

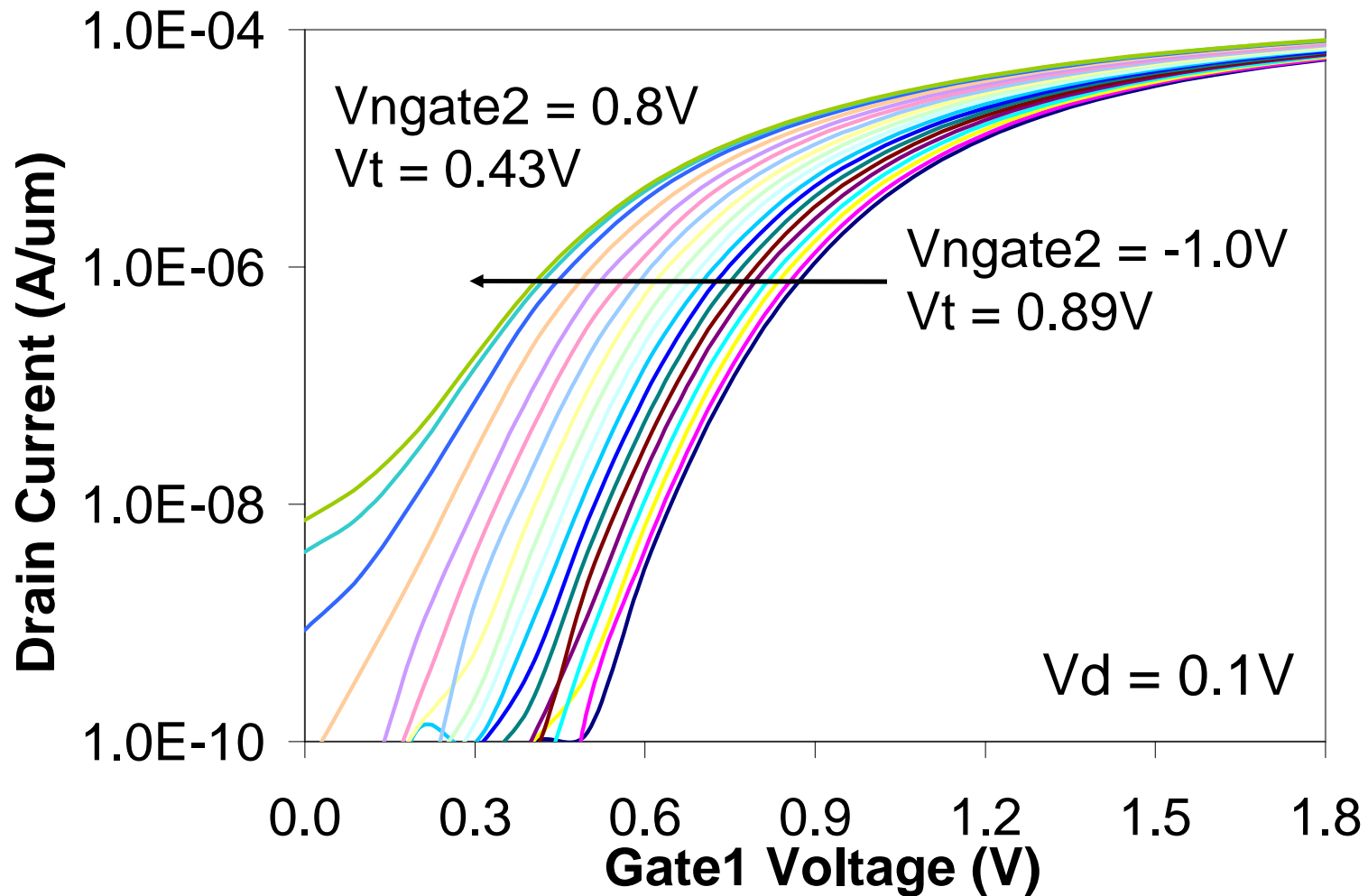
**American Semiconductor Inc.**

**Multiple Independent Gate FET  
Ring Oscillators with Dynamic Frequency Tuning**

**IEEE International SOI Conference  
7 October 2009**

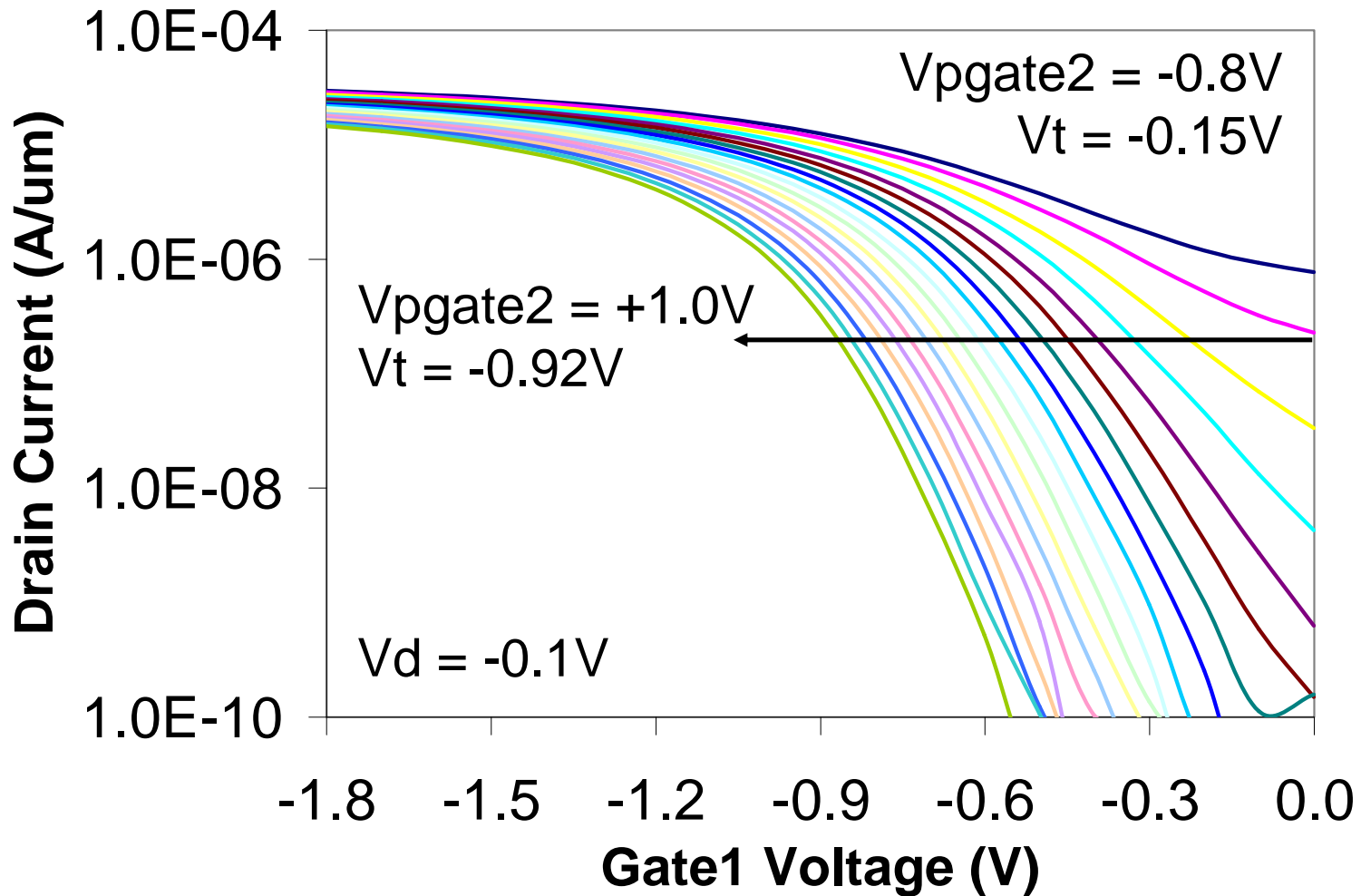
**Dale Wilson, Brian Meek, Kelly DeGregorio, and Douglas Hackler**  
*American Semiconductor, Inc.*

0.18  $\mu\text{m}$  NMOS Experimental Data with  $V_{\text{drain}} = 0.1\text{V}$

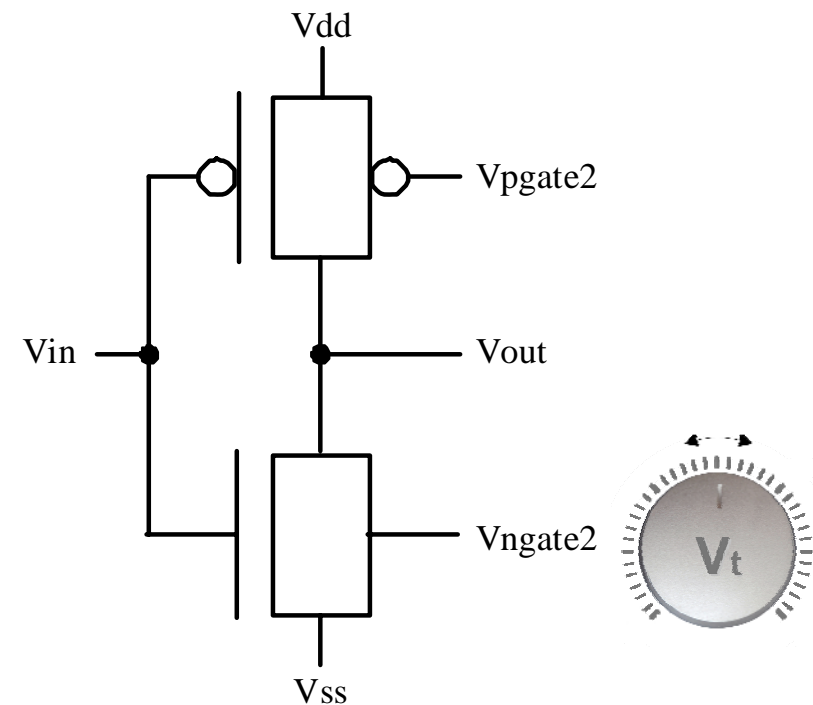


Adjusting the voltage on the 2<sup>nd</sup> gate allows dynamic tuning of the threshold voltage ( $V_t$ ) of the primary gate

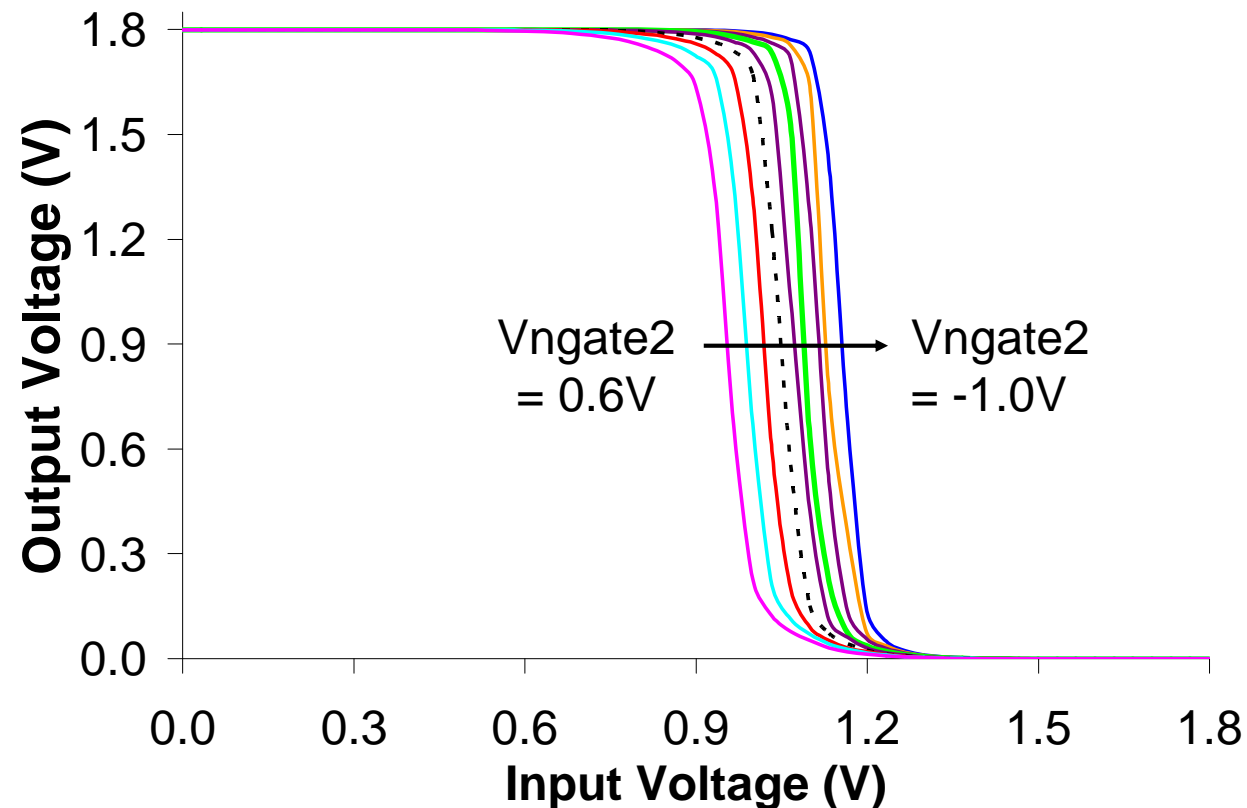
0.18  $\mu\text{m}$  PMOS Experimental Data with  $V_{\text{drain}} = -0.1\text{V}$



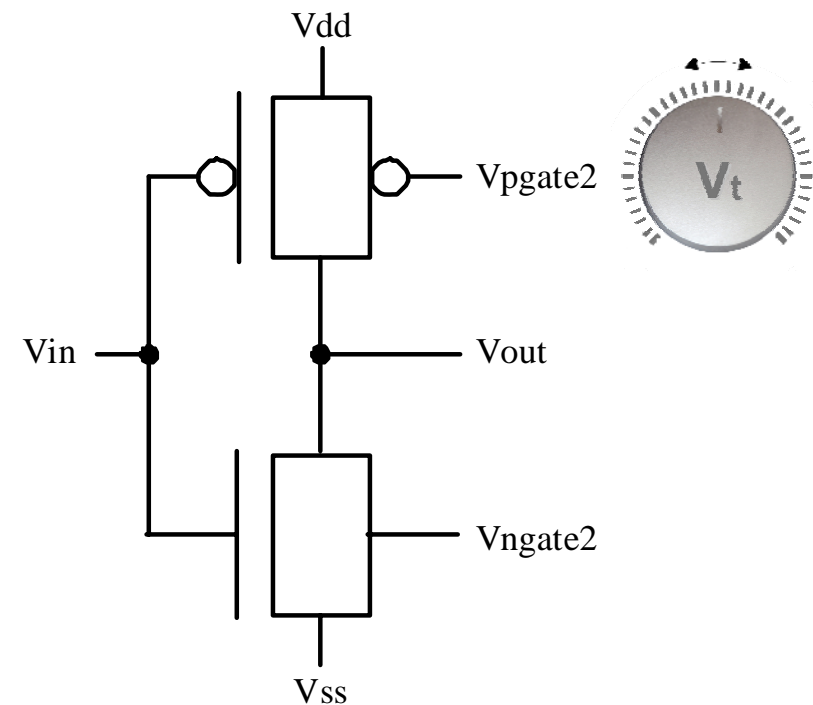
Adjusting the voltage on the 2<sup>nd</sup> gate allows dynamic tuning of the threshold voltage ( $V_t$ ) of the primary gate



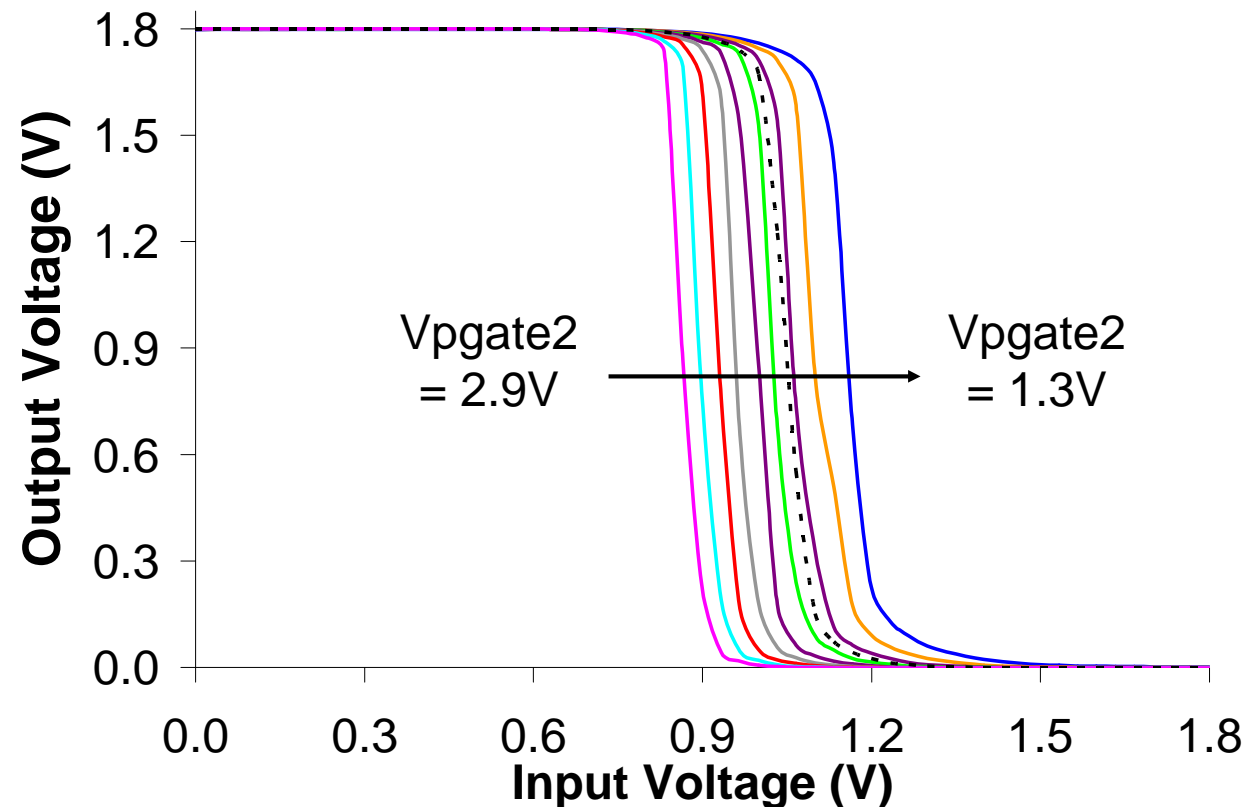
0.18 $\mu$ m MIGFET CMOS Experimental Data @ 1.8V



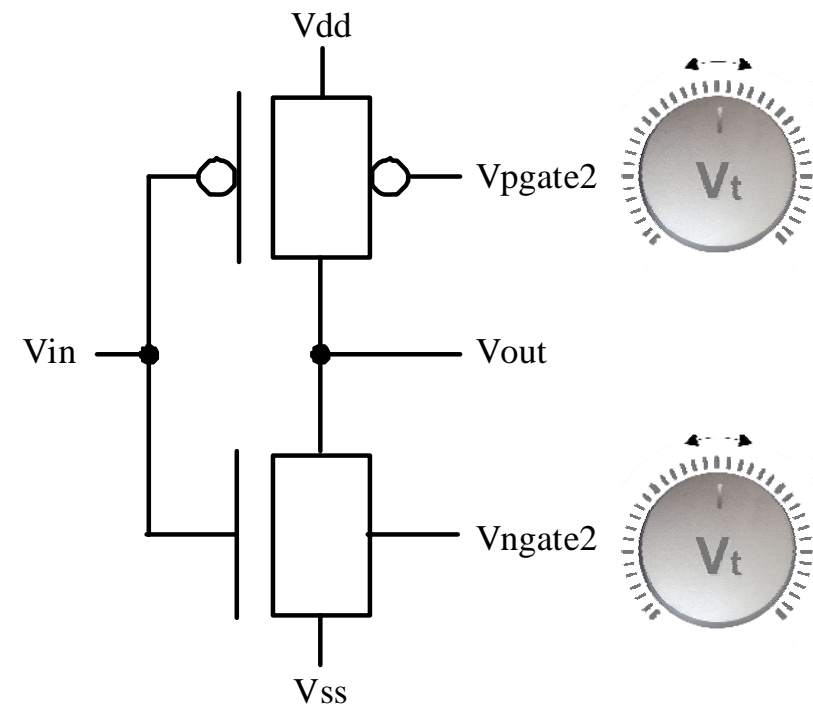
Adjusting the NMOS 2<sup>nd</sup> gate voltage changes the inverter switching point by 190mV



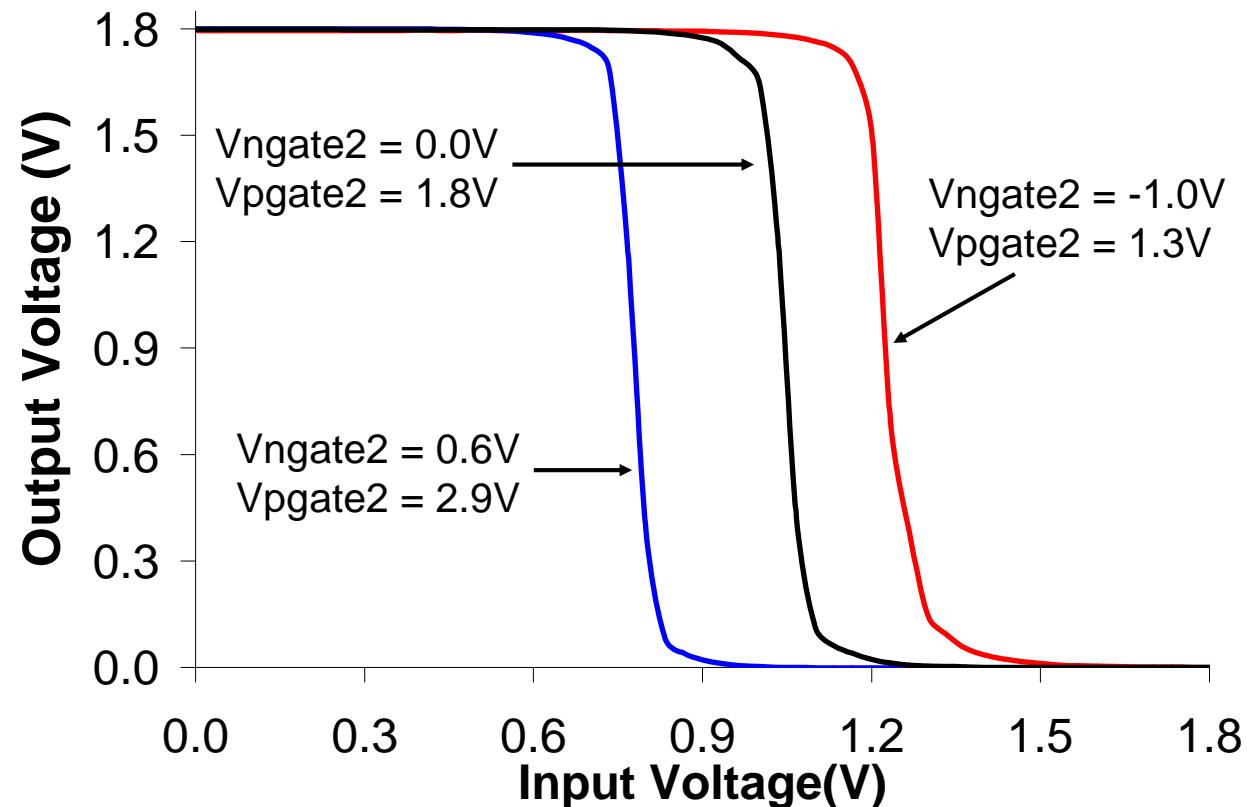
0.18 $\mu$ m MIGFET CMOS Experimental Data @ 1.8V



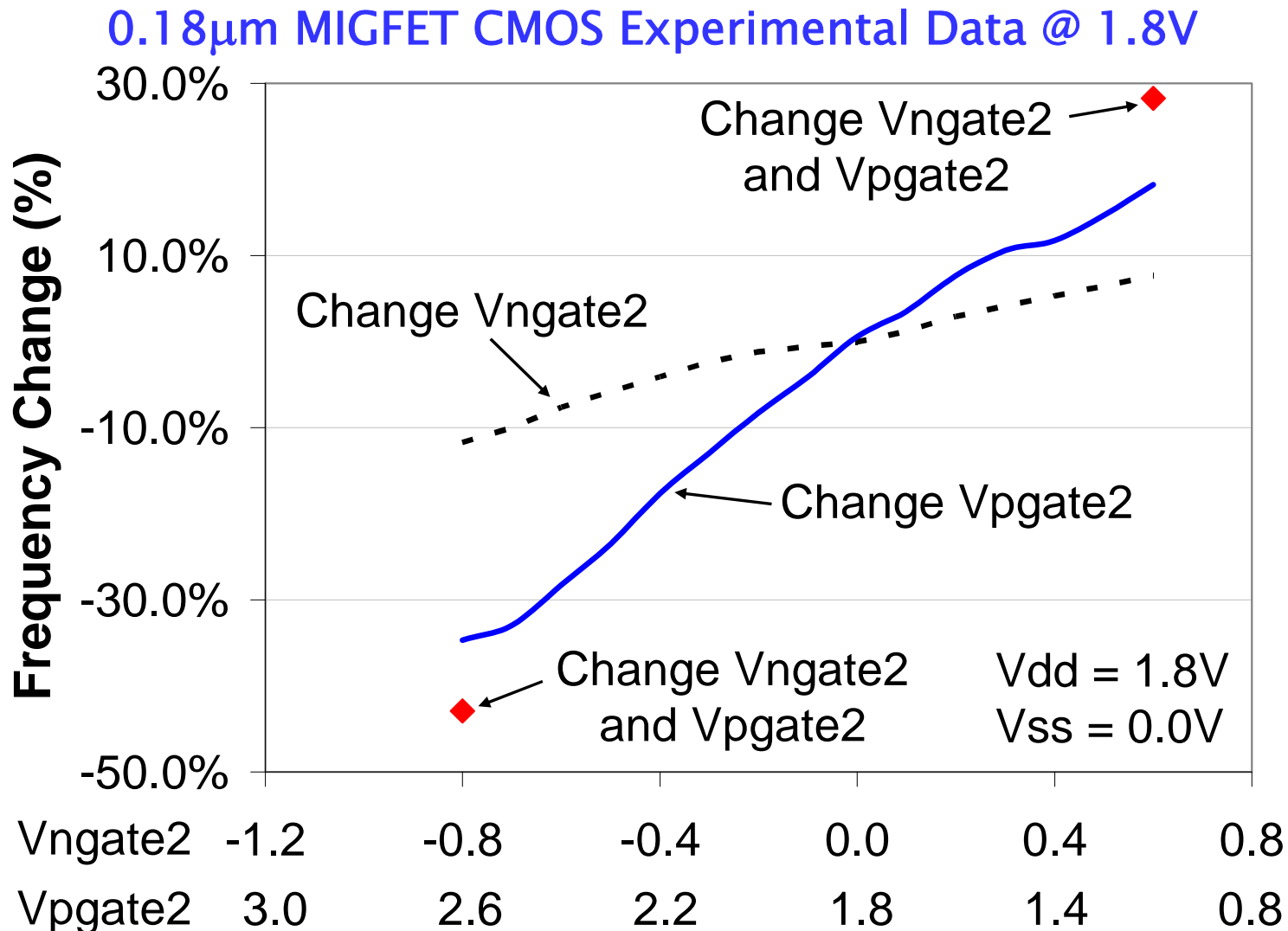
Adjusting the PMOS 2<sup>nd</sup> gate voltage changes the inverter switching point by 280mV



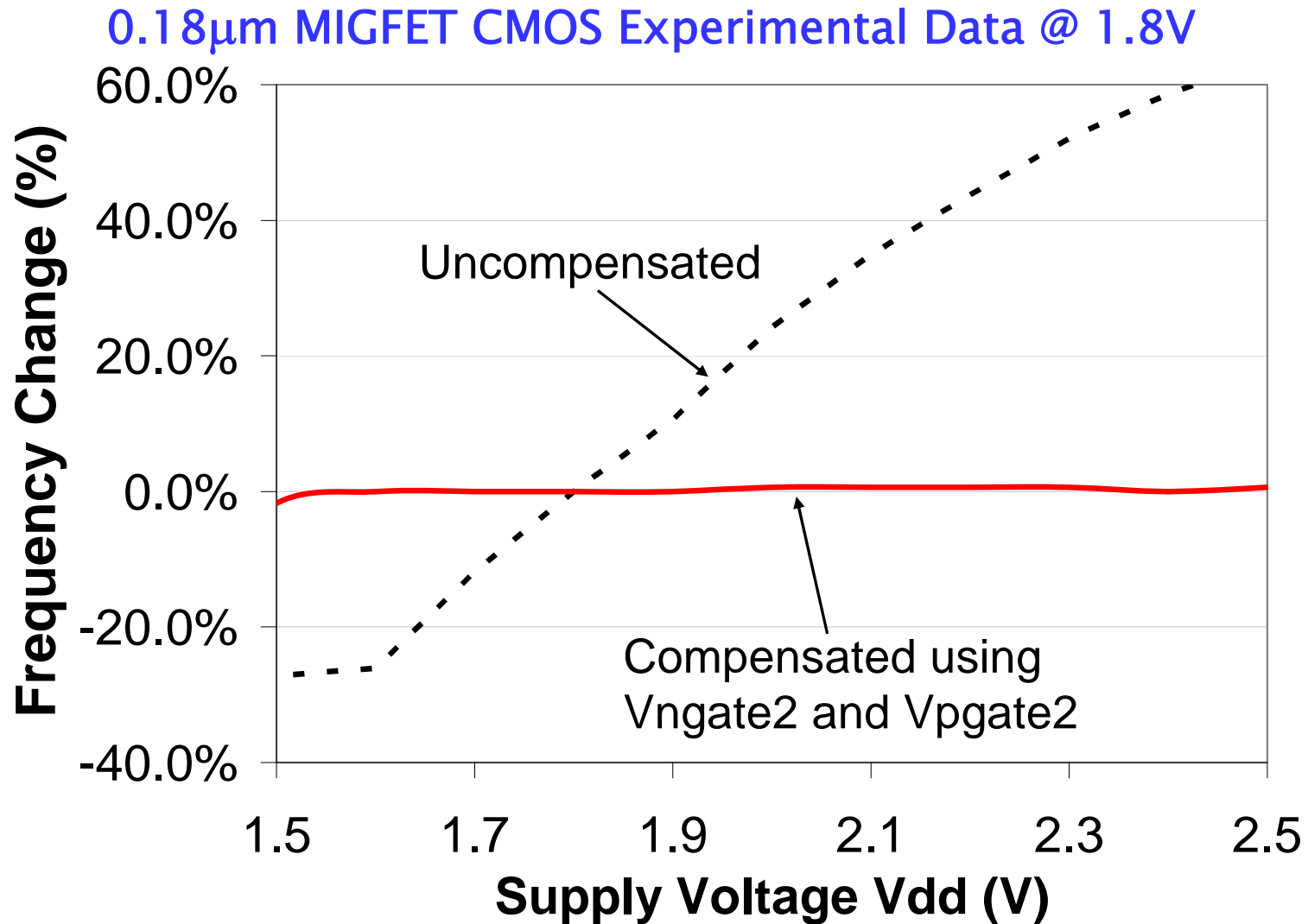
0.18 $\mu$ m MIGFET CMOS Experimental Data @ 1.8V



Adjusting both the NMOS and PMOS 2<sup>nd</sup> gate voltages changes the inverter switching point by 430mV



Frequency Tuning from Nominal = -43% to +29%

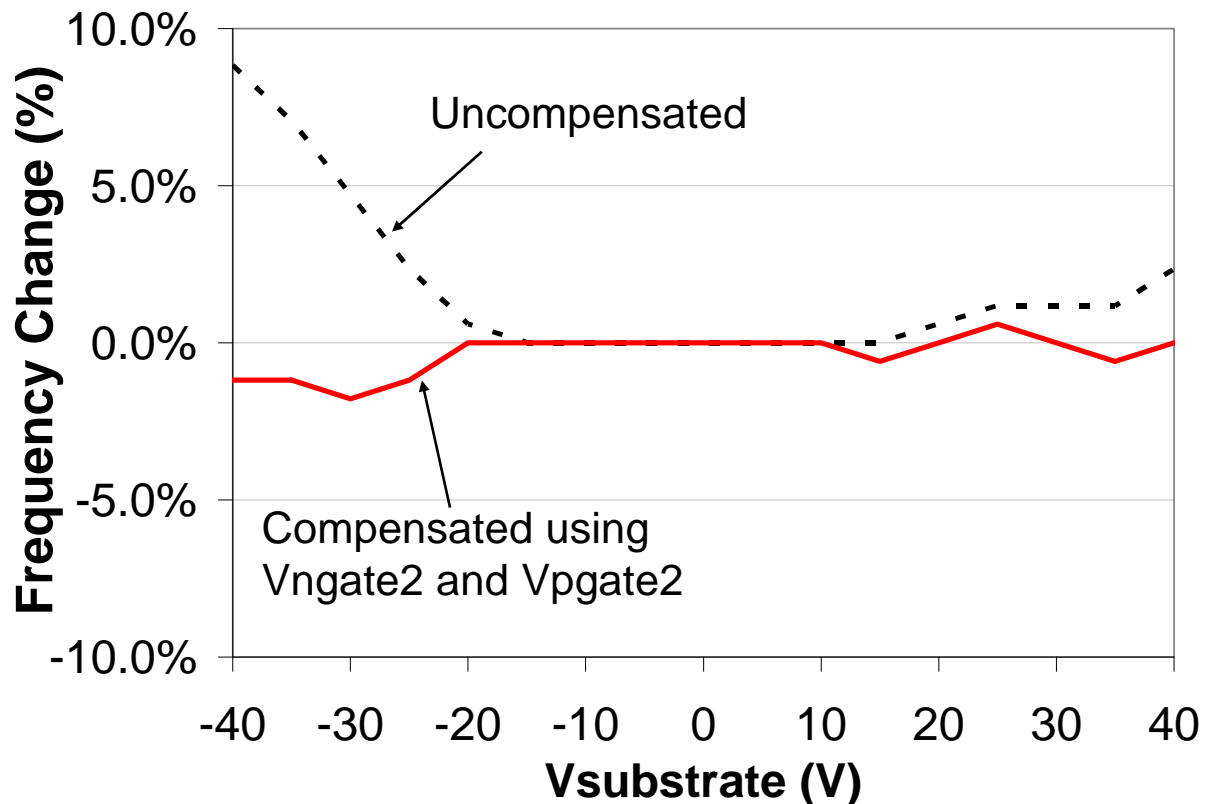


Variation before Compensation = -27% to +64%  
Variation after Compensation = -1.8% to 0.6%

} 38X Improvement

Despite a thin 1450Å BOX, the Flexfet™ MIGFET process is largely unaffected by substrate bias, but compensation still improves the results

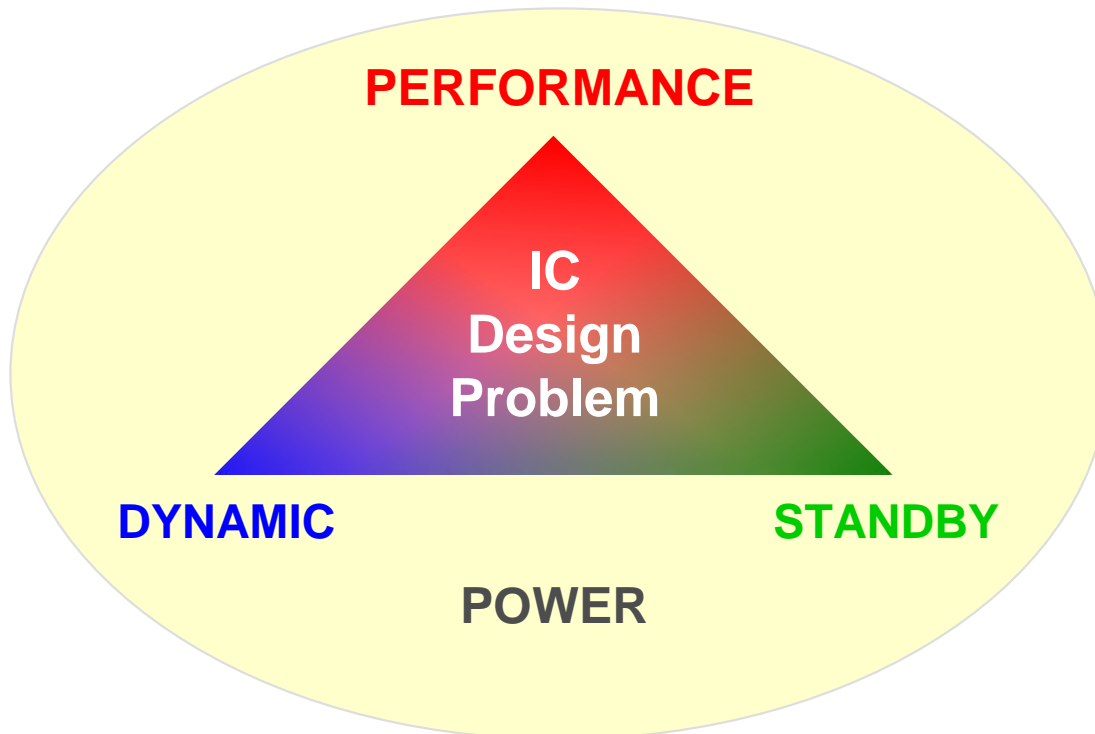
## 0.18μm MIGFET CMOS Experimental Data @ 1.8V



Variation before Compensation = +8.8% to +2.4%  
 Variation after Compensation = -1.8% to 0.6%

} 5X Improvement

- Compensation for process, supply, and temperature variation
- Analog matching and calibration
- Counteract radiation damage
- Power vs. performance optimization

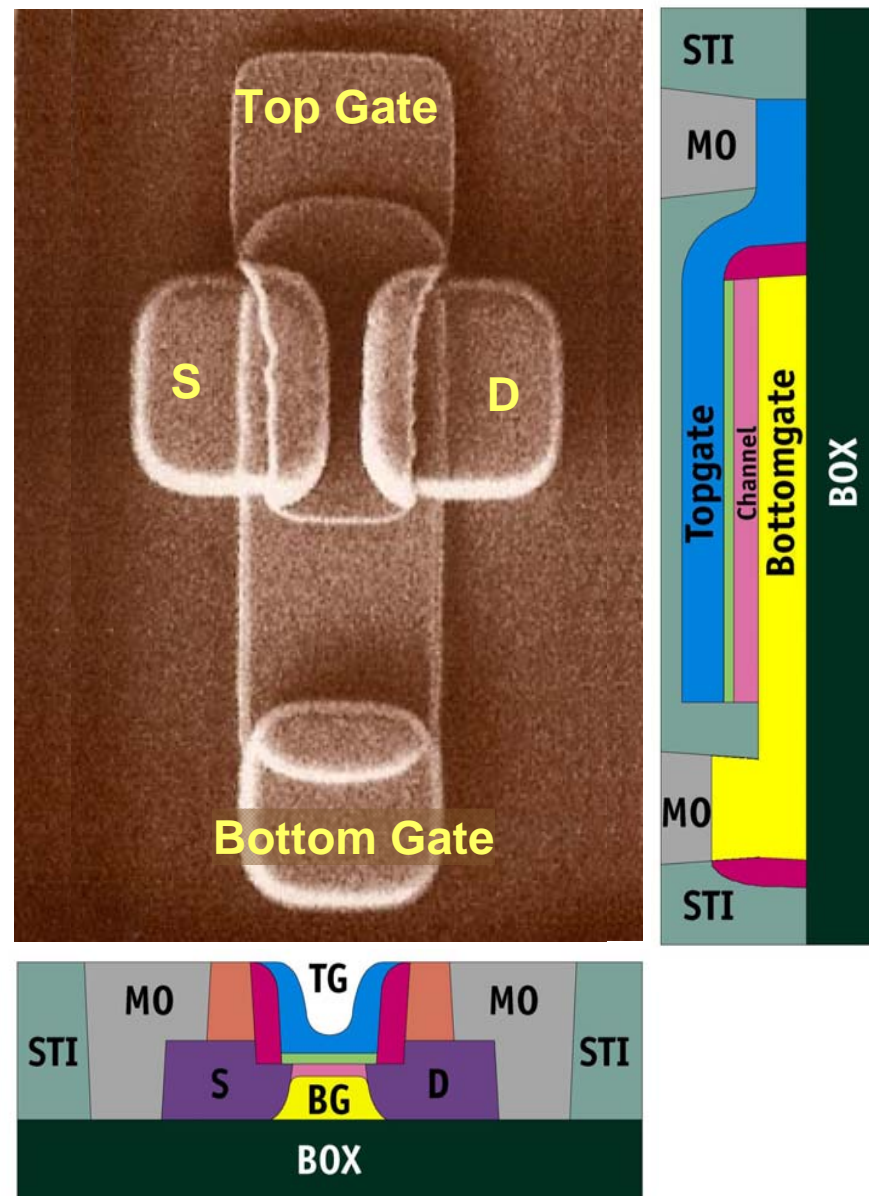
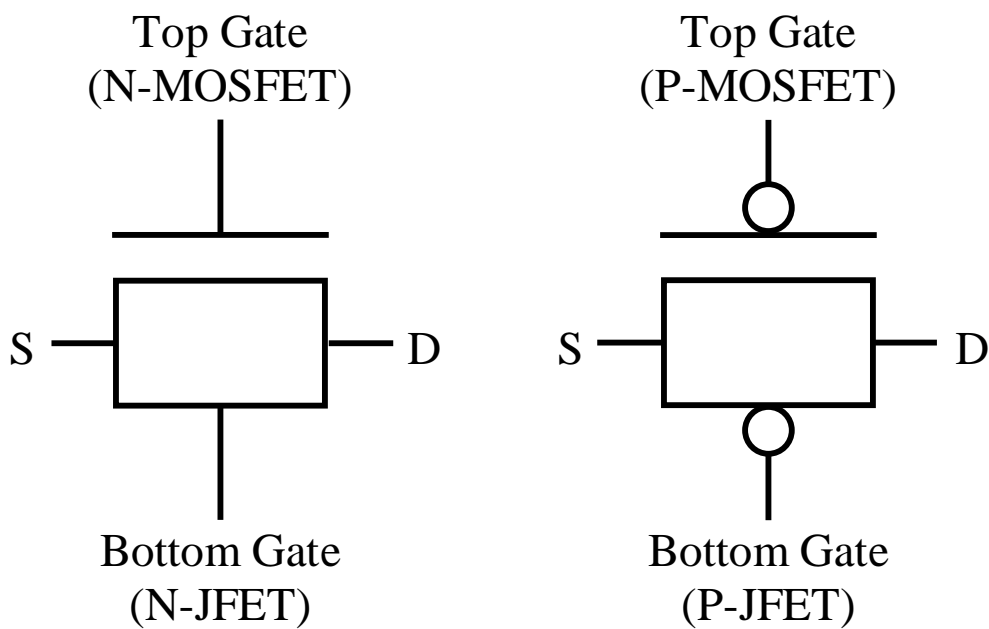


### Dynamic V<sub>t</sub> Control

- On-the-fly V<sub>t</sub> tuning
  - At transistor level
  - At circuit level
  - At chip level
- Tune for operating conditions
- Optimize for performance and power!

## Flexfet features

- Independent double gates
- Fully depleted SOI MOSFET
- Self-aligned JFET
- Dynamic Vt control



American Semiconductor would like to acknowledge the support of Air Force Research Laboratory under the following programs:



**SHARE**

Systematic Hierarchical Approach for Radiation Hardened Electronics

**CRADL**

Commercial Rad-hard Advanced Digital Library

# American Semiconductor Inc.

# Thank You

13

**American Semiconductor, Inc.**

3100 South Vista Avenue, Suite 230

Boise, ID 83705

Tel: 208.336.2773

Fax: 208.336.2752

[www.americansemi.com](http://www.americansemi.com)

© 2009 American Semiconductor, Inc. All rights reserved.  
American Semiconductor Inc., the American Semiconductor logo, Flexfet, FleX, and the Flexfet logo are trademarks of American Semiconductor, Inc. All other trademarks are the property of their respective owners.