TECHNICAL REPORT

ISO/IEC TR 24769

First edition
2008-12-15

Information technology — Real-time locating system (RTLS) device conformance test methods — Test methods for air interface communication at 2,4 GHz

Technologies de l'information — Méthodes d'essai de conformité du dispositif des systèmes de localisation en temps réel (RTLS) — Méthodes d'essai pour la communication d'interface d'air à 2,4 GHz

Reference number
ISO/IEC TR 24769:2008(E)

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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.

In exceptional circumstances, the joint technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when the joint technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

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 TR 24769, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Introduction

ISO/IEC 24730 defines the air interfaces and an application programming interface for Real Time Locating Systems (RTLS) devices used in asset management applications.

This Technical Report contains all measurements required to be made on a product in order to establish whether it conforms to ISO/IEC 24730-2.

Test methods for measuring performance of equipment compliant with ISO/IEC 24730-2 are given in ISO/IEC TR 24770.

Information technology — Real-time locating system (RTLS) device conformance test methods — Test methods for air interface communication at 2,4 GHz

1 Scope

This Technical Report defines the test methods for determining the conformance of 2,4 GHz real-time locating system (RTLS) tags with the specifications given in the corresponding parts of ISO/IEC 24730-2, but does not apply to the testing of conformity with regulatory or similar requirements.

The test methods require only that the mandatory functions, and any optional functions which are implemented, be verified. This may in appropriate circumstances, be supplemented by further, application specific functionality criteria that are not available to the general case.

The RTLS tag conformance parameters included in this document include the mandatory direct sequence spread spectrum (DSSS) 2,4 GHz radio frequency beacon. It also includes the optional on-off keyed, frequency shift keyed (OOK/FSK) short range radio frequency link and the optional magnetic air interface

Unless otherwise specified, the tests in this Technical Report apply exclusively to RTLS tags defined in ISO/IEC 24730-2.

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 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

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

ISO/IEC 24730-2, *Information technology — Real-time locating systems (RTLS) — Part 2: 2,4 GHz air interface protocol*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/IEC 19762-1, ISO/IEC 19762-3 and the following apply.

3.1 Terms and definitions

3.1.1
error vector magnitude
EVM
difference between the measured signal and a reference

NOTE A reference is a perfectly modulated signal.

3.2 Abbreviated terms

ARB	arbitrary waveform generator
BPSK	binary phase shift keying
DSSS	direct sequence spread spectrum
DUT	device under test
EIRP	effective isotropic radiated power
EVM	error vector magnitude
FSK	frequency shift keying
OOK	on-off keying
PPM	parts per million
RBW	resolution bandwidth
RTLS	real-time locating system
TIB	timed interval blink
VBW	video bandwidth

4 Conformance tests for ISO/IEC 24730-2

The following subsections describe the conformance tests.

4.1 General

This Technical Report specifies a series of tests to determine the conformance of RTLS tags to the ISO/IEC 24730-2 air interfaces. The results of this test shall be compared with the values of the parameters specified in ISO/IEC 24730-2 to determine whether the tag under test conforms.

This Technical Report also specifies a series of tests to determine the conformance of RTLS RF receivers to the ISO/IEC 24730-2 air interfaces. The results of these tests shall be compared with the values of the parameters specified in ISO/IEC 24730-2 to determine whether the RF receiver under test conforms.

This Technical Report additionally specifies tests to determine the conformance of the magnetic exciter device that is specified as an optional air interface for ISO/IEC 24730-2.

4.2 Default conditions applicable to the test methods

These conditions apply to all tests.

4.2.1 Test environment

Unless otherwise specified, testing shall take place in an environment of temperature 23 °C ± 3 °C (73° F ± 5° F) and of relative humidity 25 % to 75 %.

4.2.2 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.

4.2.3 Noise floor at test location

Noise floor at test location shall be measured with the spectrum analyzer in the same conditions as the measurement of the DUT, with a span of 10 MHz: RBW, VBW and antenna.

The spectrum analyzer shall be configured in acquisition mode for at least 1 minute.

The maximum of the measured amplitude shall be at least 60 dB below the expected value of the amplitude of the measured tag DSSS transmission at 0 dBm power with the tag placed at 1 meter from the measurement antenna.

Special attention has to be given to spurious emissions, e.g., insufficiently shielded computer monitors. The electromagnetic test conditions of the measurements shall be checked by performing the measurements with and without a tag in the field.

4.2.4 Total measurement uncertainty

The test equipment will introduce a level of measurement uncertainty. For example, the frequency accuracy of the local oscillator used in RF down-converter will add uncertainty to the calculated frequency accuracy of the measured RF. The specifications of the test equipment used shall be included in the report.

4.3 Tag DSSS RF transmission tests

This portion of the document describes the tests of the DSSS transmissions.

4.3.1 General

The DUT shall be an RTLS tag. The measurement equipment shall consist of an anechoic chamber as described in Annex A, and a measuring antenna and a vector signal analyzer for example an Agilent E4443A[1)] with 80 MHz bandwidth, as described in Annex C. Figure 1 shows the required test equipment setup.

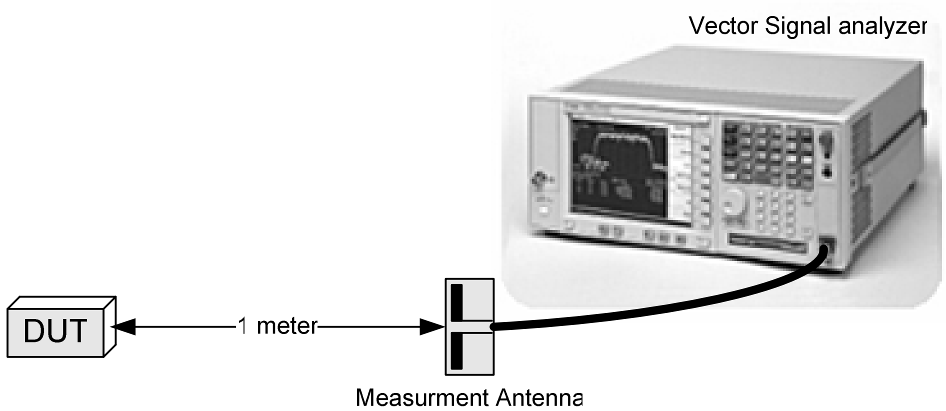

Figure 1 — Setup of equipment for DSSS RF test

1) The Agilent E4443A is an example of a suitable product available commercially. This information is given for the convenience of users of this Technical Report and does not constitute and endorsement by ISO of this product.

4.3.2 Test Objective

The objective of this test is to verify that the RTLS tag provides the appropriate DSSS modulation waveform required for proper system performance.

4.3.3 Test procedure

The tag shall be configured to transmit a 152-bit DSSS blink (as defined in paragraph 6.3.2.4 of ISO/IEC 24730-2) at an interval of 10 seconds or less. Each blink shall be configured with at least 2 sub-blinks. The tag shall be configured to transmit at a class 1 power between 0 dBm and +10 dBm EIRP. The measurement equipment shall be configured to start capturing for not less than 2.5 milliseconds after the RF energy detected is above the threshold. The post processing software shall calculate the raw samples and produce metrics for the following parameters to verify compliance of the tag.

4.3.4 Test measurements and requirements

This section describes the test measurements and requirements.

4.3.4.1 Carrier frequency

The carrier frequency shall be 2 441.750 MHz ± 61 kHz (25 PPM). The carrier frequency drift over the duration of the entire message shall be less than 5 kHz (2 PPM).

4.3.4.2 Transmit power

The transmitted power shall be calculated based on the power received at the measurement antenna. The calculated power shall be within ± 2.0 dB of the DUT specified transmit power.

4.3.4.3 Chip rate

The chip rate of the BPSK shall be 30.521875 MHz ± 763 Hz (25 PPM). No phase transitions shall occur at less than the chip rate, and all phase transitions shall occur at an integral multiple of the chip rate. An example methodology for measuring these transitions is provided in Annex F.

4.3.4.4 Message content and structure

The post processing software shall verify the 152-bit message format including preamble, status bits, tag ID, data, and message CRC are in compliance with the format specified in ISO/IEC 24730-2, sector 6.3.2.1. The post processing software shall verify differential data encoding within the message.

4.3.4.5 PN code length and polynomial

The polynomial used for driving the BPSK DSSS modulation is defined in Figure 3 of section 6.1 of ISO/IEC 24730-2. The entire captured message shall be 511 * 152 = 77 672 chips in length. The post processing software shall verify compliance with the defined PN sequence polynomial and second order non-linearity equation specified in ISO/IEC 24730-2.

4.3.4.6 Error vector magnitude

A BPSK signal shall produce a phase/amplitude constellation of two points. The post processing software shall determine the error vector magnitude of the distribution of the captured signal. The EVM must be less than 10 %.

4.3.4.7 Sub-blink interval and dither

Connect the measurement antenna to the vector signal analyzer. Set up the analyzer to trigger on the energy of the first sub-blink of a blink, and measure the time between the falling edge of the first sub-blink to the rising edge of the second sub-blink. This interval shall be nominally 125 milliseconds ± 16 milliseconds. Verify that over several successive blinks, the interval changes but does not go below 108 milliseconds or exceed 142 milliseconds.

4.3.5 Test report

The test report shall contain the tag distance to the measurement antenna and all of the measured data. A brief narrative of the post processing software used to evaluate the captured signal shall also be included as an annex to the data. As mentioned before (in 4.2.4), the report shall also contain the uncertainties of the measurement equipment.

4.4 Receiver DSSS RF tests

This section describes the conformance tests for the base station DSSS receiver (reader).

4.4.1 General

The DUT shall be an RTLS RF receiver. Example measurement equipment could consist of an Agilent E4438C[2)] Vector Signal Generator (VSG) with options 5 (6G hard drive) & 602 (Internal Baseband Generator 64Msa memory). Figure 2 shows the required test equipment set-up. An ISO/IEC 24730-2 format set-up and configuration file for the Agilent E4438C is also included in this document package in Annex E.

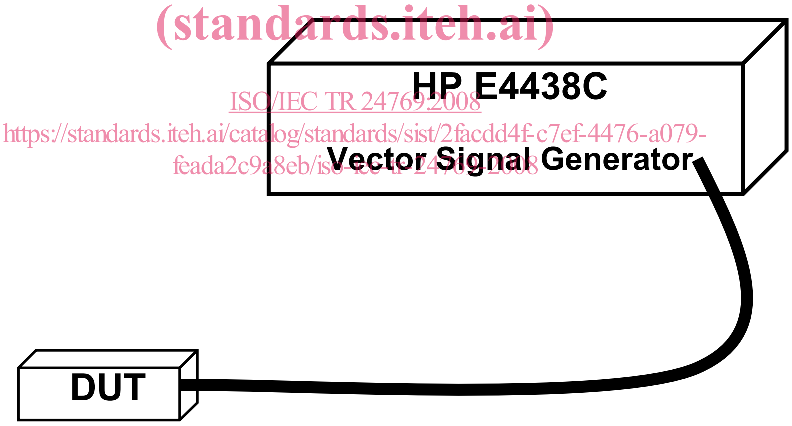

Figure 2 — Setup of equipment for DSSS RF Test

4.4.2 Test objective

The objective of this test is to verify that the RTLS RF receiver (DUT) provides the appropriate DSSS signal detection required for proper system performance.

4.4.3 Test procedure

The VSG shall be configured to transmit all four blink lengths (56-bit, 72-bit, 88-bit and 152-bit). Each blink type shall be configured with 8 sub-blinks. This should correspond to an average airtime usage of

2) The Agilent E4438C is an example of a suitable product available commercially. This information is given for the convenience of users of this Technical Report and does not constitute and endorsement by ISO of this product.

approximately 5 % for each of the four types. The post processing software shall calculate the raw samples and produce detection quality (% of total messages sent) metrics for the test parameters described below to verify compliance of the RF receiver.

4.4.3.1 152-bit blinks

A 152-bit DSSS blink (as defined in paragraph 6.3.2.4 of ISO/IEC 24730-2) is to be set at an interval of 0,42 seconds. This corresponds to an approximate air time usage of 5% for 8 sub-blink configuration.

4.4.3.2 88-bit blinks

A 88-bit DSSS blink (as defined in paragraph 6.3.2.3 of ISO/IEC 24730-2) is to be set at an interval of 0,24 seconds. This corresponds to an approximate air time usage of 5 % for 8 sub-blink configuration.

4.4.3.3 72-bit blinks

A 72-bit DSSS blink (as defined in paragraph 6.3.2.2 of ISO/IEC 24730-2) is to be set at an interval of 0,20 seconds. This corresponds to an approximate air time usage of 5 % for 8 sub-blink configuration.

4.4.3.4 56-bit blinks

A 56-bit DSSS blink (as defined in paragraph 6.3.2.1 of ISO/IEC 24730-2) is to be set at an interval of 0,15 seconds. This corresponds to an approximate air time usage of 5 % for 8 sub-blink configuration.

4.4.4 Test measurements and requirements

Stated below are the test measurements and requirements.

4.4.4.1 Carrier frequency tests

The centre carrier frequency test shall be 2 441,750 MHz. The edge carrier test frequencies shall be 2 441,811 043 75 MHz (+25 ppm) and 2 441,688 956 25 MHz (–25 ppm). The carrier frequency accuracy for all three tests should be +/– 1ppm. The carrier frequency drift over the duration of the entire message shall be less than 4,88 KHz (2 ppm) for all tests.

4.4.4.2 Receiver input RF power levels

The VSG shall be configured to provide two input signal levels to the DUT: –100 dbm (threshold sensitivity) & –40 dbm (dynamic range).

4.4.4.3 Chip rate

The chip rate of the BPSK shall be 30.521 875 MHz ± 30.5 Hz (1 PPM). No phase transitions shall occur at less than the chip rate, and all phase transitions shall occur at an integral multiple of the chip rate. An example methodology for measuring these transitions is provided in Annex F.

4.4.4.4 Message content and structure

The post processing software shall verify the 152-bit message format including preamble, status bits, tag ID, data, and message CRC are in compliance with the format specified in ISO/IEC 24730-2, sector 6.3.2.1. The post processing software shall verify differential data encoding within the message for reception error detection.

4.4.4.5 PN code length and polynomial

The polynomial used for driving the BPSK DSSS modulation is defined in Figure 3 of section 6.1 of ISO/IEC 24730-2. The entire captured message shall be 511 * 152 = 77 672 chips in length. The post processing software shall verify compliance with the defined PN sequence polynomial and second order non-linearity equation specified in ISO/IEC 24730-2. As mentioned before (in 4.2.4), the report shall also contain the uncertainties of the measurement equipment.

4.4.4.6 Detection error magnitude

For each set of the 4 message lengths, 3 test frequencies & 2 RF input levels (24 total tests), the reception error shall be better than 98 % of all sub-links sent. Each test shall consist of a minimum of 1 000 blinks X 8 sub-blinks

4.4.4.7 Sub-blink interval and dither

The sub-blink interval shall be nominally 125 milliseconds ± 16 milliseconds. Verify that over several successive blinks, the interval changes but does not go below 108 milliseconds or exceed 142 milliseconds.

4.4.5 Test report

The test report shall contain a summation detection percentage value for each of the 24 tests and all of the measured data. A brief narrative of the post processing software used to evaluate the detection percentage shall also be included as an annex to the data.

4.5 Tests for optional air interfaces

Below are the tests for the air interfaces which are optional.

4.5.1 Tag optional OOK/FSK RF tests

This subsections describes the tests for the OOK/FSK optional air interface.

4.5.1.1 Setup of equipment for optional tag OOK/FSK RF tests

The DUT shall be an RTLS tag. The test shall require an RTLS programmer, or an arbitrary waveform generator and magnetic transmit coil, to induce the OOK/FSK transmissions. The measurement equipment shall consist of an anechoic chamber and measuring antenna as described in Annex A, and a measurement antenna and a vector signal analyzer such as an Agilent E4443A, or equivalent, as described in Annex C. Figure 3 shows the required test equipment setup.