

VLSI design project, TSEK01

Project description and requirement specification

Version 1.0

Project: FM Radio Transmitter

Project number: 2

Project Group:

Name	Project members	Telephone	E-mail
	Project leader and designer 1(4)		
	Designer 2(4)		
	Designer 3(4)		
	Designer 4(4)		

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1 Background

This document describes the design requirement specification of a FM Radio Transmitter. This simple transmitter can link your home entertainment system to a portable FM radio receive. For example you can play a CD in your living room and listen to it on a portable radio in back yard.

1.1 Project goal

The project goal is to design an integrated circuit (IC) in complementary metal-oxide semiconductor (CMOS) technology. Students, participating in this project as project members and project leaders, should learn the different steps of the IC design flow. That includes the survey of different transmitter architecture, system modeling, schematic simulation, layout implementation and verification. The project students have an optional choice to manufacture the designed IC circuit on a chip. To test the manufactured chips, another course (TSEK10) is available after the project.

1.2 Milestones and deadline

1: Project selection	Week 3
2: Pre-study, project planning, and discussion with supervisor	Week 4
3: High-level modeling design and simulation result (report)	February 11
4: Gate/transistor level design and simulations result (report)	March 1
5: Layout, DRC, parasitic extraction, LVS, post-layout simulations, modification, chip evaluations, and delivery of the completed chip	May 17
6: DEADLINE , Final report, and oral presentation	May 25

1.3 Parties

The following parties are involved in this project:

- 1- Customer: Rashad.M.Ramzan
- 2- Project supervisor: Rashad.M.Ramzan

Tasks:

- Formulates the project requirements
- Provides technical support
- Reviews the project documents.

- 3- Project leader: One of the members in the design team.

Tasks:

- Responsible for organization of the team and the project planning.
- Divides the design and documentation work in an efficient way
- Organizes the team meetings as well as the meetings between the team and supervisor
- Keeps the supervisor informed about the progress of the project (at least one email or meeting per week)

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- 4- Project design members (including the project leader)
- Are equally responsible for project planning and design.
 - Participate actively in all the meetings
 - Support the team and the project leader
 - Keep the team and project leader informed about the progress of their tasks.

2 Project description

2.1 System description

The complete system to be built should include the on-chip audio amplifier, Low Pass Filter (LPF), Pre-Emphasis Circuit (Optional), VCO (Voltage Controlled Oscillator) and power amplifier. The off-chip components include microphone coupling circuit, an inductor and matching circuit for antenna.

The core of transmitter is trimless VCO whose centre frequency can be controlled by single inductor. While several oscillator topologies are viable for construction of a practical RF VCO, the one that has proven successful in many commercial VCO modules and countless discrete VCO circuits is the Colpitts common-collector. The typical advantage is the one off-chip inductor compared to other competing topologies. (Razavi Chap-7)

The 2nd most important component of design is power amplifier. The class C type power amplifier is good candidate for this application (Razavi Chap-8). The total system block level diagram is shown in Figure 1.

The matching circuit can be resistor-capacitor circuit for simplicity. The more efficient matching circuits employ both L and C components. The MIC is ELECTRET Microphone with SNR better than 50dB. The headphone-mic set used with sound card of PC can also be used.

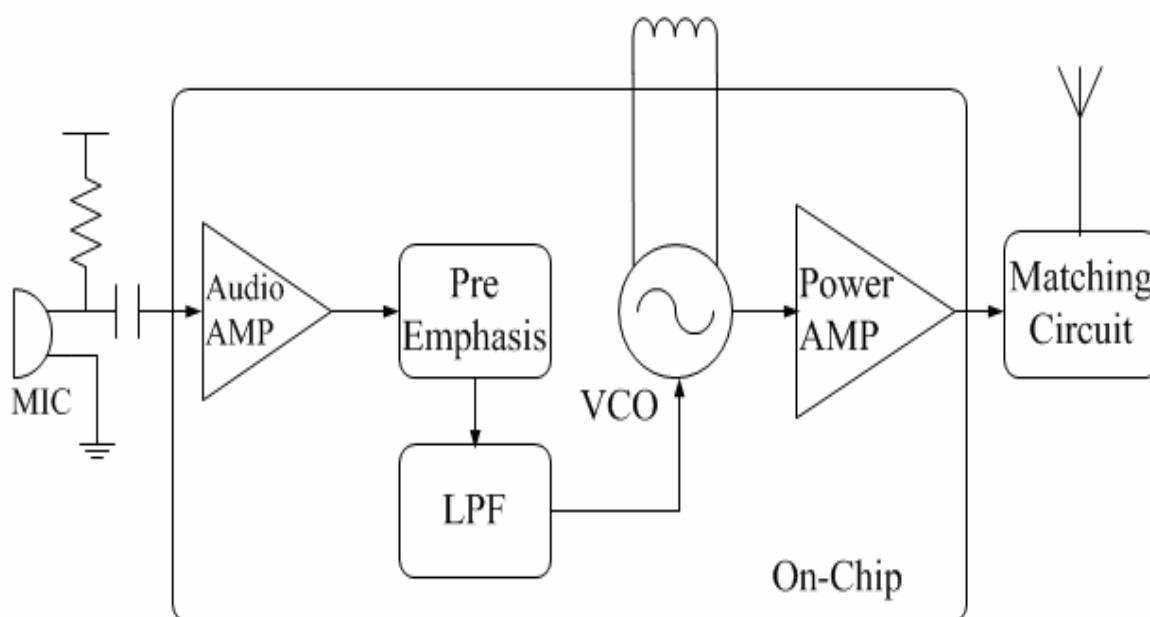


Figure 1: System Block diagram of VHF Band FM radio Receiver.

FM Radio Transmitter

2.2 Typical Design Parameters

- Power Supply 3.3V \pm 5%
- Transmitter Frequency 100 MHz
- Out Put Power 10 dBm (10mW)
- Modulation Frequency 100Hz – 5KHz (Audio)
- Frequency Deviation \pm 75 KHz
- Audio Input Sensitivity 0.5V rms for +/- 75 KHz
- Spurious Emissions Better than -45 dBc (with ref to carrier)
- Total Power Consumption \leq 200mW

3 Area Requirements

The table below summarizes the transmitter performance requirements. Each requirement has its number, formulated text, and the given degree of priority. Three degrees of priority are used: high, medium, and low. High is a firm requirement with no possibility of relaxation, while medium requirements can be relaxed somewhat after good motivation.

Requirement	Requirement text	Priority
1	Operation frequency 100 MHz	High
2	Your transmitted voice is received on FM receiver	High
3	Integrate as many system components as possible on-chip	High
4	Schematic and layout must be verified by simulation	High
5	Simulated chip power consumption < 200mW	Medium
6	Chip design area \sim 1.2 mm ² (see Figure 2)	Medium
7	Chip core area < 700 μ m x 800 μ m = 0.56mm ² (see Figure 2)	High
8	Total project pin count < 17 (max 15 active + 2 power supply)	High
9	Design technology is AMS 4-Metal 0.35 μ m CMOS	High
12	The most important system nodes should have off-chip access pins	Medium
13	On-chip current densities < 1 mA/ μ m	High

- All requirements in the table should be fulfilled in “typical”, “slow”, and “fast” process corners and temperature between 25 and 110 °C

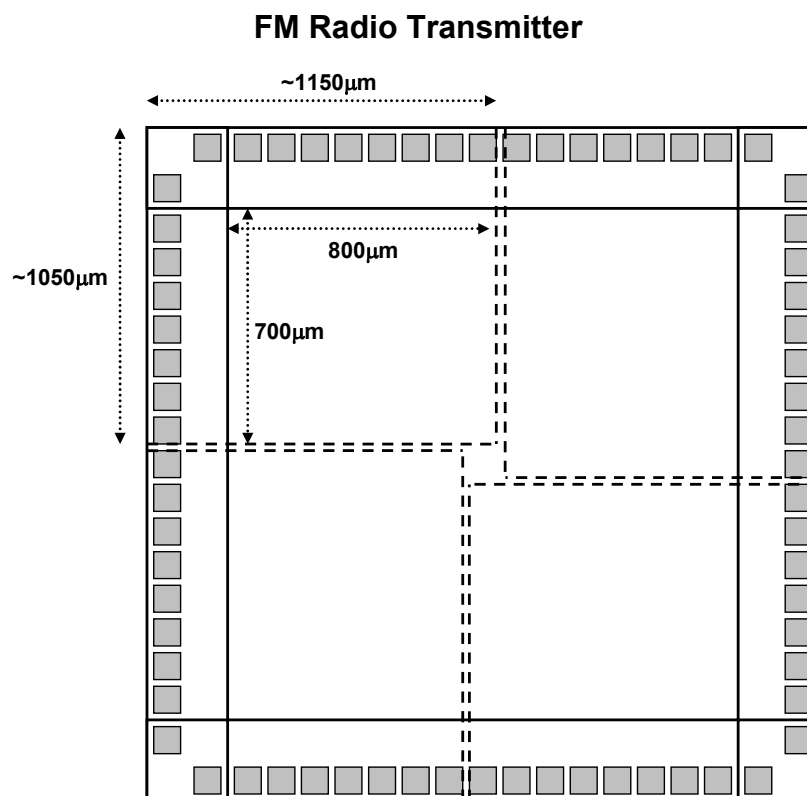


Figure 2: A 5mm^2 chip will be shared by 4 independent projects (4 teams). Each project will utilize a $700 \times 800 \mu\text{m}^2$ area for core layout and 17 pads.

3.1 Available resources

- Scientific publication database (available from LiU):
- ◆ IEL – IEEE/IEE Electronic Library, <http://www.bibl.liu.se/english/databas/>

3.2 Tools

- ◆ Circuit simulation and layout tools from Cadence[®], <http://www.cadence.com/>

NOTE – Most Countries accept emission 10dBm in FM band. So maximum output power of transmitter is limited to 10 dBm (10mW). This will give more than 50 -100 meters of range with clear reception using typical commercial FM receiver. This is solely an educational project.

4 References

- B. Razavi, RF Microelectronics, Prentice Hall, Inc. 1998
- Louis E. Frenzel, Principles of Electronics Communication Systems 2nd ed. 2002
- J.M. Rabaey, A. Chandrakasan, and B. Nikolic., “Digital Integrated Circuits”, 2nd ed., Prentice Hall, 2003, ISBN 0-13-120764-4.
- D.A. Johns and K. Martin, “Analog Integrated Circuit Design”, John Wiley & Sons, 1997.
- R.J. Baker, H.W. Li and D.E. Boyce, ”CMOS Circuit Design, Layout, and Simulation”, IEEE Press, 1998.

For more literature references consult with your supervisor.