

AN12204

i.MX RT1020的功耗及测量

Rev. 1 — 11 February 2020

Application Note

原文链接: <https://www.nxp.com/docs/en/application-note/AN12204.pdf>

1 概述

本文描述了i.MX RT1020的功耗。

- i.MX RT1020 概述
- 运行模式定义和配置
- 低功耗模式定义和配置
- 如何基于MIMXRT1020 EVK板测量功耗
- 不同工作模式下的功耗数据

本应用笔记中的开发环境是IAR Embedded Workbench。软件版本为SDK 2.6.1。硬件环境是MIMXRT1020评估板 (Rev A2)。

2 芯片概述

2.1 i.MX RT1020概述

i.MX RT1020是基于Cortex-M7的芯片，运行速度高达500 MHz，以提供较高的CPU性能与最佳的实时响应。

- 256 KB的on-chip RAM，可以灵活配置为TCM或通用on-chip RAM。
- 具有DCDC和LDO的先进电源管理模块可降低外部电源的复杂性并简化电源排序。
- 丰富的存储器接口，包括SDRAM, Raw NAND FLASH, NOR FLASH, SD / eMMC和FlexSPI。
- 用于连接外设的各种接口，例如WLAN, Bluetooth™, GPS。
- 音频功能包括SPDIF和I2S音频接口。
- 提供丰富的外设模块，例如SPI, I2C, Can, Ethernet, Flex-Timers和ADC。
- 针对工业HMI、电机控制和家用电器领域。

3 低功耗概述

3.1 电源供应

表1 介绍了 i.MX RT1020的电源导轨。

目录

| | |
|------------------------------|----|
| 1 概述..... | 1 |
| 2 芯片概述..... | 1 |
| 2.1 i.MX RT1020概述..... | 1 |
| 3 低功耗概述..... | 1 |
| 3.1 电源供应..... | 1 |
| 3.2 运行模式..... | 2 |
| 3.3 低功耗模式..... | 4 |
| 4 如何测量MIMXRT1020 EVK的功耗..... | 6 |
| 4.1 EVK板的电流测量..... | 6 |
| 5 功耗结果..... | 9 |
| 5.1 运行模式..... | 9 |
| 5.2 低功耗模式..... | 10 |
| 6 结论..... | 11 |
| 7 参考..... | 11 |
| 8 修订历史..... | 12 |



表1. 外部电源导轨

| 电源导轨 | 描述 | 最小值 (V) | 标准值 (V) | 最大值 (V) |
|--------------|--------------------------------------|---------|---------|---------|
| DCDC_IN | DCDC的输入电源 | 3 | 3.3 | 3.6 |
| SOC_IN | SOC的输入电源 | 0.925 | - | 1.3 |
| VDD_HIGH_IN | Analog的输入电源 | 3 | 3.3 | 3.6 |
| VDD_SNVS_IN | SNVS和RTC的输入电源 | 2.4 | 3.0 | 3.6 |
| USB_OTG_VBUS | USB VBUS的输入电源 | 4.4 | 5.0 | 5.5 |
| VDDA_ADC_3P3 | 12-bit ADC的输入电源 | 3 | 3.3 | 3.6 |
| NVCC_SD0 | GPIO in SDIO1 bank (3.3 V mode)的输入电源 | 3 | 3.3 | 3.6 |
| | GPIO in SDIO1 bank (1.8 V mode)的输入电源 | 1.65 | 1.8 | 1.95 |
| NVCC_GPIO | GPIO bank中GPIO的输入输出电源 | 3 | 3.3 | 3.6 |

3.2 运行模式 (Run Mode)

3.2.1 运行模式定义

表2. 运行模式定义

| 运行模式 | 定义 |
|-----------------------|--|
| 超速运行 (Overdrive Run) | <ul style="list-style-type: none"> • CPU运行在500 MHz, 过载电压达到1.275 V • 总线频率为125 MHz • 所有外设均已启用并以目标频率运行 • 所有PLL已启动 |
| 全速运行 (Full Speed Run) | <ul style="list-style-type: none"> • CPU运行在396 MHz, 满载, 电压低至1.15 V • 总线频率为132 MHz • 所有外设均已启用并以目标频率运行 • 所有PLL已启动 |
| 低速运行 (Low Speed Run) | <ul style="list-style-type: none"> • CPU运行在132 MHz, 电压低至1.15 V • 内部总线频率33 MHz • 除SYSPLL、SYSPLLPFD2和SYSPLLPFD3外, 所有PLL和PFD都被禁用 • 20%外设处于活动状态, 其他外设处于低功耗模式 |
| 低功耗运行 (Low-Power Run) | <ul style="list-style-type: none"> • CPU运行在24 MHz, 电压低至0.95 V |

表2. 运行模式定义 (续)

| 运行模式 | 定义 |
|------|---|
| | <ul style="list-style-type: none"> • 内部总线频率为12 MHz • 所有PLL关闭, OSC24M关闭, RCOSC24启用 • 高速外设断电 |

通常, 运行模式可以分为四种模式, 如上表所示。低速运行模式使用全速运行模式的总线时钟作为核心时钟。低功耗运行模式使用24 MHz内部OSC作为核心时钟源。

3.2.2 模式配置

表3. 运行模式配置

| | 超速运行 (Overdrive Run) | 全速运行 (Full Speed Run) | 低速运行 (Low Speed Run) | 低功耗运行 (Low- Power Run) |
|-----------------|----------------------------|-----------------------------|-------------------------|---------------------------|
| CPU Core | 500 MHz | 396 MHz | 132 MHz | 24 MHz |
| L1 Cache | ON | ON | ON | ON |
| IPG CLK | 125 MHz | 132 MHz | 33 MHz | 12 MHz |
| PEG CLK | 62.5 MHz | 66 MHz | 33 MHz | 12 MHz |
| FlexRAM | ON | ON | ON | ON |
| SOC 电压 | 1.275 V | 1.15 V | 1.15 V | 0.95 V |
| Analog LDO | ON | ON | ON | 处于Weak Mode |
| 24 MHz XTAL OSC | ON | ON | ON | OFF |
| 24 MHz RC OSC | OFF | OFF | OFF | ON |
| SYS PLL | ON | ON | ON | 断电 |
| SYS PFD0 | ON | ON | 断电 | 断电 |
| SYS PFD1 | ON | ON | 断电 | 断电 |
| SYS PFD2 | ON | ON | ON | 断电 |
| SYS PFD3 | ON | ON | ON | 断电 |
| USB1 PLL | ON | ON | 断电 | 断电 |
| USB1 PFD0 | ON | ON | 断电 | 断电 |
| USB1 PFD1 | ON | ON | 断电 | 断电 |
| USB1 PFD2 | ON | ON | 断电 | 断电 |

表格下页继续...

表3. 运行模式配置 (续)

| | 超速运行 (Overdrive Run) | 全速运行 (Full Speed Run) | 低速运行 (Low Speed Run) | 低功耗运行 (Low-Power Run) |
|--------------|-------------------------|--------------------------|-------------------------|--------------------------|
| USB1 PFD3 | ON | ON | 断电 | 断电 |
| Audio PLL | ON | ON | 断电 | 断电 |
| ENET PLL | ON | ON | 断电 | 断电 |
| Module Clock | ON | ON | 按需启动 | 外围时钟关闭 |
| RTC32K | ON | ON | ON | ON |

3.3 低功耗模式

3.3.1 低功耗模式定义

表4. 低功耗模式定义

| 低功耗模式 | 定义 |
|---------------------------|--|
| 系统空闲 (System Idle) | <ul style="list-style-type: none"> 没有线程运行时，CPU可以自动进入此模式 所有外围设备均可保持活动状态 CPU仅进入WFI模式，它将保持其状态，因此中断响应可能非常短CPU |
| 低功耗空闲 (Low Power Idle) | <ul style="list-style-type: none"> 与系统空闲模式相比功耗更低，退出时间更长 所有PLL关闭，模拟模块运行在低功耗模式 所有高速外设都是电源门控，低速外设可以保持低频运行 |
| 挂起模式 (Suspend) | <ul style="list-style-type: none"> 最省电的模式，退出时间最长 所有PLL关闭，XTAL关闭，除32K时钟外所有时钟关闭 所有高速外设均是电源门控，低速外设均为时钟门控 |
| SNVS | <ul style="list-style-type: none"> 除SNVS域外，所有SOC数字逻辑、模拟模块均关闭 32KHz RTC为活动状态 VDD_HIGH_IN和VDD_DCDC_IN可以关闭 |

3.3.2 低功耗模式配置

表5. 低功耗模式配置

| | 系统空闲 (System Idle) | 低功耗空闲 (Low Power Idle) | 挂起模式 (Suspend) | SNVS |
|-------------------|-----------------------|---------------------------|-------------------|------|
| CCM LPM Mode | WAIT | WAIT | STOP | - |
| CPU Core | WFI | WFI | 断电 | OFF |
| L1 Cache | ON | ON | 断电 | OFF |
| FlexRAM | ON | ON | ON | OFF |
| SOC 电压 | 1.15V | 0.95V | 0.925V | OFF |
| SYS PLL | ON | 断电 | 断电 | OFF |
| SYS PFD0 | 断电 | 断电 | 断电 | OFF |
| SYS PFD1 | 断电 | 断电 | 断电 | OFF |
| SYS PFD2 | ON | 断电 | 断电 | OFF |
| SYS PFD3 | ON | 断电 | 断电 | OFF |
| USB1 PLL | 断电 | 断电 | 断电 | OFF |
| USB1 PFD0 | 断电 | 断电 | 断电 | OFF |
| USB1 PFD1 | 断电 | 断电 | 断电 | OFF |
| USB1 PFD2 | 断电 | 断电 | 断电 | OFF |
| USB1 PFD3 | 断电 | 断电 | 断电 | OFF |
| Audio PLL | 断电 | 断电 | 断电 | OFF |
| ENET PLL | 断电 | 断电 | 断电 | OFF |
| 24MHz XTAL OSC | ON | OFF | OFF | OFF |
| 24MHz RC OSC | OFF | ON | OFF | OFF |
| LDO2P5 | ON | OFF | OFF | OFF |
| LDO1P1 | ON | OFF | OFF | OFF |
| WEAK2P5 | OFF | ON | OFF | OFF |
| WEAK1P1 | OFF | ON | OFF | OFF |
| Bandgap | ON | OFF | OFF | OFF |
| Low Power Bandgap | ON | ON | ON | OFF |

表格 下一页继续...

表5. 低功耗模式配置(续)

| | 系统空闲 (System Idle) | 低功耗空闲 (Low Power Idle) | 挂起模式 (Suspend) | SNVS |
|---------------|-----------------------|---------------------------|-------------------|------|
| AHB clock | 33MHz | 12MHz | OFF | OFF |
| IPG clock | 33MHz | 12MHz | OFF | OFF |
| PER clock | 33MHz | 12MHz | OFF | OFF |
| Module Clocks | 按需启动 | 按需启动 | OFF | OFF |
| RTC32K | ON | ON | ON | ON |

3.3.3 唤醒源

表6. 唤醒源

| | 系统空闲 (System Idle) | 低功耗空闲 (Low Power Idle) | 挂起模式 (Suspend) | SNVS |
|----------------------------------|-----------------------|---------------------------|-------------------|----------------|
| GPIO wake-up | YES | YES | YES | YES (仅一个引脚) |
| RTC wake-up | YES | YES | YES | YES |
| USB remote wake-up | YES | YES | YES | NO |
| Other peripheral wake-up sources | YES | YES | YES | NO |

注意

无论系统处于系统空闲 (System)、低功耗空闲 (Low Power Idle) 还是挂起模式 (Suspend)，都应在GPC模块中启用唤醒中断。可以在SNVS中唤醒系统的唯一引脚是IOMUXC_SNVS_WAKEUP_GPIO5_I000。外设唤醒要求外设时钟在该模式下可用。

4 如何测量MIMXRT1020 EVK的功耗

4.1 EVK的电流测量

POR_B引脚有一个内部上拉，应将R22和R179拆除。保留这些电阻会产生高于本文中所示电流的SNVS电流。

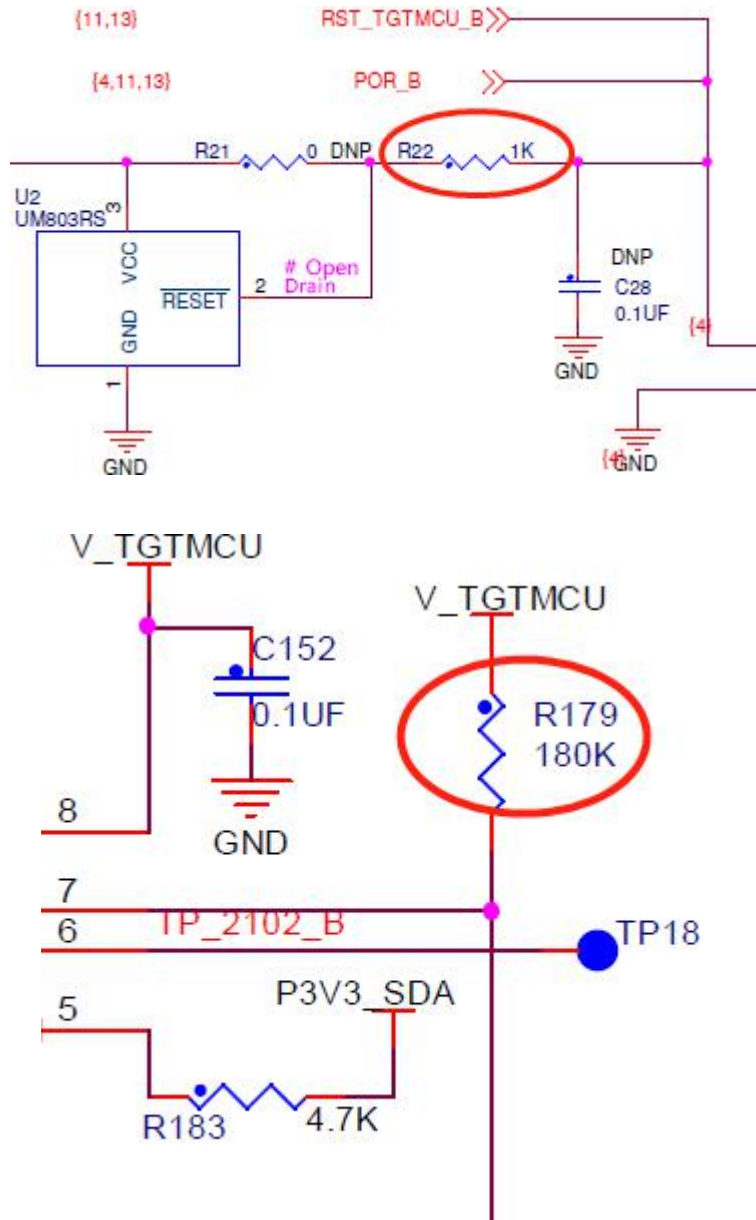


图1. 移除电阻R22 和 R179

接下来我们测量 DCDC_IN(J37), VDD_HIGH_IN (J5), VDD_SNV5_IN (J6)的电流值。

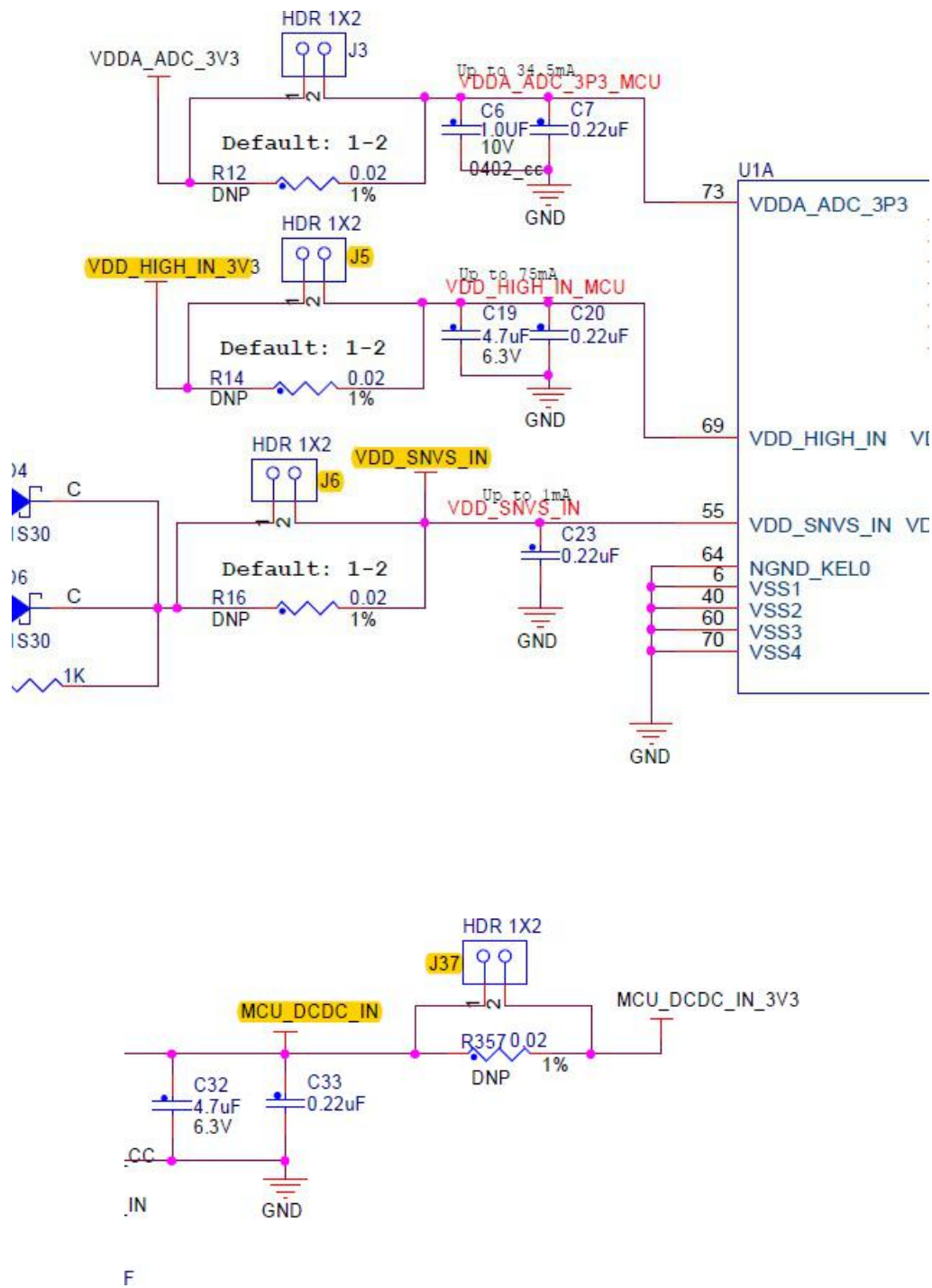


图2. DCDC_IN, VDD_HIGH_IN, VDD_SNVS_IN的测试点

5 功耗结果

功耗效果

测试代码基于SDK 2.6.1。

项目文件位于：boards\evkmimxrt1020\demo_apps\power_mode_switch_bm\iar\power_mode_switch_bm.eww

CoreMark测试项目基于power_mode_switch_bm。

5.1 运行模式

注意

所有功耗值均为25 C时的典型芯片

表 7 和 表 8 中的功耗是使用默认的SDK低功耗模式切换测量的。

表7. RAM上的运行模式

| 电源 导轨 | 超速运行 Overdrive (500 MHz) | | | 全速运行 Full Speed Run(396 MHz) | | | 低速运行 Low Speed Run (132 MHz) | | | 低功率运行 Low Power Run(24 MHz) | | |
|-----------------|-----------------------------|------------|------------|---------------------------------|------------|------------|---------------------------------|------------|------------|--------------------------------|------------|------------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| DCDC_ IN | 3.30 | 27.855 | 91.92 | 3.30 | 21.26 | 70.158 | 3.30 | 9.63 | 31.779 | 3.30 | 1.745 | 5.7585 |
| VDD_H IGH_IN | 3.30 | 13.915 | 45.919 | 3.30 | 13.92 | 45.936 | 3.30 | 5.615 | 18.529 | 3.30 | 0.34 | 1.122 |
| VDD_S NVS_IN | 3.30 | 0.0115 | 0.0379 | 3.30 | 0.012 | 0.0396 | 3.30 | 0.007 | 0.0231 | 3.30 | 0.0095 | 0.0313 |
| DCDC_ IN | 3.30 | 28.01 | 92.433 | 3.30 | 21.375 | 70.537 | 3.30 | 9.83 | 32.439 | 3.30 | 1.79 | 5.907 |
| VDD_H IGH_IN | 3.30 | 13.92 | 45.936 | 3.30 | 13.92 | 45.936 | 3.30 | 5.615 | 18.529 | 3.30 | 0.34 | 1.122 |
| VDD_S NVS_IN | 3.30 | 0.0115 | 0.038 | 3.30 | 0.0115 | 0.038 | 3.30 | 0.007 | 0.0231 | 3.30 | 0.009 | 0.0297 |

表 9 和 表 10 中的功耗是使用基于低功耗模式切换及CoreMark进行测量的。

表 9. RAM上运行 CoreMark

| 电源导轨 | 超速运行 Overdrive (500 MHz) | | | 全速运行 Full Speed Run(396 MHz) | | | 低速运行 Low Speed Run (132 MHz) | | | 低功率运行 Low Power Run(24 MHz) | | |
|-----------------|-----------------------------|------------|--------------|---------------------------------|-------------|--------------|---------------------------------|-------------|-------------|--------------------------------|------------|------------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| DCDC_IN | 3.30 | 57.096 | 188.42 16 | 3.30 | 39.256 5 | 129.54 65 | 3.30 | 14.651 5 | 48.341 | 3.30 | 2.612 | 8.6196 |
| VDD_H IGH_IN | 3.30 | 13.974 | 46.112 6 | 3.30 | 13.974 5 | 46.115 9 | 3.30 | 5.669 | 18.707 7 | 3.30 | 0.399 | 1.3167 |
| VDD_S NVS_IN | 3.30 | 0.013 | 0.0429 | 3.30 | 0.0115 | 0.038 | 3.30 | 0.0065 | 0.0215 | 3.30 | 0.0095 | 0.0314 |

表 10. Flash上运行CoreMark XIP

| 电源导轨 | 超速运行 Overdrive (500 MHz) | | | 全速运行 Full Speed Run(396 MHz) | | | 低速运行 Low Speed Run (132 MHz) | | | 低功率运行 Low Power Run(24 MHz) | | |
|-----------------|-----------------------------|-------------|-------------|---------------------------------|-------------|--------------|---------------------------------|------------|-------------|--------------------------------|------------|------------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| DCDC_IN | 3.30 | 54.391 5 | 179.49 2 | 3.30 | 37.187 5 | 122.718 8 | 3.30 | 14.583 | 48.123 9 | 3.30 | 2.5505 | 8.416 7 |
| VDD_HIGH_I N | 3.30 | 13.973 5 | 46.112 6 | 3.30 | 13.974 5 | 45.936 | 3.30 | 5.6705 | 18.712 7 | 3.30 | 0.398 | 1.313 4 |
| VDD_SNVS_I N | 3.30 | 0.0105 | 0.0347 | 3.30 | 0.0125 | 0.038 | 3.30 | 0.006 | 0.0198 | 3.30 | 0.0095 | 0.031 4 |

5.2 低功耗模式

表 11和 表 12 中的功耗是通过功耗模式切换测得的。

注意

由于不连续导通模式 (DCM) 可以提高DCDC的效率, 如果电流负载较低, 则始终建议使用。

表 11. RAM上的低功耗模式

| 电源导轨 | 系统空闲 (System Idle) | | | 低功耗空闲 (Low Power Idle) | | | 挂起模式 ¹ (Suspend) | | | SNVS ² | | |
|-----------------|--------------------|------------|------------|------------------------|------------|---------|-----------------------------|------------|------------|-------------------|------------|------------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| DCDC_IN | 3.30 | 4.5 | 14.85 | 3.30 | 1.045 | 3.4485 | 3.30 | 0.168 | 0.5544 | 0.00 | 0.00 | 0.00 |
| VDD_HIGH_I N | 3.30 | 5.62 | 18.546 | 3.30 | 0.34 | 1.122 | 3.30 | 0.1205 | 0.3977 | 0.00 | 0.00 | 0.00 |

表格 下一页继续...

表 11. RAM 上运行低功耗模式(续)

| 电源导轨 | 系统空闲 (System Idle) | | | 低功耗空闲 (Low Power Idle) | | | 挂起模式 ¹ (Suspend) | | | SNVS ² | | |
|-------------|--------------------|---------|---------|------------------------|---------|---------|-----------------------------|---------|---------|-------------------|---------|---------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| VDD_SNVS_IN | 3.30 | 0.007 | 0.0231 | 3.30 | 0.0103 | 0.0340 | 3.30 | 0.0057 | 0.0188 | 3.30 | 0.0163 | 0.0536 |

表 12. Flash上运行低功耗模式 XIP

| 电源导轨 | 系统空闲 (System Idle) | | | 低功耗空闲 (Low Power Idle) | | | 挂起模式 ¹ (Suspend) | | | SNVS ² | | |
|-------------|--------------------|---------|---------|------------------------|---------|---------|-----------------------------|---------|---------|-------------------|---------|---------|
| | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) | 电压 (V) | 电流 (mA) | 功率 (mW) |
| DCDC_IN | 3.30 | 5.225 | 17.2425 | 3.30 | 1.155 | 3.8115 | 3.30 | 0.165 | 0.5445 | 0.00 | 0.00 | 0.00 |
| VDD_HIGH_IN | 3.30 | 5.61 | 18.513 | 3.30 | 0.335 | 1.1055 | 3.30 | 0.12 | 0.396 | 0.00 | 0.00 | 0.00 |
| VDD_SNVS_IN | 3.30 | 0.0069 | 0.0228 | 3.30 | 0.0103 | 0.0338 | 3.30 | 0.0054 | 0.0178 | 3.30 | 0.0161 | 0.0531 |

注意

1. 挂起模式: 将RAM数据挂在FlexRAM (bank0) 中。
2. SNVS: SNVS模式, RTC工作。

注意

如果电流负载较低, 则不连续传导模式 (DCM) 会提高DCDC的效率, 因此始终建议使用。
为了降低功耗, 在SNVS模式以外的所有功耗模式下, VDD_SNVS_IN由VDD_HIGH_IN供电。

注意

所有功耗值均为25 °C时的典型芯片

6 结论

本文主要介绍了如何测量基于MIMXRT1020 EVK (Rev A2) 的i.MX RT上的功耗。有关设计低功耗应用程序的更多设计细节, 您可以参考应用笔记[How to use iMXRT Low Power Feature](#)。

7 参考

- i.MX RT 1020参考手册
- Arm Cortex M7参考手册

8 修订历史

表13. 修订历史

| 修订号 | 日期 | 实质性变化 |
|-----|---------|----------------------|
| 0 | 05/2018 | 首次发行 |
| 1 | 02/2020 | 更新了基于Flash和RAM的功率结果。 |

How To Reach Us

Home Page:

nxp.com

Web Support:

nxp.com/support

Information in this document is provided solely to enable system and software implementers to use NXP products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits based on the information in this document. NXP reserves the right to make changes without further notice to any products herein.

NXP makes no warranty, representation, or guarantee regarding the suitability of its products for any particular purpose, nor does NXP assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in NXP data sheets and/or specifications can and do vary in different applications, and actual performance may vary over time. All operating parameters, including "typicals," must be validated for each customer application by customer's technical experts. NXP does not convey any license under its patent rights nor the rights of others. NXP sells products pursuant to standard terms and conditions of sale, which can be found at the following address: nxp.com/SalesTermsandConditions.

While NXP has implemented advanced security features, all products may be subject to unidentified vulnerabilities. Customers are responsible for the design and operation of their applications and products to reduce the effect of these vulnerabilities on customer's applications and products, and NXP accepts no liability for any vulnerability that is discovered. Customers should implement appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP, the NXP logo, NXP SECURE CONNECTIONS FOR A SMARTER WORLD, COOLFLUX, EMBRACE, GREENCHIP, HITAG, I2C BUS, ICODE, JCOP, LIFE VIBES, MIFARE, MIFARE CLASSIC, MIFARE DESFire, MIFARE PLUS, MIFARE FLEX, MANTIS, MIFARE ULTRALIGHT, MIFARE4MOBILE, MIGLO, NTAG, ROADLINK, SMARTLX, SMARTMX, STARPLUG, TOPFET, TRENCHMOS, UCODE, Freescale, the Freescale logo, AltiVec, C- 5, CodeTEST, CodeWarrior, ColdFire, ColdFire+, C- Ware, the Energy Efficient Solutions logo, Kinetis, Layerscape, MagniV, mobileGT, PEG, PowerQUICC, Processor Expert, QorIQ, QorIQ Qonverge, Ready Play, SafeAssure, the SafeAssure logo, StarCore, Symphony, VortiQa, Vybrid, Airfast, BeeKit, BeeStack, CoreNet, Flexis, MXC, Platform in a Package, QUICC Engine, SMARTMOS, Tower, TurboLink, UMEMS, EdgeScale, EdgeLock, eIQ, and Immersive3D are trademarks of NXP B.V. All other product or service names are the property of their respective owners. AMBA, Arm, Arm7, Arm7TDMI, Arm9, Arm11, Artisan, big.LITTLE, Cordio, CoreLink, CoreSight, Cortex, DesignStart, DynamIQ, Jazelle, Keil, Mali, Mbed, Mbed Enabled, NEON, POP, RealView, SecurCore, Socrates, Thumb, TrustZone, ULINK, ULINK2, ULINK-ME, ULINK-PLUS, ULINKpro, μ Vision, Versatile are trademarks or registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere. The related technology may be protected by any or all of patents, copyrights, designs and trade secrets. All rights reserved. Oracle and Java are registered trademarks of Oracle and/or its affiliates. The Power Architecture and Power.org word marks and the Power and Power.org logos and related marks are trademarks and service marks licensed by Power.org.

© NXP B.V. 2020.
reserved.

All rights

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: salesaddresses@nxp.com

Date of release: 11 February
2020 Document identifier:
AN12204