

Scope

This document provides the estimated Power-on Hours (PoH), also known as “lifetime,” for the SAMA7G5/D6 Series products and describes a method to calculate PoH values for a given mission profile.

The document applies to the following devices:

- SAMA7G54(T)-V/4HB
- SAMA7G54(T)-E/4HB(VAO)
- SAMA7D65(T)-V/4HB
- SAMA7D65(T)-E/4HB(VAO)



The product lifetimes described here are estimates and do not represent guaranteed lifetimes for particular profiles.

Reference Documents

The following reference documents are available on www.microchip.com.

Type	Title	Literature Number
Data sheet	SAMA7G5 Series	DS60001765
Application note	SAMA7G5 Series Temperature Sensor Calibration	AN4530
Application note	SAMA7G5 Series Power Consumption and Thermal Considerations	AN4797
Data sheet	SAMA7D6 Series	DS60001851
Application note	SAMA7D6 Series Temperature Sensor Calibration	AN5812
Application note	SAMA7D6 Series Power Consumption and Thermal Considerations	AN5821

1. Introduction

The aging process of semiconductors strongly depends on the junction temperature and voltage at which devices are operated. As per Arrhenius' Law, higher temperatures or higher VDDs exponentially decrease a device's lifetime.

The lifetime estimates presented in this application note are extrapolated from high temperature and VDD tests performed on SAMA7G5/D6 Series devices. Those tests are also known as HTOL (High Temperature Operating Life) tests.



The data presented in this application note do not cover the SAMA7G5/D6 Series System-in-Package (SiP) devices with embedded SDRAM.

2. Definition of Terms

The following table provides the definition of terms and the technological data that are used in the following sections. Note that the technological data are different for Automotive and Industrial or Extended Industrial devices.

Table 2-1. Definition of Terms⁽¹⁾

Symbol	Definitions
Generic	
T_J	Device junction temperature
VDD	VDDCPU voltage
User Mission Profile Data	
MP	User Mission Profile: a set of operating points (T_J ,VDD)
POH_{MP_TARGET}	User Power-on Hours target with MP mission profile. This is the total time when the device is powered.
U%	Percentage of time spent in each MP operating point
$POH(T_J)$	Power-on Hours spent at T_J . $POH(T_J) = POH_{MP_TARGET} \times U\%$
Technological Data See Figure 3-1 and Table 3-2 for Industrial devices and Figure 4-1 and Table 4-2 for Automotive devices	
$POH_Q(T_J, VDD)$	Qualified equivalent hours at T_J , VDD, in particular $POH_Q(125^\circ C, 1.15V) =$ <ul style="list-style-type: none"> • 29576 for Industrial tier • 5733 for Automotive tier
$DR(T_J)$	Temperature-derating ratio at T_J : $POH_{TQ}(T_J, VDD) = DR(T_J) \times POH_{TQ}(125^\circ C, VDD)$ See Table 3-2 and Table 4-2 .
VAF	Voltage Acceleration Factor $POH_{TQ}(T_J, VDD) = VAF \times POH_{TQ}(T_J, 1.15V)$ <ul style="list-style-type: none"> • VAF = 2.72 for VDD = 1.05V operation • VAF = 1.00 for VDD = 1.15V operation • VAF = 0.368 for VDD = 1.25V operation
Calculated Quantities	
$POH_{MP}(125^\circ C, 1.15V)$	Mission profile equivalent Power-on Hours at one point (125°C, 1.15V): $POH(125^\circ C, 1.15V) = POH(T_J) / (VAF \cdot DR(T_J))$ If this number exceeds $POH_Q(125^\circ C, 1.15V)$ then the mission profile MP is more demanding than the HTOL test.
POH_{MP_EST}	Estimated Power-on Hours with given MP: $POH_{MP_EST} = POH_{MP_TARGET} \times POH_Q(125^\circ C, 1.15V) / POH_{MP}(125^\circ C, 1.15V)$

Note:

1. In the above table, $POH_{TQ}(T_J, VDD)$ means either $POH(T_J, VDD)$ or $POH_Q(T_J, VDD)$.

3. Industrial Device Lifetime Estimates

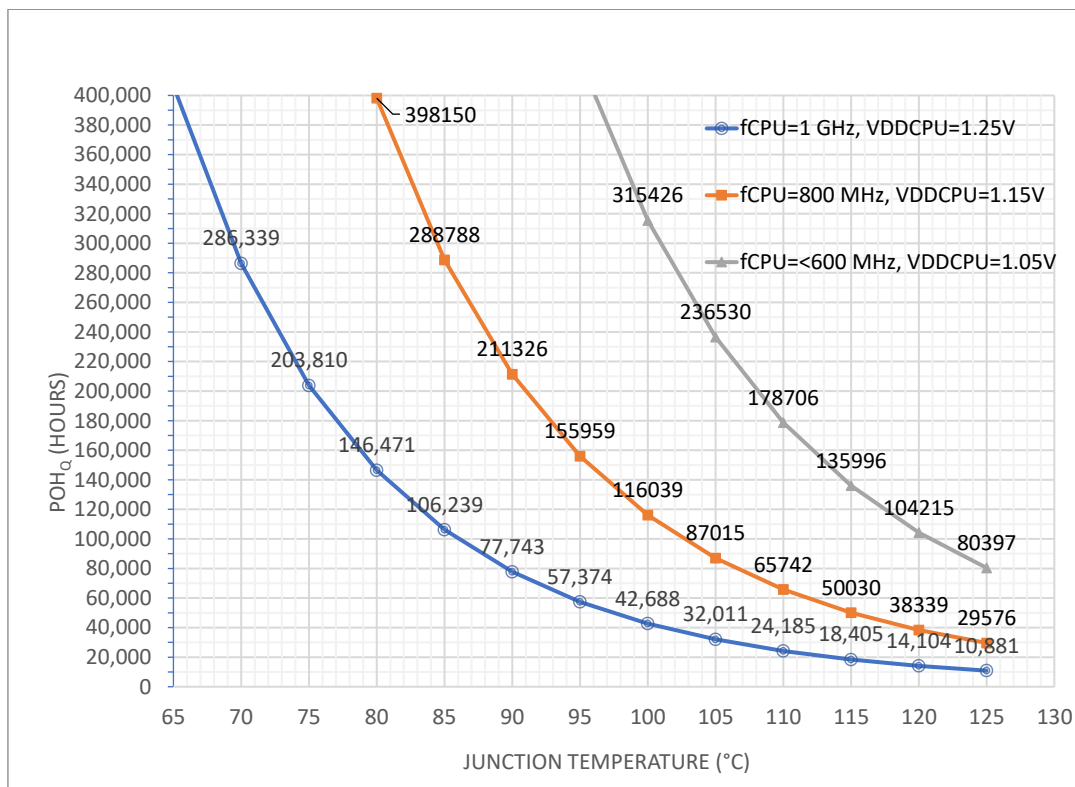
Table 3-1. Industrial Device Power-on Hours - $POH_Q(T_J, VDD)$

Marking	Tier	T_J (°C)	Arm® Core Frequency (MHz)	VDDCPU (V)	Power-on Hours (Hrs)
-V/4HB or -E/4HB	Industrial or Extended Industrial	105	1000	1.25	32,011
			800	1.15	87,015
			600	1.05	236,530
-E/4HB	Extended Industrial	125	800	1.15	29,576
			600	1.05	80,397

The following chart shows the estimated PoH for different junction temperatures and different VDDCPU values. This chart applies to both Industrial (-V/4HB) and Industrial Extended (-E/4HB) devices. VDDCORE is set to 1.15V for SAMA7G54 devices and 1.05V for SAMA7D65 devices.

Note: Industrial devices cannot be operated above a junction temperature of 105°C.

Figure 3-1. Industrial Device Power-on Hours vs VDDCPU and Derating Chart - $POH_Q(T_J, VDD)$



3.1. Industrial Device Mission Profile Example

The values shown in the section [Industrial Device Lifetime Estimates](#) are based on estimates for an always-on device (100% up time). However, all applications are not up 100% of the time and may switch from one operating point (T_J , VDD) to another. Such considerations must be taken into account when estimating lifetime.

To estimate a specific mission profile, use the following tables and examples.

[Table 3-2](#), built from applicable product qualification, temperature and voltage aging acceleration values, lists the **A**, **B**, **C** and **D** operating points referred to in the example below.

Table 3-2. Industrial Device Power-on Hours Derating Values - DR(T_J)

T_J °C < 25°C	DR(T_J)	Mission Profile Example
30	598	
35	387	
40	254	
45	169	
50	114	A
55	77.7	
60	53.6	
65	37.3	
70	26.3	B
75	18.7	
80	13.5	
85	9.8	
90	7.1	
95	5.3	
100	3.9	C
105	2.9	
110	2.2	
115	1.7	
120	1.3	
125	1	D

[Table 3-3](#) summarizes a mission profile example with the following details:

- A target lifetime: PoH_{MP_TARGET}
- 4 operating points (VDD, T_J)
- A usage percentage in each operating point

$$PoH_{MP_TARGET} = 60,000 \text{ Hrs}$$

Table 3-3. Industrial Device Mission Profile Example

MP	U%	PoH(T_J , VDD)	T_J °C	V _{DD} (V)	DR(T_J)	VAF	PoH(125°C, 1.15V)	Comment
A	25	15000	50	1.05	114	2.72	48	15000 / 114 / 2.72 = 48
B	25	15000	70	1.15	26.3	1.00	570	15000 / 26.3 / 1 = 570
C	25	15000	100	1.05	4	2.72	1406	15000 / 4 / 2.72 = 1406
D	25	15000	125	1.25	1	0.368	40774	15000 / 1 / 1 = 40774
PoH_{MP}(125°C, 1.15V) =							42799	

The $PoH(125^{\circ}C, 1.15V)$ column is computed for each line of the mission profile by derating $PoH(T_j, VDD)$ with $DR(T_j)$ and VAF (temperature and voltage derating). Computation results are then summed up into a single value.

- If the computed $PoH_{MP}(125^{\circ}C, 1.15V)$ is greater than $PoH_Q(125^{\circ}C, 1.15V)$, then the required PoH_{MP_TARGET} exceeds the device lifetime emulated during the HTOL tests, as in this example. In such a case, the mission profile must be reviewed.
- Conversely, if $PoH_{MP}(125^{\circ}C, 1.15V)$ is less than $PoH_Q(125^{\circ}C, 1.15V)$, then the mission profile MP is covered by the HTOL tests.

As explained above, $PoH_{MP_TARGET} = 60$ kHrs cannot be reached with the example mission profile MP. However, it is interesting to estimate the Power-on Hours with such a mission profile, PoH_{MP_EST} . See the applicable formula in [Table 2-1](#) and its application in the following table.

Table 3-4. Estimated PoH for Example Industrial Device Mission Profile

Result	Value in Hours	Comment
PoH_{MP_EST}	41463	60,000 * 29576 / 42799

4. Automotive Device Lifetime Estimates

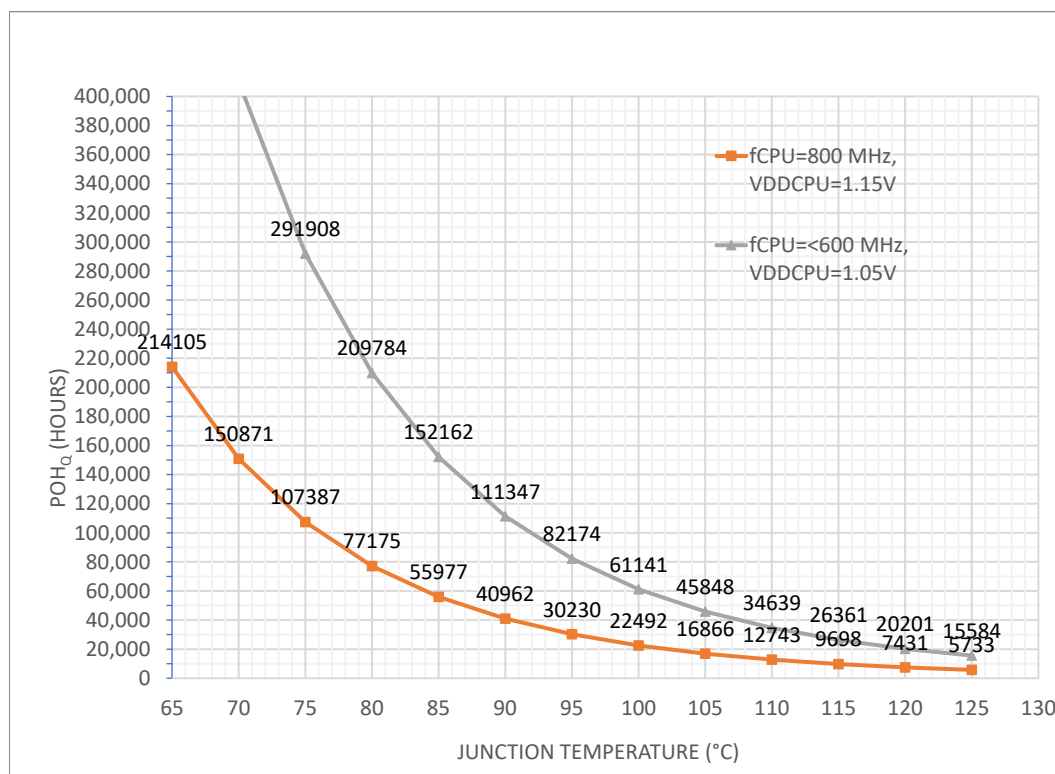
In the following sections, the estimated PoH are derived from an AEC-Q100 qualification using the following mission profile: 20 kHrs, with junction temperature usage as (-40°C = 6%, 70°C = 25%, 85°C = 25%, 100°C = 25%, 115°C = 14%, 125°C = 5%) and maximum CPU speed = 800 MHz.

Table 4-1. Automotive Device Power-on-Hours - $PoH_Q(T_J, VDD)$

Marking	Tier	T_J (°C)	Arm® Core Frequency (MHz)	VDDCPU (V)	Power-on Hours (Hrs)
-V/4HBVAO	Automotive	105	800	1.15	16,866
			600	1.05	45,848
		125	800	1.15	5,733
			600	1.05	15,584

The following chart shows the estimated PoH for different junction temperatures and 1.15V or 1.05V VDDCPU power supply. VDDCORE is set to 1.15V.

Figure 4-1. Automotive Device Power-On Hours Derating Chart - $PoH_Q(T_J, VDD)$



4.1. Automotive Device Mission Profile Example

The values shown in [Automotive Device Lifetime Estimates](#) are based on estimates for an always-on device (100% up time). However, all applications are not up 100% of the time and may switch from one operating point (VDD, T_J) to another. Such considerations must be taken into account when estimating lifetime.

To estimate a specific mission profile, use the following tables and examples.

[Table 4-2](#), built from applicable product qualification, temperature and voltage aging acceleration values, lists the **A**, **B**, **C**, **D**, **E** and **F** operating points referred to in the example below.

Table 4-2. Automotive Device Power-on Hours Derating Values

T_J	$DR(T_J)$	Mission Profile Example
$T_J < 25^\circ\text{C}$	937.50	A
30	598.14	
35	387.23	
40	254.20	
45	169.09	
50	113.90	
55	77.66	
60	53.56	
65	37.35	
70	26.32	B
75	18.73	
80	13.46	
85	9.76	C
90	7.15	
95	5.27	
100	3.92	D
105	2.94	
110	2.22	
115	1.69	E
120	1.30	
125	1	F

[Table 4-3](#) summarizes a mission profile example with the following details:

- A target lifetime: PoH_{MP_TARGET}
- 6 operating points (VDD, T_J)
- A usage percentage in each operating point

$PoH_{MP_TARGET} = 20,000$ Hrs

Table 4-3. Automotive Device Mission Profile Example

MP	U%	PoH(T_j , VDD)	T_j °C	V_{DD} (V)	DR(T_j)	VAF	PoH(125°C, 1.15V)	Comment
A	6	1200	-40	1.15	938	1	1.28	1200 / 938 / 1 = 1.28
B	25	5000	70	1.15	26.3	1	190	5000 / 26.3 / 1 = 190
C	25	5000	85	1.15	9.76	1	512	5000 / 9.76 / 1 = 512
D	25	5000	100	1.15	4	1	1274.4	5000 / 4 / 1 = 1274
E	14	2800	115	1.15	2	1	1655.3	2800 / 2 / 1 = 1655
F	5	1000	125	1.15	1	1	1000	1000 / 1 / 1 = 1000
PoH_{MP}(125°C, 1.15V) =							4633	

The PoH(125°C, 1.15V) column is computed for each line of the mission profile by derating PoH(T_j , VDD) with DR(T_j) and VAF (temperature and voltage derating). Computation results are then summed up into a single value.

- If the computed PoH_{MP}(125°C, 1.15V) is greater than PoH_Q(125°C, 1.15V), then the required PoH_{MP_TARGET} exceeds the device lifetime emulated during the HTOL tests. In such a case, the mission profile must be reviewed.
- Conversely, if PoH_{MP}(125°C, 1.15V) is less than PoH_Q(125°C, 1.15V), as in this example, then the mission profile MP is covered by the HTOL tests.

As explained above, PoH_{MP_TARGET} = 20 kHrs is reached with the example mission profile MP. However, it is interesting to estimate the Power-on Hours with such a mission profile, PoH_{MP_EST}. See the applicable formula in [Table 2-1](#) and its application in the following table.

Table 4-4. Estimated PoH for Example Automotive Device Mission Profile

Result	Value in Hours	Comment
PoH _{MP_EST}	24748	20000 * 5733 / 4633

5. Revision History

5.1. Rev. D - 05/2025

Scope extended to SAMA7D65(T)-E/4HB(VAO)
Updated [Reference Documents](#)

5.2. Rev. C - 11/2024

- Document reworked
- Scope extended to new devices

5.3. Rev. B - 12/2023

Added Automotive content throughout
Changed document status from “Distribution under Non-Disclosure Agreement (NDA)” to “Public”
Updated [Reference Documents](#)
Added Caution in [Introduction](#)

5.4. Rev. A - 05/2022

First issue.

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