
Development of a 600W Power Supply

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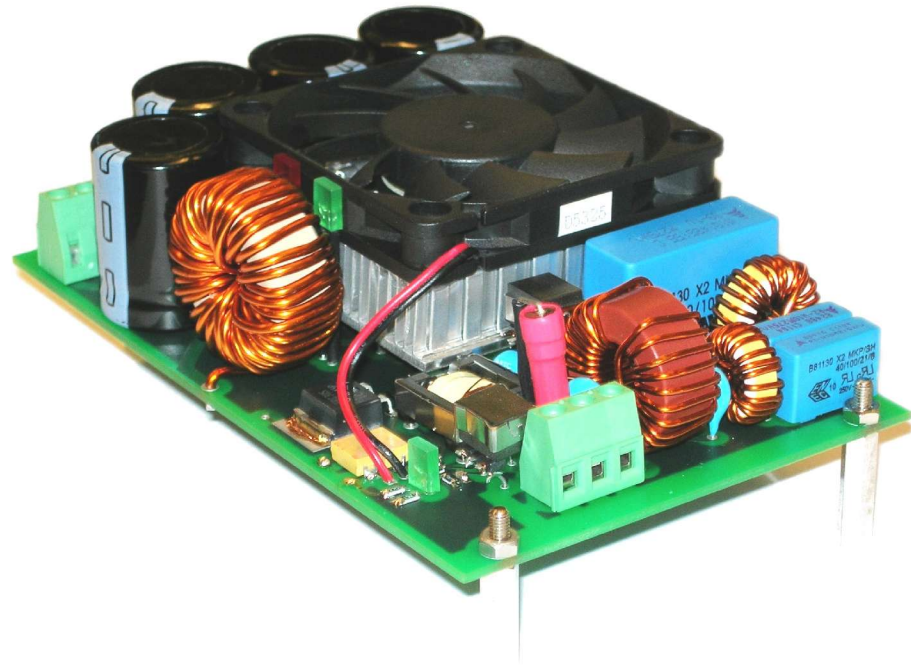
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Swiss Federal Institute of Technology Zurich



Power Electronic Systems
Laboratory

Presentation Overview

1. Introduction
2. Topology Evaluation
 - Evaluated Converters
 - Results
3. Power Circuit Design
 - Input Filter
 - Power Stage
 - Auxiliary Power Supply
 - Control
4. Construction & Testing
5. Performance
6. Unsolved Problems
7. Future Investigations

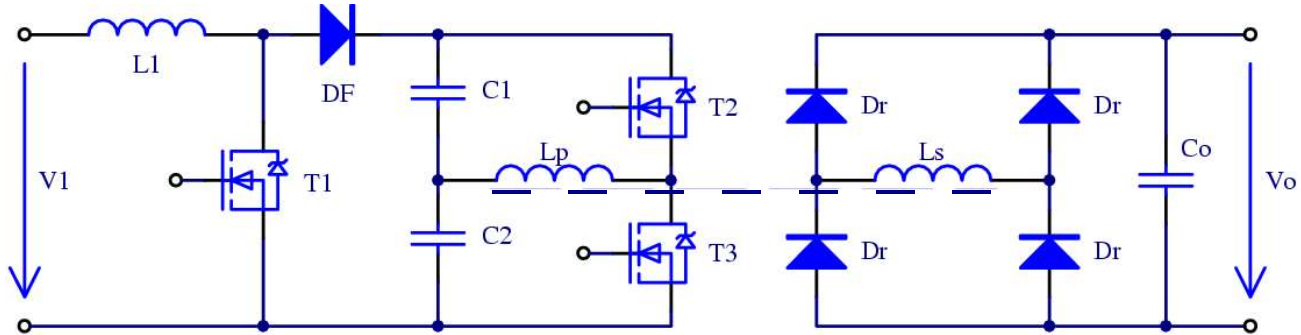


1. Introduction

- 600W PFC
- universal input
- galvanic isolation
- hold up time of half a mains period
- high efficiency
- small dimensions

2. Topology Evaluation

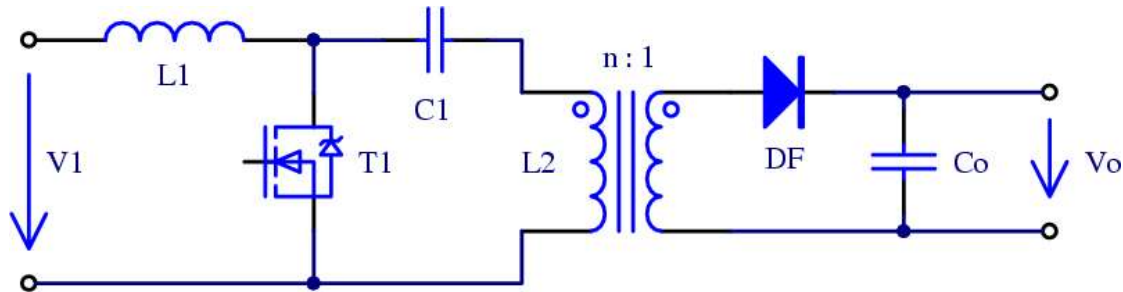
Two-Stage Converter



	I_{avg} [A]	I_{rms} [A]	P [W]
Di	4.8	3.1	3.5
L1	6.1	6.8	
T1	13.7	5.9	10.4
DF	1.5	3.5	1.2
C1,2		3.1	0.3
Lp		4.6	
T2,3	1.5	3.0	2.7
Dr	6.3	4.6	4.7
Co		2.3	0.2
		Total	50.3

2. Topology Evaluation

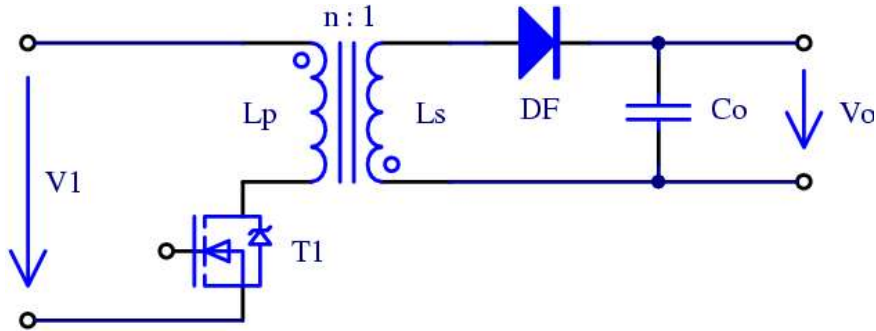
SEPIC Converter



	I_{avg} [A]	I_{rms} [A]	P [W]
Di	4.8	3.1	3.5
L1	6.1	4.8	
L2	12.5	10.1	
T1	6.1	12.2	44.6
DF	12.5	18.4	13.1
C1	0	6.8	1.4
C2	0	13.4	5.4
		Total	78.5

2. Topology Evaluation

Tripple Output Flyback Converter



	I_{avg} [A]	I_{rms} [A]	P [W]
Di	3.1	7.6	2.9
Lp	6.1	15.2	
T1	6.1	15.2	69.1
DF	4.2	13.0	5.1
Co		14.9	6.6
		Total	115.8

2. Topology Evaluation

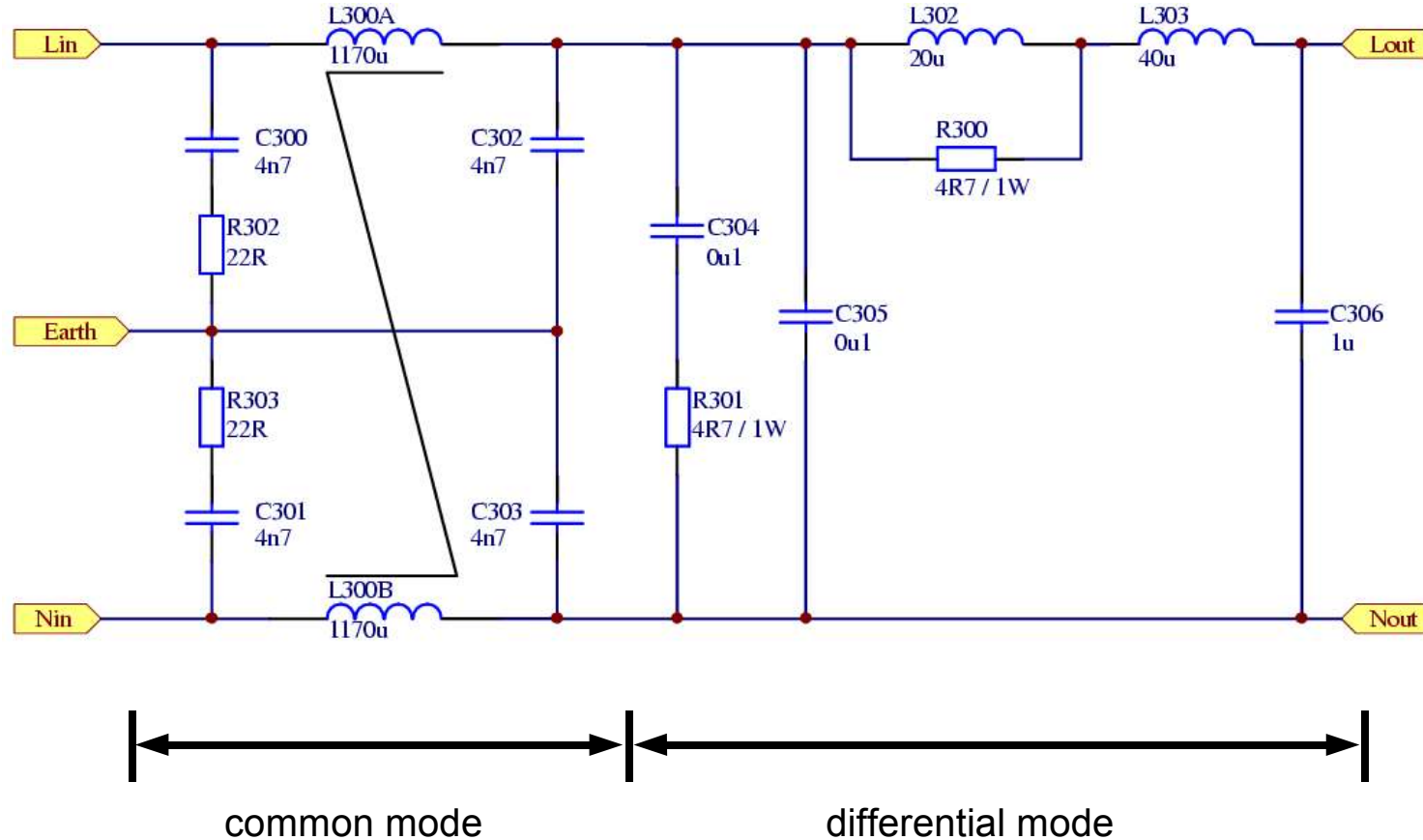
Results

	P [W]	AUX [W]	Total [W]	Eff. calc. [%]	Eff. sim. [%]
two-stage	50	13	63	89	85
sepic	79	10	89	85	69
flyback3	116	10	126	79	

- two-stage: winner
- sepic: too large currents in the switch
- flyback3: discontinuous mode, too high peak currents

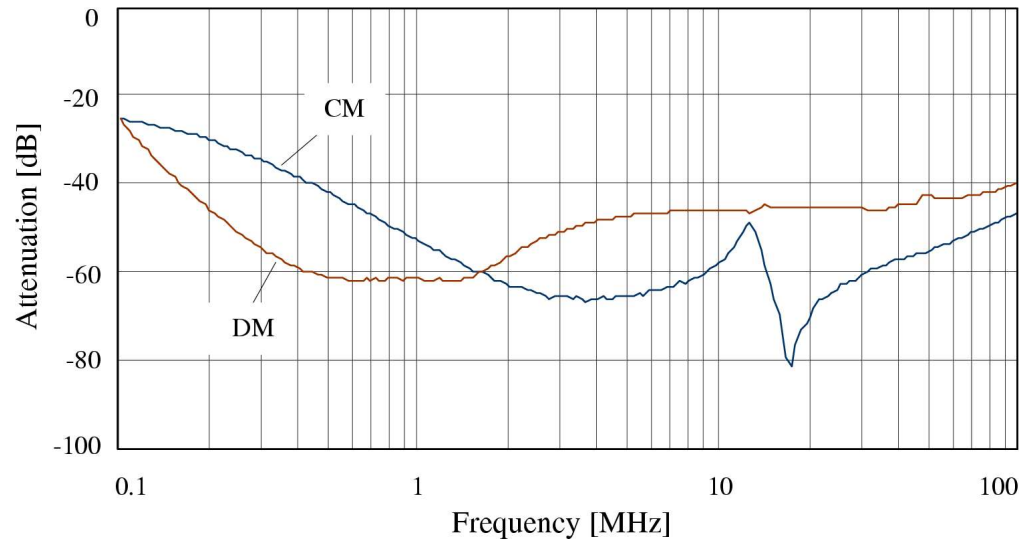
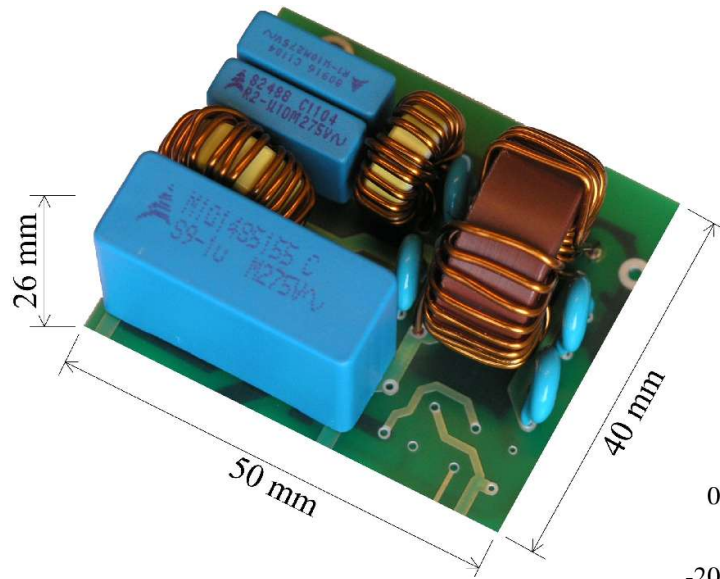
3. Power Circuit Design

Input Filter



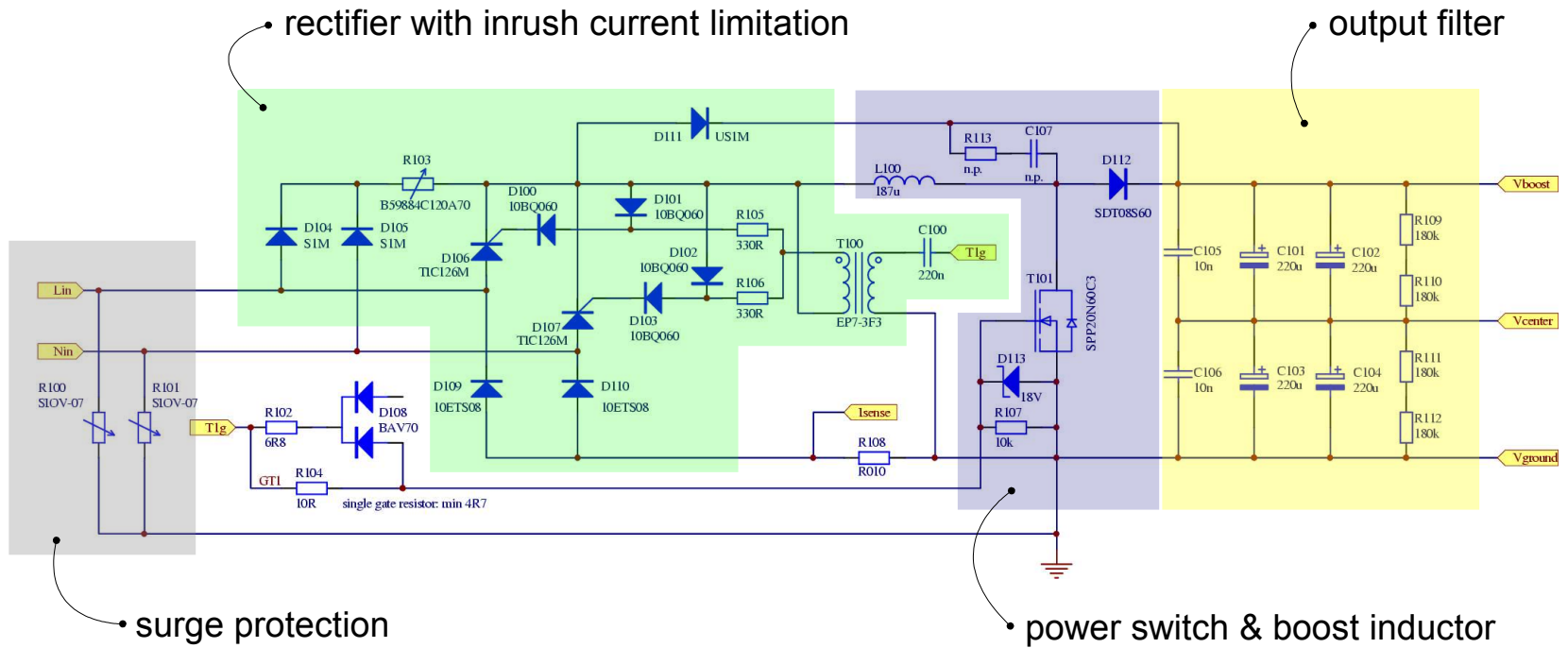
3. Power Circuit Design

Input Filter



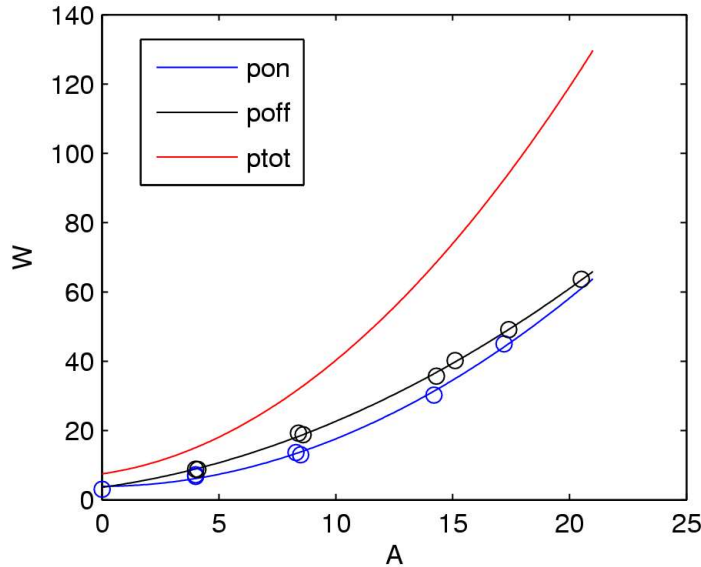
3. Power Circuit Design

Power Stage

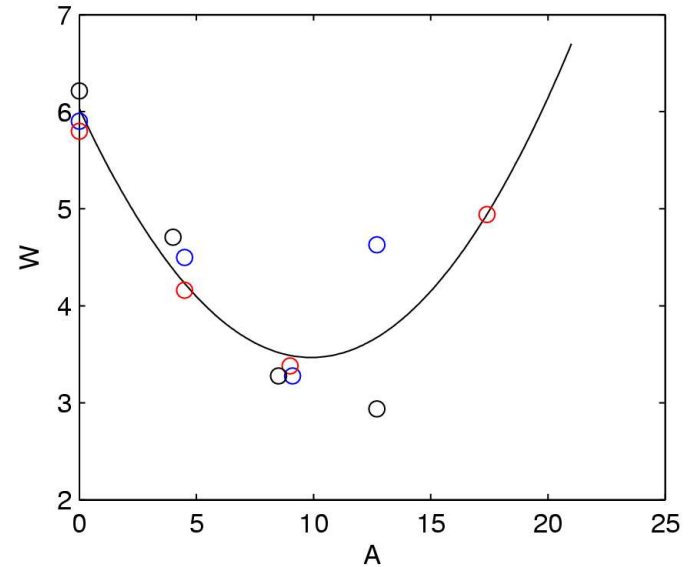


3. Power Circuit Design

Losses Measurement & Thermal Design



MOSFET, 20A, 600V
measured at 410V

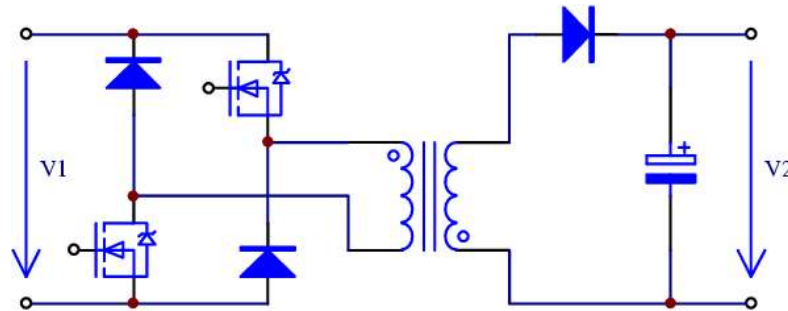


diode, 8A, 600V
measured at 410V

- total losses of 46W in the MOSFET and 7W in the diode
- for the whole converter: 6 x 6 cm heatsink with fan, $\leq 0.7\text{K/W}$ thermal resistance

3. Power Circuit Design

Auxiliary Power Supply



- minimum input voltage: 105 Vdc
- maximum input voltage: > 500 Vdc
- nominal power: 13 W
- output voltage: 15 Vdc
- continuous mode of operation at nominal load
- 250kHz, EFD15-3F3 core, ~1W copper & core losses

3. Power Circuit Design

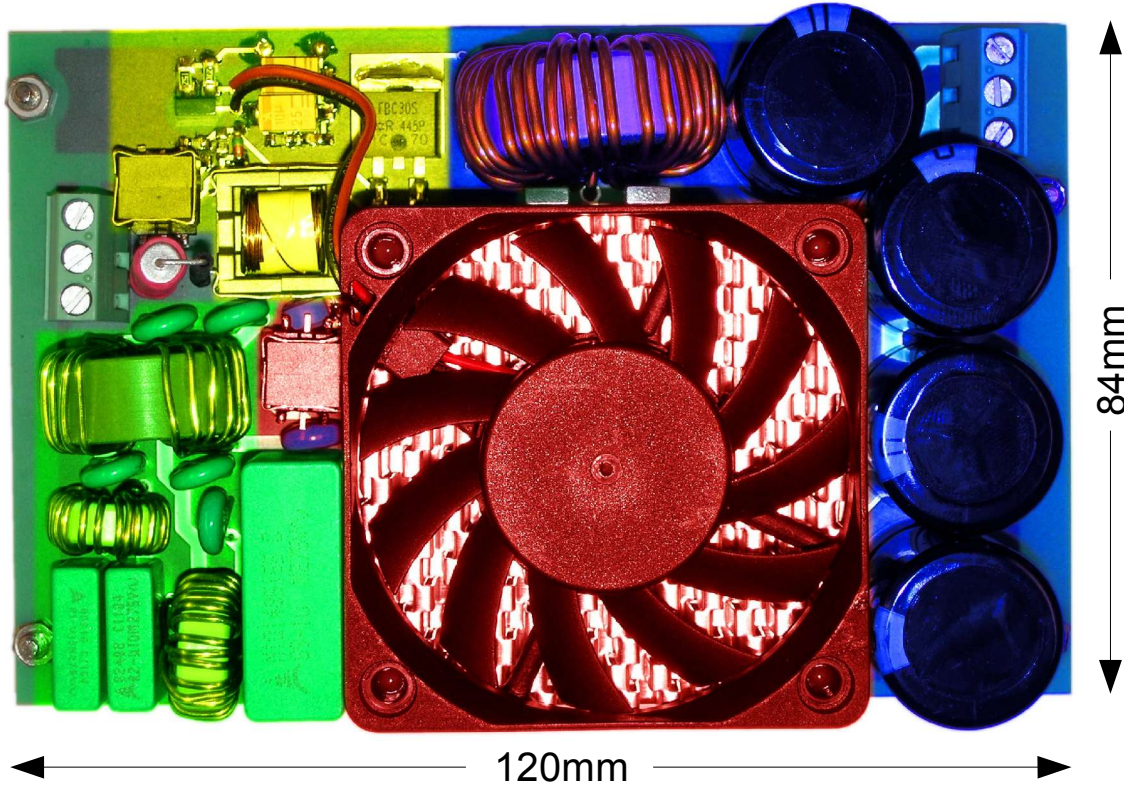
Control

- Texas Instruments UCC28513 PFC/PWM controller with two gate drivers
- second gate driver used for auxiliary power supply
- synchronised switching of boost and flyback converters

- PFC voltage control loop designed to stay stable at low loads (39° PM @ 10W)

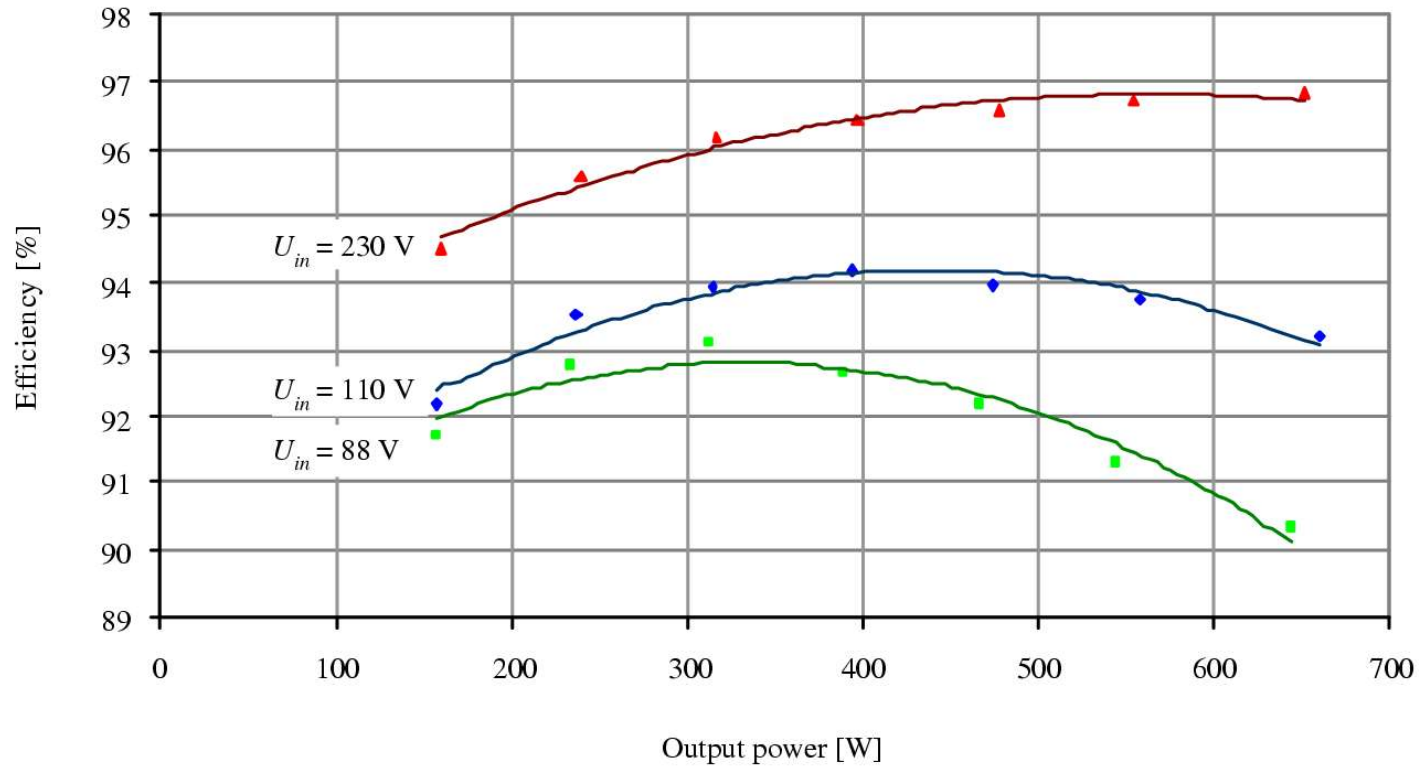
- disadvantages of the UCC28513:
 - no slow start of the PFC part supported
 - high threshold on the input voltage of the PWM part before starting it

4. Construction & Testing

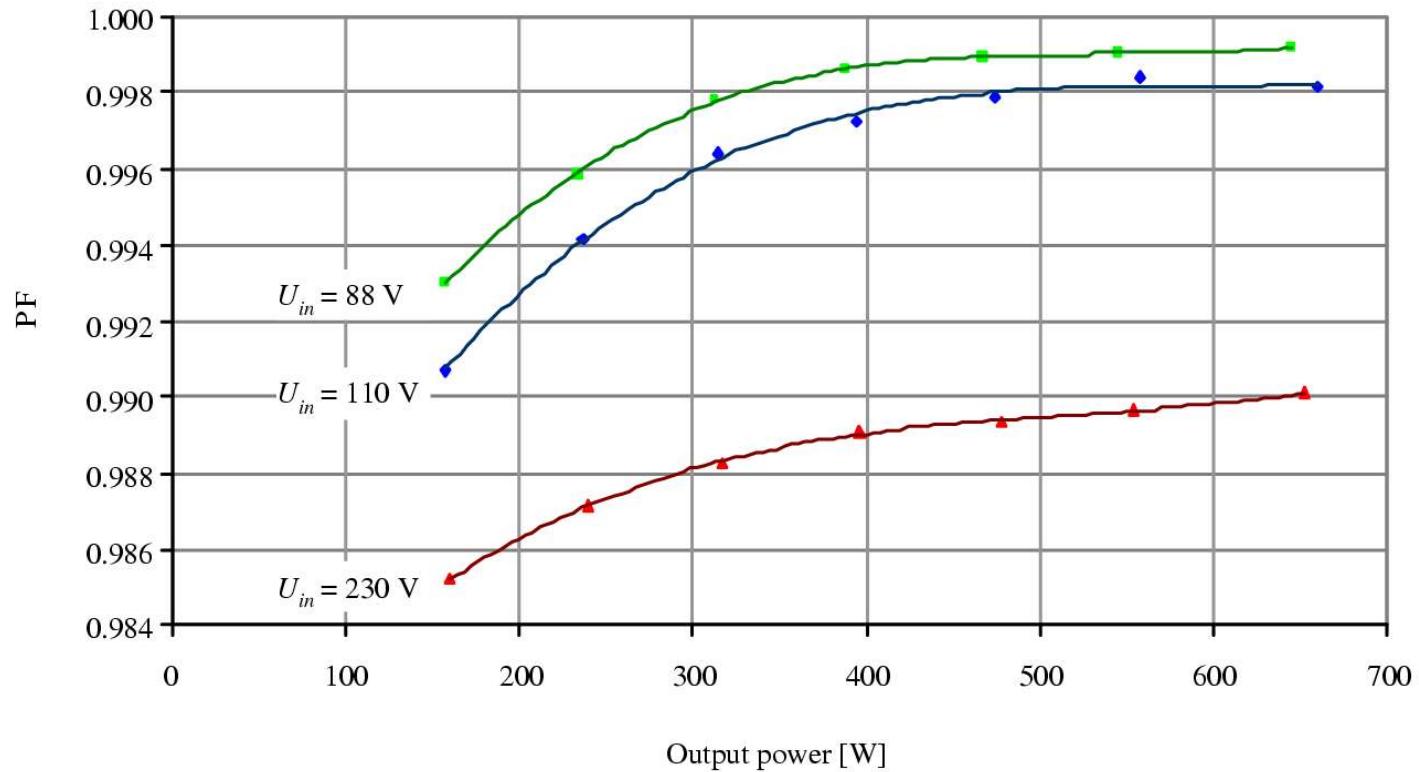


- 120 x 84 x 37mm
- 1.77 kW/l
- input filter: 13%
- power: 36%
- output filter: 29%
- aux-supply: 7%
- total: 85%

5. Performance Measurements Efficiency



5. Performance Measurements Power Factor



6. Unsolved Problems

- snap through at nominal voltages
 - probably due to large output voltage overshoot during start-up
 - problem solved by Marcelo: control loops and biasing modified
- high threshold of controller chip enables aux supply too late
 - bootstrap supply needs to be modified

7. Future Investigations

- develop another bootstrap circuit; use a separate controller for the AUX supply
- measure the losses in the flyback's MOSFETS to eventually take smaller devices
- try to drive the boost MOSFET more aggressively to reduce switching losses
- verify PFC functionality (THD, ...)

