INTERNATIONAL STANDARD

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Intelligent transport systems — Continuous air interface, long and medium range (CALM) — Infra-red systems

Systèmes intelligents de transport — Interface d'air continue, gamme longue et moyenne (CALM) — Systèmes à infrarouges

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Dedication

Exceptionally this International Standard is dedicated to the late Dipl. Ing. Helmut Strasser in grateful recognition of his leadership as the editor and project leader of ISO 21214, and for his commitment and services over more than a decade to meet the challenges of international standardization in the rapidly changing arena of ITS technology.

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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 21214 was prepared by Technical Committee ISO/TC 204, *Intelligent transport systems*.

Introduction

This International Standard is part of a family of International Standards for CALM (continuous air interface, long and medium range) which determine a common architecture, network protocols and air-interface definitions for wireless communications using cellular second generation, cellular third generation, 5 GHz, millimetre, and infra-red communications. 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/vehicle, and vehicle/point communications in the ITS sector.

This International Standard determines the air interface using infra-red systems operating in the wavelength range at 850 nm.

The fast movement of information across the longer distances using wireless technology is functionally very different from the requirements definition for dedicated short range communication (DSRC). High volumes of data are required for purposes such as traffic information and management, video downloads to vehicles for tourist information and entertainment and navigation system updates, etc.

In order to support such services, transmitters need to be able to operate over long or medium range, and to be able to hand over a session from one transmitter to another.

These International Standards are designed to enable quasi-continuous communications, or communications of protracted duration, between vehicles and service providers, or between vehicles. As such they are complementary to dedicated short range, single point, technologies standardised in various regions of the world.

The CALM concept supports multiple bearer types (such as cellular, microwave, infra-red), where an option is proposed to offer user selection of preferred media, and to enable resumption of session interruptions (whether to change bearer media, service provider, or because of signal interruption or interference).

Some applications will have the requirement that communication sessions set up in a first communication zone may be continued in following communication zones; therefore “handover mechanisms” are included. Handover mechanisms need to be defined at two levels:

— Firstly, handover mechanisms within the same technology and service provider. These handover mechanisms are defined within the frequency-specific CALM International Standards.

— Secondly, handover mechanisms at the application level, for use where either the technology or the service provider changes. These handover mechanisms will be defined within the CALM architecture International Standard (ISO 21217), within the CALM networking protocols International Standard (ISO 21210) and within the CALM lower layer SAP International Standard (ISO 21218).

Applications include the update of roadside telemetry and messaging, internet, image and video transfer, infotainment, traffic management, monitoring and enforcement in mobile situations, route guidance, car-to-car safety messaging, maintenance management, and “yellow page” services. For medium- and long-range high-speed roadside/vehicle transactions such as on-board web access, broadcast and subscription services, entertainment, yellow page and booking transactions, etc., the functional characteristics of such systems require contact over significantly longer distance than is feasible or desirable for DSRC, and often for significantly longer connection periods – in some circumstances, continuous communication.

Intelligent transport systems — Continuous air interface, long and medium range (CALM) — Infra-red systems

1 Scope

This International Standard determines the air interface using infra-red systems at 820 nm to 1 010 nm.

It provides protocols and parameters for medium-range, medium- to high-speed wireless communications in the ITS sector using infra-red systems.

Such links are required for quasi-continuous, prolonged or short communications

— between vehicles and the roadside,

— between vehicles, and

— between mobile equipment and fixed infrastructure points,

over medium and long ranges.

Vehicles may be moving or stationary.

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

Due account is given to, and use made of, any relevant parts of appropriate communications systems, such as global positioning systems (GPS), digital audio broadcasting (DAB), digital video broadcasting (DVB), radio local area networks (RLANs), digital data broadcasting (DDB), TETRA, FM subcarrier, mobile broadband systems (MBS, W-ATM), internet protocols, and dedicated short range communication (DSRC).

The International Standard:

— supports data rates of 1 Mbit/s up to 128 Mbit/s (it may support higher data rates);

— supports vehicle speeds up to a minimum of 200 km/h (closing speeds could be double this value);

— defines or references environmental parameters relevant to link operation;

— supports communication distances up to 100 m (it may support longer communication distances of 300 m to 1 000 m);

— supports latencies and communication delays in the order of milliseconds;

— is compliant to regional/national regulatory parameters;

— may support other regional/national parameters as applicable.

Application-specific requirements are outside the scope of this International Standard. These requirements will be defined in the CALM management and upper layer standards and in application standards.

Application-specific upper layers are not included in this International Standard, but will be driven by application standards (which may not be technology specific).

2 Conformance

Systems claiming conformance with this International Standard shall meet the specifications herein.

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/IEC 8802-11, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications*

IEC 60050-845, *International Electrotechnical Vocabulary. Lighting*

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*

4 Terms and definitions

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

4.1 General

4.1.1
broadcast window
BcW
window used to broadcast information to slaves, even to those which have not yet performed the "registration process"

4.1.2
chip
smallest information unit communicated over the link

NOTE Depending on the chosen coding, one information bit may be represented by one or more consecutive chips.

4.1.3
communication profile
specific set of data rate, modulation and flow control

4.1.4
communication zone
spatial zone in which two CALM-IR units are able to communicate with acceptable performance

4.1.5
compatibility window
CmpW
enables non-CALM-IR systems that follow certain rules to co-exist with a CALM-IR system without harmful interference

4.1.6
default data rate
data rate used in the "default communications profile"

4.1.7
default communications profile
communications profile used unless another communications profile is successfully negotiated

4.1.8
flush byte
8 bit sequence used to denote the end of the main body of the information to be transmitted using the *HHH(1,13)* coding procedure

4.1.9
forward direction
communication flow from master to slave

EXAMPLES forward link, forward window

4.1.10
frame length indicator
Flen
indicator is used to calculate the frame length from the last “slot index”

4.1.11
frame organisation table
FOT
table which carries all organisation data of the TDMA frame

4.1.12
free airtime indicator
FATI
indicator which signals that “free airtime” follows the current frame

NOTE This airtime may be used by units not being a slave of the current master to establish “secondary mastership”.

4.1.13
guard time
T_G
time period preceding a “command alert” (*CA*) in certain cases in order to allow the automatic gain control of the receivers to resettle

4.1.14
***HHH(1,13)* code**
special run length limited code with $d = 1$ and $k = 13$ used in the CALM-IR communications profiles 2 to 6

4.1.15
management window
first window in a CALM-IR frame, which carries all organisation information for the current frame

4.1.16
master identifier
MID
code which uniquely identifies a CALM-IR master

4.1.17
multicast window
McW
window used for communication from master to multiple slaves, forward direction only

4.1.18
private window
window which carries the information exchange between a master and a specific slave

4.1.19
registration phase
phase during which a master identifies devices newly entering its communication zone

4.1.20
slave
device that is under the control of another device

4.1.21
spare window
SpW
window, not allocated to a slave, which reserves airtime for any slaves registering during the current frame in order to enable the master to instantly allocate them a private window without the need for frame reorganisation

4.1.22
slot index
index used to count time slots

4.1.23
TDMA frame
time (division multiple access) structure based on a train of consecutive time slots (at least one)

4.1.24
time slot
subunit of a TDMA frame

4.1.25
temporary identifier
TempID
identifier used for addressing the slave device while it resides in the communication environment of the master

NOTE Each time the slave registers in a communication zone, a new *TempID* is created.

4.1.26
wake-up window
WuW
special case of a broadcast window which is used to “wake-up” sleeping units entering the communication zone of an active master

4.1.27
window
smallest addressable time span of a CALM-IR frame which may consist of one or multiple time slots

4.2 Optical parmeters

4.2.1
radiant power
radiant flux
Φ_e
power emitted, transmitted or received in the form of radiation

NOTE 1 The unit is the watt (W).

NOTE 2 Adapted from IEC 60050 (845-01-24).

4.2.2
radiant intensity
I_e
quotient of the radiant flux $d\Phi_e$ leaving the source and propagated in the element of solid angle $d\Omega$ containing the given direction, by the element of solid angle

$$I_e = \frac{d\Phi_e}{d\Omega}$$

NOTE 1 Unit: W/sr (watts per steradian).

NOTE 2 Adapted from IEC 60050 (845-01-30).

4.2.3
irradiance
E_e
quotient of the radiant flux $d\Phi_e$ incident on an element of a surface containing a given point divided by the area dA of that element

NOTE 1 Unit: W/m^2.

NOTE 2 Equivalent definition. Integral, taken over the hemisphere visible from the given point, of the expression $L_e \cdot \cos\theta \cdot d\Omega$, where L_e is the radiance at the given point in the various directions of the incident elementary beams of solid angle $d\Omega$, and θ is the angle between any of these beams and the normal to the surface at the given point.

$$E_e = \frac{d\Phi_e}{dA} = \int_{2\pi \text{sr}} L_e \cdot \cos\theta \cdot d\Omega$$

NOTE 3 Adapted from IEC 60050 (845-01-37).

4.2.4
radiant exitance
M_e
quotient of the radiant flux $d\Phi_e$ leaving an element of a surface containing a given point divided by the area dA of that element

NOTE 1 Unit: W/m^2.

NOTE 2 Equivalent definition. Integral, taken over the hemisphere visible from the given point, of the expression, where $L_e \cdot \cos\theta \cdot d\Omega$ is the radiance at the given point in the various directions of the emitted elementary beams of solid angle $d\Omega$, and θ is the angle between any of these beams and the normal to the surface at the given point.

$$M_e = \frac{d\Phi_e}{dA} = \int_{2\pi \text{sr}} L_e \cdot \cos\theta \cdot d\Omega$$

NOTE 3 Adapted from IEC 60050 (845-01-47).

4.2.5
radiance
L_e
quantity (in a given direction, at a given point of a real or imaginary surface) (L_e; L) defined by the formula

$$L_e = \frac{d\Phi_e}{dA \cdot \cos\theta \cdot d\Omega}$$

where

$d\Phi_e$ is the radiant flux transmitted by an elementary beam passing through the given point and propagating in the solid angle $d\Omega$ containing the given direction;

dA is the area of a section of that beam containing the given point;

θ is the angle between the normal to that section and the direction of the beam.

NOTE 1 Unit: W/sr.m^2.

NOTE 2 Adapted from IEC 60050 (845-01-34).

4.2.6
radiant intensity
I_e
quotient of the radiant flux $d\Phi_e$ leaving the source and propagated in the element of solid angle $d\Omega$ containing the given direction divided by the element of solid angle

NOTE Adapted from IEC 60050 (845-01-30).

4.2.7
steradian
sr
dimensionless SI unit of solid angle

NOTE 1 The steradian is the solid angle of a cone which, having its vertex in the centre of a sphere, cuts off on the surface of the sphere an area equal to that of a square with sides of length equal to the radius of the sphere. [ISO 31-1:1992, 1-2.a]

NOTE 2 Usually the abbreviation "sr" is appended, although mathematically this is incorrect.

EXAMPLE

The unity solid angle, in terms of geometry, is the angle subtended at the centre of a sphere by an area on its surface numerically equal to the square of the radius (see Figure 1). Other than the figure might suggest, the shape of the area does not matter at all. Any shape on the surface of the sphere that holds the same area will define a solid angle of the same size.

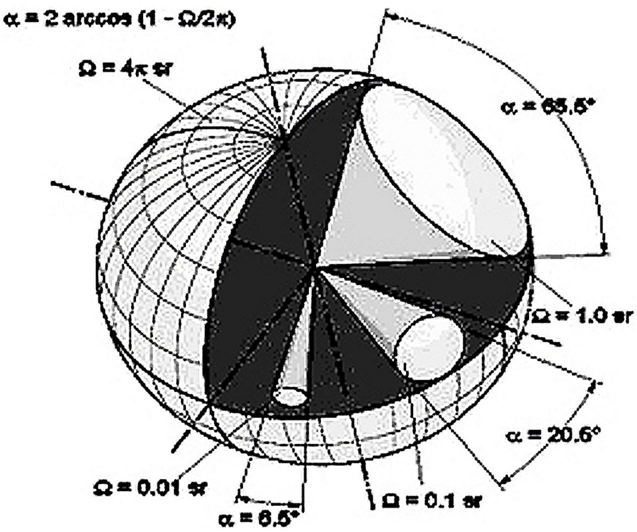

Figure 1 — Solid angle

Relation between distance r, irradiance E_e and intensity I_e

Using a single radiation point source, we get the following relation:

$$E_e = \frac{d\Phi_e}{dA} = \frac{I_e \cdot d\Omega}{dA} = \frac{I_e}{r^2}; \left[\frac{W}{m^2}\right]$$

NOTE 3 Adapted from IEC 60050 (845-01-20).

4.2.8
luminous flux
Φ_v
quantity derived from radiant flux Φ_e by evaluating the radiation according to its action upon the CIE standard photometric observer, for photopic vision

$$\Phi_v = K_m \int_0^\infty \frac{d\Phi_e(\lambda)}{d\lambda} \cdot V(\lambda) \cdot d\lambda$$

where

$$\frac{d\Phi_e(\lambda)}{d\lambda}$$

is the spectral distribution of the radiant flux and $V(\lambda)$ is the spectral luminous efficiency

NOTE 1 For the values K_m (photopic vision) and K'_m (scotopic vision), see IEC 60050 (845-01-56).

NOTE 2 Adapted from IEC 60050 (845-01-25).

4.2.9
luminous efficacy of radiation
K
quotient of the luminous flux Φ_v divided by the corresponding radiant flux Φ_e

$$K = \frac{\Phi_v}{\Phi_e}$$

NOTE 1 When applied to monochromatic radiation, the maximum value of $K(\lambda)$ is denoted by the symbol K_m:

K_m = 683 lm.W^{-1} for $\nu_m = 540 \times 10^{12}$ Hz ($\lambda_m \approx 555$ nm) for photopic vision.

K'_m = 1700 lm.W^{-1} for $\lambda'_m \approx 507$ nm for scotopic vision.

For other wavelengths, $K(\lambda) = K'_m V(\lambda)$ and $K'(\lambda) = K'_m V'(\lambda)$.

NOTE 2 Adapted from IEC 60050 (845-01-55).