

Študentska delavnica in tekmovanje

Načrtovanje elektronike za EMC²



MAHLE



TEXAS INSTRUMENTS



MULTILUX



Univerza v Ljubljani
Fakulteta za elektrotehniko

Katedra za elektroniko



Laboratorij za fotovoltaiko
in optoelektroniko

Analiza rezultatov tekmovanja Zaključek delavnice

Marko Jankovec, Dorijan Morelji

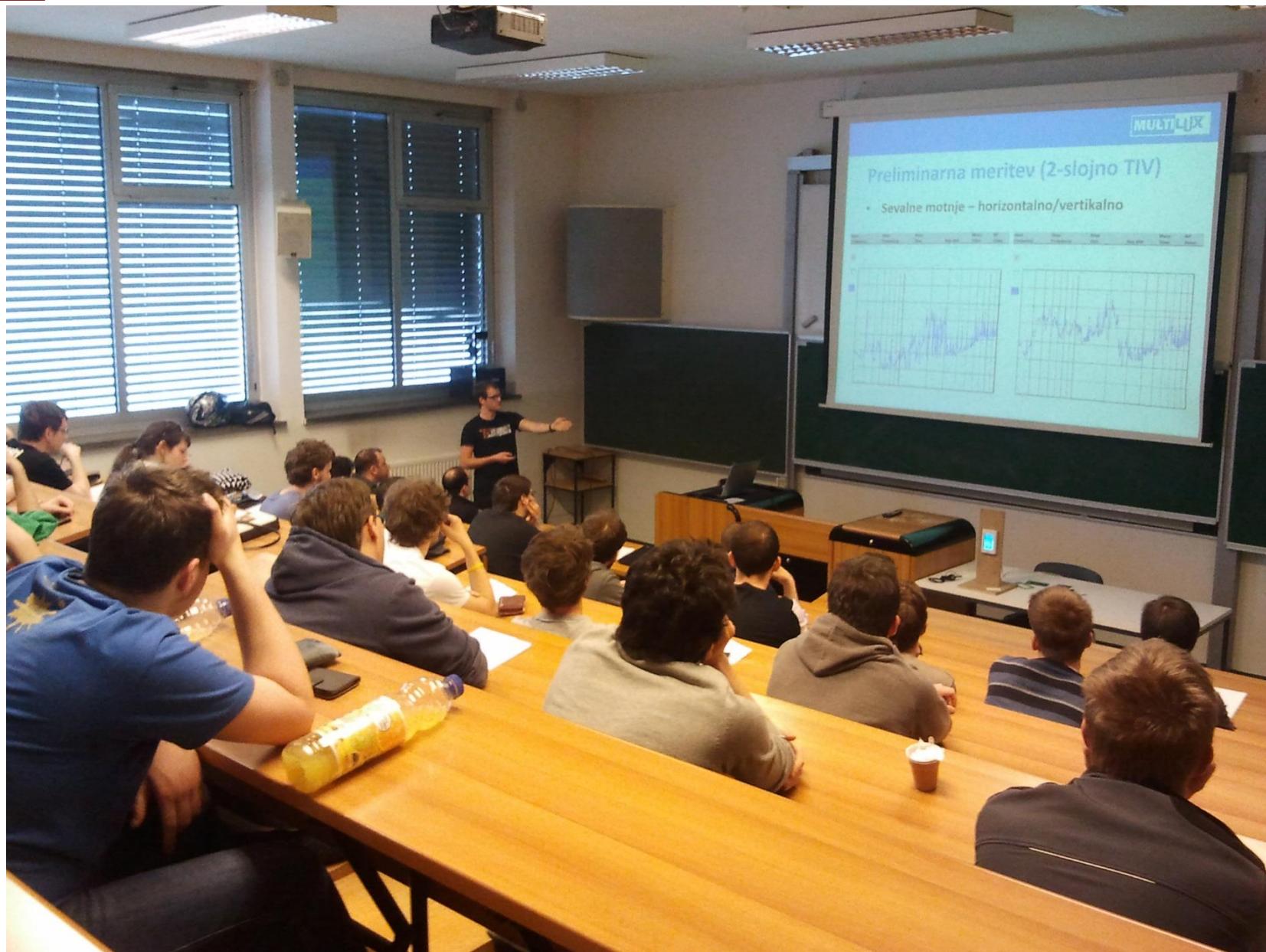




Predavanja



Predavanja



Obisk SIQ

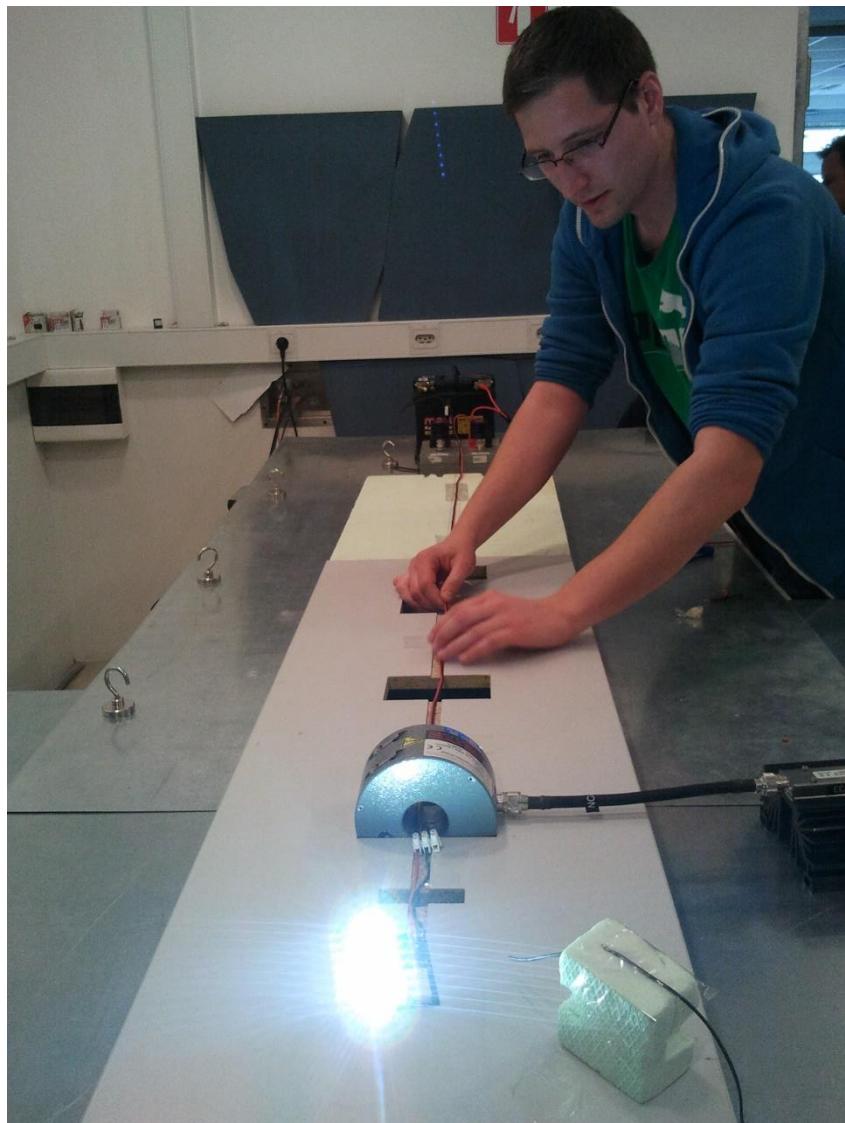


Obisk SIQ



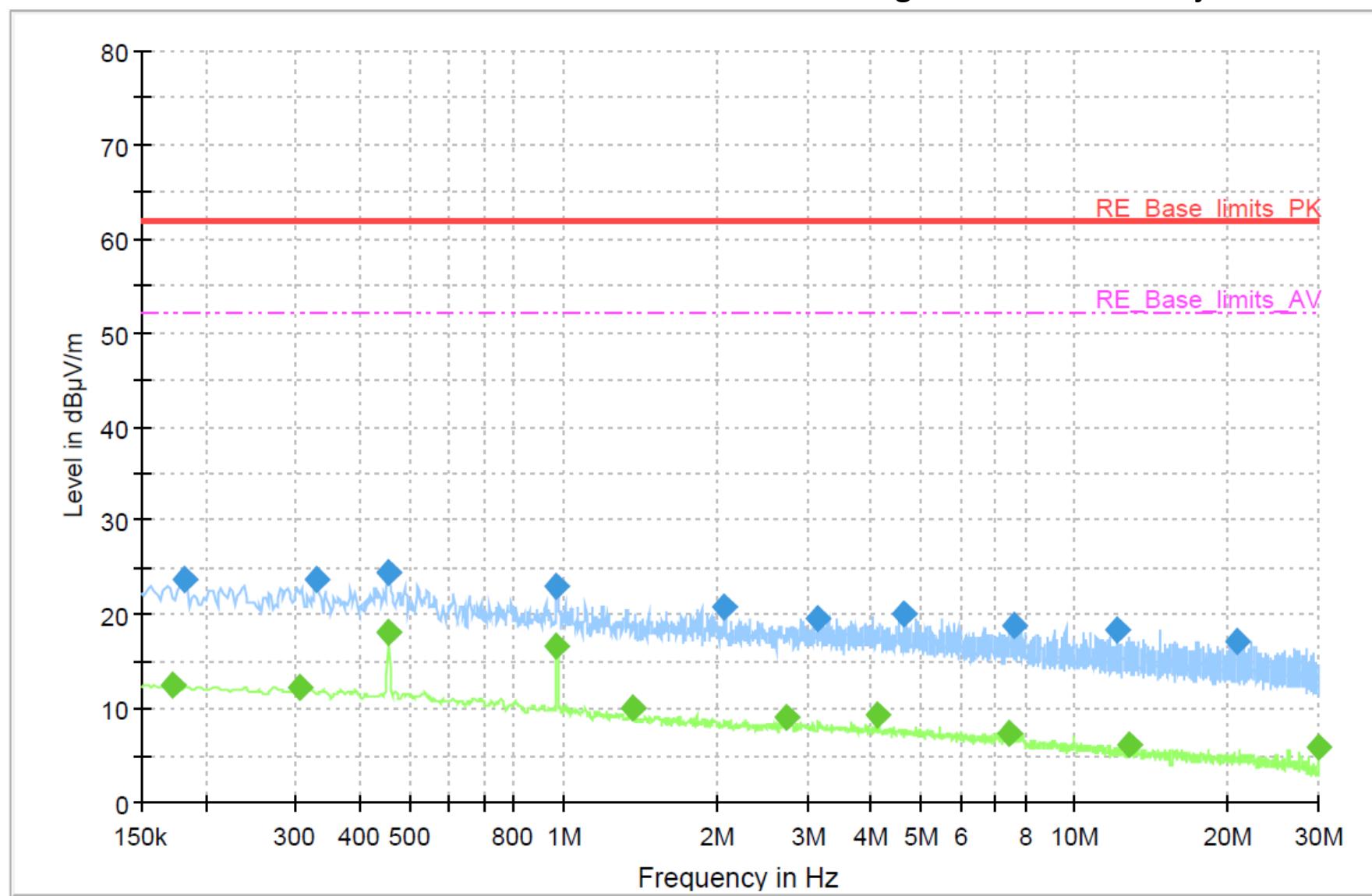
Obisk SIQ



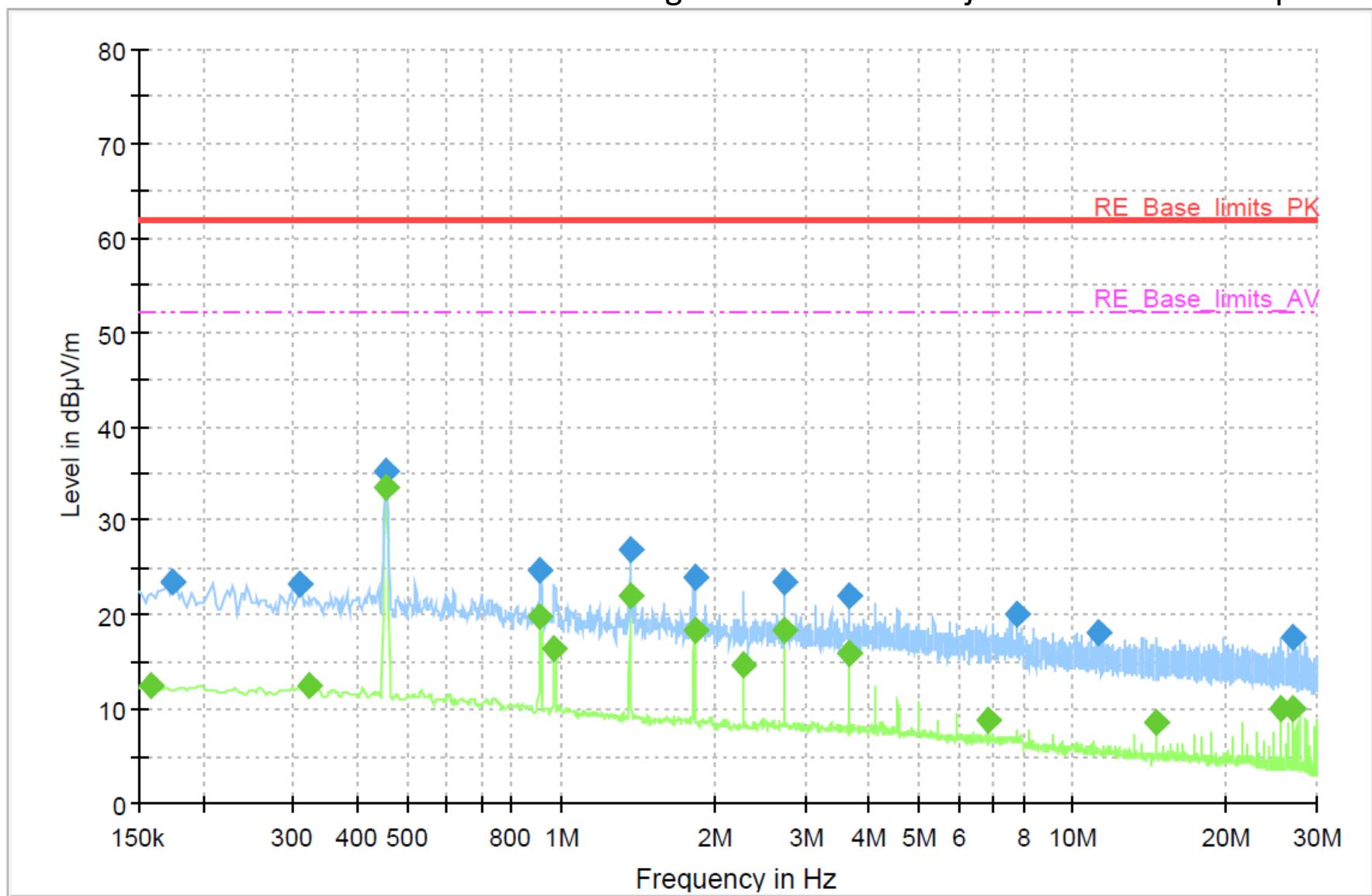


Prvi rezultati – RE30MHz

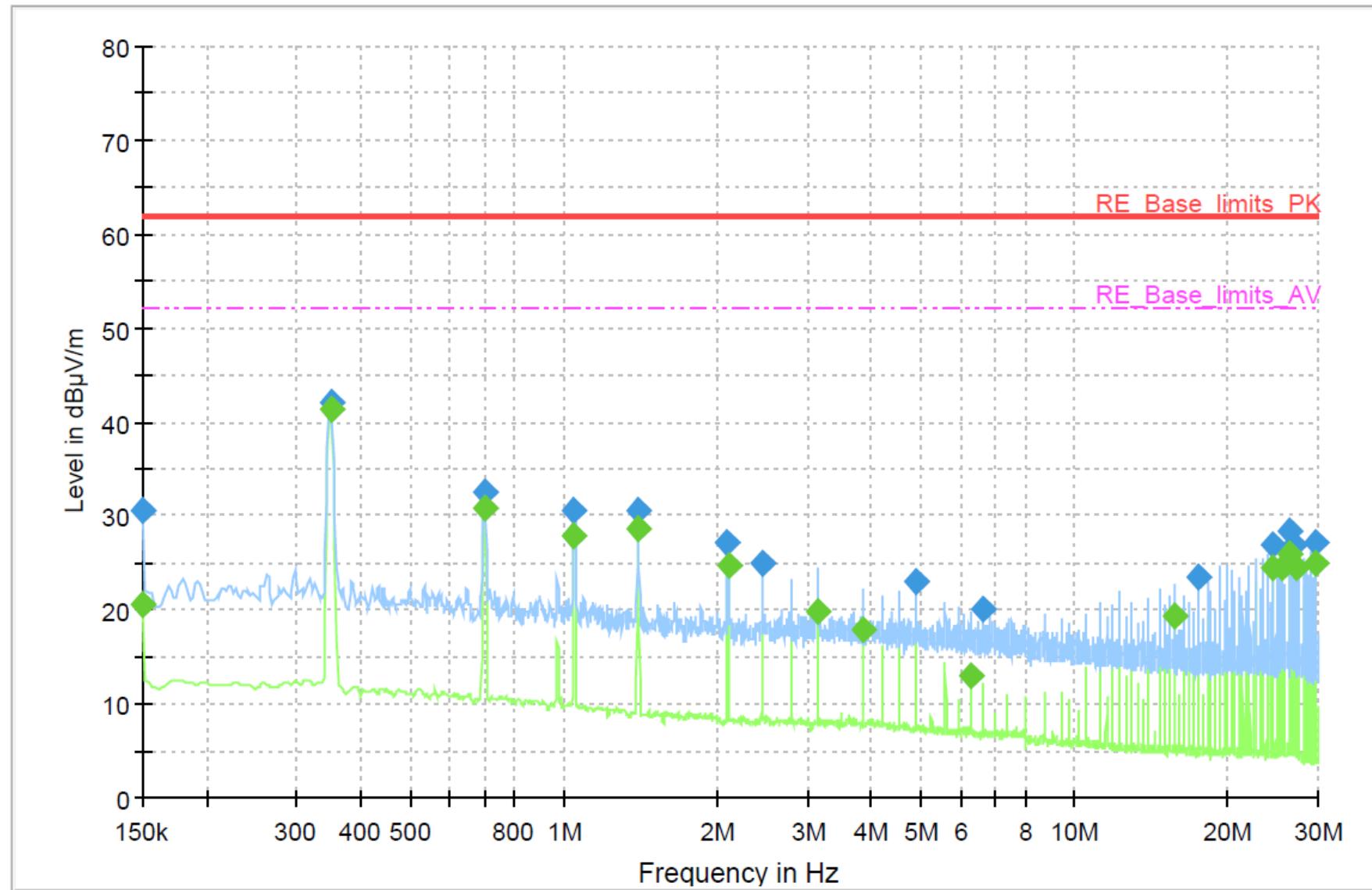
Urban Gregorc - Sevalne motnje do 30 MHz



Urban Gregorc - Sevalne motnje do 30 MHz – brez pokrova

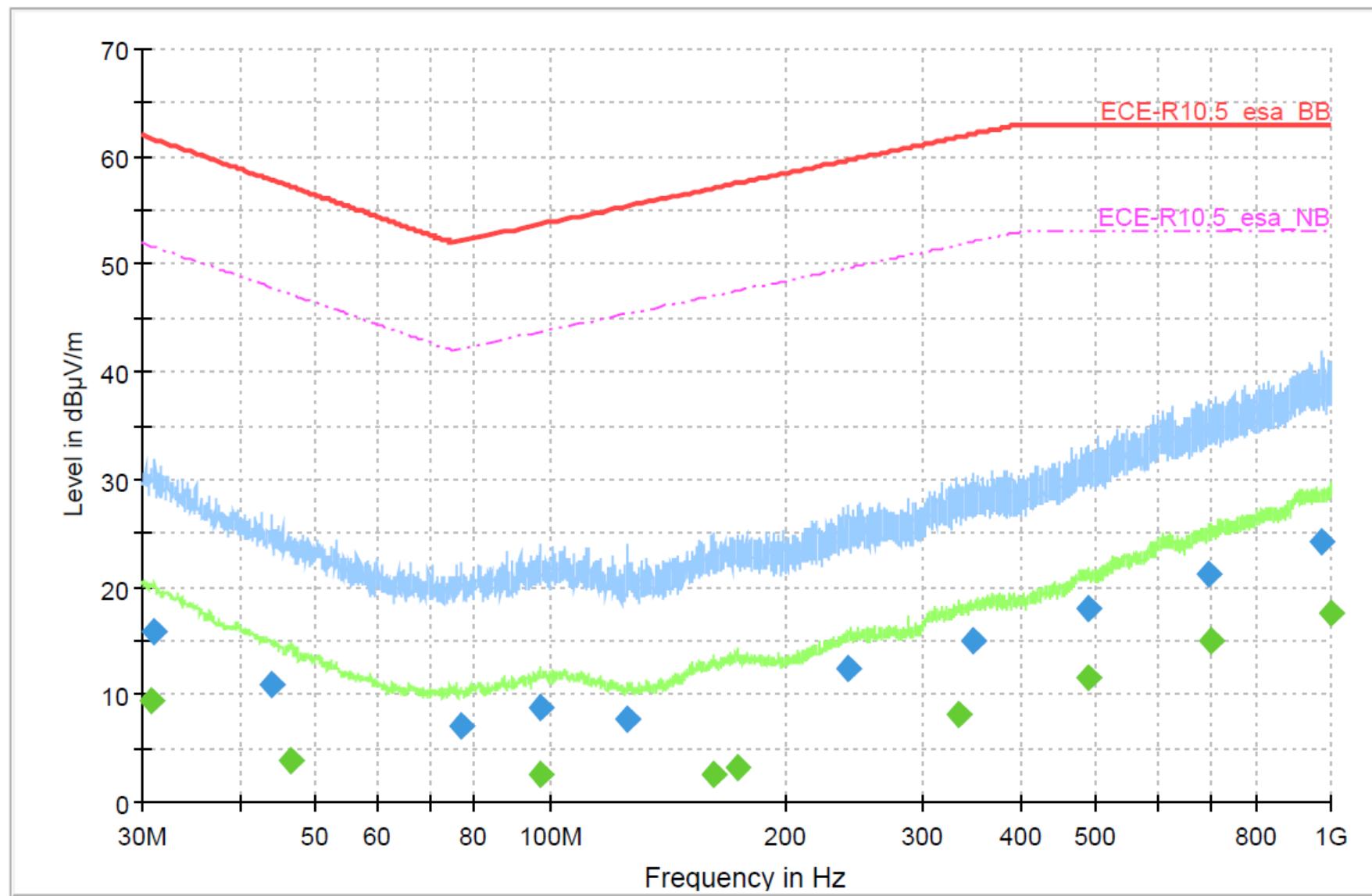


Matjaž Tome - Sevalne motnje do 30 MHz



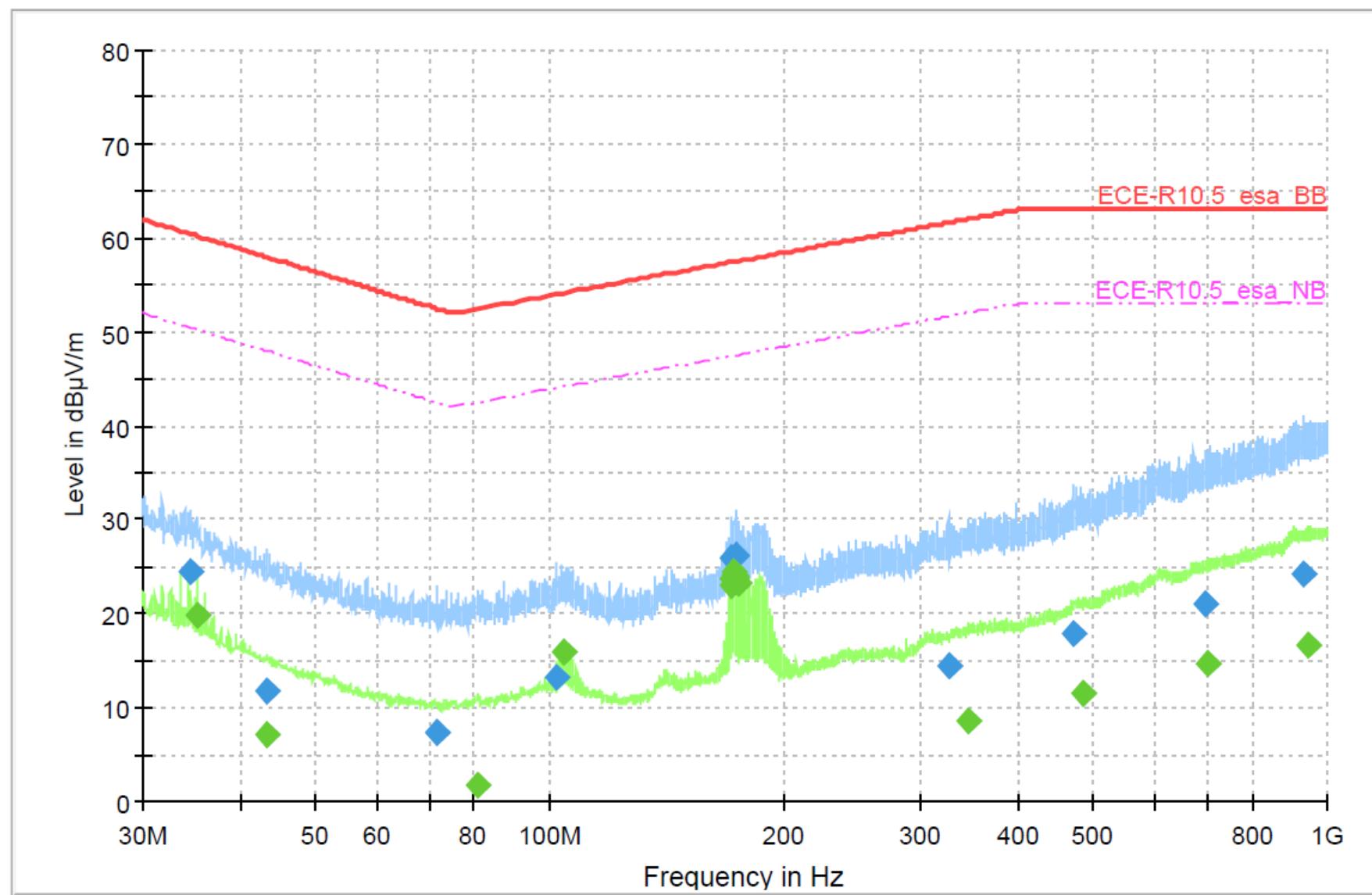
Prvi rezultati – RE1GHz

Urban Gregorc - Sevalne motnje do 1 GHz



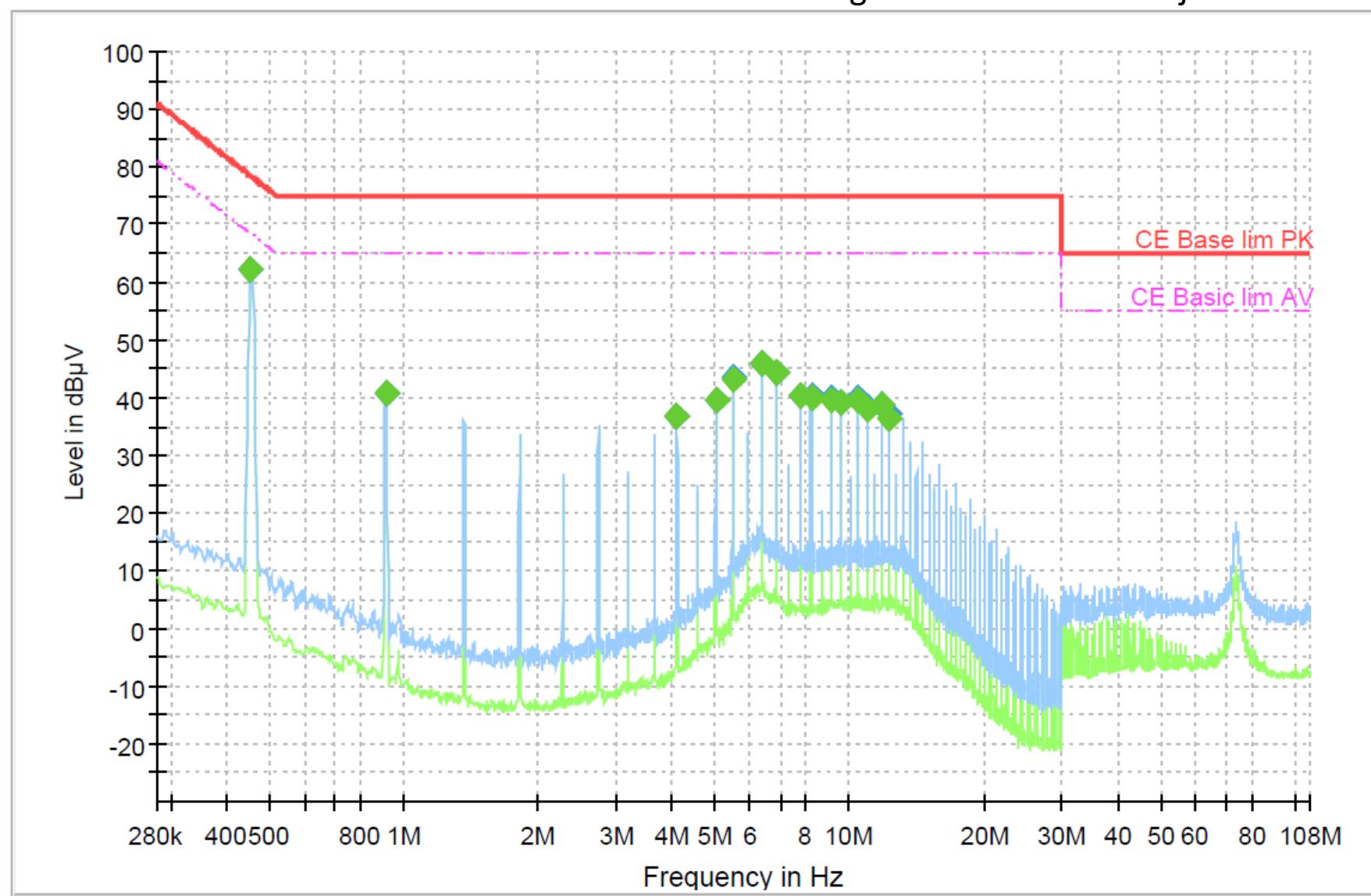
Prvi rezultati – RE1GHz

Matjaž Tome - Sevalne motnje do 1 GHz



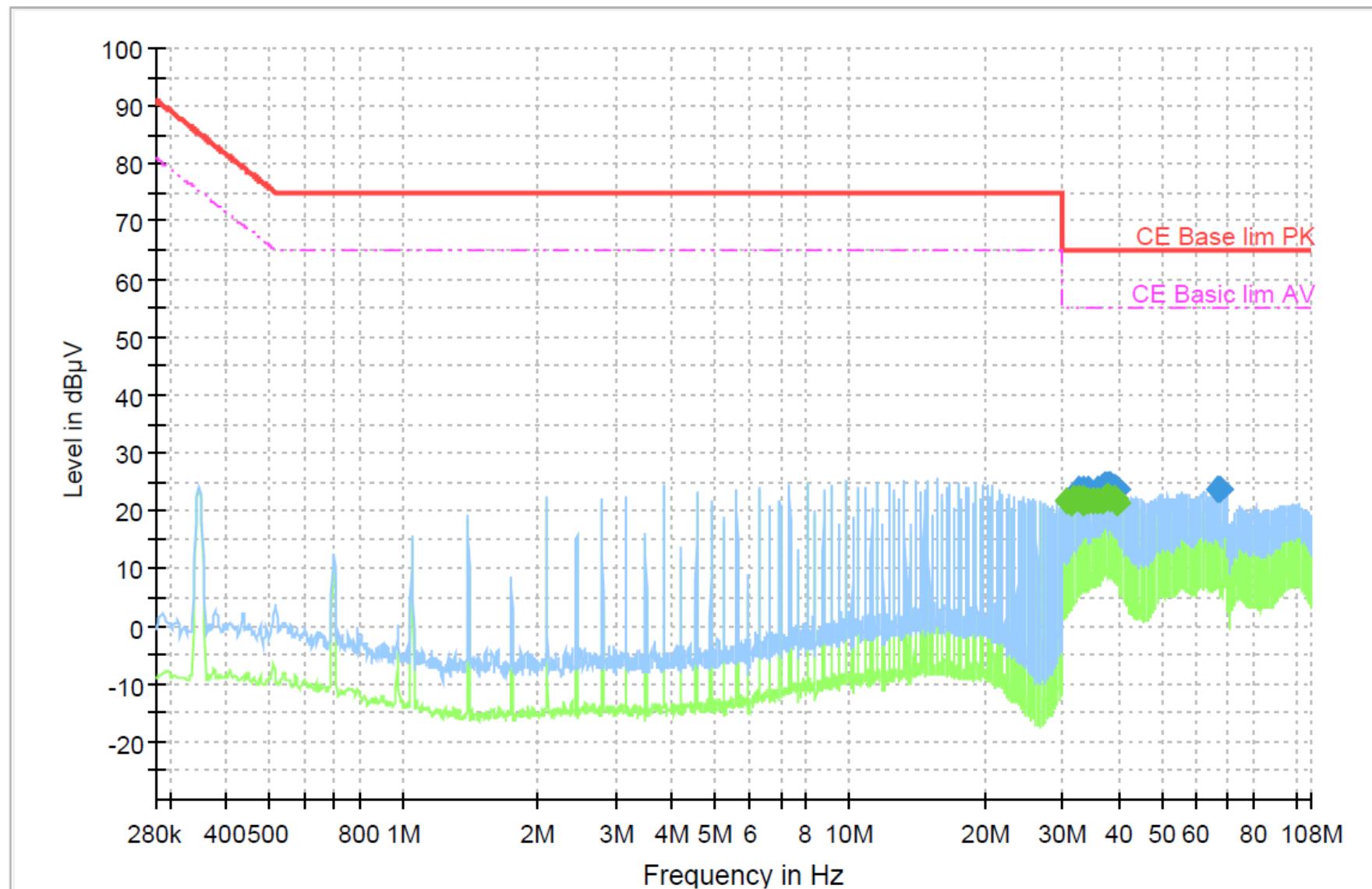
Prvi rezultati – CE

Urban Gregorc - Prevodne motnje do 100 MHz

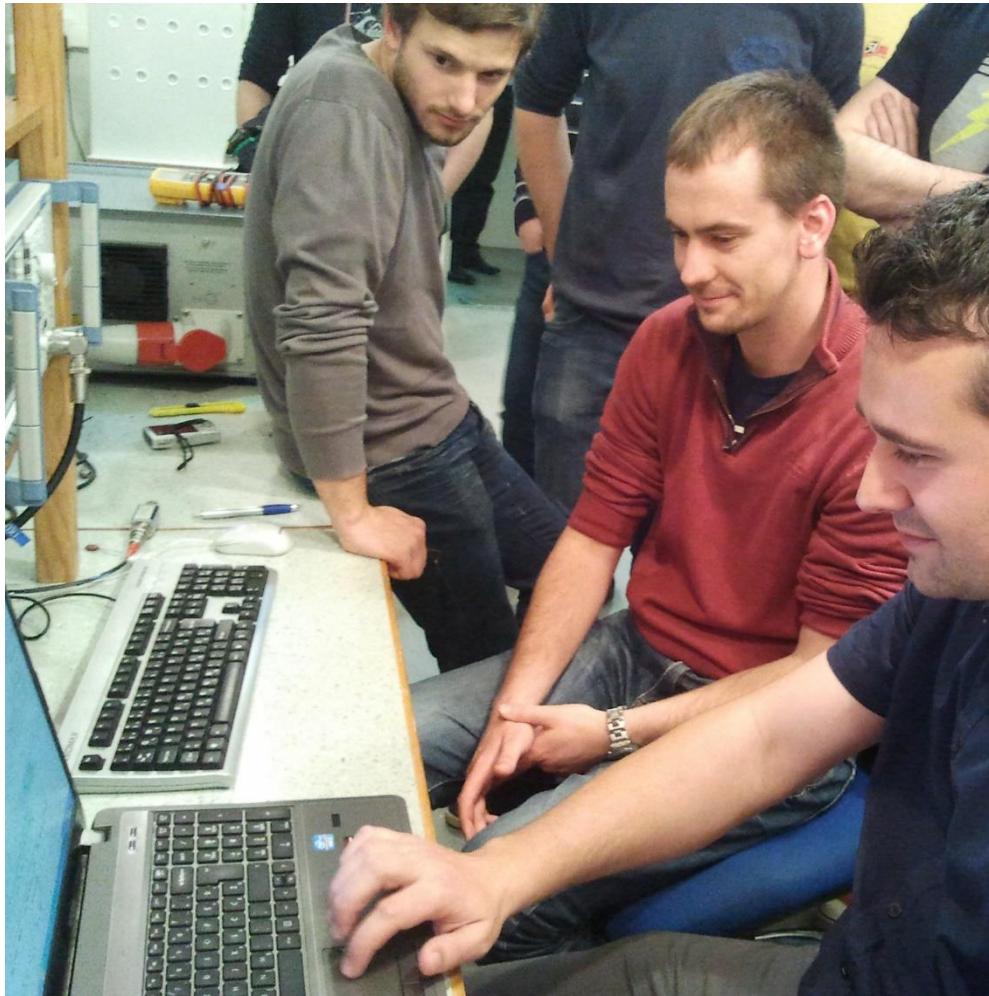


Prvi rezultati – CE

Matjaž Tome - Prevodne motnje do 100 MHz



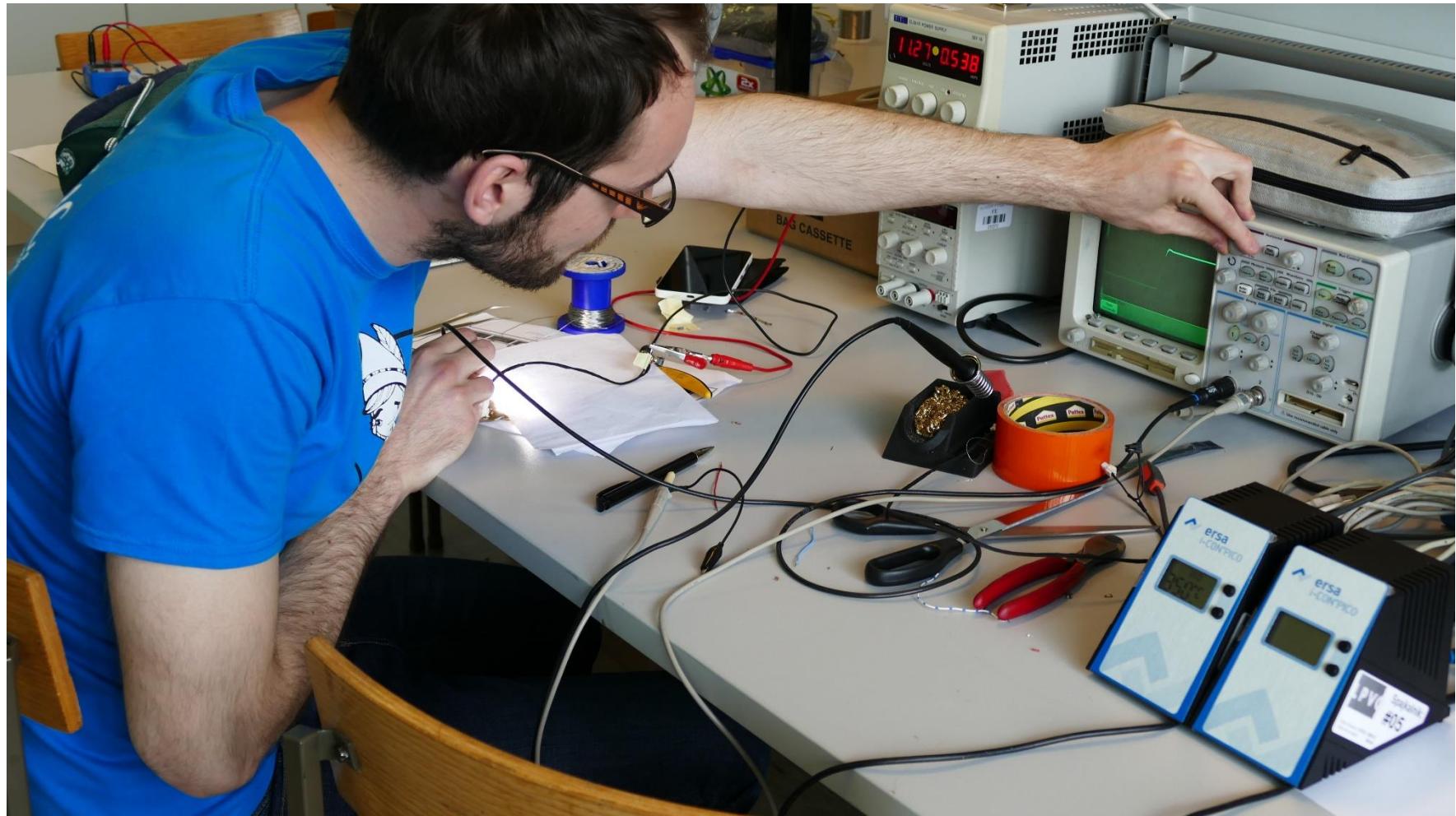
Obisk SIQ



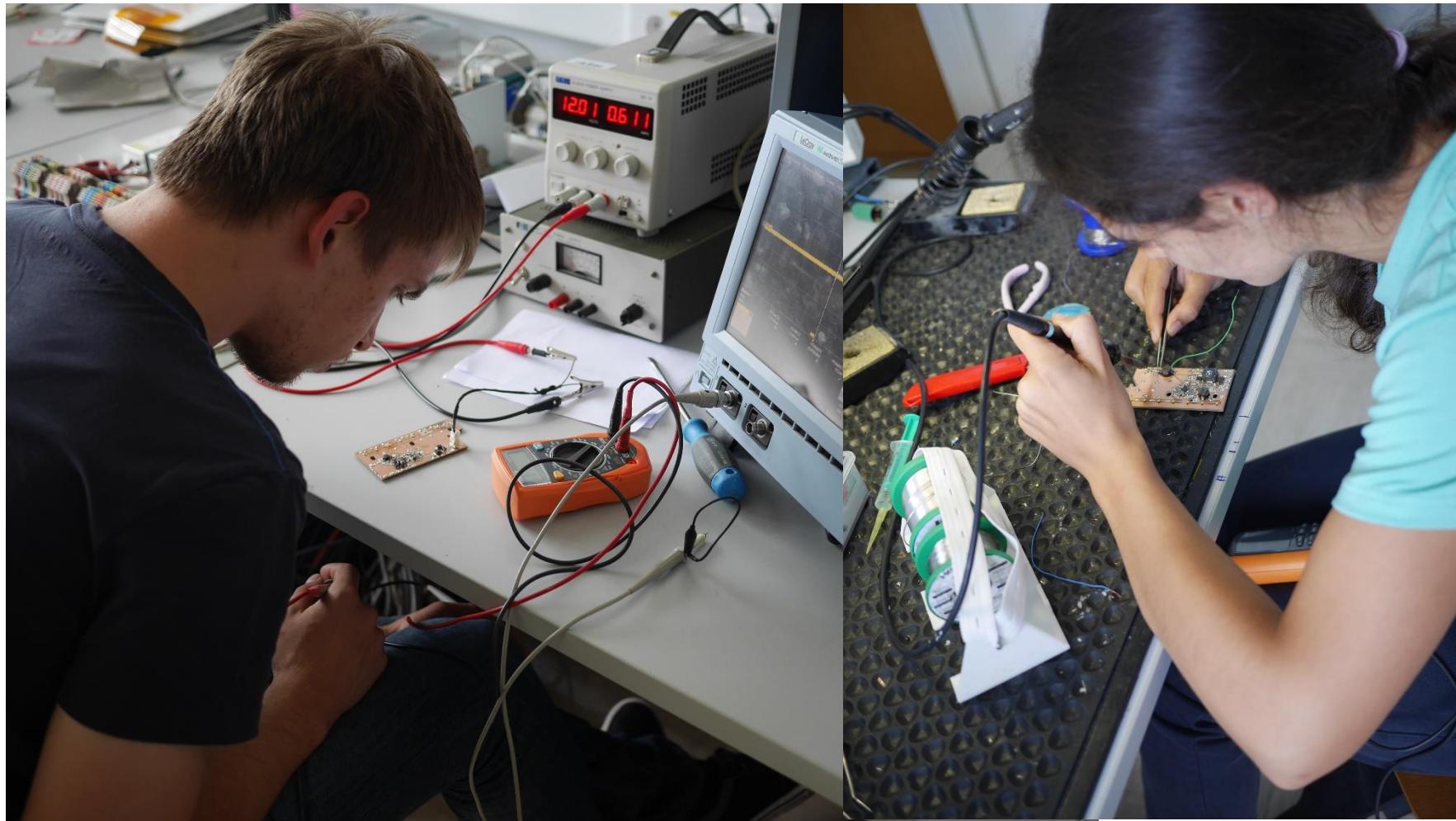
Izdelava projektov



Izdelava projektov



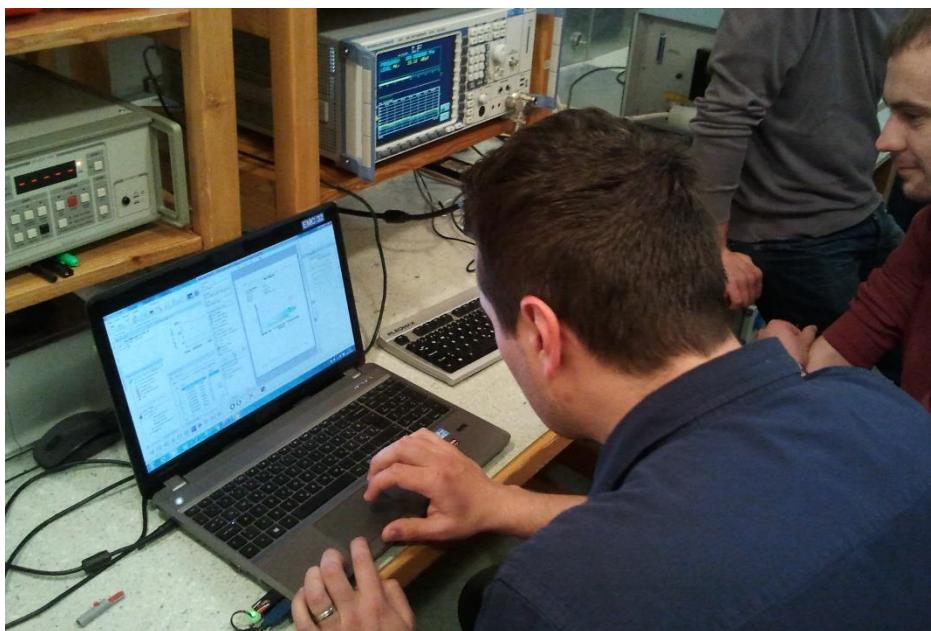
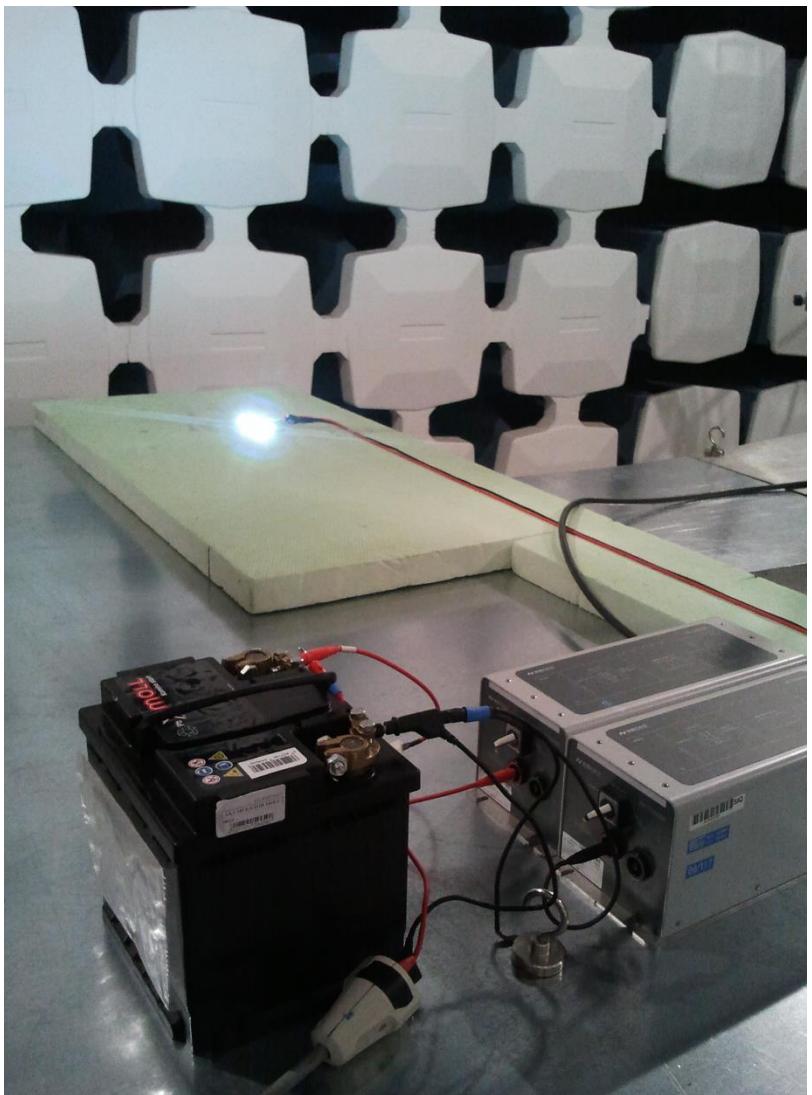
Izdelava projektov



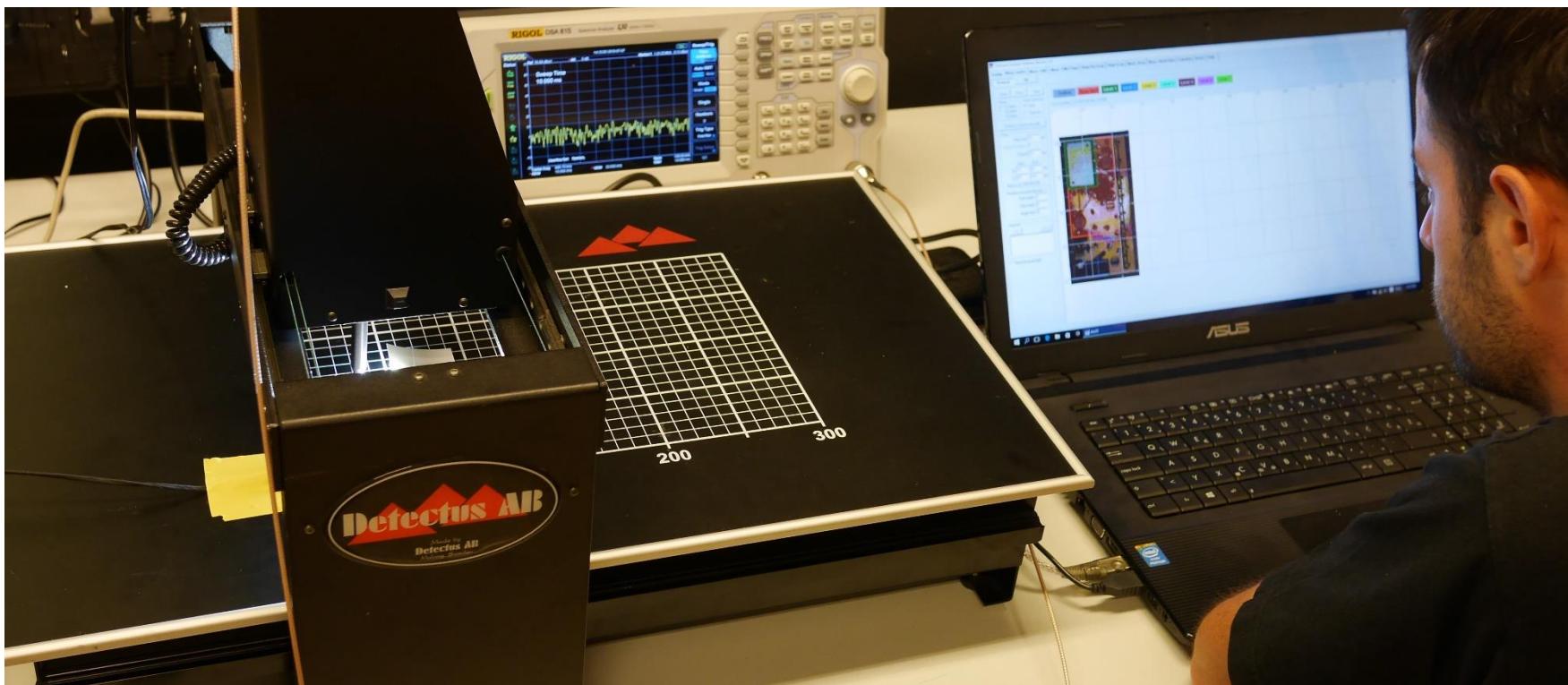
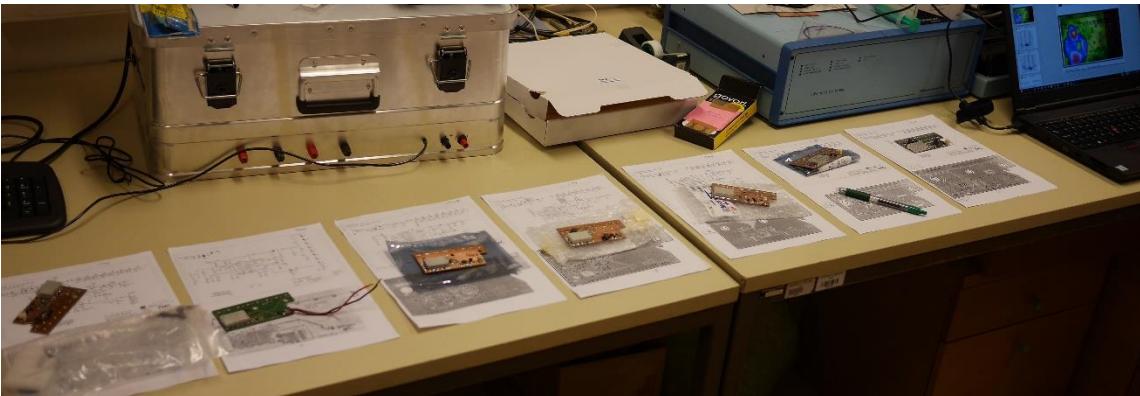
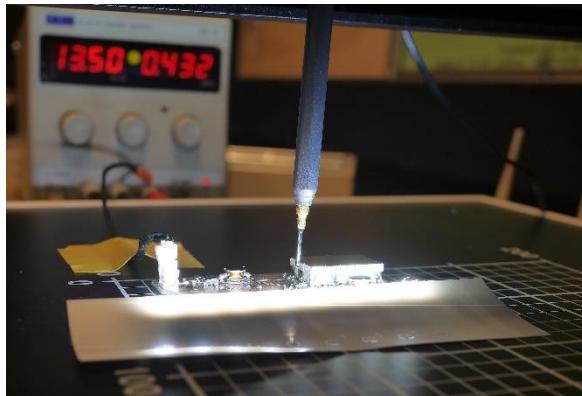
Oddaja projektov



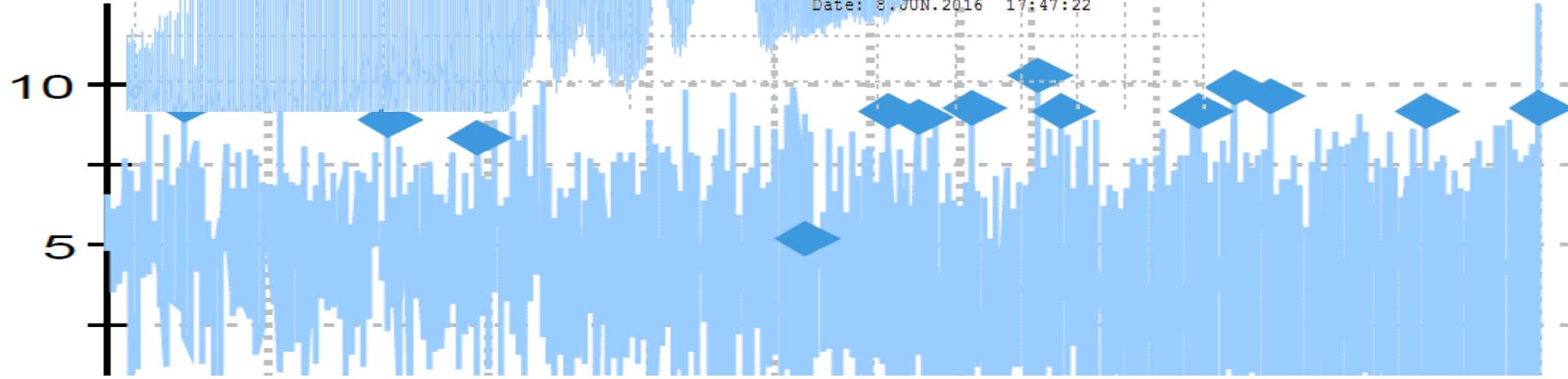
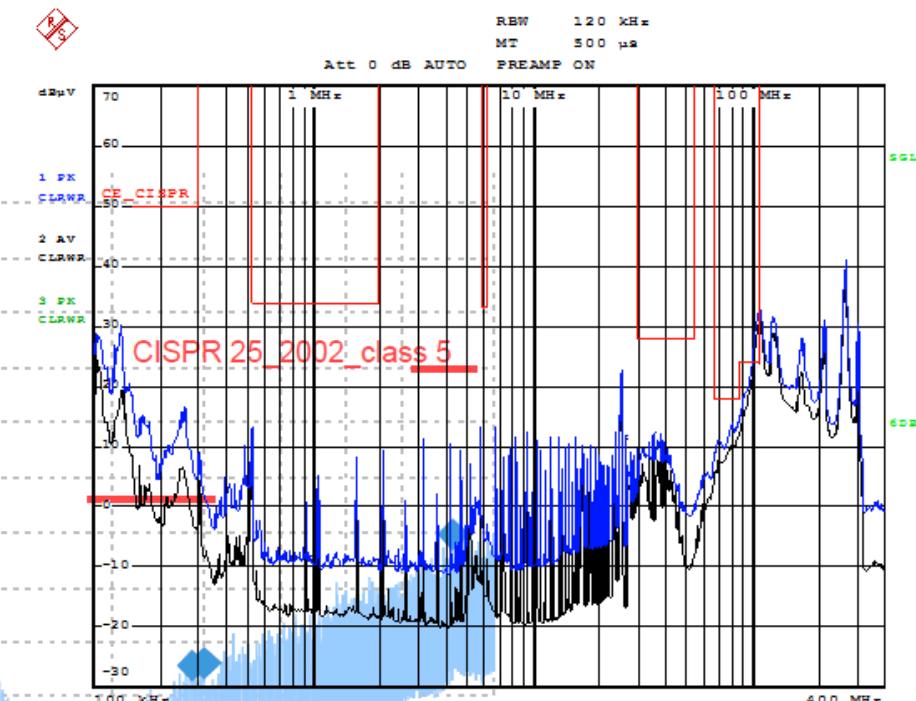
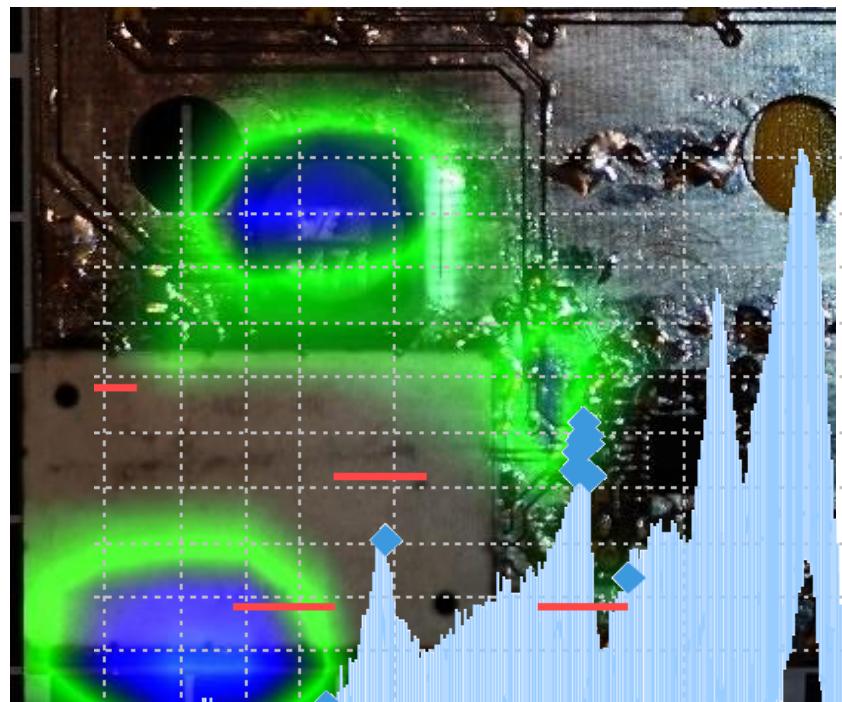
Meritve na Hellu in SIQ

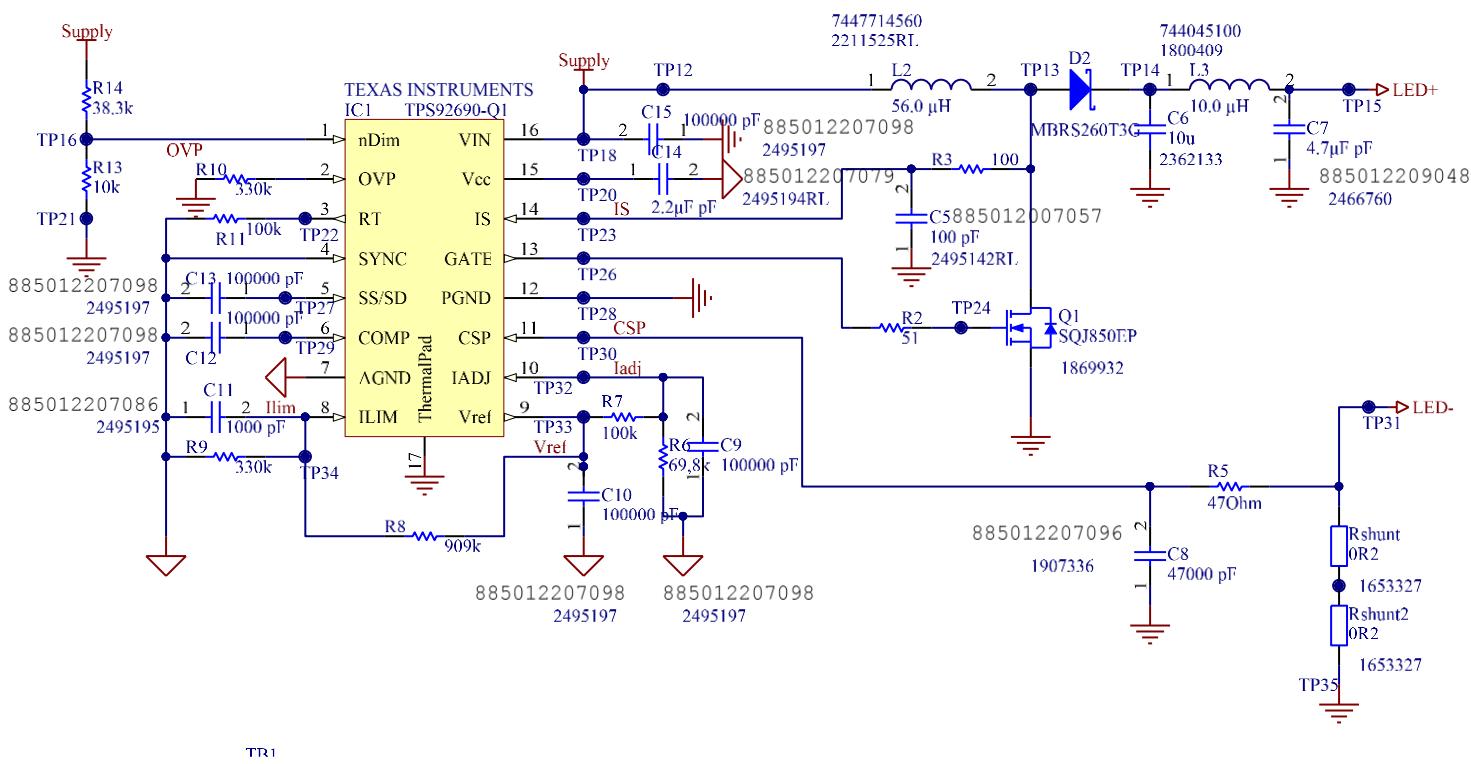
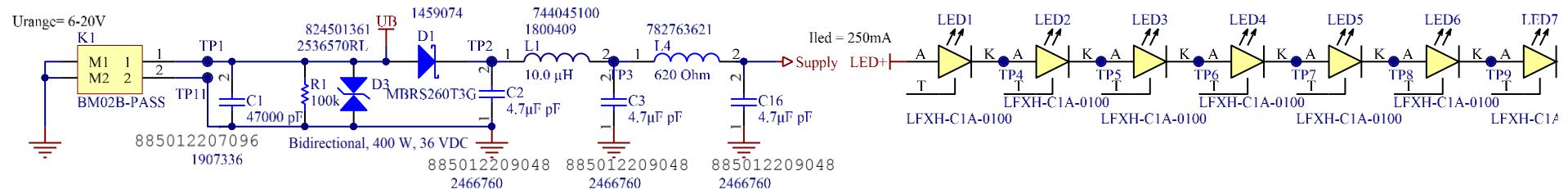


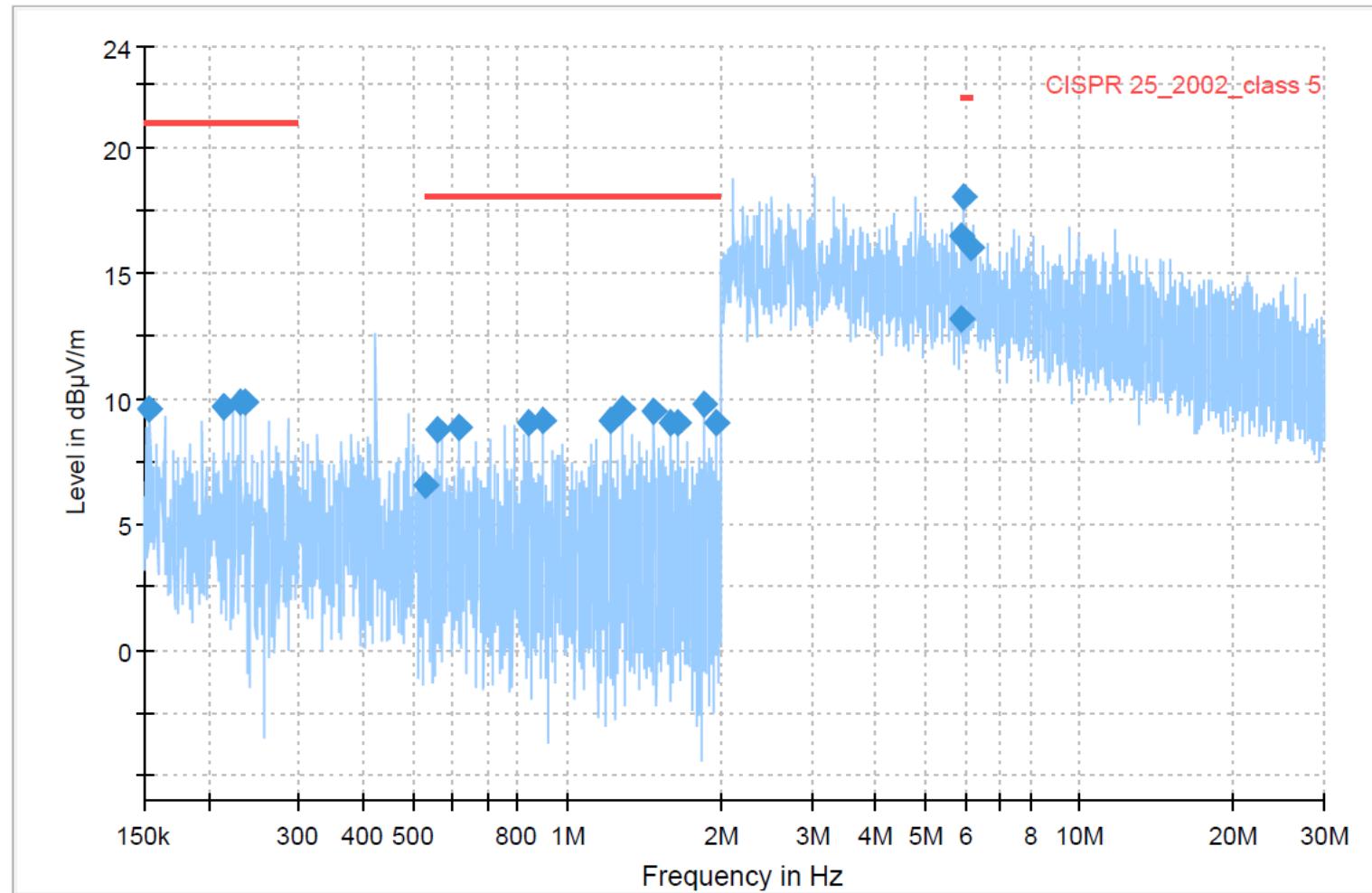
Meritve v LPVO

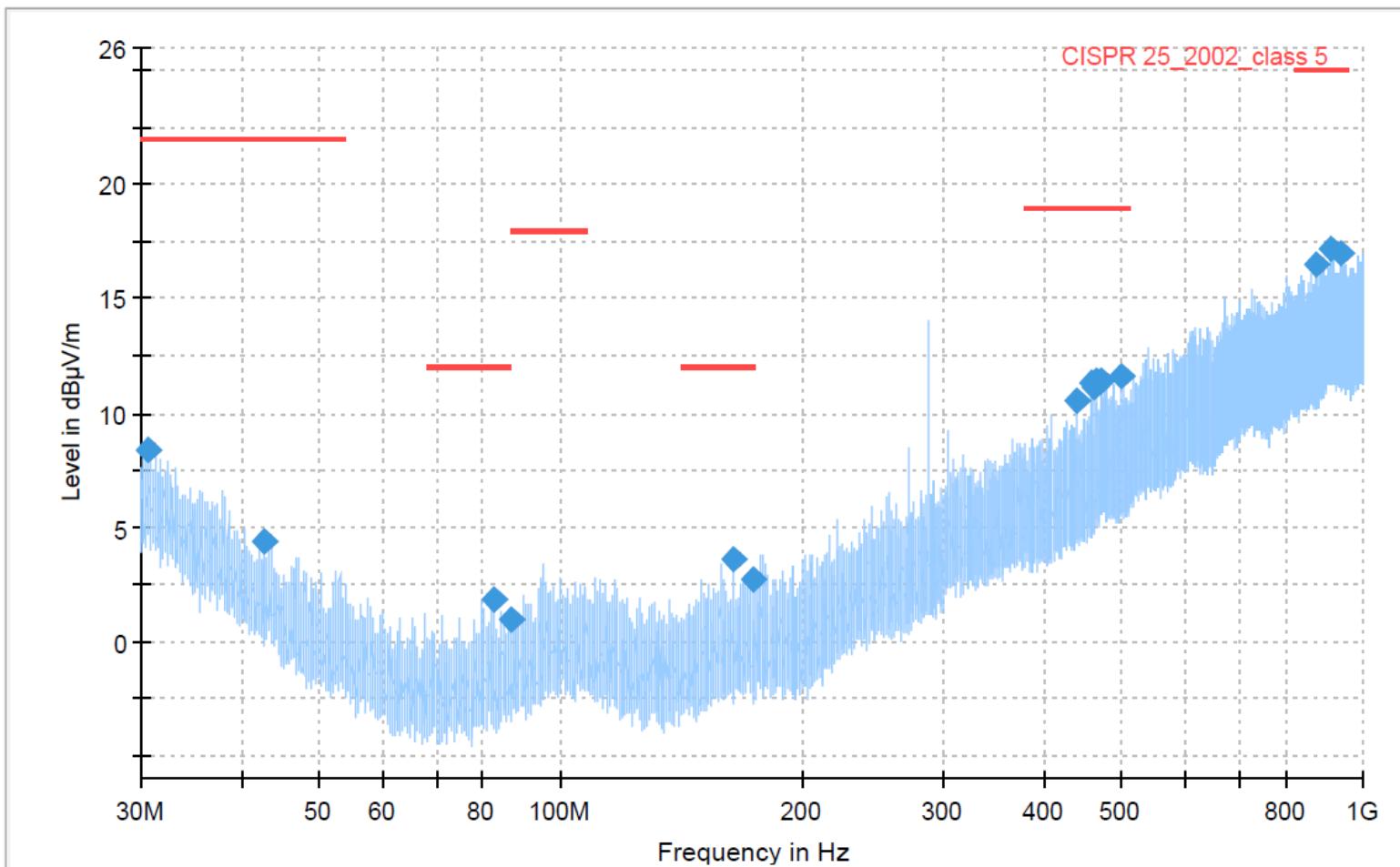


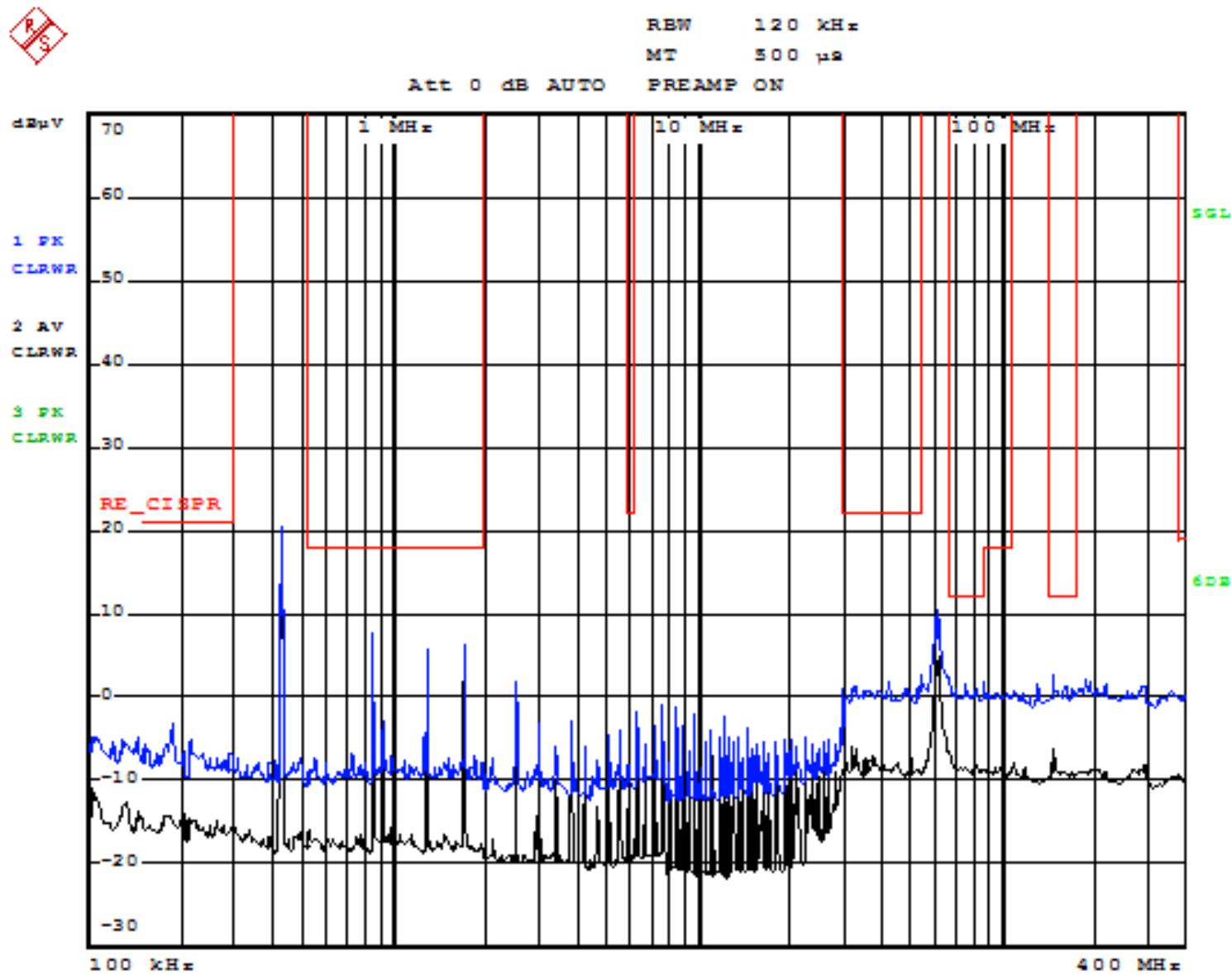
Rezultati

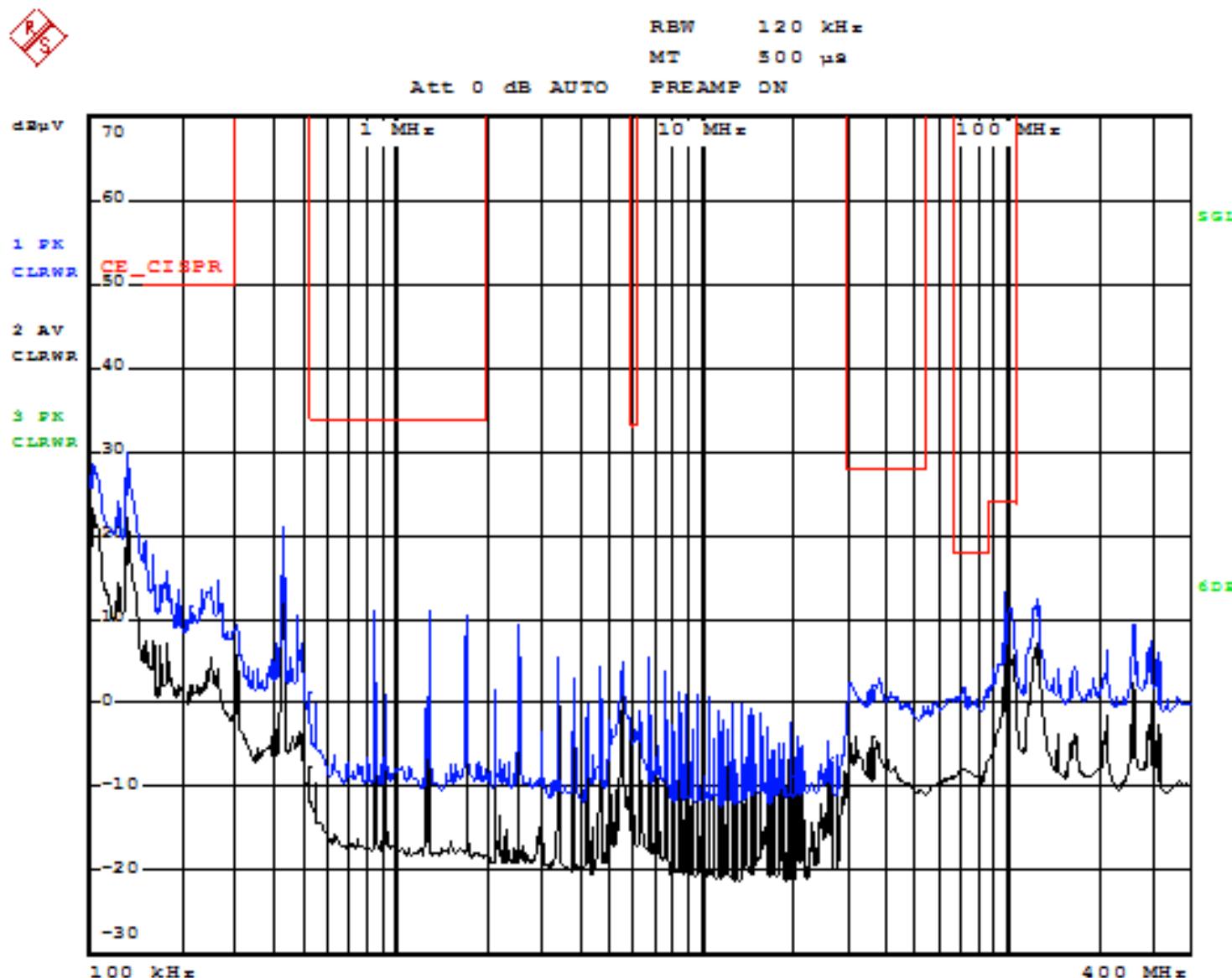


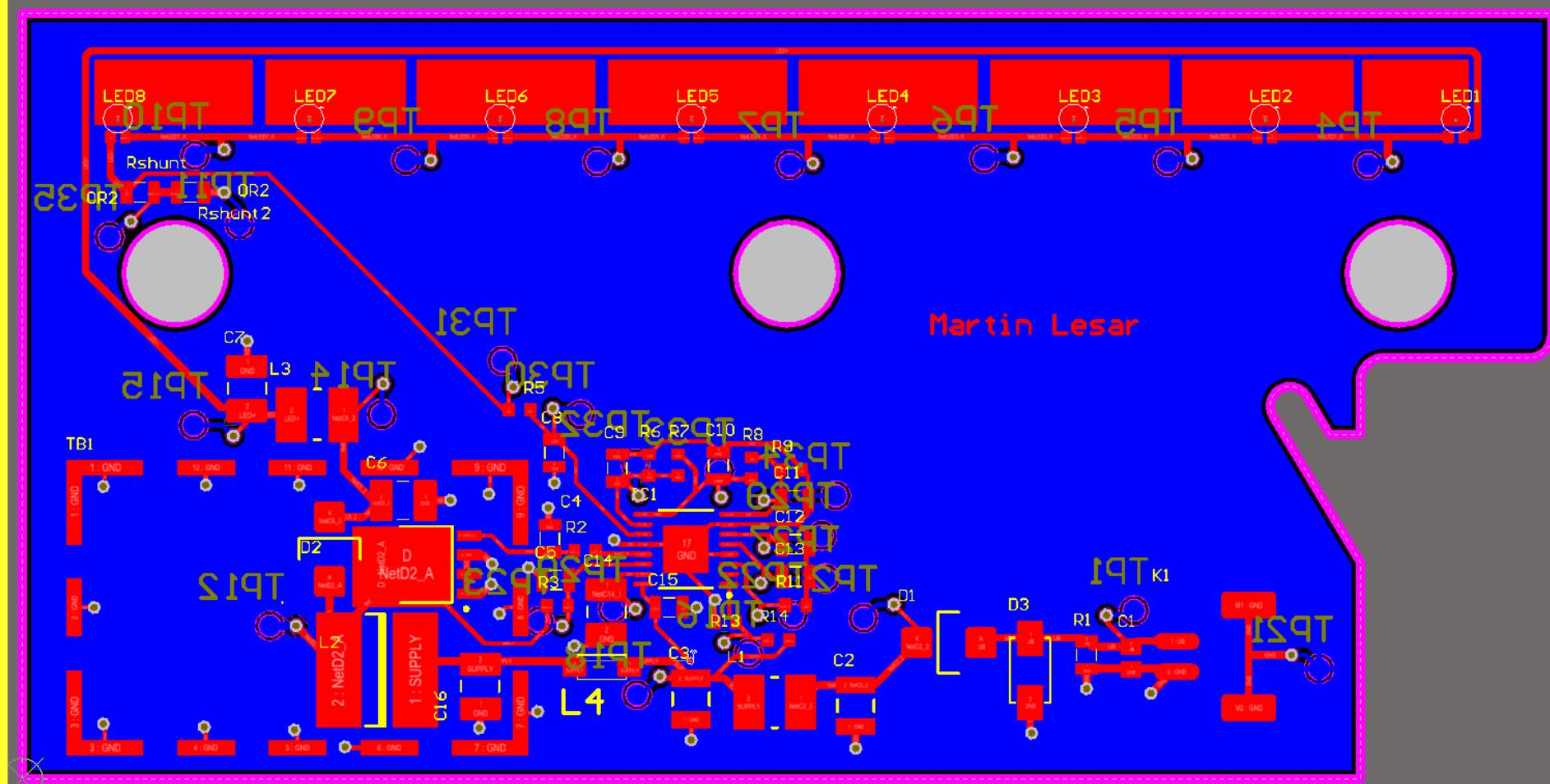


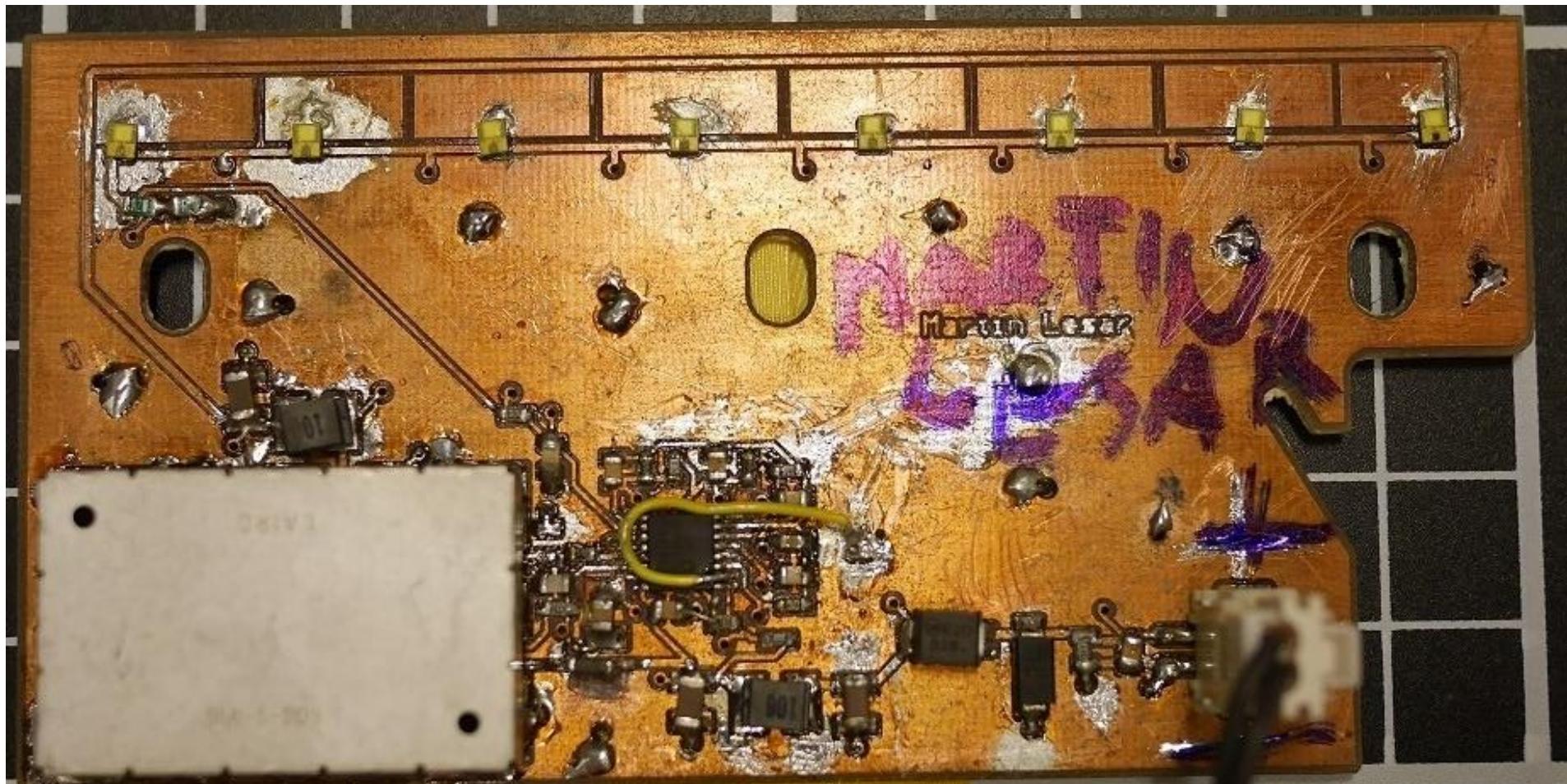




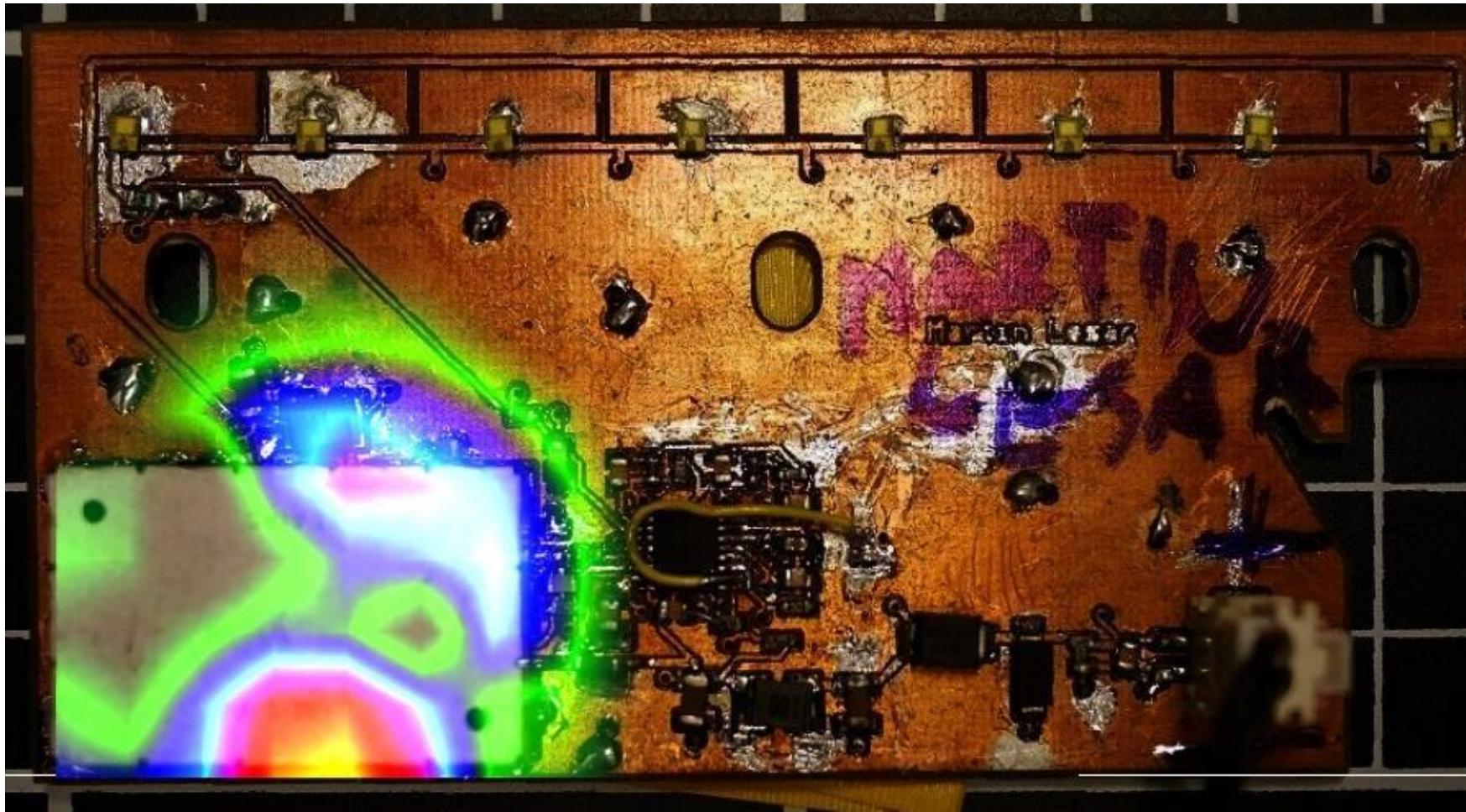


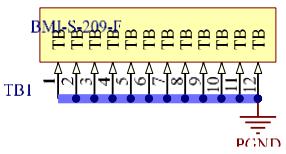
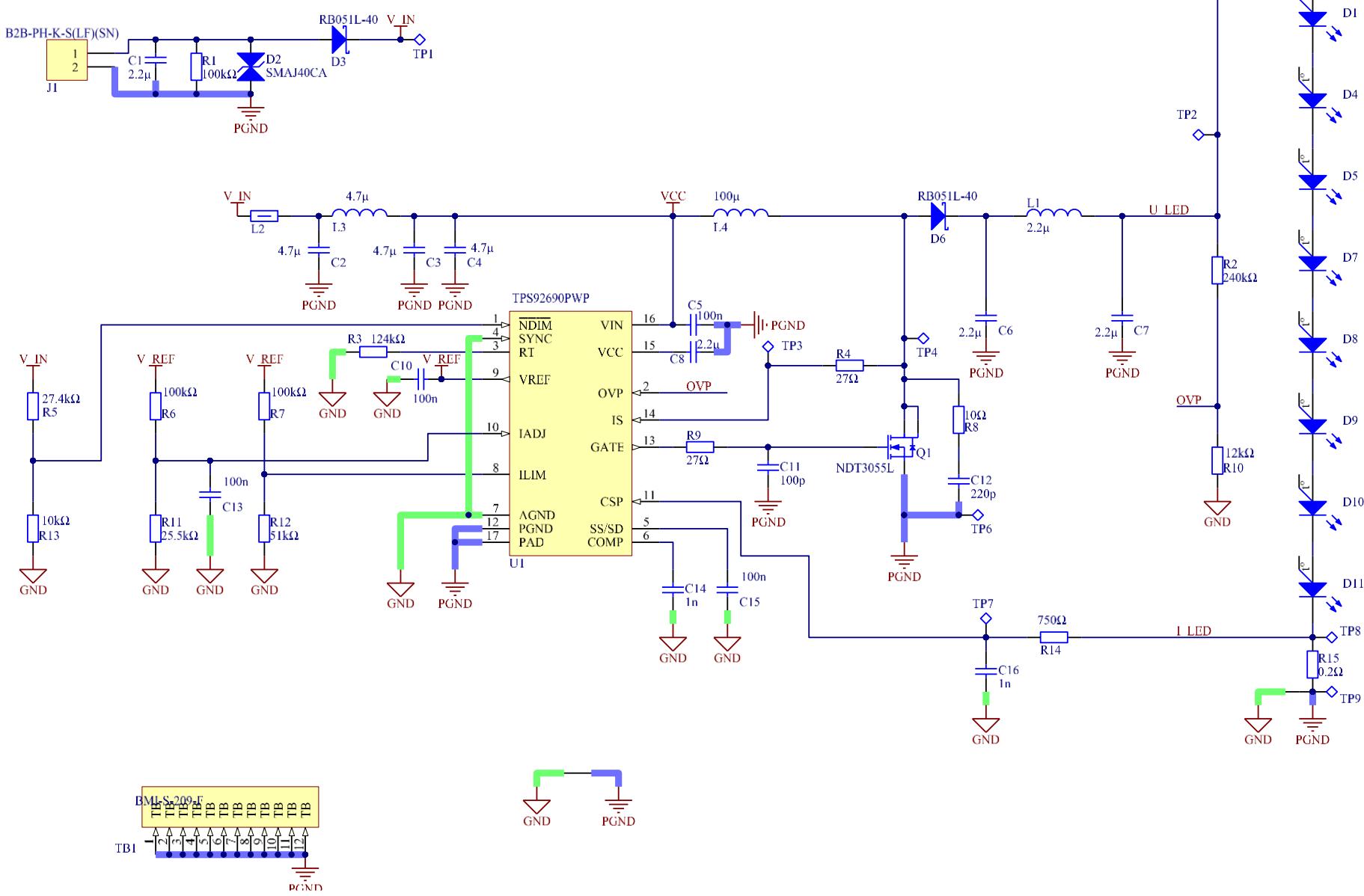


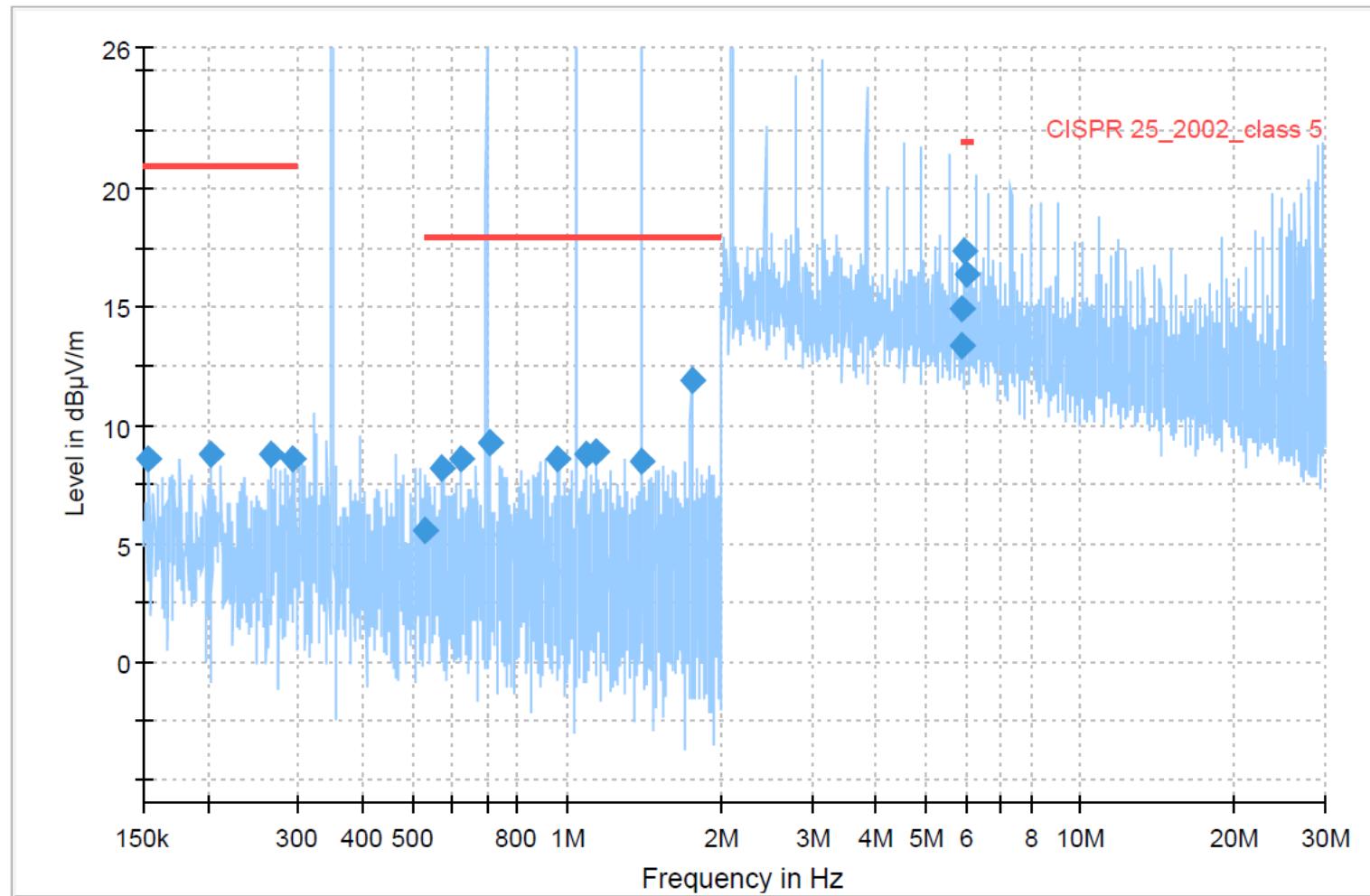


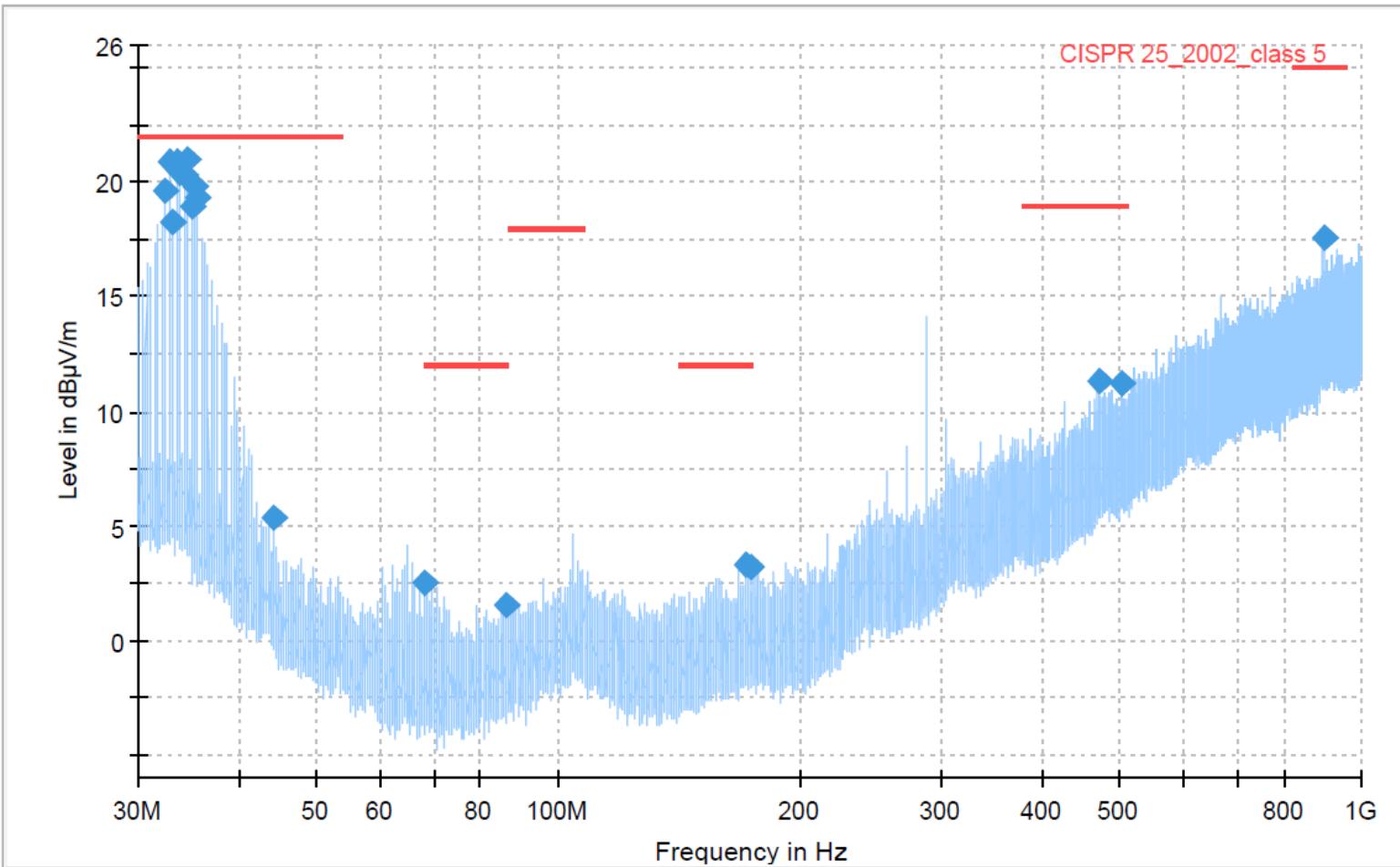


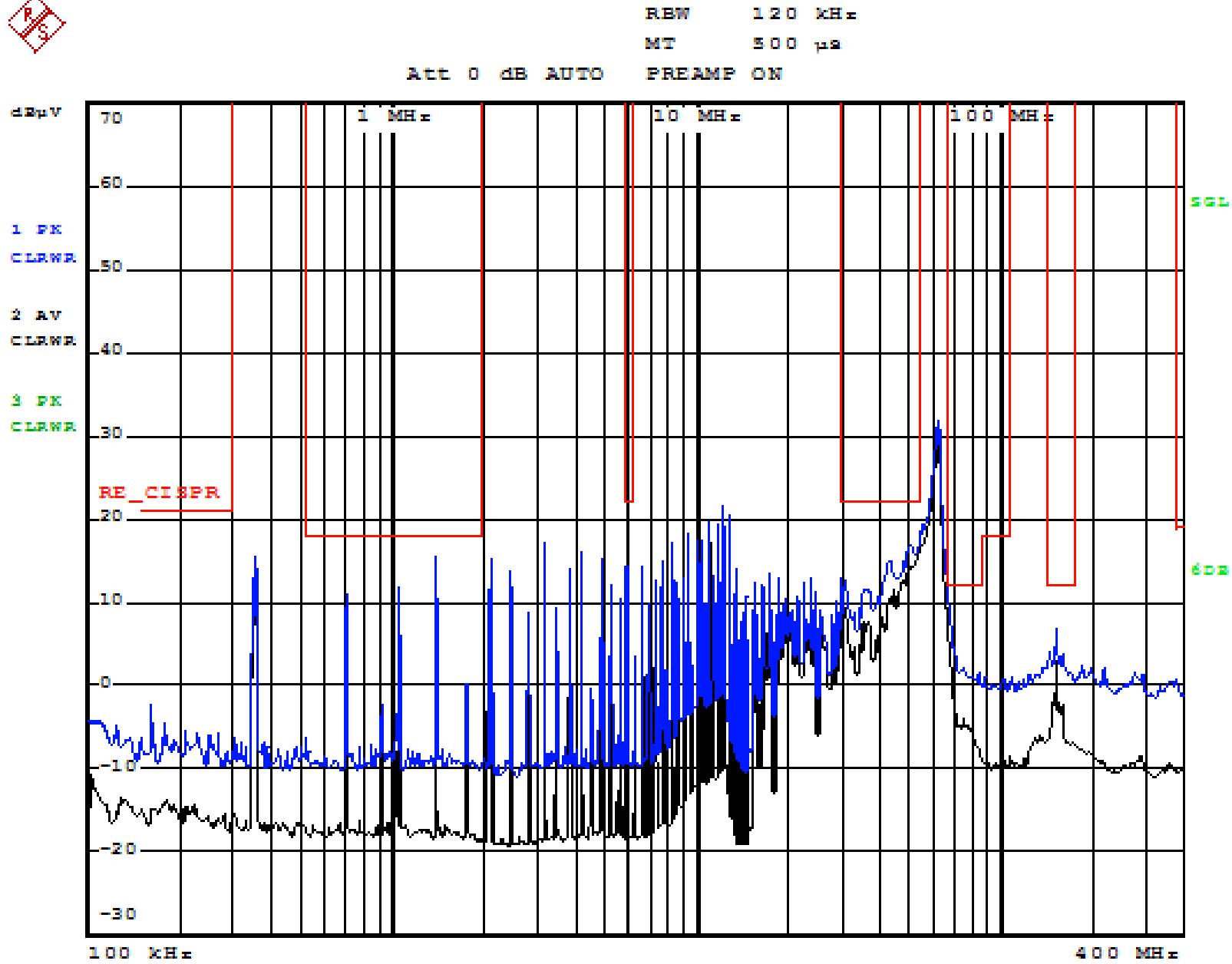
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99,40
99,03
98,66
98,28
97,91
97,54
97,16
96,79
96,42
96,04
95,67
95,30
94,93
94,55
94,18
93,81
93,43
93,06
92,69
92,31
91,94
91,57
91,19
90,82
90,45
90,07
89,70
89,33
88,96
88,58
88,21
87,84
87,46
87,09
86,72
86,34
85,97
85,60
85,22
84,85
84,48
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82,99
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82,24
81,87
81,49
81,12
80,75

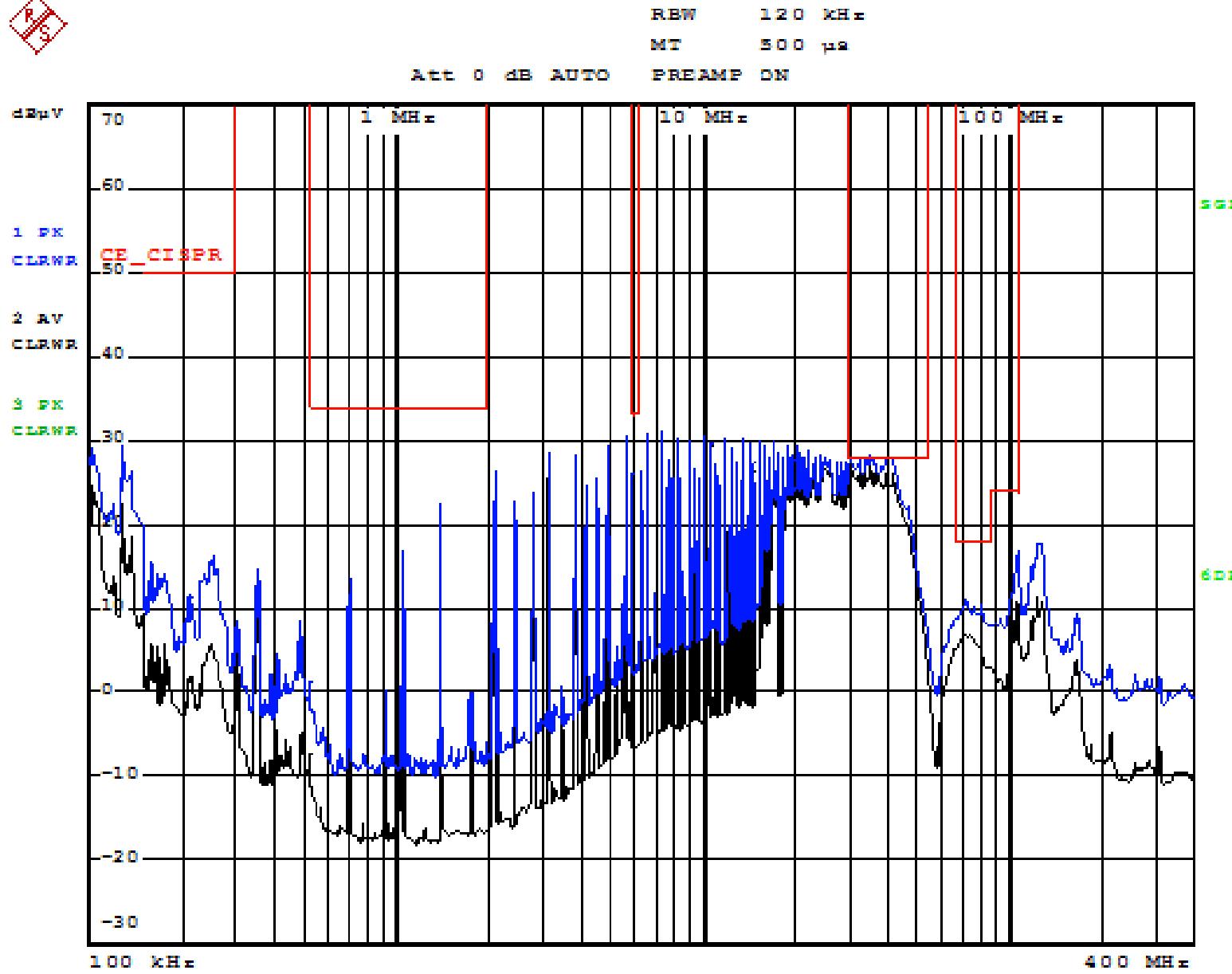


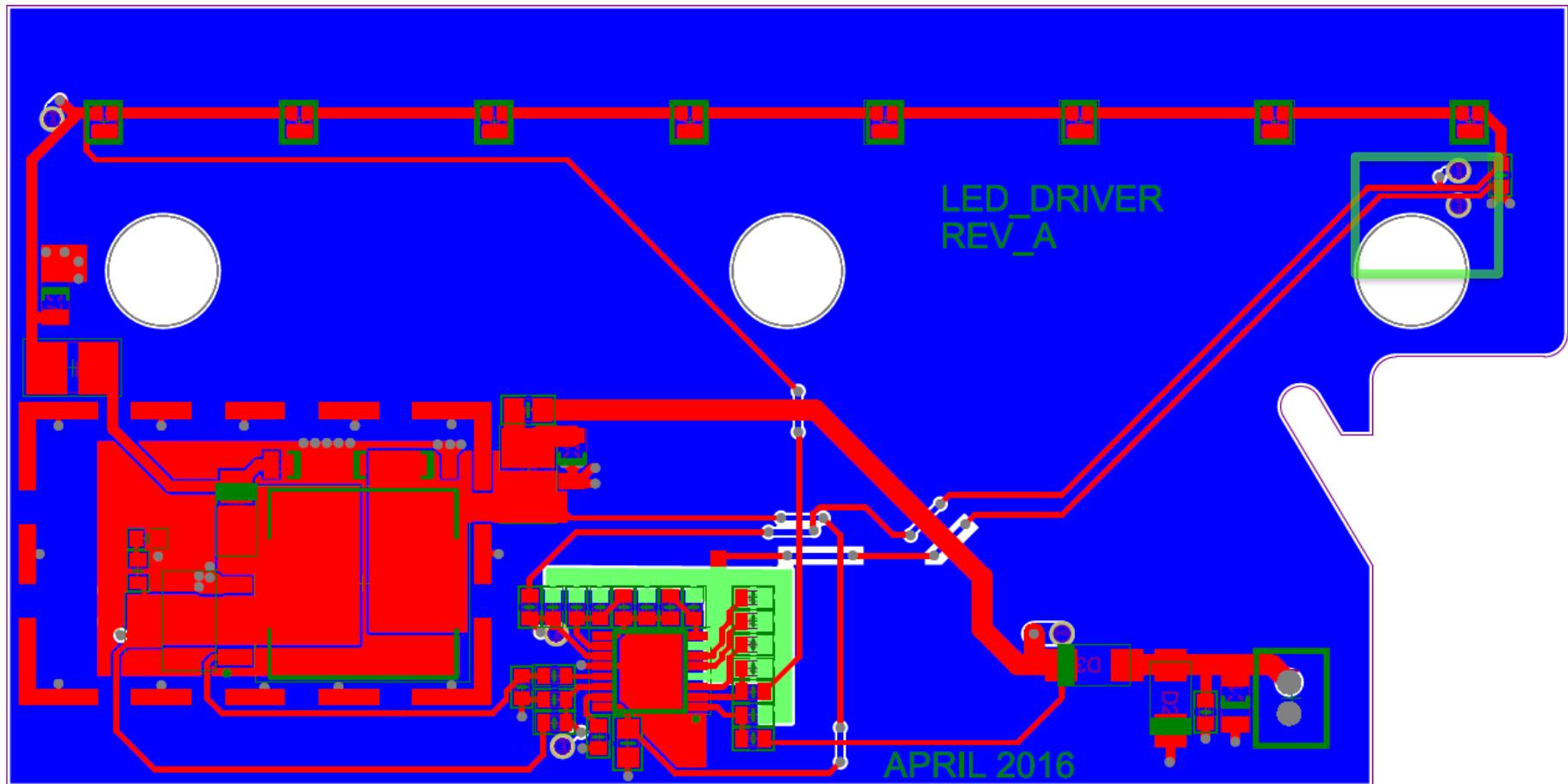


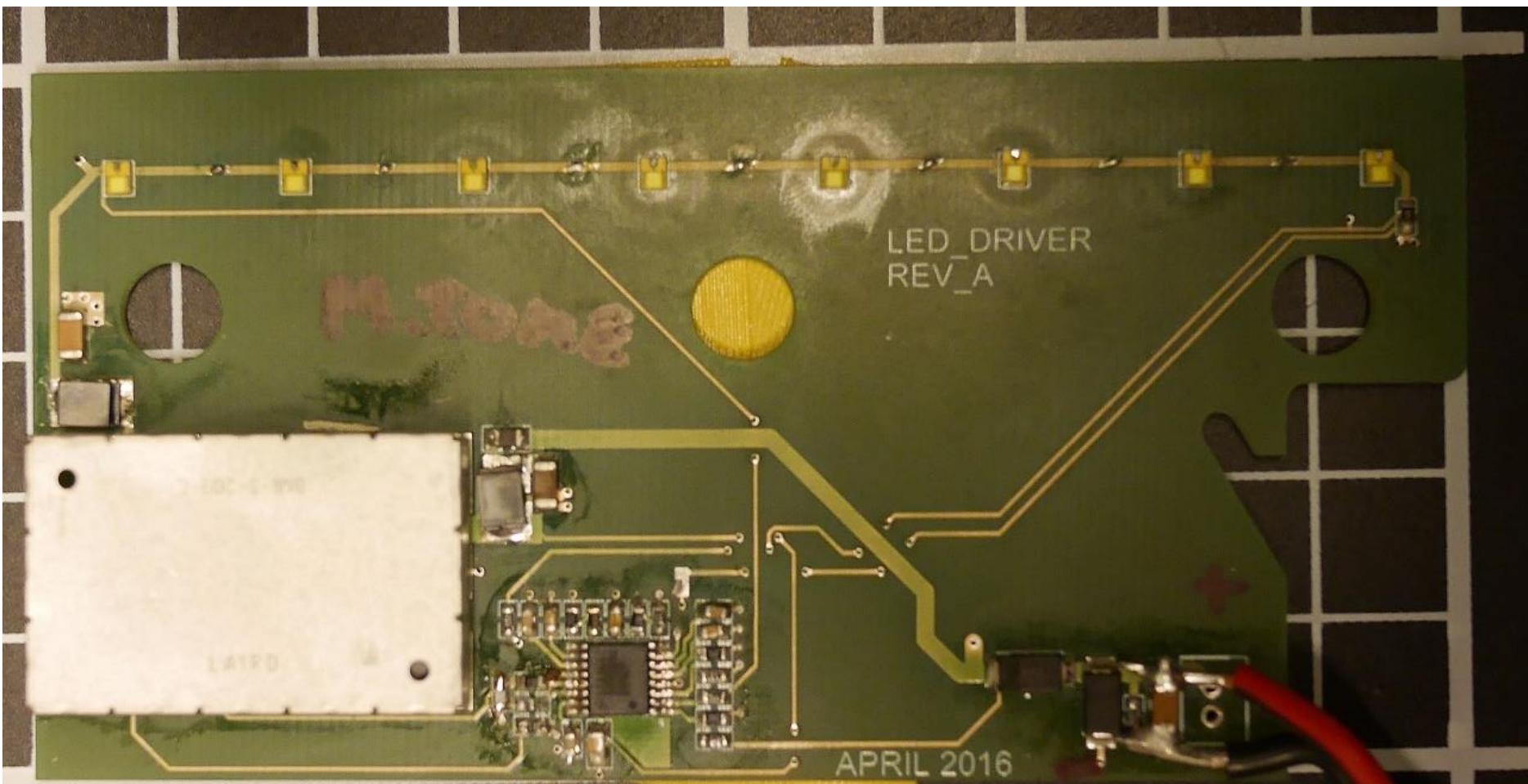


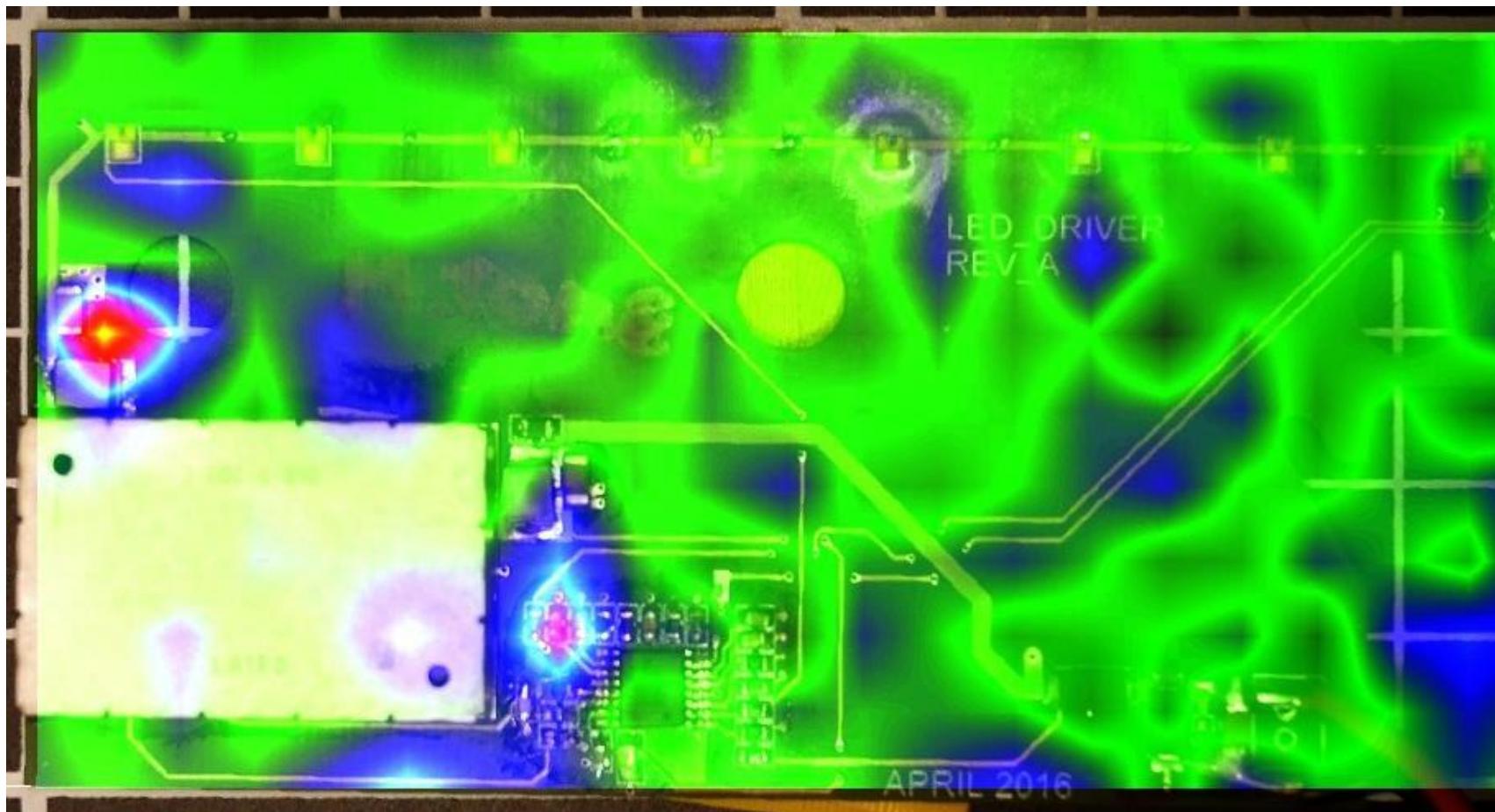




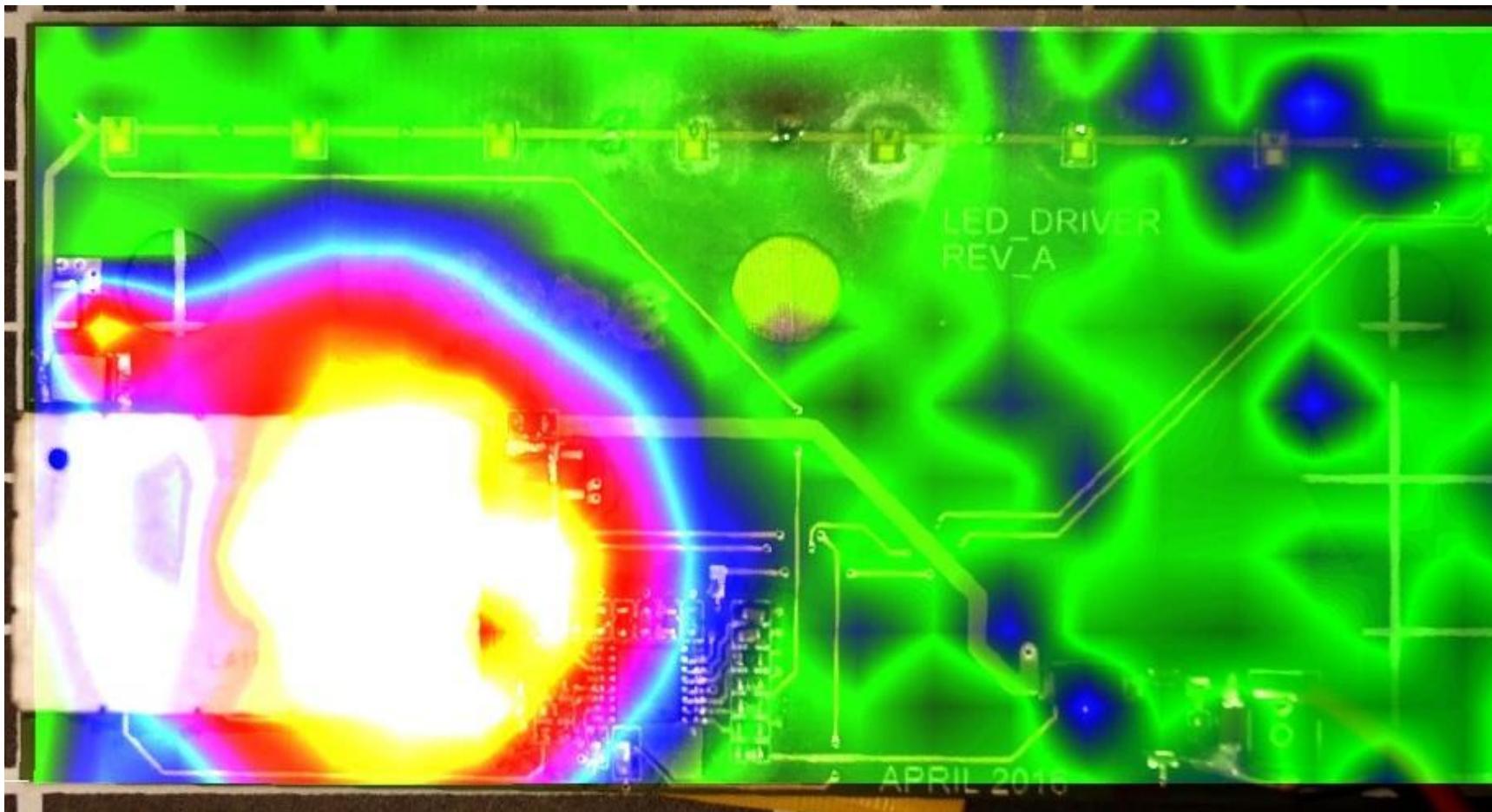




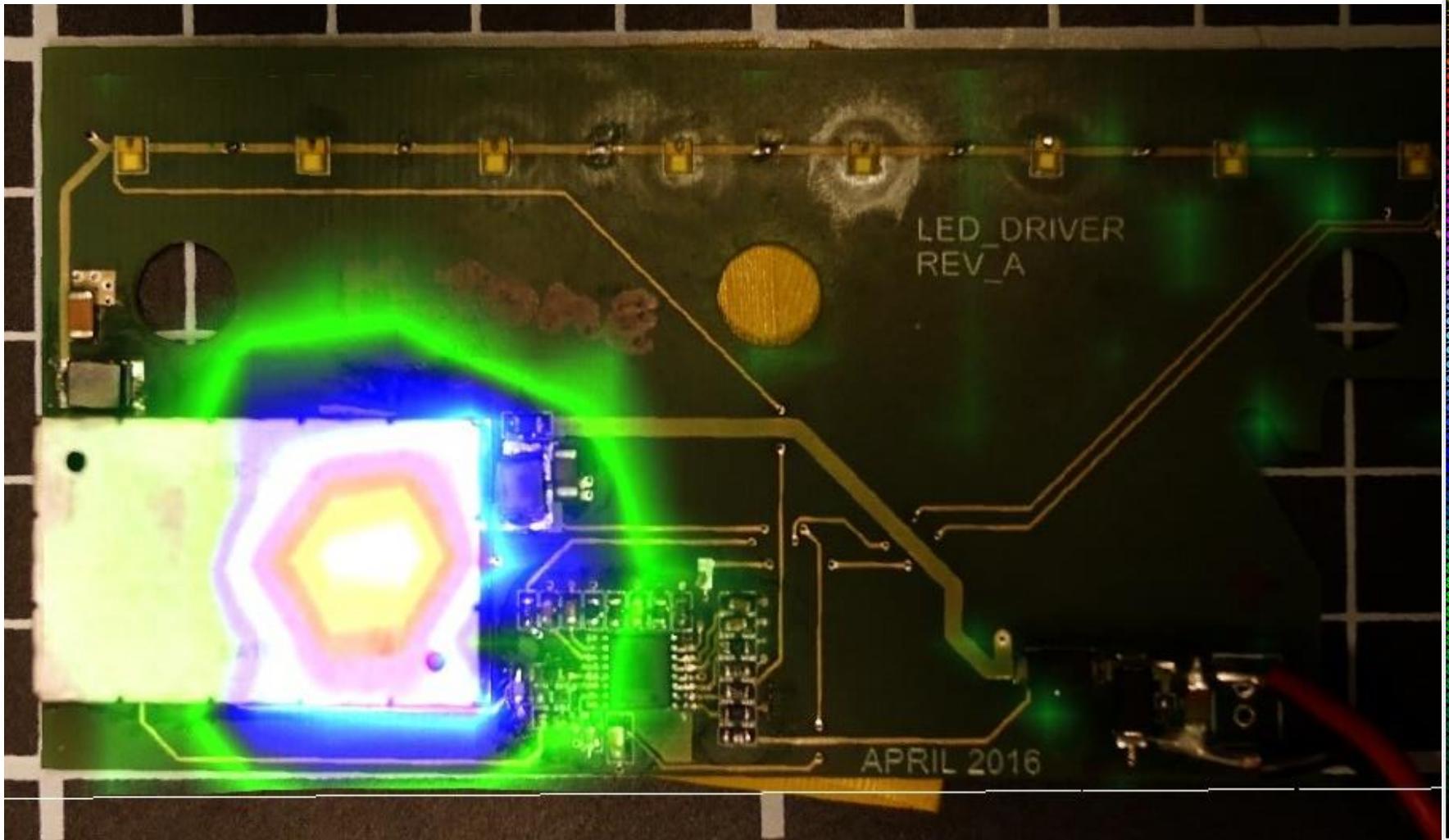




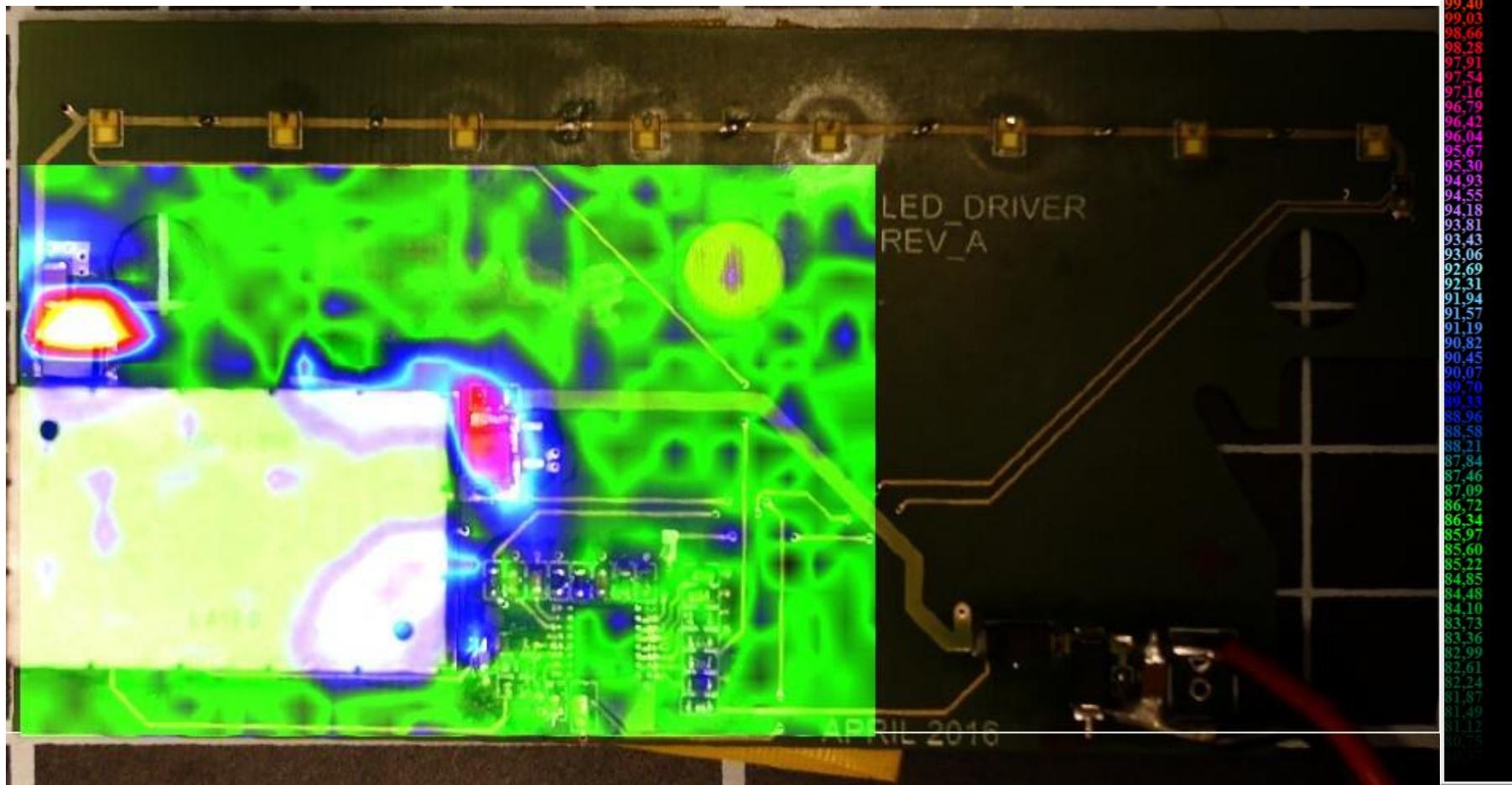
Matjaž Tome – 679 kHz odprt TB



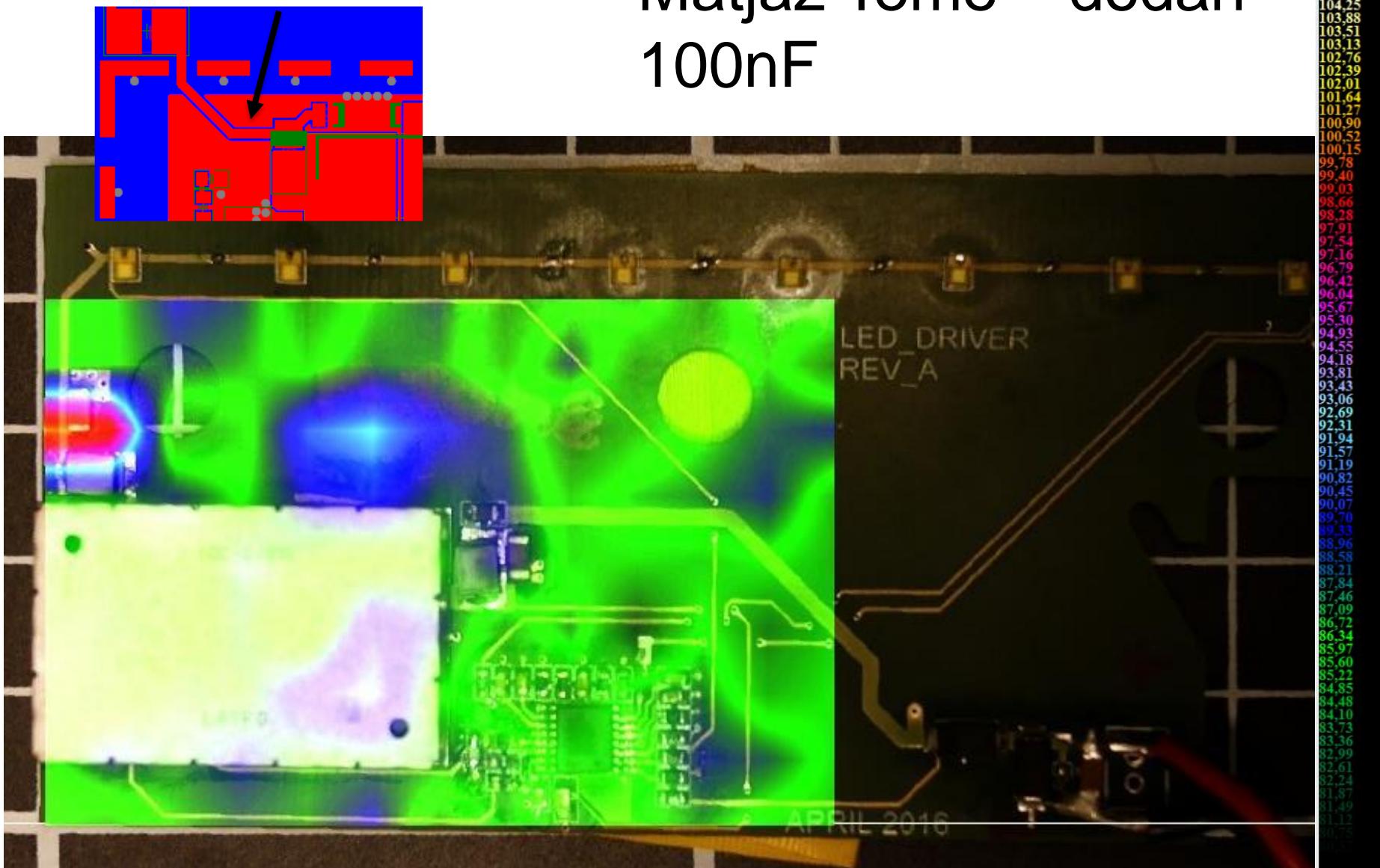
Matjaž Tome – 679 kHz razlika



Matjaž Tome – 679 kHz zaspajkan TB

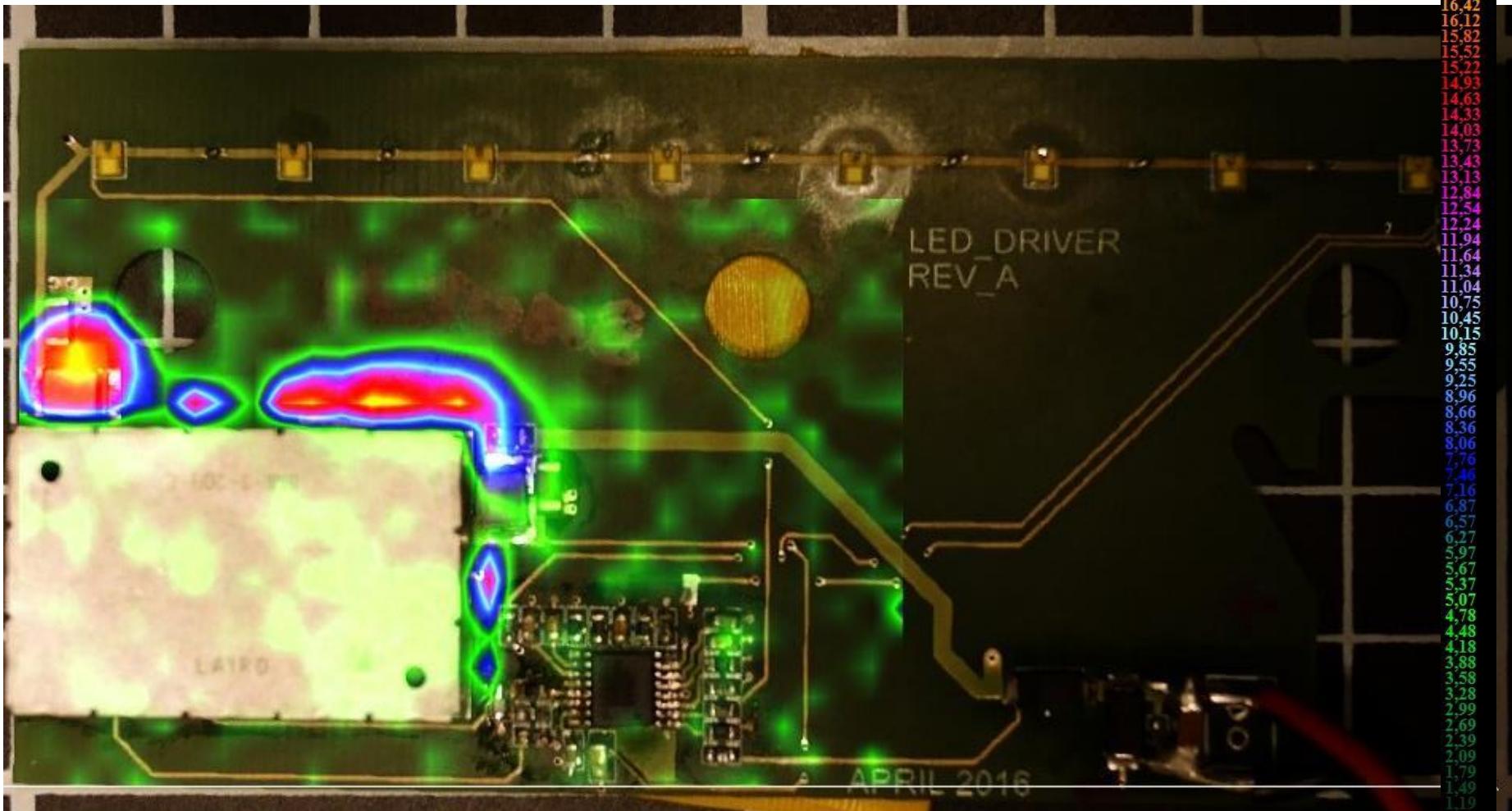


Matjaž Tome – dodan 100nF

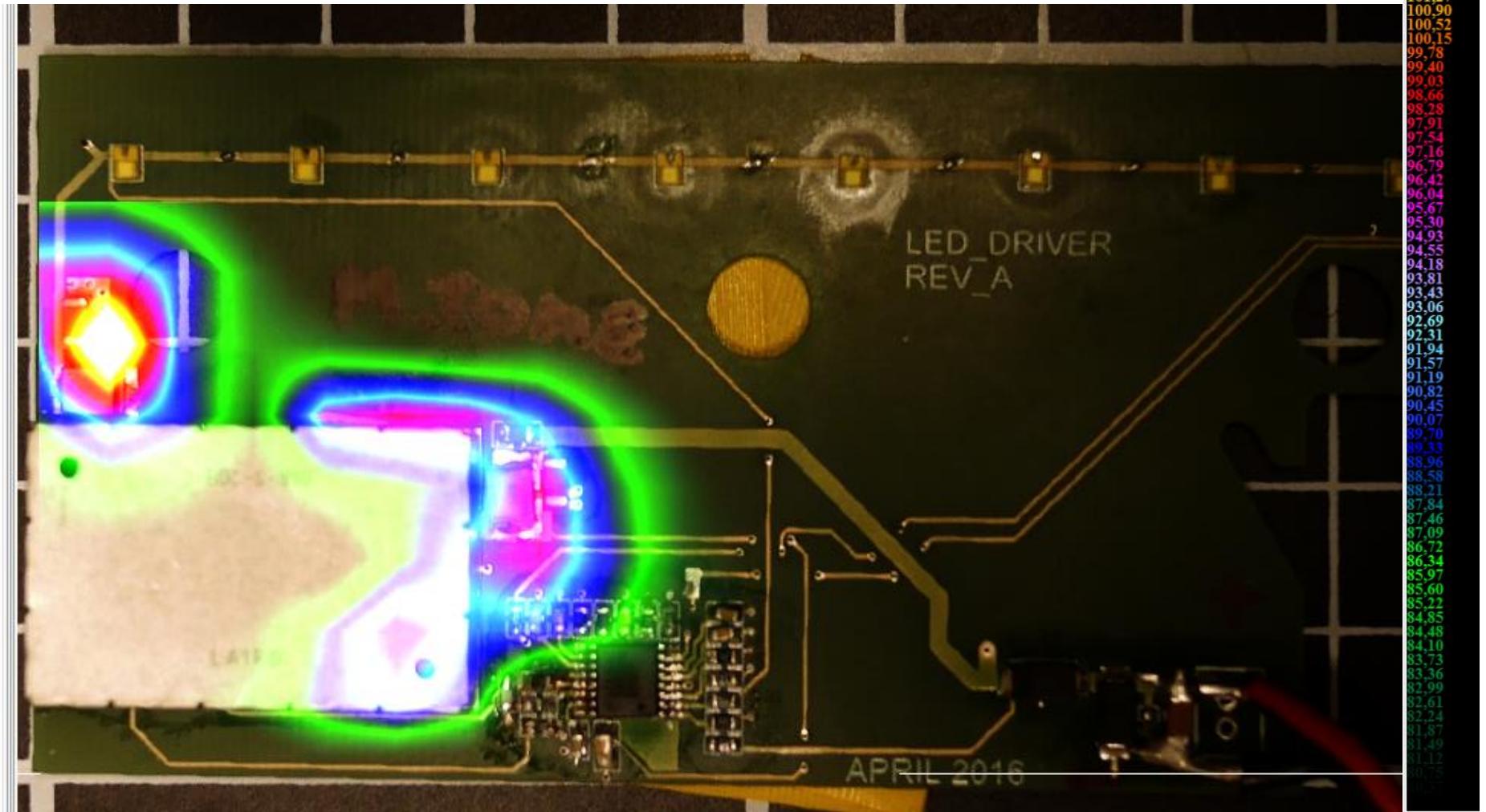


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18,81
18,51
18,21
17,91
17,61
17,31
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16,72
16,42
16,12
15,82
15,52
15,22
14,93
14,63
14,33
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13,43
13,13
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11,34
11,04
10,75
10,45
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3,28
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1,49
1,19
0,90
0,60
0,30

Matjaž Tome – razlika

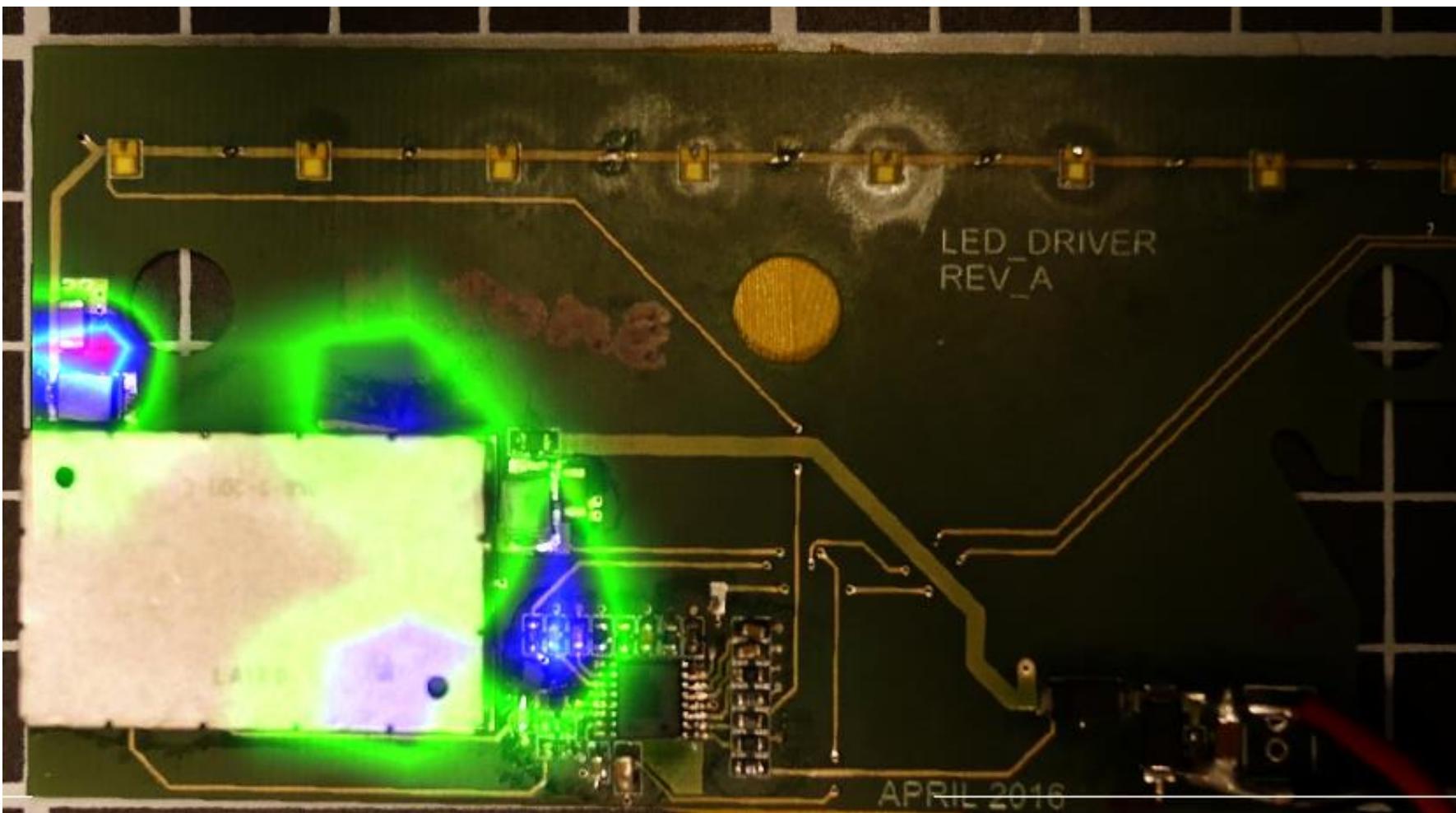


Matjaž Tome – 333 kHz zaspajkan TB



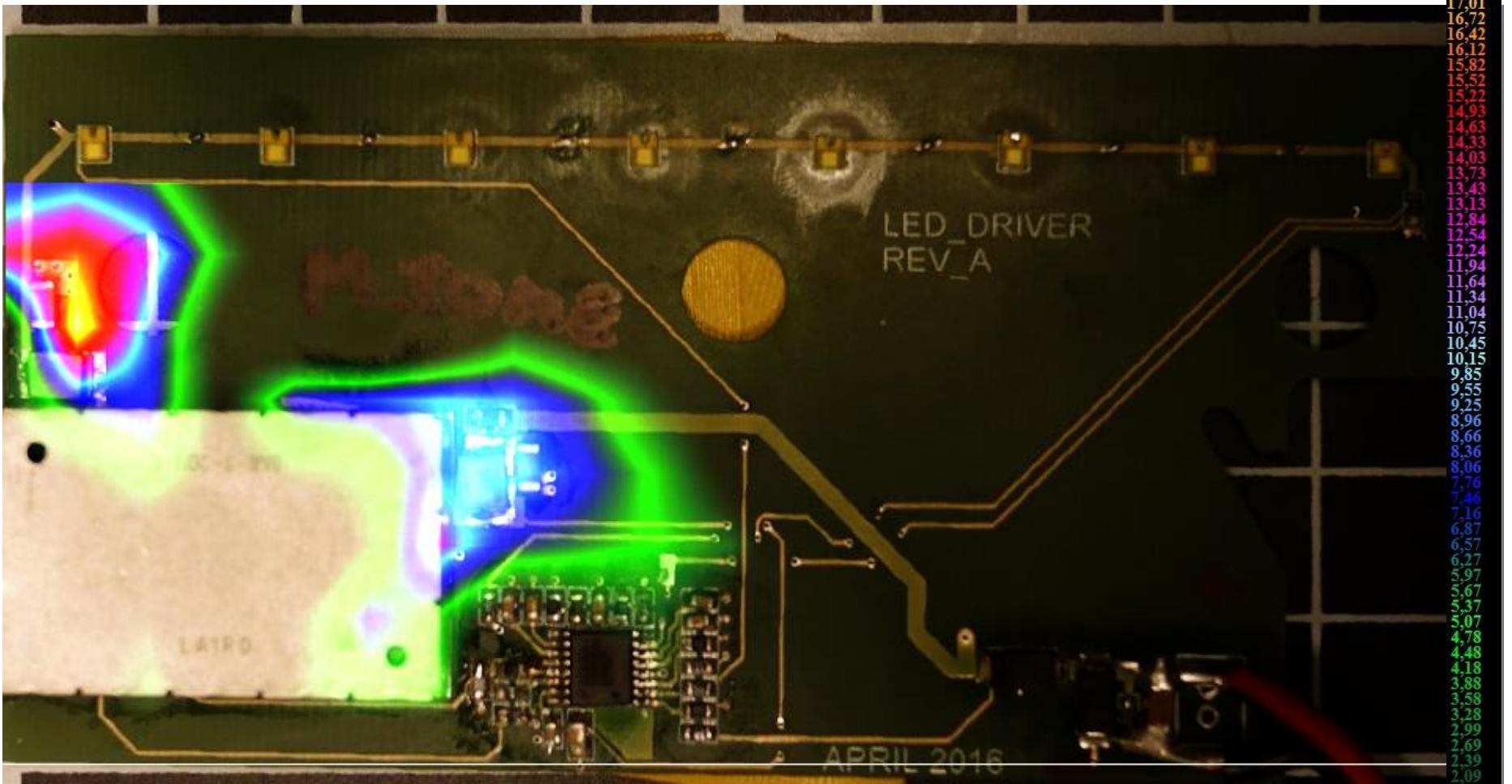
Matjaž Tome – 333 kHz dodan 100 nF

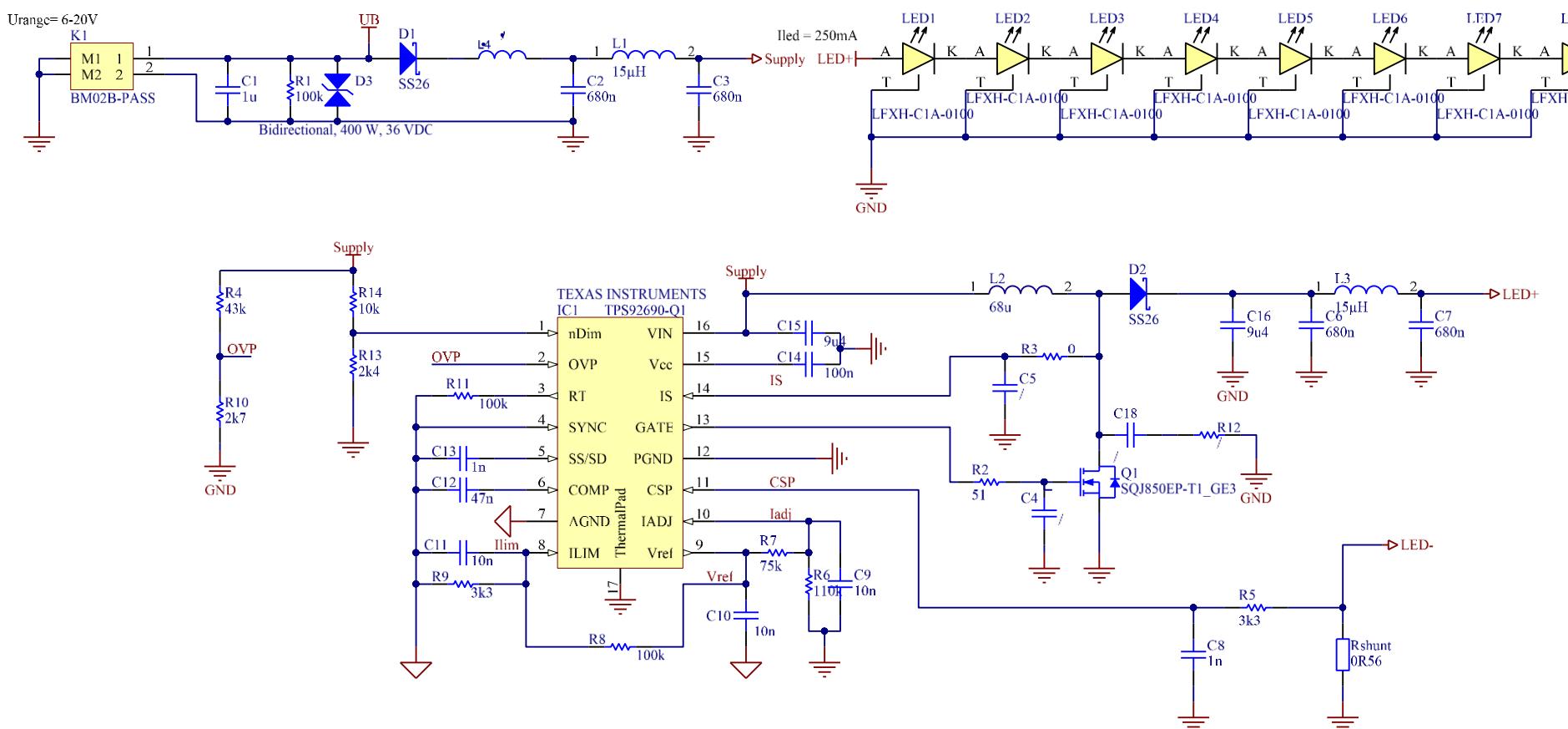
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81,12
80,75

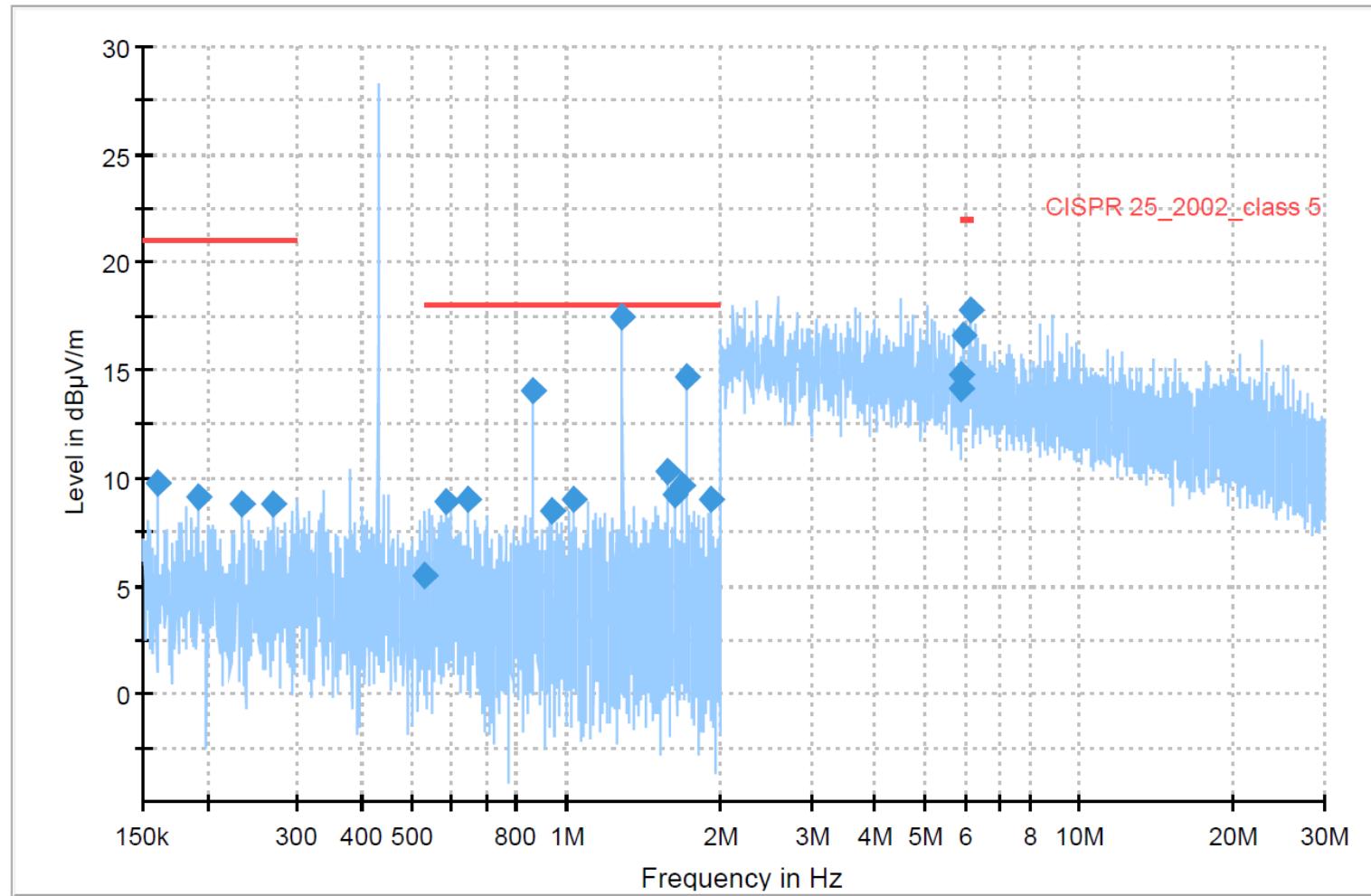


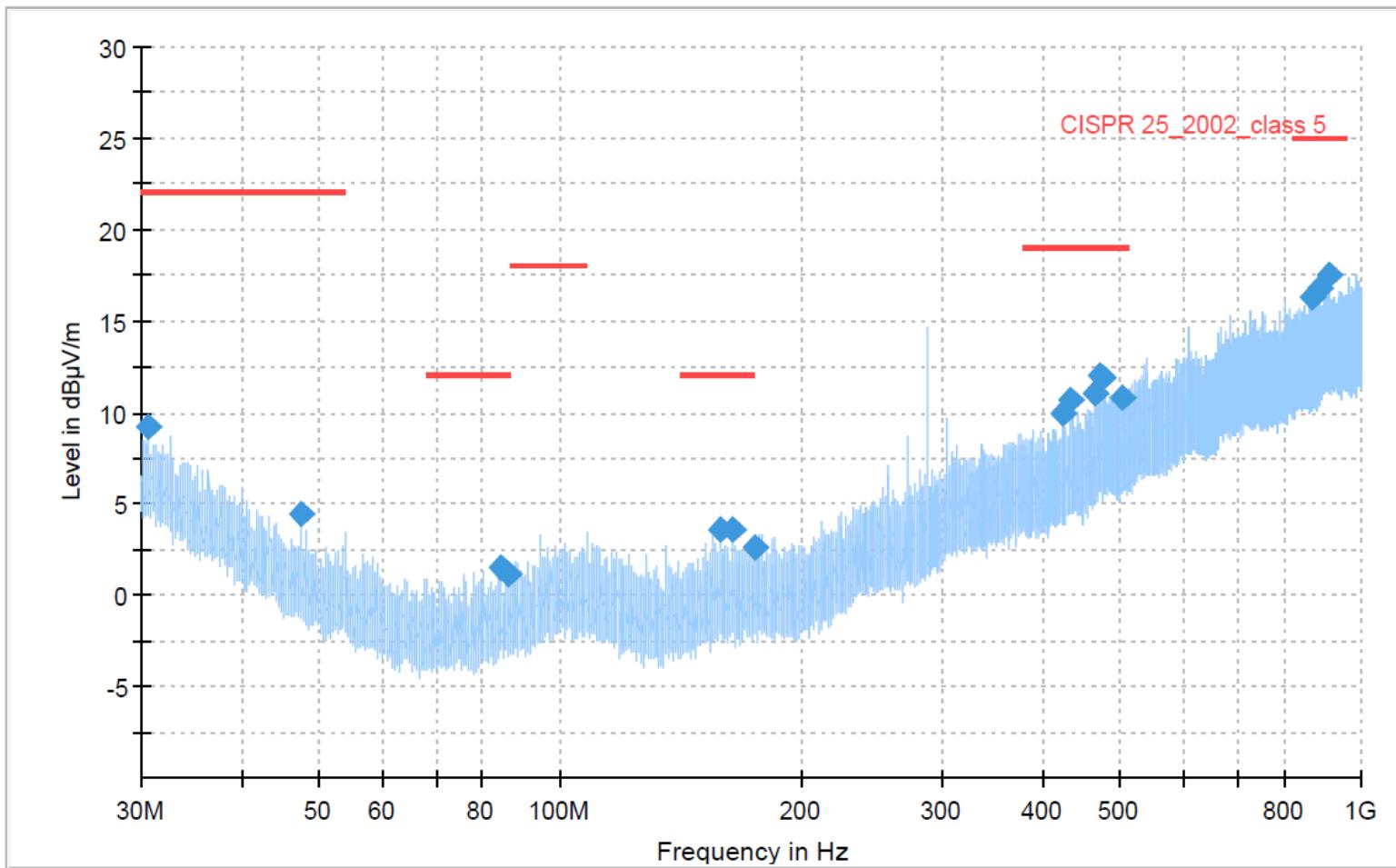
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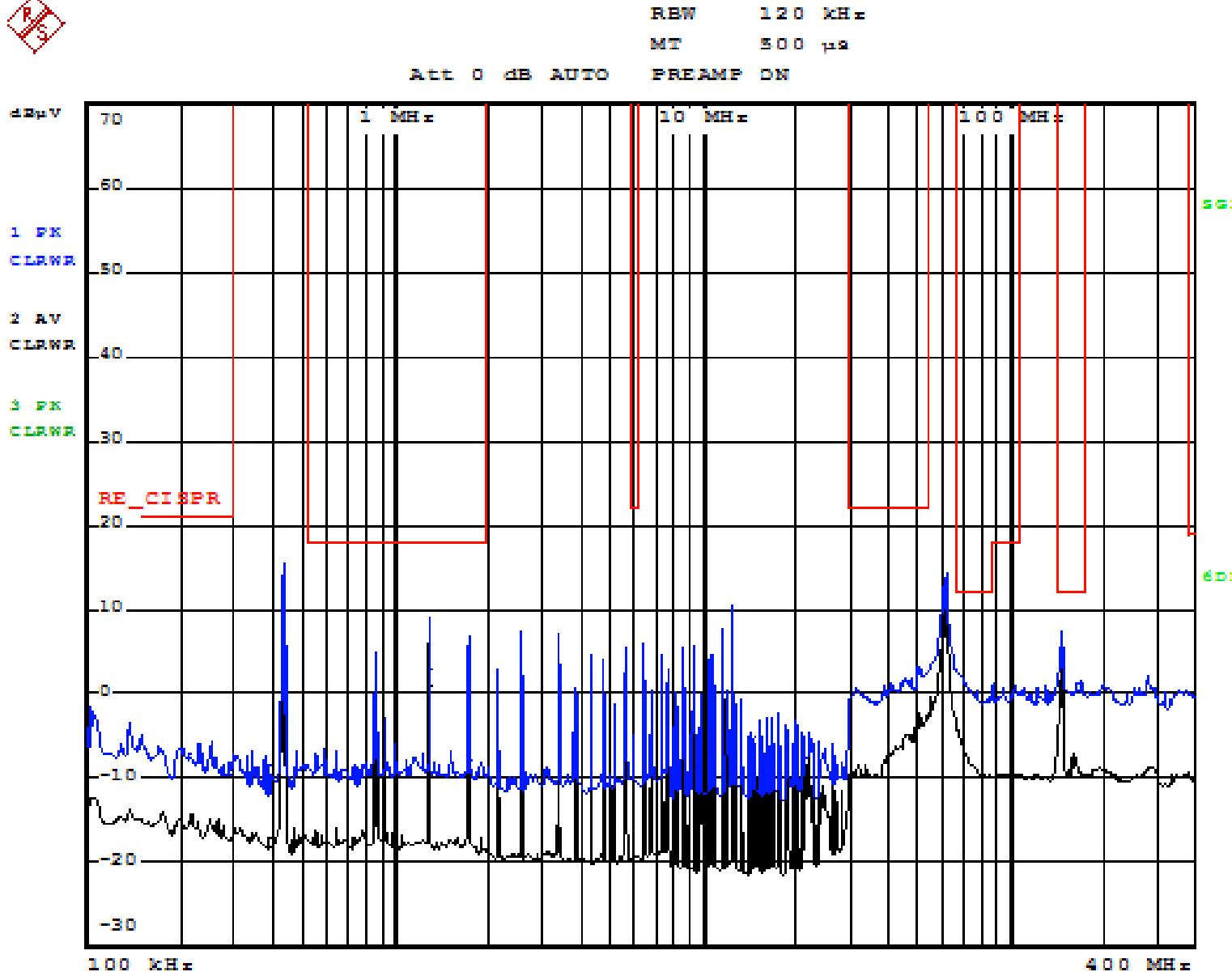
Matjaž Tome – razlika

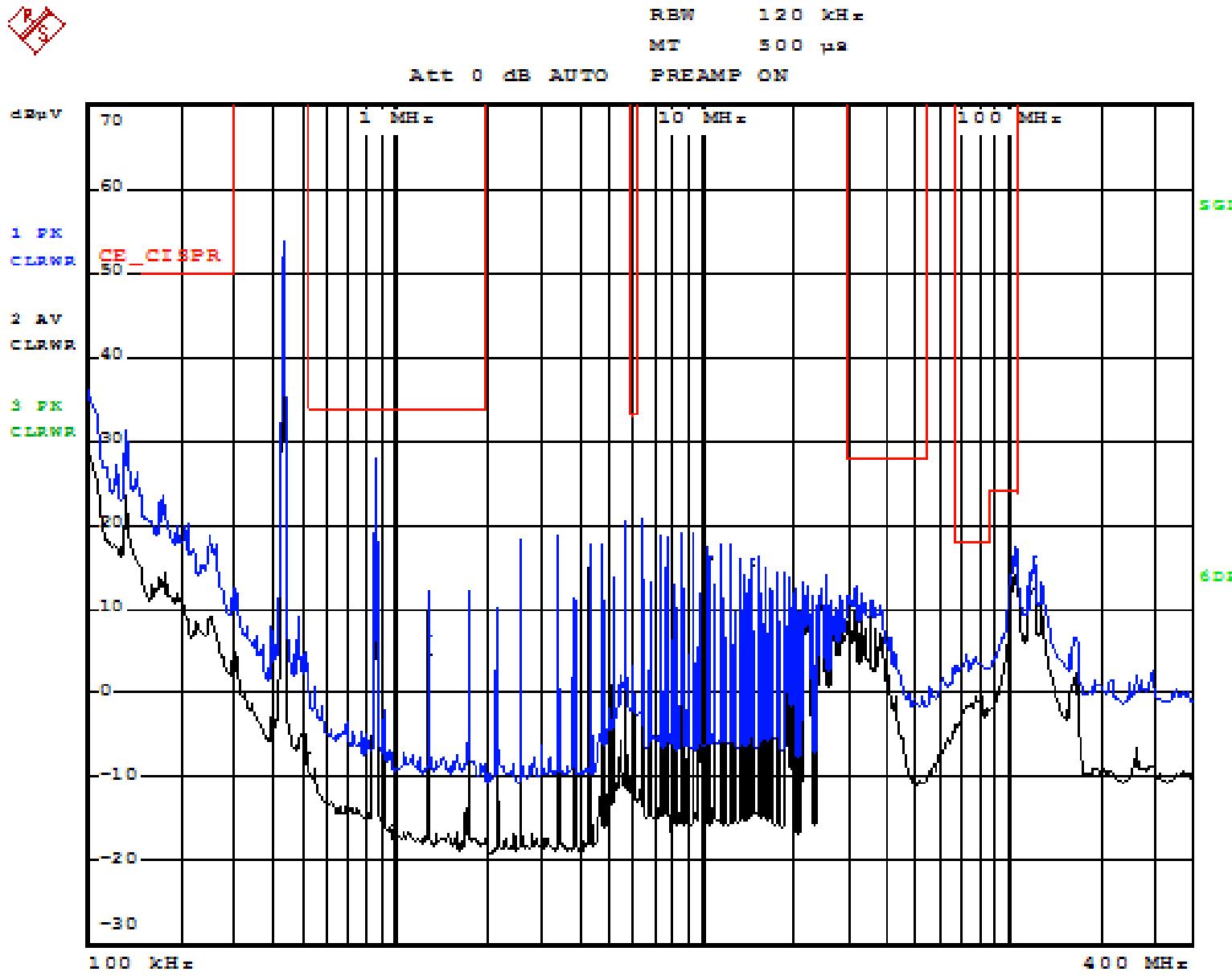




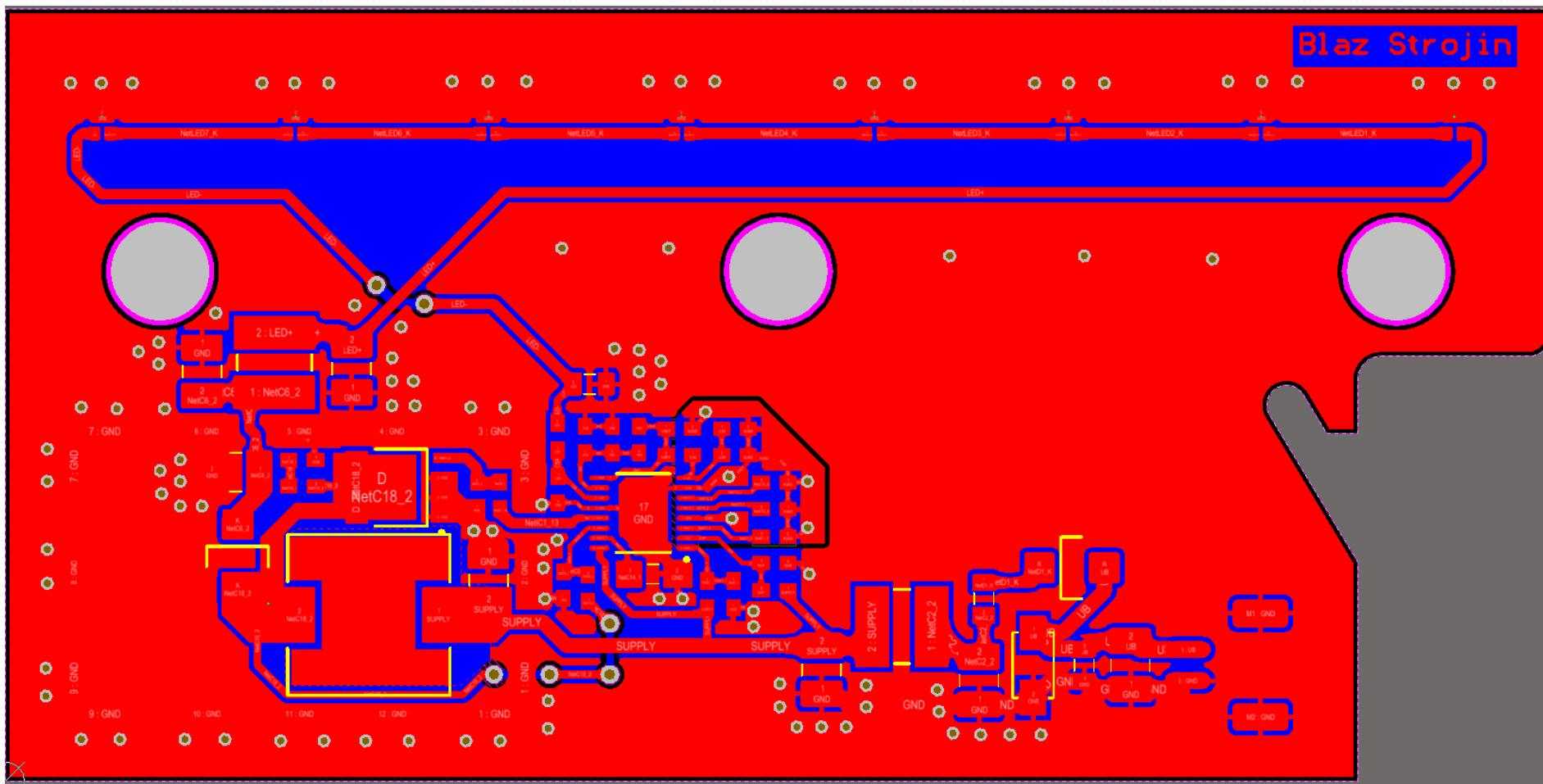


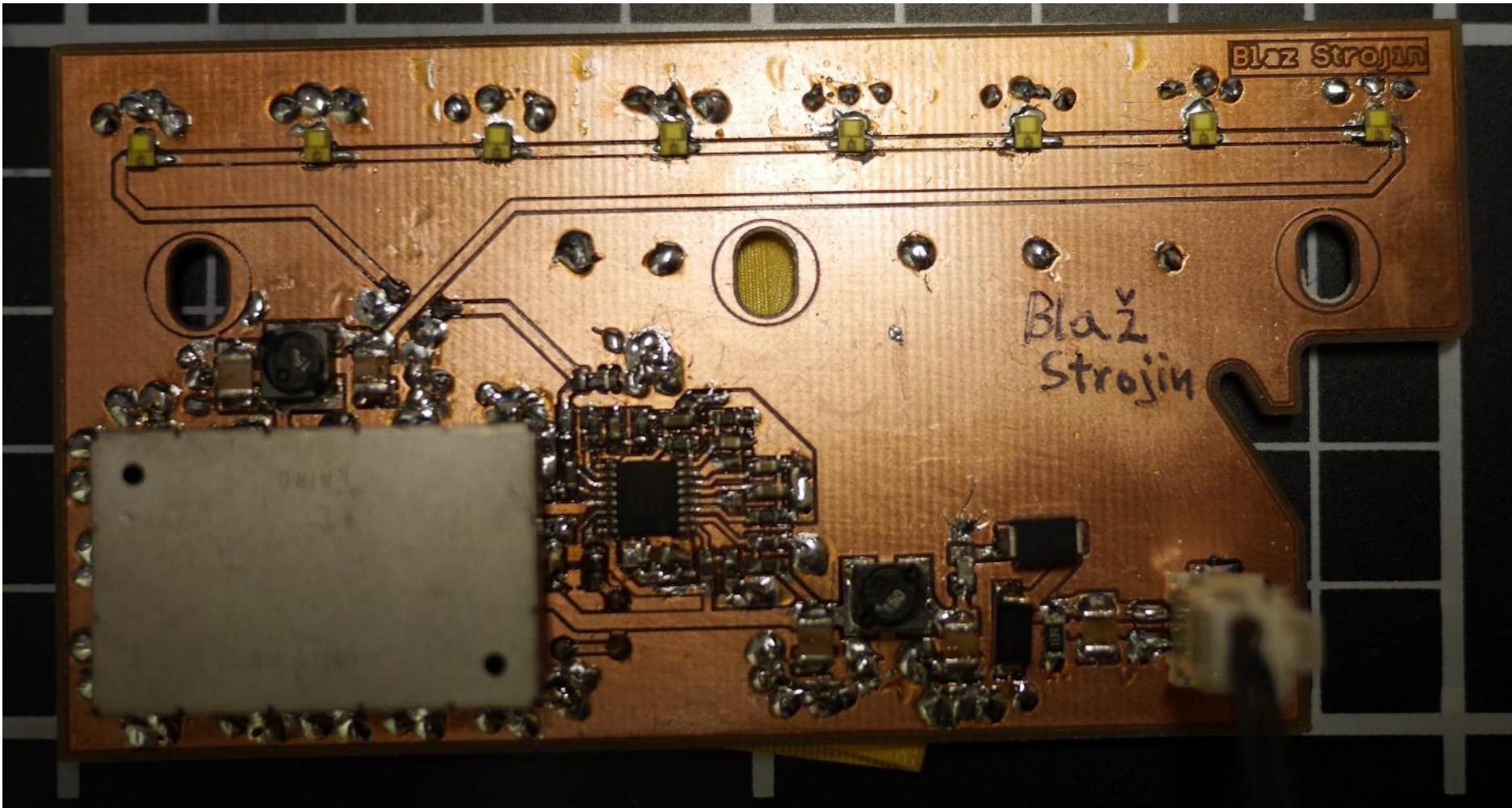


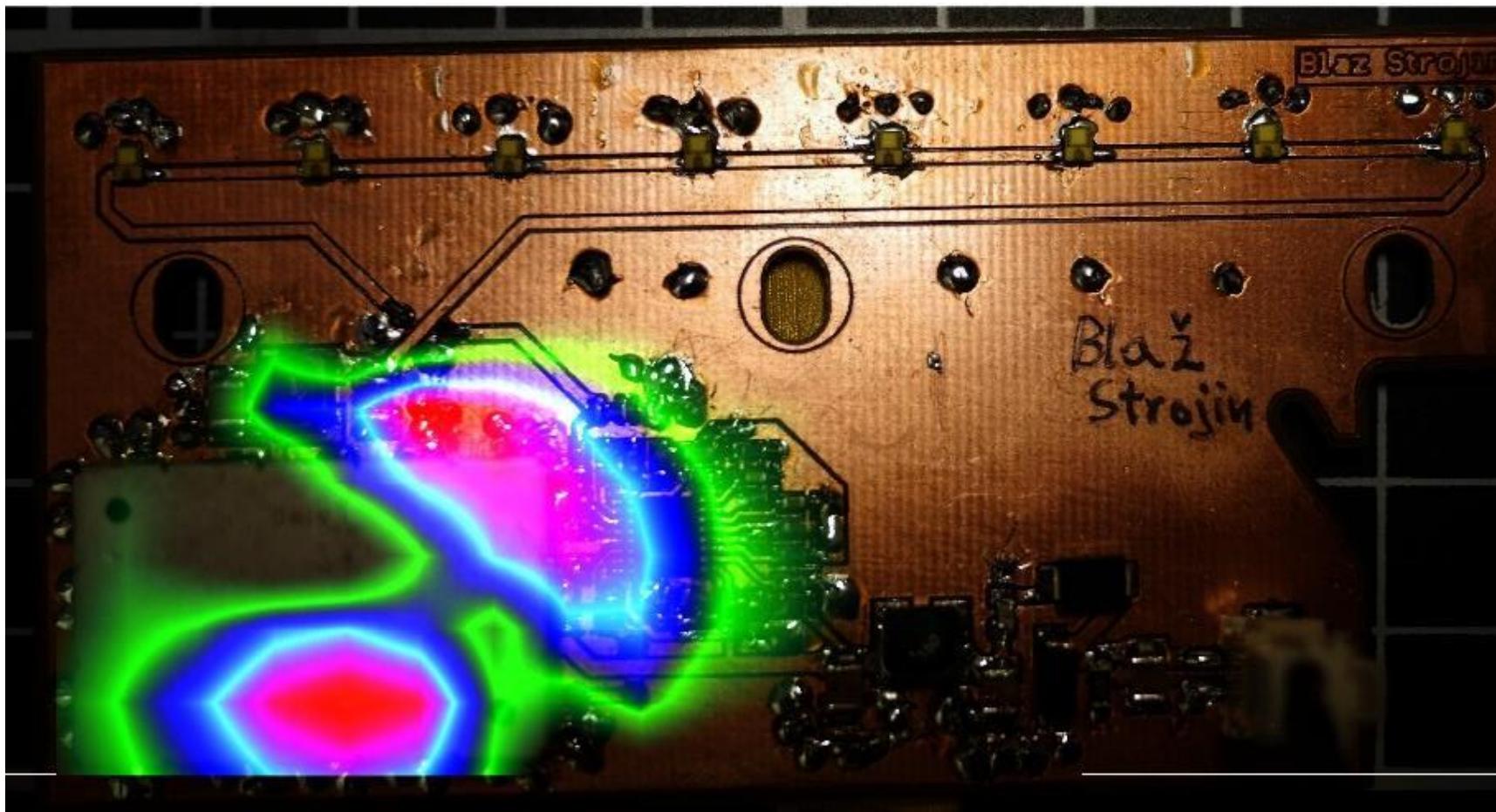


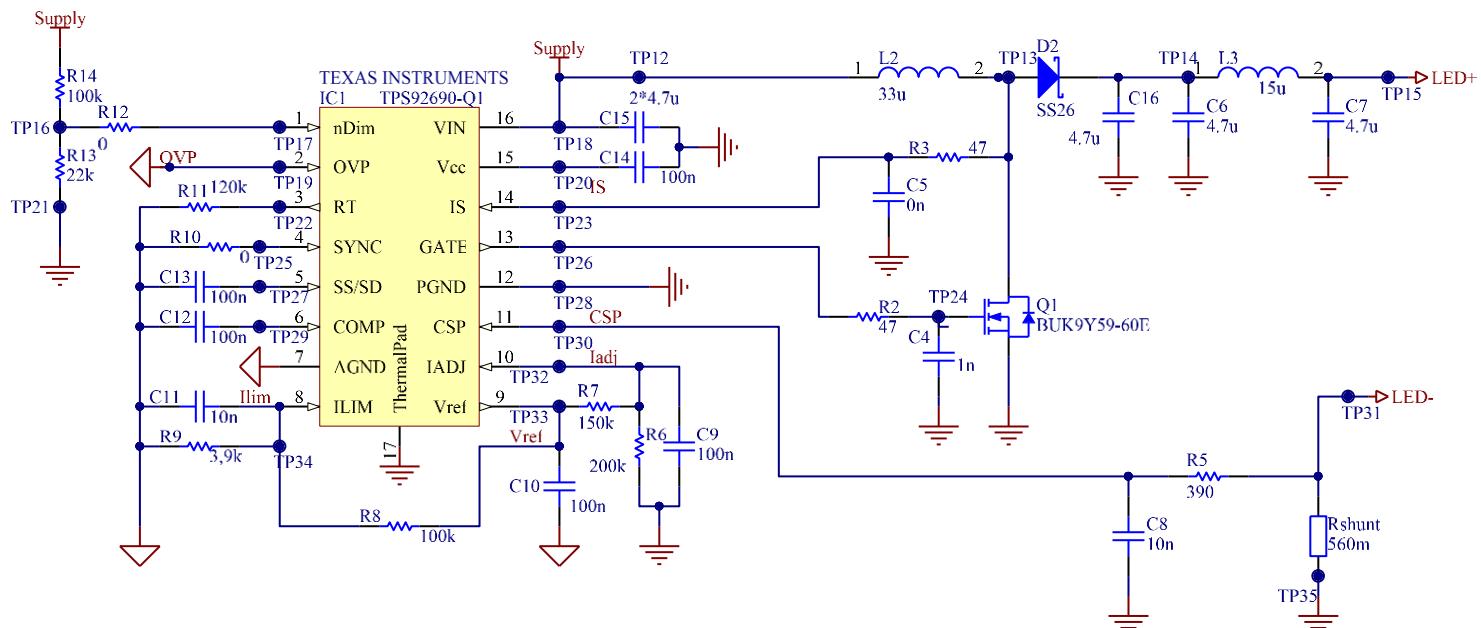
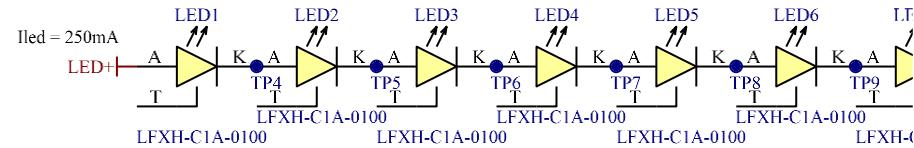
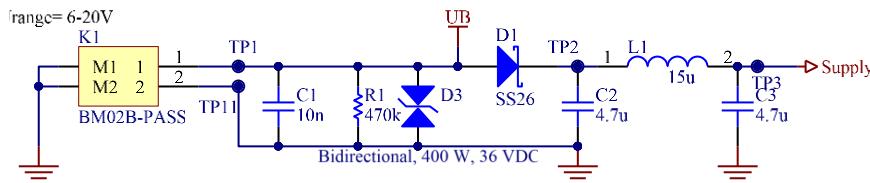


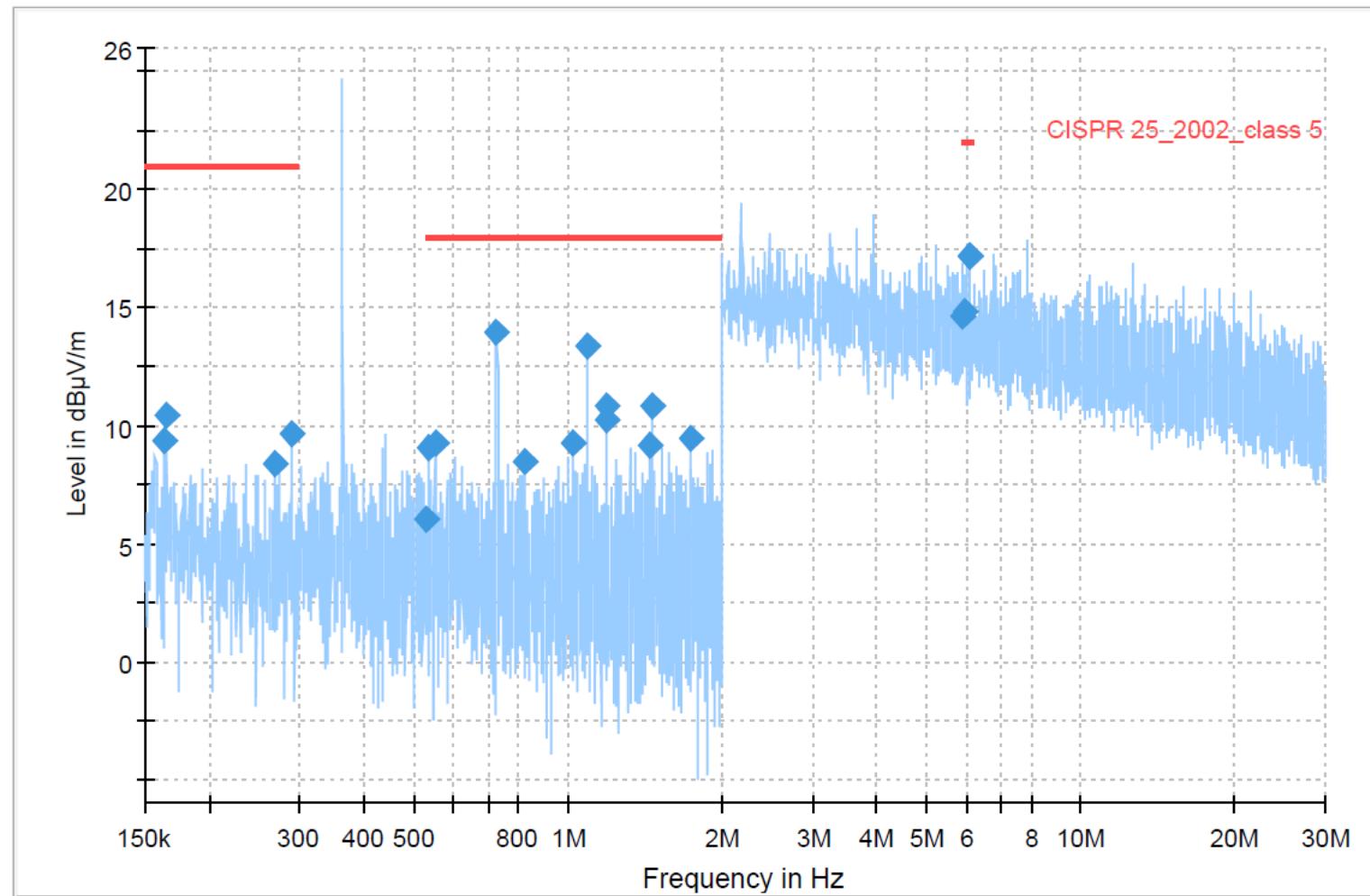
Blaž Strojin

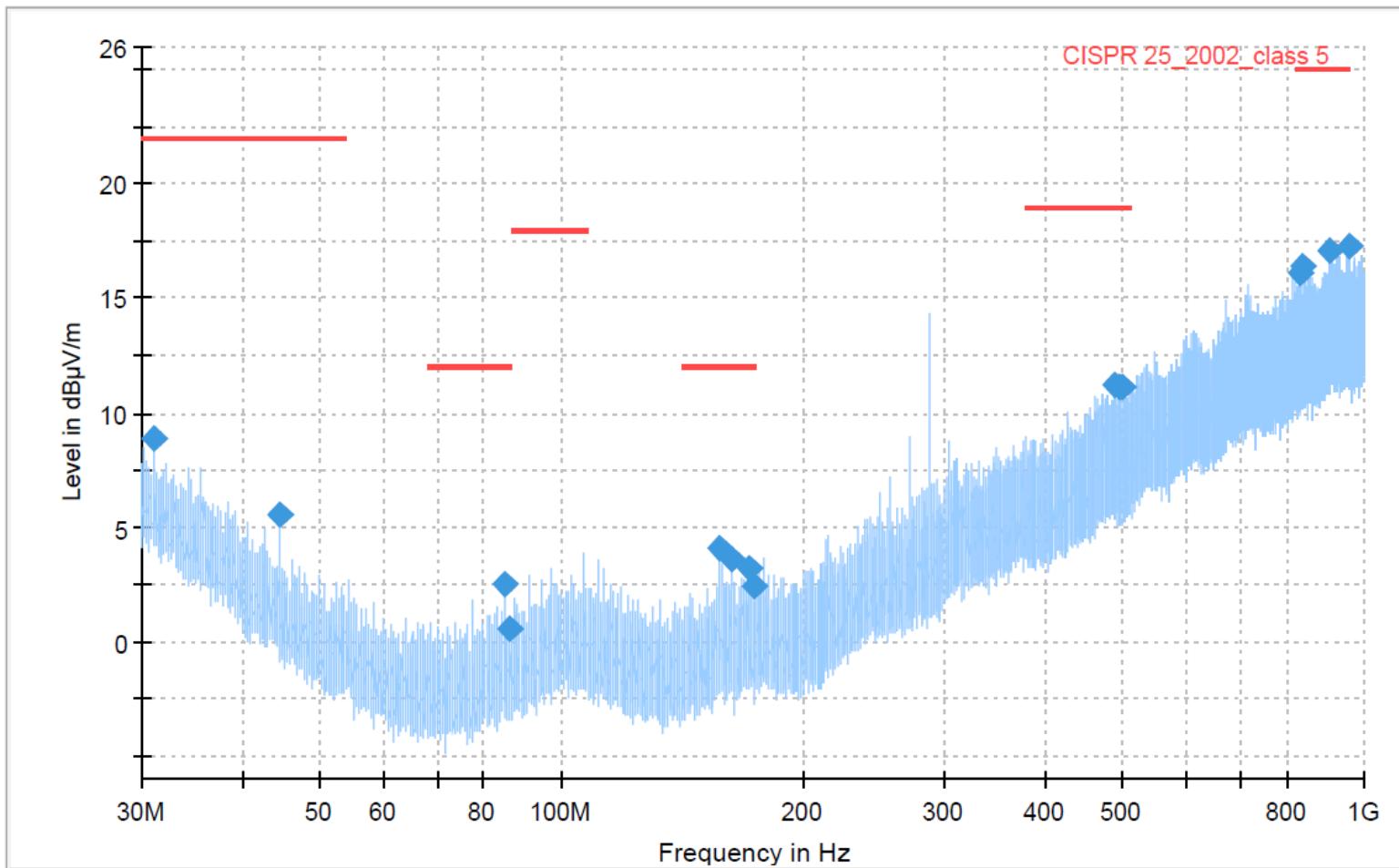


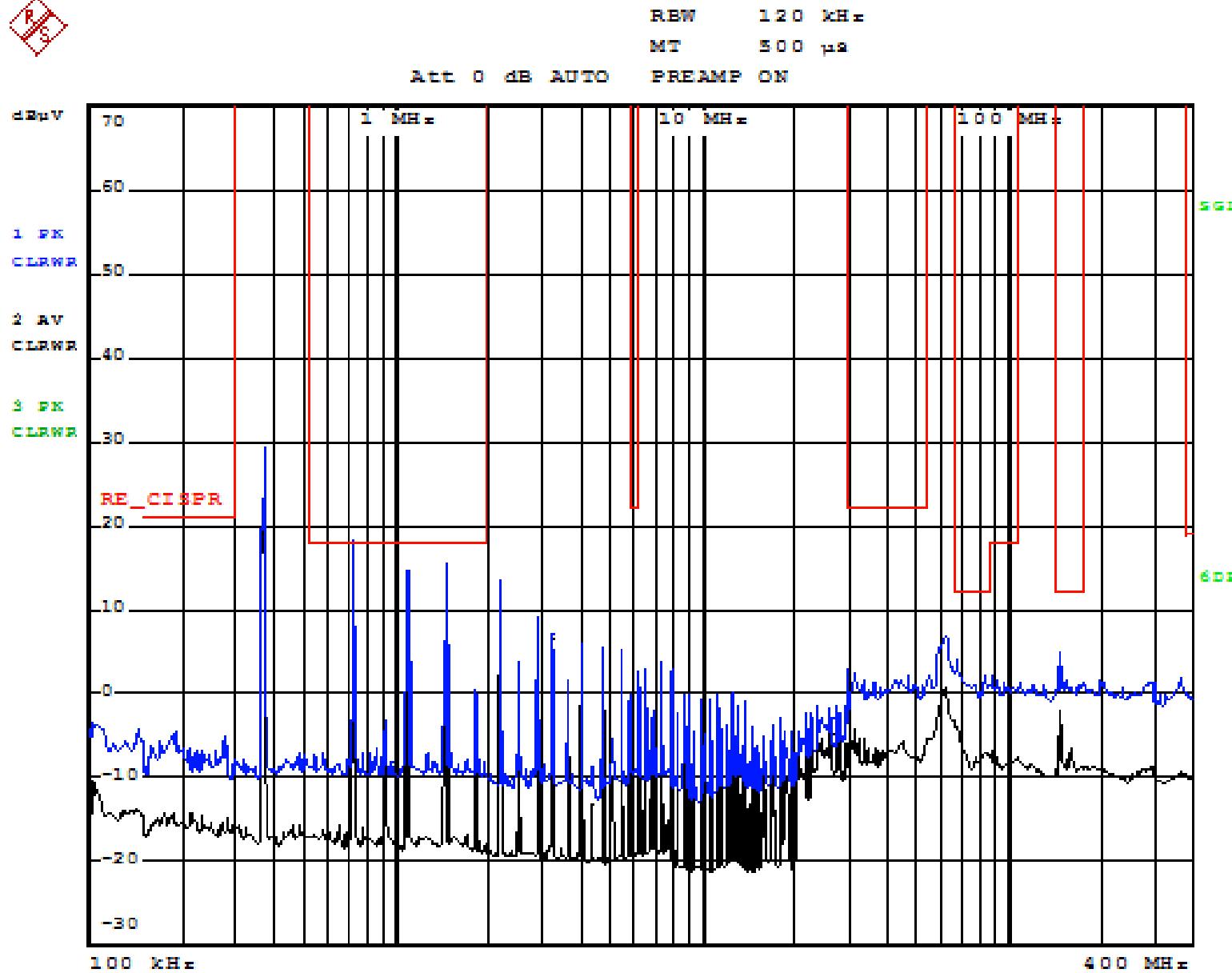


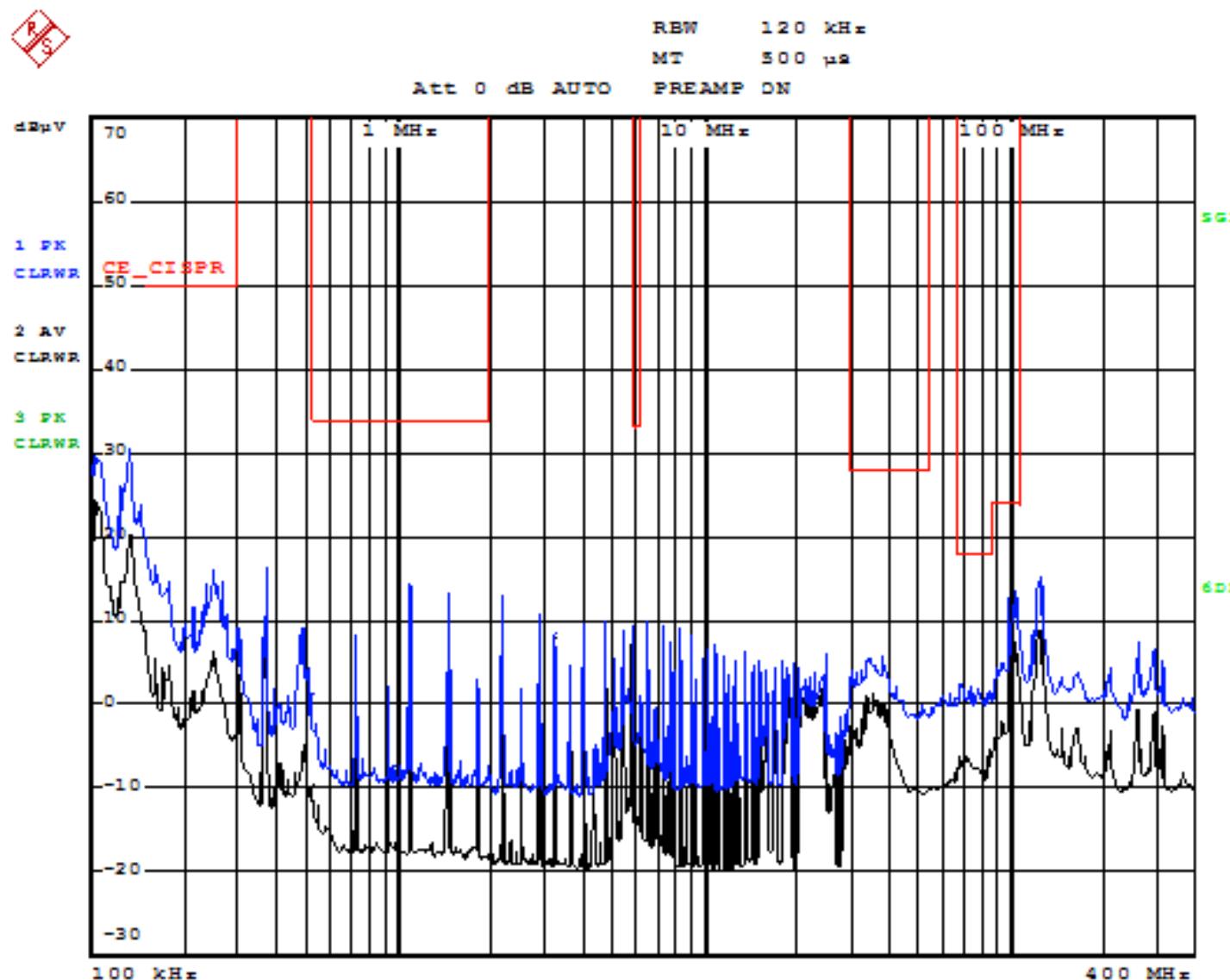


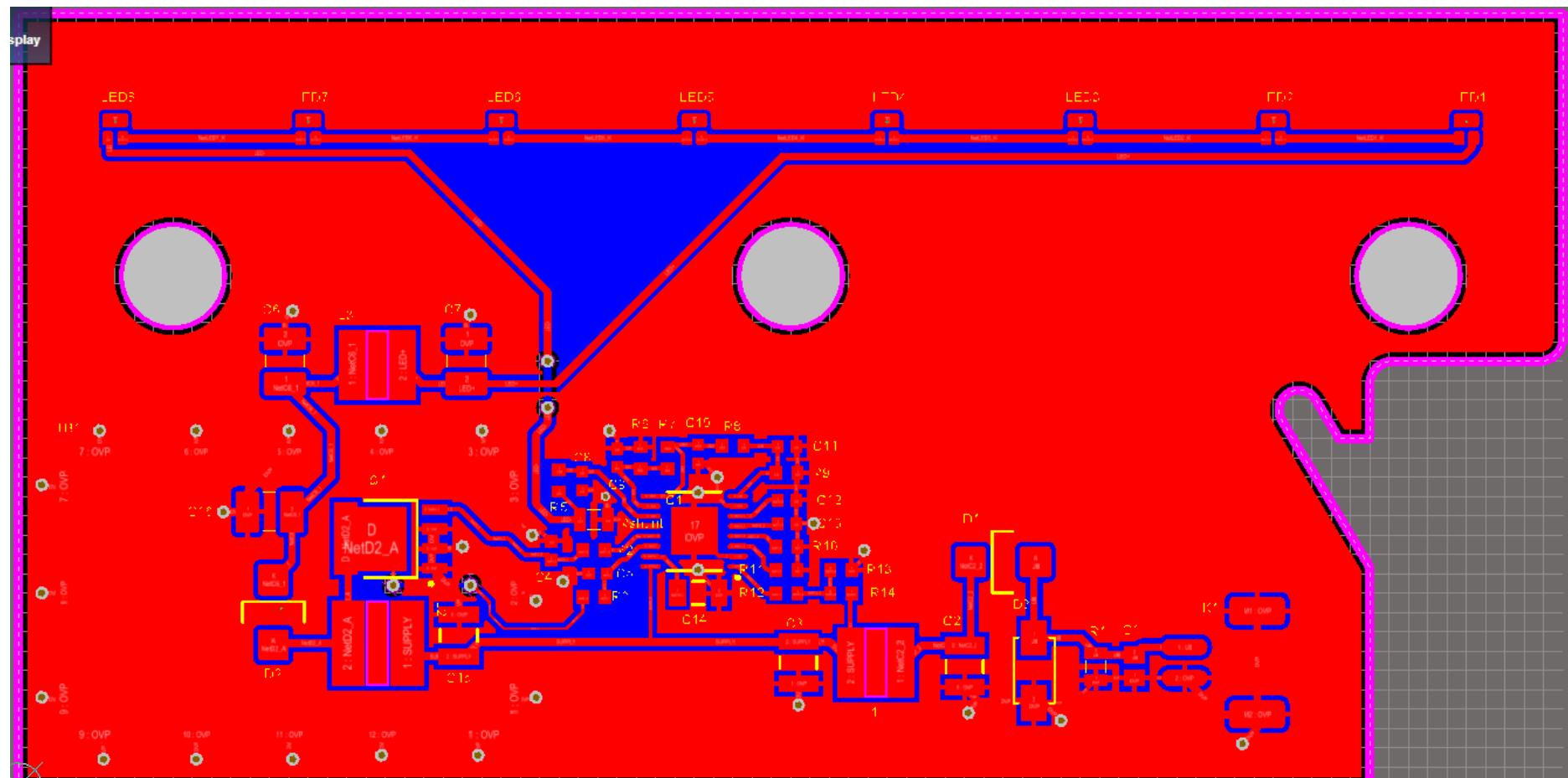


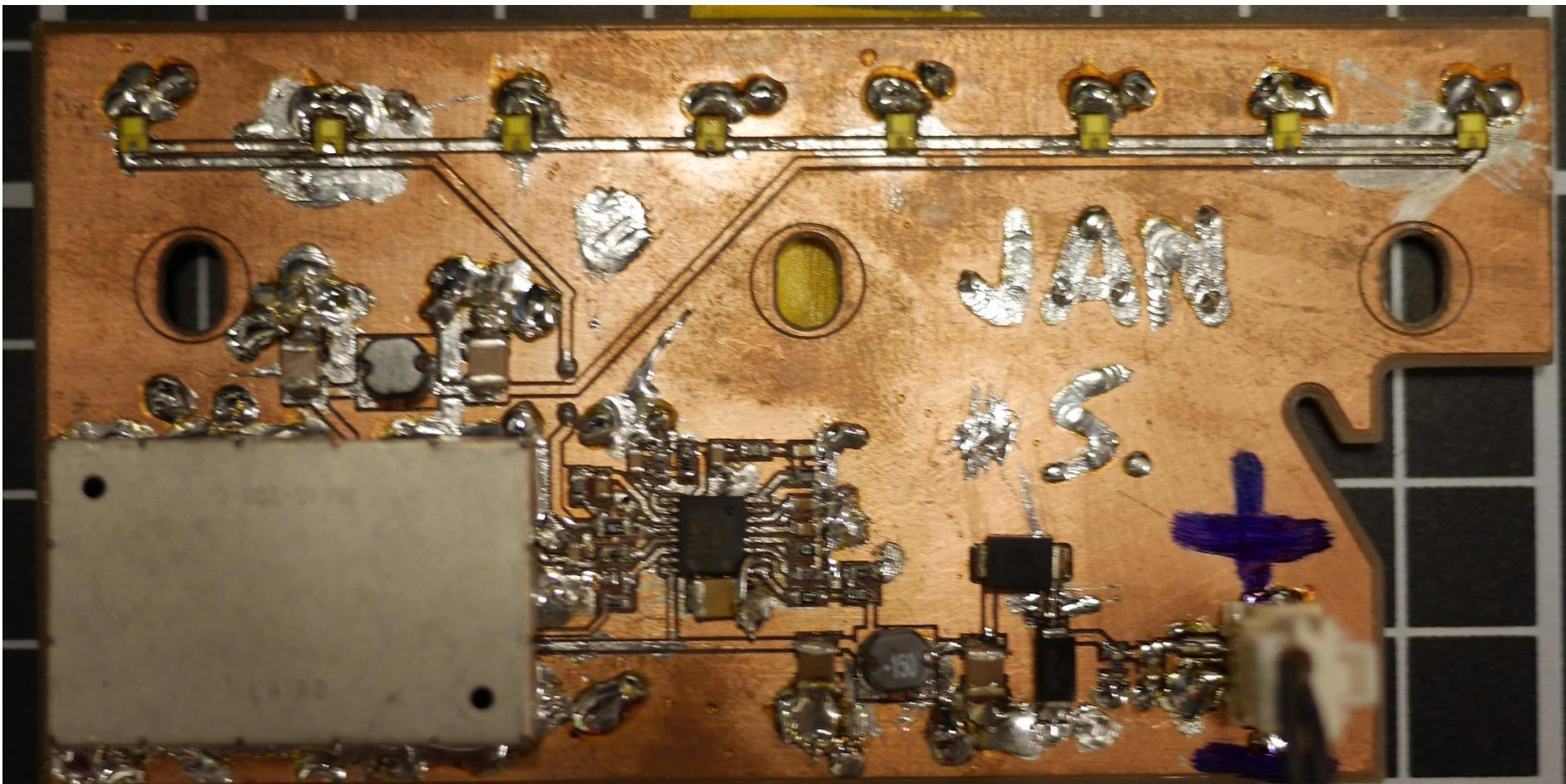


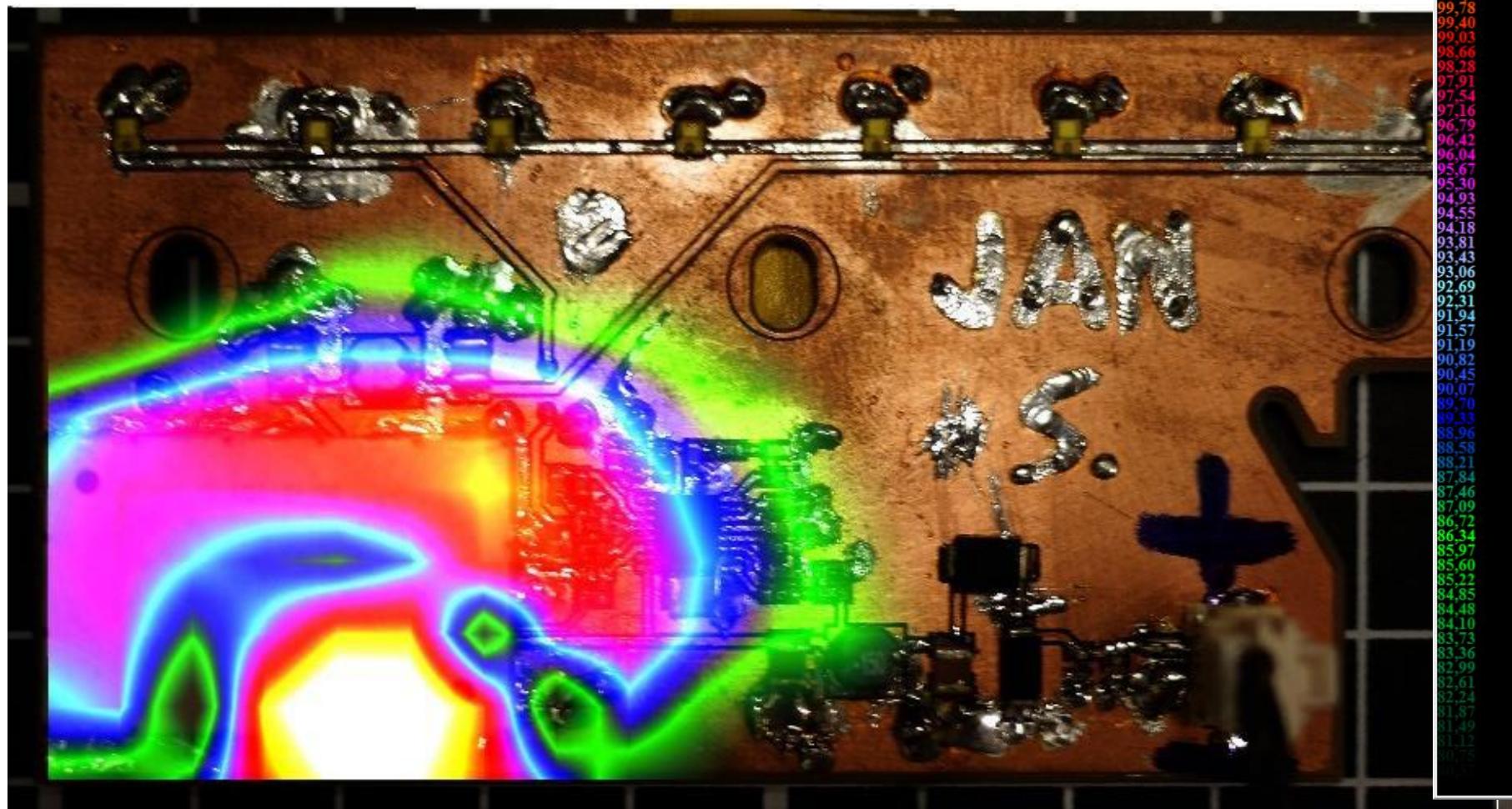


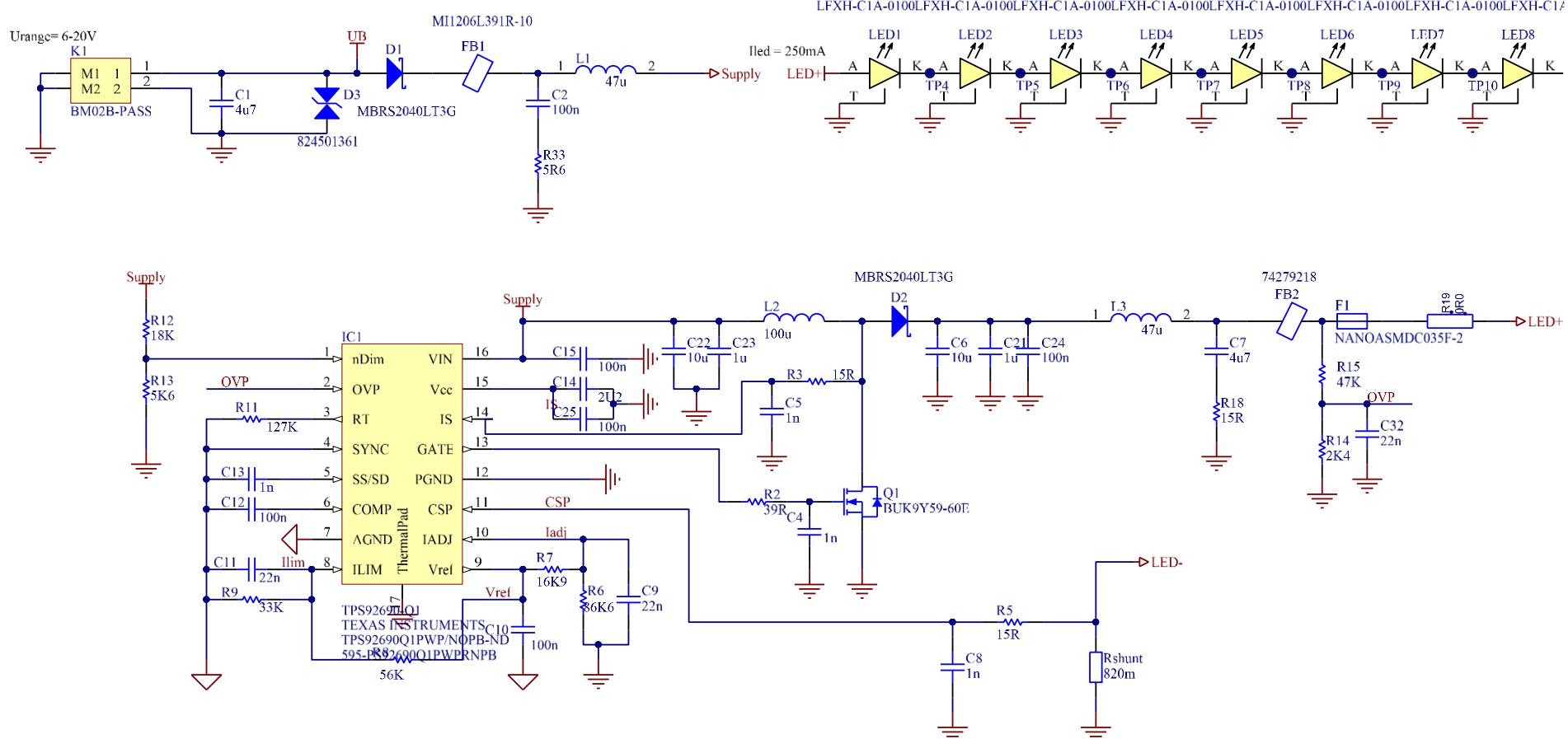


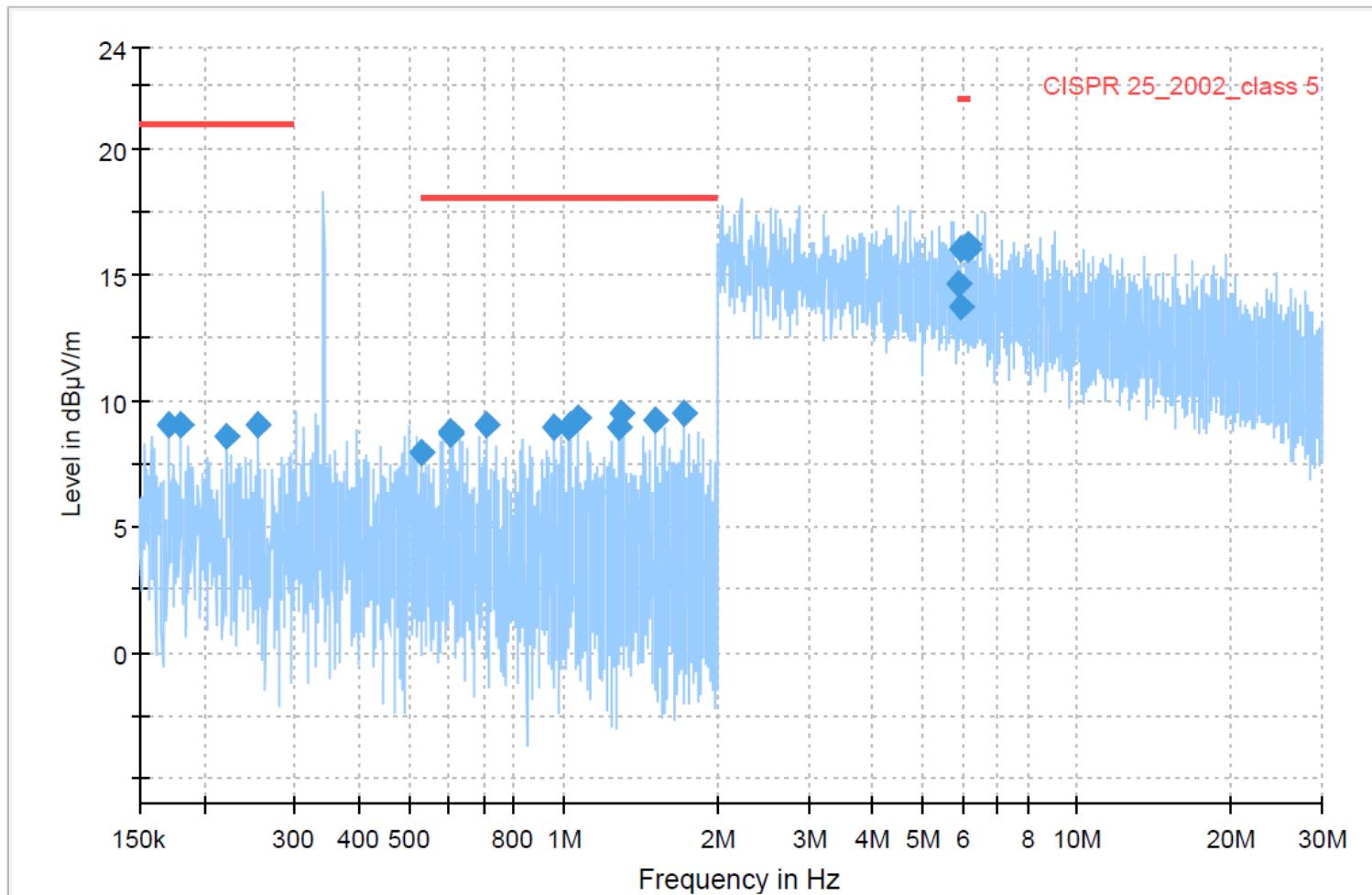


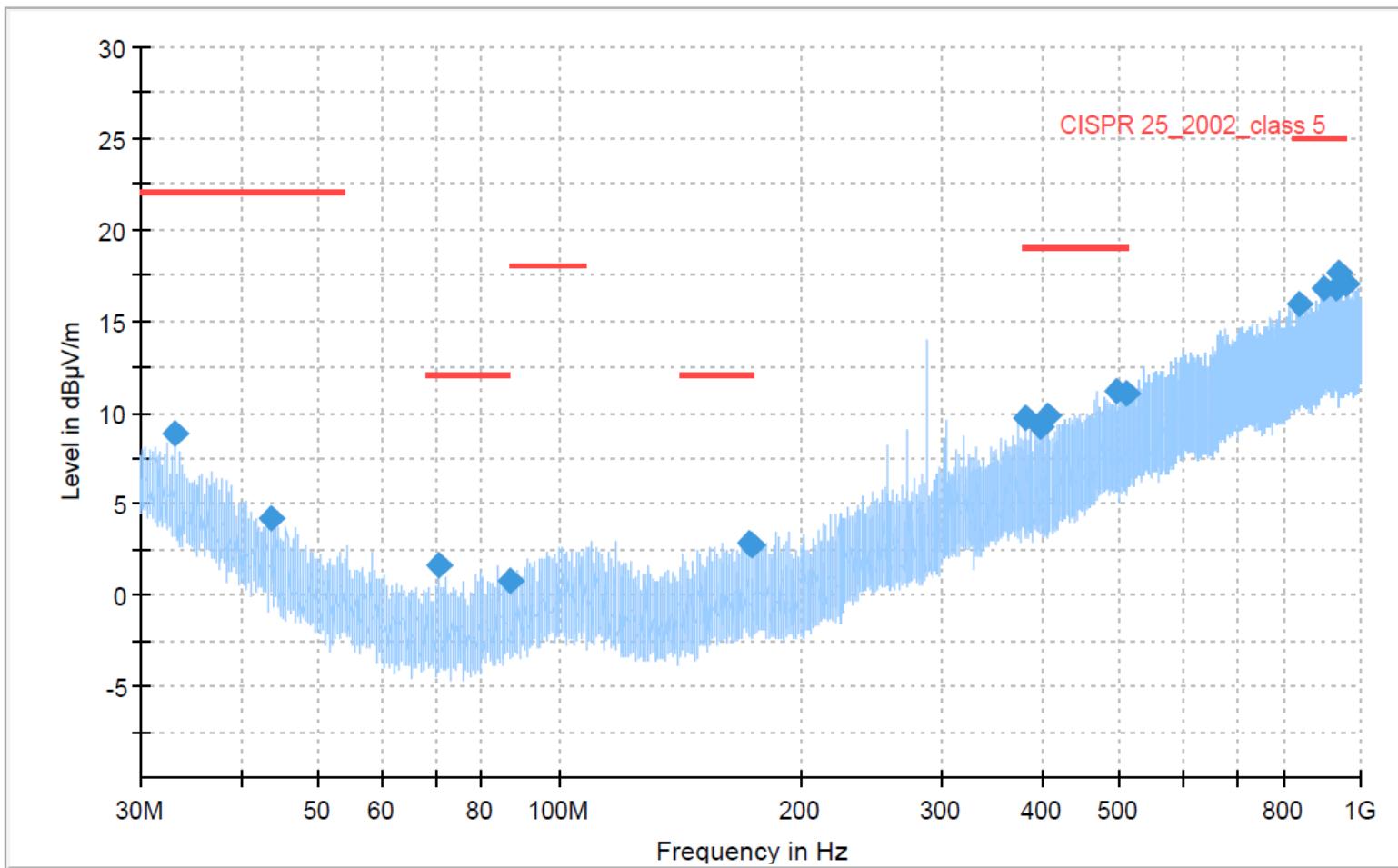


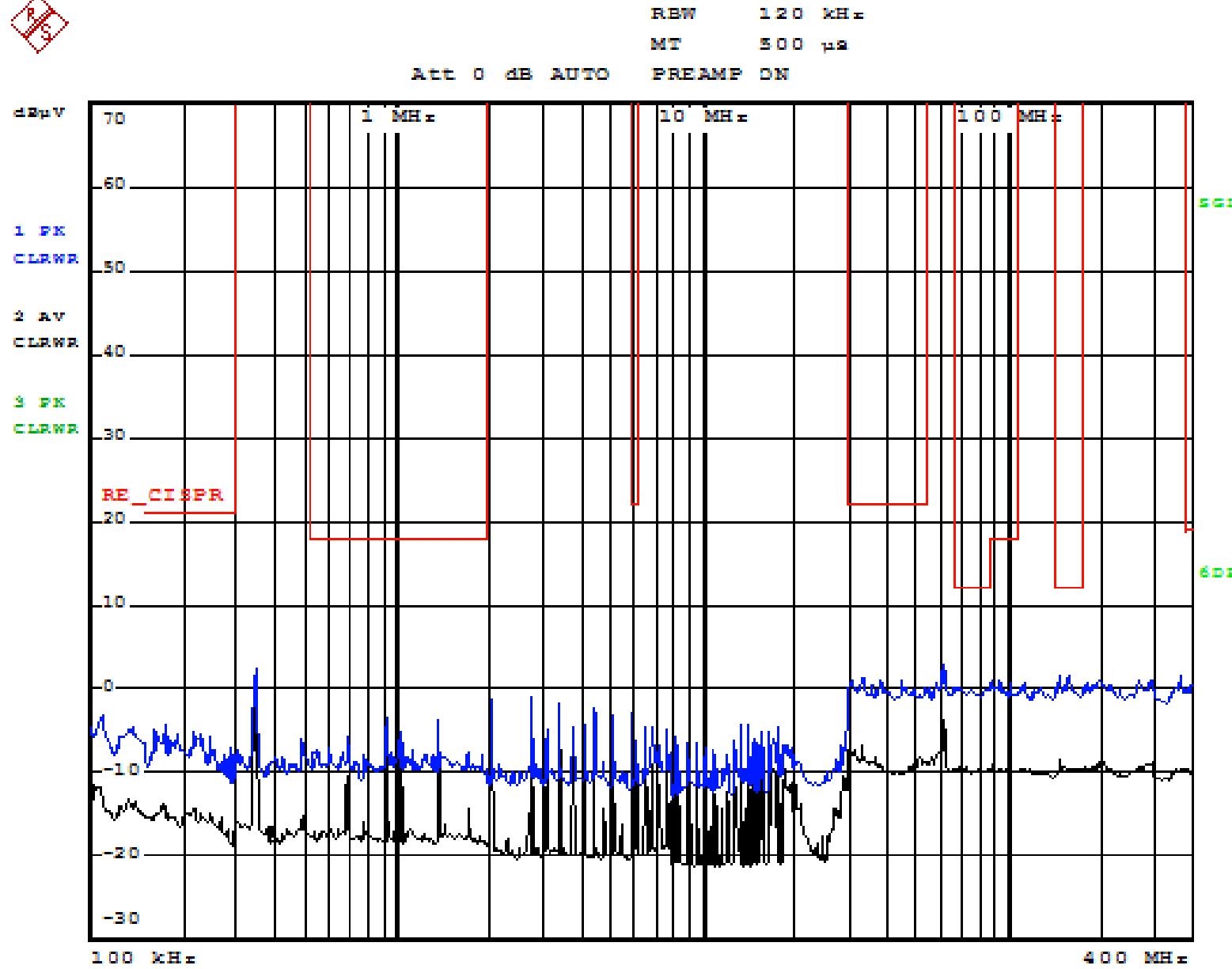








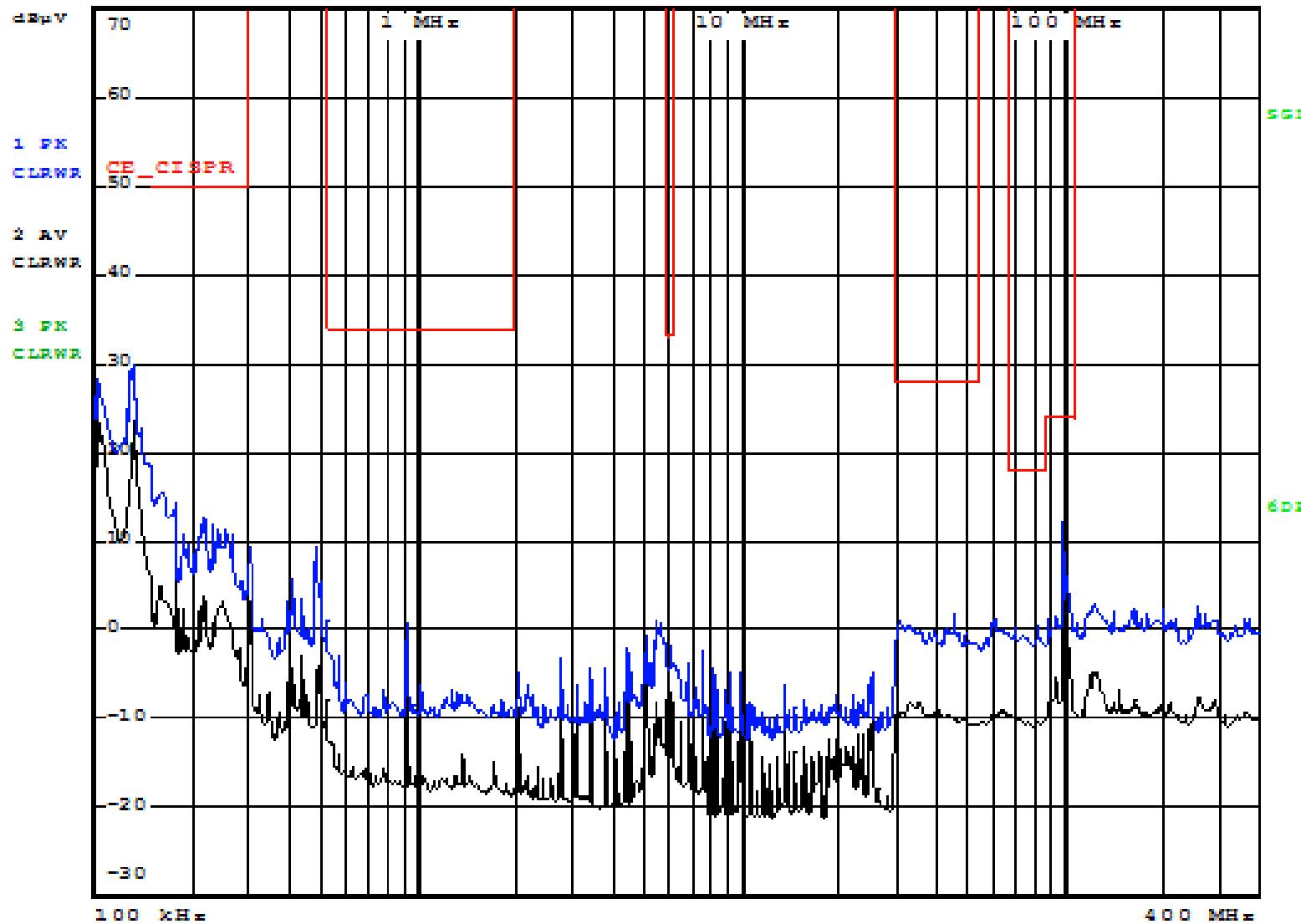




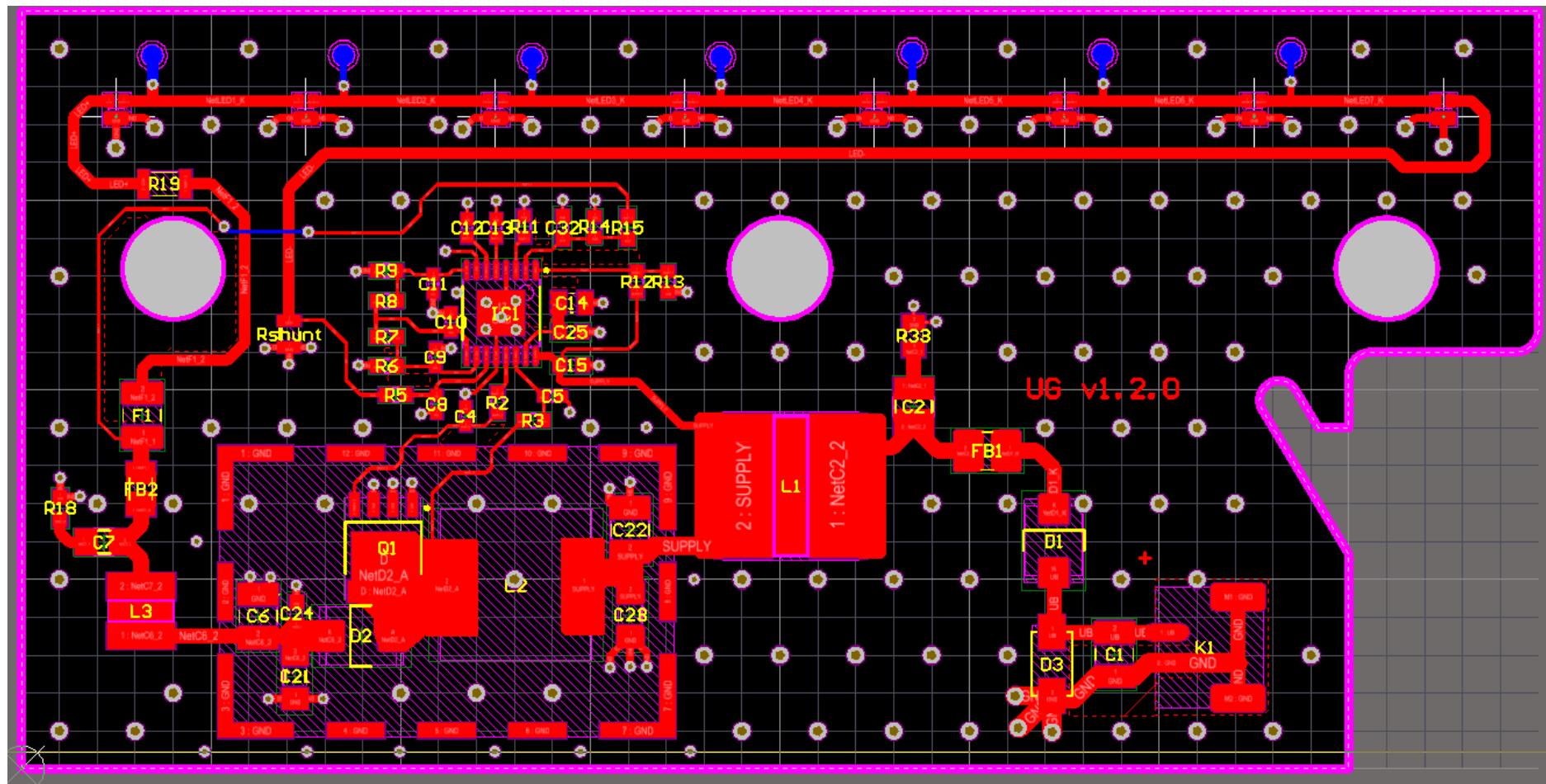


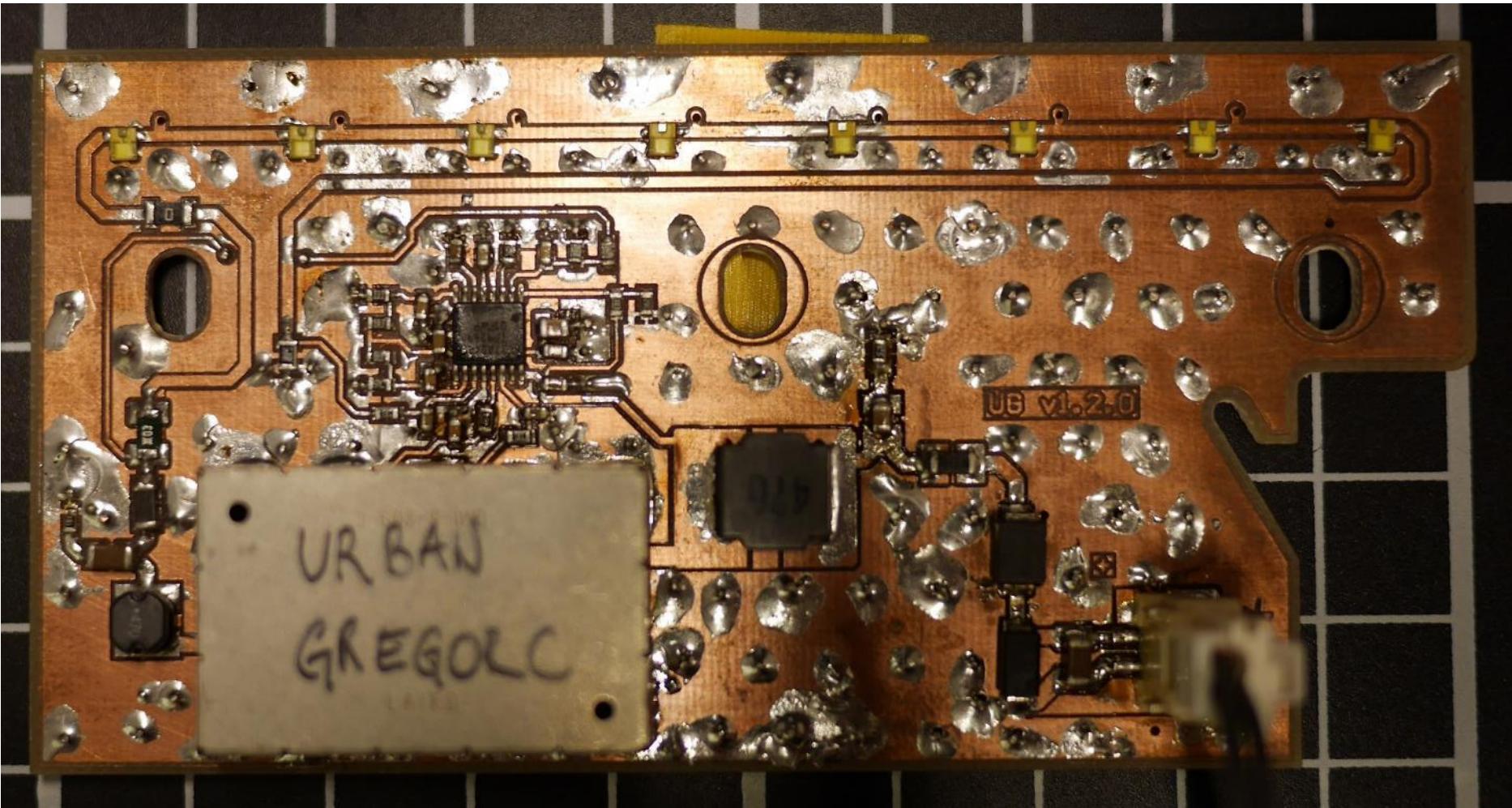
RBW 120 kHz
MT 500 μs

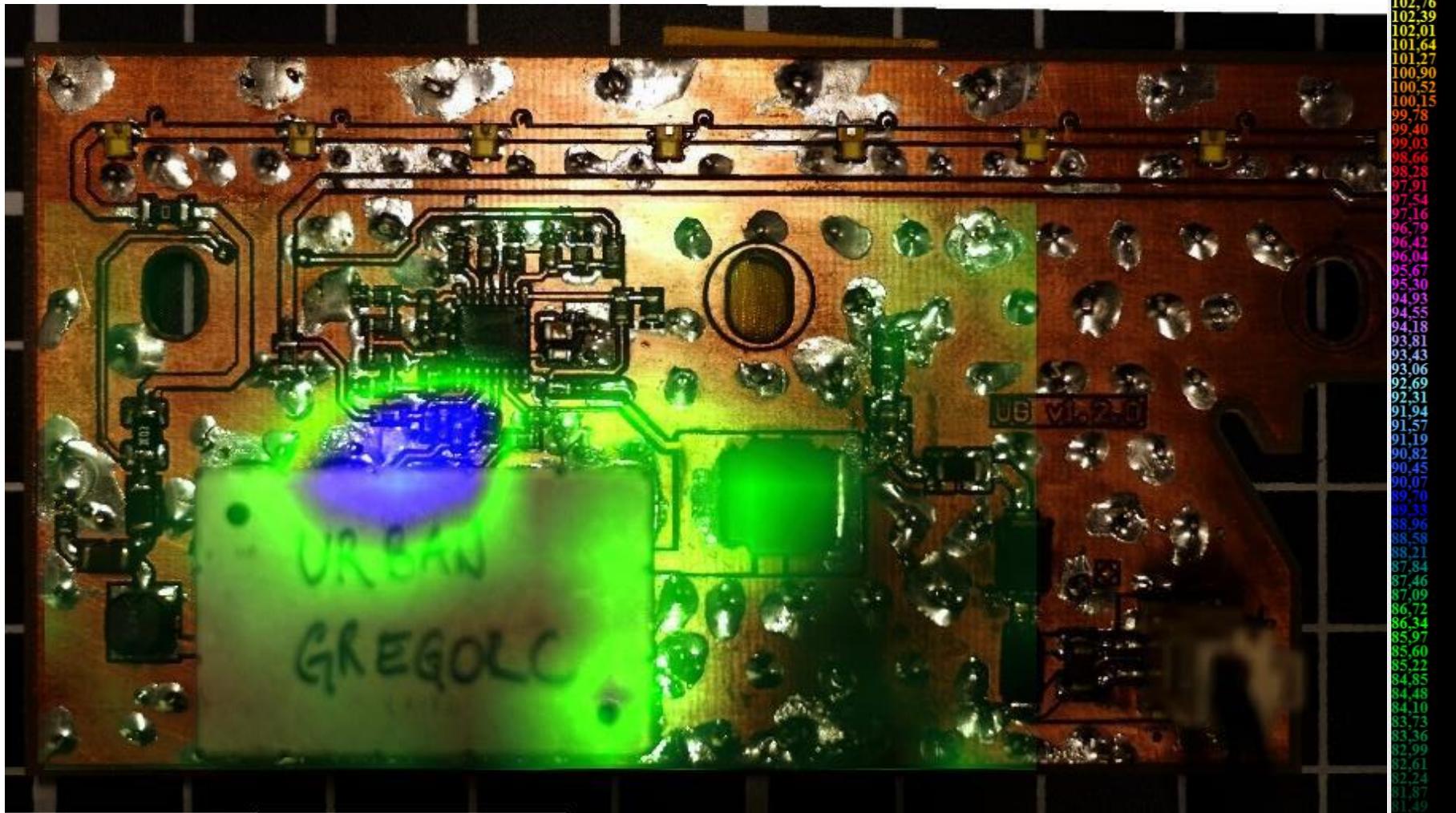
Att 0 dB AUTO PREAMP ON



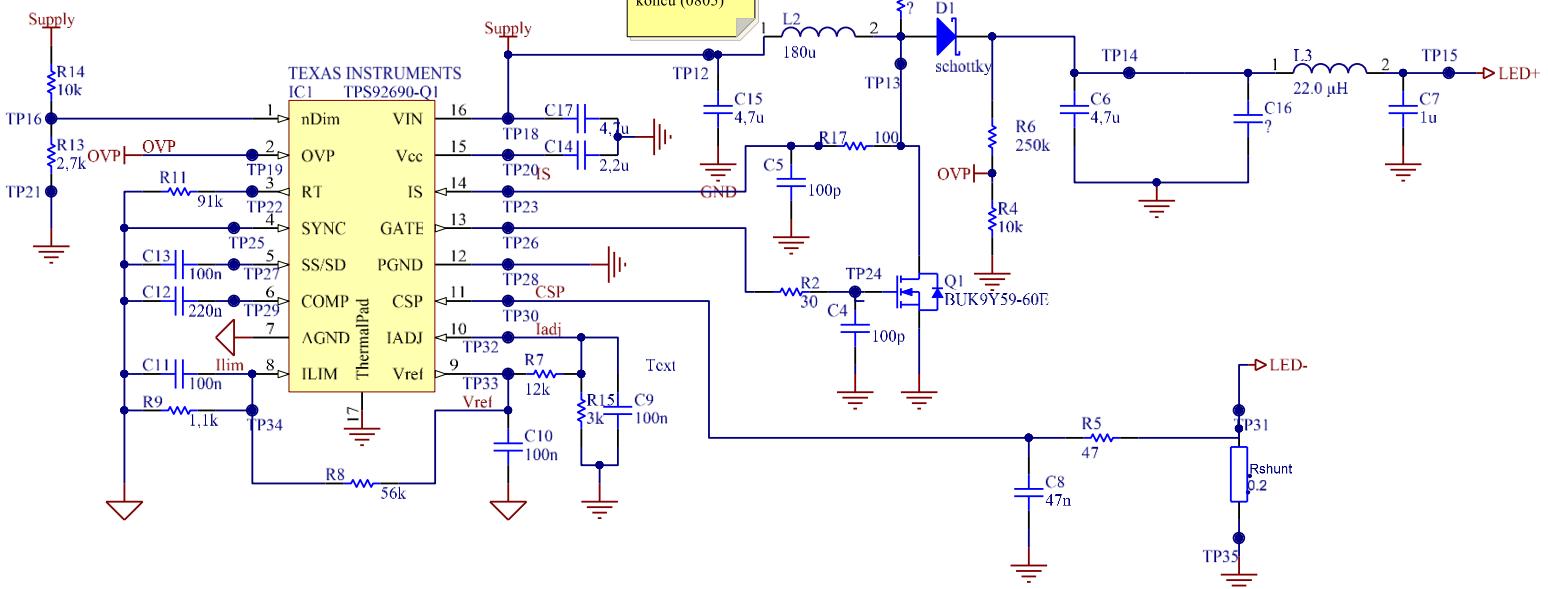
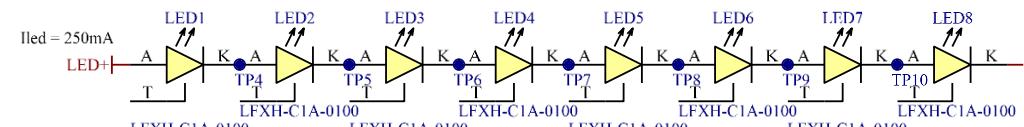
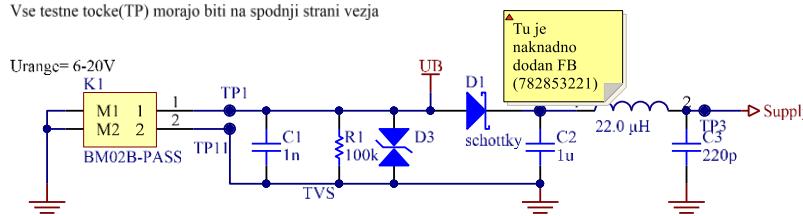
Urban Gregorc

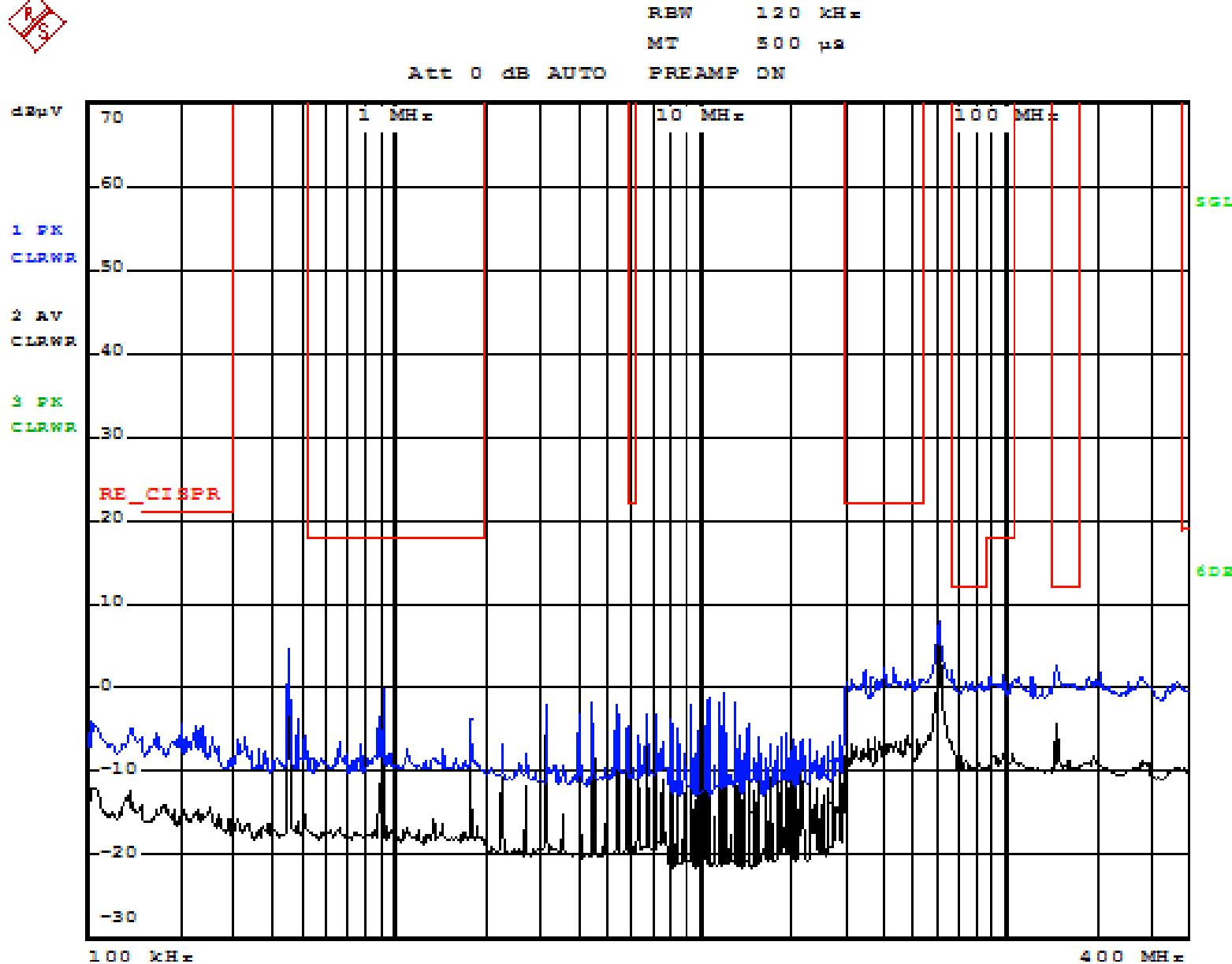


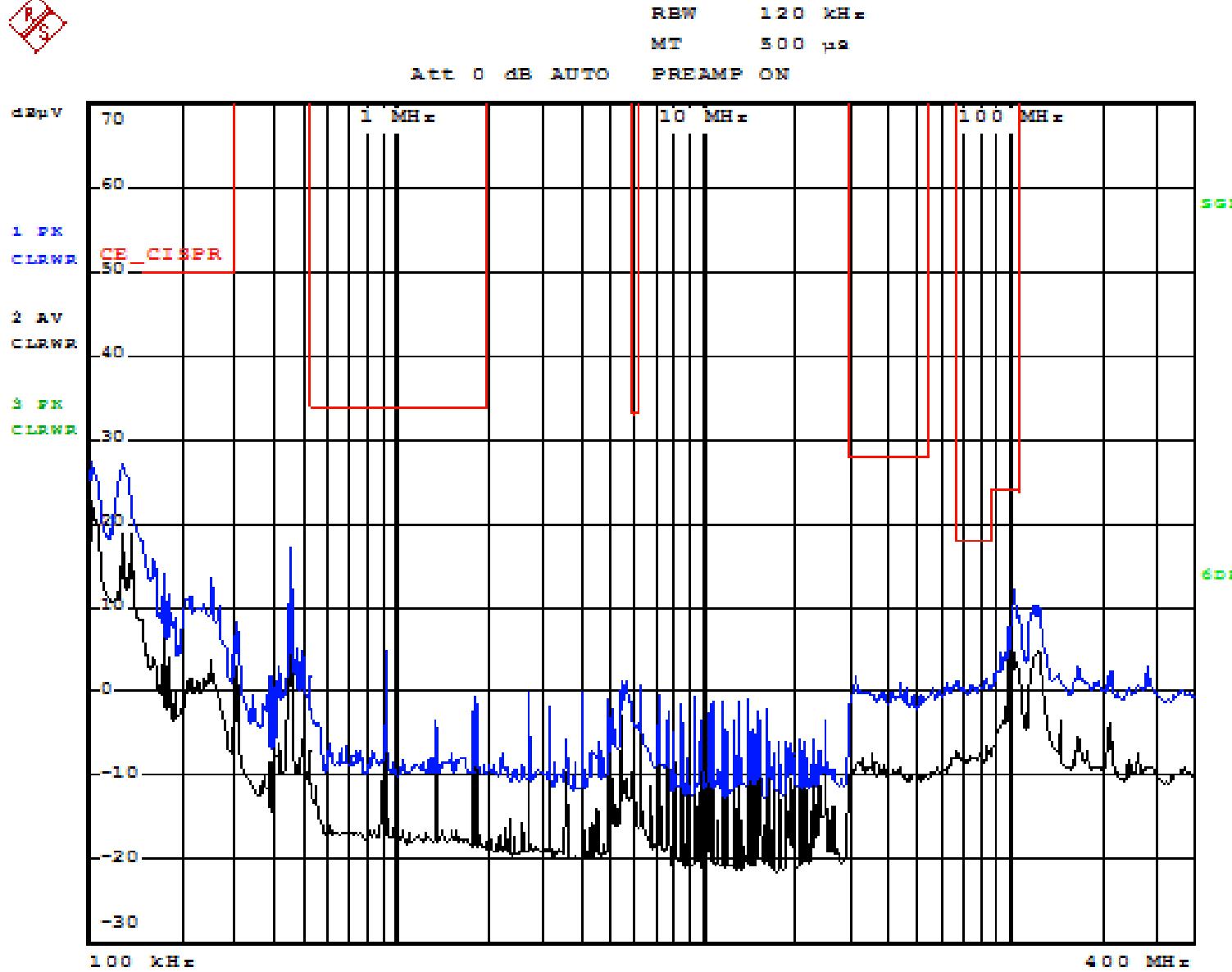


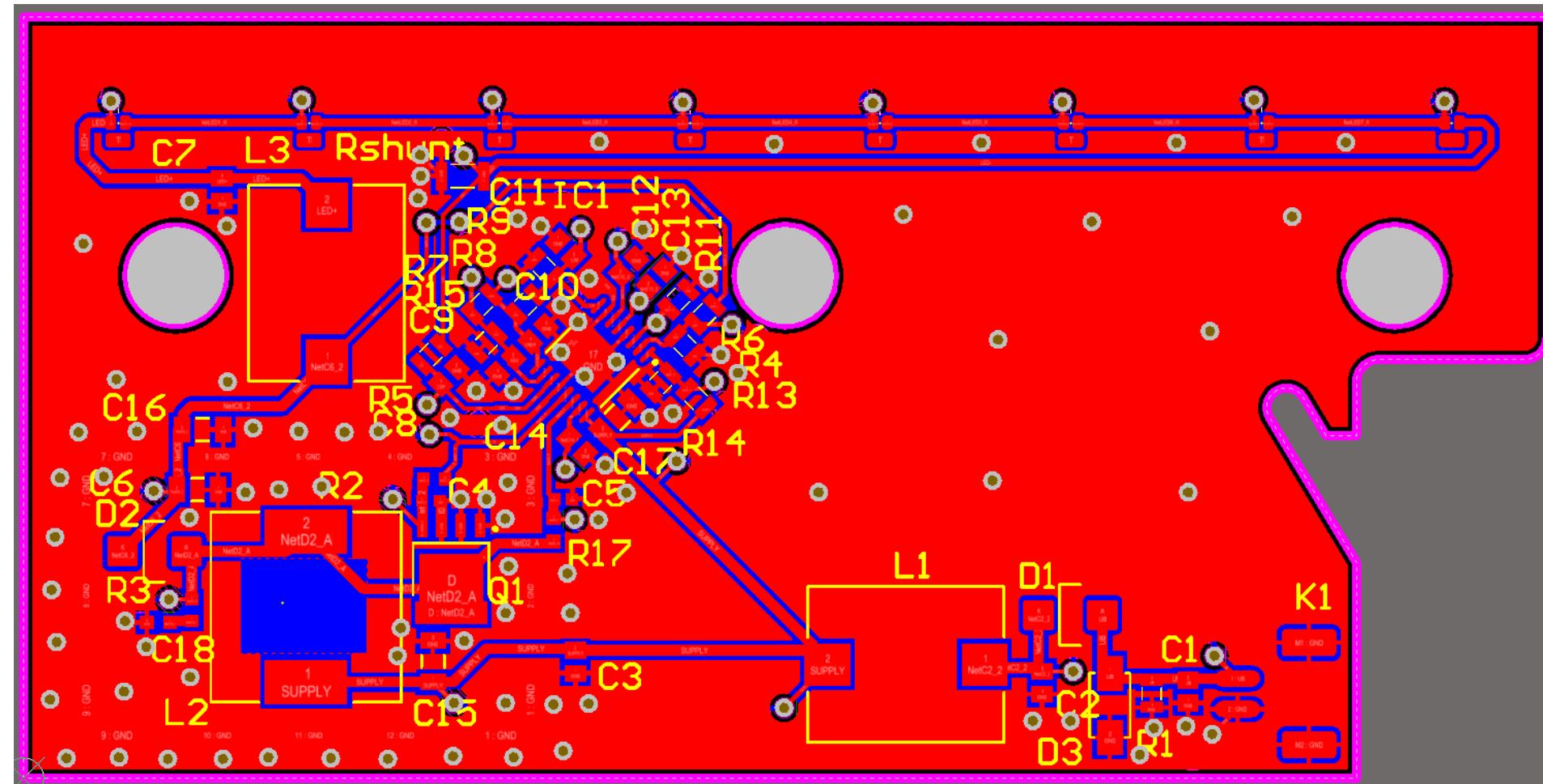


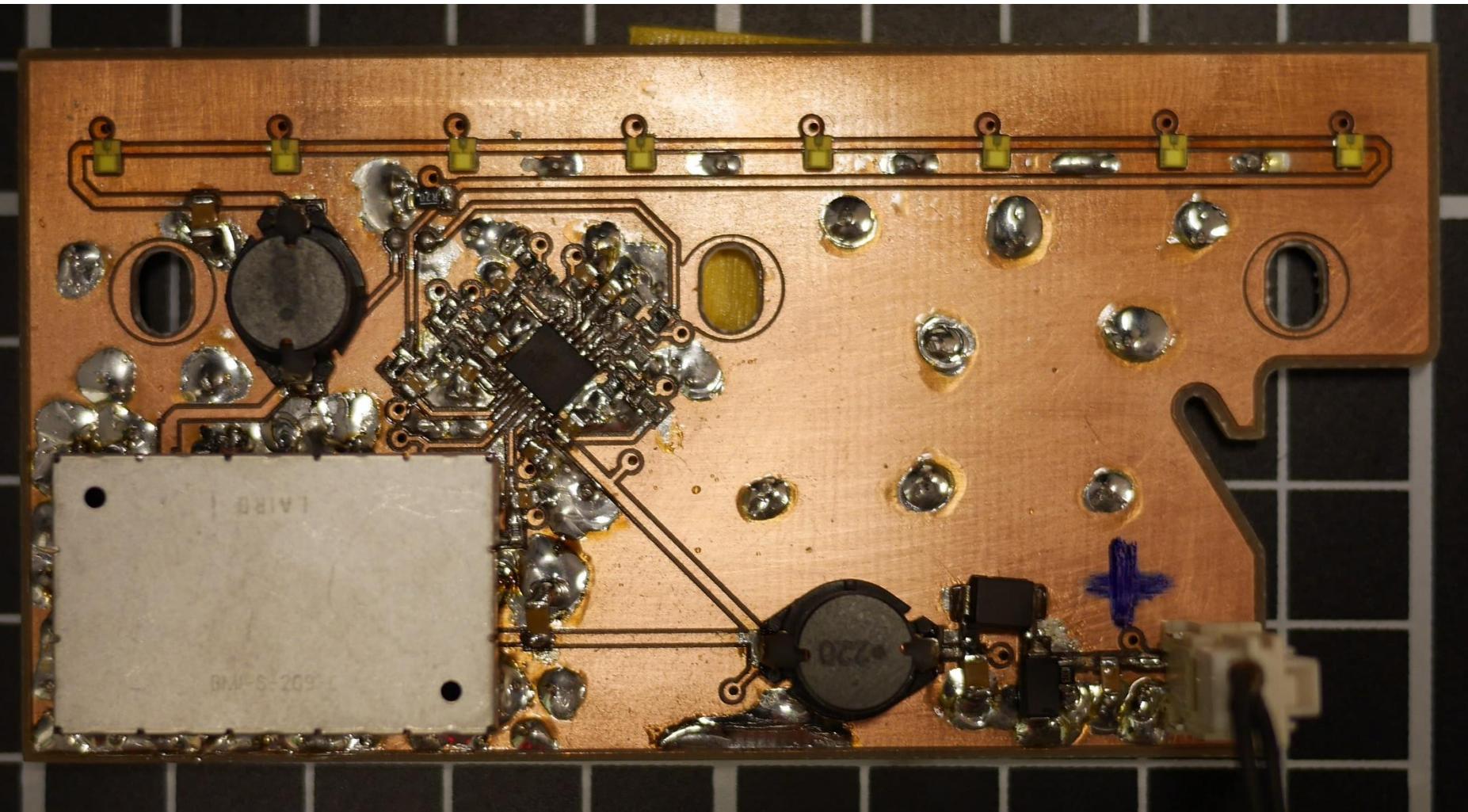
Vse testne tocke(TP) morajo biti na spodnji strani vezja

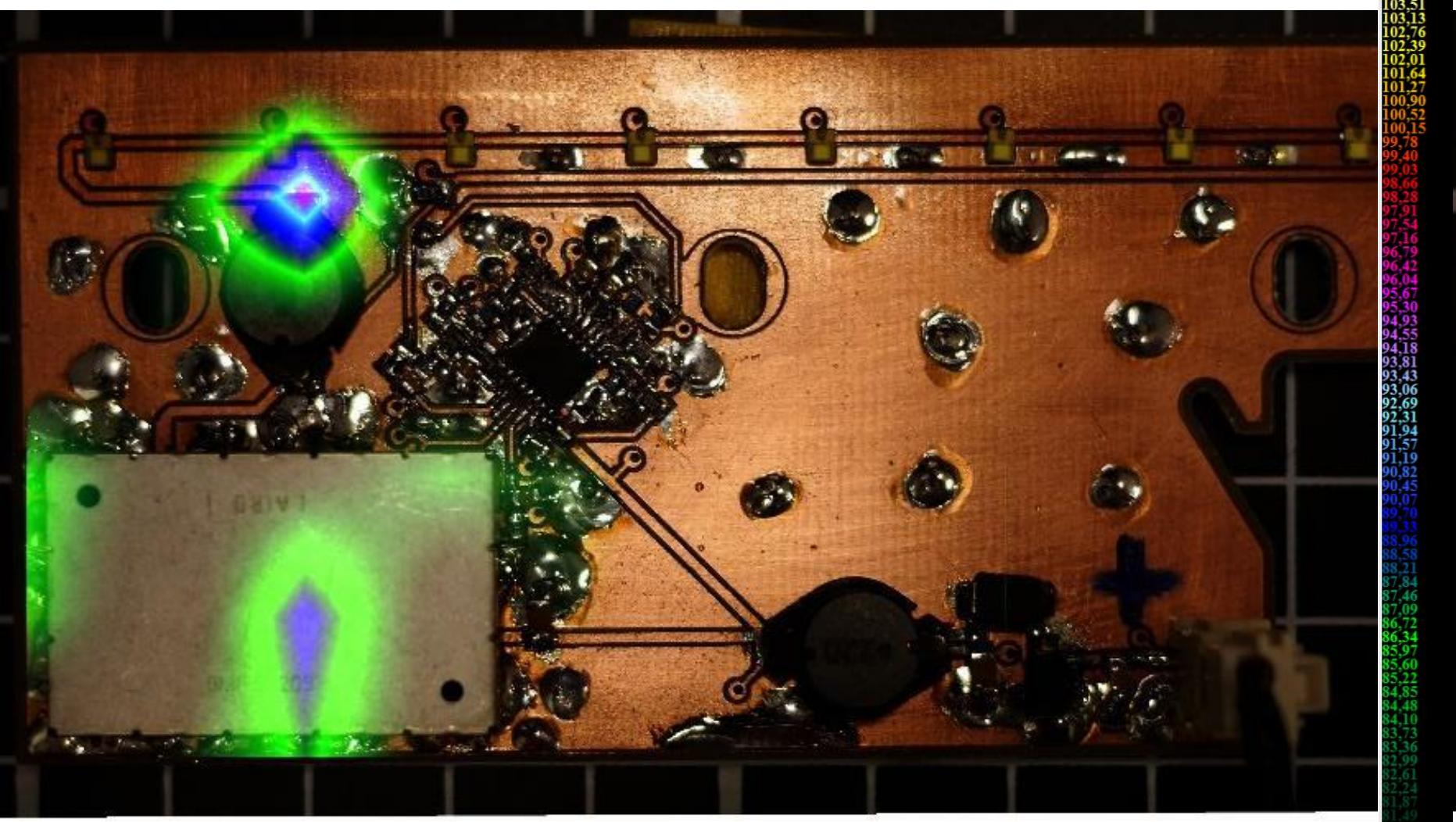


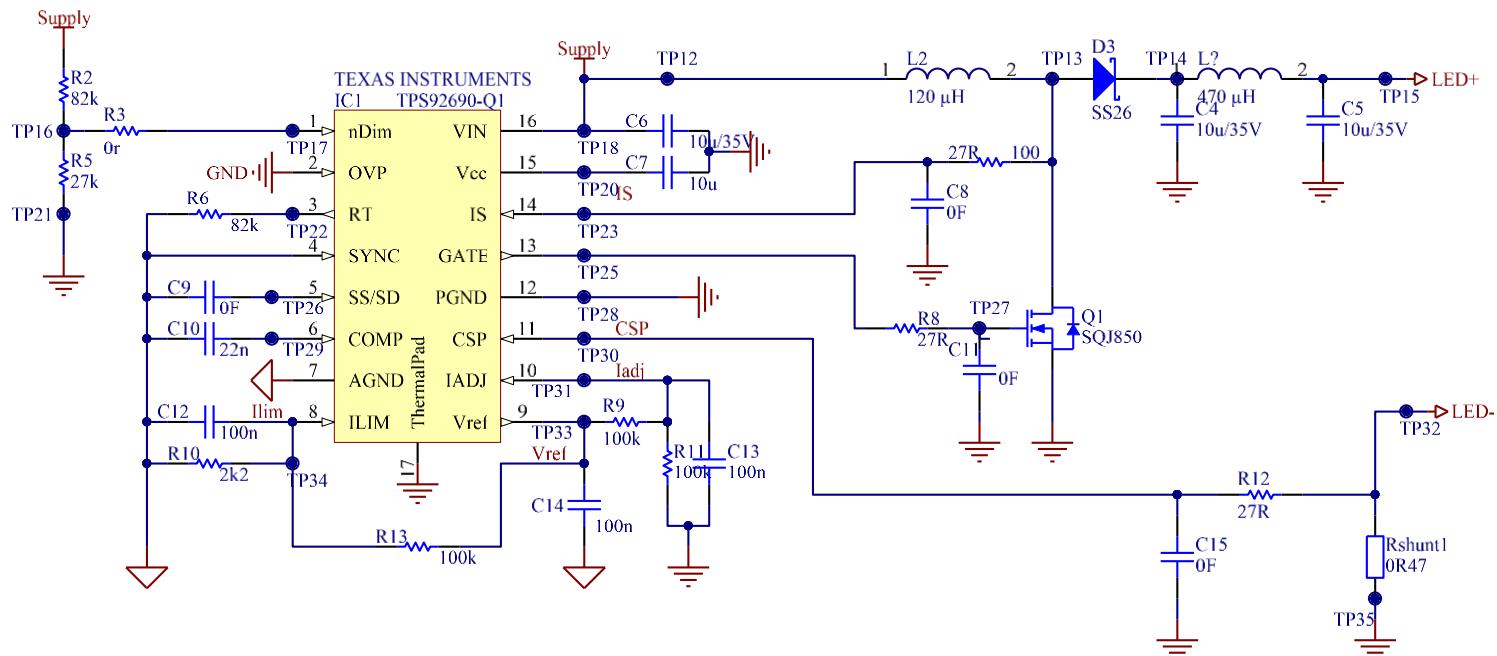
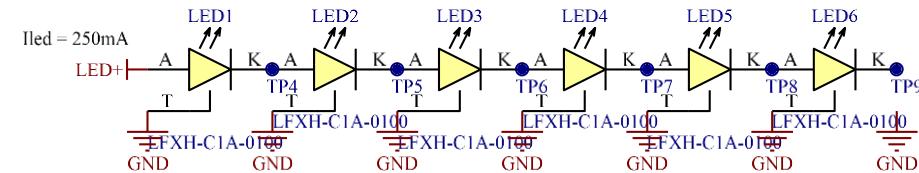
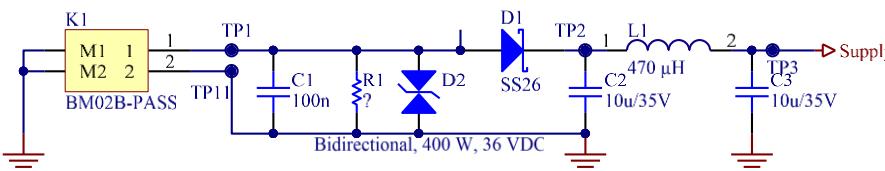


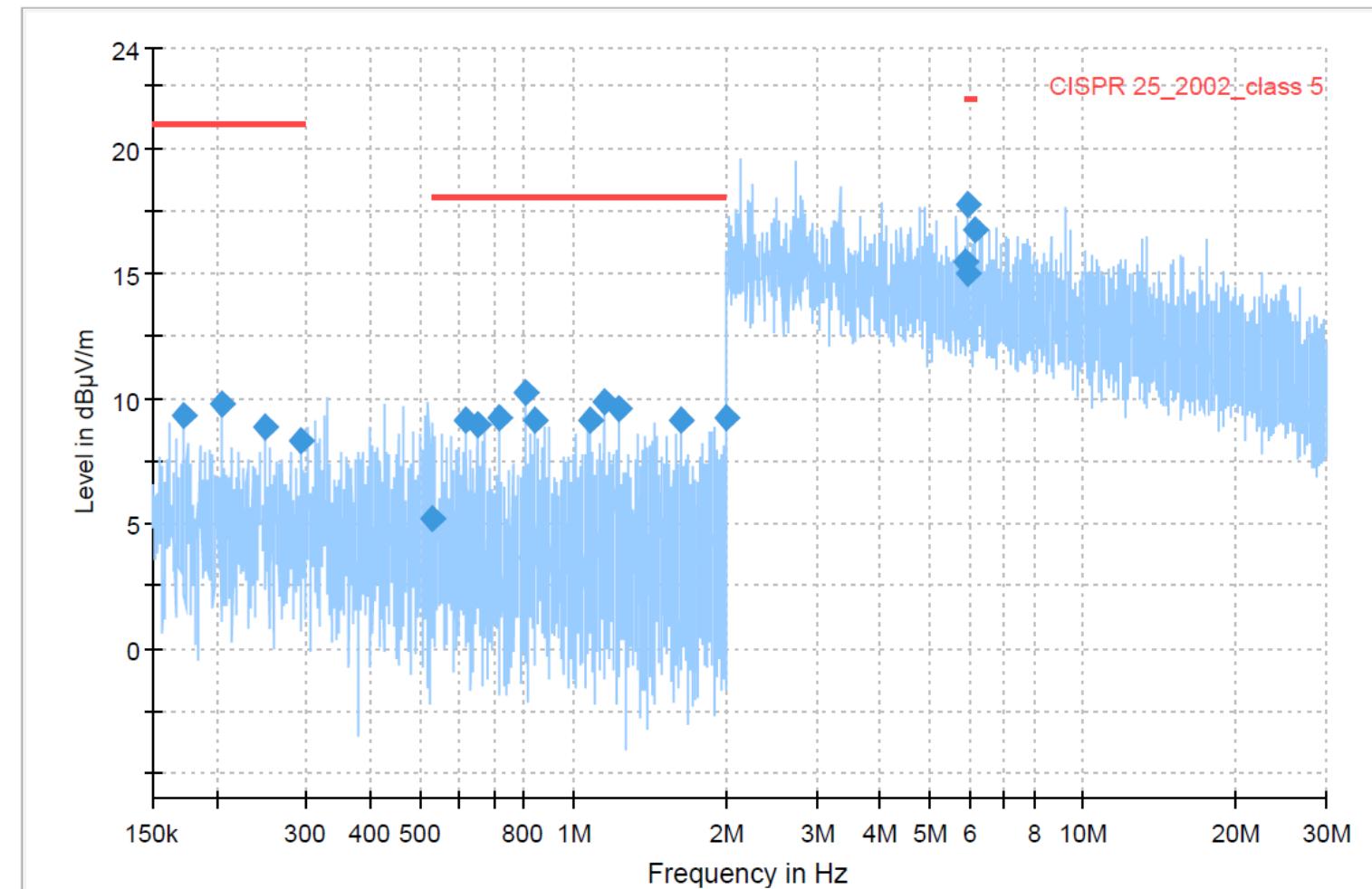


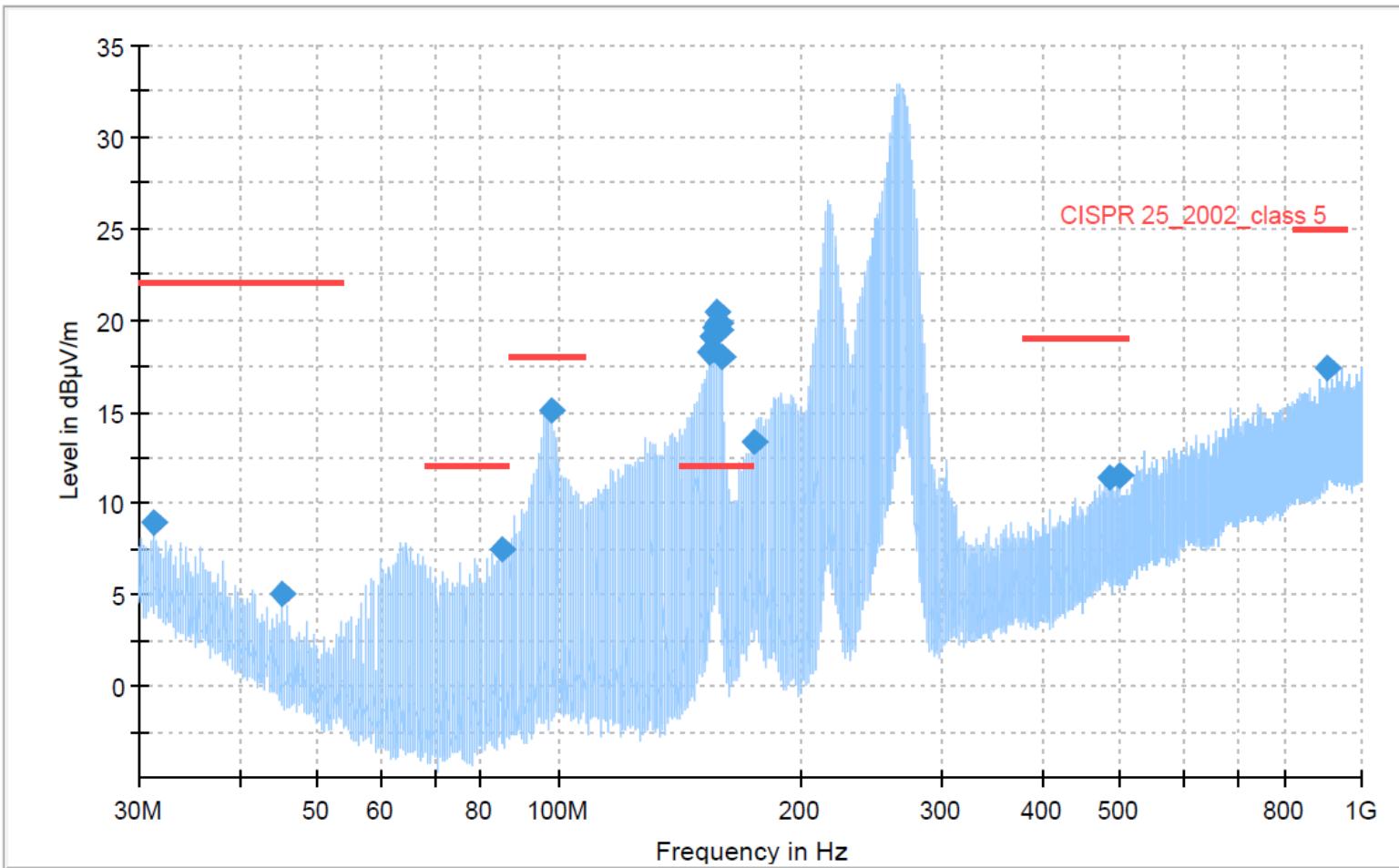












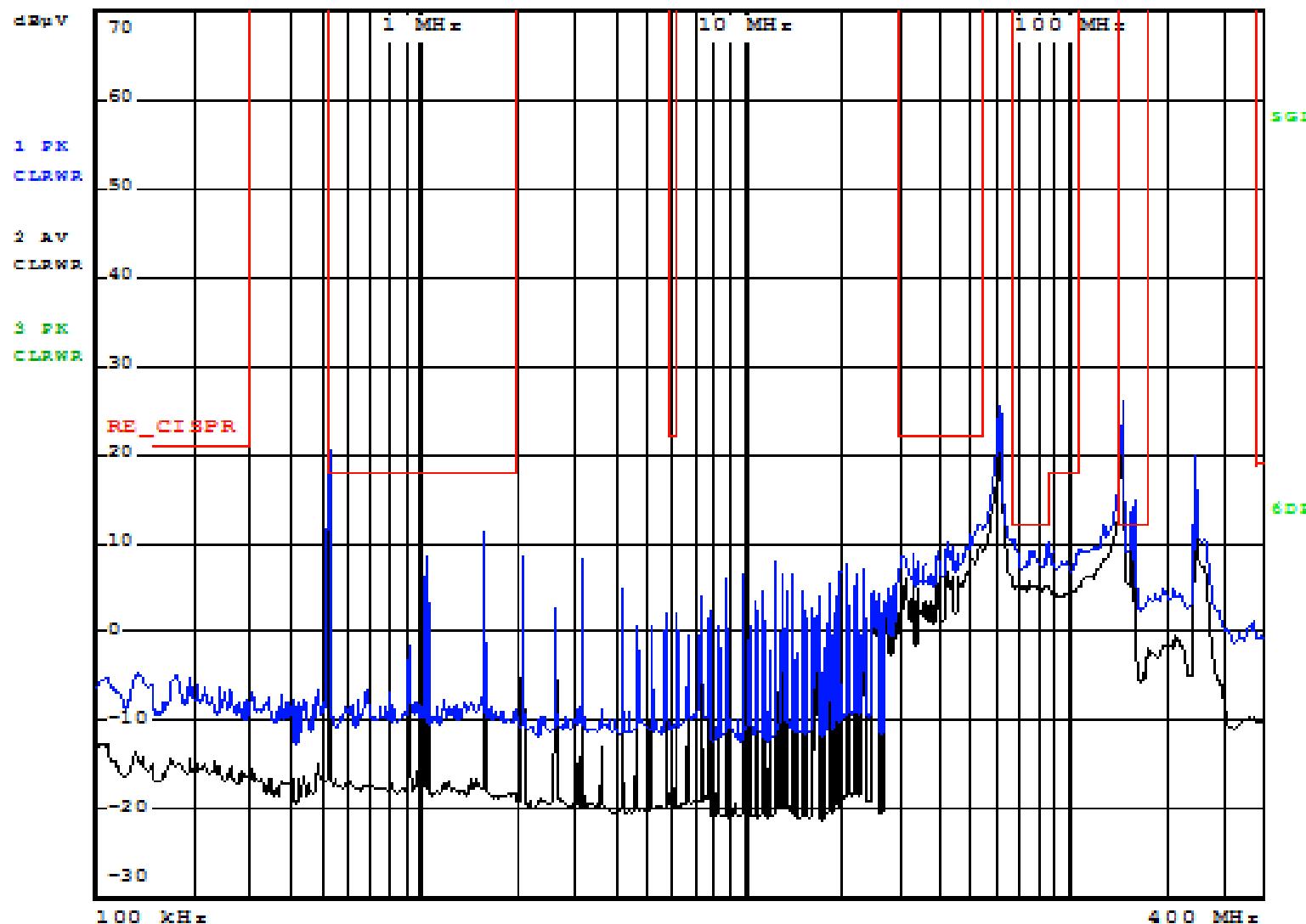


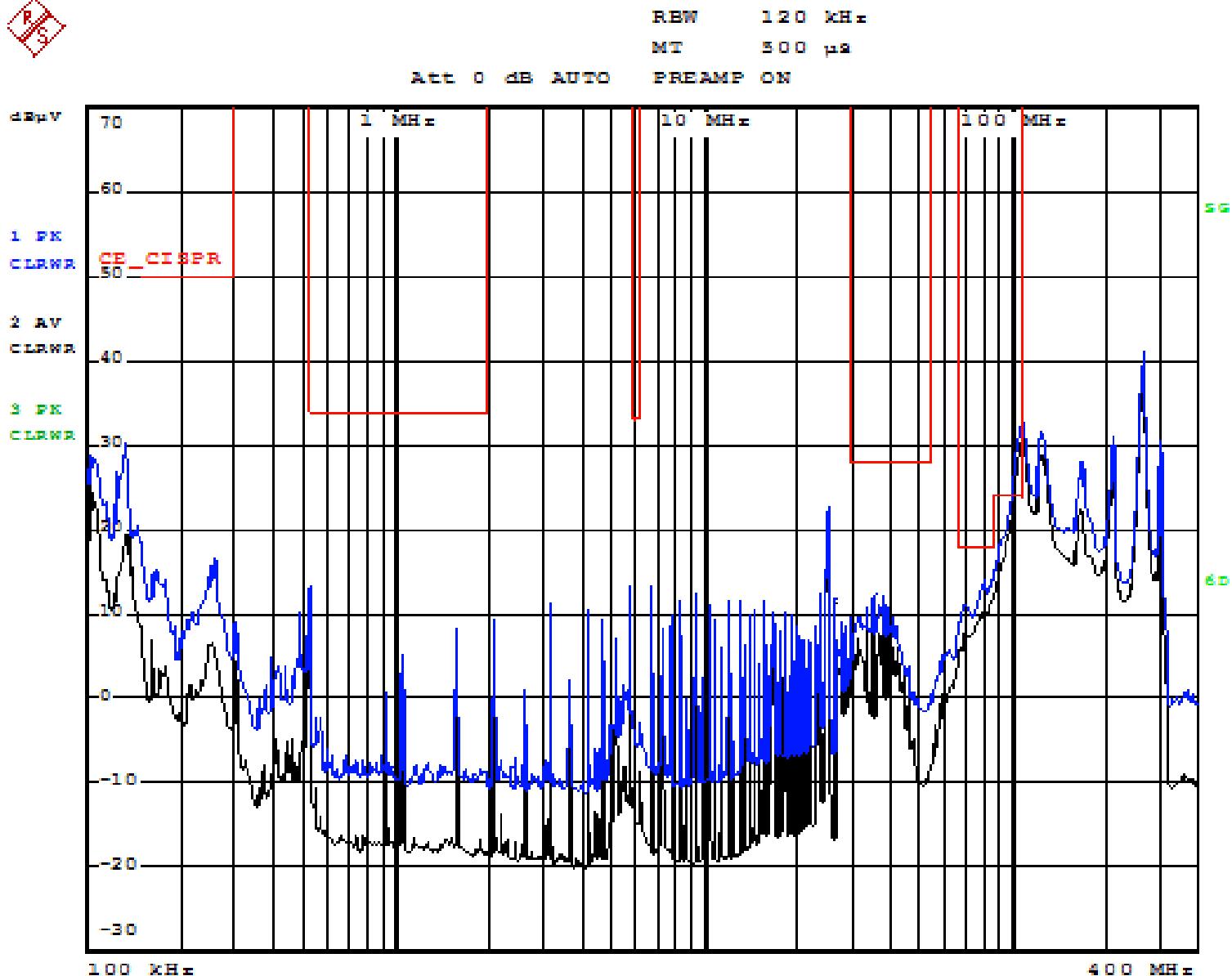
RBW 120 kHz

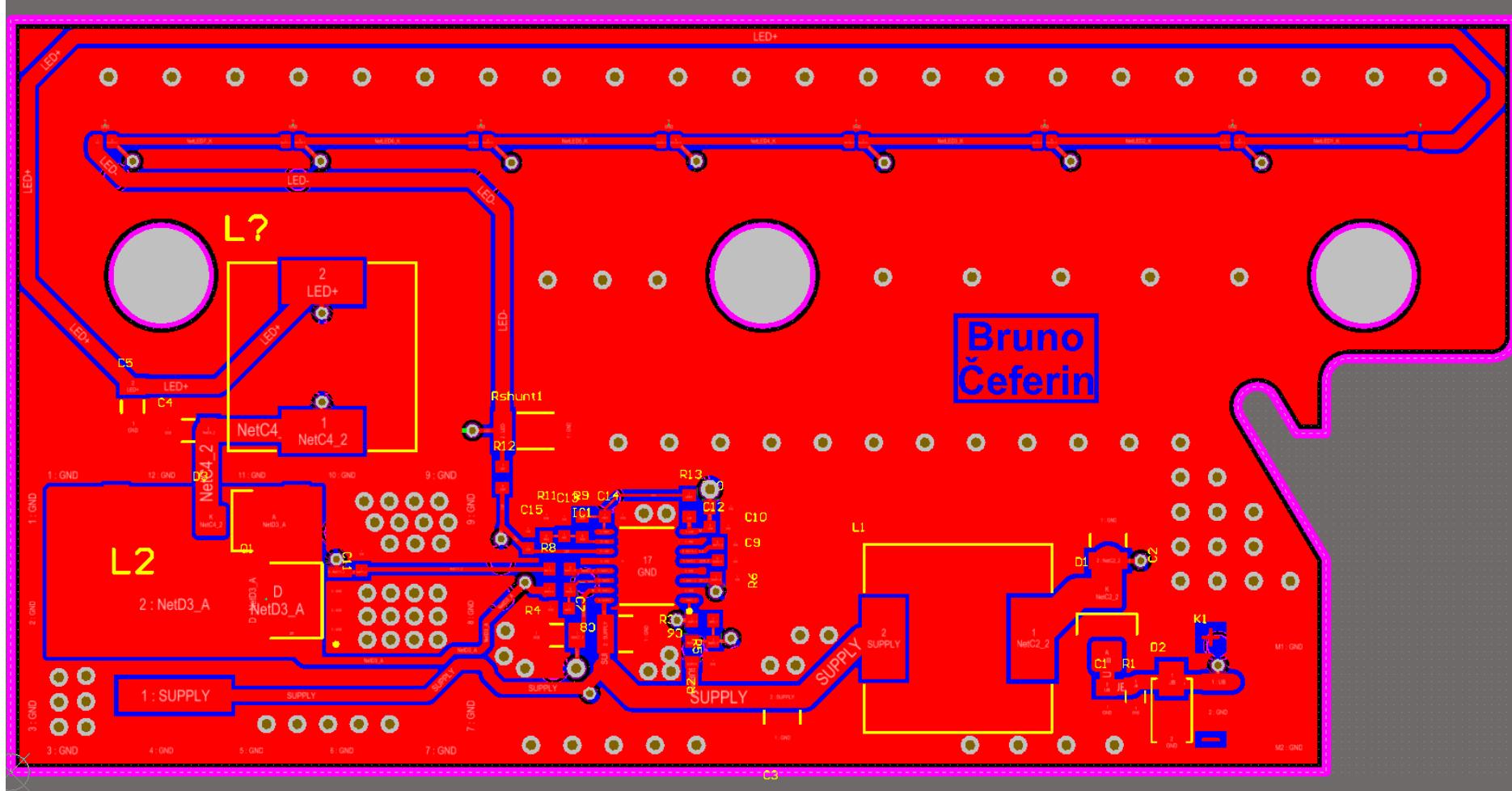
MT 500 μs

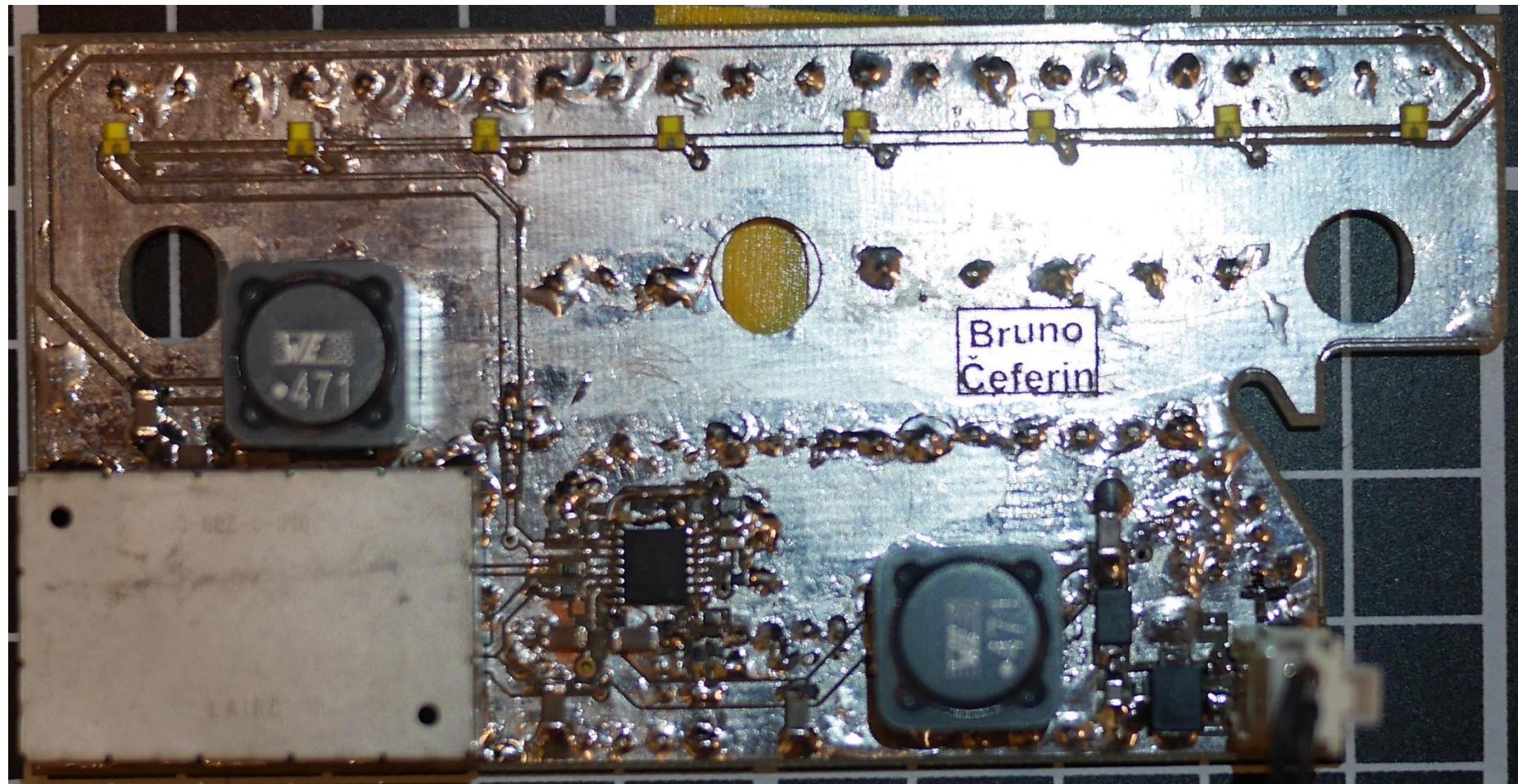
Att 0 dB AUTO

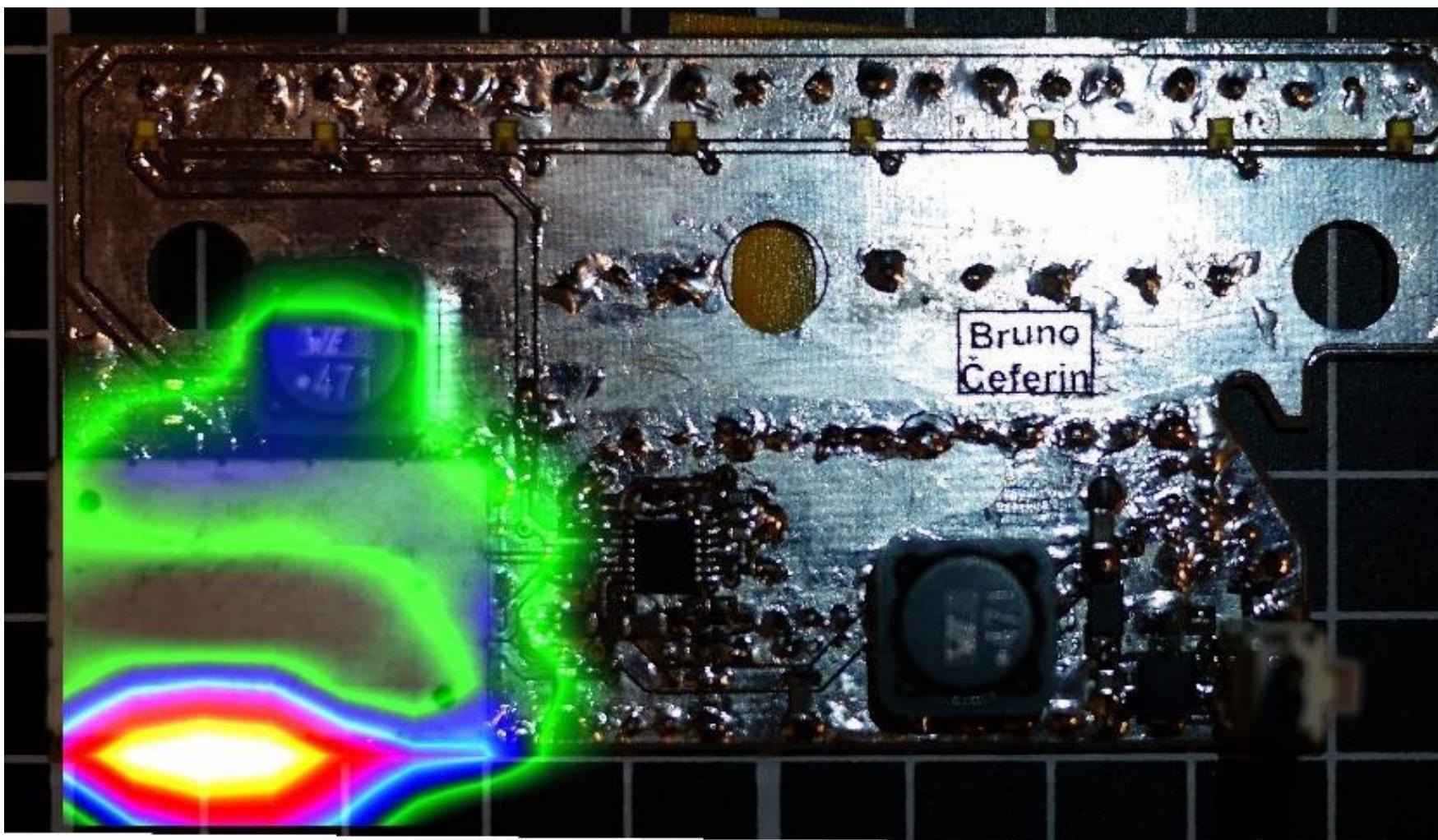
PREAMP ON

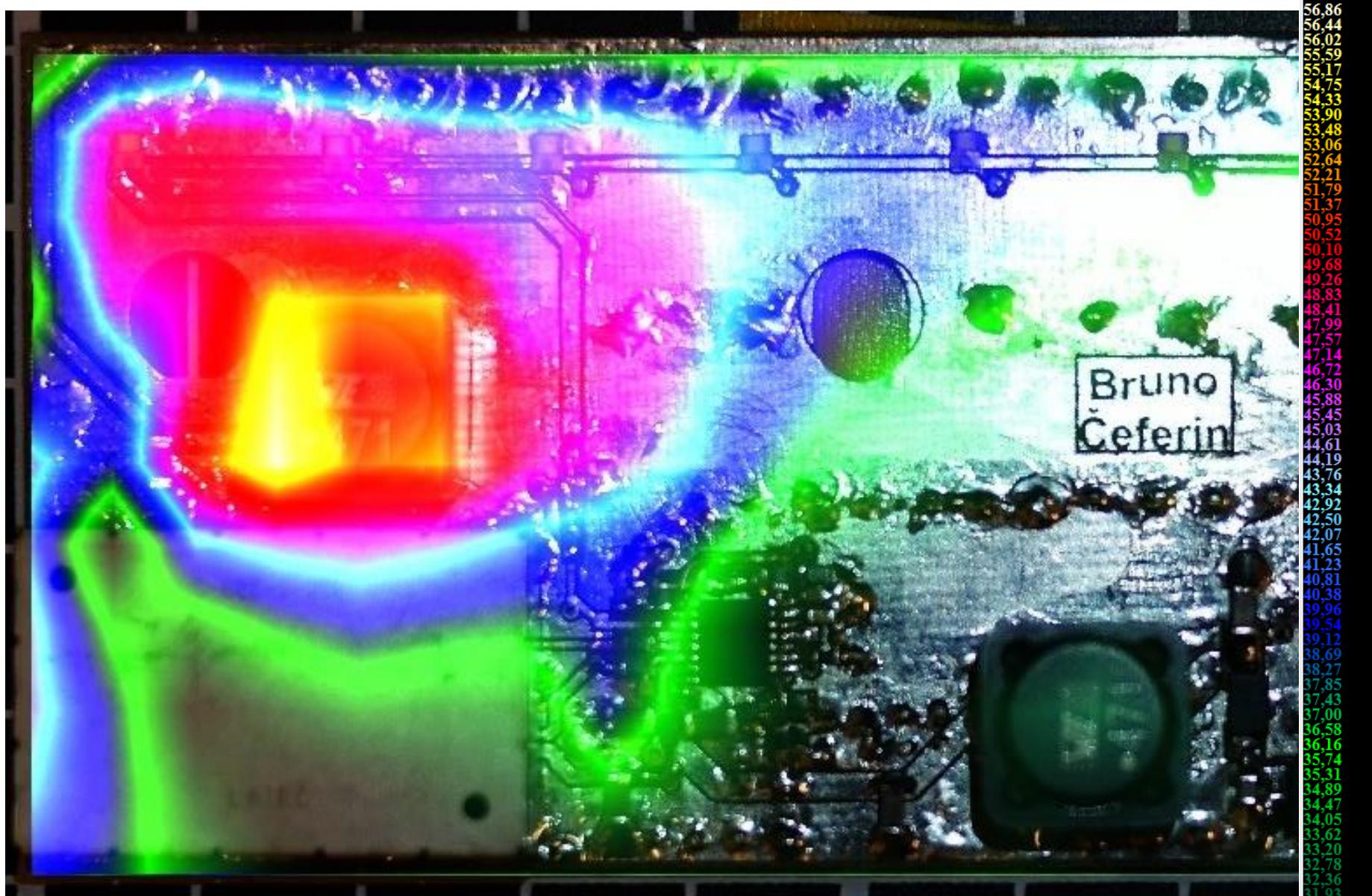












- Prevodne motnje so bile nižje pri tistih, ki so postavili Pi-filtre tako, da so dosegli minimalni presluh med vhodom in izhodom. Izbrane komponente morajo delovati učinkovito tudi pri visokih frekvencah brez izrazitih resonanc. Priporočena je uporaba feritnih dušilk.
- Pri vsakem kondenzatorju naj bo več vij na maso s čim krajšimi povezavami na kondenzator.
- Izhodna povezava iz stikalnega napajalnika naj gre neposredno iz kondenzatorja. Že majhna linija v seriji s kondenzatorjem lahko povzroči za 20 dB višje sevalne motnje na izhodu.
- Močnostna tuljava stikalnega napajalnika naj bo postavljena na sredino EMI zaščitnega oklopa, čim bolj stran od vseh robov. Tista vezja, ki so imela tuljave postavljene tik ob steni zaščitnega oklopa so imela izdatnejša sevanja na tistem mestu.
- Primerjava meritev v neodbojni sobi in v GTEM celici je pokazala, da so izmerjene motnje zelo odvisne od preferenčne smeri meritve. Meritev na SIQ zaradi postavitve antene ni dobro zajela motenj, ki so se širile od zadnje strani zaščitnega oklopa (nasprotno od svetlečih didod). Zato so tisti, ki so postavili tuljavo stikalnega napajalnika ob zadnjo steno zaščitnega oklopa imeli boljše rezultate na SIQ kljub večjem sevanju (zmerjeno v GTEM celici).



Drobni elektro material po želji iz Farnella v skupni vrednosti 500 €.



Tri ure meritev v njihovih laboratorijih po dogovoru (tržna cena 450 €) + možnost poletne prakse (in tudi kasnejše zaposlitve) + vremenska postaja [OREGON RAR213HG](#).



Trofazni 3.3kW, 72V elektromotor za skuter (AMK6143) in izposoja Tweeza za konec tedna.



Ročni TrueRMS multimeter [Keysight U1232A](#) v vrednosti 200 €.



[Komplet knjig Trilogije o ... in ABC o ...](#), in mogoče še kaj.



Knjigi "[The Art of Electronics](#)" in "[High speed digital design: A Handbook of Black Magic](#)"

Končna uvrstitev



Tekmovalec	Funkcionalnost		Min dB pod limito				Točke				Rezultat	
	Vklop	RP	CE	RE 30M	RE 1G	OP	T CE	T RE 30	T RE 1G	BCI	Vsota	Mesto
Urban Gregorc	OK	OK	12	5,83	7,35	10	10	5,83	7,35	10	43,18	1
Jan Slapšak	OK	OK	10	4,04	7,74	10	10	4,04	7,74	10	41,78	2
Martin Lesar	OK	OK	11	3,94	7,42	10	10	3,94	7,42	10	41,36	3
Blaž Strojin	OK	OK	5	0,51	7,04	10	5	0,51	7,04	10	32,55	4
Ana Čepon	Fail	OK	12			0	10	4	7	10	31	5
Matjaž Tome	OK	OK	-0,5	-13,19	0,97	10	-0,5	-13,19	0,97	10	7,28	6
Bruno Čeferin	OK	OK	-9	4,19	-8,44	10	-9	4,19	-8,44	10	6,75	7