LTCC Technology for Low Profile Magnetics Integration

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VirginiaTech Invent the Future

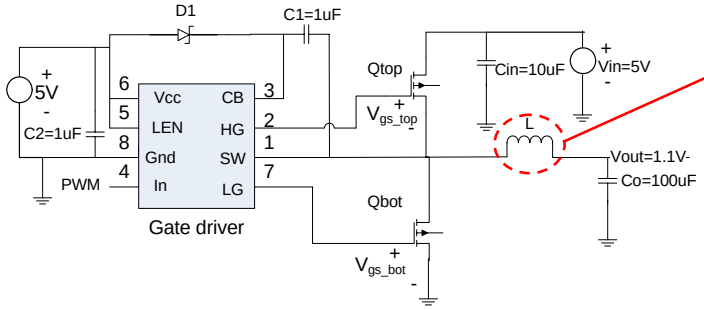
1. What is LTCC

- LTCC: **L**ow **T**emperature **C**o-fired **C**eramics
- Tapes are commercially available
- Starting material is in tape form, 60-100μm thickness
- Tapes are laminated to desired thickness before sintering
- Conductors are in paste form
- Typical sintering temperature is around 900 ºC
- All processing is done in "green" state, before sintering
- A technology useful for integrating passive components < 200 W

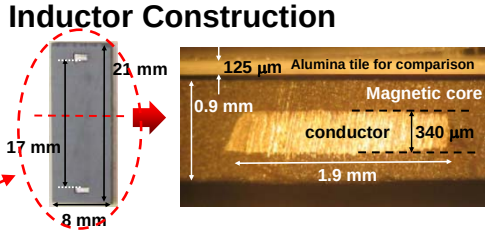
2. Motivation

- Explore the possibilities for low profile inductors for load converters using LTCC technology
- Develop a magnetics integration technique suitable for high current application

3. Converter Topology



4. Inductor Construction



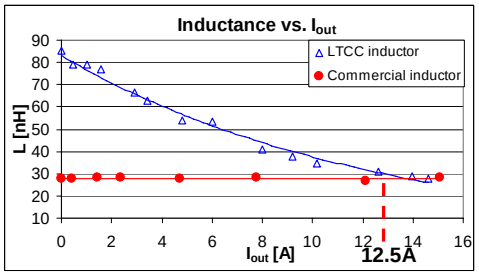
Cross-sectional view of an LTCC inductor

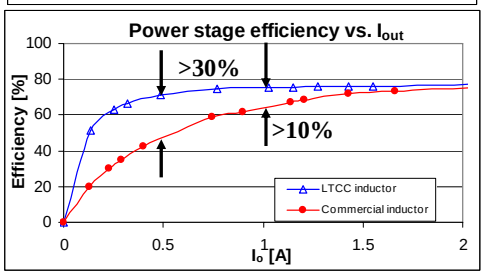
5. Comparison of LTCC Technology with PCB

	LTCC	PCB
Temperature Capability	500 ºC	135 ºC
Metal scheme	Silver alloy	Copper
Metal stability	Stable	Oxidises at elevated temperature
CTE (silicon)	4 ppm/K	4 ppm/K
CTE (metal)	-	17 ppm/K
CTE (substrate)	4-7 ppm/K	17 ppm/K
Thermal cond.	4 W/mK	0.3 W/mK
Elec. Cond. Of metal	> 1.7e7 S/m	5.8e7 S/m

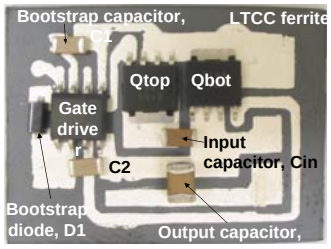
LTCC is more feasible for integrating with silicon

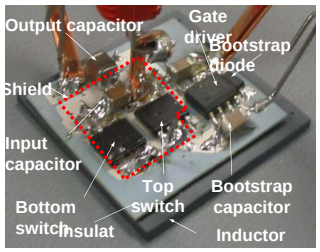
6. Light Load Efficiency Improvement using LTCC inductor

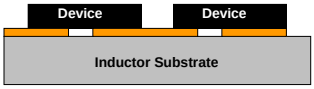




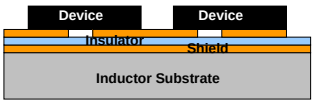
7. Shielding for LTCC Inductor as Circuit Substrate



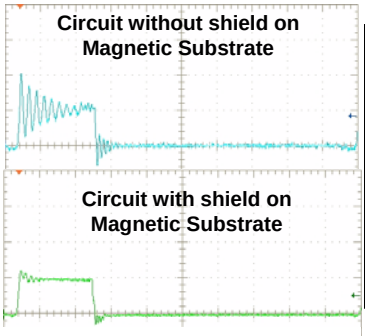




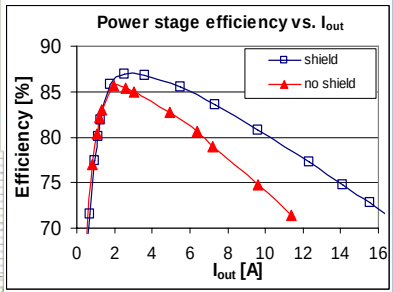
Converter Circuit on Inductor Substrate



Shielded Converter Circuit on Inductor Substrate



Voltage waveform at switching point of Buck converter



8. Advantages of Using Inductor as Circuit Substrate

- Footprint reduction
- Reduced resistive loss compared with co-packaged inductor
- Prospect of integrating with silicon devices due to good CTE match
- Improved thermal conductivity compared with polymer based substrate

9. Disadvantages of Using Substrate Inductor

- Shielding required due to presence of magnetic substrate
- Reduced thermal conductivity compared with Al_2O_3 or AlN substrate material