

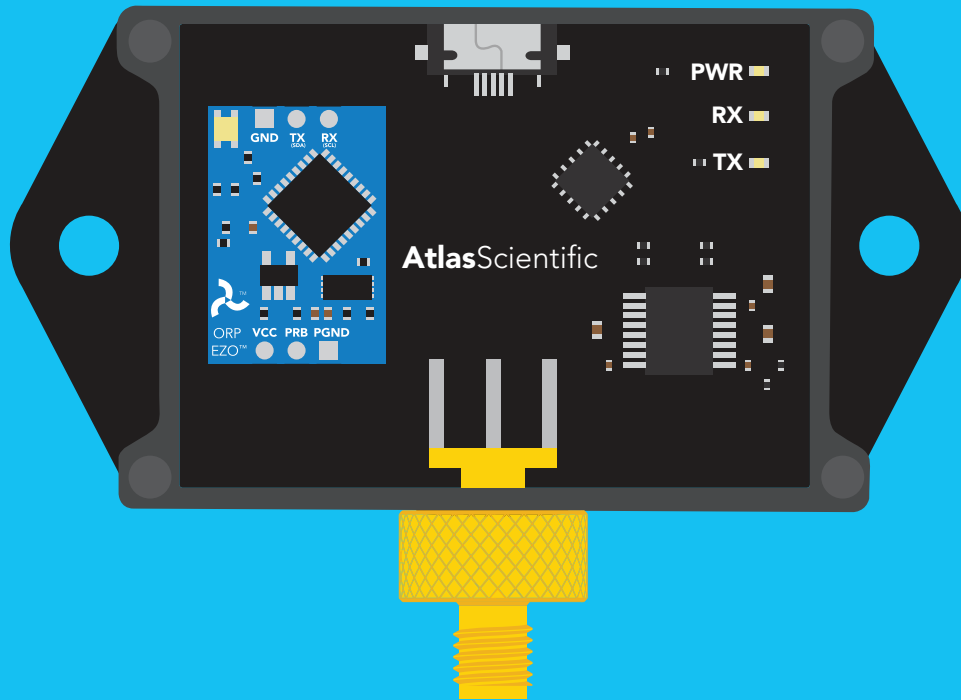
EZO Complete-ORP™

USB ORP meter

Datasheet for engineers

ISO 11271 Compliant

(determination of redox potential)



Reads	ORP	Calibration	Single point
		Recalibration frequency	~8–12 months
Range	-1020mV to 1020mV	Data protocol	Serial data through FTDI virtual comport
Accuracy	+/-1mV	Data format	ASCII
ORP reading time	800ms	Ingress protection	IP62
Supported probes	Any type & brand		



Written by Jordan Press
Designed by Noah Press

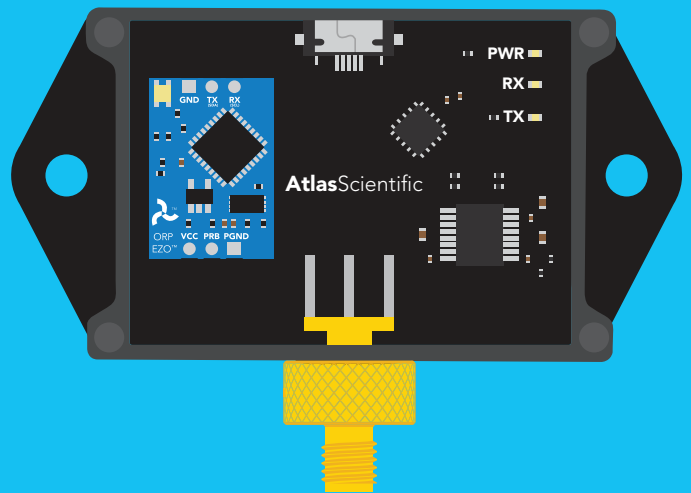
PATENT PROTECTED

This is an evolving document, check back for updates.

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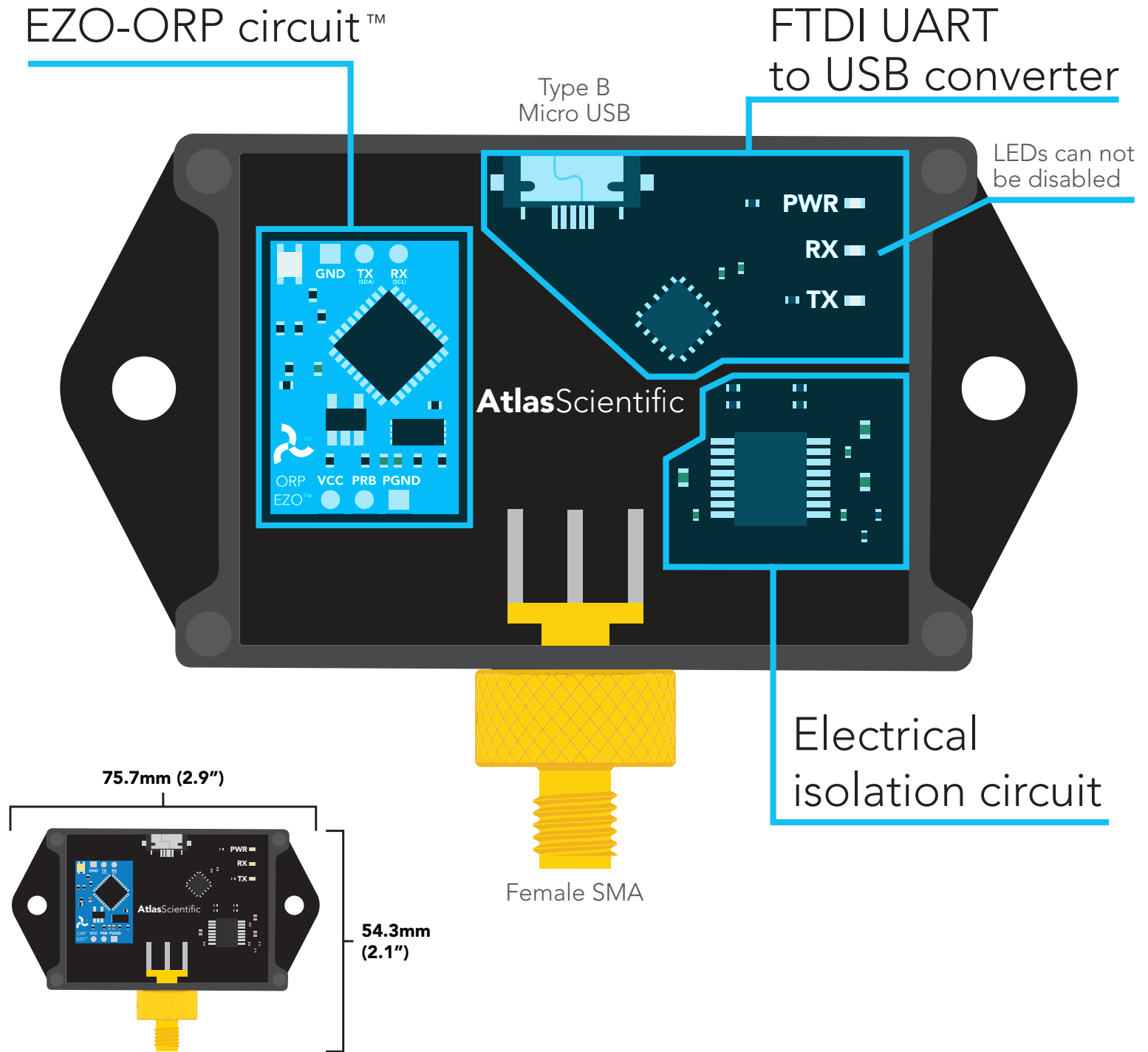
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The EZO Complete-ORP™ consists of 3 major components.



Power consumption

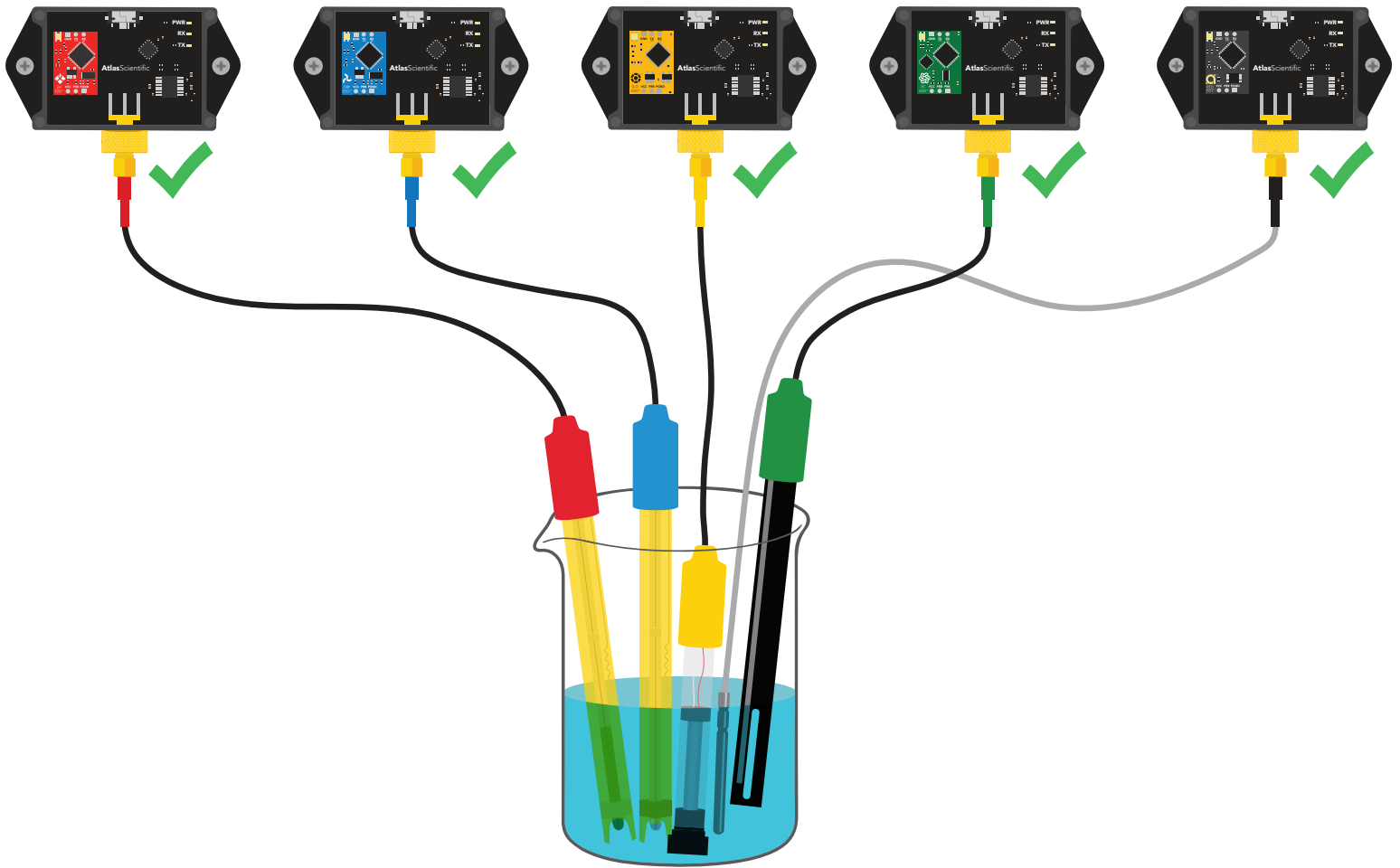
5V USB	MAX	STANDBY	SLEEP
	37.0 mA	36.8 mA	22.6 mA

Absolute max ratings

Parameter	MIN	TYP	MAX
Storage temperature	-65 °C		125 °C
Operational temperature	-40 °C	25 °C	85 °C

Interference free

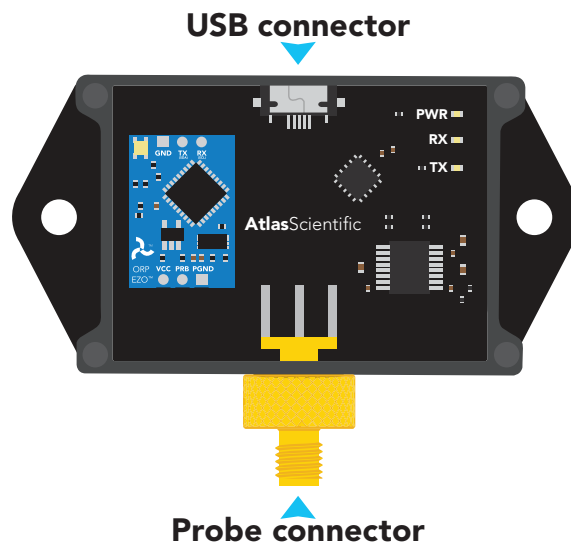
The EZO complete readings are unaffected by other sensors in the same water.



Ingress protection – IP62

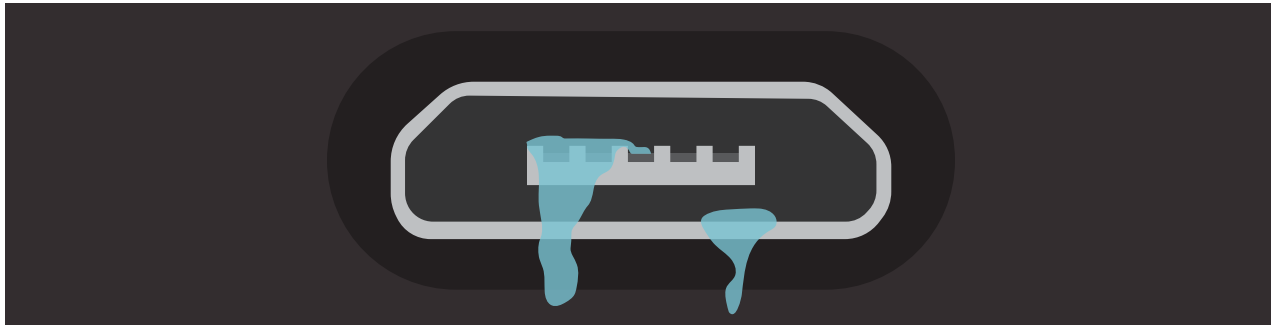
The EZO Complete-ORP™ is dust proof and resistant to splashing water.

Two areas of concern are the *USB connector* and the *probe connector*.



Ingress protection – IP62

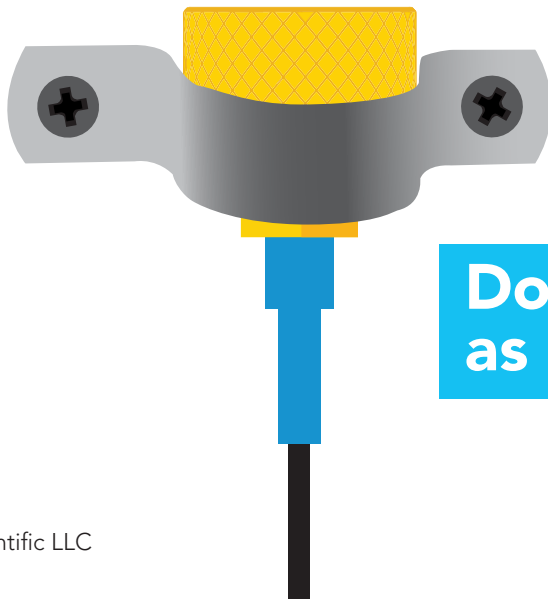
An electrical short can occur if water enters the USB connector. A USB short could permanently damage the EZO-Complete. A USB short is not covered under warranty.



A connector short can occur if water enters the SMA connector. A connector short will cause the ORP readings to pin to -1020, +1020, or the probe will respond slowly to changes in ORP. A connector short is reversible and will not damage the EZO-Complete. However, frequent shorts will eventually damage the ORP probe.

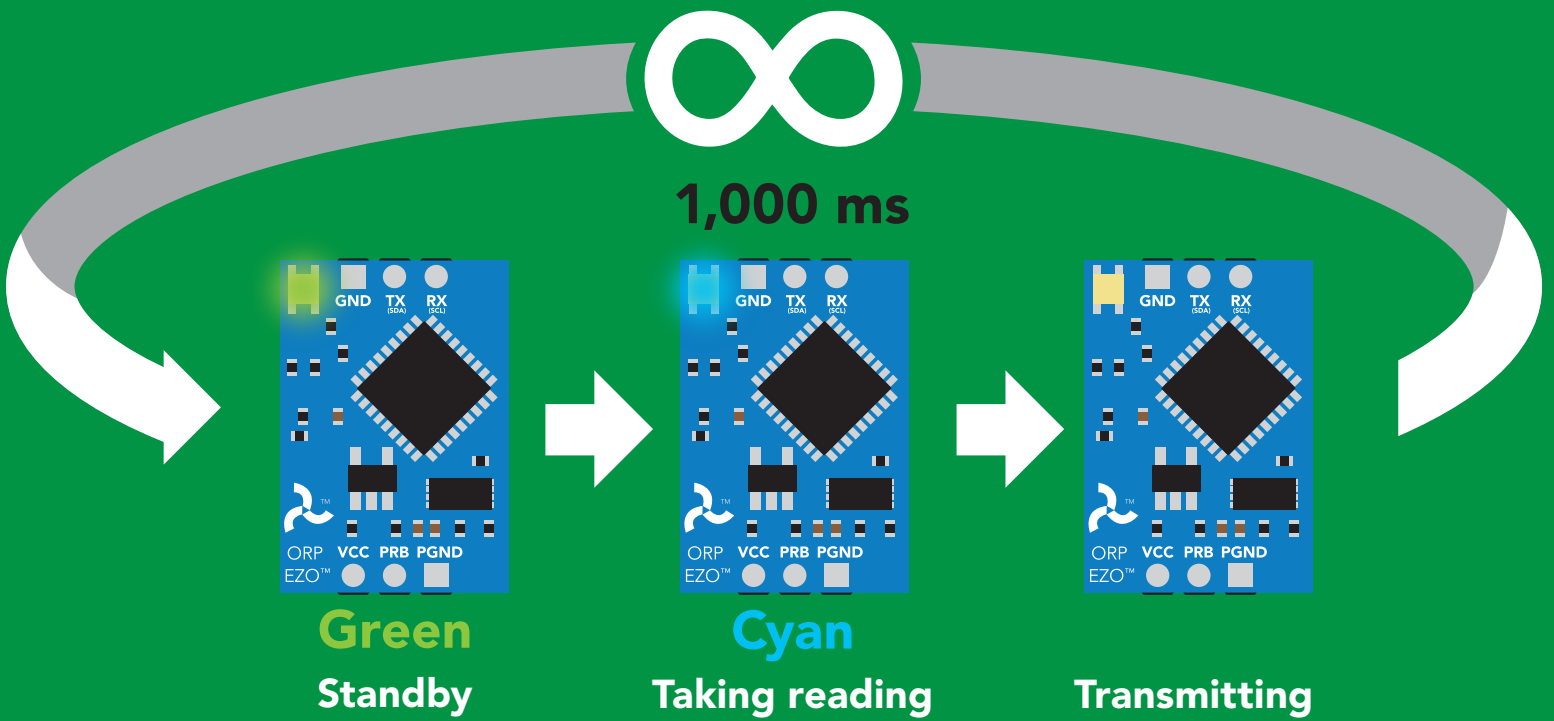


The SMA connector is part of your probe; Nothing should be in contact with this part.

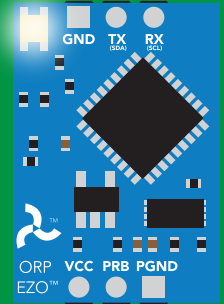
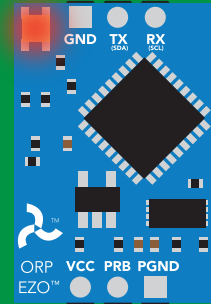
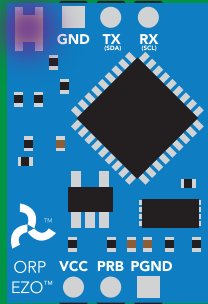
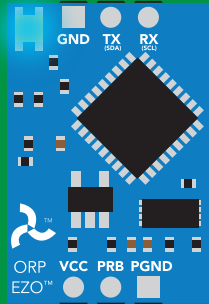
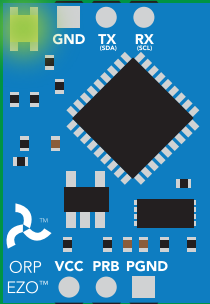


Default state

Baud 9,600
Readings continuous
Speed 1 reading per second



LED color definition



Green
UART standby

Cyan
Taking reading

Purple
Changing baud rate

Red
Command not understood

White
Find

5V

LED ON
+2.2 mA

3.3V

+0.6 mA

Settings that are retained if power is cut

- Calibration
- Continuous mode
- Device name
- Enable/disable response codes
- LED control
- Protocol lock

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

- Find
- Sleep mode
- Temperature compensation

Receiving data from device

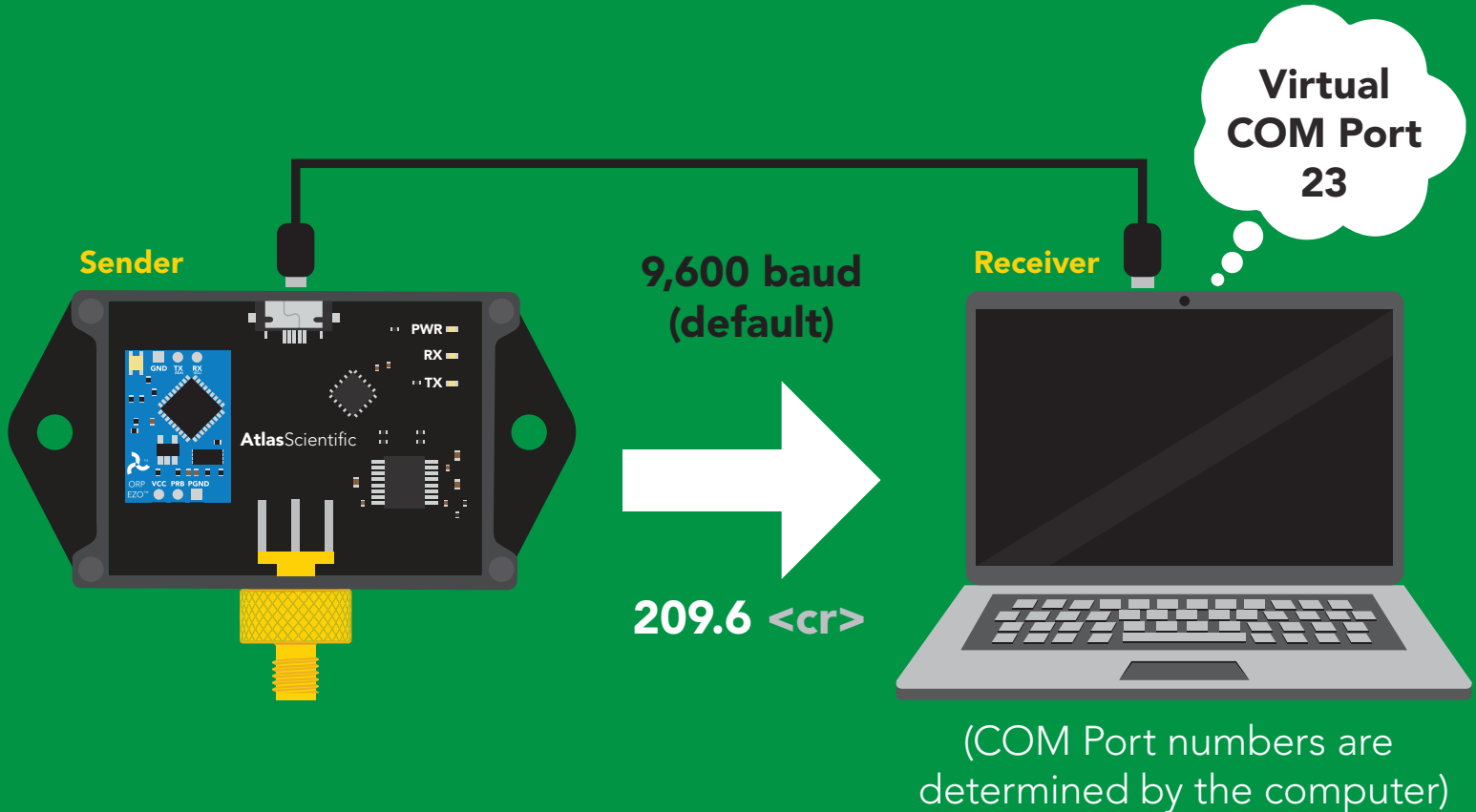
2 parts

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

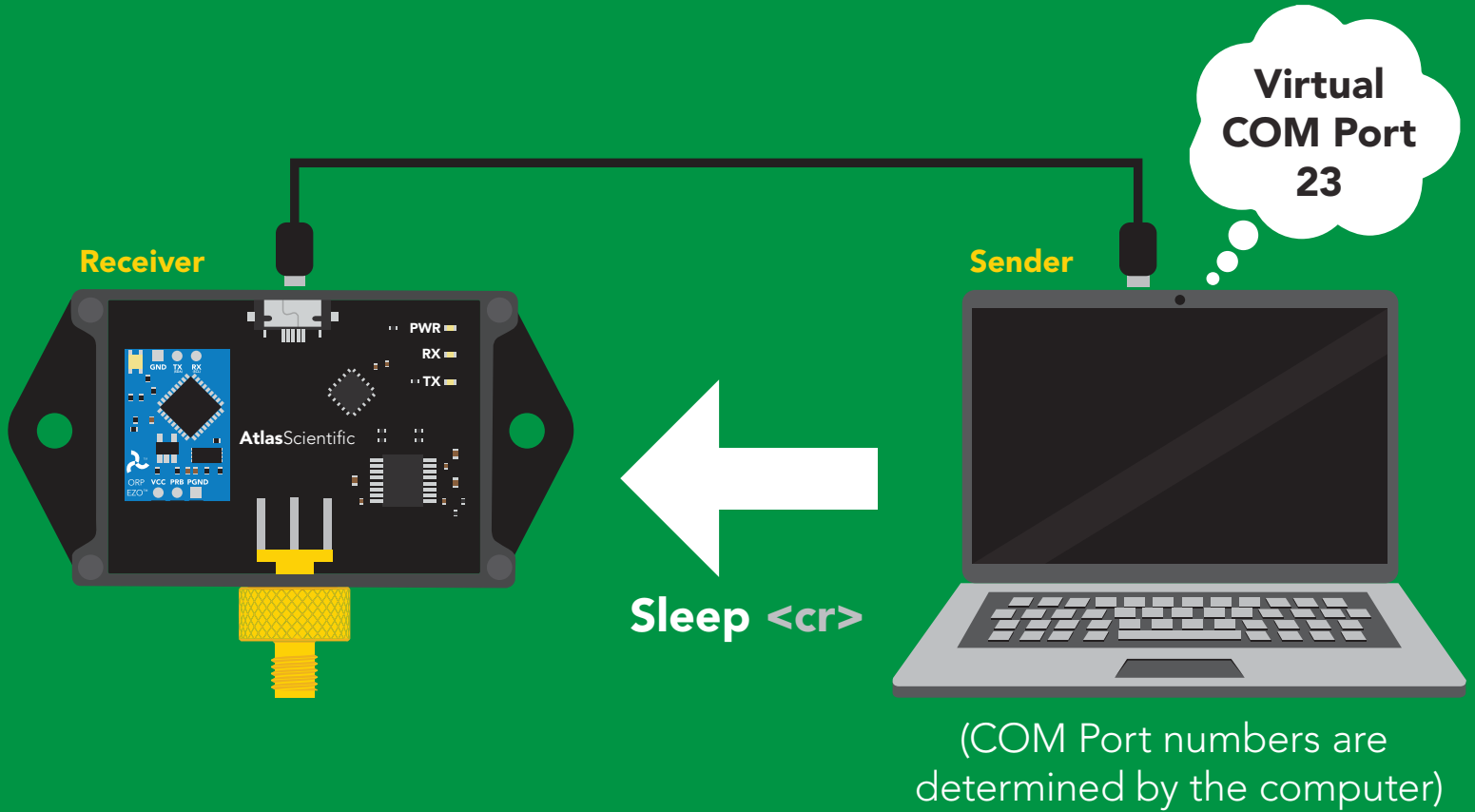
2 parts

Command (not case sensitive)

ASCII data string

Carriage return <cr>

Terminator



Advanced

ASCII: **S** **I** **e** **e** **p** **<cr>**

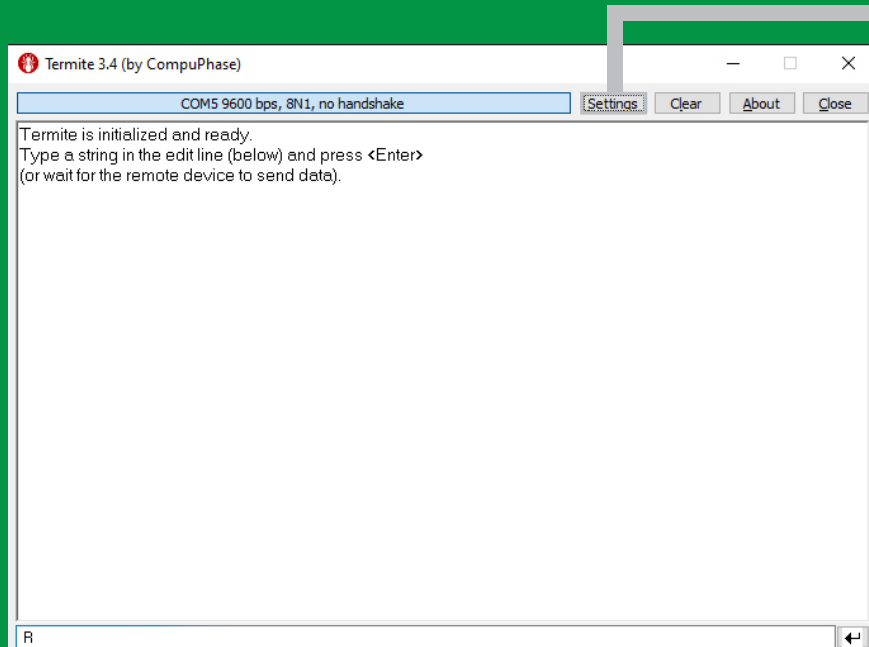
Hex: **53** **6C** **65** **65** **70** **0D**

Dec: **83** **108** **101** **101** **112** **13**

Looking for a simple serial monitor for debugging?

Termite: a simple RS232 terminal

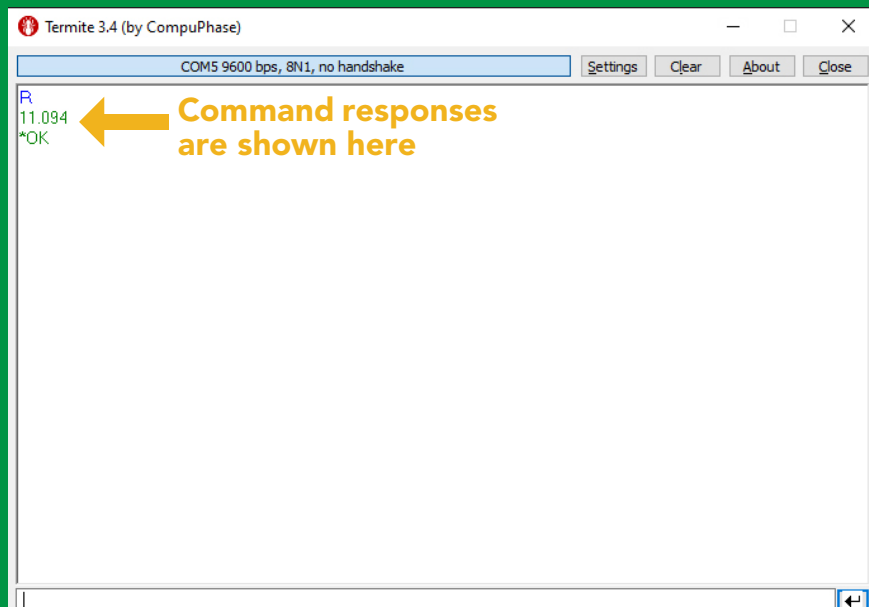
[Click here to download](#)



Settings

Baud 9600	Parity none
Data bits 8	flow control none
Stop bits 1	Forward none
Transmitted text append CR	

Enter commands here



Command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function		Default state
C	enable/disable continuous reading	pg. 14	enabled
Cal	performs calibration	pg. 16	n/a
Export	export calibration	pg. 17	n/a
Factory	enable factory reset	pg. 25	n/a
Find	finds device with blinking white LED	pg. 13	n/a
i	device information	pg. 21	n/a
Import	import calibration	pg. 18	n/a
L	enable/disable LED	pg. 12	enabled
Name	set/show name of device	pg. 20	not set
ORPext	enable/disable extended ORP scale	pg. 19	disabled
R	returns a single reading	pg. 15	n/a
Sleep	enter sleep mode/low power	pg. 24	n/a
Status	retrieve status information	pg. 23	n/a
*OK	enable/disable response codes	pg. 22	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>

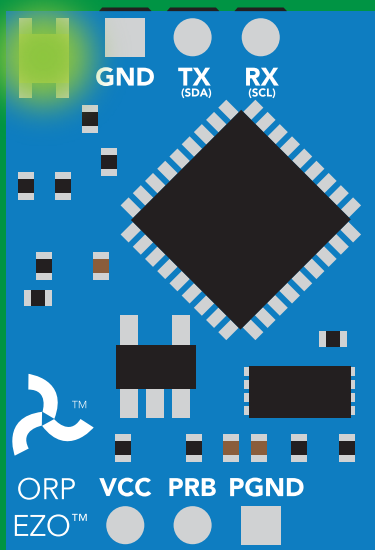
L,0 <cr>

*OK <cr>

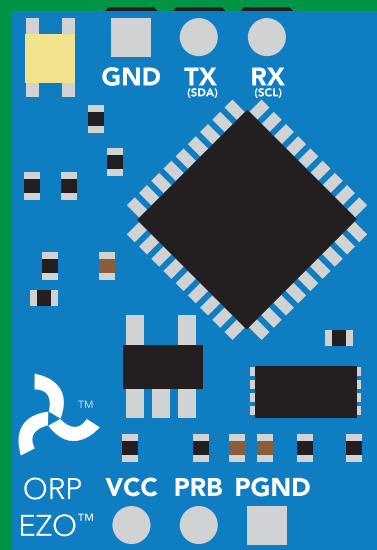
L,? <cr>

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

*OK <cr>



L,1



L,0

Find

Command syntax

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

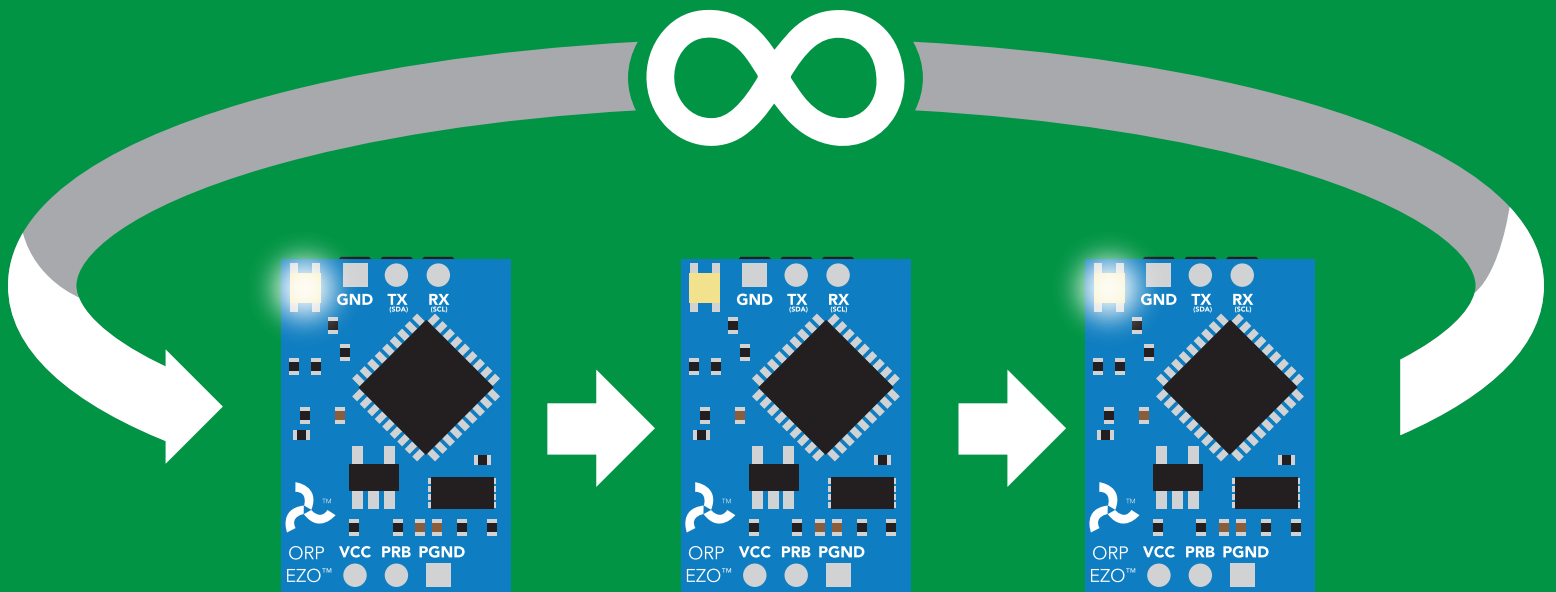
Find <cr> LED rapidly blinks white, used to help find device

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

A single reading takes 800ms

R <cr> takes single reading

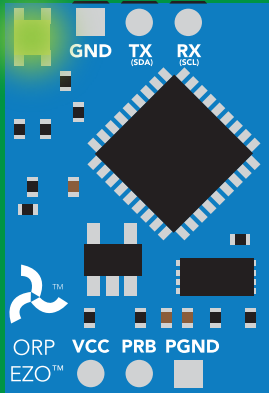
Example

R <cr>

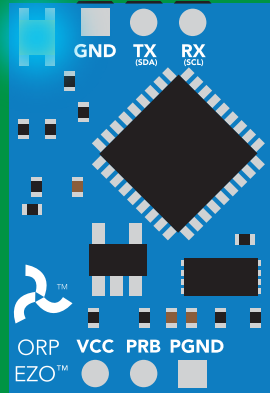
Response

9.560 <cr>

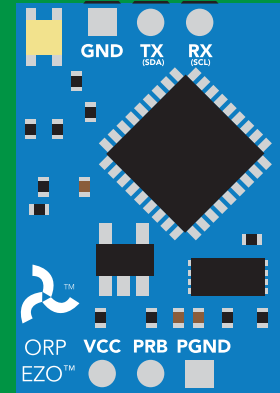
*OK <cr>



Green
Standby



Cyan
Taking reading



Transmitting



800 ms

Calibration

Command syntax

The EZO Complete-ORP™ 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>

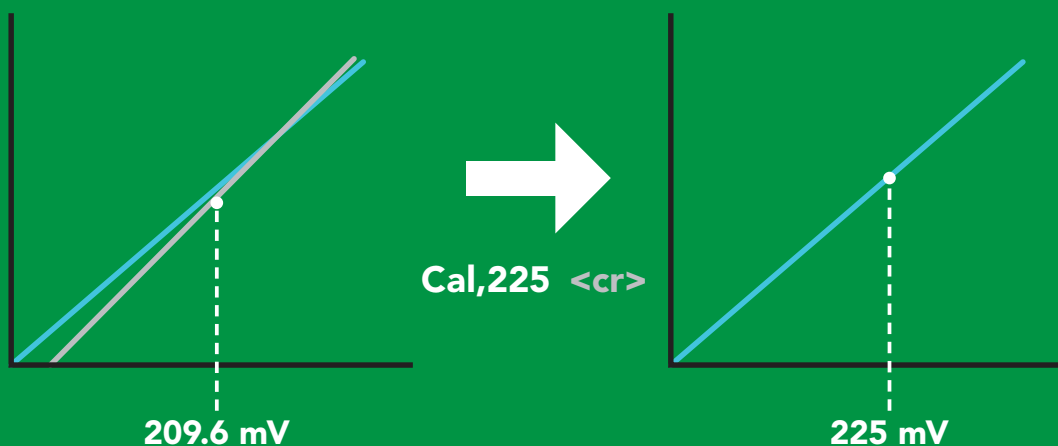
***OK** <cr>

Cal,clear <cr>

***OK** <cr>

Cal,? <cr>

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



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>

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>

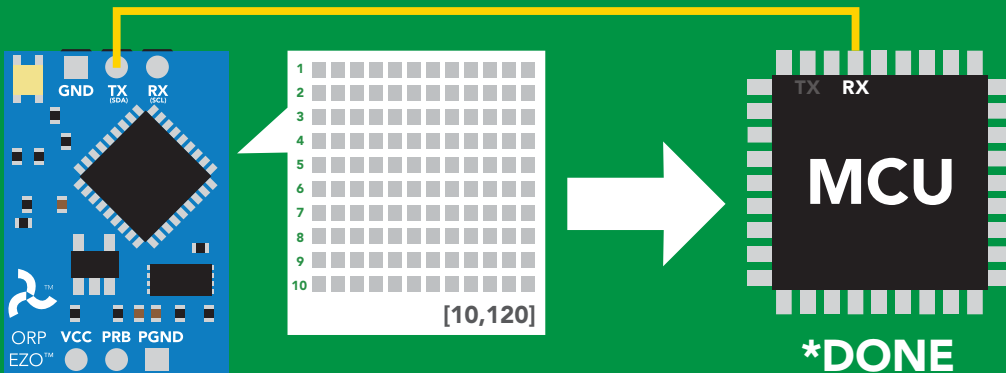
6F 6C 20 67 75 79 <cr> (10 of 10)

Export <cr>

***DONE**

Disabling *OK simplifies this process

Export <cr>



Import calibration

Command syntax

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

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

Example

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

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

⋮

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

Response

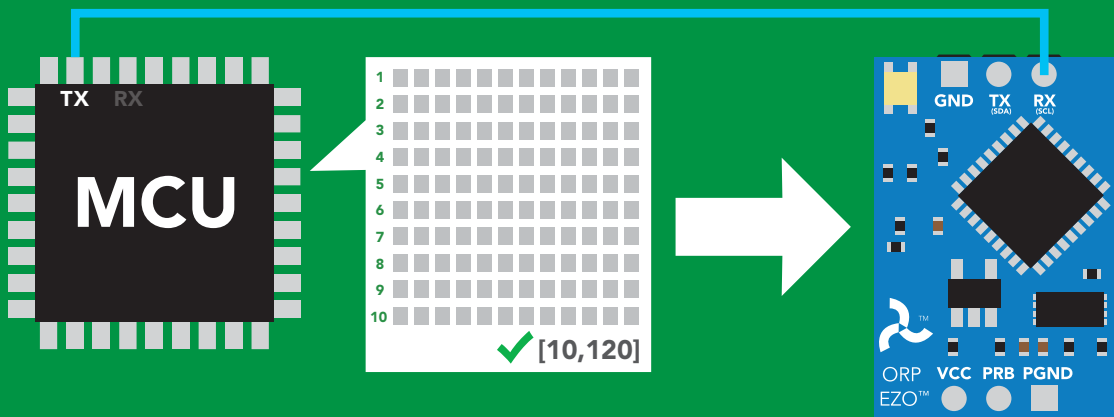
*OK <cr>

*OK <cr>

⋮

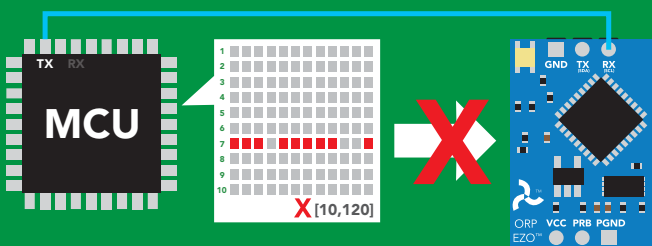
*OK <cr>

Import,n <cr>



*OK <cr>

system will reboot



*ER <cr>

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

Extended ORP scale

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

Lowest possible reading: **-2040mV**

Highest possible reading: **2040mV**

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>

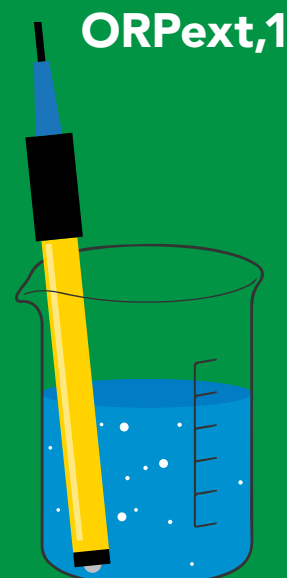
***OK** <cr>

ORPext,? <cr>

?ORPext,1 <cr> **or** **?ORPext,0** <cr>



ORP = -1020mV



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

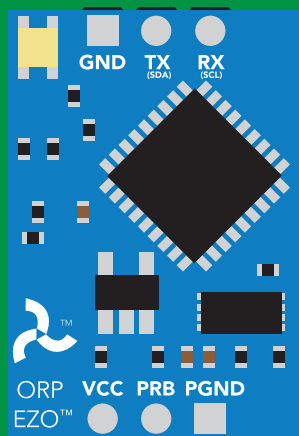
Name,zzt <cr>

*OK <cr>

Name,? <cr>

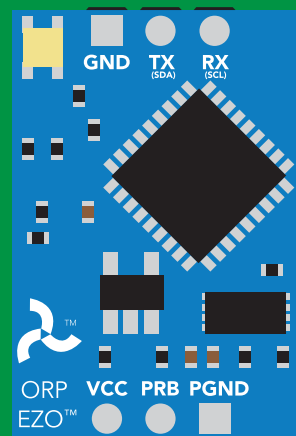
?Name,zzt <cr>
*OK <cr>

Name,zzt



*OK <cr>

Name,?



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

Device information

Command syntax

```
i <cr> device information
```

Example

```
i <cr>
```

Response

```
?i,ORP,1.97 <cr>  
*OK <cr>
```

Response breakdown

```
?i,  ORP,  1.97  
    ↑      ↑  
  Device Firmware
```

Response codes

Command syntax

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

Example

Response

R <cr>

9.560 <cr>
***OK** <cr>

***OK,0** <cr>

no response, ***OK** disabled

R <cr>

9.560 <cr> ***OK** disabled

***OK,?** <cr>

?*OK,1 <cr> or **?*OK,0** <cr>

Other response codes

- *ER** unknown command
- *OV** over volt ($VCC \geq 5.5V$)
- *UV** under volt ($VCC \leq 3.1V$)
- *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

```
Status <cr>
```

Response

```
?Status,P,5.038 <cr>  
*OK <cr>
```

Response breakdown

?Status,	P,	5.038
	↑	↑
	Reason for restart	Voltage at Vcc

Restart codes

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

Sleep mode/low power

Command syntax

Send any character or command to awaken device.

Sleep <cr> enter sleep mode/low power

Example

Response

Sleep <cr>

*OK <cr>

*SL <cr>

Any command

*WA <cr> wakes up device

5V

STANDBY

16 mA

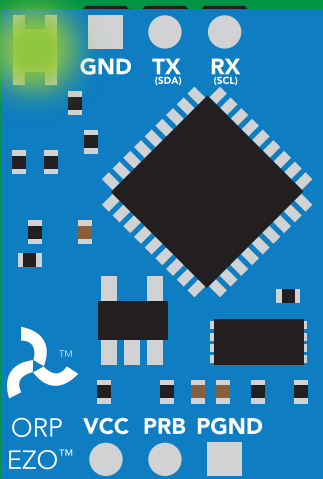
SLEEP

1.16 mA

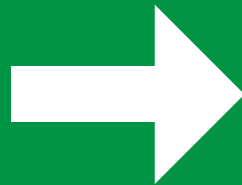
3.3V

13.9 mA

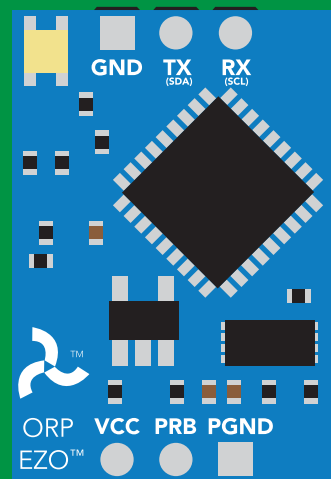
0.995 mA



Standby
16 mA



Sleep <cr>



Sleep
1.16 mA

Factory reset

Command syntax

Clears calibration
LED on
"*OK" enabled

Factory <cr> enable factory reset

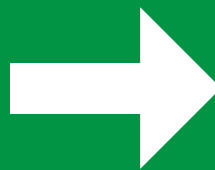
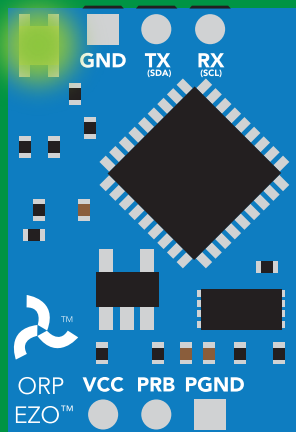
Example

Response

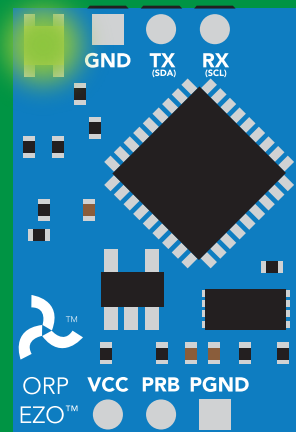
Factory <cr>

*OK <cr>

Factory <cr>



(reboot)



*OK <cr>

*RS <cr>

*RE <cr>

Baud rate will not change

Calibration theory

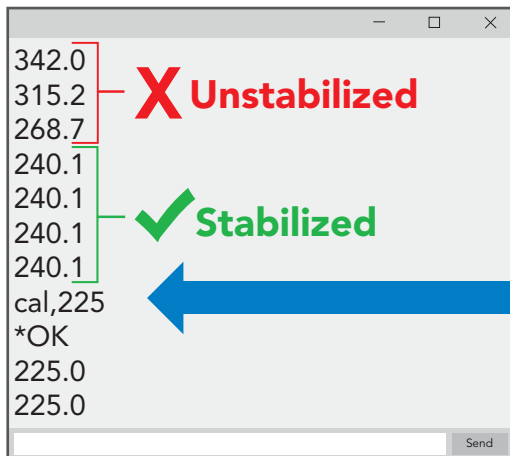
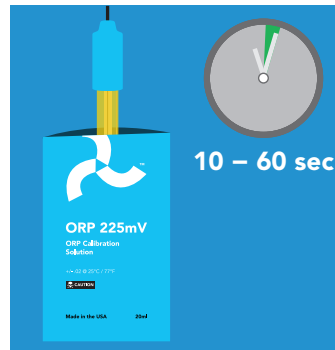
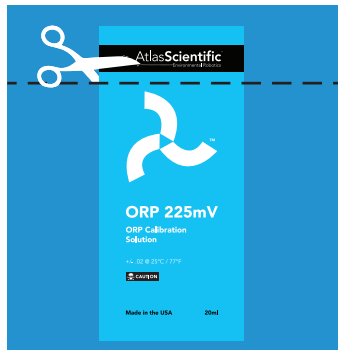
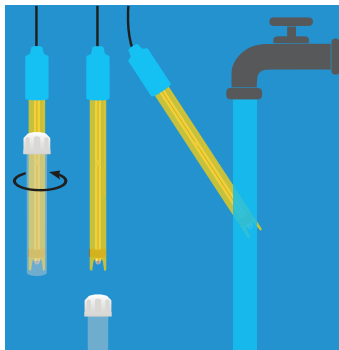
The Atlas Scientific EZO Complete-ORP™ circuit has a flexible calibration protocol, allowing singlepoint calibration to **any off the shelf calibration solution**.

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



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*).



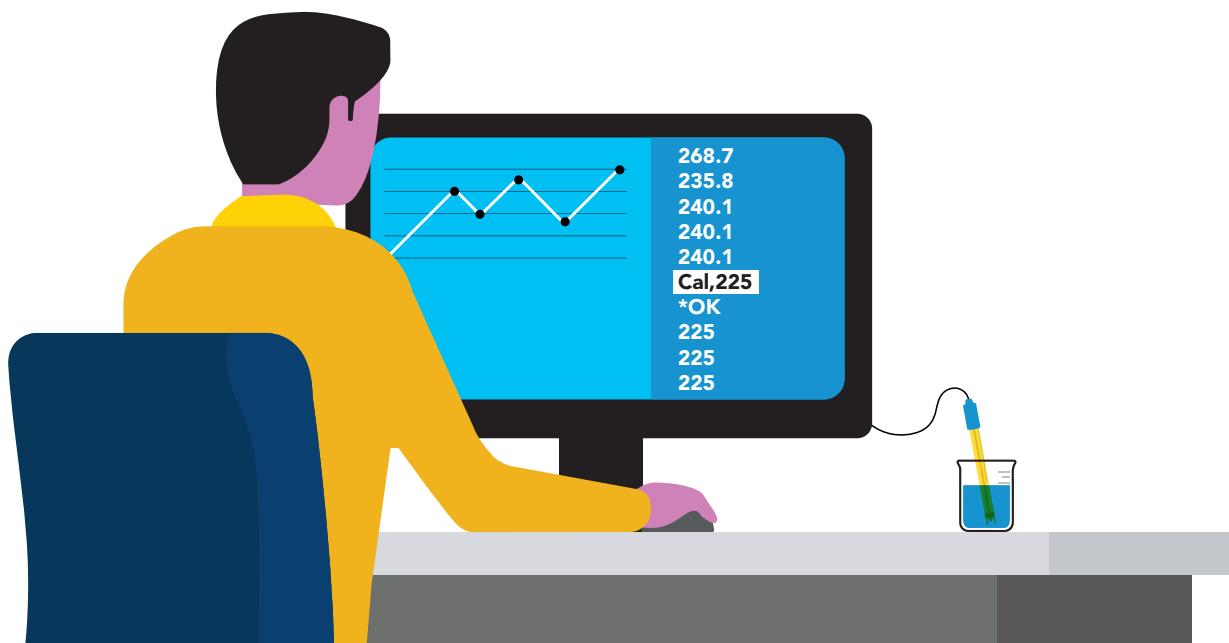
Once the readings have stabilized, issue the calibration command. In this case **"cal,225"**

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.

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.



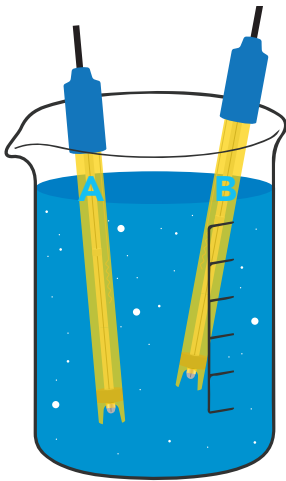
ORP measurement insights

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

The water is unreactive and has only trace amounts of electron movement. *These readings are equivalent to the readings you see with an unconnected multimeter.*

-234.6

Reading A



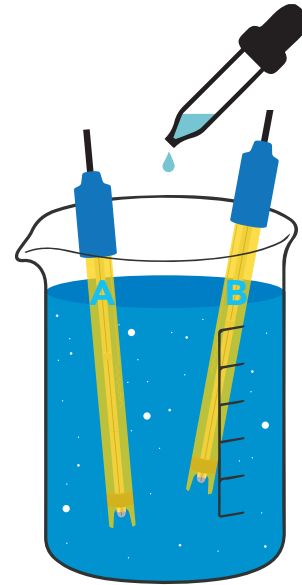
Tap water

24.2

Reading B

606.9

Reading A



Tap water

605.3

Reading B

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 a part of whatever reaction is occurring in the liquid.

Datasheet change log

Datasheet V 1.2

Added ORP Extended Scale found on page 19.

Datasheet V 1.1

Revised probe artwork.

Datasheet V 1.0

Revised entire document.

Firmware updates

V1.5 – Baud rate change (Nov 6, 2014)

- Change default baud rate to 9600

Warranty

Atlas Scientific™ Warranties the EZO Complete device to be free of defects during the debugging phase of device implementation or 30 days after receiving the EZO Complete device (*whichever comes first*).

The debugging phase

As defined by Atlas Scientific™, the debugging phase is when the EZO Complete device is connected to a computer to evaluate its output and/or is being integrated into custom software.

The following activities will void the EZO Complete device warranty:

- **Soldering any part of the EZO™ class device.**
- **Removing any potting compound.**
- **Embedding the EZO Complete device into a custom machine.**

Reasoning behind this warranty

Atlas Scientific™ does not sell consumer electronics. Once the device has been embedded into a custom-made machine, Atlas Scientific™ cannot possibly warranty the EZO Complete device against the thousands of possible variables that may cause the device to malfunction.

Please keep this in mind:

- 1. All Atlas Scientific™ devices have been designed to be embedded into a custom-made machine by you, the embedded systems engineer.**
- 2. All Atlas Scientific™ devices have been designed to run indefinitely without failure in the field.**

Atlas Scientific™ is simply stating that once the device is being used in your machine or application, Atlas Scientific™ can no longer take responsibility for the device's continued operation. Doing so would be equivalent to Atlas Scientific™ taking responsibility for the correct operation of your entire machine.