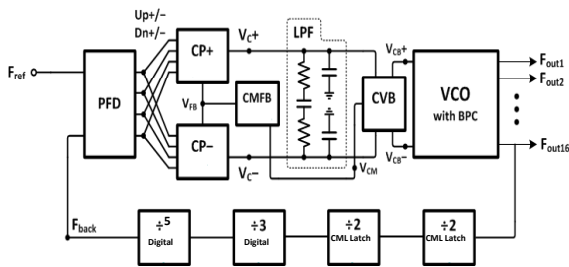


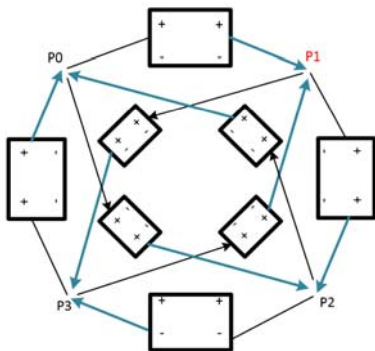
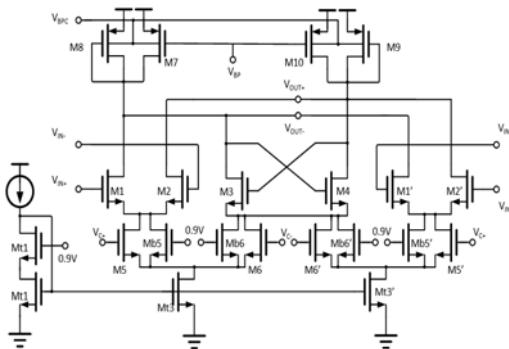
### MOTIVATION

- ◆ In high speed circuit, it is important to find a trade-off between frequency and power.
- ◆ Try to promote the frequency of differential ring oscillator .
- ◆ Try to develop a new process compensation technique for VCO, which provides less power dissipation and decreases vari:

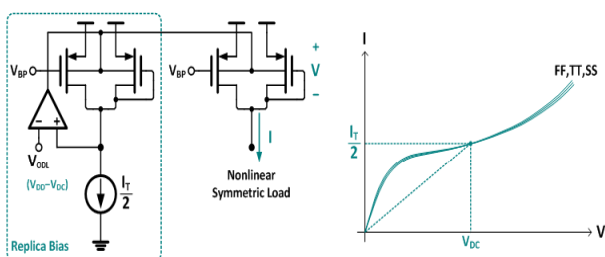
### CIRCUIT DESIGN



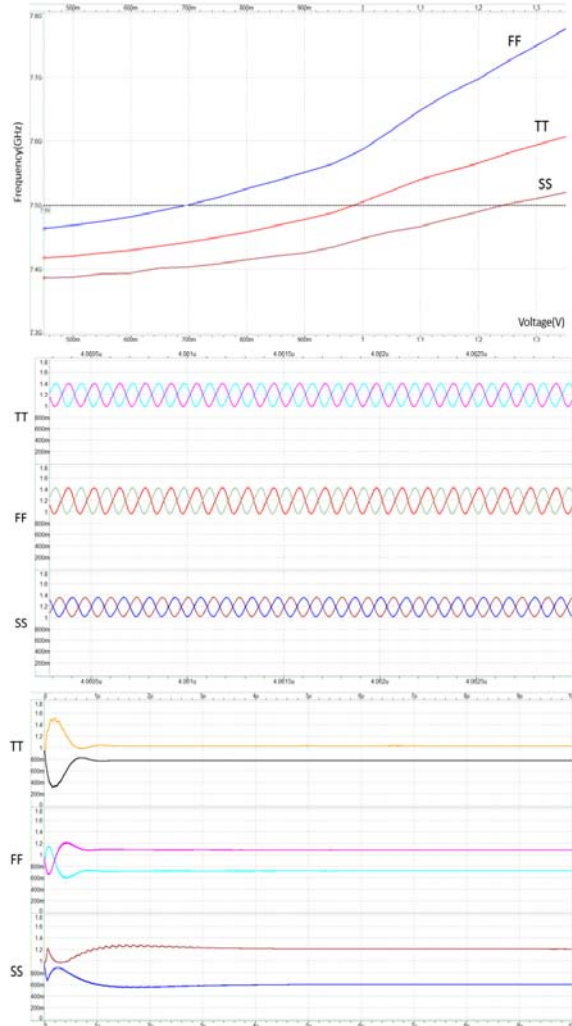
### DIFFERENTIAL RING OSILLATOR



### BULK-CONTROLLED PROCESS COMPENSATOR(BPC)



### SIMULATION



### COMPARISON

Reference	TCAS-II[23]	TCAS-II[9]	TVLSI[24]	JSSC[25]	TCAS-II[26]
Year	2009	2009	2009	2012	*2012
Technology(nm)	180	130	180	90	180
Supply Voltage(V)	1.8	1.2	1.8	1	1.8
Oscillation Frequency(GHz)	2.4	2.64	1.6	0.63~8.1	16.28
Total Power(mW)	36	31.2	17	7~26	10.8
*FOM	15	24.54	10.625	11.56	0.66

Reference	TVLSI[27]	TCAS-II[28]	JSSC[29]	[32]	This Work
Year	*2013	*2015	*2015	2015	2016
Technology(nm)	180	65	65	180	180
Supply Voltage(V)	1.8	1.2	1.2	1.8	1.8
Oscillation Frequency(GHz)	5.35	50.4~60.8	3.5	7	7.5
Total Power(mW)	8	30	21	58	50
*FOM	1.49	2.05	24.92	8.3	6.67

### CONCLUSION

- ◆ By Using simplified Bulk-Controlled Process Compensator Technique :  
Output frequency of VCO can be nearly independent to process variation.
- ◆ By Using N=4, K=3 Differential Ring Oscillator:  
Multiphase, no phase overlap, noise immunity.
- ◆ By Merging Output Load :  
Promote frequency and reduce circuit area.