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Abstract

In order to fully define integrated power transformers with magnetic cores, it is essential to not only characterize the small signal properties but also the large signal characterizations because the power delivery capability is limited by the saturation of the core which is a non-linear behavior. In this work, a method was implemented to characterize the saturation current and non-linear behavior of the transformers. In addition, a methodology was developed to accurately predict the saturation behavior.

Isolated Power Solutions

Discrete solutions with optocouplers and external transformers

- Large
- Custom designs
- Poor Reliability

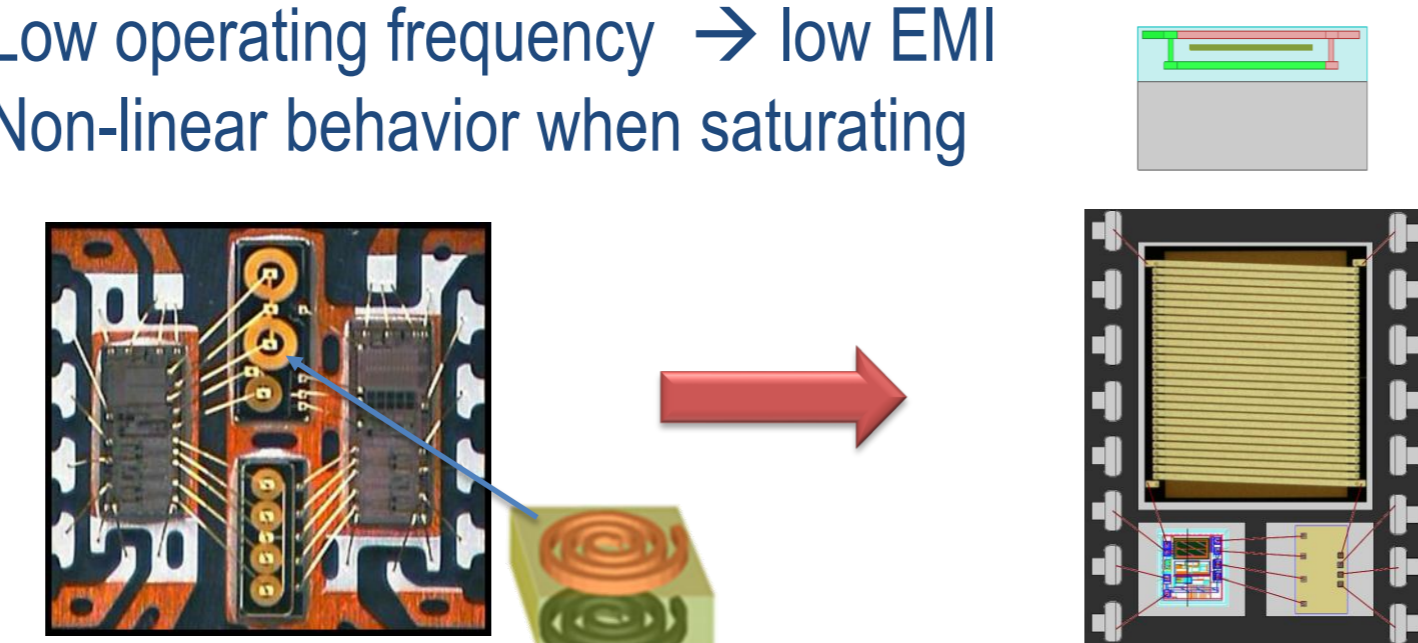
Proprietary **isoPower®** integrates data & power

- Data isolation
- DC/DC converter
- **All-in-one package**

From Air Core to Magnetic Core Transformer

Magnetic core solenoid transformers have

- High efficiency
- Low operating frequency → low EMI
- Non-linear behavior when saturating

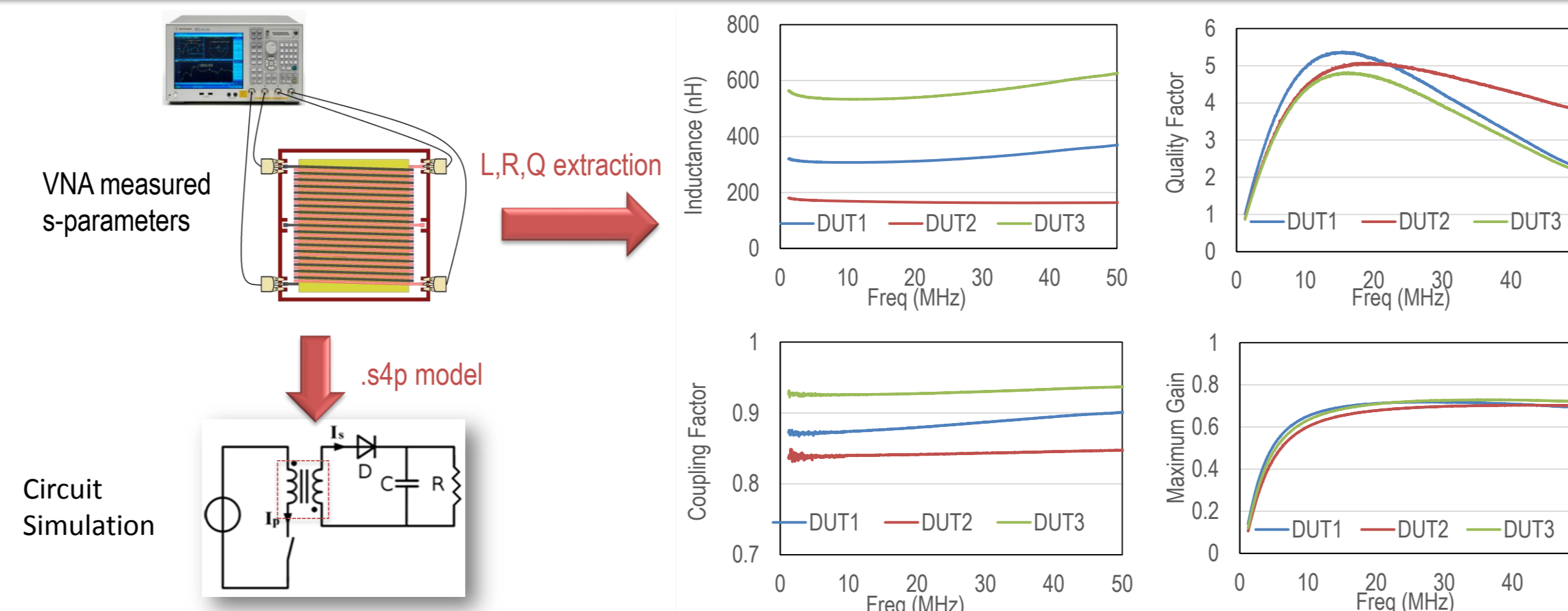


1st Gen of isoPower® with air core power transformer

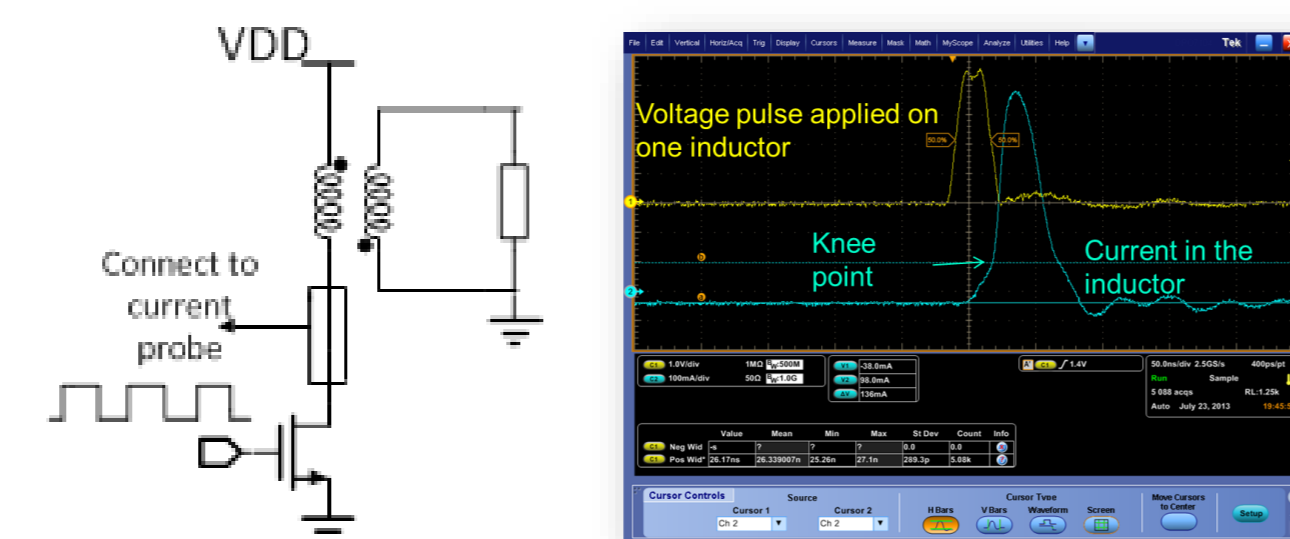
2nd Gen of isoPower® with magnetic core power transformer

| DC/DC Converter Design Goals | |
|------------------------------|--------------------------|
| Architecture | Fly-back DC/DC Converter |
| Input Voltage | 5 Volt |
| Output Voltage | 5 Volt |
| Frequency | 20 MHz |
| Power | 200mW |
| Inductance | 320nH |
| Q @20MHz | 9.4 |
| Peak Current | 0.75 Amp |

Small Signal Characterization

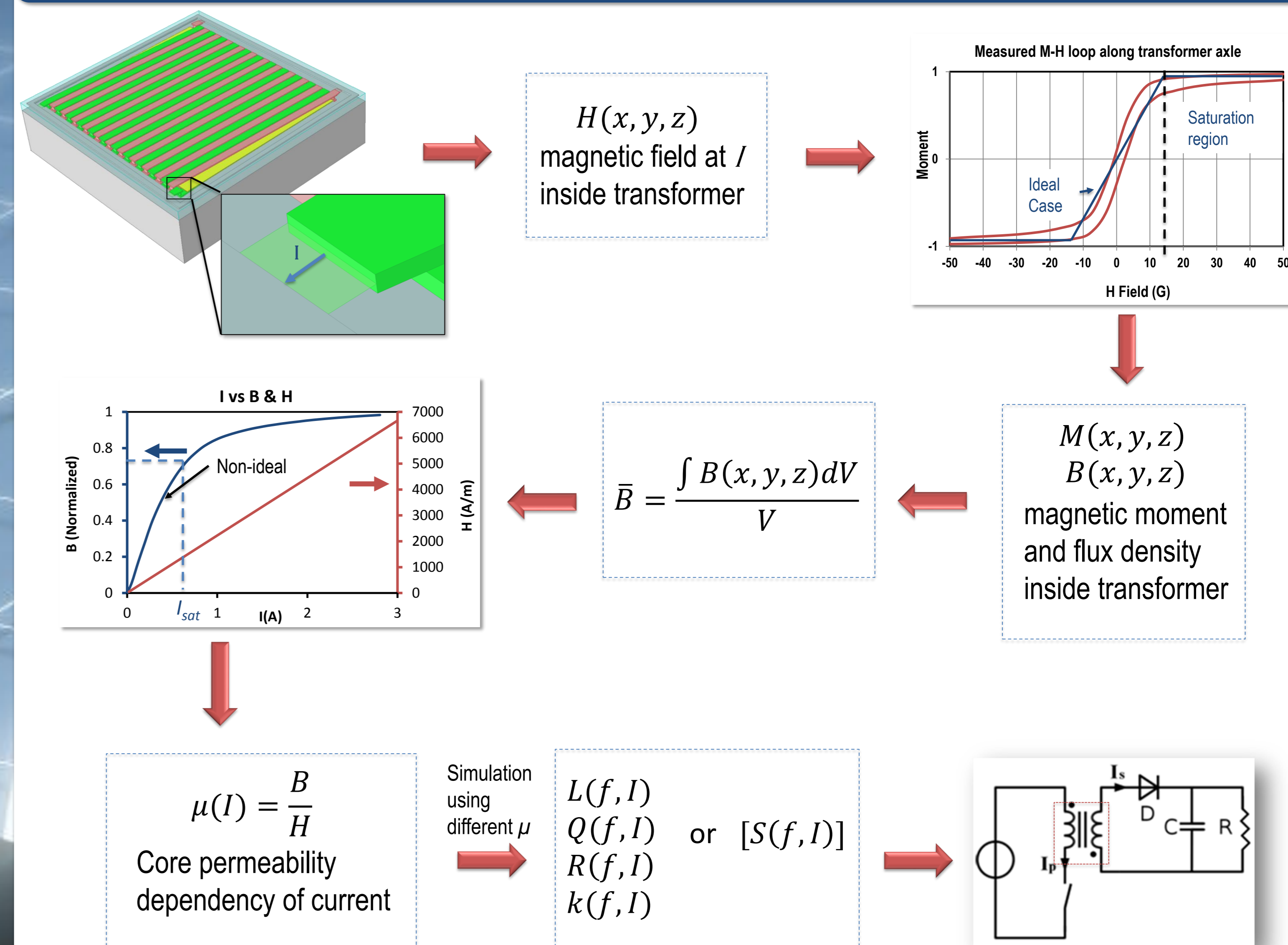


Large Signal Characterization



- Apply a square wave voltage across the inductor.
- Monitor the current through the inductor.
- Slew rate of the voltage signal has to be controlled.
- Duty cycle of the square wave has to be controlled.

Large Signal Modeling



Conclusion

- The VNA tested S-parameter models of the transformers are only suitable for small signal circuit simulation, i.e. data transmission.
- For power applications, the large signal characterization and models of the transformers need to be given.
- The magnetic core transformers are able to deliver higher power with higher efficiency but will saturate at a point.
- The saturation current could be tested by monitoring the current when a square wave voltage is applied.
- By characterizing the magnetic core, the non-linear large signal model of the transformer could be generated, and the saturation current could be predicted.

References

[1] Xing et al, "High-Bandwidth Low-Insertion Loss Solenoid Transformers Using FeCoB Multilayers", IEEE Transactions on Power Electronics, Vol 28, Issue 9, (2013).
[2] Xing et al, "RF Magnetic Properties of FeCoB/Al₂O₃/FeCoB Structure With Varied Al₂O₃ Thickness