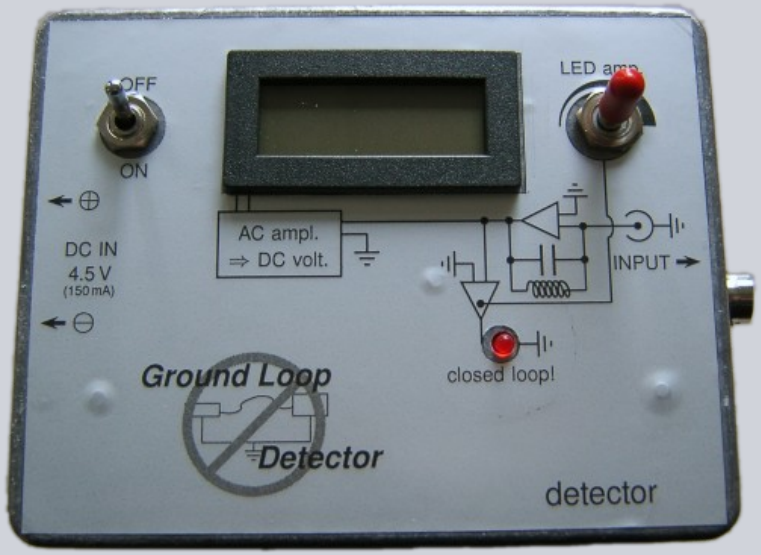
Ground Loop Detector

Christopher Braun, Markus Spanner
26. November 2007



Content

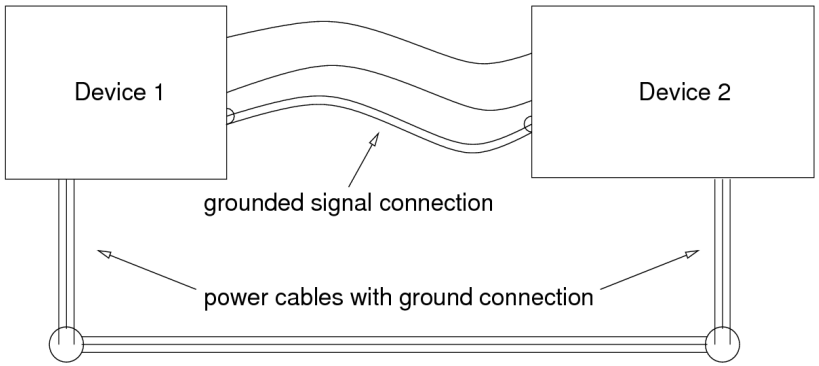
Friedrich-Alexander-Universität
Erlangen-Nürnberg
Physik

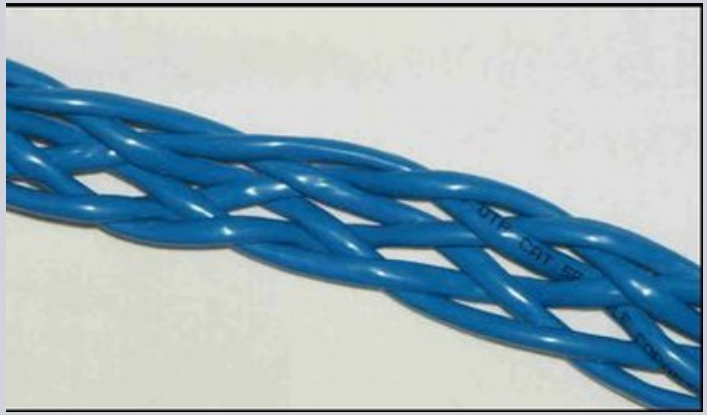
Abschlusspräsentation zum
Elektronikpraktikum im
Wintersemester 2007/2008

Christopher Braun
Markus Spanner

supervisor:
Stefano Poletto

1. The Problem





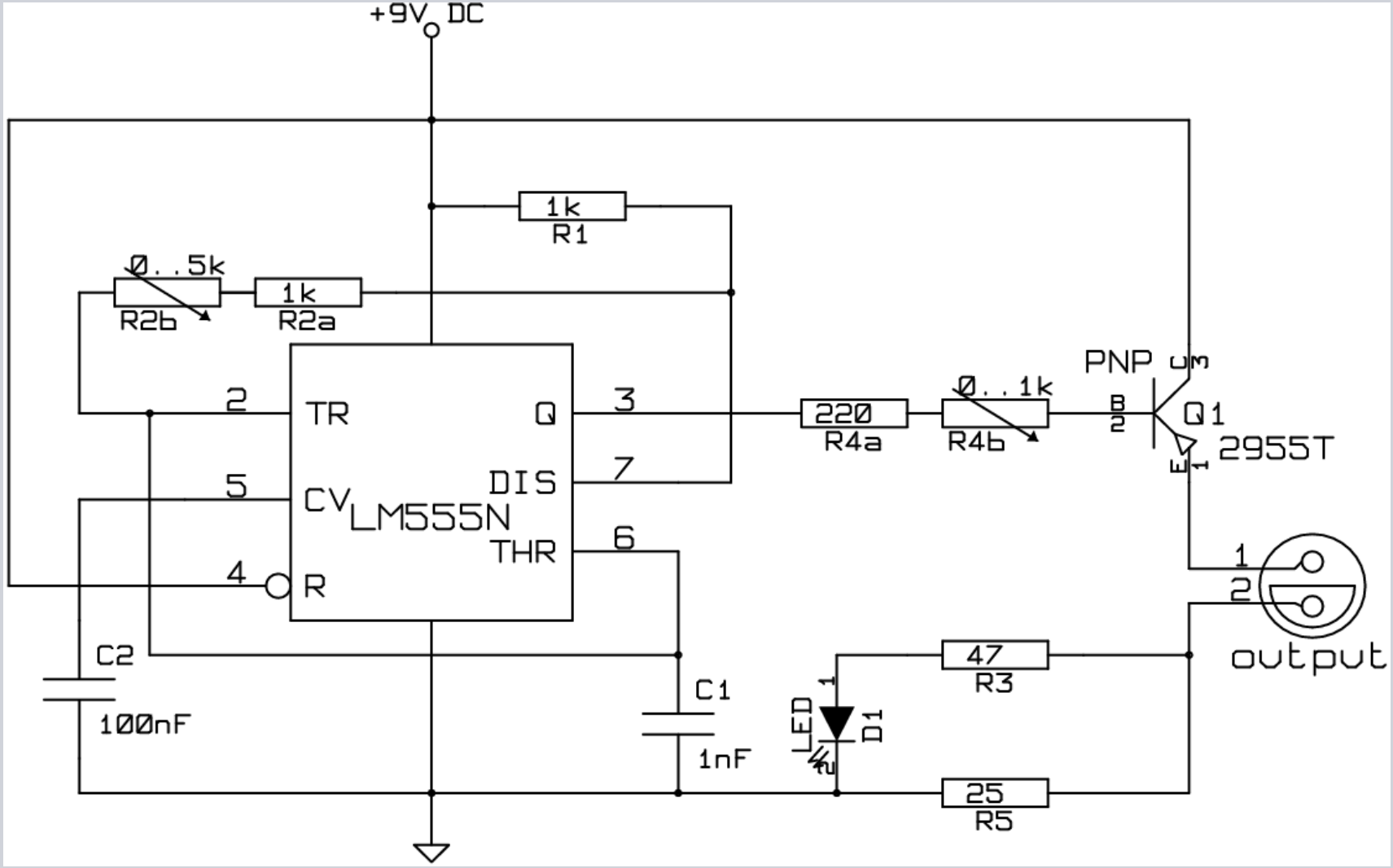
- Ground loops are a problem in sensitive meassurements
- usually searched by disconnecting wire by wire until the loop disappears
- Problems:
  - often many cables
  - multiple loops difficult to find
  - can not be done during operation
- Loops can be removed by:
  - Using batteries as power supply
  - Cutting gound connections
  - Effects can be lowered by twisting cables (smaller area enclosed by loop)

2. The Solution

- An exciter is used to induce a high frequency test signal in the ground system.
- If there is a closed loop in the ground system, a high frequency current is generated in the loop.
- A Rogowski coil is wrapped around the cables suspect to be part of a ground loop.
- The signal captured by the Rogowski coil is filtered for the test frequency, amplified and transformed into a DC signal by the detector.
- The value of the resulting DC signal is displayed on the built-in voltmeter.

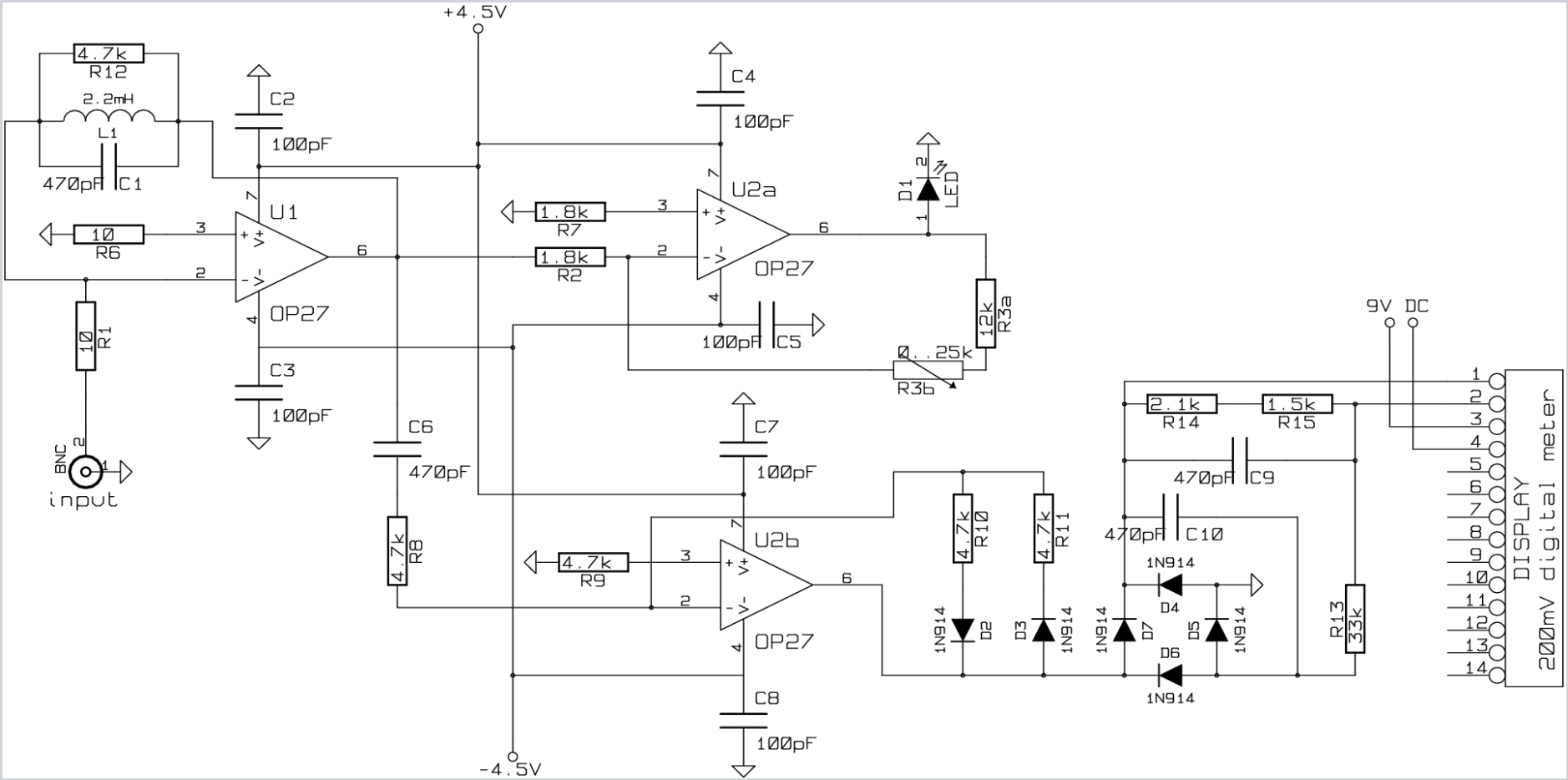
2. The Solution

- the exciter circuit -



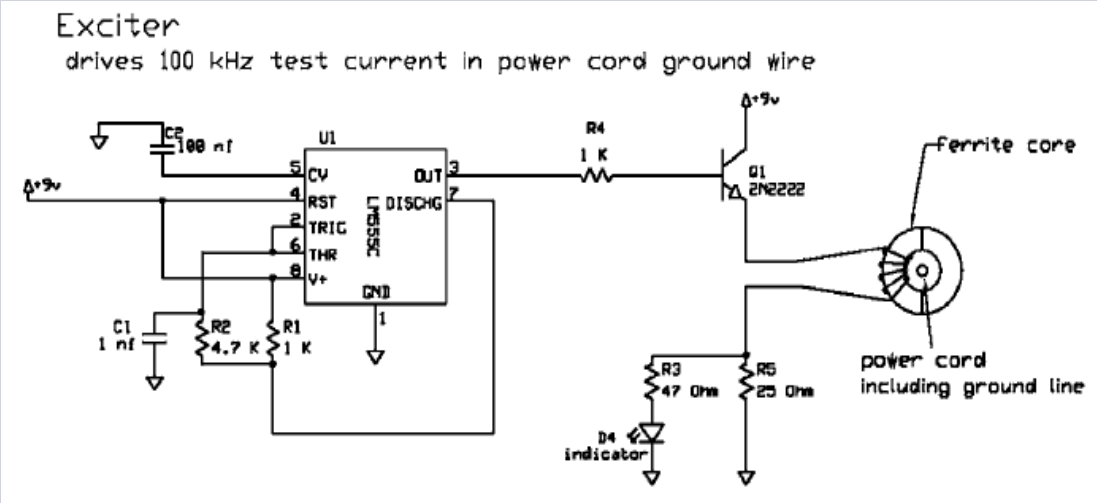
2. The Solution

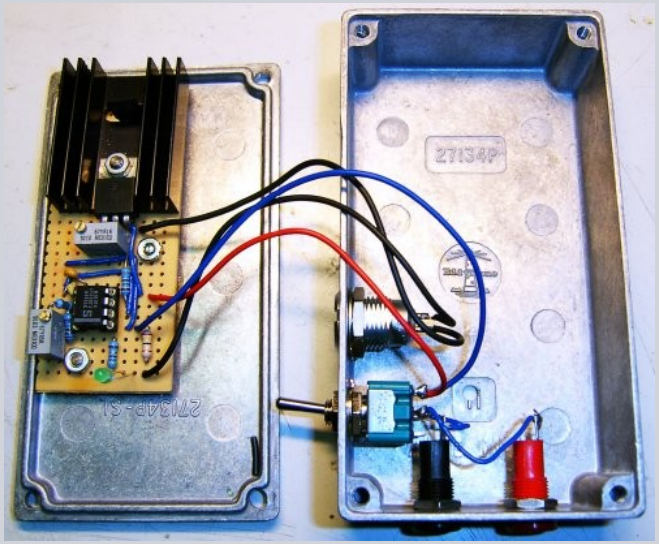
- the detector circuit -



3. Realization and Tests

- changes at the exciter -

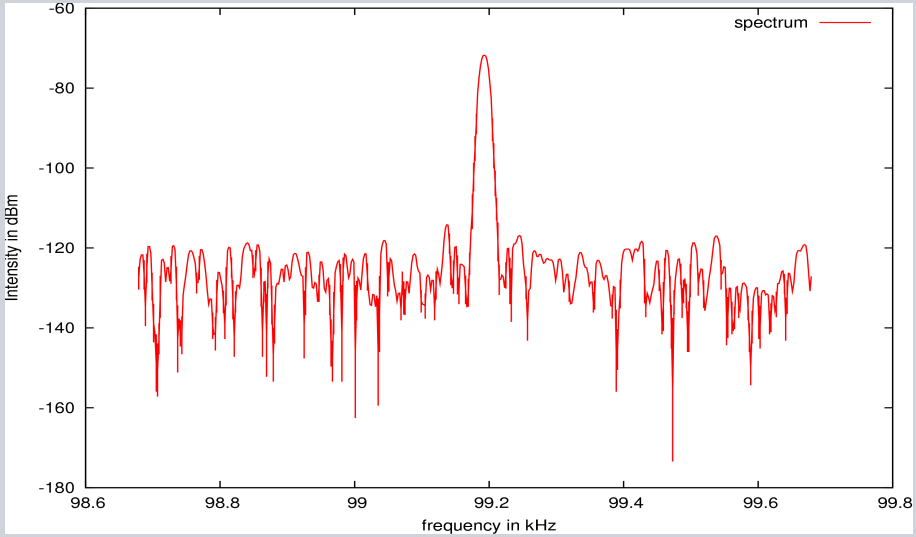


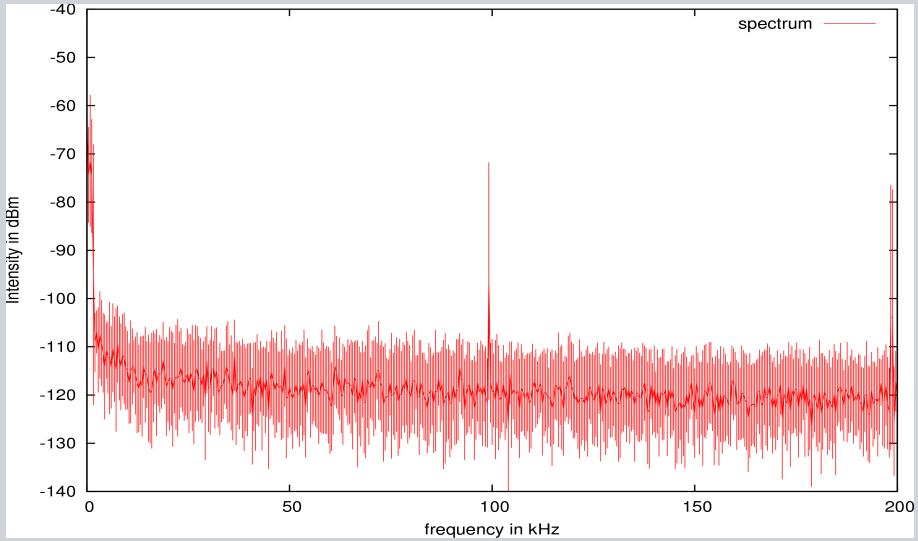


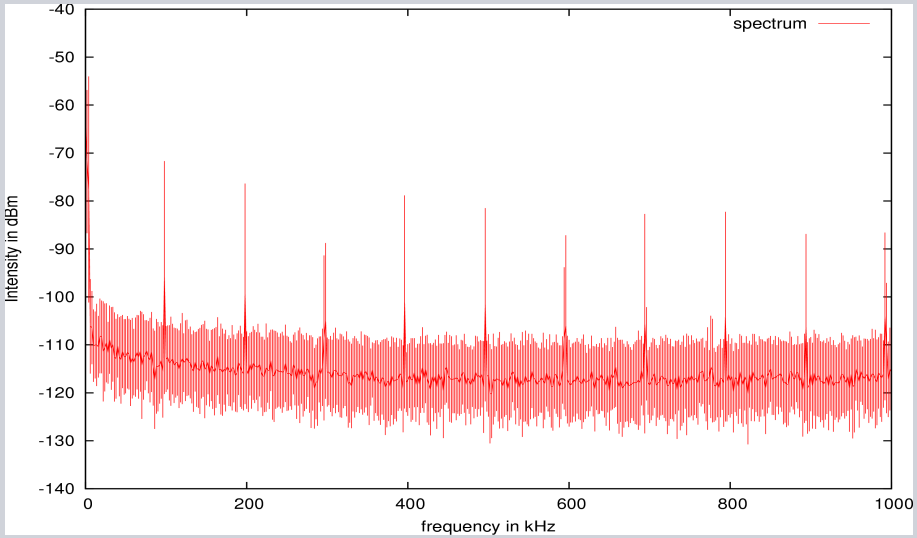
- A different transistor was needed
  (2N2222 did not stand the desired output power for longer than 10 s)
- To make the power output variable and adjust the circuit to the different transistor, R4 (1 kΩ) was replaced by a chain of a 220 Ω resistor and a 1 kΩ potentiometer
- The output frequency was not exactly 100 kHz, we also made the circuit tuneable here, by replacing R2 (4.7 kΩ) by a chain of a 1 kΩ resistor and a 5 kΩ potentiometer (f=85..130 kHz)

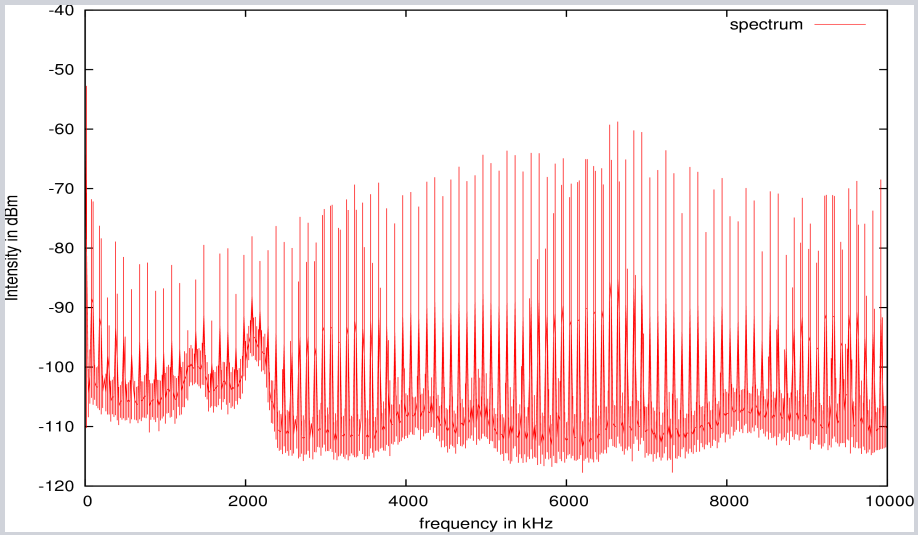
3. Realization and Tests

- spectrum of the exciter -



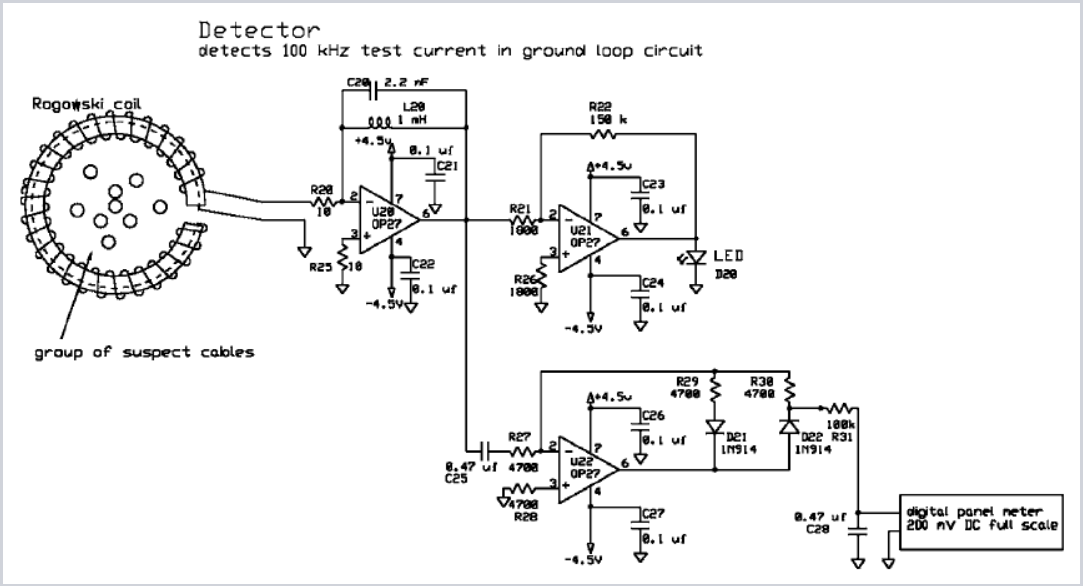


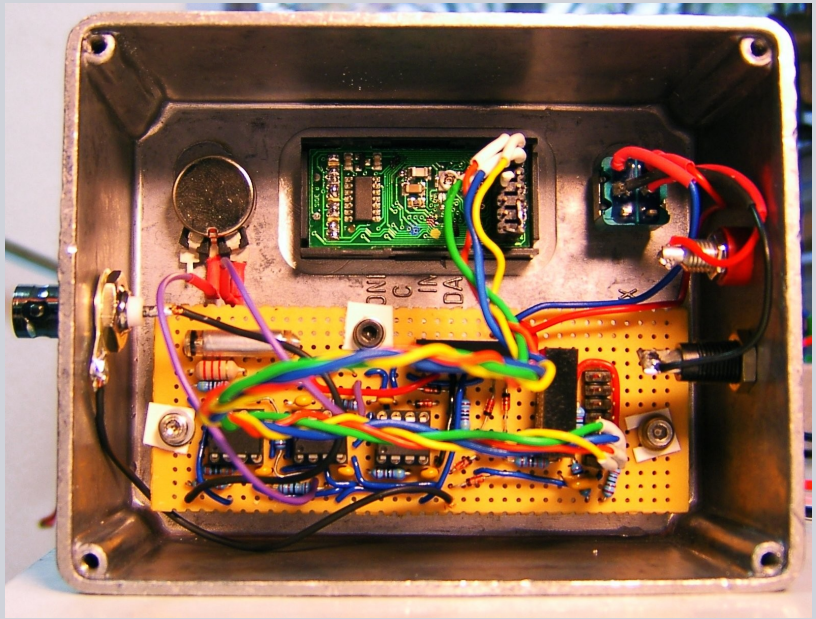




3. Realization and Tests

- changes at the detector -

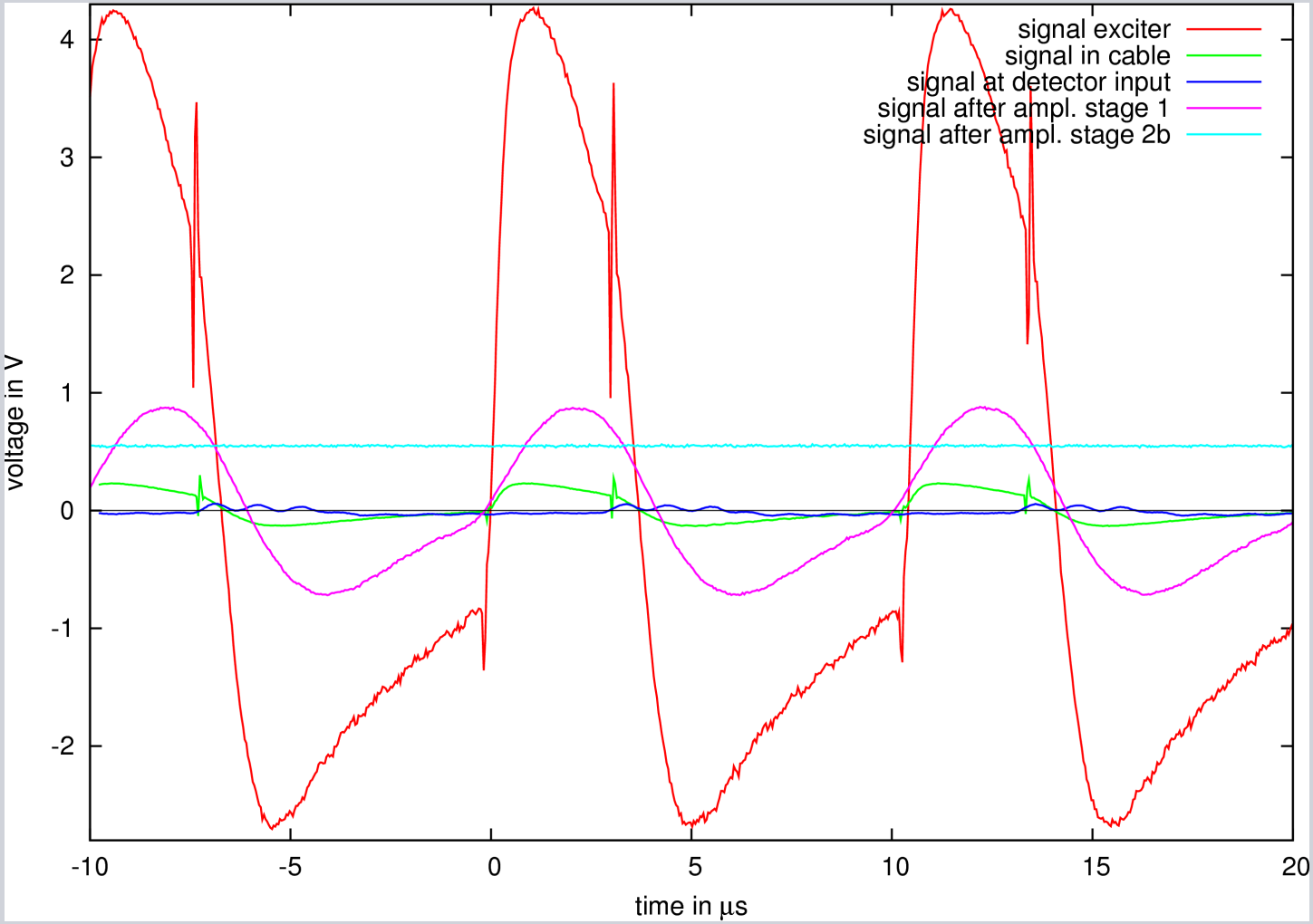




- Different capacitor and coil at amplification level 1 to get resonance as near as possible to 100 kHz, and added an additional resistor in parallel to reduce natural oscillation.
- Amplification in level 2a was modified and can now be changed with a potentiometer.
- Different AC->DC stage for digital voltmeter.
- Added 2 DCDC converters so only one 4.5 V power supply is needed.

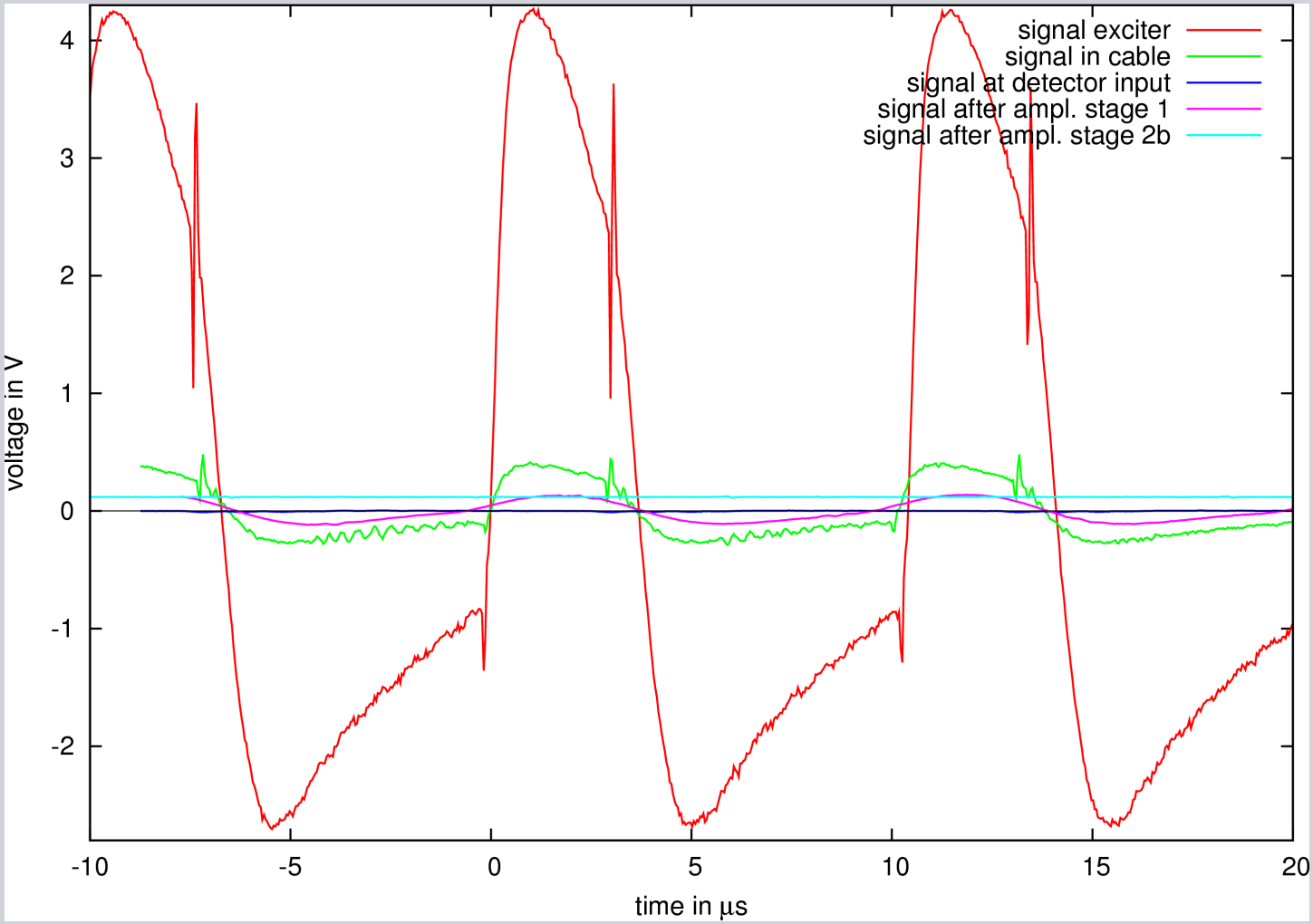
3. Realization and Tests

- signal in our detector - short cable -



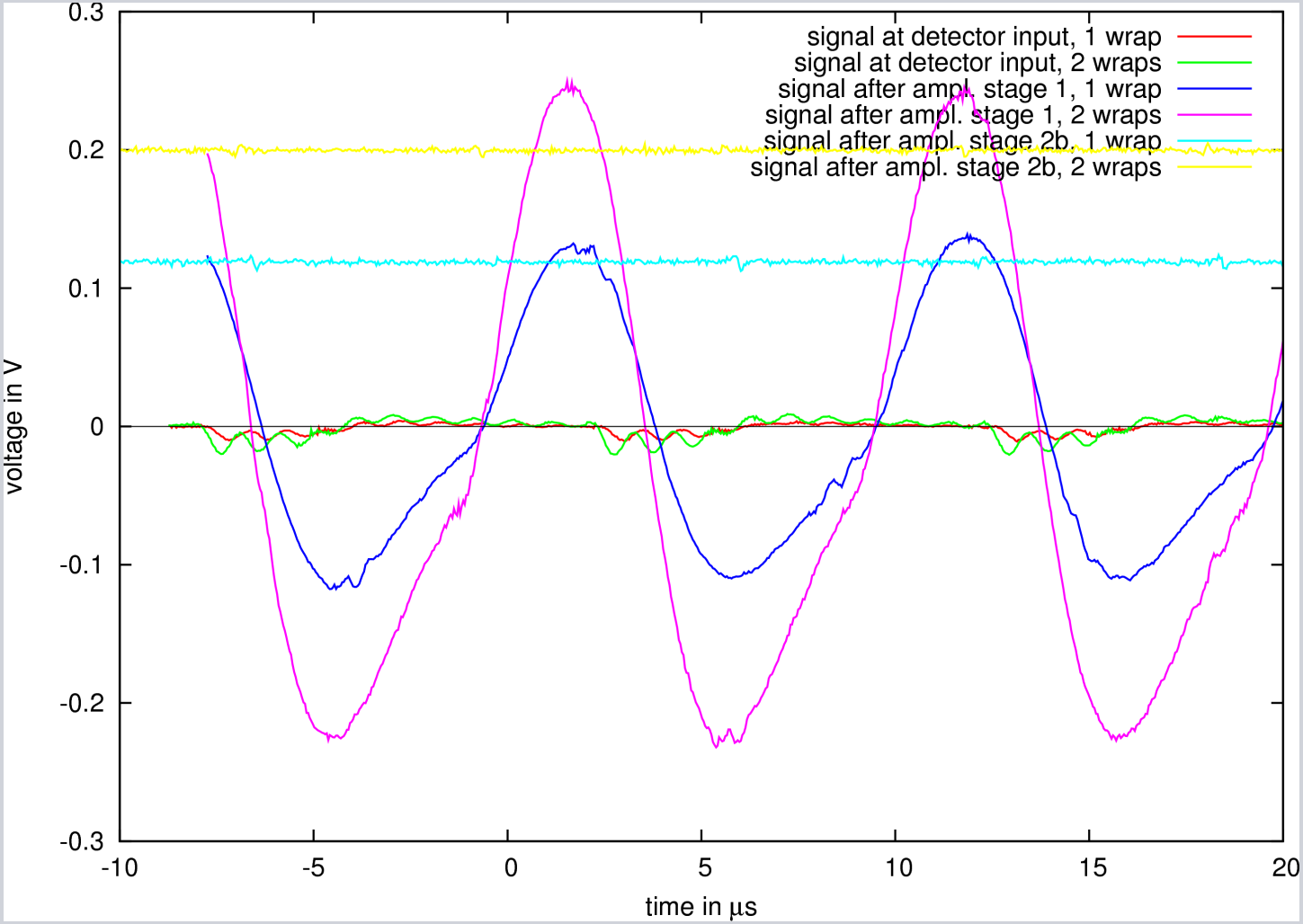
3. Realization and Tests

- signal in our detector - long cable -



3. Realization and Tests

- signal in detector - 1 vs 2 cable wraps -



4. Conclusion

- Several small changes had to be done to the circuits to work.
- Setup works surprisingly well when tested with a 10 m BNC cable loop (~120 mV closed, <10 mV open)
- From these values one can expect that the setup is working at least up to 25 m of cable.
- The LED is only working for shorter cables, but the display works well.
- The detector signal level can be increased by wrapping the Rogowski coil around the cable multiple times (if that is possible)

THE END

Thanks for listening

Thanks to:
• Elektronikwerkstatt for supplying with the components and advice
• Mechanische Werkstatt for help with the detector case
• Stefano Poletto
• Everyone at PI3 who made this course possible

References:

P. M. Bellan: „Simple system for locating ground loops“
Review of Scientific Instruments 78, 065104 (2007)