RECOMMENDATION ITU-R M.1453*

TRANSPORT INFORMATION AND CONTROL SYSTEMS – DEDICATED SHORT RANGE COMMUNICATIONS AT 5.8 GHz

(Question ITU-R 205/8)

(2000)

The ITU Radiocommunication Assembly,

considering

a) that transport information and control systems (TICS) may significantly contribute to the improvement of public safety;

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

c) that early international harmonization of TICS would have several benefits;

d) that worldwide compatibility of TICS may be dependent on common radio spectrum allocations;

e) that the International Organization for Standardization (ISO) has work under way on standardizing TICS (non-radio aspects) in ISO/TC204 which will contribute to the efforts in ITU-R,

recognizing

a) that the European Telecommunications Standards Institute (ETSI) has adopted European standards on "Road Transport and Traffic Telematics (RTTT): Technical characteristics and test methods for Dedicated Short Range Transmission Communication (DSRC) equipment operating in the 5.8 GHz Industrial, Scientific and Medical (ISM) band (ES 200 674-2)". The bands 5 795-5 805 MHz and 5 805-5 815 MHz (on a national basis) are identified for those systems;

b) that other regional organizations, such as the Asia-Pacific Telecommunications Standardization Program (ASTAP), have approved a proposal on a draft standard on "Dedicated Short Range Communications (DSRC) Equipment Operating in the 5.8 GHz band",

noting

a) that this frequency range, 5 725-5 875 MHz, is also used by other radio systems and services operating in accordance with the RR,

recommends

1 that the technical and operational characteristics of DSRC described in Annex 1 be considered representative of those operating in the 5.8 GHz frequency band;

2 that both active (transceiver) and backscatter (transponder) methods described in Annex 1 are viable for DSRC implementation.

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* This Recommendation should be brought to the attention of Radiocommunication Study Group 1.

ANNEX 1

Technical and operational characteristics of DSRC operating in the 5.8 GHz frequency band

1 General

This Recommendation outlines the technologies and characteristics for DSRC at 5.8 GHz band. This Recommendation includes both the active (transceiver) method and the backscatter (transponder) method as DSRC technologies available for TICS. The technical and operational characteristics of both methods are described.

1.1 Introduction

DSRC is a dedicated mobile radiocommunications system for vehicles that travel on roads. DSRC is a fundamental technology for TICS communications, helping link roads, traffic and vehicles covered by TICS with information technology.

DSRC refers to any short-range radiocommunication technology from a roadside infrastructure to a vehicle or a mobile platform. DSRC applications include electronic toll collection, parking payment, gas (fuel) payment, in-vehicle signing, traffic information, management of public transportation and commercial vehicles, fleet management, weather information, electronic commerce, probe data collection, highway-rail intersection warning, tractor-to-trailer data transfer, other content services, border crossing, and electronic clearance of freight.

An example of a DSRC application is electronic toll collection (ETC). By applying two-way DSRC radiocommunication technology, ETC systems on toll roads enable drivers to pay tolls automatically on a cashless basis without the need to stop at the gates. ETC systems improve traffic flow at toll plazas, and the level of pollution by reducing fuel consumption. In addition, allowing traffic to pass through the gate without stopping can increase road capacity by three or four times and relieve traffic congestion at the tollgate. It is also expected that ETC systems will reduce the operating costs of toll roads by replacing manual toll collection.

An example of the interaction of DSRC with an overall communications network for TICS applications is shown in Fig. 1.

1.2 Scope

DSRC for TICS applications is the use of non-voice radio techniques to transfer data over short distances between roadside and mobile radio units to perform operations related to the improvement of traffic flow, traffic safety and other intelligent transportation service applications in a variety of public and commercial environments. DSRC systems may also transmit status and industrial messages related to the units involved.

2 Technical and operational characteristics

The types of vehicle-roadside communication are generally spot, continuous, and wide-area. DSRC concerns the radiocommunication link of the spot type. DSRC is considered effective technology for such systems as ETC and navigation. DSRC systems have the following features:

– restricted zone communications: communications possible only within restricted zones

– short-time communications: communications possible within restricted times.

The two major components that comprise DSRC are on-board equipment and roadside equipment.

On-board equipment (OBE): OBE is attached near the dashboard or on the windshield of the vehicle, and consists of radiocommunication circuits, an application processing circuit and so on. It usually has a human-machine interface including switches, displays and buzzer.

Roadside equipment (RSE): RSE is installed above or alongside the road and communicates with passing OBE through radio signals. RSE consists of radiocommunication circuits, an application processing circuit and so on. It usually has a link to the roadside system to exchange data.

DSRC systems operate by transmitting radio signals for the exchange of data between vehicle mounted OBE and RSE. This exchange of data demands high reliability and user privacy as it may involve financial and other transactions.

Both active (transceiver) method and passive (backscatter) method have been used advantageously for existing DSRC-type services.

FIGURE 1

Interaction of DSRC with an overall communications network for TICS

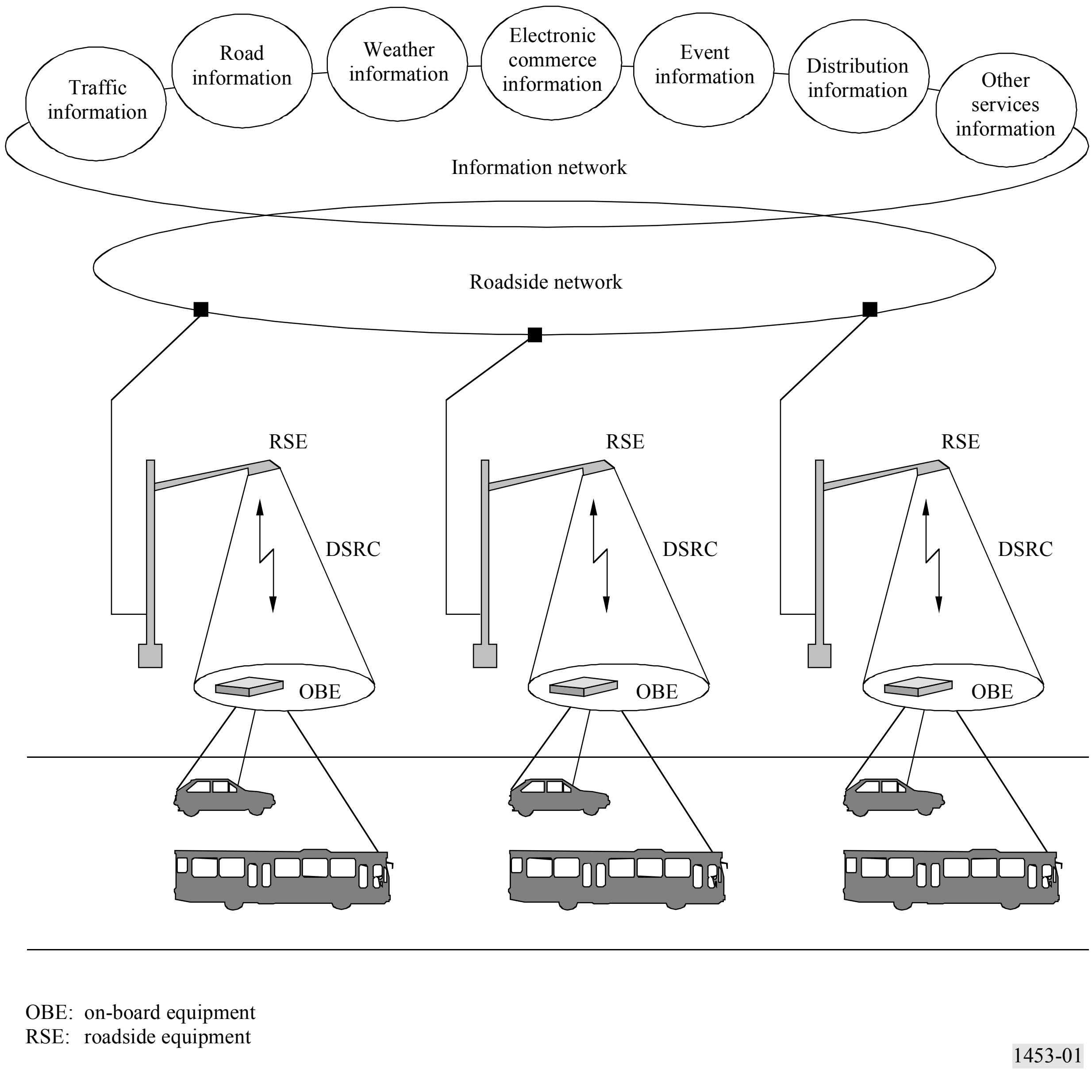
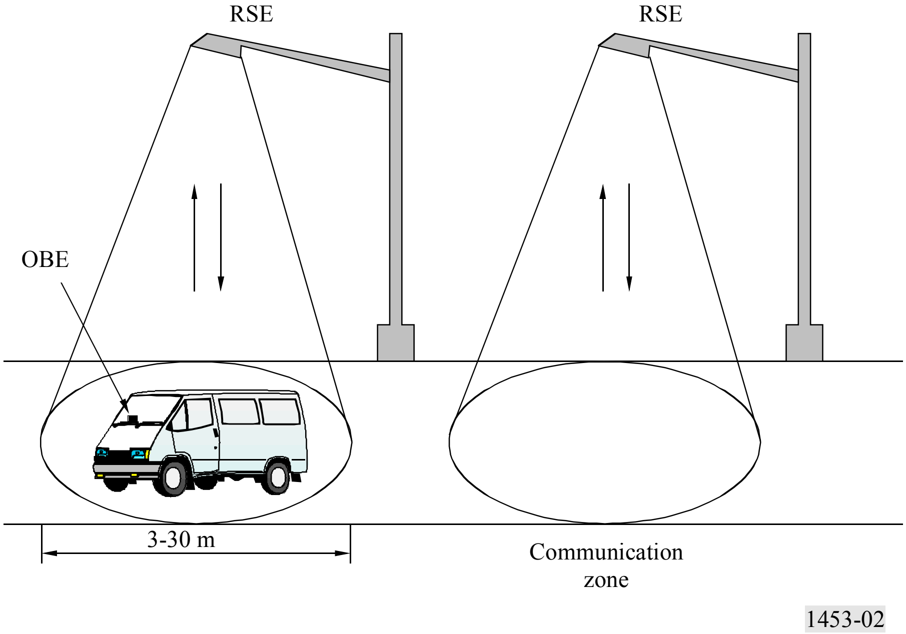


FIGURE 2

Example of communication zone



2.1 Active (transceiver) method

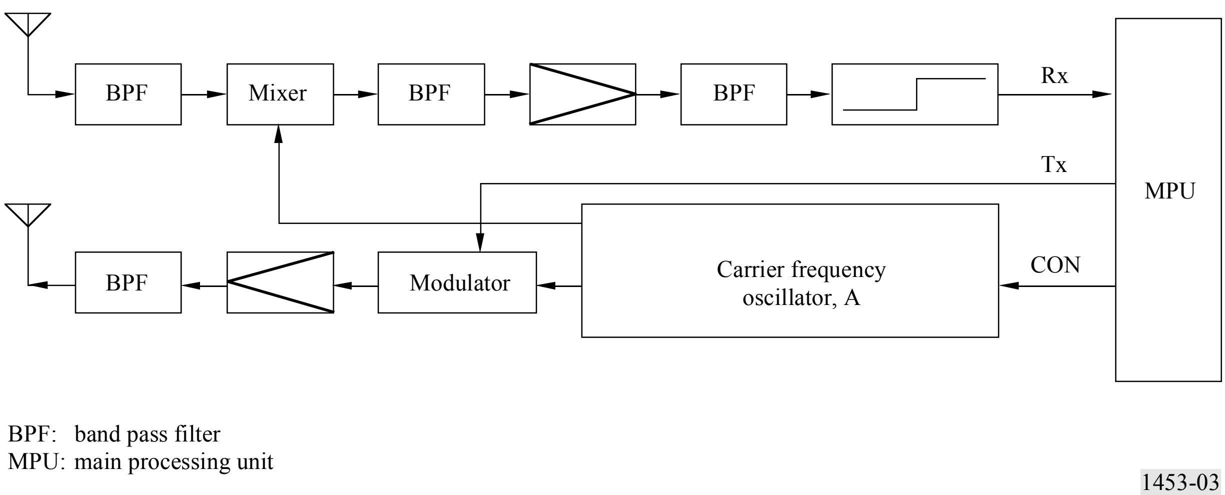
Roadside units are equipped with devices necessary for radiocommunication. For the active (transceiver) method, on-board units are equipped with the same functions as roadside units for radiocommunication. More specifically, both roadside units and OBE incorporate a 5.8 GHz band carrier frequency oscillator and have the same functionality for radio transmission.

The typical configuration of on-board units is focused on here, because an alternative scheme also exists for the configuration of OBE.

Figure 3 shows a typical block diagram for the OBE's radio circuitry.

FIGURE 3

Typical configuration of OBE in active transceiver method



The upper half is the receiver. The lower half is the transmitter. The processing part is to the right. The transmission and reception antennas may be shared. The OBE in the active (transceiver) method receives radio signals from the roadside unit with the antenna on the upper left. Each signal received passes through each functional block and is processed by the MPU as reception data. The transmission signal from the OBE is the 5.8 GHz band carrier signal from oscillator A modulated with transmission data. The signal is sent from the antenna on the bottom left.

The outline of technical characteristics required for radiocommunication facilities is as follows:

TABLE 1

Characteristics of active (transceiver) method

Item	Technical characteristic
Carrier frequencies	5.8 GHz band for downlink and uplink
RF carrier spacing (channel separation)	10 MHz
Allowable occupied bandwidth	Less than 8 MHz
Modulation method	ASK
Data transmission speed (bit rate)	1 024 kbit/s
Data coding	Manchester coding
Duplex separation	40 MHz
Communication type	Transceiver type
Maximum e.i.r.p.(1)	≤ +30 dBm (downlink) (For a transmission distance of 10 m or less. Power supplied to antenna ≤ 10 dBm)
	≤ +44.7 dBm (downlink) (For a transmission distance of more than 10 m. Power supplied to antenna ≤ 24.77 dBm)
	≤ +20 dBm (uplink) (Power supplied to antenna ≤ 10 dBm)

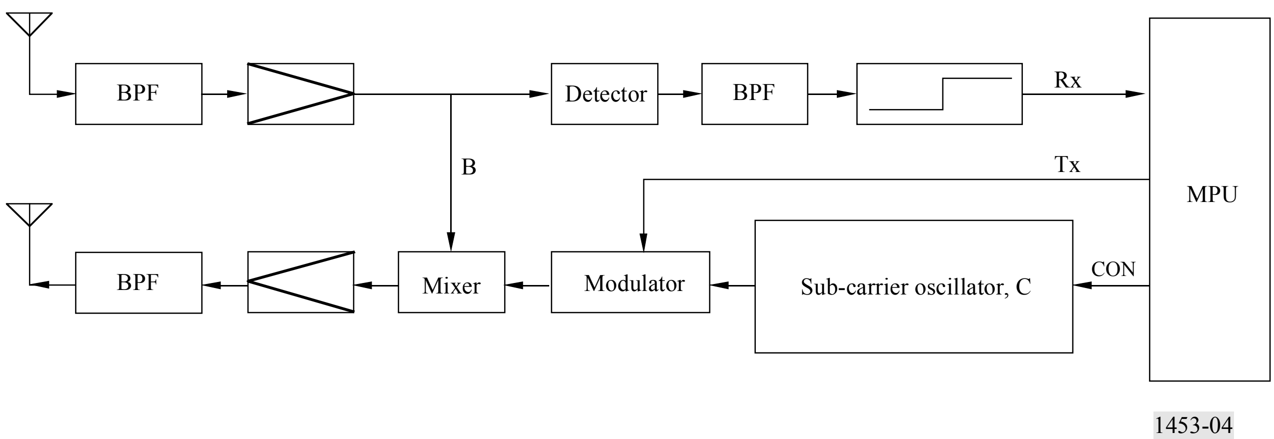
(1) European Radiocommunications Committee (ERC) Recommendation 70-03 specifies values of 2 W e.i.r.p. for active and 8 W e.i.r.p. for passive systems.

2.2 Backscatter (transponder) method

In contrast to the active (transceiver) method shown in § 2.1, the OBE for the backscatter (transponder) method does not have an internal oscillator for generating a 5.8 GHz band radio carrier signal, so it relies on the 5.8 GHz oscillator of the roadside unit with which it communicates. A detailed explanation is given in Fig. 4 with a typical functional block diagram.

FIGURE 4

Typical configuration of OBE in passive backscatter method



Signals for the backscatter (transponder) method are also processed by the MPU as receiving data after passing through each functional block. The difference from the active (transceiver) system lies with transmissions from the OBE. The backscatter (transponder) system does not have a carrier signal oscillator. As a result, when transmitting from the OBE, the roadside unit has to emit an unmodulated carrier signal continuously. The OBE receives this signal, which is input in the transmission circuit after passing through circuit B, and makes it its own carrier signal. The transmission data modulates the output of the sub-carrier signal oscillator C and mixes it with the carrier signal from C. A sub-carrier signal carries this OBE's transmission data with a different frequency (carrier signal frequency plus/minus sub-carrier frequency) from the carrier signal.

The outline of technical characteristics required for radiocommunication facilities is as follows:

TABLE 2

Characteristics of backscatter (transponder) method

Item	Technical characteristic	
	Medium data rate	High data rate
Carrier frequencies	5.8 GHz band for downlink	5.8 GHz band for downlink
Sub-carrier frequencies	1.5 MHz/2 MHz (uplink)	10.7 MHz (uplink)
RF carrier spacing (channel separation)	5 MHz	10 MHz
Allowable occupied bandwidth	Less than 5 MHz/channel	Less than 10 MHz/channel
Modulation method	ASK (downlink carrier) PSK (uplink sub-carrier)	ASK (downlink carrier) PSK (uplink sub-carrier)
Data transmission speed (bit rate)	500 kbit/s (downlink) 250 kbit/s (uplink)	1 Mbit/s (downlink) 1 Mbit/s (uplink)
Data coding	FM0 (downlink) NRZI (uplink)	
Communication type	Transponder type	Transponder type
Maximum e.i.r.p.(1)	≤ +33 dBm (downlink) ≤ –24 dBm (uplink: single sideband)	≤ +39 dBm (downlink) ≤ –14 dBm (uplink: single sideband)

(1) ERC Recommendation 70-30 specifies values of 2 W e.i.r.p. for active and 8 W e.i.r.p. for passive systems.