RF Hazars using Cellphones: the SAR controversy...

Or why you should use a phone with the highest SAR ratings...

By Pedro M.J. Wyns, B.E. (T)

Since the telecom industry is slowly getting worried about possible future claims of illness having their origin in RF radiation coming from phones, the cellphone manuals are including tenfolds of pages containing disclaimers as well as safety measurement results on the so called SAR value of the phone.

The SAR, specific absorption rate, expressed in W/kg , is a value for the energy the human head is dissipating while the phone is helt against the ear of the user. It is measured in an anechoic chamber using a copy of a human head containing RF sensors. The phones get ratings varying between 2 and 0,3 W/kg, depending on brand and type, and consumer organisations are very interested in these values and consult their members to buy phones having a low SAR value.

And this is where almost everybody is taking a fully wrong deduction. To explain this we have to dive a bit into RF design:

The legal limit for cellphones is 2 Watts (=33dBm) RF power. As there is only a limited amount of power module types available on the market in a given timeframe, most cellphone manufacturers use the very same final stages in their transmitter design. We can thus state that the RF output power at the output of all cellphones on the market is rougly the same.

The main difference between cellphones is the antenna design. In the beginning of the GSM ERA the focus was still on designing a good and efficient monoband antenna, as there were few cellphone sites and range had to be maximised. The consumer however considered these first types (example Sony CMD-X2000DR), mainly using extendable half wave rod antennas unpractical, and demanded for antennas with small form factors. First they were minimalised to “small extrusions” on the housing (example Ericsson T28s), disappearing completely after some time and becoming part of the housing/covers (example Nokia 6210).
While the very first rod antennas were a very good omnidirectional radiators, even having some gain, the short helicals and dielectrically loaded antennas are far from efficient and omnidirectional.

Even worse, apart from this downgrading trend, new frequency bands were introduced (1800 Mhz, 1900 Mhz for the US as well as 2170 Mhz for UMTS. So now the already inefficient “undercover” antennas had to offer multiband performance. Needless to say that this only compromised more the already low efficiency of the GSM antenna system.

And this is where it all goes seriously wrong. SAR is measured at the peak power of the phone. Given the fact that virtually all phones use the very same RF drive level (2 watts or 33 dBm) the resulting SAR measurement is only an alternative way to measure **antenna efficiency**.

A phone with a reasonable antenna will have a high SAR rating, while a phone that uses a low efficient dielectrically loaded antenna will loose up to 6 dB (and even more) of RF power in matching networks, triplexer/quadruplexer networks and dielectrical losses resulting eventually in a lower SAR.

Some people forget that a GSM is a two way radio system, using a real transmitter, a real receiver and a real antenna, all obeying the basic rules of reciprocity.

Let's suppose we have two phones, one at the “legal limit” having a SAR of 2W/kg and a second one having a SAR of 0,5W/kg.
In the SAR test setup the 2W/kg device will produce 4 times more energy in the head of the test person than the 0,5W/kg phone, when the test is conducted at maximum output power.

In real life use there is a totally different picture...
At a given distance from the base station the 2W/kg phone will use as an example 20 dBm transmit power during the complete conversation after a short initial handshake at 33 dBm. The 0,5W/kg phone at the very same spot location will need 26 dBm transmit power aftre the initial handshake in order to establish the same connection due to the lower antenna efficiency.
Within the whole range of the base station, the phone having the highest SAR will consistently use less power to keep the connection in comparison with the lower SAR device !

Not only the RF exposure of the user will be 4 times more with the low SAR device, the range of this phone with the given bases station will only be half of what the other phone will perform. It will also receive worse the base station signal.

Conclusion: the measured SAR values of phones are indirectly a value for antenna efficiency.

Phones having a low SAR, so lower antenna performance will need more power to establish a connection to the base station, so the mean RF exposure of the user will be higher.

Advice: One should select a phone with the highest SAR rating in order to get the best performing cellphone that uses the lowest needed output power during the whole phone conversation. The peak power produced during the initiation of the contact is that short it does not significantly contribute to the mean exposure during the complete call.

Comments appreciated: pedro.wyns@telenet.be