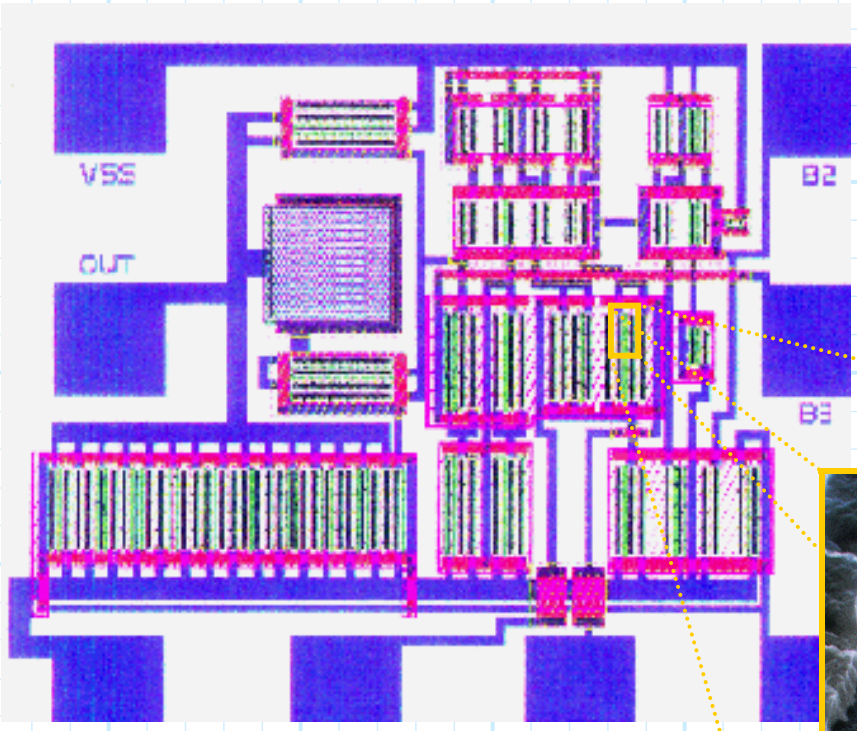
The Body Effect

In an integrated circuit using MOSFET devices, there can be **thousands** or **millions** of transistors.



As a result, there are thousands or millions of MOSFET **source terminals**!

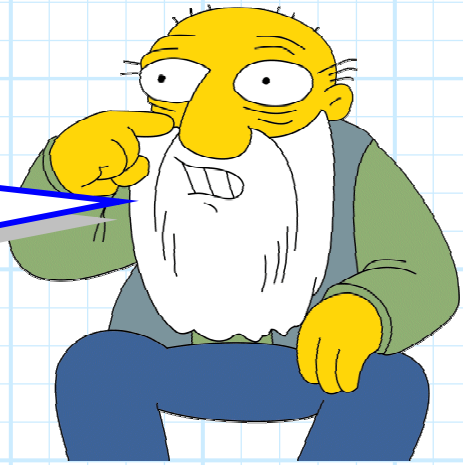
But, there is only **one** Body (B)—the Silicon **substrate**.

Thus, if we were to tie (connect) **all** the MOSFET source terminals to the single body terminal, we would be connecting **all** the MOSFET source terminals to each other!

→ This would almost certainly result in a **useless** circuit!

Thus, for integrated circuits, the MOSFET source terminals are **not** connected to the substrate body.

Q: *Yikes! What happens to MOSFET behavior if the source is **not** attached to the body ??*



A: We must consider the MOSFET **Body Effect**!

We note that the voltage v_{SB} (voltage source-to-body) is **not** necessarily equal to zero (i.e., $v_{SB} \neq 0$)! Thus, were back to a **four-terminal** MOSFET device.

There are **many** ramifications of this body effect; perhaps the most significant is with regard to the **threshold voltage** V_t.

We find that when $v_{SB} \neq 0$, a more **accurate** expression of the threshold voltage is:

$$V_t = V_{t0} + \gamma\sqrt{2\phi_f + v_{SB}} - \gamma\sqrt{2\phi_f}$$

where γ and ϕ_f are MOSFET **device parameters**.

Note the value V_{t0} is the value of the threshold voltage **when** $v_{SB} = 0$, i.e.:

$$V_t = V_{t0} \quad \text{when} \quad v_{SB} = 0.0$$

Thus, the value V_{t0} is simply the value of the device parameter V_t that we have been calling the threshold voltage up till now!

In other words, V_{t0} is the value of the threshold voltage when we **ignored** the Body Effect, or when $v_{SB} = 0$.

It is thus evident that the term:

$$\gamma\sqrt{2\phi_f + v_{SB}} - \gamma\sqrt{2\phi_f}$$

simply expresses an **extra** value added to the "ideal" threshold voltage V_{t0} when $v_{SB} \neq 0$.

For many cases, we find that this Body Effect is relatively insignificant, so we will (unless **otherwise** stated) **ignore the Body Effect**.

However, do **not** conclude that the Body Effect is **always** insignificant—it can in some cases have a tremendous impact on MOSFET circuit performance!