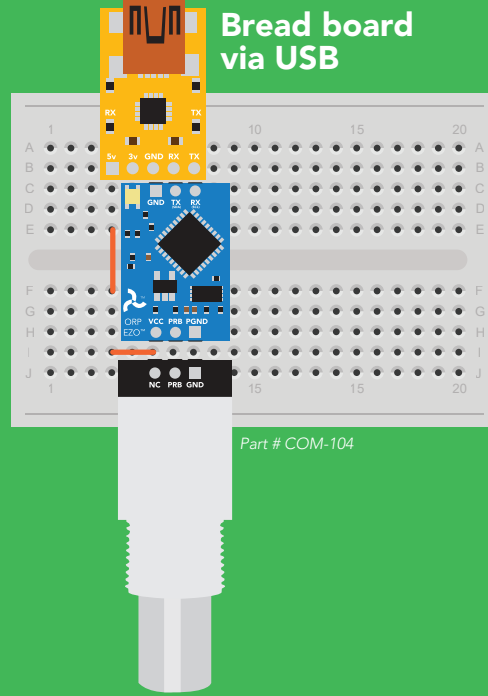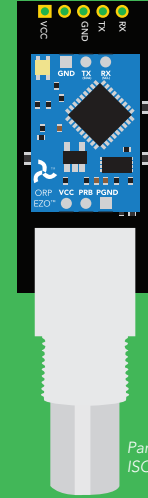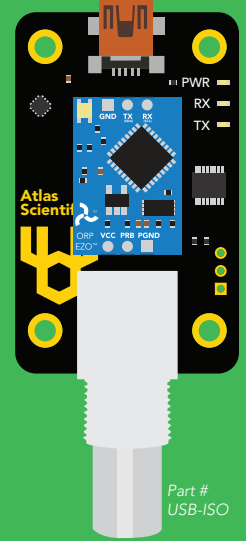
✗ Incorrect wiring

Extended leads
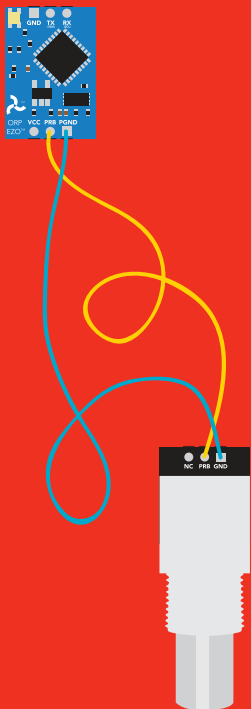
Sloppy setup
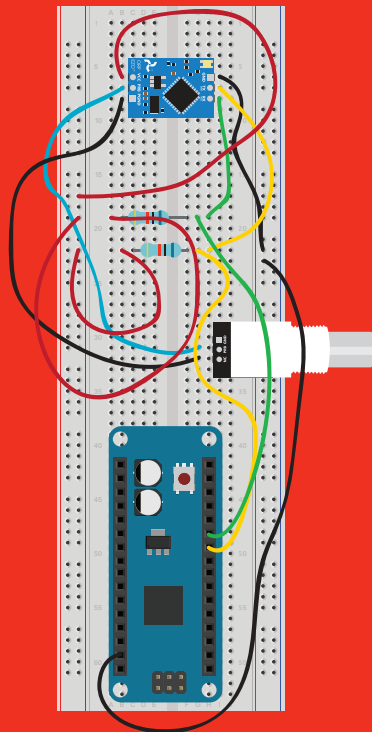
Perfboards or Protoboards
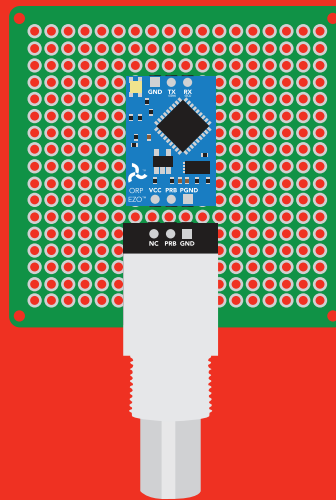
NEVER
use Perfboards or Protoboards

*Embedded into your device
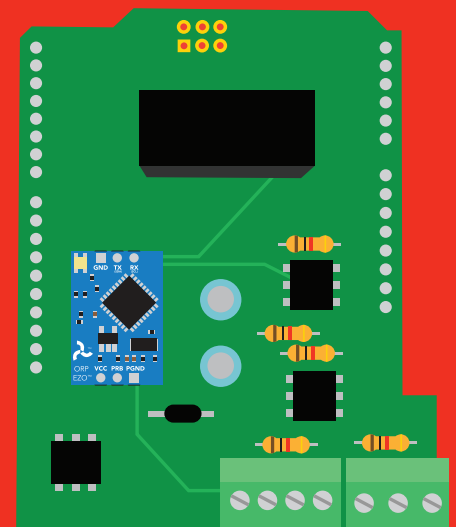
*Only after you are familar with EZO™ circuits operation

9 Copyright © Atlas Scientific LLC

AtlasScientific™
Environmental Robotics
r 0.1

NEVER EXTEND THE CABLE WITH CHEAP JUMPER WIRES!

RX
TX

5v 3v GND RX TX

GND TX RX
     (SDA) (SCL)

ORP
EZO™ VCC PRB PGND
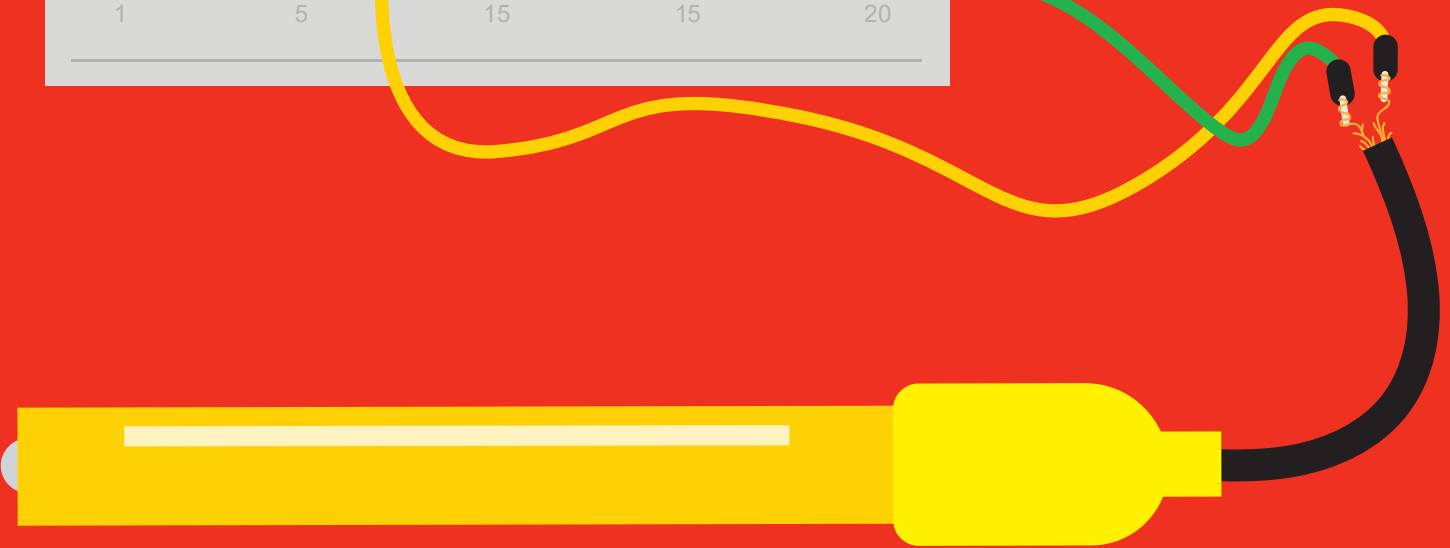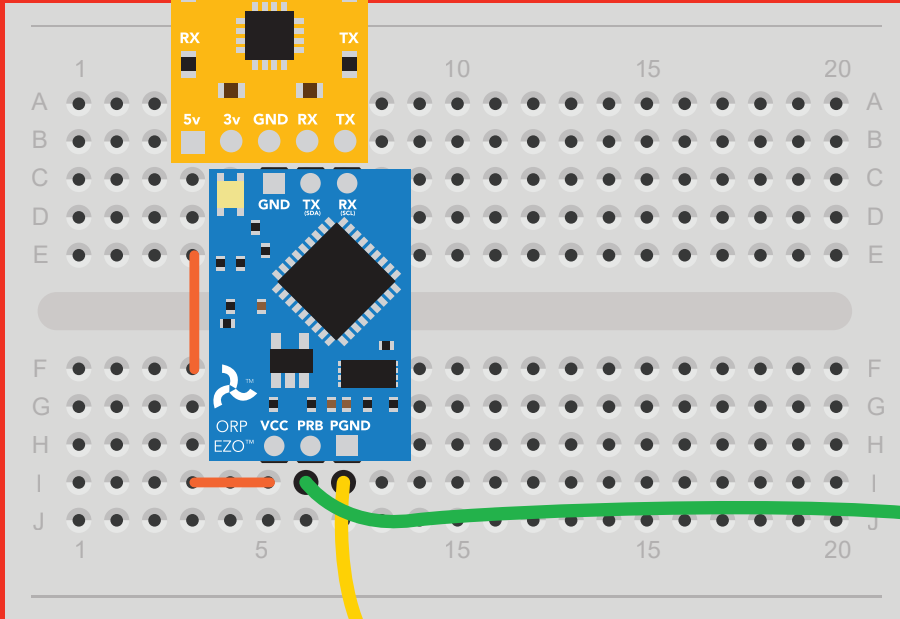
DO NOT CUT THE PROBE CABLE WITHOUT REFERING TO *THIS DOCUMENT!*

AtlasScientific™
Environmental Robotics

DO NOT *MAKE YOUR OWN UNSHIELDED CABLES!*
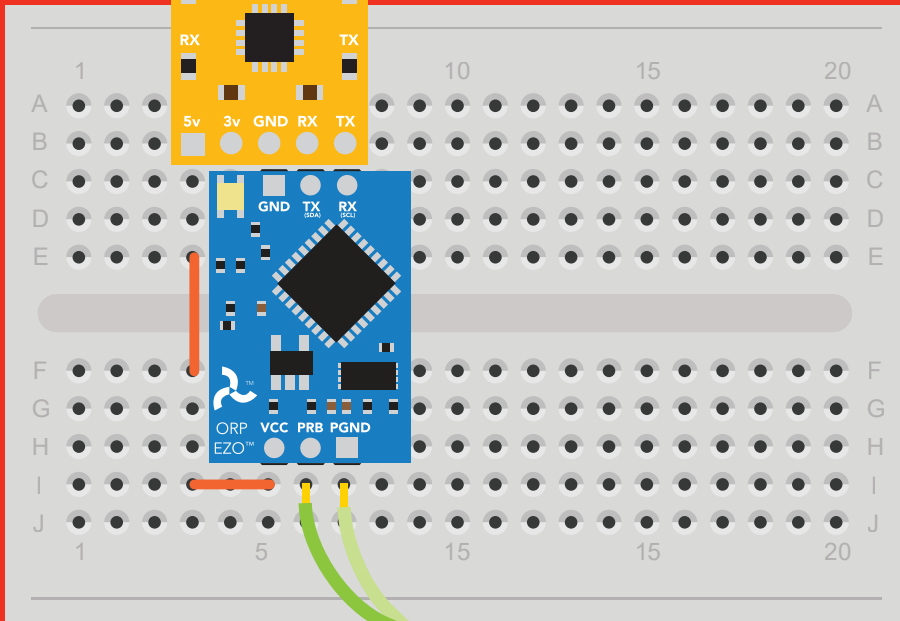
**ONLY USE SHIELDED CABLES.
REFER TO** *THIS DOCUMENT!*

AtlasScientific
Environmental Robotics

Calibration theory

UART
mode
Continuous readings

I²C
mode
Continuously request readings

152.1	
197.3	
210.6	**X** Unstabilized
295.7	
306.2	
315.7	
315.7	
315.7	✔ Stabilized
315.7	
315.7	
315.7	
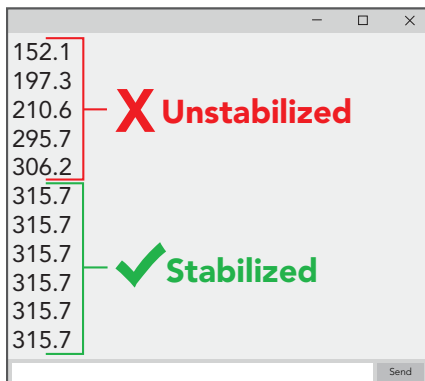
The most important part of calibration is watching the readings during the calibration process.

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.

AtlasScientific
Environmental Robotics

ORP 225mV

AtlasScientific™
Environmental Robotics

Single point calibration

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

10 – 60 sec
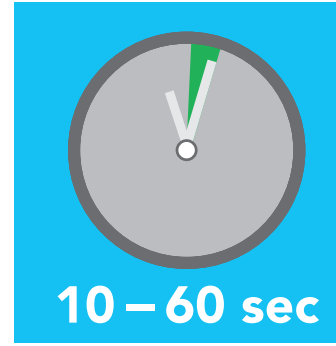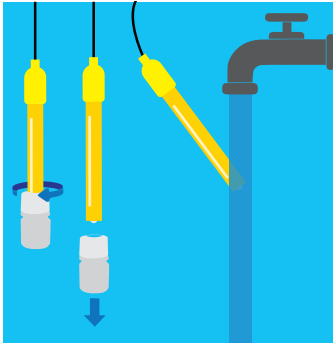
```
342.0
315.2    X Unstabilized
268.7
240.1
240.1
240.1    ✔ Stabilized
240.1
cal,225
*OK
225.0
225.0
                              Send
```

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.

AtlasScientific
Environmental Robotics

Default state
UART mode

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

∞

1,000 ms

Green

Standby

Cyan

Taking reading

Transmitting

AtlasScientific™
Environmental Robotics
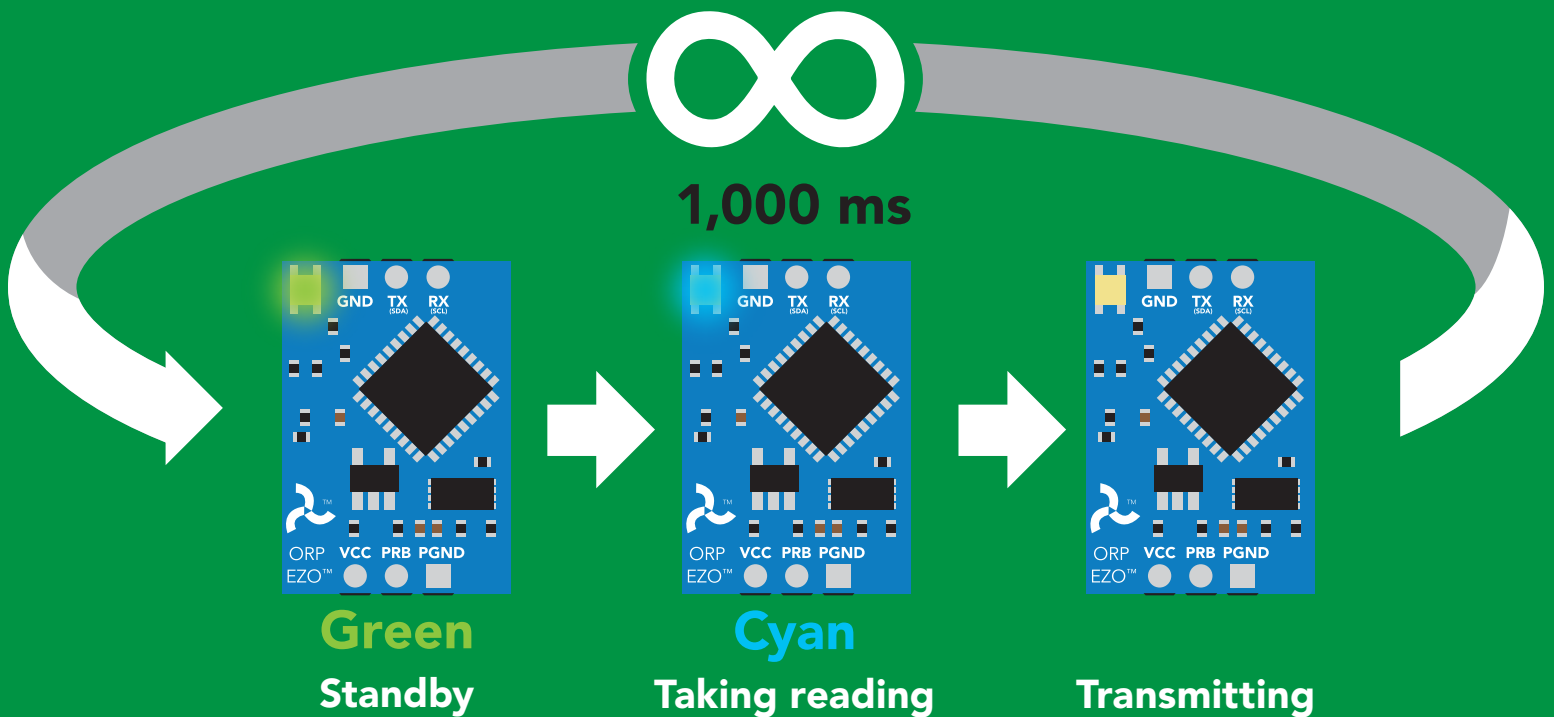
✔ Available data protocols

UART

`Default`

I²C

✗ Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

AtlasScientific™
Environmental Robotics
r 0.1

UART mode

Settings that are retained if power is cut

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

Settings that are *NOT* retained if power is cut

Find
Sleep mode

UART mode

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

RX
Data in

TX
Data out

Vcc
3.3V – 5.5V

VCC

0V   0V

TX ➡ RX ✓

RX ⬅ TX ✓

GND   TX (SDA)   RX (SCL)

ORP EZO™   VCC   PRB   PGND

TX   RX

CPU
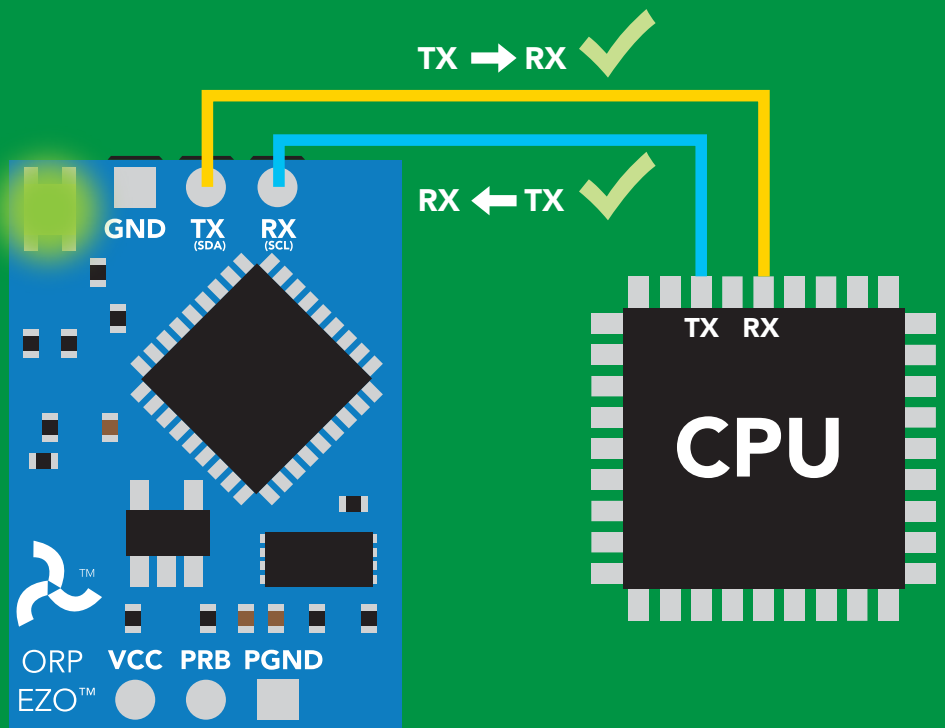
Data format

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		

AtlasScientific
Environmental Robotics

Receiving data from device

2 parts

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

9,600 baud (default)

GND TX (SDA) RX (SCL)

CPU

TX RX

209.6 <cr>

ORP EZO™ VCC PRB PGND

Sender

Receiver
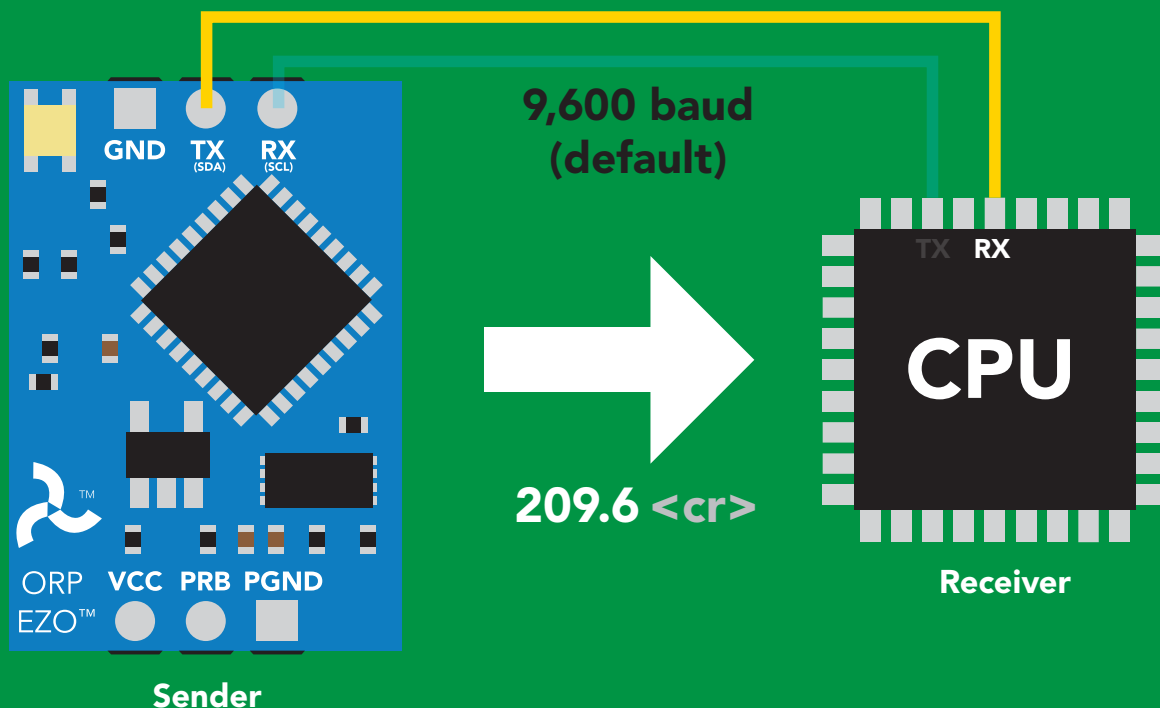
Advanced

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

Atlas**Scientific**
Environmental Robotics
r 0.1

Sending commands to device

2 parts

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

GND **TX**
(SDA) **RX**
(SCL)

CPU

TX RX

Sleep <cr>

ORP
EZO™ **VCC PRB PGND**

Receiver

Sender
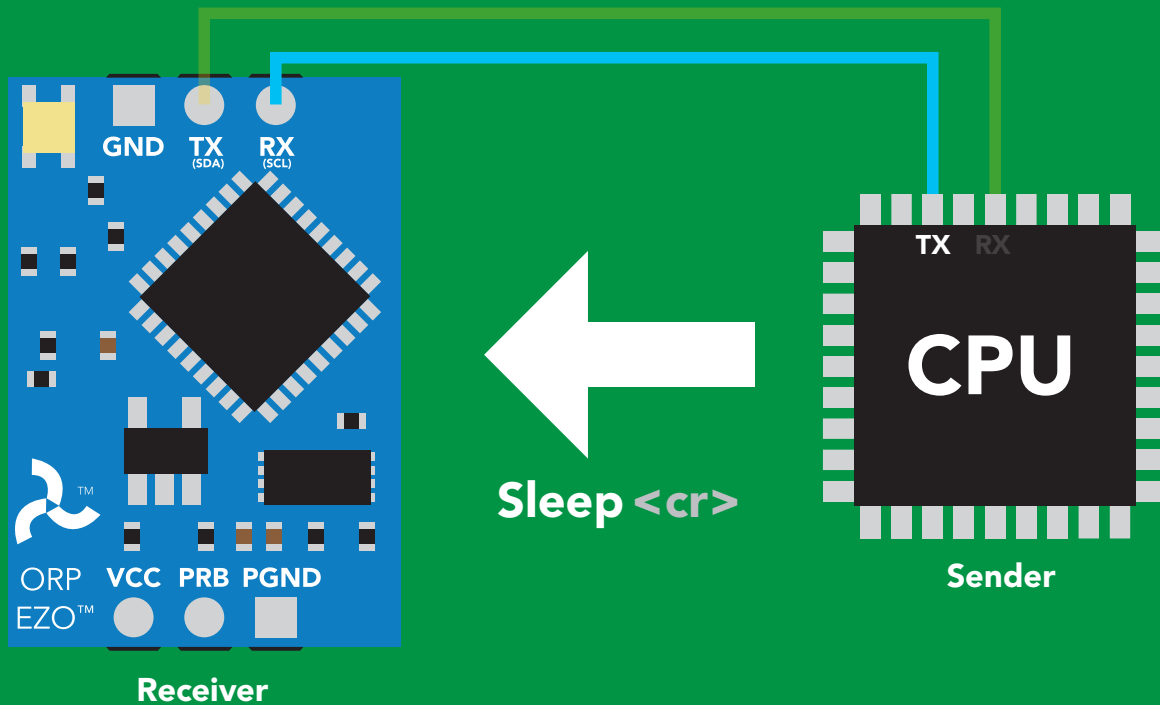
Advanced

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

Copyright © Atlas Scientific LLC

AtlasScientific™
Environmental Robotics
r 0.1

LED color definition
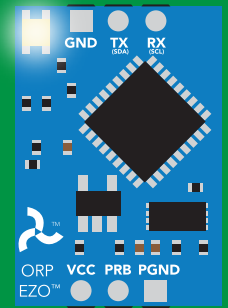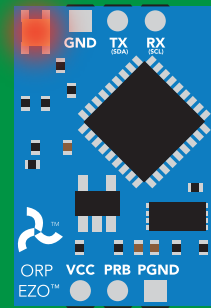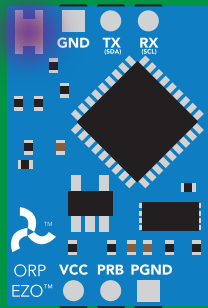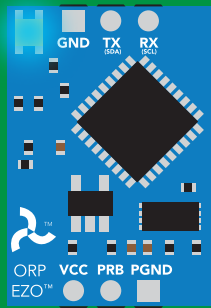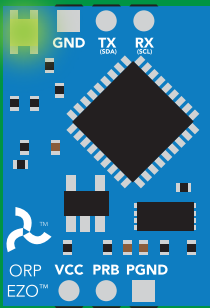
Green
UART standby

Cyan
Taking reading

Purple
Changing
baud rate

Red
Command
not understood

White
Find

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

UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

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

AtlasScientific™
Environmental Robotics

LED control

Command syntax

L,1 <cr> LED on <mark>default</mark>

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>
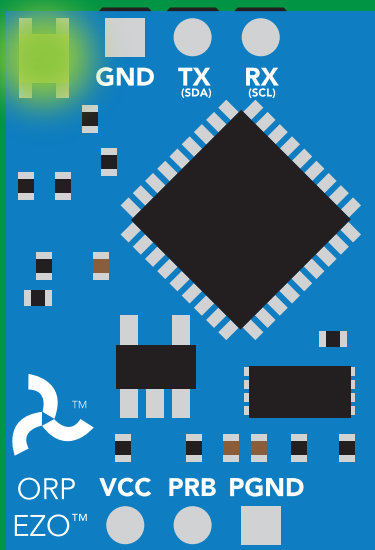
L,1
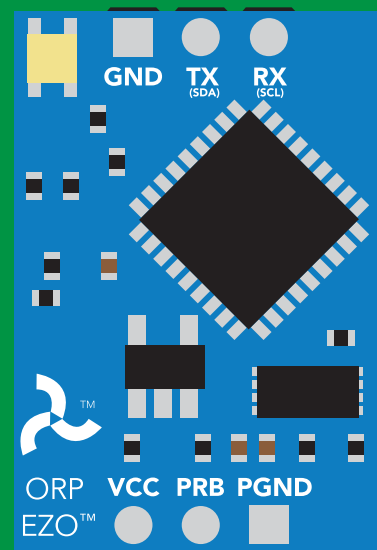
L,0

Copyright © Atlas Scientific LLC

AtlasScientific™
Environmental Robotics
r 0.1

Find

Command syntax

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

Example   Response

Find <cr>	*OK <cr>

AtlasScientific
Environmental Robotics
r 0.1

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>

AtlasScientific
Environmental Robotics
r 0.2

Single reading mode

Command syntax

R `<cr>` takes single reading

Example	Response
R `<cr>`	209.6 `<cr>` *OK `<cr>`
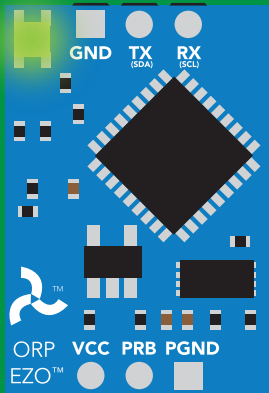
Green
Standby
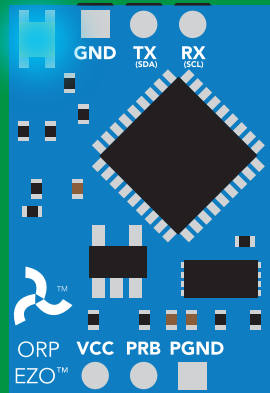
Cyan
Taking reading
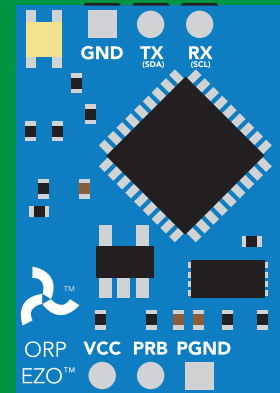
Transmitting

800 ms

AtlasScientific
Environmental Robotics
r 0.1

Calibration

Command syntax

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>`

Cal,225 `<cr>`

209.6 mV   225 mV

AtlasScientific™
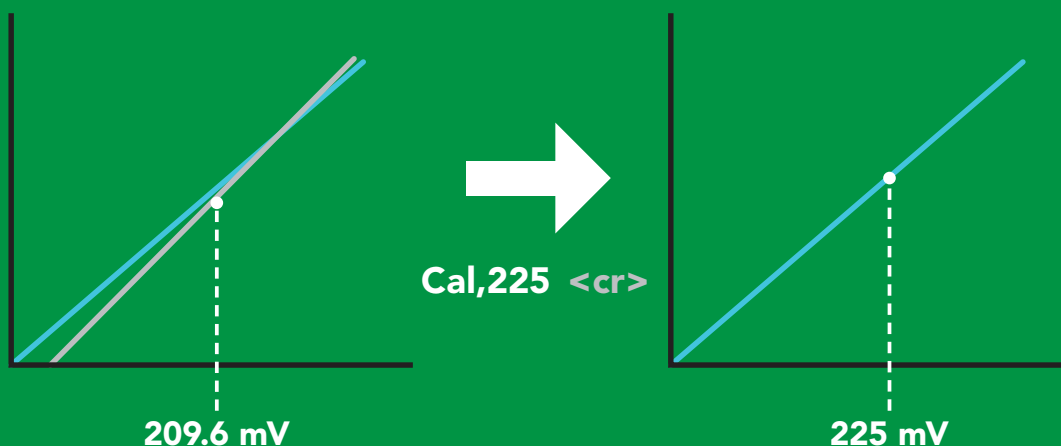Environmental Robotics

Export calibration

Command syntax

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> 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>
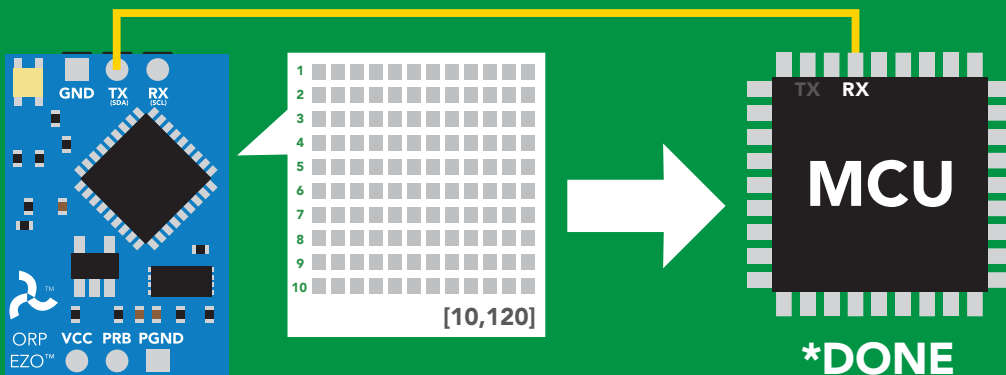
[10,120]

MCU

*DONE

Copyright © Atlas Scientific LLC

AtlasScientific
Environmental Robotics
r 0.2

Import calibration

Command syntax

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>**

TX **RX**

MCU

1 2 3 4 5 6 7 8 9 10

✔ [10,120]

GND   TX (SDA)   RX (SCL)

ORP EZO™   VCC   PRB   PGND

*OK <cr>
system will reboot

TX **RX**

MCU

1 2 3 4 5 6 7 8 9 10

✗ [10,120]

GND   TX   RX

ORP EZO™   VCC   PRB   PGND
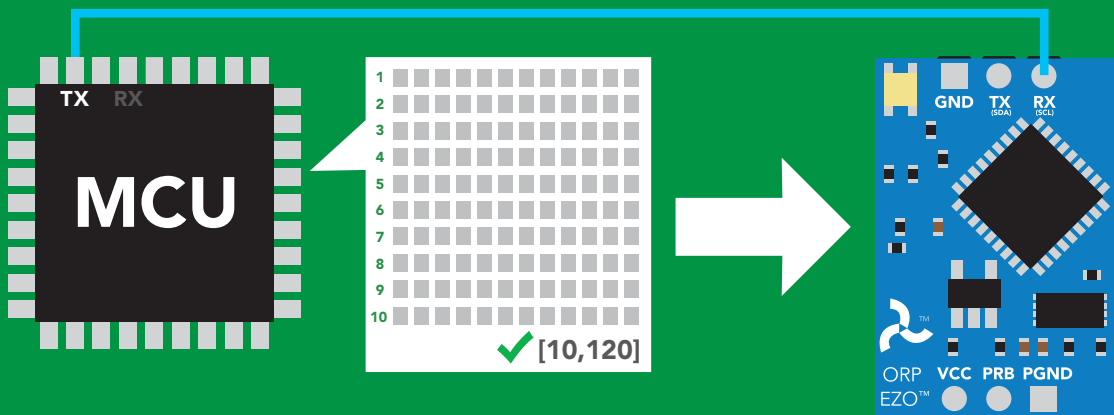
*ER <cr>
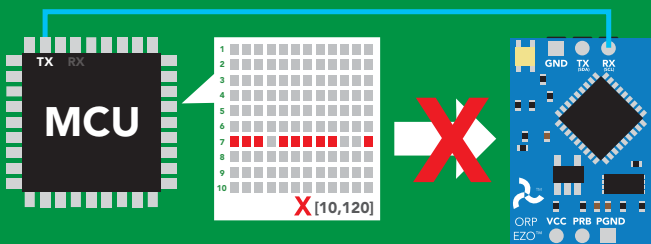
* If one of the imported strings is not correctly entered, the device will not accept the import, respond with *ER and reboot.

AtlasScientific™
Environmental Robotics
r 0.2

Naming device

Command syntax

Name,n <cr> set name

Name,? <cr> show name

n =

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

Up to 16 ASCII characters

Example | Response

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

Name,zzt

Name,?

***OK** <cr>

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

AtlasScientific
Environmental Robotics
r 0.1
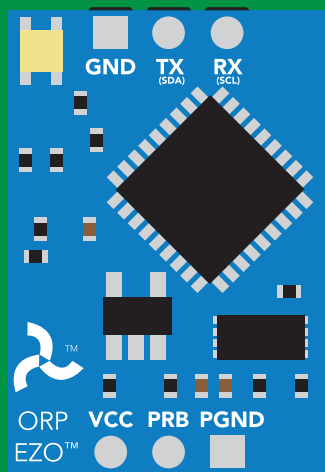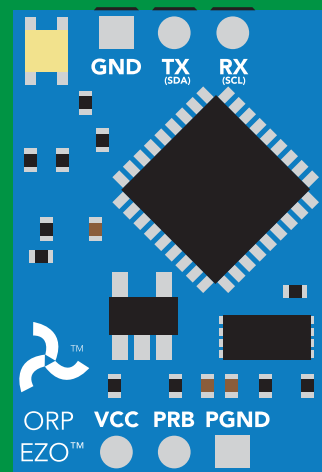
Device information

Command syntax

i **<cr>** device information

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

Response breakdown

?i, ORP, 1.97
    ↑   ↑
   Device   Firmware

AtlasScientific
Environmental Robotics
r 0.1

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

AtlasScientific
Environmental Robotics
r 0.1

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

AtlasScientific
Environmental Robotics
r 0.1

Sleep mode/low power

Command syntax

Sleep **<cr>** enter sleep mode/low power

Example

Response

Sleep **<cr>**

*OK **<cr>**
*SL **<cr>**

Any command

*WA **<cr>** wakes up device

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

Sleep **<cr>**

**Standby
16 mA**

**Sleep
1.16 mA**

AtlasScientific
Environmental Robotics
r 0.1
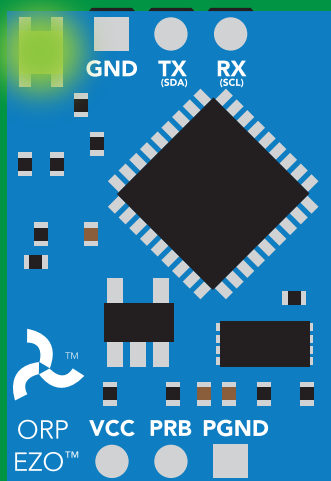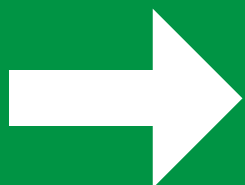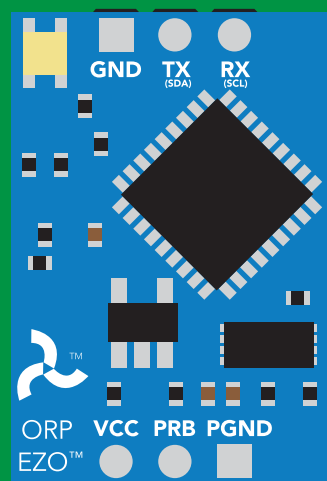
Change baud rate

Command syntax

Baud,n `<cr>` change baud rate

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

```
        ┌── 300
        │   1200
        │   2400
n =  ───┤   9600  default
        │   19200
        │   38400
        │   57600
        └── 115200
```
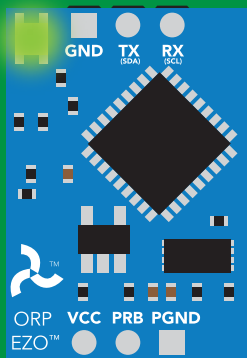

Standby

Baud,38400 `<cr>`
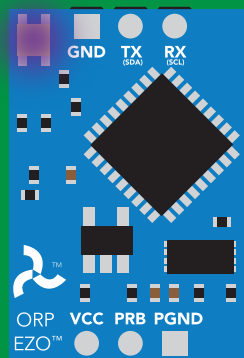
Changing
baud rate

*OK `<cr>`

(reboot)
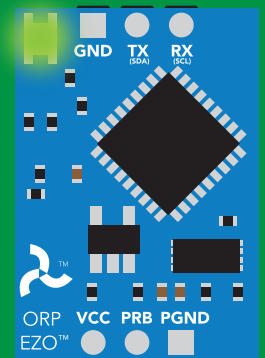
Standby

AtlasScientific
Environmental Robotics
r 0.1

Protocol lock

Command syntax

Plock,1 <cr> enable Plock

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

Plock,? <cr> Plock on/off?

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

Plock,1
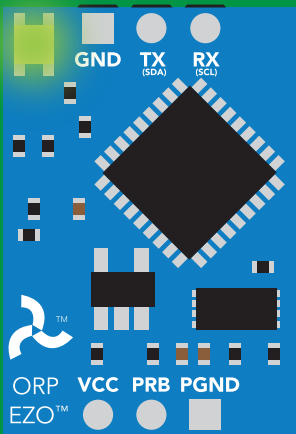
*OK <cr>

I2C,100
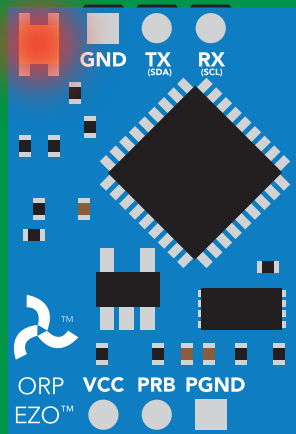
cannot change to I²C
*ER <cr>

Short
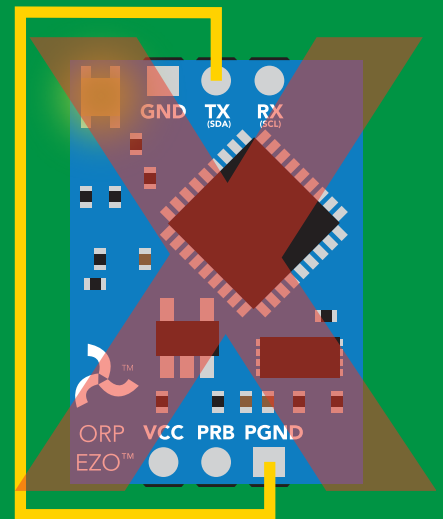
cannot change to I²C

AtlasScientific™
Environmental Robotics
r 0.1

Factory reset

Command syntax

Factory **<cr>** enable factory reset

Example	Response
Factory **<cr>**	*OK **<cr>**

Factory **<cr>**

*OK **<cr>**
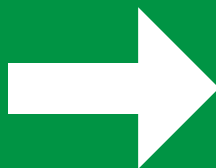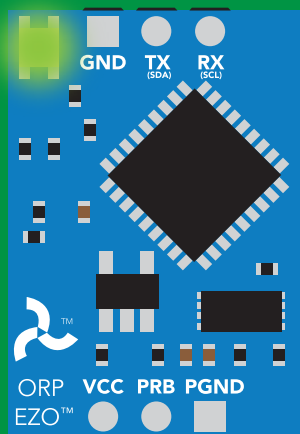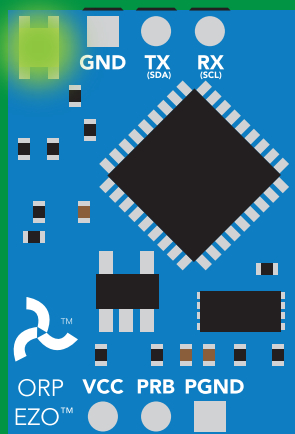
(reboot)

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

Baud rate will not change

AtlasScientific
Environmental Robotics

Change to I²C mode

Command syntax

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

n = any number 1 – 127

Example

Response

I2C,100 <cr>

*OK (reboot in I²C mode)

Wrong example

Response

I2C,139 <cr> n ≯ 127

*ER <cr>

I2C,100

GND TX (SDA) RX (SCL)

ORP EZO™ VCC PRB PGND

(reboot)

GND TX (SDA) RX (SCL)

ORP EZO™ VCC PRB PGND

Green
*OK <cr>

Blue
now in I²C mode

AtlasScientific™
Environmental Robotics
r 0.2
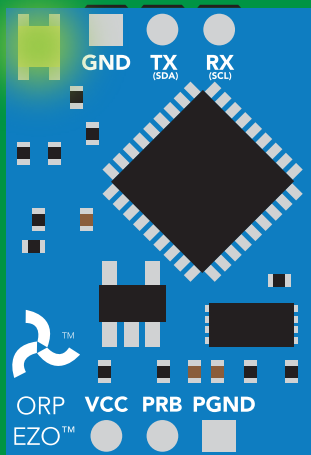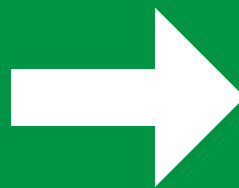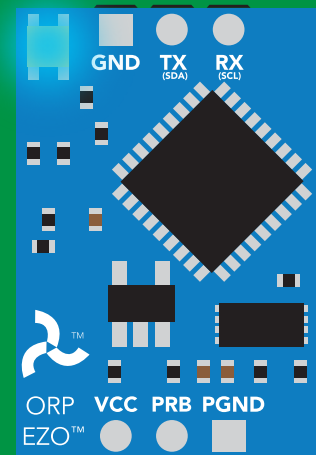
Manual switching to I²C

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

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

Example
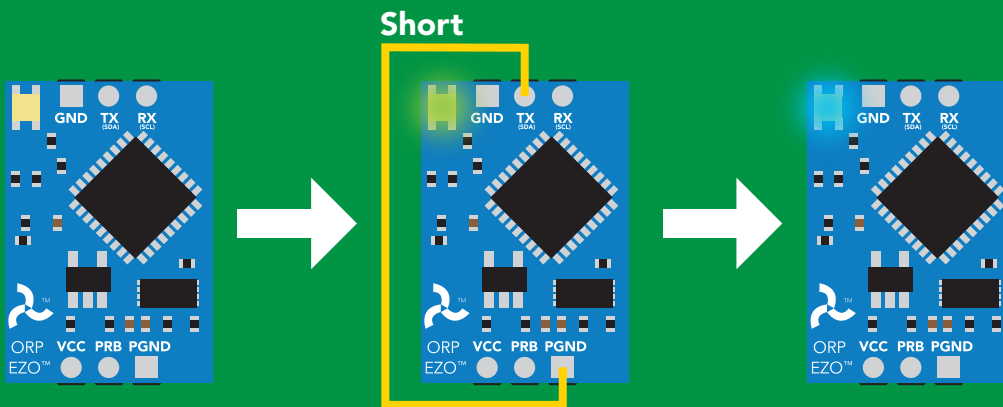
Wrong Example

← Disconnect RX line
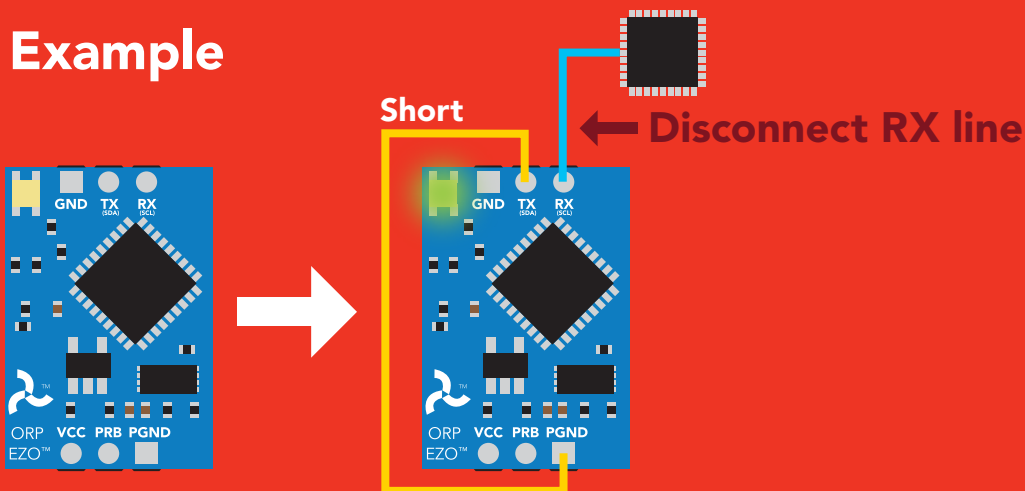
I²C mode

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

AtlasScientific
Environmental Robotics
r 0.2

I²C mode

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

Vcc   3.3V – 5.5V

Clock speed   100 – 400 kHz

SDA

SCL
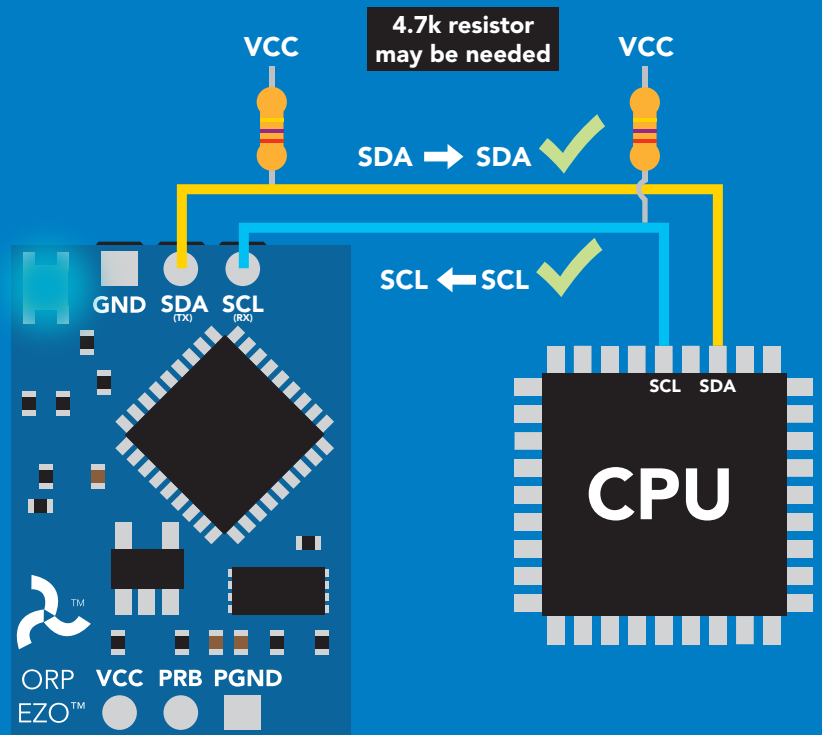
VCC
0V   0V

VCC   **4.7k resistor may be needed**   VCC

SDA ➡ SDA ✓

SCL ⬅ SCL ✓

GND SDA SCL
     (TX) (RX)

SCL SDA

CPU

ORP
EZO™   VCC PRB PGND

Data format

Reading	ORP
Units	mV
Encoding	ASCII
Format	string

Data type	floating point
Decimal places	1
Smallest string	2 characters
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

GND SDA (TX) SCL (RX)

SCL SDA

CPU

ORP EZO™   VCC PRB PGND

Advanced

Address bits

The entire command as ASCII with all arguments

SDA

A6 A5 A4 A3 A2 A1 A0 W ACK First letter of command ACK ··· Last letter of command ACK

SCL

Start

W = low

Stop

Requesting data from device

7 parts

Start	I²C address	Read	Response code	Data string	Null	Stop

98 (0x62)   1 byte   "209.6"   Terminator (Dec 0)

GND SDA SCL
(TX) (RX)

ORP EZO™   **VCC PRB PGND**

209.6

SCL SDA

CPU

Advanced

Address bits   N bytes of data   All bytes after data are Null

R = High

SDA   A6 – A0   R   ACK   Response code   ACK   Data   ACK ... Data N   ACK   Null   ACK ... Null

SCL

Start   NACK   Stop

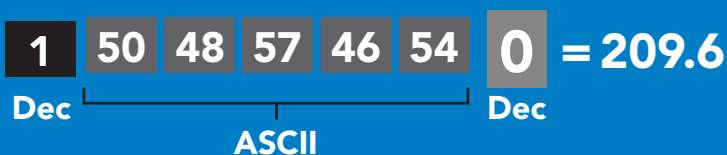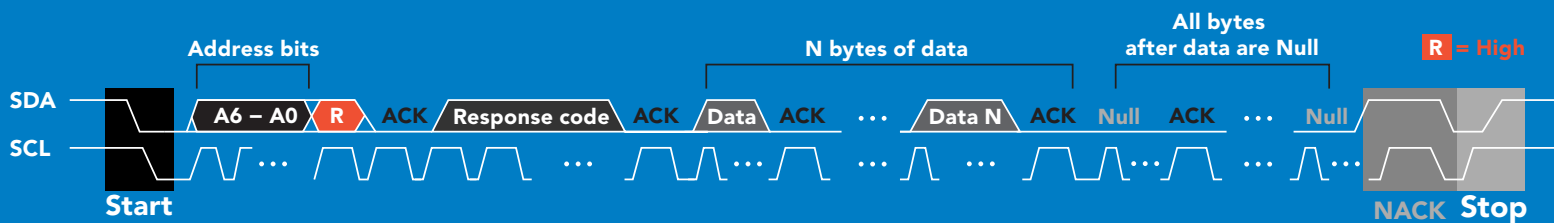| 1	50	48	57	46	54	0	= 209.6

Dec   ASCII   Dec
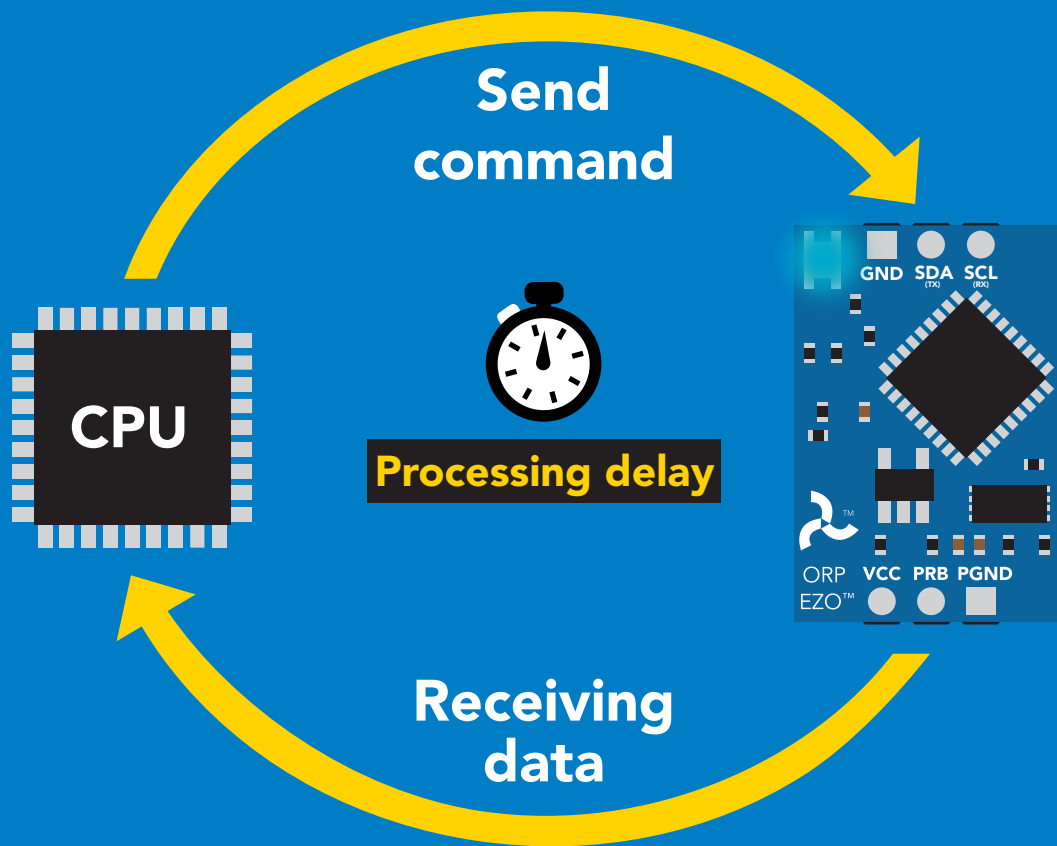
Response codes

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

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

Send command

Processing delay

GND   SDA   SCL
      (TX) (RX)

ORP
EZO™   VCC   PRB   PGND

Receiving data

Example

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

delay(300);          Processing delay

I2C_start;
I2C_address;
Char[ ] = I2C_read;
I2C_stop;
```
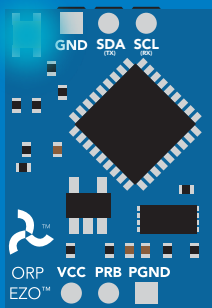
If there is no processing delay or the processing delay is too short, the response code will always be 254.

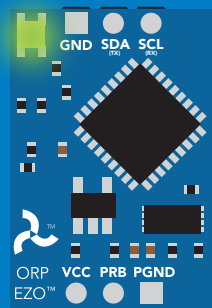### Response codes

Single byte, not string

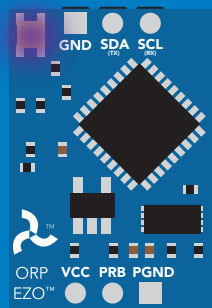|	
255	no data to send
254	still processing, not ready
2	syntax error
1	successful request

AtlasScientific™
Environmental Robotics
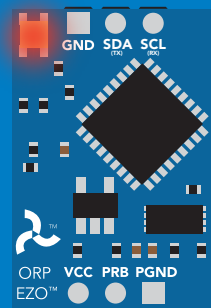r 0.2

LED color definition

Blue
I²C standby

Green
Taking reading

Purple
Changing
I²C address

Red
Command
not understood
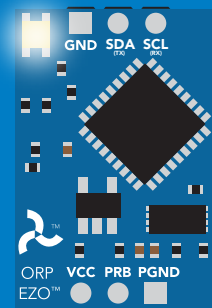
White
Find

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

I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 58
Cal	performs calibration	pg. 49
Export	export calibration	pg. 50
Factory	enable factory reset	pg. 57
Find	finds device with blinking white LED	pg. 47
i	device information	pg. 52
I2C	change I²C address	pg. 56
Import	import calibration	pg. 51
L	enable/disable LED	pg. 46
Plock	enable/disable protocol lock	pg. 55
R	returns a single reading	pg. 48
Sleep	enter sleep mode/low power	pg. 54
Status	retrieve status information	pg. 53

AtlasScientific™
Environmental Robotics

LED control

Command syntax

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

GND   SDA (TX)   SCL (RX)

ORP EZO™   VCC   PRB   PGND

L,1

GND   SDA (TX)   SCL (RX)

ORP EZO™   VCC   PRB   PGND

L,0

AtlasScientific™
Environmental Robotics
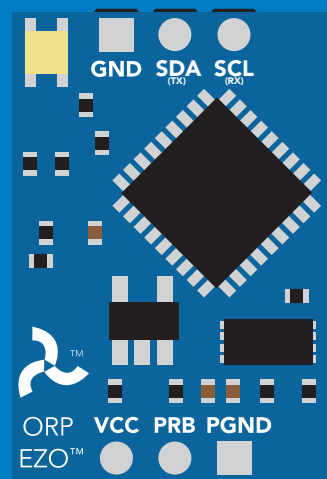r 0.1

Find

Command syntax

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

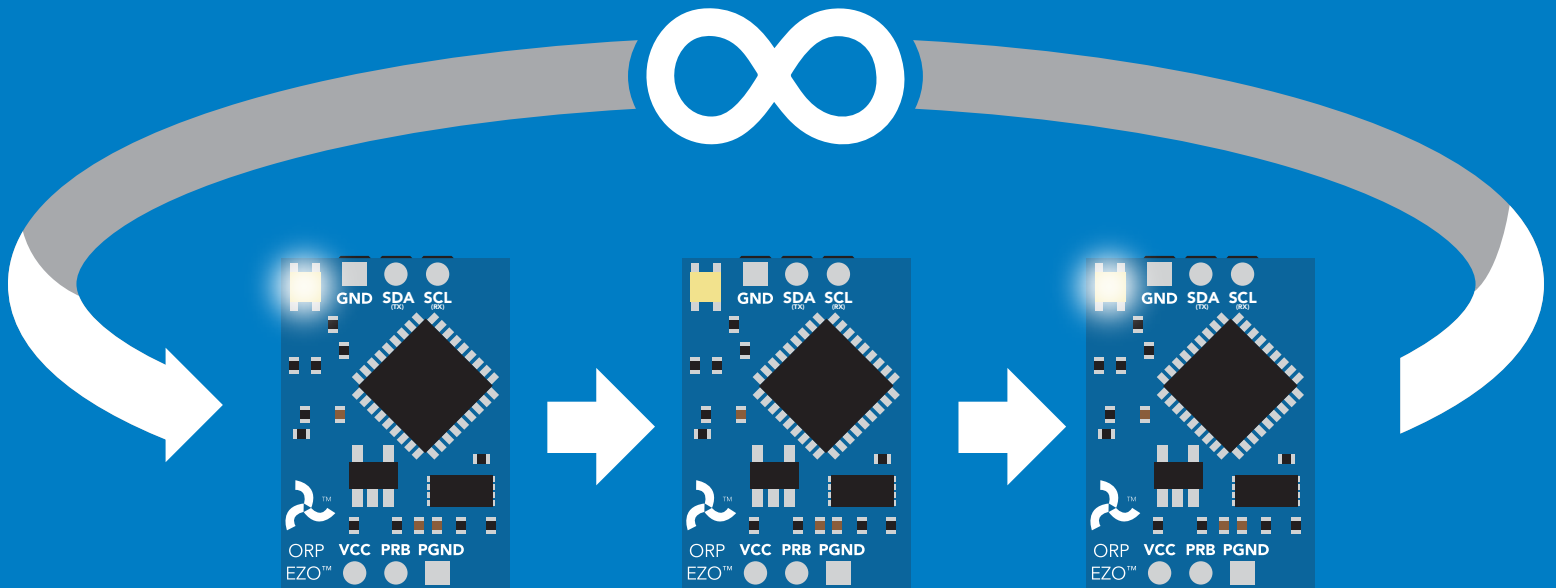**Find**   LED rapidly blinks white, used to help find device

Example   Response

Find

Wait 300ms

1 Dec   **0** Null

AtlasScientific
Environmental Robotics
r 0.1

Taking reading

Command syntax

900ms ⏱ processing delay

R   return 1 reading

Example   Response
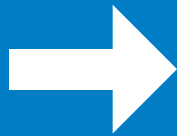
R

⏱ **Wait 900ms**

1	**209.6**	**0**
Dec	ASCII	Null

Green
Taking reading

⏱ **Wait 900ms**
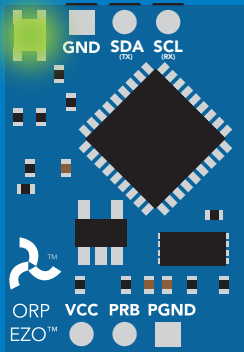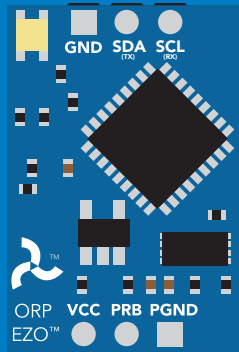
Transmitting

Blue
Standby

AtlasScientific ™
Environmental Robotics
r 0.1

Calibration

Command syntax

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

Cal,225

209.6 mV   225 mV

AtlasScientific
Environmental Robotics

Export calibration

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,?

⏱ **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

AtlasScientific ™
Environmental Robotics
r 0.2

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

MCU — SCL SDA

1 2 3 4 5 6 7 8 9 10

✔ [10,120]

GND   SDA (TX)   SCL (RX)

ORP EZO™   VCC   PRB   PGND
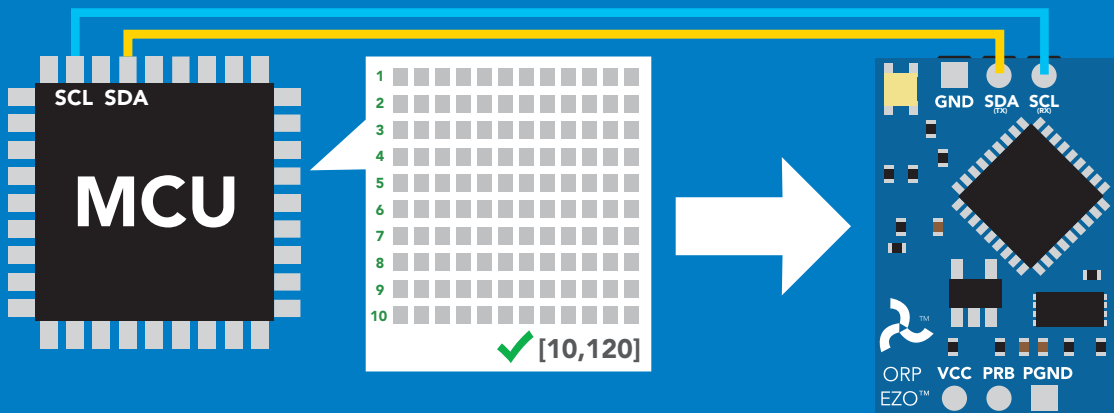
1 Dec   ***Pending** ASCII   **0** Null

system will reboot

MCU — SCL SCA

✘ [10,120]
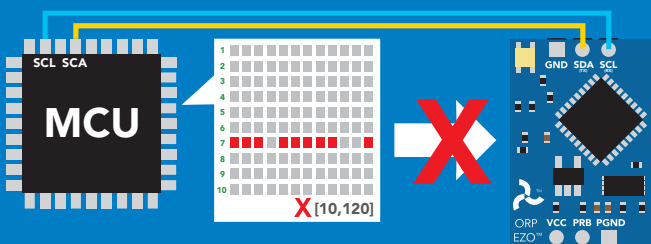
reboot

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

Atlas Scientific ™
Environmental Robotics

r 0.2

Device information

Command syntax

300ms ⏱ processing delay

i   device information

Example   Response

i

⏱ **Wait 300ms**   **1** Dec   **?i,ORP, 19.7** ASCII   **0** Null

Response breakdown

?i,   ORP,   1.97
↑ Device   ↑ Firmware

Copyright © Atlas Scientific LLC

AtlasScientific™
Environmental Robotics
r 0.1

Reading device status

Command syntax

300ms processing delay

Status   voltage at Vcc pin and reason for last restart

Example   Response

Status

Wait 300ms

1 Dec   **?Status,P,5.038** ASCII   **0** Null

Response breakdown

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

↑ Reason for restart   ↑ Voltage at Vcc

Restart codes

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

AtlasScientific
Environmental Robotics
r 0.1

Sleep mode/low power

Command syntax

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

Example · Response

Example	Response	
Sleep	no response	**Do not read status byte after issuing sleep command.**
Any command	wakes up device	

	STANDBY	SLEEP
5V	**16 mA**	**1.16 mA**
3.3V	**13.9 mA**	**0.995 mA**
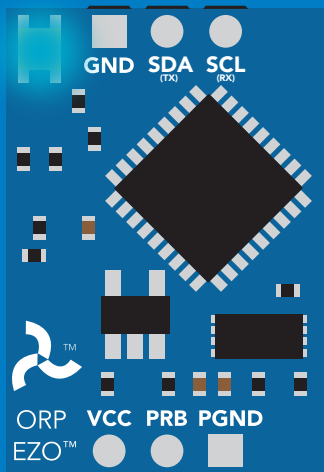
Standby → Sleep → Sleep
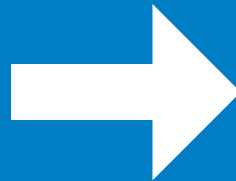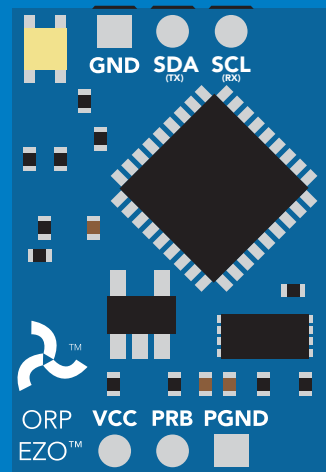
AtlasScientific
Environmental Robotics
r 0.1

Protocol lock

Command syntax

Plock,1 enable Plock

Plock,0 disable Plock **default**

Plock,? Plock on/off?

Locks device to I²C mode.

Example Response

Plock,1

⏱ **Wait 300ms** **1** Dec **0** Null

Plock,0

⏱ **Wait 300ms** **1** Dec **0** Null

Plock,?

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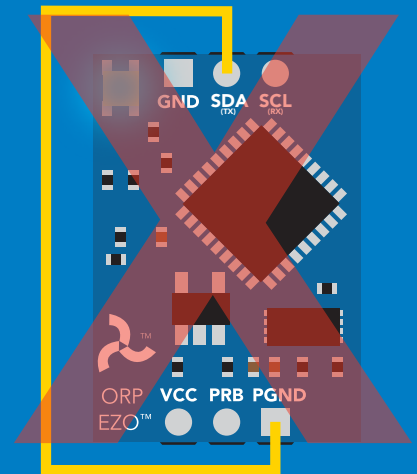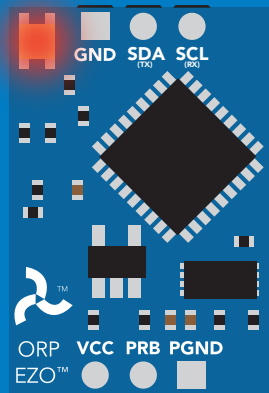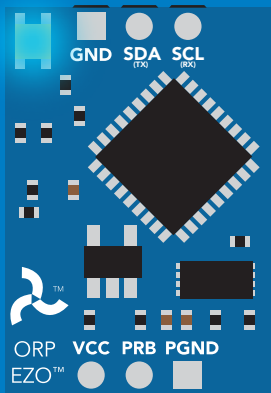
Plock,1

GND SDA (TX) SCL (RX)

ORP EZO™ VCC PRB PGND

Baud, 9600

GND SDA (TX) SCL (RX)

ORP EZO™ VCC PRB PGND

cannot change to UART

GND SDA (TX) SCL (RX)

ORP EZO™ VCC PRB PGND

cannot change to UART

AtlasScientific™
Environmental Robotics
r 0.1

I²C address change

I2C,n sets I²C address and reboots into I²C mode

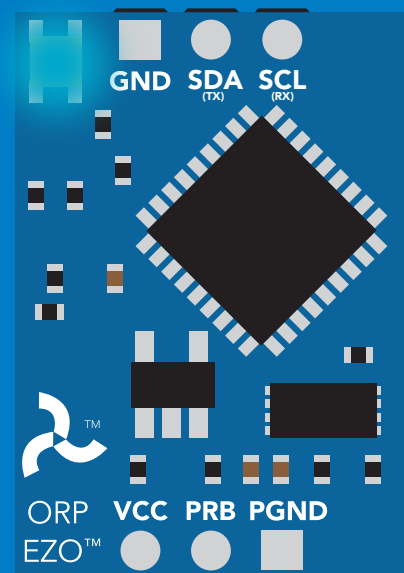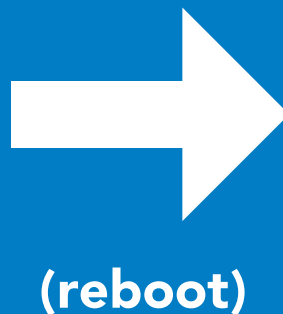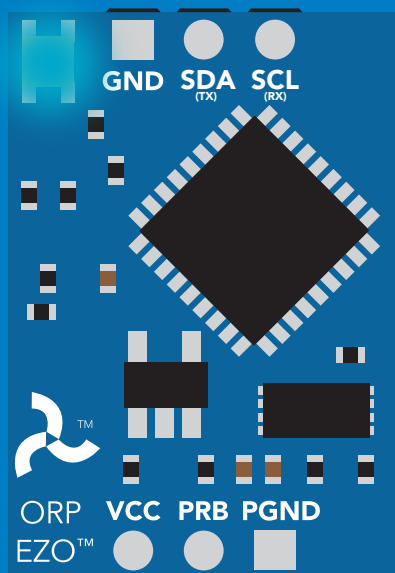| Example	Response
I2C,100	device reboot

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).

n = any number 1 – 127

I2C,100

(reboot)

AtlasScientific
Environmental Robotics
r 0.2

Factory reset

Command syntax

Factory   enable factory reset

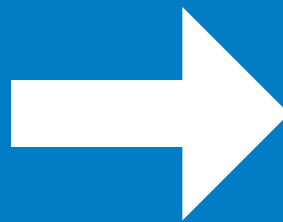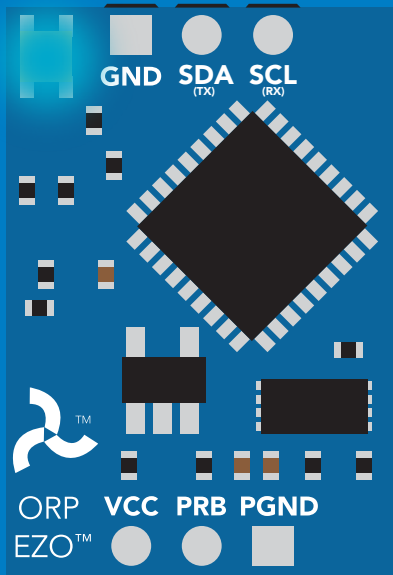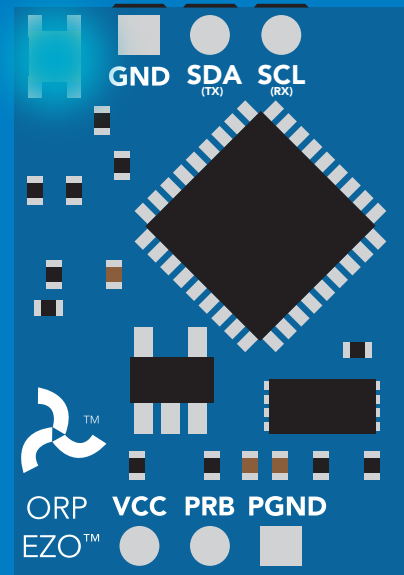| Example	Response
Factory	device reboot

Clears calibration
LED on
Response codes enabled

Factory

(reboot)

Change to UART mode

Command syntax

Baud,n   switch from I²C to UART

Example   ## Response

Baud,9600   **reboot in UART mode**

n =
- 300
- 1200
- 2400
- 9600
- 19200
- 38400
- 57600
- 115200
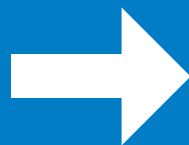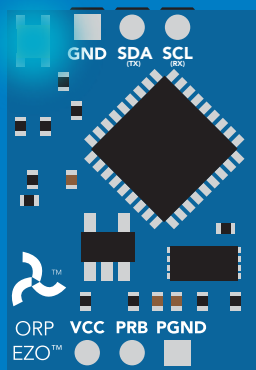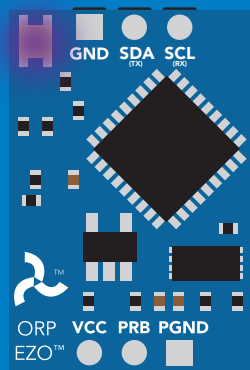
Baud,9600   **Changing to UART mode**   **(reboot)**

AtlasScientific
Environmental Robotics
r 0.1
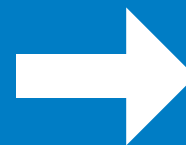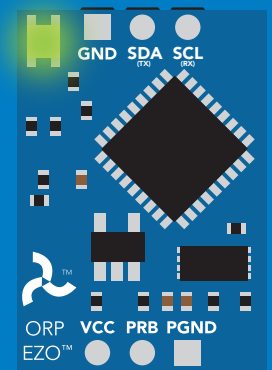
Manual switching to UART

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

Example

Short

Wrong Example

Short

Disconnect RX line

EZO™ circuit footprint

GND   **TX** (SDA)   **RX** (SCL)

ORP EZO™   **VCC**   **PRB**   **PGND**

17.78mm (0.7")

2.54mm (0.1")
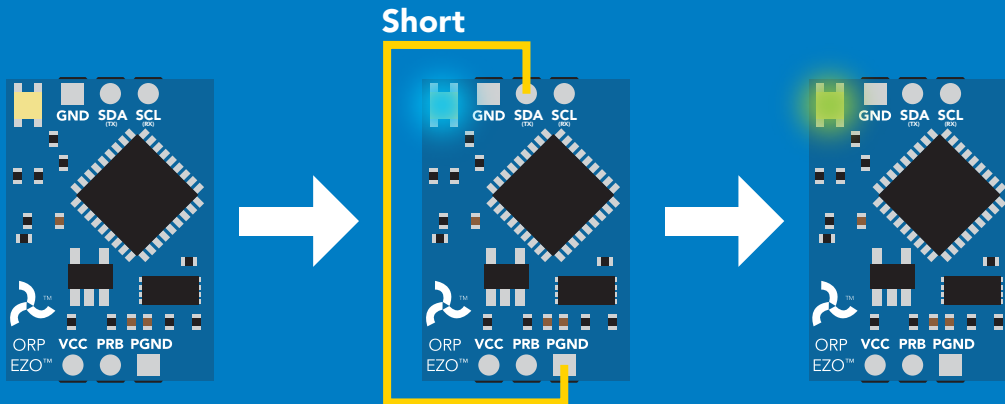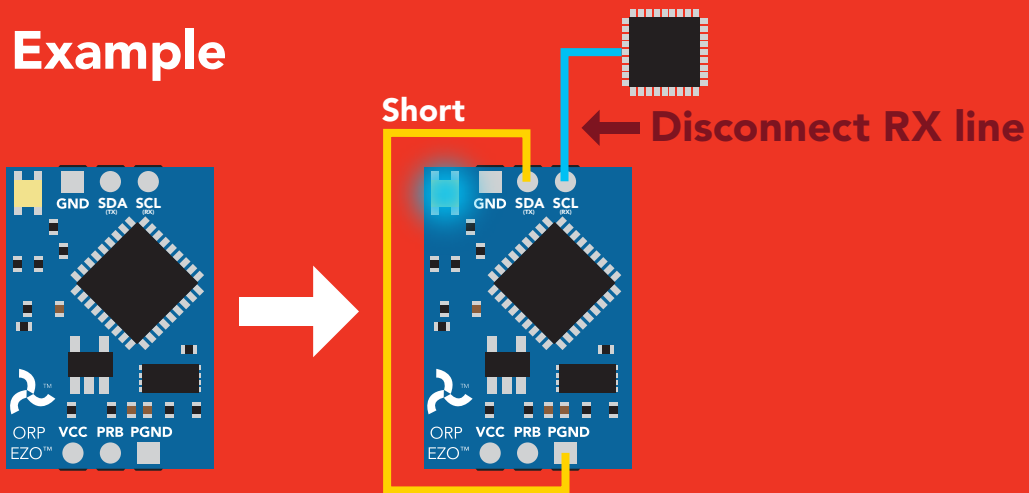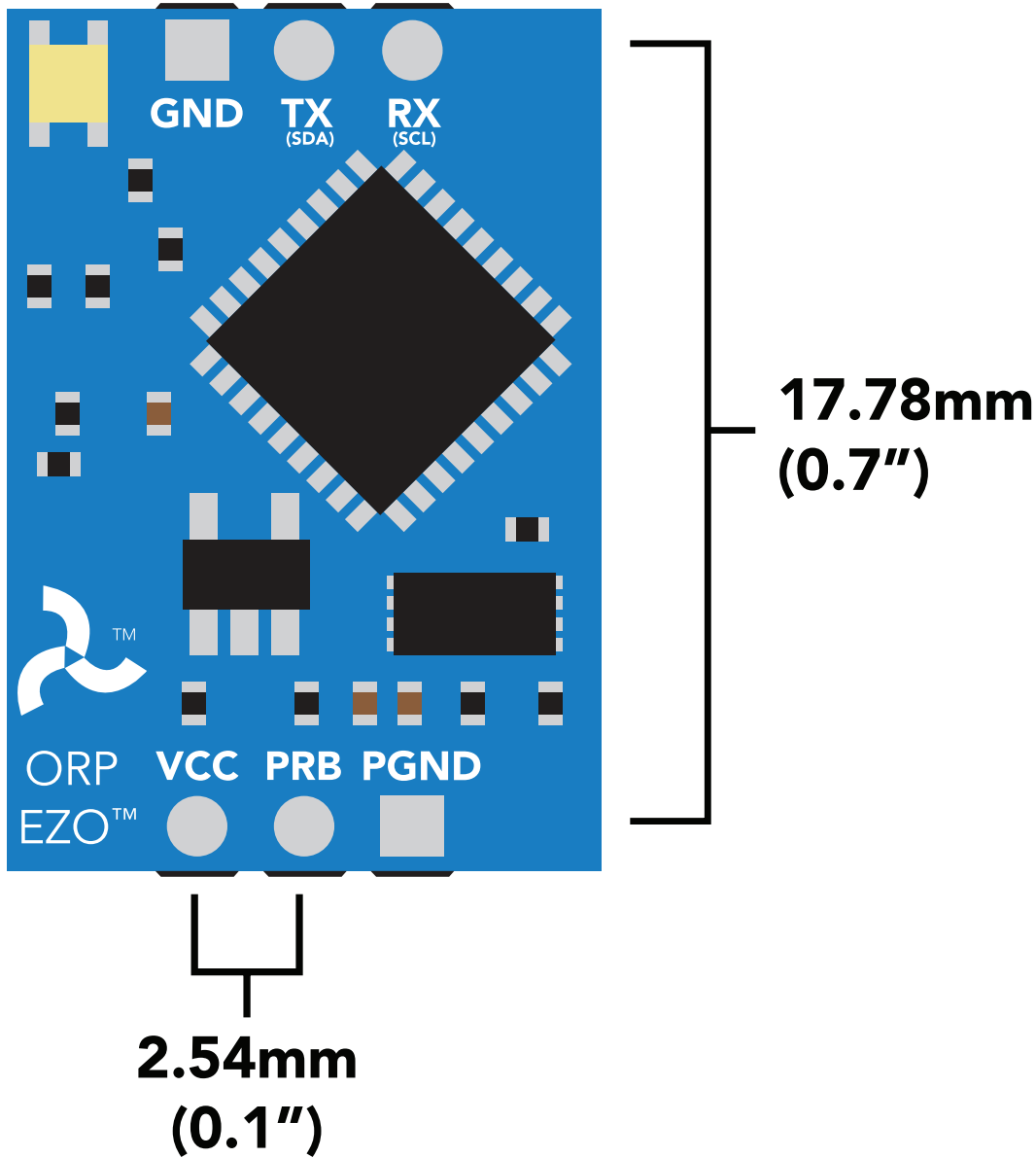
1 In your CAD software place a 8 position header.
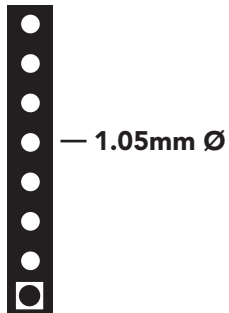
2 Place a 3 position header at both top and bottom of the 8 position.
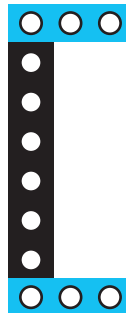
3 Delete the 8 position header. The two 3 position headers are now 17.78mm (0.7") apart from each other.

— 1.05mm Ø

17.78mm (0.7")

Copyright © Atlas Scientific LLC

AtlasScientific™
Environmental Robotics

r 0.1
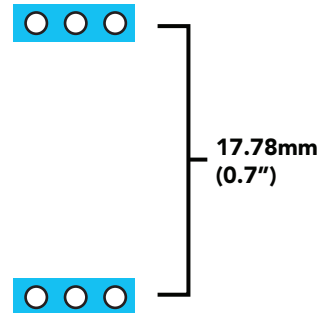
Datasheet change log

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.

AtlasScientific
Environmental Robotics

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.

AtlasScientific
Environmental Robotics

Firmware updates

V1.5 – Baud rate change (Nov 6, 2014)
• Change default baud rate to 9600

V1.6 – I^{2}C bug (Dec 1, 2014)
• Fixed I^{2}C bug where the circuit may inappropriately respond when other I^{2}C devices
  are connected.

V1.7 – Factory (April 14, 2015)
• Changed "X" command to "Factory"

V1.95 – Plock (March 31, 2016)
• Added protocol lock feature "Plock"

V1.96 – EEPROM (April 26, 2016)
• Fixed 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.

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.**

AtlasScientific™

Environmental Robotics

r 0.1

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.

AtlasScientific™
Environmental Robotics
r 0.1