



# Razvoj terminala za kontrolno dostopa in doseganje EMC

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Grega Bernot, dipl.inž.el.

# O podjetju Multilux

[www.multilux.eu](http://www.multilux.eu)

- Spin-out fakultete za elektrotehniko od leta 2013
- 3 inženirji, 3 doktorji znanosti
- Razvoj hardware, firmware, cloud software
  - Od ideje do izdelka
  - PCB design
  - Linux embedded sistemi
  - EMC design/meritve
- Lastni produkti
  - Smarthouse
  - LIPS
  - ...



# Razvoj terminala



# Zahteve

- Linux computer module
- Barvni TFT zaslon na dotik
- PoE in 12V napajanje
- 125kHz in 13.56MHz RFID
- Komunikacijski vmesniki (RS485, CAN, Wiegand)
- USB razširljivost (BLE, fingerprint reader, kamera)



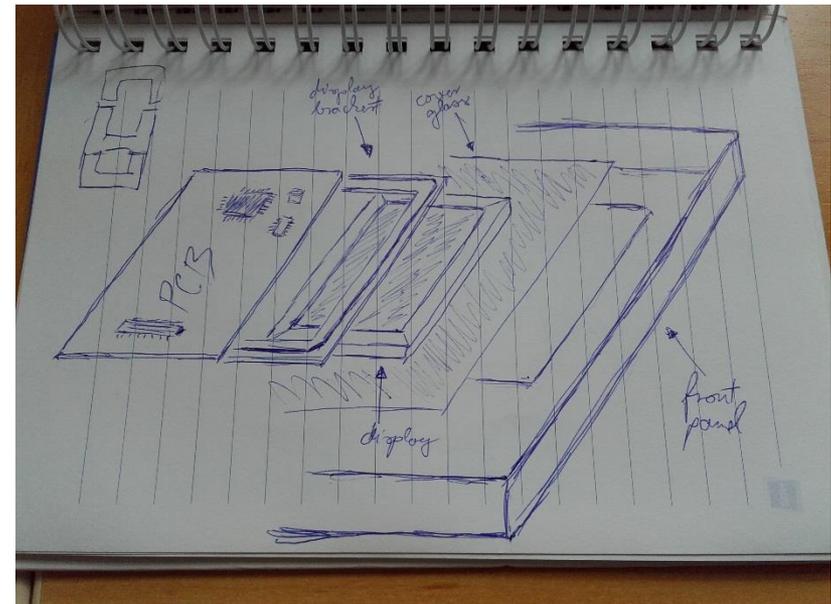
# Izzivi

- Ohranitev obstoječega ohišja
- Aftermarket display, ki se prilega v ohišje
- Uporaba čimveč obstoječih komponent

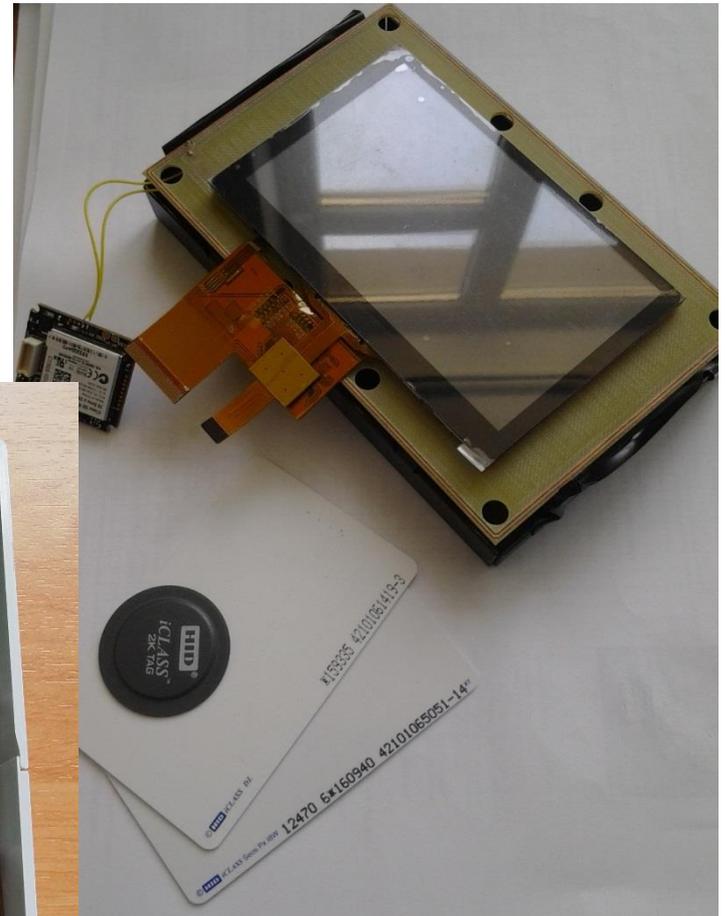
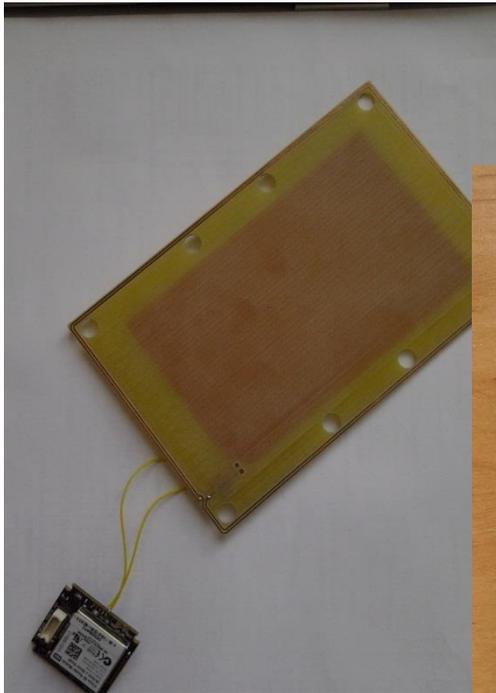
- 125kHz in 13.56MHz

RFID

- Razširljivost

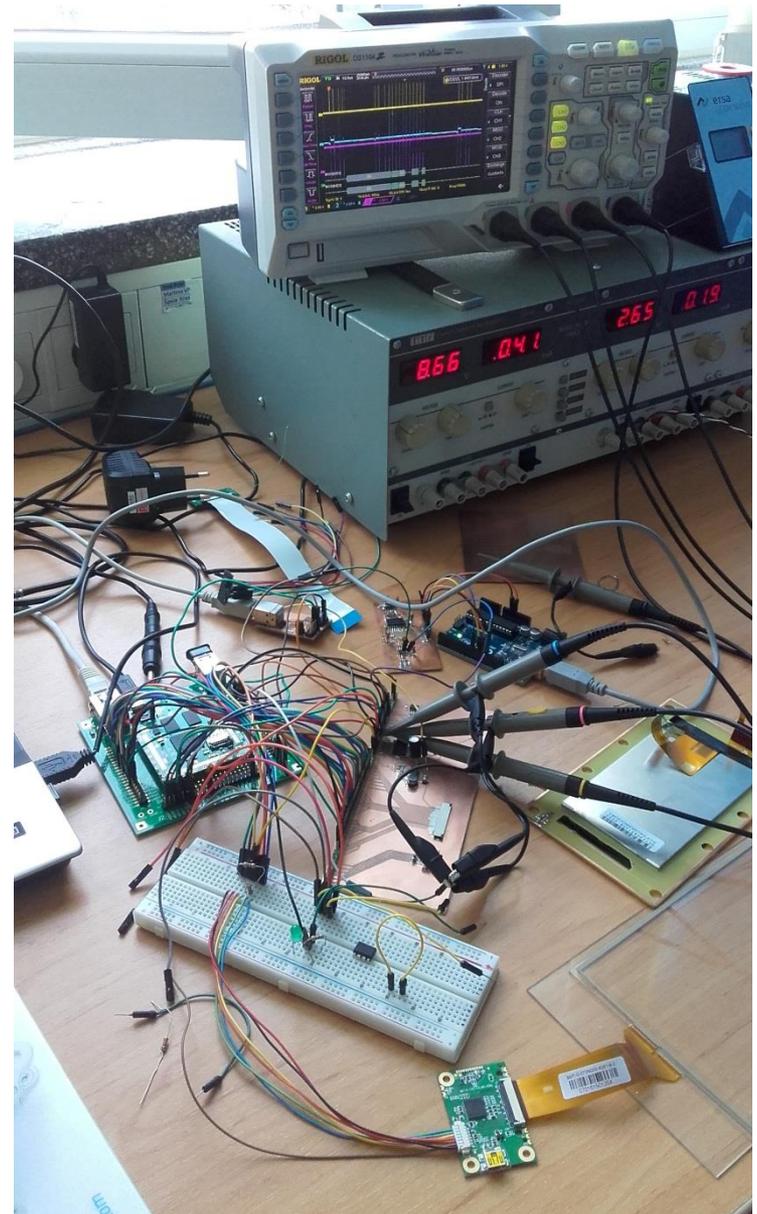
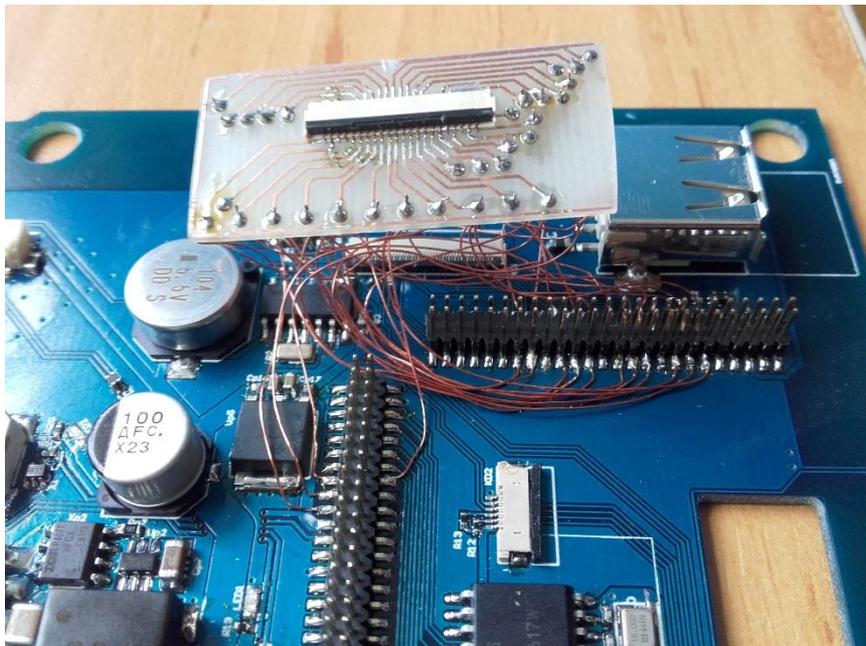


# Proof of concept



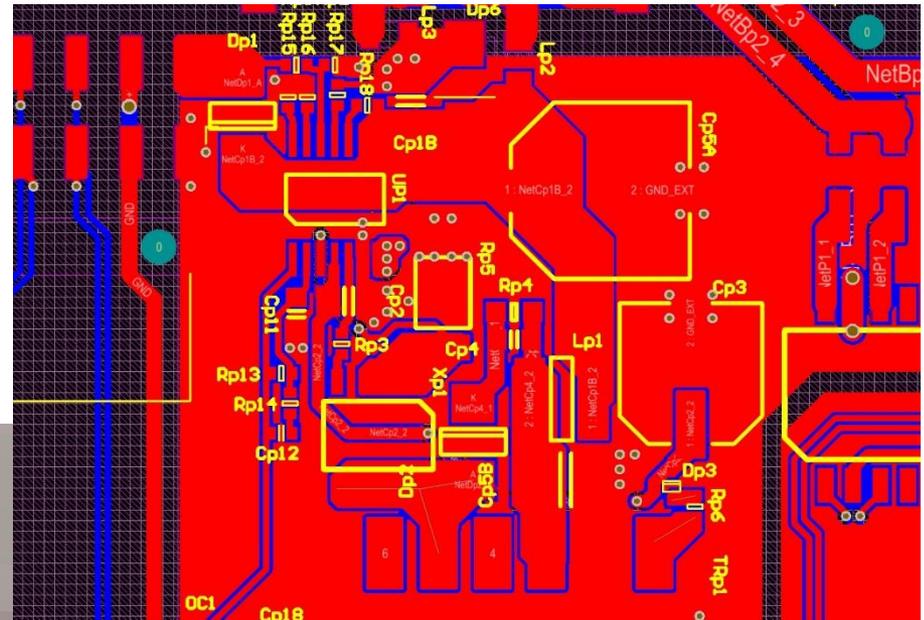
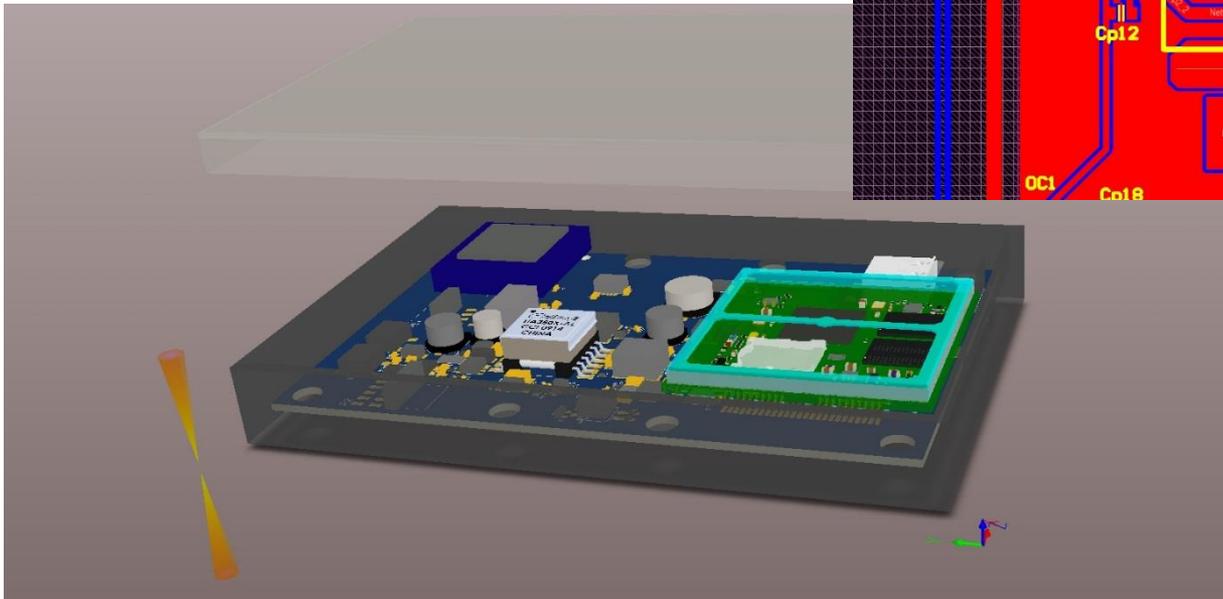
# Prototipno vezje

- Dvo-slojno tiskano vezje
- Ročno spajkanje
- Lovljenje rokov



# Prototipno vezje

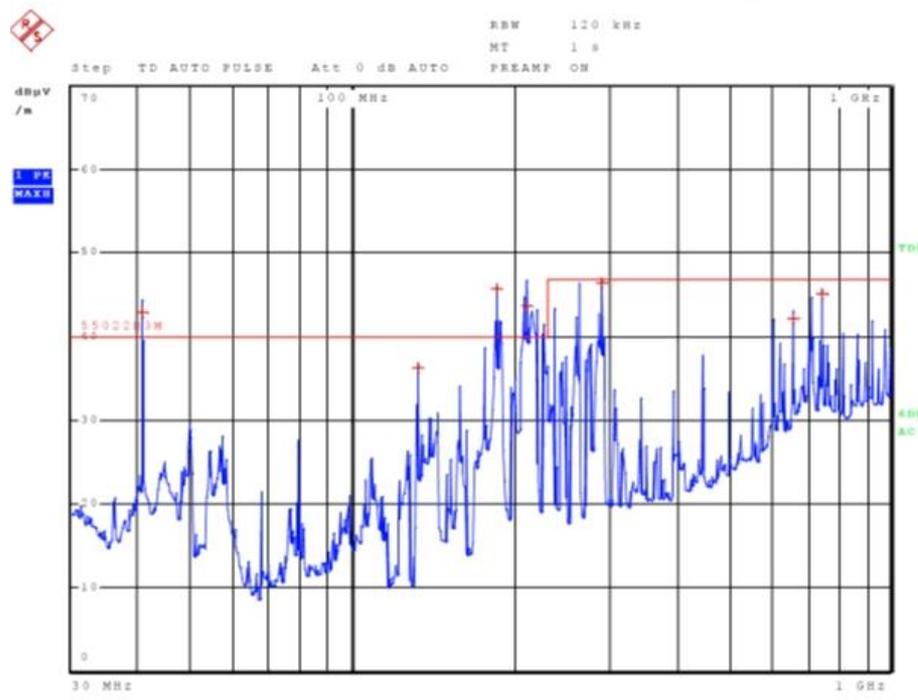
- PCB layout
- 3D model ujemanja z ohišjem



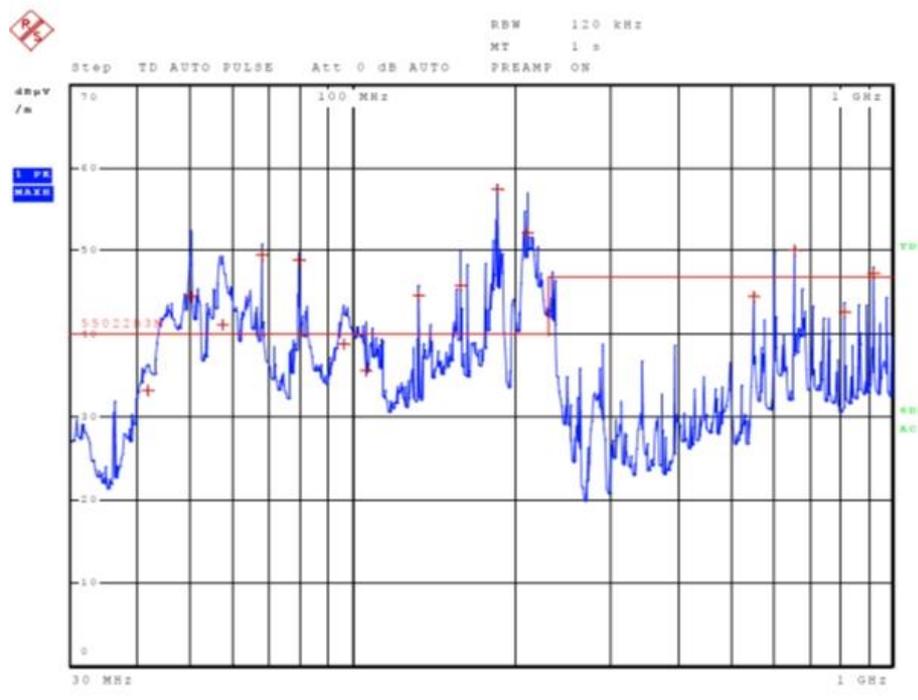
# Preliminarna meritev (2-slojno TIV)

- Sevalne motnje – horizontalno/vertikalno

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	1 ms	Auto

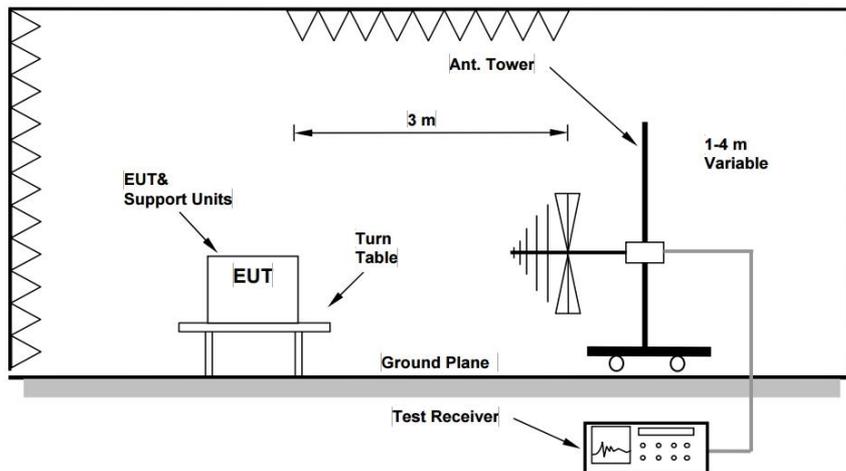


Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	1 ms	Auto



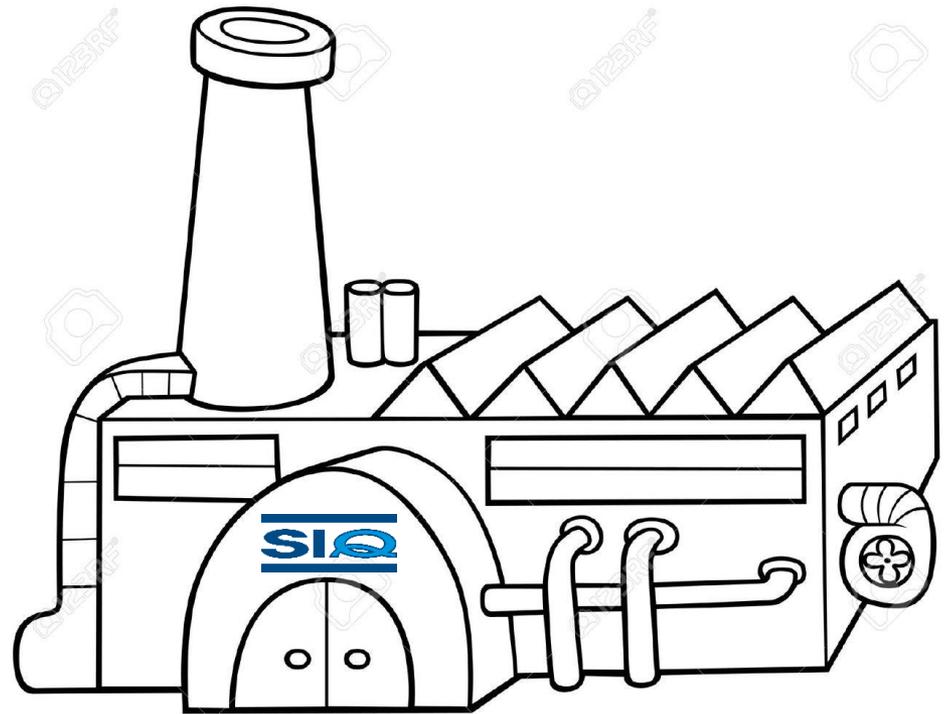
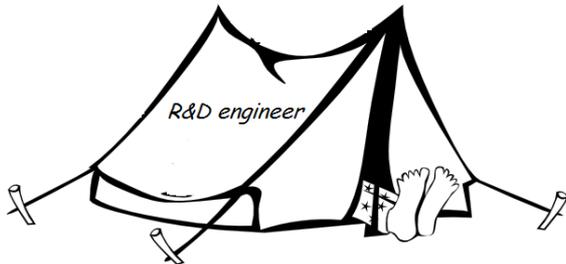
# EMC meritve

- Konduktivne motnje (150 kHz – 30 MHz)
- Sevalne motnje (30 MHz - 1 GHz, 1GHz – 6 GHz) –  
EN 55022 Class B
- Imunost, ESD



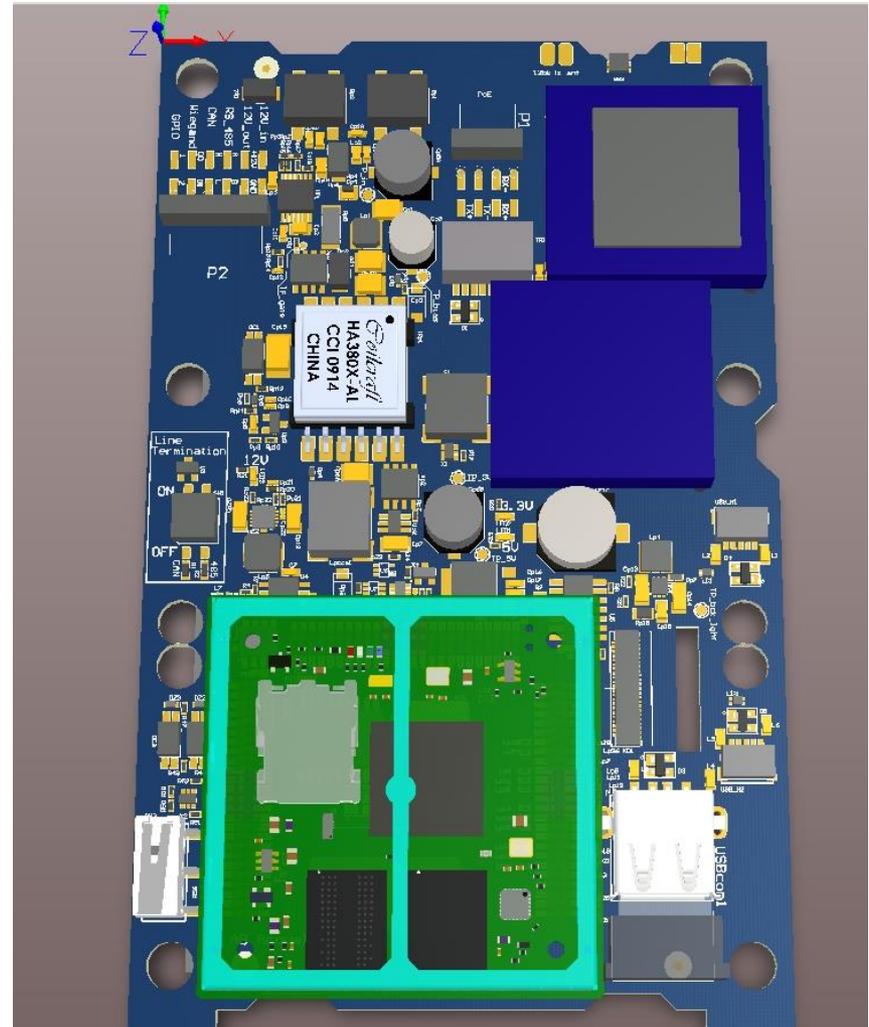
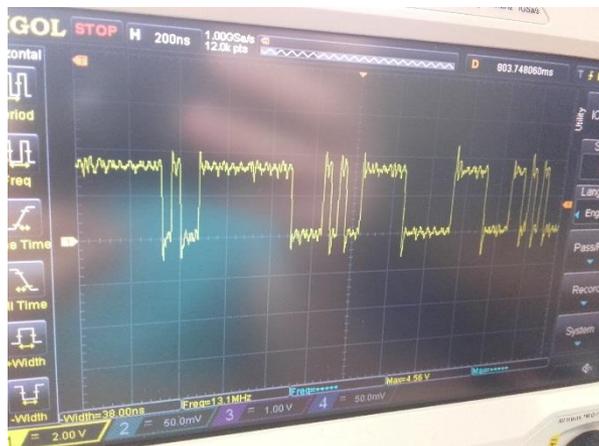
# EMC laboratorij

- Čakalna doba  
cca. 2 meseca
- Urna postavka 150€/h



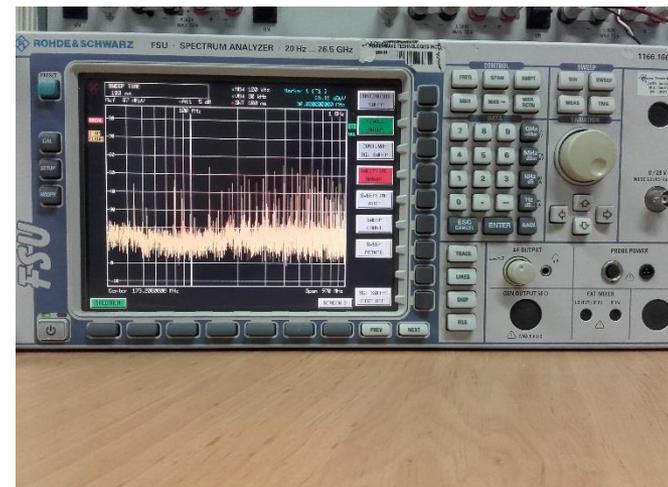
# Možni izvori EMC problemov

- DC-DC pretvornik
- Ethernet linije
- Display linije
- SoM
- ...



# Odkrivanje izvorov

- Sonda za konduktivne motnje
- PCB layout/design check
- Sonda za bližnje polje
- EMC scanner



# Sonda za konduktivne motnje

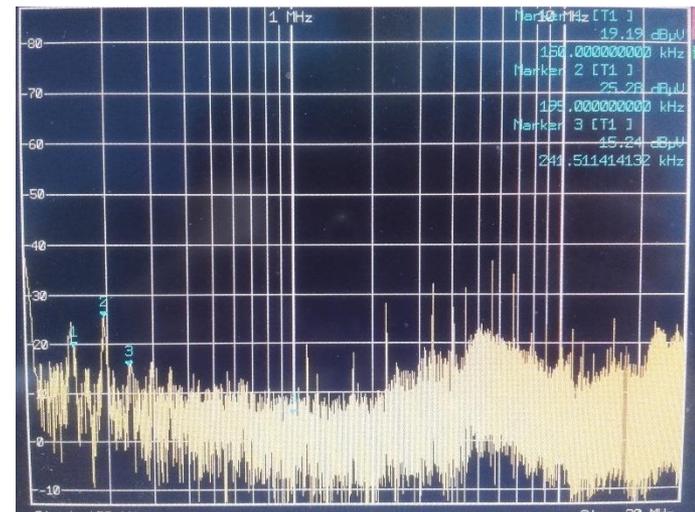
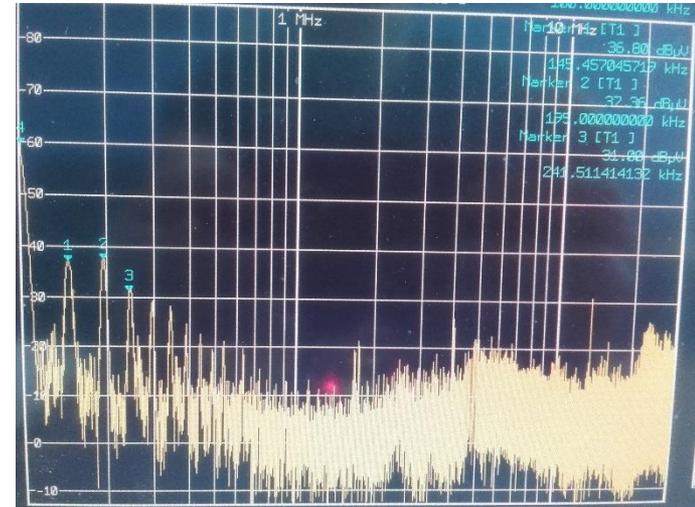
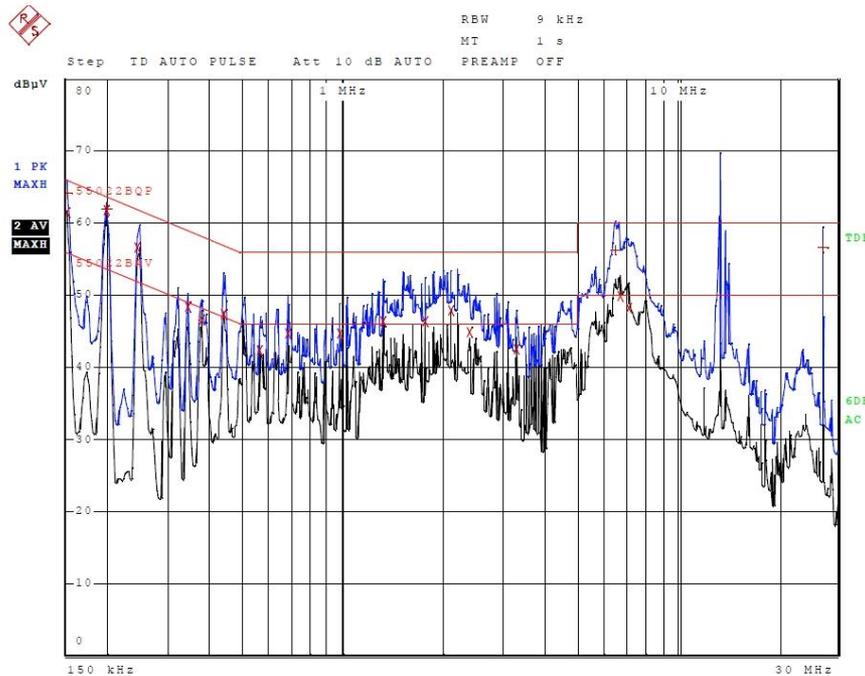
- „home-made“, feritni obroč + zanka koaksialnega kabla
- Možne primerjalne meritve ob znanih nivojih



# Konduktivne motnje

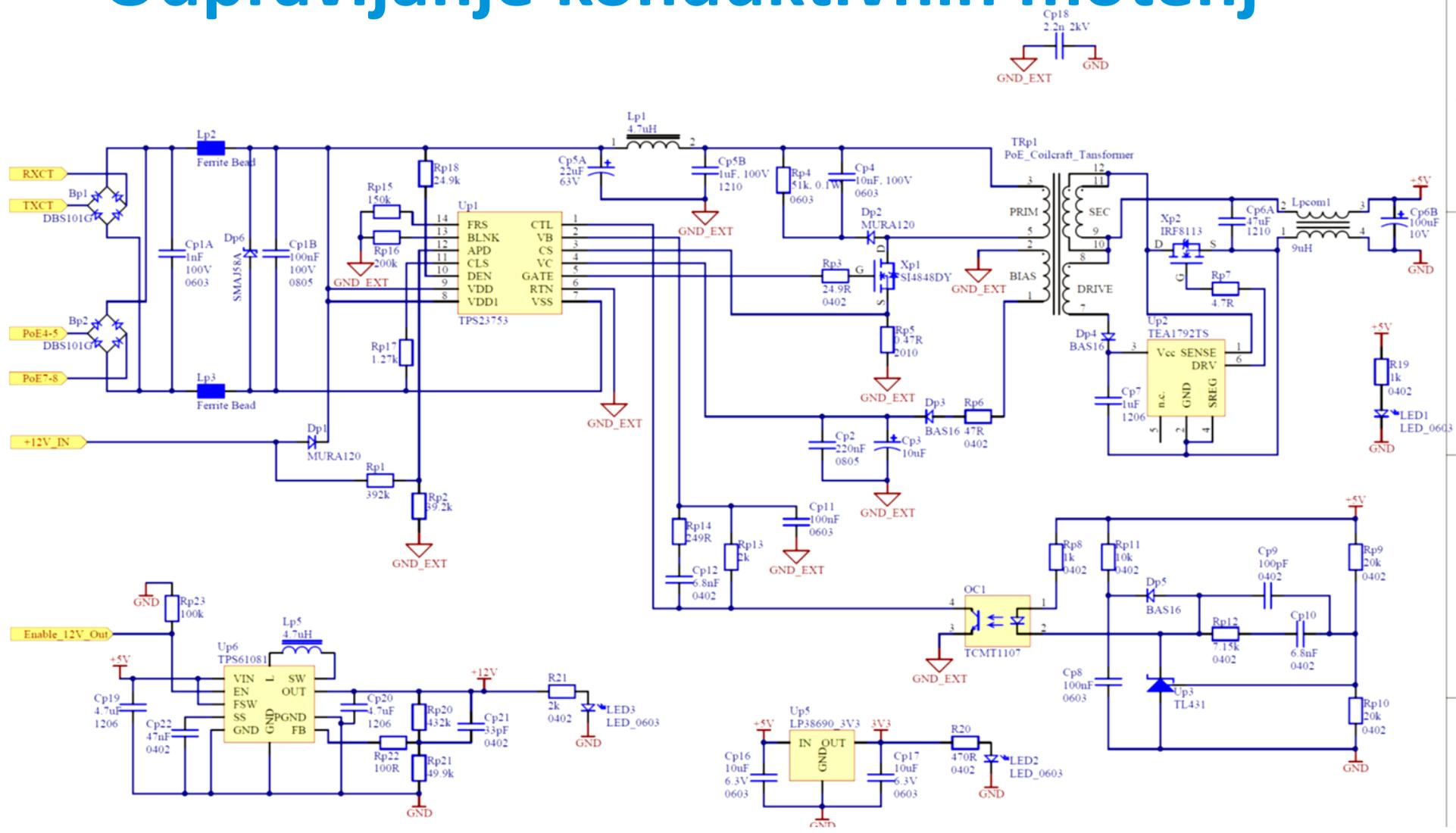
- Referenčna SiQ meritev

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
150.000000 kHz	30.000000 MHz	2.25 kHz	9.00 kHz	30 ms	Auto



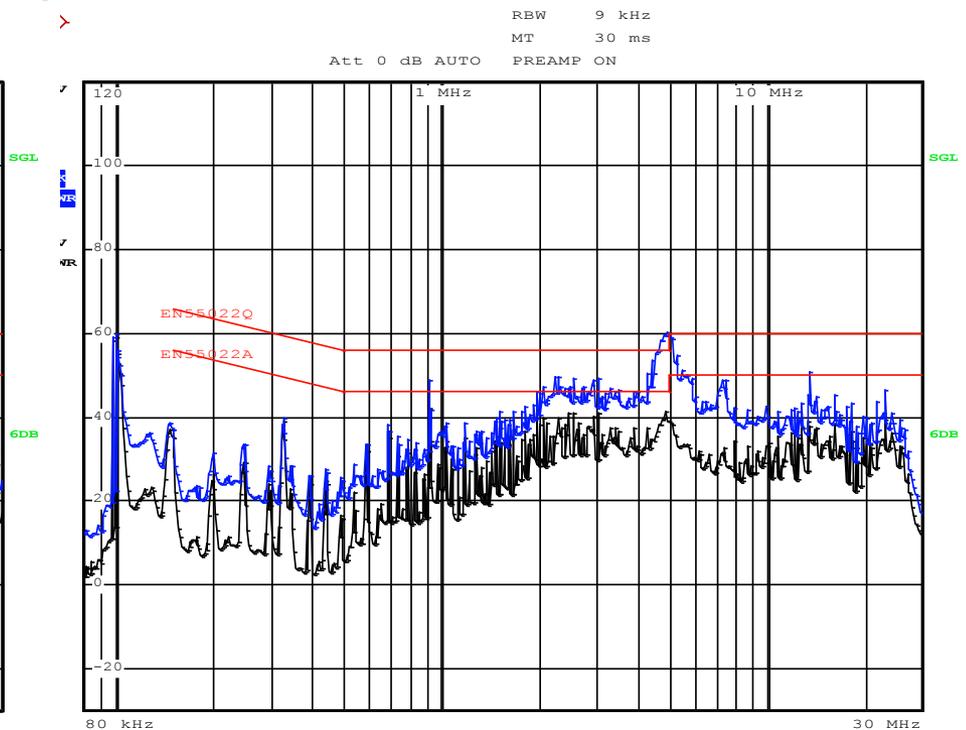
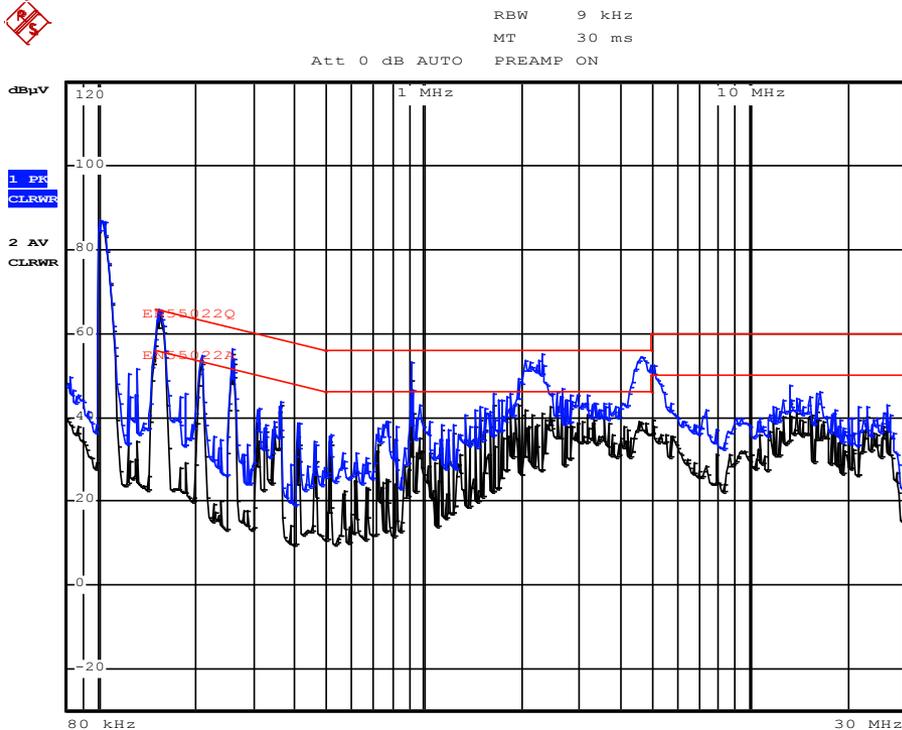
- Meritve s sondo →

# Odpravljanje konduktivnih motenj



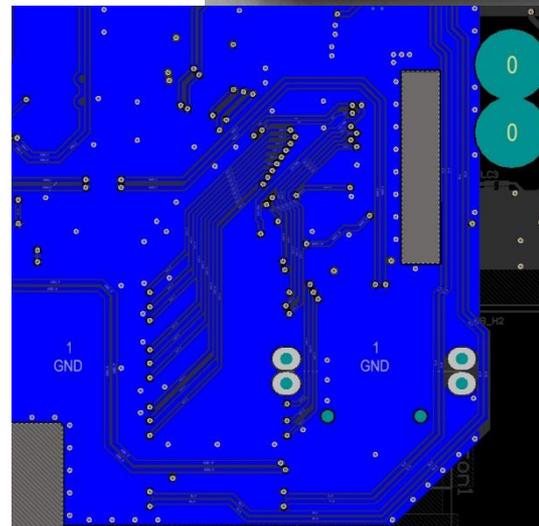
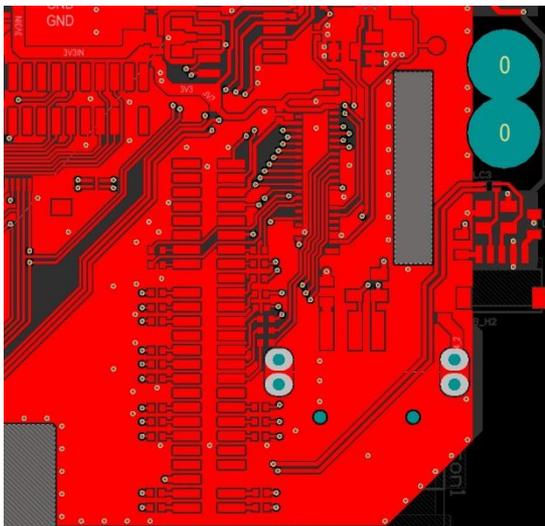
# Odpravljanje konduktivnih motenj

- Izboljšava PI filtra v napajalniku
- Dodajanje feritov



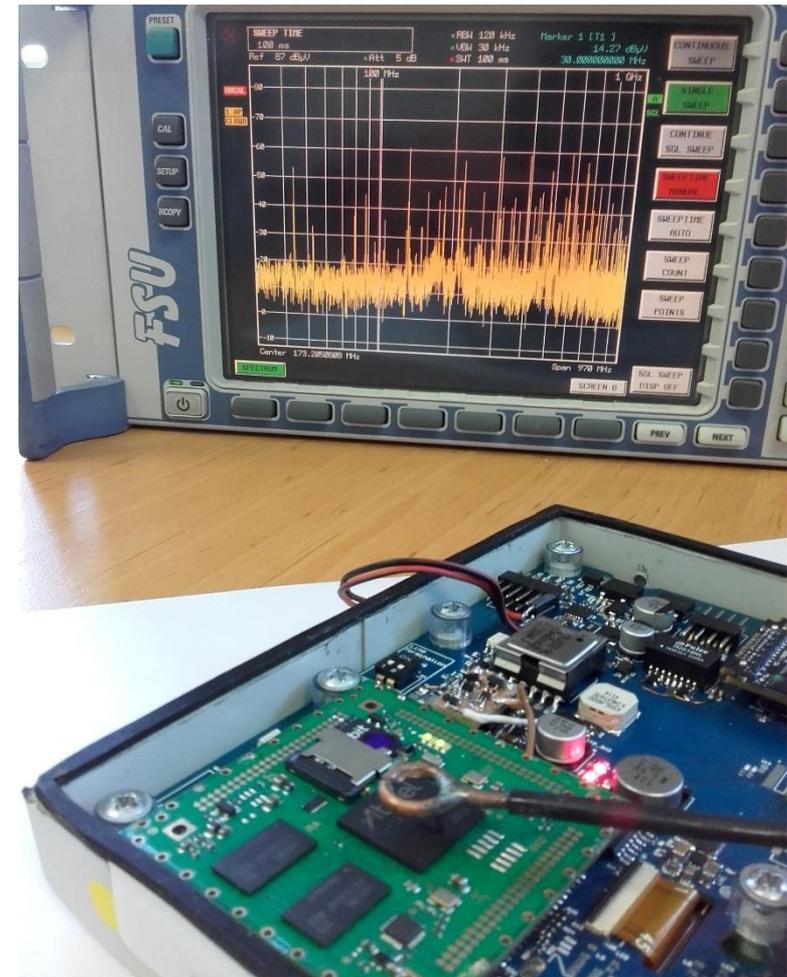
# PCB layout/design check

- 2-slojno --> 4-slojno TIV
- Impedanca linij
- layout
- Shielding



# Sonda za bližnje polje + spektralni analizator

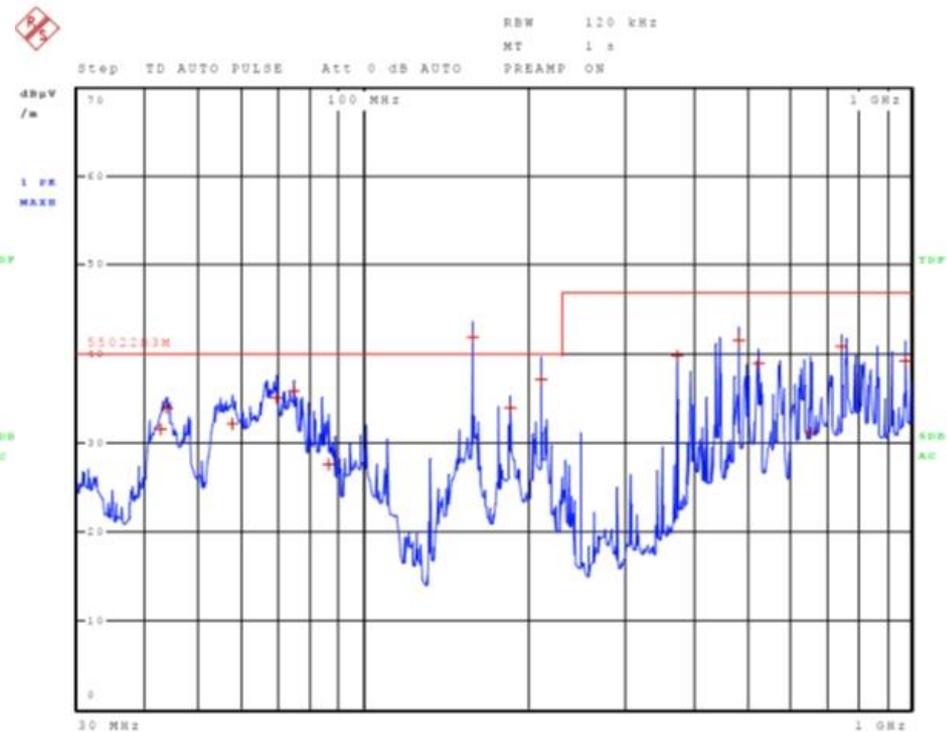
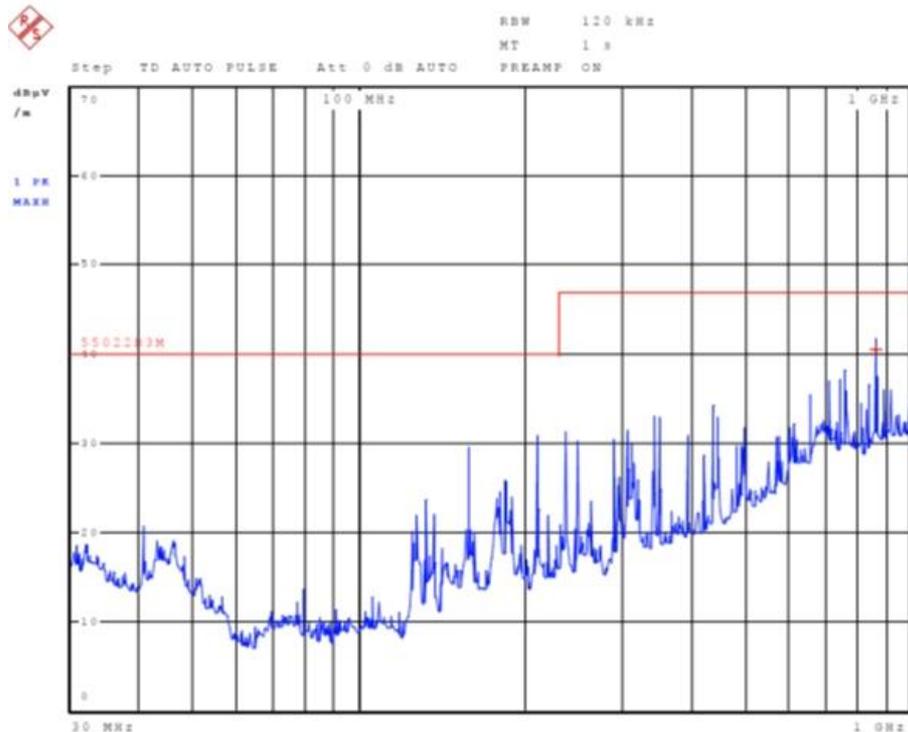
- Ročno iskanje emisij po vezju
- Slaba natančnost in ponovljivost
- Dobro za grobo iskanje in spremljanje razlik



# Meritev 1. respin (4-slojno TIV)

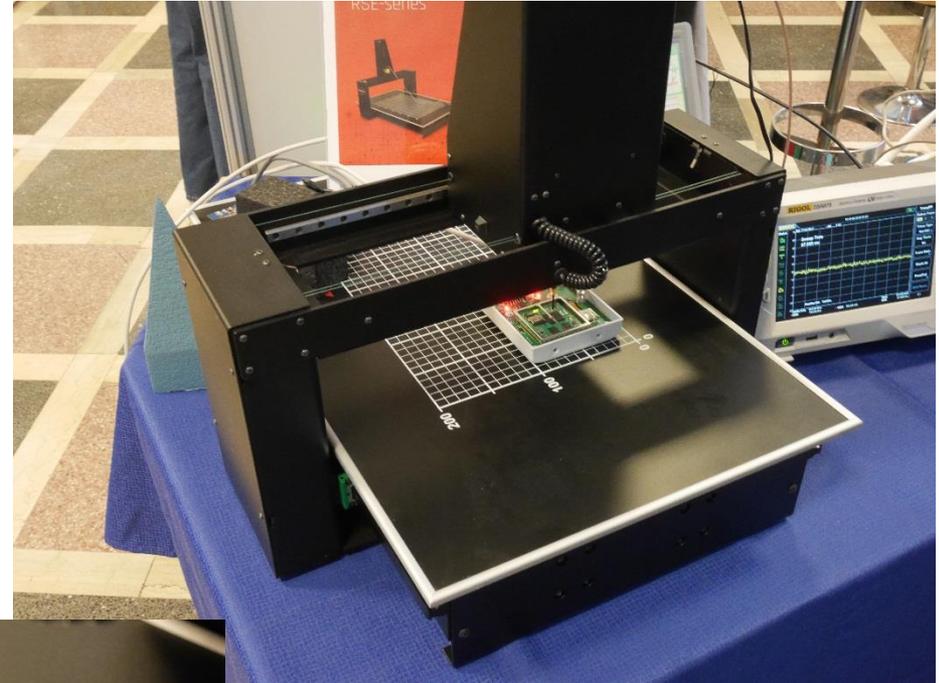
- Sevalne motnje – horizontalno/vertikalno

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto	30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto



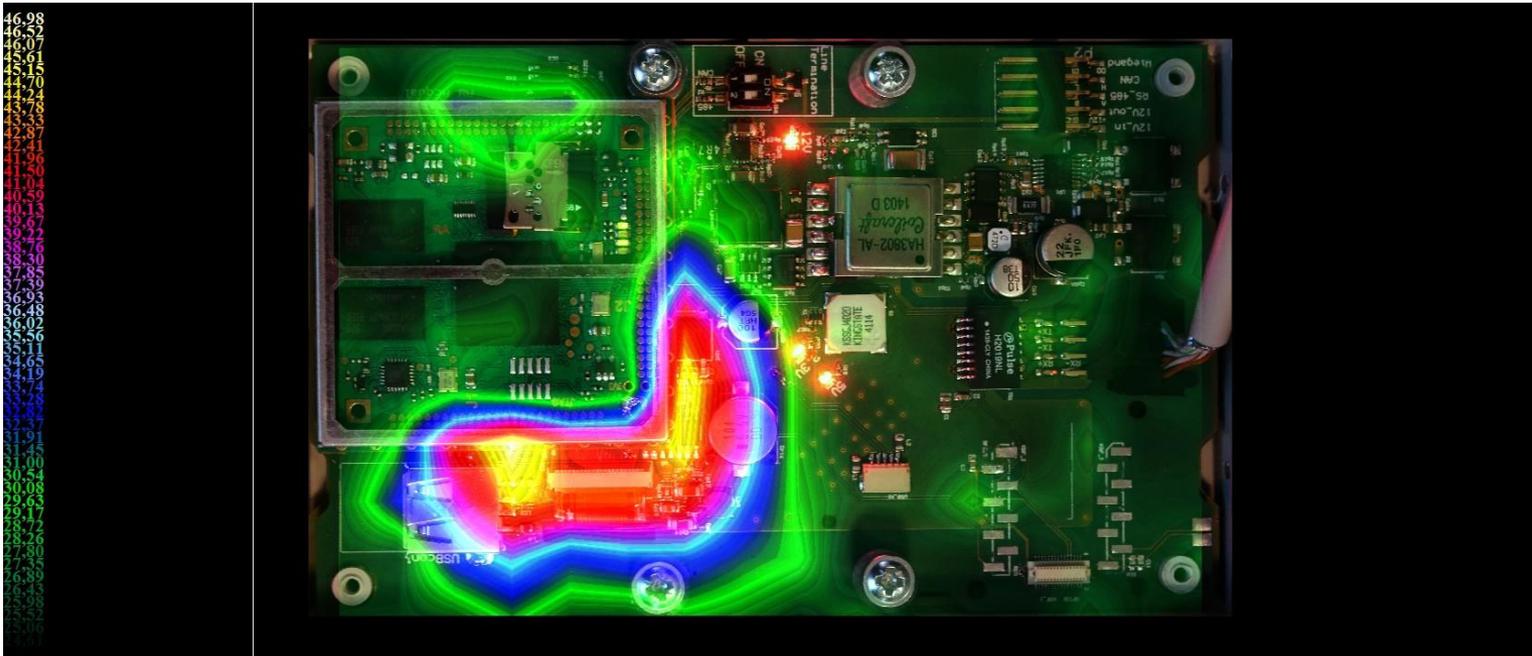
# EMC scanner

- Natančno lociranje
- Dobra ponovljivost
- Grafični prikaz
- Iskanje po frekvencah



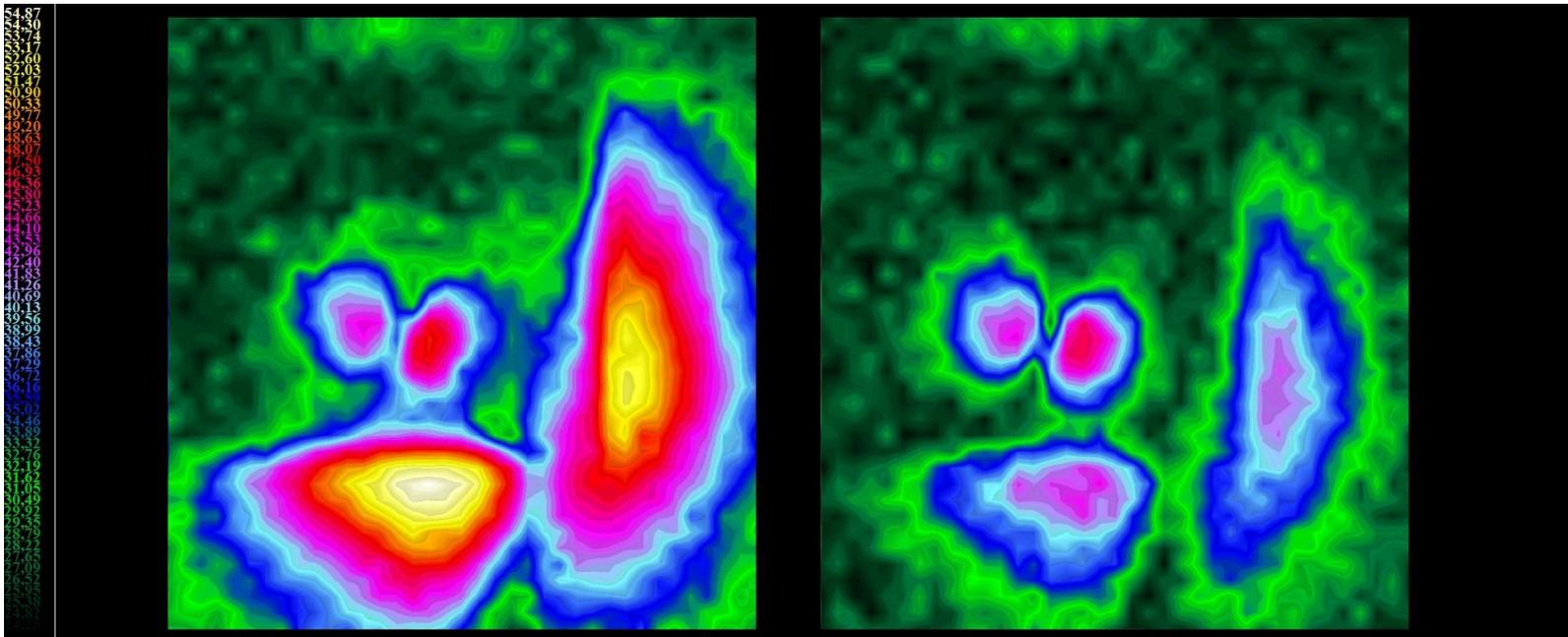
# Detectus AB scanner

- Točkovno merjenje
- Celoten spekter v vsaki točki
- Ponavljanje meritev in prikaz razlik



# Sevanje display linij

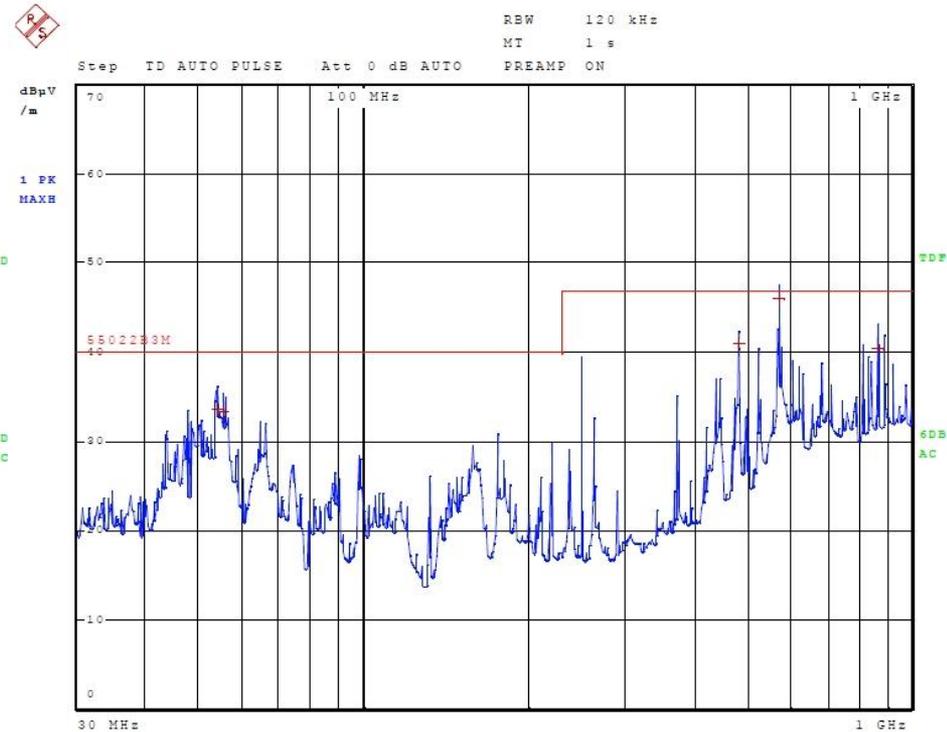
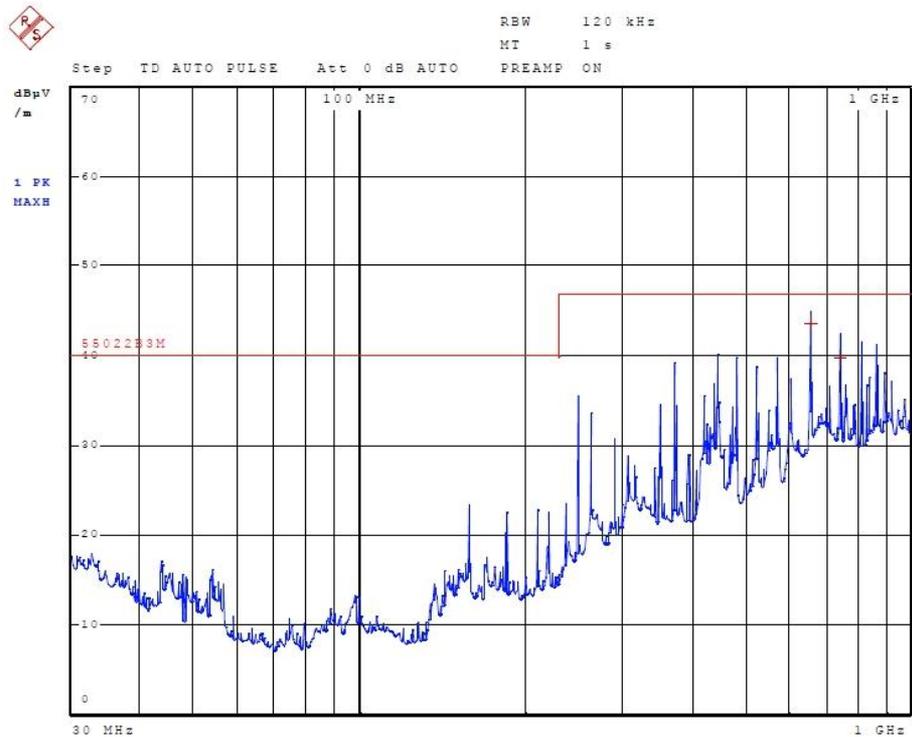
- 24bit RGB @ 25MHz
- Ferite bead-i namesto uporov
- S pravilno izbiro >10dB nižje



# Končno testiranje

- Sevalne motnje – horizontalno/vertikalno

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten	Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto	30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto



# ESD - electrostatic discharge

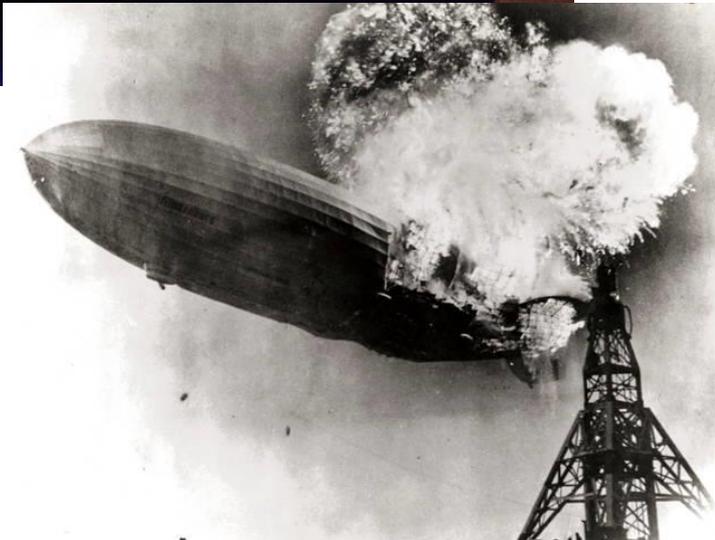
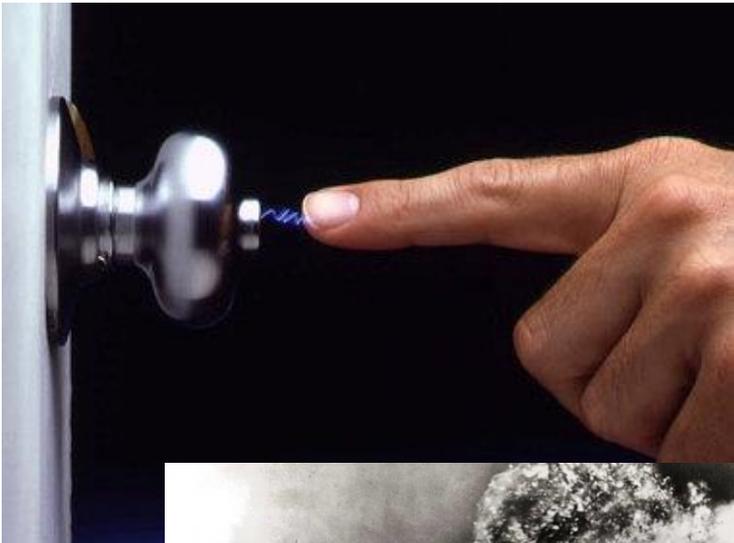


Table 2 Examples of Static Generation Typical Voltage Levels		
Means of Generation	10-25% RH	65-90% RH
Walking across carpet	35,000V	1,500V
Walking across vinyl tile	12,000V	250V
Worker at bench	6,000V	100V
Poly bag picked up from bench	20,000V	1,200V
Chair with urethane foam	18,000V	1,500V

# ESD - izvori

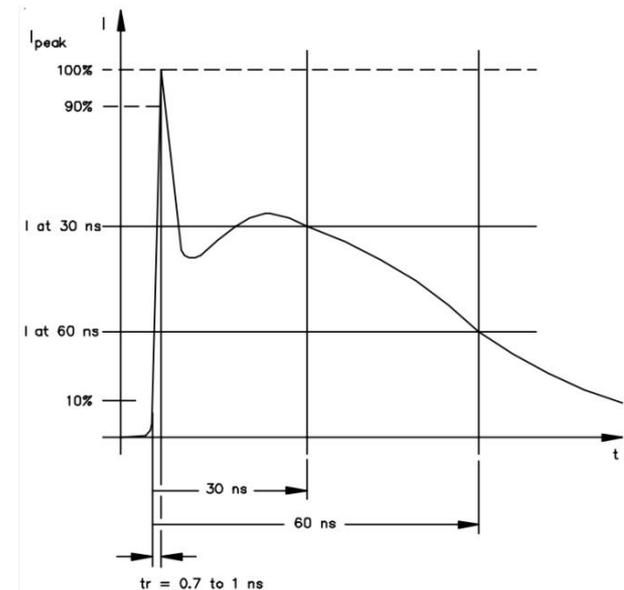
- Dotik ljudi/živali
- Pretok tekočin
- Gibanje vozil
- Primer:
  - Vesoljska vozila
  - Letala/helikopterji
  - Vrtenje gredi AC motorja v najlonskem ležaju



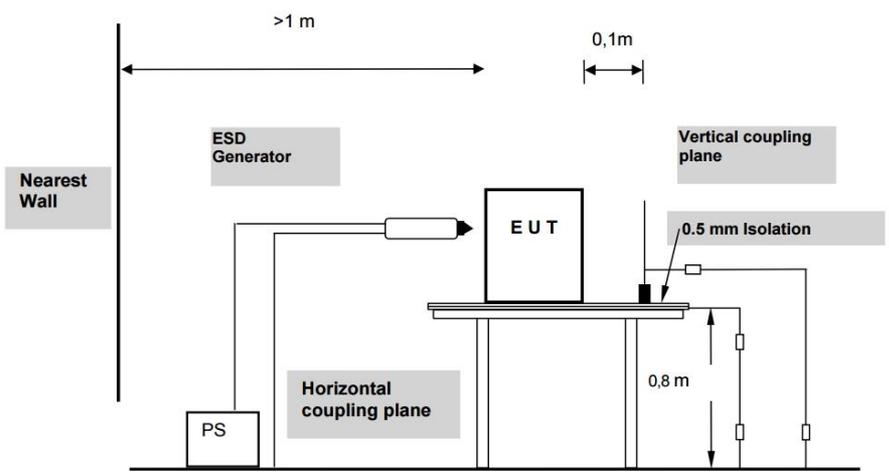
# ESD - testiranja

- EN 61000-4-2
- Različni nivoji
- 150pF/330Ω
- ±8kV, ±30A
- Automotive ISO 10605
- ±25kV powered/unpowered

Contact Discharge		Air Discharge	
Level	Test Voltage [kV]	Level	Test Voltage [kV]
1	2	1	2
2	4	2	4
3	6	3	8
4	8	4	15

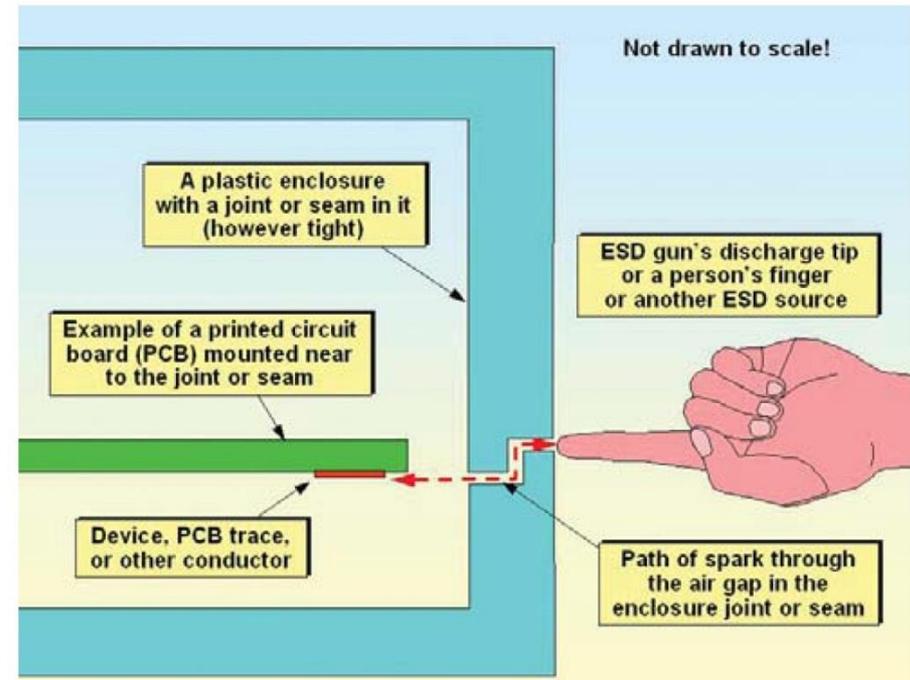


# ESD - testiranja



# ESD zaščita

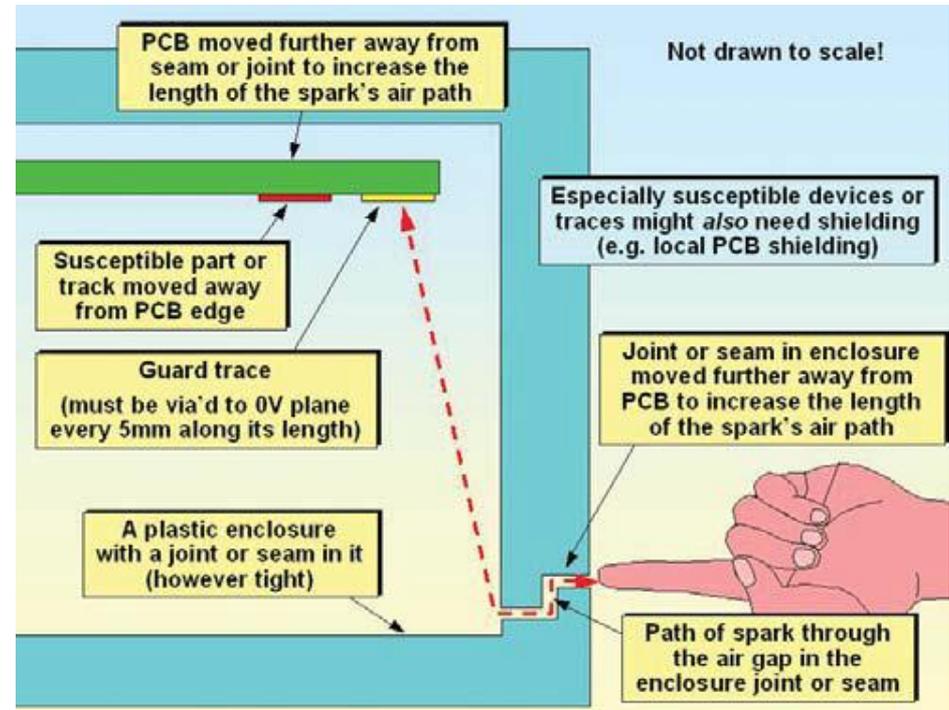
- Preprečitev nabiranja naboja
- Nadzorovani pogoji
- Preprečevanje razelektritve
- Uporaba materialov z večjo prebojno trdnostjo
- Kontrolirana razelektritev



# ESD zaščita

- **Sistemski nivo:**

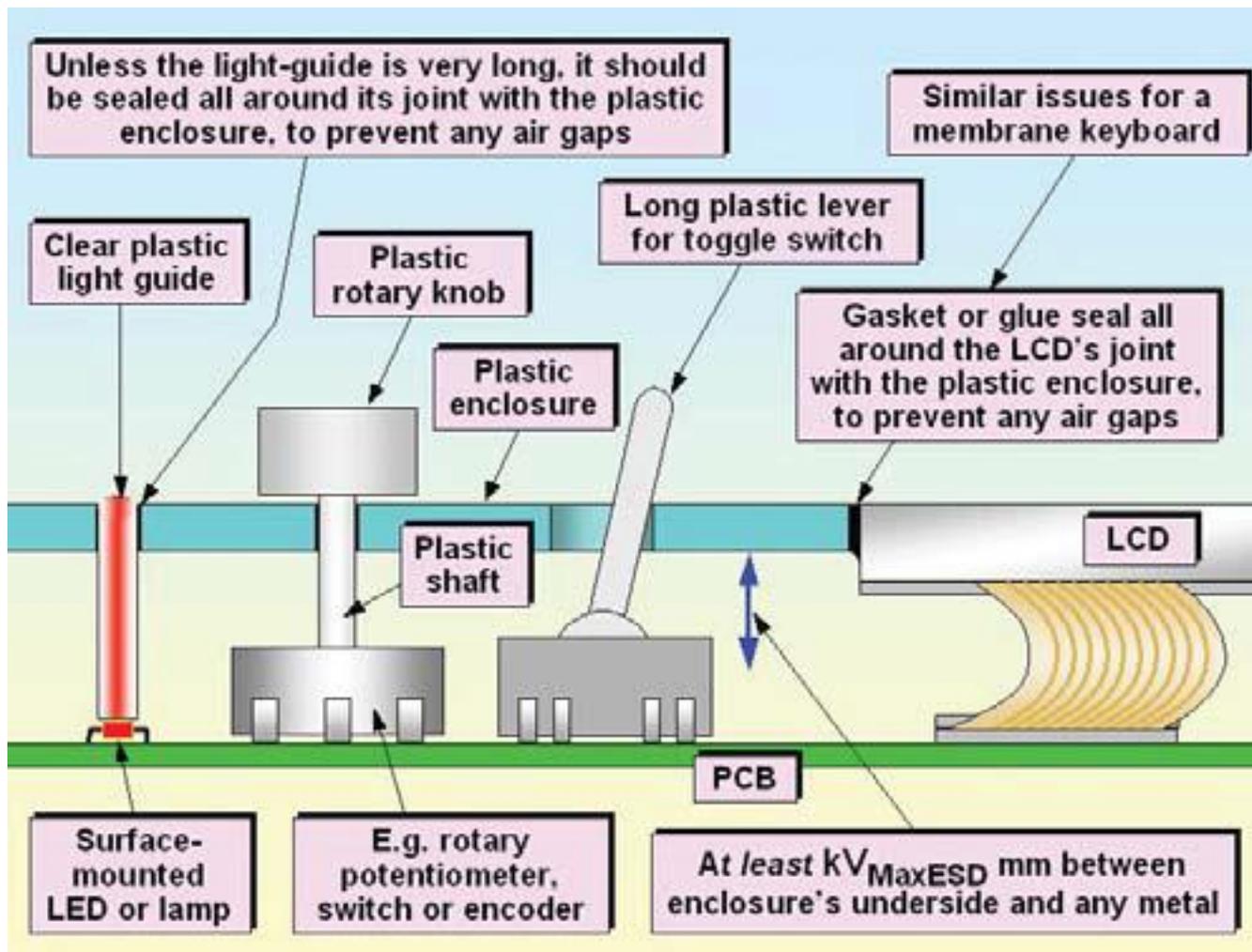
- Ohišje
- Razdalje
- Materiali



- **Komponentni nivo:**

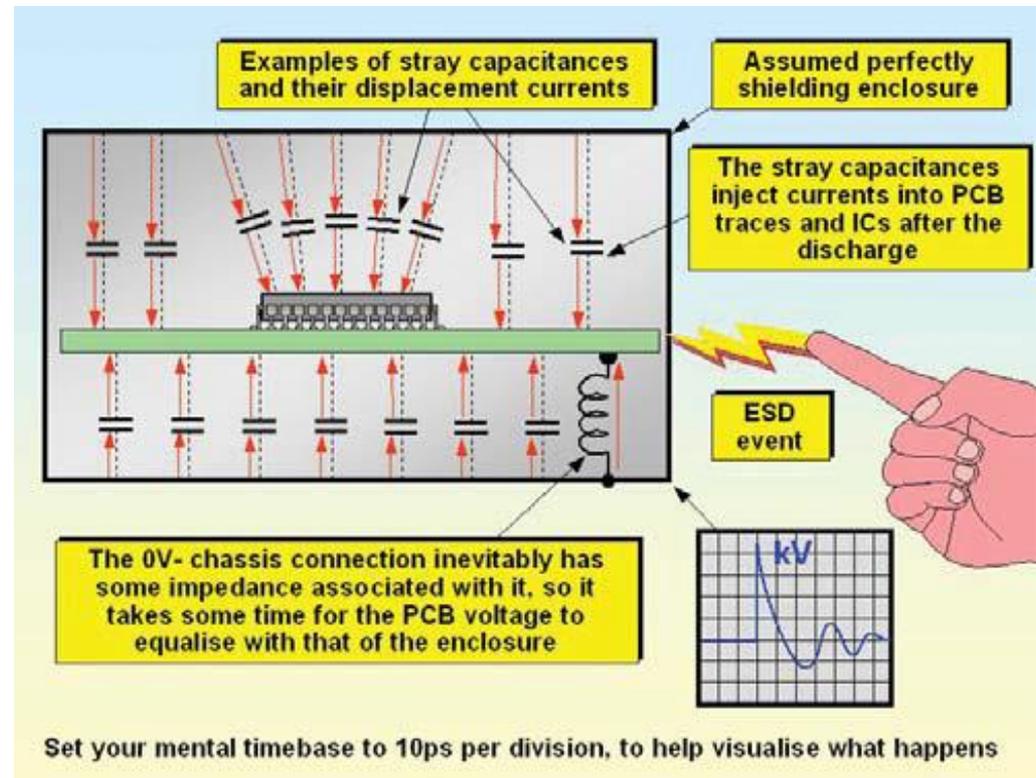
- Zaščita na vezju z elementi – TVS diode, varistorji (MOV), spark gap

# ESD zaščita



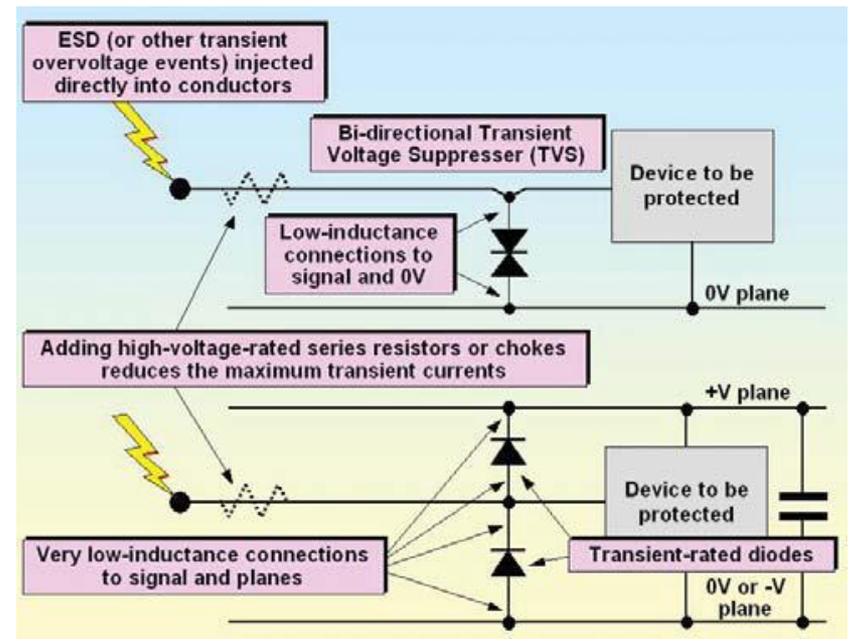
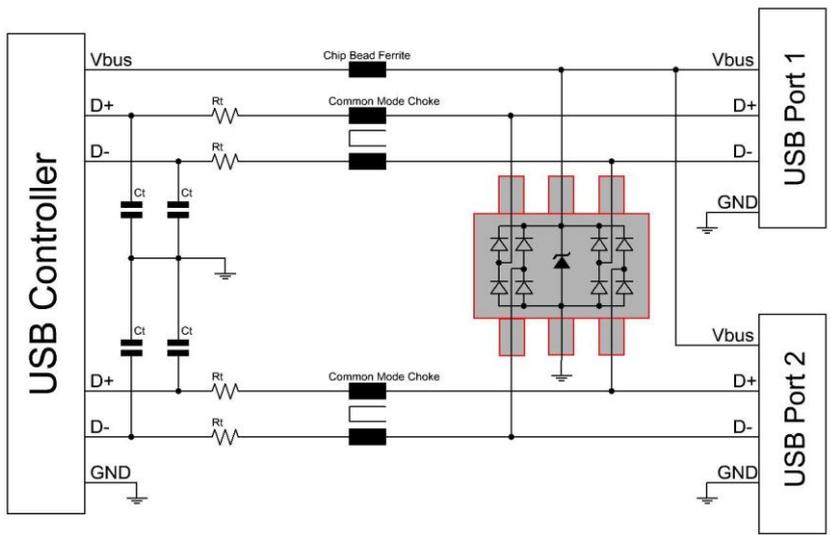
# ESD zaščita

- Kovinsko ohišje/ozemljitev?
- Hitre spremembe – 1ns
- Difuzija naboja
- Parazitne kapacitivnosti

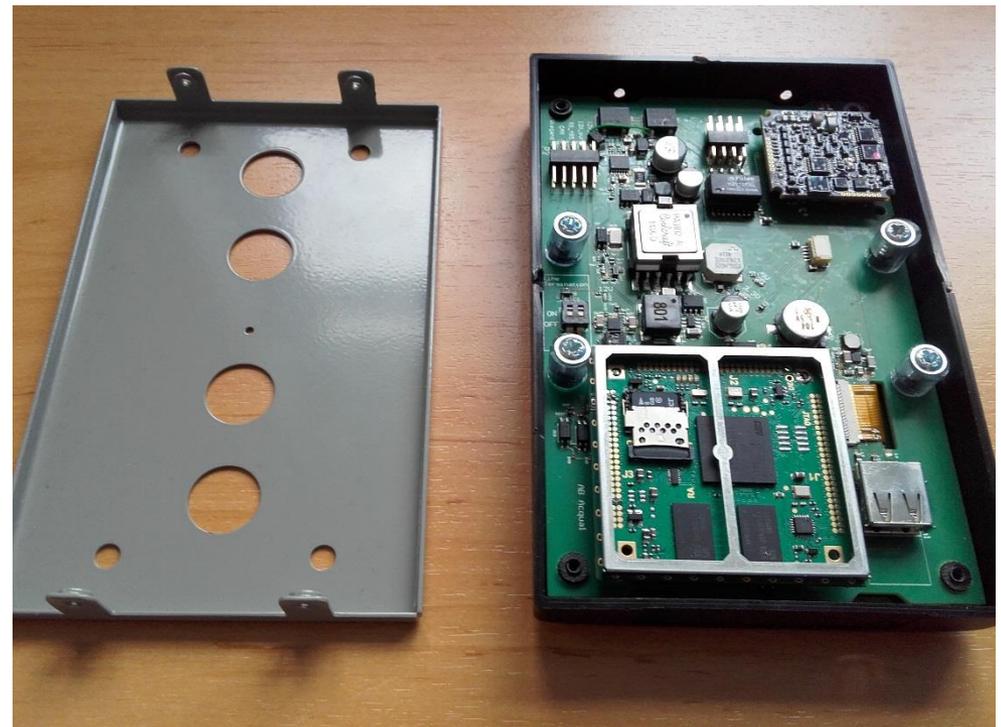


# ESD zaščita

- „lokalna“ zaščita občutljivih komponent
- TVS dioda + upor!!
- TVS array:
  - USB, ethernet, HDMI

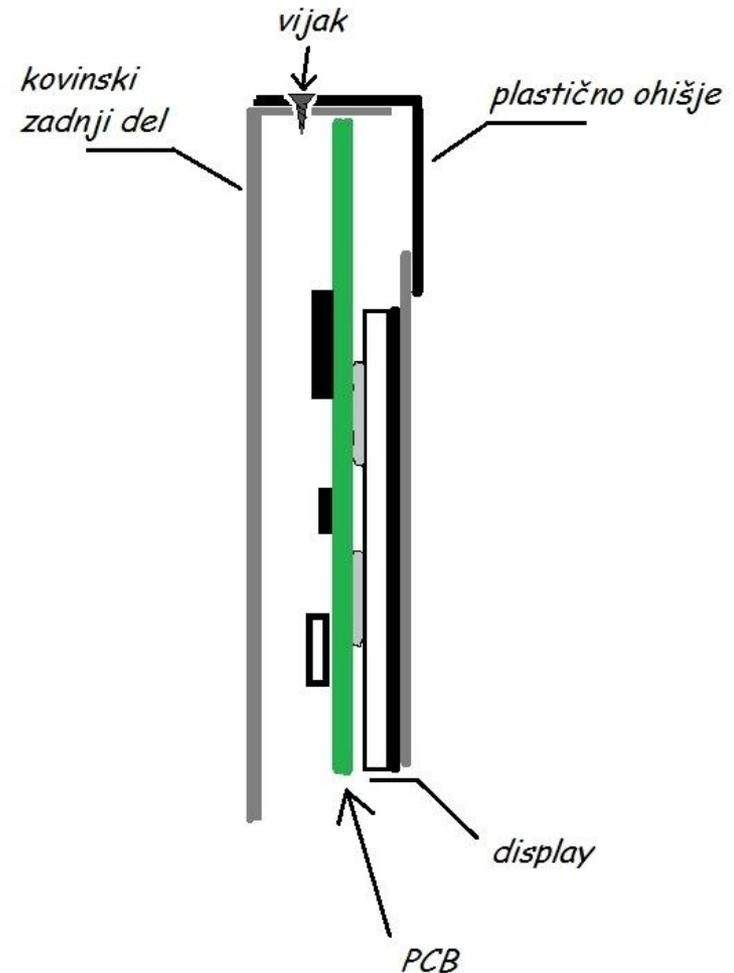


# ESD na našem primeru



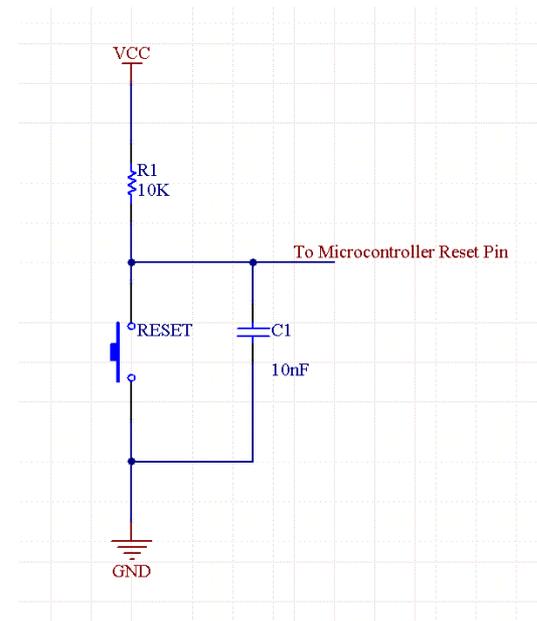
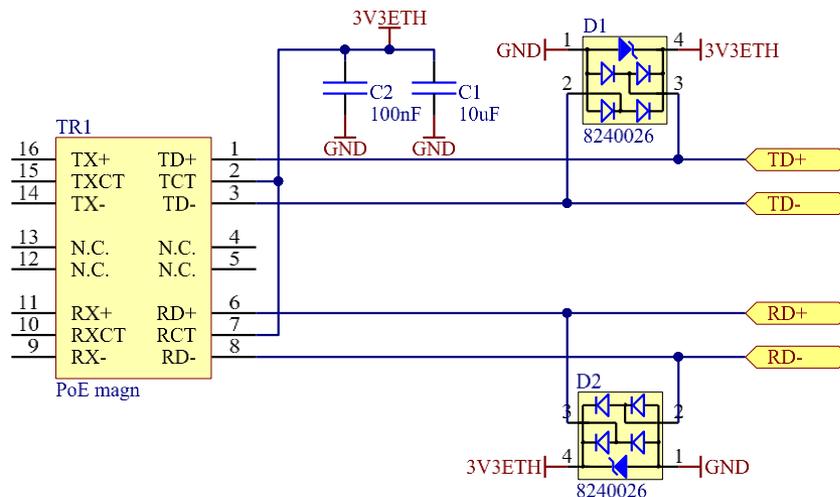
# ESD na našem primeru

- Neozemljena naprava
- Stik z uporabniki
- Ohišje z odprtini
- Neozemljen kovinski zadnji del ohišja



# ESD ukrepi

- TVS + R na vse podatkovne linije
- „močnejši“ pull-up upori na reset linijah
- Povečanje razdalje med displayem in PCB



# ESD ukrepi

- Zmanjševanje odprtih na ohišju
- Plastični montažni vijaki + nalepka
- Poglobitev zadnjega dela
- Plastičen zadnji del ohišja
- Povečanje zanesljivosti delovanja
  - Sw in hw watchdog



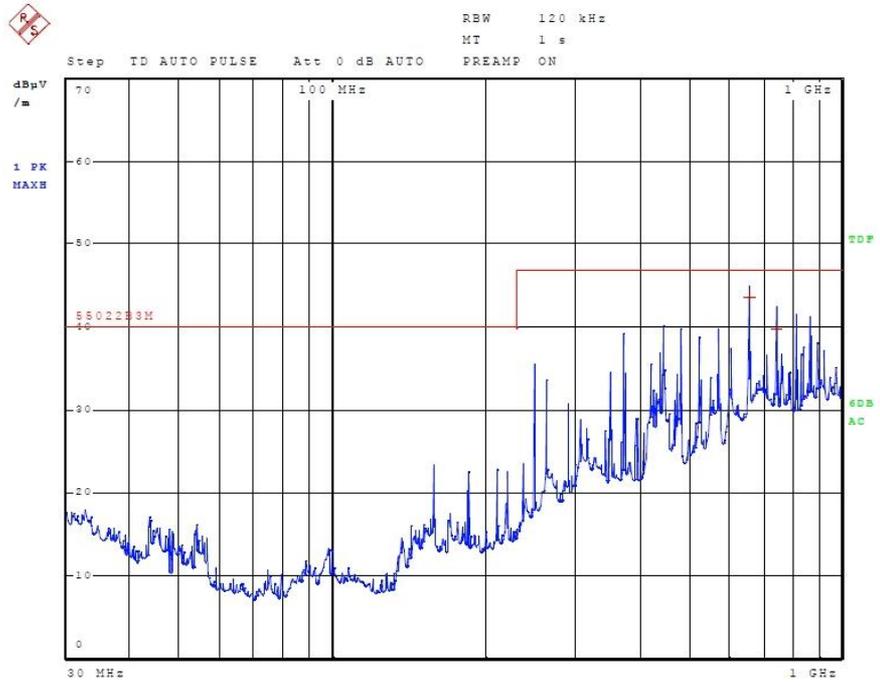
# Uspeh!

- Naprava ustreza standardom

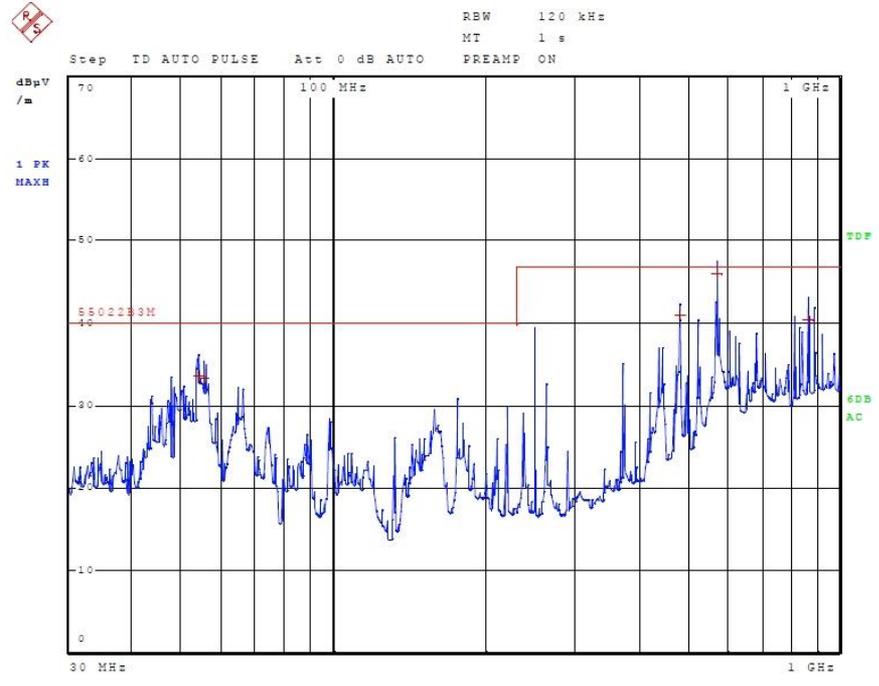


PASSED

Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto



Start Frequency	Stop Frequency	Step Size	Res BW	Meas Time	RF Atten
30.000000 MHz	1.000000 GHz	30.00 kHz	120.00 kHz	2 ms	Auto



# Uspeh!





[www.multilux.eu](http://www.multilux.eu)

**Hvala za pozornost!**

**Grega Bernot, dipl.inž.el.**

[grega.bernot@multilux.eu](mailto:grega.bernot@multilux.eu)