
**Air quality — Environmental
meteorology —**

**Part 3:
Ground-based remote sensing of wind
by continuous-wave Doppler lidar**

Qualité de l'air — Météorologie de l'environnement —

*Partie 3: Télédéttection du vent par lidar Doppler à ondes continues
basé au sol*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 5, *Meteorology*.

A list of all parts in the ISO 28902 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Lidars (“light detection and ranging”), used in this document to designate atmospheric lidars, have proven to be valuable systems for the remote sensing of atmospheric pollutants in various meteorological parameters, such as wind, clouds, aerosols and gases. Extensive optical and physical properties of the probed targets, such as size distribution, chemical composition, shape of the particles and gas concentration, and optical properties of the atmosphere, such as visibility, extinction and backscatter, can be retrieved using lidars. Atmospheric targets such as these can be spatially resolved along their line of sight by, for example, focusing the continuous-wave beam at the chosen specific range. The measurements can be carried out without direct contact and in any direction as electromagnetic radiation is used for sensing the targets. Lidar systems, therefore, supplement the conventional *in situ* measurement technology. They are suited for a large number of applications that cannot be adequately performed by using *in situ* or point measurement methods.

There are several methods by which lidar can be used to measure atmospheric wind. The four most commonly used methods are heterodyne pulsed Doppler wind lidar (see ISO 28902-2:2017^[1]), heterodyne continuous-wave Doppler wind lidar, direct-detection Doppler wind lidar and resonance Doppler wind lidar (commonly used for mesospheric sodium layer measurements). For further reading, refer to References ^[2] and ^[3].

This document describes the use of (monostatic) heterodyne continuous-wave Doppler lidar.

Voorbeeld
Preview

Air quality — Environmental meteorology —

Part 3: Ground-based remote sensing of wind by continuous-wave Doppler lidar

1 Scope

This document specifies the requirements and performance test procedures for monostatic heterodyne continuous-wave (CW) Doppler lidar techniques and presents their advantages and limitations. The term “Doppler lidar” used in this document applies solely to monostatic heterodyne CW lidar systems retrieving wind measurements from the scattering of laser light by aerosols in the atmosphere. Performances and limits are described based on standard atmospheric conditions. This document describes the determination of the line-of-sight wind velocity (radial wind velocity).

NOTE Derivation of wind vector from individual line-of-sight measurements is not described in this document since it is highly specific to a particular wind lidar configuration. One example of the retrieval of the wind vector can be found in ISO 28902-2:2017, Annex B.

This document does not address the retrieval of the wind vector.

This document can be used for the following application areas:

- meteorological briefing for e.g. aviation, airport safety, marine applications, oil platforms;
- wind power production (e.g. site assessment, power curve determination);
- routine measurements of wind profiles at meteorological stations;
- air pollution dispersion monitoring;
- industrial risk management (direct data monitoring or by assimilation into micro-scale flow models);
- exchange processes (greenhouse gas emissions).

This document can be used by manufacturers of monostatic CW Doppler wind lidars as well as bodies testing and certifying their conformity. This document also provides recommendations for users to make adequate use of these instruments.

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.

IEC 61400-12-1:2017, *Wind energy generation systems — Part 12-1: Power performance measurements of electricity producing wind turbines*

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:

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

3.1 data availability
ratio between the number of actual considered measurement data with a predefined data quality and the number of expected measurement data for a given measurement period

Note 1 to entry: In the wind industry, this term commonly applies to measurements averaged over a standard period of 10 min.

3.2 displayed range resolution
spatial interval between the centres of two successive range measurements

3.3 effective range resolution
application-related variable describing an integrated range interval for which the target variable is delivered with a defined uncertainty

[SOURCE: ISO 28902-1:2012, 3.14, modified — The example has been deleted.]

3.4 effective temporal resolution
application-related variable describing an integrated time interval for which the target variable is delivered with a defined uncertainty

[SOURCE: ISO 28902-1:2012, 3.15, modified — The symbol and the example has been deleted.]

3.5 extinction coefficient
 α
measure of the atmospheric opacity, expressed by the natural logarithm of the ratio of incident light intensity to transmitted light intensity, per unit light path length

[SOURCE: ISO 28902-1:2012, 3.10]

3.6 integration time
time spent in order to derive an independent value of the line-of-sight velocity

3.7 maximum acquisition range
 R_{MaxA}
maximum distance at which a lidar signal can be recorded and processed

Note 1 to entry: It depends primarily on the laser wavelength and transmitter aperture size; also, to some extent, it depends on the number of acquisition points and the sampling frequency.

3.8 minimum acquisition range
 R_{MinA}
minimum distance from which a lidar signal can be recorded and processed

Note 1 to entry: If the minimum acquisition range is not given, it is assumed to be zero. It can be different from zero, when the reception is blind by focusing limitations.

3.9**maximum operational range** R_{Max0}

maximum distance to which a wind speed can be derived with confidence from the lidar signal

Note 1 to entry: The maximum operational range is less than or equal to the maximum acquisition range.

Note 2 to entry: The maximum operational range is defined along an axis corresponding to the application. It is measured vertically for vertical wind profiler. It is measured horizontally for scanning lidars able to measure in the full hemisphere.

Note 3 to entry: The maximum operational range depends on lidar parameters but also on atmospheric conditions, particularly the extinction coefficient.

3.10**measurement period**

interval of time between the first and last measurements

[SOURCE: ISO 28902-2:2017, 3.10]

3.11**minimum operational range** R_{Min0}

minimum distance where wind speed can be derived with confidence from the lidar signal

Note 1 to entry: The minimum operational range is also called blind range.

Note 2 to entry: In continuous-wave lidars, the minimum operational range is determined by the closest position of the focus achievable by the transceiver optical system.

3.12**physical range resolution**

width [full width at half maximum (FWHM)] of the range weighting function

[SOURCE: ISO 28902-2:2017, 3.12]

3.13**probe length**

width [full width at half maximum (FWHM)] of the spatial weighting function selecting the region in space that contributes to the wind speed computation

Note 1 to entry: The probe length is centred on the measurement distance.

3.14**range resolution**

equipment-related variable describing the shortest range interval from which independent signal information can be obtained

[SOURCE: ISO 28902-1:2012, 3.13]

3.15**range weighting function**

weighting function of the radial wind speed along the line of sight

[SOURCE: ISO 28902-2:2017, 3.15]

3.16**temporal resolution**

equipment-related variable describing the shortest time interval from which independent signal information can be obtained

[SOURCE: ISO 28902-1:2012, 3.11]

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