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TECHNICAL REPORT

colour inside

Transmitting and receiving equipment for radiocommunication – Short-range radar technologies and their performance standard – Part 1: System applications of short-range radars

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TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – SHORT-RANGE RADAR TECHNOLOGIES AND THEIR PERFORMANCE STANDARD –

Part 1: System applications of short-range radars

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IEC TR 63385-1 has been prepared by IEC technical committee 103: Transmitting and receiving equipment for radiocommunication. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
103/235/DTR	103/257/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 63385 series, published under the general title *Transmitting and receiving equipment for radiocommunication – Short-range radar technologies and their performance standard*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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INTRODUCTION

Short-range radar systems are widely exploited in civil applications, such as automotive, weather forecast, mobile, aviation, or security inspections applications. The performance of each radar system is guaranteed in the field without any harmful interference but the frequency allocation using theoretical calculations does not consider the latest mitigation technologies. In order to increase the efficiency of the system usage without any degradation of the performance of the radars, this document describes the principles of the radar systems and their performance in applications.

This document summarizes the technological features of short-range radar systems. In addition, some practical applications are also investigated and reported.

TRANSMITTING AND RECEIVING EQUIPMENT FOR RADIOCOMMUNICATION – SHORT-RANGE RADAR TECHNOLOGIES AND THEIR PERFORMANCE STANDARD –

Part 1: System applications of short-range radars

1 Scope

This part of IEC 63385 provides a catalogue of the architecture and principles of measurement of short-range radars that are widely exploited in civil applications. The applications are related to the detection of the target for obstacle avoidance, motion sensing, or identification of devices. The mass civil use of radars sometimes creates compatibility issues among the services. This document provides clarification on the characteristics of the radar systems and additional information on applications in the field.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

No terms and definitions are listed in this document.

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.2 Abbreviated terms

AoA	angle of arrival
FFT	Fast Fourier Transformation
FM	frequency modulation or frequency modulated
FMCW	frequency modulated continuous wave
PPM	pule position modulation
radar	radio detection and ranging
RCS	radar cross-section
Rx	receiver
S/N ratio	signal to noise ratio
SSR	secondary surveillance radar
ToA	time of arrival
Tx	transmitter
UWB	ultra wide band

4 Considerations on measurement principles of radars

4.1 General

The Clause 4 introduces the measurement principle of each radar architecture. The radar comprises equipment to measure the distance D to the objects by radio waves. A schematic diagram of the radar principle is shown in Figure 1. The radars fundamentally measure the time for the round trip of the radio propagation from the transmitter to the receiver returned by the reflection at the surface of the object.

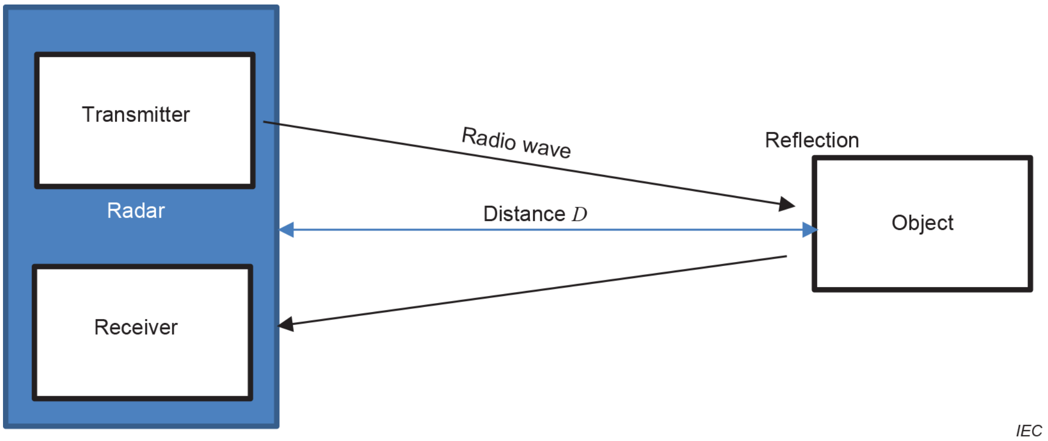

Figure 1 – Schematic diagram of radar system

The distance to the target D is calculated by multiplying the time and speed of radio waves. Several methods to measure the distance are developed for the radar systems to obtain the propagation time. The resolution of the distance measurement and sensitivity of the radar systems depend on the measurement methods. This Clause 4 provides information on the measurement methods and their characteristics for each radar system.

4.2 Pulsed radar system

Pulsed radar is one of the classic technologies and the simplest way to measure the distance to the object. A schematic diagram of the time versus power for a pulsed radar is shown in Figure 2. The attenuated signal is received at the receiver located at the same place or nearby the transmitter when the pulsed waveform is transmitted from the radar transmitter.

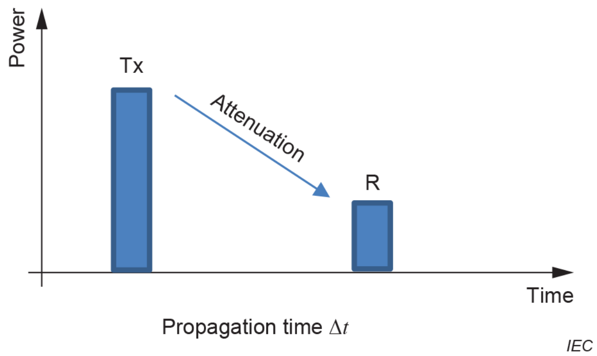

Figure 2 – Waveform and timing of transmission and reception for a pulsed radar system

The radar measures the propagation time Δt from the transmission to reception via the reflection by the target. The distance to the target is simply calculated by the measured reciprocal propagation time as follows:

$$D = \frac{\Delta t}{2c} \tag{1}$$

where

D is the distance to the target;

Δt is the propagation time;

c is the speed of the radio wave.

The distance is calculated from half of the propagation time for the reciprocal propagation divided by the speed of the light.

The power of the attenuated received radio wave P_r is calculated by the radar equation [1][1]:

$$P_r = AP_t = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 D^4} \tag{2}$$

where

A is the total attenuation of the transmitting wave;

P_t is the transmitting power of the radar;

G is the isotropic gain of the antenna;

λ is the transmitting power of the radar;

σ is the radar cross-section (RCS) of the target, which is the index of relative reflectivity assuming the cross-section of an ideal metallic sphere.

To detect the reflected signal, the receiver noise floor and the received power are compared. The radar can detect the target when the received signal should be higher than a value multiplying the thermal noise and the signal to noise (S/N) ratio as:

$$P_r > k_{SN} k_{NF} k_B B_r T_r \tag{3}$$

where

k_{SN} is the minimum S/N ratio for the detection;

k_{NF} is the noise figure of the receiver;

k_B is the Boltzmann's constant;

B_r is the total bandwidth of the receiver;

T_r is the absolute temperature of the receiver.

Near the noise floor, the noise will cause frequent instantaneous spikes in power which will mean that simple comparison between the noise and received signal will sometimes cause the misdetection of the target. Therefore, the minimum S/N ratio is designed by considering the requirement to deal with the sensitivity and error rates.

[1] Numbers in square brackets refer to the Bibliography.