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i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus Family Product Lifetime Usage Estimates

This document describes the estimated product lifetimes for the i.MX 6Dual, 6Quad, 6DualPlus, and 6QuadPlus Applications Processors based on the criteria used in the qualification process.

The product lifetimes described here are estimates and do not represent a guaranteed life time 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 is intended to provide users with guidance on how to interpret the different i.MX 6Quad/6Dual and 6DualPlus/6QuadPlus qualification levels in terms of the target operating frequency of the device, the maximum supported junction temperature (Tj) of the processor, and how this relates to the lifetime of the device.

Lowering the operating junction temperature in the application is the most effective means to increase the lifetime of the device without affecting the performance of the device. This can be accomplished by increasing the thermal dissipation capacity in the application.

In cases where the thermal properties cannot be altered, a lower operating voltage can be used to increase the lifetime of the device. Lowering the voltage may result in lowered performance; the operating frequency may have to be adjusted lower to match the voltage as specified in the datasheet.

1.1. Device qualification level and available PoH

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:

1. The target frequency for the application (extended commercial, industrial, automotive).
    a) The target frequency is determined by the input voltage to the processor's core complex (VDD_ARMxx_IN).
    b) The use of LDO-enabled or LDO-bypass mode.
        - When using LDO-Bypassed mode, the target voltage should not be set to the minimum specified in the datasheet. All Power Management IC's 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 +/-35 mV.
        - LDO-Enabled mode uses the regulators on the i.MX6. 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.
        - 1.2 GHz can only be achieved with LDO-Enabled mode.
2. The percentage of active use vs. standby.
    a) Active use means that the processor is running at an active performance mode.
        - For the Extended Commercial tier, there are 3 available performance modes: 1.2 GHz, 996 MHz, and 792 MHz.
        - For the Automotive tier, there are 3 active performance modes: 996 MHz, 852 MHz and 792 MHz.
        - For the Industrial tier, there is only 1 active performance mode: 792 MHz.
    b) In standby mode the VDD_ARMxx_IN and the VDD_SOC_IN are lowered, 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.
3. The junction temperature (Tj) of the processor.
    a) The maximum junction temperature of the device is different for a given qualification level, for instance 105 °C for extended commercial or industrial, 125 °C for automotive. It is important to note that while the automotive device is guaranteed to operate at 125 °C; operating the device at 125 °C for an extended period of time will have negative consequences on the lifetime of the device.
    b) Users must ensure that their device is appropriately thermally managed such that the maximum junction temperature is not exceeded. Refer to i.MX 6 Series Thermal Management Guidelines (document AN4579) for more details.

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 NXP as to the actual lifetime of the device.

1.1.1. Extended commercial qualification

The table below provides the number of PoH for the typical use conditions for the extended commercial device.

Table 1. Extended commercial qualification lifetime estimates

	ARM Core Speed	Power-on Hours [PoH]	ARM Core Operating Voltage	Junction Temperature [T_j]
	(MHz)	(Hrs)	(V)	(°C)
Case C1: LDO Bypassed	996	15,430	1.26	105
Case C2: LDO Enabled	996	21,900	1.225	105
Case C3: LDO Enabled	1200	21,900	1.275	105

Figure 1 and Figure 2 establish a guideline 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.

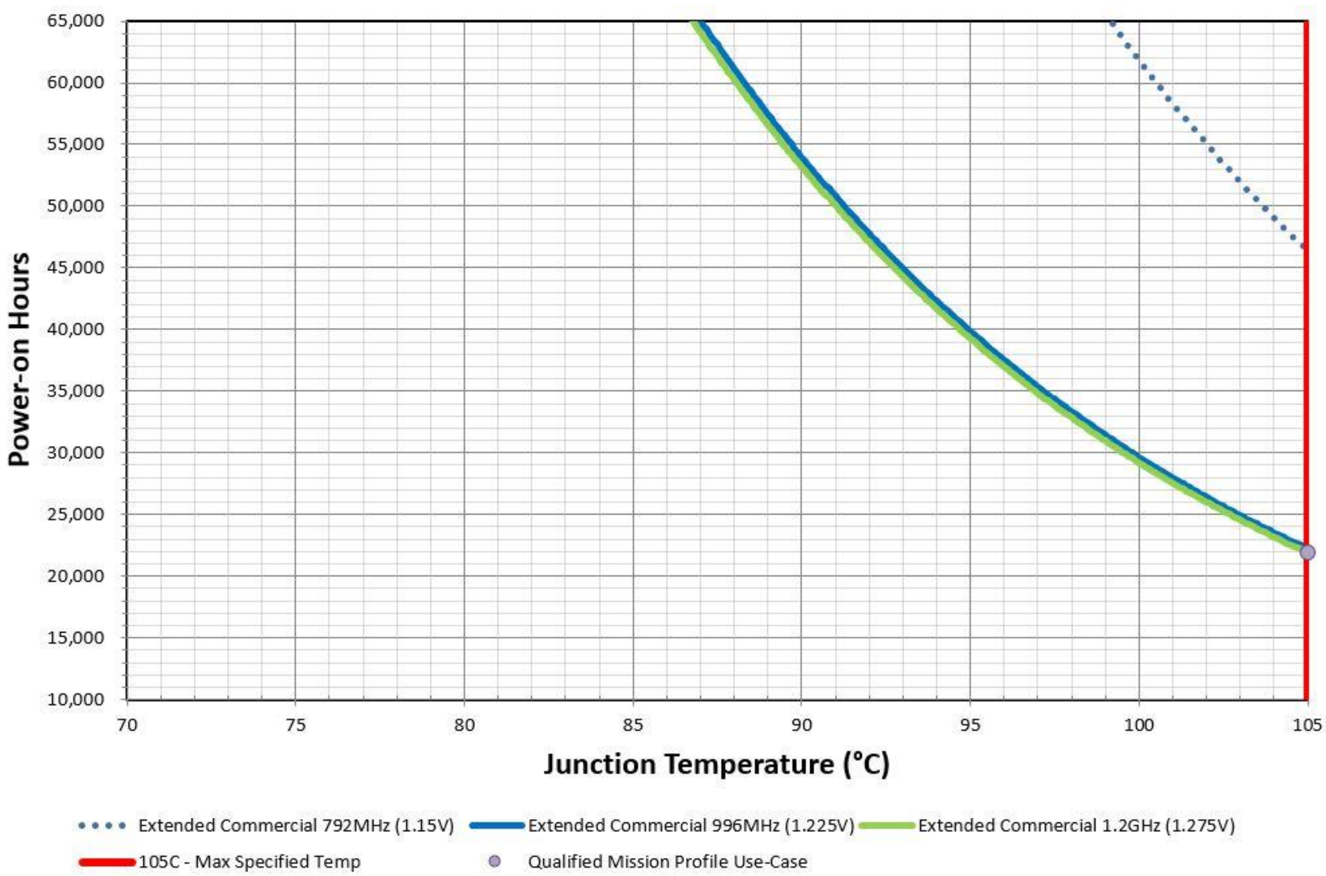

Figure 1. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus extended commercial lifetime estimates LDO enabled mode

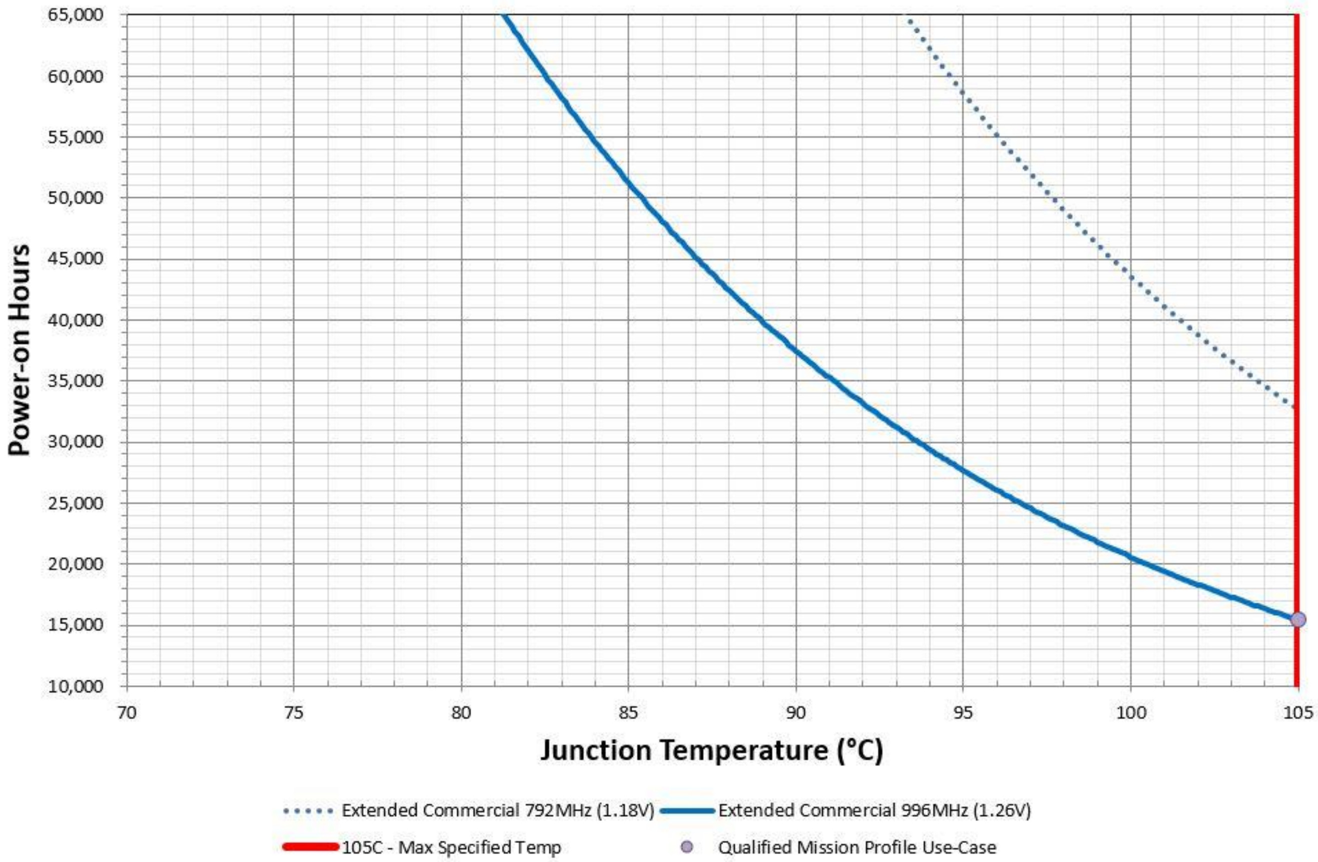

Figure 2. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus extended commercial lifetime estimates LDO bypass mode

1.1.2. Automotive Qualification

The following table provides the number of PoH for the typical use conditions for the automotive device.

Table 2. Automotive qualification lifetime estimates

	ARM Core Speed	Power-on Hours [PoH]	ARM Core Operating Voltage	Junction Temperature [T_j]
	(MHz)	(Hrs)	(V)	(°C)
Case A1: LDO Enabled	996 and 852	30,740	1.225	105
Case A2: LDO Enabled	996 and 852	10,445	1.225	125
Case A3: LDO Bypassed	996 and 852	21,660	1.26	105
Case A4: LDO Bypassed	996 and 852	7,360	1.26	125

Figure 3 and Figure 4 establish a guideline 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.

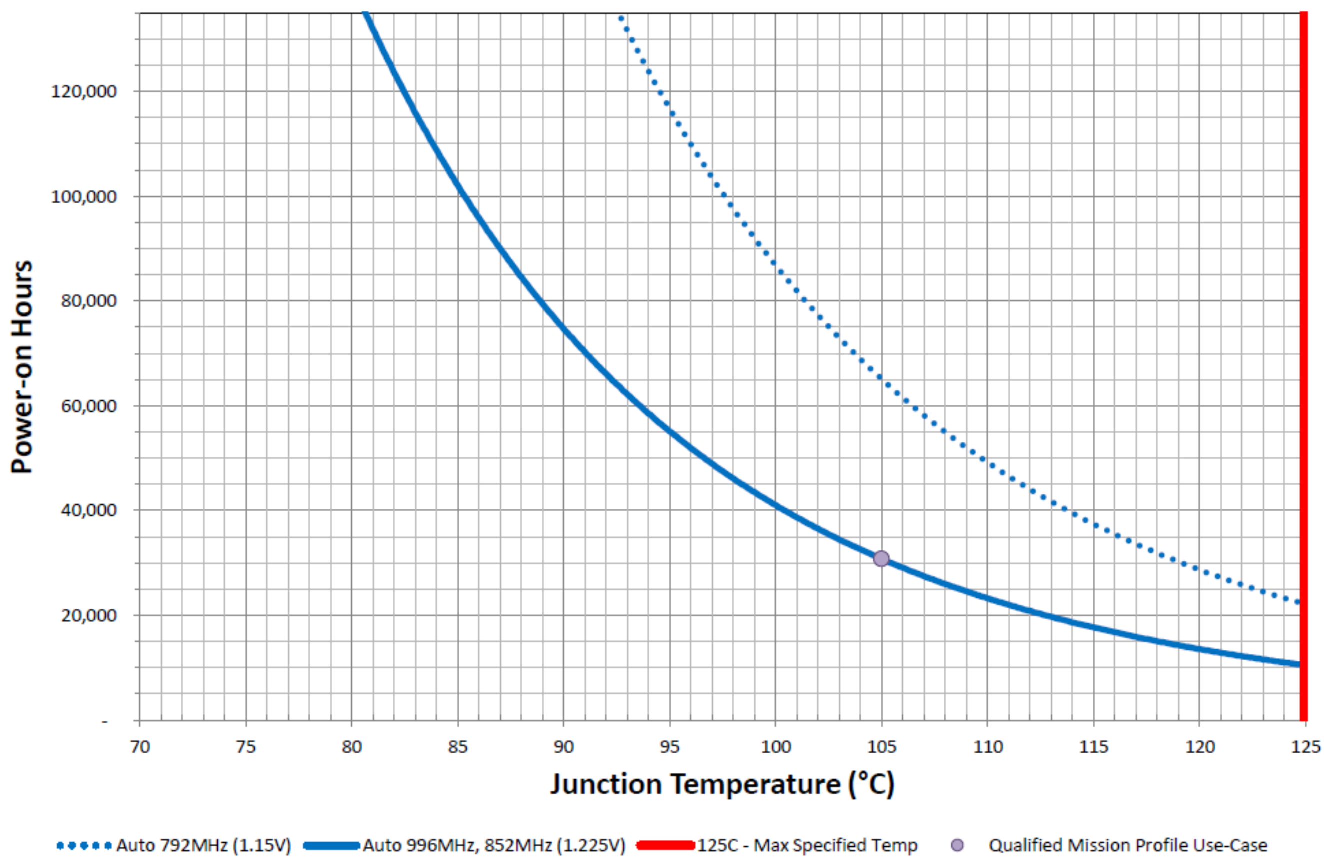

Figure 3. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus automotive lifetime estimates LDO enabled mode

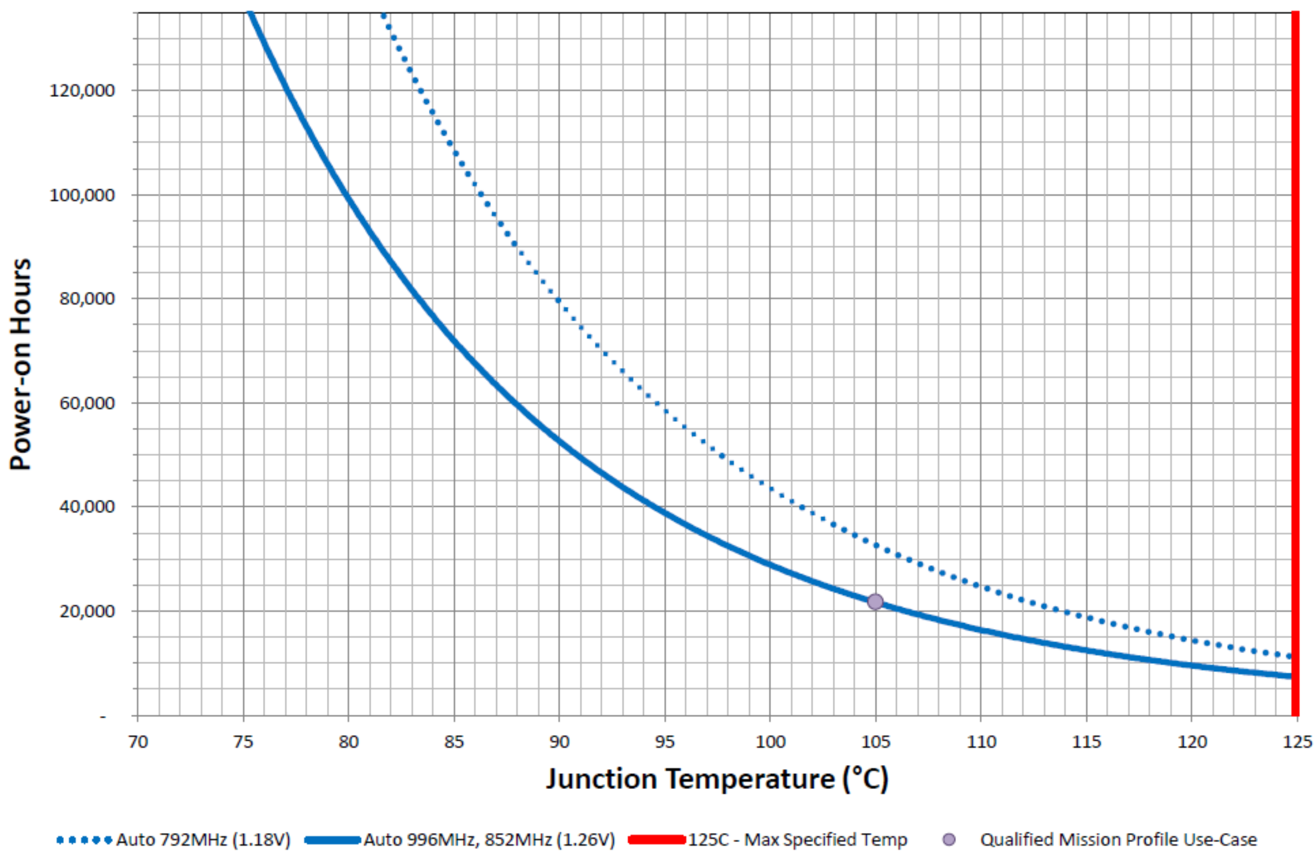

Figure 4. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus automotive lifetime estimates LDO bypass mode

1.1.3. Industrial Qualification

The following table provides the number of PoH for the typical use conditions for the industrial device.

Table 3. Industrial qualification lifetime estimate

	ARM Core Speed	Power-on Hours [PoH]	ARM Core Operating Voltage	Junction Temperature [T_j]
	(MHz)	(Hrs)	(V)	(°C)
Case I1: LDO Enabled	792	112,970	1.150	105
Case I2: LDO Bypassed	792	79,610	1.18	105

Figure 5 and Figure 6 establish a guideline 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.

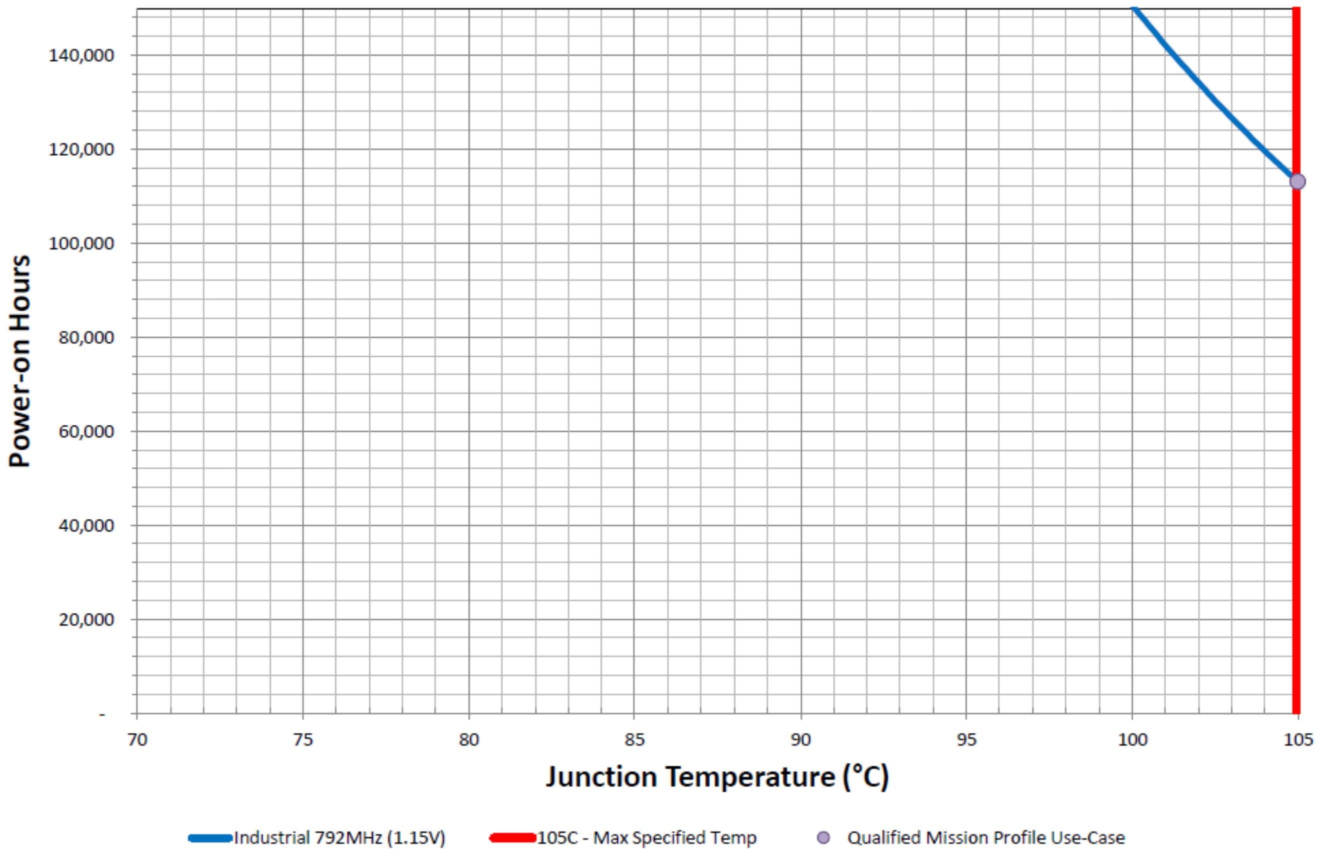

Figure 5. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus industrial lifetime estimates LDO Enabled mode

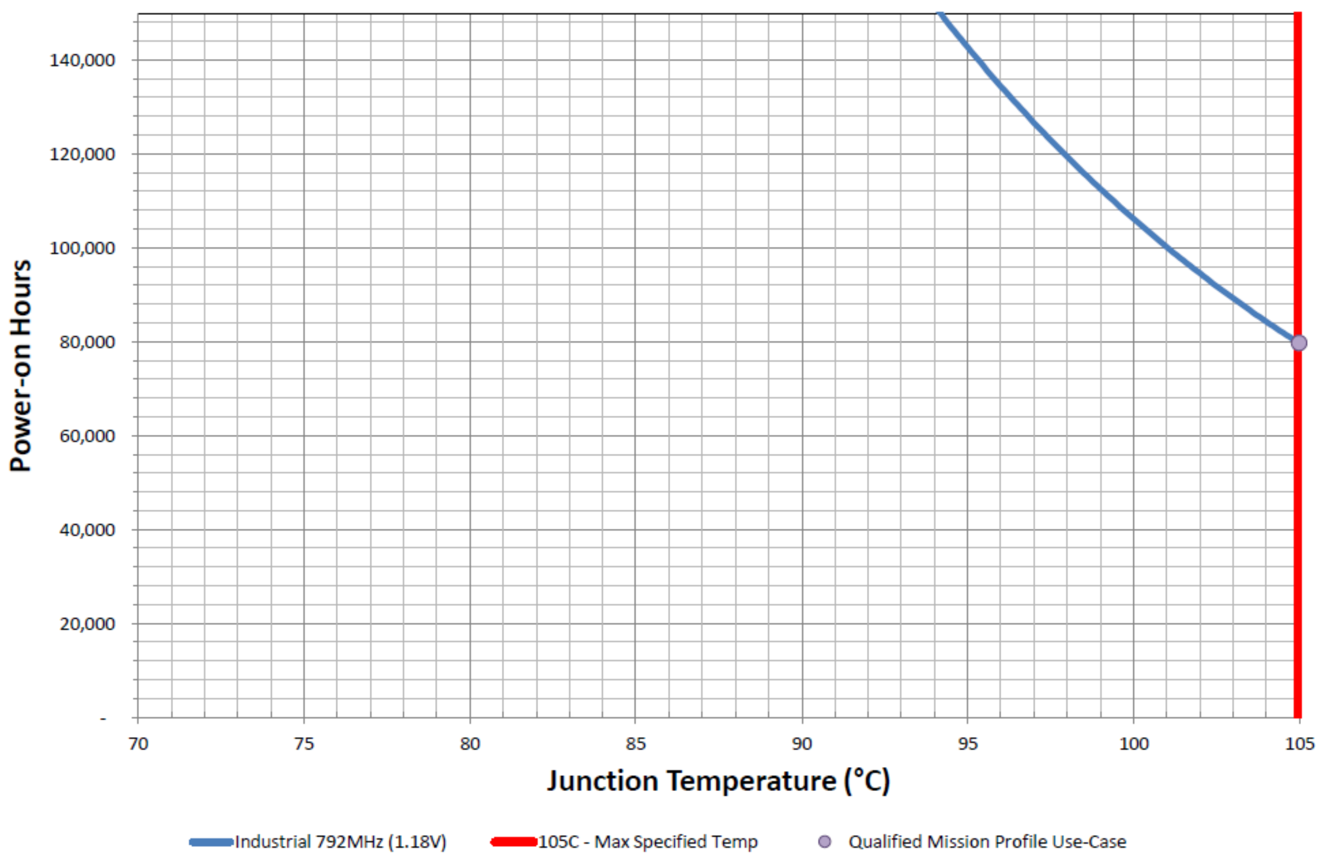

Figure 6. i.MX 6Dual/6Quad and 6DualPlus/6QuadPlus industrial lifetime estimates LDO bypass mode

2. Combining Use-Cases

A constant operating use case cannot deliver the target PoH in all applications. 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.

Scenario 1: Switching between 2 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 2 POH (read from Figure 7 below) can be combined using those percentages: 65,000 x 0.5 + 30,000 x 0.5 = 47,500 PoH.

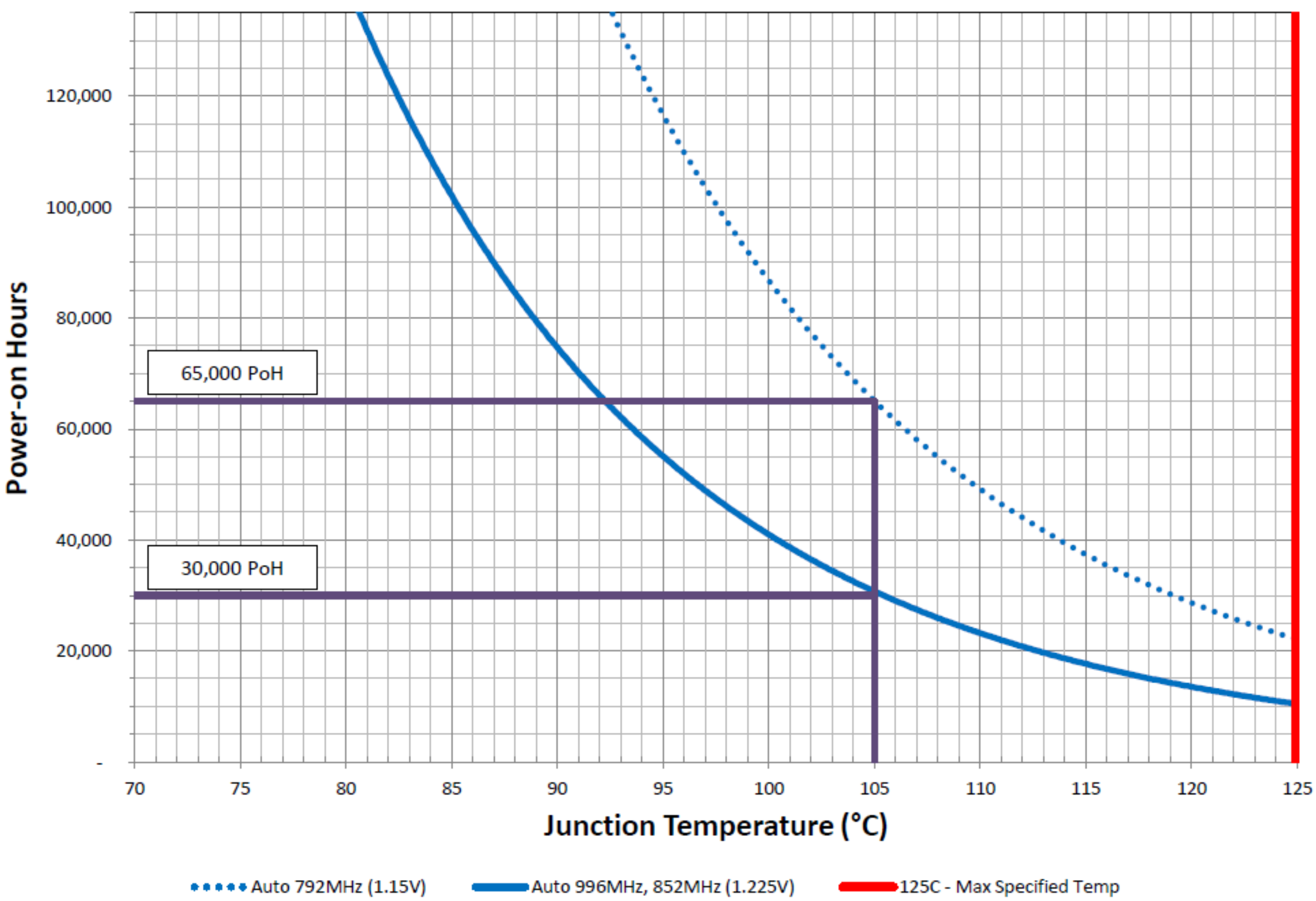

Figure 7. Multiple power state use case

Scenario 2: Switching between 2 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 may be able to be achieved by changing the frequency or by simply 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.MX6. In this scenario, the system spends 30 % of its power-on-hours at 105 °C and 70 % of its power-on hours at 125 °C (as read off the chart in Figure 8). The 2 POH can be combined as such: 30,000 x 0.3 + 10,000 x 0.7 = 16,000 PoH.

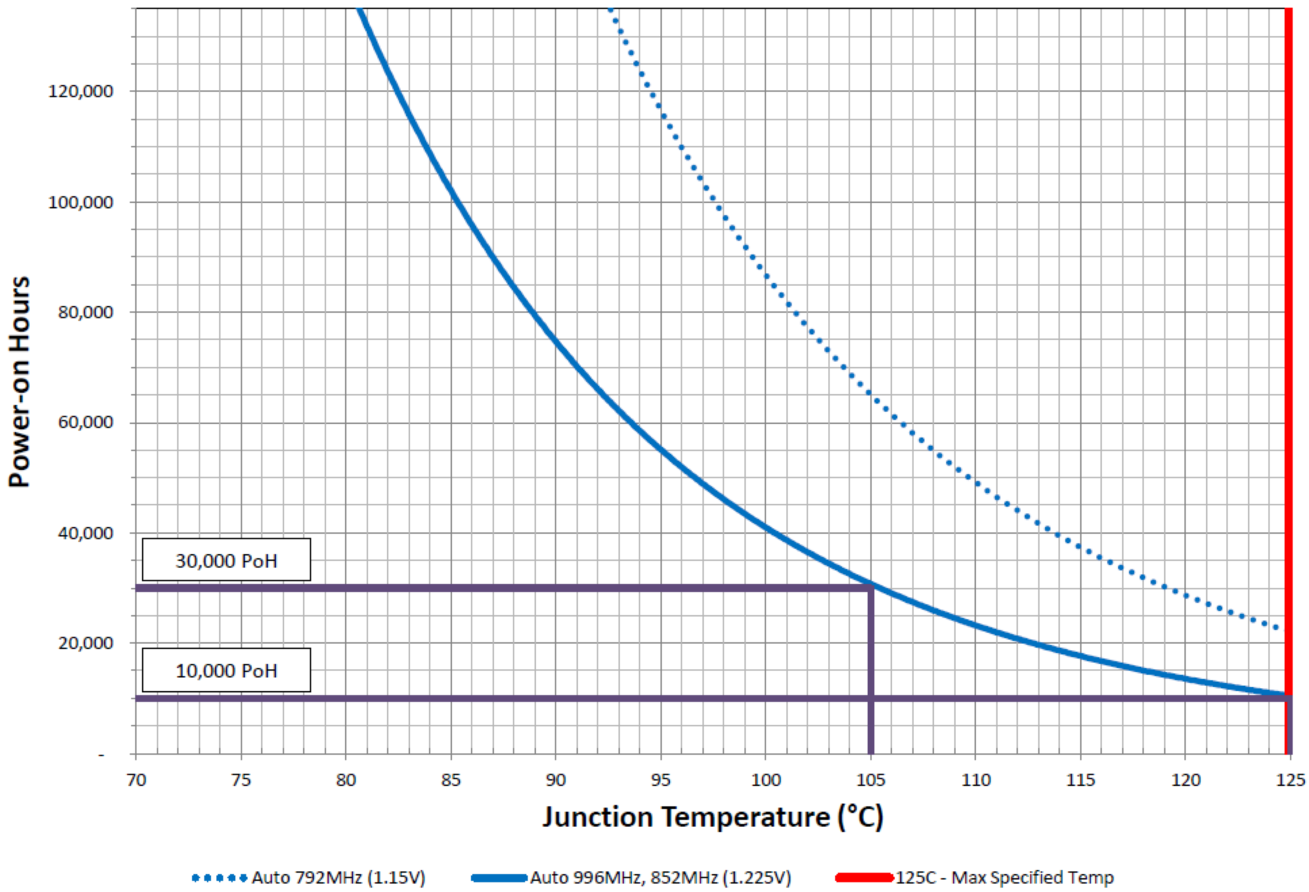

Figure 8. Multiple temperature use case

Scenario 3: Using 3 or more power states

This scenario shows how this strategy can be extended to more than 2 power states. While this example only has 3 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 the three unique modes from the two previous examples 1 GHz at 125 °C, 1 GHz at 105°C, and 792 MHz at 105 °C. Each state will be used equally one third of the time. These power states can be combined as such: 65,000 x 0.34 + 30,000 x 0.33 + 10,000 x 0.33 = 35,300 PoH.

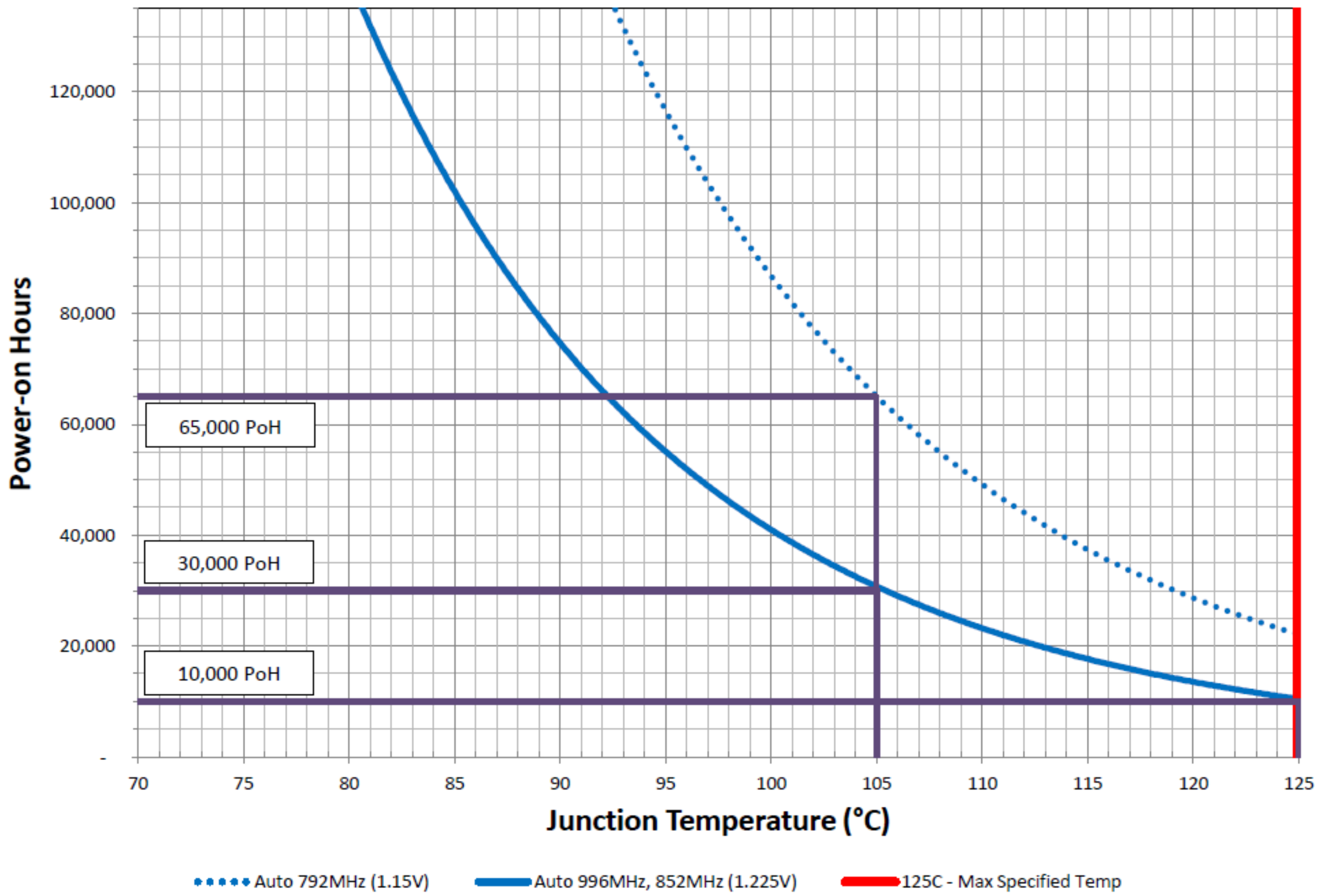

Figure 9. Various use cases

3. Conclusion

Selecting the optimal operating performance point and thermal envelope is paramount to best meet the application lifetime targets.

Trade-offs between the target operating voltage/frequency of the device and the operating junction temperature (Tj) of the processor can greatly improve the lifetime of the device.

The data and examples provided in this application note help users determine the estimated lifetime for their particular application.

4. References

i.MX 6DualPlus/6QuadPlus Applications Processors Consumer Products (document IMX6DQPCEC)

i.MX 6 Series Thermal Management Guidelines (document AN4579)

5. Revision History

Table 4. Revision history

Revision number	Date	Substantive changes
3	11/2016	– Global: Included the i.MX6 DualPlus and i.MX6 QuadPlus – Figure 1 updated – Figure 9 updated – Table 1 updated – Section 4 References added

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