KCS TraceME TM-3101 / P2E6

LoRa-based indoor CO_2 / air quality sensor

The TM-3101 / P2E6 is a product line member of KCS' advanced LoRaWAN modules. It is designed for indoor environment measurement, targeting schools, public buildings and offices.

The module is equipped with CO_2, motion detector and environmental sensors, offering unique measurement stability over a measuring period of 5 years, without any intermediate calibration.

Key Features

- CO_2 measurement, dual channel NDIR.
- Indoor air quality measurement.
- Detects a broad range of gases.
- LoRa® technology
  - EU-868MHz.
  - Up to 60km line of sight at 25mW and with integrated antenna.
- Integrated 2.45GHz. radio for BLE communication and special functions.
  - Short range, up to 30m range, line of sight
- NFC configurable.
- Tamper sensor
- User interface
  - 1 Multi-color LED (default set to Green, Orange, Red)
  - Buzzer for audible alarm
- Onboard sensors:
  - CO_2, dual channel NDIR
  - 3D accelerometer (up to 16g)
  - Temperature sensor (±0.5°C)
  - Humidity (±2%RH)
  - Baro-/ Altitude meter (±2mbar)
  - PIR motion sensor
- Optional sensors (*)
  - Air quality sensor (*)
  - Light sensor (*)
  - Sound detector (*)
- Size, 86 x 86 x 25.5mm
- Lightweight: 75 gram excl. batteries.
- Battery lifespan of more than 3 years.
- External 5VDC ±5% power supply (*)
- Wide operating range: -30˚C … +55˚C Extended temperature on request.
- Remote configurable to fit any job (both firmware and configuration files can be updated via NFC).
- Minimal maintenance, no calibration required for 5 years.

(*) Optional, please contact sales for more details.

email: Trade@trace.me • URL: www.trace.me

Applications

- Schools, universities
- Smart offices and buildings
- HVAC
- Sport / Fitness
- Process automation (demand controlled ventilation)

Terms and abbreviations

BLE	Bluetooth Low Energy
CO_2	Carbon Dioxide
HVAC	Heating, Ventilation and Air-Conditioning
IAQ	Indoor Air Quality
NDEF	NFC Data Exchange Format
NDIR	Non Dispersive Infra-Red
NFC	Near Field Communication
OLED	Organic Light Emitting Diode
OTA	Over The Air
VOC	Volatile Organic Compound

Product Summary

Fresh, clean air is a vital component of our ability to lead healthy and productive lives. Without fresh air, we are more susceptible to headaches, fatigue, dry skin and loss of concentration.

The TM-3101 / P2E6 LoRa-based CO_2 / Indoor Air Quality (IAQ) sensor is the ideal sensor used in demand controlled ventilation, building automation and process control.

The module is a 'smart' and easy to implement indoor air quality monitor equipped with environmental sensors (CO_2 + gases (*) + humidity + temperature + barometric pressure) which indicate when the air quality level in a room went below a certain quality threshold. This will generate a notification informing that the air quality has deteriorated to a point where it's time to open the windows and ventilate the room. When the air quality level has improved to an acceptable level, the device will send another notification to indicate the window can be closed again.

With the twin sensor technology (VOC and dual channel NDIR) the product offers unique measurement stability over a measuring period of 5 years, without intermediate calibration. With smart sensoring technology the power usage is almost zero. Based upon the settings, the TraceME CO_2 + Air Quality sensor operates up to 3.3 years, without recharging the battery.

The TM-3101 contains multiple internal environmental sensor (CO_2 + gases (*) + humidity + temperature + barometric pressure) to measure indoor air quality for personal wellbeing. The smart sensor technology, PIR motion detector and optional light sensor and sound detection enables low-power operating with battery life more than 3.3 years.

The multi-color LED (default set to green, orange and red) provided visual feedback about the CO_2 measurement. The buzzer alerts when the CO_2 level reaches the red indication level. The internal tamper contact indicates if the housing is opened, or when the module is removed from the wall.

Local actual readings can be obtained from the sensor using NFC technology, with the optional BLE technology or from the online stored information. The data is encrypted and securely transmitted via LoRaWAN.

(*) Optional, please contact sales for more details.

email: Trade@trace.me • URL: www.trace.me

Ordering information

The KCS TraceME TM-3101 / P2E6 can be equipped with different optional technologies and (environment) sensors. It can be fully customized dependent of the application. Please contact sales for more details.

The basic version of the TM-3101 is equipped with:

- Dual Channel NDIR CO_2 sensor, calibration free for 5 years
- Humidity
- Temperature
- Barometric Pressure
- Multicolor CO_2 level indicator LED
- BLE
- Tamper detection (motion)
- Buzzer
- NFC

NOTE: The onboard air quality sensor is optional.

Description	Sensor specification	TM-3101
CO_2	Sensor Element: 0…5000 ppm Working Range: 400…5000 ppm Accuracy at 25 °C and 1013 mbar with data averaging for smooth output: ± (50 ppm + 3 % of the measured value) Calibration Interval: 5 years Temperature and Pressure compensation	•
Barometric Pressure	Working Range: 700…1300 mbar Accuracy: ± 2 mbar (20...80 % RH)	•
Temperature	Working Range: -10…+55 °C Typical: +/- 0,2 °C	•
Humidity	Working Range: 0…100 % Typical +/- 2 %	•
Buzzer	Sound output @10cm: >85 dB Frequency: 2300 Hz +/-300 Hz	•
Tamper Detection	Working principle: 3D motion detection sensor Working Range: 0…16 g	•
PIR Motion	Working Range: up to 5 m, theoretical viewing angle 110 degrees horizontal, 90 degrees vertical. During LoRa transmissions, the PIR Motion input will be disabled.	•
BLE	Working Range: up to 30 m Protocol: BLE 4.0 and custom 2,4 GHz Sensitivity: -93 dBm	•
NFC	Working Range: up to 1 cm	•
LoRa	Semtech SX126x Working Range: 0… 20 km Frequency: 868 EU (all other frequencies on request) Protocol: LoRaWan and Custom	•
OTA-config	Settings changes OTA via NFC / downlinks Firmware updates OTA via NFC	•

Onboard sensors

3D accelerometer

The module contains an 3D accelerometer (up to 16g), which detects if the housing is opened, or when the module is removed from the wall. Upon this 'sabotage detection' an alarm is generated by sound buzzer and transmitting data over the LoRa network.

CO_2 sensor

The CO_2 measurement is based on the dual channel wavelength NDIR principle, which compensates for ageing effects, is highly insensitive to pollution and offers outstanding long term stability. A multiple point CO_2 and temperature factory adjustment procedure leads to excellent CO_2 measurement accuracy over the entire temperature working range.

Temperature and Barometric pressure sensor

Besides CO_2, the module also measures temperature (±0.5°C) and barometric pressure (±2mbar / 20…80% RH). The temperature and barometric pressure compensation with on-board sensors minimizes the impact of altitude and ambient conditions onto the CO_2 measured data.

Note: the rate of ventilation required can be determined by the dual channel NDIR CO_2 sensor.

Temperature monitoring with alarm threshold (based upon settings).

Humidity sensor

The module contains an optional humidity/temp sensor (±2%RH and ±0.2°C). The humidity represents the amount of water vapor held in the air. Humidity between 40% and 60% is ideal.

PIR motion sensor

The optional ultra-low power PIR motion detection sensor provides extra information for occupancy, but can also be used for intruder detection.

Air quality sensor (*)

The optional air quality sensor is a digital 4-in-1 sensor with gas, humidity, pressure and temperature measurement based on proven sensing principles.

The gas sensor can detect a broad range of gases to measure indoor air quality for personal well-being. Gases that can be detected include: Volatile Organic Compounds (VOC) from paints (such as formaldehyde), lacquers, paint strippers, cleaning supplies, furnishings, office equipment, glues, adhesives and alcohol.

Light sensor (*)

The optional ambient light sensor provides extra information for occupancy.

Sound detection (*)

The optional sound detector provides extra information for occupancy.

Enclosure

Front View

Rear View

- White, ABS UL94-V0
- Size: 86 x 86 x 25.5 mm
- Vented housing allows for airflow, special designed for environmental sensing & IoT applications
- Wall mountable
- Front and back clip together construction
- Recessed front face for overlays
- Recessed rear face for additional labelling

NOTE: NEVER use tape or glue for mounting. ALWAYS use screws and plugs for mounting.

Mounting instructions

- Recommended installation height is 1.60 m and a distance of at least 50 cm from the nearest wall
- Do not mount any lamps within the detection zone
- Do not expose to direct sunlight
- Do not attach to walls in front of a chimney
- Do not paint over sensor
- Do not place over windows
- Do not mount over ventilation shafts
- Do not mount near electrical devices or wires with radio output, keep at least 60 cm from such devices or wires
- Mount sensors in an accessible location to allow easy maintenance
- Avoid placing any sources of rapid temperature changes within the detection zone, e.g. air vents, fan heaters or incandescent and halogen lamps
- Ensure that the direction of air flows moves laterally to the detection zone
- Detection depends on the temperature difference between the surrounding ambient zone and the object to be detected
- The detection zone of a presence detector should not be impeded or blocked by shelves, plants or glass walls
- Do only use plugs and screws for permanent installation.

Note: False triggers and sensor damage can occur when mounting guidelines are not followed up.

User interface

The module provides different types of user interfaces.

LED

The multi-colour LED provides visual feedback about the CO_2 measurement levels, ideal for immediate actions for the people present in the room. Default set to green, yellow and red to indicate the CO_2 levels, but free configurable to any set of colours, as well as blinking pattern.

- Green: CO_2 level is ok, no ventilation required.
- Yellow: CO_2 level attention zone, take notice and prepare for action.
- Red: CO_2 level too high, ventilation of the room is required.

Buzzer

The integrated buzzer provides audible alarm indication as soon as the CO_2 level is above the defined safety threshold. The alarm duration is configurable.

NFC

With the NFC functionality, based upon the settings, the CO_2 monitor can provide instant status feedback. With the NFC, the device settings can be written to the device, as well as firmware updates can be written.

email: Trade@trace.me • URL: www.trace.me

Power supply

The device can be powered by:

- Permanent power, using a special USB 5 Volt Power Cable (to be ordered separately, not included). The 5VDC ±5% permanent power also charges the internal rechargeable battery. In case of main power loss, the internal rechargeable battery will ensure continuous operation.
- Rechargeable LiPo battery, 3100 mAh.

When the device is operated on internal rechargeable battery only, the battery will need to be recharged from time to time (depending upon settings, up to 3 years of unattended use).

Charging options are:

- Replace rechargeable battery with fully charged rechargeable battery and charge the rechargeable battery with the TraceME Battery Charger (to be ordered separately, not included).
- Battery Charging service. Please ask local distributor for details.
- External power connected to the 5VDC ±5% connector on the PCB. (professional installation required).

Battery

The module is equipped with a rechargeable battery.

• Rated voltage	3.7 Volt
• Nominal capacity	3100 mAh
• Min. required current at 3.3 Volt	150 mA
• Max. pulse current capacity	1000 mA
• Typical weight	57 gram
• Operating temperature	-20 °C ~ +55 °C. Extended temp range on request.
• Storage temperature	Max 30 °C

When fully charged, the battery voltage is about 4.14 Volt. Recharging the battery is recommended when battery voltage is lower than 3.41 Volt.

Typical power usage

Depending upon settings, the CO_2 monitor can work up to 3.3 years on a fully charged rechargeable battery. Please see ‘OEM-Setting’ section for detailed power usage.

Specifications KCS TraceME TM-3101

Data communication

LoRa	Semtech SX1261 transceiver
Frequency	EU-868MHz.
Protocol	LoRaWAN 1.0.2 and custom LoRa protocol Certified LoRaWAN stack
Transmitting power	up to +15 dBm
Sensitivity	-137 dBm

RF 2.4GHz.	Nordic nRF52832
Frequency	2.45 GHz.
Protocol	BLE 4.0 (*) and proprietary 2.4 GHz. protocol
Transmitting power	up to +4 dBm
Sensitivity	-96 dBm (BLE)

Electrical

Power supply	Internal rechargeable Lithium battery, 3100mAh
	Optional external +5VDC ±10% (Special USB power cable)
Charging Current (LiPolymer)	450 mA. Observing 0...+45 ˚C safety range for LiPolymer.
Typical power consumption	100 mA BLE transmissions
	2.4uA standby, timer and watchdog active, no transmissions

Recommended environmental conditions

Operating Temperature	-20°C to +70°C (OEM)
Humidity	10% to 90% RH (non-condensing)
Altitude	700 to 1100mbar (10.15 to 15.95 psi)

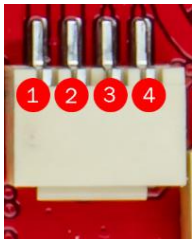
email: Trade@trace.me • URL: www.trace.me

External Connections

Battery connector

Pin	Description
1	Temperature sensor
2	Ground
3	3.4 - 4.5V Battery (+) connection

Power and I/O-connector



Pin	Description
1	External power +5VDC ±5%
2	Ground
3	Not Connected
4	Not Connected

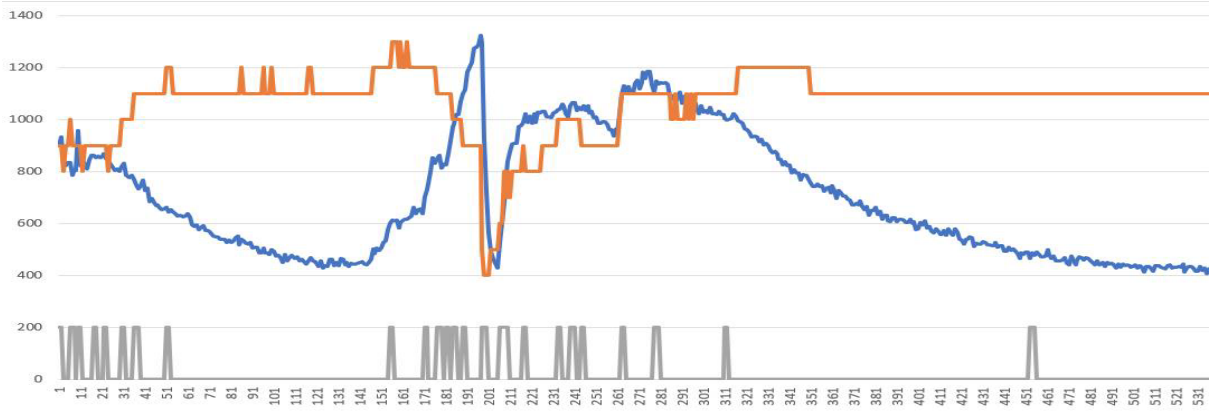
Dummy connector

The 2-pole connector is Not Connected and is used for positioning the battery.

email: Trade@trace.me • URL: www.trace.me

Data measurement

The device is equipped with smart monitoring technology. When setup for Smart Monitoring, the power consumption reduces during empty periods of monitored rooms.



Blue = CO_2
Orange = Humidity
Grey = Trigger points for increasing measurements

OEM Setting

For this specific delivery, the below mentioned settings are active on the devices:

- Every 30 minutes, 1 measurement (CO_2, Humidity, Temperature, Pressure)
- Every 30 minutes, 1 LoRaWan transmission with device payload
- LED blinks 1 time every 60 seconds
- Data averaging
- Device uses LoRaWan (SF7 … SF12)

<u>Calculated battery lifetime in office situation:</u>

0.5 mAh = standby usage
0.011 mAh = CO_2 measurement
0.030 mAh = LoRa transmission
3000 mAh = Typical output of the 3100 mAh battery

Daily usage
0.5 mAh + 48 LoRa messages * 0.011 mAh + 48* 0.030 mAh = 2.5 mAh.

3000 mAh / 2.5 mAh = 1215 days = 3.3 years

Based upon these settings, the calculated lifetime of the device (before recharging) is 3.3 years.

Device payload example

B1 94 F8 02 6F 72 00 80 17 12 34 05 78 65 80 00 00 09

B1	identifier CO_2
94F8	38136 decimal. Temperature = 38136/1000-10 = 28.1 Celsius, Humidity = 36%RH
026F	623 ppm CO_2
72	decimal 114. pressure = 900+114=1014 hPa
00	no VOC / Air Quality
80	IO31=1, IO30..IO24=0
17	23 decimal. Batt = 23*0.046+2.925=3.98V
1234	4660 decimal, settings CRC
0578	firmware 0.1400
65	101 decimal. 101 minutes of active pir sensor since powerup. + unknown multiple of 256 minutes
80000009	Bitfield for active pir sensor. Bit 0, bit 3, bit 31 are set. So last minute before transmission, the pir sensor was active. Idem for 3 minutes and 31 minutes ago.

Local status check

A quick read can be done from the device, using NDEF functionality. Hold an NDEF enabled phone near the NFC area, a weblink will be shown. After clicking the weblink, device information will be displayed.

Example Data:

```
DevEui: 7CC6C42900010800
Battery: 4.20V Ext: 4.75V
CO2: 430 temp: 23.5C Hum: 53%
Average CO2 over 100 samples: 453 (403…670)

Firmware version: 1715
Settings CRC: 20239
IO31..IO24 00001010
IO23..IO16 00011000
IO15..IO8 00000000
IO7..IO0: 00100110
```

Downlink

During installation, the TM-3101 will activate the tamper indicator, changing IO27 from 0 to 1. After the installation and each maintenance, it is recommended to reset the tamper indicator with a downlink command which will reset IO27 without a restart of the device.

```
Tamper reset downlink: 110000000008000000
```

About KCS BV

KCS BV, founded in The Netherlands in 1984, develops and manufactures electronics in-house for industrial applications, medical purposes, broad- casting solutions, etc.

KCS is ISO 9001:2015 and ISO 14001:2015 certified.

KCS is a LoRa Alliance member since 2016.

Support

Visit our support page at: www.trace.me

Sales

Contact us by email: Trade@trace.me

Disclaimer

KCS BV reserves the right to make changes without further notice to any products herein to improve reliability, function or design. KCS BV does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, nor the rights of others.

Kuipershaven 22
3311 AL Dordrecht
The Netherlands

email: Trade@trace.me
URL: www.trace.me