AN13122

iMX RT1170 Life Time Industrial, Commercial & Automotive

Rev. 2 — 9 June, 2021 Application Note

Contents

1 Introduction

This document describes the estimated product lifetimes for the i.MX RT1170 applications processor 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.

The i.MX RT series consist 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 different i.MX RT1170 qualification levels in terms of the target operating frequency of the device
- the maximum supported junction temperature (Tj) of the processor
- how Tj relates to the lifetime of the device.

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

- Target frequency for the application
  1. The target frequency is determined by the input voltage to the processor's core complex (`VDD_SOC_IN`).
  2. Use of DCDC-enabled or DCDC-bypass mode
     — When using DCDC-enabled mode or DCDC-bypass mode, the target voltage should not be set to the minimum specified in the datasheet. The On-Chip DCDC module and 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 DCDC or PMIC. The tolerance assumed in the calculations in this document is +/-25 mV.
- Percentage of active use vs. standby use
  1. Active use means that the processor is running at an active performance mode.
     — For the commercial tiers, there are two available performance modes:
       ◦ Overdrive mode: CM7 at 1 GHz and CM4 at 400 MHz
       ◦ Nominal mode: CM7 at 700 MHz and CM4 at 240 MHz
     — For the industrial and automotive tiers, there are two available performance modes:
       ◦ Overdrive mode: CM7 at 800 MHz and CM4 at 400 MHz
       ◦ Nominal mode: CM7 at 600 MHz and CM4 at 240 MHz
  2. In the STANDBY mode, the datasheet defines lower operating conditions for `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.
- Junction temperature (Tj) of the processor

1. The maximum junction temperature is 95 °C for the commercial tier device, 105 °C for the industrial, 125 °C for extended industrial and auto. This maximum temperature is guaranteed by final test.
2. Users must ensure that their device is appropriately thermally managed such that the maximum junction temperature is not exceeded.

NOTE

All data provided in this document are estimated for PoH based on extensive qualification experience and tested with the i.MX RT 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. Sales and warranty terms and conditions still apply.

2 Device qualification level and available PoH

2.1 Commercial qualification

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

Table 1. Commercial qualification lifetime estimates

	Arm core speed CM7/CM4 (MHz)	Power-on Hours [PoH] (Hrs)	Arm core Operating voltage (V)	Junction Temperature [Tj] (°C)
Case C1: Overdrive Mode	1000/400	15,644	1.125	95
Case C2: Nominal Mode	700/240	69,374	1.025	95

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

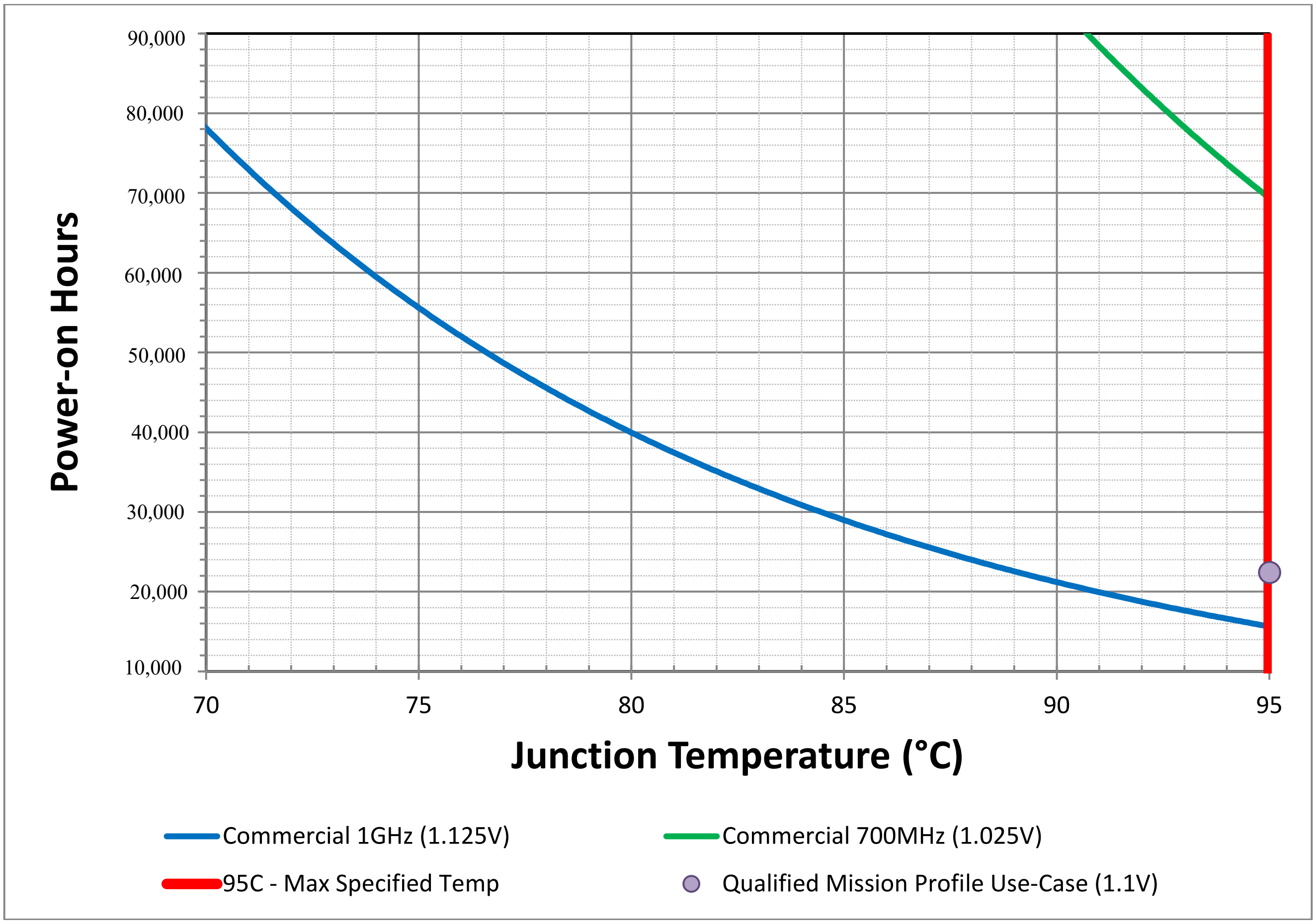

Figure 1. i.MXRT1170 commercial lifetime estimates

2.2 Industrial qualification

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

Table 2. Industrial qualification lifetime estimates

	Arm core speed CM7/CM4 (MHz)	Power-on Hours [PoH] (Hrs)	Arm core Operating voltage (V)	Junction Temperature [Tj] (°C)
Case C1: Overdrive Mode	800/400	61.158	1.125	105
Case C2: Nominal Mode	600/240	271.213	1.025	105

Figure 2 establishes guidelines for estimating **PoH** as a function of CPU frequency and junction temperature. **PoH** can be read directly off of Figure 2 to determine the necessary trade-offs to be made to CPU frequency and junction temperature to increase the estimated PoH of the device.

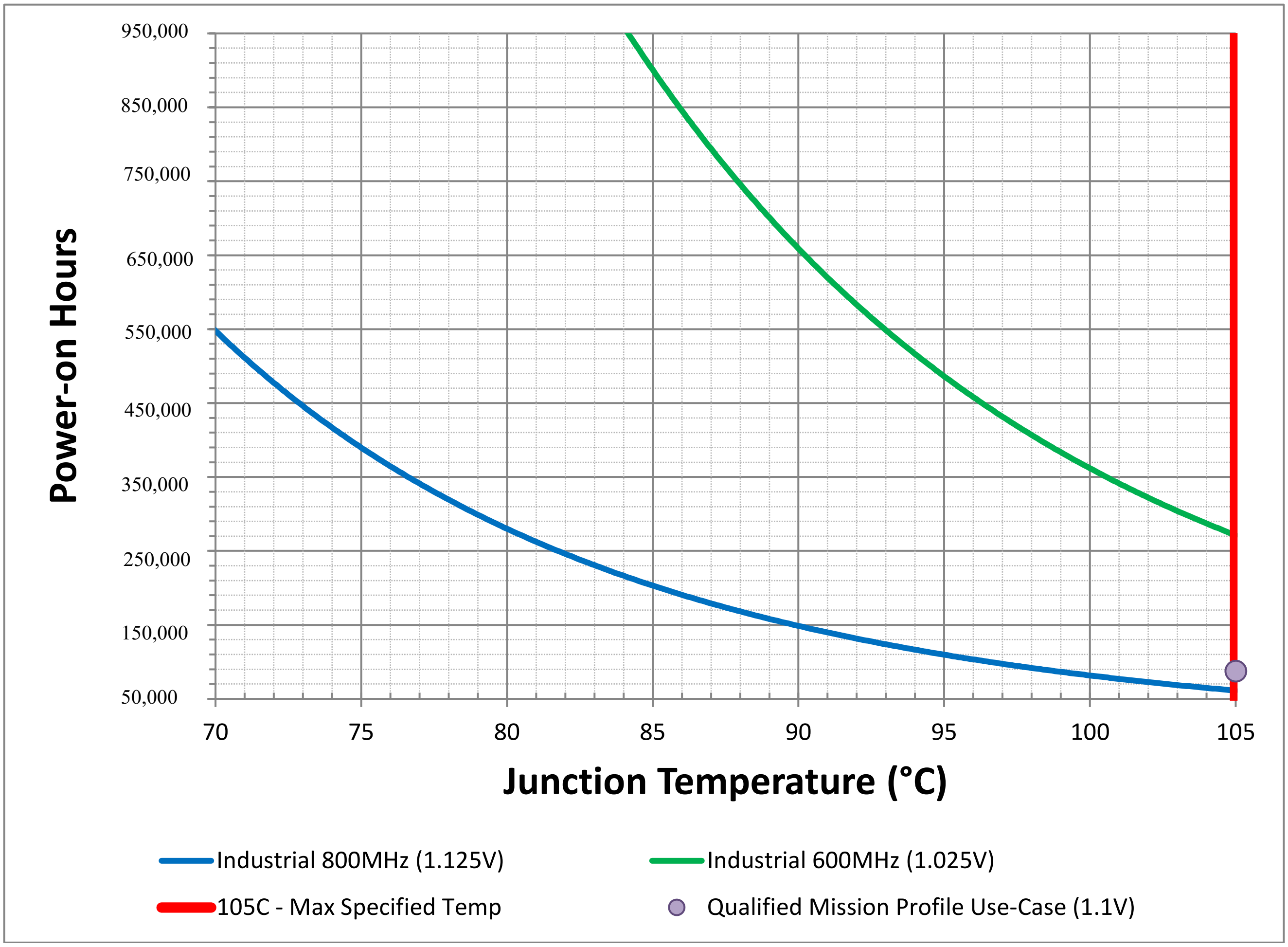

Figure 2. i.MXRT1170 industrial lifetime estimates

2.3 Automotive qualification

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

Table 3. Automotive qualification lifetime estimates

	Arm core speed CM7/CM4 (MHz)	Power-on Hours [PoH] (Hrs)	Arm core Operating voltage (V)	Junction Temperature [Tj] (°C)
Case C1: Overdrive Mode	800/400	4,750	1.125	125
Case C2: Nominal Mode	600/240	31,273	1.0	125

Figure 3 establishes guidelines for estimating **PoH** as a function of CPU frequency and junction temperature. **PoH** can be read directly from Figure 3 to determine the necessary trade-offs to be made to CPU frequency and junction temperature to increase the estimated PoH of the device.

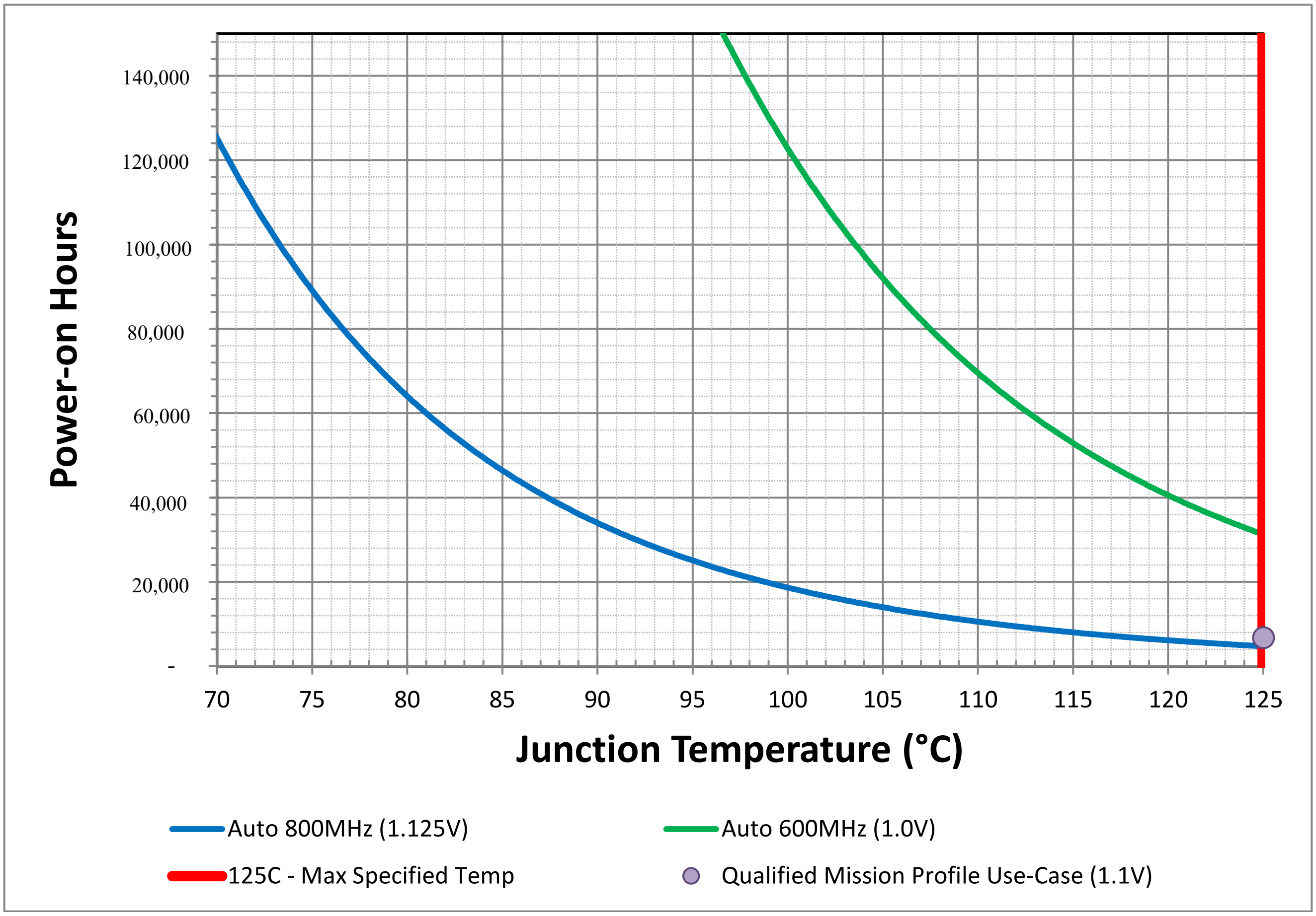

Figure 3. i.MXRT1170 automotive lifetime estimates

2.4 Extended industrial qualification

Table 4 provides the number of PoH for the typical use conditions for the extended industrial device.

Table 4. Automotive qualification lifetime estimates

	Arm core speed CM7/CM4 (MHz)	Power-on Hours [PoH] (Hrs)	Arm core Operating voltage (V)	Junction Temperature [Tj] (°C)
Case C1: Overdrive Mode	800/400	20,777	1.125	125
Case C2: Normal Mode	600/240	92.137	1.0	125

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

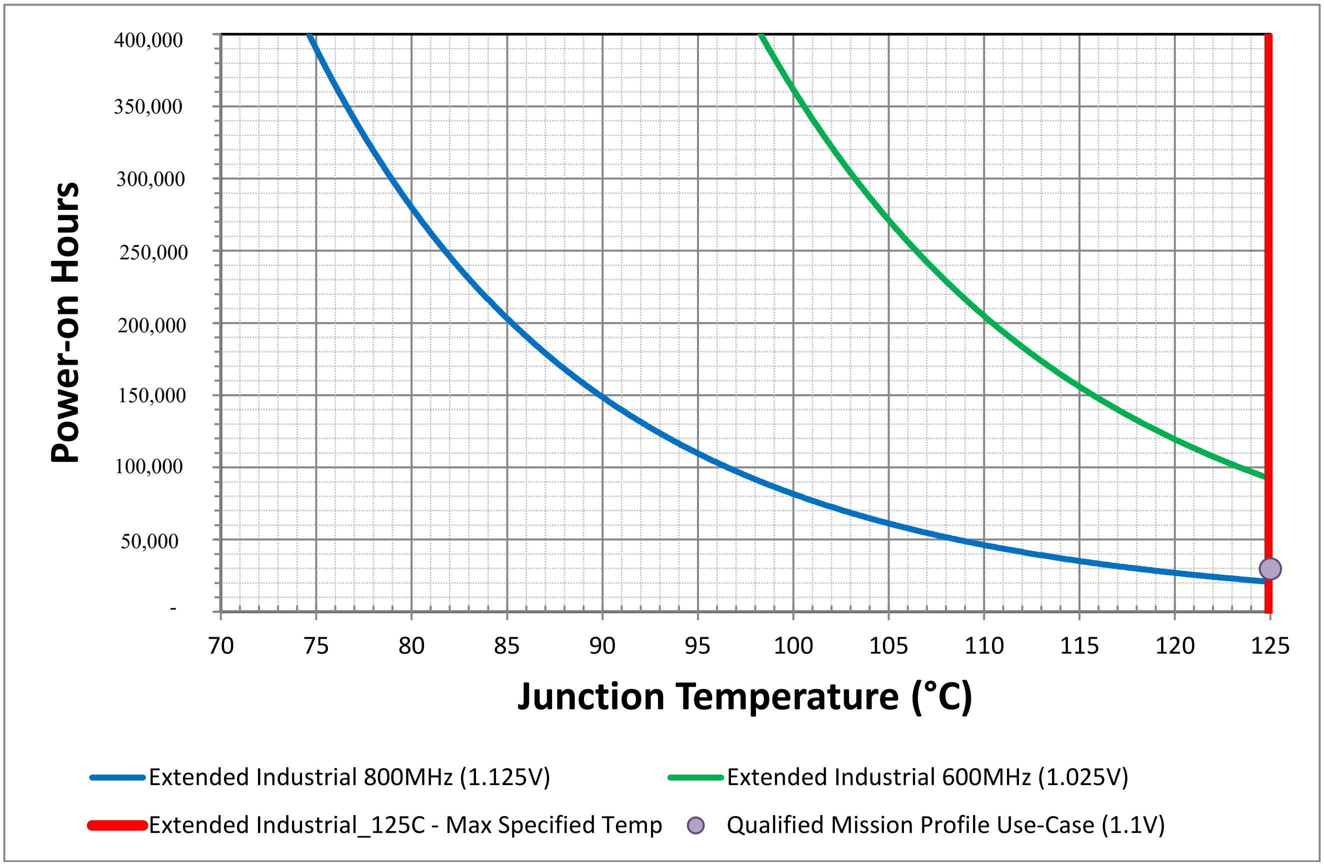

Figure 4. i.MXRT1170 extended industrial lifetime estimates

3 Combining use cases

In some applications a constant operating use case cannot deliver the target PoH. In this case, it is an advantage 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.

3.1 Scenario 1: Switching between two power states with different voltages

In this scenario, the system uses a 1 GHz full power state and a 700 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 1 GHz and 50% of its power-on-time at 700 MHz, the two POH (read from Figure 5) can be combined with using those percentages: 18,000 × 0.5 + 78,000 × 0.5 = 48,000 PoH.

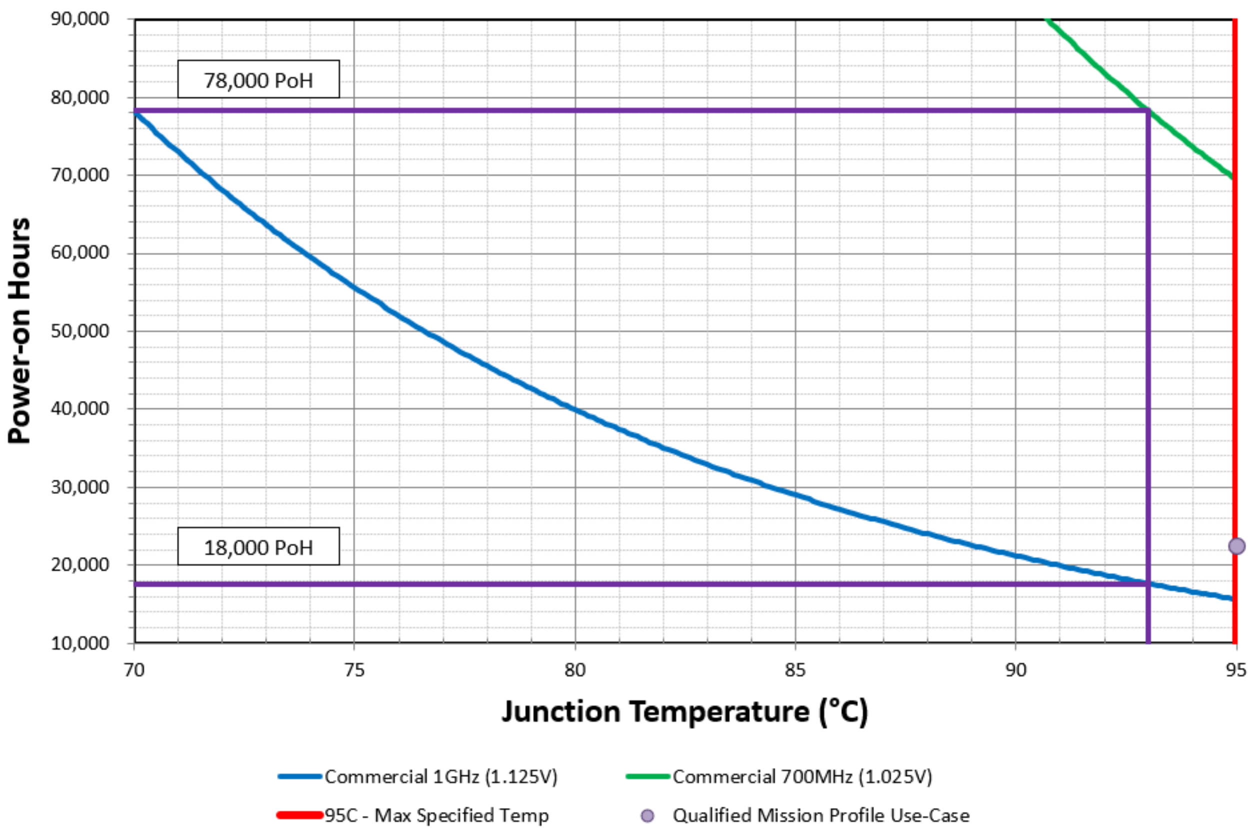

Figure 5. Multiple power state use cas

3.2 Scenario 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 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 temperature range of the i.MXRT series. In this scenario, the system spends 30% of its power-on-hours at 93 °C and 70% of its power-on hours at 85 °C (as read off the chart in Figure 6). The two POH can be combined as such: 18,000 × 0.3 + 29,000 × 0.7 = 25,700 PoH.

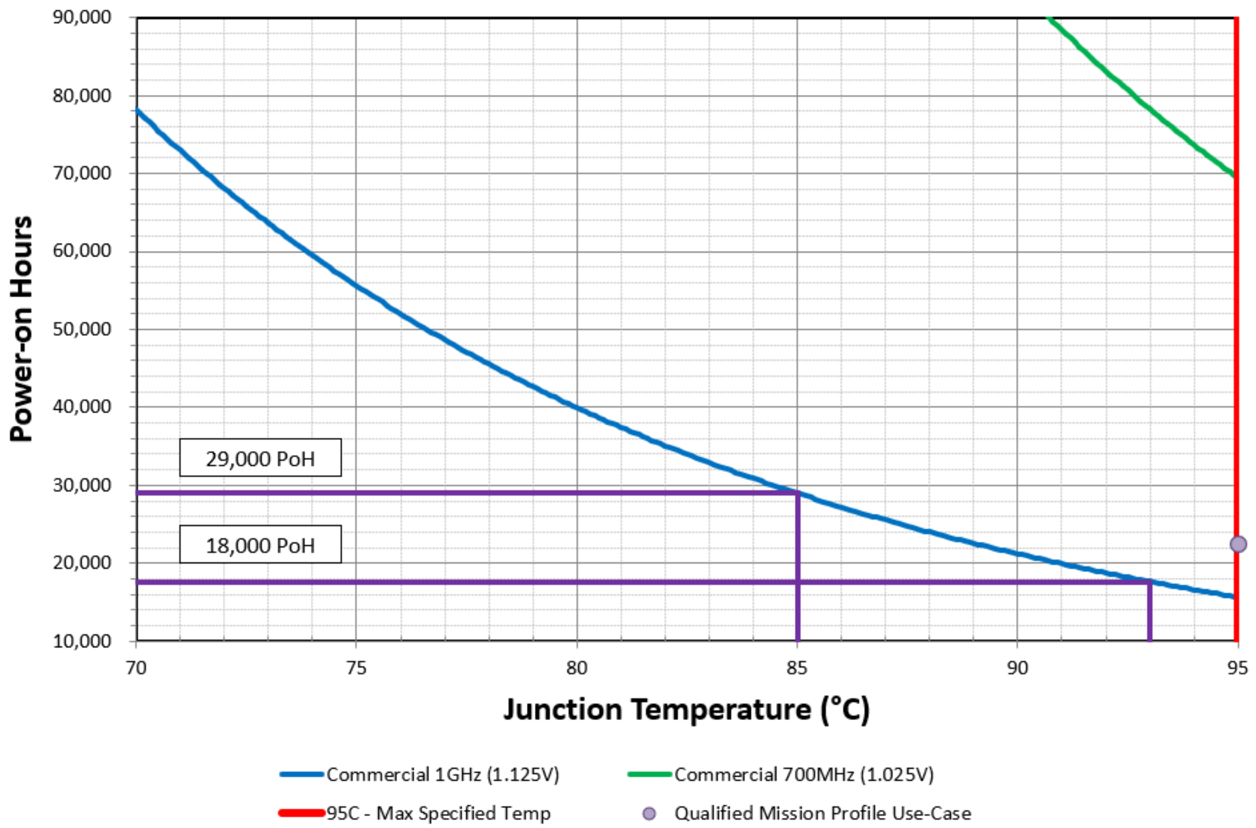

Figure 6. Multiple temperature use case

3.3 Scenario 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 700 MHz (at 93°C) and 1 GHz (at 85°C and 93°C). Each state will be used equally one third of the time. These power states can be combined as such: 78,000 × 0.34 + 29,000 × 0.33 + 18,000 × 0.33 = 42,030 PoH.

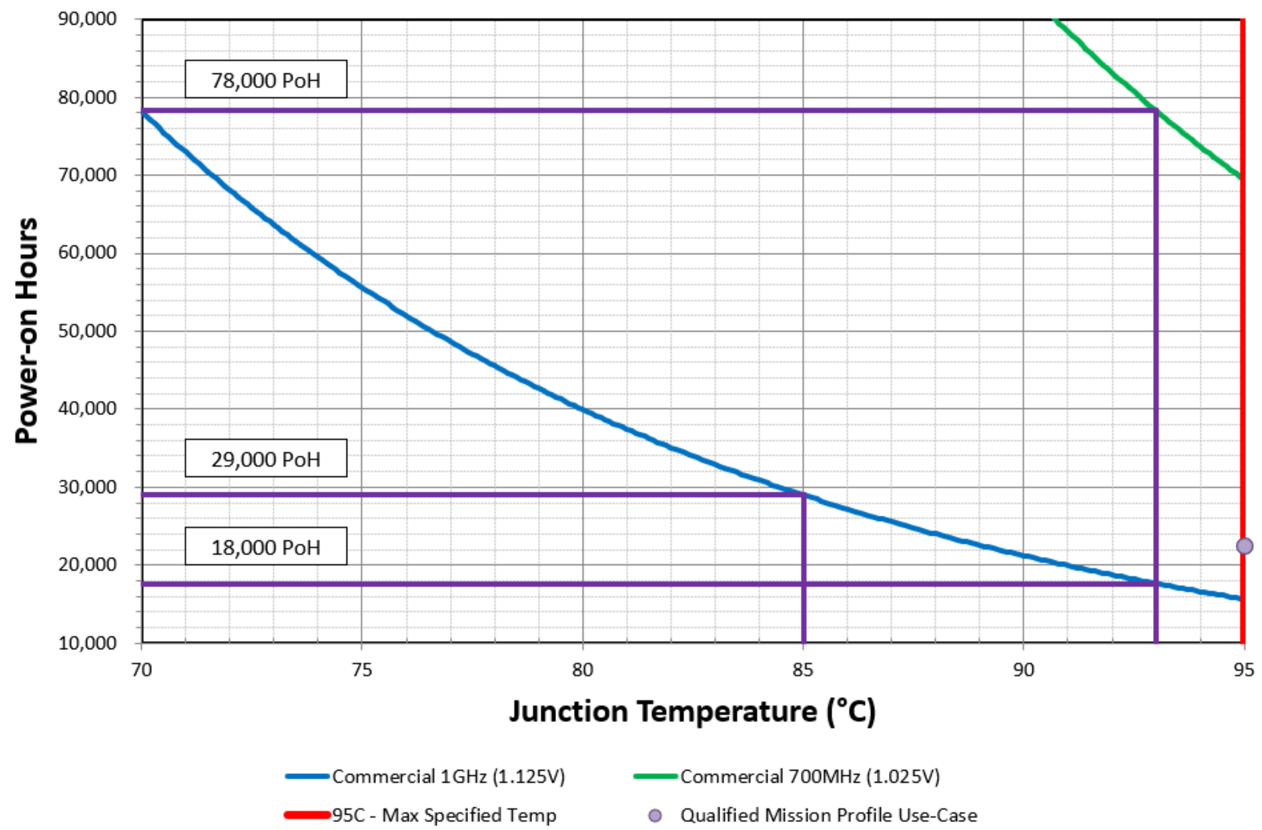

Figure 7. Various use case

4 Revision history

Rev.	Date	Substantive changes
0	February 2021	Initial release
1	30 April, 2021	• Updated images through the document • Updated the doc title from iMXRT1170 Life Time Commercial to iMXRT1170 Life Time Industrial, Commercial & Automotive • Updated Table 1 • Added Industrial qualification and Automotive qualification
2	9 June, 2021	• Updated Table 2 and Figure 2 • Added Extended industrial qualification

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