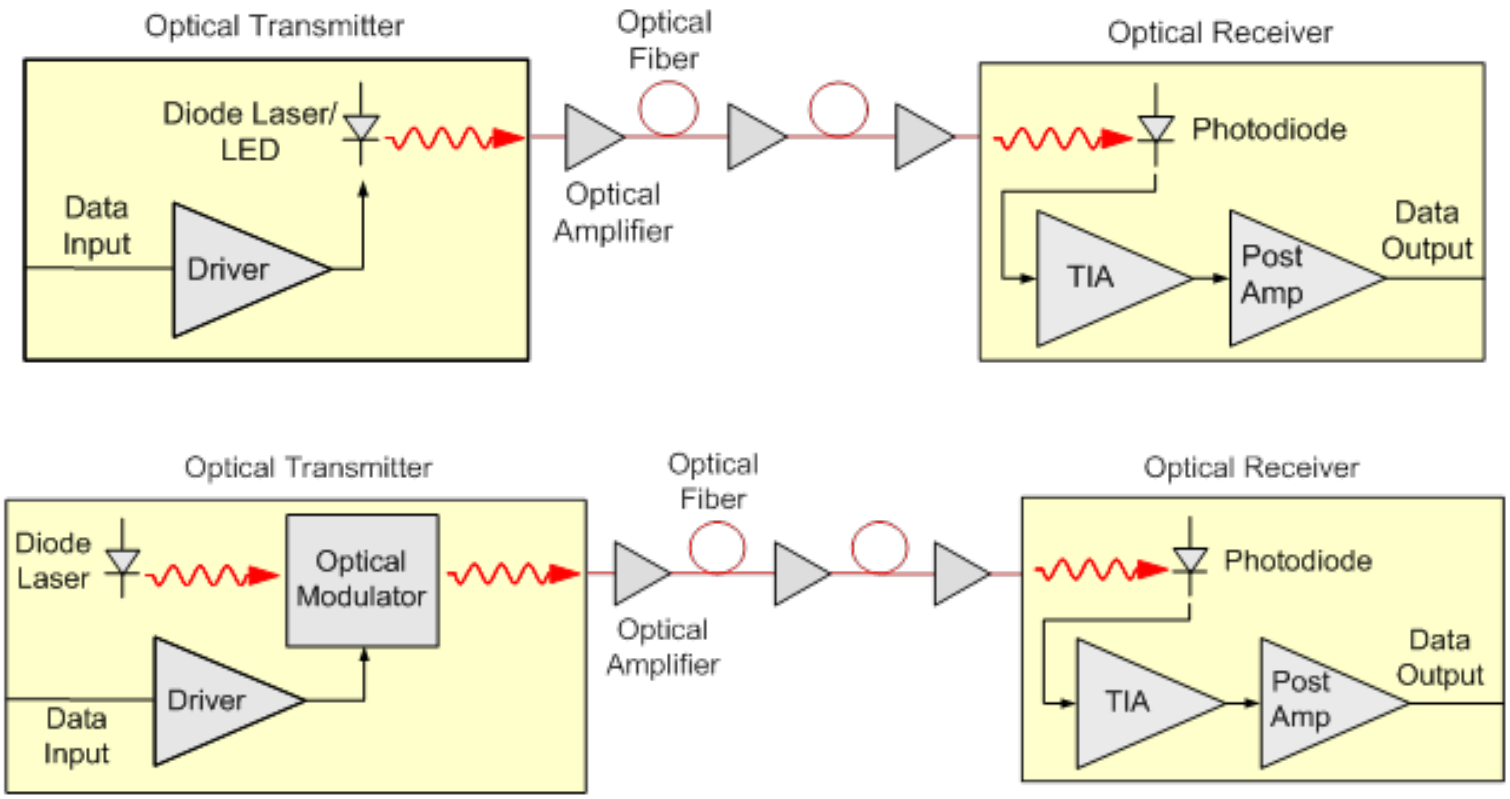
# Two Main Approaches to Optical Transmission



# Why go to the trouble of using an external modulator?

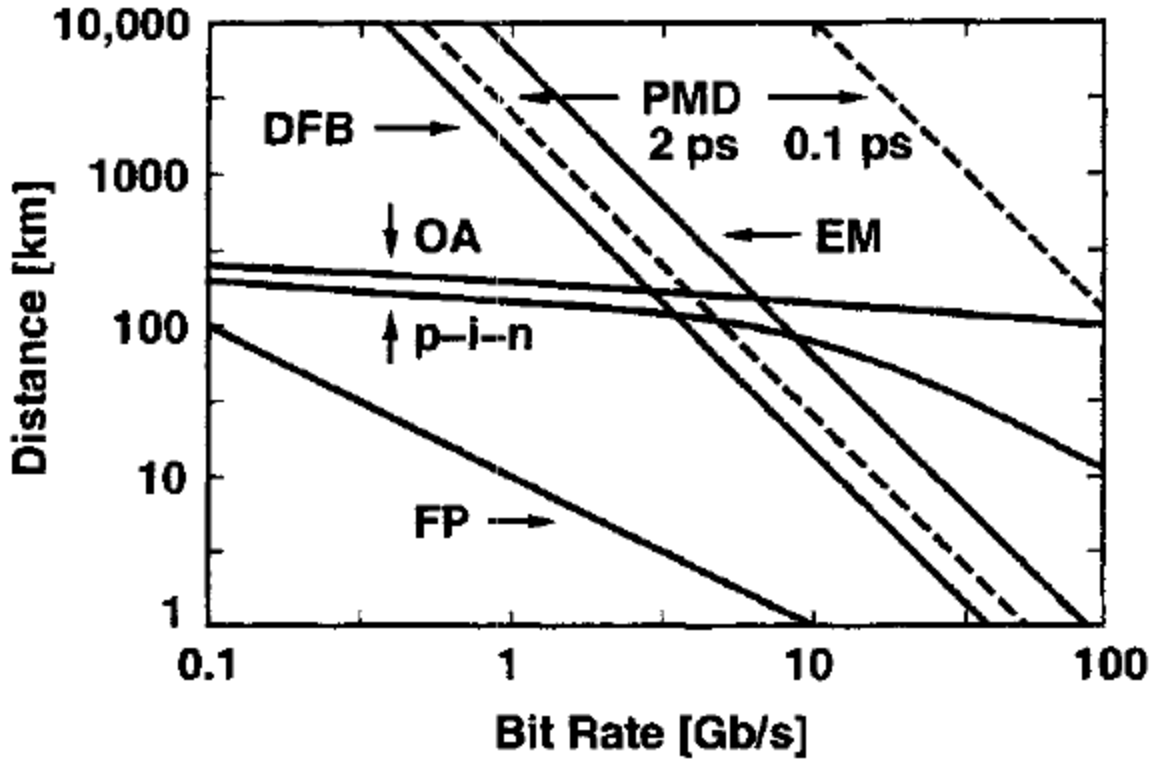
***Table 7.1*** Maximum (unrepeatered) transmission distances over an SMF at 1.55 $\mu$m for various transmitter types based on Eqs. (7.19), (7.18), and (7.16) with $D = 17\,\text{ps/(nm} \cdot \text{km)}$.

| Transmitter Type | 2.5 Gb/s | 10 Gb/s |
|---|---|---|
| Fabry-Perot laser ($\Delta\lambda = 3$ nm) | 4 km | 1 km |
| Distributed feedback laser ($\alpha = 4$) | 230 km | 15 km |
| External modulator ($\alpha = 0$) | 960 km | 60 km |

From Broadband circuits for optical fiber communication, Eduard Säckinger, Wiley 2005

- An external modulator offers extended transmission distance

# More Detailed Limits to Transmission Distance




from Broadband Circuits for Optical Fiber Communication, Eduard Säckinger, Wiley 2005

Limits Due to Chromatic Dispersion

- FP = Fabry Perot Laser
- DFB = Distributed Feedback Laser
- EM = External Modulation

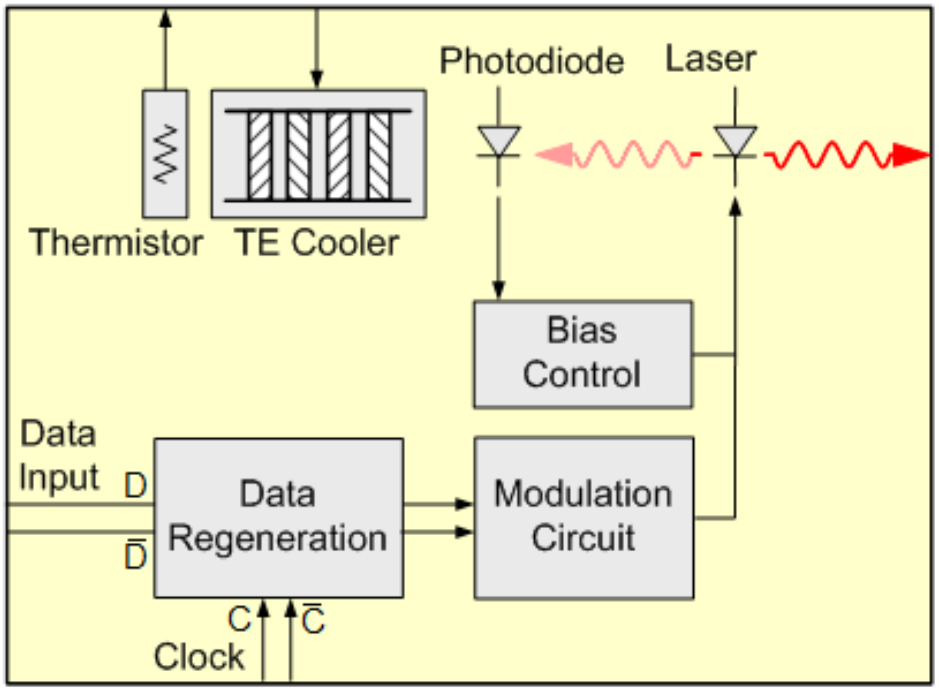
Limits due to Polarization Mode Dispersion

- PMD = Polarization Mode Dispersion

Limits due to Optical Attenuation in Fiber

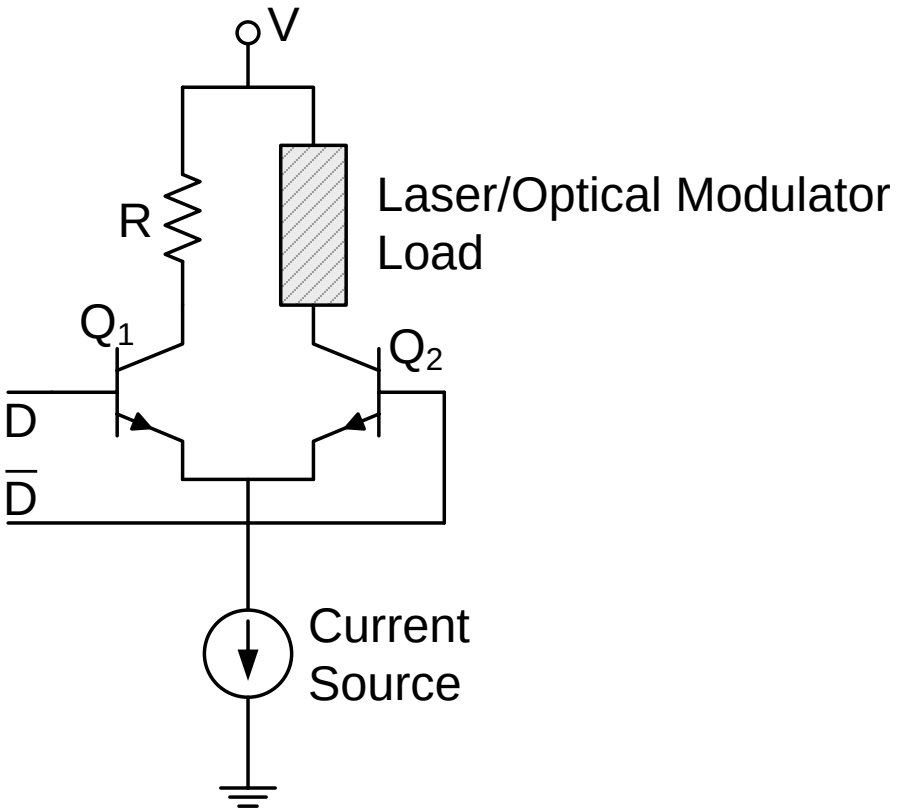
- p-i-n = Photodetector
- OA = Optically Pre-Amplified Photodetector

# The Inside of an Optical Transmitter

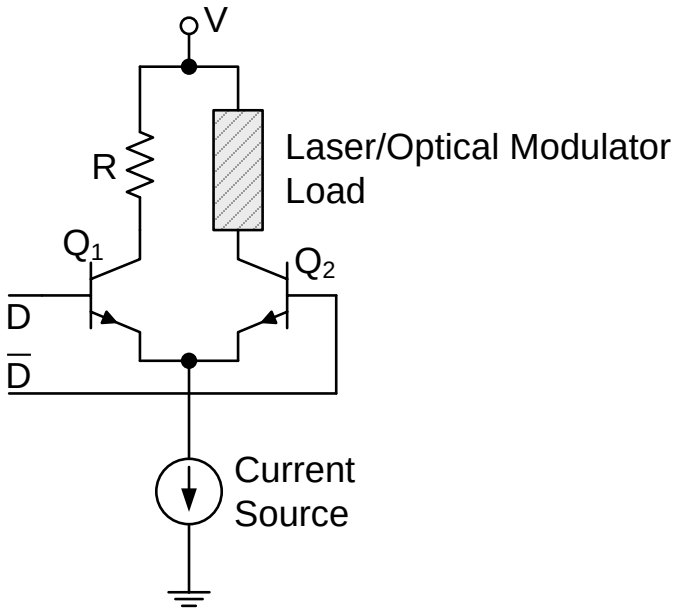



- The transmitter includes components for control of temperature and average power
- A transmitter often contains circuitry for re-shaping and re-timing data

# Basic Laser/Modulator Drive Circuitry

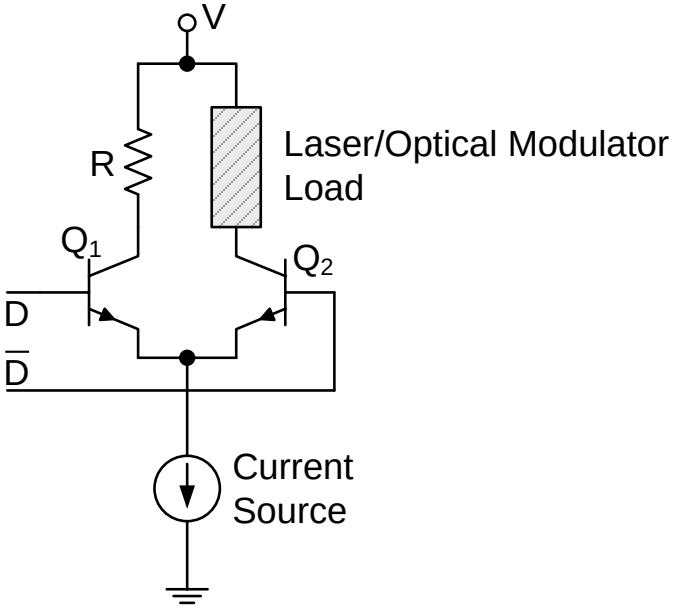


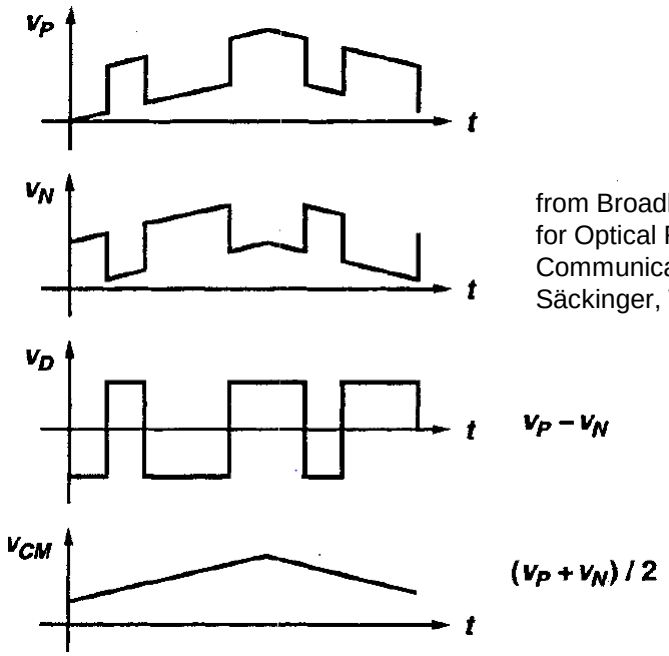
# Why do we use current steering?




- A constant current to the ground through the current source avoids current transients due to parasitic capacitances and inductances

# Why do we use differential input?

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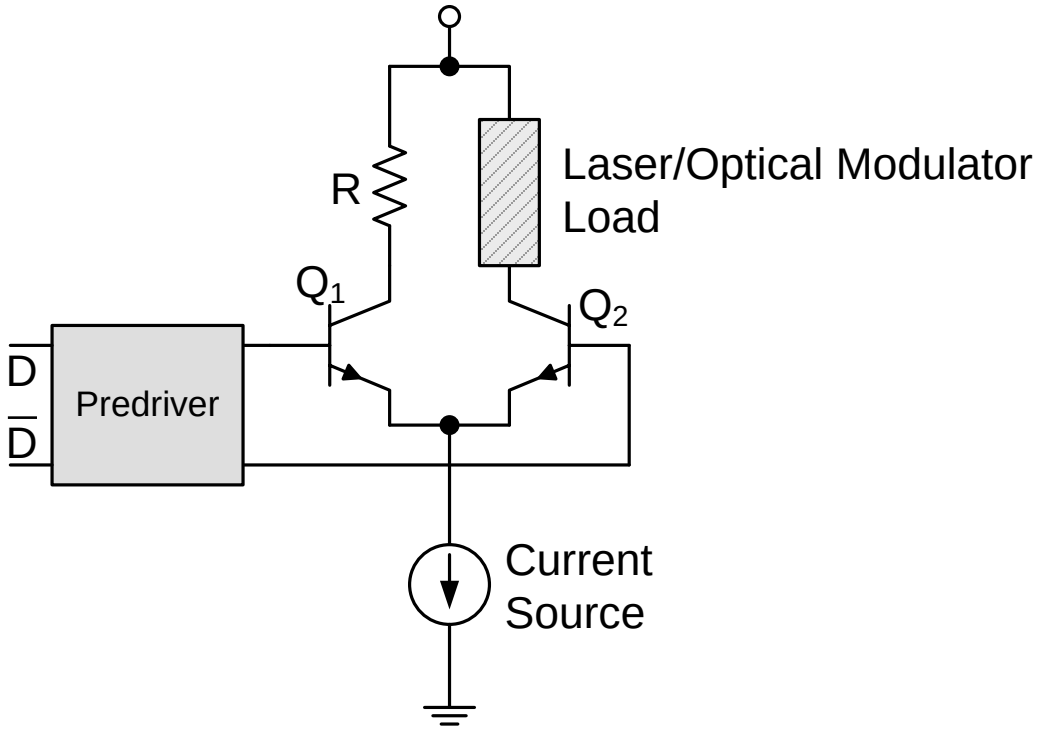
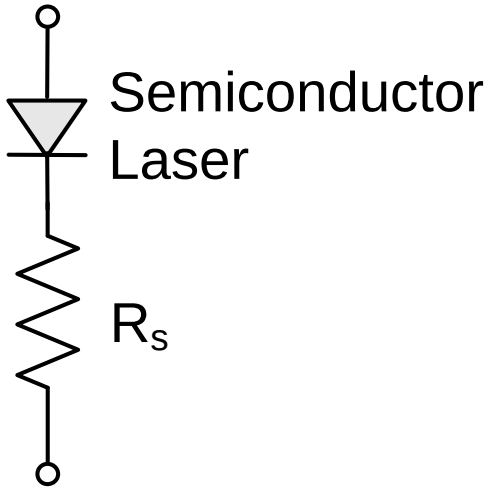
- The differential design is insensitive to common-mode noise and avoids the need for an input reference voltage

# Drive Circuitry with an Additional Predriver



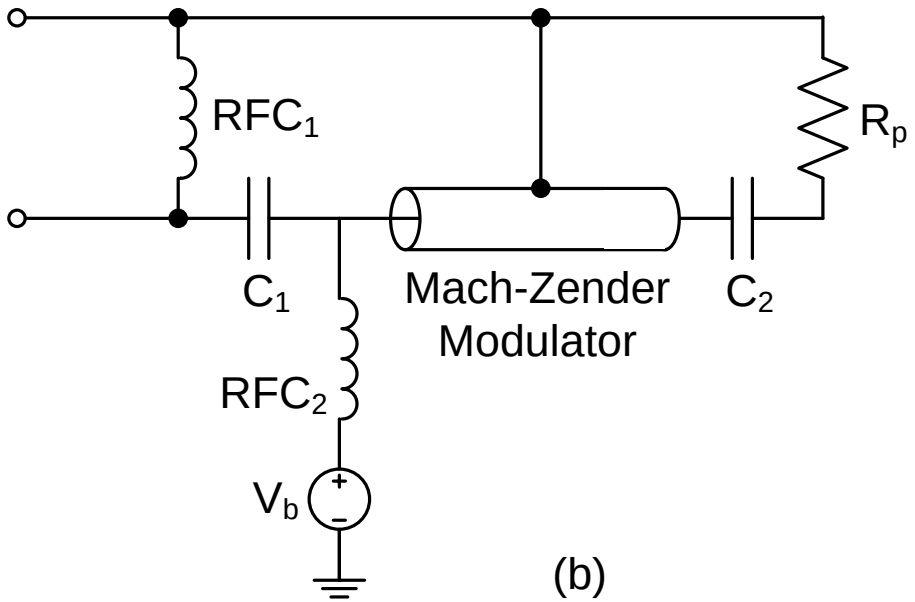

- The predriver conditions the signals for input to transistors $Q_1$ and $Q_2$

# Laser Load for the Drive Circuitry




- The resistor $R_s$, dampens current oscillations due to parasitic inductances in the circuitry

# Modulator Load for Drive Circuitry




- Load is a transmission line
- Modulator is AC coupled to the drive circuitry by inductor $RFC_1$ (RF Choke 1) and capacitor C1 (the combination is know as a “Bias T”)
- A Bias voltage $V_b$ is DC coupled to the modulator by $RFC_2$
- The drive signal is terminated by the resistor $R_p$
- The capacitor $C_2$ blocks DC current through the modulator