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TECHNICAL REPORT

Form factor of smart mobile devices – Part 1: Impact on multimedia services

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FOREWORD

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

Draft	Report on voting
100/4033/DTR	100/4067/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/publications.

A list of all parts in the IEC 63447 series, published under the general title *Form factor of smart mobile devices*, can be found on the IEC website.

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- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

Smart mobile devices (SMD) initially utilized communication services as a key element and are designed to interact both with users and other devices connected to the network. Along with advances in communication technology, various multimedia services other than communication are available on SMDs because of the developments in SMD hardware performance.

SMDs have changed and have become more compact to make it easier for users to use multimedia. For this purpose, hardware technology is developing.

This Technical Report introduces the main SMD form factors for multimedia services, explains how to design an effective SMD, and finally summarizes new work items to manage in TC 100 in the near future.

FORM FACTOR OF SMART MOBILE DEVICES –

Part 1: Impact on multimedia services

1 Scope

This document introduces various form factors of smart mobile devices and their impact on multimedia services.

It does not deal with:

a) SMD performance to process multimedia services;

b) hardware performance and technology for each part, such as the battery, the antenna, the display, the main processor, various sensors;

c) the characteristics of the SMD's operating system (Android[1], iPhone OS[2] etc.);

d) the generation characteristics of telecommunication and radio frequency (including wireless);

e) wearable devices, like smart watch, AR (augmented reality), VR (virtual reality) and so on.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

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

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

3.1.1
smart mobile device
SMD
portable device with computing, networking, and capabilities to provide multimedia services, which works independently and/or interactively with other devices

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1 Android is a trademark of a consortium of developers known as the Open Handset Alliance and commercially sponsored by Google LLC. 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

2 iOS (formerly iPhone OS) is a trademark of Apple Inc. 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.

3.1.2
form factor
hardware design aspect that defines and prescribes the size, shape, and other physical specifications of components, particularly in electronics

3.2 Abbreviated terms

AF	auto focus
AR	augmented reality
CMOS	complementary metal-oxide semiconductor
DA	display area
HDR	high dynamic range
IP	ingress protection
OIS	optical image stabilization
OS	operating system
OTT	over the top
PDA	personal digital assistant
SMD	smart mobile device
USI	Universal Stylus Initiative

4 Overview

4.1 General

Today's SMD technology has become so widespread that users often take for granted the ability to access multimedia content, take pictures, access information from around the world, map their locations, and more, all from the convenience of their handheld device.

There are arguably a few main technologies:

- smaller and ever-more efficient computer chips;
- wireless network infrastructure;
- advanced battery technology;
- high resolution display and sensitive touch screen.

4.2 SMD history

A device that featured an early touch screen and had the ability to send and receive emails and faxes was available as a first personal communicator in 1994, named “Simon”. It was an important demonstration of what was possible.

In 2007, the physical keyboard-less smartphone was lunched, named “iPhone®[3]”. This device used only a touchscreen for typing and navigation functionality, instead of the physical trackball or keyboard form factor, also the antenna was embedded in the phone.

In 2018, there was a brief period of interest in foldable SMDs, which are devices with in-foldable or out-foldable displays. One such foldable SMD had a large inner display that could be folded up, with a secondary display on the front.

[3] iPhone® is a trademark of Apple Inc. 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.

As SMD hardware (such as batteries, displays, and housing cases) continues to develop, we can expect to see rollable and slidable SMDs in the market in the near future.

4.3 Usage trends of SMD

Early on, smartphones, which are one type of SMD, were marketed primarily towards the enterprise market, attempting to bridge the functionality of standalone PDA devices. Nowadays, SMDs come equipped with high-speed processors, cinematic cameras, high-resolution displays, and various sensors, such as accelerometers, light sensors, orientation sensors, LiDAR, and more [1][4]. As a result, the use of these devices is becoming increasingly widespread.

Most SMDs feature thin and slate-like form factors with large capacitive screens that support multi-touch gestures, rather than physical keyboards. They offer users the ability to download or purchase additional applications from a centralized store, use online storage and synchronization, virtual assistants, and mobile payment services. The display of the SMD has become increasingly larger and it has a high screen-to-body ratio – it is called the display area (DA) – as the bezel is thinner.

According to a report released by the market research company eMarketer, many smartphone users turned to their devices to find information, entertainment, and human connection, albeit remotely. As a result, time spent on devices has gone up across the board to enjoy multimedia. For example, people spent an average of 49% of total SMD usage time on audio and video services in 2021 as indicated in Figure 1 [2].

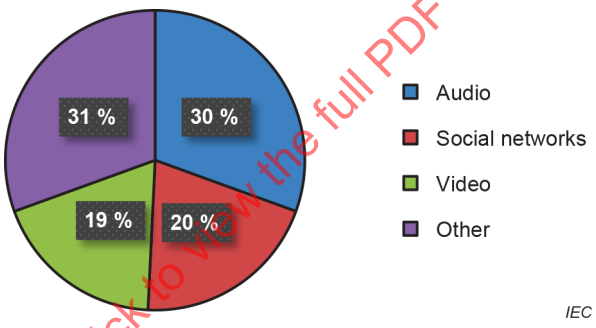


Figure 1 – Percentage of average SMD usage time per media in the USA

In 2020, roughly 3 hours and 40 minutes that people aged 16 to 64 spend using smartphones per day are spent using social and communications applications in the world and the average time spent on video and games is 30 %, as shown in Figure 2 [3]. There are some variations depending on countries where it is very different with internet users in Japan spending an average of just 45 minutes per day using social media while, in one area in the USA, many users spend 3 hours and 53 minutes using social media.

4 Numbers in square brackets refer to the Bibliography.

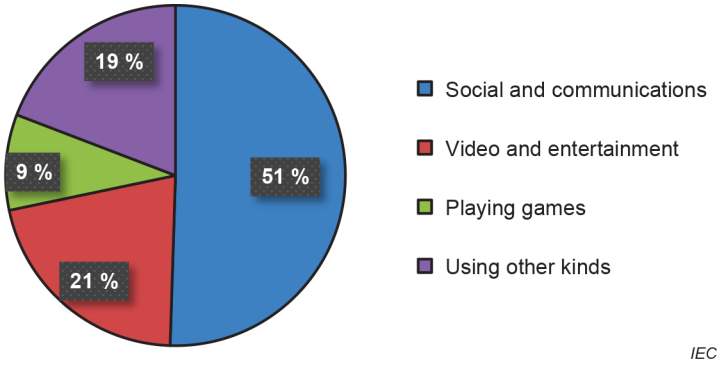


Figure 2 – Percentage of average time spent with media in the world (smartphone)

There are three main factors driving the growth of SMDs.

The first is the advancement of mobile networks and the rapid development of terminals. The establishment of the environment has expanded as the service of the mobile industry has shifted from voice-oriented to data communication (non-voice), and the bandwidth of the network has also wider and faster speed. In addition, device components such as the appearance of high-performance processors, high-resolution cameras, and a display have also become highly functional.

The second is that the entry barrier of the SMD has been lowered through the advancement of the oriented mobile OS, which has reduced SMD development costs and shortened the development process. And by using a mobile OS, the compatibility of the device has improved.

The third is that the competitiveness of SMDs has been shifted from hardware to applications through the reinforcement of software development environment.

As the trend shifted towards multimedia devices that use various applications beyond the purpose of phone calls, the hardware configuration of SMDs also developed accordingly. In addition, SMDs are equipped with waterproof and dustproof functions, enabling video shooting in underwater or dusty environments. As the frequency of use increased in various environments, the stress factor also increased, and an instrument was designed to strengthen the durability and configure a form factor that is easy for users to handle.

4.4 Multimedia services

The SMD is equipped with functions for taking, editing, and uploading pictures instantly. The latest SMD models support various photographing modes using a large main sensor and a more improved zoom camera. One of them, the night mode, allows for capturing low-noise and ultra-wide angle pictures. In addition, the video recording function has improved, providing an HDR photographing function with a resolution of 4K or more. The SMD also comes with editing functions such as removing unwanted objects, reducing noise and correcting faces, making it easy for users to edit pictures.

For the video content, according to new research, despite the widening availability of 'TV Everywhere' services, SMD (tablet PC) owners are significantly more likely to use OTT service applications than those offered by both TV networks and operators. Almost half (48 %) of adult tablet owners report using OTT video applications on occasion, compared with 37 % that use broadcast network applications, 31 % that use cable network applications, and 23 % that use TV operator applications [4].

Drawing-related application program performance using digitizers on PCs can be drawn in detail or written directly using SMDs and an active stylus pen. Various touch hardware functions and applications, described in 5.3, can be used to obtain the effect of drawing on actual paper.

The method of entering a signature on a document is to sign and scan the printed document directly, or to make only the signature part into an image file and insert it in the corresponding location of the document, or to sign using a digitizer. However, if you can enter a pen into the SMD, you can directly sign the document displayed on the SMD screen as if signing on paper.

5 Impact of SMD form factors on multimedia services

5.1 Camera

The camera is an important component in the form factor of SMD and has a great influence on multimedia services. A multimedia function of SMD is strengthened, and one of the biggest changes is the camera. With a physically small CMOS size and short focal length, due to the thickness of the SMD, cameras were initially used for information acquisition, but as the CMOS size grew, high resolution and low noise levels and several lenses were installed, cameras using multiple CMOS array were designed, as shown in Figure 3. For example, one of the three has 1,9 µm pixel size and sensor-shift OIS and dual pixel AF functions on a 12 mega pixel sensor, and another camera that can shoot the ultra-wide range is the same CMOS as the major camera, with a lower f value and a closer shot. The other camera is designed to allow telescopic photography.

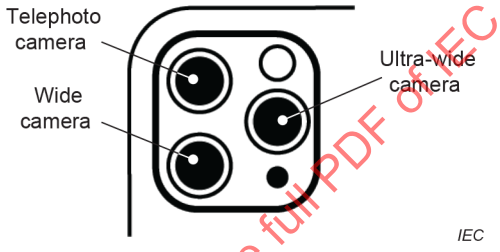


Figure 3 – Cameras in SMD

Products that maintain SMD thickness and apply a lens configuration that refracts light in the form of Figure 4 to overcome a short focal length are also being released. Consumer complaints are high as the protruding shape of the camera has emerged as a disadvantage that undermines the design of the SMD, but the camera part of the SMD remains protruding due to technical limitations to improve camera performance. If more advanced technologies are applied in the future, it is expected that the size of the prominent shape will be reduced or be completely flat.

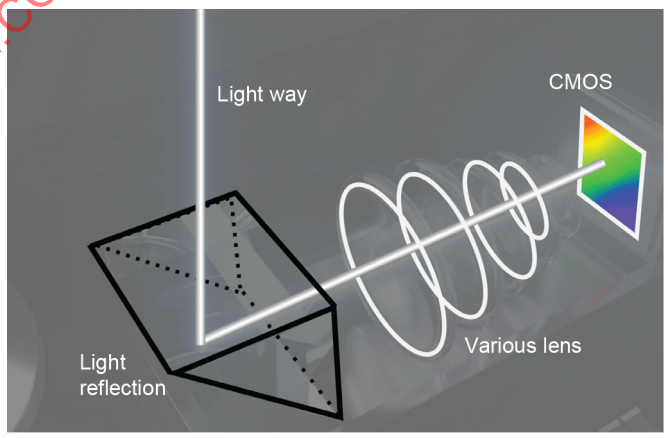


Figure 4 – Example of camera lens structure to reduce the prominent shape

Cameras from various SMDs released in 2021 can easily shoot high-definition multimedia images as they respond to 8K resolution, satisfy HDR for sensitivity, and enable high-speed frame shooting.

In addition, pop-up camera and rotating camera products, which can only be seen when camera functions are needed to enhance DA, were introduced. The forms of these cameras are shown in Figure 5 as an example.

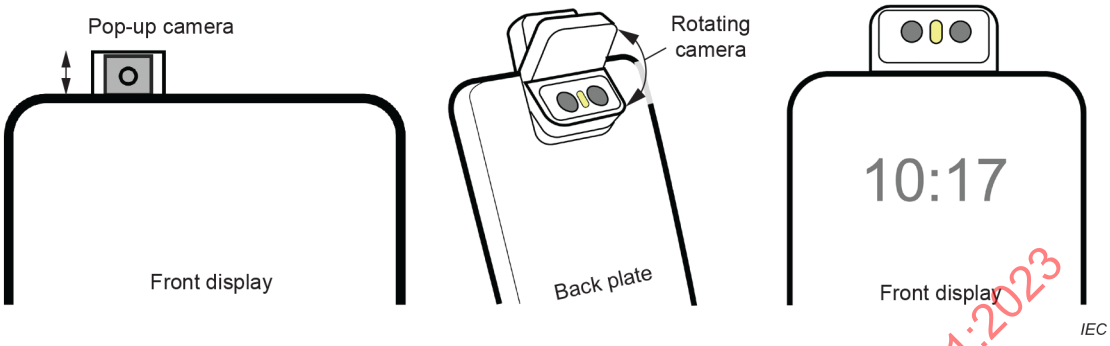


Figure 5 – Example of changeable front camera structure

5.2 Display

5.2.1 Display size changes

With the development of SMD technology, the part where the most changes and developments have continued is the display, which is an important core form factor especially in the multimedia services area. As the display area keeps increasing, the front buttonless rigid shape has become the classic form factor of SMDs. In 2019, an SMD with a foldable display was launched on the market. With the steady release of products, the market share of foldable display SMDs is increasing. Also, SMDs which have rotational and foldable functions with dual displays were also launched on the market.

The screen placed in front of the SMD is expanding every year. The displays used in the initial SMD were mainly 10,16 cm or less in size, and a bezel of some thickness was required. However, with the advantage of allowing users to perform tasks faster and the expansion of the range of use to view various contents on SMD, they have pursued a wide screen. Manufacturers are also adopting wider displays, and as of 2021, displays from 12,7 cm to 15,24 cm are being used.

As the size of the display increases and the width of the bezel decreases, the proportion of the display area to the SMD area is high. Figure 6 shows the trend of change in display size among changes in SMD display trend.

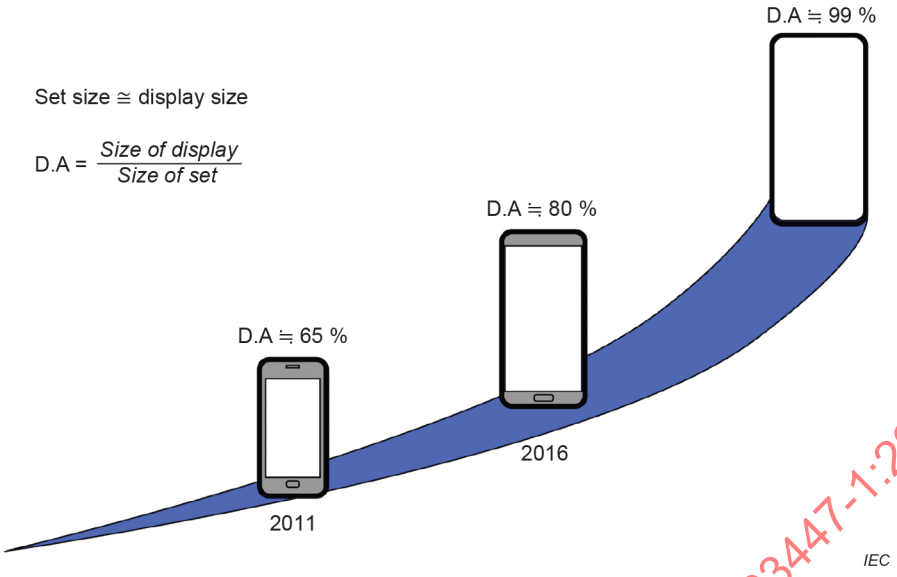


Figure 6 – SMD display trend

5.2.2 Various screen form factors

The display's cover window is glass and the SMD is rigid, but the display panel is a film material, so the notch type, pin-hole, teardrop, and dual punch-hole display, in which all set areas except the camera area are screen areas, have been released. The concepts are shown in Figure 7, Figure 8 and Figure 9.

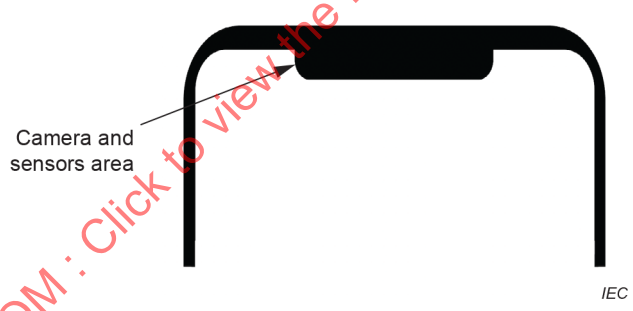


Figure 7 – Notch display

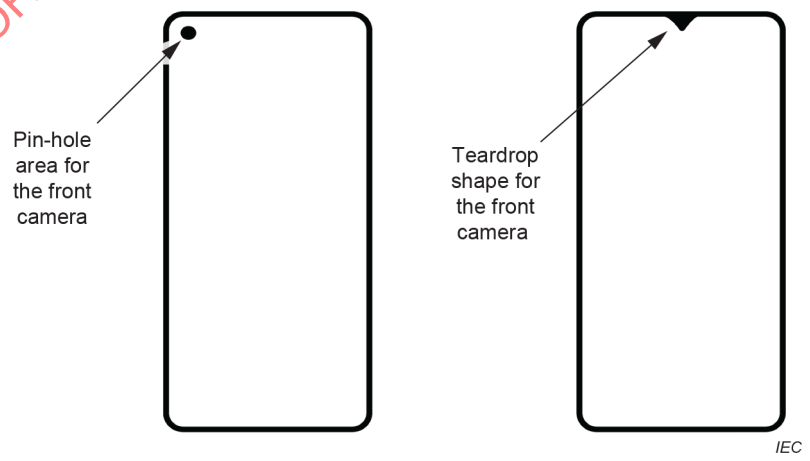


Figure 8 – Pin hole and teardrop display

Figure 9 – Dual punch hole display

5.2.3 Deformable screen

Since a flexible display was launched on the market, it has been adopted in SMDs in various forms. The SMDs with the deformable display are different from the existing rigid flat structure. This foldable SMD that can be folded and unfolded with a single screen in half like a book to display multimedia contents at the intended form. Also, the interaction form can vary depending on the folding configuration.

The foldable SMD requires bending materials. Typically, it is essential to use a foldable display and hinge. The foldable SMD can be categorized into an in-folding method (the screen is folded inward), an out-folding method (the screen is folded outward), and a multi-folding method (the screen is folded G type and Z type) in the direction. There are various folding types as shown in Figure 10. An in-folding SMD could have an additional display to give or take information when it is folded.

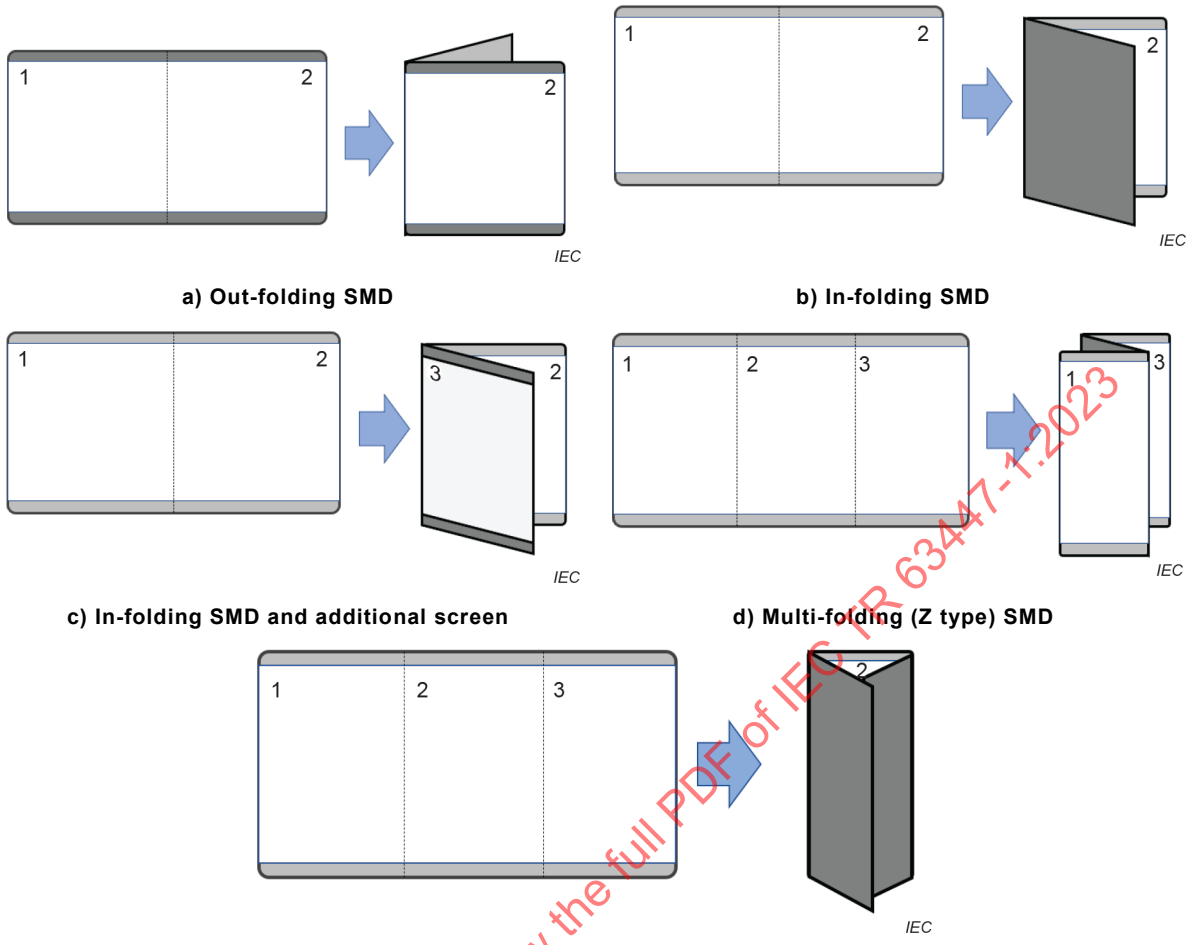


Figure 10 – Various SMD folding types

With the release of the folding SMD "foldable", a rollable SMD that rolls a display with an elongated bar type is likely to follow. The basic concept of the rollable screen SMD is intended to be easily used by varying the shape and size of the display according to the usage purpose and environment. The rollable screen SMD has the advantage of having a screen that can be changed to a variable size, unlike that of the foldable one, as shown in Figure 11.

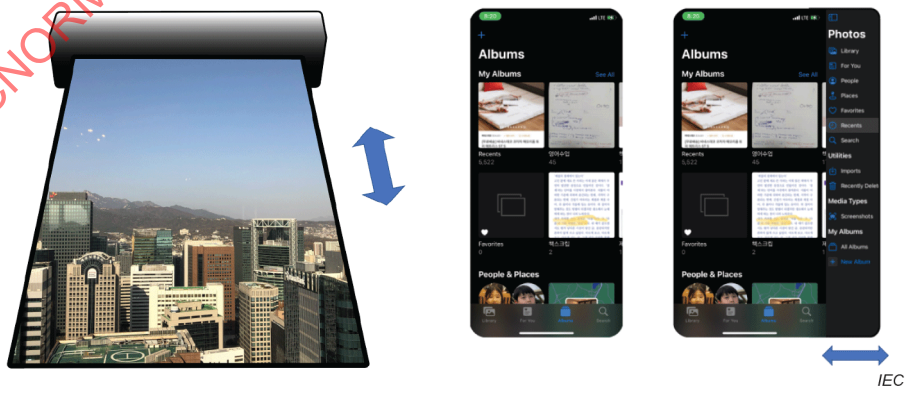
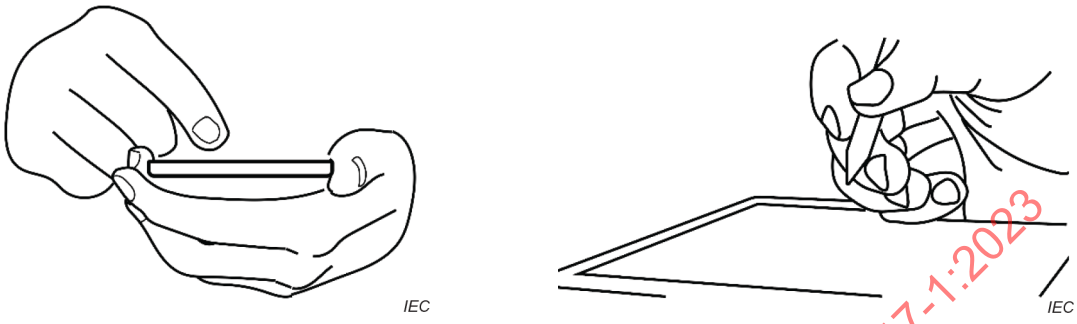


Figure 11 – Usage example of rollable SMD

5.3 Touchscreen

The multi-touch action of using fingers and pen on the screen is one of the important interactions with the SMD form factor. With the development of touchscreen technologies, the user could

use multimedia applications more intuitively. It could play the role of displaying information for the output and simultaneously performing keypad and pen writing functions as input devices. There are various applications to draw pictures, write letters and do multi-touch actions with two or three fingers for screen controls, like zooming in and zooming out a map. Figure 12 shows examples of touching with a finger or a pen touch.



a) Finger touch on the screen **b) Pen touch on the screen**

Figure 12 – Example of finger touch and pen touch

IEC TR 62908-1-3 published in 2021 describes pen touch technology and characteristics [5]. The types of touch pens can be classified. In Table 1, the first category is whether the pen has an electrical circuit or not. The next category is the method of detecting the pen touch. In addition, there are two types: one-way communication (unidirectional) and two-way communication (bidirectional) with the pen and the detection panel or the system side.

Table 1 – Classification of touch pen

Circuits Built-in or not	Pen touch sensing method	Pen type/ protocol	Uni/Bi-directional
Passive pen (Without circuits)	Resistive	General commercial pen	Unidirectional
	PCAP	General commercial pen	Unidirectional
Active pen (Built-in circuits)	PCAP	Type MPP (Microsoft Pen Protocol)	Bidirectional
		Type AP (Apple Pencil)	Bidirectional
		Type U (USI)	Bidirectional
		Universal pen	Bidirectional

5.4 Waterproofness

In recent years, SMDs have waterproofness as a key design feature, because up to 20 % of all SMD damage occurs because of immersion or contact with a liquid [6]. IEC 60529 provides the user with a more detailed guide, which rates their dust and water resistance using the IP (ingress protection) rating code [7].

To improve the durability of SMD components, various R&D results have been achieved. For example, charging a terminal, connecting a data port, and an earphone jack are made of nickel and platinum, which do not corrode with water. Additionally, rubber is used between the internal parts to prevent water from entering between external connection terminals. In addition, joints such as a display and a rear integrated back cover (external case) are filled with rubber packing.