INTERNATIONAL STANDARD

ISO/IEC 24730-62

First edition
2013-09-01

Information technology — Real time locating systems (RTLS) —

Part 62: High rate pulse repetition frequency Ultra Wide Band (UWB) air interface

Technologie de l'information — Systèmes de localisation en temps réel (RTLS) —

Partie 62: Interface aérienne ultra large bande (UWB) à impulsions haute fréquence de répétition

Reference number
ISO/IEC 24730-62:2013(E)

Contents

Page

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 24730-62 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

ISO/IEC 24730 consists of the following parts, under the general title *Information technology — Real time locating systems (RTLS)*:

— *Part 1: Application program interface (API)*

— *Part 2: Direct Sequence Spread Spectrum (DSSS) 2,4 GHz air interface protocol*

— *Part 5: Chirp spread spectrum (CSS) at 2,4 GHz air interface*

— *Part 21: Direct Sequence Spread Spectrum (DSSS) 2,4 GHz air interface protocol: Transmitters operating with a single spread code and employing a DBPSK data encoding and BPSK spreading scheme*

— *Part 22: Direct Sequence Spread Spectrum (DSSS) 2,4 GHz air interface protocol: Transmitters operating with multiple spread codes and employing a QPSK data encoding and Walsh offset QPSK (WOQPSK) spreading scheme*

— *Part 61: Low rate pulse repetition frequency Ultra Wide Band (UWB) air interface*

— *Part 62: High rate pulse repetition frequency Ultra Wide Band (UWB) air interface*

Introduction

This series of standards defines one Air Interface Protocol for Real Time Locating Systems (RTLS) for use in asset management and is intended to allow for compatibility and to encourage interoperability of products for the growing RTLS market.

This document, the high rate pulse repetition frequency (HRP) UWB Air Interface Protocol, establishes a technical standard for Real Time Locating Systems that operate at an internationally available UWB frequency bands and that are intended to provide accurate location (e.g. within some tens of centimetres) with frequent updates (for example, every second).

Real Time Locating Systems are wireless systems with the ability to locate the position of an item anywhere in a defined space (local/campus, wide area/regional, global) at a point in time that is, or is close to, real time. Position is derived by measurements of the physical properties of the radio link.

Conceptually there are four classifications of RTLS:

- Locating an asset via satellite - requires line-of-sight - accuracy to 10 meters
- Locating an asset in a controlled area, e.g., warehouse, campus, airport - area of interest is instrumented - accuracy to 3 meters
- Locating an asset in a more confined area - area of interest is instrumented - accuracy to tens of centimetres
- Locating an asset over a terrestrial area using a terrestrial mounted receivers over a wide area, cell phone towers for example – accuracy 200 meters

With a further two methods of locating an object which are really RFID rather than RTLS:

- Locating an asset by virtue of the fact that the asset has passed point A at a certain time and has not passed point B
- Locating an asset by virtue of providing a homing signal whereby a person with a handheld can find an asset

Method of location is through identification and location, generally through multilateration

- Types
  - Time of Flight Ranging Systems
  - Amplitude Triangulation
  - Time Difference of Arrival (TDOA)
  - Cellular Triangulation
  - Satellite multilateration
  - Angle of Arrival

This standard defines the air interface protocol needed for the creation of an RTLS system using HRP UWB which is a physical layer UWB signalling mechanism (based on standard IEEE 802.15.4a UWB) and employing high rate pulse repetition frequencies (PRF) 16 MHz or 64 MHz, and a combination of burst position modulation (BPM) and binary phase-shift keying (BPSK.

Information technology — Real time locating systems (RTLS) —

Part 62: High rate pulse repetition frequency Ultra Wide Band (UWB) air interface

1 Scope

This part of ISO/IEC 24730 defines the air-interface for real time locating systems (RTLS) using a physical layer Ultra Wide Band (UWB) signalling mechanism (based on IEEE 802.15.4a UWB). This modulation scheme employs high rate pulse repetition frequencies (PRF) 16 MHz or 64 MHz, and a combination of burst position modulation (BPM) and binary phase-shift keying (BPSK) giving an extremely high level of performance with a fully coherent receiver.

In addition to defining the air interface protocol (AIP) in terms of the physical layer modulation, this part of ISO/IEC 24730 also defines the AIP in terms of the messages sent over the air. This AIP supports simple one-way communication of a basic blink that may be used for a one-way Time Difference of Arrival (TDOA) based RTLS, where mobile tags periodically transmit the blink message which is received by an infrastructure consisting of a number of fixed reader nodes.

This AIP also optionally supports bidirectional communication and two-way ranging between the readers and tags of an RTLS. The support of two-way ranging depends on additionally including a UWB receiver in the tag and UWB transmitters in the reader infrastructure.

The mandatory default operational mode ensures interoperability between tags and infrastructure from various manufacturers, while the availability of several options offers flexibility to the developer of the infrastructure to adapt the behaviour of the overall system to the specific needs of his application.

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/IEEE 8802-15-4, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements Part 15-4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)*

ISO/IEC 15963, *Information technology — Radio frequency identification for item management — Unique identification for RF tags*

ISO/IEC 19762, *Information technology AIDC techniques — Harmonized vocabulary — (all parts)*

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/IEEE 8802-15-4, ISO/IEC 19762 (all parts), and the following apply.

3.1.1
burst
group of ultra wide band (UWB) pulses occurring at consecutive chip periods

3.1.2
complex channel
combination of a channel [radio frequency (RF) center frequency] and a ternary code sequence

3.1.3
frame
format of aggregated bits that are transmitted together in time

3.1.4
hybrid modulation
modulation used in the ultra wide band (UWB) physical layer (PHY) that combines both binary phase-shift keying (BPSK) and burst position modulation (BPM) so that both coherent and non-coherent receivers can be used to demodulate the signal

3.1.5
idle period
duration of time where no transceiver activity is scheduled to take place

3.1.6
local clock
symbol clock internal to a device

3.1.7
mean pulse repetition frequency (PRF)
total number of pulses within a symbol divided by the symbol duration

3.1.8
payload data
contents of a data message that is being transmitted

3.1.9
peak pulse repetition frequency (PRF)
maximum rate at which an ultra wide band (UWB) physical layer (PHY) emits pulses

3.1.10
ranging frame (RFRAME)
ultra wide band (UWB) frame having the ranging bit set in the physical layer (PHY) header (PHR)

3.1.11
ranging marker (RMARKER)
first ultra wide band (UWB) pulse of the first bit of the physical layer (PHY) header (PHR) of a ranging frame (RFRAME)

3.1.12
symbol
period of time and a portion of the transmitted signal that is logically considered to be a unit signaling event conveying some defined number of data bits or repeated portion of the synchronization signal

3.2 Abbreviated terms

AGC	automatic gain control
API	application program interface
BPM	burst position modulation
BPSK	binary phase-shift keying
CRC	cyclic redundancy check
DPS	dynamic preamble selection
DSN	data sequence number
FCS	frame check sequence
FEC	forward error correction
HRP	high rate PRF
LFSR	linear feedback shift register
LRP	low rate PRF
LSB	least significant bit
MAC	medium access control
MSB	most significant bit
PHR	PHY header
PHY	physical layer
PPDU	PHY protocol data unit
PRBS	pseudo-random binary sequence
PRF	pulse repetition frequency
PSD	power spectral density
PSDU	PHY service data unit
RF	radio frequency
RFID	Radio Frequency Identification
RFRAME	ranging frame
RMARKER	ranging marker
RTLS	Real Time Locating System
RX	receive or receiver
SFD	start-of-frame delimiter
SHR	synchronization header
SNR	signal-to-noise ratio
SYNC	synchronization
TDOA	time difference of arrival
TOF	time of flight

TX transmit or transmitter

UWB ultra wide band

4 Overview

4.1 Components

The major components of a Real Time Locating System (RTLS) and the relationship of those components are shown in Figure 1. As shown in this figure the tags communicate with an infrastructure. The infrastructure provides an Application Program Interface (API) through which an application can control the RTLS and retrieve information about location and state of tags.

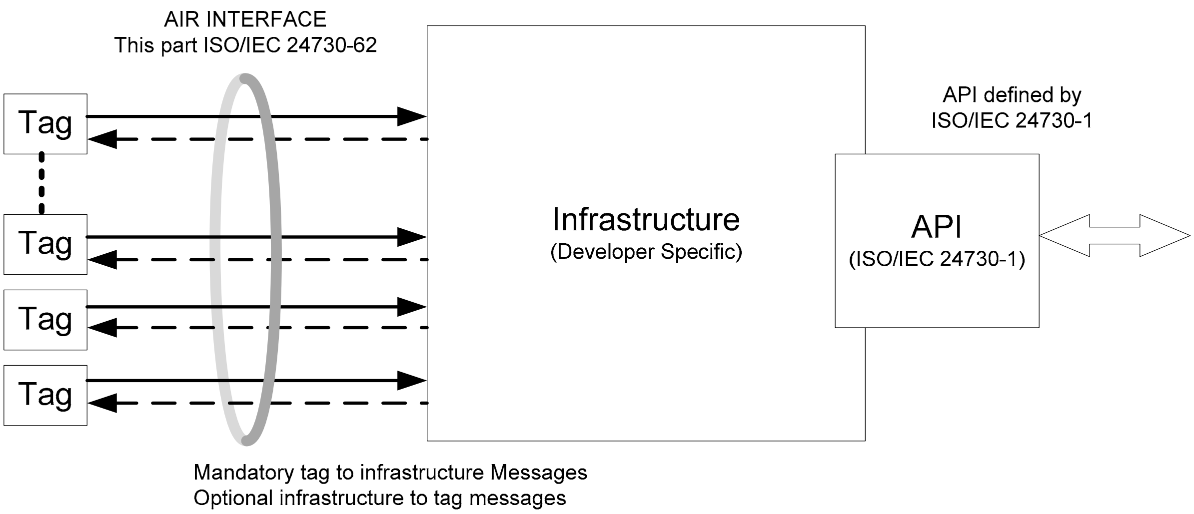

Figure 1 — RTLS components

As indicated in Figure 1 tags communicate with infrastructure over an air interface. Generally the air interface includes the definition of waveforms, formats of packets as well as commands and reports to be exchanged between tags and infrastructure. This can be depicted in a layered approach as shown in Figure 2. Similar interpretations can be found in other standards e.g. in ISO/IEC 18000-1[1].

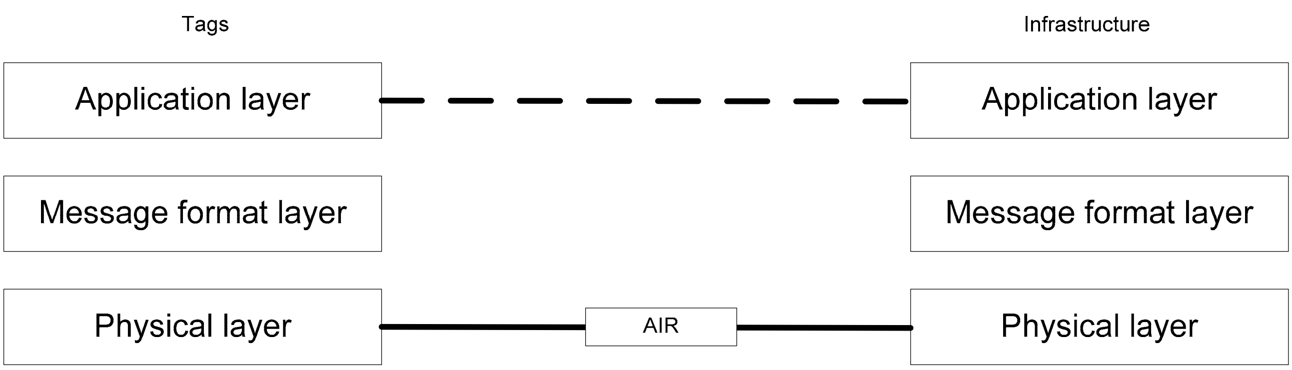

Figure 2 — air interface layers

4.2 Not covered by the standard

The design of the infrastructure is left completely to the developer, e.g. the density of RTLS reader nodes, how the RTLS reader nodes are controlled and communicate with each other, how the infrastructure is set up, etc. may be different in various scenarios and for systems from different vendors. For typical RTLS applications, at least three RTLS readers need to receive the blink message from a tag, measuring its time of arrival, in order to locate the tag.

4.3 System

After power on, a tag uses a default profile in which it blinks periodically. With each blink the tag signals its physical address and optional information about whether and when it can receive commands from the infrastructure.

The infrastructure may use the arrival times of the blink at a number of time synchronised readers to compute the tag location using TDOA mechanisms.

The infrastructure may decide (for two-way capable tags) to command the tag to perform two-way ranging to a number of similarly capable reader nodes in the vicinity. By sending commands to the tag while the tag is listening, the infrastructure may select the reader nodes with which the tag performs two-way ranging. Furthermore the infrastructure can adapt the behaviour of the tags to the actual conditions such as the number of tags in range, number of infrastructure nodes available, etc.

When a two-way tag loses connection to the infrastructure, i.e. doesn't receive any commands for a certain time, it reverts to its default blink activity.

4.4 Document structure

The remainder of this part of ISO/IEC 24730 firstly defines and specifies the Physical Layer (PHY) layer modulation and then defines the basic message format before separately detailing the messages of the default one-way communications mode of operation and the messages of the optional two-way communications mode of operation.

5 Physical (PHY) layer specification

5.1 General

The High Rate PRF (HRP) UWB physical layer herein called the UWB PHY, employs a mean PRF that is nominally 16 MHz or optionally nominally 64 MHz. The UWB PHY waveform is based upon an impulse radio signaling scheme using band-limited data pulses. The UWB PHY supports two independent bands of operation:

— The low band, which consists of four channels and occupies the spectrum from 3.1 GHz to 4.8 GHz

— The high band, which consists of eleven channels and occupies the spectrum from 6.0 GHz to 10.6 GHz

Within each channel, there is support for at least two complex channels that have unique length 31 SHR preamble codes. The combination of a channel and a preamble code is termed a *complex channel*.

A combination of burst position modulation (BPM) and binary phase-shift keying (BPSK) is used to support both coherent and non-coherent receivers using a common signaling scheme. The combined BPM-BPSK is used to modulate the symbols, with each symbol being composed of an active burst of UWB pulses. The various data rates are supported through the use of variable-length bursts.