International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R M.1452-1

(10/2009)

Millimetre wave radiocommunication systems for intelligent transport system applications

M Series

Mobile, radiodetermination, amateur and related satellite services

Foreword

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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R M.1452-1

Millimetre wave radiocommunication systems for intelligent transport system applications

(Question ITU-R 205/5)

(2000-2009)

Scope

This Recommendation provides system requirements, technical and operational characteristics of millimetre wave radiocommunication systems for intelligent transport system applications to be used for system design objectives. The Recommendation covers low power, vehicular collision avoidance radar operating in the 60-61 GHz, 76-77 GHz and 77-81 GHz bands, as well as integrated millimetre wave radiocommunication systems for ITS applications in the 57-66 GHz range for vehicle-to-vehicle radiocommunications and radiocommunications between the vehicle and roadside infrastructure.

The ITU Radiocommunication Assembly,

considering

a) that intelligent transport systems (ITS) may significantly contribute to the improvement of transportation and public safety;

b) that international standards would facilitate worldwide applications of ITS and provide for economies of scale in bringing ITS equipment and services to the public;

c) that harmonization of ITS applications is dependent on common radio spectrum allocations;

d) that high-capacity transmission systems will be required for ITS radiocommunication systems in order to support multimedia and high-resolution applications;

e) that low-capacity transmission systems will also be required for ITS radiocommunication systems to support safe vehicle operation, such as a collision avoidance radar;

f) that an integrated system of radar with radiocommunications is beneficial for safe driving and driver comfort;

g) that millimetre wave high-speed ITS communication systems using radio-over-fibre technology have been intensively studied in research fora and industries;

h) that millimetre wave frequencies have significant advantages and provide a wide bandwidth for such integrated ITS radar and communication systems;

j) that millimetre wave frequencies are also used by other radio systems and services operating in accordance with the Radio Regulations;

k) that the band 21.65-26.65 GHz is temporarily used for automotive short-range radars in the European Conference of Postal and Telecommunications Administrations (CEPT) until 1 July 2013;

l) that strong absorption in a part of millimetre wave frequency ranges due to atmospheric oxygen and water vapour has a potential to reduce the interference among different radio services operating in the ranges;

m) that technical and operational characteristics of integrated millimetre wave radiocommunication systems for ITS applications need to be identified to facilitate the global deployment of such a system,

noting

a) that the International Organization for Standardization (ISO) has published standards on non-radio aspects of ITS in ISO/TC204, taking into account the work of recognized external organizations;

b) that the European Telecommunications Standards Institute (ETSI) has published standards on radio aspects of ITS in ETSI/ERM (Electromagnetic compatibility and Radio Spectrum Matters) which may further contribute to the efforts in ITU-R;

c) that the Institute of Electrical and Electronics Engineers (IEEE) is addressing millimetre wave communication standards for wireless personal networks in the frequency range 57-66 GHz as IEEE 802.15.3c;

d) that the Land Mobile Handbook (Volume 4 on ITS) contains information on millimetre wave communications, including propagation characteristics for vehicle-to-vehicle communications and inter-vehicle communications and radar;

e) that the band 76-77.5 GHz is allocated worldwide on a primary basis to the radio astronomy service, which is particularly susceptible to disruption by mobile ITS applications because of the extremely weak cosmic signals under study and the possibility of vehicles being in proximity to radio telescopes,

recommends

1 that the operational and technical characteristics of collision avoidance radar of millimetre wave radiocommunication systems for ITS applications, given in Annex 1, should be used as a guideline for system design objectives;

2 that the operational and technical characteristics of millimetre wave radiocommunication systems for ITS applications for data communication between vehicle-to-vehicle and vehicle-to-roadside, as given in Annex 2, should be used as a guideline for system design objectives.

Annex 1

Low-power short-range vehicular radar equipment at 60 GHz and 76 GHz

1 General

1.1 Introduction

Several millimetre wave bands are considered for vehicular radar: The 76 GHz band has already been designated by the Federal Communications Commission (FCC) in the United States of America and by the Ministry of Internal Affairs and Communications (MIC) in Japan for these purposes. In the United States, vehicular radars operating in the 76 GHz band may not cause harmful interference and must accept interference that may be caused by the operation of an authorized radio system, by another intentional or unintentional radiator, by industrial, scientific and medical (ISM) equipment, or by an incidental radiator. Furthermore, in accordance with European spectrum requirements for RTTT, ETSI has adopted European standards for low power vehicle radar operating in the 76-77 GHz and 77-81 GHz band. The Japanese MIC has also allocated the 60-61 GHz band for this application. This effort has led ASTAP to consider a proposal on a draft standard for low power, short-range vehicular radar operating in the 60-61 GHz, and 76-77 GHz bands.

Today's vehicular radar systems in the millimetre wave are of two categories according to the measurement ranges and bandwidth:

– Adaptive Cruise Control (ACC) "long-range" radar, operating in the band 76-77 GHz, for measurement range up to 150 m.

– "Short-range" radar, operating in the band 77-81 GHz, is also allocated in Europe, for measurement range up to 30 m.

Since vehicles are sold worldwide, the automotive industry[1] is highly interested in a worldwide harmonization of these frequency bands and the corresponding parameters.

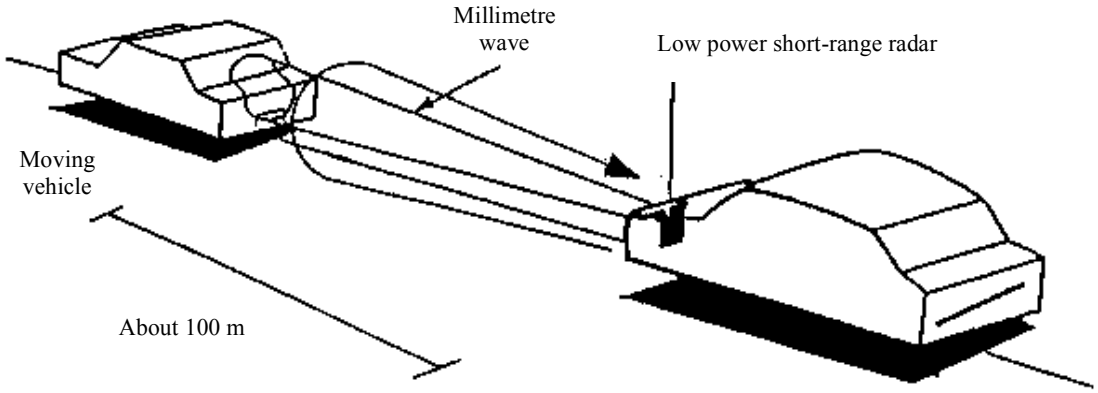
A typical radar system can detect the conditions within about 100 m from a vehicle using millimetre waves. This system is expected to avoid collisions and other accidents.

Figure 1 shows an application example of low power automotive radar.

[1] Many car manufacturers and suppliers are organized in the industrial group SARA (Strategic Automotive Radar frequency Allocation, www.SARA-group.org).

FIGURE 1

Image of vehicles using low power short-range radar



Depending on the number of radar sensors and their position it is possible to detect objects in sectors or even the complete surrounding of a car. The sensor signals are the basis not only for driver assistance systems like Adaptive Cruise Control but also for a broad variety of automotive applications of active and passive safety.

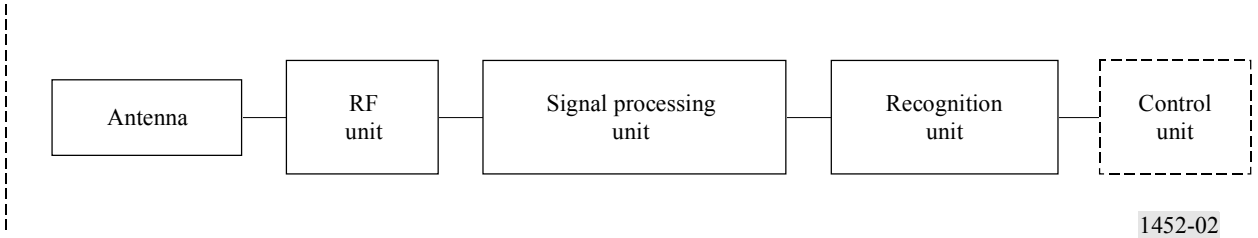
1.2 Scope

Systems for monitoring the proximity to vehicles will play an important role in ensuring driving safety. With its resistance to bad weather and dirt, automotive radar is suitable for vehicles driven in severe conditions.

Figure 2 shows the configuration of automotive radar.

FIGURE 2

Configuration of short-range radar for vehicles



Subsystems are as follows:

– *Antenna/RF unit*

This part consists of a transmitting antenna, a receiving antenna, receiving equipment and transmission equipment. Signal modulations, conversions to high frequencies, radio-wave transmission, and radio-wave reception are handled in this part. This part could be equipped with several antennas and could perform beam scanning.

– *Signal processing unit*

This unit renders distance and speed by calculating signals handed over from the RF unit. Rendering of average distance and speed, and mitigation of interference are sometimes handled here. When the antenna performs beam scanning, this unit calculates the direction of detected objects.

– *Recognition unit*

This unit can select and arrange the most wanted or necessary data depending on the needs of each system. For example, the unit will recognize the most relevant objects, and can judge whether the vehicle in front is in lane. The unit occasionally averages figures gathered, filters interference, and enhances measuring accuracy and reliability of data by tracking objects and by data fusion with data from other sensors.

2 System requirements

2.1 Radio-frequency band

60 GHz band: 60-61 GHz. This range is within a very strong absorption band caused by atmospheric oxygen, and is useful only for very short-range communications due to the high attenuation with distance.

76 GHz and 79 GHz band: 76-77 GHz and 77-81 GHz. Atmospheric absorption is much less in this band compared to 60-61 GHz.

2.2 Radar method and modulation method

The following four radar methods (with modulation methods) are recommended:

– FM-CW method (frequency modulation);

– pulse method (pulse modulation);

– pulsed frequency hopping;

– two frequency CW method (no modulation or frequency modulation);

– spread spectrum method (direct sequence spread spectrum).

2.3 Transmitting power and antenna gain

Transmitting power (power transferred to antenna) is determined by the detection range, angular range and bandwidth.

2.4 Specified bandwidth

Up to 4.0 GHz.

Annex 2

Technical characteristics of millimetre wave radiocommunication systems for data communications between vehicles and between vehicles and roadside infrastructure

1 General technical characteristics

1 Communications method: one-way, simplex, half duplex, full duplex, multicast.

2 Modulation method: as required by application.

3 Frequency band: 57.0-66.0 GHz (channel arrangements to be used for ITS applications will be specified by regions or countries separately).

4 Transmitter power (power transferred to antenna)/e.i.r.p: 10 mW or less/40 dBm or less.

5 Permissible occupied bandwidth: 2.5 GHz or less.

2 Examples of technical characteristics of millimetre wave radiocommunication systems for ITS applications

The characteristics specified for millimetre wave radiocommunication systems for ITS are shown in Table 1.

TABLE 1

Technical characteristics of millimetre wave radiocommunication systems for ITS applications

Item	Technical characteristic		
	System A	System B	System C
Communication method	One way, simplex, half duplex, full duplex, multicast		
Modulation method	The modulation method is not provided for to correspond to the upgrade of the future use		
Frequency band	63.0-64.0 GHz	59.0-66.0 GHz	57.0-64.0 GHz
Transmitter power (power transferred to antenna)	40 dBm	10 mW or less	10 mW or less
e.i.r.p.			
Permissible occupied bandwidth		2.5 GHz or less	
Antenna gain	23 dBi or less (side lobe attenuation: 20 dB)	47 dBi or less	17 dBi (47 dBi for point to point application)