



WIRELESS CO₂, HUMIDITY AND TEMPERATURE SENSOR RCT Detailed Installation and Commissioning Guide



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Overview

The CO₂ sensor (also referred to as the sensor in this guide) is a wireless, energy harvesting sensor that :

- monitors CO₂ levels from 0-2000 ppm,
- room temperature in the range of 0-51°C (32°F to 124°F) and
- relative humidity in the range of 0-100% .

The CO₂ measurement is also automatically altitude corrected using a sensitive (\pm 3ft) absolute pressure sensor. The device comes populated with a CR2032 coin cell battery to provide backup power for up to 5 years of operating time. The product is designed to operate with 3rd party receivers, controllers and gateways designed for EnOcean compatible wireless networks. The sensor is intended for indoor use only.

A button on the lower right edge of the sensor body can be used to cause the LED's to blink a code that indicates CO₂ concentration or to go into test mode (when the button is held down, see "Test Operating Modes").

Document Conventions

This document includes the following conventions to draw attention to important information.



Note: *Notes are helpful hints or information that supplement the main content.*

Echoflex's user documentation is designed for print or electronic use. Benefits to using the electronic format include using the table of contents to jump to a desired page by clicking on the heading or using word search to find a specific topic.

Cross references highlighted in this document are links to the referenced section of the guide.

■ This guide is available for free download from Echoflex Solutions website: www.echoflexsolutions.com

The RCT CO₂ Sensor

The RTC is specifically designed for building systems where indoor environmental quality and potential savings from utilizing CO₂ based demand controlled ventilation is desired.

The RTC is a versatile, wireless CO₂, temperature and humidity transmitter that operates based on energy harvested from indoor ambient light. The sensor has no wires, requires no maintenance and can be easily installed and integrated into an EnOcean® wireless network. This sensor platform is ideal for EnOcean® networks installed in new or existing buildings. EnOcean is an open, wireless protocol that allows integration with a variety of other products and systems.

Batteries are not required for everyday operation due to the advanced solar energy harvesting and power management features of the sensor. There is a clip for a coin cell battery (battery provided) to aid in quick installation and to provide extended backup in no light or low light conditions. The sensor will operate under battery power for over five years.



Note:

Tricolored LEDs provide indications to aid with installation as well as a means of displaying current CO₂ levels at the push of a button.

Radio Communications

The RTS is a wireless device capable of transmitting telegrams.

The sensor transmits status telegrams that contain the information defined within a equipment profile.

The sensor supports the following profiles:

A5-09-04: CO₂ Sensor + Temperature Sensor + Humidity Sensor

The valid ranges for each data element:

CO₂: 0 - 2000 ppm

Temperature: 0 - 51°C, (32° - 124°F)

Humidity Sensor: 0 -100% RH

Receiver Proximity

The sensor transmits to a receiver which is typically a device that is programmed to provide HVAC ventilation and temperature control in the space that the sensor is monitoring for closed loop temperature control. The sensor and receiver must be within range, preferably in the same room and installed within 50' (15.2 m) of each other. For applications exceeding 50' (15.2 m) range, greater care must be

taken to insure proper reception of the sensors transmissions at the receiver, refer to sections “Test Operating Modes” and ‘Installing Wireless Devices”.



Note:

The RCT comes populated with a CR2032 coin cell battery. The battery is not required for normal operation when the RCT receives adequate natural or artificial light. The battery is required for calibration.



Note:

Even with a brief exposure to light the sensor will operate, however for best results the sensor should be mounted in a location with exposure to 4 hours of natural or artificial light on a daily basis.

Performing a CO2 Background Calibration

It is highly recommended that the installer perform an ambient air calibration of the RCT as part of the installation process. The sensor will take the lowest CO₂ recorded since its last calibration cycle and assign this reading the value of 420ppm (outdoor air). This process takes 15-60 minutes and can be performed on-site or prior to visiting the site. Multiple sensors can be calibrated at the same time. Further instructions on other adjustments that can be made can be found [on page 10](#)

- 1) Place the sensor(s) in outside air above 32°F (0°C), and out of direct sunlight for 15 to 60 minutes. Avoid areas where people are lingering so the background CO₂ readings are not affected. The sensor will take the lowest CO₂ recorded since its last calibration cycle and assign this reading the value of 420ppm (outdoor air).
- 2). Press the function button on the sensor until the green LED is blinking, about 6 seconds.
- 3.) Tap the function button to cycle through modes. Once the Red LED (only) is blinking, press and hold for ~ 6 seconds to enter CO₂ background calibration mode, there will be a pause then the Green LED will begin blinking.
- 4). After about 6 seconds the green LED will stop blinking when calibration is complete.

Install the sensor in the targeted location and connect to an EnOcean network.

There is also an option to set a specific value for the CO₂ sensor to calibrate to. The process for doing this is explained in detail later in this guide. It is important to note that any calibrations should be done so that the air around the sensor is at the concentration to be used for calibration. Flowing calibrated gas through a tube to the

inside of the sensor is not a valid or accurate method of calibration. For commissioning purposes, the best way to evaluate the sensor is to compare the sensor to a hand held CO₂ sensor that has recently been calibrated at approximately the same altitude (\pm 500 ft).

Reading the CO₂ Concentrations

The RCT does not have a digital display but it is possible to

1. Quickly determine the general range of CO₂ concentration in the space and
2. Determine the actual concentrations in the space.

Current CO₂ range is indicated by an LED blink every 15 seconds.

Green LED: < 1100 ppm (good)

Amber LED: 100 to 1500 ppm (marginal)

Red LED: > 1500 ppm (poor ventilation)

Acquiring current CO₂ concentration:

- Press function button on lower right side for 1 second.
- Count LED blinks, add together for current level:
Green = 500 ppm
Amber = 100 ppm
Red = 25 ppm

See example [on page 6](#)

RCT Sensor - Reading the CO₂ Level

Current CO₂ Range:

Indicated by an LED blink every 15 seconds

- Green (lower LED): < 1,100 ppm (Good)
- Amber (middle LED): 1,100 to 1,500 ppm (marginal)
- Red (upper LED): > 1,500 ppm (poor ventilation)

Current CO₂ Concentration

1. Press button on lower right side for 1 second
2. Count LED blinks (and add) for current CO₂ concentration
 - Green blink = 500 ppm
 - Amber blink = 100 ppm
 - Red blink = 25 ppm



Light Harvesting Transmitter Description

In order to best manage power, the transmitting interval of the RCT is automatically managed dependent on ambient light levels, rate of measurement change and amount of power stored in the sensor. Telegrams are sent at the following intervals:

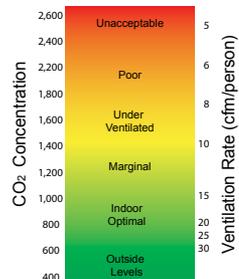
- If the temperature change between last transmitted value and the current sample is $> 0.6^{\circ}\text{C}$ (1.1°F), the sensor will transmit immediately.
- If the RH value change between last transmitted value and the current sample is $> 3\%$, the sensor will transmit immediately.
- If the CO₂ value change between samples is > 200 ppm, the sample and heartbeat rate shall adjust to 300 sec (5 min) for 1 sample period
- The CO₂ sample rate value is derived from three consecutive readings from the COZIR sensor averaged with the previous transmitted value, level 1 and 2 only. For level 3, only the 3 readings taken during the current sample are averaged.

Ambient Light	Temp/RH Sampling Rate	CO ₂ sampling Rate	Heartbeat Rate
> 200 lux (18.5 fc)	16 sec	300 sec (5 min)	300 sec (5 min)
< 200 lux (18.5 fc)	32 sec	600 sec (10 min)	600 sec (10 min)
< 50 lux for 16 hours	64 sec	1200 sec (20 min)	1200 sec (20 min)

CO₂ LED Indication

There are 3 LEDs located on the right side of the solar panel. The RCT will provide an indication of the current CO₂ measurement range by flashing every 15 seconds (with sufficient light, > 5 footcandles or 50 lux). Ranges indicated by the flash are as follows:

- Green = < 1100 ppm (Good ventilation/air quality)
- Yellow = 1100-1,500 ppm (marginal ventilation/air quality)
- Red = $> 1,500$ ppm (low ventilation & potentially poor air quality)





Note: *These LEDs are also used as feedback for the Test functions*

To determine the exact CO₂ value, press the function button on the side of the unit. The LEDs will flash in sequence to indicate the concentration where:

- Green blinks = 500 ppm/blink
- Amber blinks = 100 ppm/blink
- Red blinks = 25 ppm/blink

Add the blink values up to determine the concentration.

An example of determining exact CO₂ value from blink code:

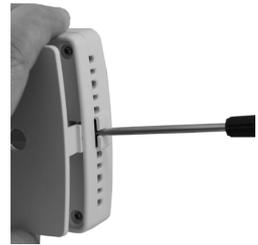
- 2 green blinks = 1000 ppm
- 3 amber blinks = 300 ppm
- 2 red blinks = 50 ppm
- Total CO₂ = 1350 ppm
- The colored chart is a guideline for mapping the CO₂ concentration and how this value reflects on the spaces ventilation rate.

Installation

The RCT can be mounted on any surface; glass, stone, concrete, wallboard, cubicle partitions, etc. The sensor can be mounted using screws (not supplied) through the removable back plate (2 keyholes) or using double-sided tape or Velcro™ (not supplied).

The mounting location of the wireless transmitter is important, as this will directly affect the receiver's reception of the telegrams. Before installing, refer to following sections in the guide detailing the installation of wireless devices, layout tips and the test operation modes.

1. The RCT has a removable back plate. The back plate has a security feature which requires a tool for the removal of the device from the back plate. To remove the back plate, insert a flat head screw driver, into the slot and exert torque on the key tab to separate the back plate from the housing body as shown in the photos. Once the tab is free, pull the body away from the back plate.



2. Mount the back plate to a bracket or the wall surface in a vertical orientation with the plastic key on the bottom. There are keyholes in the back plate that mate with standard electrical box screw patterns. Alternatively, you can mount the sensor using double sided tape or Velcro® (not supplied).



3. Once the back plate has been secured to the wall or mounting bracket, align the two top alignment tabs on the back plate with the enclosure body and press the lower edge over the plastic key until it clicks in place.

Linking the RCT Sensor to a Receiver

This process requires the controller or receiver to be mounted and powered and within range of the RCT sensor to be linked.

The sensor is a solar powered device that absorbs energy through a solar panel storing it for use during low light periods. Batteries are included to assist in start up procedures and for continual low light conditions.

1. Remove the sensor from the back plate by pressing in on the tab on the bottom of the sensor and pulling away from the back plate.
2. Activate LEARN or LINK mode at the receiver, if necessary refer to the manufacturers documentation.
3. Press the temperature sensors Link (Teach) button.
4. Deactivate LEARN mode at the receiver.



Using The Adjustment and Test Functions

The RCT uses a single button interface to allow installers and users to make adjustments to the sensor and utilize built-in test functions. Pressing the "function" button at the right side of the sensor at different intervals allows navigation to different functions. Feedback is provided by observing the color and sequence the LEDs at the side of the solar panel.

To Enter Test Mode - Press the test button (lower right) for 6 seconds

- The Green LED flashes
- There are 4 test modes. Press the Test button to cycle through the colored LEDs (flashing) Green, Amber, Red and both Green and Red flashing.



Test 1: Green LED flash, Light Level Test

-When green LED is flashing, hold the test button for 6 seconds to activate

The Green LED flash rate indicates the light level

(more details below)- The test runs for 100 seconds

Test 2: Amber LED flash, Range Confirmation®

-for future use (Requires controller that is Range Confirmation® compatible)

Test 3: RED LED flash, CO2 Background Calibration

- 1) Place the sensor(s) in outside air above 32°F (0°C), and out of direct sunlight for 15 to 60 minutes. Avoid areas where people are lingering so the background CO2 readings are not affected. The sensor will take the lowest CO2 recorded since its last calibration cycle and assign this reading the value of 420ppm (outdoor air).
- 2). Press the function button on the sensor until the green LED is blinking, about 6 seconds.
- 3.) Tap the function button to cycle through modes. Once the Red LED (only) is blinking, press and hold for ~ 6 seconds to enter CO2 background calibration mode. There will be a pause then the Green LED will begin blinking.
- 4). After about 6 seconds the green LED will stop blinking when calibration is complete.

Test 4: GREEN and RED LED flash, CO2 Calibration and Setup Mode

1. Press the function button on the sensor until the green LED is blinking, about 6 seconds.
2. Tap the function button to cycle through modes. Once the Red and Green LEDs are blinking, press and hold for ~ 6 seconds to enter CO2 calibration setup mode.

If the Green LED is blinking, Automatic Background Calibration (ABC) is enabled.

If the Red LED is blinking, ABC is disabled.

3. Press the function button to cycle through CO2 calibration mode.
 - Green LED blinking - Automatic Background Calibration (ABC) enable.
 - Red LED blinking - ABC disable
 - Amber LED blinking - calibrate to absolute CO2 value.

Step through the menu until at the desired mode. Press and hold the function button for about 6 seconds to set desired mode.

.Press and hold the test button for 6 seconds to enter any of the above modes- see more details in Test Operating Modes below.

Test Operating Modes



Note: *When entering test mode: if the red LED blinks and not the green LED, place the sensor under a lamp for 1 hour or replace the battery.*



Note: *Battery (with voltage between 2.7 and 3V) is required for installation and commissioning modes.*

Light Level Test

This test will indicate the real-time energy produced by the solar panel allowing the installer to verify a good installation location (independent from battery strength).

1. Press the function button on the sensor until the green LED is blinking, about 6 seconds.
2. Tap the function button to scroll through modes, when the Green LED is flashing, hold the test button for 6 seconds to enter Light Level Test mode, the green LED will start blinking a pattern according to the light level. (See Light Level Test Table below)
3. Hold the sensor in the location you are thinking of installing the sensor and check the light level using the Light Level Test Table below.
4. The test will repeat every 2 seconds and run for a duration of 100 seconds. You may quit the test at any time by pressing the test button for 6 seconds.

LIGHT LEVEL TEST TABLE

The green LED will blink according to the energy produced by the solar cell

Blinks	Lux	Foot Candles	Time to Fully Charge	Discharge time
0	< 50	< 4.6	Non operational	n/a
1	50-100	4.6 - 9.3	min operating level	n/a
2	100-200	9.3 - 18.6	32 hours to full charge	72 hours
3	200-500	18.6 - 246.5	16 hours to full charge	72 hours
4	500-1000	46.6 - 92.9	8 hours to full charge	72 hours
5	1000+	92.9+	4 hours to full charge	72 hours

The time to fully charge is based on the storage capacitor charging

from a non-operational condition. Discharge time indicates how long a fully charged sensor will operate in the dark.

CO2 Background Calibration

- 1) Place the sensor(s) in outside air above 32°F (0°C), and out of direct sunlight for 15 to 60 minutes. Avoid areas where people are lingering so the background CO2 readings are not affected. The sensor will take the lowest CO2 recorded since its last calibration cycle and assign this reading the value of 420ppm (outdoor air).
- 2). Press the function button on the sensor until the green LED is blinking, about 6 seconds.
- 3.) Tap the function button to cycle through modes. Once the Red LED (only) is blinking, press and hold for ~ 6 seconds to enter CO2 background calibration mode, There will be a pause then the Green LED will begin blinking..
- 4). After about 6 seconds the green LED will stop blinking when calibration is complete

Automatic Background Calibration - Explained

The Automatic Background Calibration (ABC) is a feature that looks at the lowest level of CO2 that occurs over a 3 week period and assumes it is an outside background level of 420 ppm. This feature works best where the space being monitored is periodically unoccupied for 8 hours or more in evenings or weekends at least once in a typical 3 week period. When in this mode there should be no need to calibrate the sensor over its operating life. The ABC feature is on by default. If the space being monitored is occupied 24/7 or is an industrial or greenhouse operation where elevated CO2 levels may be sustained over long periods of time, then the ABC feature should be turned off.

CO2 Calibration and Setup Mode

1. Press the function button on the sensor until the green LED is blinking, about 6 seconds.
2. Tap the function button to cycle through modes. Once the Red and Green LEDs are blinking, press and hold for ~ 6 seconds to enter CO2 Calibration Setup Mode. If the Green LED is blinking, ABC is enabled. If the Red LED is blinking, ABC is disabled.

There are 4 adjustment options selectable by pressing the test button once in Calibration and Setup Mode

3. Press the function button to cycle through CO2 calibration mode.

- Green LED blinking - Automatic Background Calibration (ABC) enable. The sensor will self calibrate every 3 weeks in this mode.
- Red LED blinking - ABC disable (if sensor is in an environment that may have sustained elevated CO2 levels).
- Amber LED blinking - calibrate to absolute CO2 value.

Absolute value calibration allows the user to select a CO2 value with 25 ppm resolution.

- Green blinks = 500 ppm
- Amber blinks = 100 ppm
- Red blinks = 25 ppm

The sensor will display the current value (pressure compensated) in blinks once entering into this mode (green then amber then red). The user must press the test mode button to increase the ppm value or the link button (on the back) to decrease the value (also pressure compensated) in 25 ppm increments. The background ppm level is set to 420 ppm.

Press and hold the test button for 6 seconds to enter any of the above modes-



Replacing the Battery

The battery is a CR2032 coin cell and is supplied with the unit. The battery is not required for normal operation when the RCT receives adequate natural or artificial light. The battery must be used during installation and has enough power to run the sensor for 5 years without light. The battery should be replaced if voltage is less than 2.7V

1. Remove back plate of the RCT by pressing a screwdriver into the slot key on the bottom of the sensor enclosure and pull the body away from the back plate. The top of round battery cover just snaps completely out to allow placement of the battery.
2. To remove old battery: Using a small flat head
3. Screwdriver or pen as a lever, insert pointed end under the clear plastic battery retaining clip's edge and pop the clip off.
4. Install or replace the battery in the clip with a new CR2032 coin cell battery insuring the positive side (+) will be facing up.
5. Align the two straight edges of the retaining clip with the battery holder and press the clip in with your finger.

Guidelines for Installing Wireless Devices

Careful planning is needed when locating the receivers and transmitters based on the construction materials in the space and possibility of tenant’s furniture disrupting the transmissions.

The temperature sensor should be installed in the space where the receiver is mounted and connected to the temperature control equipment however the signal will travel through material barriers.

Refer to the tables below for range considerations with building materials that reduce the radio signal power.

Material	Attenuation
Wood	0 - 10%
Plaster	0 - 10%
Glass	0 - 10%
Brick	5 - 35%
MDF	5 - 35%
Ferro concrete	10 - 90%
Metal	90 - 100%
Aluminum	90 - 100%

Material	Radio Range-typical
Line of sight:	80’ (24m) corridors
Line of sight:	150’ (46m) open halls
Plasterboard:	80’ (24m) through 3 walls
Brick	33’ (10m) through 1 wall
Ferro concrete	33’ (10m) through 1 wall
Ceiling:	Not Recommended

Wireless System Layout Hints

- Avoid locating transmitters and receivers on the same wall.
- Avoid locating transmitters and receivers where the telegrams must penetrate walls at acute angles. This increases the material the telegram must pass through reducing the signal power.
- Avoid large metal obstructions as they create radio shadows. Place receivers in alternate locations to avoid the shadow or use repeaters to go around the obstacle.
- Do not locate receivers close to other high frequency transmitters. Leave at least 3' (1 m) between the receiver and any other source of interference including, ballasts, LED drivers, computers, video equipment, Wi-Fi/LAN routers, GSM modems and monitors. Transmitters are not affected by these sources of interference. Agency Listings and Compliance

Product Specifications

Carbon Dioxide

Technology: Ultra Low Power, LED based NDIR

Measurement Range: 0-2000 ppm

Accuracy: ± 50 ppm

Altitude/Pressure Compensation: Built-in correction

Self-Calibration: Automatic Background Calibration

Resolution: 1 data byte (0-200 decimal), 10 ppm

Temperature

Range: 0°C to 51°C (32°F to 124°F)

Accuracy: ± 0.3 °C (± 0.5 °F)

Resolution: 1 data byte (0-255 decimal), 0.2°C (0.36°F)

Relative Humidity

Range: 0% to 100% RH

Accuracy: ± 3 % RH...10-90%, ± 7 %... 0-10%, 90-100%

Resolution: 1 data byte (0-200 decimal), 0.5%

Power Supply

Type: Integrated Solar Panel

Operational Light Levels: 50 lux

Minimum Charge Time before Operation: 10 min @ 200 lux

Charging Light Level: 200 lux

Maintain Operating Life Level: 200 lux for 6 hours

Maximum Charge Time: 16 hours @ 200 lux

Operating Life From Full Charge: 72 hrs @ 0.0 lux

Battery: for backup, start assist & test mode (supplied). Use high quality CR2032 coin cell. The battery will typically provide 5 years operating life in zero light conditions.

General

Weight: 115 g, (4 oz)

Mounting: screws or double sided tape (not included)

Agency and Regulatory Statements

Built in an ISO9001 certified facility

FCC Part 15.231 (902 MHz models only)

Contains FCC ID: STM300U

The enclosed device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions:

(i.) this device may not cause harmful interference and

(ii.) this device must accept any interference received,
including interference that may cause undesired operation.

IC RSS-210 (902 MHz models only)

Contains IC: 5713A-STM300U

CE (868 MHz models only), CE Marking



ARIB STDT108 (928MHz models only)

Complies with the Japanese radio law and is certified according to ARIB STDT108.

This device should not be modified (otherwise the granted designation or number will become invalid)



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