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Angular sweep test methods for radio frequency identification (RFID) enabled tyres

Méthodes d'essai par balayage angulaire des pneus équipés de la technologie d'identification par radio fréquence (RFID)

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Foreword

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This document was prepared by Technical Committee ISO/TC 31 *Tyres, rims and valves.*

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

This document defines a methodology for approaching "read range" specifications in the domain of radio frequency identification (RFID) enabled tyre applications and use cases.

The technical field relates to the capacity to control the communication link between a passive RFID tyre tag in the ultra high frequency (UHF) RFID band from 860 to 930 MHz, and the corresponding RFID reader set at a location where a communication transaction is expected.

The following context elements can support the need for defining such a methodology:

— RFID tags can potentially be implemented into tyres through different means and at different locations, as described in ISO 20911;

— RFID reader configurations can be diverse along the whole tyre life cycle in terms of tyre and antenna relative position, antenna count and technology, distance, orientation, and in terms of relative movement between the tyre and the antenna(s);

— the concept of controlling the RFID enabled tyre design such a way that every tyre produces a similar spatial read range response, for every tyre model, size, and for all the tyre brands, is unrealistic since the typical tyre materials and constructions must differ for controlling a variety of product functionalities, thus potentially modifying the three-dimensional tyre radio frequency signature. Although a certain variability of this radio frequency signature between RFID enabled tyre models must be acknowledged as part of the state of the art, it remains important to be able to define, measure, and control it so the industry participants can assess their respective targets with a common approach.

  — A tyre manufacturer can set minimum read range levels for its tyre model designs and tyres in production. How this target should be formulated?

  — A read point provider can want to know how to select a representative RFID enabled tyre sample so to configure the read point design and setup.

  — A read point owner can want to set requirements implying the above parties. What common language should be used so all the parties understand each other?

— as the technology is ramping up within the industry, while onboarding many participants among the technology or solution providers, read point owners and tyre manufacturers, all looking for the adequate specifications; it can be perceived as a strong need for:

  — providing clarity during the specification discussions between the participants;

  — better guiding the design and setup of read point configurations.

This document describes an angular sweep performance (ASP) indicator, intended to embrace a significantly increased set of read point configurations when compared to the only stand-alone tyre described in ISO 20912. It is acknowledged that an increased complexity is created through the introduction of one new but major angular parameter which is intended to open the road to a simplification of the specification approaches on read ranges and provide an answer for more common use cases.

The performance indicator is used on a broad category of RFID read points, in order to:

— predict if one specific RFID enabled tyre can successfully pass onto a given pre-defined read point configuration;

— select a representative RFID enabled tyre sample for designing or setting up a new read point.

Methods described in ISO 20912 allow conformance verification on the minimum read range requirement specified in ISO 20909, while the ASP indicator and the corresponding ASM methods described in this document allow read range specification construction on a variety of read point applications.

During the development of this document, the key parameters influencing the test results based on the state of knowledge and practice of the contributing participants were taken into consideration. However, other

parameters remain unspecified. Therefore, a testing lab can set those parameters to their discretion to perform the method.

This document does not set the read range requirement targets for the corresponding read points, neither for the RFID enabled tyres.

The associated ASM method is proposed at two levels of definition, so that experience can be gained and shared within the industry. An International Standard can be initiated at a later stage, when the participants have gained more experience and have identified ways to optimize and improve.

Angular sweep test methods for radio frequency identification (RFID) enabled tyres

1 Scope

The document specifies an overall read range performance indicator and its associated measurement methods for radio frequency identification (RFID) enabled tyres described in ISO 20911 and tagged in ISO 20909.

The ultra high frequency (UHF) RFID band used covers 860 to 930 MHz. Methods applying to passenger cars, light commercial and truck vehicles classes of tyres as defined in subclause 4.1.

Methods described have not been investigated for tyres beyond tyre classes defined in subclause 4.1.

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 20912, *Conformance test methods for RFID enabled tyres*

3 Terms and definitions

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

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

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

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

3.1
angular sweep performance
ASP
minimum effective isotropic radiated power threshold (EIRPMin) value set at a reference distance of 1 meter and at the best angular orientation

3.2
antenna reference point
physical extremity of an antenna

Note 1 to entry: The antenna reference point contributes to setting the actual measurement distance.

3.3
received signal strength indicator
RSSI
indicative, non-calibrated value of the received power at the reader input

Note 1 to entry: This is the power backscattered by the tag towards the reader and measured at the reader input. RSSI is sometimes used to determine a tag's distance, as the signal is stronger from a tag that is closer to the reader antenna, however, the reflections and attenuation due to different materials can distort it.

[SOURCE: ISO 20912:2020, 3.4]

3.4
read point configuration
system configuration designed for operating either a transaction or communication, or both, between the RFID tag and the reader

Note 1 to entry: Key read point configuration parameters described in this document belong to the positioning and the relative movement between the RFID enabled tyre and the antenna(s).

3.5
equivalent isotropic radiated power
EIRP
product of the power supplied to the antenna and the maximum antenna gain in one direction relative to an isotropic radiator (absolute or isotropic gain)

[SOURCE: ISO 20912:2020, 3.6, modified — Term changed from "effective isotropic radiated power" to "equivalent isotropic radiated power", formula deleted and Note 1 to entry deleted.]

3.6
minimum effective isotropic radiated power threshold
EIRPMin
minimum power emitted by the isotropic antenna from the E-field required for the tag to turn-on

Note 1 to entry: It is generated at a selected measuring distance and at a selected frequency.

3.7
minimum reader power threshold
P_t
power set at the reader level which corresponds to EIRPMin

Note 1 to entry: The Pt is obtained at a selected measuring distance and at a selected frequency considering the specific laboratory equipment as far as cabling and antenna.

3.8
anechoic chamber

test chamber where radio waves are not reflected inside and not transmitted from outside

Note 1 to entry: An anechoic chamber is a room designed for operating radio frequency tests without reflections from the delimiting surfaces in the frequency bands of interest. It is additionally equipped with a Faraday cage system preventing radio frequency emissions from travelling through the boundaries of the room. An operator typically conducts the test from the outside of the chamber.

3.9
class of tyre
type of tyres intended to be used on similar vehicles

Note 1 to entry: The relevant types of class of tyre are named and defined as follows:

— passenger car tyres: tyres conforming to ISO 4000-1;

— light commercial vehicle tyres and truck tyres conforming to ISO 4209-1.

4 Angular sweep methods (ASM)

4.1 Technical scope

The ASP indicator determined through the ASM is preferably suited for addressing the performance requirements combining tyres from the class of tyres and read points characterized by key features such as:

— individual tyres (not stacked or not too close from neighbours);

— antenna(s) facing the tyre side where the tag is located;

— tag/antenna(s) relative movement including linear displacement and/or rotation and/or rolling;

— unmounted and wheel mounted tyres;

— unmounted and vehicle mounted tyres.

Other more complex read point featured configurations such as “stacked tyres”, “tag and antenna on opposite sides of the tyre”, “tag situated on the inner tyre in dual tyres configuration” and other possible configurations beyond these here mentioned may also be explored through this performance indicator and associated measurement methods but more precautions must be taken.

See Annex C for an exploratory adaptation of ASM methods in the scope of more complex read points.

4.2 General operating conditions

The method applies specific requirements described in ISO 20912 for the following domains:

— testing sites: corresponding to the “semi-anechoic chamber” description in ISO 20912:2020, 4.3.2;

— lab test equipment: as described in ISO 20912:2020, 4.3.3. Complementary guidelines are also described in Annex B;

— general precautions and requirements described in ISO 20912:2020, 4.2.3.3 and 4.3.2, which are associated to:

  — radio frequency regulations in the geographical zone of operation;

  — electromagnetic interferences avoidance;

  — tyre stand;

  — radio frequency absorbers;

  — operator position when applicable;

  — radio wave reflection control;

  — distances control from ceiling and floor.

The testing site may be upgraded to an anechoic chamber, which provides:

— a greater flexibility on radio frequency bands and maximum reader power explorations;

— an improved repeatability of the measurements while cancelling external radio frequency interferences and internal reflections.

4.3 Angular exploration

4.3.1 Introduction

The concept of implementing an angular sweep around the tyre to identify the best available read range potential can suggest that a spatial exploration must be conducted. But, considering the dipole characteristics of the tag solutions, it is a reasonable assumption to limit the spatial exploration to a plane which is perpendicular to the direction of the tag antenna and passing through the centre of the tag, where the max radiation is expected.

Due to the read point features preferably covered by the measuring method (see 4.1), the plane exploration is limited to the 180° window facing the tagged main surface of the RFID enabled tyre.