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Information technology — Real-time locating system (RTLS) device performance test methods —

Part 5:
Test methods for chirp spread spectrum (CSS) air interface

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Foreword

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

A list of all parts in the ISO/IEC 24770 series can be found on the ISO website.

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

Introduction

ISO/IEC 24730-5 defines an air interface for real time locating systems (RTLS) devices used in asset management applications.

This document provides test methods for measuring the performance of equipment compliant with ISO/IEC 24730-5.

ISO/IEC 24769-5 contains all measurements required to be made on a product in order to establish whether it conforms to ISO/IEC 24730-5.

Information technology — Real-time locating system (RTLS) device performance test methods —

Part 5:
Test methods for chirp spread spectrum (CSS) air interface

1 Scope

This document defines the test methods for determining the performance characteristics of chirp spread spectrum (CSS) real time locating system (RTLS) equipment including tags and readers which are applicable to the selection of equipment that conforms to ISO/IEC 24730-5 for specific applications. This document does not apply to the testing in relation to regulatory or similar requirements.

The RTLS equipment performance parameters included in this document only include the chirp spread spectrum (CSS) radio frequencies link between tags and readers. Unlike ISO/IEC 18305, the tests in this document apply exclusively to RTLS equipment defined in ISO/IEC 24730-5 unless specified otherwise.

2 Normative references

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

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

ISO/IEC 24730-5, *Information technology — Real-time locating systems (RTLS) — Part 5: Chirp spread spectrum (CSS) at 2,4 GHz air interface*

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.2 Abbreviated terms

CSS   chirp spread spectrum

RF   radio frequency

RTLS   real time locating system

TDOA   time difference of arrival

TOA   time of arrival

TOF   time of flight

4   General

4.1   Performance requirements

4.1.1   Overview

This document specifies a series of tests to determine the performance characteristics of RTLS equipment relative to the ISO/IEC 24730-5 air interfaces. The results of these tests can be used to determine the suitability of RTLS equipment for applications.

4.1.2   Location accuracy

The primary function of RTLS equipment is to locate tags within the area determined by the readers. Location accuracy determines the primary performance criteria of an RTLS. Location accuracy can be characterized by comparing the system's calculated location for a given set of tags to the actual location of the tags. The system shall be able to locate tags to within the applications allowable error. In many, but not necessarily in all applications, the Euclidean distance between the calculated location of a tag and the actual location of a tag can be used as an error criterion. The location tests specified in this document are confined to line-of-sight situations. Although this is not be applicable to all applications, the complexity of all the variations of blockage and partial blockage are beyond the scope of this test.

4.1.3   Tag capacity

An RTLS shall typically locate a large number of tags. The number of tag blinks per second that can be processed and located through the readers can be used to determine a system's tag capacity. The system shall be able to provide location information for an applications peak tag blink density.

4.1.4   Location latency

The latency between when the tag blink is transmitted and, when the RTLS equipment can provide accurate location information, determines the suitability of the equipment for the application.

4.1.5   Tag orientation

The ability of an RTLS to provide real time location information should be independent of the orientation of the tag. The location reported by the RTLS should stay within the applications allowable error as the tag is rotated in any orientation relative to the readers.

4.1.6   System range and packet error rates

The length of the tag-reader link (system range) determines the reader density requirements and also affects system capacity. The packet error rate determines how often the equipment can successfully provide accurate location information for the tag. The maximum range at which a certain packet error rate is observed determines the usability of the system in meeting the applications requirements.

4.2   Default conditions applicable to the test methods

4.2.1   Overview

These conditions apply to all tests.

4.2.2 Test environment

Testing shall take place in an environment typical to that of the desired application. Testing should be performed indoors or outdoors with temperature and humidity profiles similar to that expected in the desired application. The RF noise floor at the test location should also represent typical conditions expected within the desired application.

4.2.3 Default tolerance

Unless otherwise specified, a default tolerance of ±5 % shall be applied to the quantity values given to specify the characteristics of the test equipment and the test method procedures.

4.2.4 System logging

The RTLS should provide sufficient data logging to allow determination of the number of packets received and sent.

5 Performance tests for ISO/IEC 24730-5

5.1 System locate performance

5.1.1 Test overview

The following subclauses outline tests for the quantities introduced in 4.1.

5.1.2 Test objective

The objective of this test is to evaluate the system locate performance characteristics of the ISO/IEC 24730-5 equipment.

5.1.3 Test setup

The readers shall be connected to antennas with adequate width of field to cover the test area with 4 readers. It is preferred that the RTLS locate performance characteristics be evaluated with the system installed as it would for the desired application. If that is not possible, then the equipment shall be configured as shown in Figure 1, with four readers at the corners of a square. The size of this square as defined by diagonal (D) is dependent on the expected operating mode of the devices.

In a TDOA system, the separation of the fixed (anchor) reader nodes is dependent on the ability of their receivers to receive the tags transmissions. This is not a direct feature of the air interface protocol but is rather the result of the implementation in the receiver of the physical layer protocol. The size of diagonal then should be chosen to be the range of successful tag-to-anchor communications. For ISO/IEC 24730-5 compliant tags, this depends on data rate and bandwidth, and on implementation choices in the receiver. In testing the performance of a particular system, the equipment manufacturer should be able to advise the maximum expected operating range for the system operating mode being tested. In addition to standalone tags, several tags mounted on the application's locatable assets (or items of comparable size and composition) shall be used to evaluate locate performance.
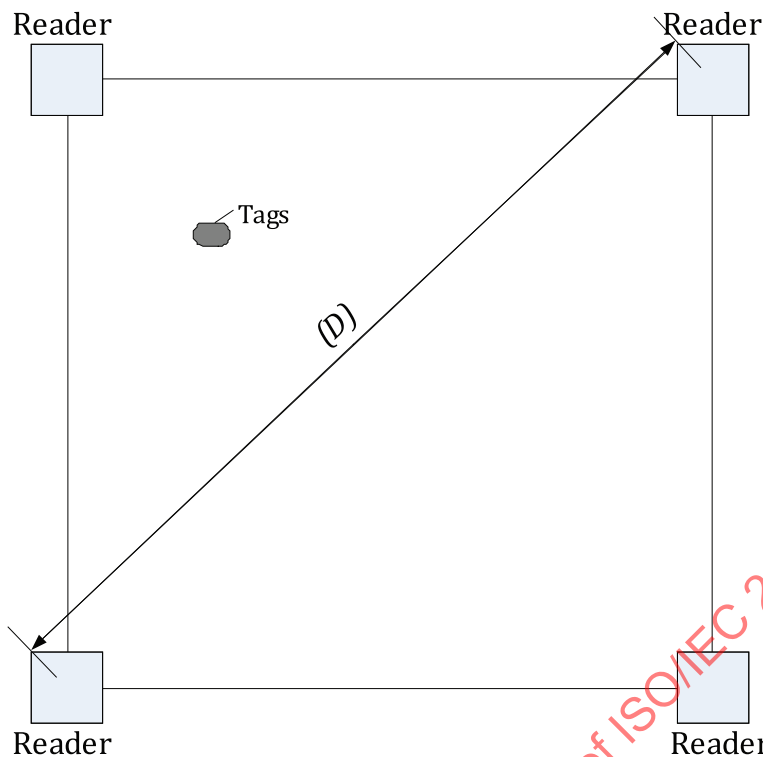
Figure 1 — Setup of equipment for RTLS locate accuracy test

5.1.4 Test procedure

The tag shall be configured to transmit at the desired blink rate as defined in ISO/IEC 24730-5.

The test shall include an evaluation of the total blink capacity as a function of blink rate for the test tags within the test area. In order to be greater than the maximum expected capacity, a test tag blink rate should be computed. This blink rate is given by the formula:

$$r_{bt} = \frac{N_{ta}}{N_{tt}} \cdot r_{b,max} \cdot 1,5$$

where

r_{bt} is the test tag blink rate,

N_{ta} is the total number of tags to be in the equivalent application area,

N_{tt} is the total tags in the test area, and

$r_{b,max}$ is the maximum blink rate expected in the application.

Unless otherwise indicated, the tags shall be configured to blink at computed test tag blink rate. The tags shall be attached to assets such as to reproduce the conditions of the desired application. Additional procedures specific to individual tests are outlined in the test measurements and requirements.

5.1.5 Test measurements and requirements

5.1.5.1 Location accuracy

Tags, or sets of tags, shall be distributed throughout the area of coverage at between 2 m to 10 m spacing as shown in Figure 2. The spacing is decided on the basis of the tag supported density and the size of

the diagonal (*D*), both of which are dependent on the tag operating mode. The actual location of all tags shall be recorded, as precisely as possible to the nearest centimetre. The test shall be run long enough to capture a minimum of 250 tag blinks from each tag. The total number of tag locates calculated during the test shall be divided by the expected number of blinks from all the tags included in the test for the duration of the test using the formula:

$$\frac{N_t \cdot t_{test}}{t_{blink}}$$

where

N_t is the number of tags,

t_{test} is the test duration,

t_{blink} is the tag blink interval.

Each location calculation shall be compared to the appropriate tag's actual location to produce the location error. The location accuracy shall be represented as a percentage of all locations calculated by the system, in which the errors fall within the specified maximum error, divided by the total number of locations calculated. The radius of acceptable error shall be determined by the requirements of the application.
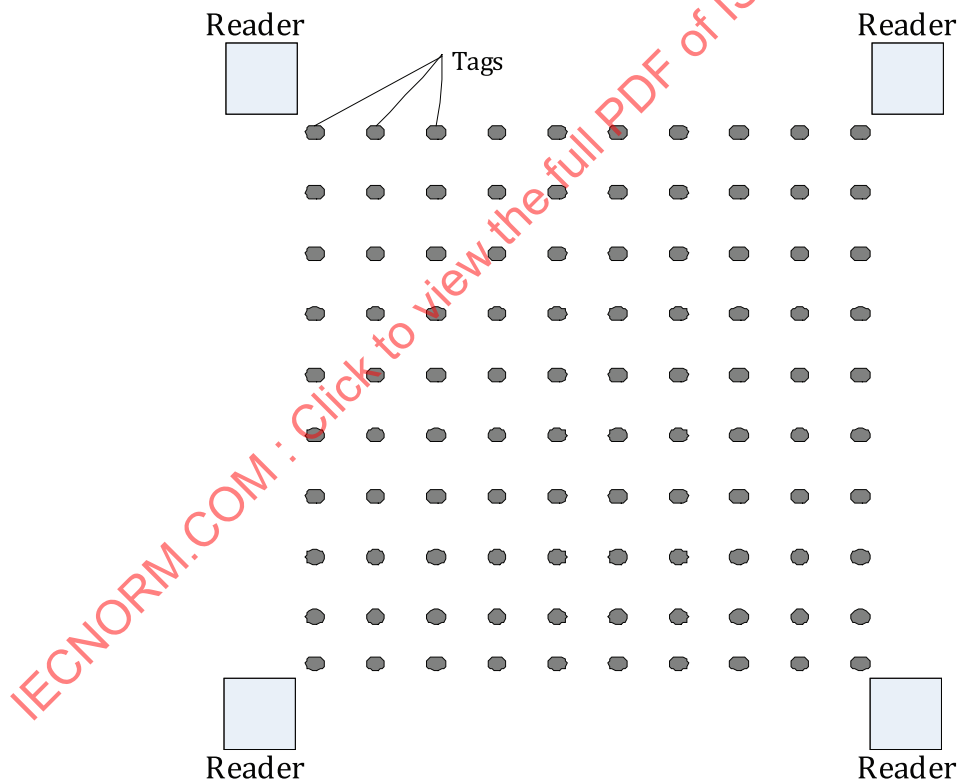

Figure 2 — Setup of equipment showing tag spacing

5.1.5.2 Location reporting latency

The test shall include at least 50 tag location changes of at least 2 m to capture a statistically significant sample. Tags, or groups of tags, shall be moved from one known location to another known location throughout the test. The exact time of each actual move shall be logged, as well as the exact time of reported location change. Record the difference between the time of reception and the time of the location report to determine which location is within the maximum error range allowed by the application.

5.1.5.3 Tag capacity

The tags shall be configured at a blink interval such that the total number of blinks per second during the test is at least 1,5 times the expected blinks per second in the application as computed in 5.1.4 of this document. This ensures that the system continues to perform at times when tag blinks cluster in time. The test shall then be repeated at half of this computed blink rate. The location accuracy and locate latency at these two different rates shall be compared to determine performance degradation.

5.1.5.4 Tag orientation

This test is required only for applications where the tag orientation (when attached to the asset) is not predictable. For the duration of the test, compare the errors in the calculated location as the tag is rotated through all three axes. Changes in location accuracy as a result of orientation should be noted quantitatively in the test report.

5.1.6 Test report

The test report shall contain location accuracy statistics evaluating the percentage of tag blinks located to within the applications required locate error radius. The report shall also contain the maximum tag blinks per second that the system can handle and still meet the required location accuracy and locate latency. The report shall also include the average latency of location information as a tagged asset is moved. If relevant to the application, the report shall also provide location variations based on tag orientation.

5.2 Tests for CSS tag to reader air interface using default blink mode

5.2.1 Test objective

The objective of this test is to evaluate the performance characteristics of the CSS air interface between the RTLS tags and the RTLS readers.

5.2.2 Test setup

The reader(s) shall be connected to antennas with adequate width of field to cover the test area. Ideally, the performance characteristics of the tag to reader interface shall be evaluated with the system installed as it would be for the desired application. If that is not possible, then the test shall be conducted with at least one reader and several tags mounted on the application's locatable assets (or items of comparable size and composition). Unless otherwise stated, the tags shall be placed at a distance from the reader comparable to the maximum distance likely to be required by the application.

5.2.3 Test procedure

The tags shall be configured to transmit at the desired ISO/IEC 24730-5 CSS blink rate appropriate to the requirements of the application. The tags shall be configured at a blink interval such that the number of tags in the test divided by the blink interval used during test is equal to or greater than the number of assets tagged in the application (within range of a given set of readers) divided by the blink interval of application tags. The tags shall be attached to assets such as to reproduce the conditions of the desired application.