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Understanding Embedded - FPGAs (Field Programmable Gate Array)

Embedded - FPGAs, or Field Programmable Gate Arrays, are advanced integrated circuits that offer unparalleled flexibility and performance for digital systems. Unlike traditional fixed-function logic devices, FPGAs can be programmed and reprogrammed to execute a wide array of logical operations, enabling customized functionality tailored to specific applications. This reprogrammability allows developers to iterate designs quickly and implement complex functions without the need for custom hardware.

Applications of Embedded - FPGAs

The versatility of Embedded - FPGAs makes them indispensable in numerous fields. In telecommunications.

Details

| | |
|--------------------------------|---|
| Product Status | Active |
| Number of LABs/CLBs | 1539 |
| Number of Logic Elements/Cells | 24624 |
| Total RAM Bits | 608256 |
| Number of I/O | 150 |
| Number of Gates | - |
| Voltage - Supply | 1.2V |
| Mounting Type | Surface Mount |
| Operating Temperature | 0°C ~ 85°C (TJ) |
| Package / Case | 256-LFBGA |
| Supplier Device Package | 256-UBGA (14x14) |
| Purchase URL | https://www.e-xfl.com/product-detail/intel/10cl025yu256c6g |



Intel® Cyclone® 10 LP Device Overview

C10LP51001
2017.05.08



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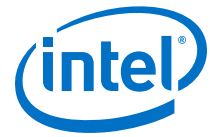


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Cyclone® 10 LP Device Overview

The Intel® Cyclone® 10 LP FPGAs are optimized for low cost and low static power, making them ideal for high-volume and cost-sensitive applications.

Cyclone 10 LP devices provide a high density sea of programmable gates, on-board resources, and general purpose I/Os. These resources satisfies the requirements of I/O expansion and chip-to-chip interfacing. The Cyclone 10 LP architecture suits smart and connected end applications across many market segments:

- Industrial and automotive
- Broadcast, wireline, and wireless
- Compute and storage
- Government, military, and aerospace
- Medical, consumer, and smart energy

The free but powerful Quartus® Prime Lite Edition software suite of design tools meets the requirements of several classes of users:

- Existing FPGA designers
- Embedded designers using the FPGA with Nios® II processor
- Students and hobbyists who are new to FPGA

Advanced users who require access to the full IP Base Suite can subscribe to the Quartus Prime Standard Edition or purchase the license separately.

Related Links

- [Software Development Tools, Nios II Processor](#)
Provides more information about the Nios II 32-bit soft IP processor and Embedded Design Suite (EDS).
- [Quartus Prime IP Base Suite](#)
- [Quartus Prime Editions](#)



Summary of Cyclone 10 LP Features

Table 1. Summary of Features for Cyclone 10 LP Devices

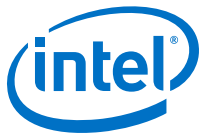
| Feature | Description |
|------------------------------|---|
| Technology | <ul style="list-style-type: none">• Low-cost, low-power FPGA fabric• 1.0 V and 1.2 V core voltage options• Available in commercial, industrial, and automotive temperature grades |
| Packaging | <ul style="list-style-type: none">• Several package types and footprints:<ul style="list-style-type: none">— FineLine BGA (FBGA)— Enhanced Thin Quad Flat Pack (EQFP)— Ultra FineLine BGA (UBGA)— Micro FineLine BGA (MBGA)• Multiple device densities with pin migration capability• RoHS6 compliance |
| Core architecture | <ul style="list-style-type: none">• Logic elements (LEs)—four-input look-up table (LUT) and register• Abundant routing/metal interconnect between all LEs |
| Internal memory blocks | <ul style="list-style-type: none">• M9K—9-kilobits (Kb) of embedded SRAM memory blocks, cascadable• Configurable as RAM (single-port, simple dual port, or true dual port), FIFO buffers, or ROM |
| Embedded multiplier blocks | <ul style="list-style-type: none">• One 18 × 18 or two 9 × 9 multiplier modes, cascadable• Complete suite of DSP IPs for algorithmic acceleration |
| Clock networks | <ul style="list-style-type: none">• Global clocks that drive throughout entire device, feeding all device quadrants• Up to 15 dedicated clock pins that can drive up to 20 global clocks |
| Phase-locked loops (PLLs) | <ul style="list-style-type: none">• Up to four general purpose PLLs• Provides robust clock management and synthesis |
| General-purpose I/Os (GPIOs) | <ul style="list-style-type: none">• Multiple I/O standards support• Programmable I/O features• True LVDS and emulated LVDS transmitters and receivers• On-chip termination (OCT) |
| SEU mitigation | SEU detection during configuration and operation |
| Configuration | <ul style="list-style-type: none">• Active serial (AS), passive serial (PS), fast passive parallel (FPP)• JTAG configuration scheme• Configuration data decompression• Remote system upgrade |



Cyclone 10 LP Available Options

Figure 1. Sample Ordering Code and Available Options for Cyclone 10 LP Devices—Preliminary





Cyclone 10 LP Maximum Resources

Table 2. Maximum Resource Counts for Cyclone 10 LP Devices

| Resource | | Device | | | | | | | |
|---------------------|---------------|---------|---------|---------|---------|---------|---------|---------|---------|
| | | 10CL006 | 10CL010 | 10CL016 | 10CL025 | 10CL040 | 10CL055 | 10CL080 | 10CL120 |
| Logic Elements (LE) | | 6,272 | 10,320 | 15,408 | 24,624 | 39,600 | 55,856 | 81,264 | 119,088 |
| M9K Memory | Block | 30 | 46 | 56 | 66 | 126 | 260 | 305 | 432 |
| | Capacity (Kb) | 270 | 414 | 504 | 594 | 1,134 | 2,340 | 2,745 | 3,888 |
| 18 × 18 Multiplier | | 15 | 23 | 56 | 66 | 126 | 156 | 244 | 288 |
| PLL | | 2 | 2 | 4 | 4 | 4 | 4 | 4 | 4 |
| Clock | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Maximum I/O | | 176 | 176 | 340 | 150 | 325 | 321 | 423 | 525 |
| Maximum LVDS | | 65 | 65 | 137 | 52 | 124 | 132 | 178 | 230 |

Cyclone 10 LP Package Plan

Table 3. Package Plan for Cyclone 10 LP Devices

| Device | Package | | | | | | | | | | | | |
|---------|------------|----------------------|------|----------------------|------|----------------------|------|----------------------|------|----------------------|------|----------------------|------|
| | Type | M164 164-pin MBGA | | U256 256-pin UBGA | | U484 484-pin UBGA | | E144 144-pin EQFP | | F484 484-pin FBGA | | F780 780-pin FBGA | |
| | Size | 8 mm × 8 mm | | 14 mm × 14 mm | | 19 mm × 19 mm | | 22 mm × 22 mm | | 23 mm × 23 mm | | 29 mm × 29 mm | |
| | Ball Pitch | 0.5 mm | | 0.8 mm | | 0.8 mm | | 0.5 mm | | 1.0 mm | | 1.0 mm | |
| | I/O Type | GPIO | LVDS | GPIO | LVDS | GPIO | LVDS | GPIO | LVDS | GPIO | LVDS | GPIO | LVDS |
| 10CL006 | — | — | 176 | 65 | — | — | 88 | 22 | — | — | — | — | |
| 10CL010 | 101 | 26 | 176 | 65 | — | — | 88 | 22 | — | — | — | — | |
| 10CL016 | 87 | 22 | 162 | 53 | 340 | 137 | 78 | 19 | 340 | 137 | — | — | |
| 10CL025 | — | — | 150 | 52 | — | — | 76 | 18 | — | — | — | — | |
| 10CL040 | — | — | — | — | 325 | 124 | — | — | 325 | 124 | — | — | |
| 10CL055 | — | — | — | — | 321 | 132 | — | — | 321 | 132 | — | — | |
| 10CL080 | — | — | — | — | 289 | 110 | — | — | 289 | 110 | 423 | 178 | |
| 10CL120 | — | — | — | — | — | — | — | — | 277 | 103 | 525 | 230 | |



Cyclone 10 LP I/O Vertical Migration

Figure 2. Migration Capability Across Cyclone 10 LP Devices

- The arrows indicate the migration paths. The devices included in each vertical migration path are shaded. Devices with lesser I/O resources in the same path have lighter shades.
- To achieve full I/O migration across devices in the same migration path, restrict I/O usage to match the device with the lowest I/O count.

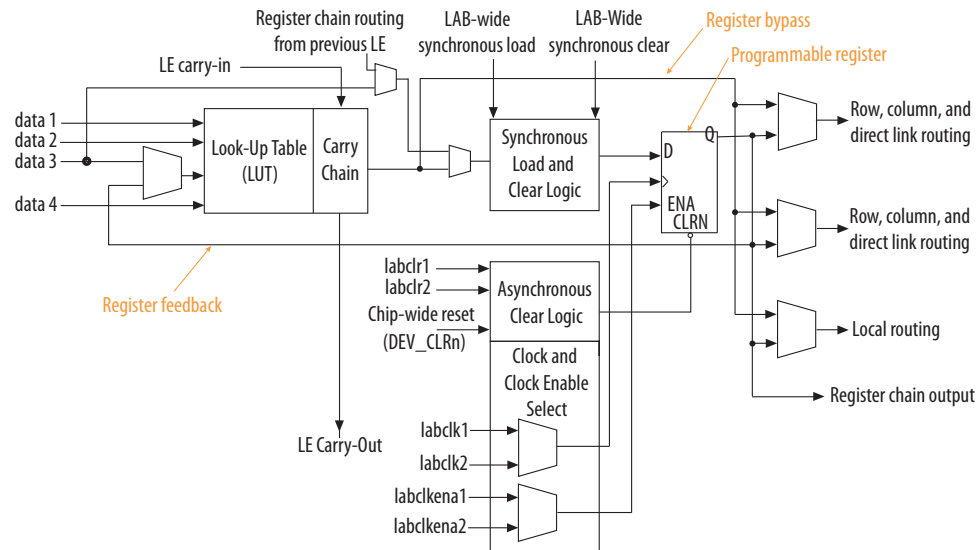
| Device | Package | | | | | |
|---------|---------|------|------|------|------|------|
| | M164 | U256 | U484 | E144 | F484 | F780 |
| 10CL006 | | ↑ | | ↑ | | |
| 10CL010 | ↑ | | | | | |
| 10CL016 | ↓ | | ↑ | | ↑ | |
| 10CL025 | | ↓ | | ↓ | | |
| 10CL040 | | | | | | |
| 10CL055 | | | | | | |
| 10CL080 | | | ↓ | | | ↑ |
| 10CL120 | | | | | ↓ | ↓ |

Note: To verify the pin migration compatibility, use the Pin Migration View window in the Quartus Prime software Pin Planner.

Logic Elements and Logic Array Blocks

The LAB consists of 16 logic elements (LE) and a LAB-wide control block. An LE is the smallest unit of logic in the Cyclone 10 LP device architecture. Each LE has four inputs, a four-input look-up table (LUT), a register, and output logic. The four-input LUT is a function generator that can implement any function with four variables.

Figure 3. Cyclone 10 LP Device Family LEs



Embedded Multipliers

Each embedded multiplier block in Cyclone 10 LP devices supports one individual 18×18 -bit multiplier or two individual 9×9 -bit multipliers. You can cascade the multiplier blocks to form wider or deeper logic structures.

You can control the operation of the embedded multiplier blocks using the following options:

- Parameterize the relevant IP cores with the Quartus Prime parameter editor
- Infer the multipliers directly with VHDL or Verilog HDL

Intel and partners offer popular DSP IPs for Cyclone 10 LP devices, including:

- Finite impulse response (FIR)
- Fast Fourier transform (FFT)
- Numerically controlled oscillator (NCO) functions

For a streamlined DSP design flow, the DSP Builder tool integrates the Quartus Prime software with MathWorks Simulink and MATLAB design environments.

Embedded Memory Blocks

The embedded memory structure consists of M9K memory blocks columns. Each M9K memory block of a Cyclone 10 LP device provides 9 Kb of on-chip memory. You can cascade the memory blocks to form wider or deeper logic structures.

You can configure the M9K memory blocks as RAM, FIFO buffers, or ROM.

**Table 4. M9K Operation Modes and Port Widths**

| Operation Modes | Port Widths |
|------------------|--|
| Single port | ×1, ×2, ×4, ×8, ×9, ×16, ×18, ×32, and ×36 |
| Simple dual port | ×1, ×2, ×4, ×8, ×9, ×16, ×18, ×32, and ×36 |
| True dual port | ×1, ×2, ×4, ×8, ×9, ×16, and ×18 |

Clocking and PLL

Cyclone 10 LP devices feature global clock (GCLK) networks, dedicated clock pins, and general purpose PLLs.

- Up to 20 GCLK networks that drive throughout the device
- Up to 15 dedicated clock pins
- Up to four general purpose PLLs with five outputs per PLL

The PLLs provide robust clock management and synthesis for the Cyclone 10 LP device. You can dynamically reconfigure the PLLs in user mode to change the clock phase or frequency.

FPGA General Purpose I/O

Cyclone 10 LP devices offer highly configurable GPIOs with these features:

- Support for over 20 popular single-ended and differential I/O standards.
- Programmable bus hold, pull-up resistors, delay, and drive strength.
- Programmable slew-rate control to optimize signal integrity.
- Calibrated on-chip series termination (R_S OCT) or driver impedance matching (R_S) for single-ended I/O standards.
- True and emulated LVDS buffers with LVDS SERDES implemented using logic elements in the device core.
- Hot socketing support.

Configuration

Cyclone 10 LP devices use SRAM cells to store configuration data. Configuration data is downloaded to the Cyclone 10 LP device each time the device powers up.

You can use EPCS or EPCQ (AS x1) flash configuration devices to store configuration data and configure the Cyclone 10 LP FPGAs.

- Cyclone 10 LP devices support 1.5 V, 1.8 V, 2.5 V, 3.0 V, and 3.3 V programming voltages and several configuration schemes.
- The single-event upset (SEU) mitigation feature detects cyclic redundancy check (CRC) errors automatically during configuration and optionally during user mode¹.

¹ User mode error detection is not supported on 1.0 V core voltage Cyclone 10 LP device variants.

**Table 5. Configuration Schemes and Features Supported by Cyclone 10 LP Devices**

| Configuration Scheme | Configuration Method | Decompression | Remote System Upgrade |
|-----------------------------|---------------------------------|---------------|-----------------------|
| Active serial (AS) | Serial configuration device | Yes | Yes |
| Passive serial (PS) | External host with flash memory | Yes | Yes |
| | Download cable | Yes | — |
| Fast passive parallel (FPP) | External host with flash memory | — | Yes |
| JTAG | External host with flash memory | — | — |
| | Download cable | — | — |

Related Links[Configuration Devices](#)

Provides more information about the EPCS and EPCQ configuration devices.

Power Management

Cyclone 10 LP devices are built on optimized low-power process:

- Available in two core voltage options: 1.2 V and 1.0 V
- Hot socketing compliant without needing external components or special design requirements

To accelerate your design schedule, combine Intel Cyclone 10 LP FPGAs with Enpirion® Power Solutions. Intel's ultra-compact and efficient Enpirion PowerSoCs are ideal for meeting Cyclone 10 LP power requirements. Enpirion PowerSoCs integrate most of the required components to provide you fully-validated and straightforward solutions with up to 96% efficiency. These advantages reduce your power supply design time and allow you to focus on your IP and FPGA designs.

Related Links[Enpirion Power Solutions](#)

Provides more information about Enpirion PowerSoC devices.

Document Revision History for Cyclone 10 LP Device Overview

| Date | Version | Changes |
|----------|------------|------------------|
| May 2017 | 2017.05.08 | Initial release. |