Focus on LLC and LCC Resonant Transformers

www.itacoilweb.com

Benefits of LLC and LCC

LLC resonant topology is rapidly growing on the market, it is becoming the most used in the design of 50...500W power converters
LCC is less known and applied, but still very beneficial in some cases
https://www.itacoilweb.com/llc-lcc-resonant-topologies/

Benefits	Drawbacks
• High efficiency	• Tank design complexity
• Low EMI-EMC	
• Reduced component stress	
• Very high transformer power density	
• High power peaks management	

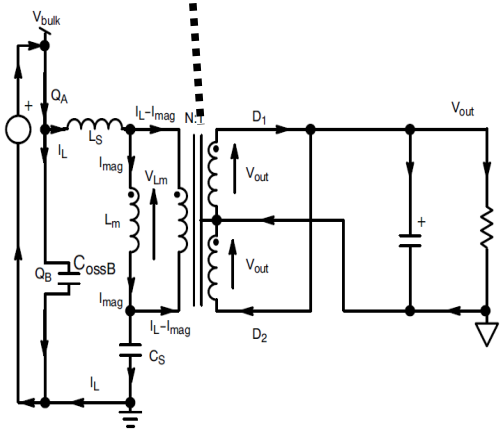
We have the solution!

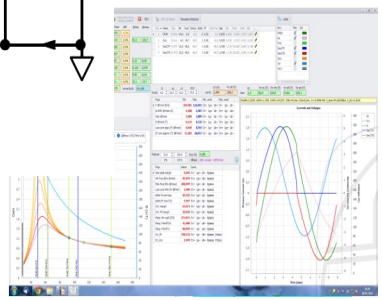
When we started...

2007 2008 2013 2014

Empirical approach

FHA based approach





LLC/LCC Tank Design

The FHA (First Harmonic Approximation) calculation method is the most commonly used BUT it introduces large approximations

Our design platform based on a high frequency SPICE engine includes:

- Check that the Zero Voltage Switching (ZVS) is kept in all the conditions considering the worse tolerances of the components
- Specific optimization for Fixed, Programmable or Adaptive Dead Time
- Algorithms for defining the most effective resonant tank
- Evaluation of all the transformer related constraints
- Accurate power loss calculation
- Tank behavior simulation
- Report with tank parameters and simulated waveforms

Benefit for Designers

- All the specific parameters of the LLC/LCC tank are defined by our design (Freq. Range, Resonant Capacity, Resonant Inductance, etc.)
- No troubles even with the first LLC/LCC project
- Development time dramatically reduced → shorter Time-to-Market
- Time to focus on the other design aspects common to all the other topologies (components selection, protections and feedback setup, etc...)

Where we are

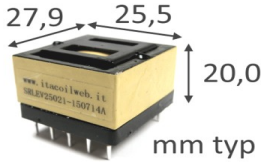
- Nowadays we are recognized as a technological leader in the resonant tank and transformer design
- We are cooperating with the leading IC manufacturers in the development of resonant demo-boards and special projects

public examples on
https://www.itacoilweb.com/portfolio/original-demo-boards/

Resonant Portfolio

- **wide range of standard LLC integrated transformers on stock**

- **best power density on the market:**
  last developed size up tp 185W
  13 W/cm³ with 50°C Trise (>40Vdc out)



- **particular dimensional requirements can be sampled in few weeks even with new bobbin design**

- **qualified electronic design consulting service on request**

more info on: https://www.itacoilweb.com/
Latest products launched: https://www.itacoilweb.com/news/

Itacoil vs. Competitors

Comparative Transformers on commercial demo-boards(*):

Evaluation board	full load efficiency	transformer power density
STMicroelectronics® STEVAL-LLL009V1 – 300W 36-48V	+1,60%	+35%
Fairchild® FEB212-003 - 200W 24V	+0,60%	+116%
NXP® UM10450 - 90W V 19,5	+0,16%	+59%
STMicroelectronics® EVL130W-SL-EU – 130W 48V	+0,84%	+65%
Power Integrations® RDR-239 – 150W 24V	+0,23%	+108%

(*) detailed comparative test reports on our website:

https://www.itacoilweb.com/portfolio/improved-demo-boards/

Efficiency at no Cost

Efficiency improvement using larger Mosfet ….. BUT with a Δ cost

LLC stage Output power (W)	Tank current (Arms)	Mosfet Type	Rds_on	conduction loss (W)	efficiency impact	mosfet cost (€ for 5k pcs)
200	1,7	FCP11N60F	380	1,10	0,55%	1,41
200	1,7	FCP190N65F	190	0,55	0,27%	1,48

efficiency improvement → +0,27% BOM impact → +0,14 €

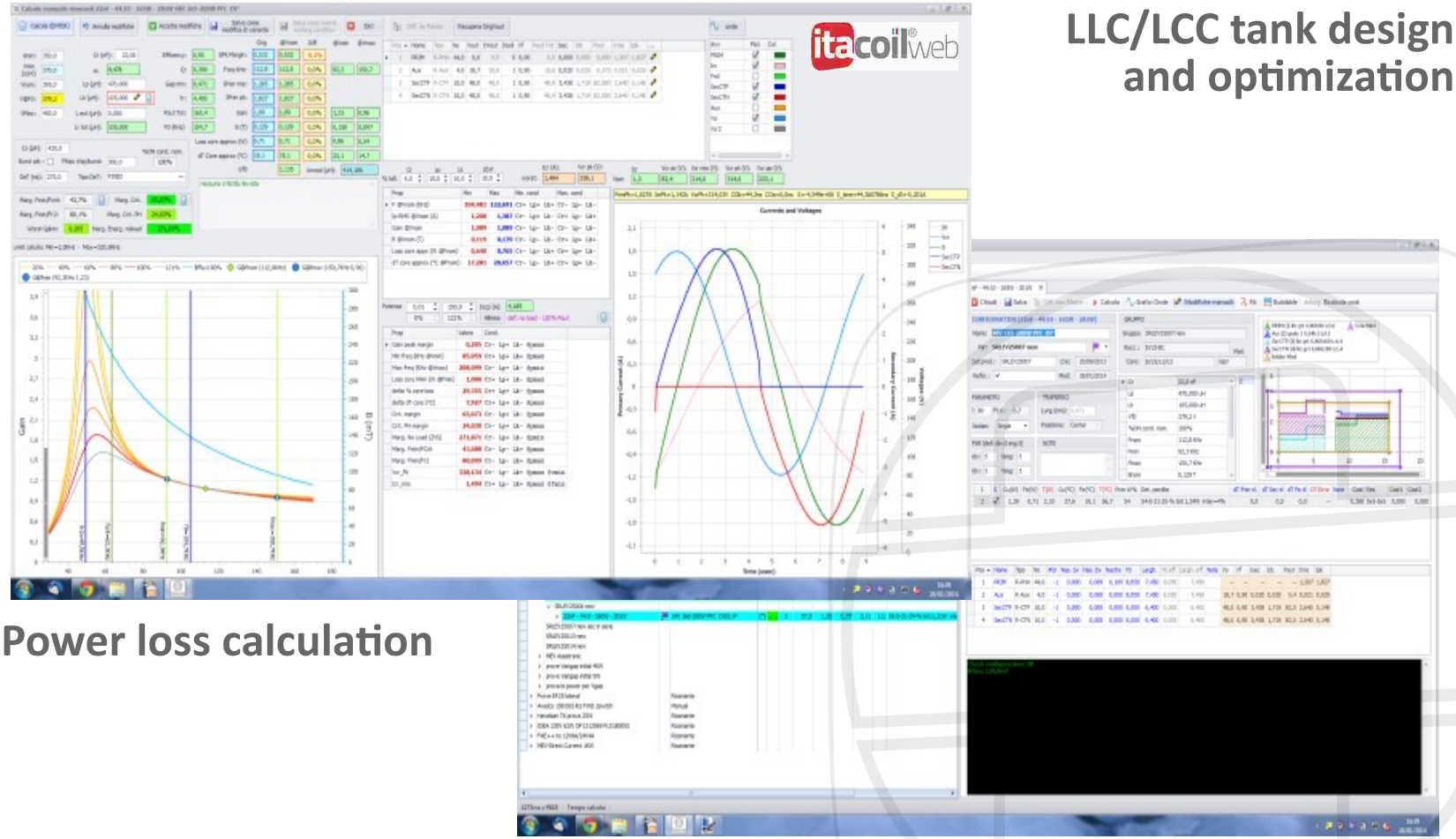
LLC stage Output power (W)	Tank current (Arms)	Mosfet Type	Rds_on	conduction loss (W)	efficiency impact	mosfet cost (€ for 5k pcs)
200	1,7	STP11NM60	400	1,16	0,58%	1,34
200	1,7	STP20NM60	250	0,72	0,36%	2,23

efficiency improvement → +0,22% BOM impact → +1,78 €

Evaluation board	full load efficiency	transformer power density	Cost Saving (*)
STMicroelectronics® STEVAL-LLL009V1 – 300W 36-48V	+1,60%	+35%	€ 0,53
Fairchild® FEB212-003 - 200W 24V	+0,60%	+116%	€ 0,12
NXP® UM10450 - 90W V 19,5	+0,16%	+59%	€ 0,15
STMicroelectronics® EVL130W-SL-EU – 130W 48V	+0,84%	+65%	€ 0,18
Power Integrations® RDR-239 – 150W 24V	+0,23%	+108%	€ 0,04

(*) : BOM cost saving estimate for 5k transformers

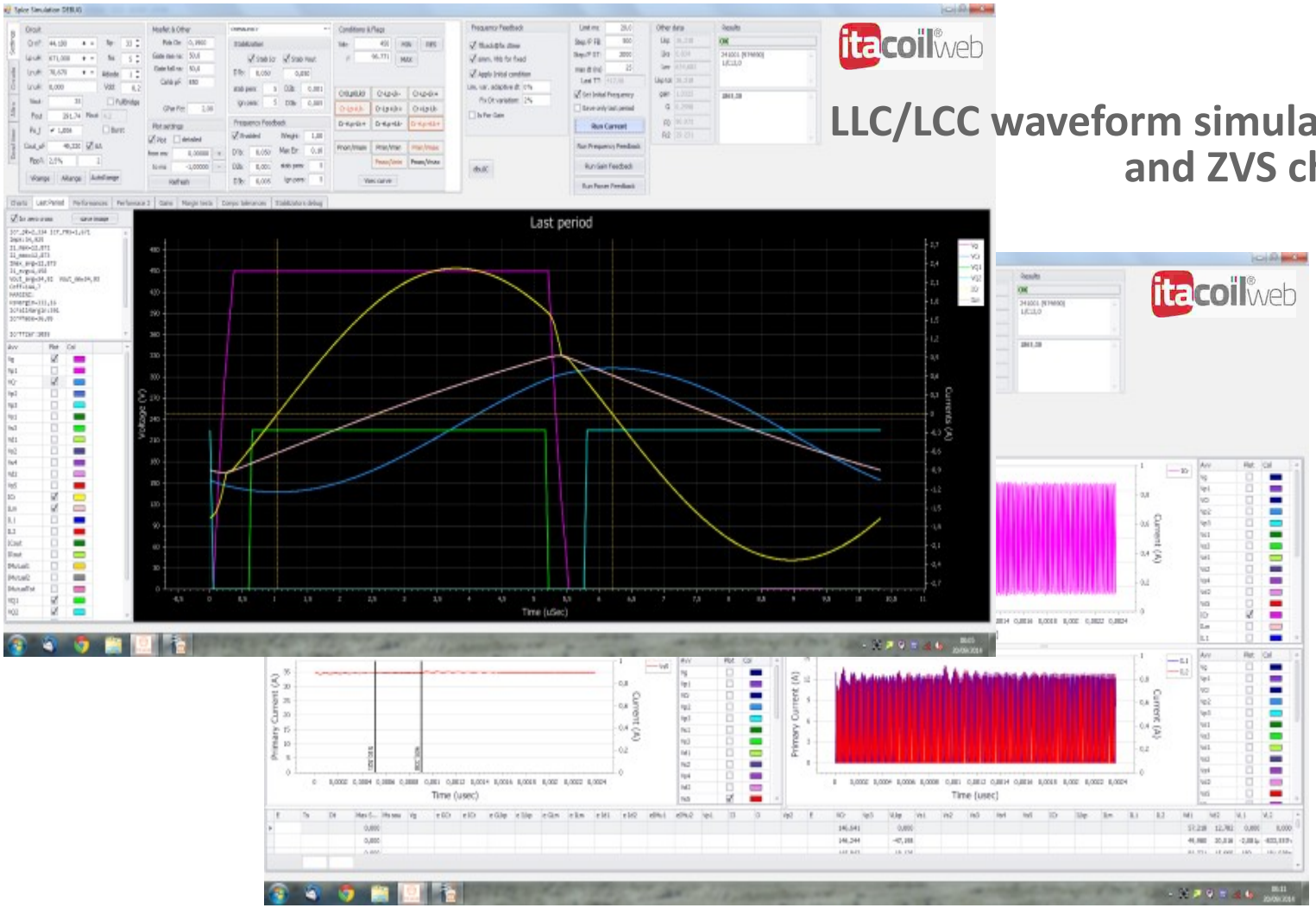
Optimization



LLC/LCC tank design and optimization

Power loss calculation

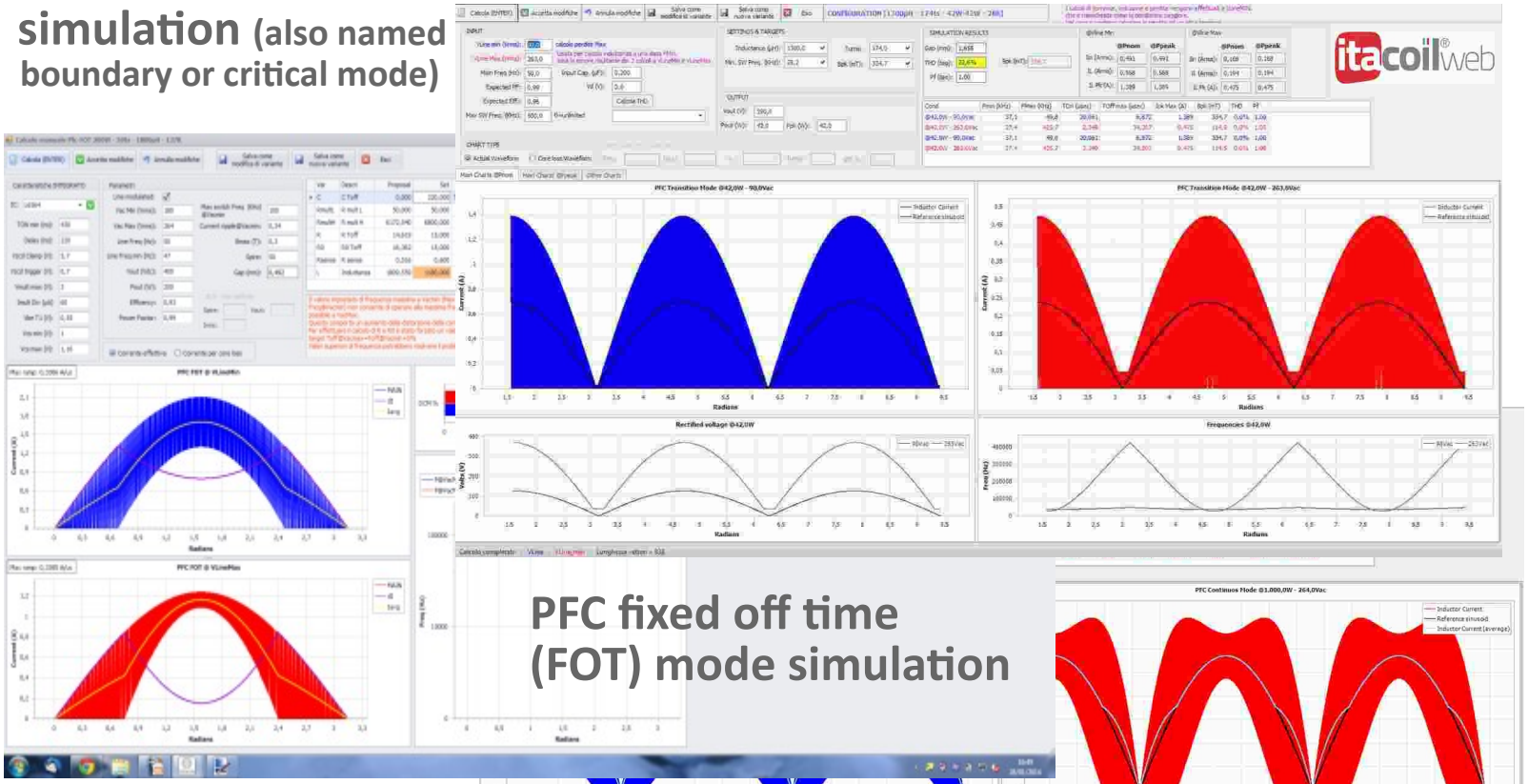
Simulation



LLC/LCC waveform simulations and ZVS checks

PFC Simulation

PFC transition mode simulation (also named boundary or critical mode)



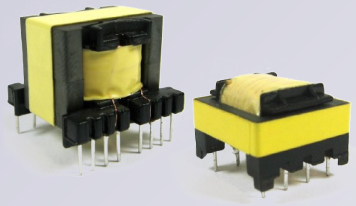
PFC fixed off time (FOT) mode simulation

PFC fixed frequency (CCM) mode simulation

Kit for LLC/LCC topology

LLC and LCC
Resonant Tr.

PFC Inductors



One-stop-shop

EMI/EMC and
Smoothing filters

Common Mode
Chokes