Indoor Environmental Quality Tool Kit

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Purpose

Indoor environmental quality (IEQ) refers to the quality of a building's environment in relation to the health and wellbeing of those who occupy space within it. IEQ is determined by many factors, including lighting, air quality, and damp conditions.

Other factors such as indoor temperatures, relative humidity, and ventilation levels can also affect how individuals respond to the indoor environment.

Typical uses include:

- Building Ventilation Verification
- Indoor Air Quality Verification
- Post-Occupancy Evaluation

Meet the Tools

01.
HOBO U12-013 Data Logger

The HOBOU12-013 data logger has a built in temperature and relative humidity sensor along with two external channels for a wide range of energy and environmental sensors. This tool can store up to 43,000 measurements of 12-bit resolution readings.

03.
CO_2 Adapter Cable

CO_2 sensor to Logger Cable (20.3cm-8 inches) for use with U12 data loggers.

02.
Telaire CO_2 Sensor

The Telair CO_2 Sensor Identifies areas with low or substandard ventilation. Identify hidden energy savings in over-ventilated spaces and determine if ventilation is a factor in air quality complaints. Locate the presence of combustion fumes from vehicles and appliances or use as a reference to calibrate wall mounted CO_2 sensors. Use the Telaire 7001 with an Onset cable to connect the HOBO logger and 120V adapter 6V, 500mA output.

04.
Temperature Sensor

Above is a temperature sensor for use with HOBO U-Series external channel data loggers. This model measures temperature in air, water, or soil. Accuracy and resolution vary accordingly with attached logger model.

05.
Bacharach Sling Psychrometer

The Sling Psychrometer is an easy and affordable way to measure relative humidity levels quickly and accurately. It is ideal for many applications, including the measurement of conditions within indoor environments, storage areas, laboratories and more.

06.
VOC and Temperature Monitor

The VOC and Temperature Monitor measures Volatile Organic Compounds and CO_2. This monitor is different from other VOC sensors because it has been optimized for Demand Controlled Ventilation. This lets you use ASHRAE's occupancy-based VRP schedule to ventilate. The sensor also picks up VOCs from other sources such as building materials, perfumes, colognes and furniture off-gassing.

07.
Fluke Handheld Infrared Thermometer

Just point, shoot, and read the temperature of transformers, motors, pumps, panels, breakers, compressors, duct, steam lines, valves, and vents. Its small size and verstaile features make it extremely easy to use. The accurate infrared technology and dual lasers provide a 12:1 distance to spot ratio, making it easier to accurately measure temperatures in hard to reach areas.

Using The Kit

Typical Uses

Typical uses for this kit includes building ventilation verification, indoor air quality verification, and post-occupancy evaluation.

Which Tools First and Why

It is recommended that the CO2 sensor be deployed in a space first because it takes a few minutes to start up and accurately report readings from the space. The next tool reccommended is the Sling Pyschrometer and to identify ideal data logger locations.

Best Place for Data Recording?

When evaluating a space for environmental quality there are a few ideal spots to place data loggers. Three spots are infiltration (Supply), exfiltration (Return), and next to the thermostat. Loggers should be kept out of direct sunlight and if placed in a public area it is recommened to leave a note explaining the purpose of the logger or speaking with the occupants of the space. This is to avoid having the logger moved, turned off, or potentially damage.

Tips and Tricks

Remember to set up data loggers before visiting the site to save time and avoid confusion. Also, have double sided tape, magnetic tape, zipties, or other materials to asssit with placing data loggers in ideal locations. Mount loggers so they are unobtrusive and cannot be disturbed easily.

FAQs

WHAT ARE THE MOST COMMON CAUSES OF IEQ PROBLEMS?

The most common causes of IEQ problems in buildings come from not enough ventilation, poor upkeep of ventilation, dampness and moisture damage due to leaks and high humidity, occupant activities, or general contaminated air.

HOW CAN I TELL IF THERE IS AN IEQ PROBLEM IN MY BUILDING?

People working in buildings with poor IEQ may notice unpleasant or musty odors, or may feel that the building is hot and stuffy. Symptoms often include headaches or feeling tired, but sometimes symptoms such as fever, cough and shortness of breathe could indicate a more serious problem.

WHAT SHOULD I TEST AND LOOK FOR?

When performing an IEQ check for your building, you should check for odors, look for water damage, leaks, dirt or pest droppings. IEQ problems can stem from these things and also from malfunctioning systems to maintain the air quailty inside. Check for standing water in the humidfiers, air conditioning units, on roofs, and in boiler pans for contamination and to make sure everything is working as intended.

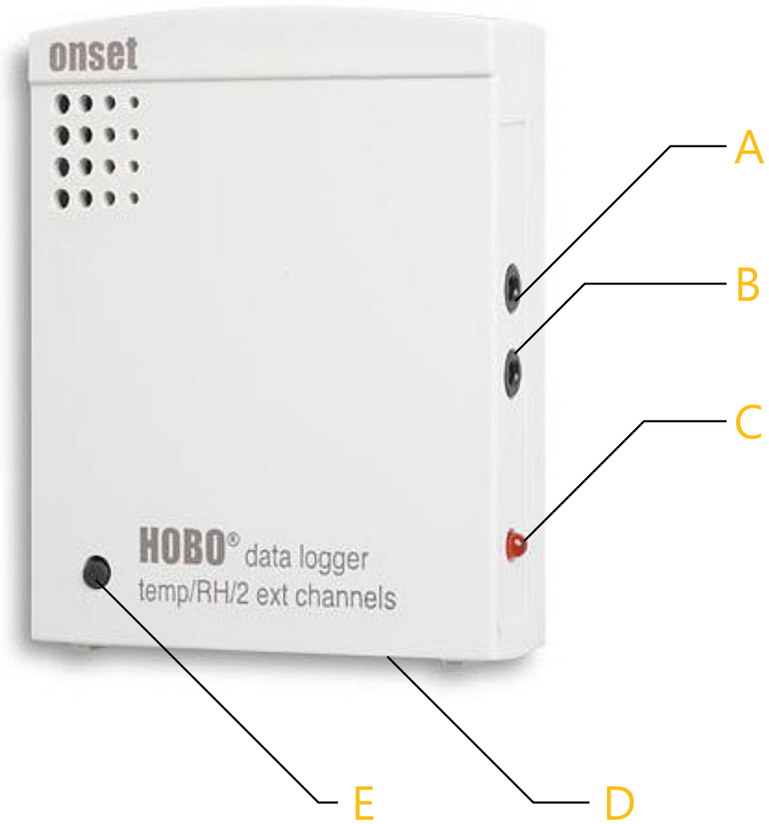
HOW OFTEN IS AN IEQ TEST NEEDED?

An IEQ test should be performed at least annually. Levels of indoor air contaminants can change quickly and it's important to monitor. Leaks can go undetected and can increase moisture buildup, so testing is recommended on a regular basis.

WHAT KIND OF THINGS AM I TESTING FOR?

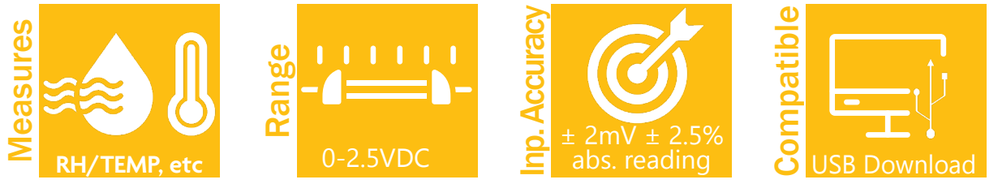
Many factors can contribute to poor IEQ. Certain materials can off-gas VOCs -paints, finishes, etc. An inbalance of CO_2 can also cause poor IEQ, this could be caused by ventilation blockage, overcrowded spaces, and leakage of outdoor contaminants.

HOBO U12-013
Data Logger



Key

A. Channel 3 External Input
B. Channel 4 External Input
C. Light
D. USB Interface cable plug
E. "Start Button"



Specifications

Measurement Range:

Temperature: -20° to 70°C (-4° to 158°F).
RH: 5% to 95% RH
External input channels: 0-2.5 VDC; 0 to 5 VDC (with CABLE-ADAP5) and 0-10VDC (with CABLE-ADAP10)

Accuracy:

Temperature: ± 0.35°C from 0° to 50°C (±0.63°F from 32° to 122°F), see Plot A
RH: +/-2.5% from 10% to 90% RH (typical), to a maximum of +/-3.5%. See Plot B
External input Channels: ± 2 mV ± 2.5% of absolute reading

Resolution:

Temperature: 0.03°C at 25°C (0.05°F at 77°F), see Plot A
RH: 0.03% RH
External Input Channels: 0.6 mV

Drift:

Temperature: 0.1°C/year (0.2°F/year) RH: <1% per year typical; RH hysteresis 1%

Response time in airflow of 1m/s (2.2mph):

Temperature: 6 minutes, typical to 90%
RH: 1 minute, typical to 90%

Time Accuracy:

±1 minute per month at 25°C (77°F), see plot C

Operating Temperature:

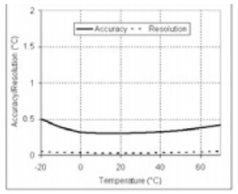
Logging: -20° to 70°C (-4° to 158°F)
Launch/Readout: 0° to 50°C (32° to 122°F) per USB specification

Memory:

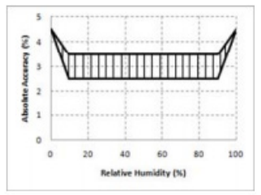
64K bytes (43,000 12-bit measurements)

Basic Operation

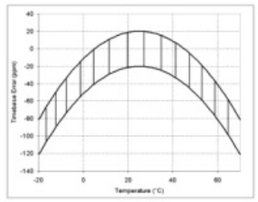
1. After downloading the HOBOware software, connect the logger to the computer.
2. Connect any external sensors to the logger and configure the logger, external sensors, and any internal sensors being used.
3. After the logger and sensors are connected and configured - deploy the logger through the settings specified, (automatic, button-start, delayed.)
4. Mount the logger and sensor in a convenient location that cannot be disturbed easily or unintentionally. This logger can be read-out at anypoint during the logging deployment.
5. When the deployment session is over, end it through the HOBOware software.



Plot A



Plot B



Plot C

Operation

The HOBO U12 Temperature/Relative Humidity/2 External Data Logger is a four-channel logger with 12-bit resolution and can record up to 43,000 measurements or events. The two external analog channels accept a wide range of Onset and third-party sensor/transducers with 0-2.5 VDC output, including external temperature, AC current, pressure, air velocity, and kW sensors. Specifications for Onset sensors can be found at onsetcomp.com, and throughout the rest of this kit. The logger uses a direct USB interface for launching and data readout by a computer. You can download HOBOware for free from onsetcomp.com.

Connecting the Logger

The U-Family logger requires an Onset-supplied USB interface cable to connect to the computer. If possible, avoid connecting at temperatures below 0°C (32°F) or above 50°C (122°F).

1. Plug the large end of the USB interface cable into a USB port on the computer.
2. Plug the small end of the USB interface cable into the bottom of the logger as shown in the following diagram.

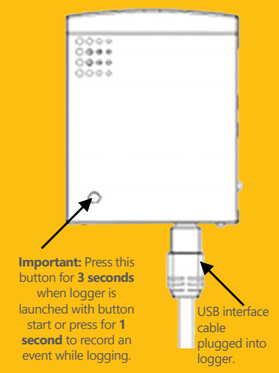
If the logger has never been connected to the computer before, it may take a few seconds for the new hardware to be detected. Use the logger software to launch and read out the logger.

If you configure the logger to start with a button start, be sure to press and hold down the button on the front of the logger for at least three seconds when you want to begin logging data.

Be sure to plug any external sensors (if applicable) into the side of the logger before logging begins. Also select the correct sensors and activate the external channels in the logger software when configuring the launch. Important: If you select an external channel, but do not plug the probe in, false data will be recorded for that channel.

You can read out the logger while it continues to log, stop it manually with the software, or let it record data until the memory is full.

Refer to the software user's guide for complete details on launching, reading out, and viewing data from the logger.

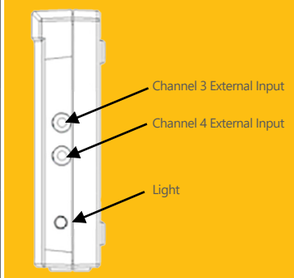


Operation

An LED light on the side of the logger confirms logger operation.

The following table explains when the logger blinks during logger operation:

When:	The light:
The logger is logging	Blinks once every one to four seconds (the shorter the logging interval, the faster the light blinks); blinks when logging a sample
The logger is awaiting a start because it was launched in Start At Interval, Delayed Start, or Button Start mode	Blinks once every eight seconds until launch begins
The button on the logger is being pushed for a Button Start launch	Blinks once every second while pressing the button and then flashes rapidly once you release the button. The light then reverts to a blinking pattern based on the logging interval



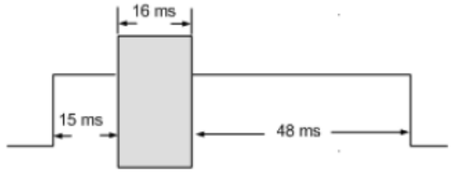
Protecting the Logger

This logger is designed for interior use only. It can be permanently damaged by corrosion if it gets wet. Protect it from condensation. If it gets wet, remove the battery immediately and dry the circuit board with a hair dryer before reinstalling the battery. Do not let the board get too hot. You should be able to comfortably hold the board in your hand while drying.

Note! Static electricity may cause the logger to stop logging. To avoid electrostatic discharge, transport the logger in an anti-static bag, and ground yourself by touching an unpainted metal surface before handling the logger. For more information about electrostatic discharge, visit the onsite support website at http://www.onsetcomp.com/Support/support.html

Using External Sensors

The external input channels have a switched 2.5 V output. This signal can be used to power a sensor directly or it can also be used to trigger an external circuit. External sensors should draw no more than 4 mA total when powered. The switched 2.5 V output turns on about 15 ms before the external channels are measured and stays powered for 48 ms after the external channels are measured as shown in the following diagram. The striped bar shows the 16 ms period during which the logger samples the input signals.



When using multiple voltage and/or current inputs, the (-) from your current source(s) and the 0 Volt line of your voltage source(s) are tied together at the logger. If these lines are at different voltage potentials, this may cause inaccurate readings or even damage your logger. Keep in mind that these lines may also be tied to earth ground through your PC interface cable when connected to your computer. Special precautions may be necessary if any of your voltage or current source common lines are not tied to earth ground.

⚠ CAUTION: Analog channel input cannot exceed 2.5 VDC. For sensor outputs up to 10 VDC, use appropriate voltage adapter cable.

Using the RH Sensor

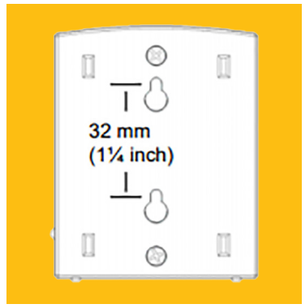
In order to take humidity measurements, the temperature sensor must be used in conjunction with the RH sensor.

Conditions outside the recommended range may offset the RH signal. Vapors may also affect the RH sensor. The diffusion of chemicals into the sensor may cause a shift in both offset and sensitivity. High levels of pollutants may cause permanent damage to the sensor.

Upon returning to normal conditions, the RH sensor will slowly return towards calibration state by itself. However, prolonged exposure to extreme conditions may accelerate aging and eventually lead to a permanent shift. To recondition the sensor, do the following.

1. Remove the Battery
2. Warm 24 hours 80-90°C (176-194°F) at < 5% RH
3. Re-hydrate 48 hours 20-30°C (70-90°F) at 75-95% RH

The Logger & Sensors



Mounting

There are four ways to mount the logger using the materials in the mounting kit included with the logger:

- Use the hook and loop tape to affix the logger to a surface.
- Attach the magnet, then place the logger on a magnetic surface.
- Use the tie wrap and tie wrap mount to tie the logger to an object.
- Fasten the logger to a surface with the two Phillips-head screws. The back of the logger has two inserts for the screws, 32 mm (1.25 inches apart).

Reading Stored Records

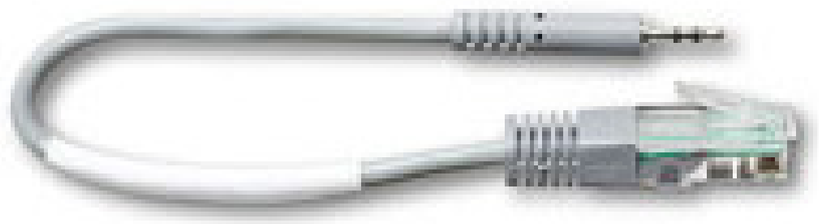
The logger requires one 3-Volt CR-2032 lithium battery. Expected battery life varies based on the temperature and the frequency at which the logger is recording data (the logging interval). A new battery will typically last one year with logging intervals greater than one minute. Deployments in extremely cold or hot temperatures or logging intervals faster than one minute may significantly reduce battery life.

To replace the battery:

1. Disconnect the logger from the computer.
2. Unscrew the logger case.
3. Lift the circuit board and carefully push the battery out with a small blunt instrument, or pull it out with your fingernail.
4. Insert a new battery, positive side facing up.
5. Carefully realign the logger case and re-fasten the screws.

⚠ WARNING: Do not cut open, incinerate, heat above 85°C (185°F), or recharge the lithium battery. The battery may explode if the logger is exposed to extreme heat or conditions that could damage or destroy the battery case. Do not dispose of the logger or battery in fire. Do not expose the contents of the battery to water. Dispose of the battery according to local regulations for lithium batteries.

CO_2 Sensor
Input Cable

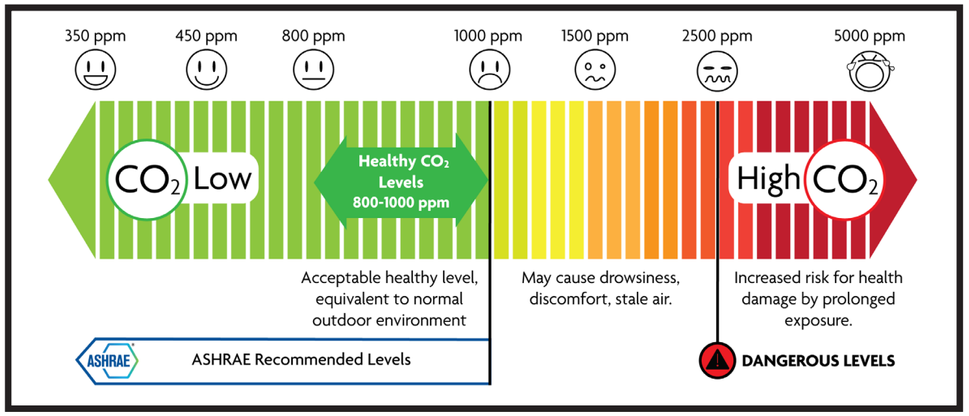


Measures - Adapter

CO_2 Sensor to Logger Cable (20.3cm - 8 inches) for use with U12 data loggers.

- Plug directly into the external input jacks of the U12 Family loggers to expand the range of measurement options and applications.
- This cable operates in an indoor environment.
- Measures carbon dioxide.
- Plug directly into the external input jacks of U12 Family loggers to expand the range of measurement options and applications.

CO_2 and Indoor Air Quality



We humans emit CO_2 when we breathe out. It also is emitted by appliances such as gas cookers and boilers. Carbon dioxide is one of the main greenhouse gasses causing global warming. Outdoor air contains approximately 400 ppm of CO_2, so indoor CO_2 levels will usually be at least 400 ppm, and usually higher. Measuring CO_2 levels indoor are a good indication of the amount of occupants using a space, and the ventilation of the space.

Carbon dioxide is not usually found at hazardous levels in indoor environments. ASHRAE (The American Society of Heating, Refrigerating and Air-Conditioning Engineers) has developed ventilation guidelines (outlined above) that should maintain a comfortable environment for most occupants.

The amount of fresh air that should be supplied to a room depends on the type of facility and room.

ASHRAE recomends ventilation supply of outdoor air at:

- 15 cfm per minute per person in elementary classrooms (1000 ft^2 room with 35 occupants)
- 17 cfm per minute per person in office spaces (1000 ft^2 room with 5 occupants)

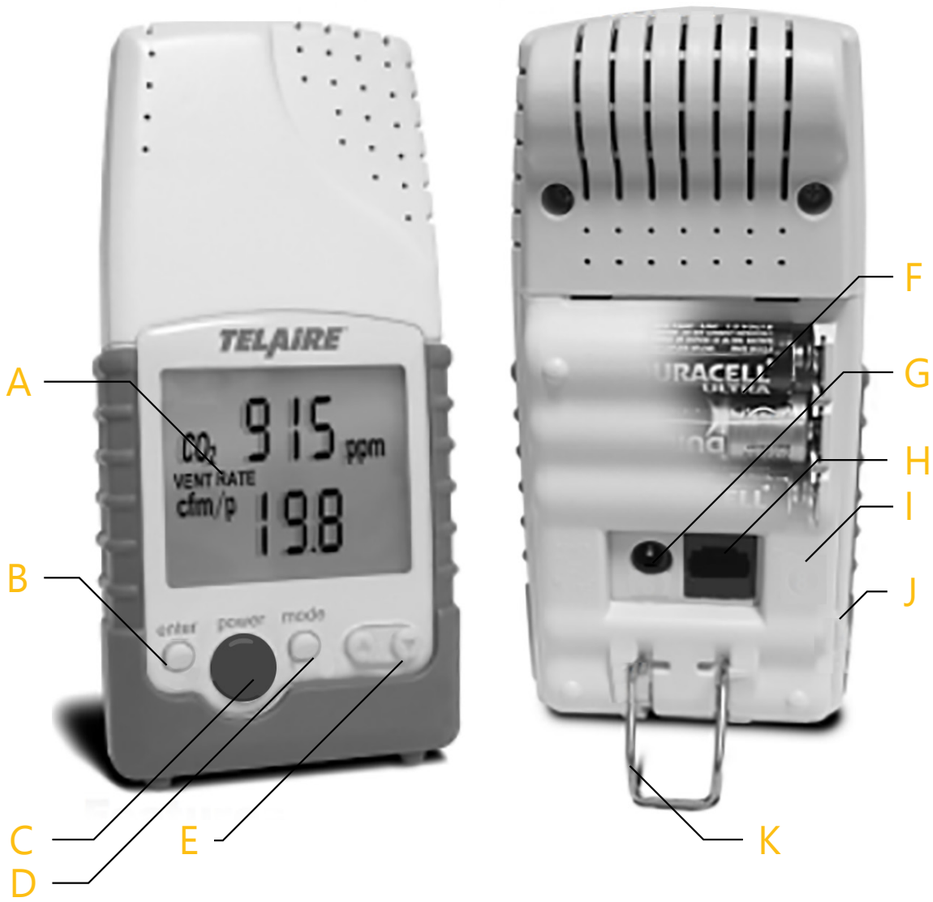
Fresh supply air correlates to the indoor level of CO_2 as:

- 15 cfm ventilation rate per occupant - aprox. 1000 ppm CO_2
- 20 cfm ventilation rate per occupant - aprox. 800 ppm CO_2

Prolongued exposure at levels above 5,000 ppm can cause CO_2 poisoning - effects of this can be headaches, dizziness, nausea, and other symptoms. At even higher levels, CO_2 exposure can lead to asphyxiation. CO_2 poisoning is rare, and in most commercial settings, excessive exposure to CO_2 doesn't normally happen. It could be more common in some industrial settings.

Telaire 7001

CO_2 and Temperature Monitor



Key

A.	LCD Display	G.	Adapter Connection
B.	Enter Button	H.	RJ-45 Connection
C.	Power Button	I.	Cal Button (under cover)
D.	Mode Button	J.	Gas Connection
E.	Up/Down Button	K.	Kickstand
F.	Battery Compartment		

Measures: CO_2 & TEMP

CO_2 Accuracy: 0-50 ppm

Temp Accuracy: ±2°F (±1°C)

Compatible: RJ-45 Cable

Specifications

Method

Dual Beam Absorption Infrared™

Display - LCD:

Independent CO_2 and temperature readings

Calculates and displays ventilation rates

Sample Method:

Diffusion or flow through (50-100ml/min)

Performance CO_2 Channel

Measurement Range:

0-10,000 ppm display

0-4,000 voltage output

Display Resolution:

±1 ppm

Accuracy:

±50 ppm or ±5% of reading up to 5,000 ppm (above 5,000 ppm not specified)

Repeatability:

±20 ppm

Temperature Dependence:

±0.1 of reading per °C of ± 2 ppm per °C, whichever is greater reference to 25°C

Pressure Dependence:

±0.13% of reading per mm Hg (corrected via user input for elevation)

Response Time:

<60 seconds for 90% of step change

Warm-Up Time:

<60 seconds at 22°C

Calibration Interval:

12 months, offset adjustment using single gas at 0-1000 ppm CO_2. Full factory calibration available

Performance Temperature Channel

Temperature Range:

Voltage output - 32 to 104°F (0-40°C)

Display - 32 to 122°F (0-50°)

Display Resolution:

0.1°F (0.1°C)

Display Options:

°F, °C, of OFF, Set with panel button

Accuracy:

±2°F (±1°C)

Response Time:

20-30 minutes (case must equilibrate with environment)

Calibration Interval:

12 months, offset adjustment using temperature standard at 50 to 86°F (10 to 30°C). Full factory calibration available

Outputs

(Analog) CO_2

0-4 VDC, 1mV/ppm (4,000 ppm max)

Temperature

0-4 VDC linear, 32 to 104°F (0 to 40°C)

Output Impedance:

100 Ohms

Digital:

RS232 for use with GE Telaire® CO_2View™ Graphing Software

(Wiring Connection):

One RJ-45 Connector

Dual analog output plus digital output

Startup Procedure

Battery

Operation:
For portable use, the monitor will operate up to 70 hours on 4 AA industrial alkaline batteries. The batteries can be installed by removing the cover from the battery compartment and following the diagram displayed on the back of the monitor.

Low Battery:
The low battery signal flashes when less than 30 minutes of battery life remains. At this point, the batteries should be replaced or the AC adapter should be used as a substitute. If ordinary operation continues, the monitor will become inoperable and only the LOW BATT signal will diplay on the LCD.

AC Power:
The sensor is shipped with a 6V DC, 500 mA AC/DC adapter. To use the adapter, connect the plug into the back of the monitor and plug the transformer into any standard wall outlet.

Power-Up Procedure

1. Press the **Power** Button and a 2 second delay will occur before the display becomes visible.
2. A duration of 10 seconds will elapse before displaying the current CO_2 readings.
3. **WARM-UP** will display for approximately 1 minute. Dring this time, adjustments cannot be made to the sensor.

Display Features

- **CO_2 Readings (Upper Display)** - Remain visible at all times.
- **Temperature and Ventilation Rates (Lower Display)** - The Up/Down arrows allow you to toggle through the Temperature and Ventilation modes. When pressing the Up arrow, the display will go through the following sequence: **Temp °C > Temp °F > Vent Rate l/p/s > Vent Rate cfm/p >Blank**

- **US Standard to Metric Conversion** - The Temperature Ventialation rates, and Elevation Readings can be viewed in US Standard or Metric Readings. The Temperature is converted from Fahrenheit (°F) to Celsius (°C): the Ventilation Rates are converted from Cubic Feet Per Minute Per Person (cfm/p) to Liters Per Second (l/p/s) and the Feet (ft) to Meters (m).

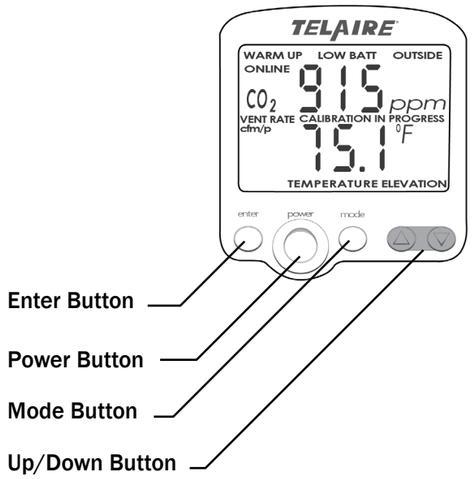
Setting up the Monitor

Elevation Correction

The sensor, like any other gas measuring device, is affected by altitude changes. The sensor is shipped with the elevation setting at 0 - or sea level. If you are located at an altitude higher than 500', an adjustment should be made to assure the max sensor accuracy.

To change the Elevation settings:

1. Press the **Mode** button until **ELEVATION** begins to blink.
2. Press **Enter**.
3. Press **Mode** to toggle the elevation reading between feet and meters.
4. Use the **Up/Down** button to adjust the altitude in increments of 500 feet or 100 meters. Once the correct altitude is set, press **Enter** to save the setting and return to normal mode.



Temperature of CFM/person

The lower display will cycle through the following units when the Up/Down button is pressed:

Temp **°F**, Temp **°C, CFM**, turn lower display **OFF**

Display Modes

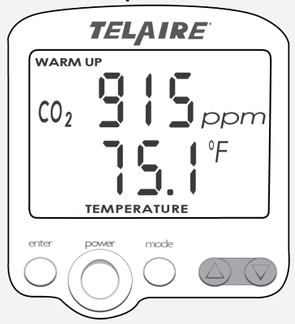
Display Features and Modes

- **WARM-UP** - Indicates a 1 minute warm-up.
- **ON LINE** - Indicates when a PC is communicating to the sensor via RJ-45 port.
- **Normal Operating Mode** - After warm-up the sensor will stabilize and display the current conditions.

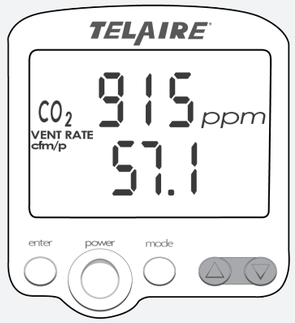
By pressing the mode button, you can scroll through the adjustment modes. Once the desired mode is displayed, press **Enter** to make adjustments. Press **Enter** again to save and leave the adjustment mode.

- **ELEVATION** - Used to compensate for elevation changes.
- **CALIBRATION** - Used when calibrating.
- **TEMPERATURE** - Used for temperature calibration.
- **OUTSIDE** - To manually input CO_2 levels for the CFM ventilation rate.
- **CALIBRATION IN PROGRESS** - Displays during calibration.

Warm-up Display with Temperature



Displaying Ventilation Rates



Overview

Press the **up/down** button until **cfm/p** is displayed. This value represents how much outside air is being introduced on a CFM per person basis. The reading is derived from calculating the outside air ventilation rate to a space based on the inside/outside CO_2 differential readings.

The current codes/standards generally require 15 to 20 CFM/Person to be delivered to most spaces to ensure acceptable air quality. Low values indicate low ventilation rates and potentially poor air quality. High levels indicate excessive ventilation and potential excessive energy usage.

To obtain accurate measurements, readings should be taken 2 to 3 hours after occupancy has stabilized in a space or at a peak in daily CO_2 concentrations.

Adjusting the Outside CO_2 Concentration

The sensor is factory set to assume an outside level of 400 ppm, which should be close to the outside concentration in most areas. The outside level of CO_2 can be changed by measuring outside levels or by manually adjusting the monitor, using the following procedure:

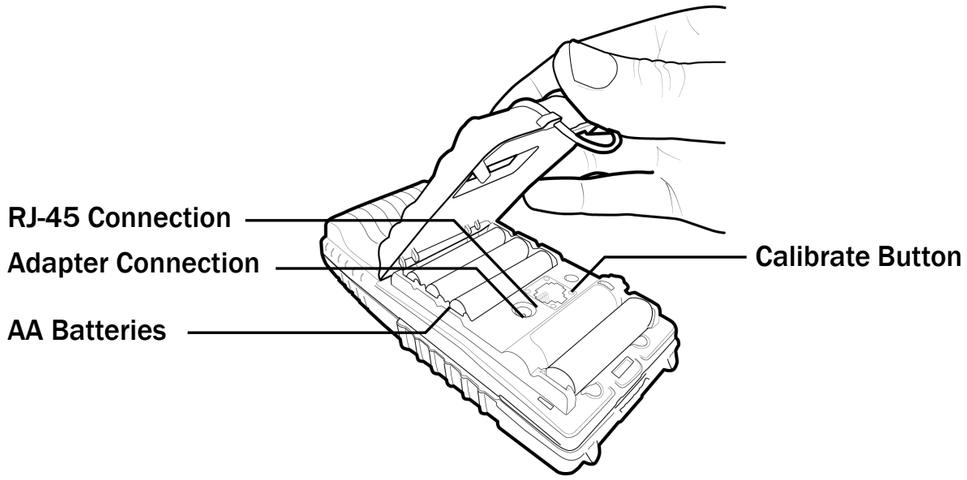
1. Power up outside and wait for CO_2 levels to stabilize (approx. 5 minutes).
2. Save the reading by holding the **Enter** button on the sensor for 5 seconds.
3. This value is used to calculate the ventilation rate based on the differential of the measured outside value and into measured inside concentration.

Manual Input of Outside Concentration

The monitor is factory set at 400 ppm. To adjust the factory setting (for the CFM/person calculation) or to verify the current setting follow the steps below:

1. Press the **Mode** button until **CO_2** and **ppm** flash.
2. Press the **Enter** button to increase/decrease the **CO_2** value.
3. Press **Enter** to save and store the value in the monitor.

The Telaire 7001 CO_2 and Temperature Monitor can be used as a standalone monitor of atmospheric, or concentrated CO_2 (with attached gas line). It also can be paired with an external datalogger via the RJ-45 cable.

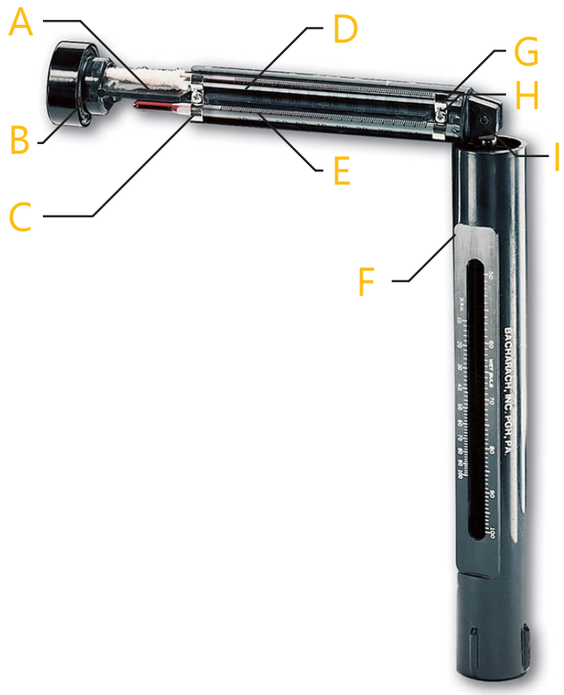


Using an External Datalogger

Use this procedure to adjust the temperature output when you wish to have the temperature output match a reference sensor.

1. Connect the supplied AC adapter to the back of the sensor.
2. Power up the sensor and place in a stable environment, free of drafts or temperature changes. Wait 30 minutes for the unit to fully stabilize in the operating environment. Do not hold the unit in your hand during this period. Press the mode button until the blinking word **TEMPERATURE** appears.
3. Press **Enter**. Both the word **TEMPERATURE** and the numeric temperature display will begin blinking in unison.
4. Use the Up/Down button to adjust the temperature reading to match the reference.
5. Press **Enter**. The temperature offset is immediately adjusted, the blinking stops, and the unit is now in normal operating mode.

Bacharach
Sling Psychrometer



Key

A. Wick
B. End Cap
C. Psychrometer Body
D. Wet Bulb Thermometer
E. Dry Bulb Thermometer
F. Tube
G. Thermometer Clips
H. Screws
I. Roll Pin

Features

The Bacharach Sling Psychrometer is an easy way to measure relative humidity levels quickly and accurately. It is ideal for many applications, including the measurement of conditions withinin indoor environments, storage areas, laboratories and more. Bacharach's Sling Psychrometer measures RH between 10 and 100% (for dry bulb temperatures between 30 and 100 °F) with an accuracy of ± 5%.

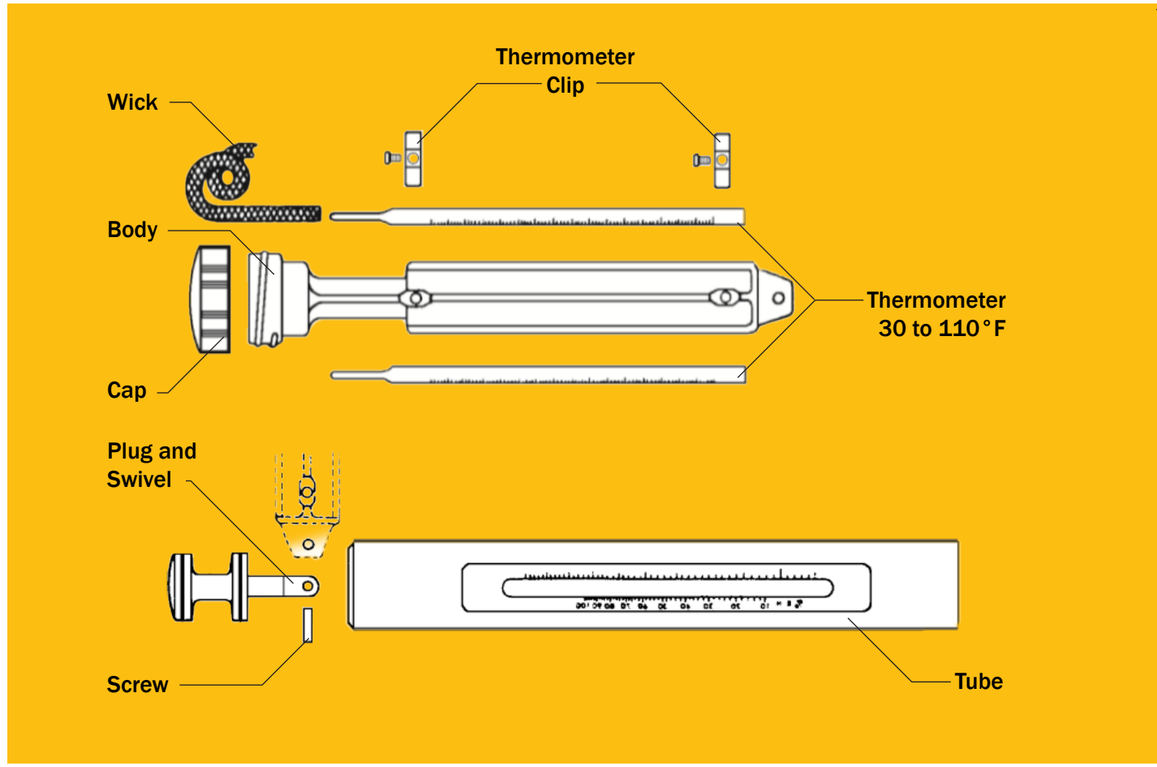
Specifications

Measurement Range:
25 to 120° or -5 to +50°C 10 to 1100W%, for dry bulb temperature between 30 and 100°F (-1 and 38°C)

Accuracy:
±1 °F ± 0.5°C

Ambient Temperature:
25 to 120°F (or -5 to 50°C)

Humidity:
1 to 100% RH (non-condensing)

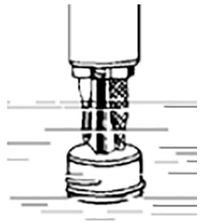


Operation and Application

Operating the Sling Psychrometer is easy and convenient. There is no need to wet the wick each time a reading is taken; the Sling Psychrometer contains a slide rule calculator which correlates wet and dry bulb thermometer indications for direct reading of relative humidity.

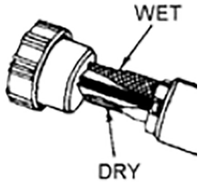
Operation

1 Remove cap and immerse end of body to saturate wick.

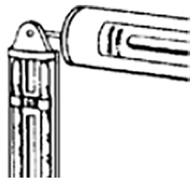


2 Fill psychrometer reservoir. Replace cap.

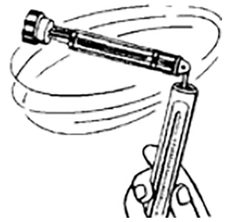
3 Be sure wick covers "wet" bulb. The other bulb is "dry".



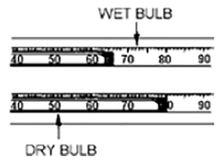
4 Pull body from tube until body hangs free.



5 Use tube as handle; whirl body about for 1-1/2 minutes.

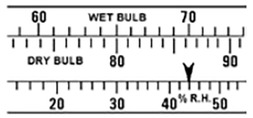


6 Read wet and dry bulb thermometers; replace body in tube.



7 Set thermometer readings on upper two calculator scales.

8 Read % relative humidity as indicated by arrow.



Application

- Wet-bulb temperature should be read first and as quickly as possible for highest accuracy. Delay in reading wet-bulb temperature may cause error.
- Keep the wick clean, saturated with water, and whirled long enough to stabilize temperatures.
- Range of psychrometer is from 10% to 100% R.H., for dry-bulb temperatures of 30° to 100°F.
- Barometric pressure and other factors will influence exact relative humidity determinations to a very minor degree.

TMC20-HD
Temperature Sensor

Length
6 ft cable

Air Response
2 min. @ 1 m/sec

H20 Response
30 sec, typ to 90%

Compatible
HOBO devices

Specifications

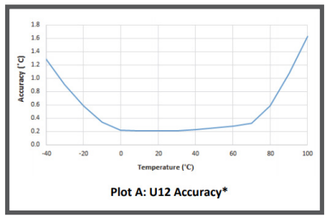
- **Measurement Range:** -40° to 50°C (-40° to 122°F) in water; -40° to 100°C (-40° to 212°F) in air.
- **Accuracy with U12:** ±0.25°C from 0° to 50°C (±0.45°F from 32° to 122°F), insert probe 2.3 cm (0.9 inches) minimum; see Plot A.
- **Accuracy with ZW:** ±0.21°C from 0° to 50°C (±0.38°F from 32° to 122°F), insert probe 2.3 cm (0.9 inches) minimum; see Plot B.
- **Accuracy with UX120-006M, MX1104, and MX1105:** ±0.15°C from 0° to 50°C (±0.27°F from 32° to 122°F), insert probe 2.3 cm (0.9 inches) minimum; see Plot C.
- **Resolution with U12:** 0.03° at 20°C (0.05° at 68°F).
- **Resolution with ZW:** 0.02°C at 25°C (0.04° at 77°F).
- **Resolution with UX120-006M, MX1104, MX1105:** 0.002° at 25°C (0.003° at 77°F)
- **Drift:** <0.1°C (<0.2°F) per year.
- **Response time in air:** 2 min. typical to 90% in air moving 1m/sec (2.2 mph).
- **Response time in stirred water:** 30 sec. typical to 90%.
- **Operating range:** Sensor tip and cable immersion in fresh water up to +50°C (122°F) for 1 year.
- **Housing:** Copper-plated sensor tip.
- **Dimensions:** 5.1 x 33 mm (0.2x 1.3 inches).
- **Weight:** 34 g (1.1 oz).

Sensor Connection

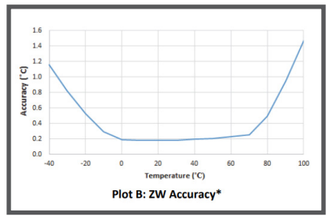
The TMC20-HD Temperature Sensor can be used with HOBO U12, UX120-006M, MX1104, and MX1105 data loggers and ZW data nodes.

To mount:

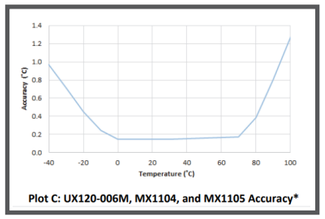
- Mount the sensor where there is good air circulation for measuring air temperature.
- Mount the sensor off the mounting surface so temperature measurements are not affected by the surface itself.



Plot A: U12 Accuracy*



Plot B: ZW Accuracy*



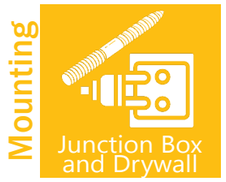
Plot C: UX120-006M, MX1104, and MX1105 Accuracy*

BAPI VOC & Temperature Monitor

VOCs are chemicals that contain carbon and have boiling points below 212°F. There are 5,000 to 10,000 unique VOCs. The BAPI VOC sensor reacts to all of them.

Families of VOCs detected are:

- CO, CH4, LPG
- Alcohols
- Ketones such as Acetone and Methyl Ethyl
- Organic acids such as Lactic acid, Acetic acid, Formic acid, Citric acid, and Oxalic acid
- Amines (ammonia)
- Aliphatic Hydrocarbons - (flammable) such as hexane, paraffin, methane and acetylene
- Aromatic Hydrocarbons - (flammable) odorous such as benzene, furan, pyridine, toluene, asphaltene and picric acid



Specifications

Power: (No AC Power)

0 to 5 VDC Output Units:

9 to 5 VDC @ 50 mA Max (9 to 15 VDC recommended)

0 to 15 VDC Output Units:

15 to 35 VDC @ 50 mA Max (15 VDC recommended)

Sensing Elements:

Humidity: Capacitive Polymer, ±2% RH Accuracy

VOCs: Micro-machined Metal Oxide

Temp Sensor: Thermistor, RTD or Semiconductor

Mounting: 2"x4" J-Box or drywall mount

VOC Detection Range: 0 to 2,000 CO_2 PPM equivalent

Response Time: Less than 60 second (after Start-Up Time)

Start-Up Time: 15 minutes

Operating Environment:

32 to 122°F

0 to 95% RH non-condensing

LCD Display:

Main Display: 0.76" 4-digit Alpha-Numeric (Numeric Values)

Minor Display: 0.34" 3-digit Alpha-Numeric (PPM, %RH, °F)

Occupied/Unoccupied BAPI Man Icon: (Blk=Occupied)

Measurement Offsets (field adjustable)

±5°F in 0.1° increments

±5% RH in 0.1% RH increments

±5% Contaminants in 0.1% increments

±100 ppp CO_2 Equivalent Contaminants in 2 ppm increments

Analog Outputs

(0 to 5, 0 to 10 or 2 to 10VDC [%RH only], >10KΩ impedance)

VOC Contaminants: 0 to 2,000 CO_2 PPM equivalent

%RH: 0 to 100% or 35 to 70% RH

Override Output:

Contact: SPST

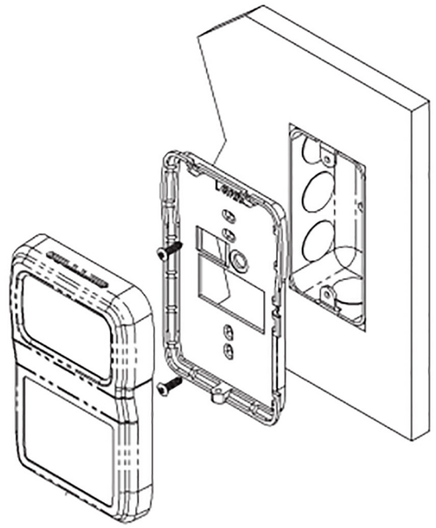
Sensor: Shorts out direct Temperature sensor (Temp)

Setpoint: Contact in parallel, resistive setpoint only

Mounting the Sensor

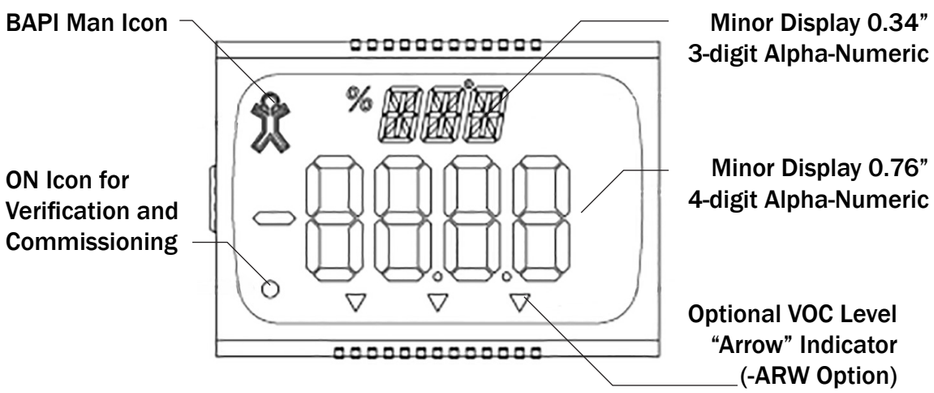
Junction Box

1. Pull the wire through the wall and out of the junction box, leaving about six inches free.
2. Pull the wire through the hole in the base plate.
3. Secure the plate to the box using 5/8 inch mounting screws.
4. Terminate the unit according to the guidelines in the Termination section.
5. Mold the foam on the unit's base to the wire bundle to prevent drafts.
6. Attach Cover by latching it to the top of the base, rotating the cover down and snapping it into place.
7. Secure the cover by backing out the lock-down screw using a 1/16" Allen wrench until it is flush with the bottom of the cover.



Drywall Mounting

1. Place the base plate against the wall where you want to mount the sensor.
2. Using a pencil, mark out the two mounting holes and the area where the wires will come through the wall.
3. Drill two 3/16" holes in the center of each marked mounting hole, DO NOT punch the hole or the drywall anchors will not hold. Insert a drywall anchor into each hole.
4. Drill one 1/2" hole in the middle of the marked wiring area.
5. Pull the wire through the wall and out of the 1/2" hole, leaving about six inches free.
6. Pull the wire through the hole in the base plate.
7. Secure the base to the drywall anchors using a 1" mounting screw.
8. Terminate the unit according to the guidelines in the Termination section.
9. Mold the foam on the unit's base to the wire bundle to prevent drafts.
10. Attach Cover by latching it to the top of the base, rotating the cover down and snapping it into place.
11. Secure the cover by backing out the lock-down screw using a 1/16" Allen wrench until it is flush with the bottom of the cover.



Output Selection

The VOC outputs may be field configured for 0 to 5 VDC or 0 to 10 VDC outputs at any time. Set the jumpers on J16 as shown in Figures 1 and 2. The humidity outputs may be field configured for 0 to 5 VDC or 0 to 10 VDC outputs at any time. Set the jumpers on J16 as shown in Figures 3 and 4.

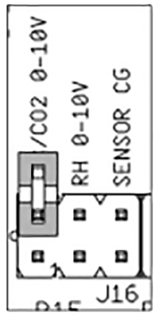


Fig 1: VOC Output 0 to 5 VDC

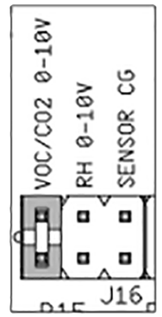


Fig 2: VOC Output 0 to 10 VDC

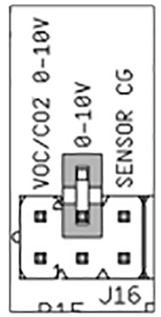


Fig 3: RH Output 0 to 5 or 1 to 5 VDC

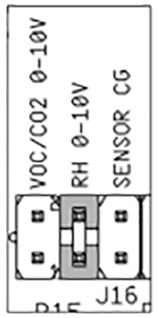
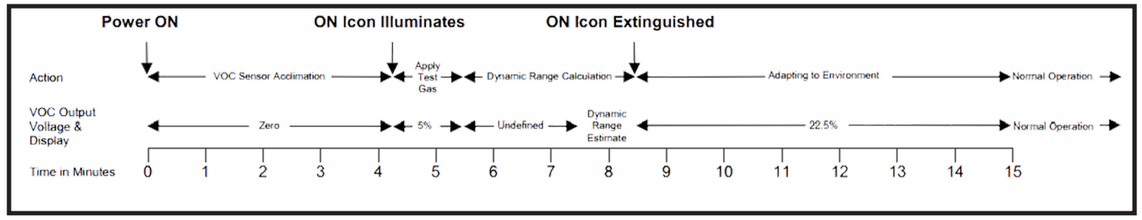


Fig 4: RH Output 0 to 10 or 2 to 10 VDC

Sensor Start-Up

Do not set control parameter to a VOC limit until the VOC sensor has been installed for a week. The first few days of install may provide different readings compared to several days later.

At each power up, the sensor enters the start-up period for 15 minutes. The main display will show the current temperature and minor display will show 123 for the first 15 seconds. The VOC output and display will follow the timing shown in Figure 5. Start-up time for the humidity output is 30 seconds, while the outputs for temperature and temperature setpoint are available immediately.



General Troubleshooting

- Determine that the input is set up correctly in the controller's and building automation software.
- Check wiring at the sensor and controller for proper connections.
- Check for corrosion at either the controller or the sensor. Clean off the corrosion, re-strip the interconnecting wire and reapply the connection. In extreme cases, replace the controller interconnecting wire and/or sensor.
- Label the terminals that the interconnecting wires are connected to at the sensor end and the controller end. Disconnect the interconnecting wires from the controller and the sensor. With the interconnecting wires separated at both ends, measure the resistance from wire-to-wire with a multimeter. The meter should read greater than 10 Megohms, open or OL depending on the meter you have. Short the interconnecting wires together at one end. Go to the other end and measure the resistance from wire-to-wire with a multimeter. The meter should read less than 10 ohms (22 gauge or larger, 250 feet or less). If either test fails, replace the wire.
- Incorrect VOC: wait 15 minutes after a power interruption. Check all software parameters. Determine if the sensor is exposed to an external environment different from the room (conduit draft).
- Incorrect Humidity: Check all software parameters. If available, check the sensor against a calibrated instrument such as a hygrometer. Determine if the sensor is exposed to an external environment different from the room (conduit draft).
- Incorrect Temperature: Determine that the temperature sensor's wires are connected to the correct controller input terminals and are not loose. Check the wires at the sensor for proper connections. Make sure sensor leads are not touching one another. Check for exposure to external environments. Compare the actual temperature of the room to the resistance of the temperature sensor inside the VOC unit.

Fluke
Mini Infrared Thermometer

The Fluke 62 MAX can perform non-contact temperature measurements on transformers, motors, pumps, panels, breakers, compressors, ducts, steam lines, valves and vents. It is handheld and easy to use. With its IP45 rating for dust and water resistance, you can rely on the Fluke 62 MAX to deliver accurate, repeatable temperature measurements, rain or shine, in even the dirtiest industrial sites.

The Fluke62 MAX features:

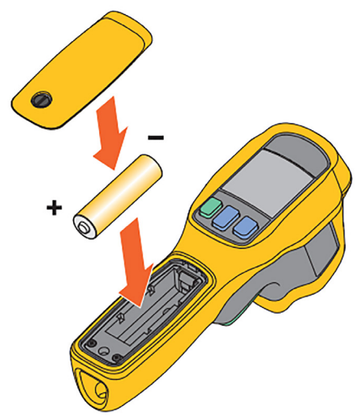
- High and low alarms for rapid detection of temperatures outside of the limits
- Powered by a single, standard AA battery
- Toolbelt Clip
- Large backlit display
- Displays Min/Max/Avg/Dif: the minimum, maximum or average temperature or the difference between two measurements

Specifications

Temperature Range: -22°F to 932°F
Accuracy:
≥32°F: ±3°F or ±1.5% of reading, whichever is greater.
≥14°F to <32°F: ±4°F
<14°F: ±6°F
Response Time: <500 ms (95% of reading)
Spectral Response: 8 to 14 microns
Emissivity: 0.10 to 1.00
Optical Resolution: 10:1 Distance to Spot (calculated at 90% energy
Display Resolution: 0.2°F
Repeatability (% of readings: ±0.8% of reading (or ±2°F), whichever is higher
Power: 1 AA IEC LR06 Battery
Battery Life: 10 hours with laser and backlight on
Operating Temperature: 32°F to 122°F
Storage Temperature: -4°F to 140°F (without battery)
Operating Humidity: 10% to 90% RH non-condensing @ 86°F
Operating Altitude: 6562 feet above mean sea level
Storage Altitude: 39,370 feet above mean sea level

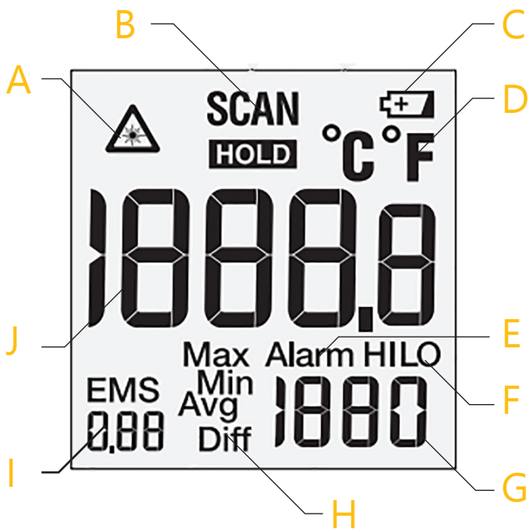
Changing the Battery

To Install or change the AA IEC LR06 battery, use a flat-head screwdriver to remove the battery compartment door. Replace the battery as shown. Be sure to observe the correct polarity.



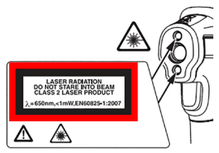
Operation

Display Specifications



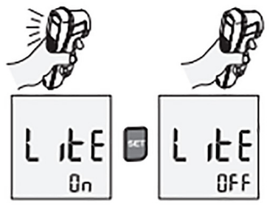
Display Key

A. Alarm Icon
B. Scanner
C. Battery Status
D. Temperature in °F or °C
E. Alarm Status
F. High/Low Beam
I. Secondary Reading
J. Max, Min, Average, and Difference
K. Alarm Icon
L. Main Reading



LASER RADIATION: DO NOT stare into beam

LCD Backlight On/Off

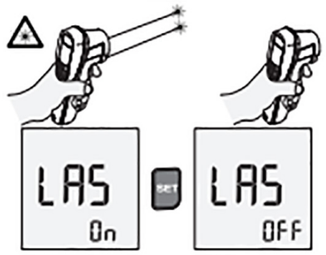


To turn on/off the LCD backlight - use the SEL button to toggle until the screen says Lite - then use the SET button to turn it On/Off

Temperature Reading °F/°C

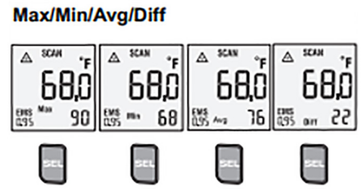
To switch between °C and °F, use the SEL button to toggle until the screen reads only °C/F. Then use the SET button to switch between them.

Laser On/Off



To turn on/off the laser - use the SEL button to toggle until the screen says LAS - then use the SET button to turn it On/Off

Displaying Max/Min/Avg/Diff

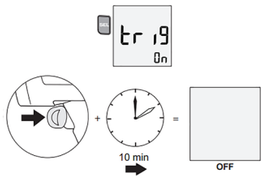


To display the Maximum, Minimum, Average, and Difference values of your measurement, press the SET button

Emmisivity

To adjust the Fluke 62 MAX Emissivity, press the SET button between 0.1 and 1 value.

Turning On/Off Trigger Auto-Turn Off

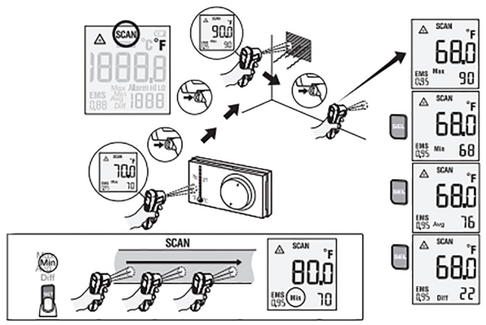


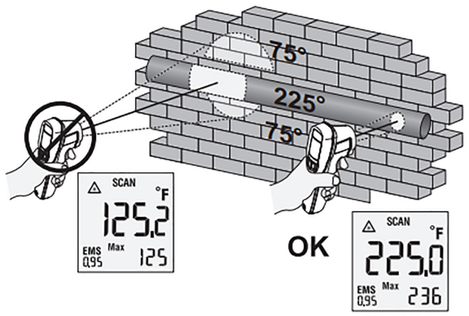
Use the SEL button to toggle until 'trig' is displayed. Press SET to turn on/off the trigger auto-turn off feature. This automatically turns off the laser after 10 minutes.

Operation and Specs

How the Fluke 62 MAX can save you time and energy:

- Check HVAC discharge air - with a ceiling discharge while standing on the ground.
- Check thermostat accuracy - Check the accuracy of the room.
- Check inlet and outlet water temperatures - Indicate proper water temperatures, heat transfer and valve operation.
- Check air handler coil temperatures - This will reduce energy waste and increase comfort.
- Check boiler hot water temperatures - A system that is even a few degrees off over the course of a heating season can result in expensive energy expenditures.
- Steam trap failure can waste energy and cause improper HVAC system operation, resulting in a system freeze-up.
- Check air distribution - A room or space may have several air distribution ducts - one or more of them may be shut off.
- Check for hot and cold spots -A large room or area may have hot or cold spots due to system design or installation.
- Check humidifier operation - Determine if water or steam is present and it is working.
- Check chiller set points - Energy is wasted if the chilled water temperature set point is incorrect.
- Check low temperature limits - To prevent freeze up of a water coil, the low temperature limit will stop the supply fan.





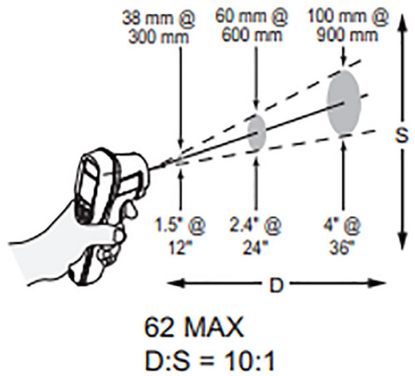
Operation Basics

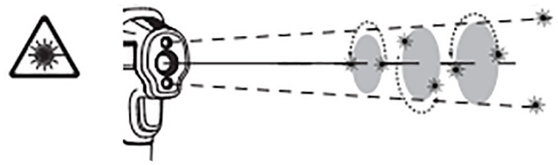
The Fluke Max has the ability to show the maximum, minimum, average, and difference between the different temperatures that the sensor is reading. While scanning, press the "Select" button to cycle through the secondary temperature values (displayed along the bottom of the LCD in smaller text).

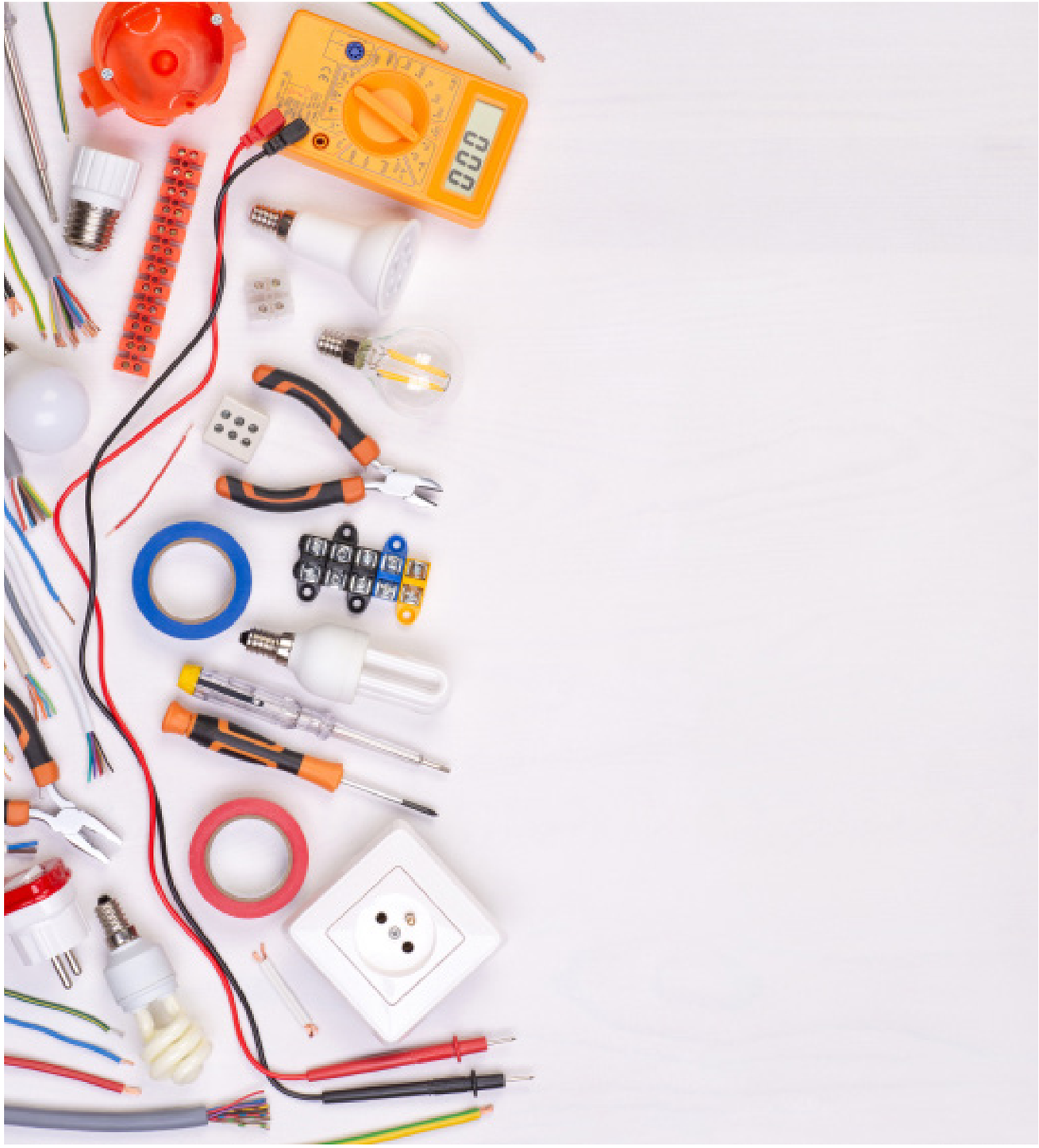
The thermometer gives an accurate reading of the targeted spot - and becomes more precise the closer you move the sensor. The Fluke MAX has a 10:1 distance to spot ratio. Move the thermometer closer to the targeted object to make the reading more accurate to what your goal for the measurement is.

Single Laser Targetting

The Fluke MAX has a 10:1 distance to spot ratio. The closer the target is, the smaller the targetted spot for reading is. Conversely, the further away the target is, the larger the targetted spot for reading is.







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