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SERIES K: PROTECTION AGAINST INTERFERENCE

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### **Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use**

ITU-T K-series Recommendations – Supplement 13

ITU-T



## Supplement 13 to ITU-T K-series Recommendations

### Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use

#### Summary

Modern mobile devices may be used for many different purposes. There are differences between the ways of using them depending on the service. Also, the exposure to radio frequency electromagnetic field (RF-EMF) is different depending on the service, environment and the conditions of the use of the mobile devices. This Supplement describes various factors that determine the level of RF-EMF exposure, as defined by the specific absorption rate (SAR) that is induced in the users of mobile and portable radiocommunication devices. Based on this technical information, practical information and guidance is provided for users of mobile devices.

#### History

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#### Keywords

Mobile phones, portable devices, SAR.

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## Introduction

Users of a mobile or portable telecommunications device are exposed to the radiofrequency electromagnetic fields that are transmitted by the device. These RF-EMF transmissions are necessary to convey the communication signals (voice or data) between the device and its corresponding wireless network.

External exposure from a device induces RF-EMF in the person using it, which in turn causes tissue heating due to dissipation of the absorbed RF energy. This internal exposure is commonly characterized as the specific (energy) absorption rate (SAR) in units of W/kg for frequencies below 6 GHz. SAR is distributed in a very non-uniform way inside the body and is typically greatest in those parts of the body closest to the device. At higher frequencies, energy is deposited superficially and the basic restrictions are given in terms of power density (W/m<sup>2</sup>) [b-ICNIRP, 1998].

Questions about device SAR generally relate to heating of the skin, brain and eyes when the device is used in talk mode against the head, or to the skin and organs of the torso when the device may be transmitting data while attached to the hip or chest. Due to low levels of output power from devices the whole body SAR is in compliance with international standards and guidelines such as [b-ICNIRP 1998] and [IEEE C95.1]. The RF-EMF exposure from the uplink signal (mobile phones and portable devices) is generally larger than the downlink (base stations).

There is a broad international consensus that device SAR should not exceed basic restriction limits that are specified in recognized international standards and guidelines such as [b-ICNIRP 1998] and [IEEE C95.1]. The SAR limits are specified as mass averages (e.g., averaged over any 10g cube of tissue) and time averages (typically over 6 minutes) in recognition of the thermal inertia and thermal diffusion characteristics of body tissues. Lower SAR limits are specified for SAR induced in the head and torso of the body compared to its extremities (arms, legs and outer ear) in order to provide a higher level of protection for temperature sensitive and critical organs. In addition, the extremities experience wider ranges of temperature in everyday activities.

Standardized techniques for the assessment of device SAR are provided in [IEC 62209-1] for exposure to the head and [IEC 62209-2] for exposure of the torso.

In Factsheet 193 [b-WHO] the World Health Organization (WHO) states that "no adverse health effects have been established as being caused by mobile phone use" and "the electromagnetic fields produced by mobile phones are classified by the International Agency for Research on Cancer (IARC) as possibly carcinogenic to humans (Group 2B)<sup>1</sup>, a category used when a causal association is considered credible, but when chance, bias or confounding cannot be ruled out with reasonable confidence".

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<sup>1</sup> The list of agents classified in Group 2B may be found in [http://monographs.iarc.fr/ENG/Classification/latest\\_classif.php](http://monographs.iarc.fr/ENG/Classification/latest_classif.php).

## Supplement 13 to ITU-T K-series Recommendations

### Radiofrequency electromagnetic field (RF-EMF) exposure levels from mobile and portable devices during different conditions of use

#### 1 Scope

The types of mobile and portable telecommunication devices considered in this Supplement are consumer items in common use by the general public including mobile phones, cordless phones, tablets, phablets and satellite phones.

Taking into account WHO documents and other ITU-T Recommendations on this subject, information is provided that explains the factors affecting personal exposure during the use of mobile and portable device and how this relates to the provision of communications functionality.

The absorption of RF-EMF energy due to devices used close to the head or body is currently assessed relative to specific absorption rate (SAR) limits for frequencies from 300 MHz to 6 GHz. Further information on the assessment of SAR for mobile devices is provided in clause 6.5 of [ITU-T K.91]. Standardized techniques for the assessment of device SAR are provided in [IEC 62209-1] for exposure to the head and [IEC 62209-2] for exposure of the torso. The SAR measurement methodologies are designed to be conservative for mobile device users. The level of SAR induced in the user of a mobile device varies dynamically. The range of considered factors that influence the level of SAR induced from devices includes: technical aspects of the devices and their corresponding networks; usage patterns of the device; how the device is held against the body; and the physical characteristics of the body. Additional information is provided to minimize misconceptions concerning the use of mobile devices and additional equipment.

#### 2 References

- [ITU-T K.52] Recommendation ITU-T K.52 (2018), *Guidance on complying with limits for human exposure to electromagnetic fields.*
- [ITU-T K.70] Recommendation ITU-T K.70 (2018), *Mitigation techniques to limit human exposure to EMFs in the vicinity of radiocommunication stations.*
- [ITU-T K.91] Recommendation ITU-T K.91 (2018), *Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields.*
- [ITU-T K-Sup.14] ITU-T K-series Recommendations – Supplement 14 (2018), *The impact of RF-EMF exposure limits stricter than the ICNIRP or IEEE guidelines on 4G and 5G mobile network deployment.*
- [IEC 62209-1] IEC 62209-1:2016, *Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz).*
- [IEC 62209-2] IEC 62209-2:2010, *Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).*
- [IEEE C95.1] IEEE C95.1:2005, *Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic and Electromagnetic Fields,) Hz to 300 GHz.*

## 3 Definitions

### 3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

- 3.1.1 **antenna** [ITU-T K.70]
- 3.1.2 **antenna gain** [ITU-T K.70]
- 3.1.3 **average (temporal) power ( $P_{avg}$ )** [ITU-T K.52]
- 3.1.4 **averaging time ( $T_{avg}$ )** [ITU-T K.70]
- 3.1.5 **basic restrictions** [ITU-T K.52]
- 3.1.6 **body mounted device – body worn device** [IEC 62209-2]
- 3.1.7 **controlled/occupational exposure** [ITU-T K.70]
- 3.1.8 **continuous exposure** [ITU-T K.52]
- 3.1.9 **electromagnetic field (EMF)** [ITU-T K.91]
- 3.1.10 **exposure** [ITU-T K.52]
- 3.1.11 **exposure level** [ITU-T K.52]
- 3.1.12 **exposure limits** [ITU-T K.70]
- 3.1.13 **exposure level** [ITU-T K.52]
- 3.1.14 **exposure, non-uniform/partial body** [ITU-T K.52]
- 3.1.15 **general population/uncontrolled exposure** [ITU-T K.52]
- 3.1.16 **general public** [ITU-T K.52]
- 3.1.17 **hand-held device (mobile handset)** [IEC 62209-2]
- 3.1.18 **near-field region** [ITU-T K.52]
- 3.1.19 **power density (S)** [ITU-T K.52]
- 3.1.20 **radio frequency (RF)** [ITU-T K.70]
- 3.1.21 **specific anthropomorphic mannequin (SAM)** [IEC 62209-1]
- 3.1.22 **short-term exposure** [ITU-T K.52]
- 3.1.23 **specific absorption rate (SAR)** [ITU-T K.52]
- 3.1.24 **transmitter** [ITU-T K.70]
- 3.1.25 **whole-body-exposure** [IEEE C95.1]
- 3.1.26 **workers** [ITU-T K.70]

### 3.2 Terms defined in this Supplement

This Supplement defines the following term:

- 3.2.1 **discontinuous transmission (DTX)**: A method of momentarily powering-down, or muting, a mobile or portable radiocommunication device when there is no voice input to the device.

## 4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

APC          Adaptive Power Control

|       |                                        |
|-------|----------------------------------------|
| BS    | Base Station                           |
| CDMA  | Code Division Multiple Access          |
| DTX   | Discontinuous Transmission             |
| EM    | Electromagnetic                        |
| EMF   | Electromagnetic Field                  |
| LTE   | Long Term Evolution                    |
| MMS   | Multimedia Messaging Service           |
| RF    | Radio Frequency                        |
| rms   | Root Mean Square                       |
| SAM   | Specific Anthropomorphic Mannequin     |
| SAR   | Specific Absorption Rate               |
| WCDMA | Wideband Code Division Multiple Access |
| Wi-Fi | Wireless Fidelity                      |

## 5 Conventions

This Supplement uses the following conventions:

|                  |                                                                                                      |
|------------------|------------------------------------------------------------------------------------------------------|
| device           | Any mobile or portable radiocommunication device as described in the scope of this Supplement.       |
| $\rho$           | tissue mass density in units of kg/m <sup>3</sup>                                                    |
| $\sigma$         | tissue conductivity in units of S/m                                                                  |
| $E_{\text{int}}$ | Internal electric field induced inside the body from exposure to device RF-EMF in units of V/m (rms) |

## 6 Information for users of mobile devices

This clause provides information for users of mobile devices on factors that affect RF-EMF exposure and related topics. Many of these factors are outside the direct control of users. The technical rationale supporting this content is provided in clause 7 and associated references. Mobile devices are designed to comply with international exposure limits for the public. These exposure limits are intended to ensure protection for all members of the public even in the case of continuous exposure, 24 hours a day, 365 days per year. When a mobile device is used to make a voice call the output power is adjusted depending on the network connection through a process called adaptive power control.

### 6.1 Voice connection

The process of adaptive power control is more sophisticated for newer mobile technologies. For a GSM phone the average output level is about 20-50% of the maximum. Whereas, for a 3G or a 4G mobile device the average level of output power is about 1% of the maximum during a voice call [b-Gati 2009], [b-Persson 2012] and [b-Joshi 2017].

### 6.2 SMS, MMS and Internet

For an SMS, the duration of transmission is very short and so the exposure is very low. The same is true for a multimedia messaging service (MMS). When browsing the Internet, most of the data is being downloaded and so the mobile device is only transmitting control information. If data is being uploaded, such as sending an email, more energy may be transmitted as more information is being

