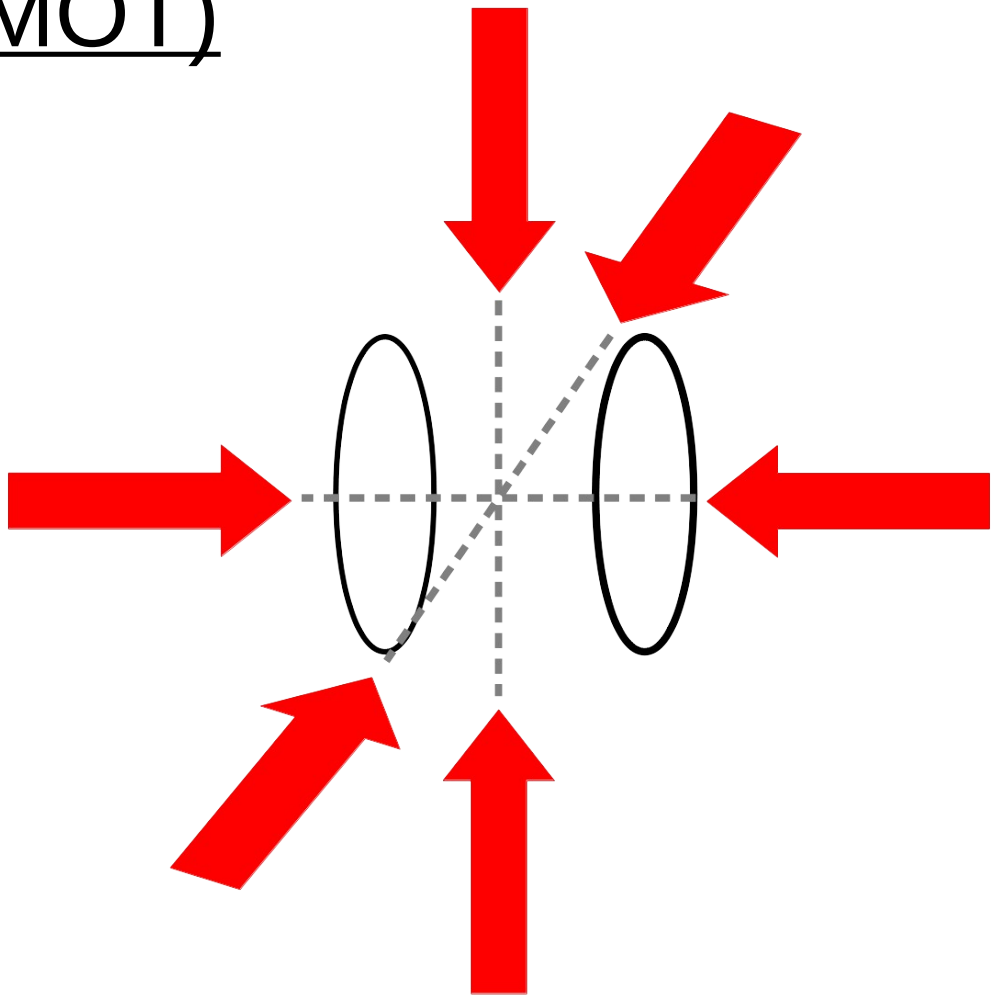
Building control system for a Magneto-Optical Trap

Jack Ringwood

Magneto-Optical Trap (MOT)

- Combination of Magnetic fields and polarised lasers used to trap atoms for cooling and state selection
- Previous MOT was of a simple design
- Upgrade has higher inductance coils, improved control system, and shim coils on each axis



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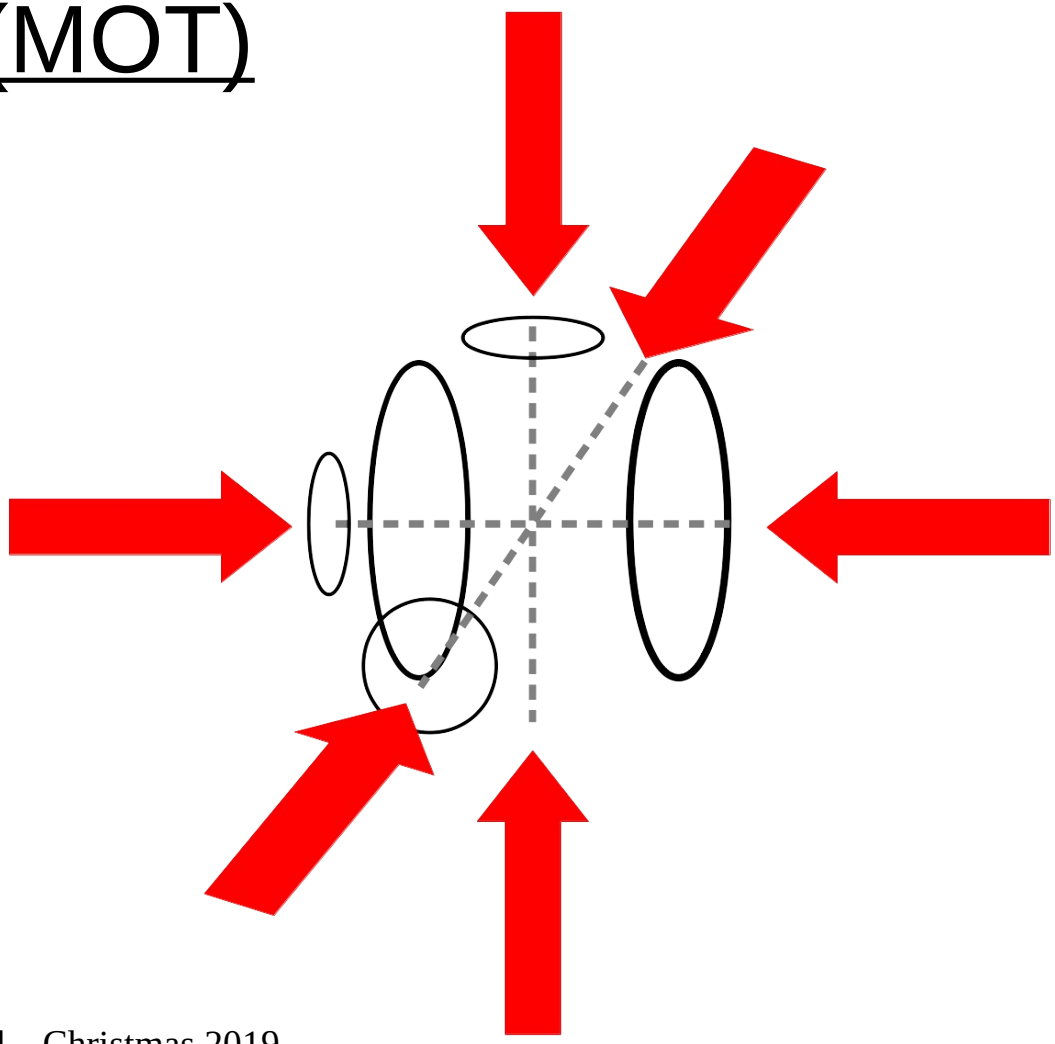
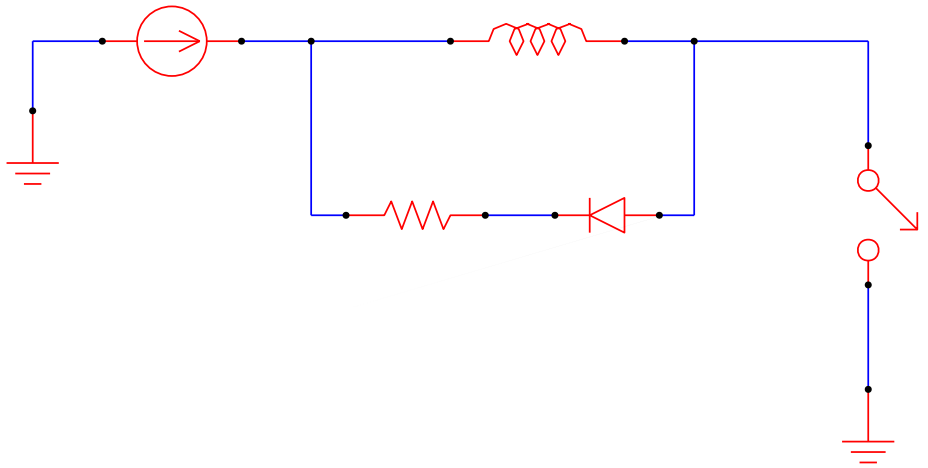


Context and Challenges

- Atom cloud undergoes thermal expansion as soon as trap is switched off
  - Wish to use atoms as soon as possible after trapping
- Inductors store energy in the form of a magnetic field
- Collapsing field generates current, damaging electronic components

Typical Approach

- Provide a return path for current
- Resistor will dissipate energy
- Current decays exponentially
  - long time to switch off



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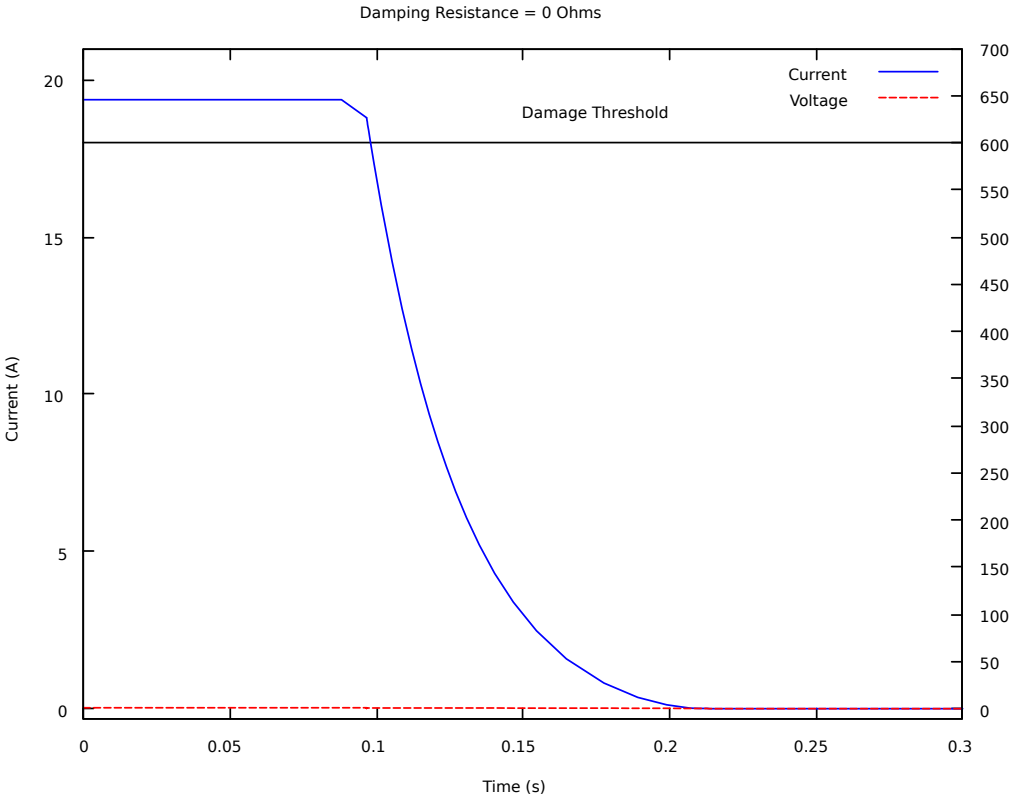

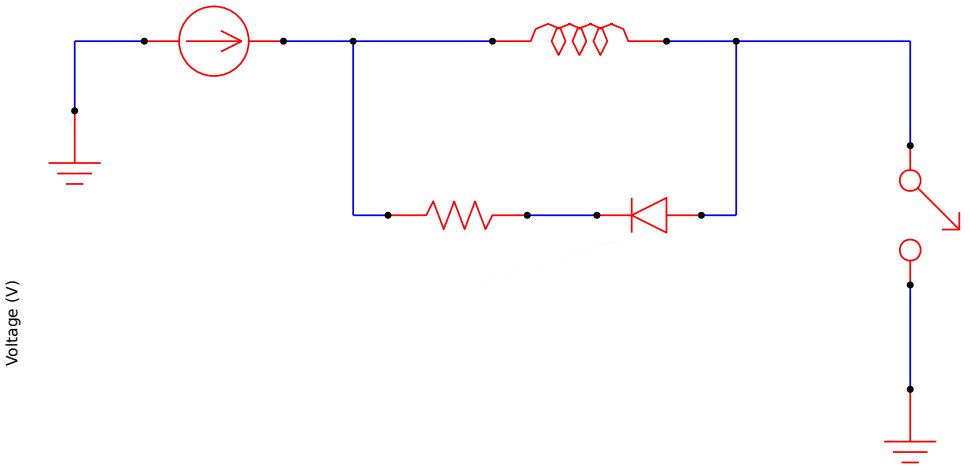

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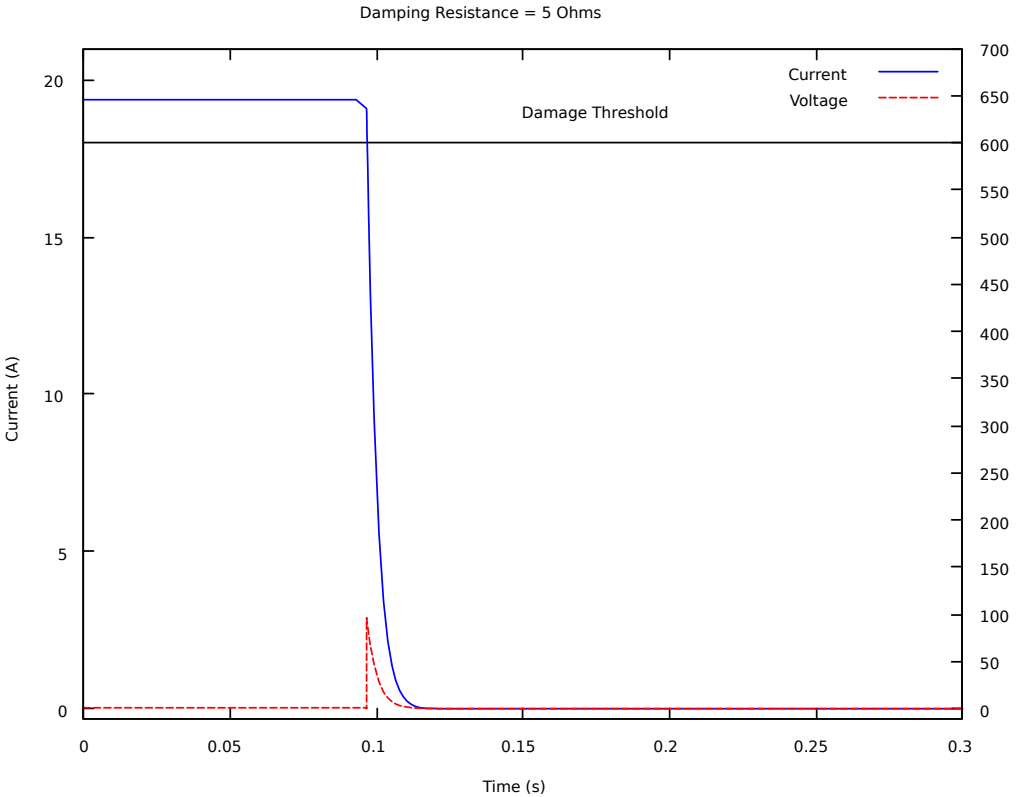

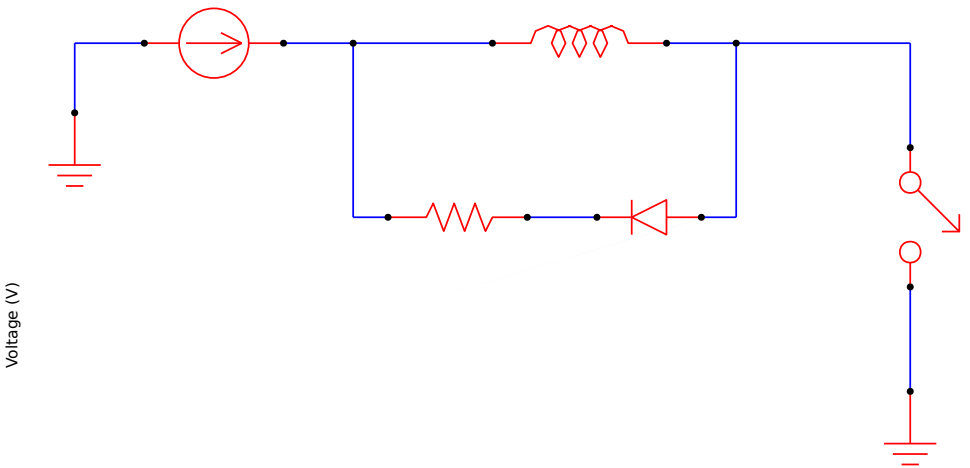

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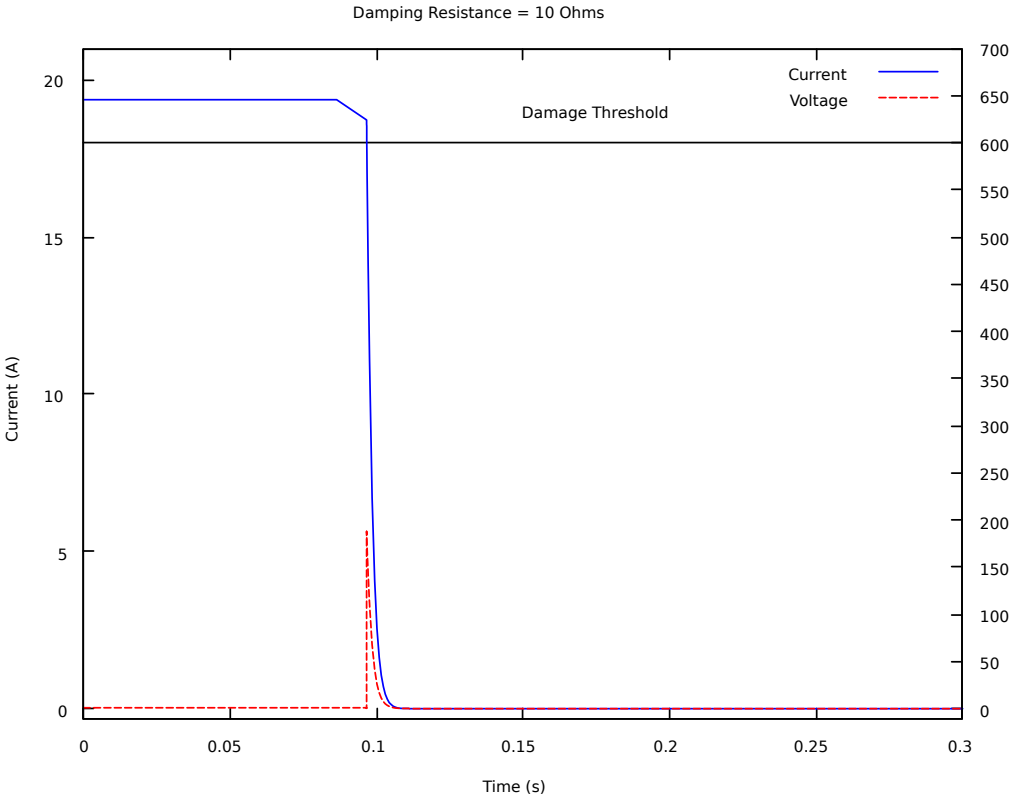

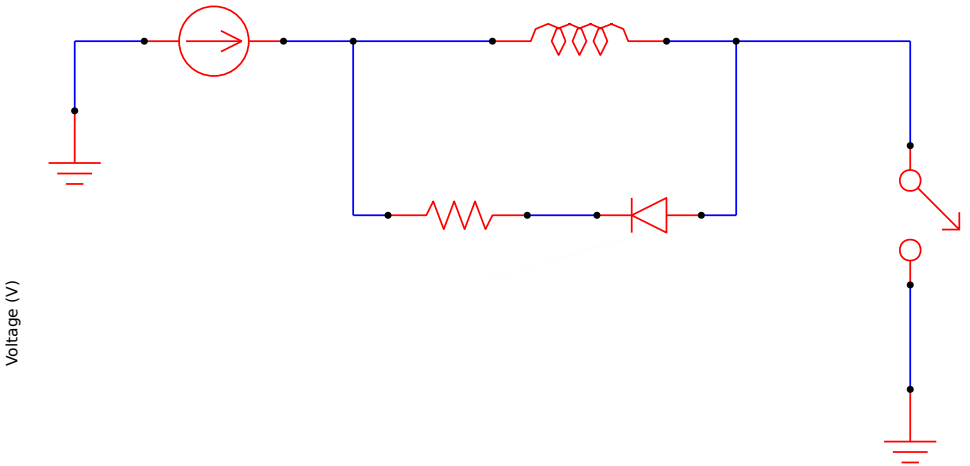

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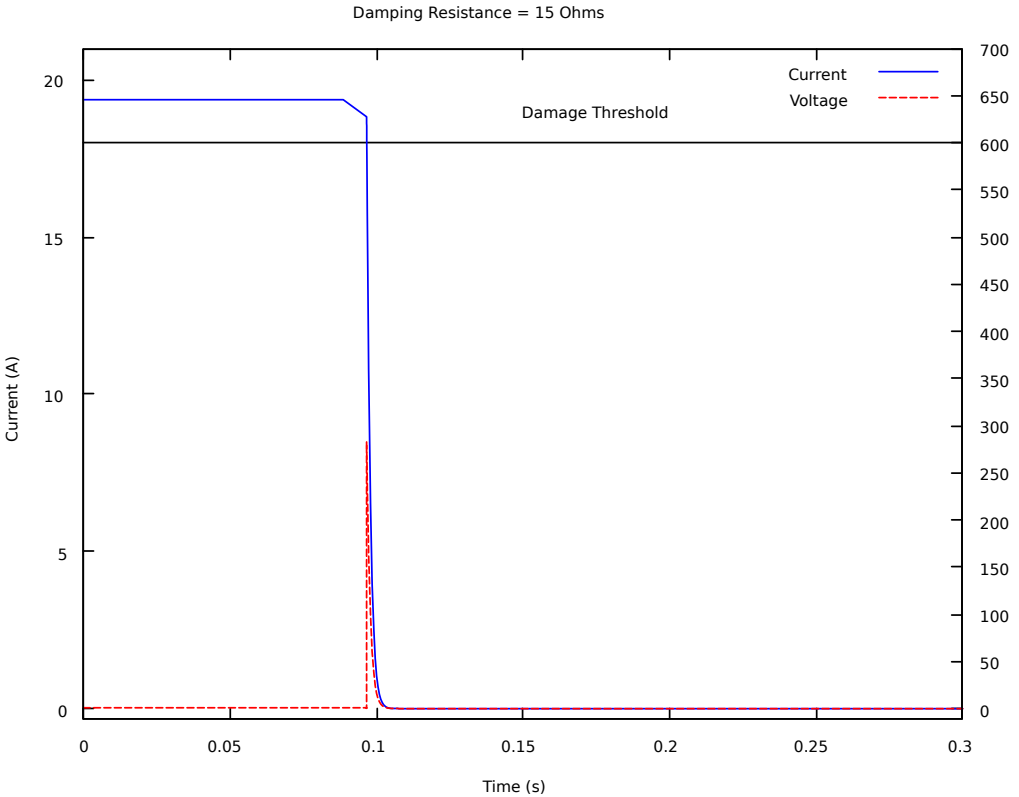

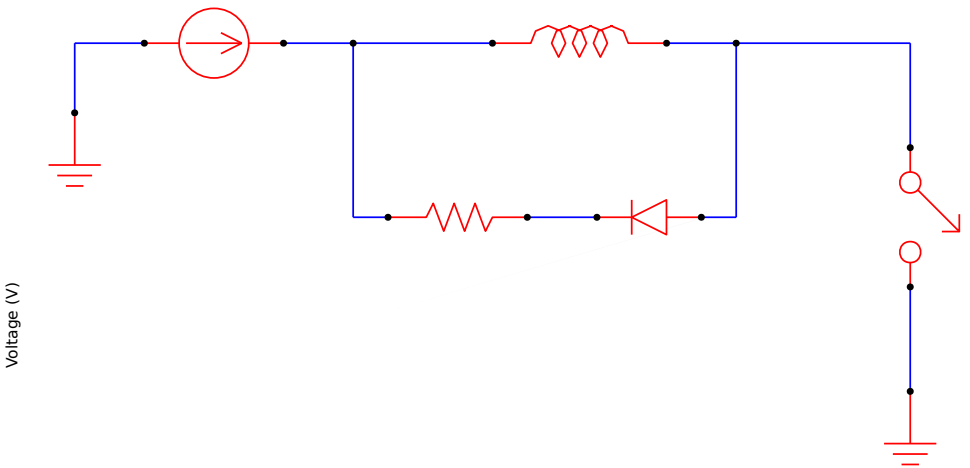

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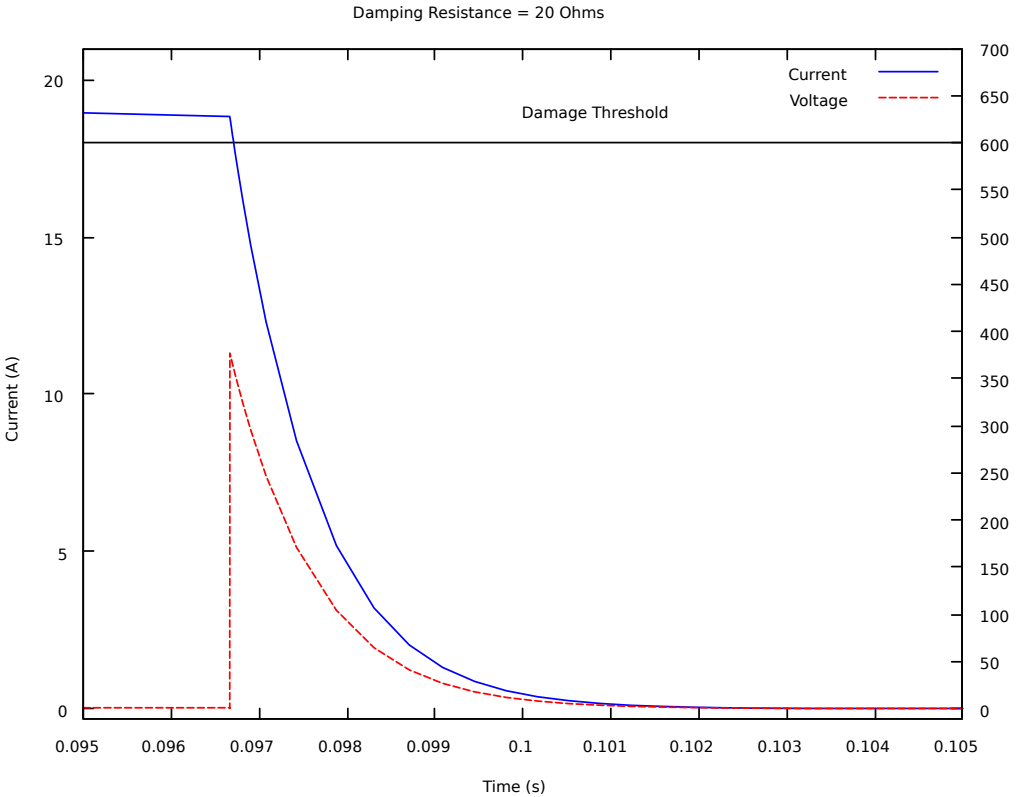

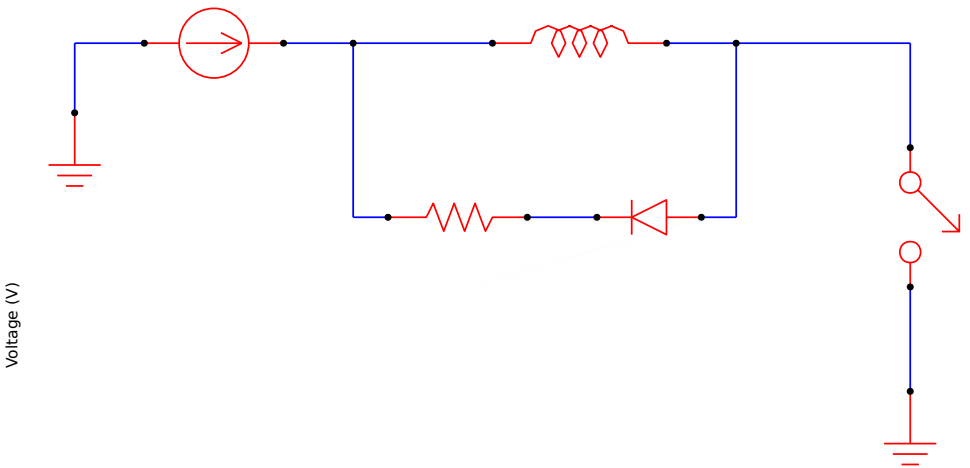

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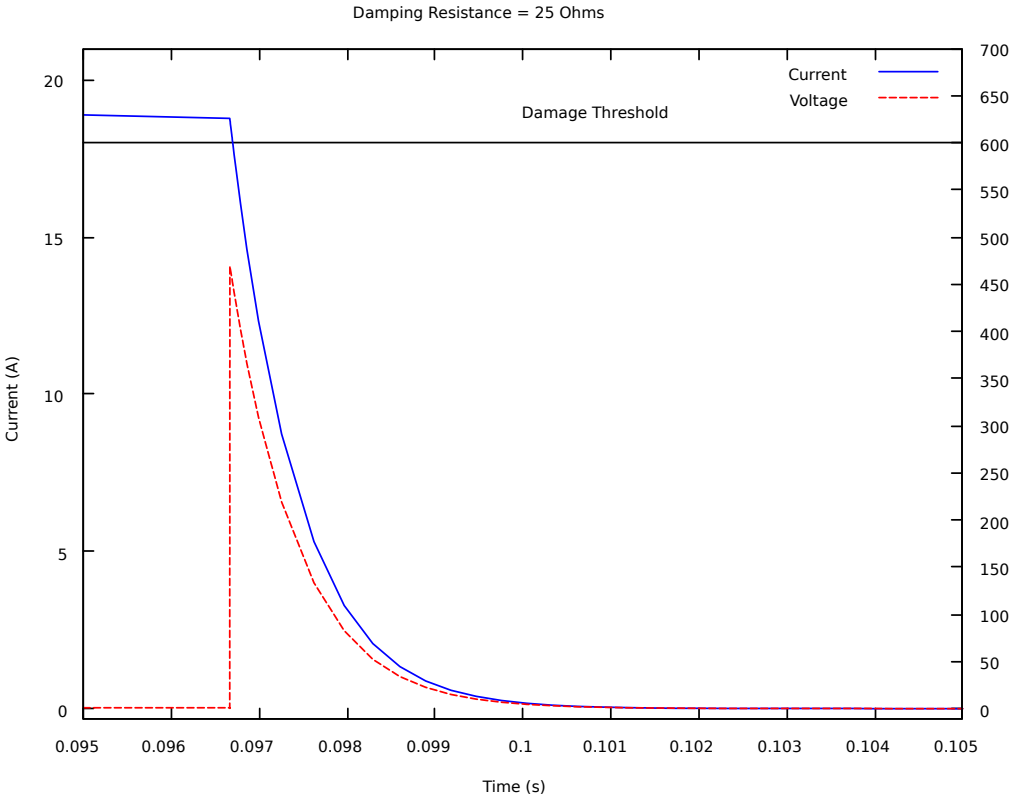

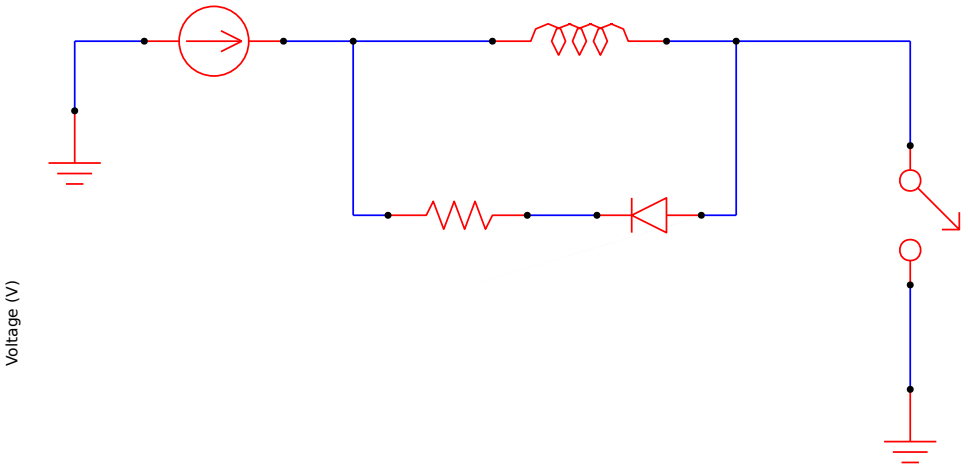

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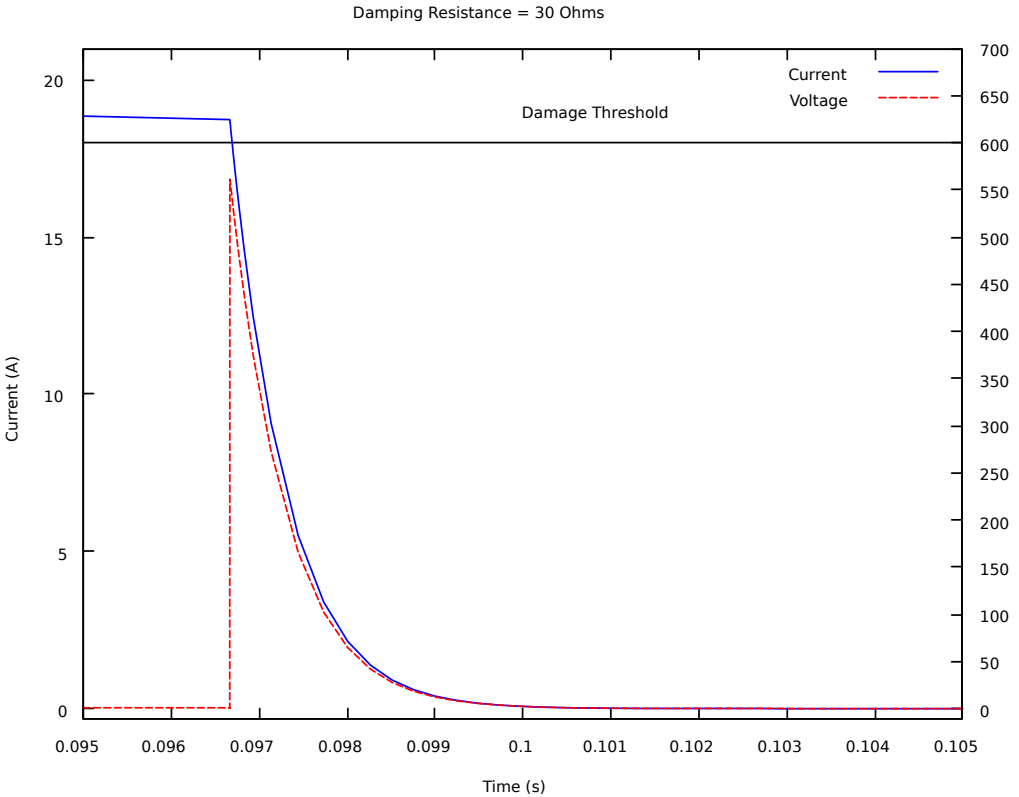

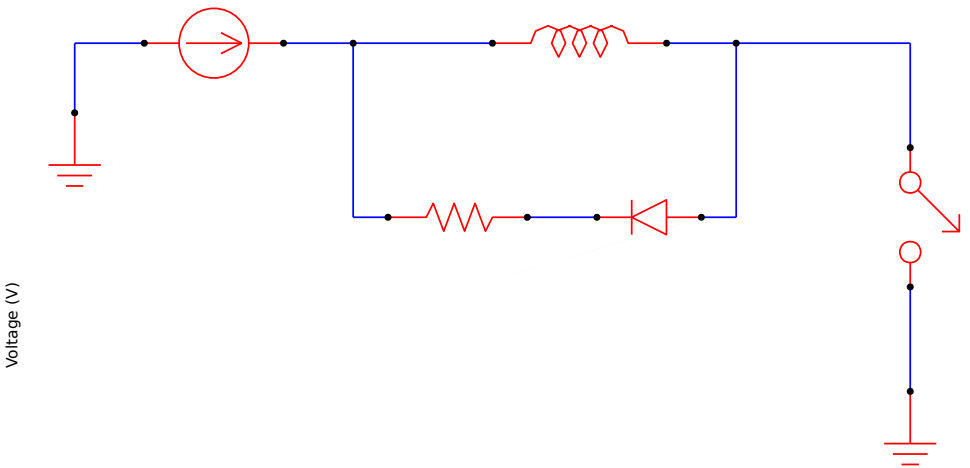

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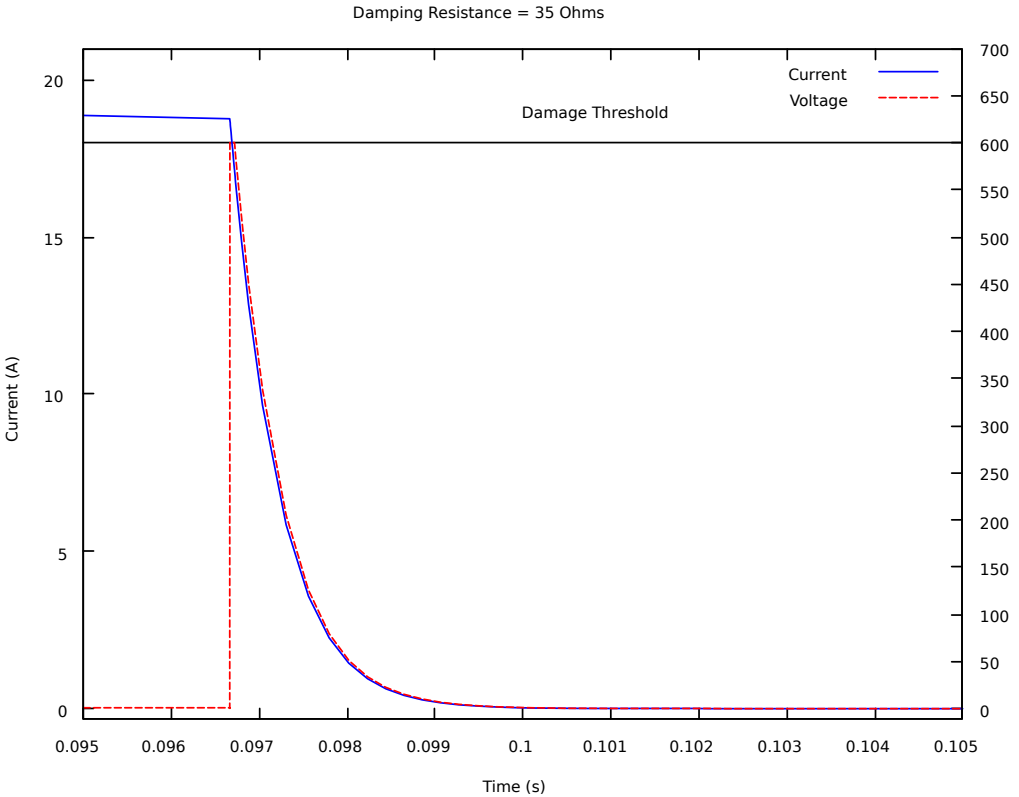
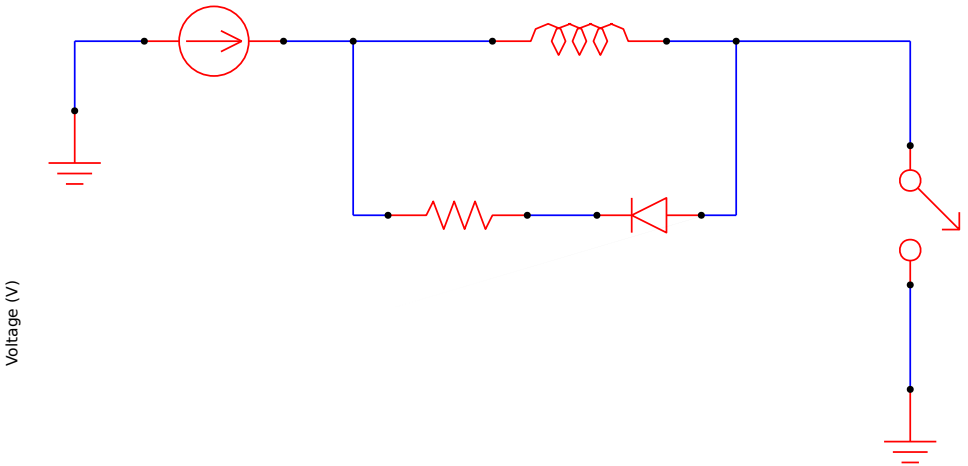
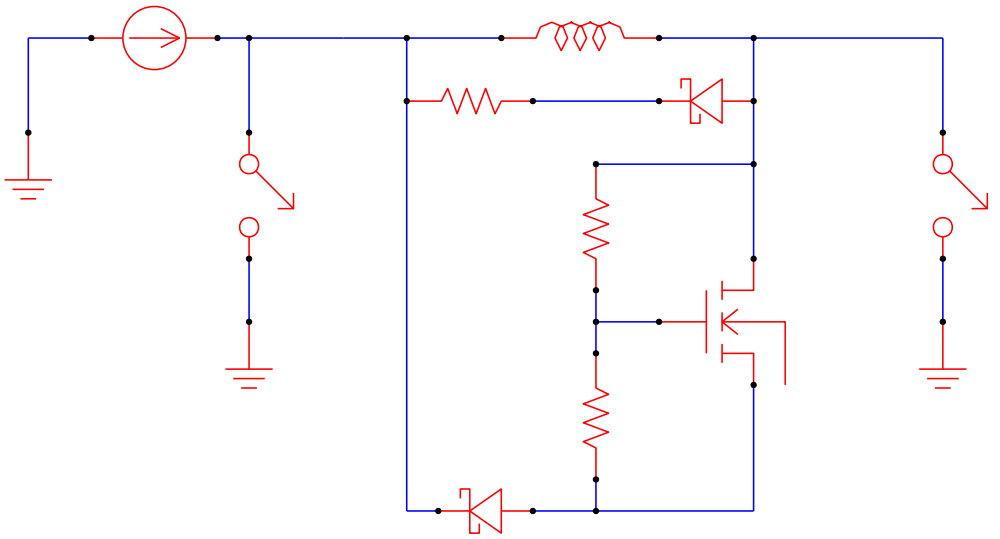




My Solution

- Complementary control signals ensure there is always a route to ground
- Transistor in return path acts as voltage clamp
- Voltage across return path fixed -> Current decay no longer exponential
  - Much faster switch off time
- Voltage build up at switch also reduced



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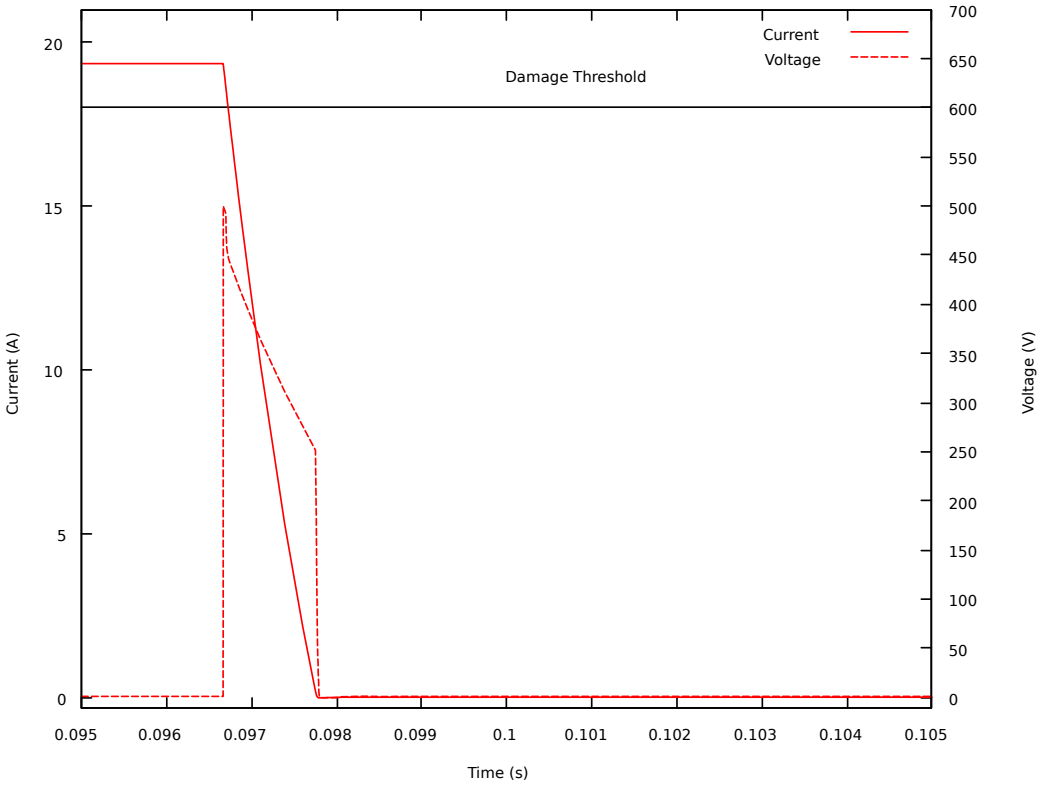

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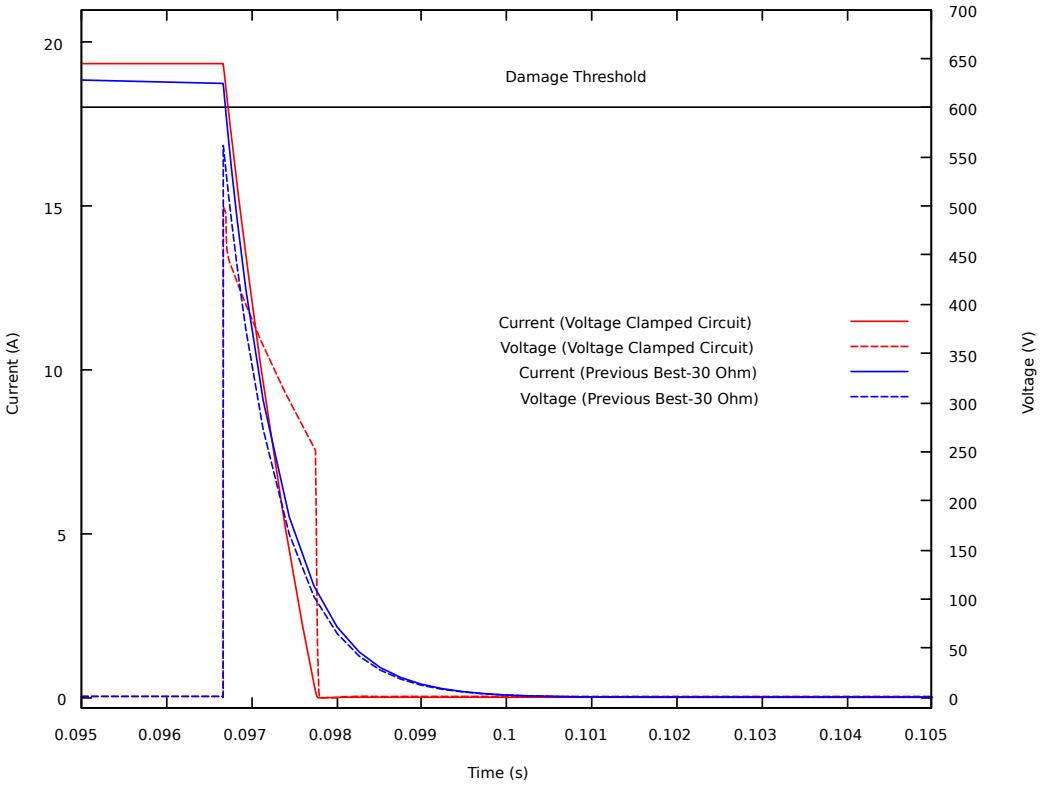
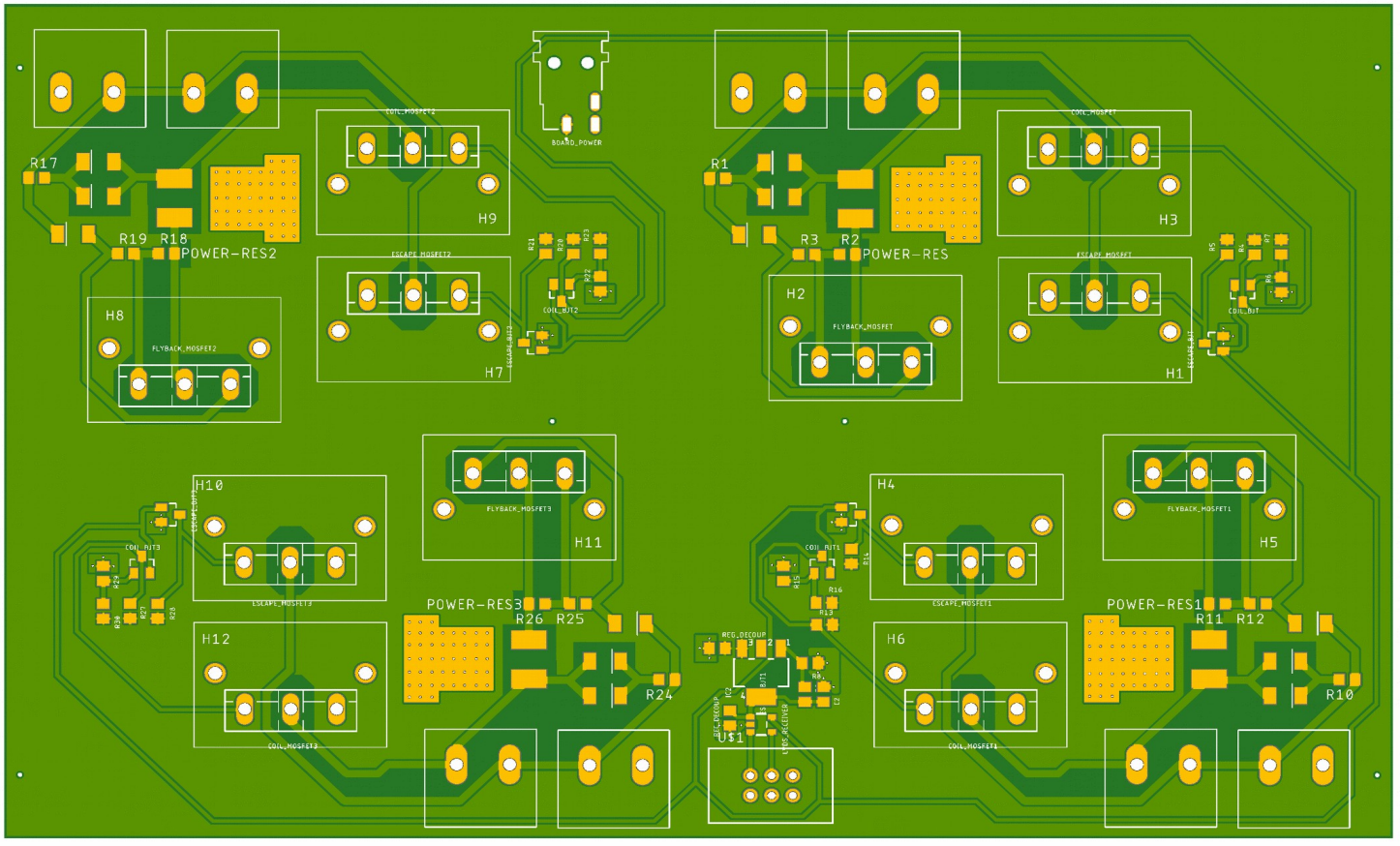


PCB design


R17
R19 R18
POWER-RES2
H9
H8
H7
R1
R3 R2
POWER-RES
H3
H2
H1
H10
H11
H12
POWER-RES3
R26 R25
R24
H4
H5
H6
POWER-RES1
R11 R12
R10
U$1

Other Work

- Identified and selected required optics and mountings for MOT and Interferometry laser beams
- Identified RF components needed to drive microwave antenna used for atomic state selection

Any Questions?