Powering Devices Across the Isolation Barrier

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Why transfer power across the isolation barrier?

Discrete vs. higher integration solutions

Integration options and tradeoffs
  - External transformer
  - Internal transformer
  - Low-cost PCB transformer
Why Transfer Power Across the Isolation Barrier?

AC Power Substation Control Center

- Isolation required to control HV system and protect operator
- Isolated grounds required between MCU and HV systems
- DC/DC converters are required to power HV output stages and MCU
- HV systems designers often too busy to spent time designing and characterizing isolated DC/DC
- DC-DC controller
- Isolated feedback
- Isolated transformer
- Integrated IsoVolt, Si88241 DC/DC solution
Integrated Solution with External Transformer

- Example of isolators with built in isolated power

![Diagram of isolation circuits and power supply](image-url)
1. DC/DC with integrated switch (Vin_max = 5.5V, Pmax = 2W)
2. Wide input output voltage ranges (scalable Vin & Pout)
3. IGBT driver with integrated DC/DC
4. Efficiency up to 83%
5. Over load protection including shorted output condition
1. IsoVolt with ferrite core transformer (low fsw)
2. Off-The-Shelf device A with integrated XFMR (high fsw with narrow peaks)
3. Off-The-Shelf device B with integrated XFMR and spread spectrum on FSW (wide lower peaks)
Low Cost PCB Transformer Implementations

- Ext. Isolated transformer with ferrite core
- Coreless PCB transformer
- Standard 4 layer FR4 PCB
- Uses layers 2&3 for maximum isolation
- FR4 provides safety insulation (40kV)
- Weakest link is distance vias-vias, vias-traces

* FR4 dielectric strength is 800V/mil to 1.5kV/mil
1. Inductance equations for the spiral coil by Harold Wheeler (1928)

2. \[ L = 9.35 \mu_0 N^2 \frac{D_{avg}}{1 + 2.8\phi} \]

3. \[ D_{avg} = \frac{D + d}{2} \]

4. \[ \phi = \frac{D - d}{D + d} \]

5. Two coils on 2 PCB layers form an air core transformer

6. Transformer mutual inductance is directly proportional to the distance between coils

7. \[ L_M = 2K_c \sqrt{L_1 L_2} \] (transformer mutual inductance)

8. Insulation performance and K coupling is inversely proportional
Tested 6 PCB transformers

Efficiency performance is greatly depended on the K coupling factor

IsoVolt with PCB transformer performance is same as IC with integrated XFMR solution
Summary of Powering Across the Isolation Solutions

- Isolators/Drivers with integrated DC-DC are cost effective turn-key solutions
- Integrated DC-DC solution with external ferrite transformers offer
  - Higher power and efficiency
  - Larger size
- Internal transformer solutions offer
  - Smaller size
  - Reduced efficiency, power, and increased EMI
- A novel PCB transformer solution was demonstrated
  - Lower cost
  - Comparable efficiency and power to internal solutions
- The best solution for your application will depend on your system needs
Thank you!

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