IEC 62779-4

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Semiconductor devices – Semiconductor interface for human body communication –
Part 4: Capsule endoscope

Dispositifs à semiconducteurs – Interface à semiconducteurs pour les communications via le corps humain –
Partie 4: Capsule endoscopique

IEC 62779-4:2020-02(en-fr)

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SEMICONDUCTOR DEVICES – SEMICONDUCTOR INTERFACE FOR HUMAN BODY COMMUNICATION –

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FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
47/2600/FDIS	47/2611/RVD

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

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

A list of all parts in the IEC 62779 series, published under the general title *Semiconductor devices – Semiconductor interface for human body communication*, can be found on the IEC website.

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

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- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

IEC 62779-1, IEC 62779-2 and IEC 62779-3 define the general requirements, measurement method and functional type of a semiconductor interface for human body communication. They include the general and functional specifications of the interface, the electrical performances of an electrode, and the operational conditions of the interface. However, an in-body to on-body channel for a capsule endoscope using galvanic coupling human body communication (HBC) is different from the channel that is described in IEC 62779-1, IEC 62779-2 and IEC 62779-3 using capacitive coupling human body communication (i.e. channel properties, such as signal loss and signal propagation mechanism, are different). Therefore, the semiconductor interface covered by IEC 62779-1, IEC 62779-2 and IEC 62779-3 cannot be used for the capsule endoscope using galvanic coupling human body communication. A common interface for a capsule endoscope using human body communication should be defined to secure communication compatibility between various capsule endoscope devices and receiving devices that are implemented on or inside the human body.

SEMICONDUCTOR DEVICES – SEMICONDUCTOR INTERFACE FOR HUMAN BODY COMMUNICATION –

Part 4: Capsule endoscope

1 Scope

This part of IEC 62779 defines general requirements on the electrical performances of a semiconductor interface for capsule endoscope using galvanic coupling human body communication. It includes general and functional specifications of the interface. The semiconductor interface that is covered in this document is the interface to handle or deliver an electrical signal between the capsule endoscope inside the human body and the HBC modem in the receiving device outside the human body.

NOTE Additional information on capsule endoscope using the human body communication is provided in Annex A.

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.

IEEE 802.15.6:2012, *IEEE Standard for Local and Metropolitan area networks – Part 15.6: Wireless Body Area Networks*

3 Terms, definitions and letter symbols

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

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

3.1 General terms

3.1.1
transmitting electrode
golden physical structure that transmits an electrical signal from a capsule endoscope to the human body while typically located inside the human body and adhering to the small bowel

Note 1 to entry: A transmitting electrode delivers an electrical signal to a non-metallic transmission channel, the human body.

3.1.2
capsule endoscope
small round and tube-shaped fixture that contains a LED module, lens module, sensor PCB, battery and power module

3.1.3
image sensor
semiconductor device that converts the luminance of light in front of the image sensor to electrical signal

3.1.4
driver
semiconductor device that delivers image data to the human body in the form of an electrical signal

Note 1 to entry: The driver is located before the transmitting electrode and outputs the electrical signal with a pre-limited current and pre-limited voltage.

3.1.5
galvanic coupling human body communication
human body communication method in which a receiver with two electrodes in-body or on-body can sense the change of electrical current caused by a transmitter through a part of the human body

3.1.6
capacitive coupling human body communication
human body communication method in which a receiver with an electrode on-body and a ground off-body can sense the change of electrical potential caused by a transmitter with an electrode on-body and a ground off-body

3.1.7
receiving electrode
physical metallic structure for receiving an electrical signal from the human body and delivering the received signal to the analog front end

Note 1 to entry: A receiving electrode delivers an electrical signal from a non-metallic transmission channel, the human body.

3.1.8
receiving device
electrical device for receiving image data transmitted from a capsule endoscope inside the human body and storing the received image data in a storage device

Note 1 to entry: The storage device can be a flash memory or hard disk drive.

3.1.9
band-pass filter
semiconductor device or circuit component in an analog front end that eliminates low frequency noise (i.e. noise from a power line or a fluorescent light) and high frequency noise (i.e. noise from a radio or a TV broadcasting, a cellular phone) that overlap in a received signal

3.1.10
analog to digital converter
ADC
semiconductor device or circuit component in an analog front end that converts filtered analog data to digital data

Note 1 to entry: The converted digital data can be processed in the modem of the receiving device.

3.1.11
data recovery circuit
DRC
semiconductor device or circuit component in an analog front end that recovers a digital data signal from a filtered signal in the receiving device

Note 1 to entry: The DRC can consist of a comparator and CDR circuit or ADC only.

3.2 Rating and characteristics

3.2.1 Capsule endoscope characteristics

3.2.1.1
single fault current between transmitting electrodes
I_{SFC}
maximum amount of short current between the electrodes of the capsule endoscope in the capsule endoscope semiconductor interface

3.2.1.2
output impedance between transmitting electrodes
Z_{EC}
impedance seen from the human body into the transmitting electrodes on the capsule endoscope in the capsule endoscope semiconductor interface

Note 1 to entry The output impedance depends on the output impedances of the driver.

3.2.2 Receiving device characteristics

3.2.2.1
input impedance of receiving electrode
Z_{ER}
impedance seen from the human body into the receiving electrode of the receiving device in a capsule endoscope semiconductor interface

Note 1 to entry: The input impedance depends on the input impedances of a band-pass filter and signal amplifier that are typically the very first stages of an analog front end.

3.2.3 Transfer characteristics

3.2.3.1
input sensitivity of receiving device
IS
minimum signal requirement for the receiving device to recover the transmitted signal from the capsule endoscope correctly

Note 1 to entry: For the definition of IS the required bit error rate should be satisfied between the capsule endoscope and the receiving device.

Note 2 to entry: This note applies to the French language only.

3.2.3.2
dynamic range
DR
ratio of a signal's maximum to minimum voltage ratio at an input of a semiconductor interface for capsule endoscope human body communication that can be tolerated without signal distortion

Note 1 to entry: Dynamic range depends on a minimum drive level of a comparator and a signal gain of a signal amplifier.

Note 2 to entry: This note applies to the French language only.

3.2.3.3
voltage gain
G_{V}
amplifying amount for the amplifier circuit or band-pass filter component in the analog front end without being attenuated or removed intentionally

3.2.3.4
lower cut-off frequency
f_{CL}
lower frequency where a receiving signal is attenuated by 3 dB as passing through a band-pass filter

SEE: Figure 1.

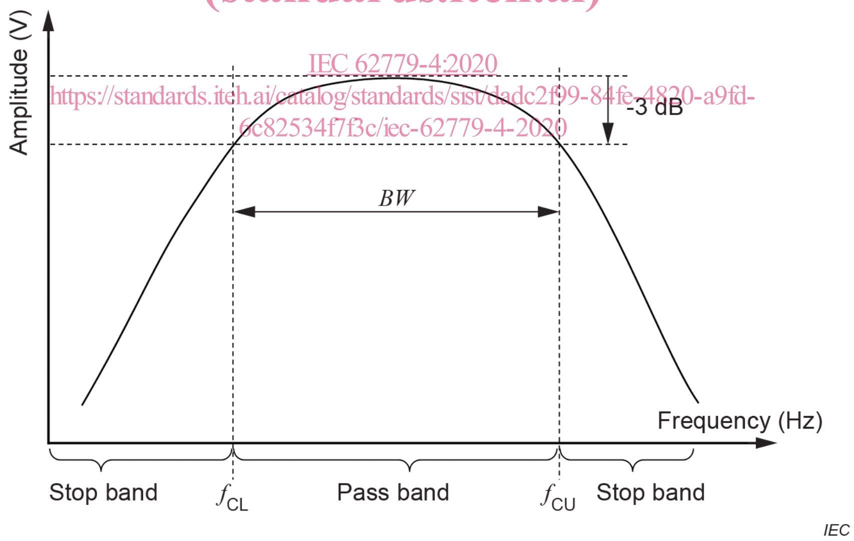
3.2.3.5
upper cut-off frequency
f_{CU}
upper frequency where a receiving signal is attenuated by 3 dB as passing through a band-pass filter

SEE: Figure 1.

3.2.3.6
bandwidth
BW
frequency width starting from the lower cut-off frequency to upper cut-off frequency without being attenuated or removed intentionally

Note 1 to entry: This note applies to the French language only.

SEE: Figure 1.



Key

BW	Bandwidth	f_{CL}	Lower cut-off frequency
f_{CU}	Upper cut-off frequency		

Figure 1 – Definition of cut-off frequency and bandwidth

3.2.3.7
propagation loss
P_L
amount of attenuation when a signal transmitted from the capsule endoscope passes through the human body

Note 1 to entry: Typically propagation loss can be defined as the ratio of the transmitting voltage swing and received voltage swing.

3.2.3.8
lock range
LR
operating frequency range of the CDR where the CDR circuit can be locked

Note 1 to entry: This note applies to the French language only.

3.2.3.9
bit width of ADC
$\boldsymbol{BIT}_{\mathbf{ADC}}$
output resolution of the ADC which can determine the processing accuracy of the modem in the receiving device

3.3 Letter symbols

Table 1 – Letter symbols

Name and designation	Letter symbol
supply voltage	V_{SC}
operating current	I_{SC}
operating time	t_{OPC}
single fault current between transmitting electrodes	I_{SFC}
output impedance between transmitting electrodes	Z_{EC}
supply voltage	V_{SR}
operating current	I_{SR}
operating time	t_{OPR}
input impedance between receiving electrodes	Z_{ER}
input sensitivity of receiving device	IS
dynamic range	DR
voltage gain	G_V
lower cut-off frequency	f_{CL}
upper cut-off frequency	f_{CU}
bandwidth	BW
propagation loss	P_L
lock range	LR
bit width of ADC	BIT_{ADC}

4 General requirements

4.1 General specifications

4.1.1 General

Clause 4 provides general specifications to specify the functional and external requirements for a semiconductor interface for a capsule endoscope using human body communication.

4.1.2 Function

4.1.2.1 Category

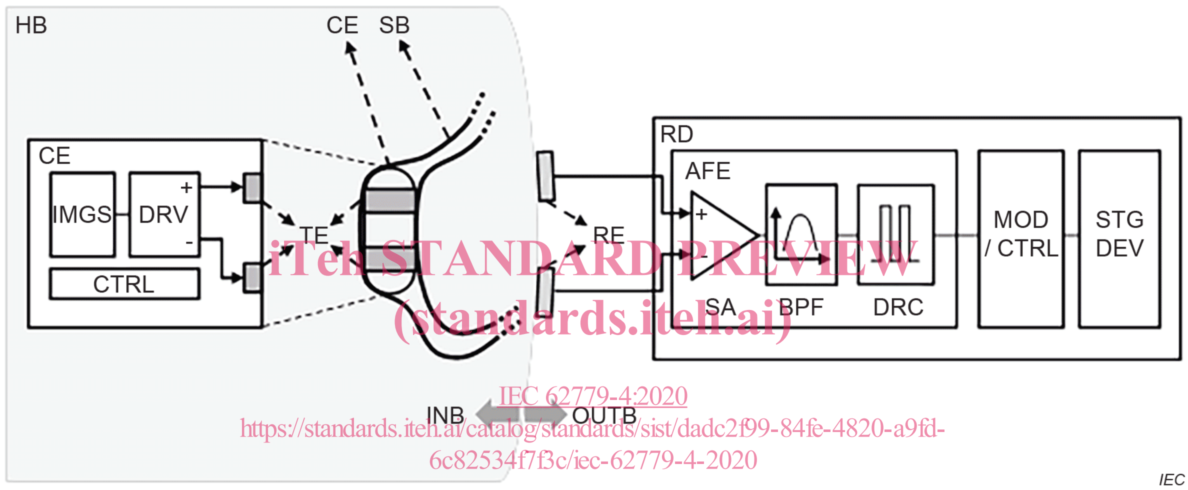
If an interface has a functional or electrical category, it shall be stated.

4.1.2.2 Functional description

A general description of the function performed by the interface shall be given.

4.1.2.3 Block diagram

The overall structure of the interface to realize the function shall be given. Details of the structure shall be given using a block diagram. A semiconductor interface for capsule endoscope using human body communication consists of a transmitting electrode and receiving electrode, capsule endoscope (CE), and receiving device (RD). A controller (CTRL) and driver (DRV) in the capsule endoscope convert the image data into an electrical signal and send it to the transmitting electrode. The received electrical signal from the human body is amplified by the signal amplifier (SA), filtered by the band-pass filter (BPF), and processed by the data recovery circuit (DRC) in an analog front end (AFE). The AFE delivers the processed data to the modem in the receiving device. (See an example in Figure 2 for more details.)



Key

CE	Capsule endoscope	AFE	Analog front end
DRV	Driver	BPF	Band-pass filter
CTRL	Controller	DRC	Data recovery circuit
RD	Receiving device	STG DEV	Storage device
SA	Signal amplifier	TE	Transmitting electrode
SB	Small bowel	RE	Receiving electrode
IMGS	Image sensor	HB	Human body
MOD	Modem	INB	Inside of human body
OUTB	Outside of human body		

NOTE The order of the components in the interface can be changed if necessary, as long as the interface satisfies the required performances.

Figure 2 – Typical example of semiconductor interface structure for capsule endoscope using galvanic coupling human body communication

If applicable, control signals that are transmitted between the interface and an HBC modem shall be defined in the block diagram.

The data recovery circuit (DRC) in the receiving device can be implemented using a comparator and CDR or it can be implemented using an ADC only. (See an example in Figure 3 for more details.)