



Titanium Reliability Report

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Introduction

The Titanium Ti60 & Ti180 FPGA features the high-density, low-power Efinix® Quantum™ compute fabric wrapped with an I/O interface in a small footprint package for easy integration.

Ti60 FPGAs are designed for highly integrated mobile and edge devices that need low power, a small footprint, and a multitude of I/Os. With ultra-low power Ti60 FPGAs, designers can build products that are always on, providing enhanced capabilities for applications such as mobile, edge, AI IoT, and sensor fusion.

Ti180 FPGAs include hardened MIPI D-PHY which can be used with Efinix® MIPI CSI-2 and DSI controller IP cores to create multi-camera, high-definition vision systems, edge computing, and hardware acceleration systems. Additionally, these FPGAs have a hardened DDR DRAM controller block that supports LPDDR4 DRAM interface. With ultra-low power Ti180 FPGAs, designers can build products that are always on, providing enhanced capabilities for applications such as vision systems, edge computing, hardware acceleration, and machine learning.

The Titanium platform consists of ten devices, built on TSMC's 16nm process, with a logic density range from 35K to 1M logic elements (LEs) and standard interfaces such as GPIO, PLLs, oscillators, MIPI, DDR, LVDS, PCI Express, etc. Titanium FPGAs target general-purpose custom logic markets (mobile, IoT, general consumer, industrial, and medical) as well as fast-growing markets such as compute acceleration and deep learning in edge devices.

This reliability report provides the reliability results for Titanium FPGAs. Efinix ensures standards compliance with this report.

Efinix Product Qualification Program

Efinix qualifies FPGAs using various reliability conditions.

Reliability Qualification Requirements

Table 1: Reliability Qualification Requirements

Refer to the data in the following sections for the sample size for each condition.

Reliability Condition	JEDEC Standard	Test Condition
Electrostatic Discharge – Human Body Model (HBM)	JS-001 AEC-Q100-002	Class 2, $\leq 2,000$ V
Electrostatic Discharge – Charged Device Model (CDM)	JS-002 AEC-Q100-011	Class C2a, ≤ 500 V
Latch-Up (LU)	JESD78 AEC-Q100-004	Class II, ± 100 mA trigger current VCC +50% on power supplies
Preconditioning (PC)	J-STD-020, JESD22-A113	Bake at 125 °C, 24 hours
		MSL 1: 85 °C/85% RH, 168 hours MSL 3: 30 °C/60% RH, 192 hours
		3 reflow cycles at 260 °C
High Temperature Operating Life (HTOL)	JESD22-A108	125 °C, 168, 500 & 1,000 hours
		125 °C, 168, 500, 1,000, 1,500 & 2,000 hours (selected devices only)
Temperature Cycling (TC)	JESD22-A104 AEC-Q006	-55 °C/150 °C, 500 & 1,000 cycles or -55 °C/125 °C, 500 & 1,000 cycles or -65 °C/150 °C, 500 & 1,000 cycles
		-55 °C/150 °C, 500, 1,000 & 2,000 cycles (selected devices only)
High Temperature Storage Life (HTSL)	JESD22-A103 AEC-Q006	150 °C, 168, 500 & 1,000 hours
		150 °C, 168, 500, 1,000 & 2,000 hours (selected devices only)
Unbiased Highly Accelerated Stress Test (uHAST)	JESD22-A118	130 °C/85% RH, 96 & 192 hours
Temperature Humidity Without Bias (TH)	JESD22-A101	85 °C/85% RH, 500 & 1,000 hours
Temperature Humidity Bias (THB)	JESD22-A101 AEC-Q006	85 °C/85% RH, V _{cc} max, 500 & 1,000 hours
		85 °C/85% RH, V _{cc} max, 500, 1,000 & 2,000 hours (selected devices only)
Power Temperature Cycle (PTC)	JESD22-A105	-40°C / 125°C, 500 & 1,000 cycles
Nonvolatile Memory Uncycled High Temperature Data Retention (UCHTDR)	JESD22-A117	150 °C, 168, 500 & 1,000 hours

Extension Reliability Test and Result by Similarity

The generation and use of generic data applied across a family of packages emanating from one base assembly process is a family qualification, or Qualification-by-Similarity (QBS). The package stresses uHAST and HTSL are considered generic for a given package technology. TC is considered generic up to an evaluated die size + package size + 10% for a given package technology. Pre-Conditioning (PC) is considered generic up to an evaluated peak reflow temperature for a given package technology.

ESD and Latch Up Qualification Data

The following sections describe the electrostatic discharge and latch-up test results.

Electrostatic Discharge - Human Body Model (ESD-HBM)

The Titanium product family was tested per the JS-001 Electrostatic Discharge (ESD) Sensitivity Test – Human Body Model – Component Level JEDEC Standard procedure or AEC-Q100-002 Human Body Model Electrostatic Discharge Test standard.

- *Test room ambient conditions*—Room temperature, humidity <60% RH
- *Test condition*—Class 2, ≤2,000 V

Table 2: ESD-HBM Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	9 units x 1 lot	Pass
	FBGA 100	-	QBS
	FBGA 225	9 units x 3 lots	Pass
	FBGA 256	-	QBS
	WLCSP 64	-	QBS
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	9 units x 1 lot	Pass
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS

	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Electrostatic Discharge - Charged Device Model (ESD-CDM)

The Titanium product family was tested per the JS-002 Electrostatic Discharge (ESD) Sensitivity Testing – Charged Device Model (CDM) – Device Level JEDEC Standard procedure or AEC-Q100-011 Charged Device Model Electrostatic Discharge Test standard.

- *Test room ambient conditions*—Room temperature, humidity <60% RH
- *Test condition*—Class C2a, ≤500 V

Table 3: ESD-CDM Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	6 units x 1 lot	Pass
	FBGA 100	-	QBS
	FBGA 225	6 units x 3 lots	Pass
	FBGA 256	6 units x 1 lot	Pass
	WLCSP 64	-	QBS
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	6 units x 1 lot	Pass
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Latch-Up (LU)

The Titanium product family was tested per the JESD78 Latch-up JEDEC Standard procedure or AEC-Q100-004 Latch-up Test standard.

- *Test room ambient conditions*—Room temperature, humidity <60% RH
- *Test condition*—±100 mA trigger current, V_{CC} +50% on power supplies, 125 °C

Table 4: LU Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	6 units x 1 lot	Pass
	FBGA 100	-	QBS
	FBGA 225	6 units x 3 lots	Pass
	FBGA 256	-	QBS
	WLCSP 64	-	QBS
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	6 units x 1 lot	Pass
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Life Data

This section describes the results of life testing.

High-Temperature Operating Life (HTOL)

The Titanium product family was tested per the JESD22-A108 High Temperature Operating Life (HTOL) JEDEC Standard procedure.

- *Stress duration*—168, 500, and 1,000 hours
- *Stress duration*—168, 500, 1,000, 1,500 and 2,000 hours (Ti60 FBGA 225 only)
- *Stress condition*— $T_j = 125\text{ }^\circ\text{C}$, maximum operating voltage

Table 5: HTOL Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	77 units x 4 lots ^{*(1)}	Pass
	FBGA 256	-	QBS
	WLCSP 64	-	QBS
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	77 units x 3 lots	Pass
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

* Note (1): 3 lots completed HTOL2000h test.

Package Qualification Data

The following sections describe the results of package qualification testing.

Preconditioning (PC)

The Titanium product family was tested per the J-STD-020 and JESD22-A113 JEDEC Standard procedure with Moisture Sensitivity Level 1 (MSL 1) or Level 3 (MSL 3). All devices stressed through temperature cycling, unbiased HAST and temperature humidity bias were preconditioned.

Table 6: PC Data (FBGA)

MSL 3: 24 hours bake at 125 °C, 30 °C/60% RH, 192 hours, 3 reflow cycles at 260 °C

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	77 units x 8 lots	Pass
	FBGA 100	77 units x 6 lots	Pass
	FBGA 225	77 units x 12 lots 45 units x 1 lot	Pass
	FBGA 256	77 units x 6 lots	Pass
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	77 units x 9 lots	Pass
	FCCSP 361	77 units x 6 lots	Pass
	HFCBGA529	77 units x 6 lots	Pass
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Table 7: PC Data (WLCSP)

MSL 1: 24 hours bake at 125°C, 85 °C/85% RH, 168 hours, 3 reflow cycles at 260 °C

Device	Package	Sample Size	Result
Ti60	WLCSP 64	77 units x 6 lots	Pass

Temperature Cycling (TC)

The Titanium product family was tested per the JESD22-A104 JEDEC Standard procedure and AEC-Q006 standard (Ti60 FBGA 225 only).

- *Stress duration*—500 and 1,000 cycles.
- *Stress duration*—500, 1,000 and 2,000 cycles (Ti60 FBGA 225 only)

Table 8: TC Data (FBGA)

Stress condition: -55 °C, 150 °C

Device	Package	Sample Size	Result
Ti60	FBGA 225	77 units x 4 lots	Pass
Ti35	FBGA 225	-	QBS
Ti180	FCCSP 484	77 units x 3 lots	Pass
Ti120	FCCSP 484	-	QBS
Ti90	FCCSP 484	-	QBS

Table 9: TC Data (FBGA)

Stress condition: -55 °C, 125 °C

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	77 units x 4 lots	Pass
	FBGA 100	77 units x 3 lots	Pass
	FBGA 256	77 units x 3 lots	Pass
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 361	77 units x 3 lots	Pass
	HFCBGA529	77 units x 3 lots	Pass
Ti120	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Table 10: TC Data (WLCSP)

Stress condition: -65 °C, 150 °C

Device	Package	Sample Size	Result
Ti60	WLCSP 64	77 units x 3 lots	Pass

Unbiased HAST (uHAST)

The Titanium product family was tested per the JESD22-A118 JEDEC Standard procedure.

- *Stress duration*—96 and 192 hours
- *Stress condition*—130°C/85% RH

Table 11: uHAST Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	77 units x 4 lots	Pass
	FBGA 100	77 units x 3 lots	Pass
	FBGA 225	77 units x 4 lots	Pass
	FBGA 256	77 units x 3 lots	Pass
	WLCSP 64	77 units x 3 lots	Pass
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	77 units x 3 lots	Pass
	FCCSP 361	77 units x 3 lots	Pass
	HFCBGA529	77 units x 3 lots	Pass
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Temperature Humidity Without Bias (TH)

The Titanium product family was tested per the JESD22-A101 JEDEC Standard procedure.

- *Stress duration*—500 and 1,000 hours
- *Stress condition*—85°C/85% RH

Table 12: TH Data

Device	Package	Sample Size	Result
Ti60	FBGA 225	77 units x 3 lots	Pass
Ti35	FBGA 225	-	QBS

High-Temperature Storage Life (HTSL)

The Titanium product family was tested per the JESD22-A103 JEDEC Standard procedure and AEC-Q100 standard (Ti60 FBGA 225 only).

- *Stress duration*—168, 500, and 1,000 hours
- *Stress duration*—168, 500, 1,000 and 2,000 hours (Ti60 FBGA 225 only)
- *Stress condition*— $T_a = 150\text{ }^{\circ}\text{C}$

Table 13: HTSL Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	77 units x 3 lots	Pass
	FBGA 100	-	QBS
	FBGA 225	77 units x 4 lots	Pass
	FBGA 256	77 units x 3 lots	Pass
	WLCSP 64	77 units x 3 lots	Pass
Ti35	FBGA SIP 100	-	QBS
	FBGA 100	-	QBS
	FBGA 225	-	QBS
	FBGA 256	-	QBS
Ti180	FCCSP 484	77 units x 3 lots	Pass
	FCCSP 361	77 units x 3 lots	Pass
	HFCBGA529	77 units x 3 lots	Pass
Ti120	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS
Ti90	FCCSP 484	-	QBS
	FCCSP 361	-	QBS
	HFCBGA529	-	QBS

Temperature Humidity Bias (THB)

The Titanium product family was tested per the JESD22-A101 JEDEC Standard procedure and AEC-Q006 standard (Ti60 FBGA 225 only).

- *Stress duration*— 500, and 1,000 hours
- *Stress duration*— 500, 1,000 and 2,000 hours (Ti60 FBGA 225 only)
- *Stress condition*— $85\text{ }^{\circ}\text{C}/85\% \text{ RH}, V_{cc} \text{ max}$

Table 14: THB Data

Device	Package	Sample Size	Result
Ti60	FBGA 225	77 units x 4 lots	Pass
Ti35	FBGA 225	-	QBS
Ti180	FCCSP 484	77 units x 3 lots	Pass

Ti120	FCCSP 484	-	QBS
Ti90	FCCSP 484	-	QBS

Power Temperature Cycle (PTC)

The Titanium product family was tested per the JESD22-A105 JEDEC Standard procedure.

- *Stress duration*— 500 and 1,000 cycles
- *Stress condition*— $T_a = -40^{\circ}\text{C}$ to $+125^{\circ}\text{C}$

Table 15: PTC Data

Device	Package	Sample Size	Result
Ti60	FBGA 225	45 units x 1 lot	Pass
Ti35	FBGA 225	-	QBS

Nonvolatile Memory Data

This section describes the results of nonvolatile memories data retention testing.

Uncycled High Temperature Data Retention (UCHTDR)

The Titanium product family was tested per the JESD22-A117 Electrically Erasable Programmable ROM (EEPROM) Program/Erase Endurance and Data Retention Stress Test JEDEC Standard procedure.

- *Stress duration*—168, 500, and 1,000 hours
- *Stress condition*— $T_a=150^{\circ}\text{C}$

Table 16: UCHTDR Data

Device	Package	Sample Size	Result
Ti60	FBGA SIP 100	77 units x 3 lots	Pass
Ti35	FBGA SIP 100	-	QBS

Revision History

Date	Version	Description
January 2022	1.0	Initial release.
March 2023	2.0	Add qualification data for Ti60 FBGA225 and Ti60 WLCSP64 devices. Add UCHTDR data for Ti60 FBGA SIP100 device.
February 2024	3.0	Add qualification data for Ti35 FBGA225, Ti90/Ti120/Ti180 FCCSP484, Ti90/Ti120/Ti180 FCCSP361 and Ti90/Ti120/Ti180 HFCBGA529 devices. Add THB data for Ti60/Ti35 FBGA225 devices.
July 2024	4.0	Add qualification data for Ti35/Ti60F100 SIP (with enhanced security features) and Ti35/Ti60F100 non-SIP packages.
August 2024	5.0	Add qualification data for Ti60/Ti35 FBGA225 device (with enhanced security features).
November 2024	6.0	Add HTOL2000h, THB2000h, TC2000x and HTSL2000h data for Ti60 FBGA225 device. Add qualification data for Ti35/Ti60F256 devices.