# Introduction to GAL® and PAL® Devices

## Overview

Lattice, the inventor of the Generic Array Logic™ (GAL®) and Programmable Array Logic™ (PAL®) families of low density, E²CMOS® PLDs is the leading supplier of low density CMOS PLDs in the world. Features such as industry leading performance, full reprogrammability, low power consumption, 100% testability and 100% programming yields make the GAL/PAL families the preferred choice among system designers. The GAL/PAL families contain a comprehensive array of product architectures with a variety of performance levels specified across commercial, industrial and military (MIL-STD-883) operating ranges to meet the demands of any system logic design.

### A Product for Any System Design Need

Lattice GAL and PAL products have the performance, architectural features, low power, and high quality to meet the needs of the most demanding system designs.

### Low Voltage Products

This rapidly growing family of 3.3V products support all speed, power and system logic level requirements. Included are the world's fastest PLDs (16LV8D, 20LV8D, 22LV10D and 26CLV12D) which are ideal for high performance, 3.3V logic applications. The 3.3V "zero power" (22LV10Z/ZD, LV22V10Z, 16/20LV8ZD) and the "low power" (16LV8C, 22LV10C) product lines offer the flexibility of working in either 3.3V or mixed 3.3V and 5V systems. In-system programmability is also available with the ispGAL22LV10.

### Standard Products

Aimed at providing a superior design alternative to the bipolar PLD, the 16V8, 20V8, 22V10, 20RA10 and 20XV10 replace over 98% of all bipolar PAL devices. These GAL and PALCE devices meet, and in most cases, beat bipolar PAL performance specifications while consuming significantly lower power and offering higher quality and reliability via Lattice electrically reprogrammable E²CMOS technology.

### Extension Products

These products provide enhanced functionality including innovative architectures (GAL18V10, GAL26CV12, PALCE24V10, PALCE26V12, PALCE29M16, PALCE610, PALCE29MA16, GAL6001/6002), 64mA high output drive (GAL16VP8 and GAL20VP8), "zero power" operation (GAL16V8Z/ZD and GAL20V8Z/ZD), and in-system programmability (ispGAL22V10).

### GAL16LV8, PALLV16V8 and GAL20LV8

**Fastest 3.3V PLDs in the World**

- Performance ranging from 3.5ns Tpd and 250MHz Fmax to 15ns Tpd and 62.5MHz Fmax
- Ideal for supporting high performance microprocessors
- Supports 5 Volt Interface
- 45 mA typical power consumption
- Available in 20-pin and 28-pin PLCC packages

### GAL16LV8ZD, PALLV16V8z and GAL20LV8ZD

**3.3 Volt and Zero Stand-by Power**

- 50µA Icc typical stand-by power (100µA MAX)
- 15ns Tpd performance
- Dedicated power-down pin
- Available in 20-pin and 28-pin PLCC packages

### GAL22LV10 and PALLV22V10

**Fastest 3.3V 22V10 in the World**

- Performance from 4 ns Tpd and 250 MHz to 15 ns Tpd and 83 MHz Fmax
- Ideal for high performance systems
- Supports 5 Volt Interface
- Available in 28-pin PLCC package

### GAL22LV10Z/ZD and PALLV22V10Z

**3.3 Volt and Zero Stand-by Power**

- 50µA Icc typical stand-by power (100µA MAX)
- 15ns Tpd performance
- Two power-down modes
  - Input transition detection (Z)
  - Dedicated power-down pin (ZD)
- Available in 28-pin PLCC package

## ispGAL22LV10
**ISP version of 3.3 Volt GAL22LV10**

- Fast 4ns/250MHz performance
- Same 28-pin PLCC footprint as GAL22LV10
- Available in space-saving 28-pin SSOP

## GAL26CLV12
**World's Fastest 3.3 Volt 28-pin PLD**

- Performance ranging from 5ns Tpd and 200MHz Fmax to 7.5ns Tpd and 142MHz Fmax
- World's fastest 28-pin PLD at 4ns
- Supports 5 Volt Interface
- Fully utilized 28-pin PLCC package gives added functionality over the 22V10 at no space premium!

## GAL16V8, PALCE16V8, GAL20V8 and PALCE20V8
**Industry Standard Architecture**

- Performance ranges from the industry's fastest at 3.5ns Tpd (16V8D-3) to popular 25ns versions
- Low power consumption with low power versions rated at 75mA typical and quarter power versions at 45mA typical
- Eight powerful Output Logic Macrocells (OLMCs) with eight product terms each
- Standard 20-pin (DIP and PLCC) and 24/28-pin (DIP/PLCC) packages

## GAL16V8Z/ZD, PALCE16V8Z and GAL20V8Z/ZD
**Zero Stand-by Power**

- 15 - 50µA Icc typical stand-by power (100µA MAX)
- 12ns Tpd performance
- Two power-down modes
  - Input transition detection (Z)
  - Dedicated power-down pin (ZD)
- Available in 20-pin DIP/PLCC/SOIC and 24/28-pin DIP/PLCC packages

## GAL16VP8 and GAL20VP8
**Ideal for Bus Interface or Memory Control Logic**

- High output drive versions of the GAL16V8 and GAL20V8
- IOL = 64mA vs standard 24mA
- Combines GAL architecture with high drive of 74XX244 buffer families
- Fast 15ns/80MHz performance
- Available in 20-pin DIP/PLCC and 24/28-pin DIP/PLCC packages

## GAL18V10
**10 Outputs in a 20-pin Package**

- 7.5ns Tpd performance
- 20-pin space-saving subset of the popular GAL22V10
- 8-10 Product Terms per OLMC
- Ideal for space constrained designs
- Only 10 output, 20-pin PLD in the market

## GAL20RA10 and PALCE20RA10
**High Performance Asynchronous Logic**

- 10 OLMCs
- 10 independently programmable clocks
- Each macrocell has an independent product term clock
- Fast 7.5ns Tpd performance
- Faster and lower power than bipolar PAL
- Available in 24/28-pin DIP/PLCC packages

## GAL20XV10
**Perfect for Fast Counters, Decoders or Comparators**

- Utilizes powerful XOR function for efficient implementation of arithmetic functions
- Replaces: PAL20L10, 20X10, 20X8 and 20X4, 12L10
- 10ns/100MHz performance significantly outperforms bipolar PALs
- Perfect for video, multimedia and graphics applications
- Available in 24/28-pin DIP/PLCC packages

## GAL22V10, PALCE22V10 and PALCE22V10Z

**Industry Standard Architecture**

- Available in industry leading 4ns/250MHz versions through 25ns versions
- Low power consumption with Low Power versions at 90mA and Quarter Power versions at 45mA typical and zeor power version at 30μA.
- 10 OLMCs with variable Product Terms per OLMC ranging from 8 to 16 for increased logic capability
- Standard 24-pin DIP and 28-pin PLCC packages

## ispGAL22V10

**Offers the Benefits of ISP in a 22V10**

- Popular 22V10 architecture
- In-system programmable
- Fast 7.5ns/111MHz performance
- Same 28-pin PLCC footprint as GAL22V10
- Also available in space-saving 28-pin SSOP

## PALCE24V10

**Universal Programmable Array Logic Device**

- 10 independently configurable macrocells
- 15ns/83MHz performance
- 28-pin PDIP and PLCC packages

## GAL26CV12 and PALCE26V12

**Expanded Logic Density in a 28-pin DIP/PLCC Package**

- 28-pin superset of the popular GAL22V10
- 7.5ns Tpd performance
- 26 inputs, 12 outputs
- Flexible 22V10 OLMC
- Fully utilized 28-pin PLCC package gives added functionality over the 22V10 at no space premium!

## PALCE29M16 and PALCE 29MA16

**High Performance Semicustom Logic Replacement**

- Up to 29 array inputs and 16 outputs
- Flexible I/O macrocells
- Varied product terms per output
- 25ns/50MHz Tperformance
- 24-pin PDIP and 28-pin PLCC packages

## PALCE610

**General Purpose Programmable Logic Device**

- 16 independently configurable macrocells
- Macrocells can be combinatorial or registered with a choice of 4 types of flip flops
- 15ns/83MHz Tperformance
- 24-pin PDIP and 28-pin PLCC packages

## GAL6001 and GAL6002

**The Logic Density of an FPLA Architecture**

- Unprecedented logic density in a 24/28-pin DIP/PLCC
- Functional equivalent of two GAL22V10s
- 38 macrocells
  - 10 input macrocells
  - 10 output macrocells
  - 10 I/O macrocells
  - 8 buried logic macrocells
- 15ns/75MHz performance
- Ideal for register-intensive applications

## Commercial/Industrial/Military Grades Available

The Lattice GAL/PAL families are available in a wide range of commercial, industrial and military grade versions. In the military arena, Lattice offers a family of Standard Military Drawing (SMD) GAL devices which have been processed to MIL-STD-883.

**Table 1. Lattice GAL and PAL Product Offering**

| | | Speed Options by Grade (Tpd in ns) | | |
|---|---|---|---|---|
| | | **Commercial** | **Industrial** | **883/Military** |
| **3.3V Products** | **GAL16LV8, PALLV16V8** | 3.5, 5, 7.5, 10, 15 | | |
| | **GAL16LV8ZD, PALLV16V8Z** | 15, 25 | 20 | |
| | **GAL20LV8** | 3.5, 5, 7.5 | | |
| | **GAL20LV8ZD Zero Power** | 15, 25 | | |
| | **GAL22LV10, PALLV22V10** | 4, 5, 7.5, 10, 15 | | |
| | **GAL22LV10Z/ZD, PALLV22V10Z Zero Power** | 15, 25 | 15, 25 | |
| | **ispGAL22LV10** | 4, 5, 7.5, 10, 15 | 7, 10, 15 | |
| | **GAL26CLV12** | 5, 7.5 | | |
| **5V Products** | **GAL16V8Z/ZD, PALCE16V8Z** | 12, 15, 25 | 12, 15, 25 | |
| | **GAL16V8, PALCE16V8H** | 3.5, 5, 7.5, 10, 15, 25 | 7.5, 10, 15, 25 | 7.5, 10, 15, 20, 30 |
| | **GAL16V8, PALCE16V8Q** | 10, 15, 25 | 20, 25 | |
| | **GAL16VP8** | 15, 25 | | |
| | **GAL18V10** | 7.5, 10, 15, 20 | | |
| | **GAL20RA10, PALCE20RA10H** | 7.5, 10, 15, 20, 30 | 7.5, 10, 15, 20 | |
| | **GAL20V8Z/ZD** | 12, 15 | | |
| | **GAL20V8, PALCE20V8H** | 5, 7.5, 10, 15, 25 | 10, 15, 25 | 10, 15, 20 |
| | **GAL20V8, PALCE20V8Q** | 15, 25 | 20, 25 | |
| | **GAL20VP8** | 15, 25 | | |
| | **GAL20XV10** | 10, 15, 20 | | |
| | **GAL22V10, PALCE22V10H** | 4, 5, 7.5, 10, 15, 25 | 7.5, 10, 15, 20, 25 | 10, 15, 20, 25, 30 |
| | **GAL22V10, PALCE22V10Q** | 10, 15, 25 | | |
| | **PALCE22V10Z** | 25 | 15, 25 | |
| | **ispGAL22V10** | 7.5, 10, 15 | 15 | |
| | **PALCE24V10** | 15, 25 | | |
| | **GAL26CV12** | 7.5, 10, 15, 20 | 10, 15, 20 | |
| | **PALCE26V12H** | 7.5, 10, 15, 20 | 10, 15, 20 | |
| | **PALCE29M16H** | 25 | | |
| | **PALCE29MA16H** | 25 | | |
| | **PALCE610H** | 15, 25 | | |
| | **GAL6001** | 30 | | |
| | **GAL6002** | 15, 20 | | |
| | **Vcc (3.3V Products)** | 3.3V ±10% | | |
| | **Vcc (5V Products)** | 5V ±5% | 5V ±10% | 5V ±10% |
| | **Operating Temperature** | 0 to 75°C | -40 to 85°C | -55 to 125°C |
| | **Packaging** | Plastic DIP, PLCC, SOIC* and SSOP** | Plastic DIP and PLCC | CERDIP and LCC |

* SOIC available with GAL16V8Z only.
** SSOP available with ispGAL22V10 and ispGAL22LV10 only.