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Power supplying scheme for wearable systems and equipment

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National foreword

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TECHNICAL REPORT

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Power supplying scheme for wearable systems and equipment

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COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POWER SUPPLYING SCHEME FOR WEARABLE SYSTEMS AND EQUIPMENT

FOREWORD

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IEC TR 63071, which is a Technical Report, has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
100/2751/DTR	100/2816/RVC

Full information on the voting for the approval of this technical report 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.

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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INTRODUCTION

Wearable devices are being introduced into the market, but each device employs its own power charging method and power source device. Wearable devices are used to support human life and health. The duration and life of the power source, as well as easy charging and replacing of a power source, is a crucial factor for wearable devices that are primarily powered by batteries. A power generator is one solution for this power duration or life, since it provides power generated by user activities and/or also from environmental sources. Also, connectivity and compatibility of power and data transmission is important.

This Technical Report does not specify the power generating or energy harvesting methods and devices themselves, but focuses on interoperability and measurement methods of power-suppling devices and systems.

POWER SUPPLYING SCHEME FOR WEARABLE SYSTEMS AND EQUIPMENT

1 Scope

This document provides models and frameworks for the power-supplying scheme for wearable systems and equipment. This document does not specify power generating or energy harvesting methods and the devices themselves.

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
energy harvest
technique to obtain energy from surroundings such as electric power from the activity of organisms

3.2
kinetic generator
generator that utilizes kinetic energy to generate electric power

4 System model

4.1 General

The power-supplying system for audio, video and multimedia systems and equipment can be applicable to wearable systems and equipment. Among them, the power supplying systems of energy harvesting devices or systems are suitable for the wearable devices because they generate energy.

Energy-harvesting devices or systems have already been used in various pieces of equipment such as electronic wrist watches. The existing model is described in 4.2.

4.2 Existing model

A major existing model of wearable equipment and power supply is the electronic wristwatch. Power supply methods for electronic wristwatches include:

- primary batteries,
- secondary batteries,
- solar cells with secondary batteries,

- a generator with a secondary battery.

To charge the secondary battery, wired power transfer is a common method. Its connector is for example a USB connector specified in the IEC 62680 series or other type of dedicated connector.

Wireless power transfer is not a common method for wristwatches, but it is applied for health band type wearable equipment that has also a watch function. However, wireless power transfer is not applied when a wristwatch is worn but applied when it is taken off and when it is charging.

Figure 1 shows the example of a solar cell with a secondary battery.

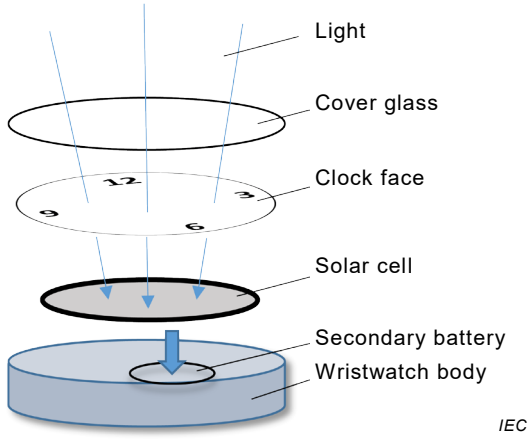

Figure 1 – Solar cell with a secondary battery wristwatch

Figure 2 shows the example of a kinetic generator with a secondary battery. The source of this generator is the arm movement. A variation of this type of generator is a stem winding method. It powers a spring that rotates a rotor.

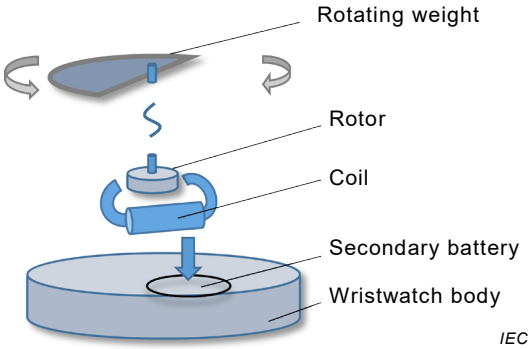

Figure 2 – Generator with secondary battery

4.3 System models of wearable devices

4.3.1 Wearable devices

Typical wearable devices are:

- wristwatches,
- eyeglasses,
- headsets,

- earphones,
- garments and textiles,
- shoes and gloves.

These wearable devices are powered by primary or secondary batteries. If the battery is a secondary battery, it needs to be recharged by electric power.

4.3.2 Charging and connections

When charging is necessary, it is carried out either while a wearable device is worn or when it is taken off. In case of a legacy wearable wristwatch, major charging shall be carried out when it is removed. In this case, charging is the same as the electronic wristwatch described in 4.2. The potential new application is charging when it is worn.

Charging when the wearable device is worn requires the live generation of electric power and a method for supplying the electric power to the client's wearable device. In the case of the wearable device incorporating the generator, the supplying of power and the control are executed with an internal connection, and no specific standard is needed.

When a wearable device and the power-supplying device are located in different parts of the user’s body, the existing technologies and standards can be considered to provide power and control. In the case where the power source and device are connected by wire, existing technologies and USB standards such as USB Type-C[1] specified in IEC 62680-1-3 can be suitable. In the case where a wireless connection is desired, industry technologies can be suitable for specific product designs. However, further study would be needed to determine feasibility of wireless charging standardization for on-body charging applications to study potential interoperability limitations between different physical product designs, locations of the wearable device and the power-supplying device, efficiency, stringent regulatory requirements for health and safety.

The content of this document includes:

- physical connection:
  - wired connector, cable or wireless connection;
- logical connection:
  - protocols for power supply and control, and information.

4.3.3 Generator utilizing physical activity of organism

There are various types of energy sources from the physical activity of an organism. Movement and other activities of an organism generate electric power called energy harvest. The activities of the body are:

- natural action or movement,
- intentional action or movement,
- pressure,
- thermal gradient,
- perspiration,
- any physiological phenomenon.

The energy-harvesting device or system converts these activities into electric power or any other kind of energy. These energy-harvesting devices or systems are, for example, solar

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[1] USB Type-C is the trademark of a product supplied by USB Implementers Forum. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

cells, Peltier elements, kinetic devices, chemical battery cells, MEMS devices and conventional motors used as generators.

This document does not mention these energy-harvesting methods and devices, because of concerns with respect to interoperability and measurement methods of the energy-harvesting device.

5 Use case

5.1 General

Any wearable device is the object of a power-supplying system. The existing major power supplying devices are a primary or secondary battery that needs changing or charging. Wearable devices need to work continuously as standalone and autonomous devices that require energy-harvesting power-supplying devices in order to be independent devices or systems.

Typical use cases are:

- watch, eyeglasses, earphones and sensor-type wearable devices that require power-supplying devices,
- power-supplying devices that are part of elements of wearable devices,
- standalone power-supplying devices with wired or wireless connections to wearable devices,
- garment or textile-type power-supplying devices with surface or membrane connection.

5.2 Use case examples

5.2.1 Generator in shoes

How to connect, transmit and control, as illustrated in Figure 3, could be the subject of standardization.

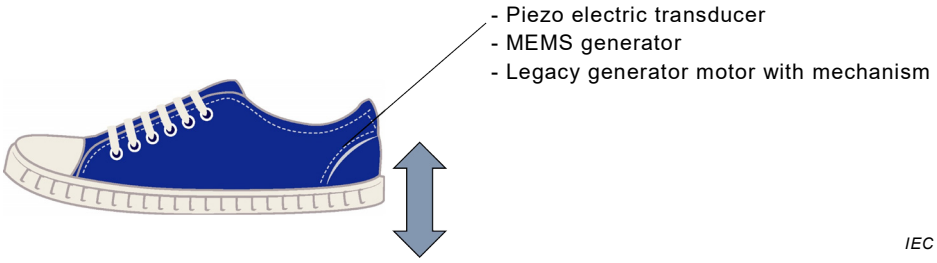

Figure 3 – Generator in shoe

5.2.2 Animal tracking

For animals, wearable devices, as illustrated in Figure 4, can be used for research purposes for their life and support. In this case, the generator is included in the wearable device because animals cannot take care of a device.

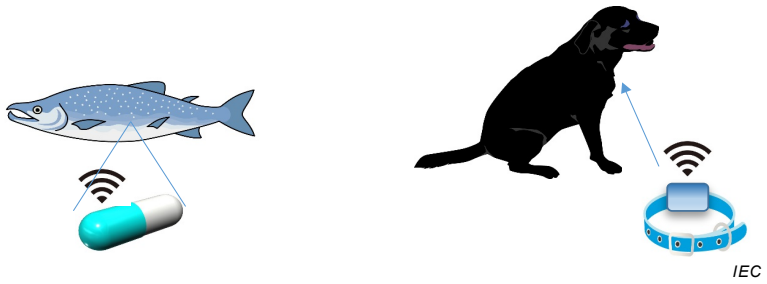

Figure 4 – Animal use

6 Interface

Interface specification for information, control and power transmission should be standardized. An existing standard is IEC 63002 that specifies an interoperability method for external power supplies.

It is desirable to standardise connectors, cables and other physical structures, however, standardization activities and use of standards depends on the market considerations and product applications. USB specified in IEC 62680-1-1, IEC 62680-1-3 and IEC 62680-2-2 are widely used standards for power transfer, and its control, information, connectors and cables can be suitable for various wearable devices. Based on small connector size, ease-of-use and flexibility, the USB Type-C™ will play a major role in wearable devices.

Wearable devices should be able to use many kinds of energy-harvesting devices. The items that should be standardized are:

- power control protocol and format,
- information on power devices and their power characteristics,
- and information on client devices and their power characteristics.

7 Measurement method

The measurement methods are also the items of specification of the energy harvesting device. To connect any energy harvesting device to any wearable device, a standard is required. Also, the measurement method is required. The major characteristics of energy-harvesting devices are that they may not always provide stable or continuous power.

Items of study are:

- power generation measurement:
  - average power,
  - intermittent power,
  - power delivery schedule,
  - environment condition appropriate for each energy harvesting method;
- power generation characteristics:
  - voltage, current, power;
- power duration and fluctuation:
  - short term,
  - long term;
- lifetime:

  - in various environments;
- power efficiency:
  - in various environments.

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