VIEWPOINT
MWF Mobile & Wireless Forum

SAR Measurement Conservativeness

The SAR value[1] is a measure of the amount of RF power absorbed by body tissue when using a mobile or wireless device. The SAR limits in many countries are based on guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)[2] or the Institute of Electrical and Electronics Engineers (IEEE)[3]. To demonstrate compliance with these limits, devices are tested under laboratory conditions according to measurement standards[4] which prescribe the testing positions and all operational characteristics of the mobile phone including testing using the maximum possible transmit power.

As a result of the conservativeness of the measurement standards, SAR values reported for each model significantly overstate real-life exposure levels. In reality, devices operate at significantly lower power levels, adapting constantly to use the minimum power required to make and receive a call, in order to maximize battery life. Additionally, many current devices utilize proximity sensors that reduce transmit power when it detects the device is close to the user's body.

Several studies of mobile phones in everyday use around the world have all shown that phones typically operate at a small fraction of the phone's maximum power output. For instance in a paper on 4G devices[5], the authors concluded:

> *The output power levels were found to be significantly below the maximum possible power, with the mean output power being less than 1% of the maximum for all considered environments.*

This was consistent with earlier studies on 3G devices[6,7] while for 5G devices,[8] the authors found:

> *…(t)he 95th percentile, the mean and the median values were found to be less than 8%, 2% and 1% respectively, of the maximum UE transmission power.*

In each of these studies, representing a large variety of typical usage conditions i.e., in city, urban, rural, indoor, outdoor environments and with voice and/or data connections, the results all show that devices typically operate at a small fraction of the phone's maximum power output as tested for under compliance testing conditions.

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[1] SAR stands for Specific Absorption Rate (SAR). Detailed information on SAR can be found at http://www.sartick.com
[2] ICNIRP Guidelines For limiting exposure to electromagnetic fields (100 kHz - 300 GHz) *Health Physics* 118(5): 483–524; 2020 https://www.icnirp.org/cms/upload/publications/ICNIRPrfgdl2020.pdf
[3] IEEE Std C95.1™-2019 "IEEE Standard for Safety Levels With Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz" https://ieeexplore.ieee.org/document/8859679
[4] SAR compliance testing of mobile phones is carried out using the standardized protocol described in IEEE/IEC 62209-1528:2020[4], which is part of the safety standards being reviewed every few years to ensure that they remain relevant in face of new technological developments. The International Electrotechnical Commission (IEC) is the world's leading organization that develops and publishes international standards for all electrical, electronics and related technologies. The IEC standards are developed by nominated experts of national committees - from research labs, governmental agencies, academia, industry, commerce, and consumer groups.
[5] P. Joshi, D. Colombi, B. Thors, L. E. Larsson and C. Törnevik, "Output Power Levels of 4G User Equipment and Implications on Realistic RF EMF Exposure Assessments," in IEEE Access, vol. 5, no., pp. 4545-4550, 2017. doi: 10.1109/ACCESS.2017.2682422
[6] Persson et al., Output power distributions of terminals in a 3G mobile communication network Bioelectromagnetics., Vol. 33, Pg. 320 - 325, 2012
[7] Dragan Jovanovic et al, Mobile telephones: A comparison of radiated power between 3G VoIP calls and 3G VoCS calls, Journal of Exposure Science and Environmental Epidemiology (2015) 25, 80–83
[8] P. Joshi, F. Ghasemifard, D. Colombi and C. Törnevik, "Actual Output Power Levels of User Equipment in 5G Commercial Networks and Implications on Realistic RF EMF Exposure Assessment" in IEEE Access, vol. 8, pp. 204068-204075, 2020. Doi:10.1109/ACCESS.2020.3036977