NXP Semiconductors
Application Notes

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i.MX 6UltraLite Product Usage Lifetime Estimates

Contents

1. Introduction

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

The product lifetimes described in this document are estimates and do not represent a guaranteed life time for a particular product. 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 guidance on interpreting the i.MX 6UltraLite 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 a device.

Each qualification level supported (commercial, industrial, automotive) defines the number of Power-on Hours (PoH) available to the processor under a given set of conditions, such as:

- The target frequency for the application (consumer, industrial, automotive)
  - The target frequency is determined by the input voltage to the processor’s core complex (VDD_SOC_IN)
  - The use of the LDO enabled or the LDO bypass modes.
    - When using the LDO bypass mode, do not set the target voltage to the minimum specified in the datasheet. All power-management ICs have allowable tolerances. Set the target voltage higher than the minimum specified voltage to account for the tolerance of the PMIC.
    - The LDO-enabled mode uses the regulators on the i.MX 6UltraLite. These regulators are well-characterized and you may set them to output an exact minimum specified voltage. To achieve higher PoH, use the LDO-enabled mode.
    - 696 MHz can only be achieved in the LDO-enabled mode.
- The percentage of active use vs. stand-by.
  - Active use means that the processor is running in an active performance mode.
    - For the automotive tier, the performance modes are 528 MHz and 696 MHz.
    - For the commercial and industrial tiers, the performance mode is 528 MHz.
    - In the stand-by/DSM mode, the datasheet defines lower operating conditions for the VDD_SOC_IN, reducing the power consumption and the 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 was powered off.
- The junction temperature (Tj) of the processor.
  - The maximum junction temperature of the device is different for each tier of the product, e.g., 95 °C for the commercial tier, 105 °C for the industrial tier, and 125 °C for the automotive tier. This maximum temperature is guaranteed by the final test.
  - Ensure that your device is appropriately thermally managed and the maximum junction temperature is not exceeded.

NOTE

All data provided within this document are estimates for PoH, based on extensive qualification experience and testing with the i.MX 6 series.

Do not view these statistically-derived estimates as a limit to the individual

device’s lifetime, nor construe them a warranty for the actual lifetime of a device. The sales and warranty terms and conditions still apply.

2. Device Qualification Level and Available PoH definitions

2.1. Commercial qualification

Table 1 provides the number of PoH for the typical use conditions of the extended commercial devices.

Table 1. Commercial qualification lifetime estimates

–	ARM® core frequency (MHz)	PoH (hours)	ARM core operating voltage (V)	Junction temperatue [Tj] (°C)
Case C1: LDO enabled	528	21,900	1.15	95
Case C2: LDO bypassed	528	16,300	1.18	95

Figure 1 and *Figure 2* provide guidelines for estimating the PoH as a function of the CPU frequency and the junction temperature. Read the PoH directly from the charts below to determine the trade-offs to be made to the CPU frequency and the junction temperature to increase the estimated PoH of the device.

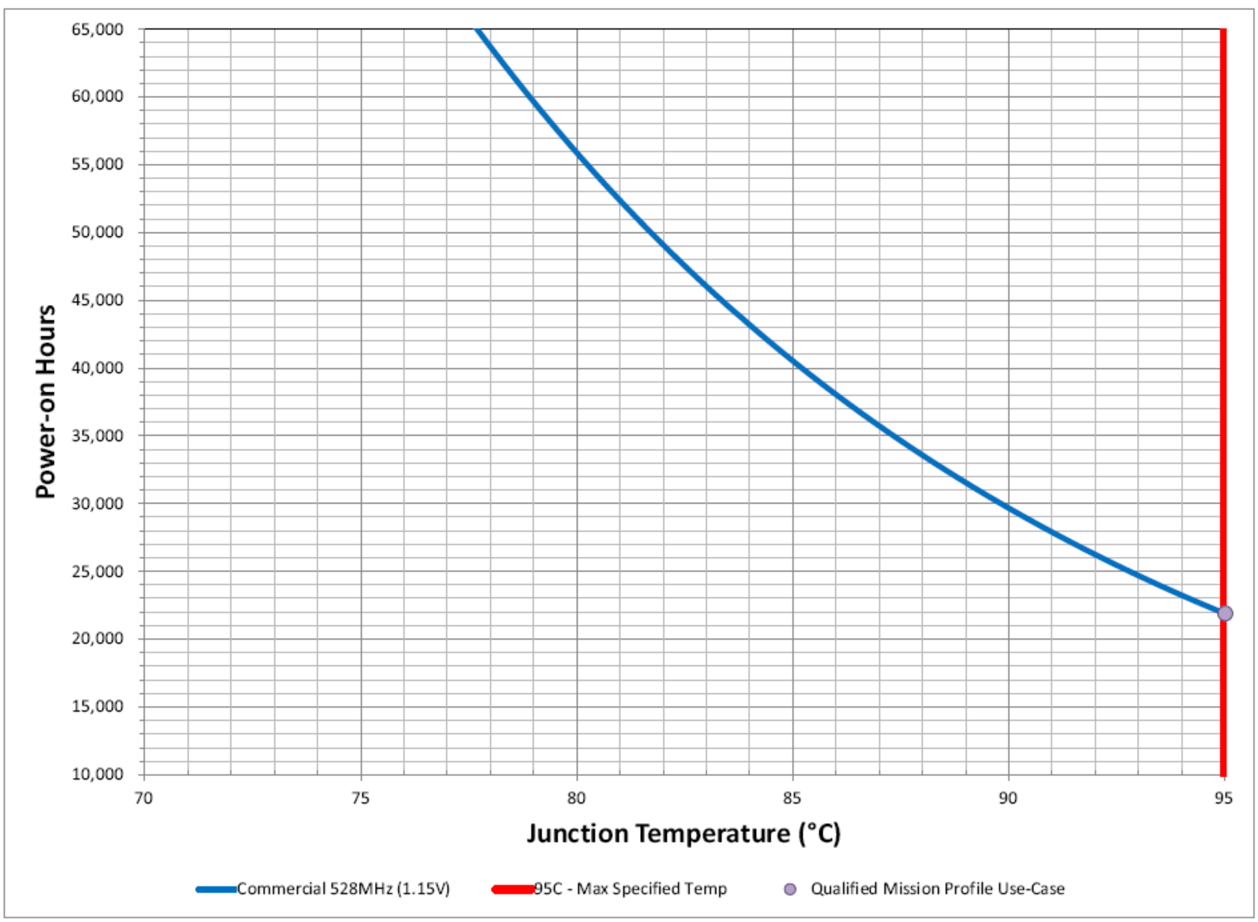

Figure 1. i.MX 6UltraLite commercial lifetime estimates in LDO enabled mode

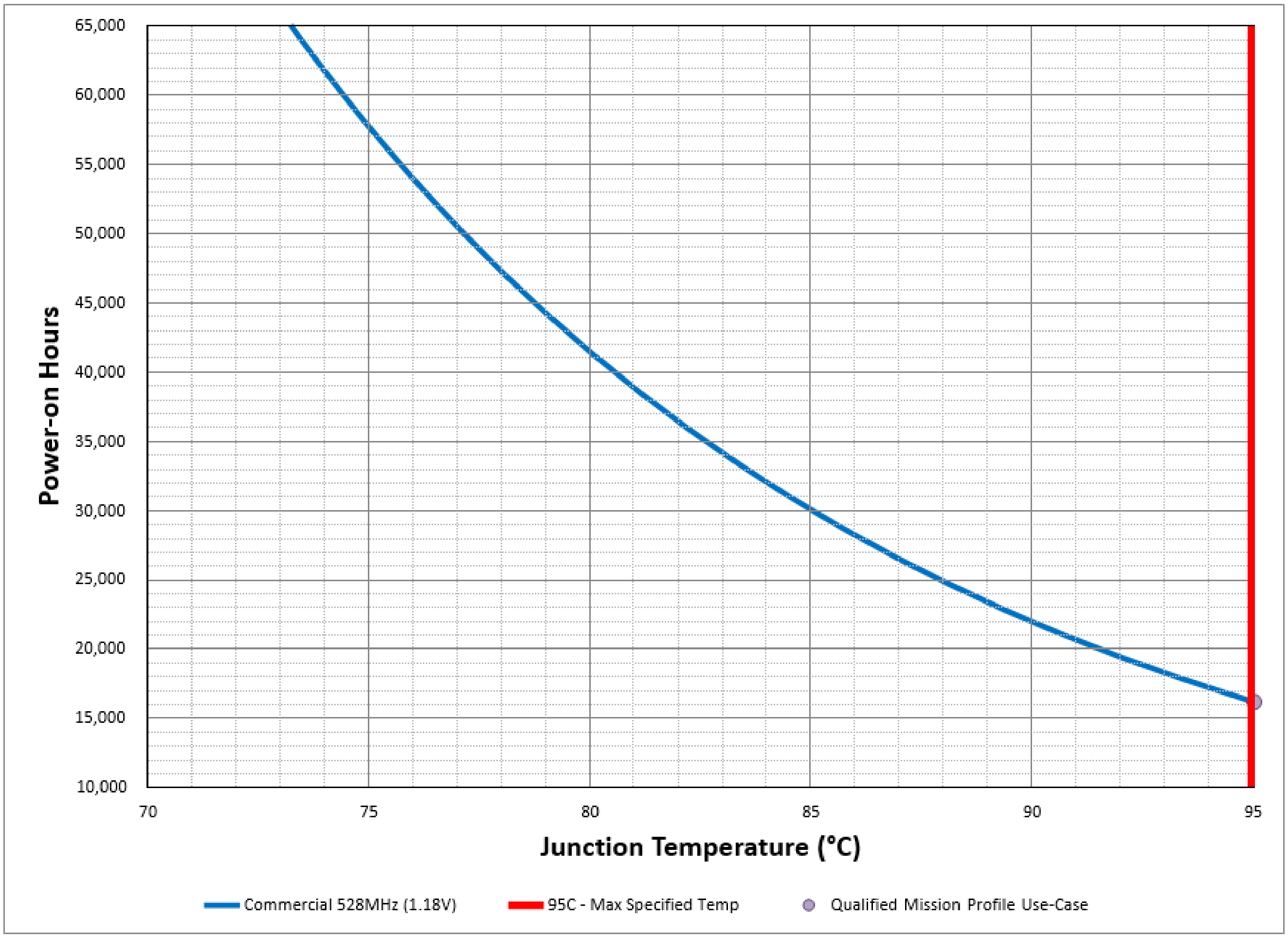

Figure 2. i.MX 6UltraLite commercial lifetime estimates in LDO bypass mode

2.2. Automotive qualification

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

Table 2. Automotive qualification lifetime estimates

_	ARM core frequency (MHz)	PoH (hours)	ARM core operating voltage (V)	Junction temperatue [Tj] (°C)
Case A1: LDO enabled	528	35,735	1.15	125
Case A2: LDO bypassed	528	26,473	1.18	125
Case A3: LDO enabled	696	13,146	1.25	125
Case A4: LDO enabled	528, 696	10,238	1.275[1]	125
Case A5: LDO enabled	528, 696	30,130	1.275[1]	105

1. This is the VDD_SOC Overdrive condition.

Figure 3 and *Figure 4* provide guidelines for estimating PoH as a function of the CPU frequency and the junction temperature. Read the PoH directly from the charts below to determine the trade-offs to be made to the CPU frequency and the junction temperature to increase the estimated PoH of the device.

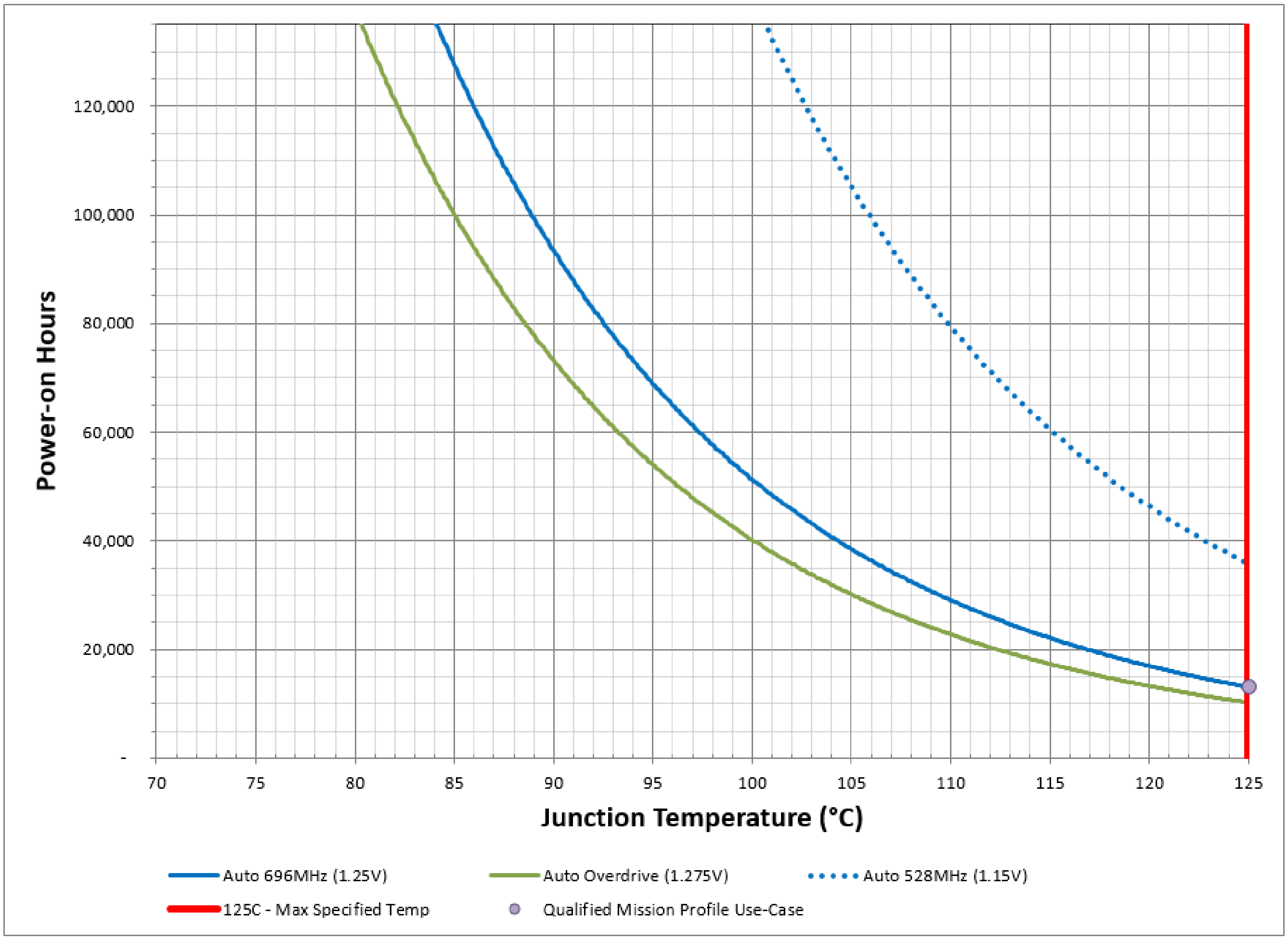

Figure 3. i.MX 6UltraLite automotive lifetime estimates in LDO enabled mode

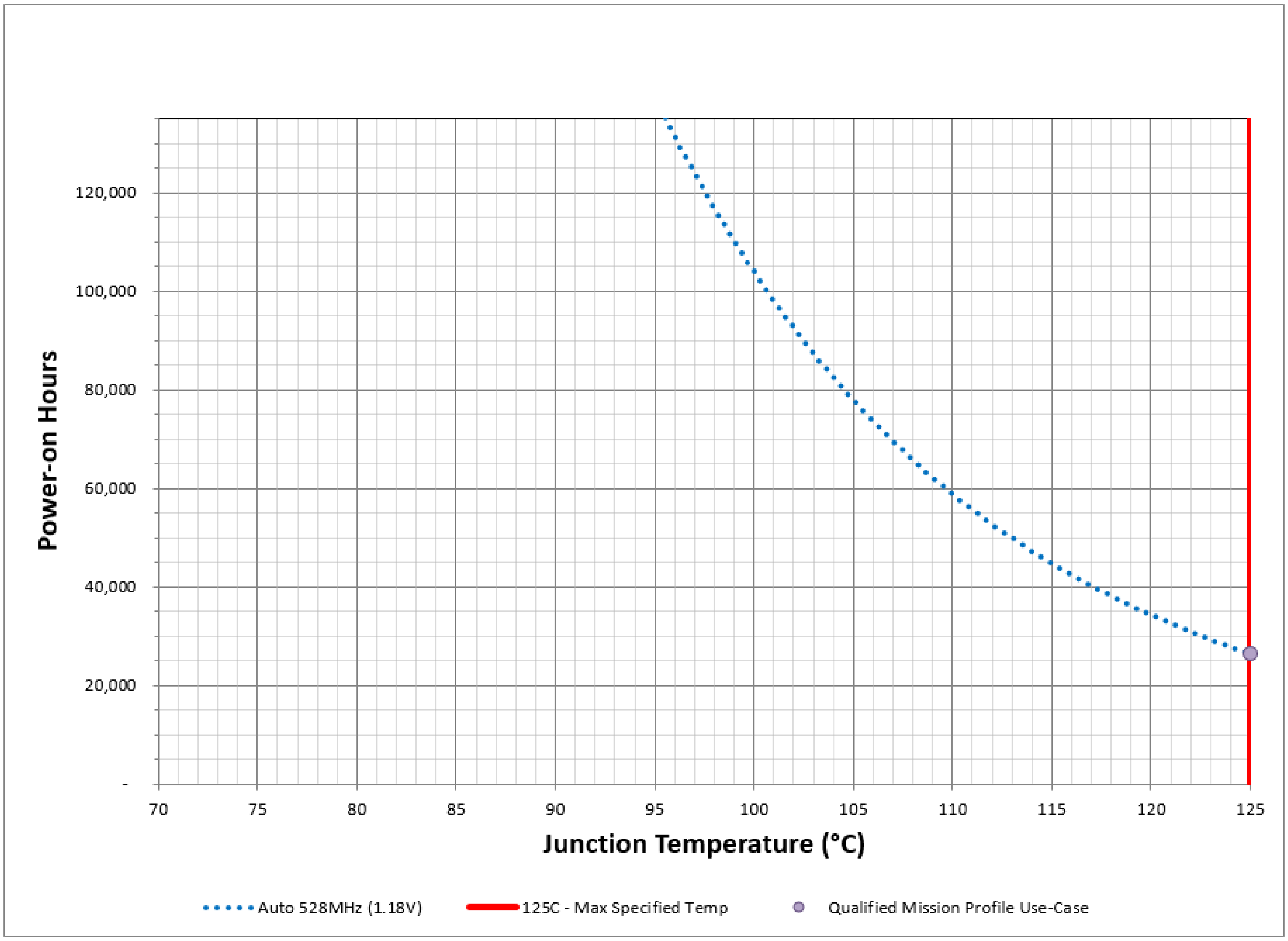

Figure 4. i.MX 6UltraLite automotive lifetime estimates in LDO bypass mode

2.3. Industrial qualification

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

Table 3. Industrial qualification lifetime estimates

–	ARM core frequency (MHz)	PoH (hours)	ARM core operating voltage (V)	Junction temperatue [Tj] (°C)
Case I1: LDO enabled	528	87,689	1.15	105
Case I2: LDO bypassed	528	64,261	1.18	105

Figure 5 and *Figure 6* provide guidelines for estimating the PoH as a function of the CPU frequency and the junction temperature. Read the PoH directly from the charts below to determine the trade-offs to be made to the CPU frequency and the junction temperature to increase the estimated PoH of the device.

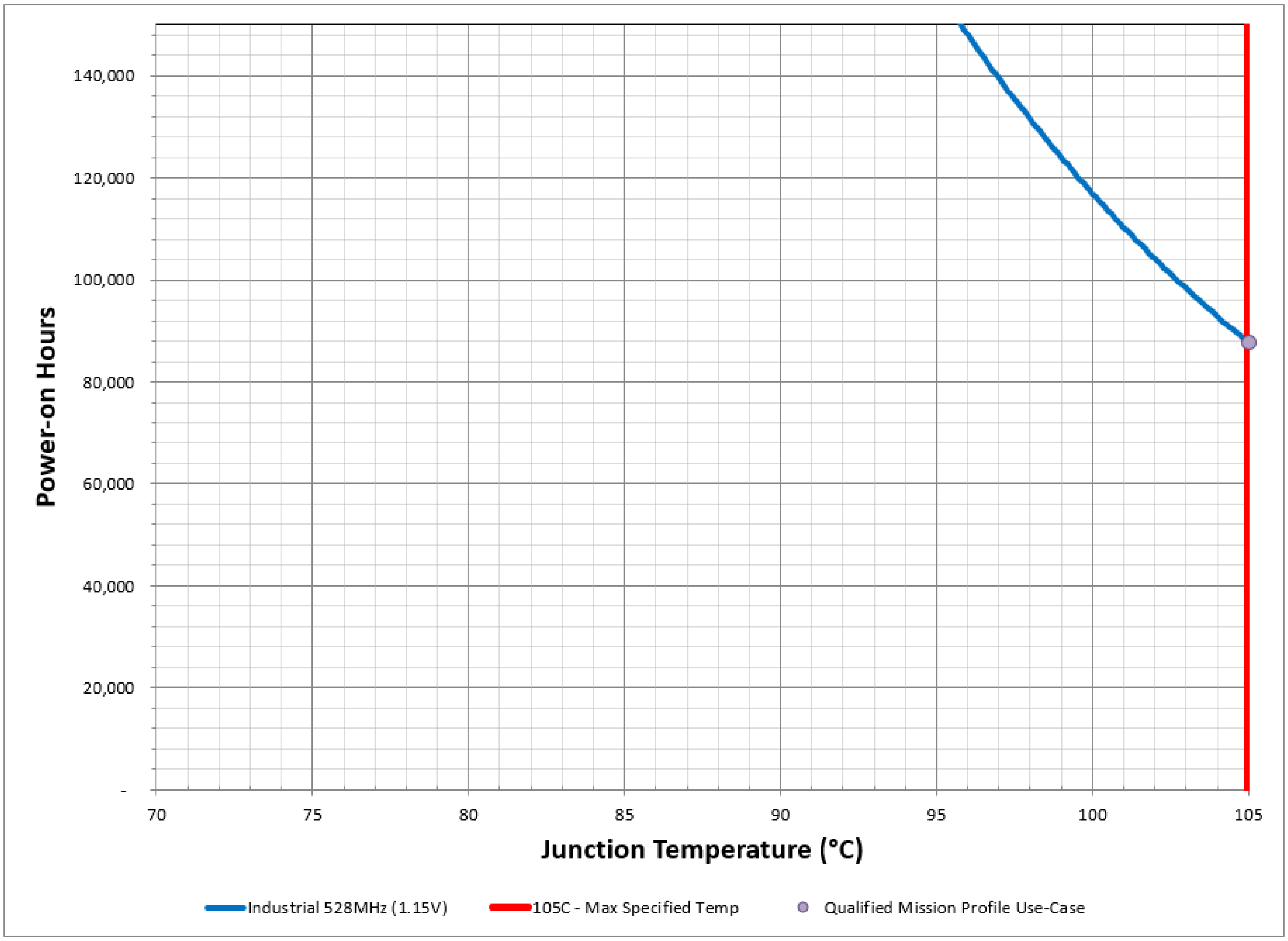

Figure 5. i.MX 6UltraLite industrial lifetime estimates in LDO enabled mode

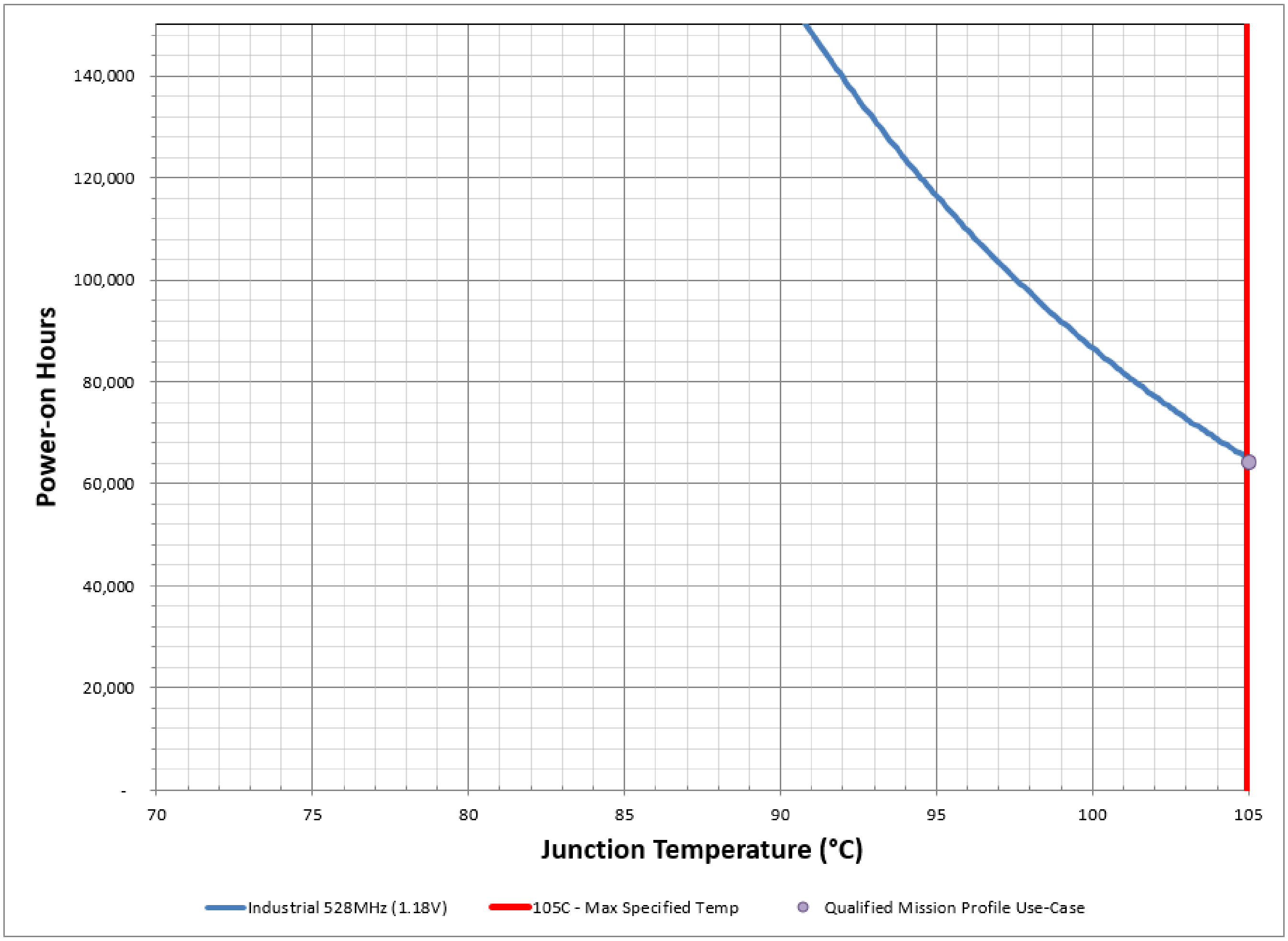

Figure 6. i.MX 6UltraLite industrial lifetime estimates in LDO bypass mode

3. Combining Use Cases

In some applications, a constant operating use case cannot provide the target PoH. In this case, use multiple operating conditions. This method provides some of the benefits of running at a lower performance, while keeping the system's ability to use the highest-performance state required by the application.

3.1. Switching between two power states with different temperatures

This scenario assumes that the system can achieve a drop in temperature by throttling back the performance, while still maintaining a constant voltage. Achieve this temperature change by changing the frequency, or by simply scaling back the load on the ARM cores and processing units. This use case is particularly useful if you want to take advantage of the full automotive temperature range of the i.MX 6UltraLite. In this scenario, the system spends 30 % of its PoH at 105 °C and 70 % of its PoH at 125 °C (as shown in *Figure 7*). Combine the two PoH values as:

$$38{,}700 \times 0.3 + 13{,}150 \times 0.7 = 20{,}815 \text{ PoH} \qquad \text{Eqn. 1}$$

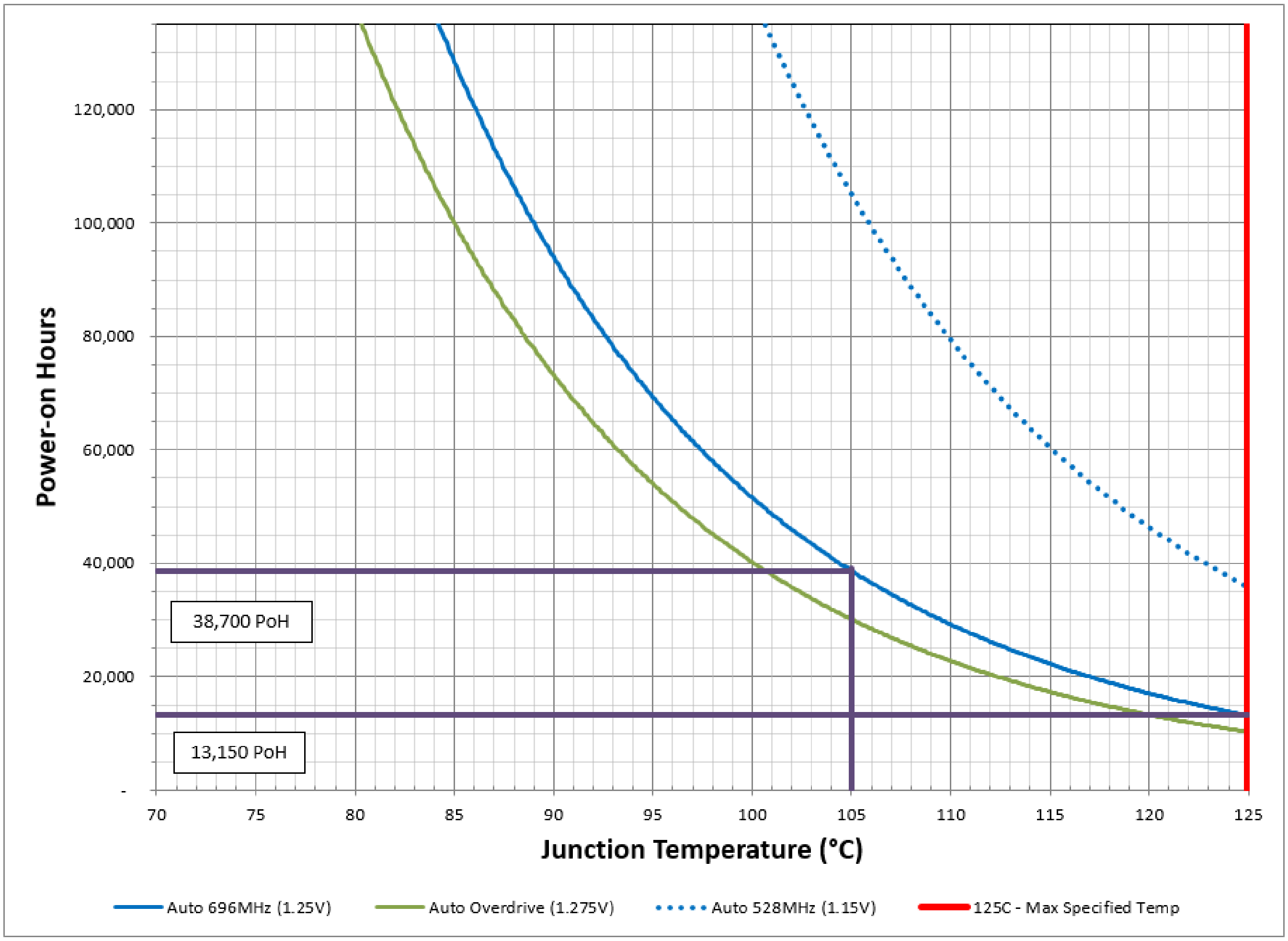

Figure 7. Multiple temperature use case

3.2. Switching between two power states with different voltages

In this scenario, the system is using the 696-MHz full-power state, and the 528-MHz reduced-power state. For these calculations, it is assumed that the temperature stays constant in either mode. If the system spends 50 % of its PoH at 696 MHz and 50 % of its PoH at 528 MHz, combine the two PoH values (as shown in *Figure 8*) with the percentages:

$$38{,}700 \times 0.5 + 105{,}000 \times 0.5 = 71{,}850 \text{ PoH} \qquad \text{Eqn. 2}$$

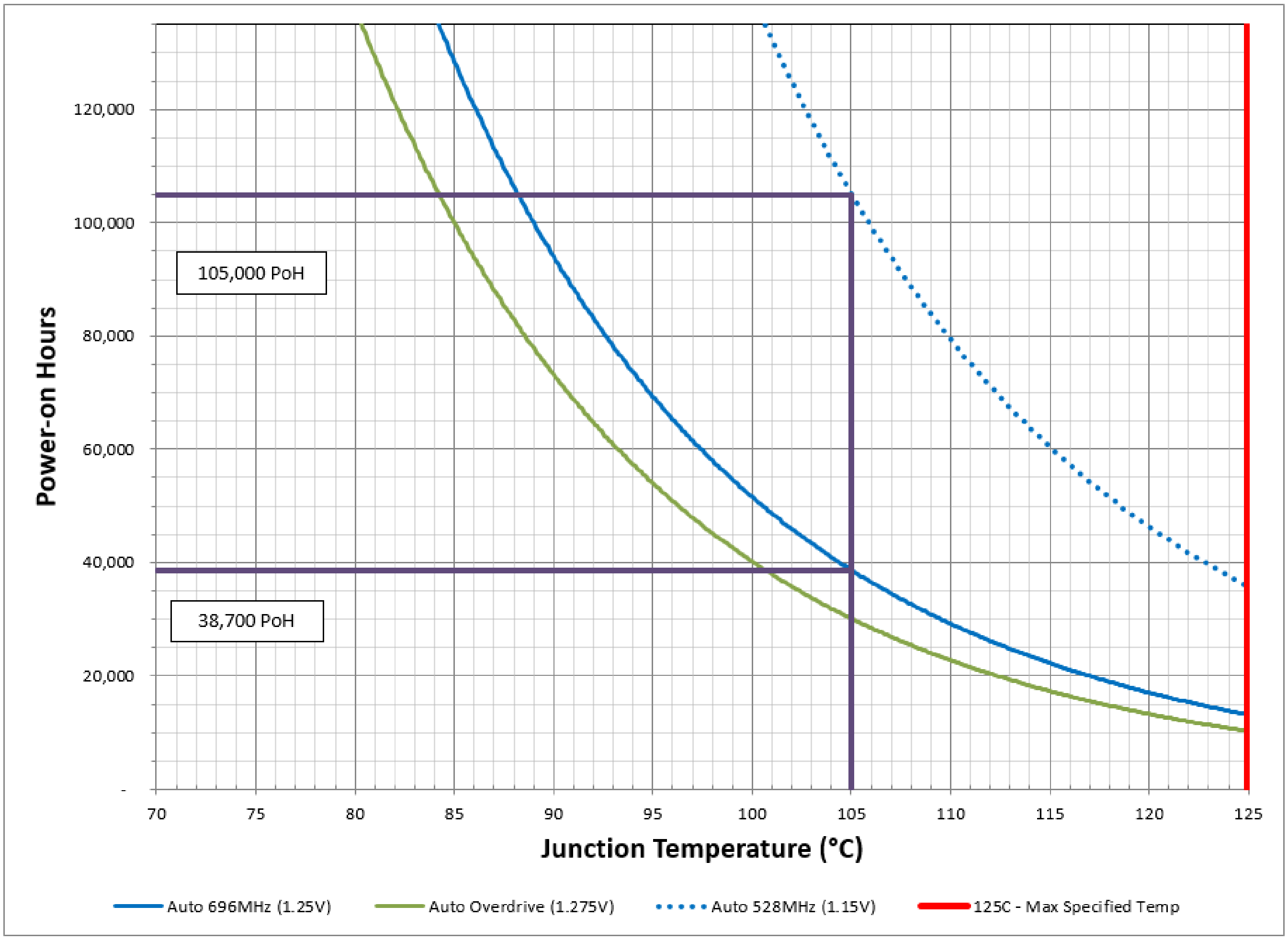

Figure 8. Multiple power state use case

4. Revision History

Table 4 summarizes the changes made to this document since the initial release:

Table 4. Revision history

Revision number	Date	Substantive changes
0	09/2015	Initial release
1	04/2016	• Updated *Section 2.2* to include the performance mode at 696 Mhz. • Updated *Section 3* to include the 969 Mhz mode in different use cases.
2	08/2016	• Updated *Section 2.2* to include the VDD_SOC override condition at 1.275 V: *Table 2* and *Figure 3*. • Updated *Section 3* to include the VDD_SOC override condition at 1.275 V *in the different use cases: Section 3.1, Figure 7, and Figure 8.*

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