

English Version

## Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air

Qualité de l'air - Évaluation des performances des systèmes capteurs de la qualité de l'air - Partie 1: Polluants gazeux dans l'air ambiant

Luftbeschaffenheit - Leistungsbewertung von Luftqualitäts-sensorsystemen - Teil 1: Gasförmige Schadstoffe in der Außenluft

This Technical Specification (CEN/TS) was approved by CEN on 17 October 2021 for provisional application.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
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## European foreword

This document (CEN/TS 17660-1:2021) has been prepared by Technical Committee CEN/TC 264 “Air quality”, the secretariat of which is held by DIN.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document is Part 1 of a series of documents published under the general title *Air quality — Performance evaluation of air quality sensor systems*.

Part 1 covers the performance evaluation of air quality sensor systems for gaseous pollutants in ambient air.

Part 2 covers the performance evaluation of air quality sensor systems for particulate pollutants in ambient air.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## Introduction

Sensor systems are generally seen as emerging measuring devices for the monitoring of air quality. Sensor systems provide a fast and low-cost alternative to the reference methods as defined in Directive 2008/50/EC on ambient air quality and cleaner air for Europe [1]. Sensor systems could allow for air pollution monitoring at a lower cost and with a higher spatial density than with the reference methods. They also allow for new air pollution applications when coupled with the global positioning system (GPS), global system for mobile communications (GSM) and smartphones including monitoring in complex topographies, at traffic junctions, in street canyons, at remote sites and for citizen science studies; e.g. monitoring around sensitive receptors, schools, or parks.

Sensor systems are making use of one or more low-cost sensors that are based on several principles of operations, e.g. amperometric sensors, metal oxides, optical sensors (infra-red absorption). However, sensor systems share some common features regarding their portability and low-cost compared to traditional reference methods. Typically, sensor systems are able to continuously monitor air pollution, with fast response times ranging between a few tens of seconds and a few minutes.

Currently, the use of sensor systems for air quality monitoring is limited by the occasional low accuracy of measurements that they can achieve. Additionally, there was no unambiguous protocol of evaluation of sensor systems with a structured metrological approach, able to ensure traceability from sensor system measurements to national and international standards. A protocol will enable exhaustive and transparent evaluations of sensor systems that can be an important step to include sensor system measurements into the monitoring of air quality for regulatory and non-regulatory purposes.

The protocol presented in this document applies to sensor systems and supports the requirements of Directive 2008/50/EC. The presented procedure evaluates if the measurement uncertainty defined in Directive 2008/50/EC as data quality objectives for indicative measurements and for objective estimation is met. However, the protocol additionally allows for a less demanding evaluation of the performance of sensor systems for non-regulatory measurements.

The protocol applies to sensor systems as individual measurement devices. This protocol does not apply to sensor systems as nodes in a sensor network. Annex A gives information on the use of sensor systems in sensor networks.

This document defines common procedures and requirements for the evaluation of the performance of sensor systems to facilitate mutual recognition by the relevant bodies or stakeholders and thereby minimise both administrative and cost burdens on manufacturers. It does not describe the roles and responsibilities of manufacturers, test laboratories and relevant bodies under these procedures.

In addition to the gaseous pollutants regulated in Directive 2008/50/EC, carbon dioxide is considered in the scope of this protocol although this compound is not listed in Directive 2008/50/EC. Consequently, there is no data quality objective for carbon dioxide. The World Health Organisation (WHO) has not set any guidelines for carbon dioxide. However, there is a growing interest in monitoring carbon dioxide in ambient air with sensor systems.

## 1 Scope

This document specifies the general principles, including testing procedures and requirements, for the classification of performance of low-cost sensor systems for the monitoring of gaseous compounds in ambient air at fixed sites. The classification of sensor systems includes tests that are performed under prescribed laboratory and field conditions.

The procedure described is applicable to the determination of the mass concentration of air pollutants. The pollutants that are considered in this document are the gaseous pollutants regulated under Directive 2008/50/EC (O<sub>3</sub>, NO/NO<sub>2</sub>/NO<sub>x</sub>, CO, SO<sub>2</sub> and benzene) in the range of concentrations expected in ambient air.

This document provides a classification that is consistent with the requirements for indicative measurements and objective estimation defined in Directive 2008/50/EC. In addition, it provides a classification for applications (non-regulatory measurements) that require more relaxed performance criteria.

This document applies to sensor systems used as individual systems. It does not apply to sensor systems as part of a sensor network. However, for some applications (e.g. in cities) sensor systems are deployed as part of a sensor network. Annex A gives information on the use of sensor systems as nodes in a sensor network.

This document gives guidance on the testing of CO<sub>2</sub> sensor systems in Annex B since, although not listed in Directive 2008/50/EC, CO<sub>2</sub> is an interesting indicator as proxy for activities involving combustion processes or for CO<sub>2</sub> evaporation from soil or water.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN ISO 14956:2006, *Air quality — Evaluation of the suitability of a measurement procedure by comparison with a required measurement uncertainty (ISO 14956:2002)*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

### 3.1 ambient air

outdoor air in the troposphere where provisions concerning health and safety at work apply and to which members of the public do not have regular access

[SOURCE: Directive 2008/50/EC]

Note 1 to entry: This does not include workplaces defined by Directive 89/654/EC.