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Samsung Galaxy smart phones and the Inductor

The large flat metal coil inside late model Samsung Galaxy smart phones gets a workout.

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Samsung has made some very innovative uses of a type of electronic device called an inductor, which is a coil of wire.

When I took the basic electronics design lab course in college, we studied and modeled three basic circuit components: resistors, capacitors and inductors. Each affects electrical signals in some interesting ways.

The induction principle is also the foundation for electric motors and loudspeakers, as well as transformers. Transformers raise or lower voltage of electricity. You have seen either large metal cylinders on telephone poles, which change electric voltage to the 110-120 volts AC we use in homes and small businesses, and sometimes you may have seen green or brown metal boxes on the ground, 4 to 5 feet tall, which do the same thing for office buildings, and for residences in areas like Reston where the power lines are buried rather than overhead.



**Illustration 1** is a photo of a very old cylindrical transformer burning atop a pole near my home in Arlington VA.

Samsung decided as of the Samsung Galaxy 6 phone to include a large flat inductor coil across much of the back of the phone. That inductor coil is used as a transmitter and receiver of high-power magnetic fields, for some very interesting purposes. Rather than the vertical coil used in transformers, loudspeakers and most electric motors, the coil inside the cell phone is a tightly wound flat spiral. I found a video on YouTube in which a Galaxy S7 phone was disassembled for replacement of the inductor. It appeared to be roughly 65% of the area of the back of the phone.

**CHARGING A SAMSUNG GALAXY PHONE WIRELESSLY**

The first purpose of the inductor is to charge the phone wirelessly. Buy a charging pad, and simply set the smart phone on the charging pad. The charging pad itself contains a similar spiral inductor and produces a magnetic field, and the smart phone induction coil uses that field to move electrons, charging the smart phone battery.

One of my kids has had a consistent record of damaging the microSUB socket on her smart phone, so that she cannot use a USB cable to charge the smart phone. The way she dealt with the need to recharge in the past was to use multiple batteries and an external charger. She could charge one battery while using another.

Now she uses a Samsung Galaxy S7, so she can use a charging pad and just set the phone on the pad. No USB cable and no change of battery necessary. The charging pad includes an inductor, just like the phone, and creates a magnetic field. The interaction of the magnetic field and the receiving inductor in the smart phone causes electrons to move through the receiving inductor, charging the phone battery.

It turns out that Samsung optimized that opportunity by making the entire back of the phone using glass, which transmits the magnetic field, instead of metal, which blocks magnetic fields. Also it turns out that the phone battery is no longer easily replaceable, by users; the back of the smart phone is sealed. Again, you can see how to open the phone and even how to replace the battery on YouTube, if that is what you want to do. It does take some specialized tools.

One side effect of using magnetic fields for charging is *inefficiency*. A significant fraction of the magnetic field power is lost to heat. The phone will heat up while sitting on the charging pad.

Apple, as it happens, built a small glass window into the back of its recent phones, such as my iPhone 6S, and placed an inductor there for the same reason, to charge the phone wirelessly. See **Illustration 2** showing the back of my iPhone 6S.



Since Samsung's inductor is big, roughly the size of the entire glass back of the phone, Samsung has been able to implement some other interesting uses of that inductor.

**USE THE SAMSUNG GALAXY SMART PHONE TO CHARGE WIRELESS EARBUDS**

The most recent use of the inductor was announced at the February 2018 announcement of the newest Samsung Galaxy cell phones.

Samsung also introduced new wireless Bluetooth earbuds. The innovation is that buyers of the new phones can set the earbuds on the back surface of the phones, atop the inductor, to charge the earbuds from the phone's battery wirelessly.

Each earbud includes a small inductor coil to receive the magnetic field created by electricity sent through the phone's inductor coil. The earbud's coil causes electrons to move through it, charging the tiny battery in the earbud

.

Remember up above I mentioned that loudspeakers contain inductors? It is possible that Samsung use the same inductors that produce sound in earbuds to receive the magnetic field from the phone and send electrons into the tiny earbud battery.

I suspect the earbuds can also be charged on a charging pad.

I am not sure how I would feel about leaving a phone upside down. I would rather be able to see the screen. It is possible that using a small shallow dish or cup, lid the screw-top lid on a jar, the earbuds can be beneath the phone and close enough so that the phone can face up and still charge the earbuds. It is still not terribly efficient, and the earbuds may heat up a bit.

I am not sure I would like to use the smart phone battery to charge earbuds frequently. I have enough trouble keeping a smart phone charged for its primary purposes.

**SAMSUNG PAY**

The most creative use of the Samsung cell phone inductor is Samsung Pay, the competitor for Apple Pay and Google Pay.

The basic issues in both Apple Pay and Google Pay is that the retailer using those payment acceptance methods must have a payment recipient account with the Apple and Google systems, and must obtain a Near Field Communications (NFC) version of credit card readers.

There are many vending machines, parking garage systems, electric vehicle recharging stations, and other points of purchase where credit cards are welcome but the payment recipient does not want to incur the expenses of accounts with Apple and Google, or the expense to purchase and roll out the NFC version of credit card readers.

Samsung Pay is accepted just about everywhere because it does not require that the vendor have a payment recipient account with Samsung and does not use NFC.

Instead, the Samsung smart phone uses its inductor coil to create the same varying magnetic field that is produced by moving the magnetic stripe of a credit card past a read head. Samsung Pay works at most credit card acceptance terminals that are not NFC capable and therefore unable to accept Apple Pay or Google Pay. It also works at all of the newer NFC-capable card acceptance terminals.

Keep in mind that the power of a magnetic field is reduced in proportion to the square of the distance between transmitter and receiver. For instance, the magnetic field power at a distance of 2 inches from the transmitting inductor is one-fourth (1/22) of the power at a distance of 1 inch from the transmitting inductor. Distance increases inefficiency dramatically. This is why the earbuds will charge most quickly when in actual contact with the charging surface, a fraction of an inch from the smart phone inductor or charging pad inductor.

The major exception for Samsung Pay is credit card readers such as those as gas pumps and USPS sales kiosks where the credit card must be inserted into the box; that means the magnetic stripe read head is also inside the box. Bury that read head deep enough inside the box, and the magnetic field from a Samsung cell phone inductor coil won't be powerful enough to be understood by the read head.

**BUY A SMART PHONE CASE**

Don't risk breaking the glass back and the inductor of your Samsung Galaxy phone. Put a case on it. The plastic material does not block a magnetic field. The case does reduce induction efficiency slightly since charging pads, earbuds, and Samsung Pay have to work across the thickness of the case.

About the author:

John Krout is a former president of the Washington Area Computer User Group, a predecessor of PATACS. He is a frequently contributor to PATACS Posts and occasionally provides presentations at meetings of PATACS. At the February 2019 PATACS/OLLI OPCUG joint meeting, he presented an introduction to Power Banks. He lives in Arlington VA and spent most of his adult life working as a C and C++ software developer for major federal systems. Today he works as a tech writer for a major maker of automated fingerprint identification systems, supporting a federal government agency using those systems. He has been interested in tech all his life, starting with the Mercury space program. He stared writing software in high school in 1969, and bought his first personal computer in 1979, 40 years ago.