Designing a better Amiga PSU

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Overview

- Existing solutions
- Original Commodore spec
- Load performance, observations
- Strategies against voltage drop
- Milestone: New specification
- Basic principle of DC-DC conversion
- Compensation circuit & performance

Existing solutions

- Commodore transformer-based PSU
- Commodore switch mode PSU
- Meanwell-based second-source
- Cisco-based second-source
- Modified ATX PSU

Original Commodore specification

- http://www.kaiiv.de/servicemanuals/A500_Power_Supply_Specification.pdf
- **Very strict specification:**

2.3 DC Output Parameters

2.3.1 Continuous power: (any combination of loads) — Minimum: 4.5 Watts, Maximum: 23 Watts

2.3.2 Output current range

Output	Output current Min.	Max.
#1 +5 VDC	0.75A.	3.0A.
#2 +12VDC	0.05A.	0.5A.*
#3 -12 VDC	0.01A.	0.1A.

* Startup surge up to 1 amp for 20 mSec., while remaining within regulation requirements (See Section 2.3.10)

2.3.3 Worst case regulation

This parameter includes line, load, initial set point, temperature, drift, cross regulation, and aging effects

Output	Regulation
#1 +5 VDC	+/-5%
#2 +12VDC	+/-10%
#3 -12 VDC	+/-10%

2.3.4 Ripple and Noise

Power supply to be set at full load, minimum input conditions

Output	Ripple and Noise, Max.
#1 +5 VDC	50mV
#2 +12VDC	120mV
#3 -12 VDC	120mV

2.3.5 Initial setting

Power supply to be set to nominal load, measured at the end of the cable

Output	Setting
#1 +5 VDC	+/-0.05V
#2 +12VDC	N/A
#3 -12 VDC	N/A

2.3.6 Overcurrent protection [1]

Power supply to be at minimum load

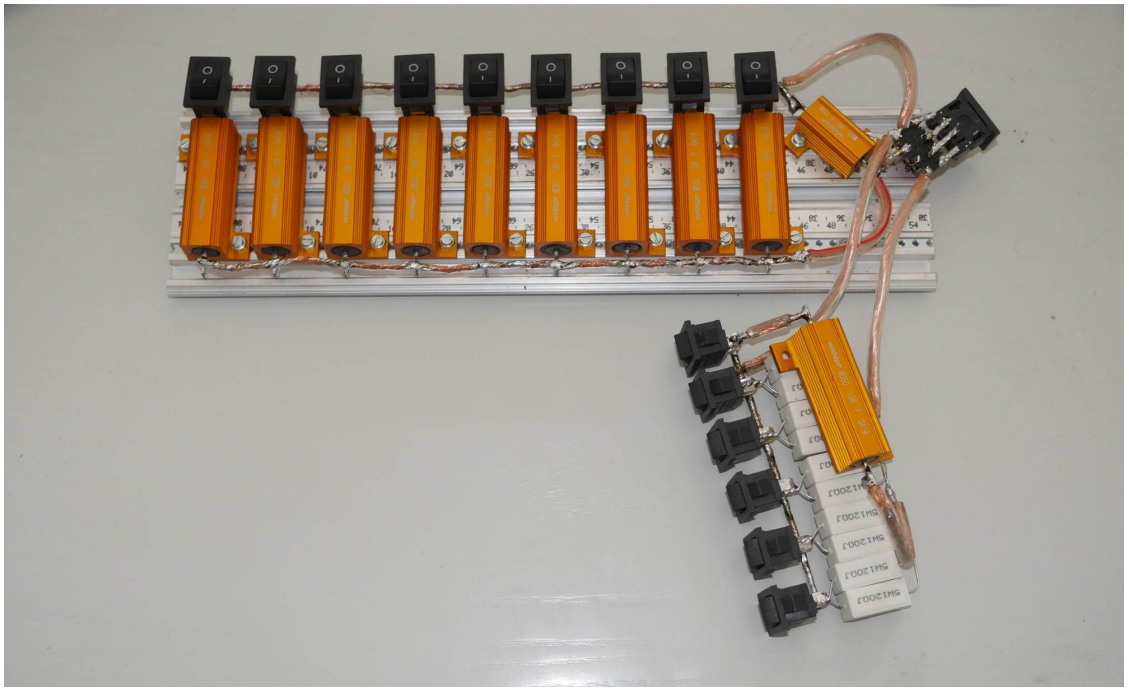
Output	Current
#1 +5 VDC	8.0 A max.
#2 +12VDC	3.0 A max. [2]
#3 -12 VDC	3.0 A max. [2]

Commodore | TITLE: POWER SUPPLY EXTERNAL

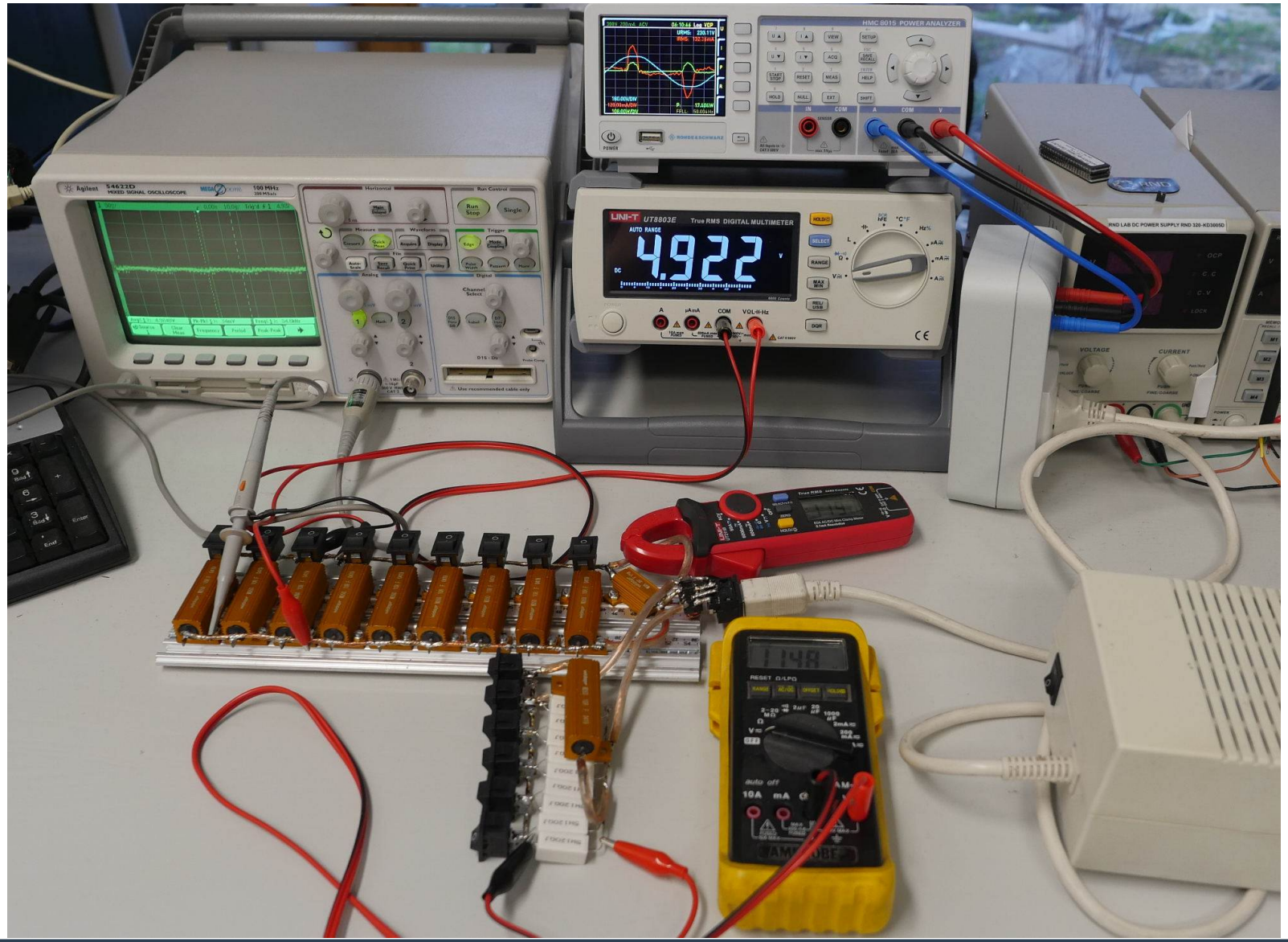
How to apply load

„electronic load“ is problematic, as it may cause oscillation

=> classic load with resistors

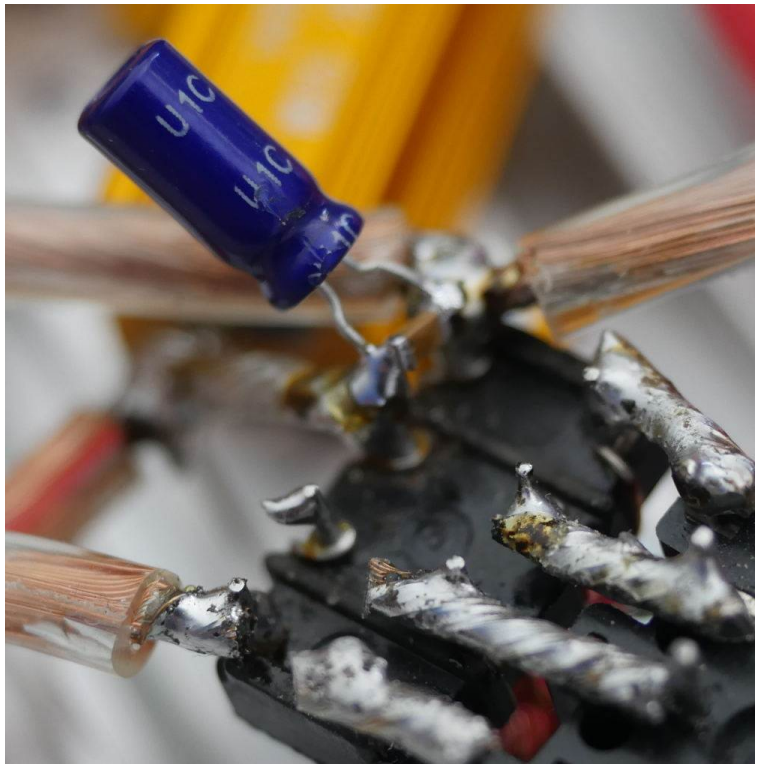


Measurement setup

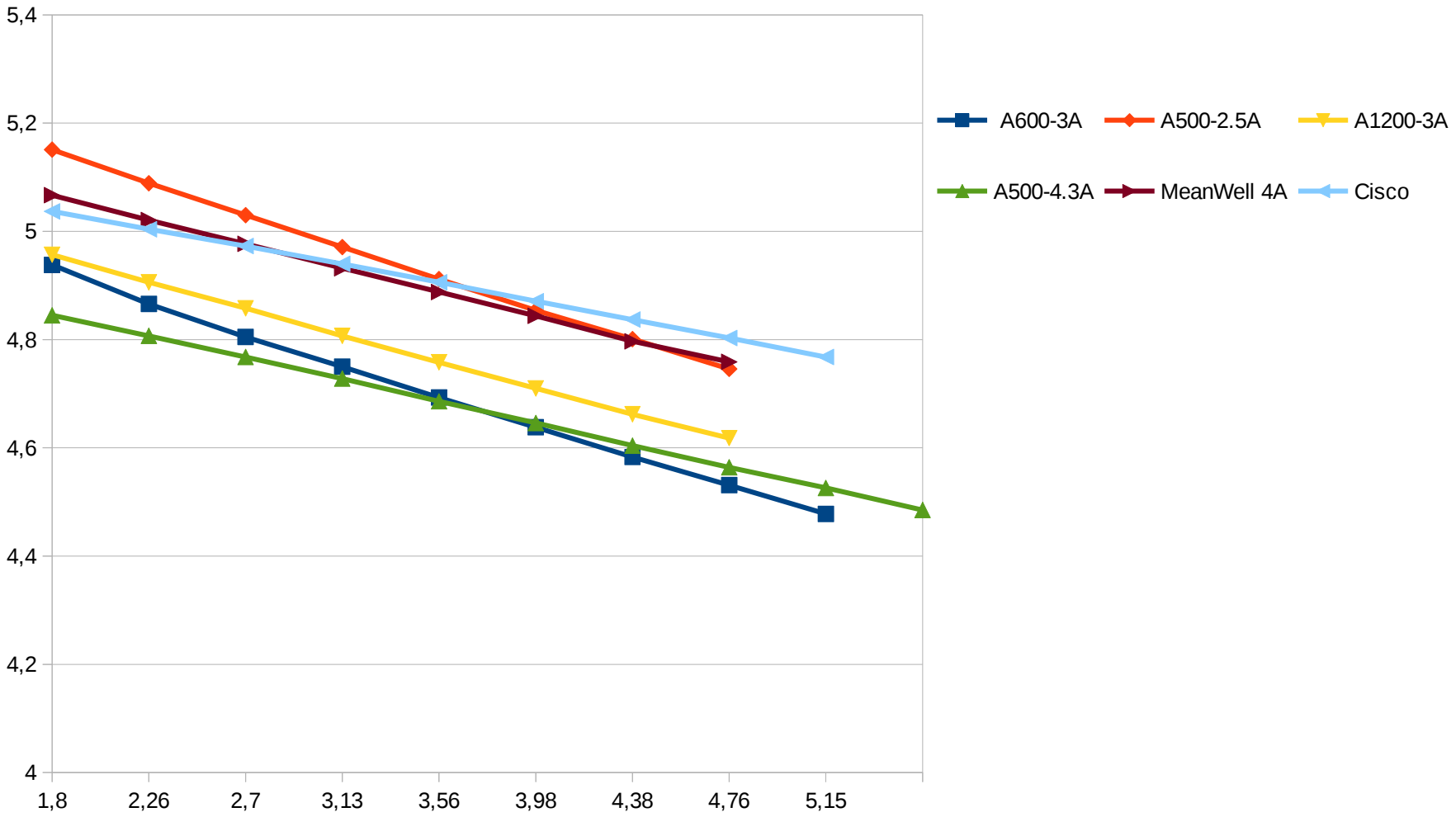


Ripple measurement (from spec)

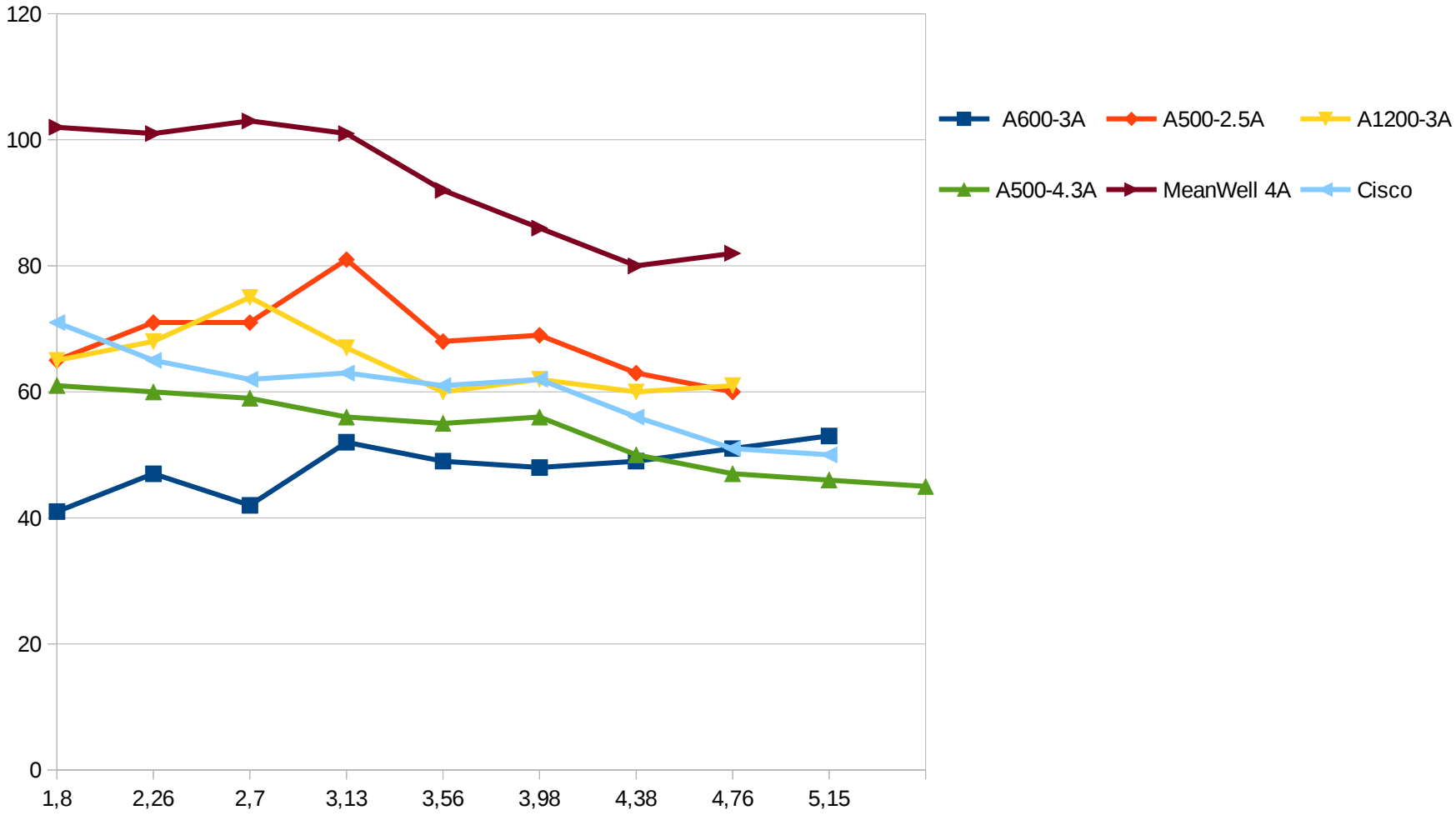
(1) Ripple and noise shall be measured at full rated load and shall be the peak-to-peak value combining noise and ripple levels for each output. (Measurements shall be recorded directly at each output connector, with each output bypassed with a 10μF and 0.01μF capacitor.)



Voltage dependency on current



Ripple voltage



Observations

- Voltage drops linear with current
- Ripple is out of spec on almost all PSUs in the series of measurement
- Overload behaviour of Cisco PSU is potentially dangerous („hickup mode“)
- 5V rail changes with load on 12V

Explanations of observations

- **Voltage drop is caused by Ohm‘s law**
- **Ripple is out of spec on old PSUs because capacitors probably dry**
- **Cisco PSU is just built like that – and therefore not suitable for an expanded Amiga.**
- **12V return current flows through the same wire as 5V return current**

Strategies against voltage drop

- **Thicker wires, shorter cables**
- **Using the shield line as additional GND: bad idea!**
- **Sense wire in the cable: Will not sense voltage drop in line filter**
- **Current-dependent voltage adaption: Method of choice!**

New specification

- For use on A500, A600 and A1200
- Should handle lots of expansions
- Shall never drop below 5V for overclocking success
- Fanless: low-noise, low-temp
- Shall keep 5V stable with varying 12V load
- the switch shall be close to the computer
- Legal constraints must be handled by a small company like iComp :-)

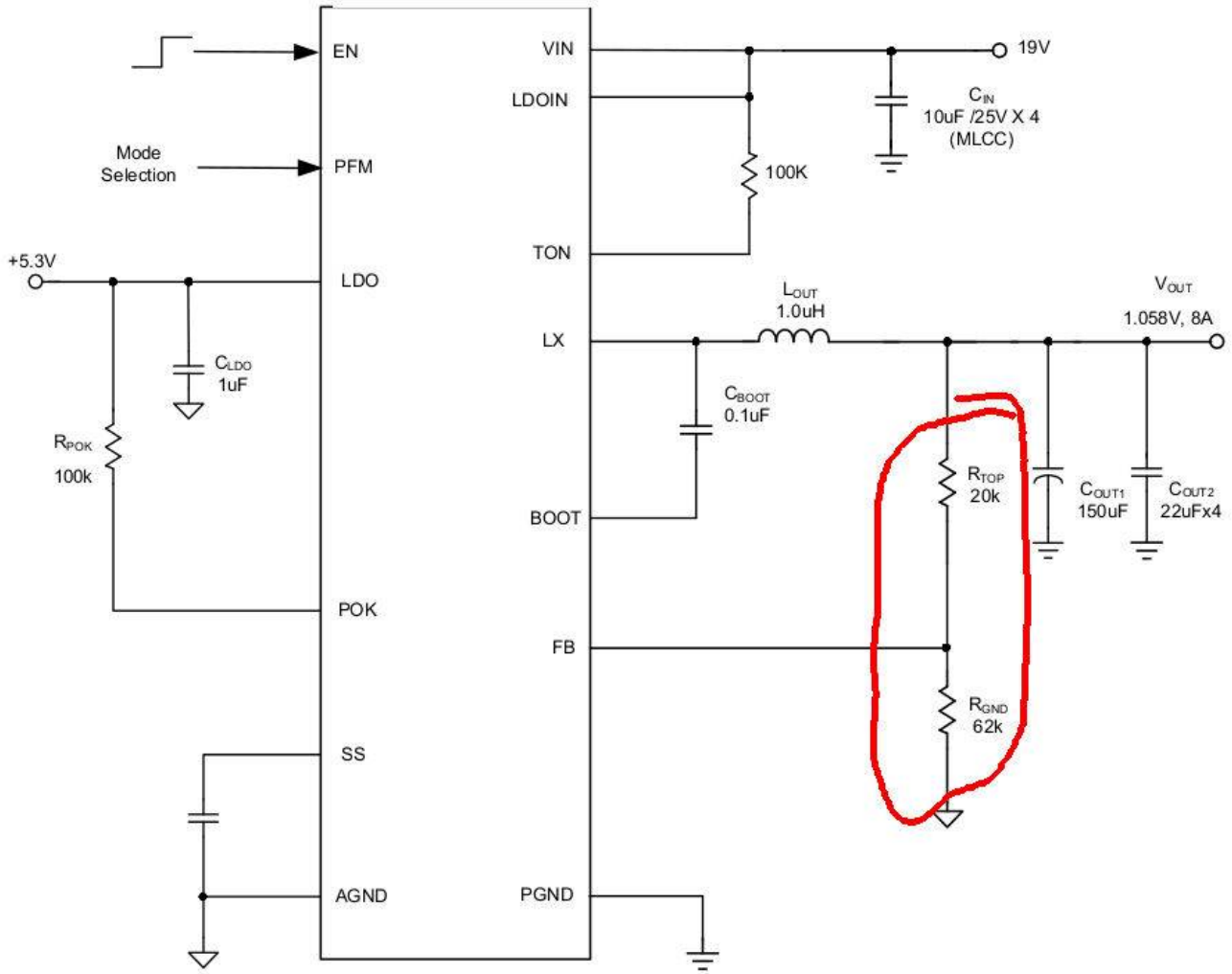
Legal constraints

- **Mains-connected devices have to go through a number of safety tests**
- **Cost of such tests are around 40.000,- EUR for global market compliance**

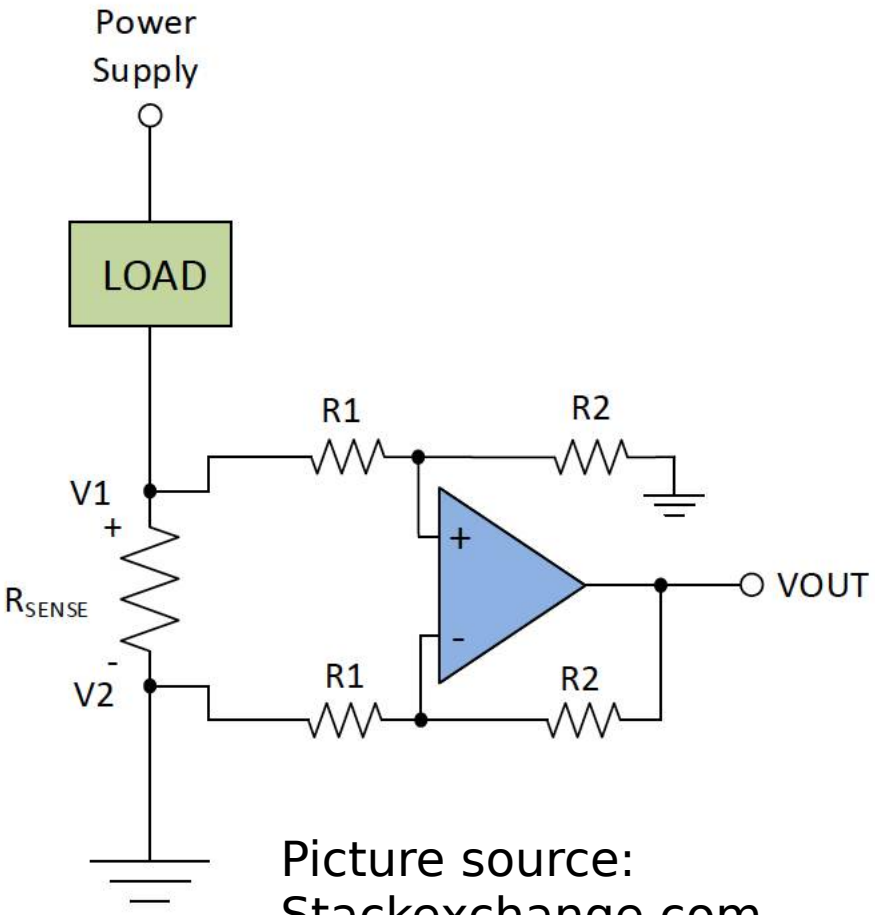
  ==> the mains-connected part must be an off-the-shelve part.
- **Malfunction might cause severe damage: We need insurance!**

DC-DC converter modding

Typical Application Circuit

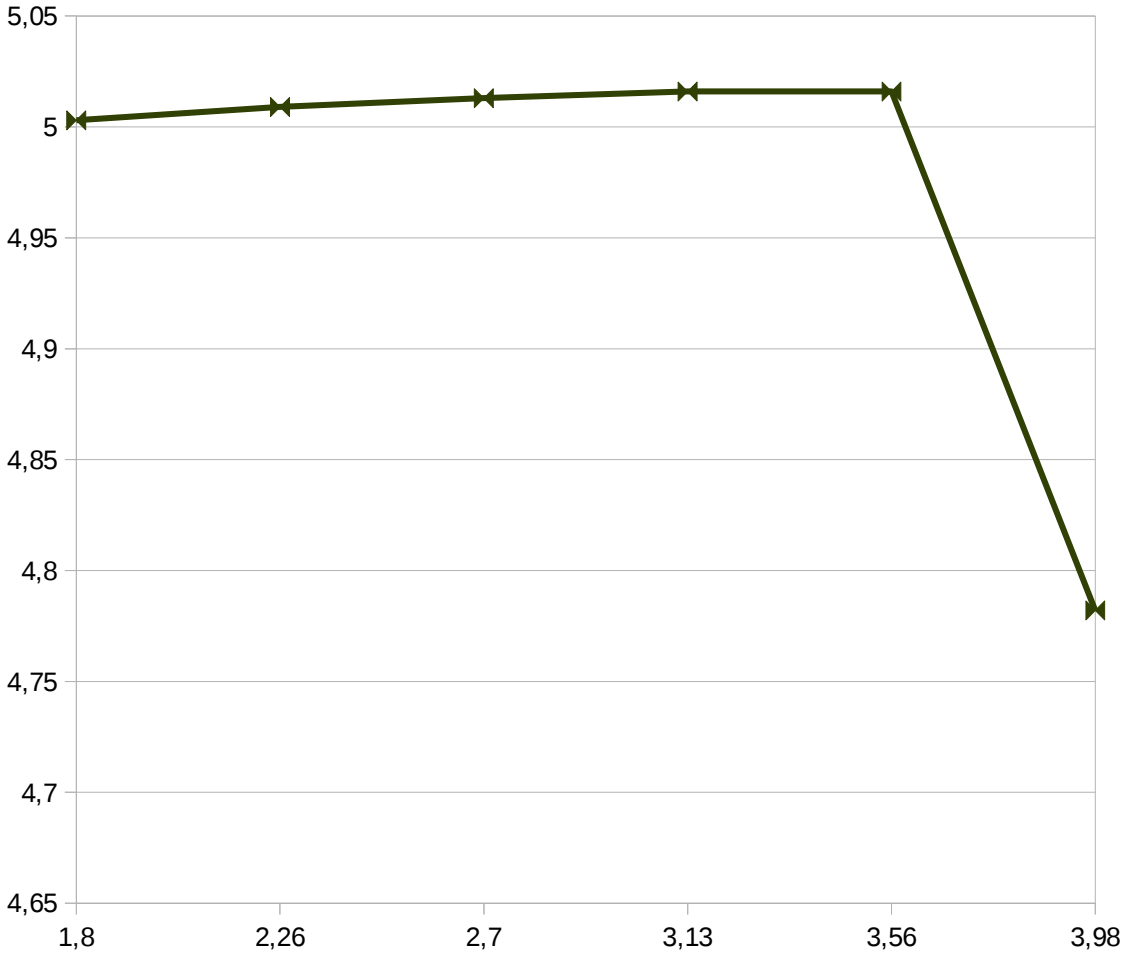


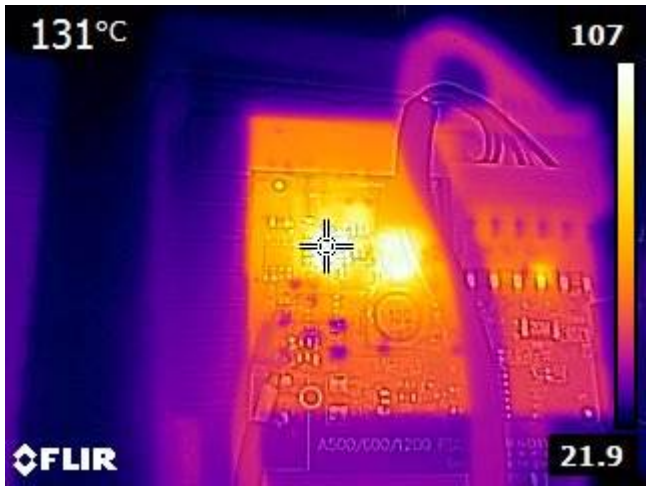
Current sensing circuit



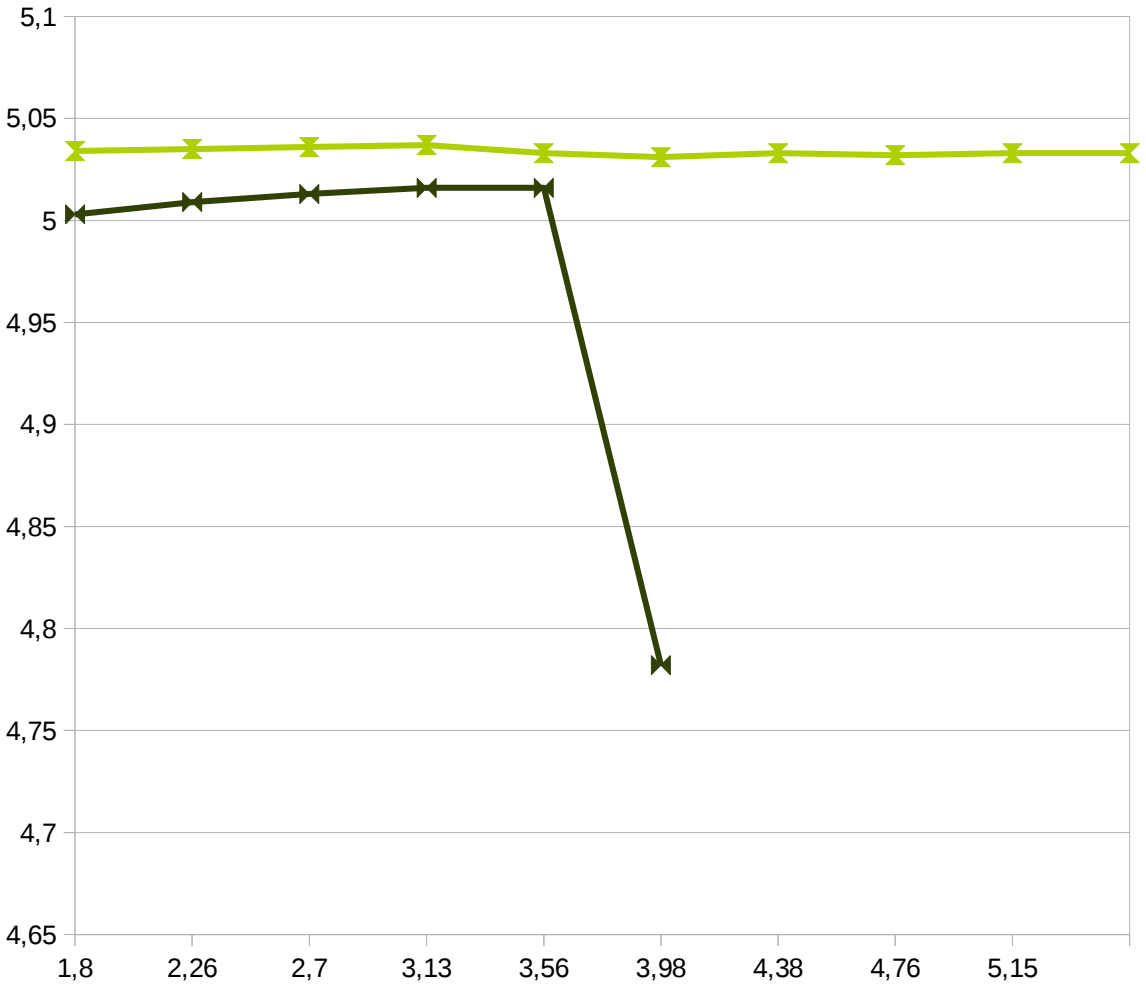
Picture source:
Stackexchange.com

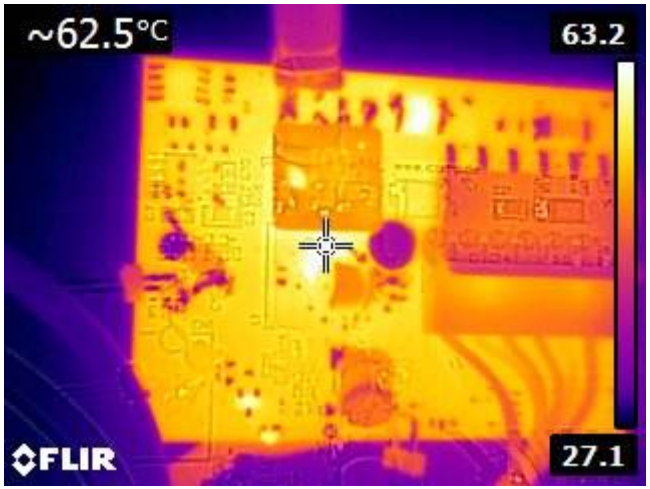
First prototype performance





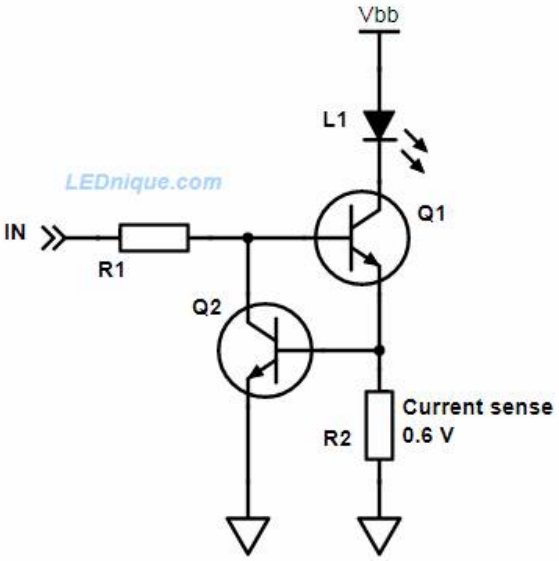
Second prototype performance



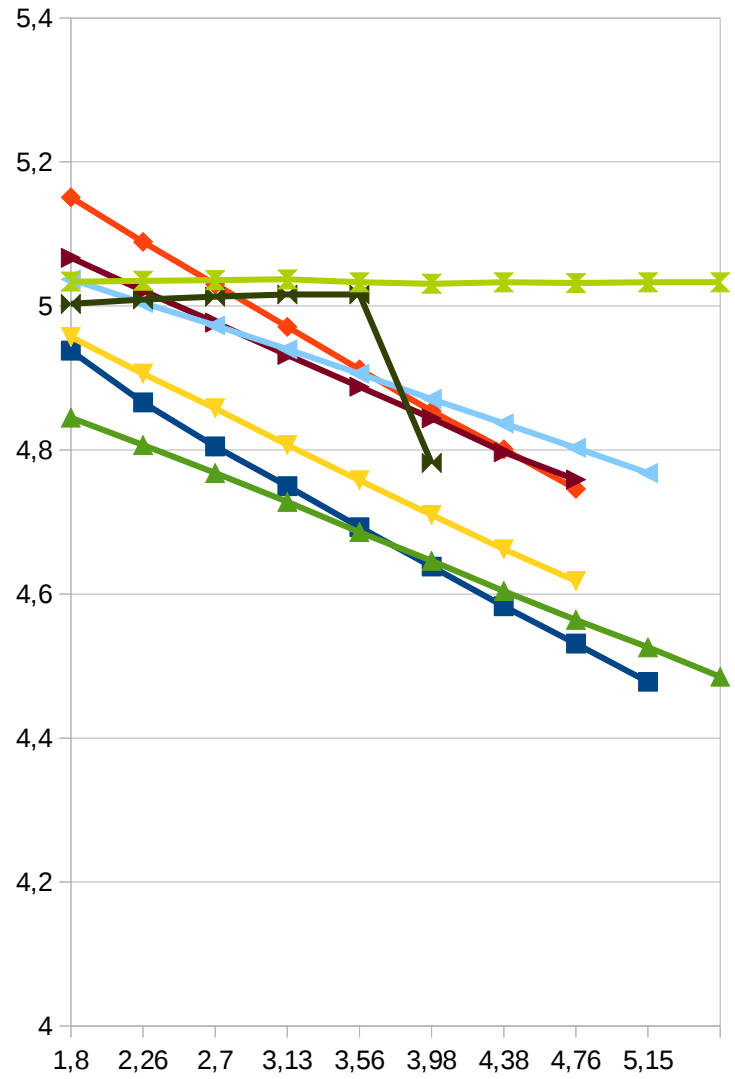


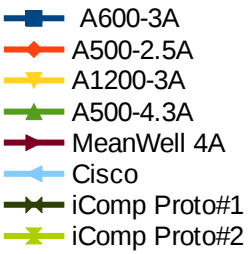
Are we there yet?

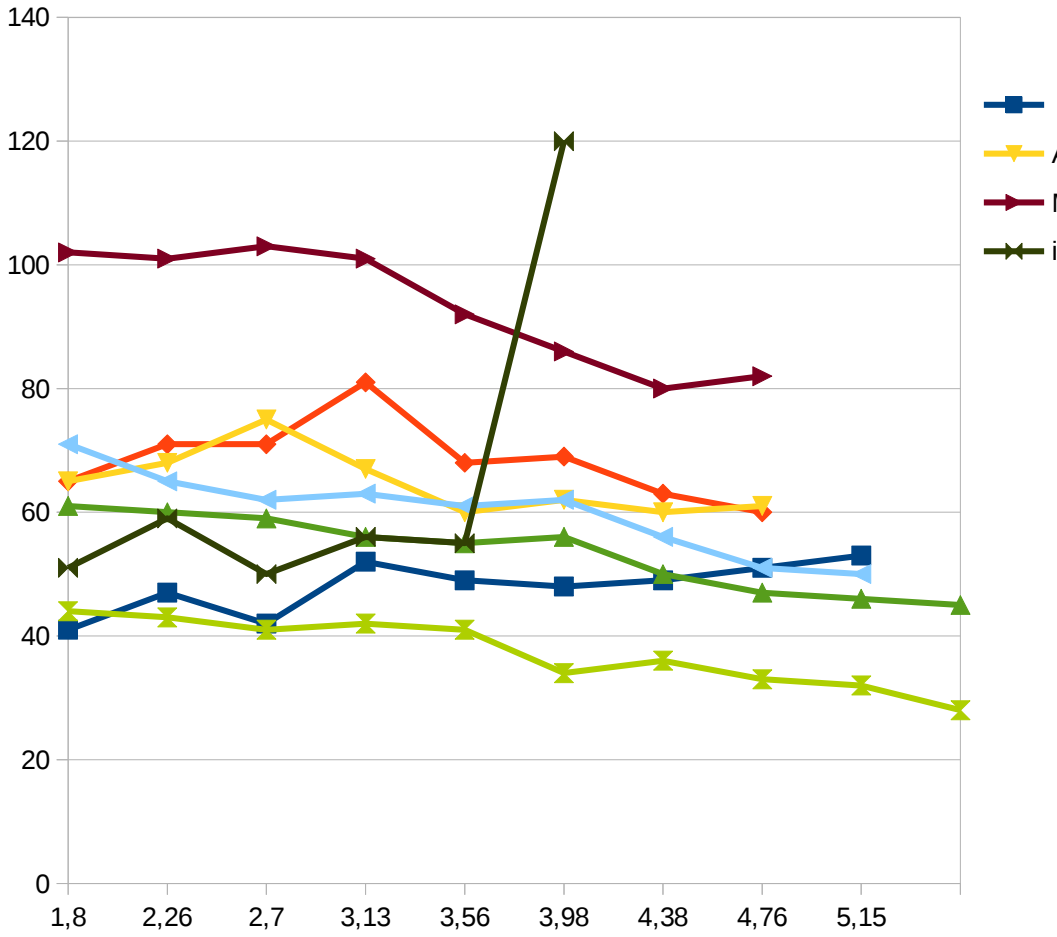
- **The power LED on the converter changes it‘s brightness depending on load**
- **Solution: Another regulation circuit!**



Final comparison







Thank you!

- Revision team
- OBS studio team
- The Libre office foundation
- The Amiga community
- The team at iComp GmbH