

## Introduction

The generic/universal architectures of Lattice Semiconductor Corporation (LSC) GAL devices are able to emulate a wide variety of PAL, EPLD and PEEL devices. GAL devices are direct functional and parametric replacements for most PLD device architectures. To use GAL devices in place of other PLD types, some conversion of the original device pattern may be needed. This conversion is not difficult, and can be accomplished at either the design or manufacturing level. The following sections describe several techniques available to convert PAL, EPLD and PEEL device patterns to LSC GAL device patterns.

## Cross Programming

### GAL16V8 and GAL20V8

The GAL16V8 and GAL20V8 devices replace most standard 20-pin and 24-pin PAL devices. To simplify the conversion process, LSC has worked with programmer hardware manufacturers to provide the ability to program GAL devices directly from existing PAL JEDEC files, or master PAL devices. LSC qualified programmers can automatically configure the architecture of a GAL device to emulate the source PAL device.

To provide a conceptual framework for the conversion from PAL devices to GAL devices, a mythical device known as a RAL device was created. A RAL device is simply a GAL device configured to emulate a PAL. There is a one-to-one correspondence between the name of a PAL device and that of a RAL device. For example, a RAL16L8 is simply a GAL16V8 configured as a PAL16L8. Some programmers list the RAL device types as choices for cross-programming, while others specifically state that a cross-programming operation is to be performed using a PAL device type as the architecture type. Other programmers list devices such as a LSC 16L8. Even though LSC does not make a 16L8 device, choosing this selection allows the programmer to accept a 16L8 JEDEC file, and will program a GAL16V8 device to emulate a PAL16L8.

To program a GAL16V8 or GAL20V8 device from an existing PAL JEDEC file, simply select the appropriate device code (either RAL type, or PAL type to cross-program from), then download the PAL JEDEC file to the programmer. Insert the appropriate GAL device that can directly emulate the PAL device (according to the chart in

the GAL16V8 or GAL20V8 data sheets). The programmer will automatically configure the GAL device to emulate the PAL device during programming. The resulting GAL device is 100% compatible with the original PAL device.

A GAL device may also be programmed from a master PAL device by reading the pattern of the master PAL into the programmer memory, then selecting the appropriate RAL device or PAL type to cross-program from. The GAL device can then be programmed from the programmer memory.

### GAL22V10/GAL20RA10

The GAL22V10 and GAL20RA10 are direct replacements for bipolar PAL devices, and are JEDEC fuse map compatible with these industry standard devices. To program a GAL22V10 or GAL20RA10 device from an existing PAL JEDEC file, simply select the appropriate GAL device code, then download the PAL JEDEC file to the programmer. The resulting GAL device is 100% compatible with the original PAL.

GAL devices also may be programmed from Master PAL devices by reading the pattern of the Master PAL into the programmer memory, then selecting the appropriate GAL device code. The GAL device can then be programmed from the programmer memory.

The GAL22V10 and GAL20RA10 also can store a User Electronic Signature (see the data sheets on these devices for more information). To use this feature, the JEDEC file must contain this information. To add the signature data to the JEDEC map, use the PALtoGAL conversion utility (see next section) or recompile the source equations for a LSC GAL device instead of a generic 22V10 type. Many programmers list two device types to differentiate between the two types of JEDEC files, and list both a GAL22V10 and a name such as GAL22V10-UES or GAL22V10-ES. Other programmers allow both types of JEDEC files to be accepted, and simply don't program the Signature fuses if they are not present in the file.

### GAL20XV10

The GAL20XV10 can be configured as a direct replacement for bipolar PAL20X10, 20X8, 20X4, and 20L10 devices. Many programmers provide cross-programming support similar to that provided for the GAL16V8/GAL20V8 devices. This allows the use of existing PAL device files to program the GAL20XV10 to emulate the PAL devices. The PALtoGAL conversion software (described below) also

# Copying PAL Patterns Into GAL Devices

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supports conversion of the PAL JEDEC files to a functionally equivalent GAL device file.

## **PALtoGAL Conversion Utility Software**

Lattice Semiconductor has created a software utility that will convert an existing PAL device JEDEC file to the appropriate GAL device JEDEC format. Called PALtoGAL, this software utility can be used to convert PAL device files to GAL device files, add/or change the User Electronic Signature without changing device functionality, and reformat existing GAL JEDEC files for readability.

Since a few programmable logic devices have features that a GAL device cannot exactly emulate, the PALtoGAL utility will clearly describe the incompatibility but will not create an output file. GAL devices programmed using files converted by PALtoGAL will be 100% compatible with the original logic device. PALtoGAL is just another method of cross-programming, and should produce the same results as using a programmer. The advantage is that a full GAL device JEDEC map is created, meaning that the appropriate GAL device may then be selected on

the programmer, which may simplify the manufacturing flow. Also, the PALtoGAL conversion software provides conversions that programmers do not.

A copy of the PALtoGAL conversion utility software can be obtained from Lattice's web site ([www.latticesemi.com](http://www.latticesemi.com)), through your local Lattice representative, or by contacting the GAL Applications Hotline at 1-888-ISP-PLDS (477-7537) or (503) 693-0201.

## **Software Compiler Conversion**

If the equation source file is available for the PAL device, it can be converted by re-compiling using a suitable logic compiler that supports GAL devices. If there are any device incompatibilities (there shouldn't be in most cases), the compiler will describe the errors. The output of the compiler will be a GAL JEDEC file that can be used to program a GAL device directly. The resulting GAL device will be 100% functionally compatible with the original device.

Suitable logic compilers are listed in the Development Tools section. If additional questions arise, contact your compiler manufacturer or a LSC Applications Engineer by calling the GAL Applications Hotline at 1-888-ISP-PLDS or (503) 693-0201.