IEC TR 63344

Edition 1.0 2021-11

TECHNICAL REPORT

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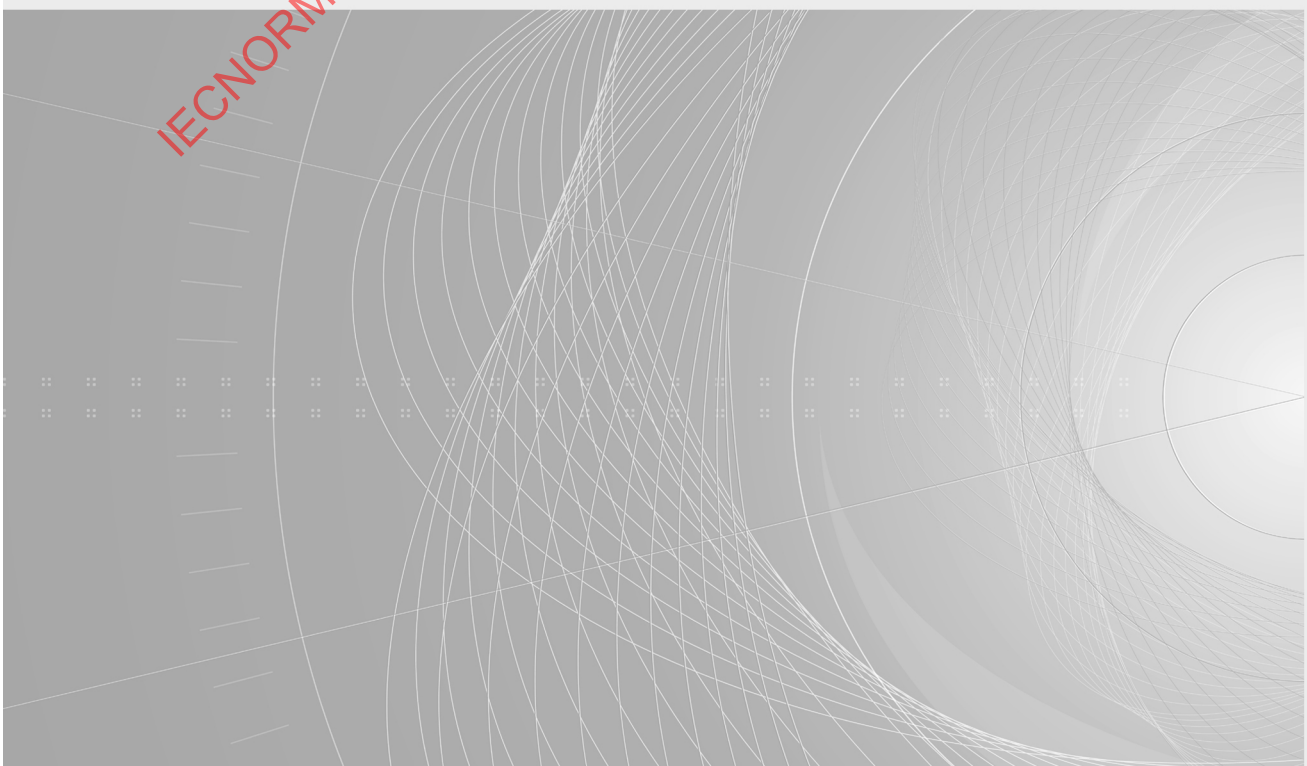
Conceptual model of standardization for haptic multimedia systems



IEC TR 63344:2021-11(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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Conceptual model of standardization for haptic multimedia systems

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.160.60

ISBN 978-2-8322-1047-1

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CONCEPTUAL MODEL OF STANDARDIZATION FOR HAPTIC MULTIMEDIA SYSTEMS

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IEC TR 63344 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
100/3573/DTR	100/3630/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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- withdrawn,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

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INTRODUCTION

The multimedia devices covered by TC 100 used to be primarily stationary audio and video devices, but now comprise mobile and wearable devices, for which it is necessary to consider different specifications from conventional stationary devices. At first, this Technical Report clarifies the conceptual model of haptics issues under the scope of TC 100, and then the details are described to understand the standardization items of haptics-related issues under the scope of TC 100.

MULTIMEDIA SYSTEMS – HAPTICS – CONCEPTUAL MODEL OF STANDARDIZATION

1 Scope

This document describes the conceptual model of vibro-tactile-based haptics in multimedia systems and equipment used in electrical appliances, computer interfaces, automobiles, amusements, and communication devices. This model describes possible standardization items.

NOTE Ergonomic aspects of haptics systems are standardised in the ISO 9241 series. The scope of that standard is focused on the physical specifications of the devices, signal properties and formats to ensure the common use with compatibility among various types of devices in haptics systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

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

3.1
haptic sensation
sensation, including tactile sensation and kinesthetic sensation perceived by bathyesthesia

3.2
tactile sensation
sensation detected by skin receptors

3.3
haptic display
device to produce touch sensation

3.4
tactile display
device that stimulates the skin receptors

3.5
haptic reproduction
creating realistic haptic sensation in VR and tele-manipulation, targeting a real sensation

3.6
haptic notification
notifying a user of necessary information by haptic stimulation

3.7
haptic guidance
guiding a user or the parts of the body to a desirable state regarding the position, direction, velocity or posture, sometimes synchronized with a specific task

Note 1 to entry: In the broader meaning, it includes guiding the user's other physical/mental conditions to desired states.

3.8
reality class
class of reality supposed in the displayed reality

3.9
haptic broadcasting
sending of haptic signals to multiple users to share the haptic experiences of a specific person

3.10
vibrotactile
mechanical vibration to produce haptic experiences

3.11
phantom sensation
illusional perception that a user feels a point stimulation at an intermediate point between a couple of stimulators placed with a certain distance

3.12
apparent motion
illusional perception that a user feels a continuous motion between a couple of stimulators placed with a certain distance when the stimulators are driven sequentially

3.13
surface haptics
technique to create haptic sensation on a flat panel by vibrations and friction control using electrostatic forces or ultrasonic vibrations

3.14
tactile electrostimulation
stimulating a skin via electrical current in the skin

3.15
mid-air haptic stimulation
stimulating a skin in a non-contact manner using airborne ultrasound or air stream

3.16
surface displacement
skin-surface displacement produced by a tactile display

Note 1 to entry: The direction of the displacement is described with the terms, vertical and lateral.

3.17
surface stress
skin-surface stress, applied force per unit area, produced by a tactile display

3.18
thermal tactile display
tactile display to control a skin surface temperature

3.19
haptic feel transfer
transferring the haptic feel of a real object

3.20
haptic communication
multimedia communication including touch sensation

4 Overview of haptics in multimedia systems

4.1 Purpose

The purpose of the standardization is to define the performance, ensure the compatibility among the different types of hardware and facilitate the development and technical spread.

4.2 Device categories

The device categories of haptics systems are summarized in Figure 1. A vibrotactile device is an apparatus to send vibration to a part of a human skin via specified device such as a game controller, wristband, joystick, or other grip-type/wearable devices, which creates haptic experiences synchronized with visual and audio information. Surface haptic devices produce various haptic sensations on a flat panel via vibration and friction control using electrostatic forces and ultrasonic vibrations. A stylus device reproduces the texture via the vibration of a pen-like device. A wear-type device creates vibrations at multiple points on a body. Tactile electrostimulation, electric current in the skin, can also create haptic with no moving parts, and airborne ultrasound or air stream can produce haptic sensations without contact, which is called mid-air haptic stimulation. The typical applications are illustrated in Figure 2.

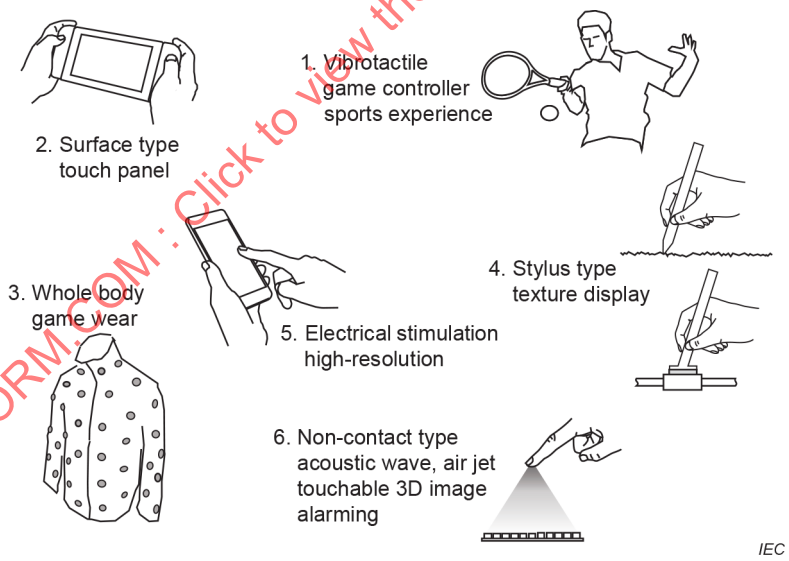
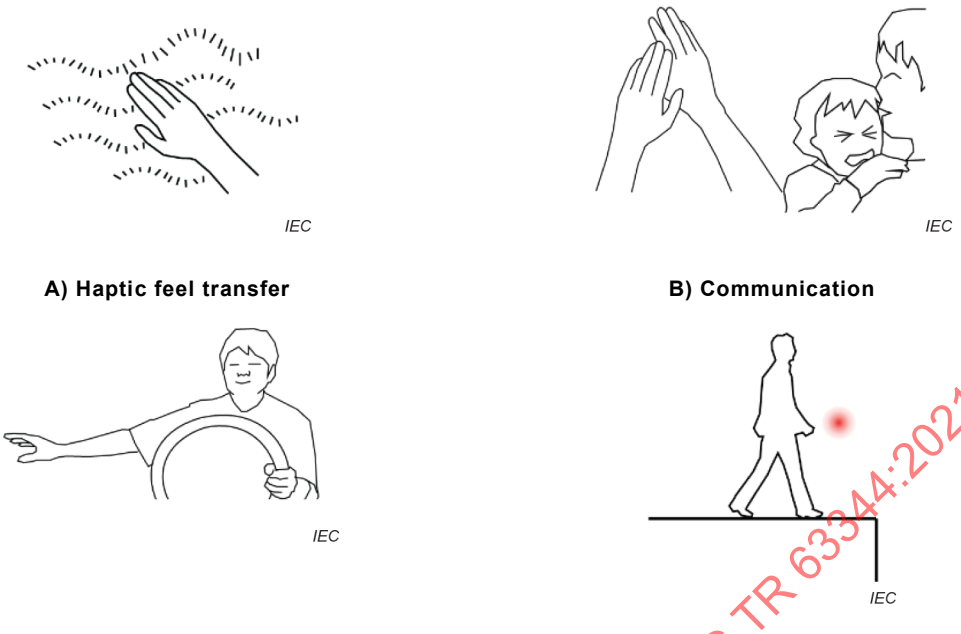


Figure 1 – Device categories



A) Haptic feel transfer **B) Communication**

C) Car driver support **D) Alarm, safety**

Figure 2 – Applications

Table 1 – Items of haptics standardization

Purpose	➢ Reproduction ➢ Notification ➢ Guidance	
Reality class	➢ Class 1: Physically faithful ➢ Class 2: Indistinguishable ➢ Class 3: Different but useful ---- Subclasses	
Interaction modality	➢ Cutaneous ➢ Proprioception/Kinesthetic ➢ Audio/Visual	
Data format and network	➢ Device category ➢ Number of stimulation point ➢ Body part	➢ Framerate ➢ Data length ➢ Data
	➢ One way, Bidirectional	➢ Bandwidth, delay
Device property	➢ Category definition ➢ Use of universal parameter	➢ Diversity of sensitivity and safety ➢ Calibration method

4.3 Items of standardization

This document deals with mechanical and thermal stimulations to users' bodies, which contains multiple layers of potential standardization summarized in Table 1. This document clarifies the items that should be standardized for:

a) purposes of haptic feedback;

b) class of performance represented by reality;

c) interaction modality;

d) data format and network topology;

e) device property.

4.4 Purposes of haptic feedback

In general, the purposes of haptic feedback are classified into Reproduction, Notification, and Guidance as follows.

Haptic reproduction is creating realistic haptic sensation in VR and tele-manipulation, targeting a real sensation. Producing the touch feel of a commercial product for Internet shopping is an example of Reproduction. In a tele-manipulation system, reproduced stimulation enables the user to handle the remote object as if touching it directly. In a communication system, users can feel the remote partner with the reproduced haptic sensation. Many applications such as computer games, sports broadcasting, and cinemas potentially need haptic reproduction.

Haptic notification is sending necessary information to users by haptic channel. A vibration from a mobile phone is a familiar example of notification. In an automobile, the driver can receive haptic signals from the seat and foot pedal to be alerted to the abnormal situation of the car, change of the road condition, and danger approaching the car. In addition to these passive cases, it is also useful in active motions. For example, a click felt by a finger notifies the completion of input action. Periodic resistance in a dial notifies the quantity that the user is controlling. These sensations facilitate the operations.

Haptic guidance is leading a user or the parts of the body to a desirable state regarding the position, direction, velocity or posture sometimes synchronized with a specific task. Haptic stimulation can inform a pedestrian of the direction to the destination. Stimulation on a steering wheel can indicate the direction suggested by the navigation system. Vibrations given on the limbs teach which limb to move at what timing. In addition to the motion guidance, haptic stimulation can induce relaxation and control the mental condition.

4.5 Reality class

Consensus on the reality is a crucial premise for practical use of haptics technologies. Users and developers need to share the reality class supposed in each application as:

- Class 1: physically faithful stimulation to real experience;
- Class 2: physically different but indistinguishable from real experience;
- Class 3: distinguishable but useful.

For example, a dot of an HD display produces Class 2 reality since it creates a faithful colour but a different spectrum from the real one. Lossy audio compression also ensures the reproduced sound satisfies the Class 2 reality.

In haptics, the major applications would belong to Class 3 while Class 2 reality is achieved in only limited applications. A standard is necessary to define the reality class before sharing the haptic information. Such a standard also facilitates the technological advancement. Subclasses would follow after Class 3.

4.6 Interaction modality

In general, haptic sensation is formed by multiple sensory perceptions. Haptic feeling is strongly affected by visual and auditory information and the context. Even within haptic modality, force perception is created by combining almost independent perception channels: cutaneous perception, and proprioception, including kinesthetics. In many haptic feedback systems, the haptic experiences are created by integrating these fragmented stimulations given to a part of the body.

Therefore, it is useful to standardize the adequate modalities to achieve the desired haptic effects and ensure the compatibilities among different sets of modalities.

4.7 Data format and network topology

4.7.1 General

This document describes the required contents and format of the transferred data. The data will contain the information of device category, type of stimulation, number of stimulation points, applied body part, as well as frame rate and data length, depending on the applications.

The network topology is also described in this layer. For example, one-to-many connection is employed for many people to share a passive haptic signal in a scene of 4D theatre, sport watching, and live concerts. In communication between two people, bidirectional one-to-one connection is employed.

4.7.2 Acceptable delay

A 1 ms delay is the desirable and sufficient delay for all kinds of applications. Such a short delay from the sensor to the haptic display enables to create a contact experience with a rigid object. But sometimes, larger delays than 1 ms are acceptable. There are many cases where 10 ms is acceptable to produce an interaction with a soft object. For the interaction with a very soft object or non-interactive applications, even a 100 ms delay is acceptable. The standard should clarify the acceptable delays for specific applications.

4.7.3 Frame rate

The sufficient frame rate for all kinds of applications is 2 kHz that can reproduce 1 kHz-bandwidth signals. In some applications of vibrotactile feedback, a 400 Hz-frame rate becomes an option that can create a 200 Hz tactile signal, the easiest-to-sense vibration in many cases. If the signal transfers only the event of a contact, a 10 Hz framerate might be enough.

4.7.4 Quantization

The standard should clarify the necessary number of quantization bits. In order to reproduce a realistic tactile feeling, 8 bits or more would be necessary, but if the purpose of haptic stimulation is only to alarm or motion inductance, a lesser number of bits or only 1 bit might be enough.

4.7.5 Data compression

In public applications where many people share a real-time haptic signal with a limited bandwidth of wireless communication, efficient data compression would be necessary.

4.8 Device property

4.8.1 General

The standard should define the categories of hardware, and standardize the specification and calibration method in each category.

4.8.2 Spatial resolution

The necessary spatial resolution of haptic devices should be defined here considering the applications. For example, 1 mm is the sufficient spatial resolution on a finger pad, 1 cm is the ideal spatial resolution on a palm, and 10 cm is acceptable in a whole-body stimulation. In some applications using the phantom sensation and apparent motion, the spacing of stimulators can be wider.

4.8.3 Use of universal parameters

In order to secure the compatibility, the stimulation signal should be described and shared by the direct physical effect to the skin, that is, surface displacement, surface stress, velocity, acceleration, or force. In thermal tactile display, the temperature change on the skin should be shared.

4.8.4 Diversity of sensitivity

A feature of haptics is the broad diversity of sensitivity among individuals. The standard should provide the average and range of the diversity and maximum stimulation amplitude.

4.8.5 Safety

The safety can be classified into two sorts: one is for electronic equipment and the other is for user interfaces. The safety of electronic equipment can be referred to (e.g. see IEC 62368-1). The safety of user interfaces should also be considered.

4.8.6 Calibration method

The standard provides the physical calibration method of the device. The above universal parameters will be measured on a standard skin with a standard viscoelasticity. This procedure is indispensable to ensure the uniformity of the haptic effect.

5 Examples

5.1 Games and entertainment

5.1.1 General

Vibration displayed on a user's hand and whole body can produce enriched user experiences in computer games. Similar technologies enable haptic broadcasting in real actions of various sports. Racket sports such as tennis as shown in Figure 3, ping-pong, badminton and baseball batting are promising examples, and volleyball and football would be the next targets. In these applications, standardization is desired as follows.

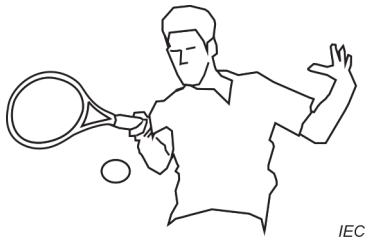


Figure 3 – Game & Entertainment

5.1.2 Computer games

Computer games is a promising application field of haptics. Vibration is applied to the user's hand and whole body synchronized with the game scenario. The system diagram is shown in Figure 4. In order to make tactile feedback effective, it is desirable to standardize the required precision, temporal throughput, and delay of the sensor the acquisition of the user's motion and posture. If the physical properties of the tactile display and driver circuit are standardized, users having various types of devices can share common experiences. Such standards are especially necessary in networked games.

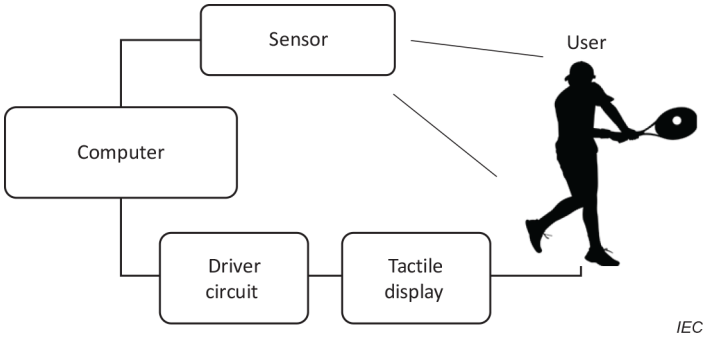


Figure 4 – Computer games

5.1.3 Immersive cinema

A vibrotactile vest creates an immersive experience in a theatre. The audience wears vibrotactile vests or jackets as shown in Figure 5 and enjoys the haptic effects. Currently, the stimulation is limited to a passive one, but it is expected that some interaction will be included. It is desirable to standardise the following items:

1) contact condition between the wear and body;
2) appropriate signal strength/waveform and effect on the body;
3) density and placement of the vibrators.

A use case is described in Annex A.

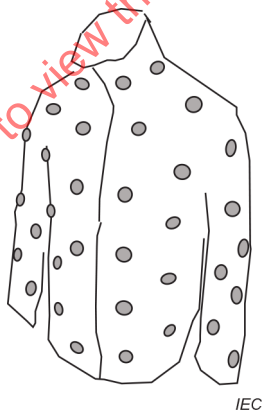


Figure 5 – Wear-type display for Immersive cinema

5.1.4 Sports broadcasting

A realistic vibration estimated from a video of a real player can be transmitted to people and reproduced being synchronized with the video. The system diagram is shown in Figure 6. In this application, it is desirable to standardise:

1) estimation quality of vibration from video,
2) tactile signal format to be shared,
3) network properties,
4) physical specifications of tactile display,

in order to share the tactile broadcasting signal.

A use case is described in Annex B.

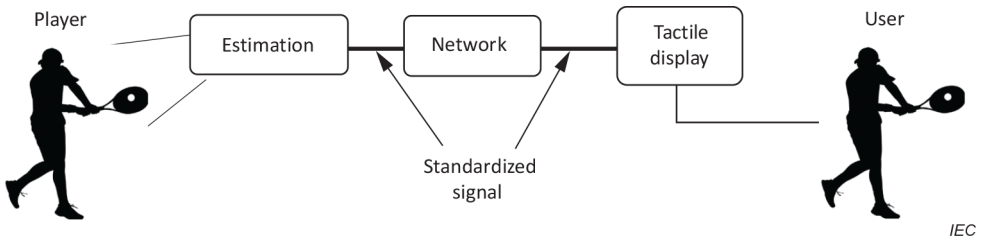


Figure 6 – Sports broadcasting

5.1.5 E-sports

E-sports is an emerging field providing new experiences of sports-like competition. Technology fills the gap of physical conditions and abilities among individuals and enables everyone to enjoy thrilling competition safely. Haptics is an essential part of the physical interaction in e-sports. The standards also cover the rules and the regulations for fair competition.

5.2 Car driver support

5.2.1 General

Automobile applications of haptics as shown in Figure 7 are promising since the user's vision is necessarily concentrated on the outside view. Various information is provided to the driver through the steering wheel, dashboard, seat, and foot pedal.

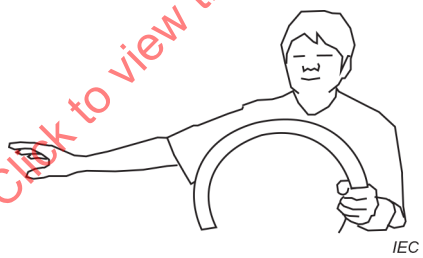


Figure 7 – Car driver support

5.2.2 Centre console interface

A touch panel device in the centre console is the main interface between the driver and the car's accessory devices. The design of the touch panel with haptic feedback as shown in Figure 8 determines the usability of the car accessory and effects on driving safety.

It is desirable to standardise the following items:

1) relative position from the driver's head;
2) vibration amplitude and direction for effective tactile feedback;
3) acceptable delay;
4) vibration waveform.

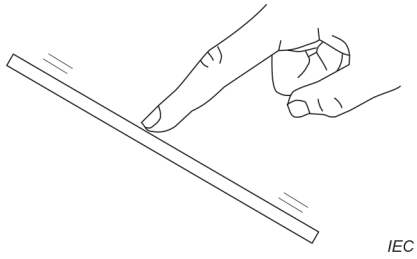


Figure 8 – Centre console interface

5.3 Haptic feel transfer

Haptic feel transfer is an emerging need in the age of internet shopping. The current haptic transfer systems conceptually illustrated in Figure 9 are still imperfect in some aspects, but is already possible to convey the feel of an object under common agreement on the imperfectness.

A standard is necessary to compensate the gap between the real tactile feel and the conveyed one. It is desirable to standardise the following items:

1) definition of the difference between real tactile feel and reproduced one;
2) agreement by users on the tactile feel difference;
3) tactile signal format;
4) physical specifications of tactile display device.

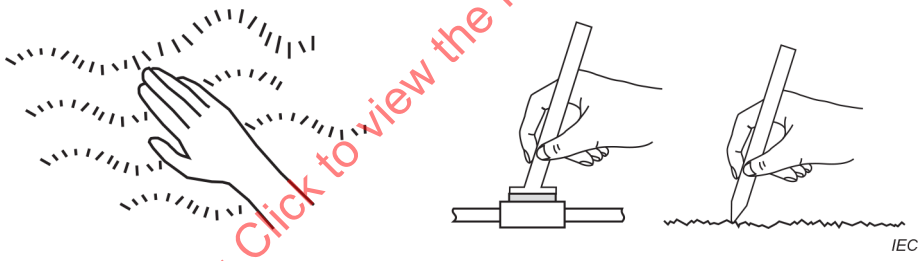


Figure 9 – Tactile feel transfer

5.4 Haptic communication

Haptic displays enable communication including haptic feel as well as audio and visual information, which is conceptually illustrated in Figure 10. Haptic stimulation is provided directly to the user's skin with 3D vision or through some stuffed toys and robots. In order to establish communication among unspecified people, a standard on the communication medium is necessary. It is desirable to standardise the following items:

1) definition and specification of haptic information;
2) middleware to compensate the differences between various devices;
3) signal format to be shared;
4) communication scheme among multiple users.

Figure 10 – Tactile communication

Annex A
(informative)

Use case[1] of vibrotactile vest

A.1 Description of the use case

A.1.1 Name of use case

Use Case Identification		
ID	***Area/ Domain(s)/ Zone(s)***	***Name of Use Case***
NA	Audio, video and multimedia systems and equipment/ Presentation / Professional	Have a vibrotactile experience at the cinema

A.1.2 Version management

Version Management				
Version No.	***Date***	***Name of Author(s)***	***Changes***	***Approval Status***
NA	2020	TC 100	NA	NA

A.1.3 Scope and objectives of use case

Scope and Objectives of Use Case	
Scope	Vibrotactile vest
Objective(s)	Provide a vibrotactile experience
Related business case(s)	https://www.sonypictures.jp/corp/press/2018-03-24

A.1.4 Narrative of use case

Narrative of Use Case
Short description
• College students Schneider and Haltrich enjoyed the cinema "Welcome to the Jungle", each wearing a vibrotactile vest. Synchronized effect of sound, vision, and vibration made them very impressed, especially for virtual body attacks. • Five-year-old Chico-chan could not be equipped because of educational care. • Yokozuna Phil could not wear a vibrotactile vest because of a big waist. • Sekitori Bob wore a vibrotactile vest but could not fully enjoy it because of his under-skin structure.
Complete description
See A.4.2.

A.1.5 General remarks

General Remarks
Home use case of vibrotactile vest may differ from the one at the cinema.

[1] This annex is constructed based on the template of IEC 62559-2.

A.2 Diagram of use case

Figure A.1 illustrates the use case described in Clause A.1.

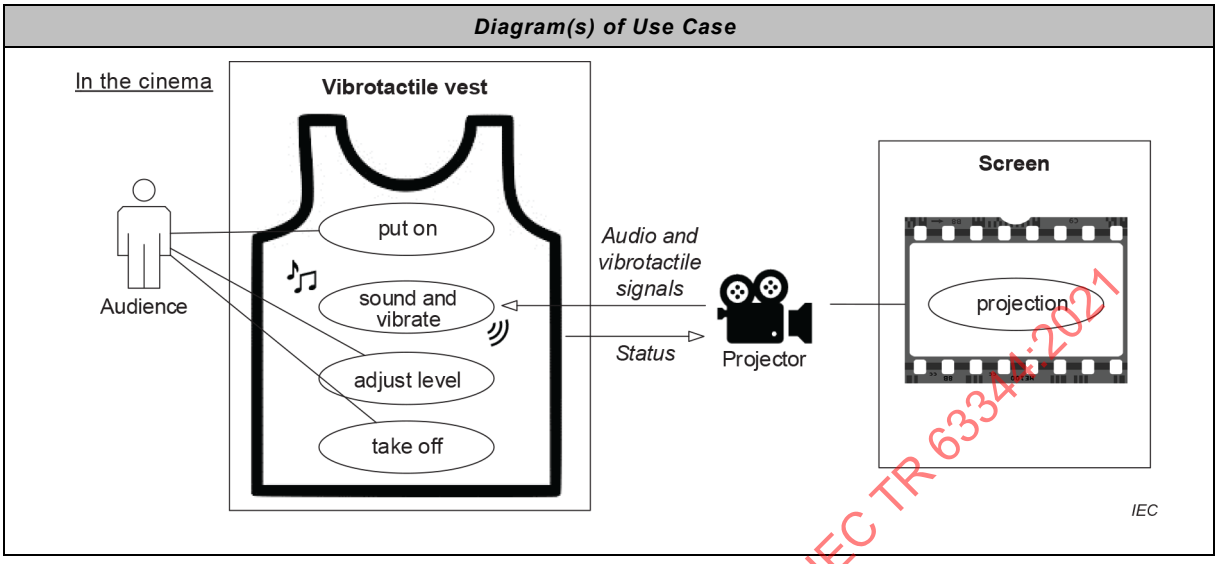


Figure A.1 – Use case diagram of vibrotactile vest

A.3 Technical details

A.3.1 Actors

Actors			
Grouping		***Group Description***	
NA		NA	
Actor Name see Actor List	***Actor Type see Actor List***	***Actor Description see Actor List***	***Further information specific to this Use Case***
Audience	Person	Person in the cinema	NA
Vibrotactile vest	Equipment	Vest comprised of vibrotactile actuators	NA
Projector	System	System that project the movie and deliver audio and vibrotactile signals to the vibrotactile vest.	NA
Screen	Device	Surface to be projected	NA
Loudspeaker	Device	Device to playback audio	NA
Actuator	Device	Device to vibrate	NA
Clark	Person	Person to manage the cinema	NA
Filmmaker	Corporation	Corporation that supplies the cinema contents	NA
Installer	Company	Company that installs the cinema systems and equipment	NA

A.3.2 Triggering event, preconditions, assumptions

Use Case Conditions			
Actor/System/Information/ Contract	***Triggering Event***	***Pre- conditions***	***Assumption***
Audience	Puts on a vibrotactile vest	Entered the cinema paying a fee.	NA
Projector	NA	Works well	NA
Vibrotactile vest	NA	Maintained well	NA

A.3.3 References

References						
No.	***References Type***	***Reference***	***Status***	***Impact on Use Case***	***Originator/ Organisation***	***Link***
1	Standard	IEC 62559-2:2015, *Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list*	IS	NA	IEC TC 8	NA
2	Standard	IEC TS 62436:2008+AMD1:2016, *Guideline for implementation of copy controlled multimedia interface*	IS	NA	IEC TC 100/TA 4	NA
3	Standard	IEC 60958 (all parts), *Digital audio interface*	IS	NA	IEC TC 100/TA 20	NA
4	Standard	IEC 61937 (all parts), *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958*	IS	NA	IEC TC 100/TA 20	NA
5	Standard	IEC 61938: 2018, *Multimedia systems – Guide to the recommended characteristics of analogue interfaces to achieve interoperability*	IS	NA	IEC TC 100/GMT	NA
6	Standard	ISO/IEC 19505-2:2012, *Information technology – Object Management Group Unified Modeling Language (OMG UML) – Part 2: Superstructure*	IS	NA	ISO/IEC JTC 1/SC 7	NA
7	Standard	ISO 9241-910:2011 *Ergonomics of human-system interaction – Part 910: Framework for tactile and haptic interaction*	IS	NA	ISO TC 159/SC 4	NA
8	Book	Alistair Cockburn, *Writing Effective Use Cases*	Publ.	NA	Addison-Wesley Professional, 2001	NA
9	Specification	Digital Cinema System Specification Version 1.3 dated 27 June 2018, *https://dcimovies.com/specification/index.html*	Publ.	NA	Digital Cinema Initiatives	NA

A.3.4 Further information on the use case for classification and mapping

Classification Information
Relation to Other Use Cases
CONCEPTUAL MODEL OF STANDARDIZATION FOR HAPTICS IN MULTIMEDIA SYSTEMS
Level of Depth
Detailed
Prioritisation
NA
Generic, Regional or National Relation
Generic
Viewpoint
Technical
Further Keywords for Classification
Haptics

A.4 Step by step analysis of use case

A.4.1 Overview Scenarios

Scenario Conditions					
No.	***Scenario Name***	***Primary Actor***	***Triggering Event***	***Pre-Condition***	***Post-Condition***
1	Put on	Audience	Put on the vest	NA	NA
2	Sound and vibrate	Projector	Cinema starts	NA	NA
3	Adjust	Audience	Control the volume	NA	NA
4	Take off	Audience	Take off the vest	NA	NA

A.4.2 Steps – scenarios

Scenario								
Step No.	***Event***	***Name of Process/ Activity***	***Description of Process/ Activity***	***Service***	***Information Producer (Actor)***	***Information Receiver (Actor)***	***Information Exchanged***	***Requirements R-ID***
Scenario Name:			**No. 1 – Put on**					
1	NA	NA	Audience puts on a vibrotactile vest.	NA	NA	NA	NA	NA
2	NA	NA	Vest recognizes the audience and sets an appropriate vibrotactile gain for them.	NA	NA	NA	NA	NA
3	NA	NA	Cinema projector provides music and vibrotactile signal to the vest before a cinema projection starts.	NA	NA	NA	NA	NA
4	NA	NA	Vest distinguishes music and vibrotactile signal appropriately, reproduces the music on loudspeakers near the Wearer's ear and vibrates the corresponding Wearer's skin portion.	NA	NA	NA	NA	NA
5	NA	NA	Audience appreciates a new music experience by accompanied vibrotactile supports.	NA	NA	NA	NA	NA
2a	NA	NA	The vest failed to recognize the wearer:	NA	NA	NA	NA	NA
2a1	NA	NA	Vest prompts wearer to put on vest again correctly.	NA	NA	NA	NA	NA
2a2	NA	NA	Three failures makes vest request to clerk for an alternative vest through the projector.	NA	NA	NA	NA	NA
2a3	NA	NA	Clerk requests to installer to bring maintenance supplies if the stock is not enough.	NA	NA	NA	NA	NA
2a4	NA	NA	Clerk gives the money back to the wearer if no alternative vest is available.	NA	NA	NA	NA	NA
4a	NA	NA	Vest failed to distinguish sound and vibrotactile signal.	NA	NA	NA	NA	NA
4a1	NA	NA	Vest stops reproducing sound and vibrotactile signals and requests an alternative vest from the clerk through the projector.	NA	NA	NA	NA	NA
4a2	NA	NA	Same as 2a3 – 2a4.	NA	NA	NA	NA	NA

Scenario								
Step No.	***Event***	***Name of Process/ Activity***	***Description of Process/ Activity***	***Service***	***Information Producer (Actor)***	***Information Receiver (Actor)***	***Information Exchanged***	***Requirements R-ID***
Scenario Name:			**No.2 – Sound and Vibrate**					
6	NA	NA	When a cinema starts to project, projector provides sound and vibrotactile signal to the vest synchronizing to the cinema film on screen.	NA	NA	NA	NA	NA
7	NA	NA	Vest distinguishes sound and vibrotactile signal appropriately, reproduces the sound on loudspeakers near the audience's ears and vibrates the corresponding audience's skin portion in accordance with the filmmaker's direction.	NA	NA	NA	NA	NA
8	NA	NA	Audience appropriates a high-presence cinema experience synchronizing sound, projection and vibrotactile presentations.	NA	NA	NA	NA	NA
7a	NA	NA	Vest failed to distinguish sound and vibrotactile signal.	NA	NA	NA	NA	NA
7a1	NA	NA	Vest stops to reproduce sound and vibrotactile signal and requests an alternative vest from the clerk through the projector.	NA	NA	NA	NA	NA
7a2	NA	NA	Same as 2a3 – 2a4.	NA	NA	NA	NA	NA
Scenario Name:			**No.4 – Take off**					
9	NA	NA	Audience takes off the vest.	NA	NA	NA	NA	NA
Scenario Name:			**No.3 – Adjust**					
*a	NA	NA	At any time, audience manipulates controller on their vest.	NA	NA	NA	NA	NA
*a1	NA	NA	Audience adjusts music/sound-reproduction level or mutes.	NA	NA	NA	NA	NA
*a2	NA	NA	Audience adjusts vibrotactile-reproduction level or stops the vibration.	NA	NA	NA	NA	NA

A.5 Information exchanged

Information Exchanged		
Name of Information (ID)	***Description of Information Exchanged***	***Requirements to information data***
Audio signal	For analogue audio, see IEC 61938. For digital audio, see IEC 60958 (all parts) and IEC 61937 (all parts).	NA
Vibrotactile signal	Polarity of vibrotactile signals is unified, where pulse swing of the signal pushes the skin.	NA
Vibration	Actuator may vibrate from 0,2 Hz to 10 kHz and sound.	NA

A.6 Requirements (optional)

Requirements (optional)	
Categories for Requirement	***Category Description***
NA	NA
Requirement ID	***Requirement Description***
NA	NA

A.7 Common terms and definitions

Common Terms and Definitions	
Term	***Definition***
NA	NA

A.8 Custom information (optional)

Custom Information (optional)		
Key	***Value***	***Refers to Section***
Connection standards conforming to SCMS	• S/PDIF (IEC 60958, IEC 61937) • i.LINK (IEC 61883-6) • Bluetooth (SCMS-T) • HDMI (Audio Sample Packet, HBR Audio Packet, ARC, e-ARC) • Ethernet AVB (IEEE 802.1 Audio/Video Bridging)	

A.9 Terms and definitions (additional)

Terms and Definitions (additional)	
Term	***Definition***
Use case	Specification of a set of actions performed by a system, which yields an observable result that is, typically, of value for one or more actors or other stakeholders of the system [SOURCE: ISO/IEC 19505-2:2012]
Vibrotactile	Vibration-based stimulation of the skin [SOURCE: ISO 9241-910:2011]
Vibrotactile vest	Vest comprised of vibrotactile actuators
Vibrotactile gain	Gain of amplified vibrotactile signal
SCMS	Serial copy management system [SOURCE: IEC TS 62436:2008+AMD1:2016]

A.10 Technologies (additional)

Technologies (additional)	
Categories for Technology	***Category Description***
Interface	Content protection
Technology ID	***Technology Description***
SCMS	Signals to be protected against pirates

Annex B
(informative)

Use case[2] of vibrotactile IPTV

B.1 Description of the use case

B.1.1 Name of use case

Use Case Identification		
ID	***Area/ Domain(s)/ Zone(s)***	***Name of Use Case***
NA	Audio, video and multimedia systems and equipment/ Presentation / Consumer	Have a vibrotactile experience at home

B.1.2 Version management

Version Management				
Version No.	***Date***	***Name of Author(s)***	***Changes***	***Approval Status***
NA	2020	TC 100	NA	NA

B.1.3 Scope and objectives of use case

Scope and Objectives of Use Case	
Scope	Vibrotactile IPTV
Objective(s)	Provide a vibrotactile experience
Related business case(s)	https://www.nttlcc.or.jp/en/archive/works/tactile-tv/

B.1.4 Narrative of use case

Narrative of Use Case
Short description
• Sport content provider creates audio-visual content with vibrotactile signal. An audience at home watches the TV with vibrotactile signal and enjoys higher-realism content.
Complete description
Alice, a director of a sports content provider company, created audio-visual content as usual. Since her company decided to transmit a vibrotactile signal via network such as Internet Protocol TeleVision (IPTV), she captured the vibration of the stadium with a low-frequency detecting microphone and added it to the vibrotactile channel of audio track. This content was broadcast all over the world via an existing content delivery network (CDN). Bob, a fan of sports games, watched the TV. He has subscribed to the "higher-realism option" from the IPTV company, so he was able to receive audio-visual content with vibrotactile signal. The sofa he sat on was vibrated by vibrotactile devices and sometimes synchronized with the games. He could enjoy it as if he were in the stadium.

B.2 Diagram of use case

Figure B.1 illustrates the use case described in Clause B.1.

2 This annex is constructed based on the template of IEC 62559-2.

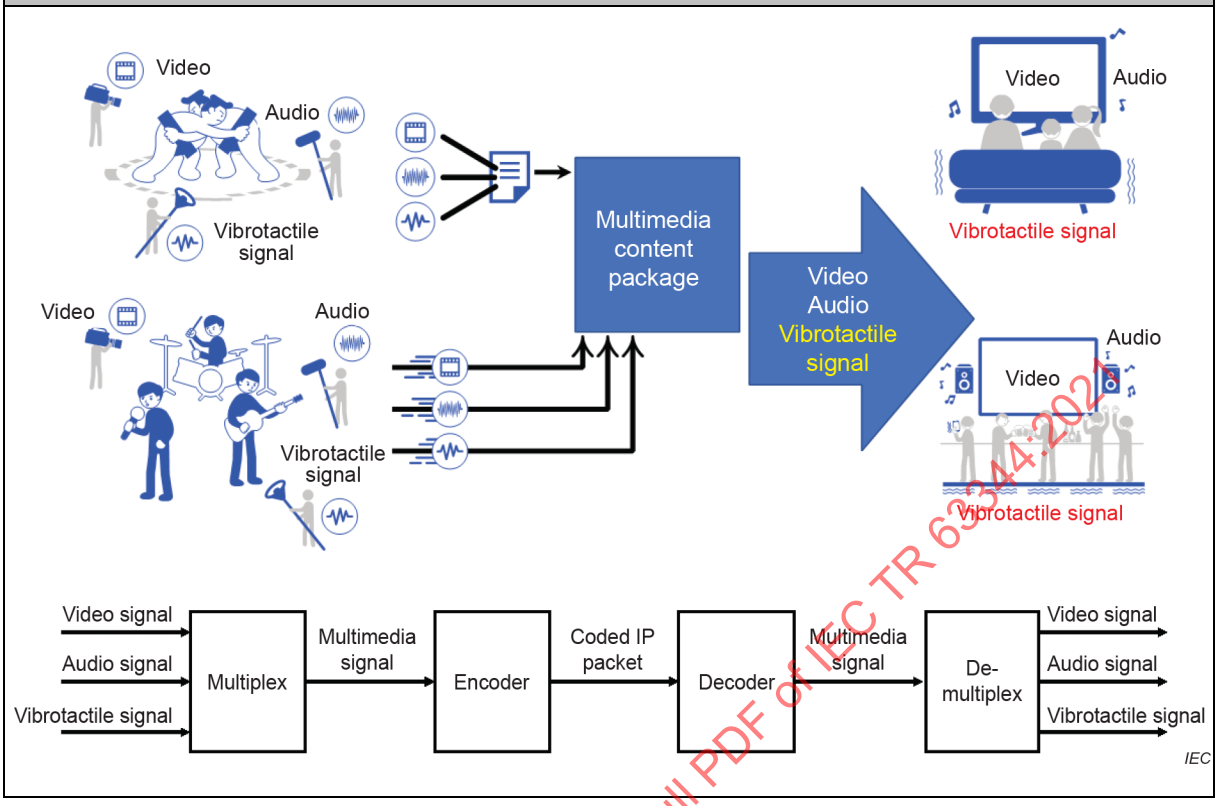
Diagram(s) of Use Case


Figure B.1 – Use case diagram of vibrotactile IPTV

B.3 Technical details

B.3.1 Actors

Actors			
Grouping		***Group Description***	
NA		NA	
Actor Name see Actor List	***Actor Type see Actor List***	***Actor Description see Actor List***	***Further information specific to this Use Case***
Audience	Person	Person in the home	NA
Vibrotactile equipment	Equipment	Equipment comprised of vibrotactile actuators	NA
TV	System	System that show the content including video and audio.	NA
Loudspeaker	Device	Device to playback audio	NA
Actuator	Device	Device to vibrate	NA

B.3.2 Triggering Event, Preconditions, Assumptions

Use Case Conditions			
Actor/System/Information/ Contract	***Triggering Event***	***Pre- conditions***	***Assumption***
Audience	Puts on vibrotactile devices	Subscribed to the vibrotactile plan, paying a fee.	NA
TV	NA	Works well	NA
Vibrotactile devices	NA	Maintained well	NA

B.3.3 References

References						
No.	***References Type***	***Reference***	***Status***	***Impact on Use Case***	***Originator/ Organisation***	***Link***
1	Standard	IEC 62559-2:2015, *Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list*	IS	NA	IEC TC 8	NA
2	Standard	IEC TS 62436:2008+AMD1:2016, *Guideline for implementation of copy controlled multimedia interface*	IS	NA	IEC TC 100/TA 4	NA
3	Standard	IEC 60958 (all parts), *Digital audio interface*	IS	NA	IEC TC 100/TA 20	NA
4	Standard	IEC 61937 (all parts), *Digital audio – Interface for non-linear PCM encoded audio bitstreams applying IEC 60958*	IS	NA	IEC TC 100/TA 20	NA
5	Standard	IEC 61938:2018, *Multimedia systems – Guide to the recommended characteristics of analogue interfaces to achieve interoperability*	IS	NA	IEC TC 100/GMT	NA
6	Standard	ISO/IEC 19505-2:2012, *Information technology – Object Management Group Unified Modeling Language (OMG UML) – Part 2: Superstructure*	IS	NA	ISO/IEC JTC 1/SC 7	NA
7	Standard	ISO 9241-910:2011, *Ergonomics of human-system interaction – Part 910: Framework for tactile and haptic interaction*	IS	NA	ISO TC 159/SC 4	NA
8	Book	Alistair Cockburn, *Writing Effective Use Cases*	Publ.	NA	Addison-Wesley Professional, 2001	NA

B.3.4 Further Information to the use case for classification / mapping

Classification Information
Relation to Other Use Cases
CONCEPTUAL MODEL OF STANDARDIZATION FOR HAPTICS IN MULTIMEDIA SYSTEMS
Level of Depth
Detailed
Prioritisation
NA
Generic, Regional or National Relation
Generic
Viewpoint
Technical
Further Keywords for Classification
Haptics

B.4 Step-by-step analysis of use case

B.4.1 Overview scenarios

Scenario Conditions					
No.	***Scenario Name***	***Primary Actor***	***Triggering Event***	***Pre-Condition***	***Post-Condition***
1	Put on	Audience	Put on the equipment	NA	NA
2	Sound and vibrate	TV	Content starts	NA	NA
3	Adjust	Audience	Control the volume	NA	NA
4	Take off	Audience	Take off the equipment	NA	NA

B.4.2 Steps – Scenarios

Scenario								
Step No.	***Event***	***Name of Process/ Activity***	***Description of Process/ Activity***	***Service***	***Information Producer (Actor)***	***Information Receiver (Actor)***	***Information Exchanged***	***Requirements, R-ID***
Scenario Name:			**No. 1 – Put on**					
1	NA	NA	Audience puts on vibrotactile equipment.	NA	NA	NA	NA	NA
2	NA	NA	The Audience appropriately sets the vibrotactile gain.	NA	NA	NA	NA	NA
3	NA	NA		NA	NA	NA	NA	NA
4	NA	NA	Set-top box of IPTV provides the content including video, audio, and vibrotactile signals appropriately. TV presents video and audio signals (the music may be reproduced on loudspeakers), and the vibrotactile devices vibrate the audience's corresponding skin portion.	NA	NA	NA	NA	NA
5	NA	NA	Audience appreciates a new content experience with accompanying vibrotactile supports.	NA	NA	NA	NA	NA
Scenario Name:			**No.2 – Sound and Vibrate**					
6	NA	NA	When the content starts to play, the TV provides video and sound, and a vibrotactile signal to the equipment synchronized with the content on TV.	NA	NA	NA	NA	NA
7	NA	NA	Vibrotactile devices distinguish the vibrotactile signal appropriately, and vibrate the audience's corresponding skin portion in accordance with the creator's direction.	NA	NA	NA	NA	NA
8	NA	NA	Audience appropriates a high-presence TV experience that synchronizes sound, projection and vibrotactile presentations.	NA	NA	NA	NA	NA
Scenario Name:			**No.4 – Take off**					
9	NA	NA	Audience takes off the vibrotactile equipment.	NA	NA	NA	NA	NA
Scenario Name:			**No.3 – Adjust**					
*a	NA	NA	At any time, the audience manipulates the remote control to adjust the gain.	NA	NA	NA	NA	NA
*a1	NA	NA	Audience adjusts music/sound reproduction level or mutes.	NA	NA	NA	NA	NA
*a2	NA	NA	Audience adjusts vibrotactile reproduction level or stops the vibration.	NA	NA	NA	NA	NA

B.5 Information exchanged

Information Exchanged		
Name of Information (ID)	***Description of Information Exchanged***	***Requirements to information data***
Audio signal	For analogue audio, see IEC 61938. For digital audio, see IEC 60958 (all parts) and IEC 61937 (all parts).	NA
Vibrotactile signal	Polarity of vibrotactile signals is unified, where pulse swing of the signal pushes the skin.	NA
Vibration	Actuator may vibrate from 0,2 Hz to 10 kHz and sound.	NA

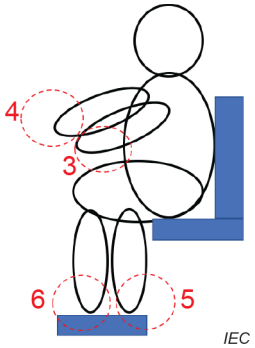
B.6 Requirements (optional)

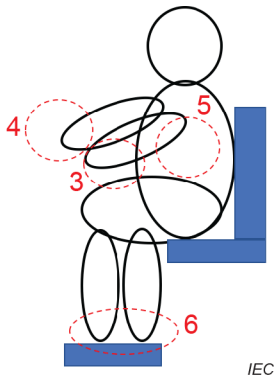
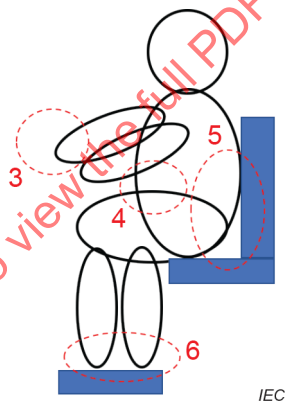
Requirements (optional)	
Categories for Requirement	***Category Description***
NA	NA
Requirement ID	***Requirement Description***
NA	NA

B.7 Common terms and definitions

Common Terms and Definitions	
Term	***Definition***
NA	NA

B.8 Custom information (optional)

Custom Information (optional)		
Key	***Value***	***Refers to Section***
Vibrotactile equipment for VR (e.g., taclim)	 1 Left loudspeaker 2 Right loudspeaker 3 Left hand actuator 4 Right hand actuator 5 Left foot actuator 6 Right foot actuator	

Custom Information (optional)		
Key	**Value**	**Refers to Section**
Vibrotactile equipment for gaming (e.g., hapbeat)	 IEC 1 Left loudspeaker 2 Right loudspeaker 3 Left hand actuator 4 Right hand actuator 5 Chest actuator 6 Foot actuator	
Vibrotactile equipment for TV (e.g., tactile TV)	 IEC 1 Left loudspeaker 2 Right loudspeaker 3 Hand actuator 4 Belly actuator 5 Back actuator 6 Foot actuator	