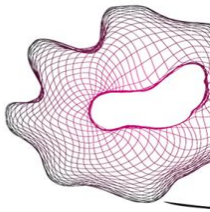
Technische problemen door vuile stroom en gevolgen voor blootstelling



Prof.dr. Frank Leferink

Vragen?

- Wat is
  - ‘’vuile energie’’ (*dirty energy)*
  - ‘’vuile spanning’’
  - ‘’vuile stroom’’
- Storingen
- Magnetische velden

Energie, vermogen, spanning, stroom, magnetisch veld

E Energie = spanning x stroom x tijd [Joule]

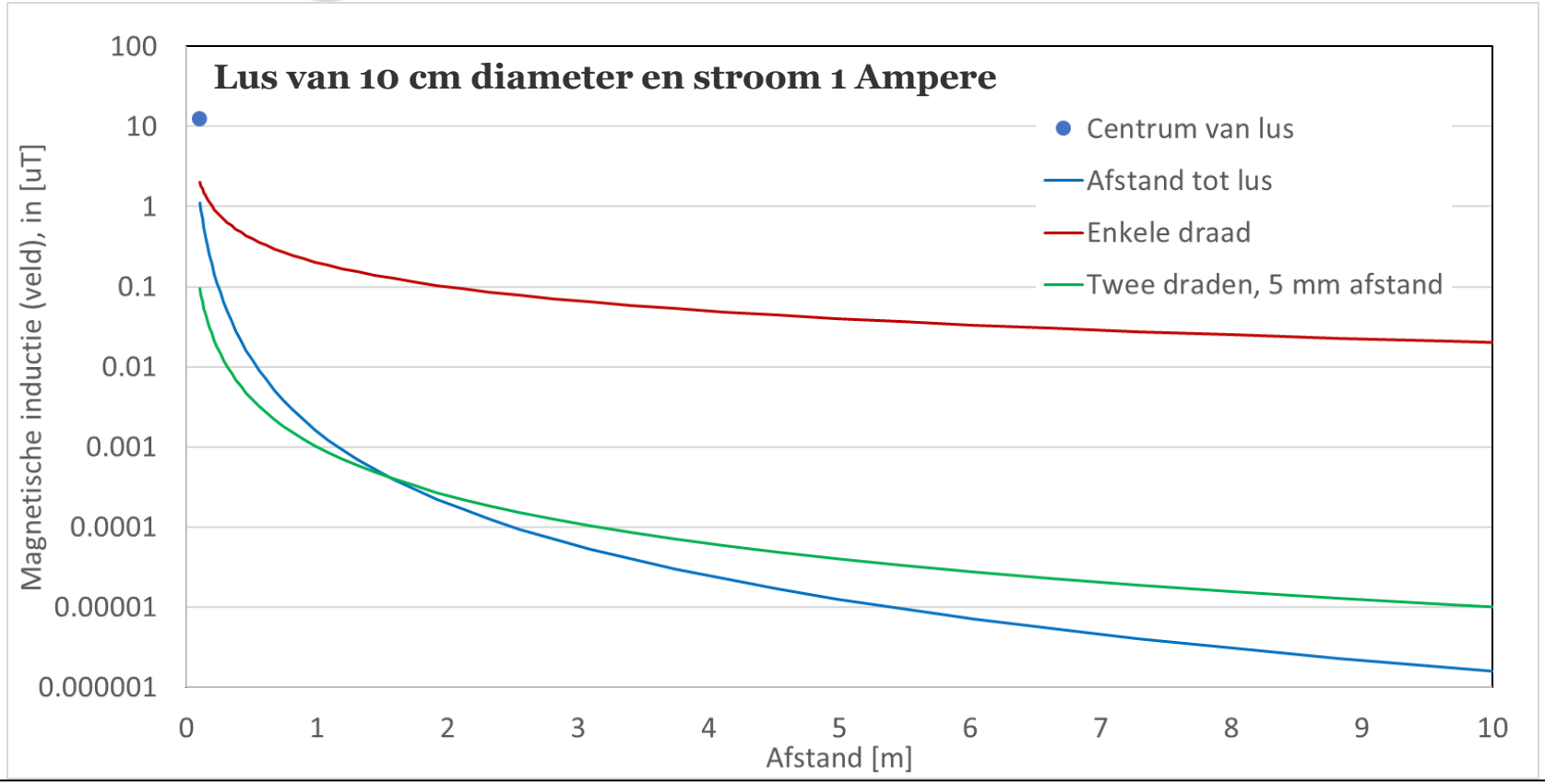
P Vermogen = spanning x stroom [Watt]

V Spanning: 230 [V]

I Stroom: gaat lopen als er een apparaat is aangesloten [A]

B Magnetische veld (inductie) = **stroom** x oppervlak [Tesla]

Veld a.g.v. stroom in lus en draad

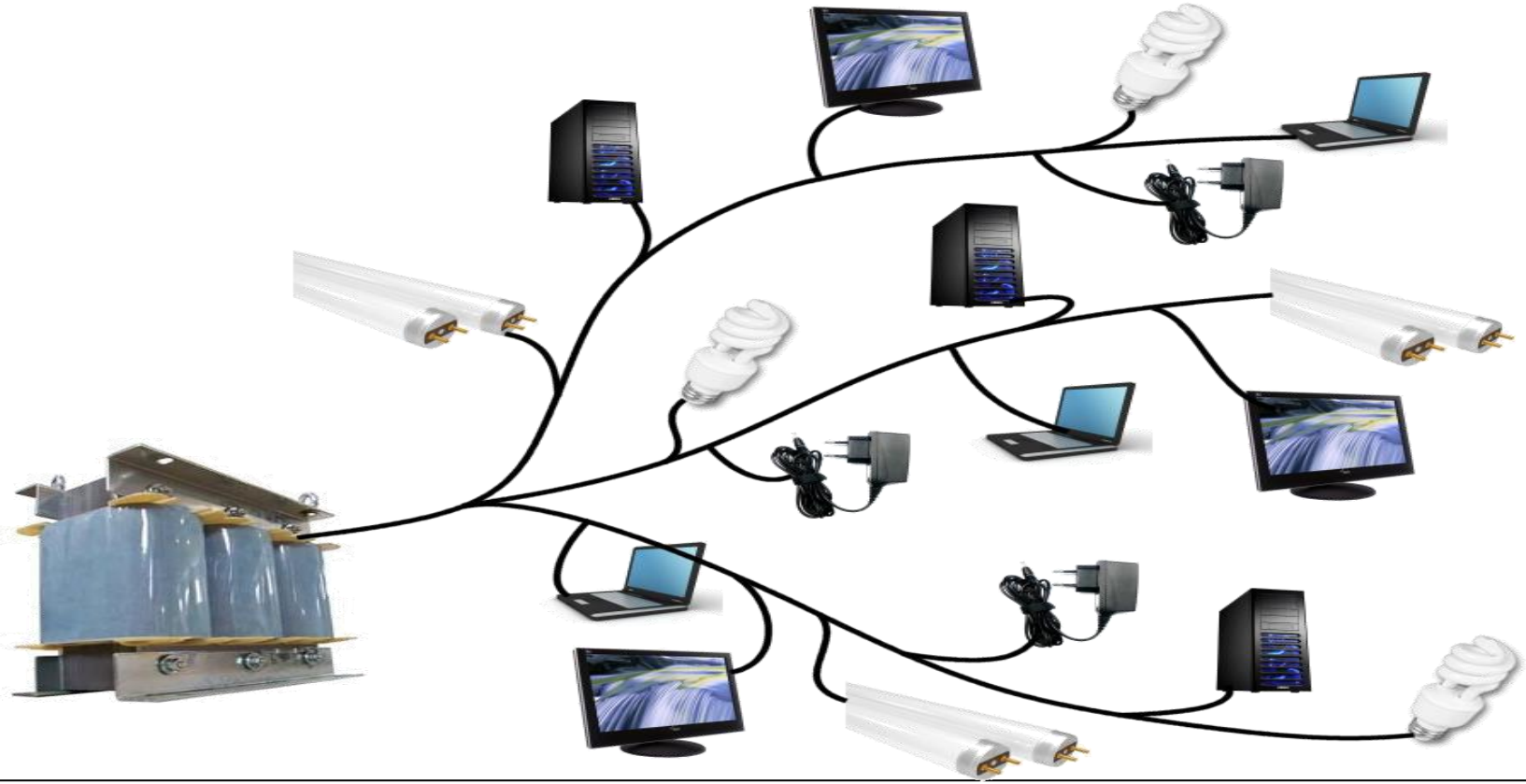


Verandering in gebruikers (stroomvorm) en storingen

Stroom, spanning en veld

- Als de spanning een pure 50 Hz sinus is
- En de gebruiker is een lineaire belasting (weerstand, spoel, condensator)
- Dan is de stroom ook een pure 50 Hz sinus
- En is het magnetisch veld ook een pure 50 Hz sinus

Moderne apparaten, energiezuinig

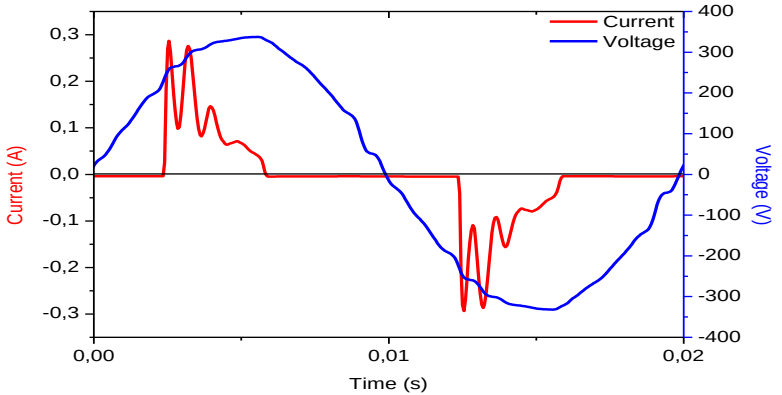


Spanningsvorm en stroomvorm

11 W CFL (~60 W gloeilamp)

P_{VA} 19 VA (60 VA gloeilamp)

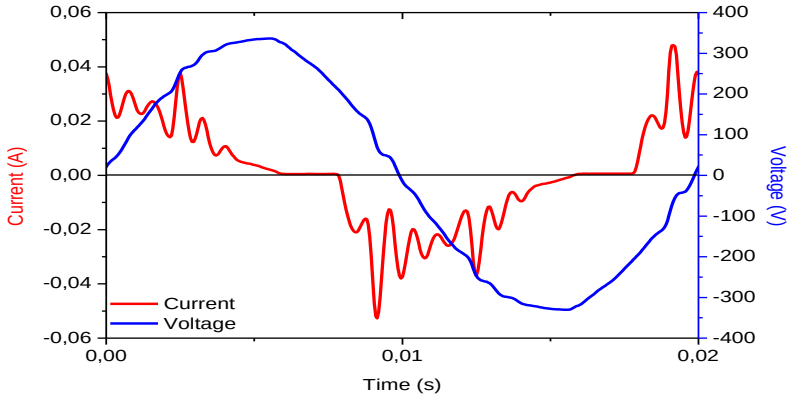
I_{pk} 0.58 A (0.75 A gloeilamp)



7.2 W LED (~60 W gloeilamp)

P_{VA} 27 VA (60 VA gloeilamp)

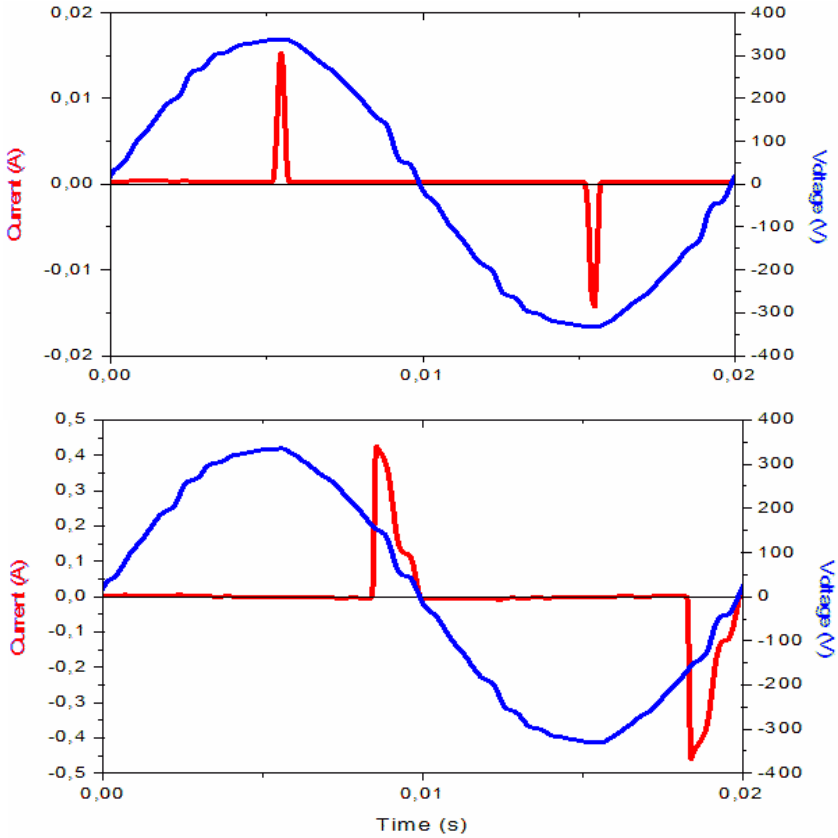
I_{pk} 0.6 A (0.75 A gloeilamp)



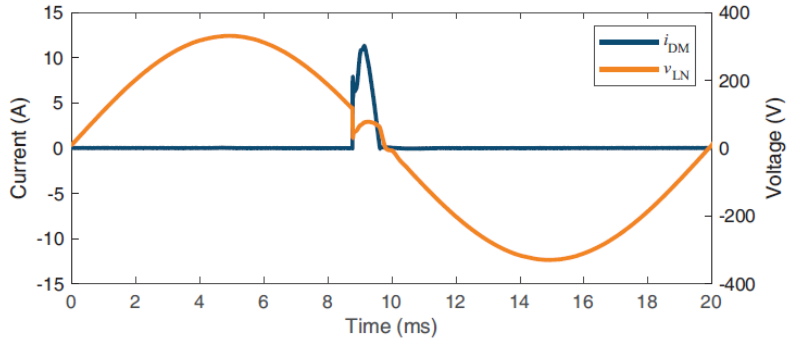
Spanningsvorm en stroomvorm

laadapparaat

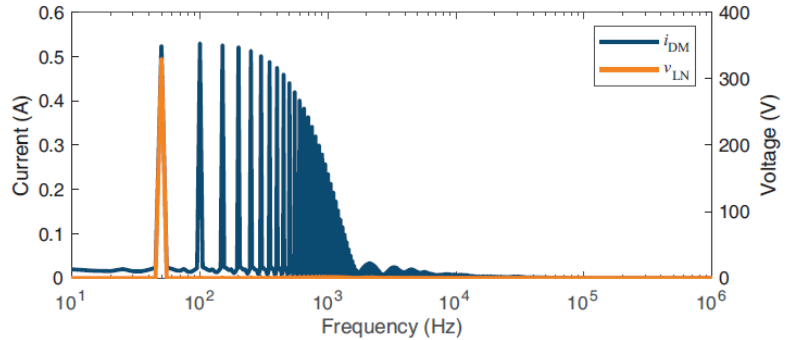
dimmer



Vijverpomp regeling



(a) Time-domain response

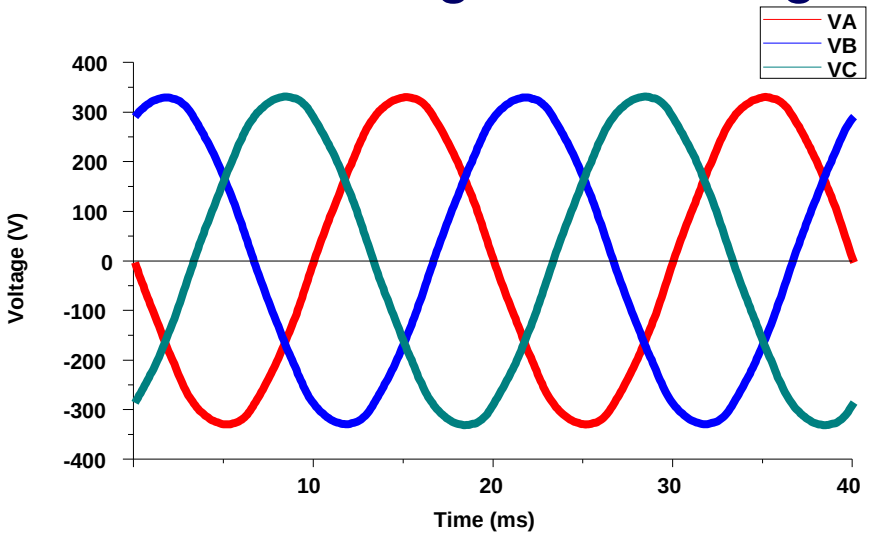


(b) Frequency-domain response

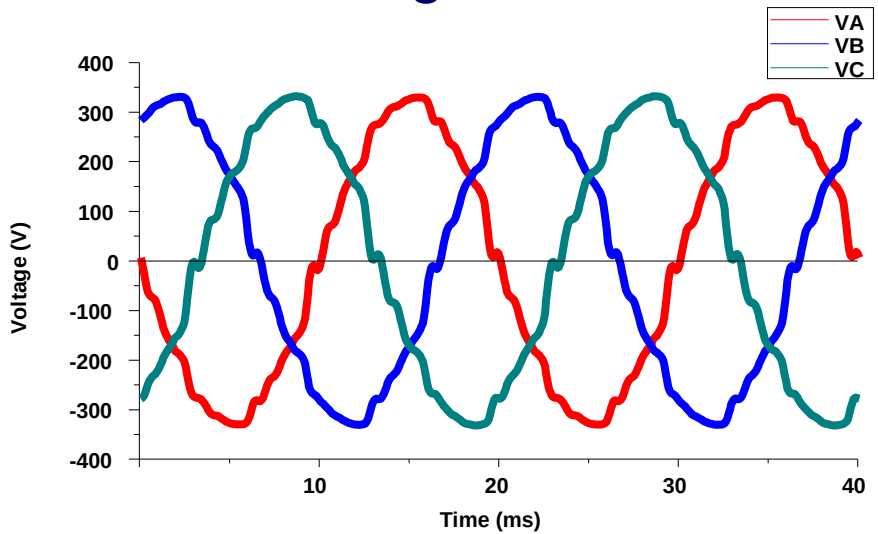
Veel storende apparaten

➡ Gevolgen voor de spanning:

Nieuw gebouw, leeg

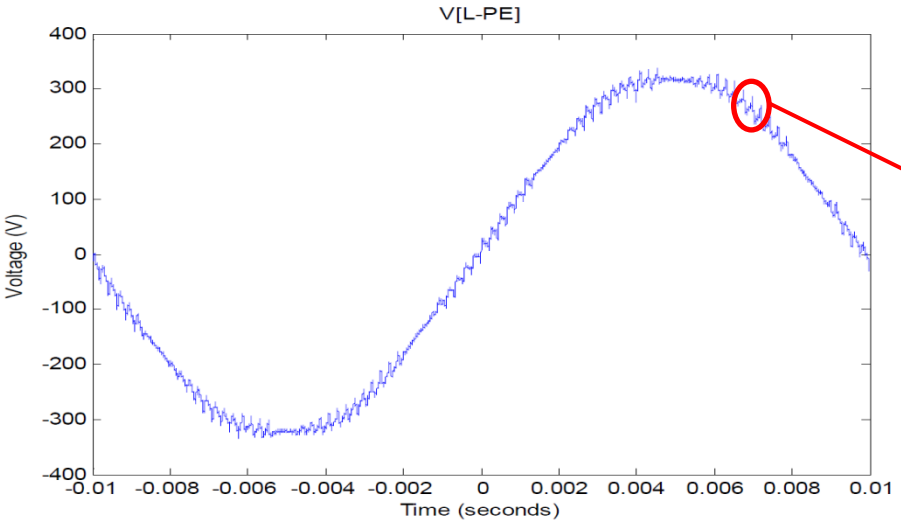


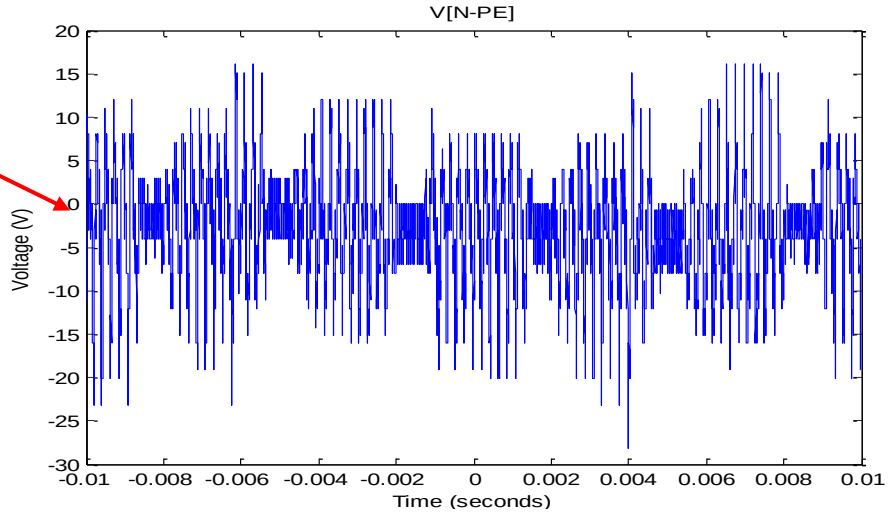
Met gebruikers



Snelheidsregeling ventilatoren stal

‘Saasveld case study’: stoorgevoelige energiemeter





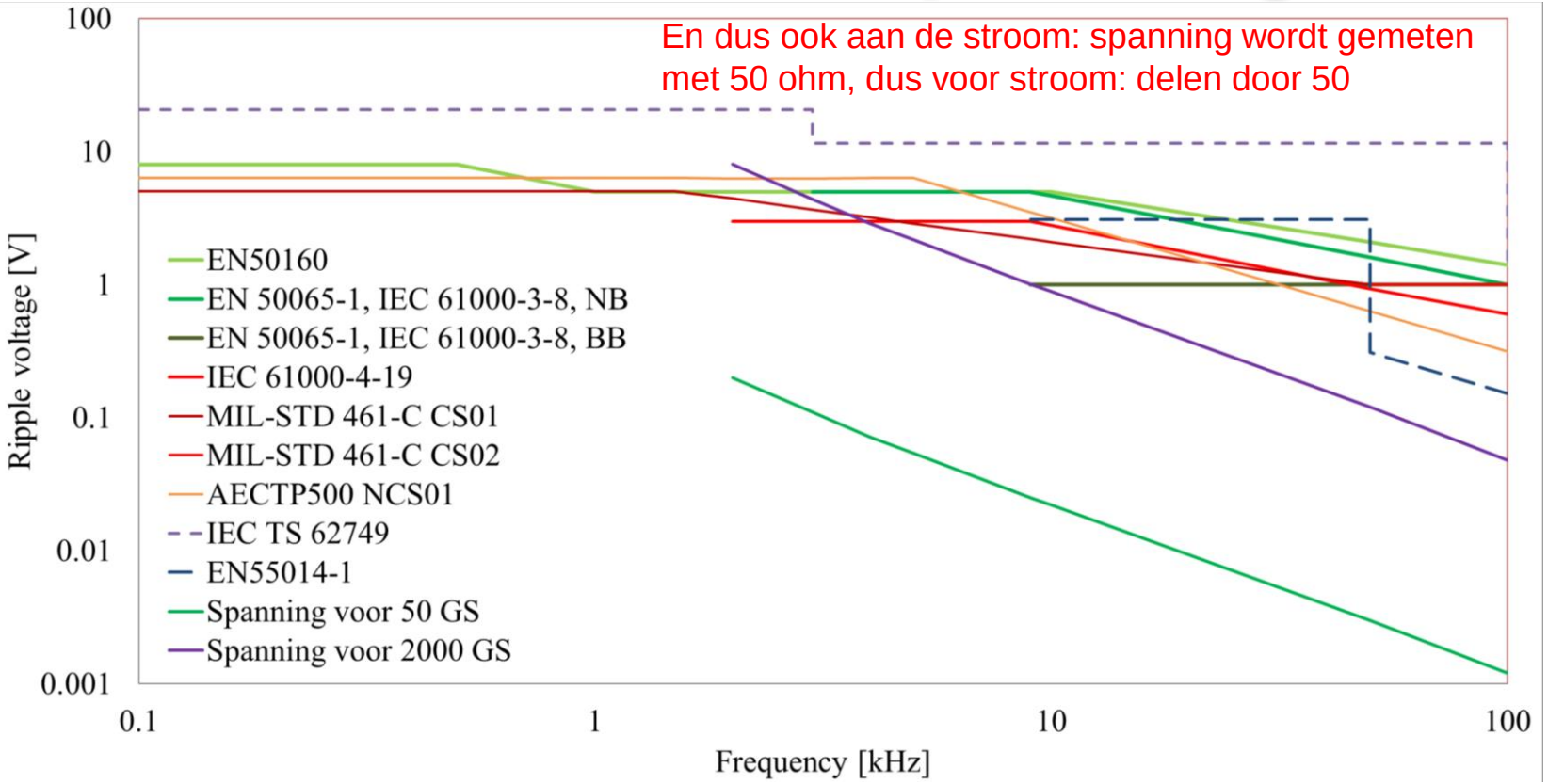
Bekende stoorbronnen

- SC 205A Study Report on Electromagnetic Interference between Electrical Equipment/Systems in the Frequency Range below 150 kHz: CLC/TR 50627
  - ⇨ Inverters and variable speed drives
  - ⇨ Switch-mode power supplies
  - ⇨ Lighting equipment (CFL, LED)
  - ⇨ Household equipment
  - ⇨ Portable mains operated tools
  - ⇨ PLC for smart meters
  - ⇨ etc

Bekende stoorgevoelige apparaten

- SC 205A Study Report on Electromagnetic Interference between Electrical Equipment/Systems in the Frequency Range below 150 kHz: CLC/TR 50627
  - Solid state energy meters
  - Electronic control (e.g. Touch Dimmer lamps (TDL), alarm systems, traffic control systems, traffic lights, street lighting, for doors, in kitchen appliances
  - Earth leakage circuit breakers (ELB)
  - Contactless magnetic card readers, credit card terminals
  - Notebooks (cursor position)
  - Road vehicle smart keys, TV and radio receivers, Mobile radio

Eisen aan de spanning



Energie, vermogen, spanning, stroom, magnetisch veld

E Energie = spanning x stroom x tijd [Joule]

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B **Magnetische veld** (inductie) = **stroom x oppervlak** [Tesla]

bronnen van magnetische veld

Bronnen van magnetische veld

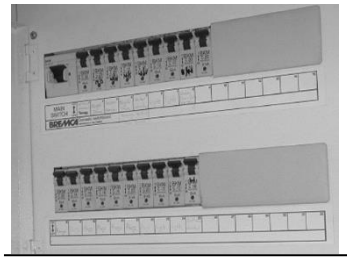
- Achtergrond magnetisch veld, aarde, 50 μT (DC)
- Typisch 50 Hz, 0.01 μT – 0.3 μT (50 Hz)
- Onder electriciteitskabels 5 μT (50 Hz)
- Sommige apparaten 150 μT (?)
- Trein (VS), 50 μT, gemiddeld 12.5 μT (25 Hz)
- Tram, 2 μT
- Monitor, 0.3 μT (3-30 kHz): TCO en MPR Eisen
- Laptop, 6 μT
- Elektrisch lassen, 3.000 μT piek, 120 μT gem./werkdag
- Inductief verwarmen, 100 kHz – 400 kHz, 20 μT piek blootstelling
- Elektrochirurgie, 200 kHz – 3.3 MHz, 15 μT

Van o.a.: 'Possible Health Effects of Exposure to Residential Electric and Magnetic Fields', http://www.nap.edu/catalog/5155.html
https://www.sciencedirect.com/topics/engineering/electrosurgery
Malka N. Halgamuge et.al., Measurement and Analysis of Electromagnetic Fields from Trams, Trains and Hybrid Cars, October 2010, Radiation Protection Dosimetry 141(3):255-68, DOI: 10.1093/rpd/ncq168
Stuchly, M. A.; Lecuyer, D. W., Exposure to Electromagnetic Fields in Arc Welding, Health Physics: March 1989 - Volume 56 - Issue 3 - p 297-302

5 μT

2 μT

10 μT



3 μT

0.15 μT

5 μT

0.5 μT

Van: 'Electric and Magnetic Fields and Your Health, Information on electric and magnetic fields associated with transmission lines, distribution lines and electrical equipment', Ministry of Health, New Zealand, 2013'

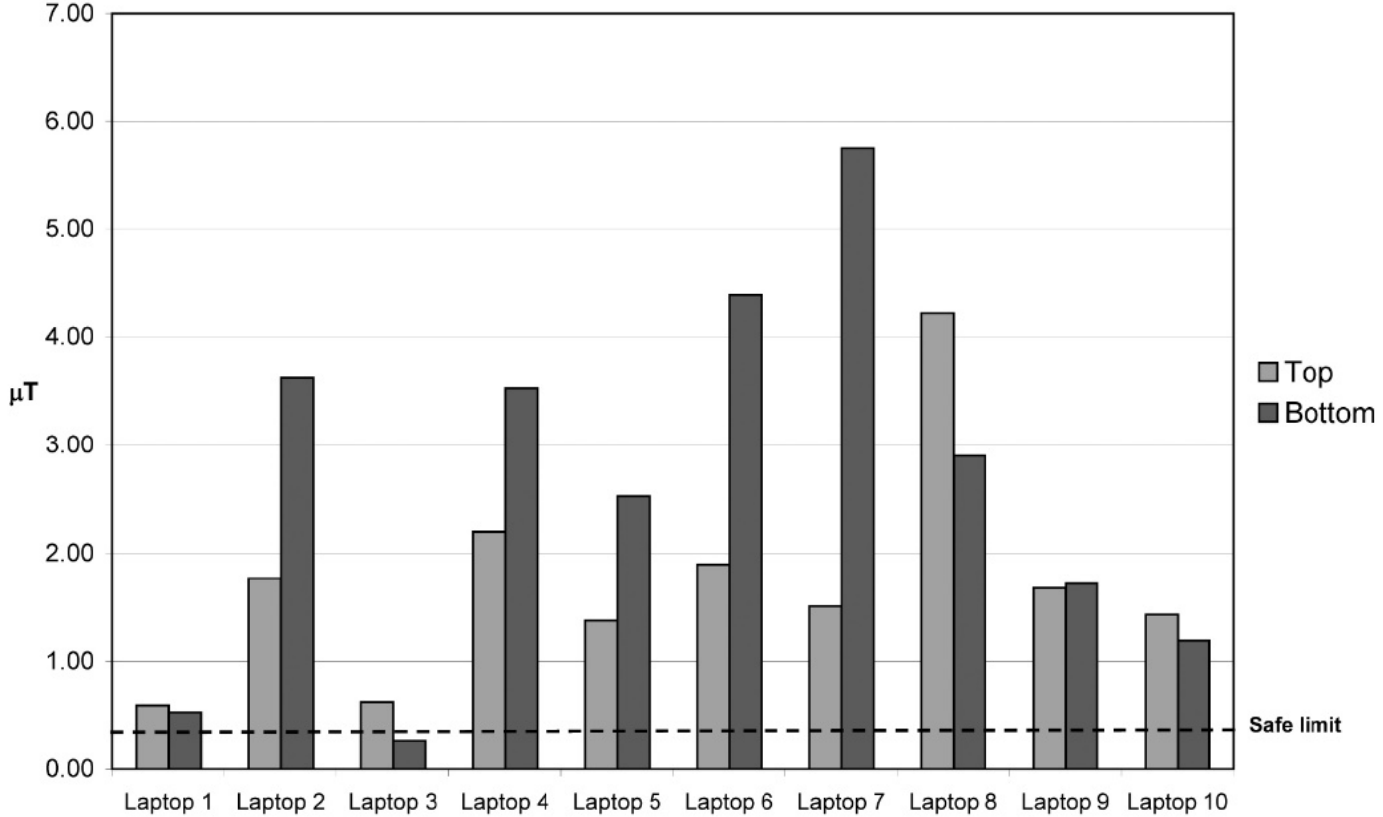
TCO Eisen aan beeldschermen

TABLE 1. TCO'03 Requirements on Emission of Electromagnetic Fields From Cathode Ray Tube (CRT) Screens [3]

Type of Field	Max Level	Comments
Electrostatic field	±500 V	
Alternating field 5 Hz–2 kHz		
Magnetic field	0.2 μT	50 cm on all sides and 30 cm in front of the monitor
Electric field	10 V/m	30 cm directly in front of the monitor
Alternating field 2–400 kHz		
Magnetic field	0.025 μT	50 cm on all sides of the monitor
Electric field	1 V/m	50 cm on all sides and 30 cm in front of the monitor

Van: 'Electromagnetic Fields in Offices', Monica Sandström, International Journal of Occupational Safety and Ergonomics, 2006, DOI: 10.1080/10803548.2006.11076677

Maximaal veld bij laptops



Darko Brodic, Measurement of the extremely low frequency magnetic field in the laptop neighborhood, Revista Facultad de Ingeniería, No. 76, pp. 39-45, 2015

Electrisch lassen

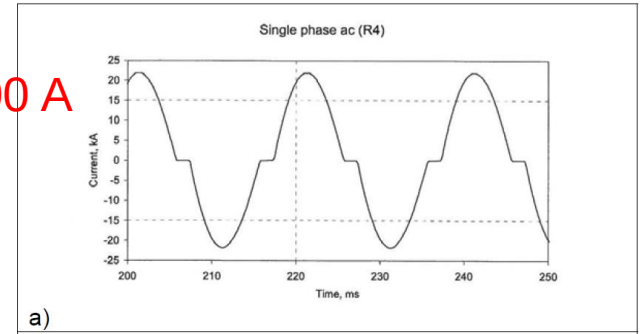
Geoff Melton and Rob Shaw, Electromagnetic Fields (EMF) in the welding environment, Health and Safety Executive, UK, 2014
Rechter figure van https://usedwelding-equipment.com/arc-welding/

Electrisch lassen

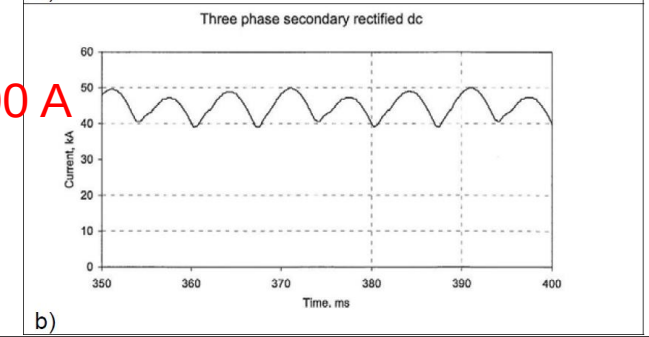
➡ Zeer veel varianten

Klassiek: 50 Hz en

20.000 A

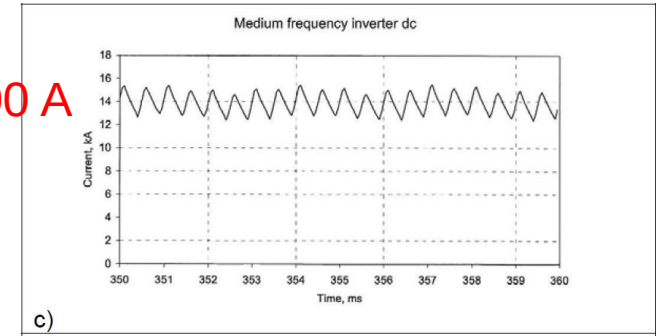


50.000 A

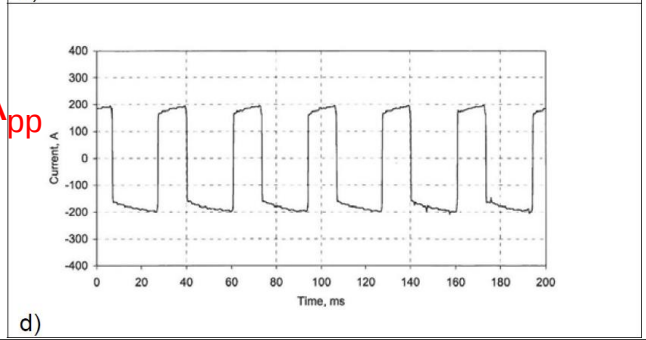


Modern: omvormers, ~1 kHz

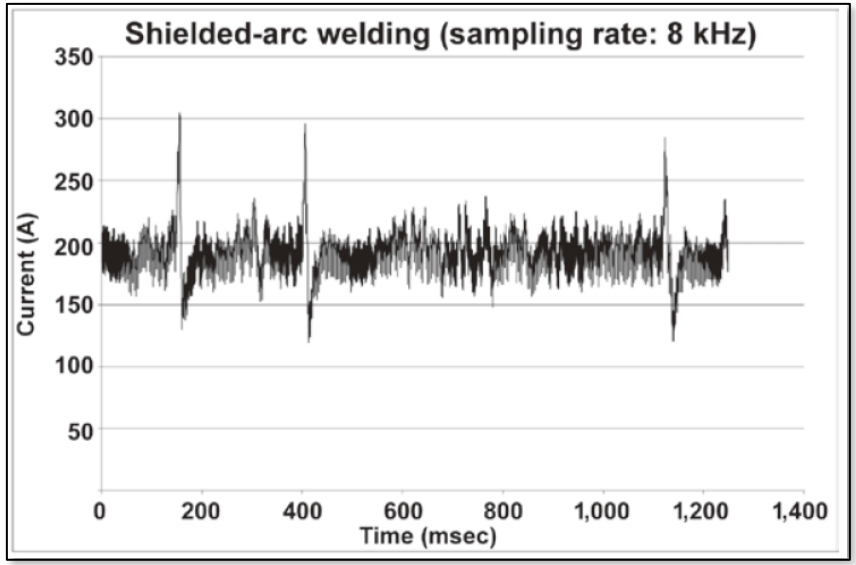
14.000 A

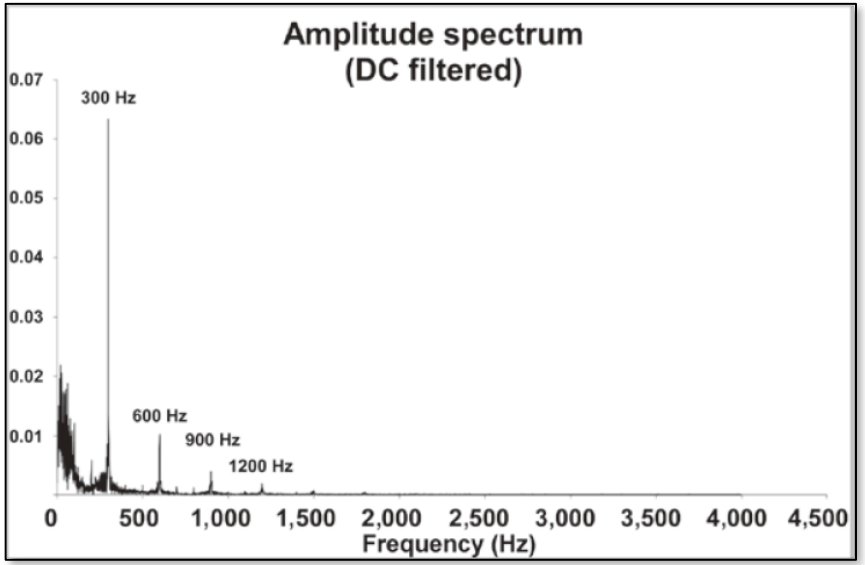


400 A_{pp}



Lassen



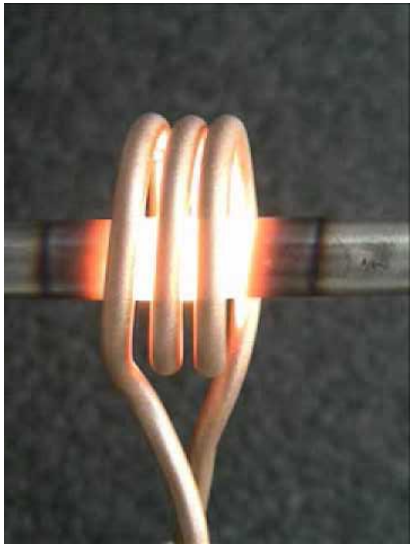


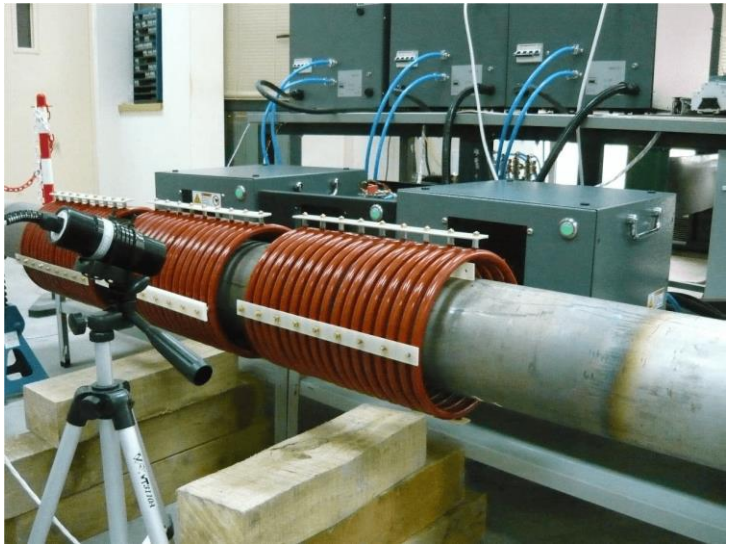
3.000 μT piek, 120 μT gemiddeld/werkdag

Van: 'Measuring Exposed Magnetic Fields of Welders in Working Time', S. Yamaguchi et. Al. , 2011

Inductief verwarmen

100 kHz – 400 kHz



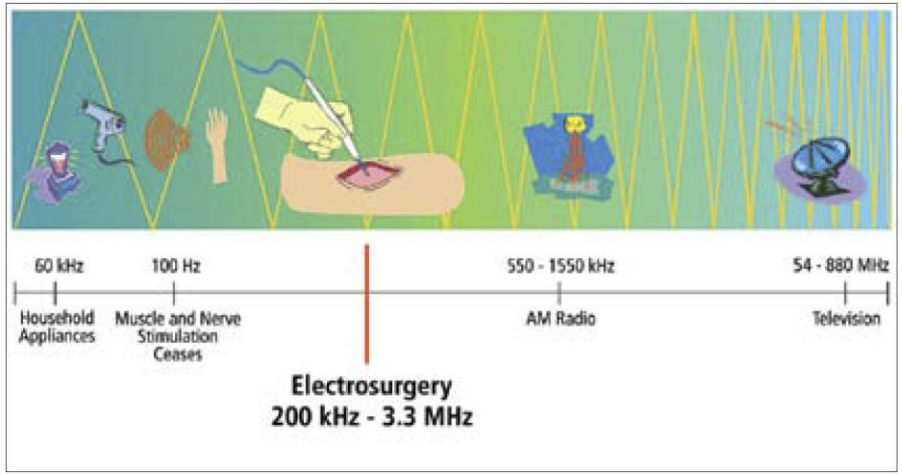


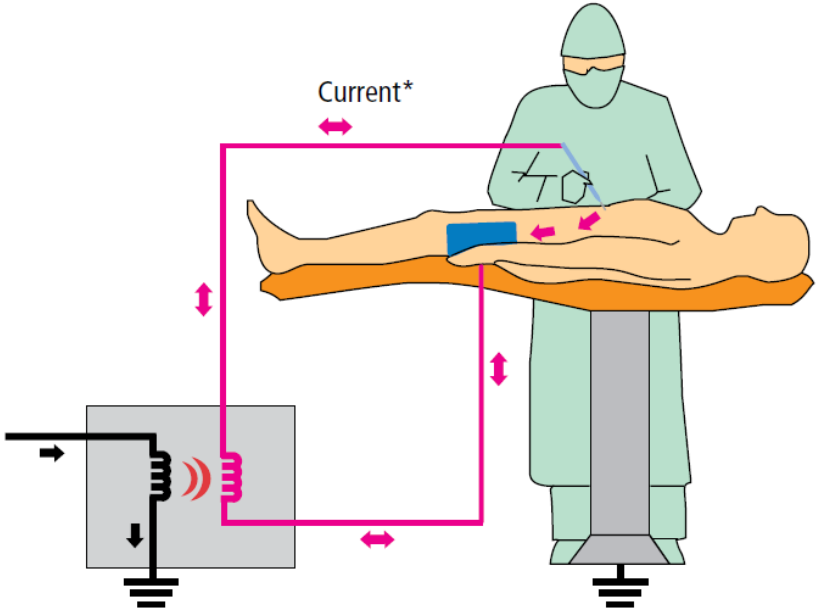
Blootstelling: 20 μT piek (ref. rechts)

Maar sommetje: 10.000 μT

Tarmo Koppel, Inese Vilcane, Risk management of magnetic field from industrial induction heater - a case study, 16th International Scientific Conference Engineering for Rural Development, May 2017, DOI: 10.22616/ERDev2017.16.N218

Elektrochirurgie

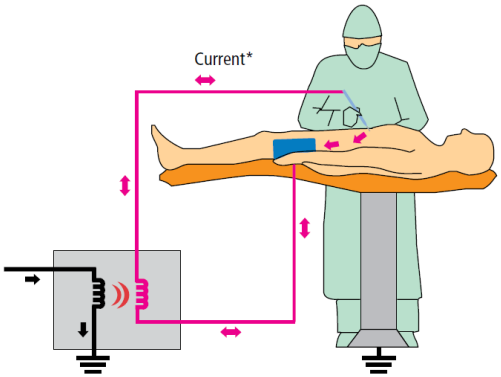


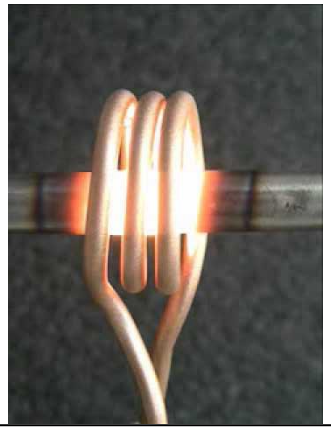


Zelf gemeten

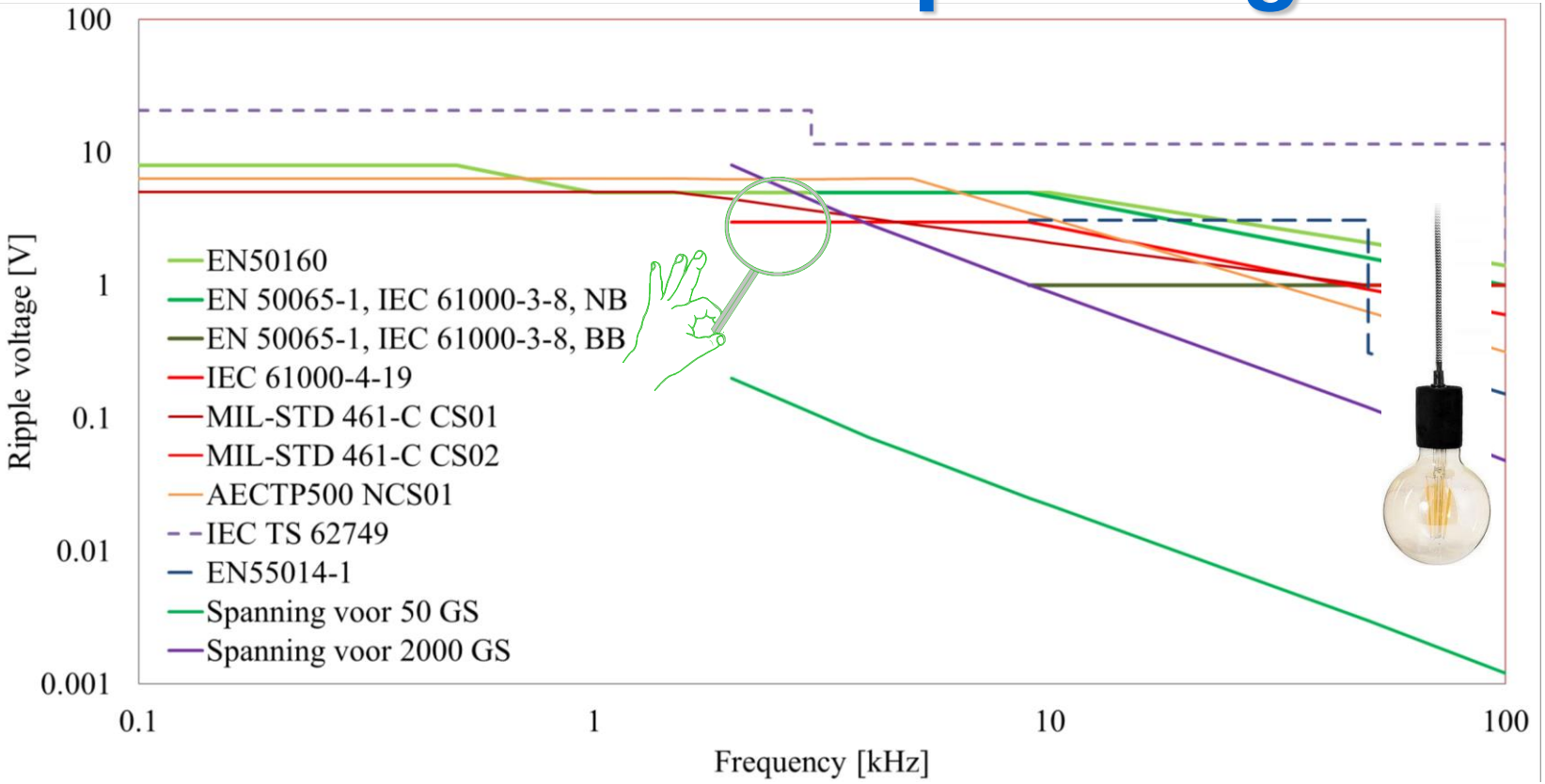
- Inductie kookplaat, 25-50 kHz, 1.5 μT @ 20 cm
- Auto laden thuis, 50 Hz, 2 μT @ 20 cm
- Auto laden snellader, ‘DC’, ca. 100 kHz, 2 μT @ 20 cm
- In electrische auto,
  - ⇨ stoelhoogte, 0.01 μT stilstand, 0.35 μT versnellend
  - ⇨ op vloer 2 x hogere waarde

Magnetisch veld = stroom x oppervlak

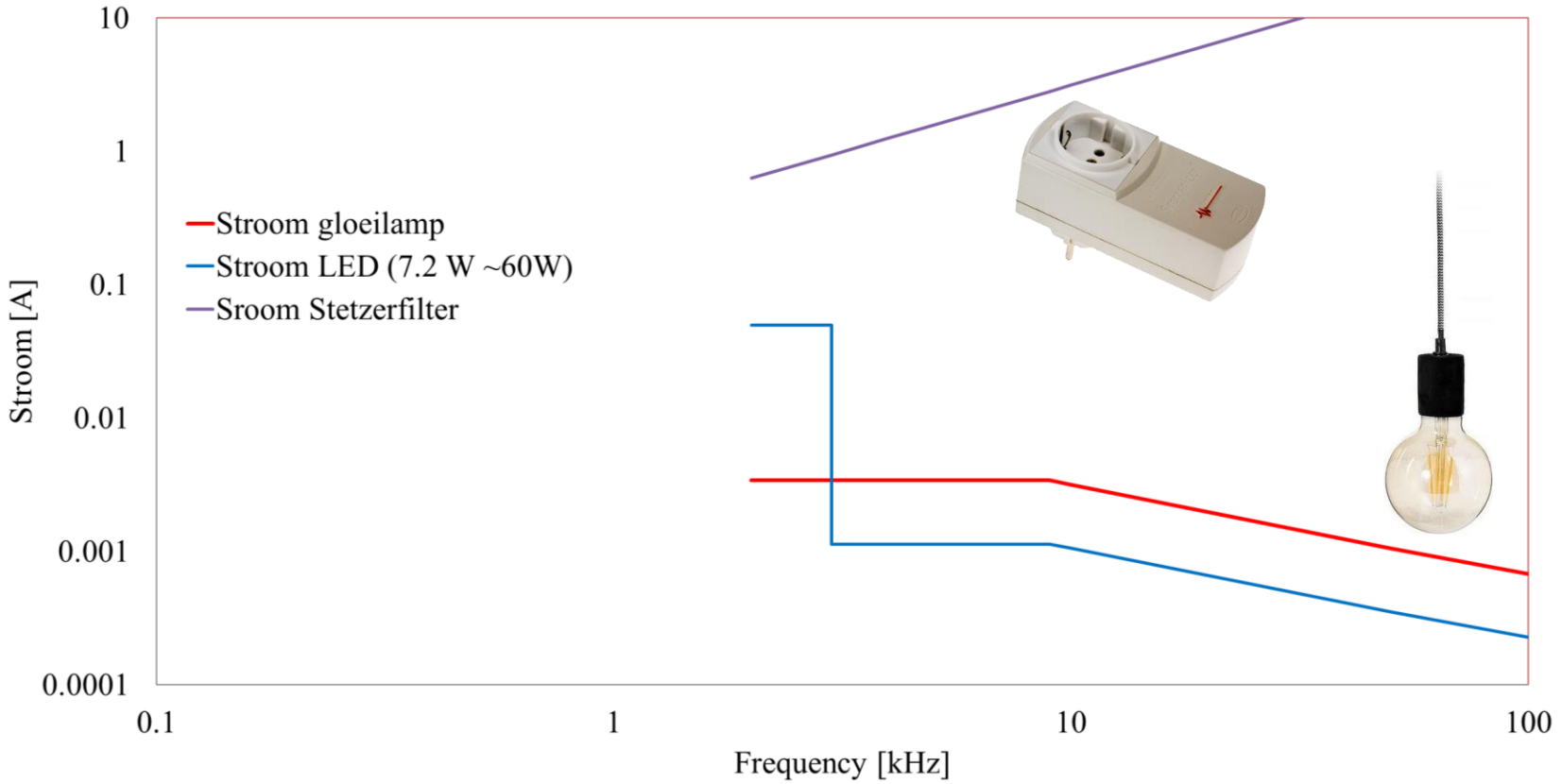




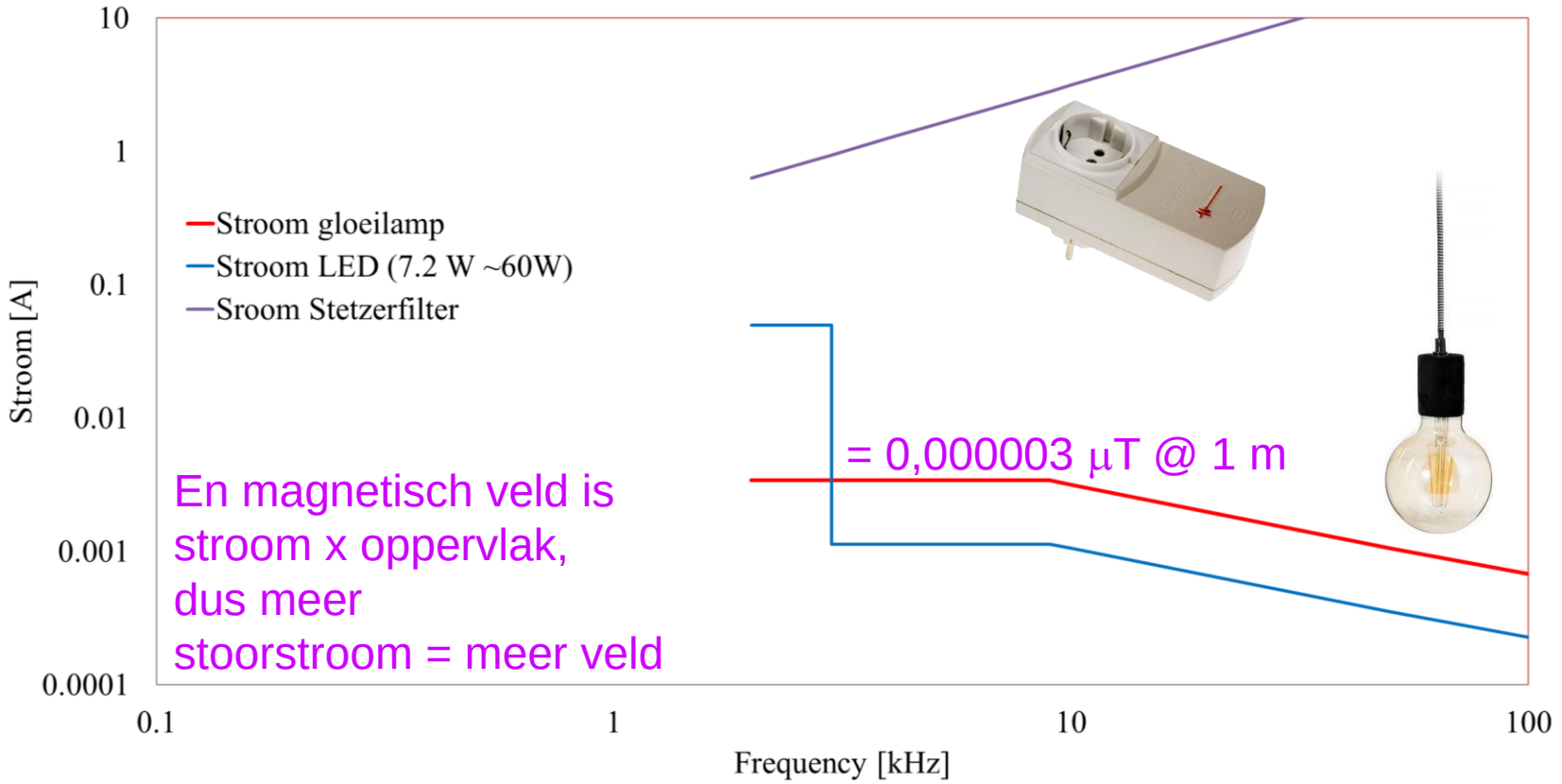
Eisen aan de spanning



Wat is dan de stroom?



Wat is dan de stroom?



En magnetisch veld is stroom x oppervlak, dus meer stoorstroom = meer veld

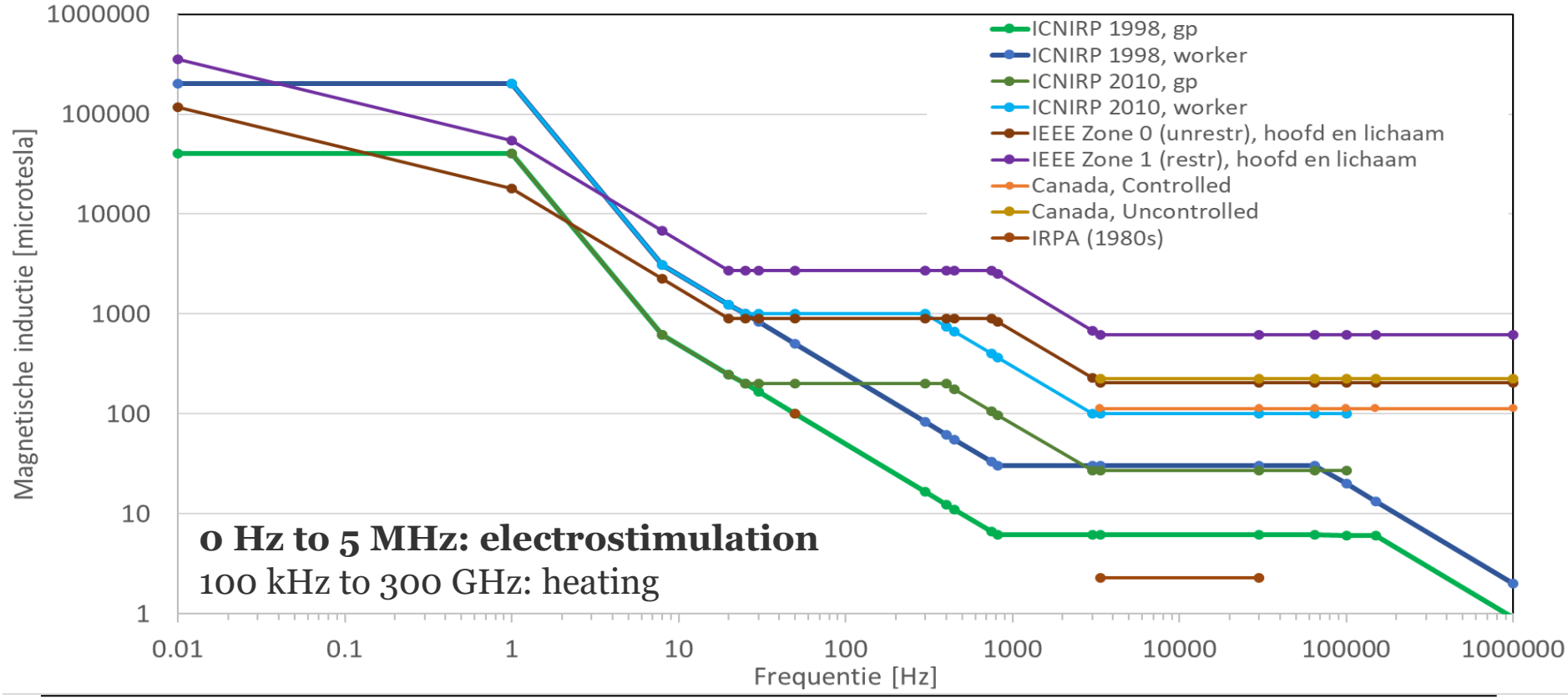
Mijn gedachten

- Grote zorgen over de vele storingen die ontstaan door electromagnetische interferentie (stoorstromen)

- Zorgen v.w.b. het gebrek aan actie bij diverse bedrijfstakken bij ‘’klassieke’’ bronnen van magnetische velden.
  Geen oordeel of het ‘’gevaarlijk’’ is, maar het is eenvoudigweg boven de limieten

- Zeer grote zorgen over die rommelproducten (levensgevaarlijk vanwege de blindstroom en dus brandgevaar) en onzinverhalen van Graham-Stetzer, Greenwave etc.

Blootstellingslimieten vergeleken



Hypothese (nooit bewezen)

- Samuel Milham, Historical evidence that electrification caused the 20th century epidemic of “diseases of civilization”

- I hypothesize that the 20th century epidemic of the so called diseases of civilization including cardiovascular disease, cancer and diabetes and suicide was caused by **electrification** not by lifestyle.
  A large proportion of these diseases may therefore be preventable.

Van: Med Hypotheses, 2010 Feb;74(2):337-45. doi: 10.1016/j.mehy.2009.08.032. Epub 2009 Sep 11.