Some electronic products require a high voltage to operate effectively. However, the desired magnitude of voltage source may not be found in the power supply. As a result, a voltage multiplier is required to increase the voltage of the supply. One of the voltage multipliers is the charge pump. A higher voltage is received when a lower voltage is fed into the charge pump.

In this project, two very different schemes: the cross-coupled charge pump and the single cell charge pump are studied. The implementation of the corresponding schemes of the basic 2x charge pump or called voltage doubler are analyzed, simulated and compared.

The size of many electronic products is made to be smaller. So, the circuit inside the products is required to be smaller. Designing in on-chip approach can greatly reduce the size of circuit.

The aim of the project is to design a fully on-chip 2x charge pumps that can deliver a load current of 10μA.

To achieve this goal, the two schemes should be studied and implemented. The better scheme should be concluded in terms of area and efficiency. Also, the efficiency of the design should at least 70%.

Device Model: CMOS 0.35μ technology

Input Voltage: 1.2V

Switching Frequency: 25MHz

Load current: 10μA

Efficiency > 70%
Comparing the above two Schemes:

**Area:** Nearly double of the capacitor area is required for the single cell 2x charge pump compared with the cross-coupled one. Other area required in transistors, ring oscillator and non-overlapping circuitry are nearly the same.

**Efficiency:** The dropout estimated firstly reduces the efficiency of both schemes. Then, the efficiency of them is further reduced by the stray capacitance. For cross-coupled 2x charge pump, other practical loss can within 3%. For single cell 2x charge pump, other practical losses can up to 6%.

Less area is required for better efficiency; the cross-coupled 2x charge pump is better.
The New Design of the fully On-Chip 2x Charge Pump:

For $V_{dd} = 1.2V$, $f_s = 25MHz$, $I_0 = 10\mu A$, $C_L = C_1 = 0.625pF$, Total Capacitance $C_T = 1.875pF$

The Simulation Result is shown below:

The efficiency = $\frac{(2.040 + 1.938)}{2} / 2V_{dd} = 82.88\%$