

# In-System Programming ProASIC™ 500K Devices with Silicon Sculptor

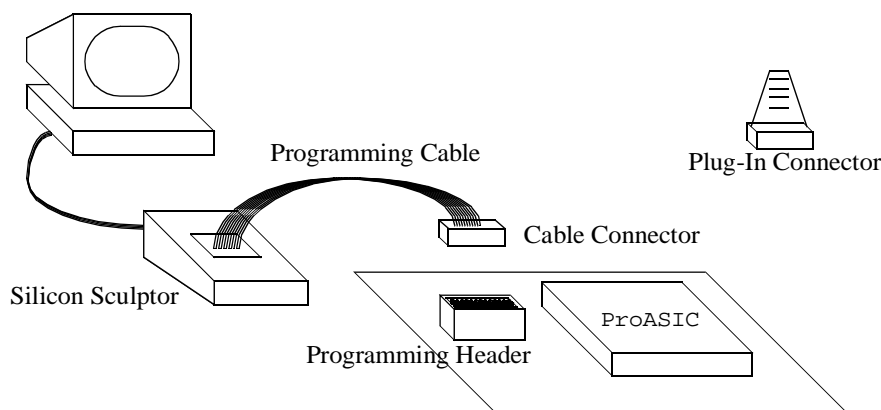
## Introduction

Design engineers today are increasingly required to work in a problem-free development and manufacturing environment to achieve success. To do this, designers often use Programmable Logic Devices (PLDs), with the capability to be programmed in a system (in-system programming - ISP). These types of PLDs are used to shorten turn-around-times and simplify manufacturing. Like PLDs, the ProASIC 500K family of devices have this same capability and can be used to get designs to market faster. This application note describes the procedure for in-system programming of a ProASIC device using Silicon Sculptor.

## ISP Kit

To facilitate ISP of ProASIC 500K devices, Actel offers an ISP kit for use with the Silicon Sculptor programmer (Figure 1). The ISP kit includes a programming cable and a plug-in connector. The programming cable provides all the necessary connections, data, and supply voltages to program a device on the system board. The programming cable signal alignment is shown in Figure 2.

The plug-in connector is used to properly place the power supply pins for normal operation. The plug-in connector prevents the user from unintentionally programming the device while the board is powered up because the device cannot be connected to the power supplies and the programmer at the same time.



**Figure 1 • Programming Setup with Silicon Sculptor**

## Programming Pins

ProASIC 500K devices use the JTAG (IEEE Standard 1149.1 1990) pins TCK, TMS, TDI, and TDO for programming. The TRST pin, an optional JTAG pin, is not used during programming. In addition to the JTAG pins, the RCK pin is used during programming. RCK is a free running clock. It is not required if RCK is guaranteed to be uninterrupted during the programming sequence.

In normal operation mode, the JTAG interface is connected to the built-in normal JTAG circuitry. In this mode the controller is in full JTAG compliance. If the built-in JTAG circuitry is not used, the JTAG pins can be configured as normal user I/Os.

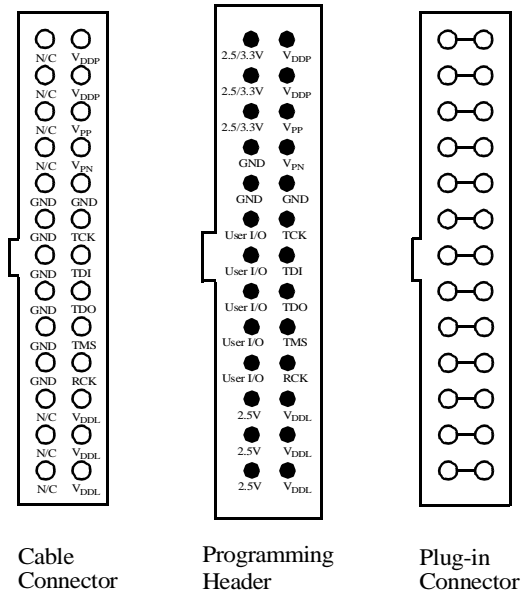
## Power Supply Configurations

### Normal Operation

Two power supplies,  $V_{DDP}$  and  $V_{DDL}$ , are needed in normal operation.  $V_{DDL}$  is used to power the core and  $V_{DDP}$  is used to power the I/O pads.  $V_{DDL}$  must be set to 2.5V and  $V_{DDP}$  can be set to either 2.5V or 3.3V (Table 1).

### Programming

During programming,  $V_{DDP}$  supplies the programming circuit with power. In addition to the low voltage power supplies ( $V_{DDL}$  and  $V_{DDP}$ ), two high voltage sources ( $V_{PP}$  and  $V_{PN}$ ) are necessary. For programming,  $V_{DDP}$ ,  $V_{PP}$ , and  $V_{PN}$  are nominally set to 2.5V, 16.5V, and -12V respectively.  $V_{DDL}$  must be held at ground (Table 2).



**Note:**

1. If the programming header is unplugged, the programming signals and the supply voltages will be separated from the rest of the board.

**Figure 2 • Programming Connectors and Header Top View**

**Table 1 • Normal Operation**

Power Supply	Voltage
V <sub>DDL</sub>	2.5V
V <sub>DDP</sub>	2.5V or 3.3V
V <sub>PP</sub>	V <sub>DDP</sub>
V <sub>PN</sub>	0V

**Table 2 • Programming Mode**

Power Supply	Voltage
V <sub>DDL</sub>	0V
V <sub>DDP</sub>	2.5V
V <sub>PP</sub>	16.5V
V <sub>PN</sub>	-12V

The typical current consumption for each programming pin during programming is as follows:

- I<sub>VPP</sub> < 35 mA @ V<sub>PP</sub> = + 16.5V
- I<sub>VPN</sub> < 15 mA @ V<sub>PN</sub> = - 12V
- I<sub>VDDP</sub> < 20 mA @ V<sub>DDP</sub> = + 2.5V
- I<sub>VDDL</sub> = 0 mA @ V<sub>DDL</sub> = + 0V

**Power Supply Considerations During ISP**

All I/O pins except for JTAG interface pins are tri-stated and the pull-up in the I/O is enabled during programming. This isolates the part and prevents the signals from floating.

Actel recommends powering down the board during programming. The tri-stated I/Os must not be driven by 3.3V signals during programming or the pads will latch-up and a high current will flow through the pad cell, which can damage the device.

**Interrupting the ISP Sequence**

Interruptions in the programming sequence may result in unpredictable behavior of a partially programmed device. Also, switches that are programmed incorrectly can cause high current flow through the circuitry, which can cause permanent damage to the device.

**Programming a Device**

Before programming a device, you must generate a programming file in a bitstream (.bit) format using ASICmaster™ software. Refer to the *ASICmaster User's Guide* for information about generating a programming file. This programming file is used by the Silicon Sculptor software.

Actel recommends checking the device ID on the ISP board design before programming a device. This is done by reading the device ID from the device using Silicon Sculptor. If there

is a problem, the programmer will fail with a bad IDCODE error. If the reason for the failure cannot be found in the connection of the circuitry or the programming voltages, it is possible that the failure was caused by noise on the TCK or RCK signals. Before programming a device, check the following:

- Make sure all signals driving the device are 2.5V; it is recommended that the board be powered down during this stage.
- Make sure only ProASIC parts are connected to the high voltage supplies.
- Make sure not to interrupt the programming.
- Take all noise precautions for the TCK and RCK signals.
- Make sure that all ESD protection measures are taken.

Use the following procedure to program a device. Refer to the *Silicon Sculptor User's Guide* for additional information about using the Silicon Sculptor software.

1. Power down the board.
2. Remove the plug-in connector from the programming header on the board.
3. Plug the programming cable into the programming header.
4. Power up the Silicon Sculptor programmer box and wait until the active LED goes off, indicating that the self-test has finished.
5. Launch the Silicon Sculptor software.
6. Select the device using the "select" menu.
7. Load the bitstream (.bit) file using the "Buffer/Load" menu.
8. Program the device by choosing the "Device/Program" menu. Wait for the programming to be verified twice.
9. Exit the Silicon Sculptor software
10. Power down the programmer box.
11. Unplug the programming cable from the board.  
*Actel recommends using a Latch/Ejector Header to easily remove the programming cable from the programming header. For example, the 3M Latch/Ejector Header Part number 3429-6502 (for 0.062" board thickness) or 3429-6503 (for 0.094-0.125" board thickness).*
12. Place the plug-in connector in the programming header on the board.
13. Power-up the board for normal operation.

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#### *References:*

IEEE 1149.1-1990 Standard Test Access Port and Boundary Scan Architecture

*ASICmaster User's Guide*

*Silicon Sculptor User's Guide*

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