Programming Technologies

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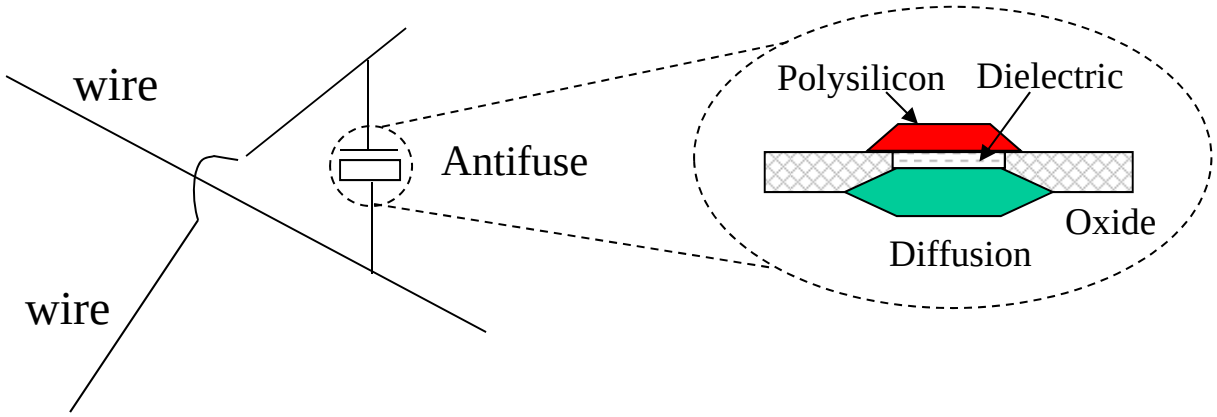
Programming Techniques in Configurable ICs

- Ploy-Diffusion Antifuse
- Metal-Metal Antifuse
- SRAM-Based Programming Technique
- EPROM-based Programming Technique
- EEPROM-based Programming Technique

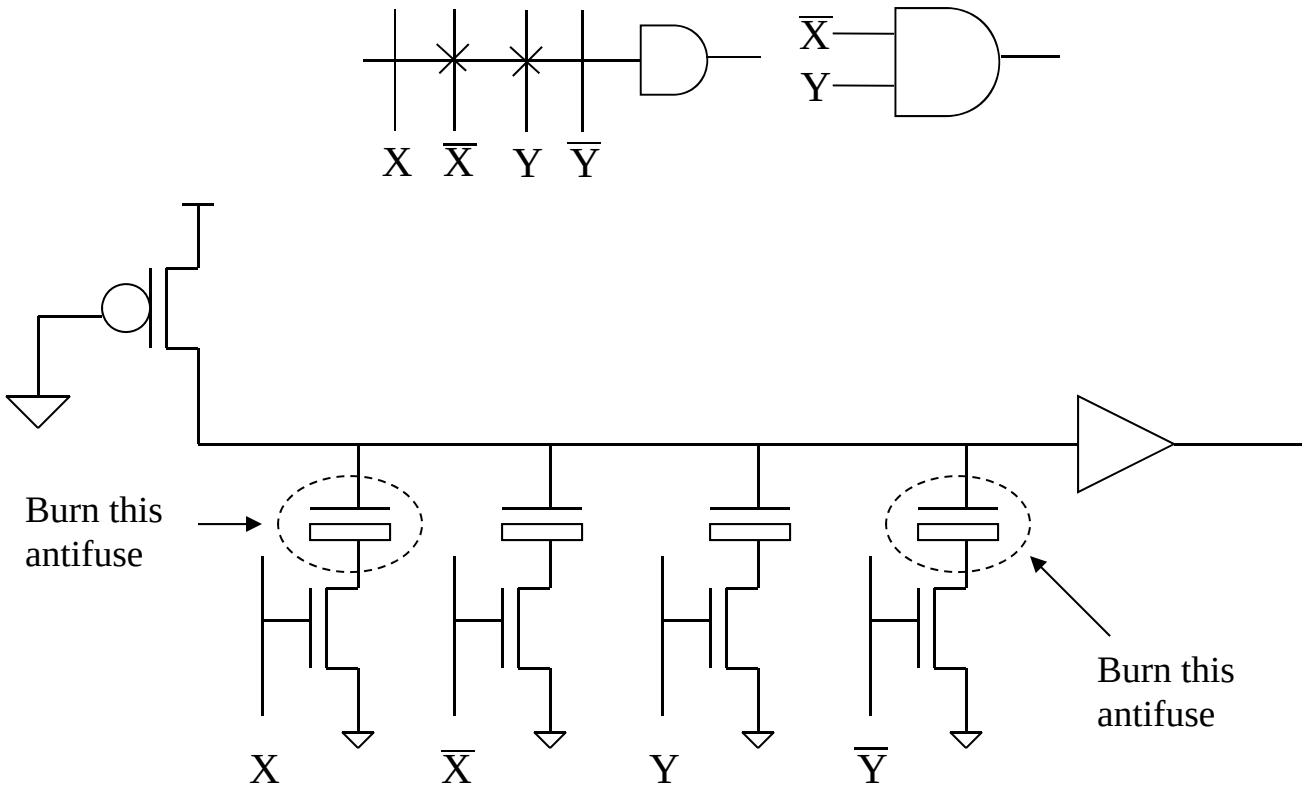
Poly-Diffusion Antifuse

- An *antifuse* is the opposite of a regular fuse. It is an open path until a programming current is forced through it by applying a high programming voltage across it.
- Advantage: small (allow denser switch population).
- Disadvantage: only one-time programmable.



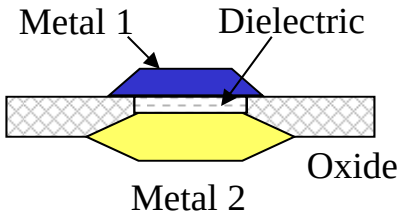
Example: Antifuse Techniques in PAL & PLA

- Implementation of wired-AND gate

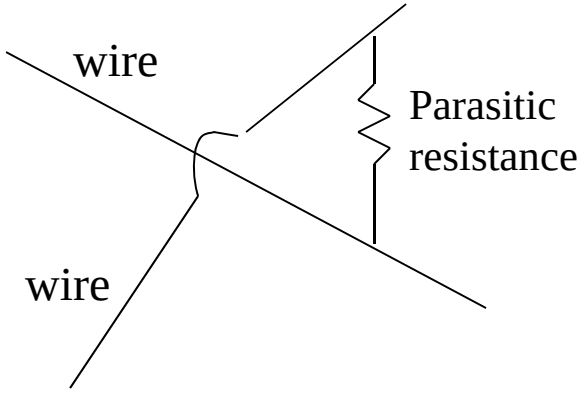


Metal-Metal Antifuse

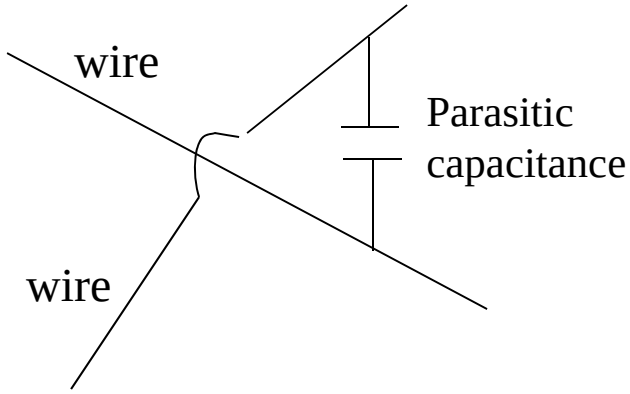
- Cross section of a metal-metal antifuse



- Parasitic effects of antifuse



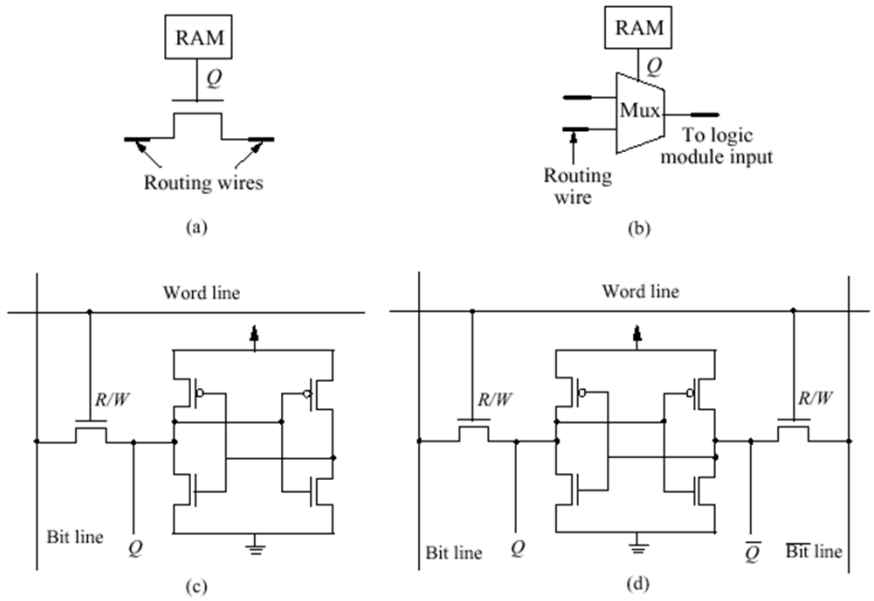
Antifuse is programmed to be ON



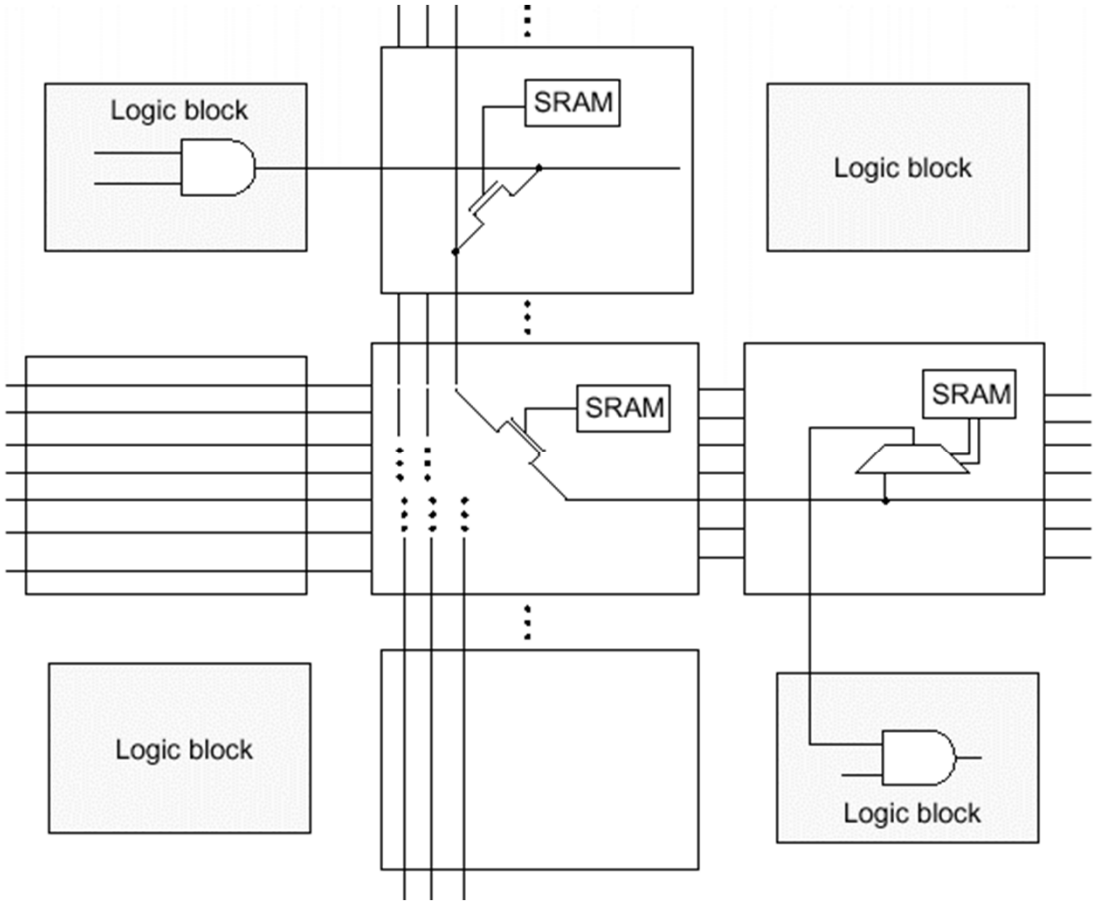
Antifuse is programmed to be OFF

SRAM-Based Programming technique

- Use SRAM cells to control pass transistors or multiplexers by the bit-content in the SRAM cells.
- Advantage: re-programmable.
- Disadvantage: occupy more space.

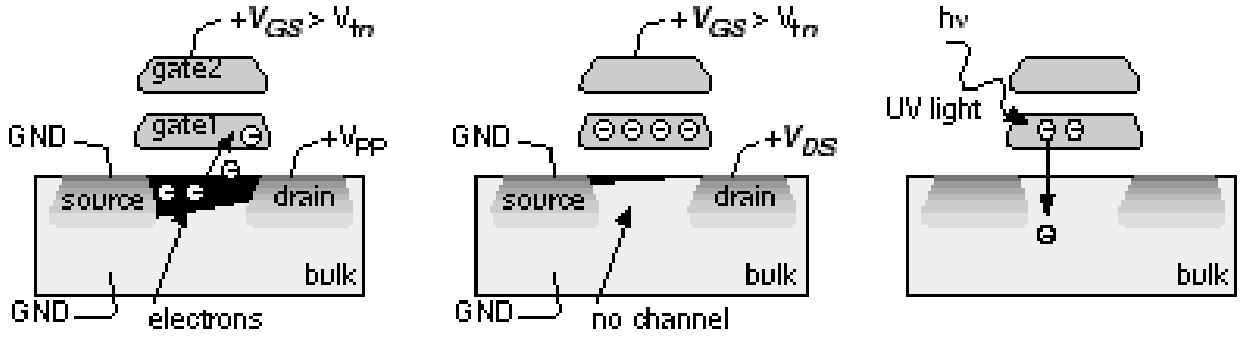


Example: SRAM-Controlled Programmable Switch



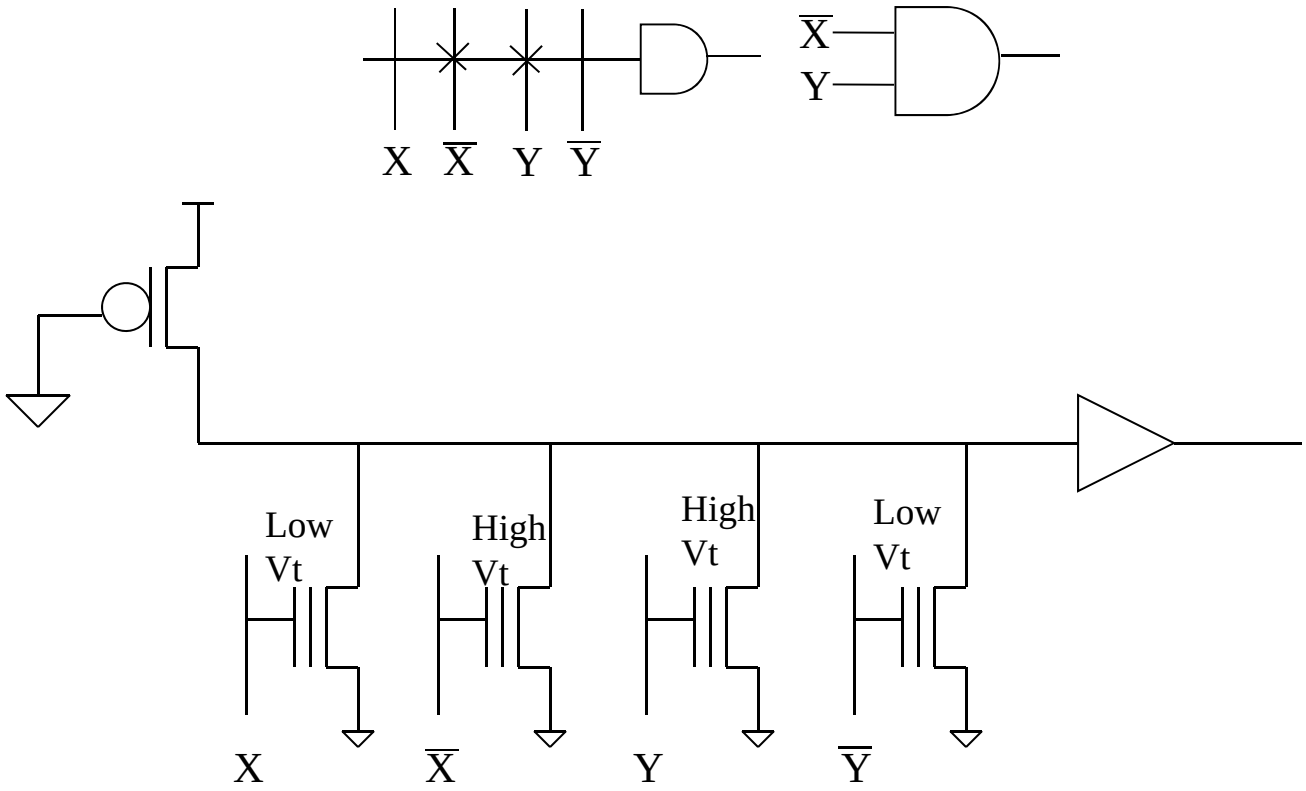
EPROM & EEPROM Programming technique

- An EPROM (r EEPROM) cell looks like a normal MOS transistor except that it has a second, floating, gate.
- To program an EPROM (or EEPROM) cell, apply a high voltage to the drain of the transistor. It results in electrons trapped in the floating gate and consequently increasing the the threshold voltage.
- To erase an EPROM cell, expose the chip to UV light.
- To erase an EEPROM cell, electrical field is used to remove electrons from the floating gate.



EPROM & EEPROM Programming technique

- Implementation of wired-AND gate



Comparison of Different Programming Techniques

Programming technology	SRAM	Poly-Diffusion antifuse	Metal-Meta antifuse	EPROM	EEPROM
Manufacturing Complexity	+	-	-	-	-
Re-programmable?	Yes In circuit	No	No	Yes Out of circuit	Yes In circuit
Physical size	Large (12X)	Small (2X)	Small (1X)	Small	Small
ON resistance (Ω)	600–800	100–500	30–80	1-4K	1-4K
OFF capacitance (fF)	10–50	3–5	1	10–50	10–50
Power consumption	++	+	+	-	-
Volatile?	Yes	No	No	No	No

+ Desirable; - no desirable