

Recommendations for Programming Actel RTSX-S, RTSX-SU, and SX-A

Introduction

This technical brief provides programming information and answers common questions regarding the programming of Actel RTSX-S (MEC fabricated, now discontinued), RTSX-SU (UMC fabricated), and SX-A (MEC and UMC fabricated) devices. This document is intended only for programming RTSX-S, RTSX-SU, and SX-A devices.

Device Selection in Designer for RTSX-S and RTSX-SU

Both RTSX-S and RTSX-SU devices share the same Family selection in the Actel Designer software (Figure 1). You should target the family to SX-A, and select the appropriate device in the **Device Selection Wizard**. For example, for RT54SX32S and the equivalent RTSX32SU devices, select **RT54SX32S** (and the intended package/speed grade/die voltage). Designs targeted to RTSX-S devices are compatible with both the RTSX-S and RTSX-SU families. RTSX-S and RTSX-SU devices have the same timing limits, as published in their respective datasheets. The generated programming file (AFM) has the same programming information and can be used to program devices from both families. For example, you can use an AFM file targeted for programming RT54SX32S devices to program the equivalent RTSX32SU devices.

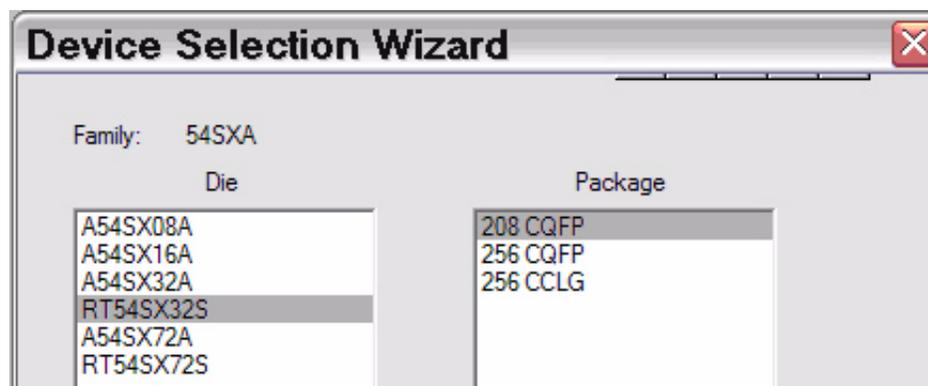


Figure 1 • Designer's Device Selection Wizard

Programming Support for RTSX-S and RTSX-SU

In the Silicon Sculptor programming software, select the appropriate device in the **Device List** (Figure 2 on page 2). For example, when programming the RT54SX32S device, select **RT54SX32S** from the Die list and the package from the Package list. When programming the RTSX32SU device, select **RTSX32SU** and the target package from the device list. Actel recommends using the latest Actel Silicon Sculptor software version and the Silicon Sculptor II device programmer (the only programmer tested by Actel prior to the software release).

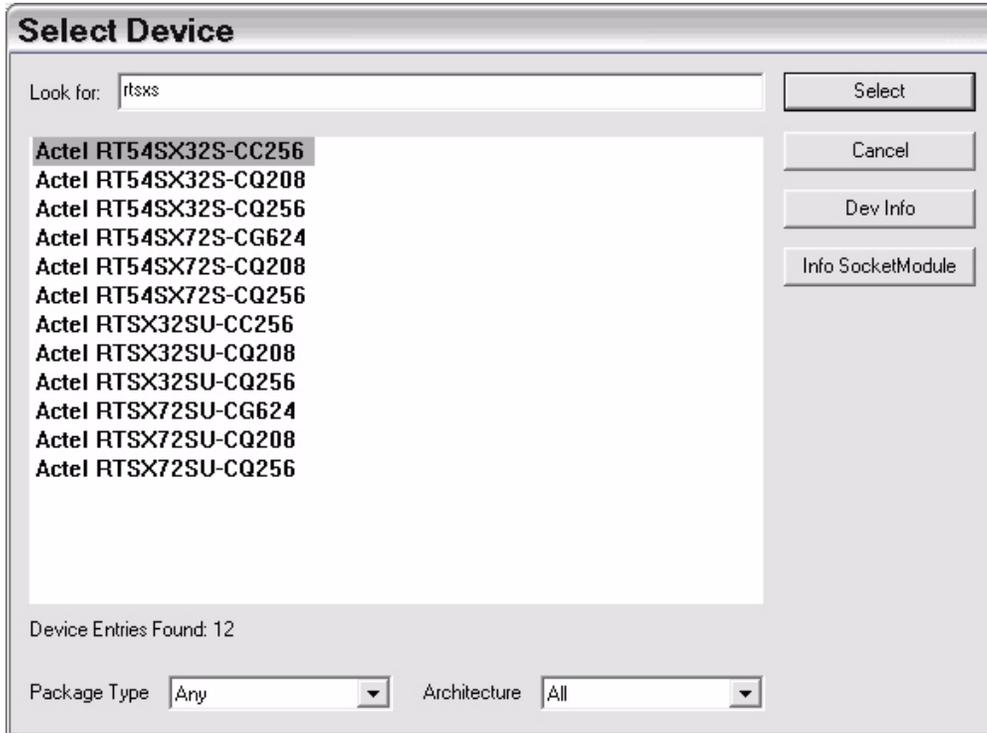


Figure 2 • Silicon Sculptor Software Device List for RTSX-S and RTSX-SU Devices

Summary of Programming Improvements

Actel has introduced a new algorithm starting with Silicon Sculptor software v3.81 DOS / v4.44 WIN for programming MEC RTSX-S devices to enhance programming performance.

Support for UMC RTSX-SU device programming was introduced starting from Silicon Sculptor software v3.83 DOS / v4.46 WIN.

Modified New Algorithm (MNA)

A modified new algorithm (MNA) was introduced, starting with Silicon Sculptor software v3.87 DOS / 4.50 WIN, to improve the programming of low current dynamic antifuses for MEC RTSX-S devices, and to further enhance the overall programming performance, yield, and reliability for MEC RTSX-S devices. The AFM programming files generated from Designer v6.1 SP1 or later contain enhanced information required to support the MNA for MEC devices. AFM programming files generated with Designer versions previous to Designer v6.1 SP1 are not supported with the enhanced Silicon Sculptor software, and do not contain the enhanced information required to support the MNA.

UMC Modified Algorithm (UMA)

A UMC modified algorithm (UMA) was introduced, starting with Sculptor software v3.90 DOS / v4.53 WIN, to improve the programming of low current antifuses for UMC RTSX-SU devices and to further enhance the overall programming performance, yield, and reliability for UMC RTSX-SU devices. The AFM programming files generated from Designer v6.1 SP1 or later contain enhanced information required to support the UMC modified algorithm. AFM programming files generated with Designer versions previous to Designer v6.1 SP1 are not supported with this enhanced Silicon Sculptor software, and do not contain the enhanced information required to support the UMC modified algorithm.

Note: With Silicon Sculptor software version 3.87 DOS / 4.50 WIN and later, the Silicon Sculptor II programmer must be used to program all RTSX-S and RTSX-SU devices due to the programmer memory limitation in the Silicon Sculptor I programmer.

S-Antifuse Loading Methodology

Actel also introduced an S-Antifuse (semi-direct antifuse) loading (SAL) methodology in Designer v6.2 SP1 and later to enhance the robustness and reliability of designs with routing tracks containing only a single S-Antifuse, which are signals that use fast connects with a fanout of 1. S-Antifuses are used to connect the output track of one logic module directly to the input track of another logic module without passing through any routing freeways. Single S-Antifuse nets have much lower capacitive loading compared to other types of nets and have faster edge rates and higher peak operational current. Figure 3 shows signal connection between two logic modules utilizing one S-Antifuse.

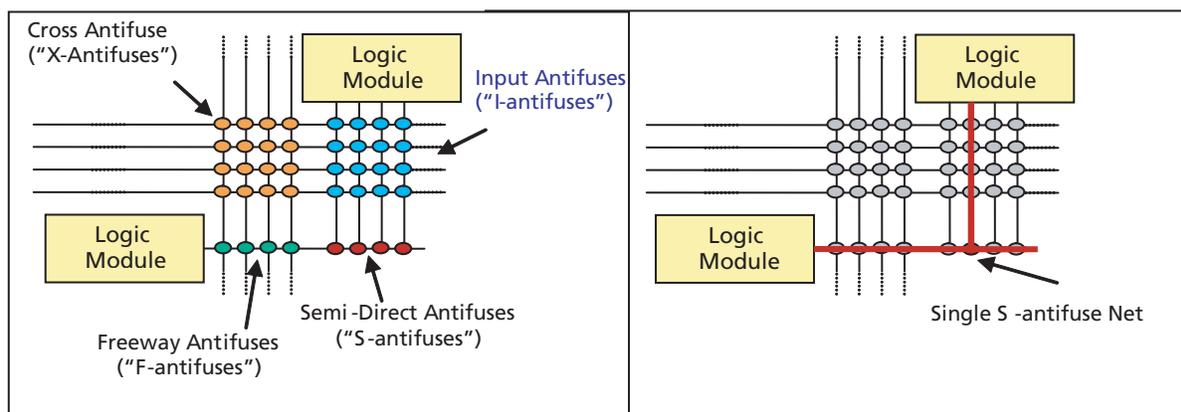


Figure 3 • Different Antifuse Types and the Use of a Single S-Antifuse to Make the Routing Connection Between Two Logic Modules

To enhance the robustness of the single S-Antifuse, an unused freeway antifuse will be connected to the net to reduce the higher peak operational current of the single S-Antifuse net. This provides more capacitive loading with minimal to no increase in routing delay.

Since this technique requires programming extra antifuses, existing designs require re-layout (with fixed placement) in Designer v6.2 SP1 or later. New designs that are laid out with Designer v6.2 SP1 or later will have this technique already incorporated. The placement will not change and only the routing capacitance is added. Timing changes are minimal but timing analysis is always encouraged. The AFM file checksum will change as the antifuse information is updated. Actel strongly recommends utilizing Designer v6.2 SP1 or later to benefit from this improvement.

AFM files generated from Designer v6.1 SP1 or later contain enhanced information to support MNA and UMA. Designs for which layout and re-layout with fixed placement is done in Designer v6.2 SP1 or later utilize SAL methodology. Designer v6.2SP1 or later is always recommended to layout/re-layout the design and generate AFM files to program RTSX-S and RTSX-SU devices. This will fully utilize the combination of the programming algorithm (MNA or UMA), and the SAL methodology.

Table 1 on page 4 shows a summary of recommendations for RTSX-S and RTSX-SU devices. A summary of the programming setup for RTSX-S and RTSX-SU devices is described in the next section. Actel recommendations for programming these devices are indicated in gray.

Table 1 • Summary of Programming Improvements Implemented for Programming RTSX-S and RTSX-SU Devices

Device	MEC RTSX-S			UMC RTSX-SU			
	New MEC Algorithm	MNA		Standard UMC Algorithm		UMA	
		With No SAL	With SAL			With No SAL	With SAL
Designer version	v6.1 or earlier	v6.1SP1 or later	v6.2SP1 or later	v6.1 or earlier*	v6.1SP1 or later	v6.1SP1 or later	v6.2SP1 or later
Design re-layout	–	No	Yes	–	–	No	Yes
Sculptor software version	v3.86.1DOS / v4.49.1WIN (v3.87DOS / v4.50WIN or later rejects AFMs from Designer v6.1 or earlier)	v3.87DOS / v4.50WIN or later (v3.86.1DOS / v4.49.1WIN or earlier rejects AFMs from Designer v6.1 SP1 or later)	v3.90DOS / v4.53WIN or later	v3.86.1DOS / v4.49.1WIN (v3.87DOS / v4.50WIN or later rejects AFMs from Designer v6.1 or earlier)*	v3.89DOS / v4.52WIN	v3.90DOS / v4.53WIN or later (v3.86.1DOS / v4.49.1WIN or earlier rejects AFMs from Designer v6.1 SP1 or later)	v3.90DOS / v4.53WIN or later
Silicon Sculptor hardware	Silicon Sculptor I / II	Silicon Sculptor II		Silicon Sculptor I / II	Silicon Sculptor II	Silicon Sculptor II	

Note: *Refer to the "Wafer Location Information" section on page 6 for details on using this version with RTSX-SU devices.

B-Antifuse Reduction (BAR)

Actel introduced a B-Antifuse Reduction (BAR) methodology in Designer v7.0, which enhances the robustness and reliability of designs by reducing the occurrence of macro function configurations containing single B-Antifuses inside combinatorial cells (C-cell). In the RTSX-SU architecture each C-cell has a dedicated local inverter, the DB-Inverter, as indicated in Figure 4. The DB-Inverter has a dedicated output routing track with a total of six B-Antifuses on it. Figure 4 shows the location inside the C-cell where B-Antifuses are located (shown by red dots). Any logically unique inputs to the C-cell may be connected to the output of the DB-Inverter by programming a B-Antifuse. When a DB-Inverter drives only one programmed B-Antifuse, it is classified as a Single B-Antifuse.

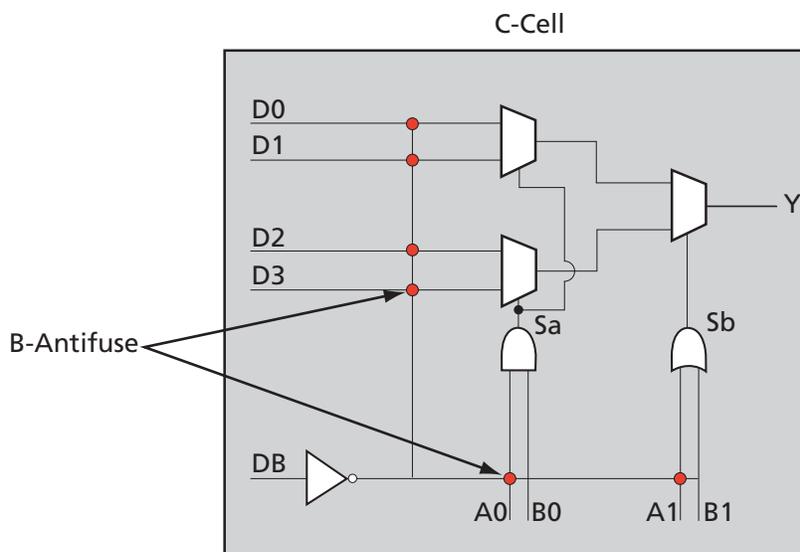


Figure 4 • C-Cell Architecture of RTSX-SU Devices

Starting from Designer v7.0, newly reconfigured library components are added to use either no B-Antifuses or multiple B-Antifuses where possible, thereby minimizing the occurrence of single B-antifuses. For existing designs, library components will be updated with these new library components when applicable, while ensuring that the updated library components will perform the same intended functions. The following message will be displayed when the user runs the design in Designer v7.0 or later: **Warning: The design uses an older library. Automatically upgrading the library components. Re-running Compile.**

New designs that are compiled with Designer v7.0 or later will have the new methodology incorporated, thus will automatically use the updated library components.

Although timing changes are minimal, Actel recommends performing timing analysis. The AFM file checksum will change as the antifuse information is updated. Actel strongly recommends utilizing Designer v7.0 or later to benefit from this improvement.

BAR is not Sculptor software specific; however, v3.87DOS/v4.50.0WIN or later must be used as these programming software versions supports AFM versions generated starting from Designer v6.2SP1.

For macro functions that must be configured to utilize C-cells with single B-Antifuses, a future software release will use an additional C-cell, in order to eliminate the use of single B-Antifuses. This option will be available in Q3 of 2006.

Wafer Location Information

Another added feature to RTSX-SU devices is the programming of the wafer location of each die to the silicon signature area. The silicon signature area is a reserved area within each die where manufacturing information is programmed at the factory. The additional information is included for failure analysis purposes and has no effect on the functionality or operation of the FPGAs.

As a result of the addition, versions of Silicon Sculptor programming software prior to v3.87DOS / v4.50.0WIN will detect this extra information in the silicon signature and will reject blank devices with a **failed blank check** message. Hence, programming cannot be achieved for RTSX-SU devices with wafer location programmed using Silicon Sculptor programming software versions prior to v3.87DOS / v4.50.0WIN.

RTSX-SU devices with wafer location programmed will only be compatible with Silicon Sculptor programming software v3.87DOS / v4.50.0WIN or later. Silicon Sculptor programming software v3.87DOS / v4.50.0WIN or later disregards the additional data in the silicon signature and allows programming to be done. Customers who are intending to program these RTSX-SU devices must use Silicon Sculptor programming software v3.87 DOS / v4.50.0WIN or later. In addition, this means RTSX-SU devices with wafer location programmed can only be programmed using AFM files generated from Designer v6.1SP1 or later. Actel's recommendation is to always use the most recent version of software. If users intend to use older AFM files generated from Designer v6.1 or earlier with devices that do not contain wafer information, against Actel's recommendation, Silicon Sculptor software v3.86.1DOS / v4.49.1WIN should be used (the last release prior to v3.87DOS/v4.50WIN).

Please note that starting in May 2006, RTSX-SU devices shipped from Actel may be factory configured with wafer location information, and therefore may not be recognized as blank devices unless v3.87DOS / v4.50.0WIN or later Silicon Sculptor programming software is used.

Note: Silicon Sculptor software v3.87DOS / 4.50WIN or later is compatible with devices that have been programmed with the wafer location information and devices that have not been programmed with the wafer location information. Therefore, once the programming software is updated to v3.87DOS / v4.50.0WIN or later, it is compatible with all devices.

Recommendations for Programming RTSX-S MEC and RTSX-SU UMC Devices

Actel strongly recommends using the programming software v3.90 DOS / v4.53 WIN or later to benefit from the MNA and SAL enhancements for RTSX-S devices and from the UMA and SAL enhancements for RTSX-SU devices, as the enhancements provide improvements to the overall programming performance, yield, and reliability.

To utilize the MNA and SAL, you must do the following:

- Use Silicon Sculptor programming software v3.90 DOS / v4.53 WIN or later.
- Re-layout designs (with fixed placement) and generate the AFM programming file using Designer v6.2 SP1 or later.
- Use the Silicon Sculptor II programmer.

To utilize MNA (RTSX-S MEC) or UMA (RTSX-SU UMC) only, you must do the following:

- Use Silicon Sculptor programming software v3.87 DOS / v4.50 WIN or later.
- Generate the AFM programming file using Designer v6.1 SP1 or later (no re-layout necessary).
- Use the Silicon Sculptor II programmer.

AFM programming files generated from Designer v6.1 SP1 or later are designed to work with programming software v3.87 DOS / v4.50 WIN or later and are not compatible with previous releases of programming software. AFM programming files generated from Designer v6.1 SP1 or later will be rejected by previous versions of programming software, v3.86.1 DOS / v.4.49.1 WIN and earlier.

If AFM files generated from Designer v6.1 or earlier are used, against Actel recommendations for RTSX-S or RTSX-SU, the following programming setup should be employed:

- Silicon Sculptor programming software v3.86.1 DOS / v4.49.1 WIN (the last release prior to v3.87 DOS / v4.50 WIN)
- Silicon Sculptor I or Silicon Sculptor II programmers

AFM programming files generated from Designer v6.1 or earlier will be rejected by v3.87 DOS / v4.50 WIN or later of the programming software.

Summary of Revision History

Table 2 provides a summary of revision history since the new MEC algorithm was introduced in v3.81 DOS / v4.44 WIN.

Table 2 • Summary of Revision History

Silicon Sculptor Software Version	Modifications
3.81 DOS 4.44 WIN	<ul style="list-style-type: none"> • New algorithm for RTSX-S (MEC) • No restrictions on AFM requirements
3.83 DOS 4.46 WIN	<ul style="list-style-type: none"> • Support for RTSX-SU (UMC) • No restrictions on AFM requirements • Improved programming tests for RTSX-S
3.85 DOS 4.48 WIN	<ul style="list-style-type: none"> • Post-programming verification change on RTSX-S and RTSX-SU (I_{CCA} fix) • Issue with SM208CQSX-ACTEL module not working on Silicon Sculptor I for RT54SX32S and RTSX32SU devices • Issue with RTSX72S programming failures • No longer support WinNT
3.86 DOS 4.49 WIN	<ul style="list-style-type: none"> • Fixed SM208CQSX-ACTEL module issue with Silicon Sculptor I for RT54SX32S and RTSX32SU devices
3.86.1 DOS 4.49.1 WIN	<ul style="list-style-type: none"> • Fixed RT54SX72S programming failures
3.87 DOS 4.50 WIN	<ul style="list-style-type: none"> • All fixes from prior releases including 4.49 and 4.49.1 are incorporated in this release • Includes MNA for RTSX-S • Requires AFM from Designer v6.1 SP1 or later • Reject AFM versions from versions of Designer prior to Designer v6.1 SP1 • There are no enhancements for RTSX-SU
3.89 DOS 4.52 WIN	<ul style="list-style-type: none"> • Device selection menu updated from same device selection for selecting RTSX-S or RTSX-SU and split into RT54SX**S for RTSX-S devices and RTSX**SU for RTSX-SU devices (where ** refers to device size: 32 or 72) • Updated warning message when programming security antifuses for RTSX-S and RTSX-SU devices
3.90 DOS 4.53 WIN	<ul style="list-style-type: none"> • Includes UMC modified algorithm for RTSX-SU • Recommends using AFM from Designer v6.2 SP1 or later to benefit from SAL and program RTSX-S and RTSX-SU

Programming Support for SX-A

Actel recommends using the latest Actel Silicon Sculptor software version and the intended programmers, Silicon Sculptor I or Silicon Sculptor II, to program these MEC or UMC fabricated devices. Only these programmers are tested by Actel prior to software release. The device wafer lot number can be used to distinguish MEC and UMC SX-A devices. MEC has a wafer lot number starting with "T" or "BP", and SX-A devices from UMC have a wafer lot number starting with "D" (e.g., lot number T25K061 is from MEC). The lot number is shown on the FPGA package. Actel no longer offers the Silicon Sculptor I and Silicon Sculptor 6X. Both items have been discontinued. Actel did support Silicon Sculptor I and Silicon Sculptor 6X by continuing to release new software that enabled improved programming of previously covered Actel devices. However, after 2005, Actel has stopped all software support for Silicon Sculptor I and Silicon Sculptor 6X programmers, and no support for these older programmers will be offered in 2006. Actel recommends all customers upgrade to a Silicon Sculptor II or a BP multi-site programmer.

Summary of Programming Improvements

Starting from Silicon Sculptor software v3.90 DOS / v4.53 WIN, Actel has incorporated the MNA and UMA for programming MEC and UMC SX-A devices. The AFM programming files generated from Designer v6.2 SP1 or later contain enhanced information to support both algorithms for SX-A devices. Actel has also implemented the SAL methodology for the SX-A devices. To utilize the SAL methodology, you must generate AFM files from designs in which layout or re-layout has been done with fixed placement in v6.2 SP1 or later.

Due to the programmer memory limitation in the Silicon Sculptor I programmer, an optimized modified new algorithm (OMNA) for MEC SX-A devices and an optimized UMC modified algorithm (OUMA) for UMC SX-A devices were developed to program with Silicon Sculptor I programmers, starting from v3.90 DOS / v4.53 WIN. The programming algorithms used in OMNA and OUMA are identical to those used in MNA and UMA respectively, with the exception that some of the programming tests were optimized in order to accommodate the memory limitation of the Silicon Sculptor I programmers. In essence, OMNA and OUMA provide identical algorithm enhancements to improve the overall programming performance, yield, and reliability for MEC and UMC SX-A devices. The AFM programming files generated from Designer v6.2 SP1 or later contain enhanced information required to support the OMNA for MEC SX-A devices and OUMA for UMC SX-A devices.

Table 3 shows a summary of the programming improvements used by the Silicon Sculptor software for programming SX-A devices. The programming algorithm used depends on the foundry of the SX-A device being programmed, the Silicon Sculptor programmer used, and the AFM file version used. All previous versions of Silicon Sculptor software utilize standard algorithms and do not contain the programming enhancements implemented in the MNA and UMA. Actel recommendations for programming these devices are indicated in gray.

Table 3 • Programming Improvements Used by Programming Software for SX-A Device Programming

Device	SX-A (MEC / UMC)				
	Standard Algorithm	OMNA/OUMA		MNA/UMA	
		With No SAL	With SAL	With No SAL	With SAL
Designer version	Designer v6.2 or earlier	Designer v6.2 SP1 or later			
Design re-layout	–	No	Yes	No	Yes
Silicon Sculptor software version	Any	v3.90 DOS / v4.53 WIN or later			
Silicon Sculptor hardware	Silicon Sculptor I/II	Silicon Sculptor I		Silicon Sculptor II	

Recommendations for Programming SX-A

Actel strongly recommends utilizing the MNA/UMA and SAL enhancements to program SX-A devices, as the enhancements provide improvements to the overall programming performance, yield, and reliability.

To utilize MNA/UMA and SAL, you must do the following:

- Use Silicon Sculptor programming software v3.90 DOS / v4.53 WIN or later.
- Re-layout designs (with fixed placement) and generate the AFM programming file using Designer v6.2 SP1 or later.
- Use the Silicon Sculptor II programmer.

To utilize OMNA/OUMA and SAL, you must do the following:

- Use Silicon Sculptor programming software v3.90 DOS / v4.53 WIN or later.
- Re-layout designs (with fixed placement) and generate the AFM programming file using Designer v6.2 SP1 or later.
- Use the Silicon Sculptor I programmer.

To utilize MNA/OMNA/UMA/OUMA only, you must do the following:

- Use Silicon Sculptor programming software v3.90 DOS / v4.53 WIN or later.
- Generate the AFM programming file using a release of Designer v6.2SP1 or later (no re-layout necessary).
- Use the Silicon Sculptor II programmer for MNA.
- Use the Silicon Sculptor I programmer for OMNA.
- Use the Silicon Sculptor II programmer for UMA.
- Use the Silicon Sculptor I programmer for OUMA.

If AFM files generated from Designer v6.2 or earlier are used for programming, any programming software versions including v3.90 DOS / v4.53 WIN or later will use the standard algorithms to program MEC and UMC SX-A devices.

AFM programming files generated from Designer v6.2 SP1 or later are designed to work with programming software v3.90 DOS / v4.53 WIN or later, and are not compatible with previous Silicon Sculptor software releases. Previous release versions will either ignore the new AFM file information added, continue to use the standard algorithms to program, or will reject the new AFM file as an invalid antifuse file type, depending on the software version. You should follow instructions for the particular software version used.

Summary of Programming Recommendations

For MEC RTSX-S, UMC RTSX-SU, and SX-A (both MEC and UMC), Actel recommends that you layout/re-layout the design in v6.2SP1 or later, generate (or regenerate) the AFM programming files from Designer v6.2 SP1 or later, use Silicon Sculptor software version v3.90 DOS / v4.53 WIN or later, and use the Silicon Sculptor II programmer.

Related Documents

Datasheets

SX-A Family FPGAs

http://www.actel.com/documents/SXA_DS.pdf

RTSX-SU RadTolerant FPGAs (UMC)

http://www.actel.com/documents/RTSXSU_DS.pdf

List of Changes

Previous Version	Changes in the current version 51900095-1/4.06	Page
51900095-0/3.05	Extensive changes have been implemented in this application note. Please read the entire document.	N/A
	The Standard UMC Algorithm column in Table 1 was updated.	4
	"B-Antifuse Reduction (BAR)" section is new.	5
	"Wafer Location Information" section is new.	6

Note: The part number is located on the last page of the document.

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