Layered DD Coil: An improved coil structure for inductive wireless power transfer

Muhammad Enagi Bima, Bhattacharya Indranil
Electrical and Computer Engineering Department

OBJECTIVES
- Implement Layered DD coil
- Compare against other coil structure
- Implement magnetic field shielding

INTRODUCTION
Wireless power transfer (WPT) has gained lots of attention and recognition in smaller consumer electronics.

MODELING
- Current direction ensures that the generated magnetic field adds up constructively thereby an increase in inductance.
- Each layer has an inductance specified by the equation

\[ L_{\text{Layer}} = L_1 + L_\text{Layer} - 2M \] (1)

EFFICIENCY
- Power Transfer
  - Comparing LDD and DD coils power transfer at air gaps of 15 and 20 mm
  - LDD transmitting more power than DD
  - Ferrite shield gives more power transfer than other shielding materials

REFERENCES

ACKNOWLEDGMENT
Special thanks goes to Department of Electrical Engineering and Center for Energy Systems Research (CESR) of Tennessee Tech

CONCLUSION
- Layered DD coil performed more efficiently that other coil types
- Using Ferrite on the transmitting side only performed almost as good as when on both sides
- Potential for saving on material usage when Ferrite is used only on the transmitting side

FUTURE RESEARCH
Implementation of Magnetic Beamforming using
- LDD coils
- various optimization algorithm.
These are intended to operate in a dynamic wireless power transfer situation.

MAGNETIC FLUX LINES
- See how the magnetic flux lines is distributed around the coil adding up constructively.

DISCUSSION AND CONTRIBUTION
1. The novel means by which the coil constructively combines the magnetic field leads to an increase in the overall magnetic field density around the coil. This translates to more inductance and power storage (self-inductance) and sharing capability (mutual-inductance).
2. Equation (2) shows a direct relationship between the mutual inductance and transfer efficiency. This explains why LDD has a better power transfer. It exhibited significant amount of inductance than the DD (See results in Inductance).
3. Ferrite exhibits the most significant shielding and it has the most magnetic permeability.
4. Both DD and LDD have similar structure, however, a much wider ground area is required for DD to achieve similar inductance as LDD.
5. This increase is not always feasible since there is usually a limitation of size.