

Application Report SPRACC7–January 2018

# AM574x Extended Power-On Hours (POH)

Mike Hannah

Catalog Processor

#### ABSTRACT

This application report provides guidelines for extending the operational lifetime of an AM574x device from 100k Power-On Hours (POH) up to 200k POH. The data provided are operational lifetime estimates and do not guarantee the lifetime of the device.

#### Contents

1	Introduction	1
2	Wear-Out Mechanisms	1
3	Guidelines for Extended POH	2
4	Summary	2
5	References	2
-		

# Trademarks

All trademarks are the property of their respective owners.

#### 1 Introduction

Many industrial applications require systems to operate 24 hours a day and seven days a week for several years. To keep those industrial systems in operation, it is important to be able to predict the wear-out of the systems so the equipment can be serviced and maintained to try to prevent a failure during normal operation. The semiconductor devices that are designed into those systems have typically been expected to reach estimated lifetimes of 100k POH at maximum junction temperature (Tj). Now, with a demand for reduced maintenance, industrial systems must meet even longer operational lifetimes. To help facilitate this at the semiconductor component level, this document details the requirements and limitations to extend the estimated operational lifetime of the AM574x processor from 100k POH up to 200k POH.

# 2 Wear-Out Mechanisms

*Calculating Useful Lifetimes of Embedded Processors* provides a methodology for calculating the useful lifetime of TI embedded processors under power when used in electronic systems. It discusses the stages of reliability, the useful life period, and complementary metal-oxide semiconductor (CMOS) wear-out mechanisms. The primary wear-out mechanism discussed in the application note was electro-migration.

As each semiconductor process node is unique, some wear-out mechanism may affect the estimated lifetime of the devices in different ways.

For the AM574x, the following CMOS wear-out mechanisms were evaluated to extend the estimated operational lifetime of the device:

- Electro-Migration
- Gate Oxide Integrity
- Negative Bias Temperature Instability
- Channel Hot Carrier

The guidelines detailed in the next section were generated as a result of that evaluation.



www.ti.com

Guidelines for Extended POH

#### **3** Guidelines for Extended POH

For extended POH up to 200k POH (greater than 20 years), the same restrictions apply as noted for 100k POH in the *Power-On Hours Limits* section of the *AM574x Sitara™ Processors Silicon Revision 1.0 Data Manual* (SPRS982).

In addition to restrictions noted for 100kPOH at  $T_J = 105^{\circ}C$  in the AM574x data manual, the following restrictions also apply to enable POH greater than 100k hours:

- MPU (Arm Cortex A15) operation only at nominal (OPP\_NOM) or overdrive (OPP\_OD) operating points
  - No OPP\_HIGH operation for the MPU voltage domain
  - No restrictions on OPP's for other domains
- To extend POH to 200k POH, Tj must be ≤90C for at least 50k hours of the extended operational profile
- All 24-bit VOUT display interfaces must be enabled only at 1.8V to allow up to 200k POH
  - VOUT operation at 3.3 V is allowed up to 100k POH at T<sub>J</sub> = 105°C
  - Other input/output interfaces multiplexed on VOUT pins may be enabled at 3.3 V with appropriate tolerance up to 200k POH
- All LVCMOS interfaces operating at 3.3 V must be constrained to 3.3 V DC+2% or reduced to 1.8 V operation
- No MMC4 interface operation beyond 100k POH. There are three other MMC interfaces on AM574x that can be used for extended operation up to 200k POH.

# 4 Summary

With some careful design considerations, the AM574x processor can enable estimated POH up to 200k hours. Adjusting the thermal design of the system to allow slightly lower junction temperature and careful consideration of LVCMOS interface design can allow systems to reach longer operational lifetimes using the AM574x.

# 5 References

- Calculating Useful Lifetimes of Embedded Processors
- AM574x Sitara<sup>™</sup> Processors Silicon Revision 1.0 Data Manual (SPRS982)

2

#### IMPORTANT NOTICE FOR TI DESIGN INFORMATION AND RESOURCES

Texas Instruments Incorporated ('TI") technical, application or other design advice, services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using any particular TI Resource in any way, you (individually or, if you are acting on behalf of a company, your company) agree to use it solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources.

You understand and agree that you remain responsible for using your independent analysis, evaluation and judgment in designing your applications and that you have full and exclusive responsibility to assure the safety of your applications and compliance of your applications (and of all TI products used in or for your applications) with all applicable regulations, laws and other applicable requirements. You represent that, with respect to your applications, you have all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. You agree that prior to using or distributing any applications. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

You are authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING TI RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY YOU AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

You agree to fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of your noncompliance with the terms and provisions of this Notice.

This Notice applies to TI Resources. Additional terms apply to the use and purchase of certain types of materials, TI products and services. These include; without limitation, TI's standard terms for semiconductor products <a href="http://www.ti.com/sc/docs/stdterms.htm">http://www.ti.com/sc/docs/stdterms.htm</a>), evaluation modules, and samples (<a href="http://www.ti.com/sc/docs/stdterms.htm">http://www.ti.com/sc/docs/stdterms.htm</a>), evaluation

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265 Copyright © 2018, Texas Instruments Incorporated