i.MX 6SoloX Product Lifetime Usage Estimates

This document describes the estimated product lifetimes for the i.MX 6SoloX applications processors based on the criteria used in the qualification process.

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

Contents

1 Introduction

The i.MX 6 series consists of an extensive number of processors that deliver a wide range of processing and multimedia capabilities across various qualification levels.

This document provides users with guidance to interpret the i.MX 6SoloX qualification levels in terms of the target operating frequency of the device, the maximum supported junction temperature (Tj) of the processor, and how these parameters relate to the lifetime of the device.

Each qualification level supported (Extended Commercial, Industrial, Automotive) defines a number of power-on hours (PoH) available to the processor under a given set of conditions, such as:

- The target frequency for the application (commercial, industrial, automotive).
  a) The target frequency is determined by the input voltage to the processor's core complex (VDD_ARM_IN).
  b) The use of LDO-enabled or LDO-bypass mode.
    – When using LDO-bypass mode, the target voltage should not be set to the minimum specified in the datasheet. All power management ICs have allowable tolerances. The target voltage must be set higher than the minimum specified voltage to account for the tolerance of the PMIC. The tolerance assumed in the calculations in this document is +/-25 mV.
    – LDO-enabled mode uses the regulators on the i.MX 6 series. These regulators are well characterized and can be set to output the exact minimum specified voltage. Longer power-on-hours can be achieved using LDO-enabled mode.
- The percentage of active use vs. standby.
  a) Active use means that the processor is running in an active performance mode.
    – For the Extended Commercial tier, there are two available active performance modes: 996 MHz and 792 MHz.
    – For the Automotive and Industrial tiers, there is only one active performance mode: 792 MHz.
  b) In standby/DSM mode the datasheet defines lower operating conditions for VDD_ARM_IN and VDD_SOC_IN reducing power consumption and junction temperature. In this mode, the voltage and temperature are set low enough so that the effect on the lifetime calculations is negligible and treated as if the device were powered off.
- The junction temperature (Tj) of the processor.
  a) The maximum junction temperature of the device is different for each tier of the product, e.g., 105^{o} C for extended commercial or industrial, and 125^{o} C for automotive. This maximum temperature is guaranteed by the final test.
  b) Users must ensure that their device is appropriately thermally managed such that the maximum junction temperature is not exceeded.

NOTE

All data provided within this document are estimates for PoH that are based on extensive qualification experience and testing with the i.MX 6 series. These statistically derived estimates should not be viewed as a limit on an individual device's lifetime, nor should they be construed as a guarantee by Freescale as to the actual lifetime of the device. Sales and warranty terms and conditions still apply.

1.1 Device qualification level and available PoH

1.1.1 Extended commercial qualification

Table 1. Extended commercial qualification lifetime estimates

	ARM® Core Speed (MHz)	Power-on Hours [PoH] (Hrs)	ARM Core Operating Voltage (V)	Junction Temperature [T_j] (°C)
Use case C1: LDO Enabled	996	21,900	1.225	105
	792	46,363	1.15	105
Use case C1: LDO Bypassed	996	12,019	1.285	105
	792	32,671	1.185	105

Figure 1 and Figure 3 establish guidelines for estimating PoH as a function of CPU frequency and junction temperature. PoH can be read directly off of the charts below to determine the necessary trade-offs to be made to CPU frequency and junction temperature to increase the estimated PoH of the device.

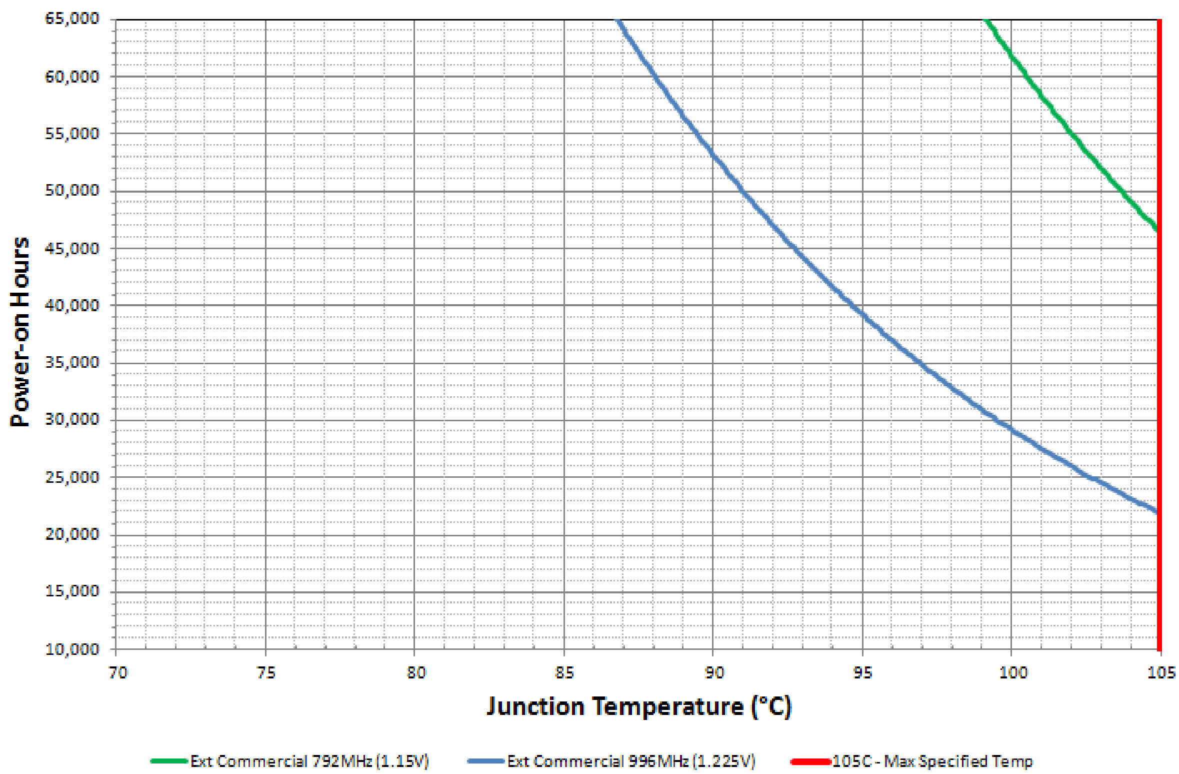

Figure 1. i.MX 6SoloX extended commercial estimates LDO enabled

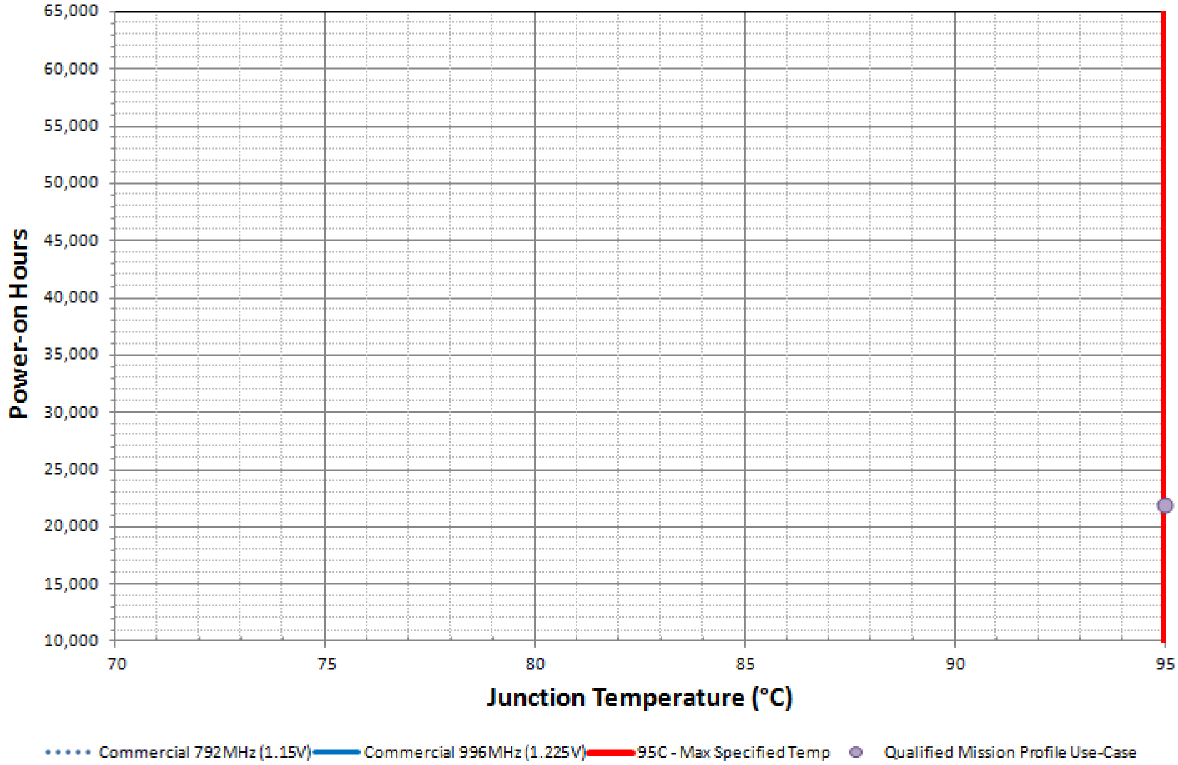

Figure 2. i.MX 6SoloX extended commercial lifetime estimates LDO bypass (a)

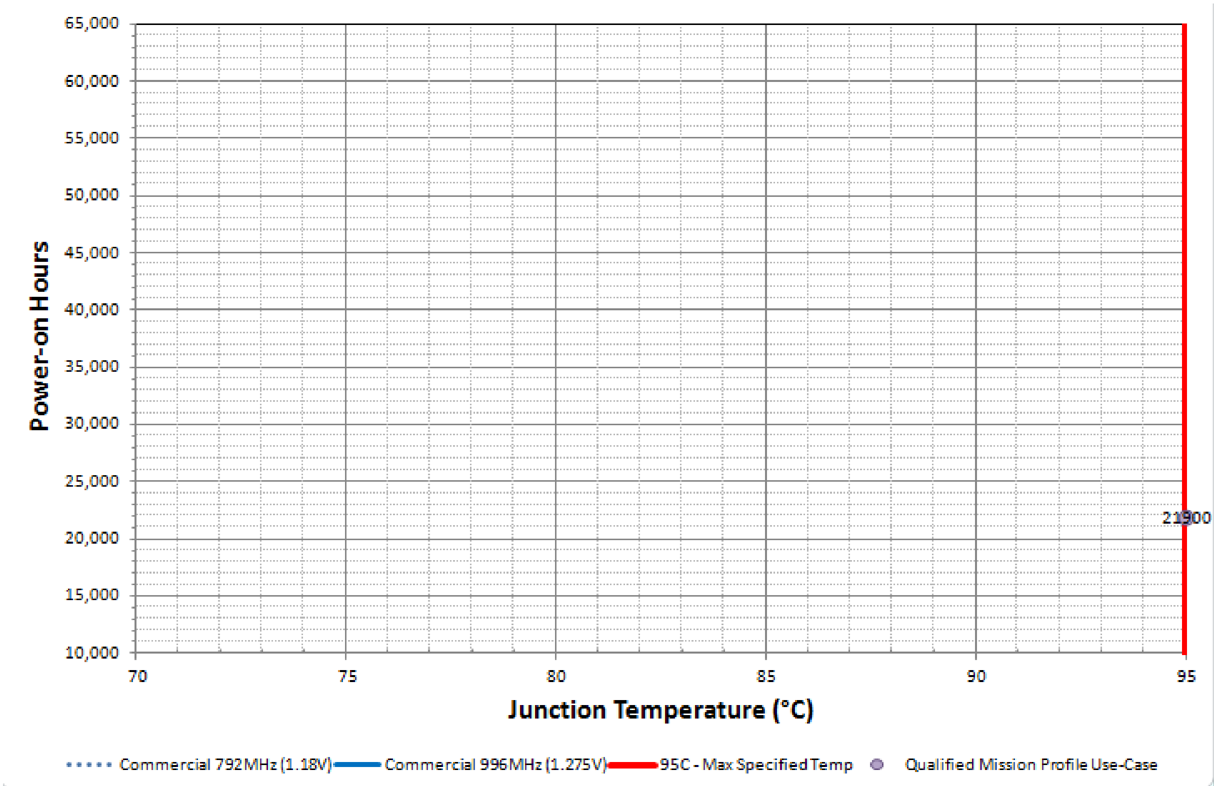

Figure 3. i.MX 6SoloX extended commercial lifetime estimates LDO bypass (b)

1.1.2 Automotive qualification

Table 2 provides the number of PoH for the typical use conditions for the automotive device.

Table 2. Automotive qualification lifetime estimates

	ARM Core Speed (MHz)	Power-on Hours [PoH] (Hrs)	ARM Core Operating Voltage (V)	Junction Temperature [T_j] (°C)
Use case C1: LDO Enabled	792	22,113	1.15	125
	792	65,075	1.115	105
Use case C1: LDO Bypassed	792	15,583	1.185	125
	792	45,858	1.185	105

Figure 4 and Figure 5 establish guidelines for estimating PoH as a function of CPU frequency and junction temperature. PoH can be read directly off of the charts below to determine the necessary trade-offs to be made to CPU frequency and junction temperature to increase the estimated PoH of the device.

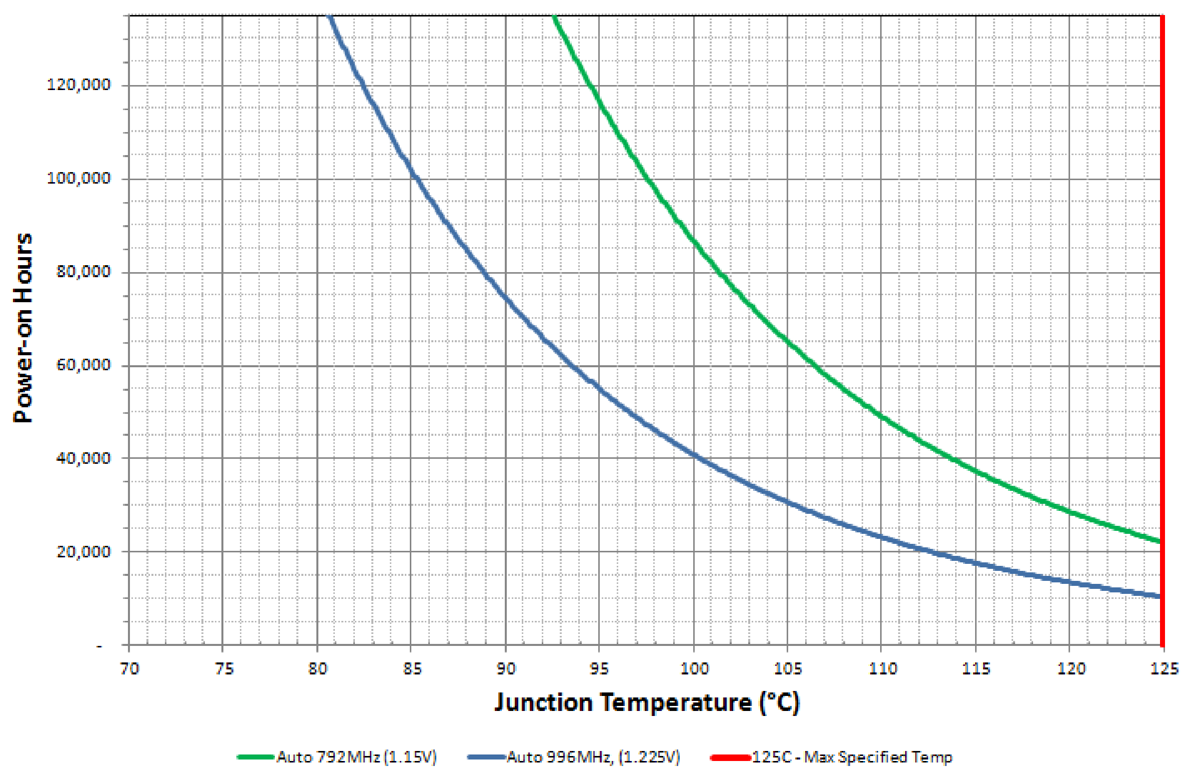

Figure 4. i.MX 6SoloX automotive lifetime estimates LDO enabled mode

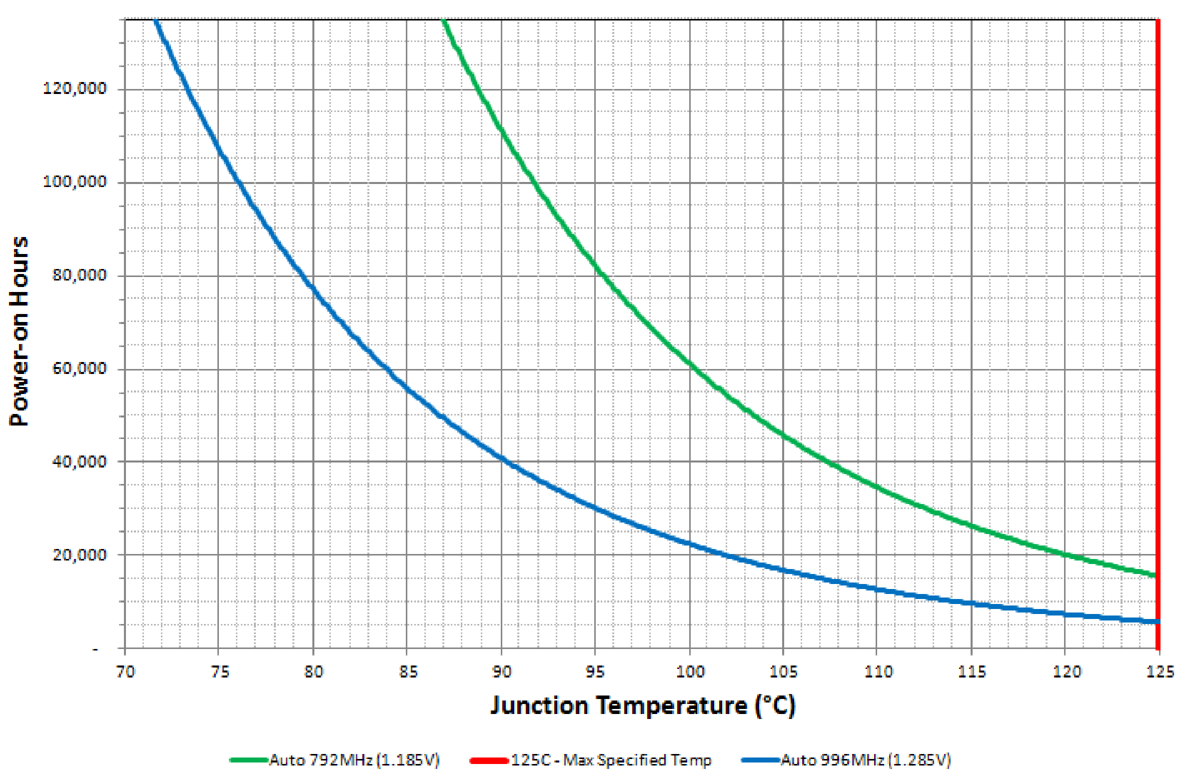

Figure 5. i.MX 6SoloX automotive lifetime estimates LDO bypass mode

1.1.3 Industrial qualification

Table 3 provides the number of PoH for the typical use conditions for an industrial device.

Table 3. Industrial qualification lifetime estimate

	ARM Core Speed (MHz)	Power-on Hours [PoH] (Hrs)	ARM Core Operating Voltage (V)	Junction Temperature [T_j] (°C)
Use case C1: LDO Enabled	792	112,970	1.15	105
Use case C1: LDO Bypassed	792	79,609	1.185	105

Figure 6 and Figure 7 establish guidelines for estimating PoH as a function of CPU frequency and junction temperature. PoH can be read directly off of the charts below, to determine the necessary trade-offs to be made to CPU frequency and junction temperature to increase the estimated PoH of the device.

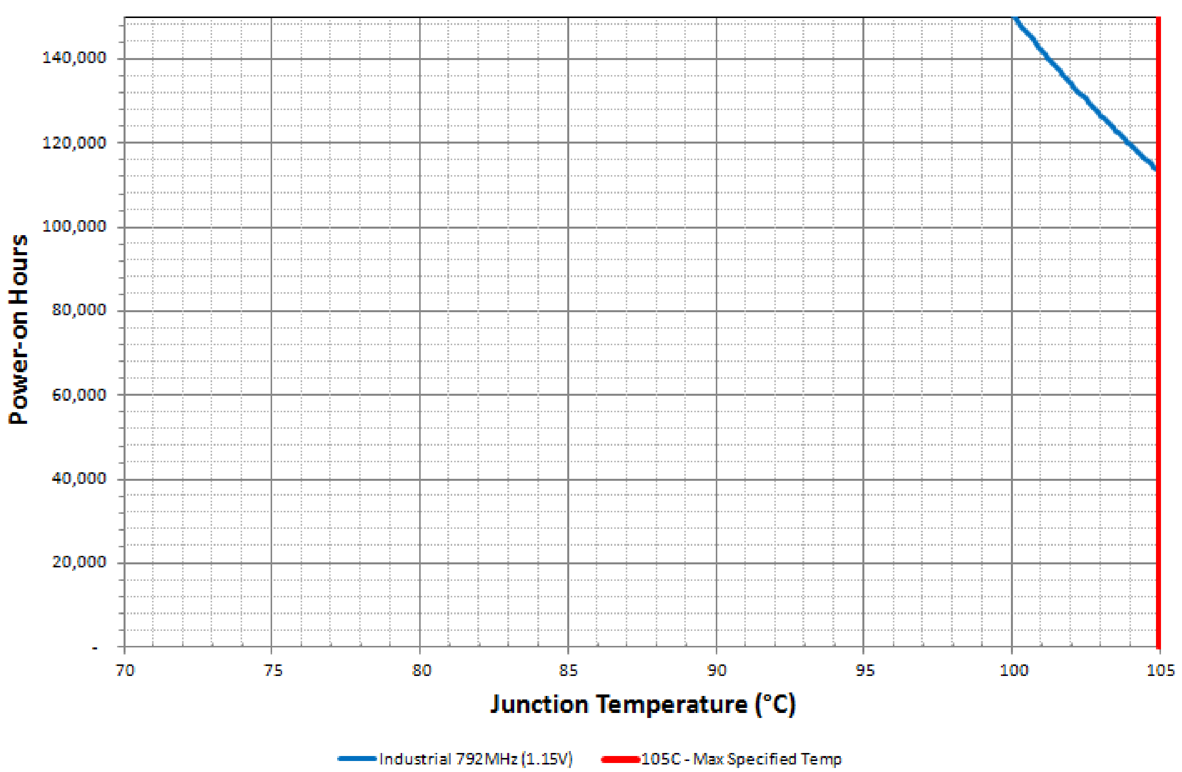

Figure 6. i.MX 6SoloX industrial lifetime estimates LDO enabled mode

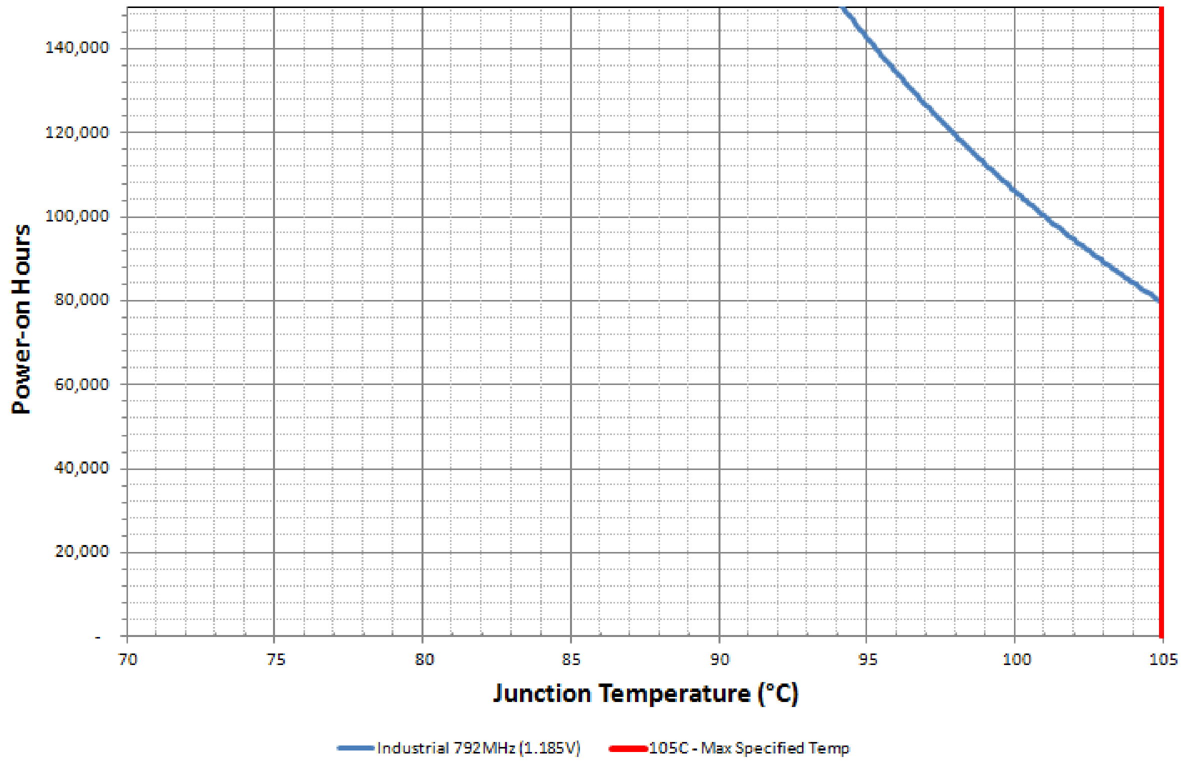

Figure 7. i.MX 6SoloX industrial lifetime estimates LDO bypass mode

2 Combining Use Cases

In some applications, a constant operating use case cannot deliver the target PoH. In this case, it is advantageous to use multiple operating conditions. This method provides some of the lifetime benefits of running at a lower performance use case, while keeping the ability of the system to use the highest performance state dictated by the application's demands.

2.1 Switching between two power states with different voltages.

In this scenario, the system is using a 996 MHz full power state and a 792 MHz reduced power state. It is assumed for these calculations that the temperature stays constant in either mode. If the system spends 50% of its power-on-time at 996 MHz and 50% of its power-on-time at 792 MHz, the two POH (as shown in Figure 8) can be combined with using those percentages: 61,500 x 0.5 + 29,000 x 0.5 = 45,250 PoH.

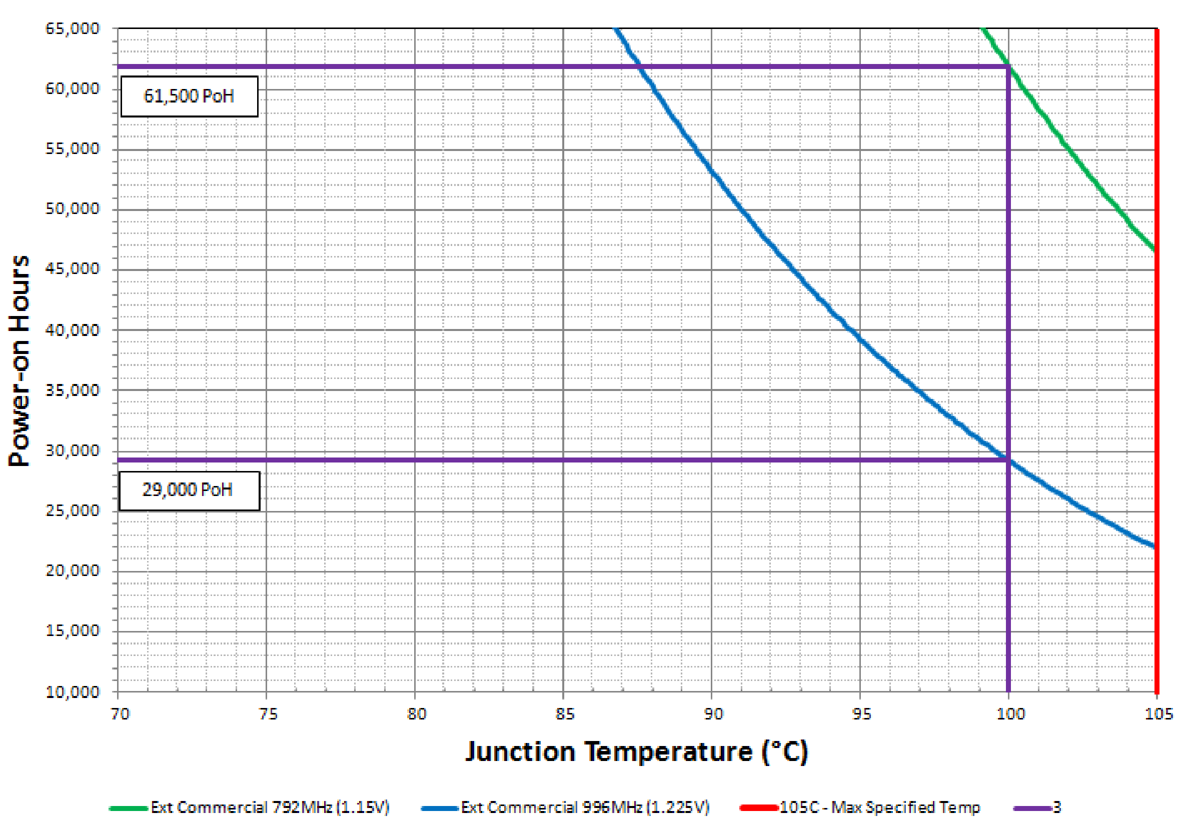

Figure 8. Multiple power state use case

2.2 Switching between two power states with different temperatures

This scenario assumes that the system can achieve a drop in temperature by throttling back in performance while still maintaining a constant voltage. This temperature change can be achieved by changing the frequency or by scaling back the loading on the ARM cores or processing units. This use case is particularly useful for customers who need to take advantage of the full automotive temperature range of the i.MX 6 series . In this scenario, the system spends 30% of its power-on-hours at 90°C and 70% of its power-on hours at 100°C (as seen in Figure 9). The two POH can be combined as such: 53,290 x 0.3 + 29,000 x 0.7 = 36,287 PoH.

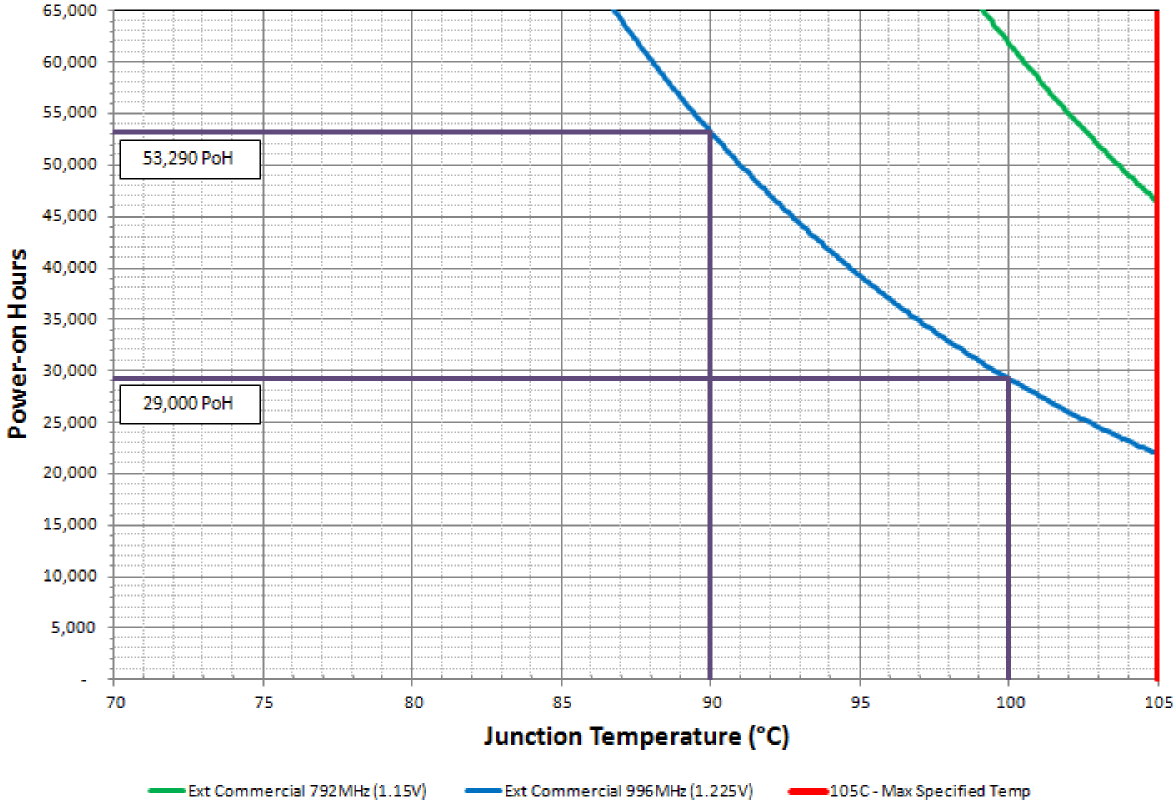

Figure 9. Multiple temperature use case

2.3 Using three or more power states.

This scenario shows how this strategy can be extended to more than two power states. While this example only has three power states, there is no limit to the actual number of power states that can be combined. The power states that are being used in this scenario are 996 MHz (at 105°C), 792 MHz (at 105°C), and 792 MHz (at 100°C). Each state is used equally for a third of the time. These power states can be combined as such: 62,000 x 0.34 + 47,000 x 0.33 + 22,000 x 0.33 = 43,850 PoH.

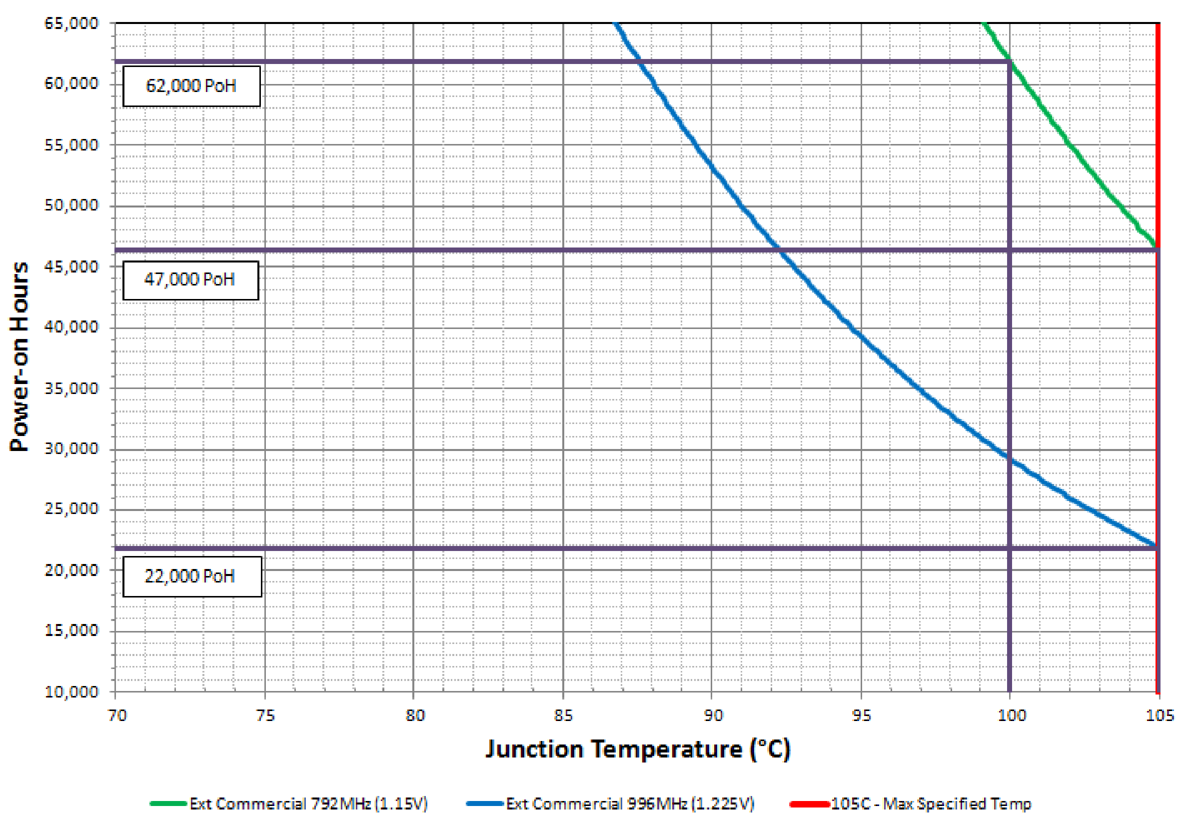

Figure 10. Various use cases

3 Revision History

Revision number	Date	Substantive changes
0	02/2015	Initial release
1	02/2016	Updated Table 1. Extended Commercial Qualification Lifetime Estimates Updated Table 2. Automotive Qualification Lifetime Estimates Updated Table 3. Industrial Qualification Lifetime Estimates

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Document Number: AN5062
Rev. 1
02/2016