Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

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Atlas Scientific™
Environmental Robotics

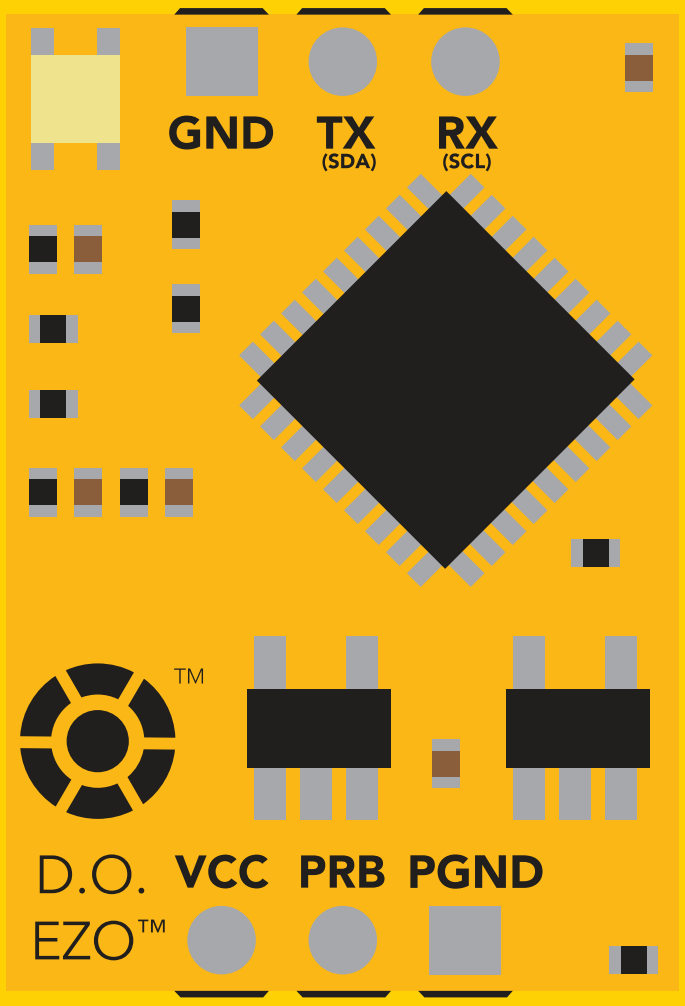
V 4.7

Revised 7/16/18

EZO-DO™

Embedded Dissolved Oxygen Circuit

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

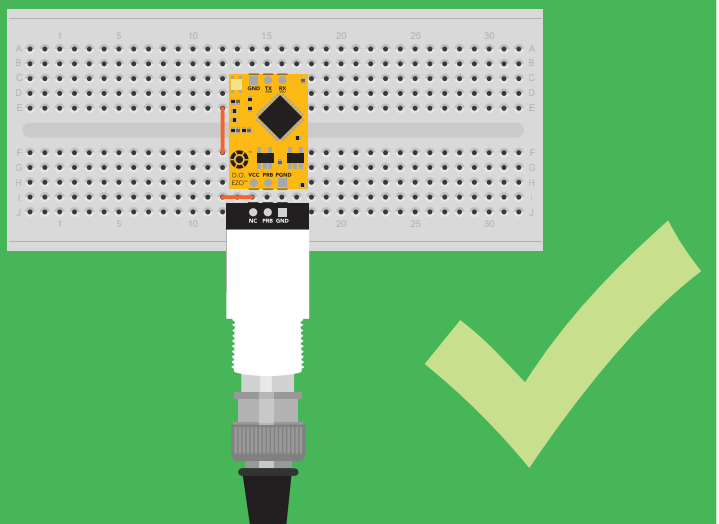
STOP

SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

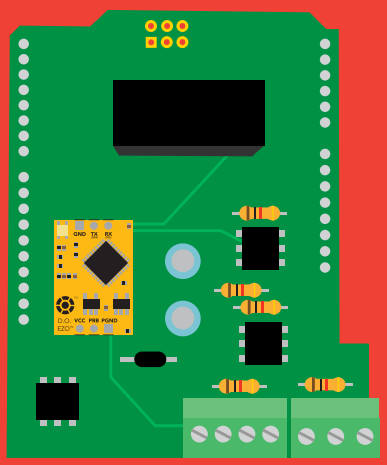
This is sensitive electronic equipment. Get this device working in a solderless breadboard first. Once this device has been soldered it is no longer covered by our warranty.

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!



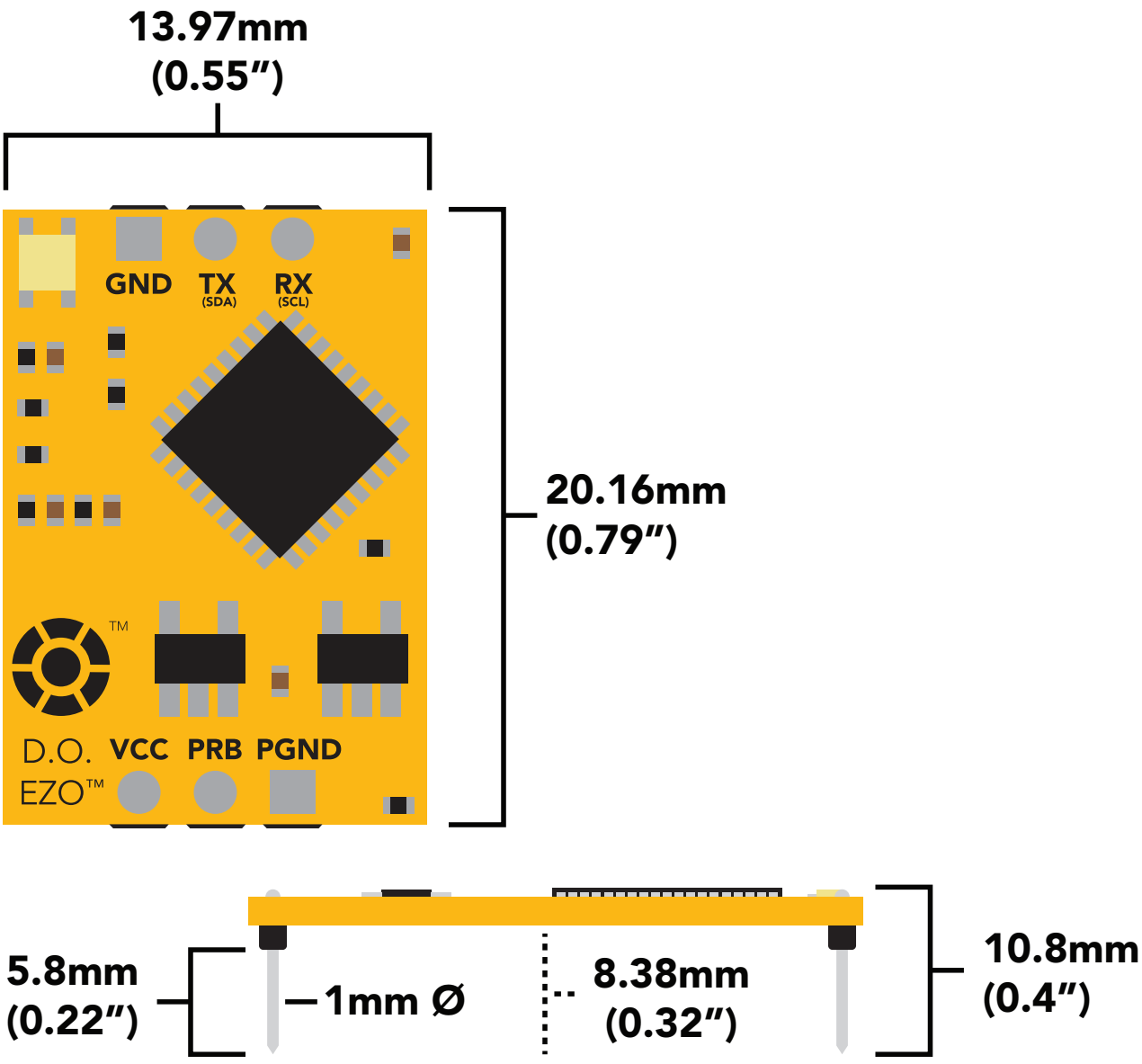
r 0.1

Table of contents

UART

I²C

EZO™ circuit dimensions



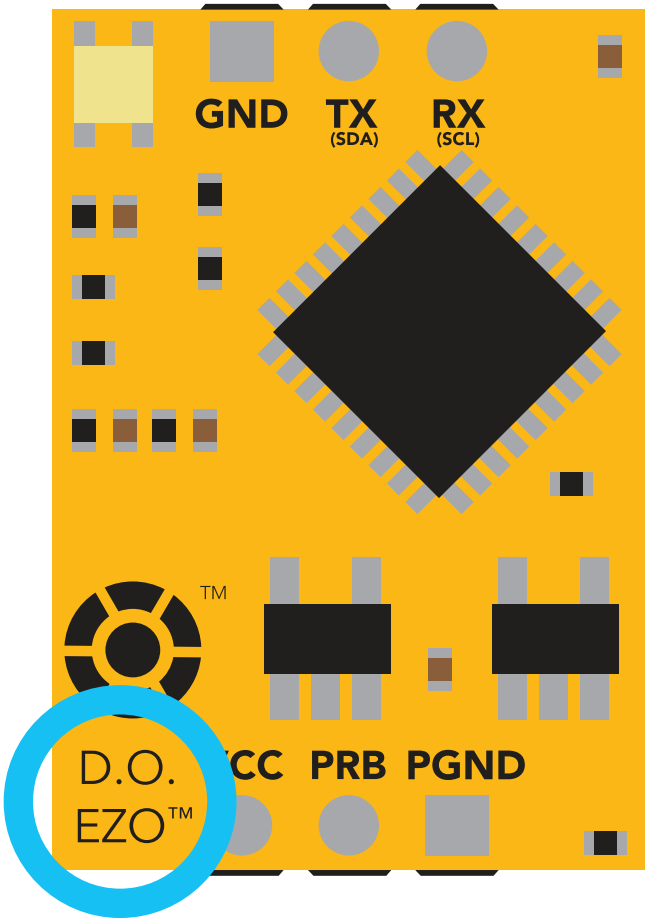
Power consumption

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

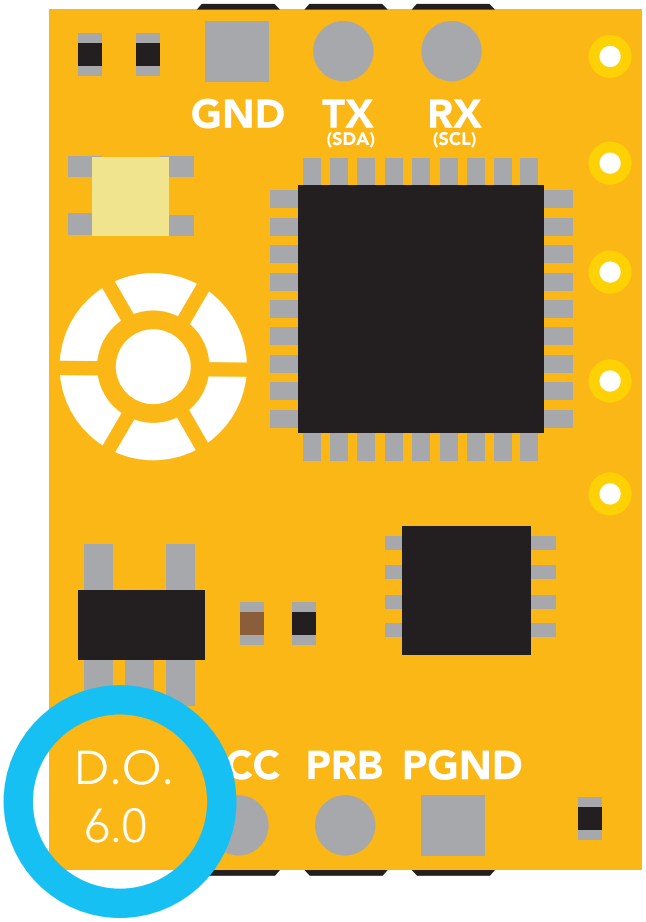
Absolute max ratings

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

EZO™ circuit identification



EZO™ Dissolved Oxygen circuit



Legacy Dissolved Oxygen circuit

Viewing correct datasheet

Viewing incorrect datasheet

Click here to view legacy datasheet

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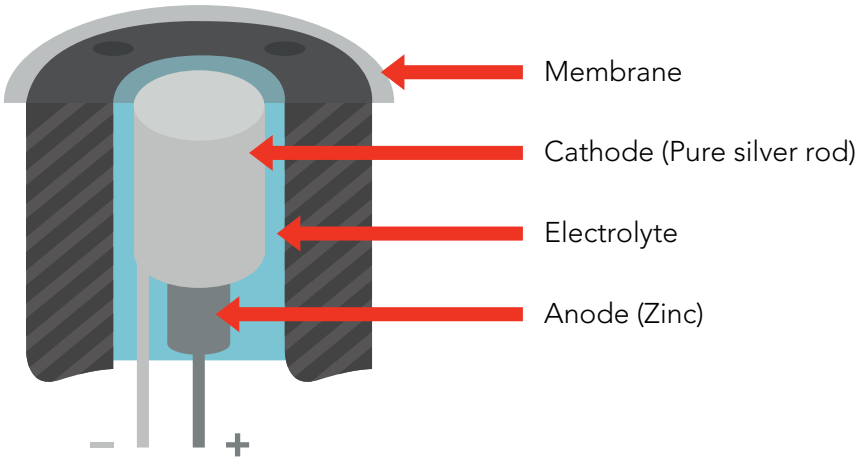
Operating principle

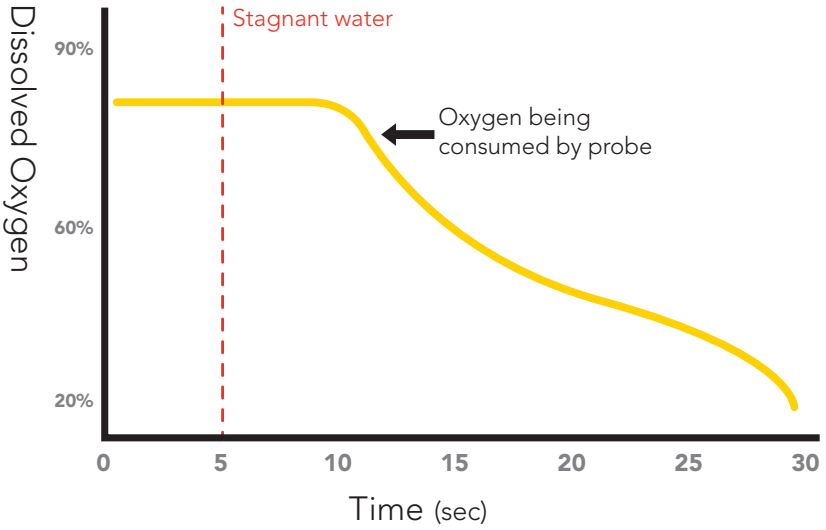
The Atlas Scientific™ EZO™ Dissolved Oxygen circuit works with:

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

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



Flow Dependence



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

Calibration theory

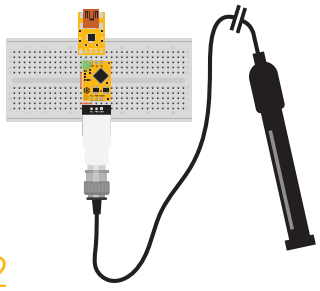
The most important part of calibration is watching the readings during the calibration process. It's easiest to calibrate the device in its default state (UART mode, continuous readings). Switching the device to I²C mode after calibration ***will not*** affect the stored calibration. If the device must be calibrated in I²C mode be sure to request readings continuously so you can see the output from the probe.

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

Calibrate first, compensate later.
Temperature, salinity and pressure compensation values have no effect on calibration.

Single point calibration

1



2

"Cal"

3

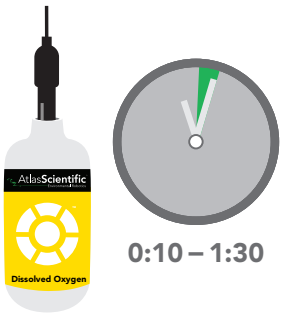
1. Pull off and discard cap from the Dissolved Oxygen probe. *(only used to protect probe during shipping)*
2. Let the Dissolved Oxygen probe sit, exposed to air untill readings stabalize *(5–30 sec)*.
3. Calibrate using the command "Cal".
4. After calibration is complete, you should see readings **~9.09 – 9.1Xmg/L**.
   (only if temperature, salinity and pressure compensation are at default values)

Dual point calibration *(optional)*

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

After you have calibrated using the command "Cal"

1



2

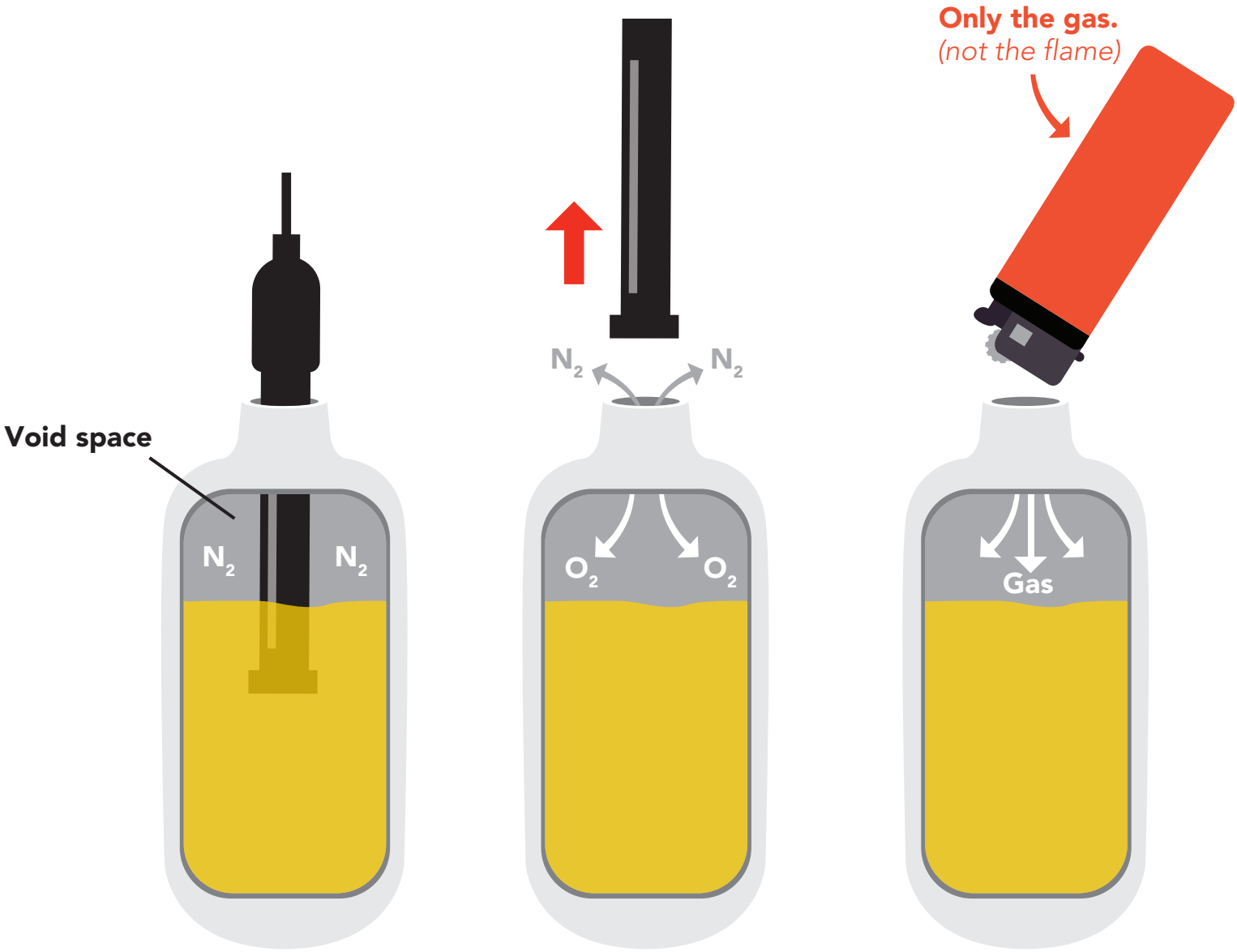
"Cal,0"

3

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

How to preserve the Zero D.O. calibration solution

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



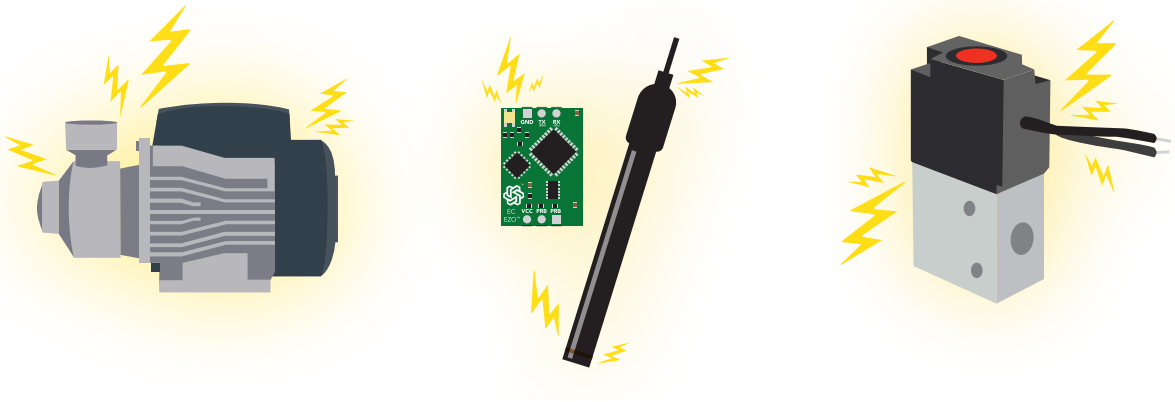
Inside each bottle of the calibration solution is a small amount of nitrogen gas that helps displace oxygen out of the bottle during the filling process. When the Dissolved Oxygen probe is removed from the bottle, oxygen will enter the bottle and begin to dissolve into the solution.

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

Power and data isolation

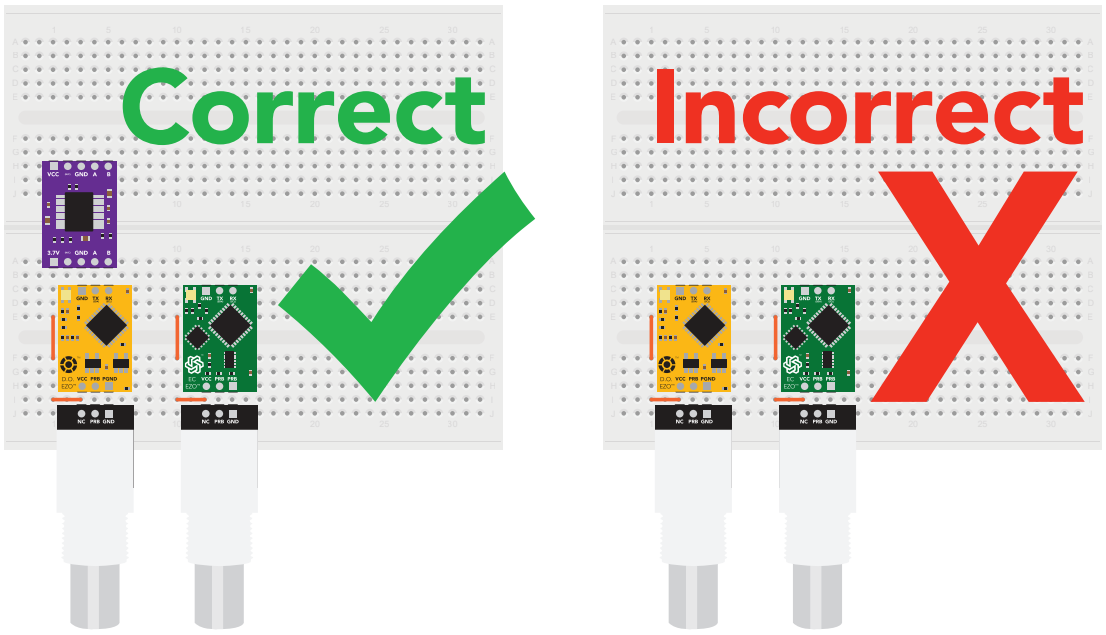
The Atlas Scientific EZO™ Dissolved Oxygen circuit is a very sensitive device. This sensitivity is what gives the Dissolved Oxygen circuit its accuracy. This also means that the Dissolved Oxygen circuit is capable of reading micro-voltages that are bleeding into the water from unnatural sources such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

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



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

Basic EZO™ Inline Voltage Isolator



Without isolation, Conductivity readings will effect Dissolved Oxygen accuracy.

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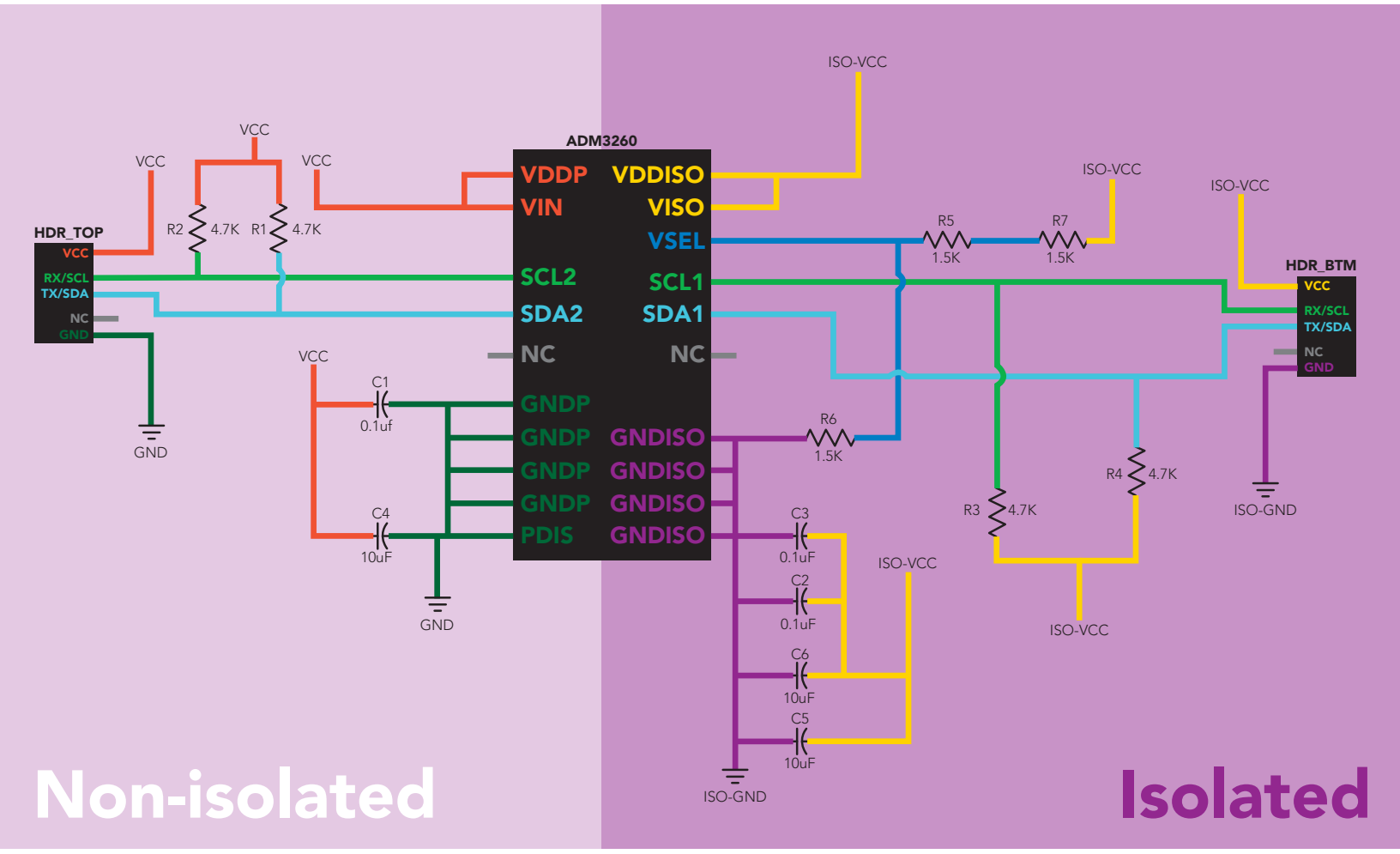
r 0.1

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.

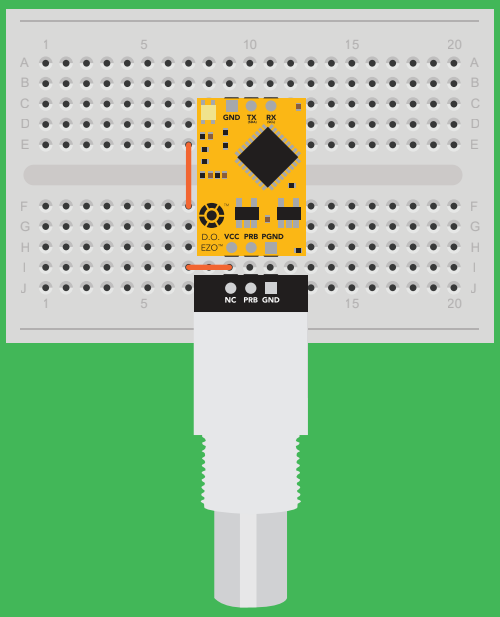
This technology works by using tiny transformers to induce the voltage across an air gap. PCB layout requires special attention for EMI/EMC and RF Control, having proper ground planes and keeping the capacitors as close to the chip as possible are crucial for proper performance. The two data channels 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 3.7V regardless of your input voltage.

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

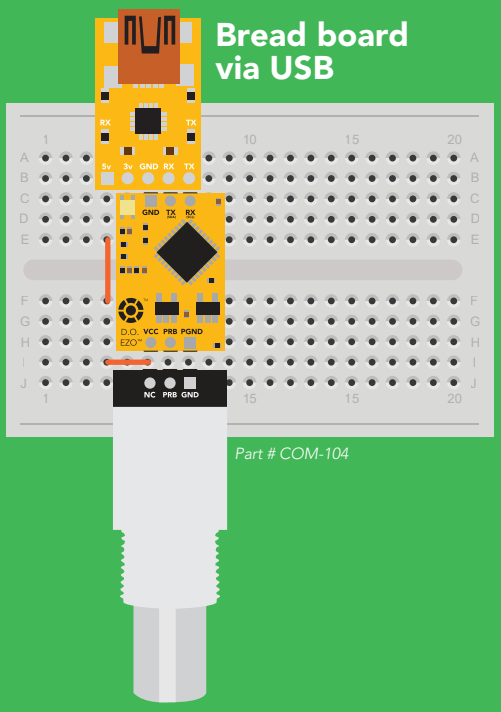


✓ Correct wiring

Bread board

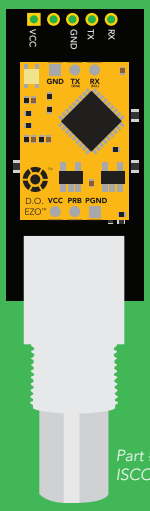


Bread board via USB



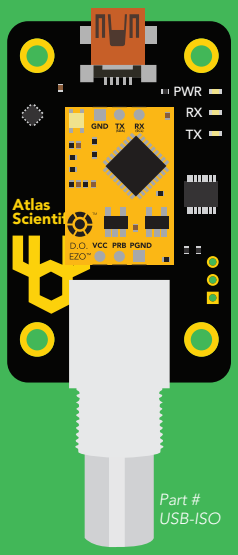
Part # COM-104

Carrier board



Part # ISCCB

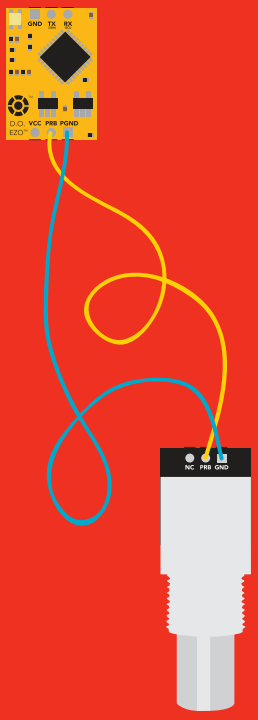
USB carrier board



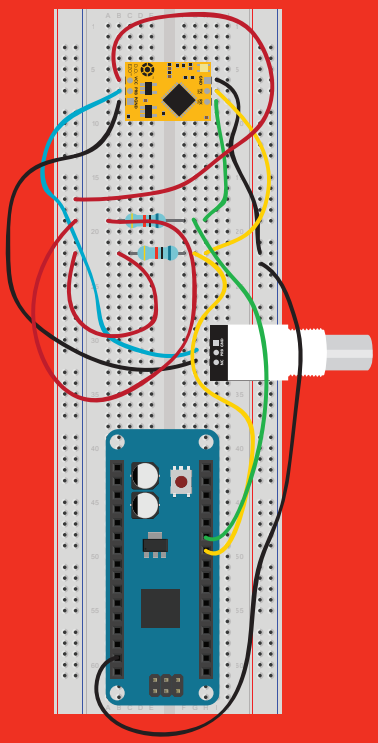
Part # USB-ISO

X Incorrect wiring

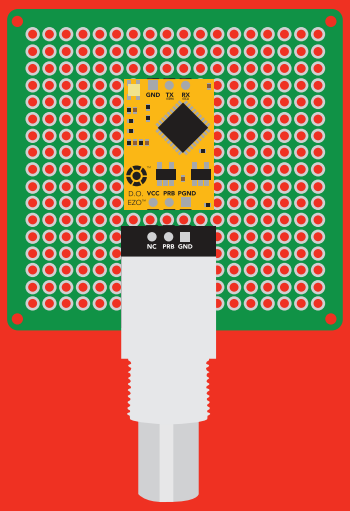
Extended leads



Sloppy setup

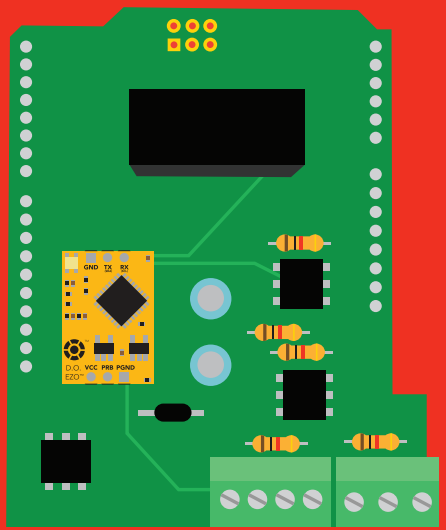


Perfboards or Protoboards



NEVER use Perfboards or Protoboards

***Embedded into your device**



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

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r 0.1

✓ Available data protocols

UART

Default

I²C

X Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

UART mode

Settings that are retained if power is cut

Baud rate
Calibration
Continuous mode
Device name
Enable/disable parameters
Enable/disable response codes
Hardware switch to I²C mode
LED control
Protocol lock
Software switch to I²C mode

Settings that are *NOT* retained if power is cut

Find
Pressure compensation
Salinity compensation
Sleep mode
Temperature compensation

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UART mode

8 data bits	no parity
1 stop bit	no flow control

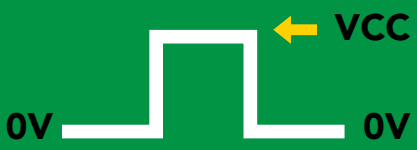
Baud

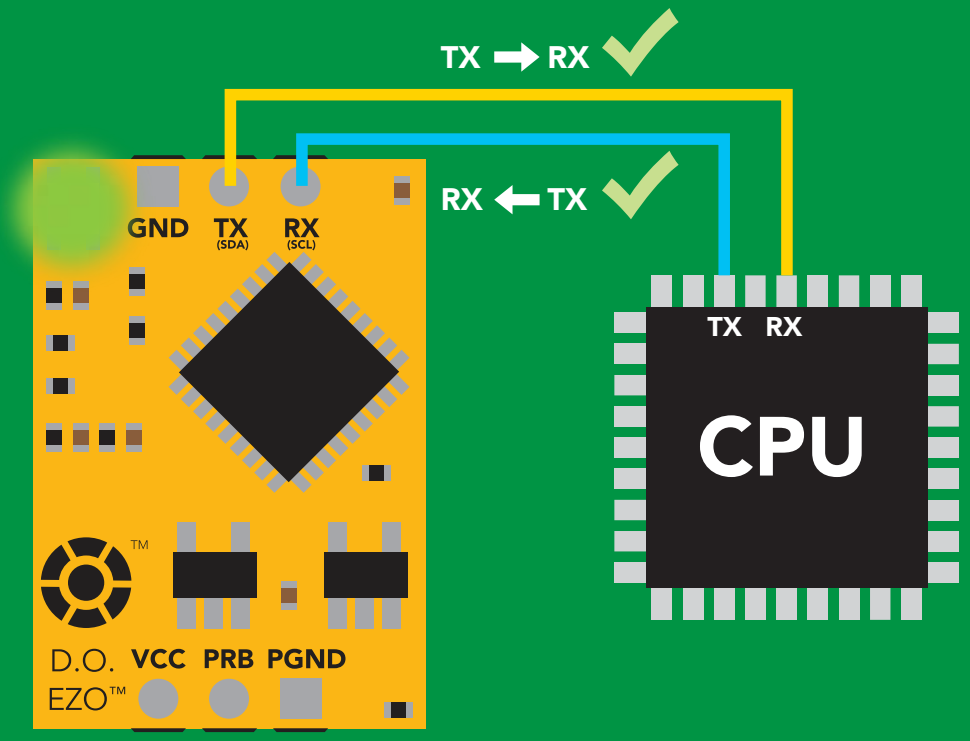
300
1,200
2,400
9,600 default
19,200
38,400
57,600
115,200

RX
Data in

TX
Data out

Vcc 3.3V – 5.5V





Data format

Reading	D.O.	**Data type**	floating point
Units	mg/L & (% sat) when enabled	**Decimal places**	mg/L = 2 % sat = 1
Encoding	ASCII	**Smallest string**	4 characters
Format	string (CSV string when % sat is enabled)	**Largest string**	16 characters
Terminator	carriage return		

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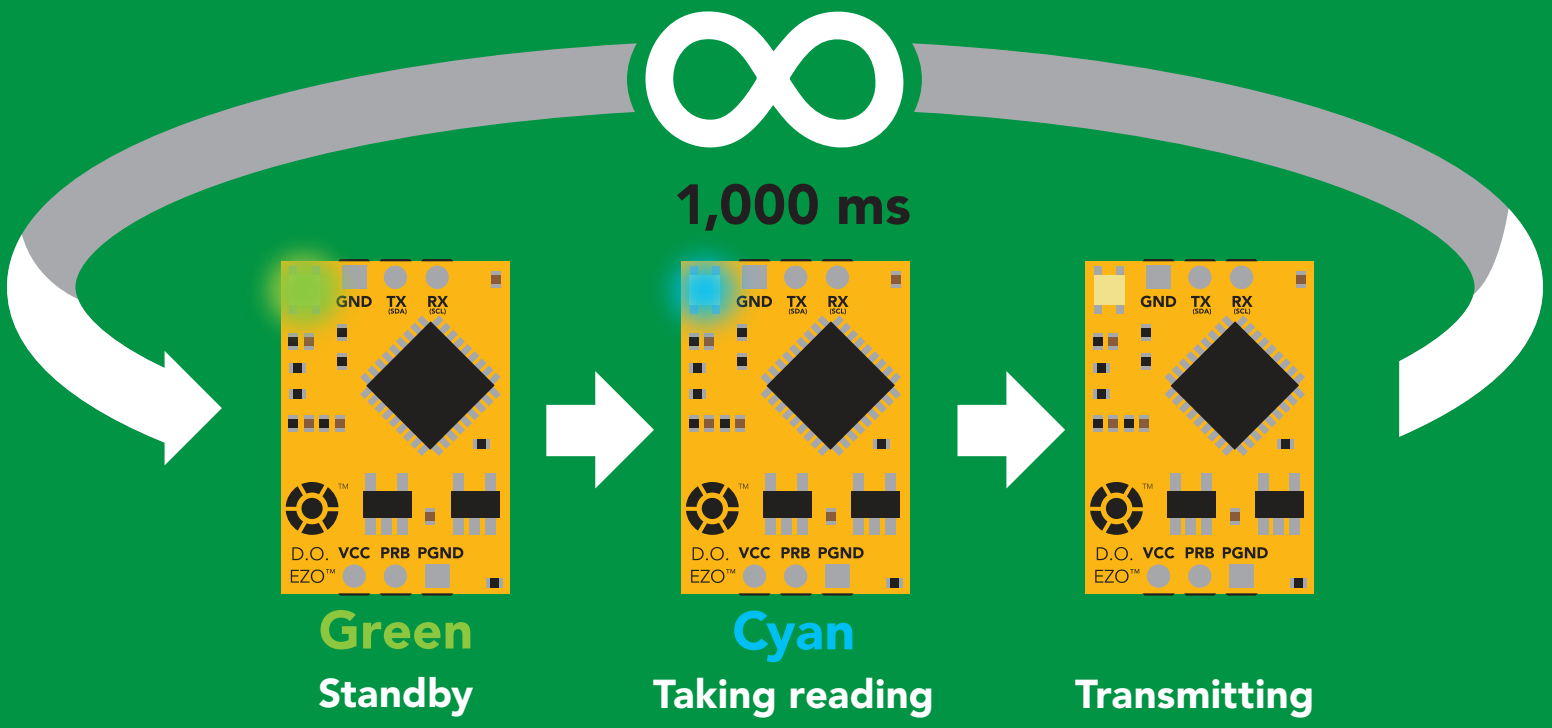
Default state

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



Receiving data from device

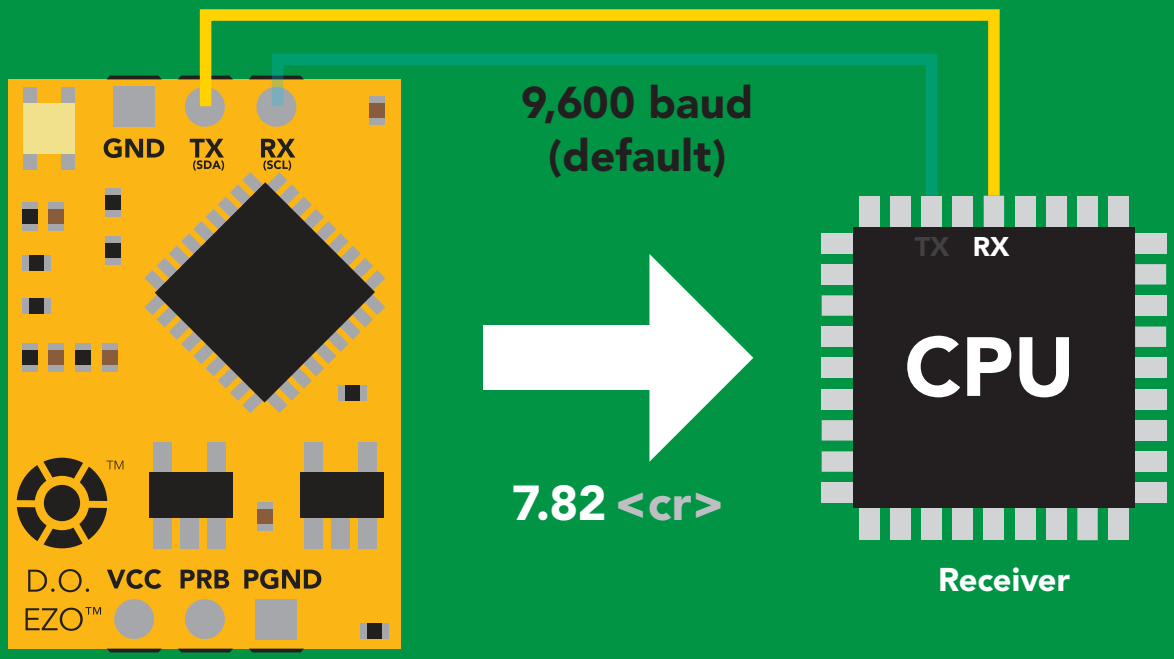
2 parts

ASCII data string

Command

Carriage return <cr>

Terminator



Sender

Receiver

Advanced

ASCII:	7	.	8	2	<cr>
Hex:	37	2E	38	32	0D
Dec:	55	46	56	50	13

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r 0.1

Sending commands to device

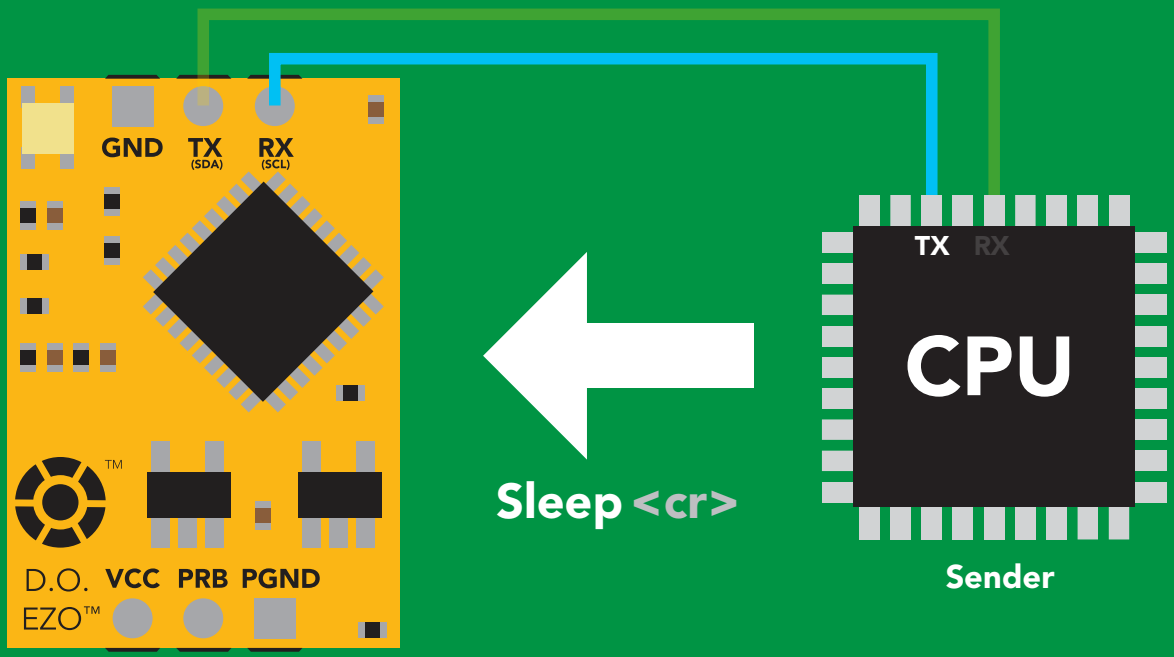
2 parts

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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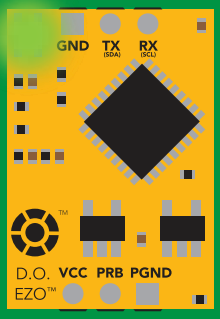
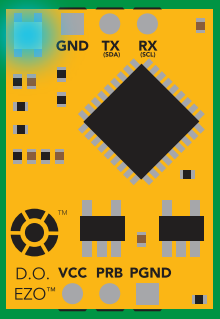
LED color definition



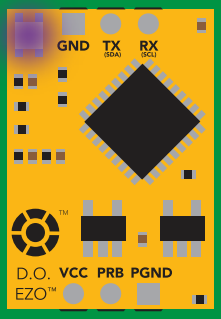
Green

UART standby



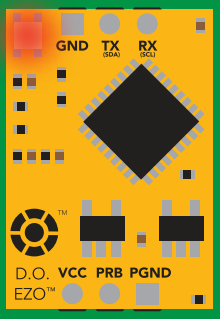
Cyan

Taking reading



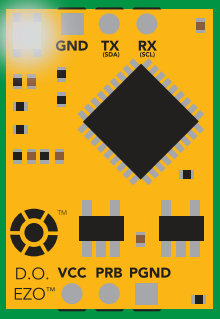
Purple

Changing baud rate



Red

Command not understood



White

Find

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

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r 0.1

UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

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

LED control

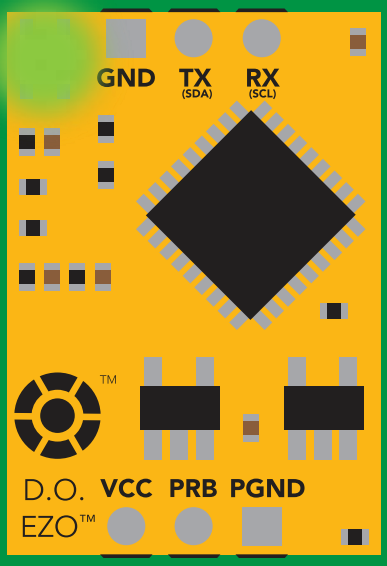
Command syntax

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

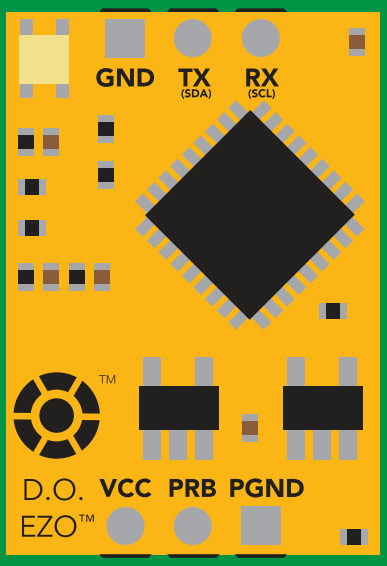
L,0 <cr> LED off

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

Example	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

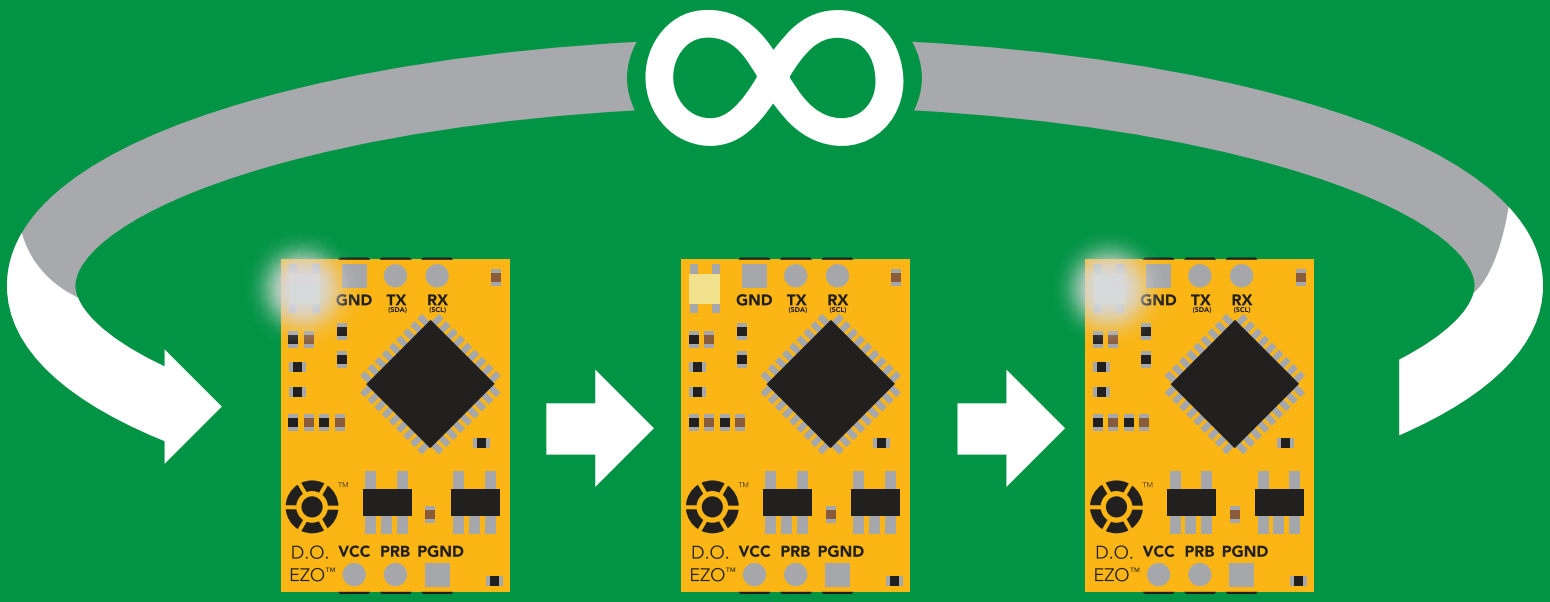
Find

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?

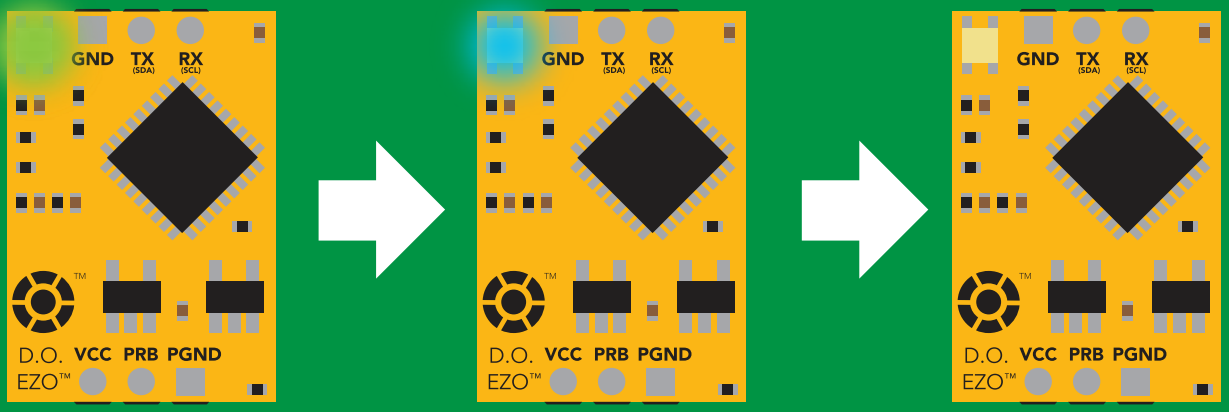
Example	Response
C,1 <cr>	*OK <cr> DO (1 sec) <cr> DO (2 sec) <cr> DO (3 sec) <cr>
C,30 <cr>	*OK <cr> DO (30 sec) <cr> DO (60 sec) <cr> DO (90 sec) <cr>
C,0 <cr>	*OK <cr>
C,? <cr>	?C,1 <cr> or ?C,0 <cr> or ?C,30 <cr> *OK <cr>

Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	7.82 <cr> *OK <cr>



Green
Standby

Cyan
Taking reading

Transmitting

600 ms

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r 0.1

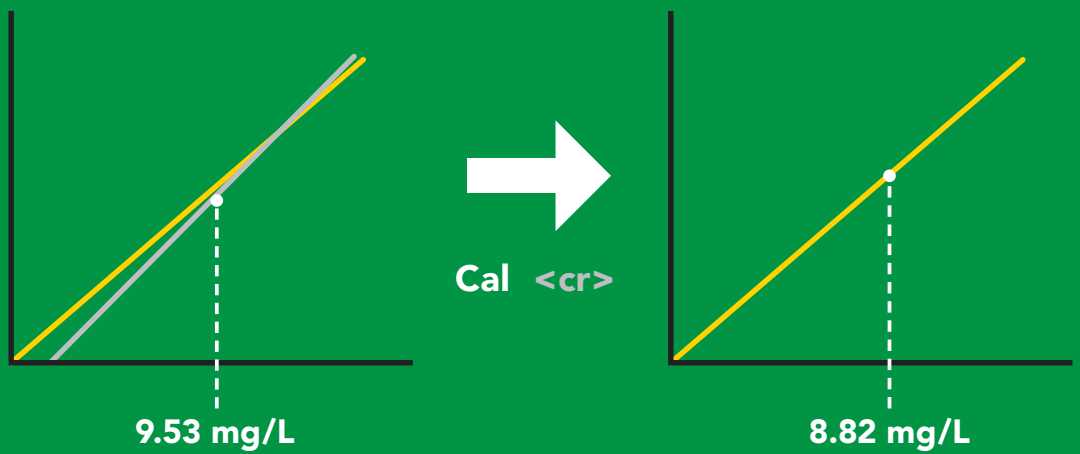
Calibration

Command syntax

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

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

Example	Response
Cal <cr>	*OK <cr>
Cal,0 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,0 <cr> or ?Cal,1 <cr> (single point) or ?Cal,2 <cr> (two point) *OK <cr>



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Export/import calibration

Command syntax

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

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

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

Disabling *OK simplifies this process

Import, n (FIFO)

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

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r 0.1