



**Table 1: Chip densities** for various scales of integration

Scales of Integration (chip density)	Siewiorek et al (1982)	Burger et al (1982)
Small Scale Integration (SSI)	< 10 gates	< 64 components
Medium Scale Integration (MSI)	< 100 gates	< 2K components
Large Scale Integration (LSI)	< 10,000 gates	< 64K components
Very Large Scale Integration (VLSI)	< 100,000 gates	< 2M components
Ultra Large Scale Integration (ULSI)	> 100,000 gates	> 2M components

**Table 2: The state of the silicon technology**

Characteristic	Silicon
Densest chip transistor circuit	CMOS
Transistors/chip (density)	1,500,000,000
Gate delay	50 - 500 ps
Process	32 nanometer

**Table 3: Summary of characteristics** for three commonly used IC families

Parameter	TTL	CMOS	ECL
Speed	Medium	Low	High
Power consumption	Medium	Low	High
Chip density	Medium	High	Low
Cost	Low	Medium	High

### Transistor-Transistor Logic (TTL) features

- ➔ TTL families : 7400 series : 74 (Standard), 74H (High speed), 74L (Low-power), 74S (Schottky), 74LS (Low-power Schottky), 74AS (Advanced Schottky), 74ALS (Advanced Low-power Schottky), 74F (Fast)
- ➔ Unused gate inputs : can be left unconnected (floating), but should be tied to a used input to be safe. Also, can connect to 1 or 0 depending on the input characteristic, via a pull-up resistor or pull-down resistor, respectively
- ➔ Gate output circuits :
  - ◆ Totem-pole (do **not** short circuit gate outputs)
  - ◆ Tri-state (gate outputs can be short circuited if only one gate is enabled)
  - ◆ Open-collector (an external pull-up resistor needed. Gate outputs can be short circuited)

### Complementary Metal Oxide Semiconductor (CMOS) features

- ➔ CMOS families : 4000 series ; 7400 series : 74HC (High-speed CMOS), 74HCT (High-speed CMOS, TTL compatible), 74AC (Advanced CMOS), 74ACT (Advanced CMOS, TTL compatible), 74FCT (Fast CMOS, TTL compatible), 74FCT-T(Fast CMOS, TTL compatible with TTL  $V_{OH}$ )
- ➔ Unused gate inputs : do **not** leave them unconnected (floating). Tie them to a used input. Also, can connect to 1 or 0 depending on the input characteristic, via a pull-up resistor or pull-down resistor, respectively
- ➔ Gate output circuits :
  - ◆ Regular (do **not** short circuit gate outputs)
  - ◆ Tri-state (gate outputs can be short circuited, if only one gate is enabled)
  - ◆ Open-drain (an external pull-up resistor needed. Gate outputs can be short circuited)
- ➔ Electrostatic discharge can **damage** CMOS chips. Unless properly grounded, one should **not** touch CMOS chips