Atlas Scientific™
Environmental Robotics

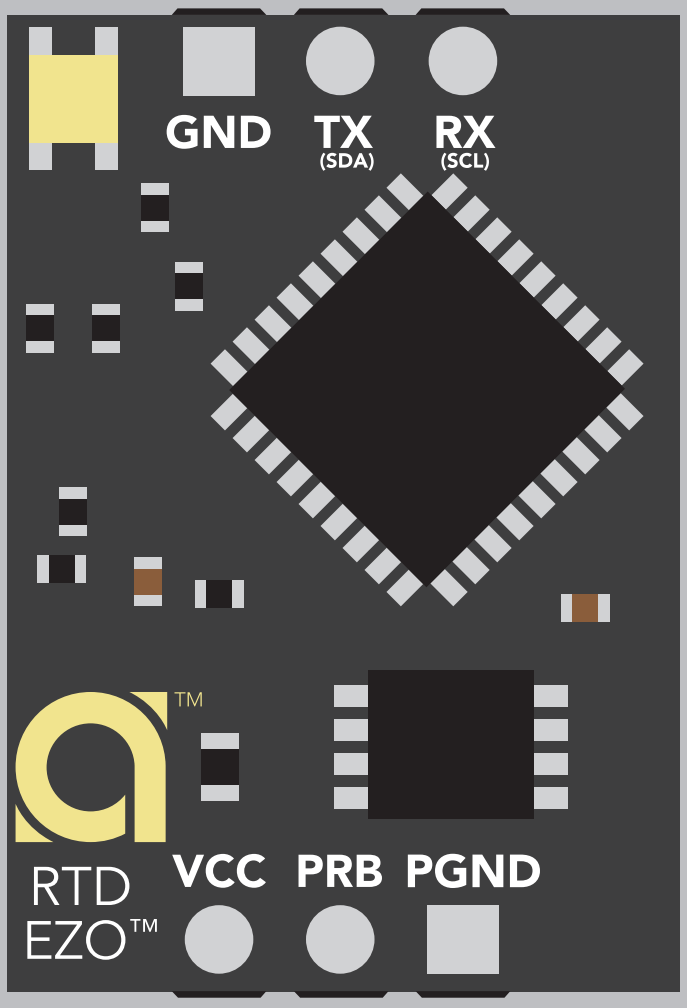
V 3.2

Revised 3/27/19

EZO-RTD™

Embedded Temperature Circuit

Reads	**Temperature**
Range	**-126.000 °C – 1254 °C**
Resolution	**0.001**
Accuracy	**+/– (0.10˚C + 0.0017 x ˚C)**
Response time	**1 reading per sec**
Supported probes	**Any type & brand PT-100 or PT-1000 RTD**
Calibration	**Single point**
Temperature output	**°C, °K, or °F**
Data protocol	**UART & I²C**
Default I²C address	**102 (0x66)**
Operating voltage	**3.3V – 5.5V**
Data format	**ASCII**
Onboard Data Logger	**50 Readings**



Electrical Isolation not needed

Written by Jordan Press
Designed by Noah Press

This is an evolving document, check back for updates.

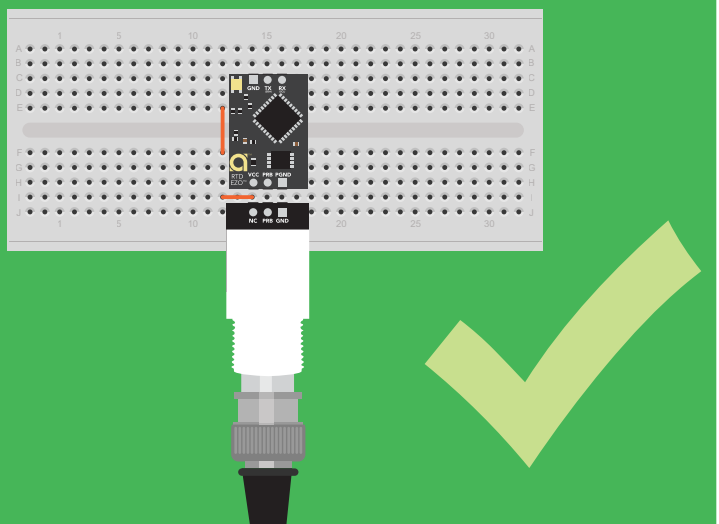
STOP

SOLDERING THIS DEVICE VOIDS YOUR WARRANTY.

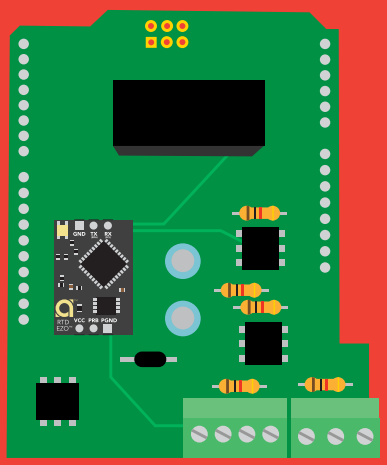
This is sensitive electronic equipment. Get this device working in a solderless breadboard first. Once this device has been soldered it is no longer covered by our warranty.

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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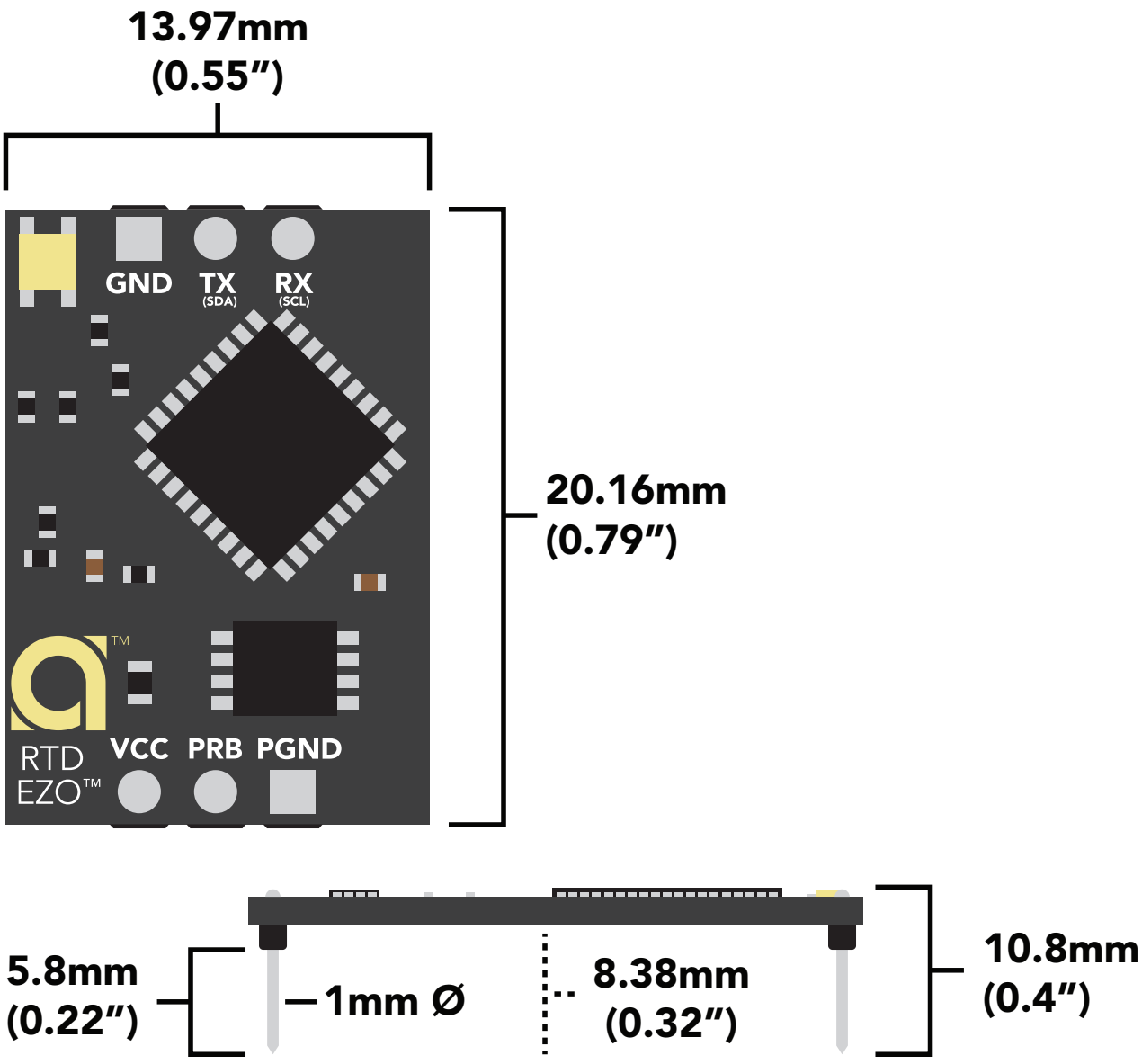
UART

I²C

EZO™ circuit dimensions



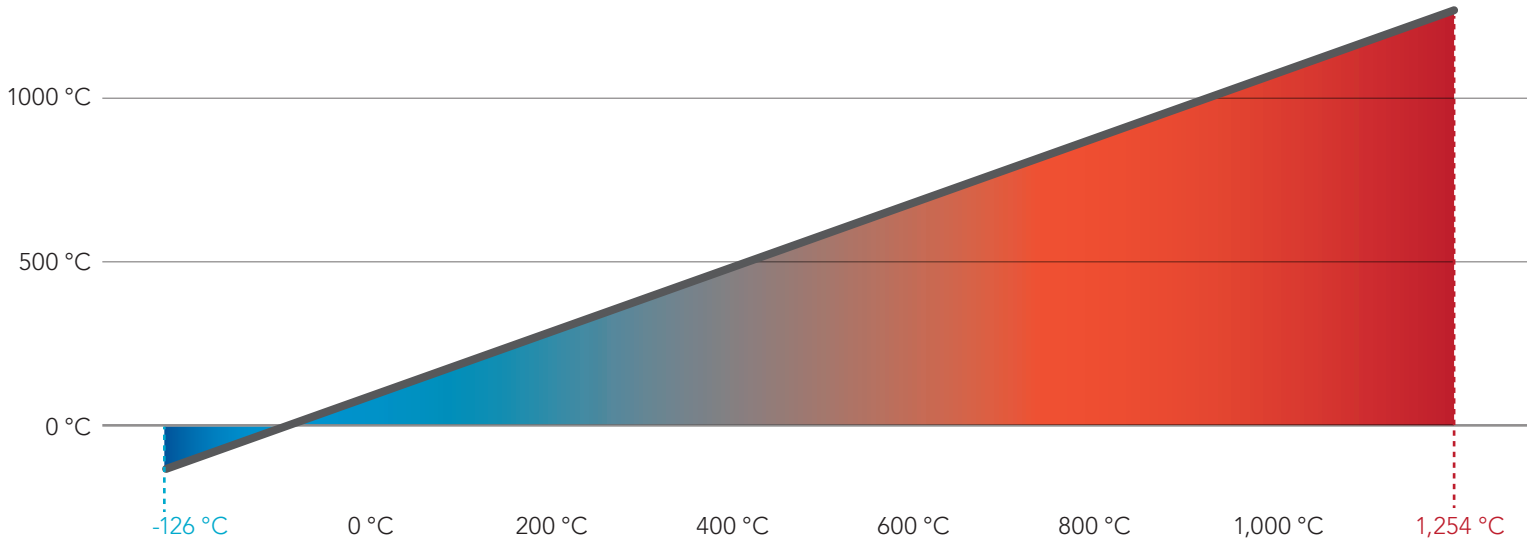
Power consumption

	LED	MAX	STANDBY	SLEEP
5V	ON	16 mA	15.4 mA	0.4 mA
	OFF	15.3 mA	15 mA	
3.3V	ON	14.3 mA	13.8 mA	0.09 mA
	OFF	14 mA	13.6 mA	

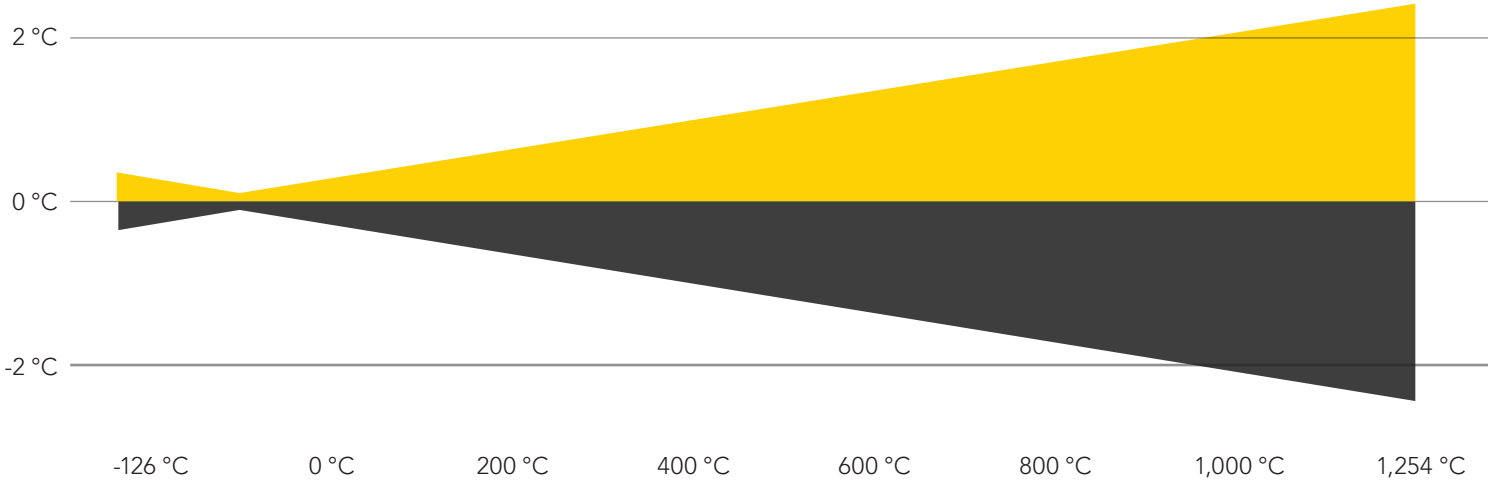
Absolute max ratings

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

EZO™ RTD temperature sensing range



EZO™ RTD temperature sensing accuracy



Atlas Scientific PT-1000 probe

- Accuracy +/- (0.15 + (0.002*t))
- Probe type: class A platinum, RTD
- Cable length: 81cm (32")
- Cable material: silicone rubber
- 30mm sensing area (304 SS)
- 6mm diameter
- BNC connector
- Reaction time: 90% value in 13 seconds
- Probe output: analog
- Full sensing range -200 °C to 850 °C
- Cable max temp 125 °C
- Cable min temp -55 °C

The Atlas Scientific EZO™ RTD Temperature circuit only works with PT-100 and PT-1000 probes.

To read temperatures above, or below the max cable temperature, an additional probe housing (thermowell) is needed to protect the cable.

100mm Temperature Thermowell

50mm Temperature Thermowell

30mm Temperature Thermowell

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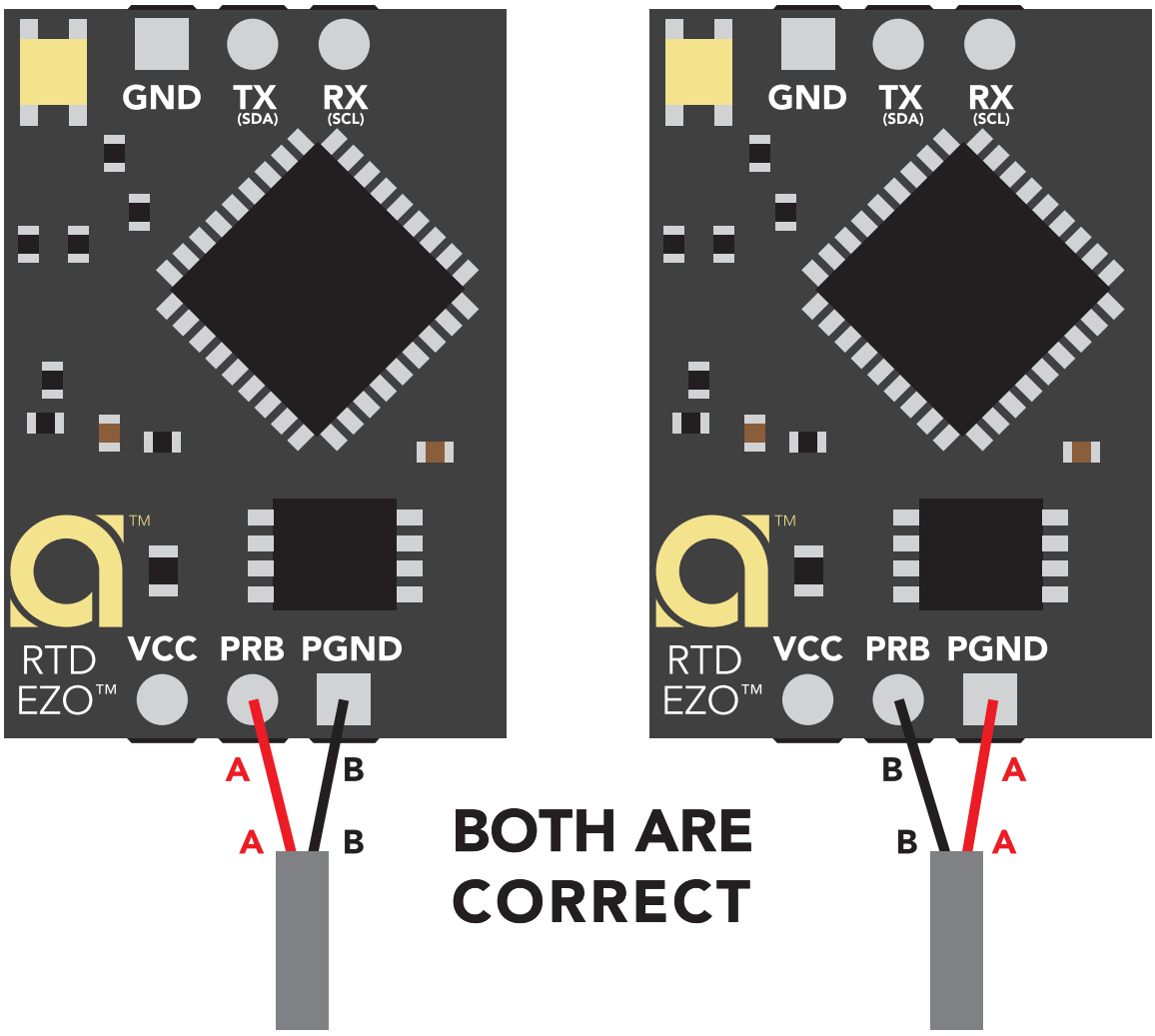
Using other brand PT-100/PT-1000

The EZO™ RTD Temperature circuit will auto-detect if the connected probe is PT-100 or PT-1000.

Probe class	Accuracy
AA	+/- (0.10˚C + 0.0017 × T)
A	+/- (0.15˚C + 0.002 × T)
B	+/-(0.3˚C + 0.005 × T)
C	+/- (0.6˚C + 0.01 × T)

It makes no difference which lead of the temperature probe is connected to the two probe pins.

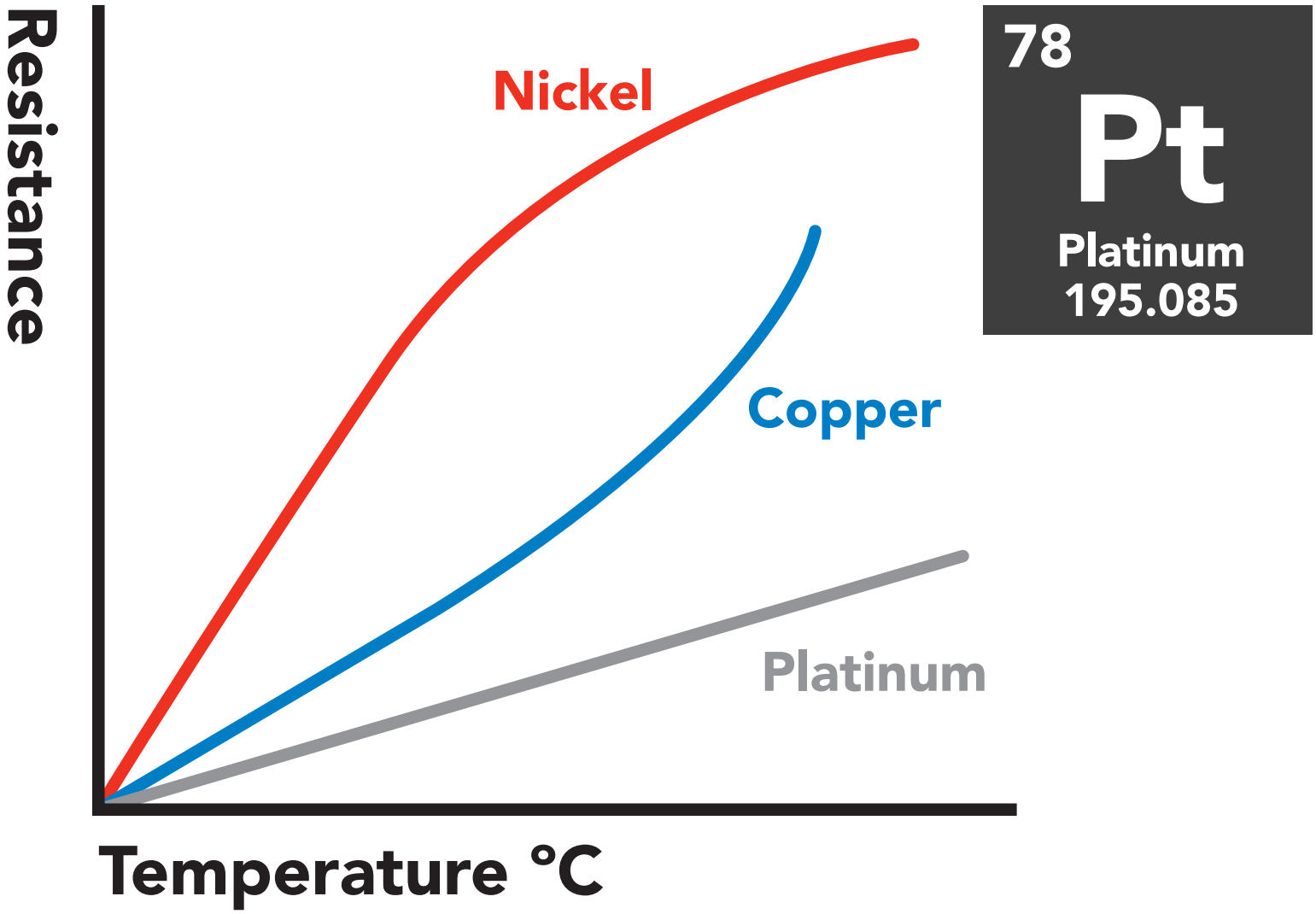


Operating principle

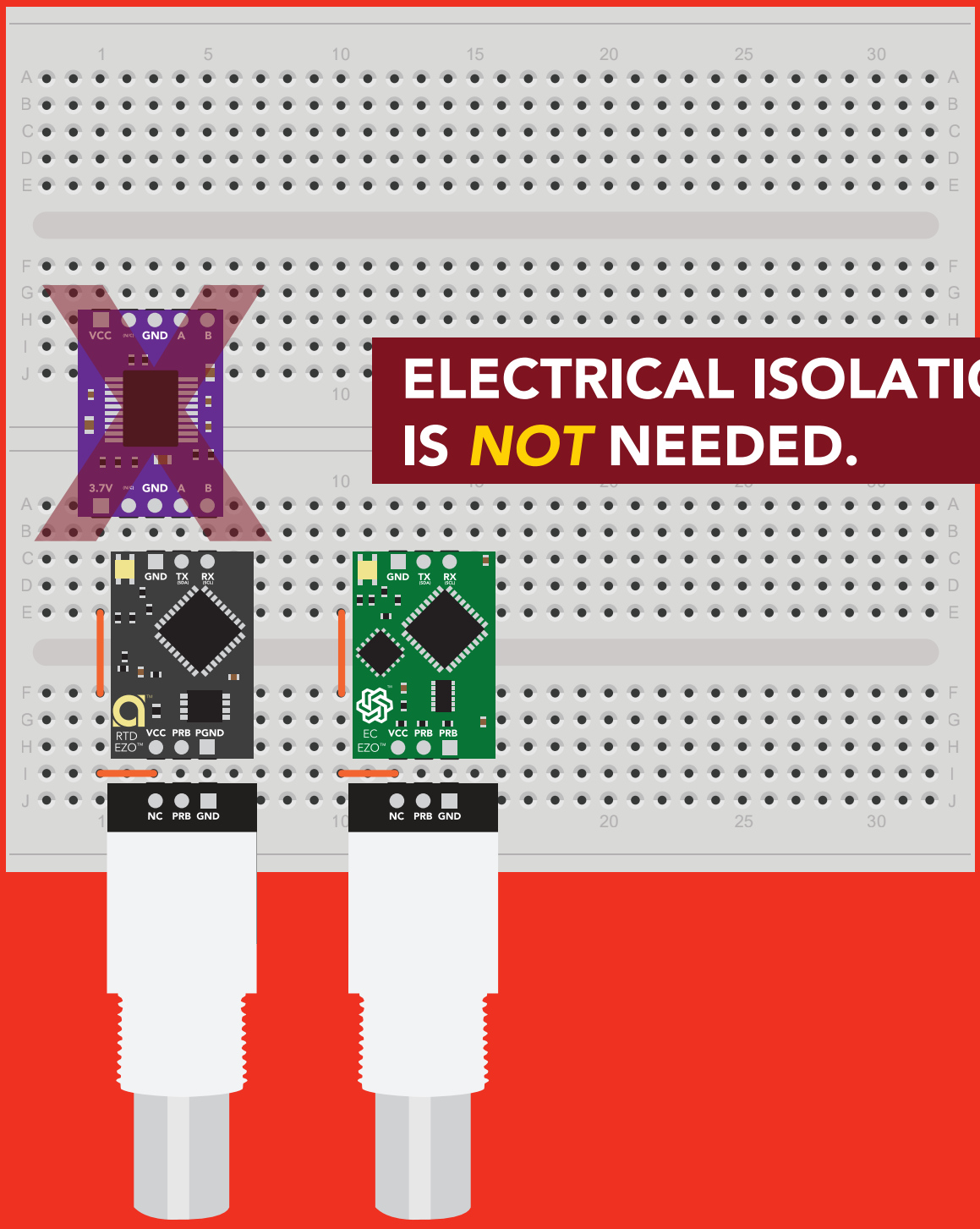
The Atlas Scientific EZO™ RTD Temperature circuit is a small footprint computer system that is specifically designed to be used in robotic applications where the embedded systems engineer requires accurate and precise measurements of temperature through a generic PT-100/PT-1000 temperature probe.

RTD = Resistance Temperature Detector
PT = Platinum
PT-100 = 100 Ω at 0˚C
PT-1000 = 1k Ω at 0˚C

Unlike any other material, platinums correlation between resistance and temperature seems to be woven into the fabric of the universe. It is for this reason, that the platinum RTD temperature sensor is the industrial standard for temperature measurement.



Power and data isolation



ELECTRICAL ISOLATION IS *NOT* NEEDED.

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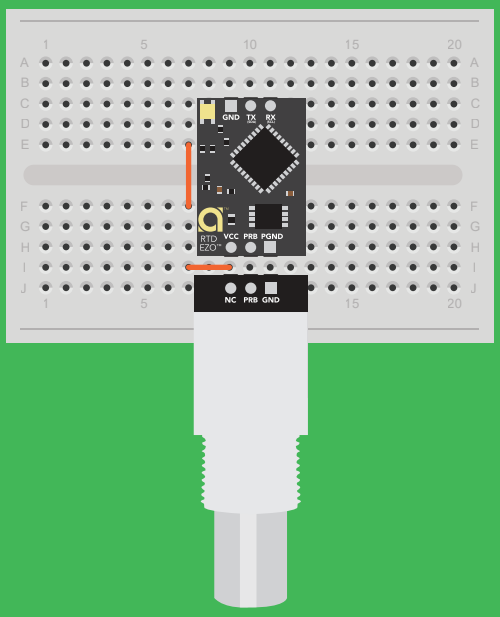
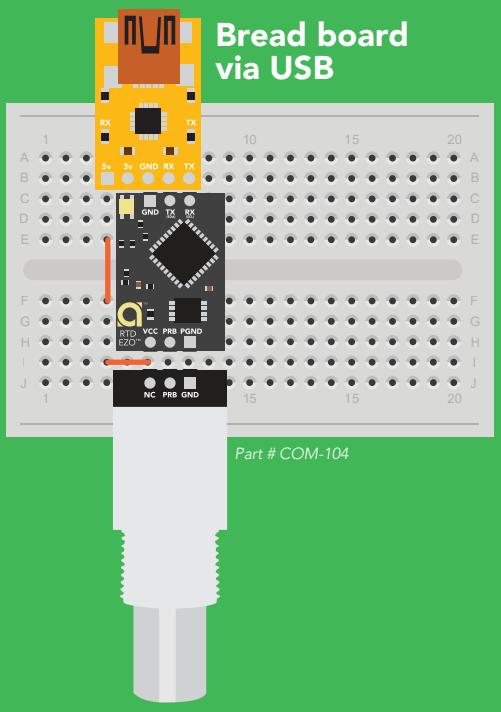
✓ Correct wiring

Bread board



Bread board via USB

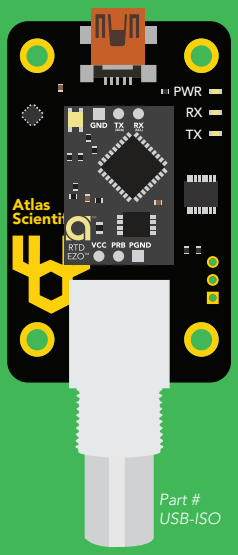


Part # COM-104

Carrier board

Part # ISCCB

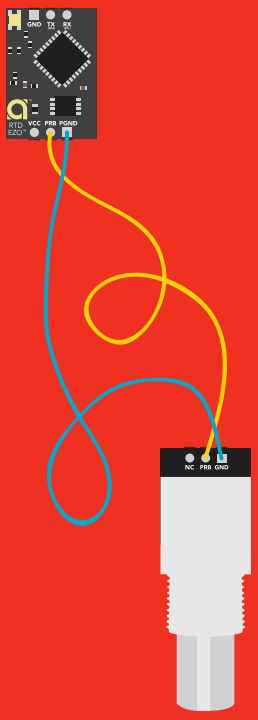
USB carrier board



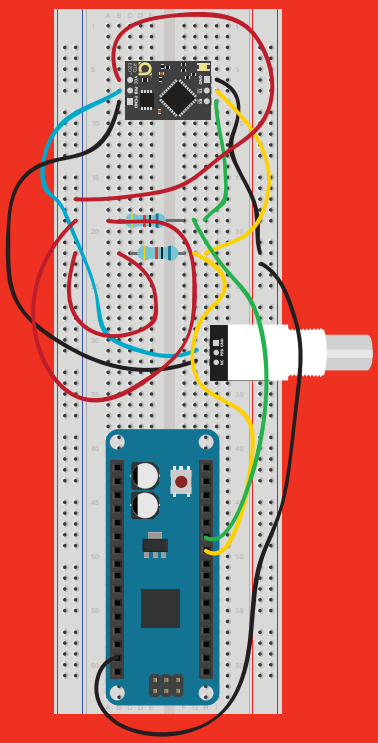
Part # USB-ISO

X Incorrect wiring

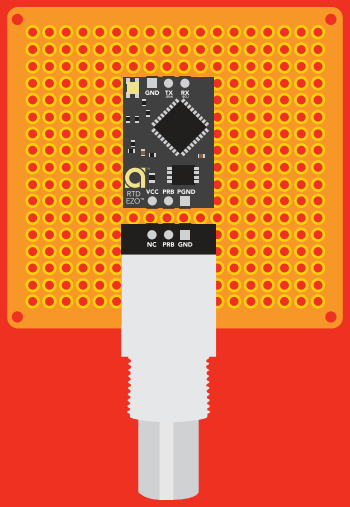
Extended leads



Sloppy setup

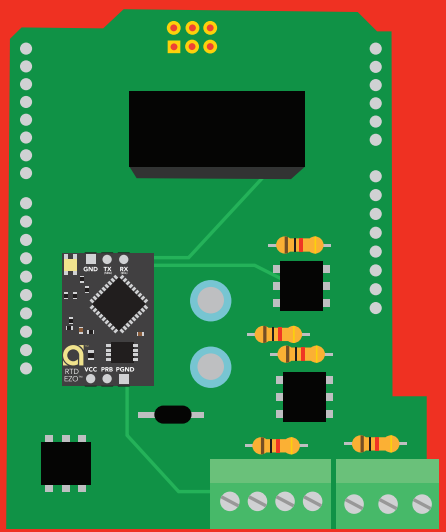


Perfboards or Protoboards



NEVER use Perfboards or Protoboards

***Embedded into your device**



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

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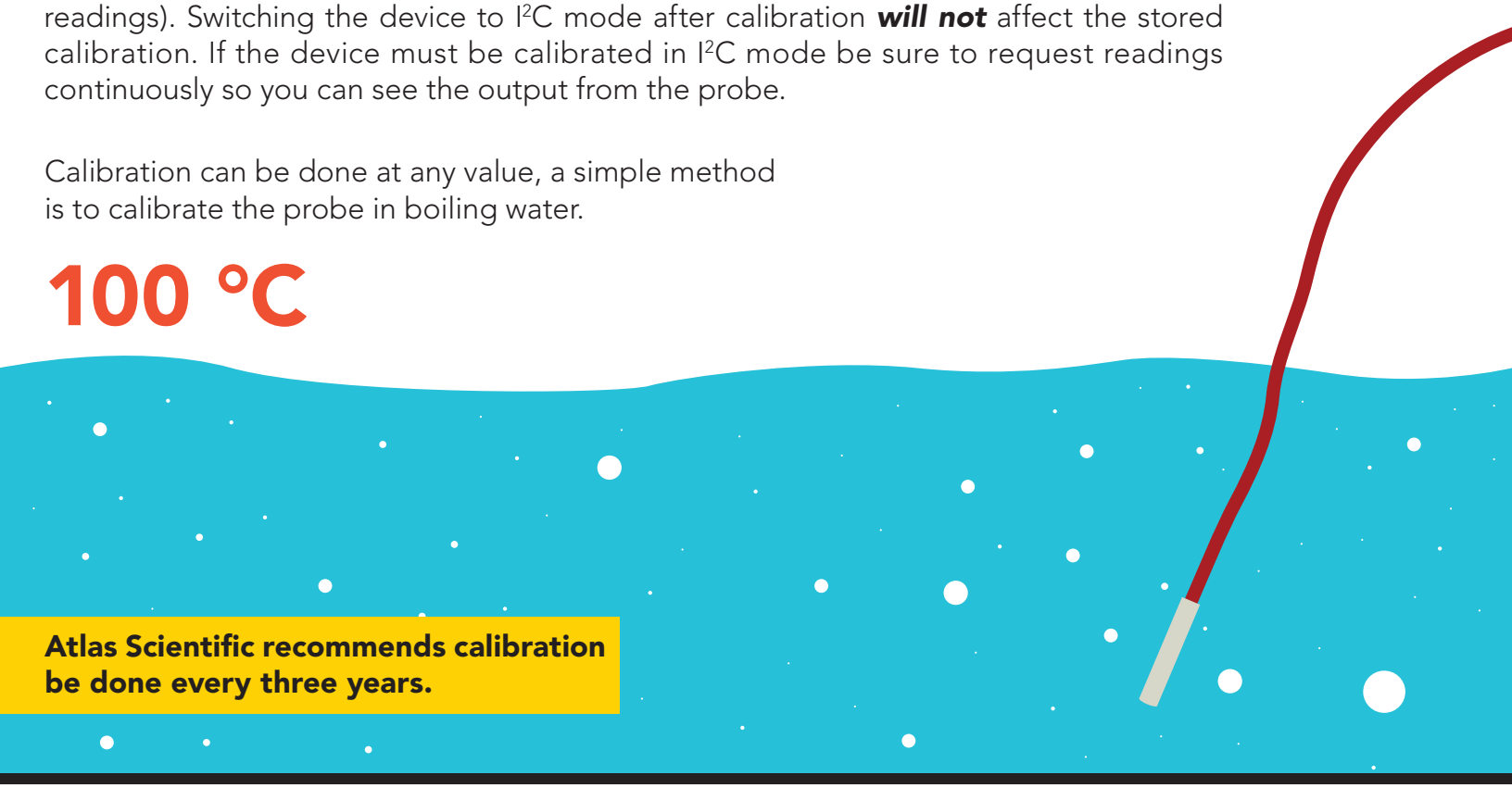
Calibration theory

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.

Calibration can be done at any value, a simple method is to calibrate the probe in boiling water.

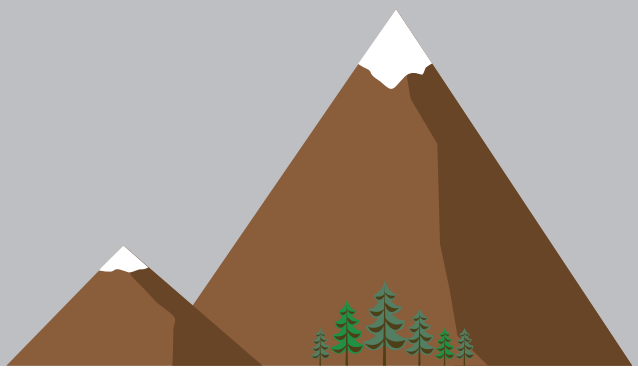
100 °C



Atlas Scientific recommends calibration be done every three years.

Elevation and boiling point table

Elevation in meters	Boiling point
305	98.9 °C
229	99.2 °C
152	99.5 °C
76	99.7 °C
0	100 °C
-76	100.3 °C
-152	100.5 °C



Use purified/distilled water

For accurate calibration using different temperature vaules, you must use a tool called a "*dry block calibrator.*"

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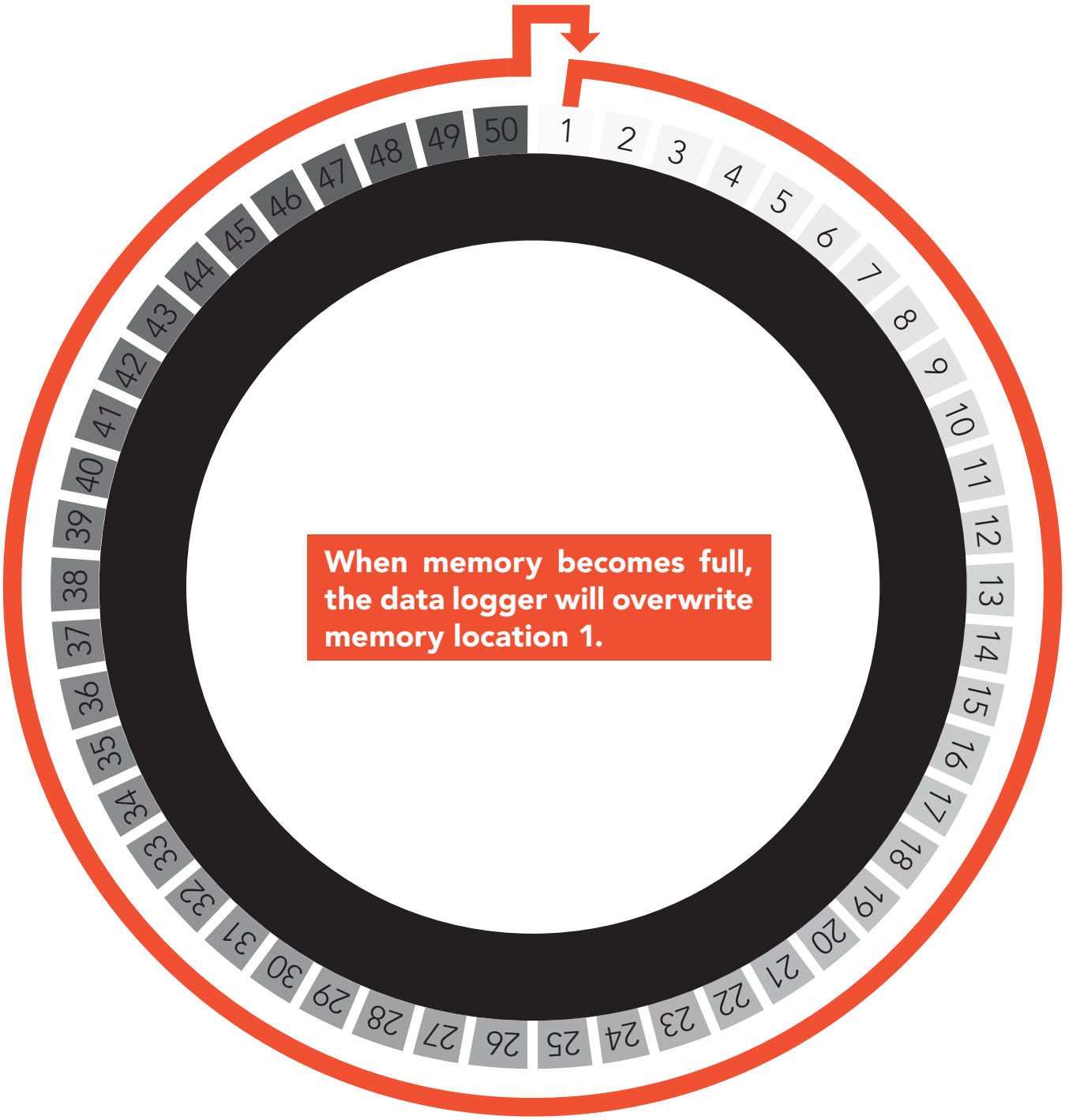
On board data logger

- 50 readings
- Programmable storage interval

Minimum – 10 seconds
Maximum – 320,000 seconds

Temperature readings that are stored to the data logger will be retained even if the power is cut.



✓ Available data protocols

UART

Default

I²C

X Unavailable data protocols

SPI

Analog

RS-485

Mod Bus

4–20mA

UART mode

Settings that are retained if power is cut

Baud rate
Calibration
Continuous mode
Device name
Enable/disable 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

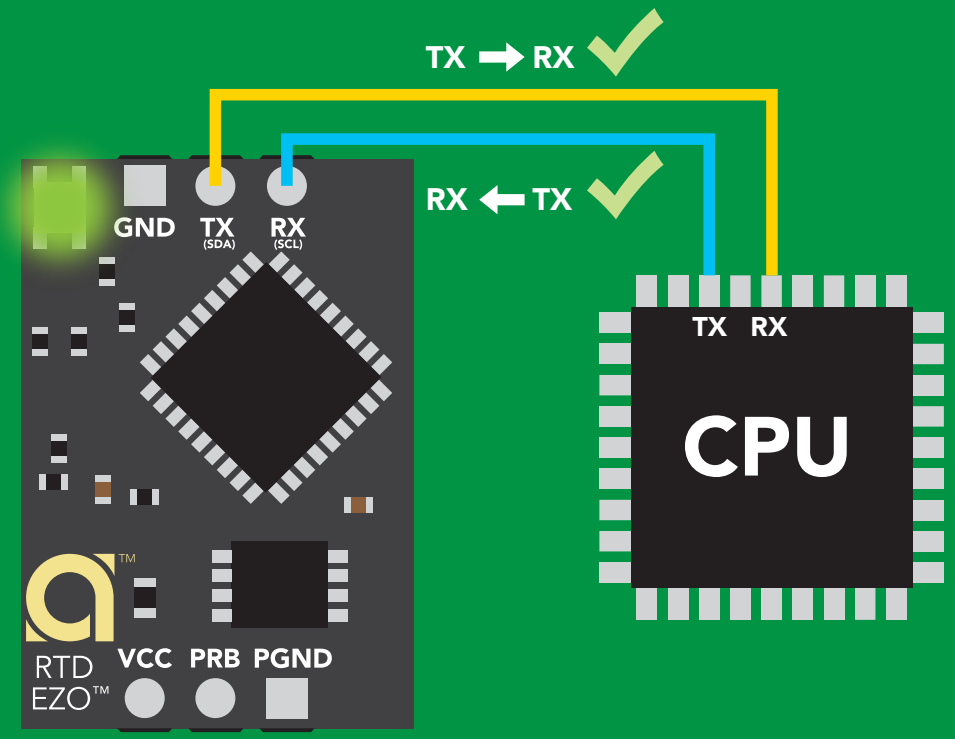
Baud

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

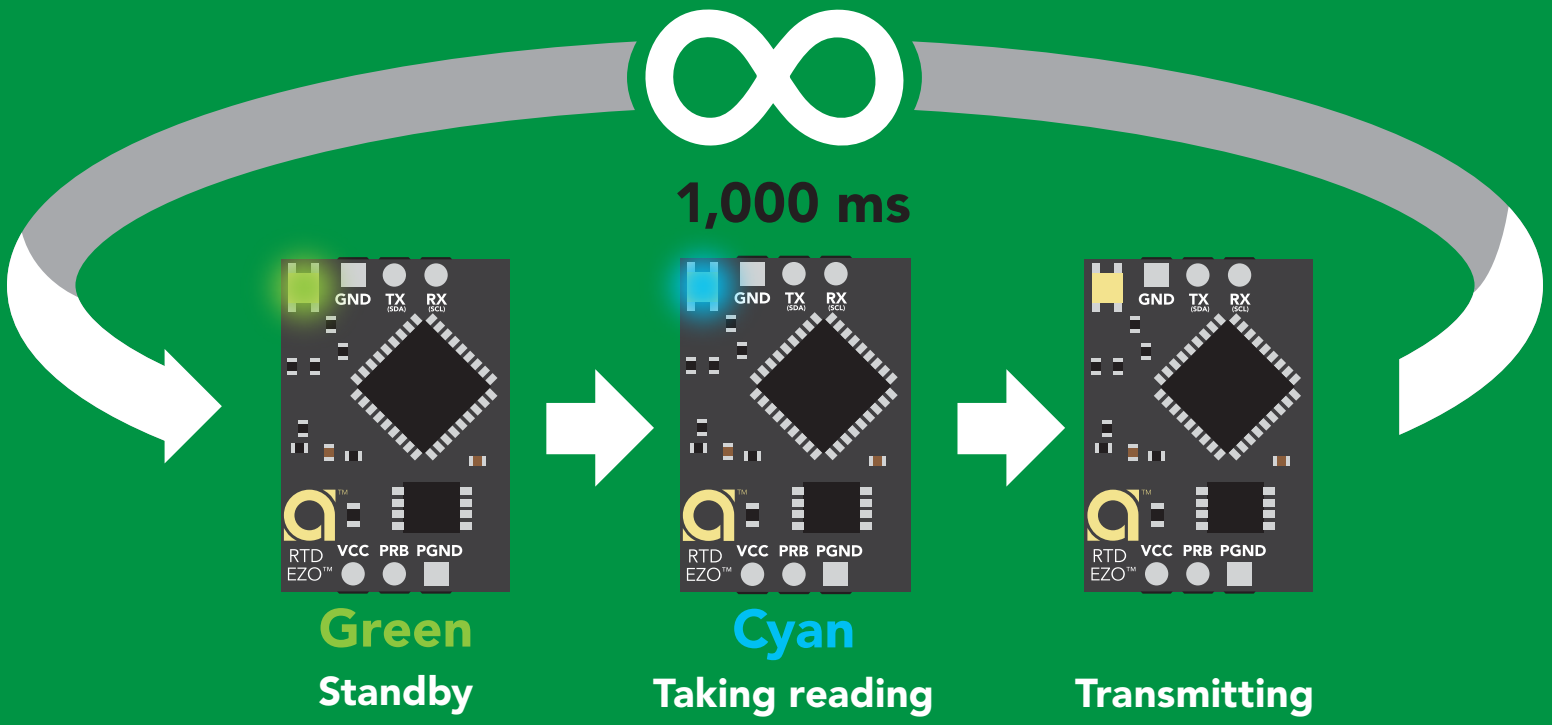


Data format

Reading	temperature	**Data type**	floating point
Units	°C, °K, or °F	**Decimal places**	3
Encoding	ASCII	**Smallest string**	4 characters
Format	string	**Largest string**	40 characters
Terminator	carriage return		

Default state

Mode	**UART**
Baud	**9,600**
Temperature	**°C**
Readings	**continuous**
Speed	**1 reading per second**
With probe	**ttt.ttt**
Without probe	**-1023.000**
LED	**on**



Receiving data from device

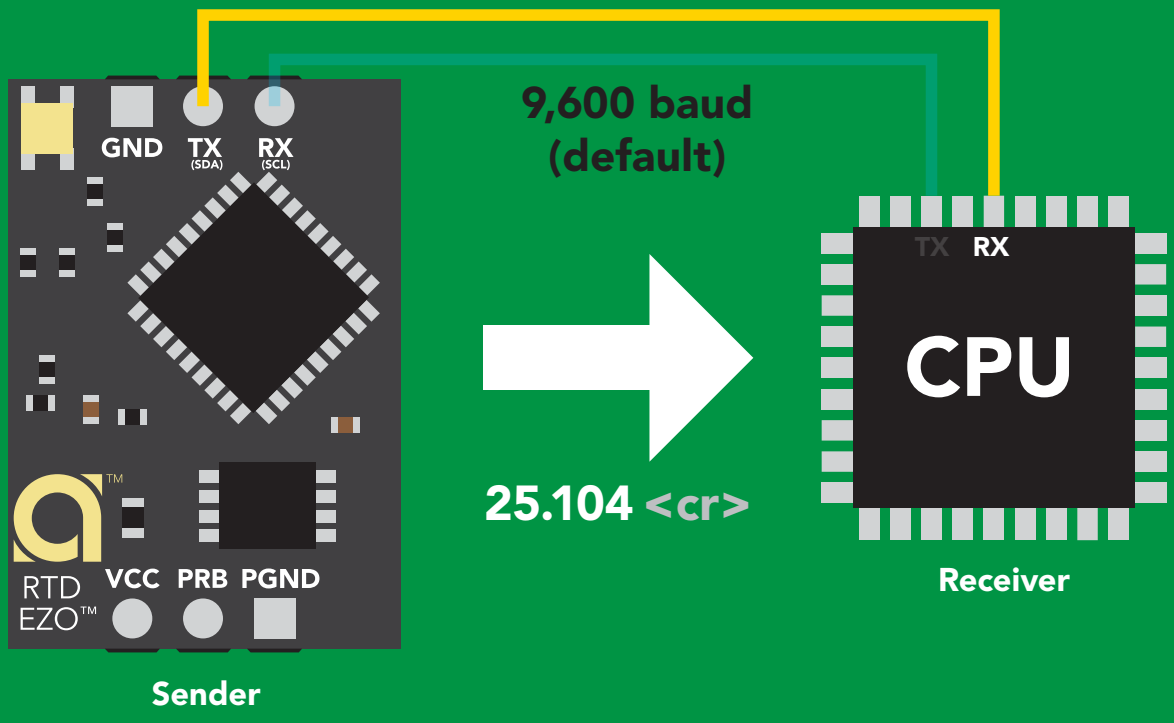
2 parts

ASCII data string

Command

Carriage return <cr>

Terminator



Advanced

ASCII:	2	5	.	1	0	4	<cr>
Hex:	32	35	2E	31	30	34	0D
Dec:	50	53	46	49	48	52	13

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Sending commands to device

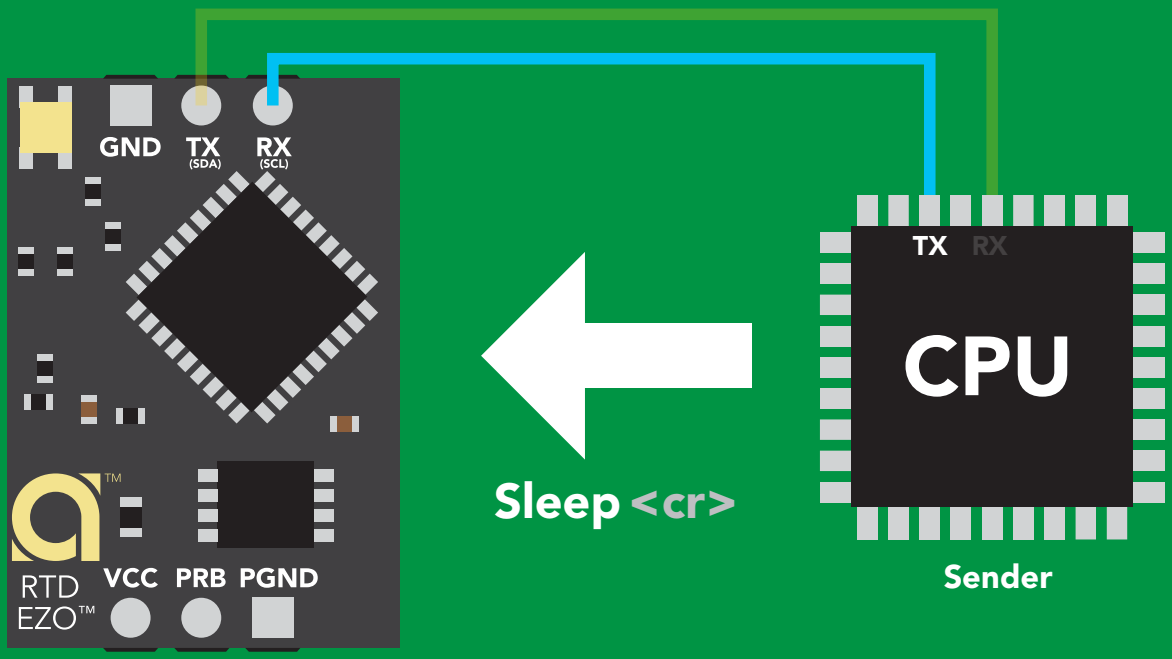
2 parts

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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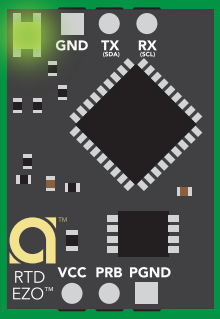
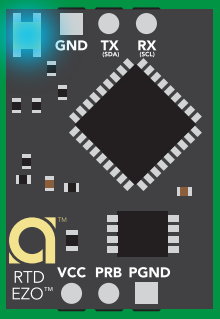
LED color definition



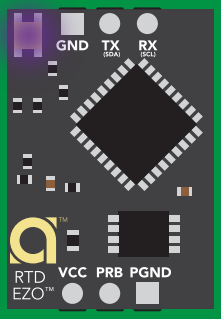
Green

UART standby



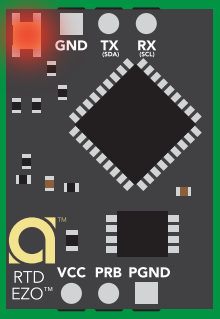
Cyan

Taking reading



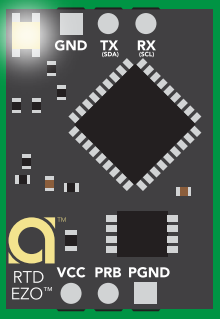
Purple

Changing baud rate



Red

Command not understood



White

Find

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

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UART mode
command quick reference

All commands are ASCII strings or single ASCII characters.

Command	Function		Default state
Baud	change baud rate	pg. 37	9,600
C	enable/disable continuous reading	pg. 23	enabled
Cal	performs calibration	pg. 25	n/a
D	enable/disable data logger	pg. 29	disabled
Export	export calibration	pg. 26	n/a
Factory	enable factory reset	pg. 39	n/a
Find	finds device with blinking white LED	pg. 22	n/a
i	device information	pg. 33	n/a
I2C	change to I²C mode	pg. 40	not set
Import	import calibration	pg. 27	n/a
L	enable/disable LED	pg. 21	enabled
M	memory recall/clear	pg. 30	n/a
Name	set/show name of device	pg. 32	not set
Plock	enable/disable protocol lock	pg. 38	disabled
R	returns a single reading	pg. 24	n/a
S	temperature scale (°C, °K, °F)	pg. 28	celsius
Sleep	enter sleep mode/low power	pg. 36	n/a
Status	retrieve status information	pg. 35	n/a
*OK	enable/disable response codes	pg. 34	enable

LED control

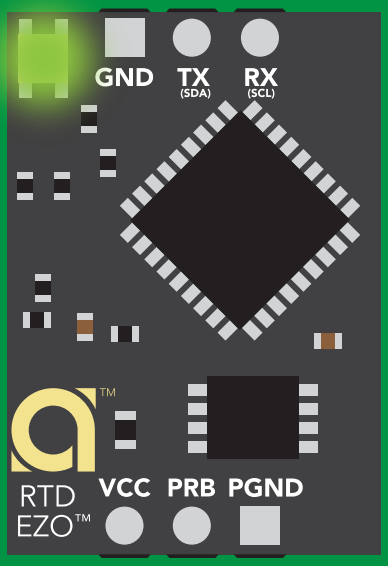
Command syntax

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

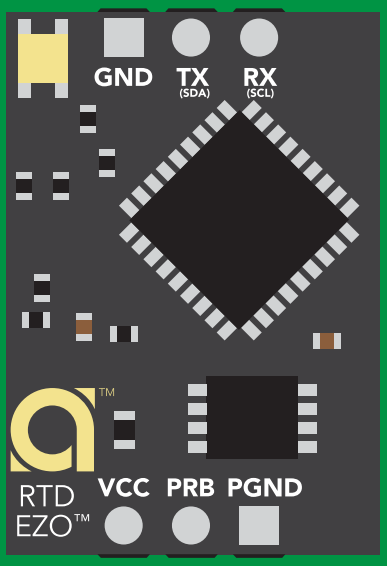
L,0 <cr> LED off

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

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



L,1



L,0

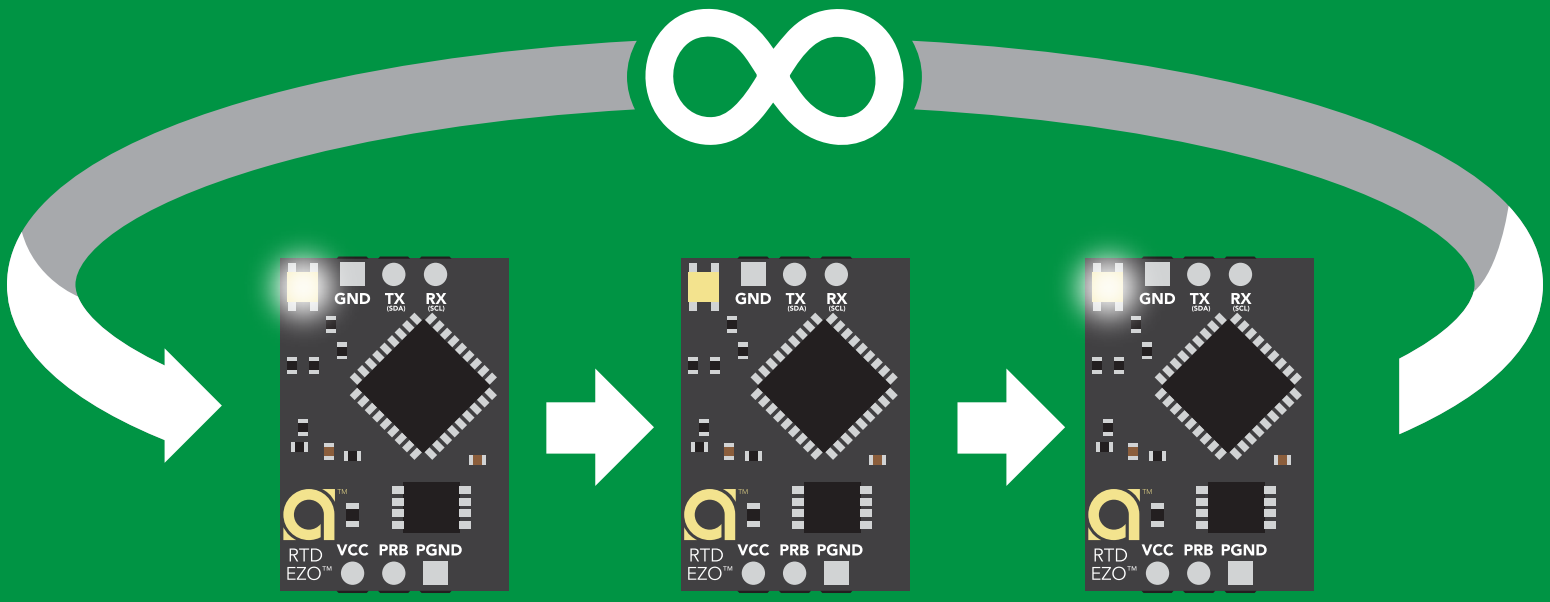
Find

Command syntax

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

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

Example	Response
Find <cr>	***OK** <cr>



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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?

Example	Response
C,1 <cr>	*OK <cr> °C (1 sec) <cr> °C (2 sec) <cr> °C (n sec) <cr>
C,30 <cr>	*OK <cr> °C (30 sec) <cr> °C (60 sec) <cr> °C (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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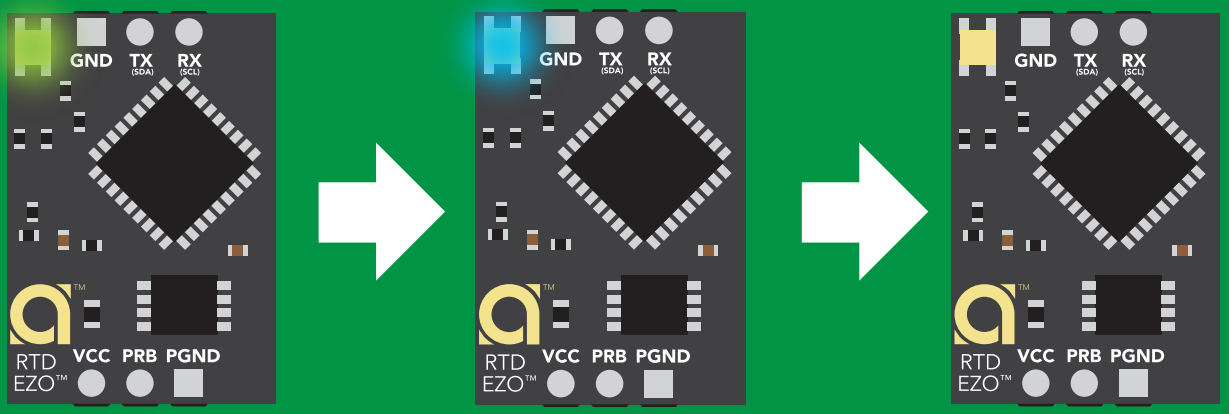
Single reading mode

Command syntax

R <cr> takes single reading

Example	Response
R <cr>	25.104 <cr> *OK <cr>



Green
Standby

Cyan
Taking reading

Transmitting

600 ms

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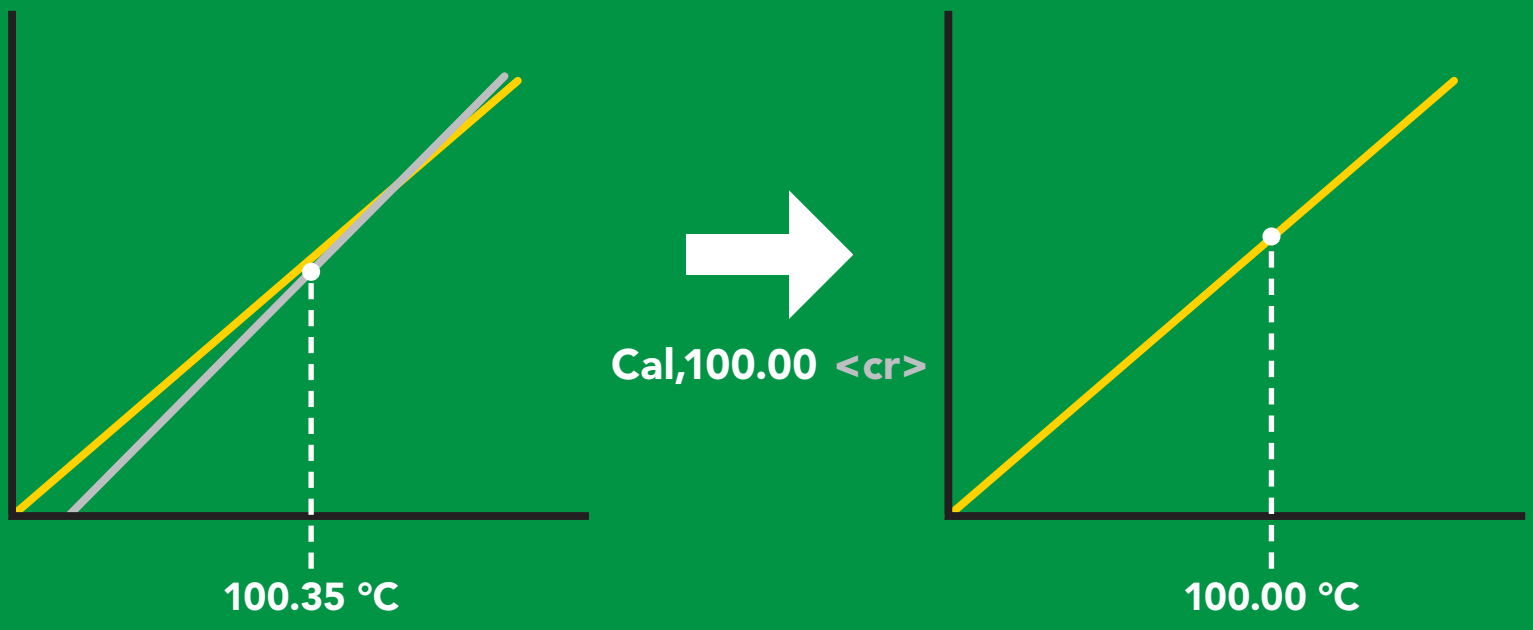
Calibration

Command syntax

The EZO™ RTD circuit uses single point calibration.

Cal,t	<cr>	t = any temperature
Cal,clear	<cr>	delete calibration data
Cal,?	<cr>	device calibrated?

Example	Response
Cal,100.00 <cr>	*OK <cr>
Cal,clear <cr>	*OK <cr>
Cal,? <cr>	?Cal,1 <cr> or ?Cal,0 <cr> *OK <cr>



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Export calibration

Command syntax

Export: Use this command to download calibration settings

Export,?	<cr>	calibration string info
Export	<cr>	export calibration string from calibrated device

Example	Response
Export,? <cr>	10,120 <cr>

Response breakdown

10, 120

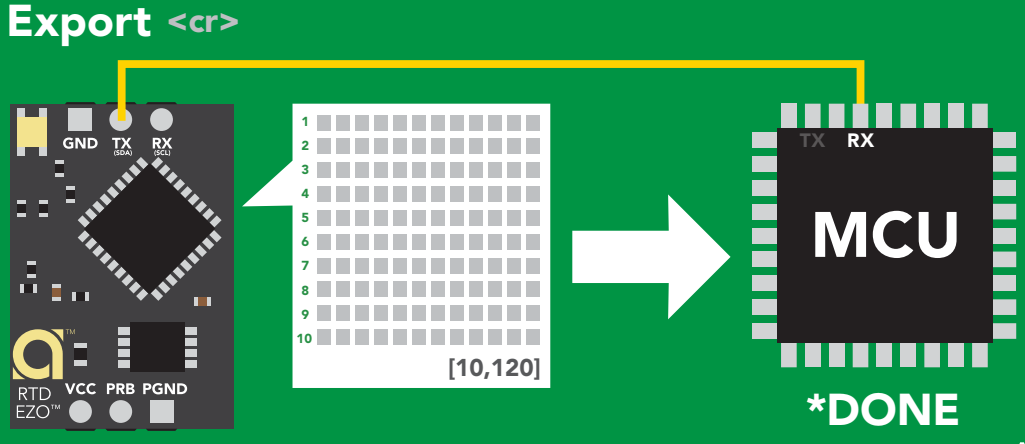
↑ # of strings to export

↑ # of bytes to export

Export strings can be up to 12 characters long, and is always followed by <cr>

Export <cr>	59 6F 75 20 61 72 <cr> (1 of 10)
Export <cr>	65 20 61 20 63 6F <cr> (2 of 10)
(7 more)	⋮
Export <cr>	6F 6C 20 67 75 79 <cr> (10 of 10)
Export <cr>	*DONE

Disabling *OK simplifies this process



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Import calibration

Command syntax

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

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

Example

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

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

⋮

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

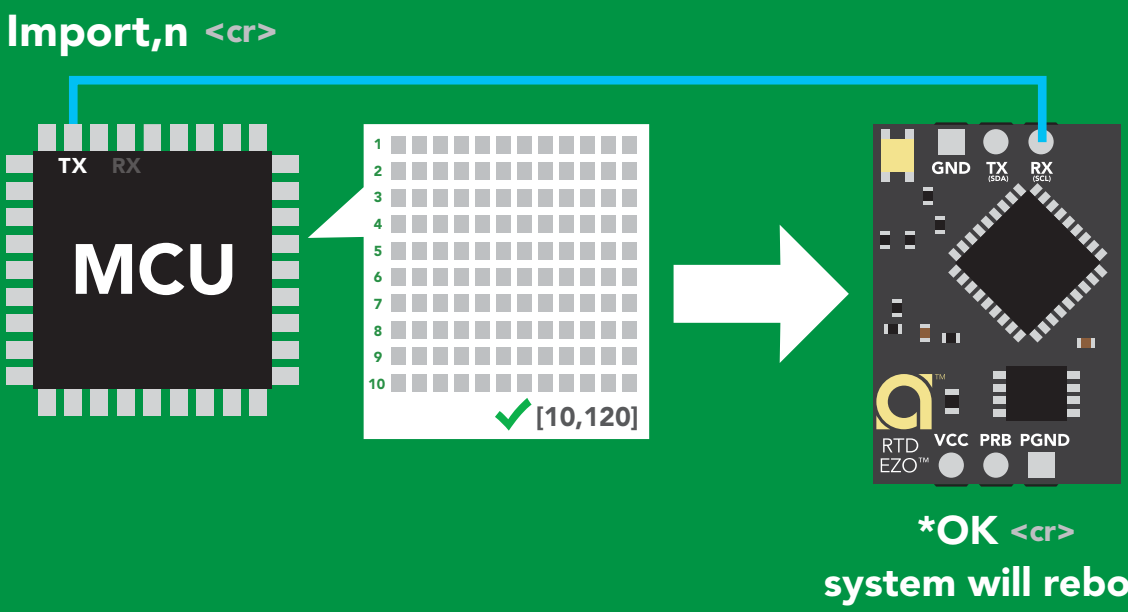
Response

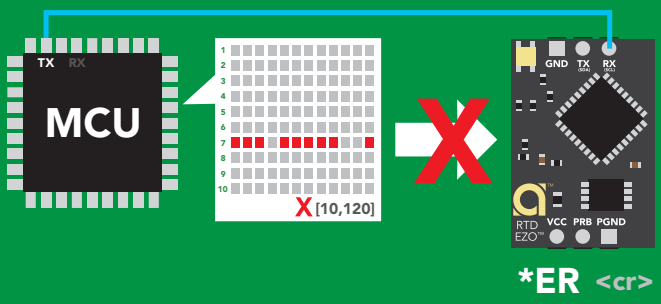
*OK <cr>

*OK <cr>

⋮

*OK <cr>





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

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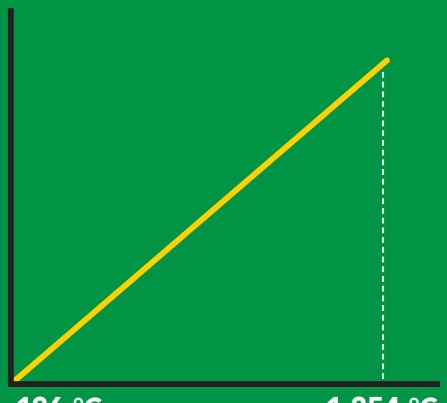
Temperature scale (°C, °K, °F)

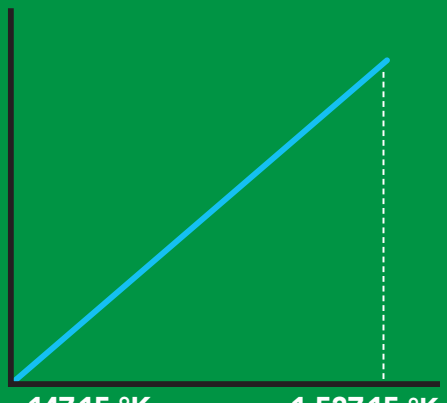
Command syntax

S,c <cr> celsius **default**
S,k <cr> kelvin
S,f <cr> fahrenheit
S,? <cr> temperature scale?

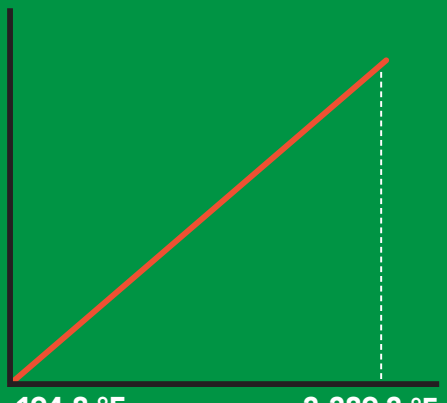
Example	Response
S,c <cr>	*OK <cr>
S,k <cr>	*OK <cr>
S,f <cr>	*OK <cr>
S,? <cr>	?S,c <cr> or ?S,k <cr> or ?S,f <cr> *OK <cr>



(celsius)



(kelvin)



(fahrenheit)

Enable/disable data logger

Command syntax

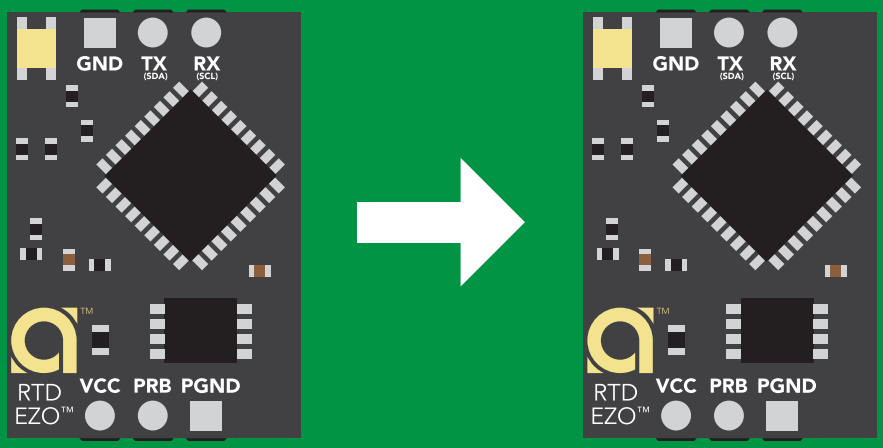
The time period (n) is in 10 second intervals and can be any value from 1 to 32,000.

D,n <cr> n = (n x 10 seconds)

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

D,? <cr> data logger storage interval?

Example	Response
D,6 <cr>	*OK <cr>
D,0 <cr>	*OK <cr>
D,? <cr>	?D,6 <cr> *OK <cr>



D,6

60 seconds

* <cr>

* indicates reading has been logged

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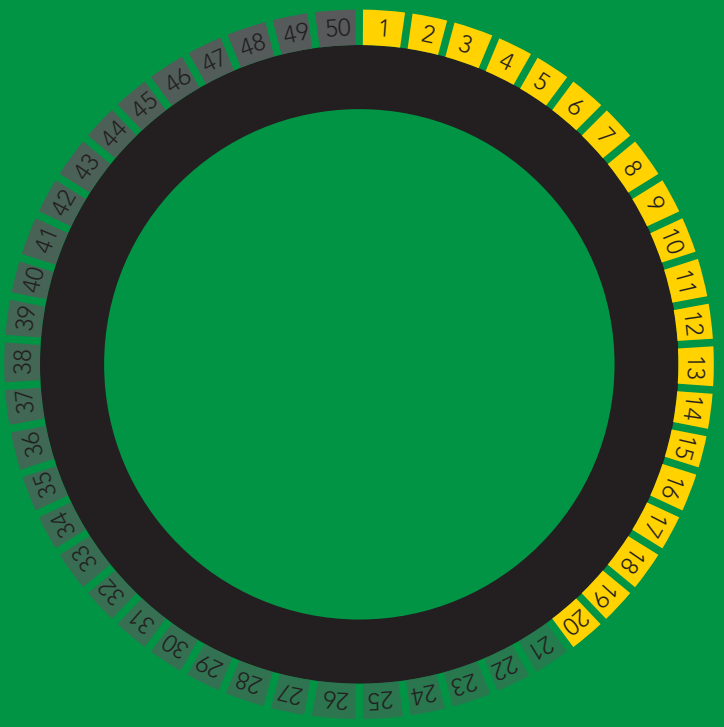
Memory recall

Command syntax

Disable data logger to recall memory.

M	<cr>	recall 1 sequential stored reading
M,all	<cr>	recall all readings in a CSV string
M,?	<cr>	display memory location of last stored reading

Example	Response
M <cr>	1,100.00 <cr> 2,104.00 <cr> *OK <cr>
M,all <cr>	100.00,104.00,108.00,112.00 <cr> Oldest Newest
M,? <cr>	?M,4 <cr> *OK <cr>



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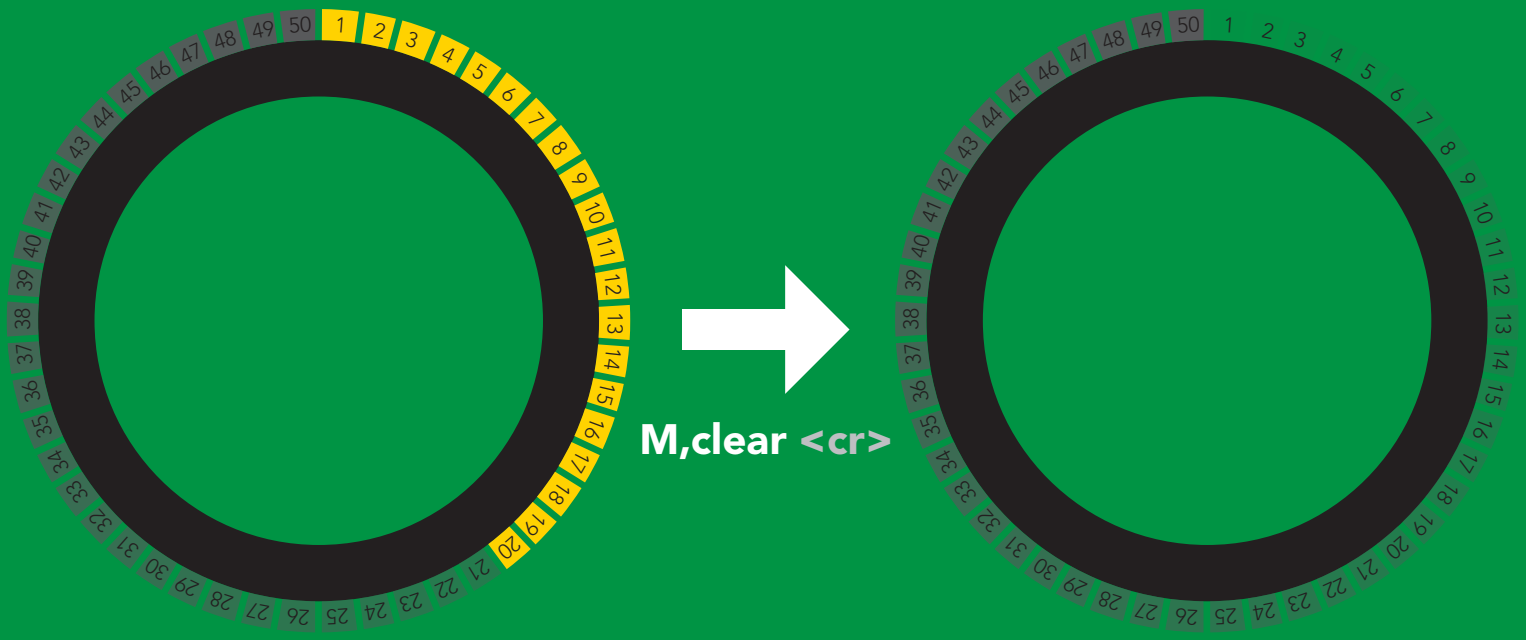
Memory clear

Command syntax

M,clear <cr> clear all stored memory

Example	Response
M,clear <cr>	*OK <cr>



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Naming device

Command syntax

Name,n <cr> **set name**

Name,? <cr> **show name**

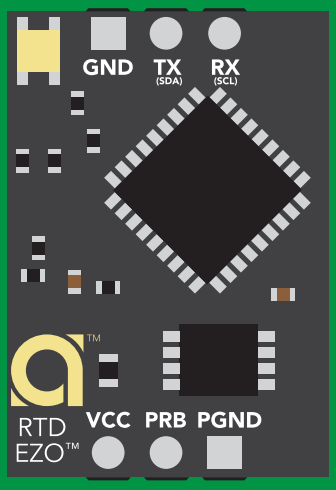
n = _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

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

Up to 16 ASCII characters

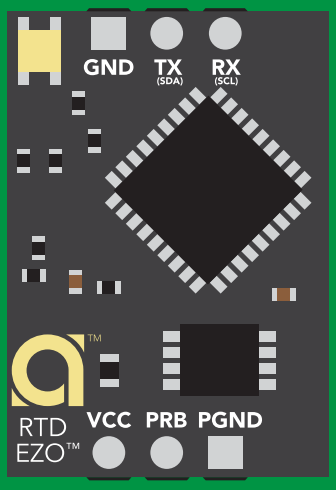
Example	Response
Name,zzt <cr>	***OK** <cr>
Name,? <cr>	**?Name,zzt** <cr> ***OK** <cr>

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,RTD,2.01 <cr> *OK <cr>

Response breakdown

?i,	RTD,	2.01
	↑ Device	↑ Firmware

Response codes

Command syntax

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

Example	Response
R <cr>	25.104 <cr> *OK <cr>
*OK,0 <cr>	no response, *OK disabled
R <cr>	25.104 <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

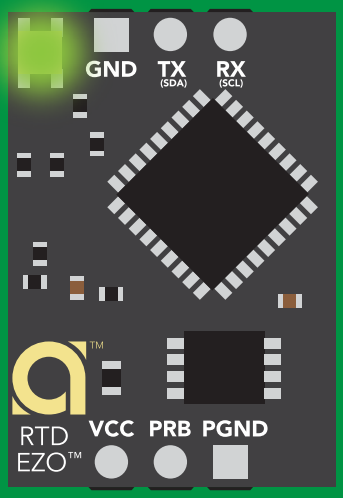
Command syntax

Send any character or command to awaken device.

Sleep <cr> enter sleep mode/low power

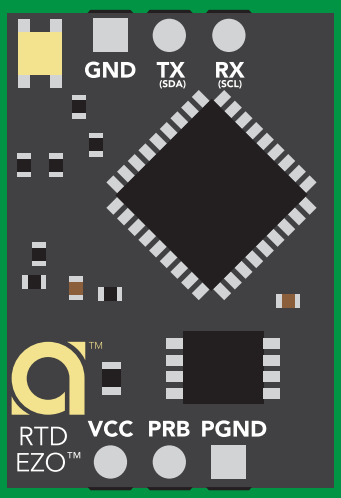
Example	Response
Sleep <cr>	*OK <cr> *SL <cr>
Any command	*WA <cr> wakes up device

	STANDBY	SLEEP
5V	15.40 mA	0.4 mA
3.3V	13.80 mA	0.09 mA



Standby
15.40 mA

Sleep <cr>



Sleep
3.00 mA

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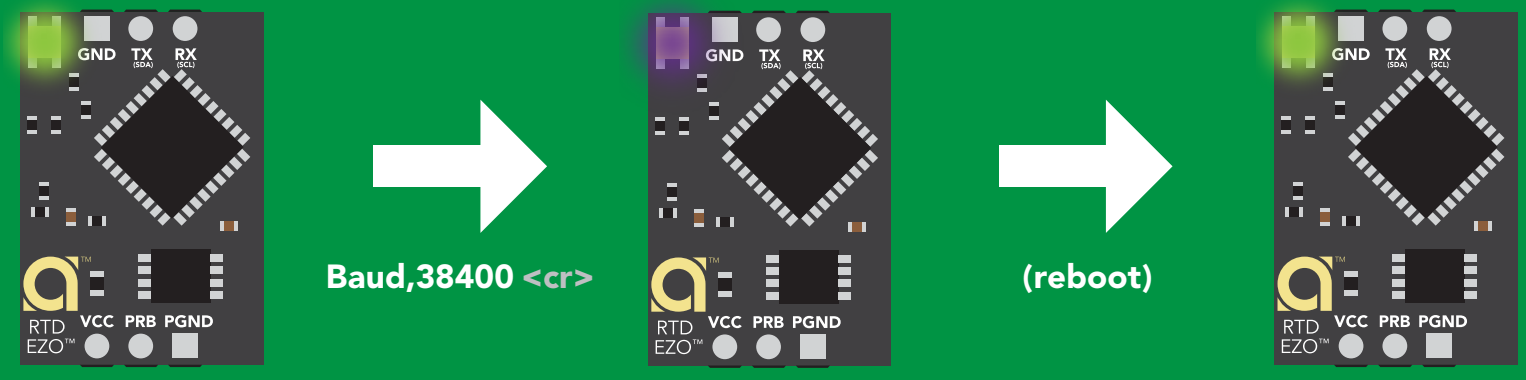
Change baud rate

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.

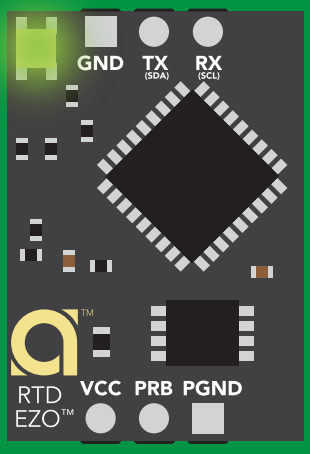
Plock,1 <cr> enable Plock

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

Plock,? <cr> Plock on/off?

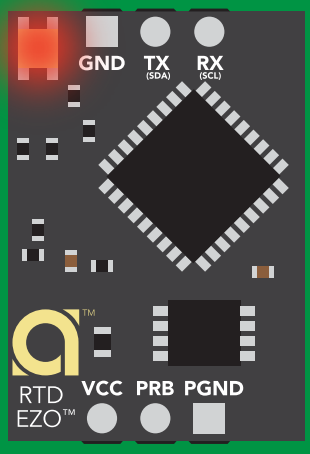
Example	Response
Plock,1 <cr>	*OK <cr>
Plock,0 <cr>	*OK <cr>
Plock,? <cr>	?Plock,1 <cr> or ?Plock,0 <cr>

Plock,1



*OK <cr>

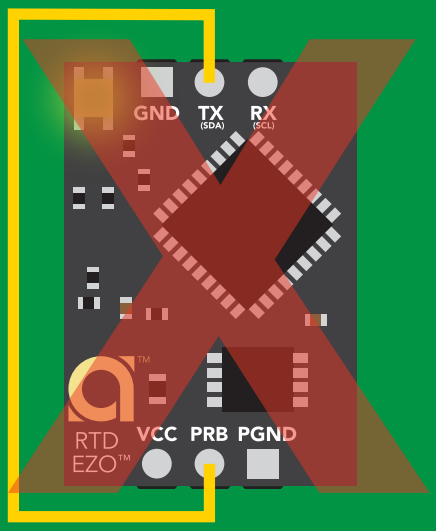
I2C,100



cannot change to I²C

*ER <cr>

Short



cannot change to I²C

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Factory reset

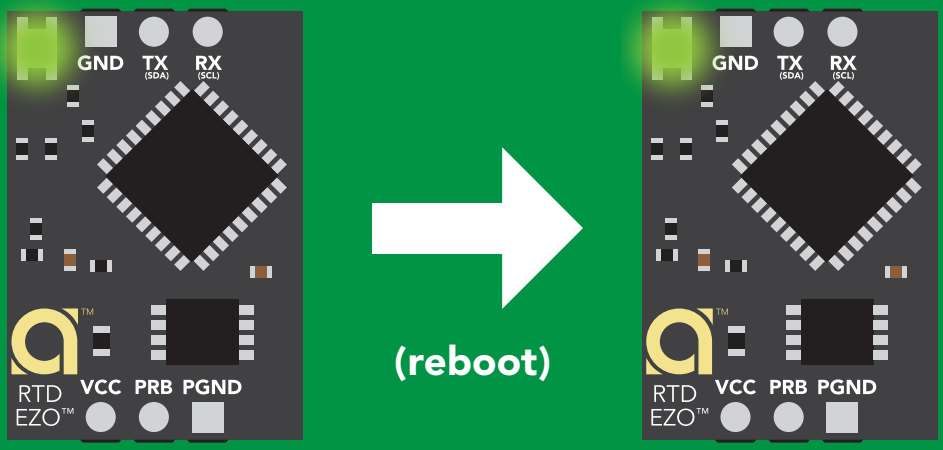
Clears calibration
LED on
"*OK" enabled
Clears data logger

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 102 (0x66)

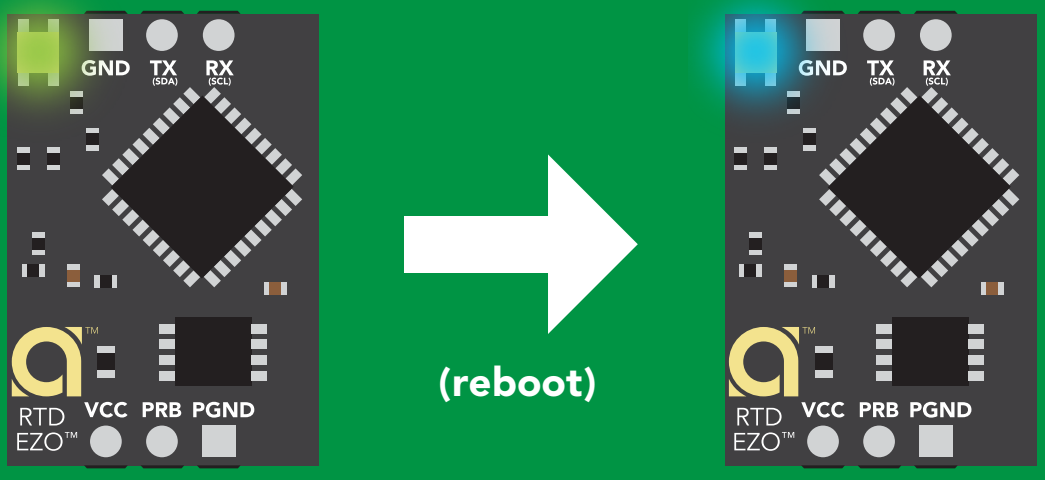
I2C,n <cr> sets I²C address and reboots into I²C mode

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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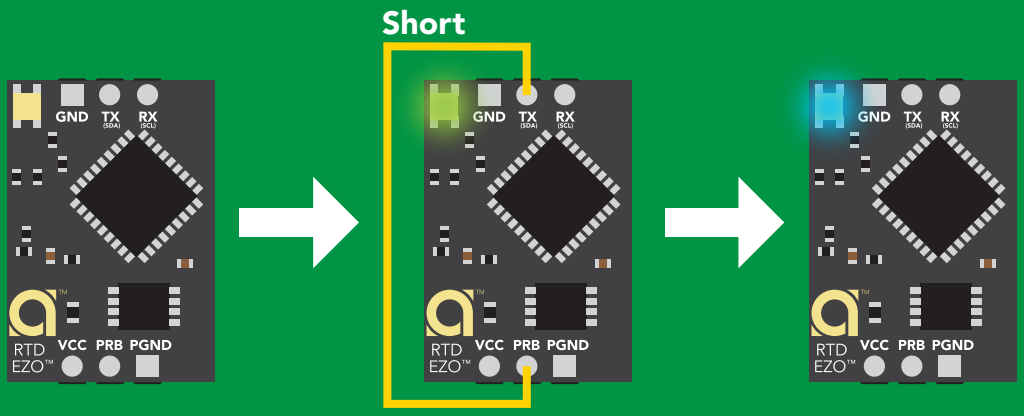
Manual switching to I²C

- Make sure Plock is set to 0
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PRB
- 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

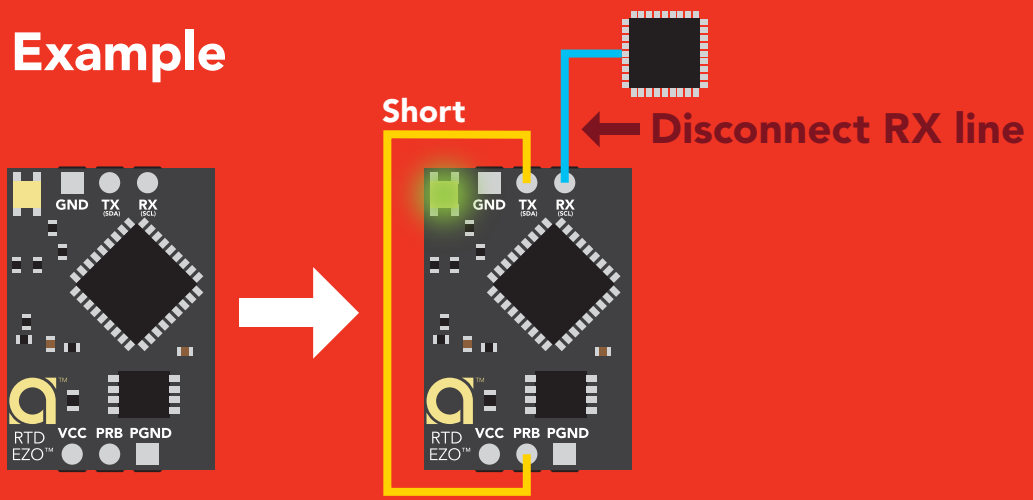
Connecting TX to PRB only works for the EZO-RTD™ and the EZO-FLO™ circuits

Manually switching to I²C will set the I²C address to 102 (0x66)

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

Find
Sleep mode

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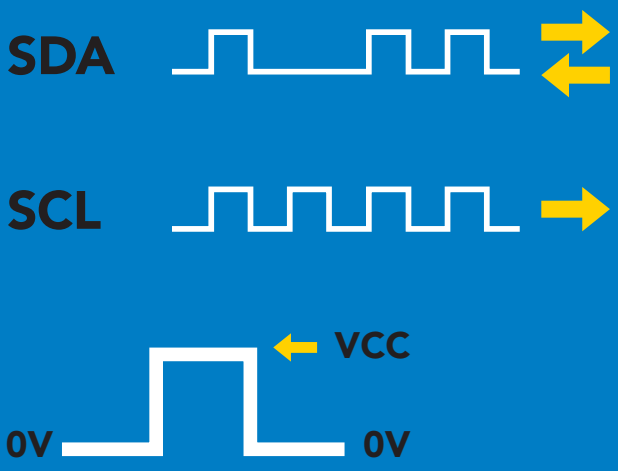
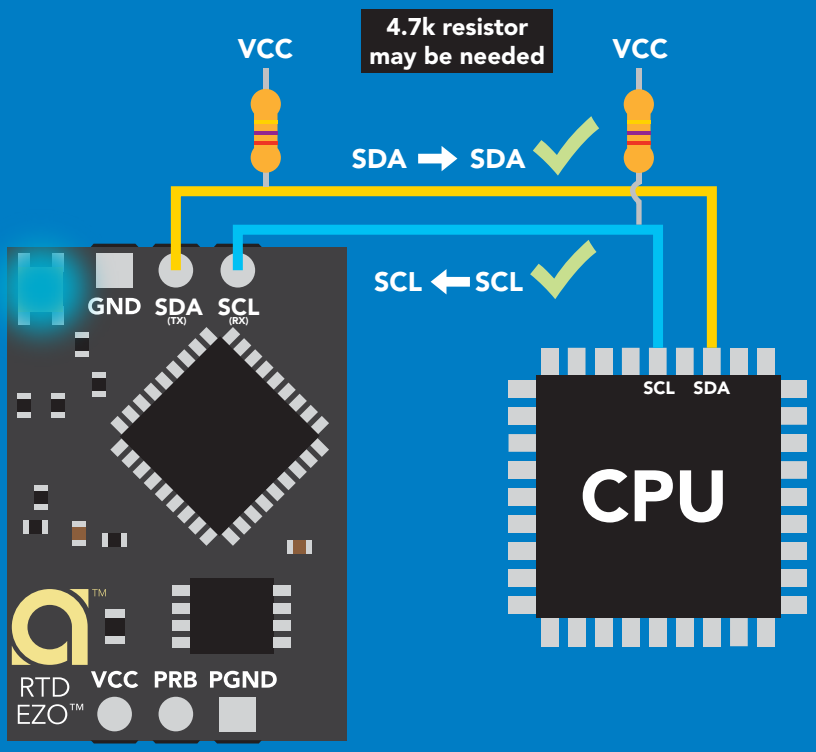
I²C mode

I²C address	(0x01 – 0x7F) 102 (0x66) default
Vcc	3.3V – 5.5V
Clock speed	100 – 400 kHz





Data format

Reading	temperature	Data type	floating point
Units	°C, °K, or °F	Decimal places	3
Encoding	ASCII	Smallest string	4 characters
Format	string	Largest string	40 characters

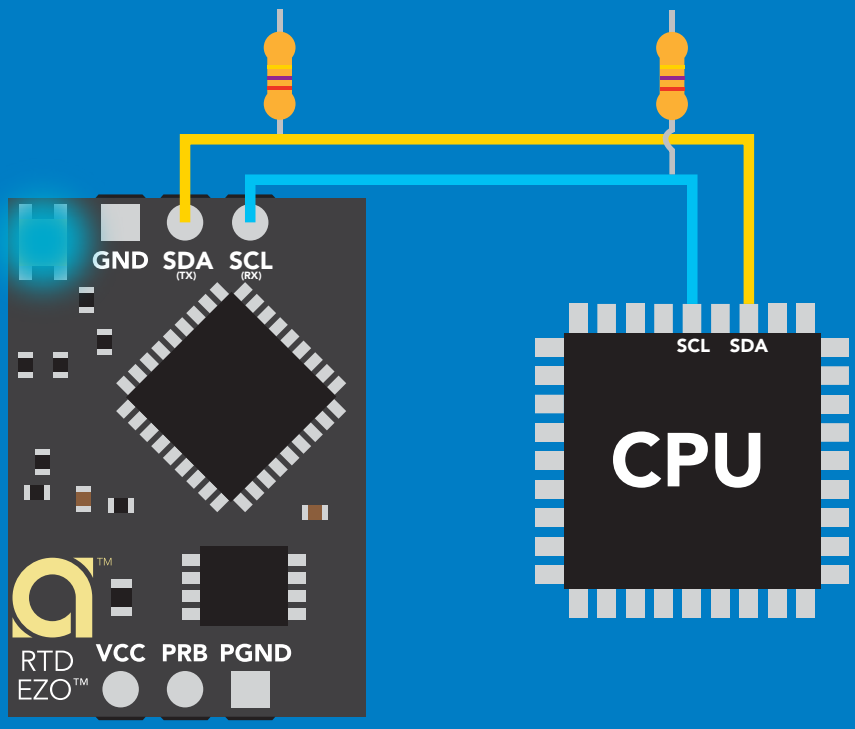
Sending commands to device

5 parts

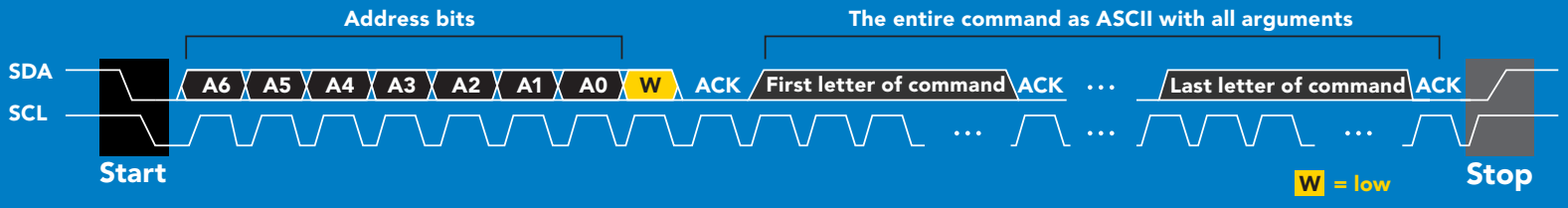
Start	I²C address	Write	Command (not case sensitive)	Stop
	102 (0x66)		ASCII command string	

Example

Start	102 (0x66)	Write	Sleep	Stop
	I²C address		Command	



Advanced



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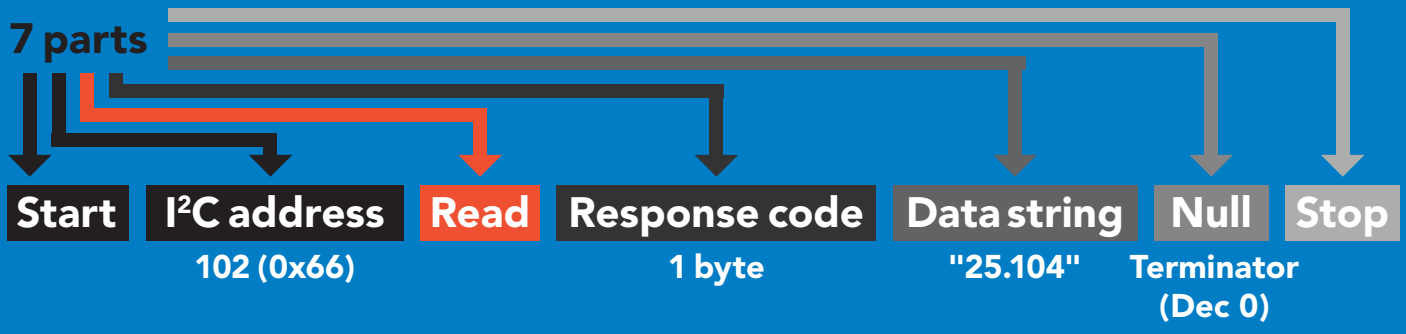
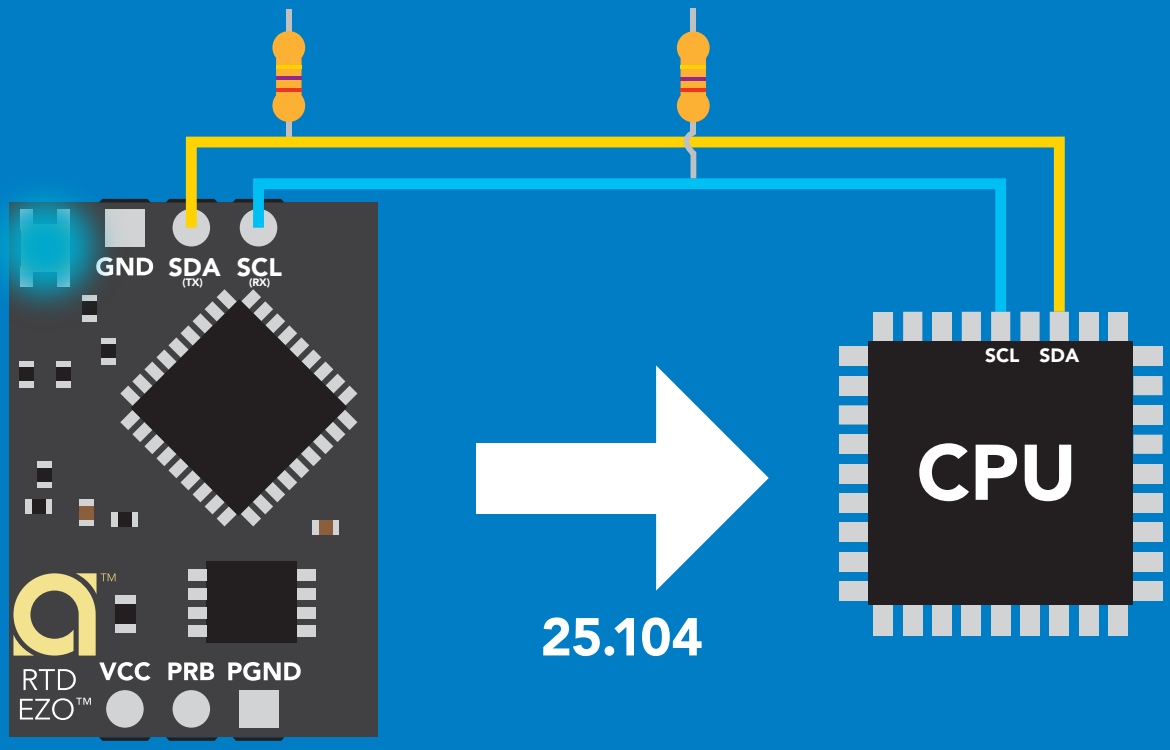
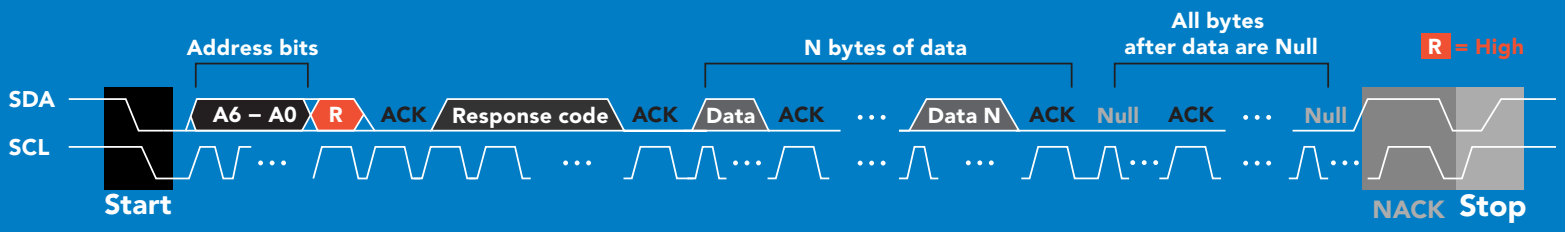
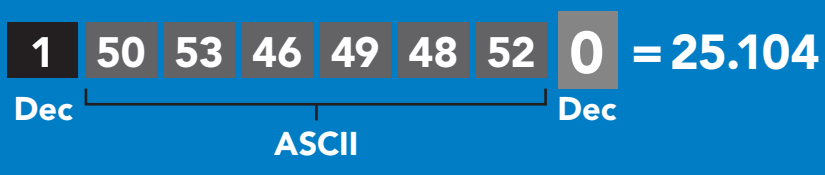
Requesting data from device





Advanced





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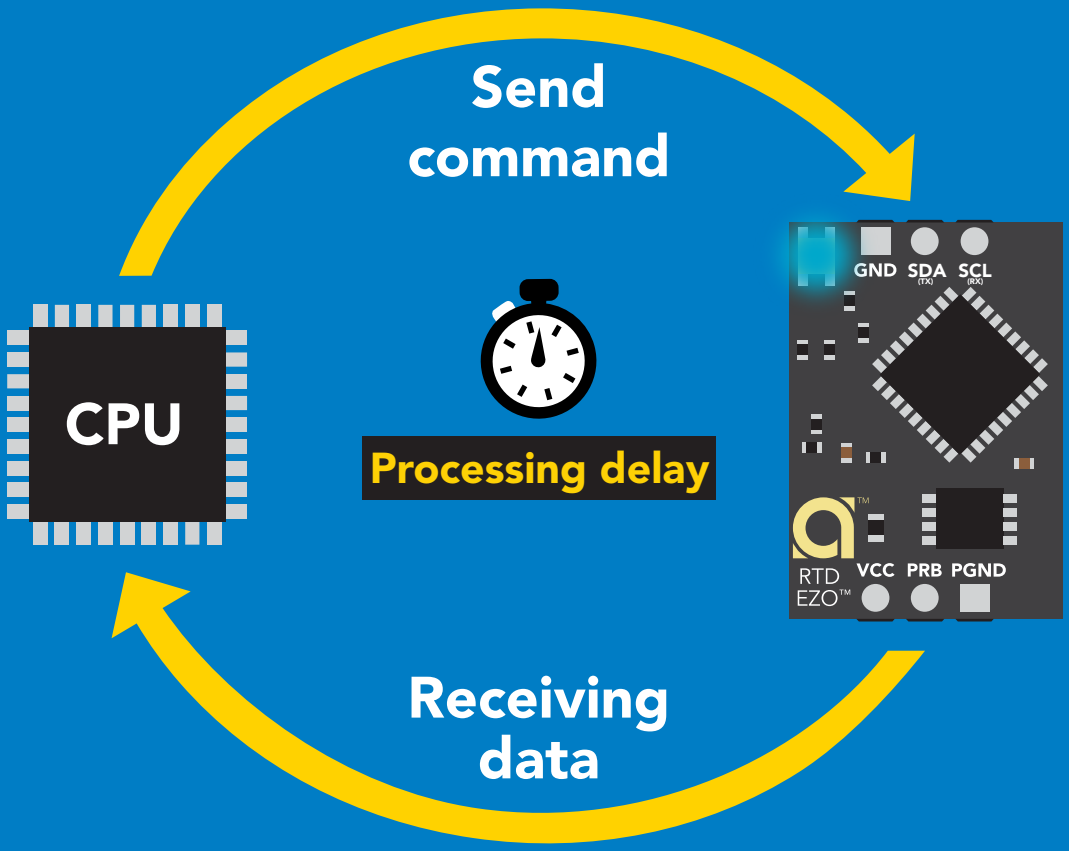
Response codes

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.



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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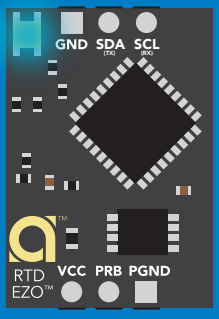
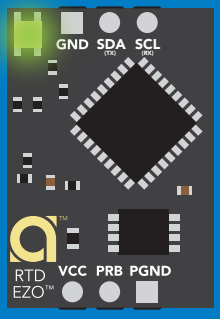
LED color definition



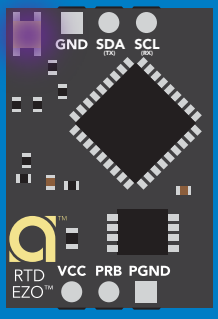
Blue

I²C standby



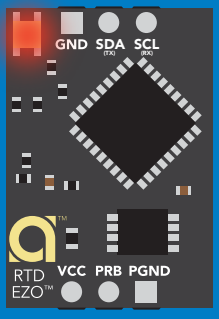
Green

Taking reading



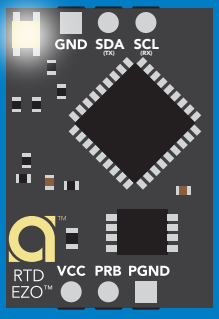
Purple

Changing I²C address



Red

Command not understood



White

Find

	LED ON
5V	**+0.4 mA**
3.3V	**+0.2 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. 65
Cal	performs calibration	pg. 52
D	enable/disable data logger	pg. 56
Export	export calibration	pg. 53
Factory	enable factory reset	pg. 64
Find	finds devices with white blinking LED	pg. 50
i	device information	pg. 59
I2C	change I²C address	pg. 63
Import	import calibration	pg. 54
L	enable/disable LED	pg. 49
M	memory recall/clear	pg. 57
Plock	enable/disable protocol lock	pg. 62
R	returns a single reading	pg. 51
S	temperature scale (°C, °K, °F)	pg. 55
Sleep	enter sleep mode/low power	pg. 61
Status	retrieve status information	pg. 60

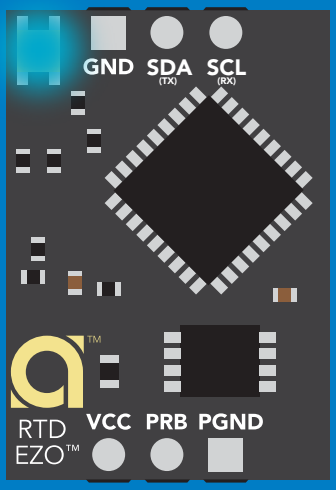
LED control

Command syntax

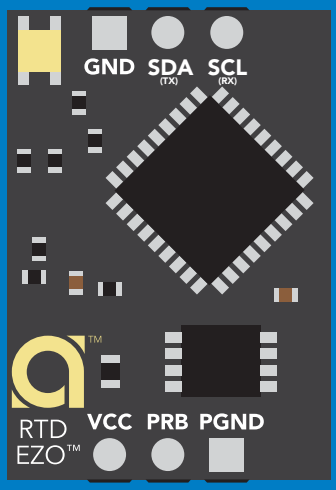
300ms processing delay

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 1 (Dec) ?L,0 (ASCII) 0 (Null)



L,1



L,0

Find

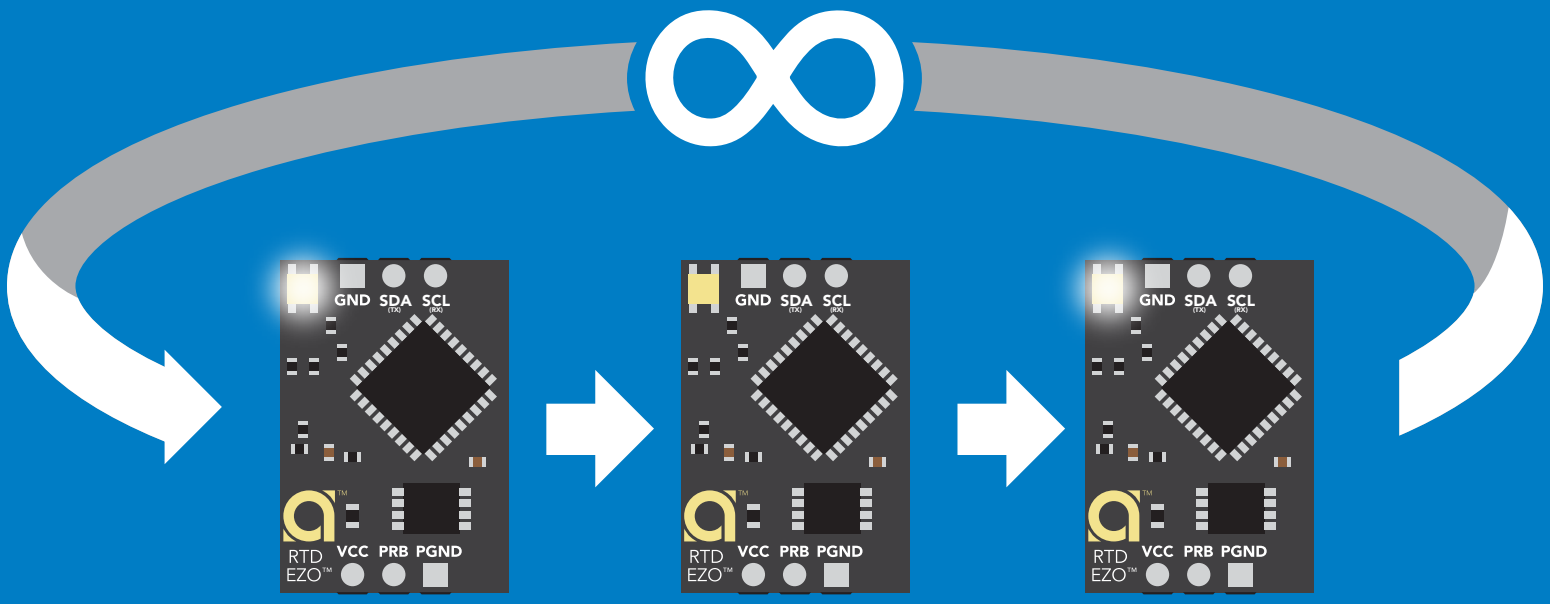
300ms processing delay

Command syntax

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

Find LED rapidly blinks white, used to help find device

Example	Response
Find <cr>	Wait 300ms 1 Dec 0 Null



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r 0.1

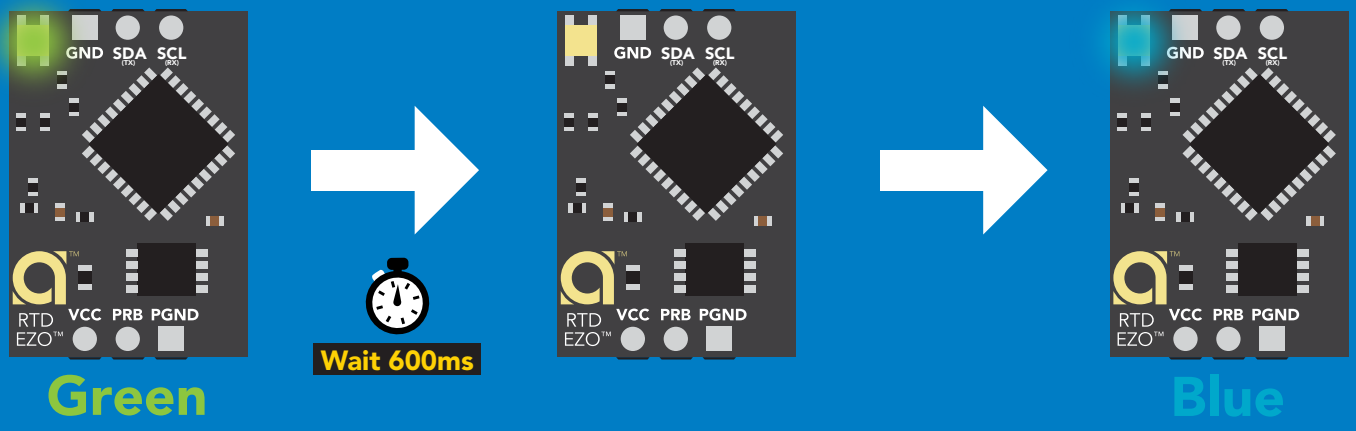
Taking reading

Command syntax

600ms processing delay

R return 1 reading

Example	Response
R	Wait 600ms 1 Dec 25.104 ASCII 0 Null



AtlasScientific™ Environmental Robotics

r 0.1

Calibration

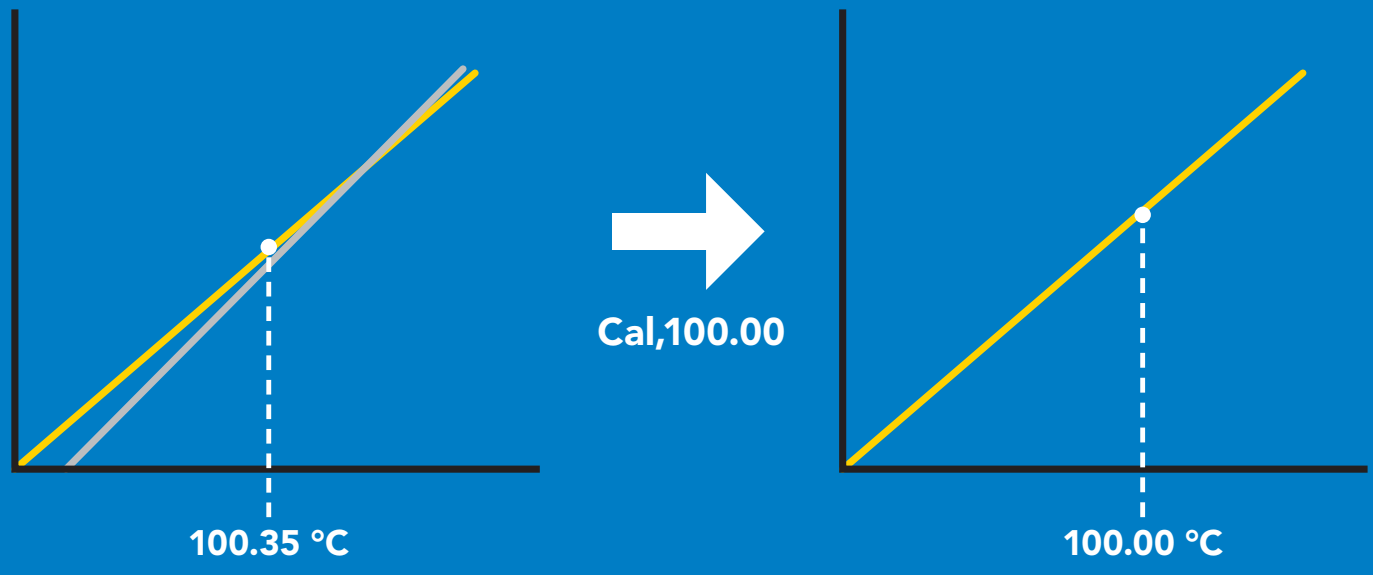
Command syntax

600ms processing delay

Cal,t	t = any temperature
Cal,clear	delete calibration data
Cal,?	device calibrated?

EZO™ RTD circuit uses single point calibration.

Example	Response
Cal,t	Wait 600ms → 1 (Dec) 0 (Null)
Cal,clear	Wait 300ms → 1 (Dec) 0 (Null)
Cal,?	Wait 300ms → 1 (Dec) ?Cal,1 (ASCII) 0 (Null) or 1 (Dec) ?Cal,0 (ASCII) 0 (Null)



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Export calibration

300ms processing delay

Command syntax

Export: Use this command to download calibration settings

Export,?	calibration string info
Export	export calibration string from calibrated device

Example

Response

Export,?

1	10,120	0
Dec	ASCII	Null

Response breakdown

10, 120

# of strings to export — # of bytes to export

Export strings can be up to 12 characters long

Export

1	59 6F 75 20 61 72	0
Dec	ASCII	Null

(1 of 10)

Export

1	65 20 61 20 63 6F	0
Dec	ASCII	Null

(2 of 10)

(7 more)

Export

1	6F 6C 20 67 75 79	0
Dec	ASCII	Null

(10 of 10)

Export

1	*DONE	0
Dec	ASCII	Null

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r 0.2

Import calibration

300ms processing delay

Command syntax

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

Import,n import calibration string to new device

Example

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

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

⋮

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

Response

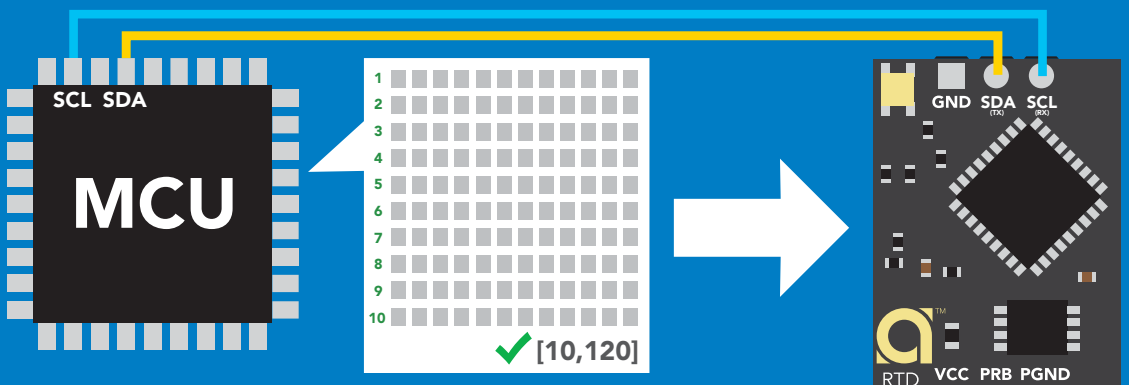
Wait 300ms 1 Dec 0 Null

Wait 300ms 1 Dec 0 Null

⋮

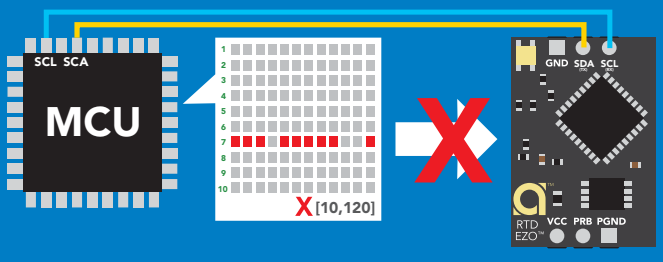
Wait 300ms 1 Dec 0 Null

Import,n



1 Dec *Pending ASCII 0 Null

system will reboot



reboot

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

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Temperature scale (°C, °K, °F)

Command syntax

300ms processing delay

S,c	celsius	default
S,k	kelvin	
S,f	fahrenheit	
S,?	temperature scale?	

Example / Response

S,c

Wait 300ms

1	0
Dec	Null

S,k

Wait 300ms

1	0
Dec	Null

S,f

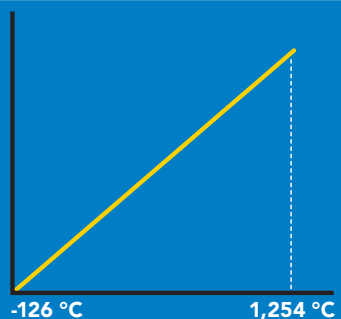
Wait 300ms

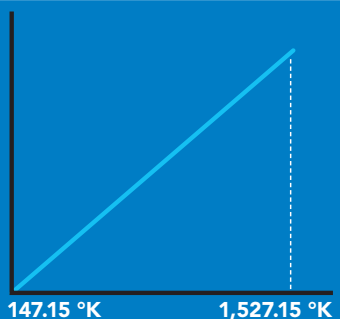
1	0
Dec	Null

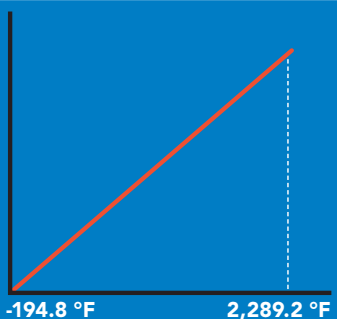
S,?

Wait 300ms

1	?S,f	0	or	1	?S,k	0	or	1	?S,k	0
Dec	ASCII	Null		Dec	ASCII	Null		Dec	ASCII	Null







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Enable/disable data logger

Command syntax

300ms processing delay

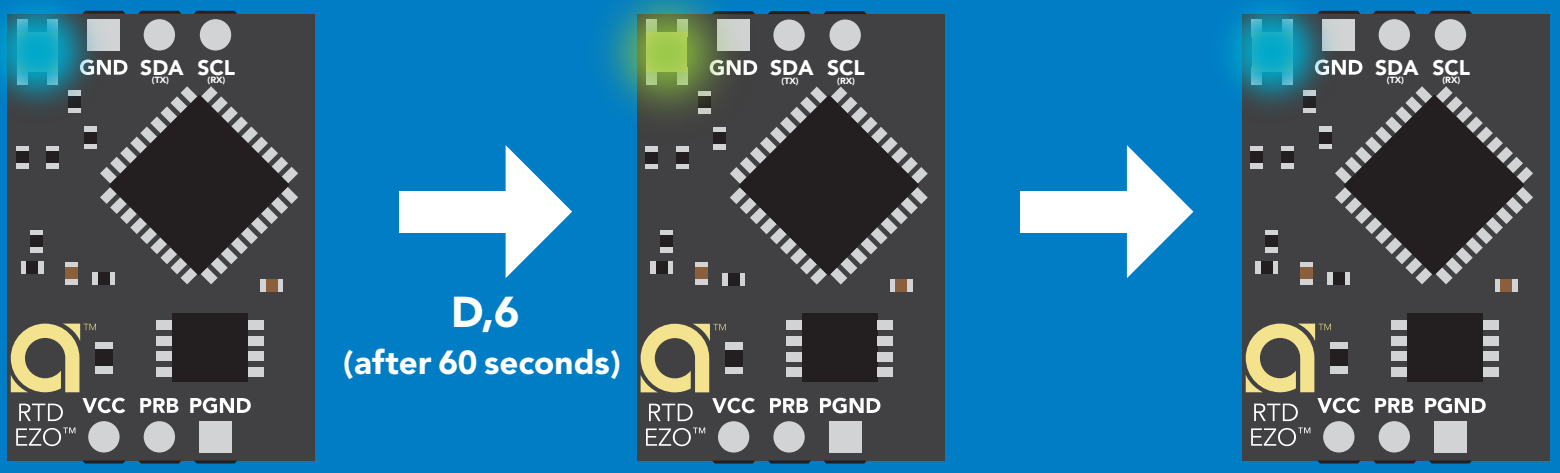
D,n n = (n x 10 seconds)

D,0 disable

D,? data logger storage interval?

The time period (n) is in 10 second intervals and can be any value from 1 to 32,000.

Example	Response
D,6	Wait 300ms → 1 (Dec) 0 (Null)
D,0	Wait 300ms → 1 (Dec) 0 (Null)
D,?	Wait 300ms → 1 (Dec) ?D,6 (ASCII) 0 (Null)



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Memory recall

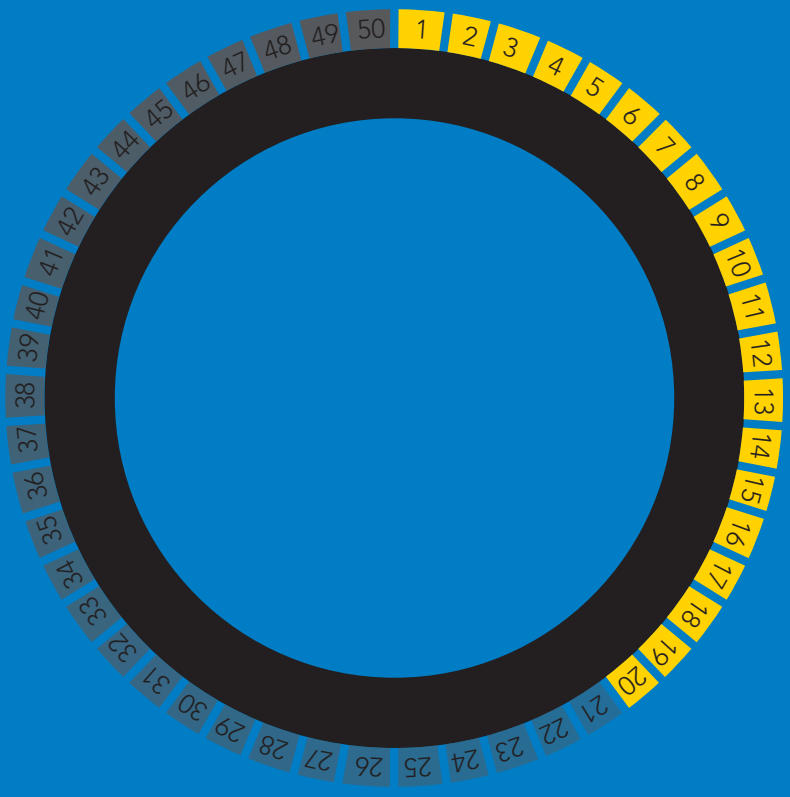
Disable data logger to recall memory.

Command syntax

300ms processing delay

M	**recall 1 sequential stored reading**
M,?	**display memory location of last stored reading**

Example	Response
M	Wait 300ms — **1** Dec — **1,100.00** ASCII — **0** Null
M,?	Wait 300ms — **1** Dec — **4,112.00** ASCII — **0** Null



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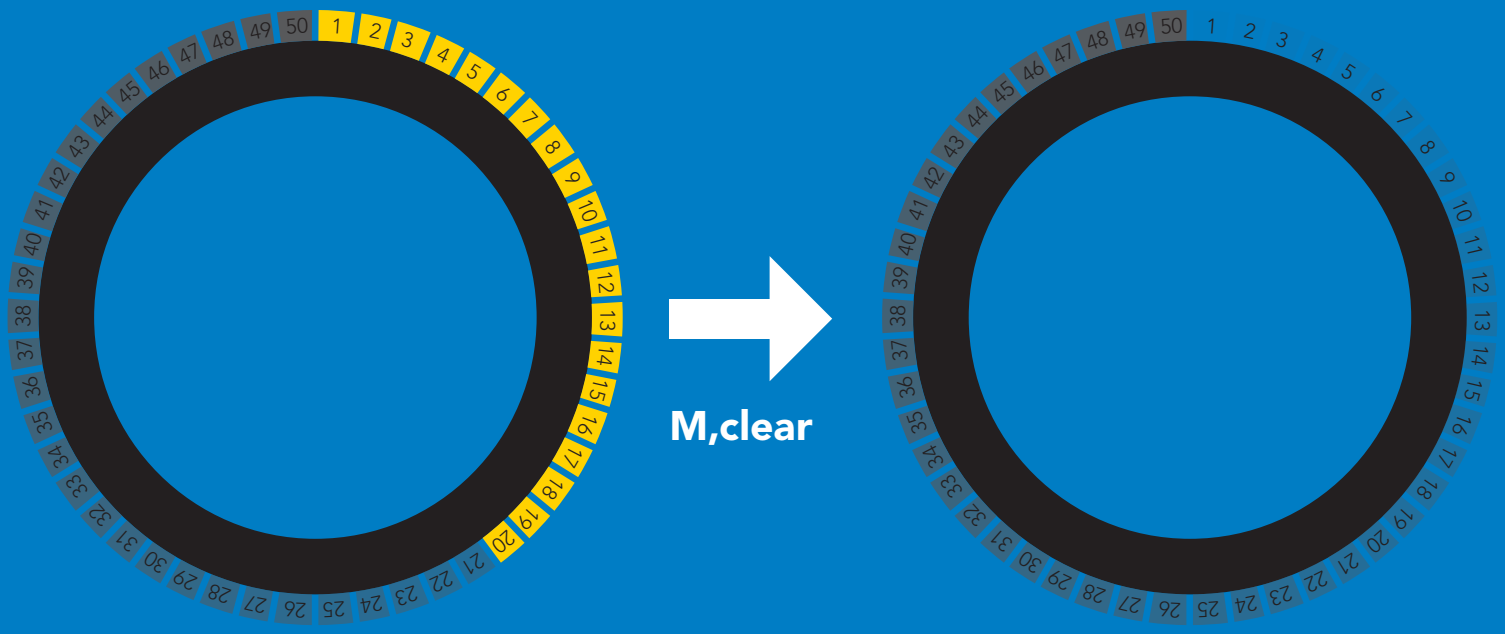
Memory clear

Command syntax

300ms processing delay

M,clear clear all stored memory

Example	Response
M,clear	Wait 300ms 1 Dec 0 Null



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Device information

Command syntax

300ms processing delay

i device information

Example

i

Response

1 Dec

?i,RTD,2.01 ASCII

0 Null

Response breakdown

?i, RTD, 2.01

RTD, ↑ Device

2.01 ↑ Firmware

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

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.

	STANDBY	SLEEP
5V	15.40 mA	0.4 mA
3.3V	13.80 mA	0.09 mA

Standby

Sleep

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Protocol lock

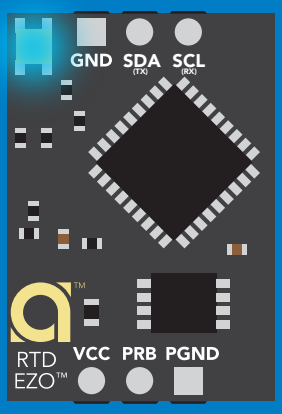
Command syntax

300ms processing delay

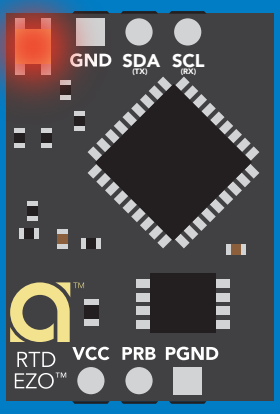
Plock,1	enable Plock	Locks device to I²C mode.
Plock,0	disable Plock	default
Plock,?	Plock on/off?	

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)

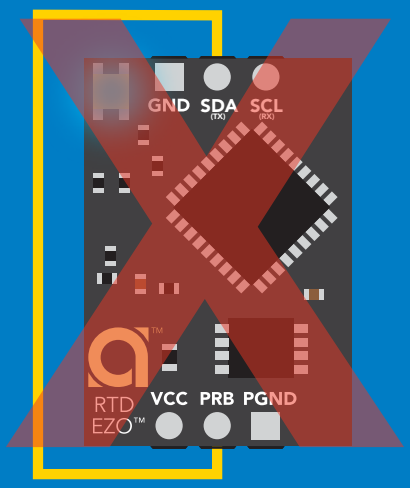
Plock,1



Baud, 9600



cannot change to UART



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

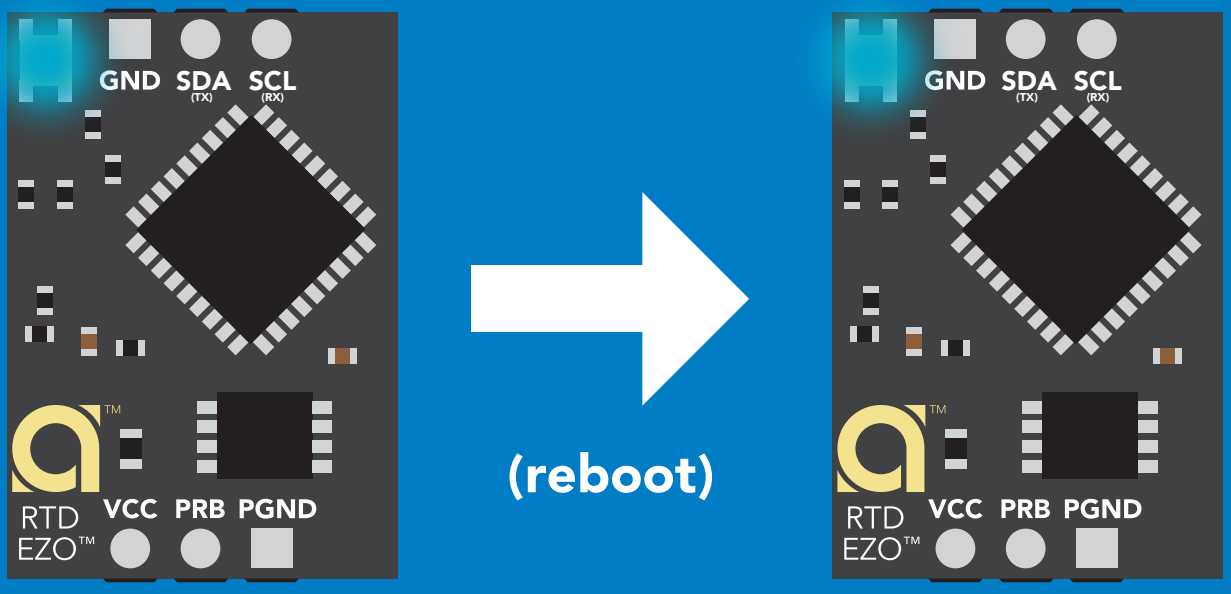
Warning!

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 102 (0x66).

n = any number 1 – 127

I2C,100



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Factory reset

Command syntax

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

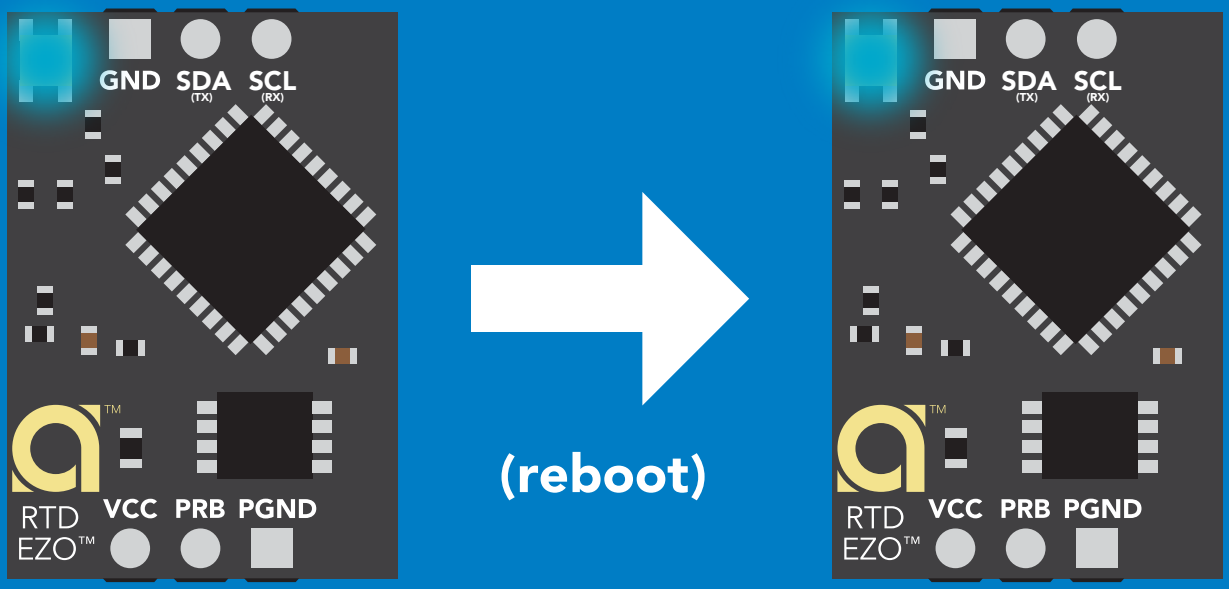
Factory	enable factory reset

I²C address will not change

Example	Response
Factory	device reboot

Clears calibration
LED on
Response codes enabled
Clears data logger

Factory



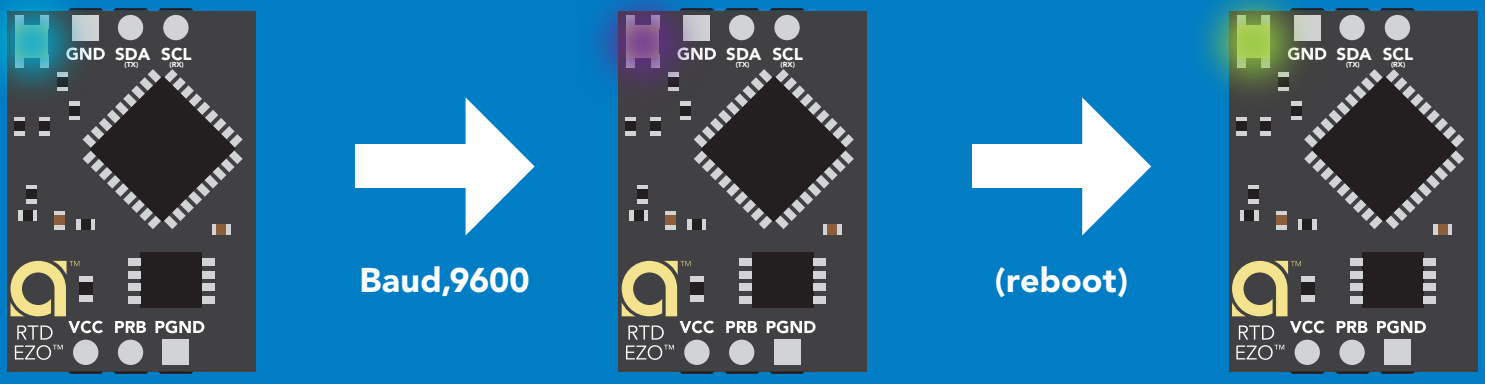
Change to UART mode

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

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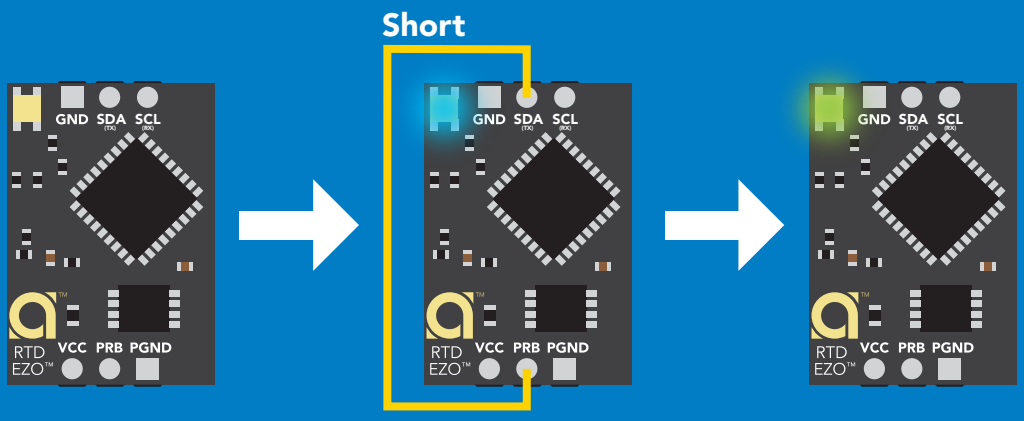
Manual switching to UART

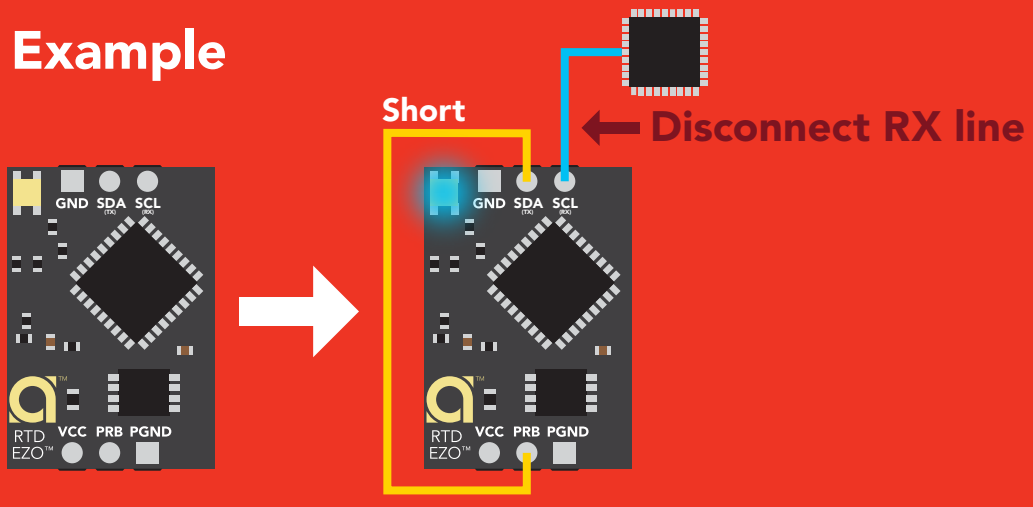
- Make sure Plock is set to 0
- Disconnect ground (power off)
- Disconnect TX and RX
- Connect TX to PRB
- Confirm RX is disconnected
- Connect ground (power on)
- Wait for LED to change from Blue to Green
- Disconnect ground (power off)
- Reconnect all data and power

Connecting TX to PRB only works for the EZO-RTD™ and the EZO-FLO™ circuits

Example



Wrong Example



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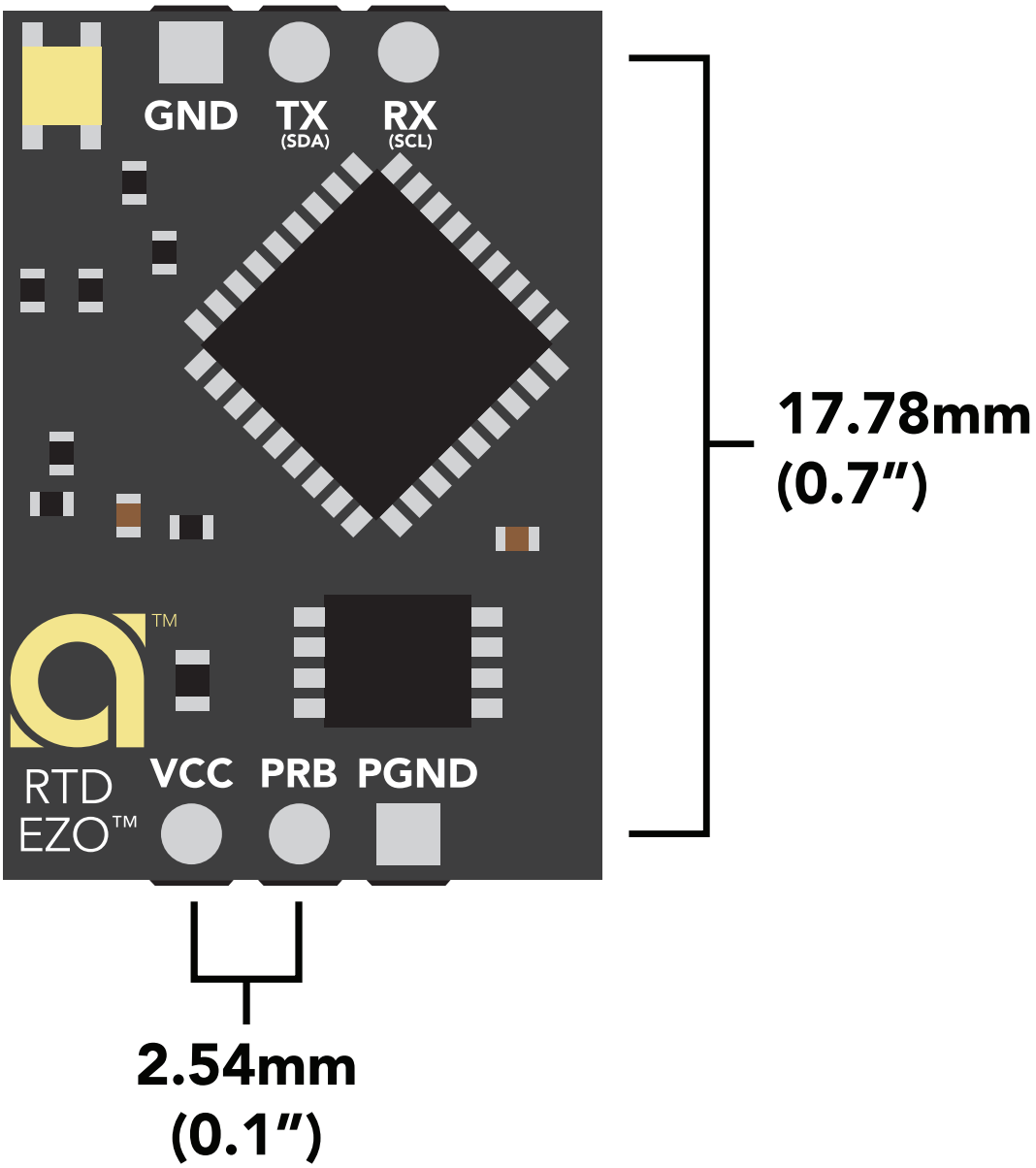
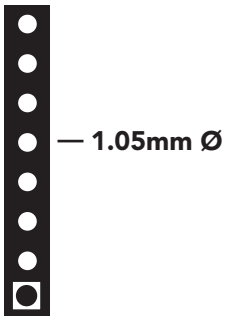
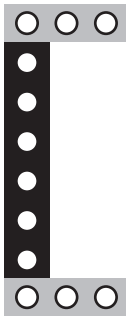
EZO™ circuit footprint



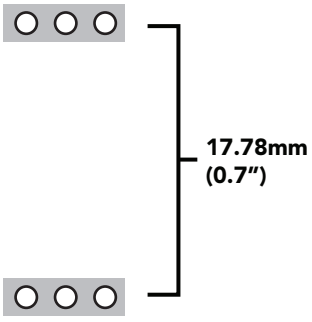
1 In your CAD software place a 8 position header.



2 Place a 3 position header at both top and bottom of the 8 position.



3 Delete the 8 position header. The two 3 position headers are now 17.78mm (0.7”) apart from each other.



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Datasheet change log

Datasheet V 3.2

Revised response for the sleep command in UART mode on pg 36.

Datasheet V 3.1

Added more information on the Export calibration and Import calibration commands.

Datasheet V 3.0

Changed "Max rate" to "Response time" on cover page.

Datasheet V 2.9

Removed note from certain commands about firmware version.

Datasheet V 2.8

Added information to calibration theory on pg 9.

Datasheet V 2.7

Revised definition of response codes on pg 45.

Datasheet V 2.6

Updated calibration processing delay time on pg.51.

Datasheet V 2.5

Revised Plock pages to show default value.

Datasheet V 2.4

Added new commands:
"Find" pages 22 & 49.
"Export/Import calibration" pages 26 & 52.
Added new feature to continous mode "C,n" pg 23.

Datasheet V 2.3

Added manual switching to UART information on pg. 59.

Datasheet V 2.2

Revised Baud command information on pg. 33.

Datasheet V 2.1

Revised entire datasheet.

Firmware updates

V1.02 – Plock (March 31, 2016)
- Added protocol lock feature "Plock"

V1.03 – EEPROM (April 26, 2016)
- Fixed bug where EEPROM would get erased if the circuit lost power 900ms into startup

V1.11 – Bug Fix (June 9, 2016)
- Fixed bug where a blank name would result in garbage ouput

V2.01 – Update (January 1, 2017)
- Replaced command "response" with "*OK"
- Replaced command "Serial" with "Baud"

V2.02 – Bug Fix (February 16, 2017)
- Fixed bug where calibration would not accept floating point numbers.

V2.10 – (May 9, 2017)
- Added "Find" command.
- Added "Export/import" command.
- Modified continuous mode to be able to send readings every "n" seconds.
- Sleep current is lowered.

Warranty

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

The debugging phase

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

- **Soldering any part of the EZO™ class RTD circuit.**
- **Running any code, that does not exclusively drive the EZO™ class RTD circuit and output its data in a serial string.**
- **Embedding the EZO™ class RTD 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™ class RTD circuit, against the thousands of possible variables that may cause the EZO™ class RTD 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 RTD circuits continued operation. This is because that would be equivalent to Atlas Scientific™ taking responsibility over the correct operation of your entire device.