Design Migration from the RT54SX32 to the RT54SX32S Device

Actel's RT54SX-S family of FPGAs is designed specifically for space applications. Although architecturally related to the earlier radtolerant RT54SX family, there are a few differences. This technical brief is intended to help designers move existing designs from the RT54SX32 device to the new RT54SX32S device.

The following are restrictions and specific requirements to consider when moving a design to RT54SX32S include:

- Architectural Differences
- Design Flows
- Timing
- Power Supplies
- Packages

Architectural Differences

Two primary differences between the RT54SX-S family and the older RT54SX family are:

- The RT54SX-S part implements special radiation-tolerant flip-flops. These SEU-hardened structures eliminate the need for TMR flip-flop designs implemented in HDL.
- The RT54SX-S device supports a wider range of I/O voltage standards. These are indicated in Table 1.

Table 1 • I/O Standard Support

I/O Standard	RT54SX	RT54SX-S
3.3V LVTTL	Yes	Yes
5.0V TTL	Yes	Yes
3.3V PCI	No	Yes
5.0V PCI	No	Yes
5.0V CMOS	No	Yes

For design migration to RT54SX-S, the RT54SX user should choose the 3.3V/2.5V (V_{CCI}/V_{CCA}) option in the RT54SX-S Device Selector Wizard in Actel Designer Series software. The input buffer trip point and the corresponding output buffer drive types are selectable on a pin-by-pin basis. However, mixed output drive voltages (i.e., 3.3V and 5.0V) are not available on the same device. For design migration purposes, the RT54SX user should select the LVTTL I/O threshold option in the RT54SX-S Device Selector.

Design Flows

Generally, the Actel Designer Series software requires four key flow steps (excluding timing, which is discussed separately below). These steps are Compile, Layout, Fuse, and Backannotate. During the conversion process some or all of the steps may need to be redone.*

If the original RT54SX design was generated in Designer R1 2000 SP4 or later, the conversion is very simple. Layout is preserved, and only the Fuse and Backannotate steps need to be redone. The same is true if an earlier version of software was employed and TRST was also used in the RT54SX design. If the TRST pin was not used for TRST, then the user may have to use PinEdit to reassign the I/O employed on the TRST pin (depending on whether or not the pin was assigned as a user I/O) and will need to rerun Layout. In all cases Fuse and Backannotate must be rerun.

Timing Considerations

The RT54SX and the RT54SX-S have different process technologies and device geometries. Although functionality may be the same after the conversion of a design, the user should verify that the faster timing of the RT54SX-S did not cause a timing error. Table 2 denotes timing differences and gives an example of pin-to-pin timing, taken from timing model simulations, for two paths – hard-wired clock-to-out and data-in-to-data-out through a combinatorial cell. Both paths use the LVTTL output option on RT54SX-S.

Table 2 • Pin-to-Pin Timing for RT54SX32 Variants (ns)

Timing Path	RT54SX32	RT54SX32S
Hard-wired Clock Path	11.0	8.5
Combinatorial Path	9.3	8.9

Power Supplies

Although the RT54SX32S has considerably more I/O flexibility than its predecessor, many military systems do not provide 3.3V or 2.5V power. Since an Actel RT54SX or RT54SX-S part may be the only component on the board requiring these voltages, the designer must provide a

**The RT54SX-S has TMR flip-flop macros as part of the hardware. If TMR flip-flops were created in HDL in the original RT54SX design, we recommend removing all TMR-specific implementations from the design and resynthesizing the design.*

voltage regulator to do the conversion from 5.0 volts. Frequently, designers search for a regulator qualified for space. Actel has described some regulator problems and compiled a list of suitable, qualified regulators. Contact Actel for additional information.

Package Considerations

The 208-pin and 256-pin CQFP packages are the only ones available for both the RT54SX32 and RT54SX32S. Nearly all pins in a given ceramic package have the same function in both parts. The common pins for the 208-pin CQFP package are illustrated in Table 3, while Table 4 on page 3 gives the pin differences.

Table 3 • *208-Pin CQFP Common Pin Assignments for RT54SX32 and RT54SX32S*

Pin Number	Function	Pin Number	Function	Pin Number	Function	Pin Number	Function
1	GND	32	I/O	63	I/O	94	I/O
2	TDI, I/O	33	I/O	64	I/O	95	I/O
3	I/O	34	I/O	65	NC	96	I/O
4	I/O	35	I/O	66	I/O	97	I/O
5	I/O	36	I/O	67	I/O	98	V_{CCA}
6	I/O	37	I/O	68	I/O	99	I/O
7	I/O	38	I/O	69	I/O	100	I/O
8	I/O	39	I/O	70	I/O	101	I/O
9	I/O	40	V_{CCA}	71	I/O	102	I/O
10	I/O	41	V_{CCI}	72	I/O	103	TDO, I/O
11	TMS	42	I/O	73	I/O	104	I/O
12	V_{CCI}	43	I/O	74	I/O	105	GND
13	I/O	44	I/O	75	I/O	106	I/O
14	I/O	45	I/O	76	PRB, I/O	107	I/O
15	I/O	46	I/O	77	GND	108	I/O
16	I/O	47	I/O	78	V_{CCA}	109	I/O
17	I/O	48	I/O	79	GND	110	I/O
18	I/O	49	I/O	80	See Table 4 on page 3	111	I/O
19	I/O	50	I/O	81	I/O	112	I/O
20	I/O	51	I/O	82	HCLK	113	I/O
21	I/O	52	GND	83	I/O	114	V_{CCA}
22	I/O	53	I/O	84	I/O	115	V_{CCI}
23	I/O	54	I/O	85	I/O	116	I/O
24	I/O	55	I/O	86	I/O	117	I/O
25	See Table 4 on page 3	56	I/O	87	I/O	118	I/O
26	GND	57	I/O	88	I/O	119	I/O
27	V_{CCA}	58	I/O	89	I/O	120	I/O
28	GND	59	I/O	90	I/O	121	I/O
29	I/O	60	V_{CCI}	91	I/O	122	I/O
30	See Table 4 on page 3	61	I/O	92	I/O	123	I/O
31	I/O	62	I/O	93	I/O	124	I/O

Table 3 • 208-Pin CQFP Common Pin Assignments for RT54SX32 and RT54SX32S (Continued)

Pin Number	Function	Pin Number	Function	Pin Number	Function	Pin Number	Function
125	I/O	146	GND	167	I/O	188	I/O
126	I/O	147	I/O	168	I/O	189	I/O
127	I/O	148	V_{CCI}	169	I/O	190	I/O
128	I/O	149	I/O	170	I/O	191	I/O
129	GND	150	I/O	171	I/O	192	I/O
130	V_{CCA}	151	I/O	172	I/O	193	I/O
131	GND	152	I/O	173	I/O	194	I/O
132	See Table 4	153	I/O	174	I/O	195	I/O
133	I/O	154	I/O	175	I/O	196	I/O
134	I/O	155	I/O	176	I/O	197	I/O
135	I/O	156	I/O	177	I/O	198	I/O
136	I/O	157	GND	178	I/O	199	I/O
137	I/O	158	I/O	179	I/O	200	I/O
138	I/O	159	I/O	180	CLKA	201	V_{CCI}
139	I/O	160	I/O	181	CLKB	202	I/O
140	I/O	161	I/O	182	See Table 4	203	I/O
141	I/O	162	I/O	183	GND	204	I/O
142	I/O	163	I/O	184	V_{CCA}	205	I/O
143	I/O	164	V_{CCI}	185	GND	206	I/O
144	I/O	165	I/O	186	PRA, I/O	207	I/O
145	V_{CCA}	166	I/O	187	I/O	208	TCK, I/O

Table 4 • Pin Differences – 208-Pin CQFP Package

Pin Number	RT54SX32 Function	RT54SX32S Function
25	V_{CCR}	NC
80	V_{CCR}	NC
132	V_{CCR}	NC
182	V_{CCR}	NC

Pin Differences – 208-pin CQFP Package

Pins 25, 80, 132, 182 – For the RT54SX32 device, V_{CCR}, the supply voltage for input tolerance, is 5.0V, and V_{CCI} is 3.3V. For the RT54SX32S device, V_{CCI} can be either 3.3V or 5.0V. V_{CCR} is eliminated in RT54SX32S; these pins are NC on that part. NC pins have no connection inside the RT54SX32S device and can be tied to GND, V_{CCA}, or V_{CCI} without any damage to the device.

Pin 65 – This pin is NC in both parts.

V_{CCA} pins - Although pin assignments are the same, voltage levels are as follows:

- RT54SX32 – 3.3V
- RT54SX32S – 2.5V

Similar information for the 256-pin CQFP package is given in Table 5 on page 4 (pin commonality) and Table 6 on page 5 (pin differences).

Pin Differences – 256-pin CQFP Package

Pins 159, 223 – For the RT54SX32 device, V_{CCR}, the supply voltage for input tolerance, is 5.0V, and V_{CCI} is 3.3V. For the RT54SX32S device, V_{CCI} can be either 3.3V or 5.0V. V_{CCR} is eliminated in RT54SX32S, as these pins are NC on that part. NC pins have no connection inside the RT54SX32S device and can be tied to GND, V_{CCA}, or V_{CCI} without any damage to the device.

Table 5 • 256-pin CQFP Common Pin Assignments for RT54SX32 and RT54SX32S

Pin Number	Function	Pin Number	Function	Pin Number	Function	Pin Number	Function
1	GND	39	I/O	77	I/O	115	I/O
2	TDI, I/O	40	I/O	78	I/O	116	I/O
3	I/O	41	I/O	79	I/O	117	I/O
4	I/O	42	I/O	80	I/O	118	I/O
5	I/O	43	I/O	81	I/O	119	I/O
6	I/O	44	I/O	82	I/O	120	I/O
7	I/O	45	I/O	83	I/O	121	I/O
8	I/O	46	V_{CCA}	84	I/O	122	I/O
9	I/O	47	I/O	85	I/O	123	I/O
10	I/O	48	I/O	86	I/O	124	I/O
11	TMS	49	I/O	87	I/O	125	I/O
12	I/O	50	I/O	88	I/O	126	TDO, I/O
13	I/O	51	I/O	89	I/O	127	I/O
14	I/O	52	I/O	90	PRB, I/O	128	GND
15	I/O	53	I/O	91	GND	129	I/O
16	I/O	54	I/O	92	V_{CCI}	130	I/O
17	I/O	55	I/O	93	GND	131	I/O
18	I/O	56	I/O	94	V_{CCA}	132	I/O
19	I/O	57	I/O	95	I/O	133	I/O
20	I/O	58	I/O	96	HCLK	134	I/O
21	I/O	59	GND	97	I/O	135	I/O
22	I/O	60	I/O	98	I/O	136	I/O
23	I/O	61	I/O	99	I/O	137	I/O
24	I/O	62	I/O	100	I/O	138	I/O
25	I/O	63	I/O	101	I/O	139	I/O
26	I/O	64	I/O	102	I/O	140	I/O
27	I/O	65	I/O	103	I/O	141	V_{CCA}
28	V_{CCI}	66	I/O	104	I/O	142	I/O
29	GND	67	I/O	105	I/O	143	I/O
30	V_{CCA}	68	I/O	106	I/O	144	I/O
31	GND	69	I/O	107	I/O	145	I/O
32	I/O	70	I/O	108	I/O	146	I/O
33	I/O	71	I/O	109	I/O	147	I/O
34	See Table 6 on page 5	72	I/O	110	GND	148	I/O
35	I/O	73	I/O	111	I/O	149	I/O
36	I/O	74	I/O	112	I/O	150	I/O
37	I/O	75	I/O	113	I/O	151	I/O
38	I/O	76	I/O	114	I/O	152	I/O

Table 5 • 256-pin CQFP Common Pin Assignments for RT54SX32 and RT54SX32S (Continued)

Pin Number	Function	Pin Number	Function	Pin Number	Function	Pin Number	Function
153	I/O	179	I/O	205	I/O	231	I/O
154	I/O	180	I/O	206	I/O	232	I/O
155	I/O	181	I/O	207	I/O	233	I/O
156	I/O	182	I/O	208	I/O	234	I/O
157	I/O	183	I/O	209	I/O	235	I/O
158	GND	184	I/O	210	I/O	236	I/O
159	See Table 6	185	I/O	211	I/O	237	I/O
160	GND	186	I/O	212	I/O	238	I/O
161	V_{CCI}	187	I/O	213	I/O	239	I/O
162	I/O	188	I/O	214	I/O	240	GND
163	I/O	189	GND	215	I/O	241	I/O
164	I/O	190	I/O	216	I/O	242	I/O
165	I/O	191	I/O	217	I/O	243	I/O
166	I/O	192	I/O	218	I/O	244	I/O
167	I/O	193	I/O	219	CLKA	245	I/O
168	I/O	194	I/O	220	CLKB	246	I/O
169	I/O	195	I/O	221	V_{CCI}	247	I/O
170	I/O	196	I/O	222	GND	248	I/O
171	I/O	197	I/O	223	See Table 6	249	I/O
172	I/O	198	I/O	224	GND	250	I/O
173	I/O	199	I/O	225	PRA, I/O	251	I/O
174	V_{CCA}	200	I/O	226	I/O	252	I/O
175	GND	201	I/O	227	I/O	253	I/O
176	GND	202	I/O	228	I/O	254	I/O
177	I/O	203	I/O	229	I/O	255	I/O
178	I/O	204	I/O	230	I/O	256	TCK, I/O

Table 6 • Pin Differences – 256-Pin CQFP Package

Pin Number	RT54SX32 Function	RT54SX32S Function
159	V_{CCR}	NC
223	V_{CCR}	NC

V_{CCA} pins - Although pin assignments are the same for both parts, voltage levels are as follows:

- RT54SX32 – 3.3V
- RT54SX32S – 2.5V

Conclusion

Actel's RT54SX-S family offers higher speed, expanded I/O standard support, and special radiation-tolerant flip-flops implemented in the hardware. The new family shares numerous architectural features with its predecessor, the RT54SX. In essence, as described in this technical brief, conversion of existing RT54SX designs to the RT54SX-S is a very straight forward process.

http://www.actel.com

Actel Europe Ltd.
Maxfli Court, Riverside Way
Camberley, Surrey GU15 3YL
United Kingdom
Tel: +44-(0)1276 401450
Fax: +44-(0)1276 401490

Actel Corporation
955 East Arques Avenue
Sunnyvale, California 94086
USA
Tel: (408) 739-1010
Fax: (408) 739-1540

Actel Asia-Pacific
EXOS Ebisu Bldg. 4F
1-24-14 Ebisu Shibuya-ku
Tokyo 150 Japan
Tel: +81-(0)3-3445-7671
Fax: +81-(0)3-3445-7668

5192679-0/8.01