112 學年第一學期專題報告全文

<u>0X/1X Regulating Rectifier in Wireless Power Transfer System</u>

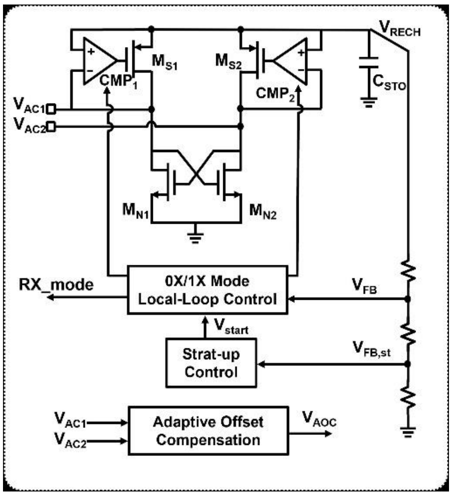
110511277 蔡東宏

A. Introduction:

Recently, the wireless power transmission technique has been widely utilized in implantable medical devices(IMDs). Conventionally, due to the limited energy storage of embedded batteries, most IMDs require periodic surgeries for battery replacement. To meet these challenges, wireless power transmission is a promising technology for providing a secure alternative approach to powering IMDs.

B. The Structure of Regulating Rectifier:

A regulating rectifier which includes 0X/1X local loop control, AOC, start-up control.



Comparator: Determine when to turn on/off active diodes M_{S1} and M_{S2}

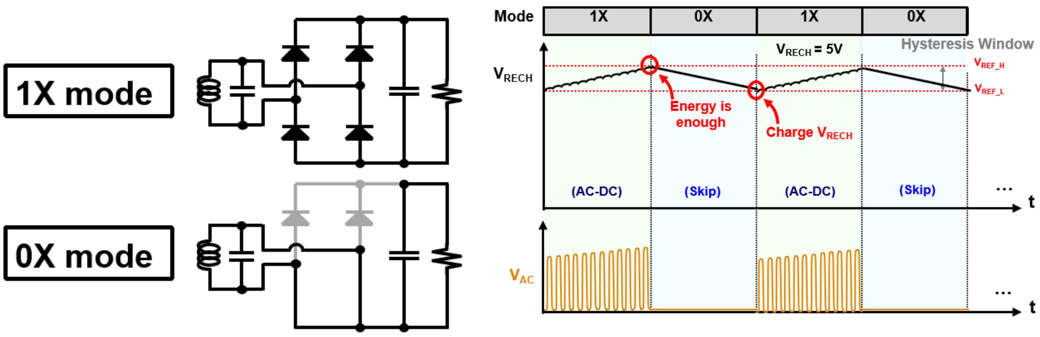
Adaptive Offset Compensation: Optimize turn-on/off timing

0X / 1X Control Circuit: Provide regulated output

Start-up Circuit : Generate VDD for rectifier at first

C. 0X/1X Mode Local Loop Control:

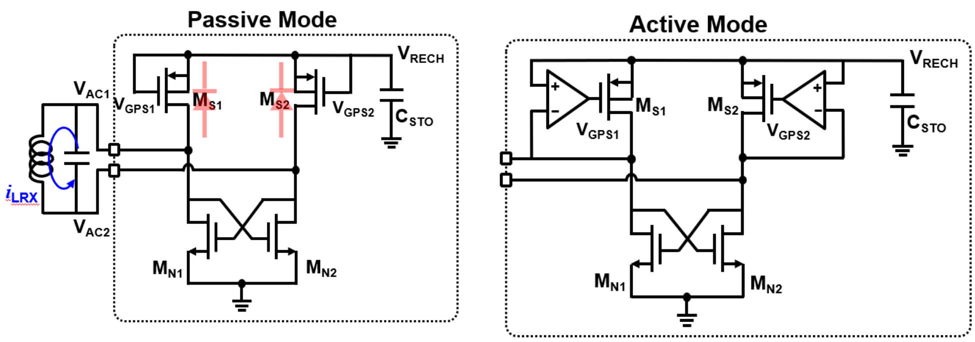
The hysteretic comparators sense the divide feedback voltages and compare with a reference V_{REF}. The control logic activates the corresponding operations mode(0Xmode or 1Xmode).



D. Startup Mechanism:

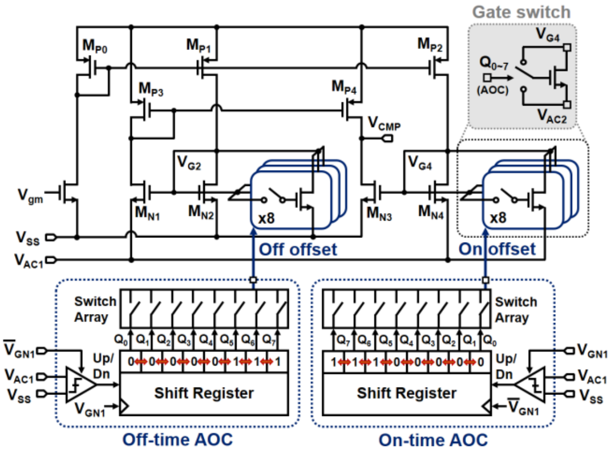
Initially, V_{STO} is not enough for RX operation, V_{STO} is charged from 0V in the passive mode until V_{STO} reaches an adequate level for RX operation.

In passive mode, intrinsic diodes of power MOS form conduction path for startup. (Diode-connected MOS and body diode)



E. Adaptive Offset Compensation:

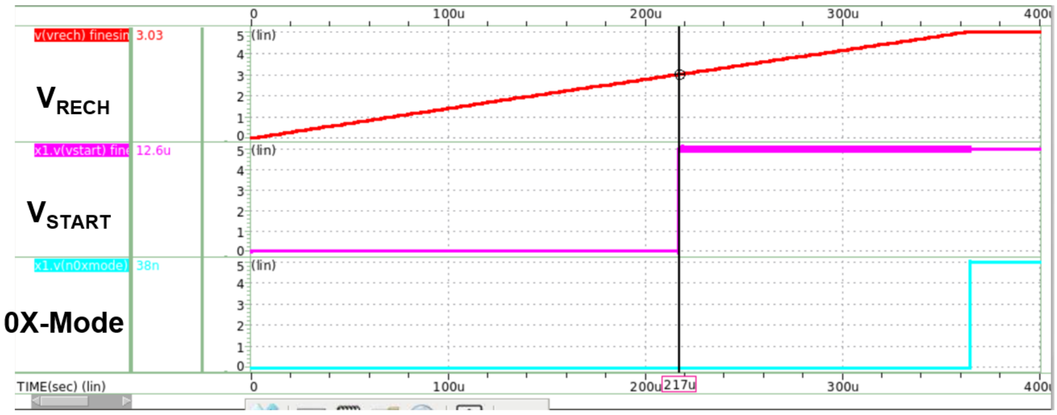
The active rectifier will not be driven accurately due to the propagation delay of the drivers and comparators, causing reverse currents and limited conduction time. To improve the switching accuracy at high operating frequency of 6.78MHz, a comparator to accompany the AOC control is required.



F. Simulation Results:

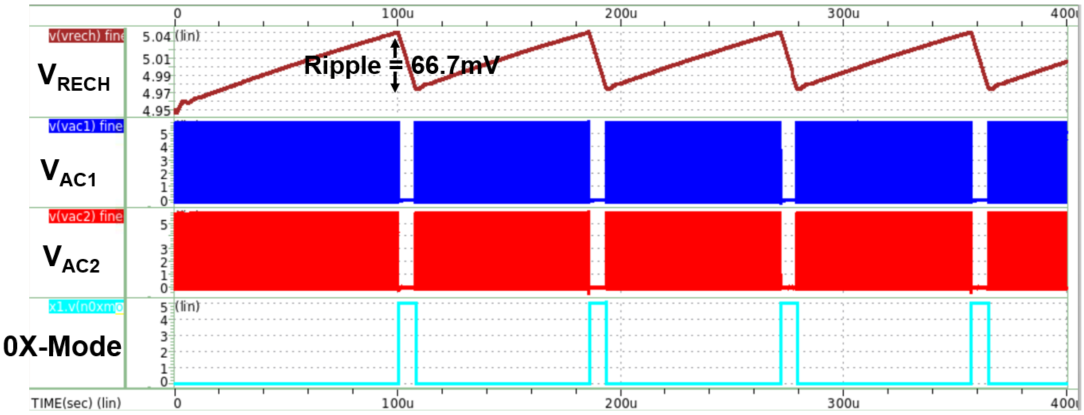
Operation of Start-up Circuit:

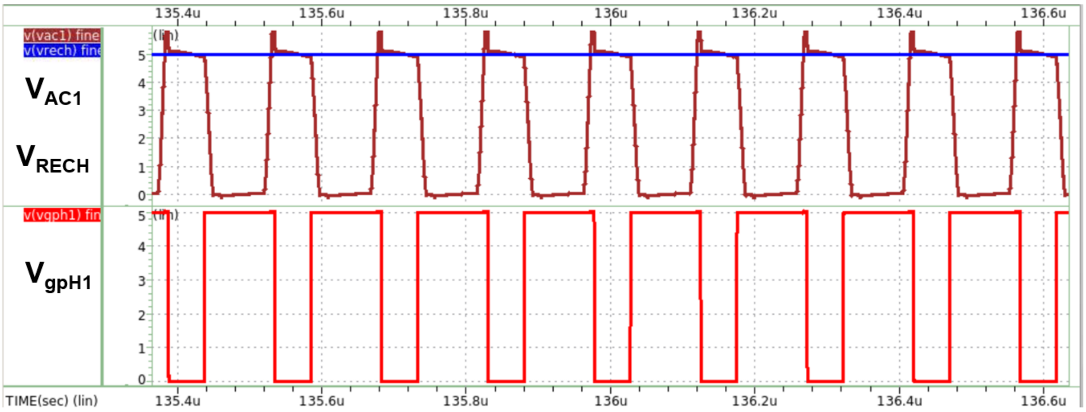
V_{RECH} is charged from 0V in the passive mode until V_{RECH} is enough (about 3.03V) for RX operation.



Operation of 6.78-MHz Active Rectifier:

V_{RECH} is regulated at 5V by switching mode between 1X/0X.





Some Parameters:

Resonant Frequency : 6.78-MHz

Receiver Structure : 0X/1X Rectifier

Output Voltage : 5-V

Output Capacitor : 4.7μF

Output Capacitor ESR : 0.6 Ω

Parameter	$I_{load} = 5mA$	$I_{load} = 10mA$	$I_{load} = 20mA$	$I_{load} = 40mA$
Output Power	25mW	50mW	100mW	200mW
Peak Efficiency	69.64%	79.5%	86.21%	89.29%

G. Conclusion:

1. With 0X/1X Mode Control, V_{RECH} is regulated at 5V.
2. At passive Mode, V_{RECH} is charged from 0V to 3.03V and starts to entering Active Mode.
3. 6.78-MHz active rectifier achieves 89.29% peak efficiency at 200mW output.