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AQI

Monitoring and Reporting Air Quality with Vyvo Technology Wearable Device

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Air Quality Index: An Overview

An Air Quality Index (AQI) reports air quality in reference to air pollution levels and associated health effects that might be of concern to the population. A higher AQI number represents greater pollution and a greater potential risk to health.

AQI measuring stations are often placed in areas with high population density to monitor air quality where people live, work, and spend time outdoors. These stations monitor various air pollutants such as particulate matter, ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide. Should appropriate agencies expect an elevated AQI for a given day, they can issue warnings for at-risk individuals to stay indoors or to use a mask when outside.

An **outdoor air quality index** provides measurements of various pollutants that affect air quality and human health. The most common AQI metrics include:

- Particulate Matter (PM), which include PM2.5 (Fine Particulate Matter) and PM10 (Coarse Particulate Matter).
- Gaseous Pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3).
- Volatile Organic Compounds (VOCs), organic chemicals that evaporate at room temperature, coming from paints, solvents, and industrial processes.
- Temperature and humidity. While these are obviously not pollutants, temperature and humidity influence air quality and pollutant behavior.

An AQI will include an overall AQI score, with a low score being best.
For indoor air measurements, the gas compounds that mostly affect human health include VOCs, total concentration of all VOCs (TVOC), carbon dioxide, sulfur-based odors, and other odors. Ethyl alcohol (EtOH) is a usual standard type of VOC for air quality evaluating, so its result is useful as a reference.

Additional applications of AQI include regulatory requirements — wherein government regulations may require the placement of measuring stations in specific locations — and scientific studies of air pollution patterns, sources, and impacts on public health and the environment.

Shortcomings of AQI

While AQI is a helpful metric, the accuracy of AQI measurements decreases as the distance from the monitoring station increases. This is especially applicable for pollutants that exhibit high spatial variability or are influenced by local sources. For example, even over short distances, pollutants like particulate matter (PM2.5 and PM10) and nitrogen dioxide (NO_2) can vary significantly due to factors such as traffic emissions, industrial activity, and geographical features.

- As a result, individuals living farther away from monitoring stations may experience air quality conditions that differ, perhaps significantly, from the AQI reported for the nearest station. Additionally, meteorological differences between locations can impact the usefulness of and accuracy of AQI readings.
- Furthermore, standard AQI reports have no way to account for the indoor air quality (IAQ) an individual may experience. This is an important consideration, as a poor IAQ should prompt an individual to go outside.

To be most helpful for users, therefore, an AQI should report both indoor and outdoor air quality close to the individual.

Monitoring AQI with Microsensors

Advancements in microtechnology can make a more personal and mobile AQI measurement avreality. These breakthroughs include air quality monitors consisting of microelectromechanicalvsystems (MEMS), chemiresistors, and microcontroller units (MCUs).

MEMS devices are tiny electromechanical systems that integrate mechanical and electrical components on a microscale. They typically consist of micrometer-sized structures, sensors, actuators, and electronics, all fabricated using microfabrication techniques. MEMS devices have revolutionized various fields, including consumer electronics, healthcare, automotive, aerospace, and telecommunications.

Chemiresistors are sensors that detect chemical compounds by measuring changes in electrical resistance. When the target compound comes into contact with the sensing material, it causes a change in the electrical properties of the material, leading to a measurable change in resistance. This change can be proportional to the concentration of the target compound in the environment being monitored.

MCUs are compact integrated circuits (ICs) that contain a microprocessor core, memory, input/output (I/O) peripherals, and other essential components required for embedded systems; they are essentially microscopic and self-contained computers. They are widely used in a diverse range of applications where control and processing capabilities are needed in a compact and cost-effective package.

A further consideration in enabling compact AQI measurement is Bluetooth Low Energy (BLE), also known as Bluetooth Smart. BLE is a wireless communication technology designed for short-range communication between devices. Its primary advantages are low power consumption and small data packet size.

Making AQI Personal & Mobile with BioSense Watch

BioSense Watch™ from Vyvo Technology is the world's only smartwatch with on-board air quality monitoring, specifically the AirSenseM1 air quality module. This module incorporates three distinct sensors to enable air quality monitoring to detect pollutants in the air around the wearer wherever he or she goes, indoors or out, in real time. AirSenseM1 uses MEMS and an MOX chemiresistor, drawing ultra-low power from the BioSense itself, plus algorithms and AI to detect as accurately as possible indoor and outdoor gas compounds. Specifically, AirSenseM1 includes:

- A gas sensor module to detect ozone and nitrogen dioxide
- A gas sensor module for TVOC and indoor air quality
- A high performance relative humidity and temperature sensor

When not worn, the device can also act as a stable air quality monitor, such as when placed on a kitchen counter.

Ambient temperature and humidity

These values represent the air surrounding the device, and do not necessarily reflect the current weather nor the body's temperature. These results report if the user is in a comfortable temperature or humidity environment. For indoor versus outdoor, there are some differences in how "comfortable" is defined, as the indoor measurement is a little stricter.

Indoor Air Measurements

BioSense Watch uses standards based on the German Umweltbundesamt (UBA, or Environment Agency), but there are some appropriate modifications for wearable air monitoring. Relative IAQ is defined in the style of the American Environmental Protection Agency (EPA) scale for Outdoor Air Quality. It is useful to unify the scales between indoor and outdoor, and between UBA and EPA in a General Air Quality Index (GAQI; see below for more).

CO2 concentration cannot be directly measured by the MEMS MOX sensor. However, there is a strong correlation between CO2 and TVOC levels caused by indoor human occupancy. Therefore, we calculate estimated CO2 (eCO2) using our robust, patent-pending algorithm using this correlation,
An indoor AQ measurement with BioSense AQI reports an overall measurement (1.0 in the image below); and data for TVOC (0.01 mg/m3); eCO2 (400.0 ppm); and EtOH (0.0 ppm). As a useful reference, the IAQ will also report perceived temperature and humidity.

Outdoor air measurements

The gas compounds that mostly affect human health are nitrogen dioxide (NO2) and ozone (O3). The EPA AQI is defined mainly based on these two gas compounds. For slow-changing outdoor environments, the EPA AQI is preferred. However, for fast changing environments — the kind in which the BioSense Watch will be mostly used — AQI FAST is preferred, which is the same AQI calculation based on a 1-minute average. The algorithm is tailored for best accuracy in the typical environmental range of 20 to 100ppb.

An outdoor AQ measurement with BioSense AQI reports an overall measurement (0.0 in the image below); and data for ozone (0.0 ppb); and an EPA measurement (0.00). Again, for the user's reference, this measurement will also report perceived temperature and humidity.

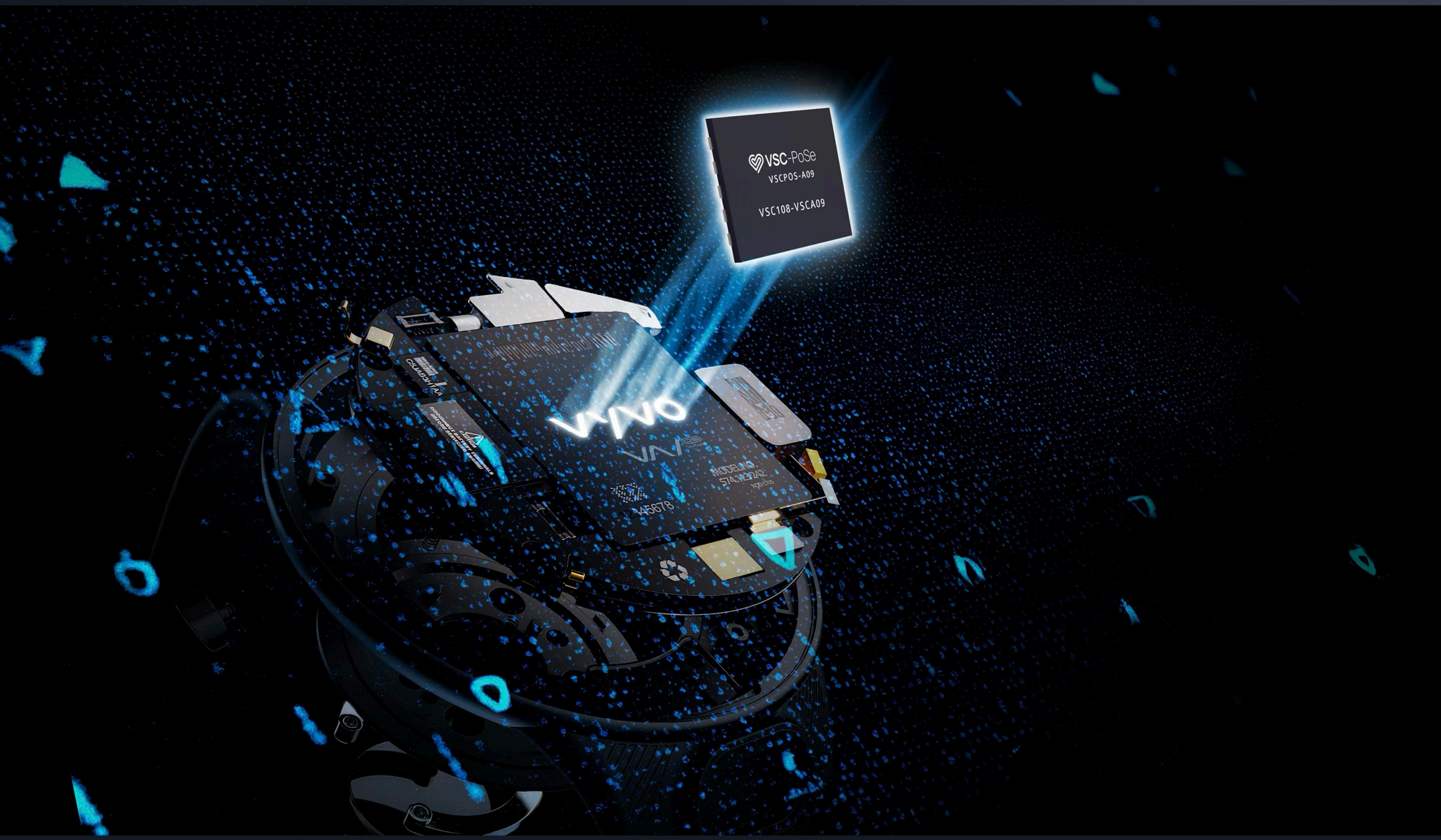
Defining and Measuring GAQI

Because BioSense Watch acts as a wearable air quality monitor, it is mostly used in fast-changing, fluctuating, and complicated circumstances. The wearer is likely to frequently move between indoor and outdoor environments, and the defining line between "indoor" and "outdoor" is hard to distinguish. For example, if someone is sitting inside next to a widely opened window. For this reason, we also employ GAQI, which reports the air quality based on all the results from the sensors, considering all measured gasses, IAQ, AQI, temperature, humidity, etc. The GAQI is the best possible representation of the air quality immediately around the device user at any given moment, and reported every 10 minutes. Equipped with this information, the device user can make informed decisions about whether to exercise, and which is the best location, indoors or out.

Proof of Sensing

BioSense Watch is also equipped with a Vyvo Smart Chain Proof-of-Sensing (PoSe) encryption chip to secure the data, including all air/environment data, with blockchain technology. Vyvo Smart Chain (VSC) — the blockchain developed by Vyvo which conforms to ETH protocols — is used to verify and validate the origin and generation of health, wellness, and environment data.

As a PoSe-enabled device, BioSense Watch can generate a reward of VSC Coin as it gathers health and environment data. The MCU sends unencrypted/unsigned data to the VSC chip, which sends back encrypted/signed data. Vyvo Technology observes the highest security requirements, and gas values will be integrated into blockchain for higher level applications.



Mobile App

In addition to algorithms built into BioSense Watch, there are higher level algorithms and AI support within the Vyvo Smart App, which in time will apply machine learning based on larger data sets, enabling more robust functions and reporting.

Breathe Easier with BioSense Watch

The real-time and very personal environmental awareness made possible by BioSense Watch — equipped with the AirSenseM — helps users make informed choices to protect their wellness. There's no substitute for knowledge, and this breakthrough feature is one more way Vyvo Technology supports healthy lifestyle choices.

Legal Disclaimer

Unless otherwise specified, Vyvo Technology Helo devices and related services are not medical devices and are not intended to diagnose, treat, cure, or prevent any disease. With regard to accuracy, Vyvo Technology Helo has developed products and services to track certain wellness information as accurately as reasonably possible. The accuracy of these products and services is not intended to be equivalent to medical devices or scientific measurement devices.

Consult your doctor before use if you have any pre-existing conditions that might be affected by your use of any Vyvo Technology product or service.

Glossary of Terms

AQI: Air Quality Index. In this article, AQI equates to EPA if no other mention.
AirSenseM: It is a combination of air quality modules designed by Vyvo. With AirSense M integrated into
BioSense Watch, users are enabled to monitor air quality.
BLE: Bluetooth Low Energy
eCO2: Estimated carbon dioxide level
EAL6+: Evaluation Assurance Level 6 Augmented
EPA: US Environmental Protection Agency
GAQI: General Air Quality Index, defined by Vyvo
IAQ: Indoor Air Quality. In this article, IAQ rates according to UBA if no other mention
MEMS: Micro-Electro-Mechanical System
MOX: Metal Oxide
O3: Ozone.
PoSe: Proof-of-Sensing
TVOC: Total Volatile Organic Compounds
UBA: Umweltbundesamt (German Federal Environmental Agency)
VOC: Volatile Organic Compounds
VSC: Vyvo Smart Chain. The blockchain developed by Vyvo.

VYVO™ TECH

SENSORS

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