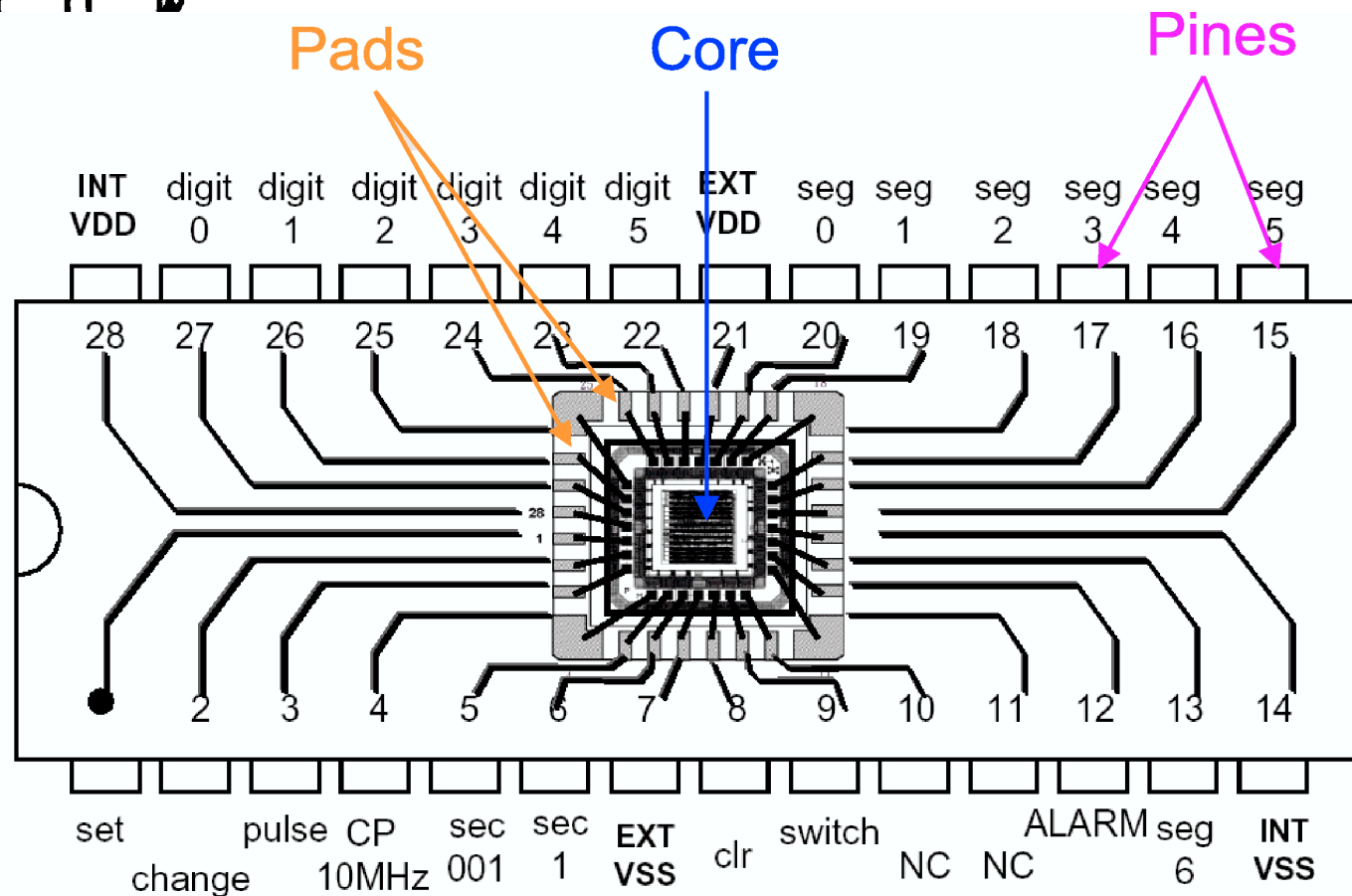
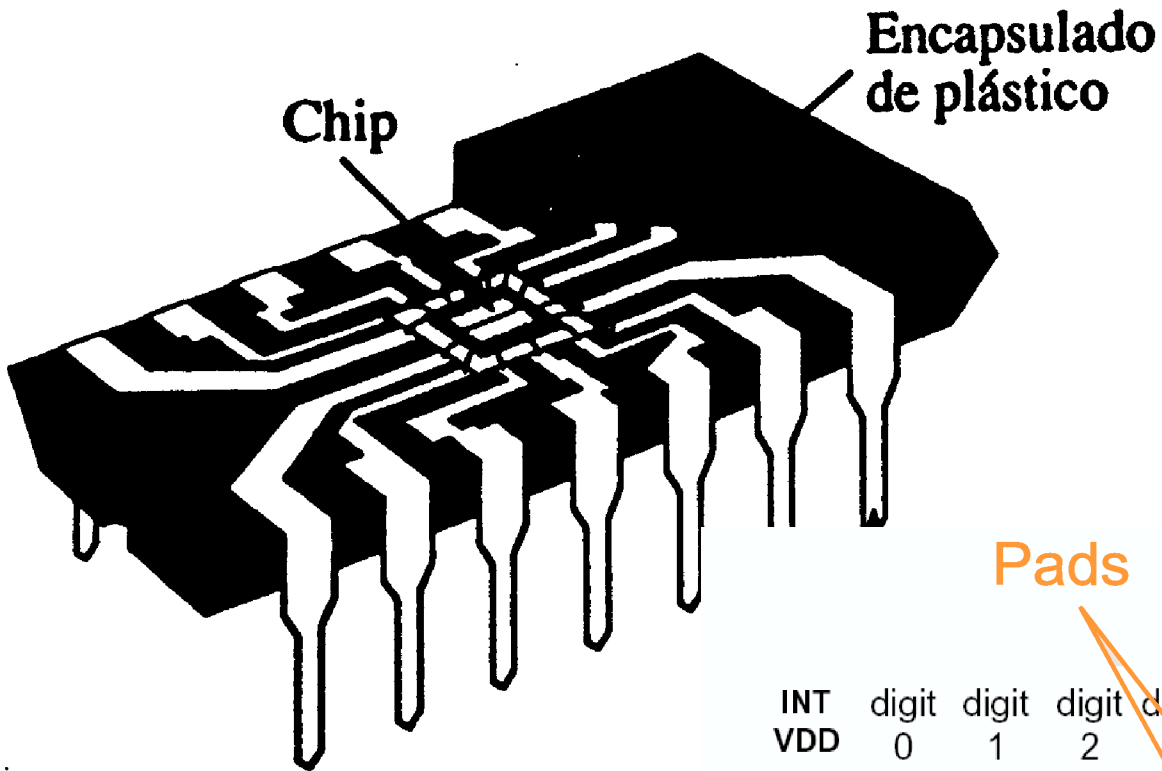
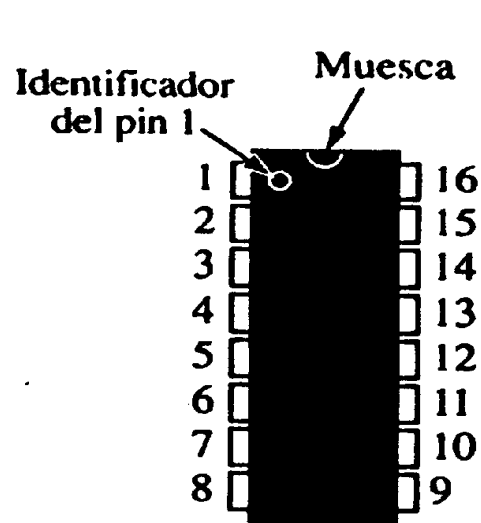


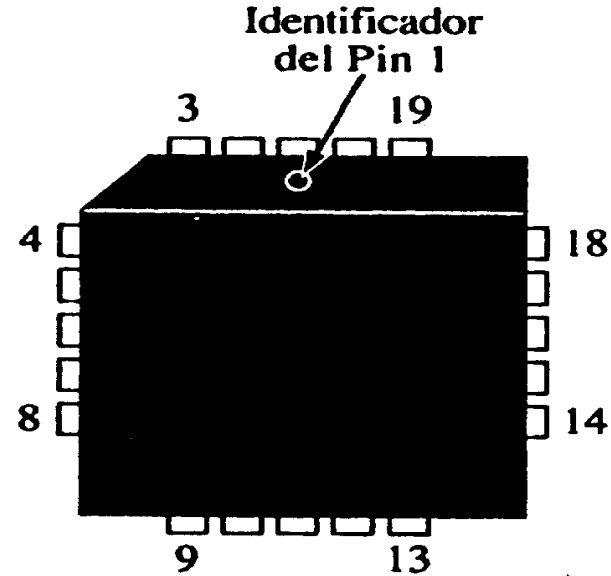
Familias Lógicas



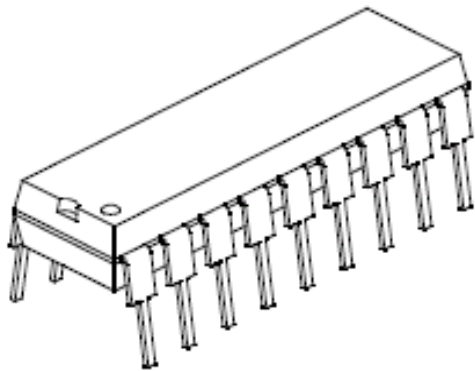
Encapsulados



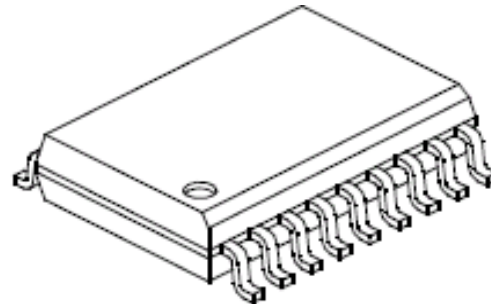
DIP o SOIC



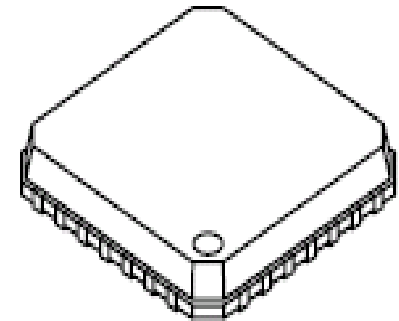
PLCC o LCCC



Dual Inline Package (DIP)

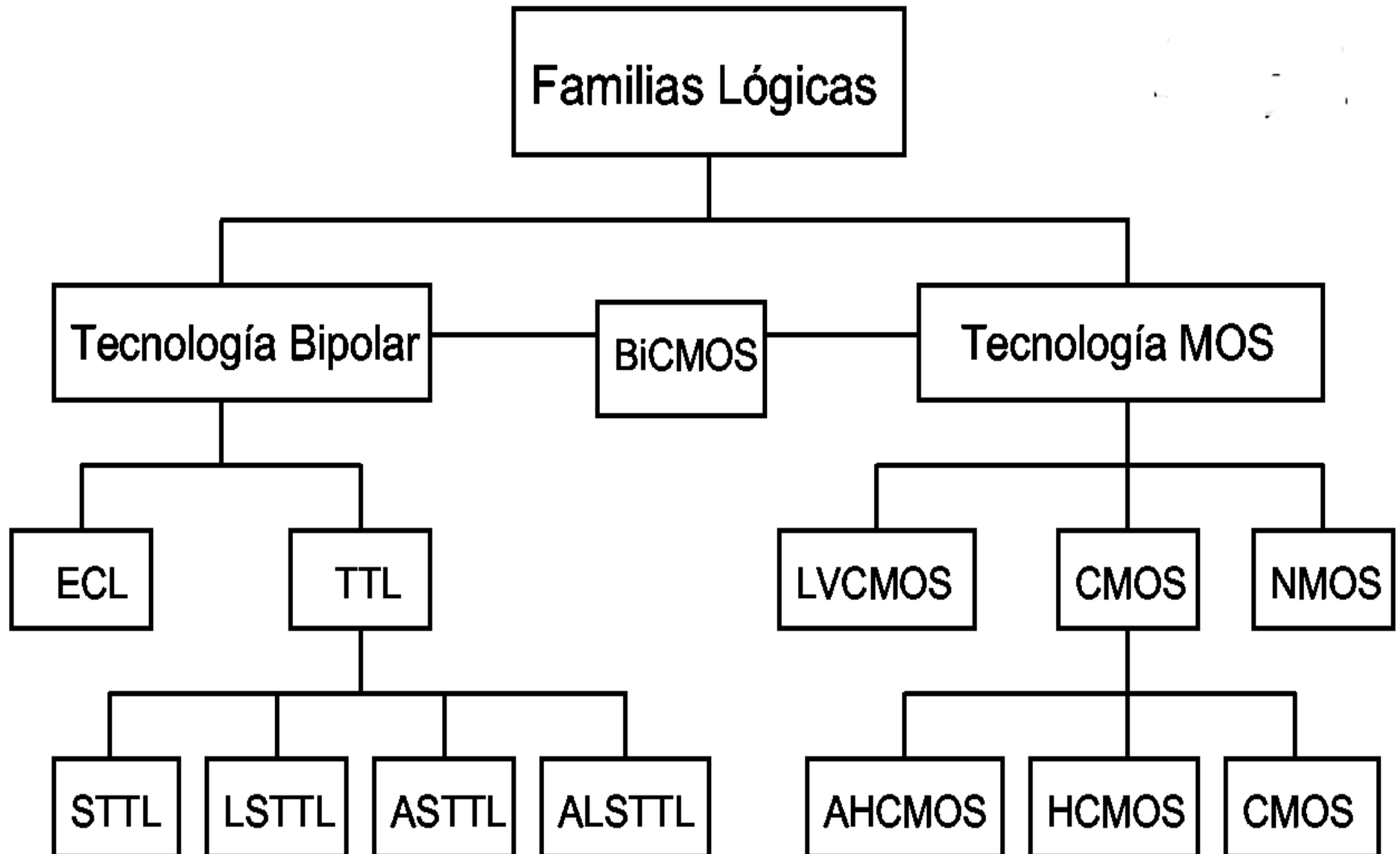


Small Outline (SOIC)

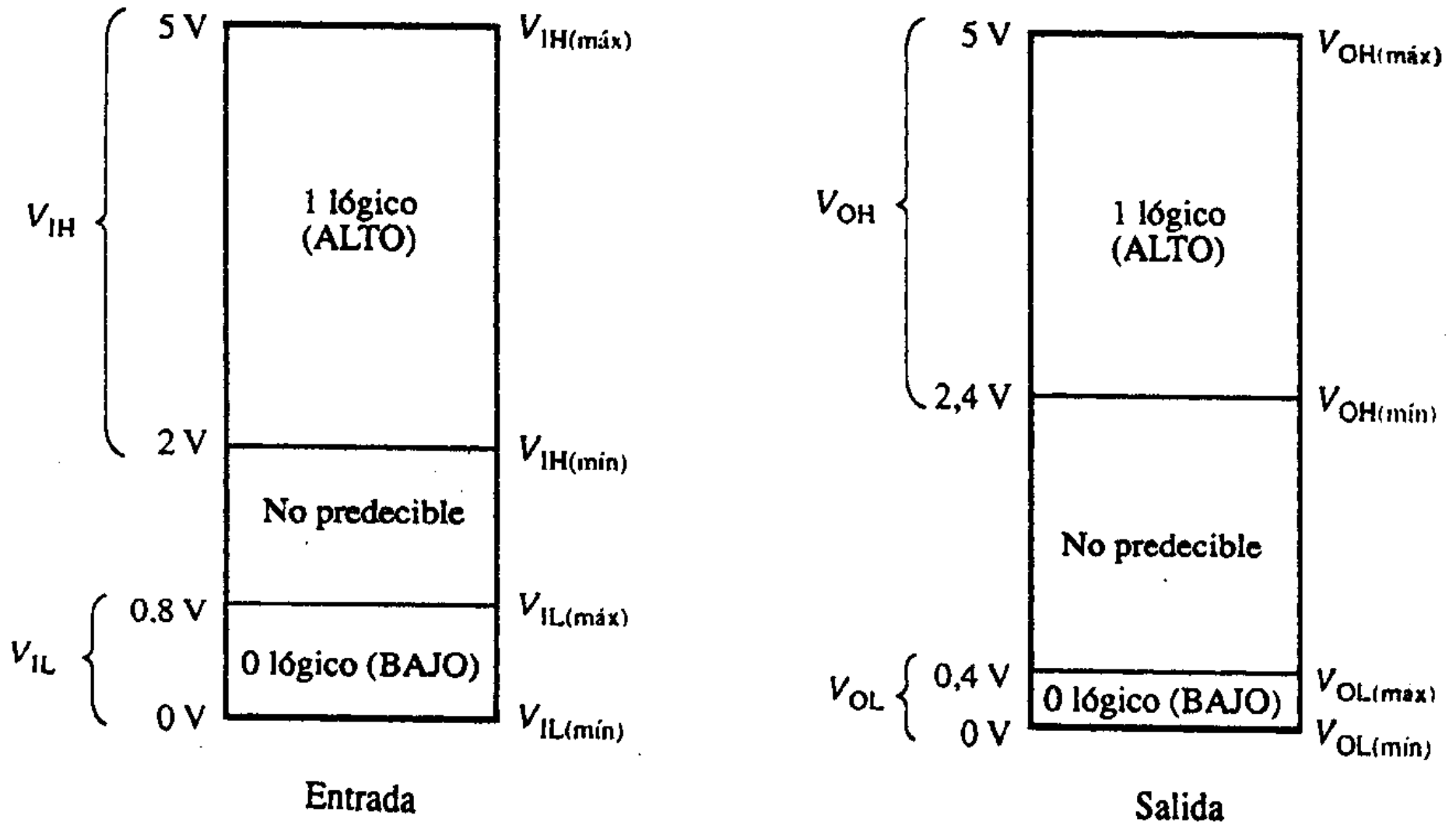


Quad Flat No Lead
Package (QFN)

Familias lógicas



Niveles lógicos (TTL)

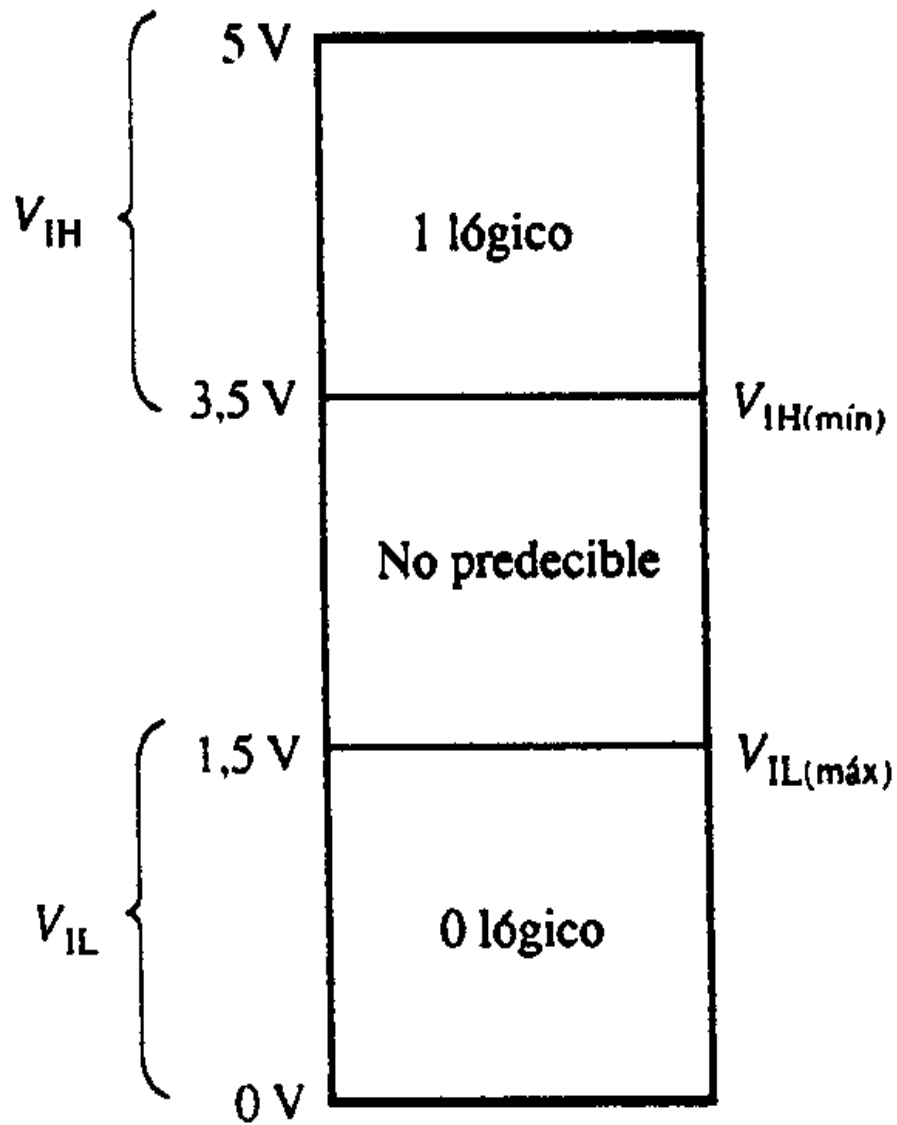


Márgenes de ruido:

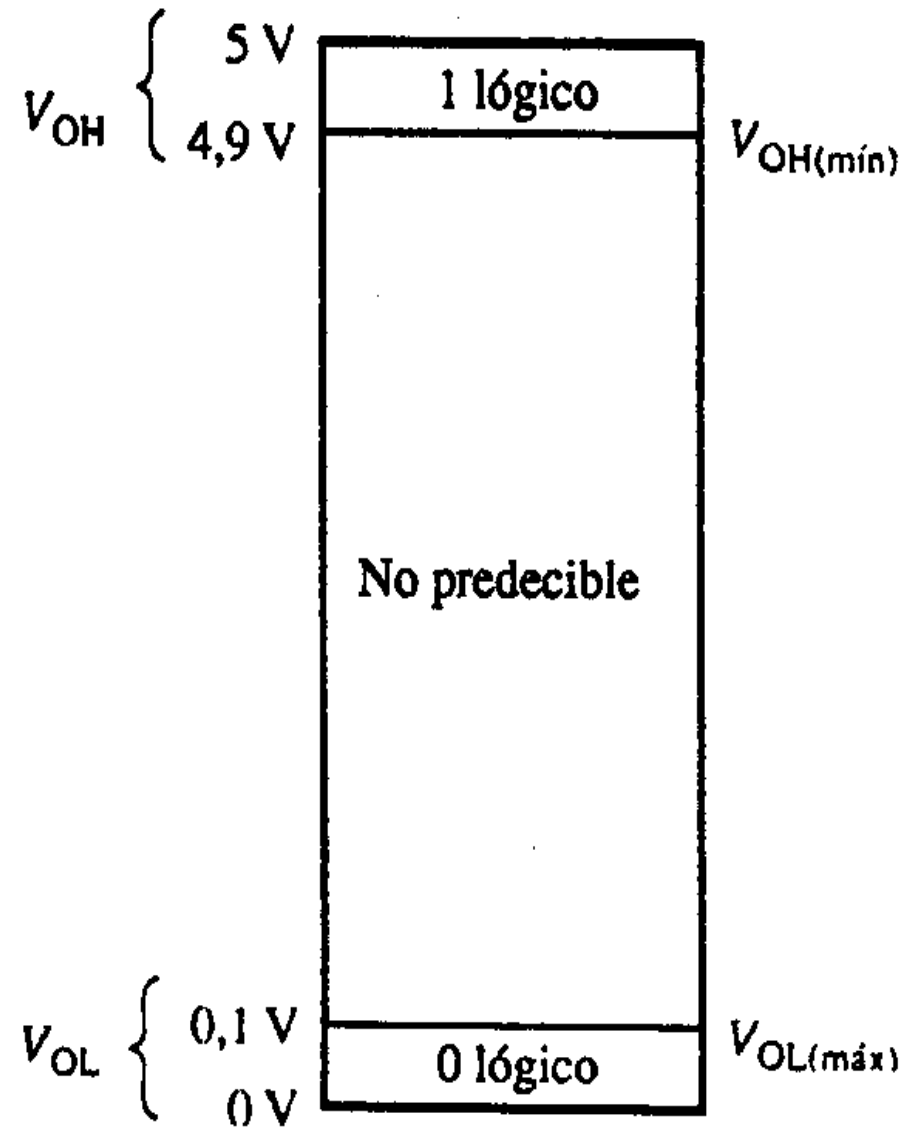
$$V_{NH} = V_{OH(min)} - V_{IH(min)}$$

$$V_{NL} = V_{IL(max)} - V_{OL(max)}$$

Niveles lógicos (CMOS)

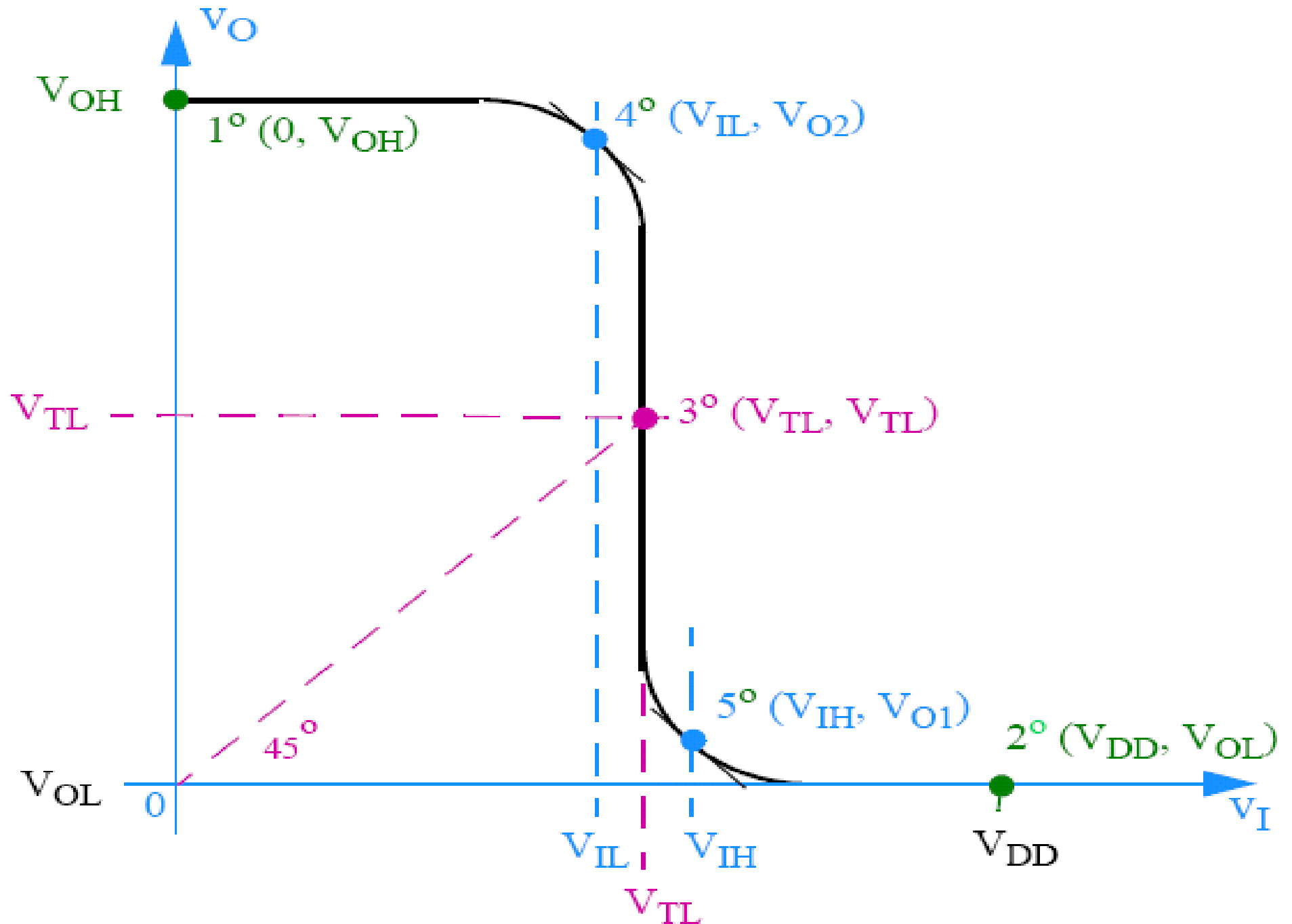


Entrada

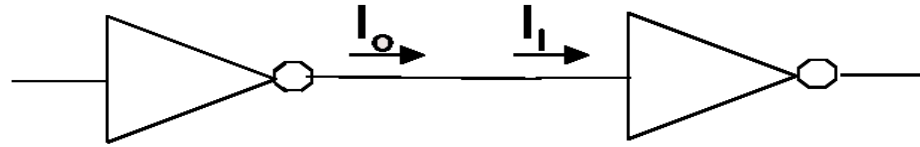


Salida

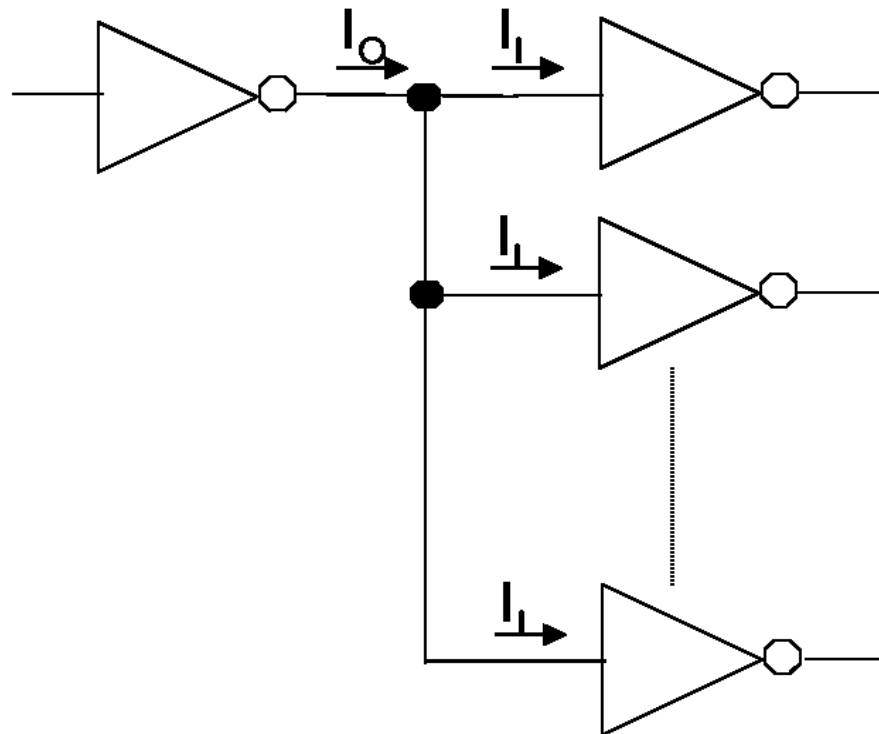
Característica de transferencia (VTC)



Corrientes y Fan-out



Necesario: $I_{OHmax} > I_{IHmax}$ y $I_{OLmax} > I_{ILmax}$



Necesario:

$$I_{OHmax} > nI_{IHmax}$$

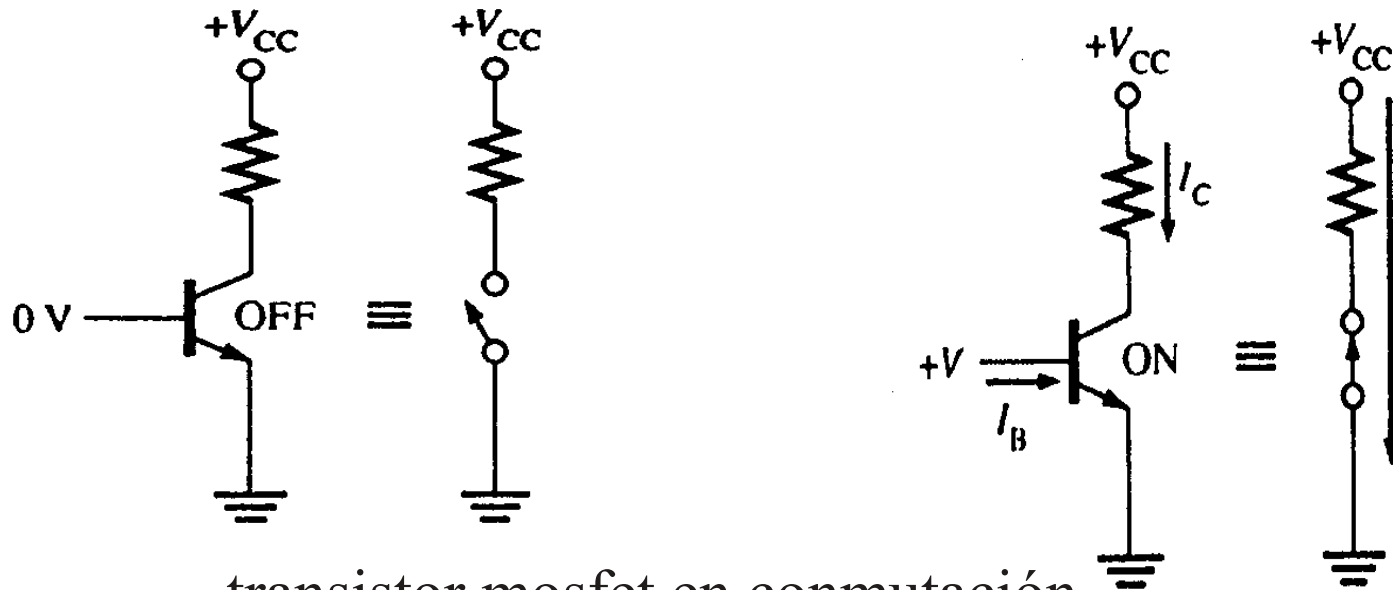
$$I_{OLmax} > nI_{ILmax}$$

$$FO_L = \frac{I_{OL(max)}}{I_{IL(max)}}$$

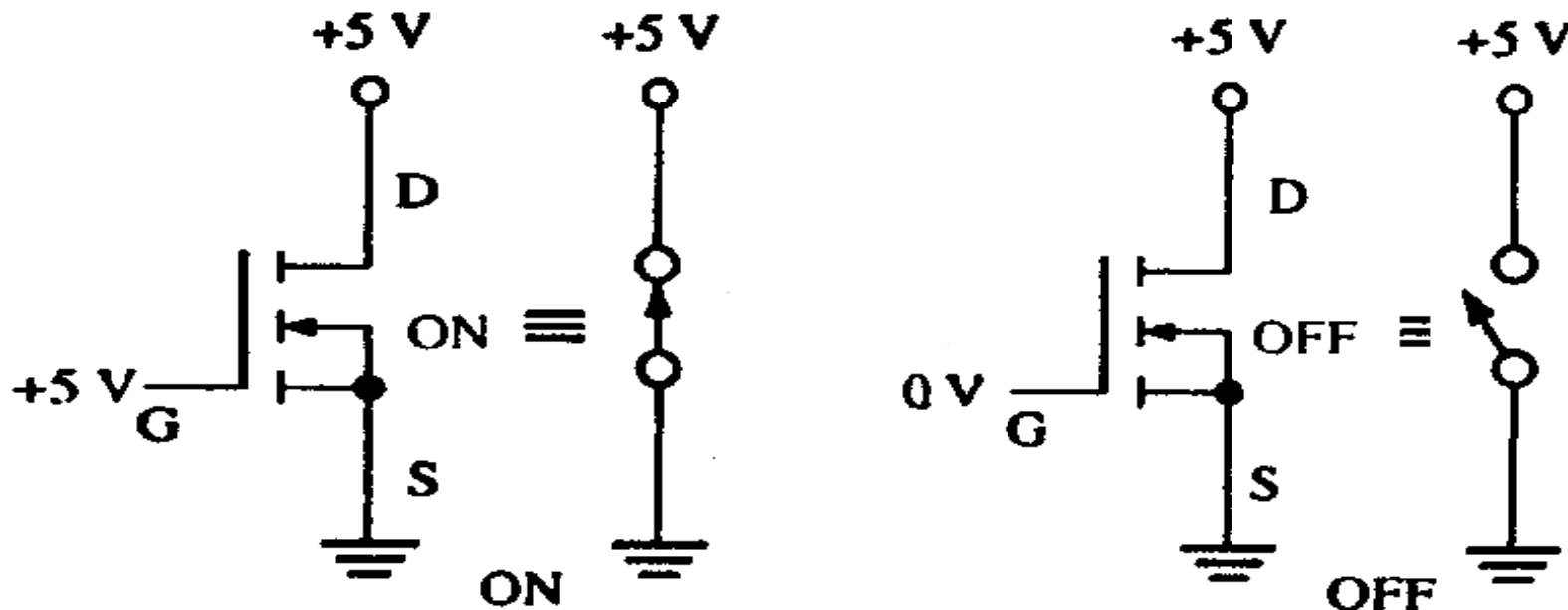
$$FO_H = \frac{I_{OH(max)}}{I_{IH(max)}}$$

Conmutación en las puertas

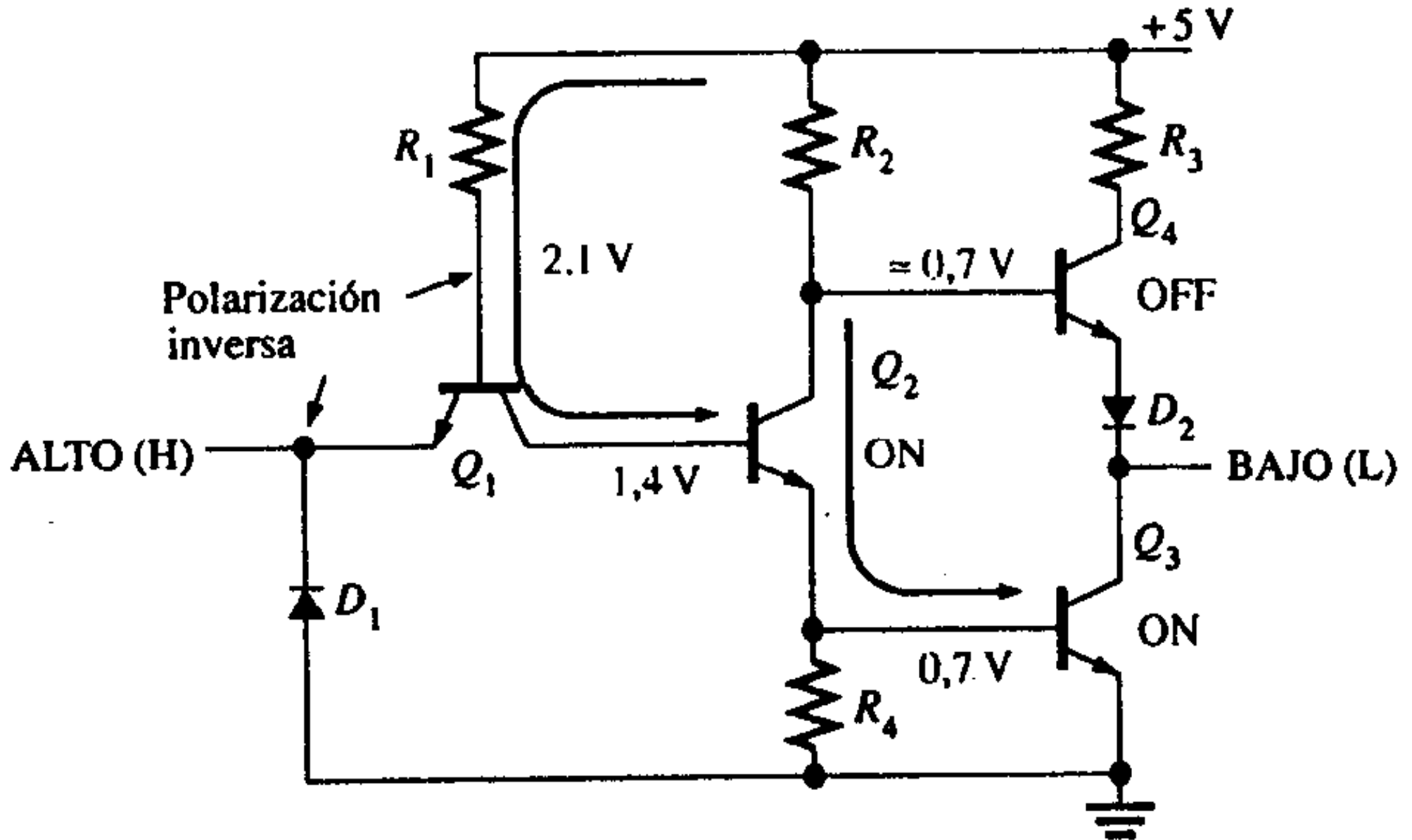
transistor bipolar en conmutación



transistor mosfet en conmutación

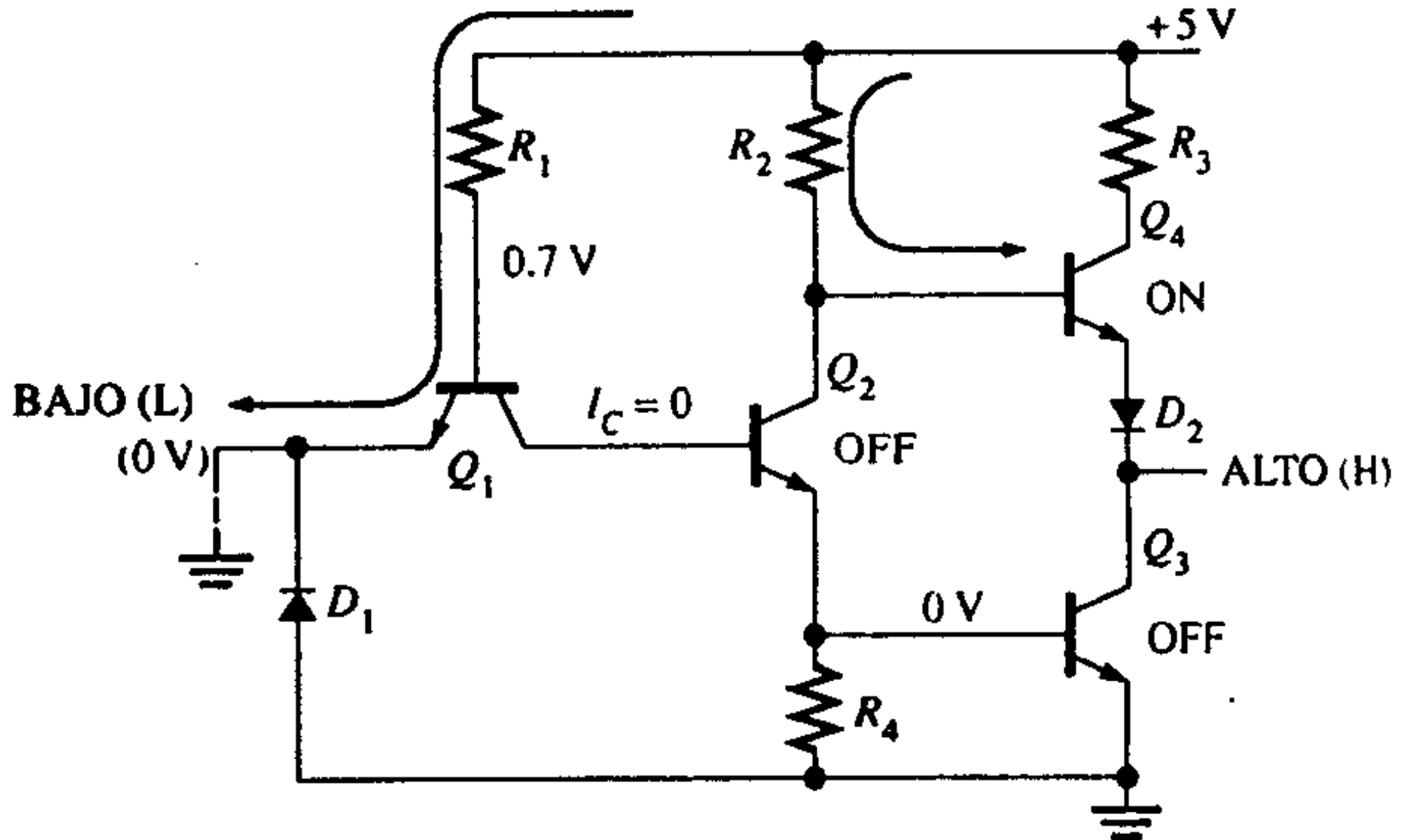


Inversor TTL entrada en alto

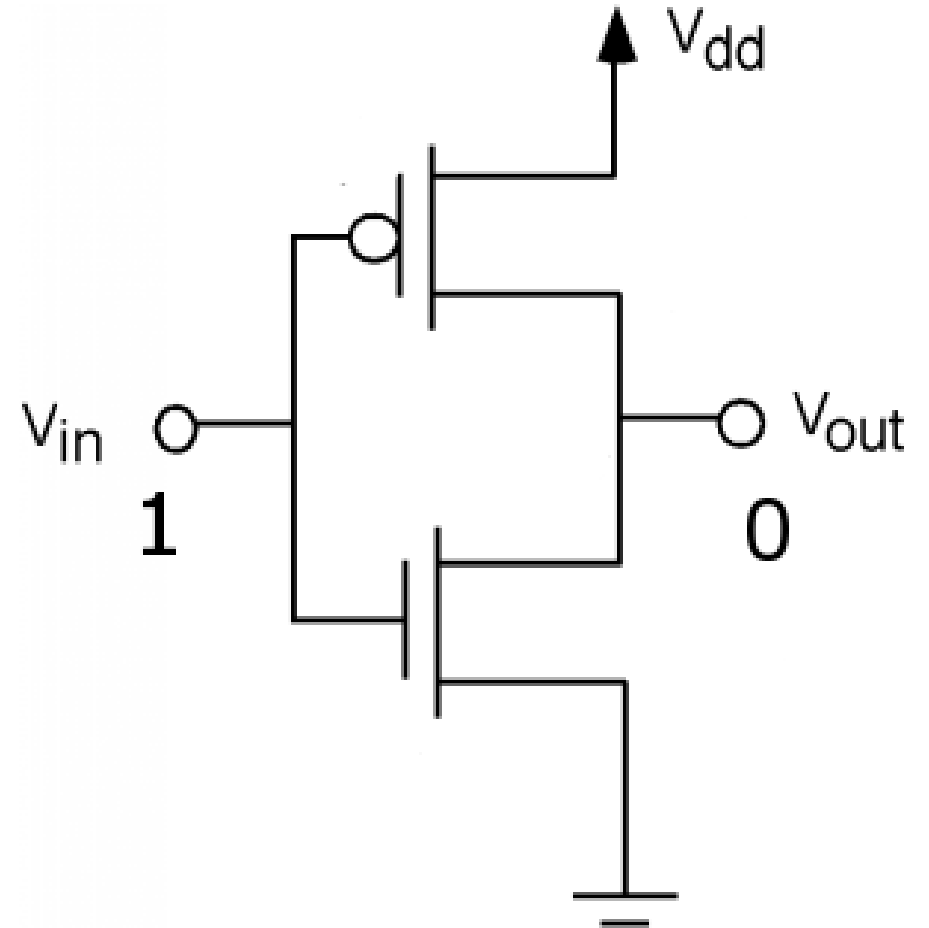
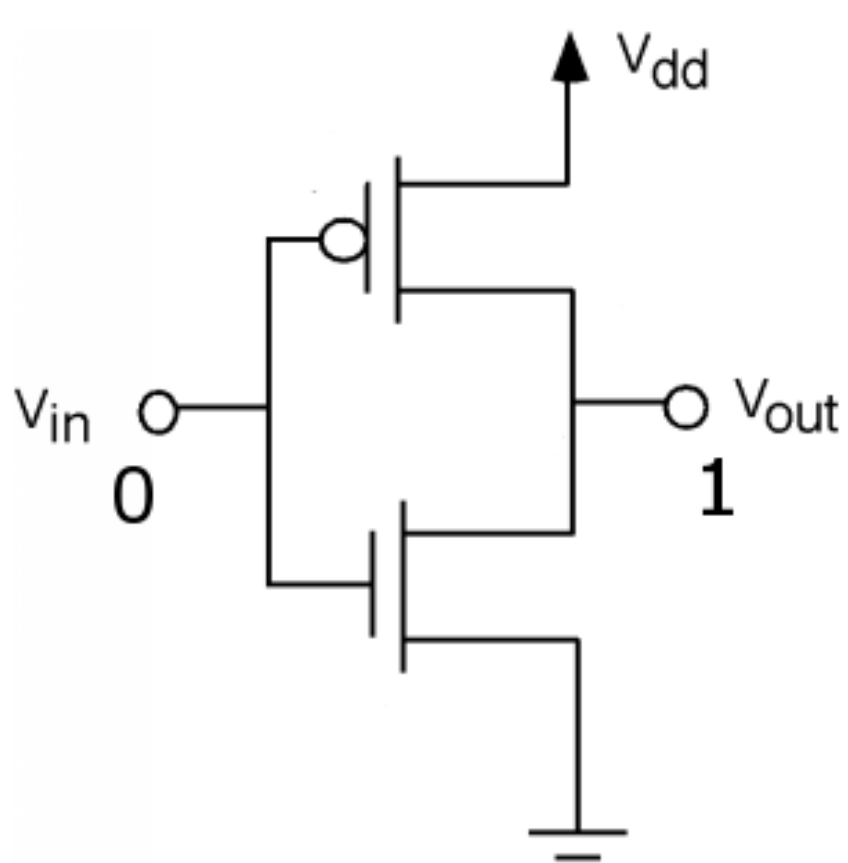


Q3-Q4 = salida Totem-Pole

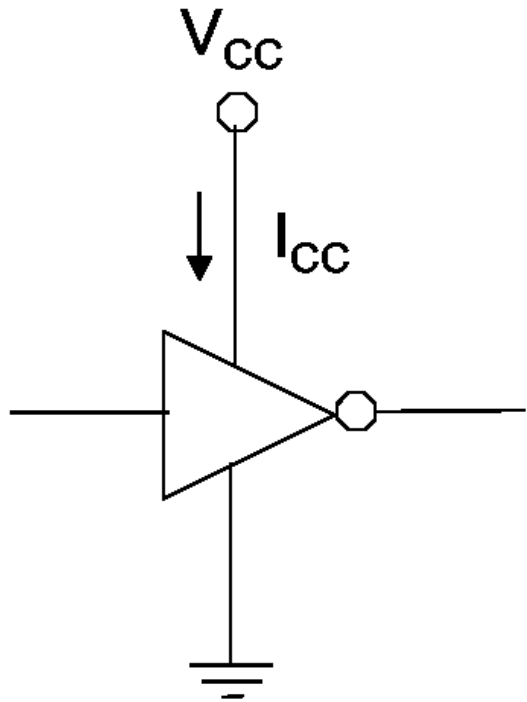
Inversor TTL entrada en bajo



Inversor CMOS



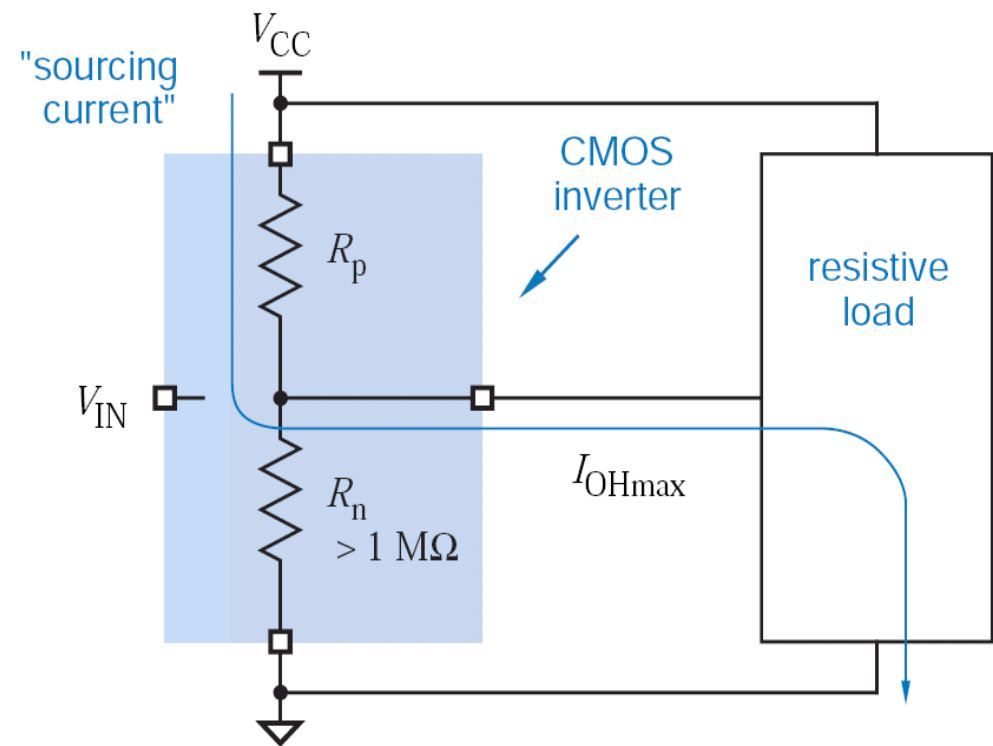
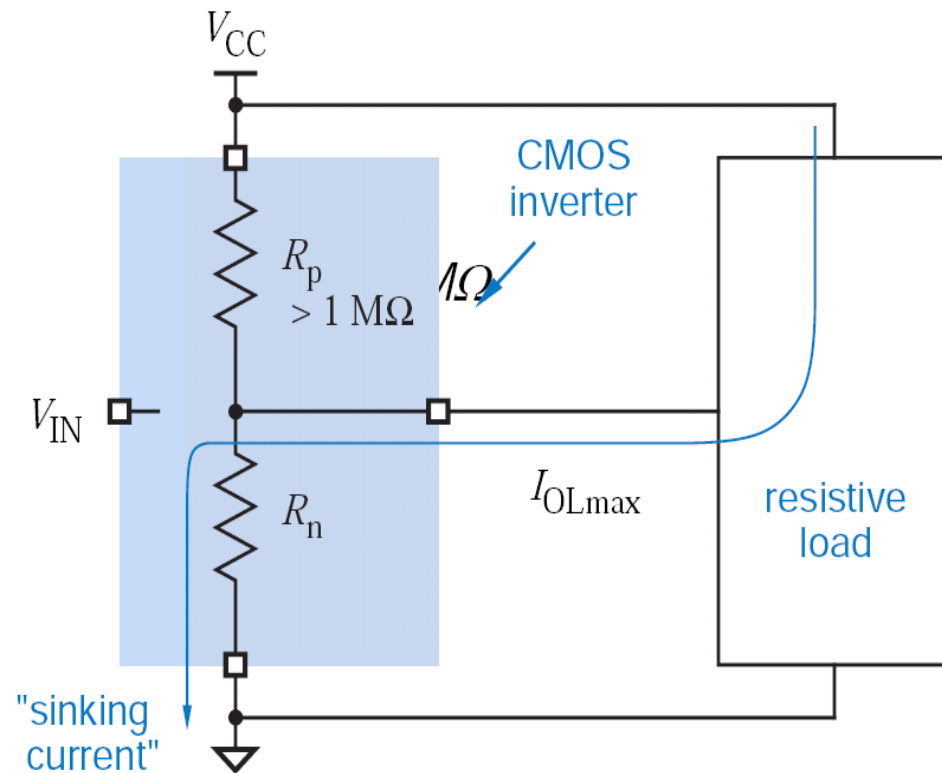
Consumo de potencia



$$P_{CC} = V_{CC} \cdot \overline{I_{CC}}$$

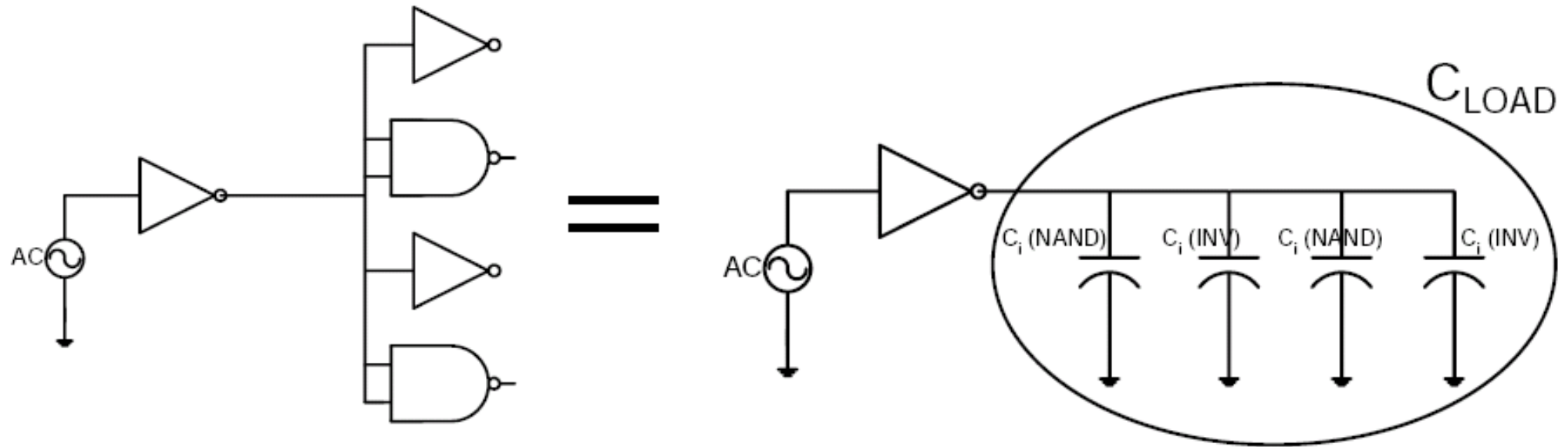
- Depende de entradas (y salida) de la puerta -> estado de los transistores internos

Carga de las puertas

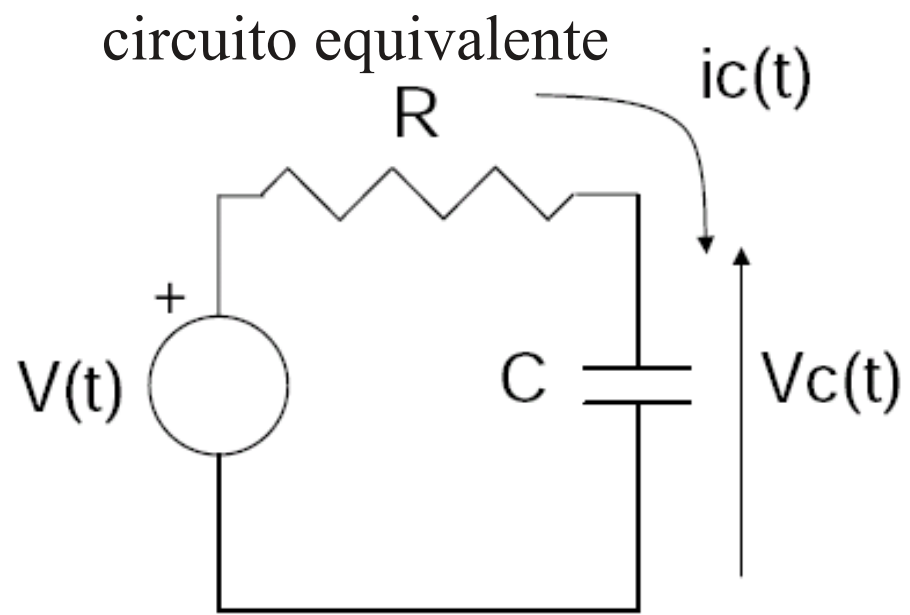
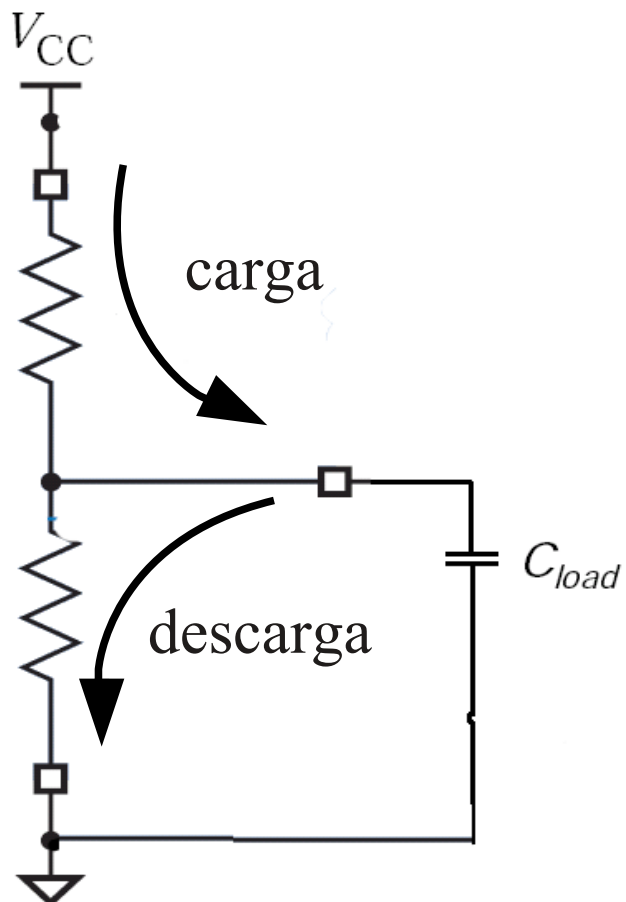


- Corriente absorbida $\Rightarrow$ resistencia pull-down $\rightarrow$ aumenta V_o
- Corriente entregada $\Rightarrow$ resistencia pull-up $\rightarrow$ aumenta V_o
- **Corrientes demasiado grandes $\Rightarrow V_o$ no válida**

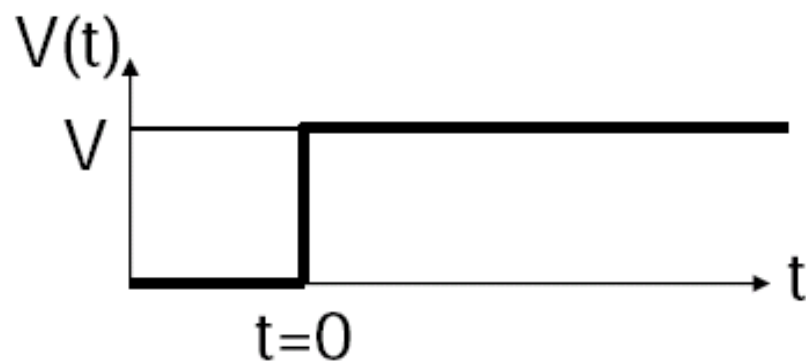
Tiempos de transición



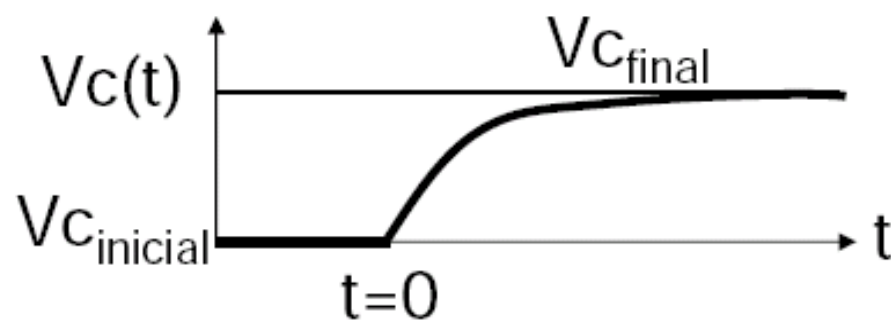
- Conmutación de la puerta $\Rightarrow$ carga y descarga de capacidades de salida
- Carga capacitiva = suma de las cargas
- Tiempo de transición = tiempo de carga RC



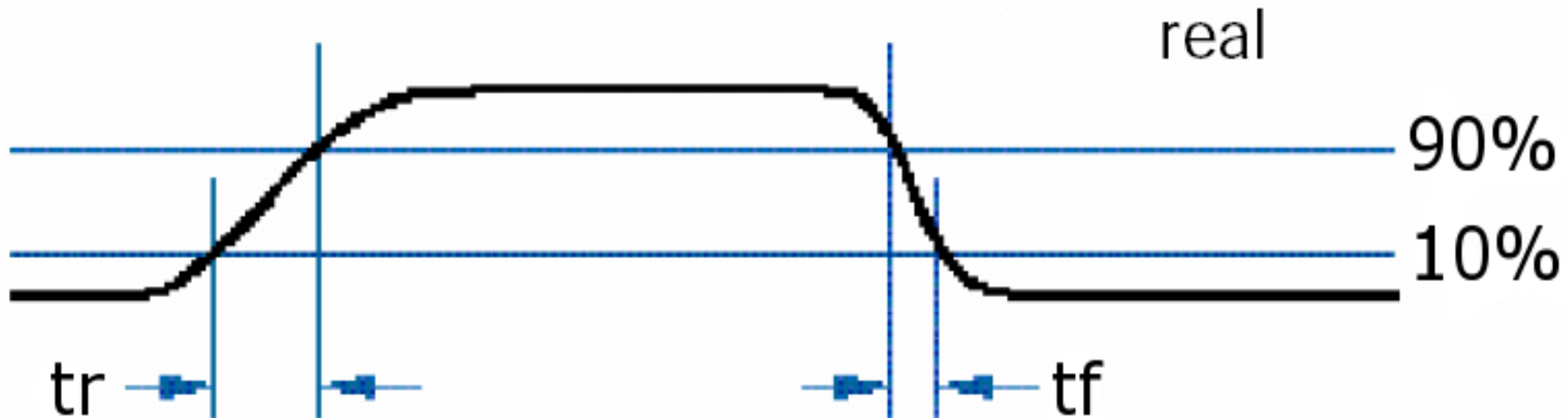
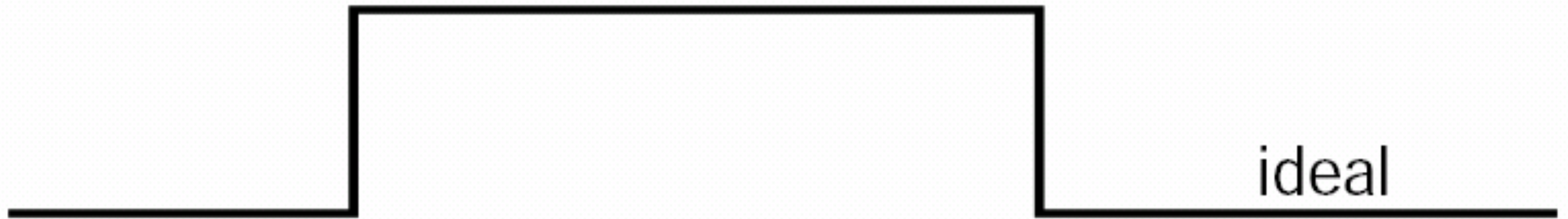
teórico



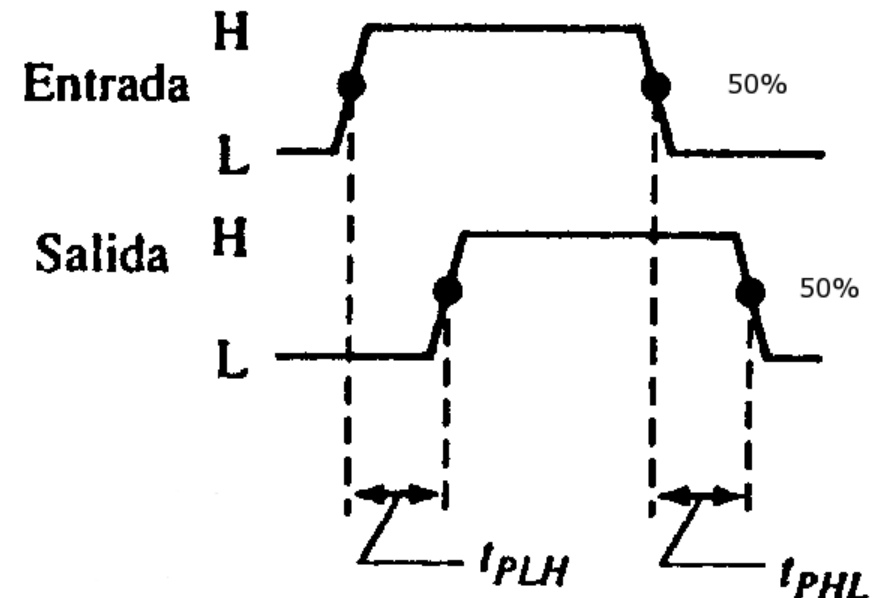
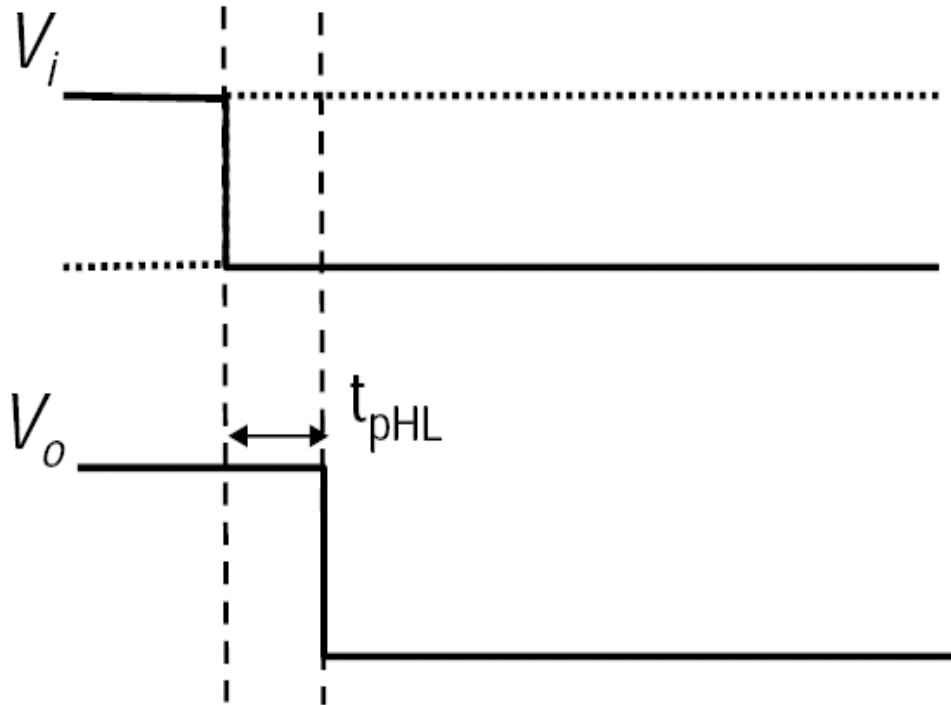
real



Tiempos de subida y bajada



Retardos de propagación

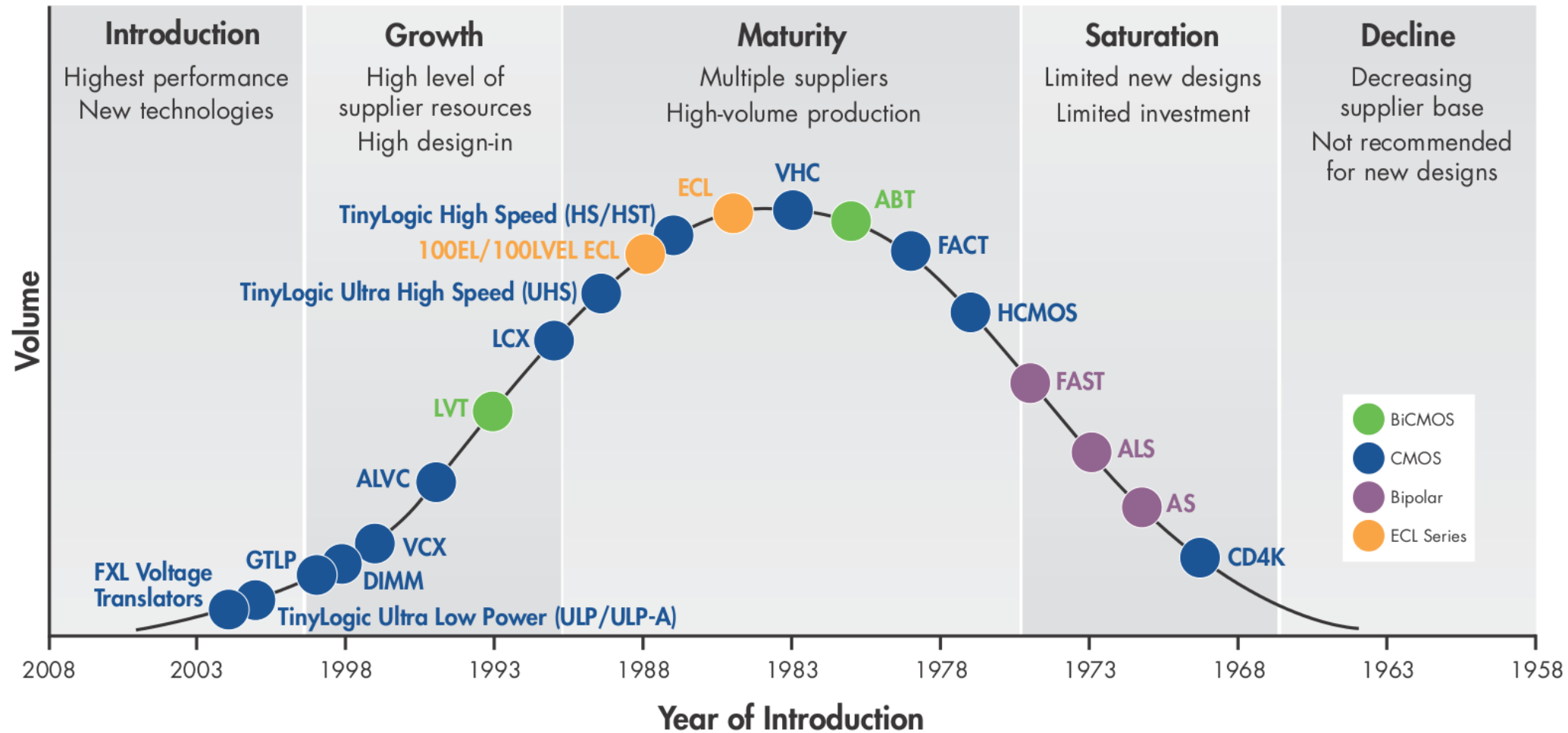


- Retardo de propagación = tiempo que tarda en “reaccionar” la puerta
- Se mide desde 50% entrada hasta 50% de la salida

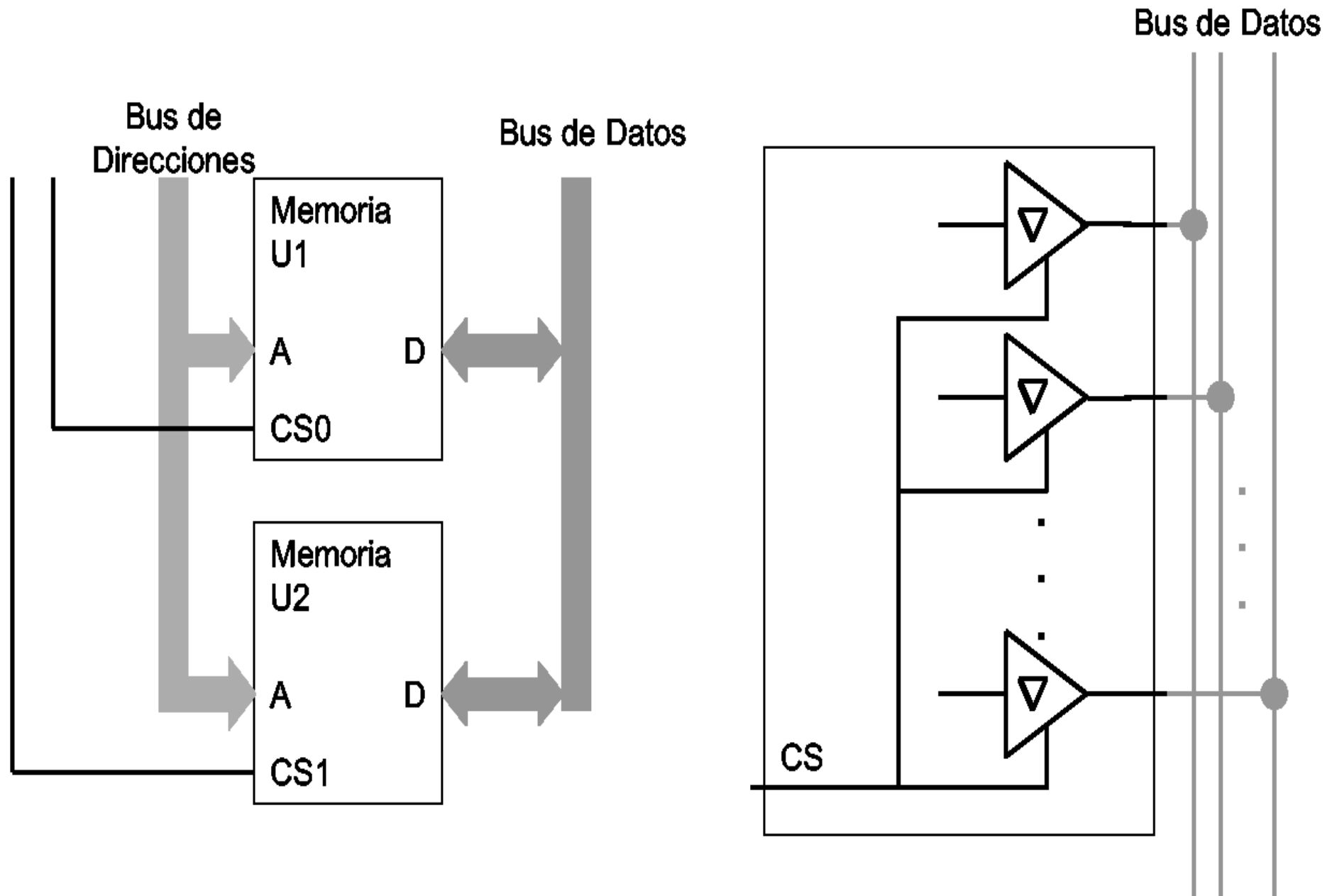
Comparativa Familias lógicas

Characteristic	Standard TTL	LS-TTL	ALS-TTL	HCMOS
V_{cc}	5 V	5 V	5 V	5 V
V_{IH}	2.0 V	2.0 V	2.0 V	3.15 V
V_{IL}	0.8 V	0.8 V	0.8 V	1.1 V
V_{OH}	2.4 V	2.7 V	2.7 V	3.7 V
V_{OL}	0.4 V	0.5 V	0.4 V	0.4 V
I_{IH}	40 μ A	20 μ A	20 μ A	1 μ A
I_{IL}	-1.6 mA	-0.36 mA	-0.2 mA	-1 μ A
I_{OH}	-400 μ A	-400 μ A	-400 μ A	4 mA
I_{OL}	16 mA	8 mA	4 mA	4 mA
Propagation delay	10 ns	9.5 ns	4 ns	9 ns
Static power disipation ($f=0$)	10 mW	2 mW	1 mW	0.0025 nW
Dynamic power disipation at $f=100$ kHz	10 mW	2 mW	1 mW	0.17 mW

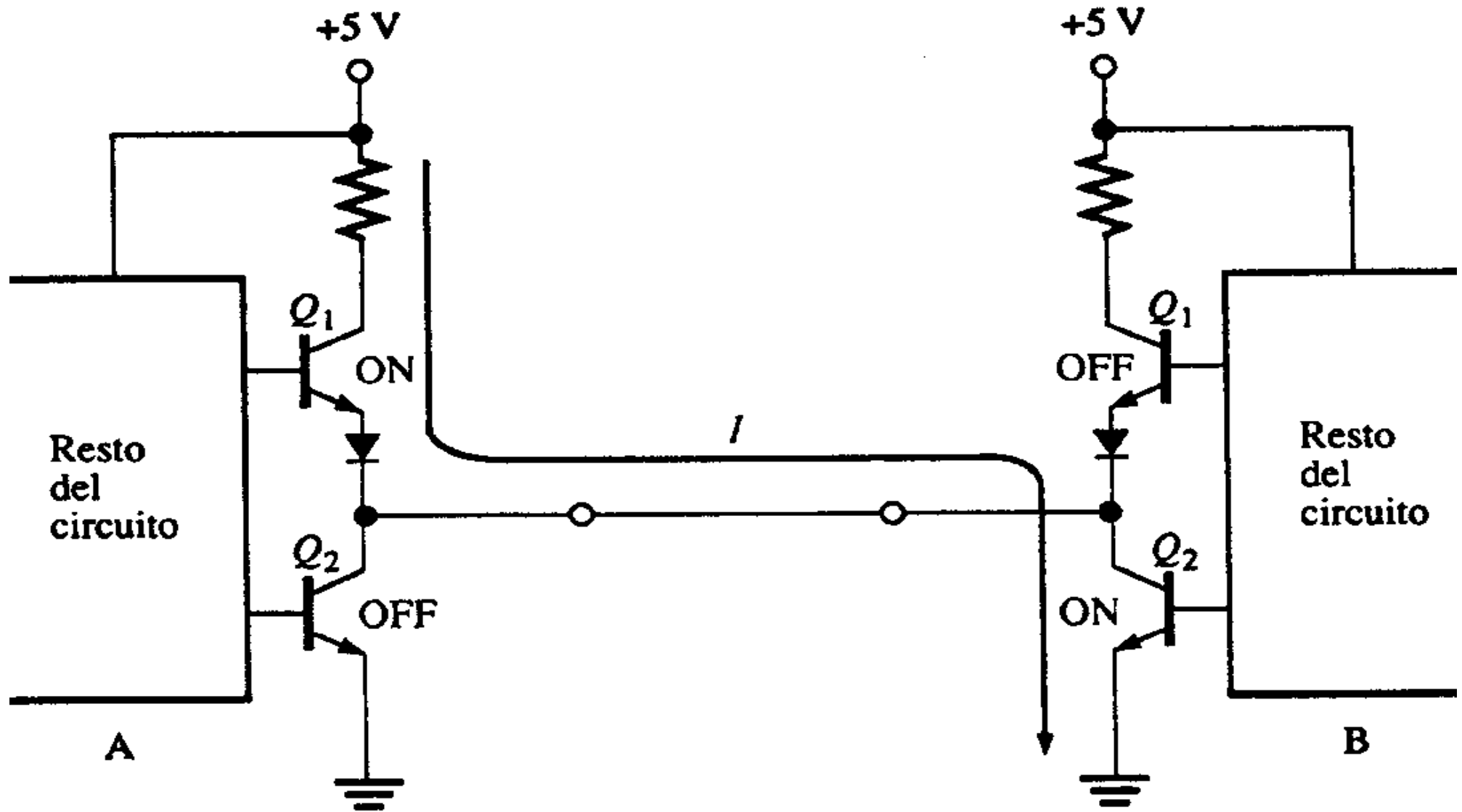
Evolución de las familias lógicas



Realización de buses



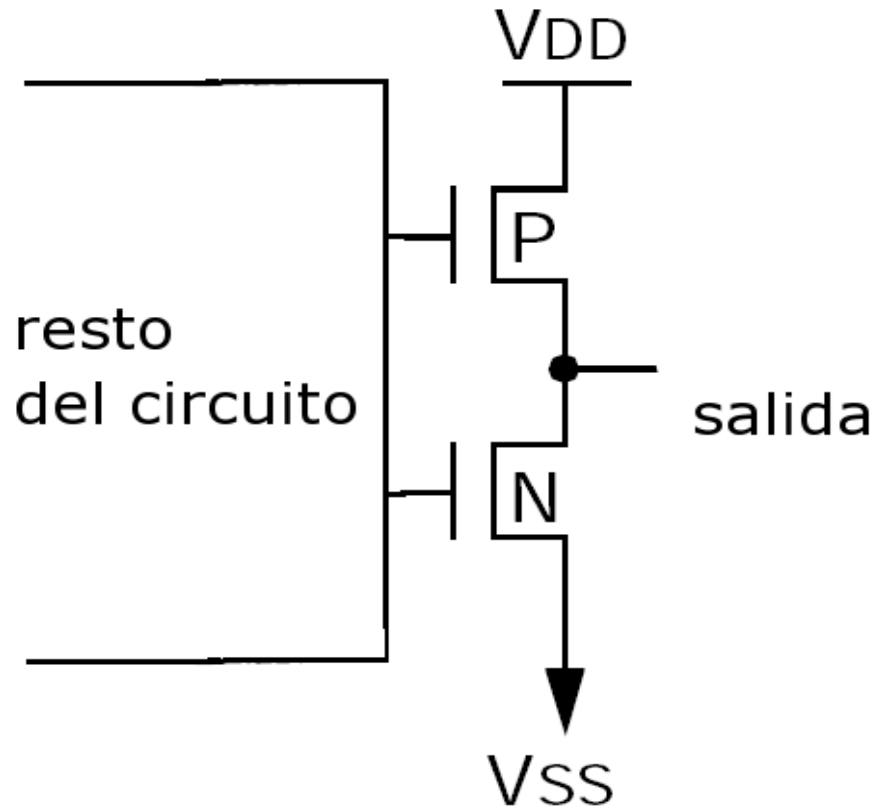
conexión de salidas totem-pole



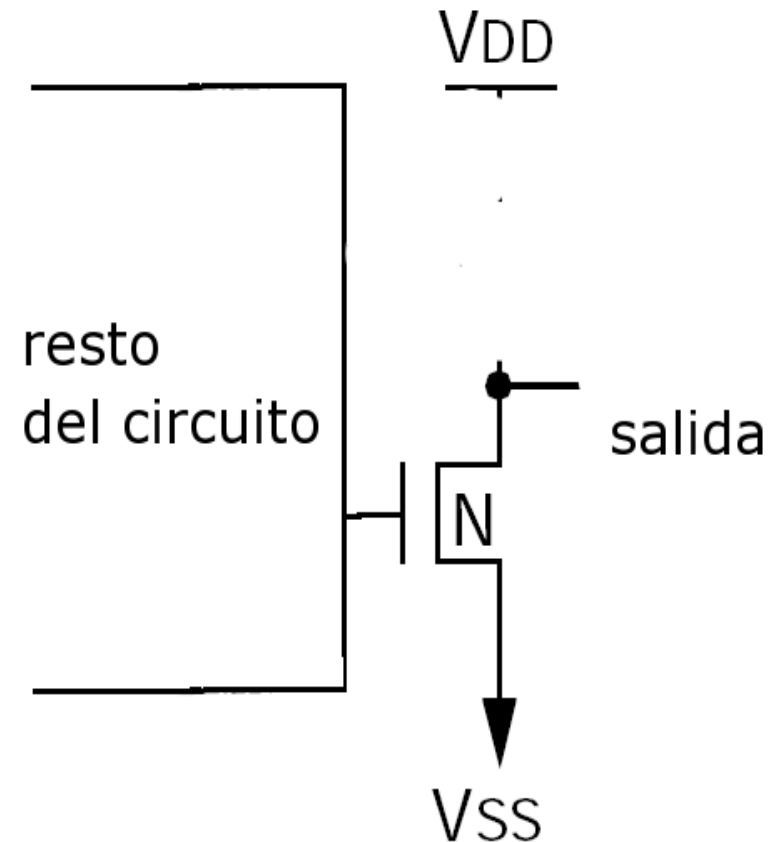
!!!!NO SE PUEDEN CONECTAR DE ESTA FORMA!!!!

Salidas en colector abierto

salida Totem-pole

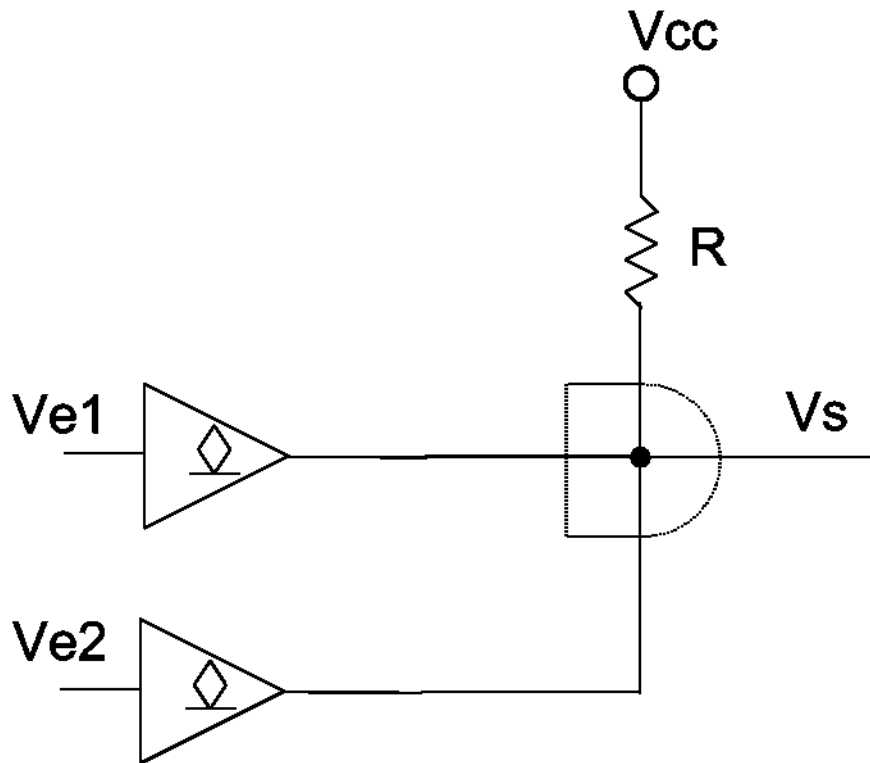


salida colector abierto



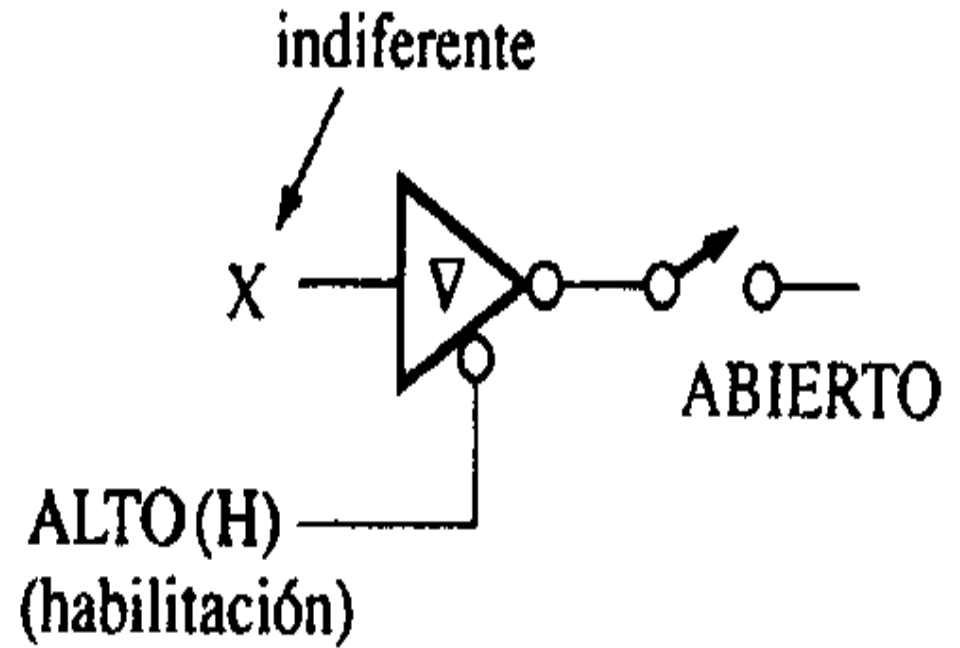
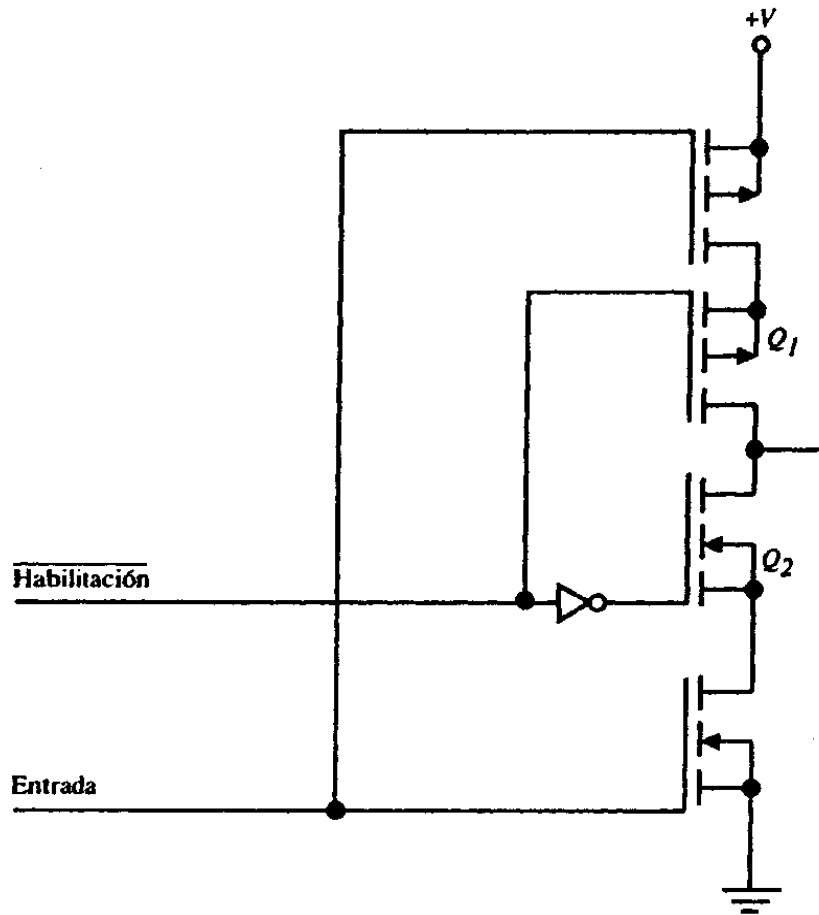
necesidad de resistencia de pull-up externa

Características de la salida en c.abierto



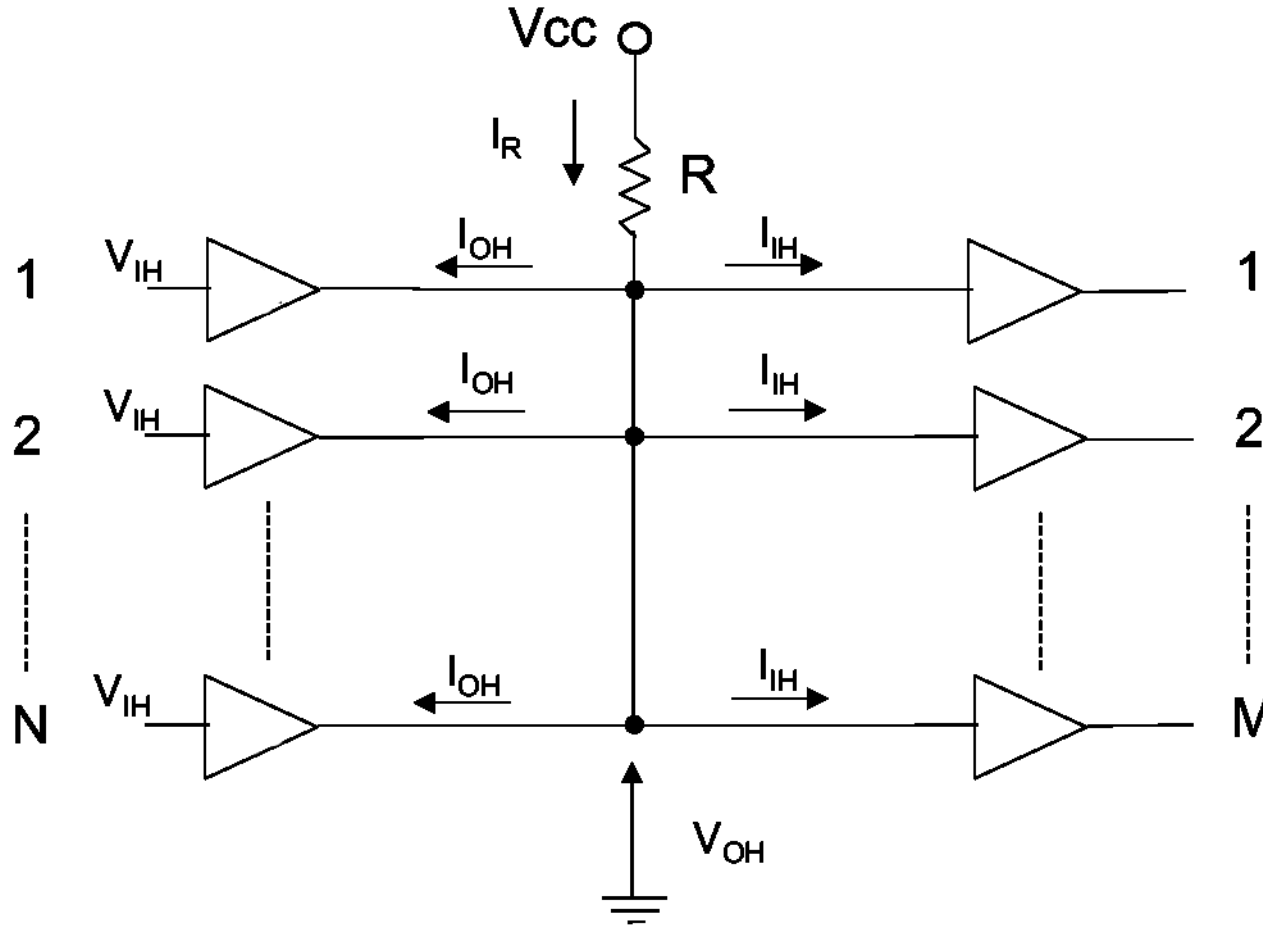
- Función AND cableada
- Valor de R limitado por los niveles lógicos y corrientes de puerta
- Mayor valor de R aumenta t_r (mayor tiempo de carga)

Puertas de tres estados



- Dos estados 0 / 1
- Tercer estado = Alta Z $\Rightarrow$ “desconectados del circuito”

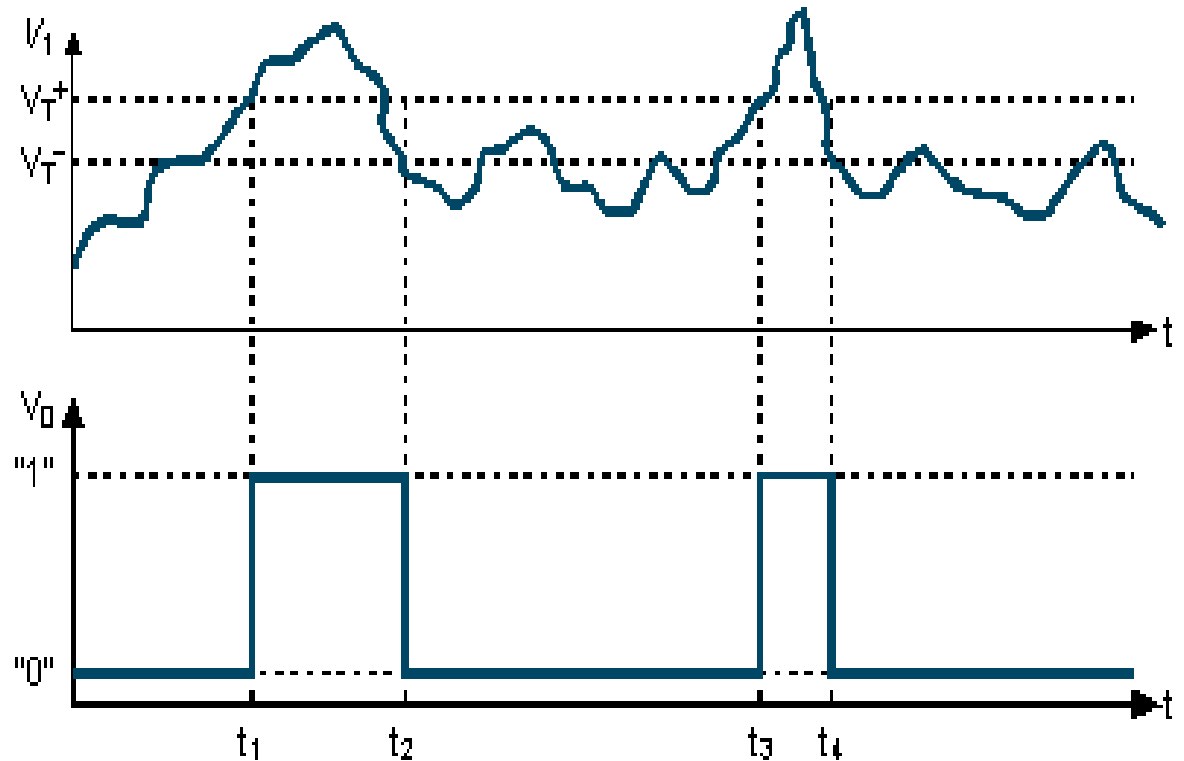
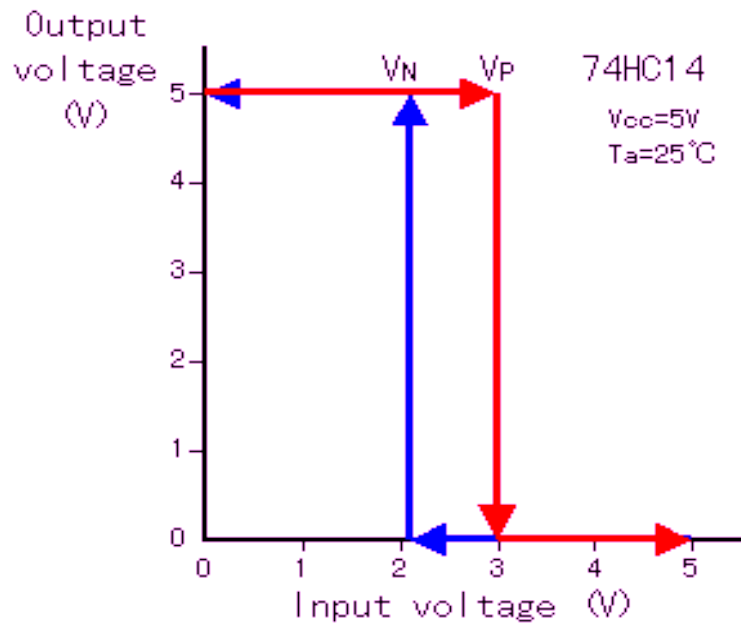
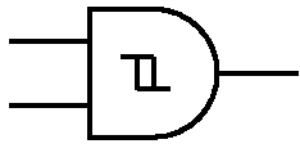
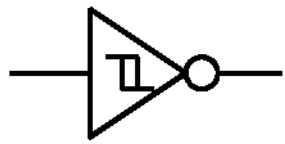
Conexión TTL-CMOS



- $V_{OHmin}(TTL) = 2,4V < V_{IHmin}(CMOS) = 3,5V \Rightarrow$ no válido
- Necesidad de resistencia externa $R_p \rightarrow$ “paralela” a la resistencia de pull-up $\Rightarrow$ reduce pull-up $\Rightarrow$ aumenta V_{OH}

$$V_{OH} = V_{CC} - R(I_{OH} + n \cdot I_{IH}) > V_{IHmin}(cmos) \Rightarrow R < \frac{V_{CC} - V_{IHmin}(CMOS)}{I_{OHmax}(CMOS) + n \cdot I_{IHmax}(TTL)}$$

Disparador trigger-schmitt



- Circuito con histéresis
- Uso -> regeneración de señales / eliminar ruido

Buffers y transceivers

- Buffers
 - Mayor capacidad de salida (I_{OH} y/o I_{OL})
 - Uso para atacar cargas (leds, motores, etc.) o aumentar el fan-out
- Transceivers -> buffers bidireccionales

