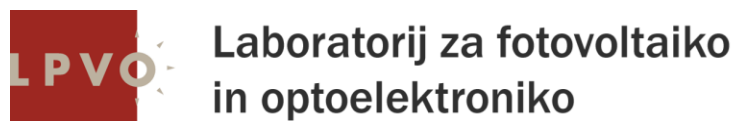


# Načrtovanje elektronike za EMC<sup>2</sup>

## S00 UL FE LPVO

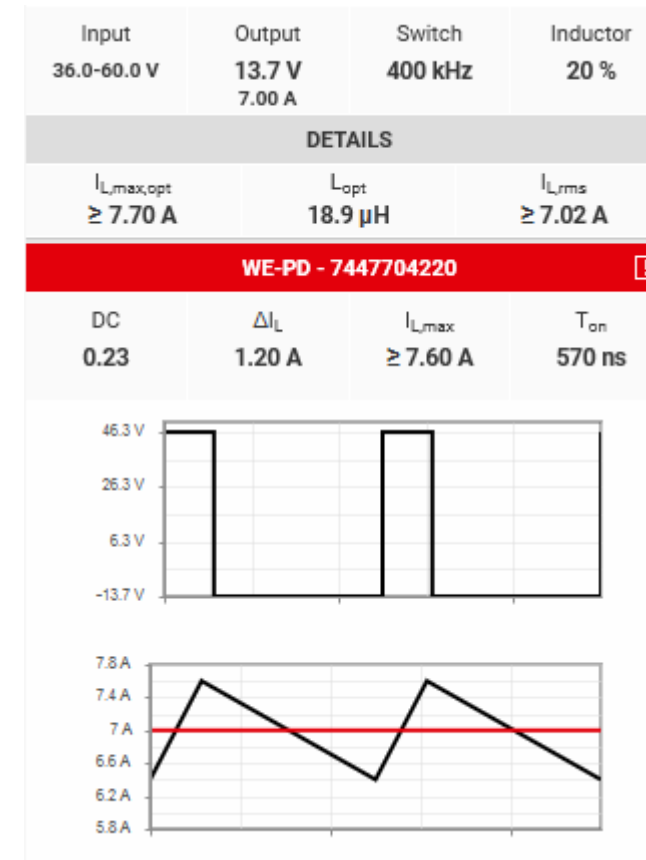


MAHLE

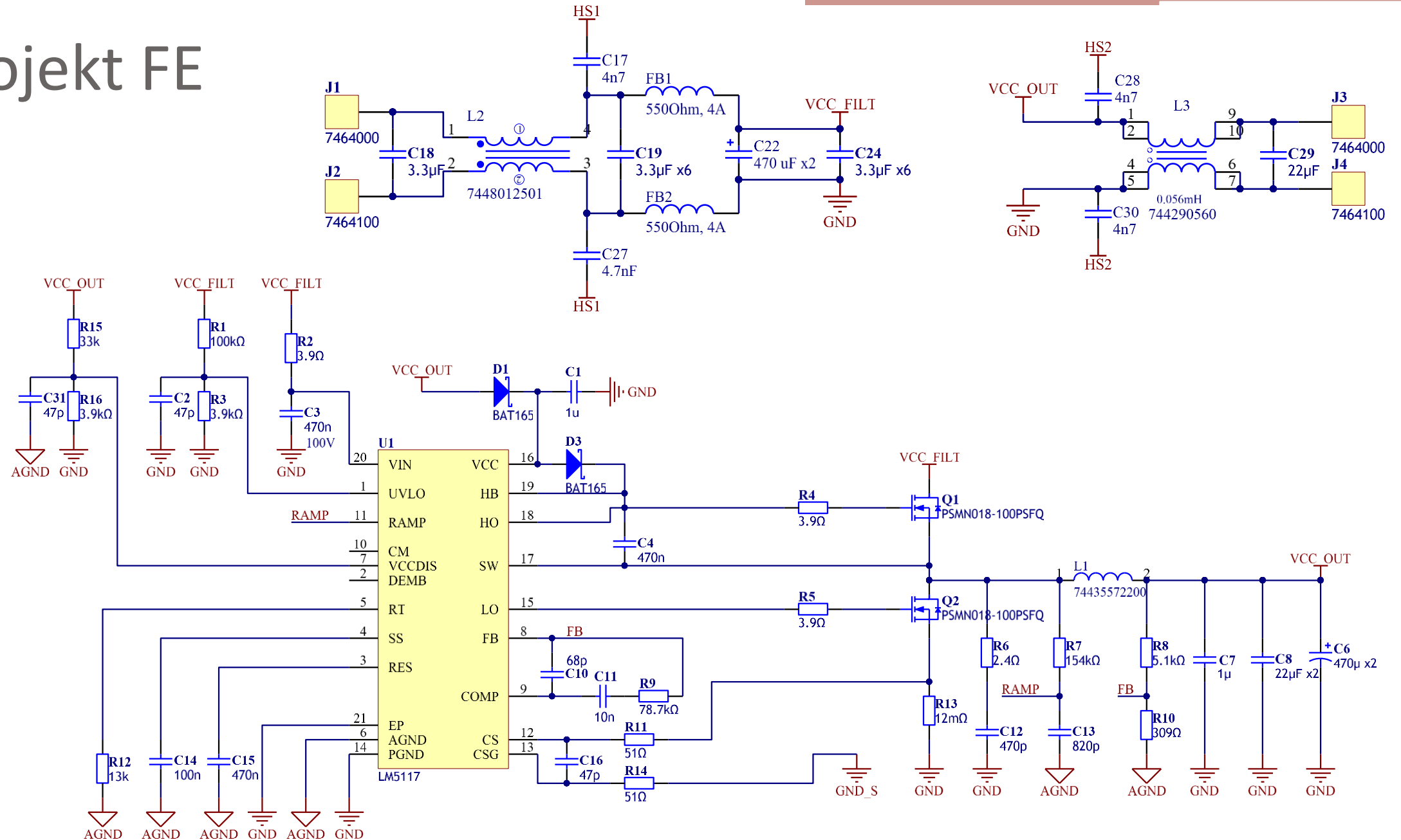


# Projekt FE

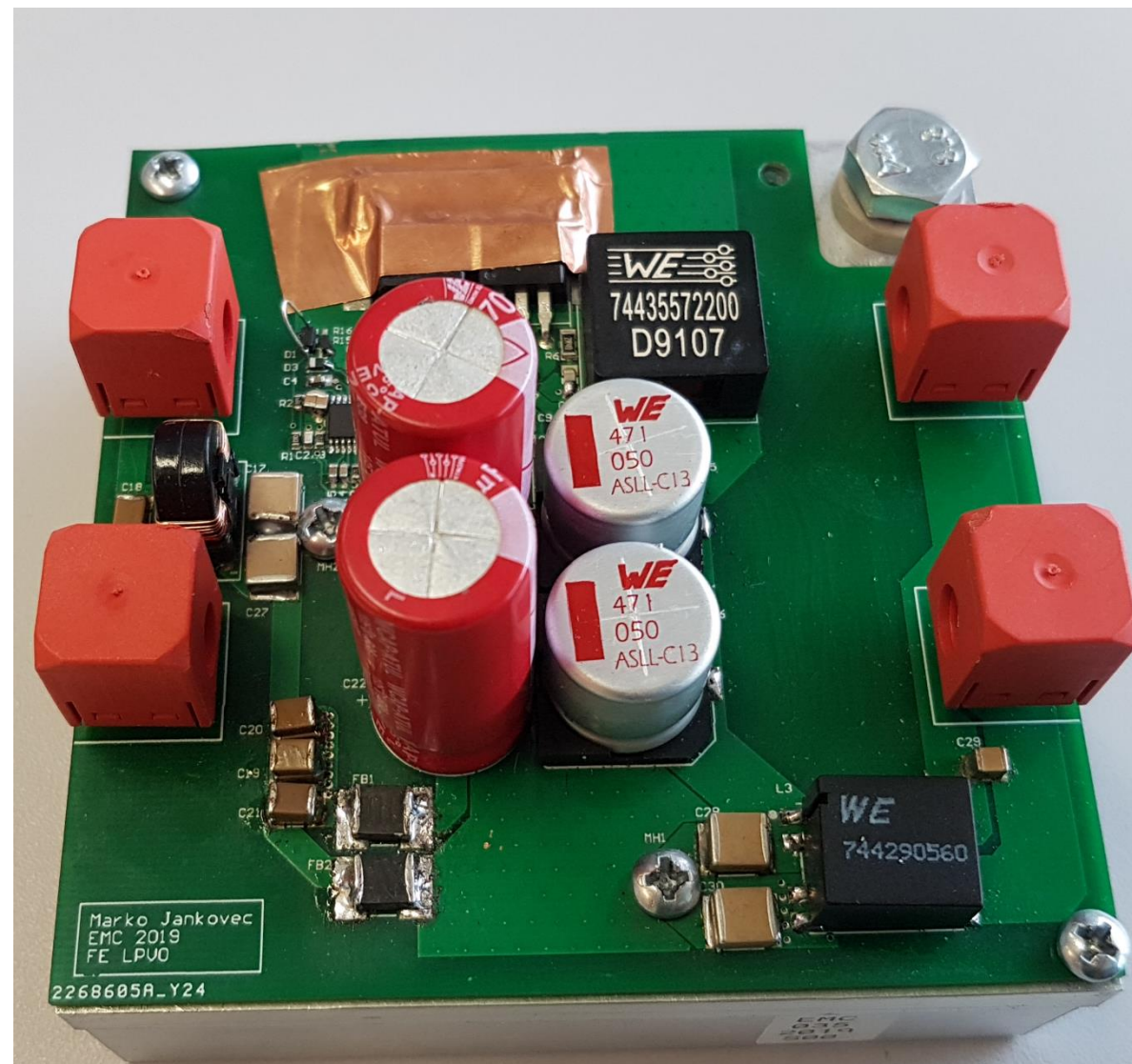
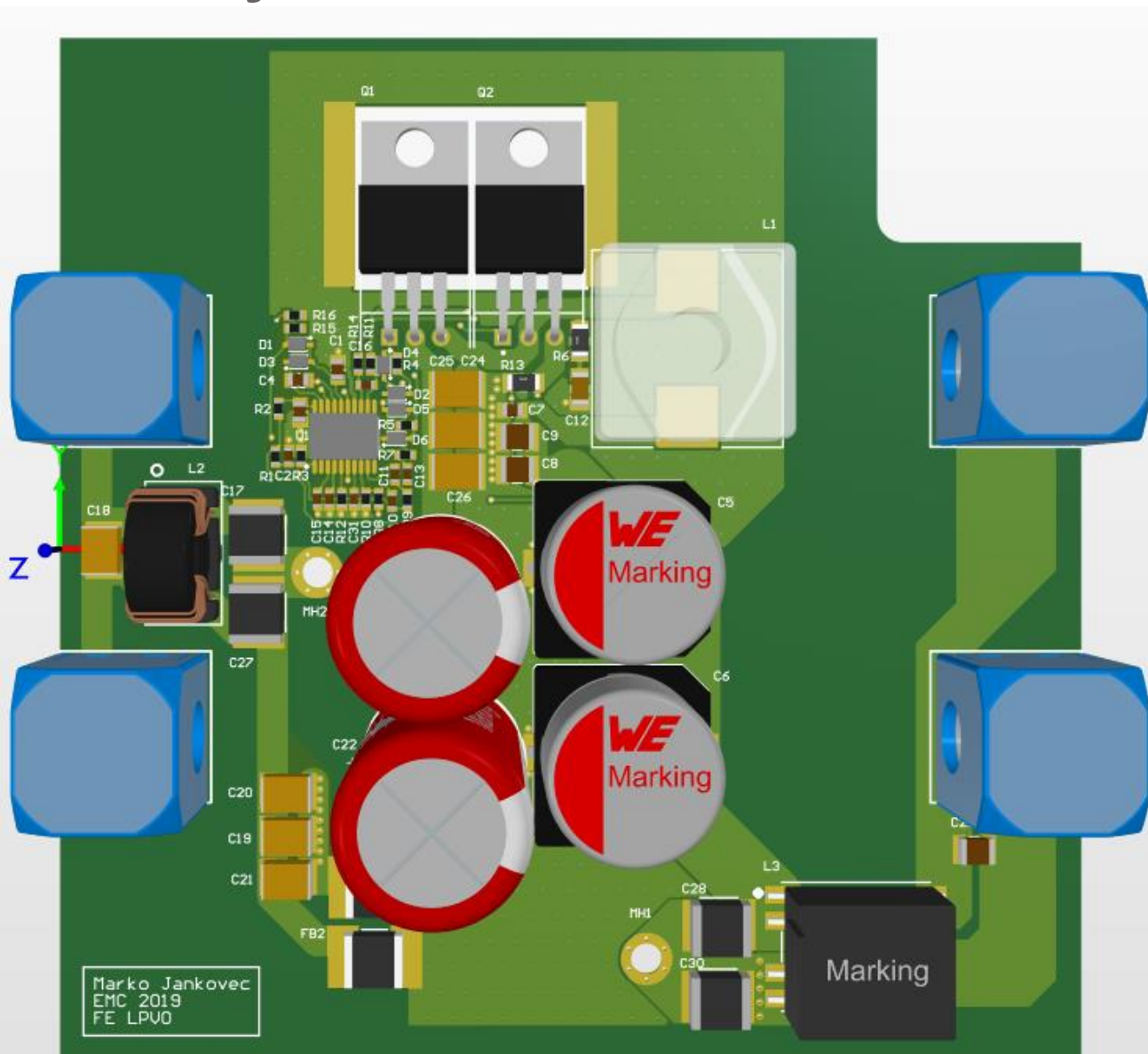
- Osnovne predpostavke
  - $f = 400 \text{ kHz}$
  - $L = 22 \text{ }\mu\text{H}$
  - $I_{Lmax} = 8 \text{ A}$
  - $\Delta I_L = 1.2 \text{ A}$



# Projekt FE



# Projekt FE



# Izbira glavne tuljave

## WE-HCI SMD Flat Wire High Current Inductor Shielded



**Buck Sync Converter**

**Reapply**

**PARAMETERS** **EDIT**

Input: 36.0-60.0 V  
Output: 13.7 V  
Switch: 400 kHz  
Inductor: 20 %

**DETAILS**

$I_{L,max,cont} \geq 7.70$  A  
 $L_{opt} = 18.9$   $\mu$ H  
 $I_{L,rms} \geq 7.02$  A

**WE-HCI - 74435572200**

DC: 0.23  
 $\Delta I_L$ : 1.20 A  
 $I_{L,max}$ :  $\geq 7.60$  A  
 $T_{on}$ : 570 ns

**Losses**

AC: 394 mW  
DC: 715 mW  
Total: 1.11 W  
 $\Delta T_{tot}$ : 29.4 K

**P vs.  $V_{in}$**

**P vs.  $f_{sw}$**

**P vs.  $I_{out}$**

Filters:  $I_{sat} \geq 2.40$  A  $I_R \geq 2.02$  A  $15.0 \mu H \leq L_0 \leq 25.0 \mu H$   $\Delta T_{TOT} \leq 80.0$  K

| Order Code  | Series | Size | Spec | Type   | $L_0$        | $R_{DC,typ}$    | $I_R$  | $I_{sat}$ | $f_{res}$ | $P_{AC}$ | $P_{DC}$ | $P_{TOT}$ | $\Delta T_{TOT}$ | L       | W       | $H_{Max}$ | $T_{Op}$ | Shi      | Material |
|-------------|--------|------|------|--------|--------------|-----------------|--------|-----------|-----------|----------|----------|-----------|------------------|---------|---------|-----------|----------|----------|----------|
| 7447709150  | WE-PD  | 1210 | PDF  | Single | 15.0 $\mu$ H | 20.7 m $\Omega$ | 7.00 A | 8.00 A    | 17.0 MHz  | 465 mW   | 1.01 W   | 1.48 W    | 60.9 K           | 12.0 mm | 12.0 mm | 10.0 mm   | 125°C    | Shielded | WE-PER   |
| 7447704150  | WE-PD  | 1510 | PDF  | Single | 15.0 $\mu$ H | 19.5 m $\Omega$ | 7.00 A | 8.80 A    | 20.5 MHz  | 971 mW   | 956 mW   | 1.93 W    | 74.6 K           | 15.0 mm | 15.5 mm | 9.50 mm   | 125°C    | Shielded | WE-PER   |
| 7447704220  | WE-PD  | 1510 | PDF  | Single | 22.0 $\mu$ H | 25.0 m $\Omega$ | 6.20 A | 7.20 A    | 11.5 MHz  | 662 mW   | 1.23 W   | 1.89 W    | 73.1 K           | 15.0 mm | 15.5 mm | 9.50 mm   | 125°C    | Shielded | WE-PER   |
| 7443551151  | WE-HCI | 1365 | PDF  | Single | 15.4 $\mu$ H | 14.0 m $\Omega$ | 9.00 A | 8.00 A    | 15.0 MHz  | 396 mW   | 686 mW   | 1.08 W    | 36.8 K           | 13.2 mm | 12.8 mm | 6.50 mm   | 155°C    | Shielded | WE-PER   |
| 7443551181  | WE-HCI | 1365 | PDF  | Single | 18.0 $\mu$ H | 22.0 m $\Omega$ | 7.50 A | 7.50 A    | 17.0 MHz  | 339 mW   | 1.08 W   | 1.42 W    | 69.8 K           | 13.2 mm | 12.8 mm | 6.50 mm   | 155°C    | Shielded | WE-PER   |
| 74435571500 | WE-HCI | 1890 | PDF  | Single | 15.0 $\mu$ H | 9.00 m $\Omega$ | 14.0 A | 14.0 A    | 14.0 MHz  | 578 mW   | 441 mW   | 1.02 W    | 31.8 K           | 18.3 mm | 18.2 mm | 9.20 mm   | 125°C    | Shielded | MnZn     |
| 74435572200 | WE-HCI | 1890 | PDF  | Single | 22.0 $\mu$ H | 14.6 m $\Omega$ | 11.0 A | 11.0 A    | 10.5 MHz  | 394 mW   | 715 mW   | 1.11 W    | 29.4 K           | 18.3 mm | 18.2 mm | 9.20 mm   | 125°C    | Shielded | MnZn     |
| 74435582200 | WE-HCI | 2212 | PDF  | Single | 22.0 $\mu$ H | 7.00 m $\Omega$ | 15.0 A | 18.0 A    | 8.50 MHz  | 470 mW   | 343 mW   | 813 mW    | 23.3 K           | 22.5 mm | 22.0 mm | 12.4 mm   | 125°C    | Shielded | MnZn     |
| 7443631500  | WE-HCF | 2013 | PDF  | Single | 15.0 $\mu$ H | 8.70 m $\Omega$ | 14.0 A | 21.0 A    | 17.4 MHz  | 261 mW   | 426 mW   | 687 mW    | 17.3 K           | 20.8 mm | 20.5 mm | 14.5 mm   | 125°C    | Shielded | MnZn     |

Click and type or drop an Order Code here

**7447709150** WE-PD - 1210 15.0  $\mu$ H - 20.7 m $\Omega$

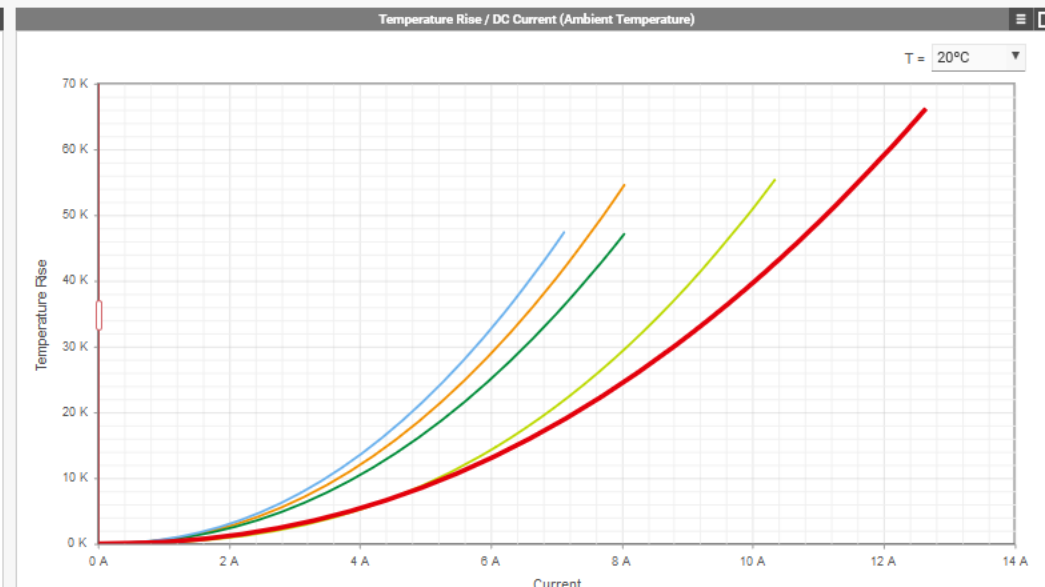
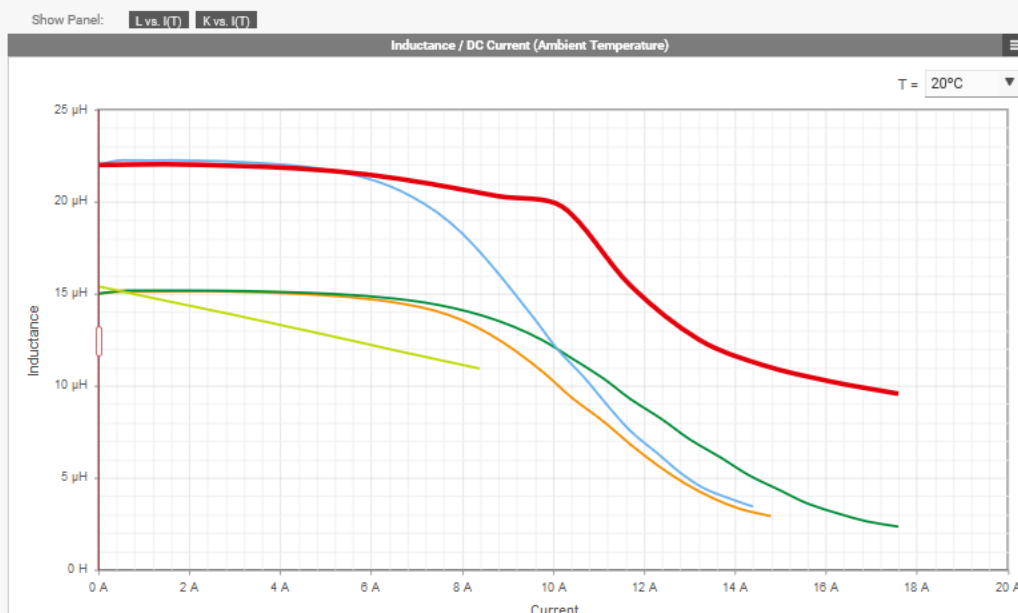
**7447704150** WE-PD - 1510 15.0  $\mu$ H - 19.5 m $\Omega$

**7447704220** WE-PD - 1510 22.0  $\mu$ H - 25.0 m $\Omega$

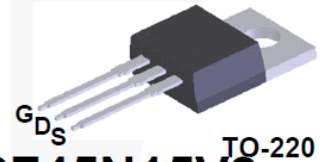
**7443551151** WE-HCI - 1365 15.4  $\mu$ H - 14.0 m $\Omega$

**ADD**

**MORE**



# Izbira tranzistorja



## FQP45N15V2 / FQPF45N15V2

### N-Channel QFET® MOSFET

150 V, 45 A, 40 mΩ

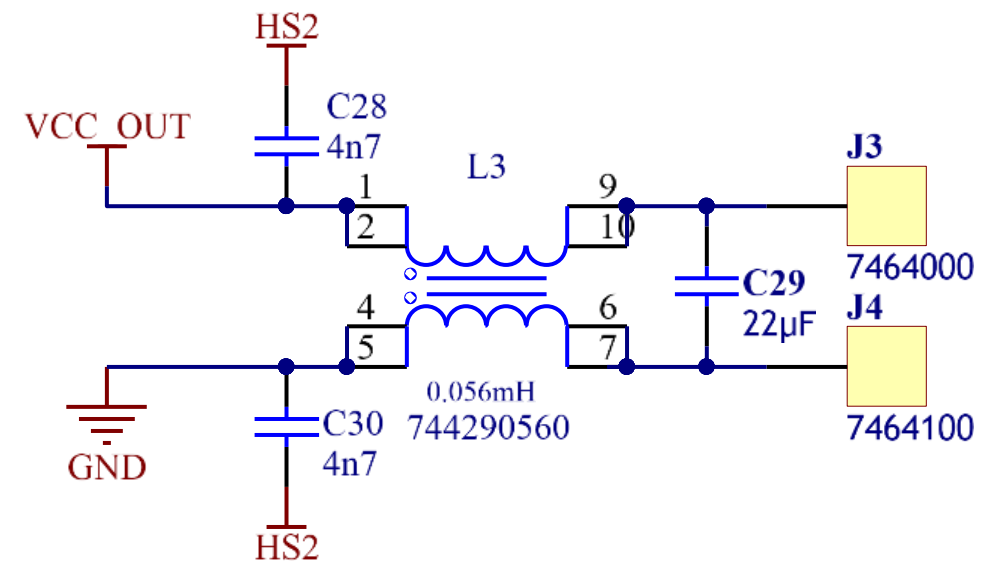
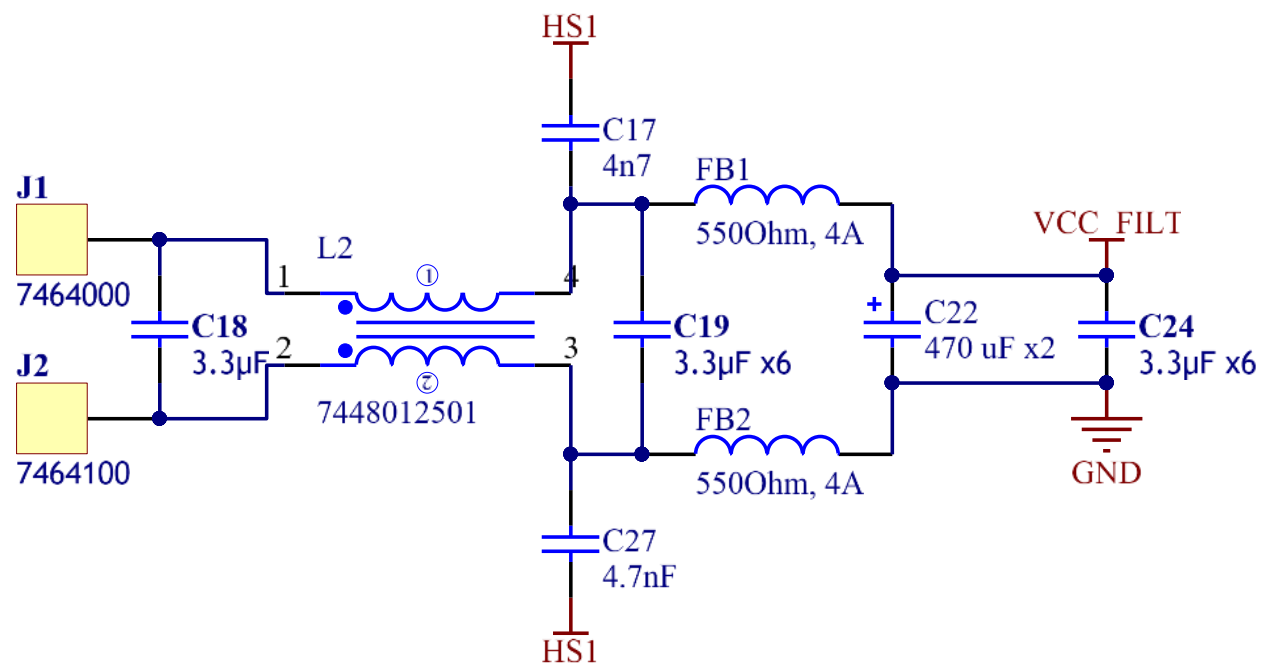
## Absolute Maximum Ratings $T_C = 25^\circ\text{C}$ unless otherwise noted.

| Symbol    | Parameter                                               | FQP45N15V2 | FQPF45N15V2 | Unit |
|-----------|---------------------------------------------------------|------------|-------------|------|
| $V_{DSS}$ | Drain-Source Voltage                                    | 150        |             | V    |
| $I_D$     | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ ) | 45         | 45 *        | A    |
|           | - Continuous ( $T_C = 100^\circ\text{C}$ )              | 31         | 31 *        | A    |

## On Characteristics

|              |                                   |                                                                                      |     |       |      |          |
|--------------|-----------------------------------|--------------------------------------------------------------------------------------|-----|-------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$                                             | 2.0 | --    | 4.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10 \text{ V}, I_D = 22.5 \text{ A}$                                        | --  | 0.034 | 0.04 | $\Omega$ |
| $Q_g$        | Total Gate Charge                 | $V_{DS} = 120 \text{ V}, I_D = 45 \text{ A},$<br>$V_{GS} = 10 \text{ V}$<br>(Note 4) | --  | 72    | 94   | nC       |
| $Q_{gs}$     | Gate-Source Charge                |                                                                                      | --  | 13    | --   | nC       |
| $Q_{gd}$     | Gate-Drain Charge                 |                                                                                      | --  | 31    | --   | nC       |

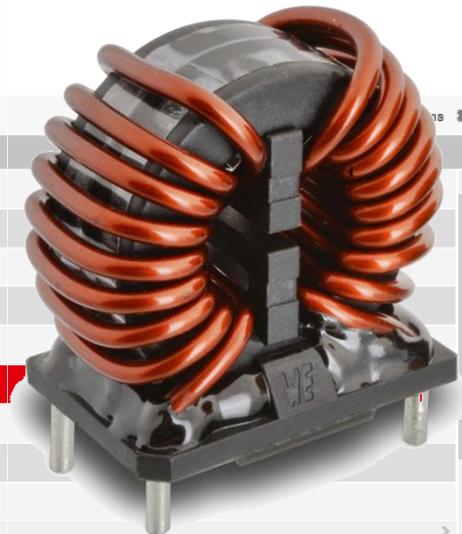
# Vhodni in izhodni filter



# Vhodna sofazna dušilka

Filters: 2.00 A ≤ I<sub>R</sub> ≤ 4.00 A Size = XS, S

| Order Code | Series       | Size | Spec | V <sub>R</sub> | L <sub>0...</sub> | I <sub>R</sub> | R <sub>DC</sub> | Lines | T <sub>op</sub> | V <sub>T</sub> | Assembli... | L       | W       | H       | Certificates |  |
|------------|--------------|------|------|----------------|-------------------|----------------|-----------------|-------|-----------------|----------------|-------------|---------|---------|---------|--------------|--|
| 744841414  | WE-CMB Ni... | XS   |      | 250 V          | 14.0 μH           | 4.00 A         | 15.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 15.0 mm | 7.00 mm | 16.5 mm |              |  |
| 744841330  | WE-CMB Ni... | XS   |      | 250 V          | 30.0 μH           | 3.00 A         | 26.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 15.0 mm | 7.00 mm | 16.5 mm |              |  |
| 744841247  | WE-CMB Ni... | XS   |      | 250 V          | 47.0 μH           | 2.00 A         | 40.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 15.0 mm | 7.00 mm | 16.5 mm |              |  |
| 744842311  | WE-CMB Ni... | S    |      | 250 V          | 110 μH            | 3.00 A         | 31.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 18.0 mm | 14.0 mm | 21.0 mm |              |  |
| 7448013501 | WE-CMBNC     | XS   |      | 250 V          | 500 μH            | 3.50 A         | 30.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 15.0 mm | 7.50 mm | 16.0 mm |              |  |
| 7448012501 | WE-CMBNC     | XS   |      | 250 V          | 1.00 mH           | 2.50 A         | 50.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 14.0 mm | 7.50 mm | 16.0 mm |              |  |
| 744821201  | WE-CMB       | XS   |      | 250 V          | 1.00 mH           | 2.00 A         | 44.5 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 14.5 mm | 7.00 mm | 16.5 mm |              |  |
| 744822301  | WE-CMB       | S    |      | 250 V          | 1.00 mH           | 3.00 A         | 35.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 17.0 mm | 12.0 mm | 20.5 mm |              |  |
| 7448012002 | WE-CMBNC     | XS   |      | 250 V          | 1.60 mH           | 2.00 A         | 90.0 mΩ         | 2     | 125°C           | 1.50 kV        | THT         | 14.0 mm | 7.50 mm | 16.0 mm |              |  |



744821201  
WE-CMB - XS  
1.00 mH - 2.00 A

744822301  
WE-CMB - S  
1.00 mH - 3.00 A

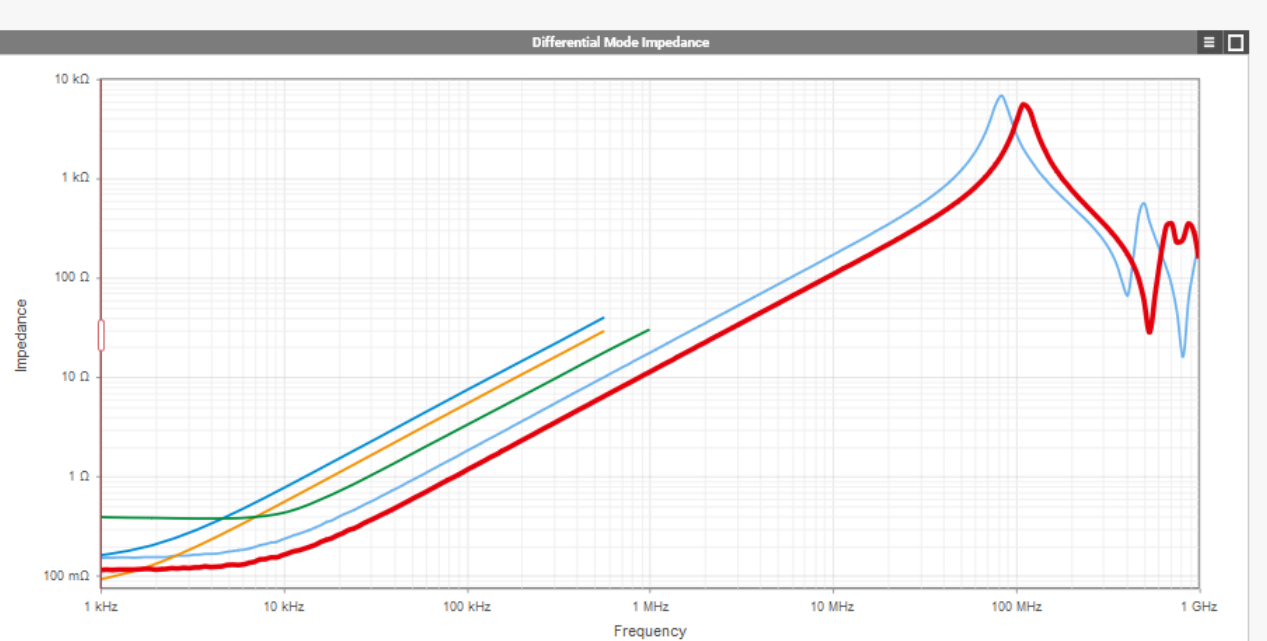
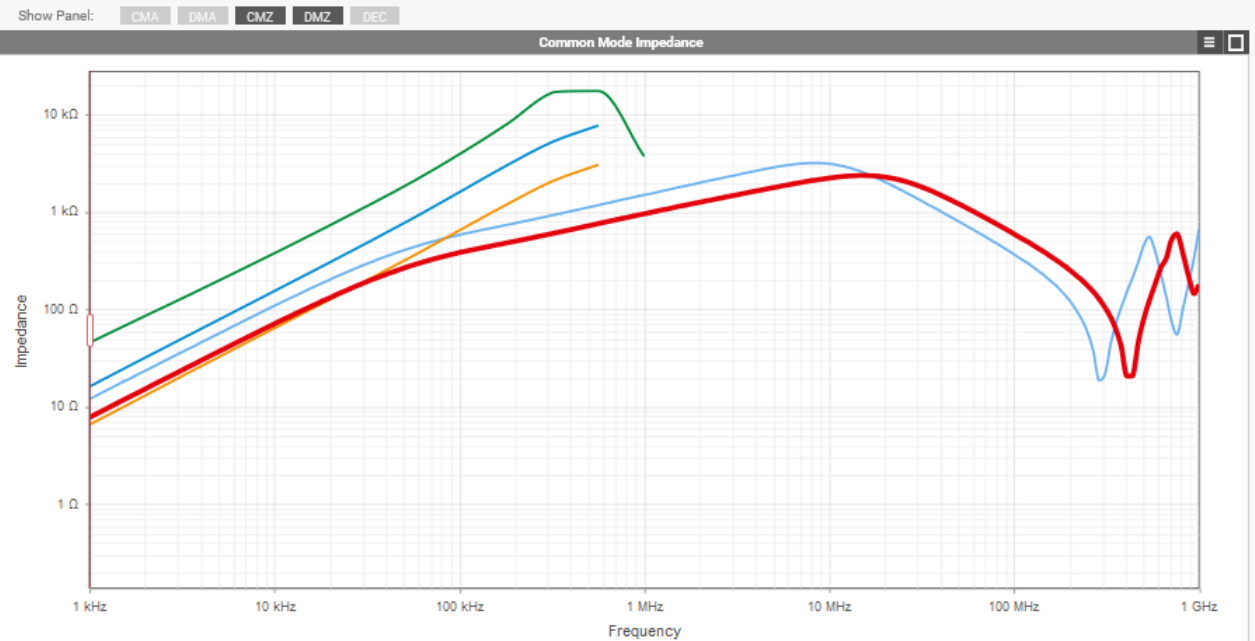
7448012002  
WE-CMBNC - XS  
1.60 mH - 2.00 A

744822222  
WE-CMB - S  
2.20 mH - 2.00 A

Click and type or drop  
an Order Code here

ADD

MORE



# Vhodna diferencialna dušilka - FB WE-MPSB EMI Multilayer Power Suppression Bead

Filters:  $3.00\text{ A} \leq I_R \leq 5.00\text{ A}$   $300\ \Omega \leq Z @ 100\text{ MHz} \leq 600\ \Omega$  9 items

| Order Code  | Series  | Size  | Spec | Type         | Z@100MHz     | Z <sub>max</sub>       | R <sub>DC</sub> | I <sub>R</sub> | L       | W       | H        | Lines | Assembl... | AECQ | Automotive |
|-------------|---------|-------|------|--------------|--------------|------------------------|-----------------|----------------|---------|---------|----------|-------|------------|------|------------|
| 742730023   | WE-MLS  | 1111  | PDF  | 4 lines      | 334 $\Omega$ | 336 $\Omega$ @70.0 MHz | 2.00 m $\Omega$ | 4.00 A         | 11.2 mm | 11.2 mm | 11.0 mm  |       | THT        | ×    | ×          |
| 742792031   | WE-CBF  | 0805  | PDF  | High Current | 300 $\Omega$ | 350 $\Omega$ @200 MHz  | 50.0 m $\Omega$ | 3.00 A         | 2.00 mm | 1.25 mm | 0.900 mm |       | SMT        | ×    | ×          |
| 742792121   | WE-CBF  | 1206  | PDF  | High Current | 300 $\Omega$ | 330 $\Omega$ @110 MHz  | 60.0 m $\Omega$ | 3.00 A         | 3.20 mm | 1.60 mm | 1.10 mm  |       | SMT        | ×    | ×          |
| 742792514   | WE-CBF  | 1812  | PDF  | High Current | 600 $\Omega$ | 900 $\Omega$ @65.0 MHz | 40.0 m $\Omega$ | 3.00 A         | 4.50 mm | 3.20 mm | 1.50 mm  |       | SMT        | ×    | ×          |
| 74279224401 | WE-MPSB | 2220  | PDF  | High Current | 400 $\Omega$ | 450 $\Omega$ @110 MHz  | 20.0 m $\Omega$ | 4.50 A         | 5.59 mm | 5.08 mm | 3.20 mm  |       | SMT        | ×    | ×          |
| 74279224551 | WE-MPSB | 2220  | PDF  | High Current | 550 $\Omega$ | 660 $\Omega$ @300 MHz  | 35.0 m $\Omega$ | 4.00 A         | 5.59 mm | 5.08 mm | 1.97 mm  |       | SMT        | ×    | ×          |
| 7427511     | WE-SUKW | 8050  | PDF  | High Current | 416 $\Omega$ | 440 $\Omega$ @100 MHz  | 11.0 m $\Omega$ | 5.00 A         | 5.50 mm | 5.00 mm | 4.60 mm  |       | SMT        | ×    | ×          |
| 7427512     | WE-SUKW | 11046 | PDF  | High Current | 580 $\Omega$ | 700 $\Omega$ @90.0 MHz | 12.0 m $\Omega$ | 5.00 A         | 8.50 mm | 4.65 mm | 5.00 mm  |       | SMT        | ×    | ×          |
| 74275022    | WE-UKW  | 40060 | PDF  | Horizontal   | 512 $\Omega$ | 512 $\Omega$ @100 MHz  | 20.0 m $\Omega$ | 3.00 A         | 10.0 mm | 6.00 mm | 40.0 mm  |       | THT        | ×    | ×          |



74279228111  
WE-MPSB - 0603  
110  $\Omega$

7427512  
WE-SUKW - 11046  
580  $\Omega$

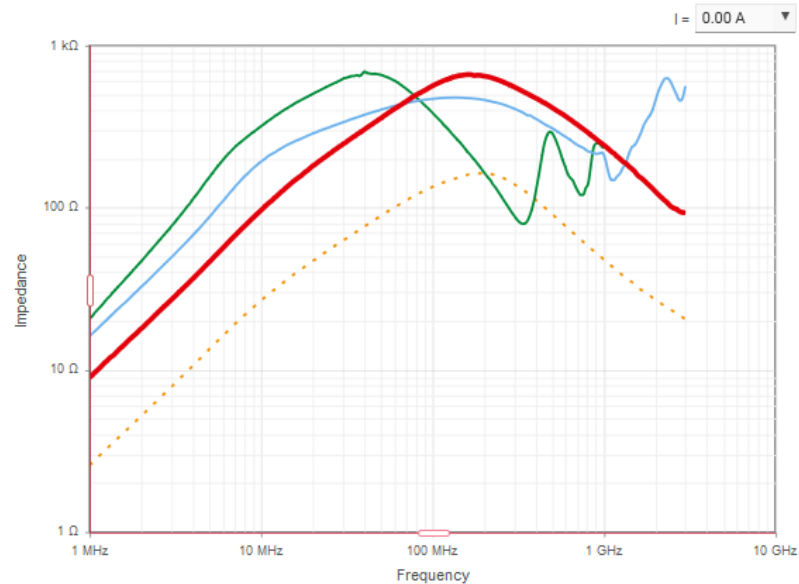
74275022  
WE-UKW - 40060  
512  $\Omega$

Click and type or drop  
an Order Code here

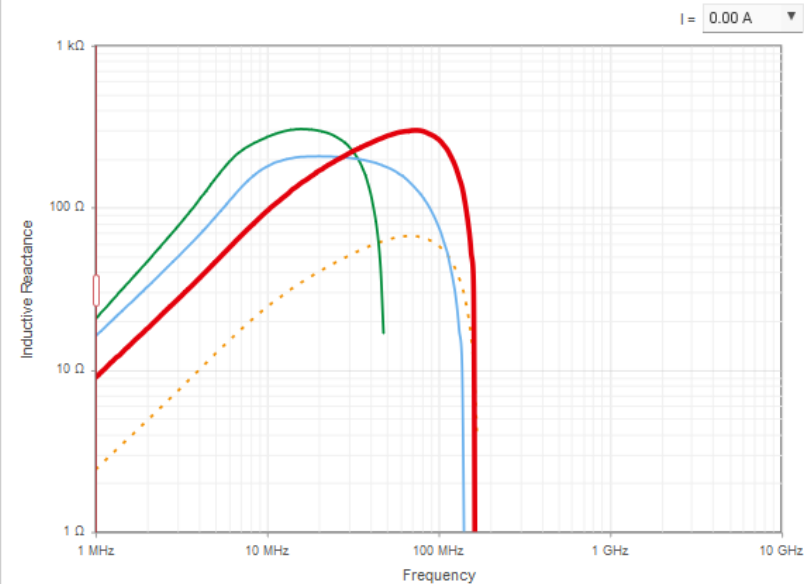
ADD  
MORE

Show Panel: Z vs. F X vs. F R vs. F I vs. PL I vs. N

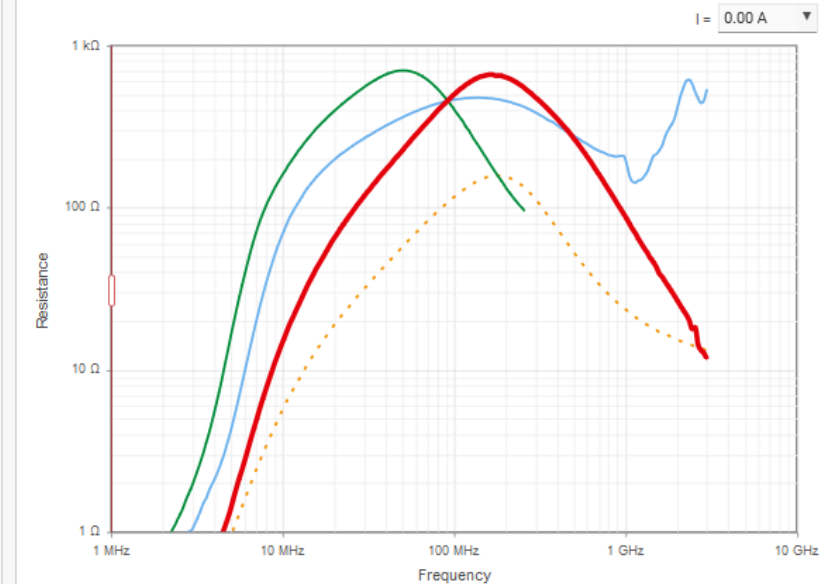
Impedance / Frequency



Reactance / Frequency



Resistance / Frequency



# Vhodni elektrolitski kondenzatorji

## WCAP-ATUL Aluminum Electrolytic Capacitors Low Leakage & Long Life

| Order Code   | Series    | Spec | Description             | C       | V <sub>R</sub> | DF      | Z <sub>max</sub> @ 100kHz | I <sub>ripple</sub> @T <sub>max</sub> °C 120Hz | I <sub>ripple</sub> @T <sub>max</sub> 100kHz | I <sub>leak</sub> | T <sub>min</sub> | T <sub>max</sub> | Width | Height  | Length | Ø       | Lifetime | Assemb... | Pins |
|--------------|-----------|------|-------------------------|---------|----------------|---------|---------------------------|------------------------------------------------|----------------------------------------------|-------------------|------------------|------------------|-------|---------|--------|---------|----------|-----------|------|
| 860040881010 | WCAP-ATUL |      | ATDL250391M100DSPA000   | 390 µF  | 100 V          | < 9.0 % | 54.0 mΩ                   |                                                | 1.74 A                                       | 390 µA            | -40.0°C          | 105°C            |       | 25.0 mm |        | 18.0 mm | 10000 h  | THT       | 0.80 |
| 860040880011 | WCAP-ATUL |      | ATDK355471M100DSPADK000 | 470 µF  | 100 V          | < 9.0 % | 47.0 mΩ                   |                                                | 1.88 A                                       | 470 µA            | -40.0°C          | 105°C            |       | 35.5 mm |        | 16.0 mm | 10000 h  | THT       | 0.80 |
| 860040881012 | WCAP-ATUL |      | ATDL315471M100DSPA000   | 470 µF  | 100 V          | < 9.0 % | 47.0 mΩ                   |                                                | 1.60 A                                       | 470 µA            | -40.0°C          | 105°C            |       | 31.5 mm |        | 18.0 mm | 10000 h  | THT       | 0.80 |
| 860040881013 | WCAP-ATUL |      | ATDL355681M100DSPA000   | 680 µF  | 100 V          | < 9.0 % | 42.0 mΩ                   |                                                | 1.72 A                                       | 680 µA            | -40.0°C          | 105°C            |       | 35.5 mm |        |         | 10000 h  | THT       | 0.80 |
| 860040881014 | WCAP-ATUL |      | ATDL410821M100DSPA1K000 | 820 µF  | 100 V          | < 9.0 % | 40.0 mΩ                   |                                                | 2.34 A                                       | 820 µA            | -40.0°C          | 105°C            |       | 41.0 mm |        |         | 10000 h  | THT       | 0.80 |
| 860240372001 | WCAP-AT1H |      | ATDC110330M016DSPA3E000 | 33.0 µF | 16.0 V         | < 16 %  |                           |                                                | 115 mA                                       | 5.28 µA           | -40.0°C          | 105°C            |       | 11.0 mm |        |         | 5000.0 h | THT       | 0.50 |
| 860240372002 | WCAP-AT1H |      | ATDC110470M016DSPA3E000 | 47.0 µF | 16.0 V         | < 16 %  |                           |                                                | 145 mA                                       | 7.52 µA           | -40.0°C          | 105°C            |       | 11.0 mm |        |         | 5000.0 h | THT       | 0.50 |
| 860240373003 | WCAP-AT1H |      | ATDD110680M016DSPA4E000 | 68.0 µF | 16.0 V         | < 16 %  |                           |                                                | 200 mA                                       | 10.9 µA           | -40.0°C          | 105°C            |       | 11.0 mm |        | 6.30 mm | 5000.0 h | THT       | 0.50 |



860040881013 ×  
WCAP-ATUL  
680 µF - 100 V

860040881014 ×  
WCAP-ATUL  
820 µF - 100 V

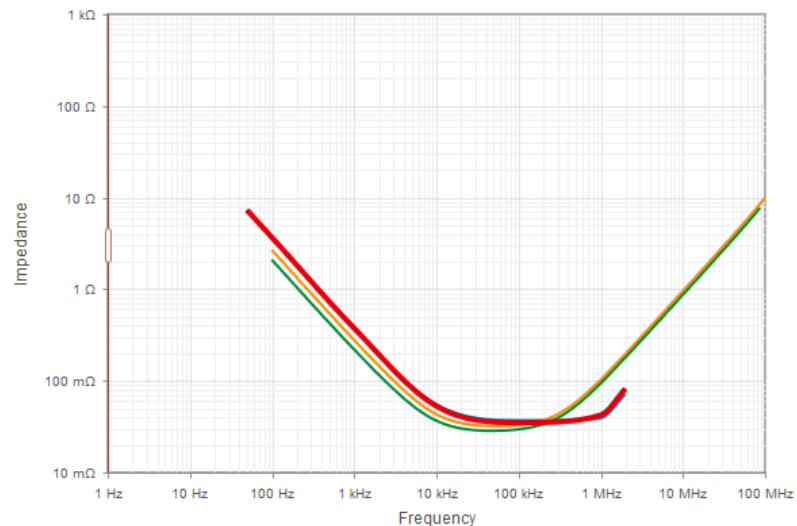
860040881012 ×  
WCAP-ATUL  
470 µF - 100 V

Click and type or drop  
an Order Code here

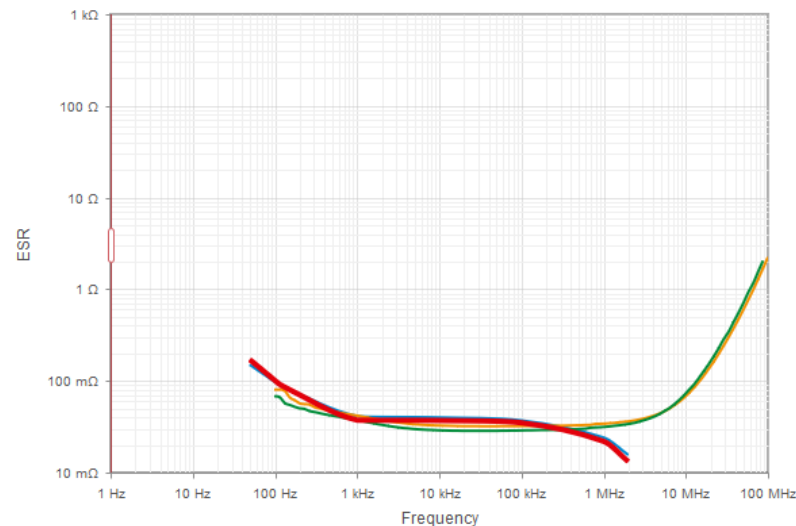
ADD  
MORE

Show Panel: Z vs. F ESR vs. F Ir vs. F

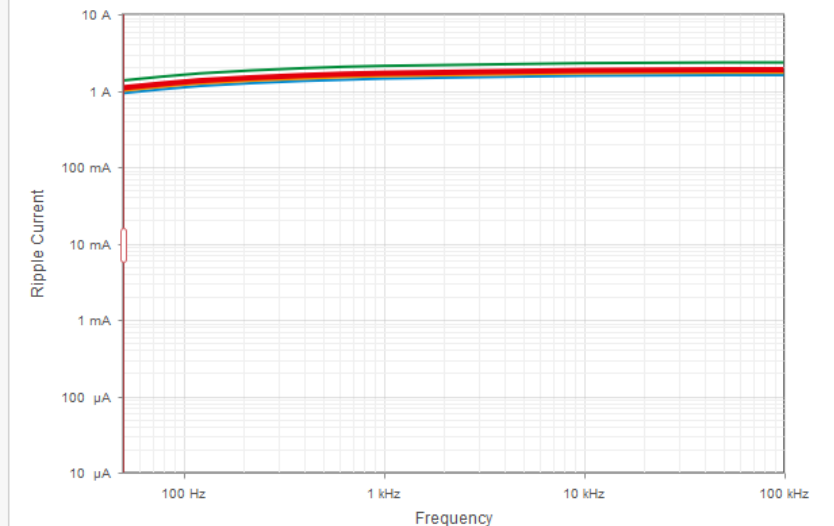
Impedance / Frequency



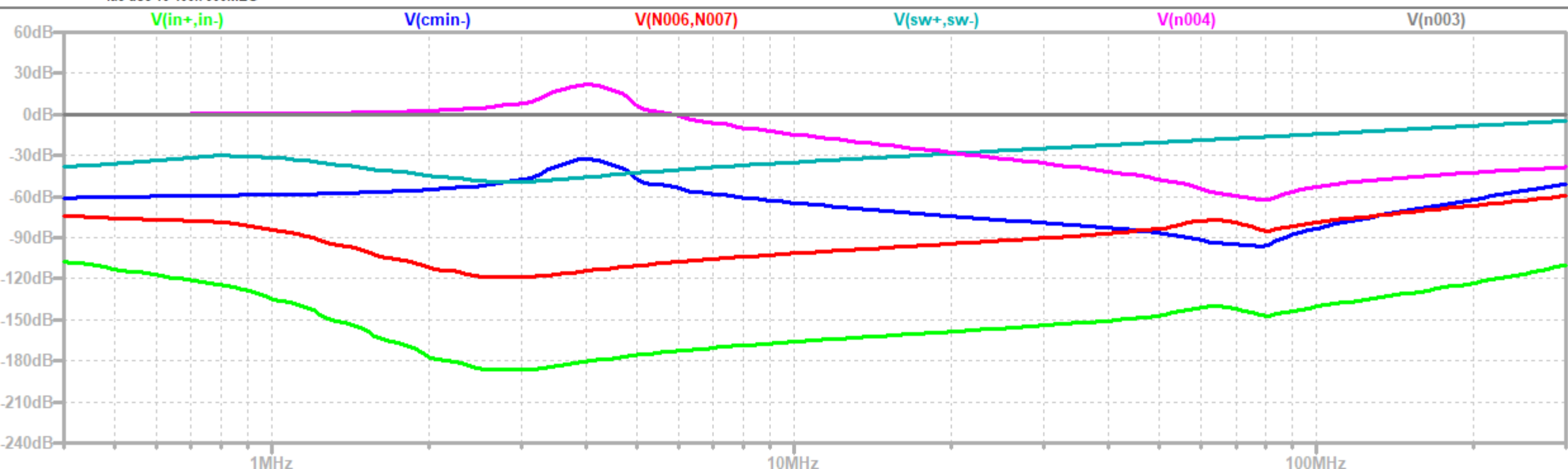
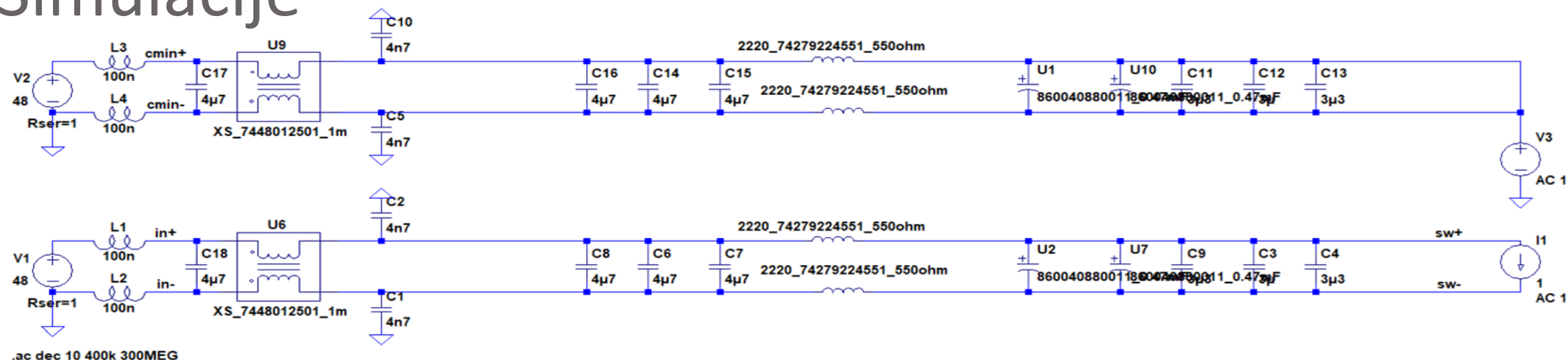
ESR / Frequency



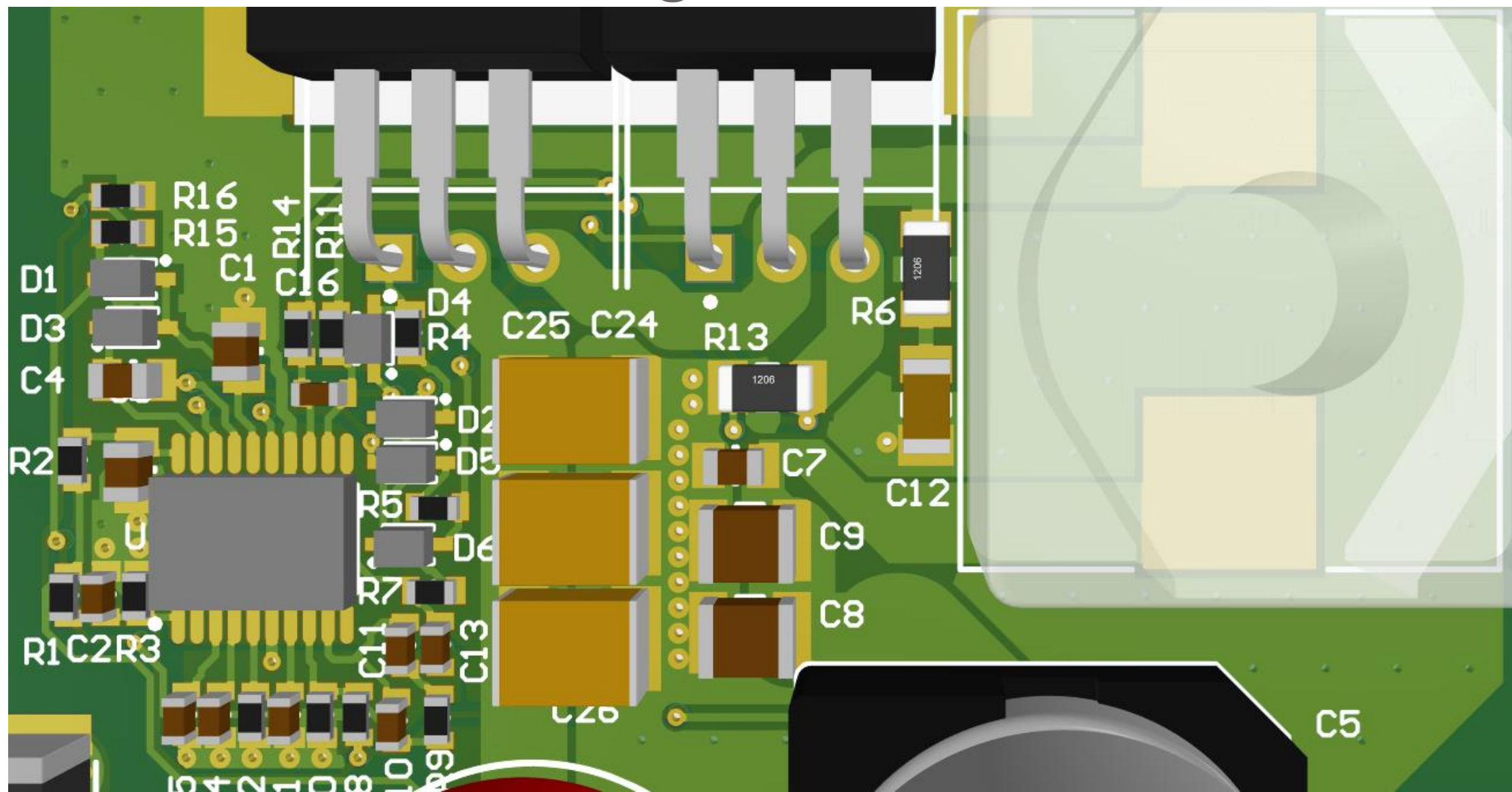
Ripple Current / Frequency



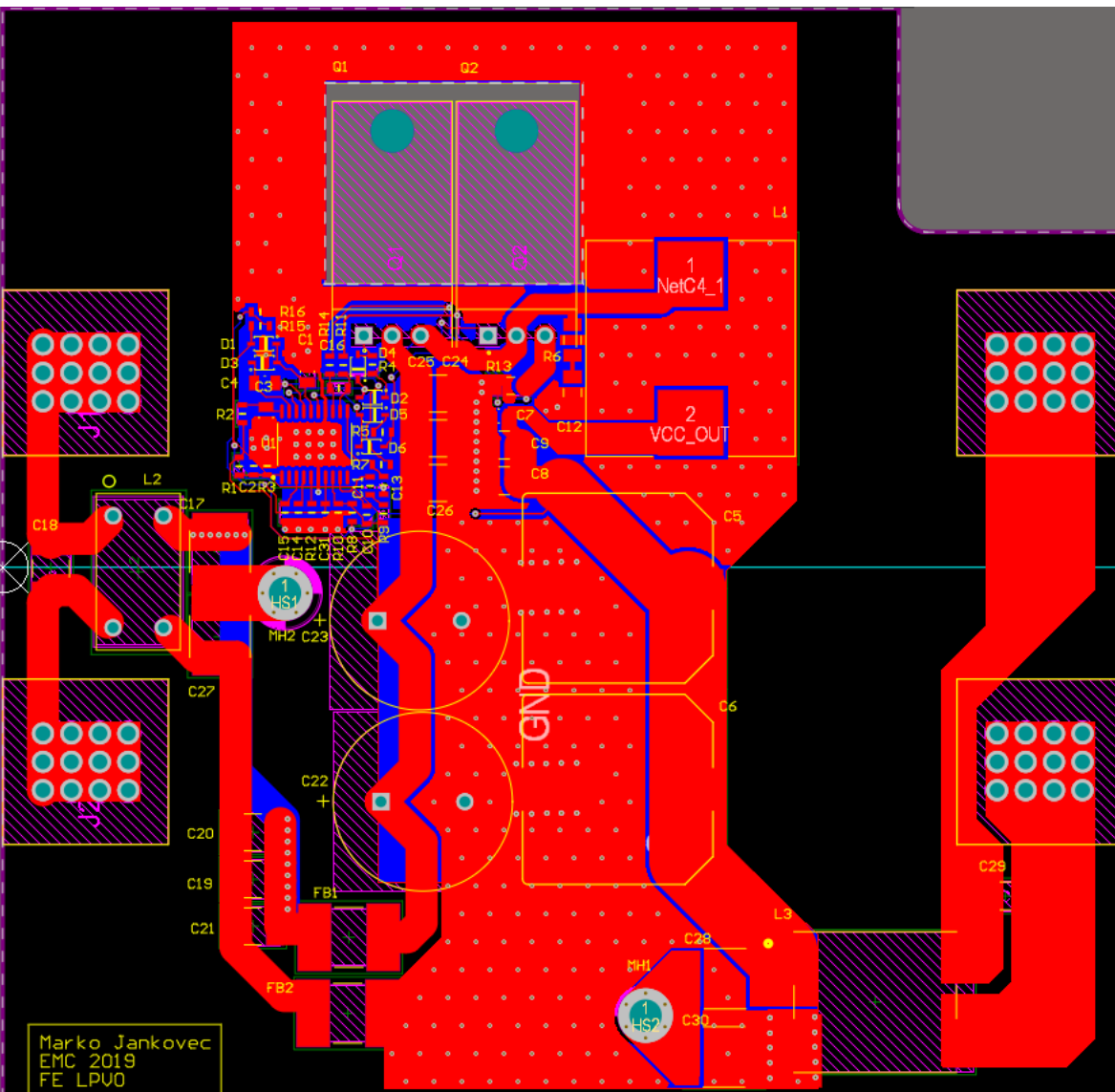
# Simulacije



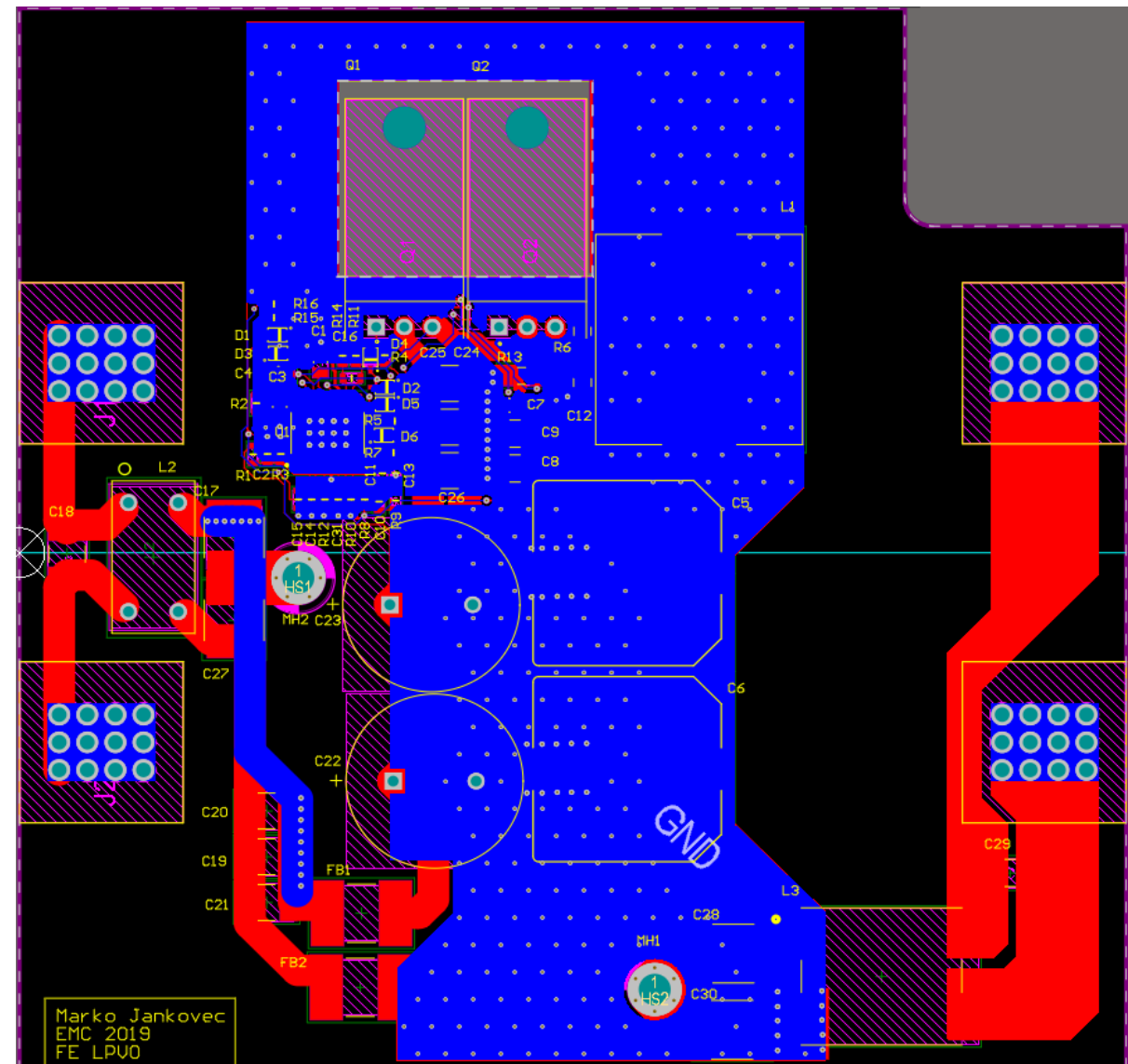
# Glavni stikalni tokokrog



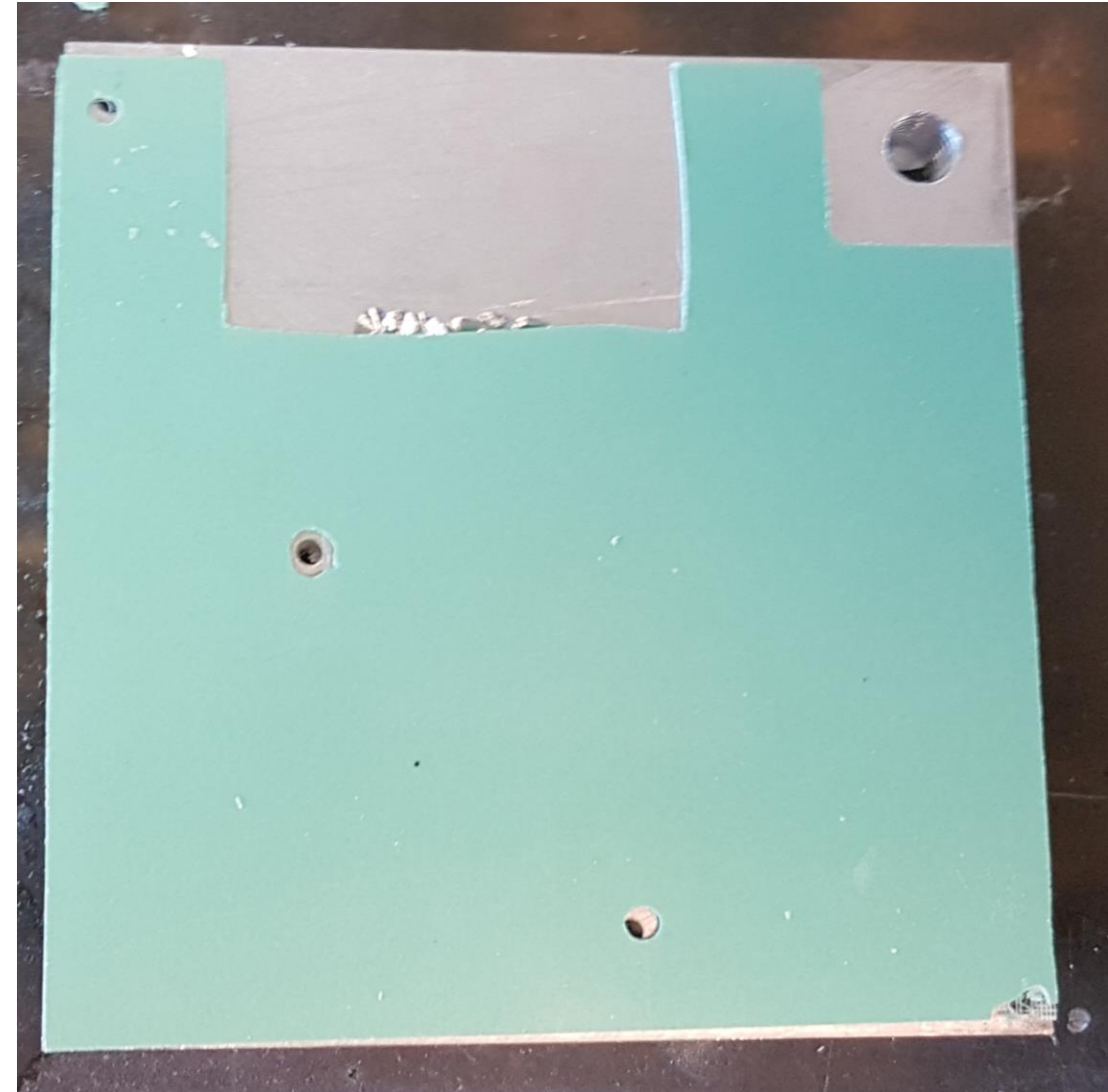
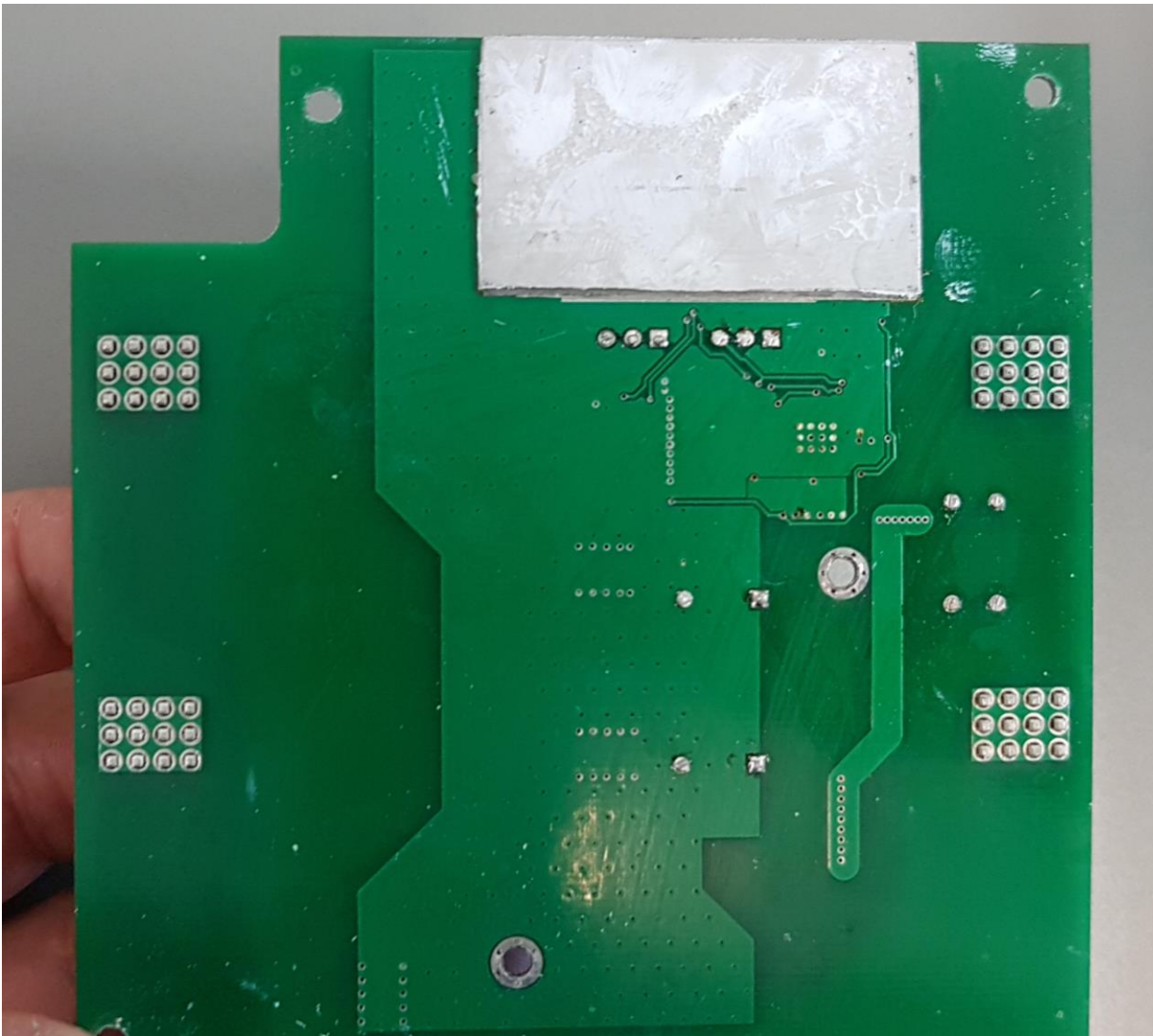
# Zgodnja stran



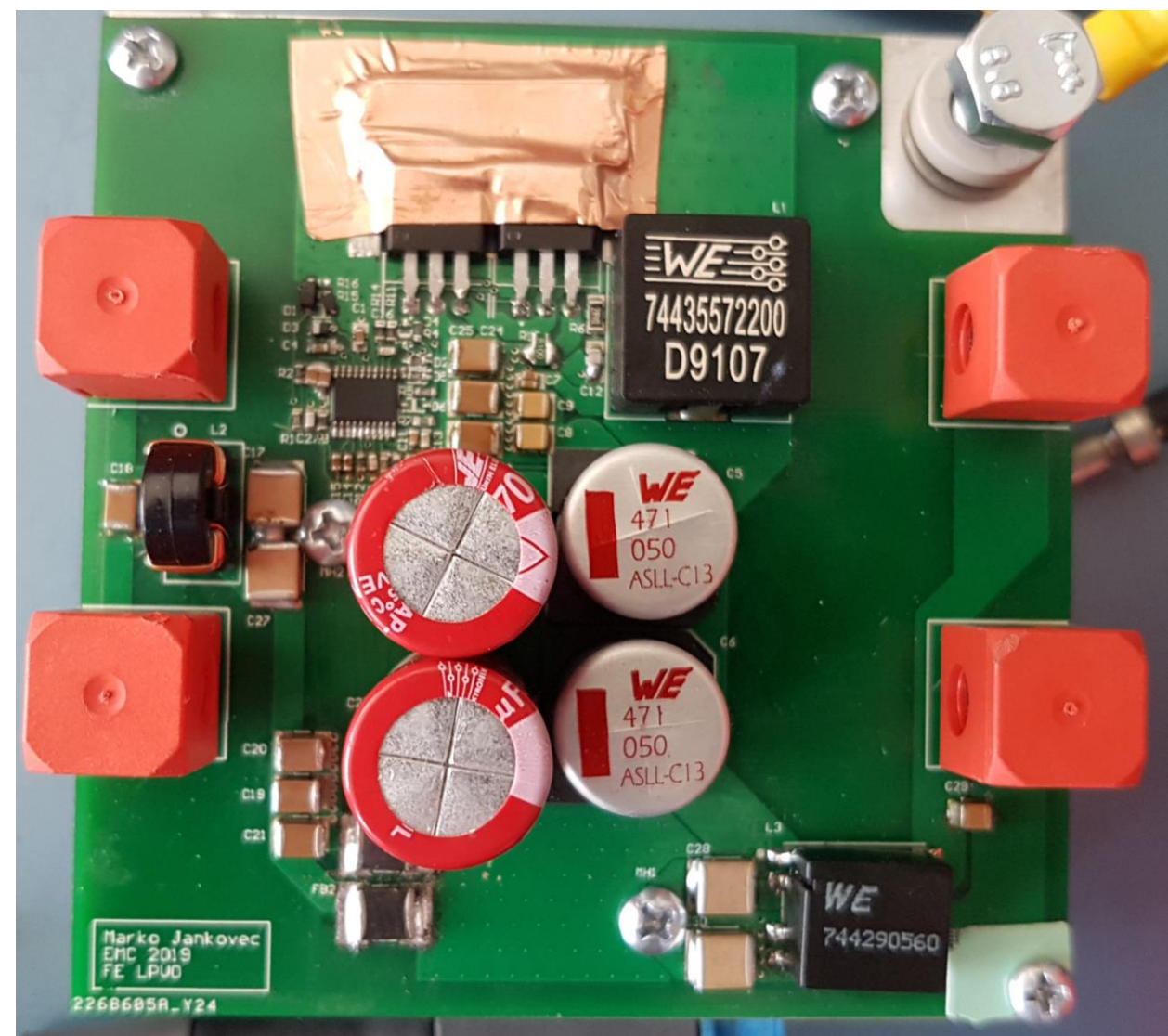
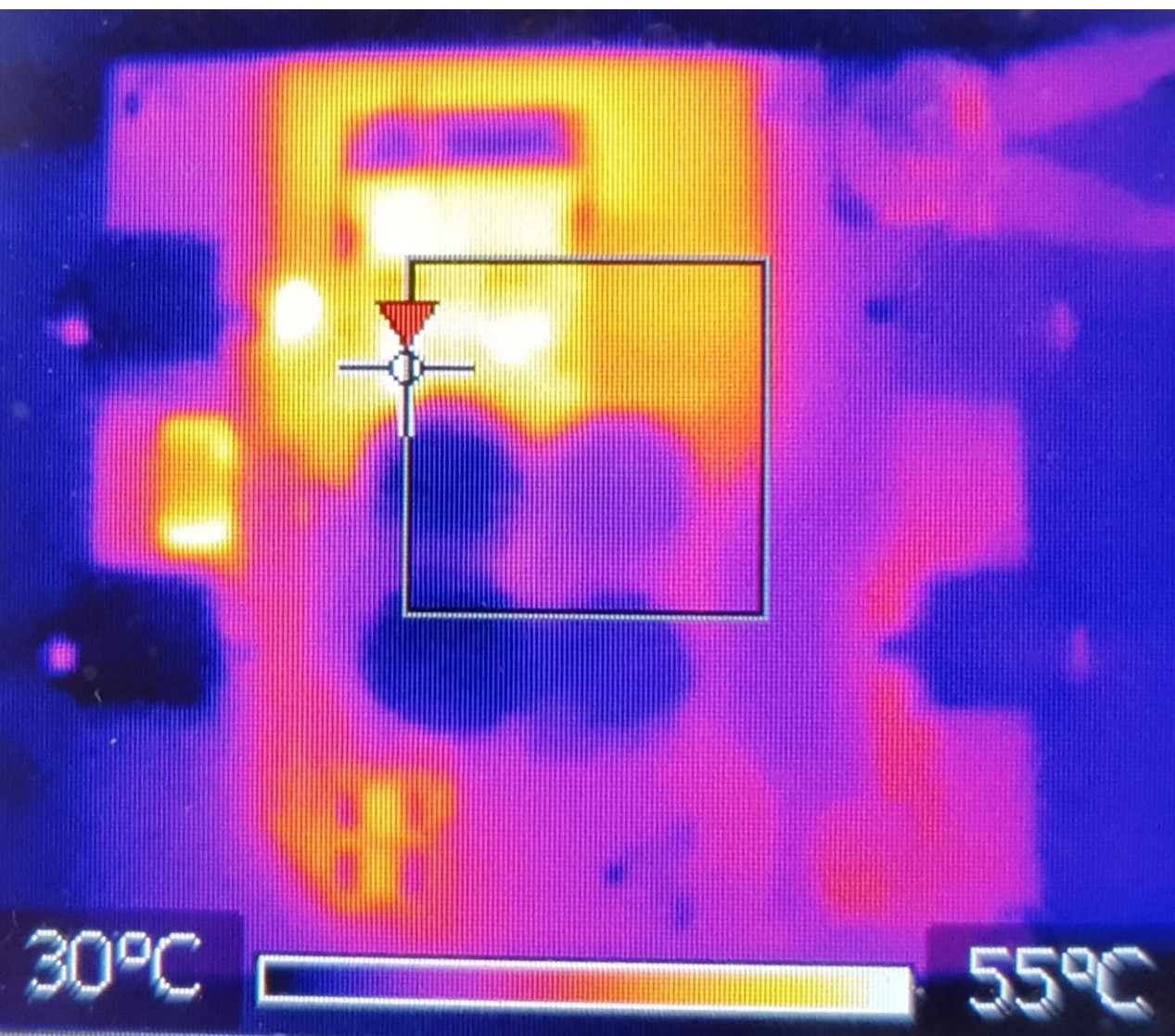
# Spodnja stran



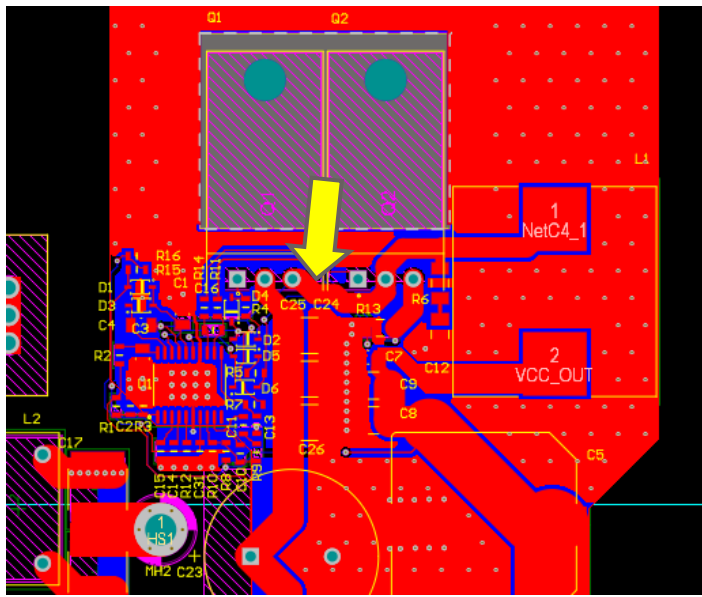
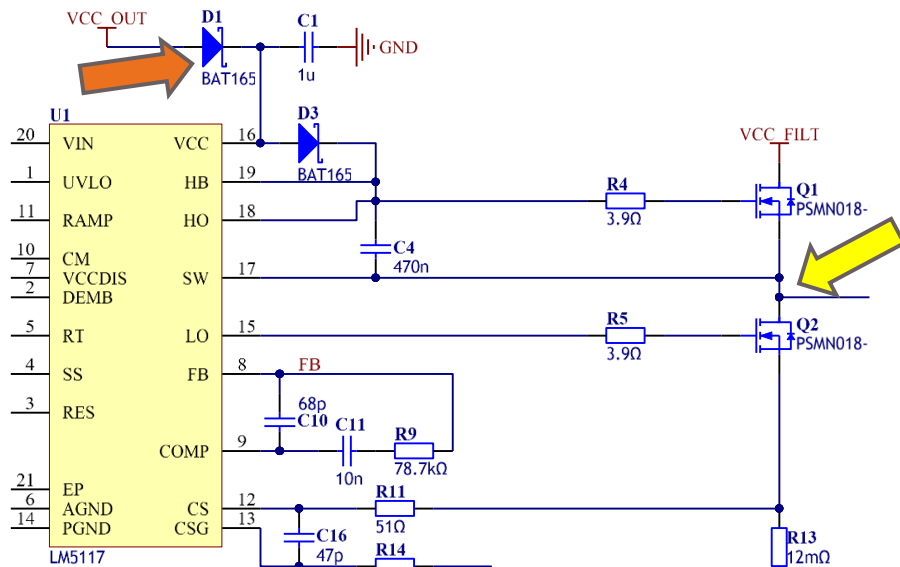
# Mehanska izvedba



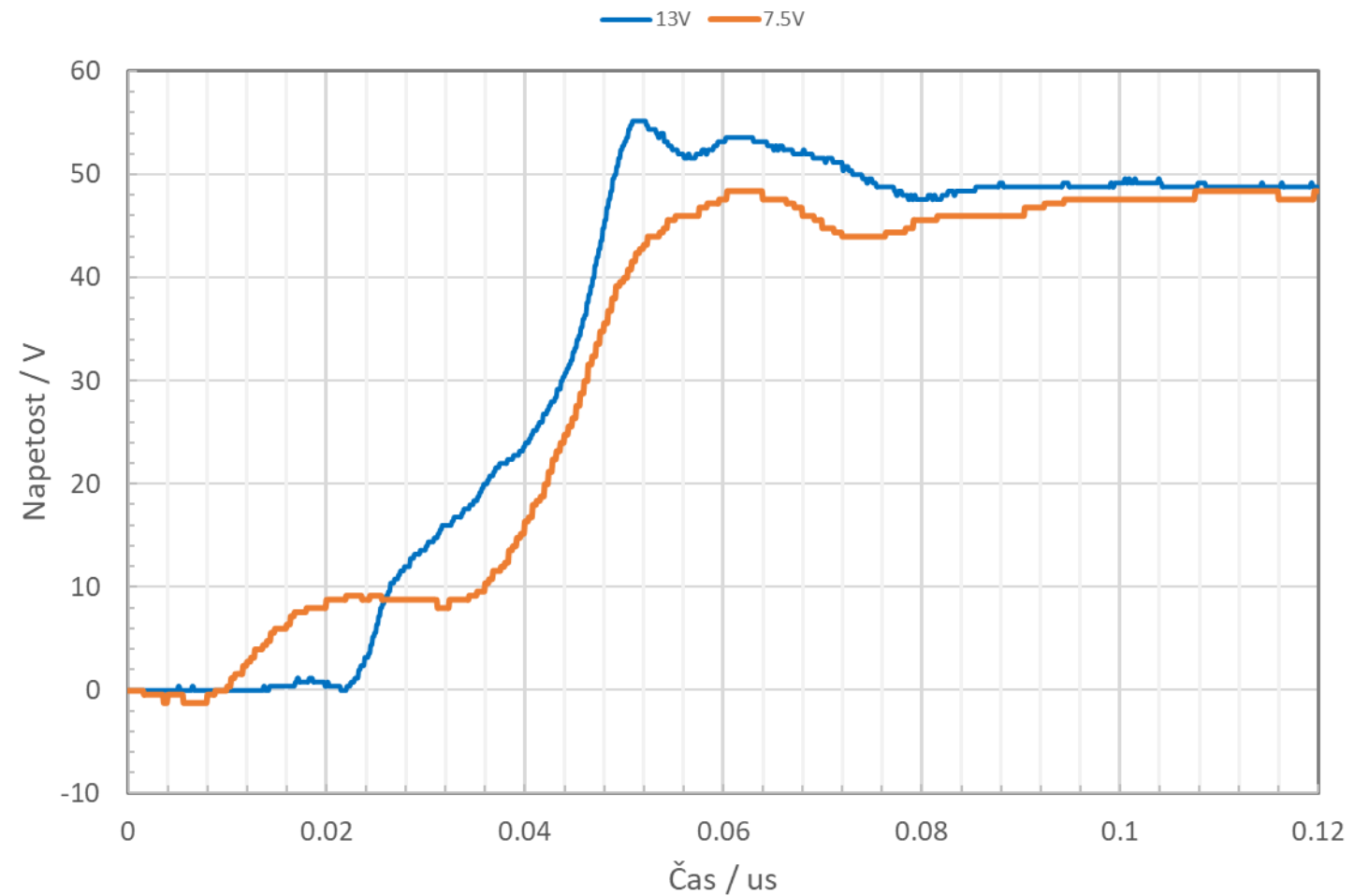
# Termične lastnosti



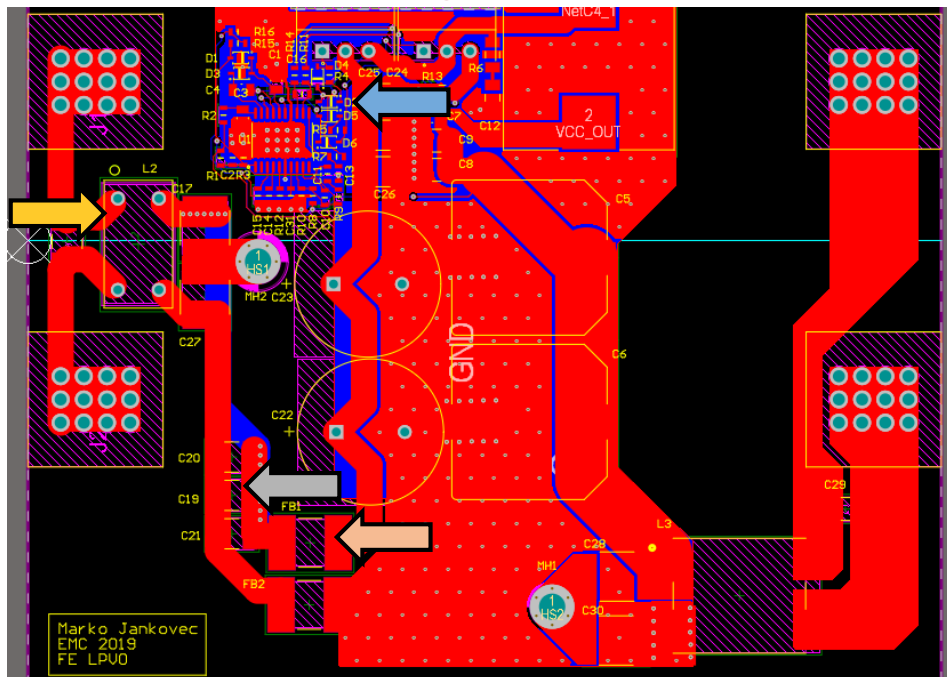
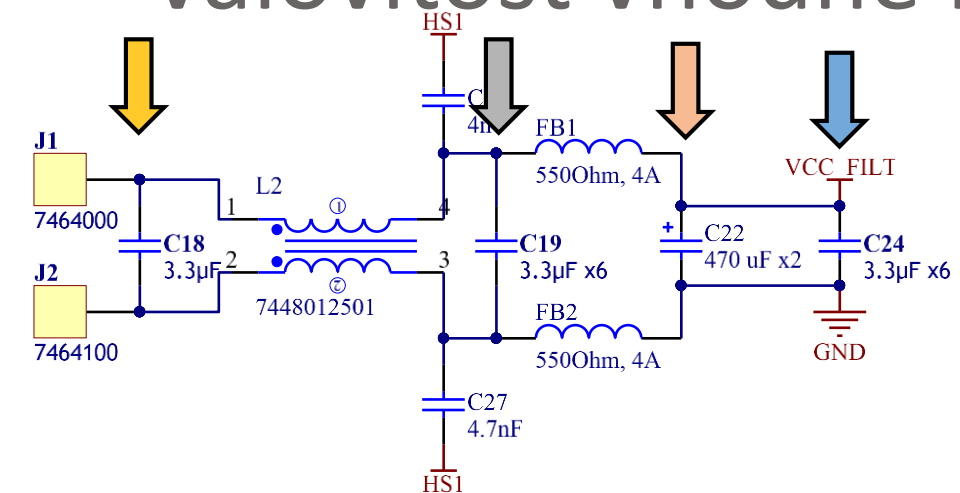
# Stikalno vozlišče



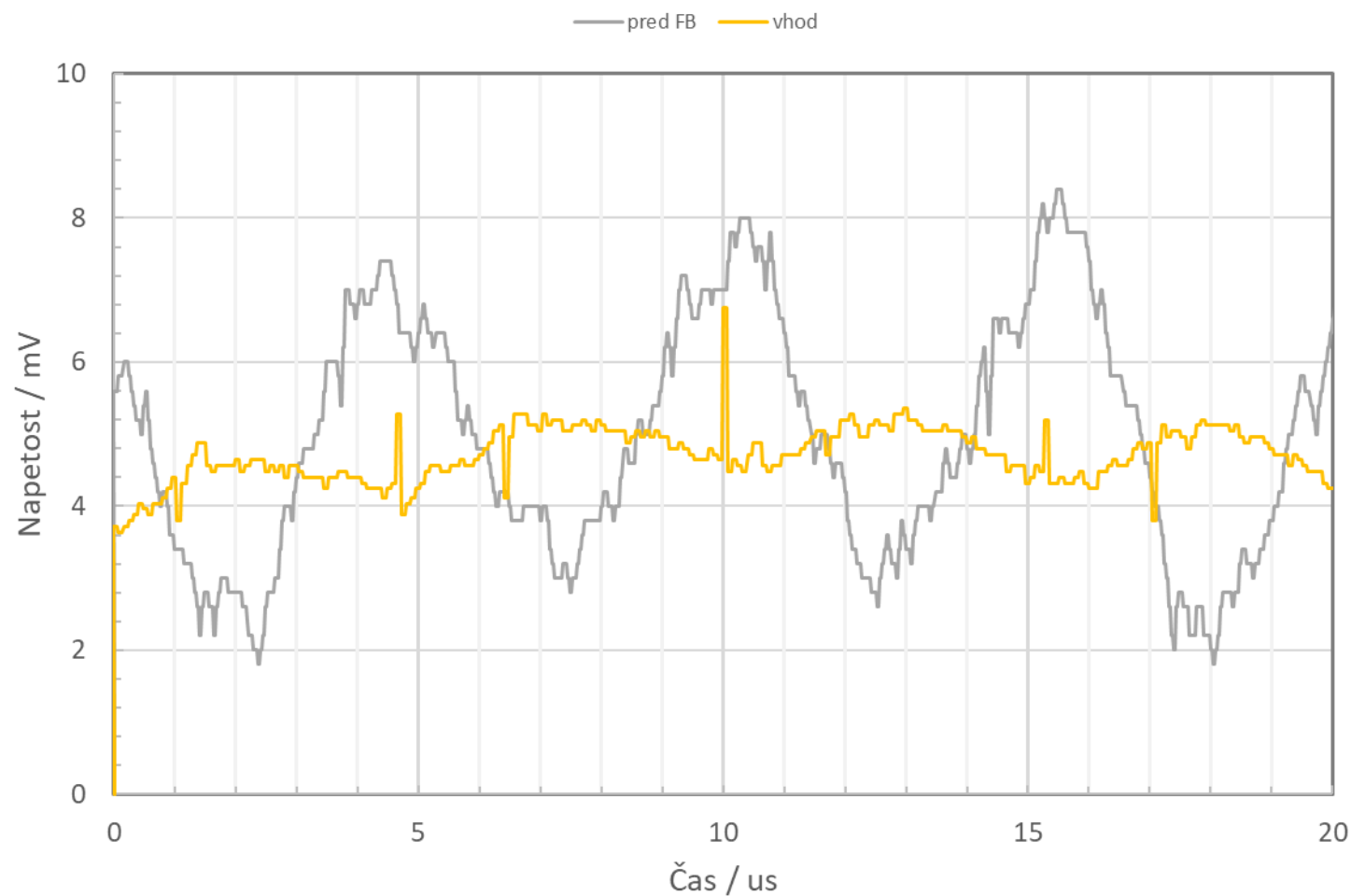
Potek napetosti stikalnega vozlišča pri različnih krmilnih napetostih



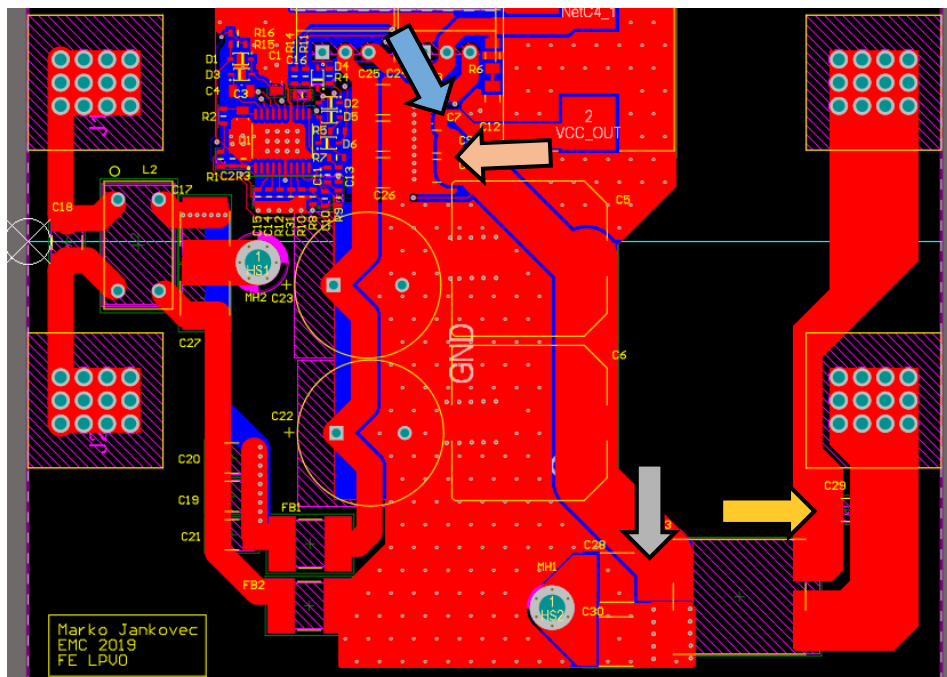
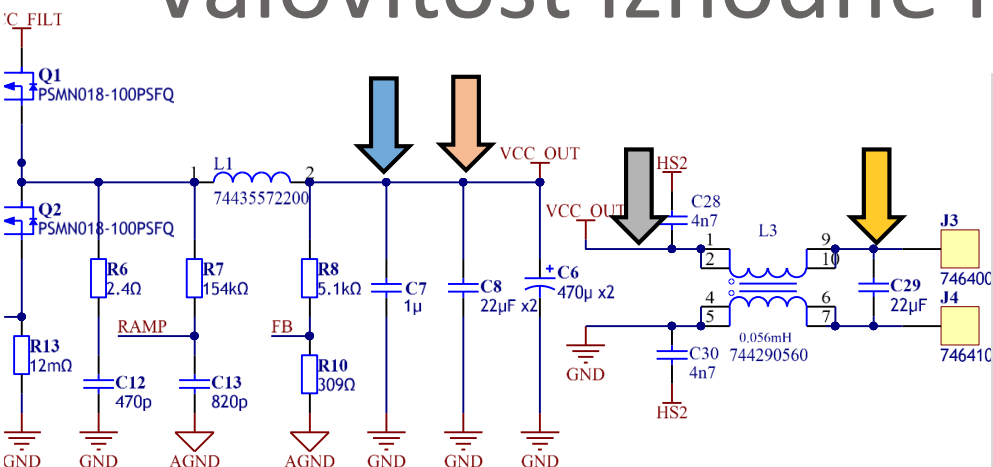
# Valovitost vhodne napetosti



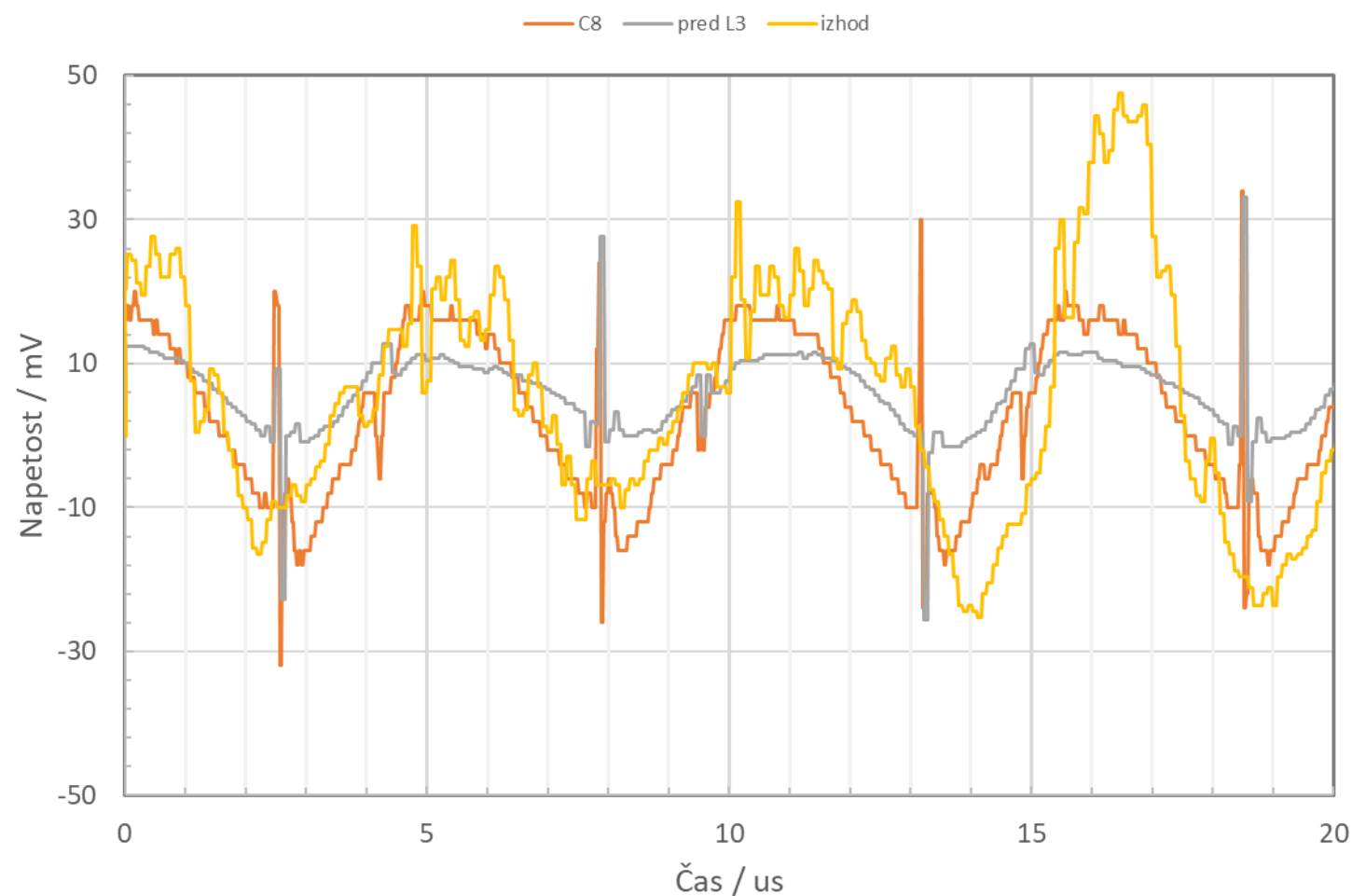
Valovitost vhodne napetosti v različnih točkah (Udrv = 7.5V)



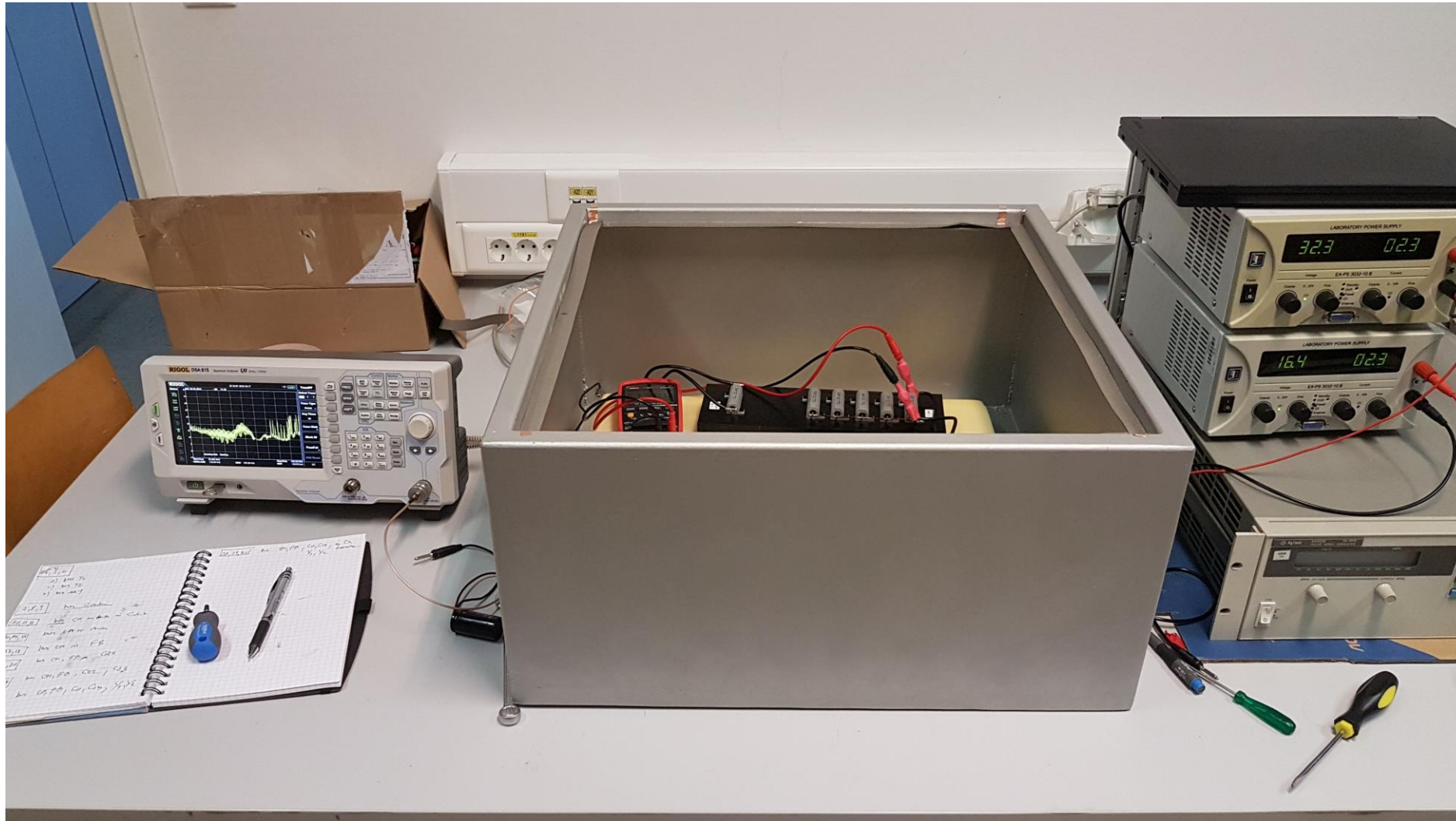
# Valovitost izhodne napetosti



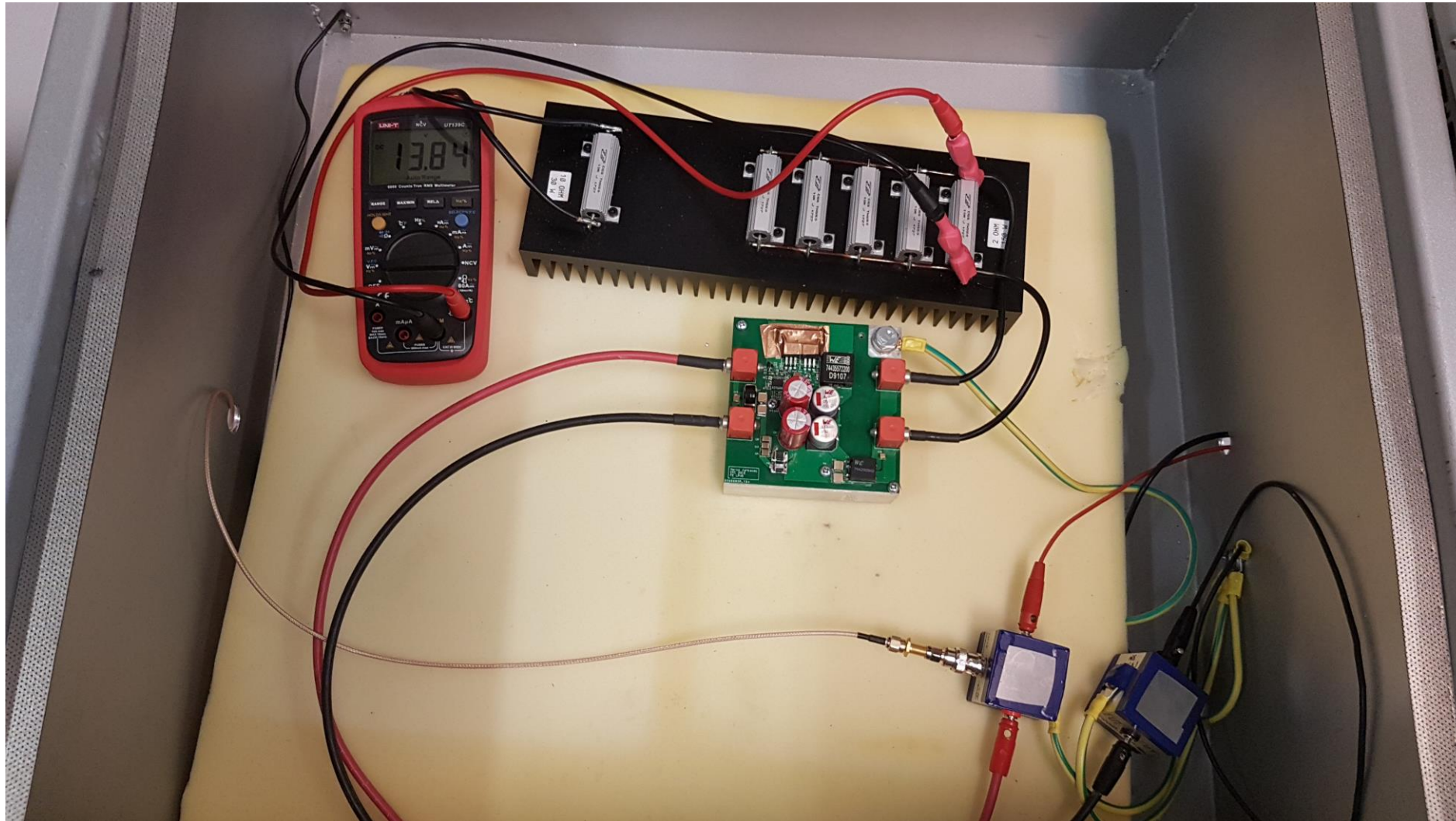
Valovitost izhodne napetosti v različnih točkah



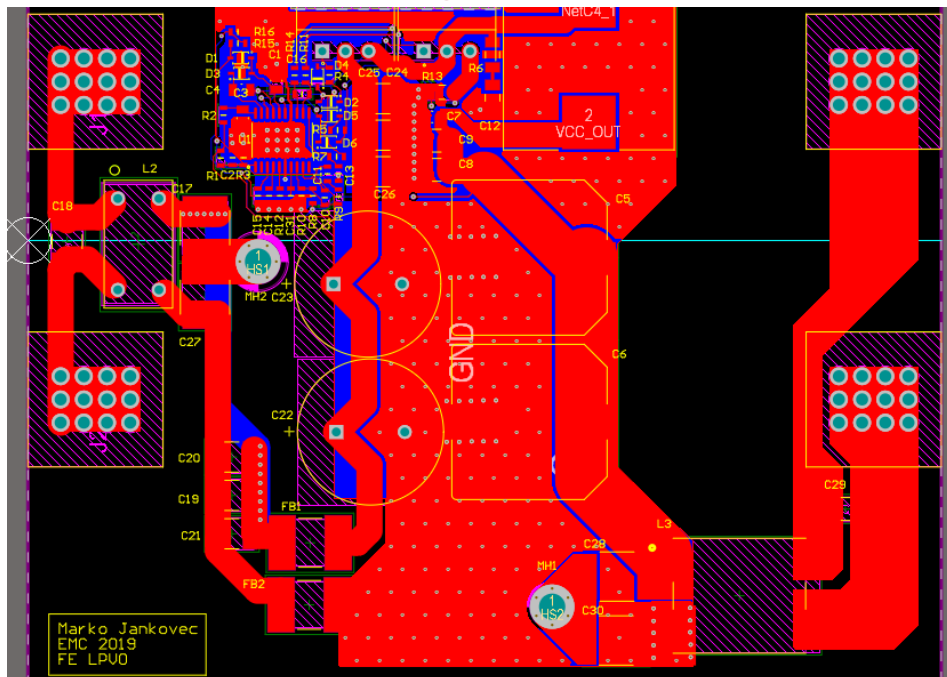
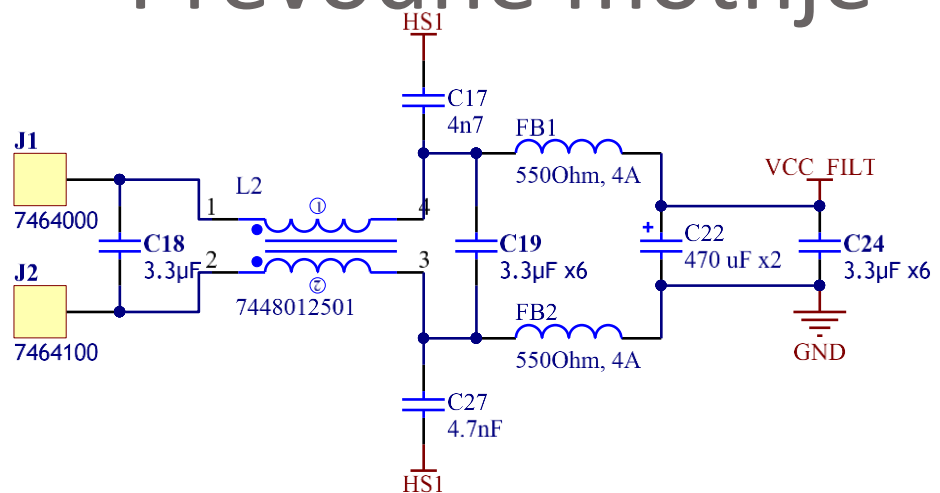
# Merilno mesto za Prevodne motnje



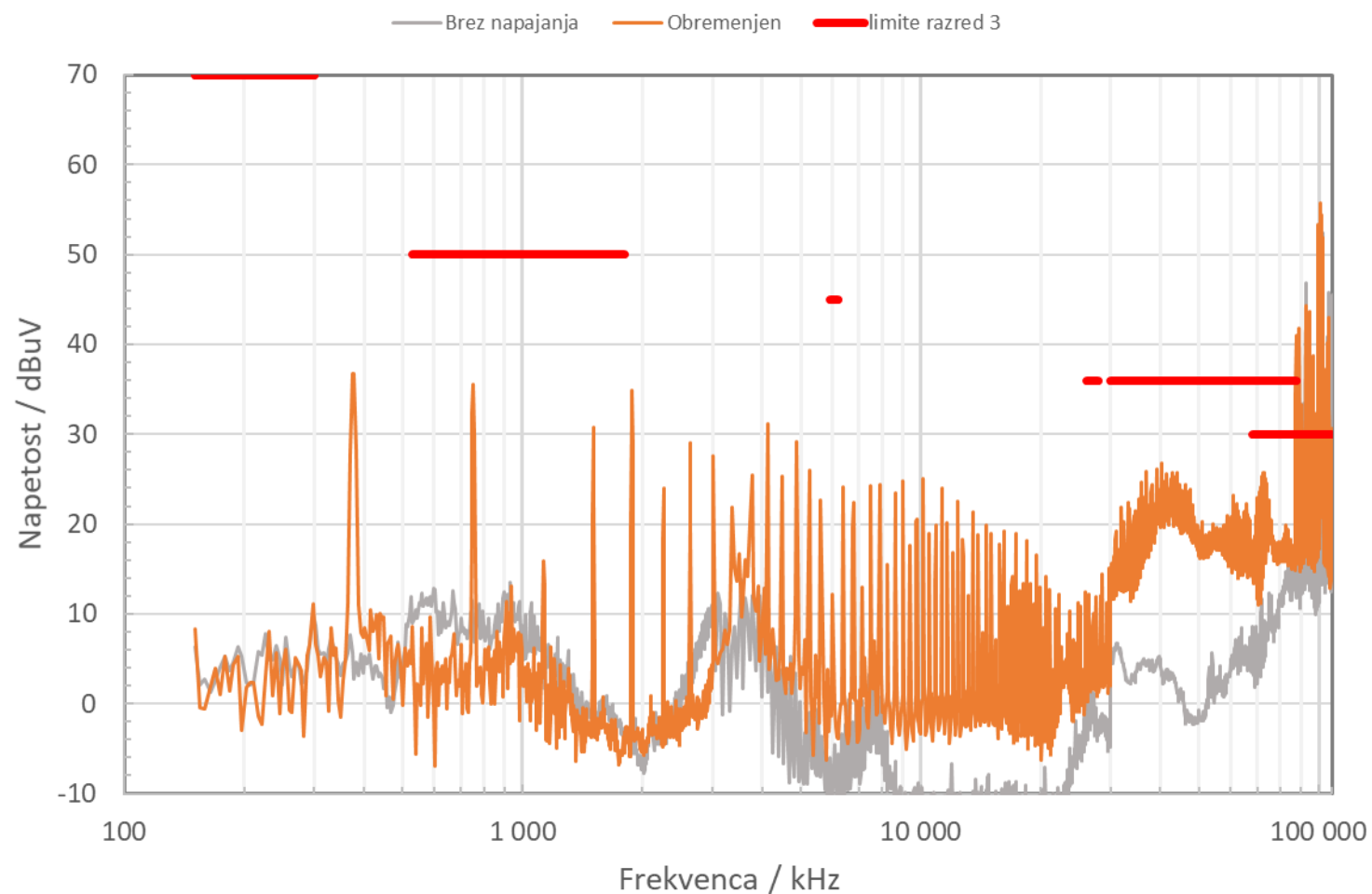
# Merilno mesto za Prevodne motnje



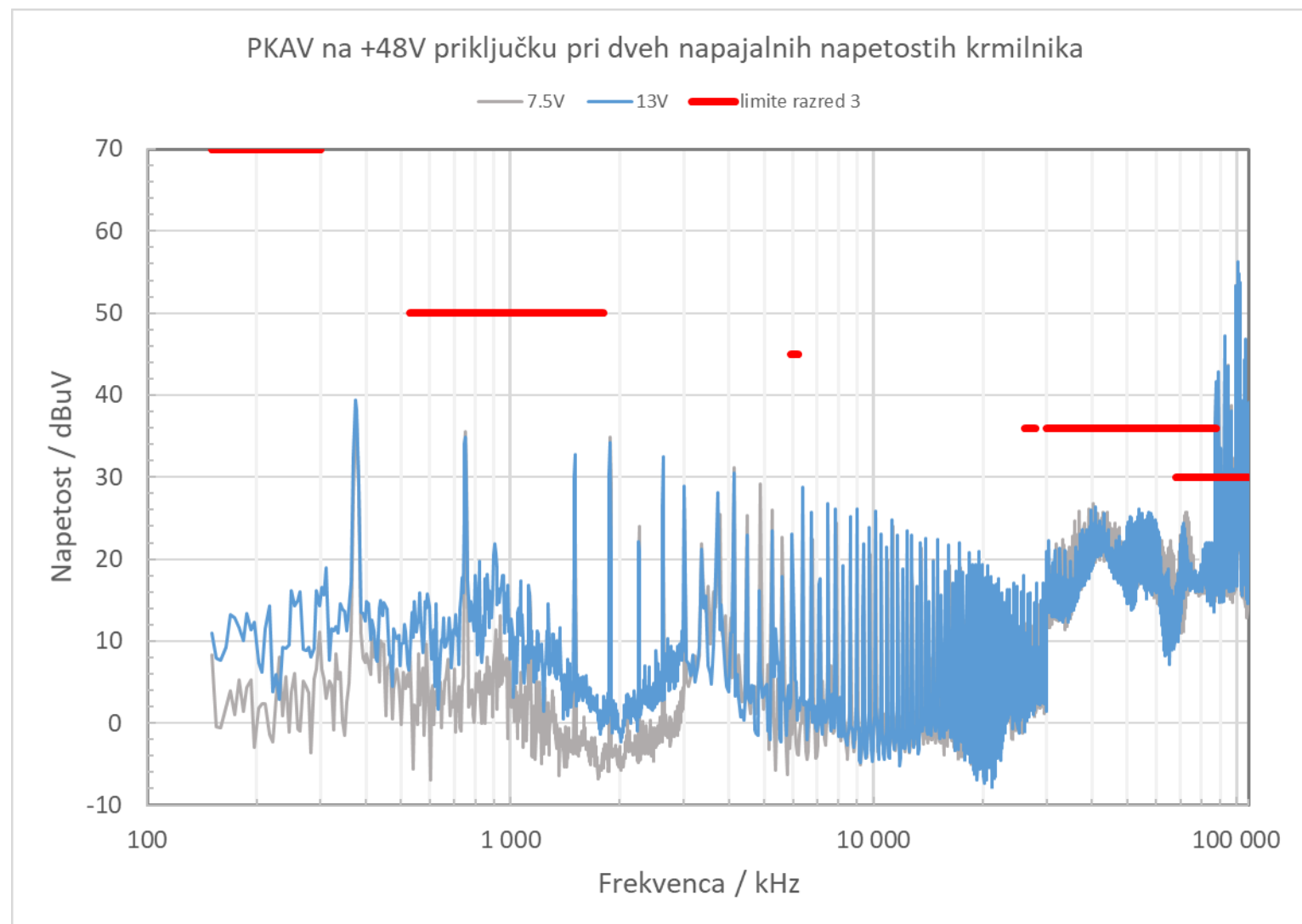
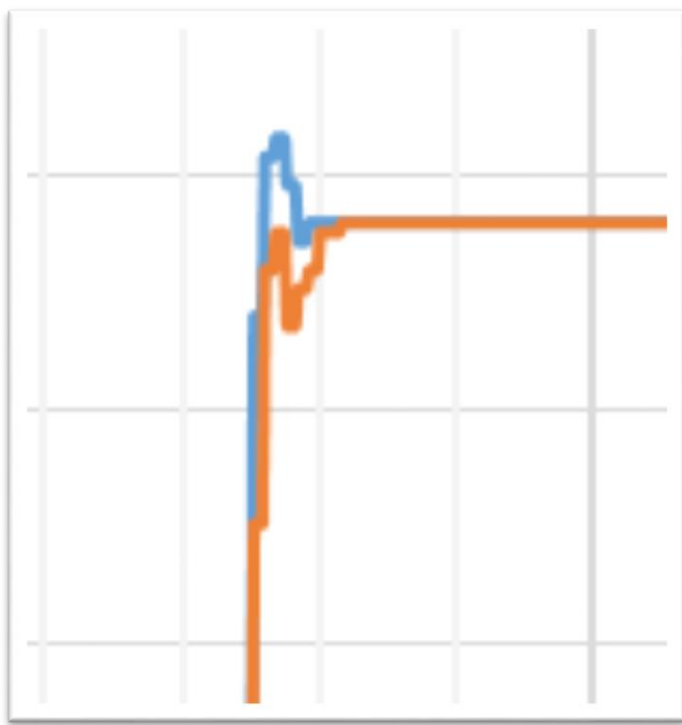
# Prevodne motnje



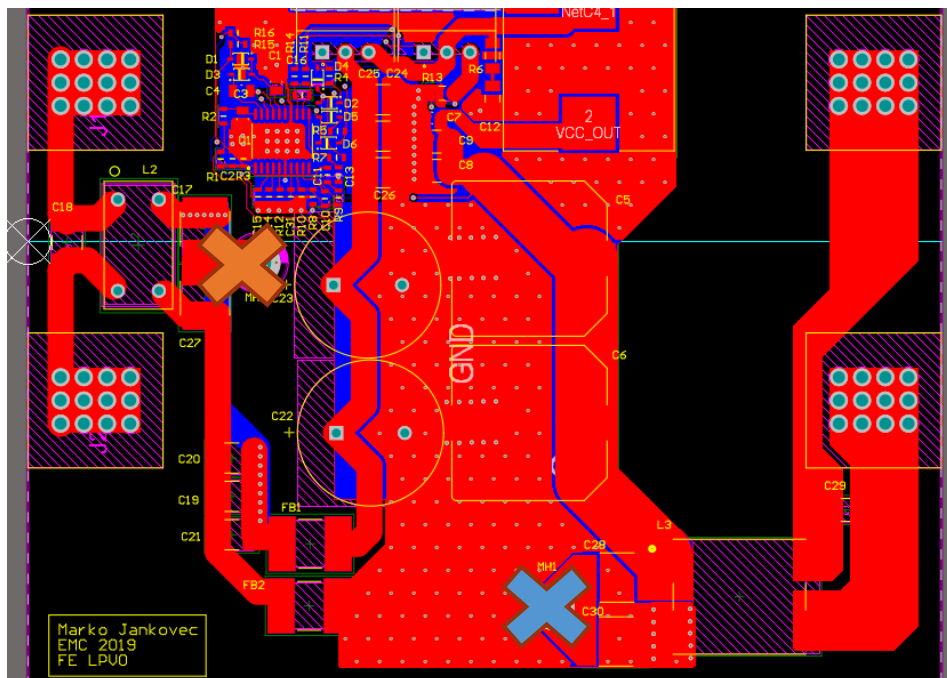
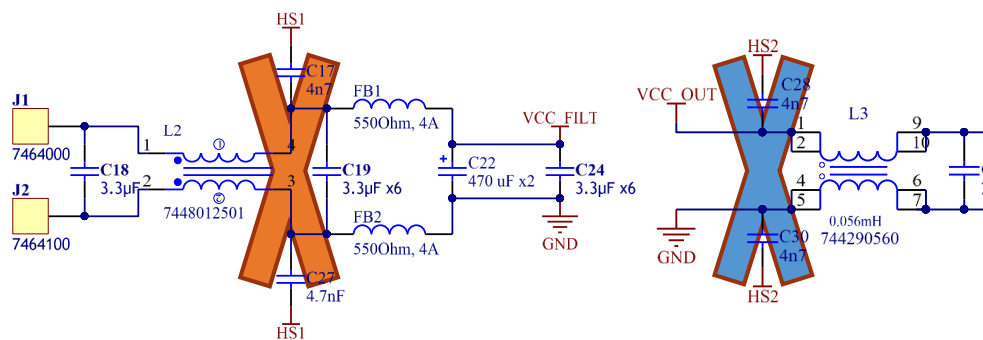
PKAV na +48V priključku pri različnih delovnih točkah pretvornika



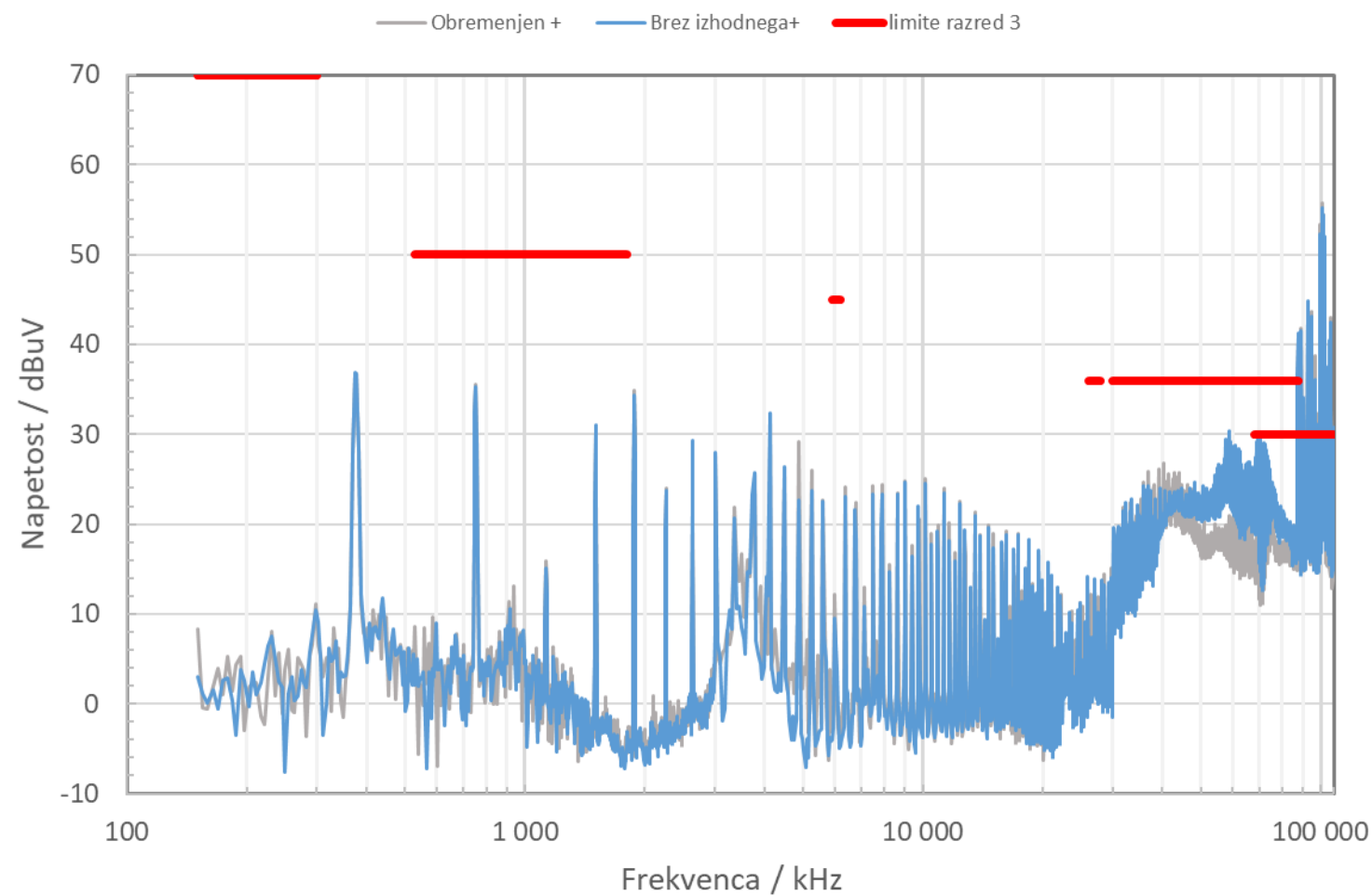
# Prevodne motnje – Vpliv krmilne napetosti



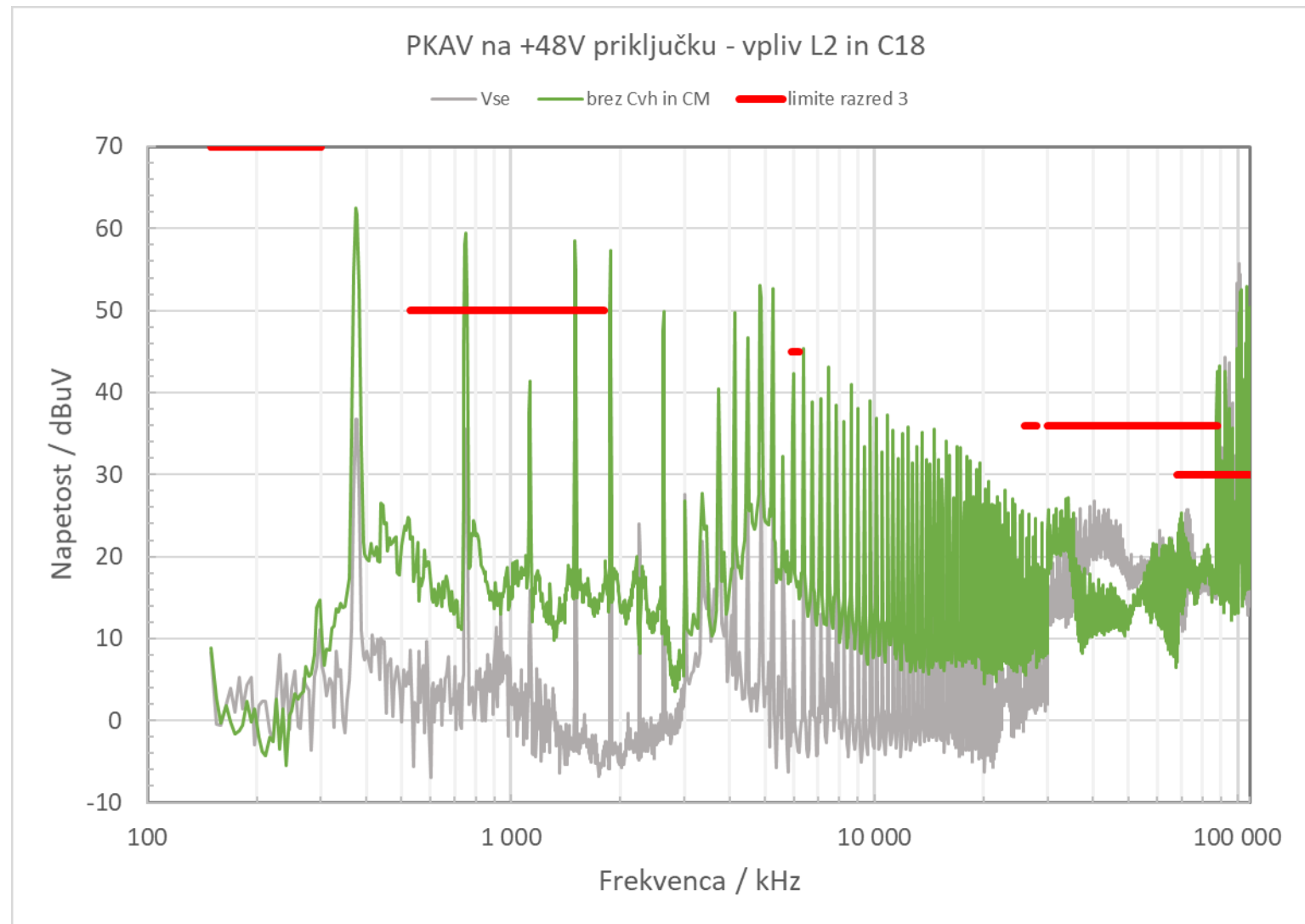
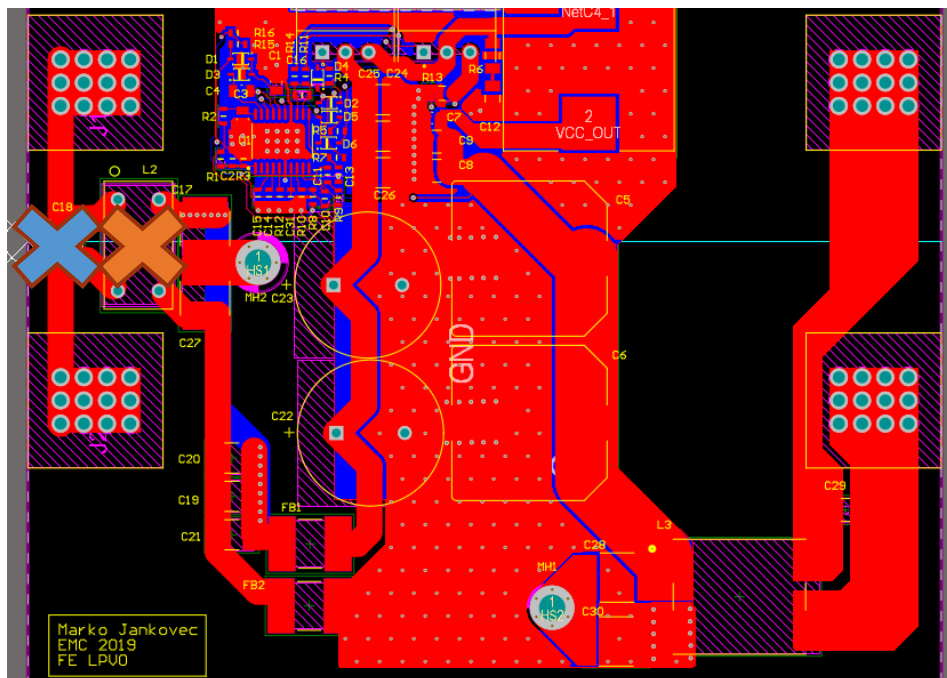
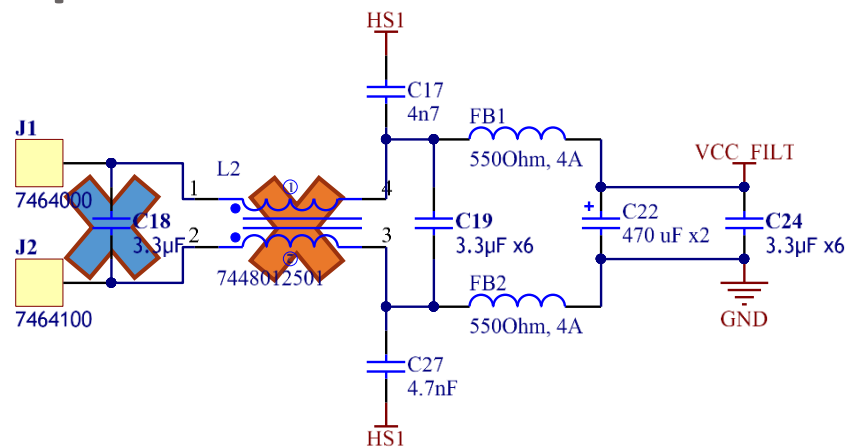
# Vpliv Y kondenzatorjev



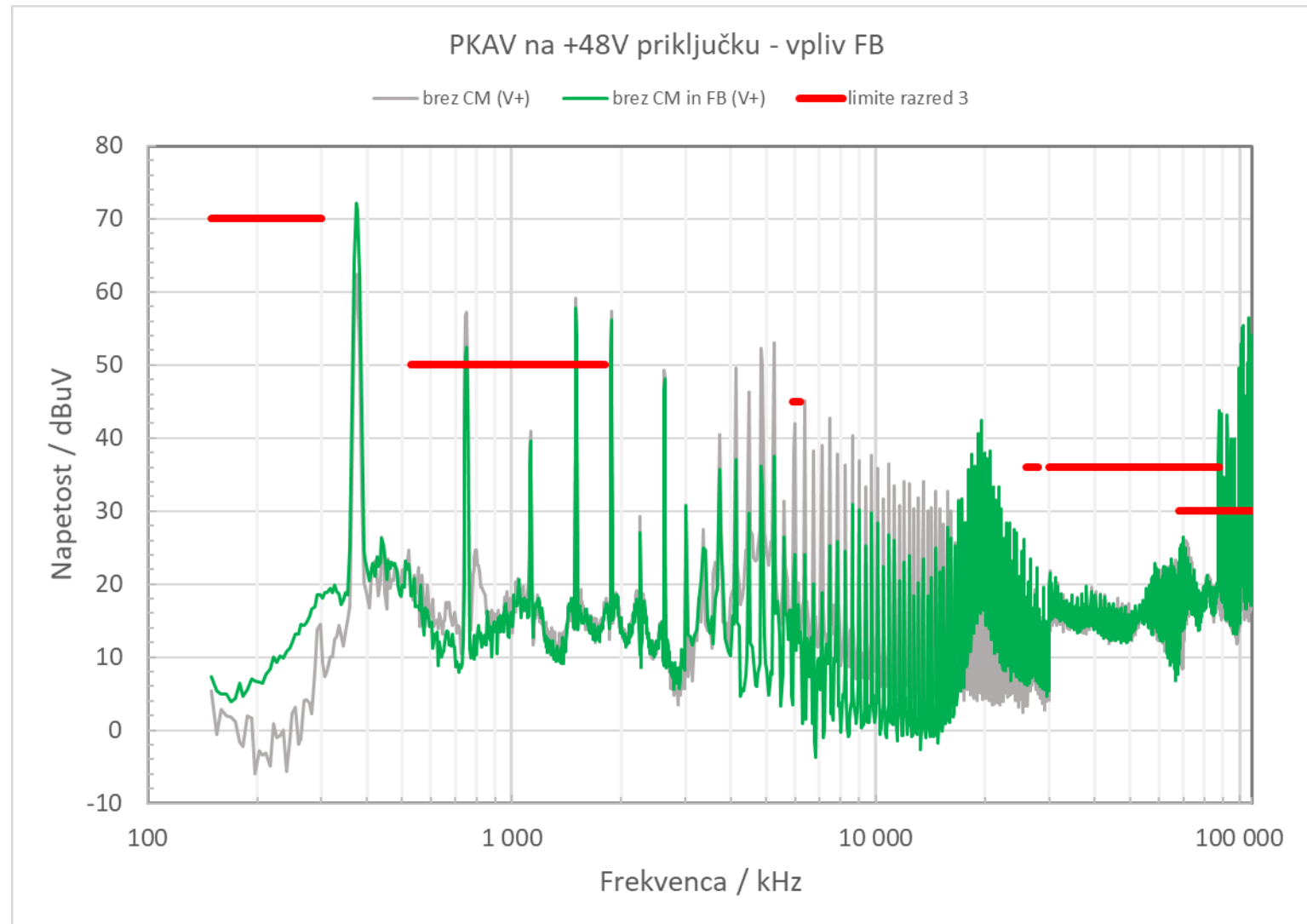
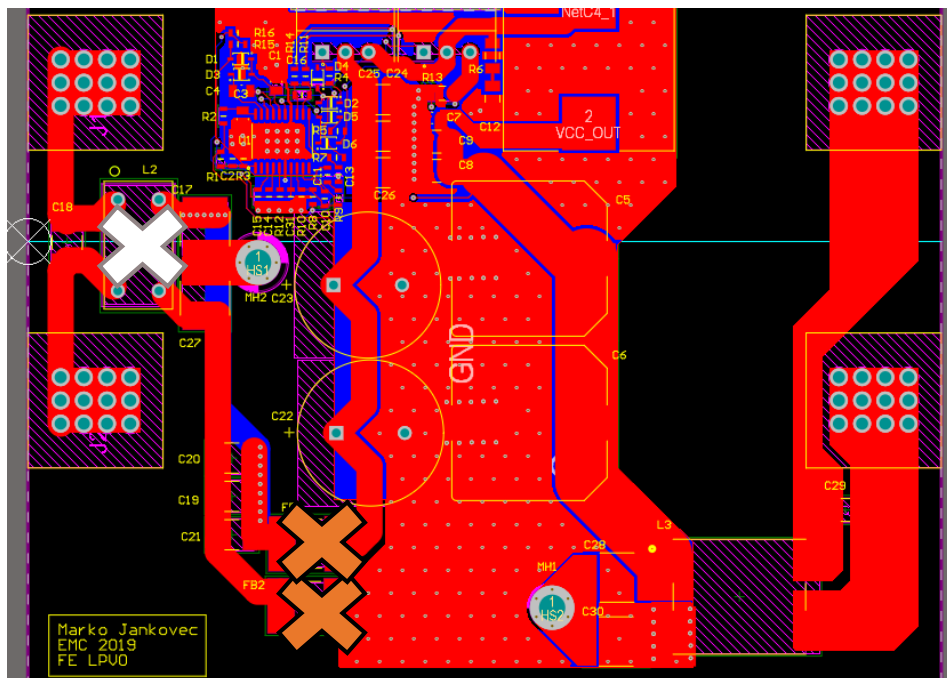
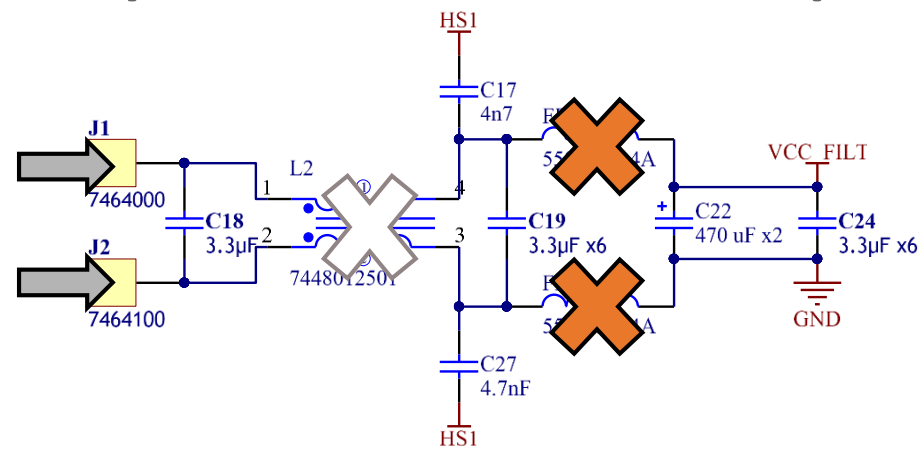
PKAV na +48V priključku pri različnih kombinacijah Y kondenzatorjev



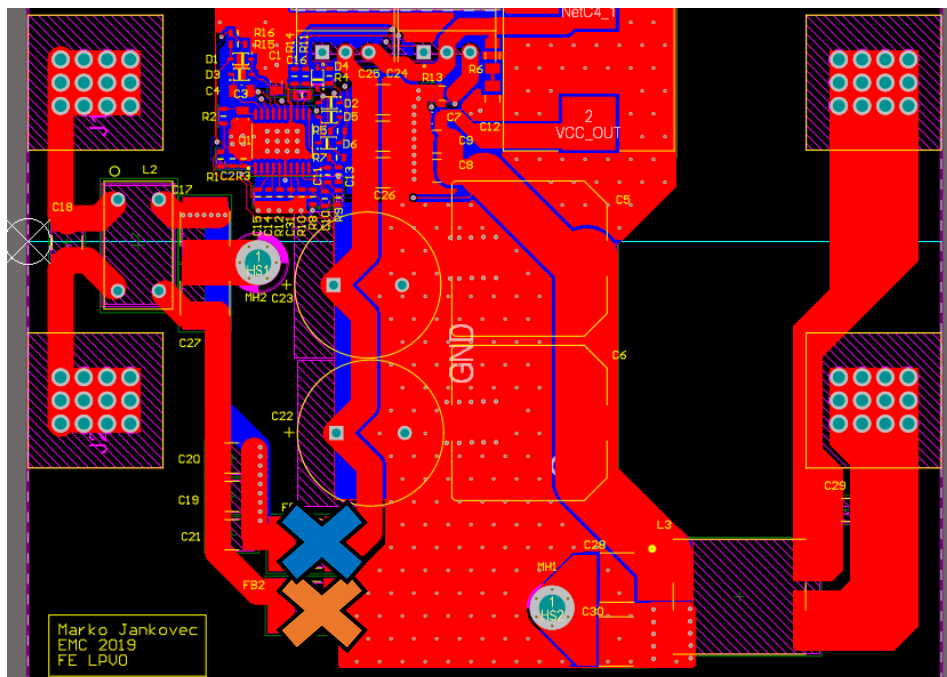
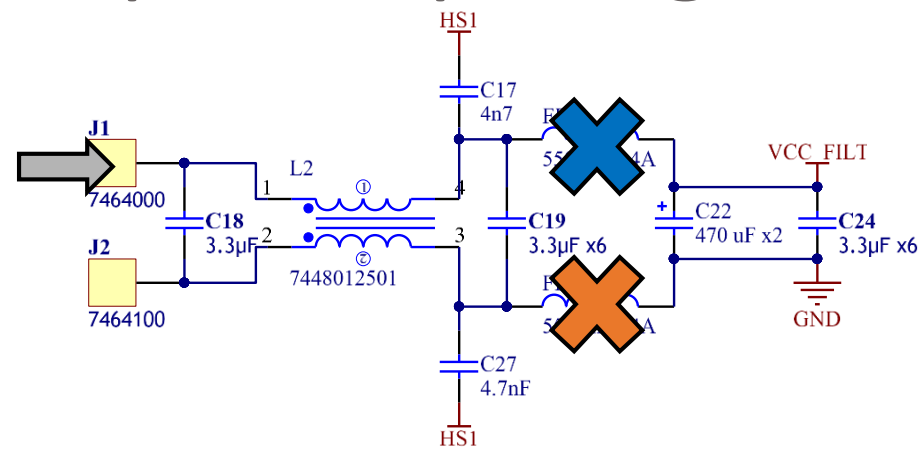
# Vpliv sofazne dušilke L2 in vhodnega kondenzatorja C18



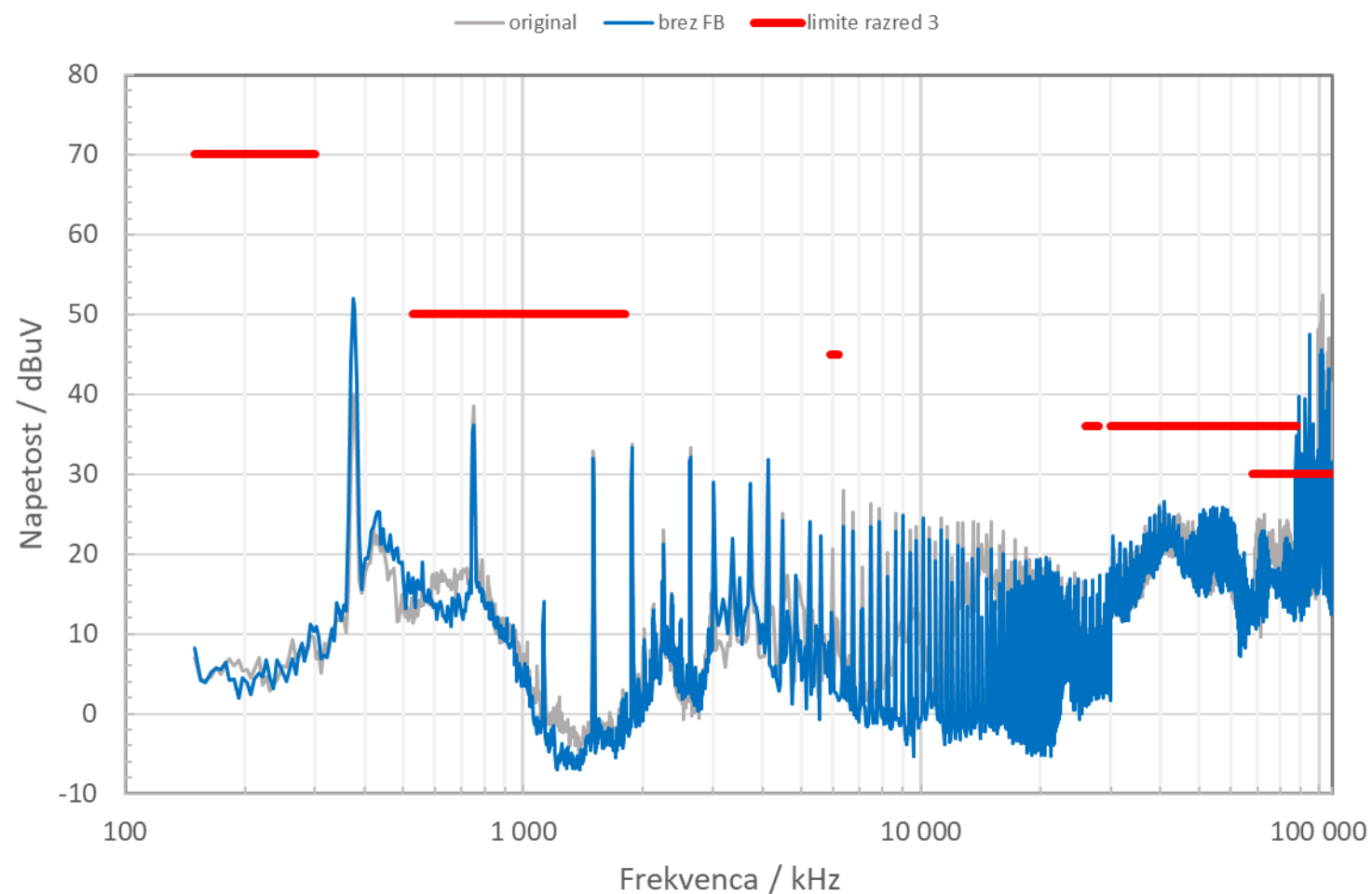
# Vpliv FB na +48V priključku



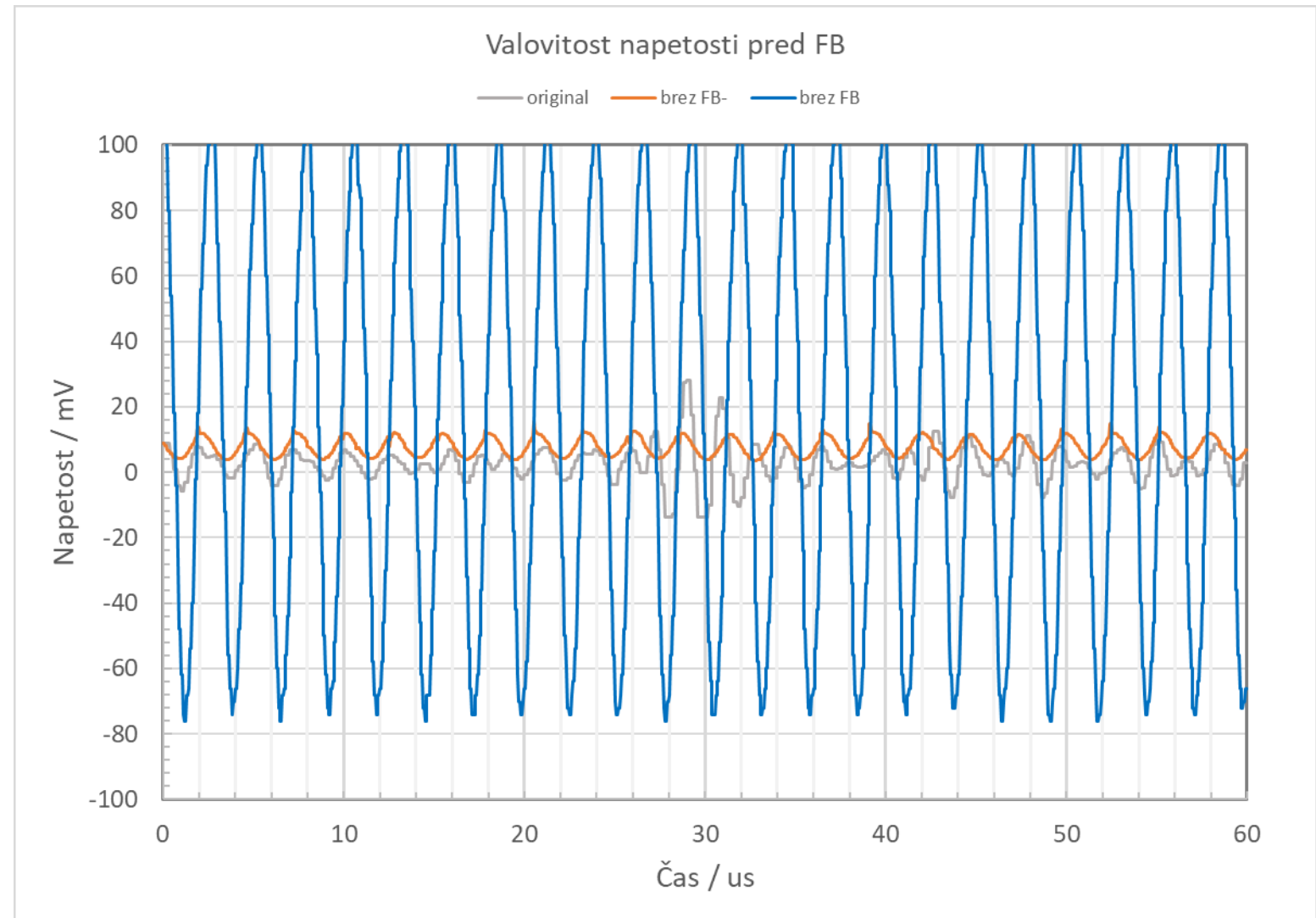
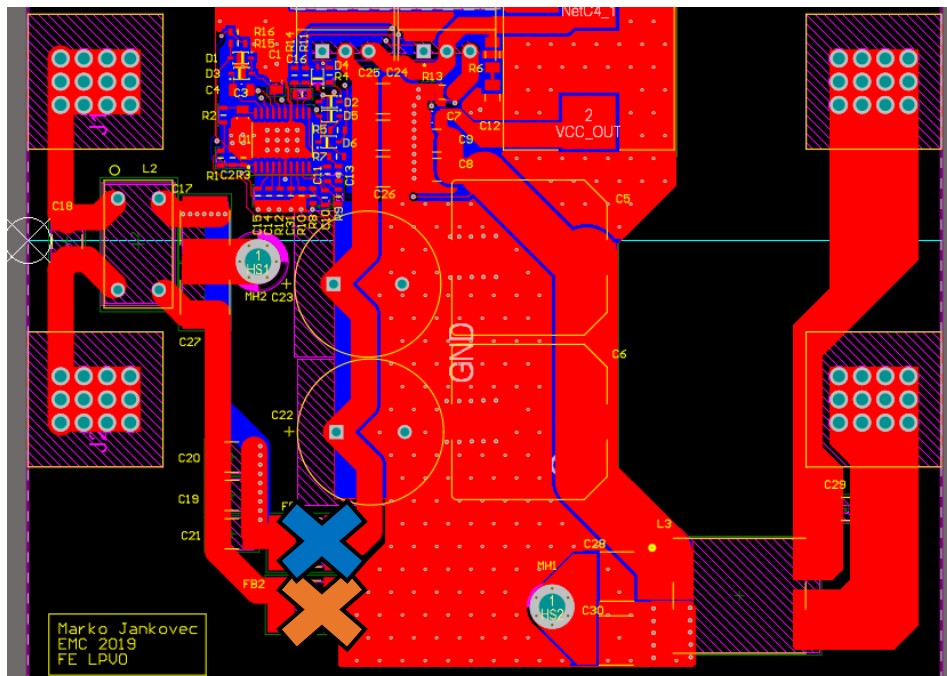
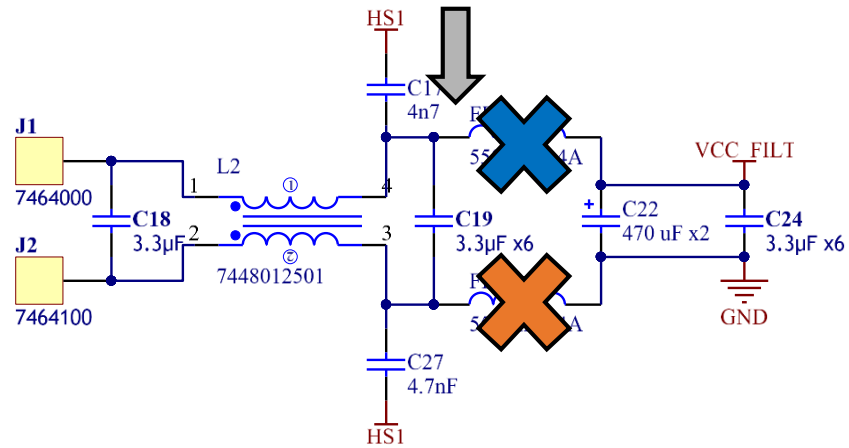
# Vpliv FB pri originalnem vezju



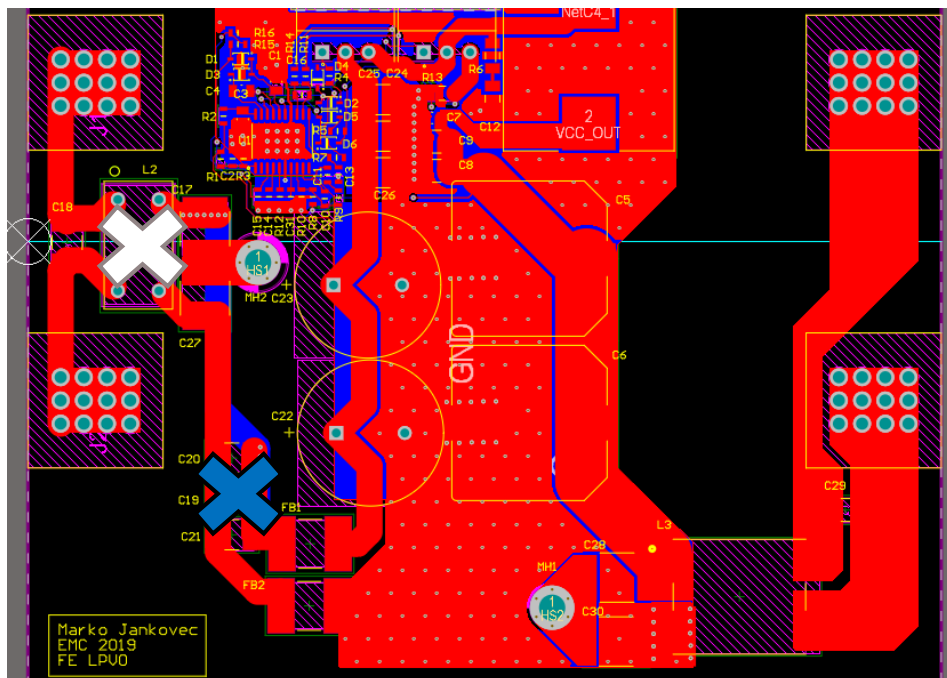
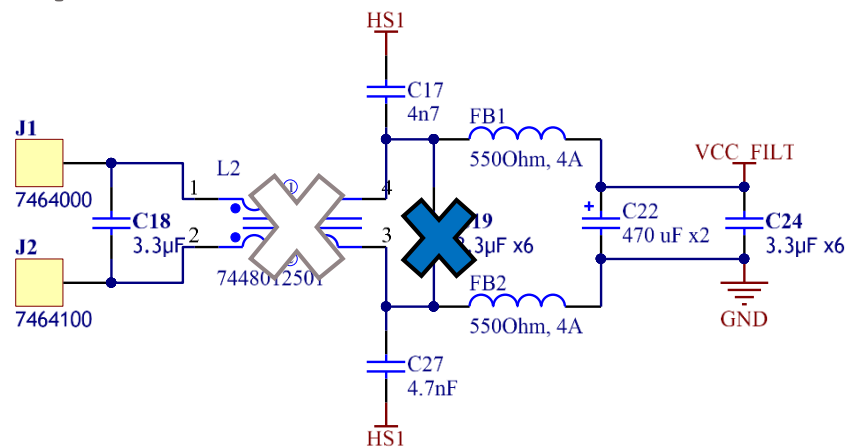
PKAV na +48V priključku - original vezje vpliv FB



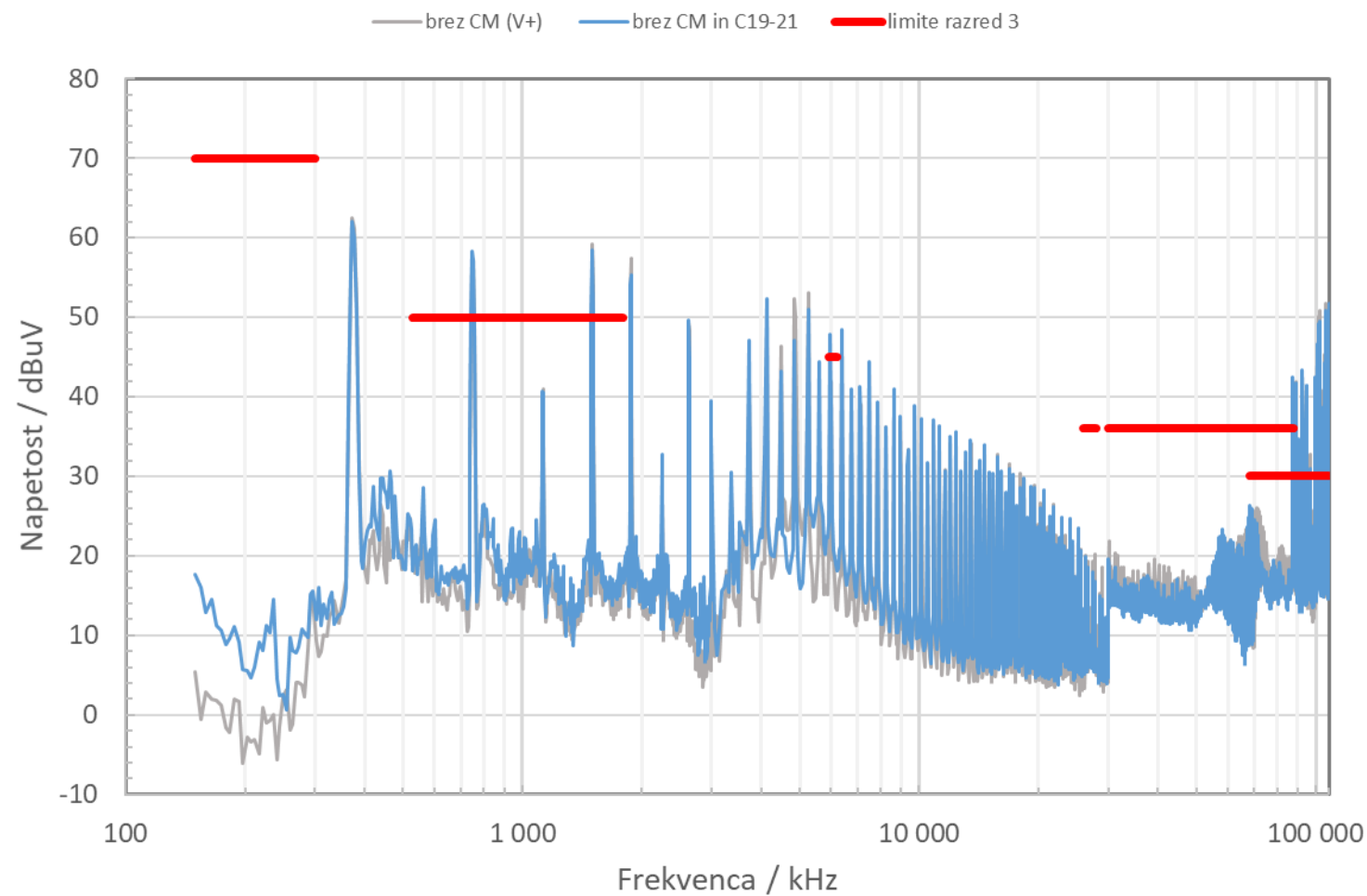
# Vpliv FB pri originalnem vezju



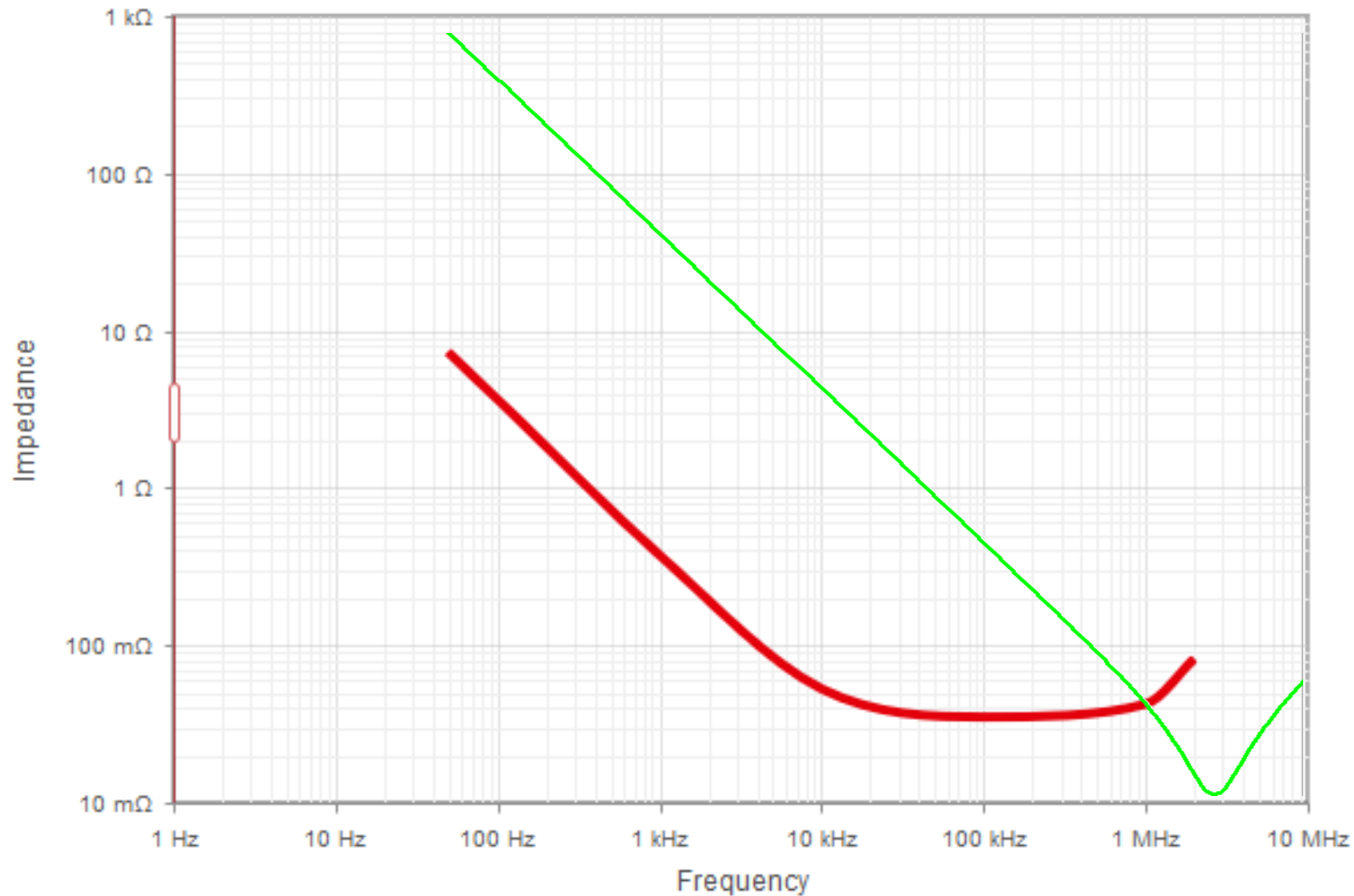
# Vpliv C19



### PKAV na +48V priključku - vpliv C19



# Vpliv C22 (elco) in C24 (keramika)



# Vpliv C22 (elco) in C24 (keramika)

