pH
EZO™
Circuit

Reads	**pH**
Range	**.001 – 14.000**
Resolution	**.001**
Accuracy	**+/– 0.002**
Max rate	**1 reading per sec**
Supported probes	**Any type & brand**
Calibration	**1, 2, 3 point**
Temp compensation	**Yes**
Data protocol	**UART & I²C**
Default I²C address	**99 (0x63)**
Operating voltage	**3.3V – 5V**
Data format	**ASCII**

GND TX (SDA) RX (SCL)

™

pH EZO™   VCC PRB PGND

RoHS COMPLIANT

PATENT PROTECTED

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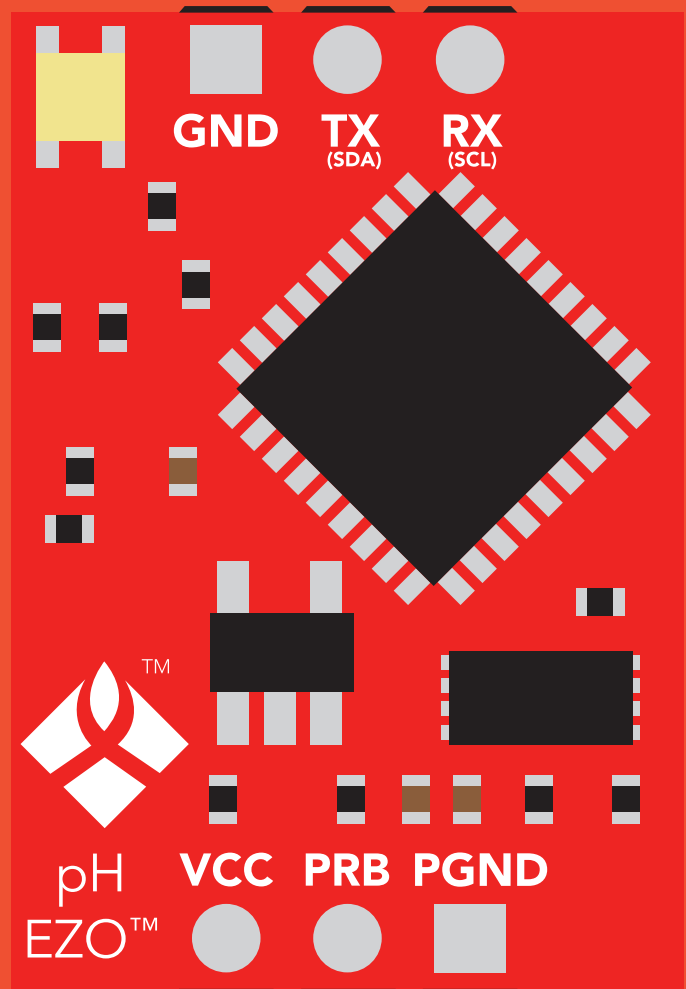
STOP

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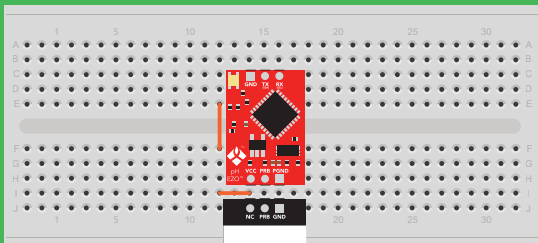
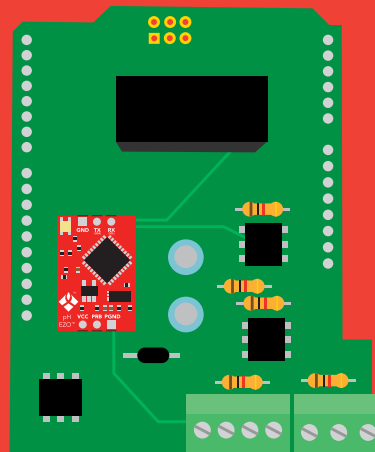**Do not embed this device without testing it in a solderless breadboard!**

r 0.1

Table of contents

UART

I²C

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EZO™ circuit dimensions

13.97mm (0.55")

20.16mm (0.79")

GND TX (SDA) RX (SCL)

pH EZO™ VCC PRB PGND

5.8mm (0.22")

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™ pH)	-65 °C		125 °C
Operational temperature (EZO™ pH)	-40 °C	25 °C	85 °C
VCC	3.3V	5V	5.5V

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EZO™ circuit identification
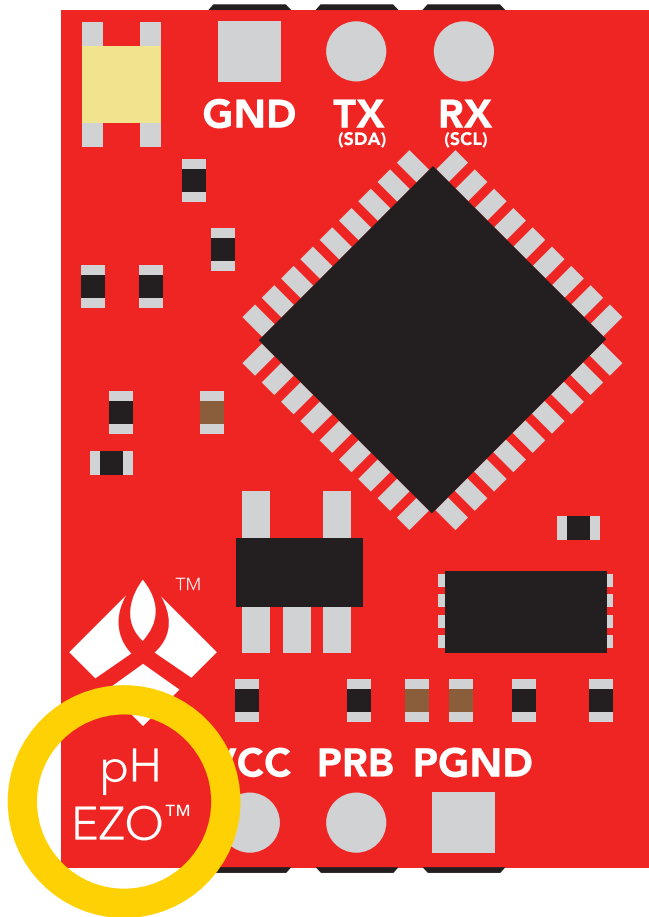
EZO™ pH circuit

Legacy pH circuit

Viewing correct datasheet

Viewing incorrect datasheet

Click here to view legacy datasheet

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Operating principle

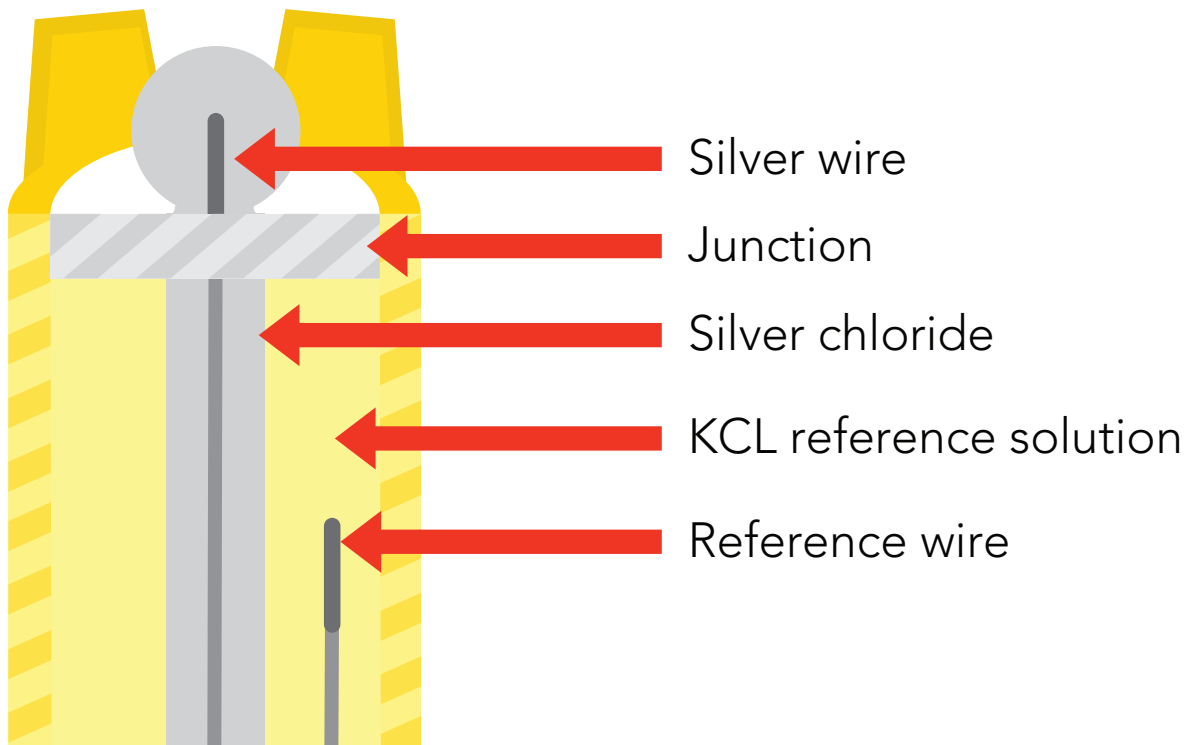A pH (*potential of Hydrogen*) probe measures the hydrogen ion activity in a liquid. At the tip of a pH probe is a glass membrane. This glass membrane permits hydrogen ions from the liquid being measured to defuse into the outer layer of the glass, while larger ions remain in the solution. The difference in the concentration of hydrogen ions (outside the probe vs. inside the probe) creates a VERY small current. This current is proportional to the concentration of hydrogen ions in the liquid being measured.

Acid: pH < 7

Neutral: pH = 7

Base: pH > 7

Silver wire

Junction

Silver chloride

KCL reference solution

Reference wire

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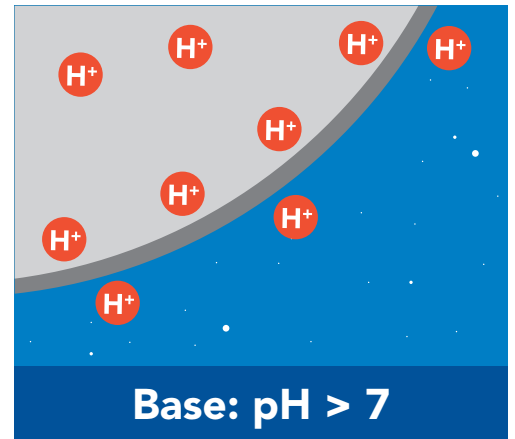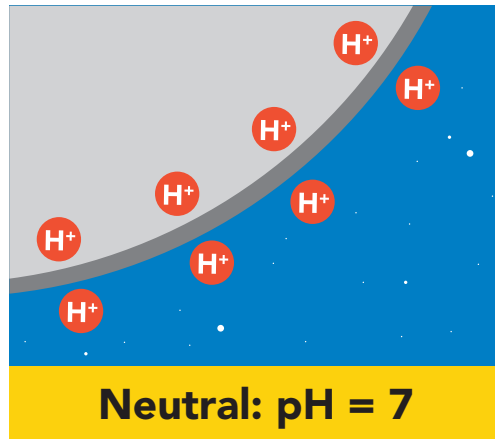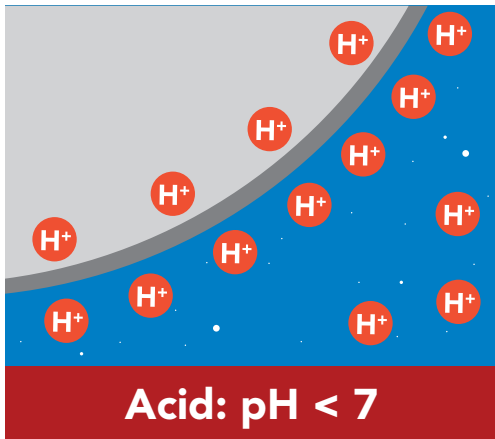
Calibration theory

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™ class pH circuit has a flexible calibration protocol, allowing for *single point, two point,* or *three point* calibration.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |

Lowpoint	Midpoint	Highpoint
"cal,low,n"	**"cal,mid,n"**	**"cal,high,n"**
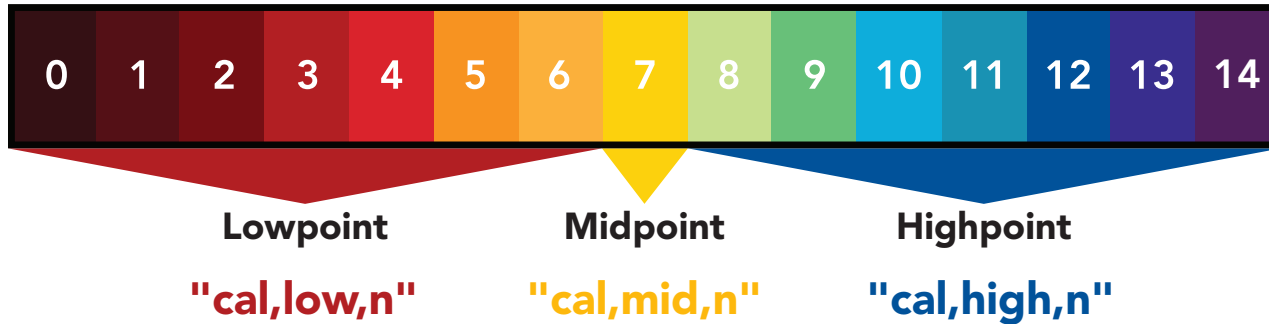
The first calibration point must be the Midpoint (pH 7)

The EZO™ pH circuits default temperature compensation is set to 25° C. If the temperature of the calibration solution is +/- 2° C from 25° C, consider setting the temperature compensation first. ***Temperature changes of < 2° C are insignificant.***

Single point calibration

1   2   3   4 — **"Cal,mid,n"**   5

1:00 – 2:00
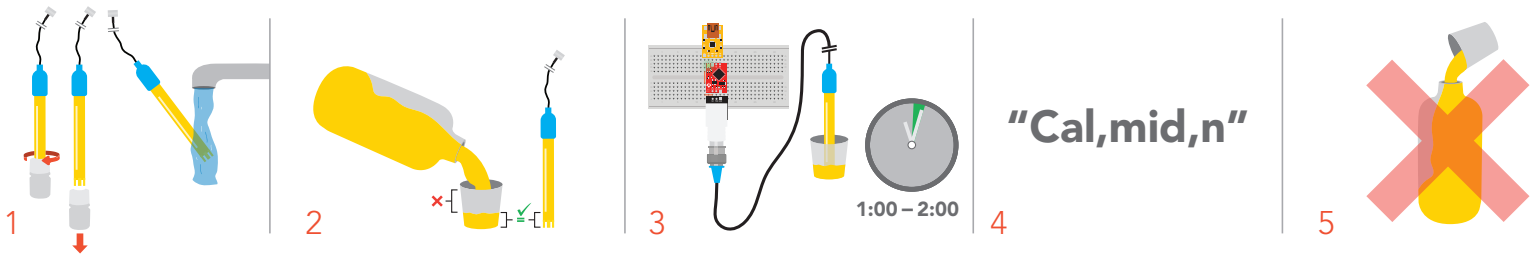
1. Remove soaker bottle and rinse off pH probe.
2. Pour a small amount of the calibration solution into a cup.
3. Let the probe sit in calibration solution untill readings stabalize *(1 – 2 minutes).*
4. Calibrate the midpoint value using the command **"Cal,mid,n"**.
   Where "n" is any floating point value that represents the calibration midpoint.
5. Do not pour the calibration solution back into the bottle.
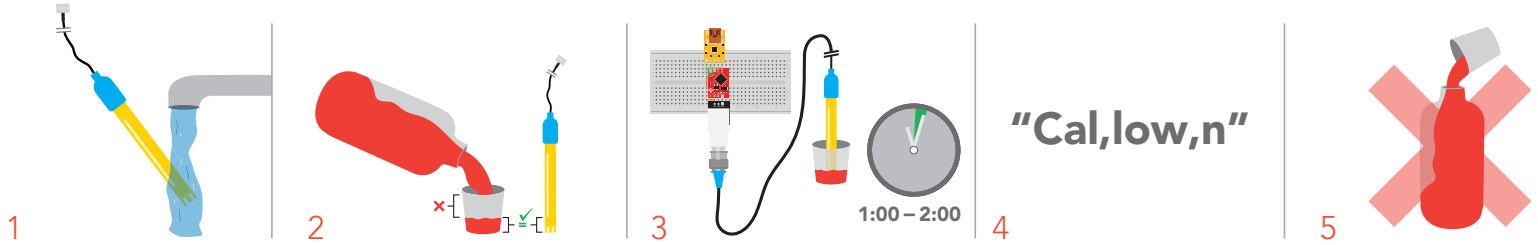
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Two point calibration

1   2   3   4   "Cal,low,n"   5

1. Rinse off pH probe.
2. Pour a small amount of the calibration solution into a cup
3. Let the probe sit in calibration solution untill readings stabalize *(1 – 2 minutes)*.
4. Calibrate the lowpoint value using the command **"Cal,low,n"**.
   Where "n" is any floating point value that represents the calibration lowpoint.
5. Do not pour the calibration solution back into the bottle.
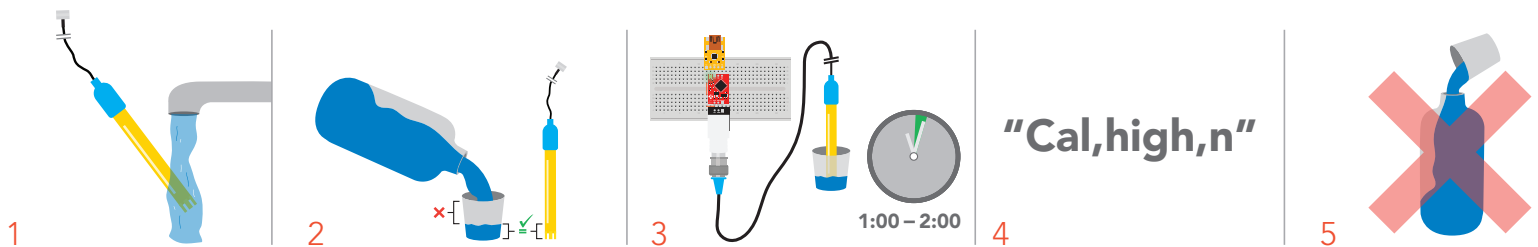

Three point calibration

1   2   3   4   "Cal,high,n"   5

1. Rinse off pH probe.
2. Pour a small amount of the calibration solution into a cup
3. Let the probe sit in calibration solution untill readings stabalize *(1 – 2 minutes)*.
4. Calibrate the highpoint value using the command **"Cal,high,n"**.
   Where "n" is any floating point value that represents the calibration highpoint.
5. Do not pour the calibration solution back into the bottle.

⚠️ **Issuing the cal,mid command after the EZO™ pH circuit has been calibrated will clear the other calibration points. Full calibration will have to be redone.** ⚠️

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Power and data isolation

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

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

**Basic EZO™
Inline Voltage Isolator**

Correct

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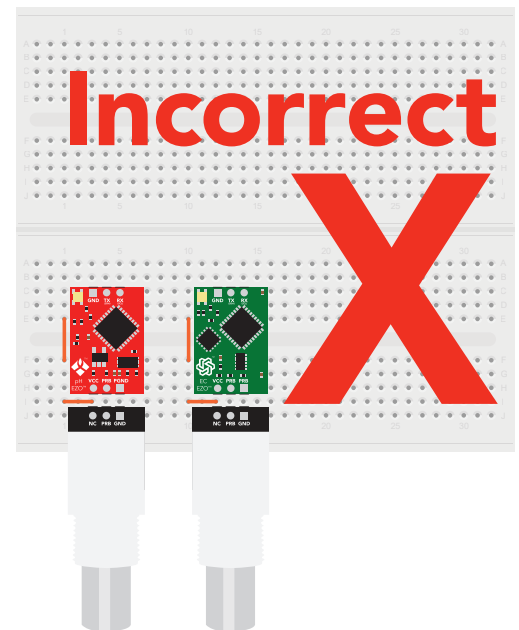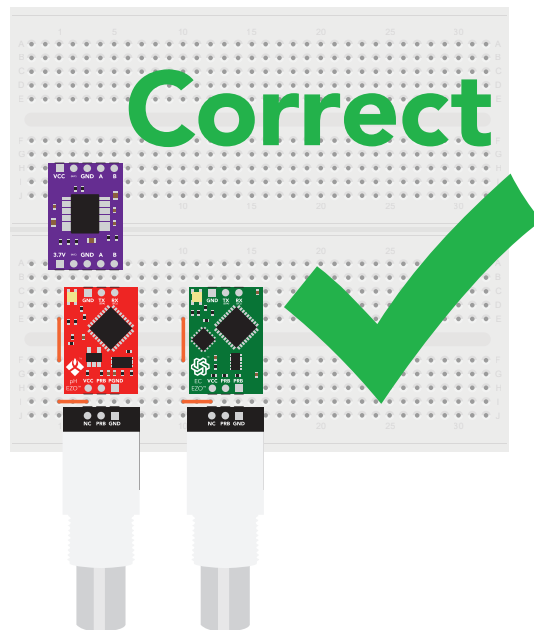
Without isolation, Conductivity and Dissolved Oxygen readings will effect pH accuracy.

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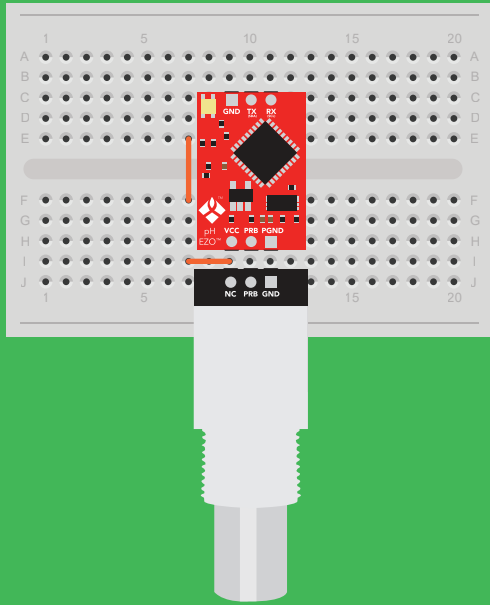
This technology works by using tiny transformers to induce the voltage across an air gap. PCB layout requires special attention for EMI/EMC and RF Control, having proper ground planes and keeping the capacitors as close to the chip as possible are crucial for proper performance. The two data channels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

Non-isolated

Isolated

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r 0.2
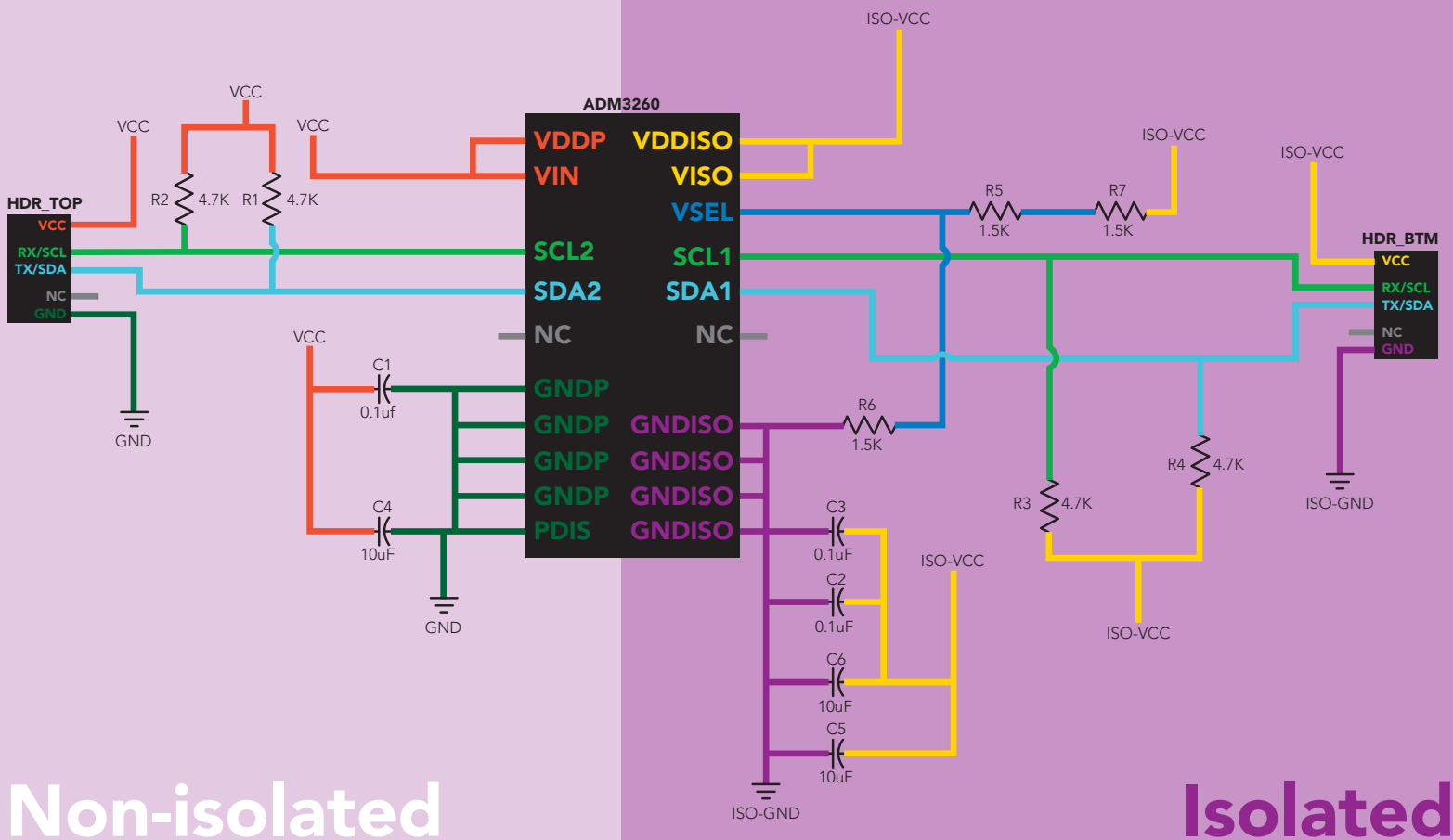
✔ Correct wiring

Bread board

Bread board via USB

Part # COM-104

Carrier board

Part # ISCCB

USB carrier board

Part # USB-ISO
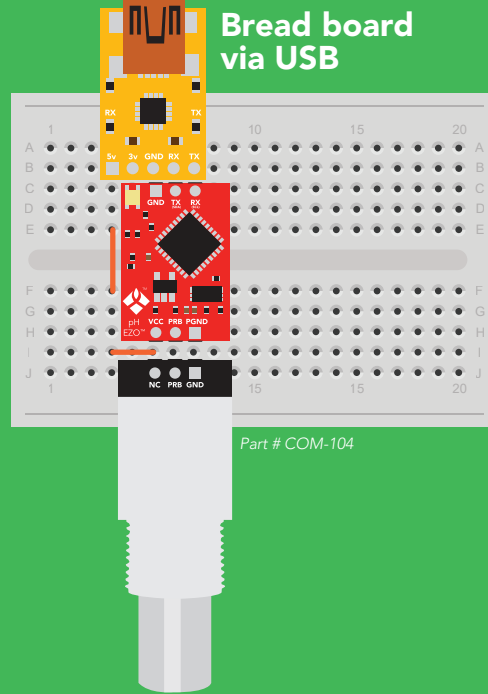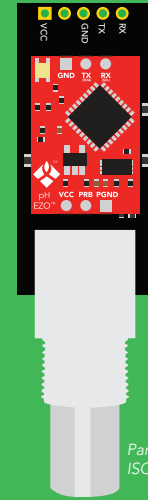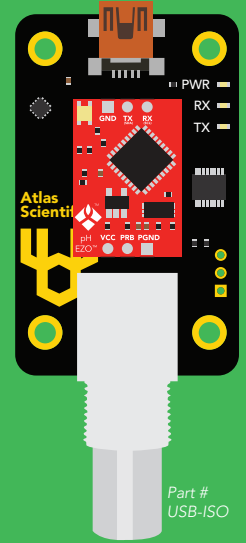
X Incorrect wiring

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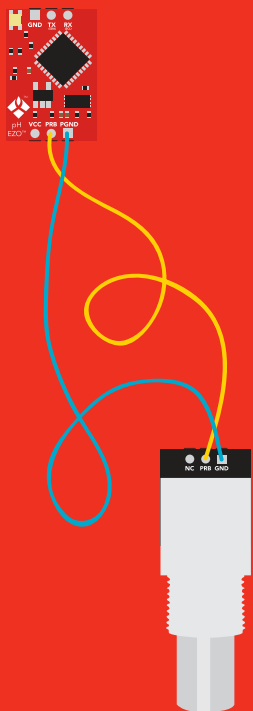
Sloppy setup
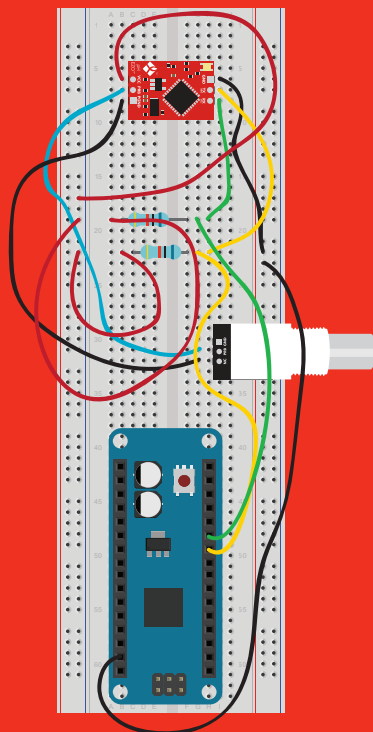
Perfboards or Protoboards
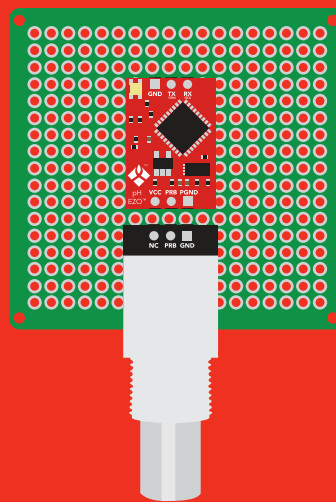
NEVER
use Perfboards or Protoboards

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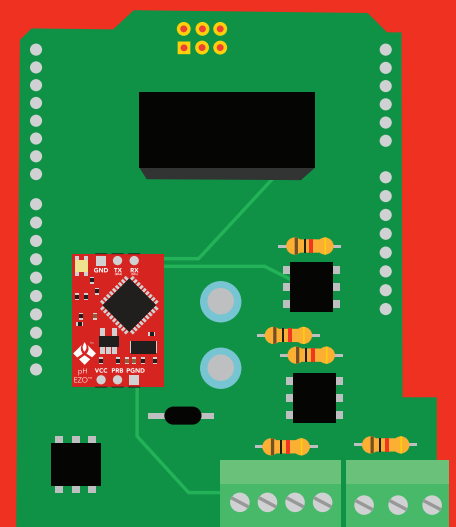
*Only after you are familar with EZO™ circuits operation

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NEVER EXTEND THE CABLE WITH CHEAP JUMPER WIRES!
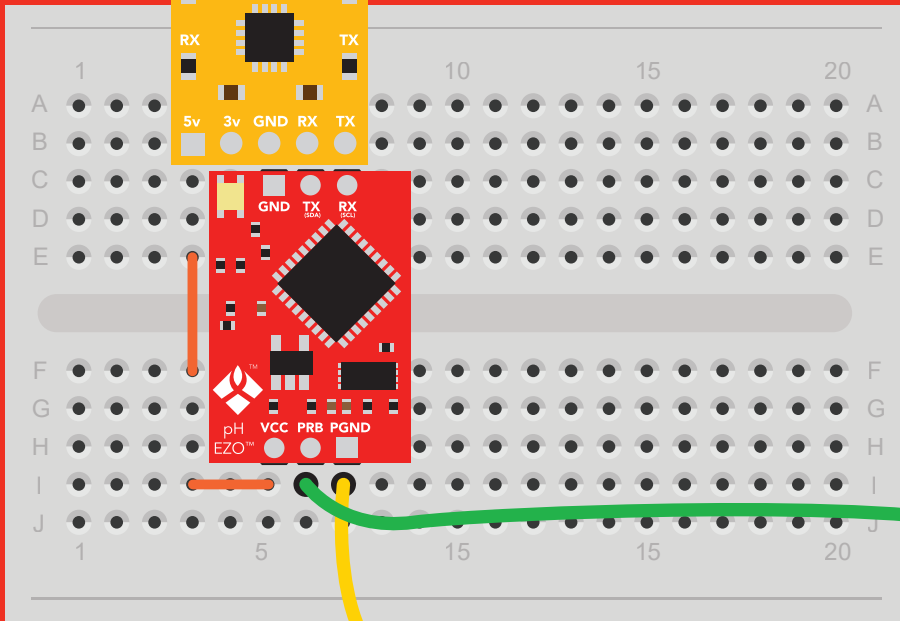
DO NOT CUT THE PROBE CABLE WITHOUT REFERING TO THIS DOCUMENT!

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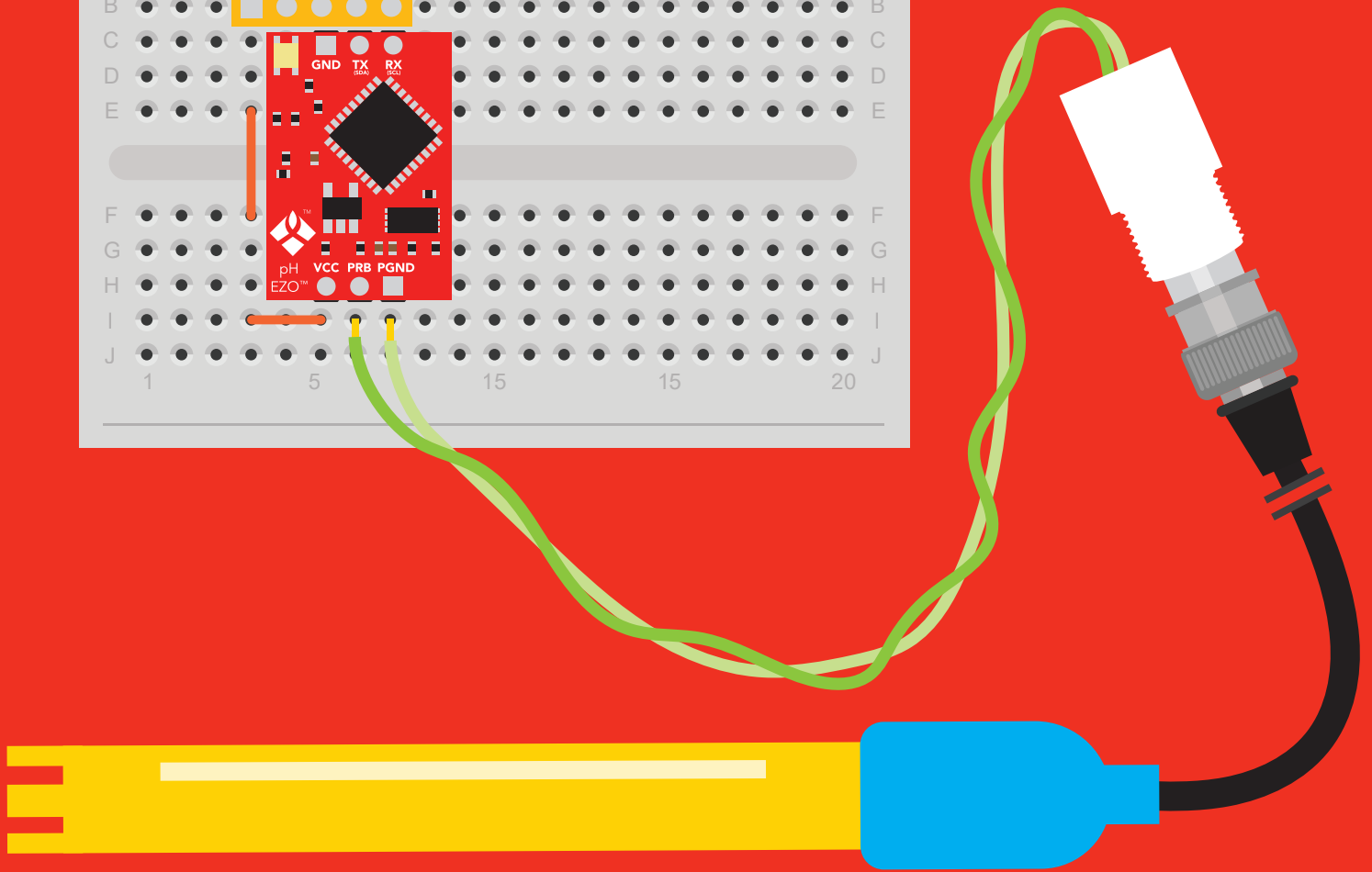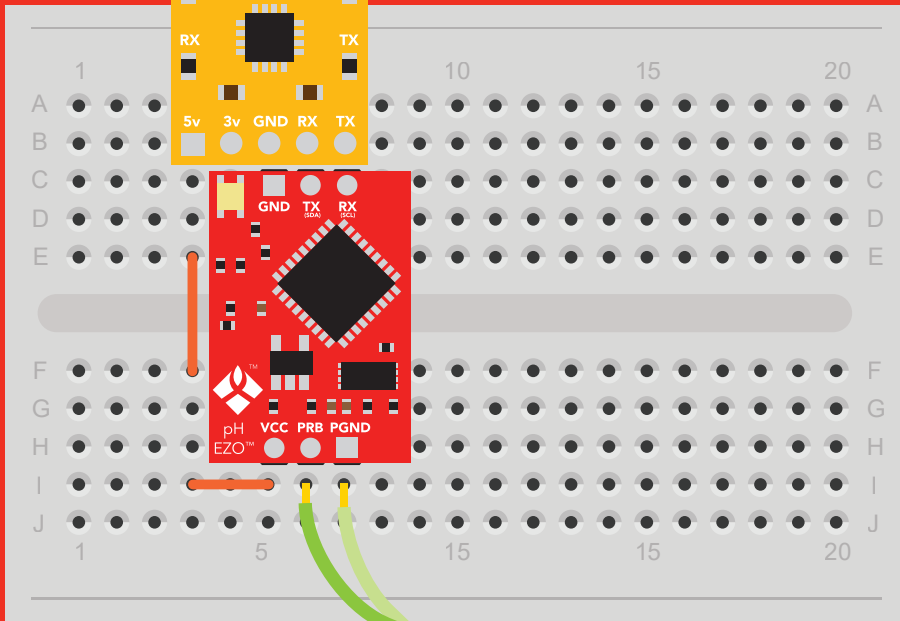
**ONLY USE SHIELDED CABLES.
REFER TO THIS DOCUMENT!**

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✓ Available data protocols

UART

Default

I²C

X Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

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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^2C mode
LED control
Protocol lock
Software switch to I^2C mode

Settings that are *NOT* retained if power is cut

Find
Sleep mode

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
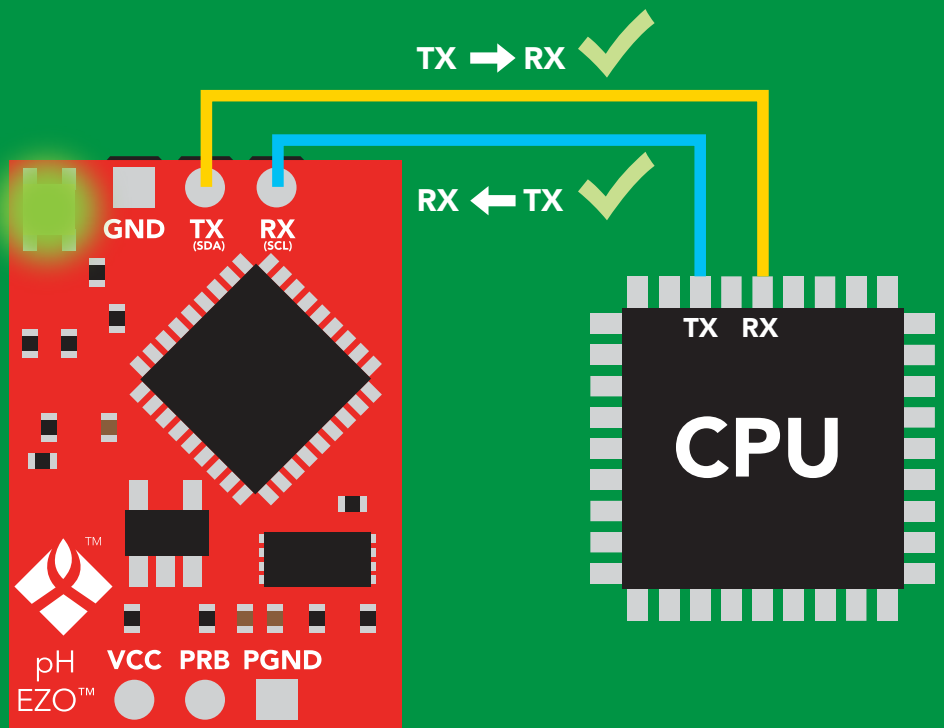
VCC

0V   0V

TX ➡ RX ✓

RX ⬅ TX ✓

GND   TX (SDA)   RX (SCL)

TX   RX

CPU

pH EZO™

VCC   PRB   PGND

Data format

Reading	pH		**Data type**	floating point
Units	pH		**Decimal places**	3
Encoding	ASCII		**Smallest string**	4 characters
Format	string		**Largest string**	40 characters
Terminator	carriage return			

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Default state

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

1,000 ms

Green
Standby

Cyan
Taking reading

Transmitting

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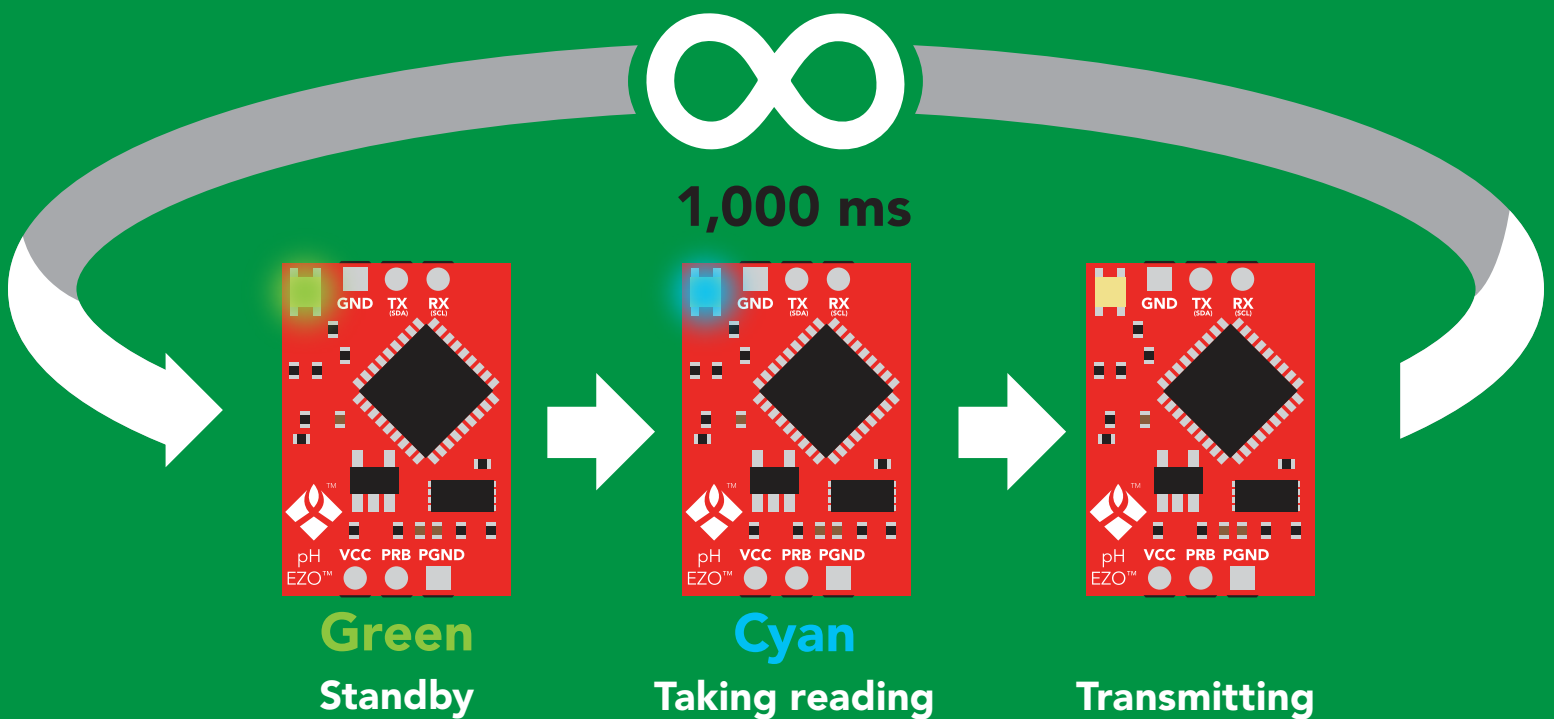
Receiving data from device

2 parts

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

9,600 baud
(default)

GND TX
(SDA) RX
(SCL)

TX RX

CPU

9.560 \<cr\>

Receiver

pH
EZO™   VCC PRB PGND

Sender
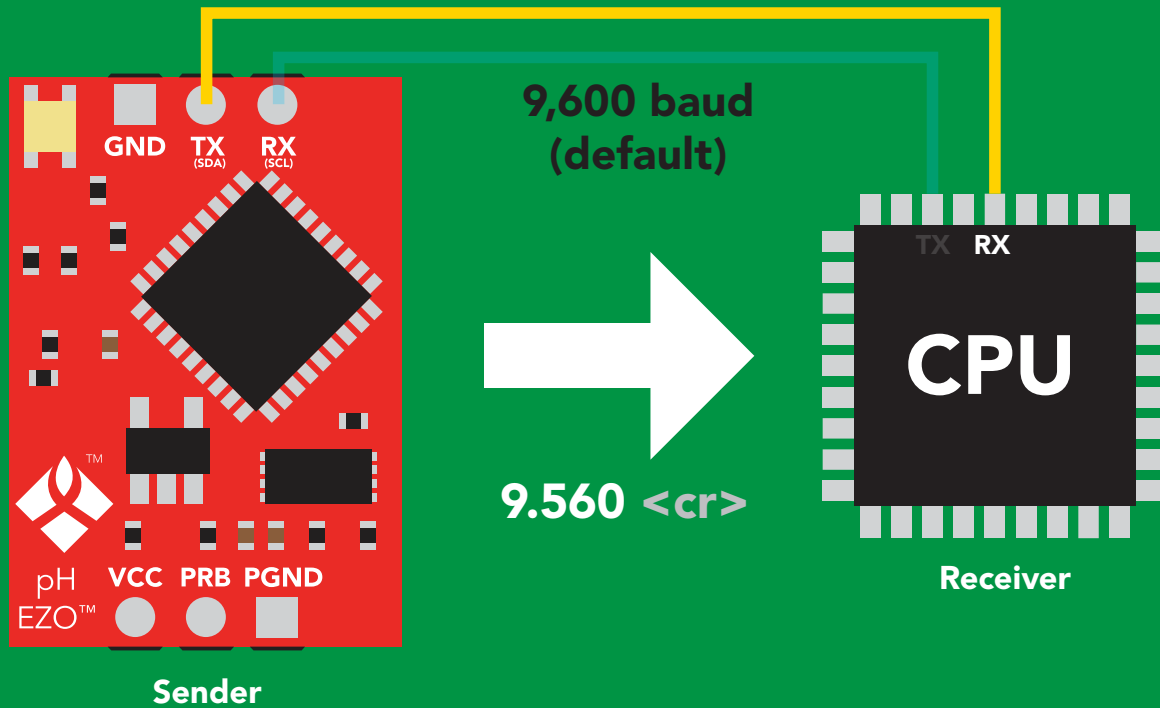
Advanced

ASCII:	9	.	5	6	0	\<cr\>
Hex:	39	2E	35	36	30	0D
Dec:	57	46	53	54	48	13

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Sending commands to device

2 parts

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

Sleep <cr>

GND TX (SDA) RX (SCL)

CPU

Sender

pH EZO™   VCC PRB PGND

Receiver
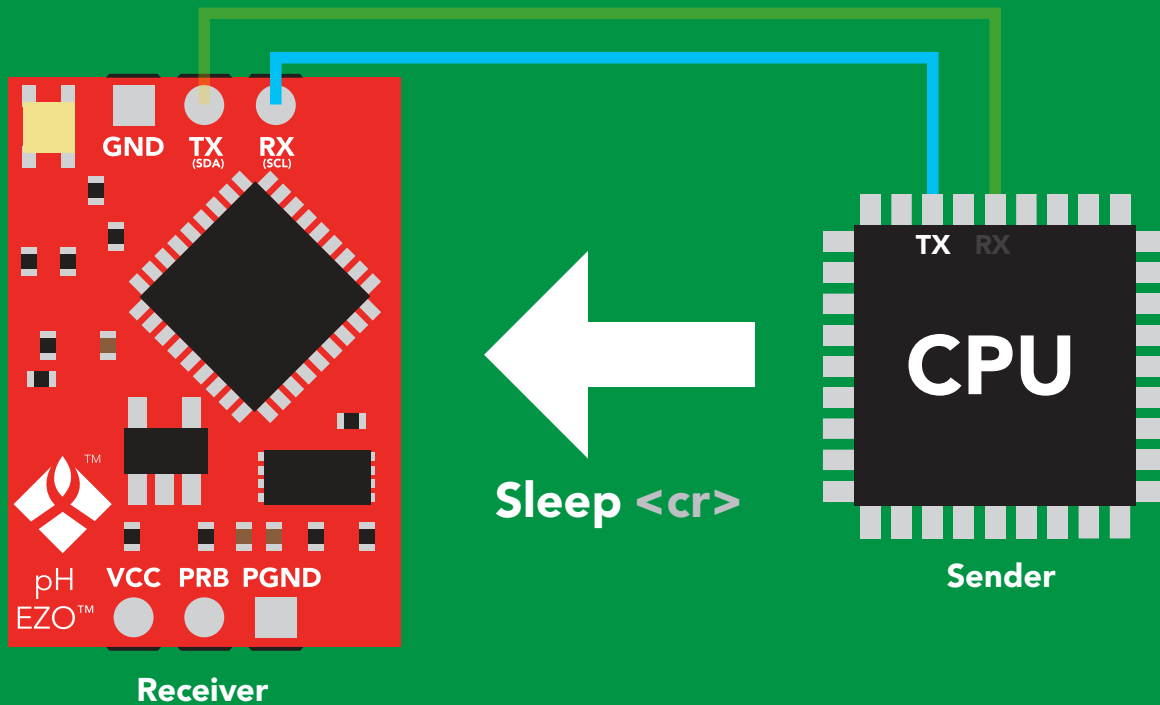
Advanced

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
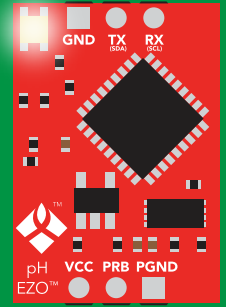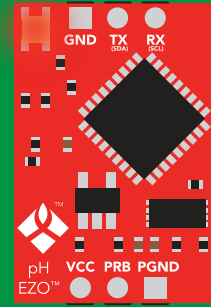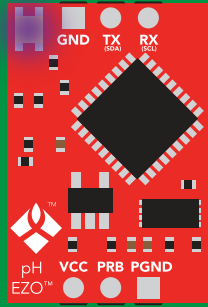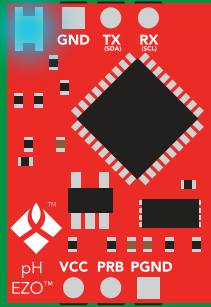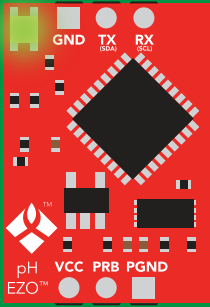
Green
UART standby

Cyan
Taking reading

Purple
Changing
baud rate

Red
Command
not understood

White
Find

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

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UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

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

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LED control

Command syntax

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

L,0 <cr> LED off

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

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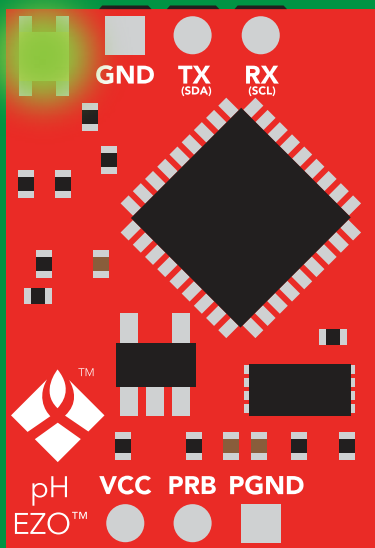
L,1
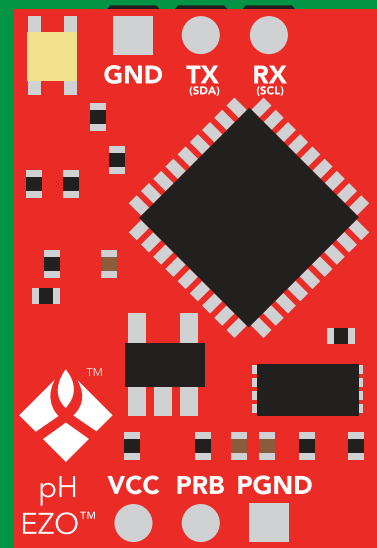
L,0

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Find

Command syntax

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

*This command is only available for firmware version 2.10 and above.

Example   Response

Find <cr>	*OK <cr>

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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?	

*This command is only available for firmware version 2.10 and above.

Example | Response

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

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Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	9.560 <cr> *OK <cr>
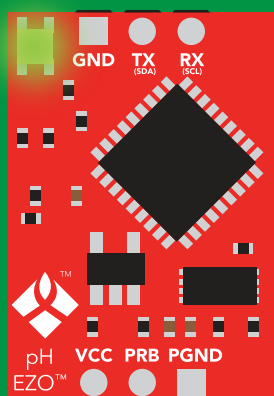
Green
Standby
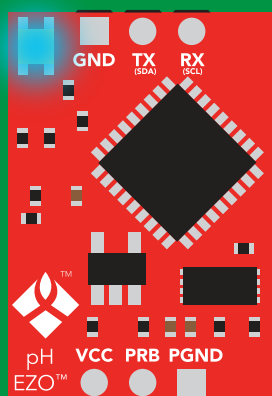
Cyan
Taking reading
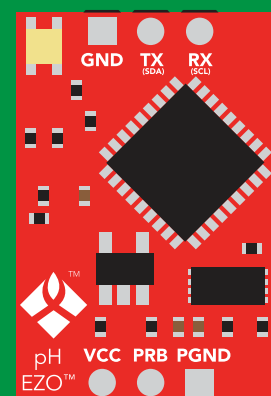
Transmitting

800 ms

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Calibration

Command syntax

Cal,mid,n   <cr>   single point calibration at midpoint

Cal,low,n   <cr>   two point calibration at lowpoint

Cal,high,n <cr>   three point calibration at highpoint

Cal,clear   <cr>   delete calibration data

Cal,?   <cr>   device calibrated?

Example	Response
Cal,mid,7.00 <cr>	*OK <cr>
Cal,low,4.00 <cr>	*OK <cr>
Cal,high,10.00 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,0 <cr> or ?Cal,1 <cr> or one point ?Cal,2 <cr> or ?Cal,3 <cr> two point three 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*

*This command is only available for
firmware version 2.10 and above.

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>

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

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Slope

Command syntax

Slope,? <cr> returns the slope of the pH probe

Example

Response

Slope,? <cr>

?Slope,99.7,100.3 <cr>
*OK <cr>

Response breakdown

?Slope,   **99.7,**   **100.3**

99.7% is how closely the slope of the **acid** calibration line matched the "ideal" pH probe.

100.3% is how closely the slope of the **base** calibration matches the "ideal" pH probe.

△ 0.3% from ideal

Zero point

1 2 3 4 5 6 7 8 9

Calibrated probe

Ideal probe

△ 0.3% from ideal

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r 0.1

Temperature compensation

Command syntax

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

T,? <cr> compensated temperature value?

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

T,19.5 <cr>

8.82

8.91

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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

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

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

Name,zzt

*OK <cr>

Name,?

Name,zzt <cr>
*OK <cr>

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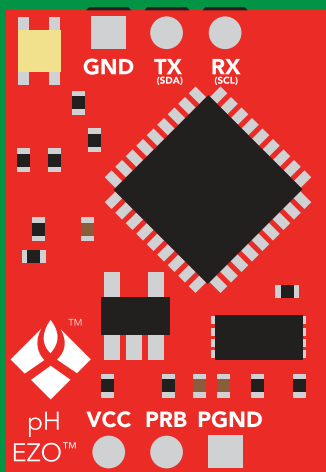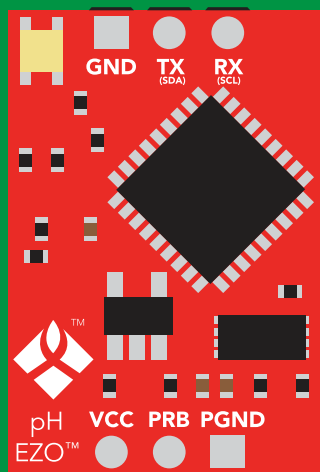
Device information

Command syntax

i **<cr>** device information

Example	Response
i **<cr>**	?i,pH,1.98 **<cr>** *OK **<cr>**

Response breakdown

?i,   pH,   1.98
       ↑   ↑
    Device Firmware

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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>=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

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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

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r 0.1

Sleep mode/low power

Command syntax

Sleep <cr> enter sleep mode/low power

Example	Response
Sleep <cr>	*SL
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

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r 0.1
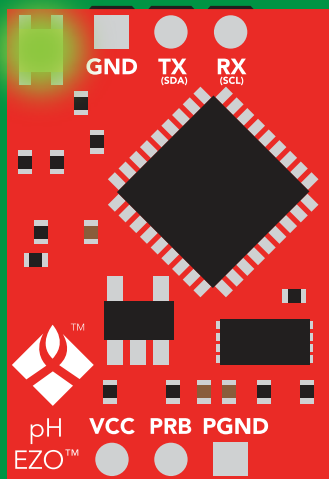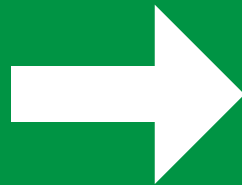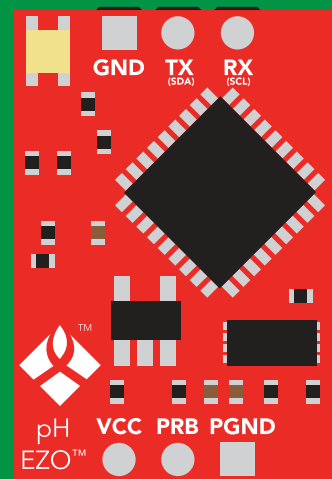
Change baud rate

Command syntax

Baud,n <cr> change baud rate

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

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

Standby

Baud,38400 <cr>

Changing
baud rate

*OK <cr>
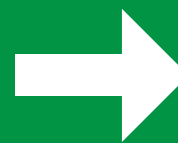
(reboot)
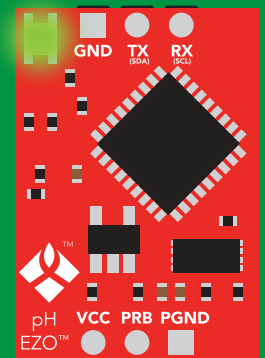
Standby

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r 0.1

Protocol lock

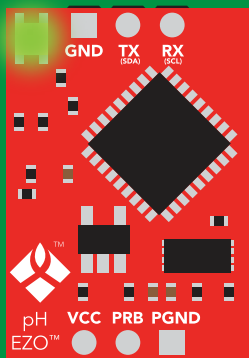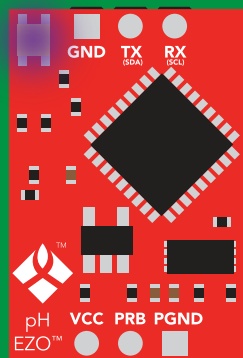## Command syntax

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
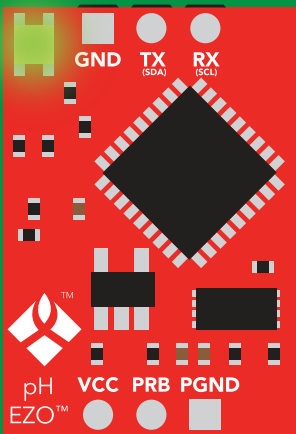
*OK <cr>

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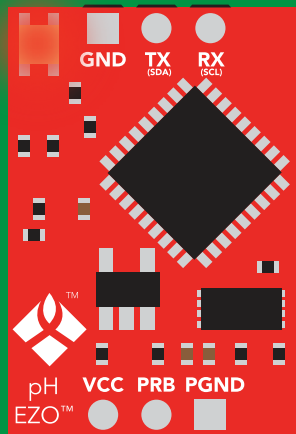
cannot change to I²C
*ER <cr>

Short
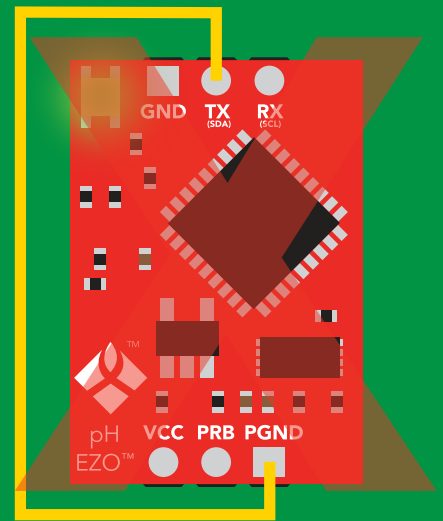
cannot change to I²C

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r 0.1

Factory reset

Command syntax

Factory <cr> enable factory reset

Example	Response
Factory <cr>	*OK <cr>

Factory <cr>
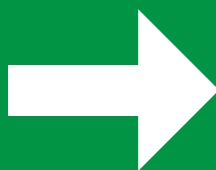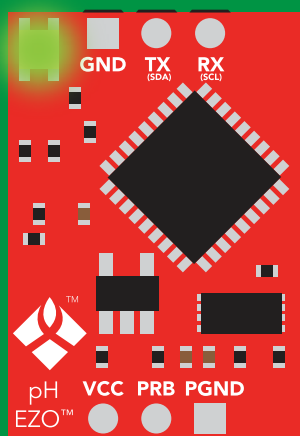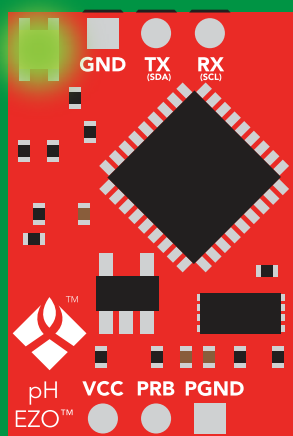
*OK <cr>   (reboot)   *RS <cr>
                                    *RE <cr>

Baud rate will not change

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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

(reboot)

Green
*OK <cr>

Blue
now in I²C mode

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r 0.2
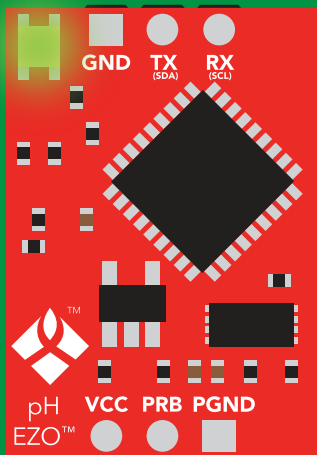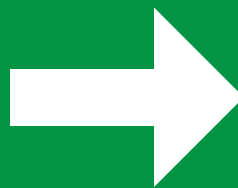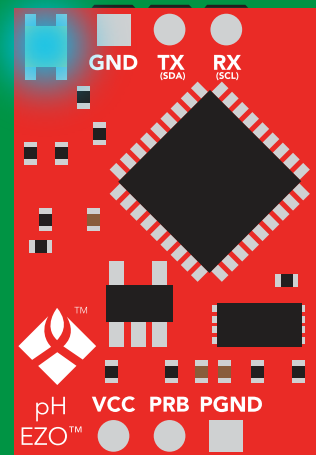
Manual switching to I²C

- **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 99 (0x63)

Example

Short

Wrong Example

Short

← Disconnect RX line

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Environmental Robotics
r 0.1
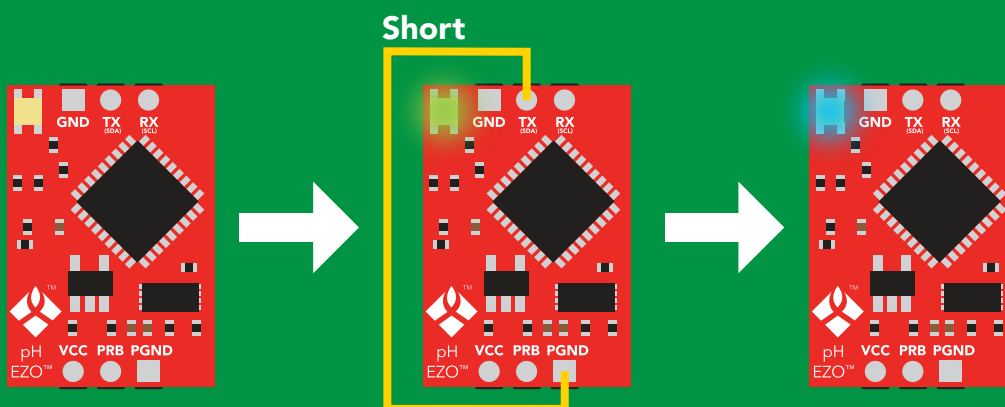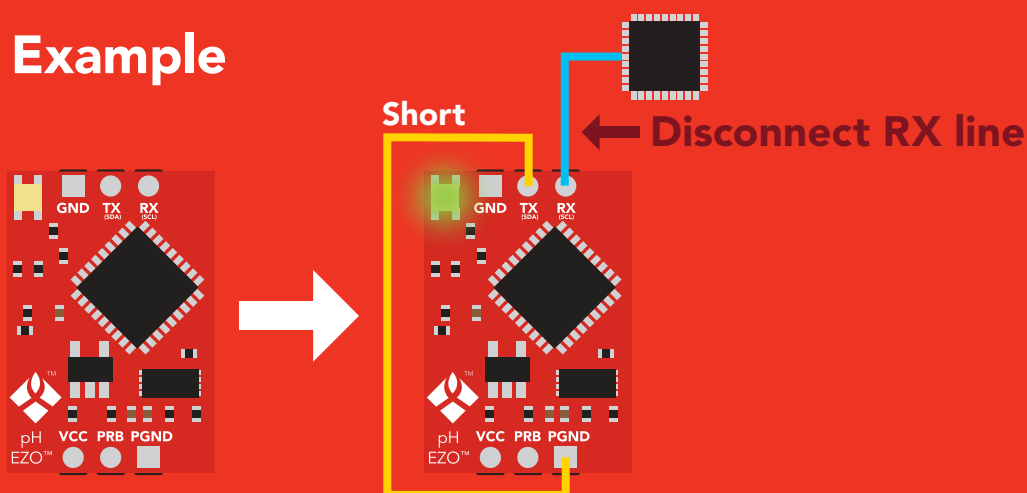
I²C mode

The I²C protocol is *considerably more complex* than the UART (RS–232) protocol. Atlas Scientific assumes the embedded systems engineer understands this protocol.

To set your EZO™ device into I²C mode click here

Settings that are retained if power is cut

Calibration
Change I²C address
Hardware switch to UART mode
LED control
Protocol lock
Software switch to UART mode

Settings that are *NOT* retained if power is cut

Find
Sleep mode

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I²C mode

I²C address   **(0x01 – 0x7F)**
99 (0x63) default

Vcc   **3.3V – 5.5V**

Clock speed   **100 – 400 kHz**

SDA

SCL
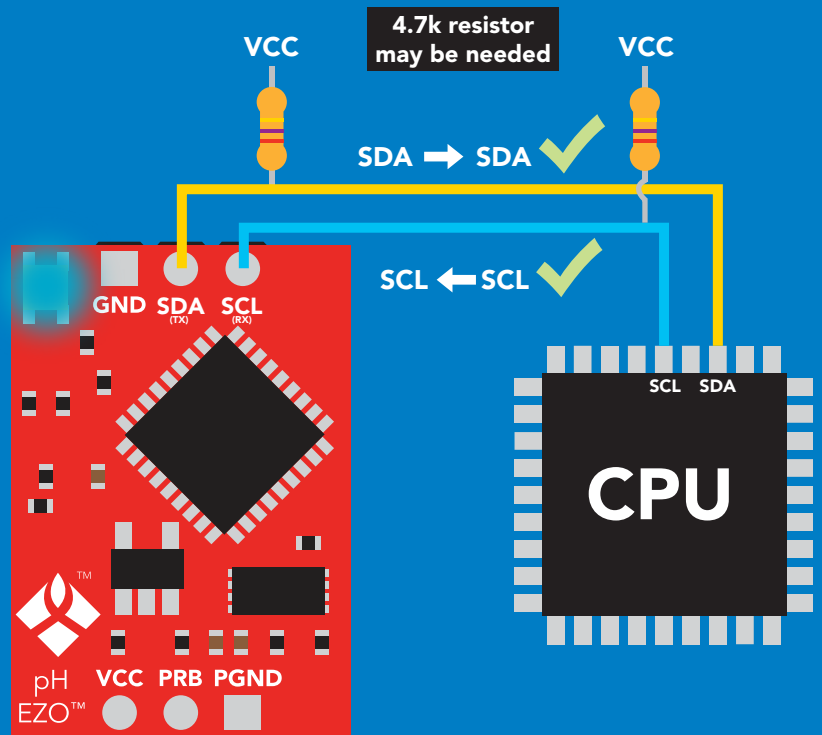
VCC

0V   0V

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

SDA ➡ SDA ✓

SCL ⬅ SCL ✓

GND SDA SCL
     (TX) (RX)

SCL SDA

CPU

pH
EZO™   **VCC PRB PGND**

Data format

Reading	pH		**Data type**	floating point
Units	pH		**Decimal places**	3
Encoding	ASCII		**Smallest string**	4 characters
Format	string		**Largest string**	399 characters

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Sending commands to device

5 parts

Start	I²C address	Write	Command (not case sensitive)	Stop

99 (0x63)   ASCII command string

Example

Start	99 (0x63)	Write	Sleep	Stop

I²C address   Command

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

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Requesting data from device

7 parts

Start	I²C address	Read	Response code	Data string	Null	Stop
	99 (0x63)		1 byte	"9.65"	Terminator (Dec 0)	

9.560

Advanced

Address bits — A6 – A0 **R** ACK Response code ACK Data ACK ... Data N ACK Null ACK ... Null

N bytes of data

All bytes after data are Null

R = High

Start · NACK · Stop

1	57	46	53	54	48	0	= 9.560
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.
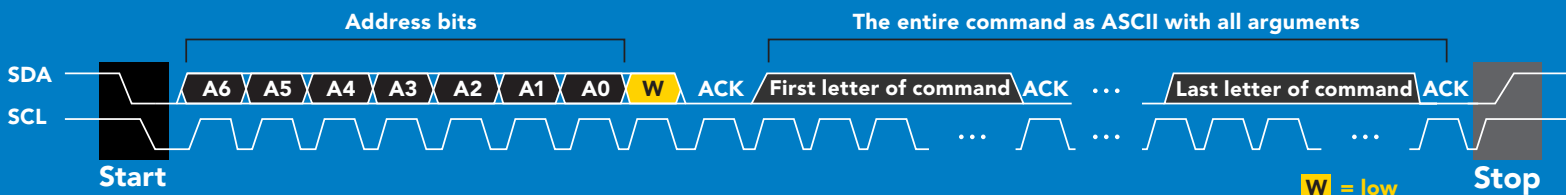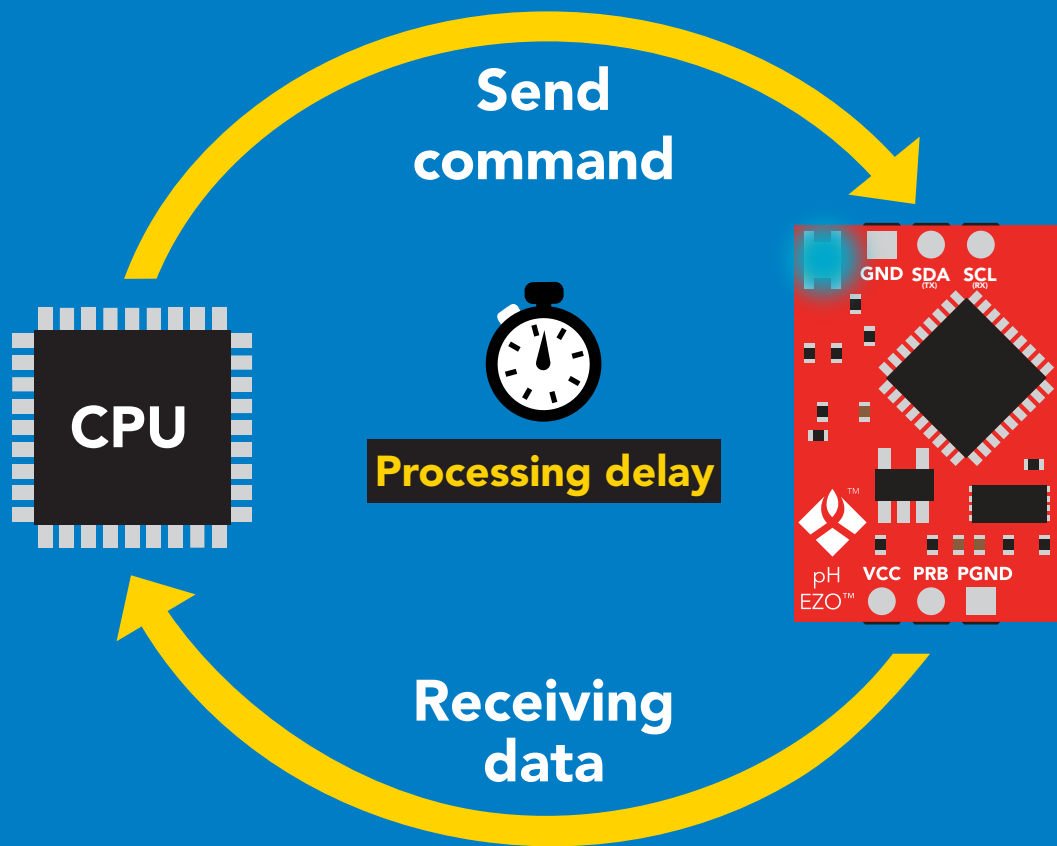
Reading back the response code is completely optional, and is not required for normal operation.

Send command

CPU

Processing delay

GND SDA SCL
(TX) (RX)

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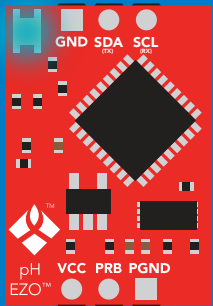
If there is no processing delay or the processing delay is too short, the response code will always be 254.

Response codes

Single byte, not string

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

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r 0.2

LED color definition

Blue

I²C standby
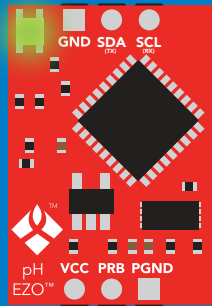
Green

Taking reading
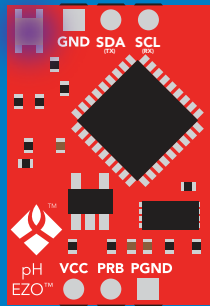
Purple

Changing
I²C ID#

Red

Command
not understood

White

Find

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

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r 0.1
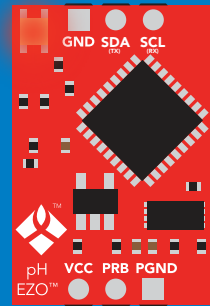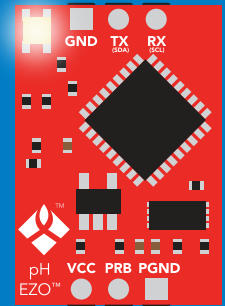
I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 60
Cal	performs calibration	pg. 50
Export/import	export/import calibration	pg. 51
Factory	enable factory reset	pg. 59
Find	finds device with blinking white LED	pg. 48
i	device information	pg. 54
I2C	change I²C address	pg. 58
L	enable/disable LED	pg. 47
Plock	enable/disable protocol lock	pg. 57
R	returns a single reading	pg. 49
Sleep	enter sleep mode/low power	pg. 56
Slope	returns the slope of the pH probe	pg. 52
Status	retrieve status information	pg. 55
T	temperature compensation	pg. 53

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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)

™ pH EZO™ VCC PRB PGND

L,1

GND SDA (TX) SCL (RX)

™ pH EZO™ VCC PRB PGND

L,0

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r 0.1
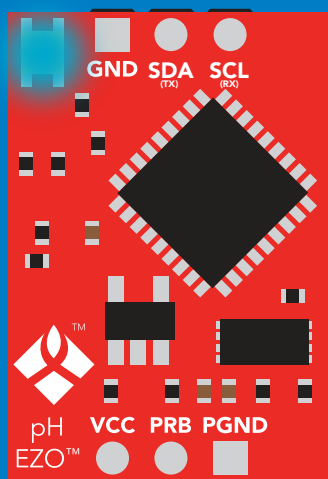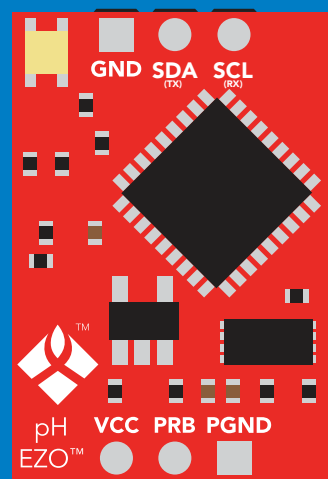
Find

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*

*This command is only available for firmware version 2.10 and above.

Example   Response

Find \<cr\>

⏱ **Wait 300ms**   **1** Dec   **0** Null

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r 0.1
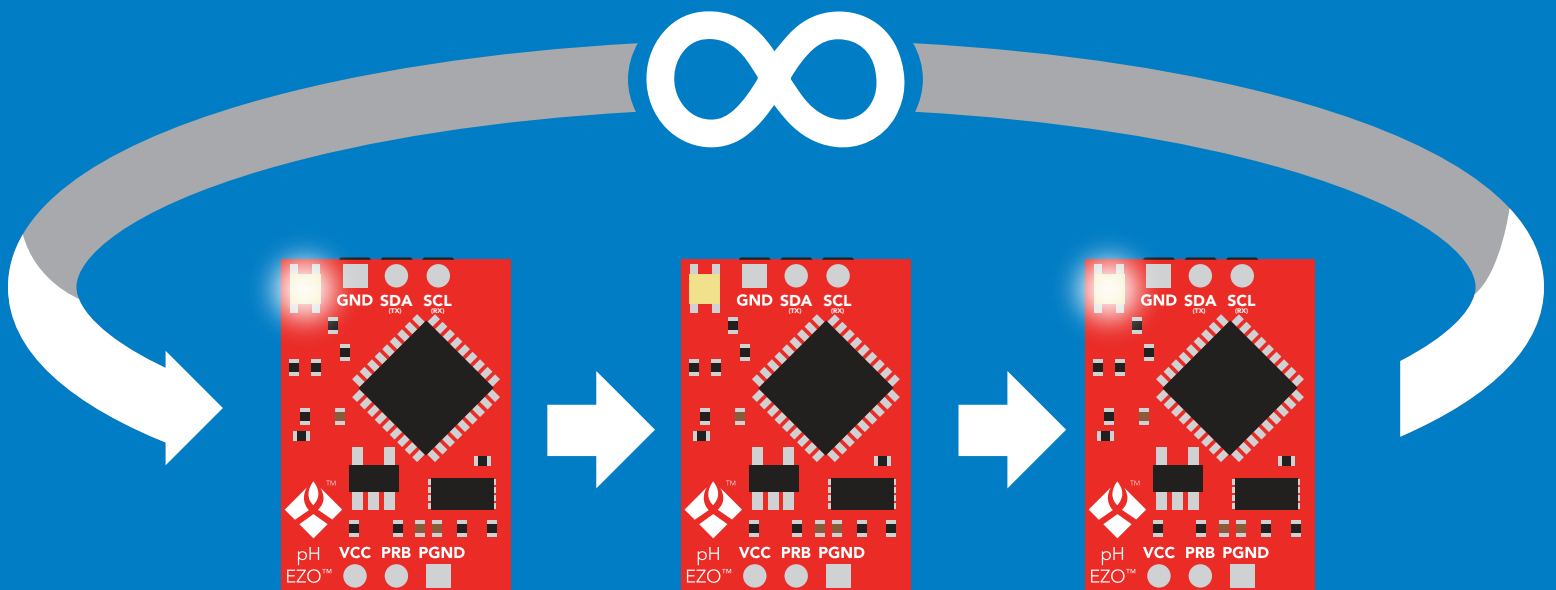
Taking reading

Command syntax   900ms ⏱ processing delay

R   return 1 reading

Example	Response
R	⏱ **Wait 900ms** **1** Dec **9.560** ASCII **0** Null
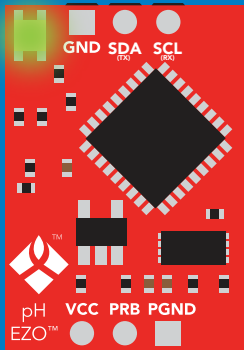
Green
Taking reading
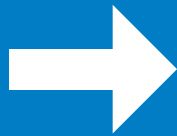
Transmitting

Blue
Standby

Calibration

300ms ⏱ **processing delay**

> Issuing the cal,mid command after the EZO™ pH circuit has been calibrated, will clear the other calibration points. Full calibration will have to be redone.

Command syntax

Command	Description
Cal,mid,n	single point calibration at midpoint
Cal,low,n	two point calibration at lowpoint
Cal,high,n	three point calibration at highpoint
Cal,clear	delete calibration data
Cal,?	device calibrated?

Example / Response

Example	Response		
Cal,mid,7.00	⏱ Wait 900ms	**1** Dec	**0** Null
Cal,low,4.00	⏱ Wait 900ms	**1** Dec	**0** Null
Cal,high,10.00	⏱ 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 one point	**0** Null
1 Dec	**?Cal,2** ASCII two point	**0** Null	or	**1** Dec	**?Cal,3** ASCII three point	**0** Null

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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	export calibration string from calibrated device*
Import	import calibration string to new device*
Export,?	calibration string info*

300ms ⏱ **processing delay**

*This command is only available for firmware version 2.10 and above.
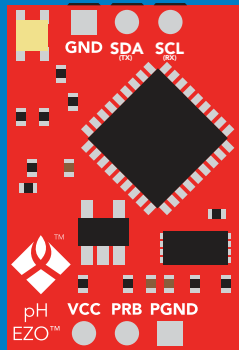
Example | Response

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)

(8 more)

⋮

Export

⏱ Wait 300ms | **1** Dec | **65 20 61 20 63 6F** ASCII | **0** Null | (10 of 10)

Export

⏱ Wait 300ms | **1** Dec | ***DONE** ASCII | **0** Null

Import, n (FIFO)

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

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r 0.1

Slope

300ms ⏱ processing delay

After calibrating a pH probe issuing the slope command will show how closely (in percentage) the calibrated pH probe is working compared to the "ideal" pH probe.

Command syntax

Slope,? returns the slope of the pH probe

Example   Response

Slope,?

⏱ **Wait 300ms** | **1** Dec | **?Slope,99.7,100.3** ASCII | **0** Null
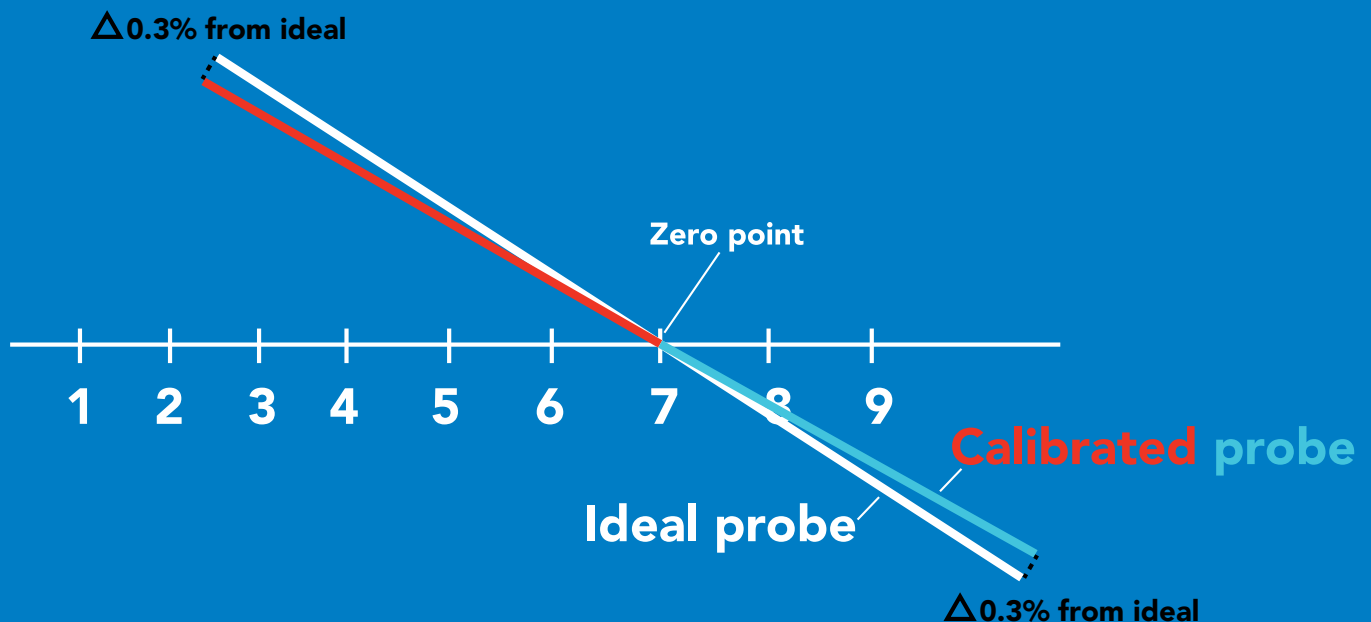
Response breakdown

?Slope,   99.7,   100.3

99.7% is how closely the slope of the **acid** calibration line matched the "ideal" pH probe.

100.3% is how closely the slope of the **base** calibration matches the "ideal" pH probe.

△0.3% from ideal

Zero point

1 2 3 4 5 6 7 8 9

Calibrated probe

Ideal probe

△0.3% from ideal

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r 0.1

Temperature compensation

Command syntax

Temperature is always in Celsius

T,n   n = any value; floating point or int
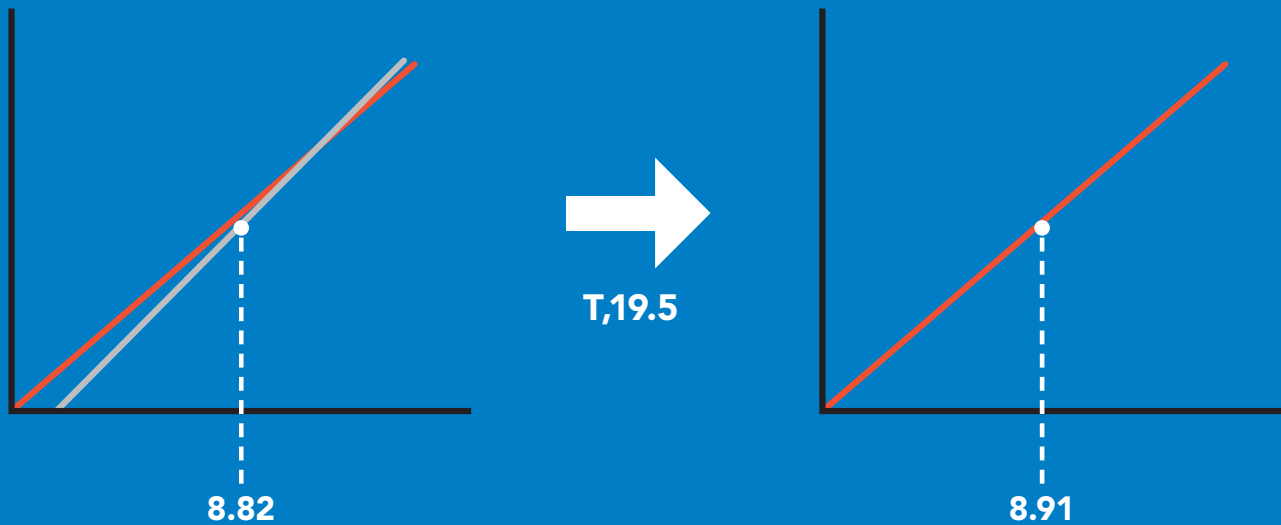
T,?   compensated temperature value?

Example	Response
T,19.5	⏱ **Wait 300ms** **1** Dec **0** Null
T,?	⏱ **Wait 300ms** **1** Dec **?T,19.5** ASCII **0** Null

T,19.5

8.82   →   8.91

Device information

Command syntax

300ms processing delay

i   device information

Example   Response

i

Wait 300ms | **1** Dec | **?i,pH, 19.8** ASCII | **0** Null

Response breakdown

?i,   **pH,**   **1.98**
Device   Firmware

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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

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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	
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

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r 0.1
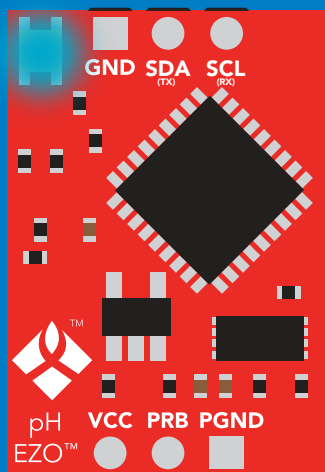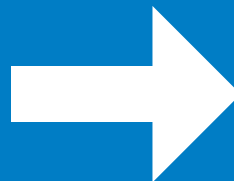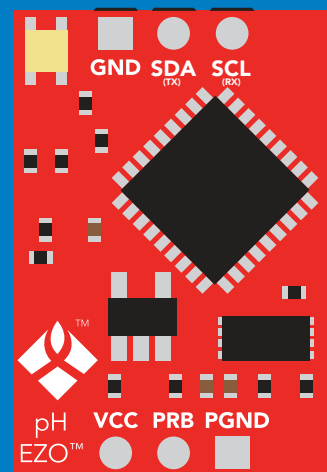
Protocol lock

Command syntax

300ms ⏱ processing delay

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   Serial, 9600

GND SDA(TX) SCL(RX)   pH EZO™ VCC PRB PGND

GND SDA(TX) SCL(RX)   pH EZO™ VCC PRB PGND

GND SDA(TX) SCL(RX)   pH EZO™ VCC PRB PGND
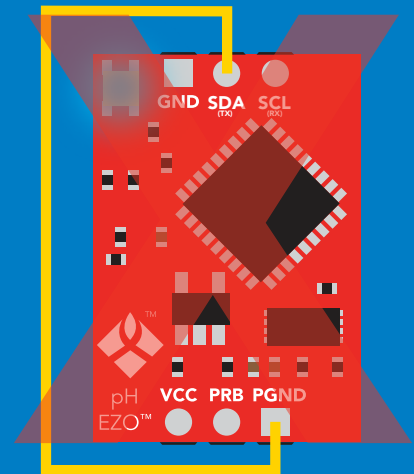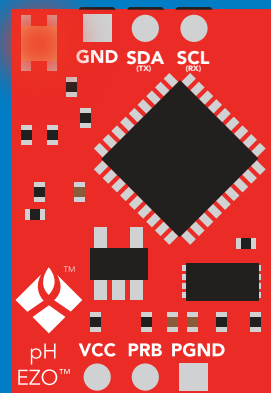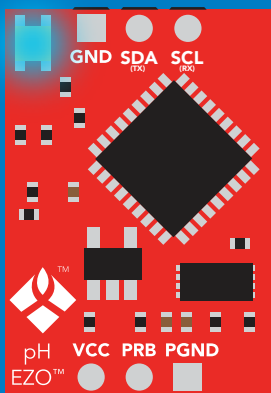
cannot change to UART   **cannot change to UART**

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I²C address change

Command syntax

300ms ⏱ processing delay

I2C,n sets I²C address and reboots into I²C mode

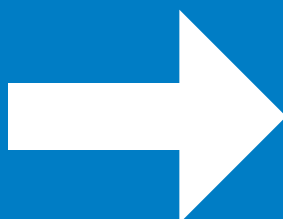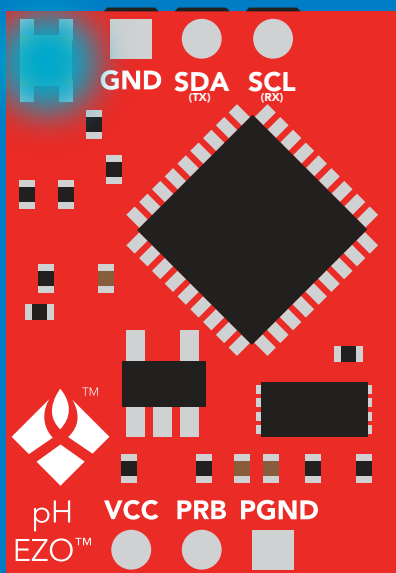| Example	Response
I2C,100	device reboot

Warning!

Changing the I²C address will prevent communication between the circuit and the CPU, until the CPU is updated with the new I²C address.
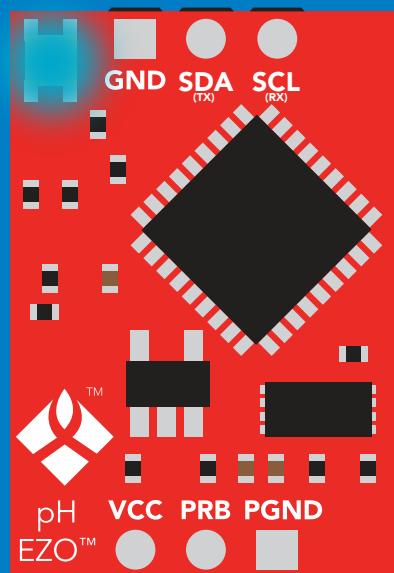
Default I²C address is 99 (0x63).

n = any number 1 – 127

I2C,100

(reboot)

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Factory reset

Command syntax

Factory   enable factory reset

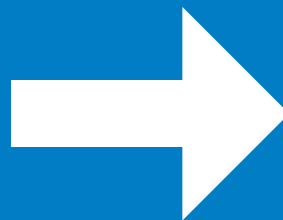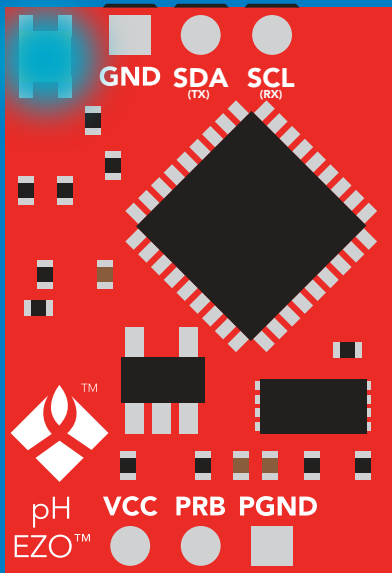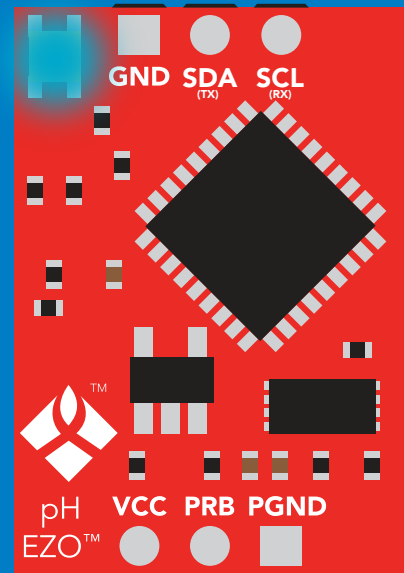| Example	Response
Factory	device reboot

Clears calibration
LED on
Response codes enabled

Factory

(reboot)

Change to UART mode

Command syntax

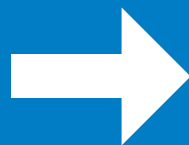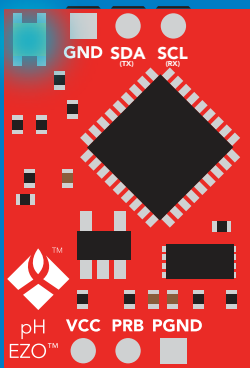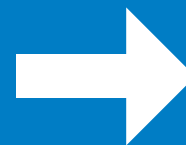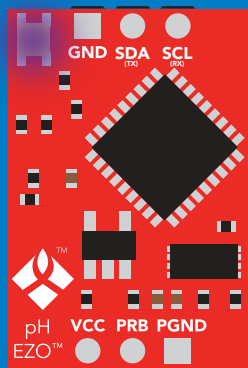Baud,n   switch from I²C to UART

Example	Response
Baud,9600	reboot in UART mode

$$n = \begin{cases} 300 \\ 1200 \\ 2400 \\ 9600 \\ 19200 \\ 38400 \\ 57600 \\ 115200 \end{cases}$$

Serial,9600
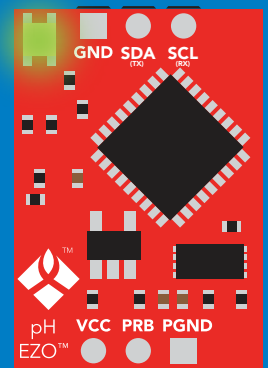
Changing to UART mode

(reboot)

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

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EZO™ circuit footprint

GND   TX
       (SDA)   RX
               (SCL)

pH
EZO™   VCC   PRB   PGND

**17.78mm
(0.7")**

**2.54mm
(0.1")**
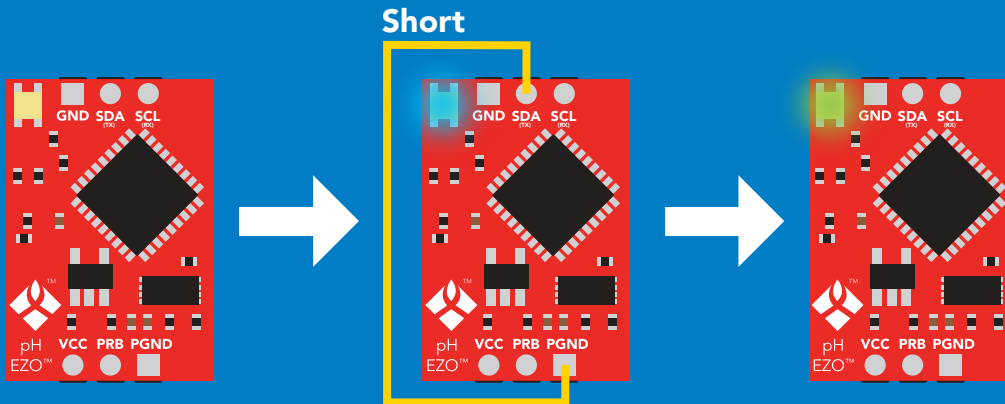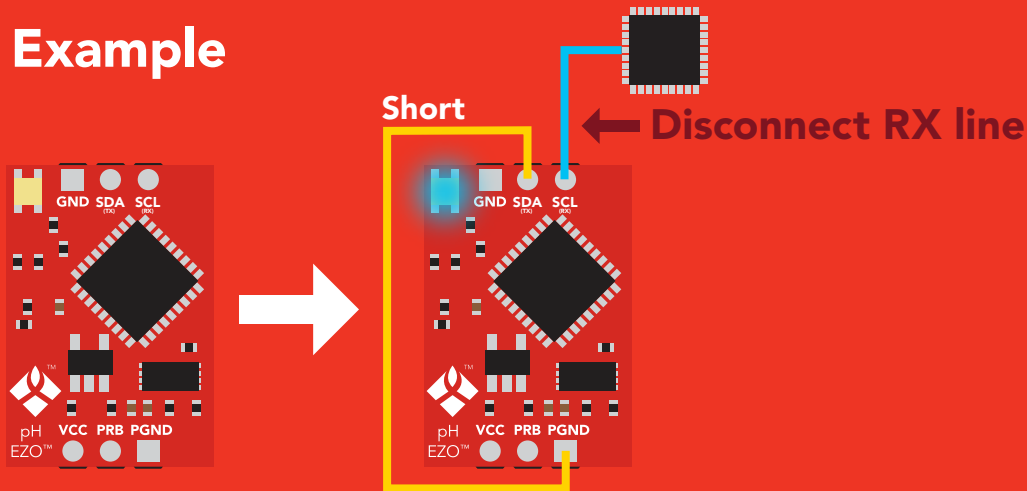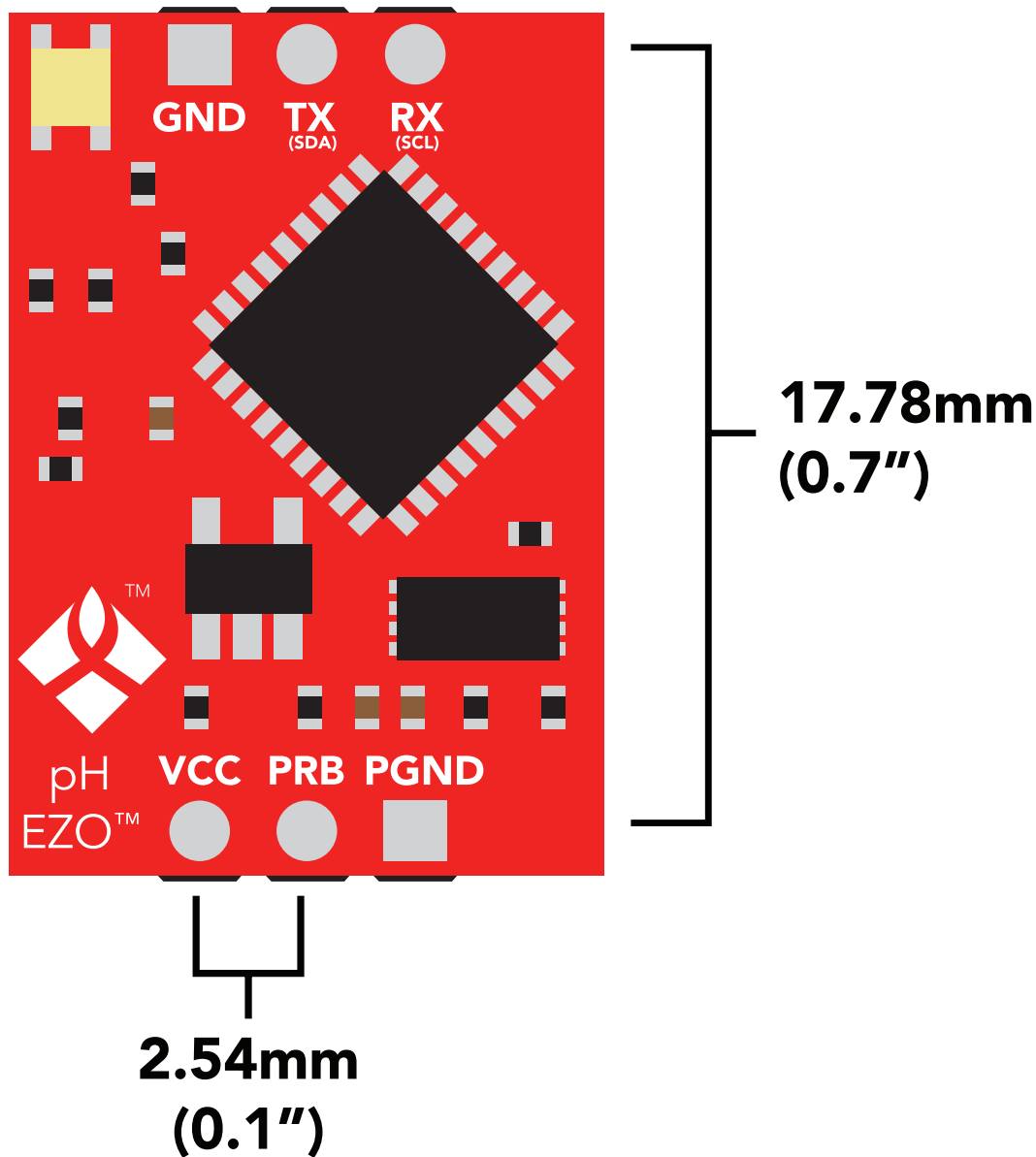
1 In your CAD software place an 8 position header.

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.

**17.78mm
(0.7")**

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Datasheet change log
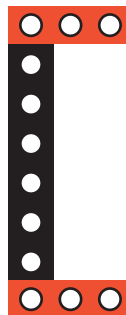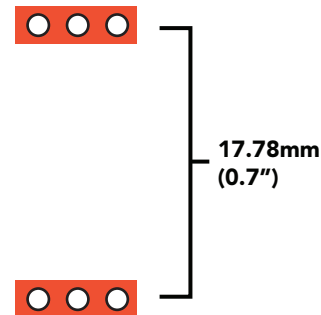
Datasheet V 4.6

Added information to calibration theory on pg 7.

Datasheet V 4.5

Revised definition of response codes on pg 44.

Datasheet V 4.4

Added resolution range to cover page.

Datasheet V 4.3

Revised isolation information on pg 9.

Datasheet V 4.2

Revised Plock pages to show default value.

Datasheet V 4.1

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

Datasheet V 4.0

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

Datasheet V 3.9

Revised calibration theory on pg. 7.

Datasheet V 3.8

Revised entire datasheet.

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Firmware updates

V1.1 – Initial release (Oct 30, 2014)
• Change output to mg/L, then percentage (was previously percentage, then mg/L)

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

V1.6 – I^2C bug (Dec 1, 2014)
• Fix I^2C bug where the circuit may inappropriately respond when other I^2C 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 glitch where EEPROM would get erased if the circuit lost power 900ms
  into startup

V1.97 – EEPROM (Oct 10, 2016)
• Added the option to save and load calibration.

V1.98 – EEPROM (Nov 14, 2016)
• Fixed glitch during calibration process.

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 – (June 12, 2017)
• Fixed "I" command to return "pH" instead of "PH".

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Warranty

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

The debugging phase

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

• **Soldering any part of the EZO™ class pH circuit.**

• **Running any code, that does not exclusively drive the EZO™ class pH circuit and output its data in a serial string.**

• **Embedding the EZO™ class pH circuit into a custom made device.**

• **Removing any potting compound.**

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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 pH circuit, against the thousands of possible variables that may cause the EZO™ class pH 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 pH circuits continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.

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