IEC 62943

Edition 1.0 2017-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Visible light beacon system for multimedia applications

Système de balise de lumière visible pour applications multimédias

IEC 62943:2017-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
100/2850/FDIS	100/2857/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

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VISIBLE LIGHT BEACON SYSTEM FOR MULTIMEDIA APPLICATIONS

1 Scope

This International Standard aims at establishing a unified standard concerning the lower communication layer common to multimedia applications, and does not deal with the upper communication layer which depends upon individual applications.

This document specifies a unidirectional visible light communication protocol using visible light, named "visible light beacon system for multimedia applications". This document does not specify the type of receivers. Dimming can be done by such methods as pulse width control or amplitude control, but the dimming is out of the scope of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

There are no normative references in this document.

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

3.1
visible light beacon transmitter
transmitter utilizing visible light beacon of visible light transmission standard

3.2
visible light beacon receiver
receiver utilizing visible light beacon of visible light transmission standard

3.3
visible light beacon system
unidirectional beacon system utilizing visible light as its carrier

3.4
ID resolution
resolution of information related to the ID

3.5
ID resolution server
server capable of ID resolution from inquired ID

3.6
carrier
signal consisting of a visible light in the case of visible light communication for transmission of information through (wired or wireless) communication media

3.7
modulation
processing and transforming of a carrier according to information in order to enable the information to be transmitted efficiently and correctly through communication media

3.8
frame
assembly of information continued for a certain length of time

3.9
preamble
signal to inform reception side about preparation and time position of start of the frame

3.10
communication protocol
set of rules decided for mutual communication between transmitters and receivers

3.11
encode
adapting the transmitted data array to be consistent with the transmission protocol

4 System outline

4.1 Interface points and protocol rules

The IF-a (interface point a) part in the visible light beacon system in Figure 1 shall be used.

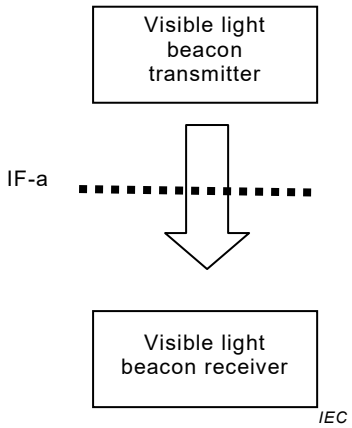


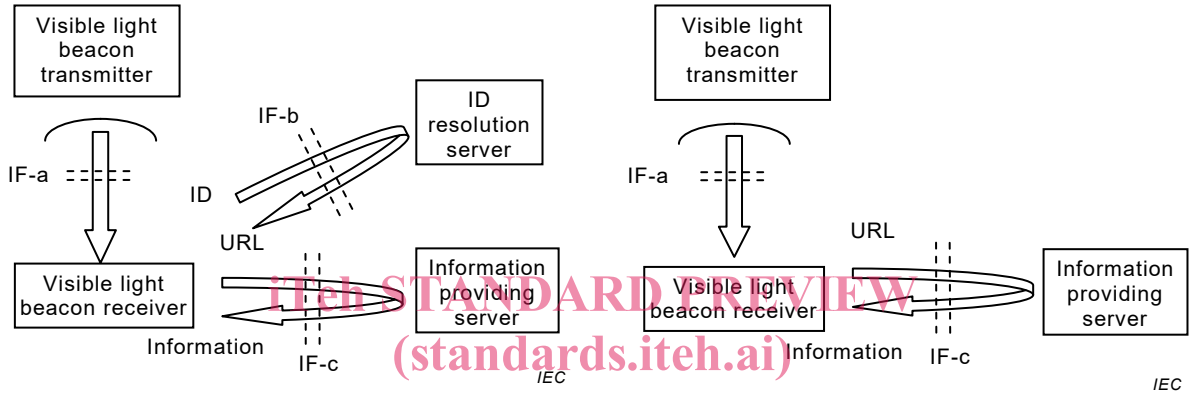
Figure 1 – Visible light beacon system for multimedia applications

Figures 2 a), b), c) and d) represent interface standard points between system structure figures and element systems of visible light beacon system for multimedia applications.

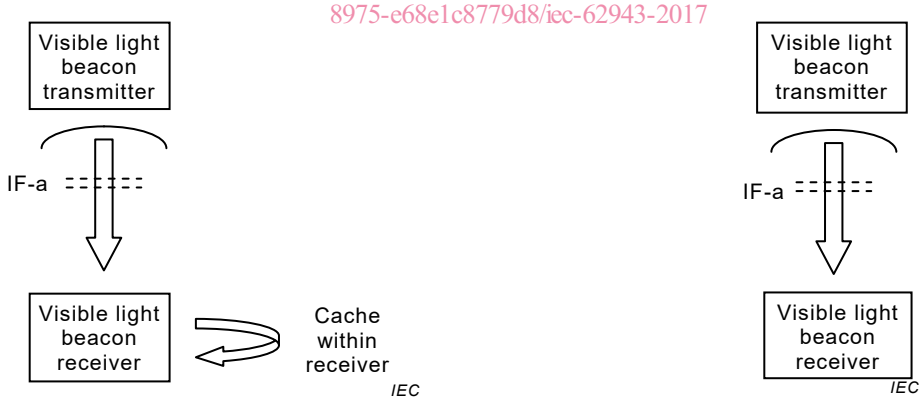
- Figure 2 a) is the whole structure (standard structure) of most common visible light beacon system for multimedia applications. The visible light beacon receiver sends the beacon received from a visible light beacon transmitter to an ID resolution server, obtains the address of the information providing server where target information exists, and obtains the target information from the information providing server using the address.

- Figure 2 b) is the system structure (degeneracy system structure 1) for obtaining target information by implementing ID resolution in the beacon receiver, referring to ID resolution table incorporated in the visible light beacon receiver, and directly accessing the information providing server based on the result.
- Figure 2 c) is the system structure (degeneracy system structure 2) for preliminarily caching target information, in addition to ID resolution table, in the visible light beacon receiver, and directly indicating the selected target information based on the received beacon.
- Figure 2 d) is the system structure (direct information delivery structure) for the visible light beacon receiver to directly receive delivery of target information itself from visible light beacon transmitter.

The interface point a common to Figure 2 a) to 2 d) shall be used.



a) **Standard structure** b) **Degeneracy system structure 1**



c) **Degeneracy system structure 2** d) **Direct information delivery structure**

Figure 2 – Visible light beacon system for multimedia applications: structure and interface point

All the system structures above assume that there is one visible light beacon transmitter. If there are multiple light sources and the visible light beacon receiver receives signals from multiple light sources at the same time, it can cause interference. The interference problem can be solved by aligning the optics of a transmitter and a receiver. However, the alignment is outside the scope of this document.

4.2 Functions

The visible light beacon transmitter can transmit information. The transmitted information can be either arbitrary data or an ID code. The ID code system used is selectable, and various services can be provided or enjoyed through ID resolution (drawing information related to ID).

5 Physical layer

5.1 Wavelength

The wavelength of the system optical output shall be in the visible range with peak wavelength from 380 nm to 780 nm.

5.2 Data rate

Data rate shall be 4,8 kb/s with tolerance of ±0,5 %.

5.3 Data transmission system

The transmission system for modulation of visible light should use Inverted 4PPM encoding. Such a modulation method is called I-4PPM (Inverted 4PPM). Figure 3 shows I-4PPM signal waveform. Although the signal is represented by square wave, actually waveform shaping is required to comply with spurious rules as individual electronic instruments. The same applies to Figure 4.

The bit ordering of the transmitted data after preamble is LSB (least significant bit) first, meaning that the least significant bit is transmitted first.

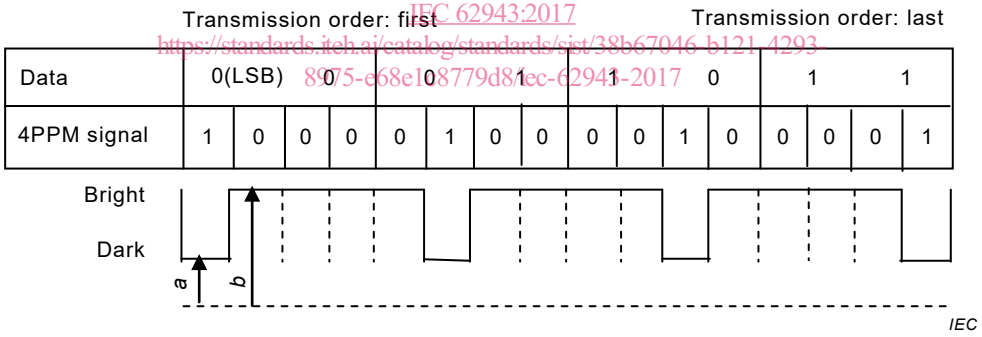


Figure 3 – I-4PPM signal waveform

With waveform intensities a and b shown in Figure 3, signal amplitude and modulation index are defined as below.

$$\text{signal amplitude} = b - a$$

$$\text{modulation index} = (b - a)/b$$

The 4PPM encoding system distributes evenly a specific length of time defined as symbol time (D_1) to 4 slots (C_1), it converts a pulse of 1 slot width in 1 symbol time, and transmits information of 2 bits assigned to existing slot time position of the pulse. Encoding rule of slot time position are illustrated in Figure 4. For example:

$$\text{Symbol time } D_1 = 2 \times (1/4\,800) = 0{,}416 \text{ ms}$$

$$\text{Slot time } C_1 = D_1 / 4 = 0{,}104 \text{ ms}$$

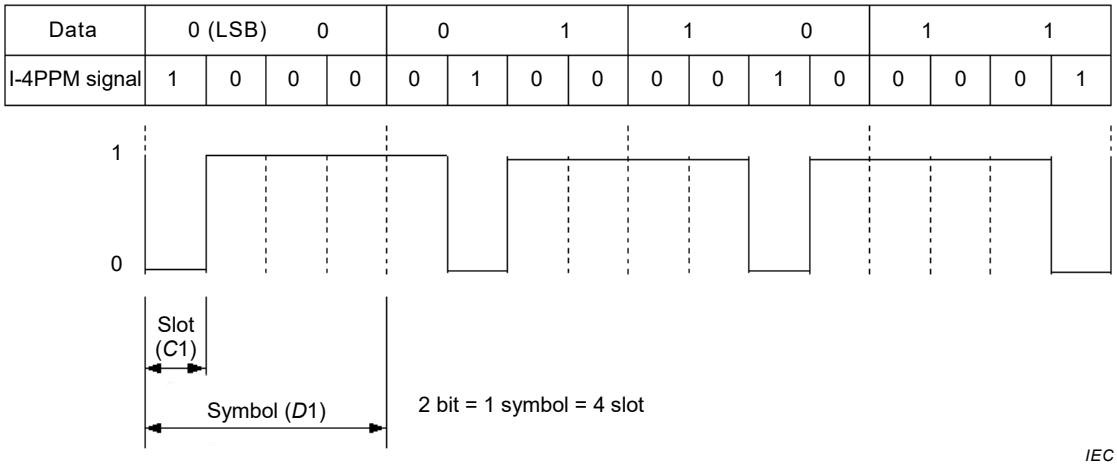


Figure 4 – I-4PPM Slot and Symbol

5.4 Spurious

The details of this item are defined in each application standard. For example, visible light beacon transmitters using LED lighting systems should be defined in electrical spurious standard for lighting equipment.

6 Frame layer

6.1 Single frame transmission

6.1.1 Frame structure

Figure 5 shows a frame structure for a single frame transmission. The frame consists of preamble (PRE), ID length (IDLEN), ID type (IDTYPE), ID and/or data (ID/DATA), and cyclic redundancy code (CRC) fields.

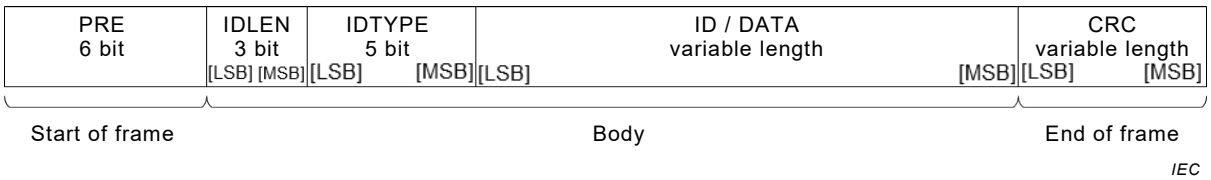


Figure 5 – Frame structure for single frame transmission

6.1.2 Preamble (PRE)

The pattern of "1" in three sequential slots followed by nine "0" slots, which does not occur by I-4PPM encode of data, is set as a preamble for single frame transmission as shown in Figure 6.

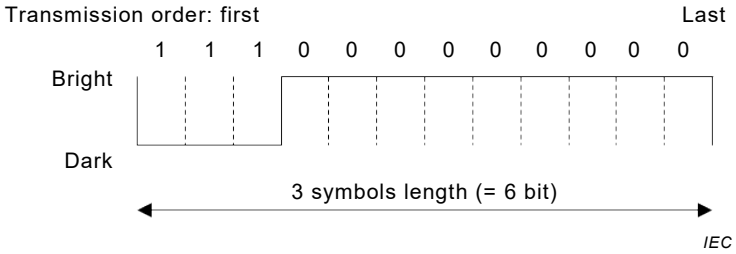


Figure 6 – Preamble for single frame transmission

6.1.3 ID length (IDLEN)

The IDLEN field indicates the length of the following ID/DATA field as shown in Table 1.

Table 1 – ID length

IDLEN [bit]	Length of ID/DATA [bit]
[MSB] 000 [LSB]	reserved
001	32
010	64
011	128
100	256
101	512
110	1 024
111	reserved

6.1.4 ID type (IDTYPE)

The IDTYPE field indicates how the information in the ID/DATA field should be parsed. When the IDTYPE value is 0, the ID type is a default type which does not require the access to a server. On the other hand, when the IDTYPE value is not 0, a server may be accessed to obtain necessary information.

6.1.5 CRC

The CRC field checks IDLEN, IDTYPE, and ID/DATA fields. The length of the CRC field depends on length of bits to be checked as shown in Table 2. Since visible light beacon system for multimedia applications uses a unidirectional communication, incapable of submitting re-transmission requests, received data is discarded if errors are detected.

Table 2 – Length of CRC and generator polynomial

Length to be checked	Length of CRC	Generator polynomial
≤ 16	8	X8+X7+X6+X4+X2+1
≤ 64	12	X12+X11+X3+X2+X+1
≤ 256	16	X16+X15+X2+1
> 256	24	X24+X23+X18+X17+X14+X11+X10+X7+X6+X5+X4+X3+X+1

6.2 Multiple frames transmission

6.2.1 Frame structure

Information may be transmitted with multiple frames. Figure 7 shows the frame structure for a multiple frames transmission.

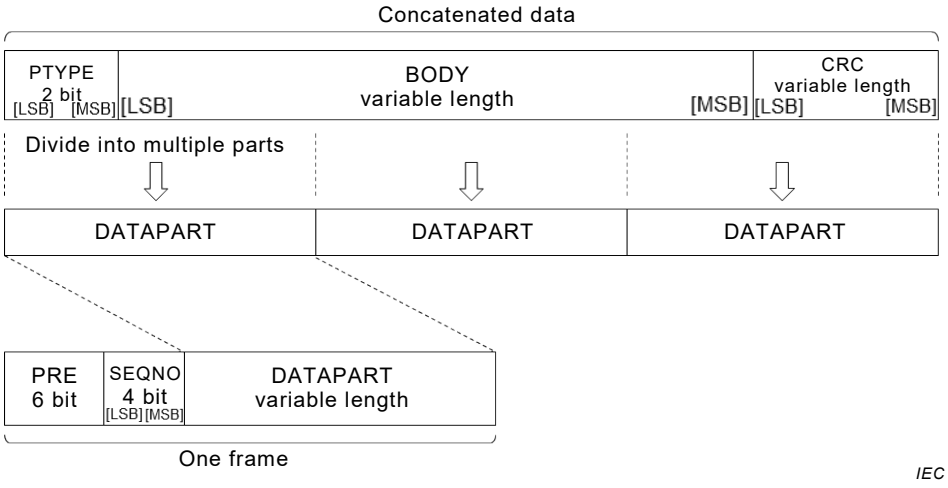


Figure 7 – Frame structure for a multiple frames transmission

Multiple frames transmission has two types (PTYPE) of BODY modes: "Single frame compatible" and "Data stream". The BODY of "Single frame compatible" type for multiple frames transmission contains a frame that is compatible with a single frame transmission. On the other hand, the BODY of "Data stream" type for multiple frames transmission contains arbitrary data stream.

Possible length of concatenated data is shown in Table 3. The numbers with underlines in Table 3 indicate the length of the concatenated data in "Single frame compatible" mode.

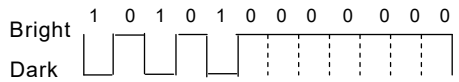
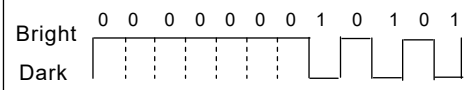
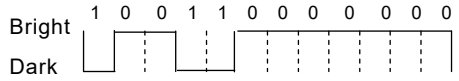
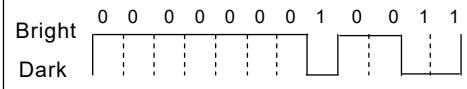
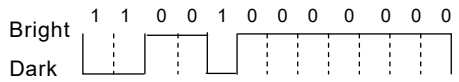
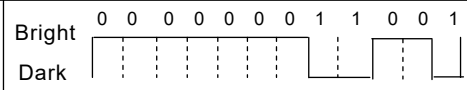
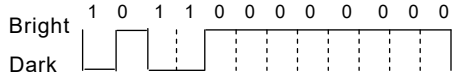
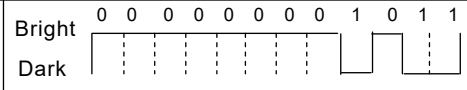
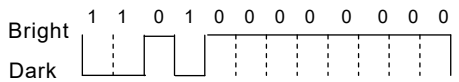
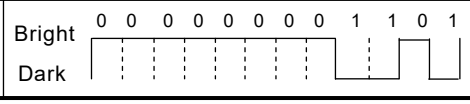
Table 3 – Possible length of concatenated data

Number of frames	Length of DATAPART [bit]				
	4	8	16	32	64
1	4	8	16	32	64
2	8	16	32	64	128
3	12	24	48	96	192
4	16	32	64	128	256
5	20	40	80	160	320
6	24	48	96	192	384
7	28	56	112	224	448
8	32	64	128	256	512
9	36	72	144	288	576
10	40	80	160	320	640
11	44	88	176	352	704
12	48	96	192	384	768
13	52	104	208	416	832
14	56	112	224	448	896
15	60	120	240	480	960
16	64	128	256	512	1 024

6.2.2 Preamble (PRE)

The PRE field for multiple frames transmission indicates length of the following DATAPART field and whether or not the following SEQNO field indicates the last sequence number as shown in Table 4. All of the PRE fields are distinguishable from any other fields by I-4PPM encoding rule violation.

Table 4 – Preambles for multiple frames transmission

PRE [slot]		Length of DATAPART [bit]
Last sequence number	Not last sequence number	
Transmission order: first → last	Transmission order: first → last	
		4
		8
		16
		32
		64

6.2.3 Sequence number (SEQNO)

The SEQNO field indicates a sequence number of the following DATAPART field as shown in Table 5.

Table 5 – Sequence number

SEQNO [bit]	Sequence number of DATAPART
[MSB] 0000 [LSB]	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15

6.2.4 Partition type (PTYPE)

The PTYPE field indicates the types of BODY field as shown in Table 6.