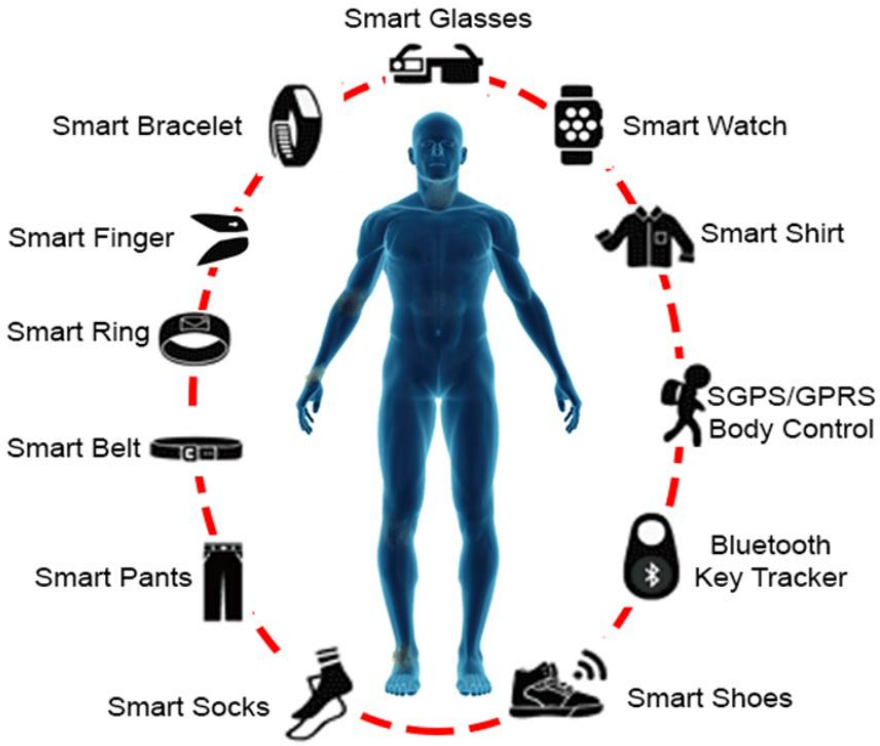
COMPENDIUM ON STANDARDIZATION FOR WEARABLE ELECTRONIC DEVICES AND TECHNOLOGIES



भारतीय मानक ब्यूरो

BUREAU OF INDIAN STANDARDS

उपभोक्ता मामले, खाद्य और सार्वजनिक वितरण मंत्रालय, भारत सरकार

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1. INTRODUCTION

Wearable electronic devices are compact, body-worn technological systems embedded with sensors, processors, and communication capabilities, designed to collect, process, and transmit data for various personal, professional, or health purposes. These are intended to be located '*near to*', '*on*', or '*in*', a human body. These include patchable materials and devices, implantable materials and devices, ingestible materials and devices, and electronic textile materials and devices.

Wearable Technologies are broadly classified into the following categories:

A. Patchable Materials and Devices:

Wearable patchable materials and devices are a type of wearable technology that can be applied directly to the skin like a patch to monitor, sense, or interact with the body.

Examples: Fever patches, ECG monitoring patch, smart drug-delivery patches etc.

B. Implantable Materials and Devices:

Implantable materials and devices are biocompatible systems that are surgically or non-surgically placed inside the human body to monitor, support, or enhance biological functions.

Examples: cochlear implants, glucose monitors, etc.

C. Ingestible Materials and Devices:

Ingestible materials and devices are miniaturized systems or substances designed to be swallowed to perform specific diagnostic, monitoring, therapeutic functions.

Examples: Ingestible bio-sensors

D. Electronic Textile Technologies

These are wearables integrated directly into fabrics or garments, often referred to as e-textiles. These are flexible, washable materials having sensors and circuits embedded or printed and are used in healthcare, sports and fashion.

Examples: Smart shirts with heart rate and respiration sensors, Heating jackets with embedded temperature control, Socks with pressure sensors, Athleisure wear that tracks muscle activity or hydration etc.

E. Wearable Devices

Wearable devices are electronic gadgets that are worn on the body to monitor, track, or enhance various aspects of a person's health, fitness, or daily activities. They are typically equipped with sensors, microprocessors, and wireless communication technologies.

Examples: Fitness trackers, Smart rings, Smart glasses etc.

2. WEARABLE STANDARDISATION - NATIONAL & GLOBAL EFFORTS

LITD 33 committee of Bureau of Indian Standards is the Bureau of Indian Standards' committee for Standardization in the area of Wearable Electronic Devices and Technologies. The Committee comprises of members from various stakeholders' groups coming from Government organization, industry, Academia, R&D institutes, Consumer organizations etc. The institutions like IIT Kanpur, IIT Delhi, IIT Madras, TCS, Titan Wearables, boaT, Apple, Samsung, Ministry of Electronics & IT, CSIR, etc. are active participants on this Committee.

Wearables being a technology which transcends boundaries, the LITD 33 committee works in sync with the International standardization work of IEC TC 124 'Wearable Electronic Devices and Technologies', committee of International Electro-Technical Commission (IEC). Experts from 25 countries, including India participate in the work of this technical committee.

3. WEARABLES - KEY TOPICS OF STANDARDISATION

- **Terminology**
- **Wearable Electronic Textiles**
- **Wearable Materials**
- **Wearable Devices**

3.1 Terminology:

i. IS/IEC 63203-101-1:2021 'Wearable Electronic Devices and Technologies - Terminology'

It provides the essential terminology for wearable electronic devices and technologies. It defines terms for devices located near, on, or in a human body, and for electronic textiles. It acts as a fundamental for anyone working with or referring to standards in this field, ensuring consistent language and understanding.

3.2 Wearable Electronic Textile:

ii. IEC 63203-201-1:2022 'Wearable electronic devices and technologies - Electronic textile – Measurement methods for basic properties of conductive yarns

It specifies test methods for basic properties of conductive yarns used in electronic textiles, such as those for transmitting signals or supplying power.

iii. IEC 63203-201-2:2022 'Wearable electronic devices and technologies - Electronic textile – Measurement methods for basic properties of conductive fabrics and insulation materials'

It specifies measurement methods for properties of conductive fabrics and insulation materials in electronic textiles. It is used for evaluating the basic conductive and insulating components of e-textiles that form parts of wearable devices.

iv. ***IS/IEC 63203-201-3:2021 'Wearable electronic devices and technologies – Electronic textile – Determination of electrical resistance of conductive textiles under simulated microclimate'***

It defines test methods for determining the electrical resistance of conductive textiles, specifically under simulated microclimate conditions. It is important for assessing how the electrical performance of conductive textiles is affected by environmental conditions encountered during wear.

v. ***IEC 63203-201-4:2024 'Wearable electronic devices and technologies – Electronic textile – Test method for determining sheet resistance of conductive fabrics after abrasion'***

It specifies a test method to measure the change in sheet resistance of conductive fabrics after undergoing abrasion. It is used to assess the mechanical durability of conductive fabrics and how abrasion affects their electrical conductivity in e-textiles.

vi. ***IS/IEC 63203-204-1:2023 'Wearable electronic devices and technologies – Electronic textile – Test method for assessing washing durability of e-textile products'***

It specifies test methods for evaluating the durability of e-textile products against washing processes. It is crucial for ensuring the long-term functionality of e-textiles which are intended to be laundered like conventional garments.

vii. ***IEC 63203-204-2:2025 'Wearable electronic devices and technologies – Electronic textile – Test method to characterize electrical resistance change in knee and elbow bending test of e-textiles'***

It defines a test method to characterize how the electrical resistance of e-textiles changes when bent, simulating movement at body joints like knees and elbows. It is used to evaluate the mechanical robustness and electrical stability of conductive elements within e-textiles under repeated bending stress.

viii. ***IS/IEC TR 63203-250-1:2021 'Wearable electronic devices and technologies – Electronic textile – Snap fastener connectors between e-textiles and detachable electronic devices'***

It provides insights into common connection methods for detachable components in e-textiles and highlights areas where further standardization is needed.

ix. ***IEC 63517 Wearable electronic textiles - Test methods for performance of heating products - Heating temperature and power consumption (under development)***

It outlines standardized test methods to assess the heating temperature and power consumption of wearable electronic textiles. It ensures consistent performance evaluation for safety, efficiency, and user comfort in heated textile products like jackets.

3.3 Wearable Materials:

i. IEC 63203-301-1:2024 'Wearable electronic devices and technologies – Test method of electrochromic films for wearable equipment'

It specifies test procedures and definitions for evaluating electrochromic films used in wearable equipment. It provides standardized methods for testing the performance and durability of electrochromic films used in applications like dynamic tinting in wearable devices.

3.4 Wearable Devices:

i. IS/IEC 63203-401-1:2023 'Wearable electronic devices and technologies – Devices and systems: functional elements – Evaluation method of the stretchable resistive strain sensor'

It specifies an evaluation method for stretchable resistive strain sensors, which are functional elements in wearable equipment. It is used to assess the performance, reliability, and durability of stretchable strain sensors integrated into wearable devices for applications like movement tracking or health monitoring.

ii. IEC 63203-402-2:2024 'Wearable electronic devices and technologies – Performance measurement of fitness wearables – Step counting'

It specifies test methods for measuring and evaluating the performance, reliability, and accuracy of the step counting feature in fitness wearables. It provides standardized procedures for manufacturers and consumers to assess how accurately fitness wearables count steps.

iii. IEC 63203-402-3:2024 'Wearable electronic devices and technologies – Performance measurement of fitness wearables – Test methods for the determination of the accuracy of heart rate'

It specifies test methods for measuring and evaluating the performance and accuracy of the heart rate measurement function in fitness wearables. It provides standardized procedures for testing the accuracy of heart rate monitoring features in fitness and health-related wearable devices.

iv. IS/IEC 63203-406-1:2021 'Wearable electronic devices and technologies – Test method for measuring surface temperature of wrist-worn wearable electronic devices while in contact with human skin'

It defines test methods for measuring the surface temperature of wrist-worn wearable electronic devices while they are in contact with human skin. It specifies standard conditions and methods for determining temperature rise due to the device's operation. It is essential for assessing the thermal safety of wrist-worn wearables that have prolonged contact with the skin.

v. PWI 124-9 Future IEC 63203-402-X: Wearable electronic devices and technologies - Performance of stress measurements in wearables (under development)

It establishes evaluation methods for the accuracy and reliability of stress monitoring features of fitness trackers. It supports the validation of physiological and psychological stress indicators, promoting trusted use in health and wellness applications.

vi. PWI 124-11 'IEC 63203-402-X: Wearable electronic devices and technologies - Performance Measurement of Fitness Wearables - Sleep Measurements' (under development)

It specifies methods to assess the accuracy and reliability of sleep tracking features in fitness wearables. It aims to ensure standardized evaluation of sleep stages and duration, supporting credible health insights for users.

vii. IEC 63203-402-X 'Wearable electronic devices and technologies - Performance Measurement of Fitness Wearables - Test methods of glove-type motion sensing products' (under development)

It defines test methods for evaluating the performance of glove-type motion sensing products used in fitness wearables. It focuses on measuring motion accuracy, responsiveness, and data reliability during physical activities.

3.5 Wearable Communications:

i. IS/IEC 63203-801-1:2022 'Wearable electronic devices and technologies – Smart body area network (SmartBAN) – Enhanced ultra-low power physical layer'

It specifies the enhanced ultra-low power physical layer (PHY) for Smart Body Area Networks (SmartBAN). It details PHY aspects such as packet formats, modulation, and forward error correction for wireless communication between wearable sensors and a hub.

ii. IS/IEC 63203-801-2:2022 'Wearable electronic devices and technologies - Smart body area network (SmartBAN) – Low complexity medium access control (MAC) for SmartBAN'

It describes MAC specifications including channel structure, frame formats, and functions for efficient wireless communication. It defines the specifications for how devices in a SmartBAN access and share the wireless medium, optimizing communication within wearable networks.

iii. PNW 124-323 Information Technology-Telecommunications and information exchange between systems - Wearable suit area network (WSAN) (under development)

This standard specifies communication protocols for Wearable Suit Area Networks (WSAN), enabling seamless data exchange between interconnected wearable devices. It supports reliable, real-time interaction for applications in health monitoring, sports, and augmented reality.

4. International Standardisation - Under India's leadership

Indian experts who are part of the BIS committee on Wearable Electronic Devices and Technologies have been actively contributing in the activities of IEC TC 124 in bringing out International Standards on "Wearable Electronic Devices and Technologies". Some of the International Standards have been conceptualized with in BIS committee and Indian experts have taken these further to the International Committee. Such projects are being developed as International Standards under the leadership of Indian experts. Some of these are as listed below:

a. ***PWI 124-12 'Future IEC 63203-80X-X: Wearable electronic devices and technologies - Mobile wearable device data security' (under development) [Project Leader: Dr. Sanjeev Singh, Delhi University]***

It focuses on establishing data security requirements for mobile wearable devices, addressing encryption, authentication, and secure communication. It aims to safeguard personal and biometric data handled by wearables in increasingly connected environments.

b. IEC 63203-203-1: Wearable electronic devices and technologies - Test method for measuring performance of fabric-based triboelectric generator (under development) [Project Leader: Dr. Bipin Kumar, IIT Delhi]

It ensures consistent assessment of energy harvesting capabilities in case of energy being generated through triboelectricity, supporting their practical applicability in powering low-energy wearable devices.

c. IEC 63203-203-2: Wearable electronic devices and technologies - Test method for measuring performance of fabric-based piezoelectric generator (under development) [Project Leader: Dr. Wazed Ali, IIT Delhi]

It ensures consistent assessment of energy harvesting capabilities in case of energy being generated through piezoelectricity to analyse the power generation performance under stretching, compression, and bending modes of electronic textiles, supporting their practical applicability in powering low-energy wearable devices.