

# **EE 240B – Spring 2018**

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## **Advanced Analog Integrated Circuits Lecture 22: Biasing and References**



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## **Biasing: Current Mirror**

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## **Biasing: Cascode**

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## **Reference Circuits**

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- **Where did those constant currents come from?**
  - May need to generate those internally – usually known as a “reference”
- **Tons of “constant X” reference circuits in the literature**
  - Important considerations include power, accuracy, PSRR, output impedance, etc.
- **Most important question: what do you really want to be constant?**

## **Constant Current Bias?**

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## **Constant Gain Example**

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## Supply “Independent” Biasing

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## Improved $V_{GS}$ Reference

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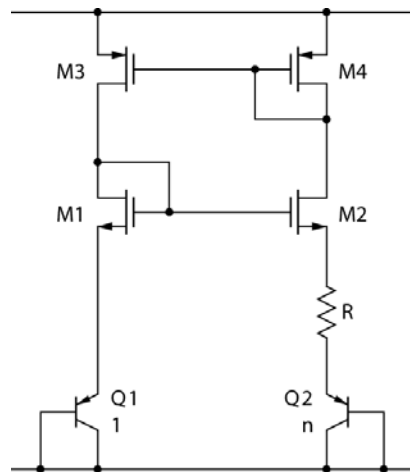
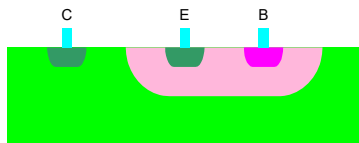
# PTAT Reference

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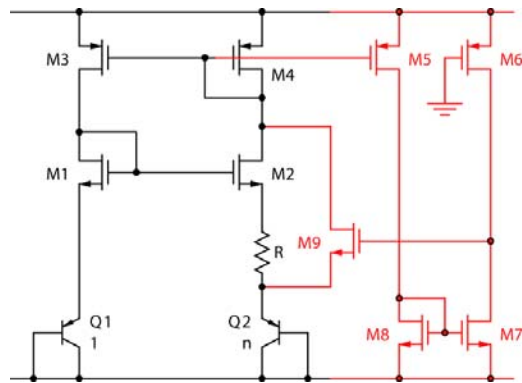
# CMOS PTAT Reference

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■ p<sup>+</sup> substrate      ■ p<sup>+</sup> diffusion  
■ n<sup>-</sup> well            ■ n<sup>+</sup> diffusion



## Startup Circuit

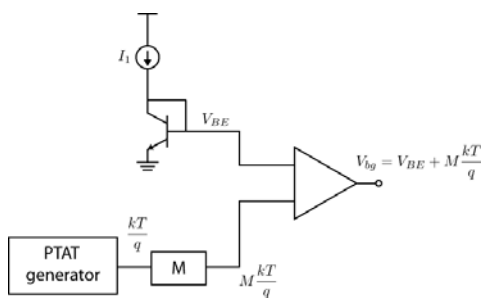


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## Conceptual Band-Gap



- $V_{BE}$  has a tempco of roughly  $-2 \text{ mV}/^\circ\text{C}$
- Add  $V_{BE}$  to PTAT voltage (with right  $M$ )  $\rightarrow V_{bg}$  independent of  $T$
- Reference derived from band-gap of Si (1.205V)

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# Constant $g_m$ Reference

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