Combinational Rogowski Coil with Enhanced DC Measurement Capability for Double Pulse Test (DPT) Applications

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PCB Based Combinational Rogowski Coil

Commercial Rogowski Coil (CWT MINiHF)

- ❑ High Bandwidth 250MHz
- ❑ Coil Length 12.56mm
- ❑ Low insertion inductance
- ❑ Self-integrating property combined with the differentiating region

- ❑ High Bandwidth 50MHz
- ❑ Coil Length 100mm
- ❑ No self-integrating property

Ref: W. Zhang, S. B. Sohid, F. Wang, H. Cui and B. Holzinger, "High-Bandwidth Combinational Rogowski Coil for SiC MOSFET Power Module," in IEEE Transactions on Power Electronics, vol. 37, no. 4, pp. 4397-4405, April 2022, doi: 10.1109/TPEL.2021.3127545.

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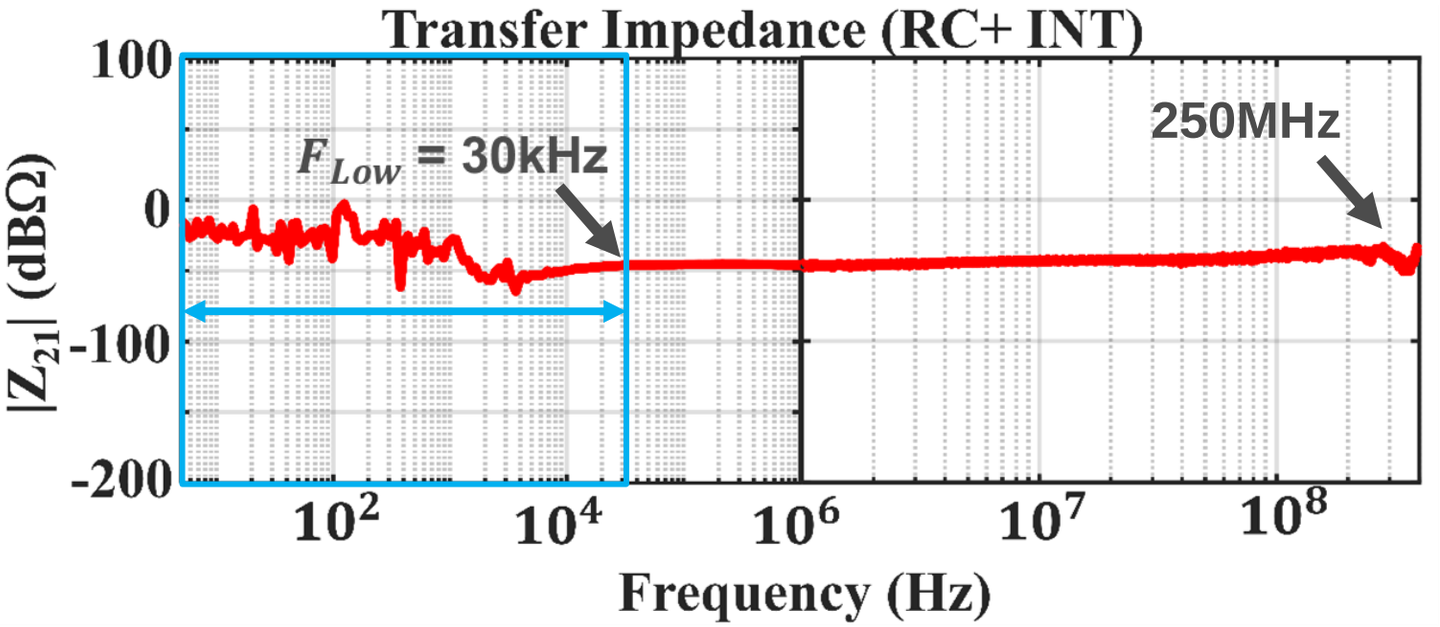
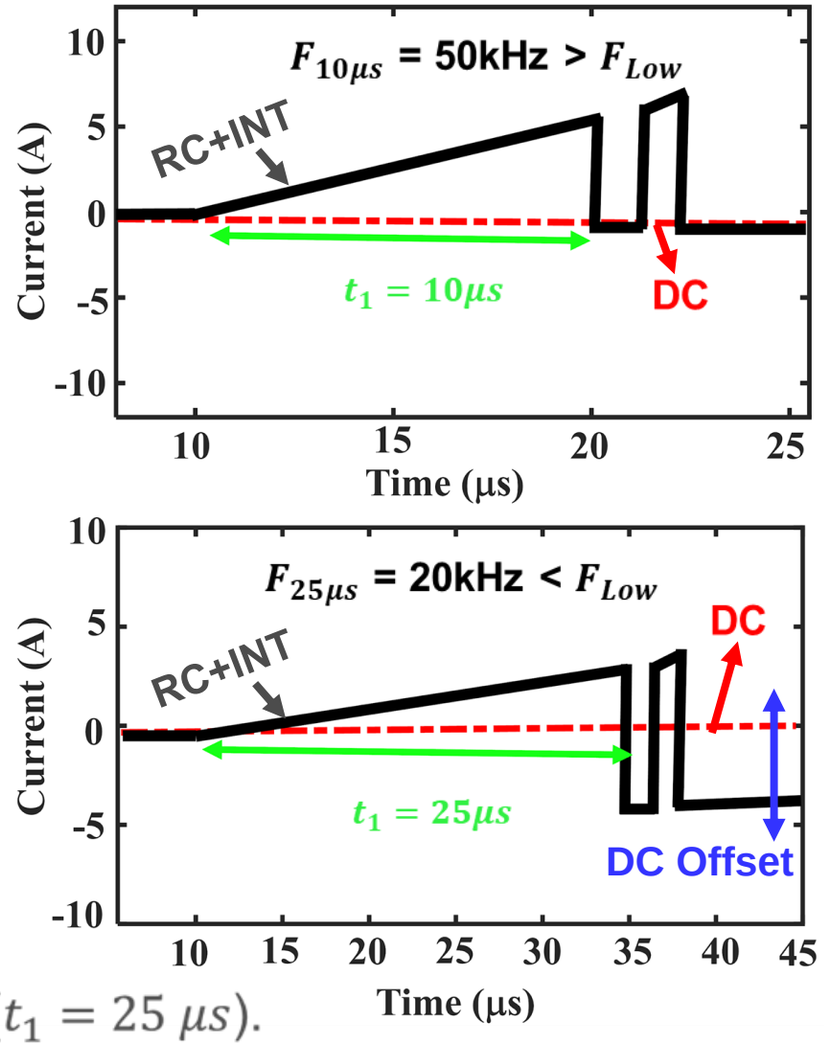
Limited DC Measurement Capability

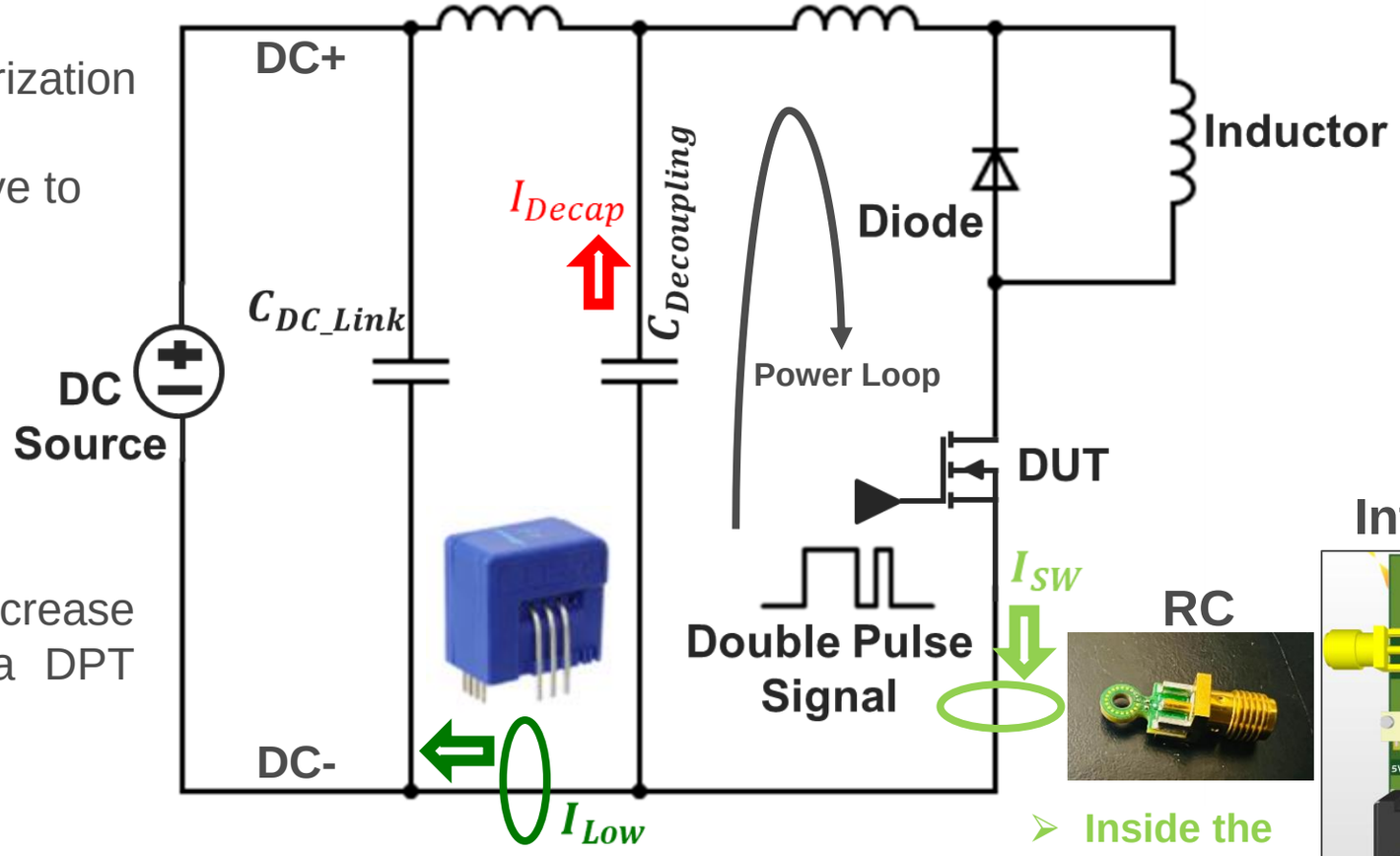




- The low frequency bandwidth is compromised to $F_{Low} = 30$ kHz.
- The required bandwidth, $F_{t_r} = \frac{0.5}{t_r\ (rise\ time)}$
- The higher pulse width waveform starts to create more DC offset. ($t_1 = 25\ \mu s$).

Proposed Method for DC Improvement in a DPT Circuit

- DPT - dynamic behavior characterization
- Wide bandgap devices are sensitive to power loop inductance.
- Inclusion of DC sensor will not increase the power loop inductance of a DPT circuit.

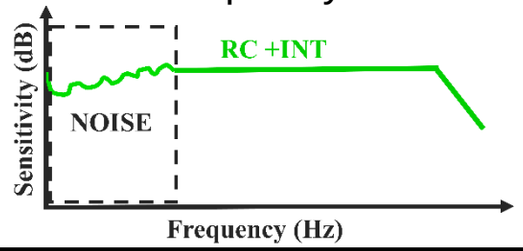


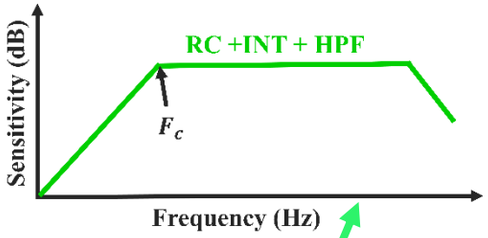
I_{Low} → Low Frequency Components

I_{SW} → High Frequency (I_{Decap}) + Low Frequency (I_{Low})

The Probe Layout Model

- Low frequency noise range □ **30kHz**

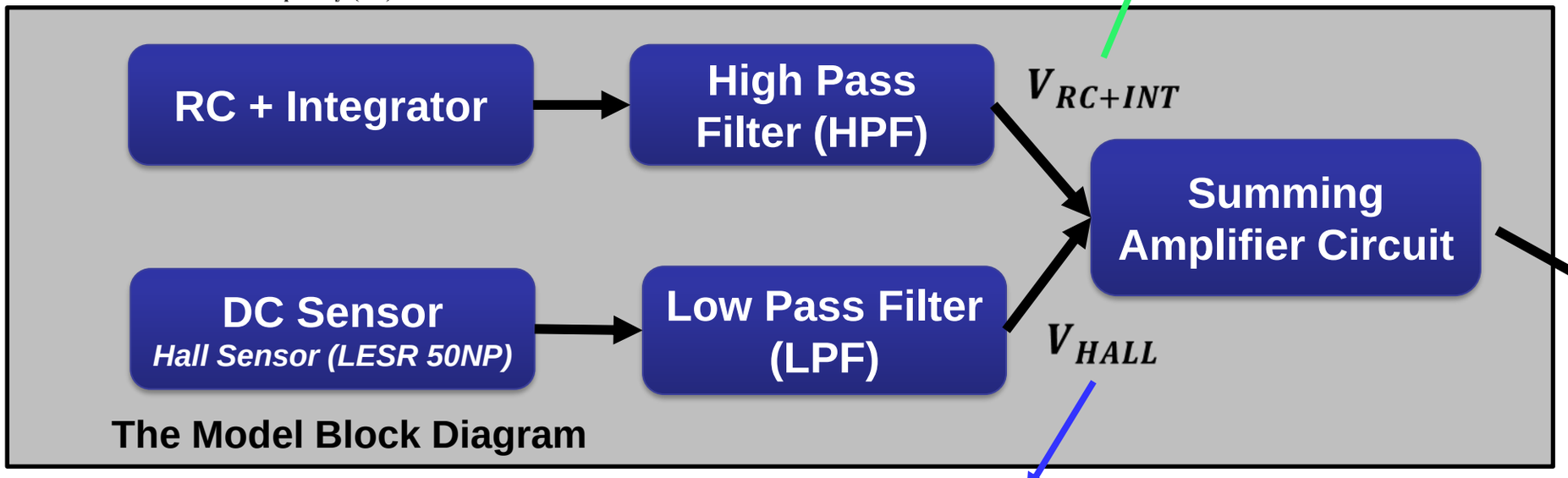


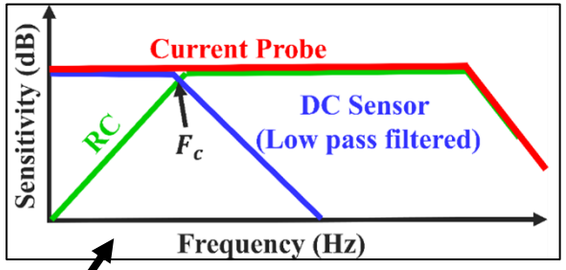


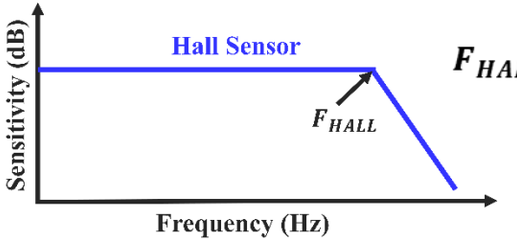
- The cut-off frequency of the HPF –

$$F_C = \frac{1}{2\pi R_H C_H} = 48kHz$$

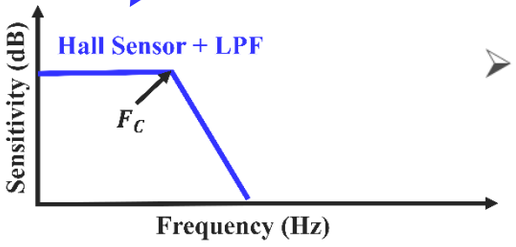
F_C → Adjusted Cut-off Frequency







F_{HALL} → Hall Sensor Bandwidth



- The cut-off frequency of the LPF –

$$F_C = \frac{1}{2\pi R_L C_L} = 48kHz$$

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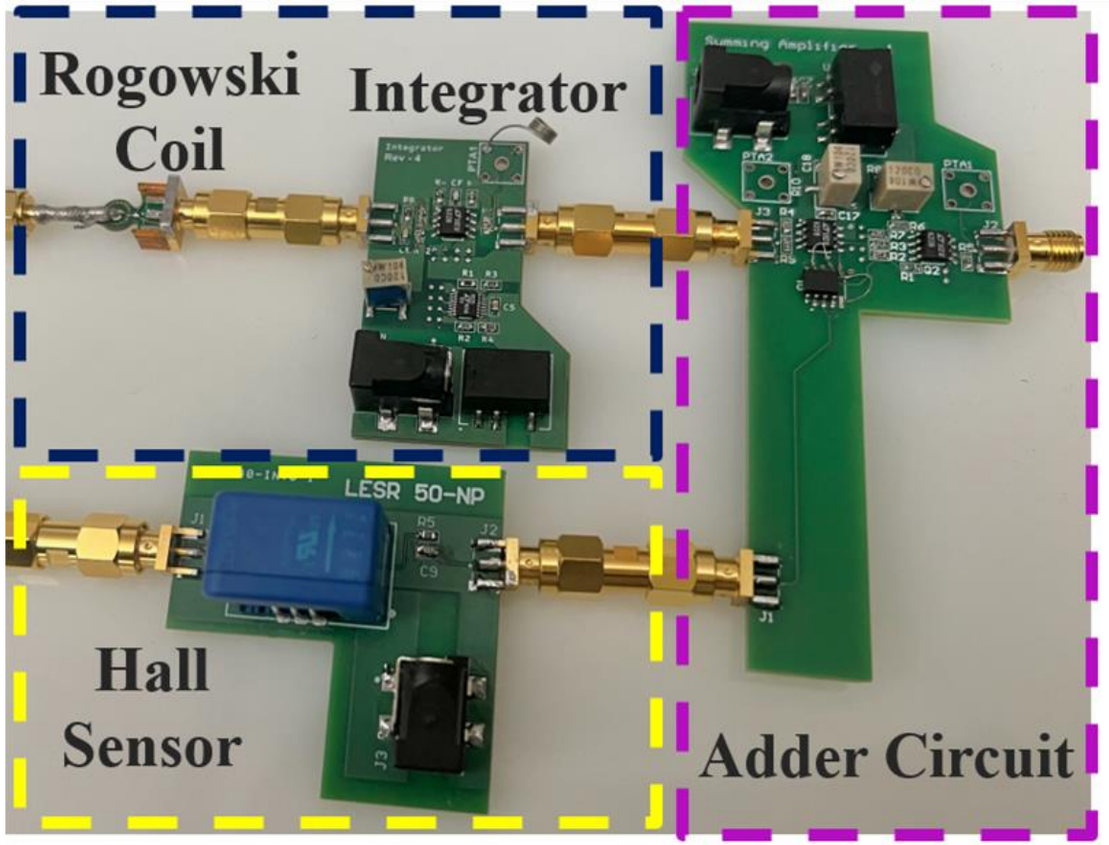
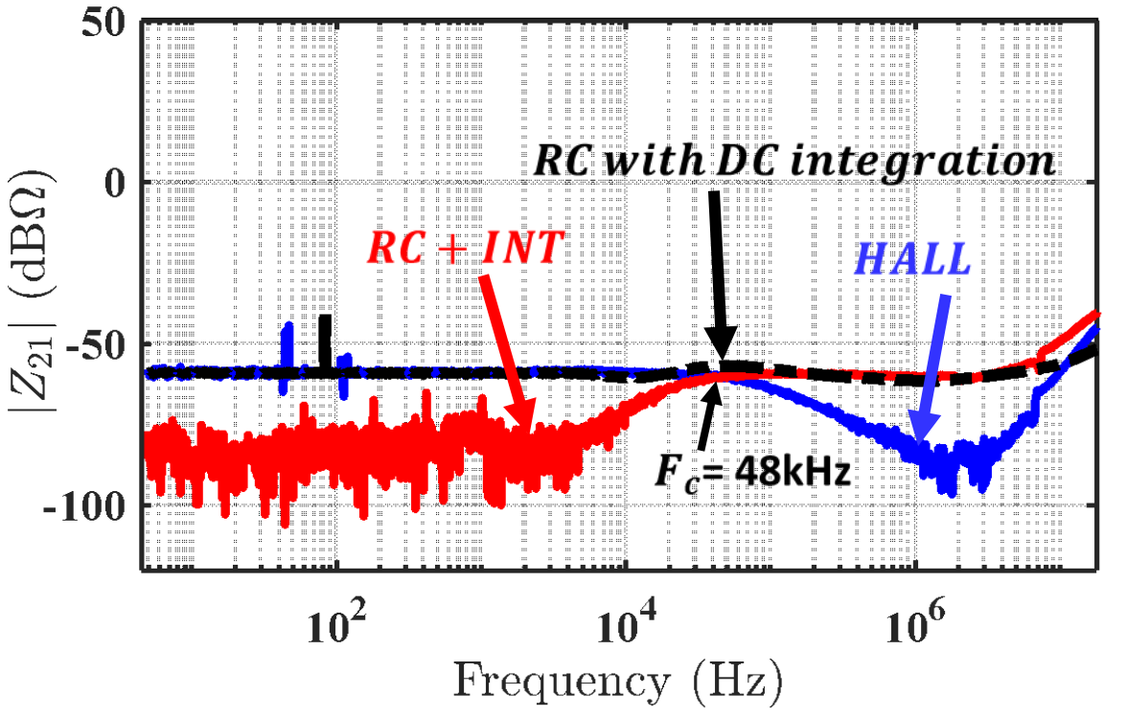
The Probe Prototype & Frequency Domain Measurement

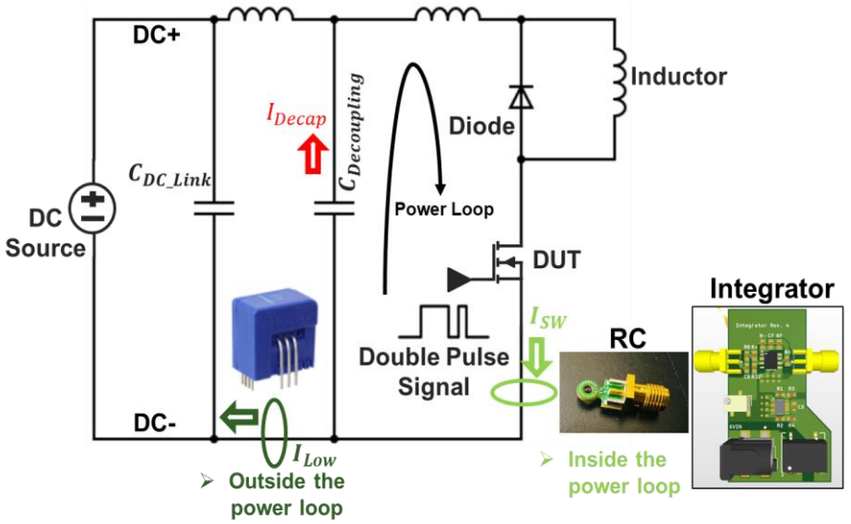


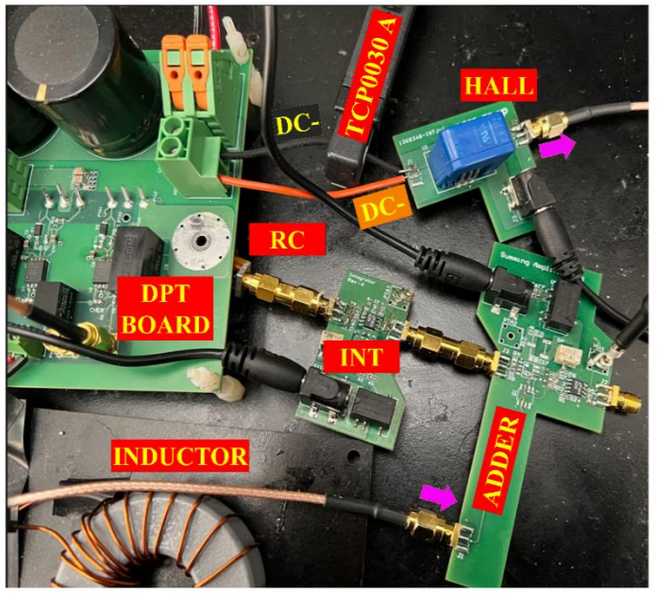


- The RC and the Hall sensor are connected in series.
- Used Network Analyzer for the frequency domain measurement.
- Hall sensor response dominates the LF noise.
- **Flat gain curve over a wide frequency range**

Probe Implement in the DPT Board & Time Domain Measurement

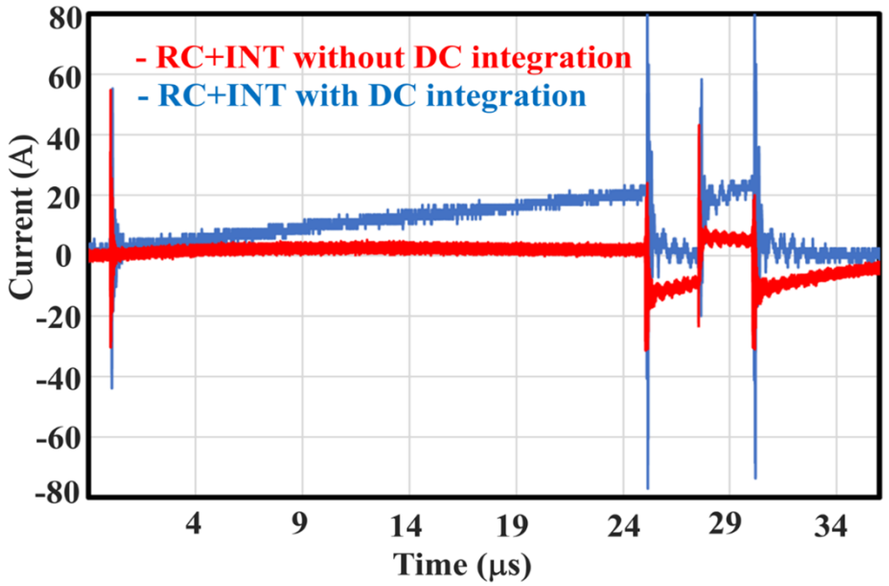
- The RC coil is placed inside the power loop.
- The hall sensor is placed outside of the power loop.
- There is no increase in the power loop parasitic with the inclusion of the Hall sensor.





Experimental Setup

Time Domain Response



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