Atlas Scientific™
Environmental Robotics

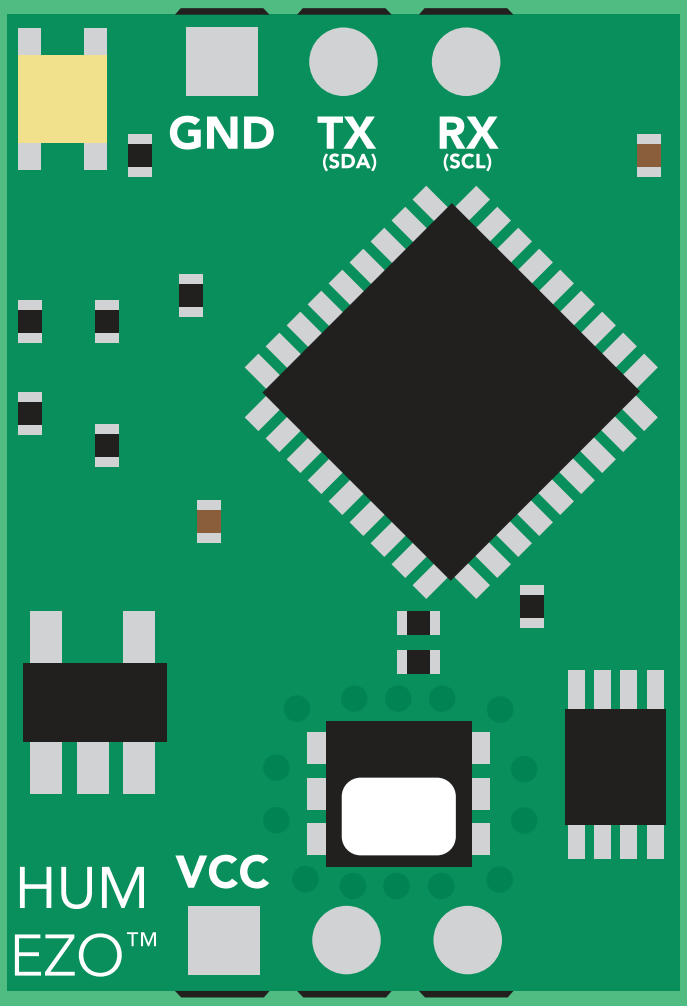
V 1.1

Released 11/22

EZO-HUM™

Embedded Humidity Circuit

Reads	**Relative humidity** **Dew point** **Air temperature**
Range	**0 – 100%**
Calibration	**Factory calibrated**
Response time	**1 reading per second** (UART mode) **1 reading per 300 milliseconds** (I2C mode)
Accuracy	**+/- 2%**
Data protocol	**UART & I²C**
Default I2C address	**111 (0x6F)**
Operating voltage	**3.3V – 5V**
Data format	**ASCII**



RoHS COMPLIANT

Written by Jordan Press
Designed by Noah Press

This is an evolving document, check back for updates.

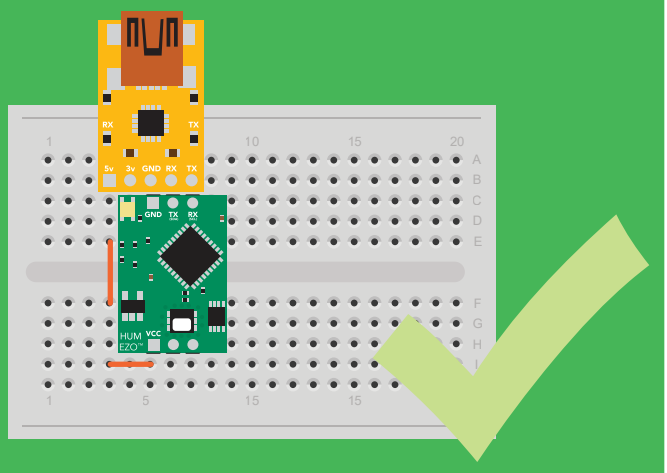
STOP

SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

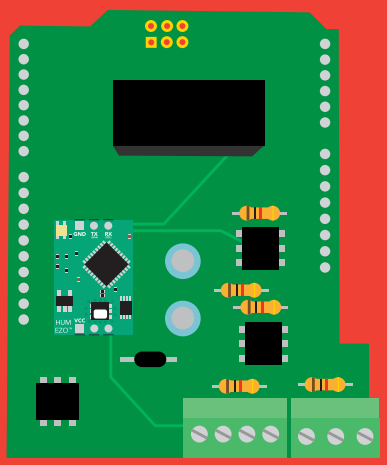
This is sensitive electronic equipment. Get this device working in a solderless breadboard first. Once this device has been soldered it is no longer covered by our warranty.

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!



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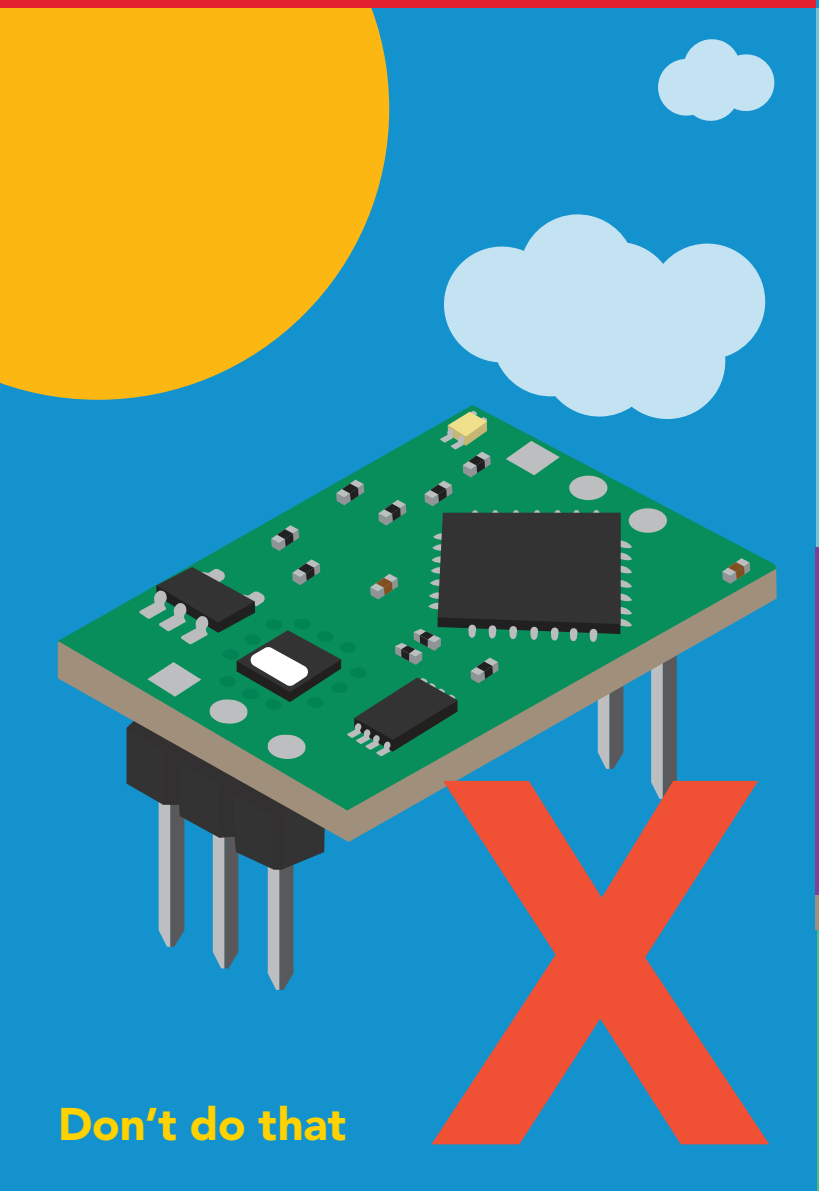
UART

I²C

Attention

The EZO-HUM™ is 100% operational out of the box.
CALIBRATION IS UNNECESSARY

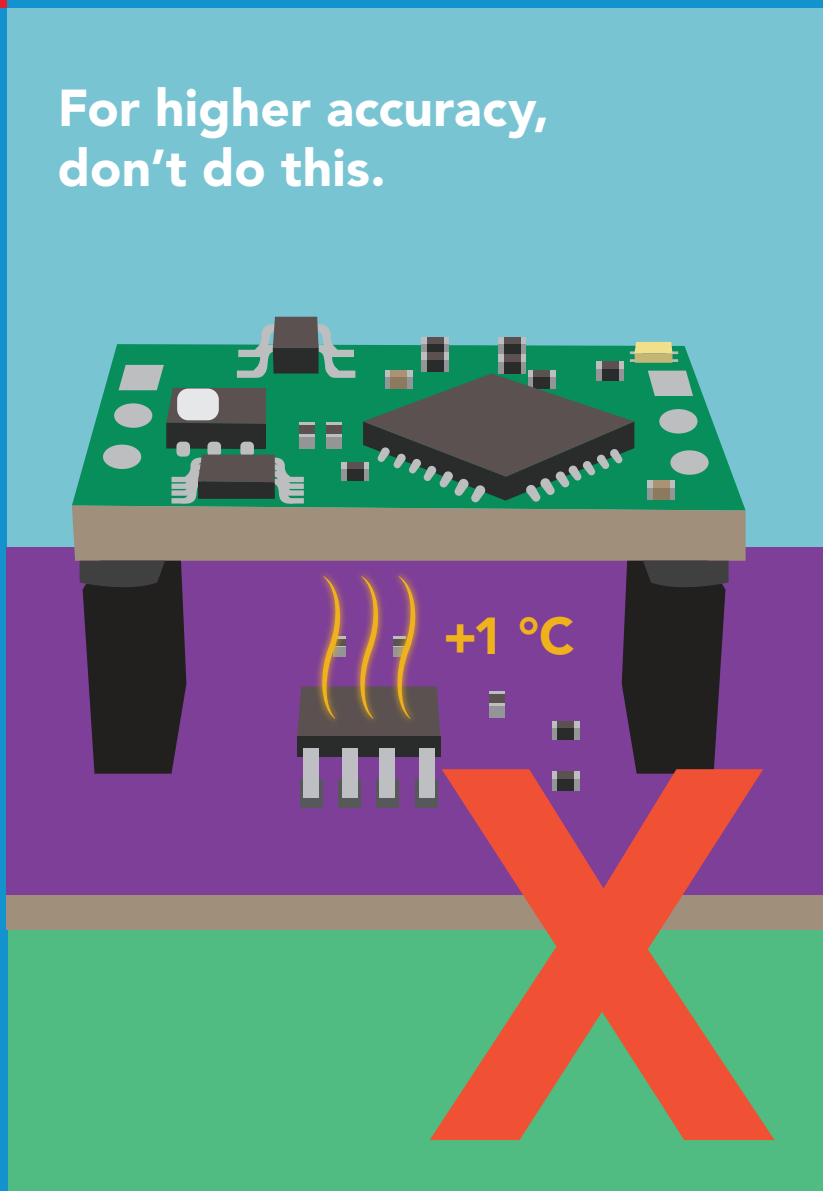
Direct sunlight will heat the circuit above the air temperature, making the readings incorrect.



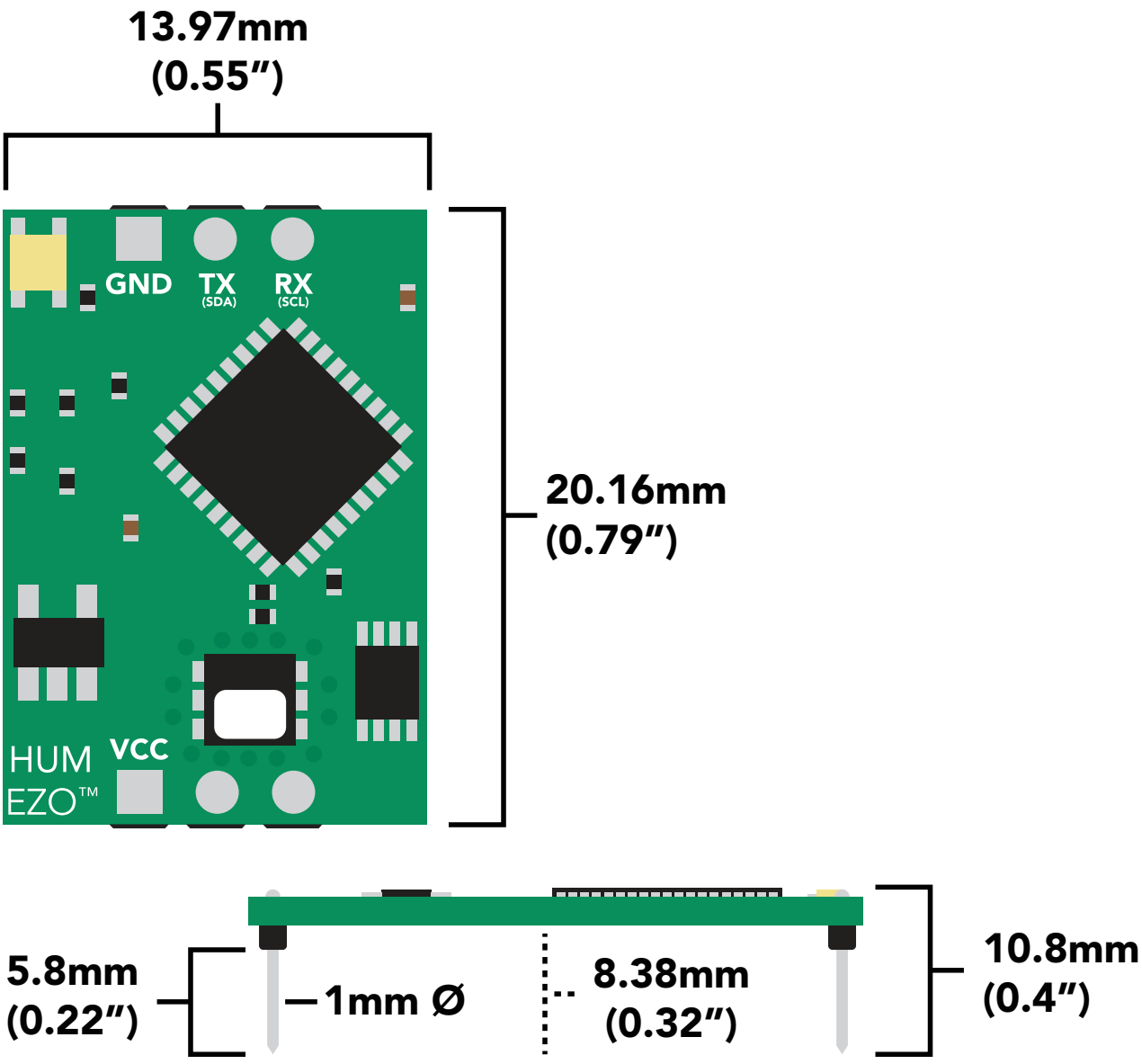
Don't do that

A small amount of heating can have a noticable change to the humidity readings.

For higher accuracy, don't do this.



EZO™ circuit dimensions



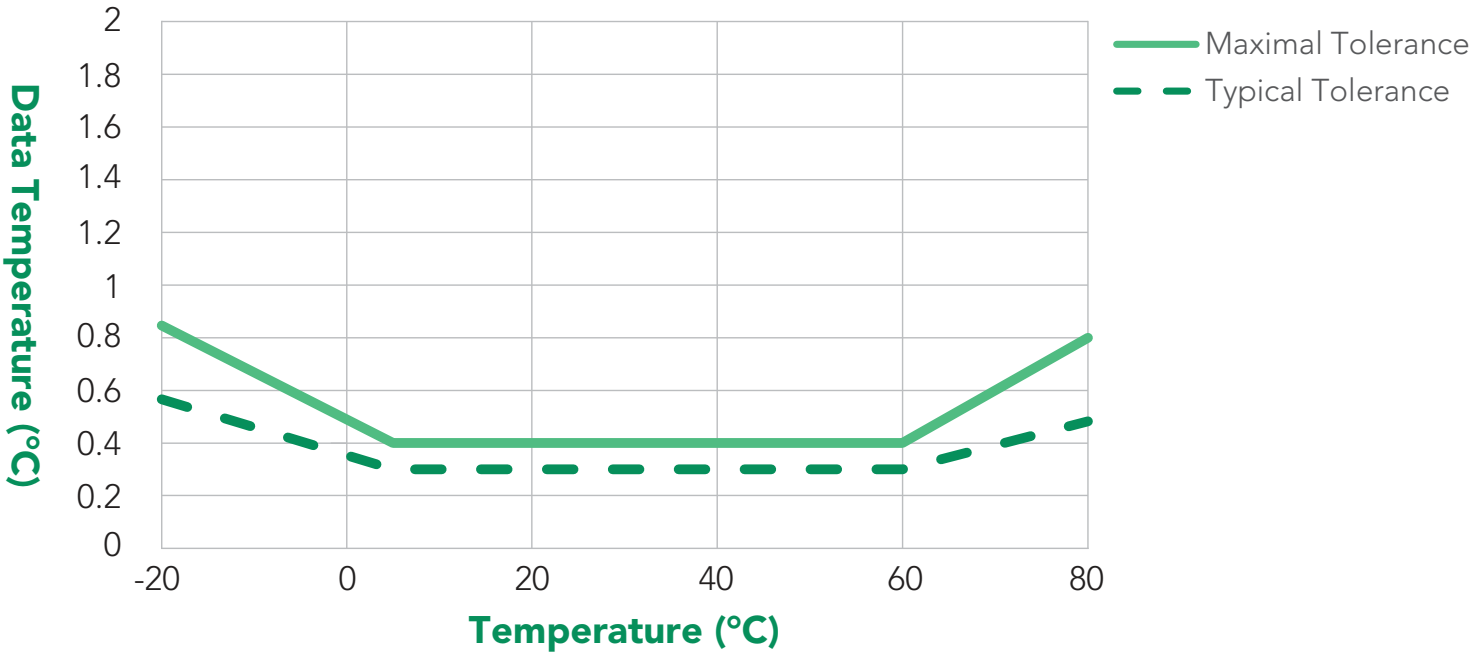
Power consumption

	LED	MAX	SLEEP
5V	ON	2.6 mA	0.5 mA
	OFF	2.4 mA	
3.3V	ON	2.2. mA	0.3 mA
	OFF	2.0 mA	

Absolute max ratings

Parameter	MIN	TYP	MAX
Storage temperature	-30 °C		75 °C
Operational temperature	-20 °C	25 °C	80 °C
VCC	3.3V	3.3V	5.5V

Air temperature



Calibration theory

The Atlas Scientific EZO-HUM™ Embedded Humidity Circuit comes pre-calibrated. The factory calibration data is permanently stored in the circuit and cannot be erased.

Custom calibration

This circuit does not require recalibration, and does not offer onboard custom calibration.

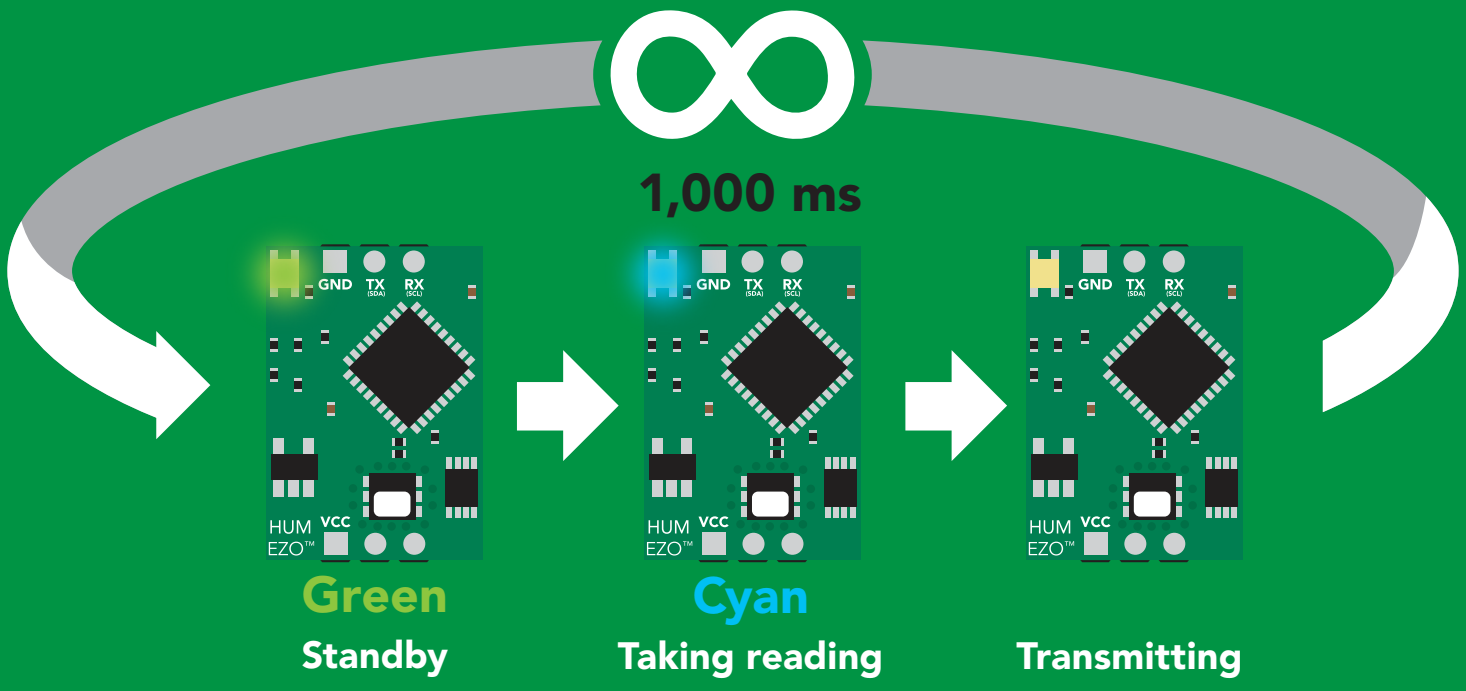
Electrical isolation

Electrical isolation is not needed.

Default state

UART mode

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



✓ 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

Auto monitor
Baud rate
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

Sleep mode

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UART mode

8 data bits	no parity
1 stop bit	no flow control

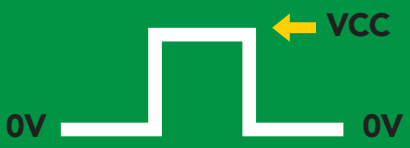
Baud

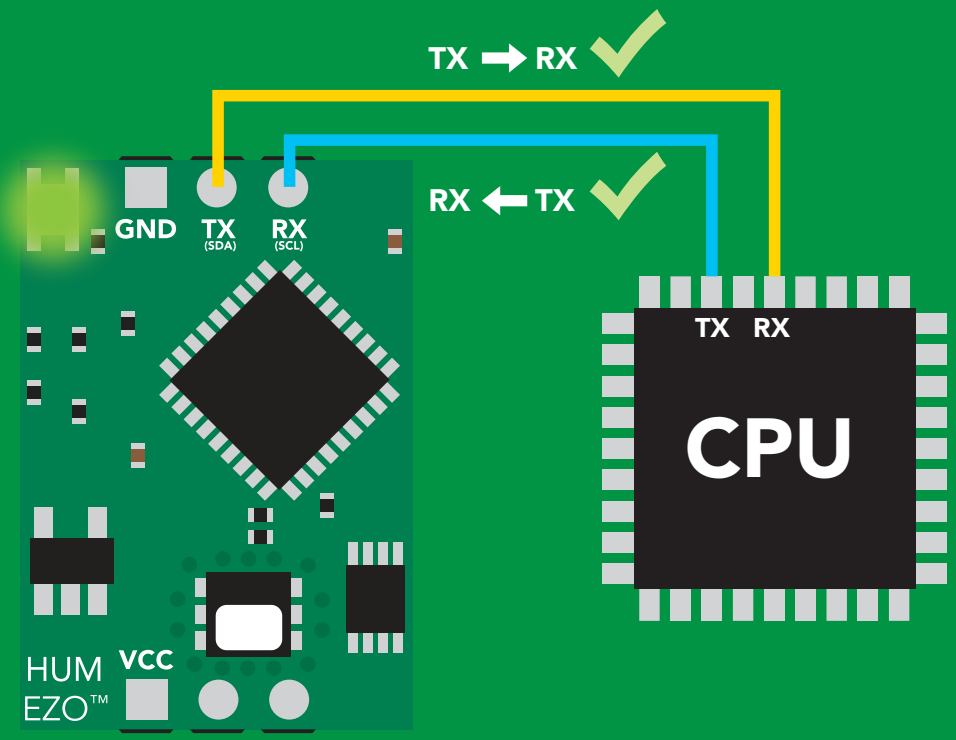
300
1,200
2,400
9,600 default
19,200
38,400
57,600
115,200

RX
Data in

TX
Data out

Vcc 3.3V – 5V





Data format

Reading	Humidity Air Temperature Dew point
Units	% Relative humidity Air Temperature °C *(when enabled)* Dew point Temperature °C *(when enabled)*
Encoding	ASCII (CSV string if temp/ dew point enabled)
Terminator	carriage return

Data type	floating point
Decimal places	2
Smallest string	4 characters
Largest string	24 characters

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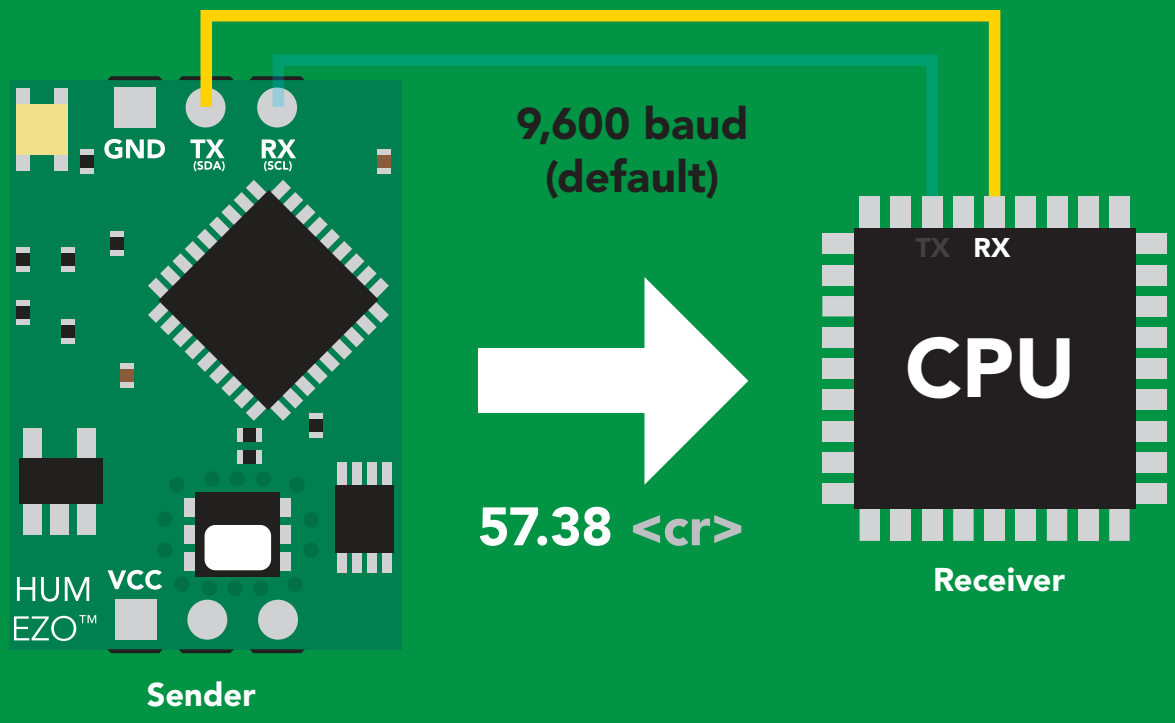
Receiving data from device

2 parts

ASCII data string
Command

Carriage return <cr>
Terminator



Advanced

ASCII:	5	7	.	3	8	<cr>
Hex:	35	37	2E	33	38	0D
Dec:	53	55	46	51	56	13

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Sending commands to device

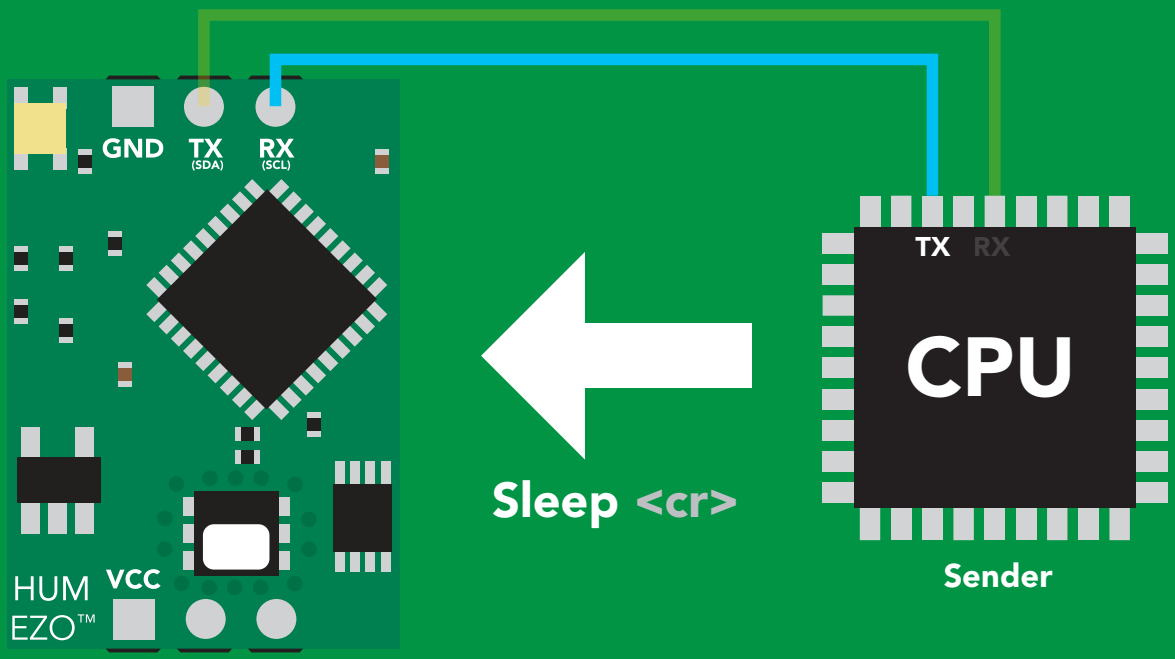
2 parts

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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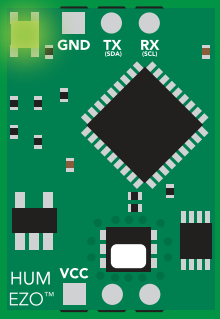
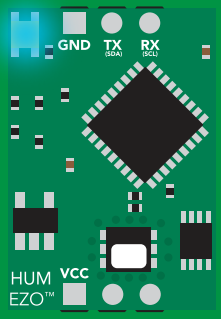
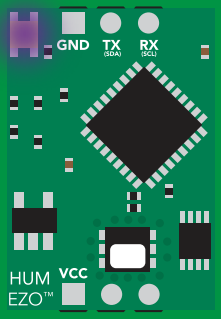
Indicator LED definition



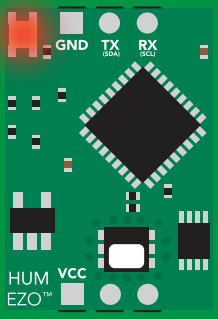
Green
UART standby



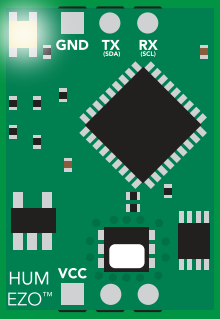
Cyan
Taking reading



Purple
Changing baud rate



Red
Command not understood



White
Find

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

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UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

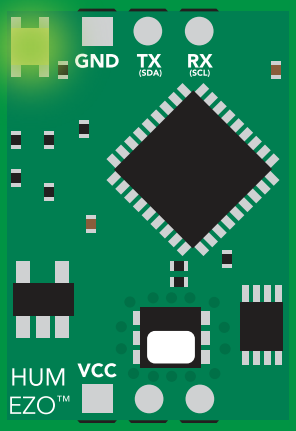
Command	Function		Default state
Baud	change baud rate	pg. 25	9,600
C	enable/disable continuous mode	pg. 17	enabled
Factory	enable factory reset	pg. 27	n/a
Find	finds device with blinking white LED	pg. 16	n/a
i	device information	pg. 21	n/a
I2C	change to I²C mode	pg. 28	not set
L	enable/disable LED	pg. 15	enabled
Name	set/show name of device	pg. 20	not set
O	enable/disable parameters	pg. 19	HUM
Plock	enable/disable protocol lock	pg. 26	n/a
R	returns a single reading	pg. 18	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	n/a

LED control

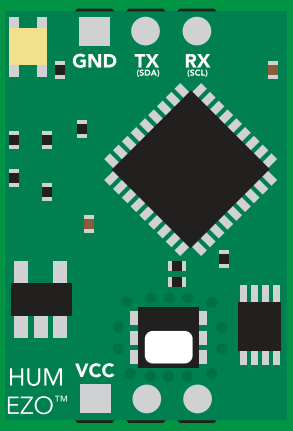
Command syntax

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

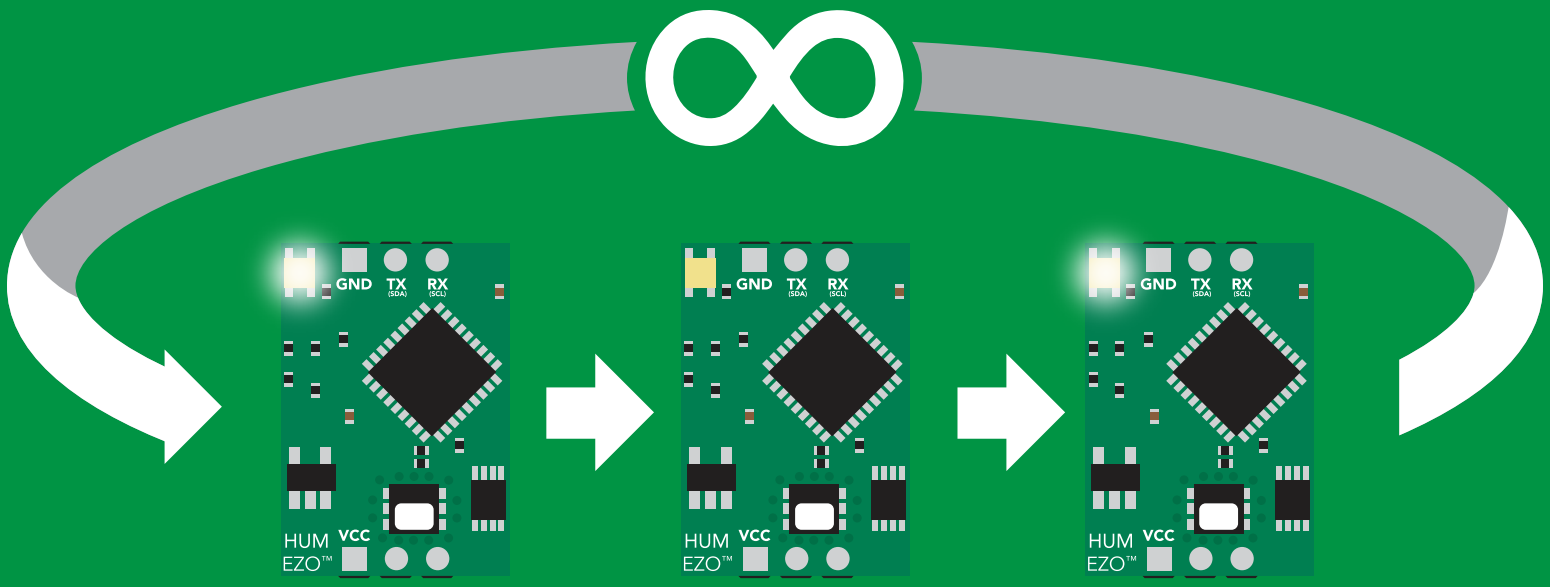
Find

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>



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Continuous 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 mode settings

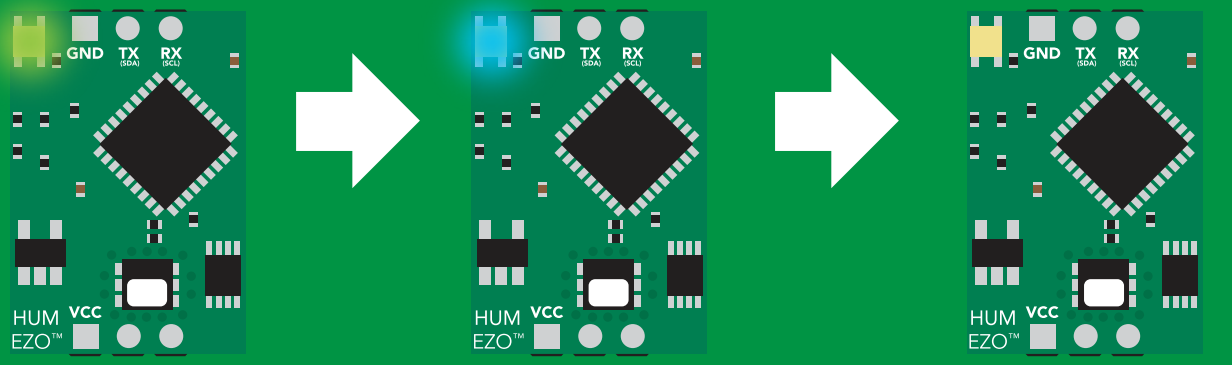
Example	Response
C,1 <cr>	*OK <cr> HUM (1 sec) <cr> HUM (2 sec) <cr> HUM (n sec) <cr>
C,30 <cr>	*OK <cr> HUM (30 sec) <cr> HUM (60 sec) <cr> HUM (90 sec) <cr>
C,0 <cr>	*OK <cr>
C,? <cr>	?C,1 <cr> or ?C,0 <cr> or ?C,30 <cr> *OK <cr>

Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	57.38 <cr> *OK <cr>



Green
Standby

Cyan
Taking reading

Transmitting

1 second

Enable/disable parameters from output string

Command syntax

O, [parameter],[1,0]	<cr>	enable or disable output parameter
O,?	<cr>	enabled parameter?

Example	Response
O,HUM,1 / O,HUM,0 <cr>	*OK <cr> enable / disable humidity
O,T,1 / O,T,0 <cr>	*OK <cr> enable / disable temperature
O,Dew,1 / O,Dew,0 <cr>	*OK <cr> enable / disable dew point
O,? <cr>	?,O,HUM,T,Dew <cr> if all enabled

Parameters

Hum	Humidity
T	Air temperature in °C
Dew	Dew point

Followed by 1 or 0

1	enabled
0	disabled

* If you disable all possible data types your readings will display "no output".

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Naming device

Command syntax

Do not use spaces in the name

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

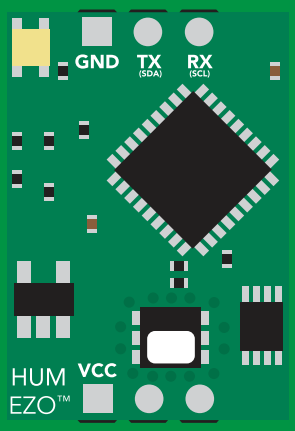
n =

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

Up to 16 ASCII characters

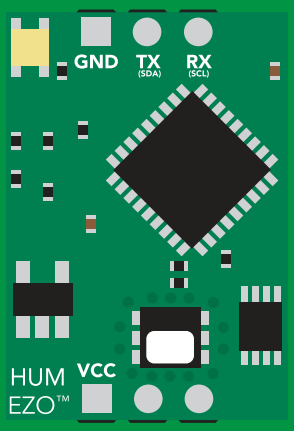
Example		Response	
Name,	<cr>	*OK <cr>	name has been cleared
Name,zzt	<cr>	*OK <cr>	
Name,?	<cr>	?Name,zzt <cr> *OK <cr>	

Name,zzt <cr>



*OK <cr>

Name,? <cr>



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

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Device information

Command syntax

i <cr> **device information**

Example	Response
i <cr>	?i,HUM,1.0 <cr> *OK <cr>

Response breakdown

?i, HUM, 1.0

HUM: Device

1.0: 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>	57.38 <cr> *OK <cr>
*OK,0 <cr>	no response, *OK disabled
R <cr>	57.38 <cr> *OK disabled
*OK,? <cr>	?*OK,1 <cr> or ?*OK,0 <cr>

Other response codes

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

These response codes cannot be disabled

Reading device status

Command syntax

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

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

Response breakdown

?Status, P, 5.038

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

Restart codes

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

Sleep mode/low power

Command syntax

Send any character or command to awaken device.

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

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

	MAX	SLEEP
5V	**2.6 mA**	**0.5 mA**
3.3V	**2.2 mA**	**0.4 mA**

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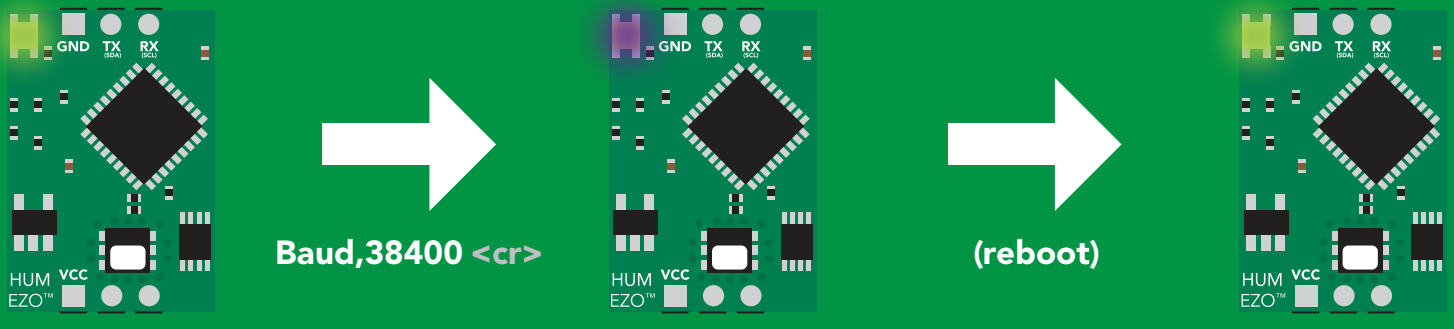
Change baud rate

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

Changing baud rate

*OK <cr>

Standby

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Protocol lock

Command syntax

Locks device to UART mode.

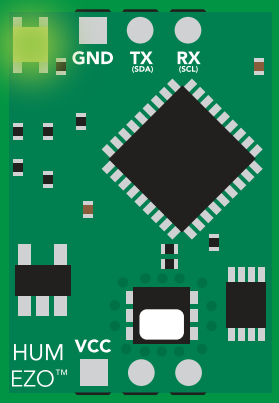
Plock,1 <cr> enable Plock

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

Plock,? <cr> Plock on/off?

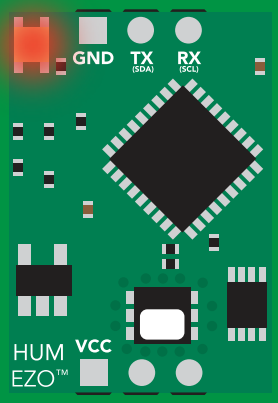
Example	Response
Plock,1 <cr>	*OK <cr>
Plock,0 <cr>	*OK <cr>
Plock,? <cr>	?Plock,1 <cr> or ?Plock,0 <cr>

Plock,1



*OK <cr>

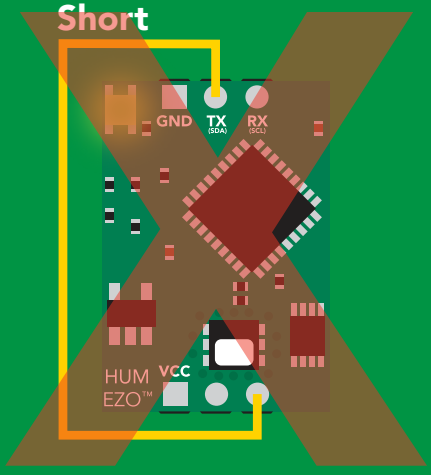
I2C,100



cannot change to I²C

*ER <cr>

Short



cannot change to I²C

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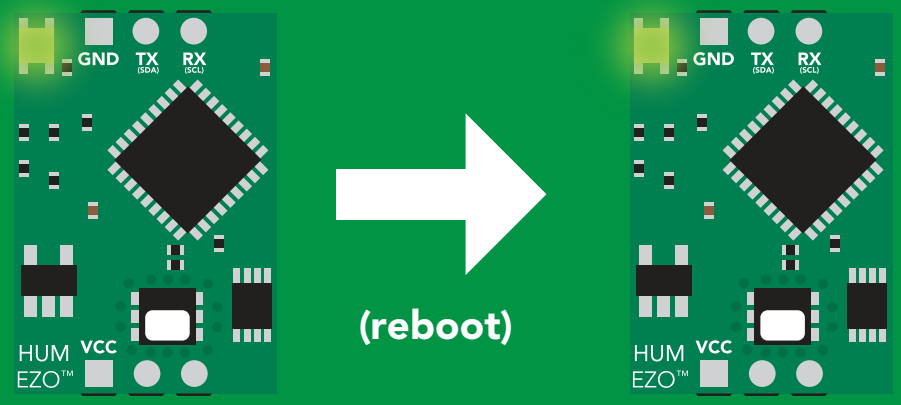
Factory reset

Command syntax

Factory <cr> enable factory reset

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

Factory <cr>



***OK** <cr>

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

Baud rate will not change

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Change to I²C mode

Command syntax

Default I²C address 111 (0x6F)

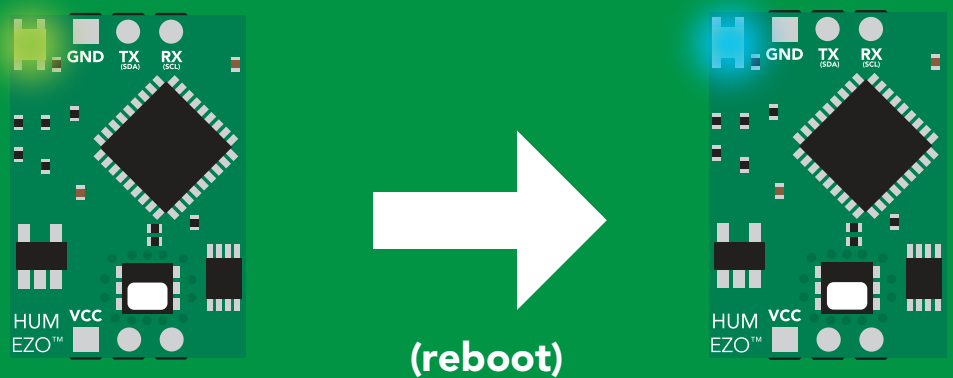
I2C,n <cr> sets I²C address and reboots into I²C mode

n = any number 1 – 127

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

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

I2C,100



Green
*OK <cr>

Blue
now in I²C mode

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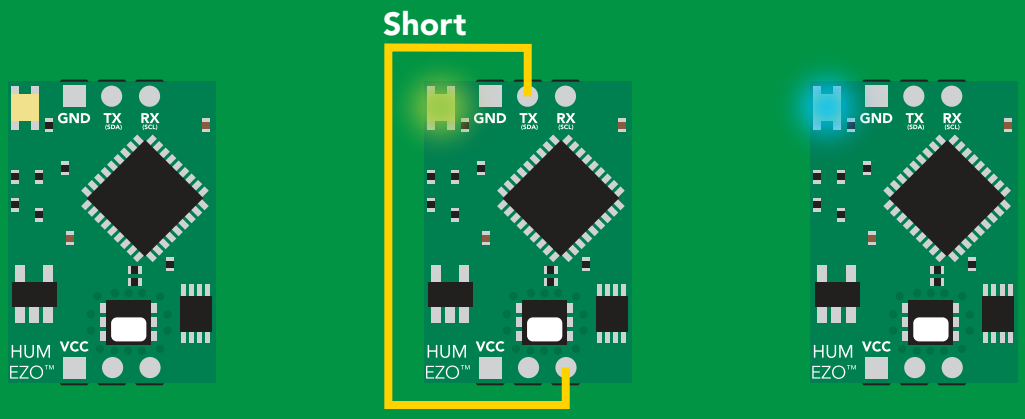
Manual switching to I²C

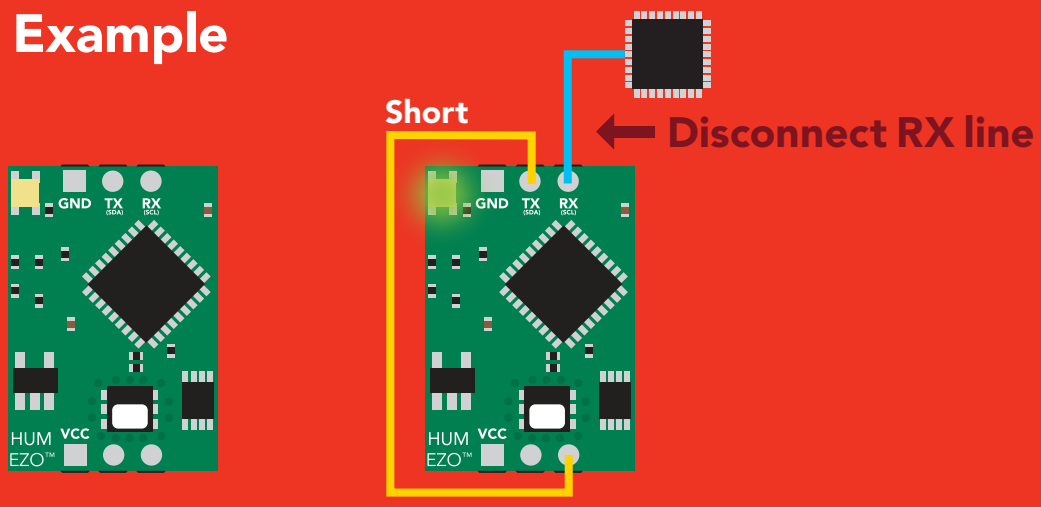
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PGND
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Green to Blue
- Disconnect ground (power off)
- Reconnect all data and power

Manually switching to I²C will set the I²C address to 111 (0x6F)

Example



Wrong Example



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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

Sleep mode

I²C mode

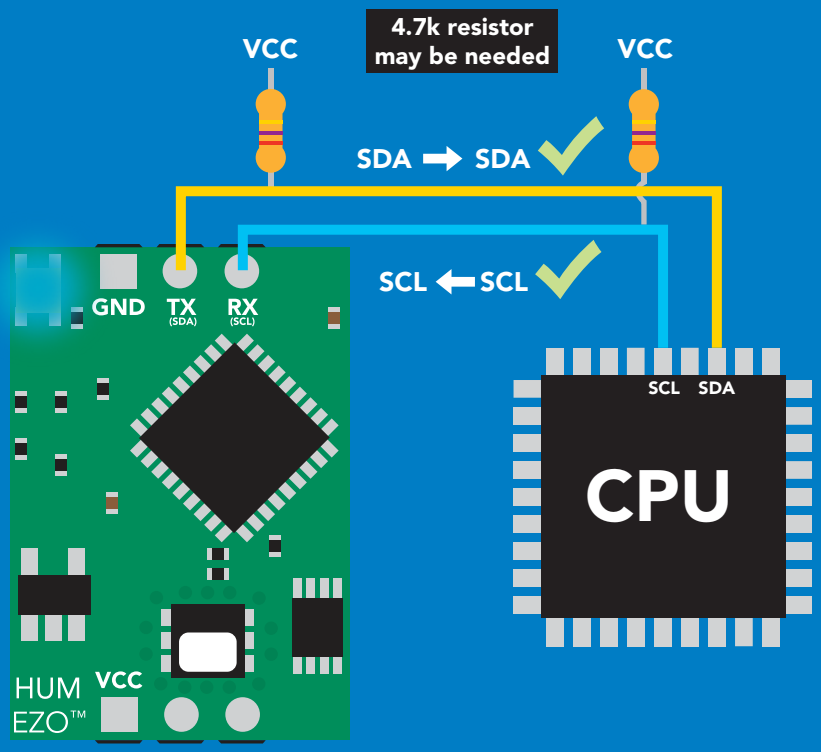
I²C address (0x01 – 0x7F)
111 (0x6F) default

Vcc 3.3V – 5.5V

Clock speed 100 – 400 kHz

SDA

SCL



Data format

Reading
Humidity
Air Temperature
Dew point

Units
% Relative humidity
Air Temperature °C *(when enabled)*
Dew point Temperature °C *(when enabled)*

Encoding ASCII (CSV string if temp/ dew point enabled)

Data type floating point
Decimal places 2
Smallest string 4 characters
Largest string 24 characters

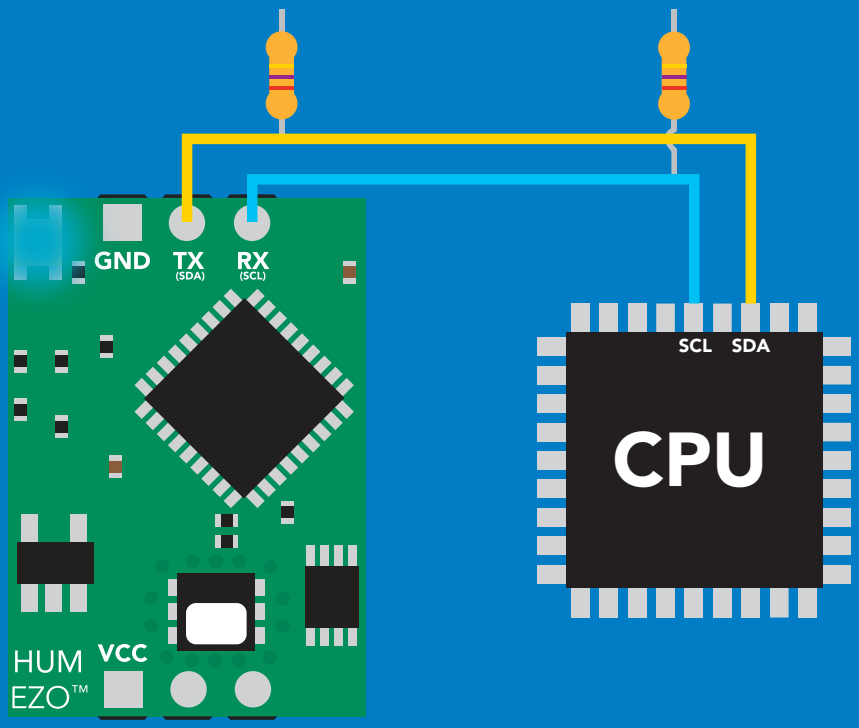
Sending commands to device

5 parts

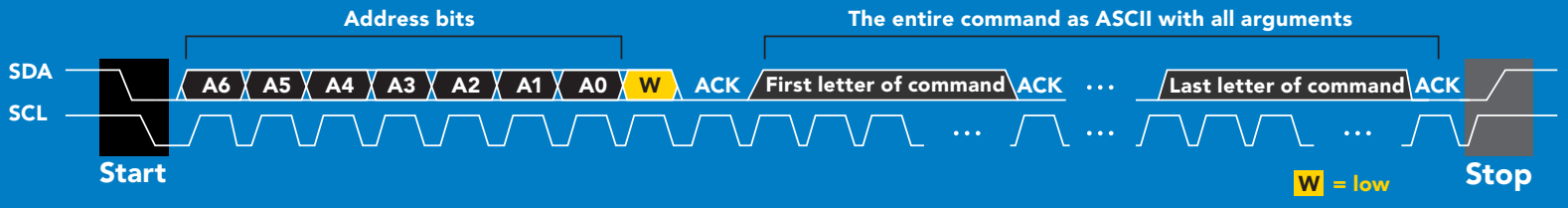
Start	I²C address	Write	Command (not case sensitive)	Stop
	111 (0x6F)		ASCII command string	

Example

Start	111 (0x6F)	Write	Sleep	Stop
	I²C address		Command	



Advanced



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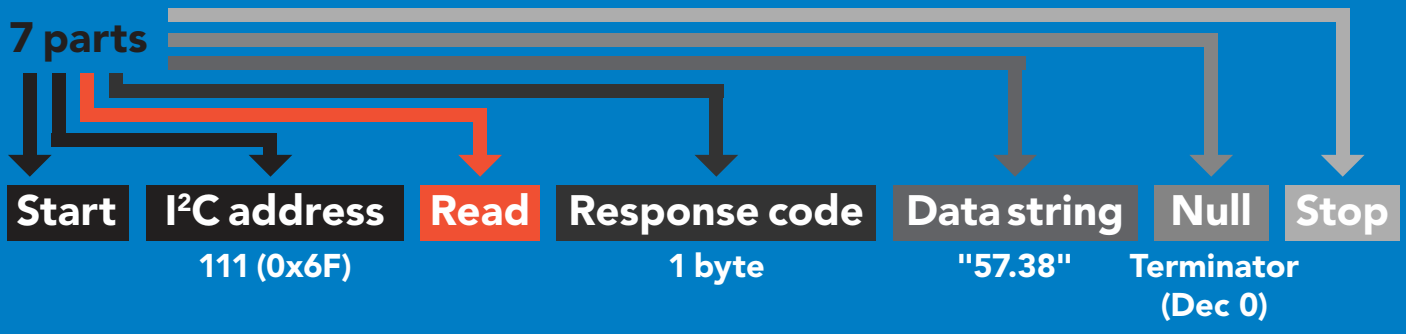
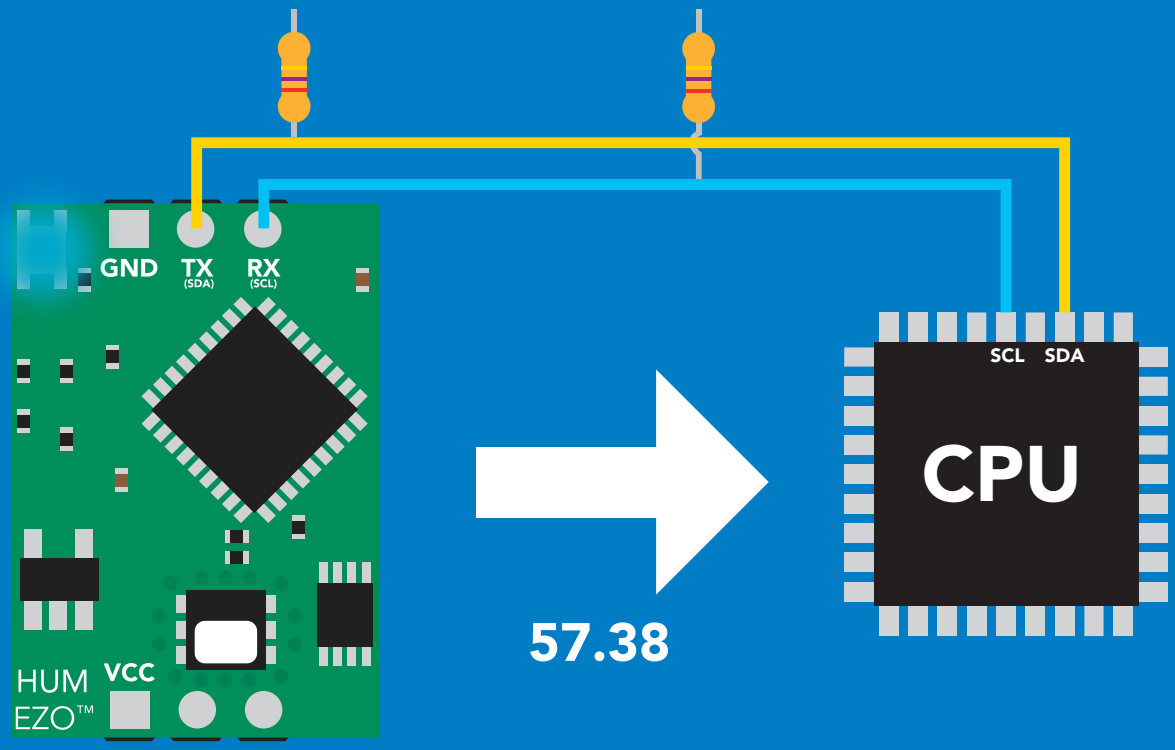
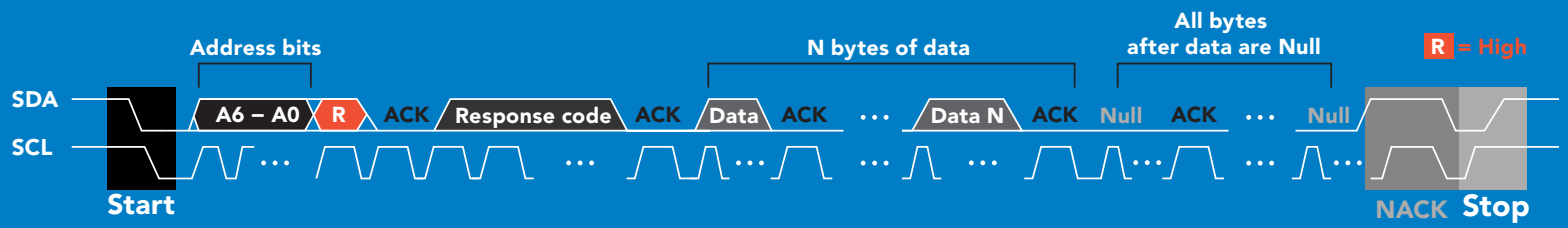
Requesting data from device





Advanced



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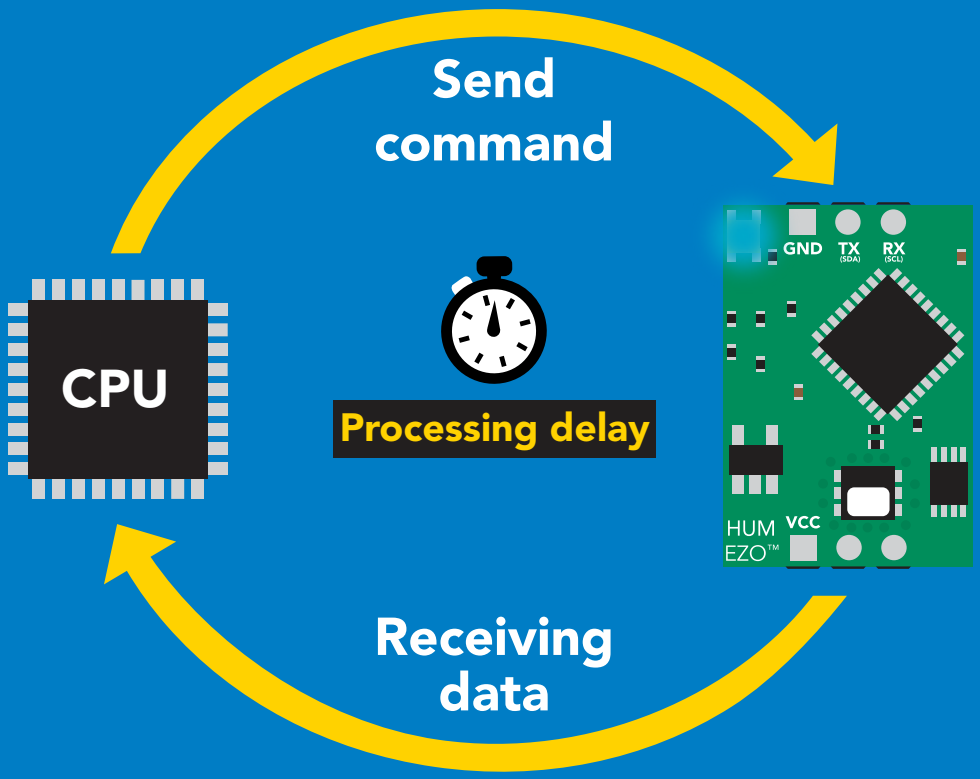
Response codes & processing delay

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

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



Example

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

delay(300);        Processing delay

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

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

Response codes

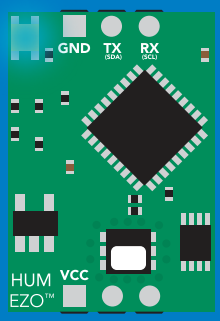
Single byte, not string

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

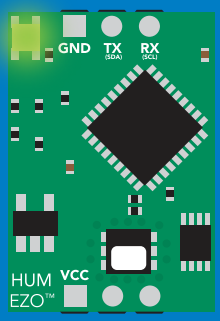
Atlas Scientific™ Environmental Robotics

r 0.2

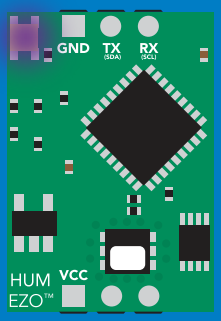
Indicator LED control



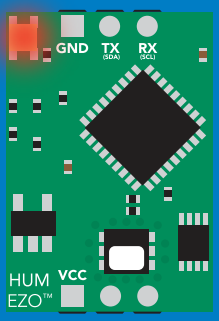
Blue
I²C standby



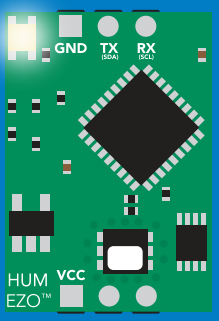
Green
Taking reading



Purple
Changing I²C address



Red
Command not understood



White
Find

5V	+0.2 mA
3.3V	+0.2 mA

I²C mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function	
Baud	switch back to UART mode	pg. 48
Factory	enable factory reset	pg. 47
Find	finds device with blinking white LED	pg. 38
i	device information	pg. 42
I2C	change I²C address	pg. 46
L	enable/disable LED	pg. 37
Name	set/show name of device	pg. 41
O	enable/disable parameters	pg. 40
Plock	enable/disable protocol lock	pg. 45
R	returns a single reading	pg. 39
Sleep	enter sleep mode/low power	pg. 44
Status	retrieve status information	pg. 43

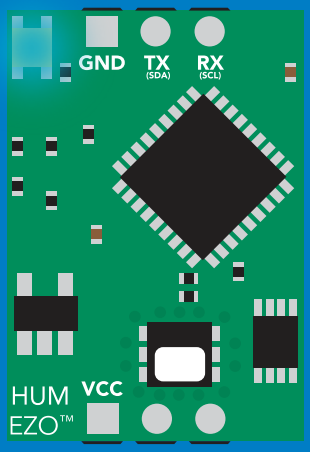
LED control

Command syntax

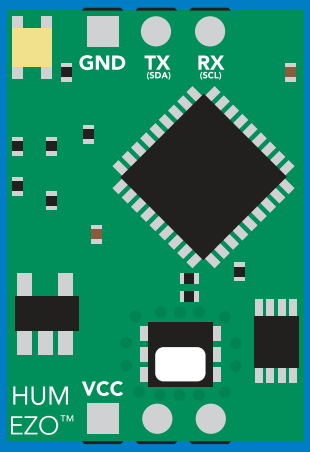
300ms processing delay

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

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



L,1



L,0

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r 0.1

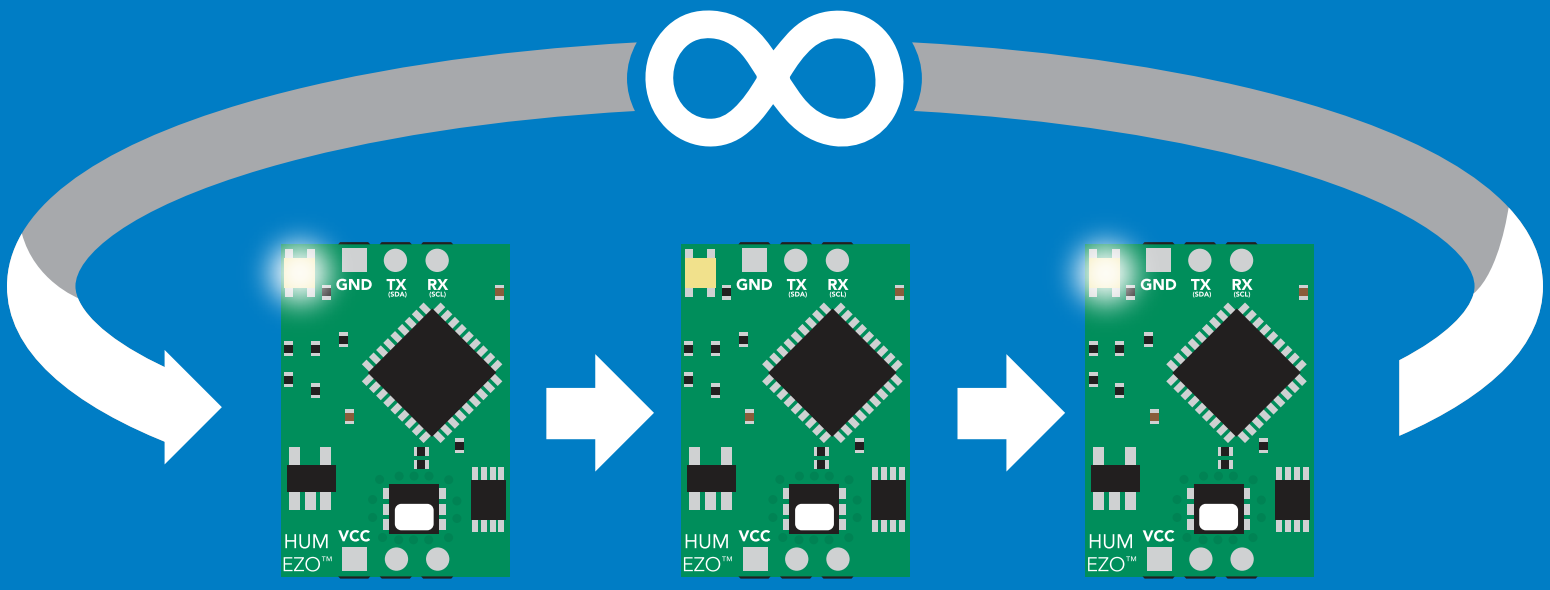
Find

Command syntax

300ms processing delay

Find LED rapidly blinks white, used to help find device

Example	Response
Find	Wait 300ms 1 Dec 0 Null



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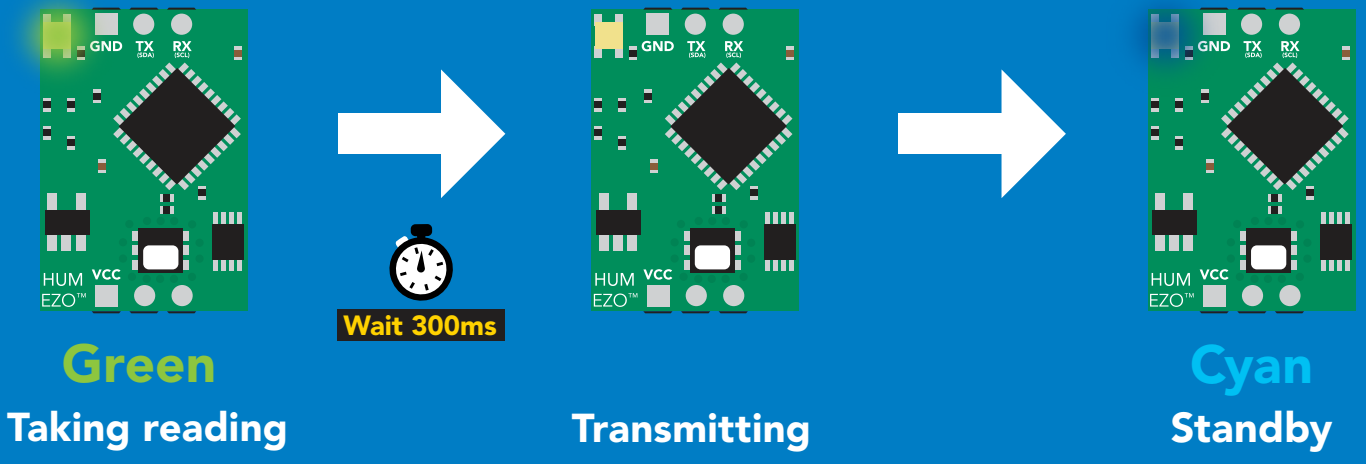
Taking reading

Command syntax

300ms processing delay

R return 1 reading

Example	Response
R	Wait 300ms 1 Dec 57.38 ASCII 0 Null



Green
Taking reading

Transmitting

Cyan
Standby

Enable/disable parameters from output string

Command syntax

O, [parameter],[1,0]	enable or disable output parameter
O,?	enabled parameter?

Example	Response
O,HUM,1 / O,HUM,0	 Wait 300ms — 1 Dec — 0 Null — enable / disable humidity
O,T,1 / O,T,0	 Wait 300ms — 1 Dec — 0 Null — enable / disable temperature
O,Dew,1 / O,Dew,0	 Wait 300ms — 1 Dec — 0 Null — enable / disable dew point
O,?	 Wait 300ms — 1 Dec — ?,O,HUM,T,Dew ASCII — 0 Null — if all enabled

Parameters

Hum	Humidity
T	Air temperature in °C
Dew	Dew point

Followed by 1 or 0

1	enabled
0	disabled

*** If you disable all possible data types your readings will display "no output".**

Atlas Scientific™ Environmental Robotics

Naming device

300ms processing delay

Command syntax

Do not use spaces in the name

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

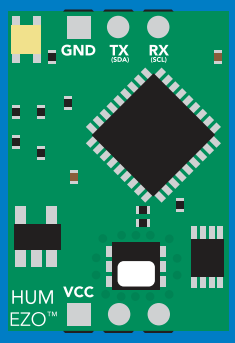
n =

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

Up to 16 ASCII characters

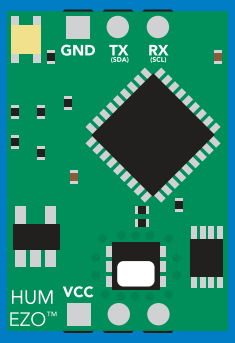
Example	Response
Name,	Wait 300ms → 1 (Dec) 0 (Null) — name has been cleared
Name,zzt	Wait 300ms → 1 (Dec) 0 (Null)
Name,?	Wait 300ms → 1 (Dec) ?Name,zzt (ASCII) 0 (Null)

Name,zzt



1 0

Name,?



1 ?Name,zzt 0

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Device information

Command syntax

300ms processing delay

i device information

Example

i

Response

1 Dec

?i,HUM,1.0 ASCII

0 Null

Response breakdown

?i, HUM, 1.0

HUM: Device

1.0: Firmware

Atlas Scientific™ Environmental Robotics

Reading device status

Command syntax

300ms processing delay

Status voltage at Vcc pin and reason for last restart

Example

Status

Response

1	?Status,P,5.038	0
Dec	ASCII	Null

Response breakdown

?Status, P, 5.038

P, ↑ Reason for restart

5.038 ↑ Voltage at Vcc

Restart codes

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

Atlas Scientific Environmental Robotics

Sleep mode/low power

Command syntax

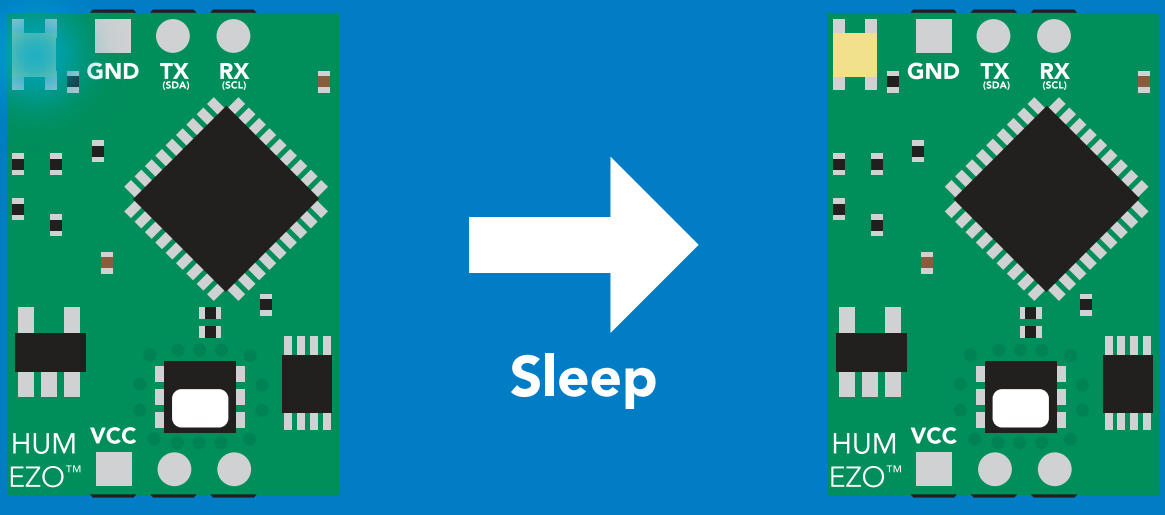
Sleep	enter sleep mode/low power

Send any character or command to awaken device.

Example	Response
Sleep	no response
Any command	wakes up device

Do not read status byte after issuing sleep command.

	MAX	SLEEP
5V	2.6 mA	0.5 mA
3.3V	2.2 mA	0.4 mA



Standby

Sleep

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Protocol lock

Command syntax

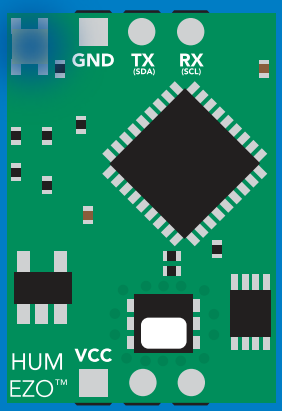
300ms processing delay

Plock,1	enable Plock	
Plock,0	disable Plock	default
Plock,?	Plock on/off?	

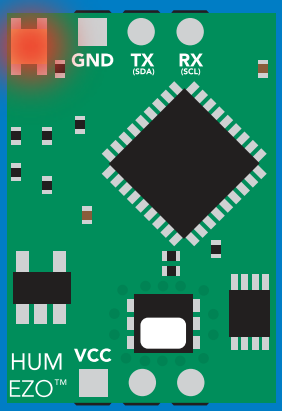
Locks device to I²C mode.

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

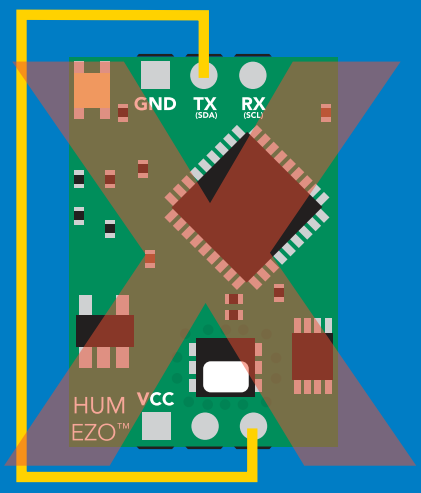


Baud, 9600



cannot change to UART

Short



cannot change to UART

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I²C address change

Command syntax

I2C,n	sets I²C address and reboots into I²C mode

Example	Response
I2C,101	device reboot

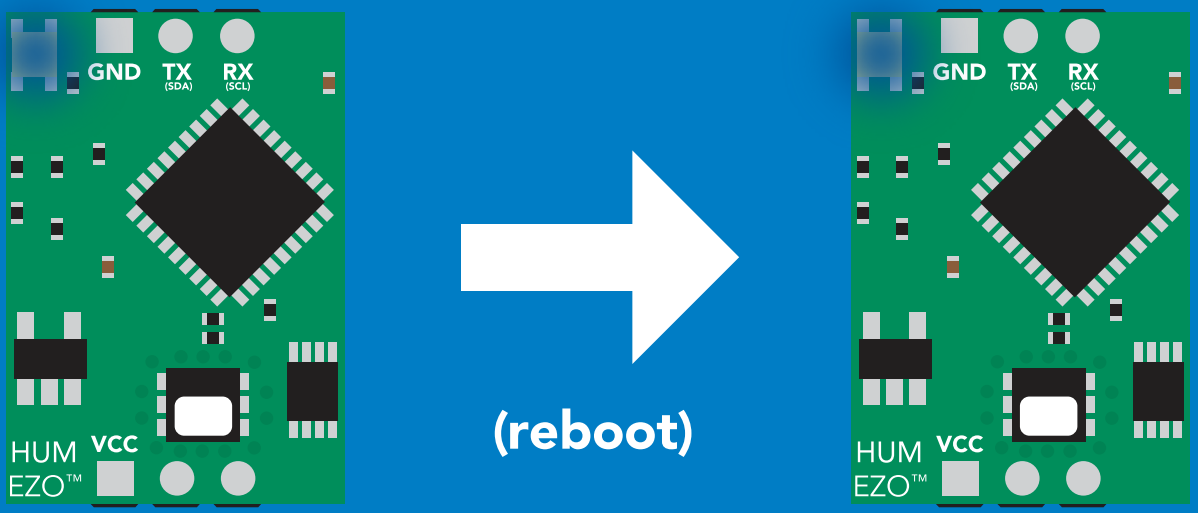
Warning!

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 111 (0x6F).

n = any number 1 – 127

I2C,101



Factory reset

Command syntax

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

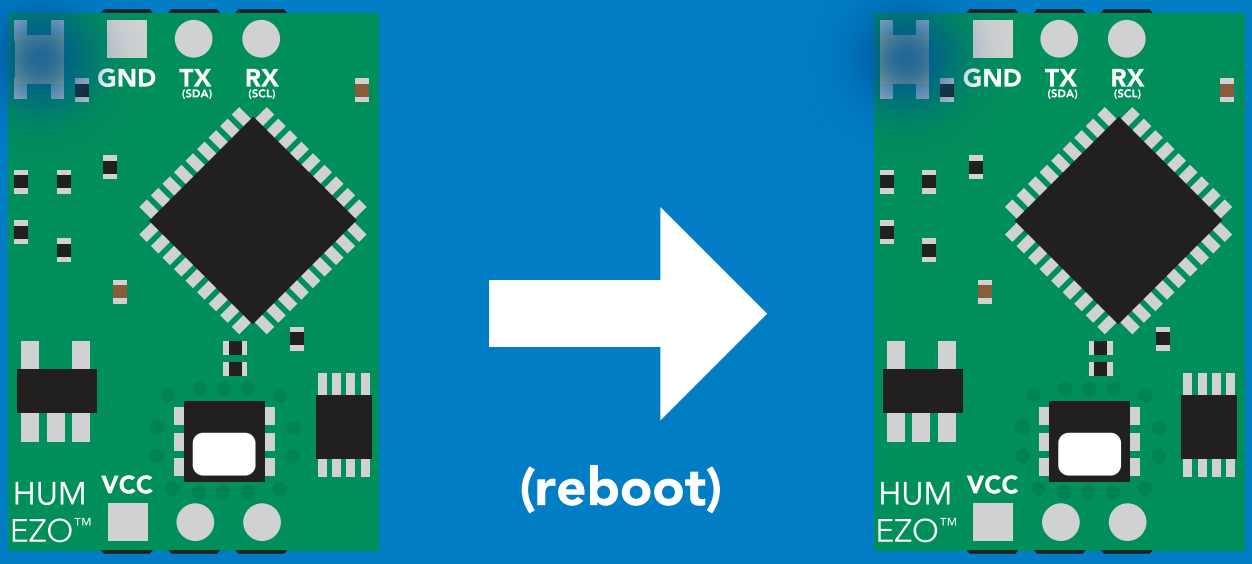
Factory	enable factory reset

I²C address will not change

Example	Response
Factory	device reboot

Clears custom calibration
LED on
Response codes enabled

Factory



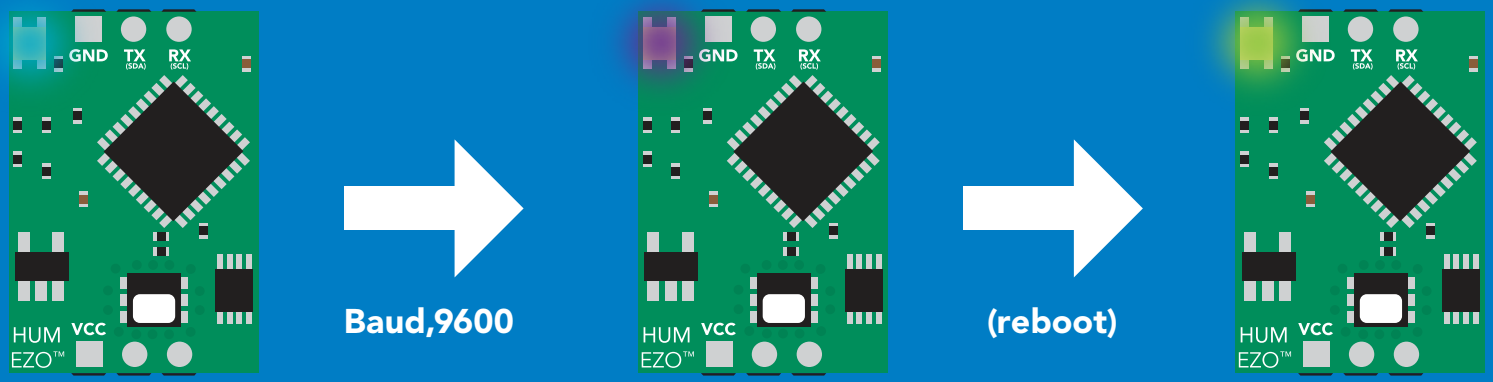
Change to UART mode

Command syntax

Baud,n	switch from I²C to UART

Example	Response
Baud,9600	reboot in UART mode

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



Changing to UART mode

Atlas Scientific™ Environmental Robotics

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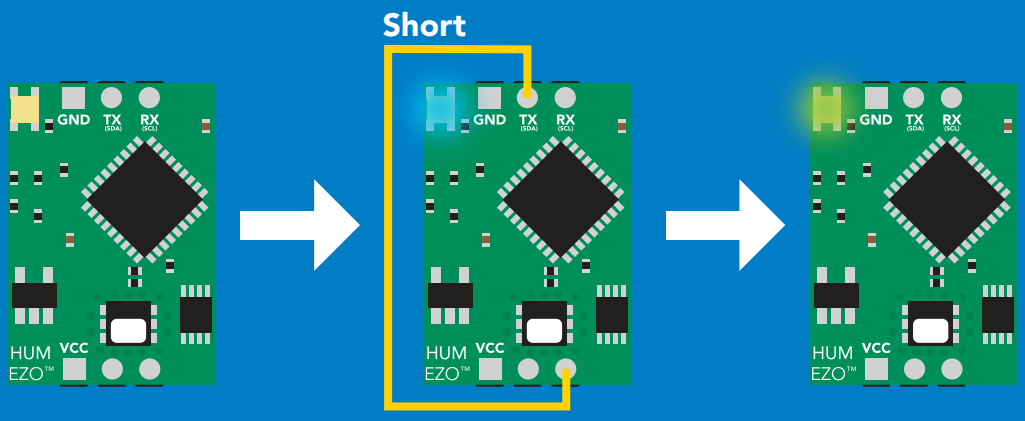
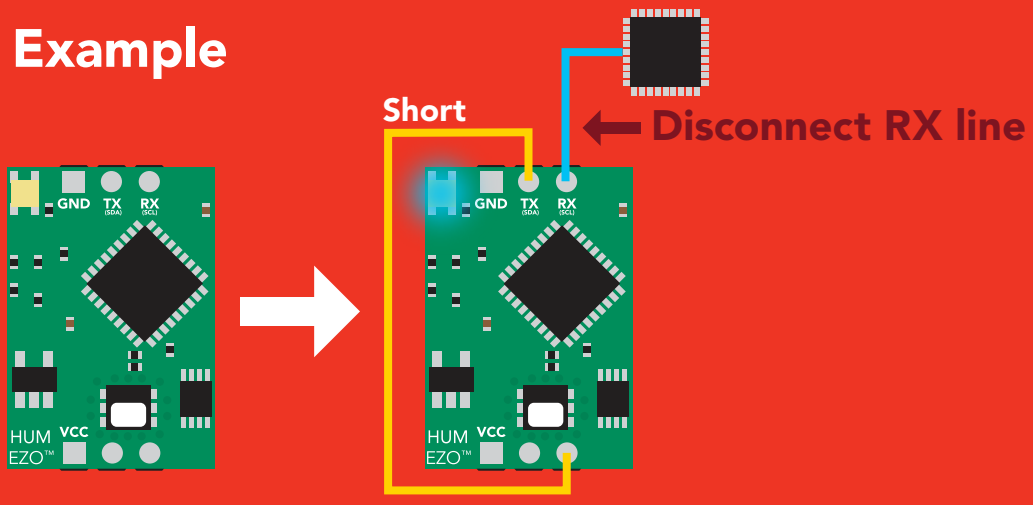
Manual switching to UART

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

Example



Wrong Example



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Datasheet change log

Datasheet V 1.1

Added Air Temperature chart on pg 6.

Datasheet V 1.0

New datasheet

Firmware updates

V1.0 – Initial release (November, 2021)

Warranty

Atlas Scientific™ Warranties the EZO-HUM™ Embedded Humidity Circuit to be free of defect during the debugging phase of device implementation, or 30 days after receiving the EZO-HUM™ Embedded Humidity Circuit (which ever comes first).

The debugging phase

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

- **Soldering any part to the EZO-HUM™ Embedded Humidity Circuit.**
- **Running any code, that does not exclusively drive the EZO-HUM™ Embedded Humidity Circuit and output its data in a serial string.**
- **Embedding the EZO-HUM™ Embedded Humidity Circuit into a custom made device.**
- **Removing any potting compound.**

Reasoning behind this warranty

Because Atlas Scientific™ does not sell consumer electronics; once the device has been embedded into a custom made system, Atlas Scientific™ cannot possibly warranty the EZO-HUM™ Embedded Humidity Circuit, against the thousands of possible variables that may cause the EZO-HUM™ Embedded Humidity 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-HUM™ Embedded Humidity Circuit continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.