INTERNATIONAL STANDARD

ISO 21216

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Intelligent transport systems — Communication access for land mobiles (CALM) — Millimetre wave air interface

Systèmes intelligents de transport — Accès aux communications pour mobiles de terrain (CALM) — Interface d'air à ondes millimétriques

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member 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 shall not be held responsible for identifying any or all such patent rights.

ISO 21216 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

This second edition cancels and replaces the first edition (ISO 21216:2011), which has been technically revised.

Introduction

This International Standard is part of a family of standards for communications access for land mobiles (CALM) which determine a common architecture, network protocols and air interface definitions for wireless communications using a range of communication bearers, such as Cellular 2nd Generation, Cellular 3rd Generation, microwaves, millimetre waves and Infrared light. Other air interfaces may be added at a later date. These air interfaces are designed to provide parameters and protocols for broadcast, point-point, vehicle-to-vehicle, and vehicle-point communications for intelligent transport systems (ITS) applications.

This International Standard provides specifications for the PHY part of a communications interface for systems operating within the millimetre frequency range of 57 GHz to 66 GHz. This communications interface (referred to as CALM MM) is designed to provide up to medium range, medium-to-high speed wireless communications links in the ITS sector. Such communication links are required for quasi-continuous, brief or prolonged communications between

— vehicles and the roadside communication infrastructure, and

— vehicles.

Vehicles can be moving or stationary.

Wherever practicable, this International Standard has been developed by reference to suitable existing standards, adopted by selection. Required regional variations are provided for.

ITS applications which can be enhanced or are enabled by the CALM architecture and media include car-to-car and point-to-multipoint safety messaging, collision avoidance, the update of roadside telemetry and messaging, probe data collection, general internet access, image and video transfer, infotainment, traffic management, monitoring and enforcement in mobile situations, route guidance, maintenance management, and “yellow pages” services.

The millimetric frequency band is suitable for applications which require the transfer of a large quantity of data, or of combinations of applications which together require a high data transfer because they need to be able to coexist.

This International Standard recognizes that frequency allocations in the millimetric range around 60 GHz differ in different parts of the world. In Europe (ITU Region 1), the band 63 GHz to 64 GHz has been designated for ITS applications, while in some countries in ITU Regions 2 and 3 ITS applications can take place within the wider range of 57 GHz to 66 GHz, in which a variety of generic application types is allowed. The emission limits vary among regions or countries. A frequency band specifically designated for ITS applications is not required in order to implement this International Standard.

Because of these variations, this International Standard describes the physical layer parameters which need to be standardized to characterize the air interface. This description will enable equipment to be designed which has functional interoperability in the same country or region, but which will have detailed parameters limited in accordance with the appropriate national standards. It also describes those parameters characterizing the operation of the radio which are needed for interfacing to the CALM architecture, in accordance with ISO 21218.

Intelligent transport systems — Communication access for land mobiles (CALM) — Millimetre wave air interface

1 Scope

This International Standard covers the open systems interconnection (OSI) Layer 1 physical layer (PHY) air interface for a communications medium operating in the 60 GHz millimetric frequency range by providing the parameters for medium range, medium-to-high speed wireless communications in the ITS sector. It specifies the parameters required to interface the Layer 1 of such a system to the communications access for land mobiles (CALM) architecture.

Application-specific requirements are not included in this International Standard. These requirements are defined in the CALM management and upper layer standards, including the CALM application management International Standard, ISO 24102.

2 Conformance

Conformance to the requirements of this International Standard shall be verified in accordance with the relevant national or regional regulatory requirements.

3 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 21217, *Intelligent transport systems — Communications access for land mobiles (CALM) — Architecture*

ISO 21218:2008, *Intelligent transport systems — Communications access for land mobiles (CALM) — Medium service access points*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21217 and ISO 21218 apply.

5 Symbols and abbreviated terms

For the purposes of this document, the following symbols and abbreviated terms apply. Reference should also be made to ISO 21217.

4QAM	4 level Quadrature Amplitude Modulation
BPSK	Binary Phase Shift Keyed
CALM	Communications Access for Land Mobiles
CEPT	European Committee for Posts and Telecommunications
CFR	Code of Federal Regulations
CI	Communications Interface
dB	Decibel

dBi	power gain in decibels relative to an isotropic antenna
dBm	power in decibels relative to 1 mW
DLL	Data Link Layer
ECC	European Communications Committee
e.i.r.p.	equivalent isotropic radiated power
FCC	Federal Communications Commission (US)
GHz	Giga Hertz (10^9 Hertz)
IEEE	Institution of Electrical and Electronics Engineers
IF	Intermediate Frequency
IN	Interface-Network SAP
ITS	Intelligent Transport Systems
ITU	International Telecommunications Union
IVC	Inter-Vehicle Communications
km/h	kilometre per hour
MHz	Mega Hertz (10^6 Hertz)
MI	Management-Interface SAP
µW	micro watt (10^{-6} watt)
mW	milli watt (10^{-3} watt)
MM	millimetre (as applied to a millimetric band communication system)
OBU	On-Board Unit
OFDM	Orthogonal Frequency Division Multiplexed
OSI	Open Systems Interconnection
PDNR	Preliminary Draft New Recommendation
PHY	Physical layer
ppm	parts per million
QPSK	Quadrature Phase Shift Keyed
RF	Radio Frequency
RSU	Road Side Unit
RVC	Roadside-to-Vehicle Communications
SAP	Service Access Point
SI	Security-Interface SAP

6 Requirements

6.1 Architecture

CALM MM shall comply with the overall CALM architecture as specified in ISO 21217. Details of CALM MM, including interfaces to other elements of the CALM architecture, are illustrated in Figure 1. Details of the interfaces MI and IN shall be as specified in ISO 21218.

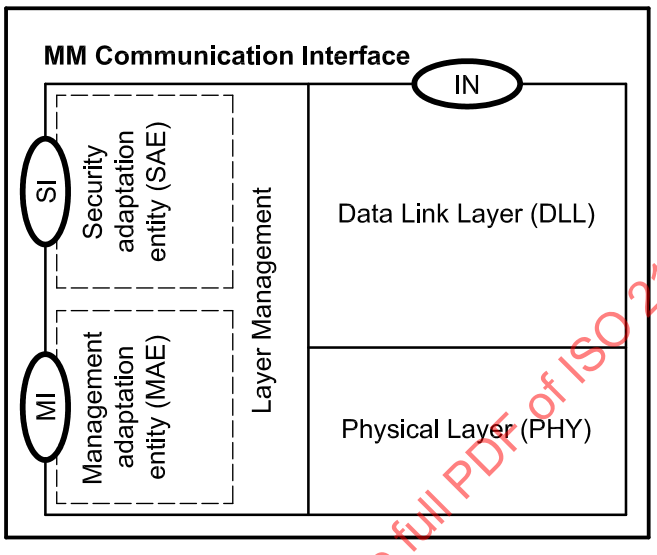

Figure 1 — MM architecture schematic

In Figure 1, the PHY is specified by this International Standard and the data link layer and the layer management by anticipated future standards.

6.2 Adoption of other standards and internationally adopted practices

This International Standard recognizes that frequency allocations and emission levels in the millimetric range around 60 GHz differ in different parts of the world. A frequency band specifically designated for ITS applications is not required in order to implement this International Standard.

Information is provided below which shows the current position in selected countries or regions.

Within ITU Region 1, this International Standard operates in the environment of, and to the parameters defined in, the following ITU Recommendation and national or regional standards:

a) ECC/DEC/(09)01 [1];

b) ERC/REC Recommendation 70-03, Annex 5: 63-64 GHz [2];

c) ITU-R M.1452-1 [3].

Within ITU Region 2, this International Standard operates in the environment of, and to the parameters defined in, the following ITU Recommendation and national standards:

d) US FCC, 47 C.F.R., Part 15, 255 [4]; and

e) ITU-R M.1452-1 [3].

Within ITU Region 3, this International Standard operates in the environment of, and to the parameters defined in, the following ITU Recommendation and national standards:

f) Japanese Regulations: Radio Law Administrative Regulations, Article 6 (59-66 GHz), Ministry of Internal Affairs and Communications, Japan, 2000 [5];

g) Korean Regulation, MIC RRL Notice 2007-22: 57-64 GHz [6];

h) ITU-R M.1452-1 [3].

6.3 Physical (PHY) layer parameters

The physical layer parameters are defined by reference to national or regional regulatory requirements for ITS. Annexes A, B and C give the current or proposed regulations in Europe, USA, Japan and Korea.

Implementations of this International Standard shall as a minimum

a) minimize harmful interference with other standardized regional radio units in this spectrum in accordance with regional/national regulatory parameters,

b) support individual vehicle speeds to a maximum of 220 km/h in mobile communication systems (but this requirement does not apply to static communications systems), and

c) be compliant with one set of regional/national regulatory parameters, and may support other regional/national parameters as applicable.

Implementations of this International Standard shall, in addition, specify the parameters outlined in 6.3.1 to 6.3.4.

6.3.1 Spectrum

For global use, the millimetric radio part shall be capable of operating within the range of 57 GHz to 66 GHz.

For regional or national use, the millimetric radio part may cover a limited spectrum.

Bandwidth usage shall comply with national or regional regulations.

The radio part shall operate on those frequencies specified by the authorizing national regulatory body.

6.3.2 Transmitter power

The transmitter power of the millimetric radio part shall not exceed the maximum power level given in the relevant regional or national standard.

Power control, where specified, shall be implemented in accordance with the relevant regional or national standard. This functionality shall not be available to the user of the equipment. Over-riding the power control function shall not be available to the user of the equipment.

The operational power level may be negotiated between two OBUs or between OBUs and RSUs, starting from a locally defined initial power level, with the objective of best spectrum utilization.

6.3.3 Directivity

The angular characteristics of the antennas used for transmitting or receiving shall comply with regional or national standards.

6.3.4 Modulation

Different modulation schemes to be used in the millimetric radio part may result in different data rates. The modulation schemes shall be implemented as defined in regional or national regulatory requirements.

Where an adaptive modulation scheme is specified, a basic modulation scheme shall be used for a negotiation header. The modulation scheme negotiated in the header shall be used for the remainder of the frame.

6.4 Regional and/or national limitations on radio parameters

Mobile equipment (OBU) shall comply with those regulations applicable to the intended operating area or areas. Any mobile equipment intended for multi-area or open, global use shall be re-configurable when moving

between the relevant regulatory jurisdictions. This re-configuration shall be performed automatically and securely. End users shall not have any access to this procedure.

OBUs may also be configured for local/regional use only. Such units need only follow the relevant national/regional requirements.

The automatic re-configuration, based on an update on regulatory information, shall be performed in accordance with ISO 21218.

6.5 Provision of PHY Communications Interface (CI) parameters

The provision of MM-PHY-CI parameters shall be in accordance with ISO 21218:2008, Annex A, Table A.1, as shown in Table 1.

Table 1 — MM-PHY-CI parameters required to interface with the CALM architecture

MM-PHY-CI parameter No.	ISO 21218:2008, Annex A, Table A.1	Parameter name
1	3	Rxsensitivity
2	4	Txpower
3	5	DataRate
4	6	DataRateNW
5	7	DataRatesNW
6	9	Directivity
7	16	CommRangeRef
8	20	CommProfil
9	22	Medium
10	25	RegulatoryInformation
11	49	TXpowMax

6.6 Over the air transaction protocols

The over the air transaction protocols are outside the scope of this International Standard and may be defined in other national or regional standards.

Annex A
(informative)

ITU Region 1

A.1 ITS profile 1

This profile, shown in Table A.1, is under consideration within ETSI TC-ITS (Intelligent transport systems).

Table A.1 — ITS profile 1

	63-64 GHz RVC and IVC
Total Tx power at antenna feed	<+18 dBm Peak
Bandwidth (−3dB)	127 MHz
Channel separation	192 MHz
Channel frequencies	63.116, 63.308, 63.5, 63.692, 63.884 GHz
Rx noise figure	<8 dB
Modulation and channelization	BPSK, 4QAM 4 single carriers at 20 Mbaud.
Single carrier centre spacing	~28 MHz (see Figure A.1 and note)
Maximum e.i.r.p. (total power in channel)	+40 dBm

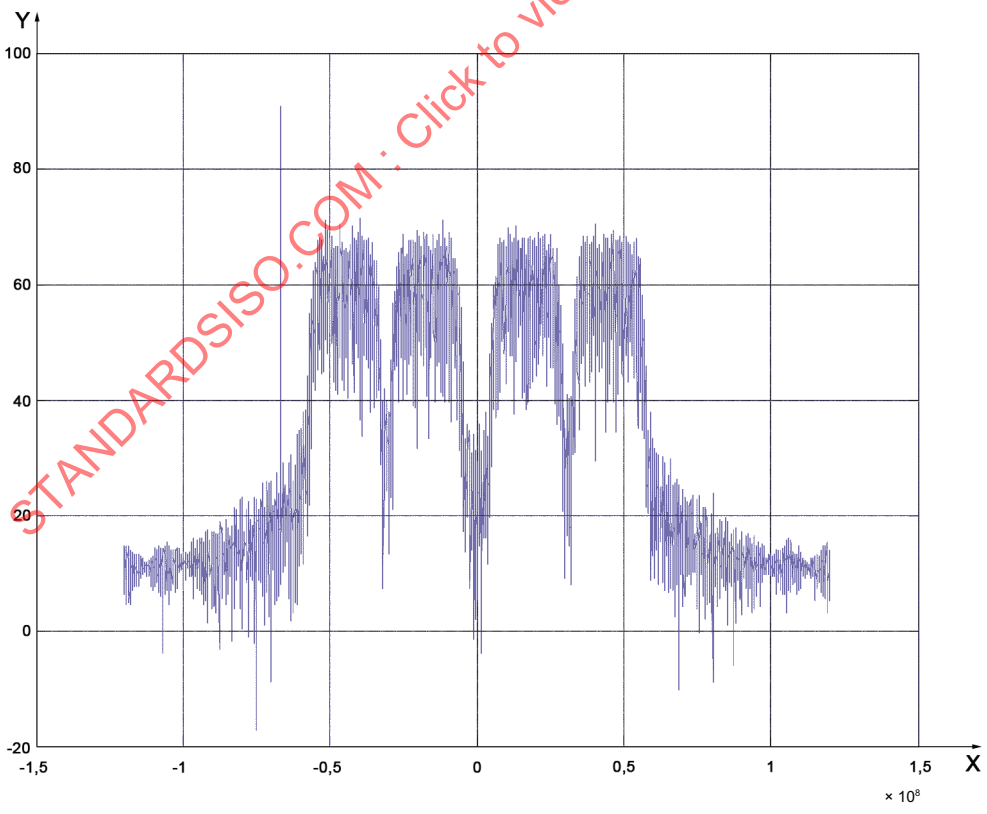

Figure A.1 — Baseband power spectrum of an RF channel

NOTE Taking the centre frequencies of the pilot signal and the 4 IF channels and centring the spectrum about DC, the following arrangement of pilot and IF channels (the pilot tone and the IF channels have the same spectral density) are reached:

— Pilot signal −67 MHz;

— IF channel 1 −45 MHz;

— IF channel 2 −17 MHz;

— IF channel 3 17 MHz;

— IF channel 4 45 MHz.

A.2 ITS profile 2

This profile is applicable to the case when IEEE 802.11a [7], is used to define the modulation scheme, data rates and MAC, and when the RF signal exists in the band 63 GHz to 64 GHz.

It is possible to select one of a range of RF centre frequencies, and then to use any of the set of sub-carrier frequencies defined by IEEE 802.11a. If necessary, multiple IEEE 802.11a units can be multiplexed, before upconverting to the selected RF carrier.

This supports IVC, RVC or a combination within a set of vehicles and roadside units. It allows dynamically reconfigurable networking, with a communication range up to 500 metres. The orthogonal frequency division multiplexed (OFDM) structure in the IEEE 802.11a definition provides resilience to multipath interference, and the presence of four pilot tones provides a frequency tracking facility which makes the system highly resilient to received frequency changes due to Doppler effects between moving vehicles with high relative velocity.

Table A.2 — ITS profile 2

	63-64 GHz	Notes
Total Tx power at antenna feed	<+18 dBm Peak	
Maximum e.i.r.p.	+40 dBm	Antenna gain = <22 dBi
Phase noise	<−90 dBc/Hz at 100 kHz from carrier	
Frequency stability	<15 ppm	
Frequency range	63 GHz to 64 GHz	
Carrier frequencies (GHz)	63.18, 63.34, 63.50, 63.66, 63.82 GHz	
Modulation	BPSK, QPSK	
Data rates (per sub-carrier)	6, 9, 12, 18 Mbit/s	24, 36, 48 and 54 need lower phase noise than specified above
Bandwidth (−3dB)	136.6 MHz	Total frequency span of 7 secondary channels
Primary channel separation	160 MHz	
Secondary channel separation	20 MHz	IEEE 802.11a
Rx noise figure	<8 dB	

A.3 Additional profiles

Additional profiles may be defined in future standards.

Annex B
(informative)

ITU Region 2

For operation in the band 57.05 GHz to 64 GHz, the relevant regulation is given in US FCC 47 C.F.R., Part 15, 255: 57.05-64 GHz [4].

Operation specifically for ITS applications is currently under consideration.