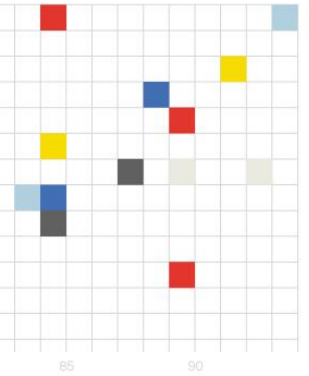


Transducer development at Justervesenet



Kåre Lind
Justervesenet, Norway



TRANSDUCERS DEVELOPED AT JV

- AC/DC current shunts 30 mA to 20 A, DC to 1 MHz, 100kHz
- Voltage dividers 10 V to 1 V, 400 V to 1 V, 1000 V to 1 V
Frequency range DC to 100 kHz

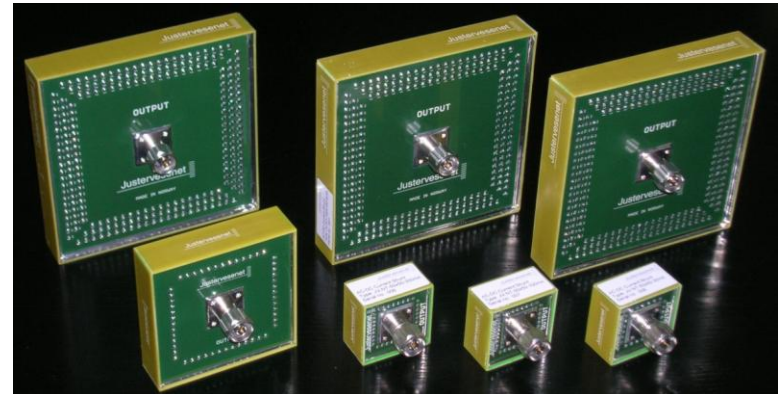
Early shunt developments

Realising that the Fluke A40 shunts were unsuitable for frequencies above 10 kHz, JV decided to design new shunts for wider frequency coverage.

The current ranges were 30 mA to 10 A in a 1 - 3 - 10 range sequence. In addition, a 5 A shunt was developed.



Input side



Output side



New shunt developments

The early low-current shunts, 30 mA to 300 mA ranges, were cumbersome to produce, and the circuit board material was critical to a good result, especially for frequencies above 100 kHz.

The 1 A to 10 A shunts also had some potential for improvement.

The current ranges 30 mA to 300 mA have been totally redesigned, to give a reasonably flat AC-DC response above 100 kHz.

The 1 A design has been changed to use fibreglass/PTFE material instead of FR-4 (fibreglass/epoxy).



New low-current shunts



30 mA

100 mA

100 mA
Flange
mount

300 mA

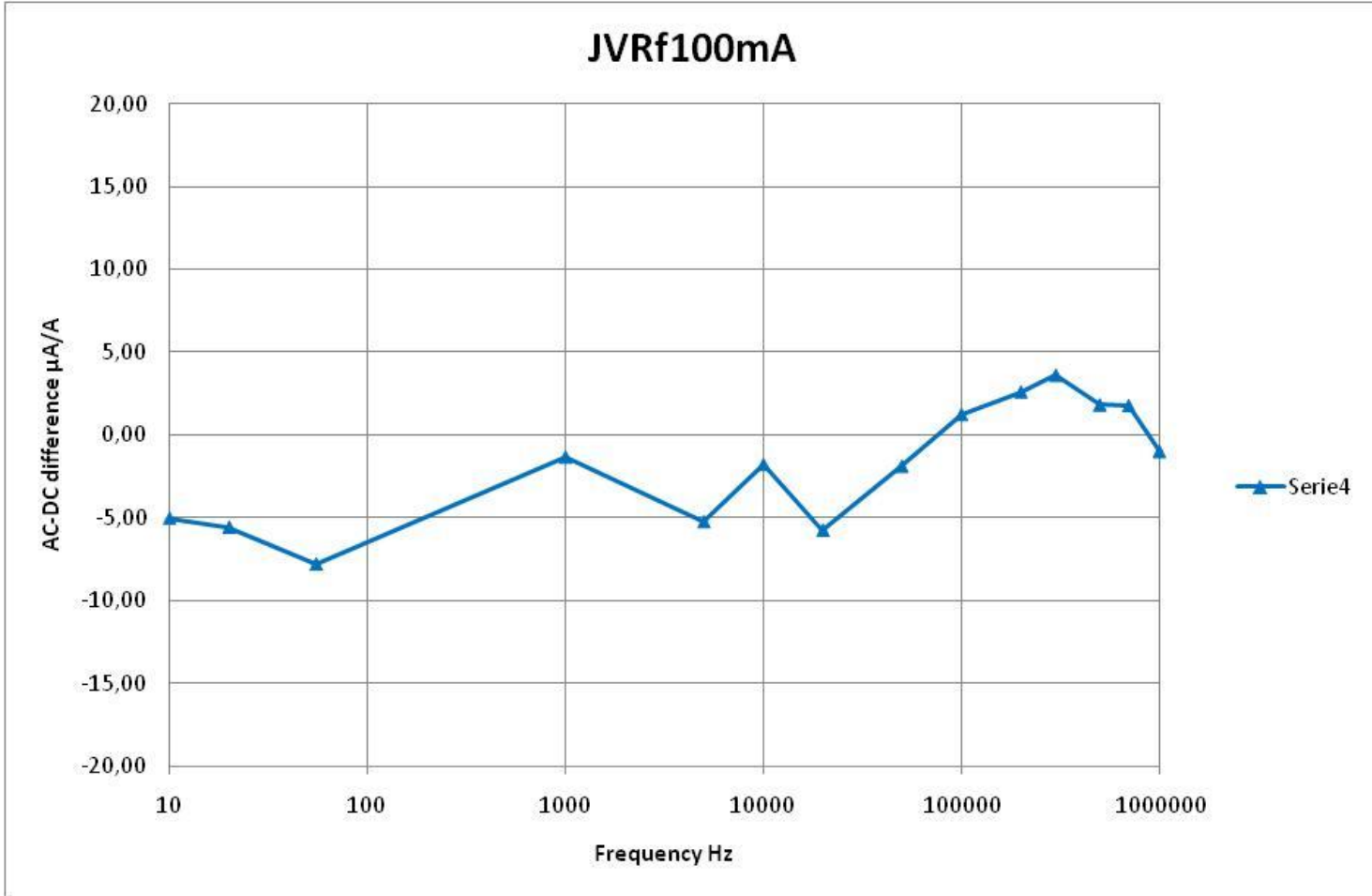




The ultimate low-inductance, low-capacitance , low-current shunt

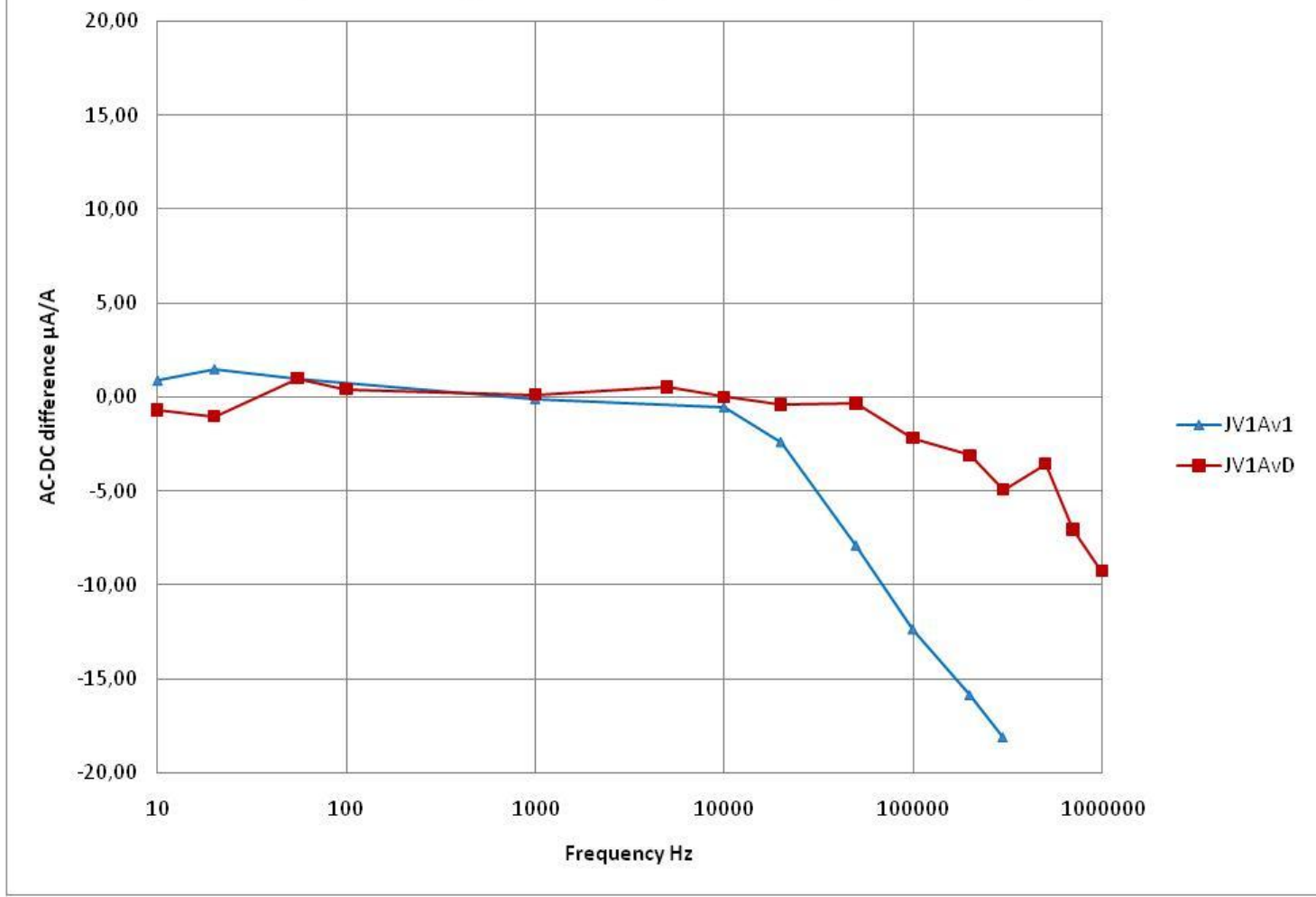


JVRf100mA



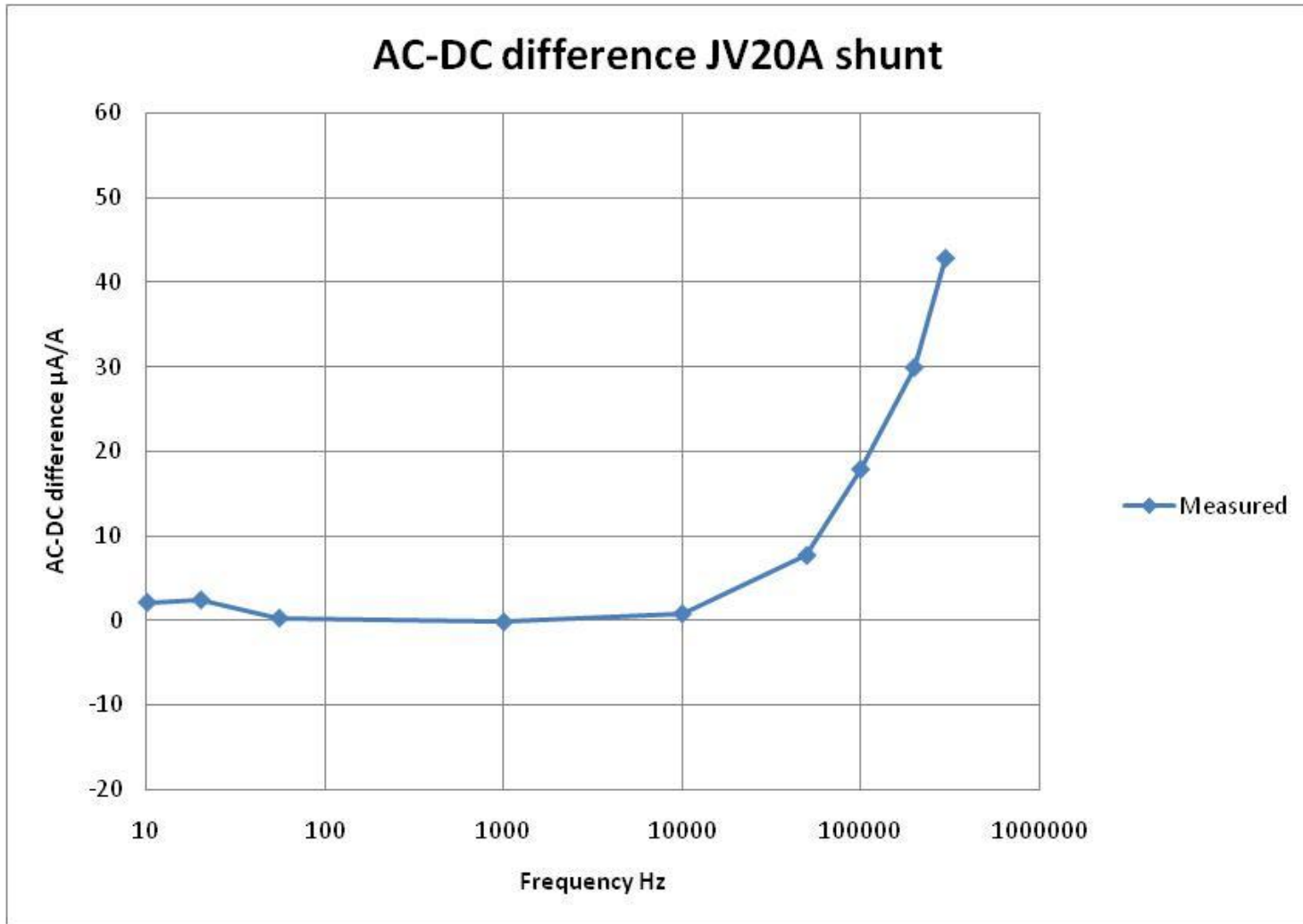


Previous (Version 1) and new (Version D) shunt designs at 1A





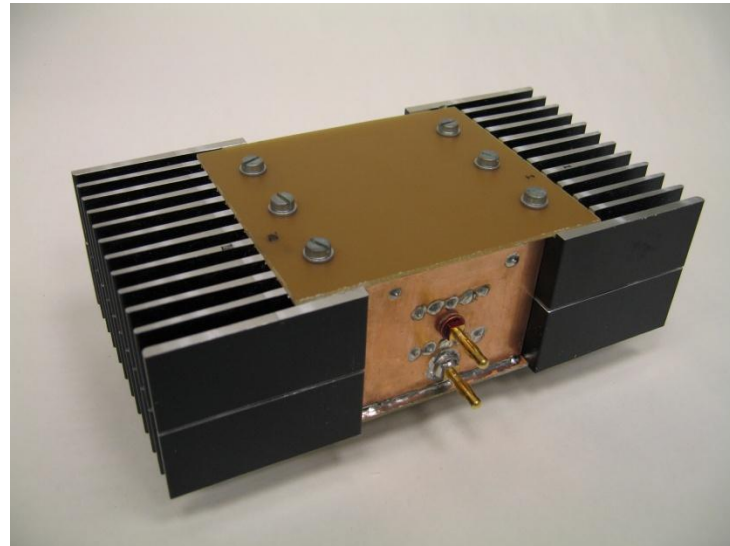
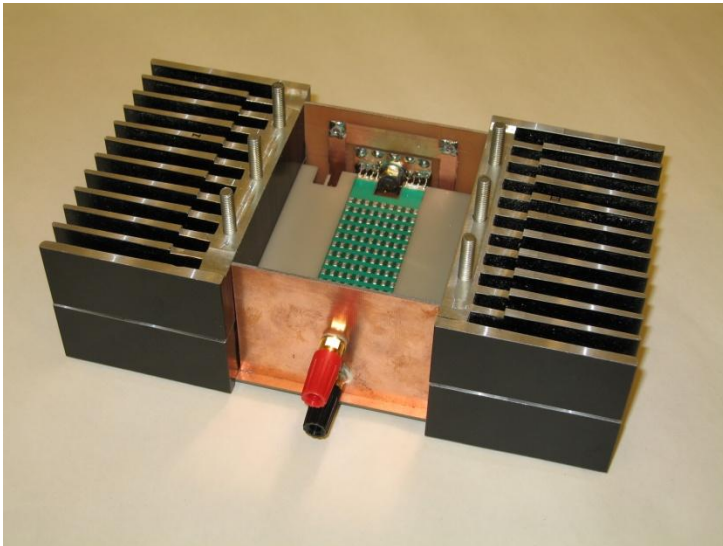
AC-DC difference JV20A shunt





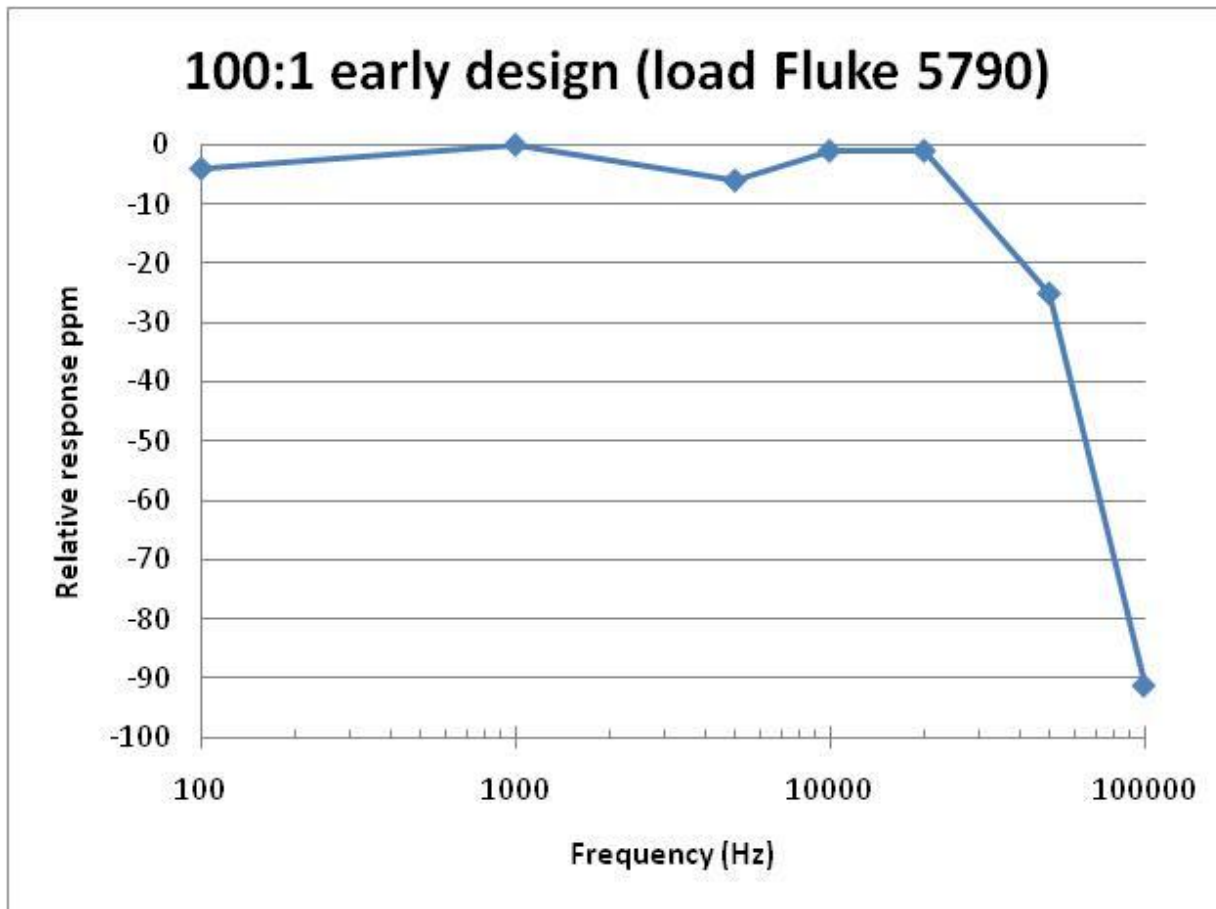
Voltage dividers

Early design of voltage divider 100 V : 1 V





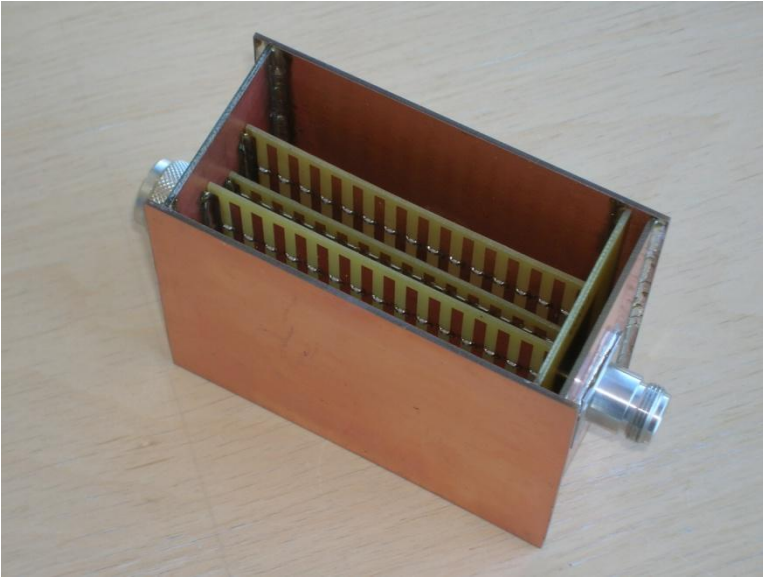
Frequency response of early design





New voltage divider design

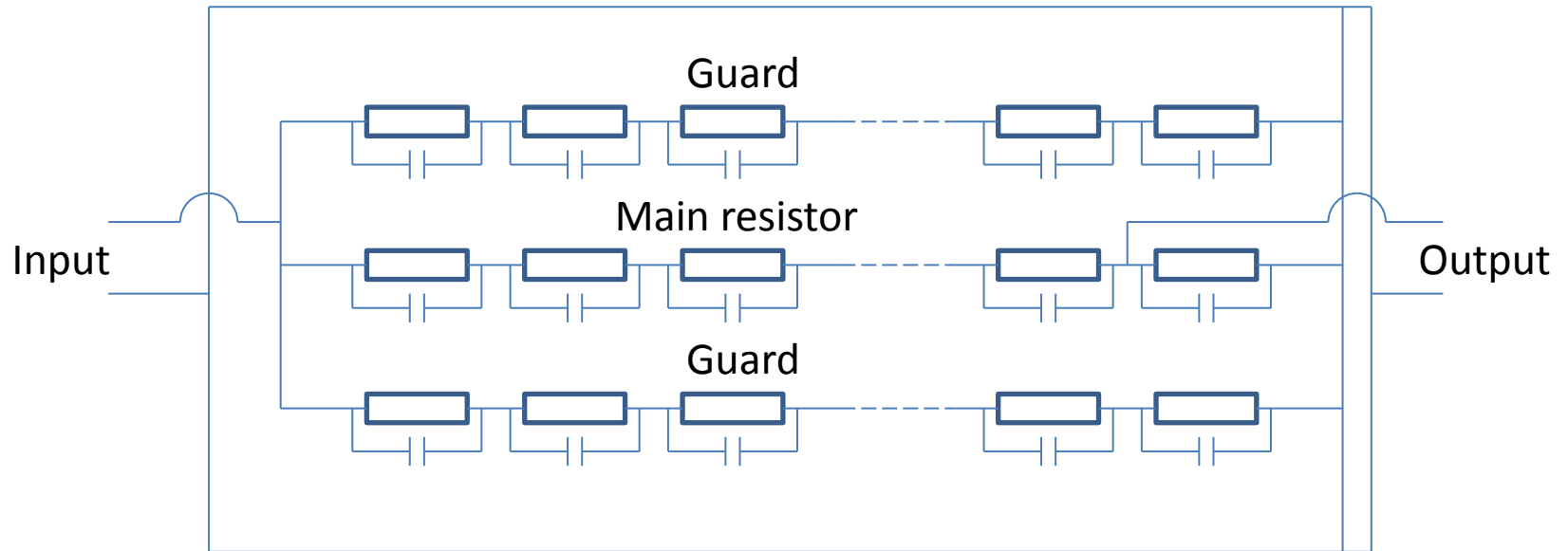
Simple prototype of new design



1000:1 simple prototype using FR-4 circuit board material



Approximate equivalent diagram of new prototype divider

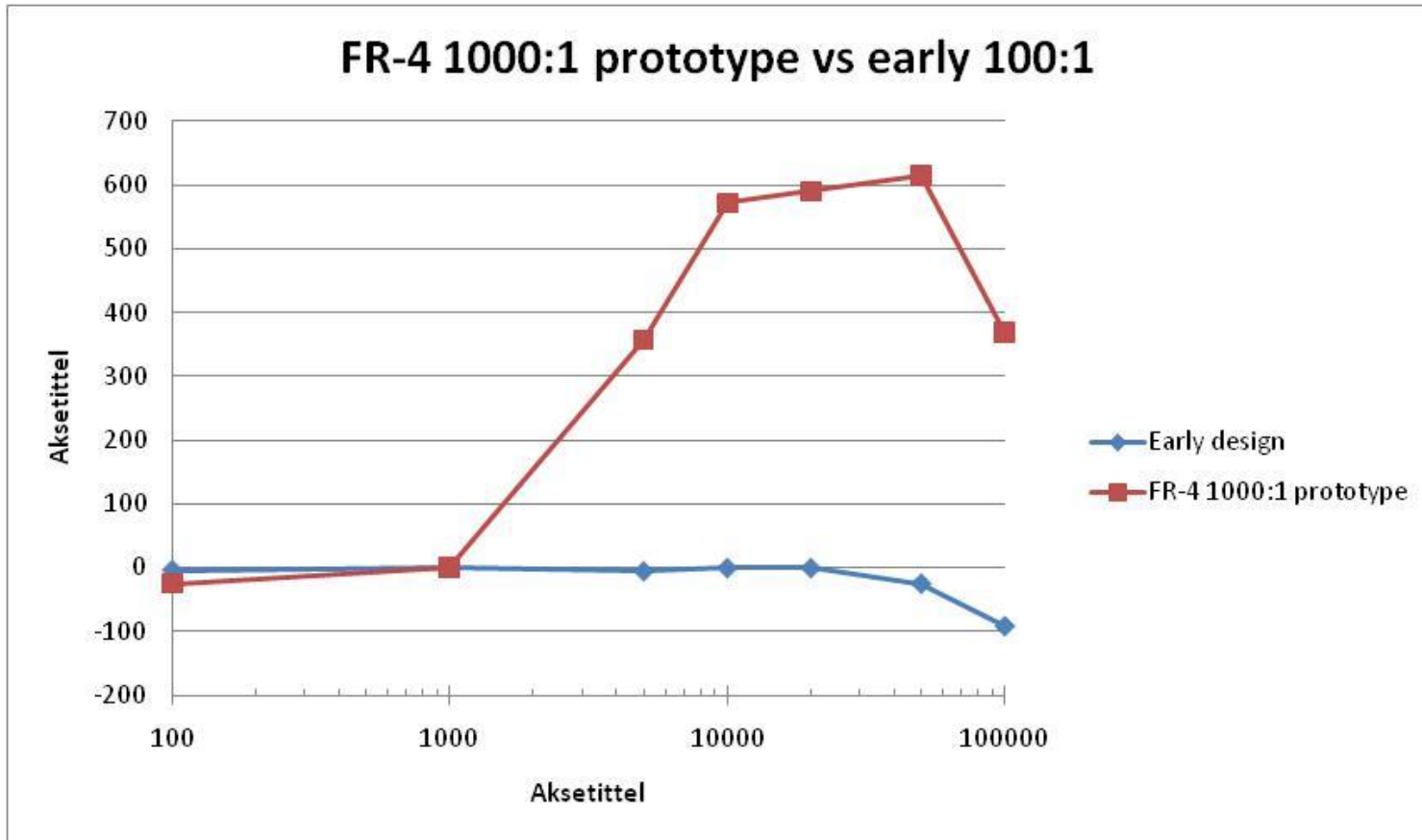


Output voltage should be taken across lowest segment of main resistor



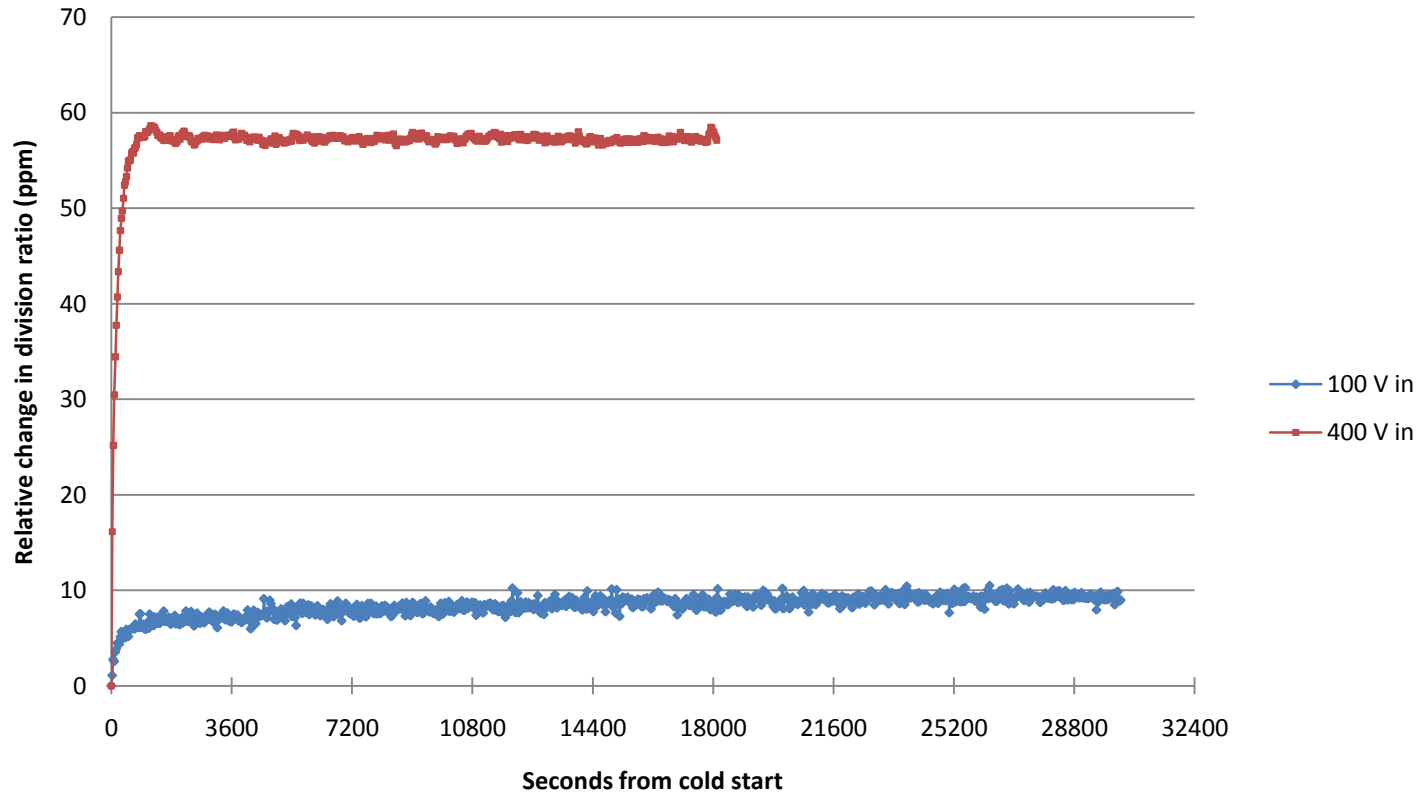
New voltage divider design

Simple prototype of new design; coarsely measured frequency response
Load: Fluke 5790.



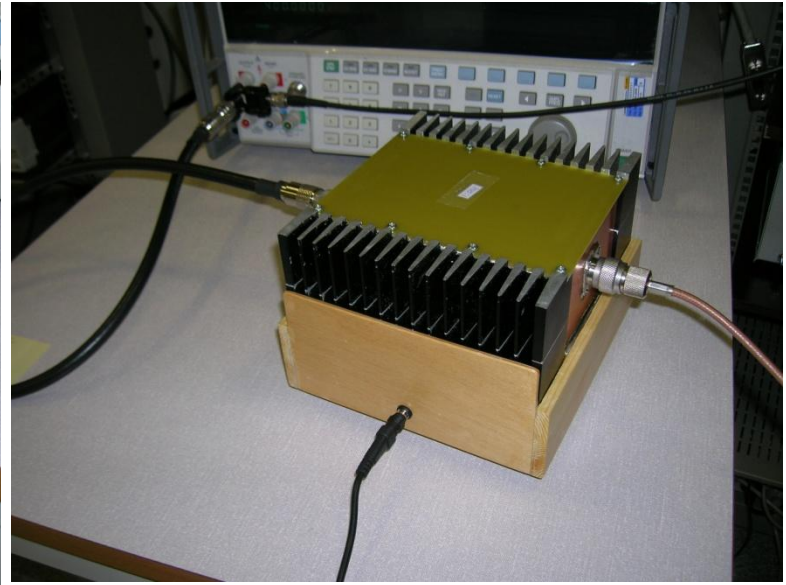


FR4 substrate 400:1 divider Voltage dependency



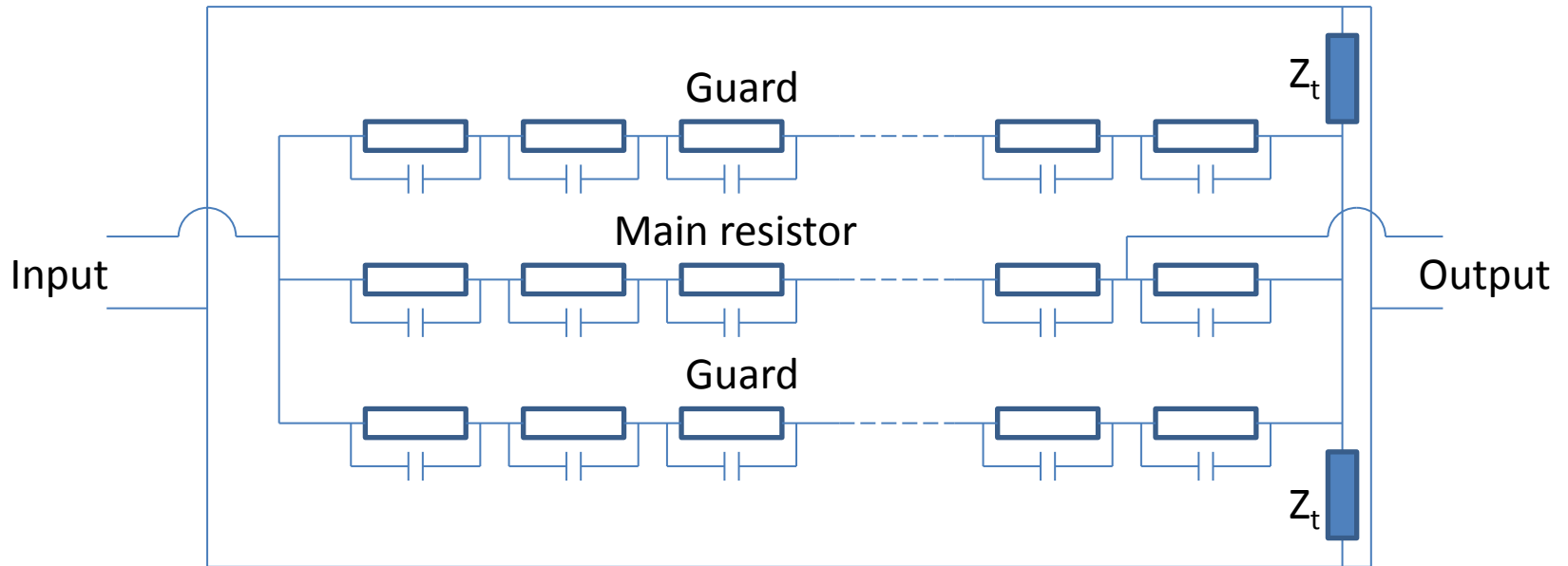
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New voltage divider design



Cooling jig

New voltage divider design

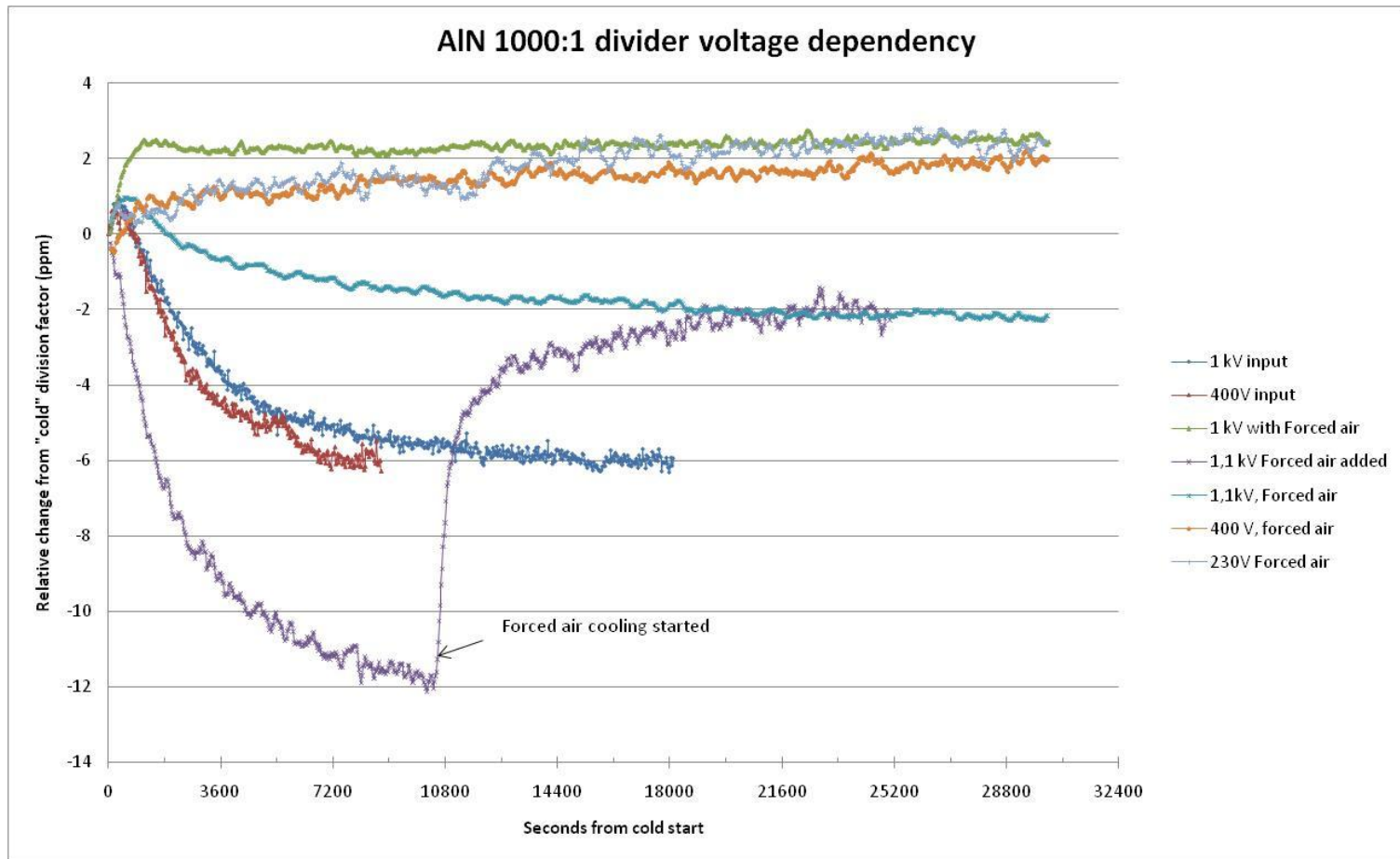


Z_t is a parasitic impedance in the physical structure of the divider.



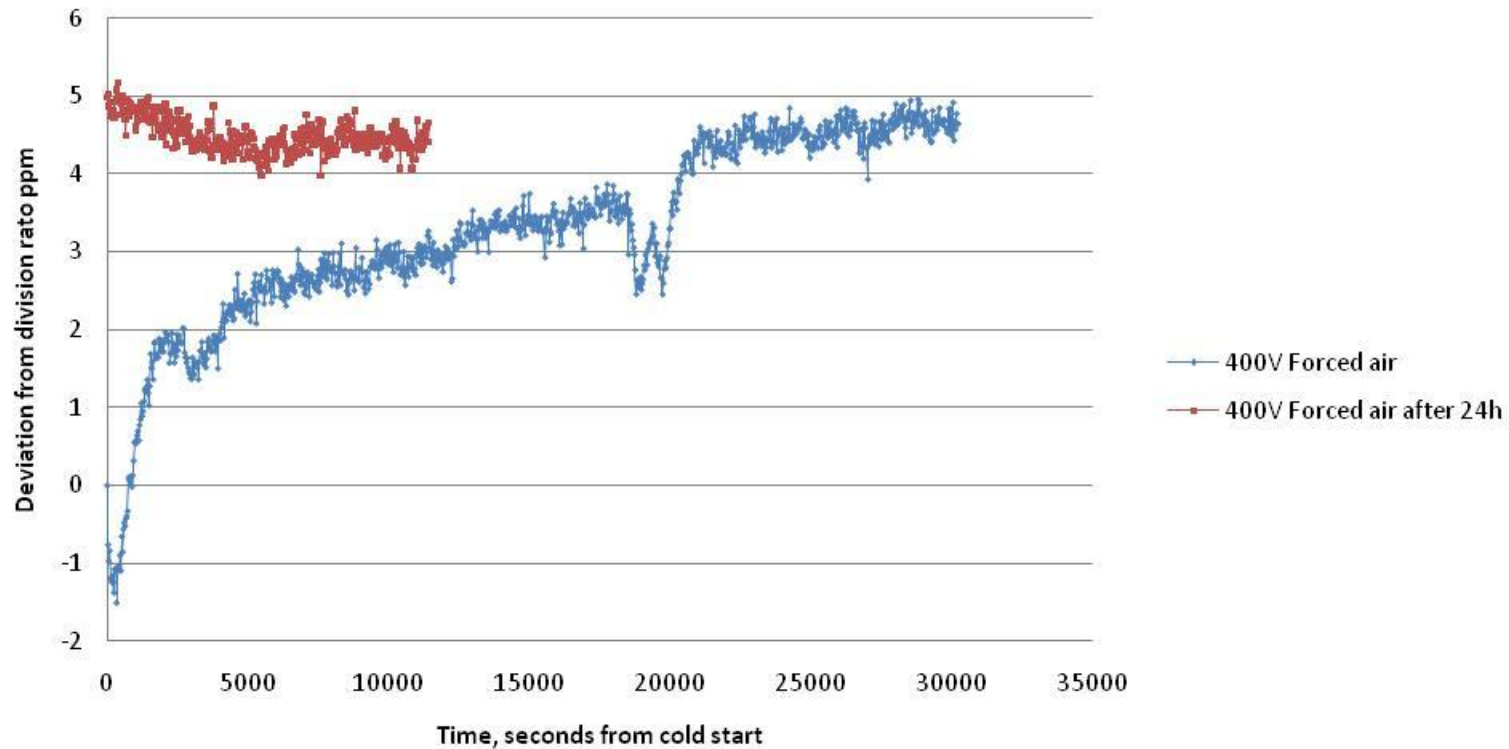
New voltage divider design

DC stability of 1000:1 divider



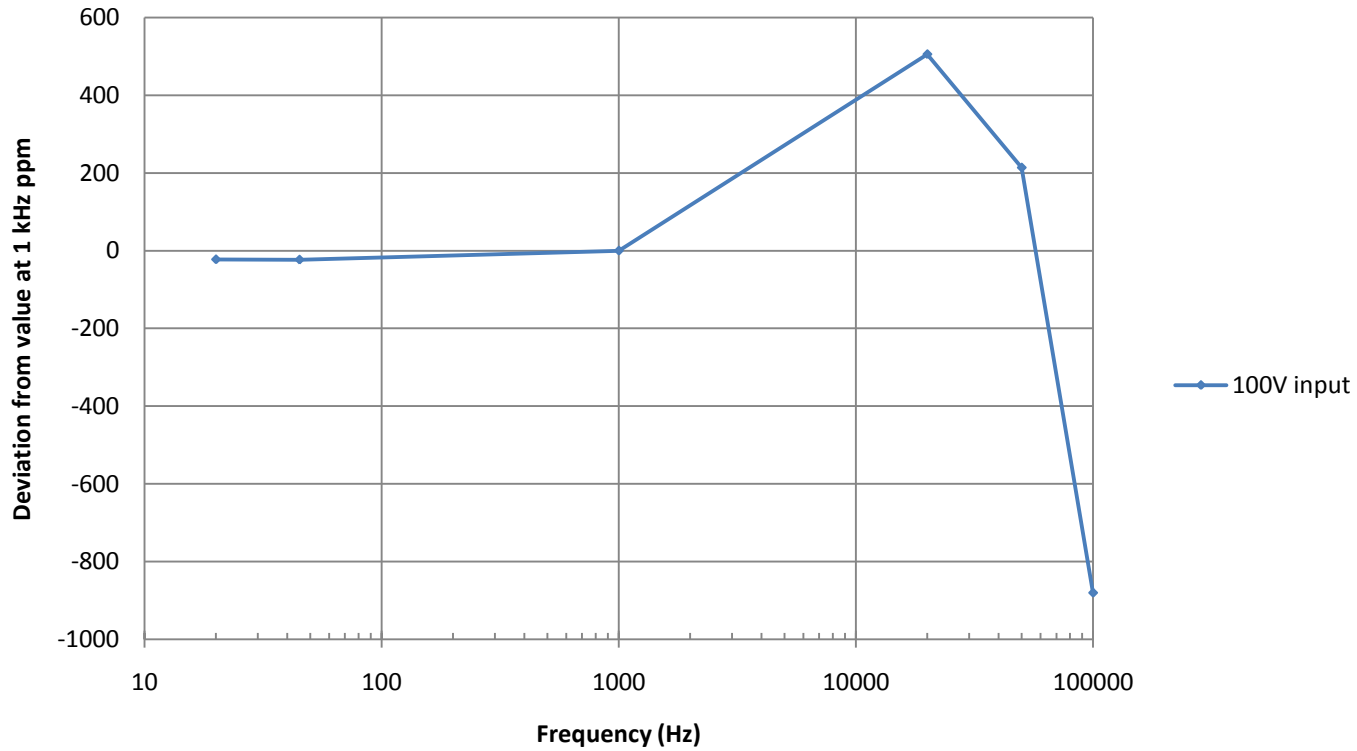


AIN 400:1 divider voltage dependency



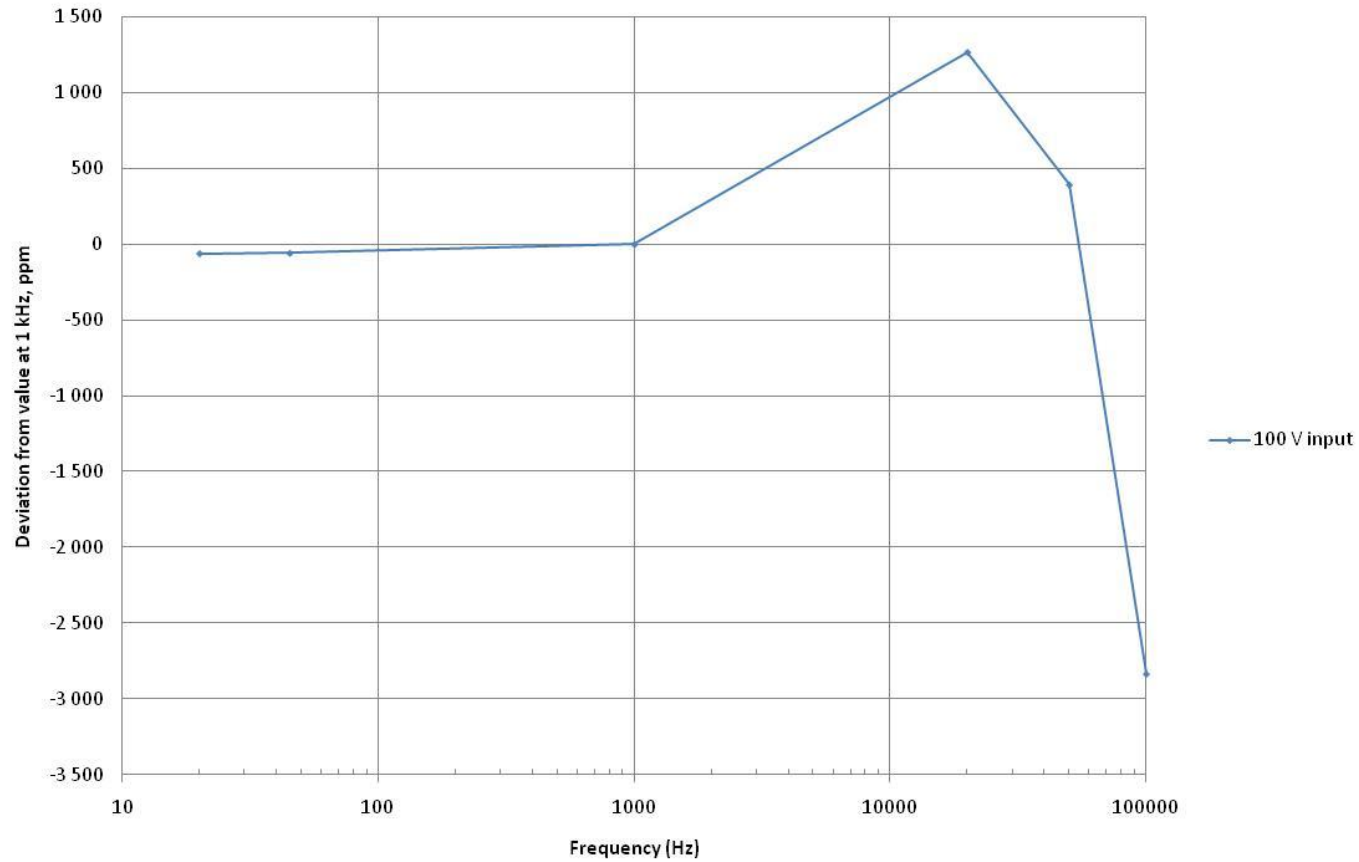


Frequency response 400:1 AIN divider





Frequency response of AIN 1000:1 divider





Comments on the frequency response of AIN substrate dividers.

The AIN substrate dividers are clearly over-compensated for capacitive effects. This applies both to the guard dividers and the main divider.

The over-compensation can be remedied by changing the capacitance at the lower leg in both guards and the main divider .

The steep rolloff at 100 kHz can mostly be attributed to loading effects by the Fluke 5790 used for the measurements.



Conclusion

1. A new set of current shunt has been developed, with frequency response extending up to 1 MHz for currents up to 300 mA.
2. A new set of voltage dividers with input voltages 1000V, 400 V and 10 V, with ratios 1000:1, 400:1 and 10:1, in the frequency range DC to 100 kHz
Some work remains in order to verify the final design.