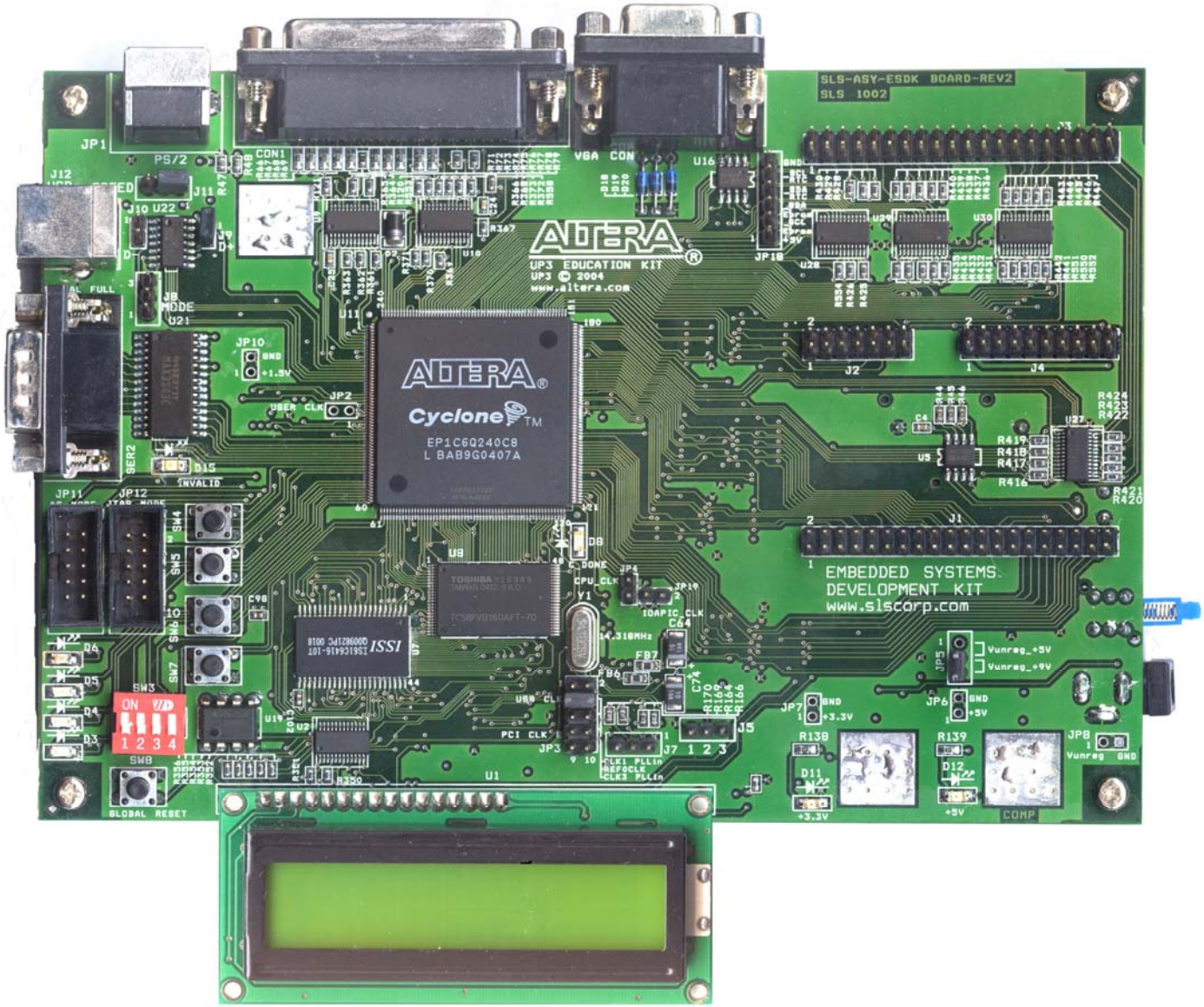


**Figure 2.1** The Altera UP 3 board.

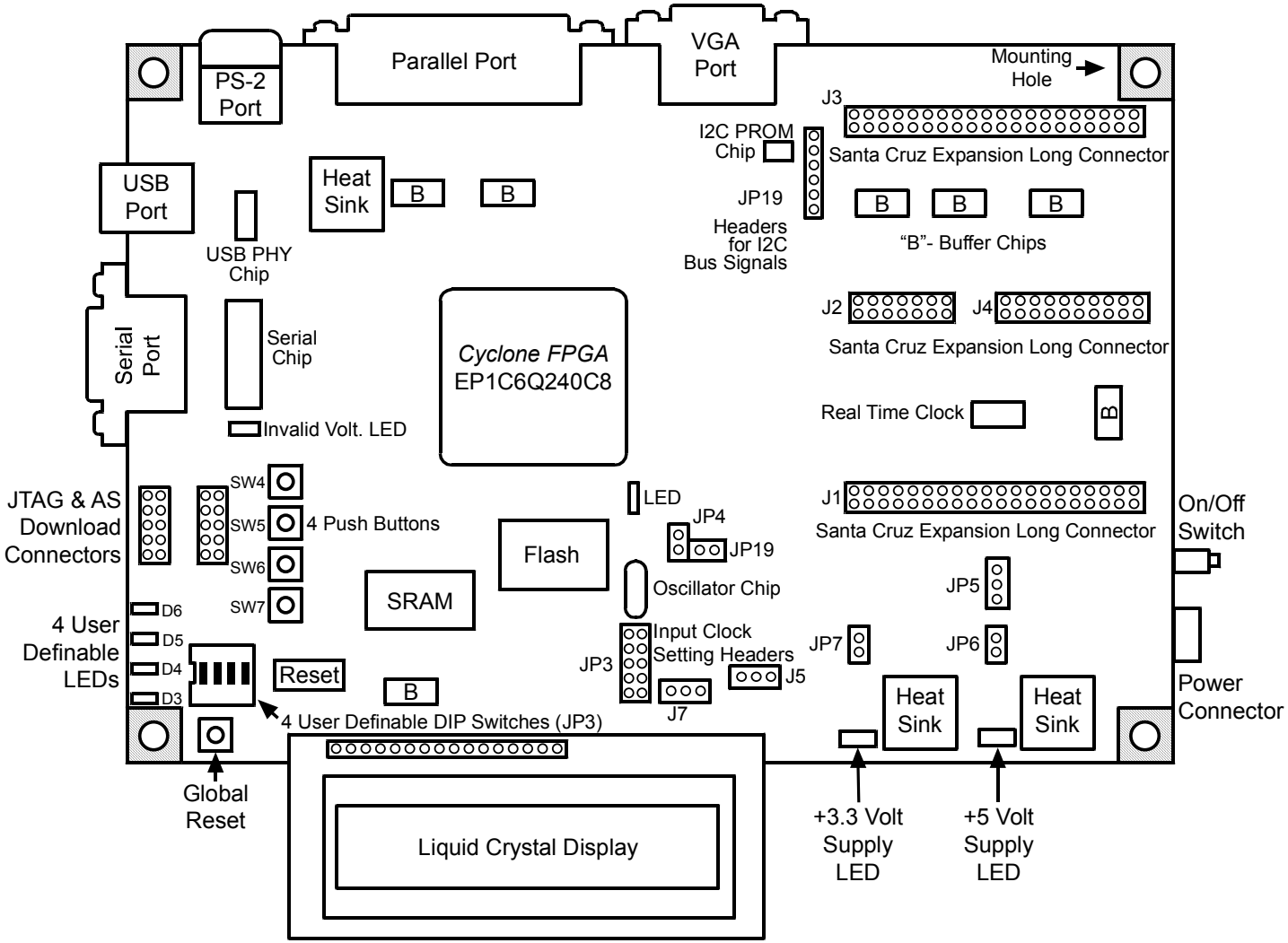


**Figure 2.2** The Altera UP 3 board's features.

Table 2.1 UP 3 Board's Cyclone FPGA Features

| **Cyclone FPGA Feature** | **EP1C6Q240** | **EP1C12Q240** |
|---|---|---|
| Logic Elements (LEs) | 5,980 | 12,060 |
| 4K bit RAM blocks (M4Ks) | 20 | 52 |
| Total Internal RAM bits | 92,160 | 239,616 |
| Phase Locked Loops (PLLs) | 2 | 2 |
| User I/O pins | 185 | 173 |

Table 2.2 UP 3 Board's Memory Features

| Memory Device | Size | Part Number |
|---|---|---|
| SRAM | 64K by 16 bits | ISSI IS61C6416 |
| SDRAM | 1M by 16 bits | ISSI IS42S16400B |
| Flash Memory | 1M by 16 bits | Toshiba TC58FVB106AFT-70 |
| $I^2C$ EEPROM | 16K by 1bit | ISSI IS24C16 |
| Serial Flash Memory | 1M by 1bit | Altera EPCS1 |

Table 2.3 Overview of the UP 3 Board's I/O Features

| I/O Device | Description | Hardware Interface Needed |
|---|---|---|
| USB 1.1 | Full Speed and Low Speed | Processor & USB SIE engine core |
| Serial Port | RS 232 Full Modem | UART to send and receive data |
| Parallel Port | IEEE 1284 | State machine or Proc. for handshake |
| PS/2 Port | PC Keyboard or Mouse | Serial Data - PS/2 state machine |
| VGA Port for Video Display on Monitor | RGB three 1-bit signals provide 8 colors | State machine for sync signals & user logic to generate RGB color signals |
| IDE Port | Connector | Processor & IDE Device Driver |
| Reset Switch | Use for Global Reset | Must use a reset in design |
| Pushbutton Switches | 4 Non-debounced (0=HIT) | Most applications will need a switch debounce Circuit |
| Expansion Card | Santa Cruz Long 72 I/O | Depends on expansion card used |
| LEDs | 4 User Definable (1=ON) | None |
| LCD Display | 16 Character by 2 line ASCII Characters | State machine or Processor to send ASCII characters and LCD commands |
| Real Time Clock | $I^2C$ clock chip | Serial Data - $I^2C$ state machine |
| DIP Switch | 4 Switches (1=ON) | None or Synchronizer Circuit |

Table 2.4 UP 3 Board's most commonly used FPGA I/O pin names and assignments

| Pin Name | Pin# | Pin I/O Type | Function of Pin |
|---|---|---|---|
| PS2_CLK | 12 | Bidirectional | PS2 Connector |
| PS2_DATA | 13 | Bidirectional | PS2 Connector |
| RESET | 23 | Input | Power on or SW8 pushbutton reset ( Reset = 0 ) |
| USB_CLK | 29 | Input | USB 48MHz Clock - jumper |
| USER_CLOCK | 38 | Input | External Clock from J2 Pin 2 |
| PBSWITCH_4 | 48 | Input | Pushbutton SW4 (non-debounced, 0 = button hit) |
| PBSWITCH_5 | 49 | Input | Pushbutton SW5 (non-debounced, 0 = button hit) |
| LCD_E | 50 | Output | LCD Enable line |
| LED_D6 | 53 | Output | LED D3 (0 = LED ON, 1= LED OFF) |
| LED_D5 | 54 | Output | LED D4 (0 = LED ON, 1= LED OFF) |
| LED_D4 | 55 | Output | LED D5 (0 = LED ON, 1= LED OFF) |
| LED_D3 | 56 | Output | LED D6 (0 = LED ON, 1= LED OFF) |
| PBSWITCH_6 | 57 | Input | Pushbutton SW6 (non-debounced, 0 = hit) |
| DIPSWITCH_1 | 58 | Input | DIP Switch SW3 #1 ( ON = 1, OFF = 0) |
| DIPSWITCH_2 | 59 | Input | DIP Switch SW3 #2 ( ON = 1, OFF = 0) |
| DIPSWITCH_3 | 60 | Input | DIP Switch SW3 #3 ( ON = 1, OFF = 0)" |
| DIPSWITCH_4 | 61 | Input | DIP Switch SW3 #4 ( ON = 1, OFF = 0) |

Table 2.4 (continued) UP 3 Board's most commonly used FPGA I/O pin names and assignments

| Pin Name | Pin# | Pin I/O Type | Function of Pin |
|---|---|---|---|
| PBSWITCH_7 | 62 | Input | Pushbutton SW7 (non-debounced, 0 = hit) |
| LCD_RW | 73 | Output | LCD R/W control line |
| MEM_DQ[0] | 94 | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[1] | 96(133) | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[2] | 98 | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[3] | 100 | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[4] | 102(128) | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[5] | 104 | Bidirectional | Memory/LCD Data Bus |
| MEM_DQ[6] | 106 | Bidirectional | Memory/LCD Data Bus |
| LCD_RS | 108 | Output | LCD Register Select Line |
| MEM_DQ[7] | 113 | Bidirectional | Memory/LCD Data Bus |
| VGA_GREEN | 122 | Output | VGA Connector Green Video Signal |
| CPU_CLOCK | 153 | Input | CPU Clock 100 or 66MHz - jumper |
| VGA_BLUE | 170 | Output | VGA Connector Blue Video Signal |
| VGA_VSYNC | 226 | Output | VGA Connector Vert Sync Signal |
| VGA_HSYNC | 227 | Output | VGA Connector Horiz Sync Signal |
| VGA_RED | 228 | Output | VGA Connector Red Video Signal |