In this study, the effects of a static magnetic field on the skin effect resistance of a conductor are considered by observing the change in resistance in a circuit. A theoretical derivation over possible effects is derived from implementing the free-electron model. A decrease in the effective resistance due to the skin effect was predicted to occur in the presence of a static magnetic field of specific configuration. The conductor under study was a thin sheet of silicon steel, with the slab placed under a strong static magnetic field. The resistance was measured across the conductor before and indirectly after the application of the static magnetic field for increasing values of frequency through the measurement of the voltage input to voltage output ratio.

The skin-effect is a phenomena that occurs in conductors exposed to high frequency alternating currents (AC). Specifically, the resistance of a conductor tends to increase as the frequency of the AC inside the conductor increases [1]. The current in the conductor tends to flow along the edges of the conductor, hence the increase in resistance [4]. The effects of such increase in resistance in response to a strong static magnetic can be predicted from mathematical principles. The currents flowing through the static magnetic field tend to have transient changes in position [3]. Thus, their dynamics can be predicted by incorporating the magnetic effects on the resistance of a material [2]. The resulting equation (bottom left) is different than that derived from standard skin effect theory (bottom right). This indicates that the dynamics can be different than those that arise with the skin-effect.

\[
\psi \left( \frac{\partial \mathbf{E}_x}{\partial x} \right) = \psi^2 \left( \frac{1}{\sigma} \right) - i \omega \mu
\]

Three portions of the experiment were executed. In the first portion, a resistive circuit was implemented in the measurement of the voltage output of one resistor over the total input voltage. The resulting ratio was varied over frequency. In the second portion of the experiment, the same procedure as in the first portion of the experiment was conducted. In the second portion of the experiment, such was done with the integration of a silicon steel rectangular sheet in series with the series resistors. In the last portion of the experiment, the procedure outlined in the second portion was executed but with the silicon steel slab exposed to a strong static magnetic field. The mentioned voltage ratios were measured accordingly with varying frequencies.

**RESULTS**

The resulting graph for the voltage ratio of the first portion of the experiment is shown on the upper left. The data from the second portion is shown in the upper right. The data from the last portion is shown on the lower left.

The equation for the voltage ratio measured is shown below:

\[
\frac{V_{\text{rms}}}{V_{\text{in}}} = \frac{Z_1}{Z_2}
\]

**CONCLUSION AND FUTURE WORK**

In conclusion, the results indicated quite possibly two effects at play when a conductor under the skin effect is exposed to an external static magnetic field. The inductance and/or the effective resistance change upon being exposed to the magnetic field. As indicated by the mathematical model derived in this study, if the electron mobility wasn’t significant enough, then research into the above experiment with a sample of a material displaying large electron mobility (i.e., semiconductors) may render different results. Exposing said sample to a much stronger DC magnetic field may also yield results that indicate a decrease in the effective resistance due to the skin-effect. The material with large electron mobility would also have to behave according to the free-electron model. If the material does not obey the free-electron model for the regime under study, then a more complicated model may be necessary in order to predict any changes to the skin effect within a conductor. As such, research should be done in determining whether how the magnetic field affects both the inductance and effective resistance due to the skin effect in a separate manner. An experiment relating the reactive and real power consumed by the circuit can also be used to hone in on the exact cause of any reported changes in the total effective resistance. Instruments with higher resolution must be used as well.

**REFERENCES**


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