Cell-Phone Antennae and the Human Body:
The Power Amplifier Perspective

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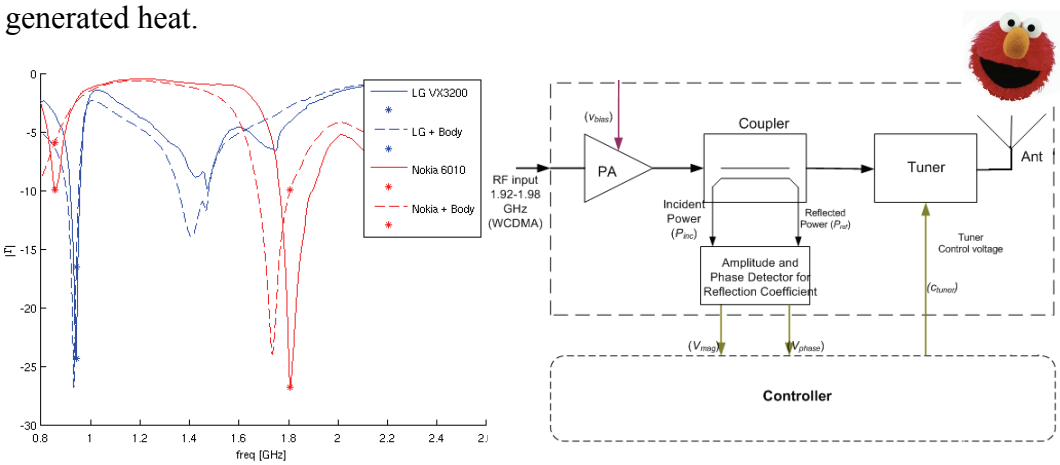
The goal of this paper is to investigate the effects of human body loading on a cell-phone antenna from the perspective of the transmitter power amplifier (PA). The human body is in the near field of the antenna and affects the impedance presented to the power amplifier output. This in turn reduces the radiated power, but also affects the PA operating conditions and can lead to excess heat generation, and ultimately amplifier failure. To protect the PA from high antenna VSWR, typically isolators or circulators are used, which tend to be lossy, large and are not amenable to monolithic integration. In this work, we start from rough measurements that determine the range of VSWR when a cell-phone antenna is in the proximity of the body. The change in antenna input impedance is measured and discussed for two different types of dual 850/1900 MHz band antennae in two types of phones: an LG VX3200 and a Nokia 6010. An example measured return loss change when an antenna is placed next to the head is shown in the figure below. Using the block diagram in the figure, the impact on the PA is predicted for a standard class AB output stage. If the isolator is removed, the PA mismatch can be controlled with a tuning circuit (see, e.g. R.B. Whatley, Z. Zhou, K.L. Melde *Ant. and Prop.* vol.54, no.2, pp. 470-478), as shown in the block diagram. The disadvantages of adding a tuner are additional loss and added complexity, and these are balanced with the advantages of improved radiated power efficiency and the possibility of feedback to control the PA power supply for additional efficiency. The goal of this work is to investigate the requirements on the tuner network that reduce the reflection from the antenna due to the presence of the human body, thus improving the efficiency of the transmitter and reducing extra generated heat.



Left: Example of measured return loss for antennae with and without a head in proximity.
Right: Block diagram of output stage of transmitter with tuner and antenna loaded with a head.