Programming Actel Devices

This overview of different programming options for Actel FPGAs describes the types of programming available and the hardware solutions currently offered by Actel and other vendors. The electronic version of this document includes active links to all programming resources and is available at **http://www.actel.com/products/tools/prog.asp**.

Programming Basics

When choosing a programmable solution, there are a number of choices you can make about how to program your devices. This section gives a brief overview of the options available to you. The next sections provide more detail on those options as they apply to Actel FPGAs.

Reprogrammable or OTP?

Depending on the technology you choose, your devices may be reprogrammable or one-time-programmable (OTP). As the name implies, a reprogrammable device can be programmed many times. Generally such a device will overwrite the entire program when reprogrammed.

An OTP device is programmable one time only. Once programmed, no more changes can be made to the contents. Some technologies are reprogrammable, with an option to make them OTP for maximum security. While reprogrammability is generally desirable, OTP technologies like that used in Actel's antifuse families provide other important performance, security, and radiation-tolerant features that are a top priority for many designers.

Actel's reprogrammable ProASIC^{PLUS} family also provides the option of disabling the reprogrammability for security purposes. This allows you to combine the convenience of reprogrammability during design verification with the security of an OTP technology for highly sensitive designs.

Device Programmer or ISP?

There are two fundamental ways to program an FPGA: use a device programmer, or, if the technology permits, use in-system programming (ISP). A device programmer is a piece of equipment that can reside in a lab or a production floor that is used for programming devices. The devices are placed into some kind of a socket, and the appropriate electrical interface is applied. The device can then be placed onto the board. A typical programmer used during development would program a single device at a time, and is referred to as a Single-Site programmer.

With ISP, the unprogrammed device is mounted onto the board, and some method is provided to get to the programming pins. Most commonly this is through a JTAG interface and header, which can be connected to a simple external programmer. Once the device is in place, it can be programmed repeatedly. If the application requires it, it is also possible to design the system to reprogram itself without the use of any external programmer. ISP is described in more detail below.

For production, there are high-volume Multi-Site production programmers and handlers for those designs using a device programmer. If ISP is being used, it is

possible to program the devices using the system tester. In addition, Actel can pre-program your devices for you so that the devices you receive can be mounted directly on your boards with no further need for programming. This service is referred to as in-house programming (IHP).

Live at Power-Up or Boot PROM?

Choosing technologies can make a big difference in how your system powers up, and what kind of design considerations you need for power-up. Some technologies are nonvolatile, and are therefore functional, or "live" as soon as power reaches the operational level. All of Actel's FPGA technologies are live at power up; you are never required to do any extra work to ensure that an Actel FPGA will be operational as soon as power is applied.

By contrast, SRAM technology is volatile and devices built using SRAM cells lose their contents every time power is removed. These devices must be reprogrammed every time power is applied, and your design must include nonvolatile storage for the contents as well as the means to reprogram. In addition, there is a delay before these devices are functional; other parts of the board have to come alive first in order to reprogram these types of FPGAs. Such devices can therefore never be part of critical boot circuits. Actel makes no SRAM-based FPGAs.

Do I Want To Protect the Contents of My FPGA?

Design security is a growing concern for systems designers. The choice of programming methodology and technology can affect how secure your system is. Actel programming technologies are the most secure option available, providing much better protection than SRAM-based devices and ASICs. As detailed below, Actel provides a number of options for ensuring that your designs are protected. General information on design security can be found at
http://www.actel.com/products/rescenter/security/index.html

Programming Features for Actel Devices

Actel provides two types of FPGAs, antifuse and Flash. Some programming methods are common to both and some are exclusive to Flash. To simplify the choice of programming solution, we will first review the programming features for antifuse and Flash.

Table 1 • *Programming Features for Actel Devices*

Feature	Flash	Antifuse
Reprogrammable	Yes	No
In-System Programmable	Yes	No
One Time Programmable	Yes (option)	Yes
Live at power-up	Yes	Yes
Secure	Yes	Yes
Single Site Programmer Support	Yes	Yes
Multisite Programmer Support	Yes	Yes
In-House Programming Support	Yes	Yes

Flash Devices

The Flash devices supplied by Actel are reprogrammable using either a programmer or using ISP. ISP is becoming a common requirement on programmable devices. Actel supports ISP using JTAG, which is supported by both the FlashPro, FlashPro Lite, and Sculptor programmers. For further information on ProASIC^{PLUS} Devices please refer to
http://www.actel.com/products/proasicplus/index.html and for ProASIC devices, refer to
http://www.actel.com/products/proasic/index.html

Since Flash devices are nonvolatile, they are live at power up. This is different from an SRAM based device, which needs to load its programming information when it is powered up. The SRAM devices can take in the order of 100's of milliseconds before the system is active.

There are multiple levels of security available in Flash devices. You can provide a security key, which will lock the device. The device can then only be unlocked or reprogrammed by someone with the security key. It can also be locked permanently,

which means there is no key that can access the device. The command to secure the device is embedded within the programming file, but the programming software gives you the option to turn it on or off. This is also referred to as the OTP version of Flash, which you can program once and lock. This is discussed in more detail in the *Implementation of Security in Actel's ProASIC and ProASIC^{PLUS} Flash-Based FPGAs* application note at
http://www.actel.com/documents/FlashSecurityAN.pdf

Flash devices can also be programmed using single site or multisite programmers as well as using volume-programming services either from Actel or from other vendors.

Antifuse Devices

The antifuse architecture is OTP by design. Antifuse devices are not in-system programmable. For details of the Antifuse Architectures please refer to **http://www.actel.com/products/devices.html**.

Antifuse technology is also nonvolatile, so it is live at power up and inherently very secure. Security types and implementation are discussed in the *Implementation of Security in Actel Antifuse FPGAs* application note at
http://www.actel.com/documents/AntifuseSecurityAN.pdf

Antifuse devices are mainly programmed using single site or multisite programmers as well as using volume-programming services either from Actel or from other vendors.

Types of Programming

Depending on the number of devices you wish to program and the type of device, you can choose from the following programming methods.

- In-System Programming (Flash Only)
  - Using a Microprocessor or Microcontroller
  - Using a Programmer
- Device Programmers
  - Single Site Programmers
  - Multisite programmers, Batch programmers or Gang Programmers
- Volume Programming Services
  - Actel In House Programming
  - Programming Centers

Each type is described in more detail below.

In System Programming (ISP)

Device Type Supported: Flash

Description: ISP refers to programming your FPGA on your system board. You can also pre-program a device and then reprogram it later using this method.

Advantages: This method allows you to upgrade your FPGA design many times without any changes to your board. This eliminates the requirement to use a socket for the FPGA, saving cost and improving reliability. This also reduces the amount of programming hardware you need to buy, since one programmer will program an FPGA in any package.

Trade-offs: Depending on the approach used, some board overhead is required.

There are two methods of in-system programming: External and Internal.

Programmer ISP

Using an external programmer and a cable you can program the device through a header on your system board. In Actel documentation, this is referred to as external ISP. Actel provides FlashPro, FlashPro Lite, or Silicon Sculptor II to perform external ISP.

Advantages: The programming algorithms and hardware are available from Actel. The only hardware required on the board is a programming header. Allows local control of programming and data files for maximum security.

Trade-off: A negligible board space requirement for the programming header and JTAG signal routing.

Documentation: For details on External ISP please refer to *In-System Programming ProASIC^{PLUS} Devices*: **http://www.actel.com/documents/External_ISP_AN.pdf**

Microprocessor ISP

Using a microprocessor and an external or internal memory, you can store the program in memory and use the microprocessor to perform the programming. In Actel documentation this is referred to as internal ISP. Both the code for the programming algorithm and the FPGA programming file must be stored on memory on the board. Programming voltages must also be generated on the board.

Advantages: The programming code is stored on the system memory. No connection to the board is required during programming.

Trade-off: This is the approach that requires the most design work, since some way of getting and/or storing the data is needed; a system interface to the device must be designed; and the low-level API interface to the programming firmware must be written and linked in to the code provided by Actel. While there can be benefits to this methodology, serious thought and planning should go into the decision.

Documentation: For details on Internal ISP please refer to *Performing Internal In-System Programming Using Actel's ProASIC^{PLUS} Devices*: **http://www.actel.com/documents/PAplusISPAN.pdf**

Device Programmers

Device Type Supported: Flash and antifuse

Device Programmers are used to program a device before it is mounted on the system board. It can either be programmed before being soldered (usually done in production) or programmed before putting it into a socket (used for prototyping). This is recommended for antifuse devices and in production runs for Flash where you do not expect the program in the FPGA to change.

Advantages: The advantage of using device programmers is that there is no programming hardware required on your system board. Therefore no additional components or board space are required.

Trade-off: A separate piece of equipment is required, typically costing more than an ISP programmer.

If you intend to program devices frequently with different programs, or if you use relatively small volumes of devices, buying a single site device programmer is the simplest solution. For some military or space designs you would also want to use programming onsite to maintain control of the devices at all times.

With your programmer, you purchase adapter modules to support the packages of FPGA you are intending to use. When you receive the FPGA you would place it in the adapter module and run the programming software from a PC. Actel supplies the programming software for all of the Actel programmers. The software allows you to select the device you are using, select the programming files, program, and verify the device.

Single Site Programmers

A single site programmer programs one device at a time. Actel offers Silicon Sculptor II as a single site programmer.

Advantages: Lower cost than multisite programmers. No additional overhead for programming on system board. Allows local control of programming and data files for maximum security. Allows on demand programming onsite.

Trade-off: Only programs one device at a time.

Multisite Programmers

Often referred to as batch or gang programmers, can program multiple devices together with the same programming file. This is often used for larger volume programming and by programming houses. You need to buy multiple adaptor modules for the same package to use with a multisite programmer. Silicon Sculptor programmers can be cascaded to program multiple devices in a chain. Multisite programmers can also be purchased from BP Micro.

Advantages: Provides the capability of programming multiple devices at the same time. No additional overhead for programming on system board. Allows local control of programming and data files for maximum security.

Trade-off: More expensive than a single-site programmer.

Volume Programming Services

Device Type Supported: Flash and antifuse

When you are ready to run your design in production, you can buy large volumes of parts and have them programmed before you receive them.

Advantages: This is much easier than having a large programming capability in house, since programming centers will have multiple programmers running in parallel and can deliver programmed parts more cost effectively.

Trade-off: Programming files must be sent to the programming service provider. Nondisclosure Agreements (NDAs) can be signed to help ensure that your data will be protected. Any programs that will not allow files to be sent offsite will not be able to use this approach.

Table 2 • *Volume Programming Services*

Programmer	Vendor	Availability
In House Programming	Actel	Contact Actel Sales
Distributor Programming Centers	Pioneer and Unique	Contact Distribution
Independent Programming Centers	Various	Contact Direct

Actel In-House Programming (IHP)

When you purchase your Actel devices in volume, you can request IHP as part of the purchase. If you do this, there is a small add on charge for each device to be programmed. Each device is marked with a special mark to distinguish it from blank parts. When you have your programming files ready you send them to Actel and will receive sample parts back programmed with your design. Once you approve the First Articles, programming can proceed. To request Actel IHP please contact your local Actel Representative.

Distributor Programming Centers

If you buy your devices through a distributor, many of them will perform programming for their customers. This can be an advantage when looking at yield and RMA requirements for antifuse devices. You should consult with your preferred distributor about this option.

Independent Programming Centers

There are many programming centers that specialize only in programming but are not directly affiliated with Actel or our distributors. These programming centers must follow the guidelines for programming Actel devices and be using certified programmers to program the Actel devices. Actel does not have recommendations on external Programming Centers.

Programming Solutions

Details of the programming solutions compatible with Actel devices are described in this section.

Table 3 • *Programming Solutions*

Programmer	Vendor	ISP	Single Device	Multi Device	Availability
FlashPro (Flash only)	Actel	Only	Yes	Yes	Available
FlashPro Lite (ProASIC^{PLUS} only)	Actel	Only	Yes	Yes	Available
Silicon Sculptor II	Actel	Yes	Yes	Cascade option	Available
Silicon Sculptor	Actel	Yes	Yes	No	Discontinued
Sculptor 6X	Actel	No	Yes	Yes	Discontinued
Activator	Actel	No	Yes	Model 2 only	Discontinued
BP Micro Programmers	BP Micro	No	Yes	Yes	Contact BP Micro at **http://www.bpmicro.com/**

Details for the available programmers can be found in the programmer User's Guides, which are listed at the end of this application note.

All of the programmers except the FlashPro or FlashPro Lite require adapter modules, which are designed to support device packages. The modules are all listed on the Actel website at **http://www.actel.com/products/tools/silisculpt/modules.html**. They are not listed here, since the list is updated occasionally for new package options and any upgrades required improving programming yield or supporting new families.

Programmer Ordering Codes

The products shown below can be ordered through Actel Sales and will be shipped from Actel direct. They can also be ordered from Actel Distributors, but will still be shipped from Actel direct. The table includes ordering codes for the full kit, as well as codes for replacement items and any related hardware. Some additional products can be purchased from external suppliers for use with the programmers. Ordering Codes for adapter modules used with Silicon Sculptor are available at **http://www.actel.com/products/tools/silisculpt/modules.html**

Table 4 • *Programmer Ordering Codes*

Description	Vendor	Ordering Code	Comment
FlashPro ISP Programmer	Actel	FLASH PRO	Supports Small Programming Header or Large Header through Header Converter (not included)
FlashPro Lite ISP Programmer	Actel	FLASH PRO LITE	Supports Small Programming Header or Large Header through Header Converter (not included)
Silicon Sculptor II	Actel	SILICON-SCULPTOR II	Requires add on Adapter Modules to support devices
Silicon Sculptor ISP Module	Actel	SMPA-ISP-ACTEL-2-KIT	Ships with both Large and Small Header Support
Concurrent Programming Cable	Actel	SS-EXPANDER	Used to cascade Silicon Sculptor's together
Software for Silicon Sculptor	Actel	SCULPTOR-SOFTWARE-CD	**http://www.actel.com/custsup/updates/silisculpt/**
ISP Cable for Small Header	Actel	ISP-CABLE-S	Supplied with Silicon Sculptor II
ISP Cable for Large Header	Actel	PA-ISP-CABLE	Supplied with Silicon Sculptor II
Header Converter	Actel	Header-Converter	Converts from Small to Large Header
Small Programming Header	Samtec	FTSH-113-01-L-D-K	Supported by FlashPro, FlashPro Lite, and Silicon Sculptor
Large Programming Header 0.062 Board Thickness	3M	3429-6502	Supported by Silicon Sculptor by default and FlashPro, FlashPro Lite, with Header Converter
Large Programming Header 0.094-0.125 Board Thickness	3M	3429-6503	Supported by Silicon Sculptor by default and FlashPro, FlashPro Lite, with Header Converter
Plug in Header Small	Actel	SMPA-ISP-HEADER-S	Required for Small Header for ProASIC only, not used for ProASIC^{PLUS}
Plug In Header	Actel	SMPA-ISP-HEADER	Required for Large Header for ProASIC only, not used for ProASIC^{PLUS}
Vacuum Pen for PQ, TQ, VQ fewer than 208 pins	Actel	PENVAC	
Vacuum Pen for PQ, TQ, VQ greater/equal to 208 pins	Actel	PENVAC-HD	

Programmer Device Support

Programmers are listed in historic order, since this makes the information easier to read. The devices are split into general purpose, RadHard/RadTolerant and Legacy devices.

General Purpose Actel Devices

To learn more about the different Actel families, refer to the Actel website: **http://www.actel.com/products/devices.html**.

Table 5 • *Programmer Device Support*

Actel Family	Device	Activator	Silicon Sculptor	Silicon Sculptor 6x	Silicon Sculptor II	FlashPro	FlashPro Lite
ProASIC^{PLUS} Flash	APA075 APA150 APA300 APA450 APA600 APA750 APA1000	No	Yes	Yes	Yes	Yes	Yes
ProASIC Flash	A500K50 A500K130 A500K180 A500K270	No	Yes	Yes	Yes	Yes	No
Ax Antifuse	AX125 AX250 AX500 AX1000 AX2000	No	No	No	Yes	No	No
SX-A Antifuse	A54SX08A A54SX16A A54SX32A A54SX72A	No	Yes	Yes	Yes	No	No
SX Antifuse	A54SX08 A54SX16 A54SX16P A54SX32	Yes	Yes	Yes	Yes	No	No
eX Antifuse	eX64 eX128 eX256	No	Yes	Yes	Yes	No	No
42MX Antifuse	A42MX16 A42MX24 A42MX36	Yes	Yes	Yes	Yes	No	No
40MX Antifuse	A40MX02 A40MX04 A40MX09	Yes	Yes	Yes	Yes	No	No

RadHard and RadTolerant Devices

Since RadHard and RadTolerant devices are one time programmable and expensive, it is important to ensure the correct functioning of your programming equipment prior to programming. You should refer to the RadHard and RadTolerant programming guide for instructions on correct calibration and programming procedures. This document is available at: **http://www.actel.com/documents/radhardPG.pdf**

Table 6 • *Programmer Support for RadHard and RadTolerant Devices*

Actel Device	Activator	Silicon Sculptor	Sculptor 6x	Silicon Sculptor II	FlashPro	FlashPro Lite
RH1020	Yes	Yes	Yes	Yes	No	No
RH1280	Yes	Yes	Yes	Yes	No	No
RT1020	Yes	Yes	Yes	Yes	No	No
RT1280	Yes	Yes	Yes	Yes	No	No
RT1425	Yes	Yes	Yes	Yes	No	No
RT1460	Yes	Yes	Yes	Yes	No	No
RT14100	Yes	Yes	Yes	Yes	No	No
RT54SX16 (discontinued)	Yes	No	No	No	No	No
RT54SX32 (discontinued)	Yes	No	No	No	No	No
RT54SX32S	No	Yes	Yes	Yes	No	No
RT54SX72S	No	Yes	Yes	Yes	No	No

Legacy Actel Devices

The devices listed below cover all of the Legacy parts from Actel. All parts beginning with the letters shown are supported.

Table 7 • *Programmer Support for Legacy Actel Devices*

Actel Family	Device	Activator	Silicon Sculptor	Sculptor 6x	Silicon Sculptor II	FlashPro	FlashPro Lite
ACT1	A1010 A1020 A1010A A1020A A1010B A1020B	Yes	Yes	Yes	Yes	No	No
ACT2	A1225 A1240 A1280 A1225A A1240A A1280A	Yes	Yes	Yes	Yes	No	No
ACT3	A1415A A1425A A1440A A1460A A14100A	Yes	Yes	Yes	Yes	No	No
1200XL	A1225XL A1240XL A1280XL	Yes	Yes	Yes	Yes	No	No
3200DX	A3265DX A32100DX A32140DX A32200DX A32300DX	Yes	Yes	Yes	Yes	No	No

Certified Programming Solutions

Actel's list of certified programmers is Silicon Sculptor I and II, FlashPro, FlashPro Lite, Activator, and any programmer that is built by BP Microsystems. All other programmers are considered non-certified programmers.

- Silicon Sculptor I & II, FlashPro, FlashPro Lite,

  Actel only tests the programming of Actel devices on the FlashPro, FlashPro Lite, Silicon Sculptor, and BP Programmers. Each release of the Silicon Sculptor and FlashPro, FlashPro Lite, software goes through a rigorous testing procedure to ensure the best programming yield possible. This test procedure includes programming of devices and functionally testing the programmed devices.

- Activator

  Activator has been discontinued and we no longer provide software updates. We recommend that all customers upgrade to Silicon Sculptor II. We will accept reasonable RMA requests, but will not perform any engineering analysis of programming failures.

- Non-certified Programmers

  Actel does not test programming solutions from any other vendors, and CANNOT guarantee programming yield. We will accept programming failure RMAs up to the allowed fallout (please see programming failure guidelines in the price book), but reserve the right to reject any RMA requests if the fallout is excessive. We also will not perform any failure analysis on devices programmed by hardware from other vendors.

Programming Centers

- Our programming hardware policy will also apply to programming centers. We expect all programming centers to use certified programmers to program Actel devices. If a programming center uses non certified programmers to program Actel devices, then our non certified programmer policy will apply.

Programming Yield and RMA Procedures

For full details of the Programming and Functional Failure guidelines please contact your local sales office or contact tech support at **tech@actel.com**

Related Documents

In this section we include a list of documents, there location on the website, and a short description of the details found in each one.

Silicon Sculptor II

Description: **http://www.actel.com/products/tools/silisculpt/index.html**

Includes a Description of Both Silicon Sculptor I and II.

User's Guide: Silicon Sculptor User Guides

- Windows User's Guide: **http://www.actel.com/documents/sculptorUGw.pdf**
- DOS User's Guide: **http://www.actel.com/documents/sculptorUGd.pdf**
- Calibration Procedure for the Silicon Sculptor: **http://www.actel.com/documents/SiliSculptProgCali.pdf**
- ProASIC Daisy-Chain Programming: **http://www.actel.com/documents/daisy_chain.pdf**

Includes hardware and software setup, calibration, use instructions, and troubleshooting/error message guide

FlashPro

Description: **http://www.actel.com/products/tools/flashpro/index.html**

Contains details of what is included when you purchase a FlashPro

User's Guide: **http://www.actel.com/documents/flashproUG.pdf**

Includes hardware and software setup, self-test instructions, use instructions and troubleshooting/error message guide.

FlashPro Lite

Description: **http://www.actel.com/products/tools/flashprolite/index.html**

Contains details of what is included when you purchase a FlashPro Lite

User's Guide: **http://www.actel.com/documents/flashproUG.pdf**

Includes hardware and software setup, self-test instructions, use instructions and troubleshooting/error message guide.

Application Notes

In-System Programming ProASIC^{PLUS} Devices:
http://www.actel.com/documents/External_ISP_AN.pdf

Contains all information required to connect the FlashPro, FlashPro Lite, or Silicon Sculptor ISP solutions to ProASIC^{PLUS} devices. Use this application note along with the device programmer's user's guide.

Performing Internal In-System Programming Using Actel's ProASIC^{PLUS} Devices:
http://www.actel.com/documents/PAplusISPAN.pdf

Contains a description of how to use the on-board processor to perform ISP.

Implementation of Security in Actel's ProASIC and ProASIC^{PLUS} Flash-based FPGAs:
http://www.actel.com/documents/FlashSecurityAN.pdf

Describes the different types of security available in Flash devices and also how to implement the security.

Implementation of Security in Actel Antifuse FPGAs:
http://www.actel.com/documents/AntifuseSecurityAN.pdf

Describes the different types of security available in antifuse devices and also how to implement the security.

Documentation for Discontinued Products

Since many of our customers are still using Sculptor one or Activator, we have included the documentation.

Silicon Sculptor I: **http://www.actel.com/products/tools/silisculpt/index.html**

Silicon Sculptor 6X Programming Procedure: **http://www.actel.com/documents/prgrm6x.pdf**

Activator: **http://www.actel.com/documents/ActivatorUG.pdf**

Contacting the Customer Applications Center

Highly skilled engineers staff the Customer Applications Center from*7:30 A.M. to 5:00 P.M., Pacific Time, Monday through Friday*. You can contact the center by:

Electronic Mail

You can communicate your technical questions to our e-mail address and receive answers back by e-mail, fax, or phone. Also, if you have design problems, you can e-mail your design files to receive assistance. We constantly monitor the e-mail account throughout the day. When sending your request to us, please be sure to include your full name, company name, and your contact information for efficient processing of your request. The technical support e-mail address is **tech@actel.com**.

Telephone

Our Technical Message Center answers all calls. The center retrieves information, such as your name, company name, phone number and your question, and then issues a case number. The center then forwards the information to a queue where the first available applications engineer receives the data and returns your call. The phone hours are from 7:30 A.M. to 5:00 P.M., Pacific Time, Monday through Friday.

The Customer Applications Center number is (800) 262-1060.

European customers can call +44 (0) 1256 305600.

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