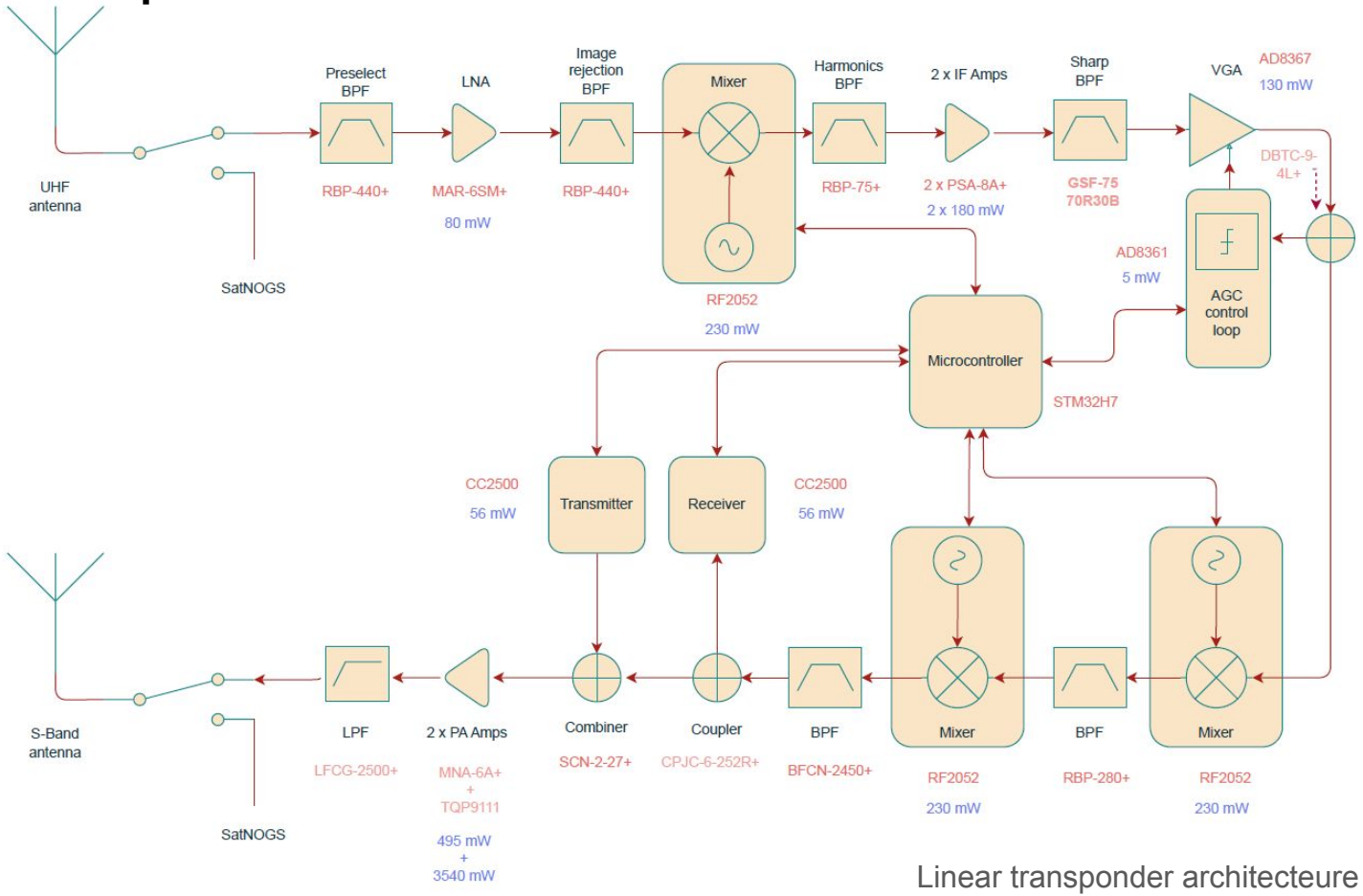
Design of a PA for a linear transponder on a CubeSat

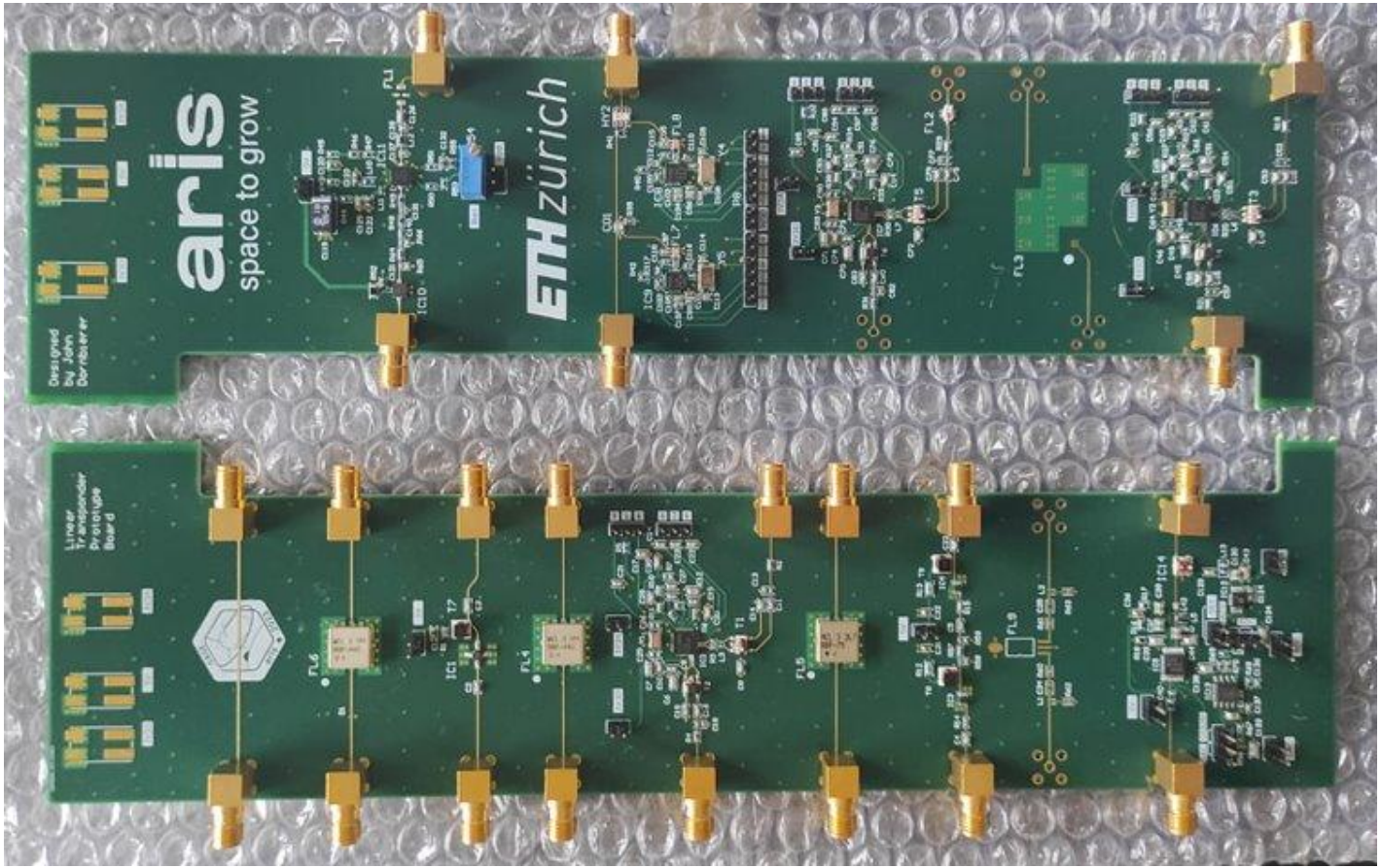
Semester thesis

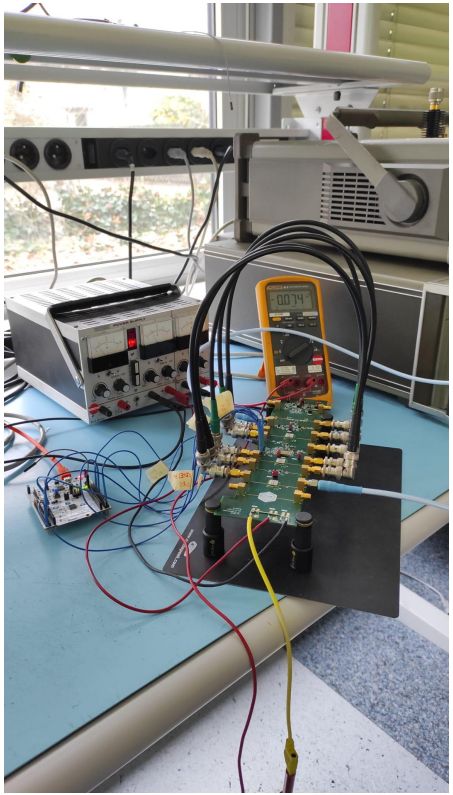
Linear transponder



Linear transponder architecteure

Prototype PCB

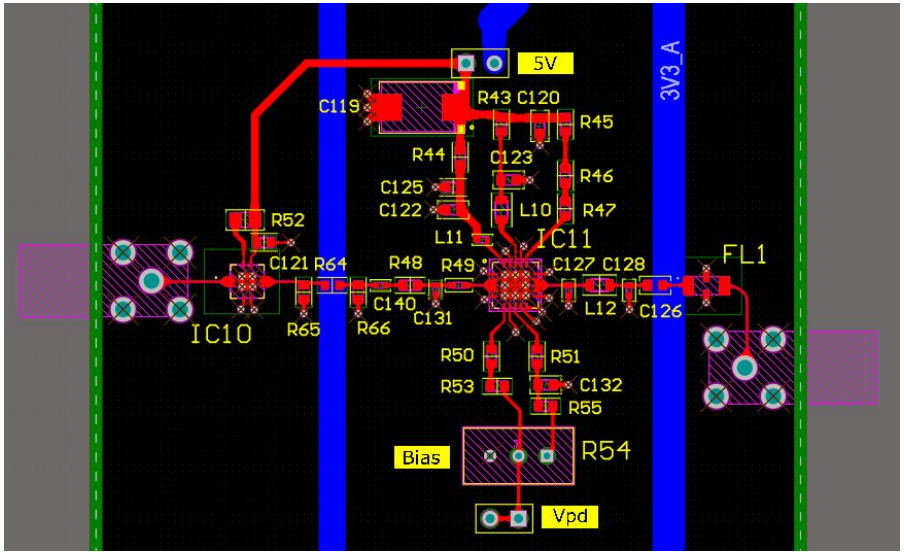




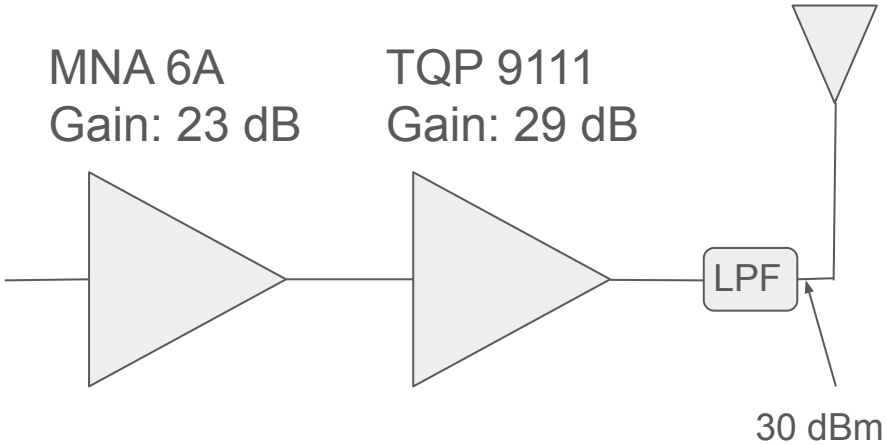
Prototype PCB v1.0 (left)
Testing RC chain (top)

Previous Work

- Prototype PCB with 2.4 GHz PA stage with combined gain of 52 dB

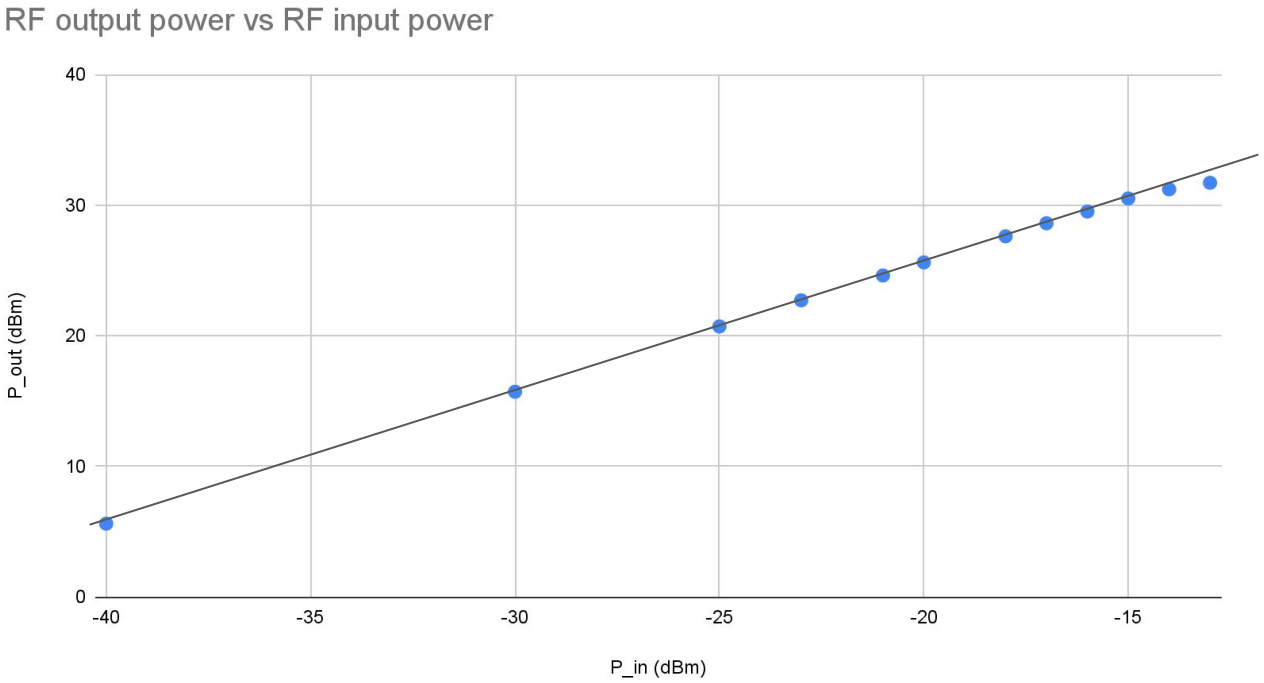


Altium PA layout



PA devices

Measurements



P1dB:

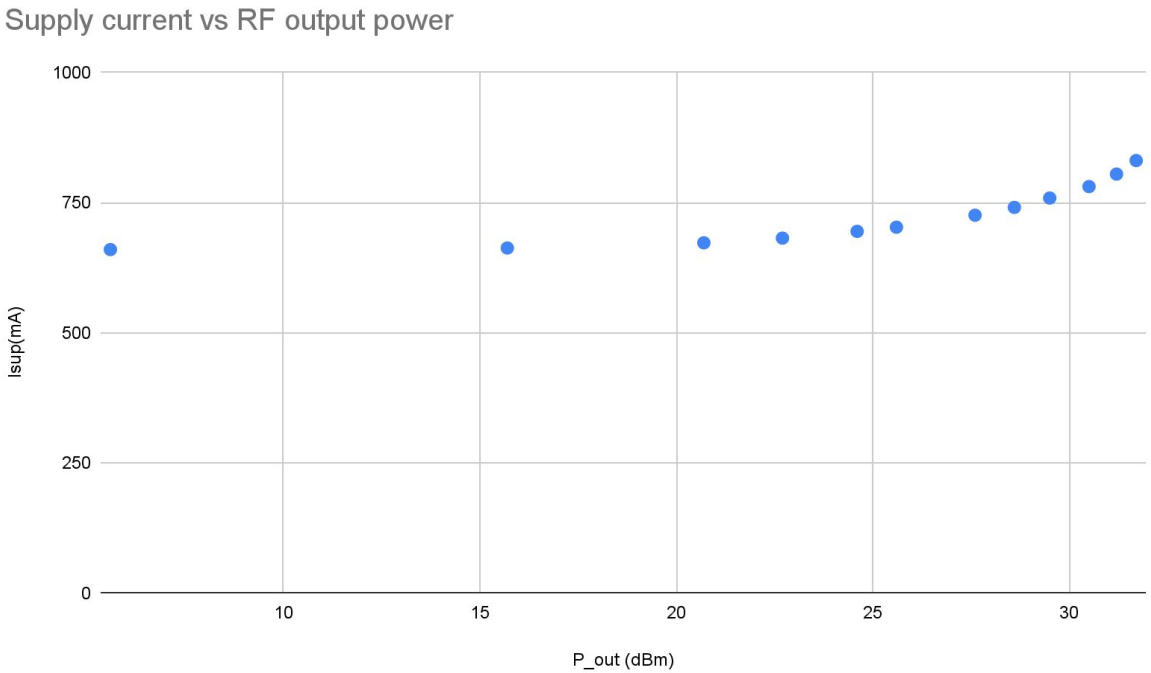
Measured: 31.7 dBm

datasheet: 32.8 dBm

Gain:

Measured: 45.7 dB

Expected: 52 dB



P_out:

30.5 dBm

Isup:

781 mA (including preamp)

~ 681 mA (without preamp)

Power consumption

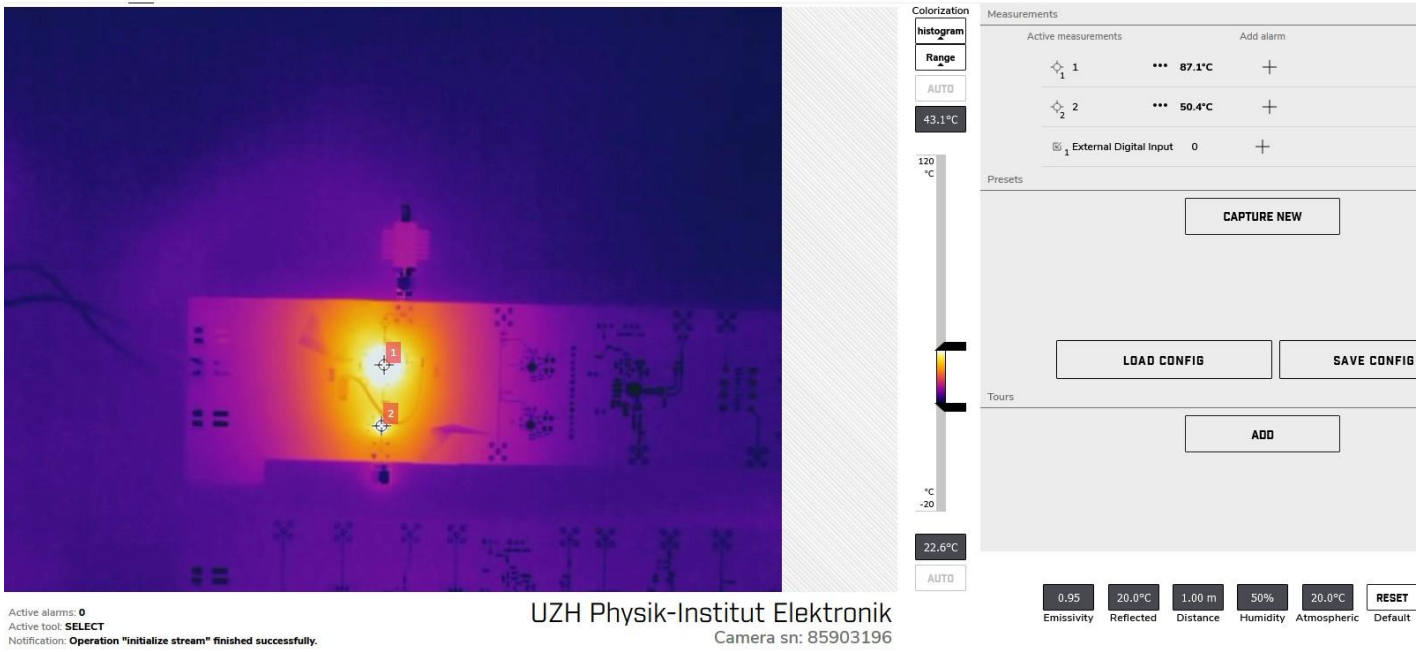
~3.4 W

Power dissipation

~2.28 W

Issues

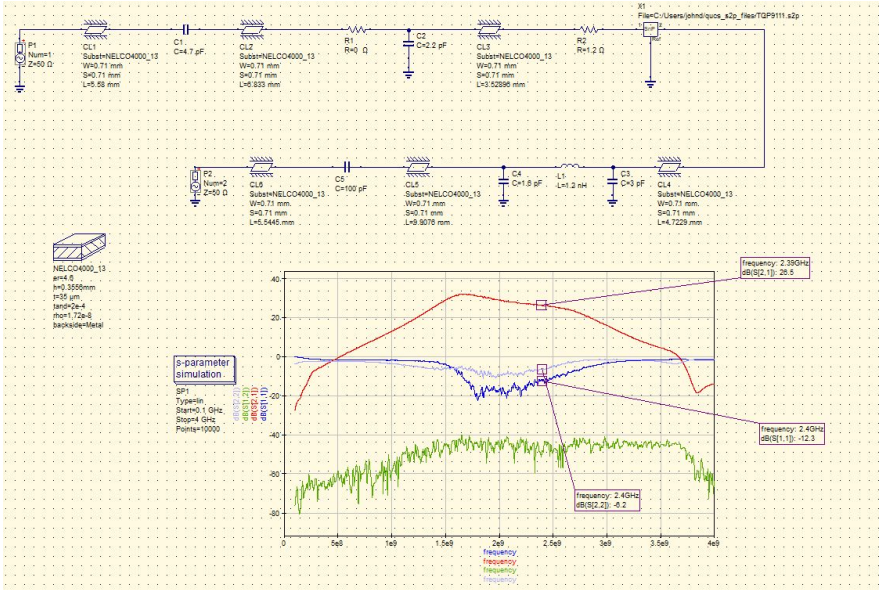
- Overheating: Prototype wasn’t designed with a heatsink
- TQP9111 reached 150°C at at DC operation
- With small heat sink taped onto vias: 87°C
- → Design an adequate cooling system



Thermal image (not in vacuum, capture after 1 min of DC operation)

Bad impedance matching:

- TL lengths must be adapted (Manufacturer Dev board uses NELCO substrate, we use FR4) → 6.3 dB gain difference compared to expected gain
- → simulate adapted matching in Qucs



Qucs simulation of adapted TL lengths for FR4 substrate

Plan

- Failure Analysis → already done
- Redefine system requirements for PA, since there are no clear defined requirements and check if correct PA choice was made

  Gain: 52 dB

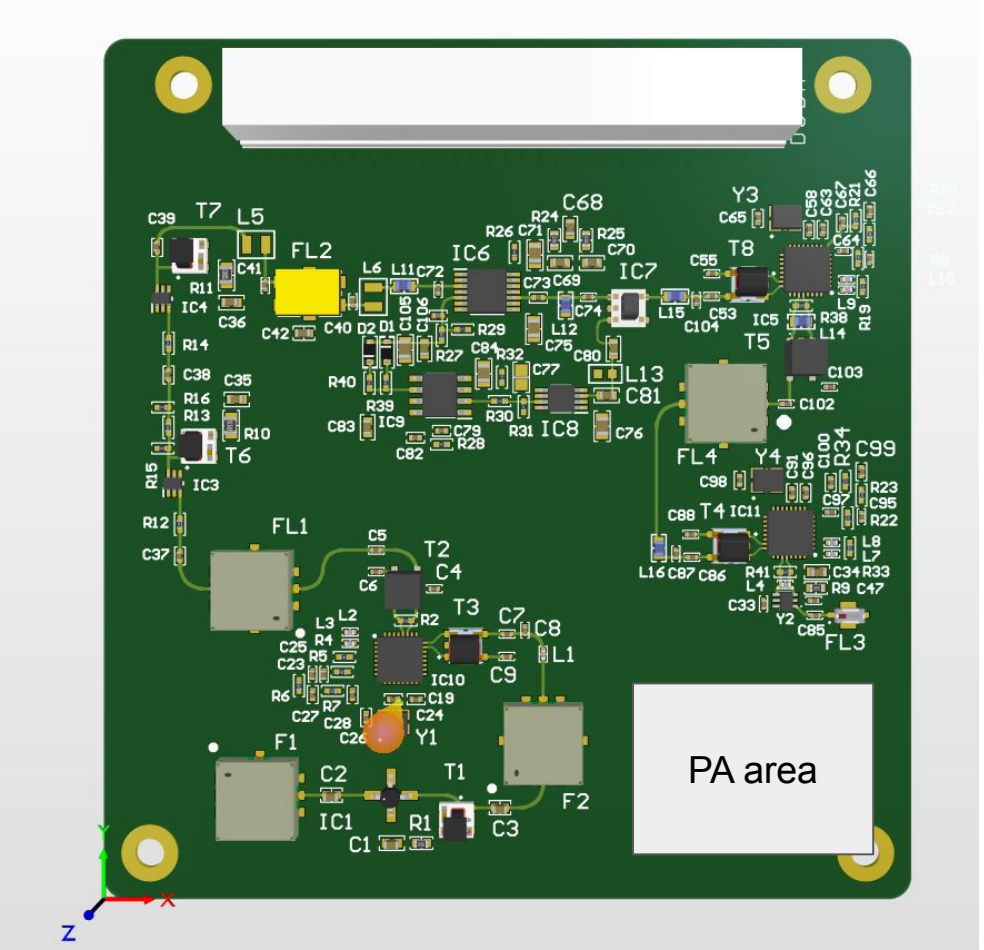
  P_out: 30 dBm

  ACLR, Linearity requirements?

- Redesign a prototype PA PCB
- Implement on Cubesat PCB

Cubesat PCB

- Space constraints (only 20x30 mm approximately)



Preliminary Cubesat PCB