INTERNATIONAL STANDARD

ISO 12188-1

First edition
2010-03-15

Tractors and machinery for agriculture and forestry — Test procedures for positioning and guidance systems in agriculture —

Part 1: Dynamic testing of satellite-based positioning devices

Tracteurs et matériels agricoles et forestiers — Modes opératoires d'essai des systèmes de positionnement et de guidage utilisés en agriculture —

Partie 1: Essai dynamique des dispositifs de positionnement par satellite

Reference number
ISO 12188-1:2010(E)

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Published in Switzerland

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 12188-1 was prepared by Technical Committee ISO/TC 23, *Tractors and machinery for agriculture and forestry*, Subcommittee SC 19, *Agricultural electronics*.

ISO 12188 consists of the following parts, under the general title *Tractors and machinery for agriculture and forestry — Test procedures for positioning and guidance systems in agriculture*:

— *Part 1: Dynamic testing of satellite-based positioning devices*

The following parts are under preparation:

— *Part 2: Satellite-based auto-guidance systems tested during straight and level travel*

Introduction

Satellite positioning devices have become more common in agricultural applications. They are not only used as position sensors for georeferencing data or site-specific application tasks, but are also part of more complex navigation systems for agricultural machines.

In the early stages of development of this part of ISO 12188, the only existing standards for satellite-based, positioning-device performance specification focused on the static accuracy of the device. There was no existing standard that adequately specified methods for testing or reporting the accuracy of the receivers while they are in motion. This part of ISO 12188 is intended to fill this void by providing a framework for testing receivers that are subject to the type of motion typically experienced by receivers used in agricultural field operations. It provides an implementable methodology for conducting the tests while still providing a means to equitably compare the performance of different satellite-based positioning devices.

Tractors and machinery for agriculture and forestry — Test procedures for positioning and guidance systems in agriculture —

Part 1: Dynamic testing of satellite-based positioning devices

1 Scope

This part of ISO 12188 provides a procedure for evaluating and reporting the accuracy of navigation data determined using positioning devices that are based on GPS, GLONASS, Galileo or similar global navigation satellite systems (GNSS). It focuses on the performance of the positioning devices while they are subject to motions typical of ground-based agricultural field operations and specifies common performance parameters that can be used to quantify and compare the dynamic performance of different positioning devices.

2 Terms and definitions

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

2.1 General terms related to positioning device testing

2.1.1
positioning device
PD
instrument that is capable of determining and reporting the position of its antenna centre point in geographic coordinates and in real time using satellite-based radio-navigation signals

2.1.2
navigation data record
NDR
report of geographic coordinates, elevation, course, travel velocity and other navigation-related parameters computed by a PD

2.1.3
travel course
TC
predefined route of travel during the test

2.1.4
reference navigation system
RNS
fixture or measurement device capable of either precisely controlling the path of the PD or recording the actual path that the PD traversed

2.1.5
geographic coordinates
geographic latitude, longitude and elevation with respect to an internationally defined geodetic coordinate system

2.1.6
travel speed
distance travelled in a unit of time

NOTE Travel speed is expressed in metres per second.

2.1.7
course over ground
horizontally projected direction of travel measured clockwise from true north, as defined by NMEA 0183

NOTE The projected direction of travel is expressed in degrees.

2.1.8
time
Universal Time Coordinated (UTC) with corresponding date, as defined by NMEA 0183

2.1.9
initialization time
time elapsed between the point in time when the positioning device is powered and the beginning of the first test run

2.2 Terms describing position accuracy and error measurements

2.2.1
off-track error
perpendicular deviation from the actual travel course

2.2.2
horizontal position error
horizontally projected deviation from absolute position

NOTE This measurement does not include positioning device latency.

2.2.3
vertical position error
vertically projected deviation from absolute position

2.2.4
latency
time between reception of satellite signals at the antenna and transmission of the first character or message of the NDR

2.2.5
absolute horizontal [vertical] positioning accuracy
extent to which an NDR conforms to RNS data

2.2.6
relative horizontal [vertical] positioning accuracy
extent to which an NDR conforms to other NDRs from the same PD at the same location at different times

2.2.7
short-term dynamic accuracy
short-term dynamic performance determined from off-track errors along straight segment passes occurring within a 15 min time frame

NOTE Short-term dynamic accuracy is similar to what is commonly called pass-to-pass accuracy.

2.2.8
long-term dynamic accuracy
dynamic performance determined from off-track errors along straight segment passes occurring within a time period of not less than 24 h

2.2.9
U-turn accuracy
dynamic performance determined from off-track errors occurring during traverse of a 180° turn

3 Requirements

3.1 General

The following applies for testing.

a) The travel course (TC) shall include at least two straight segments and a U-turn segment. The straight segments shall be at least 90 m long and shall be oriented between 35° and 55° from true north. The U-turn shall traverse 180° at a constant radius of turn between 5 m and 10 m and shall connect directly at either end to straight segments. The course shall have a change in elevation no greater than 1 m. There shall be no obstructions visible from any point on the test course, at an elevation of the PD antennae higher than 10° above a horizontal horizon, that interfere with or block satellite signals. There shall be no metallic or other surfaces within 50 m of the course that could cause multipath interference. Course location and geometry shall be documented with appropriate detail to allow exact replication.

b) Before the initialization time begins, all firmware and user-configurable settings on the PD shall be reset to default. Changes to user-configurable settings are permitted after this reset; they shall be made before the initialization period and shall not be altered throughout the entire test. All device settings shall be explicitly documented.

NOTE User-configurable settings include, but are not limited to, firmware version, differential correction services and settings, mask angle, enabled filters, output data format, and other device-specific parameters.

c) NDRs shall be logged at the maximum rate facilitated by the PD and shall include at least the date, time, position, elevation, geoidal separation, speed, course over ground, number of satellites, correction status, and satellite constellation configuration. All receiver outputs shall be described and documented clearly. The PD output port and data communication protocol used shall also be documented clearly.

NOTE The satellite constellation configuration can be quantified by the horizontal dilution of precision (HDOP).

d) The RNS shall have sufficient absolute position accuracy and data output rate to produce reference navigation data that are at least an order of magnitude (10 times) more accurate than the tested PD anywhere along the TC. Reference navigation data shall be synchronized with the PD output to ±1 m/s uncertainty. The specifications of the RNS shall be reported and any interpolation or other computational techniques used to calculate the actual TC shall be clearly documented. Reference measurement devices are not limited to satellite-based equipment.

e) When conducting tests on a non-fixed course, the test course shall be replicated during each pass by the carrying vehicle with a deviation of less than 1 m.

f) During all tests an independent tool shall be used to record actual (not predicted) satellite signal and constellation parameters such as satellite visibility, configuration and signal quality for the test location and time. In addition to graphs of critical parameters, the report shall include mean, minimum and maximum values for numerical parameters.