

Altera FPLD Overview

- MAX 5000 (obsolete), **7000 (in Salcic book)**, 9000 (newer), 3000 (newest)
 - AND-OR cells, EEPROM programming
 - 32 to 560 macrocells, approximately equal to 600 to 12,000 usable gates
- FLEX **8000 (obsolete, in Salcic book)**, 10K, 6000 (new)
 - FLEX = “Flexible Logic Element Matrix”
 - Look-up-table cells plus embedded array blocks (memory), SRAM programming
 - 10,000 to 250,000 gates
- APEX 20K (new)
 - MultiCore cells (LUT, product term, embedded memory), SRAM programming
 - 100,000 to 1,000,000 gates

Altera MAX 7000 Macrocell

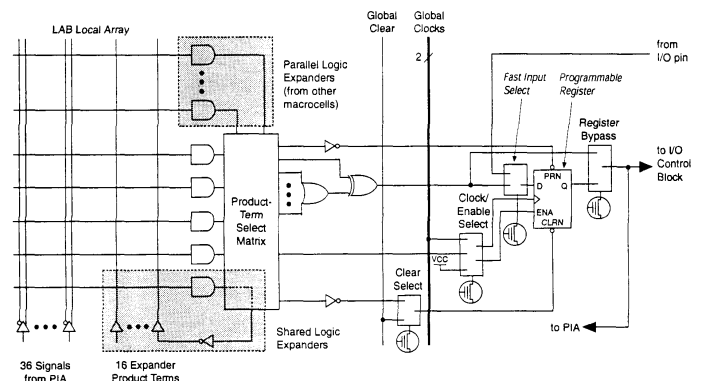


Figure from Altera technical literature

- A MAX 7000 chip contains 2 to 16 Logic Array Blocks (LABs)
 - Each LAB contains 16 macrocells, so a MAX 7000 contains 32 to 256 macrocells
- Macrocell has two parts
 - Logic array and product term selection matrix (combinational)
 - Programmable register (D, T, JK, SR ff)

Altera MAX 7000 Macrocell (cont.)

- Logic array (inside macrocell):
 - 36 inputs from programmable interconnect array (PIA)
 - Each in true and complemented form
 - 5 product terms (*pterms*) (AND gates)
 - *Product term matrix* selects pterms to send to rest of macrocell
 - The *sharable expander* pterm can also be inverted and fed back around to act as an input to any macrocell in that LAB
 - “Broadcast” a value within the LAB
 - Some or all of the pterms in a macrocell can also be “borrowed” by an adjacent macrocell in that LAB
 - These are called *parallel expanders*
 - The output of that macrocell’s OR gate is connected to the input of borrower’s OR
 - One macrocell can have as many as 3 sets (≤ 5 pterms) of parallel expanders, for a total of up to 20 pterms into its OR

Altera MAX 7000 Macrocell (cont.)

- Product term matrix selects pterms to send to either:
 - OR gate — gives SOP form
 - XOR gate — if “1”, inverts the output of the OR gate
 - Register control inputs (clear, preset, clock, clock enable)
- Register:
 - Can emulate a D, T, JK, or SR flip-flop
 - Can be bypassed to use the macrocell as purely combinational logic
 - Three clocking modes:
 - Global clock signal
 - Global clock with pterm matrix providing clock enable signal
 - Pterm matrix providing clock signal
 - Preset and clear from pterm matrix

Logic Expanders, etc.

■ Consider the function

$$F = A'CD + B'CD + AB + BC'$$

- Can't be implemented using a 3-input OR gate — but what if that's all we have?

● Rewrite as follows:

$$F = (A'+B')CD + (A+C)'B$$

$$F = (AB)'(CD) + (A'C)'B$$

- Get some of the pterms (e.g., $(AB)'$ and $(A'C)'$) from a sharable expander

■ Consider the function

$$F = AB' + AC' + AD' + A'CD$$

- Again, can't use a 3-input OR gate...

● Generate complement instead:

$$F' = ABCD + A'D' + A'C'$$

- Switch 1's and 0's on Karnaugh map
- Use XOR to invert F' to get F

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Altera MAX 7000 Routing

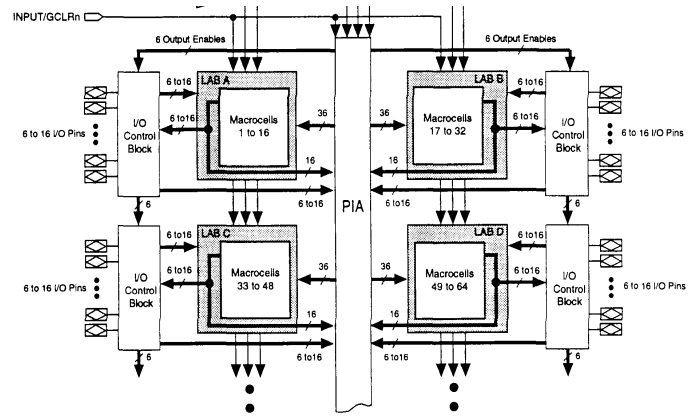


Figure from Altera technical literature

■ Logic Array Block (LAB):

- Contains 16 macrocells (macrocell array), including parallel expanders
- Connects to
 - Programmable Interconnect Array (PIA) (the 36 inputs described earlier)
 - I/O control block (off-chip connections)

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Altera MAX 7000 Routing (cont.)

■ I/O Control Block

- I/O pins connect to
 - I/O control blocks
 - Programmable Interconnect Array (PIA)
- I/O control block contains the circuitry necessary to program an I/O pin as either:
 - Dedicated output
 - Dedicated input (some devices)
 - Bidirectional pin (some devices)

■ Programmable Interconnect Array (PIA)

- Connects any source signal to any destination the PIA connects to
- Sources: dedicated inputs, bidirectional I/O pins, and macrocell outputs
- Layout is fixed, so delay is predictable

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MAX Devices

■ MAX 7000

- 5.0 volt MAX 7000
 - 600–10,000 gates, 200 MHz, 44-256 pins
- 3.3 volt MAX 7000A, 2.5 volt MAX 7000B
- Many packaging options & speed grades

■ MAX 9000 (newer)

- 6,000–12,000 gates, 145 MHz, 84-356 pins
- Only “bigger” devices, 5v only, fewer speed grades

■ MAX 3000A (newest)

- 600–5,000 gates, 192 MHz, 44-208 pins
- Only “smaller devices”, 3.3 v, several speed grades
- Lowest price per macrocell

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