AN14194

MCX A153/2和A143/2的产品使用寿命估算

第1版 — 2024年2月1日 应用笔记

文档信息

信息	内容
关键词	AN14194、MCX、MCX A、使用寿命、上电时间、温度、PoH
摘要	本应用笔记介绍了根据认证过程中使用的标准，针对MCX A153/2和MCX A143/2（器件）的估算产品上电时间（PoH）。

1 介绍

本文根据在认证过程中使用的标准，介绍了MCX A153/2和MCX A143/2（**器件**）的估算产品上电时间（PoH）。

此处描述的产品PoH是一个估算值，并不代表产品的实际保证使用寿命。

本文提供了关于如何根据目标工作电压、支持的最高结温（T_j）以及这些因素与器件的PoH的关系等来解读不同器件的认证等级的指南。

本文档中的数据是为了方便阅读而提供的。然而，这些数据并不代表所有潜在的故障机制，也可能无法准确代表所有的任务描述或应用程序的行为。它们基于单独的工作能量和电压加速参数，将阿伦尼乌斯公式用于温度加速和电压加速的幂律，结合高温工作寿命（HTOL）期间收集的数据，演示了温度是如何影响产品的PoH的。

2 器件认证等级及可达到的上电时间PoH

每个支持的认证等级（如工业级），都定义了某个器件在特定工作条件下可达到的不同上电时间（PoH），这些条件包括：

- 某个应用（如工业级）的目标核心电压（内部LDO核心电压的输出）
- 器件的结温（T_j）
  - 需要注意的是，虽然器件可以在其数据手册中列出的最大T_j下运行，但器件在此温度下长时间运行会降低其运行PoH。
  - 应始终确保对器件进行了适当的散热管理，不超过其最高结温。

器件的结温（T_j）是器件中晶体管的温度。它的测量值与外壳温度和环境温度不同。大多数应用在运行期间没有一个恒定的结温T_j。

本文档提供的图表展示了T_j与上电时间之间的关系。不同温度下的上电时间的百分比是定义每个任务描述的一个部分。当客户在应用期间的结温不恒定时，可使用阿伦尼乌斯因子加权来计算有效结温（$T_{j\text{-}eff}$）（有关$T_{j\text{-}eff}$的更多信息，请参阅第3节）。

注：

本文中提供的所有数据都是根据本产品的认证实测数据和经验来对上电时间（PoH）进行的估算。这些估算值不能被视为对单个器件的产品使用寿命的限制，也不能被解释为恩智浦对产品实际使用寿命的保证。销售和保修条款和条件仍然适用。

2.1 工业级认证产品

图1展示了工业级器件在规定使用条件下的PoH值。PoH值假定产品已上电且始终处于激活状态（100%占空比）。它可以直接从下面的曲线中读取，以确定在所列条件下对结温的影响。

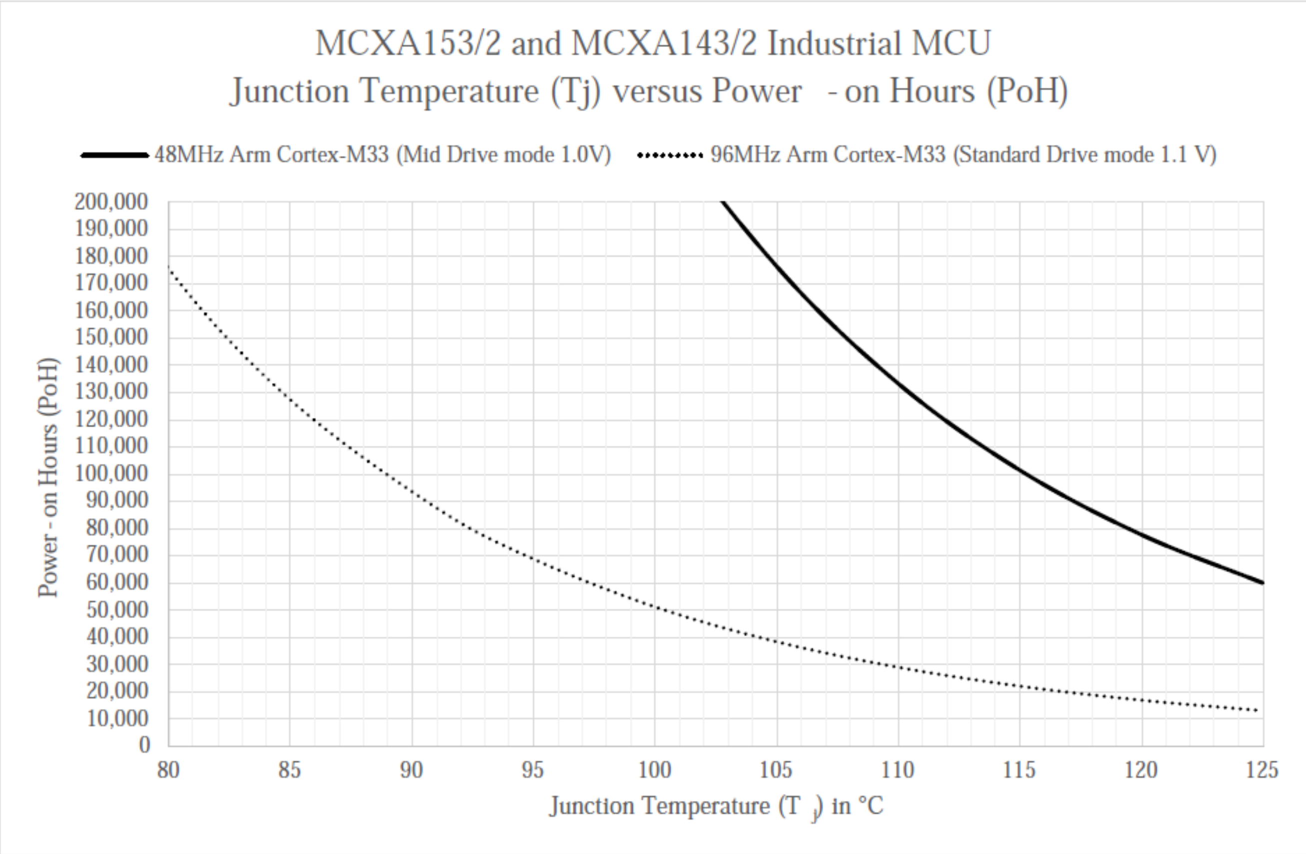

图1. MCX A153/2和MCX A143/2的工业级PoH估值

3 有效结温

器件的结温（T_j）是器件中的晶体管的温度。它的测量值与外壳温度和环境温度不同。大多数的应用在运行期间并没有恒定的结温T_j。

本文中的图表展示了T_j与上电时间之间的关系。不同温度下的上电时间的百分比是定义每个任务描述的一个部分。有效结温（T_{j-eff}）是代表任务描述的单个T_j，可用来推算上图中的PoH。

- T_{j-eff}仅取决于一个任务描述的开机工作周期内的温度。器件掉电时的温度不会影响T_{j-eff}。
- T_{j-eff}不是温度的一个简单平均值，因为较高温度下的上电时间会比较低温度下的上电时间消耗更多的运行寿命。
- 当客户在应用期间的结温不恒定时，可使用阿伦尼乌斯因子加权来计算T_{j-eff}。

3.1 计算有效结温T_{j-eff}

假设温度依赖性遵循阿伦尼乌斯行为，则可使用以下方法计算T_{j-eff}：

1. 确定在一小组离散温度（T_n）下，应用程序的上电时间（t_n）百分比。
2. 使用阿伦尼乌斯法计算平均故障率。

$$FR_{AV}=\left[t_1\cdot e^{\frac{-E_A}{k\cdot T_1}}+t_2\cdot e^{\frac{-E_A}{k\cdot T_2}}+\ldots+t_n\cdot e^{\frac{-E_A}{k\cdot T_n}}\right] \tag{1}$$

3. 然后即可计算出有效温度。

$$T_{j\text{-}eff}=\frac{-E_A}{k\cdot\ln(FR_{AV})} \tag{2}$$

以下是对上述公式中使用的变量和常数的一些说明：

- E_A = 工作能量。典型值为0.7eV，用于生成本文档中的图表。
- k = 玻耳兹曼常数，8.62 × 10^{-5}。
- T_n = 温度必须以开尔文为单位。$T_{j\text{-}eff}$的最终结果也以开尔文为单位。
- t_n = 在给定温度下的时间百分比，必须用十进制表示。例如，50%为0.50。

下面是一个简单示例，是对于一个具有两个不同常数值的应用计算其$T_{j\text{-}effd}$。在此示例中，器件上电的50%时间中，T_j为100°C，另外50%的时间为50°C，因此平均温度为75°C。

$$FR_{AV}=\left[0.5\cdot e^{\frac{-0.7}{k\cdot 373.15}}+0.5\cdot e^{\frac{-0.7}{k\cdot 323.15}}\right]=1.83\times10^{-10} \tag{3}$$

$$T_{j\text{-}eff}=\frac{-0.7}{k\cdot\ln(FR_{AV})}=362.18\ K=89.03℃ \tag{4}$$

在此示例中，可以看到89°C的$T_{j\text{-}eff}$远高于75°C的平均温度。这表明，较高的温度对器件寿命的影响更大。

4 结论

选择最佳工作性能点和热封套对于满足目标应用的PoH是至关重要的。在器件的目标工作电压/频率和器件的工作结温（T_j）之间进行权衡，可以显著提高器件的PoH。

在不影响器件性能的情况下，降低应用中的工作结温是提高器件的PoH的最有效的方法。这可以通过增加应用的散热能力来实现。在热性能无法改变的情况下，可以使用较低的工作电压来提高器件的PoH。降低电压也可能会导致性能下降；工作频率可能就需要相应地降低，才能匹配数据手册中规定的电压。

本应用中提供的数据和示例旨在作为参考以支持客户应用的开发。

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5 修订历史

表1总结了本文档的修订情况。

表1. 修订历史

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