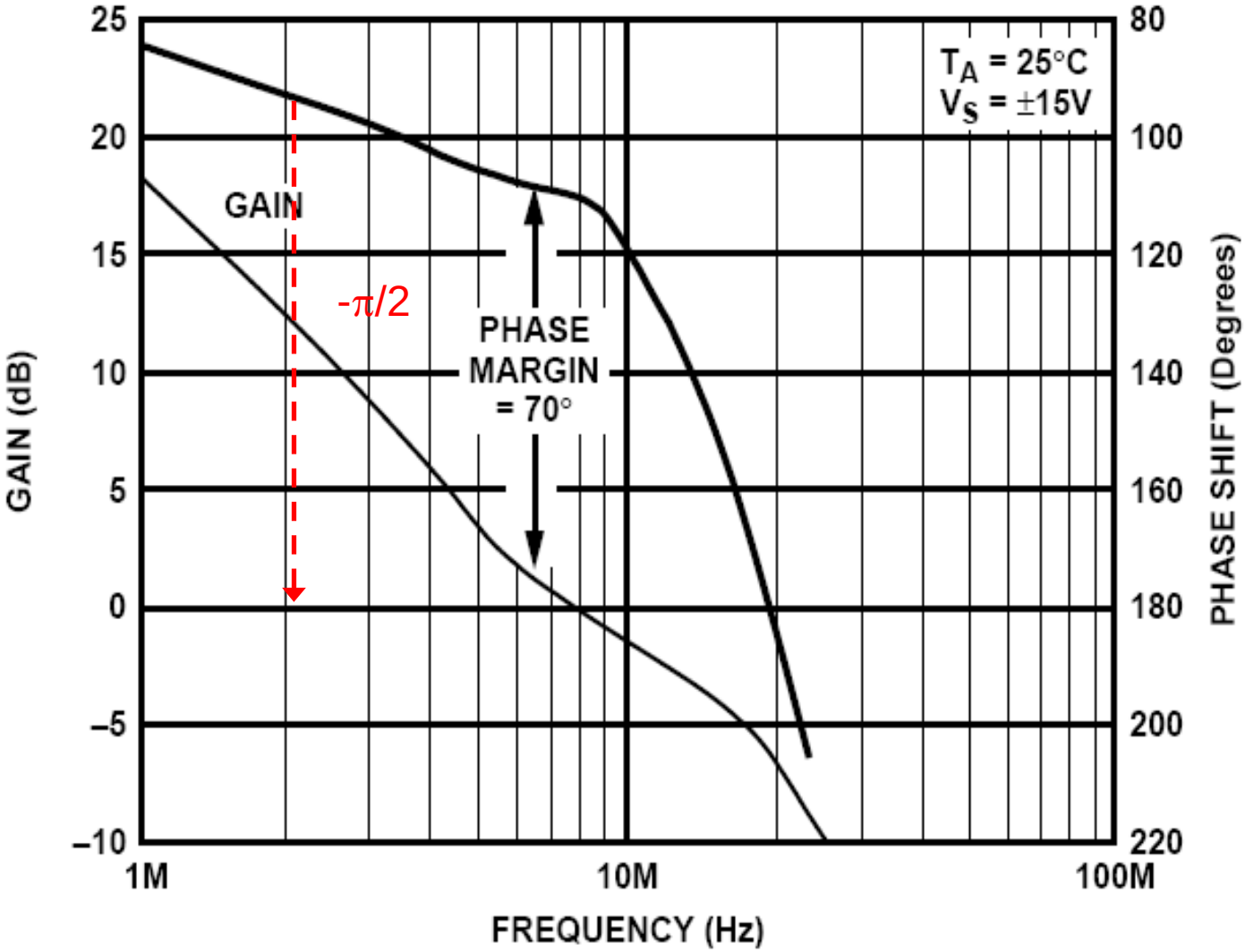
Op-amp Buffet

MENU:

- Op-amps and complex impedances.
  - → **Integrators** and active low-pass filters.
  - → **Differentiators** and active high-pass filters.
- Op-amps and **power amplifiers.**
  - → Op-amps with transistor outputs.
- Op-amp **constant current sources.**
- Op-amps and **photodiodes**.

Watch out for positive feedback !!!



[OP27 Datasheet Rev. F, Analog Devices (2006)]

When would you use an op-amp integrator or differentiator?

- **Do not use an op-amp for a high-pass or low-pass filter.**

  → R and C components work up to very high frequencies, but op-amps have limited bandwidth.

  → **exception:** RC op-amp circuits can imitate the impedance of a perfect inductor → make ideal "RLC" circuits.

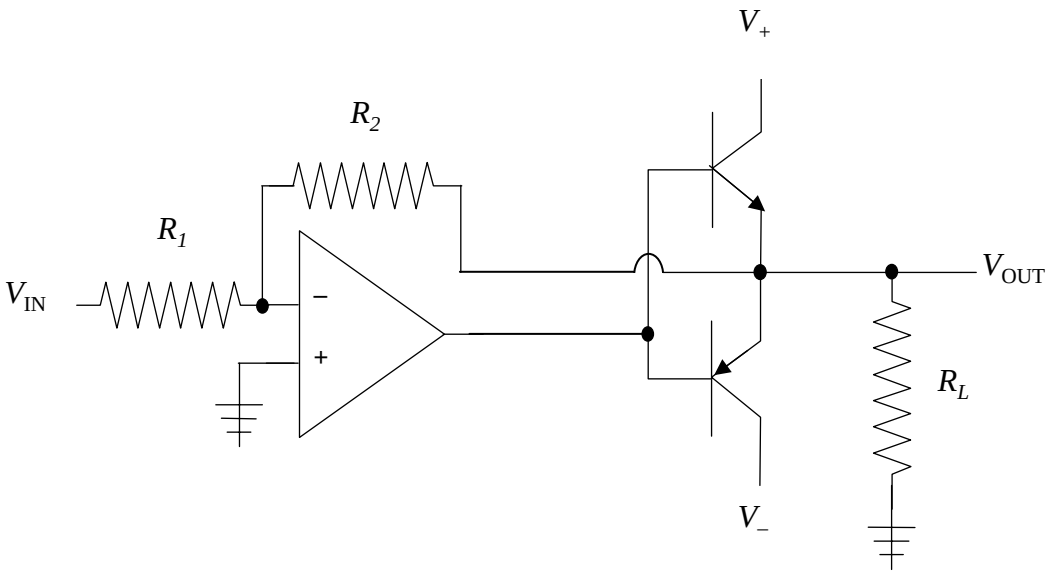
- RC op-amp circuits are good if you need a true differentiator or integrator, or very high fidelity performance.

  → more on this next week.

  → A true integrator can measure charge (particle physics).

- Integrators and differentiators were the basis of analog computers (outdated).

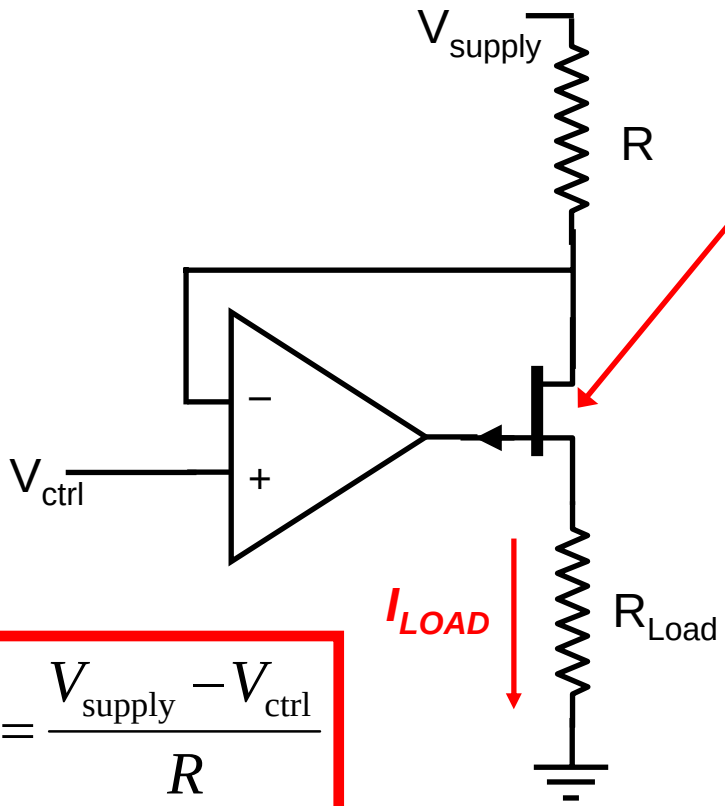
Op-amps for power amplifiers



Inverting amplifier with a push-pull buffer inside the feedback loop.

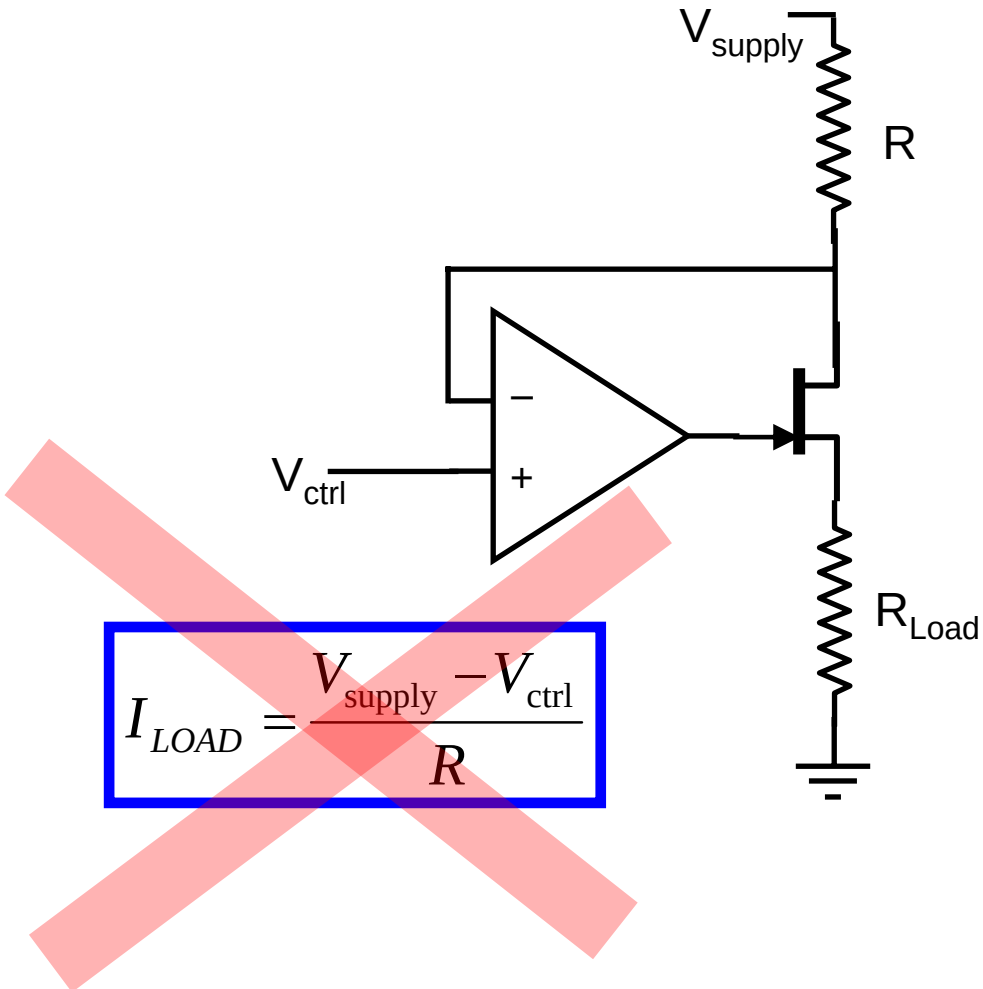
If the signal is not too fast (i.e. slower than the slew rate ~ 1 V/μs), then the feedback of the op-amp will significantly suppress cross-over distortion (which is due to the 0.6 V diode drop of the base-emitter path).

Constant Current Source with Grounded Load

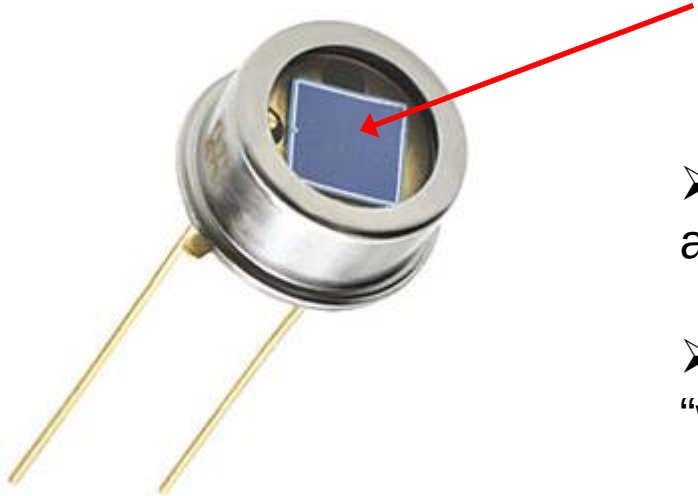


$$I_{LOAD} = \frac{V_{supply} - V_{ctrl}}{R}$$

Bonus Question:
Why doesn't this circuit work?
(as a constant current source)



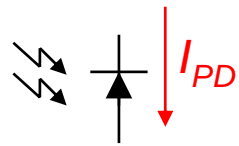
Photodiodes and Op-amps

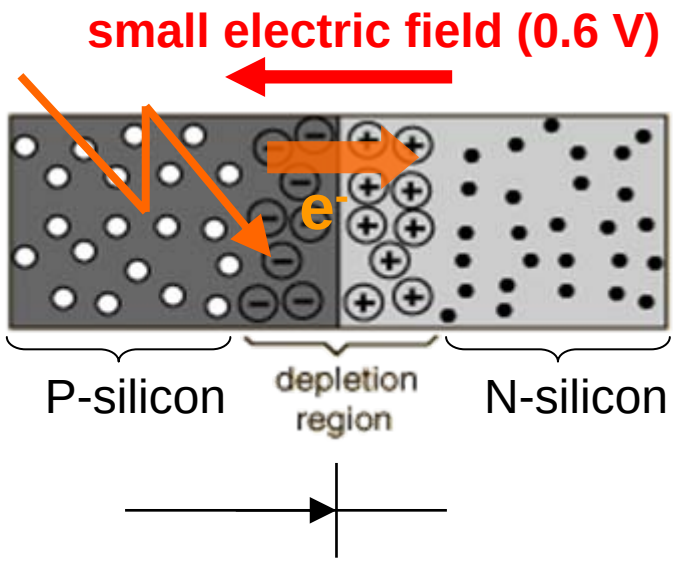


FDS100 photodiode

[Image from www.thorlabs.com]

- Each incident photon will produce about 0.5-0.9 photo-electrons.
- The photo-current goes in the "wrong" direction.





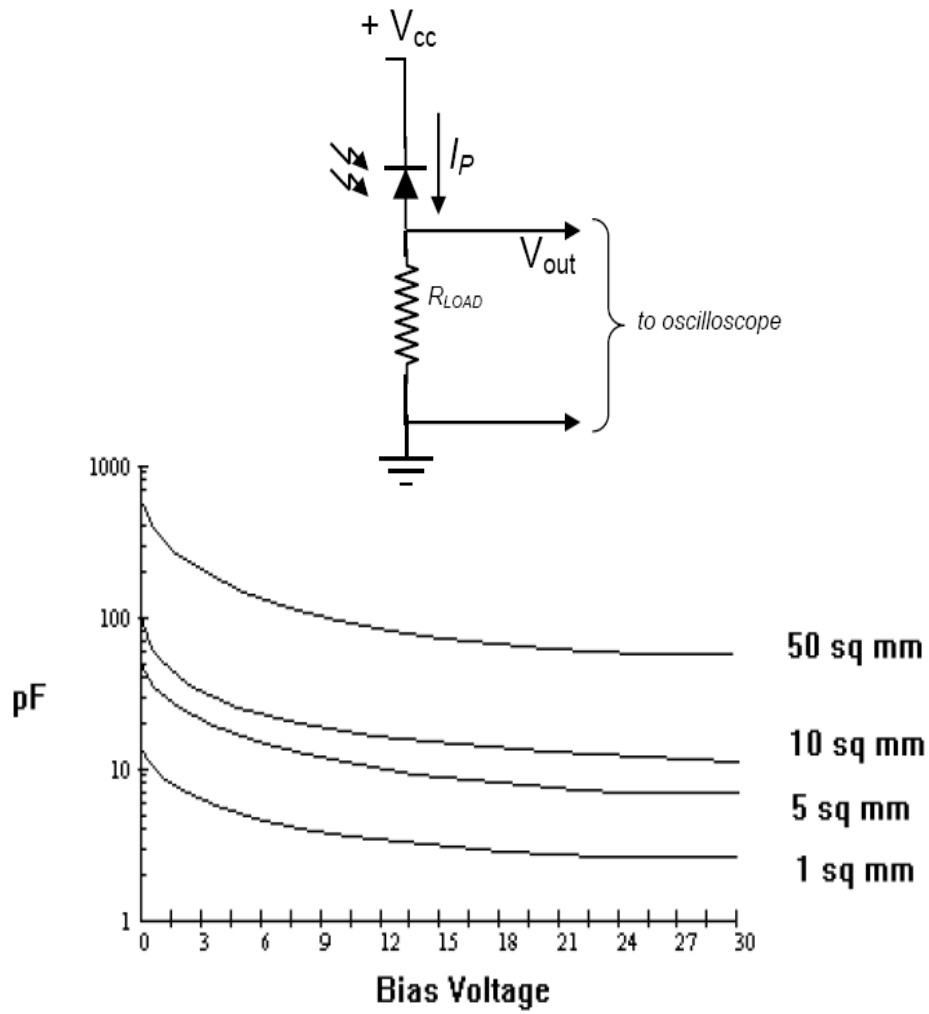
Reverse-biasing Photodiodes

Why use reverse-biasing?

- It reduces the PN junction **capacitance**.

→ **Faster time response**.

- It improves the **linearity** of the photo-current (i.e. photo-electrons per photon) at higher illumination.



[figure from www.centrovision.com]

Drawback: *increased noise at ultra-low intensities.*