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BREEZE/BREEZE-V/VIVID+

User Guide

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1.1	March 22, 2022	Release	Shania Stewart	Removed “Confidential” from footers.
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1.3	August 5, 2022	Release	Shania Stewart	• Minor typo fixes. • Updated sensor mounting information. • Updated citations.
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1.5	January 12, 2023	Release	Shania Stewart	• Minor corrections on technical information. • Added proposition 65 warning. • Updated citations.

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List of Acronyms

ADR .....Adaptive Data Rate
ALOHA.....Additive Links On-line Hawaii Area
BLE.....Bluetooth Low Energy
CO_2 .....Carbon Dioxide
CSS.....Chirp Spread Spectrum
DTS .....Digital Transmission System
EU .....European
FCC.....Federal Communications Commission
FH .....Frequency-Hopping
FHSS .....Frequency-Hopping Spread Spectrum
I2C or I^2C.....Inter-Integrated Circuit
IoT .....Internet of Things
IP .....Ingress Protection
ISM .....Industrial, Scientific, and Medical
LoRa .....Long-Range
LoRaWAN.....Long-Range Wide-Area Network
LPWAN .....Low-Power Wide Area Network
LTC.....Lithium Thionyl Chloride
MAC.....Media Access Control
MCU .....Microcontroller Unit
NA .....North American
NS .....Network Server
OD .....Operational Description
PCBA.....Printed Control Board Assembly
PRNG .....Pseudo-Random Number Generator
RF .....Radio Frequency
RSSI .....Received Signal Strength Indicator
Rx .....Receive
SPI .....Serial Peripheral Interface
Tx.....Transmit

1 Product Description

1.1 Overview

IMPORTANT: While the Vivid+ is discussed in this document, it is not commercially available at this time.

The Breeze/Breeze-V/Vivid+ is a multi-purpose LoRaWAN IoT sensor packed into a very small form factor. The Breeze, Breeze-V, and Vivid+ are all variants in the same sensor family, each with different sensing capabilities. The Sensor is ideal for monitoring and reporting CO_2 concentration, human motion, temperature, humidity, light, and barometric air pressure in an indoor environment.

The Sensor is also designed to communicate with a 2.9'' wireless e-Ink BLE Display that allows room occupants to locally view the latest measurements from select transducers taken in real-time. The Display will show the most recent CO_2, temperature, and humidity measurements taken from the Sensor, as well as the remaining battery capacity of the Sensor and Display. The Sensor is designed to only communicate with the BLE Display that is shipped with the Sensor.

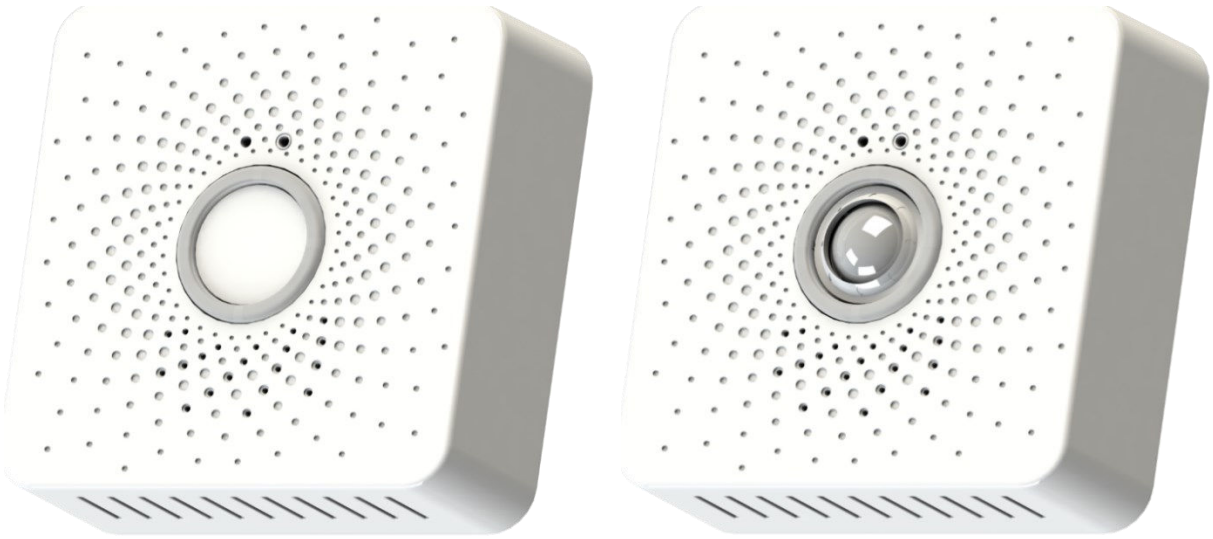
All three functional variants are LoRaWAN-capable end-devices that are capable of supporting Tx/Rx in the following frequency bands as specified in the LoRaWAN Regional Parameters [1]: AS923, AU915, EU868, IN865, KR920, RU864, and US915. The variants that support BLE Tx/Rx operate in the 2.4 GHz band according to the BLE 5.2 specification [2].

Table 1-1 presents the features available in the three functional variants (Breeze, Vivid+, and Breeze-V).

Table 1-1: Transducers in Breeze/Breeze-V/Vivid+

Sensing Function	Sensor Model		
	Breeze (T0007838)	Vivid+ (T0007848)	Breeze-V (T0007806)
Temperature	X	X	X
Relative Humidity	X	X	X
Light	X	X	X
Barometer	X		X
CO_2	X		X
PIR		X	X

Figure 1-1 illustrates the Breeze, Breeze-V and Vivid+ variants. All variants share the same external dimensions.



(a) Breeze Model **(b) Vivid+/Breeze-V Models**

Figure 1-1: Breeze/Breeze-V/Vivid+ Enclosures

Figure 1-2 shows the enclosure external interfaces for each model. Four indicator LEDs are present underneath the circular light pipe on the front of the enclosures. There are two push buttons accessible by pin through holes on the front of the enclosures. There are also air vents on the front of the enclosures and on two sides of the enclosure to provide adequate airflow for the CO_2 transducer. The enclosures are kept closed with 4 screws at the back. The PIR transducer is surrounded by a PIR mask located at the center of the enclosure for models that include a PIR transducer.

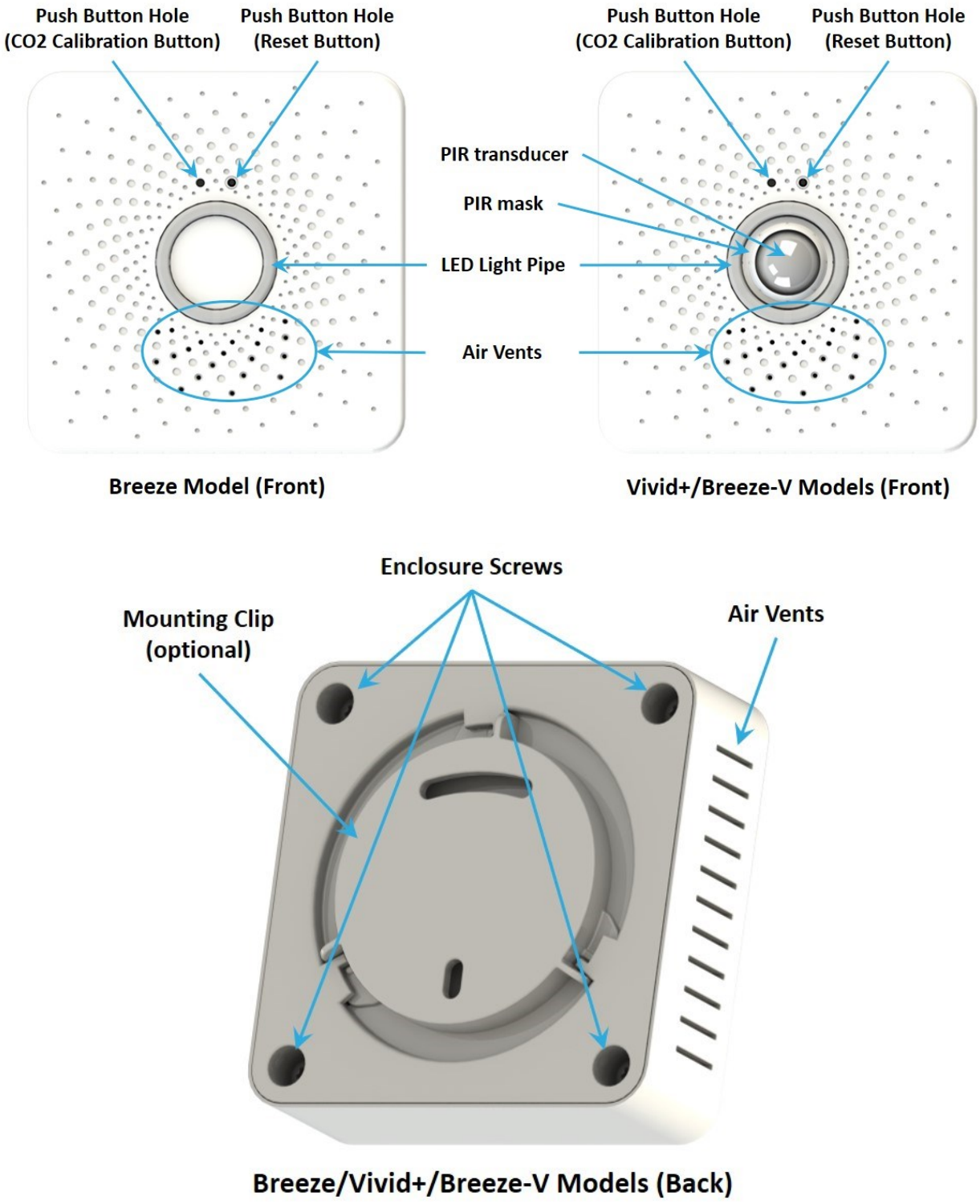


Figure 1-2: Breeze/Breeze-V/Vivid+ External Interfaces

1.2 Specifications

The Breeze/Breeze-V/Vivid+ specifications are listed in Table 1-2.

Table 1-2: Breeze/Breeze-V/Vivid+ Specifications

Parameter	Specification
Use environment	Indoor commercial/residential only
Operating temperature	0°C–60°C
Storage temperature	-40°C–60°C
RH	5%–95%, non-condensing
Size	80 mm x 80 mm x 26 mm (without mounting clip) 80 mm x 80 mm x 30 mm (with mounting clip)
Weight	128 g (with battery)
Power source	Battery operated (2xAA), with diode-based reverse polarity protection.
Network technology/Frequency band	LoRaWAN with different regional variants (see [1]) and BLE operating in 2.4 GHz ISM frequency bands
Air interface	LoRa and BLE
Sensor Lifetime	Breeze model with optimum settings and baseline use case:[1] • > 6.0 years with 2xAA LTC batteries Breeze-V model with optimal settings and baseline use case: • > 5.0 years with 2xAA LTC batteries
Maximum transmit power	LoRa: 15 dBm BLE: 0 dBm
Number of indicator LEDs	4 (2 green, 1 yellow, and 1 red)
Measurement sensing functions	Temperature, humidity, light, pressure, CO_2
Detection sensing functions	Human movement
Temperature measurement accuracy	$< \pm 0.3$°C between 0°C and 5°C ± 0.2°C between 5°C and 60°C
Humidity measurement accuracy	$< \pm 4$% between 0% and 100% ± 2% between 20% and 80%
Light sensitivity	Detection of weak light to typical work light conditions (5 lux to 1000 lux)[2] Peak sensitivity at 550 nm
Pressure measurement accuracy	$< \pm 2.5$ hPa between 300 hPa and 1100 hPa ± 1.5 hPa at 750 hPa and 25°C
CO_2 concentration measurement accuracy	± 30 ppm +3% of reading between 400 ppm and 5000 ppm Extended range ± 10% of reading for an extended range of up to 10,000 ppm[3]

[1] Baseline use case assumes room temperature, LoRa Tx power of 15 dBm, LoRa SF 10, and LoRa BW of 125 kHz. Optimal battery settings use the default report settings and with dynamic reporting mode enabled. PIR motion detection is assumed to be very frequent during active hours and very infrequent during inactive hours.
[2] The sensor provides light intensity measurements, but they are not calibrated in lux. See the Technical Reference Manual for more details [3].

Parameter	Specification
Motion detection	Pyroelectric infrared sensor Ceiling mount: • X-angle: 104° (no mask) • Y-angle: 104° (no mask) Height: 3 m (no mask)

1.3 Transducer Details

1.3.1 Temperature/Humidity Transducer

The Breeze/Breeze-V/Vivid+ includes a combination temperature/humidity transducer from Sensirion (SHTC3). It is a small footprint, very low power device. It features operation over I^2C protocol and operates from 0% to 100% RH and -40°C to 125°C with a typical accuracy of ±2% RH and ±0.2°C. The typical and maximum accuracies specified across the operating relative humidity and temperature range of the sensor are shown in Figure 1-3 and Figure 1-4, respectively.

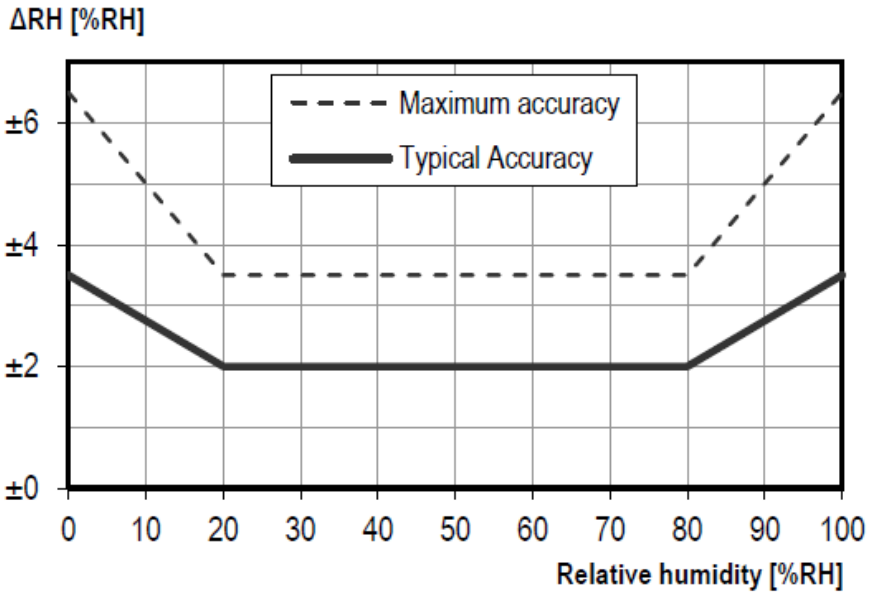


Figure 1-3: The typical and maximal tolerance for %RH at 25°C

[3] No data available from manufacturer on performance outside the range of 15°C to 35°C and 0% to 80% RH.

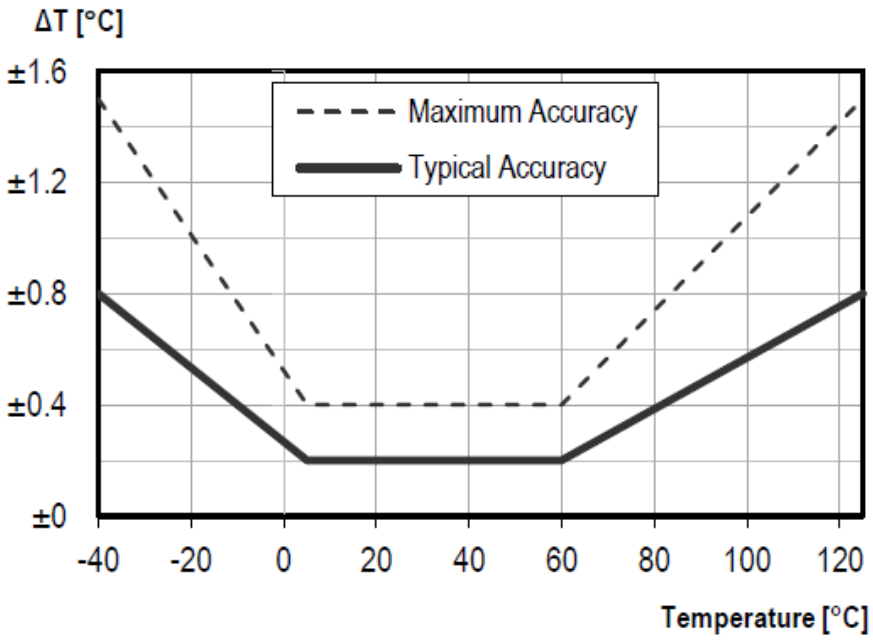


Figure 1-4: The typical and maximal tolerance for the temperature transducer at 25°C

1.3.2 Ambient Light Transducer

A phototransistor and bias resistor form a light detection transducer on the Breeze/Breeze-V/Vivid+. The light sensor provides a sufficient window of detection to allow detection of desired light levels. The output of the light transducer is an analog voltage that is read by the MCU ADC and translated into a current measurement reported to the user.

Vishay's TEMT6200FX1 is a phototransistor specifically designed for ambient light sensing as it includes a filter to give a response similar to the human eye, thus being capable of detecting weak light to typical work light conditions.

1.3.3 Barometer

A barometer is included in the Breeze/Breeze-V in order to measure the barometric air pressure. TE Connectivity's MS5607-02BA03 is designed for low power applications while provided highly accurate measurements. The barometer can operate over a range of 10 hPa to 1200 hPa and can communicate over I^2C or SPI protocols. The typical pressure accuracy of the barometer is given as ±1.5 hPa at 25°C and 750 hPa, while the error band (representing the worst-case accuracy) is ±2.5 hPa between 300 hPa and 1100 hPa while operating between -20°C and 85°C. The barometer supplies measurements to the CO_2 transducer in order to pressure compensate the CO_2 concentration for improved accuracy to the current environmental conditions.

1.3.4 CO_2 Transducer

The Breeze/Breeze-V/Vivid+ includes the Senseair Sunrise to measure the CO_2 concentration using non-dispersive infrared (NDIR). It operates over an I^2C interface and can measure in the range of 400 ppm to 5000 ppm with an accuracy of up to ±30 ppm +3% of the reading. This sensor also features an extended range of up to 10000 ppm with a projected accuracy of extended range ±10% of the reading.

1.3.5 PIR Transducer

A motion detection feature on the Breeze/Breeze-V/Vivid+ is implemented with a PIR sensor. Panasonic's EKM1291111 is specifically designed to be sensitive enough to detect small movements with a wide field of view of 104° x 104°.

The motion detection system uses a ceiling mount type lens that has an expected coverage area of 7.7 m x 7.7 m when ceiling mounted at a height of 3 m. Note that this is the theoretical maximum sense range claimed by the transducer manufacturer. The sense range is determined as the projection of the transducer FoV on the ground, and therefore, should not be interpreted as the coverage area where the sensor can detect moving people. In general, due to the conical nature of the transducer FoV, people need to be closer to the sensor to be detected. The amount of IR radiation from a moving person, which is also impacted by the person's clothing or type of skin cover, also plays an important role at determining the detection range.

2 Installation

2.1 Included Product and Installation Material

The following items are included with each sensor:

- A Breeze, Breeze-V, or Vivid+
- e-Ink Display (if one is ordered with the Sensor)
- Mounting Bracket
- Quick start guide

2.2 Safety Precautions

The following safety precautions should be observed:

- The Breeze/Breeze-V/Vivid+ is intended for indoor use only.
- The Breeze/Breeze-V/Vivid+ contains lithium batteries.
- NEVER allow small children near batteries: if a battery is swallowed, immediately seek medical attention.
- To reduce risk of fire, explosion or chemical burns: replace only with approved 2xAA LTC batteries; DO NOT recharge, disassemble, heat above 100°C (212°F) or incinerate battery

2.3 Unpacking and Inspection

The following should be considered during the unpacking of a new Breeze/Breeze-V/Vivid+:

1. Inspect the shipping carton and report any significant damage to TEKTELIC.
2. Unpacking should be conducted in a clean and dry location.
3. Do not discard the shipping box or inserts as they will be required if a unit is returned for repair or re-configuration.

2.4 Required Equipment for Installation

There are no tools required for Breeze/Breeze-V/Vivid+ installation.

2.5 Breeze/Breeze-V/Vivid+ Mounting

The Breeze/Breeze-V/Vivid+ is designed to be mounted using the supplied mounting bracket. The bracket can be attached using two (2) M3 screws appropriate for the material being mounted to or using double-sided tape when mounting within 2 m of the floor.

When mounting on a vertical surface, ensure that the Sensor will not be orientated with the case retaining screws towards the ceiling. This could cause the Sensor to accidently slip off the mount and fall. There are no orientation concerns when the Sensor is mounted to a horizontal surface.

3 Power Up, Commissioning, and Monitoring

3.1 Required Equipment

No special equipment is required to power on the Breeze/Breeze-V/Vivid+.

3.2 Power Up/Down Procedure

Once the sensor information has been added to the Network Server, pull out the battery tabs to engage the battery. The batteries must be removed to turn off the device, but the external reset button can be pushed to simply reset the device; see Section 4.4.2 for description of the reset function.

4 Operations, Alarms, and Management

4.1 Configuration

The Breeze/Breeze-V/Vivid+ supports a full range of Over-the-Air (OTA) configuration options. Specific technical details are available in the Breeze/Breeze-V/Vivid+ Technical Reference Manual [3]. All configuration commands need to be sent OTA during a sensor's downlink windows.

4.2 Default Configuration

If dynamic reporting mode is enabled, the default configuration of the Breeze/Breeze-V/Vivid+ is as shown in Table 4-1. If dynamic reporting mode is not enabled, the Sensor will act as if it is exclusively in active mode. Dynamic reporting mode is not enabled by default.

Table 4-1: Breeze/Breeze-V/Vivid+ Default Reporting Behavior

Parameter	Report Destination	Default Reporting Frequency	
		During Active Mode	During Inactive Mode
Remaining Battery Capacity of the Sensor	NS and Display	Every 5 (five) minutes	Every 1 (one) hour
Remaining Battery Capacity of the Display	NS and Display	Every 5 (five) minutes	Every 1 (one) hour
Ambient Temperature	NS and Display	Every 5 (five) minutes	Every 1 (one) hour
Ambient Relative Humidity	NS and Display	Every 5 (five) minutes	Every 1 (one) hour
CO2 Concentration	NS and Display	Every 5 (five) minutes	Every 1 (one) hour
Pressure	NS only	Every 5 (five) minutes	Every 1 (one) hour
Motion	NS only	Report motion after 1 (one) PIR event Clear motion after 5 (five) minutes of no motion	Report motion after 1 (one) PIR event Clear motion after 5 (five) minutes of no motion

Note:

- CO_2 concentration and pressure are reported by Breeze and Breeze-V models only. For the Vivid+ model, the Sensor will update the Display such that the CO_2 concentration field will be blank.
- Motion is reported by Vivid+ and Breeze-V models only.

4.3 LED Behavior

The Breeze/Breeze-V/Vivid+ is equipped with four LEDs: two green (G1 and G2), one yellow (Y1), and one red (R1). Figure 4-1 shows the placements of each LED relative to a user facing the Sensor for reference.

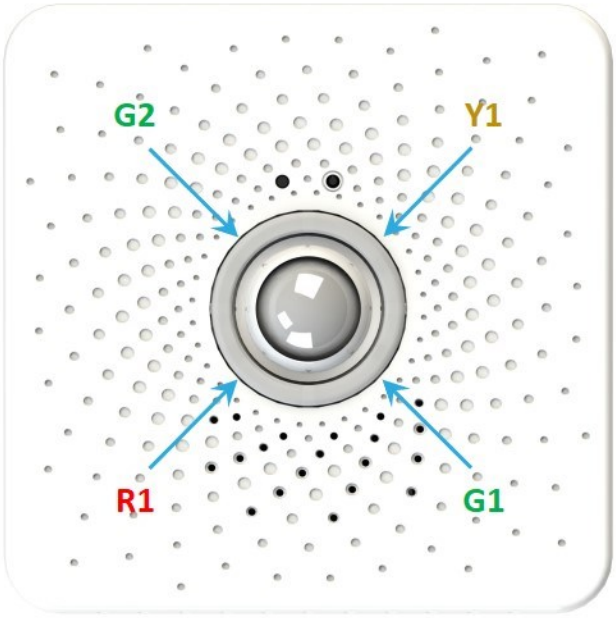


Figure 4-1: Breeze/Breeze-V/Vivid+ With Marked LED Positions

During the join procedure:

- After the Sensor has gone through the initial boot procedure, the join procedure will begin. During that time, the **Y1** will blink continuously until the sensor has joined a network.

During normal operation:

- **G1** will blink when the Sensor transmits or receives a LoRa packet.
- **G2** will begin to blink while the Sensor attempts to communicate with the Display.
  - **G2** will blink twice if the connection was successful.
  - **R1** will blink twice if the connection was unsuccessful.
- **Y1** will blink after the CO_2 calibration push-button is pressed and released.
  - **G2** blinks three times if any CO_2 calibration was successful.
  - **R1** blinks three times if any CO_2 calibration was unsuccessful.

4.4 Push-Button Functions

The Sensor includes two push buttons: one to manually calibrate the CO_2 transducer, and one to reset the Sensor. Figure 1-2 shows the location of the CO_2 calibration and reset buttons relative to a user facing the Sensor.

4.4.1 CO_2 Calibration Button

The Sensor features a push-button that can be used to manually calibrate the CO_2 transducer when it is exposed to fresh air. The CO_2 calibration button must be pressed for 2 to 10 seconds, and 30 seconds after the button is released, the Sensor performs a background CO_2 calibration with a target of 400 ppm.

For optimal results, users should ensure that the Sensor is exposed to fresh air for several minutes before the calibration occurs. It is also recommended that users move away from the Sensor after pressing the button so as to reduce the risk of an inaccurate calibration. More information on how to calibrate the CO_2 transducer can be found in the Technical Reference Manual [3].

4.4.2 Reset Button

There is a reset button on the device, that can be pushed by a pin, such as a paper clip. The button should not be pushed hard. The reset is instant, i.e., the button does not need to be kept pushed. The reset restarts the microprocessor. All the FW load and configuration parameters in the Flash are remembered during the reset.

5 Compliance Statements

Federal Communications Commission

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

To comply with FCC exposure limits for general population / uncontrolled exposure, this device should be installed at a distance of 20 cm from all persons and must not be co-located or operating in conjunction with any other transmitter.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Innovation, Science and Economic Development Canada

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

This device should be installed and operated with minimum distance 0.2 m from human body.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

(1) L'appareil ne doit pas produire de brouillage.
(2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Cet appareil doit être installé et utilise à une distance minimale de 0.2 m du corps humain.

California Proposition 65:

⚠ **WARNING:** This product can expose you to chemicals including lead, nickel, and carbon black, which are known to the State of California to cause cancer, birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov [4].

References

[1] LoRa Alliance, "LoRaWAN Regional Parameters," ver. 1.0.2rB, Feb 2017.

[2] Bluetooth SIG, "Bluetooth Core Specification v5.2," 31 December 2019.

[3] TEKTELIC Communications Inc., "Breeze/Breeze-V Technical Reference Manual," ver1.1, September 2022.

[4] OEHHA, "Proposition 65," California Office of Environmental Health Hazard Assessment, [Online]. Available: https://oehha.ca.gov/proposition-65. [Accessed 12 January 2023].