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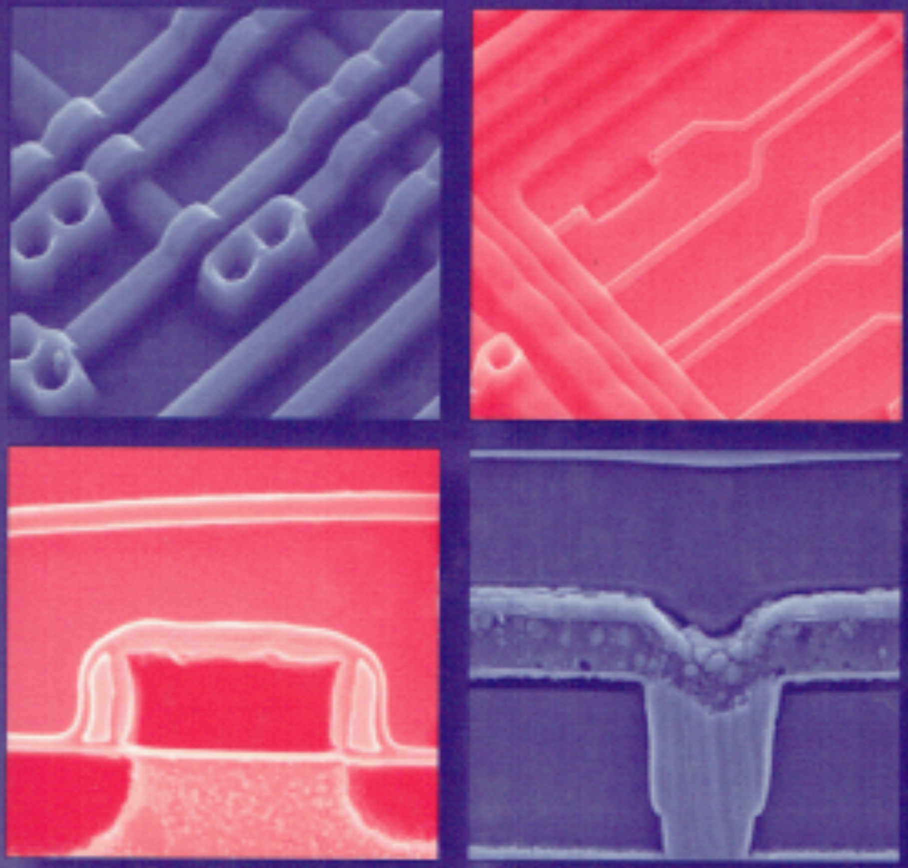
CIRCUIT DESIGN, LAYOUT, AND SIMULATION



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current in M5 and M6. When the output of the oscillator is low, M3 is on and M2 is off. This allows the constant current from M4 to charge C. When the voltage across C reaches V_{SPH}, the output of the Schmitt trigger swings low. This causes the output of the oscillator to go high and allows the constant current from M1 to discharge C. When C is discharged down to V_{SPL}, the Schmitt trigger changes states. This series of events continues, generating the square wave output.

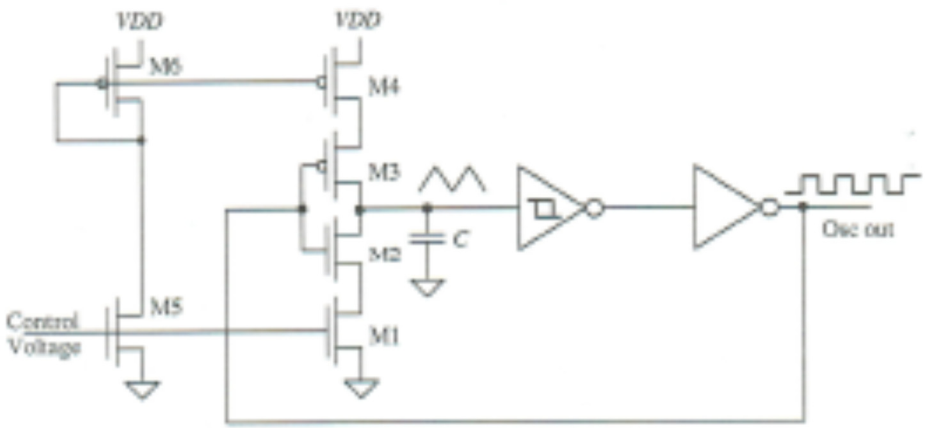

Figure 18.8 Voltage-controlled-oscillator using Schmitt trigger and current sources. MOSFETs M2 and M3 are used as switches.

If we label the drain currents of M1 and M4 as I_{D1} and I_{D4}, we can estimate the time it takes the capacitor to charge from V_{SPL} to V_{SPH} as

$$t_1 = C \cdot \frac{V_{SPH} - V_{SPL}}{I_{D4}} \tag{18.14}$$

and the time it takes to charge from V_{SPH} to V_{SPL} is

$$t_2 = C \cdot \frac{V_{SPH} - V_{SPL}}{I_{D1}} \tag{18.15}$$

The period of the oscillation frequency is, as before, the sum of t_1 and t_2.

This type of oscillator is termed a voltage-controlled oscillator (VCO) since the output frequency can be controlled by an external voltage. The currents I_{D1} and I_{D4}, (Fig. 18.8) are directly controlled by the control voltage. As we will see in Ch. 20, the current in M5 is mirrored in M1, M4, and M6, with an appropriate scaling factor dependent on the size of the transistors.

18.1.4 High-Speed Schmitt Trigger

It turns out in practice that the Schmitt trigger of Fig. 18.3 is not easily optimized for high speed. The effective switching resistances of the MOSFETs are difficult to reduce