DESIGN FOR EMC – BOOST CONVERTER DESIGN AND MEASUREMENT

Mohamed AlAlami — Senior Field Application Engineer

Robert Schillinger — Field Application Engineer

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

NOISE PROPAGATION

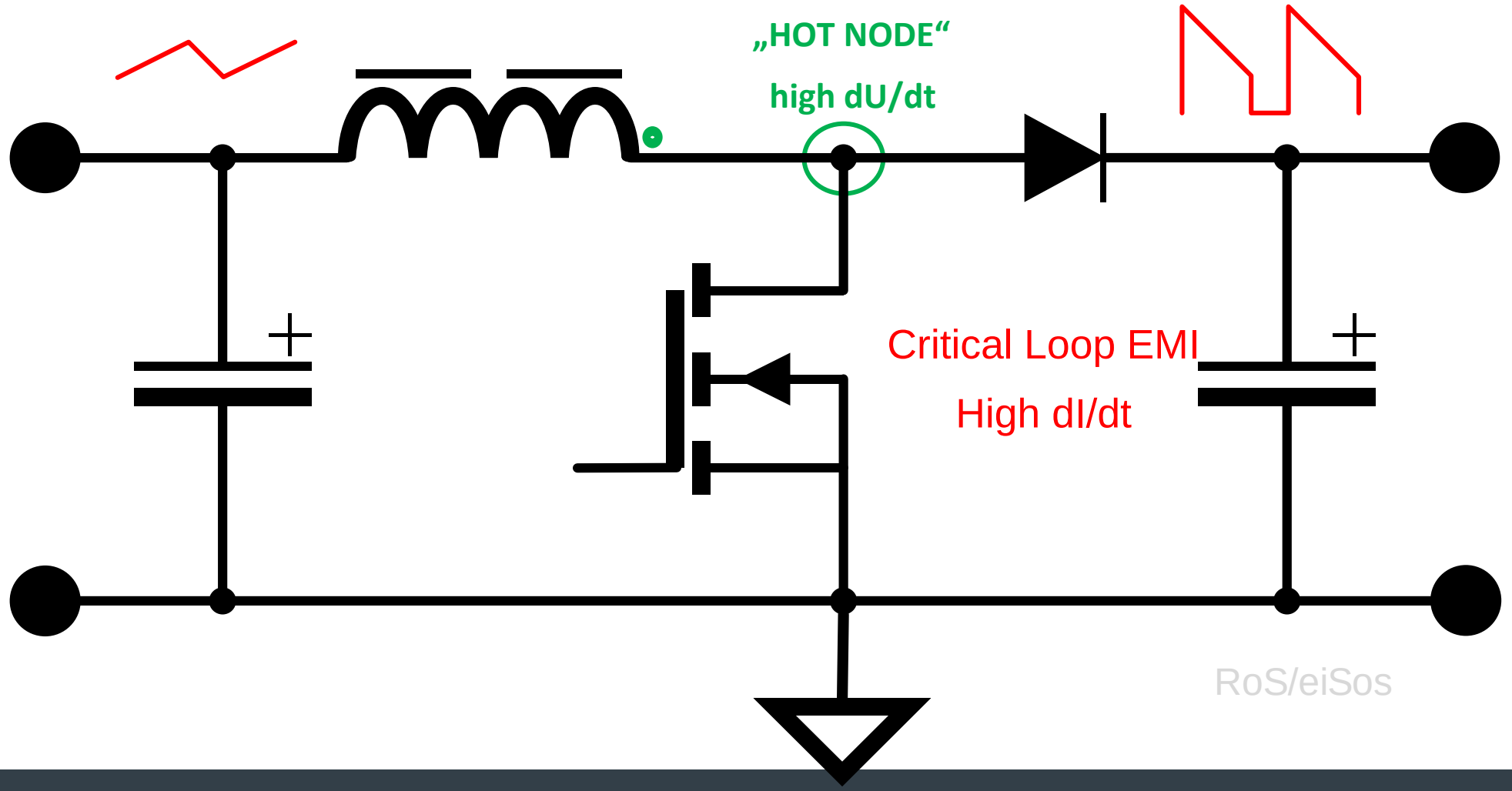
NOISE PROPAGATION

CM & DM Noise Currents

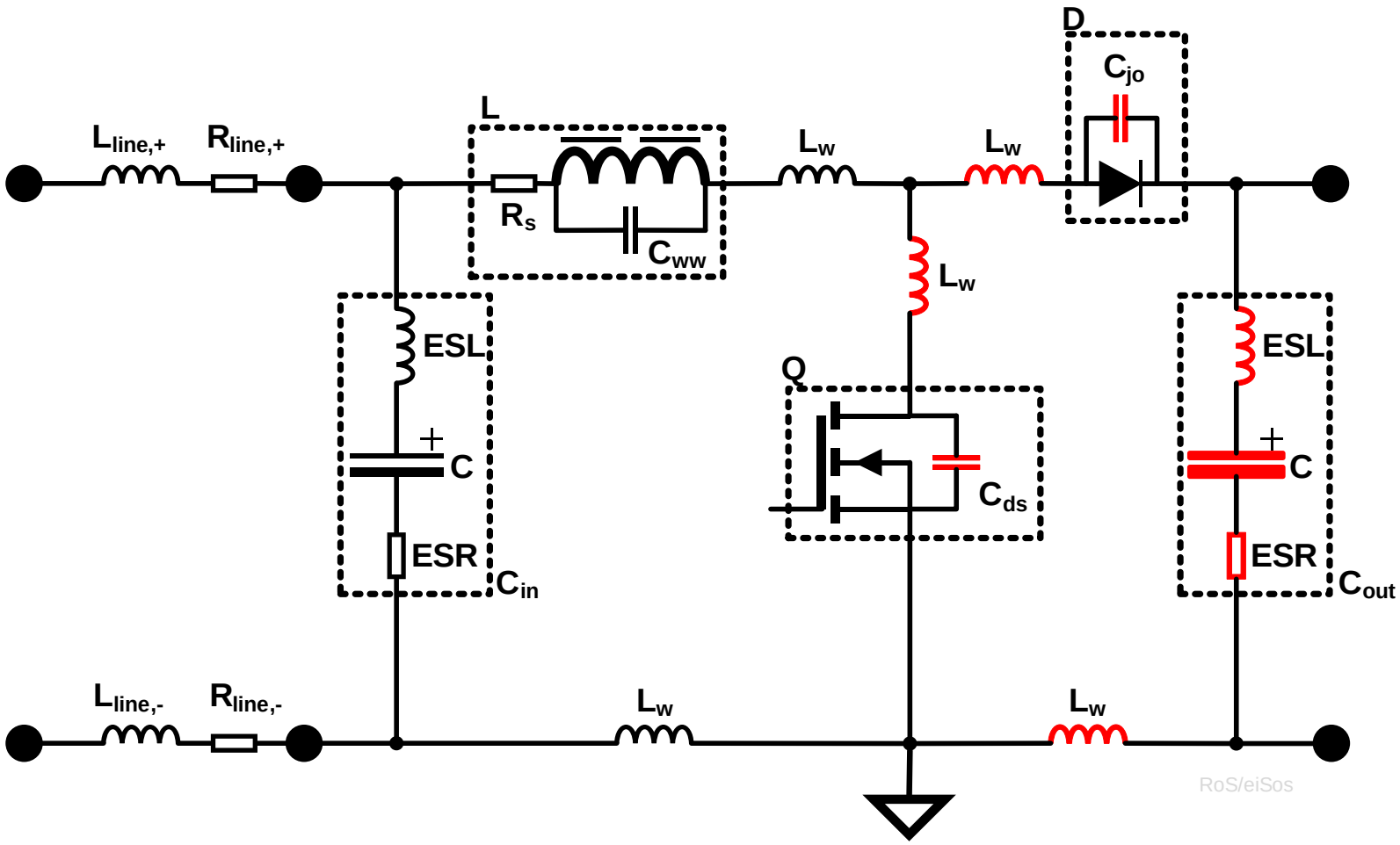
- Differential mode current (DM)
  - Current path as in the schematic
  - Easier to understand the noise paths
  - High currents, di/dt and dv/dt
  - Conducted EMI problems
- Common mode current (CM)
  - Current path unexpectedly
  - Return current path very big
  - Relative low currents (some µA)
  - Radiated EMI problems

BOOST CONVERTER NOISE SOURCES

Boost Converter Noise Sources



Parasitic Boost Model

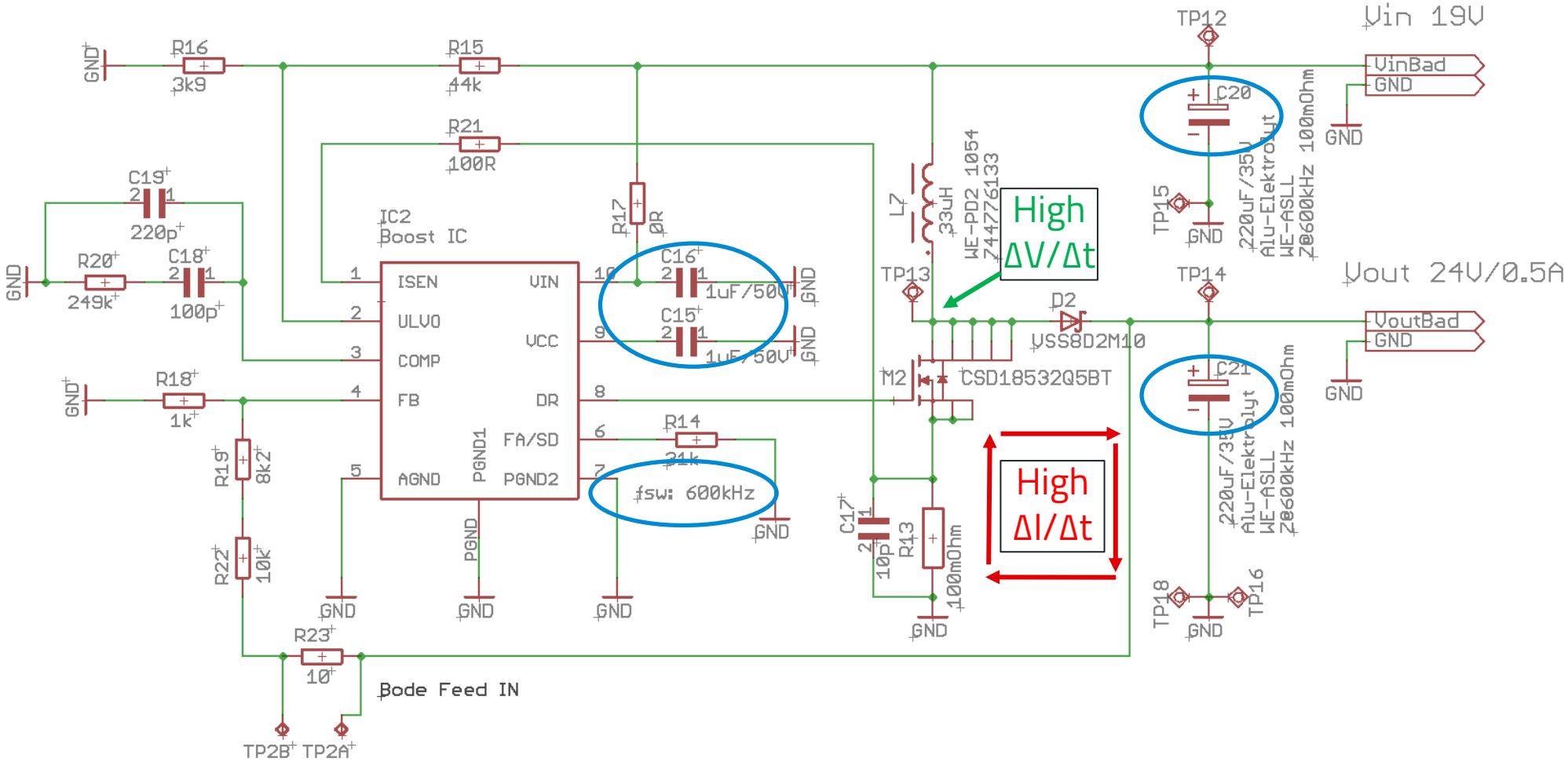


PRACTICAL BOOST EXAMPLE

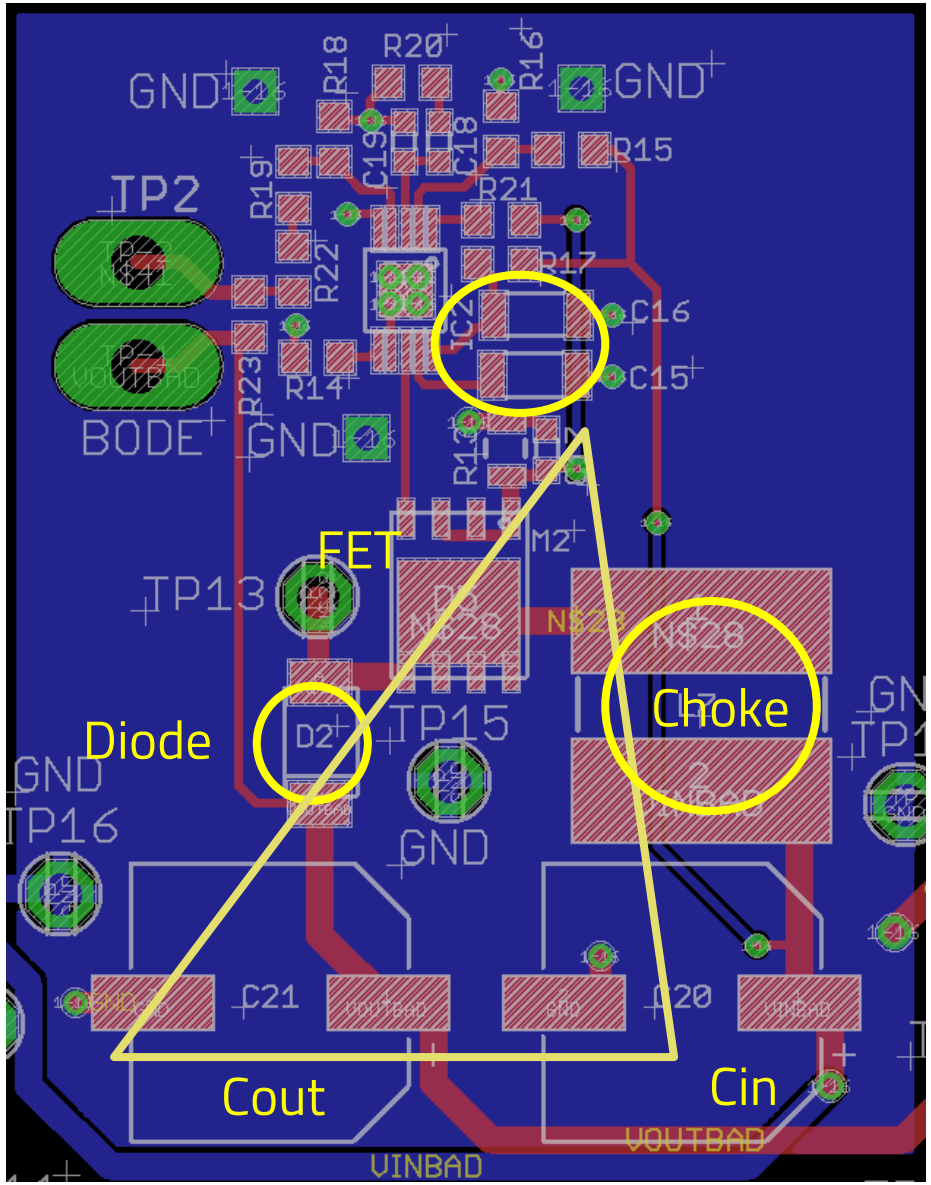
BAD Design Practice

Schematic Bad Design

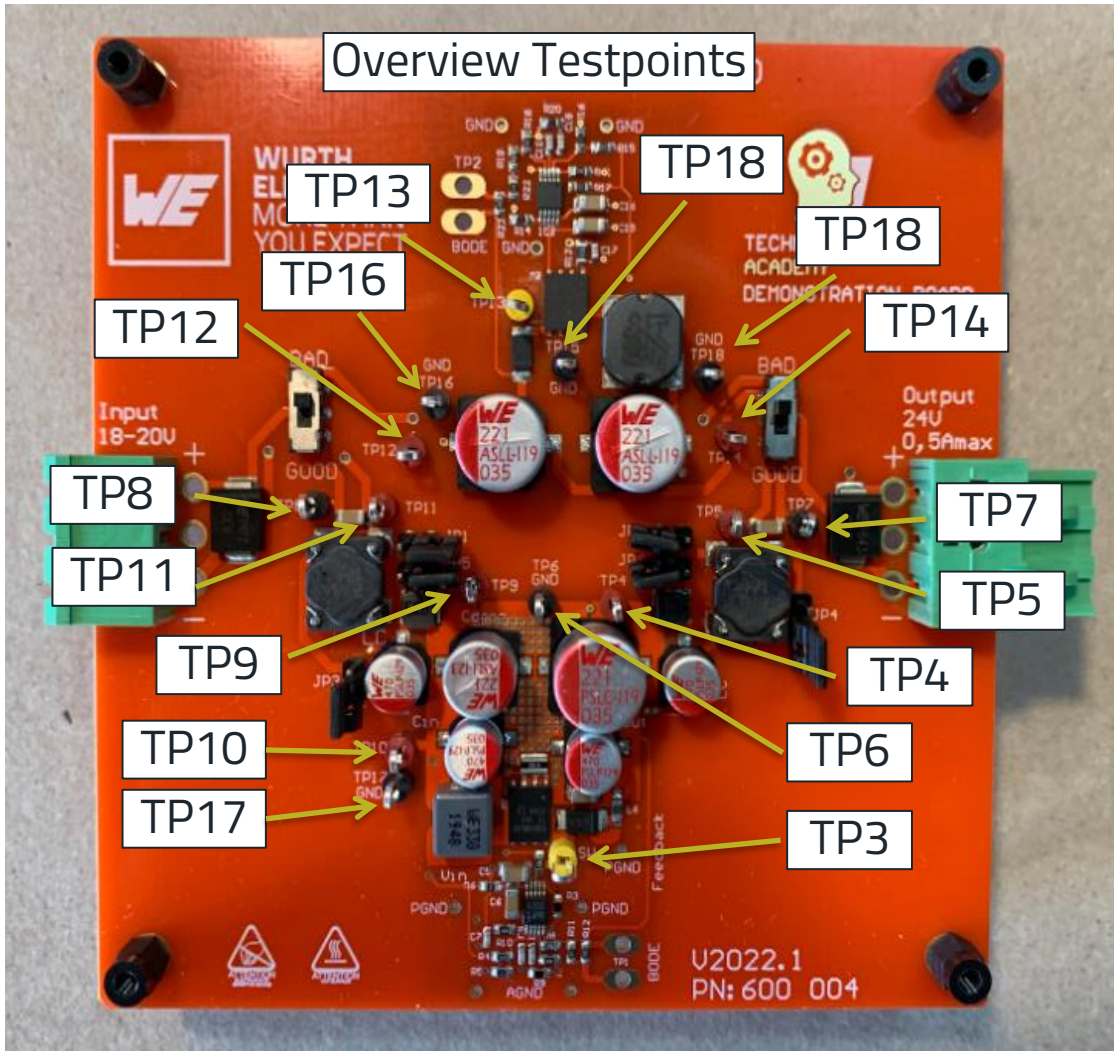
19V → 24V/0,5A

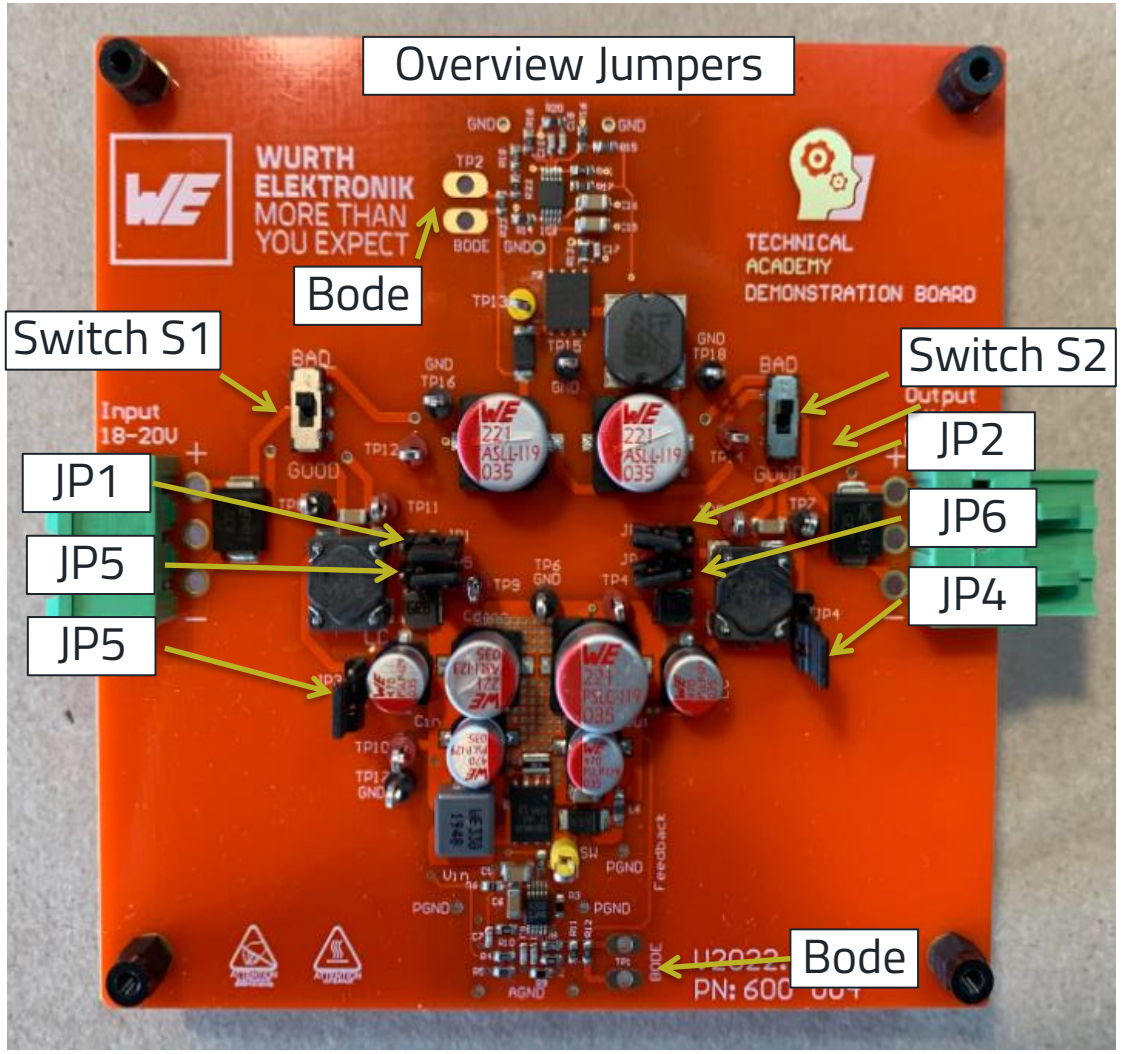


PCB Layout Bad Design



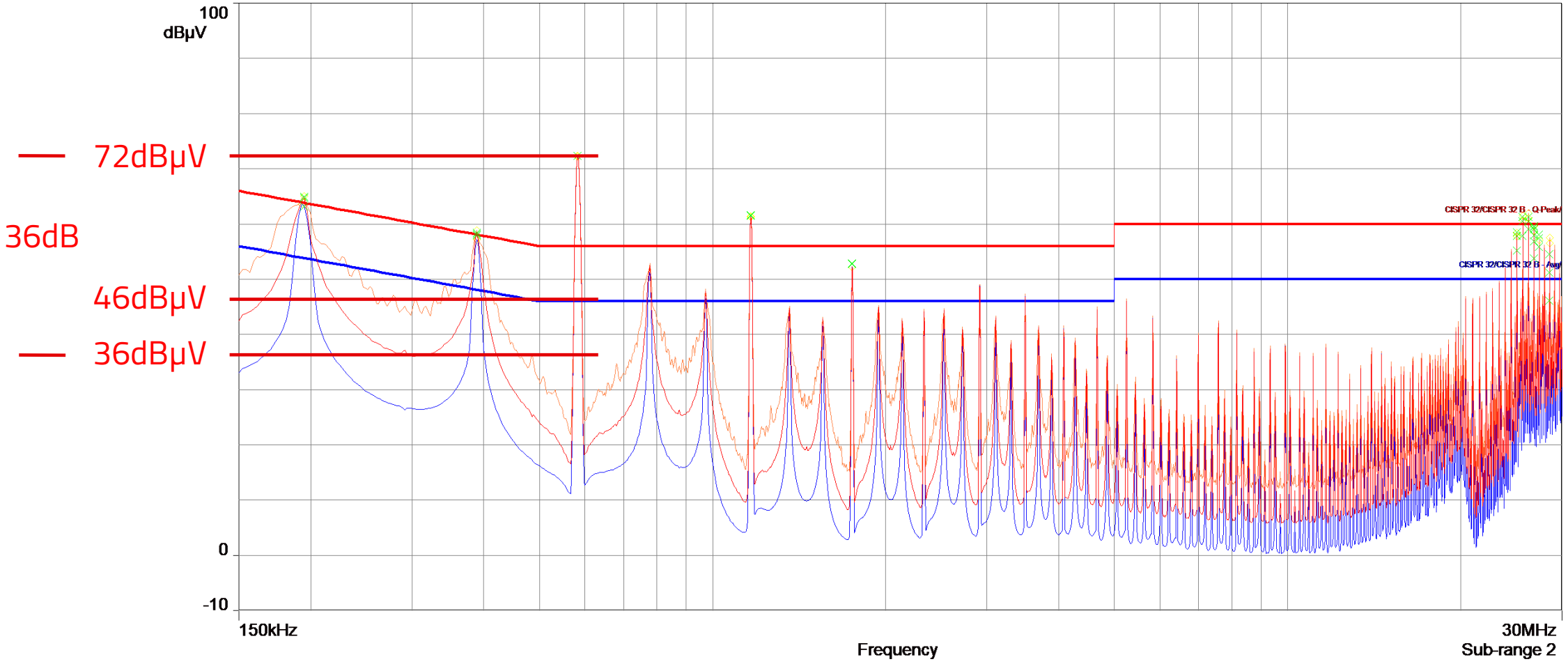
PCB Overview





Bad Design Practice: EMC Test Lab

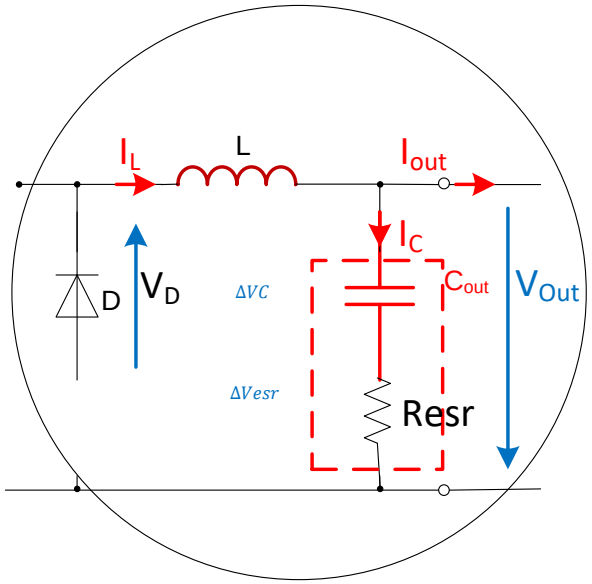
CISPR32 Conducted Emission – input w/o Filtering

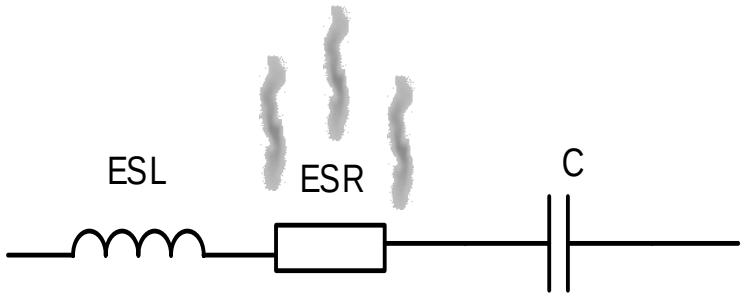


IMPROVEMENT OF NOISE REJECTION/REDUCTION

1. Selection of Different Capacitors

Ripple current





- Aluminum Electrolytic Capacitors
  - Ripple current can be critical, shortening of lifetime, and
  - For too high ripple explosive failure -> blown vent and electrolyte leakage
- Ceramic Capacitors
  - Lowest ESR /mostly have no ripple current limitation
- Film capacitors
  - Low ESR, but ripple current can cause damage

1. Selection of Different Capacitors:

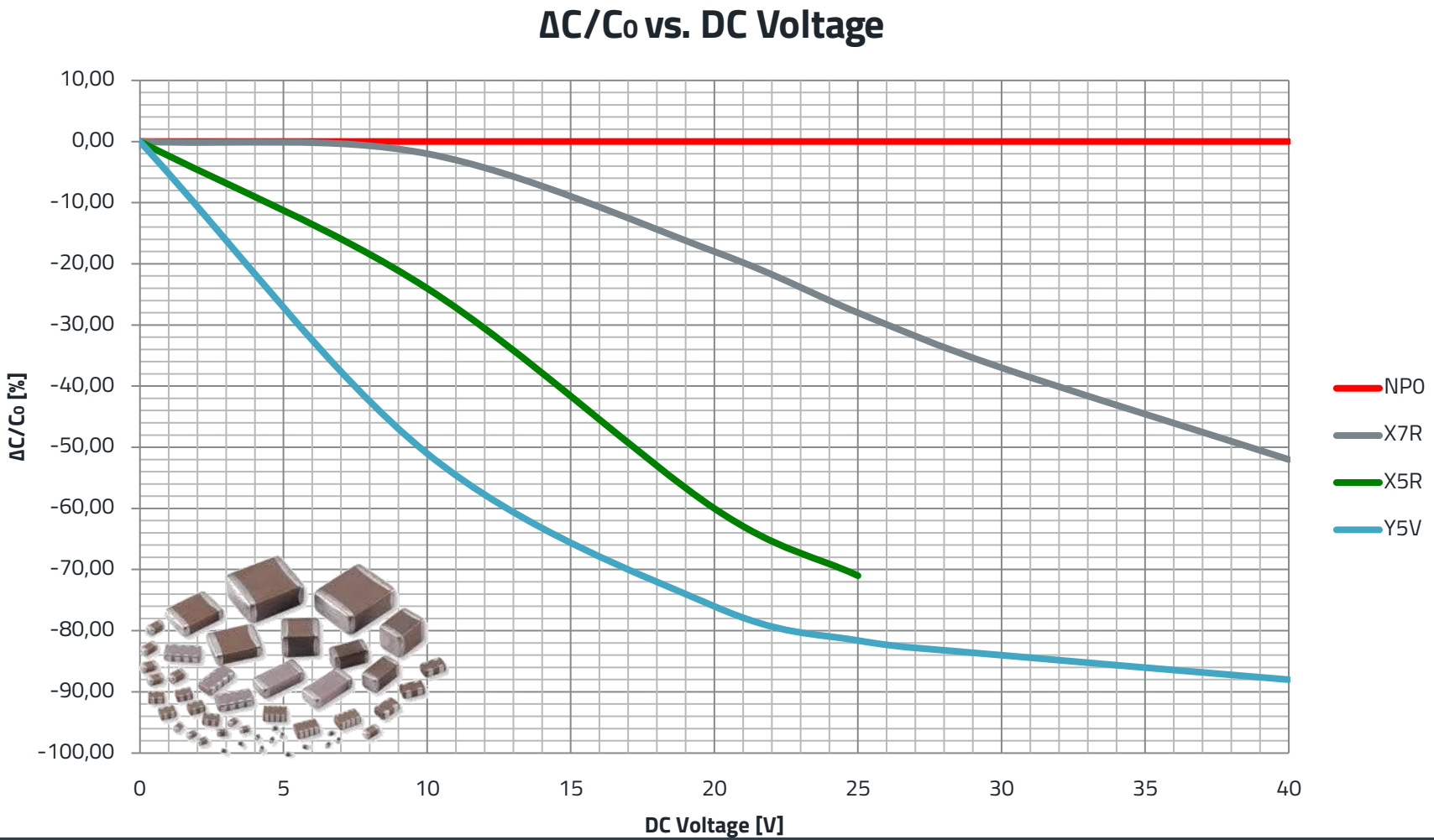
Polymer Vs Electrolytic - Comparison

- **Aluminum- Electrolytic-Capacitor**
  - higher voltage ratings available
  - is currently cheaper (same capacity and voltage rating)

- **Polymer- Electrolytic-Capacitor:**
  - smaller ESR as an Alu-Cap >> higher allowed ripple current
  - No dry-out behavior like Alu-Cap (solid electrolytic)
  - higher expected lifetime / load life

1. Selection of Different Capacitors

MLCC Voltage Dependence



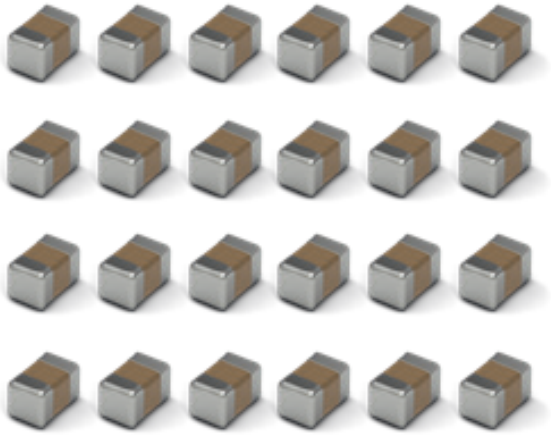
1. Selection of Different Capacitors

False Economy

Save Space on your PCB

24 x MLCCs

- P/N: 885012107006 with 47 µF
- 24 x 47 µF = 1128 µF
- $V_R = 6.3\,V_{DC}$
- Size 0805 ➔ 2 x 1.25 mm
- **C @ 6 V_{DC} = 216 µF due to DC-Bias**
- **A = 255 mm²**

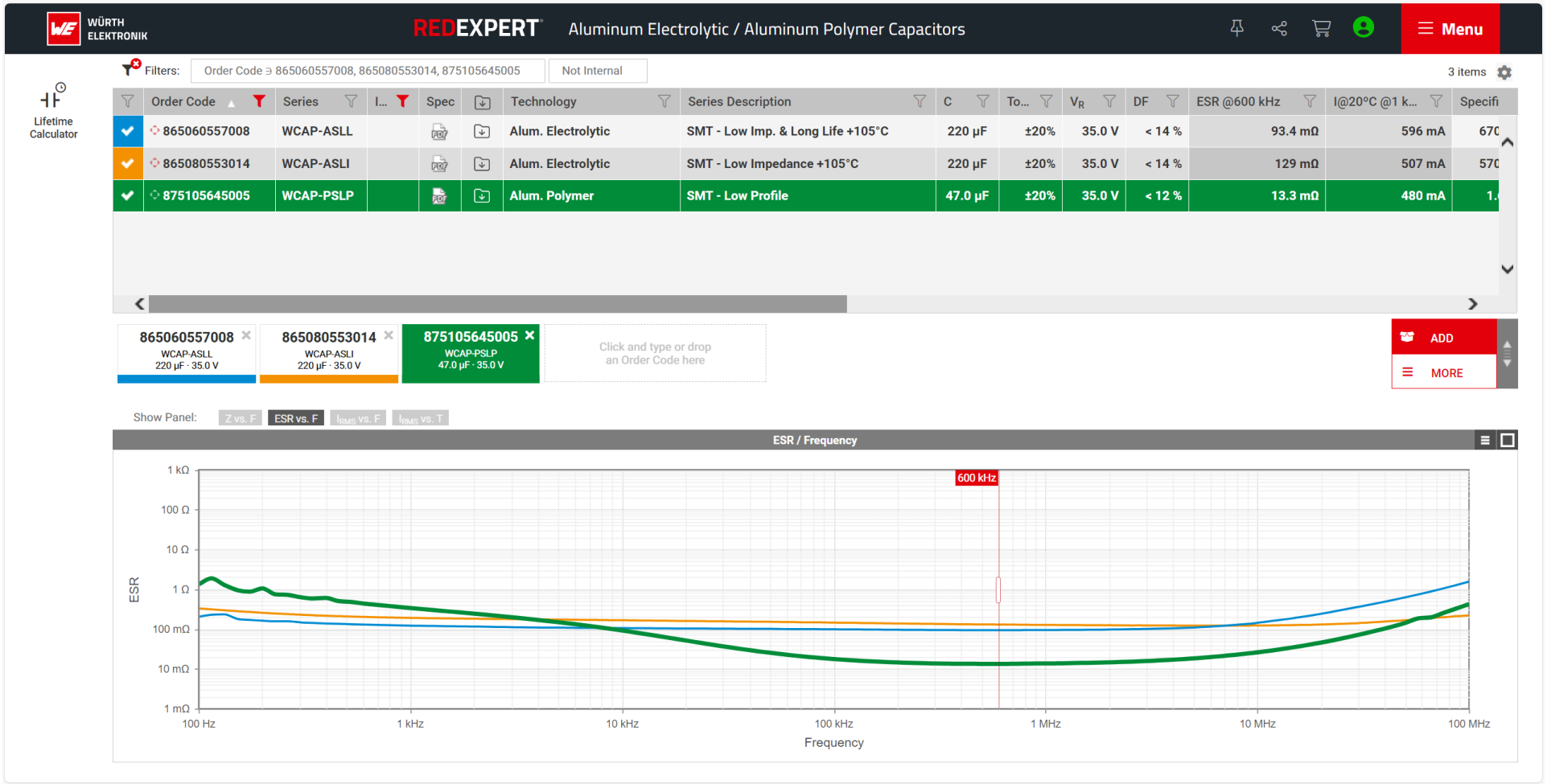


1 x H-Chip Aluminum Polymer Capacitor

- P/N: 875015119006 with 220 µF
- 1 x 220 µF = 220 µF
- $V_R = 6.3\,V_{DC}$
- Size 2917 ➔ 7.3 x 4.3 mm
- **C @ 6 V_{DC} = 220 µF**
- **A = 44 mm²**

1. Selection of Different Capacitors

Different input capacitors

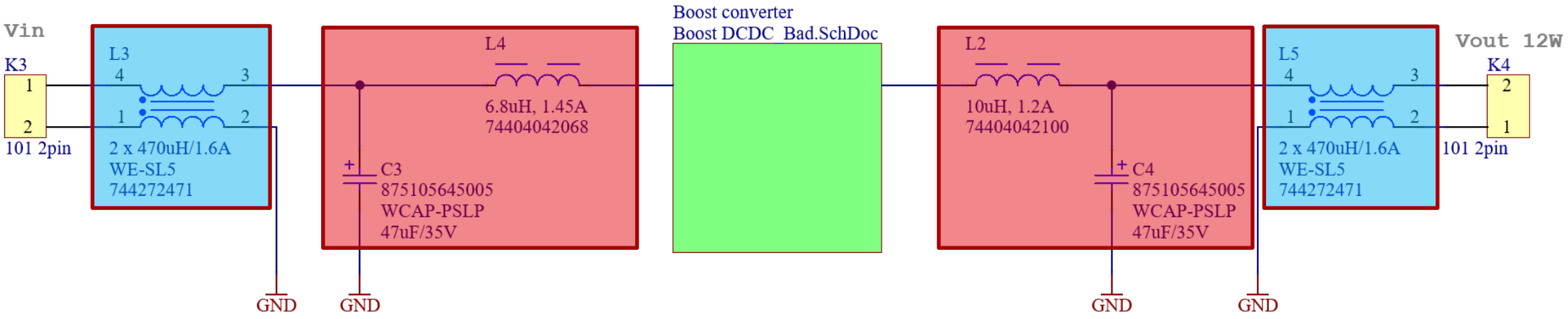


1. Selection of Different Capacitors

Measurement of input capacitors

2. Filtering of Input and Output

CM and DM Filtering



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Schematic Good Design

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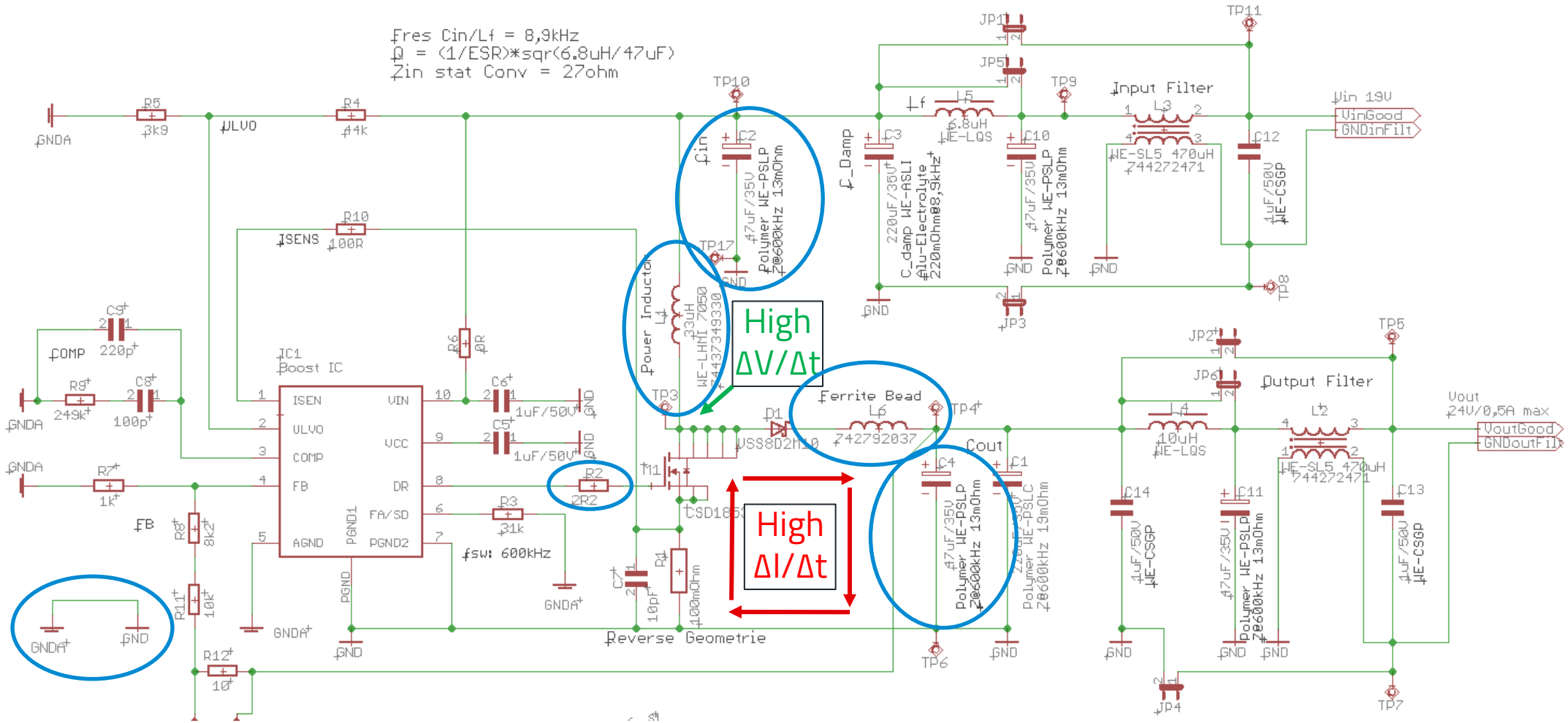
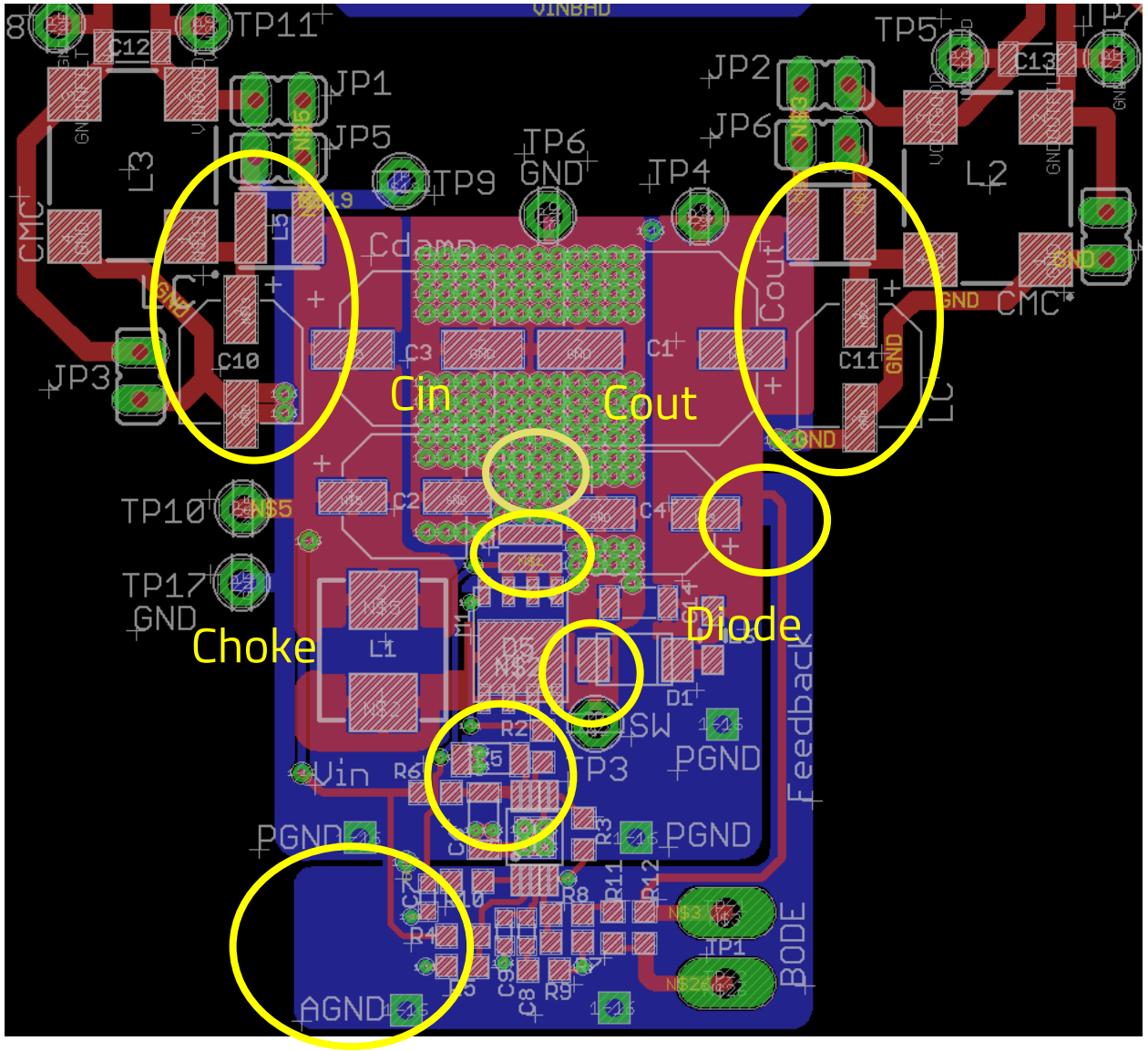


PCB Layout Good Design



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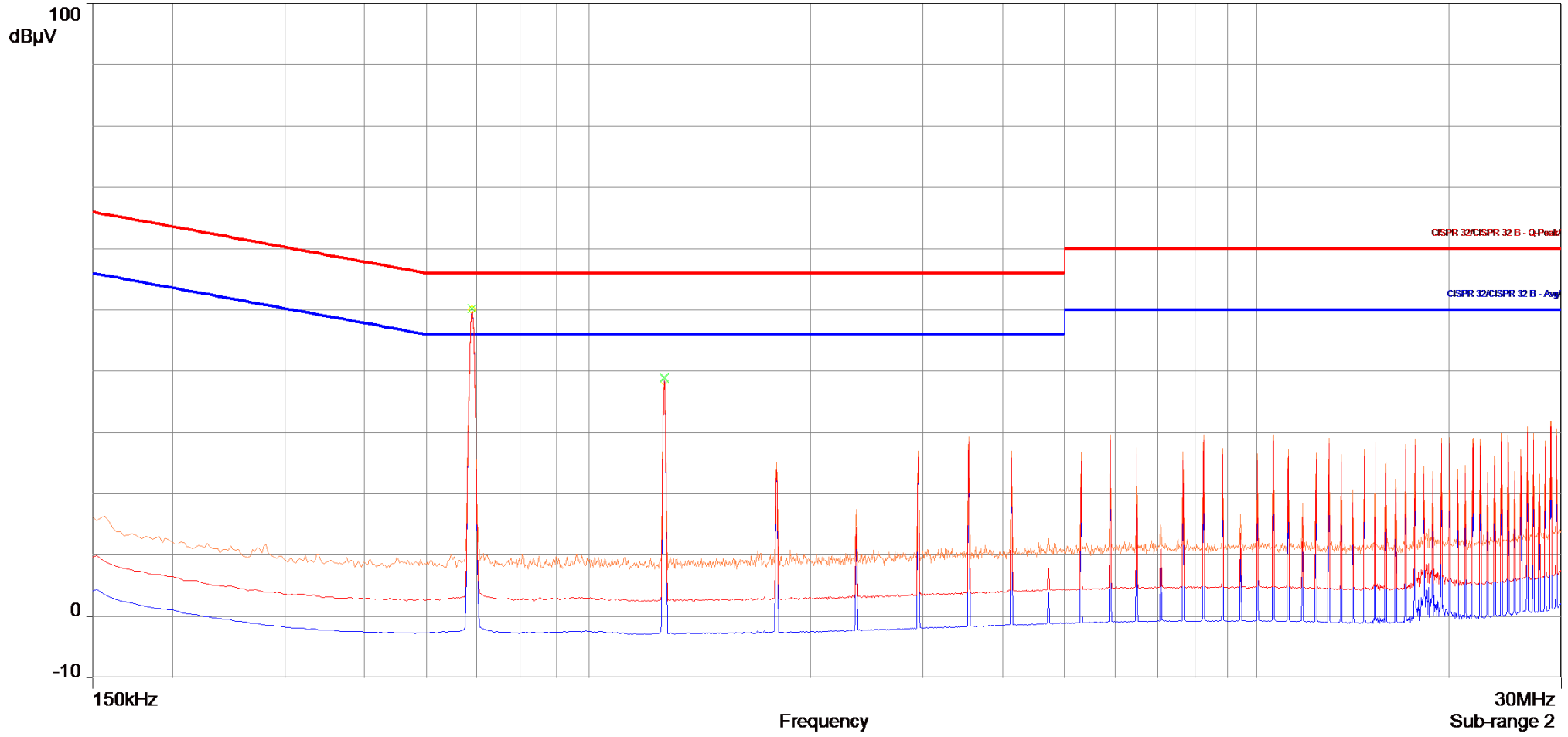

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CISPR32 Conducted Emission – input with Filtering