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PARAMETRIC COMPARISON OF ADDITIVE MANUFACTURED ROGOWSKI COIL DIAGNOSTICS FOR FAST NANOSECOND PULSES

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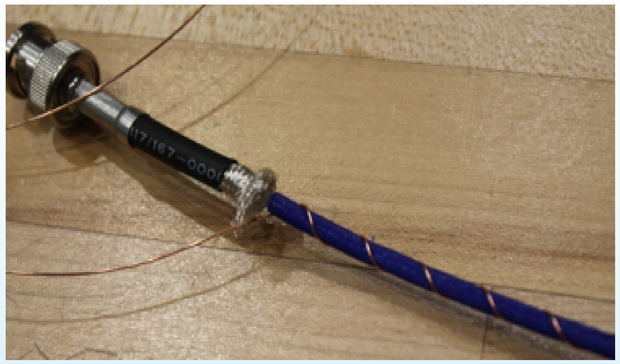
Introduction

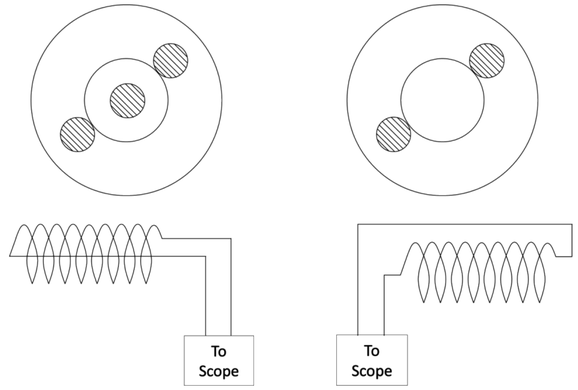
Current monitoring Rogowski coils are often implemented in pulsed power systems that produce large currents at high dI/dt, often in the nanosecond regime, primarily due to their high bandwidth and non-contact inductive pickup. Classically, these coils can be built rigid or semi-flexible and are intended to be installed surrounding a current carrying conductor. In addition to its simple construction, other important features are high bandwidth, non-saturation coil, non-intrusive and good linearity [1]. Typically, Rogowski coils are often wound by hand which can lead to batch sensitivity variations that impact measurement and accuracy. For example, irregular spacing of the windings, insulator to shield variations, length variations etc. Attempting to mitigate these inconsistencies we have employed Additive Manufacturing (AM) where the center form is printed with a helical guide on a low-cost fused deposition modeling (FDM) printer. The implementation of additive manufacturing offers exceptional control of the geometry, symmetry of the windings and positioning of the conductors. Early data on the performance of AM designed Rogowski coils are compared with classical derivative Rogowski's with minimal differences noted.

Rogowski Design Considerations

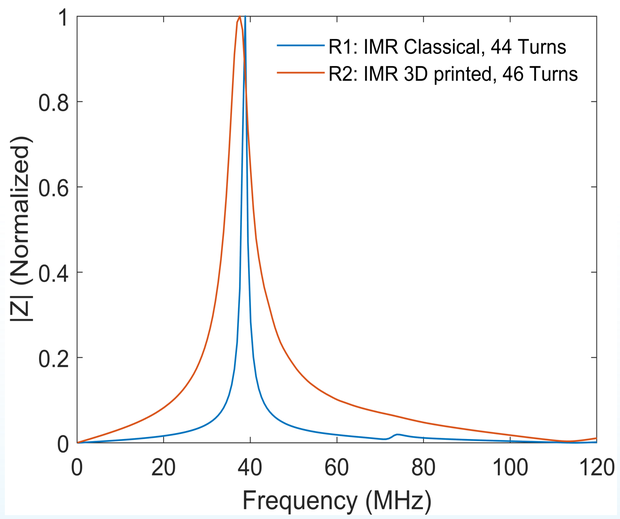
- Limited space design constraint (< ~6mm in diameter).
- Additive Manufactured (AM) Rogowski coil advantages:
  - Implement grooves on the core
  - Ease of construction
  - Reproducibility
  - Variable diameter
  - Flexibility



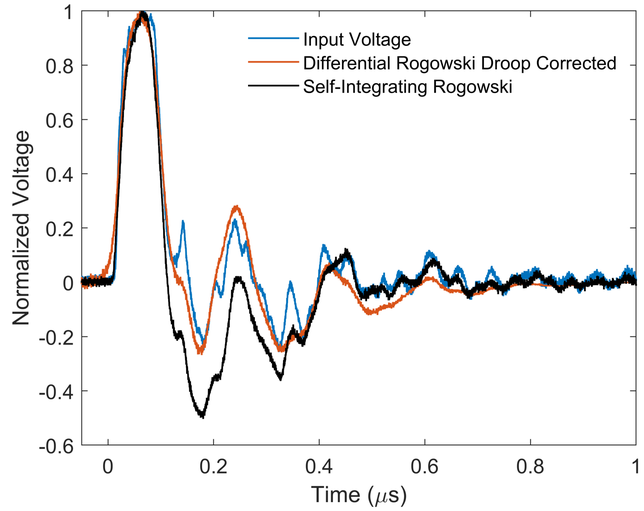
Preliminary Results



Left: Rogowski coil with return conductor through the center enclosed by an electrostatic shield with the outer winding connected to it. Right: Coil is connected directly to an electrostatic shield with no return conductor through the center.



- Resonant peak is nearly identical at ~40MHz with AM Rogowski's impedance broadened.
- Performance could be improved if the design parameters are optimized.



- Differential Rogowski has a slower response time but tracks voltage better.
- Self-integrating has faster response time but higher undershoot due to higher inductance.

Conclusions

- Preliminary study on the AM Rogowski offers similar performance as classically designed Rogowski coils.
- Response of a differential and self-integrating AM Rogowski with trade-offs.
- Further work will focus on optimizing the design parameters that could improve the performance.

References

1. W. F. Ray, and C. R. Hewson, *IEEE Industry Applications Conference, 2000*

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NNSA National Nuclear Security Administration

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