



RADIATION HEALTH IMPLICATIONS OF THE USE OF MOBILE PHONES

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ABSTRACT

Mobile phone (also known as Global system for mobile communications (GSM), cellular phone, cell phone and hand set) is a device that can make and receive telephone calls over a radio link. Telecommunication industry is experiencing a robust growth on a global scale and cell phones are becoming essential tools in the global modern society. This paper discusses the health implications of mobile phones such as thermal and non-thermal radiation effects. It also highlights the methods of evaluating average exposure using statistical tools, and using digital signal processing techniques called Fast Fourier Transform in examining the effect of electromagnetic radiations on human brain. With respect to radiation from cell phone, it is found from literature that the rate at which energy is absorbed by the human body is measured by the specific Absorption rate (SAR) so as to avoid various health problems such as deafness, migraines, high blood pressure, brain cancer, etc.

Keywords: Phones, radiation, communication, radio frequency, cancer

INTRODUCTION

The telecommunication industry is experiencing a robust growth on a global scale and cell phones are becoming essential tool in the global modern society as they allow people to maintain constant and continuous communication without hampering their freedom of movement. Since the introduction of cell phones in the mid - 1980's, there has been significant increase in the number of cell phone users and installations of base stations. As of 2005, statistics showed that there were 1.6 billion cell phone subscribers worldwide (Iftekhhar and Jannatul, 2010). Though phone manufacturers, regulatory agencies and service providers assure that cell phones are safe, the global debates and controversy over the health effects of these products continue. Several studies on health effects present irrefutable evidence confirming that increased occurrences of some symptoms

and diseases are directly related to the exposure of cell phone operating frequencies and output power levels.

An Independent expert group in UK in April, 2000 issued a report on Mobile phone effects on health based on rigorous assessment of research in this area. This report showed no evidence of the impact of mobile phones to human health. However a number of studies have been carried out to confirm this research work (Abdullah, 2003).

The World Health Organization reported that the agency will now list mobile phone use in the same "carcinogenic hazard" category as lead, engine exhaust and chloroform. Cell phones use non-ionizing radiation, which doesn't damage DNA the way ionizing radiation does. The cell phone radiation operates more like very low power microwaves (WHO, 2011). Safety is a legitimate concern of the users of wireless equipment, particularly, in regard to possible hazards caused by electromagnetic (EM) fields.

There has been growing concern about the possible adverse health effects resulting from exposure to Radiofrequency Radiations (RFR), such as those from mobile communication devices. Mobile communication is where signal is transferred via electromagnetic wave through radio frequency and microwave signals (Iftekhhar and Jannatul, 2010). This signal produces electromagnetic radiation in the form of thermal radiation that consists of harmful ionizing radiation and harmless non-ionizing radiation. When using mobile phone, electromagnetic wave is transferred to the body which causes health problems especially at the place near ear skull region where they are known to affect the neurons. The radiations interfere with the electrical impulses that two neurons connect each other with. This can lead to deafness and migraines. People using cell phones are prone to high blood pressure and other symptoms such as hot ears, burning skin, headaches and fatigue (Aruna et al, 2011).

There have been various studies into the connection between mobile phones and memory loss. Because of their smaller heads, thinner

skulls and higher tissue conductivity, children may absorb more energy from a given phone than adults. International guidelines on exposure levels to microwave frequency limit the power levels of wireless devices and it is uncommon for wireless devices to exceed the guidelines. But these guidelines only take into account thermal effects, as non-thermal effects have not yet been conclusively demonstrated (Binhiet al, 2002). This paper shows that the non-thermal radiation affects the human brain. Global System for Mobile Communications or GSM is the world's most popular standard for mobile telephone systems. GSM is a cellular network, which means that mobile phones connect to it by searching for cells in the immediate vicinity. GSM networks operate in a number of different carrier frequency ranges.

Electromagnetic radiation is a form of energy exhibiting wave-like behavior as it travels through space. Electromagnetic radiation has both electric and magnetic field components, which oscillate in phase perpendicular to each other and perpendicular to the direction of energy propagation. Electromagnetic radiation can be classified into ionizing radiation and non-ionizing radiation, based on whether it is capable of ionizing atoms and breaking chemical bonds Non-ionizing radiation is associated with two major potential hazards: electrical and biological (Aruna et al, 2011).

Extremely high power electromagnetic radiation can cause electric currents strong enough to create sparks (electrical arcs) when an induced voltage exceeds the breakdown voltage of the surrounding medium. These sparks can then ignite flammable materials or gases, possibly leading to an explosion. The biological effect of electromagnetic fields is to cause dielectric heating. Complex biological effects of weaker non-thermal electromagnetic fields also exists, including weak Extremely Low Frequency magnetic fields (Delgado et al, 1982) and modulated Radio Frequency and microwave fields (Aalto et al., 2006). Magnetic fields induce circulating currents within the human body and strength of these magnetic fields depends directly on the intensity of the impinging magnetic field. These

currents cause nerves and muscles to stimulate which in turn affects biological processes.

Previous studies show also little evidence that exposure to mobile phone radiation causes a stress response in mammalian cells, judged by elevated gene expression, the results on nematode worms are indicative of a non-thermal influence on gene expression (Preece et. al., 1999). Previous experiments on deoxyribonucleic acid synthesis also do not indicate changes in cell proliferation under conditions that mimic emissions from mobile phones or base stations. Human laboratory studies of the acute effects of exposure to mobile phone signals suggest that exposure to mobile phone signals at exposure levels that fall within existing exposure guidelines have biological effects that are of sufficient magnitude to influence behavior. The causal mechanism is unclear, but could include a small, localized heating effect (Preece et. al., 1999).

Frey et al (2000) opined that blood–brain barrier, which prevents large molecules from crossing into the cerebrospinal fluid from the blood, might be susceptible to low level pulsed RF fields. They also report that increased penetration of the blood–brain barrier of anaesthetized rats after acute low level exposure to pulsed or continuous-wave 1.2 GHz fields.

Braune et al, (1998) have reported acute effects on blood pressure in human volunteers exposed to a conventional GSM digital mobile phone positioned close to the right side of the head. After 35 minutes of exposure, heart rate, blood pressure and capillary perfusion were measured with the subject either supine or standing for 60 seconds. They found that the heart rate during these tests was slightly lower after exposure to RF radiation than following non-exposed control sessions, and both systolic and diastolic blood pressure were elevated by 5–10 mm of mercury. The objective of this study is to discuss the numerous reports on the health implications of radiation from wireless devices using mobile phone.

MOBILE PHONE TECHNOLOGY AND RADIO FIELDS

Mobile phone (also known as cellular phone, cell phone and hand phone) is a device that can make and receive telephone calls over a radio link while moving around a wide geographical area. It does so by connecting to a cellular network provided by a mobile phone operator (network provider), allowing access to the public telephone network. By contrast, a cordless telephone is use only within short range of a single, private base station.

In addition to making and receiving calls, modern mobile phone support a wide variety of other services such as text messaging, multi-media message service, email, internet access, short-range wireless communication (infrared and Bluetooth), business applications, gaming, photography, music, video etc. Some these are discuss below. Below are pictures of some mobile phones.



Figure 2: NOKIA ASHA 309 and SAMSUNG GALAXI NOTE T879

Nokia Asha 309 is a mild range phone and the successor to the Nokia Asha 306, the phone was announced in September 2012.the phone features a cap active touch screen. Samsung Galaxy Note T879 is an android smart phone, produced march 2012. It has a touch pen compliant screen, it has LCD display screen.



Figure 3: Samsung Nexus 10 and iPad KA09

Samsung Nexus 10: The Samsung Nexus as an android phone it's also a smart phone with symbian application and is very affordable compared to the IPad KA09. IPad KA09 is a nokia product phone which possesses the Hi-phone qualities.



Figure 4: iPhone and Blackberry touch Phones

Blackberry Touch Phones is a line of wireless hand held devices and services designed and marked by research in motion limited (Rim). The first blackberry device was released in 1999. **Hi phone** is one of the many brands of cellular phone manufactured in china. The Hi phone is an iPhone-clone or a phone designed to look and perform like an actual iPhone, most iPhone, Samsung, HTC and blackberry and Hi phones. The Hi phone is longer, wider and heavier that the iPhone.



Figure 5: iPhone and Sony Ericsson phones 3998

IPHONES: This is one of the many brands of cellular phones manufactured in china. The iPhone is an iPhone clone or a phone designed to look and perform like an actual iPhone. Most iPhones, Samsung, HTC and black Berry are iPhones. The iPhone is shorter,



narrower and lighter than the Hi phone. Sony Ericsson php 3998 also known as Sony Ericsson Xpress is an android smart phone produced in 2011. It is also called Sony Ericsson ST17i, nbb or ST17a

Figure 6: Super Flat Hi Phone and Apple iPad Mini

Apple iPad Mini: This is a mini table computer designed, developed and marketed by Apple computer. It was announced on 23rd October, 2012 as the fifth major product in the lpad line. It is also a smart phone with Symbian application. **Super Flat iPhone** is a brand of cellular phones that is manufactured in china. It is an iPhone clone/ designed like an iPhone while some are Symbian enabled phone.

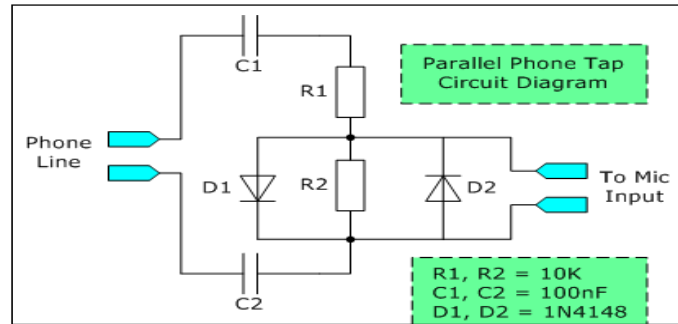


Figure 7: Schematic Diagram of Nokia N95

Figure 7 shows schematic diagram of Nokia N95. The input microphone, the output ear piece is parallel. R_1 and R_2 are the resistors connected in series. C_1 and C_2 are the capacitors connected in parallel and D_1 and D_2 are the diodes. The circuit show the major components found in a modern mobile phone and the basic connection. Figure 7 is a schematic diagram of Nokia N95 showing the circuit connection showing, the front shows the display unit, input and the key connection while the back view show the components connection and the output (speaker) units. The gates helps in digital display, the ICs in the circuit have different function. The EPROM IC acts as a memory device, the photolithography IC help to capture images, the microphone IC act as input unit, it receive sound energy and convert it to electrical energy which then travel as radio wave to the receiver, the speaker IC converts electrical energy to sound energy. There are other ICs in the device that perform various functions such as for audio and video ICs, signal ICs etc. There amplifiers in the phone which help to amplify sound and signal.

The inductors which are passive components in the device are two terminal electrical components that stores energy in its magnetic field. An inductor is made up of wire of or conductor wound to increase the magnetic field.

Figure 8 shows the diagram of Nokia N95 printed circuit board. Printed circuit board or PCB for short is used to mechanically support and electronically connect electronic component using conductive pathway, tracker or signal traces etched from copper sheet laminated onto a non-conductive substrate.

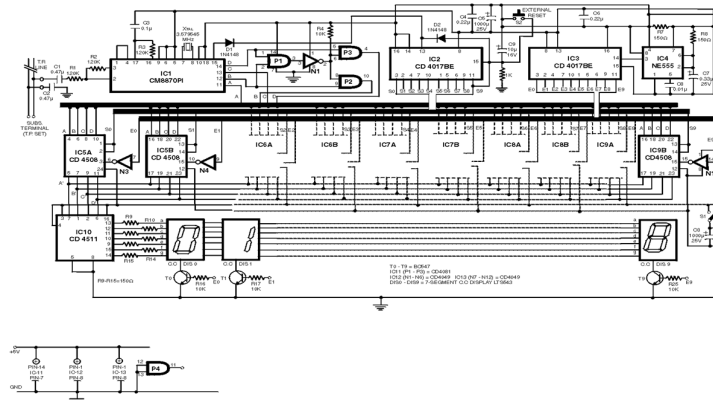


Figure 8: Schematic Diagram of Nokia N95 showing the circuit connection (Front view)

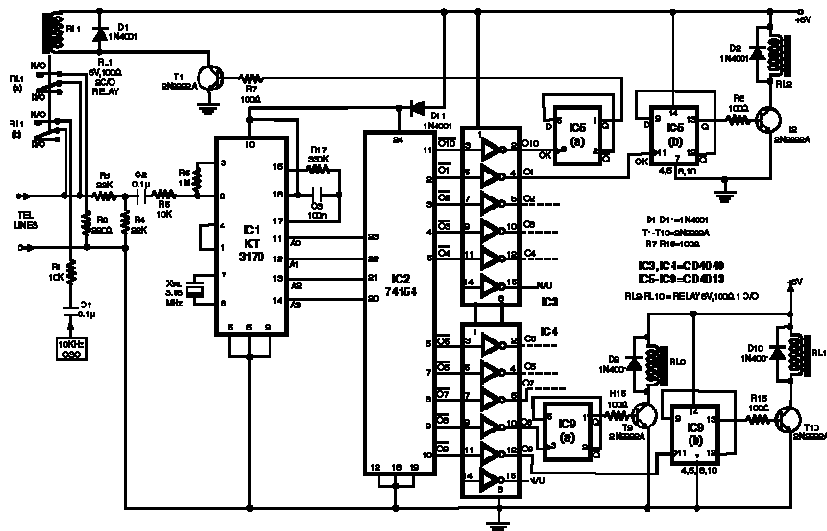


Figure 9: Schematic Diagram of Nokia N95 showing the circuit connection (Back view) NBB

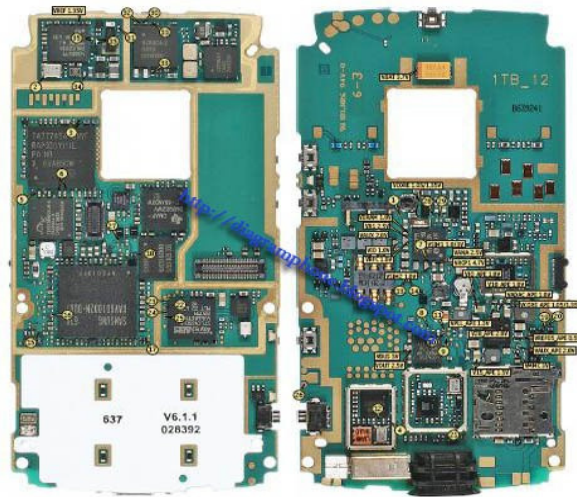


Figure 10: Schematic Diagram of Nokia N95 PBC

IMPORTANT USES OF MOBILE PHONE

In addition to standard voice function, mobile culture has evolved where the phone becomes a key and social tool for people. They rely on their phone address book to get in touch with their families, friends and colleagues. Mobile phone provides services such as SMS and MMS for text messages, email for chatting and sending messages, touch light for seeing through dark areas, MMS for sending and receiving photos, Video and music for entertainment etc.

RADIATION EXPOSURE

The cellular phone has to emit radio frequency energy at levels high enough to reach base stations (antennas towers). Since the energy is emitted as a microwave in the direct vicinity of the users head there are concerns about the safety of this technology. There are reports from cell studies as well as animal studies that there may be a significant risk of developing cancer tumors, foremost brain tumors in the user of cellular phones. Depending on the level of exposure, radiation can adversely affect individuals directly and their descendants indirectly. Radiation can affect cells of the body, increasing the risk of cancer or harmful genetic mutations that can be passed on to future generations; or, if the dosage is large enough to

cause massive tissue damage, it may lead to death within a few weeks of exposure (Aruna et. al., 2011; Binhiet al., 2002; Delgado et. al., 1982).

SPECIFIC ABSORPTION RATIO (SAR)

SAR is a measure of the amount of radio frequency (RF) energy that is absorbed by the tissue in the human body that is measured in watts per kilogram. This measurement is used to determine whether a cell phone complies with the safety guidelines. The exposure limit takes in consideration with the body's ability to remove heat from the tissues that absorb energy from the cell phone & is set well below levels known to show biological effects. The United State Federal Communications Commission (FCC) and International Commission on Non-Ionizing Radiation Protection (ICNIRP) recommend the localized SAR in the head is to be limited to 1.6 W/Kg in 1 g of tissues in the head

$$SAR = s * E^2$$

The maximum powers that GSM mobile phones are permitted to transmit by the present ICNIRP standards are 2 W and 1 W at 900 Hz and 1800 Hz, respectively. Radio frequency induced RF electric fields in tissue a part of the radiated energy will be absorbed in tissues. The power absorbed per unit mass is given by the following expression (Kari and Helsinki 1999):

Where s is electrical conductivity of tissue and E is the mass density. SAR is the specific energy absorption rate and is measured in watts per kilogram. It varies from point to point in the body both because the electric field changes with position and because the conductivity is different for different types of tissue. In most cases, SAR is directly proportional to $1/d^p$ where d is the distance between the antenna and the head and p varies from 1.5-2.

SAR VALUES

SAR (specific absorption rate) is a measurement of how much electromagnetic radiation is absorbed by body tissue whilst using a mobile phone. The higher the SAR the more radiation is absorbed.

In Europe, the European Union Council has adopted the recommendations made by the International Commission on Non-ionizing Radiation Protection (ICNIRP Guidelines 1998). These recommendations set a SAR limit of 2.0 W/kg in 10g of tissue. The UK Government has endorsed this limit (following a report by the Independent Expert Group on Mobile Phones) and the five mobile phone network. As SAR information is not always easy to find, I have compiled a list of SAR values for most phones available.

You should note that while the SAR values of individual phones may vary, every phone available for sale complies with ICNIRP guidelines. You should also be aware that the SAR values shown are maximum values and in practice emissions from mobile phones will normally be lower than these figures. The emissions depend on factors such as distance from a transmission mast, whether the phone is used indoors or outdoors, how close the phone is held to the ear and other operating factors. It is important to realize that a phone with a high SAR rating may actually operate with much lower emissions in practice, and conversely a phone with a lower SAR rating may operate with emissions higher than a high SAR phone in practice. We should not rely on a low SAR rating to guarantee your health.

CONCLUSION

Cell phones have brought on a whole new age of technology and they do make life more convenient in terms of communication. But cell-phones emit low level of non-ionizing radiation when in use. The type of emission emitted radiation by cell phone is also referred to radio frequency (RF) energy. As stated by the national cancer institute, finally there is currently no consistent evidence that non-ionizing radiation increases cancer risk in humans.

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