UiO : Department of Physics
University of Oslo

FYS4260 – Spring 2018
Microsystems and electronic packaging and interconnection technologies

# Lab Project

# 1 - Introduction

# Lab supervisors

- Halvor Strøm
- Erlend Bårdsen

- Stein Lyng Nielsen
- David M. Bang

- Offices at ELAB, rom FV115
- kurs-fys4260@fys.uio.no

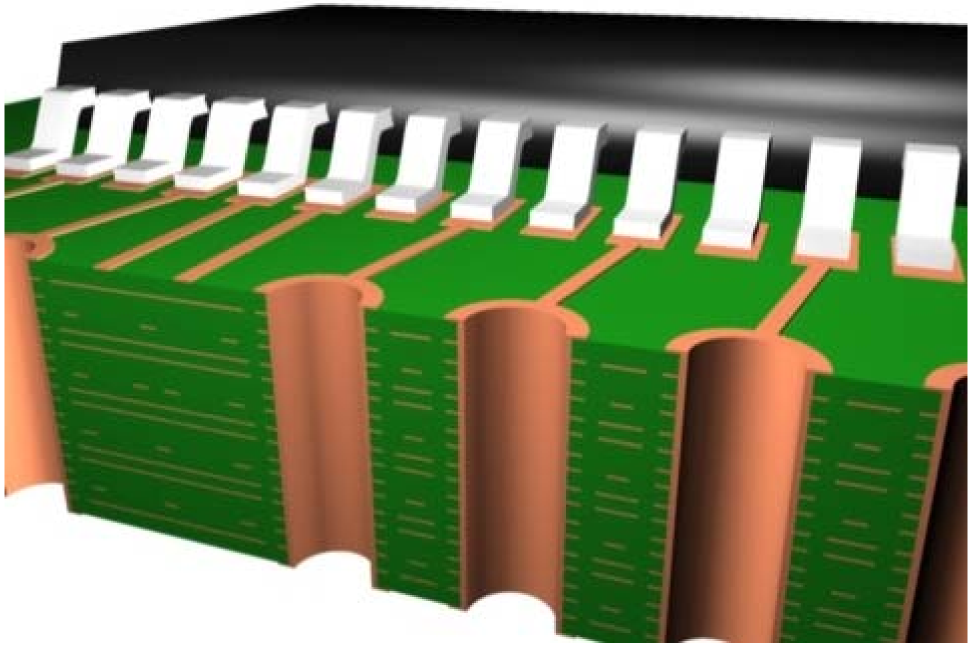
- Available all week, come by at elab, send us an email or give us a call if you need help.

# Project objective

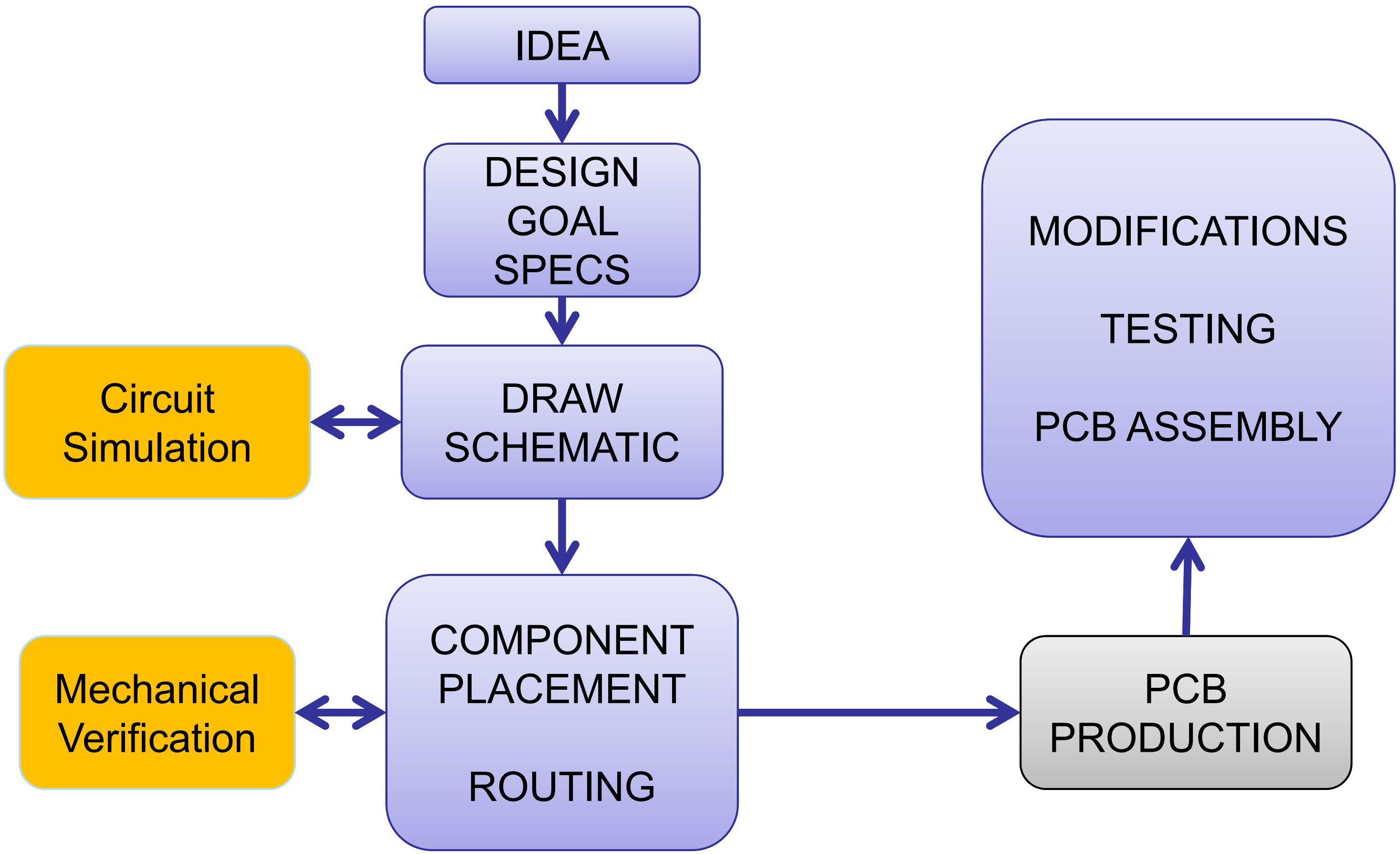
Create and build your own electronic circuit board, from idea to an assembled, fully working and tested PCB (Printed Circuit Board).

# What is a PCB?

- A **printed circuit board (PCB)** mechanically supports and electrically connects electronic components using conductive tracks.
- Components are soldered to pads on the surface of the PCB.
- Using vias to connect the different conductive layers.



# Process Flow



# Lab work

- At room FV204
- 10 computers.
- Organized as «workshops», where each week a short tutorial will be given, explaining the next step in the design phase.
- One workshop on the lecture slot on thursdays. Depending on the number of students more times will be organized as needed.
- Show up on one of the workshops each week.
- It’s mandatory to show your work once a week, preferably in the lab!

# Lab work

- Access to FV204 outside normal workours (8-16) only with activated access cards. If you need access send an email to the common course email with your full name, student card nr and UiO username.
- CadSTAR can be installed on any computer only in the UiO domain.
- It's mandatory to show your work once a week, preferably in the lab!

# Lab info

- Everyone has to make their own schematics and PCB, but you are welcome to collaborate with each other on the same design.
- There is a big difference between working togheter and ending up with almost identical PCBs, and just copying someone else design.
- -> You will not learn anything, and I *will* see the difference … ;)

# Lab «Process Flow steps»

1. Find/decide on a design you want to do.
2. Make the schematics in CadSTAR.
3. Route the design in CadSTAR PR Editor.
4. Generate production files.
5. The PCB is produced externally.
6. Assemble the board at ELAB.
7. Test the board, do modifications.
8. Write a report.
9. Oral presentation.

# Time scedule 2018

- 31/1 – Deadline for project choice
- 7/2 – Deadline for Design Goal Specifications
- 14/2 – Deadline for delivering final schematics
- 21/3 – Deadline for delivering final pcb production files
- 24-26/4 – Assembly of boards at ELAB.
  - Two groups, one day each
  - Starts at 0900!
- 5/5 – Deadline for delivering project report
- 15/5 – Oral presentation

# Project lectures, workshops and lab days

| Week | Date | Time | Activity | Place | Who |
|---|---|---|---|---|---|
| 3 | Th. 18. Jan. | 14:15–16:00 | Introduction to Lab projects | Aud Ø257 | ELAB |
| 4 | Th. 25. Jan. | 14:15–16:00 | CadSTAR Schematics | Aud Ø257 | ELAB |
| 5 | | | | | |
| 6 | | | Workshop 1 | FV204 | ELAB |
| 7 | | | Workshop 2 | FV204 | ELAB |
| 8 | | | | | |
| 9 | | | Workshop 3 | FV204 | ELAB |
| 10 | | | Workshop 4 | FV204 | ELAB |
| 11 | | | Workshop 5 | FV204 | ELAB |
| 12 | | | Workshop 6 | FV204 | ELAB |
| 17 | Tu 24 + Th 26. Apr. | All day | Lab project assembly day | ELAB FV110 | ELAB |

# About the design

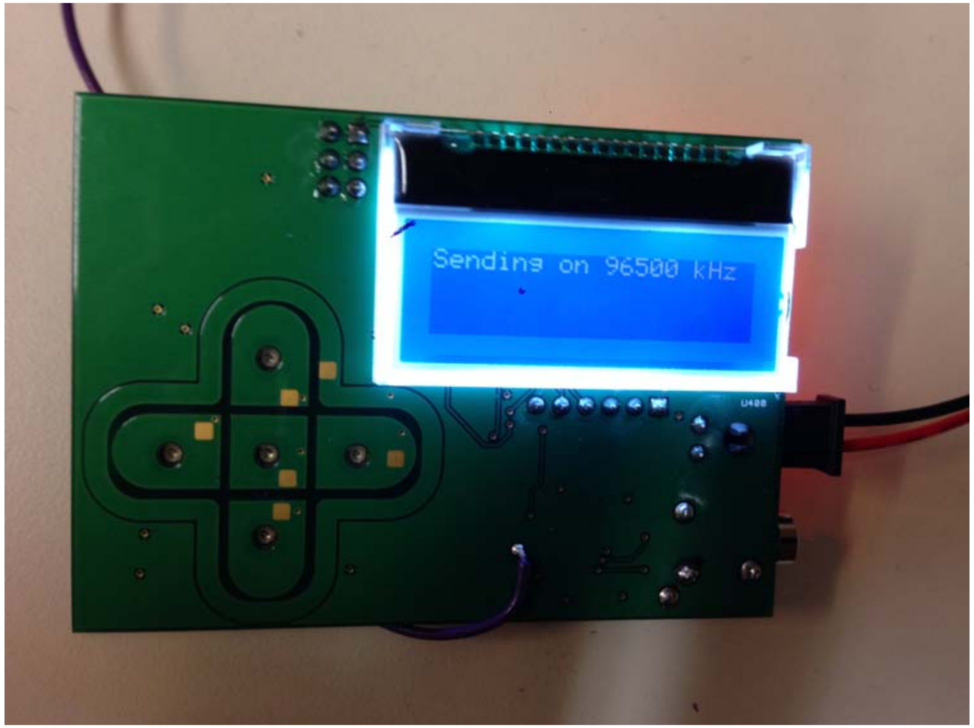
- Find a design you want to do!
- Ideas at www.discovercircuits.com

or pick one of these:

- Low Power ISM Tranceiver
- Headphone Amplifier
- FM Transmitter (Mobile to car FM stereo)

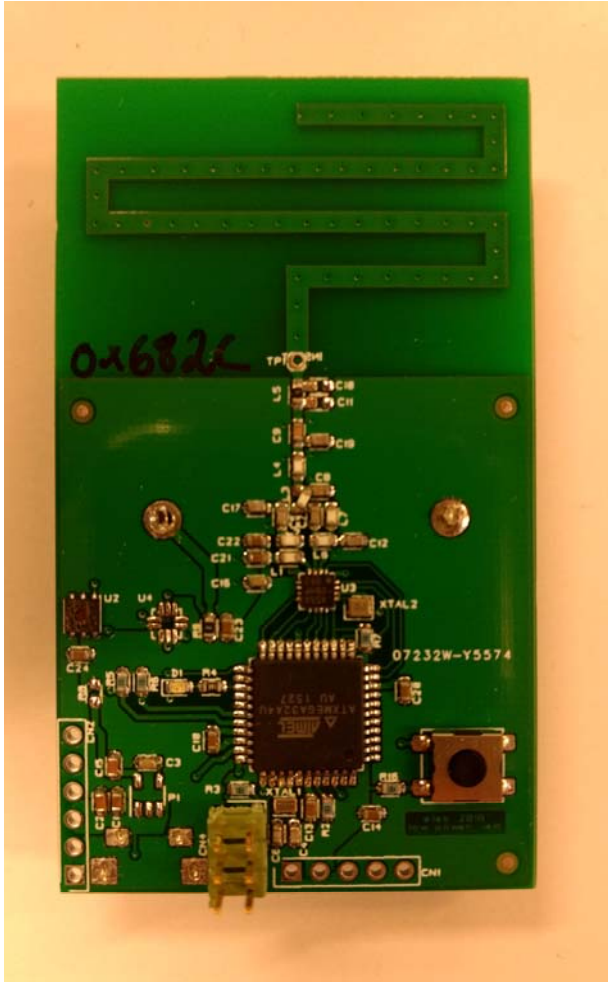
# FM Transmitter

- Si4713 FM Transmitter
- ATMega48/328 8-bit Microcontroller
- Capacitive Touch Buttons
- 128 x 32 pixels LCD



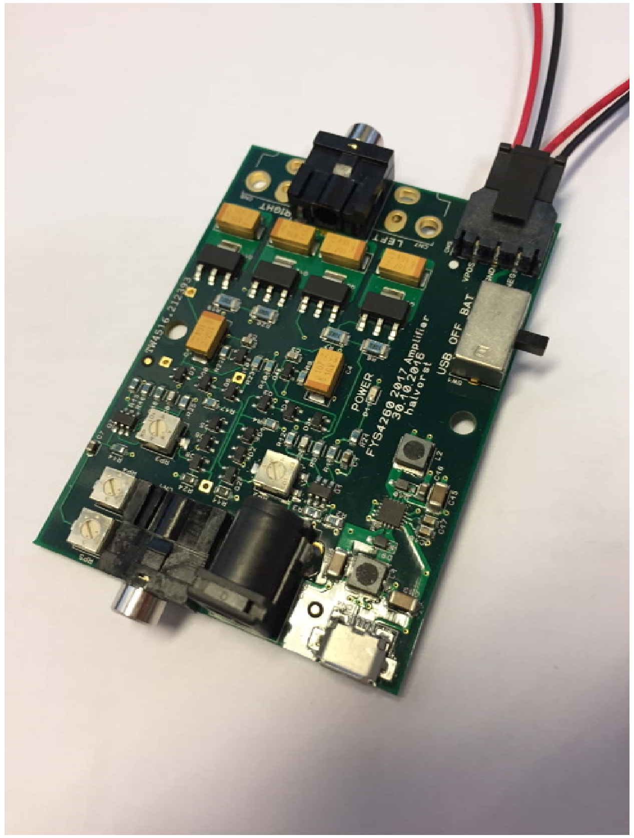
# Low Power ISM Tranceiver

- ATXMega32 MCU
- Si4455 ISM Radio at 868MHz
- UART (serial) to PC or Rasberry Pi
- Temp and Humidity sensors



# Discrete OpAmp (Amplifier)

- OpAmp built with discrete components
- No Microcontroller
- Dual Channel
- ~2W max
- Runs on batteries or from 5V switcher



# Custom Design?

- Only components already in library
  - Possible to ask for new components, but strict rules to what we might accept.
  - Database at http://tid.uio.no/elab/FYS4260_html_Lib/index.htm
- No high power / high current designs.
- No new microcontroller designs!
  - Use FM or ISM design as a start, and add modifications (without altering original functionality) if you want to build a «custom» microcontroller board.
- Each custom design needs to be approved by us!

# About the circuit layout (pcb)

- Starting size 5x7cm
- Use ELAB components
- Four layers
- SMD Components only on top side
- Use default FYS4260 settings

# Project Tools

- For this course we are going to use CadSTAR as our main tool.
  - Design Editor to create the schematics
  - PR Editor to place and route the design
  - Mechanical models in Boardmodeller
  - (Circuit simulations in Pspice/LTspice)

# LAB PROJECTS WALK TROUGH

# FM Transmitter

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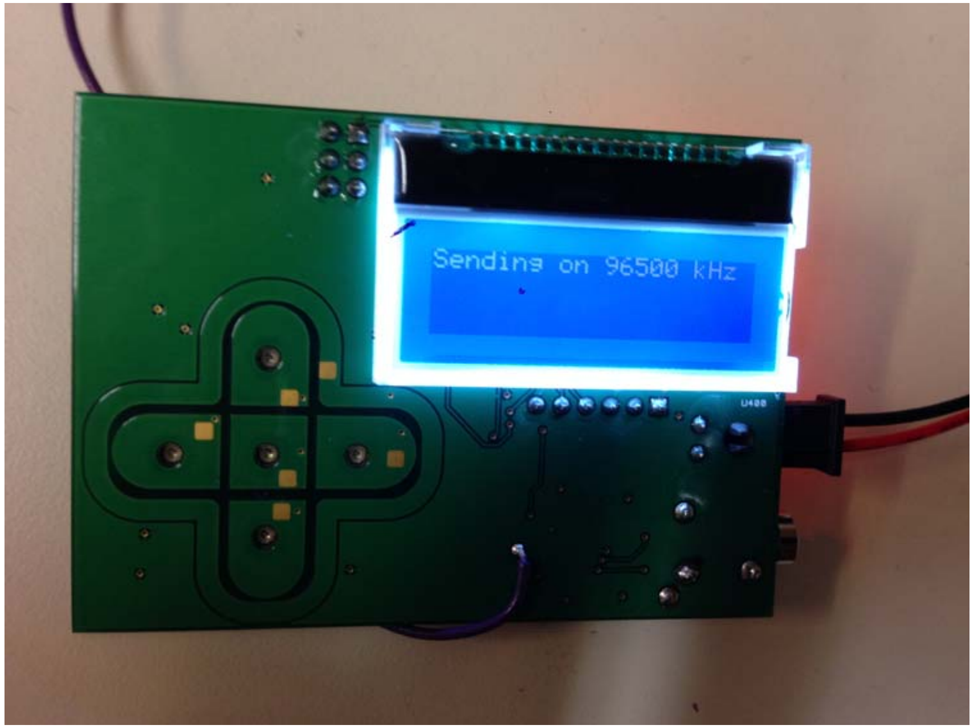
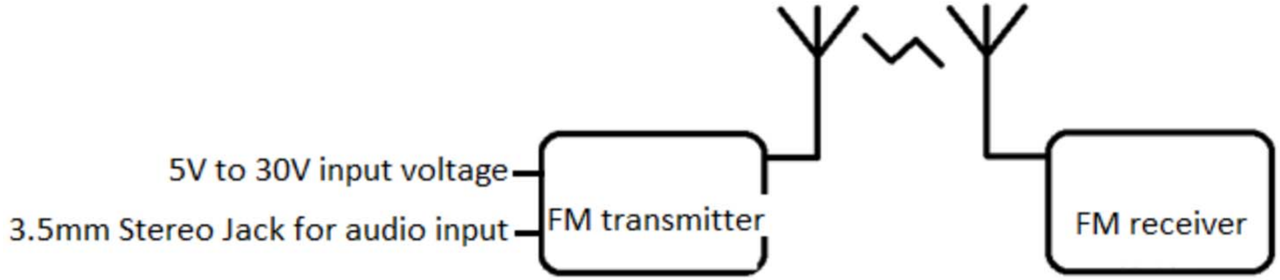
- Capacitive Touch Buttons
- 128 x 32 pixels LCD

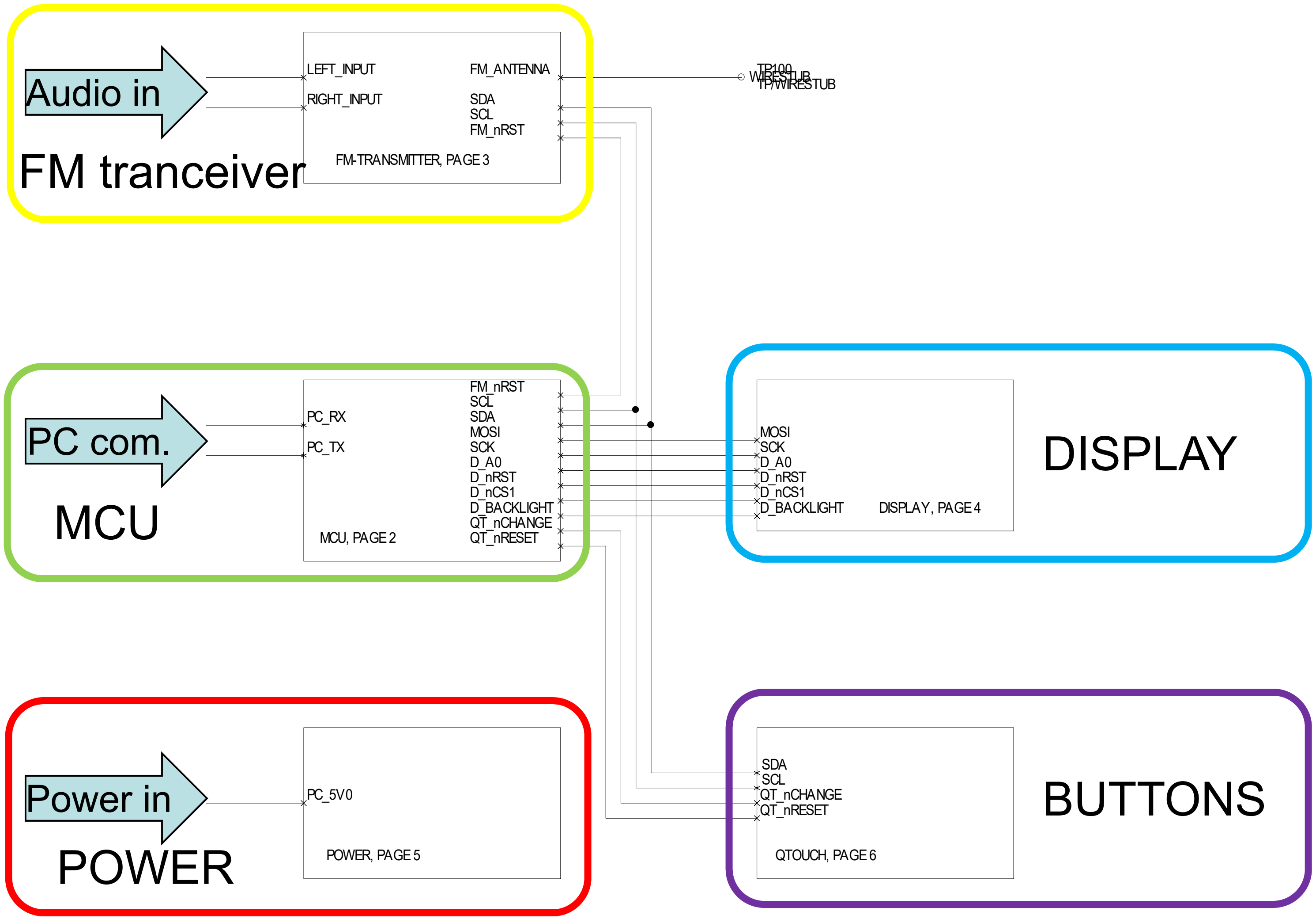


# FM Transmitter Description




- Consists of a MCU which controls a FM transmitter, monitors the touch pads and updates the display.
- FM transmitter will transmitt the audio signal input on the 3.5mm stereo jack connector.
- Large input DC converter

# FM Transmitter Top Schematics



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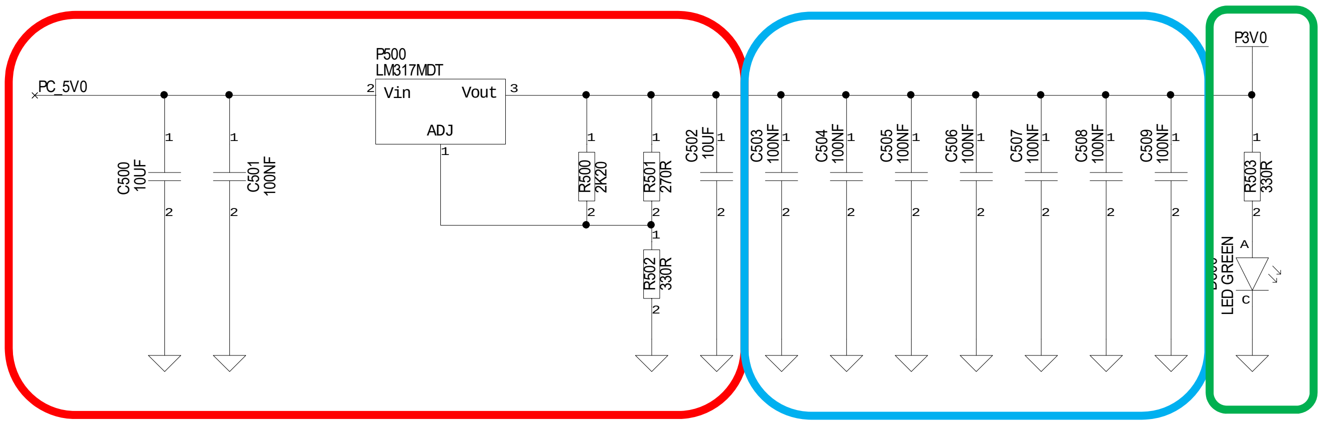
# FM Transmitter Schematics - Power



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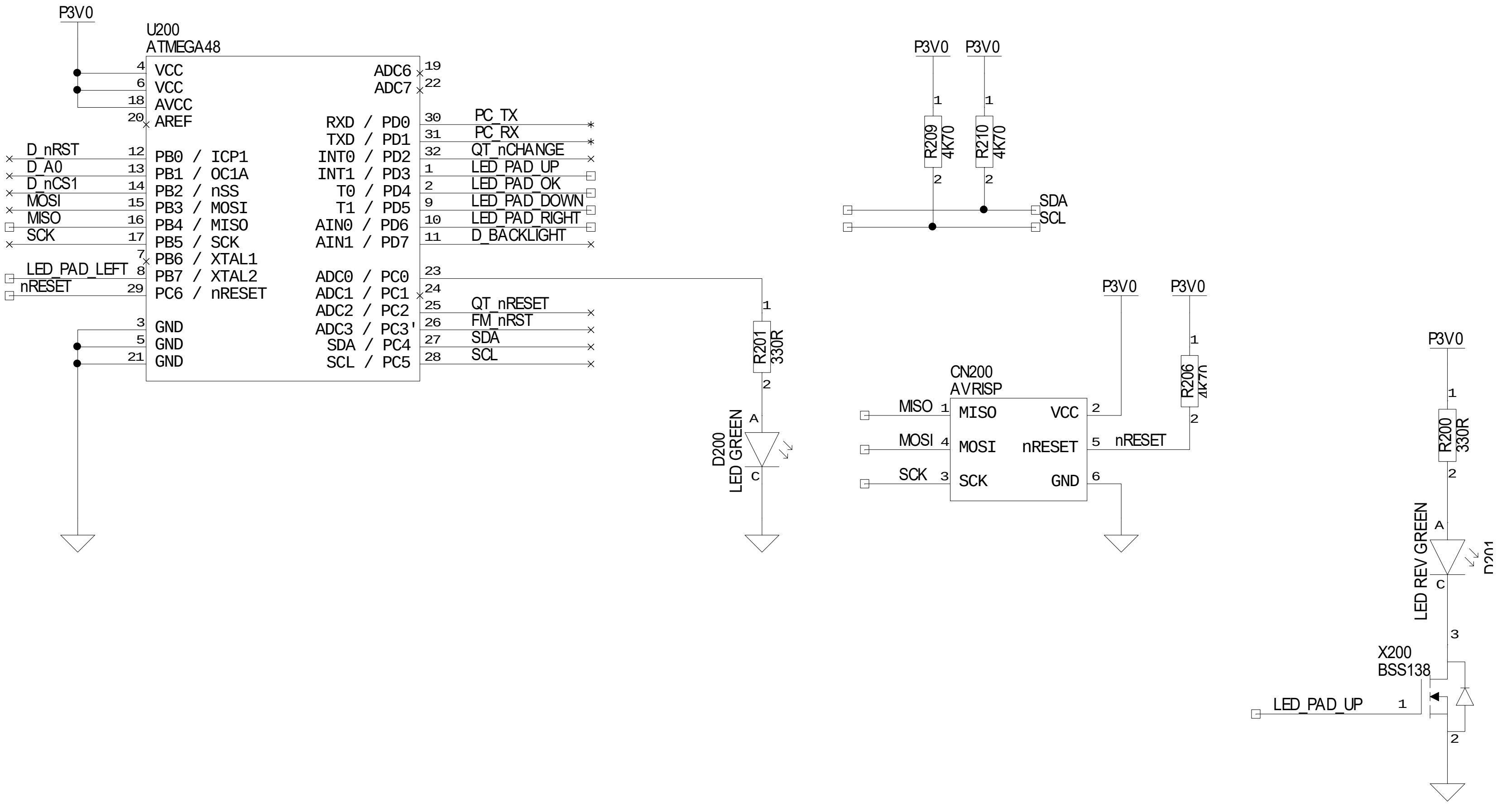
# FM Transmitter Schematics - MCU



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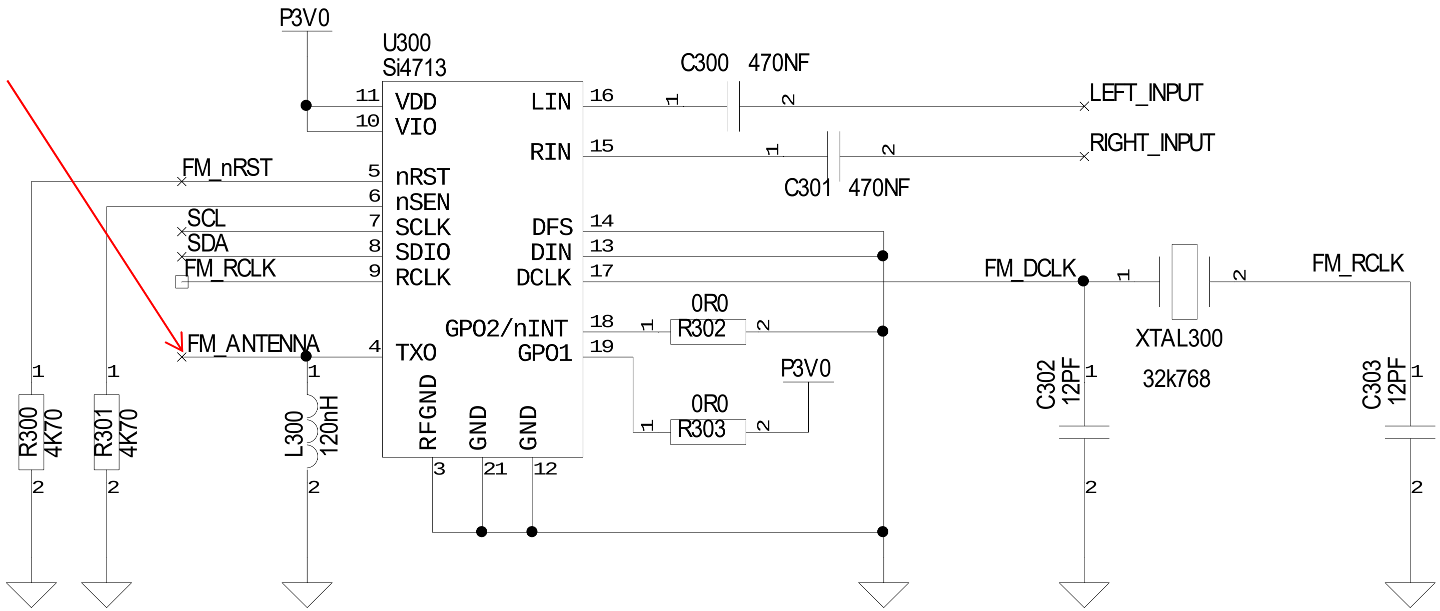
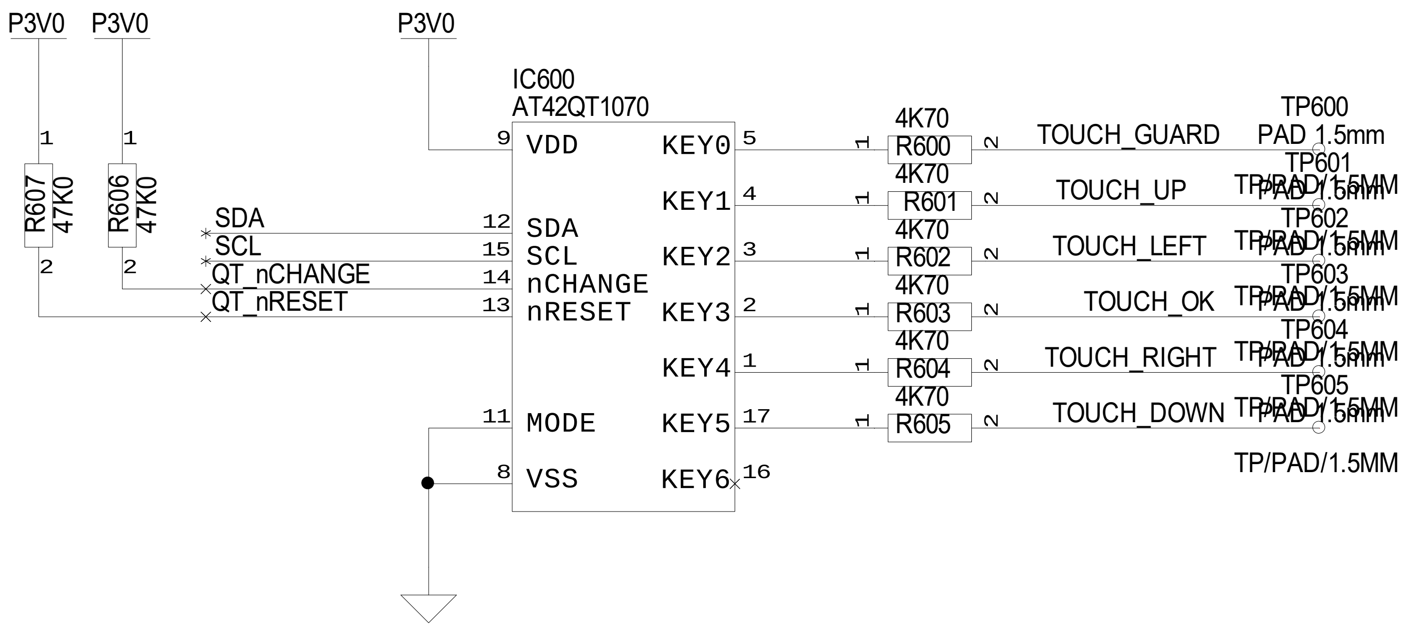
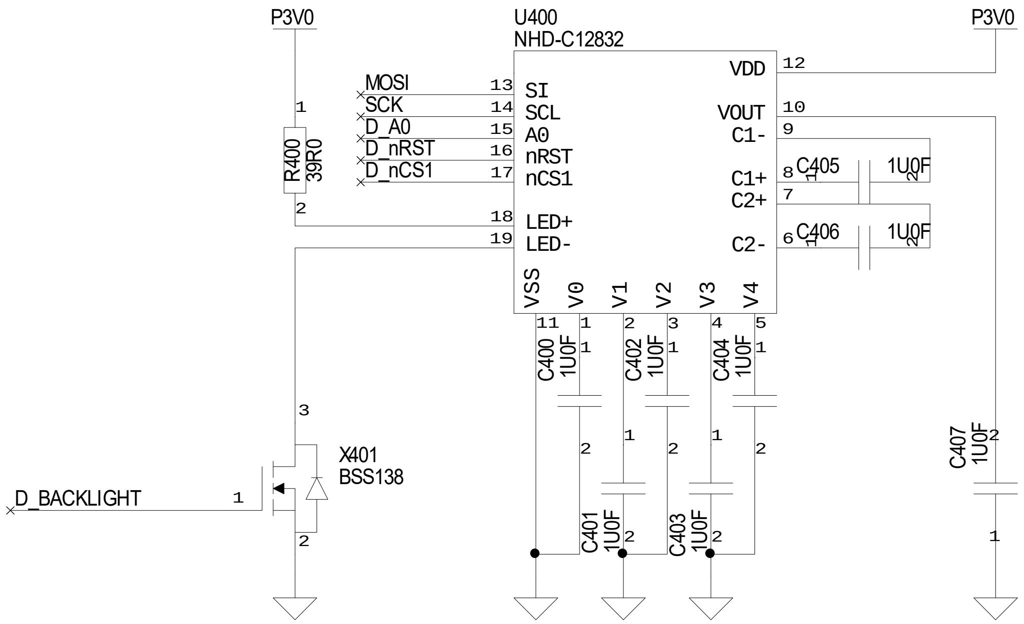
# FM Transmitter Sch - Tranceiver



# FM Transmitter Schematics – Capacitive Buttons



# FM Transmitter Sch – Display



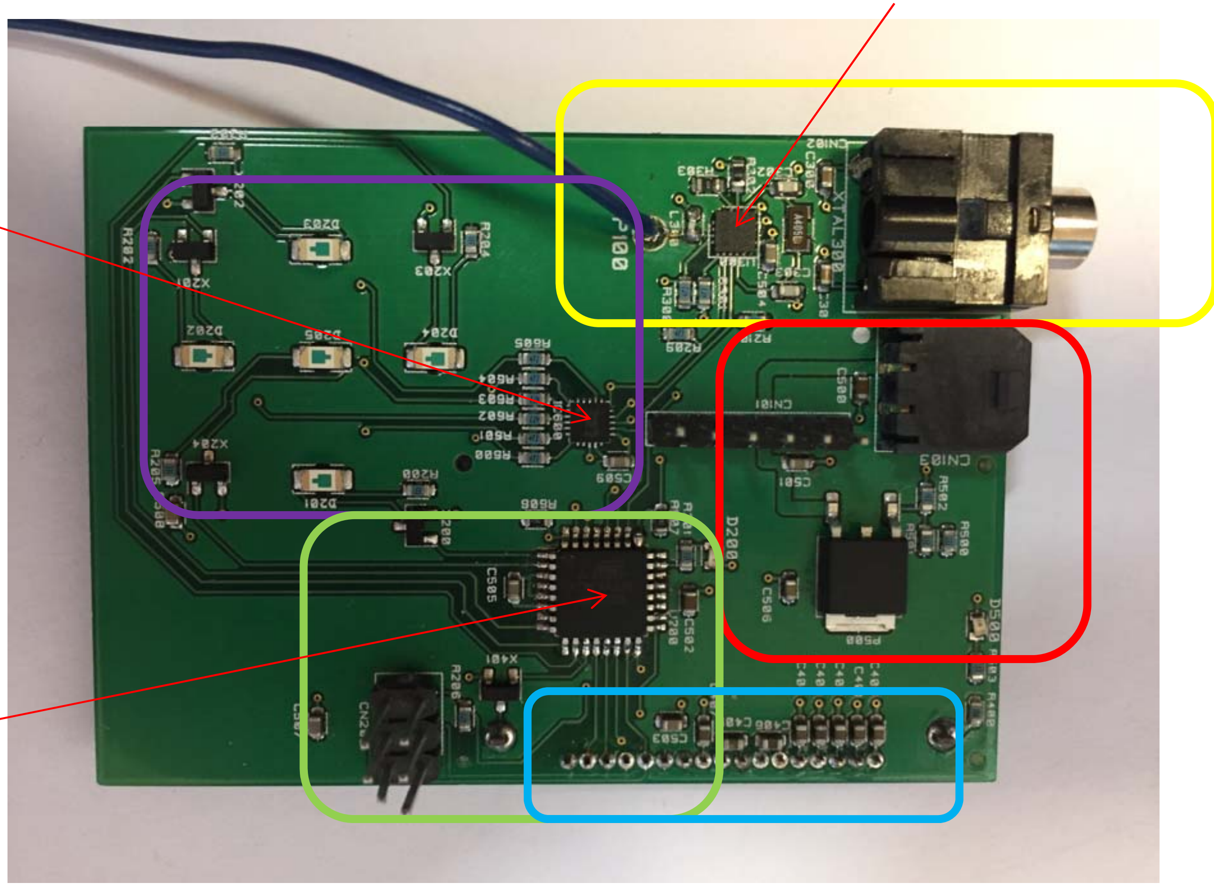
# Key points

- Few components
- Mechanical planning important, how do you want to «interface» with your board, used in what environment (multiroom, car, inhouse)?
  - Capacitive buttons (with LEDs?)
  - Display
  - Antenna (internal/external)
  - Power source (eg wall transformer, car adapter, battery, …)
- Possible to extend with own functionality?

# Component Side

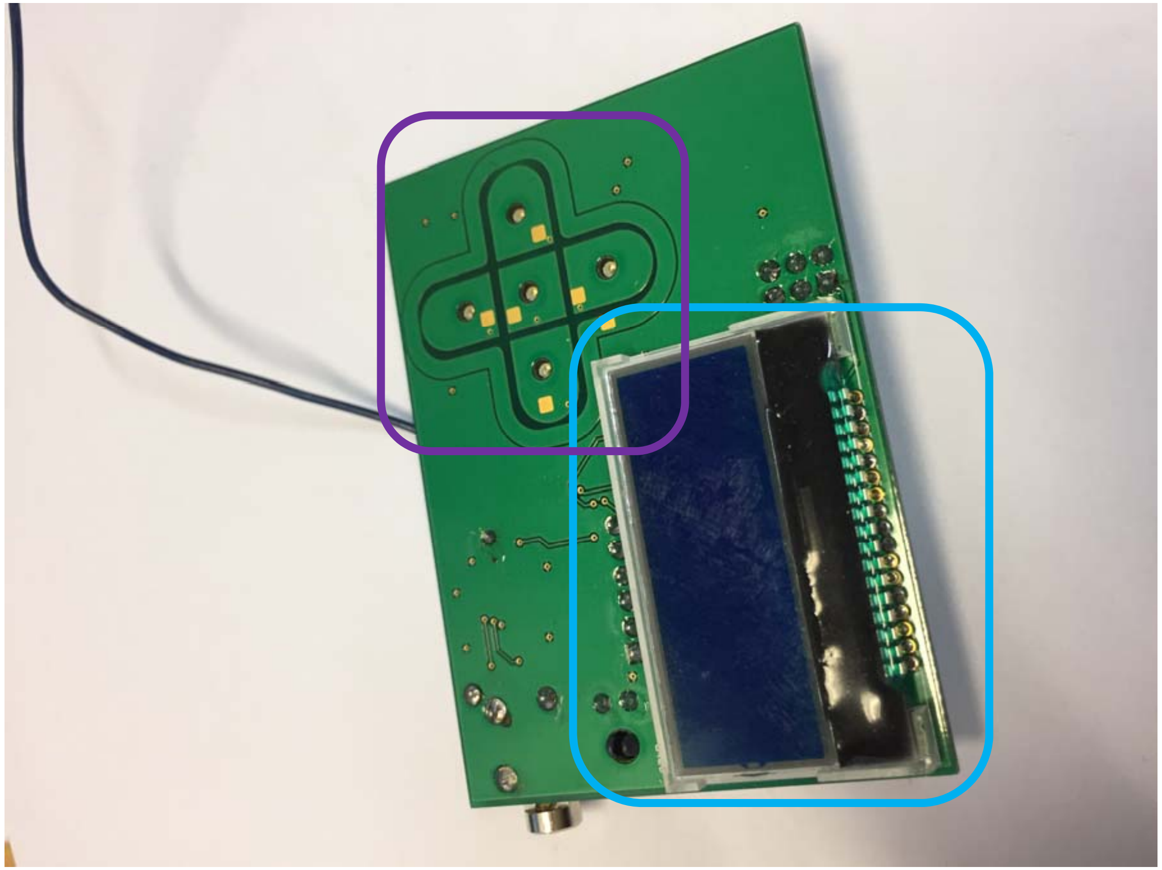
FM Tranceiver
Si4713

Qtouch
AT42QT107D



MCU
ATMega328

# Bottom Side (User front)



# Low Power ISM Tranceiver

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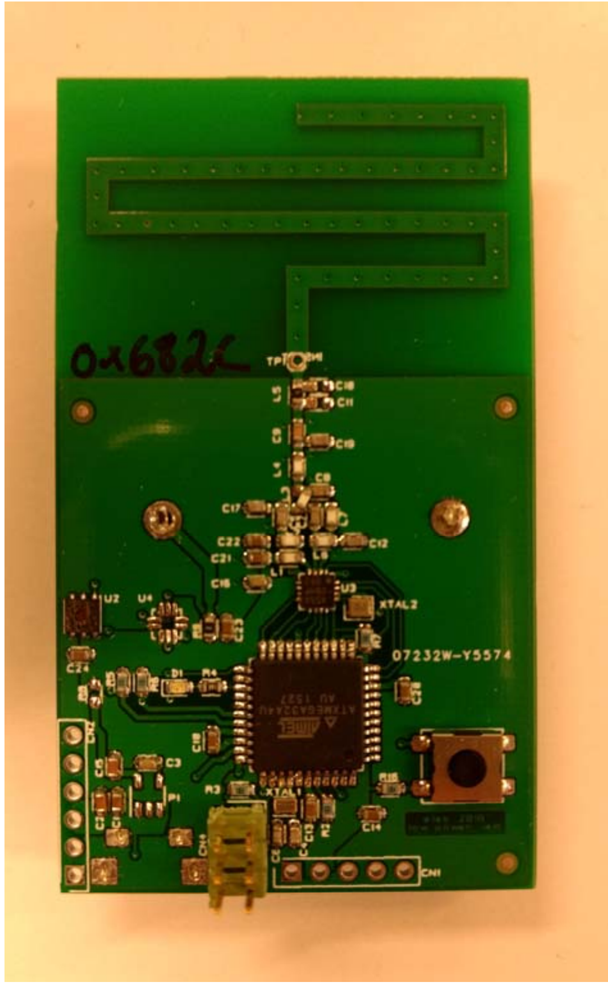
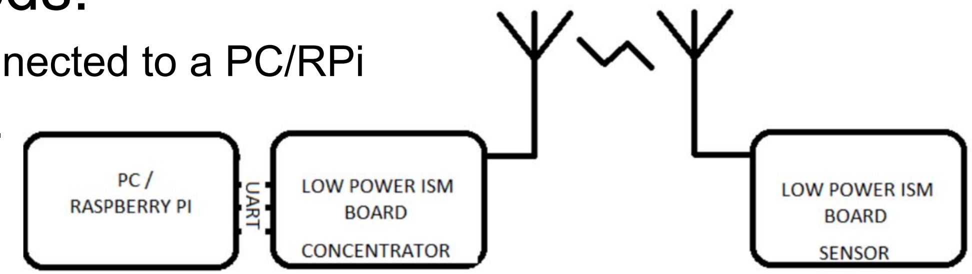


# Low Power ISM Description

- Consist of a MCU which execute programmed logic, sensors, and an ISM radio transmitting and receiving data packets to and from other low power ISM boards.
- A complete setup needs:
  - One concentrator board connected to a PC/RPi
  - One or more sensor boards.




- Only difference between the concentrator board and the sensor board are the code uploaded to the MCU, you shall only make on design!

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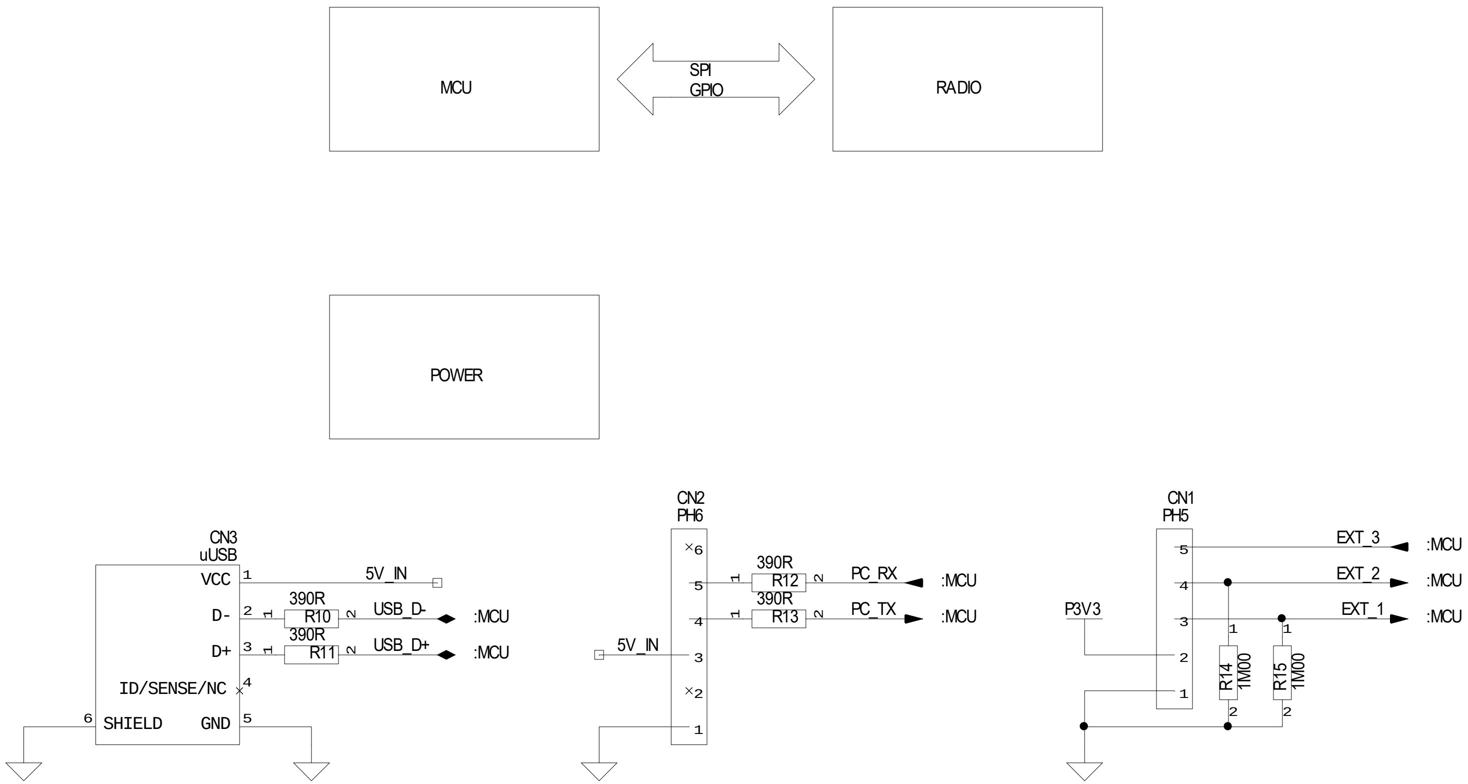
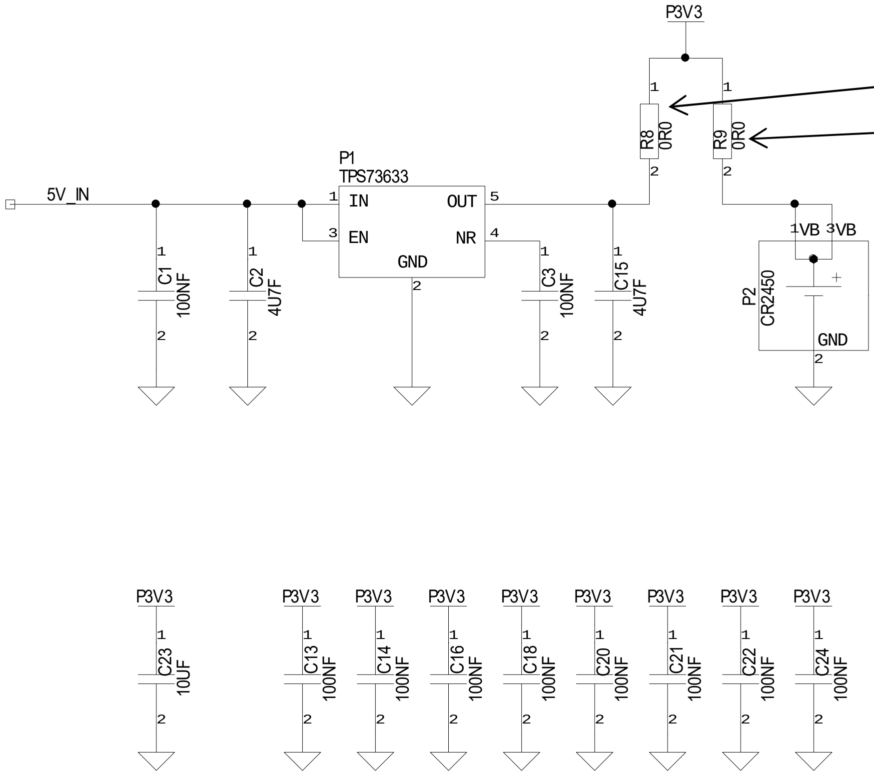
# ISM Top Schematics



# ISM Schematics - Power

Use to select power source.
- 5V
- Battery



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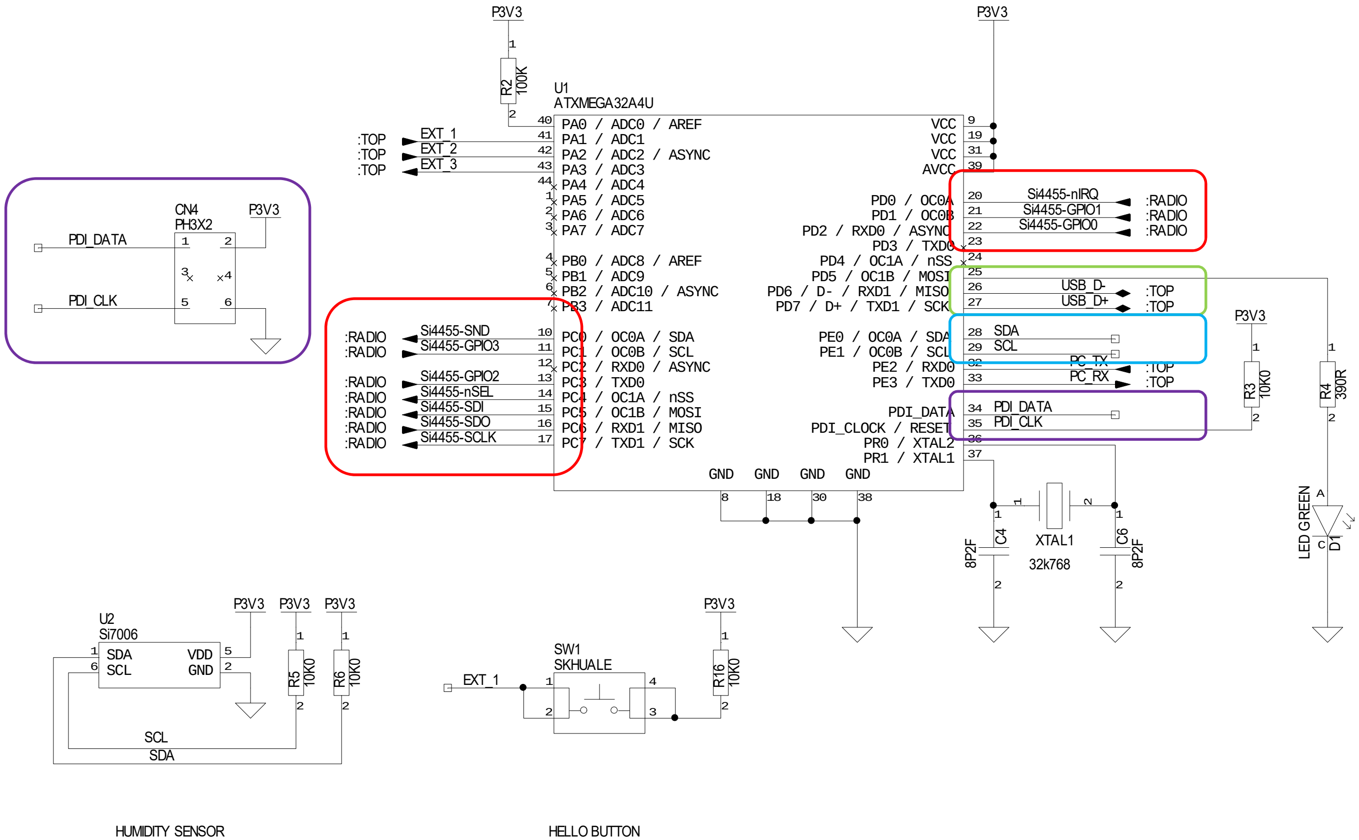
# ISM Schematics - MCU



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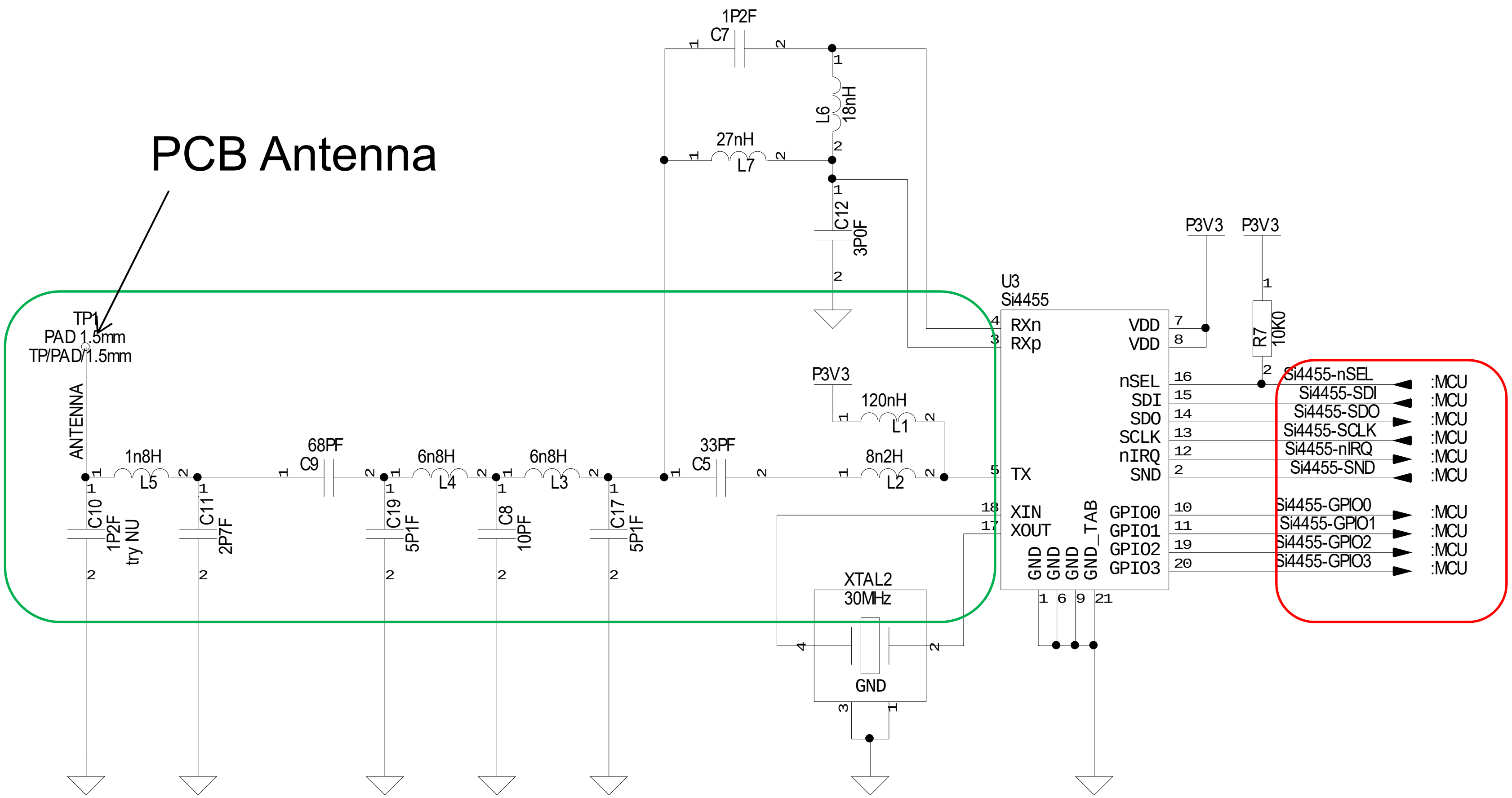
# ISM Schematics - Radio

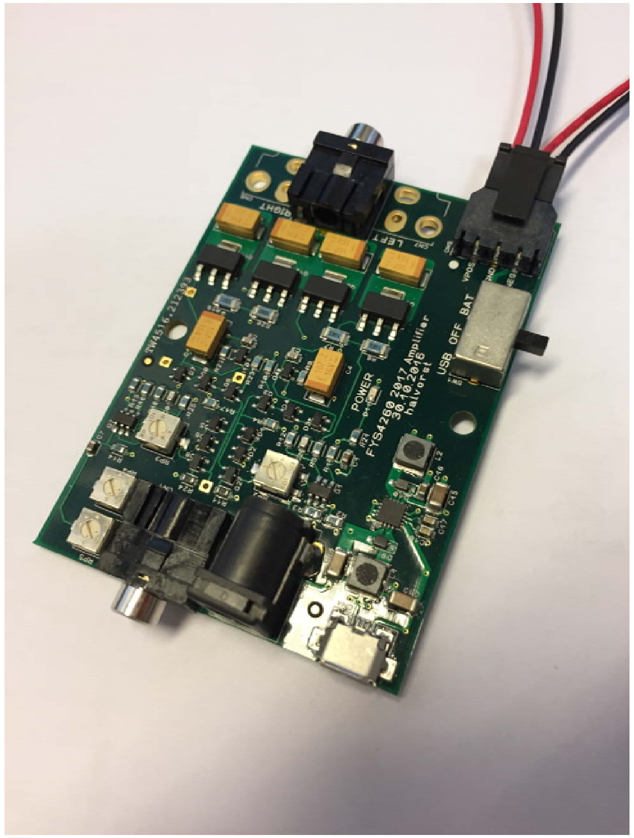


# Key Points

- Measures humidity and temperature
  - Three pins supported in firmware for custom intructions.
- PCB Antenna needs to be very accurately designed!
- Needs two boards to communicate => more work on assembly day.
- Depends on a PC/Rpi etc to have any meaningfull function.
- Many pins available for own functionality.

# Discrete OpAmp (Amplifier)

- OpAmp built with discrete components
- No Microcontroller
- Dual Channel
- ~2W max
- Runs on batteries or from 5V switcher



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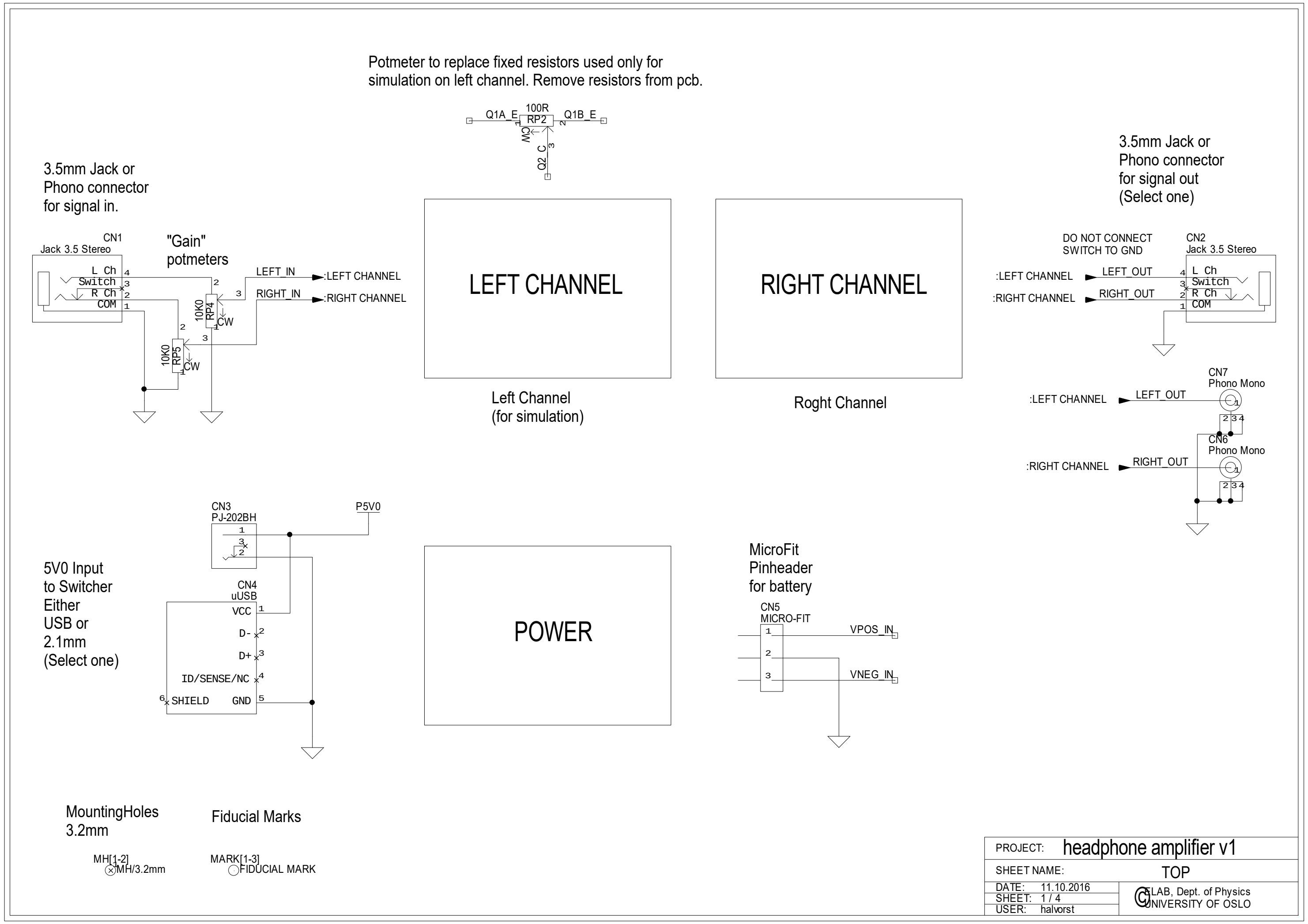
# Amplifier Schematics - Top



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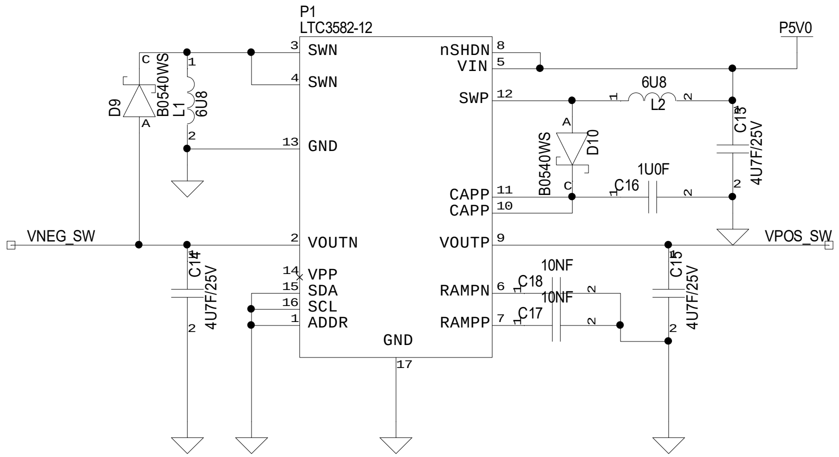
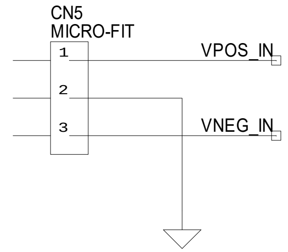
# Amplifier Schematics - Power

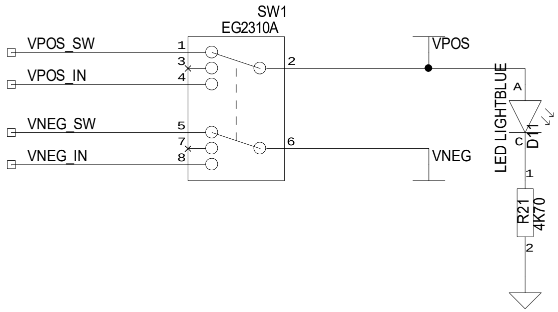
Switcher circuit 5V -> +/-12V



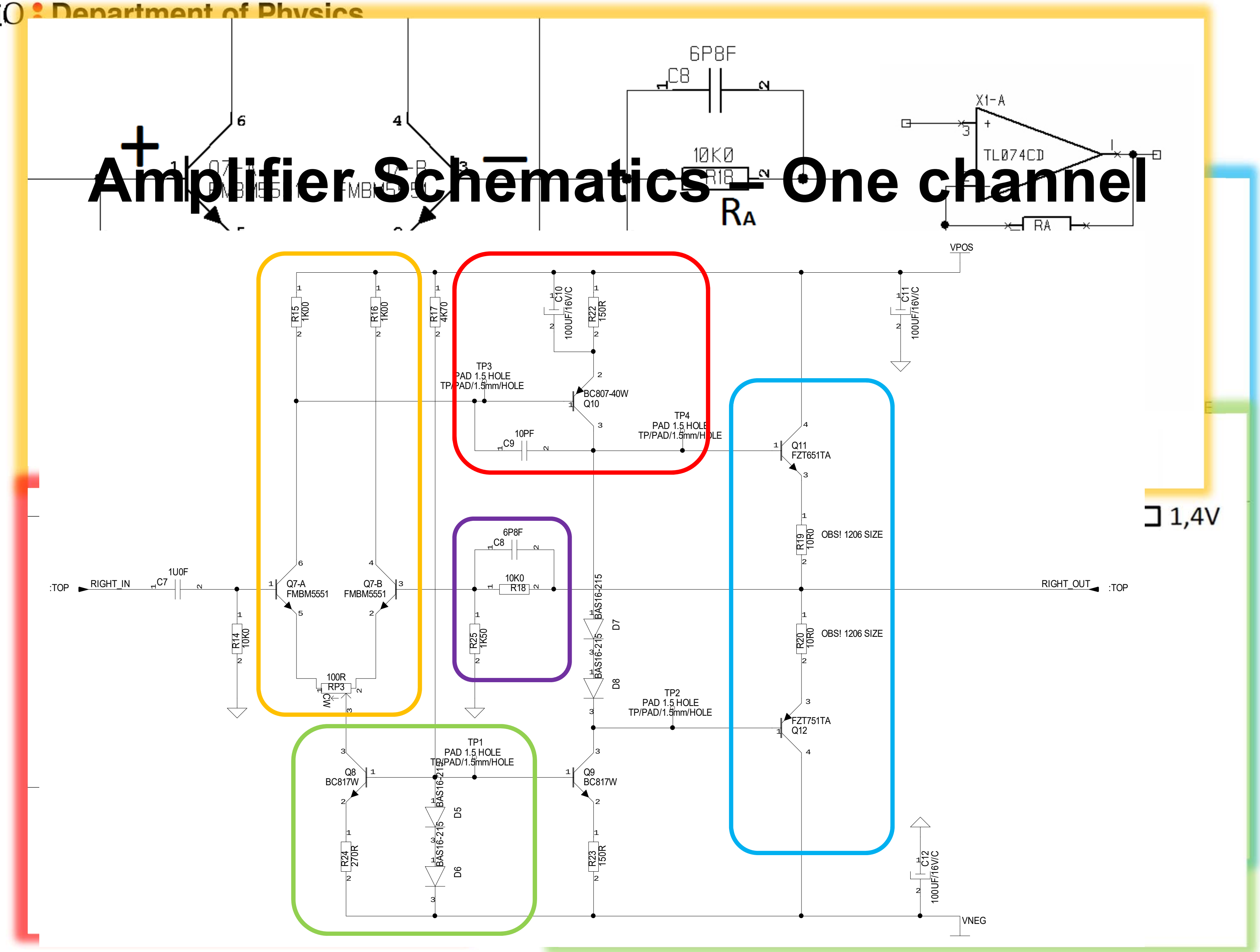

MicroFit
Pinheader
for battery



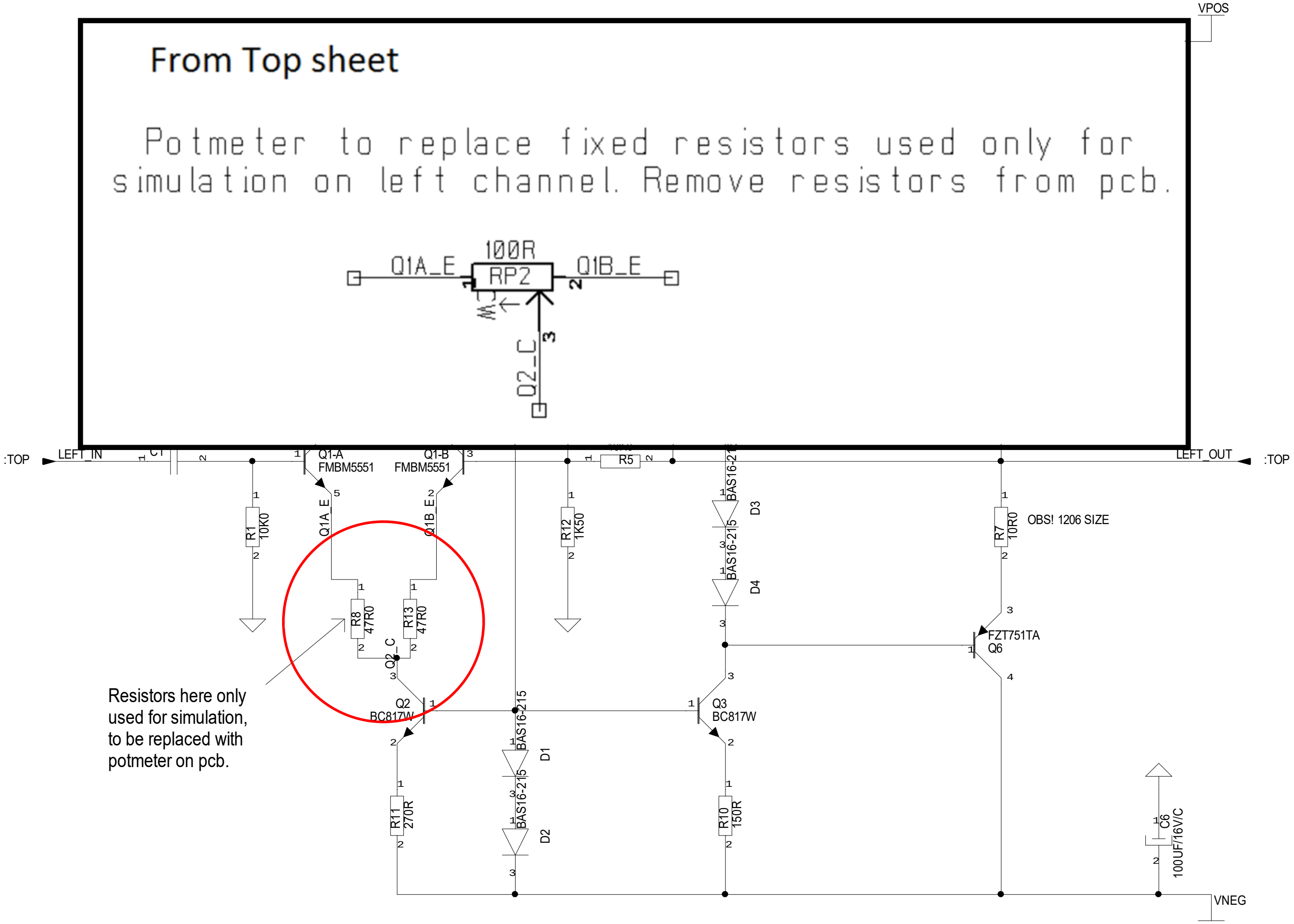

Switch to select
Power Source:
TOP - Switcher
MID - Off
BOT - Direct



# Amplifier Schematics – One channel



# Amplifier Schematics – Simulation channel



# Key Points

- Analog design
- Most components…?
- Easiest debugging…?
  - Includes simulations, reveals most errors.
- Standard packages = easy assembly and rework.