
**Information technology — Radio
frequency identification device
performance test methods —**

**Part 1:
Test methods for system performance**

*Technologies de l'information — Méthodes d'essai des performances
du dispositif d'identification par radiofréquence —*

Partie 1: Méthodes d'essai des performances du système

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC 18046-1:2011

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC 18046-1:2011



COPYRIGHT PROTECTED DOCUMENT

© ISO/IEC 2011

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

| | |
|--|----|
| Foreword | iv |
| Introduction..... | v |
| 1 Scope | 1 |
| 2 Normative references | 1 |
| 3 Terms and definitions | 1 |
| 4 Abbreviated terms | 2 |
| 5 Conditions applicable to the test methods..... | 2 |
| 5.1 Selection of the tests | 2 |
| 5.2 Selection of the devices to be tested | 2 |
| 5.3 Test environment..... | 2 |
| 5.4 RF environment | 2 |
| 5.5 Pre-conditioning | 3 |
| 5.6 Default tolerance | 3 |
| 5.7 Total measurement uncertainty | 3 |
| 5.8 Test Read and Write | 3 |
| 5.9 Test speed motion..... | 3 |
| 5.10 Test mounting material..... | 3 |
| 5.11 Test communication parameters | 3 |
| 5.12 Test equipment limits..... | 3 |
| 5.13 Human exposure to EMF | 4 |
| 5.14 Test result reporting..... | 4 |
| 5.15 Tag arrangement | 4 |
| 6 Inductive systems | 5 |
| 6.1 Portable Interrogator..... | 5 |
| 6.2 Interrogator with one side antenna(s) configuration..... | 10 |
| 6.3 Interrogator gate antenna configuration..... | 19 |
| 6.4 Interrogator 3 dimension antenna configuration (tunnel)..... | 25 |
| 7 Propagative system according ISO/IEC 18000-6..... | 31 |
| 7.1 Portable Interrogator..... | 31 |
| 7.2 Interrogator with one side antenna(s) configuration..... | 36 |
| 7.3 Interrogator gate antenna configuration..... | 47 |
| 7.4 Interrogator 3 dimension antenna configuration (tunnel)..... | 52 |
| 8 Propagative System according ISO/IEC 18000-7 | 61 |
| 8.1 Fixed Interrogator..... | 61 |
| Annex A (Normative) Table of general parameters for the test report..... | 64 |
| Bibliography..... | 65 |

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national 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 and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 18046-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This first edition (ISO/IEC 18046-1) cancels and replaces the first edition (ISO/IEC 18046:2006).

ISO/IEC 18046 consists of the following parts, under the general title *Information technology — Radio frequency identification device performance test methods*:

- *Part 1: Test methods for system performance*
- *Part 2: Test methods for interrogator performance*
- *Part 3: Test methods for tag performance*

Introduction

RFID technology has broad applicability to the Automatic Identification and Data Capture (AIDC) industry in item management. As a wireless communication technique based on Radio Frequency technology the applications cover multiple levels of the industrial, commercial and retail supply chains. These can include:

- freight containers,
- returnable Transport Items (RTI),
- transport units,
- product packaging, and
- product tagging.

Performance tests define test methods that deliver results that allow the comparison of different RFID systems, interrogator and tags in order to select among them for use in a particular application.

The performance characteristics of devices (tags and interrogation equipment) can vary drastically due to application factors as well as the particular RFID air interface (frequency, modulation, protocol, etc.) being supported. Of key concern is the matching of the various performance characteristics to the user application. Additionally, in an open environment users of such technology demand multiple sources for these devices from technology providers. A key challenge is a method of evaluating the differences between various technology providers' products in a consistent and equitable manner.

This part of ISO/IEC 18046 provides a framework for meeting the above noted concern and challenges. To this end, clear definitions of performance as related to user application of RFID technology in the supply chain are provided. Based on such application-based definitions, test methods are defined with attention to the test parameters required for a consistent evaluation of RFID devices.

Of particular significance, these tests are defined for RFID devices having one antenna. It is common practice to have products with both single and multiple antennas to define an RFID transaction zone sufficient for the application. The defined methods can easily be extended from equipment with a single antenna to apply to equipment with multiple antennas, in order to evaluate performance under conditions more closely matching those of a particular application.

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC 18046-1:2017

Information technology — Radio frequency identification device performance test methods —

Part 1: Test methods for system performance

1 Scope

This part of ISO/IEC 18046 defines test methods for performance characteristics of RFID systems for item management, and specifies the general requirements and test requirements for systems which are applicable to the selection of devices for an application. It does not apply to testing in relation to regulatory or similar requirements.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC Guide 98-3, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-4, *Sampling procedures for inspection by attributes — Part 4: Procedures for assessment of declared quality levels*

ISO 2859-10, *Sampling procedures for inspection by attributes — Part 10: Introduction to the ISO 2859 series of standards for sampling for inspection by attributes*

ISO/IEC 19762-3, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 3: Radio frequency identification (RFID)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-3 and the following apply.

3.1

one side antenna(s)

system with one antenna or multiple antennas which are positioned on the same plane and same side in front of the tag

3.2

gate

system with a minimum of two antennas set in parallel vertical plans at a given distance with a tag that moves between these antennas

**3.3
tunnel**

system with a minimum of three antennas, two of them being set in parallel vertical plans, and one being set in a horizontal plan with a tag that moves between those three antennas

4 Abbreviated terms

- D Distance between tag and antenna of interrogator
- D_G Distance between antennas for gate configuration
- D_{HT} Horizontal distance between antennas for tunnel configuration
- EMF Electro Magnetic Field
- MPE Maximum Permissive Exposure
- SAR Specific Absorption Rate

5 Conditions applicable to the test methods

5.1 Selection of the tests

The system integrators and/or end users will have to select the applicable tests according to a specific application while ignoring the ones which do not apply to this (these) application(s).

5.2 Selection of the devices to be tested

Unless otherwise specified, testing shall be performed on:

- The population of tag to be tested shall be chosen in accordance with ISO/IEC 2859-1, ISO/IEC 2859-4, and ISO/IEC 2859-10.
- The interrogator given for testing.

The equipment shall be the same for all the tests selected for the testing program.

5.3 Test environment

Unless otherwise specified, testing shall take place in air environment of temperature 23°C ± 3°C (73°F ± 5°F) and of relative humidity 30 % to 60 %.

5.4 RF environment

The tests shall be performed in a known RF environment. RF environment must be measured to operate the test. Spurious transmissions in functional band for the test must be less than -80 dBm.

All measurement shall be done with spectrum analyser and antenna (loop antenna for BF and HF band, and Log periodic antenna or horn for UHF band).

The spectrum analyser must be configured on the RF band and on "Max hold" measurement. The time of measurement must be more than 5 min.

5.5 Pre-conditioning

The RFID System to be tested shall be conditioned to the test environment for a period of 24 hours before testing.

5.6 Default tolerance

Unless otherwise specified, a default tolerance of $\pm 5\%$ shall be applied to the quantity values given to specify the characteristics of the test equipment (e.g. linear dimensions) and the test method procedures (e.g. test equipment adjustments).

5.7 Total measurement uncertainty

The total measurement uncertainty for each quantity determined by these test methods shall be stated in the test report in accordance with ISO/IEC Guide 98-3.

5.8 Test Read and Write

The hexadecimal characters written in the user memory shall be alternatively 0xAA and 0x55

Without specific requirement, the user memory addresses used for these tests shall be the first address and the last address. Others addresses could be tested and these addresses shall be noted in the report.

The size and position of data in the memory to be read or written may influence the results and shall therefore be noted.

Measure the maximum read and write rate for the system under test and these rates shall be noted in the report.

5.9 Test speed motion

For all Tests Speed Motion, the unique important factor is that the motion speed be constant within the volume tested. It implies that the tag be moved from outside the reading volume at a constant speed throughout the volume tested.

The interrogator shall be configured to repeat the inventory command. The delay between two inventory commands shall be such that the tag is still in the identification volume (read zone).

5.10 Test mounting material

The tags shall be mounted on the mounting materials for which they are intended for the application. The mounted material attached to the tag shall be considered as integral part of the tag.

5.11 Test communication parameters

All the tests shall be done for various communication parameters (forward and return link). The tests conditions shall be recorded in the test report.

5.12 Test equipment limits

If the test equipment limits the performance measurement, these limits shall be noted in the test report.

5.13 Human exposure to EMF

High magnetic or electromagnetic field strength shall not exceed the limits of maximum permissible human exposure to EMF, in accordance with local regulations. FCC guidelines for MPE and SAR or EC 1999/519/CE are examples for relevant documents.

5.14 Test result reporting

Each test result shall include: identification number of tag (UII, Tag ID,.. in relation with air interface standards), type, description, reference number (serial number) of the interrogator, minimum value, maximum value, mean value and standard deviation of the results.

In order to evaluate the results, the interrogator antenna properties, model etc. shall also be specified, as well as the type of interrogator, and type of connection between interrogator and antenna.

The type of command and the number of bits written shall be indicated in the report.

For the tests requiring measurement curves, additionally to the curves on minimum value, maximum value, mean value and standard deviation, the individual curves of 5 randomly selected measured devices shall be shown in the test report.

5.15 Tag arrangement

The geometric arrangement of the tags in a population under test may be linear (1D, see Figure 1), array (2D, see Figure 2), or volume (3D, see Figure 3). The spacing of the tags within the defined geometry shall be uniform. Tag spacing shall be measured as the distance between the geometric centroid of each tag. The diagrams below represent the three basic types of tag arrays.

The minimum distance between two tags shall be two times the maximum length of the tag's antenna.

The tag population shall be arranged in a volume smaller than the Identification volume (read zone).



Figure 1 — 1D linear tag

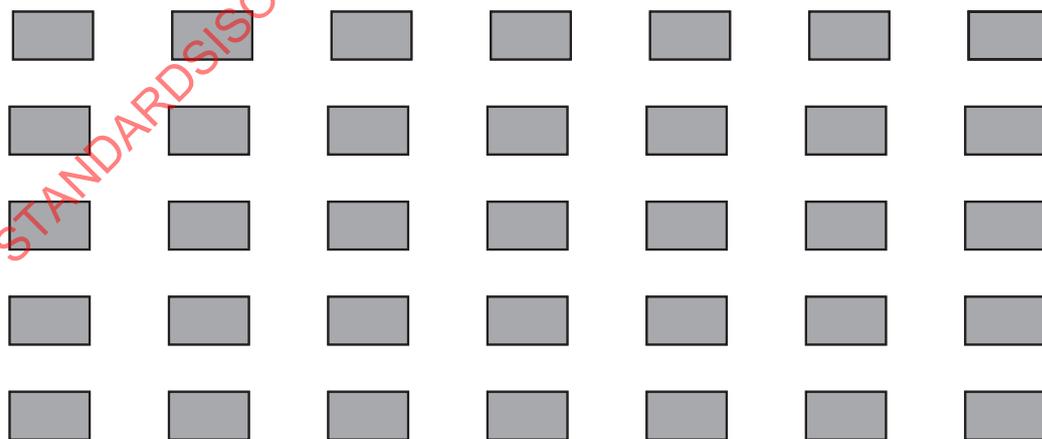


Figure 2 — 2D tag array

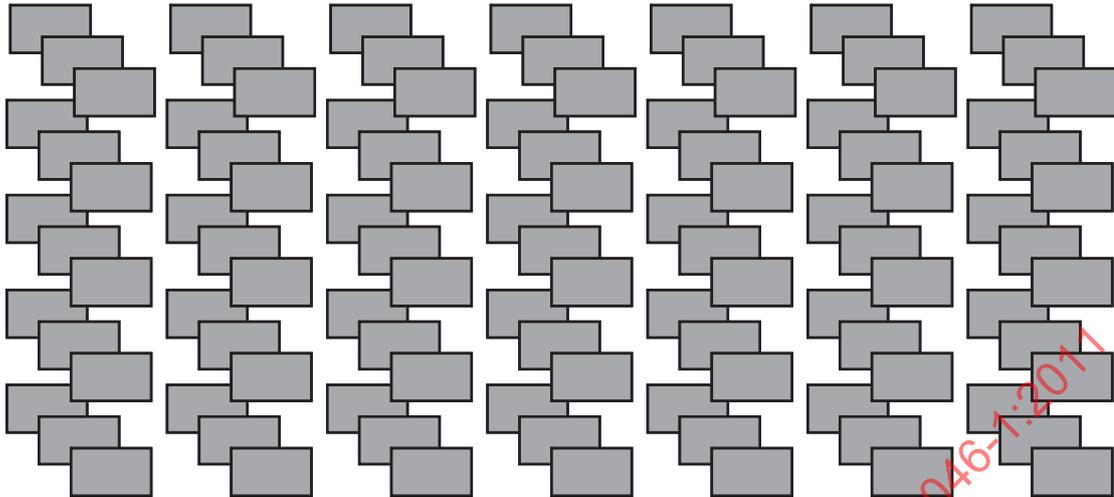


Figure 3 — 3D tag volume

6 Inductive systems

6.1 Portable Interrogator

6.1.1 Operated Range Test

6.1.1.1 Purpose

This test determines the maximum identification distance, read distance and writes distance in front of the antenna of the interrogator.

6.1.1.2 Test set-up

Figure 4 below shows the test set-up for range measurement:

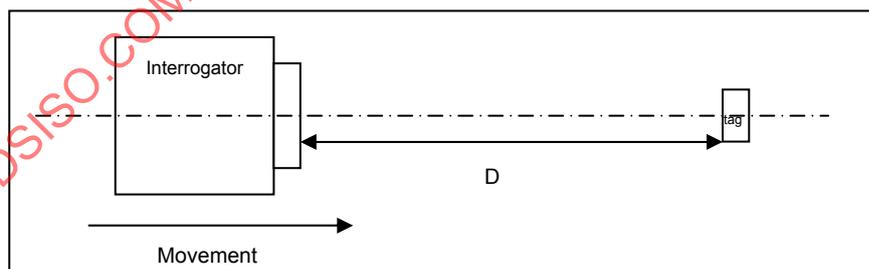


Figure 4 — Test setup for Operated Range Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.1.1.3 Test procedure

6.1.1.3.1 Test procedure for identification and read range

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The interrogator shall be moved closer to the tag by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The Inventory command or Read command (as applicable) shall be sent by the interrogator and the existence of a communication link shall be verified.
- 4- If the communication link does not exist, the step 2 shall be repeated.
- 5- If the communication link exists, the reading command shall be sent 5 times without move the reader.
- 6- If one out of the 5 communication links does not exist, then the step 2 shall be repeated.
- 7- If the communication link exists for each of the 5 tests then the distance D shall be noted in the report as the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable).

6.1.1.3.2 Test procedure for write range

The interrogator shall be set in relation to the tag and in accordance with radio frequency recommendation.

- 1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The interrogator shall be moved closer to the tag by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The writing command shall be sent by the interrogator with hexadecimal characters 0xAA.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- If the correct data is not read, the step 2 shall be repeated.
- 6- If the correct data is read, the writing command shall be sent by the interrogator with hexadecimal characters 0x55.
- 7- The reading command shall be sent to verify that the correct data is written.
- 8- If the correct data is not read, the step 2 shall be repeated.
- 9- If the correct data is read, the step 3 shall be repeated. This step shall be repeated 5 times.
- 10- If the writing command is valid for each of the 5 tests then the distance shall be noted in the report as the "WRITE_RANGE".

6.1.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.
The results of the test shall be recorded according to Table 1

Table 1 — Parameters that shall be recorded for this measurement

| Test Results | | | | | |
|------------------------|---------|---------|---------|---------|---------|
| EUT | Tag 1 | Tag 2 | Tag 3 | Tag 4 | ... |
| IDENTIFICATION_RANGE : | xx.x cm |
| Or | | | | | |
| READ_RANGE | | | | | |
| Or | | | | | |
| WRITE_RANGE | | | | | |

6.1.2 Operated Volume Test

6.1.2.1 Purpose

This test determines maximum identification volume, read volume and write volume in front of the antenna of the interrogator.

6.1.2.2 Test set-up

Figure 5 shows the test set-up for identification volume, read volume and write volume measurement:

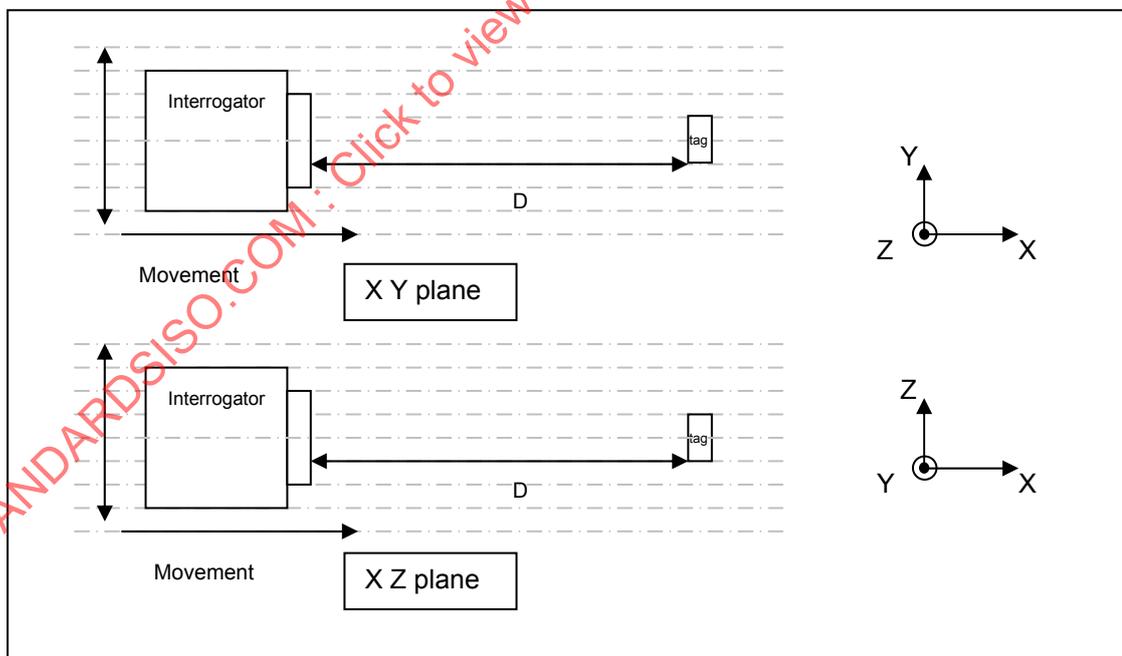


Figure 5 — Test setup for Operated Volume Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.1.2.3 Test procedure

6.1.2.3.1 Test procedure for identification and read volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable) as defined in § 6.1.1.3.1.
- 2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions..
The interrogator shall be moved along the Y and Z axis by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The identification or reading (as applicable) command shall be sent
- 4- Repeat step 2 until the identification rate or read drops to zero
- 5- Noting identification rate or read success (as applicable) at each step before drops to zero, Repeat step 2

6.1.2.3.2 Test procedure for write volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "WRITE_RANGE" as defined in § 6.1.1.3.2.
- 2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions until the identification rate or read drops to zero.
The interrogator shall be moved along the Y and Z axis by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The writing command shall be sent by the interrogator with appropriate value defined in part 5.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- Repeat step 2 until the write drops to zero.
- 6- Noting identification write success at each step before drops to zero, Repeat step 2

6.1.2.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A. The results of the test shall be recorded according to Table 2.

Example of graph results is shown in Figure 6.

Table 2 — Parameters that shall be recorded for this measurement

| | | | | | |
|---|---------|---------|---------|---------|---------|
| Operated Volume Test | | | | | |
| Test Results: EUT 1 | | | | | |
| Identification rate / Read / Write success | YES/NO | YES/NO | YES/NO | YES/NO | YES/NO |
| Distance on X axis : | xx.x cm |
| | | | | | |
| X = 30% | | | | | |
| Identification rate success / Read success / Write success | Y | | | Z | |
| YES/NO | Yy | | | Zz | |
| YES/NO | Yy | | | Zz | |
| ... | ... | | | ... | |
| X = 50% | | | | | |
| Identification rate success / Read success / Write success | Y | | | Z | |
| YES/NO | Yy | | | Zz | |
| YES/NO | Yy | | | Zz | |
| ... | ... | | | ... | |
| X = 80% | | | | | |
| Identification rate success / Read success / Write success | Y | | | Z | |
| YES/NO | Yy | | | Zz | |
| YES/NO | Yy | | | Zz | |
| ... | ... | | | ... | |

STANDARDSISO.COM Click to view the full PDF of ISO/IEC 18046-1:2011

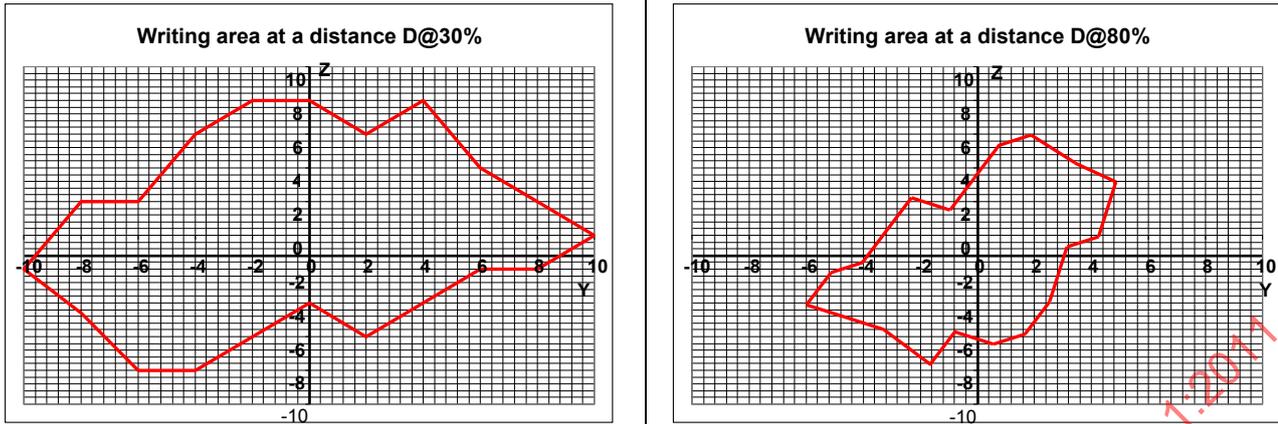


Figure 6 — Example of graph result for writing area distance at 30% and 80% of WRITE_RANGE

6.2 Interrogator with one side antenna(s) configuration

6.2.1 Operated Range Test

6.2.1.1 Purpose

This test determines the maximum identification distance, read distance and writes distance in front of the antenna of the interrogator.

6.2.1.2 Test set-up

Figure 7 shows the test set-up for range measurement.

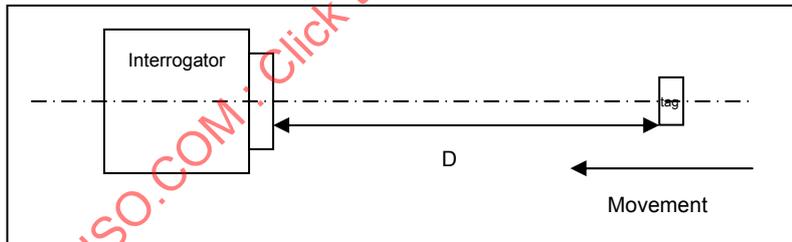


Figure 7 — Test setup for Operated Range Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.2.1.3 Test procedure

6.2.1.3.1 Test procedure for identification and read range

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the interrogator.
- 2- The tag shall be moved closer to the interrogator by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The Inventory command or Read command (as applicable) shall be sent by the interrogator and the existence of a communication link shall be verified.
- 4- If the communication link does not exist, the step 2 shall be repeated.
- 5- If the communication link exists, the reading command shall be sent 5 times without move the reader.
- 6- If one out of the 5 communication links does not exist, then the step 2 shall be repeated.
- 7- If the communication link exists for each of the 5 tests then the distance D shall be noted in the report as the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable).

6.2.1.3.2 Test procedure for write range

The interrogator shall be set in relation to the tag and in accordance with radio frequency recommendation.

- 1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The interrogator shall be moved closer to the tag by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The writing command shall be sent by the interrogator with appropriate value defined in part 5.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- If the correct data is not read, the step 2 shall be repeated.
- 6- If the correct data is read, the writing command shall be sent by the interrogator with appropriate value defined in part 5.
- 7- The reading command shall be sent to verify that the correct data is written.
- 8- If the correct data is not read, the step 2 shall be repeated.
- 9- If the correct data is read, the step 3 shall be repeated. This step shall be repeated 5 times.
- 10- If the writing command is valid for each of the 5 tests then the distance shall be noted in the report as the "WRITE_RANGE".

6.2.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 3.

Table 3 — Parameters that shall be recorded for this measurement

| Test Results | | | | | |
|------------------------|---------|---------|---------|---------|---------|
| EUT | Tag 1 | Tag 2 | Tag 3 | Tag 4 | ... |
| IDENTIFICATION_RANGE : | xx.x cm |
| Or | | | | | |
| READ_RANGE | | | | | |
| Or | | | | | |
| WRITE_RANGE | | | | | |

6.2.2 Operated Volume Test

6.2.2.1 Purpose

This test determines maximum identification volume, read volume and write volume in front of the antenna of the interrogator.

6.2.2.2 Test set-up

Figure 8 shows the test set-up for identification volume, read volume and write volume measurement:

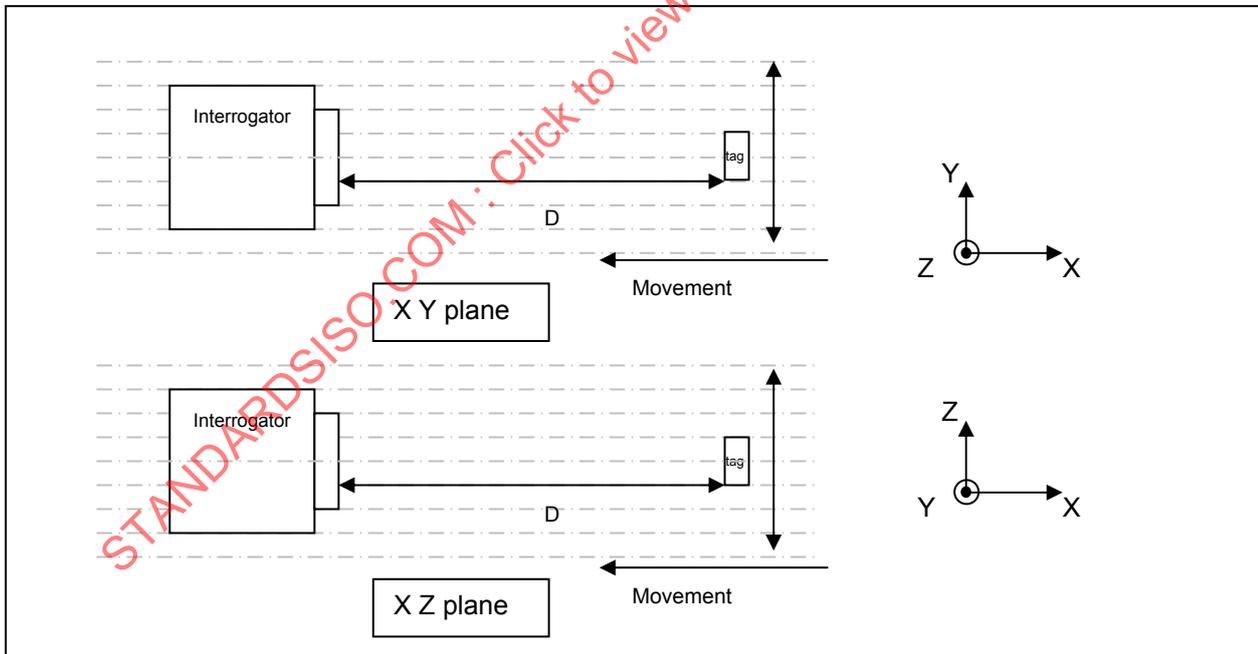


Figure 8 — Test setup for Operated Volume Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.2.2.3 Test procedure

6.2.2.3.1 Test procedure for identification and read volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on X axis at a distance of 30% 50% and 80% of the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable) as defined in § 6.2.1.3.1,
- 2- For each X axis distance, the tag shall be moved in steps as specified below in both positive and negative Y and Z directions.
The tag shall be moved along the Y and Z axis by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The identification or reading (as applicable) command shall be sent.
- 4- Repeat step 2 until the identification rate or read drops to zero.
- 5- Noting identification rate or read success (as applicable) at each step before drops to zero, Repeat step 2.

6.2.2.3.2 Test procedure for write volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on X axis at a distance of 30% 50% and 80% of the "WRITE_RANGE" as defined in § 6.2.1.3.2,
- 2- For each X axis distance, the tag shall be moved in steps as specified below in both positive and negative Y and Z directions until the identification rate or read drops to zero.
The tag shall be moved along the Y and Z axis by the following step:
 - 0.5 cm step if $D < 10$ cm.
 - 1 cm step if $10 \text{ cm} \leq D \leq 50$ cm.
 - 2 cm step if $D > 50$ cm.
- 3- The writing command shall be sent by the interrogator with appropriate value defined in part 5.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- Repeat step 2 until the write drops to zero.
- 6- Noting identification write success at each step before drops to zero, Repeat step 2.

6.2.2.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A. The results of the test shall be recorded according to Table 4.

Table 4 — Parameters that shall be recorded for this measurement

| | | | | | |
|--|---------|---------|---------|---------|---------|
| Operated Volume Test | | | | | |
| Test Results: EUT 1 | | | | | |
| Identification rate / Read / Write success | YES/NO | YES/NO | YES/NO | YES/NO | YES/NO |
| Distance on X axis : | xx.x cm |
| X = 30% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |
| X = 50% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |
| X = 80% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |

Example of graph result is given in Figure 9.

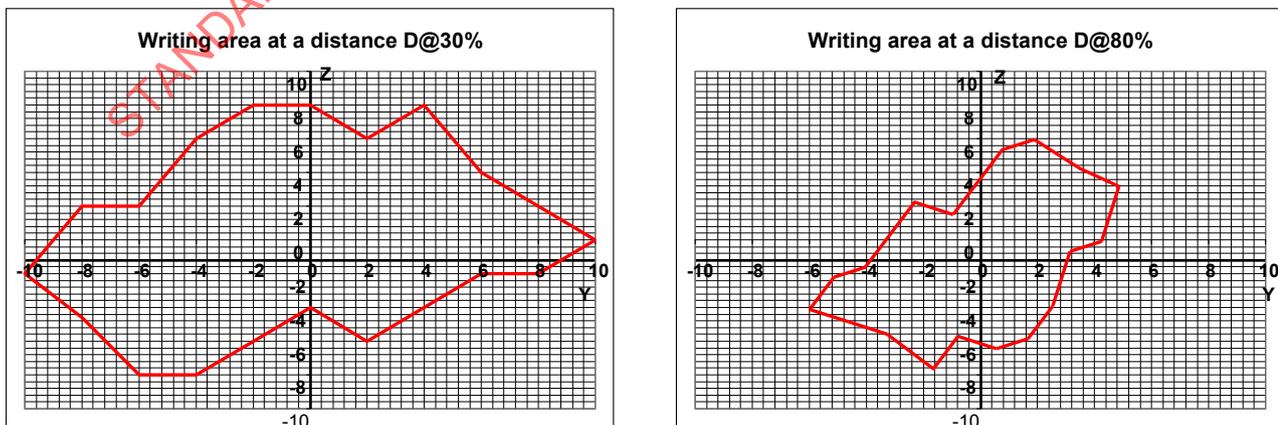


Figure 9 — Example of graph result for writing area distance at 30% and 80% of WRITE_RANGE

6.2.3 Identification speed motion

6.2.3.1 Purpose

This test determines maximum motion speed of tag in operational volume in front of the antenna of the interrogator.

6.2.3.2 Test set-up

Figure 10 shows the test set-up for speed motion measurement:

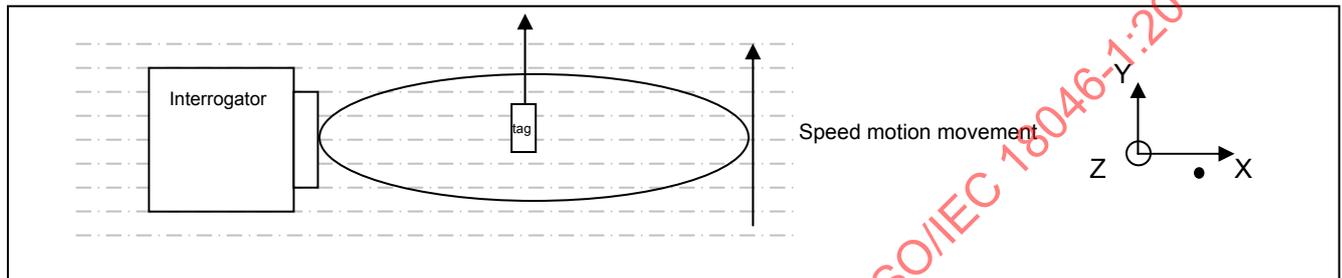


Figure 10 — Test setup for identification speed motion

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.2.3.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed at the distance equal to 50% of IDENTIFICATION_RANGE. The tag motion will be on Y axis.
- 2- The tag speed shall be increased by steps.
- 3- The inventory command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.
- 4- If the communication link exists, the step 2 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report.

6.2.3.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A. The results of the test shall be recorded according to Table 5.

Table 5 — Parameters that shall be recorded for this measurement

| |
|--|
| Test: IDENTIFICATION SPEED MOTION |
| Test Results: TAG 1 |
| Speed = xx m/s |

| | |
|---------------------|----------|
| X | Z |
| 50% | Zz |
| 50% | Zz |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| 50% | Zz |
| Test Results: TAG 2 | |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| 50% | Zz |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| 50% | Zz |

6.2.4 Identification Number of tags (for static tags)

6.2.4.1 Purpose

This test determines the capability of interrogator to read a population of tags inside the reading volume.

6.2.4.2 Test set-up

Figure 11 shows the test set-up for identification number of tag (for static tag):

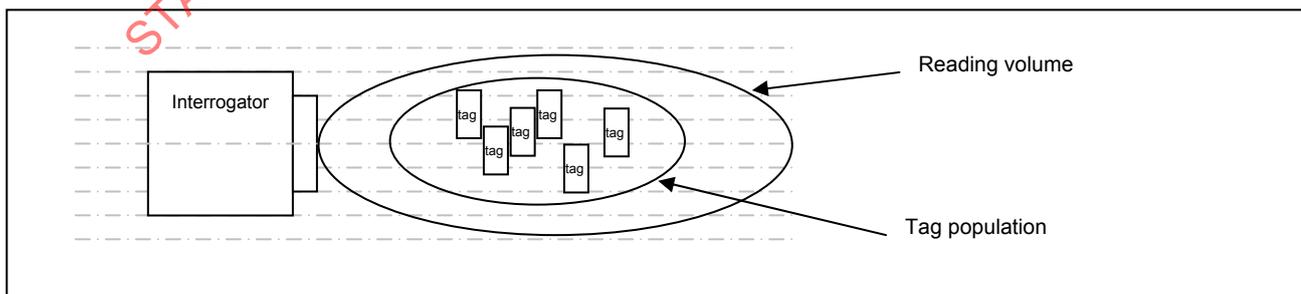


Figure 11 — Test setup for identification number of tags

The interrogator will be set on a fixed part of the test bench.

The tag population shall consist of a group of tags arranged according to the arrays defined in the paragraph 5.15.

The reference point for the position of the tag population shall be the geometric centroid of the tag population.

6.2.4.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed inside the reading volume for a defined tag arrangement. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The inventory command shall be sent by the interrogator (as applicable). A chronometer is started. The elapsed times to read 80%, 90% of the tags 100% of the tags are recorded.
- 3- If the 90% read or 100% read is not obtained, the test shall be stopped after a time equivalent to $t = 5 \times t_{@80\%}$
- 4- This test shall be performed for different positions of the tags population as required by the application. Each position shall be recorded in the test report.
- 5- The test shall be repeated for each tag arrangement.

Note: if 80% read is not reached, the time to reach the maximum percentage read shall be recorded as well as the maximum number of tags read.
The test will be stopped if 80% of the tags are not read within 10 seconds.

6.2.4.4 Test report

The test report shall give the time to reach 80%, 90% and 100 % of the tag population.

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 6.

Table 6 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION NUMBER OF TAGS (for static tags) | | |
|---|--------------------|---|
| Results TAG ARRANGEMENT 1 | | |
| X | Y | Z |
| | | |
| Maximum read: xx % | Test Results: xx s | |
| Test Results 80%: xx s | | |
| Test Results 90%: xx s | | |
| Test Results 100%: xx s | | |
| Results TAG ARRANGEMENT 2 | | |
| X | Y | Z |
| | | |
| Maximum read: xx % | Test Results: xx s | |

| |
|-------------------------|
| Test Results 80%: xx s |
| Test Results 90%: xx s |
| Test Results 100%: xx s |

6.2.5 Identification speed motion for tag population

6.2.5.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator with one side antenna(s) configuration.

6.2.5.2 Test set-up

Figure 12 shows the test set-up for identification Speed motion measurement for tag population:

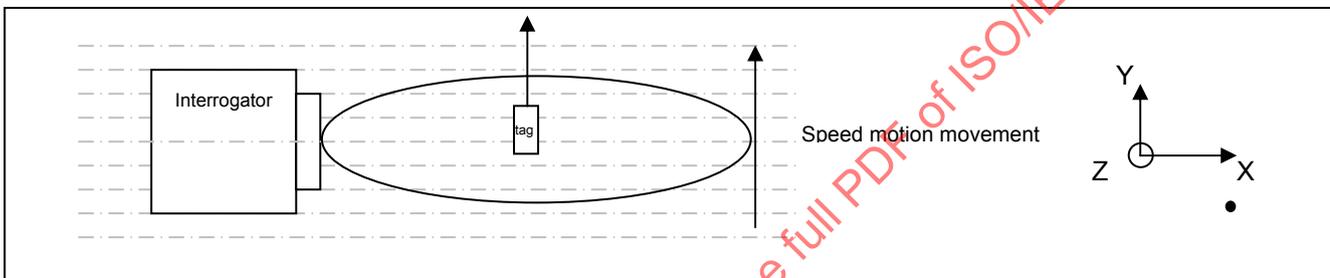


Figure 12 — Test setup for identification Speed motion for tag population

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

6.2.5.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed as required by the intended application. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The tag population shall be moved along the Y axis with the centroid at a distance of 50% of the IDENTIFICATION_RANGE.
- 3- The group speed shall be increased in steps, starting at a speed at which 100% of the tags can be identified.
- 4- If 100% of the tags are identified, step 3 shall be repeated. The highest speed at which 100% of the tags can be identified shall be noted in the report.
- 6- This test shall be performed for different positions and arrangements of the tags population as required by the application. Each position shall be recorded in the test report.

6.2.5.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The tag population arrangement, the number of tag and the spacing between each tag shall be recorded.

The results of the test shall be recorded according to Table 7.

Table 7 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION SPEED MOTION FOR TAG POPULATION | |
|--|---------------|
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

6.3 Interrogator gate antenna configuration

6.3.1 Identification speed motion

6.3.1.1 Purpose

This test determines maximum speed motion of the tag identification in the interrogator gate antenna configuration.

6.3.1.2 Test set-up

Figure 13 shows the test set-up for identification speed motion measurement:

.....

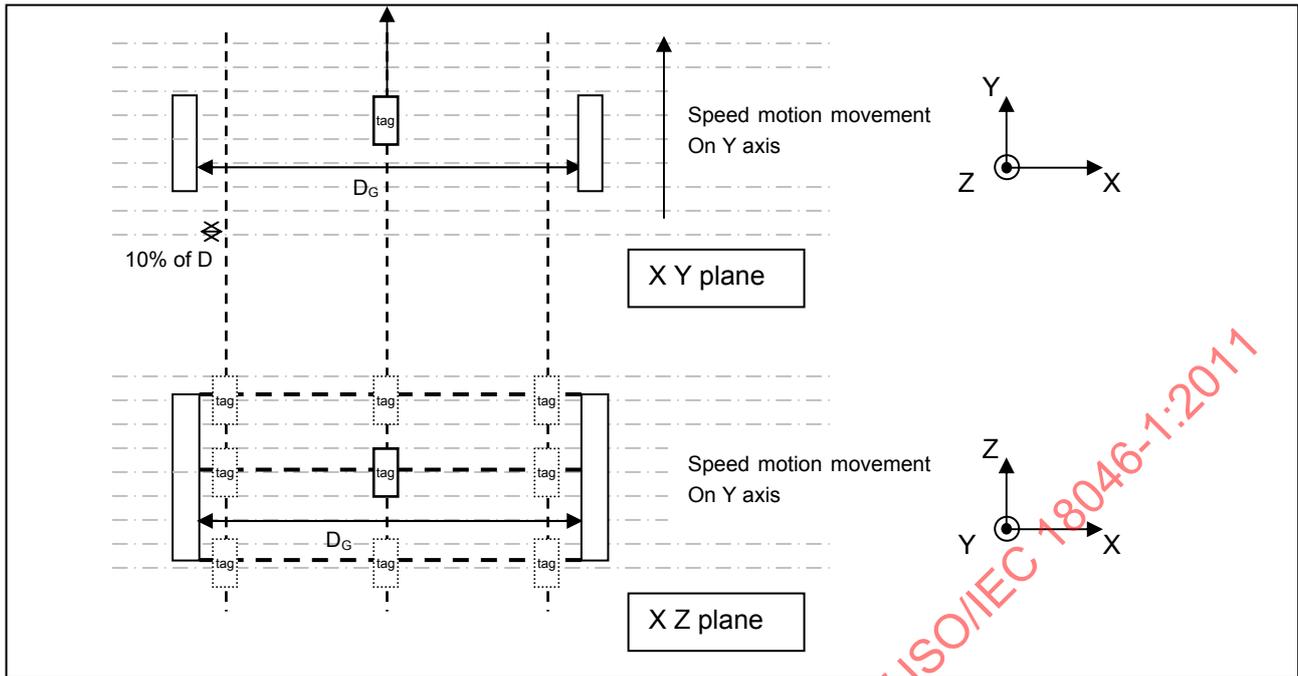


Figure 13 — Test setup for identification Speed motion

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.3.1.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on one of the positions defined in Figure 13 here above. The tag shall be moved on Y axis according to the application.
- 2- The tag speed shall be increased by the following steps:
 - If the tag is successfully identified more than eight times, the speed will be doubled.
 - If the tag is successfully identified more than four times, the speed will be increased by 50 %.
 - Else the speed is increased by 10%.
- 3- The Identification command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.
- 4- If the communication link exists, the step 3 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report, The step 1 shall be repeated.

6.3.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 8.

Table 8 — Parameters that shall be recorded for this measurement

| | |
|--|----------|
| Test: IDENTIFICATION SPEED MOTION | |
| Test Results: TAG 1 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Test Results: TAG 2 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |

6.3.2 Identification number of tag (for static tags)

6.3.2.1 Purpose

This test determines the capability of interrogator to identifier a population of tag inside the reading volume.

6.3.2.2 Test set-up

Figure 14 shows the test set-up for identification number of tag (for static tag):

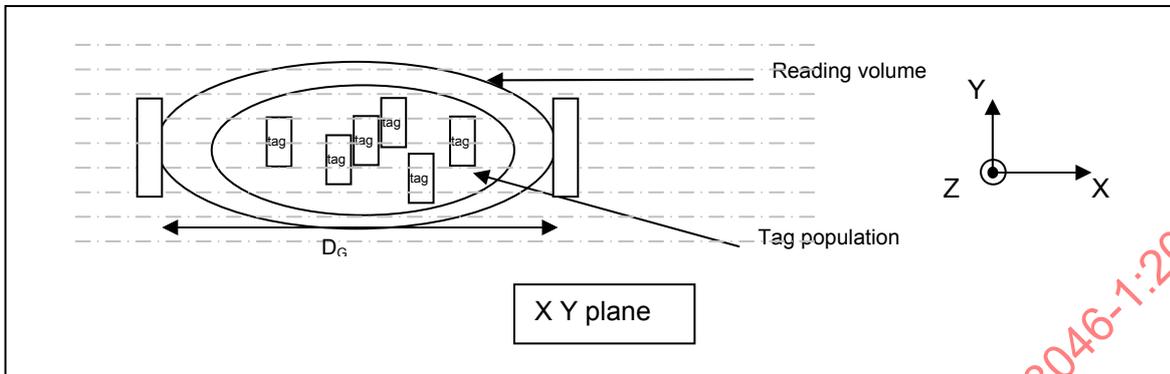


Figure 14 — Test setup for identification number of tag

The interrogator will be set on a fixed part of the test bench.

The tag population shall be arranged in a volume smaller than the identification volume

The tag population shall consist of a group of tags arranged according to the arrays defined in part 5. The reference point for the position of the tag population shall be the geometric centroid of the tag population.

6.3.2.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed inside the reading volume for a defined tag arrangement. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The inventory command shall be sent by the interrogator. A chronometer is started. The elapsed times to read 80%, 90% of the tags, 100% of the tags are recorded.
- 3- If the 90% read or 100% read is not obtained, the test shall be stopped after a time equivalent to $t = 5 \times t_{@80\%}$
- 4- This test shall be performed for different positions of the tags population as required by the application. Each position shall be recorded in the test report.
- 5- The test shall be repeated for each tag arrangement.

Note: if 80% read is not reached, the time to reach the maximum percentage read shall be recorded as well as the maximum number of tags read.
The test will be stopped if 80% of the tags are not read within 10 seconds.

6.3.2.4 Test report

The test report shall give the time to reach 80%, 90% and 100 % of the tag population.

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 9.

Table 9 — Parameters that shall be recorded for this measurement

| |
|---|
| Test: IDENTIFICATION NUMBER OF TAGS (for static tags) |
|---|

| Results TAG ARRANGEMENT 1 | | |
|------------------------------|----|--------------------|
| X | Y | Z |
| Xx | yy | Zz |
| Maximum identification: xx % | | Test Results: xx s |
| Test Results 80%: xx s | | |
| Test Results 90%: xx s | | |
| Test Results 100%: xx s | | |
| Results TAG ARRANGEMENT 2 | | |
| X | Y | Z |
| Xx | yy | Zz |
| Maximum identification: xx % | | Test Results: xx s |
| Test Results 80%: xx s | | |
| Test Results 90%: xx s | | |
| Test Results 100%: xx s | | |

6.3.3 Identification speed motion for tag population

6.3.3.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator gate antenna configuration.

6.3.3.2 Test set-up

Figure 15 shows the test set-up for identification Speed motion measurement for tag population:

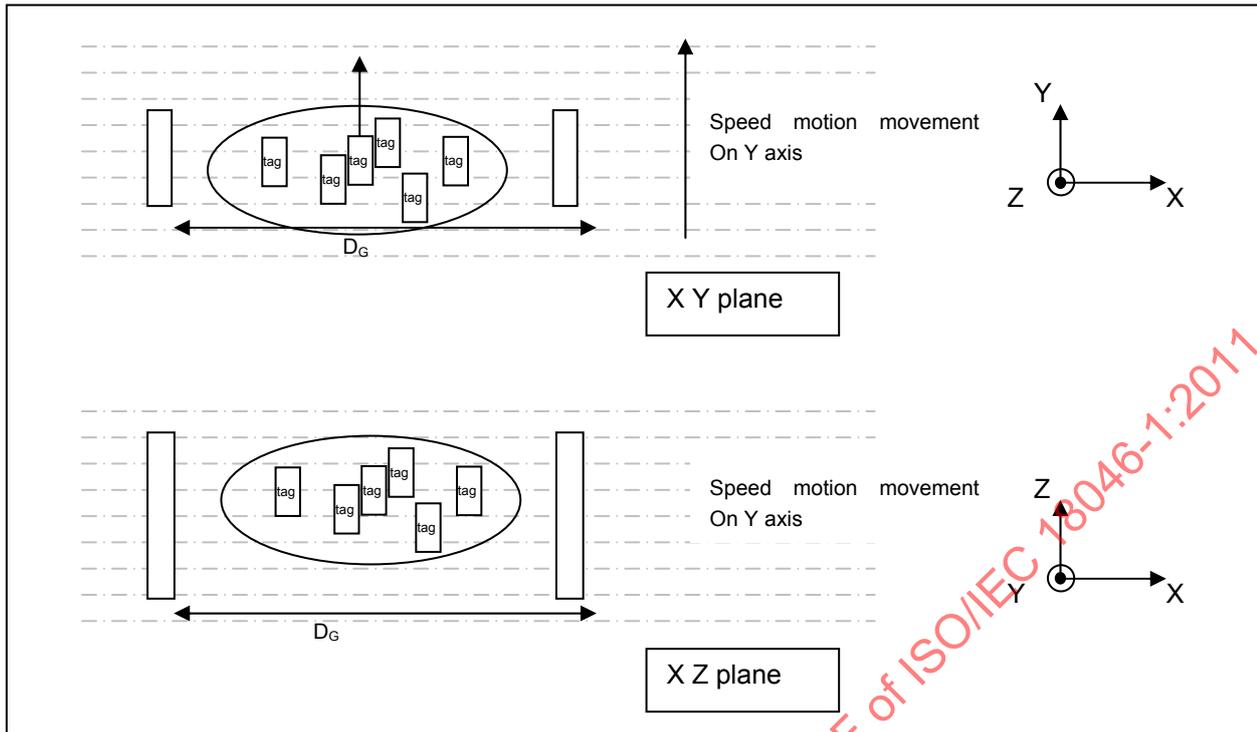


Figure 15 — Test setup for identification Speed motion for tag population

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

6.3.3.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed as required by the intended application. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The tag population shall be moved along the Y axis with the centroid as required by the application in the case of gate configuration.
- 3- The group speed shall be increased in steps, starting at a speed at which 100% of the tags can be identified.
- 4- If 100% of the tags are identified, step 3 shall be repeated. The highest speed at which 100% of the tags can be identified shall be noted in the report.
- 5- This test shall be performed for different positions and arrangements of the tags population as required by the application. Each position shall be recorded in the test report.

6.3.3.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The tag population arrangement, the number of tag and the spacing between each tag shall be recorded.

The results of the test shall be recorded according to Table 10.

Table 10 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION SPEED MOTION FOR TAG POPULATION | |
|--|---------------|
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

6.4 Interrogator 3 dimension antenna configuration (tunnel)

6.4.1 Identification speed motion

6.4.1.1 Purpose

This test determines maximum speed motion of the tag identification in the interrogator gate antenna configuration.

6.4.1.2 Test set-up

Figure 16 shows the test set-up for Identification Speed motion measurement:

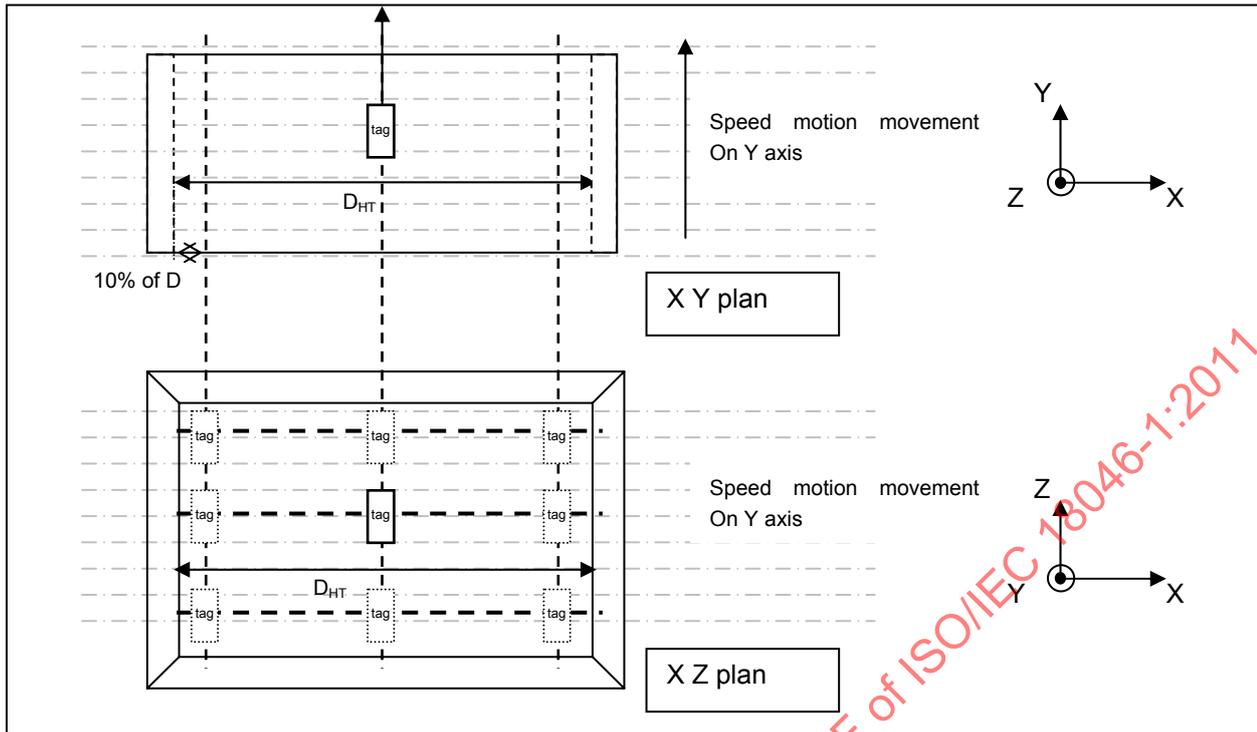


Figure 16 — Test setup for Identification Speed motion

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench:

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

6.4.1.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on one position of the all position defined in Figure here above. The tag shall be moved on Y axis is according the application.
- 2- The tag speed shall be increased by following steps:
 - The tag us successfully indetified more than eight times, the speed can be doubled.
 - The tag us successfully indetified more than four times, the speed can be increased by 50 %.
 - Else the speed is increased by 10%.
- 3- The Identification command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.
- 4- If the communication link exists, the step 3 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report, The step 1 shall be repeated.

6.4.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 11

Table 11 — Parameters that shall be recorded for this measurement

| | |
|--|-----------|
| Test: IDENTIFICATION SPEED MOTION | |
| Test Results: TAG 1 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Test Results: TAG 2 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Xx | Zz |

6.4.2 Identification Number of tags (for static tags)

6.4.2.1 Purpose

This test determines the capability of interrogator to identifier a population of tag inside the reading volume.

6.4.2.2 Test set-up

Figure 17 shows the test set-up for number of tag identification (for static tag):

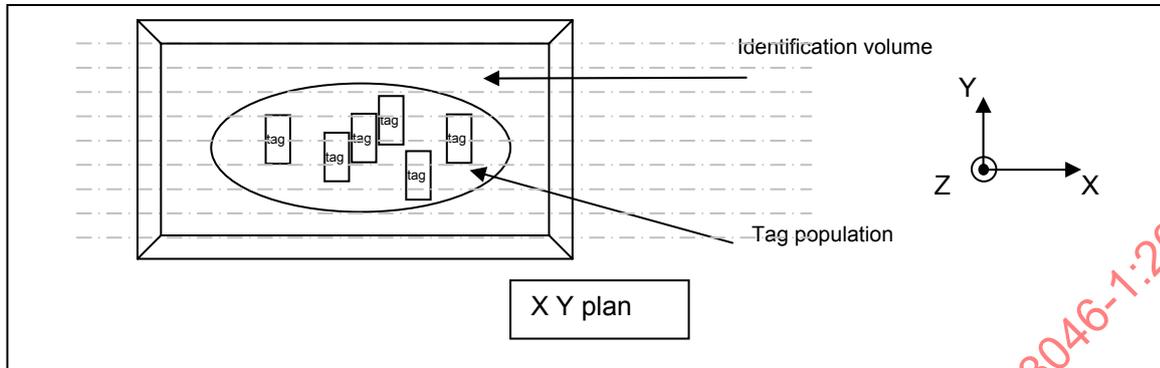


Figure 17 — Test setup for identification number of tags

The interrogator will be set on a fixed part of the test bench.

The tag population shall consist of a group of tags arranged according to the arrays defined in part 5. The reference point for the position of the tag population shall be the geometric centroid of the tag population.

6.4.2.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed inside the reading volume for a defined tag arrangement. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The inventory command shall be sent by the interrogator. A chronometer is started. The elapsed times to read 80%, 90% of the tags 100% of the tags are recorded.
- 3- If the 90% read or 100% read is not obtained, the test shall be stopped after a time equivalent to $t = 5 \times t_{@80\%}$
- 4- This test shall be performed for different positions of the tags population as required by the application. Each position shall be recorded in the test report.
- 5- The test shall be repeated for each tag arrangement.

Note: if 80% read is not reached, the time to reach the maximum percentage read shall be recorded as well as the maximum number of tags read.
The test will be stopped if 80% of the tags are not read within 10 seconds.

6.4.2.4 Test report

The test report shall give the time to reach 80%, 90% and 100 % of the tag population. The general parameters of the test shall be recorded according to the Table given in Annex A. The results of the test shall be recorded according to Table 12.

Table 12 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION NUMBER OF TAGS (for static tags) | | |
|---|----------|--------------------|
| Results TAG ARRANGEMENT 1 | | |
| X | Y | Z |
| Xx | Yy | Zz |
| Maximum identification: xx % | | Test Results: xx s |
| Test Results 80%: xx s | | |
| Test Results 90%: xx s | | |
| Test Results 100%: xx s | | |
| Results TAG ARRANGEMENT 2 | | |
| X | Y | Z |
| Xx | Yy | Zz |
| Maximum Identification: xx % | | Test Results: xx s |
| Test Results 80%: xx s | | |
| Test Results 90%: xx s | | |
| Test Results 100%: xx s | | |

6.4.3 Identification speed motion for tag population

6.4.3.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator 3 dimension antenna configuration.

6.4.3.2 Test set-up

Figure 18 shows the test set-up for identification Speed motion measurement for tag population:

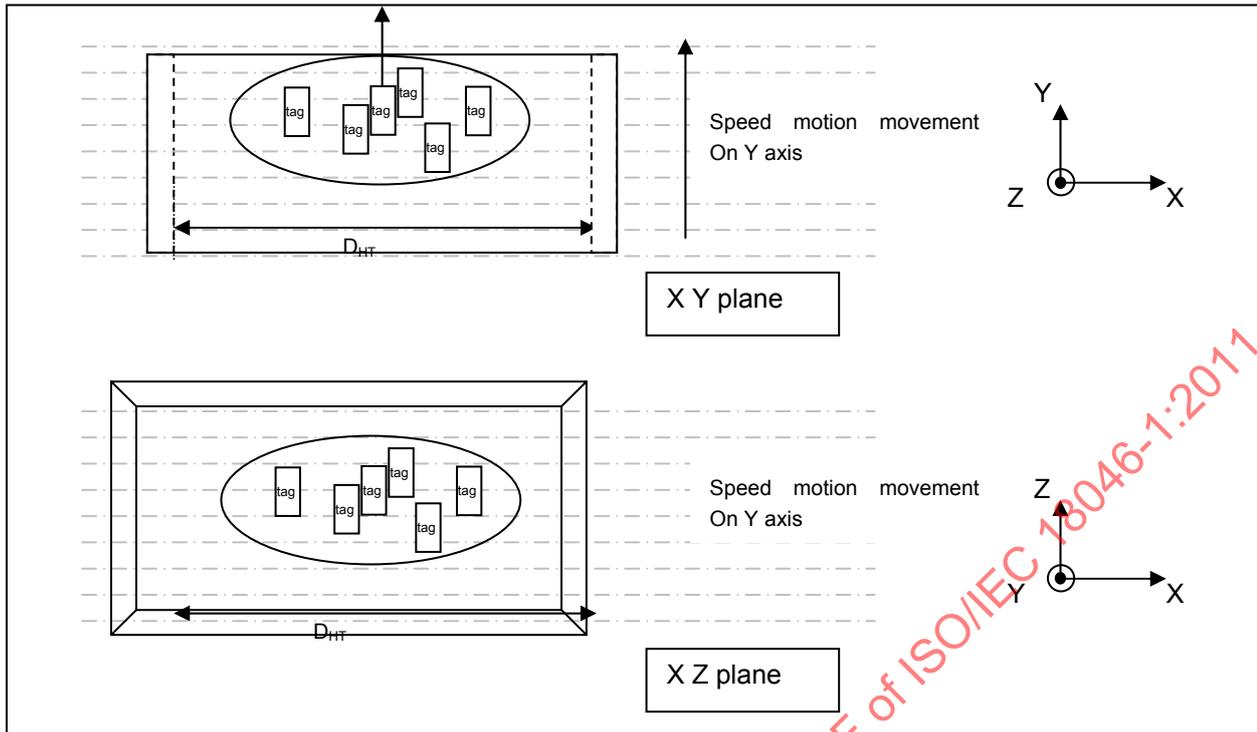


Figure 18 — Test setup for identification Speed motion

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

6.4.3.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed as required by the intended application. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The tag population shall be moved along the Y axis with the centroid as required by the application in the case of tunnel configuration.
- 3- The group speed shall be increased in steps, starting at a speed at which 100% of the tags can be identified.
- 4- If 100% of the tags are identified, step 3 shall be repeated. The highest speed at which 100% of the tags can be identified shall be noted in the report.
- 5- This test shall be performed for different positions and arrangements of the tags population as required by the application. Each position shall be recorded in the test report.

6.4.3.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The tag population arrangement, the number of tag and the spacing between each tag shall be recorded.

The results of the test shall be recorded according to Table 13.

Table 13 — Parameters that shall be recorded for this measurement

| Test: SPEED MOTION FOR TAG POPULATION | |
|---------------------------------------|---------------|
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

7 Propagative system according ISO/IEC 18000-6

7.1 Portable Interrogator

7.1.1 Operated Range Test

7.1.1.1 Purpose

This test determines the maximum identification distance, read distance and writes distance in front of the antenna of the interrogator.

7.1.1.2 Test set-up

Figure 19 shows the test set-up for range measurement:

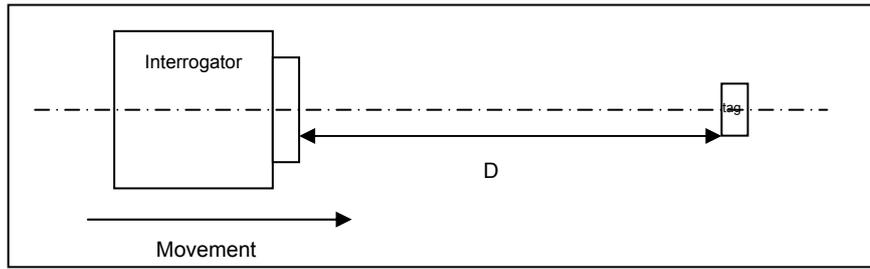


Figure 19 — Test setup for Operated Range Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

7.1.1.3 Test procedure

7.1.1.3.1 Test procedure identification and read range

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The interrogator shall be moved closer to the tag by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $50 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The Inventory command or Read command (as applicable) shall be sent by the interrogator and the existence of a communication link shall be verified.
- 4- If the communication link does not exist, the step 2 shall be repeated.
- 5- If the communication link exists, the reading command shall be sent 5 times without move the reader.
- 6- If one out of the 5 communication links does not exist, then the step 2 shall be repeated.
- 7- If the communication link exists for each of the 5 tests then the distance D shall be noted in the report as the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable).

7.1.1.3.2 Test procedure for write range

The interrogator shall be set in relation to the tag and in accordance with radio frequency recommendation.

- 1- The interrogator shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The interrogator shall be moved closer to the tag by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $50 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The writing command shall be sent by the interrogator with hexadecimal characters 0xAA.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- If the correct data is not read, the step 2 shall be repeated.
- 6- If the correct data is read, the writing command shall be sent by the interrogator with hexadecimal characters 0x55.

- 7- The reading command shall be sent to verify that the correct data is written.
- 8- If the correct data is not read, the step 2 shall be repeated.
- 9- If the correct data is read, the step 3 shall be repeated. This step shall be repeated 5 times.
- 10- If the writing command is valid for each of the 5 tests then the distance shall be noted in the report as the "WRITE_RANGE".

Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 14.

Table 14 — Parameters that shall be recorded for this measurement

| Test Results | | | | | |
|------------------------|---------|---------|---------|---------|---------|
| EUT | Tag 1 | Tag 2 | Tag 3 | Tag 4 | ... |
| IDENTIFICATION_RANGE : | xx.x cm |
| Or | | | | | |
| READ_RANGE | | | | | |
| Or | | | | | |
| WRITE_RANGE | | | | | |

7.1.2 Operated Volume Test

7.1.2.1 Purpose

This test determines maximum identification volume, read volume and write volume in front of the antenna of the interrogator.

7.1.2.2 Test set-up

Figure 20 shows the test set-up for identification volume, read volume and write volume measurement:

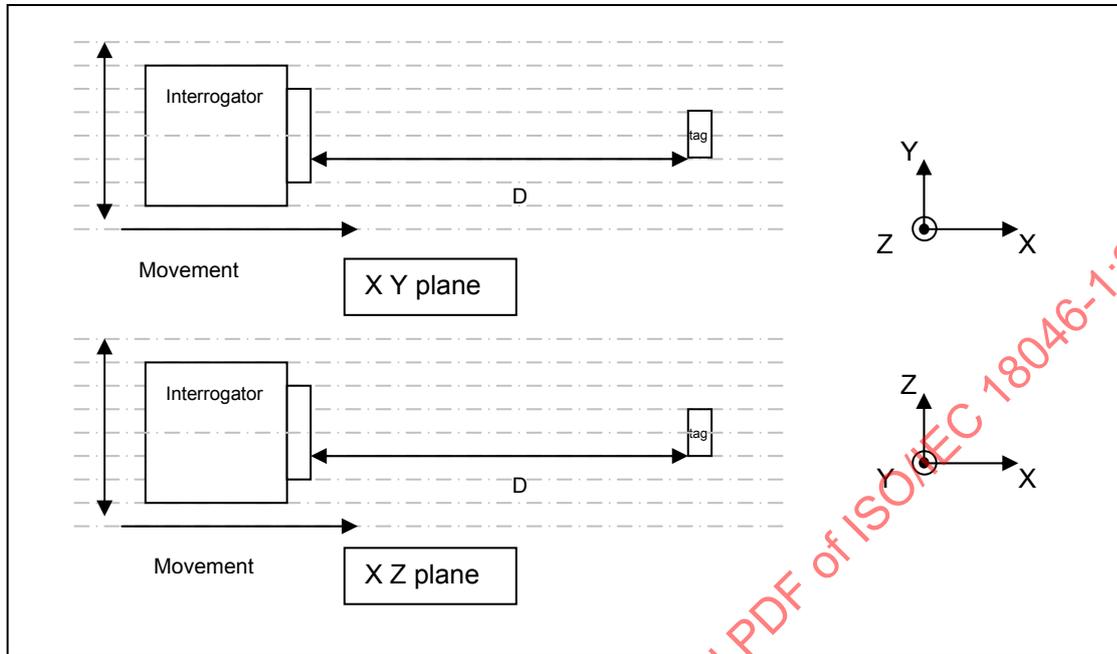


Figure 20 — Test setup for Operated Volume Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The interrogator will be fixed on a mobile part of the test bench.

The tag will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

7.1.2.3 Test procedure

7.1.2.3.1 Test procedure for identification and read volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable) as defined in § 7.1.1.3.1,
- 2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions.
 The tag shall be moved along the Y and Z axis by the following steps:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $10 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The identification or reading (as applicable) command shall be sent.
- 4- Repeat step 2 until the identification rate or read drops to zero.
- 5- Noting identification rate or read success (as applicable) at each step before drops to zero, Repeat step 2.

7.1.2.3.2 Test procedure for write volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The interrogator shall be placed on X axis at a distance of 30% 50% and 80% of the "WRITE_RANGE" as defined in § 7.1.1.3.2,
- 2- For each X axis distance, the interrogator shall be moved in steps as specified below in both positive and negative Y and Z directions until the identification rate or read drops to zero.
The tag shall be moved along the Y and Z axis by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $10 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The writing command shall be sent by the interrogator with appropriate value defined in part 5.
- 4- The reading command shall be sent to verify that the correct data is written.
- 5- Repeat step 2 until the write drops to zero.
- 6- Noting identification write success at each step before drops to zero, Repeat step 2.

7.1.2.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 15.

Table 15 — Parameters that shall be recorded for this measurement

| | | | | | |
|---|----------------|----------------|----------------|----------------|----------------|
| Operated Volume Test | | | | | |
| Test Results: EUT 1 | | | | | |
| Identification rate / Read / Write success | YES/NO | YES/NO | YES/NO | YES/NO | YES/NO |
| Distance on X axis : | xx.x cm |
| X = 30% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |
| X = 50% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |

| | | |
|--|-----|-----|
| X = 80% | | |
| Identification rate success / Read success / Write success | Y | Z |
| YES/NO | Yy | Zz |
| YES/NO | Yy | Zz |
| ... | ... | ... |

Example of graph result is given in Figure 21.

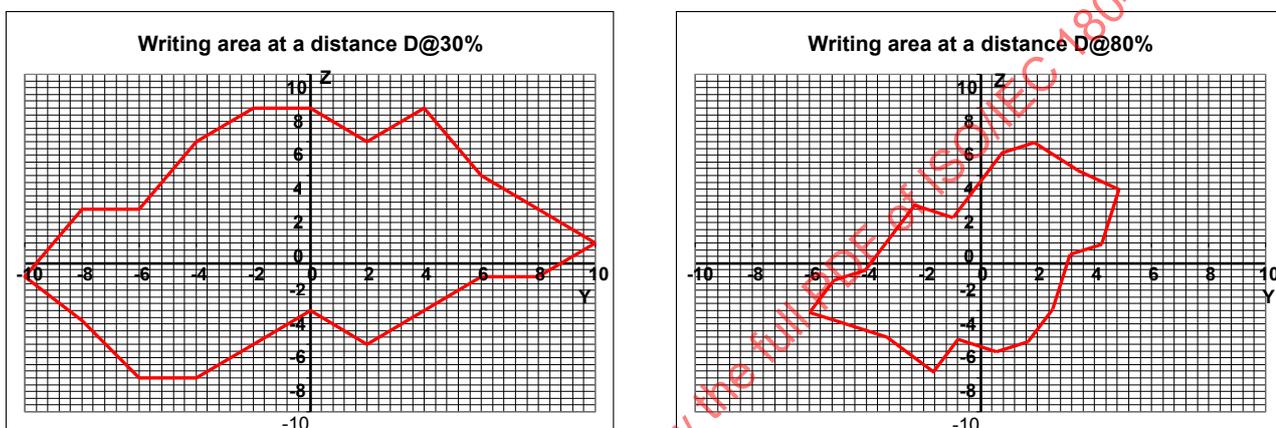


Figure 21 — Example of graph result for writing area distance at 30% and 80% of WRITE_RANGE

7.2 Interrogator with one side antenna(s) configuration

7.2.1 Operated Range Test

7.2.1.1 Purpose

This test determines the maximum identification distance, read distance and write distance in front of the antenna of the interrogator.

7.2.1.2 Test set-up

Figure 22 shows the test set-up for range measurement:

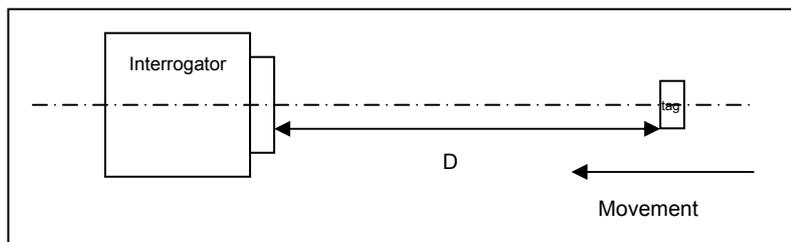


Figure 22 — Test setup for Operated Range Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

7.2.1.3 Test procedure

7.2.1.3.1 Test procedure identification or read range

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the tag.
- 2- The tag shall be moved closer to the interrogator by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $50 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The Inventory command or Read command (as applicable) shall be sent by the interrogator and the existence of a communication link shall be verified.
- 4- If the communication link does not exist, the step 2 shall be repeated.
- 5- If the communication link exists, the reading command shall be sent 5 times without move the reader.
- 6- If one out of the 5 communication links does not exist, then the step 2 shall be repeated.
- 7- If the communication link exists for each of the 5 tests then the distance D shall be noted in the report as the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable).

7.2.1.3.2 Test procedure for write range

The interrogator shall be set in relation to the tag and in accordance with radio frequency recommendation.

- 1- The tag shall be placed at a distance D greater than the maximum expected or specified range so that the interrogator is not able to decode any response from the interrogator.
- 2- The tag shall be moved closer to the interrogator by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $50 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The Write command shall be sent by the interrogator with hexadecimal characters 0xAA.
- 4- The Read command shall be sent to verify that the correct data is written.
- 5- If the correct data is not read, the step 2 shall be repeated.
- 6- If the correct data is read, the writing command shall be sent by the interrogator with hexadecimal characters 0x55.
- 7- The Read command shall be sent to verify that the correct data is written.
- 8- If the correct data is not read, the step 2 shall be repeated.
- 9- If the correct data is read, the step 3 shall be repeated. This step shall be repeated 5 times.
- 10- If the Write command is valid for each of the 5 tests then the distance shall be noted in the report as the "WRITE_RANGE".

7.2.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 16.

Table 16 — Parameters that shall be recorded for this measurement

| Test Results | | | | | |
|------------------------|---------|---------|---------|---------|---------|
| EUT | Tag 1 | Tag 2 | Tag 3 | Tag 4 | ... |
| IDENTIFICATION_RANGE : | xx.x cm |
| Or | | | | | |
| READ_RANGE | | | | | |
| Or | | | | | |
| WRITE_RANGE | | | | | |

7.2.2 Operated Volume Test

7.2.2.1 Purpose

This test determines maximum identification volume, read volume and write volume in front of the antenna of the interrogator.

7.2.2.2 Test set-up

Figure 23 shows the test set-up for identification volume, read volume and write volume measurement:

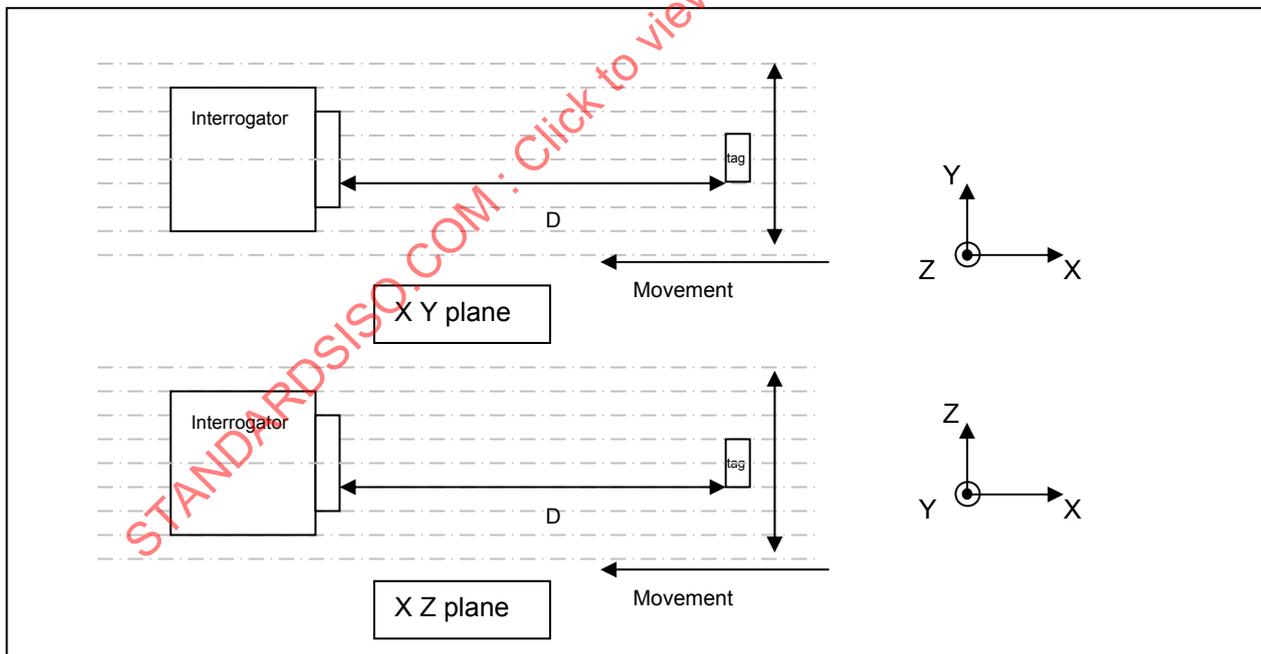


Figure 23 — Test setup for Operated Volume Test

The antenna of the interrogator and the antenna of the tag shall be put in the best coupling configuration.

The tag will be fixed on a mobile part of the test bench.

The interrogator will be set on a fixed part of the test bench.

Neither the interrogator nor the tags shall be rotated in any way during the displacement along the Y and Z axes.

7.2.2.3 Test procedure

7.2.2.3.1 Test procedure for identification and read volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on X axis at a distance of 30% 50% and 80% of the "IDENTIFICATION_RANGE" or "READ_RANGE" (as applicable) as defined in § 7.2.1.3.1,
- 2- For each X axis distance, the tag shall be moved in steps as specified below in both positive and negative Y and Z directions.
The tag shall be moved along the Y and Z axis by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $10 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The identification or reading (as applicable) command shall be sent.
- 4- Repeat step 2 until the identification rate or read drops to zero.
- 5- Noting identification rate or read success (as applicable) at each step before drops to zero, Repeat step 2.

7.2.2.3.2 Test procedure for write volume

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on X axis at a distance of 30% 50% and 80% of the "WRITE_RANGE" as defined in § 7.2.1.3.2,
- 2- For each X axis distance, the tag shall be moved in steps as specified below in both positive and negative Y and Z directions until the identification rate or read drops to zero.
The tag shall be moved along the Y and Z axis by the following step:
 - 1 cm step if $D < 50$ cm.
 - 5 cm step if $10 \text{ cm} \leq D \leq 2$ m.
 - 10 cm step if $D > 2$ m.
- 3- The Write command shall be sent by the interrogator with appropriate value defined in part 5.
- 4- The Read command shall be sent to verify that the correct data is written.
- 5- Repeat step 2 until the write drops to zero.
- 6- Noting identification write success at each step before drops to zero, Repeat step 2.

7.2.2.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table17. The results give the limits of communication zone.

Table 17 — Parameters that shall be recorded for this measurement

| | | | | | |
|--|---------|---------|---------|---------|---------|
| Operated Volume Test | | | | | |
| Test Results: EUT 1 | | | | | |
| Identification rate / Read / Write success | YES/NO | YES/NO | YES/NO | YES/NO | YES/NO |
| Distance on X axis : | xx.x cm |
| X = 30% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |
| X = 50% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |
| X = 80% | | | | | |
| Identification rate success / Read success / Write success | Y | | Z | | |
| YES/NO | Yy | | Zz | | |
| YES/NO | Yy | | Zz | | |
| ... | ... | | ... | | |

STANDARDSISO.COM · Click to view the full PDF of ISO/IEC 18046-1:2011

Example of graph result is given in Figure 24.

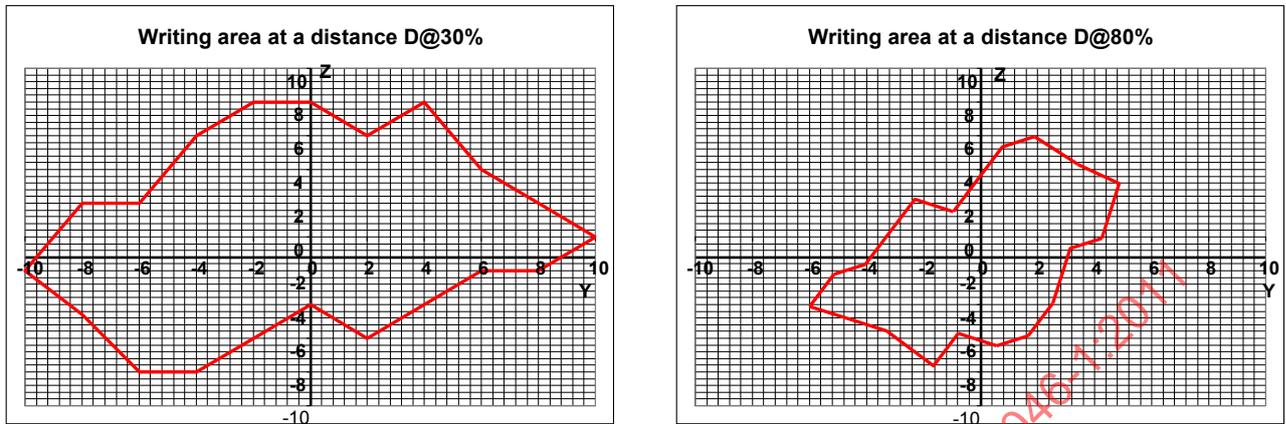


Figure 24 — Example of graph result for writing area distance at 30% and 80% of WRITE_RANGE

7.2.3 Identification speed motion

7.2.3.1 Purpose

This test determines maximum speed motion of tag in operational volume in front of the antenna of the interrogator.

7.2.3.2 Test set-up

Figure 25 shows the test set-up for speed motion measurement:

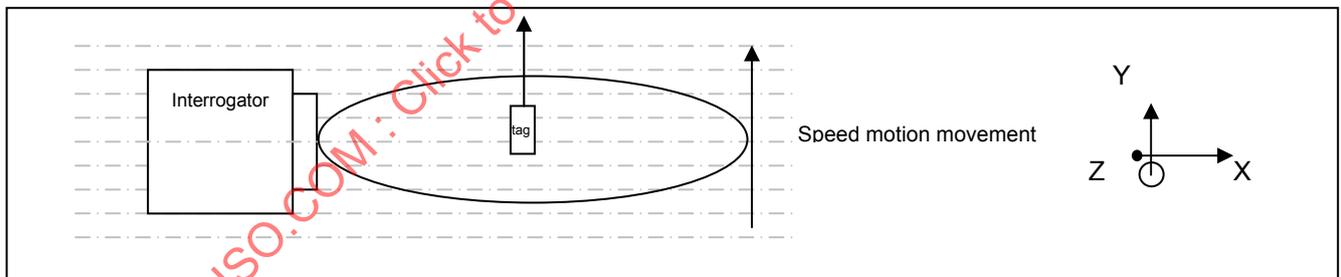


Figure 25 — test setup for identification speed motion

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

7.2.3.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

1. The tag shall be placed at the distance equal to 50% of IDENTIFICATION_RANGE. The tag motion will be on Y axis.
2. The tag speed shall be increased by steps.
3. The inventory command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.

4. If the communication link exists, the step 2 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report.

7.2.3.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 18.

Table 18 — Parameters that shall be recorded for this measurement

| | |
|--|----------|
| Test: IDENTIFICATION SPEED MOTION | |
| Test Results: TAG 1 | |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| Test Results: TAG 2 | |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |
| Speed = xx m/s | |
| X | Z |
| 50% | Zz |

7.2.4 Identification Number of tags (for static tags)

7.2.4.1 Purpose

This test determines the capability of the interrogator to identification a population of tags inside the reading volume.

7.2.4.2 Test set-up

Figure 26 shows the test set-up for identification number of tag (for static tag):

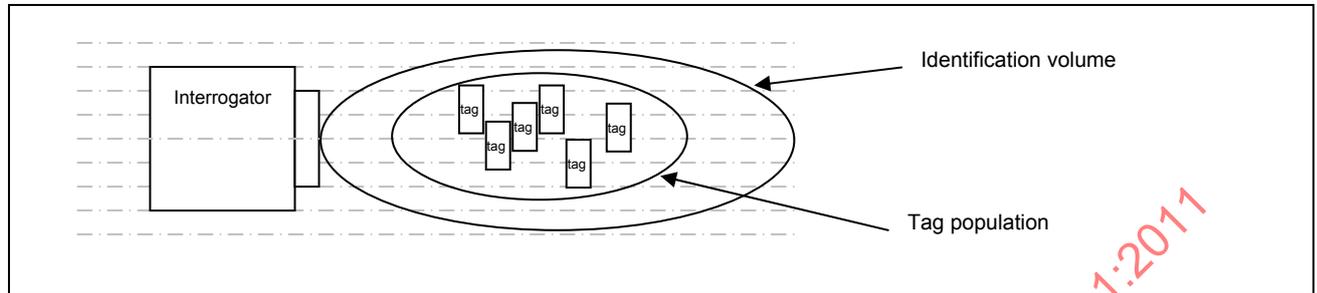


Figure 26 — Test setup for identification number of tags

The interrogator will be set on a fixed part of the test bench.

The tag population shall be arranged in a volume smaller than the Identification volume

The tag population shall consist of a group of tags arranged according to the arrays defined in paragraph 5.14. The reference point for the position of the tag population shall be the geometric centroid of the tag population.

7.2.4.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed inside the reading volume for a defined tag arrangement. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The inventory command shall be sent by the interrogator (as applicable). A chronometer is started. The elapsed times to read 80%, 90% of the tags 100% of the tags are recorded.
- 3- If the 90% read or 100% read is not obtained, the test shall be stopped after a time equivalent to $t = 5 \times t_{@80\%}$
- 4- This test shall be performed for different positions of the tags population as required by the application. Each position shall be recorded in the test report.
- 5- The test shall be repeated for each tag arrangement.

Note: if 80% read is not reached, the time to reach the maximum percentage read shall be recorded as well as the maximum number of tags read.
The test will be stopped if 80% of the tags are not read within 10 seconds.

7.2.4.4 Test report

The test report shall give the time to reach 80%, 90% and 100 % of the tag population, the position of tag population, the tag arrangement, the environment conditions and the communication parameters. If 80% of the tags are not read before the test stopped then the number of tags and percentage of tags read shall be recorded. All these parameters shall be recorded according to Table 19.

Table 19 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION NUMBER OF TAGS (for static tags) | | |
|---|---|--------------------|
| Results Population 1 | | |
| X | Y | Z |
| | | |
| Maximum Identification: xx % | | Test Results: xx s |
| Maximum Identification ≥ 80 % | | Test Results: xx s |
| Maximum Identification ≥ 90 % | | Test Results: xx s |
| Maximum Identification = 100 % | | Test Results: xx s |
| Results Population 2 | | |
| X | Y | Z |
| | | |
| Maximum Identification: xx % | | Test Results: xx s |
| Maximum Identification ≥ 80 % | | Test Results: xx s |
| Maximum Identification ≥ 90 % | | Test Results: xx s |
| Maximum Identification = 100 % | | Test Results: xx s |

7.2.5 Identification speed motion for tag population

7.2.5.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator with one side antenna(s) configuration.

7.2.5.2 Test set-up

Figure 27 shows the test set-up for identification Speed motion measurement for tag population:

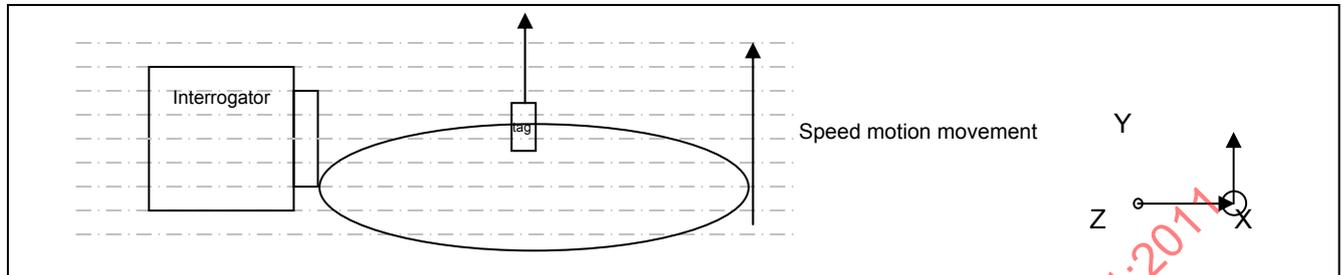


Figure 27 — Test setup for identification Speed motion for tag population

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

7.2.5.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed as required by the intended application. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The tag population shall be moved along the Y axis with the centroid at a distance of 50% of the IDENTIFICATION_RANGE.
- 3- The group speed shall be increased in steps, starting at a speed at which 100% of the tags can be identified.
- 4- If 100% of the tags are identified, step 3 shall be repeated. The highest speed at which 100% of the tags can be identified shall be noted in the report.
- 5- This test shall be performed for different positions and arrangements of the tags population as required by the application. Each position shall be recorded in the test report.

7.2.5.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A. The tag population arrangement, the number of tag and the spacing between each tag shall be recorded. The results of the test shall be recorded according to Table 20.

Table 20 — Parameters that shall be recorded for this measurement

| | |
|--|---------------|
| Test: IDENTIFICATION SPEED MOTION FOR TAG POPULATION | |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

STANDARDSISO.COM : Click to view the full PDF of ISO/IEC 18046-1:2011

7.3 Interrogator gate antenna configuration

7.3.1 Identification speed motion

7.3.1.1 Purpose

This test determines maximum identification speed motion of the tag in the interrogator gate antenna configuration.

7.3.1.2 Test set-up

Figure 28 shows the test set-up for identification speed motion measurement:

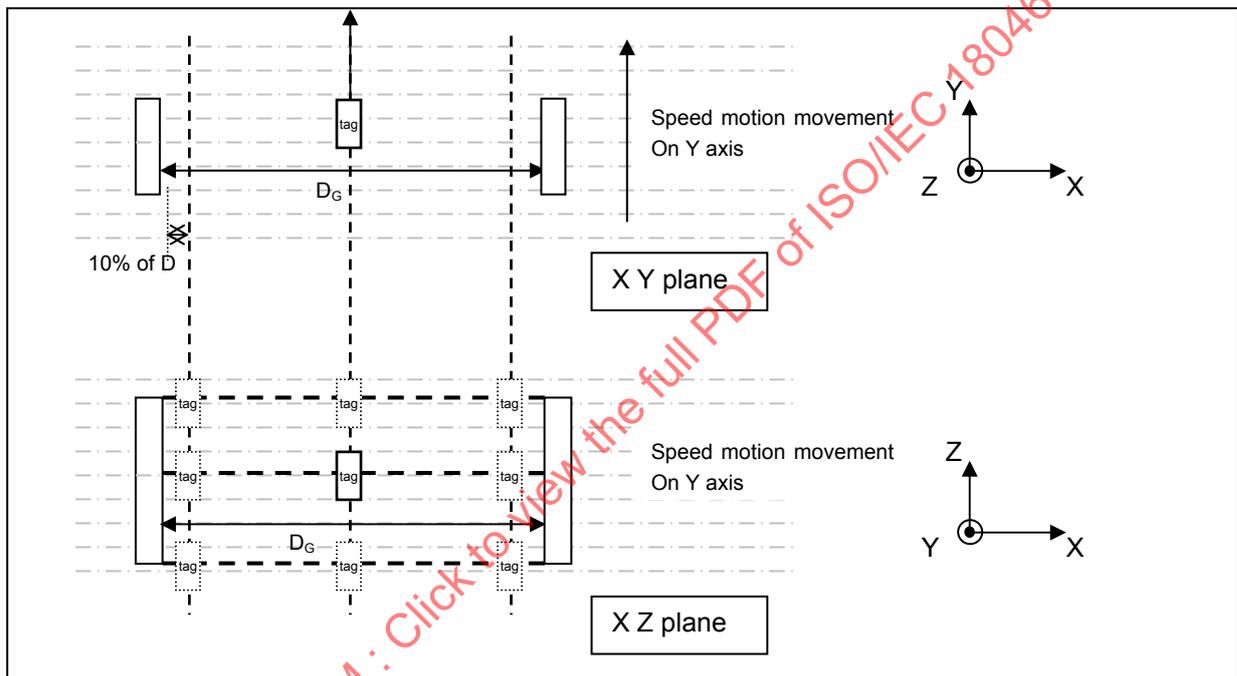


Figure 28 — Test setup for identification Speed motion

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

7.3.1.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on one position of the all position defined in Figure here above. The tag shall be moved on Y axis is according the application.
- 2- The tag speed shall be increased by following steps:
 - The tag us successfully indentified more than eight times, the speed can be doubled.
 - The tag us successfully indentified more than four times, the speed can be increased by 50 %.
 - Else the speed is increased by 10%.

- 3- The Identification command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.
- 4- If the communication link exists, the step 3 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report, The step 1 shall be repeated.

7.3.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A. The results of the test shall be recorded according to Table 21.

Table 21 — Parameters that shall be recorded for this measurement

| | |
|--|----------|
| Test: IDENTIFICATION SPEED MOTION | |
| Test Results: TAG 1 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Test Results: TAG 2 | |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

7.3.2 Identification Number of tags (for static tags)

7.3.2.1 Purpose

This test determines the capability of the interrogator to identify a population of tags inside the reading volume.

7.3.2.2 Test set-up

Figure 29 shows the test set-up for number of tags identification (for static tag):

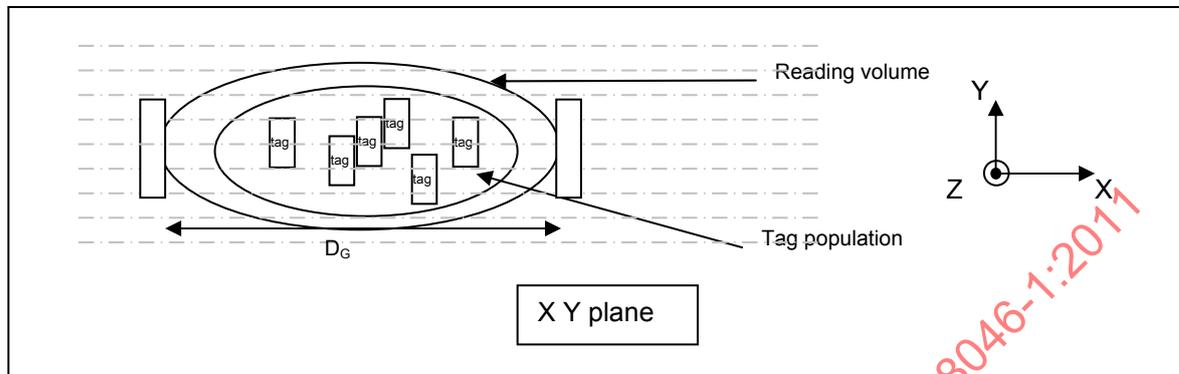


Figure 29 — Test setup for identification number of tags

The interrogator will be set on a fixed part of the test bench.

The tag population shall consist of a group of tags arranged according to the arrays defined in part 5. The reference point for the position of the tag population shall be the geometric centroid of the tag population.

7.3.2.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed inside the reading volume for a defined tag arrangement. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The inventory command shall be sent by the interrogator. A chronometer is started. The elapsed times to read 80%, 90% of the tags 100% of the tags are recorded.
- 3- If the 90% read or 100% read is not obtained, the test shall be stopped after a time equivalent to the maximum of $t = 5 \times t_{@80\%}$, or 10 s.
- 4- This test shall be performed for different positions of the tags population as required by the application. Each position shall be recorded in the test report.
- 5- The test shall be repeated for each tag arrangement.

Note: if 80% read is not reached, the time to reach the maximum percentage read shall be recorded as well as the maximum number of tags read.

The test will be stopped if 80% of the tags are not read within 10 seconds.

7.3.2.4 Test report

The test report shall give the time to reach 80%, 90% and 100 % of the tag population.

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 22.

Table 22 — Parameters that shall be recorded for this measurement

| | | |
|---|--------------------|---|
| Test: IDENTIFICATION NUMBER OF TAGS (for static tags) | | |
| Results TAG ARRANGEMENT 1 | | |
| X | Y | Z |
| | | |
| Maximum read: xx % | Test Results: xx s | |
| Maximum Identification \geq 80 % | Test Results: xx s | |
| Maximum Identification \geq 90 % | Test Results: xx s | |
| Maximum Identification = 100 % | Test Results: xx s | |
| Results TAG ARRANGEMENT 2 | | |
| X | Y | Z |
| | | |
| Maximum read: xx % | Test Results: xx s | |
| Maximum Identification \geq 80 % | Test Results: xx s | |
| Maximum Identification \geq 90 % | Test Results: xx s | |
| Maximum Identification = 100 % | Test Results: xx s | |

7.3.3 Identification speed motion for tag population

7.3.3.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator gate antenna configuration.

7.3.3.2 Test set-up

Figure 30 shows the test set-up for identification Speed motion measurement for tag population:

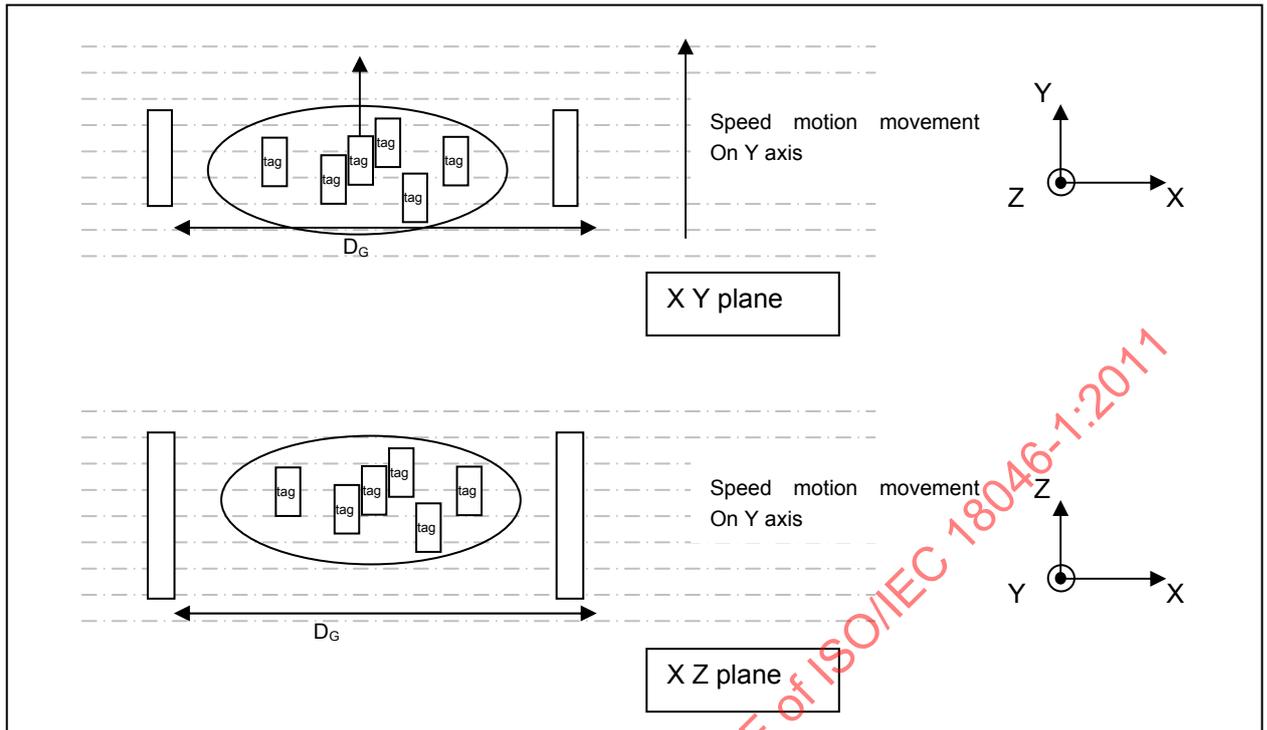


Figure 30 — Test setup for identification Speed motion for tag population

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

7.3.3.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag population shall be placed as required by the intended application. The position of tag population in relation with the antenna interrogator shall be noted.
- 2- The tag population shall be moved along the Y axis with the centroid as required by the application in the case of gate configuration.
- 3- The group speed shall be increased in steps, starting at a speed at which 100% of the tags can be identified.
- 4- If 100% of the tags are identified, step 3 shall be repeated. The highest speed at which 100% of the tags can be identified shall be noted in the report.
- 5- This test shall be performed for different positions and arrangements of the tags population as required by the application. Each position shall be recorded in the test report.

7.3.3.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The tag population arrangement, the number of tag and the spacing between each tag shall be recorded.

The results of the test shall be recorded according to Table 23.

Table 23 — Parameters that shall be recorded for this measurement

| Test: IDENTIFICATION SPEED MOTION FOR TAG POPULATION | |
|--|---------------|
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Tag population arrangement: | Number of tag |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |
| Speed = xx m/s | |
| X | Z |
| Xx | Zz |

7.4 Interrogator 3 dimension antenna configuration (tunnel)

7.4.1 Identification speed motion

7.4.1.1 Purpose

This test determines maximum speed motion of the tag identification in the Interrogator 3 dimension antenna configuration.

7.4.1.2 Test set-up

Figure 31 shows the test set-up for identification Speed motion measurement:

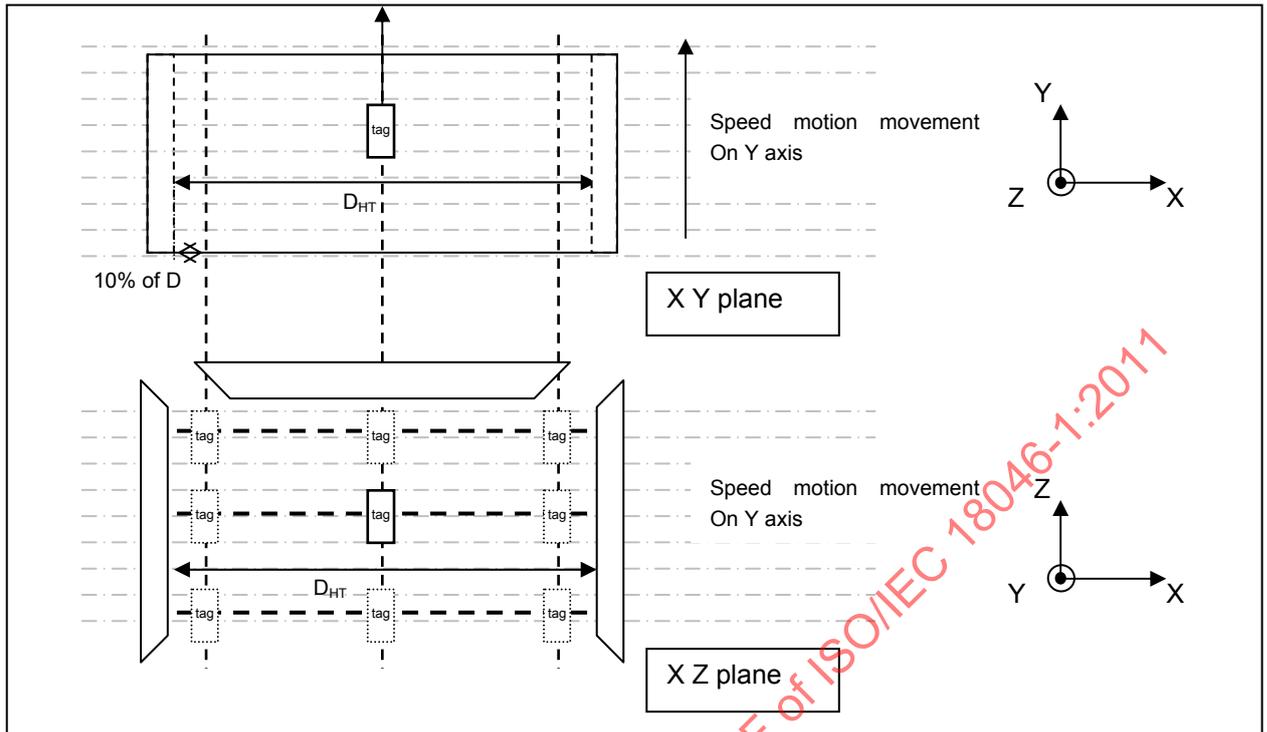


Figure 31 — Test setup for identification Speed motion

The interrogator will be set on a fixed part of the test bench.

The tag will be fixed on a mobile part of the test bench so that the best coupling configuration will be maintained during the displacement of the interrogator.

7.4.1.3 Test procedure

The interrogator shall be set in relation to the tag and in accordance with radio frequency local regulations.

- 1- The tag shall be placed on one position of the all position defined in Figure here above. The tag shall be moved on Y axis according the application.
- 2- The tag speed shall be increased by following steps:
 - The tag us successfully indentified more than eight times, the speed can be doubled.
 - The tag us successfully indentified more than four times, the speed can be increased by 50 %.
 - Else the speed is increased by 10%.
- 3- The Identification command shall be sent by the interrogator and the existence of a communication link shall be verified. This step must be repeated 5 times at the same speed motion.
- 4- If the communication link exists, the step 3 shall be repeated. If the communication link does not exist for these 5 tests then the position (X, Z) and speed motion before this test shall be noted in the report, The step 1 shall be repeated.

7.4.1.4 Test report

The general parameters of the test shall be recorded according to the Table given in Annex A.

The results of the test shall be recorded according to Table 24.